STATE OF OHIO
C. WILLIAM O'NEILL, Governor
DEPARTMENT OF NATURAL RESOURCES
HERBERT B. EAGON, Director
DIVISION OF GEOLOGICAL SURVEY
RALPH J. BERNHAGEN, Chief

BULLETIN 57

THE GEOLOGY AND MINERAL RESOURCES OF ATHENS COUNTY, OHIO

BY
MYRON T. STURGEON
AND ASSOCIATES

COLUMBUS
1958

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DIVISION OF GEOLOGICAL SURVEY
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Chapter 1

INTRODUCTION

PURPOSE AND SCOPE OF INVESTIGATION

Geology is the study of the earth, and this bulletin summarizes the present and former geologic investigations made in Athens County, Ohio. It is part of an over-all program by the Ohio Division of Geological Survey to make known to the public the geology and geologic resources of the Hocking Valley region. Surveys similar to the present one are already completed or are in progress in the adjacent counties of Hocking (Merrill and Hall), Perry (Flint, 1951), and Vinton Counties (Stout, 1927).

The purpose of regional geologic surveys is to determine the basic facts concerning the bedrock, drainage and surface features, geologic history, and the mineral and rock resources of an area. Since the earth is our home and the ultimate source of all materials used in our daily lives, it is of utmost importance that we have adequate knowledge of both local and regional geology. Geologic information is essential to farmers for the best use of soils, fertilizers, drainage systems, water, and conservation practices; to industrialists for factory sites, raw materials, and transportation routes; to engineers in planning and constructing bridges, buildings, dams, railroads, roads, etc.; and to military leaders in considering camp sites, landing operations, transportation problems, and over-all strategy. We are all concerned in these geologic aspects and in many others such as our domestic and industrial water supplies; ores of a long list of metals ranging from aluminum to zinc; nonmetallic raw materials for abrasives, cement, clay products, building materials, chemical and industrial minerals and rocks, gemstones, and scenery of the landscape.

Athens County does not contain all the above-listed mineral resources, but much of the income in the county has come from minerals and mineral industries in the past. The more important resources are coal, clay and shale, limestone, sandstone, and sand and gravel. Considerable activity in the mineral industries is now present, and the promise for the future is good.

It should be added that the need for geologic investigations is a continuing one and that geology is a science with ever-expanding frontiers. Known sources of economic minerals and rocks become exhausted, and new ones must be found. Changes in prices, development of new processes and techniques, new uses and needs, or new transportation facilities permit the exploitation of unused mineral deposits. The strength of our State and Nation depends not only upon the people and climate but also upon the land and its geologic resources. In the maintenance of our power, few public expenditures yield as large a return per dollar spent as those spent for an adequate geologic survey.

It is also hoped that this bulletin will be a source of information and stimulation to geology students at Ohio University as well as providing geologic information and understanding to the residents of Athens County and vicinity.

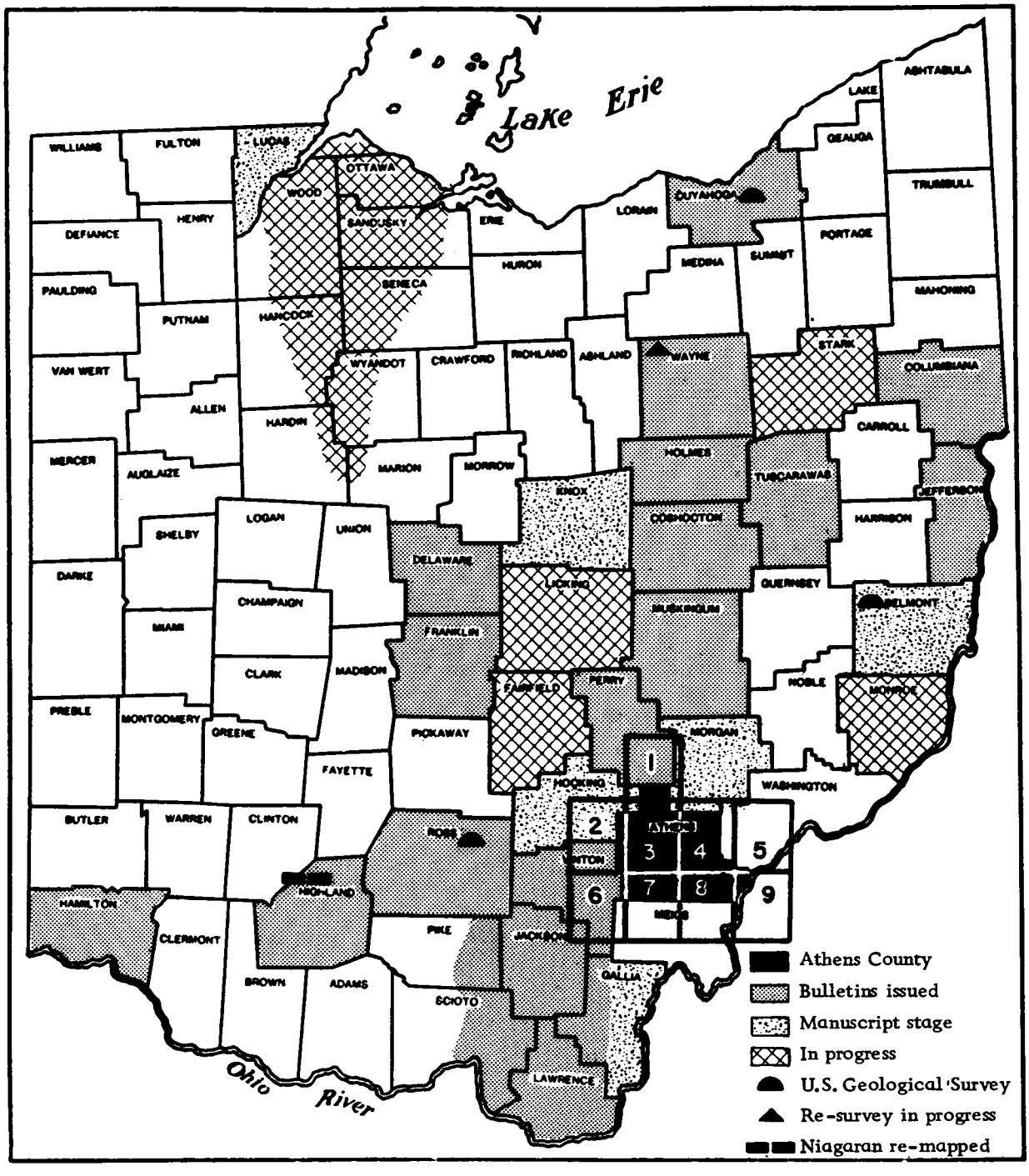


Figure 1 - Index map of Ohio showing location of Athens County and the progress of geologic bulletins of other counties. The nine topographic quadrangles covering Athens County are: 1, New Lexington, 2. Zaleski, 3. Athens, 4. Chesterhill, 5. Parkersburg, 6. Wilkesville, 7. Pomeroy, 8. Keno, 9. Belleville.

LOCATION AND AREA

Athens County, with an area of 504 square miles, is located in southeastern Ohio, as shown in figure 1. Its irregular outline is tangent along the Ohio River to Wood County, West Virginia, for a distance of about three miles. Ohio counties adjacent to Athens County are Washington County on the east; Hocking, Morgan, and Perry Counties on the north; Hocking and Vinton Counties on the west; and Meigs County on the south. There are 14 civil townships within the county: Alexander, Ames, Athens, Bern, Canaan, Carthage, Dover, Lee, Lodi, Rome, Trimble, Troy, Waterloo, and York (plate 1).

36	30	24	18	12	6
35	29	23	17	11	5
34	28	22	16	10	4
33	27	21	15	9	3
32	26	20	14	8	2
31	25	19	13	7	1

Figure 2 - Diagram showing manner of numbering sections of a township in the Ohio Company's Purchase.

Athens County was originally part of the Ohio Company's Purchase, an area now comprising not only Athens County but also Meigs County and parts of Gallia, Hocking, Lawrence, Morgan, Perry, Vinton, and Washington Counties. Townships in this Purchase normally have 36 square miles, but the system of numbering sections within a township is different from the standard prevailing system of numbering employed in the United States conventional land survey. In that system sections are commonly numbered with section 1 in a township's northeast corner and with additional numbers continuing consecutively back and forth across the township to section 36 in the southeast corner. In the Ohio Company's Purchase, including Athens County, section 1 is in the southeast corner, and numbers extend from south to north in each tier of sections so that section 36 is in the northwest corner of a township (figure 2). There are also considerable areas incompletely surveyed or unsurveyed in respect to sections and, hence, unnumbered sections occur in several townships. This imperfection in sectioning is more prevalent along the Hocking River, except in Alexander and Athens Townships which are completely without sections.

The area of Athens County is covered by the nine following 15-minute United States Geological Survey topographic maps: Athens, Belleville, Chesterhill, Keno, New Lexington, Parkersburg, Pomeroy, Wilkesville, and Zaleski (figure 1). Except for the Athens and Chesterhill maps, much of the area covered by these maps is outside the county. The topographic maps show that the limits of the county lie approximately between 39° 11' and 39° 33' north latitude and between 81° 43' and 82° 18' west longitude.

There are no large cities within the area. Athens, nearly centrally located, is the largest city (population, 1950 - 11,660) and the county seat. Other towns and villages include Buchtel, Chauncey, Murray City, and Nelsonville in the northwest part; Glouster, Jacksonville, and Trimble in the north-central part; Amesville in the northeast part; Coolville, Guysville, Hockingport and Stewart in the east and east-central parts; Albany, Carbondale, Mineral, and New Marshfield in the southwest and west-central parts (plate 1). There are also quite a number of smaller communities scattered throughout the county.

Although many rural roads have been abandoned in Athens County during recent years, transportation facilities are good. Ohio Route No. 7 stretches diagonally across Troy Township along a northeast-southwest course; U. S. Route No. 33 extends from the northwest corner of the county southeast across the west-central area; and U. S. Route No. 50 extends from the county's southwest corner to Athens, where it divides and continues northeast or east and southeast. Seventeen state routes connect the various communities of the county with one another and with outside localities. Few county and township roads are black-topped, and the remainder are surfaced mostly with gravel or crushed limestone and are kept in good repair. Mileages along main highways from Athens to nearby cities are: Columbus, 75 miles; Lancaster, 45 miles; Logan, 27 miles; Marietta, 45 and 51 miles; McArthur, 28 miles; Pomeroy, 27 miles; and Zanesville, 55 miles.

Railroads serving this area include branches or divisions of the Baltimore and Ohio Railroad extending east-west across the county, the Chesapeake and Ohio Railroad projecting from the northwest corner of York Township to Athens, and the New York Central Railroad following a north-south line across the county (plate 1). Several outlying villages are served by spur lines built originally to haul coal. The railroads tend to follow the larger stream valleys.

PREVIOUS GEOLOGIC WORK IN ATHENS COUNTY AND VICINITY

Hildreth (1836), in his observations on the bituminous coal deposits of the Ohio Valley, published the first significant contribution to the geology of southeastern Ohio. Briggs and Hildreth (1838) made separate short reports describing the geology--with mention of brines, coals, iron ores, limestones, sandstones, and shales--in the First and Second Annual Reports of the Geological Survey of Ohio.

Although development of the mineral industries continued, little systematic geologic work was done until the establishment of the Second Geological Survey of Ohio in 1869. Andrews was in charge of the geologic work of the second district, which included the Hocking Valley region. He published two progress reports (1870, 1871), a report on Athens County (1873), and a supplemental report on Perry County and portions of Hocking and Athens Counties (1878). Newberry (1874) summarized the known facts for the Carboniferous system with some mention of the Hocking Valley region, and Orton (1884) discussed the Lower Coal Measures. Both Read (1878) and Orton (1884) wrote on the Hocking Valley coal field, and Lovejoy (1888) described the Pomeroy and Federal Creek coal fields. Mention or short discussion of the Hocking Valley's iron ores was made by Orton (1884), of oil and gas also by Orton (1888), and of the clay industries by the younger Orton (1893).

Ohio Geological Survey reports published since 1900 and describing at least in part the geology and mineral resources of Athens County and vicinity include: petroleum and natural gas (Bownocker, 1903), salt deposits (Bownocker, 1906); coal analyses (Bownocker and Dean, 1929), Conemaugh formation (Condit, 1912), Perry County (Flint, 1951), industrial water supplies (Foulk, 1925), limestone (Lamborn, 1951), shales and surface clays (Lamborn, Austin, and Schaaf, 1938), Federal Creek coal field (Smith, 1952), Vinton County (Stout, 1927), iron ore bearing formations (Stout, 1944), coal formation clays (Stout, Stull, McCaughey, and Demorest, 1923), brines (Stout, Lamborn, and Schaaf, 1932), geology of water (Stout, Ver Steeg, and Lamb, 1943), occurrence of flint (Stout and Schoenlaub, 1945), and Dunkard series (Stuaffer and Schroyer, 1920). These reports are mostly economic in scope, although the Conemaugh and Dunkard bulletins are largely descriptive of the bedrock and those on flint and iron ores contain much historical information. To the above list should be added the compiled survey report on mineral resources of southeastern Ohio by Bengston, Moore, Ramsey, and Lund (1950) which was published by the Geological Survey.

Many persons have described and interpreted drainage, surface, and glaciofluvial features of southeastern Ohio, but most of their works are published elsewhere than in the reports of the State Geological Survey. The more important of these publications are cited below.

Stout and Lamb (1938, 1939) have described the general drainage and surface features. Cole (1934, 1935, 1937, and 1941), Sharp (1932), and Ver Steeg (1930, 1931, 1932, 1939, 1940, and 1942) in a series of papers have discussed the erosion surfaces and their problems of the Appalachian region including eastern Ohio. Others have studied and written incidentally upon the same subject but are not listed here. Glaciation, glaciofluvial deposits, and drainage changes resulting from glaciation in the Hocking Valley region are the subjects of publications by Happ (1934), Leverett (1902), Merrill (1953), Stout (1927), Stout, Ver Steeg, and Lamb (1943), Tight (1903), Ver Steeg (1946), White (1939), and Wright (1884).

Only a few studies pertaining to the fossils of this region have been made or are in progress. Briggs (1838) and Hildreth (1838) mentioned the occurrence of both fossil shells and plants in the Ohio Geological Survey's First and Second Annual Reports. The paleontological reports of the Second and Third Surveys contain little information on the fossils of the Hocking Valley region except for one report by Whitfield (1893). Two bulletins of the Fourth Survey contain essential fossil data. Mark (1912) identified many and described some fossils from the Conemaugh formation, and several of her collections came from Athens County. Morningstar (1922) identified, described, and figured many Pottsville and some Allegheny fossils from nearby localities. Sturgeon and Merrill (1949) listed a few Allegheny fossils from Athens County, and Sturgeon has additional fossils under study. M. L. Abbott, A. H. Blickle, and A. T. Cross have individual studies on fossil plants in progress.

ACKNOWLEDGMENTS

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These persons made significant contributions in thesis studies on the following subjects: M. F. Aukland, geology of Lee and Waterloo Townships; J. Kempton, Illinoian and Wisconsin outwash deposits; J. T. Laubach, Cow Run and Lower Freeport sandstones; H. A. Schuh, geology of Lodi Township; G. E. Smith, geology of Ames Township; and R. H. SoRelle, testing coal formation underclays. R. E. Abbott helped during the first field season, and several Ohio University geology students served as field assistants, in preparation of fossil illustrations, in reading proof, and in various other ways. Geological Survey personnel who have aided by preparation or revision of manuscript include: R. A. Brant, coal production and reserves; R. DeLong, Monongahela series; G. H. Denton, Dunkard series; J. Forsyth, physiography and glaciofluvial deposits; and B. D. Middleton, oil and gas summary. R. A. Brant, R. M. DeLong, J. Forsyth, J. Kempton, G. E. Smith, and W. H. Smith performed essential services in compiling the geologic map; H. J. Flint and F. W. Twitty drafted the maps and other illustrations. R. L. Bekeny made photographs, excluding those of the fossils, and D. R. Hyde did the final typing of the manuscript for photolithography as well as directing the major editing and arranging of the manuscript.

Baltimore and Ohio Railroad, Chesapeake and Ohio Railroad, New York Central Railroad, Ohio Department of Highways, U. S. Coast and Geodetic Survey, and Corps of Engineers, U. S. Army, provided basic data on elevations. Many Athens County citizens and businesses gave freely and courteously much information and permission to trespass during all phases of the work. Special mention should be made of O. Gandee, Ohio Mining Company; H. G. Roy, Sunnyhill Coal Company; and C. D. Walker, Sunday Creek Coal Company.

Special acknowledgment is due Dr. Aureal T. Cross, formerly of the West Virginia Geological Survey, for use of his paper on the fossil flora of the Dunkard group published herein.

A special appropriation for geologic studies has defrayed printing costs for the report and the geologic map.

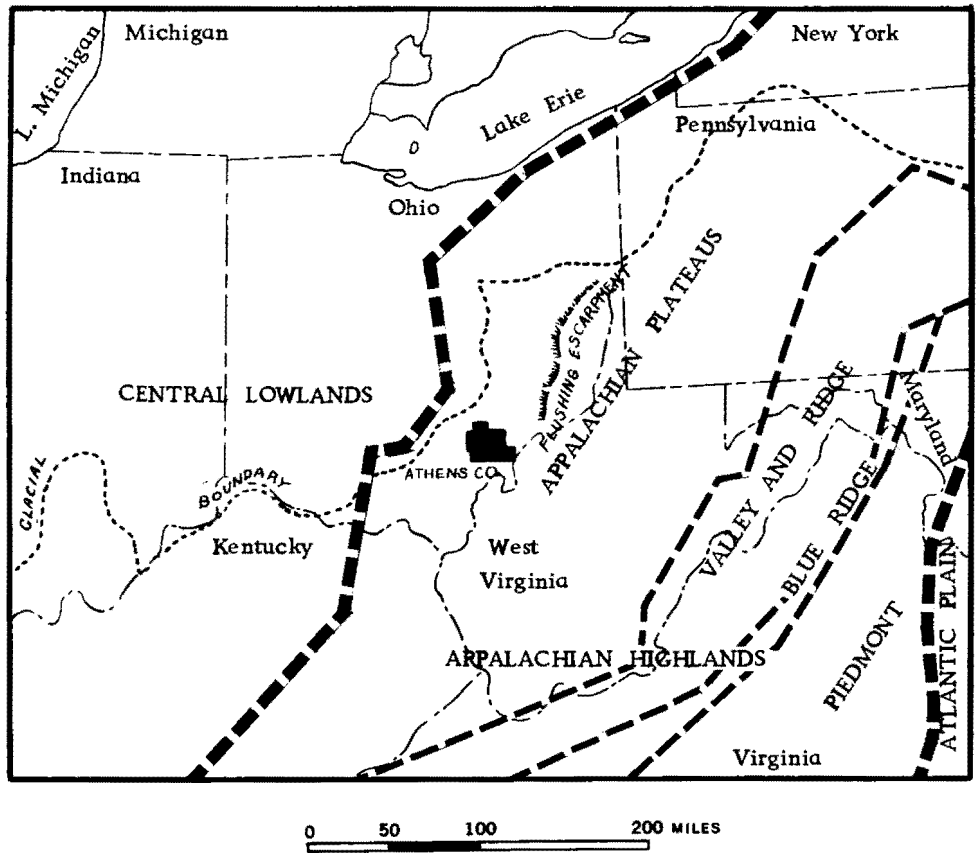


Figure 3 - Map showing physiographic divisions of Ohio and adjacent regions (modified after Fenneman).

Chapter 2

PHYSIOGRAPHY

PHYSIOGRAPHIC SETTING

Physiography is, generally speaking, the study of the earth's surface. Weathering and erosion working upon the rocks of the earth's crust are responsible for the development of its surface features. Critical in determining the appearance of a land surface in any one area are its climate, bedrock, types of weathering dominant, principal agents of erosion active, elevation above and distance from the sea, and stage in the erosion cycle.

Surface features of the land play a basic role in the cultural development of an area. The location of roads, railroads, factories, cities, dams, recreation areas, and other cultural features all depend in great part on the presence or absence of mountains, valleys, flat land, lakes, rivers, etc. Therefore, a knowledge of physiographic facts and principles is essential for the best utilization of any area.

Athens County is located in southeastern Ohio, which is a mature region of steep-sided narrowly rounded hills and deep, narrow, V-shaped valleys. It lies (figure 3) within the Kanawha section of the Appalachian Plateaus province (Fenneman, 1931, map in pocket). Southeastern Ohio is readily recognizable as a plateau, for the summit level or skyline is rather even and smooth (figure 4), not much affected by the variation in resistance of the rocks underlying its surface. If the present valleys could be completely filled, the resulting surface would be a gently undulating plain. Such a plain, called a "peneplain," is interpreted to have been produced by long-continued stream erosion. The peneplain in southeastern Ohio is imperfect and therefore should more properly be called simply an erosion surface. Here and there are higher areas, called "monadnocks," which rise above the general level and owe their existence either to great local resistance of the rocks or to a more favorable geographic position far from the major streams. A peneplain, after it has been developed, may be uplifted by forces within the earth, thus restoring erosive power to the streams and initiating a new cycle of erosion. This has happened in Athens County; slow, unequal, and intermittent uplift of all of southeastern Ohio in the geologic past has caused the rate of stream erosion to increase, resulting in the carving of the present hills and valleys.

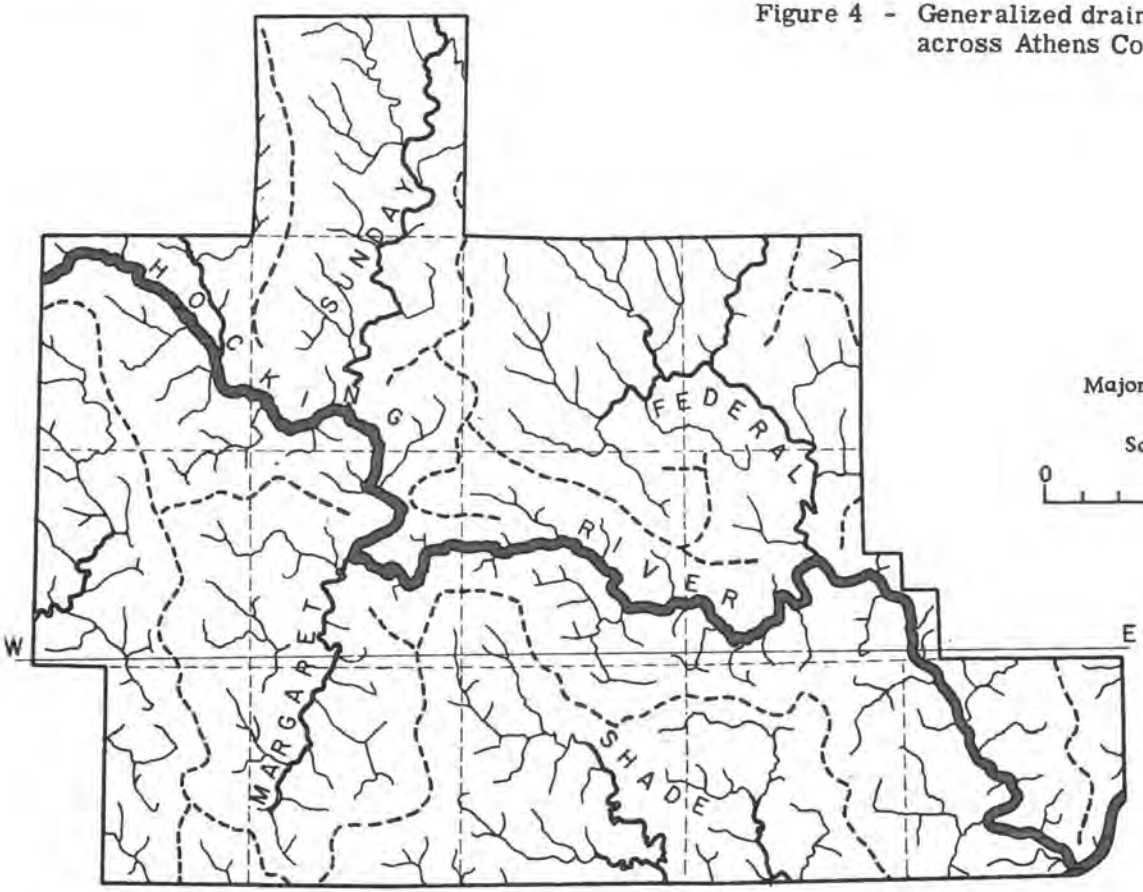
Since that time, repeated glaciation in northern and western Ohio during the Pleistocene (glacial) epoch has produced significant additional changes in the surface features of Athens County.

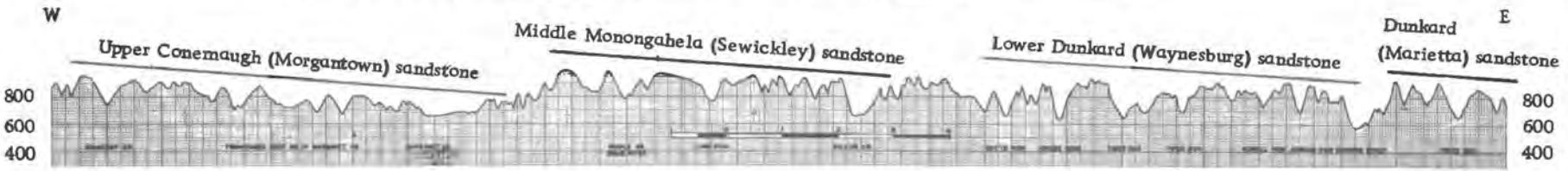
RELIEF AND SURFACE FEATURES

The relief of a region is defined as the difference in elevation between its highest and lowest points, but, in a broad sense, relief includes all inequalities or irregularities of a land surface, considered collectively.

The highest elevations in Athens County are in Ames, Dover, and York Townships, where several hilltops rise to more than 1,060 feet above sea level; the lowest point, along the Ohio

Figure 4 - Generalized drainage map and cross section across Athens County.





CROSS SECTION SHOWING LOW ESCARPMENTS PRODUCED BY GENTLY EASTWARD - DIPPING RESISTANT ROCK UNITS
SECTION TAKEN ALONG EAST - WEST LINE ABOUT SIX MILES NORTH OF SOUTHERN EDGE OF ATHENS COUNTY

FWT



Plate 3 - The Plains - an Illinoian terrace adjacent to Pennsylvanian hills.



Plate 4 - Air view showing strip mining and woodland, south of Nelsonville and west of Hocking River.

River at the Athens-Meigs County line, is below 560 feet. The maximum relief, therefore, is approximately 500 feet. The average local relief is much less; it usually does not exceed 250 to 300 feet along the Hocking River and elsewhere it is less.

The relatively even Athens County skyline, formed by the tops of the high hills and ridges, lies generally between 900 and 1,000 feet above sea level. In 359 of the 485 square miles in the county (as determined from topographic maps) the highest point lies within this range of elevations. These higher elevations generally occur on or near divides separating the larger drainage basins within the county (figure 4): those between Federal and Sunday Creeks, Federal and Wolf Creeks, Monday and Sunday Creeks, Margaret Creek and Shade River, Hocking River and Raccoon Creek, and Hocking and Shade Rivers. Divides adjacent to the Stroud Run and Sugar Creek basins also rise to high elevations.

South and west of Nelsonville, in the northwest corner of York Township, elevations between 1,000 and 1,060 feet mark one of the highest areas in the county. This high area outlines an old divide, dating from preglacial times when the drainage system was different than it is today, which crossed the present Hocking Valley near East Clayton. This preglacial divide continues southward into the Raccoon Creek drainage basin, marked by points above 1,000 feet along the western border of Waterloo and York Townships near the Athens-Hocking County line.

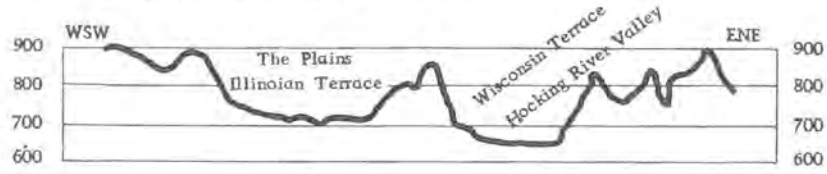
Elevations of greater than 1,000 feet occur in the Sunday Creek basin east of the Monday-Sunday Creek divide in Dover and Trimble Townships. A still larger number of similar elevations are present in the Federal Creek basin of Ames and Bern Townships, where the highest hills rise above 1,060 feet. The Ames-Bern area and the associated Federal-Sunday Creek divide have the largest number of high elevations in all Athens County, with a considerable number of hills 1,000 to 1,060 feet high. The presence of numerous monadnocks along the divide is understandable, but those within the Federal Creek basin, some of which are very close to Federal Creek itself, are more difficult to explain. Rock resistance and location near headwater areas of the basin are factors which probably contribute to their preservation.

The lowest summit elevations occur in Carthage Township (highest elevation 960 feet), Lee Township (960 feet), Rome Township (980 feet), and Troy Township (920 feet). The lowness of these elevations is due primarily to the presence of abandoned valleys of the preglacial drainage which cross the townships or lie nearby (plate 2). However, present stream erosion and the nonresistance of the local rocks certainly have contributed also, but to an unknown extent. The effects of preglacial and present drainage in producing lower elevations are best illustrated in Troy Township.

Flat land is not common and occurs principally as small areas along the major streams. The Hocking River and its larger tributaries of Federal, Margaret, Monday, and Sunday Creeks, and their tributaries, have the largest areas. Smaller areas of flat land are found along the lesser Hocking tributaries, such as Butts, Dorr, Green, Hamley, Jordon, Miller, Minkers, Piper, Rowell, Stroud, and Tiger Runs, and Sugar and Willow Creeks. There is not much flat land along the Ohio River where it touches Athens County except in the vicinity of Hockingport.

The abandoned valleys of ancient streams also contain areas of flat land, some of which are almost as large as those along the Hocking River. The best-known and one of the largest is the area called "The Plains," located 2 to 4 miles northwest of Athens in Athens and Dover Townships (plate 3). Other areas, some of which are still larger, occur in a discontinuous distribution along the course of the extinct Albany River and its tributaries between Hamley Run and Luhrig and between Luhrig and Fisher in Athens and Waterloo Townships. These continue southward along Margaret Creek in Alexander and Lee Townships from Fisher to the vicinity of Hebbardsville and Albany, where the flats attain their best development and preservation (figure 5, cross sections of Margaret Creek Valley in vicinity of Albany). The valley of the former Marietta River crosses Troy Township from northeast to southwest, and wide flats still exist in the vicinities of Coolville and Torch, and just over the line in Meigs County at Tuppers Plains. Still smaller remnants of abandoned valleys are present in Canaan, Carthage, Lee, Rome, and Waterloo Townships.

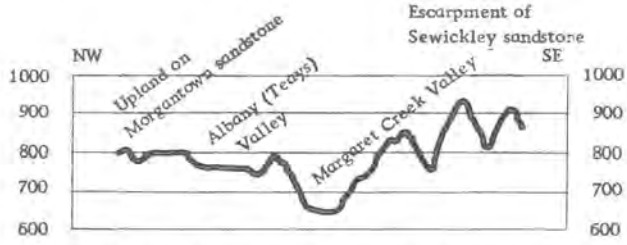
1. Cross section at The Plains showing old Illinoian stage level and modern alluvium (horizontal scale: 1 inch = approximately 1 mile).



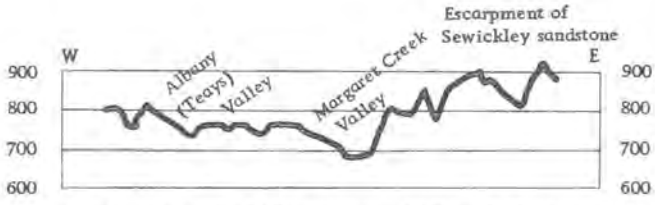
2. Four cross sections of Margaret Creek Valley, taken at different locations, showing its relationship to the old (Teays) high level Albany Valley (horizontal scale: 1 inch = approximately 1 mile).



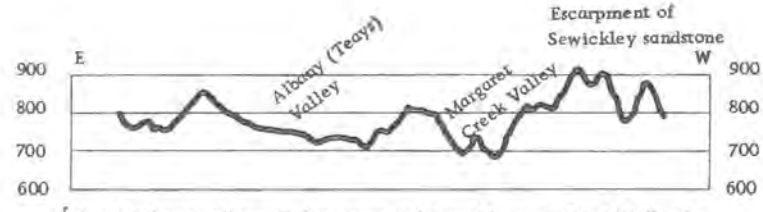
a. Half a mile south of Grosvenor (almost no Albany Valley level above Margaret Creek).



b. At Fisher (Albany Valley broader and separated from Margaret Creek Valley by narrow upland remnant).



c. One mile north of Albany (dissected Albany Valley broader still, adjacent to Margaret Creek Valley).



d. At Albany (Albany Valley separated from Margaret Creek Valley by broad upland remnant).

Figure 5 - Selected cross sections illustrating relationships between modern and ancient valleys.

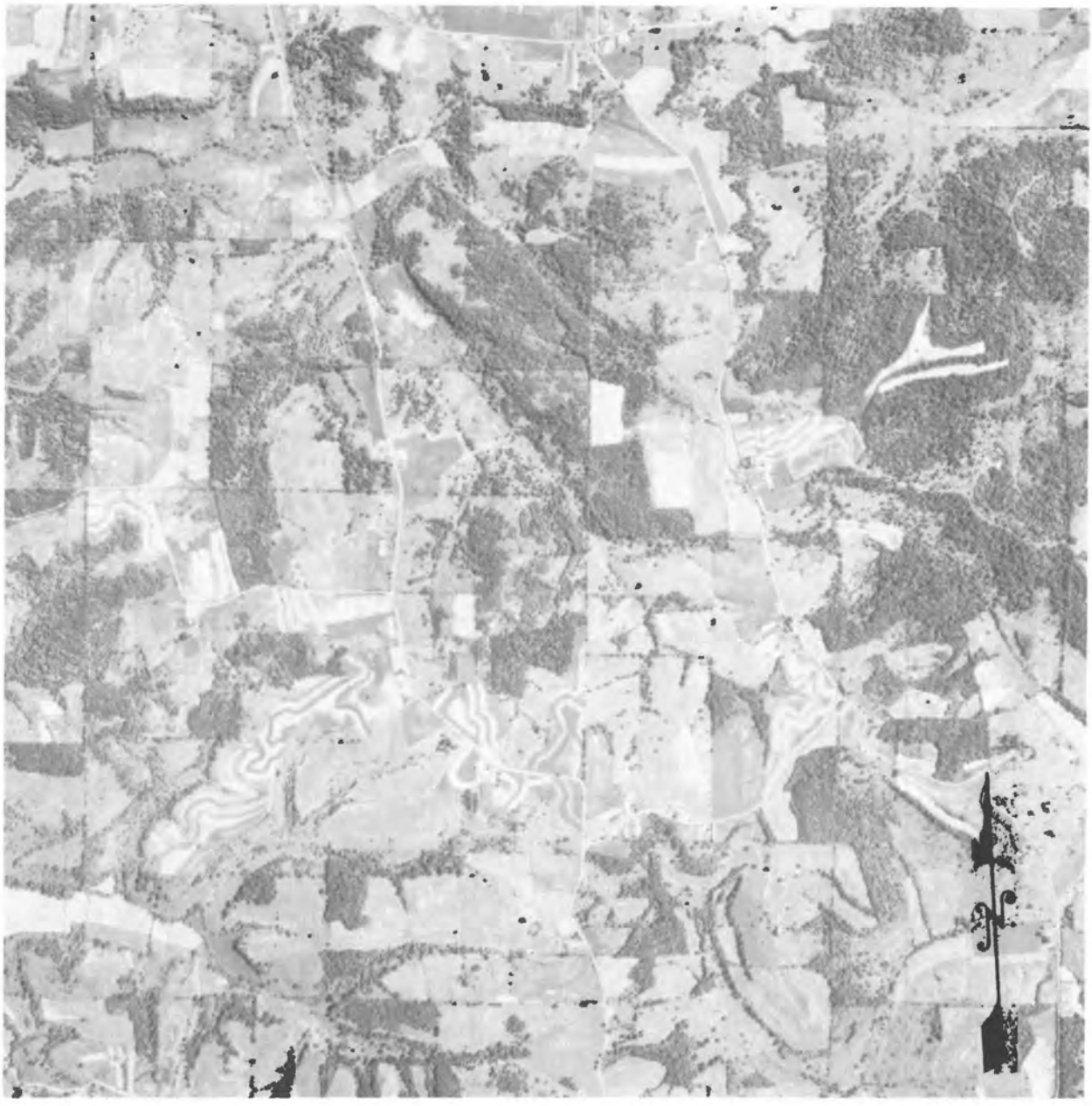


Plate 5 - Pleasant Hill area, showing wooded and farmed hills. Note especially the strip cropping.



Plate 6 - City of Athens, showing adjacent wooded hills and the Hocking River with agriculture on the floodplain.

The Plains is an exception in that it represents a younger deposit, its surface is more deeply underlain by silt, sand, and gravel, and it is little eroded except along its margins. Those small valleys which have formed are best developed at the contact between the stream deposits under The Plains and the rock hills on either side (figure 5, cross profile of Plains). A summary of the known extent and history of these different ancient stream systems is presented later in this chapter.

The influence on human culture of lowlands along ancient and present streams in Athens County is out of proportion to the limited area these lowlands occupy. Almost without exception, all communities, large and small, are located in valleys, for flat bottom land, good water, and means of transportation all lie here. Athens, Guysville, Hockingport, Nelsonville, and Stewart are in the Hocking Valley; Buchtel, Doanville, and Murray City lie in Monday Creek Valley; Chauncey, Glouster, Jacksonville, Millfield, and Trimble are found in Sunday Creek Valley; Amesville and several other communities, now mostly deserted, exist along Federal Creek and its tributaries; Coolville is in the abandoned Marietta River Valley; Albany and Hebbardsville are in the old Albany Valley; and Carbondale and Mineral lie in Hewett Fork's valley. The smaller communities, too, lie in some minor valley, with very few exceptions.

The Baltimore and Ohio (Baltimore and Ohio Southwestern) Railroad follows the old Marietta River Valley and the valleys of Skunk Run, Hocking River, Factory Creek, Grass Run, and Hewett Fork across the county; it passes from the Hocking River basin to that of Raccoon Creek through an abandoned valley at New Marshfield. A spur line extends along Hewett Fork from Carbondale to Mineral. The Chesapeake and Ohio (Hocking Valley) Railroad and its spurs follow the Hocking Valley and its tributaries. The New York Central (Toledo and Ohio Central) Railroad has its low level route along the valleys of Margaret and Sunday Creeks and the Hocking River. Spur lines extend into several tributary valleys of Sunday Creek, and one from Palos to Amesville and Lathrop, recently abandoned, crossed over into the valleys of Federal Creek. In former times, the Hocking Valley Canal paralleled the Hocking River as far southeast as Athens.

The main highways, likewise, follow the larger valleys. Ohio Route No. 7 follows the course of the old Marietta River across Troy Township. U. S. Route No. 33 remains in the Hocking Valley southeast to Athens and then crosses over the divide into the valleys of the Shade River drainage. U. S. Route No. 50 follows the old Albany River and Margaret Creek Valleys to Athens, where the route divides. One branch remains in the Hocking Valley to Guysville and then crosses through the hills, in part in abandoned preglacial valleys, to Fourmile Creek Valley to join Route No. 7 southwest of Coolville; the remainder of its route within the county is northeast along Route No. 7 in the old Marietta Valley. The other branch follows the Hocking Valley from Athens along Route No. 33 to Sugar Creek, where it turns and continues up Sugar Creek and over the divide into McDougall Branch of Federal Creek. The route follows both McDougall Branch and Sharps Fork to Sharpsburg and then moves up onto the ridge tops before leaving the county. The 17 state routes stay mostly in valleys. Many of the rural roads are also restricted to valleys, but there are a considerable number which also traverse ridge tops for at least part of their courses.

Because Athens County is so hilly, the land is not well adapted to agriculture; the best land for cultivated crops is always the flatter, smoother areas. Suitable land is not common in Athens County, occurring only along the valleys of the Hocking River and its tributaries, on The Plains, and in the valleys of the abandoned Albany and Marietta Rivers. Farm land on the modern stream bottoms is, of course, subject to floods. Prosperous farming areas are present in Lee Township in the vicinity of Albany and Hebbardsville, near Amesville in Ames and Bern Townships, and around Coolville in Troy Township.

Farm lands in the hills present problems of soil erosion; maintenance of the soils and fertility is more difficult than on the valley flats. As a result, many hill farms have been abandoned, reverting to brush or forest. About 35 per cent of Athens County is classified as forest land, much of which has never been cultivated (plate 4). Farming practices on the hill farms still in use have changed. Where cultivated crops are grown, contour plowing, strip farming, and a greater use of commercial fertilizers are becoming increasingly popular (plate 5). The chief products today are hay, sown grains, and dairy or beef cattle.

PRESENT DRAINAGE

RAINFALL AND RUNOFF

Athens County receives an average of 40 inches of rainfall annually, with a yearly runoff of between 10 and 15 inches (Langbein et al., 1949).

Runoff usually constitutes only about a third of the total rainfall in any area, as a considerable portion sinks into the ground, evaporates, or is adsorbed by plants. The actual amount of runoff for any individual region depends primarily on its climate, manner and volume of precipitation, slope of the ground, stage of the erosion cycle, nature of the rocks and soils, and amount and kind of vegetation.

Runoff starts over the ground as a film of sheetwash, gathers as rills in gullies, and finally merges into larger streams. In Athens County, the land is well drained, for stream valleys reach every section. The only natural lakes and swamps are on the floodplains of the larger streams. All but these larger streams flow in deep, narrow valleys with steep gradients (fall in feet per mile tabulated in table 1). The large amount of surface in slope, the steepness of the slopes, the resistance of the bedrock, and the thinness of most of the soils all favor the relatively large runoff, which increases the problems of flood control, soil erosion, and maintenance of a permanent stream flow.

The drainage pattern of most of the streams throughout Athens County is dendritic (the map pattern made by a main stream and its tributaries somewhat similar to the arrangement of veins in the leaf of a tree). The West Branch of Margaret Creek is a good example (also Johnson Run, see figure 6). An acute angle between the main stream and each tributary in an upstream direction is characteristic of such a drainage pattern.

Local imperfections in the dendritic stream pattern do occur, as a result of the dip of the rocks and the different orientation of the extinct preglacial drainage. The rock layers in Athens County dip down to the southeast at about 30 feet per mile, which causes north-south-oriented steams generally to have longer tributaries on their west sides than on their east sides. This asymmetric tributary development is well shown by Snow Fork of Monday Creek (figure 6) and to a lesser extent by Sugar Creek and Opossum Run in the Federal Creek system. The preglacial Teays drainage had an asymmetry of pattern that was better developed than that of any of the present streams (plate 2), though many of the later streams have inherited, in part, some of this ancient asymmetry. Other irregularities in stream pattern have developed where one stream has cut back into the drainage area of another stream by a process known as stream "capture" or stream "piracy." Along the "captured" part of a stream, tributaries tend to enter the main stream at an acute angle in a downstream direction and are said to be "barbed." Fine examples of barbed tributaries and changed stream patterns occur along Big and Brill Runs in the Federal Creek system (figure 6); along Green, Jordan, and Rowell Runs south of the Hocking River in Carthage and Rome Townships; and along Rockcamp Creek of the Raccoon Creek system in Lee and Waterloo Townships.

All runoff from Athens County flows directly or indirectly into the Ohio River. The Hocking River system has the largest drainage area of any of the streams within the county; the Shade River, Raccoon Creek, Wolf Creek, and Leading Creek systems drain smaller areas in diminishing order of size (table 1). These drainage systems will now be discussed, the Hocking River and its tributaries first, and then the various streams of the other drainage systems in the order given above.

HOCKING RIVER

The main stream of the Hocking River system originated rather recently, during the Pleistocene glacial epoch, and is composed of segments of several preglacial streams. It is

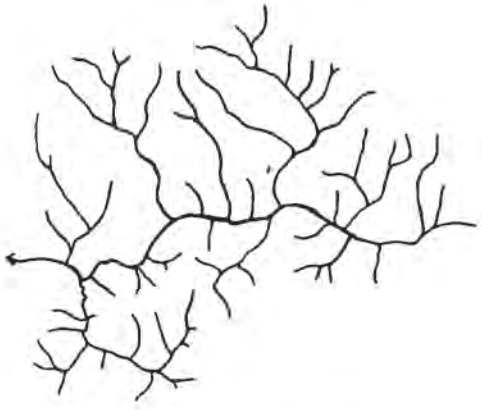
Figure 6 - Drainage patterns of selected Athens County streams which illustrate the area's typical dendritic drainage modified by barbed tributaries and asymmetric development.



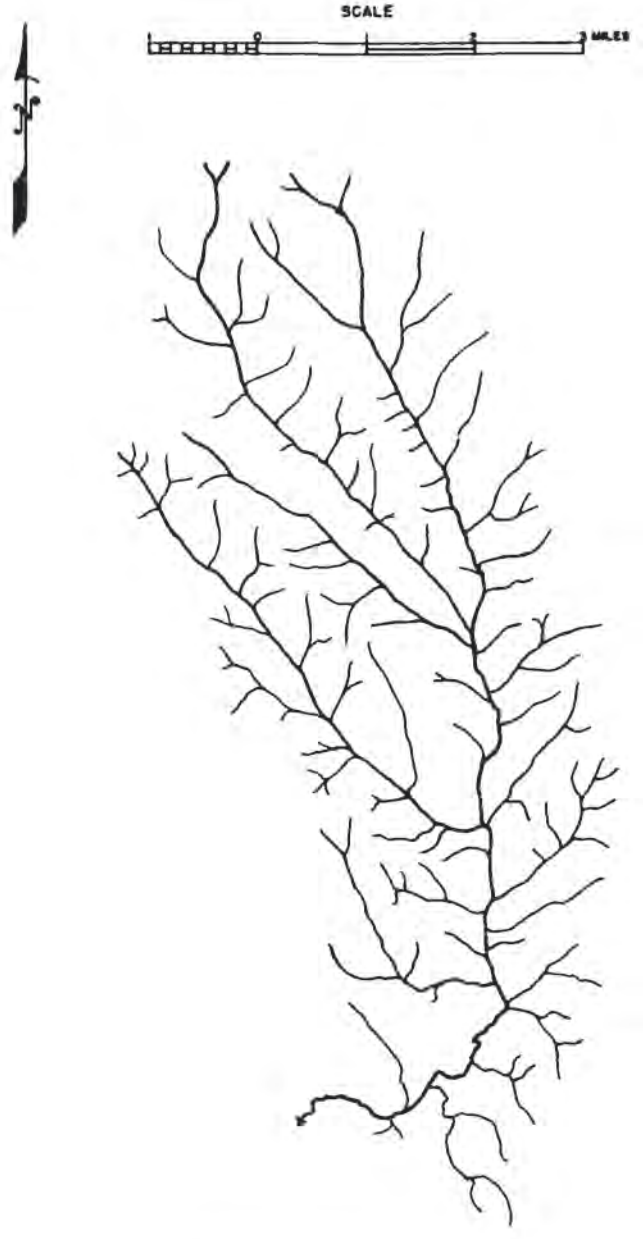
Opossum Run, illustrating dendritic drainage and asymmetry of tributary development.



Johnson Run, illustrating dendritic drainage.



Big Run, illustrating barbed tributaries.



Snow Fork, tributary of Monday Creek, showing striking asymmetry of tributary development (most coming in from west).

Table 1

Drainage Data For All Streams in Athens County
(Modified from Division of Water data)

Stream Name	Total Length (Miles)	Length in Athens Co.	Average Fall Feet per Mile	Flows Into	Total Drainage Area sq. mi.	Drainage Area in Athens Co. sq. mi.
		HOCKING RIVER BASIN				
Hocking River	94.9	53.3	4.6	Ohio River	1199.5	337.98
McGill Run	1.3		114.6	Hocking River	0.66	
Ross Run	2.4		74.6	Hocking River	1.99	
Fourmile Creek	4.5		45.8	Hocking River	16.35	
East Fourmile Creek	3.8		46.1	Fourmile Creek	6.89	
Wolfpen Creek	2.5		78.0	Fourmile Creek	2.81	
Tar Creek	1.0		75.0	Fourmile Creek	0.96	
Skunk Run	4.5		45.4	Hocking River	4.55	
Frost Run	3.7		64.3	Hocking River	5.40	
Jordan Run	5.1		48.4	Hocking River	7.44	
Lead Run	1.4		186.5	Hocking River	0.75	
Rowell Run	2.4		64.2	Hocking River	2.47	
Twomile Run	2.4		105.4	Hocking River	2.22	
Federal Creek	23.8		19.1	Hocking River	144.9	86.56
Sharps Run	3.6		48.4	Federal Creek	5.60	
Herrold Run	3.0		103.3	Federal Creek	1.83	
Big Run	5.5		46.4	Federal Creek	11.89	
Nellis Run	0.6		241.7	Big Run	0.34	
Joes Run	1.9		162.0	Big Run	0.90	
Wildcat Run	2.2		104.4	Big Run	1.75	
Spring Run	2.6		77.7	Federal Creek	1.47	
Marietta Run	5.8		49.4	Federal Creek	10.12	
Brill Run	2.6		80.7	Marietta Run	3.23	
Sharps Fork	14.5		28.9	Federal Creek	35.70	
Opossum Run	5.7		47.4	Sharps Fork	8.95	
Joy Run	1.5		96.8	Sharps Fork	1.12	
McElfresh Run	2.5		72.5	Sharps Fork	1.75	
McDougall Branch	7.9		34.2	Federal Creek	37.57	
Wyatt Run	4.9		51.2	McDougall Branch	6.78	
Mush Run	5.3		45.6	McDougall Branch	12.96	
Sugar Run	4.3		44.2	Mush Run	5.88	
Bryson Branch	5.4		44.5	McDougall Branch	7.77	
Linscott Run	5.5		50.2	Federal Creek	5.04	
Ewing Run	2.4		106.2	Linscott Run	1.32	
Hyde Fork	10.7		24.2	Federal Creek	26.84	
Hyde Branch	4.6		60.9	Hyde Fork	6.53	
Miners Fork	6.2		37.6	Hyde Fork	10.21	
Piper Run	2.6		79.3	Hocking River	2.00	
Miller Run	2.4		59.5	Hocking River	2.62	
Tiger Run	2.2		82.7	Hocking River	1.50	
Green Run	3.6		54.4	Hocking River	2.43	
Butts Run	2.9		58.9	Hocking River	2.65	
Rocky Run	1.2		136.5	Hocking River	0.52	
Willow Creek	5.2		45.2	Hocking River	12.72	
Lick Run	1.6		84.4	Willow Creek	1.35	
Canaanville Run	2.0		82.5	Hocking River	1.50	
Stroud Run	4.5		56.5	Hocking River	7.26	
Margaret Creek	12.9		14.7	Hocking River	60.2	60.03
Factory Creek	6.3		31.6	Margaret Creek	12.48	
Little Factory Creek	3.8		31.3	Factory Creek	3.25	
West Branch	5.5		31.8	Margaret Creek	10.75	
Sugar Creek	5.0		51.2	Hocking River	6.87	
Mill Creek	2.0		97.5	Sugar Creek	1.47	
Sunday Creek	27.2		11.5	Hocking River	138.5	20.88
Bailey Run	3.8		52.6	Sunday Creek	7.80	
North Branch	3.4		67.7	Bailey Run	2.40	

Table 1 - Drainage Data For All Streams in Athens County - continued

Stream Name	Total Length (Miles)	Length in Athens Co.	Average Fall Feet per Mile	Flows Into	Total Drainage Area sq. mi.	Drainage Area in Athens Co. sq. mi.
Greens Run	3.0		65.0	Sunday Creek	5.25	
Taylor Run	3.2		65.6	Greens Run	2.74	
Congress Run	3.3		48.5	Sunday Creek	3.19	
West Branch	14.0		23.2	Sunday Creek	42.53	
Mud Fork	4.8		34.0	W. Branch Sunday Ck.	7.26	
Johnson Run	3.5		27.5	W. Branch Sunday Ck.	4.17	
East Branch	15.5		21.6	Sunday Creek	32.59	
Hamley Run	5.8		35.5	Hocking River	8.20	
Monday Creek	27.0		10.4	Hocking River	116.1	7.3
Snow Fork	10.7		17.3	Monday Creek	26.97	
Minkers Run	3.6		38.6	Hocking River	5.36	
Dorr Run	2.8		35.7	Hocking River	2.98	
		RACCOON CREEK BASIN				
Raccoon Creek	109		3.8	Ohio River	683.5	44.69
Flat Run	6.8		14.7	Raccoon Creek	5.85	
Onion Creek	5.9		27.1	Raccoon Creek	10.51	
Hewett Fork	15.4		15.3	Raccoon Creek	40.36	
Rockcamp Creek	4.4		26.2	Hewett Fork	7.28	
Coal Run	1.5		80.0	Rockcamp Creek	0.89	
Pine Run	1.1		31.9	Hewett Fork	0.21	
Grass Run	2.7		57.5	Hewett Fork	2.75	
		SHADE RIVER BASIN				
Shade River	38.2		7.9	Ohio River	220.6	76.51
East Branch Shade River	21.9		15.4	Shade River	55.54	
Guthrie Creek	3.8		39.2	E. Branch Shade R.	5.44	
Palk Hollow	1.9		119.5	E. Branch Shade R.	1.04	
Dog Hollow	3.3		55.4	E. Branch Shade R.	4.38	
Middle Branch Shade River	28.5		11.0	Shade River	57.26	
Pratts Fork	8.4		38.9	M. Branch Shade R.	10.30	
West Branch Shade River	20.8		12.2	Shade River	72.14	
		WOLF CREEK BASIN				
Wolf Creek	47.4	1.9	8.5	Muskingum River	221.0	3.60
Buckeye Run	2.6		38.8	Coal Run	3.35	
		LEADING CREEK BASIN				
Leading Creek	29.5		8.4	Ohio River	151.08	

by far the largest stream within Athens County, although the Ohio River, which touches the southeastern edge, is much bigger. The Hocking heads about 40 miles to the northwest near Lancaster in Fairfield County and flows across Hocking County before entering Athens County near East Clayton. It flows diagonally southeast across the county past Nelsonville, Doanville, Chauncey, Athens, Guysville, Stewart, and several smaller places, into the Ohio River at Hockingport. Its valley cuts across preglacial divides at East Clayton, at a point just east of Athens, and possibly between Beebe and Frost about three miles east of Stewart.

The width of the valley floor varies along its course from 0.2 to 0.7 mile and averages about 0.4 mile. In the vicinity of East Clayton, the floodplain is narrow because of the presence of a preglacial divide, but just east of Athens another preglacial divide has little effect on valley width. A more resistant rock may be present in the valley wall here. The narrowness of the Hocking Valley from Beebe to Hockingport may be caused by the outcrop of the thick Waynesburg sandstone, though a preglacial divide may have been present here, also. On the other hand,

several thick massive sandstones present in the valley wall near Athens do not prevent the valley here from being wider than average; greater meander development in a loop around Athens may be responsible for this greater valley width. Variations in valley width, therefore, seem to be the result of a complex set of factors, most important of which are preglacial divides and resistant rock outcrops. The valley is also wider near the mouths of larger tributary valleys, as for example those of Monday and Sunday Creeks.

Extending southeast from Beaumont for about two miles through The Plains is an abandoned part of the Hocking Valley floor; the river now flows from near Chauncey to the vicinity of Sugar Creek in what was formerly the lower part of the Sunday Creek Valley (figure 5). A part of the former divide between the Hocking River and Sunday Creek is now isolated in the form of an elongate rock hill between The Plains and the present Hocking Valley southeast of Beaumont. A similar but much smaller remnant of the Hocking-Monday Creek divide is located about 0.5 mile south of Doanville. Hills of this type are known technically as hills of circumalluviation.

The Hocking River has a relatively low gradient in Athens County, only 2.11 feet per mile from the mouth of Monday Creek to the Ohio River (table 1). Low water elevations, tabulated below, emphasize this low gradient.

Table 2

Low Water Elevations Along Hocking River, Athens County, Ohio

Location	Distance above mouth	Low Water elevation
Mouth of Hocking River.	0.0 mile	552 feet
Coolville, just below mill dam . . .	5.2 "	565 "
Mouth of Federal Creek	14.6 "	583 "
Guysville, just below mill dam . . .	19.4 "	593 "
Athens gauge at Mill Street Bridge. .	30.9 "	618 "
Athens, just below Whites Mill dam .	34.0 "	624 "
Mouth of Sunday Creek	40.4 "	637 "
Mouth of Monday Creek.	45.9 "	649 "

Some effect of this low gradient is reflected in the numerous bends or meanders of the Hocking channel, which are well shown in the Athens area. Meanders are responsible for widening valleys; those of both the Hocking and Monday Creek undoubtedly account for the isolation of the small rock hill (hill of circumalluviation) south of Doanville. In valleys with such gentle gradients, flood waters remain longer than in valleys with steeper slopes.

The floor of the Hocking Valley is almost everywhere underlain by alluvial (stream) deposits of sand and gravel, with lesser amounts of clay and silt, to depths of 60 feet or more. Most of this material was originally derived from glacial deposits far upstream to the northwest. Though no glacier came as far as Athens County, the Hocking River headed in glaciated country. Consequently glacially borne rocks from as far away as Canada, called erratics, are present in the Hocking Valley deposits, though their percentage decreases downstream (and the percentage of local debris increases) as the distance from the glacial boundary becomes greater. Since the disappearance of the glaciers from Ohio, the Hocking has lowered its channel, cutting a new level, the present floodplain, into these older deposits, which have been left as higher level terraces or second bottoms. Thus, the materials in these terraces and beneath the floodplain are generally the same, though a layer of finer materials has been deposited on the floodplain since the end of the glacial period.

The drainage pattern of the Hocking is dendritic, though it is somewhat imperfect and asymmetrical. Barbed tributaries occur where it crosses preglacial divides, Margaret Creek being

one of the largest and best examples. Most of its drainage basin lies north of the main valley; with the exception of Margaret Creek and Clear Creek (in Hocking County), all the longer, larger tributaries are on the north side (figure 4). The cause of this unequal length of tributaries from the north and south can be attributed mainly to the fact that the Hocking is a system composed of parts of several preglacial stream systems, all of which flowed southward. The Hocking developed athwart these ancient drainage lines, inheriting the broad, well-developed upper reaches of these earlier streams to the north, while much of the drainage on the south still flows south, away from the Hocking River. Regional dip of the bedrock to the east, which causes tributaries from the west to be longer and better developed, has been an additional factor complicating tributary development, in both preglacial and more recent times.

The larger tributaries on the north side of the Hocking River include Federal Creek (144.9 square miles of drainage area), Sunday Creek (138.5), Monday Creek (116.1), Stroud Run (7.26), Sugar Creek (6.87), and numerous smaller ones (figure 4, plate 2, table 1). Each of these, plus Margaret Creek from the south, are discussed individually on the following pages.

FEDERAL CREEK

Federal Creek is the largest tributary of the Hocking River in Athens County, and its headwaters also drain large areas in Morgan and Washington Counties. The main valley appears to lie along the same line as that section of the Hocking River from just below Stewart to Hockingport; it probably formed the headwaters of a former stream which, in addition to the present drainage basin, once drained the areas east of Athens and along present Sunday Creek.

Federal Creek has some interesting features. Its main channel, which is only 9.3 miles long, is somewhat sinuous and lies in a deep, narrow valley. Tributaries entering Federal Creek in this area, which include Big, Brill, Herrold, Joes, Marietta, Nellies, and Spring Runs, flow in rather narrow valleys. It is an area of abandoned roads and farms, much covered by brush and forests. Upstream from this gorge, about a mile and a quarter east of Amesville, two main streams, McDougall Branch and Sharps Fork, join to form Federal Creek. These two streams and most of the other tributaries in this area are longer and have much broader valleys than those farther downstream. As a result, this is one of the best farming areas of Athens County.

Some of these streams have somewhat unnatural orientations, probably inherited from the preglacial drainage patterns. Big and Brill Runs have well-developed barbed tributaries, evidence that much of the territory drained by these two streams has been captured from the Little Hocking River system to the east. Other drainage adjustments and changes appear to have taken place in areas drained by Herrold, Sharps, Sugar, and Wyatt Runs and between Big and Twomile Runs. The hamlet of New England lies in a col (divide within a valley, or low gap in a ridge) between Sharps and Sugar Runs, suggesting that these two valleys were once part of a single, through drainage. Cutler, about three miles east of the county line, is in another col between Big Run and Burnett Run of the Little Hocking system. All settlements, main roads, and the former railroad within the basin are in valleys, whether presently occupied by a stream or abandoned.

Throughout the county, valley sides are so steep that rock outcrops are abundant. Along Federal Creek and some of its tributaries, the Pittsburgh coal crops out and has been extensively mined.

SUNDAY CREEK

Sunday Creek lies along the axis of the preglacial Albany River and drains part of what were

the headwaters of that ancient stream (plate 2). The present drainage area is fan shaped, expanded toward the north and restricted to the south. Most of its drainage comes from outside the county, gathering its headwaters (Stout et al., 1943, p. 59), "...in Perry County north of Santoy, Rendville, Congo, and Hemlock, and in Morgan County south of Portersville." In Athens County, Sunday Creek drains much of Trimble Township, the northern half of Dover Township, and small areas in Ames and York Townships. The valley has a wide floor throughout, with terraces in the lower reaches, and is somewhat winding. The average gradient for its entire length is 11.5 feet per mile (table 1). Within the county the gradient is less and the channel has a strong tendency to meander. Its principal tributaries in Athens County are Bailey, Congress, Greens, and Johnson Runs, Mud Fork, and East and West Branches, plus an additional unnamed tributary with a relatively wide valley east of Millfield. Northwest of Chauncey, an almost rectangular drainage pattern prevails in the tributary system to Bailey Run, evidence of the drainage changes that have taken place there. The effect of the bedrock dip to the east is conspicuous throughout the Sunday Creek drainage, for the longer tributaries are on the west.

The lowlands of Sunday Creek Valley are the setting for a number of villages and towns, including Chauncey, Glouster, Jacksonville, and Trimble. The valley is also followed by the New York Central Railroad and several important highways. Recently the Thomas A. Jenkins Dam was completed on East Branch near Burr Oak, in section 6 of Trimble Township, though most of the reservoir itself is located in Homer and Union Townships of Morgan County.

The valley has long been an area of mining operations in the Middle Kittanning (No. 6) and Upper Freeport (No. 7) coals. Formerly, several ceramic plants produced bricks at Glouster and Trimble.

MONDAY CREEK

Monday Creek, parallel to and immediately to the west of Sunday Creek, empties into the Hocking River near Doanville. Only 7.3 of its 116 square miles of drainage area are in Athens County; the remainder lie in Hocking and Perry Counties. That part lying in Athens County includes a small northwest corner of Dover Township, a somewhat larger area in the northeast corner of York Township, and a strip about a mile wide along the western edge of Trimble Township. Both Monday Creek and its principal tributary in Athens County, Snow Fork, meander in broad gentle valleys and have terraces containing both alluvial and lake deposits (Merrill, 1953).

The drainage basin of Monday Creek is fan-shaped, similar to that of Sunday Creek, but its drainage pattern (mostly outside the county) lacks regularity of arrangement, a manifestation of a complicated drainage history. In preglacial times, the eastern part of the present Monday Creek system drained into Teays-stage Luhrig Creek, a tributary of the Albany River, and the western part flowed through several branches into the Logan River. Stout et al., (1938, 1943) and Merrill (1953) have presented many of the details of this history; Merrill has shown that the integration of the present Monday Creek occurred sometime between preglacial (Teays) and Illinoian times.

The asymmetric drainage pattern of Snow Fork and its tributaries (figure 6) and the small hill of circumalluviation south of Doanville have already been discussed (pages 12 and 16).

Buchtel and Doanville, the only villages within the Monday Creek basin in Athens County, are located on the flats of the main stream. Murray City, located just over the boundary in Ward Township of Hocking County, also lies in this valley. Monday Creek and Snow Fork Branches of the Chesapeake and Ohio (Hocking Valley) Railroad and several state and county highways also follow the valley bottom. Farming is not significant in this area, good agricultural land being present only along the main streams.

Coal mining has been a persistent and widespread industry throughout the basin and still continues to a limited extent. Iron ore was formerly mined near Buchtel, where a blast furnace

was operated for a number of years. A new Sylvania Electric Company plant has recently been built near the junction of Monday Creek and Snow Fork.

MARGARET CREEK

Margaret Creek is the only large tributary entering the Hocking River from the south in Athens County. This north-flowing stream has a basin less than half the size of those of Federal and Sunday Creeks, and a little more than half that of Monday Creek (table 1, figure 4). Its drainage area is more rectangular in shape than those of Monday and Sunday Creeks and is restricted almost entirely to the county (less than half a square mile lies in Meigs County to the south).

Margaret Creek heads three miles southeast of Albany in section 30, Scipio Township, Meigs County, and flows north to the Hocking River at Grosvenor. This is almost the same course as that of the preglacial Albany River, though this latter flowed in the opposite direction, toward the south. Margaret Creek is thus a reversed system. There are numerous evidences of this reversal. Its tributaries, especially those on the west side such as Factory and Little Factory Creeks, West Branch, and one near Hebbardsville, are barbed and flow in a southeast direction, oriented toward the extinct south-flowing master stream. To the northwest and west of the present divide, parts of the former Albany system have been lost to tributaries of the Raccoon Creek system (Hamley and Grass Runs, Onion and Rockcamp Creeks), as shown by alignment of valleys, barbed tributaries, and modern divides located within through valleys.

The modern Margaret Creek Valley is neither as deep nor as wide as those of Monday and Sunday Creeks, and its gradient, though a little steeper, is insufficient to prevent meandering of its channel. In many places to the south, its shallowness is more apparent than real, however, for here the valley has been cut into the old Albany Valley, the tops of the modern bluffs in this area reaching only as high as the bottom of the old abandoned valley. Farther north, nearer its junction with the Hocking, at Grosvenor, Margaret Creek flows through higher bedrock hills in a valley that is deeper and more narrow (figure 5, cross section at Grosvenor).

Distinct silt terraces at the same level as the Wisconsin gravel terraces in the Hocking Valley are present in the lower reaches not only of Margaret Creek, but also of Factory and Little Factory Creeks. The surfaces on these terraces and on the higher graded floor of the abandoned Albany Valley include some of the best farm land in Athens County, as is evidenced by the fine farms in this area. Albany and Hebbardsville, the only villages in the Margaret Creek basin, are located in this prosperous farming area.

U. S. Route No. 50 follows the ancient Albany Valley from Fisher southwest through Hebbardsville and Albany and beyond, toward the Vinton County line. The New York Central Railroad has its right-of-way along Margaret Creek from Grosvenor southward to the vicinity of Albany, where it crosses over a low divide into the valley of Leading Creek.

No coal is mined along Margaret Creek, but there are several quarries in the thick Brush Creek limestone, exposed along the floor of the Albany Valley or along the headwater streams of Leading and Onion Creeks in the vicinity of Albany.

LESSER HOCKING TRIBUTARIES

The more important of the smaller Athens County streams flowing directly into the Hocking River are: Butts, Dorr, Frost, Green, Hamley, Jordan, Miller, Minkers, Piper, Ross, Rowell, Skunk, Stroud, and Twomile Runs; and Fourmile, Sugar, and Willow Creeks.

All of these streams are less than six miles long. Most of them have drainage basins of less than five square miles and only two have basins larger than ten square miles. Their gradients (fall in feet per mile) are steep, since they flow from high ridges to the floor of the Hocking Valley in very short distances, most of the fall being up near their sources. Data on length, gradient, and drainage area for each of the above streams are listed in table 1.

Though most of the valleys are very narrow, that of Hamley Run is rather broad, and those of Stroud Run and Sugar and Willow Creeks are moderately so. Well-preserved terraces occur along Hamley, Jordon, Miller, and Minkers Runs, and Willow Creek; those in Willow Creek Valley are among the best examples in the county (plate 1). Drainage patterns and locations of cols indicate that extensive drainage changes have taken place in the area drained by Butts, Green, Tiger, and Jordon Runs, Fourmile Creek, and the East Branch of the Shade River; where through Teays streams once flowed south, an east-west divide has developed, separating the Hocking River drainage from the Shade River drainage.

The valley of Hamley Run is the site of the recently built Poston Electric Generating Plant. The new C. L. Dow Dam and Reservoir are in Stroud Run Valley, where a state forest is also being developed. The Baltimore and Ohio Railroad follows the valley of Skunk Run as it leaves the Hocking Valley going toward the northeast.

Minkers and Hamley Runs and Sugar Creek Valleys have been important coal mining areas in the past.

SHADE RIVER SYSTEM

Various tributaries of the Shade River drain about 75 square miles of Athens County, mostly in Alexander, Carthage, and Lodi Townships, but also extending into Athens and Canaan Townships (table 1, figure 4). These tributaries include all of the Shade River's three main branches: East Branch and its tributaries, Guthrie Creek and Dog and Palk Hollows; Middle Branch and its tributaries, Long Run and Pratts Fork; and West Branch. The lower reaches of the Shade River lie to the south in Meigs County. Athens County contains the rugged headwaters region, characterized by generally narrow and steep-sided valleys, with high stream gradients. Stream capture is threatened by the Hocking's tributaries along the headwaters of Long Run and Middle Branch.

Settlements are sparse in the area drained by the Shade River tributaries and include only such small hamlets as Garden, Pleasanton (Pleasant Hill), Pratts Fork, and Shade. There are no railroads or factories. U. S. Route No. 33 extends southeast along Middle Branch and cuts across to Shade and Pratts Fork before reaching Meigs County. The chief occupations are farming and mining. The Pittsburgh (No. 8) coal is mined to some extent.

RACCOON CREEK SYSTEM

The western halves of Lee and Waterloo Townships are drained by the Raccoon Creek system. Hewett Fork and its tributaries carry most of the drainage from the area, but Flat Run and Onion Creek drain the southwestern part of Lee Township. The main part of the Raccoon Creek system lies to the west in Vinton County.

Hewett Fork follows an unusual course from its source, flowing in a meandering valley just west of the Hocking-Raccoon divide and then zig-zagging westward and southward in the vincinity of Carbondale and eventually joining Raccoon Creek near Moonville in Vinton County. Much of Hewett Fork basin was formerly part of the extinct Albany River drainage, the divide at that time being about a mile west of the western edge of Waterloo and York Townships, instead of in

its present location two to five miles to the east. The headwaters of Hewett Fork, which lie in sections 3 and 4 of Starr Township (Hocking County) and sections 28, 33, and 34 of York Township, flow eastward as if into tributaries of the Hocking River because of their original orientation as part of the old Albany River.

The valley of Hewett Fork southeast of Carbondale follows the course of an old Albany River tributary which headed in section 1 of Starr Township (Hocking County) and extended southeast into section 22 of Waterloo Township, from where it probably flowed east for a short distance along Grass Run and then south through a col into another Grass Run, between Mineral and New Marshfield. It may be followed still farther southeast across another col, at the southwest edge of New Marshfield, into the upper end of West Branch of Margaret Creek and across still another col in section 1 of Waterloo Township. The second Grass Run is a reversed stream as shown by its barbed tributaries and the col at the southwest edge of New Marshfield. This course is shown in figure 7. Northeast of New Marshfield is still another col through which the Baltimore and Ohio Railroad passes from the Hocking River watershed to that of Raccoon Creek. The col at New Marshfield seems to be the result of headward erosion by Factory Creek and Grass Run tributaries rather than stream capture.

Rockcamp Creek, another stream in the Raccoon Creek system, is also reversed; at one time it included in its headwaters King Hollow and probably Pine Run drainage west of Hewett Fork. There are numerous barbed tributaries between its junction with Hewett Fork and the col in section 17, Lee Township, through which its waters previously flowed into the headwaters of present Onion Creek. Coal Run in sections 19 and 20 is a prime example of one of these barbed tributaries. The headwaters of Onion Creek occupy part of the old north-south valley of an Albany River tributary, just north of Albany. Flat Run drains the southwest portion of Lee Township; its shallow meandering valley follows, in large part, that of the old Albany Valley.

It is thus apparent that the area in Athens County drained by Raccoon Creek and its tributaries has been extended several miles eastward and has changed in orientation from north-south to east-west. During or subsequent to the disruption of the south-flowing Albany system, west-flowing Raccoon Creek tributaries took over this additional area by stream piracy, or by increased downcutting.

Carbondale and Mineral are hamlets located in valleys of the Raccoon Creek basin, and New Marshfield lies in a col in the divide between Margaret and Raccoon Creeks. The main Baltimore and Ohio line follows the valley of Grass Run westward from New Marshfield to Mineral and continues along Hewett Fork to Ingham at the Vinton County line. The main road of the area, U. S. Route No. 50, follows the old Albany Valley through Albany toward Hebbardsville and Athens. State Route No. 56 goes westward from New Marshfield along Grass Run and then turns northwestward through the col between the two Grass Runs. From here it runs along the valley of northern Grass Run to Hewett Fork, which it follows to the Hocking County line beyond Carbondale.

The vicinity of Carbondale and Mineral is underlain mostly by thick sandstones and has steep slopes and poor soils. Much of this area has been abandoned by farmers and is in part occupied by the Waterloo State Forest and the Waterloo State Game Farm. Good farm land is present is southern Lee Township in the Flat Run basin.

The valley of Hewett Fork from Mineral to Carbondale has been an area of extensive coal mining in the past, and some local mining is still done. Large mines were in operation at Carbondale until 1947, and the Carbondale Branch of the Baltimore and Ohio Railroad still exists and hauls a small tonnage of coal.

LEADING CREEK SYSTEM

The headwaters of Leading Creek drain all of section 1 and parts of sections 2, 7, 8 and 9

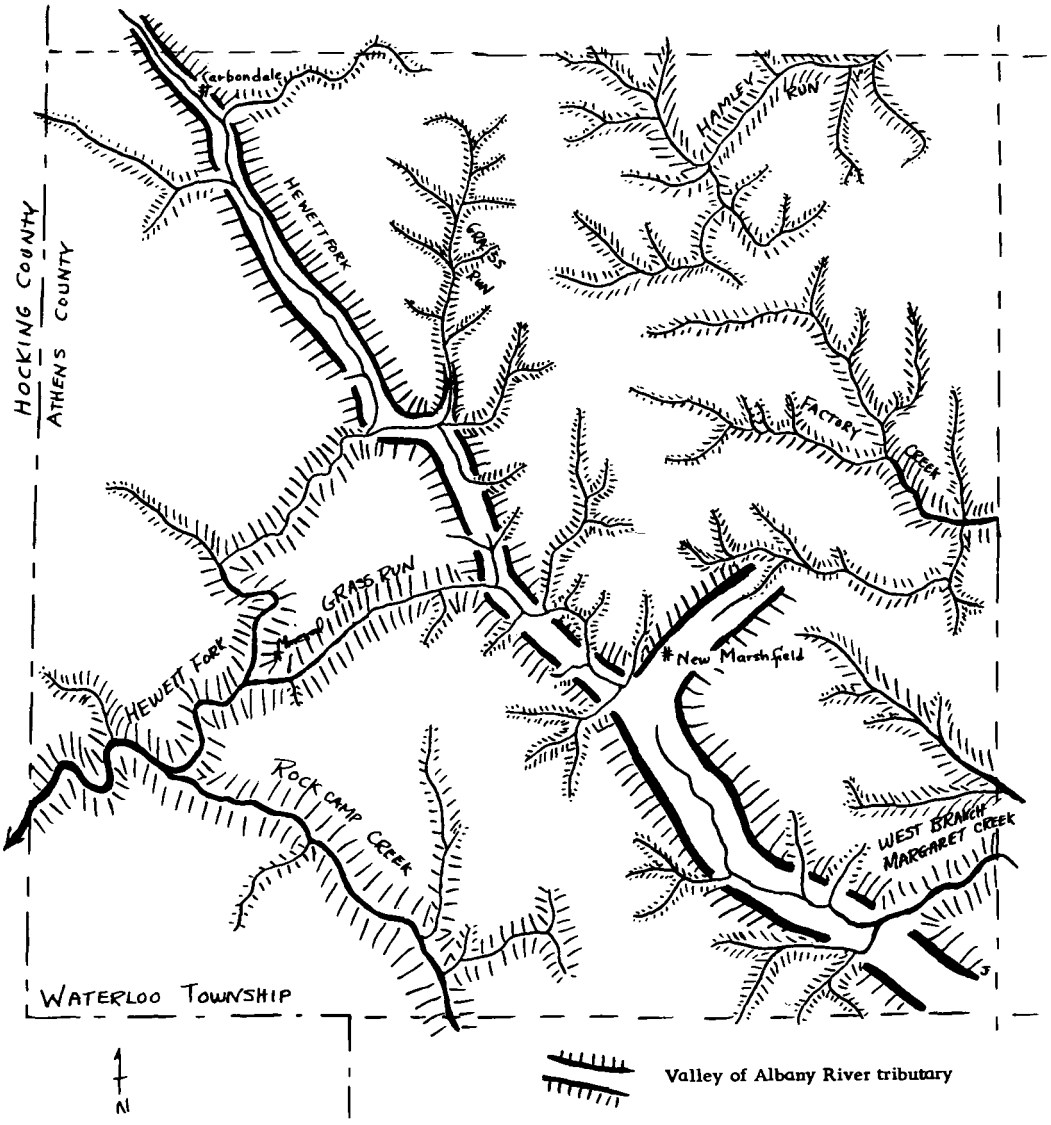


Figure 7 - Map showing relationship of valley of Albany River (Teays) tributary and modern streams in Waterloo Township.

of Lee Township and what would be parts of sections 25, 31, and 32 of Alexander Township, a total of only 4.07 square miles. The main stream heads just west of Albany and about one mile northwest of the wide Albany Valley, which it crosses in a shallow trench of its own before cutting a deep gorge into the south wall of the Albany Valley. This feature, present drainage cutting across a preglacial valley, is rather common (though unexplained) in the area of abandoned Teays stage valleys in southeastern Ohio.

Small as the Leading Creek drainage area is in Athens County, it is significant because fertile farms are present here, as well as quarries in the Brush Creek limestone. The village of Albany lies on its northern edge. U. S. Route No. 50 extends from Albany southwest across the area, and the Toledo and Ohio Central Railroad of the New York Central Railroad crosses the divide from Margaret Creek half a mile southeast of Albany, continuing southward along a tributary into the main valley of Leading Creek.

WOLF CREEK OF THE MUSKINGUM RIVER SYSTEM

The northeast corner of Athens County is in the Wolf Creek watershed of the Muskingum River system. This area, which contains only 3.6 square miles, is drained by tributaries to Coal Run, the largest of which is Buckeye Run, which flows east and then north into West Branch of Wolf Creek. The underlying rocks include thick sandstones, calcareous clay-shales and fresh-water limestones. Farm and wood products are the only items of economic importance from this small area. Plantsville, the only town, is located in the northwest corner. U. S. Route No. 50-A crosses the area in an east-west direction.

LITTLE HOCKING RIVER

The northern third of section 6 and the northeast corner of section 12, Troy Township, are drained by an unnamed tributary of the Little Hocking River. It has a total drainage area of less than half a square mile in Athens County.

MINOR OHIO RIVER TRIBUTARIES

In the eastern part of Troy Township, a few square miles are drained directly into the Ohio River by Dunfee, Sawyer, and Swan Runs, and several lesser unnamed streams. Except for some relatively smooth land in the old Teays-stage Marietta Valley near Torch, the terrain adjacent to the deep Ohio Valley is rugged.

South of the Hocking River, along the southern edge of Troy Township, Indian Run and its tributaries drain parts of a few sections, a total area of less than half a square mile, in Athens County.

PREGLACIAL PHYSIOGRAPHIC HISTORY

EROSION SURFACES

The general upland level in Athens County, marked by summit elevations of 900 to 1,000

feet above sea level, represents a well-developed erosion surface called by many a peneplain, which, before it was dissected, must have had an undulating relief of about 150 feet. Monadnocks rising above this surface are present along or near the divides on the east and west sides of the Albany River basin in Ames, Athens, Canaan, Dover, Trimble, and York Townships; along or near the present divide between Federal Creek and the Little Hocking River in Bern Township; and on scattered hill and ridge tops in Ames and Bern Townships. These monadnocks appear to owe their height largely to favorable positions on the old surface. The lowest elevations on this surface are in the Marietta Valley near Tuppers Plains and in the Albany Valley near Albany, although the original maximum depths of those valleys is unknown.

The level of the surface varies somewhat in elevation as a result of the effect of certain more resistant rock units in the section, which, because of the gentle dip of the strata, form low dissected cuestas. These cuestas are clearly shown on the cross section of the county (fig. 4).

Those who have made careful studies of Appalachian erosion surfaces and their correlations are now agreed that the general surface in Athens and neighboring counties is the Lexington (Worthington) surface (Stout and Lamb, 1938, p. 58; Ver Steeg, 1940, p. 206; and Cole, 1941, p. 134), though they disagree in some minor details. The Lexington surface was named from Lexington, Kentucky, in the Bluegrass region, where it is the best developed erosion surface. From here it can be traced north and west into Ohio, Indiana, and Illinois. In western Ohio this is the principal surface of the Central Lowlands (figure 3), though it has been covered by glacial (Pleistocene) deposits; here it is developed on weak limestones and shales at elevations mostly less than 1,000 feet above sea level.

In the Appalachian Plateau region of eastern Ohio, the rocks are generally more resistant than those underlying the Central Lowlands; so the erosion surface occurs at higher elevations. Because the difference in summit elevations is largely a result of this difference in rock resistance, the two erosion surfaces, though at different elevations, are considered to be of the same age and should both be called Lexington.

There are also two levels within the Appalachian Plateaus, separated by the Flushing Escarpment, a striking north-south divide and physiographic boundary extending from Columbiana County south to Monroe County. The lower of these two levels, with general ridge elevations of from 930 to 990 feet above sea level (Stout and Lamb, 1938, p. 58), lies west of the Flushing Escarpment. The second and higher level occurs between the Flushing Escarpment and the Ohio River and is characterized by average elevations of from 1,260 to 1,280 feet for the higher ridges (Stout and Lamb, 1938, p. 52). The lower western area penetrates the higher eastern one as strath valleys, and the higher eastern surface persists as monadnocks to the west. These two levels are also both Lexington; the difference in summit elevations is a result of the early physiographic history of the area. In preglacial times, each area belonged to a different drainage basin; the area east of the Flushing Escarpment was drained by long high-level streams flowing east to the Atlantic Ocean, while those from the level to the west flowed by a shorter, lower route west to the Gulf of Mexico.

The name Harrisburg has been applied by some to the higher of the two plateau surfaces in eastern Ohio; Stout and Lamb (1938, p. 50-58) assert that the Harrisburg surface is present as a general surface east of the Flushing Escarpment and that "... west of the Flushing escarpment the Harrisburg peneplain level is identified by the higher ridge crests throughout much of the area. The common elevation, however, descends considerably below that in the highland area east of the Flushing escarpment. Throughout much of Carroll, Tuscarawas, Holmes, western Harrison, southwestern Ross, western Pike, and eastern Adams counties many ridges reach the 1,260-foot level. In much of Coshocton, Guernsey, Muskingum, Noble, Washington, Morgan, Hocking, and Athens counties they range between 1,100 and 1,260 feet, whereas in Meigs, Gallia, Lawrence, and Scioto counties they seldom exceed 1,000 feet and many are much below this." The summits with these elevations have been correlated with the Harrisburg peneplain. However, the type Harrisburg area lies in eastern Pennsylvania across the Appalachian Mountains from Ohio, so it seems wise not to attempt such a long-range correlation and to call all these Ohio erosion surfaces Lexington, even though the time of their development may be the same as that of the Harrisburg surface (table 3).

Table 3

Erosion Surfaces of Eastern Ohio, Including Athens County, and Equivalent Surfaces of Eastern Pennsylvania

(Data modified from Cole, 1941, and Stout and Lamb, 1938)

Appalachian Plateau Erosion Surfaces	Representation in Eastern Ohio	Representation in Athens County	Probable Equivalent Erosion Surfaces in Eastern Pennsylvania
Upland	Not present	Not present	Upland
Allegheny	Monadnocks east of Flushing Escarpment	Not present - Allegheny surface higher than any elevations in the county	Schooley
Lexington	General summit levels east and west of Flushing Escarpment	Summits at elevations of from 900 to 1,000 feet above sea level	Harrisburg
Parker Strath	Remnants of mature valleys of Teays River and its larger tributaries, with some river and lake deposits	Remnants of mature valleys of Albany and Marietta Rivers and their tributaries, with some river and lake deposits	Somerville

No precise information is available concerning the age of the Lexington surface except that it is considerably younger than the Paleozoic rocks in which it is cut and older than the Parker (Teays) strath, the erosion of which was interrupted by the first advance of the Pleistocene glaciers. These facts suggest, however, that the Lexington may be Tertiary, possibly late Tertiary, in age.

High monadnocks east of the Flushing Escarpment (east of Athens County) represent remnants of a still higher surface identified as the Allegheny peneplain farther east in the Appalachians.

Athens County lies west of the Flushing Escarpment, but within the Applachian Plateaus. Consequently, the high summits within the county correlate with the lower of the two plateau erosion surfaces.

TEAYS RIVER SYSTEM

That a large river system, called the Teays, drained southeastern Ohio in preglacial times, is shown from observations by Hildreth (1838), Tight (1900, 1903), Leverett (1902), Stout (1927), Stout and Schaaf (1931), Happ (1934), Stout and Lamb (1938), and Stout et al. (1943). Locally, well-preserved remnants of this ancient river system occur in the form of abandoned valley segments and smaller areas, with deposits of alluvial (river) and lacustrine (lake) sediments. Tight was the first to trace out the details of the Teays system in southeastern Ohio and adjacent regions; his work has since been checked and enlarged by Stout. Stout et al. (1943, p. 52-53), have given an excellent account of this entire mature system; their description is quoted below:

"The Teays, the master or at least the type stream of the system, gathered its headwaters out in the Piedmont Plateau of Virginia and North Carolina, flowed northward from Ashville,

North Carolina, to White Sulphur Springs, Virginia, thence northwestward across the mountains to Charleston, West Virginia. From Charleston its course was along the broad open Teays Valley past St. Albans, Milton, and Barboursville to what is now the valley of the Ohio River at Huntington. From this place the course of the Teays was much the same as that of the present stream, the Ohio River, to Wheelersburg, Ohio, where the two courses changed radically. From Huntington to Wheelersburg, however, the present stream did not obliterate all traces of the older Teays as the floor of the latter is well recognized by wide silted flats south of Ashland and by prominent terraces with typical accumulations between Franklin Furnace and Wheelersburg on the Ohio side.

"From Sun Hill at Wheelersburg much physiographic history is plainly revealed. Here the present stream, Ohio River, turns abruptly and flows westward to Portsmouth, Maysville, and Cincinnati, whereas the older Teays River continued northward past Minford, Stockdale, Glade, Beaver, and Givens to Waverly through a high level, broad, open valley clearly defined as to its origin. Between Waverly and Richmondale the Scioto River has degraded and partially obliterated the Teays but the floor of the latter exists as broad upland flats in the vicinity of Omega and Higby. From Richmondale the Teays continued northwestward past Vigo and Londonderry to Chillicothe where the old floor passes under a thick mantle of Wisconsin drift and is thus obscured from visual identification.

"Through scattered evidence, but sufficient for delineation, the old Teays River is traced northwestward from Chillicothe past Andersonville and Clarksburg in Ross County, Atlanta in Pickaway County, Waterloo in Fayette County, and London in Madison County, to Vienna, where the stream received a large tributary, the Groveport River, from the east, which drained an extensive area in central Ohio.

"From Vienna the Teays River flowed westward toward Springfield in Clark County, thence northwestward past Bowlusville in Clark County, St. Paris in Champaign County, Pemberton, Port Jefferson, and Botkins in Shelby County, to the southeastern part of Washington Township in Auglaize County, where the major stream was augmented by Wapakoneta Creek, a small tributary from the north. The continued course of the Teays River was then westward under the eastern end of the St. Marys Reservoir in Mercer County, thence northward past the village of Mercer to Rockford, and thence westward to the Ohio-Indiana state line in the northwestern part of Buck Creek Township in Mercer County. Beyond the Ohio line or in Indiana this drainage system has not been definitely traced but the general course appears to be westward to the Wabash River and thence southwestward along this great valley and that of the Ohio and Mississippi Rivers to the Gulf of Mexico.

"The rock floor of the Teays River has an elevation of approximately 700 feet at Scary on the Kanawha River; 660 feet at Huntington, West Virginia; 650 feet on Dogwood Ridge near Wheelersburg, Scioto County, Ohio; 645 feet near Glade, Jackson County; 640 feet at Givens and 630 feet at Omega, Pike County; 610 feet at Vigo, 592 feet at Schooley, and 590 feet at Chillicothe, Ross County; 572 feet near Atlanta, Pickaway County; 530 feet near London, Madison County; and 460 feet under the St. Marys Reservoir in Mercer County. The gradients and floor levels of the tributary streams conform quite well, indicating that the elevations along the floor of the old Teays River are approximately correct.

"From Huntington in West Virgina to Schooley in Ross County, Ohio, the distance is close to 90 miles and the rock floor of the old Teays River descends in elevation from 660 feet at Huntington to 592 feet at Schooley. Therefore the gradient of the steam is about 9 inches to the mile. The route traversed is largely through shales and sandstones with only moderate resistance to erosion and weathering. From Schooley in Ross County to the St. Marys Reservoir in Mercer County the distance is approximately 133 miles and the fall in the rock floor 132 feet or nearly 1 foot to the mile. Most of the way the stream flowed on dolomites and limestones, generally hard, dense, and resistant. Throughout the distance from Huntington to the St. Marys Reservoir, 223 miles, the gradient is 10.76 inches per mile.

"The Teays River was thus quite mature as is shown by the low gradient, by the broad valley in which it flowed, and by the bordering hills well rounded and degraded. In southern

Ohio the width of the Teays Valley, where little disturbed by later erosive and modifying agencies varies from 1 to 2 miles but averages close to 1.45 miles. Its size thus compares favorably to that of the present Ohio Valley. In general, the old Teays Valley maintains a rather uniform width with a slight expansion downstream through the addition of tributaries. Throughout southern Ohio from Wheelersburg to Chillicothe the bordering hills rise from 200 to 300 feet above the valley floor. Locally the maximum relief reaches more than 600 feet. The uplands of the basins were highly dissected into hills and valleys by the tributary streams the patterns of which are decidedly dendritic even to the small runs at the headwaters."

Two large tributaries of the Teays River drained Athens County, and their courses, as well as those of their principal tributaries in this area, are shown in plate 2. The larger of these two tributaries, the Marietta River, flowed southwest across Troy Township from Torch past Coolville to Tuppers Plains. Stout and Lamb (1938, p. 65-66) describe the Marietta River system as follows:

"... The largest of the tributaries was the Marietta River, a stream that gathered its headwaters near Marietta, flowed southwestward past Parkersburg, West Virginia, Little Hocking, Coolville, Tuppers Plains, and Chester, Ohio, to Hartford, West Virginia, thence across Mason County in that state to Cheshire, Ohio, thence southwestward along the present valley of the Ohio to near Gallipolis, where its course was deflected northwestward past Rodney, Rio Grande, Centerville, Clay, Camba, Keystone, Jackson, and Cove to Glade, there joining the Teays River. Some of the larger tributaries of the Marietta were the Albany River, Hamden Creek, and Barlow Creek."

Stout et al. (1943, p. 57-58) give a more detailed description of the Marietta River as follows:

"The larger headwater tributaries of the Marietta River show distinctive Teays features in elevation, in outline, and in valley filling. The rock floor of the main stream near Parkersburg, West Virginia, has an elevation approximating 720 feet. The general course is then westward into Ohio near the village of Little Hocking in Washington County. At Torch and Coolville in Athens County and at Tuppers Plains in Meigs County the old valley is clearly defined, is broad, not far from one-half mile in width, and contains much material of the Minford silt type. Here the floor stands at about 700 feet elevation. From Tuppers Plains the stream was deflected westward to Alfred, then southward to Sumner, Chester, and Fivepoints to Racine on the Ohio River. Much of this part of the course is highly dissected by later streams but some little disturbed valley is present between Fivepoints and Racine.

"At Racine the Marietta River passed southward into West Virginia, thence westward, appearing again in Ohio just north of Gallipolis in Gallia County. From this place the stream flowed northwestward past Mills and Kerr to just north of Rio Grande, where it was joined by the Albany River, a stream draining parts of several counties. The molding sands prepared for the trade at Mills, Kerr, Evergreen, and Bidwell are found in these old stream beds. They vary in character from silty sands to sandy silts, are commonly well oxidized through their elevated position and through later stream dissection, and are known in the trade as 'Gallia Reds.' Near Rio Grande the rock floor has an elevation not far from 680 feet.

"From the village of Rio Grande the Marietta River flowed westward past Centerville, Gallia County, thence northwestward past Clay, Jackson County, and Camba to Keystone, where Hamden Creek, a small stream, entered from the north. Near Keystone the rock floor stands at an elevation of 670 feet. Throughout this part of the course the old valley contains thick deposits of fine-grained sand and Minford silt. At Clay the town of Oak Hill takes its water supply from the sands resting on the rock floor.

"From Keystone northwestward to Jackson this ancient valley is clearly defined and much filled with the characteristic deposits from which Jackson derives its municipal water supply. The old stream then turned westward and southwestward from Jackson past Cove and Glade and entered the master stream, the Teays River, near the Jackson-Pike county line. South of Jackson the valley is wide, often one mile or more, but west of this place it is restricted to one-half mile through the influence of the massive Sharon conglomerate.

"The main stream of the Marietta River was about 117 miles in length and not particularly tortuous in outline. It drained a large area in southeastern Ohio, including all of Gallia, Meigs, Athens, Morgan, and Washington counties and parts of Jackson, Lawrence, Vinton, Hocking, Noble, and Monroe counties. Further, it drained a rather large area in West Virginia, mainly in Pleasants, Wood, Ritchie, Wirt, Jackson, and Mason counties. Throughout the course of the stream from Parkersburg, West Virginia, to Glade, Ohio, the gradient of the rock floor is close to 10 inches per mile. Its chief tributaries were gathered from the north. Their general direction of flow was not far from that of the strike of the rocks, that is slightly west of south. The tributaries of the Marietta River of most importance and worthy of description were Hamden Creek, Albany River, and Barlow Creek."

Much of Athens County (including all of Ames, Bern, Carthage, Lodi, Rome, and Troy Townships and parts of Alexander, Athens, Canaan, Dover, and Trimble Townships) was drained by tributaries of the Marietta River, though these tributaries actually entered the Marietta River to the south in Meigs County (plate 2). The largest was Frost Creek, which headed between Beebe and Frost and followed the course of the present Hocking River, pouring its waters into the main stream at Coolville. Several shorter tributaries, entirely or largely within the county, flowed parallel to Frost Creek before entering the master stream. Several other large streams also headed within or flowed through Athens County, entering the Marietta River in Meigs County to the south. The larger of these are described briefly below; these descriptions can be followed best by referring to the map showing the Teays drainage (plate 2).

Beebe Creek headed north of Big Run in southwestern Bern Township and western Decatur and Wesley Townships of Washington County, crossed the course of the present Hocking River just east of Beebe, and flowed southward along present-day Rowell and Jordan Runs to a junction with the Teays-stage Mills School Creek in section 9, Carthage Township. Stewart Creek, another Teays tributary, drained most of the Federal Creek basin southeast of Armadale (except present Brill Run drainage and part of Big Run), flowed southwest from the mouth of Federal Creek along the present Hocking Valley past Stewart, and joined Teays-stage New England Creek in either section 19 or 20, Rome Township. One-half mile southwest of Stewart (the village from which it received its name), Stewart Creek received a sizeable tributary from the north, which drained parts of present Herrold and Sharps Run basins. New England Creek drained the present areas of Mush and Sugar Runs, the headwaters of McDougall Branch including Bryson Branch, and parts of Sharps and Wyatt Runs. Beyond its junction with the largest Teays-stage tributary, Amesville Creek, it drained the remainder of Wyatt Run and an extensive area to the north. Amesville Creek drained the territories of modern Hyde and Miners Forks, Linscott Run, and the lower part of McDougall Run and, through Teays-stage Lathrop and Joy Creeks, gathered the drainage of the present Sharps Fork and Opossum Run. Canaan Creek was another Teays-stage creek which drained the modern Hocking Valley from Guysville to east of Athens and included the modern Stroud and Tucker Runs and part of the Willow Creek drainage. New England and Stewart Creeks joined to form Mill School Creek which flowed into the Marietta River in Meigs County. The principal tributaries of Mill School Creek were Beebe and Canaan Creeks, already mentioned, several smaller tributaries draining western Carthage and eastern Lodi Townships, and a few miscellaneous tributaries. Another ancient creek, Lysander Creek, drained the area now occupied by tributaries of the Shade River in western Lodi and eastern Alexander Townships.

In western Athens County, the Albany River and its tributaries had a considerable drainage area, which included all of Lee, Waterloo, and York Townships, most of Alexander, Athens, Dover, and Trimble Townships, and a tiny fraction of Ames Township (plate 2). Stout et al. (1943, p. 59-60) have given a description of the Albany River system that is quoted below:

"The Albany River gathered its headwaters in southeastern Perry, western Morgan, southeastern Hocking, and northwestern Athens counties, largely through two tributaries which for clearness may be called Chauncey Creek and Luhrig Creek, the former somewhat larger than the latter. Chauncey Creek originated in Perry County north of Santoy, Rendville, Congo, and Hemlock, and in Morgan County south of Portersville. It then added waters in Trimble, Dover, and Athens townships and united with Luhrig Creek in Alexander Township. Luhrig Creek headed south of the divide southwest of New Straitsville in Coal Township, Perry County, flowed

southward past Murray, Buchtel, Doanville, Eben Glen, and Luhrig to Fisher, where the combined streams formed the Albany River proper. On the present Hocking River the col or divide was near the Athens-Hocking county line above Nelsonville. Floor elevations of Chauncey Creek are approximately 780 feet at Glouster, 800 feet at Bishopville, 770 feet at Millfield, 760 feet near ' The Plains,' and 750 feet at Fisher; and those of Luhrig Creek are 780 feet at Murray, 770 feet at Doanville, and 760 feet at Luhrig.

"From Fisher the old valley is especially well defined past Hebbardsville to Albany, the source of the name. Throughout this section of the valley thick deposits of fine-grained sands and silts of the Minford type are conspicuous. Its correlation with the Teays cycle is evident. At Albany the rock floor stands close to 740 feet above tide. Beyond Albany the course of the old stream was southwestward to Mt. Blanco in Meigs County, southward with slight meanders for several miles, thence southwestward to Wilkesville in Vinton County, where the broad upland flat is a distinctive feature of the landscape. Near Mt. Blanco the floor elevation is 720 feet and at Wilkesville 690 feet.

"From Wilkesville the Albany River flowed southward to Raccoon Creek, thence on in the same general direction past Ewington, Vinton, and Harrisburg to Rio Grande, where it joined the Marietta River. Throughout this part of the course the gradation plains are only locally well preserved as the present streams have obliterated much of the old valley. They have left, however, a sufficient number of silt-covered terraces so that the route may be traced with confidence. At Ewington the rock floor stands at 670 feet elevation and is overlain by 20 to 30 feet of fine-grained sands and laminated silts, typical of the Teays Stage of drainage."

The Albany drainage pattern was clearly asymmetrical, although the west-side tributaries to Chauncey Creek (name applied south of the confluence of Glouster and McLeish Creeks) were limited in length by the position of Buchtel and Luhrig Creeks. A few east-side tributaries were moderately large, but two of the largest, Glouster and Burr Oak Creeks, turned, a short distance upstream from their junctions with Chauncey Creek, and followed a north-south course. Thus, nowhere was the drainage basin of Chauncey Creek east of the trunk stream very wide. Poston Creek and one or two unnamed streams in the vicinity of Albany and Hebbardsville were the only other significant tributaries from the east. From Glouster southward to The Plains, about half a dozen southeast-flowing tributaries joined Chauncey Creek on the west side. The main trunk of Luhrig Creek started near Carbon Hill in Ward Township, Hocking County, flowed south to a union with Chauncey Creek at Fisher, and received tribute waters from the following Teays-stage streams: East Clayton, York, Carbondale, Lee, Knox, and Bolins Mills Creeks. The extent of these tributary streams and their relationships to present drainage are shown in plate 2. All eastern tributaries to Luhrig Creek were small except Buchtel Creek, which was really the main stem for the Luhrig system north of York Township.

Such was the mature drainage of Athens County at the beginning of the Pleistocene. The enigma of the seemingly unnatural courses of present streams in respect to Teays drainage, which has been studied and discussed by Tight (1903), Happ (1934), Stout et al. (1938, 1943), Frye (1940), Merrill (1953), Kempton (1956), and others is now generally understood, though there is as yet no full agreement on the details of the courses and mechanics by which the various stream diversions were accomplished. The most complete summary for Ohio was made by Stout and his co-workers (1943, p. 51-106), but many details remain to be learned and some present interpretations are still extremely tentative.

PLEISTOCENE (GLACIAL) HISTORY

by John P. Kempton

During the Pleistocene epoch, continental glaciers advanced southward and melted back four different times (see geologic time table, table 5). In Ohio there is definite evidence for at least three of these. Although Athens County was not invaded by these glaciers, evidences of glaciation are present in the county. It was the first of the glaciers (the Nebraskan or the Kansan) which blocked the Teays River system, forming long slender "finger" lakes in which silts accumulated. Both the Illinoian and Wisconsin glaciers, which came only to the upper end of the Hocking Valley near Lancaster, in Fairfield County, provided sand and gravel outwash, which was carried down the Hocking Valley by glacial meltwater. These deposits are found now in ancient abandoned valley segments and at scattered points along the present valley. Following each stage of deposition, much of the deposit was removed by river erosion. Each subsequent deposit occurred at a lower level, so, as a result, each of the depositional stages is recorded now by a set of terraces. A total of nine or more terraces have been recognized, representing Teays fill, pre-Illinoian outwash, Illinoian outwash, Illinoian lake sediments, "early" Wisconsin outwash, "late" Wisconsin outwash, Wisconsin lake sediments, one or more levels of cut (eroded) Wisconsin terrace, and the modern floodplain (Kempton, 1956). Because many of these types occur in such small, restricted areas, only the major levels are mapped, generalized into the following groups: Illinoian outwash terrace and lake silts, Wisconsin outwash terrace, Wisconsin lake silts, and modern floodplain alluvium.

TEAYS VALLEY FILL

When the first glacier (the Nebraskan or the Kansan--its exact identity is not known) advanced into central Ohio, it blocked the northward flow of the preglacial Teays River system. In the narrow "finger" lakes that were formed in the Teays valleys, deposits accumulated. Actually, probably only one section was blocked at one time, the area of ponded water extending upstream (southeasterly) as the ice continued to advance. Most of the deposits in this valley in Athens County are silts (called the "Minford" silts), though some coarser material is also present. Locally, where it has not eroded away, the deposit may be 50 feet thick or more.

DEEP STAGE

The thickness of the sand and gravel deposits below the present floodplain of the Hocking shows that the valley was once eroded to a depth considerably deeper than at present. The occurrence of Illinoian and younger outwash deposits in these deeply eroded valleys identifies the time of their cutting as pre-Illinoian (Yarmouth ?). Whether this valley was in two segments heading in opposite directions from the divide at East Clayton or in one through, southeastward-sloping valley has not yet been determined.

ILLINOIAN OUTWASH

During the Illinoian glacial stage, a great volume of outwash sand and gravel was deposited in the "Deep Stage" Hocking Valley, filling it to a level of from 60 to 90 feet above the present river. After the Illinoian glacier melted back from the vicinity of Lancaster, and throughout the subsequent Sangamon interglacial stage, most of this outwash was removed by erosion. The remains of this deposit range from only a few scattered pebbles at numerous localities high on the hillsides above the Hocking Valley to the extensive fill of old abandoned valley segments such as The Plains, northwest of Athens.

In the vicinity of The Plains, numerous road and stream cuts, and also gravel pits, expose these high level sand and gravel deposits, while well logs show that the fill is deeper than 100 feet. The surface of the outwash is relatively flat though it tends to slope down somewhat towards the center axis of the old valley. The surface of The Plains is probably at an elevation very close to that of the original Illinoian outwash. Remnants of this high level outwash are particularly numerous in the vicinity of Stewart in Rome Township. Others are also present underlying portions of the upland area of the City of Athens. On most of these terrace remnants, the original flat surface of the outwash has been considerably modified by stream erosion. Comparing the elevations of the various terrace remnants gives evidence of the fairly smooth profile of the original outwash surface, with maximum elevations of 745 feet above sea level at Nelsonville, about 735 feet at The Plains, 720 feet at Athens, and 685 feet at Stewart.

Nearly all of these terrace remnants are composed of bedded sand, silt, and gravel, with a deep, red, clayey soil, often deeper than 15 feet, developed at the surface. A capping of windblown silt (loess), sometimes as much as three or four feet thick, is often present on the surface. From an economic standpoint, it should be noted that where the unaltered gravel is exposed below the soil, the sand and gravel are often tightly cemented by calcium carbonate (lime). The sand and gravel are generally bedded, with occasional lenses of finer sand and silt. Some cobbles or boulders up to a foot across are present, but the gravel rarely contains pieces more than six inches across. Counts of one- to three-inch pebbles from these deposits show an average of 18 per cent carbonate rocks (limestone and dolomite), 14 per cent chert, 35 per cent sandstone, and 29 per cent crystalline (granites, etc.). In individual counts, the percentage of sandstones increases downstream (at the expense of the other, erratic materials), as the distance from the glacial boundary becomes greater.

WISCONSIN STAGE

During the Wisconsin glacial stage, outwash was again deposited in the Hocking Valley. There is actually evidence of two periods of outwash deposition. The first, very early in the Wisconsin stage (the "early" Wisconsin), filled the trench cut into the Illinoian outwash to a level averaging about 35 feet above the present river and 40 to 50 feet below the highest level of Illinoian outwash. Erosion of this outwash followed cessation of active deposition. The second advance (the "late" Wisconsin) built another level of outwash about 15 feet below the earlier Wisconsin level. With the final retreat of the ice from the area, the present Hocking River came into existence. Since then, a considerable amount of outwash has been eroded away, leaving the remnants of the second outwash level about 20 feet above the present stream. Some lower terrace levels have since been developed by erosion into these Wisconsin depositional terraces. Because they are so low, these terraces are often difficult to distinguish. The Wisconsin-age terraces are not differentiated on the geologic map.

The Wisconsin terraces are limited to small areas. Terrace remnants of the higher Wisconsin level are present only in the Hocking Valley: at an elevation of 682 feet above sea level about two miles southeast of Nelsonville, at 674 feet at Athens, at 638 feet southeast of Guysville, several remnants at about 635 feet in the vicinity of Beebe, and several elongate patches along the sides of the valley at about 625 feet just north of Coolville. The terrace remnant near Nelsonville exposes well the outwash forming this terrace level, which is composed of stratified sand and gravel with a silt capping of locally more than three feet, over about four feet of clayey weathered gravel. The largest pebbles are generally less than six inches across. Gravel pit operators report gravel to a depth of 90 feet below the top of this terrace (elevation 682 feet). The composition of the gravel here is 33 per cent carbonate, 7 per cent chert, 43 per cent sandstone, and 15 per cent crystalline rock types. Below Athens, the higher Wisconsin terraces are composed of thin alternating beds of sand and clay. Where pebbles are present here, local rock types make up a higher percentage than was present back upstream near Nelsonville.

Remnants of the lower Wisconsin outwash level are present at an elevation of about 660 feet south and southeast of Chauncey, at 658 feet at Athens, and at 625 feet near Stewart. These

small terraces are composed of stratified sand and fine gravel with a soil between five and six feet thick developed on them.

WISCONSIN LAKE SILTS

Terraces composed of clay, silt, and sand, some of which is laminated, occur in the lower portions of Monday, Sunday, Margaret, Willow, and Federal Creeks and in many of the smaller tributaries to the Hocking River. These deposits appear to have accumulated in lakes formed when gravel outwash in the Hocking Valley dammed their mouths. Terraces composed of clay are also found in the Hocking Valley and some of its tributaries below Athens, apparently associated with the higher Wisconsin terraces. Many of the terraces are about 645 feet high and are composed of a blue-gray, locally laminated silty and clay of uniform appearance. These may have been formed in a single lake dammed by outwash in the Ohio River Valley, before and during "early" Wisconsin time.

Since the end of Wisconsin glaciation, the Hocking River is again eroding its valley, though the amount of erosion has not been extensive, and forming a new floodplain.

The pre-Pleistocene and Pleistocene history of the Hocking River Valley has been summarized on a table by Merrill (1953, p. 145), from information from Stout et al. (1943). This table, with a few slight modifications, is reproduced here.

Table 4

Drainage Chronology of Southeastern Ohio and the Hocking Valley

Modified by Merrill (1953, p. 145) after Stout, Ver Steeg, and Lamb (1938, 1943).

Southeastern Ohio				Hocking Valley				
DRAINAGE STAGE	AGE	CLOSED BY	RESULTS	HOCKING VALLEY STREAM	RESULTS IN HOCKING VALLEY DRAINAGE SYSTEM	EVIDENCE IN HOCKING VALLEY DRAINAGE SYSTEM	DIRECTION OF FLOW	LOCATION OF HEADWATERS
Post-Wisconsin	Recent		Incision of valleys into Wisconsin valley trains; deposition of alluvium.	Hocking River	Incision of present valley into Wisconsin valley train; deposition of alluvium.	Present drainage system.	Southeast	In glacial drift northwest of Lancaster.
Wisconsin	Wisconsin	Ice Retreat	Deposition of valley trains; diversions and reversals.	Glacial drainage	Diversion of stream from old valley into gorge from Rockbridge to Logan and in area of The Plains, deposition of valley train.	Present drainage system.	Southeast	In glacier near Lancaster.
Post-Illinoian	Sangamon	Wisconsin Glaciation	Incision of valleys into Illinoian valley trains.	Haydenville River	Erosion of Illinoian outwash; completed cutting of gorge southeast of Haydenville.	Pre-Wisconsin valley cut into Illinoian outwash; gorge southeast of Haydenville.	Southeast	In glacial drift northwest of Lancaster.
Illinoian	Illinoian	Ice Retreat	Ponding of Deep Stage drainage; many diversions and reversals; deposition of valley trains.	Glacial drainage	Reversal of direction of flow of Hocking Valley from northwest to southeast; deposition of valley train; development of Monday Creek; initial cutting of gorge southeast of Haydenville.	High terraces of Illinoian outwash sloping gently southeast.	Southeast	In glacier near Lancaster.
Deep Stage	Interglacial (Yarmouth ?)	Illinoian glaciation	Deep incision of valleys below Teays and modern valley floors.	Lancaster River	Cutting of deep valley now filled with later glacial outwash.	Elevations on buried bedrock floor of Hocking Valley and abandoned valley segments.	Northwest	In divide southeast of Haydenville.
Pre-Illinoian glacial	Kansan ?	Ice retreat	Ponding of Teays system; deposition of Minford silts and coarser materials on Teays Valley floors; many diversions and reversals.	"Finger" Lakes	Ponding of Hocking River northwest of divide southeast of Haydenville.	Minford silts on remnants of Teays system valley floors.		In divide southeast of Haydenville.
Teays	Late Tertiary through Pliocene	Pre-Illinoian (Kansan?) glaciation	Development of a mature drainage system.	Albany and Marietta tributaries of the Logan River	Development of the original Hocking Valley drainage system.	Remnants of Teays Valley floors and barbed tributaries, cols in through valleys, abandoned valley segments, widening of main Hocking Valley upstream to northwest.	Northwest	In divide southeast of Haydenville.

Chapter 3

STRATIGRAPHY AND BEDROCK GEOLOGY

INTRODUCTION

Rocks include not only the hard and solid foundation of the earth but the loose materials at the surface as well. These loose materials are composed of the weathered products from older rocks, are mixed with humus, more or less completely cover the solid rocks beneath, and are collectively called the mantle or mantle rock. The thickness of the mantle varies from nothing to hundreds of feet in different localities, and in Athens County probably averages less than 25 feet in depth. Along the Hocking and Ohio Rivers and their larger tributaries are the greatest depths to bedrock, and in the Hocking Valley this covering has an approximate maximum thickness of 100 feet. The mantle can be weathered and residual or transported to other localities. Except along the streams the mantle rock in Athens County is considered to be residual, in spite of the fact that it is slowly creeping down the hillsides toward the valley floors. This creep of the mantle, with occasional local rapid flow, is widespread and accounts basically for many problems in maintenance of roads, buildings, drains, fences, etc., on hillsides in many regions including southeastern Ohio. Creep and flow are stronger and more troublesome where the mantle contains appreciable quantities of clay-sized particles. The rock fragments comprising the mantle are classified on the basis of size as follows:

Boulder	-	256 millimeters* (10+ inches) or more in diameter
Cobblestone	-	64-256 millimeters ($2\frac{1}{2}$ to 10 inches) in diameter
Pebble	-	2-64 millimeters (1/12 to $2\frac{1}{2}$ inches) in diameter
Sand	-	1/16 - 2 millimeters in diameter
Silt	-	1/256 - 1/16 millimeter in diameter
Clay	-	1/256 millimeter or less in diameter

Cobblestones and pebbles commonly mixed with sand are the gravel of commerce. Fine silt and clay, when dry, are commonly called dust and, when wet, mud. The top part of the mantle, so modified that rooted plants flourish in it, is technically the soil, although that term is sometimes used in a sense equivalent to mantle.

The solid portion of the earth is the bedrock, and the outer few miles that can be observed by one method or another by geologists is the earth's crust. Three main classes of rocks compose the bedrock:

1. Igneous rocks or those that are or once were molten. Examples: lava and granite.

2. Sedimentary rocks or those formed by weathering of older rocks of all classes and the erosion, deposition, and cementation or compaction of the products of weathering into new rocks. Examples: sandstone, shale, and limestone.

3. Metamorphic rocks or those derived by subjecting rocks of classes 1 and 2 to heat, pressure, and chemical change to the extent that their original characteristics are much altered. Examples: marble from limestone, slate and schist from shale and fine-grained igneous rocks, and gneiss from granite.

*25.4 millimeters = 1 inch.

In Ohio the only igneous and metamorphic rocks at the surface are loose specimens in the glacial and glaciofluvial deposits. All of Ohio's bedrock is sedimentary in origin to depths ranging from several thousands of feet to more than two miles.

The deposition of sediments is not a continuous process, and sediments already deposited can be removed by subsequent weathering and erosion. As a result the surface between superadjacent strata may represent a period of no deposition (diastem) or a buried erosion surface (unconformity). Unconformities are of several kinds and of various magnitudes, and the most common type is the disconformity, which is a buried erosion surface with the rock layers above and below that surface more or less parallel to each other. Disconformities are rather common in the sedimentary rocks of Ohio, and local disconformities are not uncommon at the base of massive sandstones in Athens County.

Stratigraphy is that branch of geology concerned with the broad study of sedimentary rocks and involves identification and classification of those rocks; study of their mineral and fossil content; determination of their origin, age relationships, and history; and mapping and correlation of those of one region with those of other regions. It is a most important branch of geologic science, since about 80 per cent of the earth's land surface is covered by sedimentary rocks.

Stratigraphers recognize sedimentary rock units according to kind of rock, thickness, and extent, and names are given to these units for convenience in use. The rock unit most commonly used is the formation which is a layer or several different layers grouped together because of similar conditions of origin and for convenience in description and mapping. Rock unit names, including those of formations, are taken from some geographic feature, e. g., Pennsylvanian system (state), Conemaugh formation (river), Ames limestone (township), and Middle Kittanning coal (city). All formations can be grouped into larger rock units as series or groups and these in turn into systems; and some formations can be subdivided into smaller units or members (geological time chart, table 5). Each of the five formations or series present in Athens County contains numerous members (see stratigraphic charts for Athens County, tables 7, 11, and 14).

Sedimentary rocks are classified into three groups on the basis of texture and composition. The first group includes those composed of fragments (gravel, sand, silty, and clay) weathered from older rocks and cemented into firm and compact rocks by compaction and mineral cements. The more common rock types in this group are conglomerate, sandstone, and various shale types. Shale and kindred rocks are the most abundant and common of all sedimentary rocks. The second group comprises those deposited by chemical action, and the more common examples are rock salt, rock gypsum, anhydrite, chert and flint, and some limestones and iron ores. The third group contains those rocks deposited by action of animals and plants. Better known rocks of organic origin are coal and petroleum, bituminous and carbonaceous shales, and many limestones.

Since sedimentary rocks are the products of weathering, erosion by streams, wind, and glaciers, and deposition in the sea, in lakes, along rivers, or on land, all sedimentary rocks have several of the following physical characteristics: 1, fragments (if fragmental) commonly rounded, sorted according to size and weight, and arranged in lenses, layers, or strata (singular, stratum); 2, fossils or preserved remains and traces of animals and plants; 3, concretions or concentrations of mineral matter; 4, mud or sun cracks formed by cracking of drying mud layers; 5, ripple marks or a series of small, closely spaced, rounded or pointed, parallel ridges formed by wave or current action; 6, raindrop impressions; 7, rill and wave marks.

Sedimentary rocks are important not only because of their widespread occurrence but also as sources of many economic mineral raw materials: coal and petroleum; ores of aluminum, iron, lead, zinc, etc.; salt and gypsum; sulphur; clay; cement and fertilizer materials; building and monumental stone; sand and gravel; and water. Most of well known details of geologic history have been learned from study of sedimentary rocks.

In Athens County shale and related rocks are the most abundant, and in decreasing amounts sandstone, limestone, coal, and ironstone. The limestones are of two kinds: 1, those

deposited in shallow seas (marine) and 2, those deposited in lakes (lacustrine). Loose weathered rock products including soil at the top cover the uplands in a more or less continuous sheet, and alluvial deposits of silt, sand, and gravel occur along many of the streams. Natural outcrops of the bedrock occur along the channels of many streams and along the slopes and tops of the hills. Artificial bedrock exposures are common in road and railroad cuts, in mines and quarries, especially in coal strip mines, and in other excavations. Bedrock exposures are abundant throughout the county but not always of the quality desired for adequate and thorough geologic investigations.

GENERAL REGIONAL ROCK STRUCTURES

The rocks of Ohio are arranged in a great arch, called the Cincinnati arch, one branch (Findlay) of which extends north-south across the State from the vicinity of Cincinnati to that of Toledo as shown in figure 8. All rock formations of central and eastern Ohio slope or dip and, in some cases, thicken eastward with minor structures into the thick trough-like mass of sedimentary rocks (Appalachian geosyncline) underlying the Appalachian Highlands (fig. 8). Thus, the deepest and oldest rock strata outcrop in western Ohio and the youngest ones show along the Ohio River in the east. In eastern Ohio the belts of rock outcrop extend (or strike) more or less north-south except in northeastern Ohio where the dip is strongly southeast and the strike is more or less parallel to the axis of the Lake Erie basin. It should be added here that strike is expressed by a compass direction, for example, N. 45° W., and that dip is a compass direction at right angles to the strike as well as the angle of slope of a stratum (rock layer).

The small dip affecting the strata in southeastern Ohio is expressed in feet per mile rather than in degrees and is roughly 30 feet per mile in a direction a little south of east. While this is only an approximate figure, it is reliable enough to enable one to predict with a reasonable degree of accuracy the elevation of a given stratum at a specified locality. It should be noted, however, that there are many local and minor irregularities in dip as well as effects from thickening and thinning of rock layers. The average dip is an amount so small that, ignoring local variations, strata appear essentially horizontal in a single exposure. It does represent a descent of one vertical foot in a horizontal distance of 176 feet in the direction of dip, and in the distance across Athens County from west to east totals about 900 feet of dip for any given stratum. For example, the Middle Kittanning (No. 6) coal is near the hilltops in position in the northwest corner of York Township west of Nelsonville, just above floodplain level at Doanville, about 150 feet deep at the eastern end of The Plains, around 200 feet deep at Athens, and over 400 feet in depth at Canaanville. More precise determinations of regional dip and strike were made on the Ames limestone and Middle Kittanning coal, and the results are given below:

Strike:	N. $17\frac{1}{2}^{\circ}$ E.
Direction of dip:	$72\frac{1}{2}^{\circ}$ SE.
Amount of dip:	30.75 feet per mile

As is apparent for the State as a whole, the oldest exposed rocks are in the western part of the county and the youngest in the east.

GENERALIZED STRATIGRAPHIC SECTION

As human history is divided into periods on the basis of significant changes and events, earth history, as shown in table 5, is likewise divided into eras, periods, epochs, and ages punctuated by physical events and changes in life. Time units in human history are measured in years, decades, centuries, and thousands of years, and those in earth history are much

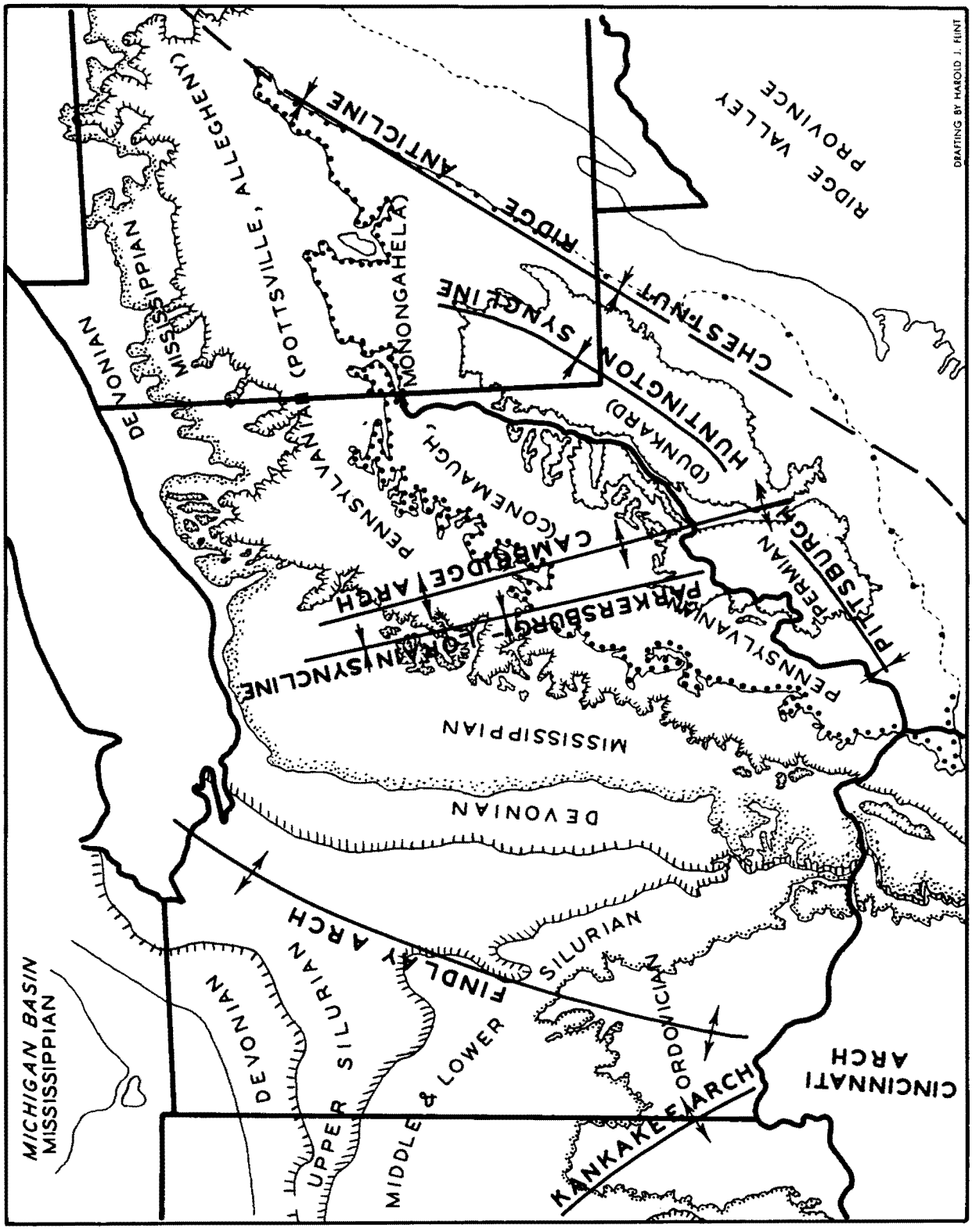


Figure 8 - Generalized geologic map of Ohio and adjacent areas showing major recognized structural features.

Table 5

General Geologic Time Table

with Notes on Geology of Ohio and Athens County

Era	Period and System[1]	Approx. No. of million years ago[6]	Approx. length in millions of years[6]	Ohio and Athens County
CENOZOIC[2] (Age of birds, mammals, and flowering plants.)	CENOZOIC[2] / QUATERNARY[3] / PLEISTOCENE[4] / Recent[5]	0 - 1	1	Final erosion of present surface features; stream and lake deposits in northern and western Ohio, stream deposits in southeastern Ohio and Athens County; present drainage systems.
	Wisconsin glacial			Most present surface features completed by erosion and glaciation; glacial and glaciofluvial deposits in northern and western Ohio, glaciofluvial deposits in southeastern Ohio including Hocking and Ohio Valleys; Teays drainage disrupted by early glaciation and a series of drainage changes inaugurated that continued from time to time throughout Pleistocene; present Ohio and Hocking River systems formed.
	Sangamon interglacial			
	Illinoian glacial			
	Yarmouth interglacial			
	Kansas glacial			
	Aftonian interglacial			
	Nebraskan (Jerseyan) glacial			
	TERTIARY[3] / Pliocene	1 - 12	11	No rocks present in Ohio; a time of erosion and development of many present surface features; Teays drainage system well developed and mature during Pliocene in much of Ohio including all of Athens County and in parts of adjacent Kentucky and West Virginia.
	Miocene	12 - 28	16	
	Oligocene	28 - 40	12	
	Eocene	40 - 60	20	
	Paleocene			
MESOZOIC (Age of reptiles, dinosaurs, cycads, pines, and flowering plants.)	Cretaceous	60 - 130	70	No rocks present in Ohio; a time of erosion, details unknown.
	Jurassic	130 - 155	25	
	Triassic	155 - 185	30	
PALEOZOIC (Age of invertebrate animals, fish, amphibia, and primitive reptiles and of primitive plants, ferns, club mosses, horsetails, and pines.)	Permian	185 - 210	25	Rocks present at surface in eastern Ohio and in eastern Athens County.
	Pennsylvanian	210 - 235	25	Rocks present at surface in eastern Ohio and in most of Athens County.
	Mississippian	235 - 265	30	Rocks present at surface in east-central, northeastern, and northwestern Ohio; 300 to 1500 feet deep in Athens County.
	Devonian	265 - 320	55	Rocks present at surface in central, northeastern, and northwestern Ohio; 1100 to 2000 feet deep in Athens County.
	Silurian	320 - 360	40	Rocks at surface in central and western Ohio; 2500 to 4200 feet deep in Athens County.
	Ordovician	360 - 440	80	Rocks present at surface, outcrops confined to southwestern Ohio; 3600 to 5600 feet deep in Athens County.
	Cambrian	440 - 520	80	Rocks under cover; no exposures in Ohio; uncertain depth in Athens County; (5000-7100 feet).
PRE - CAMBRIAN (Fossils few and uncertain.)	Proterozoic / Archeozoic	520 - 2100 +	1600 +	Rocks present under deep cover, no exposures in Ohio; 5000 or more feet deep in Athens County.

1 - Epoch and series names given for Cenozoic.
2 - Cenozoic used both as era and period names.
3 - Older five Cenozoic epochs commonly grouped together and called Tertiary, Pleistocene, and Recent epochs grouped together and called Quaternary; less commonly done at present.
4 - Glacial and interglacial ages given for Pleistocene epoch.
5 - Oldest units at bottom of table, youngest at top.
6 - Report of the National Research Council, Committee on the Measurement of Geologic Time, 1949-1950.

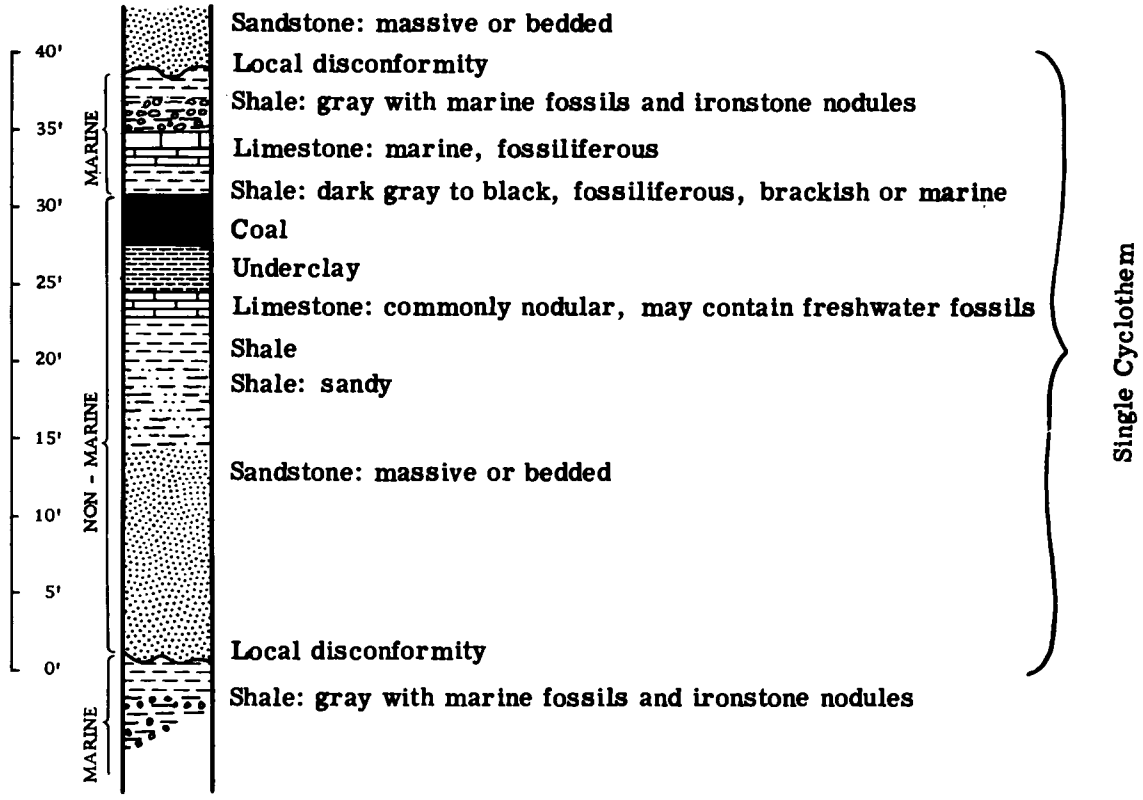
longer and are measured in millions, tens of millions, and even hundreds of millions of years. Only the Pleistocene and Recent epochs are spanned in thousands of years. Recent estimates based upon the best data available indicate that the earth is more than two billion years old, that the Cambrian period began approximately 500 million years ago, that the bedrock at the surface in Athens County was deposited between 200 million and 250 million years ago, that the Mesozoic era began 170 million years ago and the Cenozoic era 70 million years ago, that Pleistocene glaciation began one million years ago, and that Recent times began a little more than ten thousand years ago. Hence, most geologic time had elapsed before the beginning of Cambrian times when the first good fossils were preserved. The Pre-Cambrian geologic record is not very well preserved or known, and the record for later geologic periods, while by no means perfect, is much better. The rocks formed during a period constitute a system and have the same name as that of the period. For example, Pennsylvanian period was a certain period of time elapsed in the geologic past, and the Pennsylvanian system includes rocks formed during the Pennsylvanian period that are still in existence. Periods and systems are subdivided into smaller and smaller units of time and rocks.

All exposed bedrock in Ohio is Paleozoic in age, and the mantle is composed of Pleistocene and Recent deposits (table 5 and figure 8). Pre-Cambrian and Cambrian rocks are present under deep cover and are known only from well records within the limits of the State. A profound erosion interval represents all of Mesozoic and most of Cenozoic time, and a major disconformity occurs between the glacial deposits and the underlying bedrock wherever the glaciation occurred. The bedrock of central and western Ohio is dominantly marine limestones and shales, Ordovician to Devonian, inclusively, in age, and that of eastern Ohio is largely nonmarine shales and sandstones with lesser amounts of marine shales, sandstones, and limestones Mississippian to Permian, inclusively, in age.

Exposed rocks in Athens County include Pennsylvanian and Permian bedrock and Pleistocene and Recent mantle rock. Pennsylvanian strata outcrop in every township and underlie more than three-fourths of the county, and Permian rocks occur in Bern, Canaan, Carthage, Lodi, Rome, and Troy Townships. As mentioned elsewhere, the Pleistocene and Recent deposits are along the stream valleys, and the mantle is almost universally present. There is a distinct and easily recognized disconformity between the Mississippian and Pennsylvanian systems in Ohio (below drainage in Athens County), but no greater disconformity exists between the Pennsylvanian rocks and overlying Permian than occurs between certain members within both systems.

Pennsylvanian and Permian strata at many localities were deposited under a more or less regular succession of varying environmental conditions that was repeated many times during those periods. As a result certain definite succession of strata represents one succession of changing sedimentary conditions, and each sequence of strata matching one depositional cycle is now called a cyclothem. Certain early students of Pennsylvanian stratigraphy recognized and mentioned the repeated successions of strata, but it remained for J. M. Weller (1930, 1931, and with Wanless, 1932) and other recent stratigraphers to formulate today's interpretation and understanding of cyclothems.

Cyclothems differ somewhat from one region to another and in different parts of the stratigraphic section in the same region. An ideal or typical cyclothem in Kansas is somewhat different from one in Illinois, which in turn differs in detail from one in Pennsylvania. Stout (1931, p. 197-202) pointed out that in Ohio cyclothems of the lower Pennsylvanian (Pottsville and lower Allegheny) vary from those in the middle Pennsylvanian (upper Allegheny and lower and middle Conemaugh), and that cycles of the upper Pennsylvanian (upper Conemaugh and Monongahela) and Permian (Dunkard) are more or less alike but differ from the two types occurring on the following page. Hence, any ideal cyclothem must be selected arbitrarily and pertain to a selected locality or part of the stratigraphic column and, for the lower Pennsylvanian in Ohio, is usually considered to include the following members:



The above is very close to Weller's original cycle in his first paper on cyclical sedimentation (1930, p. 102), to Wanless and Weller's cyclothem in their paper defining that term (1932, p. 1004-1005), to Willman and Payne's "ideally complete cyclothem" (1942, p. 86), and to Flint's "composite cyclothem" for Perry County, Ohio (1951, p. 10). In Ohio the more complete cyclothems of the upper Allegheny and lower and middle Conemaugh series approach an ideal cyclothem in completeness. Cyclothems below the Middle Kittanning cyclothem lack freshwater limestones and those above the Skelley limestone lack marine members with the exception of thin inconspicuous brackish limestones and shales. Typical cyclothems for the upper Pennsylvanian and Permian systems of Ohio, Pennsylvania, and West Virginia as modified from Cross and his co-workers (1950, p. 99-100) are given below:

Monongahela (except upper part) series:

9. Shale, sandy, or disconformity
8. Shale, silty, calcareous
7. Shale, clayey, with roof coals and plant fossils
6. Limestone, dark, with brackish water fauna
5. Coal
4. Clay shale
3. Limestone, thin-bedded, fresh-water (?)
2. Siltstone, calcareous
1. Sandstone

Uppermost Monongahela, Washington, and Lower Greene Series:

11. Shale, silty, calcareous, or disconformity
10. Shale, silty, calcareous, with roof coals
9. Shale, clayey, with plant fossils

8. Coal, bony, shaly
7. Limestone, dark, with brackish water fauna
6. Coal
5. Clay shale, thin
4. Limestone, gray-green, argillaceous, nodular, with microfossils
3. Limestone, green and purple, argillaceous, nonfossiliferous
2. Limestone, silty, nonfossiliferous
1. Sandstone

Cyclothems that occur in the upper Conemaugh, Monongahela, and Dunkard series of Athens County are characterized locally, in part, by a facies of red and variegated shales and mudstones (Arkle, 1953, p. 2-8) (collectively called redbeds in this report), either bedded or massive; by thick nodular, bedded, or massive limestones, often earthy or marly; by sandstones locally reduced in coarseness and thickness; and by very thin coals and underclays. In fact, the underclays are at many localities less than an inch thick, and the coals may be represented by a mere sooty or carbonaceous film on top of the underclay. Discovery and recognition of these thin coals and underclays in field work is not as difficult as one might anticipate since the red shales and mudstones below those horizons are massive and break irregularly with a starch-like fracture, and those above are bedded and fissile and can be split parallel to bedding into flakes or sheets. Fossil clams, clam-like estherids (shelled crustaceans), and plants also occur, but not universally, in the bedded rocks just over the coal horizons (Arkle, 1953, p. 4). No dark limestones containing brackish water fossils have been recognized in Athens County.

Lateral or facies change in cyclothems from one region to another and the vertical differences among cyclothems in the same region offer numerous challenges in correlation of strata and for interpretation of origin. Thickness and degree of completeness of different cyclothems vary widely; for example, the Bolivar cyclothem is incomplete and thin, while the underlying Lower Freeport cyclothem is nearly complete and much thicker. Member beds fluctuate in thickness even to the extent of pinching out completely, or vary in character from one rock type to another in short horizontal distances. Hence a cyclothem, when traced laterally, can show thickening or thinning of individual members or in its entire thickness, gain or lose members, change widely in its lithologic characteristics, appear or disappear, or exhibit features that render correlation difficult. On the other hand, the lateral extent of certain members and their features, such as the nodular and shaly lithology (physical characteristics) of the Portersville limestone or the persistent partings in the Middle Kittanning (No. 6) coal can be surprisingly widespread. In spite of all inconsistancies it is possible to trace and to correlate members and cyclothems across geographic areas ranging from townships or less to states or larger in size. In recent years Bownocker and Dean (1930), Condit (1912), Conrey (1921), Cross et al. (1950), Flint (1951), Lamborn (1930, 1951, and 1954), Lamborn et al. (1939), Morningstar (1922), Stout (1916, 1918, 1927, and 1930), Stout and Lamborn (1924), and White (1949) have done considerable description and correlation of Pennsylvanian strata in Ohio; and Cross et al. (1950) and Stauffer and Schroyer (1920) have made similar studies on the Permian rocks of the State. Only Cross et al., Flint, and Stout (1931) have made general use of the cyclothem concept in their publications. Workers elsewhere have applied the cyclothem principle to Pennsylvanian and Permian stratigraphy at too many places and times to list them here. In inter-regional correlation cyclic sedimentation is recognized and considered, but correlation is based more upon lithology, fossils, and tracing of beds than upon the cyclic succession of the strata (Moore et al., 1944; Wanless, 1939, 1946, and 1950).

Flint (1951) and Merrill (1950) have named Ohio cyclothems, with both uniformly and differently named members, from their coal members, and that method is used in this report. Since cyclothems are cyclic deposits of strata, boundaries between adjacent cyclothems might arbitrarily be drawn between any two members of the succession. In addition to the boundary, originally proposed by Weller (1930, p. 101-102), other acceptable limits have been proposed at the base of the coals by Stout (1931, p. 212-216) and at the top of the coals informally by others. Regional and vertical lithologic variations in cyclothems and varied and somewhat haphazard nomenclature of members introduce some serious complications in selecting a definite and generally acceptable cyclothemic boundary applicable to all cyclothems.

A typical cyclothem is partly marine and partly nonmarine, and the cyclothemic boundary can most logically be placed between marine and nonmarine beds -- at the top of the coal or at the base of the sandstone. Although by no means perfect, the boundary at the coal's roof has several cogent points in its favor, and were it not for long established and often illogical use of member names, that limit for cyclothems would have been employed in this report. The top of the coal, or in the absence of the coal the top of the underclay, is one of the more easily found and recognized planes of separation in an entire cyclothem. Coal and/or underclay or any overlying marine member are more persistent in regional extent and therefore are most useful for purposes of correlation. In cyclothems containing marine members this plane marks the separation of the underlying nonmarine rocks from the overlying marine rocks more certainly than the boundary above or below where marine rocks are succeeded upward by nonmarine ones. Furthermore, coal, underclay, and marine limestones are valuable mineral resources and hence are desirable units for mapping purposes in preparation of geologic, economic, and structural maps.

Study of the Generalized Section of Rocks of Ohio (Stout, 1930, 1947) soon reveals that placing the cyclothemic boundaries at the top of the coals also has some serious limitations. Different members having the same name fall in different cyclothems; for example, Lower Brush Creek coal would be in the Lower Brush Creek cyclothem, but the overlying Lower Brush Creek limestone would be in the Upper Brush Creek cyclothem. Coal and marine members that have long been considered and used together for descriptive and mapping purposes would be separated in different cyclothems, e. g., the well known Brookville coal and Putnam Hill limestone. As is well illustrated in the Monongahela series, many but not all of these nomenclatural discrepancies are solved by placing cyclothemic boundaries at the base of the sandstone member. That is the boundary used here but with admission of several shortcomings. One of these is that the massive sandstone is absent from cyclothems at many places, and certainly in the absence of massive sandstone the cyclic boundary is often difficult to ascertain in the field. Another is that marine members are locally or completely missing from cyclothems.

A cyclic boundary at the base of coals, likewise, has favorable considerations and imperfections. None of the proposed cyclothemic boundaries is perfect, and as shown briefly above, much can be presented for and against each of them. The boundary used here, although usable and rather widely accepted, may not be the one finally approved by most Pennsylvanian stratigraphers. Some of the problems inherent in selection of a cyclothemic boundary are, as cited above, in member names that have been proposed and used without any definite plan during more than a century of progress in Coal Measure stratigraphy. Member names are further complicated by errors in correlation. It might be well that a committee composed of leading Pennsylvanian stratigraphers working in the Appalachian and other regions consider and seek solutions for boundary and nomenclatural problems of cycles and members.

THE SURFACE ROCKS OF ATHENS COUNTY

INTRODUCTION

The Pennsylvanian and Permian rocks of the northern Appalachian region, including eastern Ohio, are divided on the basis of presence or absence of important minable coals into six stratigraphic units which have been variously classified as formations, groups, measures, or series, and which in this bulletin are considered as series. These six units are listed on the following page in the right hand column of table 6.

This is an artificial classification not based primarily upon unconformities or differences in lithology or fossils, although all of those are considered to some extent, but a somewhat practical classification based, as several of the older descriptive names indicate, upon the occurrence of important coal beds. Many limitations or imperfections occur in this system of classification; for example, the older names for Pottsville rocks were given in reference to the presence of thick conspicuous conglomerates and sandstones, but conglomerates and

Table 6

Principal Subdivisions of Pennsylvanian and Permian Rocks in Eastern Ohio

System	Group	Series
Permian (Coal Measures)*	Dunkard (Upper Barren Group)	Greene
		Washington
Pennsylvanian (Coal Measures or Carboniferous)		Monongahela (Upper Productive group)
		Conemaugh (Lower Barren group)
		Allegheny (Lower Productive group
		Pottsville (Seral or Carboniferous conglomerate, Millstone grit)

sandstones also occur throughout the entire thickness of Pennsylvanian and Permian rocks in the Appalachian basin and valuable coals are present in Pottsville rocks. Stout (1931, p. 197-202) pointed out that fresh-water limestones are absent below the middle of the Allegheny series and that marine members are absent in the upper part of the Conemaugh series and upward. One marine or brackish member was known in the Permian at that time and other inconspicuous ones, some in the upper part of the Pennsylvanian system have since been discovered (Cross et al., 1950, p. 1-104). During the last two decades attempts have been made to formulate a more natural classification of the Pennsylvanian system based upon the cyclothem concept, and while progress has been made and more is expected, no system of classification offers perfection among rocks as heterogeneous in lithology and origin as those in our Pennsylvanian and Permian systems in any one region and from one region to another.

All the series listed in table 6, as shown on the folded geologic map in pocket, outcrop in Athens County, although the Pottsville and Greene series are exposed or present only to a limited extent.

PENNSYLVANIAN SYSTEM

POTTSVILLE SERIES

The Pottsville series, named from the City of Pottsville in the anthracite region of eastern Pennsylvania, comprises the oldest Pennsylvanian rocks between the Mauch Chunk (Mississippian) rocks below and the Lower Productive Coal Measures (Allegheny) above in the Appalachian region. Older designations based upon the presence of massive conglomerates and sandstones or the use of some of the conglomeratic beds for millstones include Blackwater sandstone, Millstone grit, Carboniferous conglomerate, and Seral or No. XII conglomerate. Lesley (1876, p. 221-227) first used the name Pottsville for lower Pennsylvanian rocks in Pennsylvania, but it was not until 1900 that O'Harra (p. 113-115) introduced this name into Maryland and a little later that Prosser (1901, p. 191-199) did the same in Ohio.

* Some names or terms formerly used but now discarded are given in parentheses. Wording of these older names varied somewhat in different publications.

In the northern Appalachian region, including Ohio, the Pottsville series has commonly been defined to include all Pennsylvanian strata from the base of the Brookville coal downward to the top of the underlying Mississippian formations. Flint (1951, p. 40) and Merrill (1950, p. 122, 157, 158) have included the Brookville underclay and Homewood sandstone in the Brookville cyclothem. If accepted, their decision logically extends the base of the overlying Allegheny series to the base of the Homewood shale and sandstone. Even though the newly suggested boundary is adopted, as is done here, mapping of the Pottsville-Allegheny series contact will undoubtedly continue to be based on either the Brookville coal or Putnam Hill limestone as in the past and as is shown on the folded Athens County map accompanying this bulletin.

The outcrop belt of Pottsville rocks in Ohio forms a great arc from Mahoning and Trumbull Counties along the Ohio-Pennsylvania border south and southwest to Lawrence and Scioto Counties on the Ohio River. There are also wide areal prongs and numerous outliers extending northward into Cuyahoga, Geauga, Medina, Portage, and Summit Counties. Stout (1923, p. 104) wrote that in Ohio the Pottsville series varies between 175 and 400 feet in thickness and averages about 250 feet. The more conspicuous Pottsville rocks are thick massive nonmarine conglomerates and sandstones, but there are also thick nonmarine shales and thin nonmarine beds of coal, underclay, and ironstone and thin marine members of flint, limestone, shale, and ironstone. Fresh-water limestones are unknown and apparently are absent. Several of the coals, underclays, flint, ironstone, conglomerate, and sandstone are or have been significant mineral resources within the State.

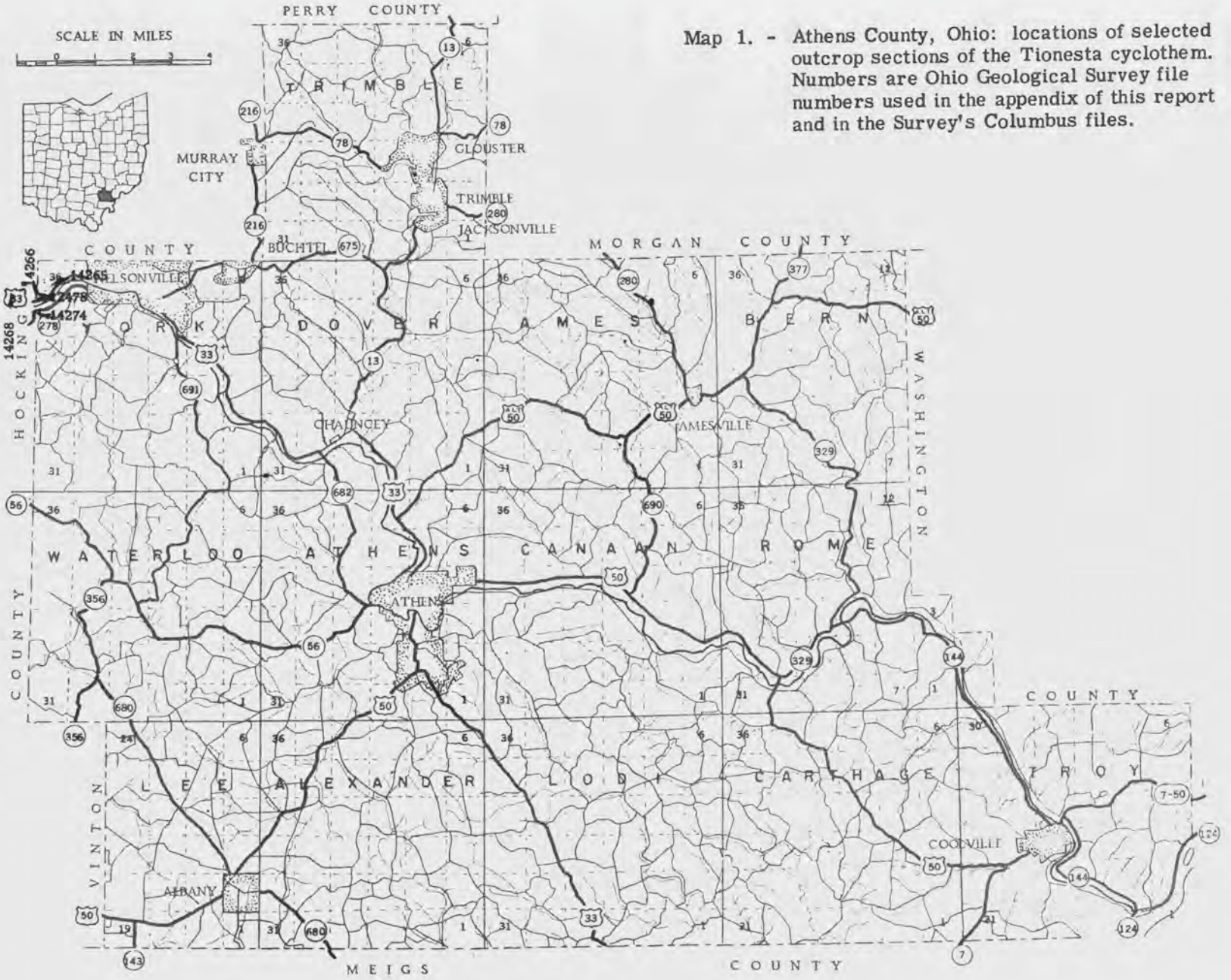
In Athens County only the Tionesta cyclothem of the Pottsville series is exposed for a total thickness of about 15 feet. A greater thickness, possibly including additional members, would be exposed were it not for the fact that located low on the valley sides Pottsville rocks are mostly covered by mantle. The exposed Pottsville rocks are limited to nonmarine shale, sandstone, coal, and underclay, which are briefly described on following pages.

Tionesta Cyclothem

H. D. Rogers (1858, v. 2, pt. 1, p. 476-477) named the Tionesta group from exposures along the Allegheny River near the village of Tionesta, county seat of Forest County, Pennsylvania. Orton *1884, p. 10, etc.) recognized Tionesta members, especially the coal, in Ohio and was first to use the name in this State. The underclay of this cyclothem, a valuable ceramic clay, is the best known Tionesta member in Ohio and has been carefully traced by Stout et al. (1933, p. 195-215) along the outcrop.

The Tionesta cyclothem is incomplete and has the only three members of shale and sandstone, underclay, and coal as shown in table 7. These members are all recognized in Athens County; and the coal member, composed mostly of black shale, is divided into two submembers. The Tionesta coal and underclay are normally about midway between the Upper Mercer and Putnam Hill limestones. Locally, however, both the Tionesta coal and overlying Homewood sandstone are absent, and the Tionesta underclay coalesces upward with the Brookville underclay.

The Tionesta members' outcrop closely follows the Pottsville-Allegheny contact from Columbiana and Mahoning Counties on the north to Lawrence and Scioto Counties on the south. Athens County outcrops of Tionesta members are limited to the Hocking Valley from the Athens-Hocking County line southeast about halfway to Dorr Run on the north side of the river and to beyond East Clayton on the south side (Map 1). All known exposures occur in the northwest quarter of section 35 and in the western half of section 36 in York Township. The better exposures include one (Ay-46 (14274)) on the south side of the Hocking Valley in the SW¼ NW¼, sec. 35; and two on the north side, one (Ay-54 (14266)) in the NW¼ NW¼, sec. 35; and another (Ay-53 (14265)) along an abandoned length of Route 33 in the NW¼ SE¼, sec. 36; and a final one (Ay-60 (12478)) near a strip mine in the SW¼ SW¼, sec. 36. On the north side of the valley these rocks can be traced with some continuity along Route 33, but just east of the Athens-Hocking line in the northwest corner of section 35, the overlying Homewood sandstone has cut out and replaced



Map 1. - Athens County, Ohio: locations of selected outcrop sections of the Tionesta cyclothem. Numbers are Ohio Geological Survey file numbers used in the appendix of this report and in the Survey's Columbus files.

the Tionesta coal and underclay and coalesced with the underlying Tionesta sandstone. A better and more extensive thickness of these Pottsville strata is well exposed on the north side of Route 33 about half a mile west of the county line and just east of the National Fireproofing Company's plant at Diamond.

Tionesta Shale and Sandstone Member. - Rogers (1858, v. 2, pt. 1, p. 476-477) applied the name Tionesta to the present Homewood sandstone, but Tionesta, as now applied to clastic members, is restricted to shale and sandstone below the Tionesta underclay and overlying the Upper Mercer cyclothem. Full thickness of this member is not exposed in Athens County, and the greatest exposed thickness in the northwest corner of section 35 (Ay-54 (14266)) totals less than 12 feet. No shale is exposed, and only thin-bedded, fine-grained, micaceous sandstone with the usual light gray to greenish gray fresh colors and limonite stained weathered surfaces was observed.

Tionesta Underclay Member. - The Tionesta underclay is locally an important ceramic clay in Ohio and has been much used in nearby Hocking and Perry Counties, but it is of no economic importance in Athens County. In three exposures (map 1) its thickness ranges from 1 foot 2 inches to 1 foot 8 inches with an average thickness of 1 foot 4 inches. Its clay, which is plastic with varying degrees of plasticity, is light gray to gray in fresh color, micaceous, may be locally sandy or have fossil plants and carbonaceous streaks. The floor, where visible, is sandstone, and the roof is either coal or dark carbonaceous shale.

Tionesta Coal Member. - Tionesta coal is present with its underclay in Athens County but is of no value as a source of fuel. It consists of only two to three inches of shaly coal with bright streaks. The coal and possibly the underclay are largely replaced by dark gray to black, bony, carbonaceous shale which has a maximum observed thickness of 3 feet 8 inches and an average thickness of about 2 feet. Thicker Tionesta coal occurs about half a mile west of the Athens-Hocking County line in the vicinity of the National Fireproofing Company's plant at Diamond, where as much as 2 feet 7 inches of coal is present. The coal at Diamond also is inferior in quality, and the top 1 foot 2 inches is definitely shaly. There, little or no black shale is present in place of coal.

ALLEGHENY SERIES

In the Allegheny River Valley of western Pennsylvania is the type area for the Allegheny series. H. D. Rogers, first State Geologist of Pennsylvania (1840, p. 150), applied the name Allegheny to all rocks between the Homewood sandstone and the Pittsburgh coal, which includes not only the rocks of the present Allegheny series but also those of the Conemaugh series. Rogers later (1858, v. 1, p. 109; v. 2, pt. 1, p. 16) classified the present Allegheny series as the Lower Productive Coal Measures and the Conemaugh series as the Lower Barren Coal-Shales. In 1873 Stevenson (p. 16) defined the Allegheny River series as extending from the Great Conglomerate (Pottsville) up to the Mahoning sandstone, and his definition corresponds very closely to the present interpretation of the Allegheny series. Platt (1875, p. 5-8) made similar use of the name Allegheny in western Pennsylvania to that employed by Stevenson. Orton (1884, p. 1-3; 1893, p. 4, 5, 36, 37) still used Rogers' terms of Seral Conglomerate (Pottsville), Lower Coal Measures (Allegheny), etc., in Ohio and continued to do so until the end of his tenure as State Geologist in 1899. Shortly thereafter O'Harra (1900, p. 113-128) began to use the current Pennsylvanian series names in Maryland, and soon afterwards Prosser (1901, p. 191-199) did likewise in Ohio.

Stout et al. (1923, p. 243) stated that in Ohio the Allegheny series' "thickness varies from 175 to 250 feet but averages about 200 feet," and those figures do not include the Brookville underclay and Homewood sandstone, which are herein included as part of the Brookville cyclothem, nor the Uffington shale above the Upper Freeport coal, which is also included in the Allegheny series in this report.

The Allegheny outcrop belt extends across the State from Columbiana, Jefferson, and Mahoning Counties on the northeast to Lawrence and Scioto Counties in the south in a strip 15 or more miles in width.

In keeping with the cyclothem boundaries used in this report, the lower limit for the Allegheny series is placed between the base of the Homewood sandstone and the top of the Tionesta coal, as Flint (1951, p. 40) and Merrill (1950, p. 122, 157, 158) have previously done, and the top boundary between the top of the Uffington shale and the base of the Lower Mahoning shale and sandstone. This course of action transfers the Homewood sandstone and Brookville underclay from the Pottsville to the Allegheny series and the Uffington shale from the Conemaugh to the Allegheny series.

There are 13 cyclothems with varying degrees of completeness and local development in the Allegheny series of Ohio, as shown in table 7. The most complete of these cycles are associated with the Middle Kittanning (No. 6), Lower Freeport (No. 6a), and Upper Freeport (No. 7) coals, each of which locally has fresh-water limestone associated with its underclay and at some places a marine or brackish member above its coal. There is no known locality where all Allegheny cyclothems and members occur, and several of them are recognized only in small local areas.

Separation of the Pennsylvanian rocks in Ohio into a lower division without nonmarine limestones and a middle division with both marine and nonmarine limestones occurs near the middle of the Allegheny series, where the lowermost fresh-water limestone (Hamden) occurs very locally in the Strasburg cyclothem. Below the Hamden member there are no nonmarine limestones, unless ironstones such as the Canary ironstone in the Clarion cyclothem represent a lacustrine deposit, and the only representatives of limestones in that lower division are the marine and brackish limestones and shales overlying a number of the coals. From the middle of the Allegheny series to the middle of the Conemaugh series both marine and nonmarine limestones are present, and from there upward, for all practical considerations, nonmarine rocks make up the entire thickness of beds.

In the seven cycles of deposition below the Hamden limestone there are the following members, in order from the base upward: Brookville (No. 4), Ogan, Winters, Clarion (No. 4a), Scrubgrass, Lawrence, and Lower Kittanning coals and associated underclays; four marine members including the Putnam Hill, Zaleski, Vanport, and an unnamed member of limestone, flint, or shale which overlie the Brookville, Ogan, Scrubgrass, and Lower Kittanning coals, respectively; two ironstones in the nonmarine Canary ironstone at the base of the Clarion underclay and the marine Ferriferous ironstone at the top of the Vanport limestone; and interbedded shale and sandstone. Only the more important of the minable coals are numbered from the base upward in the Pennsylvanian of Ohio, and hence the majority are without numbers.

In the six deposition cycles above the Lower Kittanning coal there are in ascending order the following coals and underclays: Strasburg, Middle Kittanning (No. 6), Upper Kittanning, Lower Freeport (No. 6a), Bolivar, and Upper Freeport (No. 7). Only three marine members occur, and each of them is a shale, with the Washingtonville shale over the Middle Kittanning coal, the Dorr Run shale over the Lower Freeport coal, and Uffington shale over the Upper Freeport coal. Except for the Upper Kittanning cyclothem, each has a fresh-water limestone associated with its underclay. The limestones in the Freeport cyclothems have the same name as the coals, but the Hamden limestone is in the Strasburg cyclothem, the Salem limestone in the Middle Kittanning cyclothem, and the Shawnee limestone in the Bolivar cyclothem. Ironstone members are common in the upper part of the Allegheny series and in some cases appear in place of the nonmarine limestones, as the Hamden ironstone for the limestone, the Snow Fork ironstone for the Salem limestone, the Yellow Kidney ironstone for the Lower Freeport limestone, the Sour Apple ironstone for the Shawnee limestone, the Bessemer or Buchtel ironstone for the Upper Freeport limestone. Kidney ironstone is commonly associated with Middle Kittanning coal and blackband ironstone with Upper Freeport coal.

Large amounts of high grade coal and underclay make the Allegheny series the most important economic series in the Pennsylvanian system of Ohio. Brookville, Clarion, Lower

Table 7

Generalized Stratigraphic Column for Allegheny and Topmost Pottsville Series in Ohio

(An asterisk beside names of cyclothems and members indicates those not known to occur in Athens County Thicknesses and descriptive data are based on Athens County occurrences. Thickness figures are based upon measurements only where the strata occur.)

No.	Series	Cyclothem	Member	Description	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
13	Allegheny	Upper Freeport	*Uffington	Shale, marine, not observed in Athens County.	0	0	23	1	262	9
			Upper Freeport	Coal, No. 7, unsteady, locally thick and good.	2	10				
				Underclay, persistent, impure, plastic.	2	0				
				Limestone and/or ironstone, freshwater, bedded or nodular, ferruginous, very local in distribution.	1	3				
				Shale, sandy, and sandstone, shaly, with ferruginous zones.	17	0				
12		Bolivar	Bolivar	Coal, absent at most places.	0	1	17	1	239	8
				Underclay, rather persistent, impure, plastic.	3	9				
			Shawnee	Limestone, freshwater, bedded or nodular, locally ferruginous, rather steady.	1	3				
			Bolivar	Shale, sandy, and sandstone, shaly.	12	0				
11		Lower Freeport	Dorr Run	Shale, dark, fossiliferous, marine.	1	9	45	9	222	7
			Lower Freeport	Coal, No. 6a, thin but steady, locally thick	1	8				
				Underclay, quite persistent, impure, plastic.	2	4				
				Limestone, unsteady, nodular, ferruginous	1	0				
				Sandstone, thick, massive, or sandy shale, and shaly sandstone.	39	0				
10		Upper Kittanning	Upper Kittanning	Coal, shaly, very local.	0	6	13	10	176	10
				Underclay, unsteady, impure, plastic or flinty.	0	10				
				Shale, silty, and sandstone, with carbonaceous and ferruginous zones.	12	6				
9		Middle Kittanning	* Washingtonville	Shale, marine, not observed in Athens County.	0	0	26	9	163	0
			Middle Kittanning	Coal, No. 6, persistent, thick, 3- and 4-bench, good quality.	7	4				
				Underclay, steady, thin, impure, plastic.	1	2				
			Snow Fork (Salem)	Ironstone, persistent, nodular, with numerous plant fossils.	4	3				
			Middle Kittanning	Shale, sandy, and fine, bedded sandstone.	14	0				
8		Strasburg	Strasburg	Coal, shaly, very local.	0	2	20	4	136	3
			Oak Hill	Underclay, quite persistent, impure, plastic.	5	4				
			Hamden	Limestone and/or ironstone, freshwater, local, nodular, and lenticular.	2	0				
			Strasburg	Shale, sandy, or sandstone, shaly.	12	10				
7		Lower Kittanning	* Unnamed	Shale and limestone, marine, not observed in Athens County.	0	0	10	6	115	11
			Lower Kittanning	Coal, No. 5, steady in thickness and quality, good quality.	2	6				
				Underclay, steady, thick, high quality, plastic.	8	0				
				Shale and/or sandstone, not observed in Athens County.	0	0				
6		Lawrence	Lawrence	Coal, smut streak, seldom present.	0	0	5	0	105	11
				Underclay. (See Lower Kittanning underclay above.)	-	-				
				Shale, sandy, poorly developed.	5	0				

Table 7 - Generalized stratigraphic column
for Allegheny and topmost Pottsville series in Ohio - continued

No.	Series	Cyclothem	Member	Description	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
5	Allegheny	Scrubgrass	Ferriferous	Ironstone, steady, grainy.	0	6	10	6	100	11
			* Vanport	Limestone, flint, or shale, marine, not observed in Athens County.	0	0				
			Scrubgrass	Coal, not observed in Athens County.	0	0				
				Underclay, not observed in Athens County.	0	0				
				Shale and sandstone, variable.	10	0				
4		Clarion	Clarion	Coal, No. 4a, unsteady.	trace		24	6	90	5
				Underclay, unsteady, impure, plastic.	3	6				
			Canary	Ironstone, nodular, grainy.	2	0				
			Clarion	Sandstone, massive, or sandy shale and shaly sandstone.	19	0				
3		Winters ?	Winters ?	Coal, shaly.	0	1	4	1	65	11
				Underclay, impure, plastic.	1	6				
				Sandstone, fine-grained, bedded.	2	6				
2		Ogan	Zaleski	Shale, ferruginous, fossiliferous, marine.	0	8	26	10	61	10
			Ogan	Coal, thin, bright to shaly, local.	0	2				
				Underclay, thin, impure, plastic, local.	1	0				
				Sandstone, massive, or sandy shale.	25	0				
1		Brookville	Putnam Hill	Limestone, shaly, and calcareous shale, fossiliferous, marine, steady.	2	0	35	0	35	0
			Brookville	Coal, No. 4, thin, unsteady.	0	6				
				Underclay, sandy, plastic, unsteady.	2	6				
			Homewood	Sandstone, white, flaggy, or massive.	30	0				
1	Pottsville	Tionesta	Tionesta	Shale, black, carbonaceous.	2	0	15+	6	15+	6
				Coal, shaly, rather persistent.	0	2				
				Underclay, variable, plastic.	1	4				
				Sandstone, fine, micaceous.	12+	0				

Kittanning, Middle Kittanning, and Upper Freeport have been and still are valuable minable coals, and of these the Middle Kittanning ranks first. The Winters and Lower Freeport coals are of lesser importance, but locally have contributed substantial amounts of fuel within the State. The remaining coals are of no importance or have yielded only small amounts of domestic fuel. Brookville, Clarion, Lawrence-Lower Kittanning, and Oak Hill are the more important of ceramic clays, and the Lawrence-Lower Kittanning members far exceed the combined ceramic importance of all other Allegheny underclays. The Freeport underclays are of minor importance, and the other underclays are of little or no importance. Other economic mineral products from Allegheny rocks include shale for ceramic purposes, limestone and sandstone for various purposes, minor quantities of oil and gas, and underground supplies of water. In former times the ironstone deposits were important as iron ore and the flint members as buhrstone. At still earlier times the Vanport and Zaleski flints were raw material from which the American Indians fashioned many of their tools and weapons, and iron oxides from the ironstones provided pigments for their war paint.

In Athens County Allegheny rocks outcrop only in the western part of the county along the Hocking River as far southeast as the vicinity of Hamley Run, along Monday and Sunday Creeks and their tributaries, along Hewett Fork and its tributaries, and to a limited extent along Factory Creek in the vicinity of Luhrig (see folded map in pocket). These are small linear areas of outcrop as far as the surface rocks of the county are concerned, but the Allegheny series, because of the wealth of thick high quality coal and clay, exceeds the value of mineral wealth produced from all other surface rocks in the county.

Allegheny cyclothems and members recognized in Athens County are given in table 7, and thickness given for each is based upon measurements taken within the county. Total average thickness for the series is about 260 feet, and in the vicinity of locality 12478 in section 36 of York Township, the entire thickness was observed in a single exposure and totals approximately 230 feet. It is apparent from examination of table 7 that most Allegheny cyclothems and members are present in Athens County, although there is some uncertainty in respect to those members below the Lawrence-Lower Kittanning underclay. In brief, seven of the 13 coal and underclay beds are definitely present and identified, five other coals are present but are identified with some degree of uncertainty, and one additional coal is apparently absent. The coals of poor or uncertain development and correlation are the Bolivar, Clarion, Lawrence, Ogan, and Winters members, and the missing coal with its underclay is the Scrubgrass member. The Lawrence underclay is believed to represent the lower part of the thick Lower Kittanning underclay. The fresh-water limestone, ironstone, and nonmarine shale and sandstone beds are well represented, but, on the other hand, of the six possible marine beds of shale, flint, or limestone only two, the Putnam Hill and Zaleski members, are present, and they are represented by thin, impoverished, and inconspicuous shale and shaly limestone beds.

All Allegheny strata below the Lower Kittanning coal are poorly exposed in Athens County, except for several exposures in recently active strip mines. Outcrops of those beds are restricted to the northwestern part of York Township and extend from the Athens-Hocking County line southeast along the Hocking and its tributaries to the vicinity of Nelsonville. Other exposures are along Dorr Run and Monday Creek and their tributaries. Since all these exposures are near valley floors or on lower slopes of the valley sides, outcrops are naturally poor and discontinuous. In addition, several members due in this interval are apparently absent in the area under consideration, a fact which adds to the difficulty in observation and correlation of members. Except for the Brookville and Lower Kittanning cyclothems, it is an uncertain stratigraphic interval.

Brookville Cyclothem

This cyclothem, the lowest one in the Allegheny series, takes its name from Brookville in Jefferson County, Pennsylvania. H. D. Rogers (1858, v. 3, pt. 1, p. 476) first used the name for the coal. Under the present classification used here only four members--the Homewood sandstone, the Brookville coal and underclay, and Putnam Hill limestone and shale--comprise the Brookville cyclothem (table 7).

As mentioned elsewhere, the base of the Brookville cyclothem is placed at the base of the Homewood sandstone, and hence that sandstone and the Brookville underclay, which are commonly considered to be the top two members of the Pottsville series, become the bottom two members of the Allegheny series. As shown in table 7, the other members in this cyclothem are the Brookville coal and the marine Putnam Hill limestone and shale.

Outcrop distribution in Athens County of Brookville cyclothem members is limited to a small area along the valleys of Dorr Run and the Hocking River in the vicinity of Nelsonville and westward in the northern tier of sections in York Township as shown on map 2. All members except the Brookville coal seem to be quite persistent in the area of outcrop. Thicknesses of the several members change markedly in short horizontal distances. Changes in thicknesses and occurrence just above floodplain level make recognition and correlation of these members a difficult and painstaking task, and if it were not for artifical exposures along roads and in strip mines, it would be extremely difficult to find and to observe them.

Both Brookville members and the Putnam Hill limestone are locally important mineral resources in Ohio but not within the limits of Athens County.

Homewood Sandstone Member. - I. C. White (1878, p. 67) gave this sandstone its name from Homewood (Station) on the west side of the Beaver River in Beaver County, Pennsylvania.

At the type exposure the Homewood is reported to include coalesced sandstones of several cycles of deposition, but in Ohio the Homewood member is recognized as the sandstone immediately below the Brookville members and above the Tionesta coal.

All observed exposures of Homewood sandstone are on the north side of the Hocking Valley between Nelsonville and the National Fireproofing Company's Diamond Plant just over the Athens-Hocking line in Starr Township, Hocking County. Selected localities are shown on map 2, and complete thickness is known from only the Diamond locality (14263) and another below a strip mine in the SW¼ sec. 36, York Township (12478). At these two localities we have extremes in thickness varying from 33 feet at the Diamond locality to only two feet at the York Township locality. Thicknesses at all other localities are incomplete, and from such measurements as are available an estimated average thickness is 15 feet.

At all Athens County localities the Homewood member is light gray to almost white, fine to medium, micaceous sandstone that tends to weather into rather regular slabby layers. Its nearly white color and flaggy aspect on weathering are distinctive features in comparison with other sandstones in the section. At Diamond the top 15 feet are very similar in appearance to that at the Athens County exposures, and the lower 18 feet are massive sandstone showing some evidence of bedding and cross-bedding on weathered surfaces -- a relationship which suggests the possibility of two coalesced sandstones. Here its base appears to be in disconformable contact with the underlying shale. Either Brookville underclay or marine Putnam Hill shale overlies the Homewood sandstone, and the contact, where seen, is a thin gradational one.

Brookville Underclay Member. - Map 2 shows Athens County localities for the Brookville members, at which the underclay varies from one inch to more than six feet in thickness. These few available exposures indicate that the underclay tends to decrease in thickness southeastward along the Hocking Valley and to disappear entirely before it goes below drainage at Nelsonville. It is, moreover, somewhat variable in thickness, and abrupt and noticeable thickness changes occur in short horizontal distances. West of Athens County in northern Hocking County its thickness averages 4 feet 6 inches according to Merrill (1950, p. 160), but at Diamond near the county line there are only 2 feet 7 inches and 3 feet at locality 12478 just over in Athens County, less than 6 inches along the east side of Dorr Run and entirely absent at the west edge of Nelsonville. There is one exception to the diminution in thickness, where at locality 14264, about 0.6 mile west of Dorr Run, 6 feet 5 inches of Brookville underclay are exposed about 30 feet above the level of Route 33. This much greater thickness is in keeping with a thickness of 5 feet 4 inches described by Merrill (1950, p. 419) and also previously reported by Sturgeon and Merrill (1949, p. 6) about one mile to the northwest in the S½ NW¼, sec. 31, Ward Township, Hocking County. Average thickness for the several Athens County measurements and the one at Diamond is 2 feet 6 inches to 3 feet, but the prevailing thickness is undoubtedly much less over much of this outcrop in York Township.

Throughout the area Brookville underclay is light gray, massive, and plastic. Wherever more than a few inches thick, the lower part is sandy and micaceous and grades rather abruptly into the underlying Homewood sandstone, and the thin deposits are sandy and micaceous through the full thickness. The upper contact is distinct and sharp whether overlain by Brookville coal or by Putnam Hill shale and limestone.

Brookville (No. 4) Coal Member. - As indicated in the discussion of its underclay, the Brookville coal is present in Athens County only along the north side of the Hocking Valley in section 36 of York Township. There along Route 33 at locality 14301, shaly and bony coal with a thickness up to one foot underlies marine Putnam Hill limestone and shale in the midst of a sequence of sandstone. Locally the overlying Ogan sandstone seems to replace the coal and its associated underclay and marine member so that the Ogan sandstone rests upon the Homewood sandstone with little or no trace of the Brookville and Putnam Hill members remaining. At the nearby localities 12478 and 14263, the coal is two inches thick, and elsewhere, as at localities 14269 and 11595, the coal is entirely absent and Putnam Hill marine shale rests directly upon the Brookville underclay.

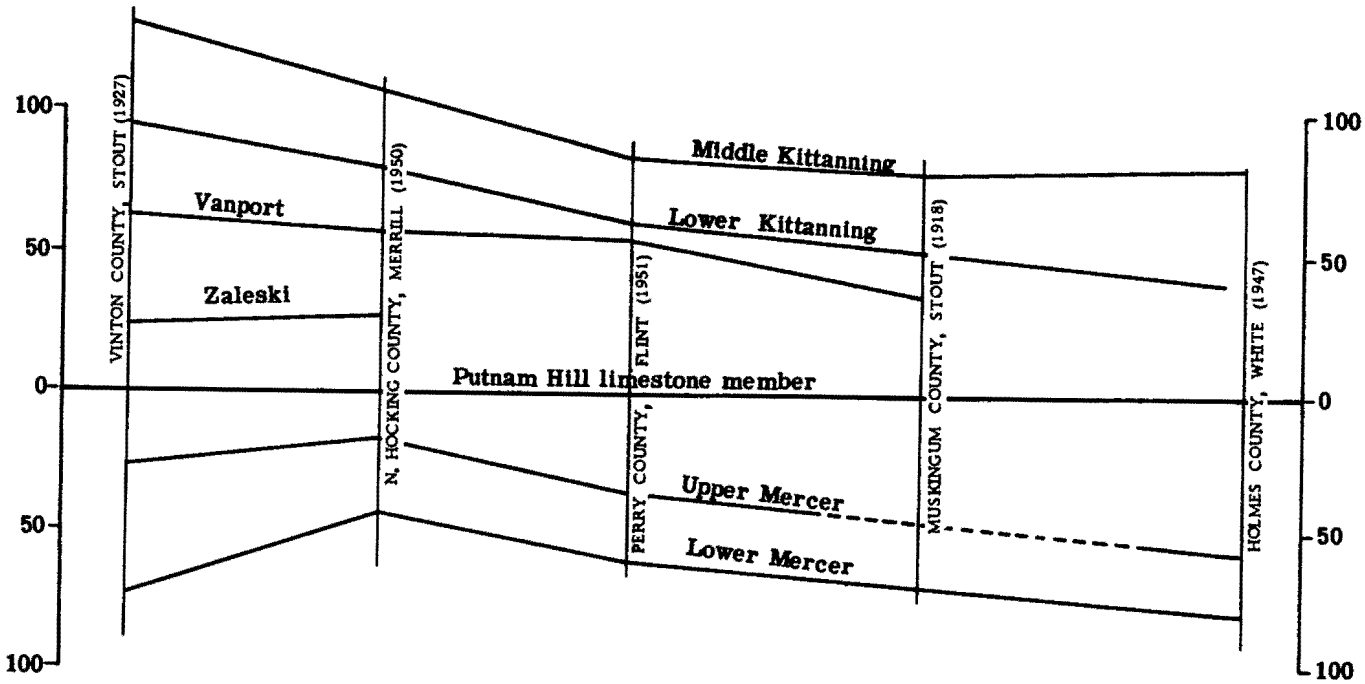


Figure 9 - Interval chart of the Allegheny series in Ohio.

Except for the one small area of thick Brookville underclay in section 36 of York Township and section 31 of Ward Township, the Brookville members are of interest only to stratigraphers and paleontologists for correlation purposes.

Putnam Hill Limestone Member. - Putnam Hill limestone is one of the marine limestones (Upper Mercer and Vanport limestones in addition) formerly designated "Gray limestone" in contrast to "Blue limestone" (Lower Mercer limestone) by early Ohio geologists. E. B. Andrews (1870, p. 84-85) gave this limestone its present name from Putnam Hill at Zanesville in Muskingum County, and his name has long since replaced the appellation of "Gray limestone." Morningstar (1922, p. 116-129) described sections and fossils from southern and east-central Ohio under the name of McArthur limestone. Until the late 1930's the Putnam Hill member was known only in Ohio, but it is now correlated by Wanless (1939, p. 99) with the Lost Creek or Fossil limestone of Kentucky and with the Buffalo Creek limestone of West Virginia. It is not known to extend northeastward beyond Alliance in Stark County, Ohio, and apparently does not extend into western Pennsylvania.

In Ohio the Putnam Hill member is best developed from Muskingum County northward in Coshocton, Holmes, Stark, and Tuscarawas Counties, in which area it is typically limestone and an excellent stratigraphic guide. South of Muskingum County it is apt to be thin and locally only a fossiliferous shale, although it is moderately well developed in Vinton and Jackson Counties, where it formerly was called the McArthur limestone. The best units for comparison of the Putnam Hill's stratigraphic position in Athens County are the Lower Kittanning (No. 5) coal and the Middle Kittanning (No. 6) coal, 60 to 65 and 85 to 90 feet, respectively, higher in the section. Figure 9 presents average intervals in various parts of eastern Ohio between the Putnam Hill member and other key members from various publications. As far as comparisons can be made, the interval above to the Middle Kittanning coal seems to be most constant, and the interval to the Lower Kittanning coal seems to be about the same in Athens, Hocking, and Perry Counties.

The Putnam Hill member is described as typically a gray to bluish gray, hard, compact and dense limestone with numerous marine fossils and locally with nodules and zones of chert or flint. Marine shale occurs at numerous places above and below the limestone, and from Perry County southward marine shale alone or shaly limestone dominates its lithology throughout most of that area. Thickness varies (Lamborn, 1951, p. 25) "from a few inches to about 13 feet with a mean of about 3 feet." It is very thin locally in its shaly southern area, where both thinness and shaly character combined have caused geologists previously to overlook its presence. Merrill (1950, p. 161) has called this oversight to our attention in northern Hocking County, where he found it to be consistently present over wide areas formerly considered to be lacking any development of the Putnam Hill member. With this discovery in mind a more careful search by geologists might reveal its presence as a thin marine shale farther into northeastern Ohio and on into western Pennsylvania, where up to the present it has not been recognized.

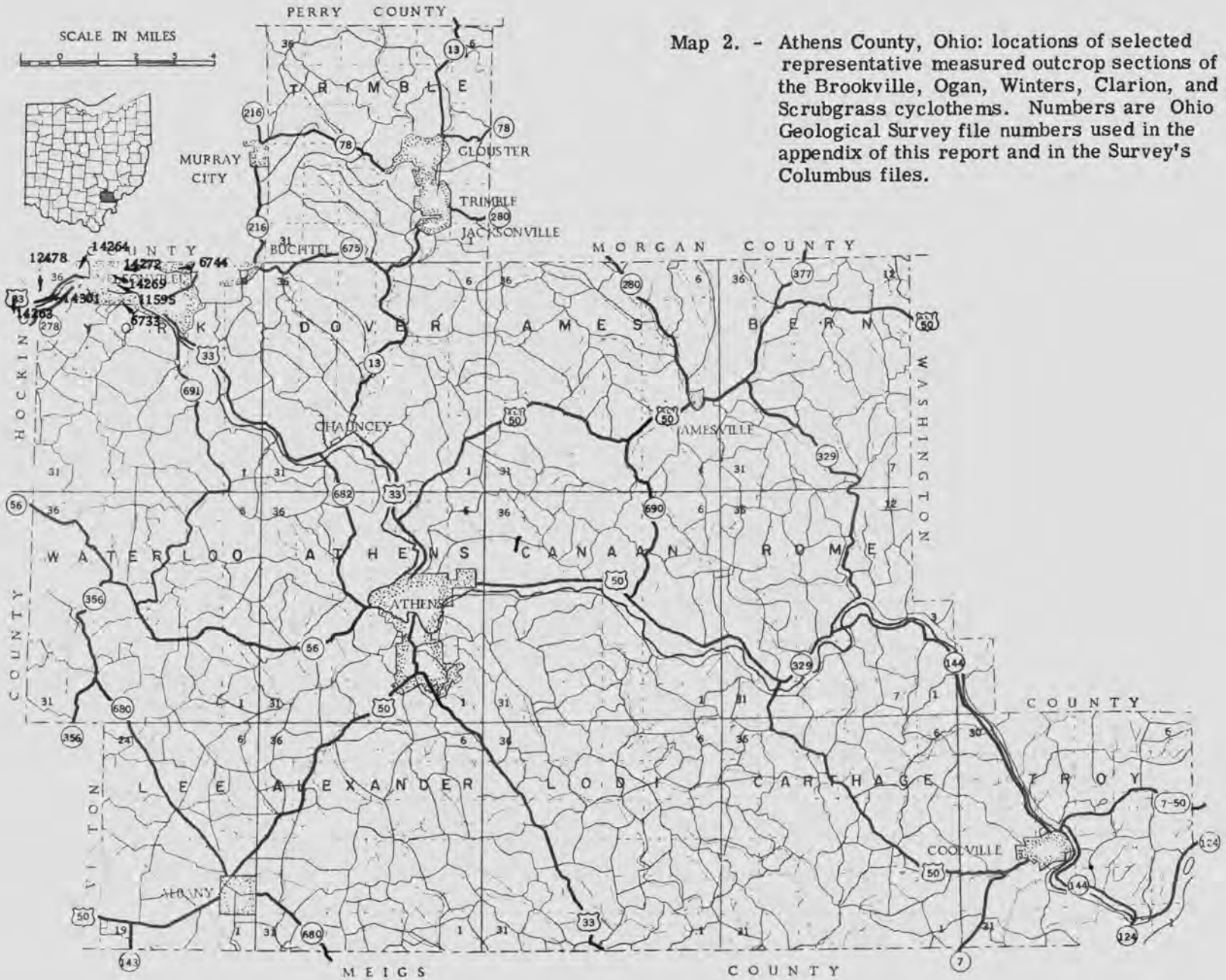
Without the recent discovery of thin shaly Putnam Hill in adjacent Hocking County, it is unlikely that this member would have been recognized in Athens County, where it was studied at four localities (map 2 and fig. 10), as well as at the exposure at nearby Diamond in Hocking County. In Athens County the Putnam Hill member is usually not limestone but soft, laminated, gray usually stained somewhat by limonite, argillaceous to silty, and micaceous shale with impressions of marine fossils. Originally the shale must have been calcareous but on the outcrop the carbonate minerals are largely leached out. At two of the localities it is also sandy, and at one of these it rests on sandstone and its basal thickness is especially sandy. A few small ferruginous nodules occur in the thickest exposure (11595). The gray impure limestone at locality 14301 and nearby locality at Diamond in section 6, Starr Township, Hocking County, in part has calcite veins and is septarian in nature. Fossils are few and occur as impressions along the bedding planes. The Brookville coal is present at only one of the Athens County localities. At two localities (14264 and 14269) the underlying stratum is Brookville clay and the plane of separation is distinct and sharp. At the other exposure (11595) both Brookville members are absent and the Homewood sandstone underlies and is separated by a thin gradational contact. Where well exposed, the beds overlying the Putnam Hill shale are shale similar in lithology but without apparent marine fossils.

Thickness varies from 5 inches to 3 feet 10 inches.

Ogan Cyclothem

The generally inconspicuous Ogan cyclothem consists of four members including shale and sandstone, underclay, coal, and marine flint and limestone (table 7). The coal and marine members attain their maximum development in Jackson and Vinton Counties, and Stout (1927, p. 176) named the coal and underclay from an exposure on the Ogan farm in section 14, Elk Township, Vinton County, and the marine member with the type exposure in section 12 of the same township from the nearby village of Zaleski. The name Ogan is also now given to the shale and sandstone member underlying the Ogan underclay. Outside the immediate vicinity of the type area members of the Ogan cyclothem are seemingly poorly developed elsewhere in Ohio and have not been generally recognized. Except for the shale and sandstone member, the other members are uncertain units in the stratigraphic column of Athens County, although marine fossils have recently been found at the horizon of the Zaleski member. In general the coal, underclay, and marine member are covered by mantle rock, have been eroded and replaced by channel-fill of sandy shale and sandstone, or were locally never deposited.

Ogan Shale and/or Sandstone Member. - The only complete exposure of this member observed lies west of the Athens-Hocking County line near the National Fireproofing Company's Diamond Brick Plant in section 6, Starr Township, Hocking County. At that place, locality 14263, there are almost 29 feet of gray, silty to sandy, micaceous, fairly evenly bedded shale occupying the full interval between the Putnam Hill and Zaleski members. There are several Athens County localities (11595; 12478, 14264, 14269) where strata in this interval are exposed, but each one is partly covered, lacks one or more key beds, or is largely given over to massive



Map 2. - Athens County, Ohio: locations of selected representative measured outcrop sections of the Brookville, Ogan, Winters, Clarion, and Scrubgrass cyclothems. Numbers are Ohio Geological Survey file numbers used in the appendix of this report and in the Survey's Columbus files.

sandstone as at locality 14264. Where the full interval can be measured, thickness is from 30 to 38 feet.

The lower part of this interval is argillaceous shale similar to the Putnam Hill shale below and may belong to the Putnam Hill member. This lower part contains some small scattered ferruginous nodules. Above, there is a gradual change to more micaceous, silty, and sandy shale and finally to sandstone (localities 12478, 14264). Where thick massive sandstone takes over, the top part may be coalesced sandstones belonging to the Clarion and/or Winters cyclothems. In fact, the large thickness assigned to this member may be caused not only by inability to separate Putnam Hill shale at the base but also by the addition of coalesced sandstones at the top. Precise and exact limits of this member are difficult to observe.

Ogan Coal and Underclay Members. - In Athens County the 60-foot interval between the Putnam Hill and Lower Kittanning members is poorly exposed, and where exposures do occur 20 to 35 feet of sandstone generally replace partly or entirely the Clarion, Ogan, and Winters cyclothems. Since a sandstone facies is locally well developed, there is little opportunity for the members of these several cyclothems to be present, and the Ogan coal and underclay and the Zaleski marine member are missing at most places in the area.

There are, however, five localities in York Township where these several members should occur. The first is locality 12478 in section 36, and there only a poor representation of the Zaleski member is present at 40 feet below the Lower Kittanning coal. Another is locality 14272 along William Street at the northeast edge of Nelsonville, where a thin coal with a partial exposure of its underclay but without any trace of marine fossils lies 40 feet below the Lower Kittanning coal. It is estimated that these two members are at least 20 feet above the Putnam Hill horizon. Only one foot of lean, micaceous, laminated underclay with carbonaceous films in the top part is exposed. Thickness of the coal is a mere four inches, of which the lower two-thirds are bright and shaly coal interbedded with light gray clay and the top one-third is bright blocky coal with thin partings of fusain and pyrite. Above the coal is a succession of gray, argillaceous, non-fossiliferous shale, nodular ironstone, and light gray silty shale with a total thickness of 12 feet. The third is locality 6744 along the ridge south of Snake Hollow in section 18, where three inches of bright to bony pyritiferous coal lie 40 feet beneath the Lower Kittanning coal. There are an inch of carbonaceous shale above and below the coal, two inches of underclay below, and nine inches of impure underclay above the upper carbonaceous shale. Still higher are about two feet of ferruginous shale containing several layers of flattened ironstone masses and some scattered carbonaceous fragments.

The coals in these last two exposures are comparable in thickness, quality, distance below the Lower Kittanning coal, and the presence of ironstone layers a short distance above. The distance below the Lower Kittanning coal is the same as for the nodular and ferruginous Zaleski member at locality 12478, a fact that suggests that ironstone above the coals may represent the Zaleski member.

The remaining two exposures in which Ogan-Zaleski members ought to occur are localities 11595 and 14264, but in these, massive sandstone and mantle covering replace or obscure them. Near St. Mary Hospital a calcareous zone in the sandstone might possibly represent the Zaleski member.

Zaleski Marine Member. - Stout (1927, p. 176, 183) named the Zaleski marine member from an exposure along a now abandoned road in the SW¼, sec. 12, Elk Township, Vinton County, Ohio. In its type area this bed is normally a flint described (Stout, 1927, p. 181) as "black or brownish black flint, hard and lustrous." Locally in the type area it is also represented by "calcareous flint, siliceous limestone, calcareous shale, and iron ore." It is marine and fossiliferous, the calcareous flint and siliceous limestone very fossiliferous; and Morningstar (1922, p. 130-138) has described its fauna.

The Zaleski member has been recognized at very few localities in Ohio beyond its type

area. Merrill (1950, p. 164-166) reported probable occurrences in Green and Ward Townships of Hocking County, and the writer has seen and recorded nodular fossiliferous marine limestone and shale in Sandy Township, Tuscarawas County, at the horizon of the Zaleski member. During the present field work, W. H. Smith first found marine fossils at the Zaleski horizon at the Diamond Brick Plant in section 6, Starr Township, Hocking County (locality 14263). Rather careful search has failed to reveal Zaleski fossils except at one locality (12478) in section 36, York Township. A calcareous zone in the sandstone some 20 feet above the Putnam Hill shale at locality 11595 below St. Mary Hospital at the west edge of Nelsonville may represent reworked Zaleski sediments. This possibility is supported by observations to the west in Hocking County where a calcareous zone occurs in the same approximate stratigraphic position at several localities.

The fossiliferous marine shale at Diamond Brick Plant of the National Fireproofing Company (locality 14263) is eight inches thick and consists of bedded silty to sandy, micaceous, limonite stained shale with small, scattered, ferruginous masses. It resembles very closely the shale above and below its zone and can easily be overlooked. The fossils were first discovered in float pieces down the hillside and are mostly clams and few brachiopods preserved as external and internal molds. At locality 12478 the lithology is similar to that described above, but it is limited above and below by sandstone, and fossils are extremely rare. It is little wonder that the Zaleski member has been overlooked beyond its type area, if the Athens County exposures are typical of its lithology elsewhere.

Winters Cyclothem

Orton (1884, p. 161, 999) first introduced the name Winters in print for a coal in the vicinity of McArthur in Vinton County, which he believed to be the Brookville coal. Orton's Winters coal is not the Brookville coal and actually, as Stout (1927, p. 175-176) has clearly shown, included both the Ogan coal and the Winters coal as now restricted to the coal just above the Zaleski flint.

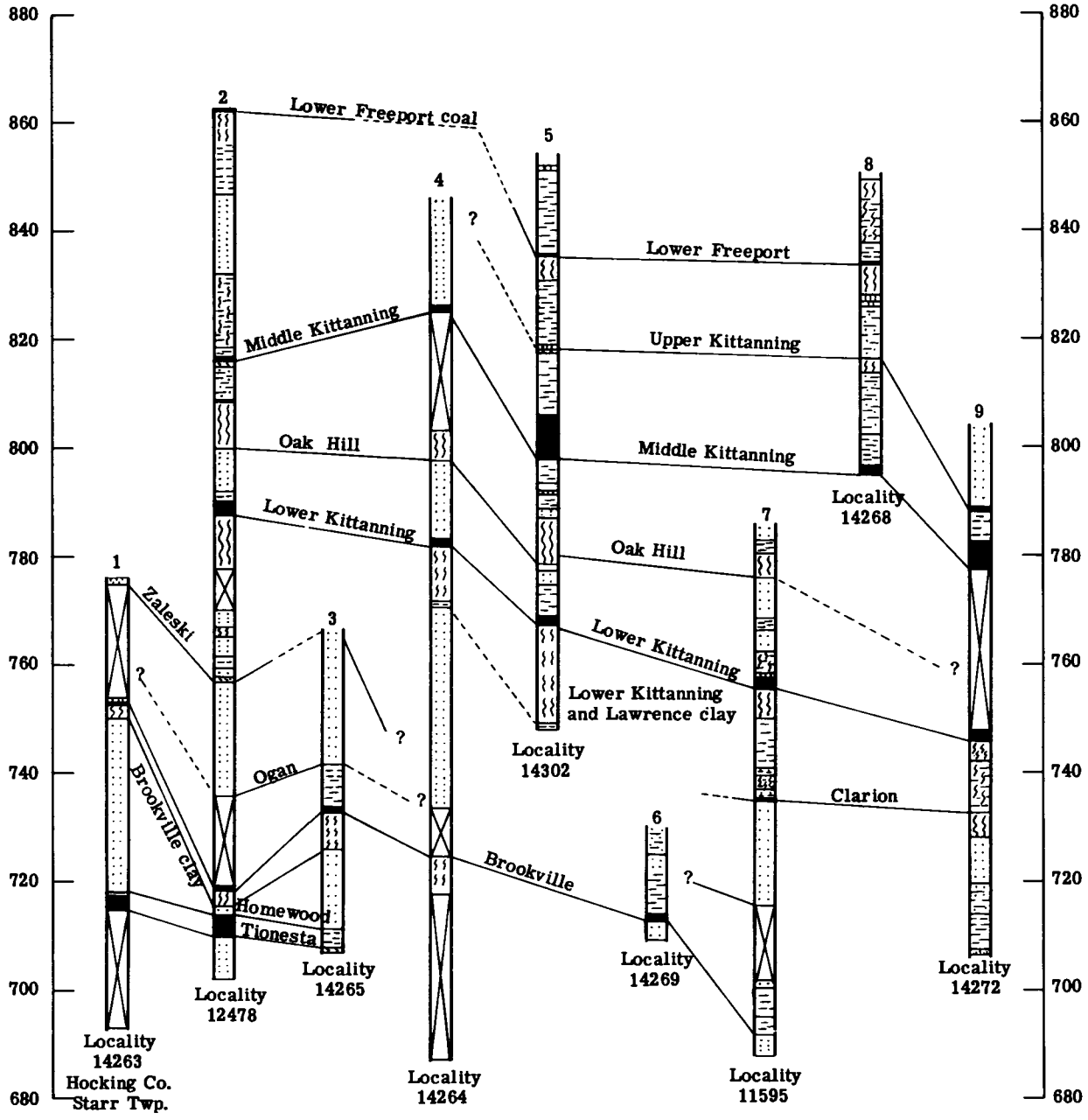
The cyclothem containing the Winters coal is a very incomplete one and consists essentially of a coal and an underclay and heretofore has been recognized only in southern Vinton and northern Jackson Counties. A shale and sandstone member, in addition to the coal and underclay, is tentatively identified in section 36, York Township, but the entire cyclothem is an uncertain one in Athens County. Map 2 shows only two localities (6744 and 12478) for Winters members, and table 7 summarizes some stratigraphic data for them.

Winters Shale and/or Sandstone Member. - At locality 12478 less than two feet of fine micaceous bedded sandstone occurs above the Zaleski marine member and below a coal and underclay zone tentatively identified as Winters coal and clay.

Winters Coal and Underclay Members. - A thin carbonaceous and clayey shale definitely representing a coal zone lies above the thin sandstone overlying the Zaleski member at locality 12478 in section 36, York Township. These may represent Winters coal and clay and are classified as such, but with considerable uncertainty. At locality 6744 in section 18, York Township, nine inches of impure underclay lie directly over a thin coal identified as Ogan. In two feet of shale immediately above this clay there are carbonaceous fragments. The clay and carbonaceous fragments may possibly represent the Winters members, but again it is an uncertain identification.

Clarion Cyclothem

H. D. Rogers (1858, v. 2, pt. 1, p. 474-477) used Clarion as a group name for beds



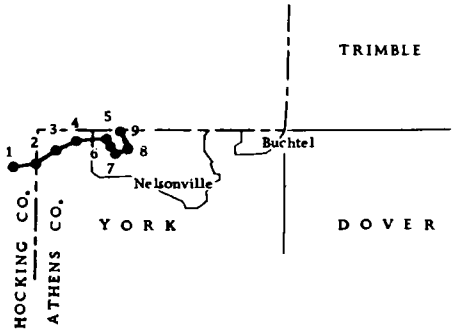


Figure 10 - Sections correlated in northwestern Athens County (York Township).

between the Freeport (Lower ?) sandstone above and the Tionesta sandstone below. As originally defined it included beds now assigned to the Brookville, Lower, Middle, and Upper Kittanning, Lawrence, and Scrubgrass cyclothems as well. Type area is in the Clarion River Valley of western Pennsylvania. Table 7 shows that the Clarion cyclothem is now restricted to four members lying between the Scrubgrass and Winters cyclothems. These include the Clarion shale and sandstone, coal, and underclay, and the Canary ironstone lying between the shale and sandstone and the underclay members.

This is another minor and uncertain cyclothem in Athens County, although all members have been tentatively recognized. Elsewhere in Ohio the Clarion members are locally well developed and are or have been important mineral resources. Within the county in northern York Township several possible exposures were observed along the Hocking Valley from Nelsonville west to the county line (map 2). These are discussed briefly in the following paragraphs.

Clarion Shale and/or Sandstone Member. - Sandstone and shale referred to the Clarion cyclothem occur at several localities in sections 24, 30, and 36 of York Township (map 2). Figure 10 shows a thick sandstone at localities 11595 and 14264 with approximate thicknesses of 20 and 35 feet, respectively, but the figure also shows that the sandstone is a lens with less than $3\frac{1}{2}$ feet at locality 12478 and less than 10 feet of rather shaly sandstone at locality 14272. As mentioned previously, the interval between the Brookville and Lower Kittanning coals is locally occupied by coalesced sandstone belonging to several deposition cycles. The 35 feet of sandstone exposed at locality 14264 has differences in bedding and a zone of ferruginous conglomerate near the middle of its thickness, facts which suggest that the base of one sandstone rests upon the top of another sandstone. It is possible that this sandstone may include sandstones from the Ogan to Lawrence cyclothems inclusively.

It is a fine to medium, silty, micaceous sandstone that weathers brownish to yellowish in color. Bedding varies from thin-bedded to massive. Along Dorr Run (locality 14269) and below St. Mary Hospital (11595) bedding becomes more massive upward except at the extreme top where bedded character is again apparent. Even the exposure of generally massive stone at locality 14264 shows bedding and cross-bedding near the conglomeratic zone in the middle of its thickness. Along William Street in Nelsonville (14272) the sandstone is not only thin-bedded but also interbedded with thin layers of argillaceous shale. Basal contacts exposed along Dorr Run and on William Street are more or less gradational with the shales below, but in a strip mine in the $SW\frac{1}{4}$, sec. 36 (locality 12478) the contact with the underlying shale is relatively sharp. Shale in this interval is argillaceous, ferruginous, micaceous, and poorly laminated, but exposures are too few to be really representative.

Canary Ironstone Member. - The Canary member is typically a calcareous concretionary ironstone that was a minor ore in Scioto County during the heyday of the early iron industry in Ohio. Its position at the base of the Clarion underclay is stratigraphically the same as that of the nonmarine limestones higher in the Pennsylvanian system.

The only credible occurrence noted in Athens County is at locality 11595, below St. Mary Hospital, where grainy textured, nodular limonite masses are embedded in about two feet of clay shale in a complex of clay and clay shale, tentatively identified as Clarion. This ironstone zone lying 17 feet below the Lower Kittanning coal is apparently not the Ferriferous member, as there is another grainy ironstone at the base of the Lower Kittanning underclay in the same exposure.

Clarion Underclay and Clarion (No. 4a) Coal Members. - The Clarion coal and underclay are well developed and economically important members southwest of Athens County in parts of Vinton County. In Athens County they are, however, absent or poorly developed, and map 2 indicates only three localities (14272, 11595, and 12478) for them.

The best development is on William Street in Nelsonville where there are five feet of light gray to gray somewhat iron-stained plastic clay with a mere trace of coal at its top.

Downward toward its base the clay is sandy and has silt and mica flakes throughout the full thickness. The coal smut within 13 feet of the base of the Lower Kittanning coal is only a mere trace of coal. The interval between the coal and clay, here called Clarion, and the Lower Kittanning coal is thin, but the correlation is believed to be correct for reasons discussed under the Ferriferous ironstone member.

The exposure (11595) with nodular ferruginous zone identified as Canary ironstone has a rather uncertain complex of several clays, clay shales, and shale only a few feet in total thickness. Only two feet of light gray, micaceous, plastic clay are present in the strip mine exposure in the SW¼, sec. 36, York Township (locality 12478).

These exposures with a meager development of Clarion coal and underclay clearly show that they are of no commercial significance and are difficult and uncertain for correlation purposes.

Scrubgrass Cyclothem

The most important member in the Scrubgrass cyclothem is the Vanport marine member, which is usually considered as being associated with the Clarion cyclothem, since the Vanport member at many places directly or closely overlies the Clarion coal. At other places there is an incomplete cyclothem interposed between the Clarion and Vanport members. This cycle consists only of a shale and sandstone, an insignificant and nonpersistent coal called Scrubgrass, and the Ferriferous ironstone, in addition to the already mentioned Vanport member (table 7). The type area for the Scrubgrass coal is along Scrubgrass Creek in Venango County, Pennsylvania, where H. D. Rogers first mentioned the coal in 1858 (v. 2, pt. 1, p. 573), but it was not until 1879 that Lesley (p. 212) called this coal and its underclay by their present name. Orton (1884, p. 10, 17, etc.) first recognized the Scrubgrass coal in Ohio, and Stout (1927, p. 249-255) has summarized considerable detail concerning the coal and associated beds in Ohio and especially for Vinton County, where the coal probably reaches its best development in the State. Stout (1927, p. 250) noted that the Scrubgrass coal has little or no underclay but also stated (1927, p. 249) that the Scrubgrass coal is not a split from the Clarion coal as believed by some geologists.

The Scrubgrass cyclothem is poorly represented in Athens County by shale and sandstone and by the inconspicuous Ferriferous ironstone. The Scrubgrass coal and Vanport marine member were not observed.

Scrubgrass Shale and/or Sandstone Member. - This member is represented by shale or sandy shale at five localities in York Township north of the Hocking River (localities 6733, 11595, 12478, 14264, and 14272), all of which are shown on map 2. Were it not for a grainy ironstone identified with reasonable certainty as the Ferriferous member at the top of these exposures of shale, this part of the stratigraphic section would be considered as part of the combined Lawrence-Lower Kittanning cyclothems, as has been commonly done. Thicknesses range from about 8 feet to more than 15 feet, and average thickness for 3 complete measurements is approximately 10 feet.

The fresh shale varies from light gray to light greenish gray but is usually stained with various amounts of yellowish to brownish limonite. Parts are clayey and others silty and sandy; all are finely micaceous. At locality 6733 in section 23, York Township, the exposed part of this member shows sandy shale and medium-grained micaceous, and ferruginous sandstone.

Scrubgrass Underclay and Coal Members. - No trace of Scrubgrass coal or underclay was observed in Athens County, although this coal probably attains its best development within Ohio nearby in Vinton County.

Vanport Flint, Limestone, or Shale Member. - Although remarkably persistent along its outcrop belt across Ohio and represented by several facies in adjacent Hocking, Perry, and Vinton Counties, the Vanport member has not been recognized in the limited possible outcrop area of York Township, Athens County. Its stratigraphic position within the county can best be traced by the Ferriferous ironstone described below.

Ferriferous Ironstone Member. - H. D. Rogers (1858, v. 2, pt. 1, p. 491) first applied the name Ferriferous to the Vanport limestone in deference to the ironstone layer commonly present on top of that limestone. Later I. C. White (1878, p. 60-66) renamed the limestone Vanport from exposures at Vanport in Beaver County, Pennsylvania. Ferriferous is now generally used for only the ironstone, and it is one of the few descriptive names still used as a name for rock units in our Pennsylvanian rocks.

Flint (1951, p. 46, 139, 149) has shown that locally in Monday Creek Township, Perry County, about six to eight miles from the northwest corner of York Township, the Lawrence-Lower Kittanning underclay lies immediately upon the Ferriferous member, which in turn overlies the Vanport flint. Between Flint's Perry County localities and those in Athens County the Ferriferous ironstone was observed at two places in Starr Township, Hocking County. One of these is in section 6 just northwest of the National Fireproofing's Brick Plant at Diamond, and the other is along an abandoned secondary road extending southeast from an abandoned school house in the $S\frac{1}{2}$, sec. 11. At the Diamond locality it is six inches thick and located at the base of the Lawrence-Lower Kittanning underclay, and in section 11 it is about two feet thick and separated from the Lower Kittanning underclay by several feet of sandstone and shaly sandstone. Merrill (1950, p. 167) reports similar occurrences in Falls Gore, Green, and Ward Townships of Hocking County.

The lithology of the Ferriferous member at all observed localities in Starr and York Townships is very similar and quite distinctive. It is an impure yellowish brown limonite with a definite grainy texture. Its texture along with its close association with Lawrence-Lower Kittanning underclay throughout the area under consideration in Athens, Hocking, and Perry Counties and its position upon the Vanport flint in Hocking and Perry Counties establishes its identity without reasonable doubt. Hence, the Ferriferous member is a most useful bed for correlation in a series of beds lacking distinguishable members in Athens County, and without its positive identification recognition of any members of the Scrubgrass cyclothem within the county would have been most uncertain or impossible.

Stout (1927, p. 268-276) has well summarized the former importance of Ferriferous ironstone as an iron ore in Ohio. At present its only uses are as a stratigraphic guide for correlation purposes and locally as a source of marine fossils.

Lawrence - Lower Kittanning Cyclothems

The type area of the three (Lower, Middle, and Upper) Kittanning cyclothems is in the vicinity of Kittanning, Pennsylvania, located on the Allegheny River in Armstrong County. H. D. Rogers (1858, v. 2, pt. 1, p. 476-477) called one of the coals in his Clarion group the Kittanning coal. Somewhat later, J. P. Lesley and I. C. White (1876) employed the term Kittanning group, and White's 1878 (p. xvii) definition included those members from the top of the Upper Kittanning coal downward to the top of the Ferriferous ironstone. The exact correlation between the several Kittanning cyclothems in Pennsylvania and the Kittanning cyclothems and the Lawrence and Strasburg cyclothems in Ohio is still uncertain. The members for each of these several cyclothems in Ohio and Athens County are given in table 7.

Stout et al. (1923, p. 269) named the Lawrence coal and clay from Lawrence Furnace in Elizabeth Township, Lawrence County, Ohio. Since the Lawrence coal and the Lower Kittanning shale and sandstone are seldom present, the underclays of these two cyclothems are commonly coalesced and extend along their outcrop belt in Ohio as a single thick high grade underclay

known as the Lower Kittanning or Number 5 clay. Locally slight development of the Lawrence coal or differences in color of the clay enables observers to distinguish between members compris ing this clay. In this report the shale and sandstone and underclay members of the Lawrence and Lower Kittanning cyclothems are discussed as combined units rather than individually. The unnamed marine shale and limestone over the Lower Kittanning coal has in recent years been described under the name Hamden, a name which should be used for nonmarine limestone and ironstone associated with the Oak Hill underclay of the Strasburg cyclothem.

The few Athens County exposures of the Lawrence-Lower Kittanning cyclothems are with one exception in northwestern York Township and are limited to the Hocking Valley westward from the vicinity of Nelsonville and to the tributary valleys on the west side of Monday Creek. Lower Kittanning coal is reported to have been exposed formerly along Minker's Run near Kimberly. Limited exposures also occur along Hewett Fork in the vicinity of Ingham in section 32, Waterloo Township. Exposures for these two cyclothems are shown on map 3 and several sections are plotted on figure 10.

Lawrence Shale and/or Sandstone Member. - As discussed above, shale and sandstone below the thick so-called Lower Kittanning underclay actually is a member of the Lawrence cyclothem but is usually called the (Lower) Kittanning shale and sandstone. Stout et al. (1927, p. 269) have shown that the true Lower Kittanning shale and sandstone belongs above the Lawrence coal and clay and is rarely present. Likewise, the Ferriferous ironstone is at the base of or close below the combined Lawrence and Lower Kittanning underclays in Athens County, so that the Lawrence shale and sandstone is thin, uncertain in development, or absent.

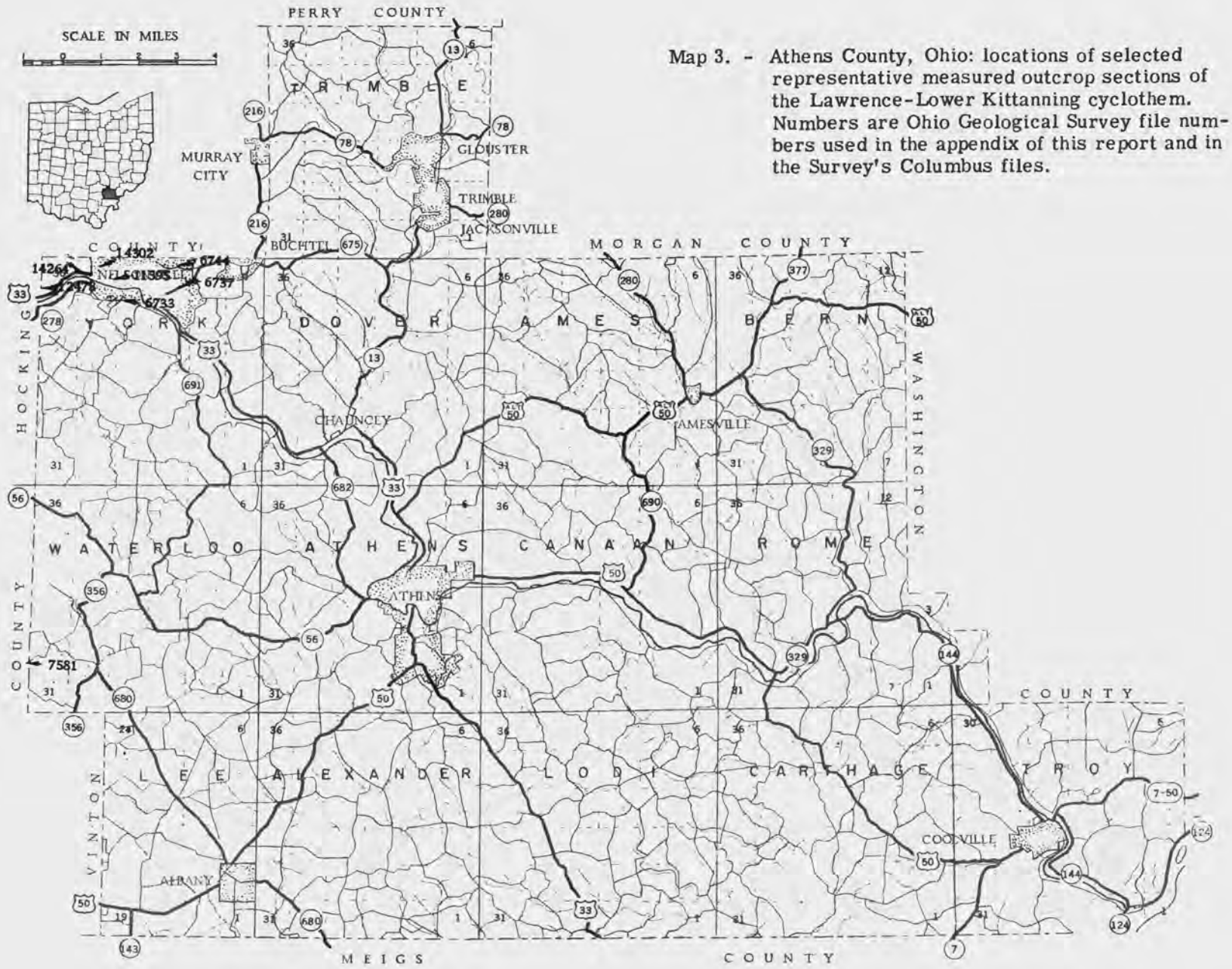
In the NW¼, sec. 30, York Township (locality 14264) about five feet of micaceous sandy shale lies below the Lawrence-Lower Kittanning underclay and above a massive sandstone. This sandstone probably is a combination of at least two sandstones, and the top part may belong to the Lawrence cyclothem. The shale is assigned to the Lawrence cycle, as no Ferriferous ironstone was observed between the shale and the overlying underclay. Elsewhere, as at locality 6744 in section 18, there are several feet of variable clayey to sandy shale with carbonaceous fragments and with several ferruginous zones. This last shale with ironstone may represent the Ferriferous ironstone member. It is estimated that the Lawrence shale and sandstone member is about five feet thick.

Lawrence Underclay Member. - Since this underclay is united with that of the Lower Kittanning and at most places cannot readily be separated, it will be discussed under the Lower Kittanning underclay.

Lawrence Coal Member. - The Lawrence coal is thin and irregular in occurrence but occurs here and there along the belt of potential outcrop across Ohio from Columbiana and Mahoning Counties on the northeast to Lawrence County in the south. Its stratigraphic position is from a few inches to several feet below the Lower Kittanning coal, from which coal it is separated by underclay or by a combination of underclay and shale and sandstone.

In Athens County no thickness of Lawrence coal is present, but its horizon can be recognized south of Nelsonville at locality 6733 where a coal smut overlies about five feet of underclay and is separated from the Lower Kittanning coal above by an additional four feet of underclay. Poor exposures probably prevented its recognition at some places, but at most it is definitely absent.

Lawrence and Lower Kittanning Underclay Members. - The Lawrence underclay is combined at most places with the Lower Kittanning underclay so that those two members are, in fact, one thick, persistent, valuable, plastic and flint clay along much of their outcrop across eastern Ohio. This combined bed is by far the most important source of raw ceramic material in the State and undoubtedly has contributed more than any other single factor to Ohio's top



Map 3. - Athens County, Ohio: locations of selected representative measured outcrop sections of the Lawrence-Lower Kittanning cyclothem. Numbers are Ohio Geological Survey file numbers used in the appendix of this report and in the Survey's Columbus files.

position in the ceramic industry of the nation. Orton (1893, p. 65-66) and Stout et al. (1923, p. 268-365) have summarized data concerning the distribution, occurrence, quality, and uses of this widespread and very significant underclay.

The Lawrence-Lower Kittanning underclay is well developed in its small outcrop area of Athens County (map 3) and Stout et al. (1923, p. 290) have written as follows:

"In Athens County, Lower Kittanning clay is present above drainage only along the Hocking River in the northern part of York Township. It passes below cover south of Nelsonville. In this small area the bed is especially well developed and is utilized in a large way for paving block, glazed building brick, and fire proofing. The average thickness of the clay is about 7 feet 6 inches and that of the overlying coal 1 foot 10 inches. The position of the clay is about 30 feet below the great bed of Middle Kittanning coal from which the fuel supply is drawn. The Lower Kittanning clay is also reputed to hold good thickness under deep cover but so far it has been worked only by level-free mines."

During Stout's field observations on Pennsylvanian underclays of Ohio, almost four decades ago, there were three brick factories using Lawrence-Lower Kittanning underclay in the Nelsonville vicinity, and several excellent exposures of the clay were available in the mines and pits. The brick plants are now abandoned, and those former clay exposures are weathered and slumped. There are, however, several good exposures in York Township as follows: the SW¼, sec. 24 (locality 6733), at St. Mary Hospital in the NE¼, sec. 30 (locality 11595), in an abandoned strip mine on the east side of Dorr Run, in the NE¼, sec. 30 (locality 14302), on north side of Route 33 at line between sections 30 and 36 (locality 14264), and in strip mines in the SW¼, sec. 36 (locality 12478). Other outcrops occur in the area but are too weathered and slumped for accurate measurements. Average thickness of 7 measurements is approximately 8 feet with variations from 5 to 10 feet. A thickness of 18 feet was apparently taken for ceramic purposes at locality 14302, but the lower part of that thickness is shale.

The lithology, according to Stout and by observation, is plastic clay at all recorded exposures within the county. The greater part is light gray clay with numerous slickensides with a definite tendency to become gradually silty, micaceous, and sandy downward, and in the top 4 to 12 inches to be dark gray and carbonaceous. Trace of the Lawrence coal was recognized only at locality 6733 where a thin coal smut lies about 5 feet above the base and a 1-foot zone of ferruginous "shot" overlies the coal smut. Thickness, quality, and favorable conditions for mining make the Lawrence-Lower Kittanning underclay the most important ceramic resource in Athens County. Further details of uses and tests are given under economic geology on page 241.

Lower Kittanning (No. 5) Coal Member. - In the vicinity of Nelsonville the Lower Kittanning coal has an approximate average thickness of two feet, and outcrop locations are the same as for the Lawrence-Lower Kittanning underclay (map 3). Its stratigraphic position is from 22 to 37 feet, with an average of 29 feet, below the Middle Kittanning coal in less than ten measurements, and varies from 61 to 74 feet above the Putnam Hill member in three available measurements.

This coal is normally in a single bench, although it is a two-bench coal with a thicker lower bench and a 1-inch parting of dark clay shale or carbonaceous shale at localities 6733 and 11595. It is mostly firm bright coal with thin dull partings. Fusain and pyrite, either in thin films or in finely disseminated masses, are the principal visible impurities, although locally small amounts of bone and canneloid coal occur. Stratigraphic sections listed in the appendix under Lawrence-Lower Kittanning underclay, record general descriptive details of Lower Kittanning coal in Athens County.

Because of competition from the much thicker Middle Kittanning and Upper Freeport coals, no mining of Lower Kittanning coal has been done in the area except incidentally in the mining of its thick underclay or locally on a small scale for domestic use. It is commonly left as roof in the mining of the clay in deep mines or discarded in the spoil piles in strip mines. Economic importance and reserves of this coal are discussed on pages 219-220, 222-223.

Unnamed Marine Member. - A fossiliferous marine shale and limestone member overlies the Lower Kittanning coal in parts of Ohio and is present in Muskingum and Perry Counties and on northeastward through Coshocton, Tuscarawas, Stark, Carroll, Columbiana, and Mahoning Counties. To this member Stout (1918, p. 173-174) applied the name Hamden, which he had earlier (1916, p. 252) used for an ironstone near Hamden Furnace in Vinton County. Hamden has since been generally applied to both the marine horizon overlying the Lower Kittanning coal and to the ironstone and ferruginous limestone in or under the Oak Hill underclay. This practice is in part an error, since type Hamden in Vinton County is a fresh-water ironstone and limestone and that called Hamden in east-central and northeastern Ohio is definitely marine. Hence, the name Hamden should be restricted to nonmarine limestone, ferruginous limestone, or ironstone which belongs stratigraphically at the base of or within the Oak Hill underclay. The marine member over the Lower Kittanning coal is, consequently, without a name. Where the marine member and even the Strasburg shale and sandstone are missing, the fresh-water Hamden rests on the Lower Kittanning coal. At most places where the marine member is present, the true Hamden member is absent--hence, the general belief that they are the same. It is unfortunate that the true Hamden is the nonmarine member, as the name as been much more widely used for the marine member. Further details are given under the discussion of the Hamden member. The marine member was not observed in Athens County.

Strasburg Cyclothem

In the interval between the Lower and Middle Kittanning coals there is one incomplete cyclothem and possibly more, consisting essentially of a coal and an underclay. For all coal beds, if there are more than one, the name Strasburg is used in Ohio, and for the clay(s), the name Oak Hill. In view of the uncertainty and for convenience in discussion of a single cyclothem, only the Strasburg is recognized in this interval and its members are listed in table 7.

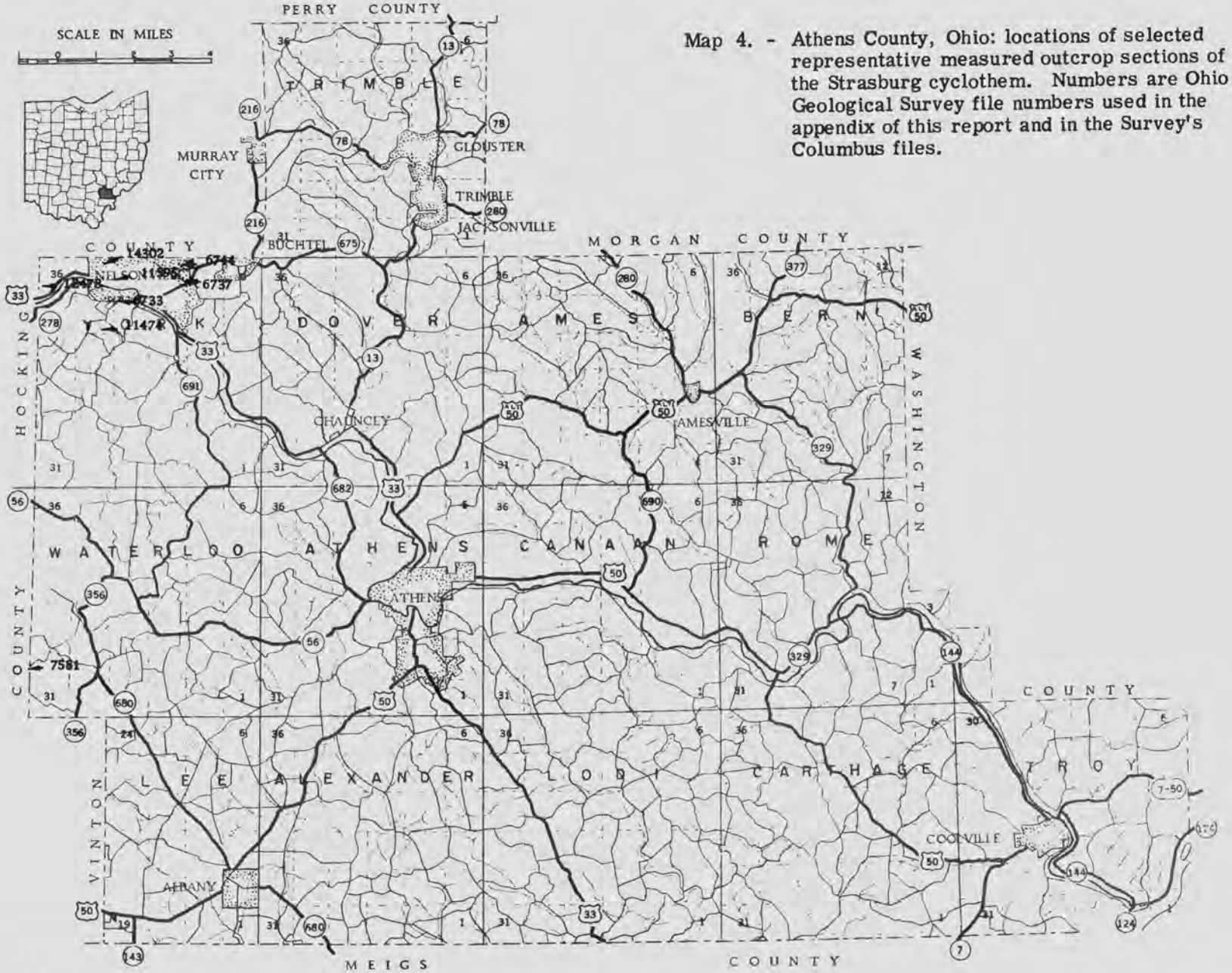
The names Strasburg and Oak Hill for the coal and underclay, respectively, are well chosen. The coal has its thickest development near Strasburg in Tuscarawas County, but even there is unimportant as a source of fuel. The best underclay in this interval is near Oak Hill in Jackson County, where that clay is extensively used. It will be noted that the Hamden limestone is here placed as a fresh-water member at the base of the Oak Hill clay instead of as a marine member over the Lower Kittanning coal. Reasons for this change are discussed above under the unnamed marine horizon over the Lower Kittanning coal.

Exact correlation of the Strasburg cyclothem with the Kittanning cyclothems in their type area in western Pennsylvania is still uncertain.

In Athens County best exposures of the Strasburg cyclothem are limited to York Township, with exposures in sections 18, 24, and 30 (map 4). Elsewhere in areas of outcrop, which are essentially the same as those of the Lower Kittanning cyclothem, these members are largely covered and slumped.

Strasburg Shale and/or Sandstone Member. - Information on this member is limited to the few exposures of the Lower Kittanning coal and underclay and the Oak Hill underclay (map 4). Average thickness for seven measurements is almost 14 feet, and thicknesses for beds within the member are quite variable, with lensing and channel features.

It is typically interbedded underclay, shale, and sandstone. Most of the shale is light gray to olive drab, argillaceous to sandy, and has scattered, small, iron-bearing concretions; but lying directly over the Lower Kittanning coal is black carbonaceous shale that may be micaceous and may also have ironstone concretions, fossil plants, and fossil fish scales. Associated above, or less commonly below, there are at several localities (6733, 11595, and 14302) underclay zones interbedded with shale and sandstone. The sandstone of this member is light gray, and usually with some limonite stain, fine to medium grained, silty, micaceous, and normally



Map 4. - Athens County, Ohio: locations of selected representative measured outcrop sections of the Strasburg cyclothem. Numbers are Ohio Geological Survey file numbers used in the appendix of this report and in the Survey's Columbus files.

bedded. Where sandstone is present in some thickness, the black shale and underclay zones are directly below the sandstone.

Hamden Limestone Member. - Stout et al. (1923, p. 367, 368, 371-373, 376, 378, and 381-383) and Stout and Lamborn (1924, p. 127-129) have described in the Oak Hill underclay a carbonate zone consisting of limestone, ferruginous limestone, and/or ironstone. Restudy of the type Hamden limestone during preparation of this report has revealed that the member is a nonmarine limestone and not a marine limestone as Stout (1918, p. 173; 1927, p. 303) intimated, and that it most certainly belongs to the Oak Hill underclay and not to the marine shale and limestone overlying the Lower Kittanning coal. Stout (1927, p. 303) did state that "Where bedded within the clay (Oak Hill), the horizon is less definitely marked, the most common representative being concretions and ill-shaped bodies of ferruginous limestone and impure iron ore."

Evidence given in the discussion of the unnamed marine member overlying the Lower Kittanning coal (p. 64) verifies that the name Hamden cannot be used for both a marine member and a nonmarine member. Hence, that name is restricted to the limestone and ironstone member associated with the Oak Hill underclay.

The only previous mention of Hamden limestone in Athens County was reported by Stout et al. (1923, p. 380-381) and by Stout and Lamborn (1924, p. 129) at Plant No. 1 of the now-abandoned Nelsonville Brick Company in section 30, York Township. There it is described as "Clay (Oak Hill), light, with small limestone nodules."

Our observations in Athens County corroborate those of Stout and others, and several of the Oak Hill underclay exposures examined during this investigation show either a ferruginous basal part to its thickness or scattered ironstone masses up to a maximum size of eight inches. These observations indicate that the Hamden member, where present, is represented by a somewhat uncertain zone of ironstone--iron carbonate, if fresh, and limonite, if weathered. There is a striking exception to the occurrence of ironstone at locality 12478 in the SW¼, sec. 36, York Township, where a lens of impure limestone up to two feet thick is embedded in the Oak Hill member (figure 11). This lens lies toward the top of a thickened part of the underclay where a channel-like relationship into the underlying Strasburg shaly sandstone permits a downward extension of the underclay's base. The limestone is full gray on freshly broken surfaces and a lighter gray on exposed areas. It is dull, dense, massive, impure rock that is not very firm or hard and that appears to have considerable clay in its body.

The Hamden member, except for small amounts of high phosphorous iron ore formerly mined in the vicinity of Hamden (Stout, 1927, p. 304-305), is of no economic value; and where its pellets and nodules are scattered through the mass of Oak Hill underclay, they are detrimental to the clay for ceramic uses. Its position as the lowest of the recognized nonmarine limestones in the Pennsylvanian system of Ohio is of special interest to stratigraphers. Its discontinuous occurrence and variable lithology and its position on or close above the Lower Kittanning coal have caused confusion in correlation of the marine member over that coal and in the recognition of the true stratigraphic relationships in the interval between the Lower Kittanning and Strasburg coals.

Oak Hill Underclay Member. - The Oak Hill underclay consisting of both good flint and plastic clay in the Oak Hill area of Jackson County, Ohio, is an important ceramic clay in its type area and for many years this clay has been used for refractory ware. Orton (1884, p. 666; 1893, p. 66) referred to it as the Kittanning underclay(s). Stout (1916, p. 254.255) first recognized that this underclay was separate from either the Lower or Middle Kittanning underclays, and he applied the appropriate name Oak Hill to it. He also recognized a poorly developed coal over the Oak Hill underclay and in 1927 (p. 307) he used the name Strasburg for the coal. Stout et al. (1923, p. 366-367) described the features of Oak Hill distribution and stratigraphy in part as follows:



Figure 11 - Exposure of Lower Kittanning (No. 5) coal and clay, Strasburg shale and sandstone, Oak Hill underclay, and lens of Hamden limestone in abandoned strip mine (locality 12478), $SW\frac{1}{4}$, $SW\frac{1}{4}$, sec. 36, York Township, Athens County, Ohio.

"... The bed, however, is far from continuous. In many areas it was never deposited as the interval is made up of normal shale sediments. In a few regions where massive sandstones prevail the clay may have been removed by current action prior to deposition....

"The Oak Hill clay lies between the Lower Kittanning and the Middle Kittanning coals. Its position, however, with reference to these well known members is very erratic..."

Elsewhere Stout (1927, p. 306) gave details on its relationship to the Kittanning coals:

"... The average position of the bed is 7 feet above the top of the Lower Kittanning coal and 20 feet below the base of the Middle Kittanning; but these relations are variable. The Oak Hill clay may be present anywhere from 1 to 25 feet above the Lower Kittanning coal, may lie directly on the coal, or in the absence of this stratum, may rest with no sharp line of demarcation on the Lower Kittanning clay..."

Exposures of Oak Hill clay are present in sections 18, 23, 24, 30, and 36, York Township and at the western edge of section 32, Waterloo Township, as shown on map 4. Along the Hocking Valley from Nelsonville to the county line and in the Waterloo Township locality, exposures show underclay ranging from 4 to almost 10 feet thick. Even the thickest deposits are erratic, however, and in the Monday Creek basin northeast of Nelsonville, one outcrop of only 2 feet was observed.

The clay is generally impure and consists of light gray to full and even dark gray plastic clay at all known Athens County exposures. Its ceramic qualities are, hence, poor, as it usually is calcareous and/or ferruginous and carbonaceous and locally has sandy, micaceous, and shaly zones. A very conspicuous carbonaceous zone occurs near its base in the thick exposures west of Nelsonville. It has been used in the past only incidentally in conjunction with Lower Kittanning clay and is not used at present. It does offer some possibility to the amateur ceramist, who might select satisfactory samples from the thick deposits.

Strasburg Coal Member. - The coal overlying the Oak Hill underclay is a thin coal with a very limited distribution in Ohio. It has its best development near Strasburg in Tuscarawas County, where locally it is known as the 5a coal, and from that locality Stout (1927, p. 307) gave the name. It is commonly present at fewer places than the Oak Hill underclay, and in Athens County was seen only at three localities in sections 18, 23, and 36 of York Township (map 4). The greatest thickness is at locality 6733 in section 23 where 11 inches of weathered shaly coal are present, and the usual thicknesses are only one to two inches of shaly coal with streaks of bright coal and pyrite. The Strasburg member warrants no attention except for correlation purposes and its fossil plant spores.

Middle Kittanning Cyclothem

The Middle Kittanning cyclothem is named from Kittanning, Pennsylvania; and the Salem, Snow Fork, and Washingtonville members are named from Ohio localities. The various members outcrop in a belt extending from Columbiana, Jefferson, and Mahoning Counties in eastern Ohio to Gallia and Lawrence Counties in southern Ohio. Their outcrop extends across the northwestern part of Athens County (map 5), where exposures mostly occur in Waterloo and York Townships. The Middle Kittanning coal has, however, been extensively deep mined in Athens, Canaan, Dover, and Trimble Townships, and some of those locations are also shown on map 5.

Comparison of members of the Middle Kittanning cyclothem shown in table 7 with those of an ideal cyclothem for the Lower Pennsylvanian in Ohio, discussed and shown on page 40, shows that the Middle Kittanning cyclothem is the lowest cycle of deposition in this State that is basically complete. All members of an ideal cyclothem are present in the Middle Kittanning cyclothem except a marine limestone member. The Washingtonville marine member is typically a black carbonaceous fissile shale characterized by large fossil clams, but locally, in Coshocton

and Muskingum Counties, it is a gray argillaceous shale with an abundance of marine fossils. Both the coal and underclay members are persistent in occurrence. The coal is generally thick and good quality coal, and the underclay is commonly thin and inferior ceramic clay. Although ironstone is quite persistent in this interval, the Snow Fork ironstone and Salem limestone have not been traced far from their type areas. The shale and sandstone are normally thin and inconspicuous in outcrop.

Neither the Salem limestone nor the Washingtonville marine shale is known to occur in Athens County, but the type area for the Snow Fork ironstone is in York Township. The Middle Kittanning underclay and the shale and sandstone are thin but steady members in the county. By far the most important member is the Middle Kittanning (No. 6) coal, which attains its maximum thickness for Ohio in the Hocking Valley region, including parts of Athens, Hocking, and Perry Counties. This coal has been, on basis of amount and quality, the most important of Ohio's minable coals. It is characteristically a 3-bench good coal, and in the Hocking Valley coal field it has an additional bench on top of the three regular benches. Details concerning the Middle Kittanning cyclothem in Athens County are given on subsequent pages.

Middle Kittanning Shale and/or Sandstone Member. - The interval between the Strasburg-Oak Hill members and the Middle Kittanning coal or, in the absence of the Strasburg cyclothem, the interval between the Lower and Middle Kittanning coals is largely occupied by shale and sandstone. Hence, the presence or absence of the Strasburg-Oak Hill members materially affects the thickness of the shale and sandstone assigned to the Middle Kittanning cyclothem. Complete exposures of this shale and sandstone are not abundant in Athens County and are confined to Waterloo and York Townships. In ten full measurements the extremes in thickness are 5 and 34 feet, commonly 7 to 25 feet, and the average is about 14 feet. The shale, which normally exceeds the amount of sandstone, is argillaceous to sandy but usually sandy and micaceous with considerable yellow and brown hydrated iron oxide stain (limonite) on weathered surfaces. Small scattered clay ironstone concretions, also generally weathered to limonite, are usually present, and fossil plants occur at some localities. The sandstone is typically light gray when fresh but normally somewhat weathered and stained to some shade of brown or yellow, fine to medium grained, micaceous, bedded, locally with cross-bedding or a shaly appearance, but at several localities replaced by massive sandstone lenses showing cross-bedding on weathered surfaces.

Snow Fork Ironstone (Salem Limestone) Member. - In their report on the geology of Columbiana County, Stout and Lamborn (1924, p. 146-150) were first to recognize a thin fresh-water limestone between the Oak Hill underclay and the Middle Kittanning coal. Since their description of this limestone includes consideration of possible correlation across Ohio, it is in part quoted below:

"In parts of Columbiana County a thin bed of fresh-water limestone is found at or not far below the base of Middle Kittanning clay and on or only a few feet above Oak Hill clay where this member is present. As this limestone was first observed near Salem and as it needs some distinctive title in order that it may be traced without confusion, this bed is therefore called Salem limestone.... (I)n the interval between Lower Kittanning and Middle Kittanning coals, iron ores were formerly mined at many places for use in the old charcoal furnaces. In Jackson County a bed lying 6 to 20 feet above Lower Kittanning coal is called Red Kidney ore. This horizon throughout part of the Hocking Valley field yielded small quantities of ore for iron smelting. The kidneys are irregularly distributed in a few feet of shale or clay and lie from 2 to 15 feet below Middle Kittanning coal. They are probably correlative with the Black Kidney ore of Vinton County but are not so regularly gathered into a distinct stratum. The shell ore of Tuscarawas County is found about midway in the interval between the two Kittanning coals. The limestone found below Middle Kittanning coal in Columbiana County is evidently correlative with some of the iron ores found in the central and southern parts of the state.

"In Columbiana County the Salem limestone lies 4 inches to 10 feet below Middle Kittanning coal. The usual measurement, however, is 1 to 3 feet. Where both limestone and Oak

Hill clay are present, the limestone lies directly on or only a foot or two above the clay. The Salem member varies in thickness from 5 inches to 1 foot 2 inches but averages nearly 8 inches. It is bluish gray, rather hard and dense, and blocky in form. It is generally siliceous and ferruginous and in places changes into a calcareous sandstone and in other places into iron ore. No fossils, except small gastropods, were observed in any of the materials. The fauna indicates that the limestone is of fresh water origin. . .."

Since the above was written the Salem limestone has been found to extend northward into Mahoning County and to have locally in Columbiana County a rather abundant fauna of ostracods. The gastropods also mentioned above seem to be the tubes of the coiled annelid worm Spirorbis.

As far as known, the Salem limestone does not occur in Athens County, but in the same stratigraphic position below the Middle Kittanning coal there are scattered nodules or layer(s) of nodular clay ironstone, locally containing fossil plants, which long ago Briggs (1838, p. 143-144) described as follows:

"The most continuous, and probably the most valuable, deposit of iron ore in this county, is a few feet below the Nelsonville (Middle Kittanning) coal. This is a very heavy, compact ore, of a bluish color, and varies in thickness, from 6 to 10 inches. It contains impressions of ferns and other extinct vegetables. It is well disclosed at Whittimore's, on the Snow fork of Monday Creek, resting on a bed of shale, which disintegrates into a yellowish, ochrey clay... Above it is a bed of shale containing nodules of good iron ore..."

Andrews (1870, p. 120) wrote in a similar manner concerning the Snow Fork ore:

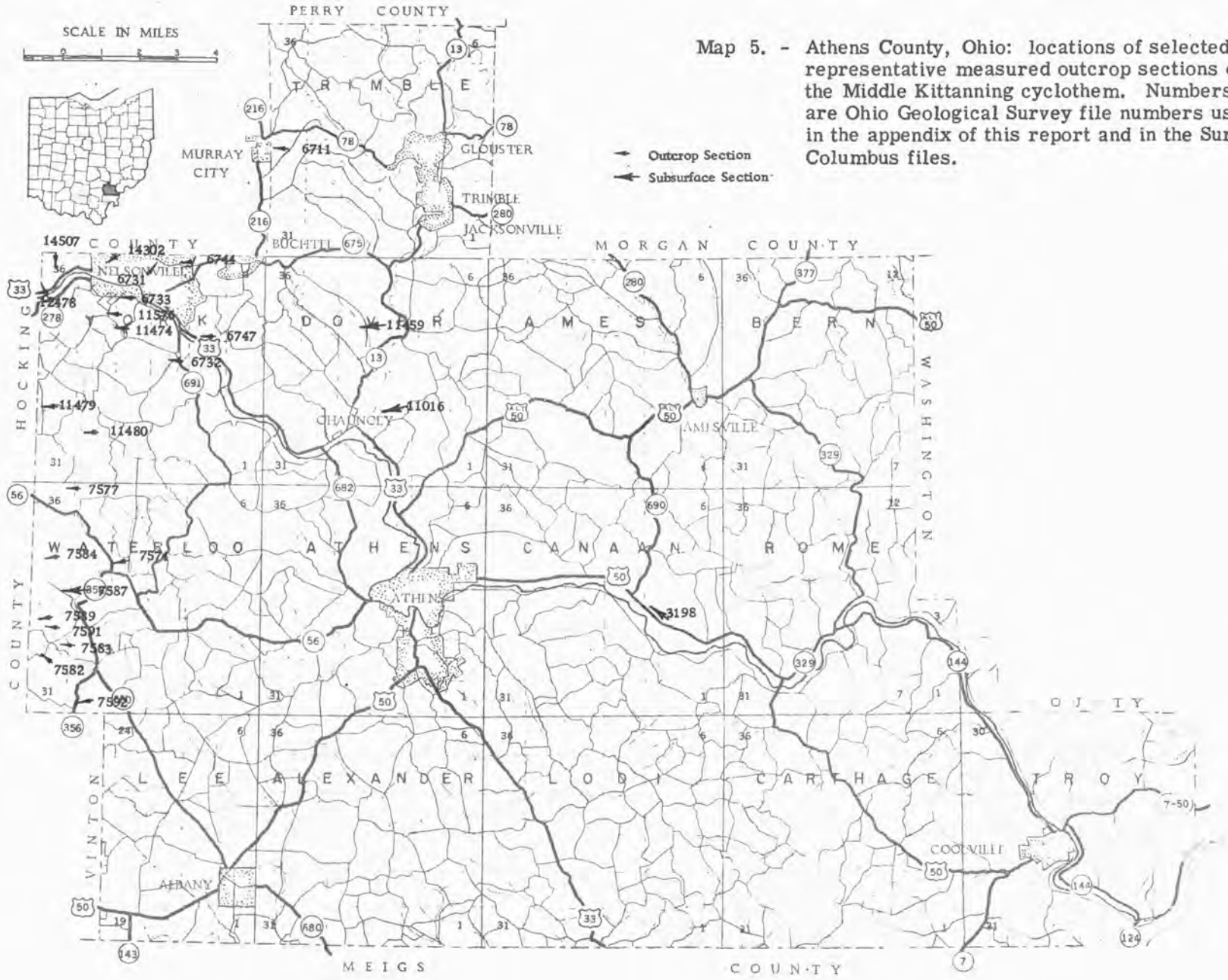
"Nowhere have we found so persistent a horizon of ore as that formed a few feet below the great coal (Middle Kittanning) seam.... Scarcely anywhere was a section made of this part of the vertical range of strata without the discovery of this ore. It is in nodules, often small, but sometimes very large and heavy .... The ore is siderite or carbonate of iron, and yields 31.50 per cent metallic iron. It is often filled with beautiful impressions of coal plants...."

Since the search for and mining of iron ore is no longer pursued in Athens County and since even the mining of coal is much reduced, many of the outcrops of Snow Fork ironstone seen by former geologists are no longer exposed. Three localities (6737, 6744 and 14507) of this ironstone bearing fossil plants were observed in York Township, and loose float nodules also containing fossil plants occur south of the Hocking River at Nelsonville (locality 6733). Wherever exposed, the shale between the Lower and Middle Kittanning coals has scattered siderite-limonite concretions of varying sizes, usually only a few inches in maximum size. At three additional localities in York Township (6731, 6747, and 11474) and at one locality in Waterloo Township (7589) the ore nodules are concentrated and appear to represent the Snow Fork member. In the seven sections listed above, the Snow Fork member varies in thickness from 18 inches to almost 8 feet and averages 4 feet and 3 inches and lies from 10 inches to 9 feet below the Middle Kittanning coal with an average distance of 3 feet 6 inches. Our observations show that the Snow Fork member is a shale with abundant plant fossils and numerous clay ironstone nodules.

The Snow Fork ironstone has no economic value as iron ore, but its interest to geologists for its possible correlation with the Salem limestone and to paleobotanists for its fossil plants is significant.

Middle Kittanning Underclay Member. - Stout et al. (1923, p. 393) summarized the overall characteristics of Middle Kittanning underclay in Ohio as follows:

"The Middle Kittanning clay, like the Middle Kittanning coal with which it is directly associated, is a persistent bed across the State, extending with few wants from Lawrence County on the south to Columbiana County on the northeast. The member has fair thickness along most of its outcrop but in parts of the field it is lacking in the qualities necessary for ceramic work other than common products. In many places it is so shaly that the material scarcely deserves the name clay....



Map 5. - Athens County, Ohio: locations of selected representative measured outcrop sections of the Middle Kittanning cyclothem. Numbers are Ohio Geological Survey file numbers used in the appendix of this report and in the Survey's Columbus files.

"The Middle Kittanning is everywhere a plastic clay, seldom showing a tendency even to vary towards the harder varieties. The color varies from light gray to dark gray and to bluish shades. The principal coloring pigments are iron compounds and carbonaceous matter. The texture is usually coarse and gritty, far more so than the average plastic clay. The clay is not above the average in hardness except the siliceous parts which are somewhat stony. The bonding power is low...."

In Athens County natural exposures of Middle Kittanning coal and its underclay are limited almost entirely to Waterloo and York Townships (map 5), although this coal has been extensively deep mined in Athens, Canaan, Dover, and Trimble Townships. The underclay is usually not well shown in mining operations except occasionally in drainage ditches or in other excavations.

Within the county it is everywhere thin and light gray plastic clay. Twelve exposures of its entire thickness show extremes of 6 inches to 1 foot 9 inches with an average thickness of only 1 foot 2 inches. While its color is dominantly light gray, locally part or its entire thickness may be gray, and limonite stain varies from little on surfaces to much throughout the mass. Visible impurities include quartz sand, silt, mica, and carbonaceous and ferruginous materials. Fossil plants, including Stigmaria, are present at some localities.

Middle Kittanning (No. 6) Coal Member. - The Middle Kittanning coal is a persistent minable coal along its outcrop belt across the State from Columbiana and Mahoning Counties in northeastern Ohio to Lawrence County in the south. This great coal attains its maximum thickness and importance in the Hocking Valley field, which includes parts of Athens, Hocking, and Perry Counties, and where it has been known by such different names as Big Seam, Great Vein, Carbondale, Hocking Valley, Nelsonville, Shawnee, Straitsville, and Upper New Lexington coal or seam. Nelsonville would have been a very appropriate name for this coal, because Nelsonville was long an active center for mining the coal and also because the name apparently antedates Middle Kittanning in geologic reports.

This thick coal early attracted attention of explorers where it outcropped in the Hocking Valley, and pamphlets and maps indicated presence of coal in the valley as early as 1787 and 1788 (Eavenson, p. 264-265). The early settlers probably soon used this coal for local needs, among which were blacksmith shops and salt works. Eavenson (1942, p. 266) also states that in 1817 coal mines were reported plentiful in Athens County, but it should be remembered some early references to coal mines applied only to coal outcrops. It is also not certain that all early references to Hocking Valley coal refer only to the Middle Kittanning coal. Construction of canals and railroads in the 1860's and 1870's gave opportunity for shipment to outside markets, and a large coal industry developed for a time into the most important coal-producing district in Ohio. In Athens County important centers for mining this coal grew up in the vicinities of Carbondale, Mineral, Nelsonville, and at various localities along Monday and Sunday Creeks and Hamley and Minkers Runs.

Numerous reports, including a number of private ones, have been made from time to time on the Middle Kittanning coal in this district. Geologists (Briggs, 1838, p. 84-86, 138-141) of the First Geological Survey of Ohio gave attention to and published brief notes on the Hocking Valley coal under the title of Nelsonville coal. Andrews (1871, p. 80-91), in charge of geologic investigations in the Second District (Southeastern Ohio) for the Second Geological Survey of Ohio, made the first public detailed systematic survey of the Middle Kittanning coal of the Hocking Valley field, which was still known as Nelsonville or Straitsville coal or seam. Orton (1884, p. 912-982) gave an excellent and probably the best account to date of the Hocking Valley coal and mines during the acme of mining which continued until after World War I. In fact, his summary for the entire field is worth quoting in part almost 75 years after publication:

"In structure, the Hocking Valley coal always has three benches of the normal Middle Kittanning seam, with some addition of its own.... (T)he Great Vein consists of the normal, three-bench seam of Middle Kittanning age, covered and reinforced by a Hocking Valley supplementary seam, the latter consisting of one or two or more benches. The supplementary seam is



Figure 12 - Exposure of beds between Lower Kittanning (No. 5) underclay and horizon of Lower Freeport (No. 6a) coal, including thick Middle Kittanning (No. 6) coal, Oak Hill underclay, and horizons of Strasburg, and Upper Kittanning coals, etc., in abandoned strip mine in NE¼, sec. 30, York Township, Athens County, Ohio. This is locality 14302 on tributary to Dorr Run.

separated from the original seam by a thin shale parting, which is often disregarded in mining, but which is, for the most part, distinctly recognizable when looked for....

"There is no foundation whatever for the theory which accounts for the thickness of the Great Vein' by the coalescence with the normal Middle Kittanning seam of one or both of the Freeport coals (Nos. 6a and 7). There are numerous localities in which both of the latter seams appear in the same vertical section with the great seam; also, the character of the Freeport coals is quite different from that of the top coal of the Hocking Valley seam.

"The lower bench of the normal seam ranges from 6 to 30 inches in thickness. In the western part of the field it is thinnest; it attains its greatest thickness in the Sunday Creek Valley. The lower slate or parting, which makes the upper boundary, is seldom more than 1 inch in thickness, and ½-inch is the common measure.

"The middle bench of the normal seam ranges from 4 to 28 inches in thickness. It is thinnest in the Sunday Creek Valley, and thickest in the Straitsville and Monday Creek regions. The second slate, which covers the second bench of coal, is very steady and regular. In fact, it is very nigh coextensive with the Middle Kittanning seam. In thickness it ranges between 2 and 4 inches.

"The third or upper bench of the normal seam, which is from 12 to 24 inches in thickness, is generally poor in quality, at least for part of its volume. It holds this character almost everywhere, through Muskingum and northern Perry, where the seam is single, being known as 'bone

coal' and very seldom being taken down as fuel. Directly above the second slate there is always throughout the Hocking Valley field a band of inferior coal. It is known as bone coal, hard bone, soft bone and soft coal, and the miner is almost everywhere instructed to reject it .... Very often, after rejecting 4 to 8 inches of soft coal at the bottom of this bench, a good piece of coal is found above. This bench is of the best character in the Straitsville and Monday Creek districts.

"The supplementary seam of the Hocking Valley is, in the general view, counted with the upper bench of the normal seam, the whole being known as top coal. It has a maximum thickness of 10 feet. All the thickness of the Hocking Valley seam in excess of 6 feet, and in many parts of the field in excess of $4\frac{1}{2}$ feet, is to be credited to the supplementary seam. Its value is small in proportion to its volume. In the Sunday Creek Valley, where it reaches its maximum, it has been found impossible to market more than $3\frac{1}{2}$ feet of the 10 that belong to it. Its coal could scarcely sustain itself in market if separated from the lower benches of the normal seam. It is always open-burning and low in sulphur, but it inclines to excess of ash. It mines large, and has great strength to bear transportation and handling."

In Athens County, outcrops of the Middle Kittanning occur in Waterloo and York Townships and just beyond at the western edge of Trimble Township, as shown on the geologic map in pocket. Shaft mines have exposed, at one time or another, or drill records have indicated this coal's presence under deep cover in Athens, Canaan, and Dover Townships, and drill records reveal its existence in southwestern Ames Township and possibly in part of Lee Township (Ray, 1930, map op. p. 72). Selected localities for outcrop areas and deep mines are shown on map 5.

The following table summarizes the thicknesses for the several benches and partings of the Middle Kittanning coal in Athens County -- mostly from measurements made during the present investigation.

Table 8

Summary of Thickness Data Pertaining to Benches and Partings of the Middle Kittanning (No. 6) Coal in Athens County, Ohio

Unit	Number of Measurements	Thickness							
		Maximum		Minimum		Average		Total	
		Ft.	In.	Ft.	In.	Ft.	In.	Ft.	In.
Roof Coal	18	3	0	0	3	1	7	7	$4\frac{1}{2}$
Upper Parting . . .	16	1	11	0	2	0	$6\frac{1}{2}$	5	$9\frac{1}{2}$
Upper Bench Coal .	30	4	9	0	1	1	11	5	3
Middle Parting. . .	30	0	6	0	2	0	$3\frac{1}{2}$	3	4
Middle Bench Coal .	33	2	6	0	6	1	$10\frac{1}{2}$	3	$0\frac{1}{2}$
Lower Parting. . .	33	0	2	0	$0\frac{1}{4}$	0	1	1	2
Lower Bench Coal .	33	2	6	0	4	1	1	1	1

The measurements used to compile the above table show a maximum total thickness, including partings, of about 10 feet (locality 6744) and a minimum thickness of only 4 inches (locality 12478). The average thicknesses agree very closely with those determined by Merrill (1951, p. 174) for northern Hocking County. At two localities in Waterloo Township (7582 and 7589) massive Lower Freeport sandstone has cut out the top two benches of coal and rests upon the middle bench. At four other localities in the same township (7584, 7591, etc.) the same sandstone rests upon the

upper bench with the roof coal missing. Wherever the base of the Lower Freeport sandstone rests on or near the top of the coal, the coal is apt to be thin and variable and its extent uncertain. There are rather extensive areas in the Hocking Valley field in which the Middle Kittanning coal is absent or much reduced in thickness and replaced by sandstone, shale, flint and plastic clay, limestone, and ferruginous sediments. Such areas are known as the "Jumbo fault," although they are not true faults and represent either areas of non-deposition of the coal-forming peat or areas from which the peat was eroded and sand, mud, and even calcareous and ferruginous sediments were deposited in its place. Excellent exposures of the "Jumbo fault" are now available (1957) in strip mines at locality 12478 in the SW¼, sec. 36, York Township, but only a mile distant to the northeast Middle Kittanning coal is present and has been mined. The so-called fault areas make serious problems in coal mining operations and have been subject of serious investigation by Merrill (1950, p. 175-195) and Ray (1930, map. op. p. 72).

The lower bench of Middle Kittanning coal is good coal consisting mostly of bright blocky coal with thin dull partings and with some fusain and pyrite. Its average thickness for the county is only 13 inches. Based upon the above unequal number of measurements the greatest thickness of the lower bench appears to be in Canaan, Dover, and Trimble Townships and to be thinner in Waterloo and York Townships. It is thinnest in Waterloo Township where 15 measurements indicate a remarkable consistent thickness from 6 to 8 inches.

The parting between the lower and middle benches is thin and is generally about one inch thick. It is known locally to the miners as the "little slate." It ranges from light gray clay to gray or black shale of variable character; is clayey, carbonaceous, and micaceous; and locally has slickensides, coaly streaks, and fossil plants.

The middle bench is also good coal but apparently less so than the lower one. It consists primarily of bright coal with thin dull partings including fusain and locally bony or shaly parts. Limited occurrences of pyrite and of calcite along vertical joint planes are present. Its thickness is greater than for the lower bench and averages almost two feet.

The parting between the middle and upper benches varies from two to six inches in thickness and is commonly three to four inches thick. It is the miners' "big slate." This parting is more apt to be shale than the lower parting and is most often gray to black shale or clay shale. Coaly streaks and traces of fossil plants, including Stigmaria rootlets, are present at numerous locations, and mica and slickensides are less common than in the lower parting.

The upper bench is thicker at some localities than either of the two benches below, but is also, in part, inferior coal in comparison with those benches. The greater thicknesses in Trimble Township are in the thick Sunday Creek section described by Orton (1884, p. 926-940); and the small thicknesses in Waterloo Township are, in part, accounted for by sandstone cutouts. The upper bench contains less bright coal and much larger amounts of fusain and as in proportion to the lower and middle benches. Bone, cannel, and shale, especially in the bottom and toward the top, are more prevalent in this bench. At some localities (7584, 7592) in Waterloo Township it is shaly with bright coal streaks. Pyrite is visible at many localities, fossil plant remains at some, and thin calcite films along joint planes at a few. In the thick area in the Sunday Creek district more than half the thickness of this bench was rejected in two separate parts in mining (Orton, 1884, p. 930).

The parting between the upper bench and roof coal or top coal is dark gray to black, bony, carbonaceous shale containing pyrite, fossil plants, and locally mica. It is generally 3 to 6 inches thick and varies from 2 to 21 inches.

The roof coal (Orton's supplementary seam) present throughout the Hocking Valley field in addition to the three regular benches elsewhere, varies from 3 inches to 2 feet 6 inches in 18 measurements with an average thickness of 1 foot 7 inches. Observations show it to be missing throughout most of Waterloo Township and regularly present in the remainder of the Middle Kittanning field in Athens County. Orton (1884, p. 922) reported that the roof coal attains its maximum development in the Sunday Creek district. It is largely bony and shaly in composition, with some bright coal, and is reported to mine in large strong blocks (Orton, 1884, p. 923). As can

be anticipated from its bony and shaly nature, it is high in ash, but it is unexpectedly low in sulphur. Some discernible fusain and pyrite does occur locally. It was usually left hanging in deep mining operations.

Details on quality, mined out areas, and reserves of Kittanning coal in Athens County are given on pages 220-221, 226-227.

Washingtonville Shale Member. - Stout and Lamborn (1924, p. 175-181) named this member from exposures at Washingtonville in section 36, Green Township, Mahoning County, Ohio. The known distribution of the Washingtonville member is in disconnected outcrops from the type area southwest to Perry County and possibly as far as Hocking County. It is brackish and marine in origin and consists of black, bony, carbonaceous shale distinguished at many localities by conspicuous fossil clams. Locally, in addition, as in parts of Coshocton and Muskingum Counties, there is a supplemental upper thickness of gray argillaceous to silty shale with an abundance of varied marine fossils. The Washingtonville member varies from 1 to 6 feet in thickness and normally rests directly upon or is separated from the Middle Kittanning coal by several feet of unfossiliferous shale.

Washingtonville shale has not been recognized in Athens County. The nearest known definite exposure is about 15 miles beyond the northern edge of the county near New Lexington in Perry County. There, in strip mines, it is thin but typical black shale with large fossil brachiopods instead of the usual fossil clams. Marine fossils in ironstone nodules between the Middle Kittanning and Lower Freeport coals in Hocking County, some distance west of Athens County, may belong to the Washingtonville member, but correlation is uncertain at present.

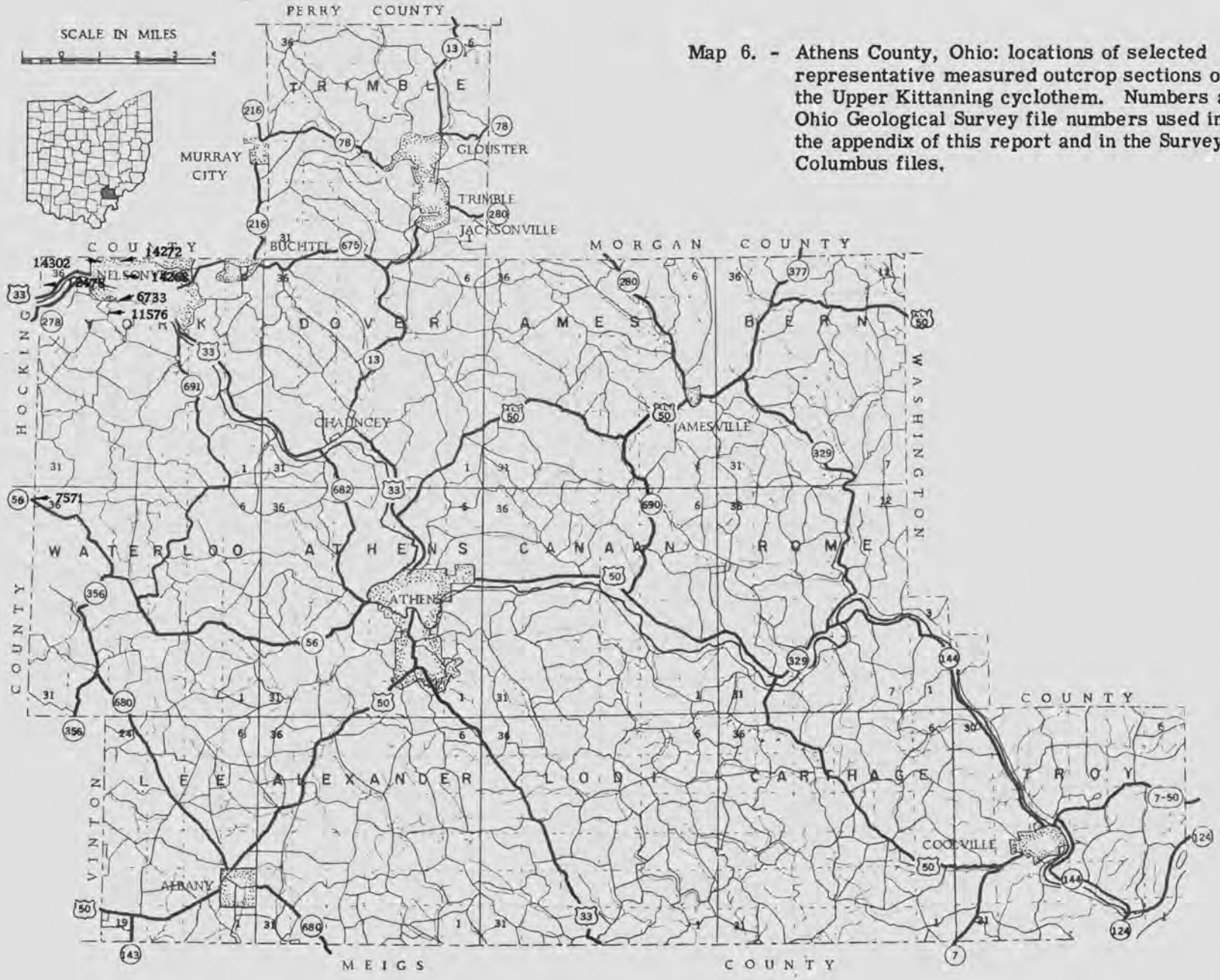
Upper Kittanning Cyclothem

The third and uppermost Kittanning cyclothem is named from the Upper Kittanning coal. There are only a few records of this coal and its associated members in Ohio, even if all correlations of the Kittanning cyclothems are correct. Although the Upper Kittanning coal is a minor coal even in the type area, its distribution is apparently much more regular and widespread in Pennsylvania than in Ohio (Ashley, 1928, p. 113); and Waage (1950, p. 82) also found that the Upper Kittanning coal is persistent in Maryland. In addition to the coal and underclay, a shale and sandstone member is present in Ohio, and Waage (1950, p. 29) has reported a nodular nonmarine limestone under the coal in Maryland.

Orton (1884, p. 51, ff.), in his description of the stratigraphic sequence of coals in the Lower Coal Measures, mentioned the Upper Kittanning coal in Ohio.. Elsewhere in the same report (p. 209, 215) he referred specifically to this coal in Jefferson County. Lamborn (1930), in his bulletin on the geology of Jefferson County, made no mention of Upper Kittanning coal, although Stout and he (1924, p. 182-184) had previously recognized occurrences of that coal in Columbiana County just north of Jefferson County.

The Upper Kittanning cyclothem is apparently both weak in development and discontinuous in distribution. Part of the absence of its members is undoubtedly caused by no deposition of the original sediments, but much of their omission along the possible outcrop is most certainly due to the presence of the massive Lower Freeport sandstone, which occupies channels of ancient streams that meandered through and partially eroded the peat bogs and mud and sand flats during and following the deposition of Upper Kittanning sediments. Unless the Upper Kittanning coal and underclay are recognized, shale and sandstone immediately above the Middle Kittanning coal are considered as part of the Lower Freeport cyclothem.

In northern York Township there are about a half dozen exposures in the immediate vicinity of Nelsonville, in which there is a thin coal or coaly zone lying 6 to 17 feet above the Middle Kittanning coal. These exposures, plus one additional one in section 36, Waterloo Township (locality 7571), are the only occurrences of the Upper Kittanning cyclothem observed in Athens County, and the above coal and the associated underclay, shale, and sandstone are tentatively correlated



Map 6. - Athens County, Ohio: locations of selected representative measured outcrop sections of the Upper Kittanning cyclothem. Numbers are Ohio Geological Survey file numbers used in the appendix of this report and in the Survey's Columbus files.

with that cyclothem. Several of these localities are shown on map 6 and include localities 6733 and 11576 south of Nelsonville, and localities 12478, 14302 and 14268 north and west of the same city.

Upper Kittanning Shale and/or Sandstone Member. - Based upon five measurements this member has an average thickness of 12 feet 6 inches, with a minimum thickness of only 6 feet (locality 14272) and a maximum of 17 feet 6 inches (locality 14268). It is typically composed of light gray to gray or olive drab limonite-stained shale that varies in lithology from micaceous, silty to sandy shale. Clayey or carbonaceous zones, the latter associated with fossil plants, scattered ironstone concretions, and interbedded sandstone layers occur locally. At locality 12478 the shale of this interval is a tan, massive, flinty-appearing clay shale characterized by a starch-like fracture.

In absence of the Upper Kittanning coal and underclay it is impossible to distinguish this member from overlying shale and sandstone, and it is treated as part of the Lower Freeport cyclothem in this report.

Upper Kittanning Underclay Member. - This underclay is light to dark gray, thin, and impure clay. Its known thickness changes from a mere 2 inches (locality 14272) to more than 18 inches (locality 14302) and averages 10 inches for 5 measurements. At the few places observed, it varies from massive to somewhat bedded and from impure flinty to micaceous plastic clay. On the whole it seems to be a rather lean clay in plasticity. In summary, this thin and low quality clay of discontinuous distribution is of interest only for its stratigraphic implications.

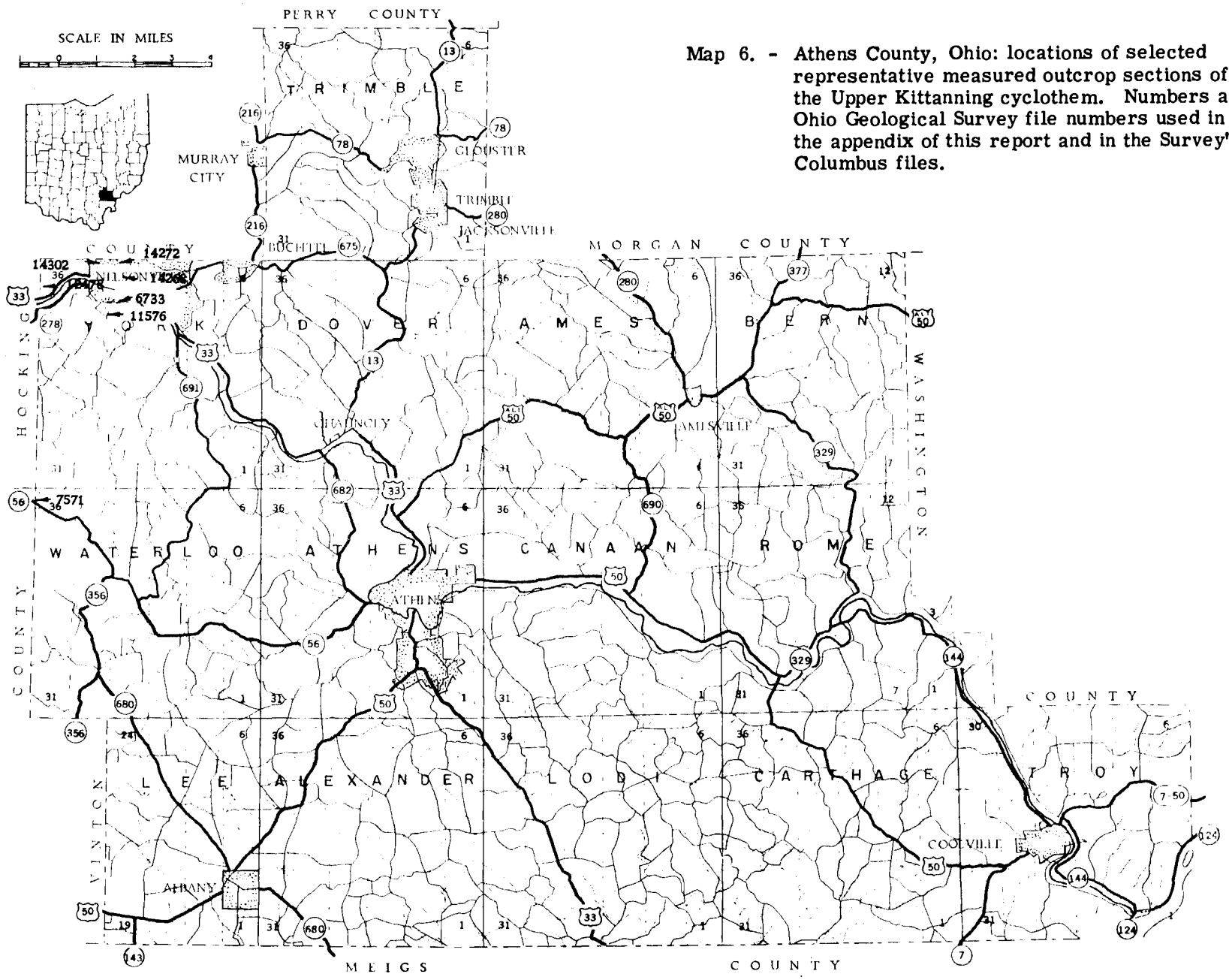
Upper Kittanning Coal Member. - Upper Kittanning coal was observed at only three or four localities in Athens County, but at several additional localities its underclay is present without any coal. Thickness ranges from 3 to 9 inches with an approximate average of 6 inches. At all three localities it is at least in part a shaly coal, and at locality 11576 it is represented only by dark gray, carbonaceous, and sandy shale. At locality 14302, on the east side of Dorr Run in section 30, York Township, there are 5 inches of bright blocky coal associated with 4 inches of shaly coal in two zones and a 9-inch underclay parting. It is worthless as fuel and merits attention only for its stratigraphic consideration.

Lower Freeport Cyclothem

As early as 1858 H. D. Rogers (v. 2, pt. 1, p. 474-492) used Freeport as a group name for those strata between the Lower Freeport and Lower Mahoning sandstones. This name was taken from the town of Freeport in Armstrong County, Pennsylvania. Strata in the above interval are now recognized as including three cyclothems which are, from the base upward, the Lower Freeport, Bolivar, and Upper Freeport cyclothems. The Bolivar cyclothem is a minor one, and most of the thickness of Rogers' Freeport group is occupied by members of the Freeport cyclothems. Both Freeport cyclothems are nearly complete, although the marine member in each is not fully developed and consists only of shale.

The Lower Freeport members, although discontinuous, can be traced along the belt of outcrop across eastern Ohio. The massive Lower Freeport sandstone is one of the outstanding sandstones in the Allegheny series, and the limestone is the lowest of the fresh-water limestones to be fairly well developed and widespread in the State.

All members of the Lower Freeport cyclothem listed in table 7 are present with some degree of regularity along the outcrop across Athens County. Since the interval between the Middle Kittanning and Lower Freeport coals is normally only about 40 feet, the outcrop of the Lower Freeport members follows very closely that for the Middle Kittanning coal shown on the geologic map in the pocket. Exposures are limited to Dover, Trimble, Waterloo, and York Townships.



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The coal and underclay are the most uninterrupted of all the members across the county, the fresh-water limestone is least persistent, and the sandstone, where thick and massive in development, is most prominent.

Lower Freeport Shale and/or Sandstone Member. - In the general absence of the Washingtonville marine shale and of the Upper Kittanning members, the Lower Freeport shale and sandstone rest upon the top of the Middle Kittanning (No. 6) coal. At some 50 localities in Athens County (map 7) rocks overlying the Middle Kittanning coal were observed.

The normal sequence directly above that coal is gray to dark gray or even black shale containing carbonaceous material and locally recognizable fossil plants, some of which beds may really belong to the Middle Kittanning cycle of deposition. If this shale is not cut out by massive sandstone, it typically grades upward into silty, sandy, micaceous shale which may be interbedded with fine- to medium-grained, micaceous sandstone in layers or lenses. These are definitely bedded or stratified rocks, and their thickness is variable depending in large part upon the development of massive Lower Freeport sandstone.

The Lower Freeport sandstone is a striking member in respect to its thickness, massive character, and extent. In 23 measurements within the county it varies from 11 feet to 66 feet in thickness and averages approximately 39 feet. The average thickness for 9 measurements in which its full thickness was exposed is 42 feet and 8 inches. The average is about 13 feet greater than that determined by Laubach (1953, p. 27), who found that its thickness increases southward from Trimble and York Townships, where the average is under 20 feet, to just over 40 feet in Waterloo Township. The absence of the Lower Freeport coal, underclay, and limestone above most of the thicker sections of massive sandstone indicates that at those localities the Lower Freeport and Bolivar or Upper Freeport sandstones are coalesced at the expense of the missing Lower Freeport members.

Laubach's recent description (1953, p. 23, 26) of the Lower Freeport sandstone is given below:

"The Lower Freeport member is the most prominent sandstone in the upper part of the Allegheny formation in Athens County. It is conspicuous not only for its thickness but also for its continuity along the outcrop. Stratigraphically it lies just above the Middle Kittanning #6 coal. Where the Lower Freeport sandstone is absent or restricted in thickness, its place is taken by the Lower Freeport shale. At a number of localities minor thicknesses of this shale occur between the Lower Freeport sandstone and the Middle Kittanning coal, and the contact between the sandstone and shale is disconformable. In section 2, Ward Township, Hocking County, in a stretch of 75 feet at an abandoned strip mine, this disconformity has 5 feet of relief. At other places the base of the sandstone forms the roof of the coal and no shale is present.

"In Ward Township, Hocking County, and in Trimble and York Townships, Athens County, the shale between the sandstone and coal is particularly well developed. This interval ranges from 1 foot 4 inches to 23 feet 10 inches in thickness and averages about 8 feet in this area. In northern York Township there is a small area in which the sandstone member is absent and the entire Lower Freeport interval is occupied by shale, mudstone, and clay. In Waterloo Township, the shale at the base of the sandstone is thin and only locally present....

"The Lower Freeport sandstone is medium grained and is gray to light gray on weathered surfaces. On freshly exposed surfaces the color is pale yellow, light tan, or buff. This difference is caused by a very thin coating of ferric iron oxide on the sand grains where weathered. Concentration of the iron oxide is localized along joints and at these places the sandstone is dark brown. The iron oxide also acts as a cementing agent. The cement is so weak, however, that at many localities the sandstone is friable and can be easily pulverized. The Lower Freeport sandstone is very massive. Even where the thickness is restricted, bedding planes are absent. The Lower Freeport member contains much colorless mica, which, like that in the Cow Run sandstone, has probably been bleached."

Laubach's study found that most of the quartz grains in this sandstone are enlarged by secondary crystalline outgrowths and that in addition to mica, garnet, tourmaline, and zircon, opaque heavy minerals also occur. In samples tested from three localities proportions among the heavy minerals varied markedly. Silt and clay particles are mentioned as present but no discussion of them is given.

Sandstones such as the Lower Freeport are now classified as sub-graywackes, concerning which Laubach (1953, p. 40) summarized as follows:

"... This type of sandstone is of local accumulation and is produced by local 'winnowing or washing of graywacke, resulting in the removal of much of the silt and clay. Quartz grains do not become well rounded.

"Field relations, such as the disconformable lower contact, the local presence of conglomerate and plant fossils, and its lenticular nature, mark the Cow Run as a cut-and-fill type of sand body associated with a deltaic environment. Deposition probably occurred in stream channels on the subaerial portion of a distributary system, the washing process being accomplished for most part during transportation.... "

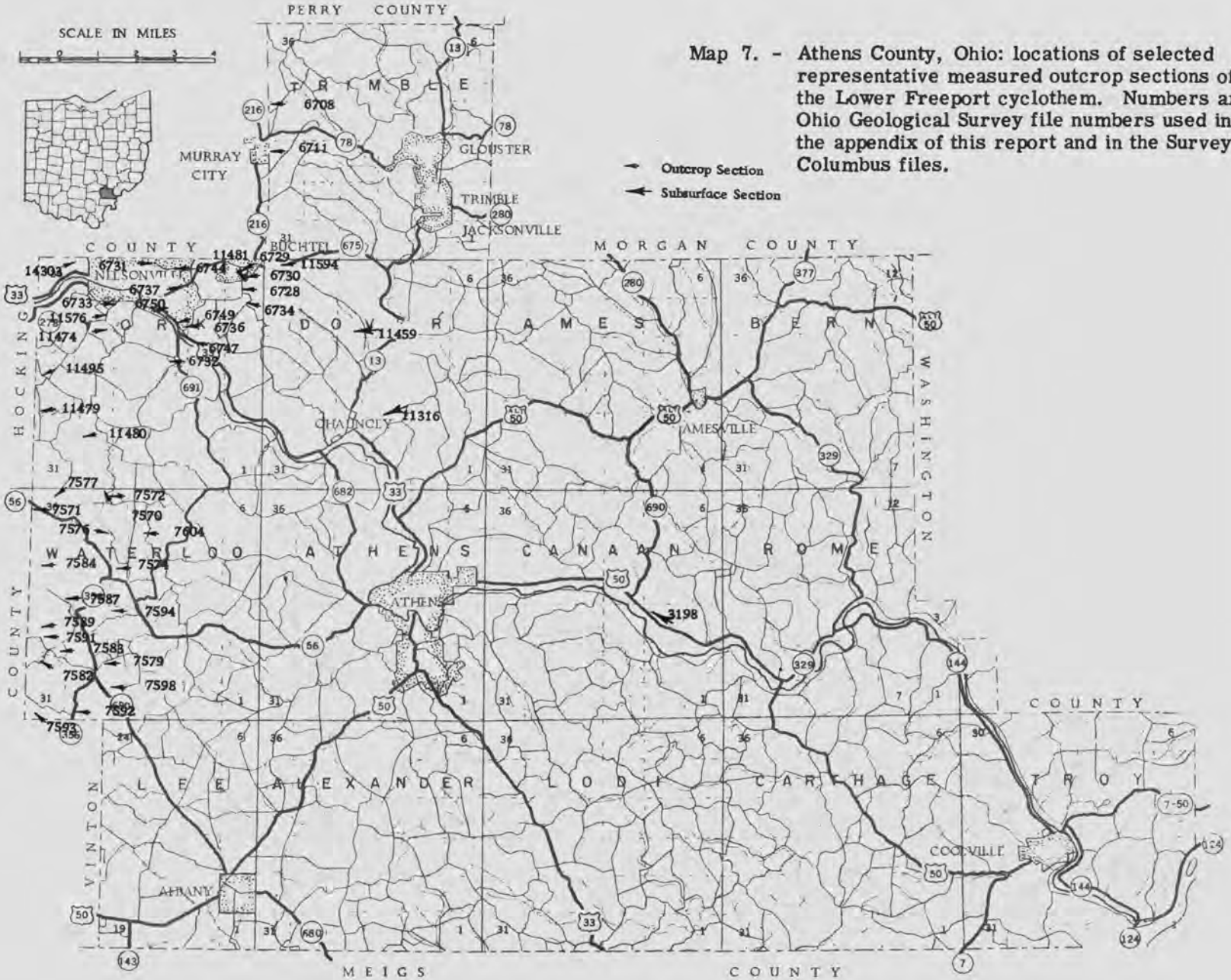
Lower Freeport Limestone Member. - This member is the lowest widespread freshwater limestone in the Pennsylvanian system of Ohio (Stout, 1927, p. 335). Only the Hamden (restricted) and Salem limestones are lower in the stratigraphic section, and those are limited in geographic occurrence. Lamborn (1951, p. 27) summarized the characteristics of the Lower Freeport limestone and its occurrence as follows:

"... the (Lower Freeport) limestone is local in occurrence and is invariably thin and of mediocre quality. The stone is generally gray or bluish gray in color and dense and compact in structure. The fossils... are limited to the fresh or brackish water types. Impurities in the form of clay and iron carbonate are generally present in varying amounts.... the member generally consists of nodules and lens-like masses of varying size occurring at the base of or embedded in the Lower Freeport clay. Where present on the outcrop the limestone varies in thickness from a few inches to a maximum of 4 or 5 feet...."

In Athens County, the Lower Freeport limestone is generally absent and was recognized at less than 10 scattered localities in Waterloo and York Townships. In part it seems to be replaced by massive sandstone and in part to be absent due to lack of development - - even where the overlying underclay and coal are present. In a number of localities the limestone and underclay between the Lower Freeport and Lower Mahoning sandstones are interpreted as belonging to either the Bolivar or the Upper Freeport cyclothem. This is primarily because of the large thickness of Lower Freeport sandstone, possibly including Upper Freeport sandstone as well, and its general stratigraphic relationship to the Lower Mahoning sandstone.

The thickness varies from 8 inches to 8 feet and is in most available measurements about 1 foot which is the approximate average thickness. The color is some shade of gray, usually full to dark gray but locally even greenish. Surfaces and near surface zones often weather to lighter shades than the unweathered rock and regularly are stained by iron oxides to varying shades and intensities of brown and yellow. Stratification is usually nodules arranged in layers or scattered in clay or shale, but locally it can be described as massive or shaly. The texture is typically dense, often with small crystalline masses and veins of calcite, limonite, or pyrite. Weathered surfaces may become pitted and spongy and cone-in-cone is present at locality 7592 in section 25, Waterloo Township. The composition is variable and always inferior to pure limestone and may contain mica or carbonate, oxides, and sulphides of iron, and various clastic materials from sand to clay sizes. Locally the iron content is sufficient to affect noticeably the weight of the unweathered rock (locality 7592). Fossils are not abundant or conspicuous, and are small forms including ostracods and Spirorbis.

Lower Freeport Underclay Member. - The following taken from Stout, et. al. (1923,



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p. 417, 418, 423, 424) summarizes the stratigraphy, distribution, and properties of the Lower Freeport underclay in Ohio:

"The Lower Freeport clay adds but little to the ceramic resources of Ohio, as the bed lacks continuity and as the material with few exceptions fails to meet the requirements for clay product . . . . The usual position of the Lower Freeport clay is nearly midway between the Middle Kittanning coal and the Upper Freeport coal, . . . with few exceptions the coal immediately associated with the Lower Freeport clay is thin and uncertain and is poor in quality. In some localities deposits of Lower Freeport limestone are found directly on or only a few feet below the member under consideration.

"The common argillaceous material on the Lower Freeport horizon is plastic clay which is light to dark gray in color, usually coarse in texture, and rather low in bonding properties. In places lenses or irregular masses of flint clay are found interbedded with the plastic. . . . The flint clay is usually dark gray in color, but some of it is often mottled or banded with shades of red and yellow. Organic matter and iron compounds appear to be the chief pigments. The texture varies from fine to coarse, depending largely on the content of siliceous material. . . . The thickness of the Lower Freeport clay varies from 1 to 20 feet but averages less than 3 feet.

"The Lower Freeport clay may be traced with many wants and irregularities from the Ohio River in Lawrence County northeast across the State to the Ohio-Pennsylvania line in Columbiana County. . . .

"The horizon yields both flint and plastic clay of which the plastic far exceeds the flint in quantity. The apparent impurities most detrimental in the plastic clay are siderite and limonite in the nodular forms. In places the clay is also heavily charged with pyrite crystals. It is everywhere siliceous and the sandy matter is coarse-grained. The flint clay contains about the same kinds of injurious constituents."

Recorded Athens County exposures of Lower Freeport underclay total approximately 30 outcrops confined mostly to Waterloo and York Townships but including a few in Dover and Trimble Townships (map 7). This number indicates some persistence along the outcrop, but the entire thickness was observed at only 19 of the exposures. The thickness varies from only 6 inches at locality 7571 in Waterloo Township to 5 feet 10 inches at locality 6744 in York Township and averages 2 feet 4 inches. The color is normally light gray to gray but limonite stain to some extent is common, and at some localities to a considerable extent. Fragmental materials include sand, silt, mica, calcareous substances, and limestone. The darker gray parts of the clay are apt to be carbonaceous and to contain traces of fossil plants, and even coaly streaks are present at several places.

Lower Freeport Coal Member. - The Lower Freeport coal is one of the minor coals mined in the Allegheny series of Ohio. Although widely distributed it is usually represented by only a few inches of coal or of carbonaceous shale. It has sufficient thickness and quality for mining in only a few local areas and is best developed in Columbiana and Jefferson Counties. Its stratigraphic position is about midway in the interval between the Middle Kittanning and Upper Freeport coals.

Athens County is one of the areas in which the Lower Freeport coal attains better development in Ohio, and it has been mined locally to a small extent. It suffers in importance in comparison with the Lower and Middle Kittanning, Pittsburgh, and Upper Freeport coals which far surpass the Lower Freeport coal in extent, thickness, and reserves within the county.

Outcrops of this coal were seen at 26 localities in Athens County, and at almost half of these exposures the coal had been mined or prospected. The localities are distributed as follows: 1 near the northwest corner of Dover Township, 8 in Waterloo Township, and 17 in York Township (map 7).

The thickness of the Lower Freeport coal varies from 1 inch at three localities in Waterloo and York Townships to more than 3 feet at three localities along the north side of the Hocking Valley just east of Nelsonville in York Township. The average thickness is 1 foot 8 inches for all measurements in Athens County, but the average shrinks to only 9 inches where the coal occurs in a single bench (12 localities) and expands to 2 feet 6 inches where present in two benches (14 localities). A parting located near the middle of the seam and consisting usually of gray shale has an average thickness of 2 inches. The two benches are nearly equal in thickness; the lower bench averages 1 foot 3 inches and the upper one 1 foot 1 inch. The measured thicknesses are not always in the same order as the averages, for at 5 localities both benches have the same thickness and at 4 others the upper bench is thicker than the lower one.

The coal in both benches tends to be bright and blocky with numerous thin dull partings including considerable fusain. Pyrite is usually present to some extent in thin sheets and less commonly in small masses. The upper bench tends to be shaly, especially toward its top, and may be dull shaly coal with streaks of bright coal. At single bench localities the coal is prone to be shaly. Melanterite, copiapite, etc., appear on weathered surfaces of the coal as decomposition products of the pyrite.

The parting varies from one to four inches in thickness and is most commonly shale or clay shale and less commonly clay. Its color is gray to dark gray or even black with limonite stain where weathered and stained, and its visible composition includes carbonaceous and coaly materials, fossil plants, fine mica flakes, and pyrite.

Details of production and reserves for Lower Freeport coal in Athens County are given under Economic Geology on pages 219, 223, 235.

Dorr Run Shale Member. - Although Andrews (1871, p. 87) had noted fossils on this horizon as early as 1870, it was not until recently that Sturgeon and Merrill (1949, p. 1-11) described and named this member. The Dorr Run member is known only in a small area in Athens, Hocking, and Perry Counties, and the type exposure is at a strip mine in the valley of Dorr Run in the SW¼ NW¼, sec. 31, Ward Township, Hocking County. Throughout the above area Dorr Run shale is rather persistent, but it has not been recognized elsewhere.

Its lithology is typically a gray to dark gray or black, argillaceous, carbonaceous, marine or brackish shale and represents only the initial near-shore deposition of the marine part of a cyclothem. Thicknesses range from an inch to more than 10 feet with an average of about 1 foot 6 inches. In position Dorr Run shale closely or directly overlies the Lower Freeport coal. Lithologically Dorr Run shale cannot be distinguished from similar but unfossiliferous overlying shale, which occurs at a number of localities. At such places the top limit of the Dorr Run member can be located only after painstaking search for the presence or absence of fossils. Characteristic Dorr Run fossils are numerous Lingula and pectinoid clams. Other brachiopods and clams as well as gastropods, scaphopods, conodonts, and fish remains are present. When better known and traced to its maximum extent the Dorr Run member will be useful in identifying and correlating the Lower Freeport coal.

More than half of the known outcrops of Dorr Run shale are in Athens County, where it was recognized at 7 exposures in Waterloo Township and at 10 more in York Township. Thickness ranges from 4 inches to more than 10 feet, and the greatest thicknesses are in York Township in section 6 near Buchtel (locality 11481); northwest of Nelsonville in section 36 (locality 14303); along Minkers Run in sections 16 (locality 6732), 23 (locality 6733), and 29 (locality 11576); along Hewett Fork and its tributaries in sections 26 (locality 11480) and 32 (locality 11479); and in Waterloo Township along Hewett Fork northeast of Carbondale in section 30 (locality 7570). At these localities thicknesses are from 3 feet 6 inches to 10 feet; at all other localities thicknesses are 2 feet or less and more than half are 1 foot or less. Average thickness for those exposures in Waterloo Township is 1 foot 2 inches and for those in York Township is 2 feet 1 inch, and the average for all exposures recorded within the county is 1 foot 9 inches. Where similar dark gray or black shale occurs above the Dorr Run member, the top

boundary has been drawn at the upper limit of marine fossils. It is possible that more careful search would reveal fossils still higher in those exposures and greater thickness for the shale under consideration.

Little need be added here to the general description of the Dorr Run shale. Its dark color, carbonaceous and argillaceous nature, brackish or marine fossils, and position above the Lower Freeport coal identify it in the field. A zone of carbonaceous shale approaching cannel coal in composition occurs in the Minkers Run area. Fine mica flakes, small pyrite masses or sheets, and fossil plants are locally present. Weathered portions tend to break into thin plates or sheets with limonite stain or crusts, to have secondary radiating clusters of needle-like gypsum crystals along the bedding planes, and to have the fossils generally obliterated. The more argillaceous parts weather and become soft clay-like masses.

Bolivar Cyclothem

The Bolivar cyclothem consists of a basal shale and sandstone, a nonmarine limestone, an underclay, and a seldom-present coal. Its best known member is the underclay which locally near Bolivar in Pennsylvania is a w ll known ceramic clay, is the best known member. Not only is this cyclothem an incomplete one, but its members tend to be irregular in geographic occurrence.

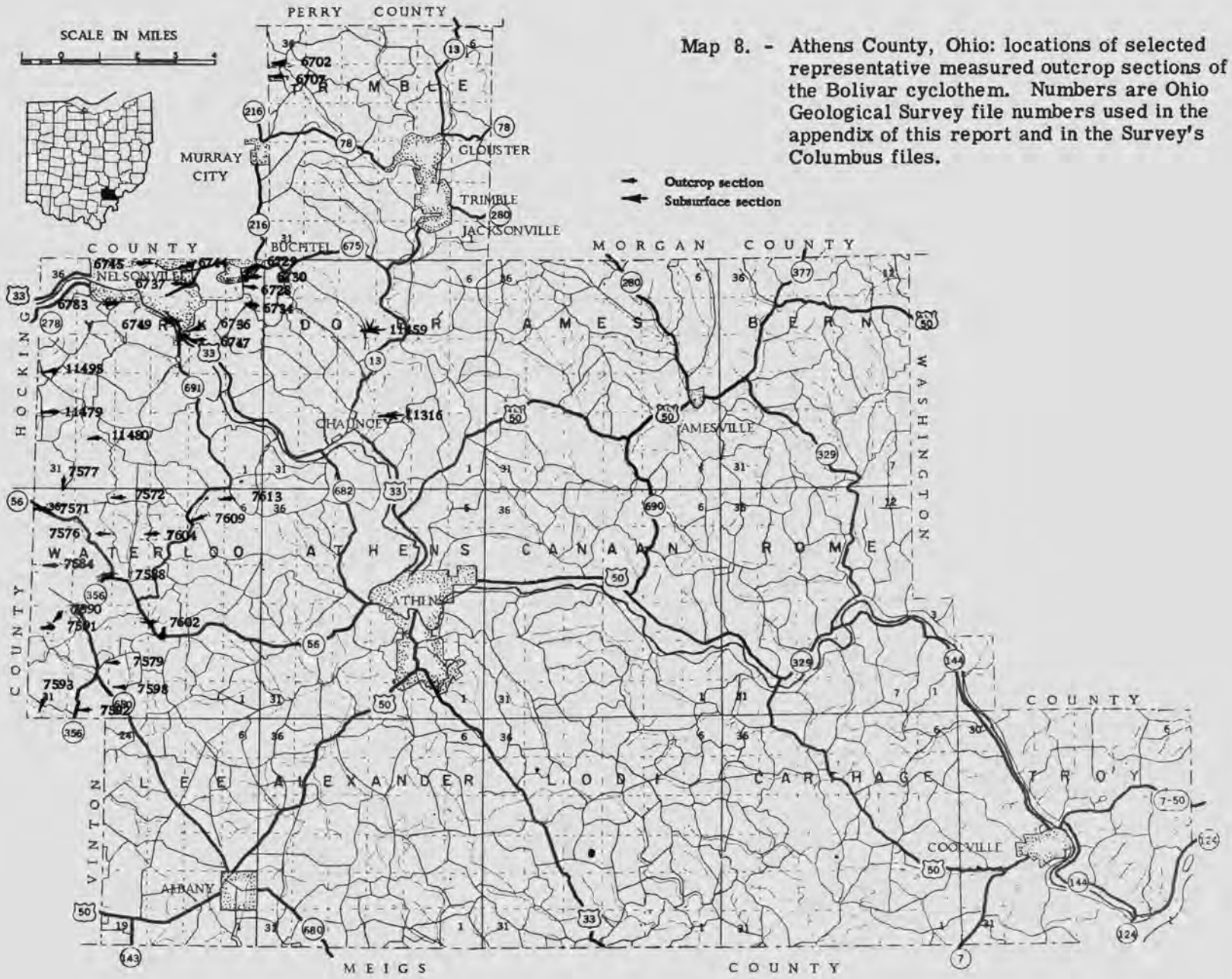
In Ohio the occurrence of Bolivar cyclothem's members is in keeping with that of its members elsewhere, and they can be traced with reasonable certainty along the outcrop belt from Columbiana to Lawrence Counties. The underclay is the best known, the coal is almost everywhere absent, and the limestone, which heretofore has been generally misunderstood and miscorrelated, is apparently widespread but not in a continuous distribution.

The Bolivar members are fairly persistent in Athens County, and map 8 shows localities of outcrops in Dover, Trimble, Waterloo, and York Townships.

Bolivar Shale and/or Sandstone Member. - In Ohio, shale and sandstone that occur in the interval between the Lower Freeport coal and the Bolivar underclay are called Upper Freeport. In fact, it is general practice to call any shale and sandstone between the Freeport coals Upper Freeport. Actually there are two shale and sandstone members separated by the Bolivar cyclothem in the interval between the Lower and Upper Freeport coals. Wherever the Bolivar members are absent these two shale and sandstone members coalesce, and it is impossible to distinguish them as separate units. Where it is impossible to separate the two shale and sandstone members, Upper Freeport can and should be applied as a name, but where the two can be recognized the lower shale and sandstone are herein called Bolivar. This lower member may correlate with the Butler sandstone in Pennsylvania.

Exposures of Bolivar shale and sandstone in Athens County are confined almost entirely to Waterloo and York Townships. Minimum and maximum extremes in thickness are 5 and 22 feet, respectively, and average thickness of this member based on 25 complete measurements in Dover, Waterloo, and York Townships is approximately 12 feet. A number of other outcrops were studied but are either incomplete in exposure or uncertain in interpretation with respect to the limits of the other Bolivar members.

Shawnee Limestone Member. - Although it has not been generally recognized in eastern Ohio and elsewhere, field evidence in Athens County indicates the strong possibility that a limestone separate from the Upper Freeport limestone is intimately associated with the Bolivar underclay. This limestone usually occurs embedded within, at the bottom of, or even at the top of that underclay, but at a few places limestone is present without any trace of underclay. The limestone associated with the Bolivar underclay is separated from the Lower Freeport coal below by the Dorr Run shale and the Bolivar shale and sandstone with an average combined thickness of about 14 feet. The interval to the base of the Upper Freeport coal is somewhat greater



Map 8. - Athens County, Ohio: locations of selected representative measured outcrop sections of the Bolivar cyclothem. Numbers are Ohio Geological Survey file numbers used in the appendix of this report and in the Survey's Columbus files.

and is occupied by the Upper Freeport shale and sandstone, limestone, and underclay with a total thickness of about 20 feet. Thicknesses of these members and intervals are variable; for instance, the Bolivar-Upper Freeport interval varies from less than 7 feet to more than 30 feet.

This limestone is undoubtedly correlative with the Shawnee limestone named by Orton (1878, p. 895, pls. op. p. 900, 912, and 921) from exposures near Shawnee in Perry County, Ohio. Orton later (1884, p. 104-106) correlated the Shawnee limestone with the Upper Freeport limestone and that correlation has been accepted and followed by Ohio geologists. The following evidence, however, strongly suggests that the Shawnee limestone really belongs in the Bolivar cyclothem instead of in the Upper Freeport cyclothem:

1. Thickness of interval between Shawnee limestone and base of Upper Freeport coal.

2. Lithology of interval between Shawnee limestone and base of Upper Freeport coal, including regularly underclay, shale and sandstone, and occasionally fresh-water limestone.

3. Occurrence of a fresh-water limestone at base of or within Upper Freeport underclay at several localities (6702, 6707, 7590, and 7593) in Trimble and Waterloo Townships (map 8).

4. Presence of limestones associated with both Bolivar and Upper Freeport limestones in same exposure (locality 7604) and possibly (locality 7609) in Waterloo Township (map 8).

Thickness of the entire Bolivar cyclothem's interval varies from 6 feet 6 inches to 30 feet 10 inches with a rather general distribution within the extremes. Half of the 28 sections available have thicknesses in excess of 20 feet. More significant than the thickness of the interval is the presence almost without exception of shale and sandstone between the Shawnee limestone and Bolivar underclay and the Lower Freeport coal below and the Upper Freeport limestone and underclay above. The normal succession in a Pennsylvanian cyclothem is shale and sandstone upward to fresh-water limestone and underclay (page 40 - typical cyclothem). The occurrence of limestone associated with the Upper Freeport underclay and only 2 to 4 feet below the Upper Freeport coal is in marked contrast with limestone associated with the Bolivar underclay on an average of 20 feet below the base of the Upper Freeport coal. A single exposure with limestones combined with both Bolivar and Upper Freeport underclays would clinch the interpretation of two limestones in the interval without doubt, but it must be admitted that at most exposures only one limestone is present. The best possible example of two limestones at the same locality is in the $S\frac{1}{2}$ $NE\frac{1}{4}$, sec. 23, Waterloo Township (locality 7604), where Shawnee limestone and Bolivar underclay are in normal development and the lower half of the Upper Freeport underclay is strongly impregnated with calcareous and ferruginous materials. Elsewhere ferruginous concretions occur in the Upper Freeport underclay or in the shale and sandstone below and may well represent the Upper Freeport limestone. It is probable that in eastern Ohio the deposition of calcareous and ferruginous sediments in shifting lacustrine basins was more or less continuous between the deposition of the Lower and Upper Freeport coals. A considerable period of mud and sand deposition with some ferruginous sediments, however, separated an early rather widespread (Bolivar) clay and limestone deposition from a later and more localized (Upper Freeport) limestone deposition.

It is proposed that the name Shawnee be reinstated to good standing and be used for the fresh-water limestone associated with the Bolivar underclay and that the name Upper Freeport, as applied to limestone, be restricted to limestone associated closely with the Upper Freeport underclay. The Shawnee limestone stratigraphically is below the Upper Freeport shale and sandstone, and the Upper Freeport limestone is above the same shale and sandstone.

Early designation of several Pennsylvanian limestones in eastern Ohio was in reference to their characteristic color, e. g., Blue (Lower Mercer) limestone, Buff (Shawnee) limestone, or Gray (Putnam Hill and Vanport) limestones; or to local geographic names, e. g., Gore (Upper

Mercer) limestone, Shawnee (limestone under discussion), or Zoar (Lower Mercer) limestone. The Shawnee limestone was first known as the Buff Limestone both locally and in the publications of the Second Geological Survey of Ohio, later as the Shawnee limestone, and still later as the Upper Freeport limestone.

Fresh unweathered Shawnee limestone varies in color from light to full gray, and weathered specimens are various shades of brown and yellow--hence the former name Buff Limestone. Its composition ranges from relatively pure calcium carbonate with small amounts of iron carbonate and other impurities to calcareous iron carbonate. The stone is usually firm and dense textured rock with or without thin veins and small masses of crystalline calcite and small inconspicuous fossils or cemented breccia. Stratification is in form of a single layer or several layers separated by clay or shale or of nodules embedded in clay or clay shale. It is probably more commonly nodular than regularly stratified. Weathered surfaces of the rock are mostly undulating and smooth but may be closely pitted and spongy or show a rough uneven surface composed of angular fragments in a differentially weathered breccia. Fossils are generally present and consist principally of ostracods, coiled tubes of Spirorbis, and fish scales and teeth. The more ferruginous parts are iron carbonate under cover and limonite on weathered outcrops.

At 26 places in Dover, Waterloo, and York Townships limestone was recognized as Shawnee, and the average thickness for all of these is 15 inches. The extremes in thickness are 3 inches to 3 feet.

Bolivar Underclay Member. - In Ohio the Ortons seem to have applied the name Bolivar to this underclay in 1884 (p. 22, 660), but I. C. White (1891, p. 159-160) is credited later with establishing the name in geologic literature. The type area is near the town of Bolivar in Westmoreland County, Pennsylvania, where it is an important ceramic clay. The Bolivar underclay and the overlying thin and seldom present Bolivar coal have been traced in discontinuous distribution across eastern Ohio. The best stratigraphic guides in finding and tracing the Bolivar members are the Lower Freeport members below and the Upper Freeport members above. On the average the interval to the Lower Freeport coal is 30 to 35 feet and to the Upper Freeport coal about 20 feet, but locally the Upper Freeport limestone and underclay are reported to rest directly upon the Bolivar underclay.

In Athens County Bolivar clay was recognized at 18 localities in Dover, Trimble, Waterloo, and York Townships (map 8) and seems to be rather persistent but not continuous along the belt of possible outcrop. This is contrary to the findings and interpretations of other geologists (Aukland, 1952, p. 24; Hall, 1951, p. 99; Merrill, 1950, p. 147) working recently in the Hocking Valley area, but Flint (1951, p. 55) found a more general distribution northwest in parts of Perry County. Contrary to average intervals for Ohio its mean position is only 12 to 14 feet above the Lower Freeport coal and approximately 20 feet below the Upper Freeport coal, although there is considerable variation from the average thicknesses. The average thickness of the underclay, excluding interbedded limestone layers, is 3 feet 9 inches; the minimum and maximum are 1 and 7 feet.

Clay of the Bolivar member is light gray to gray, commonly limonite stained, impure, plastic clay, and flint clay associated with the plastic variety was found only at three localities. The most prevalent impurities include ferruginous materials which are generally present at least in part of the thickness and may be disseminated or nodular and concretionary in form. Limestone occurs at top or bottom or as layer(s) or nodules within the clay. Mica flakes, quartz grains, and carbonaceous matter were recognized at few places.

Bolivar Coal Member. - The Bolivar coal is absent at most places including those where the Bolivar underclay is present. The coal's almost universal absence seems to have been caused by lack of deposition of coal-forming peat rather than by subsequent erosion of coal or peat.

Athens County presents no exception in the absence of Bolivar coal, for, barring one possibility, coal was not found along the probable outcrop. In section 36, Waterloo Township

(locality 7577), one inch of poor coal is interbedded with clay and clay shale at the Bolivar horizon. Even the Bolivar underclay seems usually to lack carbonaceous material and traces of fossil plants.

Upper Freeport Cyclothem

The Upper Freeport is a geologically significant cyclothem not only because it is the topmost cyclothem in the Allegheny series but also because it is quite persistent in occurrence and nearly complete in members. The top of the Upper Freeport (No. 7) coal has long been considered the top of the Allegheny or Lower Productive series. Locally there is a fossiliferous marine shale called the Uffington overlying the coal. In this report the Uffington member, although unknown in Athens County, is considered as topmost member in the Upper Freeport cyclothem and for purposes of description the topmost member of the Allegheny series.

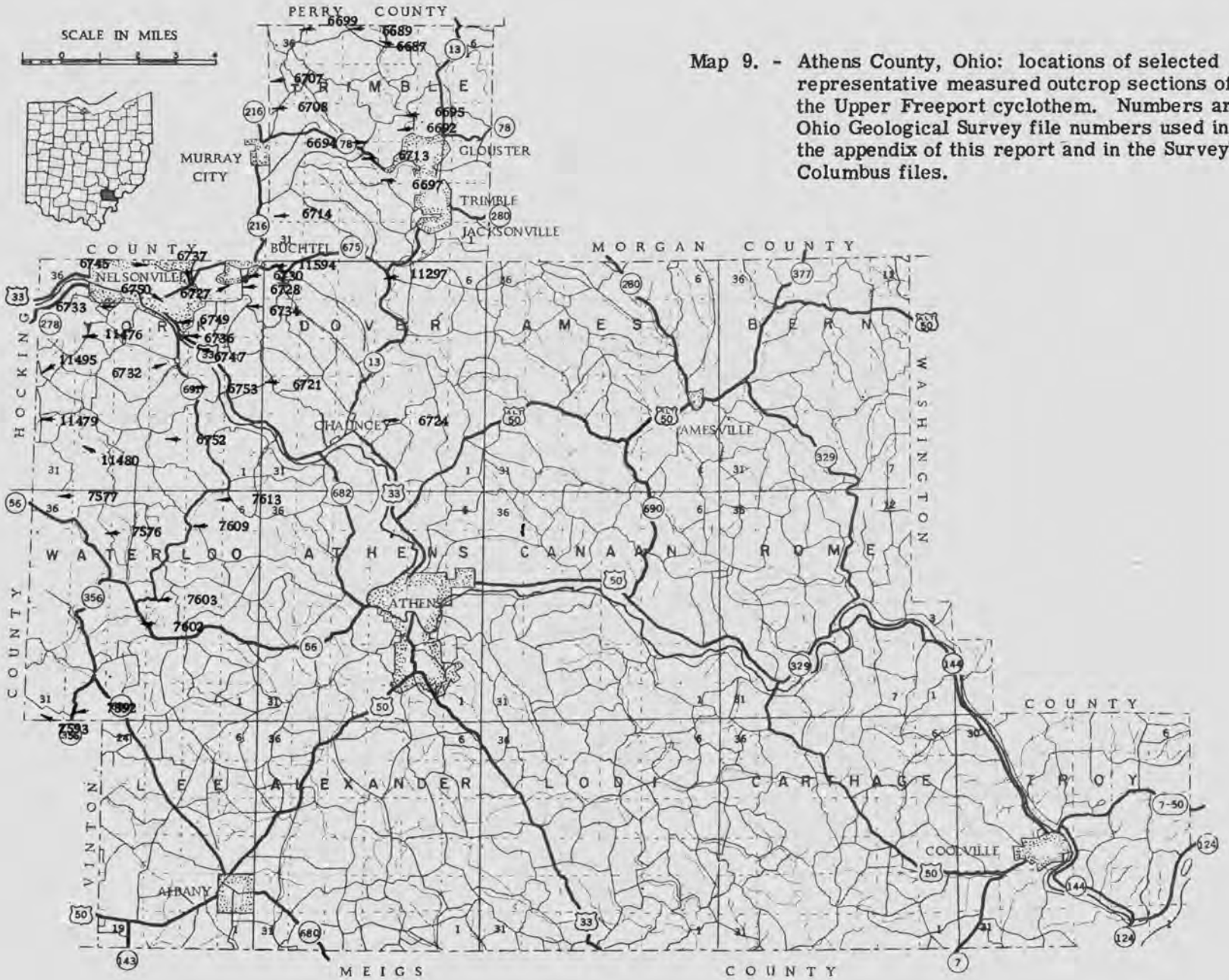
Several members in this cyclothem are major members, and the others are minor ones in importance. The Upper Freeport coal, although unsteady in occurrence, is locally a thick and minable coal and is one of the most important in the entire Allegheny series of Ohio. The underclay is rather persistent but generally thin and inferior in quality. The nonmarine limestone member is also thin, locally impure, and unsteady in occurrence. The true Upper Freeport shale and sandstone compare more favorably in thickness and lithology with the Bolivar shale and sandstone than with the thick massive Lower Freeport and Mahoning sandstones. Ferruginous nodules and blackband zones occur in or closely associated with the Upper Freeport cyclothem at several localities within the State.

Average thickness of the Upper Freeport cyclothem in Athens County is about 23 feet. The Upper Freeport coal is a significant reference stratum for distances to other members above and below, and those figures can be seen in the interval chart (fig. 9, p. 52). Athens County localities of Upper Freeport members occur in Dover, Trimble, Waterloo, and York Townships and possibly at the west edge of Athens Township along Factory Creek as shown on map 9.

Upper Freeport Shale and/or Sandstone Member. - The interval between the Bolivar underclay and the Upper Freeport limestone and underclay is occupied by shale and sandstone. Twenty-eight measurements of this member range in thickness from 5 feet to more than 28 feet, with an average of 17 feet. Shale exceeds sandstone in amount present in this space and is usually sandy and micaceous and in addition often is ferruginous. The sandstone is mostly micaceous, fine grained, bedded or even shaly appearing, and confined to the lower part of the interval or interbedded in shale. Massive, medium- to coarse-grained sandstone is rare, and only along Johnson Run near the north edge of Trimble Township (locality 6699) was a considerable thickness of 40 feet exposed.

The clay ironstone and limonite nodules, either scattered or in layers, are worthy of some attention, as they probably represent the downward extension of kidney ore of the Upper Freeport limestone horizon. This ironstone was formerly mined as ore for the Akron Furnace in the vicinity of Buchtel, where it was originally known as the Bessemer and later the Buchtel ore. Orton (1884, p. 410) has given a good description of the Buchtel ore at the time when it was being mined and when numerous fresh exposures were available. His description is given below:

"The Buchtel ore is a lean carbonate of iron, always calcareous, often passing by easy gradations into an impure limestone. The nodules or bowlders that compose it are of large size, and are very hard and heavy. They are embedded in clay, and are light gray in color, sometimes inclining to blue. The thickness of the seam at its best is between 5 and 6 feet, and there are considerable areas where it exceeds two feet in thickness. The Upper portion, where the seam is thickest, generally consists of a separate layer of nodules, more calcareous than the main seam, and called, distinctively, bowlder ore."



Map 9. - Athens County, Ohio: locations of selected representative measured outcrop sections of the Upper Freeport cyclothem. Numbers are Ohio Geological Survey file numbers used in the appendix of this report and in the Survey's Columbus files.

Upper Freeport Limestone Member. - The Upper Freeport limestone in this report is limited to fresh-water limestone at or near the base or within the Upper Freeport underclay. As a restricted definite limestone the Upper Freeport member was recorded at less than half a dozen places in Trimble and Waterloo Townships and ferruginous nodules at several more localities in those townships and in York Township in addition. If, however, ferruginous nodules in the underlying shale are included, as they probably should be, then the Upper Freeport limestone member is of general occurrence along the outcrop.

Five exposures of limestone are from 8 inches to 2 feet 9 inches in thickness and average 1 foot 3 inches. It is separated from the base of the Upper Freeport coal by 2 to 4 feet of underclay. In appearance the rock is similar to the Shawnee limestone. When fresh, it is gray to light gray and may have greenish spots; when weathered, it becomes yellow and brown. Its texture is dense, and at some localities it has thin veins and small masses of crystalline calcite. Fossils include the usual fresh-water forms and occur in both the limestone and associated clay shale. Its stratification is either as nodules embedded in the Upper Freeport underclay or bedded layers with thin clay partings. Always ferruginous, it grades locally into calcareous clay ironstone which weathers on the outcrop into limonite. At one locality in Trimble Township (locality 6689) limestone grades downward through a sandy and micaceous phase into sandstone.

Upper Freeport Underclay Member. - The Upper Freeport underclay is rather steady in occurrence along its outcrop in Athens County. Its average thickness in 38 measurements in Dover, Trimble, Waterloo, and York Townships is an even 2 feet. The minimum thickness observed was only two inches at locality 6750 in York Township and the maximum 4 feet 6 inches at another York Township locality (6734), excluding one exposure in Waterloo Township (locality 7602) of interbedded clay and clay shale totaling 9 feet. Its stratigraphic position is directly under the Upper Freeport coal and over the Upper Freeport limestone. The underclay is present at many places where the coal is absent due to replacement by the overlying massive Lower Mahoning sandstone or to lack of peat deposition, and at such places massive sandstone or shale overlies the clay. Where the limestone is absent, as it commonly is, the clay rests on shale or sandstone. As an example of the above conditions, throughout much of Waterloo Township Upper Freeport coal and limestone are missing, and the underclay alone is present. Elsewhere the coal and underclay are usually present, and the limestone, except for ferruginous nodules, is absent.

In lithology this underclay is everywhere light gray to gray plastic clay which is generally sandy and micaceous and ferruginous in character. Flinty clay was observed at only one locality in Waterloo Township (locality 7577). The thicker deposits tend to have nodular masses of calcareous and ferruginous materials. The iron-bearing minerals are chiefly carbonate or hydrated oxides, the latter often distributed as stain. Pyrite was seldom noticed in the field, but washing of samples would probably reveal its more general occurrence. Carbonaceous material and traces of fossil plants are locally present, especially in the upper part.

Upper Freeport (No. 7) Coal Member. - Upper Freeport, or coal No. 7, outcrops in Dover, Trimble, Waterloo, and York Townships and is an important coal in several areas (map 9). Some of the early names, such as Bailey Run and Happy Hollow coal, by which this coal was known in Athens County, are indicative of local areas of thick coal. The thicker exposures are along the Hocking Valley and its tributaries between Nelsonville and Chauncey. The tributary valleys of Hamley and Minkers Runs, Monday Creek and Snow Fork, and Sunday Creek and its west side tributaries, especially Bailey and Johnson Runs and Mud Fork, are notable areas adjacent to the Hocking Valley. Regional dip of the strata carries this coal below drainage in the vicinity of Beaumont and along Sunday Creek. The thickness and even the presence of Upper Freeport coal fluctuate widely from one place to another. It is generally absent throughout most of Waterloo Township and hence is missing, where due, along Hewett Fork and its tributaries.

From available measurements in Athens County the Upper Freeport coal is approximately 35 and 75 feet above the Lower Freeport and Middle Kittanning coals, respectively, and 45 and

165 feet below the Lower Brush Creek and Ames limestones, respectively. The average thickness of the coal for 52 measurements taken within the county is only 2 feet 10 inches, although in the areas where the coal is mined the thickness is somewhat greater. It should also be remembered that the average figure is materially reduced by measurements from the large area of very thin or no coal in Waterloo Township. Thickness data, when broken down by townships, are as follows:

Table 9

Maximum, Minimum, and Average Thickness For Upper Freeport Coal in Athens County, Ohio*

Township	Number of Measurements	Minimum Thickness Ft.	In.	Maximum Thickness Ft.	In.	Average Thickness Ft.	In.
Dover.	5	4	0	4	10	4	5
Trimble. . . .	14	1	5	4	8	3	6
Waterloo . . .	13	0	0	6	3	0	9
York	20	0	3	6	11	3	3
All Townships .	52	0	0	6	11	2	10

* Includes partings

At 11 localities the coal occurs in two benches separated by clay or shale, and at eight more places three benches and two partings are present. Table 10 below presents thickness data for the several benches and partings:

Table 10

Maximum, Minimum, and Average Thickness For The Several Benches and Partings of the Upper Freeport Coal Athens County, Ohio*

Bench or Parting	Number of Measurements	Maximum Thickness Ft.	In.	Minimum Thickness Ft.	In.	Average Thickness Ft.	In.
Top Bench . . .	8	1	3	0	1	0	$7\frac{1}{2}$
Upper Parting .	8	1	6	0	$0\frac{1}{4}$	0	5
Middle Bench. .	19	2	8	0	2	1	0
Lower Parting .	19	0	5	0	$0\frac{1}{4}$	0	3
Bottom Bench. .	19	3	4	1	7	2	5

* On assumption that the top bench is an added one, thicknesses for bottom and top or middle benches, where two and three benches are present, were averaged.

Total average thicknesses are different in the two tables, because table 9 is based on all measured localities where the coal is or should be present and table 10 is based only on those localities where the coal is present in two or three benches.

Maximum observed thickness of Upper Freeport coal is in section 6, York Township, where in a small area just south of Buchtel, thickness including parting is almost 7 feet. Thicknesses of 4 to 5 feet are present in the Bailey Run area where the coal has been extensively mined in Dover Township; in the valleys of Greens and Johnson Runs, Mud Fork, and West Branch of Sunday Creek, and in the vicinity of Glouster in Trimble Township; along the east side tributaries in both of the above townships; along both sides of the Hocking River between Nelsonville and Hamley Run and the tributary valleys, especially those of Hamley and Minkers Runs in York Township (Isopach Map, figure 20, p. 222).

Thickness of the Upper Freeport coal is unsteady, and locally it thickens or thins rapidly in short horizontal distances. Hence, in areas of thick coal there are patches of thin coal or even no coal. Southwestern York Township and most of Waterloo Township are areas of thin or no Upper Freeport coal.

The lower and middle benches, if three benches are present, are usually bright blocky coal with thin parting of dull coal including fusain and thin sheets or small masses of pyrite. Pyrite is often heavily concentrated in the basal inch or two. The top bench is commonly bony and shaly with streaks of bright coal and some fusain and pyrite. If only two benches are present, the upper bench is likely to be bony or shaly toward the top, and the same condition may occur in the thicker single bench coal. The lower parting varies from gray clay to dark gray or black, bony, carbonaceous shale with or without mica, fossil plants, and coaly streaks. The upper parting is shale or clay shale, gray to black in color, either argillaceous or silty and micaceous, or carbonaceous lacking or containing pyrite and coaly streaks.

Uffington Shale Member. - At the village of Uffington, which is located on the east side of the Monongahela River and just south of Morgantown in Monongalia County, West Virginia, there is a thick (20 to 40 feet), dark, sandy shale containing marine fossils and fossil plants. I. C. White in 1903 (p. 323-327) named and described this shale and listed more than 30 species of marine fossils collected at Uffington by J. J. Stevenson and identified by F. B. Meek and approximately 40 species of fossil plants collected and identified by David White from the roof shale of the Upper Freeport (Stockton) coal in the Kanawha Valley. The Uffington shale lies below the Lower Mahoning shale and sandstone and is here considered as the top member of the Upper Freeport cyclothem and, hence, as a member in the Allegheny series rather than in the Conemaugh series. If the shale over the Upper Freeport coal represents deposition in both marine and nonmarine environments, the name Uffington ought to be restricted to one or the other, most certainly to the marine shale. The plant-bearing and nonfossiliferous shale could be given a separate member name or referred to either the Upper Freeport or Lower Mahoning members as the facts of the stratigraphic relations might indicate.

Marine Uffington shale is known to occur in Ohio. Flint (1951, p. 55, 117) found 4 inches of black shale with the brachiopods Lingula and Orbiculoidea over the Upper Freeport coal in section 33, Harrison Township, Perry County. Earlier Stout and Lamborn (1924, p. 238, 258) had reported few fossils in dark shale overlying the same coal in Center and Madison Townships, Columbiana County. These few and widely scattered occurrences of marine fossils probably indicate that fossils have been overlooked at other localities.

No marine fossils were found in shale over the Upper Freeport coal in Athens County and it is doubtful whether any recognition should be given to the Uffington member within the area. Fossil plants do occur over the Upper Freeport coal at a number of places (localities 6692, 6694, 6695, 6697, 7613, and 11297) along its outcrop within the county, and an excellent collection of plant fossils has been made from this stratigraphic source in the last decade. The shale bearing fossil plants is either light or dark colored, and some of the best fossil plants occur in light gray, silty, micaceous or even sandy shale. Under the present uncertainties the Uffington member is not recognized in Athens County.

CONEMAUGH SERIES

The type area of the Conemaugh series is in western Pennsylvania, where F. Platt (1875, p. 5-8) named this series from exposures along the Conemaugh River Valley. At an earlier date H. D. Rogers (1840, p. 150) designated the presently defined Conemaugh series as part of his Allegheny series, which included the underlying Allegheny series as well. In 1844 Rogers (p. 156) called the Conemaugh rocks the Older Shales, and in 1858 (p. 16, 19) he applied the terms Older Coal Shales or Lower Barren Group to the strata between "the top of the Upper Freeport coal and ... the bottom of the great Pittsburgh bed." These upper and lower limits are the same as those employed by Platt in 1875, and are essentially the same as those used today, except Wilmarth (1938, p. 503) states "that the thin clay underlying the Pittsburgh coal has for many years been included in the Monongahela fm." As with the other currently used series names in the northern Appalachian basin, it was not until 1900 that O'Harra (p. 118-123) introduced them into Maryland and 1901 that Prosser (p. 191-199) first used these modern names for the Ohio Coal Measures. Condit (1912) published an excellent reconnaissance report on the Conemaugh series in Ohio, and in the same bulletin Mark reported on the Conemaugh marine fossils collected during Condit's field work.

In Ohio the Conemaugh series outcrops in a wide belt from Columbiana and Jefferson Counties in the northeast to Gallia and Lawrence Counties in the south. Since these rocks average approximately 400 feet in thickness, their outcrop belt is the widest for any Pennsylvanian series in the State, with a maximum width of roughly 40 miles.

Condit (1912, p. 15) summarized the generalized Conemaugh stratigraphy for Ohio as follows:

"As to lithologic character, the formation consists mostly of sandstone, sandy shale and clay, much of which has a reddish-brown color. Coal seams and limestones are few and thin. All of the beds are characterized by lack of persistence, and vary greatly as to thickness and appearance from place to place. Local erosion planes and unconformities of small magnitude are extremely abundant and occur at all horizons. These hiatuses are shown by conglomerates and truncated strata. Frequently the material of the conglomerates can be traced to some nearby fossiliferous limestone bed or coal seam.

"... The marine limestones of the lower half of the formation are the most persistent and lithologically uniform beds, but even these have suffered contemporaneous erosion and locally failed to form, owing to unfavorable conditions, such as the presence of shoals in the sea and continuous sedimentation from rivers."

Conemaugh rocks are much like the other Pennsylvanian rocks in series above and below but do differ somewhat in quantity of certain rocks. Rogers' term Lower Barren Group was given in reference to the prevalent absence of minable coals, although the number (14) of coals exceeds the number of coals in any other series of the Ohio Coal Measures. This last statement is not true for other areas in the Northern Appalachian region; for in West Virginia the number of Pottsville coals is much larger than the number of Conemaugh coals. Conemaugh underclays are as numerous as Conemaugh coals but are impure and thin in comparison with the high grade and thick Allegheny and Pottsville underclays. Other Conemaugh sedimentary rock types are more nearly normal, except the claystones or redbeds mentioned below. Gray to yellowish or brownish, sandy and silty shales; similarly colored, thick, massive or bedded shaly sandstones; marine limestones, locally cherty or flinty, and shaly; nodular and marly fresh-water limestones and ironstone; and varicolored, argillaceous, and calcareous claystones (redbeds) abound. Bedded shales are probably the most abundant rock type, but the massive sandstones and varicolored claystones are more conspicuous. The varicolored, especially red, claystones, which appear lowermost between the base and middle of the Conemaugh, almost without exception do not occur in the underlying Pennsylvanian rocks but are common in the overlying Pennsylvanian and Permian beds. These varicolored claystones will be referred to as "redbeds" in this report. Marine members occur in the lower two-thirds of the Conemaugh and underlying Allegheny and Pottsville series and are absent or inconspicuous in the overlying Monongahela and Dunkard

Table 11

Generalized Stratigraphic Column for Conemaugh Series in Ohio

(An asterisk beside names of cyclothems and members indicates those not known to occur in Athens County. Thicknesses and descriptive data are based on Athens County occurrences. Thickness figures are based upon measurements only where the strata occur.)

No.	Cyclothem	Member	Description	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
15	Upper Little Pittsburgh	Upper Little Pittsburgh	Coal, very local, thin, shaly.	0	1	32	7	546	9
			Underclay, very local, thin, impure.	1	0				
			Limestone, very local, nodular or thin bed, freshwater.	2	6				
			Redbed, varicolored, calcareous, lenticular claystone.	11	0				
			Sandstone, bedded or massive, and sandy shale.	18	0				
14	Lower Little Pittsburgh	Lower Little Pittsburgh	Coal, generally absent.	0	1	54	1	514	2
			Underclay, unsteady, impure, plastic.	1	0				
		Lower Pittsburgh	Limestone, freshwater, doubtfully present.	0	0				
		Connellsville	Redbed, local, varicolored, calcareous, claystone.	8	0				
			Sandstone, local, thick, massive.	45	0				
13	Little Clarksburg	Little Clarksburg	Coal, local, thin, shaly, locally with thick development.	1	0	58	4	460	1
		Clarksburg	Underclay, impure, plastic.	0	10				
			Limestone, unsteady, nodular, freshwater.	4	6				
			Redbed, local, varicolored, calcareous claystone.	19	0				
		Morgantown	Sandstone, unsteady, variable.	21	0				
			Redbed, very local, varicolored, calcareous claystone.	12	0				
12	Elk Lick	Elk Lick	Coal, very local, shaly.	0	1	52	7	401	9
			Underclay, local, impure clay or clay shale.	2	0				
			Limestone, very unsteady, impure, nodular, freshwater.	3	6				
		Upper Grafton	Sandstone, local, thick, massive.	24	6				
		Birmingham	Redbed, local, varicolored, claystone.	22	6				
11	Duquesne	Skelley	Limestone, bedded or nodular, impure, fossiliferous, marine.	0	8	37	8	349	2
			Shale, and sandstone, rather steady, variable.	12	9				
		Duquesne	Coal, very local, thin, impure.	0	1				
			Underclay, unsteady, thin, impure.	1	6				
			Limestone, rather persistent, nodular, freshwater.	1	8				
			Redbed, quite persistent, varicolored, calcareous claystone.	12	6				
		Lower Grafton	Shale and sandstone, rather steady, bedded to massive.	8	6				
10	Gaysport	Gaysport	Limestone, nodular or bedded, impure, sandy, fossiliferous, marine.	0	7	13	1	311	6
			Shale and sandstone, variable, bedded.	12	6				
9	Ames	Ames	Limestone, very steady in lithology and thickness, bedded, fossiliferous, marine	1	8	16	10	298	5
			Coal, local, thin, shaly.	0	3				
			Underclay, rather steady, variable clay and clay shale.	1	2				
			Shale and sandstone, persistent, bedded.	13	9				

Table 11 - Generalized stratigraphic column for Conemaugh series in Ohio - continued

No.	Cyclothem	Member	Description	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
8	Harlem	Harlem	Shale, carbonaceous.	2	0	35	7	281	7
			Coal, moderately steady, shaly.	0	2				
			Underclay, fairly steady, variable clay.	2	3				
		Rock Riffle	Limestone, very local, nodular, freshwater.	4	6				
		Round Knob	Redbed, rather steady, varicolored, calcareous, claystone.	17	0				
		Saltsburg	Shale and sandstone, variable.	9	8				
7	Upper Bakerstown	*Upper Bakerstown?	Coal, not observed in Athens County.	0	0	29	7	246	0
			Underclay, probably absent in Athens Co.	0	0				
		Ewing	Limestone, unsteady, nodular, variable, freshwater.	3	9				
		Cow Run	Sandstone, locally thick and massive.	25	10				
6	Anderson	Portersville	Shale and limestone, steady gray shale with nodular limestone, fossiliferous, marine.	2	4	22	8	216	5
		Anderson	Coal, persistent, thin.	0	8				
			Underclay, steady, impure, plastic.	2	8				
		Bloomfield	Limestone, fairly steady, nodular, impure, freshwater.	4	0				
		Bakerstown	Shale and sandstone, variable.	13	0				
5	Wilgus	Cambridge	Limestone, steady, variable, sandy, fossiliferous, marine.	1	0	27	0	193	9
		Wilgus	Coal, normally absent in Athens County.	0	0				
			Underclay, very local, impure, plastic.	1	9				
		*Meyersdale	Redbed, not observed in Athens County.	0	0				
		Buffalo	Shale and sandstone, locally massive sandstone.	24	3				
4	Upper Brush Creek	Upper Brush Creek	Limestone, persistent, variable, fossiliferous, marine.	2	0	27	0	166	9
			Coal, very local, shaly.	0	6				
			Underclay, very local, impure, plastic.	2	6				
			Shale and sandstone, steady, variable.	22	0				
3	Lower Brush Creek	Lower Brush Creek	Limestone, very steady, variable, fossiliferous, marine.	6	0	35	9	139	9
			Coal, very local, thin, impure.	0	5				
			Underclay, unsteady, impure, plastic.	1	4				
			Redbed, unsteady, varicolored claystone.	10	0				
			Shale and sandstone, variable.	18	0				
2	Mason	Mason	Shale, unsteady, dark, fossiliferous, marine.	10	0	55	4	104	0
			Coal, unsteady, thin, shaly.	0	10				
			Underclay, unsteady, impure, plastic.	2	6				
		Upper Mahoning	Redbed, very local, varicolored, claystone.	12	0				
			Sandstone, locally thick and massive.	30	0				
1	Mahoning	Mahoning	Coal, very local, thin, shaly.	0	4	48	8	48	8
		Thornton	Underclay, unsteady, impure, plastic.	3	4				
		Lower Mahoning	Limestone, very local, nodular, freshwater.	1	6				
			Redbed, unsteady, varicolored, calcareous claystone.	9	0				
			Sandstone, locally thick, massive.	34	6				

series. Ironstone facies and members are few in Conemaugh strata. A count of presently recognized members in the Conemaugh series indicates the following members are present at some place or another in Ohio: coal with underclay - 14; massive, named sandstone - 11; fresh-water limestone - 9; and marine limestone or shale - 8. These figures indicate at least 15 cycles of deposition (table 11).

A small addition can be made to Condit's statement pertaining to areal variations among members in the Conemaugh series. The most persistent and uniform members are the marine limestones and shales, but, as Condit indicated, those members are confined to the lower part of the series and are locally absent or varied in lithology. The Ames limestone is the most persistent and constant member in our Conemaugh, but even it has its absences and variations and can in some places in southern Ohio be confused lithologically with the Lower Brush Creek limestone. The Brush Creek limestones, especially the Lower member, are probably next to the Ames limestone in steadiness, but they vary from light to dark gray, from rather pure to cherty or ferruginous or from shaly to sandy, and from thin separate to thick coalesced limestones up to 25 or more feet in thickness. The Portersville member is a widespread, abundantly fossiliferous gray shale with nodular limestone and is a rather distinctive unit. It, too, has some regional variation in lithology and at many places, although present, is weathered, slumped, and concealed. The other marine members are more difficult to use for stratigraphic purposes. The Gaysport and Skelley limestones are irregular in occurrence and apt to be thin and inconspicuous. The Cambridge limestone is variable and to quote Condit (1912, p. 44) again: "...the Cambridge limestone is very irregular, and is missing in numerous places. Furthermore, it is very changeable in appearance, thickness and faunal content.... "

Conemaugh coals and underclays are thin and uncertain in distribution and, hence, have been difficult to trace and to correlate unless associated with some other recognizable member(s). The Anderson coal under the Portersville marine shale is one of the thicker and most persistent Conemaugh coals in Ohio, and has the largest known coal reserves of any Conemaugh coal in the State. It is, however, thin at many localities, but when used in conjunction with the Portersville member the combination makes one of the best stratigraphic guides in the entire Conemaugh series. Other thicker Conemaugh coals include the Harlem, Mahoning, Mason, and Wilgus coals, although areas of minable thickness are scattered and small; of these the Mahoning member has the largest coal reserves.

Recent field studies by Cross and his co-workers (1950, p. 96-104) in eastern Ohio and adjacent areas have shown Conemaugh, Monongahela, and Dunkard coals to be much more continuous in distribution than formerly believed. Their observations have conclusively demonstrated that differences in lithology above and below coal horizons indicate where a coal should occur. At such positions careful inspection will usually reveal positive evidence of a coal horizon, and these evidences include traces of underclay, thin carbonaceous or coaly films, and fossils of plants, clams, estheriids, etc. The key to recognition of these coal horizons is the fact that basically the strata below coals or their horizons are essentially massive and nonbedded and those above are bedded or stratified. In the interval below coals are light gray to gray underclays, and varicolored (various shades of red, brown, yellow, purple, and green) claystones, herein called redbeds, that break characteristically like laundry starch and which, at least in in part, are calcareous and marly with or without nodular or pellet-bearing fresh-water limestone. The layered rocks immediately above a coal are commonly gray or some shade of red or brown, argillaceous to silty, micaceous, thin-bedded shales with or without fossil plants, clams, estheriids, etc. These shales are in turn overlain by stratified sandy shales and sandstones. Nonbedded rocks of the next-above-cyclothem occur above the sandy shales and sandstones. This simple basic concept is, of course, complicated by local massive channel sandstones and gray, silty-sandy shale facies and varicolored redbed facies at different places in the same interval. Such stratigraphic variations do not destroy the use of Cross' discovery but do require extreme care in its application.

This newer understanding of stratigraphy in the upper Pennsylvanian and Permian rocks of the Ohio Valley region has been the most important contribution to solving many stratigraphic problems. For example, knowledge of this basic principle enables field geologists to search at proper levels for coal horizons and often with little experience to trace successfully coals or

coal horizons far and wide, where formerly the presence of coals or their horizons was overlooked. This fact is undoubtedly most useful in field study of redbed facies but is everywhere very useful in upper coal measure stratigraphy.

Outcrops of Conemaugh rocks cover approximately 250 square miles in Athens County and occur above drainage in every township within the county with exceptions of Carthage and Troy Townships. The areas of outcrop are shown on the large folded geologic map in pocket in the back of this report. Large areas of exposure covering more than half of each township occur in Alexander, Athens, Dover, Lee, Trimble, and Waterloo Townships; areas of approximately 50 per cent in Ames and York Townships; areas between 25 and 50 per cent in Canaan Township; and relatively small areas in Bern, Lodi, and Rome Townships. The main area of Conemaugh outcrop is a belt 6 to 7 miles wide and trending northeast to southwest in alignment. The western edge of this belt is approximately the north-south border between Dover and York Townships and a southwest trending line from the northeast corner of Waterloo Township to the northwest corner of Lee Township. The eastern border begins at the north side of the county at the northwest corner of Ames Township, extends almost due south along the boundary between Ames and Dover Townships, and swings a little southwest across Athens and Alexander Townships to the south-center of Alexander Township. The margins of this outcrop belt are much affected by the topography and are very sinuous lines, as the map readily shows. In York and northwestern Waterloo Townships Conemaugh rocks are confined to the ridge tops; and east of the general belt of outcrop those rocks are exposed only along the lower reaches of the larger and deeper valleys.

Not all Conemaugh members known to be present in Ohio have been recognized in Athens County, but the series does have an approximate thickness of 545 feet, which is in excess of the apparent average thickness in Ohio as a whole. Table 11 lists all Conemaugh members recognized in Ohio to date, and those not known to occur in Athens County are noted with an asterisk. Brief descriptions of lithologies and average thicknesses for members and cyclothems within the county are also included.

Mahoning Cyclothem

The Mahoning is an incomplete cyclothem, but significant as it is the lowest Conemaugh cyclothem and has several well-known members in it--Lower Mahoning sandstone, Thornton underclay, and Mahoning coal. Moreover, the Lower Mahoning redbed is the lowest redbed recognized in Athens County and is the lowest redbed generally present in the Pennsylvanian rocks of the northern part of the Appalachian coal basin. A nonmarine limestone is also present, but no marine horizon over the Mahoning coal is known.

The name Mahoning, taken from Mahoning Creek(s) in Indiana and Jefferson Counties, Pennsylvania, was first used in geologic literature by Lesley (1856, p. 94, 97-98). Mahoning has had not only a long but also a somewhat varied use as a name (Wilmarth, 1938, p. 1269) and has been applied primarily to sandstones lying between the Upper Freeport (No. 7) coal and the Lower Brush Creek limestone. Two Mahoning sandstones are commonly present, known as the Lower and Upper Mahoning sandstones. The Mahoning coal and associated beds normally separate the Mahoning sandstones, but at some places the Upper rests directly on the Lower. Mason coal and associated beds lie above the Upper Mahoning sandstone, and that sandstone is a member of the Mason cyclothem. The application of Mahoning, Upper and Lower Mahoning, and other member names to members of the Mahoning and Mason cyclothems is given in table 11, and it is not with full confidence that all the names are used. In addition, other members of coal and variegated beds occur in Pennsylvania and West Virginia but, as far as known, none of these has been recognized in Ohio with the possible exception of the Piedment coal.

A coal called Piedmont coal by Swartz et al. (1919, p. 585; 1920, pl. 6) is reported to lie between the Upper Freeport and Mahoning coals in Maryland. Ashley (1928, p. 109) suggested that he was "strongly inclined to believe that the Piedmont coal would prove to be at the same horizon as the Mahoning ..." Blake (1952, p. 22) found a rather persistent coal about 21 feet -



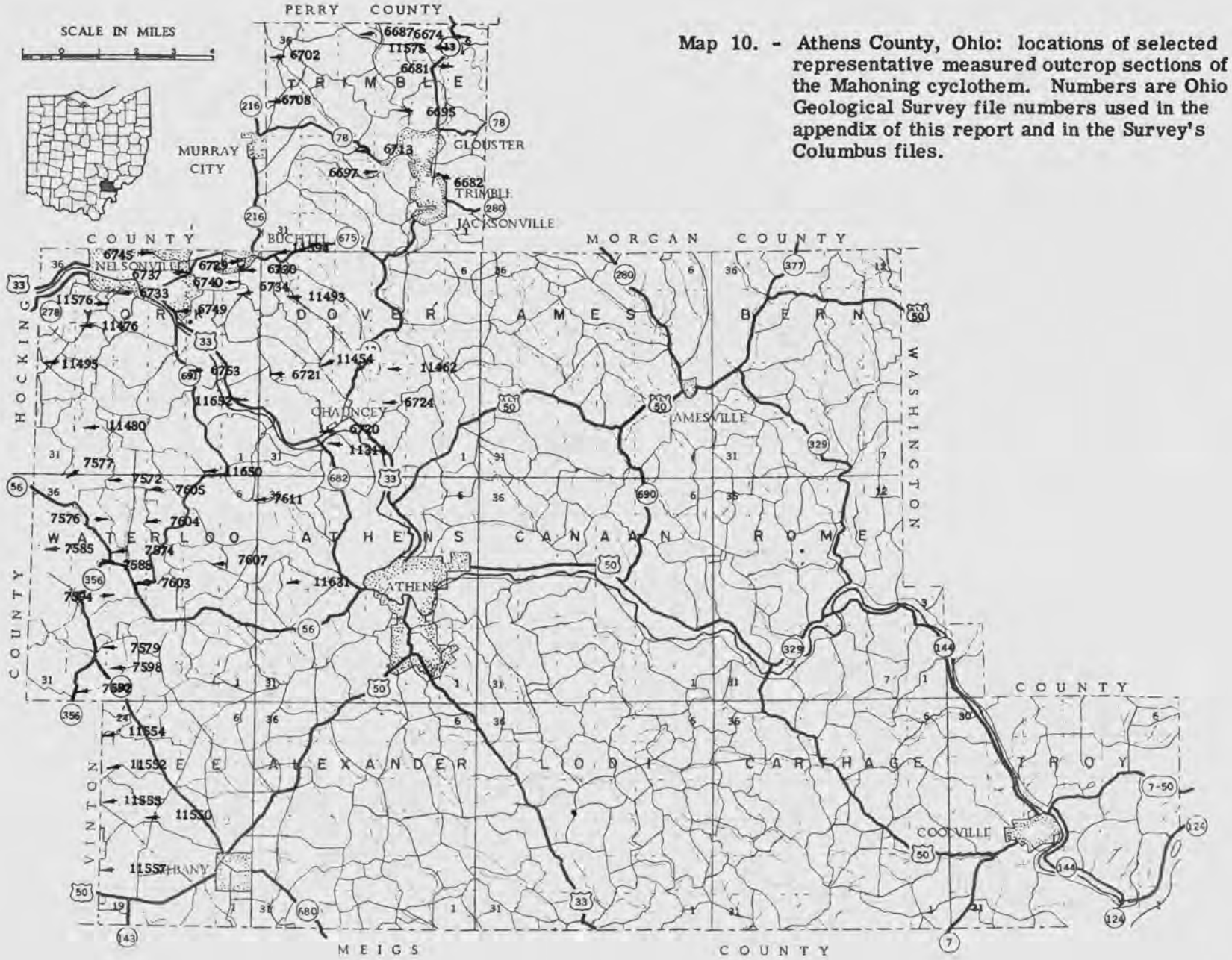
Figure 13 - Upper Freeport coal bed in SE¼, sec. 8, York Township, Athens County. Note the auger holes in the highwall of the strip pit. The shale which overlies the coal may be the Uffington, though no marine fossils were noted and this shale is in turn overlain disconformably by the Lower Mahoning sandstone.

above the Upper Freeport coal and about 24 feet below the Mahoning coal throughout western Gallia County, Ohio, and he correlated that coal with the Piedmont coal. Little or no evidence for the Piedmont cyclothem, if it exists elsewhere, was observed in Athens County, and no further discussion will be attempted here (see locality 11555, map 10).

Outcrop of the Mahoning cyclothem extends across eastern Ohio from Columbiana to Lawrence Counties and can be easily traced by the line separating the Allegheny and Conemaugh series on the geologic map of Ohio. Athens County outcrops of the Mahoning cyclothem are in Athens, Dover, Trimble, Waterloo, and York Townships (map 10).

Lower Mahoning Sandstone Member. - In Ohio Lower Mahoning sandstone is typically a massive one but actually at many places is represented by bedded sandstone, sandy shale, or a combination of those lithologies. Condit (1912, p. 59-60) has summarized its features as follows:

"It varies from coarse-grained, massive and structureless to fine-grained, shaly and cross-bedded sandstone. Locally, it is conglomeratic in the basal portion and has quartz pebbles of hazelnut size. Papery seams of coal are frequently interstratified with the sandstone, especially where the latter reaches below the Upper Freeport horizon, as is the case in many localities.... Usually the sandstone and coal are in direct contact, but occasionally they are separated by several feet of carbonaceous shale. Where sandstone rests directly on the coal, the contact is very irregular.... "



Map 10. - Athens County, Ohio: locations of selected representative measured outcrop sections of the Mahoning cyclothem. Numbers are Ohio Geological Survey file numbers used in the appendix of this report and in the Survey's Columbus files.

To Condit's description can be added that of Stout (1927, p. 350), whose abridged description for the Lower Mahoning sandstone in Vinton County is as follows:

"... Usually the Lower Mahoning sandstone is soft and friable, ferruginous and argillaceous in character, and fine to medium in size of grain. Aside from quartz, the most conspicuous mineral is muscovite in bright splendid flakes. Weathering rapidly reduces this rock to sand."

In Athens County Lower Mahoning sandstone outcrops in Athens, Dover, Trimble, Waterloo, and York Townships (map 10) where locally it forms steep slopes and conspicuous cliffs or ledges. Extremes in thickness range from 5 feet (locality 6737) to 83 feet 6 inches (locality 7592), and average thickness for 26 measurements is 34 feet 6 inches. Where the sandstone is thin, this interval has bedded, sandy, micaceous shale with or without interbedded layers of fine micaceous sandstone. Thicknesses of 40 feet or more probably include not only the Lower Mahoning sandstone but also the Upper Mahoning sandstone, which at those localities has replaced the Mahoning members of claystone, coal, limestone, and underclay and has coalesced with the underlying Lower Mahoning sandstone.

Lithology here is similar to that described elsewhere in Ohio. Its original color is light gray, but exposed bedding and joint surfaces are invariably stained with limonite or weathered to a dull gray. The rock is normally massive, medium to coarse, micaceous, and somewhat friable sandstone. Weathered surfaces also tend to show rounded corners and edges, exfoliation, loosened and crumbling sand grains, and traces of bedding and cross-bedding. Decrease in grain size, development of stratification, and tendency to become shaly are apparent toward the top of some exposures. Shale lenses and shaly zones are apt to be present within the thicker exposures, as at locality 11576, and are interpreted as reworked fine Lower Mahoning clastic sediments in the base of the Upper Mahoning sandstone. Parts of the rock are locally argillaceous and, less commonly, calcareous. Pebbles, coaly streaks, and fossil plants may occur near the base; these probably indicate a disconformity at some exposures and perhaps at all of them (figure 13).

Lower Mahoning Redbed Member. - Waage (1950, p. 35-39) has called attention to two facies in the Upper Freeport coal - Brush Creek limestone interval of western Maryland as follows (p. 35):

"... In one phase the rocks in the interval are predominantly sandy and a coal bed, the Mahoning coal, is present. In the other phase, the interval is characterized by a preponderance of claystone, a double redbed zone is present, sandy zones are poorly developed, and no coal is present. Intermediate stages between these two phases are represented in many of the drill-hole sections. In none of them, however, is the Mahoning coal present in the same section as a redbed."

On pages 37 and 38 he presents a generalized description of the Mahoning redbed (claystone) phase, part of which is quoted below:

"The average section of the redbed phase of the Upper Freeport - Brush Creek interval has a preponderance of claystone including two zones of mottled green and red claystone. Sandstone is relatively rare and no coal is present. Except at the top and the base, the succession of units is not clearly defined and the individual beds vary in thickness and lateral extent.

"The beds at the base of the interval are in most places sandy. The Lower Mahoning sandstone is present locally but more commonly is represented by interbedded siltstone and sandstone or by beds of siltstone in gray claystone. The uppermost part of the interval, the Brush Creek underclay zone, differs from that of the Mahoning coal phase only in the greater abundance of freshwater limestone.

"Between the Lower Mahoning sandstone and the Brush Creek underclay the strata commonly consist of two zones of green and red claystone beds separated by a zone of siltstone, silty claystone, or interbedded siltstone and fine sandstone. In many places this silty zone is

also greenish in color. Each of the redbeds contains a fairly persistent bed of fragmental clay and claystone. The lower redbed locally contains limestone pellets and where these are present the fragmental clay is commonly absent. The upper redbed rarely contains limestone....

"...The two phases just described are apparently the extremes of lithologic variation in the Upper Freeport - Brush Creek interval. Most sections do not conform strictly to either of these phases but appear to represent gradations between them. In the sections intermediate in type red claystone is present only in the upper zone, whereas the lower one is commonly represented by green claystone beds that contain either a clay bed or a zone of limestone pellets. In such sections thin sandstone beds or beds of interbedded siltstone and sandstone separate the two redbed zones.

"The red-colored claystones lack lateral persistence and are of little value in correlating from the redbed phase to the sandy phase. The change from dominantly red claystone to green claystone is coincident with an increase in the silt content of the claystone. No red-colored claystone is known to occur in any section where either silt or sand is a major constituent of the redbed zone.

"The most persistent unit in the sections of intermediate type is the clay bed associated with the lower redbed. It is considered to be equivalent to the Thornton clay of the Mahoning coal phase because it is similar to it in lithologic character, occurs at approximately the same distance above the Upper Freeport coal, and can be demonstrated to lie between the upper and lower splits of the Mahoning sandstone. This correlation suggests that the lower redbed of the redbed phase is equivalent to the Mahoning coal bed and its associated shale and clay of the coal phase.... "

Redbed is herein applied to variously colored massive, impure -- usually calcareous and ferruginous and possibly silty, sandy, or micaceous -- clay beds that break with an irregular fracture similar to the fracture of common laundry starch. Upon weathering, some of these redbeds become somewhat plastic, while others, from appearances, do not. Such varicolored claystones occur as low as the Lower Mahoning cyclothem in Athens County and possibly lower elsewhere in the Pennsylvanian system of Ohio and continue upward throughout the Conemaugh, Monongahela, and Dunkard series, although by no means are they present in every cyclothem.

Lower Mahoning redbed was recognized at about a dozen localities in Dover, Trimble, Waterloo, and York Townships where it has an average thickness of 9 feet with minimum and maximum measurements of 2 and 22 feet, respectively. In Waterloo Township a poorly exposed outcrop (locality 7607, not used in average thickness determinations) has a possible thickness of 54 feet and probably is combined Lower and Upper Mahoning redbeds. Lower Mahoning redbed is mottled or variegated in various shades of gray, green, red, or purple and may be stained or weathered shades of red, brown, or yellow. Most of the exposures exhibit calcareous and ferruginous pellets or nodules, which may be concentrated in base or top or scattered more or less throughout. Thornton (Mahoning) underclay occurs at most places in Athens County above this claystone, and in striking contrast to Waage's observations in Maryland, Mahoning coal occurs in half of the local exposures showing Lower Mahoning claystone. At still another locality (7598) in section 19, Waterloo Township, no coal is present but fossil plants occur in overlying shale.

Lower Mahoning Limestone Member. - Lower Mahoning limestone occurs as impure, ferruginous pellets and nodules in the Lower Mahoning claystone, and simple field tests usually indicate the calcareous nature of the claystone. Discussion for the redbed (p. 96, 100) includes some details for the limestone as well, and little needs to be added here. At only one locality (11454) in section 27 of Dover Township are the nodules large and concentrated enough to make a layer of nodular limestone about 18 inches in thickness. Elsewhere limestone pellets and nodules are too small or too few or their concentration too limited to be considered a true limestone bed.

The stratigraphic position and relationships and lithologic nature indicate fresh-water origin

for both the redbed and limestone. No fresh-water fossils were observed but careful search might reveal their presence.

Thornton (Mahoning) Underclay Member. - I. C. White (1903, p. 322) gave the name Thornton fire clay to the Lower Mahoning underclay from Thornton in Taylor County, West Virginia, and that name is now widely used in Maryland, Ohio, and West Virginia. In Ohio, Thornton underclay and overlying Lower Mahoning coal have a discontinuous distribution along their outcrop belt. The underclay is present at more places than the coal, and in Athens County the Thornton member was recognized in 18 exposures and the Mahoning coal at only 10 of these localities (map 10). Thickness of this clay varies from 2 inches to 7 feet and averages 3 feet 4 inches. If the underlying Lower Mahoning redbed were included in measurements of Thornton clay, as has sometimes been done, maximum and average thicknesses would be materially increased. Best reference members for Lower Mahoning coal and underclay are the Upper Freeport coal lying about 35 feet below, the Lower Brush Creek limestone 40 to 45 feet above, and the Ames limestone approximately 165 feet above (fig. 14).

Thornton clay is typically a plastic underclay, and in Athens County only one exposure shows any flint clay and that merely a 1-inch zone at the top. Color is normally light gray to gray with some limonite stain. Shades of buff, green, maroon, pink, and purple also occur, but if the underlying claystone is carefully excluded, the variegated parts will probably be largely excluded as well. Plasticity is well developed, and at very few localities is it lean enough to be only slightly or somewhat plastic. Thornton underclay has its best development within the county in the vicinity of Buchtel where it is light gray to gray plastic clay 3 to 7 feet thick "more or less charged with impurities" (Stout et al., 1923, p. 444-445). Most common impurities include iron compounds, silt, mica, calcite, and carbonaceous materials, and iron and carbon are most abundant and common of these.

Lower Mahoning Coal Member. - Mahoning coal is an important minable coal in parts of Carroll, Columbiana, and Jefferson Counties in northeastern Ohio. Elsewhere along its outcrop it is patchy and thin but can be traced across the State from Columbiana to Lawrence Counties. Its distribution in Athens County is the same as for the other members of the Lower Mahoning cyclothem, although it occurs at fewer localities than the sandstone and underclay (map 10). Thicknesses for ten exposures range from $\frac{1}{4}$ inch to 1 foot 9 inches, commonly 1 to 4 inches, and the average thickness is less than 4 inches. Carbonaceous shale, bony or shaly coal, dull coal with bright streaks, or bright coal with dull streaks and much fusain are the lithologies representing this coal, and shaly coal seems to be the most common type. At several places fossil plants in shale over the Thornton underclay or carbonaceous and coaly streaks in that clay are all that represent the coal.

Mason Cyclothem

I. C. White (1903, p. 281, 285) gave the name Mason to an underclay, a coal, and a dark marine shale from the type area at Mason on Elk River, Kanawha County, West Virginia. These several members underlie the Lower Cambridge (Lower Brush Creek) limestone, and there has been some uncertainty and confusion regarding the Mason coal and the coal immediately underlying the Lower Brush Creek limestone. Both of the coals apparently are seldom, if ever, present in the same exposure, and Waage (1950, p. 38-39) has discussed some of the aspects of this problem as follows:

"If the lower Mahoning redbed has a coal-bearing phase the question arises whether or not the upper redbed horizon has a similar phase. In Maryland no coal was found at this horizon in the Bureau of Mines drill holes. Swartz gives generalized sections (Swartz, Price, and Bassler, 1919, pl. 14) from parts of Maryland showing a coal he calls the Gallitzin at this horizon but in at least one of these sections his correlations are in error. The Gallitzin coal in Pennsylvania has often been said to lie between the Mahoning coal and the Brush Creek coal approximately at

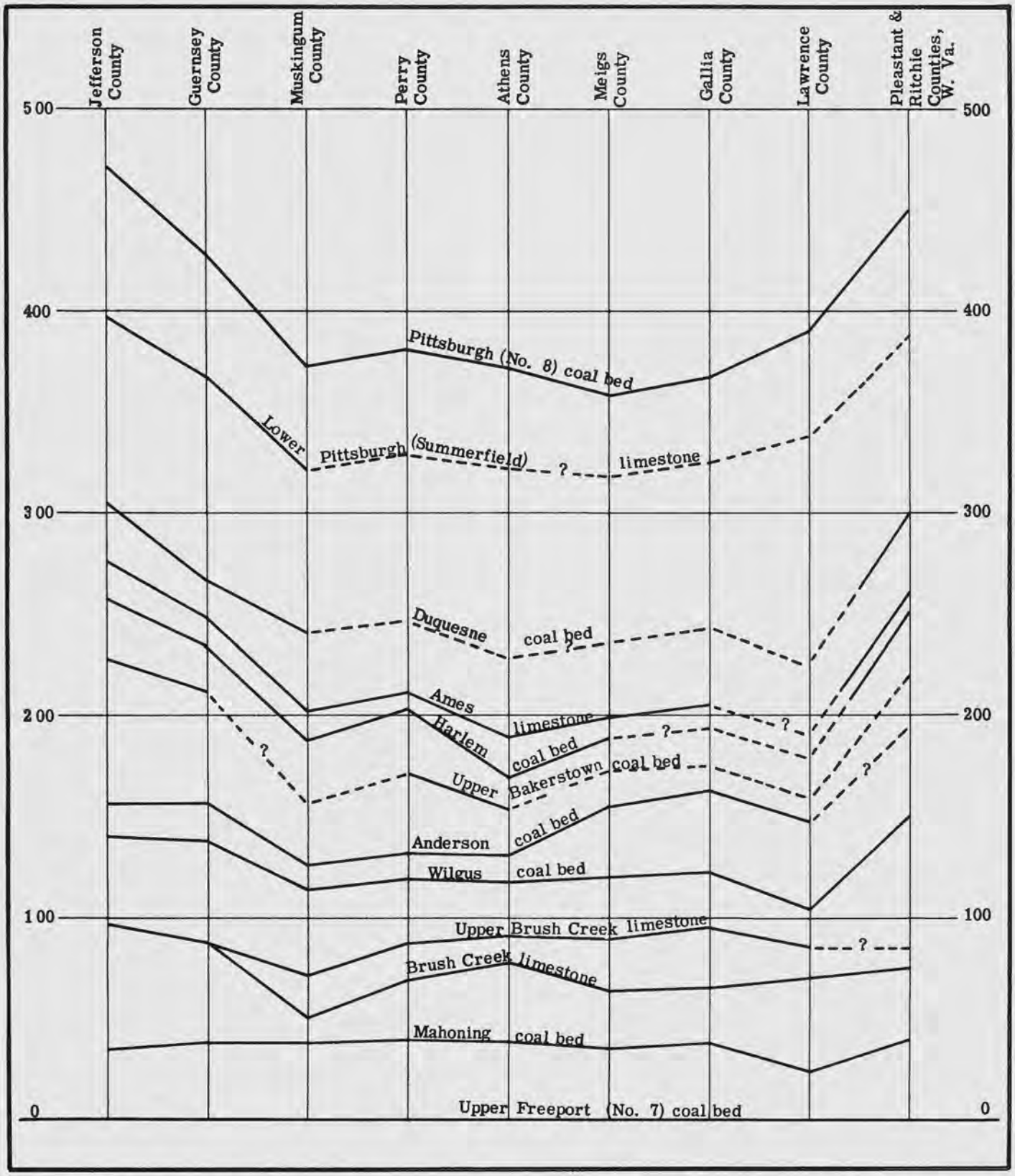


Figure 14 - Interval chart of Conemaugh strata in Ohio and one adjacent area. Data principally from Condit (1913) with modifications; the West Virginia section is from Cross (1956, p. 55).

the horizon in question. Ashley (1928, p. 109) states that he has correlated the Gallitzin coal with the Brush Creek coal all through central Pennsylvania. However, no stratigraphic data have been published to support this contention, so the possibility still exists that the coal known as the Gallitzin bed is distinct from the Brush Creek. This possibility is strengthened by the occurrence of the Mason coal in the Conemaugh formation of Ohio which was shown by Stout (1947), in his most recent edition of the stratigraphic section of the Ohio Coal Measures, to occur between the Mahoning coal and the Brush Creek coal. More specific reference to the Mason coal and its surrounding lithologies was made by Lamborn (1930, p. 113), who states that in Jefferson County it lies 'about 32 feet below the Brush Creek marine shale and 37 feet above the Mahoning coal.' Lamborn also noted that the underclay of the Mason coal is 'usually gray in color but at some localities is mottled pink or red.' The Mason coal and its equivalent in the 'Gallitzin' coal beds in Pennsylvania are quite possibly the coal-bearing phase of the upper Mahoning redbed and have the same stratigraphic relationship to it that the Mahoning coal has to the Lower Mahoning redbed."

Stout and Lamborn (1924, p. 317-318) published some very informative geologic sections from Columbiana County, Ohio, in which are shown representation of the several coals and underclays between the Upper Freeport coal and (Lower) Brush Creek limestone. Since coal and underclay of all these possible cycles occur in the same exposure, existence of the Mason cyclothem is a certainty. Their generalized stratigraphic section of the Conemaugh series (1924, op. p. 288) shows the Mason coal occurring about 23* feet below the Brush Creek limestone, approximately 30 feet above the Mahoning coal, and almost 75 feet above the Upper Freeport coal. Stout (1927, p. 349-350) found in general these same intervals somewhat less in Vinton County than in Columbiana County and also quite variable, as indicated by this statement (1927, p. 354):

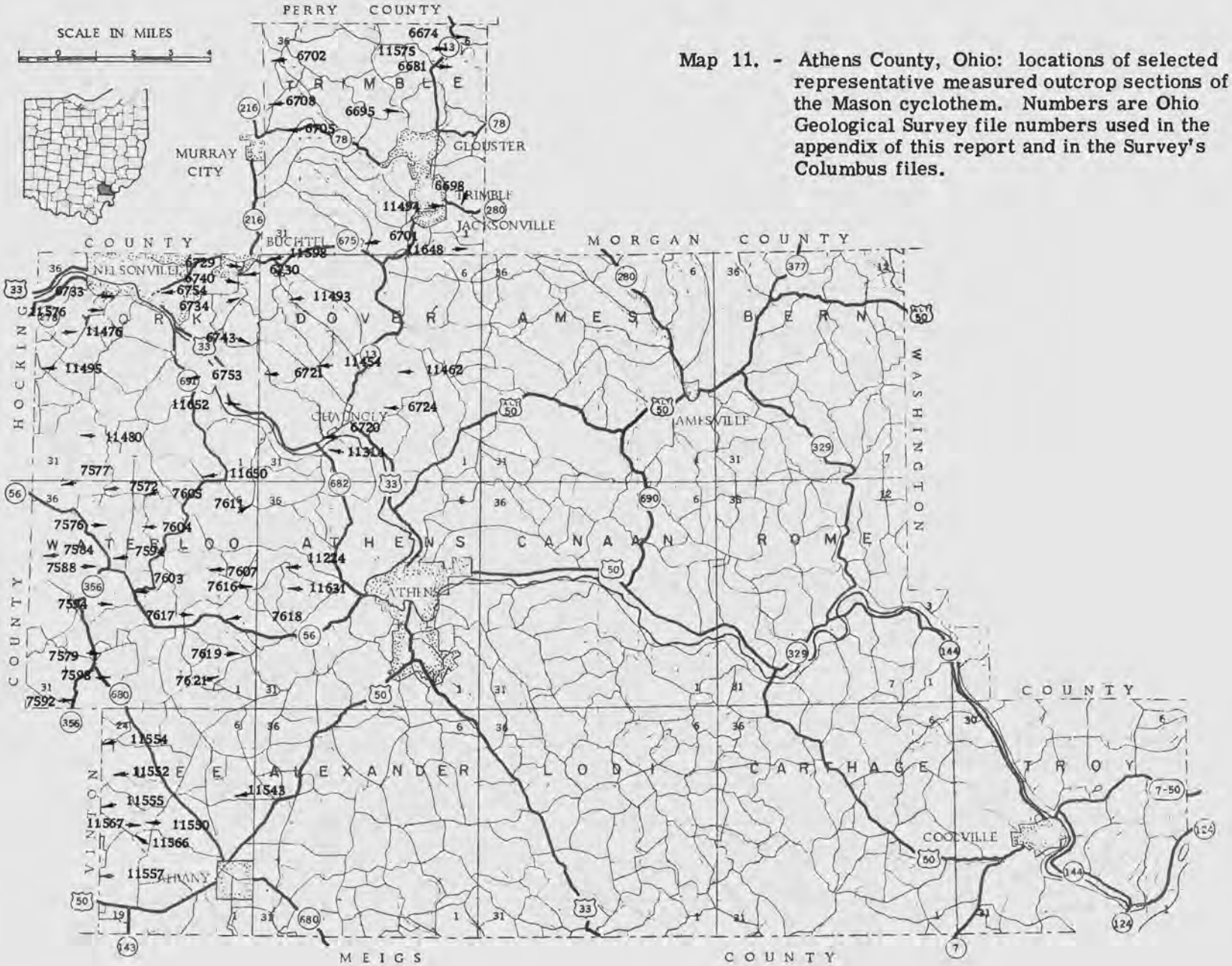
"Normally the Mason member (coal) lies nearly 23 feet below the lower bench of the Brush Creek limestone; but this interval varies from 1 to 35 feet due to the irregularity in deposition of both the coal and the limestone."

Perusal of Stout's Vinton County stratigraphic sections indicates that possibly both Lower Brush Creek coal (1927, p. 355, top) and Mahoning coal (1927, p. 356-357) may have been identified as Mason coal at some places, which would account for the wide range in interval thickness between Mason coal and Lower Brush Creek limestone.

It is thus apparent that some uncertainty and possibly confusion has existed in correlation of coals between the Mahoning coal and Lower Brush Creek limestone. In this report coal at the base of the Lower Brush Creek limestone or near the base of and separated from that limestone by shale and even sandy beds that tend to have marine fossils is called Lower Brush Creek coal. Any coal at some distance, usually between 10 and 30 feet, below the Lower Brush Creek limestone and separated at least in part from that limestone by nonmarine, sandy, micaceous shale or bedded, fine, micaceous sandstone is designated as Mason coal. These generalizations are by no means perfect and cannot be followed as easily as might be anticipated. Observations of the stratigraphy and consideration of possibilities reveal the following potential problems. First, dark, sparingly fossiliferous, marine shale over the Mason coal can be confused with the dark marine shale under the Bush Creek limestone, especially in absence of sandy shale and bedded sandstone between the coal and limestone. Second, in most places where Lower Brush Creek underclay and coal occur, a variegated claystone similar to that in the Mahoning and Mason cyclothems likewise is present. Unless both Mason and Lower Brush Creek coals and associated strata are present, and usually only one cyclothem seems to be represented, the coal and allied beds might be interpreted as belonging to either cyclothem. Finally, there is question of identity of coal near the base of the Lower Brush Creek limestone but separated from the limestone by sandy shale or bedded sandstone with no apparent marine fossils.

Upper Mahoning Shale and/or Sandstone Member. - Twenty-five measurements of the Upper Mahoning sandstone and shale interval have an average thickness of 30 feet. Where massive sandstone of both Mahoning intervals are joined together the thickness of sandstone alone

* Slightly different from figures given in text of their report.



Map 11. - Athens County, Ohio: locations of selected representative measured outcrop sections of the Mason cyclothem. Numbers are Ohio Geological Survey file numbers used in the appendix of this report and in the Survey's Columbus files.

may exceed 80 feet (locality 7592). Lithology of this interval is very similar to that of the Lower Mahoning sandstone and shale interval and consists characteristically of medium to coarse, micaceous, massive sandstone which upon weathering becomes friable and shows evidence of bedding and cross-bedding on exposed surfaces. Most exposures are in part shale, usually sandy and micaceous, and some include only shale, or shale and bedded, fine to medium sandstone. Rarely seen are disconformity or conglomerate at the base of the massive sandstone, although those features may be more widely present than the exposures indicate. Carbonaceous layers occur in bedded shale at one locality in Trimble Township (locality 6702).

Upper Mahoning Redbed Member. - Only three exposures of variously colored claystone at the Upper Mahoning horizon were recognized in Athens (locality 11224), Dover (locality 6724), and Waterloo (locality 7618) Townships. Two additional exposures in York Township (localities 6733, 11576) south of Nelsonville on opposite sides of the ridge between the Hocking River and Minkers Run, may have Upper Mahoning claystone instead of varicolored Mason underclay, which is the present tentative correlation. At another locality in Waterloo Township (locality 7607) a thickness of 54 feet of variegated clay, claystone, and fresh-water limestone may, in part, be Upper Mahoning redbed member.

Claystone thickness in the three above exposures varies from 5 feet to more than 17 feet and has a very generalized average of 12 feet. Color is usually mottled and includes different shades of gray, buff, and red. The bedding is massive, and the rock breaks with the usual starch-like fracture. Two of the exposures have some degree of plasticity in spite of being silty and micaceous. Limestone nodules or pellets occur in the base of one exposure (locality 11224), and coaly fragments and carbonaceous material at the top of another (locality 6724). Mason coal and underclay may be represented in the latter section. If the above sections are correctly correlated, then a fresh-water limestone as well as a coal occurs with the Upper Mahoning claystone, neither of which members was recognized by Waage in the United States Bureau of Mines drill cores in the Pennsylvanian rocks of western Maryland. Exposures in Athens County reveal that the Upper Mahoning claystone is not as well developed as the Lower Mahoning claystone and is overall the weakest member in the Mason cyclothem.

Mason Underclay Member. - Mason coal and underclay were observed at about 25 exposures in Athens, Dover, Lee, Trimble, Waterloo, and York Townships (map 11). These members are unsteady in occurrence and are absent at numerous localities where they are due in the stratigraphic section. Where present they usually occur together, and at very few places does one member occur without the other. At one or two exposures the coal rests on shale and sandstone or upon varicolored claystone, and at several localities underclay or claystone is present without coal.

The Mason underclay is everywhere plastic clay whose unweathered color is light gray or in a few examples maroon to purple. It is an impure clay and commonly is silty, sandy, or micaceous to some extent and at some localities even shaly. Limestone nodules or pellets are rarely present, and coal and carbonaceous partings are uncommon. Two exposures of variegated clay in York Township, localities 6733 and 11576, may represent the Upper Mahoning redbed or claystone rather than Mason underclay. Average thickness of 19 exposures is 2 feet 7 inches, and thicknesses range from a few inches to more than 7 feet, if the varicolored clays belong to this member. Otherwise the maximum thickness is about 6 feet.

Mason Coal Member. - Distribution of Mason coal in Athens County is briefly discussed along with Mason underclay above. Best stratigraphic references for this coal are the Upper Freeport coal approximately 65 feet below, the Mahoning coal about 30 feet below, and the Lower Brush Creek limestone on the average almost 20 feet above. Twenty-two measurements of the Mason-Brush Creek interval in this county show extremes of 9 and 32 feet and an average thickness of 18 feet. According to published reports of the Ohio Division of Geological Survey, Mason coal has its best development in Gallia, Lawrence, Meigs, and Vinton Counties.

Measured overall thicknesses, including partings, of Mason coal within this county vary from one inch to more than three feet, and the average thickness for 24 measured exposures is ten inches. Mason coal is at most places dull or shaly coal with bright streaks and less commonly bright and blocky coal with dull or shaly streaks and shale partings. Fusain and pyrite are visible constituents at some exposures. The shaly nature of this coal causes it to weather readily; and the outcrops, especially the thinner ones, tend to be represented by sooty blossom or smut streak. Black carbonaceous shale or coal streaks and fossil plants in underclay are all that represent the Mason coal at some few localities. In summary, the Mason is a discontinuous, thin, and impure (shaly) coal.

Mason Marine Shale Member. - I. C. White's (1903, p. 281) original description of this member is as follows:

"The dark or black shales immediately under the Lower Cambridge (Lower? Brush Creek) limestone, frequently contain marine fossils, in their upper half especially, in Pennsylvania, Maryland, and northern West Virginia, while in the basal portion of the same, many fossil plant remains occur. They are especially rich in fossil plants at Mason, on Elk River, seven miles above Charleston, Kanawha County, and this shale has been designated from that locality. The same horizon is rich in fossil plants in many other regions.... "

Mason shale has not been previously recognized in Ohio, although careful search should reveal its presence at scattered localities. At four Athens County localities in Lee (11567), Trimble (11494, 11648), and Waterloo (7618) Townships Mason coal is overlain by 10 to 12 feet of gray to dark gray or black shale containing a few marine fossils immediately above the coal (map 11). The darkest shale is in the Trimble Township exposure, and there a few fossil plants are also present. Dark carbonaceous shale with fossil plants occurs at another locality (7607) in Waterloo Township above a coal believed to be the Mason coal. Marine fossils are few in number and include the well known brachiopods Lingula and Marginifera, the first of which suggests a brackish water environment of deposition. The shale is bedded and micaceous in all exposures and varies from argillaceous to sandy. Elsewhere, strata above the Mason coal are lighter colored and apparently without any trace of marine fossils. These few occurrences of marine shale extend the known distribution of marine Mason shale into Ohio and also indicate that marine fossils do occur at some places immediately above the Mason coal.

Lower Brush Creek Cyclothem

I. C. White (1878, p. 34) first applied the stratigraphic name of Brush Creek to marine shale and limestone at the position of the Lower (?) Brush Creek limestone. The type area is in western Pennsylvania, along Brush Creek in Cranberry Township, Butler County. Brush Creek is now applied to a series of different beds comprising two more or less complete cyclothems (table 11), which are now designated Lower Brush Creek and Upper Brush Creek, respectively. Stout (1927, p. 357-358) described the occurrence of the two Brush Creek marine members in Ohio and part of his excellent description is quoted below:

"The Brush Creek limestone ... is a well recognized stratum in the Conemaugh formation of Ohio. It extends with some wants from Columbiana County on the north to Lawrence County on the south, but along its outcrop it shows much variation in character. The member may be represented by dark, carbonaceous shale; by this with nodules of dark to gray limestone; by dark gray limestone; by gray, calcareous shale; by gray to nearly black flint; by gray, shaly flint; and by various combinations of these. In general the most common representative is dark shale with nodular limestone in eastern Ohio and gray shale with gray to dark limestone or flint in the southern part of the State. With few exceptions in eastern Ohio the member consists of only one stratum of calcareous material but in central and southern Ohio it is normally made up of two beds of limestone or flint separated by from 10 to 30 feet of shale. This double structure is well recognized in Lawrence, Gallia, Vinton, Meigs, Athens, Perry, and Morgan counties.

As indicated by the fauna, the Brush Creek member is largely of marine origin, commonly being very fossiliferous. In small areas, however, the strata appear to have been deposited in brackish water.... The Brush Creek member serves as a bench for reference in stratigraphic work as it is a fossiliferous stratum, as it is widely distributed, and as it is easily recognized along the outcrop. In a general way the deposits thicken in their extension southward across the State. The average measurement of the member is about five feet in eastern Ohio and at least 22 feet in the southern part of the field.... "

Stout further described the Brush Creek members in Vinton County, which lies just southwest of Athens County and where conditions are very similar to those observed in Athens County. His account of the Brush Creek limestones in Vinton County is abridged below:

"... Although the Brush Creek member is the most definite stratigraphic unit in the Conemaugh formation of Vinton County, it is not a persistent deposit and undergoes some changes in character. It is wanting through lack of development and also through replacement by sandstone. This applies to both the lower and the upper benches of the member which normally are separated by about 27 feet of shale and sandstone. The lower stratum consists usually of dark, fossiliferous shale, of this with hard limestone, and of gray to dark flint; whereas the upper one is made up of gray siliceous limestone or of gray to nearly black flint. From many measurements the average thickness of the lower bench is 11 inches and that of the upper layer is 2 feet. The materials on both of these horizons are very fossiliferous and the shales intervening in many places contain a few scattered remains. Conditions, especially locally, were not entirely marine throughout the stage of Brush Creek deposition, for in some areas sandstone, shale, and even coal in an impoverished form are present in the interval between the two regular benches of the member. The upper stratum of the Brush Creek limestone in southern Ohio appears to be the only part represented in the eastern portion of the State, the lower layer disappearing through lack of deposition long before it reaches that part of the field.... "

Two significant facts are given in the above summary. First is the occurrence of nonmarine shale, sandstone, and coal between the Brush Creek limestones, which along with evidence reported by Lamborn (1930, p. 119) and with other evidence to be presented from Athens County, reveals that the Brush Creek members in parts of Ohio constitute two incomplete cycles of sedimentary deposition. The second statement that the Brush Creek limestone of eastern Ohio is the Upper Brush Creek limestone of southern Ohio is probably verified by stratigraphic relationships traced along the outcrop across the State, but the lithology of the Lower Brush Creek limestone in Athens County more nearly matches the lithology of the Brush Creek limestone of eastern Ohio than does the lithology of the Upper Brush Creek member. Lamborn (1930, p. 119), in a published stratigraphic section from Jefferson County in eastern Ohio, shows dark or black shale and limestone representing both Brush Creek limestones and coal and underclay occurring only beneath the Upper Brush Creek limestone. His generalized Conemaugh stratigraphic section on pages 101-102, however, has coal only below the Lower Brush Creek member. Since lithology and interval thicknesses are quite variable and since coal is locally present at or near the base of both Brush Creek limestones, caution is to be used in determining which Brush Creek limestone is present in eastern Ohio, where only one limestone occurs.

Table 11 shows that the Lower Brush Creek cyclothem lacks only a nonmarine limestone for completeness, and even a nonmarine limestone may be represented in calcareous phases of the redbed member. The marine limestone and shale in some variety occurs almost everywhere in rock sections where it is due and is a most useful stratigraphic member. The basal member of interbedded shale and sandstone is the second most persistent member but is rather inconspicuous, because prominent massive sandstone is not characteristically developed in this interval. The redbed member is known at a number of places described below, and the Lower Brush Creek coal and underclay members are normally missing in exposures.

All known members of the Lower Brush Creek cyclothem are, however, present within the limits of Alexander, Athens, Dover, Lee, Trimble, Waterloo, and York Townships as shown on map 12. Brief descriptions of each member are given in following pages.

Lower Brush Creek Shale and/or Sandstone Member. - Average thickness of 24 exposures between the Mason coal and Lower Brush Creek limestone is 18 feet, about midway between the extremes of 9 and 32 feet. The most common type of rock occurring in this interval is stratified, silty, sandy, and micaceous shale, which is present in more than half of the recorded sections and which also comprises more total thickness than any other rock type occurring in this interval. Bedded, fine to medium, micaceous sandstone and interbedded sandstone similar to that just described and sandy shale like that described above occur in some outcrops. In other areas the sandy shale is replaced by other rock types. Massive shale or clay shale occupies all or most of the interval in about one-third of the outcrops. Mottled claystone is present at several places and strongly suggests a variegated claystone (redbed) in the Lower Brush Creek cyclothem. Poorly exposed fresh-water limestone occurs in only one section, and massive sandstone seems to be generally absent. Marine shale overlying the Mason coal has already been described on page 107, and marine fossils in shale immediately underlying the Lower Brush Creek limestone will be cited in description of that member. Lower Brush Creek coal, underclay, and redbed will be discussed as individual members.

Lower Brush Creek Redbed Member. - At almost every locality where coal and underclay underlie the Lower Brush Creek limestone, variegated claystone or shale underlies the underclay in turn. As mentioned previously on pages 102, 104, there has been confusion and doubt about the Mason and Lower Brush Creek coals and associated strata. It is possible that this claystone may belong to the claystone underlying the Mason coal and underclay and where separated from the Lower Brush Creek limestone by shale or sandstone, the name Mason is generally applied, and where no shale or sandstone intervenes the appellation is Brush Creek. The same principle in use of names applies to the underclay and coal members as well. Stout and Lamborn's stratigraphic sections from Columbiana County, already cited on page 102, and limited evidence from Athens County strongly indicate that there are both Mason and Lower Brush Creek cyclothems in eastern Ohio.

Outcrops of Lower Brush Creek redbed in Athens County vary in thickness from 5 to almost 16 feet and have an average thickness of 10 feet. These occur in Athens (localities 11224, 11631, 12158), Lee (locality 11550), Trimble (locality 6705), and Waterloo (localities 7596, 7604, and possibly 7621) Townships. These sections are included in appendix and their locations are shown on map 12. This member tends to be less a claystone and more a silty micaceous shale than the claystone members of the Mahoning and Mason cyclothems, and its color more generally gray and less variegated, although mottling in one or more shades of red, brown, buff, and green is usually present at most exposures. Small ferruginous limestone masses occur at one locality (7604) and at least part of the mass at another (locality 12158) is definitely calcareous. No distinct boundary between claystone and underclay is apparent in several of the exposures, and in two of these (localities 11550, 11631) carbonaceous and coaly materials occur in the upper part.

Lower Brush Creek Underclay Member. - Lower Brush Creek underclay is an impure, thin, and unsteady clay throughout its outcrop belt in Ohio. In Athens County it was recognized in about a dozen places in Athens, Lee, Trimble, Waterloo, and York Townships (map 12), which is only about 15 per cent of the places where Lower Brush Creek limestone was observed. Precise locations are listed under Lower Brush Creek redbed described in previous paragraphs. Most occurrences are in association with claystone and coal, and only at a few localities does it occur alone, undifferentiated from the claystone, or with coaly material intermixed in its own mass. Thickness in 11 observed exposures ranges from 4 inches to 4 feet and averages 16 inches. It is a gray to light gray plastic clay which may be micaceous, silty to sandy, or in part carbonaceous. Lime and iron impurities appear to be scarce, except for small amounts of limonite stain.

Lower Brush Creek Coal Member. - Coal in measurable thickness at or near the base of the Lower Brush Creek limestone or shale was found at only nine localities in Athens County. These locations are in Athens and Waterloo Townships, where the coal is associated with

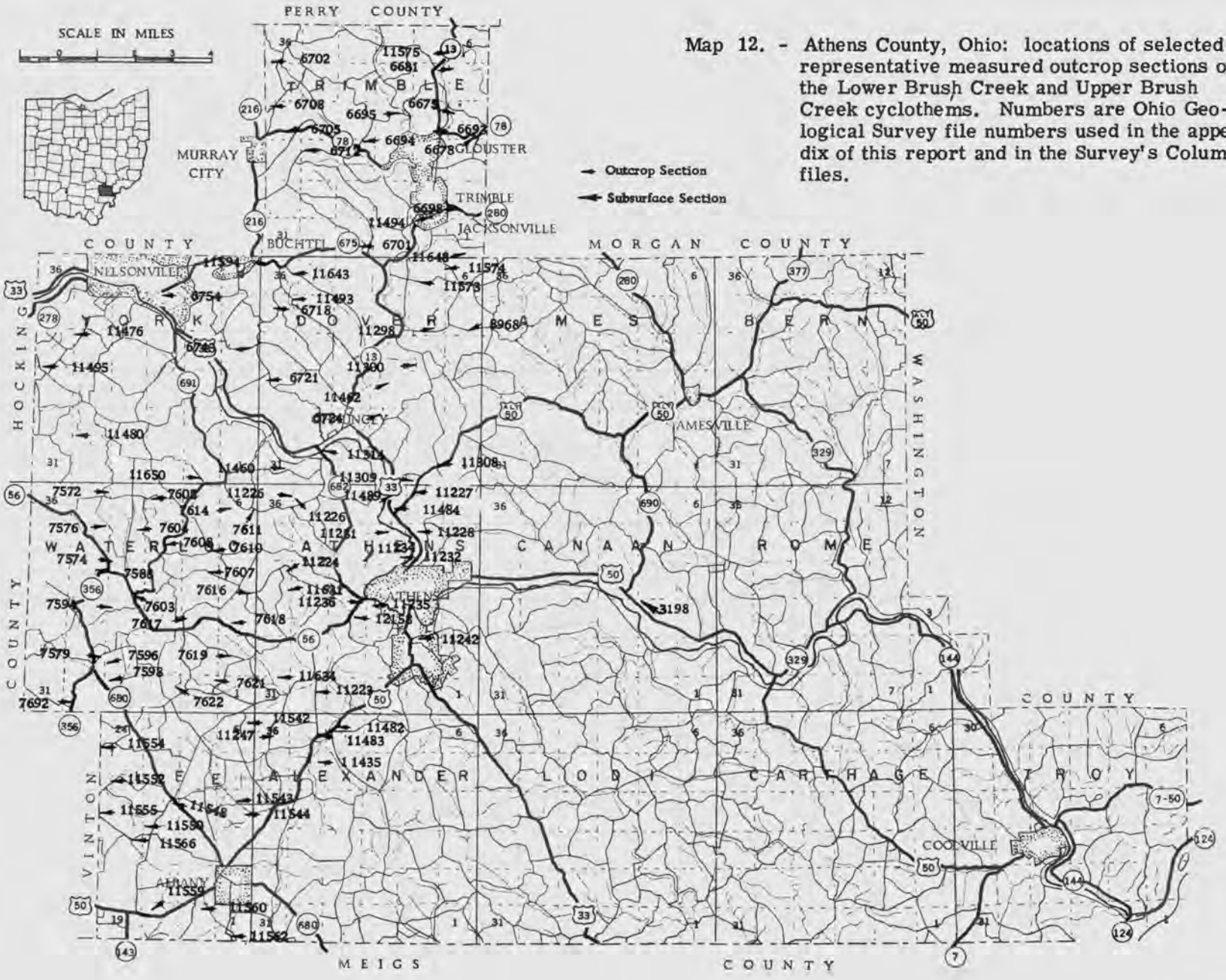
underclay and/or claystone, the distribution of which is shown on map 12. This coal is not only restricted geographically but is also thin. Thickness varying from 1 to 15 inches averages about 5 inches for the nine known occurrences. Carbonaceous material also occurs in the upper part of the underclay at several other localities. As a coal it is poor in quality and is mostly dull and shaly. Fusain and pyrite are likewise present. Being shaly and thin it tends to weather to a soft sooty mass along natural outcrops. The best coal is at two exposures in Athens Township (localities 11224, 12158), where 3 to 5 inches of bright blocky coal with dull streaks is present.

Lower Brush Creek Limestone Member. - Lower Brush Creek limestone is the lowest exposed marine member of widespread occurrence in Athens County, and outcrops are present in Alexander, Athens, Dover, Lee, Trimble, Waterloo, and York Townships. In general, exposures are along and west of the valleys of Margaret and Sunday Creeks, and some of the better and more significant outcrops are shown on map 12. Fluctuation in lithology and thickness as well as variation in the rather small intervals among the Brush Creek and Cambridge limestones makes their use for correlation purposes rather difficult, especially where one or more of them are inconspicuous or missing. Coalescence of the two Brush Creek marine members also makes determination of their average thicknesses somewhat of an uncertainty. Over 70 measurements on strata identified as Lower Brush Creek limestone and related marine beds show an average thickness of over 6 feet for the Athens County area. This figure may actually be too much, as all thick deposits were included, and these thicker deposits, in all probability, include part of the Upper Brush Creek member.

The Lower Brush Creek limestone really consists of varied beds of marine origin limestone, shale, or flinty chert, and at many places is some combination of these different lithologies. The thin deposits tend to be 1 to 2 feet of limestone in one or several layers, and the thick deposits are prone to be dark calcareous shale with calcareous or ferruginous nodules or thick beds of light gray cherty limestone separated by shale partings of variable thickness. Associated marine shale commonly is interbedded and above any limestone present, but locally dark or even light sandy shale with marine fossils occurs beneath the limestone layers.

Much of the limestone is dark gray to almost black and is quite impure. Some of this dark limestone is dense and fine textured and weathers with smooth surfaces resembling basalt in appearance, and other tends to be imperfectly laminated with an abundance of mica and silt and on weathering takes on a shaly appearance. This last type of limestone grades into dark gray shaly limestone and into similarly colored calcareous shale, both of which are commonly abundantly fossiliferous with conspicuous crinoid stems or solitary horn corals. There is also gradation from dark dense limestone into gray or light gray, partly crystalline limestone, locally marked by an abundance of crinoid stems. In the thicker deposits the lighter gray limestone tends to be dense or fine-textured and cherty. The fresh chert is various shades of gray and weathers into a porous residuum of pale yellow or light brown color. The light gray semi-crystalline, crinoidal limestone very closely resembles typical Ames limestone, but those two can be distinguished readily by their different stratigraphic positions and by the larger number of calcite crystals in the Brush Creek limestone. Sandy beds of sandstone or sandy shale frequently are associated with the Brush Creek limestones and locally may even replace the marine limestone and shale. Locally calcareous, micaceous, fossiliferous sandstone or conglomerate with an abundance of marine limestone pebbles and cobblestones represent those members.

Fossils are usually abundant and conspicuous and are particularly evident in the shale and dark limestone facies, in which the calcite of the shells is lighter in color than the limestone matrix. The largest variety of fossils occurs probably in the shaly limestone and calcareous shale, where molluscs, solitary horn corals, crinoid stems, and small chonetid and productid brachiopods locally abound. Fossil bryozoa are very abundant in some of the light shaly partings in parts of Lee and Waterloo Townships. Large brachiopods occur mostly in the light gray, dense, cherty limestone.



Map 12. - Athens County, Ohio: locations of selected representative measured outcrop sections of the Lower Brush Creek and Upper Brush Creek cyclothems. Numbers are Ohio Geological Survey file numbers used in the appendix of this report and in the Survey's Columbus files.

Upper Brush Creek Cyclothem

Heretofore the Upper Brush Creek members have been discussed in published reports along with the Lower Brush Creek members. In fact, little attention has been given to the nonmarine members of the Upper Brush Creek cyclothem, although the double nature of the Brush Creek limestone has long been recognized. Condit (1912, p. 49) wrote as follows:

"... The fossiliferous Brush Creek limestone ordinarily consists of two parts separated by 25 to 30 feet of shale, which also has marine fossils in some exposures, giving a continuous series of fossiliferous beds 30 to 45 feet thick. Since the upper and lower limestones are so closely related it is best that they be included under the same name. In more eastern counties, coal and clay may be found between these, but along the western outcrop the interval shows increasing signs of being entirely of marine origin. It is true, that in many places one or both of the limestones is missing and sandstone may occupy the entire interval, but such occurrences are only local."

Subsequent authors, who have dealt with the Brush Creek members in publications of the Ohio Geological Survey, have also noted the double development of these marine limestones, with the exception of Flint (1951, p. 65) who did not find double development of the Brush Creek limestones in Perry County. Lamborn (1930, p. 119) in Jefferson County and Stout (1927, p. 359) in Vinton County also described coal between the Brush Creek limestones, and similar occurrences are locally present here in Athens County.

Throughout the local Brush Creek outcrop area the two marine limestones, Lower and Upper Brush Creek, are separated by an average interval, based on almost 40 measurements, of 25 feet. Table 11 lists the complete sequence of strata, including coal and underclay, in this interval, but it is commonly filled by sandy shale and sandstone. Condit and others have already been cited as calling attention to the marine shale, flint, or limestone filling the entire interval at many places in southern Ohio, and such a condition also occurs locally in Athens County, where the maximum thickness of uninterrupted marine beds ranges from 10 to 20 or even 30 feet at localities of greatest thickness. The best stratigraphic references for the Brush Creek limestones are the Upper Freeport coal below and the marine members up to and including the Ames limestone above. Figure 14 (p. 103) gives summaries of all available data between the Brush Creek limestones and other pertinent members, and only a few need be cited here. Upper Brush Creek limestone lies on an average of 101 feet above the Upper Freeport coal and 44 feet below the Cambridge limestone, 67 feet below the Portersville shale and limestone, and 104 feet below the Ames limestone.

Upper Brush Creek Shale and/or Sandstone Member. - Thicknesses of nonmarine shale and sandstone lying between the Brush Creek limestones vary from 5 to 40 feet and usually range between 20 and 30 feet. Average thickness of this member in 30 Athens County measurements is 22 feet. Shale is more abundant than sandstone in this interval; where associated with sandstone it is usually sandy and micaceous, and where alone is more apt to be argillaceous. The sandstone is normally fine or fine- to medium-grained, micaceous, and stratified, but locally several feet of heavier bedded to massive sandstone occur beneath the Upper Brush Creek limestone (localities 11227, 11228, 11231, 11232, and 11234). At some places part of the shale or sandstone is calcareous, and siderite concretions now largely weathered to limonite are also common features in the member.

Since locally all beds between the two Brush Creek limestones are marine, the regular stratification of the nonfossiliferous beds may indicate deposition in or very near a marine environment.

Upper Brush Creek Underclay Member. - Clay or clay shale is present under the Upper Brush Creek coal or, in absence of the coal, under the Upper Brush Creek marine limestone in four different localities in Athens (11236, 11489), Dover (6718), and Waterloo (7604) Townships. The thickness varies from eight inches to more than four feet with an average of 2 feet 5 inches.

Not only is it a thin clay and seldom present but also it is of poor quality as a clay, being silty, sandy, micaceous, or carbonaceous. This member is of only minor stratigraphic and of no economic interest.

Upper Brush Creek Coal Member. - A coal member is present between the two Brush Creek limestones at a few places in Athens County, and similar occurrences are recorded elsewhere in Ohio (p. 108-109). Measurements were made at only four places on this coal in Athens (localities 11236, 11489, 11634) and Dover (locality 6718) Townships, where thicknesses range from one inch to one foot. Average thickness for these four measurements is about six inches, but this figure has no real significance as the coal is developed at very few localities. Its best development is between the valleys of the Hocking River and Sugar Creek, where the coal lies some distance below and is separated from the Upper Brush Creek limestone by nonmarine shale and sandstone. At only one locality, in a ravine west of the 987 road junction in section 35 of Dover Township, was coal observed immediately below the limestone. At best this coal is shaly, although in some places it has bright streaks and with much fusain and fossil plants. Such a coal is of significance only stratigraphically; along with the underlying clay, shale, and sandstone, it indicates a definite Upper Brush Creek cyclothem.

Upper Brush Creek Limestone Member. - The Upper Brush Creek limestone was observed and measured at over 50 places in Alexander, Ames, Athens, Dover, Lee, Trimble, and Waterloo Townships with most exposures occurring in the last five of the above townships (map 12). The average thickness for all these exposures is only two feet, which is less than one-third the average thickness of the Lower Brush Creek limestone. Attention was called on page 110 that in part this difference mav be due to the fact that most thick deposits of Brush Creek limestones are classified as the Lower Brush Creek member although actually the top part of these thicker deposits may well represent the Upper Brush Creek member. Where these two limestones are coalesced, it is impossible, at present, to recognize a plane of separation from known data.

The over-all lithology of the two Brush Creek limestones is very similar, and suites of available hand specimens, each containing more than 50 local specimens from each member, are strikingly similar. On the whole, the Lower Brush Creek suite has more dark gray, more shaly, and more cherty specimens than does the Upper Brush Creek collection. The Upper Brush Creek member varies from dark to light gray, from dense to partly crystalline, from relatively pure to sandy or shaly limestone. The darker colored stone is usually dense-textured, and the light gray is more apt to be conspicuously crystalline or sandy. There are exceptions to these generalities: some dark speciments are partly crystalline and some light gray specimens are dense and fine-textured. Among available specimens chert is rare or missing entirely and ferruginous or shaly examples are uncommon. Where associated with sandstone, quartz sand grains are abundant accessory minerals, and mica is conspicuous in the shaly specimens.

Although fossils generally are present, they are less abundant in kinds and numbers than in the Lower Brush Creek member. Casual inspection indicates that productid and other large brachiopods, along with crinoid stems and horn corals, are more common but usually not abundant in the light gray facies, and chonetid brachiopods are often abundant in darker and shaly limestone. At present the fauna has been little collected and is essentially unknown

Wilgus Cyclothem

The Wilgus cyclothem has five recognized members in eastern Ohio, as shown in table 11, and seems to lack only a well-developed fresh-water limestone member, which may in fact be represented by the Meyersdale redbed. The most persistent beds are the Buffalo and Cambridge members, and the others are of very limited occurrence. The main areas of the Wilgus coal and its underclay are locally south of Athens County, where they attain in a few places fair development.

Those two members are generally absent in Athens County and on northward in the State. The Meyersdale varicolored shale or claystone is also absent in Athens County, but its lithology is recognized elsewhere in eastern Ohio.

The outcrop belt of all Wilgus cycle's members in Athens County is shown on map 13, on which the locations of better outcrops are marked. Exposures extend over most areas in Athens, Dover, Lee, and Trimble Townships and are restricted to the eastern portions of Waterloo and York Townships and to the northwestern part of Alexander Township. The principal outcrops are along the valleys and tributary valleys of Hamley Run, Margaret, Sunday, and Sugar Creeks, and the Hocking River.

In this county there is normally a two-fold representation of the Wilgus cyclothem, viz., the Buffalo shale and sandstone and the Cambridge limestone. The Buffalo comprises the major part of the total thickness. The total average thickness is 27 feet, and 22 of these are occupied by the Buffalo member alone. The Cambridge limestone is more easily recognized as an individual unit, but is, however, thin and locally missing. In spite of being more easily recognized in limited outcrops than the Buffalo member, the Cambridge is more difficult to trace laterally than most other marine members in the Conemaugh series of Athens County.

Buffalo Shale and/or Sandstone Member. - I. C. White (1878, p. 33) first used the name Buffalo for the thick sandstone between the Brush Creek and Cambridge (Pine Creek in Pennsylvania) limestones. Up until that date this sandstone was considered as part of the Mahoning sandstone. The type area for White's name is along Buffalo Creek, Buffalo Township, Butler County, Pennsylvania. In 1903 Adams (p. 350) called shale between the Cambridge limestone and Brush Creek coal Buffalo shale.

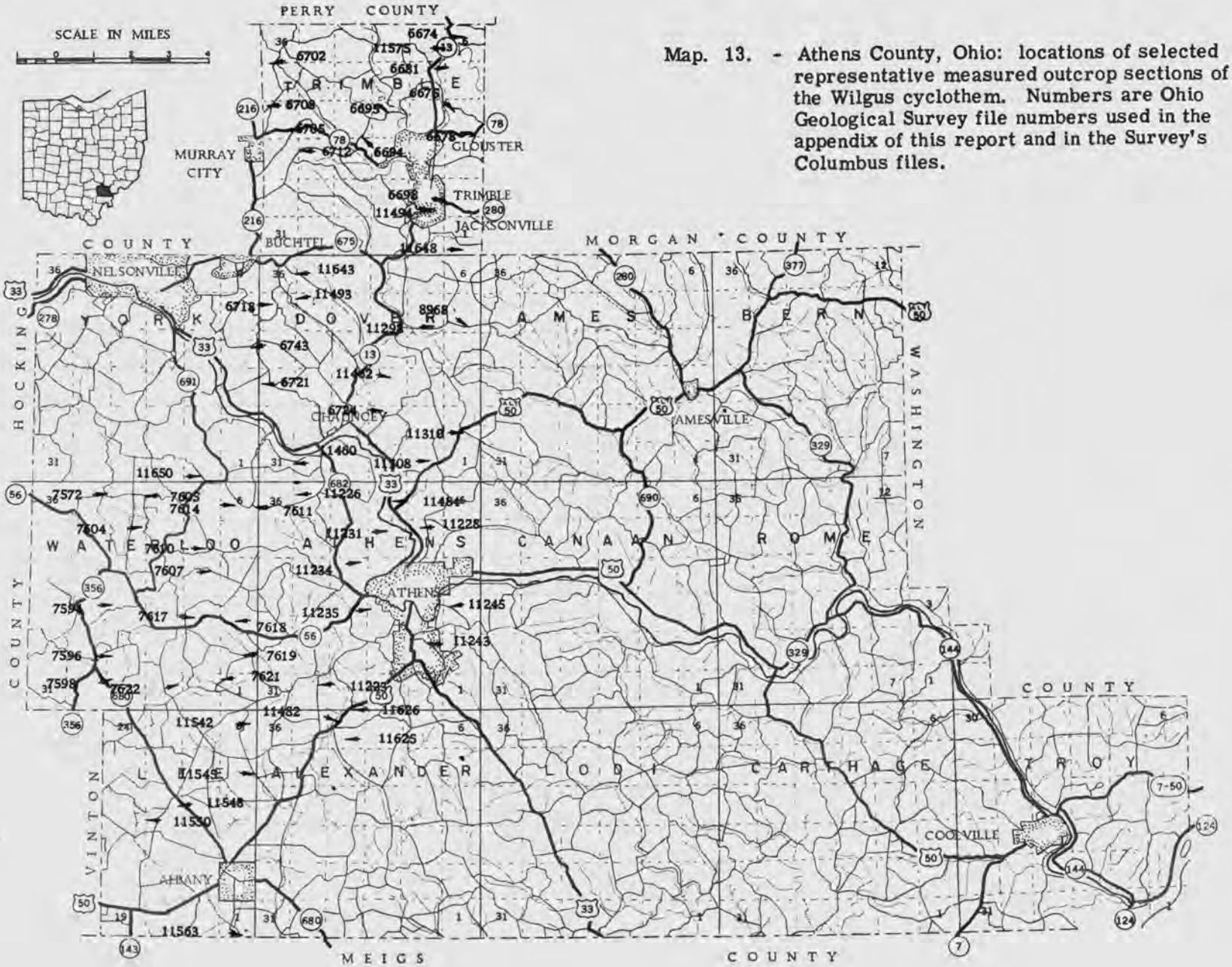
In Ohio both sandstone and shale between the Brush Creek and Cambridge limestones are called Buffalo (Bownocker and Dean (Stout), 1930, chart op. p. 6; Lamborn, 1939, p. 190), although the name is commonly considered as applied to sandstone. Flint's description (1951, p. 65) of Buffalo shale in Perry County fits that of the Meyersdale redbed rather than that of the Buffalo member. The term is here used for both shale and sandstone.

Nearly all rock exposures below the Cambridge limestone in Athens County show some combination of bedded, sandy, silty, micaceous shale and fine or fine- to medium-grained micaceous sandstone. Shale and sandstone may be interbedded or grade laterally or vertically into each other. With few exceptions the shale is thicker than the sandstone, although in numerous sections sandstone predominates in the upper part of the interval. The sandstone is commonly stratified rather than massive and in a few places ripple marked. Those stratigraphic sections showing massive sandstone are the thickest sections known for the interval and tend to be conglomeratic and disconformable at base. Coal and underclay separate shale and sandstone from the Cambridge limestone at less than half a dozen localities observed in the county, nor was any varicolored claystone seen in the interval. Fossils are rare and those found consist of fragmented plant remains. Fresh color of both shale and sandstone is light gray and that of weathered rock tends to become olive drab with varying amounts of brown to yellow limonitic stain.

Thickness of this member varies from 7 to 8 feet (localities 11223, 11462) to almost 43 feet (localities 6674, 11575). Most measured exposures are between 20 and 30 feet thick, and the average thickness of 36 complete exposures is 24 feet and 3 inches.

Meyersdale Redbed Member. - Swartz et al. (1919, p. 574) proposed the name of Meyersdale for redbeds above the Buffalo sandstone and below the Lower Bakerstown (Anderson or Thomas) coal. The type exposure is along the Western Maryland Railroad east of Meyersdale, Pennsylvania.

Meyersdale member (see locality 11236) is not present in Athens County as far as known. Its typical lithology has been, however, reported elsewhere in Ohio by several geologists, although none has used the name of Meyersdale in this State. Stout et al. (1923, p. 451), in



Map. 13. - Athens County, Ohio: locations of selected representative measured outcrop sections of the Wilgus cyclothem. Numbers are Ohio Geological Survey file numbers used in the appendix of this report and in the Survey's Columbus files.

describing the Wilgus underclay of Gallia, Lawrence, and Meigs Counties, wrote as follows:

"... In some localities the (Wilgus) clay is underlain by argillaceous shale, leaving a pink or red color, and a thickness of 10 to 20 feet...."

Lamborn (1930, p. 125-127) described red clay shale 5 to 18 feet thick below the Wilgus underclay in Jefferson County. Flint (1951, p. 65), in his description of the "Buffalo" shale in Perry County, wrote as follows:

"Shale or clay shale of various gray, green, purple, and red shades comprises the Buffalo member in Perry County. Within this shale are numerous hematite, siderite, and limonite nodules, some of which are calcareous. The clay shale weathers rapidly to a nondescript mass showing no bedding and resembling clay, but fresh exposures reveal the characteristic bedding of shale. The thickness of the member averages 33 feet and ranges from 23 to 52 feet."

Flint's description and thickness figures compare very favorably with those of Waage (1950, p. 41) for the Meyersdale redbed in Maryland, where it differs in being more massive and in being split into two redbeds by interbedded siltstone and fine sandstone.

This member is apparently only locally developed in Ohio and merits some consideration for its stratigraphic significance. Geologists should be on the alert for its local presence elsewhere.

Wilgus Underclay and Coal Members. - The Wilgus coal and underclay members are of such minor importance in Athens County that they will be treated together.

Condit (1912, p. 48) named the Wilgus coal from the Village of Wilgus in Mason Township, Lawrence County, and the same name is also applied to its underclay. This coal was formerly known as the Limestone coal from its association beneath the Cambridge limestone. As stated previously, the Wilgus coal and underclay are best developed in parts of Gallia, Lawrence, and Meigs Counties and are of little consequence throughout the remainder of possible outcrop area in Ohio. Condit (1912, p. 47-48) and Bownocker and Dean (1930, p. 173-175) have described the coal in its best area in southern Ohio, and Stout et al. (1923, p. 451-452), have done the same for the underclay.

These two members are thin, poor in quality, and rarely present in Athens County. Wilgus coal was recognized at only one place, located in the valley east of Millfield in Dover Township (locality 8968), where it is merely a smut streak that is only locally present. Condit (1912, p. 98) reported a locality in the valley of Leading Creek, a little more than a mile southeast of Albany, where Wilgus coal was formerly mined or prospected. This locality should be in section 1, Lee Township, and is apparently the northern limit of thick Wilgus coal in southern Ohio.

The county record of the underclay is little better than that of the coal. Exposures of clay shale which seem to represent Wilgus underclay are in Dover (locality 6724), Trimble (locality 6678), and York (locality 6743) Townships. In quality it is micaceous and sandy, and the material tends to approach a light gray, massive, plastic clay at only one locality (6743). Thicknesses vary from 8 inches to 3 feet 7 inches. The average thickness of 1 foot 9 inches is rather meaningless, since it is based on only three measurements.

Cambridge Limestone Member. - Andrews (1873, p. 262) named the Cambridge limestone from Cambridge in Guernsey County, Ohio. This member has also been called the Upper Cambridge limestone and Pine Creek limestone, the latter a name which is still used in Pennsylvania.

The Cambridge member is the third important marine member above the base of the Conemaugh series in Ohio. Condit (1912, p. 43-47) described the Cambridge limestone from his observations across the State as variable in lithology and fauna and in stratigraphic intervals to

other members. On page 47 he listed average intervals to the Ames limestone above, ranging from 68 to 130 feet, and to the Upper Freeport coal below, from 108 to 145 feet. In general those intervals decrease from north to south along the outcrop belt and attain minimum thicknesses in Athens and Meigs Counties. Numerous details of lithologic variation can be gotten from Condit's pages cited above. A brief general summary of Cambridge features in Ohio by Lamborn (1951, p. 30) is given below:

"The Cambridge is extremely variable in chemical and general physical character. At a few scattered localities it is a bluish gray somewhat nodular fossiliferous limestone of fair quality. Over large areas, however, it is represented by either a thin nodular iron ore, a thin nodular, highly ferruginous limestone, a highly siliceous limestone, or nodular limestone embedded in fossiliferous shale. The member reaches its thickest known development in Ohio in western Guernsey and in northeastern Muskingum County where it is a highly siliceous limestone having a maximum depth of about 12 feet.... "

Its outcrop extends from Columbiana and Jefferson Counties in eastern Ohio to Lawrence County in southern Ohio. Stout and Lamborn (1924, p. 336) report best development of Cambridge limestone in Gallia, Guernsey, Lawrence, and Muskingum Counties.

The Cambridge limestone is generally thin and also variable in lithology and in intervals to other key beds in Athens County. Locations of principal outcrops recorded are shown on map 13. The Cambridge is approximately the following distances from key beds: 125 feet above the Upper Freeport (No. 7) coal, 45 feet above the Lower Brush Creek limestone, and 25 feet above the Upper Brush Creek limestone, 15 feet below the Anderson-Portersville members, and 80 feet below the Ames limestone. Ranges of interval thicknesses and more precise average thicknesses are given in table 11. Average thickness for 40 Cambridge limestone measurements in Athens County is 1 foot 3 inches. Thicknesses vary from 3 inches to 7 feet with only four measurements exceeding 3 feet. More than half of the measurements are less than one foot, and an average thickness of one foot or less would be more representative. Sandstone has cut out and replaced the Cambridge limestone at some places, and representative samples of such exposures occur in Athens (locality 11231), Lee (localities 11548, 11550, 11563), and Waterloo (locality 7622) Townships.

The Cambridge outcrop was the most difficult of the major Conemaugh marine members to trace across the county, largely because of thinness, variable lithology, and tendency over considerable areas to be incorporated in sandy beds characterized by few or no apparent fossils. In general, sandstone, both above and below, is close to or in contact with the Cambridge member, which locally degenerates into nonfossiliferous calcareous sandstone. The Cambridge is most likely to be confused with the Upper Brush Creek limestone because of local similarity in lithology and of close stratigraphic positions. Where the Cambridge and both Brush Creek members or where Upper Brush Creek, Cambridge, and Portersville members are present, identification of marine members is certain, but where Upper Brush Creek becomes united with Lower Brush Creek limestone, where the Upper Brush Creek is suppressed or absent, or where two thin marine limestones (Brush Creeks or one Brush Creek and Cambridge) occur, identification and correlation become uncertain. The Upper Brush Creek is apt to be sandy, micaceous, and sparingly fossiliferous, as is the Cambridge, but is less apt to be as ferruginous. Stratigraphic succession and any lithologic peculiarities available are the best stratigraphic guides to be used in identification and correlation.

Bedding of the Cambridge member is commonly stratified but may be nodular or massive. Fresh rock specimens are most likely light greenish gray in color, but shades of light bluish gray, light gray, or gray also occur. Sufficient iron content is generally present so that weathered material shows one or more shades of brown or yellow arranged in an irregular color pattern. The rock is often sandy, silty, and micaceous as well as ferruginous. It is a compact, firm, and usually heavy stone with freshly broken surfaces granular from sand grains, mica flakes, or calcite crystals, the latter in some specimens arranged in small veins. The dense texture and iron content are largely responsible for heavy weight of most specimens. Fine-texture specimens are dull in luster, and fine-textured specimens with a smooth glossy luster are not common. Purer limestone is gray to light gray in color, lighter in weight and more fossiliferous than the

ferruginous specimens. Compared with the Ames, Lower Brush Creek, and Portersville limestones the Cambridge limestone is less fossiliferous, but locally conspicuous fossils abound. More common Cambridge fossils are Composita sp., chonetids, and productids among the brachiopods, pectinoids among the pelecypods, and carinate Euphemites among the gastropods. The Cambridge member is reported to be more fossiliferous elsewhere in Ohio than in Athens County. Mark (1912, p. 268-276) has listed and briefly discussed Cambridge limestone fossils from a number of eastern Ohio localities. Its fauna, as well as the fauna of other Conemaugh marine members, is in need of restudy.

Anderson Cyclothem

For eastern Ohio the Anderson cyclothem is a rather complete cycle as shown in table 11. Both marine and nonmarine limestones are present, as well as coal, shale and sandstone, and underclay. The Bloomfield fresh-water limestone is not well developed at most places as a layered rock but is composed rather of nodules and pellets of limestone embedded in clay and shale. Thus, the fresh-water limestone in the Anderson cyclothem may more nearly represent a claystone or redbed member than a typical nodular or bedded nonmarine limestone. A claystone or redbed member is, moreover, not generally recognized in this cyclothem, although red shale is locally reported (Lamborn, 1930, p. 134). The Anderson, Bakerstown, and Portersville members are quite steady in occurrence along the outcrop belt across eastern Ohio although not always conspicuous in exposures. This coal, marine shale, and underclay tend to weather, soften, and slump easily and, hence, they often occur in landslides below their real stratigraphic position and do not form prominent ledges.

With exception of the coal and underclay, each member has a different name now employed in Ohio, and this is further complicated by use of other names in Maryland, Pennsylvania, and West Virginia. Some names employed in the four-state area are given below in table 12, compiled from various sources:

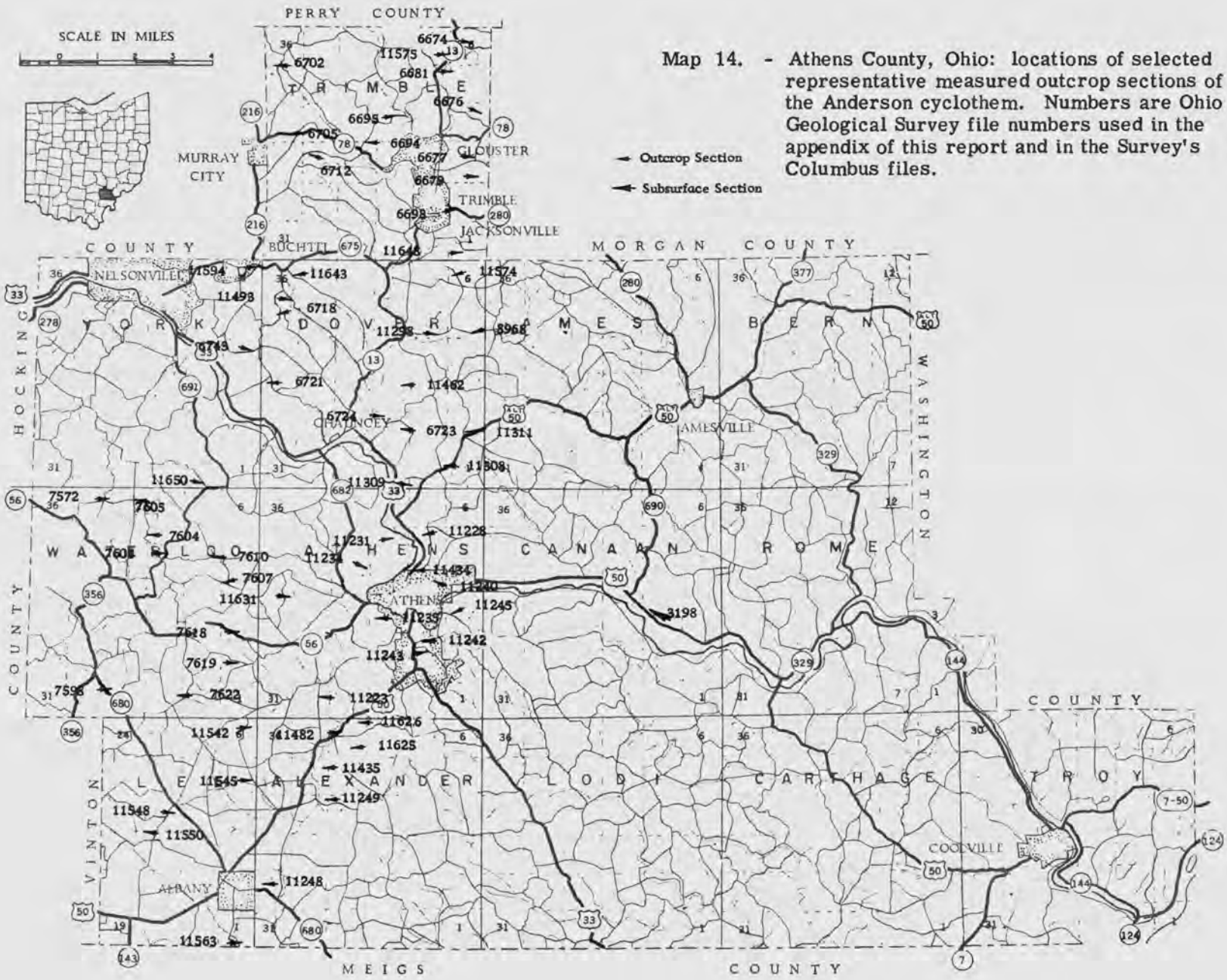
Table 12

Comparison of Various Names Used for the Several Members of the Anderson (Lower Bakerstown) Cyclothem in the Northern Appalachian Region

Ohio	Maryland	Pennsylvania	West Virginia
Portersville sh. & ls.	Friendsville, Woods Run	Woods Run	Portersville
Anderson (Norwich, Patriot) coal	(Lower) Bakerstown, Thomas	Lower Bakerstown, Hagar, Anthony?	Bakerstown
Anderson underclay	Thomas	Bakerstown ?	Bakerstown
Bloomfield ls.	Albright, Thomas	Albright	Albright
Bakerstown (Anderson) sh. & ss.	?	Bakerstown	?

Such a variety of names widely used in many cyclothems indicates the desirability for geologists working with coal measure stratigraphy in this immediate region to adopt a more uniform nomenclature.

Map 14 depicts selected better exposures of Anderson cyclothem members in Athens County.



Map 14. - Athens County, Ohio: locations of selected representative measured outcrop sections of the Anderson cyclothem. Numbers are Ohio Geological Survey file numbers used in the appendix of this report and in the Survey's Columbus files.

Outcrops are confined to Alexander, Athens, Canaan, Dover, Lee, Trimble, Waterloo, and York Townships in a distribution pattern similar to that of principal outcrops of members of the Wilgus cyclothem. Numerous exposures show members of both as well as members of adjacent cycles of deposition.

The total average thickness of the Anderson cyclothem in Athens County is 22 feet 8 inches, a figure which is less than that for any other Conemaugh cyclothem below the Bakerstown shale and sandstone.

Bakerstown Shale and/or Sandstone Member. - Bakerstown has not been used as a stratigraphic name in Ohio previous to the preparation of this bulletin and map. J. P. Lesley (1878, p. 305-308) applied this name in Pennsylvania to sandstone underlying the Bakerstown (Anthony) coal and overlying the Lower Barren Measure (Conemaugh) red shales, which rest on Pine Creek (Wilgus ?) coal. From Lesley's definition it seems logical to use Bakerstown for the shale and sandstone member of the Anderson cyclothem in Ohio. Heretofore this member has been nameless or called Anderson, as by Flint (1951, p. 66).

In Athens County the Bakerstown member has a maximum and minimum thickness of 32 and 3 feet, respectively, with an average thickness of 13 feet for 23 measurements. Where the underlying Cambridge and Wilgus members are absent or indistinct and replaced by sandy and shaly beds, it is difficult to separate the Bakerstown member from the Buffalo member, and undifferentiated Buffalo-Bakerstown shale and sandstone members attain considerable combined thickness.

The Bakerstown member is composed of more shale than sandstone, and the shale is typically silty, sandy, and micaceous but may be clayey, calcareous, or ferruginous. The beds are seldom clay shale, but frequently small ferruginous masses, nodules, and stain are present. Usual colors are light gray, gray, or olive drab with varying amounts and shades of brown and yellow stain. Maroon shale and clay shale is present at two locations (localities 8968 and 11493). Dark gray to black shale seems to be absent. Sandstones occur at all observed exposures with shale, either interbedded or above and/or below. Sandstone colors are similar to those in the shale except for maroon, and sandstone lithology is typically fine to medium, silty and micaceous, and stratified in thin to heavy beds. Calcareous zones are locally present and tend to be at top or bottom of the sandstone where sandstone forms top or bottom layers. At two localities (6743, 7610) shale and sandstone separate fresh-water limestone layers from the overlying Anderson members. In the area studied the Bakerstown member is not coarse, massive, or thick sandstone.

Bloomfield Limestone Member. - In Ohio the Bloomfield member is a well-developed limestone only in Muskingum County where Stout (1918, p. 242 - 243) named it from the village of Bloomfield in Highland Township. According to Waage (1950, p. 42), at an earlier date Hennen and Reger (1914, p. 93, 140) named an equivalent limestone in Preston County, West Virginia, the Albright limestone. Thus, Albright has precedence over Bloomfield as a name and probably should be used also in Ohio. However, until the correlation between Albright and Bloomfield limestones is established without reasonable doubt, Bloomfield will be retained as a stratigraphic name for the nonmarine limestone in or just below the Anderson underclay, but it is recommended that Albright replace Bloomfield if and when positive correlation is determined.

In the type area the Bloomfield limestone is a light gray, dense, hard, bedded limestone about 18 inches thick and lying 2 to 6 feet below the Anderson coal and 2 to 20 feet above the Cambridge limestone. Elsewhere in Ohio this member is represented by limestone pellets and nodules embedded at the base of or in the basal part of the Anderson underclay. This second type of occurrence is that of the Bloomfield member in Athens County, where its thicknesses range from 3 inches to 6 feet and average about 4 feet in 17 exposures. Its base is usually distinct but its top grades upward without a sharp plane of separation into the overlying Anderson underclay. Prevailing over-all colors of matrix and limestone masses are light gray, greenish gray, or gray, locally with shades of red and purple. Weathered colors are shades of brown and yellow, and

buff is a common shade. The limestone particles are mostly small and of pellet size, although nodules up to three inches in size do occur (locality 11625). In composition they are largely calcareous except for noticeable iron content at a few places (localities 6676, 11542). Fossil ostracods were observed at one locality (11550), which definitely indicates the true limestone nature of these clay deposits containing calcareous and ferruginous pellets and nodules.

The Bloomfield limestone is typically a basal calcareous phase of the Anderson underclay except, as stated above, in parts of Muskingum County, where it is bedded limestone.

Anderson Underclay Member. - This underclay takes its name from the overlying Anderson coal in Ohio. Elsewhere in the Northern Appalachian region it is known as the (Lower) Bakerstown or Thomas clay.

Both Anderson members are steady in outcrop along a belt extending from Columbiana to Lawrence Counties in eastern Ohio. The underclay is, on the whole, more persistent and thicker than the coal. Stout et al. (1923, p. 456) described the Anderson as an impure plastic clay characterized by calcareous andfferruginous materials. This statement is in part based on the fact that in most descriptions calcareous clay representing the Bloomfield limestone is also included. At best, Anderson clay is a low grade plastic clay for ceramic purposes. Except for one locality (11243) Anderson clay is separated from the Cambridge limestone by the Bakerstown sandstone. It normally lies directly below the Anderson coal, although the coal may be reduced to paper thinness.

Anderson underclay in Athens County has an average thickness of only 2 feet 8 inches for 33 measurements, which is much less than the average thickness usually given, since the basal calcareous part with limestone masses is excluded. Thicknesses vary from 6 inches to 8 feet 6 inches, and the usual thickness is less than 4 feet. It is everywhere a semi-plastic to plastic clay or clay shale and when fresh is light gray in color. It stains or weathers shades of brown and yellow and is similar in that respect to the Bloomfield member. In addition to calcite and iron compounds the most common impurities are mica and silt. Carbonaceous matter and fossil plants are rare and were noted only at one locality (11648).

Anderson Coal Member. - The Anderson coal, named by Andrews (1874, p. 539) from a small mine in Guernsey County, is the equivalent of the Norwich and Patriot coals elsewhere in Ohio. Locally it is called the 18-inch seam, but its thickness seldom justifies that term. Beyond the borders of Ohio this coal is the (Lower) Bakerstown or Thomas coal. Areas of outcrop in Athens County are shown on map 14.

In spite of being a rather thin coal, the Anderson is one of the thicker and more persistent coals in the Conemaugh series, which is noted rather for thin unsteady than for thick persistent coals. Thickness at most places is less than 3 feet, and the average for the State is 1 foot 8 inches. Over considerable areas it is absent or nearly so and can be traced as a coal horizon from the underclay below and marine Portersville shale and limestone above or as a smut plane and associated beds. In other areas, where coal is present, it is almost impossible to find traces because of weathering and slump, not only of the Anderson coal but also of the underlying clay and the overlying Portersville shale. In Athens County Anderson coal might well be called the 8-inch seam, for that is its average thickness for 41 measurements. It varies in thickness from a mere film to more than 2 feet. While this coal is seemingly very steady in this area of the Hocking Valley, its thickness is unreliable and may change from a film to a thickness of 8 to 12 inches in short horizontal distances -- no more than 100 yards at some places.

Anderson coal in Athens County is mostly dull coal with bright bands, or a nearly equal mixture of bright and dull coal. Fusain is commonly present and, as far as observed, much more prevalent than pyrite, although elsewhere in Ohio pyrite is common. Part or all the thickness may be shaly or bony, and along the outcrop this coal tends to weather to a soft sooty mass. No analyses are available from Athens County samples, but analyses of Anderson samples from Guernsey and Muskingum Counties (Bownocker and Dean, 1930, p. 176 - 177) show ash content

from 8 to 12 per cent and sulphur from 2 to 5 per cent. The coal is, however, generally well liked where it is mined and used locally. It has been mined or prospected at only a few places in Athens, Dover (locality 11574), Trimble (locality 6712, 11648), and Waterloo (locality 7618) Townships and is of little or no economic worth as a coal resource in the Hocking Valley region.

Portersville Shale and Limestone Member . - Typical Portersville shale and nodular limestone is the most distinctive marine member in the Conemaugh series of Ohio. In fact, in some respects it is the most distinctive member in the entire Conemaugh series of Ohio, both in lithology and in fauna. Because of ease in weathering and slumping, the Portersville member fails in its promise to be the most useful stratigraphic marker in our Conemaugh rocks and in that capacity is certainly surpassed by the Ames limestone and possibly by the Brush Creek limestones as well.

Type area of the Portersville member is near the village of Portersville in Perry County about 25 miles north of the city of Athens, where Condit (1912, p. 41 - 42) described it as follows:

"From 12 to 30 feet above the Cambridge limestone is another fossiliferous horizon which is seldom more than a calcareous or pyritous shale, forming the roof of the Anderson coal. The name Portersville is chosen for this bed from the village of that name, near the eastern edge of Perry County. Excellent exposures may be seen in section 24, Bearfield Township, along the abandoned right of way of the Wabash Railroad. The section follows:

		Ft.	In.
4.	Limestone, in irregular nodules full of fossils	0	5
3.	Shale, black, fossiliferous	3	0
2.	Coal, Anderson	1	0
1.	Clay, with nodular limestone		

"The roof shales of the coal are rich in brassy pyrite and many of the fossils have pyritized shells. A collection from this locality gives about 80 species, among which are Chonetes verneuilanus and Derbya crassa. There is a remarkably large number of diminutive specimens of gastropoda and pelecypoda.

"The section at Portersville is representative of the horizon as far south as Athens, Athens County, coal being found nearly everywhere and three feet above it the usual thin layer of dark, nodular limestone....

"South of Athens County, the Portersville beds are generally present but are so inconspicuous that identification is difficult. The fossiliferous shale weathers to clay on the outcrop; hence, the fossils are seldom recognizable. Here and there is an impure, limonitic, concretionary layer which, under cover, is iron carbonate.... In a few places it is underlain by the Anderson coal (Patriot of Lovejoy).

"As to the Portersville horizon eastward from the type locality: the black, pyritous, fossiliferous shale is found immediately over the Anderson coal almost everywhere in Morgan, Muskingum and Guernsey counties. In some places solid masses of Derbya crassa, preserved as pyrite, rest directly upon the coal, and the overlying beds are rich in remains of Chonetes verneuilanus, Ambocoelia planoconvexa, Lophophyllum profundum, and numerous other forms.

"Similar conditions are found in Harrison County, but the Portersville beds and Anderson coal are missing in some localities, and the horizon is occupied by sandstone.... To the north, in Columbiana County, the Portersville is a shaly, sandy limestone, with few recognizable fossils, Ambocoelia planoconvexa and Lophophyllum profundum being the most noteworthy."

Friendsville shale is an equivalent marine member in Maryland and Woods Run limestone in Pennsylvania to the Portersville in Ohio. Woods Run is the oldest name that has been used and has been applied to both the Cambridge and Portersville members. Raymond's original definition (1910, p. 147) applies to Portersville rather than the Cambridge member.

Principal exposures of Portersville and associated strata in Athens County are shown on map 14. Most outcrops are between 1 and 5 feet in thickness, but several are as thin as 4 to 6 inches. Average thickness for 41 exposures is only 2 feet 4 inches, which is undoubtedly too small because of weathered and slumped condition of beds along the outcrop and because of difficulty in determining the top of the fossil zone at some localities. Its stratigraphic position is approximately 130 feet above the Upper Freeport coal, 15 feet above the Cambridge limestone, 60 feet below the Ames limestone, and 250 feet below the Pittsburgh coal.

The Portersville member is usually called a limestone, but its dominant lithology is light to dark gray, argillaceous, calcareous, fossiliferous, bedded shale with a 4-inch nodular marine limestone at its top. Normal colors are gray to dark gray with dark gray prevalent in the lower part of its thickness and lighter shades of gray above. The dark gray shale is carbonaceous, and locally the gray shale is silty and visibly micaceous. Pyrite may be present, usually as replacement in the fossils. Fossils are numerous at many places. Shale of the nature of the Portersville yields readily to weathering agents and processes with resultant softening of clay constituents, oxidation of pyrite, and leaching of calcite. Hence, the Portersville and underlying Anderson members form one of the zones subject to marked sliding and slumping down hillsides where they outcrop. Weathering also releases fossils from the shale, and at favorable localities clean fossils, especially chonetid brachiopods, can be picked from weathered surfaces in abundance. Loose fossils weathered from the shale are aids in finding the Portersville on poorly exposed slopes.

Portersville limestone nodules have the following dimensions: thickness 2 to 6 inches, average 4 inches; length and width up to 15 or more inches, commonly 4 to 8 inches. In shape they are irregular to rounded and mostly are elongated or flattened. Surfaces may vary from relatively smooth with depressions or projections marking positions of partially embedded fossils to very rough knobby surfaces. There is a strong tendency for surfaces to be irregular and granular rather than even and smooth. Type Portersville limestone as well as limestone of this member over much of eastern Ohio is dark gray in color, but only two of 20 specimens collected in Athens County are definitely dark gray, and the prevalent color for most specimens is some shade of light gray. Weathered surfaces and weathered parts of the rock tend to be pale greenish gray. Fresh rock is compact and dense except for scattered crystalline calcite in fossil shells. No chemical analysis is available, but impurities appear to be mostly clay and iron minerals. The grainy weathered surfaces are due to tiny brown grains of iron-bearing material interspersed and projecting from light gray rock. Some weathered near-surface parts show numerous minute pores.

Mark (1912, p. 276-283, 296-299) has summarized details concerning collections of Portersville fossils from Athens, Morgan, Muskingum, and Perry Counties. Certain brachiopods are numerous as individuals, but in number of species the fauna is dominated by a host of dwarfed clams and snails. Mark's excellent faunal report was based only upon six collections and is now largely outdated by changes in nomenclature for many species. The Portersville fauna is in need of restudy which should include collections from the entire outcrop area and bring up to date the classification of the fossils themselves.

Upper Bakerstown Cyclothem

In Ohio the coal from which this cyclothem is named has heretofore been called the Barton coal, and Flint (1951, p. 68) has used the name Barton for the cyclothem under discussion. Waage (1950, p. 43), however, stated that "the Barton coal of Ohio ... is equivalent to the Upper Bakerstown coal of Maryland." Waage (1950, p. 34) has also shown that the true Barton coal is above the Ames limestone, which is contrary to Condit's (1912, p. 37) interpretation. The name Upper Bakerstown will be used here, since Condit's correlation is certainly in error.

Only two basal members, Cow Run sandstone and Ewing fresh-water limestone, of the four members assigned to this cyclothem, were observed in Athens County. Flint (1951, p. 71) found similar absences in Perry County. Localities for Cow Run and Ewing members are shown on map 15, and exposures are limited to Alexander, Athens, Canaan, Dover, Lee, Trimble, and

Waterloo Townships. Total average thickness for the two members is 29 feet 6 inches. Where the Anderson-Portersville members are present, the base of the Cow Run member is easily ascertained, but in the general absence of the Upper Bakerstown coal and underclay and local absence of Ewing limestone, the top of the cyclothem is difficult to determine.

Cow Run Sandstone Member. - The name Cow Run was originally applied to an oil-bearing sandstone in shallow wells in Lawrence Township, Washington County, Ohio. This name has since been used and misused for various Pennsylvanian sandstones, and today a First Cow Run sandstone (to which name was first give and one under consideration here), lying in the interval between the Ames and Cambridge limestones, and a deeper Second Cow Run sandstone (Lower Freeport), lying above the Middle Kittanning coal, are recognized. Andrews (1874, p. 497), Condit (1912, p. 39-41), Laubach (1953, p. 8-13), Minshall (1888, p. 444-447), Smith (1948, p. 17-20), and Stevenson (1906, p. 154) have given or summarized the history of the use of the name and correlation of the Cow Run sandstones. The Cow Run member under discussion is generally considered to be the local massive thick sandstone lying just above the Anderson cyclothem and at some places cutting out and replacing members of that cycle. Here, Cow Run will be used not only for massive sandstone but also for bedded sandstone and shale lying between the Portersville and Ewing members.

Average thickness for 20 exposures of the Cow Run member in Athens County is approximately 26 feet, and Laubach (1953, p. 19) found the massive sandstone phase to average only 14 feet and the maximum thickness to be 48 feet. Most exposures show shale or a combination of shale and sandstone. Over much of the area just above the Portersville member there is an evenly laminated reddish brown to chocolate colored shale up to several feet in thickness (localities 7618, 11248, 11313, 11434, etc., are representative); at one locality in section 2, Dover Township (11311) shale of this type with nodules of marine limestone up to 6 inches in size occurs about 14 feet above the Portersville member, and a similar occurrence but without apparent fossils is present in section 6, Columbia Township, Meigs County, which is located just over the county line south of section 1, Lee Township (locality 11563). Perhaps this chocolate-colored shale zone above the Portersville belongs to that member, although its thickness here is counted in the Cow Run member.

Much of the rock is the usual light gray to light bluish gray shale that weathers some shade of brown and yellow. In composition it is an argillaceous, silty to sandy, and micaceous shale, locally with ferruginous concretions and with calcareous masses at top or bottom. Less commonly carbonaceous material is present in the shale. Sandstones interbedded in the shale are mostly fine grained, silty, and micaceous. Laubach (1953, p. 16-23) studied recently the typical massive Cow Run sandstone in Athens County in considerable detail, and some of his description is quoted below:

"The Cow Run sandstone is a typical sandstone member of the Conemaugh formation. Its only consistent characteristic is its lack of uniformity. The Cow Run sandstone occupies the interval between the Portersville limestone below and the Ewing limestone above. However, it is common to find its basal contact disconformable, indicating that a considerable thickness of beds was removed prior to deposition of the Cow Run. The sandstone then commonly overlies a buff mudstone. At many localities the Cow Run sandstone grades upward into sandy shale, and the placing of the contact is arbitrary.

"The dominant colors of the weathered surface of the Cow Run are dull, drab-gray, light-gray, buff, tan, yellow, and chocolate brown. These colors are due to the presence of ferric iron oxide which occurs as a thin coating on the quartz grains. When the sandstone is encountered in drilling it is a clean white quartz sandstone which commonly appears gray because of the presence of much dark mica. Surface exposures of the Cow Run are also micaceous, but the mica is colorless and transparent and apparently has been bleached. The bleaching of the mica probably furnished much of the ferric iron oxide which colors the sandstone.

"The Cow Run sandstone generally lacks bedding planes, and shale partings are rare except where the unit grades upward into sandy shale.

"Cross lamination is rather common. Notable examples of this may be seen at four localities in sections 17 and 18 of Athens Township. The laminations are concave upward, with the upper end truncated by the next succeeding bed and the lower end approximately tangent to the true bedding.

"At a number of outcrops the Cow Run sandstone is conglomeratic. In general the conglomerate is composed of rounded limestone pebbles that range up to 1½ inches (38 mm) in diameter, and white subangular quartz pebbles approximately ¼ inch (6.3 mm) in diameter, which are embedded in medium-grained calcareous sandstone. The limestone and quartz pebbles make up 35 to 60 percent of the rock in which they occur. In the southwest ¼ of section 17, Athens Township, the conglomerate is cross-laminated and the pebbles are mostly soft shale or mudstone that are less resistant to weathering than the sandstone matrix. Here, differential weathering of the soft pebbles and harder matrix had given the surface of the outcrop a honeycomb or pockmarked appearance. The conglomeratic phase may occur at any level within the Cow Run.

"In the southeast ¼ of section 19, Athens Township, the top seven feet of sandstone is conglomeratic, with limestone pebbles present. At this locality plant remains are found in the sandstone matrix. These fossils, which are stems or branches, occur as imprints. They belong to the Arthrophyta group and are commonly referred to as calamites. Similar fossils are also present in the northwest ¼ of section 9, and the southwest ¼ of section 12, Dover Township. At the latter locality, however, the sandstone is thin bedded and fine grained rather than conglomeratic.

"Along its outcrop in Athens County the average thickness of the Cow Run sandstone is 14 feet. That is considerably less than figures quoted in previous reports on nearby regions. Average thicknesses computed by townships show that the Cow Run thins in a southerly direction. In Trimble Township on the north its average thickness is 19 feet, 6 inches: in Dover Township 15 feet, 4 inches: Athens Township 14 feet, 8 inches: and in Alexander Township 11 feet, 3 inches. In Waterloo Township, which borders Athens Township on the west, the average is 10 feet, 5 inches. In Alexander and Waterloo Townships the outcrops of the Cow Run are extremely patchy and the averages quoted are based on a small number of outcrops. The maximum thickness recorded in Athens County, 48 feet, occurs in the northwest ¼ of the southwest ¼ of section 2, Trimble Township, in an abandoned shale pit. Some 600 feet away, at the opposite end of the shale pit, the sandstone is only 31 feet thick. The minimum measured thickness of the Cow Run also occurs in Trimble Township, in the southeast ¼ of the northwest ¼ of section 4, where the member consists of a bed of buff-yellow fine-grained micaceous sandstone one foot thick.

"In general the Cow Run sandstone is not thick enough to have any positive physiographic expression. Only in the areas where it attains its maximum development is it of sufficient thickness to control the angle of slope of the hillsides. Thus, at the Trimble shale pit where the Cow Run crops out near the top of the hill, the slopes may be seen to be unusually steep.

"Lateral variation in thickness is common and often abrupt in the Cow Run sandstone. In a distance of 750 feet laterally the member in the southern ½ of section 11, Dover Township, diminishes in thickness from 23 to 3½ feet. Where the latter thickness was recorded the base of the sandstone is in contact with the Anderson coal, the Portersville limestone being absent. In the gully to the northwest where the sandstone is 23 feet thick, both the coal and the limestone are missing and the base of the sandstone is in contact with mudstone. At both localities, however, the interval from the top of the sandstone to the Ames limestone is identical. One-half mile to the east of this area, in section 5, Dover Township, the Cow Run sandstone is absent and its place is taken by mudstone and shale.

"At the Trimble shale pit in section 2, Trimble Township, two stratigraphic sections have been measured. The shale pit faces south and makes an east-west traverse of about 200 yards. At the east end the normal sequence of units occurs with no disconformity at the base of the Cow Run sandstone. At this point, just above the road level, 3 feet of arenaceous limestone containing marine fossils is identified as the Cambridge limestone. Next above is 9½ feet of blue-gray shale stained red, and gray clay. This unit is overlain by 1½ feet of Anderson coal. Above the coal is the Portersville shale, 1 foot 7 inches thick, which contains many fragmentary remains

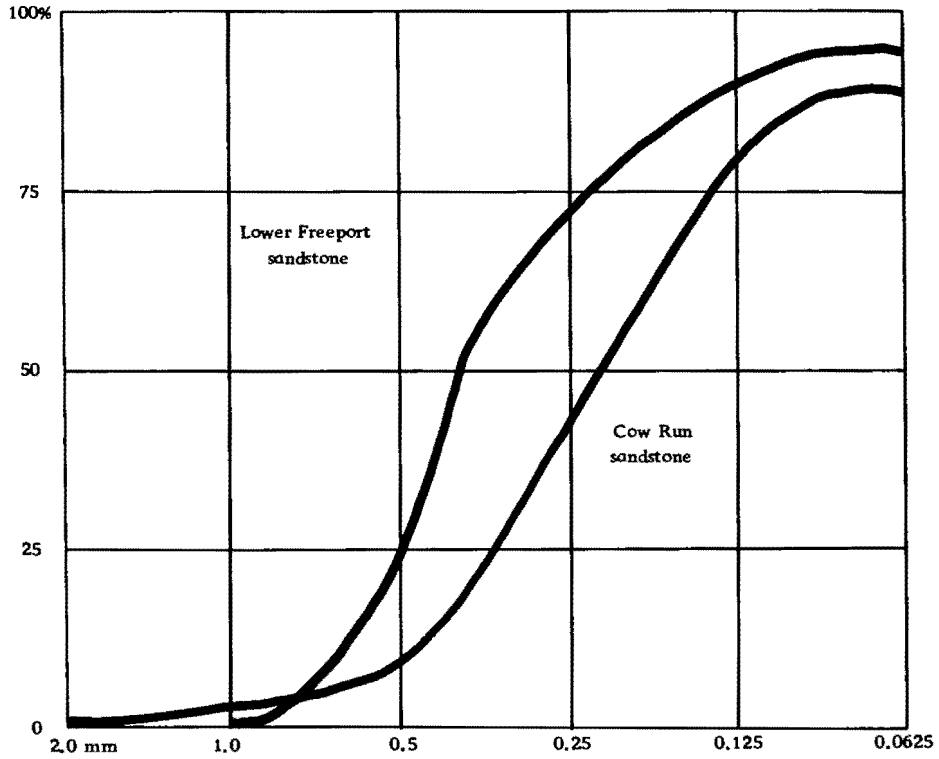


Figure 15 - Average curves of the Cow Run and Lower Freeport sandstones, showing difference in grain size and sorting.

of marine fossils. Overlying this unit is the Portersville limestone, which consists of nodular gray dense fossiliferous limestone 6 inches thick. Upon this unit lies 32 feet of Cow Run sandstone.

"At the opposite end of the shale pit the Cambridge member is present, as is the shale and clay unit overlying it. The Anderson coal and Portersville limestone are missing, however, and overlying the shale and clay unit with a disconformable contact is the Cow Run sandstone.

"At most other localities where the Cow Run is thick, the Anderson coal and the Portersville limestone are missing and the sandstone is identified on the basis of its interval to other key horizons...."

Laubach also performed laboratory studies pertaining to grain size, sorting coefficient, and heavy minerals in the Cow Run sandstone and made comparisons with similar properties in the Lower Freeport sandstone. Figure 15, as copied from Laubach's report, shows average grain size and sorting in both sandstones. His summary of the data shown in figure 15 follows (1953, p. 33):

"The 1/8 to 1/16 mm grain size from the Cow Run and Lower Freeport sandstones was used for the examination of heavy minerals with the petrographic microscope. The examination was limited to the commoner non-opaque minerals. These make up 50 to 60 per cent of the heavy-mineral fraction, the remainder being composed of opaque minerals and a little quartz. Although the study was by no means exhaustive, nevertheless several interesting factors come to light....

" ...The Cow Run sandstone is less well sorted and is finer grained than the Lower Freeport sandstone. A greater percentage of the Cow Run is in the silt and clay sizes. The Cow Run sandstone may be termed a fine-grained sandstone and the Lower Freeport a medium-grained sandstone."

Laubach's discussion (1953, p. 33-39) of heavy minerals in the Cow Run and Lower Freeport sandstones and sphericity of component grains is given below:

"Listed in order of their predominance from samples of three Cow Run localities are mica, zircon, tourmaline, and garnet which are common to very common.

"The mica occurs as thin colorless flakes. Two types of zircon and tourmaline are commonly present. Zircon occurs either as colorless euhedral grains showing very little rounding, or as very well rounded grains that are dusky brown. A few of the euhedral grains are broken. The tourmaline, which is strongly pleochroic, is pink, violet, light brown, or dark brown at the extinction position. At all other positions the mineral is colorless. Some of the tourmaline occurs in the euhedral form, appearing fresh and showing little sign of wear. The crystals are not outgrowths from rounded grains, and are therefore of allogenic origin. Other tourmaline grains are present as irregularly shaped, slightly abraded fracture particles. The garnet particles are irregular, subrounded and colorless.

"The same heavy minerals are found in the Lower Freeport sandstone, but in proportions that differ markedly from place to place. Tourmaline is very abundant at Wah 2 (a locality), but only common at Yoa 10 and Waa 32. At Yoa 10 mica is very abundant, but it is scarce at Wah 2. The two types of zircon and tourmaline noted in the Cow Run sandstone are equally well developed in the Lower Freeport.

"Determination of sphericity values was attempted, by the method outlined by Rittenhouse (1943, p. 79-81). It was found, however, that most quartz grains from the Cow Run and Lower Freeport sandstones have crystalline outgrowths of secondary quartz, and therefore that sphericity values are not indicative of the sorting history of these units. Those values determined range from .65 to .83, based on a value of 1.0 for a perfect sphere. No definite trend could be discovered in the sphericity values of grains from the Cow Run or Lower Freeport sandstones."

Laubach (1953, p. 40) summarizes the Cow Run sandstone's general features in part thus:

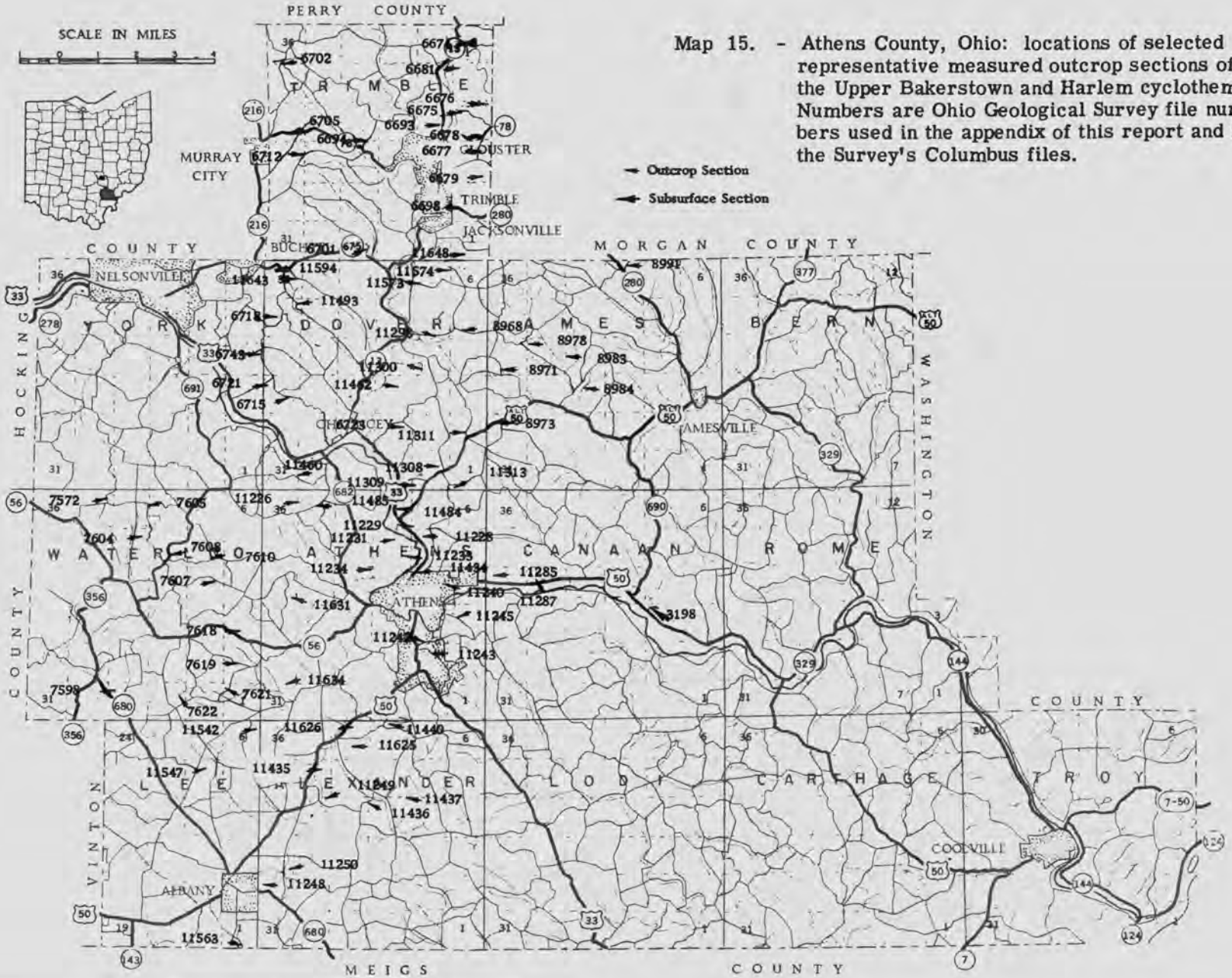
"Although it has some of the characteristics of a quartzose sandstone, the Cow Run is a very low-rank graywacke, (subgraywacke). Perhaps a more accurate term is 'cleaned graywacke' as defined by Pettijohn (1949, p. 242, 243). This type of sandstone is of local accumulation and is produced by a local 'winnowing' or washing of graywacke, resulting in the removal of much of the silt and clay. Quartz grains do not become well rounded.

"Field relations, such as the disconformable lower contact, the local presence of conglomerate and plant fossils, and its lenticular nature, mark the Cow Run as a cut-and-fill type of sand body associated with a deltaic environment. Deposition probably occurred in stream channels on the subaerial portion of a distributary system, the washing process being accomplished, for the most part, during transportation. It is evident, however, that the washing process was not intense, as the Cow Run contains approximately 10 percent clay and silt, as well as much mica."

Ewing Limestone Member. - The type area for this limestone is in the vicinity of Ewing Site (now Jacksonville) located in sections 7 and 8, Trimble Township, Athens County. Orton (1878, p. 889-890) named and briefly described the Ewing member but did not designate a type section for it. No good exposures seem to be available in the immediate vicinity of Jacksonville today. Orton's original description reads, in part, as follows:

"... it is a ferruginous limestone, five feet in thickness, about eighty feet above the Cambridge (Brush Creek) and forty feet below the Ames. It holds its place throughout the counties southward to the Ohio River.... It weathers easily and is so often hidden by the products of its own decomposition that escapes general notice."

At a later time, in a generalized stratigraphic section for the Hocking Valley coal field, Orton (1884, p. 918) stated that the Ewing limestone is nodular, uncertain, and often replaced by ironstone. The given thickness is from 0 to 3 feet.



Map 15. - Athens County, Ohio: locations of selected representative measured outcrop sections of the Upper Bakerstown and Harlem cyclothems. Numbers are Ohio Geological Survey file numbers used in the appendix of this report and in the Survey's Columbus files.

Since Orton's reports were published, geologic field work in Ohio has shown that the Ewing limestone is widespread along its outcrop belt. Condit (1912, p. 37-39) and Lamborn (1951, p. 31) have described both its extent in outcrop and its general features. The following is taken from Lamborn's description:

"... the Ewing occurs widely distributed on the outcrop from Lawrence County to Jefferson County. The member consists for the most part of nodules or discontinuous nodular layers of gray to bluish gray dense-textured somewhat ferruginous limestone embedded in the clays underlying the Barton (Upper Bakerstown) coal. In places the limestone shows brecciation and elsewhere it may be so highly ferruginous that it approaches an iron ore in composition. The thickness of the limestone and associated calcareous clays may range from a few inches to 10 feet or more. The Ewing is more continuously represented on the outcrop in Noble, Guernsey, and Harrison Counties and probably has its poorest development in Jefferson and southeastern Columbiana Counties."

A paragraph from Condit (1912, p. 38) adds to the above description:

"Fossils of types generally regarded as freshwater are abundant in the Ewing limestone. Spirorbis is the most numerous of these and ostracod carapaces are next in abundance. Fish teeth are not uncommon and reptilian bones are also present."

Ewing limestone is an unsteady and variable limestone in Athens County. It is either absent or unrecognizable at many localities, and thicknesses vary from 2 inches to more than 15 feet. The thicker deposits are not solid limestone but rather limestone masses in shale or clay shale. Average thickness for about 20 measured sections is 3 feet 9 inches. It is not a conspicuous member even adjacent to its type area, where in sections 1 (locality 11648) and 2 (locality 6698), Trimble Township, it is represented by a considerable thickness of shale or shale and sandstone containing nodules and veins of limestone. Throughout its outcrop area shown on map 15, the Ewing is represented by three different lithologic varieties. First is a single nodular layer 2 to 12 inches thick of light gray to gray, dense, brecciated, or sandy micaceous limestone. A second type includes layers but more commonly nodules and veins of limestone distributed in thicknesses up to 15 feet of sandy shale and shaly sandstone. The third type comprises small nodules of limestone embedded in clay shale. Limestone in any of these three types may be ferruginous, and in section 14, Dover Township (locality 6723), a 6-inch layer of ironstone represents the Ewing member. Fossil ostracods and Spirorbis were seen at one locality in Athens Township (locality 11434) and at another in Waterloo Township (locality 7621).

Flint's description (1951, p. 70) indicates that the Ewing limestone is similar in Perry County to that in Athens County.

Upper Bakerstown Coal and Underclay Members. - Barton is the name previously used for these members in Ohio, and Waage (1950, p. 43) has shown that they correlate with the Upper Bakerstown coal and underclay in Maryland. Hence, the name of Upper Bakerstown should be substituted for Barton as a name for these members in Ohio.

As far as Athens County is concerned, the Upper Bakerstown coal and underclay seem to be absent, although there is a possibility that one of the underclays or calcareous underclays between the Ames and Portersville marine members may represent the Upper Bakerstown underclay. In this interval where nodular Ewing and Rock Riffle fresh-water limestone embedded in calcareous clay and Round Knob redbed occur, where shales and sandstones become thick, thin, or disappear and where coals are more apt to be absent than present, correlation of underclay members is often uncertain. No positive identification of Upper Bakerstown clay has been made.

Harlem Cyclothem

There are five recognized members in the Harlem cyclothem of Ohio as shown in table 11,

and locations of representative outcrops of these members in Athens County are shown on map 15. This cycle of strata seems to lack only a marine limestone necessary for a complete cyclothem, but a marine horizon is present in West Virginia. In Athens and Muskingum Counties a black carbonaceous shale commonly overlies the Harlem coal, and if examined carefully this shale might yield at least brackish water fossils in Ohio. Thus far no fossils have been reported other than fossil plants, but marine fossils do occur over the Harlem coal in West Virginia (George Denton, 1957, oral communication). The several member names employed and the average thicknesses in Athens County for the individual members are given in table 11.

The Saltsburg sandstone, named from Saltsburg, Pennsylvania, is only moderately steady in occurrence and moreover lacks massive development in Athens County. The Round Knob redbed, also known as the Pittsburgh redbed farther east, is thick and conspicuous but is not everywhere present. The Rock Riffle limestone, which is named in this report from exposures along Rock Riffle Run just east of Athens, is absent at more places than present. The type area for the Harlem members is in Carroll County, Ohio, and they are fairly persistent in Athens County and along their outcrop belt across the State.

As sources of mineral products members of this cyclothem are of little worth. In a very small way the Harlem coal is locally in Ohio a source of fuel, and the Round Knob member, when weathered, contributes to landslides.

Saltsburg Shale and/or Sandstone Member. - Saltsburg (also Saltzburg) is the name applied to the basal shale and sandstone member in the Harlem cyclothem and was originally used by Stevenson (1878, p. 22) for exposures near Saltsburg, Pennsylvania. There it is a massive sandstone 25 to 40 feet thick, but in eastern Ohio it is generally much thinner and apt to be shaly sandstone and sandy shale. It is thinnest and most likely to be shaly or replaced by other rocks of any clastic member below the Ames limestone in Athens County. Ten exposures have an average thickness of less than 10 feet and range in thickness from 5 feet to 22 feet. At one locality in Athens Township (11231) massive Saltsburg sandstone may be part of the massive Cow Run sandstone. This locality, as well as others for the Saltsburg sandstone in Ames, Athens, Canaan, Dover, Lee, and Trimble Townships is shown on map 15. The Athens County exposures of this member vary from silty, sandy, micaceous, bedded shale to fine, silty, micaceous, layered sandstone but more usually are a combination of those rock types. The sandstone may be calcareous in part, the shale may be argillaceous, and ferruginous concretions up to more than four inches in size occur at one locality (6723) in Dover Township.

Round Knob Redbed Member. - Widespread variegated clays and shales occur at many places in Maryland, Ohio, Pennsylvania, and West Virginia in the interval between the Portersville (Friendsville) shale and limestone and the Ames limestone. Thicknesses range up to 50 or even to as much as 100 feet. To these beds in Ohio Condit (1912, p. 35-37) gave the name Round Knob from exposures near a monadnock of that name in Madison Township, Columbiana County. Part of his general description of this member is as follows:

"The beds vary from structureless, purplish-red clay to deep-red, even-bedded shale, which may alternate with bluish layers. The more sandy portions frequently show ripple-marks and sun-cracks. Lenticular siderite concretions are common in the bluish shales and nodules of limestone and hemitite (hematite) in the structureless red clay.... Land slips are very common at the Round Knob horizon; hence the soft red clay becomes distributed over a great vertical range, thus giving an appearance of considerable thickness."

Elsewhere in the Northern Appalachian region these clays and shales are known as the Pittsburgh red shale or redbed, a name given by White (1903, p. 263-265) and a name which Condit (1912, p. 36) deemed unsatisfactory because of previous and general use of Pittsburgh for the great Number 8 coal and for its underlying limestone. Condit's opinion is valid, and the name Round Knob has been used for these beds in reports of the Geological Survey of Ohio.

White (1903, p. 263) and Waage (1950, p. 43) corroborate Condit's descriptive summary. White stated that " ...as a rule, the measures below the Ames limestone and Friendsville coal, consist of deep red and variegated shales, often marly and containing nuggets of impure limestone and iron ore." Waage's description based on observations on drill cores from Maryland is as follows: "The interval between the Saltsburg sandstone and the limestone beneath the Harlem coal is occupied chiefly by green or red and green clays and claystones locally containing zones of limestone pellets or thin beds of fresh-water limestone...."

Round Knob redbed is well developed in Athens County, and Condit (1912, p. 107) found for it an average thickness of 29 feet. Present measurements, which mostly exclude sandy zones included by Condit, have an average thickness of 17 feet for 15 observations. Minimum thickness observed is as little as 5 feet, and maximum thickness exceeds 30 feet. In the general stratigraphic interval in which Ames, Ewing, and Rock Riffle calcareous clays and nodular limestones also occur it is often difficult to separate one of these members from another, and hence measurements and average thicknesses may be somewhat in error. Good and certain development occurs in the vicinity of Athens where Condit (1912, p. 36-37) described the now largely concealed section in the shale pit of the abandoned Athens Brick Company (locality 13399):

"The shale pit of the Athens Brick Company at Athens shows 24 feet of structureless, red clay immediately beneath the Ames limestone, and still lower, sandy shale of alternating reddish-brown and bluish color, having finely preserved ripple-marks and sun-cracks. Here as in numerous other localities, the red beds occupy the place of the Harlem coal...."

An excellent outcrop (locality 11287) is now exposed just west of the J. G. Hope farm buildings on the north side of Route 50 about 2.0 miles east of Athens, where highway relocation has exposed the strata below the Lower Grafton sandstone.

As limited here the Round Knob member consists of mottled or variegated - - shades of gray, green, red, brown, and yellow - - argillaceous, massive clay shale. It commonly breaks with a starch-like fracture and weathers to a plastic clay-like mass. Pellets and small nodules of fresh-water limestone or ironstone are present at least in half the outcrops and usually restricted more or less to the basal part of the bed. These redbeds often grade laterally or vertically into silty, sandy, and micaceous shales. Brief mention of some problems in stratigraphic identification has already been made.

In section 22, Ames Township (locality 8983) bedded shale and sandstone occur between clay shale and limestone identified as Round Knob and coal and clay identified as Harlem. In section 33, Dover Township (locality 6715) Round Knob clay shale and limestone appear to have replaced the Harlem coal and clay, but the clay shale and limestone may represent the Harlem underclay and Rock Riffle limestone. Similar relationship for the Round Knob and Harlem members occurs in section 36 (locality 11594) but with the possibility of Ewing limestone occurring below the Round Knob member.

Rock Riffle Limestone Member. - Ohio geologists have made little or no mention of a fresh-water limestone beneath or in the lower part of the Harlem underclay. Over most of the Harlem outcrop area in Ohio its underclay is reported to be thin, siliceous (sandy?), and quite steady rather than thick and calcareous. A fresh-water limestone does occur at this horizon in Maryland, Pennsylvania, and West Virginia, and there is sufficient field evidence that a limestone is associated with the Harlem underclay locally in Athens County. Waage (1950, p. 43) has shown that the limestone in the Harlem underclay is not the Ewing limestone, with which it has sometimes been correlated, but actually is unnamed. Since Waage did not propose a name for this limestone in and beneath the Harlem underclay, the name Rock Riffle limestone is designated from exposures in Athens Township (locality 11245) along the channel of Rock Riffle Run, a small tributary on the south side (actually east side as the river here flows north for a short distance) of the Hocking River, where this limestone has its best observed development in Athens County. There it is located between 0.5 and 0.6 mile up Rock Riffle Road from its junction with Hasting Road and Riverside Drive (figure 16). Here the limestone, with a thickness of 4 feet 6 inches, lies 20 feet and 4 inches below the Ames limestone and 5 feet 5 inches below the Harlem



Figure 16 - Rock Riffle limestone, type locality.

coal. It is well to add that the Ames limestone is a ledge about 1 foot 8 inches thick and forms a small waterfall in Rock Riffle Run just above the fifth bridge up Rock Riffle Road and that the Harlem coal is represented mostly by black carbonaceous shale.

Type Rock Riffle is gray limestone weathering greenish gray and is nodular to bedded and enclosed in greenish gray clay shale. The only fossils seen are those characteristic of Pennsylvanian fresh-water limestones, such as smooth ostracods and coiled tubes of the annelid worm Spirorbis. It is underlain by 17 feet of variegated shale with scattered limestone pellets and nodules, which represent the Round Knob member and are separated from the Harlem coal above by about 5 feet 6 inches of greenish gray clay shale. The lower limit of the limestone is more distinct than its top surface.

Other Rock Riffle limestone exposures were recorded in Dover Township (locality 6718), where in section 35 it is 1 foot 5 inches of nodular ferruginous limestone embedded in sandy clay shale and lying 4 feet 9 inches below the Harlem coal and 23 feet below the Ames limestone; and in Lee Township, where in section 11 (locality 11547) it consists of 1 foot 6 inches of numerous, light gray, dense, limestone nodules up to five inches long in a matrix of clay shale. At this last locality it is only 2 feet 3 inches below the Harlem coal but almost 23 feet below the Ames limestone. Elsewhere the Harlem underclay is without any limestone and is barely calcareous at a very few places. It is possible that locally the upper part of the Round Knob member may include unrecognized Rock Riffle limestone.

Harlem Underclay Member. - The Harlem underclay has the same name as its overlying coal. Stout et al. (1923, p. 458) reported the Harlem clay to be thin but rather persistent and to be impure and shaly in quality along its outcrop across eastern Ohio.

Harlem coal and clay commonly occur together, and both are present in more than 80 per cent of the localities. There are, however, numerous possible localities where both are absent and are replaced by the Round Knob redbed or by sandy shale and sandstone. Harlem coal and underclay were each observed at 18 places in Alexander, Ames, Athens, Canaan, Dover, Lee, and Trimble Townships, and the more representative of these localities are shown on map 15. The underclay ranges in thickness from three inches to more than five feet and has an average thickness of 2 feet 3 inches. About one-third of the thicknesses were one foot or less in thickness and another third were more than three feet thick.

In Athens County Harlem underclay is represented either by clay, clay shale, or shale or by a combination of the first two lithologies. Where they occur together the clay is thinner than and lies above the clay shale. Prevailing clay colors are some shade of gray mottled locally by tints of buff, yellow, or tan. The clay shale tends to be similar to the clay in basic color but to have maroon mottling. Common visible impurities are mica and silt and less common ones are calcareous, carbonaceous, and ferruginous matter and quartz sand. Ferruginous materials occur as fine "shot" or larger nodules and masses, and calcareous substances are finely disseminated. At more than half of the known exposures plasticity is lean, and at best the clay is only somewhat plastic.

In summary, Harlem underclay is moderate in occurrence but poor in thickness and quality in Athens County.

Harlem Coal Member. - Newberry (1874, p. 156) first used the name Harlem in geologic literature for this coal from the Village of Harlem Springs in Carroll County, Ohio, in which vicinity the coal has long been mined as a local source of fuel. It is likely that Newberry adopted a name that was already in common local use. Some have correlated the Harlem coal with the Friendsville coal of Maryland, but the Friendsville coal most certainly correlates with the Ames coal which lies a few feet higher in the geologic section.

Extent and persistence of Harlem coal in Ohio have already been mentioned in discussing its underclay. It is one of the better developed Conemaugh coals in the State and attains its best

thickness and quality in Carroll, Jefferson, and Muskingum Counties. In spite of being a good coal for the Conemaugh series, it is at most places thin and shaly and an unimportant coal when compared to the better coals of the Allegheny, Monongahela, and Pottsville series.

There are 18 recorded localities for Harlem coal in Athens County, where the coal and its underclay usually occur together. Map 15 shows locations of some better representative outcrops for both members within the county. The coal is thin and does not exceed five inches in thickness at any observed exposure, although Condit (1912, p. 35) reported a thickness of one foot about three miles east of Athens. The average thickness of the 18 exposures is only two inches for the coal itself, but at almost half of the outcrops from one foot to more than four feet of black carbonaceous shale overlies the coal. As a coal it is mostly composed of dull or shaly coal with bright coal streaks, but at one locality (8978) in section 28, Ames Township, the five inches of Harlem coal is bright blocky coal with dull streaks. At another locality (11231) in Athens Township the basal part of four inches of coal is canneloid. Locally fusain, pyrite, and fossil plants occur, and of these fusain is most common. The Harlem coal seems to resist weathering better than equal thicknesses of the Anderson coal.

Ames Cyclothem

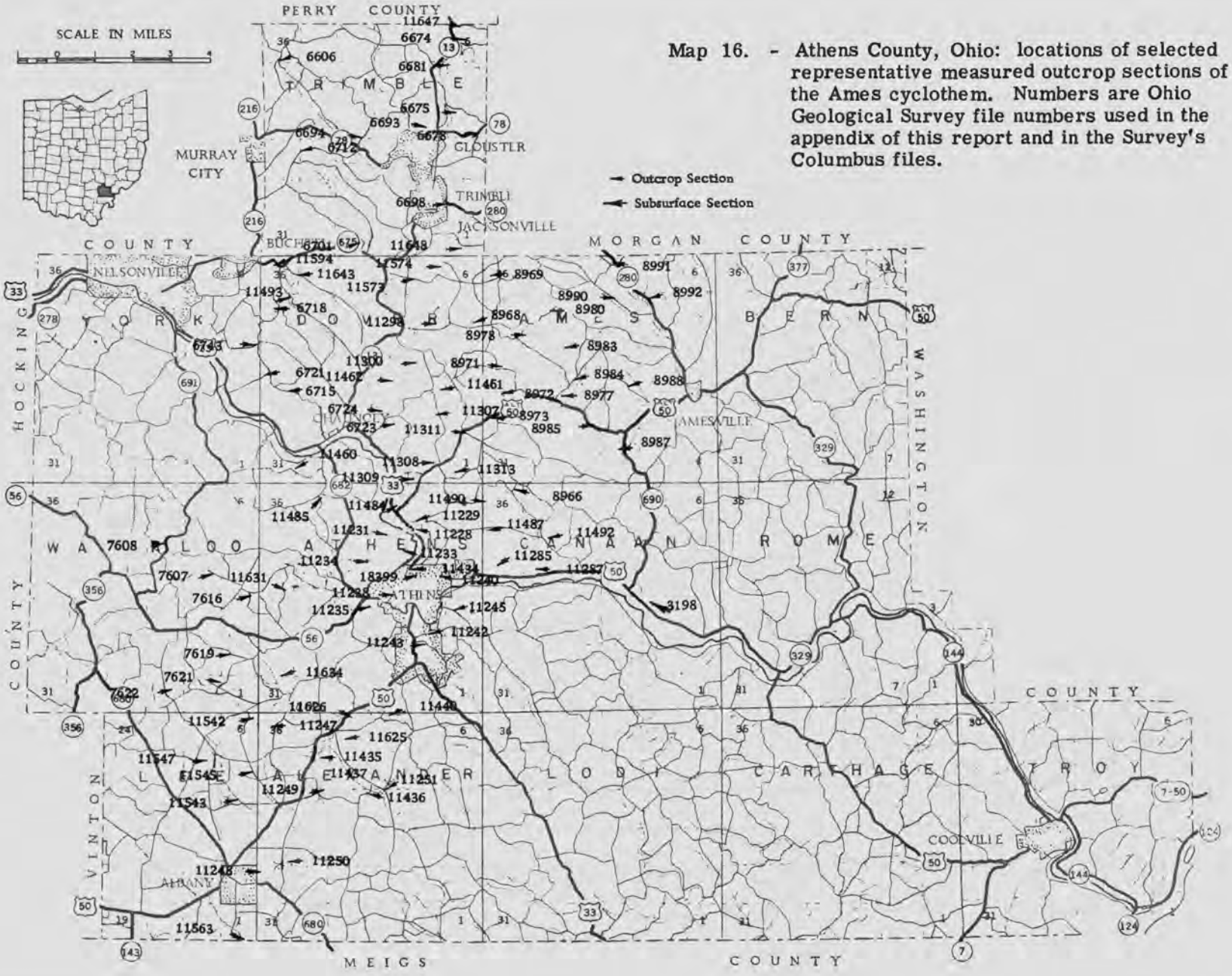
In Ohio the Ames cyclothem is one of the few in which all members have the same name. The best known and key member is the Ames marine limestone, and there are in addition a rather steady shale and sandstone member and very unsteady coal and underclay members. Until quite recently only the limestone was called Ames, as the coal and underclay were correlated with the Harlem coal and underclay and the shale and sandstone member was nameless. Hence, the name for the cyclothem is really taken from its marine limestone, which in turn was named from Ames Township in this county. A type section (locality 8984) is designated in this report, in which all four members are present and at least moderately well developed (see discussion under Ames coal). It should be noted that no fresh-water limestone or redbed members are recognized in Ohio; but where the Round Knob redbed member is thick, it locally replaces members of the Harlem and Ames cyclothems and lies close below the Ames limestone.

Selected stratigraphic sections for members of this cyclothem are shown on map 16; outcrops, which are rather widespread, occur in the following townships: Alexander, Ames, Athens, Canaan, Dover, Trimble, Waterloo, and York. Average thicknesses for the members and for the cyclothem as a whole are small. These are given in table 11, where the total average thickness is shown to be less than 17 feet.

Ames Shale and/or Sandstone Member. - This is one of the more persistent shale and sandstone members exposed in Athens County, and at most places these beds lie immediately beneath the Ames limestone or are separated from that limestone by small thicknesses of underclay and more rarely by coal and underclay. In fact, if the Ames limestone were inconspicuous along its course, its position could readily be determined by the steady and usually well exposed outcrops of this shale and sandstone. At a few localities it is largely or entirely replaced by the Round Knob redbed, and its thickness at such places is much or completely reduced, as shown in section 36, Dover Township (locality 11594) and in sections 1, 7, and 13, Waterloo Township (localities 7621, 7622). The opposite extreme occurs where thickness of more than 40 feet of shale and sandstone lie below the Ames limestone, which may represent a union of the Ames and Saltsburg shales and sandstone. An exposure (locality 11240) along Cable Lane, an extension of May Avenue, at the northeast edge of Athens is such a section.

Ames shale and sandstone were observed in more than 50 exposures, and accurate measurements were secured at 40 of those locations. Average thickness based on those measurements is almost 14 feet, with extremes ranging from nothing to more than 30 and even more than 40 feet, if the exposure along Cable Lane, cited above, includes only Ames shale and sandstone.

The lithology is a combination mostly of fine-grained, silty, micaceous, bedded sandstone



Map 16. - Athens County, Ohio: locations of selected representative measured outcrop sections of the Ames cyclothem. Numbers are Ohio Geological Survey file numbers used in the appendix of this report and in the Survey's Columbus files.

and bedded, silty to sandy, micaceous shale. These rock types occur in various combinations of stratification and in different amounts of each type from one location to another. The sandstones are mostly thin and even-bedded, and thick massive beds more than several feet in thickness are uncommon although massive ledges do occur in Dover Township (locality 11463). Ripple marks are present at a number of places, as at localities 11249 and 11437 in Alexander Township and at locality 6678 in Trimble Township. Cross-bedding may be present but it is not common or conspicuous. Locally the shales are clayey and silty and even thin zones of clay are present, for example, in section 2, Dover Township (locality 11311). Fossil plants are present in shales at some places, as at localities 11234 and 11245 in Athens Township, localities 6675 and 11647 in Trimble Township, and rarely in sandstone as at locality 11437 in Alexander Township. Calcareous and ferruginous zones and masses are uncommon.

Ames Underclay Member. - This underclay and its coal have heretofore been correlated with the Harlem underclay and coal in Ohio, but it is now certain that they are distinct from the Harlem members (see discussion of Ames coal below). The Ames underclay is present at more places than the Ames coal, which is seldom present. The underclay was recognized at 25 different places in Alexander, Ames, Athens, Canaan, Dover, and Trimple Townships (map 16). It is a thin clay, and thicknesses range from 6 inches to 2 feet 9 inches, with an average thickness of 1 foot 2 inches.

In quality this underclay is a low grade plastic clay, which varies from argillaceous shale through clay shale to plastic clay. Usual color is light gray with some limonite stain, but here and there part or all the thickness may contain enough carbonaceous material to be gray or dark gray. Silt and mica are the ordinary impurities in both the clay and clay shale, and others include calcareous and carbonaceous materials. The shaly exposures are all definitely argillaceous and tend to be laminated, and the clay exposures are massive with starch-like fracture. Plasticity tends to be only moderate at best for most exposures , although a few samples are definitely plastic clay.

In section 14, Dover Township (locality 6723) almost 2 feet of clay shale are between a 2-inch coal bed and the base of the Ames limestone.

Ames Coal Member. - This coal is the Crinoidal or Friendsville (Maryland, not Illinois), and in part the Harlem coal of previous reports. Crinoidal is a descriptive name formerly used in deference to the coal's position immediately below the Crinoidal (Ames) limestone. Martin (1902, p. 136) gave the name Friendsville to this coal from Friendsville, Garret County, Maryland. White (1903, p. 261 - 262) stated that the Crinoidal or Friendsville coal "underlies the Ames limestone without any intervening shale or other rock whatever." Hickok and Moyer (1940, p. 96) correlated the Harlem coal with the Crinoidal or Friendsville coal. In Ohio the Ames and Harlem coals have been believed to be the same coal as Stout et al. (1923, p. 458), in describing the Harlem underclay, wrote:

"... The position of these beds (Harlem coal and clay) is best referred to the Ames limestone. In places the coal lies directly below this member but in other parts of the state it is separated from the limestone by shale 1 to 20 feet in thickness..."

More recently Flint (1951, p. 71) correlated plastic clay lying beneath the Ames limestone tentatively with the Harlem underclay. He did not report any coal between the underclay and the limestone.

The answer to the above correlation problems is on the east side of Bryson Branch in section 21, Ames Township. There, along the southeast side of the road just southwest of the 770 road junction (Athens topographic map, 1903 ed.) is an excellent exposure (locality 8984, figure 17) which shows one coal lying beneath the Ames limestone and another coal lying about 12 feet below the upper coal. These two coals are separated by silty sandy shale and sandstone in the lower part of the interval between them and by clay shale and clay near top of the interval. The upper coal herein called Ames is the equivalent of the Crinoidal or Friendsville coal in Maryland



Figure 17 - Type section of Ames coal bed associated with the overlying Ames limestone. About 18 feet below is the Harlem coal bed. Photo taken along road southeast of road junction 770 in the $W\frac{1}{2}$ $SE\frac{1}{4}$ $NW\frac{1}{4}$, sec. 21, Ames Township, Athens County.



Figure 18 - Typical Ames limestone exposure associated with sandstone and clay shale below. The Ames coal is absent at this locality. Photo taken along road northeast of road junction 690 in $E\frac{1}{2}$ $SE\frac{1}{4}$, sec. 27, Ames Township, Athens County.

and West Virginia, and the lower coal is the true Harlem. Confusion seems to have arisen from the fact that both coals are seldom present in the same exposure, and in many exposures both are absent. Where the Ames coal is absent and the Harlem coal present, the coal was usually identified correctly as Harlem; but where the Harlem coal is absent and the Ames coal present, identification was commonly made as Harlem in Ohio and as Crinoidal or Friendsville elsewhere. All presently known members of the Ames cyclothem are exposed in the above outcrop, and since no particular type section was ever designated for the Ames limestone, the above section should be considered as type for the Ames limestone and for the other three members recognized in the Ames cyclothem as well. It should be added that in this type section below the Harlem coal is exposed its underclay and Round Knob and Saltsburg members and that above the Ames limestone a considerable thickness of shale and sandstone along with the Gaysport and Skelley marine limestones are present.

It is urged that Ames be adopted as the name for this coal and replace the names Crinoidal and Friendsville. Crinoidal is a descriptive term and probably no longer used except in an informal manner. Friendsville has been used variously as a name in Maryland for the equivalent of the Portersville marine member, for a coal in Illinois (Wanless, 1939, p. 84), for a formation in Indiana (Wanless, 1939, p. 84), and in addition for the coal under consideration.

The Ames coal is not a very good coal in Athens County or in Ohio for that matter. It was found only at seven localities in Ames, Dover, and Trimble Townships as coal and at a few other places as carbonaceous underclay or carbonaceous streaks in underclay. Its thickness is usually only an inch or two, but in the type section eleven inches of dull shaly coal with additional carbonaceous shale represent the member. At best it is dull shaly coal with thin streaks of bright coal, and at several places it is only a black or dark gray carbonaceous shale.

Ames Limestone Member. - The Ames limestone is one of the best known and most useful stratigraphic members to geologists and to those interested in the geology and mineral resources of east-central and southeastern Ohio. Its distinctive appearance and persistent outcrop over wide areas make this limestone a most reliable stratigraphic marker. Local people familiar with this rock and the well driller whose bit penetrates it commonly call it the fossil limestone, and geologists in the past have called it the green crinoidal limestone in reference to numerous fossil crinoid stems and also to its noticeable greenish color at many places. The importance of the Ames limestone as a stratigraphic guide was soon recognized in early field work on the Conemaugh rocks in Ohio, and Newberry (1874, p. 156) wrote accordingly:

"... The crinoidal (Ames) limestone is one of the most constant elements in the Barren measures (Conemaugh), as it runs through the entire series of counties underlaid by this group. This is Prof. Andrew's Ames limestone and is frequently mentioned in his reports on the southern counties. Its normal place is 140 to 150 feet below the Pittsburgh coal; and in the central and southern portions of the state it is so constant in its presence and position that it forms a most useful guide. This is illustrated by the fact that the late Prof. Hodge, when connected with the survey, in making a reconnoisance of Jefferson, Harrison, and Carroll counties used to call it the ' blessed little limestone,' thereby expressing his appreciation of its usefulness and reliability as a geological guide. In southeastern Ohio the Ames limestone is reported by Prof. Andrews to be as universal in its distribution and as inflexible in its position as farther north...."

Andrews (1873, p. 235) named the Ames limestone from exposures near Amesville, Ames Township, Athens County, Ohio. Andrews' brief original description is quoted below:

"... From 80 to 85 feet above this limestone (Cambridge) we find another fossiliferous limestone, the place of which is approximately 140 feet below the Pomeroy coal....This upper limestone"..."which I have called the Ames limestone from a location in Ames Township, Athens County ..."

Andrews did not designate a specific type locality, although he (1873, p. 270-271) did present "A good representative geological section of the more important strata... north of the village of Ames(ville), on the land of Jason Rice...." This exposure on the Rice farm might be

considered the type for the Ames limestone, but as stated on page 134, it is urged that stratigraphic section 8984 be used as the type exposure for all presently known members of the Ames cyclothem, including the limestone. Locality 8984 is suitable as a type section for these members for the following reasons: 1. It lies within the type area indicated by Andrews; 2. It contains all known members of the Ames cyclothem as well as the Harlem coal below and the Gaysport and Skelley limestones above; 3. Ames limestone is represented by typical lithology.

Condit (1912, p. 29-30) summarized the usefulness and general features of the Ames limestone as follows:

"The Ames is geologically one of the most important horizons in the Conemaugh, since it is of great service as a stratigraphic key. Although seldom more than two or three feet thick, and only a nodular layer over large areas, the rock has certain distinctive features which make easy its identification wherever found. There are certain lithologic characteristics which are remarkably constant and they alone enable one to distinguish it from other limestones. These may be briefly summarized as follows: It is a gray or greenish-gray limestone, ordinarily in a single bed one to three feet thick. Fossils are abundant, especially crinoids, which stand out in relief on the weathered surface. The rock on fracture shows a more or less granular, crystalline texture, due to cleavage faces of calcite and is frequently spotted with minute, greenish, glauconitic grains.

"The most reliable method of identification is by means of the fossils. As the old name 'Crinoidal' would imply, crinoid remains are abundant nearly everywhere and locally make up the body of the rock. In addition, there are numerous species of brachiopoda, pelecypoda, gastropoda, and other forms, which altogether make this one of the richest fossil-bearing horizons in the Pennsylvanian series....

"The Ames horizon is well marked nearly everywhere along its Ohio outcrop, and has been recognized in every country from Lawrence to Columbiana. It is however missing or very inconspicuous over much of the southern part of the State, and does not have any prominence to the northward until Meigs County is reached; thence northeastward to the Pennsylvania line it is quite uniformly persistent and easily discovered..."

A fact or two from Lamborn (1951, p. 32) will be added to Condit's excellent summary:

"... Where a greater thickness is found the member is generally represented by two or more more layers separated by bedding planes or by thin partings of calcareous shale. The stone is hard and tough and, being more resistant to weathering than the associated shale, breaks up into rectangular blocks which are strewn over the surface below the place of outcrop..."

To the above descriptions can be added that thin persistent ledges as well as loose rectangular blocks and small waterfalls mark the Ames outcrop at many places. In general the Ames limestone is a high calcium carbonate limestone, although both Condit and Lamborn mention that locally the Ames is highly ferruginous.

The Ames limestone was observed at more localities than any other stratigraphic member in Athens County. It is remarkably steady in lithology and thickness. The extremes in thickness are from five inches to more than nine feet. Those exposures more than three feet thick contain fossiliferous marine shale, and where shale separates two beds of the limestone the upper limestone may represent the Gaysport limestone. Most of the measurements vary only between eight inches and two feet, and the average thickness for 100 measurements is 1 foot 8 inches. Areal distribution of selected outcrops of the Ames limestone are given on map 16, and locations are shown in Alexander, Ames, Athens, Dover, Lee, Trimble, Waterloo, and York Townships.

For the Ames limestone in Athens County little is to be added to the general description previously given. It is mostly light gray, locally with tiny scattered masses of green glauconite or with limonite stain and impregnations, dense to partly crystalline, tough, massive, fossiliferous, marine limestone. Corners and edges of exposed blocks are rounded by weathering, and

surfaces are characteristically roughened by projecting fossils and rarely marked by shallow rounded pits from differential solution. Associated bedded fossiliferous shales are light gray, or light greenish gray to light drab, buff, pale tan, or chocolate brown and are commonly argillaceous but may be silty and finely micaceous.

Mark (1912, p. 283-290) reported a rich fauna from the Ames limestone at a dozen different localities along its outcrop. Most conspicuous fossils are the numerous crinoid stem fragments and shells of large chonetid, productid, and spiriferid brachiopods. Other conspicuous brachiopods include Composita sp.; Chonetes granulifer, Derbya sp.; and locally abundant Crurithyris planoconvexa. A large number of molluscan species are present but individuals are uncommon. Fusulinids are locally common and represent the genus Triticites (Smyth, 1957, p. 259; Thompson, 1936, p. 683). An abundant microfauna of conodonts, foraminifera, and ostracods awaits study. There is an apparent tendency for the fossils to be zoned in occurrence, with the crinoids and larger brachiopods mostly in the lower three-fourths of the thickness, fusulinids in the upper one-fourth, and a coquina of Crurithyris locally at top.

At a few places the Brush Creek limestones resemble the Ames in being light gray, partly crystalline, crinoidal limestones, and have been mistaken for Ames limestone. The Brush Creek rock is usually more crystalline than the Ames limestone, and faunal and stratigraphic relationships will help to identify correctly the respective limestones.

In Athens County the Ames limestone is approximately 200 feet above the Upper Freeport (No. 7) coal and 180 feet below the Pittsburgh (No. 8) coal. Its position in respect to other key strata is given in figure 14.

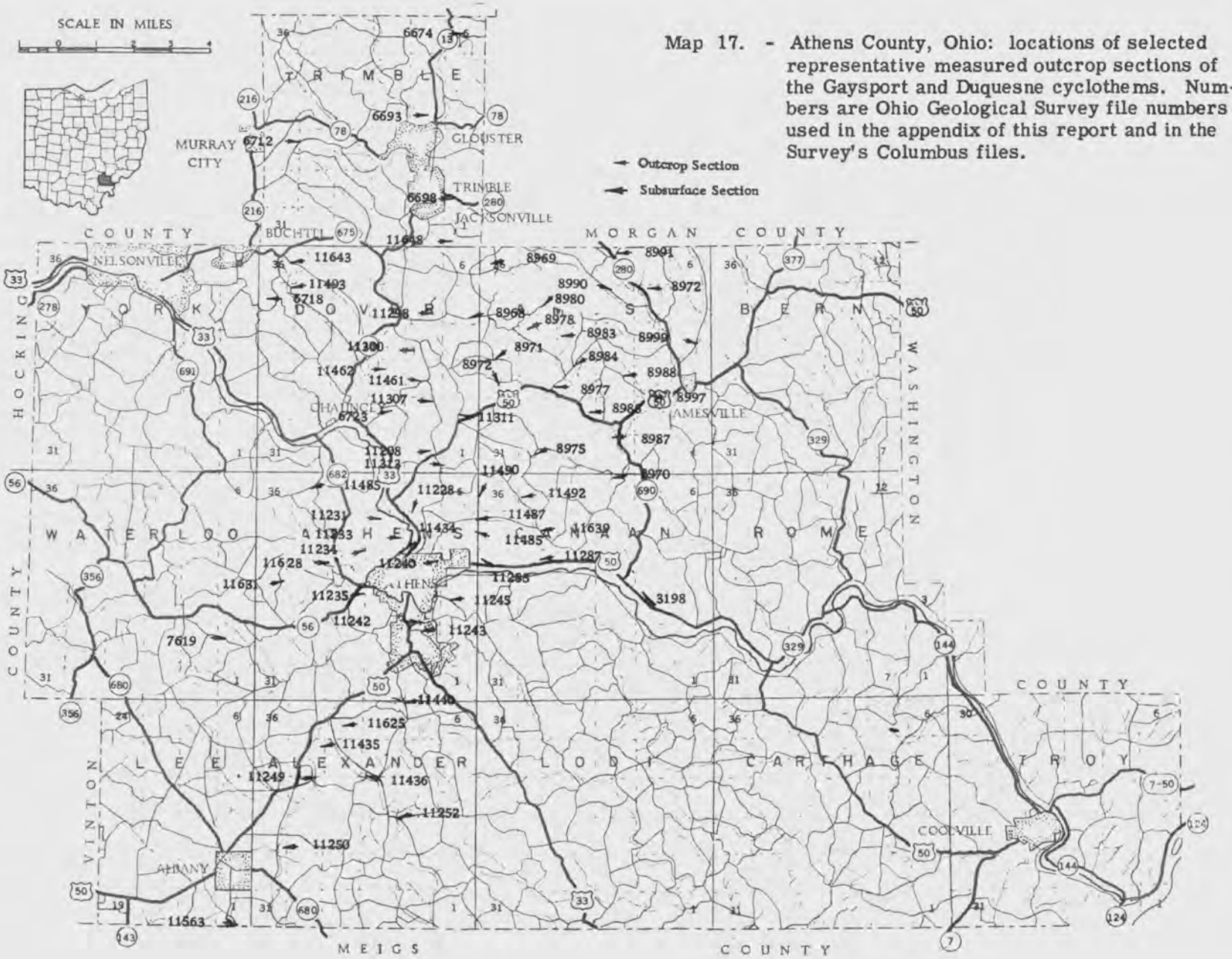
Gaysport Cyclothem

It is uncertain whether there is a Gaysport cyclothem, but for purposes of discussion the Gaysport limestone and beds between it and the Ames limestone will be considered as representing an incomplete cycle of deposition. No coal, underclay, or fresh-water limestone is present in Athens County nor is any of those beds reported elsewhere. In this area beds between the marine Ames limestone below and the marine Gaysport limestone above are mostly bedded silty micaceous shale or a combination of shale and bedded fine micaceous sandstone. Rarely does clay shale fill this interval.

Elsewhere there is some evidence that the Gaysport limestone is a split from the Ames limestone, but confirmation is inconclusive in the area under consideration. Farther east in Maryland and West Virginia the Ames member is marine shale 15 to 30 feet thick with local thin marine limestones. In Athens County the Ames-Gaysport interval is at most places nonmarine, and only at a few doubtful localities does marine fossiliferous shale occupy that space. One of the most significant of these is in Ames Township (locality 8972) where there is a double Ames limestone separated by fossiliferous shale with definite Gaysport and Skelley limestones above in the section.

Members and average thicknesses in the Gaysport cyclothem are listed in table 11, and locations for selected representative exposures are shown on map 17.

Gaysport Shale and/or Sandstone Member. - In Ohio the strata between the Ames and Gaysport limestones have been unnamed, and the name Gaysport will be used for them in this report. This is a thin interval occupied almost everywhere observed in Athens County by shale or by shale and sandstone. Average thickness for 44 measurements is approximately 12 feet 6 inches; minimum thickness is 4 to 5 feet and maximum is more than 25 feet. Where the Gaysport limestone is absent or unrecognizable, the top is arbitrarily taken at what appears most likely to be the base of the Duquesne cyclothem, redbed, basal calcareous sandstone, and more rarely a zone of ferruginous nodules.



Map 17. - Athens County, Ohio: locations of selected representative measured outcrop sections of the Gaysport and Duquesne cyclothems. Numbers are Ohio Geological Survey file numbers used in the appendix of this report and in the Survey's Columbus files.

By far the most prominent lithology in this interval is that of a light gray to olive and tan, argillaceous, silty, micaceous shale, which is invariably stained by some limonite. Where more sandy sediments are present, the tendency is for the shale to give way upward into fine-grained, thin-bedded sandstone with much the same color range as the underlying shale. Both the sandstone and shale occurring in the upper part of this interval may lose their identity and grade vertically and especially laterally into each other. As previously mentioned, the entire thickness contains widespread ferruginous material in conspicuous although small amounts, which causes yellow, brown, or red stain to the rocks' surfaces and even into the mass of the rocks. Ferruginous masses are at some places found in zones, particularly in the upper portion, and at places ferruginous sandstone is at or near the top.

In addition to the more or less typical lithologies this interval is locally occupied by variegated clay shale, whose most prevalent colors are bluish green, maroon, and chocolate brown. These masses of clay shale appear rather ferruginous; contain in a majority of such outcrops nodules and masses of siderite, limonite, or hematite; and impart a red to maroon stain over the rocks. Where the Gaysport limestone, itself, as true limestone cannot be found, the sandy shale or shaly sandstone near the top of this member may embody calcareous material, demonstrating that despite unfavorable conditions for limestone deposition, a concentration of calcareous sediment did occur and permits the recognition of the horizon of the normal marine member. Some of these calcareous zones possibly are reworked Gaysport limestone.

Gaysport Limestone Member. - The type area for the Gaysport limestone is near the Village of Gaysport in Bluerock Township, Muskingum County, Ohio, where Stout (1918, p. 258-259) described and compared it with the Skelley limestone in these words:

"In local areas, in Muskingum County, a well-defined fossiliferous bed occurs on the average about 16 feet above the Ames limestone and 20 feet below the Skelley member. The stratum is bedded in the same series of gray shales and shaly sandstones in which the Ames limestone is found, and it thus represents another calcareous sediment laid down in this general invasion of the sea. In composition the rock varies from a calcareous sandstone to a ferruginous, siliceous limestone and in thickness from 2 inches (localities 8969, 8991) to 2 feet 6 inches (locality 11487). The average measurement of the stratum, however, is about 1 foot 2 inches....

"This limestone differs from the Skelley, with which it may be confused, in several respects. The Gaysport is everywhere a very impure limestone or a calcareous sandstone, whereas the Skelley is a relatively pure limestone. As previously stated, the Gaysport member is bedded in gray shales and shaly sandstones, but the Skelley limestone with few exceptions is stratified in red or mottled clay shales. Although both beds are fossiliferous, the Skelley contains by far the most preserved forms and the largest number of species. All the fossils noted were types common to the underlying Ames limestone, but the paleontology of the member has not been carefully studied...."

Cross (A. T., 1952, oral communication) has called attention to the possibility that Stout's Gaysport limestone may actually correlate with type Skelley limestone. Should this possibility be confirmed, then the first marine limestone above the Ames limestone in eastern Ohio has had both names Gaysport and Skelly used for it, and the second limestone above the Ames, although now called Skelley, is actually without a name. Until positive correlation of these limestones is determined, Gaysport and Skelley will be retained as Stout used them in the Muskingum County bulletin. Several points should be remembered in considering the correlation of marine members above the Ames limestone in eastern Ohio:

1. That Gaysport has been identified as Skelley, and vice versa,
2. That the Gaysport may be only a split from the Ames,
3. That locally in Athens County the Ames limestone is definitely two limestone benches separated by several feet of fossiliferous marine shale.

This last statement is definitely demonstrated by an exposure in section 33, Ames Township

(locality 8972), where the Ames limestone is truly split into two limestone benches separated by 4 feet 6 inches of shale, with the Gaysport limestone about 13 feet and the Skelley 34 feet above the top bench of the Ames.

The Gaysport limestone as accepted in this report is a persistent although rather inconspicuous member lying on the average of 12 feet 6 inches above the Ames limestone and averaging 7 inches in thickness. Its distance above the Ames varies from 7 to 18 feet and its thickness from 2 inches to 6 feet of fossiliferous shale and limestone. The thickness is usually less than 1 foot, commonly less than 8 inches, and exceeds 2 feet at only 2 localities, one in Athens Township (11487) and another in Canaan Township (11285). As Athens is approached from the north and northwest the interval between the Ames and Gaysport limestones, occupied by nonmarine beds, diminishes in thickness to 5 or 7 feet (localities 11231, 11233, 11434). In the immediate vicinity of Athens no Gaysport has been recognized unless the nodular limestone lying $2\frac{1}{2}$ feet to $5\frac{1}{2}$ feet above and separated from the Ames by fossiliferous marine shale represents the Gaysport member.

Fresh specimens of Gaysport limestone vary from light olive gray to various darker shades of bluish and greenish gray. Weathered specimens may be light gray on surfaces but are more apt to be variable shades of brown and yellow, commonly dark brown, and weathered outcrops tend to be inconspicuous, brown and yellow, fossiliferous nodules. It is usually silty and sandy, often micaceous, and at places a calcareous and ferruginous sandstone. Its texture may be almost dense but commonly finely granular to definitely grainy. Calcite cleavage surfaces are quite apparent at some localities.

At several places the Gaysport is overlain by a small thickness of fossiliferous shale, olive drab with limonite stain, and silty and micaceous. This shale is usually only a few inches thick; but at Athens Township locality 11487 there are two thin layers of limestone separated by a small thickness of dark blue shale, and at Canaan Township locality 11285, limestone nodules are distributed more or less evenly throughout the shale's thickness of more than five feet.

The Gaysport fauna is a reduced Ames fauna both in numbers and in species. At some places most diligent searching will fail to disclose marine fossils, but some fossils are normally present. Locally the bed is very fossiliferous, and its fauna very closely resembles that of the coquina found at the top of the Ames limestone, dominated by numerous specimens of the small brachiopods Crurithyris planoconvexa and Chonetes granulifer. Derbya sp. also occurs as well as a few productids, spiriferids, and corals. Other fossils are rare, but among these are fusulinids and conodonts. Fusulinids are abundant and conspicuous at few localities as at Athens Township (locality 11231) and at Dover Township (locality 11307).

Duquesne Cyclothem

This cyclothem, named for the Duquesne coal, is one of the more complete Conemaugh cyclothems (table 11). Except for the Skelley marine limestone, members of the Duquesne cyclothem are inconspicuous and not very well known in eastern Ohio. In Athens County this is a rather thick cyclothem with all members at least present but with several not well developed. It is an unusual cycle in that about the same thickness of shale and sandstone occurs not only as the basal member but also between the Duquesne coal and the Skelley limestone. Elsewhere the Duquesne coal normally lies directly beneath the Skelley limestone without any intervening shale and sandstone. The two shale and sandstone members suggest the possibility that the Duquesne coal, underclay, and limestone are absent in Athens County and that another incomplete cyclothem lies above the Gaysport limestone. For the present, however, in deference to convenience in description of these members and until regional correlations are more certain, those members listed in table 11 under Duquesne will be considered parts of an unusual cyclothem. For purposes of discussion the lower shale and sandstone member will be called Lower Grafton and the upper one, Skelley (table 11). This choice of names is in part based upon the fact that the Lower Grafton sandstone farther east lies above the Ames marine member, where the Ames is

thick marine shale with local thin limestones, and that our Gaysport limestone may be a split from the Ames limestone.

The two shale and sandstone and the Duquesne redbed members are rather persistent, but the Duquesne coal, underclay, and limestone are unsteady in occurrence and somewhat uncertain in lithology. The shale and sandstone and redbed members comprise also most of the cyclothem's thickness, and the other members are thin. Total average thickness for the entire Duquesne cyclothem as interpreted here is between 35 and 40 feet. Most outcrops are in Alexander, Ames, Athens, Canaan, and Dover Townships as shown on map 17.

Lower Grafton Shale and Sandstone Member. - The name Lower Grafton has been variously applied by different authors for sandstones between the Ames limestone and beds occupying the position of the Birmingham redbed. The usage here is that of Waage (1950, p. 44), who used the name Lower Grafton for sandstone between the Ames limestone and the Federal Hill (Duquesne) coal of Maryland.

In Athens County this member appears to be generally present but may grade laterally into redbed lithology. The shale is most often light gray to light olive, usually limonite-stained, micaceous and argillaceous to silty. At some places ferruginous crusts and masses are also present. The associated sandstone is typically light gray to buff, tan or light olive, usually much stained by limonite, fine to medium grained and usually thin bedded but occasionally heavy bedded to massive. It is commonly micaceous and silty.

This member in Athens County has an average thickness of only 8 feet 6 inches; however, greater thicknesses are not uncommon. Locally, the Grafton coalesces with similar shales and sandstones above the Duquesne coal where the coal and its accompanying beds are absent.

Duquesne Redbed Member. - The Duquesne redbed is fairly persistent, with an average thickness of 12 feet 6 inches with most thicknesses between 5 and 20 feet. In its thickest exposures --for example, locality 8980 in Ames Township-- it probably is joined directly to the overlying Birmingham redbed. Twenty-five measurements and observations were made on this member in Alexander, Ames, Athens, and Dover Townships as shown on map 17. Lying about midway between the Gaysport and Skelley limestones, it is separated from the Gaysport below by the Lower Grafton shale and sandstone and from the Skelley limestone above almost everywhere by the Skelley shale and sandstone and locally by the Duquesne coal, underclay, and limestone as well. At locality 8985 in Ames Township, redbed clay shale fills the entire interval between the Gaysport and Skelley limestones, and elsewhere it is part of the variegated but dominantly red strata which locally, as at Alexander Township locality 11625, comprise much of the thickness between the Ames limestone and top of the Conemaugh series. The other extreme is present in Athens Township, where at locality 11228 massive sandstone has cut out and replaced almost all of the Duquesne cyclothem.

The almost universal rock type in the Duquesne redbed is variegated calcareous clay shale with scattered pellets and small nodules of fresh-water limestone. Common colors are red, maroon, reddish brown, green, purple, or gray with lesser amounts of tan, buff, and yellow in varying shades and mottled arrangement. In addition to being calcareous, silt and mica are common ingredients and sand less common. About one-fifth of all exposures have scattered ferruginous masses, some of which, as at localities 8975 and 8985 in Ames Township, contain nodules of hematite. Varicolored argillaceous shale is present here and there, and rarely comprises the full thickness. Massive bedding and starch-like fracture are prevalent.

The almost universal occurrence of calcareous material and limestone nodules and pellets in the Duquesne redbed indicates that it is combined with the Duquesne limestone. This is further indicated by scarcity of that limestone member as definite limestone.

Duquesne Limestone Member. - The Duquesne limestone generally occurs as scattered

pellets and small nodules of freshwater limestone in variegated clay shales of the Duquesne redbed and is almost as widespread as the redbed itself (map 17). Based on occurrences in the redbed, it has a thickness measured in several feet, but average thickness based upon five localities in Alexander, Ames, and Dover Townships, where the limestone nodules are abundant enough to be recognized as layers of nodular limestone, is only about 18 to 20 inches. Fundamentally, these five examples do not differ from the scattered limestone pellets and nodules in the redbed but only in concentration and size of the nodules in the variegated clay shales. The best exposure of Duquesne limestone observed is in section 10, Dover Township (locality 11300) where more than 4 feet of thickness is assigned to the limestone. In Alexander Township at locality 11440, nodules are concentrated in 3 feet of shale but only in the top 6 inches are the nodules really abundant.

Most pellets and nodules of Duquesne limestone are light gray, but at one locality in Ames Township (8966) the nodules are ferruginous and at the thick deposit in Dover Township, mentioned above, the nodules in the top two feet of thickness are pinkish. The clay shales in which the limestone nodules are embedded are variegated, as is characteristic of the Duquesne redbed, of which they are a part.

The Duquesne limestone is of value only for the lime its weathering contributes to the soil and for its stratigraphic interest.

Duquesne Underclay Member. - The coal and underclay identified as Duquesne in Athens County are usually separated from the Skelley limestone above by about 12 feet of shale and sandstone, in spite of the fact that Duquesne coal and clay normally lie at the base of the Skelley limestone in eastern Ohio. At only one observed locality, Trimble Township 6674, does coal or underclay lie directly beneath the Skelley limestone. The presence of shale and sandstone between the Duquesne (?) and Skelley members causes some uncertainty in correlation of the coal and clay as members of the Duquesne cyclothem. Tentatively they are assigned to that cyclothem, since there is no other known cycle in Ohio to which they can be committed.

The underclay called Duquesne in this county is unsteady and thin in occurrence. It was recognized at about a dozen places in Alexander, Ames, Athens, Dover, and Trimble Townships. Thicknesses vary from one inch to more than three feet, and average thickness for all exposures is 1 foot 6 inches. At best it is a low grade semiplastic clay with slight to moderate plasticity. Prevailing color is light gray, but darker shades of gray and shades of olive drab and buff are also present. Some amount of limonite stain is usually present. Silt and mica are the more abundant impurities; and sand, carbonate, and carbonaceous materials are less prevalent. The small amount of apparent carbonate is unexpected, as the associated redbed is calcareous with pellets and nodules of limestone. Massive bedding, starch-like fracture, and slickensides are common.

This underclay merits consideration only for its stratigraphic interest.

Duquesne Coal Member. - The geographic occurrence, stratigraphic position, and correlation of this coal are the same as for its associated underclay, and those items are briefly summarized under the above heading of the underclay or shown on map 17.

The name is taken from Duquesne, a locality in the Pittsburgh, Pennsylvania, Metropolitan District. It is the equivalent of the Federal Hill coal of Maryland and possibly the Berlin coal of the Burgettstown-Carnegie area in Pennsylvania. It apparently lies below the Federal Hill coal of Pennsylvania and West Virginia.

As a coal this is one of the poorest in all Athens County, yet its scattered outcrops in five different townships and its association with underclay and redbed indicate that it is a definite coal member. This conclusion is further strengthened by the presence of fossil estheriids at Athens Township locality 11245. At best, it is never represented by more than one to two inches of coaly or carbonaceous material, and at some places by only a coal smut or carbonaceous clay. The underclay and redbed are more persistent than the coal.

Skelley Shale and Sandstone Member. - Immediately above the Duquesne coal and separating it from the Skelley marine limestone there usually occurs a thickness of shale and sandstone similar to the underlying Lower Grafton. This member of shale and sandstone is herein designated as Skelley due to its direct association with the Skelley limestone and due to the uncertainty as to the correct name for it.

As previously mentioned, the Lower Grafton and Skelley members may replace the Duquesne coal, underclay, limestone, and redbed, forming a continuous sequence of shale and sandstone between the Gaysport and Skelley limestones. When such development is present, the total thickness of the two averages about 21 feet 6 inches.

The Skelley shale and sandstone member as presently defined separates the Duquesne coal from the Skelly limestone by an average thickness of 12 feet 9 inches in Athens County.

The member's lithology is nearly a repetition of that of the Lower Grafton, further adding to the difficulty of separating the two when none of the members associated with the Duquesne coal is present. It consists mostly of olive drab to tan and buff, silty to sandy, micaceous shale and light gray to light olive, limonite-stained, fine-to medium-grained, micaceous, usually bedded, but at some places massive sandstone. These shales and sandstones are frequently interbedded.

In exposures where the Duquesne coal and its accompanying strata are absent a more massive basal sandstone occupying this position will help to distinguish it from the underlying Lower Grafton member, which tends to become thinner bedded upward.

Skelley Limestone Member. - The Skelley limestone, named by Condit (1912, p. 27) from Skelley Station in Jefferson County, Ohio, is the highest of conspicuous marine members of the Pennsylvanian system in Ohio. The possibility that type Gaysport limestone correlates with type Skelley and that the limestone under consideration is actually without a name was mentioned in the discussion of the Gaysport limestone. At present the best choice seems to be to use both names in current usage until their correlation is shown to be in error. That mistaken field identity of the Gaysport and Skelley limestones has been made is indicated by statements from Mark (1912, p. 290) and Lamborn (1951, p. 32) that the Skelley occurs 15 to 35 feet above the Ames limestone.

Various published descriptions indicate that in Ohio the Skelley limestone is similar to and that the Gaysport limestone is unlike the Ames limestone in lithology. Such is not the case in Athens County where neither Gaysport nor Skelley closely resembles the Ames limestone but do resemble each other. Stratigraphic position and sequence of beds are most useful criteria in identifying these two like limestones. The Gaysport normally lies 7 to 18 feet and averages about 12 feet and the Skelley 30 to 50 feet with an average of about 35 feet above the Ames limestone. In sequence of beds the Gaysport is almost everywhere overlain by Lower Grafton shale and sandstone, but the Skelley is succeeded upward at numerous places by the Birmingham redbed. Apparent fossils are less abundant in the Gaysport member, but so far fusulinids have been found in the Gaysport but not in the Skelley.

Skelley limestone is not everywhere present in Athens County, and some of the absences, as at Ames Township locality 8987 and Athens Township locality 11434, are due to erosion channels filled with massive sandstone. The Skelley is typically a nodular bed, often difficult to detect, but it may appear as a stratum. In thickness it averages eight inches for 35 measurements with extremes of three inches and six feet at Ames Township localities 8968 and 8975, respectively. Deposits are mostly less than 12 inches thick, and those that are thicker consist of nodules of the limestone in fossiliferous shale. It is generally an impure limestone, and the most prevalent impurities are ferruginous materials, mica, silt, and sand. The fresh rock is bluish or greenish gray, but surfaces and weathered parts may be deeply stained by limonite -- often to a dark brown. A few localities are noteworthy because of overlying fossiliferous shale, as at Ames Township locality 8970.

Fossils are normally few in number and kind, and are not well preserved. The fauna is similar to that of the Gaysport and Ames limestones. The more delicate forms are usually

missing, probably due in large part to the silty-sandy sediments, which were unfavorable to the existence and preservation of such types. For example, fusulinids and conodonts, known from the other Conemaugh marine limestones, are unknown from the Skelley. One fossil locality worthy of special attention is in Ames Township (8972), where numerous large allorismid pelecypods occur.

Marine fossils occur in the Birmingham shale of western Pennsylvania and probably represent the horizon of the Skelley limestone.

Elk Lick Cyclothem

As shown in table 11 the Elk Lick cyclothem has five members, including the Birmingham redbed, Upper Grafton shale and sandstone, and Elk Lick fresh-water limestone, coal, and underclay. It consists essentially of redbed and shale and sandstone members, and the Elk Lick members are poorly developed in eastern Ohio and in Athens County. A rather intricate facies relationship exists between the Birmingham redbed and the Upper Grafton shale and sandstone, and their thickness may be represented largely or entirely by redbed, by bedded shale and sandstone, by massive sandstone, or by a variable combination of redbed and bedded shale and sandstone.

Although the Elk Lick members are seldom present, the limestone and underclay are most often developed. The coal as definite coal was seen at only one locality in Ames Township. Outcrops of members of the Elk Lick cycle occur in Alexander, Ames, Athens, Canaan, and Dover Townships (map 18).

Birmingham Redbed Member. - Stevenson (1876, p. 79) named the Birmingham member from Birmingham Station near Pittsburgh, Pennsylvania. Its stratigraphic position, broadly limited, is between the Duquesne and Elk Lick coals, and it may coalesce with redbeds above and below to fill much of the interval between the Ames limestone and Pittsburgh coal. Johnson (1929, p. 57-60) has shown that in the type area there is a facies relationship between redbed and/or shale and sandstone and that in places sandstone largely or entirely replaces the redbed lithology. Condit (1912, p. 26) also reported that the Morgantown (Upper Grafton of this report) locally replaces the Birmingham redbed in eastern Ohio. Raymond (1909, p. 941) found marine fossils in part of this member near Pittsburgh, and those marine beds are probably equivalent to the Skelley marine zone in eastern Ohio.

Map 18 shows locations of the Birmingham shale in Alexander, Ames, Athens, Canaan, and Dover Townships. Similar conditions of occurrence and thickness prevail in Athens County as elsewhere in eastern Ohio and western Pennsylvania for the Birmingham redbed. It is absent at many places; and, where present, thicknesses vary from as little as 2 to 5 feet, as in section 17, Ames Township (locality 8990) and in section 2, Dover Township (locality 11311), to 88 feet in section 22, Ames Township (locality 8983). Thick exposures, as this last one cited in Ames Township, undoubtedly represent other redbeds in part. Shale and sandstone occur below this redbed at Ames Township localities 8983, 8990, 8991, and 8999 and at Athens Township locality 11242 (map 18). Complete or partial replacement by Upper Grafton sandstone seems to account for absence or thinness at Athens Township locality 11228 and at Dover Township locality 11311.

The Birmingham's lithology is similar in color, composition, and texture to that of other redbeds in the upper part of the Conemaugh series. Prevailing colors are the usual shades of gray, green, purple, yellow, brown, and red with profusion of red and dark reddish brown. Mottling of colors and staining by limonite are common. The rock is typically massive clay shale with a starch-like fracture or an argillaceous to silty, micaceous shale. Scattered fresh-water limestone pellets and small nodules are mixed in the clay shale matrix at about one-half of the exposures, and ferruginous masses, including pyrite, at several. The Birmingham, however, appears to be less calcareous and less ferruginous than the Duquesne redbed below. At Canaan Township locality 11490 in section 36 and extending into section 6 of Athens Township is

an interesting and unusual exposure of interbedded clay shale, shale, and fresh-water limestone, much of which is contorted by penecontemporaneous folding of the beds.

Upper Grafton Shale and Sandstone Member. - Upper Grafton is used in this report for shale and sandstone, locally massive sandstone, which heretofore has been called Morgantown in Ohio. Upper Grafton is the name for these beds, as Waage (1950, p. 44) stated that "A thin sandstone ... is present in some places above the Federal Hill (Duquesne coal) and Birmingham beds." Type Morgantown sandstone is above the Elk Lick members, and Condit (1912, p. 25) wrote:

"At Morgantown, West Virginia, the type locality for this sandstone, its base is about 58 feet above the Ames limestone, and the interval contains the Elk Lick and underlying Birmingham shales."

These two statements clearly differentiate between which member should be called Morgantown and which should be known as Upper Grafton. Condit recognized that there is considerable difference in interval between the Ames limestone and base of the Morgantown sandstone in its type area and what he called Morgantown sandstone in eastern Ohio, but he explained the difference by the fact that the Conemaugh series thins from east to west. Part of Condit's general description of the Upper Grafton (his Morgantown) is given below (1912, p. 25):

"... Like all of the sandstones of the Conemaugh, this bed is very irregular in its occurrence, being conspicuous at one place and entirely wanting a short distance away. The rock varies from a fine-grained, bluish-gray freestone, similar to the Berea at Cleveland, to a coarse-grained, massive, yellowish-gray bed 30 feet or more in thickness.

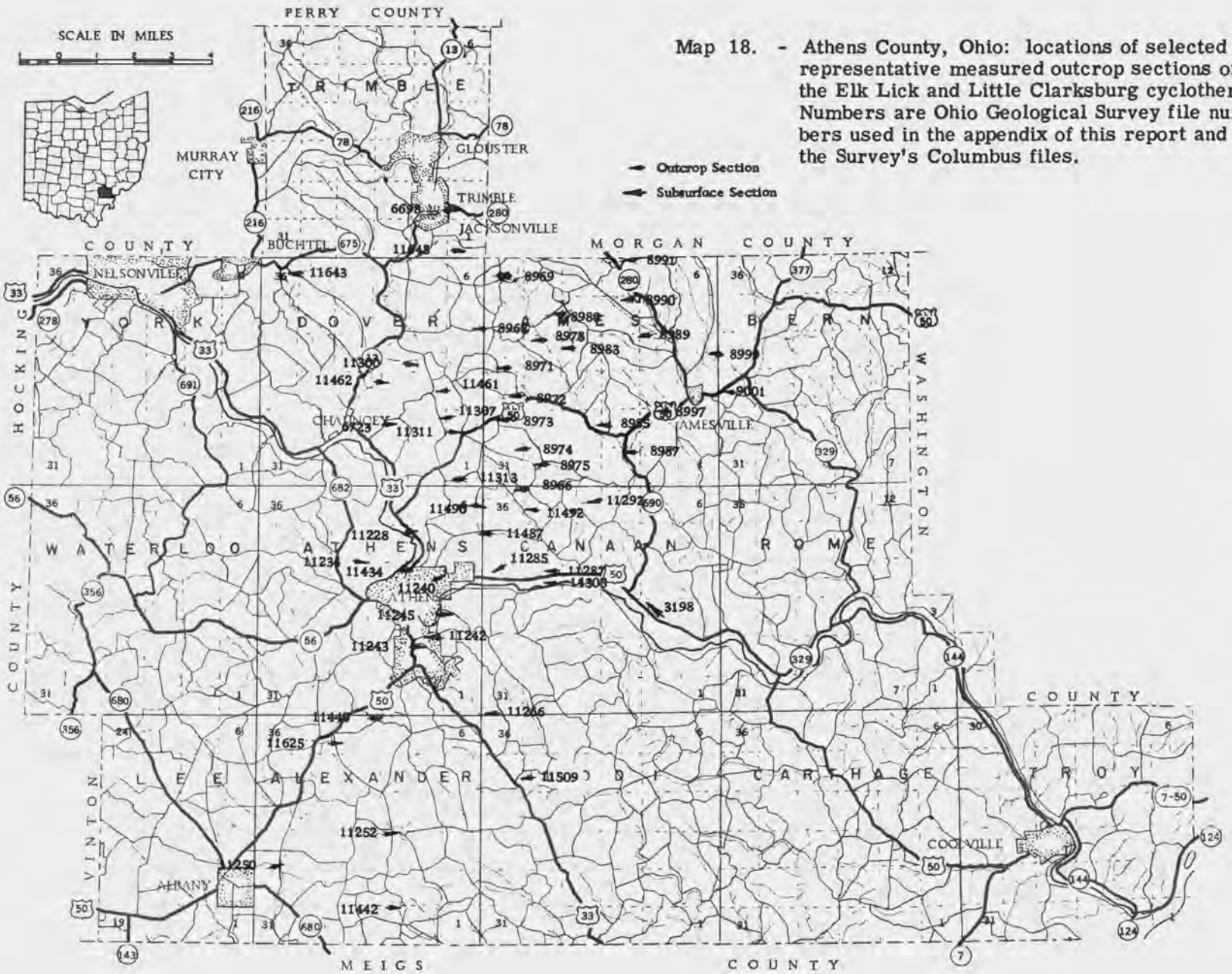
"Where present in massive form the Morgantown (Upper Grafton) sandstone is seldom separated from the underlying Ames fossiliferous limestone by more than 25 feet of shale, and often the interval is only 10 or 15 feet. Less commonly, the sandstone reaches the Ames horizon and replaces that limestone over limited areas. In such instances there is a basal conglomerate consisting largely of fossiliferous limestone pebbles, intermixed with other material. A conglomerate of this description was noted on the south side of the Hocking River at Athens, Athens County."

The Upper Grafton member seems to be fairly typical in Athens County in comparison with descriptions of that member elsewhere in Ohio. Exposures are located primarily in Ames, Athens, and Dover Townships with several additional ones in Alexander and Canaan Townships (map 18). Its thickness is variable as it is succeeded above and below by and grades laterally into redbeds. Thickness varies from as little as seven feet of bedded shale and sandstone to more than 40 feet of massive sandstone. Average thickness for 16 measurements is almost 25 feet.

Most of the thinner exposures are bedded micaceous shale varying from argillaceous to sandy or more commonly a combination of interbedded shale and bedded, fine, silty, micaceous sandstone. Shale and sandstone may be interbedded or occur with shale below and sandstone or interbedded shale and sandstone above. Some of the sandstone layers, generally in the basal part of the thickness, are calcareous, and ferruginous concretions occur in some of the shales.

About half of the Upper Grafton exposures measured are thick massive ledges ranging from 25 to 40 feet thick; they consist of coarse, massive, micaceous, rather friable sandstone. The base of the sandstone is disconformable, and the lower part of the rock is commonly conglomeratic. Thick exposures of massive sandstone occur at Ames Township localities 8975 and 8987, at Athens Township localities 11228 and 11434, and at Dover Township localities 11311, 11313, 11461, and 11462 (map 18). These are some of the more prominent series of sandstone exposures in the county.

Elk Lick Limestone Member. - F. and W. G. Platt (1877, p. 60) named the Elk Lick limestone from exposures near the village of Elk Lick, Somerset County, Pennsylvania, where it is described as being 6 to 12 feet thick. In eastern Ohio this limestone and associated coal and



Map 18. - Athens County, Ohio: locations of selected representative measured outcrop sections of the Elk Lick and Little Clarksburg cyclothems. Numbers are Ohio Geological Survey file numbers used in the appendix of this report and in the Survey's Columbus files.

underclay are very poorly developed. Lamborn (1951, p. 33) stated that the Elk Lick limestone has been recognized only in Jefferson County. There are a few exposures in which the Elk Lick members are present in Athens County, although none is conspicuous and several are subject to interpretation.

Limestone in sufficient development for recognition of the Elk Lick member occurs in about a half dozen localities in Alexander, Ames, Athens, Canaan, and Dover Townships (map 18). Elsewhere the principal lithology is variegated calcareous redbeds with scattered limestone pellets and small nodules. Average thickness for the few definite localities is 3 feet 6 inches, a figure that is probably too much as two of the exposures have thicknesses from 7 to 9 feet. An average thickness of 1 to 2 feet would likely be more representative. The thickest observed exposure, consisting of nodules and pellets of limestone distributed in variegated clay shale, is along the north side of the Hocking Valley just east of Athens at Athens Township locality 11240. The best limestone is at Alexander Township locality 11625 in a small wash at the north edge of abandoned Buck's Speedway, where there is a massive ledge of limestone about one foot thick with variegated clay shale containing limestone nodules and pellets above and below. The Elk Lick limestone can best be described as calcareous multicolored redbed lithology with a concentration of limestone nodules and pellets as in the base of the Clarksburg redbed in Athens and Canaan Townships cited above. Such concentrations are interpreted as Elk Lick limestone, although there may be little or no development of the overlying coal and underclay.

This limestone warrants no consideration except for its stratigraphic significance.

Elk Lick Underclay Member. - The Elk Lick underclay, named from its overlying coal, is a little more persistent than its coal, but both are usually absent in Athens County. Its average thickness for nine recorded outcrops is about two feet, but thicknesses range from nothing to nine feet. It is usually no more than a light gray semi-plastic clay or clay shale, but locally, as in section 20, Ames Township (locality 8985), the top part at least becomes a plastic clay with carbonaceous specks. The clay and clay shale of this horizon are normally silty and micaceous, light to dark gray in color, the latter due to disseminated carbonaceous matter, and with the usual lesser or greater amount of limonite stain.

Elk Lick Coal Member. - The name Elk Lick has long been used in Pennsylvania for a coal lying between the Duquesne and Little Clarksburg coals. The type area is near Elk Lick in Somerset County, Pennsylvania. In Maryland the same coal is known as the Barton coal. The name Elk Lick will be retained here for this coal, although Barton is reported to have priority as a name. Barton has been used erroneously for the Upper Bakerstown coal in Ohio, and the substitution of Barton for Elk Lick as a name might lead to some confusion at least for the time. Moreover, Elk Lick is already established as a name for this coal in Ohio.

The Elk Lick coal and associated underclay and limestone are not well developed in Athens County, and these beds are commonly absent. Their stratigraphic position may be occupied by a redbed series more or less continuous with that of the Birmingham member below and the Clarksburg above. Where the redbeds occupy the entire interval the Elk Lick horizon is represented by a row or zone of limestone nodules and pellets in the redbed. Morgantown shale and sandstone replace the Elk Lick beds at other places.

Where present, the Elk Lick coal is little more than a carbonaceous streak in clay, and the average thickness is only one inch. At one locality in section 8, Ames Township (8997), it is a true coal although of very poor quality.

Elk Lick coal has only minor importance in Athens County even stratigraphically, as it is thin, irregular, and usually wanting. At present it is known with some degree of certainty only in Ames Township.

Little Clarksburg Cyclothem

Several member names in this cyclothem seem to be inconsistent in that the coal is known as the Little Clarksburg and members immediately below it are called simply Clarksburg. Furthermore, the basal two members bear the name of Morgantown. Table 11 shows that this cycle is also unusual in the presence of two redbed members -- one, the Morgantown redbed, below the shale and sandstone of the same name; and the other above the shale and sandstone and below the Clarksburg limestone. Since redbeds characteristically not only lie above or below shale and sandstone members but also grade laterally into shale and sandstone, it is difficult to determine representative average thicknesses for those members. Inspection of table 11 shows that those cyclothems with redbed members are thicker than those without redbeds. The Little Clarksburg cyclothem, with an average thickness of almost 60 feet, is the thickest of any Conemaugh cyclothem in Athens County, although the Elk Lick and Lower Little Pittsburgh cyclothem are almost as thick. It is likely that determined average thicknesses for such cycles is too large, as no adjustment was made for lateral gradation of beds.

In Athens County, members of the Little Clarksburg cyclothem occur in a discontinuous distribution in Alexander, Ames, Canaan, Dover, and Lodi Townships; locations of representative outcrops are shown on map 18. Of the several members, none is of any economic importance. The coal is at several places of good thickness but is too shaly to be attractive for mining.

Morgantown Redbed Member. - Swartz et al. (1922, pl. 6) called redbeds that are a facies of the Morgantown sandstone the Morgantown redbed. The name should apparently be applied to redbeds below or at the position of the Morgantown shale and sandstone. It is possible that redbeds in the stratigraphic position of the Morgantown are a tongue belonging to the Clarksburg redbed above. Where more or less continuous redbed lithology extends from or below the Elk Lick members to the Clarksburg members or even higher, the name Clarksburg is used in this report.

Two localities, 8997 and 9001, in Ames Township and possibly a third, 11625, in Alexander Township, can be assigned to the Morgantown redbed. At these places 4 to 20 feet of variegated shale and clay shale lie below the Morgantown shale and sandstone and above the Elk Lick members. At one locality (8997) scattered nodules and pellets of fresh-water limestone occur throughout the 20 feet of thickness.

Morgantown Shale and Sandstone Member. - Morgantown shale and sandstone occupies the position between Elk Lick and Clarksburg members and locally may be replaced by redbed. The sandstone which Condit (1912, p. 25-27) assigned to the Morgantown member is now believed to belong to the Upper Grafton member. True Morgantown shale and sandstone do occur at a few localities in Alexander, Ames, Canaan, and Dover Townships (map 18), and an average thickness for seven measurements is about 21 feet.

It is not as persistent as the Upper Grafton shale and sandstone but its thickness and lithology are quite similar to those of the Upper Grafton member. It consists of bedded micaceous, argillaceous to silty shale, and thin-bedded, micaceous, fine-grained sandstone, or massive, medium to coarse, micaceous, friable sandstone that may be somewhat granular or conglomeratic. The bases of the massive exposures are disconformable, and the top part of the thickness is somewhat bedded or cross-bedded. A good example of interbedded shale and sandstone is at Ames Township locality 8997 and of massive sandstone at Ames Township locality 8966 or Dover Township locality 11307. Calcareous siltstone in the basal ten feet occurs in sections 29 and 30, Canaan Township, and a six-inch ferruginous zone at Ames Township locality 8966. The fresh rock is light gray to light bluish gray and weathered masses and surfaces are shades of red, brown, or yellow.

A 2-foot conglomerate in section 32, Ames Township, has limestone pebbles in a sandy matrix at the stratigraphic position of this member.

Clarksburg Redbed Member. - Hennen (1912, p. 240) named the redbed below the Clarksburg limestone the Clarksburg red shales from exposures near Clarksburg, West Virginia.

The Clarksburg member is one of the rather thick and conspicuous redbeds that locally more or less unite to fill the interval between the Ames limestone and the Connellsville sandstone or even up to the Pittsburgh coal. Excluding several exposures of the Morgantown redbed, about ten outcrops of the Clarksburg redbed were recorded in Alexander, Ames, Athens, Canaan, Dover, and Lodi Townships, and locations of selected representative exposures are shown on map 18. Thicknesses range from less than 5 feet to more than 32 feet, and the average thickness for eight full measurements is 19 feet. As is characteristic of other Conemaugh redbeds, this member is locally replaced by shale and sandstone.

The Clarksburg redbed is a typical variegated massive calcareous clay shale with starch fracture and fresh-water limestone pellets and small nodules scattered throughout or concentrated in base. The usual colors are various shades of gray, red, maroon (dark reddish brown), green, purple, yellow, and brown, usually in mottled patterns. Locally there are clay zones, e.g. at Canaan Township locality 11292,and ferruginous limestone nodules, e.g. at Ames Township locality 8973 and at Canaan Township locality 14305. The rock may also be silty and micaceous.

Clarksburg Limestone Member. - White (1891, p. 88) named this limestone from exposures along Elk Creek and West Fork River near Clarksburg, West Virginia. There it is from 20 to 30 feet thick, directly underlies the Little Clarksburg coal, and is separated from the Morgantown sandstone below by 25 to 40 feet of soft shales.

The Clarksburg limestone is poorly developed in Ohio, and according to Lamborn (1951, p. 33) has been positively identified only in Athens, Jefferson, and Meigs Counties. In Athens County there are about ten localities where nodules and pellets of limestone in the upper part of the Clarksburg redbed warrant recognition of the Clarksburg limestone. These are scattered in Alexander, Ames, Athens, Canaan, Dover, and Lodi Townships (map 18). Thicknesses extend from as little as six inches to more than ten feet, and average thickness for seven complete measurements is 4 feet 6 inches.

The limestone itself is usually some shade of gray--light gray to almost white and, less commonly dark gray. The rock is dense or partly crystalline, with lenses and masses of calcite. The only fossils reported are coiled tubes of the annelid worm Spirorbis at Ames Township locality 8971, but a more careful search would probably reveal more fossil localities and a wider variety of forms. Fossil fish fragments common in the type area have not been found in Athens County.

In eastern Ohio the Clarksburg limestone is important only for stratigraphic purposes.

Clarksburg Underclay Member. - This underclay, named by Hennen (1912, p. 236) from its association with the overlying Little Clarksburg coal, is of minor stratigraphic significance and of no economic importance in eastern Ohio and Athens County.

In Athens County it is a thin and unsteady underclay but is usually associated with some development of the Little Clarksburg coal above and the Clarksburg limestone and/or redbed below. It was recognized at ten localities in Alexander, Ames, Athens, Canaan, Dover, and Lodi Townships (map 18). The maximum recorded thickness is less than three feet, and the average for seven complete measurements is only ten inches.

In lithology it is light to dark gray clay or clay shale with low to moderate plasticity. It is commonly massive and may be calcareous, micaceous, silty, and sandy. The dark gray clay is somewhat carbonaceous.

Little Clarksburg Coal Member. - This is generally a poorly developed and often absent coal. White (1891, p. 88) wrote as follows concerning it:

"... By this name (Little Clarksburg) has been designated a bed of slaty coal which occasionally makes its appearance close under the Connelsville sandstone....

"At Clarksburg, West Virginia, the coal in question crops out along the bed of Elk Creek for a considerable distance, and is 1½ to 2 feet thick, but poor and slaty. It is called Little Clarksburg to distinguish it from the Pittsburgh coal, which is extensively mined in the vicinity of that town, and is locally known as the Clarksburg bed."

White in redescribing this same coal in 1903 (p. 248-249) mentioned localities very near Clarksburg which show the coal in a "double character" comprising two benches separated by a few inches to several feet of black shale. This same type of development is present locally in Athens Township at localities 11243 and 11245. At the latter locality the total thickness of the coal exceeds 4 feet 6 inches and consists of alternating beds of dark shale and shaly coal with some bright laminae. In addition, Condit (1912, p. 119) measured a thickness of 30 inches for this coal in section 36, Lodi Township.

Elsewhere in Athens County the Little Clarksburg coal is coaly shale averaging only an inch in thickness and is a mere carbonaceous film at some places. Including the thick exposures the average thickness is still only about one foot. It is known from stratigraphic sections in Alexander, Ames, Athens, Dover, and Lodi Townships (map 18).

Locally in Ames Township at locality 8989, there may occur an unnamed coal a few feet above the Little Clarksburg horizon. If this represents a true coal horizon, it is probably correlative with one of the numerous upper Conemaugh coals farther east, but its exact stratigraphic position is uncertain.

Lower Little Pittsburgh Cyclothem

Two Little Pittsburgh cyclothems underlie the Pittsburgh (No. 8) coal in parts of the northern Appalachian coal basin. In general these two cycles are irregular and uncertain in development, and at many places most or even all members of one or both cyclothems seem to be missing. Hence, correlation of Little Pittsburgh members is often uncertain.

In Athens County only the Connellsville sand and redbed members of the Lower Little Pittsburgh cyclothem are well developed, and the sandstone is one of the most prominent sandstones in southeastern Ohio. On map 19 localities for both Little Pittsburgh cyclothems are shown limited to Alexander, Ames, Athens, Bern, Canaan, and Rome Townships.

Connellsville Shale and Sandstone Member. - F. Platt (1876, p. 19) named the Connellsville sandstone from massive exposures near Connellsville, Pennsylvania. Outcrops of this member are widely distributed in western Maryland and Pennsylvania, eastern Ohio, and northern West Virginia.

Condit (1912, p. 24-25) pointed out that in east-central Ohio the Connellsville member is represented by shaly and thin-bedded sandstone or by sandy shale and clay but that thick massive sandstone occurs locally in Athens County and on southward. He wrote as follows concerning the massive sandstone in southeastern Ohio:

"To the southwest the first prominent occurrence of the Connellsville sandstone is in central Athens County, where the rock forms abrupt cliffs along Hocking River east of the city of Athens. The thickness is over 50 feet in places and the rock extends up to within 15 feet of the Pittsburg coal, its base being about 100 feet above the Ames limestone.

.....

"South of Hocking River, in Athens and Meigs counties, the sandstone is extensively present

as a massive bed and forms abrupt walls along the valleys. Where it lies higher in the hills there are steep terraces or even a continuous cliff along the hillsides. Cavernous overhanging ledges and waterfalls are plentiful in the ravines.

"The great irregularity of this sandstone is noteworthy. In Meigs County, the massive, coarse-grained rock may be found to appear and disappear several times in a few miles, and where wanting its place is not uncommonly occupied by sandy shale.

"This same sandstone, together with higher beds, controls the steep topography so characteristic of the Ohio valley southward for many miles from Gallipolis .... The same irregularity found in Meigs County is also characteristic of the rock farther south."

While by no means represented everywhere by massive sandstone in Athens County, the Connellsville is truly one of the prominent and thick sandstones in the county. It attains a maximum thickness of more than 102 feet at locality 11287, section 28, Canaan Township. Other exposures of massive sandstone, 70 to 80 feet thick, are present in Ames, Athens, Canaan, and Dover Townships. Exposures of varying lithology occur in these townships and in Alexander and Bern Townships in addition. Selected representative localities are shown on map 19. Average thickness for all complete measured stratigraphic sections of the Connellsville member is about 45 feet.

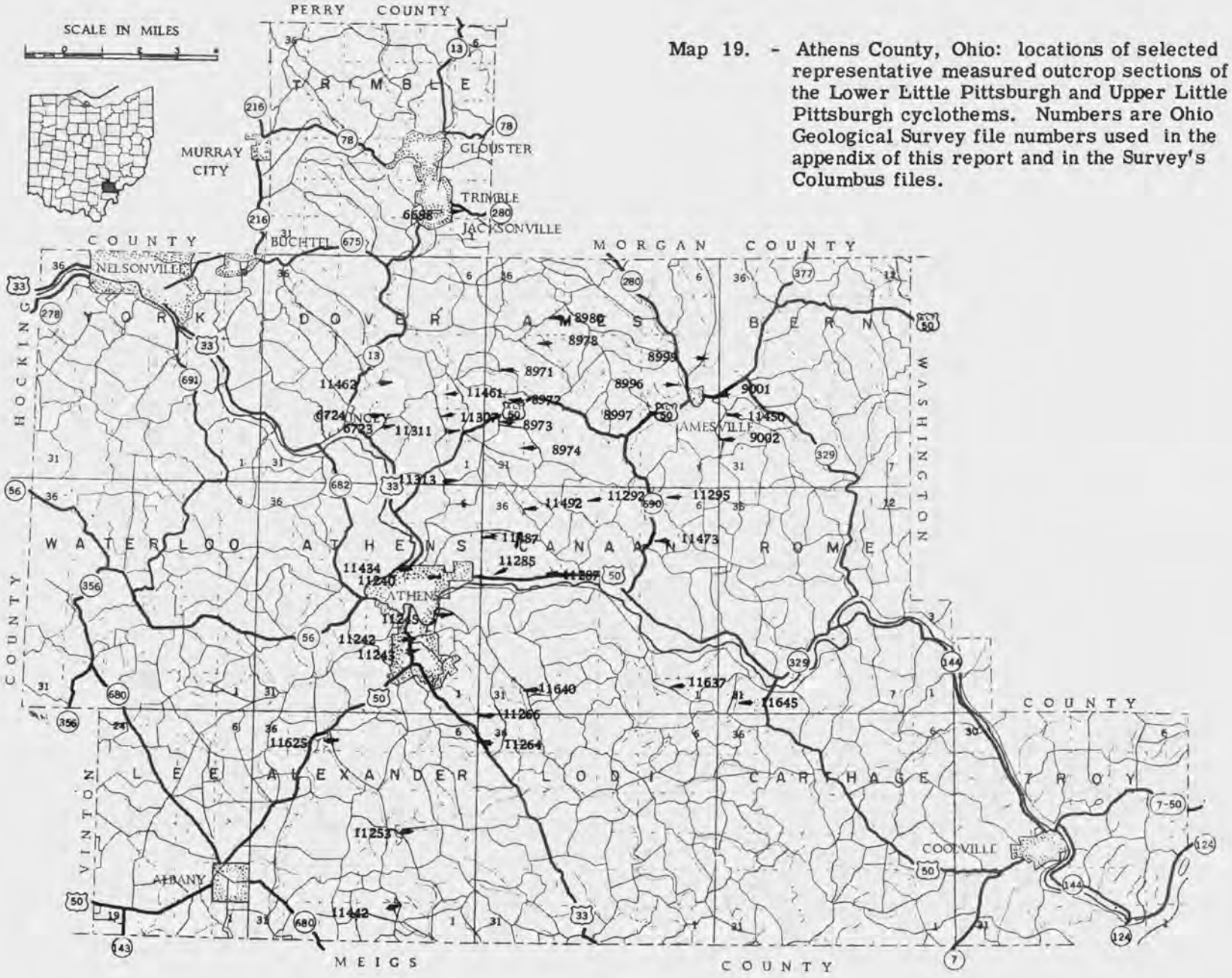
In its massive development the Connellsville is coarse to medium, micaceous, and often rather friable and porous sandstone that shows some bedding and cross-bedding on weathered surfaces and is finer grained and thinner bedded in the top part of its thickness. Arkosic and conglomeratic zones are present at some places. Fresh rock is light gray to light bluish gray, but exposed and weathered parts are usually variable shades of brown and yellow often with mixed coloration and possibly with some case hardening. Base of the massive sandstone is a disconformity, so that thicknesses vary appreciably in short horizontal distances. The thickest parts of this sandstone, especially where the Pittsburgh coal horizon is but a short distance above its top, are undoubtedly in part sandstones of the Little Pittsburgh cyclothems coalesced with the true Connellsville. Such a relationship is indicated by a coaly zone about 50 feet above the base at Canaan Township locality 11287. Part of the poor development of the Little Pittsburgh cycles in Athens County is explained by the union of Connellsville and overlying sandstones.

Where bedded shale and sandstone replace the massive sandstone in the county, they are the usual fine-grained micaceous sandstone and silty to sandy micaceous shale that are generally interbedded to some extent. These are usually thinner than the massive sandstone, although thicknesses of more than 30 feet and possibly as much as 50 feet occur.

Connellsville Redbed Member. - At places in Athens County the interval between the Little Clarksburg and Pittsburgh coals is occupied almost entirely by redbeds. The lowermost of these is the Connellsville redbed, whose position is equivalent to the upper portion of the Connellsville sandstone. In 1922 Swartz et al. (pl. 6) first applied the name to this redbed member. Their plate 6 shows in an excellent fashion the relationship of these several upper Conemaugh redbeds.

Only a few measurements in this county reveal this redbed with certainty in Alexander, Ames, Bern, and Canaan Townships (map 19). Its average thickness is 8 feet, but it varies from 3 to 19 feet. It is at most places gray, mottled maroon, and red, usually silty, and often micaceous. The fracture is usually starch-like, and it may contain small nodules and pellets of freshwater limestone.

Lower Pittsburgh Limestone Member. - The only possible representation of this freshwater limestone member observed in Athens County consists of small limestone nodules and pellets in the Connellsville redbed at Canaan Township locality 11473. Condit (1912, p. 23) applied the name Summerfield to this limestone, but since F. and W. G. Platt (1877, p. 286) had used Lower Pittsburgh for the same limestone and since that name was already well established,



Map 19. - Athens County, Ohio: locations of selected representative measured outcrop sections of the Lower Little Pittsburgh and Upper Little Pittsburgh cyclothems. Numbers are Ohio Geological Survey file numbers used in the appendix of this report and in the Survey's Columbus files.

Condit abandoned Summerfield as its name in 1923 (p. 17). Both names are still printed on the Generalized Section of Ohio by the Ohio Division of Geological Survey, but it is generally agreed that Summerfield should be dropped as a name for this member. The member merits no further attention here.

Lower Little Pittsburgh Underclay Member. - This underclay derives its name from the overlying Lower Little Pittsburgh coal. Since the Lower Pittsburgh limestone is generally not developed in this county, the Lower Little Pittsburgh clay rests directly on top of the Connellsville sandstone or more frequently on top of the Connellsville redbed. Despite its restricted development, this clay appears more commonly than does its associated coal. In the several places where it appears it is light gray to gray, somewhat plastic, silty, and slightly micaceous, and may contain carbonaceous matter. In spite of limited occurrence this clay has fair geographic distribution in Athens County. It has been found in Ames, Athens, Bern, and Canaan Townships (map 19). In these four townships it presents an average thickness of 11 inches where present, and varies from 2 inches to 2 feet.

Lower Little Pittsburgh Coal Member. - The characteristics of the two coals commonly recognized in the interval between the Lower Pittsburgh limestone and the Pittsburgh coal are well presented by Johnson (1929, p. 48), who stated:

"The name Little Pittsburgh (Lower and Upper) has been used to designate thin and unimportant coal beds which occur as lenses of small areal extent from 9 to 52 feet below the base of the Pittsburgh coal."

White (1891, p. 87) described the occurrence of the Little Pittsburgh coals as being "quite persistent at the northern end of the Appalachian coal basin;" they disappear to the south, causing the coals to be almost unrecognizable in southern Ohio sections.

The Lower Little Pittsburgh coal has been recognized at a single location in Athens County, Canaan Township (locality 11473), where it is developed as a shaly, coaly smut one-half inch in thickness.

Upper Little Pittsburgh Cyclothem

The Upper Little Pittsburgh cyclothem is similar in over-all development to that of the Lower Little Pittsburgh cyclothem, in that it has a fairly steady shale and sandstone member, a redbed with some but uncertain development, and very few traces of coal, underclay, or limestone members. Its sandstone is much less prominent than the Connellsville sandstone in the Lower Little Pittsburgh cycle.

Selected localities of this cyclothem in Athens County are also shown on map 19.

Upper Little Pittsburgh Sandstone Member. - Condit (1912, p. 22) named a sandstone closely underlying the Pittsburgh coal Bellaire for the city of that name in Belmont County, Ohio. But he also stated in the same description:

"It is also prominent in Pennsylvania where it has been called the Lower Pittsburgh Sandstone."

Stout (in Bownocker and Dean, 1930, chart op. p. 6) placed the Bellaire sandstone in the Upper Little Pittsburgh cyclothem rather than in its correct position as a correlative of the Lower Pittsburgh sandstone, that is, as basal member of the Pittsburgh cyclothem. Unless it can be demonstrated that the Lower Pittsburgh sandstone is absent in the type area of the Bellaire sandstone, then Stout's correlation of the Bellaire sandstone is in error as indicated by Condit's original definition of the Bellaire member.

The basal sandstone of the Upper Little Pittsburgh cyclothem is fairly well developed in Athens County, being recorded in Alexander, Ames, Bern, Canaan, and Rome Townships (map 19). Its thickness is rather constant, varying from roughly 10 to 30 feet and averaging 18 feet. It is typically gray to tan, buff or olive drab, usually somewhat stained, silty and micaceous. Only locally is it represented by sandy shale, and most commonly it is thin-bedded to shaly sandstone. At a few places in Alexander, Ames, and Bern Townships--localities 11264, 8974, and 11450, respectively--it becomes quite massive and its grain size increases from fine to medium or even coarse. However, this member is usually characterized by its fine grain size in addition to its thin bedding and rather constant thickness.

As with most of these upper Conemaugh sandstones, this member appears to be lenticular and is more often absent than not, with its position occupied by redbed.

Upper Little Pittsburgh Redbed Member. - The redbed phase of the Upper Little Pittsburgh cyclothem will be designated the Upper Little Pittsburgh Redbed in this report. Its position can best be described as overlying the Upper Little Pittsburgh sandstone and as being separated from the Upper Little Pittsburgh coal by that coal's associated limestone and underclay where these are present. As with all redbeds in the Conemaugh series above the Connellsville sandstone, this redbed commonly cannot be separated with certainty from beds above and below when such key beds as coals and sandstones are not developed.

The Upper Little Pittsburgh redbed has been measured with certainty in about a half dozen localities, although probably present in a good many more. Its thickness is quite variable, ranging from 7 to 21 feet and averaging about 11 feet. It consists of clay shales and shales gray to greenish gray, mottled maroon, purple and yellow. These clay shales and shales are usually quite silty, often micaceous, and may be calcareous. Limestone pellets are generally present, being scattered throughout the redbed, but at one locality in Alexander Township (11264), the nodules are concentrated at the top of the redbed and seem to represent the Upper Little Pittsburgh limestone.

Upper Little Pittsburgh Limestone Member. - The limestone associated with the Upper Little Pittsburgh coal, here called the Upper Little Pittsburgh limestone, is very poorly developed in Athens County and was recognized with certainty in only two stratigraphic sections in addition to the Alexander Township locality 11264 mentioned above: Ames Township (locality 8996), where it consists of small limestone pellets embedded in shale, and Dover Township (locality 11311), where it is an irregular ledge 8 inches thick. At these places it is light gray to buff or yellow brown limestone with impurities of silt, sand, and mica.

These two measurements average 2 feet 6 inches, which is almost certainly too large an average for such an inconspicuous member.

Upper Little Pittsburgh Underclay Member. - At only one locality, Ames Township (8980), was a developed underclay noticed beneath the Upper Little Pittsburgh coal. It attains a thickness of one foot and is gray to dark gray, silty, micaceous; it is actually more of a clay shale than a true clay.

Upper Little Pittsburgh Coal Member. - This coal has been observed and measured at only four localities in Athens County, and each is in a different township. Thickness at each locality is one inch. These observed localities are: Alexander 11264, Ames 8980, Canaan 11473, and Rome 11645 (map 19). As a coal at these places it is very impure and is best described as a carbonaceous shale. It is usually without a well-developed underclay, being a dark zone in the top of its redbed.

Table 13

Generalized Stratigraphic Column for Monongahela Series in Athens County

No.	Cyclothem	Member	Description	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
		Cassville	Shale, "roof shale", unsteady.	1	6				
12	Waynesburg	Waynesburg	Coal, thin, fairly steady.	0	1	20	8	401	0
			Underclay, frequently absent.	0	1				
			Redbed, varicolored, calcareous.	9	6				
		Gilboy	Shale and sandstone, variable.	11	0				
11	Little Waynesburg	Little Waynesburg	Shale, "roof shale", unsteady.	0	7	37	11	380	4
			Coal, thin, fairly steady.	0	1				
			Underclay, impure, frequently absent.	0	11				
		Waynesburg	Limestone, freshwater, nodular to bedded.	2	4				
		Little Waynesburg	Redbed, varicolored, calcareous.	12	6				
		Uniontown (Annabelle)	Shale and sandstone, massive to bedded.	21	6				
10	Uniontown	Uniontown	Shale, "roof shale", unsteady.	0	6	22	10	342	5
			Coal, persistent.	0	3				
			Underclay, unsteady, impure.	0	3				
		?	Limestone, freshwater, absent.	0	0				
		Uniontown	Redbed, varicolored, calcareous.	14	0				
		Lower Uniontown "Big Run"	Shale and sandstone, very local.	7	10				
9	Lower Uniontown		Shale, "roof shale", absent.	0	0	26	8	319	7
			Coal, absent.	0	0				
			Underclay, usually absent.	1	8				
		Uniontown	Limestone, bedded to nodular, variable.	7	0				
		Ritchie	Redbed, varicolored, calcareous, variable.	10	0				
		Arnoldsburg	Shale and sandstone, variable, unsteady.	8	0				
8	Arnoldsburg	Arnoldsburg	Shale, "roof shale"	1	4	44	4	293	11
			Coal, unsteady.	0	1				
			Underclay, unsteady, impure.	0	11				
			Limestone, nodular to bedded, variable.	13	6				
			Redbed, varicolored, calcareous, variable.	13	3				
		Fulton	Green shale and sandstone, local.	15	3				
7	Benwood	Benwood	Shale, "roof shale", absent.	0	0	65	8	249	7
			Coal, very local.	0	1				
			Underclay, absent.	0	0				
			Limestone, nodular to bedded, variable.	7	5				
		Tyler Reds	Redbed, varicolored, calcareous, variable.	31	2				
		Sewickley	Shale and sandstone, persistent.	27	0				
6	Sewickley	Sewickley (Meigs Creek)	Shale, "roof shale"	1	1	33	5	183	11
			Coal, locally double-benched, variable.	1	4				
			Underclay, variable, impure.	2	0				
			Limestone, absent.	0	0				
			Redbed, variable.	9	0				
		?	Shale and sandstone, persistent.	20	0				
5	Lower Sewickley	Lower Sewickley	Shale, "roof shale", absent.	0	0	19	9	150	6
			Coal, very local.	0	1				
			Underclay, absent.	0	2				
			Limestone, nodular, local.	9	0				
			Redbed, varicolored.	5	0				
			Sandstone, persistent.	5	6				

Table 13 - Generalized stratigraphic column for Monongahela series in Athens County - continued

No.	Cyclothem	Member	Description	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
4	Fishpot	Fishpot	Shale, "roof shale", absent.	0	6	43	10	130	9
			Coal, thin, persistent.	0	1				
			Underclay, variable, impure.	1	1				
			Limestone, variable, nodular to bedded.	15	8				
			Redbed, varicolored, calcareous, variable.	14	6				
		Pomeroy	Shale and sandstone, massive to bedded.	12	0				
3	Redstone	Redstone (Pomeroy)	Shale, "roof shale", usually absent.	0	9	34	8	86	11
			Coal, steady.	0	11				
			Underclay, variable, impure.	1	0				
			Limestone, freshwater, nodular to bedded.	5	0				
			Redbed, varicolored, calcareous, variable.	8	0				
		Upper Pittsburgh	Shale and sandstone, massive to bedded.	19	0				
2	Upper Pittsburgh	Upper Pittsburgh	Shale, "roof shale", local.	0	0	11	10	52	3
			Coal, local.	0	2				
			Underclay, local.	0	8				
		?	Limestone, freshwater, local.	1	3				
			Redbed, absent.	0	0				
			Shale and sandstone, local, bedded.	9	9				
1	Pittsburgh	Pittsburgh "rider"	Coal, thin, local, impure.	0	2	40	5	40	5
		Pittsburgh	Shale, "roof shale", carbonaceous.	1	6				
			Coal, persistent, locally thick.	1	9				
			Underclay, variable clay, clay shale, etc.	2	0				
		Upper Pittsburgh	Limestone, rather steady, locally thick, nodular or bedded, or calcareous shale, freshwater.	11	0				
		Lower Pittsburgh (Bellaire)	Redbed, varicolored, flinty appearing claystone.	17	0				
			Shale and sandstone, lenticular, variable.	7	0				

MONONGAHELA SERIES

Above the Conemaugh series a group of rocks named the Monongahela series occurs. As defined in this report, the stratigraphic limits of the Monongahela series are the base of the Pittsburgh cyclothem and the top of the Waynesburg (No. 11) coal bed. The Monongahela series is succeeded upward by the Dunkard series of the Permian system.

Rogers, in 1840 (p. 149-150), first used this term,but in this early classification his Monongahela included part of the Conemaugh, the entire Monongahela series as recognized today, and the strata of the Permian system. Rogers assigned all rocks of Pennsylvanian age below the Monongahela series to the Allegheny series.

Rogers, in 1858 (v. 1, p. 109; v. 2, p. 16-20), revised his own two-fold classification and proposed a five-fold one which dropped the term "Monongahela" and substituted "Upper Productive Coal Measures." The latter term was accepted and used by geologists until I. C. White (1891, p. 43) called this series the "Monongahela River or Upper Productive series," after which time the name Monongahela series became the preferred term.

Because of the prominence and widespread recognition of the Pittsburgh coal bed, its base almost from the time of inception has been designated the base of the Monongahela series. Since

there are no important minable coals in the Conemaugh rocks, it seems logical and proper, following the original definition of these two series and the present cyclothemic concept used in this report, to include the entire Pittsburgh cyclothem in the Monongahela series. The base of the Monongahela series under this proposed revision will be at the bottom of the Lower Pittsburgh (Bellaire) shale and sandstone. The top of the series was shifted to different positions by the various early workers because there was no important stratigraphic break or change, but it was finally defined in 1880 by W. M. Fontaine and I. C. White as a result of their study of fossil plants. The boundary which they established and which was consequently followed by other geologists was placed at the top of the Waynesburg coal bed and at the base of the Cassville shale. The problems dealing with this boundary are discussed in the section on the Permian system in Ohio.

The Monongahela series underlies large areas in Ohio, West Virginia, and Pennsylvania; and a minor part of Maryland. Where the axis of the depositional basin crosses West Virginia and Pennsylvania, the series is over 400 feet thick. In Ohio, on the western flank of this basin, the Monongahela series is thinner, and in Athens County it averages 270 feet. The rate of decrease in thickness from the axis of the basin to the western margin is steady and progressive by modification of the upper part of the series (Stout, 1954, p. 4).

The mode of deposition and the kind of rock in the Monongahela series compares favorably with the upper part of the Conemaugh series, and results in a rock sequence that displays a remarkable repetition of rock types. The most striking difference of the two and what has been the basis for their separation is the occurrence of minable coal beds in the Monongahela series in contrast to the thin coal beds of the Conemaugh series. Coal beds of the Monongahela series that contribute greatly to Ohio's coal reserves are: the Pittsburgh (No. 8), the Redstone (No. 8a), and the Meigs Creek (No. 9); of these only the Pittsburgh (No. 8) coal bed is prominent in Athens County. Sandstone beds are generally a minor lithologic element, although locally they may be prominent or represented as a bedded shale, and are indistinguishable from those of the upper Conemaugh series. The shales of the calcareous "redbed" type which are also common to the upper part of the Conemaugh are intimately associated with fresh-water limestone strata and are commonly interfingered with them. Underclay beds and roof shales are thin and constitute only a minor part of the Monongahela series.

These rock types occur in repetitive cyclical sequences that are divided into cyclothems. In the absence of marine strata the cyclothem boundary in the Monongahela series is placed at the contact of the roof shale and overlying sandstone strata. The name of a cyclothem is derived from the name of the coal bed included within its boundaries. A complete Monongahela cycle consists of the following members:

6. Roof shale
5. Coal
4. Underclay
3. Fresh-water limestone
2. Redbeds
1. Shale and sandstone

A full suite of these members is not always present, and where the underclay, coal bed, and roof shale are missing, the base of the next higher cyclothem is placed at the contact of the sandstone and underlying redbeds or fresh-water limestone. This contact is considered to "mark" the horizon, or position at which the coal bed is due.

The generalized geologic column for the Monongahela series in Athens County is shown in table 13. However, several of these cyclothems are poorly developed in Athens County and are discontinuous in their lateral extent.

Some part of the Monongahela series is exposed from the central part of the county where the Pittsburgh (No. 8) coal bed occurs on the hilltops, to the Ohio River where the Waynesburg (No. 11) coal bed may be found close to stream level. A full thickness above drainage is displayed in Bern, Carthage, Rome, and Lodi Townships; Alexander, Ames, Athens, Canaan, Dover,

Trimble, and Troy Townships show only parts of the Monongahela series above drainage. The total area underlain by the Monongahela series in Athens County, as shown on the geologic map in pocket, is approximately 240 square miles.

Pittsburgh Cyclothem

Members of the Pittsburgh cyclothem, named from the great Pittsburgh (No. 8) coal, are, as classified in this report, in the Monongahela series.

In addition to the Pittsburgh coal, which locally is often thin and inconspicuous, other distinctive members are locally a rather thick-bedded nonmarine limestone and an easily identified red to orange or yellow flinty-appearing claystone. This redbed claystone, where present, is one of the most distinctive members in the entire Pennsylvanian system in Athens County.

Lower Pittsburgh (Bellaire) Shale and/or Sandstone Member. - For the details of the usage of the names Lower Pittsburgh and Bellaire see the discussion of the Upper Little Pittsburgh sandstone on page 156.

Locally, lenses of shale and sandstone occupy part of the interval of the Lower Pittsburgh redbed. In Athens County these are uncommon but do occur locally and represent the Lower Pittsburgh sandstone or Bellaire sandstone of Condit. The average thickness of these lenses is about seven feet.

The shales of this interval are gray to tan and olive, silty, micaceous, and appear as zones and lenses within a dominantly sandstone interval. These sandstones are colored quite similarly to the shales and are fine to very fine, micaceous, and usually thin to almost shaly in their bedding. Both the shales and sandstones usually exhibit considerable limonite stain.

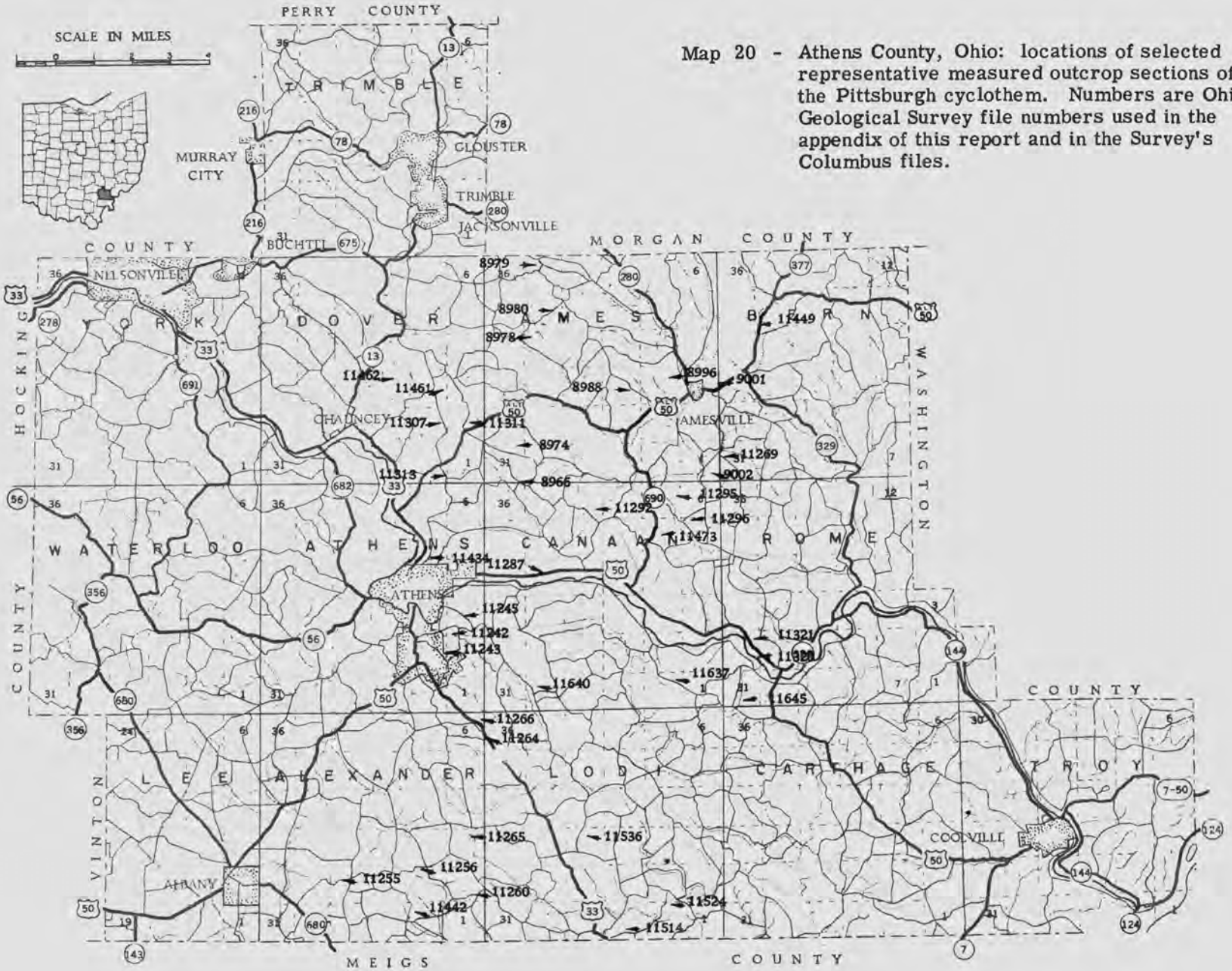
This member is best shown in Canaan Township (localities 11296, 11473) and in Rome Township (locality 11645).

Lower Pittsburgh Redbed Member. - This member is one of the more persistent and most distinctive members of the lower portion of the Monongahela series, with over 20 measurements in Alexander, Ames, Bern, Canaan, Dover, and Rome Townships (map 20). It varies in thickness from 3 feet 6 inches to nearly 30 feet, with an average thickness of about 17 feet.

Its most typical lithology in Athens County is as follows: a gray to tan limonite-stained clay shale or claystone, with mottling of maroon, yellow, and red with some purple and orange. Usually silty and at some places sandy, it is more frequently than not visibly micaceous. Only rarely is it calcareous, and then these zones are usually confined to the top or to the base, and nodules and pellets of limestone are extremely rare. Slickensides are common and plastic clay zones and carbonaceous streaks somewhat rare.

The most outstanding feature of this member, however, is the flint clay-like appearance of these clay shales. So widespread is this condition that because of it the member can be distinguished from all other redbeds. In addition, it almost invariably displays a starch-like fracture and contains a large amount of yellow and orange coloration, more so than do any of the redbeds beneath it. These distinguishing criteria can often be used in the field to separate it from the underlying redbed when the latter lacks its limestone, underclay, coal sequence.

Upper Pittsburgh Limestone Member. - H. D. Rogers as early as 1858 (v. 2, pt. 1, p.



Map 20 - Athens County, Ohio: locations of selected representative measured outcrop sections of the Pittsburgh cyclothem. Numbers are Ohio Geological Survey file numbers used in the appendix of this report and in the Survey's Columbus files.

628-635) used the name Pittsburgh for limestone immediately below the Pittsburgh coal. It is thought that Rogers' original definition included Little Pittsburgh limestones as well (Wilmarth, 1935, p. 1674). Strange as it may seem, this limestone in the Pittsburgh cyclothem is now generally called Upper Pittsburgh limestone and is so called in this report.

The Upper Pittsburgh is one of the thickest, best developed, and most widespread freshwater limestones in the entire Pennsylvanian of Athens County. It has an average thickness of 11 feet for 27 observed complete measurements in Alexander, Ames, Bern, Canaan, Dover, and Rome Townships (map 20), and outcrops occur in Lodi Township in addition. It is not strictly a pure limestone, as it consists of nodules or beds of nodular and irregular limestone up to more than one foot thick and embedded in or separated by clay shale or shale. Where the shale partings are thin and the limestone layers thick, the entire thickness appears from a distance as a solid ledge of limestone. The limestone itself is light gray to gray; often weathered very light gray to almost white and less commonly to tan, buff, or yellow; and usually firm and dense but locally somewhat brecciated. The clay shale or shale is various shades of gray, buff, olive drab, etc., and may be calcareous and less commonly slightly carbonaceous, especially in the upper reaches of the rock. Fossils, where present, are fresh-water molluscs, ostracods, and fish remains.

In the Athens County area, which is rather deficient in limestone suitable for agricultural, building, and road purposes, the Upper Pittsburgh member is of sufficient quality and thickness in parts of eastern Canaan Township (localities 11296, 11473, and 11637) and of southwestern Rome Township (localities 11320, 11321, 11645) for use as road metal and other similar purposes. Quarries have been operated in sections 6, 7, and 12, Canaan Township; and in the SW$\frac{1}{4}$, section 33, Rome Township along the valleys of Sugar Creek and the Hocking River and its immediate tributaries.

Pittsburgh Underclay and Shale Member. - Clay and shale occupy the interval between the Pittsburgh coal and limestone. Where both the coal and limestone are present, this member is easily recognized, and about 30 records and measurements of it are available. The thickness of this interval varies from one inch to almost eleven feet, and the average thickness is almost two feet. Exposures are well distributed in Alexander and Ames Townships and to lesser extent in Athens, Bern, Canaan, Dover, Lodi, and Rome Townships (map 20).

Some clay and shale are present but the most abundant rock type is clay shale. Prevailing color of the shale and clay shale is gray to dark gray, and the clay, light gray to gray. The shale and clay shale are mostly silty and micaceous but may be sandy, carbonaceous, or calcareous. The clay is more massive than the shale, may be slightly silty, and usually is somewhat plastic. Fossil plants are also present locally in the clay.

That this member represents a transition zone from the deposition of lacustrine limestone to swamp peat is verified by gray to dark gray color, occurrence locally of calcareous material and even limestone nodules, and the presence of fossil clams, snails, and ostracods as at Alexander Township (locality 11260), at Ames Township (locality 9002), and at Canaan Township (locality 11473).

Pittsburgh (No. 8) Coal Member. - The Pittsburgh coal bed was first described by H. D. Rogers (1839, p. 96-97) for exposures in the Pittsburgh, Pennsylvania, area but was first referred to in Athens County as the Federal Creek coal bed. The latter name, derived from excellent thicknesses along Federal Creek in northeastern Athens County, was discontinued after early workers demonstrated the correlation between the Federal Creek coal bed and the Pittsburgh coal bed in its type area.

In Athens County the Pittsburgh coal bed is exposed in a north-northeast trending belt almost ten miles wide that occupies a position slightly east of center of the county. It is most extensive in Alexander, Ames, Bern, Canaan, and Lodi Townships with smaller areal extent in Athens, Dover, and Rome Townships. Representative outcrop locations of this member are shown on map 20.

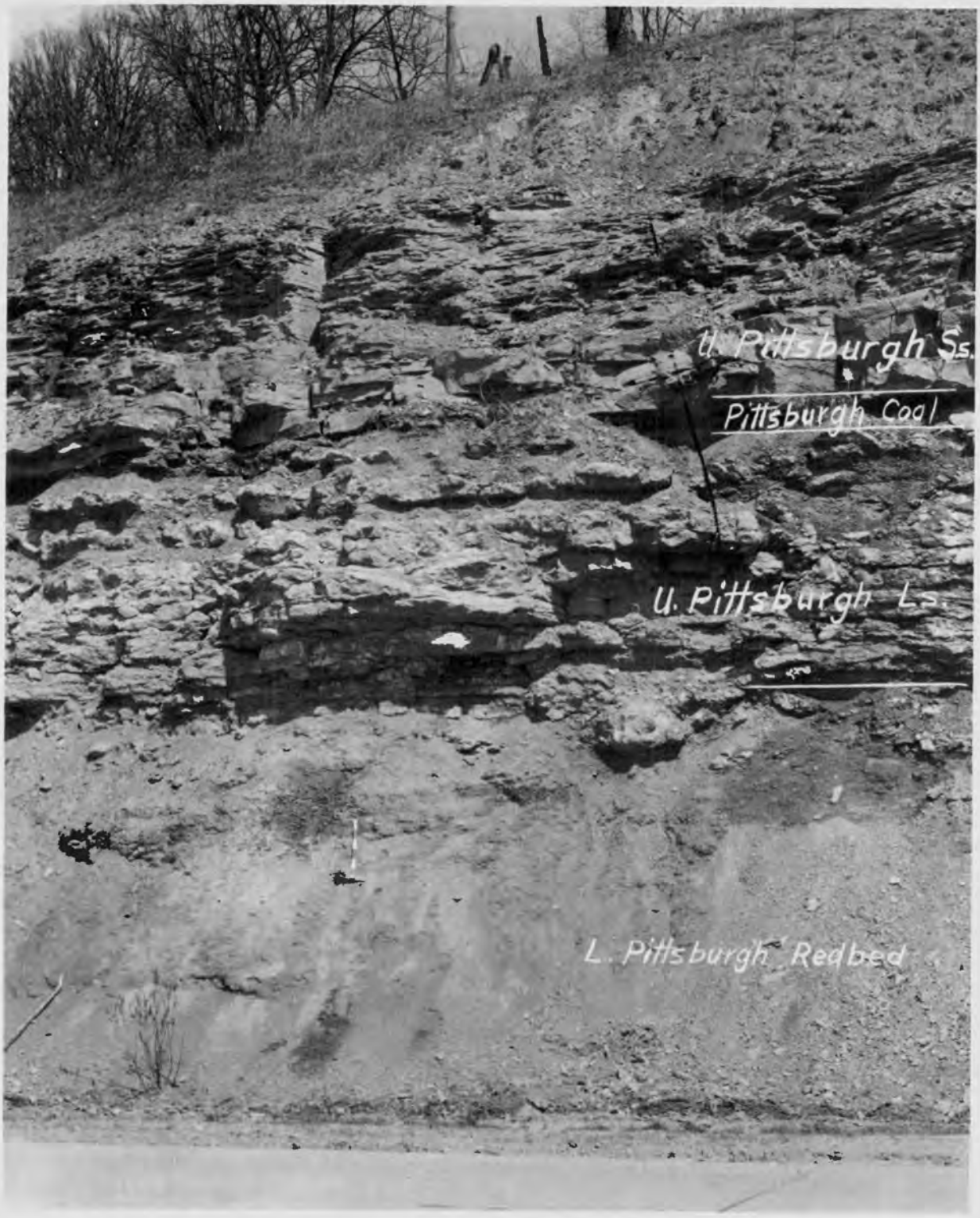


Figure 19 - Exposure of Upper Pittsburgh sandstone, Pittsburgh coal horizon, Upper Pittsburgh limestone, and Lower Pittsburgh redbed on north side of Route 50 about three-fourths of a mile northwest of Guysville, NE¼ SE¼, section 32, Rome Township, Athens County, Ohio.

The Pittsburgh coal bed, an important bench of reference, lies on an average 183 feet above the Ames limestone and 89 feet below the Meigs Creek coal bed, both of which are persistent and important marker beds. The average interval from the Pittsburgh coal bed to the less important overlying Redstone and Fishpot coal beds are 29 and 60 feet respectively.

The Federal Creek field, which has made the Pittsburgh coal bed famous in Athens County, is most extensive and prominent in Bern Township but also contains large reserves in Ames and Rome Townships. The Pittsburgh coal bed also is of minable thickness in southwestern Canaan and northwestern Lodi Townships in what is known as the Shade Creek field. In Alexander and southern Lodi Townships, the coal bed is patchy and irregular but has been mined to a small extent. The average of the measurements on this bed in Athens County is 33 inches.

The area of nonminable coal far exceeds that of minable coal in Athens County. In its lateral extension from field to field the coal bed may be represented by a thin coal streak or a carbonaceous shale to a coal bed of only a few inches thickness. It is, however, nearly always present and constitutes an important stratigraphic marker across the county. At the edges of the productive fields, this coal bed is seen to increase in thickness very rapidly. At its optimum in the Federal Creek field in Bern Township the bed thickens from 12 inches to over 90 inches in less than one mile.

Limitations on the thickness of the Pittsburgh coal are nondeposition, replacement by sandstone, and lateral facies changes. Across the broad barren Pittsburgh coal bed area in Athens County the paucity of this coal bed is attributed mainly to nondeposition, i. e., environment not favorable to the accumulation of thick coal deposits at this time. In areas of thick coal, as in the Federal Creek field and Shade Creek field, there are local depressions or thinning that may be due to any of the three above causes.

Throughout the Federal Creek field this coal bed is characterized by a double-benched structure that is separated by a clay parting of several inches to about 1 foot in thickness. The lower bench is the more uniform in thickness, usually 3 to 4 feet, and contains thin, unsteady partings of a bony or pyritic nature. It is generally, but not universally, inferior in quality to the upper bench. The upper bench is variable in thickness and it, too, contains thin irregular partings of clay, bone, and pyrite. The coal in both benches is bright and blocky with thin dull fusain partings. Where the Pittsburgh coal bed attains its thickest development the upper bench commonly exceeds the lower bench in thickness as well as quality. The variability in thickness seen in the upper bench is due mainly to nondeposition or to channeling out of the coal and refilling with sandstone. A rarer limitation of Pittsburgh coal thickness can be seen at Sharpsburg, Bern Township, where it has changed laterally from a coal bed of almost eight feet to a zone of hackly, nonbedded, mottled yellow, tan, and maroon clay shale. This shale facies that was deposited during the Pittsburgh coal forming period probably represents local accumulation of clastic material by water moving sluggishly through the swamp.

The Pittsburgh coal bed in the Shade Creek field is a double-benched bed with a one-foot clay parting separating the two benches. The lower bench is the more regular and averages about 2 feet 6 inches in thickness. The irregularities of the upper bench which cause the thickening and thinning of the bed within this field are due to non-deposition or replacement by sandstone. Both benches contain thin, irregular partings of clay, shale, or pyrite. The coal in both benches is usually bright and blocky. The only analysis of both benches held on file at the Ohio Division of Geological Survey indicates that the upper bench is slightly superior in quality to the lower bench.

In the southern part of Alexander and Lodi Townships the minable Pittsburgh coal bed is without its characteristic double-benched structure. Instead, it is a single-benched seam of bright blocky coal which contains indiscriminate partings of clay, shale, or pyrite. It is not known if this single bench of coal is correlative to the upper or lower bench in the Shade Creek field, or to both benches. In these townships this coal bed varies abruptly within short distances from a minable seam to a seam of coal with interbedded carbonaceous shale, or a thin streak of coal, or carbonaceous shale marked more by the underclay than by the coal itself.

Roof Shale Member. - A roof shale over the Pittsburgh coal bed in Athens County is found to occur in every township where it is due, but it is common for this member to be missing from the measured geologic section. Measured thicknesses vary from a few inches to a maximum of 5 feet, with an average of about 1½ feet.

Whenever present, this member is a clay shale of various shades of gray with limonite stain, silty, with considerable mica and carbonaceous streaks or plant fossils. It is not uncommon for the clay to be semi-plastic upon weathering, and more sandy in areas of thin coal than in areas of thick coal. Only rarely is the roof coal a black carbonaceous shale with coaly bands. Ostracods and fish remains have been reported in this member but are rare.

Pittsburgh "Rider" Coal Member. - In Lodi Township, Athens County, the Pittsburgh coal bed carries a "rider" coal bed in a position similar to that in Pennsylvania, as indicated by Ashley (1928, p. 392). In Athens County the Pittsburgh "rider" coal bed is a streak of coal 1 to 3 inches thick and is separated from the Pittsburgh coal bed by 1½ to 6 feet. The coal is dull to bright. The intervening shale is gray, non-bedded to laminated, semi-plastic on weathering, and contains carbonaceous material and plant fossils.

The locations of stratigraphic sections (localities 11504 and 11498) in the appendix which illustrate this horizon are given on map 20.

Upper Pittsburgh Cyclothem

The Upper Pittsburgh cyclothem is the oldest cyclothem that lies entirely within the Monongahela series. It is of minor importance for its occurrence has been recorded in only one measured geologic section (locality 11640) in Canaan Township. Here the thickness of the Upper Pittsburgh cyclothem is 12 feet and the interval between the Upper Pittsburgh coal bed and the Redstone coal bed is 25 feet.

The occurrence of the Upper Pittsburgh coal bed breaks the normal cyclical sequence of strata that extend from the roof shale of the Pittsburgh coal bed to the roof shale of the Redstone coal bed into two cyclothems, one the Upper Pittsburgh cyclothem, the other a thin Redstone cyclothem that succeeds the Upper Pittsburgh cyclothem. Due to the sparse occurrence of the Upper Pittsburgh cyclothem, names have not been given to the various rock units that lie in the Pittsburgh-Upper Pittsburgh coal bed interval.

Shale and Sandstone Member. - This unit overlies the Pittsburgh coal bed and is a light gray sandy shale to shaly sandstone that is 9 feet 9 inches thick. Laterally this unit coalesces with the Upper Pittsburgh sandstone of the Redstone cyclothem.

Redbed Member. - This member is not present as a unit but is found as the matrix of the the overlying fresh-water limestone.

Limestone Member. - This member is a nodular bed, 1 foot 3 inches thick, of gray limestone imbedded in a matrix of olive clay shale.

Underclay Member. - The underclay of this section is an 8-inch bed of gray clay shale with carbonaceous flecks.

Upper Pittsburgh Coal Member. - The name Upper Pittsburgh coal bed has been used as field term by Ohio geologists to designate a thin coal horizon that is occasionally observed

between the Pittsburgh and Redstone coal beds. This term has also been used by Cross and Schemel (1956, p. 86) to designate a coal horizon associated with the pelecypod zone that occurs above the Pittsburgh coal bed.

In Athens County, the Upper Pittsburgh coal bed is represented as a gray carbonaceous clay two inches thick but is not known to be associated with the pelecypod zone.

Roof Shale Member. - The roof shale that is due over the Upper Pittsburgh coal bed has not been observed in Athens County.

Redstone Cyclothem

Except for the locality where the Upper Pittsburgh cyclothem is developed, this cyclothem includes the rock units from the top of the Pittsburgh roof shale to the top of the Redstone roof shale. Wherever the Redstone cyclothem extends downward to the top of the Pittsburgh roof shale, all members common to Monongahela cyclothems are present; names applied to the Redstone cyclothem in the generalized geologic section are applied to both cyclothem conditions.

Where the base of the Redstone cyclothem rests on the Upper Pittsburgh coal bed this cyclothem is 25 feet thick; however, where its base overlies the Pittsburgh roof shale, which is usually the case, the average thickness is 35 feet.

The geographic extent of this cyclothem is illustrated in a general way by map 21, which shows the location of selected geologic sections included in the appendix.

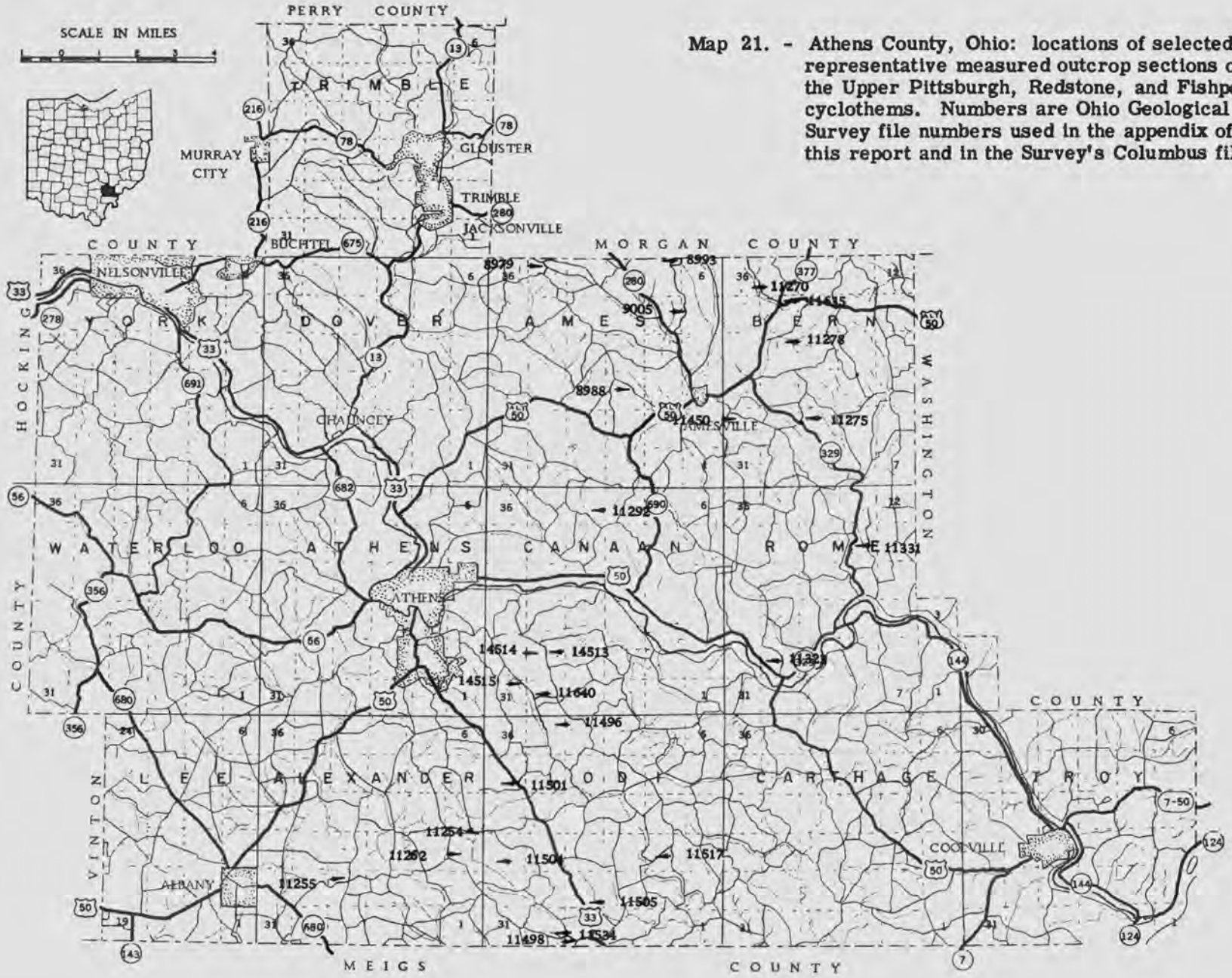
Upper Pittsburgh Shale and Sandstone Member. - In 1858 H. D. Rogers (v. 2, p. 505) designated the conspicuous sandstone strata that occur between the Pittsburgh and Redstone coal beds along the Conemaugh and Loyalhanna streams in Pennsylvania as the Upper Pittsburgh sandstone. The coarse clastic material at this position has been similarly designated by the Ohio and West Virginia Geological Surveys.

In Ohio this member is commonly represented by sandy shale containing sandstone interbeds with local variations of prominent sandstone. Athens County contains the most conspicuous of these variations, but even here this unit is predominantly shale and siltstone. The average thickness of this member in Athens County is 19 feet, but it ranges from 3 to 60 feet, and is 22 feet 6 inches thick where it overlies the Upper Pittsburgh cyclothem.

The fine clastic strata, shale and siltstone with interbedded fine-grained sandstone, is found in the areas of thin Pittsburgh coal. These fine clastic beds are light gray to buff or tan in color on a fresh break, silty to sandy with mica, and laminated to thin-bedded. Limonite stain is nearly always present, and occasionally scattered siderite nodules are found. The shale and sandstone interbeds grade laterally and vertically into each other.

The wide variability of thickness of this member is due to a lateral gradation from the thin, fine-grained lithology described above to a thick, massive phase. Although this member is sometimes found to be thin over a thick deposit of Pittsburgh coal, it is usually massive in the minable areas of this same coal bed. The maximum thickness in the county is found in Lodi Township, where the sandstone is as much as 60 feet; thicknesses are nearly as great in adjoining parts of Alexander and Canaan Townships, and in Bern Township. A thickness of 40 feet, however, is more common for this massive phase. In these places of pronounced thickening, this member occupies the entire interval of the Redstone cyclothem.

The base of the massive phase of the sandstone is irregular and usually rests on a few feet of shale except locally where the sandstone has cut down to the Pittsburgh coal bed. The sandstone is a light gray or buff to tan color on a fresh break, fine to medium grained, massive to



Map 21. - Athens County, Ohio: locations of selected representative measured outcrop sections of the Upper Pittsburgh, Redstone, and Fishpot cyclothems. Numbers are Ohio Geological Survey file numbers used in the appendix of this report and in the Survey's Columbus files.

medium bedded and frequently a cliff former. In this massive phase, the sandstone is frequently cross bedded and friable, and contains considerable mica. Rarely is it conglomeratic or with calcareous inclusions. The upper part of this member is composed of irregular thin to medium sandstone beds with silty or sandy shale interbeds.

Redstone Redbed Member. - This member is composed of calcareous shale and occurs in a wide variety of colors. Red to maroon or purple are the most common colors, but it may also be gray, yellow, or mottled. The shale is silty to argillaceous and contains abundant limestone pellets. It weathers rapidly to a grainy dust or, when wet, to a slick mud.

The thickness of this member varies from 3 to 20 feet and averages 9 feet, but it is absent in the Upper Pittsburgh-Redstone coal bed interval. This variation in thickness is a result of lateral gradation of redbed to fresh-water limestone and to sandstone. Because this lateral change is common, the redbed lithology is dominant at one place and subordinate to other rock types of the Redstone cyclothem at other places. Wherever the Upper Pittsburgh sandstone is exceptionally thick the Redstone redbed member may be entirely missing, its interval occupied by sandstone.

Redstone Limestone Member. - Wherever present, this member lies close to or directly under the Redstone coal bed, and because of this proximity the name Redstone limestone was applied to this unit by the Pennsylvania Geological Survey (Platt, 1877, p. 62).

In Athens County this member is a nodular to bedded, light gray, hard, and dense limestone. The nodular limestone is imbedded in a gray, yellow, or red clay shale that is easily weathered. In weathering, the clay inclusions at the surface of the limestone nodules deteriorate rapidly to give the nodules a fretted or honeycomb appearance. Fossils found in the limestone include ostracods and Spirorbis.

This member is very irregular because of its lateral gradation to redbed and locally may not be present. The average thickness of this member in the normal Redstone cyclothem is 5 feet; the range is from 1 to 13 feet. Where the Upper Pittsburgh cyclothem is present the limestone measures 1 foot 10 inches in thickness.

Redstone Underclay Member. - The underclay of the Redstone coal bed is a clay shale, light to dark gray, semi-plastic to grainy on weathering, and silty with some mica present. The thickness of this member ranges from a few inches to less than two feet, with an average of one foot. Its continuity is irregular in Athens County, and locally it may be absent.

Redstone (Pomeroy) (No. 8a) Coal Member. - This name was designated by H. D. Rogers (1858, p. 505) to define a coal bed that occurs 40 feet above the Pittsburgh coal bed along Redstone Creek in Fayette County, Pennsylvania. Pennsylvania, West Virginia, and Maryland geologists have since followed Rogers' terminology of Redstone for the coal at this position in the geologic section. For many years this coal bed was known as Pomeroy in Ohio, and it is still widely referred to by that name. However, since the name Redstone antedates the term Pomeroy, the former name has been adopted for this report.

The Redstone coal bed is of some importance only in the southern tier of sections in Alexander and Lodi Townships. Here, coal thicknesses locally exceed 14 inches and represent the northern margin of the Pomeroy coal field. North of here the coal bed is thin or wanting. Its average thickness in the county is 11 inches.

Where it is minable in Alexander and Lodi Townships, the Redstone coal bed is very irregular, for its character and thickness both show rapid lateral changes. In places the coal occurs as a single bench with some thin partings, and in a short distance it may change to a bed with multiple benches separated by shale, carbonaceous shale, or clay. Elsewhere in Athens County

the Redstone coal bed is represented by a thin coal streak, a clay bed with smut, or an underclay alone, or is entirely lost in a sequence of redbeds that extend vertically from the Redstone cyclothem through much of the Fishpot cyclothem.

Roof Shale Member. - This member of the Redstone cyclothem is most persistent in the southern part of Athens County where the Redstone coal bed is thickest, but even here, as elsewhere in the county, this member is not always present in the geologic section. Only rarely does the thickness exceed one foot and the average is nine to ten inches. It is composed of bedded clay shale and varies from gray, blue-gray, to maroon in color. Carbonaceous material in this member is most abundant in the southern part of the county.

Fishpot Cyclothem

This cyclothem, although a major one, cannot be traced across Athens County as readily as the Pittsburgh or Meigs Creek cyclothems because of the irregularity of its members. The Fishpot coal bed with its associated underclay and roof shale is in some localities replaced by other rock types and causes the cyclothem boundary to be indeterminable. The interval of this cyclothem may be entirely occupied by the Pomeroy sandstone where that member is found with exceptional thickness in southern Athens County; elsewhere in the county, the redbeds of this cyclothem may be continuous with the redbeds of the Meigs Creek cyclothem. The normal succession of members is illustrated in the generalized column (table 13).

The thickness of the Fishpot cyclothem in Athens County averages 44 feet and varies from 15 to 50 feet. This variability is attributed to thickening and thinning of the Pomeroy sandstone.

Map 21 illustrates the location of measured geologic sections of this cyclothem and of the Redstone cyclothem.

Pomeroy Sandstone Member. - The term Pomeroy sandstone was first used by Ellis Lovejoy (1888, p. 635) for the prominent sandstone overlying the Pomeroy or Redstone coal bed in the vicinity of Pomeroy, Ohio, and later by Bownocker (1908, p. 106) in another report on the same area. Since that date other names applied to this member include Redstone sandstone (Swartz, C. K. et al., 1919, p. 567-596) and Cedarville sandstone (Reger, D. B., 1916, p. 124) in Maryland and West Virginia. However, as the name Pomeroy antedates the other proposals, Pomeroy is retained in this report.

In Athens County this member averages 12 feet in thickness but varies from nothing to over 30 feet. A diversity in detritus sizes gives rise to lateral variations extending from a coarse-grained, massive sandstone to a bedded sandy shale; the most common rock type, however, is a fine-grained, medium-bedded sandstone of light gray or olive gray color on a fresh break, with some shale interbeds. The shale facies is more variable in color, usually gray but also buff, brown, olive-drab, and mottled with red or maroon. The shale is thinly laminated or irregularly bedded. Wherever this member is composed of silt or clay size particles, the base of the unit is conformable upon the lower unit.

The Pomeroy sandstone member is more persistent and thicker in the southern half of Athens County than in the northern half. At a few localities in Alexander and Lodi Townships, this member is found to attain a thickness of 30 to 50 feet. At these places it is a coarse-grained, massive sandstone with considerable silt and mica. The base of this rock type is usually unconformable and rests directly on or separated from the Redstone coal bed by a few inches of shale.

This unit may, in part or the entire interval, grade laterally into redbeds within a short distance. This phenomenon accounts for the wide thickness variation of the Pomeroy sandstone and the overlying redbed member.

Fishpot Redbed Member. - The redbed member that occurs between the Redstone and Fishpot coal beds has been observed in every township in Athens County where it is due but is not always present in the geologic section. The irregularity of this member is a result of its susceptibility to lateral change into sandstone or fresh-water limestone, the latter change occurring more commonly. The average thickness in the county is nearly 15 feet, with a minimum of only a few feet and a maximum of nearly 30 feet.

This member is a clay shale of many colors that include gray, green, tan, red, or maroon, and is commonly mottled. It is nonbedded and breaks with a starch-like fracture. Calcareous masses and limestone pellets or nodules are found throughout the member, and thin, nodular, fresh-water limestone interbeds are common. When exposed, this unit is readily weathered to a grainy dust and when saturated becomes a slick mud that is subject to landsliding.

Fishpot Limestone Member. - The Fishpot limestone was named by J. J. Stevenson in 1875 (p. 67) for deposits along Fishpot Creek in Washington County, Pennsylvania. Condit, in 1923 (p. 51), was the first to use this term in Ohio to designate the limestone strata underlying the Fishpot coal bed.

In Athens County the Fishpot limestone is persistent but irregular, for indiscriminate thinning and thickening occurs with lateral changes from fresh-water limestone to redbeds, and locally the member is entirely absent from the geologic section. The average thickness of this member is about 16 feet, and a maximum thickness of 34 feet has been observed in Ames Township, where the most persistent and thickest deposits of this member are found.

The beds of this member are generally nodular but sometimes massive at the top. The color of the limestone on a fresh break is light gray, but the nodular limestone weathers to a yellow or brown and the surface becomes fretted by the rapid deterioration of clay inclusions. The nodular limestone is imbedded in a silty argillaceous clay shale of gray, maroon, or mottled color. Ostracods are the only fossil forms that have been observed in this member.

Fishpot Underclay Member. - The underclay of the Fishpot coal bed is erratic in its occurrence but has been found in every township where it is due except in Lodi Township. It is not, however, a typical plastic underclay but a calcareous shale or clay shale with considerable silt and mica. The average thickness of 22 measurements of the underclay is about one foot, with a minimum of one inch and maximum of three feet.

Fishpot Coal Member. - A persistent coal bed that lies between the Redstone and Sewickley or Meigs Creek coal bed occurs in Pennsylvania, West Virginia, Maryland, and Ohio. Although this stratum was recorded in measured sections by early workers, it was not described or named until 1905 by Clark and Martin (v. 5, p. 311), who termed it the Lower Sewickley coal bed.

In Ohio the name Lower Meigs Creek was used by Condit (1923, p. 17-18) for this stratum, but in 1930 (Lamborn, p. 233) the name Fishpot was adopted by the Geological Survey of Ohio because of its association with the Fishpot limestone.

With a few exceptions, the Fishpot coal bed in Ohio is thin and of no economic importance. It is, however, of stratigraphic significance, for it is on an average 60 to 33 feet above the Pittsburgh and Redstone coal beds, respectively, and underlies the Meigs Creek coal bed by 27 feet in Athens County.

This coal bed in Athens County is represented by a few inches of bony coal, or its position is marked by a thin underclay that may contain some carbonaceous material. When neither the underclay nor coal is present the position at which this stratum is due can be placed at the contact of the Fishpot limestone and the overlying Lower Sewickley sandstone, providing both are present and developed.

Fishpot Roof Shale Member. - This top member of the Fishpot cyclothem is thin and irregular in occurrence in Athens County. Although it is frequently missing from the geologic section, it is occasionally present where both the coal and underclay are absent and, thus, indicates the position at which the Fishpot coal bed could be expected to occur.

This member is an argillaceous clay shale with some silt and fine mica, gray, maroon, chocolate, brown, or tan color, and weathers chippy or semi-fissile. Clams have been reported but are rare. The average thickness of the member is about six inches and only rarely does it exceed one foot.

Lower Sewickley Cyclothem

In the interval between the Fishpot and Sewickley coal beds another coal bed of local occurrence is found. Although observed in only six measured sections, an adequate cyclical sequence of lithologies is found both above and below the coal bed to establish a new cyclothem. That this horizon is of some areal extent is indicated by the report of a coal bed at a similar position in eastern Ohio by Fagerstrom (1954, p. 347), which he called the "Lower Split" of the Sewickley coal bed. However, it is suggested that this coal bed and cyclothem be designated the Lower Sewickley until further field work demonstrates its true relation to the Sewickley coal bed.

The Lower Sewickley cyclothem in Athens County possesses a complete suite of members although the fresh-water limestone member is usually missing. The average thickness of this cyclothem is 19 feet, extreme measurements are 10 and 20 feet. The locations of measured sections included in the appendix which illustrate this cyclothem are given on map 22.

Lower Sewickley Shale and Sandstone Member. - In Ohio the sandstone lying between the Fishpot and Sewickley coal beds has been referred to as the Lower Sewickley sandstone and the Fishpot sandstone. The name Lower Sewickley, suggested by Hennen (1912, p. 201), antedates the name Fishpot, proposed by Lamborn (1930, p. 235), and is the accepted terminology.

The Lower Sewickley sandstone is fine grained, gray to olive gray in color, thin bedded, and shaly. It is a fairly thin unit with an average thickness of 5 feet 6 inches in Athens County, and it weathers readily.

Wherever the Lower Sewickley coal bed and its overlying sandstone are absent, this sandstone is the basal member of the Sewickley cyclothem and is considerably thicker, and in places it occupies the position of the Lower Sewickley coal bed and its associated members.

Lower Sewickley Redbed Member. - The name for this member is taken from the name of the cyclothem to which it belongs. In Athens County this member occurs in normal sequence above the Lower Sewickley sandstone and averages 5 feet 8 inches in thickness. Of the sections in which the Lower Sewickley cyclothem has been observed, this member occurs in all but one (locality 11635), and here its lithology is found interbedded with limestone. The member also grades laterally into sandstone and, hence, is a highly variable unit.

In the localities where the base of the Sewickley cyclothem is drawn at the top of the Fishpot coal bed, this member is indistinguishable and lost. Because of this member's variability of lithology, it may be represented in the Sewickley cyclothem as either redbed or sandstone.

Lower Sewickley Limestone Member. - This member, like the Lower Sewickley redbed, derives its name from the Lower Sewickley cyclothem. Lower Sewickley limestone has been found to occur in only one measured section (locality 11635) and represents the only recorded occurrence of fresh-water limestone in the Fishpot to Sewickley coal bed interval. In this section the limestone totals nine feet in thickness but is interbedded with sandstone and redbeds. The limestone is nodular to bedded and gray to yellow in color.

Lower Sewickley Underclay and Coal Members. - These two members are considered together, as they are thin and appear on the outcrop as a coal zone or smut. The maximum thickness of the Lower Sewickley underclay and coal is 5 inches, and the average is 2 inches. It consists of semi-plastic clay or clay shale with carbonaceous material and some coaly streaks. In some sections this coal zone is missing, but the position at which it should occur is indicated by a sandstone overlying redbeds.

Lower Sewickley Roof Shale Member. - The Lower Sewickley coal bed does not carry a roof shale, or if present, it is thin and is considered a part of the coal zone.

Sewickley Cyclothem

Considerable variation in thickness is displayed by this cyclothem in Athens County, for it ranges from 11 to 64 feet and averages 33 feet. This variation in thickness is accounted for in part by where the basal boundary is drawn. Usually the base of the Sewickley cyclothem is placed at the top of the Fishpot coal bed and roof shale; however, if the Lower Sewickley cyclothem is present, the base is drawn at the top of the Lower Sewickley coal bed, which results in an average thickness of 17 feet for the Sewickley cyclothem.

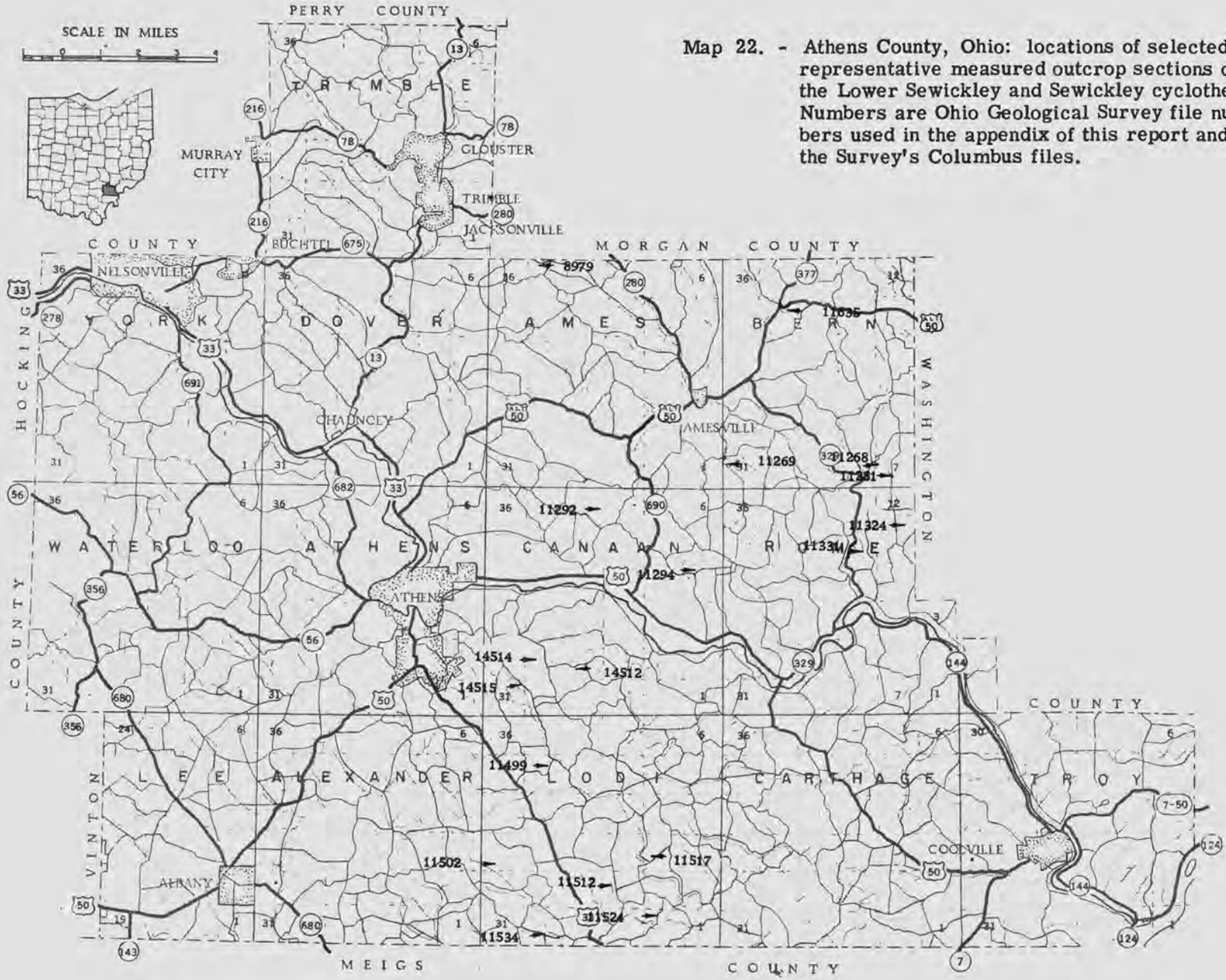
Wherever the Lower Sewickley cyclothem is present the base of the Sewickley cyclothem is placed at the top of the Lower Sewickley coal zone, and an unnamed shale and sandstone of local occurrence become the basal member of the Sewickley cyclothem. Laterally, this sandstone grades into redbed or is lost in a thick deposit of Lower Sewickley sandstone and cannot be identified. Wherever this unnamed sandstone and the underlying Lower Sewickley coal zone can not be carried laterally, the Lower Sewickley cyclothem is lost and the base of the Sewickley cyclothem is then drawn at the top of the Fishpot coal bed and roof shale.

The name Lower Sewickley shale and sandstone is used for the lowest unit of the Sewickley cyclothem when its lower boundary rests on the Fishpot cyclothem because it is the proper term for this lithology in the usual Fishpot to Sewickley coal bed interval, and is continuous with the Lower Sewickley shale and sandstone of the Lower Sewickley cyclothem. Also, the Lower Sewickley redbed member may be represented laterally as either a redbed or sandstone facies of the Sewickley cyclothem when the base of that cyclothem is considered to be at the top of the Fishpot coal and roof shale. However, under this condition the name Sewickley redbed is more appropriate than Lower Sewickley redbed and is adopted for this facies where the Lower Sewickley cyclothem is absent.

Unnamed Shale and Sandstone Member. - Two units of shale and sandstone appear in the Sewickley cyclothem, depending upon where the lower boundary is drawn, as explained above in the general discussion of this cyclothem. The upper one, which rests on the Lower Sewickley coal bed, is unnamed; the lower one is the Lower Sewickley sandstone, which is recognized as the lowermost member of this cyclothem where the lower boundary is placed above the Fishpot coal bed.

The unnamed sandstone ranges from 10 to 21 feet in thickness and averages slightly over 20 feet. It is a fine-grained, thin-bedded, gray sandstone that is very similar in appearance to the Lower Sewickley sandstone. Laterally, this unit may coalesce with a thick deposit of Lower Sewickley sandstone or grade into redbed; in either case its identity is lost.

Wherever the Lower Sewickley cyclothem is absent this basal sandstone unit is considered to be the Lower Sewickley sandstone. Under this circumstance, which is the usual one, the Lower Sewickley sandstone is characteristically composed of fine sandy material and considerable amounts of clayey material, which results in fine-grained sandstone or siltstone and sandy shale, usually interbedded with one another. Coarse-grained sandstone lenses and ledges that do occur, grade laterally to fine clastic sediments. Gray is the most common color although the sandstone



Map 22. - Athens County, Ohio: locations of selected representative measured outcrop sections of the Lower Sewickley and Sewickley cyclothems. Numbers are Ohio Geological Survey file numbers used in the appendix of this report and in the Survey's Columbus files.

also occurs as tan, buff, and olive green, and sometimes as red to maroon at the base of the member. Minor amounts of calcareous material are found at the base and limonite staining is found throughout the member. On the outcrop this unit commonly has a slabby or shaly appearance, although occasionally it is massive bedded. It is readily weathered and never forms conspicuous ledges as do the Pittsburgh and Pomeroy sandstones. Although fine-grained and shaly in appearance, this member is 20 feet and seldom is it seen less than 10 feet or greater than 30 feet in thickness. It is sometimes interbedded with redbeds, but does not give way to this higher member to the extent that the Pomeroy sandstone does.

Sewickley Redbed Member. - The name for this member is derived from the cyclothem name and is applied to this lithology regardless of the presence or absence of the Lower Sewickley cyclothem.

In the succession of strata over the Lower Sewickley coal bed the Sewickley redbed averages 9 feet 10 inches in thickness and is typically gray to maroon, calcareous clay shales. Wherever the Lower Sewickley cyclothem is missing, this member coalesces with the redbed strata of the elongated Sewickley cyclothem or grades laterally into Lower Sewickley sandstone.

Where the base of the Sewickley cyclothem rests on the Fishpot coal bed, the redbed member ranges in thickness from 2 to 26 feet, but most of the measurements of this member are close to the average of 9 feet. Usually this member varies proportionally in thickness as the interval of the Sewickley cyclothem thickens and thins, but there are some thickness variations due to lateral change of sandstone or shale to redbeds. This member, like its counterpart above the Lower Sewickley coal bed, is a calcareous clay shale that is gray, brown, maroon, red, or green in color, and silty to sandy with considerable mica. It is nonbedded, weathers to a grainy dust, and the rock breaks with a starch-like fracture. Small limestone nodules and pellets occur in the member, either scattered or in thin layers.

Sewickley Limestone Member. - The name Sewickley limestone was first used by F. and and G. W. Platt (1877, p. 63) to designate the fresh-water limestone underlying the Sewickley coal bed in Somerset County, Pennsylvania. White (1891, p. 61-62) continued the use of this term but applied it to all the limestone strata between the Redstone and Sewickley coal beds, and it was not until after Clark and Martin (1905, v. 5, p. 411) named and described the Fishpot coal bed that the Sewickley limestone was restricted to the interval between the Fishpot and Sewickley coal beds.

Although this member is prominent in parts of West Virginia and Pennsylvania, it is thin or wanting in Athens County, Ohio. Although limestone occurs as thin layers and ledges interbedded with redbeds, none are persistent or regular enough to be recognized as a unit. However, it may be expected to occur in the geologic section of Athens County since a transition from redbeds to limestone has been observed in every Monongahela cyclothem but this one.

Sewickley Underclay Member. - In Athens County the underclay of the Sewickley coal bed is discontinuous in its lateral extent but has been observed in every township where it is due. Usually it occurs in association with the Sewickley coal bed but in places it has been observed where the coal is missing. Wherever the Sewickley coal bed occurs in minable thickness in Bern and Rome Townships, the underclay is present in a thickness of about two feet. Elsewhere, the thickness of this unit is from a fraction of a foot to four feet and averages slightly over two feet. The clay is plastic to semi-plastic and sometimes laminated, with some silt and fine mica present. In color the clay is light gray with local changes to olive green.

Sewickley (Meigs Creek) (No. 9) Coal Member. - As a result of naming of this prominent stratum in widely separated areas before correlations were established, this coal bed has been referred to in Ohio as both the Meigs Creek (No. 9) and the Sewickley (No. 9) coal bed. The name Sewickley was applied by Rogers in 1858 (v. 2, p. 501) for exposures along Sewickley

Creek in Westmoreland County, Pennsylvania, where it occurs 100 feet above the Pittsburgh coal bed. In Ohio, the name Meigs Creek was suggested by Brown (1884, p. 1059). Some Ohio geologists (Bownocker and Dean, 1930, p. 248; Smith, W. H. et al., 1952, p. 5) have followed Brown's terminology of Meigs Creek whereas others (Lamborn, 1930, p. 236; Stout, 1954, p. 33) prefer to use the name Sewickley for this coal bed. Because the name Sewickley antedates the name Meigs Creek, it should be the preferred terminology and has been adopted for this report.

The productive area of Sewickley coal, which constitutes an important part of Ohio's coal reserve, lies adjacent to Athens County, with only small patchy occurrences of thick coal in Bern and Rome Townships. In the remaining townships where it is found, this coal bed is represented by a few inches of coal or a zone of interbedded clay and coal. The average thickness of the Sewickley coal bed in Athens County is 16 inches. Although thin, the Sewickley coal bed is persistent, and only locally is this member wanting. In the stratigraphic sequence in Athens County this member occupies a position that is on an average 90 feet above the Pittsburgh (No. 8) coal bed and 96 feet below the Uniontown (No. 10) coal bed.

Where the Sewickley coal bed attains minable thickness in Bern and Rome Townships, the bed displays a double benched structure separated by a clay shale parting that averages about one foot in thickness. Of the two the lower bench is usually the thicker. Both benches consist of bright, blocky coal with thin partings and pyrite. For greater detail of area and quality of coal reserve the reader is referred to page 225 on the coal reserves for Athens County.

Sewickley Roof Shale Member. - The roof shale that overlies the Sewickley coal bed in Athens County is a persistent clay shale that averages a little over one foot in thickness and ranges from 3 or 4 inches to 5½ feet. The color on a fresh break is usually gray, but red, maroon, brown, and olive green have also been observed. Carbonaceous material occurs where the Sewickley coal bed is thick, but generally the amount is small. The bedding of this member is irregular to laminated, and there are varying amounts of silt , sand, and mica present. Calcareous material is sometimes found but is not common to this member.

Benwood Cyclothem

The succession of strata above the Sewickley coal bed consists generally of a persistent sandstone, the Sewickley, and a long section of redbeds and fresh-water limestones that are interbedded and grade into each other. This thick sequence of shale and limestone was first termed the "Great Limestone" by Rogers (1839, p. 100-104) and defined by him to extend from the Sewickley to the Uniontown coal beds. Except for some modification by Rogers this classification stood until 1875 when Stevenson (p. 64) divided the "Great Limestone" into an Upper Division and a Lower Division. The next important proposed change of nomenclature was in 1906 by Grimsley (p. 90-91), when he assigned the name Uniontown limestone to Stevenson's Upper Division and adopted White's term Benwood limestone for the Lower Division. Grimsley also recognized an arenaceous green shale separating the two limestone deposits, which he named the Fulton green shale (1906, p. 92).

These limestone deposits have been still further subdivided by later workers. Upon the recognition of the Arnoldsburg coal bed and the overlying Arnoldsburg sandstone, Reger, in 1929 (p. 143), defined the Arnoldsburg limestone to extend from the Fulton green shale to the Arnoldsburg coal bed and restricted the term Uniontown limestone to those beds that lie between the Arnoldsburg sandstone and the Uniontown coal bed.

Hickock and Moyer, in 1940 (p. 122-123), in their work in Pennsylvania, recognized the Benwood coal bed. This stratum in Fayette County, Pennsylvania, occupies a position about midway in the Benwood limestone and, hence, subdivides this unit into a Lower and Upper Benwood limestone. In Athens County, Ohio, the Benwood coal bed has been recognized but is found to occur between the limestone and the Fulton green shale; hence, the limestone deposit is not subdivided and is recognized as the Benwood limestone.

The Benwood cyclothem is seldom found intact in its area of occurrence in Bern, Canaan, Lodi, Rome, and Alexander Townships of Athens County. Usually the upper limit of this cyclothem cannot be determined owing to the absence of the members above the Benwood limestone and below the Arnoldsburg redbed. Also, clean exposures greatly facilitate the identification of the Benwood coal bed, for it can be easily missed in a poorly exposed section. The best exposures of the intact Benwood cyclothem were seen in cuts made for the Texas Eastern Pipeline, which are now covered.

Wherever it is found complete, this cyclothem displays a normal suite of members as shown on the stratigraphic column (table 13). The thickness of the cyclothem varies little from its average of 65 feet. Measured geologic sections included in the appendix illustrate the Benwood cyclothem (localities 11269, 11331); the geographic location of these sections is shown on map 23.

Sewickley Shale and Sandstone Member. - The Sewickley sandstone was named by White (1891, p. 60) in his study of the Pennsylvanian coal fields of Ohio, West Virginia, and Pennsylvania. In much of its area of occurrence this member is known to vary radically from a thin flaggy sandstone to a massive one from 20 to 60 feet thick, or to give way entirely to limestone or redbeds.

In Athens County this member is represented by all gradations of a sandy shale to a massive sandstone and is remarkably persistent throughout the county, for seldom is it missing entirely in the measured geologic sections. The average thickness for the member is 27 feet 0 inches, and the minimum and maximum measurements are 9 and 53 feet. Most of the measurements fall near the average thickness.

In composition, texture, and structure this member does not differ from the sandstone members lower in the Monongahela series. Typically, it is a fine-grained, shaly sandstone that weathers to a dark gray, and on a fresh break it is light gray, buff, tan, or olive color. Limonite staining and mica are universally present. On the outcrop this member is commonly thin-bedded and slabby in appearance, and laterally it grades into a coarse-grained, massive sandstone or changes entirely to a sandy shale or siltstone. However, the massive facies is generally discontinuous and irregular.

Locally this member gives way laterally almost in its entirety to the redbed facies; more commonly, it is the upper part of the member that grades laterally into redbeds and in places is interbedded with them.

Tyler Redbed Member. - This member was named the Tyler reds by Stevenson in 1907 (p. 44) for its prominence in an area centered about Tyler County, West Virginia. In Athens County the measurements on this member average approximately 31 feet. This unit is, however, variable, for it grades laterally into either sandstone or shale, and fresh-water limestone and redbeds may be interbedded with either the Sewickley sandstone or Benwood limestone.

The characteristics of this member are very similar to those of the underlying redbeds of the Monongahela and Conemaugh series and show the usual varied colors, including gray, olive green, yellow, pink, purple, red, and a mottling of several of these colors. Its nonbedded structure gives this member a hackly or starch-like break to the rock and results in grainy weathering. When wet it becomes a slick clayey mud and is subject to landsliding. The shale also contains minor amounts of silt and mica. Ostracods and clams also are occasionally found.

Fresh-water limestone in the form of thin ledges, layers of nodular limestone, and scattered pellets is universally present in this member. On a fresh break the limestone is light to dark gray and partly crystalline.

Benwood Limestone Member. - As noted above, the term Benwood limestone has been

continued for the fresh-water limestone above the Sewickley sandstone and below the Fulton green shale. In Athens County this unit lacks the division of upper and lower units as in Pennsylvania, and, hence, the entire limestone deposit is referred to as the Benwood limestone.

In Athens County the Benwood limestone is a highly variable unit and ranges from a few feet to 38 feet in thickness with an average of 7 feet 5 inches. This wide variability of thickness is a result of interfingering with the underlying Tyler redbed, which may entirely replace or be replaced by the limestone.

The Benwood limestone in Athens County occurs as nodules or ledges and is interbedded with calcareous clay shale of the redbed type. The thicker deposits are usually predominantly of the bedded type. On the weathered surface the limestone is sometimes fretted and is a light gray, yellow, or brown color; on a fresh break it is a light gray to olive green. The limestone is hard, dense, and may contain crystalline masses of calcite.

Benwood Underclay and Coal Members. - The Benwood underclay takes its name from the Benwood coal, which was named by Hickock and Moyer in 1940 (p. 122-123). In Athens County these two units are thin and inseparable, for the position of the Benwood coal bed frequently consists of a carbonaceous plastic clay or smut that averages about one inch in thickness and immediately overlies limestone or clay shale. The best exposures of these members were seen in fresh cuts along the Texas Eastern pipeline in southeastern Canaan Township, and here (locality 14513) the maximum thickness is 3 inches. In most places the Benwood underclay and coal are absent, but the position at which they are due is indicated by a cyclical lithologic change of fresh-water limestone overlain by a bedded sandstone.

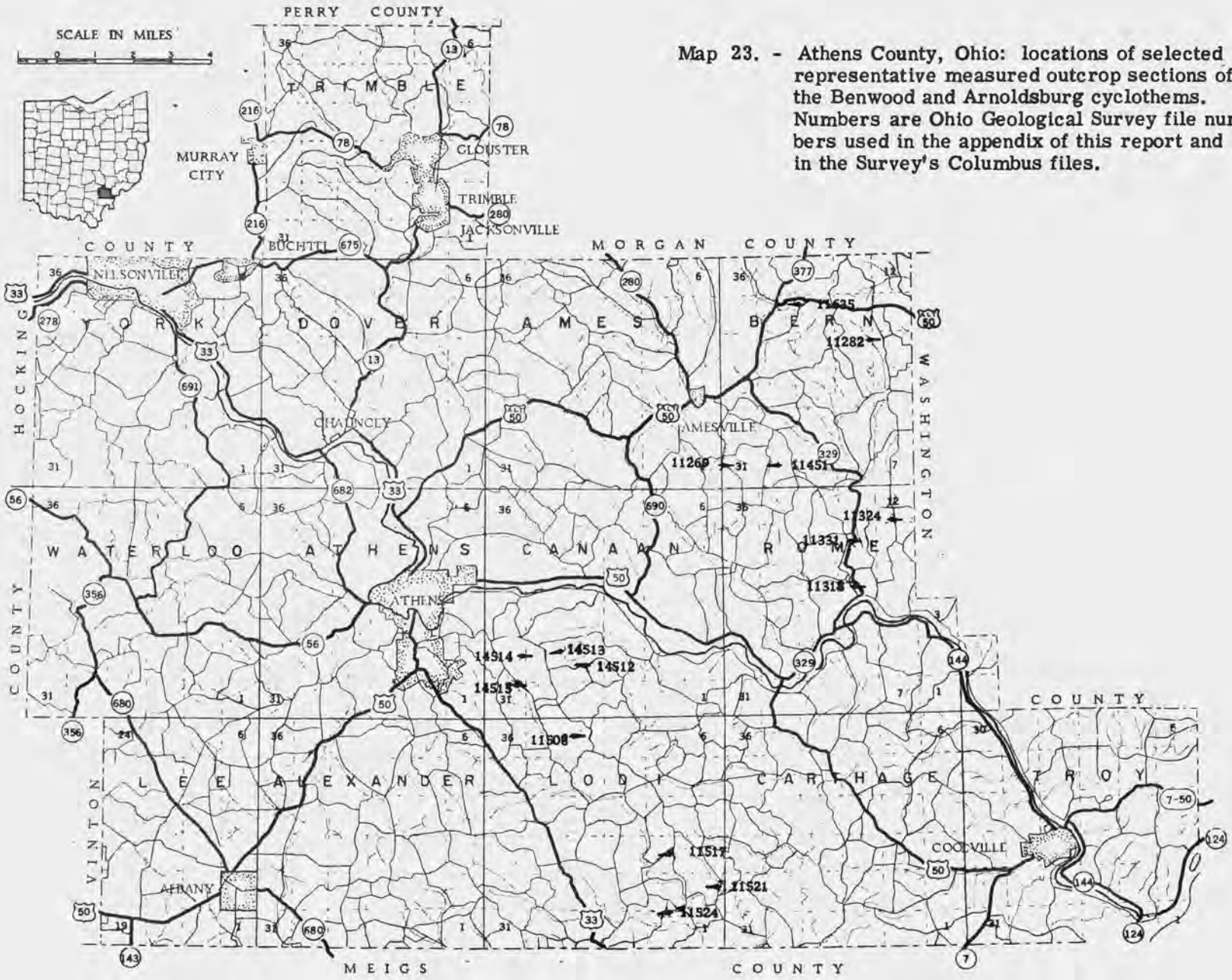
Benwood Roof Shale Member. - In Athens County the roof shale overlying the Benwood coal bed is absent and, therefore, the coal is the uppermost member of the Benwood cyclothem. The Fulton green shale and sandstone directly overlie the Benwood coal bed.

Arnoldsburg Cyclothem

The Arnoldsburg cyclothem is not well known in its vertical extension from the Benwood coal bed owing to the usual absence of the Benwood coal and its associated members. In its normal position between the Benwood coal bed and the Arnoldsburg sandstone its average thickness in Athens County is slightly over 16 feet. Because the individual members of the cyclothem do not regularly appear in the section, their thickness frequently exceeds the average thickness of the entire Arnoldsburg cyclothem. This is particularly true of the redbed and limestone members, and indicates a rapid lateral facies change from one to the other. The basal arenaceous sediments of this cyclothem are more persistent and are present wherever the underlying Benwood coal is found.

As already indicated, the Benwood cyclothem is of local occurrence, and where it is absent the base of the Arnoldsburg cyclothem is considered to lie above the roof shale of the Sewickley coal bed. Where the base of the cyclothem is drawn at this position its average thickness is 71 feet. This means that under these circumstances the Sewickley sandstone, Tyler redbed, and Benwood limestone members are placed in the Arnoldsburg cyclothem. The Sewickley sandstone and Tyler redbed members do not change character or thickness, whether placed in the Benwood or Arnoldsburg cyclothem, and these will not be discussed here. However, the Benwood limestone cannot be separated from the overlying Arnoldsburg limestone when the Fulton green shale is absent, and the entire deposit may be referred to as the Benwood-Arnoldsburg limestone. Therefore, some consideration of the Benwood limestone is given in the discussion of the Arnoldsburg limestone.

Fulton Shale and Sandstone Member. - Grimsley, in 1907 (p. 92), proposed this name



Map 23. - Athens County, Ohio: locations of selected representative measured outcrop sections of the Benwood and Arnoldsburg cyclothems. Numbers are Ohio Geological Survey file numbers used in the appendix of this report and in the Survey's Columbus files.

for a stratum of green shale that occurs 80 to 90 feet above the Sewickley coal bed throughout much of Ohio County, West Virginia.

In Athens County, a distinctive olive green shaly sandstone that occurs above the Benwood coal bed has been identified as the Fulton "Green" shale. Here the Fulton shale is separated from the Benwood coal by a bedded sequence of silty shale or fine-grained sandstone that averages nearly ten feet in thickness. The Fulton shale, itself, is an olive green, massive, calcareous, and micaceous unit that contains shaly partings and averages 4 feet 6 inches in thickness.

Arnoldsburg Redbed Member. - This unit of variegated claystone takes its name from the Arnoldsburg cyclothem and is recognized only if the Benwood cyclothem is intact. In Athens County this unit has an average thickness of 13 feet and in places is quite distinctive because of its fair thickness and lavender color. This unit is also found with olive green, gray, red, and mottled coloring. Limonite staining is common and the rock breaks with a starch-like fracture. Limestone in the form of stringers and knots is interspersed throughout the shale and, in places, this unit grades into limestone and may go out entirely.

Where the Arnoldsburg cyclothem is considered to be at the base of the Sewickley sandstone, the lateral equivalents of this unit are lost in the Tyler redbed and Benwood limestone sections.

Arnoldsburg Limestone Member. - The Arnoldsburg limestone, by definition (Reger, 1929, p. 143), is that limestone which occurs between the Fulton shale and the Arnoldsburg sandstone. In Athens County only one measurement of this limestone in its defined position has been made; here it measured 13 feet 6 inches and consisted of nodular and bedded limestone with clay shale interbeds. The Arnoldsburg redbed member is absent from this section, probably having graded laterally into limestone.

Owing to the sparse occurrence of the Fulton shale and the underlying Benwood coal bed, most of the measured sections show a thick limestone unit in the interval between the Sewickley sandstone and Arnoldsburg coal bed. This limestone, in the elongated Arnoldsburg cyclothem, is referred to as the Benwood-Arnoldsburg limestone, for their lateral equivalents cannot be separated when the Fulton shale is absent. The thickness of this member in Athens County ranges from 9 to 42 feet and averages almost 25 feet. This wide variability of thickness is not a result of regional thickening or thinning but, rather, due to local interfingering with the redbed facies. The thickest deposits of limestone are found along the Hocking River and Federal Creek in Rome and Bern Townships. It is in this area that prospecting for quarry sites may be best directed. This unit is well exposed in stratigraphic sections 11318 and 11331, where it was formerly quarried. South of the Hocking River, in Lodi and Carthage Townships, this member thins as a result of replacement by redbeds.

The limestone occurs as nodules or ledges interbedded with calcareous clay shale of the redbed type. The limestone on a fresh break is gray to olive gray but it sometimes weathers yellow and has a fretted appearance. Because of its nodular character the limestone weathers out as "boulders" and where it is thick its approximate position on the hillsides is sometimes indicated by a litter of these boulders. The rock is very hard and dense and occasionally contains crystalline masses of calcite. Ostracods are found but are uncommon in occurrence.

Arnoldsburg Underclay Member. - This member is of little consequence, because it is thin, seldom present, and lacks the usual plastic characteristics of typical underclays. The thickest measurement, 2 feet 6 inches, was taken in Bern Township, where the bed is also most persistent; it is generally absent in Lodi and Rome Townships, where it fails to exceed one foot thickness. The average thickness is 11 inches. Wherever found it is a clay shale, usually gray or olive gray and commonly with some red or purple coloring. The nonbedded character of the rock results in irregular fracturing and grainy weathering on the outcrop. Silt, mica, and some calcareous material are generally present.

Arnoldsburg Coal Member. - The Arnoldsburg coal bed in Athens County, at its best, does not exceed a few inches thickness and more commonly the position of this member is indicated by the contact of fresh-water limestone and the arenaceous sediment of the Arnoldsburg sandstone. A thin clay or coaly zone at this position locally represents the Arnoldsburg coal bed.

This coal bed was formerly known as the Lower Uniontown coal bed. However, because of its association with the better-known Arnoldsburg limestone and sandstone, it has become known as the Arnoldsburg coal bed.

Arnoldsburg Roof Shale Member. - The roof shale of the Arnoldsburg coal bed in Athens County is usually wanting and where present is less than one foot thick. This stratum is shale, gray to maroon in color, silty and micaceous, and contains some fossil plants.

Lower Uniontown Cyclothem

Interposed within the boundaries of the Uniontown cyclothem is the Lower Uniontown cyclothem. Although the Lower Uniontown cyclothem is found with considerable consistency to the northeast in Washington and Monroe Counties, it is of irregular occurrence and minor importance in Athens County. In Athens County the Lower Uniontown cyclothem has been measured in only two geologic sections (localities 11275, 11331), both of which are included in the appendix and their location shown on map 24.

Arnoldsburg Shale and Sandstone Member. - This member was named by Hennen in 1911 (p. 202) for exposures in the vicinity of Arnoldsburg, Calhoun County, West Virginia, where it is a coarse to conglomeratic sandstone 35 to 45 feet in thickness and underlies the Uniontown sandstone by 40 to 50 feet.

The Arnoldsburg sandstone of the Lower Uniontown cyclothem in Athens County is represented as a silty shale of olive gray color, approximately eight feet thick where it is present.

Wherever the Lower Uniontown coal bed is absent, as it usually is, this member is considered the basal member of the Uniontown cyclothem. The characteristics of the Arnoldsburg sandstone, as it occurs in the Uniontown cyclothem, are given in the discussion of the Uniontown cyclothem.

Ritchie Redbed Member. - The redbed facies which occurs over the Arnoldsburg sandstone is found over a wide area of eastern Ohio and neighboring counties of West Virginia. Stevenson (1907, p. 44) named this unit the Ritchie reds and described it as being considerably thicker in West Virginia than in Ohio.

In Athens County, the Ritchie redbed of the Lower Uniontown cyclothem is not well known, owing to the poor exposures of the few sections in which it occurs. Its thickness, however, is probably close to ten feet, and it is composed of variegated clay shale with calcareous inclusions.

This unit is also considered a member of the Uniontown cyclothem wherever the upper boundary of the Lower Uniontown cyclothem is lost, and its characteristics under this condition are considered in the discussion of the redbed member of the Uniontown cyclothem.

Lower Uniontown Limestone Member. - The name of this member is designated by the cyclothem name in which it is found. Owing to poor exposures, this member is not well known in Athens County but it probably averages about seven feet in thickness. It is both nodular and bedded in occurrence, gray in color, and dense.

Wherever the Lower Uniontown coal bed or its position is indeterminable, this member is considered a part of the Uniontown cyclothem and its strata coalesce with the Uniontown limestone or grade laterally into Ritchie redbed.

Lower Uniontown Underclay Member. - The underclay of the Lower Uniontown coal bed is a clay shale of gray to tan color, slightly carbonaceous, silty, and somewhat plastic. The average thickness of the two measurements in Athens County is 1 foot 8 inches.

Lower Uniontown Coal Member. - Coal at this position has not been observed in Athens County, but its possible occurrence and position are indicated by carbonaceous material in the Lower Uniontown underclay.

Lower Uniontown Roof Shale Member. - Although some laminated shale carrying plant impressions has been found overlying the Lower Uniontown coal zone, a roof shale has not been positively identified in Athens County.

Uniontown Cyclothem

The Uniontown cyclothem is analogous to the Sewickley cyclothem in that its normal interval is broken by the local occurrence of an irregular cyclothem. In Athens County the base of the Uniontown cyclothem is usually seen to rest on the Arnoldsburg coal bed and roof shale and to extend upward uninterrupted to the top of the Uniontown roof shale. However, where the Lower Uniontown cyclothem is developed the base of the Uniontown cyclothem is considered to overlie the Lower Uniontown coal bed.

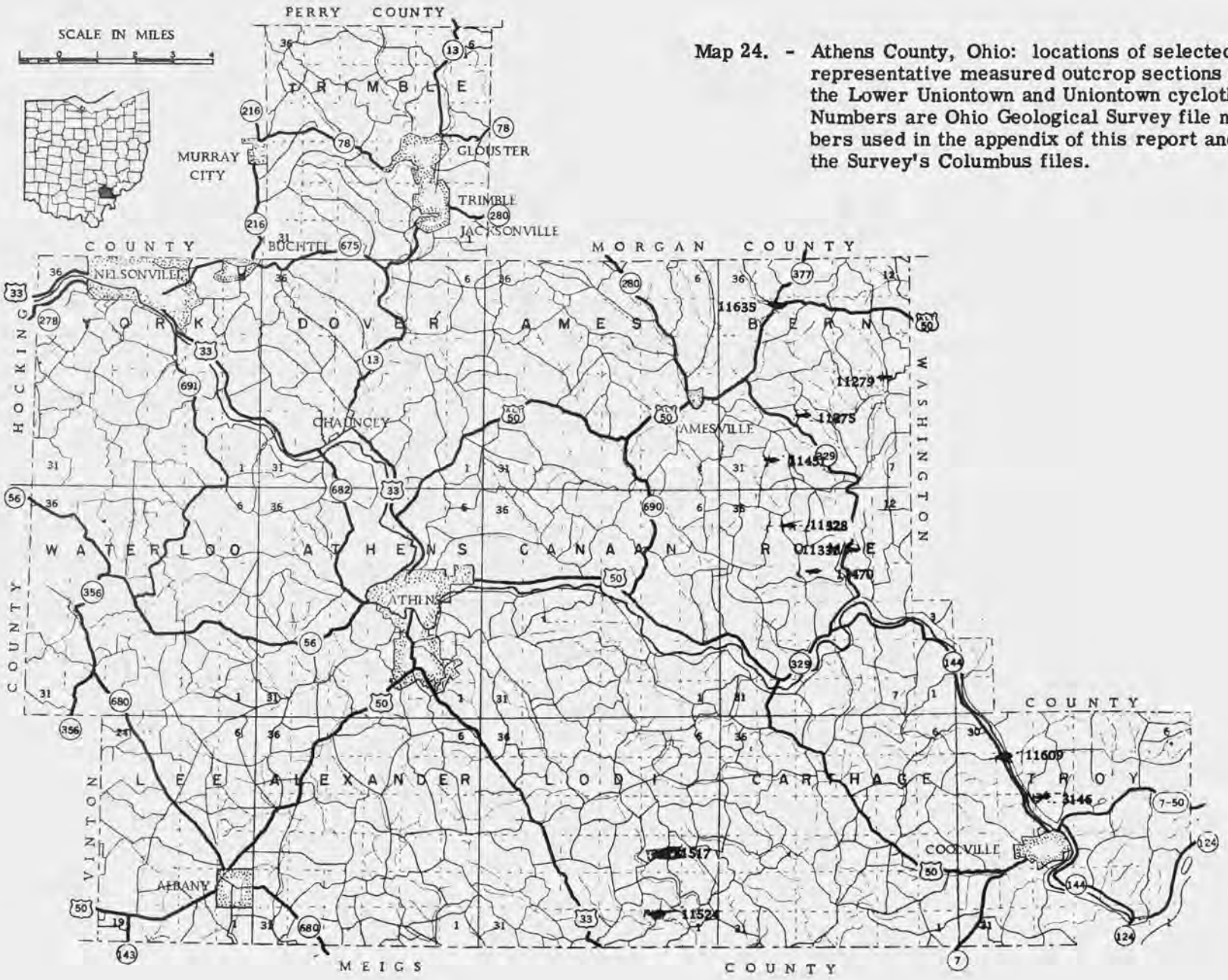
The Arnoldsburg sandstone and Ritchie redbed members of the Lower Uniontown cyclothem are continuous laterally, irrespective of the presence or absence of the Lower Uniontown coal horizon, and these names are carried in the Uniontown cyclothem wherever its boundary is placed over the Arnoldsburg coal horizon. Consideration of the characteristics of these two members is given below in the discussion of the Lower Uniontown sandstone and Uniontown redbed members.

The thickness of the Uniontown cyclothem varies with the position of its lower boundary. The average thickness of the measurements where the lower boundary is placed at the Arnoldsburg coal zone is 33 feet, and 15 feet wherever the Lower Uniontown cyclothem occurs.

Map 24 shows the location of selected measured geologic sections which exemplify this cyclothem.

Lower Uniontown Shale and Sandstone Member. - The Lower Uniontown shale and sandstone has been recognized by A. T. Cross and co-workers along Big Run Creek and vicinity in Monroe County, Ohio. Here the member is a locally prominent channel deposit with rapid lateral variations. However, in Athens County the Lower Uniontown shale and sandstone occurs only in one measured geologic section (locality 11331), where it is an olive gray to brownish yellow shale that is silty and micaceous. The measured thickness of this unit is 7 feet 10 inches and, owing to a covered interval, may be as much as 13 feet.

The Arnoldsburg sandstone, as a member of the Uniontown cyclothem in Athens County, ranges from 3 to 28 feet and averages 11 feet in thickness. Laterally it grades from a fine- to medium-grained and thin-bedded sandstone to a laminated, arenaceous shale or siltstone that weathers readily and is exposed almost exclusively in artificial cuts. The color on a fresh break is gray, tan, or olive, with some red and yellow hues in the shale facies.



Map 24. - Athens County, Ohio: locations of selected representative measured outcrop sections of the Lower Uniontown and Uniontown cyclothems. Numbers are Ohio Geological Survey file numbers used in the appendix of this report and in the Survey's Columbus files.

Uniontown Redbed Member. - The name for this member is derived from the cyclothem name and is intended to apply to this lithology only where it is underlain by the Lower Uniontown coal bed. Of the two measured sections where the Lower Uniontown coal bed is found, this member occurs in only one locality (11275), where it occupies the entire Lower Uniontown-Uniontown coal bed interval.

Where the Lower Uniontown coal bed is absent, this member is coalesced with the Ritchie Redbed of the Lower Uniontown cyclothem. In this elongated Uniontown cyclothem the Ritchie redbed is extremely variable as a result of lateral change to fresh-water limestone, particularly in the eastern and northeastern parts of the county. In appearance and composition this member is similar to underlying redbeds of the Monongahela and Conemaugh series. The member consists of a clay shale that occurs in a variety of hues including red, purple, maroon, gray, yellow, green, pink, or a mottling of these colors. Calcareous masses and limestone pellets and nodules are dispersed indiscriminately through the shale. Because of its nonbedded character, the rock breaks with an irregular or hackly fracture and weathers to dusty granules. The unit is very susceptible to weathering, and when wet it turns into a slick mud that is subject to landsliding.

Uniontown Limestone Member. - This term, in its present usage, indicates the fresh-water limestone between the Arnoldsburg sandstone and the Uniontown coal bed, for this lithology is not present in the Lower Uniontown-Uniontown coal bed interval. The limestone is closely associated with the underlying Ritchie redbed and is frequently interbedded with or grades laterally into them. The limestone is best developed along the Hocking River in northwestern Troy Township and in Rome Township, where it has been quarried for local use. Measured geologic sections (localities 3146 and 11609) given in the appendix and shown on map 24 illustrate the character and thickness of this unit at localities where it has been quarried. Elsewhere in the county the redbed facies is predominant.

The limestone is a light gray on the fresh break but weathers to a yellow or dark gray. It is a hard, dense limestone that occurs as nodular or bedded layers. In either case, it is associated with calcareous shale of the redbed type. Where present, the thickness of this member in Athens County varies from a few inches to 20 feet, but in places it is totally absent and its position occupied by redbeds.

Uniontown Underclay Member. - The Uniontown coal bed is most commonly found resting directly upon the Uniontown limestone or redbeds. There is, however, a very sporadic occurrence of the underclay, and wherever it is present it is thin, averaging about three inches in thickness. The underclay is a gray, semi-plastic clay shale that may contain carbonaceous matter, silt, and sparse remains of ostracods and gastropods.

Uniontown (No. 10) Coal Member. - This coal bed was early recognized by Rogers (1858, p. 501, 506) as an important bench of reference, and he named it for exposures in the vicinity of that town in Fayette County, Pennsylvania. Andrews (1873, p. 462) recognized its importance in Ohio but, unaware of its correlation, termed this coal bed the Hobson seam. Later, when the relationship of the Hobson and Uniontown coal beds was realized, Ohio geologists adopted the Pennsylvanian name for it.

In Athens County the Uniontown (No. 10) coal bed occurs as a single-benched seam that varies from a paper-thin streak to a bed of 13 inches in maximum thickness, and the average of the measurements is 3 inches. In places the coal is represented by a dark carbonaceous shale or a thin clay with carbonaceous streaks, or its position is inferred by a vertical lithologic change of sandstone overlying the Uniontown limestone.

Although economically worthless as a fuel, the Uniontown coal bed is a valuable stratigraphic marker, for it is the most steady and discernible horizon between the Sewickley and the Washington coal beds. The Uniontown coal bed is on an average 96 feet above the Sewickley coal bed and underlies the Little Waynesburg, Waynesburg, and Washington coal beds by 35, 63, and 169 feet, respectively.

Uniontown Roof Shale Member. - This member is a thin, irregular, and unimportant unit of the Uniontown cyclothem. In thickness it ranges from only a few inches to slightly more than a foot, with an average of about half a foot. It has been observed only in part of the measured sections of Bern and Rome Townships.

Wherever present the roof shale member is a clay shale, laminated or massive, that grades vertically into shale. The color on a fresh surface is gray or tan, brown, red or maroon. It is silty, with some fine mica and few clams or fossil plants.

Little Waynesburg Cyclothem

The Little Waynesburg cyclothem is extensive in Bern, Rome, and Carthage Townships, in the hilltops in the eastern part of Lodi Township, and along the valley of the Hocking River and its tributaries in Troy Township, Athens County. Its interval consists almost entirely of two members that laterally grade into each other, the Uniontown sandstone and the redbed member. The Waynesburg limestone and underclay members are thin and very sporadic in occurrence; the Little Waynesburg coal bed is extremely thin but remarkably persistent, and, therefore, an important unit of this cyclothem. The members of the Little Waynesburg cyclothem are listed in table 13 and locations of representative exposures are shown on map 25.

The thickness of this cyclothem ranges from 26 to 45 feet and averages 35 feet. The interval from the Little Waynesburg coal bed to the Waynesburg coal bed is an average of 24 feet.

Uniontown Sandstone Member. - I. C. White, in 1891 (p. 58-59), proposed this name for the sandstone that occurs 60 to 70 feet below the Waynesburg coal bed, because of its relation to the underlying Uniontown coal. In West Virginia a shale facies at this position has been designated the Annabelle shale by Hennen and Reger (1913, p. 250).

In Athens County this member is highly variable in thickness, rock type, and prominence. Invariably this member rests directly on or is separated from the Uniontown coal bed by only a few inches of shale. It is the most resistant unit between the Sewickley sandstone and the Little Waynesburg coal bed, but in prominence it is overshadowed by the cliff-forming sandstone units that are stratigraphically higher.

The average thickness of the Uniontown sandstone in Athens County is 21 feet 6 inches, with minimum and maximum measurements of 5 and 39 feet. Frequently within this interval, a number of rock types may be displayed in a single exposure, both laterally and vertically. Its predominant facies is gray or tan, fine- to medium-grained, thin- to medium-bedded sandstone, with numerous silty-sized grains. Siltstone and sandy shale with interbeds of brown, olive green, red, and pink, as well as gray and tan, are common to this unit. Massive, coarse-grained, and cross-bedded sandstone sometimes occurs, but this grades both vertically and laterally into the lithologies described above.

Redbed Member. - This member of the Little Waynesburg cyclothem is a soft, nonresistant clay shale that displays characteristics very similar to those of underlying redbeds. Its colors are the normal array of grays, purple, maroon, red, yellow, and mottled variations of these. Some silty and fine mica, along with numerous calcareous masses and limestone pellets or nodules, are dispersed throughout the interval of this member. Its nonbedded character causes the rock to break in an irregular fracture and weather to dusty granules. Although redbeds are known to be intimately related to fresh-water limestone, this member in all measured geologic sections in Athens County does not give way to limestone. It does, however, grade laterally into sandstone or shale, with the result that both members vary in thickness. The thickness of the redbed member ranges from 2 to 20 feet and averages 12 feet 6 inches.

Waynesburg Limestone Member. - This member was named by Stevenson in 1876 (p. 62) for its association with the Waynesburg coal bed which it underlies in its type area by 20 to 40 feet. In a later publication the discovery of another coal bed directly overlying the Waynesburg limestone was reported and named by Stevenson the Little Waynesburg coal (1877, p. 34). Although this member is not directly related to the coal bed from which its name was derived, the name Waynesburg has been retained and is firmly entrenched in the geologic literature.

Little Waynesburg Underclay Member. - The underclay of the Little Waynesburg coal bed is an argillaceous clay shale similar to the underlying redbeds. It is light to dark gray with some green and yellow hues, nonbedded, sometimes grainy weathering, and somewhat plastic. It is transitional upwards from the clay shale of the redbeds and thus gives an indefinite lower boundary to this unit.

The observed thickness of this unit ranges from one inch to three feet and averages slightly less than one foot. The member holds little significance because of its sparse occurrence in Athens County.

Little Waynesburg Coal Member. - J. J. Stevenson, in 1877 (p. 34) named the coal immediately overlying the Waynesburg limestone the Little Waynesburg coal. White (1891, p. 58) as well as Stevenson recognized this stratum as a thin coal or black shale that is persistent throughout the areas they studied.

In Athens County this member is surprisingly persistent when its poor quality as a coal is considered. As a coal bed it is practically nonexistent, but its position can almost always be found marked by a thin black shale, a smut streak, or a horizon determined by vertical lithologic change.

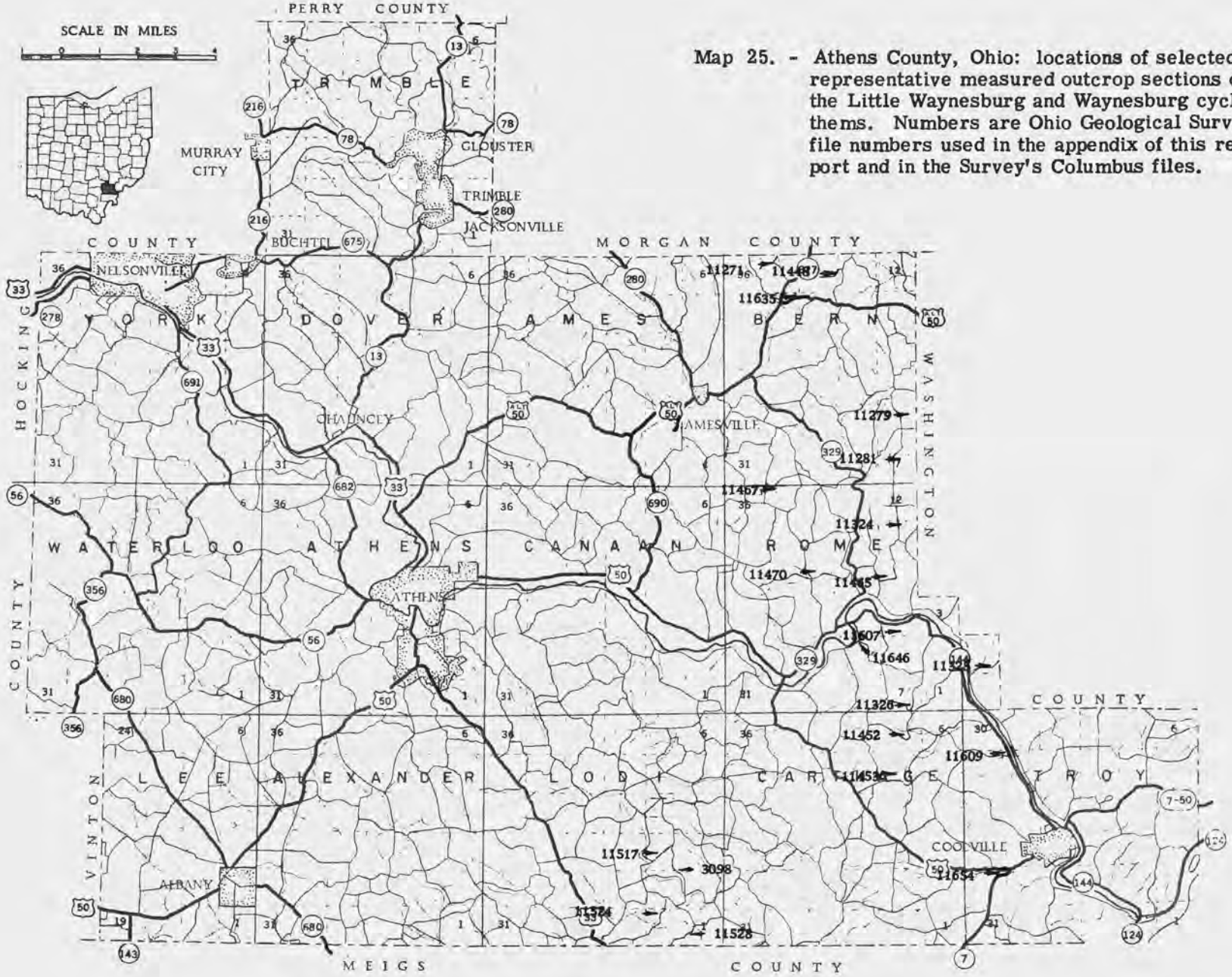
Although the Little Waynesburg coal bed is of no economic value, its persistence and average position of 35 feet above the Uniontown coal bed and 24 feet below the Waynesburg coal bed are significant and important.

Little Waynesburg Roof Shale Member. - In the normal sequence of cyclical sediments, this member is due immediately above the Little Waynesburg coal bed, but it is wanting in Athens County. Therefore, the highest member of the Little Waynesburg cyclothem is the Little Waynesburg coal.

Waynesburg Cyclothem

This is the youngest cyclothem in the Pennsylvanian system of the Appalachian region. The Waynesburg cyclothem, like the Pittsburgh cyclothem, transcends two major systems, the Pennsylvanian and Permian. By drawing the boundary of these two systems at the top of the Waynesburg coal, the Cassville shale, which is the top member of the Waynesburg cyclothem, automatically becomes the basal member of the Permian system. This boundary was established by White (1891, p. 20) on the basis of fossil plants. For a full treatment of this boundary and the problems it involves, the reader is referred to the next section on the Permian system in Athens County.

Although this cyclothem and the identification of the Waynesburg coal are critical to the stratigrapher, they are not distinctive in the field. For positive identification and separation from both higher and lower cyclothems a long measured section to determine intervals from other key horizons is necessary. In Athens County the average interval from the underlying Uniontown coal bed to the Waynesburg coal bed is 63 feet, and 140 feet from the Waynesburg to the overlying Washington coal bed.



Map 25. - Athens County, Ohio: locations of selected representative measured outcrop sections of the Little Waynesburg and Waynesburg cyclothems. Numbers are Ohio Geological Survey file numbers used in the appendix of this report and in the Survey's Columbus files.

The Waynesburg cyclothem is confined to the eastern third of Athens County, an area that includes the eastern edge of Lodi Township; extensive parts of Bern, Carthage, and Rome Townships; and along the Hocking River and its tributaries in Troy Township. Map 25 illustrates, in a general way, the geographic distribution of this cyclothem. The suite of Waynesburg cyclothem members is given in table 13.

The average thickness of this cyclothem is 20 feet, and this interval is filled by two members, the Gilboy sandstone and the redbed member. This cyclothem is persistent in its lateral extent in Athens County but is frequently covered because the Gilboy sandstone is commonly composed of shale and thin sandstone beds that are readily decomposed, as is the redbed member.

Lateral continuity of the Waynesburg cyclothem is broken wherever the Gilboy and Waynesburg sandstones are coalesced. Another consideration is the occurrence of the Little Waynesburg Rider cyclothem, a thin cyclothem complete to sandstone and redbed members, lying between the Little Waynesburg and Waynesburg coal beds. The Little Waynesburg Rider occurs in Troy Township and is present in the measured geologic section (locality 11654) which is included in the appendix.

Gilboy Sandstone Member. - The Gilboy sandstone, the lowest member of the Waynesburg cyclothem in Athens County, was named by White (1903, p. 150) for a prominent stratum exposed in the Gilboy cut on the B. & O. Railroad east of Mannington, West Virginia. According to White's description, its position is five to ten feet below the Waynesburg coal.

In Athens County the Gilboy sandstone seldom forms bold, conspicuous cliffs, as it frequently does in West Virginia. In many of the measured geologic sections this member is in part a gray, massive, medium-grained sandstone very resistant to weathering. These zones, however, give way laterally and vertically to less resistant lithologies, as fine- to medium-grained, thin- to medium-bedded sandstone or shaly sandstone interbedded with sandy, platy shale. The average interval from the top of the Gilboy sandstone to the Waynesburg coal bed is nine feet, but this is variable because the upper part grades laterally to redbeds; this results in a thickening and thinning of both the Gilboy sandstone member and the redbed member. Thicknesses of the Gilboy sandstone range from 8 to 40 feet and average 11 feet.

In a few of the measured geologic sections in Bern Township a thick sandstone sequence begins at the stratigraphic position of the Gilboy sandstone and is continuous vertically to the Waynesburg sandstone, with which member it is coalesced. When coalesced, the two sandstone units cannot be separated or distinguished because there is no physical break and the lithology of the expanded sandstone sections is uniform, gray to tan, fine- to coarse-grained, thin- to massive-bedded, friable, and limonite-stained. The lateral extent of these elongated sandstone units could not be determined satisfactorily because suitable exposures are lacking.

Waynesburg Redbed Member. - This member, together with the Gilboy sandstone member, accounts for virtually the entire interval between the Little Waynesburg and Waynesburg coal beds. The average thickness of the redbed member in Athens County is 9 feet 6 inches, but because of lateral gradation to sandstone the range is from 3 to 20 feet. Generally, throughout the county this member is somewhat thinner than the underlying Gilboy sandstone.

This member shows a typical redbed lithology. Red, maroon, and purple are the predominant colors, but gray, yellow, green, tan, and especially a mottling of several colors are also common to this clay shale unit. Calcareous material is also common in the form of calcareous masses and thin nodular limestone beds, none of which are distinctive or persistent. The nonbedded character is also typical and creates a hackly break and weathers to dusty granules.

Fresh-water Limestone Member. - The occurrence of fresh-water limestone at this position is so local throughout the Appalachian region that it has not been assigned a name. If ever a name is applied to limestone strata at this horizon, the member cannot take the Waynesburg

cyclothem name because that name is already occupied by the limestone that underlies the Little Waynesburg coal.

This member has not been recognized in any of the measured geologic sections in Athens County, but it has been reported locally in Monroe and Washington Counties.

Waynesburg Underclay Member. - An underclay to the Waynesburg coal is rarely found and, if present, is less than a foot thick. However, what is frequently termed the Waynesburg "horizon" is an underclay with carbonaceous matter rather than coal or coaly shale.

Waynesburg (No. 11) Coal Member. - The Waynesburg coal is the highest stratigraphic unit of the Monongahela series and of the Pennsylvanian system. It was named by Rogers (1858, v. 2, pt. 1, p. 19) for exposures near Waynesburg, Greene County, Pennsylvania, but it was not until 1891 that this stratum assumed its vital stratigraphic importance of marking the top of the Pennsylvanian system. The history and character of the boundary between the Pennsylvanian and Permian systems are discussed in detail in the following pages and to which the reader is referred.

The Waynesburg coal is of some economic importance in Belmont County, where it has been mined for local use, but elsewhere in Ohio the bed is too thin to be minable. In Athens County it never exceeds a few inches of coal; usually the member is marked by the occurrence of a thin clay with carbonaceous matter, coaly shale, or in the absence of all of these, by a vertical change in lithology. The member is persistent but normally covered because of its association with soft shales below. Where a coalescence of the Gilboy and Waynesburg sandstones occurs, the position of the Waynesburg coal bed can not be ascertained.

PERMIAN SYSTEM

GENERAL CONSIDERATIONS

Historical Account

The Permian system is the uppermost subdivision of the Paleozoic rocks and contains the youngest sedimentary beds of the Appalachian coal fields.

The Permian system was originally defined in 1841 by Sir Roderick Murchison, the great English geologist, and named from the old province of Perm in Russia, where rocks of this age are typically exposed. In the United States, rocks of the Permian system had not been recognized at that time. The youngest rocks of the Appalachian coal fields were believed to be of Carboniferous age, and were subdivided into the Lower and Upper Carboniferous. The Lower Carboniferous was nearly equivalent to the present Mississippian system and the Upper Carboniferous was approximately equivalent to the present Pennsylvanian system. The Upper Carboniferous or Coal Measures rocks were further subdivided into the Lower Productive group, the Lower Barren group, the Upper Productive group, and the Upper Barren group.

The possibility that rocks of Permian age exist in the United States was brought to light in 1857-1858 through fossils collected in Kansas by Hawn and described by F. B. Meek (Grimsley, 1906, p. 70). It was Meek's opinion that some of these fossils were definitely Permian in age. However, most of these fossils were mingled with Carboniferous species and the beds which contained them were gradational with the underlying Coal Measures and it was impossible to establish a definite boundary line. J. S. Newberry (1873, p. 80) stated, "None of the Coal Measures of Ohio are high enough to contain them (these fossils), but it is not unlikely that they will be discovered in the uppermost strata in the axis of the trough of the Allegheny coal field in West Virginia."

In acknowledgment of both the indications of Permian affinity in these fossils and the inconclusiveness of the evidence, the name Permo-Carboniferous was gradually applied to strata of the Upper Barren Measures and to rocks in this Pennsylvanian-Permian transition zone.

The presence of any Permian age strata in the Appalachian area was doubtful until 1880 when Drs. W. M. Fontaine and I. C. White published The Permian or Upper Carboniferous Flora of West Virginia and Southwestern Pennsylvania, in which they concluded that the Upper Barren Measures, formerly considered to be Upper Carboniferous (Pennsylvanian) in age, were Permian in age. Most of White and Fontaine's material for this study came from the roof shales of the Waynesburg and Washington coal beds. White and Fontaine (1880, p. 111) determined that "out of 107 fossil plants found in these measures in West Virginia, 22 occur in the Coal Measures proper, while 28 are found also in the Permian of Europe. Of the 22 species which are common to the Upper Barrens and to the Coal Measures below them, 16 are also found in the European Permian, leaving six not hitherto found in the Permian."

Drs. White and Fontaine's summarization of evidence for the Permian age of the Upper Barren Measures is as follows (1880, p. 120):

1. The evidence from the identity of species.
2. The evidence from allied species.
3. The evidence from the decadence of Coal Measures forms.
4. The introduction of types characteristic of later formations.
5. The evidence of an important physical change at the beginning of the series.
6. The nature of the lithology; the disappearance of coal; the diminution in the amount of plant life.

Professor W. F. Cummings (1890, p. 400, 413) divided the Permian of Texas into three divisions: Wichita, Clear Fork, and Double Mountain beds, in ascending order. Both floral and faunal evidence indicated the age of the Wichita to be Permian. Dr. I. C. White identified the fossil flora of this group to be similar to that found in the roof shale of the Waynesburg coal in Ohio, Pennsylvania, and West Virginia. Waagen (1891, p. 238) correlated the Wichita with the Zechstein deposits of the Permian in Europe.

Subdivisions of the Permian System of the Appalachian Area

I. C. White (1891, p. 20) assigned the name Dunkard Creek series to the Upper Barren group for excellent exposures of this strata along Dunkard Creek which heads near the West Virginia-Pennsylvania line, on the eastern slope of the drainage divide separating the Ohio and Monongahela River drainage systems, and flows eastward, emptying into the Monongahela two miles above Greensboro, Greene County, Pennsylvania. The Dunkard Creek series embraces all the strata from the roof shale (Cassville shale) of the Waynesburg coal to the topmost beds of the Appalachian coal field. The name Dunkard Creek was later shortened to Dunkard by O'Harra (1900, p. 86-128) and Prosser (1901, p. 428).

Stevenson (1876, p. 34-35), as a matter of convenience, divided the Upper Barren Measures into the Washington County group, which extended up to and included the Upper Washington limestone; and the Greene County group, which included all the strata above the Upper Washington limestone. The type area of the Washington County group is in Washington County, Pennsylvania; that of the Greene County group type locality is in Center Township, Greene County, Pennsylvania.

The present boundaries of the Washington series are from the top of the Waynesburg coal to the top of the Upper Washington limestone. The Greene series includes the remaining strata above the Upper Washington limestone.

Pennsylvanian - Permian Controversy

In the years since White and Fontaine's classic report, the occurrence of deposits of Permian age in the Appalachian area have been questioned by many American geologists. Dr. David White (1902, p. 541), former paleobotanist of the United States Geological Survey, re-examined the localities described by White and Fontaine. The conclusions of David White (1903, p. 538-542) agreed for the most part with those of White and Fontaine and gave additional support to the Permian age of the Dunkard series. Scudder (1895, p. 11-21) described fossil cockroaches from several localities in Ohio and West Virginia. His identifications indicated that the fauna from the Cassville shale was certainly younger than any previously described material from Pennsylvania or Illinois. Prof. Scudder noted that the assemblages found in the Cassville shale are similar to assemblages found in the Lower Dyas or Lower Permian of Saxony.

A more recent interpretation is presented by Stout (1954, p. 434), who states, "The demarcation (Monongahela-Washington series boundary) was based on the character of the plant fossils in the roof of the Waynesburg coal, on the supposition that this coal is the highest member of importance in the coal series, and on the general changes in the sediments assumed to take place near this horizon. The division as far as stratigraphic conditions are concerned is entirely arbitrary. The Waynesburg is simply one coal bed (in 53) in a wide range of sediments (1,740 feet) that change more or less gradually from mainly marine to wholly fresh-water. The marine limestones or ores begin with the Sharon (ore) and end with the Skelley (limestone) and the fresh-water limestones begin with the Salem (limestone) and end with the Gilmore (limestone in Ohio). Red Beds, aside from "pink-eye" clay, appear at the Lower Freeport limestone horizon, become prominent in the upper part of the Conemaugh series, and are rather characteristic strata throughout the entire Permian system. Thus, assigning the Waynesburg coal to the top of the Pennsylvanian system offers some convenience in handling such a large number of members, but it is not based on specific geological changes at this horizon."

Stout's interpretation is further augmented by Cross and Arkle (1951, p. 101) who state, "It is not possible to demonstrate any major change in general lithology or types of sediments from the middle of the Conemaugh series to the top strata of the Dunkard (about 1,450 feet). The microfossil flora shows no principal change from mid-Conemaugh to mid-Dunkard. There is no major change in sequence of the individual rock units comprising cyclothems in this sequence except where facies lines are crossed."

There was no major paleobotanical investigation of the Dunkard flora of the Appalachian after David White's re-examination of I. C. White and Fontaine's collections in 1902 until the early 1940's when Dr. A. T. Cross began a systematic restudy of the Dunkard flora of the Appalachian region. The final results of this study have not yet been published. However, in 1954, Dr. Cross presented a summarization of his studies before the 8th International Botanical Congress in Paris. The results of Cross's investigation indicate that there should be a considerable reduction in the number of valid species presently referred to the Dunkard strata. Cross's studies further indicate that both impression floras and microfossils suggest that the Dunkard flora is essentially a reduced remnant of late Pennsylvanian time with few Permian precursors introduced. With Cross's permission, the complete manuscript of his paper presented in Paris (1954) is published herewith.

FOSSIL FLORA OF THE DUNKARD STRATA OF EASTERN UNITED STATES

by Aureal T. Cross, Ph. D.

Dunkard strata consist of about 1,200 feet of interbedded sedimentary rocks grouped in cyclothems containing a coal or coal horizon about every 25 feet. This indicates that about 50 coal and fossil plant horizons may be expected to occur. The lower 400 feet of this sequence is called the Washington formation by some geologists, and the upper part is called the Greene formation. The coals become thinner and less numerous toward the top.

Collections have been made from over 150 localities representing 36 of these horizons distributed throughout the entire sequence. Eighteen horizons including the lowermost member of the Dunkard series, the Cassville shale, have yielded important floras. The next best fossil plant horizons, besides the Cassville shale, are roof shales of the Washington and Washington "A" coals. The distribution of collections from strata in the upper half of the Dunkard becomes decreasingly representative because of the limited number of localities available in the knob-like, weathered hill tops.

For the last ten years I have been collecting coals and fossil plants from the Dunkard sediments in West Virginia, southeast Ohio, and southwest Pennsylvania in most of the area of their occurrence. For the most part, such collections are disappointing in that they contain only very few species from each locality in each horizon. There are very few places where open mines make possible large collections of roof shales. Therefore, we must rely principally on stream banks or road cuts for collecting sites. With few exceptions, the weathering of the strata has progressed to such depth that it is difficult to collect large specimens.

Another major difficulty in collecting Dunkard plants is the condition of their preservation. In a few instances well-preserved carbonaceous compressions are found in fine-grained or clayey roof shales. In numerous places the prominent sandy character of the Dunkard rocks prevail and in the roof shales which are intermittently silty or sandy only the gross characters of the fossil plants have been preserved, very often as brittle, carbonaceous films (vitrain). In most instances, however, the many coal horizons of the Dunkard are represented by leached clayey zones, old soil lines, or thin carbonaceous smut-streaks with only the occasional development of a few inches or more of coal. The shales above such horizons are very often grayish-red, pink, or purplish in color, grading to greenish-gray. In the instance of either type of roof shale the plants are preserved only as impressions in the fine-grained clayey shale. Occasionally the venation of leaves is accentuated by difference in color, the blade of the leaf being some shade of pink or red and the veins being green. This phenomenon is due to the greater reduction or leaching action of the veins or other thick parts of normal or coriaceous leaves on the iron oxide in the red shales.

In summary, it can be said that the collections of plants from Dunkard strata are, for the most part, inferior to those of the lower coal-bearing strata because of siltiness of some zones, lack of preservation of carbonaceous matter, depth of weathering of old surfaces, reduced number of localities, and lack of active coal mines.

In 1880, W. M. Fontaine and I. C. White published a report of the fossil plants of the Dunkard strata of West Virginia and southwestern Pennsylvania. No plants from the Dunkard of Ohio were included except for one long-ranging Neuropteris (N. hirsuta) from the Upper Conemaugh near Bellaire, Ohio. Reference to specimens from Bellaire which are similar to Alethopteris gigas was also made. In this notable report, 108 species and varieties were described and illustrated with line drawings. Of these, 72 were new. It has been ascertained that the collections were obtained from five horizons (or possibly as many as seven, depending on later correlations) and 14 localities. The most remarkable locality, the Cassville shale, which includes the upper parting in and the roof shale above the Waynesburg coal at Cassville near Morgantown, West Virginia, yielded 71 species. Another locality at West Union, West Virginia, yielded 37 species. Though this collection was made from the roof shale of what was presumed to be the Waynesburg coal, it is now believed to be Uniontown. This slightly older stratum is in the Monongahela series.

One other locality, near Brown's Bridge (Mill) on Dunkard Creek near Pentress, West Virginia, is especially noteworthy because of the occurrence there in the roof shales of the Washington coal of Callipteris conferta (Sternb.) Brongt and Callipteris (Sphenopteris)lyratifolia (Grand' Eury) var. coriacea (Font. & I. C. W.) D. White. It is remarkable that this single locality and horizon should have provided such a number of fine specimens of this genus as may be inferred from the original illustrations of Fontaine and White and from published comments by D. White in 1904 on the collection, which he saw in 1902.

One major feature of the flora which should be called to attention immediately is that it contains many elements which are common to earlier strata of the Upper Allegheny, Conemaugh, and Monongahela (equals most of Westphalian D up to Autunian) in other parts of the Appalachian

coal basin. Only an occasional list of plants is available for comparison with the Dunkard flora of the Monongahela and Conemaugh. The several illustrated lists of Allegheny age flora, e. g., Mazon Creek, Illinois (Carbondale); Henry County, Missouri (Des Moinesian); Nova Scotia (Pictou-Morien-Stellarton); give a more of a complete basis for comparison.

W. A. Bell has divided the flora of the Pictou beds of Nova Scotia and their equivalents into three groups, the Lonchopteris, Linopteris, and Ptychocarpus unitus zones, in that order from base upwards. He considered the Lonchopteris zone to be late Westphalian B (late Kanawha), the Linopteris obliqua zone as principally Westphalian C (upper Kanawha and lower Allegheny through the Kittanning coals), and the zone of Ptychocarpus unitus as Westphalian D or Radstockian (probably equivalent to upper Allegheny, Conemaugh, and Monongahela).

Bell has selected eighteen species, from among the many identified, as characteristic of the Ptychocarpus zone or that range up through the Linopteris-Ptychocarpus zones. Of these, we have identified fourteen from our Dunkard collections. Ptychocarpus unitus, Acitheca polymorpha, Dicksonites pluckeneti, Alethopteris friedeli, Sphenophyllum oblongifolium, Neuropteris ovata, and a form closely similar to if not conspecific with Mariopteris (?) ribeyroni have been found in Dunkard strata. Only Sphenophyllum majus, of these eight plants considered to be characteristic of the Westphalian D age Pictou beds, has not been found in Dunkard.

Annularia sphenophylloides, A. stellata, Astrophyllites equisetiformis, Asterotheca cf. robbi, Neuropteris rarinervis, and N. Scheuchzeri are found in Dunkard strata from among ten listed by Bell as characterizing both the Linopteris obliqua and Ptychocarpus unitus (Westphalian C and D) zones. The remaining three have not been found above lower Monongahela in our collections.

Only one species, Dactylotheca (Pecopteris) plumosa-dentata, of the ten which he lists as characterizing the Linopteris obliqua zone, has been recognized with certainty in the Dunkard. Thus, a remarkable similarity exists between the two widely separated floras, Dunkard and upper Pictou, and indicates near equivalence of age.

Anthony J. Miklausen has published an abstract of his study of a flora from one general locality of Pittsburgh coal roof shales which is lowermost Monongahela (about mid-Westphalian D). He has identified nine species of Pictou flora, and only one, Alethopteris serlii, of the Linopteris zone. In our collections of the Pittsburgh coal roof flora and those at the University of Cincinnati, several more of the eighteen species are present at the Pittsburgh horizon.

The top of the Monongahela is considered as uppermost Pennsylvanian in the old classifications. There is a considerable relationship of the Dunkard flora to that of the Monongahela. Again, comparing with Miklausen's list a number of close similarities are to be found. Of the ten pecopterids which he records, we have seven: Pecopteris miltoni, P. arborescens, P. oreopteroides, P. squamosa, P. hemitelioides, possibly P. feminaeformis, and Dicksonites pluckeneti. Of the seven neuropterids, we have four: Neuropteris (Mixoneura) ovata, N. plicata, N. Scheuchzeri, and N. flexuosa. Five others have been identified in our Dunkard collections with some certainty: N. loschii, N. odontopteroides, N. rarinervis, N. cordata, and form somewhat similar to N. gigantea. The intergradation of these will be discussed later. Of five species of Sphenophyllum which Miklausen records, we have only S. oblongifolium and S. angustifolium from Dunkard horizons, though at least two other species occur. His record of S. Thonii is important for, even though he found it in only a single place, but there abundantly, it is reasonable to anticipate the occurrence of this late form in the Dunkard. Of Miklausen's calamarians, we have both species of Annularia which he records, A. stellata and A. sphenophylloides, as well as a minute form, A. asteris or A. minuta; and one of his Asterophyllites, i. e., A. equisetiformis. Two other genera should be noted. Both our collections from the Dunkard and Miklausen's of Pittsburgh show Danaeities emersoni and the alethopterids, Alethopteris grandini, A. serlii, and possibly A. sullivantii. Thus, we have in our own Dunkard collections twenty of the thirty species of seven principal genera recorded by Miklausen for lower Monongahela rocks.

Arnold's flora of the Michigan coal basin provides for comparison a recent study of the Allegheny flora. He records eight out of ten species listed by Bell as typical of those ranging

through the Linopteris-Ptychocarpus zone. But he has only one of eight listed by Bell as typical of the Ptychocarpus zone. This is Sphenophyllum majus, which we have not found in the Dunkard or, in fact, higher than lower Allegheny. He has two species listed from among the ten Bell considered characteristic of the Linopteris (Westphalian C) zone. Thus, his flora would appear slightly older than our Dunkard and also older than the upper part of the Pictou.

C. B. Read, in his study of Pennsylvanian floral zones of North America, listed thirteen species from the Chanute shale of the Virgil series of Kansas (upper Conemaugh and Monongahela). Of these, Dicksonites pluckeneti, Alethopteris virginiana, A. grandini, Neuropteris plicata, N. Scheuchzeri, Annularia stellata, and Sphenophyllum oblongifolium are common in the Dunkard. The complex of odontopterids, which he considers to be characteristic of those strata, actually increases above the Monongahela in the Appalachian area. These are additional points in favor of a close relationship between the Conemaugh, Monongahela, and Dunkard plants.

Some of the longer ranging plants are found commonly from the top of the Kanawha through the Dunkard strata. These apparent long ranges may be due in part to misidentification or to lack of specific characters. Various common genera which are found in the Dunkard, such as Cordaites principalis, Sigillaria Brardii, and Calamites Suckowii, various seeds and some fructifications of Macrostachya, Calamostachys, etc., are not considered particularly conclusive though they are common to the above floras described by Bell, Arnold, and Miklausen.

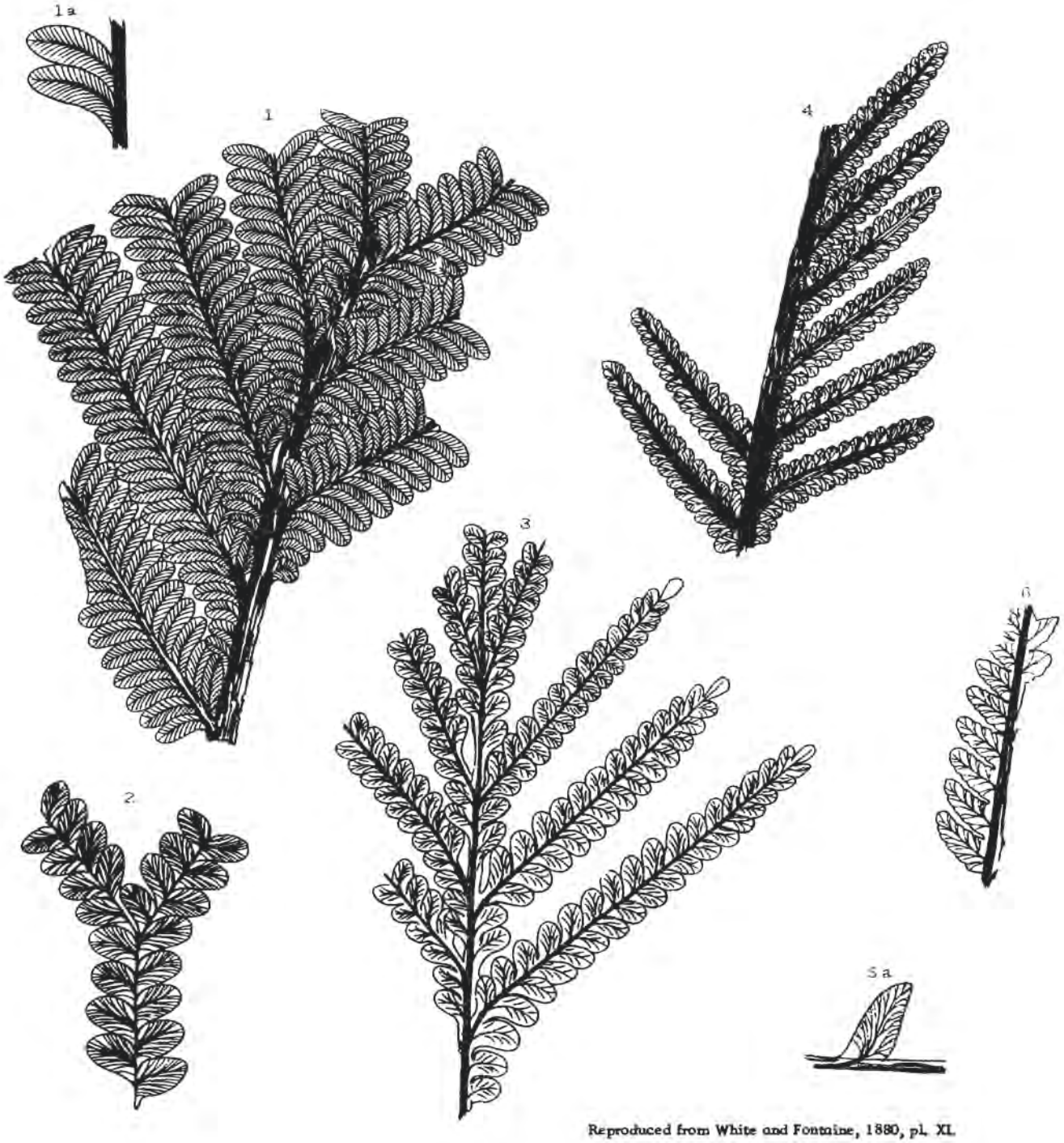
There are a number of genera recorded in the Dunkard flora, and of which we have several representatives which are considered to indicate a much later age than the Monongahela-Conemaugh and upper Allegheny, i.e., Permian. There seems little doubt as to the general evolution of the flora and the sparse addition of a few new genera or species, but for the most part the sequence indicated from the upper Allegheny through the Dunkard seems to reflect a great dying out of prominent middle and upper Pennsylvanian (uppermost Carboniferous) plants.

One genus, Callipteris, was mentioned earlier as being of special interest because of the general Permian distribution of the genus. Of the two species illustrated by Fontaine and White, Callipteris conferta has been reported from other localities in the Dunkard. But upon examination of these specimens which were collected later, where they could be found, we have come to the conclusion that most of the identifications cannot be verified. In most instances such specimens are poorly preserved, usually in silty or sandy shales, and are very fragmentary. In none except the collections by D. White from the type locality at Brown's Bridge, have we been able to see the accessory pinnules along the rachis, a feature which appears to be most distinctive. In none of our more extensive suite of collections from the Dunkard have we found a single uncontroversial specimen of Callipteris. Our collections not only represent many of the later horizons of the Dunkard, but also many localities of the Washington coal roof shale, including the Brown's Bridge locality of Fontaine. The collection which was made at Brown's Bridge by D. White, in company with I. C. White in 1902, is the only one containing uncontroversial Callipteris.

Another enigma of the flora presented by Fontaine and White is met within the restricted occurrence of the diverse flora from the Cassville locality. All the plants and a large number of insects were taken from a single place in one opening (local mine) of the Waynesburg coal. All other openings in the area together have not yielded more than 30 species to the present time.

A final and correlative obstacle in a restudy of the flora is the fact that the entire Fontaine and White collection appears to have been destroyed in a fire many years ago. We have been unable to locate satisfactory duplicate material in other museums. The nearby pits, some as little as 100 feet away from the original opening, do not yield a comparable rich flora. The old opening has fallen shut and is buried by an earth fill for a main highway. It should be noted again that the original Cassville collection from the very base of the Dunkard did not contain Callipteris. Its single occurrence was almost 200 feet higher in the Washington coal roof shales.

More recently, Darrah has reported on the occurrence of several of these plants of some concern in the matter of correlation of the flora with Permian plants elsewhere. He reports, without adequate illustration, new occurrences of Callipteris, Walchia, and Taeniopteris. He



Reproduced from White and Fontaine, 1880, pl. XI.

Figure 20

1. Callipteris conferta (Brongt.) - natural form.
1a. Enlarged pinnules of the same.
2. Terminal portion of a pinna.
3. Fragment from the upper part of a compound pinna.
4. Fragment of a compound pinna from the upper part of one frond.

reports but two specimens of Walchia in the Appalachian area, one from the Conemaugh and the other reportedly from the Greene formation (upper Dunkard) near Mt. Morris, Pennsylvania. This is a very tenuous record and needs amplification before it can be seriously considered as an indicator of the Permian age of the Dunkard flora. Taeniopteris has been illustrated from the Monongahela and at the very base of the Dunkard. It is an extremely rare plant, probably less than a dozen specimens having been recorded. There is some doubt as to the accuracy of identification of some of the specimens reported. The third plant which Darrah has reported, Callipteris, is also extremely rare as has already been noted. It does not appear "en masse" at the base of the Greene formation, or even commonly. We have examined a number of the specimens reported to be Callipteris in the various collections and invariably we have found them to be too poorly preserved or too fragmentary for verification.

Such genera as Baieria, Saportea, Namatophyllum, and Equisetides, which Fontaine and White illustrated, are open to serious question. Among our collections we have a number of dissected cyclopteroid pinnules of varying sizes up to 12 cm. diameter which are precisely the same form and appearance as Fontaine and White's Baieria virginiana (transferred to Jeanpaulia (Baieria) virginiana by David White) and their Saportea salisburyoidea. Saportea grandifolia appears to be more difficult to explain, but in the absence of photographs of the lost type material, it must be relegated to a status of incertae sedis as must the Baieria and Saportea salisburyoides. The fragmentary nature of the specimens illustrated as Equisetides will not allow their correlation with Mesozoic Equisetum.

Because of the fragmentation of most specimens, it is difficult to make certain identification of polymorphic species. A large number of species assigned to Pecopteris, Neuropteris, and Alethopteris are almost certainly based on different leaf forms of a few species. One of the best examples of this is illustrated by one lot of several hundred specimens from the Washington "A" coal horizon on Turkey Run in Wetzel County, West Virginia. In this entire lot, only three valid species are identified, one specimen of Annularia stellata, several fragmentary specimens one Pecopteris cf. arborescens, and hundreds of specimens of a heteromorphic Neuropteris probably ultimately referable to N. Scheuchzeri. Within the intergrading forms of this species, some found on the same fronds as the others, may be identified individual fragments referable to the genera Neuropteris, Mixoneura, Odontopteris, and Cyclopteris. Specifically, these include the following Neuropteris species given by Fontaine and White: Neuropteris flexuosa, N. dictyopteroides, N. hirsuta, N. platynervis, N. odontopteroides, N. auriculata, and N. cordata. The simple leaflets may be attached more or less terminally on a frond or laterally. Lobation may occur on one side of a single pinnule, in the lower half of the pinnule, toward the top of the pinnule, on several successive pinnules on one side or the other of the midrib or both, on occasional pinnules, etc. The lobes may be set off by crenulations, indentations, or dissection to the midrib with subdivisions on long or short points of attachment or nearly sessile to completely sessile. In fact, the sessile lobes are of the long-leaved odontopterid-type, closely approaching the appearance of Megalopteris. The lobation may result in a somewhat lobed or partially dissected pinna, or in a pinnule of ordinary size with the blade of the leaf merely cut to the midrib or slightly modified but with odontopteroid venation, or a pinnule may be of gigantic size, 30 cm or more in length and with the blade branched in several ways from that of a Megalopteris type to a type with intermixed large and small pinnules, of N. Scheuchzeri to N. ovata and N. cordata or N. auriculata, often several kinds on the same frond. The individual leaflets may be feather-shaped, sword-shaped, sickle-shaped, spade-shaped, or thread-like.

Problems such as this exist in regard to Pecopteris. Twenty-seven species were differentiated by Fontaine and White. These, together with several of the species of Callipteridium and Goniopteris, constitute almost one-half of all the species described in their memoir. On the basis of the study of thousands of specimens of the pecopterid type from our Dunkard collections and field observations, we are inclined to group many of these "species" together into perhaps about a dozen natural species.

Another line of evidence which we are exploring is the study of the microfossil floras of the coal seams. Suffice to say we find the predominant Dunkard species to be virtually indistinguishable from the Monongahela. They are characterized by complete dominance of the Laevigatosporites type of spore, which gradually becomes more ornamented during the Monongahela and

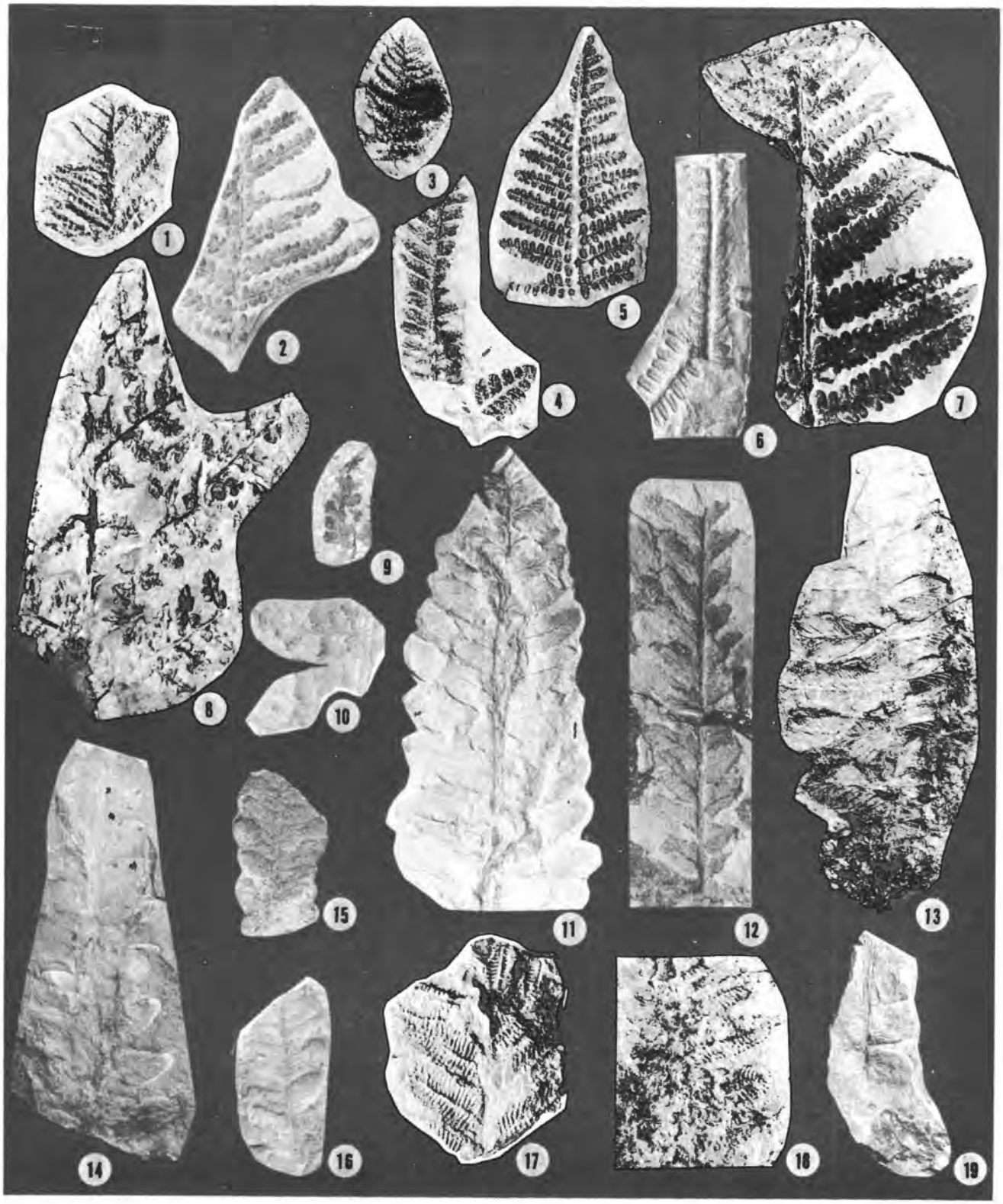


Plate 7 - Typical Monongahela-Dunkard plant fossils. 1.- Pecopteris dentata (?) Brongniart. 2.- Pecopteris (Dactylotheca) plumosa Artis. 3.- Pecopteris squamosa (?) Lesquereux. 4.- Pecopteris unita Brongniart. 5.- Pecopteris arborescens (Brongniart). 6.- Pecopteris cf. unita Brongniart. 7.- Pecopteris miltoni Artis. 8.- Mariopteris sp. 9.- Sphenopteris minuti-secta Fontaine & White (cf. arberi Kidson). 10.- Sphenopteris cf. acrocarpa Fontaine & White. 11, 12.- Pecopteris ? (Cymoglossa) breviloba Fontaine & White. 13, 14.- Callipteridium grandifolium Fontaine & White (obverse and reverse sides of one specimen). 15, 16.- Callipteridium spp. 17, 18.- Danaeites emersoni Fontaine & White. 19.-Odontopteris nervosa (?) Fontaine & White. From Cross & Schemel, 1956, p. 87.

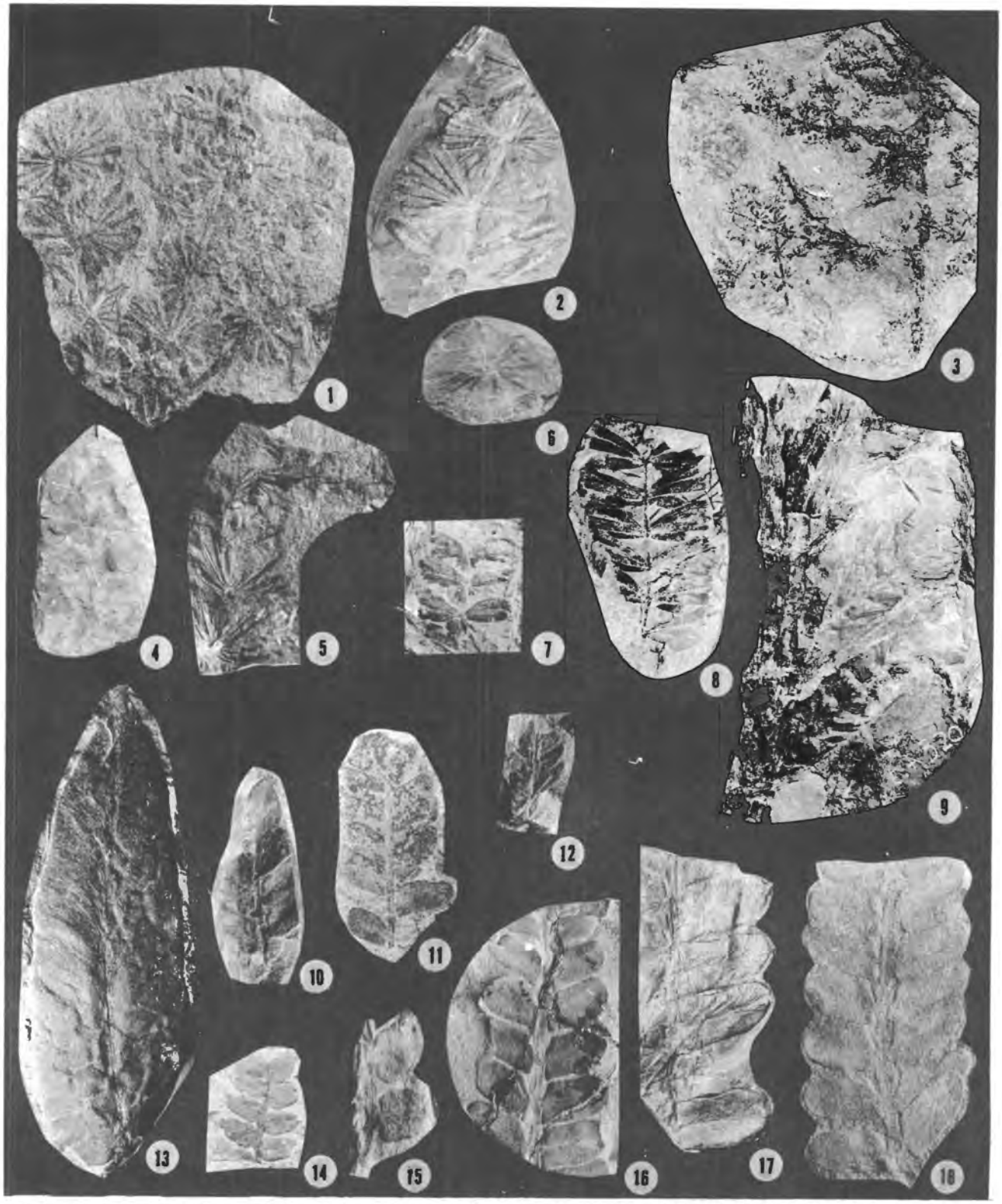


Plate 8. - Typical Monongahela-Dunkard plant fossils. 1, 2.-Annularia stellata (Schlotheim) (Martin?). 3.-Annularia cf. minuta Brongniart. 4.-Sphenophyllum oblongifolium Germar & Kaulfuss. 5.-Asterophyllites equisetiformis Schlotheim. 6.-Sphenophyllum bifurcatum Lesquereux. 7.-Sphenophyllum oblongifolium Germar & Kaulfuss. 8.-Sphenophyllum cf. tenuifolium Fontaine & White (= S. oblongifolium?). 9.-Asterophyllites equisetiformis Schlotheim. 10.- Neuropteris (Mixoneura) sp. 11.-Neuropteris ovata (?) Hoffmann. 12.- Callipteridium sp. 13.-Neuropteris scheuchzeri Hoffmann. 14,-15.-Neuropteris (Mixoneura) odontopteroides Fontaine & White. 16.- Neuropteris ovata (?) Hoffmann: (= N. loschii Brongniart). 17.-Neuropteris sp. 18.-Neuropteris loschii Brongniart.
From Cross & Schemel, 1956, p. 84.

Dunkard. Many of the other spore types are generally rare and their parent plants are uncertain. There are no extensive studies of microfossil floras of Permian coals of the northern hemisphere available to aid in the interpretation of those of the Dunkard.

A number of localities have minor amounts of petrified wood. The two principal genera, Psaronius and Cordaites, which are fairly common in the upper Allegheny, Conemaugh, and Monongahela, have been found but rarely in the Dunkard. A few sigillarian casts are found along with some unidentifiable Calamites casts. One species which appears to be new is found in the Washington coal. This line of evidence for age determinations or floral composition of the Dunkard will probably never have much influence.

Thus, many of the records of the Dunkard flora must be studied and, in some instances, re-evaluated in order to obtain an accurate dating of the strata. The identifications we have made are not conclusive nor final. Many of the specimens in our collections have not been identified. We do have a stable basis for some revision of the existing record.

THE PERMIAN SYSTEM IN OHIO

Introduction

For the purposes of this report, the Permian will be subdivided as follows: the Dunkard group, which will be further divided into the Washington and Greene series. Since White (1891, p. 20) used the name Dunkard in discussing several outcrop sections in Ohio, Prosser (1905, p. 5-7) accepted this term as applicable to the Permian section in Ohio and used it in his report "Revised Nomenclature of the Ohio Geological Formations."

The following section represents I. C. White's type section of his Dunkard Creek series (1891, p. 22):

Dunkard Creek Series Type Section

Section on Dunkard Creek, Greene County, Pennsylvania, from the head of its Pennsylvania fork in Gilmore Township, Greene County, eastward to where the stream veers northward back into Pennsylvania at Mount Morris.

	Thickness Ft.	Thickness In.	Interval From Base Ft.	Interval From Base In.
			1,162	3
Concealed from top of Shough's knob	165	0	997	3
Sandstone, massive, Gilmore	40	0	957	3
Shales, with limestone at base	15	0	942	3
Sandstone, shale, and concealed	100	0	842	3
Shale, red	2	0	840	3
Shales, gray	20	0	820	3
Shale, marly	2	0	818	3
Sandstone and shale	35	0	783	3
Shale, red	3	0	780	3
Sandstone and shale	50	0	730	3
Red shale	3	0	727	3
Shales and sandstone, Nineveh	25	0	702	3
Shales	20	0	682	3
Coal, Nineveh	1	6	680	9
Shales	28	0	652	9
Limestone, (No. X), Nineveh	7	0	645	9
Shales, sandstone, and concealed	100	0	545	9

	Thickness Ft.	Thickness In.	Interval From Base Ft.	Interval From Base In.
Sandstone, massive, Fish Creek	20	0	525	9
Shales, with fossil plants	10	0	515	9
Coal (Dunkard coal)	0	5		
Slate (Dunkard coal)	0	1	514	9
Coal (Dunkard coal)	0	6		
Limestone	1	0	513	9
Sandstone	10	0	503	9
Shales	17	0	486	9
Limestone, Jollytown	1	6	485	3
Shales and sandstone	25	0	460	3
Coal, Jollytown	1	1	459	2
Calcareous shale, fossiliferous, fish teeth	0	6	458	8
Limestone, Upper Washington	4	0	454	8
Shales and sandstone	115	0	339	8
Limestone, Middle Washington	3	0	336	8
Shales	40	0	296	8
Sandstone	35	0	261	8
Shale	5	0	256	8
Coal, impure (Washington "A" coal)	1	2		
Fireclay (Washington "A" coal)	2	6	252	6
Coal (Washington "A" coal)	0	6		
Shales and sandstones	60	0	192	6
Limestone, Lower Washington	5	0	187	6
Shales	5	0	182	6
Coal, slaty, Washington	5	0	177	6
Shales and sandstones, including a coal bed near center	110	0	67	6
Coal, Waynesburg "A"	2	6	65	0
Shales	10	0	55	0
Sandstone, Waynesburg	50	0	5	0
Shales, with fossil plants, Cassville	5	0	0	0

As has been previously mentioned, J. J. Stevenson (1876, p. 34) had already subdivided this group of rocks into two units, the Greene County group and the Washington County group. The following is Stevenson's (1876, p. 35) type section of the Greene County group from Centre Township, Greene County, Pennsylvania:

	Thickness Ft.	Thickness In.	Interval From Base Ft.	Interval From Base In.
			726	4
Concealed	80	0	646	4
Limestone (XIV)	8	0	638	4
Reddish shale	80	0	558	4
Limestone (XIII)	4	0	554	4
Sandstone	50	0	504	4
Limestone (XII)	10	0	494	4
Sandstone and shale	80	0	414	4
Limestone (XI)	2	6	411	10
Argillaceous shale	12	0	399	10
Sandstone	30	0	369	10
Nineveh coal bed	1	8	368	2
Sandstone	36	0	332	2
Bituminous shale	1	0	331	2

	Thickness		Interval From Base	
	Ft.	In.	Ft.	In.
Limestone (X)	2	6	329	8
Sandstone, shaly, massive, (Fish Creek)	100	0	229	8
Dunkard coal bed	1	6	228	2
Limestone (1Xb)	3	0	225	2
Sandstone and shale	30	0	195	2
Limestone (1X2)	15	0	180	2
Sandy shale	70	0	110	2
Limestone (VIII)	5	0	105	2
Coal, local bed	1	8	103	6
Sandstone	30	0	73	6
Limestone (VII)	2	6	71	0
Sandstone	31	0	40	0
Shale and iron ore	10	0	30	0
Limestone, Upper Washington (VI)	30	0	0	0

Stevenson found some difficulty in designating any one section as the type section of the Washington County group. Therefore, he presented the following section (1876, p. 44) as an approximate representation of the maximum development of the Washington County group in Washington County, Pennsylvania:

General Washington County Group Section

	Thickness		Interval From Base	
	Ft.	In.	Ft.	In.
			326	0
Coal or shale	1	0	325	0
Limestone, Upper Washington (VI)	30	0	295	0
Sandstone	40	0	255	0
Jollytown coal bed	1	0	254	0
Sandstone	40	0	214	0
Limestone, Middle Washington (IV)	15	0	199	0
Sandstone and shales	60	0	139	0
Limestone (III)	8	0	131	0
Sandstone and shale	20	0	111	0
Bituminous shale or coal bed	1	0	110	0
Limestone, Lower Washington (II)	20	0	90	0
Washington coal bed	10	0	80	0
Laminated sandstone	12	0	68	0
Little Washington coal bed	1	0	67	0
Shale	6	0	61	0
Limestone (Ib)	20	0	41	0
Waynesburg "B" coal bed	1	0	40	0
Sandstone	30	0	10	0
Limestone (Ia)	8	0	2	0
Waynesburg "A" coal bed	2	0	0	0
Waynesburg sandstone	-	-		

The relationships and correlations of these sections and lithologies to similar lithologies and horizons in Ohio will be discussed in detail in subsequent sections on the Permian system. Permian system.

Distribution in Ohio

The Permian strata of the Appalachian coal field are distributed in an oval-shaped basin lying in the central portion of the northern part of the Appalachian coal field. The area covered lies in three states, eastern Ohio, southwestern Pennsylvania, and northeastern West Virginia, and covers approximately 8,000 square miles (figure 21).

The Permian or Dunkard rocks in Ohio are exposed in a belt about 30 miles wide along the eastern edge of the State, extending from southern Jefferson County to the southern tip of Meigs County, roughly paralleling the Ohio River. The whole area measures approximately 1,213 square miles (Stauffer and Schroyer, 1920, p. 12).

The Clark Hill Road section, in Salem Township, Monroe County, represents the most complete stratigraphic section of Permian strata in Ohio. It extends from the base of the Washington formation to within one hundred feet of the top of the Greene formation exposed in Ohio and includes 665 feet of measured strata. Dr. A. T. Cross, who measured this section, has recognized eleven cyclothems and associated coaly zones in the Washington formation and 21 cyclothems and associated coaly zones in the Greene formation. This section is too lengthy for publication here and has no immediate bearing upon this report. However, it is available in the Survey files and has been previously published in the Field Guide on the Stratigraphy, Sedimentation, and Nomenclature of the Upper Pennsylvanian and Lower Permian Strata of the Northern Portion of the Dunkard Basin (Cross et al., 1950, p. 54-62).

THE PERMIAN SYSTEM IN ATHENS COUNTY

Distribution in Athens County

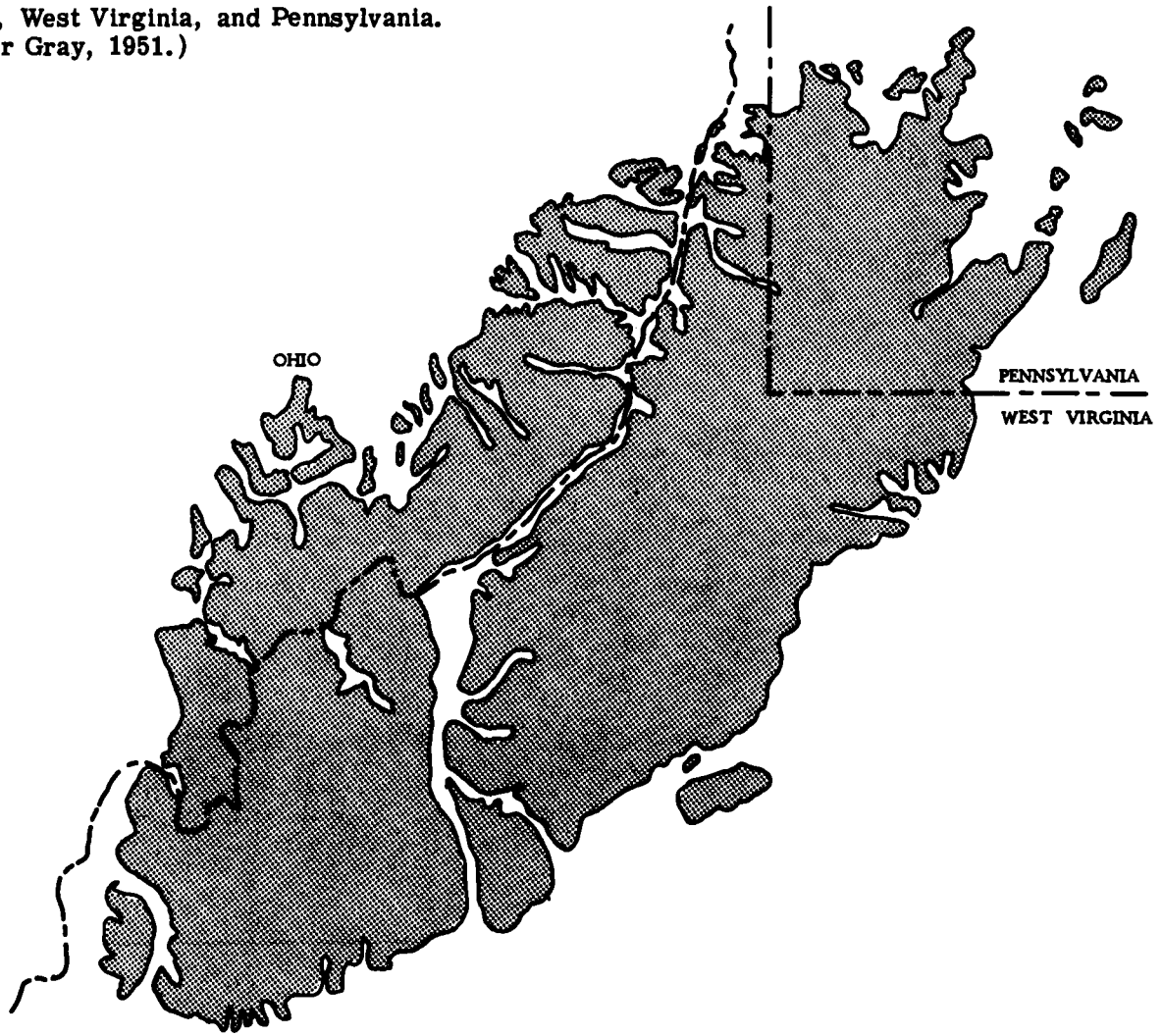
The Permian outcrops in Athens County are confined to the eastern edge of the county (see geologic map in pocket). All the surface rocks of Troy Township are of Permian age, with the exception of a narrow belt exposed along the Hocking River and its tributaries. The surface rocks in the eastern half of Carthage Township belong to the Permian system as well as do the majority of the strata on the hilltops in the western half of the township. Rocks in the southeastern corner and along the eastern edge of Rome Township are all Permian in age, as are also the rocks on the extreme eastern margin of Bern Township. The high ridges and hilltops in the western portions of Bern and Rome Townships are capped by rocks of Permian age and, to the south, a few isolated high points in the eastern third of Lodi Township are composed of Permian strata as well as several high ridges and hilltops along the extreme eastern edge of Canaan Township. Geographically, therefore, Permian age strata in Athens County are exposed only in six townships--Lodi, Canaan, Bern, Rome, Carthage, and Troy--and cover an area of approximately 80 square miles.

Character of the Sediments

Two predominant types of rocks characterize the Permian strata of Athens County. They are shales and sandstones. Approximately 79 per cent of the rocks in the Permian column in Athens County are sandstone and 20 per cent are shale, based upon all of the measured geologic sections of the Permian in the county.

The sandstone beds are quite variable in nature. They are massive- to thin-bedded and range from conglomeratic, coarse and medium-grained, to fine-grained and silty. They are quite variable laterally, grading into siltstones and shales, often within a short distance of perhaps only a few hundred feet. These sandstone beds may be deposited unconformably on the underlying sediments in one area, and the same sandstones in other areas of the county will be found

Figure 21 - Areal distribution of Dunkard strata in Ohio, West Virginia, and Pennsylvania. (After Gray, 1951.)



to grade upward regularly and evenly from underlying beds of shaly siltstones and silty shales into the sandstones themselves.

Cementing materials of these Permian sandstones in Athens County are usually a carbonate-calcium carbonate or iron carbonate cement. The type and quality of cementing material is sometimes indicated by the weathered surfaces of these sandstone beds. Iron carbonate cement material gives some discoloration to the sandstone and is usually responsible for the characteristic limonite stain found on a weathered surface of the sandstone. Development of coves, honeycombs, and sugary texture on weathered surfaces of these sandstones is due, in part, to the solution and leaching of the lime cement material from the sandstones. The Mannington and Waynesburg sandstones along the Ohio River in the vicinity of Hockingport are good examples of this type of weathering effects.

Shale, the other major rock type comprising the Permian strata of Athens County, is also quite variable. The shale beds are usually varicolored, dusky red, brown, purple, maroon, pink, or light, medium, or dark gray. They are often variegated red and green or gray and green with red or purple mottling. A. T. Cross (1950, p. 145) notes, "The important and notable feature of these red and green alternating shales is that the lines of demarcation between them are generally well defined and traceable for great distances. There is an orderly, cyclical sequence of occurrence of these variegated shales."

These shales may be bedded or nonbedded. The nonbedded portion usually occurs below the coal bed or its lateral horizon. Conversely, the bedded shale is usually found overlying the coal seam or its lateral expression as a smut streak or horizon. When a coal seam is absent in certain areas or is only represented by a smut streak, the contact between the bedded and nonbedded shales is often the only basis of establishing the position or horizon of a coal bed in the geologic column of a particular area.

The bedded shales are frequently thick-bedded but more often are thinly laminated and platy, weathering chippy to fissile. The nonbedded shales are usually massive and contain numerous slickensides. These shales are quite often indurated and contain scattered irregular and impure limestone knots and nodules, which laterally may represent a limestone. The nonbedded shales usually weather with a crumbly to hackly appearance.

Other rock types represented in the Permian rocks of Athens County are limestone, underclay, and coal. These three rock types constitute less than one per cent of the total Permian rock column for the county. Limestone beds are, in general, absent from Permian strata in the county. However, in the few sections in which limestones are present, they are found to be very irregular, nodular, limey zones occurring above the nonbedded shale and below the coaly zones and are not traceable for very great distances.

The underclays are also quite variable in thickness but, along with the coaly zones, are probably the most persistent rock type found in the Permian column. They are usually no more than a few inches of clayey shale, light to medium gray in color, weathering to a soft plastic consistency. Occasionally there is some carbonaceous debris scattered throughout these underclay zones.

The coal, or more appropriately, the coaly zone, is the remaining type of lithology in the Permian strata of the county. There is very little true coal found in this group of rocks. All that is indicative of coal in this area are smut streaks of coaly material or carbonaceous debris intercalated into a clay shale. However, to the geologist, this smut zone represents a facies change or local development of a coal which laterally may attain minable thickness and be of good quality. These coaly zones are very persistent throughout most of the Athens County area and may be traced for considerable distances with remarkable accuracy; they are the primary basis of correlation of one section with another. Cross (1950, p. 147) clearly illustrates this in writing, "The coals often show lithologic features which are relatively constant for a greater portion of their extent but there are many features of a local nature which often make proof of lateral continuity difficult on a lithologic basis."

Table 14

Generalized Stratigraphic Column for the Permian System in Athens County

No.	Cycle	Member	Description	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
4	Washington	Washington	Roof shale, medium to dark gray or varicolored dusky red and green, contains some scattered carbonaceous debris and thin coaly lenses; well-bedded.	1	0	53	2	147	6
			Coal, bony to blocky and bright to carbonaceous shale and coal smut in gray clay shale; quite variable laterally. Has locally been mined in Athens County.	0	2				
		Washington Fire Clay Shale	Underclay, light gray with maroon mottling, contains some carbonaceous debris.	0	8				
		Bristol	Limestone, fresh-water, usually a limestone zone of irregular, impure limestone nodules in a dark green to gray shale matrix.	5	6				
			Redbed, shale, clayey, dusky red to maroon, gray, green, and purple, variegated or mottled, contains limestone knots, crumbly and non-bedded.	19	4				
		Washington (in part Mannington)	Shale and sandstone, olive gray to bluish gray to tan, coarse- to fine-grained to silty, massive- to medium-bedded, cross-bedded, micaceous, generally coalesced with underlying Mannington sandstone in Athens County.	26	6				
3	Little Washington	Little Washington	Roof shale, light to dark gray, silty to argillaceous, some limonite staining.	2	5	52	4	94	4
			Coal, smut streak in gray plastic clay shale to horizon.	0	1				
			Underclay, absent.	-	-				
			Limestone, fresh-water, absent.	-	-				
			Redbed, shale, bluish gray to maroon, mottled purple, sandy to silty in some areas, contains limestone knots which laterally develop into a thin impure limestone streak.	5	9				
		Mannington	Shale and sandstone, olive gray to gray, weathers tan to buff with limonite stain, massive- to thin-bedded, often coalescing with sandstone beds above and below, coarse-to fine-grained, micaceous.	44	1				
2	Waynesburg "A"	Waynesburg "A"	Roof shale, gray to dark gray with some carbonaceous shale zones scattered throughout.	1	0	36	4	42	0
			Coal, carbonaceous to coaly smut in greenish gray to light gray clay shale; often develops a lower bench.	0	2				
			Underclay, clay shale, light gray, weathers soft and plastic.	1	3				
		Mount Morris	Limestone, fresh-water, absent.	-	-				
			Redbed, shale, maroon to purple with gray mottling, contains small limestone knots and nodules, calcareous, crumbly, non-bedded.	9	6				
		Waynesburg	Shale and sandstone, yellowish brown to tan to gray and greenish gray; coarse, medium, and fine-grained to silty, contains both shale and conglomeratic zones, micaceous, cross-bedded; often coalesces with sandstone units above and below.	24	5				
1	Elm Grove	Elm Grove	Roof shale, maroon, silty to argillaceous, micaceous.	0	6	15	8	15	8
			Coal, carbonaceous shale to coaly smut in dark gray shale.	0	3				
			Underclay, shale, light gray, soft, argillaceous.	0	1				
		Elm Grove	Limestone, fresh-water, absent.	-	-				
			Redbed, shale, clayey to silty, variegated or maroon to pink.	6	2				
			Shale and sandstone, bluish gray to light greenish gray, medium- to fine-grained or silty, thin-bedded.	8	8				

Stratigraphy

The stratigraphy of the Permian or Dunkard rocks of Athens County will be discussed on the same basis of cyclothem groupsings as has been the preceding section dealing with Pennsylvanian stratigraphy. It has already been demonstrated that there is essentially very little change in the lithology and character of the strata between the Pennsylvanian and Permian rocks of Athens County. The Permian rocks also exhibit an orderly, cyclical sequence of accumulation.

There are approximately 330 feet of Permian strata in the county, which include at least 15 recognizable cyclothemic groupings. In accordance with the groupings of members of a cyclothem presented in the preceding section on Pennsylvanian stratigraphy, the typical Permian cyclothem will be divided into six members, beginning at the base of a sandstone or top of a coaly horizon and ending at the base of the next overlying sandstone. The cyclothem includes 1. massive shale, sandstone and/or sandy shale member, 2. redbed member, 3. fresh-water limestone member, 4. underclay member, 5. the coal bed, coaly horizon, or coaly zone, and 6. roof shale member. The cyclothem will be named for the coal bed which occurs within it. A seventh member, the marine limestone, is not recognized in Permian strata of Athens County.

Elm Grove Cyclothem

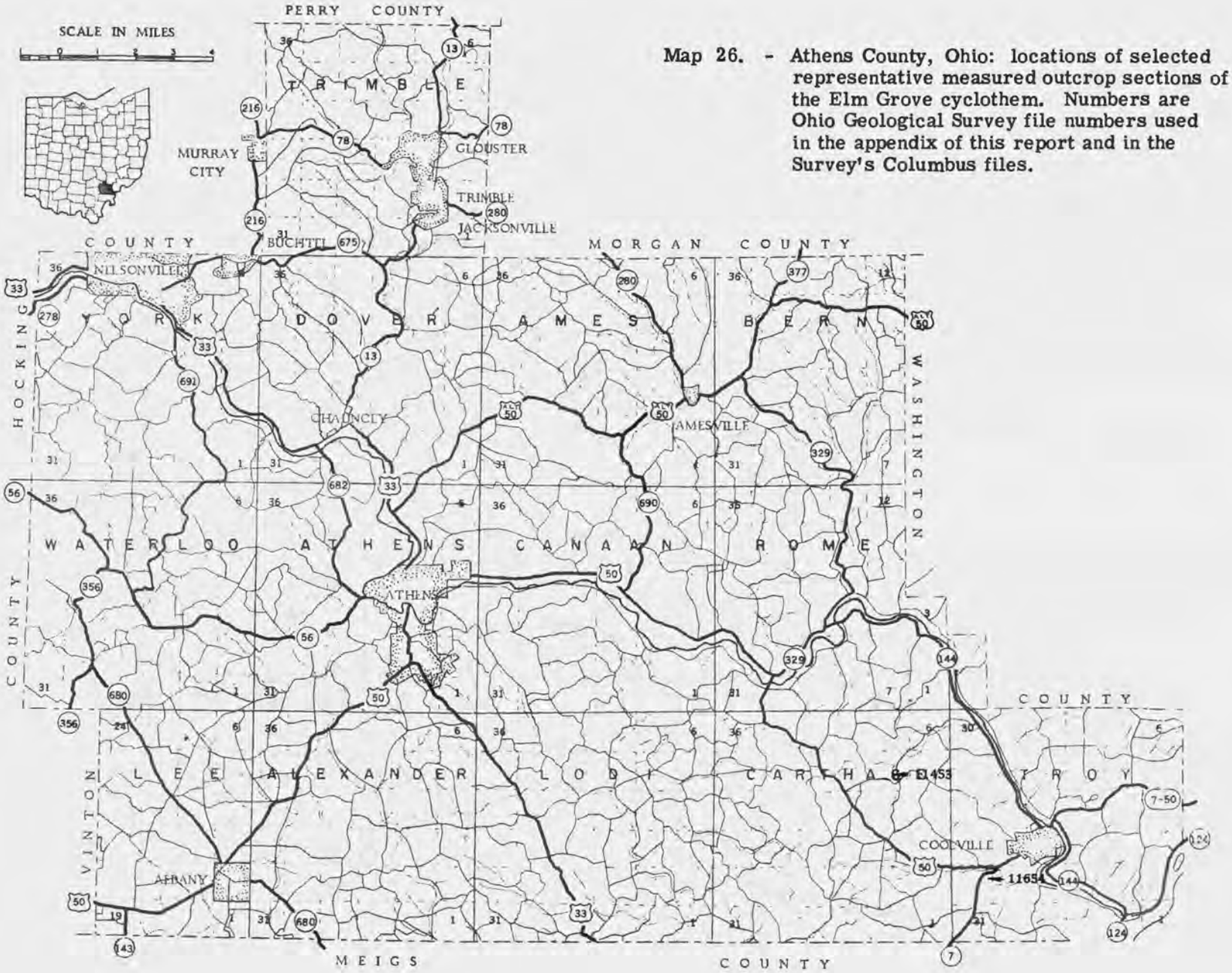
The Elm Grove cyclothem is the first recognized cyclothem in the Washington series. In Athens County this cycle is poorly developed and is recognized in only two measured sections in Troy and Carthage Townships (map 26). In these three sections a coaly zone occurs about 10 to 15 feet above the Waynesburg coal. The identification of this coaly zone in Athens County is problematical, but it occurs here with the same interval to the Waynesburg coal as it does to the north in Monroe and Belmont Counties where the Elm Grove coal is better developed. This coal zone is usually identified by its association with the underlying Elm Grove limestone. Unfortunately, in Athens County there is no evidence of the Elm Grove limestone in this sequence. However, the writer prefers to identify this coaly zone occurring 10 to 15 feet above the Waynesburg coal as the Elm Grove coal. Because of the lack of adequate information on this cyclothem in Athens County, the individual members will not be discussed. Thickness data for the cyclothem are presented in the generalized column (table 14) introducing this section.

Waynesburg "A" Cyclothem

The Waynesburg "A" cyclothem is the first major cyclothem of widespread occurrence and distribution in the Dunkard strata of Athens County. Without considering the Elm Grove cyclothem, which has just been discussed, and the Lower Waynesburg "A" cyclothem, which will be considered in the discussion of this cyclothem, both of which are extremely local in their development in Athens County, the Waynesburg "A" cyclothem includes all the strata from the top of the Cassville shale to the base of the Mannington sandstone. This cyclothem or parts of this cyclothem are present in Bern, Carthage, Lodi, Rome, and Troy Townships (map 27). Selected stratigraphic sections which include this cyclothem are in the appendix to this report.

Variations in thickness and boundaries of this cyclothem are due to lack of lateral persistence of the Elm Grove and Lower Waynesburg "A" coal horizons or a result of the erosional down-cutting and/or coalescence of the Waynesburg sandstone with the overlying and underlying sandstones, as shown in figure 22.

Waynesburg Shale and Sandstone Member. - The Waynesburg sandstone is the first major sandstone occurring in the Washington series. It was named for its outcrop and massive development in the vicinity of Waynesburg, Greene County, Pennsylvania. Due to the massive nature and persistent occurrence of this sandstone, it has previously been used to separate the Permian system from the Pennsylvanian system. Both the top and the bottom of this member have been used in the past as the Pennsylvanian-Permian contact.



Map 26. - Athens County, Ohio: locations of selected representative measured outcrop sections of the Elm Grove cyclothem. Numbers are Ohio Geological Survey file numbers used in the appendix of this report and in the Survey's Columbus files.

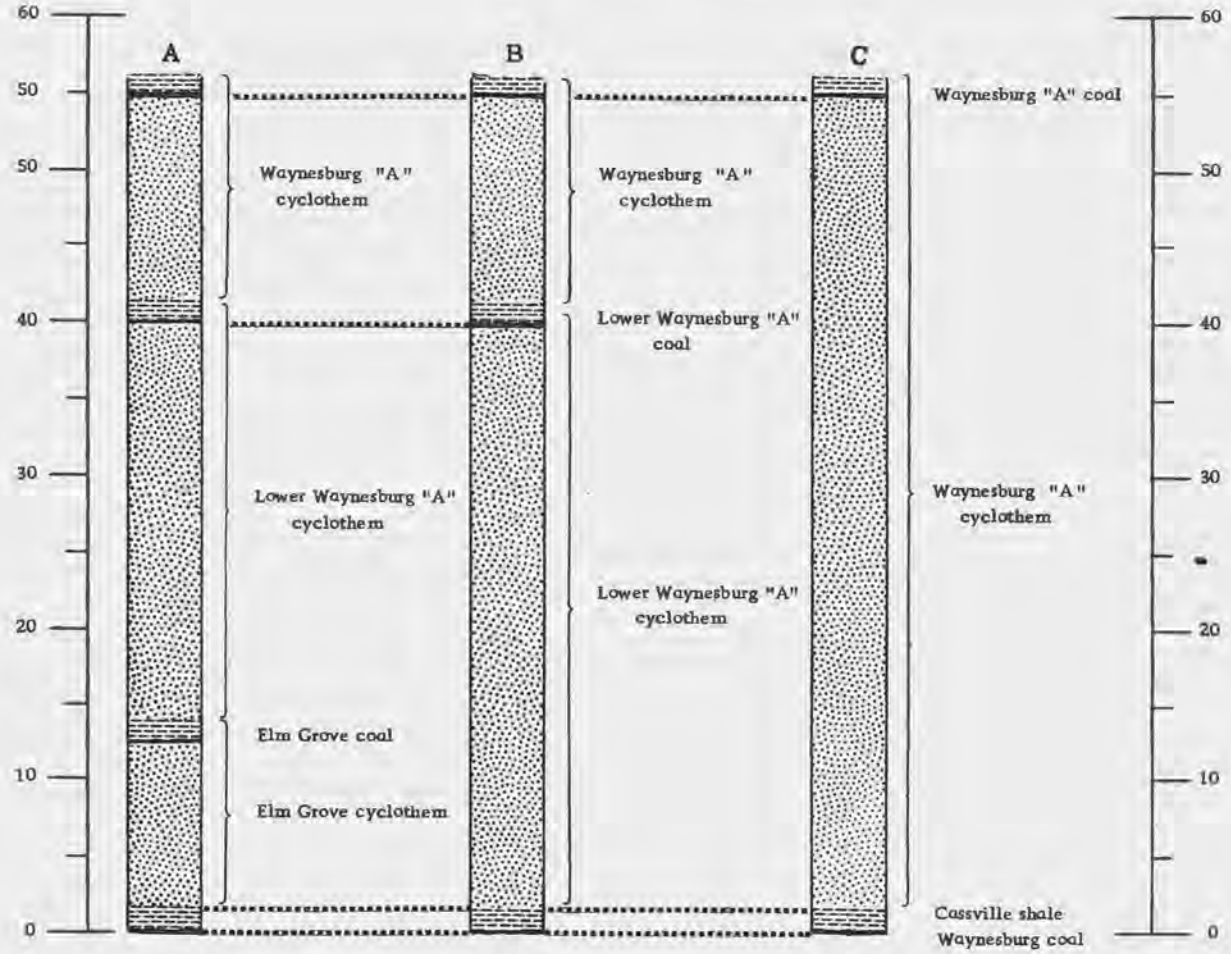
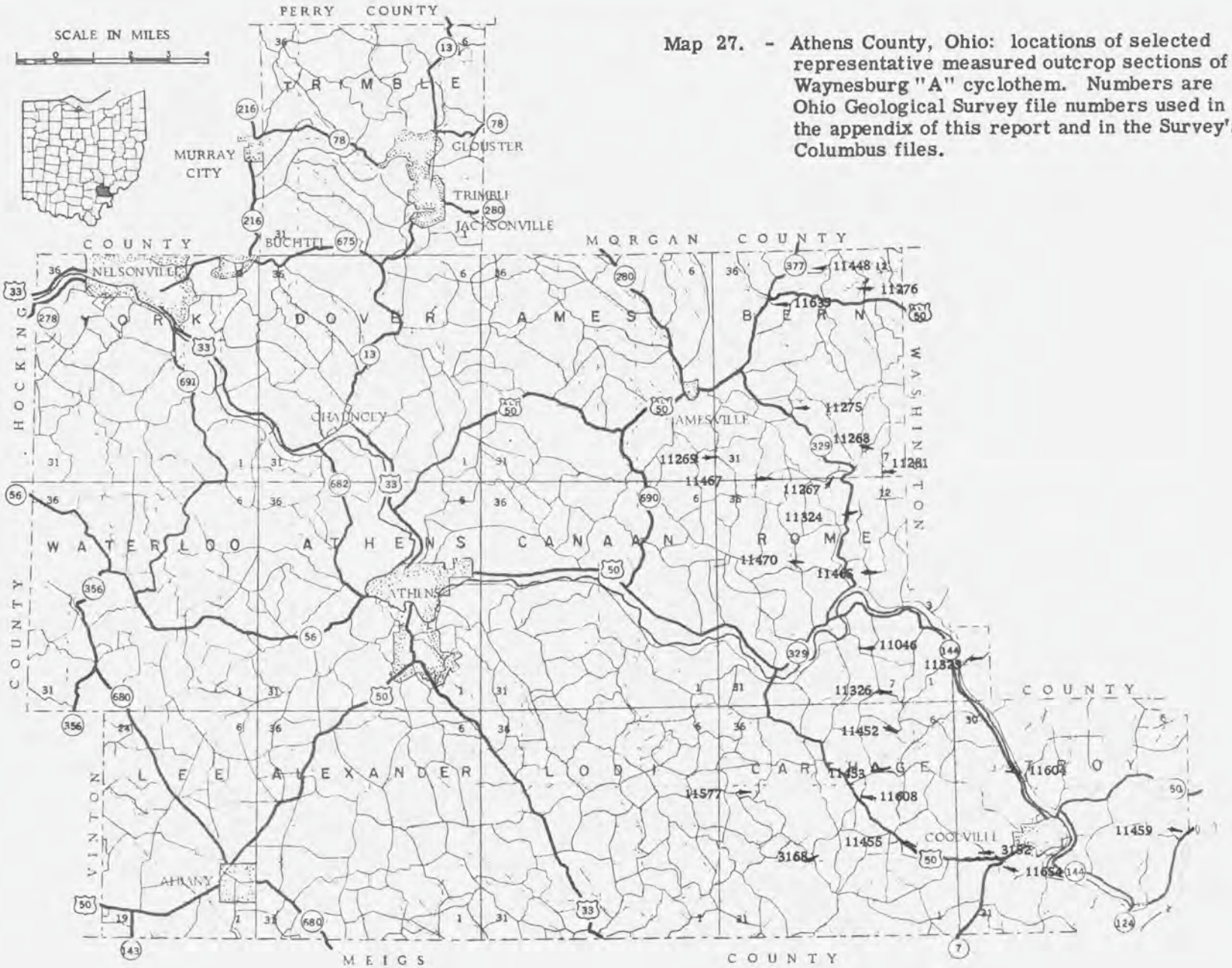


Figure 22 - Generalized geologic sections showing variations in cyclothems due to lack of lateral persistence of the Elm Grove and Lower Waynesburg "A" coal horizons and coalescence or down-cutting of massive sandstones.

I. C. White (1891, p. 40) describes the Waynesburg sandstone as "one of the most persistent members of the Dunkard series, since its eastern outcrop can be followed in an almost constant line of cliffs from Greene County, Pennsylvania, clear across West Virginia to the Big Kanawha River at Winfield. This stratum is only one in the series that is generally conglomeratic or contains quartz pebbles larger than coarse sand grains. Along the western border of the outcrop of this rock it dwindles down and changes its character entirely, being frequently represented in Washington County, Pennsylvania; Marshall and Ohio Counites, West Virginia; Belmont and Monroe Counties of Ohio, by sandy shales and flaggy sandstones, and occasionally even a stratum of limestone may be found at this horizon." In another publication (1903, p. 118), White notes, "This same stratum (Waynesburg sandstone) comes out of the Ohio River along the Ohio shore in the vicinity of Blennerhassett Island, and its massive top is frequently visible at low water in the bed of the Ohio at many localities between Parkersburg (or Belpre in Ohio) and Letart (or Letart Falls in Ohio)."

At Muses Bottom, Jackson County, West Virginia, across the Ohio River from Hazael, Lebanon Township, Meigs County, Grimsley (1909, p. 443) describes the Waynesburg sandstone as follows: "The stone varies from a light gray to a light buff in color, and is more or less banded by white mica flakes. The gray stone is close grained but under a small lens is seen to be composed of well marked quartz grains. Some of the layers are conglomerates with the pebbles loosely held together and enclosing vitreous quartz fragments reaching a length of three-fourths inch."



Map 27. - Athens County, Ohio: locations of selected representative measured outcrop sections of Waynesburg "A" cyclothem. Numbers are Ohio Geological Survey file numbers used in the appendix of this report and in the Survey's Columbus files.

The description of the Waynesburg sandstone as it occurs in Athens County is very much the same as in the preceding paragraphs. It is the massive sandstone which forms the prominent cliffs outcropping along the Hocking River and its tributaries as they cut through Rome, Carthage, and Troy Townships. The Waynesburg sandstone caps the ridges and hill tops in eastern Lodi and western Carthage Townships. As it occurs in Athens County, the Waynesburg sandstone is yellowish brown to tan or gray to greenish gray in color. It can be massive, medium or thin bedded. It ranges in grain size from coarse, medium, to fine grained. The sandstone often contains silty and shaly zones or conglomeratic zones. It is usually micaceous and cross-bedded and weathers with a sugary texture and characteristic limonitic stain.

A massive cliff-forming sandstone as much as 90 feet thick occurs in the vicinity of Hockingport in Athens County along the Ohio River (figure 23). This has been called the Hockingport sandstone (Martin, 1955). This massive sandstone is the coalesced Waynesburg-Mannington sandstones. The "Hockingport" sandstone almost completely occupies the interval between the Waynesburg coal and the Washington coal horizons. The horizon of the Washington coal is evident in all of the measured sections along the Ohio River in the vicinity of Hockingport, while the Waynesburg coal is at or just below the level of the Ohio River and is generally covered by silts and muds of the river banks. In some areas of the county this massive sandstone development is the coalesced Waynesburg sandstone and underlying Gilboy sandstone. In other areas, the Mannington, Waynesburg, and Gilboy sandstones all coalesce to form one massive sandstone stratum. Martin (1955, p. 20) writes that "The Hockingport sandstone is composed of a network of buried stream channel structures. Sandstone and conglomerate lenses rather than sandstone strata prevail. Cross-laminated channel structures occur in greatest abundance in the lower half of the sandstone with the upper portion being nearly structureless in some areas." Martin further describes the Hockingport sandstone (p. 26-27) as "a 'muddy' sandstone, a subgraywacke. The deposit is made up of approximately 65 per cent quartz, the remainder consisting mostly of rock fragments and argillaceous material."

Stout, in his field work in the Athens County area, identified this big massive sandstone as the Chesterhill sandstone. During his field work Stout applied this name both to the Mannington, Waynesburg, and Gilboy sandstones individually and to the massive coalesced facies of the three beds where they outcrop in Athens County.

Redbed Member. - This member is typical of the red shale members of the Dunkard cyclothems. It is characteristically calcareous and nonbedded. It is usually maroon to purple in color with some gray mottling. The shale weathers crumbly to soft and becomes somewhat silty in some areas. This member contains small irregular and impure limestone knots and nodules scattered throughout. It is quite variable in thickness, varying from 1 foot to 27 feet in thickness, averaging 9 feet 6 inches.

Mount Morris Limestone Member. - This unit is generally absent from the Waynesburg "A" cyclothem in Athens County. In Monroe and Belmont Counties the Mount Morris limestone is usually present and fairly well developed and should, therefore, be introduced into the Ohio geologic column. In West Virginia and southwestern Pennsylvania it is a good marker limestone to identify the Waynesburg "A" coal, and in some areas it has an upper and lower development with a sandstone occupying the interval between them.

Underclay Member. - As a true underclay, this member was recorded only in Carthage Township. However the Waynesburg "A" coal is usually represented as a mere smut streak intimately associated with a gray, plastic clay shale. This shale is all that is indicative of an underclay development in the Waynesburg "A" cycle.

Waynesburg "A" (No. 11a) Coal Member. - In Athens County, the Waynesburg "A" coal occurs at an average of 52 feet above the Waynesburg coal and approximately 37 feet above the Elm Grove coal when it is present. The Waynesburg "A" coal horizon occurs in all five townships



Figure 23 - Waynesburg (Hockingport) sandstone along road and Ohio River just south of Athens-Meigs County line and north of Indian Run.

in Athens County which contain Dunkard strata. The coal is usually represented by a smut streak, carbonaceous debris, or coaly material in a greenish gray to light gray clay shale. At some localities, its position or horizon is all that is indicated.

The Waynesburg "A" coal often has an upper and lower development. This is probably due to splitting or the development of a rider coal. This upper and lower development has been tentatively named by various workers in the field as the Upper or Lower Bench of Waynesburg "A" coal or as the Upper or Lower Waynesburg "A" coal. To the north in Monroe County, where these benches are better developed, the average interval between the Upper and Lower Waynesburg "A" coal beds is 13 feet. This interval is usually occupied by 8 to 10 feet of sandstone or sandy shale and 3 to 5 feet of calcareous red shale. In Athens County, the average interval between these two coals is 14 feet. In this county, the writer is calling the persistent, better developed, upper horizon the Waynesburg "A" coal and the lower coal, the Lower Waynesburg "A". This lower coal was found at only three localities in the county and could not be traced for any great distance. The representative cyclothem is given below:

	Average Known Thickness		Interval From Base	
	Ft.	In.	Ft.	In.
Lower Waynesburg "A" cyclothem			31	1
6. Roof shale	0	4	30	9
5. Lower Waynesburg "A" coal. Smut streak in clay shale to horizon or position . .	0	4	30	8

	Average Known Thickness		Interval From Base	
	Ft.	In.	Ft.	In.
4. Underclay, missing	-	-	30	8
3. Fresh-water limestone, missing	-	-	30	8
2. Redbed, shale, maroon, limonite-stained, contains small limestone nodules in lower portion	18	1	12	7
1. Sandstone and sandy shale. Sandstone olive green to blue-gray to tan, limonite stained; micaceous; fine-grained to silty and shaly; thin-bedded; plant fossils found in shale partings	12	7	0	0

Roof Shale Member. - This stratum directly overlies the Waynesburg "A" coal bed. As it occurs in Athens County it appears as a gray to dark gray shale, seldom containing plant fossils, but occasionally having thin,coaly to carbonaceous shale stringers or bands scattered throughout its thickness. This unit,averaging one foot in thickness, is not a persistent member of the cyclothem in Athens County, either due to the lack of good development of the Waynesburg "A" coal or due to erosion and downcutting by the overlying Mannington sandstone

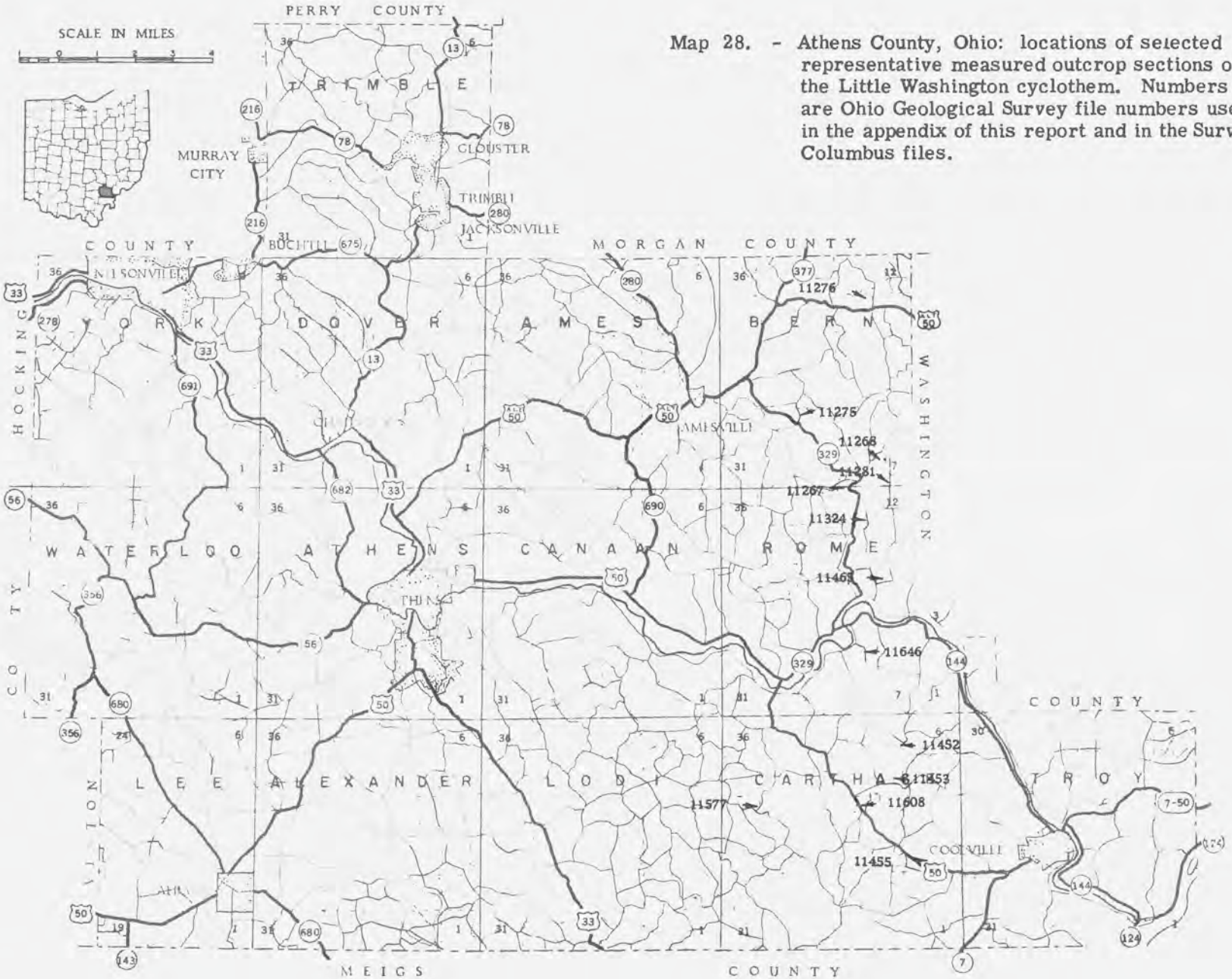
Little Washington Cyclothem

The next cyclothem which occurs above the Waynesburg "A" cyclothem in Athens County is the Little Washington cyclothem. It extends from the base of the Mannington sandstone to the top of the roof shale of the Little Washington coal. The representative cyclothem for Athens County is presented in the generalized geologic column (table 14).

Representative geologic sections which include this cyclothem are located on map 28 and are in the appendix to this report. The Little Washington cyclothem appears in only Bern, Rome, and Carthage Townships. In Troy Township it is poorly defined and hard to demonstrate due to the coalescing of the Mannington and Waynesburg sandstones. Even the overlying Washington sandstone of the Washington cyclothem may join with these two beds to become part of the massive, cliff-forming "Chesterhill" and "Hockingport" sandstones.

Mannington Shale and Sandstone Member. - The Mannington sandstone was first named by Grimsley (1909, p. 440-441) for its development in the vicinity of Mannington, Marion County, West Virginia. Grimsley (1909, p. 440) describes the sandstone thus : "The stone has a greenish gray color and is finely laminated along planes formed of black mica. The quartz grains are very small giving the rock a close texture and white and black mica specks occur all through the stone, though especially abundant along the foliation planes." With very little modification this description could suffice for the Mannington sandstone in Athens County. Here the sandstone is olive gray to gray, weathering tan to buff with considerable limonite stain on its surface. It is micaceous, coarse to fine grained in texture, and is massive- to thinly bedded. The sandstone ranges from 31 to 52 feet in thickness and is often coalesced with the overlying Washington sandstone and the underlying Waynesburg sandstone to form massive cliffs up to 100 feet in height.

In some areas, particularly to the north in Monroe and Belmont Counties in Ohio and the northeast in West Virginia and southwestern Pennsylvania, the Mannington sandstone has an upper and lower division. The Waynesburg "B" coal occurs between these two benches. However, in Athens County, the Mannington sandstone appears as a single continuous unit lacking a lower and upper development and the Waynesburg "B" coal in the section. To the southwest in section 3, Orange Township of Meigs County, there are a lower and upper bench of sandstone at the position



Map 28. - Athens County, Ohio: locations of selected representative measured outcrop sections of the Little Washington cyclothem. Numbers are Ohio Geological Survey file numbers used in the appendix of this report and in the Survey's Columbus files.

of the Mannington with a thin, dark green shale zone overlying a maroon clay shale which occurs between these two benches of sandstone. This smutty, dark green shale zone is probably the horizon of the Waynesburg "B" coal and, with a more detailed field study, this horizon and sandstone development perhaps could be traced into Athens County.

Redbed Member. - This unit is similar in its development and character to most other redbed members of any Permian cyclothem in Athens County. It is typically calcareous and clayey. It ranges from blue gray to maroon in color and has a purplish mottling. It is often micaceous, and is sandy to silty in some areas. This shale unit contains scattered layers or zones of irregular and impure limestone knots and nodules which, in Carthage Township, develop into a thin limestone bed. This limestone development is probably equivalent to Stevenson's Limestone Ib (1976, p. 35) and may be correlative with the Woodglen limestone of Hickock and Moyer (1940, p. 147) or the Bristol limestone of Hennan (1912, p. 168-169).

Fresh-Water Limestone Member. - This member is not present in the Little Washington cyclothem in Athens County. However, its lateral development was noted in geologic section 11455 in Carthage Township. Fresh-water limestone and the red shale members in Athens County are usually undistinguishable as an individual unit, particularly the limestone. Cross and Arkle (1951, p. 110) in discussing some of the fundamental features of the lithology of the upper Pennsylvanian and lower Permian strata of the Appalachian area, demonstrate clearly the changes in lithology of these fresh-water limestones. They state, "The fresh water limestones show conspicuous changes laterally. From east to west (or north to south) the limestones change in lithology from the fairly massive, hard gray type with few, thin, gray, calcareous shale partings to hard, gray limestones with more numerous and often thicker gray shale partings. Westward these hard zones become increasingly thinner; the shale zones become thicker and more numerous and gradually change from gray to red. In the westernmost areas and in many instances toward the south, there is little or no hard limestone and that which is present is colored purplish-red rather than gray....(Note: This is true in Athens County)...The red shaly limestones or limy shales dominate the sections in the west whereas in the eastern areas the gray limestones occupy 75 to 90 per cent of the total thickness of sediments in each cycle. This facies gradation is virtually the same for each series but the facies from each series are not superimposed. There appears to be a steady migration of the basin of accumulation of the purer limestones to the east and south, possibly an onlap of the lake or sea."

Underclay Member. - The underclay member of the Little Washington cyclothem is also absent from the geologic section in Athens County. This is unusual as the underclay is usually the most persistent member of the cyclothem. It is likely that the coaly zone and the underclay are analogous in this cycle as the horizon of the Little Washington coal in Athens County is always found to be a smutty streak, occurring in a gray, plastic, clay shale matrix. The underclay zone is also difficult to distinguish from the red shale zone. The contact between them is gradational or transitional and very difficult to define in the field.

Little Washington Coal Member. - The Little Washington coal was first named and described by Stevenson (1876, p. 54) from exposures in Washington and Greene Counties, Pennsylvania. Stevenson described the Washington coal - Little Washington coal interval as follows: "It is not even approximately parallel to the Washington coal, but invariably describes short waves, two to three feet deep and six to thirty feet long. In these irregularities the upper bed does not participate, and all variations are at the expense of the intervening rocks."

In Athens County the Washington coal-Little Washington coal interval varies from 16 to 33 feet, averaging 23 feet. The Little Washington is usually represented by a horizon or smut streak in a gray, plastic weathering, clay shale, usually only about one inch thick. It is very local in its occurrence and was observed in only a few measured sections which contain strata of the Washington coal-Waynesburg "A" coal interval.

Little Washington Roof Shale Member. - This member is usually a well-bedded, gray, clayey shale, and is often silty to sandy. It frequently has a limonite stain on a weathered surface. This unit ranges in thickness from 1 foot 3 inches to a maximum of four feet, averaging about 2 feet 6 inches. No plant fossils have been recorded from this member in Athens County.

Washington Cyclothem

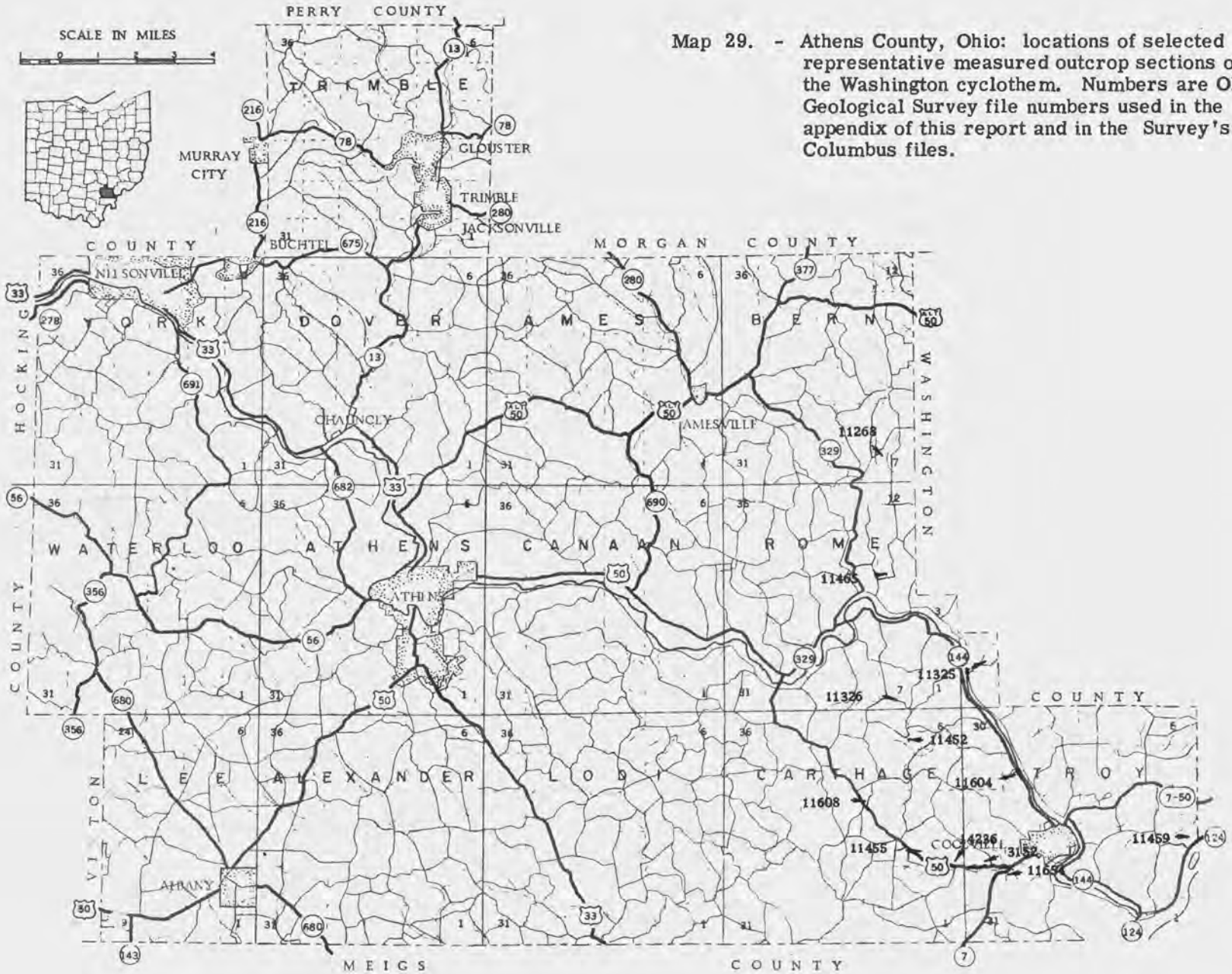
The next cyclothem above the Little Washington cycle is the Washington cyclothem. It extends from the base of the Washington sandstone to the top roof shale of Washington coal. The average Washington coal - Little Washington coal interval in Athens County is 23 feet. When the Little Washington coal is missing from the strata, the lower boundary of this cyclothem is then placed at the base of the Mannington sandstone. For this reason the thickness of the Washington cyclothem is variable due to boundary differences in that the absence or presence of the Little Washington coal is the controlling factor. A similar situation exists for this cycle as for the Waynesburg "A" cyclothem illustrated in figure 22. However, the Washington cyclothem is fairly well developed in Athens County and is found in Bern, Carthage, Rome, and Troy Townships (map 29).

Washington Shale and Sandstone Member. - Stevenson (1876, p. 53) first named the Washington sandstone for exposures of this bed in Washington County, Pennsylvania. He described this sandstone (1876, p. 53) as "a thinly laminated micaceous sandstone, varying in color from dark gray to bluish gray, and in thickness from eight to eighteen feet."

In Athens County, this sandstone member can probably be more correctly identified stratigraphically with the Mannington sandstone. This is due, in part, to the lack of good development of the Little Washington coal. In areas where the Little Washington coal is absent, and the Waynesburg "A" - Washington coal interval is occupied by a massive sandstone, this sandstone would then be equivalent to the Mannington sandstone. It can be stated, however, that time-wise the upper portion of this sandstone may be equivalent to the Washington sandstone. This may be one explanation of the "Hockingport" sandstone as it is developed in Troy Township (figure 23). Discounting coalescence as one explanation, another inference could be a continuous deposition of sandstone in a major stream channel of a delta from Waynesburg time to Washington time. Martin (1955, p. 20) points out that the "Hockingport sandstone is composed of a network of buried stream channel structures." Laterally, there were interruptions in this continuous deposition of sand with the formation of the Waynesburg "A", and Little Washington coals. In other areas of the county where the Waynesburg, Mannington, and Washington sandstones are separate entities, they could merely be channel deposits in tributaries of the main "Hockingport" trunk channel which were migrating upward through time. Therefore, three geologic time divisions of the "Hockingport" sandstone could be inferred. The lower portion could be equivalent to the Waynesburg sandstone, the middle portion to the Mannington sandstone, and the upper portion to the Washington sandstone. The relationship of these sandstone bodies is still obscure. The lack of good development of coal beds is one factor which prevents good correlation of these sandstones or sandstone facies from one area to another within the county. A very detailed field study of the inter-relationships of these three sandstone beds in Athens County, similar to that of Martin, is recommended.

Redbed Member. - This member of the Washington cyclothem occurs just above the Washington sandstone and averages about 20 feet in thickness, ranging from 7 feet 4 inches to 25 feet 8 inches. It is varicolored dusky red, maroon, gray, green, and purple. It is often variegated or mottled. This varicolored member has a very singular appearance on a weathered face. It easily weathers to a fine dust-like consistency, and this effect in combination with its bright coloration makes it a useful marker in identifying the overlying Washington coal. This unit is calcareous and contains small limestone knots and nodules.

Bristol Limestone Member. - This member occurs as an irregular nodular limestone



Map 29. - Athens County, Ohio: locations of selected representative measured outcrop sections of the Washington cyclothem. Numbers are Ohio Geological Survey file numbers used in the appendix of this report and in the Survey's Columbus files.

zone. It is quite impure and is not persistent in its development in Athens County. It was observed in only two measured sections, one in Rome Township and one in Troy Township. The zone averages 5 feet 6 inches in thickness and represents the first major limestone development in the Dunkard strata of Athens County. The writer has correlated it to the Bristol limestone but this is only a tentative correlation as there is not enough control to establish its true identity. Hennen (1912, p. 168) places the Bristol limestone just below the Washington Fire Clay Shale. There are two other named fresh-water limestones, the Colvin Run and the Woodglen limestones, which occur between the Waynesburg "A" coal and the Washington coal. They both have been placed stratigraphically below the Waynesburg "B" coal. Unfortunately, there is not evidence of Waynesburg "B" or Little Washington coal in areas where this limestone member is encountered. Therefore, this limestone zone more nearly fits the stratigraphic position of the Bristol limestone than do either the Colvin Run or the Woodglen limestones.

Washington Fire Clay Shale Member. - Immediately underlying the Washington coal in Athens County a yellowish green, gray, or mottled maroon clay shale occurs. This underclay zone has been designated the Washington Fire Clay Shale by Hennen (1911, p. 163-164). This underclay zone represents the closest development in Permian age strata to a true fire clay type of underclay, typical of Allegheny and Pottsville age deposits. The clay has been mined further north, in the vicinity of Marietta, and has been used in the manufacture of bisque ware. However, irregularities in thickness and unfavorable analyses make this clay undesirable as a source of ceramic clay.

In Athens County, this underclay is everywhere associated with the Washington coal or its horizon. This member is difficult to recognize as an individual unit as it is usually gradational with the underlying red shale zone. In addition, the overlying Washington coal is usually represented by a smut streak which is intimately associated with this clayey zone. Its maximum thickness,as it occurs in Athens County, is about one foot and its average thickness about 8 inches.

Washington (No. 12) Coal Member. - The Washington coal has been described by many geologists as the most persistent and most valuable,from an economic standpoint, of any coal bed in the Dunkard group.

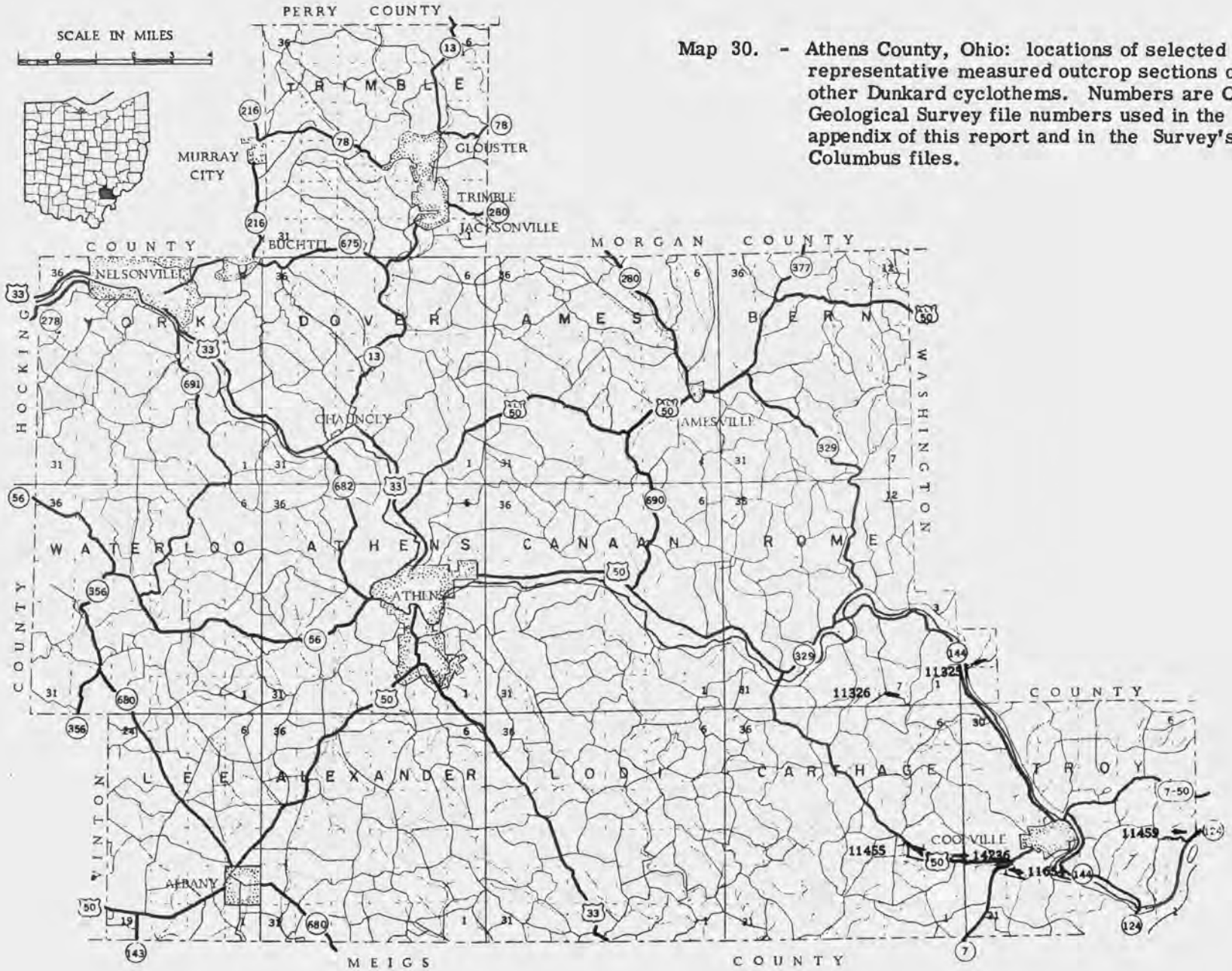
This coal bed was originally named the Brownsville coal by I. C. White (1874, p. 51) but was later named the Washington coal by Stevenson (1876, p. 51) for its better development at Washington, Pennsylvania.

In Athens County, the Washington coal horizon is fairly persistent throughout its outcrop area and is found in Bern, Carthage, Rome, and Troy Townships. The coal is usually represented by smut streaks, carbonaceous debris, or thin vitrinized coaly bands intercalated into a gray clay shale matrix. However, 0.3 mile to the west of geologic section 11455 in Carthage Township (see map 29 and appendix), a gob pile from an old mine opening in the Washington coal was noted.

Washington Roof Shale Member. - The roof shale of Washington coal in Athens County is usually a clayey, bedded shale. It is often varicolored dusky red or green but generally it is medium to dark gray in color. In several sections carbonaceous debris or thin coaly lenses were noted, but no plant fossils are recorded. The average thickness for this member is about one foot.

Other Dunkard Cyclothems of Athens County

There are at least ten remaining cyclothems above the Washington coal that have been recognized in Athens County. The upper half of the Dunkard group in Athens County become decreasingly representative because of the limited number of outcrops available in the knob-like, weathered hill tops. For this reason, the remaining cycles are presented as a group. There are only



Map 30. - Athens County, Ohio: locations of selected representative measured outcrop sections of other Dunkard cyclothems. Numbers are Ohio Geological Survey file numbers used in the appendix of this report and in the Survey's Columbus files.

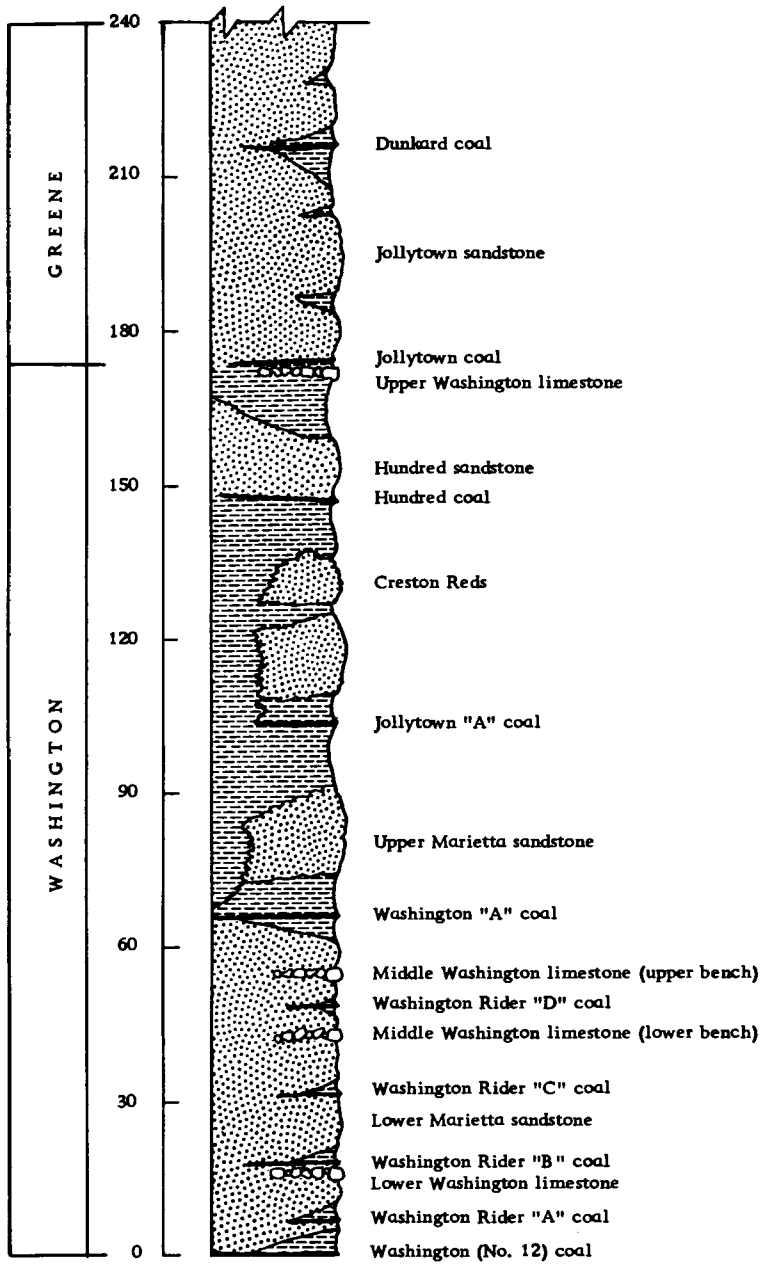


Figure 24 - Generalized geologic column showing relationship of strata above the Washington coal in Athens County.

a few localities in Rome and Troy Townships where strata above the Washington coal horizon have been measured (map 30). The remaining cyclothems above the Washington coal horizon include the Washington Rider "A", Washington Rider "B", Washington Rider "C", Washington Rider "D", Washington "A", Jollytown "A", Hundred, Jollytown, and the Dunkard cyclothems. Several geologic sections are included in the appendix which show the character of these remaining cyclothems.

Stevenson (1876, p. 48) originally placed the Jollytown coal below the Upper Washington limestone. I. C. White (1891, p. 22, 34) placed the Jollytown coal above the Upper Washington limestone and applied the name Washington "A" coal to Stevenson's original Jollytown coal (p. 35). Stauffer and Schroyer (1920, p. 16), in carrying these correlations into Ohio, to avoid confusion assigned the name Jollytown "A" to the Jollytown coal of White and placed the Jollytown "A" coal above the Upper Washington limestone. However, Cross et al., during the course of field work in their study and correlation of the Dunkard group, discovered that the coal identified as Jollytown "A" by Stauffer and Schroyer was not equivalent to the true Jollytown coal of White. They found that the Jollytown "A" coal occurs several cycles below the Jollytown coal.

Figure 24 represents a generalized geologic column to show the stratigraphic position of the coal beds and cyclothems above the Washington coal.

In Athens County the interval between the remaining coal horizons above the Washington coal is occupied chiefly by sandstone, sandy shale, and calcareous red shale beds. There is little evidence of the limestone units which farther north in Belmont, Monroe, and Washington Counties are very well developed.

Summary

There is much work still to be done on Dunkard strata in Ohio. Much of the information gathered by the Geological Survey on the Dunkard group needs further evaluation. The stratigraphy of the Washington series in Ohio is fairly well established. However, further investigations are needed before the stratigraphy of the Greene series can be satisfactorily presented. Athens County does not contain enough strata of the Greene series to lend itself to a detailed study of these rocks. The final stratigraphic relationships of the Dunkard group in Ohio will have to come from study of the geology of Monroe and Washington Counties, where most of the Dunkard strata are better exposed and better developed than they are in Athens County. The lack of any well developed coal zones above the Uniontown coal in Athens County indicates that most of these coaly zones or horizons represent deposition on the outer edge or margin of their basins of accumulation. It is in these areas of deposition that stratigraphic continuity breaks down, probably as a result of constant changes or fluctuations in coal forming and general sedimentary conditions.

Some stratigraphers disagree that any emphasis can be placed on smut streaks, carbonaceous debris in clay shale, or thin carbonaceous shale zones as indicators or lateral equivalents of coal beds which elsewhere may attain minable thicknesses. These coaly zones, along with their associated underclays, are by far the most persistent members of cyclothems. Correlations using other members of a cyclothem quickly become hard to establish or maintain because of the transitional nature of one member with another or because of their lack of persistence.

In areas such as Athens County, the smut streaks and coaly horizons, and the intervals between them, complemented by local correlations from one section to another utilizing other members of a cyclothem, are the only basis of establishing widespread stratigraphic identifications.

Chapter 4

ECONOMIC GEOLOGY

COAL RESOURCES

THE COAL FORMATIONS

Representation of all the Pennsylvanian formations is found in Athens County. Some of these are rich in coal content; others are only modestly endowed with this resource. Athens County's coal fame rests principally with the Middle Kittanning (No. 6) coal bed although other coal beds have contributed to the mining history of the county. The following statements will summarize the state of knowledge of the coal reserves of the county and briefly mention those coal beds whose occurrence is unimportant or only of geologic interest.

Pottsville Series. - As previous parts of this report show, the coal-bearing Pennsylvanian system of rocks are divided into four series, and the Permian system is divided into two. Oldest, lowest, or deepest of these (see stratigraphic column, table 7, p. 48-49) is the Pottsville series. Coal beds and related rock units of the Pottsville are found at the surface only in the northeastern part of the county, and here only the uppermost part of this formation is exposed. West of Nelsonville, in the Hocking River Valley, outcrops of impure (shaly) coal identified as the Tionesta coal bed are exposed. This is the only Pottsville coal bed known to outcrop in the county, although it is possible that other, more deeply buried minable coal members may exist here. At present there is insufficient information to make an affirmative statement relative to the occurrence of minable bodies of Pottsville coal beds.

Allegheny Series. - The Allegheny formation contains several members, some of which are important sources of coal. In all, 13 coal beds or horizons are known in the Allegheny formation of Athens County; these coal beds from bottom to top are Brookville (No. 4), Ogan, Winters, Clarion (No. 4a), Scrubgrass, Lawrence, Lower Kittanning (No. 5), Strasburg, Middle Kittanning (No. 6), Upper Kittanning, Lower Freeport (No. 6a), Bolivar, and Upper Freeport (No. 7).

The Brookville, Ogan, Winters, Scrubgrass, Lawrence, Strasburg, Upper Kittanning, and Bolivar coal beds are usually thin or mere horizons marked by adjacent characteristic rock types. As far as is known, these do not contain minable coal reserves in Athens County. However, Athens County has not been sifficiently explored by drilling for it to be said positively that minable coal bodies do not occur in the above-mentioned members.

Among the coal beds of intermediate importance may be listed the Lower Kittanning (No. 5), Lower Freeport (No. 6a), and Upper Freeport (No. 7) coal beds. These beds, although not completely known in Athens County, are well indicated in the outcrop sections and a few mines. Occurrence of these beds may be somewhat restricted in minable extent; however, outcrop indications tend to point to a moderately large reserve in at least Lower Kittanning and Upper Freeport coal beds. Less is known about the Lower Freeport coal and its minable occurrence, but this coal bed is generally unimportant in both area and thickness as shown in the outcrops.

The principal coal bed of Athens County and the one that has accounted for most of the coal produced in the county is the Middle Kittanning. The foundation of much of Athens' early economy

was based on this bed of coal. Many reports have discussed the Hocking Valley coal field and described its lusty coal mining industry of yesteryear. The best record of the mining industry of the Hocking Valley coal field was written by Edward Orton, Sr. (1884, p. 912-982; see also this report, p. 72-74).

Conemaugh Series. - Overlying Allegheny rocks the Conemaugh series is found. The Conemaugh contains many coal beds or horizons of coal beds, but none of the known occurrences are sufficiently thick and extensive to warrant consideration as a minable reserve. It is true, however, that modest amounts are mined from time to time to supply local or household use. There are about 18 separate coal-bearing members in the Conemaugh formation, but these are usually characterized by the lack of the expected coal bed rather than its occurrence.

Monongahela Series. - The shallowest or youngest of the Pennsylvanian rocks is the Monongahela series; these rocks underlie the east central part of the county. The base of the formation is the Pittsburgh (No. 8) coal bed, and the overlying strata contain nine other coal beds or horizons. However, only one of the coal units attains moderate extent, the Pittsburgh (No. 8) coal bed; other coal beds show only a few local areas of minable thickness. Those that show occasional promise of local mining are the Pomeroy (No. 8a), Meigs Creek (No. 9), and the Uniontown (No. 10) coal beds. The others, as well as many of the previously mentioned coal members, are manifest merely as a thin coal bed such as a smut streak or mere marking of a horizon by adjacent rock types.

Permian Units. - The Permian rocks, which are the youngest of coal-bearing rocks in the state, follow immediately above the Pennsylvanian sequence. Although many coal horizons are present the Washington coal is the only one which attains minable thickness in Athens County. Even this coal bed is generally thin throughout most of its outcrop area. However, there are several localities where the Washington coal has been mined for local fuel. The reader is referred to pages 200 to 218 for geologic description of the Permian rocks, including the coal beds.

DESCRIPTION OF THE COAL RESERVES

Pottsville Series

Coal beds of economic extent in the Pottsville series are unknown. Only a small amount of the Pottsville is exposed, the upper part; and only in one place is any of the coal beds exposed. This exposure shows the Tionesta coal bed, which is only about two feet thick and impure. Nothing is known of other Pottsville coal beds.

Allegheny Series

Coal beds or their horizons in the Allegheny series underlie virtually the entire county. Although 13 coal horizons are present, only a few contribute significantly to the over-all reserve of the county. The following descriptions are in order of economic importance.

Middle Kittanning (No. 6) Coal Bed. - Athens County shares a large part of the Hocking Valley coal field, and has produced a great quantity of Middle Kittanning coal. The minable occurrence of this coal is estimated for the western three quarters of the county (see figure 25). The eastern minable coal limit is set, not because the coal is known to be thin, but because of lack of sufficient information to make an estimate. To the south and west, however, in Vinton and western Meigs Counties, the Middle Kittanning coal is known to be generally less than 14

inches thick over large areas. Such data are used to infer the extent of coal to the east and indicate a possible area of thin coal in southern Athens County.

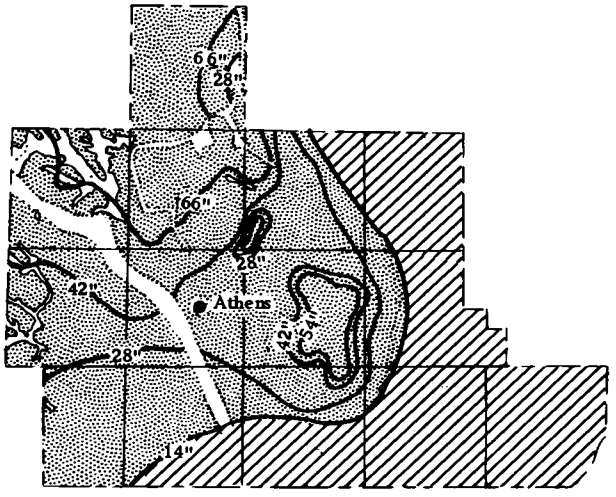


Figure 25 - Generalized thickness map of the Middle Kittanning (No. 6) coal bed.

From the areas of thick coal in the northwestern part of the county where measurements show 100 inches in Trimble and 120 inches in York Townships, the thickness gently decreases to the south and east. An area of about two square miles is apparently less than 14 inches thick in the southwestern part of Ames Township. A reversal of the thinning trend is found in Canaan Township, for nearly the entire township is underlain by Middle Kittanning coal thicker than 42 inches. Drill data show that the eastern half of the township contains this coal at thickness of over 54 inches. This area is the site of the Canaan shaft, where the coal was taken out years ago. The mined-out area is less than one square mile. The "Jumbo Fault" is known in the Athens County area of the Middle Kittanning coal, extending as a band approximately a mile or more wide to the southeast, nearly parallel to the Hocking River (see figure 25).

An original reserve of 1,304,501,000 short tons is estimated for the Middle Kittanning coal in Athens County (Brant, 1956). Table 15, following, shows the distribution by category.

Table 15

Estimated Original Reserves of the Middle Kittanning Coal Bed in Athens County
(In thousands of short tons)

Reliability Category	Thickness								
	14"-28"	28"-42"	42"-54"	54"-66"	66"-78"	78"-90"	90"-102"	102"-over	Total
Proven	2,088	37,536	22,445	174,868	39,732	47,309	70,788	7,360	402,126
Probable	31,627	190,726	38,301	134,601	159,749	46,117	38,711	4,089	643,921
Strongly Inferred	83,285	105,916	2,135	1,363	6,474	2,385	-	-	201,558
Weakly Inferred	54,941	1,955	-	-	-	-	-	-	56,896
Total	171,941	336,133	62,881	310,832	205,955	95,811	109,499	11,449	1,304,501

Upper Freeport (No. 7) Coal Bed. - This coal bed is of considerably less value in Athens County than the Middle Kittanning coal bed. Apparently a single minable body occurs in this bed in the northern part of the county (see figure 26), in York, Trimble, and Dover Townships and small areas fringing these. The thickness ranges from less than 14 inches to over 66 inches in northeast York Township. A uniform body of this coal at over 42 inches thickness is inferred within Dover Township. Estimated original reserves amount to 321,743,000 tons, as shown in table 16.

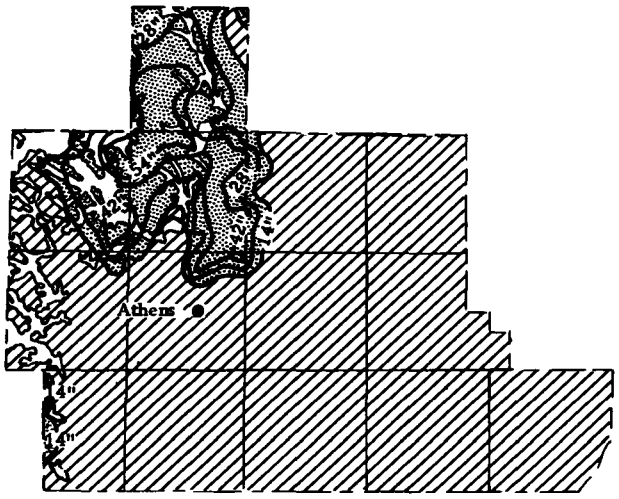


Figure 26 - Generalized thickness map of the Upper Freeport (No. 7) coal bed.

Table 16

Estimated Original Reserves of the Upper Freeport Coal Bed in Athens County

(In thousands of short tons)

Reliability Category	Thickness					
	14" - 28"	28" - 42"	42" - 54"	54" - 66"	66" - over	Total
Proven	16,260	44,792	72,106	20,501	3,816	157,475
Probable	32,202	39,390	38,665	52,024	-	162,281
Strongly Inferred	1,987	-	-	-	-	1,987
Weakly Inferred	-	-	-	-	-	-
Total	50,449	84,182	110,771	72,525	3,816	321,743

Lower Kittanning (No. 5) Coal Bed. - The Lower Kittanning coal bed outcrop enters the county in the northwestern corner of York Township and follows the Hocking River Valley and its tributaries for about five miles downstream. The coal thickness is not exceptional and probably averages 21 inches in this area. In the southeast the area is contiguous to regions of known thin coal and to those of little or doubtful thickness. The outcrop is also found in northern Waterloo Township, where the coal measures only 13 inches at the county line. Table 17 gives a résumé of the estimated original reserves of the Lower Kittanning coal bed in the county, and table 21 lists the estimates by township. Very little mining of this coal has been done in the county.

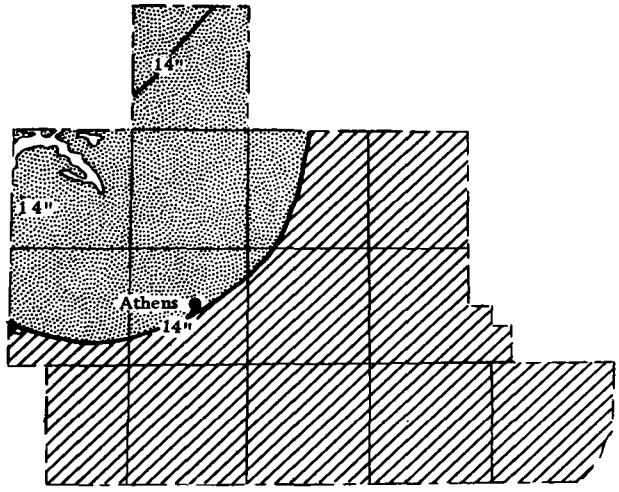


Figure 27 - Generalized thickness map of the Lower Kittanning (No. 5) coal bed.

Table 17

Estimated Original Reserves of the Lower Kittanning Coal Bed In Athens County

(In thousands of short tons)

Reliability Category	Thickness			
	14" - 28"	28" - 42"	42"-over	Total
Proven	3,931	-	-	3,931
Probable	22,840	-	-	22,840
Strongly Inferred	63,058	-	-	63,058
Weakly Inferred	232,723	-	-	232,723
Total	322,552	-	-	322,552

Other Coal Beds of the Allegheny Series. - Other coal beds of the Allegheny formation are of little, if any, economic importance. Exception to this statement may be taken in a small way with regard to the Lower Freeport coal bed. A number of measurements show that a few areas may warrant additional consideration as, indeed, is shown by the occurrence of an occasional mine in the Lower Freeport coal bed. However, Ray (1929) did not indicate that any area in Athens County, or the rest of the state for that matter, contained minable Lower Freeport (No. 6a) coal. For Athens County, F. R. Clark (1917) estimated 424,000,000 tons of Lower Freeport coal on the original basis. The average thickness used was 34 inches and the area 130 square miles. It appears that the estimate of Clark is far too generous for the amount of supporting data and that of Ray (1929) much too stringent. It would seem that there may be an occurrence of reserve in bodies of sufficient lateral extent and thickness to support an occasional small mining operation.

Inasmuch as Waterloo and York Townships have yielded the principal measurement of coal and at least a small amount of mining activity, it is reasonable to make at least a modest allowance for resources from this bed in Athens County. It is, therefore, estimated from the data at hand that 20 square miles of the county contains the Lower Freeport coal at least 24 inches in thickness. This results in an estimated 46,000,000 tons of coal from the Lower Freeport coal bed.

Conemaugh Series

No coal reserves are estimated for the Conemaugh coal beds. Some of the coal beds attain possible minable thickness in small areas. These are the Anderson and Mason. These beds are regarded as insignificant to the reserve of the county; they are generally thin and the thicker portions are erratically distributed and, hence, are not included in the resources appraisal. Coal from the Anderson was formerly mined in section 1 of Trimble Township. This coal was for local, home use.

Monongahela Series

Pittsburgh (No. 8) Coal Bed. - The Pittsburgh coal bed has moderately wide distribution in Athens County and is of economic importance in two main areas: the Federal Creek field in northeastern Athens County and the Shade Creek field in the south-central part of the county. Of the two, the Federal Creek field contains the greatest coal reserves.

An episode of coking the Pittsburgh coal is indicated at Utley. At this place there are ruins of beehive ovens. Little is known about the ovens and production of coke except that they operated for only a short time.

Except for the Belmont field area, Athens County has the richest Pittsburgh coal deposit in Ohio, the estimated original reserves totaling 217,697,000 tons. Of this tonnage, only 11 per cent is estimated as thin (14" - 28") coal and approximately 95 per cent of the total tonnage falls within the proven and probable categories of reliability. Table 18 shows the tabulations by thickness and reliability categories of the estimated original tonnage (DeLong, 1955; see also Smith, 1952).

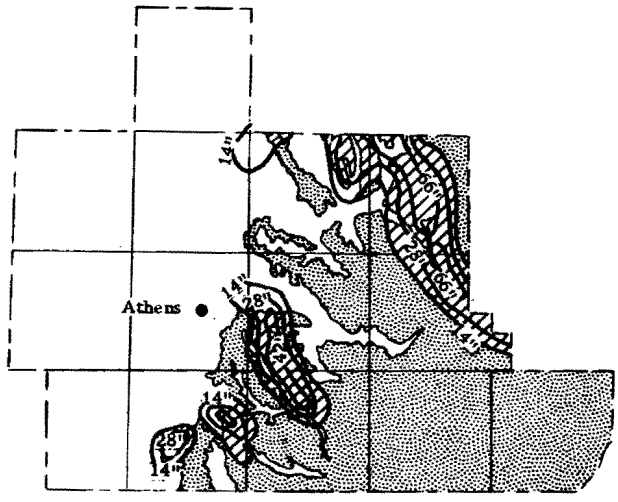


Figure 28 - Generalized thickness map of the Pittsburgh (No. 8) coal bed.

Table 18

Estimated Original Reserves of the Pittsburgh Coal Bed in Athens County
(In thousands of short tons)

Reliability Category	Thickness						
	14" - 28"	28" - 42"	42" - 54"	54" - 66"	66" - 78"	78" - over	Total
Proven	8,629	10,214	19,630	17,223	16,382	25,232	97,310
Probable	13,204	16,330	17,648	13,018	28,546	19,329	108,075
Strongly Inferred	988	1,310	2,258	3,053	1,797	-	9,406
Weakly Inferred	786	1,613	507	-	-	-	2,906
Total	23,607	29,467	40,043	33,294	46,725	44,561	217,697

Redstone (Pomeroy) (No. 8a) Coal Bed. - The Redstone coal bed is of limited extent and of minor importance in Athens County. This coal bed in southern Athens County forms the thin northern margin of the Pomeroy field and occurs as small separate pockets of minable (14" - 28") coal in Lodi and Alexander Townships. The estimated total original reserves of the Redstone coal bed in Athens County is a moderate amount of 5,805,000 tons, the smallest reserve of all counties for which the Redstone coal was estimated. Table 19, below, shows the reserve estimate of this coal bed for Athens County (DeLong, 1955).

Table 19

Estimated Original Reserves of the Redstone Coal Bed in Athens County
(In thousands of short tons)

Reliability Category	Thickness						
	14" - 28"	28" - 42"	42" - 54"	54" - 66"	56" - 78"	78"	Total
Proven	1,431	-	-	-	-	-	1,431
Probable	4,193	-	-	-	-	-	4,193
Strongly Inferred	181	-	-	-	-	-	181
Total	5,805	-	-	-	-	-	5,805

Meigs Creek (No. 9) Coal Bed. - The Meigs Creek coal bed is known only in northeast Rome and southeast Bern Townships, where data indicate possibly as much as 60 inches of coal present in the lower bench. The upper bench ranges from 18 to 24 inches in thickness, and it is found in the same area as the lower bench. The parting is persistent with a thickness of about 24 inches. There are an estimated 11.2 square miles of the Meigs Creek coal of minable thickness in Athens County, although 40 linear miles of outcrop are indicated for coal more than 14 inches thick. No reports for production are known, but it is entirely possible that local mining in the bed has taken place (see table 20) (Smith et al., 1952).

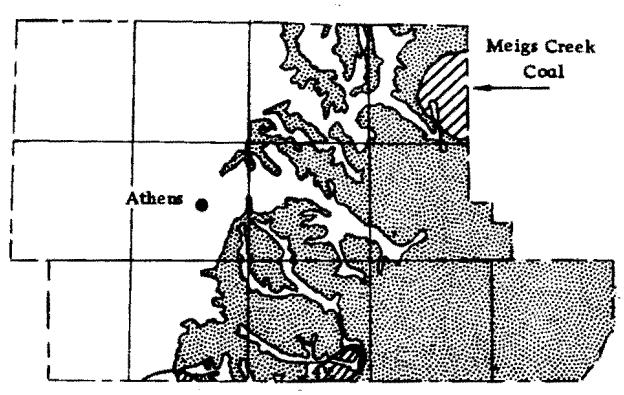


Figure 29 - Outcrop area and minable coal area of Redstone coal. Minable area of Meigs Creek coal is also shown. The outcrop lines of the two coal beds are similar.

Table 20

Estimated Original Reserves of the Meigs Creek Coal Bed in Athens County*

(In thousands of short tons)

Reliability Category	Thickness				
	14" - 28"	28" - 42"	42" - 54"	54" - over	Total
Proven	824	817	673	2,287	4,601
Probable	9,906	4,185	6,412	2,971	23,474
Inferred**	16,144	7,716	1,121	-	24,981
Total	26,874	12,718	8,206	5,258	53,056

* Both upper and lower bench reserves.
** Strongly inferred.

Permian Units

No estimate is made because it is believed that no significant amount of minable coal is present in the Permian coal beds in Athens County.

Summary of the Coal Reserves in Athens County

A tabulation of the recently estimated coal reserves of the different coal beds of Athens County is shown in table 21. The total is over $2\frac{1}{4}$ billion tons. This estimate may be altered with the addition of more information from those areas that show large amounts of inferred coal. However, the approach to the reserves problem is one which is considered conservative; thus, acquisition of future data may increase the current estimates rather than reduce them.

Considerable amounts of coal have been mined in the past; the production from 1800 to 1956, as shown in table 22, totals 196,034,664 tons. Figure 30 shows the annual production graphically. If an over-all recovery figure of 50 per cent is used, it may be said that two times the production equals coal mined and lost in mining. Mining losses include coal left in pillars and in the

Table 21

Coal Reserves in Athens County, Ohio, by Township, Seam, Probability Category, and Thickness

(In thousands of short tons - add 3 zeros)

Seam, Probability, and Thickness	Total	TOWNSHIP													
		Alexander	Ames	Athens	Bern	Canaan	Carthage	Dover	Lee	Lodi	Rome	Trimble	Troy	Waterloo	York
LOWER KITTANNING (NO. 5) COAL															
Proven 14" - 28"	3,931	-	-	-	-	-	-	-	-	-	-	-	-	-	3,931
28" - 42"	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
42" - over	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total	3,931	-	-	-	-	-	-	-	-	-	-	-	-	-	3,931
Probable 14" - 28"	22,840	-	-	-	-	-	-	-	-	-	-	-	-	2,701	20,139
28" - 42"	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
42" - over	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total	22,840	-	-	-	-	-	-	-	-	-	-	-	-	2,701	20,139
Strongly inferred 14" - 28"	63,058	-	-	-	-	-	-	12,680	-	-	-	6,229	-	16,591	27,558
28" - 42"	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
42" - over	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total	63,058	-	-	-	-	-	-	12,680	-	-	-	6,229	-	16,591	27,558
Weakly inferred 14" - 28"	232,723	-	32,517	34,917	-	1,008	-	62,697	-	-	-	57,032	-	31,711	12,841
28" - 42"	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
42" - over	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total	232,723	-	32,517	34,917	-	1,008	-	62,697	-	-	-	57,032	-	31,711	12,841
Total 14" - 28"	322,552	-	32,517	34,917	-	1,008	-	75,377	-	-	-	63,261	-	51,003	64,469
28" - 42"	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
42" - over	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total	322,552	-	32,517	34,917	-	1,008	-	75,377	-	-	-	63,261	-	51,003	64,469
MIDDLE KITTANNING (NO. 6) COAL															
Proven 14" - 28"	2,088	-	616	40	-	-	-	398	318	-	-	716	-	-	-
28" - 42"	37,536	-	629	1,756	-	10,535	-	1,259	-	2,485	398	1,093	-	19,381	-
42" - 54"	22,445	-	318	1,772	-	11,223	-	1,681	-	1,136	-	1,227	-	4,316	772
54" - 66"	174,868	-	2,896	7,554	-	50,774	-	52,761	-	3,976	-	795	-	738	55,374
66" - over	165,189	-	10,870	-	-	-	-	93,937	-	-	-	22,785	-	-	37,597
Total	402,126	-	15,329	11,122	-	72,532	-	150,036	318	7,597	398	26,616	-	24,435	93,743
Probable 14" - 28"	31,627	-	1,650	40	318	-	1,670	-	13,954	2,386	8,229	3,360	-	20	-

28" - 42"	190,726	-	25,973	21,634	-	54,730	596	-	563	22,992	10,336	7,454	-	46,448	-
42" - 54"	38,301	-	3,862	7,451	-	5,543	-	-	-	1,499	1,090	8,042	-	10,723	91
54" - 66"	134,601	-	8,917	27,772	-	12,381	-	15,164	-	1,022	170	17,606	-	20,730	30,839
66" - over	248,666	-	10,757	-	-	-	-	76,671	-	-	-	133,932	-	-	27,306
Total	643,921	-	51,159	56,897	318	72,654	2,266	91,835	14,517	27,899	19,825	170, 394	-	77,921	58,236
Strongly inferred..14" - 28"	83,285	5,089	11,648	5,148	4,492	-	3,498	-	27,451	14,709	8,408	99	-	2,743	-
28" - 42"	105,916	133	30,910	38,497	-	11,231	-	-	-	2,319	-	232	-	22,594	-
42" - 54"	2,135	-	-	-	-	-	-	-	-	-	-	-	-	2,135	-
54" - 66"	1,363	-	-	-	-	-	-	-	-	-	-	170	-	1,193	-
66" - over	8,859	-	-	-	-	-	-	-	-	-	-	8,859	-	-	-
Total	201,558	5,222	42,558	43,645	4,492	11,231	3,498	-	27,451	17,028	8,408	9,360	-	28,665	-
Weakly inferred... 14" - 28"	54,941	41,087	2,127	1,391	-	-	-	-	10,018	318	-	-	-	-	-
28" - 42"	1,955	-	-	1,955	-	-	-	-	-	-	-	-	-	-	-
42" - 54"	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
54" - 66"	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
66" - over	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total	56,896	41,087	2,127	3,346	-	-	-	-	10,018	318	-	-	-	-	-
Total.....14" - 28"	171,941	46,176	16,041	6,619	4,810	-	5,168	398	51,741	17,413	16,637	4,175	-	2,763	-
28" - 42"	336,133	133	57,512	63,842	-	76,496	596	1,259	563	27,796	10,734	8,779	-	880,423	-
42" - 54"	62,881	-	4,180	9,223	-	16,766	-	1,681	-	2,635	1,090	9,269	-	17,174	863
54" - 66"	310,832	-	11,813	35,326	-	63,155	-	67,925	-	4,998	170	18,571	-	22,661	86,213
66" - over	422,714	-	21,627	-	-	-	-	170,608	-	-	-	165,576	-	-	64,903
Total	1, 304,501	46,309	111,173	115,010	4,810	156,417	5,764	241,871	52,304	52,842	28,631	206,370	-	131,021	151,979
UPPER FREEPORT (NO 7) COAL															
Proven.....14" - 28"	16,260	-	4,214	1,352	-	-	-	3,916	636	-	-	4,711	-	855	576
28" - 42"	44,792	-	5,102	3,545	-	232	-	21,435	-	-	-	8,614	-	2,021	3,843
42" - 54"	72,106	-	1,954	7,406	-	182	-	42,800	-	-	-	17,447	-	-	2,317
54" - 66"	20,501	-	-	511	-	-	-	8,121	-	-	-	9,711	-	-	2,158
66" - over	3,816	-	-	-	-	-	-	1,022	-	-	-	-	-	-	2,794
Total	157,475	-	11,270	12,814	-	414	-	77,294	636	-	-	40,483	-	2,876	11,688
Probable.....14" - 28"	32,202	-	3,995	3,240	-	1,471	-	6,818	1,690	-	-	9,382	-	1,352	4,254
28" - 42"	39,390	-	398	497	-	364	-	13,417	-	-	-	15,968	-	-	8,746
42" - 54"	38,665	-	-	-	-	-	-	6,770	-	-	-	25,489	-	-	6,406
54" - 66"	52,024	-	-	-	-	-	-	14,710	-	-	-	33,111	-	-	4,203
66" - over	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total	162,281	-	4,393	3,737	-	1,835	-	41,715	1,690	-	-	83,950	-	1,352	23,609
Strongly inferred..14" - 28"	1,987	-	-	-	-	-	-	-	-	-	-	1,073	-	-	914
28" - 42"	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
42" - 54"	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
54" - 66"	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
66" - over	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total	1,987	-	-	-	-	-	-	-	-	-	-	1,073	-	-	914

Table 21 - Coal Reserves in Athens County, Ohio, by Township, Seam, Probability Category, and Thickness - continued

Seam, Probability, and Thickness	Total	TOWNSHIP													
		Alexander	Ames	Athens	Bern	Canaan	Carthage	Dover	Lee	Lodi	Rome	Trimble	Troy	Waterloo	York
Weakly inferred...14" - 28"	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
28" - 42"	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
42" - 54"	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
54" - 66"	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
66" - over	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total.....	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total .....14" - 28"	50,449	-	8,209	4,592	-	1,471	-	10,734	2,326	-	-	15,166	-	2,207	5,744
28" - 42"	84,182	-	5,500	4,042	-	596	-	34,852	-	-	-	24,582	-	2,021	12,589
42" - 54"	110,771	-	1,954	7,406	-	182	-	49,570	-	-	-	42,936	-	-	8,723
54" - 66"	72,525	-	-	511	-	-	-	22,831	-	-	-	42,822	-	-	6,361
66" - over	3,816	-	-	-	-	-	-	1,022	-	-	-	-	-	-	2,794
Total.....	321,743	-	15,663	16,551	-	2,249	-	119,009	2,326	-	-	125,506	-	4,228	36,211
		PITTSBURGH (NO. 8) COAL													
Proven.....14" - 28"	8,629	2,863	605	60	605	1,210	40	101	-	3,145	-	-	-	-	-
28" - 42"	10,214	2,520	1,848	101	739	1,982	-	-	-	3,024	-	-	-	-	-
42" - 54"	19,630	2,212	5,161	-	1,935	4,101	-	-	-	5,760	461	-	-	-	-
54" - 66"	17,223	-	518	-	11,117	2,938	-	-	-	1,786	864	-	-	-	-
66" - over	41,614	-	725	-	32,980	2,350	-	-	-	-	5,559	-	-	-	-
Total.....	97,310	7,595	8,857	161	47,376	12,581	40	101	-	13,715	6,884	-	-	-	-
Probable..... 14" - 28"	13,204	1,673	726	383	2,863	2,701	20	60	-	3,649	1,109	20	-	-	-
28" - 42"	16,330	1,378	1,209	-	4,805	4,234	-	-	-	2,822	1,882	-	-	-	-
42" - 54"	17,648	922	2,903	-	6,589	2,258	-	-	-	2,442	2,534	-	-	-	-
54" - 66"	13,018	-	-	-	7,546	1,613	-	-	-	-	3,859	-	-	-	-
66" - over	47,875	-	-	-	30,655	829	-	-	-	-	16,391	-	-	-	-
Total.....	108,075	3,973	4,838	383	52,458	11,635	20	60	-	8,913	25,775	20	-	-	-
Strongly inferred..14" - 28"	988	-	-	-	161	-	-	-	-	-	827	-	-	-	-
28" - 42"	1,310	-	-	-	-	-	-	-	-	-	1,310	-	-	-	-
42" - 54"	2,258	-	-	-	-	-	-	-	-	-	2,258	-	-	-	-
54" - 66"	3,053	-	-	-	-	-	-	-	-	-	3,053	-	-	-	-
66" - over	1,797	-	-	-	-	-	-	-	-	-	1,797	-	-	-	-
Total.....	9,406	-	-	-	161	-	-	-	-	-	9,245	-	-	-	-
Weakly inferred...14" - 28"	786	-	-	-	-	-	-	-	-	-	786	-	-	-	-
28" - 42"	1,613	-	-	-	-	-	-	-	-	-	1,613	-	-	-	-
42" - 54"	507	-	-	-	-	-	-	-	-	-	507	-	-	-	-
54" - 66"	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
66" - over	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total.....	2,906	-	-	-	-	-	-	-	-	-	2,906	-	-	-	-

Total	14" - 28"	23,607	4,536	1,331	443	3,629	3,911	60	161	-	6,794	2,722	20	-	-	-
	28" - 42"	29,467	3,898	3,057	101	5,544	6,216	-	-	-	5,846	4,805	-	-	-	-
	42" - 54"	40,043	3,134	8,064	-	8,524	6,359	-	-	-	8,202	5,760	-	-	-	-
	54" - 66"	33,294	-	518	-	18,663	4,551	-	-	-	1,786	7,776	-	-	-	-
	66" - over	91,286	-	725	-	63,635	3,179	-	-	-	-	23,747	-	-	-	-
Total		217,697	11,568	13,695	544	99,995	24,216	60	161	-	22,628	44,810	20	-	-	-
							REDSTONE (NO. 8a) COAL									
Proven	14" - 28"	1,431	262	-	-	-	-	-	-	-	1,169	-	-	-	-	-
	28" - 42"	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	42" - 54"	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	54" - 66"	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	66" - over	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total		1,431	262	-	-	-	-	-	-	-	1,169	-	-	-	-	-
Probable	14" - 28"	4,193	141	-	-	-	-	-	-	-	4,052	-	-	-	-	-
	28" - 42"	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	42" - 54"	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	54" - 66"	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	66" - over	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total		4,193	141	-	-	-	-	-	-	-	4,052	-	-	-	-	-
Strongly inferred	14" - 28"	181	-	-	-	-	-	-	-	-	181	-	-	-	-	-
	28" - 42"	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	42" - 54"	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	54" - 66"	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	66" - over	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total		181	-	-	-	-	-	-	-	-	181	-	-	-	-	-
Weakly inferred	14" - 28"	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	28" - 42"	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	42" - 54"	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	54" - 66"	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	66" - over	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total	14" - 28"	5,805	403	-	-	-	-	-	-	-	5,402	-	-	-	-	-
	28" - 42"	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	42" - 54"	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	54" - 66"	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	66" - over	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total		5,805	403	-	-	-	-	-	-	-	5,402	-	-	-	-	-
							MEIGS CREEK (NO. 9) COAL									
Proven	14" - 28"	824	-	-	-	-	-	-	-	-	-	824	-	-	-	-
	28" - 42"	817	-	-	-	-	-	-	-	-	-	817	-	-	-	-
	42" - 54"	673	-	-	-	359	-	-	-	-	-	314	-	-	-	-

Table 21 - Coal Reserves in Athens County, Ohio, by Township, Seam, Probability Category and Thickness - continued

Seam, Probability, and Thickness	Total	TOWNSHIP													
		Alexander	Ames	Athens	Bern	Canaan	Carthage	Dover	Lee	Lodi	Rome	Trimble	Troy	Waterloo	York
54" - over	2,287	-	-	-	2,287	-	-	-	-	-	-	-	-	-	-
Total	4,601	-	-	-	2,646	-	-	-	-	-	1,955	-	-	-	-
Probable 14" - 28"	9,906	-	-	-	3,315	-	-	-	-	-	6,591	-	-	-	-
28" - 42"	4,185	-	-	-	2,125	-	-	-	-	-	2,060	-	-	-	-
42" - 54"	6,412	-	-	-	6,188	-	-	-	-	-	224	-	-	-	-
54" - over	2,971	-	-	-	2,971	-	-	-	-	-	-	-	-	-	-
Total	23,474	-	-	-	14,599	-	-	-	-	-	8,875	-	-	-	-
Strongly inferred 14" - 28"	16,144	-	-	-	11,495	-	-	-	-	-	4,649	-	-	-	-
28" - 42"	7,716	-	-	-	7,716	-	-	-	-	-	-	-	-	-	-
42" - 54"	1,121	-	-	-	1,121	-	-	-	-	-	-	-	-	-	-
54" - over	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total	24,981	-	-	-	20,332	-	-	-	-	-	4,649	-	-	-	-
Total 14" - 28"	26,874	-	-	-	14,810	-	-	-	-	-	12,064	-	-	-	-
28" - 42"	12,718	-	-	-	9,841	-	-	-	-	-	2,877	-	-	-	-
42" - 54"	8,206	-	-	-	7,668	-	-	-	-	-	538	-	-	-	-
54" - over	5,258	-	-	-	5,258	-	-	-	-	-	-	-	-	-	-
Total	53,056	-	-	-	37,577	-	-	-	-	-	15,479	-	-	-	-
TOTAL ALL BEDS															
Proven 14" - 28"	33,163	3,125	5,435	1,452	605	1,210	40	4,415	954	4,314	824	5,427	-	855	4,507
28" - 42"	93,359	2,520	7,579	5,402	739	12,749	-	22,694	-	5,509	1,215	9,707	-	21,402	3,843
*42" - 54"	114,854	2,212	7,433	9,178	2,294	15,506	-	44,481	-	6,896	775	18,674	-	4,316	3,089
*54" - 66"	214,879	-	3,414	8,065	13,404	53,712	-	60,882	-	5,762	864	10,506	-	738	57,532
66" - over	210,619	-	11,595	-	32,980	2,350	-	94,959	-	-	5,559	22,785	-	-	40,391
Total	666,874	7,857	35,456	24,097	50,022	85,527	40	227,431	954	22,481	9,237	67,099	-	27,311	109,362
Probable 14" - 28"	113,972	1,814	6,371	3,663	6,496	4,172	1,690	6,878	15,644	10,087	15,929	12,762	-	4,073	24,393
28" - 42"	250,631	1,378	27,580	22,131	6,930	59,328	596	13,417	563	25,814	14,278	23,422	-	46,448	8,746
*42" - 54"	101,026	922	6,765	7,451	12,777	7,801	-	6,770	-	3,941	3,848	33,531	-	10,723	6,497
*54" - 66"	202,614	-	8,917	27,772	10,517	13,994	-	29,874	-	1,022	4,029	50,717	-	20,730	35,042
66" - over	296,541	-	10,757	-	30,655	829	-	76,671	-	-	16,391	133,932	-	-	27,306
Total	964,784	4,114	60,390	61,017	67,375	86,124	2,286	133,610	16,207	40,864	54,475	254,364	-	81,974	101,984
Strongly inferred 14" - 28"	165,643	5,089	11,648	5,148	16,148	-	3,498	12,680	27,451	14,890	13,884	7,401	-	19,334	28,472
28" - 42"	114,942	133	30,910	38,497	7,716	11,231	-	-	-	2,319	1,310	232	-	22,594	-
*42" - 54"	5,514	-	-	-	1,121	-	-	-	-	-	2,258	-	-	2,135	-
*54" - 66"	4,416	-	-	-	-	-	-	-	-	-	3,053	170	-	1,193	-
66" - over	10,656	-	-	-	-	-	-	-	-	-	1,797	8,859	-	-	-
Total	301,171	5,222	42,558	43,645	24,985	11,231	3,498	12,680	27,451	17,209	22,302	16,662	-	45,256	28,472

Weakly inferred...14" - 28"	288,450	41,087	34,644	36,308	-	1,008	-	62,697	10,018	318	786	57,032	-	31,711	12,841
28" - 42"	3,568	-	-	1,955	-	-	-	-	-	-	1,613	-	-	-	-
*42" - 54"	507	-	-	-	-	-	-	-	-	-	507	-	-	-	-
*54" - 66"	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
66" - over	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total	292,525	41,087	34,644	38,263	-	1,008	-	62,697	10,018	318	2,906	57,032	-	31,711	12,841
Total .....14" - 28"	601,228	51,115	58,098	46,571	23,249	6,390	5,228	86,670	54,067	29,609	31,423	82,622	-	55,973	70,213
28" - 42"	462,500	4,031	66,069	67,985	15,385	83,308	596	36,111	563	33,642	18,416	33,361	-	90,444	12,589
*42" - 54"	221,901	3,134	14,198	16,629	16,192	23,307	-	51,251	-	10,837	7,388	52,205	-	17,174	9,586
*54" - 66"	421,909	-	12,331	35,837	23,921	67,706	-	90,756	-	6,784	7,946	61,393	-	22,661	92,574
66" - over	517,816	-	22,352	-	63,635	3,179	-	171,630	-	-	23,747	165,576	-	-	67,697
Total	2,225,354	58,280	173,048	167,022	142,382	183,890	5,824	436,418	54,630	80,872	88,920	395,157	-	186,252	252,659

* - 42" - 54" combined with 42"-over in Lower Kittanning.
54" - 66" combined with 54"-over in Meigs Creek.

Table 22

Coal Production in Athens County, 1800 - 1956

Year	Total	Strip	Year	Total	Strip	Year	Total	Strip
1800	-	-	1855	20,852	-	1910	5,943,638	-
1801	-	-	1856	11,675	-	1911	4,532,595	-
1802	-	-	1857	27,286	-	1912	4,886,476	-
1803	-	-	1858	37,000	-	1913	5,239,631	-
1804	-	-	1859	47,000	-	1914	3,415,057	-
1805	-	-	1860	56,204	-	1915	2,536,793	-
1806	-	-	1861	65,000	-	1916	3,743,672	-
1807	-	-	1862	74,000	-	1917	6,313,619	200
1808	-	-	1863	83,000	-	1918	6,742,867	-
1809	-	-	1864	92,000	-	1919	5,181,643	-
1810	-	-	1865	101,788	-	1920	6,872,646	-
1811	-	-	1866	190,036	-	1921	4,154,994	-
1812	-	-	1867	196,922	-	1922	3,368,351	-
1813	-	-	1868	168,590	-	1923	4,444,351	-
1814	-	-	1869	150,000	-	1924	2,972,483	-
1815	-	-	1870	131,140	-	1925	2,502,126	-
1816	-	-	1871	142,000	-	1926	2,765,451	107,650
1817	-	-	1872	550,000	-	1927	1,229,575	42,127
1818	-	-	1873	575,000	-	1928	1,084,098	9,103
1819	-	-	1874	448,726	-	1929	2,875,220	5,159
1820	200	-	1875	509,586	-	1930	3,056,822	-
1821	200	-	1876	484,675	-	1931	2,698,595	-
1822	200	-	1877	519,745	-	1932	1,244,918	-
1823	200	-	1878	623,126	-	1933	2,093,732	-
1824	200	-	1879	373,630	-	1934	2,330,358	-
1825	200	-	1880	835,000	-	1935	2,368,358	-
1826	200	-	1881	831,976	-	1936	2,793,218	-
1827	200	-	1882	923,624	-	1937	2,918,258	-
1828	200	-	1883	832,515	-	1938	1,582,368	-
1829	500	-	1884	627,944	-	1939	1,649,151	-
1830	900	-	1885	823,139	-	1940	1,867,104	79
1831	1,300	-	1886	899,046	-	1941	2,031,070	-
1832	1,600	-	1887	1,083,543	-	1942	2,232,113	-
1833	2,000	-	1888	1,336,698	-	1943	2,069,486	-
1834	2,400	-	1889	1,466,328	-	1944	2,285,496	156,872
1835	2,700	-	1890	1,420,280	-	1945	1,868,266	296,070
1836	3,000	-	1891	1,374,320	-	1946	1,738,267	383,591
1837	3,200	-	1892	1,590,507	-	1947	2,009,233	482,885
1838	3,200	-	1893	1,632,851	-	1948	1,494,586	491,339
1839	3,300	-	1894	1,457,579	-	1949	821,308	237,669
1840	3,368	-	1895	1,435,744	-	1950	866,008	203,191
1841	1,222	-	1896	1,383,709	-	1951	965,910	145,165
1842	1,297	-	1897	1,299,454	-	1952	795,956	147,723
1843	4,000	-	1898	1,533,188	-	1953	551,143	75,187
1844	36,000	-	1899	1,761,775	-	1954	503,812	32,985
1845	33,000	-	1900	2,594,859	-	1955	649,296	67,126
1846	30,000	-	1901	3,066,533	-	1956	552,128	101,506
1847	26,307	-	1902	3,666,993	-			
1848	28,604	-	1903	3,905,904	-	Total	196,034,664	2,985,627
1849	10,527	-	1904	3,854,078	-			
1850	10,273	-	1905	3,848,440	-			
1851	10,600	-	1906	4,370,912	-			
1852	17,287	-	1907	4,753,044	-			
1853	60,000	-	1908	4,170,995	-			
1854	80,000	-	1909	4,354,074	-			

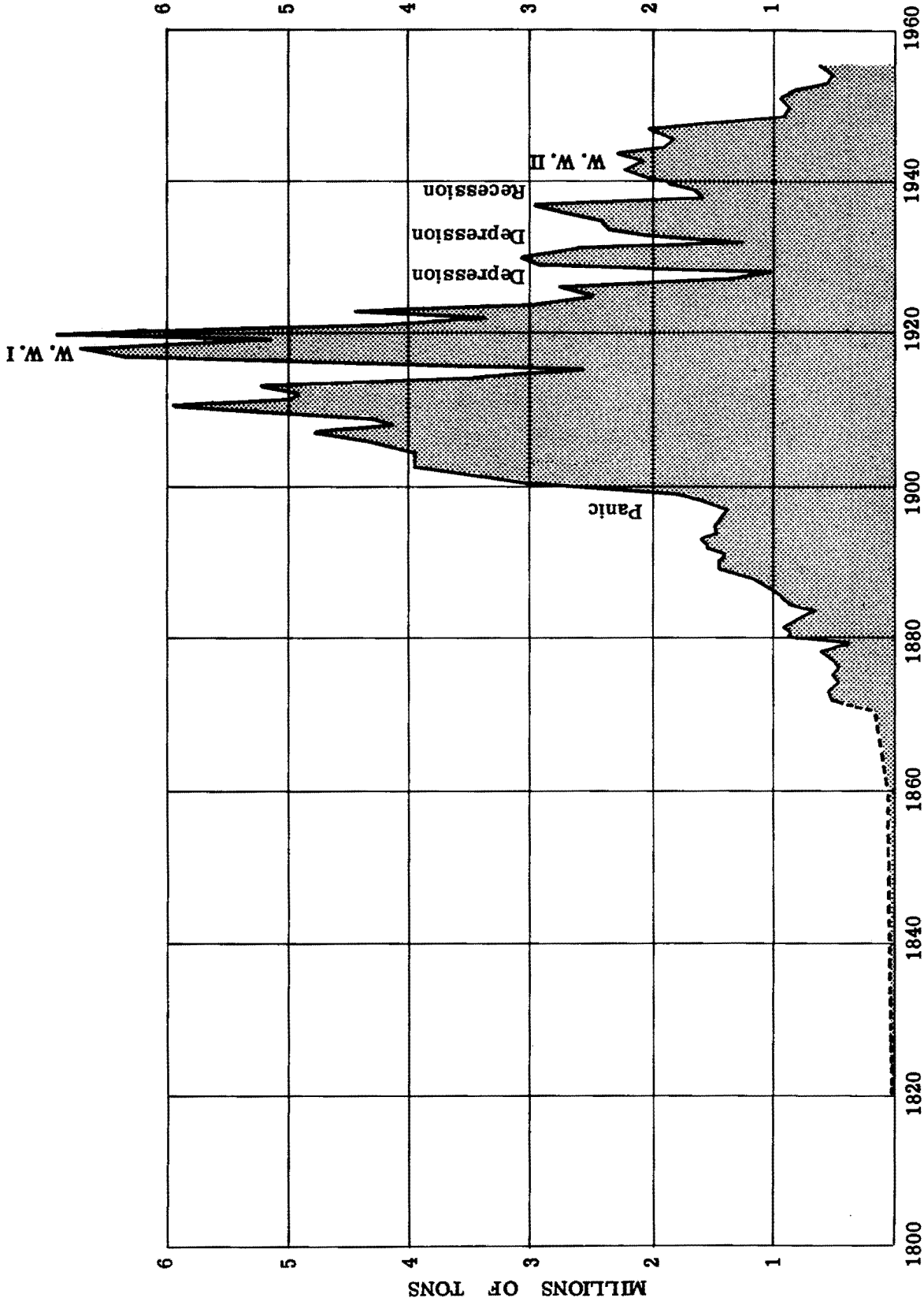


Figure 30 - Coal production in Athens County, 1800 - 1956.

roof or floor for the normal mining operation. In any single mining operation the recovery factor may be greater, say 70 per cent, or possibly 60 per cent as indicated by Flint (1949, p. 100). However, in a regional consideration, losses of coal include barrier pillar between mines, and coal left under highways and rivers. It is believed that 50 per cent recovery is a reasonable factor for estimating purposes and should include a modest factor of safety with regard to possible overestimating of reserves. The following table indicates the categories of remaining and recoverable reserves and how their values are obtained:

Table 23

Resume of Athens County Coal Reserves

Reserves estimate of all coal beds 14 inches thick or greater	
Total estimated original reserve (14" or greater)	2,271,354,000 tons
Total mined and lost (195,482,536 x 2) (through 1955)	390,965,000 tons
Remaining reserve	1,980,389,000 tons
Recoverable reserve at 50% recovery	990,194,500 tons
Reserves of all portions of coal beds 28 inches thick or greater	
Total estimated original reserve in beds 28 inches or greater	1,624,126,000 tons
Total mined and lost (195,482,536 x 2) (through 1955)	390,965,000 tons
Remaining reserve	1,233,161,000 tons
Recoverable reserve at 50% recovery	616,580,500 tons

The figure of 616,580,500 tons should be considered as the lowest estimate of recoverable reserves possible for Athens County, for additional data will likely add to the estimated reserves. In view of the fact that the Middle Kittanning bed contributes the greatest percentage of production, the following analysis of estimate of reserves and mining may be of interest.

Table 24

Recoverable Reserves of the Middle Kittanning Coal Bed

Estimated original reserves 14" and greater	1,304,501,000 tons
* Mined and lost in mining (production x 2)	309,965,000 tons
Remaining reserves (through 1955)	994,536,000 tons
Recoverable reserves at 50% recovery	497,268,000 tons
Estimated original reserves 28" and greater	1,132,560,000 tons
* Mined and lost in mining (production x 2)	390,965,000 tons
Remaining reserves (through 1955)	941,595,000 tons
Recoverable reserves at 50% recovery	470,797,500 tons

*Through 1955.

Eighty per cent of the Middle Kittanning coal reserves are in proven or probable classes of reliability. Analysis of remaining and recoverable coal reserves show that a large quantity of thick minable coal remains in Athens County in the Middle Kittanning coal bed (tables 21, 24).

Decline of mining in Athens County is probably attributable in part to displacement of market by strip coal. Such coal is much cheaper to produce than were the deep underground resources which were mostly hand mining operations. Possibly the future of coal mining in Athens County will hinge on several factors. Among these are 1) depletion of strip coal reserves in other parts of the State; 2) mechanization developments for underground mines--underground mining techniques may, in the future, be developed to a point where competition in terms of investment and operating costs may be competitive with surface mining techniques; 3) need for coal in the future, which, if great, may bring about demands that cannot be entirely met by strip mines.

QUALITY OF THE COAL

Analytical Data

Analyses are available for the Pittsburgh (No. 8), Upper Freeport (No. 7), Lower Freeport (No. 6a), and Middle Kittanning (No. 6) coal beds. Table 26 lists a number of coal face sample analyses to show the qualities of the different coal beds.

Table 25 is a summary showing average and range of various analytical values. The B.t.u. value (Table 26) and Fixed Carbon values show that all of the coal beds discussed herein are of high volatile bituminous "B" rank (fixed carbon less than 69 per cent and B. t. u. range 13,000 - 14,000) (A. S. T. M., 1939). Ash and sulphur values indicate that the highest quality coal is that of the Middle Kittanning (No. 6) bed. It should be pointed out that consideration and further exploration or experimental work on the cokability of the Middle Kittanning coal is of interest. There are apparently large quantities of "deep" coal remaining, and the indication of the low sulphur values in all but two analyses (both from Waterloo Township) indicate that low sulphur coal occurs in large quantity in the Athens County area.

Table 25

Summary of Analyses of Coal Face Samples From Athens County

		Heating Value			Sulphur			Ash		
		British Thermal Units			Per Cent			Per Cent		
	No.	Ave.	Min.	Max.	Ave.	Min.	Max.	Ave.	Min.	Max.
Middle Kittanning	13	13,375	12,960	13,725	1.02	0.51	2.28	6.63	4.96	8.49
Lower Freeport	1	13,661	-	-	2.90	-	-	7.55	-	-
Upper Freeport	9	13,414	12,942	14,562	3.18	1.21	5.20	7.56	4.34	15.30
Pittsburgh	15	13,608	13,056	14,318	4.10	2.78	6.49	9.03	6.86	11.49

COAL PRODUCTION

Graphically presented, figure 30 shows the history of coal production in Athens County. There are few data to show the production of years 1800-1872, during which time small quantities were shipped by canal and later by rail. With the growth of the State and the increased demands for fuel, coal mining in Athens County filled a large part of the demand. The thick deposits in the Hocking Valley area were mined at an early date; all production then was from drift and shaft mines. One of the remarkable features of Athens County's early (up to 1924) coal production is that most of the coal was mined by hand.

Production rates increased over the years and reached a peak in 1920. Many interruptions in the trends are accounted for by strikes and economic depressions. Later years have been marked by a decline in production, and this production has come from smaller underground mining operations and strip mines. Recently, auger mining has been developed and has produced a relatively small quantity of coal.

Although there has been a marked decline in production, it does not mean that the resources of coal are depleted. The circumstances of economics and mining costs have aided in the decline of coal production in Athens County. It is probable that Athens County's deeper coal resources will be mined when the areas of easily mined strip coal deposits are depleted. The production of coal from Ohio by strip methods amounted to over 62 per cent in 1955. The fact that there is increased production from shallower beds of coal hastens the renewal of deep coal mining.

Table 26

Analyses of Athens County Coal, by Township and Seam

Location		1	2	3		4	Proximate Analysis				Ultimate Analysis					Heat Value	
Township	Seam	File Number	Kind	Source	Year	Condition	Moisture	Volatile Matter	Fixed Carbon	Ash	Sulphur	Hydrogen	Carbon	Nitrogen	Oxygen	Calories	B. t. u.
Alexander	Pittsburgh	188	1	2	1928	1	7.13	41.51	42.09	9.27	4.52	5.40	64.40	0.96	15.45	6,559	11,807
						2	-	44.70	45.32	9.98	4.87	4.97	69.34	1.03	9.81	7,062	12,713
						3	-	49.66	50.34	-	5.41	5.52	77.03	1.14	10.90	7,846	14,122
						4	-	48.48	51.52	-	-	-	-	-	-	8,004	14,408
						5	8.15	44.52	47.33	-	-	-	-	-	-	7,353	13,235
Athens	Middle Kittanning	298	1	2	1902	1	6.17	36.40	49.61	7.82	0.90	5.43	69.22	1.30	15.33	6,868	12,362
						2	-	38.80	52.87	8.33	0.96	5.05	73.77	1.39	10.50	7,319	13,174
						3	-	42.33	57.67	-	1.05	5.51	80.47	1.52	11.45	7,984	14,371
						4	-	41.72	58.28	-	-	-	-	-	-	8,060	14,508
						5	6.78	38.89	54.33	-	-	-	-	-	-	7,514	13,526
Bern	Pittsburgh	277	1	1	2	1907	1	6.60	35.05	48.15	10.20	3.41	5.13	66.61	0.93	13.72	6,607	11,893
						2	-	37.53	51.55	10.92	3.65	4.71	71.32	1.00	8.40	7,074	12,733
						3	-	42.13	57.87	-	4.10	5.29	80.06	1.12	9.43	7,941	14,293
						4	-	40.83	59.17	-	-	-	-	-	-	8,088	14,559
						5	7.58	37.73	54.69	-	-	-	-	-	-	7,476	13,457
Bern	Pittsburgh	277	2	1	2	1907	1	4.51	38.24	45.76	11.49	4.88	5.10	65.92	0.99	11.62	6,636	11,945
						2	-	40.05	47.92	12.03	5.11	4.82	69.03	1.04	7.97	6,949	12,508
						3	-	45.53	54.47	-	5.81	5.48	78.47	1.18	9.06	7,899	14,218
						4	-	44.00	56.00	-	-	-	-	-	-	8,084	14,552
						5	5.31	41.66	53.03	-	-	-	-	-	-	7,656	13,780
Bern	Pittsburgh	278	1	1	2	1928	1	5.94	40.15	45.26	8.65	3.35	5.32	67.82	1.28	13.58	6,774	12,194
						2	-	42.68	48.12	9.20	3.56	4.96	72.10	1.36	8.82	7,202	12,964
						3	-	47.00	53.00	-	3.92	5.46	79.41	1.50	9.71	7,932	14,277
						4	-	45.99	54.01	-	-	-	-	-	-	8,062	14,512
						5	6.69	42.92	50.39	-	-	-	-	-	-	7,522	13,540
Bern	Pittsburgh	278	2	1	2	1928	1	5.66	43.96	43.52	6.86	4.10	5.46	68.25	1.08	14.25	6,939	12,491
						2	-	46.60	46.13	7.27	4.35	5.12	72.34	1.14	9.78	7,355	13,240
						3	-	50.25	49.75	-	4.69	5.52	78.01	1.23	10.55	7,932	14,278
						4	-	49.33	50.67	-	-	-	-	-	-	8,060	14,508
						5	6.27	46.24	47.49	-	-	-	-	-	-	7,556	13,600
Bern	Pittsburgh	279	A	1	2	1907	1	5.78	37.43	48.79	8.00	4.19	5.14	67.55	0.95	14.17	6,833	12,299
						2	-	39.73	51.78	8.49	4.45	4.78	71.69	1.01	0.58	7,252	13,053
						3	-	43.42	56.58	-	4.86	5.22	78.35	1.10	10.47	7,925	14,264
						4	-	42.17	57.83	-	-	-	-	-	-	8,064	14,516
						5	6.49	39.43	54.08	-	-	-	-	-	-	7,542	13,575
Bern	Pittsburgh	279	B	1	2	1929	1	3.62	44.84	44.69	6.85	3.74	-	-	-	-	6,980	12,564
						2	-	46.52	46.37	7.11	3.88	-	-	-	-	7,242	13,036
						3	-	50.08	49.92	-	4.18	-	-	-	-	7,796	14,033
						4	-	49.23	50.77	-	-	-	-	-	-	7,911	14,239
						5	4.00	47.26	48.74	-	-	-	-	-	-	7,594	13,669
Bern	Pittsburgh	279	C	1	2	1929	1	3.70	43.85	44.61	7.84	4.24	-	-	-	-	6,949	12,508

							2	-	45.53	46.33	8.14	4.40	-	-	-	-	7,216	12,989
							3	-	49.56	50.44	-	4.79	-	-	-	-	7,855	14,139
							4	-	48.56	51.44	-	-	-	-	-	-	7,989	14,381
							5	4.15	46.55	49.30	-	-	-	-	-	-	7,658	13,784
Bern	Pittsburgh	281	1	1	2	1928	1	5.87	41.93	43.39	8.81	4.01	5.35	67.06	1.05	13.72	6,806	12,251
							2	-	44.54	46.10	9.36	4.26	5.00	71.24	1.12	9.02	7,230	13,015
							3	-	49.14	50.86	-	4.70	5.52	78.59	1.24	9.95	7,977	14,359
							4	-	48.07	51.93	-	-	-	-	-	-	8,123	14,622
							5	6.65	44.88	48.47	-	-	-	-	-	-	7,583	13,650
Bern	Pittsburgh	281	2	1	2	1928	1	6.31	43.16	42.95	7.58	3.75	5.49	67.28	1.52	14.38	6,879	12,383
							2	-	46.07	45.84	8.09	4.00	5.11	71.81	1.62	9.37	7,342	13,217
							3	-	50.13	49.87	-	4.35	5.56	78.14	1.76	10.19	7,988	14,380
							4	-	49.20	50.80	-	-	-	-	-	-	8,119	14,615
							5	7.03	45.74	47.23	-	-	-	-	-	-	7,549	13,588
Bern	Pittsburgh	583	1[5]	1	3	1952	1	0.72	47.48	4.01	47.79	6.49	-	-	-	-	1,783	3,209
							2	-	47.82	4.04	48.14	6.54	-	-	-	-	1,796	3,232
							3	-	92.21	7.79	-	12.61	-	-	-	-	3,463	6,232
							4	-	93.11	6.89	-	-	-	-	-	-	3,634	6,541
							5	1.61	91.61	6.78	-	-	-	-	-	-	3,576	6,436
Bern	Pittsburgh	583	2[5]	1	3	1952	1	1.53	28.21	25.54	44.72	2.48	-	-	-	-	4,068	7,322
							2	-	28.65	25.94	45.41	2.52	-	-	-	-	4,131	7,436
							3	-	52.48	47.52	-	4.62	-	-	-	-	7,567	13,622
							4	-	48.43	51.57	-	-	-	-	-	-	8,192	14,746
							5	3.04	46.96	50.00	-	-	-	-	-	-	7,944	14,299
Bern	Pittsburgh	583	3[5]	1	3	1952	1	1.77	43.19	44.34	10.70	6.31	-	-	-	-	6,934	12,482
							2	-	43.97	45.14	10.89	6.42	-	-	-	-	7,059	12,707
							3	-	49.34	50.66	-	7.20	-	-	-	-	7,922	14,260
							4	-	47.85	52.12	-	-	-	-	-	-	8,123	14,622
							5	2.08	46.85	51.07	-	-	-	-	-	-	7,954	14,318
Bern	Pittsburgh	605	1	1	3	1954	1	5.80	38.04	43.83	12.33	6.54	-	-	-	-	6,344	11,419
							2	-	40.38	46.53	13.09	6.94	-	-	-	-	6,735	12,122
							3	-	46.46	53.54	-	7.99	-	-	-	-	7,749	13,948
							4	-	44.56	55.44	-	-	-	-	-	-	7,973	14,352
							5	6.98	41.45	51.57	-	-	-	-	-	-	7,417	13,350
Bern	Pittsburgh	605	2	1	3	1954	1	6.51	37.83	43.99	11.67	6.32	-	-	-	-	6,307	11,354
							2	-	40.47	47.05	12.48	6.76	-	-	-	-	6,746	12,145
							3	-	46.24	53.76	-	7.72	-	-	-	-	7,708	13,877
							4	-	44.40	55.60	-	-	-	-	-	-	7,922	14,259
							5	7.76	40.95	51.29	-	-	-	-	-	-	7,307	13,153
Canaan	Pittsburgh	275		1	2	1928	1	7.37	39.02	42.53	11.08	4.20	-	-	-	-	6,407	11,533
							2	-	42.12	45.92	11.96	4.54	-	-	-	-	6,917	12,451
							3	-	47.84	52.16	-	5.16	-	-	-	-	7,857	14,142
							4	-	46.52	53.48	-	-	-	-	-	-	8,028	14,451
							5	8.60	42.52	48.88	-	-	-	-	-	-	7,338	13,208
Canaan	Middle Kittanning	297		1	2	1907	1	6.36	34.19	50.96	8.49	0.51	5.40	69.25	1.43	14.92	6,919	12,454
							2	-	36.51	54.42	9.07	0.54	5.01	73.95	1.53	9.90	7,389	13,300
							3	-	40.15	59.85	-	0.59	5.51	81.33	1.68	10.89	8,126	14,626
							4	-	39.56	60.44	-	-	-	-	-	-	8,201	14,762
							5	7.02	36.79	56.19	-	-	-	-	-	-	7,625	13,725
Dover	Upper Freeport	488		1	2	1929	1	8.11	37.44	50.11	4.34	1.21	5.62	62.32	1.23	25.28	6,885	12,393
							2	-	40.74	54.53	4.73	1.32	5.14	67.82	1.34	19.65	7,493	13,487

Table 26 - Analyses of Athens County Coal, by Township and Seam - continued

Location		[1]	[2]	[3]		[4]	Proximate Analysis				Ultimate Analysis					Heat Value	
Township	Seam	File Number	Kind	Source	Year	Condition	Moisture	Volatile Matter	Fixed Carbon	Ash	Sulphur	Hydrogen	Carbon	Nitrogen	Oxygen	Calories	B. t. u.
Dover (continued)	Upper Freeport (continued)	488	1	2	1929	3	-	42.76	57.24	-	1.39	5.40	71.18	1.41	20.62	7,865	14,156
						4	-	42.30	57.70	-	-	-	-	-	-	7,918	14,252
						5	8.57	38.68	52.75	-	-	-	-	-	-	7,238	13,030
Dover	Upper Freeport	492	1	2	1930	1	6.97	39.68	47.35	6.10	2.78	-	-	-	-	6,936	12,485
						2	-	42.54	50.90	6.56	2.99	-	-	-	-	7,458	13,425
						3	-	45.53	54.47	-	3.20	-	-	-	-	7,982	14,368
						4	-	44.72	55.28	-	-	-	-	-	-	8,081	14,545
						5	7.59	41.33	5,108	-	-	-	-	-	-	7,465	13,437
Dover	Middle Kittanning	299	1	2	1902	1	7.14	34.22	51.92	6.72	1.65	5.56	69.32	1.30	15.45	6,863	12,353
						2	-	36.85	55.91	7.24	1.78	5.14	74.65	1.39	9.80	7,390	13,302
						3	-	39.73	60.27	-	1.92	5.54	80.48	1.50	10.56	7,967	14,340
						4	-	38.99	61.01	-	-	-	-	-	-	8,049	14,488
						5	7.77	35.96	56.27	-	-	-	-	-	-	7,423	13,361
Dover	Middle Kittanning	486 A	1	1	1930	1	9.3	35.4	50.0	5.3	0.9	-	-	-	-	6,850	12,330
						2	-	39.0	55.1	5.9	1.0	-	-	-	-	7,552	13,594
						3	-	41.4	58.6	-	1.1	-	-	-	-	8,026	14,446
						4	-	40.9	59.1	-	-	-	-	-	-	8,078	14,540
						5	9.9	36.9	53.2	-	-	-	-	-	-	7,278	13,100
Dover	Middle Kittanning	486 B	1	1	1930	1	8.8	35.5	50.3	5.4	0.6	-	-	-	-	6,900	12,420
						2	-	38.9	55.2	5.9	0.7	-	-	-	-	7,566	13,618
						3	-	41.3	58.7	-	0.7	-	-	-	-	8,040	14,472
						4	-	41.0	59.0	-	-	-	-	-	-	8,094	14,570
						5	9.4	37.1	53.5	-	-	-	-	-	-	7,333	13,200
Dover	Middle Kittanning	486 C	1	1	1930	1	9.8	35.4	48.7	6.1	0.8	-	-	-	-	6,717	12,090
						2	-	39.2	54.0	6.8	0.9	-	-	-	-	7,447	13,404
						3	-	42.1	57.9	-	1.0	-	-	-	-	7,990	14,382
						4	-	41.6	58.4	-	-	-	-	-	-	8,050	14,490
						5	10.5	37.2	52.3	-	-	-	-	-	-	7,200	12,960
Dover	Middle Kittanning	486 D[6]	1	2	1930	1	6.02	39.28	49.74	4.96	0.81	4.41	71.32	0.98	17.52	7,067	12,720
						2	-	41.80	52.93	5.27	0.86	3.98	75.88	1.04	12.97	7,518	13,532
						3	-	44.13	55.87	-	0.91	4.20	80.10	1.10	13.69	7,936	14,285
						4	-	43.73	56.27	-	-	-	-	-	-	7,986	14,375
						5	6.39	40.94	52.67	-	-	-	-	-	-	7,478	13,460
Dover	Middle Kittanning	486 K	1	1	1930	1	8.6	35.3	50.0	6.1	0.8	5.6	69.4	1.4	16.7	6,817	12,270
						2	-	38.6	54.8	6.6	0.9	5.1	75.9	1.5	10.0	7,456	13,420
						3	-	41.3	58.7	-	1.0	5.4	81.3	1.7	10.6	7,989	14,380
						4	-	40.9	59.1	-	-	-	-	-	-	8,056	14,500
						5	9.3	37.0	53.7	-	-	-	-	-	-	7,306	13,150
Dover	Middle Kittanning	606 1	3	3	1954	1	4.11	36.87	51.94	7.08	0.68	-	-	-	-	6,962	12,532
						2	-	38.45	54.17	7.38	0.71	-	-	-	-	7,260	13,069
						3	-	41.51	58.49	-	0.77	-	-	-	-	7,838	14,110
						4	-	41.00	59.00	-	-	-	-	-	-	7,902	14,223
						5	4.47	39.17	56.36	-	-	-	-	-	-	7,549	13,588
Dover	Middle Kittanning	606 2	3	3	1954	1	3.33	34.55	45.18	16.94	2.11	-	-	-	-	6,197	11,156
						2	-	35.74	46.74	17.52	2.18	-	-	-	-	6,410	11,540
						3	-	43.33	56.67	-	2.64	-	-	-	-	7,772	13,991

							4	-	41.90	58.10	-	-	-	-	-	-	7,950	14,310
							5	4.13	40.17	55.70	-	-	-	-	-	-	7,622	13,720
Dover	Middle Kittanning	606	3	3	3	1954	1	2.77	39.08	40.86	17.29	3.48	-	-	-	-	6,267	11,281
							2	-	40.19	42.03	17.78	3.58	-	-	-	-	6,446	11,602
							3	-	48.88	51.12	-	4.35	-	-	-	-	7,840	14,111
							4	-	47.36	52.64	-	-	-	-	-	-	8,051	14,491
							5	3.49	45.71	50.80	-	-	-	-	-	-	7,770	13,986
Dover	Middle Kittanning	606	9	3	3	1954	1	3.43	36.73	46.02	13.82	1.96	-	-	-	-	6,455	11,620
							2	-	38.03	47.66	14.31	2.03	-	-	-	-	6,684	12,033
							3	-	44.38	55.62	-	2.37	-	-	-	-	7,800	14,042
							4	-	43.24	56.76	-	-	-	-	-	-	7,945	14,301
							5	4.08	41.48	54.44	-	-	-	-	-	-	7,621	13,717
Lodi	Pittsburgh	274	1	1	2	1928	1	8.52	39.15	42.44	9.89	3.06	5.41	64.19	1.60	15.85	6,442	11,595
							2	-	42.79	46.40	10.81	3.34	4.87	70.17	1.75	9.06	7,042	12,675
							3	-	47.98	52.02	-	3.74	5.46	78.68	1.96	10.16	7,896	14,211
							4	-	48.93	53.07	-	-	-	-	-	-	8,034	14,462
							5	9.72	42.38	47.90	-	-	-	-	-	-	7,253	13,056
Lodi	Pittsburgh	274	2	1	2	1928	1	6.73	41.20	40.99	11.08	2.78	5.34	64.57	1.13	15.10	6,500	11,700
							2	-	44.17	43.95	11.88	2.98	4.92	69.23	1.21	9.78	6,969	12,544
							3	-	50.12	49.88	-	3.38	5.58	78.57	1.37	11.10	7,909	14,235
							4	-	49.14	50.86	-	-	-	-	-	-	8,051	14,492
							5	7.78	45.32	46.90	-	-	-	-	-	-	7,425	13,365
Trimble	Upper Freeport	489		1	2	1929	1	6.78	40.87	45.87	6.48	2.46	5.34	60.07	0.91	24.74	6,842	12,315
							2	-	43.84	49.21	6.95	2.64	4.93	64.44	0.98	20.06	7,339	13,211
							3	-	47.11	52.89	-	2.84	5.30	69.25	1.05	21.56	7,887	14,198
							4	-	46.38	53.62	-	-	-	-	-	-	7,981	14,366
							5	7.40	42.95	49.65	-	-	-	-	-	-	7,391	13,303
Trimble	Upper Freeport	491		1	2	1929	1	6.26	41.19	46.56	5.99	2.27	4.83	69.63	1.10	16.18	7,016	12,629
							2	-	43.94	49.57	6.39	2.42	4.41	74.28	1.17	11.33	7,486	13,475
							3	-	46.94	53.06	-	2.59	4.71	79.35	1.25	12.10	7,997	14,395
							4	-	46.27	53.73	-	-	-	-	-	-	8,084	14,552
							5	6.78	43.14	50.08	-	-	-	-	-	-	7,534	13,562
Trimble	Upper Freeport	526	A	1	1	1948	1	6.9	40.5	44.4	8.2	5.1	5.5	66.4	1.2	13.6	6,739	12,130
							2	-	43.5	47.7	8.8	5.5	5.1	71.3	1.3	8.0	7,239	13,030
							3	-	47.8	52.2	-	6.1	5.6	78.2	1.4	8.7	7,938	14,290
							4	-	46.5	53.5	-	-	-	-	-	-	8,100	14,580
							5	7.8	42.8	49.4	-	-	-	-	-	-	7,467	13,440
Trimble	Upper Freeport	526	B	1	1	1948	1	6.6	40.2	45.6	7.6	5.2	5.5	67.3	1.2	13.2	6,800	12,240
							2	-	43.0	48.9	8.1	5.6	5.2	72.1	1.3	7.7	7,278	13,100
							3	-	46.8	53.2	-	6.1	5.6	78.5	1.4	8.4	7,919	14,270
							4	-	45.6	54.4	-	-	-	-	-	-	8,083	14,550
							5	7.4	42.2	50.4	-	-	-	-	-	-	7,483	13,470
Trimble	Middle Kittanning	295		1	2	1902	1	7.28	32.38	53.61	6.73	0.86	5.45	69.46	1.34	16.16	6,894	12,409
							2	-	34.92	57.82	7.26	0.93	5.00	74.91	1.45	10.45	7,435	13,383
							3	-	37.65	62.35	-	1.00	5.39	80.78	1.56	11.27	8,017	14,431
							4	-	37.06	62.94	-	-	-	-	-	-	8,084	14,552
							5	7.89	34.14	57.97	-	-	-	-	-	-	7,447	13,404
Waterloo	Middle Kittanning	293		1	2	1902	1	6.70	35.36	51.19	6.75	2.28	5.49	69.21	1.18	15.09	6,921	12,458
							2	-	37.90	54.87	7.23	2.44	5.09	74.18	1.26	9.80	7,418	13,352
							3	-	40.85	59.15	-	2.63	5.49	79.96	1.36	10.56	7,996	14,393
							4	-	40.01	59.99	-	-	-	-	-	-	8,091	14,563
							5	7.33	37.07	55.60	-	-	-	-	-	-	7,498	13,497

Table 26 - Analyses of Athens County Coal, by Township and Seam - continued

Location		[1]	[2]	[3]		[4]	Proximate Analysis				Ultimate Analysis					Heat Value	
Township	Seam	File Number	Kind	Source	Year	Condition	Moisture	Volatile Matter	Fixed Carbon	Ash	Sulphur	Hydrogen	Carbon	Nitrogen	Oxygen	Calories	B. t. u.
Waterloo	Middle Kittanning	294	1	2	1902	1	6.80	36.90	48.25	8.05	2.14	5.49	67.40	1.37	15.55	6,794	12,229
						2	-	39.59	51.77	8.64	2.30	5.07	72.32	1.47	10.20	7,290	13,122
						3	-	43.33	56.67	-	2.52	5.55	79.16	1.61	11.16	7,979	14,363
						4	-	42.48	57.52	-	-	-	-	-	-	8,083	14,549
						5	7.54	39.28	53.18	-	-	-	-	-	-	7,472	13,450
York	Upper Freeport	528 1	1	1	1948	1	8.3	39.5	47.8	4.4	1.9	5.8	70.1	1.3	16.5	6,944	12,500
						2	-	43.0	52.2	4.8	2.1	5.3	76.5	1.4	9.9	7,572	13,630
						3	-	45.2	54.8	-	2.2	5.5	80.3	1.5	10.5	7,954	14,310
						4	-	44.6	55.4	-	-	-	-	-	-	8,022	14,440
						5	8.8	40.8	50.4	-	-	-	-	-	-	7,316	13,168
York	Upper Freeport	528 2	1	1	1948	1	8.7	35.4	45.7	10.2	2.2	5.5	64.4	1.2	16.5	6,372	11,470
						2	-	38.8	50.1	11.1	2.4	4.9	70.6	1.3	9.7	6,978	12,560
						3	-	43.7	56.3	-	2.7	5.5	79.4	1.5	10.9	7,849	14,130
						4	-	42.6	57.4	-	-	-	-	-	-	7,972	14,350
						5	9.9	38.4	51.7	-	-	-	-	-	-	7,190	12,942
York	Upper Freeport	528 3	1	1	1948	1	4.9	35.3	44.5	15.3	5.5	4.8	60.4	1.2	12.8	6,133	11,040
						2	-	37.1	46.9	16.0	5.7	4.5	63.5	1.3	9.0	6,450	11,610
						3	-	44.2	55.8	-	6.8	5.4	75.7	1.5	10.6	7,678	13,830
						4	-	42.1	57.9	-	-	-	-	-	-	7,906	14,230
						5	6.1	39.6	54.3	-	-	-	-	-	-	7,434	13,381
York	Lower Freeport	524 1	1	1	1948	1	5.4	40.6	45.6	8.4	2.9	5.5	67.9	1.3	14.0	6,822	12,280
						2	-	42.9	48.2	8.9	3.0	5.2	71.8	1.4	9.7	7,211	12,980
						3	-	47.1	52.9	-	3.3	5.7	78.8	1.5	10.7	7,915	14,240
						4	-	46.2	53.8	-	-	-	-	-	-	8,032	14,458
						5	6.0	43.4	50.6	-	-	-	-	-	-	7,547	13,584
York	Lower Freeport	524 2	1	1	1948	1	5.3	41.3	46.7	6.7	2.9	5.5	69.5	1.2	14.2	7,000	12,600
						2	-	43.6	49.3	7.1	3.1	5.2	73.5	1.3	9.8	7,394	13,310
						3	-	47.0	53.0	-	3.3	5.6	79.1	1.4	10.6	7,959	14,330
						4	-	46.1	53.9	-	-	-	-	-	-	8,064	14,516
						5	5.8	43.4	50.8	-	-	-	-	-	-	7,589	13,661
York	Middle Kittanning	485	1	2	1930	1	7.40	39.28	47.92	5.40	0.97	4.47	69.85	0.98	16.33	7,029	12,652
						2	-	42.42	51.75	5.83	1.04	3.95	75.44	1.05	12.69	7,591	13,663
						3	-	45.05	54.95	-	1.10	4.19	80.11	1.12	13.48	8,061	14,509
						4	-	44.60	55.40	-	-	-	-	-	-	8,119	14,615
						5	7.90	41.08	51.02	-	-	-	-	-	-	7,478	13,460

1. Explanation of file numbers: A basic 6-digit sample number is used. Suffixes 'A' through 'D' indicate samples taken at different points in the same location; 'K' denotes composite of these samples. Suffixes '1' through '8' indicate samples taken vertically or in benches at same point; '9' denotes composite of these samples. When samples have been taken vertically at one point only, letter suffix is not needed or used.
2. Kind of sample: 1- channel (mine); 2- channel (outcrop); 3- column or core.
3. Source: 1- U. S. Bureau of Mines and/or U. S. Geological Survey; 2- Ohio Geological Survey; 3- Engineering Experiment Station, O. S. U.
4. Condition: 1- as received; 2- moisture-free; 3- moisture- and ash-free; 4- dry unit coal; 5- moist unit coal.
5. Condition 1 'air-dried'. Boghead coal.
6. Not in composite 486-K.

CLAY RESOURCES

Athens County contains a large reserve of underclay which is suitable for the production of various types of ceramic ware. The most important beds are the Brookville, Lower Kittanning, Oak Hill, Upper Freeport, Thornton, and Anderson. Several other members are suitable for ceramic purposes; however, because of inadequate or variable thickness they contribute very little to the clay resources, except as a possible source of material for ceramic classes in schools or for those interested in ceramics as a hobby.

At present, there are no ceramic plants operating in Athens County, but clay is mined in the Nelsonville-Buchtel area and hauled to plants in Haydenville and Diamond in Hocking County. The principal clay mined in the area is the Lower Kittanning.

The chief products manufactured at Haydenville and Diamond plants are conduits, flue liners, tile, and building blocks. Paving brick and building block were formerly produced in large volume, but demand has dwindled in recent years.

Summaries of the chemical and ceramic properties of selected Athens County clays are reported by Stout (1923).

BROOKVILLE CLAY

The Brookville clay in Athens County is either too thin or too variable in thickness for mining, with possibly one exception. Exposures in section 30, York Township, Athens County, and in nearby Ward Township, Hocking County, indicate an area between the Dorr Run and Hocking Valley in which the Brookville clay is 5 to 6 feet thick.

This area is accessible for mining from either the Hocking or the Dorr Run Valley, but the extent of the area of thick clay should be determined before development is attempted. Roof material could present a problem, as the Brookville coal is very thin or absent and a shale overlies the clay in many places.

No chemical tests are available for the Brookville clay in Athens County, but the clay resembles in appearance Brookville deposits in Hocking County which are used for various ceramic products such as sewer pipe and tile.

LOWER KITTANNING CLAY

The outcrop area of the Lower Kittanning clay in Athens County extends from the northern part of York Township along the Hocking River Valley to the area south of Nelsonville where it passes under cover. The average thickness calculated from five measured sections is 5 feet; the range is 3 feet 7 inches to 6 feet 7 inches. Well and mine information shows that it also maintains a favorable minable thickness in the subsurface. The Lower Kittanning clay member represents the largest reserve of high quality clay occurring in the county.

The clay is plastic, relatively free from undesirable chemical constituents, and has been found suitable for a wide variety of ceramic products.

OAK HILL CLAY

The Oak Hill clay occurs in York Township along the valley of the Hocking River. The clay is present only in isolated pockets within this area. The clay is plastic in character, and contains calcareous and ferruginous concretions which are scattered irregularly throughout the member. The average thickness, calculated from seven measured sections, is 5 feet 4 inches.

The Oak Hill clay is relatively unimportant in Athens County because of its erratic occurrence and low quality. Formerly it was blended with the Lower Kittanning clay and with shale by the Nelsonville Brick Company near Nelsonville for the manufacture of fireproofing and building block (Stout et al., 1923, p. 331).

There are no chemical or physical test data available for the Oak Hill clay in Athens County.

UPPER FREEPORT CLAY

The Upper Freeport clay has not been utilized for ceramic purposes in Athens County. The average thickness, calculated from 38 measured sections, is 2 feet 8 inches. However, the thickness is extremely variable, ranging from 10 feet 5 inches to 2 inches. The area in which the clay is most favorable for mining is in York Township, near Buchtel, where the thickness varies from 2 to 6 feet and averages about 4 feet 6 inches. The clay is shaly and siliceous in composition, containing small calcareous and ferruginous concretions throughout.

THORNTON CLAY

The Thornton clay is thickest in Dover Township and in the vicinity of Buchtel, York Township. The average thickness of the clay, calculated from 21 measured sections, is 2 feet 8 inches. The minimum recorded thickness is 2 inches; the maximum is 7 feet 1 inch.

Although no chemical tests are available for the Thornton clay, it has been determined from field observations that it contains some ferruginous and calcareous material.

In the Buchtel area, the Thornton clay occurs on the hilltops closely overlying the Upper Freeport coal. The coal is of minable thickness in this area, and the clay could be obtained during the stripping of the overburden.

SoRelle (1952, p. 52-55) tested two samples from York Township, Athens County, and two more from nearby Ward Township, Hocking County, with generally good results in respect to working and firing qualities. Ceramic classes at Ohio University have used this clay and have found it satisfactory for their purposes.

The extent and thickness of the Buchtel deposit and the results of SoRelle's tests probably warrant further testing of the deposit for possible additional ceramic uses.

ANDERSON CLAY

The Anderson clay is fairly persistent in Athens County. The average thickness calculated from 22 measured sections is 2 feet 6 inches. Although the thickness varies from a few inches to over seven feet, the majority of the sections exhibit 1 foot 6 inches to 4 feet of clay.

At present, the Anderson member is not mined anywhere in the county. Formerly, small quantities were used near Glouster for the manufacture of paving brick.

The quality of the clay is generally low because of the ferruginous and calcareous material in concretionary form that occurs throughout the member. A summary of the chemical and ceramic properties is given in Stout et al., 1923, p. 434.

OTHER CLAYS

Many other clays outcrop in Athens County, but they are too thin to be mined or contain impurities that are undesirable in high quality ceramic wares. These clays are fully discussed in the stratigraphic section of this report.

SHALE RESOURCES

Shale is a prominent segment of the Pennsylvanian and Permian systems in Athens County, as it is elsewhere in Ohio. The composition of shale in the coal bearing series is highly variable, both at different horizons and laterally within the same horizon. Materials such as silica, iron oxide, and calcium carbonate are present in the Pennsylvanian and Permian shales in sufficient quantities to be detrimental for refractory purposes.

In Athens County some shale horizons were the basis for the manufacture of paving brick, but with the discontinuation of brick for road construction no production has been reported for several years. Plants utilizing local shale sources were located at Nelsonville, Athens, and Glouster and Trimble in Trimble Township. The shales that were utilized occurred, for the most part, in the lower part of the Conemaugh formation, with one horizon in the Allegheny formation. The shales of the Monongahela and Permian are too calcareous to yield a good ceramic product.

The Athens Brick Company at Athens was the largest single producer among these plants that used shale as raw material. Two horizons, one between the Portersville and Ames limestones, the other above the Ames limestone, were here utilized for the manufacturing of paving block (Lamborn, 1938, p. 200-201, 207). This plant has long since been abandoned.

The Buffalo shale which overlies the Upper Brush Creek limestone and coal was the most extensively used shale in Athens County. Three concerns--the Nelsonville Brick Company at Nelsonville, the Trimble Brick Manufacturing Company at Trimble, and the Hisylvania Coal Company at Glouster--all used this shale in the manufacturing of paving block and fireproofing during the 1920's. The results of tests on the Buffalo shale sampled at Nelsonville and Glouster are given in Shales and Surface Clays, by R. E. Lamborn et al., Bull. 30, 4th series, p. 191-194, of the Ohio Geological Survey.

The Nelsonville plant mixed 2 per cent Lower Kittanning clay with the Buffalo shale, to improve working qualities. In Trimble Township shale from above, the Mason coal bed was used for a time, but this practice was discontinued because of the high carbonaceous and calcareous content. The Middle Kittanning shale, which overlies the Strasburg coal bed was also used successfully at Nelsonville by mixing it with Lower Kittanning clay.

Recent investigations by the Ohio State University Engineering Experiment Station (1957) reveal that the Middle Kittanning shale and the Brush Creek shale in Trimble Township show promise as a suitable material for expanded aggregate (Everhart et al., 1958, p. 8).

SANDSTONE RESOURCES

In the Pennsylvanian rocks of Athens County there is an abundance of local massive sandstones with average thicknesses commonly from 20 to 40 feet and at a few places with thicknesses of 60 to 80 or even 100 feet. Every cyclothem has a variable basal member of shale, sandy shale, shaly sandstone, and/or massive sandstone, or usually some combination of those lithologies, although in one or two cycles, as in the Lower Kittanning cyclothem, no basal member of shale and sandstone was recognized in the county. The following shale and sandstone members are most commonly developed in a massive sandstone phase:

Pottsville	Allegheny	Conemaugh
1. Homewood	3. Upper Freeport	8. Lower Pittsburgh
	2. Lower Freeport	7. Connellsville
	1. Clarion	6. Morgantown
		5. Upper Grafton
		4. Cow Run
		3. Buffalo
		2. Upper Mahoning
		1. Lower Mahoning

Monongahela	Dunkard
6. Gilboy	8. Dunkard
5. Uniontown	7. Jollytown
4. Upper Sewickley	6. Hundred
3. Lower Sewickley	5. Upper Marietta
2. Pomeroy (Redstone?)	4. Lower Marietta
1. Upper Pittsburgh	3. Washington
	2. Mannington
	1. Waynesburg

Bedded shale and sandstone, however, in variable amounts, lithology, and stratigraphic relationships comprise most of the rock in basal members of the usual cyclothems. All these beds tend to be silty, micaceous, locally clayey, and, if sandstone, fine-grained and thin-bedded. Bedding varies from less than an inch to several inches and less commonly a foot or more in thickness and may be fairly even and regular to uneven, irregular, and cross-bedded. Association of shale and sandstone beds varies from all shale to mostly sandstone, with one or the other lithology at top, middle, or bottom in any amount of each type. Facies changes in lateral and vertical directions occur commonly in all cycles.

Economic use of such variable beds as these shales and sandstones has been small. In the past, but not at present, some use of these and adjacent beds above and below was made in the manufacture of brick and some related ceramic products in the vicinity of Athens (Ames, Cow Run, Gaysport, Saltsburg), Glouster-Trimble (Buffalo, Lower Brush Creek, Mason), and Nelsonville (Buffalo, Strasburg, Freeport) (Condit, 1912, p. 235-239; Lamborn et al., 1938, p. 149, 162, 179, 186, 191-194, 200, and 207). Flaggy sandstone beds have been used locally for walks and other similar purposes.

At almost any locality in the county one or more massive sandstones occur, and in certain areas, as for example in the Mineral-Waterloo vicinity along Hewett Fork, around Athens and Nelsonville, and between Sharpsburg and Hockingport, thick massive sandstones are conspicuous (see figures 13, 23). Weathered surfaces of these massive rocks usually show traces of bedding and cross-bedding. Cementing materials are predominantly calcareous and ferruginous, and except for local areas and zones these sandstones are not firmly cemented and tend to be friable. Fresh colors are light gray to almost white, but exposed parts are weathered and stained various shades of gray, red, brown, and yellow - - usually some combination of brownish yellow

or yellowish brown or mottled colors of gray and iron oxides. Some sandstones are attractive, but colors of the majority are not appealing. The principal mineral is quartz, and there is some variation in composition among the several sandstones with a gradual change from lower to higher members. The Allegheny and Pottsville sandstones are more nearly pure quartzose sandstones with muscovite mica as the most conspicuous accessory mineral, and the upper Conemaugh and higher sandstones have increasing quantities of rock fragments, feldspar, and mica including biotite. Some, and probably all, are locally pebbly and have pebbly and conglomeratic zones. Pebbles consist of several varieties of quartz, feldspar, and pieces of rock, and occur at various positions within the thickness of the beds - - commonly toward the base or in zones where one sandstone rests directly upon another.

In spite of their general friable nature and lack of attractive colors, sandstones were locally used for abutments, bridges, chimney and hearth stones, cistern and well walls, culverts, foundations, headstones, paving blocks, retaining walls, section corners, steps, walks, and other purposes from early pioneer times. Brick, concrete and other materials gradually replaced sandstone for most local purposes about the beginning of the present century, so that present use of local sandstones is limited to small incidental uses, about the farm or home, of stone picked up from the fields, stream channels, strip mines, or other accessible outcrops.

As far as determined, there never were any very extensive quarrying operations for sandstone within the county. There were, however, numerous small local quarries located as close to the place of use for the stone as possible. Hence, the quarries were operated intermittently, and often utilized slump blocks below outcropping ledges, or the rock in beds and banks of stream channels. Time, with the processes and agents of weathering, erosion, slump, growth of vegetation, and rubbish dumps, has obliterated or partially concealed locations of many of these small quarry sites, and many are unknown to present passersby.

With an abundance of easily available sandstone in the Pennsylvanian and Permian sandstones of eastern Ohio and in an industrial age in which sand and gravel are the most extensively used of any mineral resource, it is unfortunate that Ohio's sandstones are not more exploited at present. Stout (1944, p. 75-88) has summarized information concerning Ohio sandstones and their uses, and most certainly Athens County sandstones are suitable for numerous uses. One opportunity open to stimulate additional use of these sandstones would be a research program on their detailed occurrence, petrology and petrography, and inexpensive beneficiation methods to make them suitable as a source of pure quartz sand and to recover any usable by-products.

LIMESTONE RESOURCES

GENERAL CONSIDERATIONS

There are 20 separate limestone members outcropping in Athens County but only five attain sufficient thickness to be utilized commercially. The limestones that are in the above-mentioned category are the Brush Creek and Upper Pittsburgh of the Conemaugh series; the Fishpot, Benwood, and Arnoldsburg of the Monongahela series.

Quarries have operated at various times in Rome, Carthage, Bern, Lee, and Ames Townships. However, the life of such operations is generally short, as the rugged topography usually prevents the removal of large quantities of stone before the overburden becomes too thick for profitable quarrying. The chief product marketed is aggregate which is used locally for roads and structures. Agricultural lime has been produced from time to time but only in insignificant amounts.

The limestone quarried at Columbus, Ohio, and shipped to Athens County by rail and truck provides keen competition for the local producers. The stone at Columbus is quarried on such a

large scale that the production cost per unit is low enough that the stone can be shipped long distances and still be competitive with stone produced from small local operations.

MAXVILLE LIMESTONE

The Maxville limestone occurs in the subsurface in Athens County at depths of approximately 450 to 1,200 feet. The formation occurs nearest to the surface in Lee and Waterloo Townships at depths ranging from 450 to 600 feet,with a thickness from 20 to 70 feet (Lamborn, 1951, p. 45). The largest deposit known to date is in Lodi-Canaan Township area. At this locality thicknesses as great as 60 feet, at depths varying from 950 to 1,150 feet, have been recorded. Wells drilled for oil and gas have encountered scattered remnants of the Maxville in Lodi, Canaan, Ames, Lee, and Waterloo Townships.

The Maxville has been utilized for cement manufacture at other localities in Ohio. The stone tends to be uniform in composition in the different areas for which tests have been made; therefore, it is probable that the Athens County deposits could be used for similar purposes. Its suitability for use as a fluxstone or as a chemical limestone can be determined only by analyses of material obtained by core drilling.

BRUSH CREEK LIMESTONE

The Brush Creek limestone is extracted at the Dickson Brothers' quarry and the Diamond Stone Quarries, Inc., near Albany in southeastern Lee Township.

The Brush Creek member is reported to be approximately 18 feet thick in the above area, of which only 6 feet is minable. However, this is only a local thickening, as the limestone is usually 1 to 2 feet thick in the other areas of outcrop in Athens County.

Below is a chemical analysis of Brush Creek limestone from quarry on Fred Johnston property, section 13, Lee Township, Athens County. E. Chadbourn, analyst (Lamborn, 1951, p. 46):

	Per Cent
Silica, SiO_2	38.38
Alumina, Al_2O_3	2.19
Ferric oxide, Fe_2O_3	0.19
Ferrous oxide, FeO	0.71
Iron disulphide, FeS_2	0.04
Magnesium oxide, MgO	0.49
Calcium oxide, CaO	31.10
Sodium oxide, Na_2O	0.37
Potassium oxide, K_2O	0.18
Water, hydroscopic, H_2O-	0.31
Water, combined, H_2O+	0.86
Carbon dioxide, CO_2	24.68
Titanium dioxide, TiO_2	0.13
Phosphorus pentoxide, P_2O_5	0.16
Sulphur trioxide, SO_3	0.04
Manganous oxide, MnO	0.17
Total	100.00

According to the above analysis, the Brush Creek member could be used only for road metal,as it contains too much silica for cement manufacture, flux stone or chemical limestone.

The only favorable area for further economic development is in Lee Township. In addition to the local thickening, the topography is less rugged than in the remainder of the county. As a result, the limestone is under shallow cover over a wide area.

UPPER PITTSBURGH LIMESTONE

The Upper Pittsburgh limestone is the most persistent and best developed fresh-water limestone of the Conemaugh series in Athens County. It has an average thickness of 11 feet as calculated from 27 measured sections in Alexander, Ames, Bern, Canaan, Dover, and Rome Townships.

The member consists of nodules or beds of nodular and irregular-bedded limestone, some more than 1 foot thick, and separated by shale partings. The limestone is usually firm and dense but locally may be somewhat brecciated.

The Upper Pittsburgh is of sufficient quality and thickness in parts of eastern Canaan Township and in southwestern Rome Township for use as road metal and other similar purposes.

Quarries have been operated in sections 6, 7, and 12, Canaan Township, and in section 33, Rome Township, along the valley of Sugar Creek and the Hocking River and immediate tributaries. The principal obstacle to future development is the rugged topography throughout the area of outcrop. This limits the strippable area to a very narrow band along the outcrop line.

FISHPOT LIMESTONE

The Fishpot limestone is the principal source of stone quarried in eastern Athens County. At present, the Amesville Stone Company is producing stone from this member in section 20, Rome Township. Other quarries have operated at various times in Bern and Rome Townships.

The member is regularly bedded with shale partings separating the layers. The upper part tends to be more massive and is the portion that is usually quarried. The thickness of the member ranges from 1 to approximately 30 feet; however, the latter thickness includes a high percentage of interbedded shale.

Below is a chemical analysis of Fishpot limestone from quarry of State Highway Department, section 20, Rome Township, Athens County. Nalin Laboratories, analysts (Lamborn, 1951, p. 50-51):

	Per Cent
Silica, SiO_2	5.73
Alumina, Al_2O_3	1.48
Ferric oxide, Fe_2O_3	0.80
Ferrous oxide, FeO	0.59
Iron disulphide, FeS_2	<0.01
Magnesium oxide, MgO	0.93
Calcium oxide, CaO	49.09
Strontium oxide, SrO	<0.01
Barium oxide, BaO	0.08
Sodium oxide, Na_2O	0.19
Potassium oxide, K_2O	0.22
Water, hydroscopic, H_2O-	0.10
Water, combined H_2O+	0.23
Carbon dioxide, CO_2	39.81

	Per Cent
Titanic oxide, TiO_2	0.10
Phosphorus pentoxide, P_2O_5	0.04
Sulphur trioxide, SO_3	0.16
Manganous oxide, MnO	0.03
Carbon, organic, C	0.55
Hydrogen, organic, H	0.05
Total	100.18

This chemical analysis shows the Fishpot limestone to be suitable for fluxstone, for cement manufacture, and as a chemical limestone. However, future development of quarries is limited by the variable thickness, small area of outcrop, and small area with thin overburden.

BENWOOD AND ARNOLDSBURG LIMESTONES

The Benwood and Arnoldsburg limestones, although they are separate members, will be considered as one unit due to the absence of the Fulton green shale which usually separates them. The thickness ranges from 5 to 40 feet of limestone strata with thin interbedded shales. The Benwood-Arnoldsburg is similar in occurrence to the members discussed previously, in respect to variable thickness, small outcrop area, and thick overburden, which are deterrents to development. The limestone was formerly worked in the L. T. Jenkins quarry, located in section 16, Rome Township. At present, the stone is not being quarried in Athens County.

OTHER LIMESTONES

The remainder of the limestones outcropping in Athens County, due to their discontinuity, undesirable lithology, or lack of adequate thickness, contribute little to the limestone resources. They are of value only for stratigraphic purposes and for the lime added to the local soils by their weathering. These limestones will not be discussed here, but their stratigraphy and lithology are discussed in the stratigraphic section of this report.

SAND AND GRAVEL RESOURCES

The significant deposits of gravel in Athens County are restricted to the Hocking River Valley. The gravel here occurs predominantly in the floodplain and in widely scattered glacial terraces along the sides of the valley.

The glacial terraces of Wisconsin age are found up to 20 feet above the modern floodplain, and those of Illinoian age are generally about 60 feet above the floodplain. The largest deposit of Illinoian gravel is located beneath The Plains, an abandoned segment of the Illinoian deposit left almost undissected because of a local shift in the position of the Hocking River. The depth of the unconsolidated material here has not been determined, but the deepest water well drilled at The Plains ended in gravel at a depth of 115 feet (Kempton, 1956, p. 42).

The depth of soil developed in the Wisconsin terraces is not great, varying from 4 to 8 feet, but in the Illinoian terrace gravels it is 12 to 15 feet deep, a depth almost prohibitive to exploitation, except in very large deposits.

The quality of the gravel in Athens County is such that it is suitable for most uses. A high percentage of chert makes it undesirable in aggregate for high quality concrete, for the bond between concrete and chert is rather weak, resulting in "popouts" and cracks due to freezing and thawing. Fragments of locally derived shale and sandstone, undesirable because of their rapid breakdown under weathering, are also present in the Hocking River alluvium, with an abundance which increases downstream. A method of beneficiation known as "heavy media separation," which recently has been used successfully elsewhere to process marginal quality gravel, might be applied economically in Athens County.

All of the areas of potential gravel deposits in Athens County are accessible to truck transportation,and in many areas railroad transportation could be used also.

At present, there are two pits from which gravel is produced commercially in the county. These are the John Slater pit south of The Plains and the Athens Building Materials pit in Athens.

Reserves of gravel are adequate for future average needs, but, for construction projects requiring high quality aggregate, it will be necessary to beneficiate the local gravel, transport aggregate into the county from another source, or use crushed limestone from one of the local quarries.

GROUND WATER RESOURCES

The principal source of ground water is the outwash sand and gravel deposits underlying the flood plain of the Hocking River and the shallow sandstones underlying the uplands.

From 40 to 60 feet of unconsolidated glacial outwash and alluvium is present beneath the flood plain of the Hocking River, from which it is possible to develop large diameter wells capable of yielding several hundred gallons per minute. A typical sequence of materials found in this valley fill is shown in the following well log of a water well drilled at the City of Athens well field:

	Feet
Top soil	0 - 4
Sandy loam	4 - 20
Dark gray sand	20 - 30
Gray sand, some pebbles	30 - 40
Sand and gravel	40 - 45
Coarse sand and gravel	45 - 52

Static level: 24 feet 9 inches.
Tested at 500 gallons per minute with drawdown of 17 feet.

Below is a summary of ground water sources in several towns and villages in Athens County:

Albany - Public water supply from wells about 80 feet deep drilled into bedrock. Individual wells do not yield large amounts of water.

Athens - Public supply obtained from large diameter wells developed in the outwash sand and gravel underlying floodplain of the Hocking Valley.

Buchtel - No public system. Private wells obtain water from bedrock or from shallow valley fill underlying Snow Fork.

Coolville - Public supply derived from wells in sand and gravel along Hocking River.

Chauncey - Public system supplied from wells drilled in sand and gravel along floodplain of Hocking River.

Glouster - Public system derived from wells about 50 feet deep in Sunday Creek Valley. The supply is generally not satisfactory and is believed to be from the bedrock.

Guysville - No public system. Private wells drilled into both bedrock and sand and gravel. Relatively large supplies should be available from sand and gravel in the Hocking Valley.

Jacksonville - Public supply derived from wells drilled into sandstone.

It is of interest to note that communities such as Glouster, Trimble, and Jacksonville are scheduled to obtain future water supplies from the proposed pipeline from Tom Jenkens Reservoir.

BRINE RESOURCES

Salt was first produced in Athens County about 1820 when wells were drilled and furnaces erected in Dover and York Townships. The brine was obtained from the Big Injun sand at a depth of about 530 feet. The industry survived as late as 1877.

Stout (1932) has shown that porous rock strata containing brine are present throughout most of the sedimentary rock sequence in Ohio. In Athens County several brine-producing formations exist, but in most instances qualitative and quantitative values are not available.

Brine has been reported in such Pennsylvanian sands as the Macksburg, Cow Run, Massillon, and Sharon. It is also known to be present in the Keener, Big Injun, and Berea of Mississippian age. The two prominent brine horizons in the Big Lime are present in Athens County. On the basis of drillers' reports, the First Water is present, but not in abundance, while the Second Water is reported to be relatively copious. Undoubtedly, brine is contained within some of the deeper formations of Ordovician and Cambrian age, but lies at depths below the deepest hole drilled to date.

OIL AND GAS RESOURCES

INTRODUCTION

According to Bownocker (1903, p. 269) the search for oil and gas in Athens County probably began in both northern Ames and northern Bern Townships shortly after the discovery of the Chesterhill oil field in southern Morgan County in 1861.

These developments were closely followed in 1865 by drilling along Sugar Creek, in northern Athens Township, and in the Stroud Run field about three miles northeast of the City of Athens. This early drill activity resulted in a small amount of oil and gas production; however, most of the wells were reported as dry holes. During the 30 years that followed, 30 to 40 wells were

Table 27

Generalized Section of Bedrocks Penetrated in Wells Drilled in Athens County

SYSTEM	FORMATION, SERIES OR GROUP		CHARACTER OF ROCKS PENETRATED IN WELLS	DRILLERS' TERMS		THICKNESS IN WELLS FEET	
Permian	Dunkard		Limestone, clay, shale, sandstone and coal.	Slate or shale, lime, sand, coal, and redrock		100 to 300	
Pennsylvanian	Monongahela		Similar to above, more coal.			600 to 700	700 to 1,000
	Conemaugh		Similar to below, but very little coal present.	First Cow Run, Buell Run, Macksburg 300			
	Allegheny		Limestone, clay, shale, sandstone, coal, and conglomerate.	Second Cow Run, Macksburg 500			
	Pottsville		Sandstone, shale, coal, and limestone.	Macksburg 700, 800, and Stray, Salt, and Maxton sands. Slate or shale, lime or Shell and coal			
Mississippian	Maxville		Limestone and dolomite, local.	Lime or Keener Lime or Jingle Rock		15 to 40	450 to 665
	Logan		Shales, gray, brown-black, and black with thin sandy zones and sandstones, locally.	Keener sand, slate, or shale and shale and shells		50 to 70	
	Cuyahoga		Shales, gray to gray-black, with thin sands and siltstones and sandstone, locally.	Big Injun sand, slate, or shale, slate or shale shells		380 to 530	
	Sunbury		Shale, brownish-black, carbonaceous.	Black shale or "Coffee shale"		10 to 25	
	Berea		Siltstone, fine-grained.	Berea Cap		4 to 70	
			Sandstone, white and gray, hard.	Berea sand or grit	First Berea		
			Shale, discontinuous.	"Break"			
			Sandstone, white and gray, hard.	Berea sand			
	Bedford		Shale, gray and reddish-brown, sandstone locally.	Second Berea sand, slate, shale, or redrock		50 to 80	1,170 to 2,100
Devonian	Ohio Olentangy		Shale, gray, gray-black, and brown-black.	Shale or Cinnamon when brownish black		1580 to 1630	
	Onondaga		Limestone, gray to brown with some chert and shale.	Lime	Big Lime	70 to 140	810 to 1,160
	Oriskany		Sandstone, fine- to medium-grained.	First Water or Oriskany sand		9 to 25	
	Helderberg		Limestone, gray to brown with chert.	Lime		600 to 700	
Silurian	Bass Island		Dolomite, gray-brown to brown with traces of anhydrite.	Lime			
	Niagara	Lockport	Dolomite and limestone, gray to brown and drab.	Second Water at top		100 to 260	
		Clinton	Limestones, gray and brown. Shales, reddish-brown, gray-black and bluish gray.	Shale and "Green Cave", Little Shell		150 - 270	175 to 525
	Medina		Dolomite.	Shale or Big Shell (Little Lime of Packer Shell)		10 to 25	
			Shales, bluish-gray, with white, gray to red-brown sand and siltstone bodies.	Clinton sands, Shale or shale and shells		15 to 215	
				Medina sand		4 to 15	
Ordovician	Cincinnatian		Shale, reddish-brown.	"Red Medina" or Queenston		55 plus	

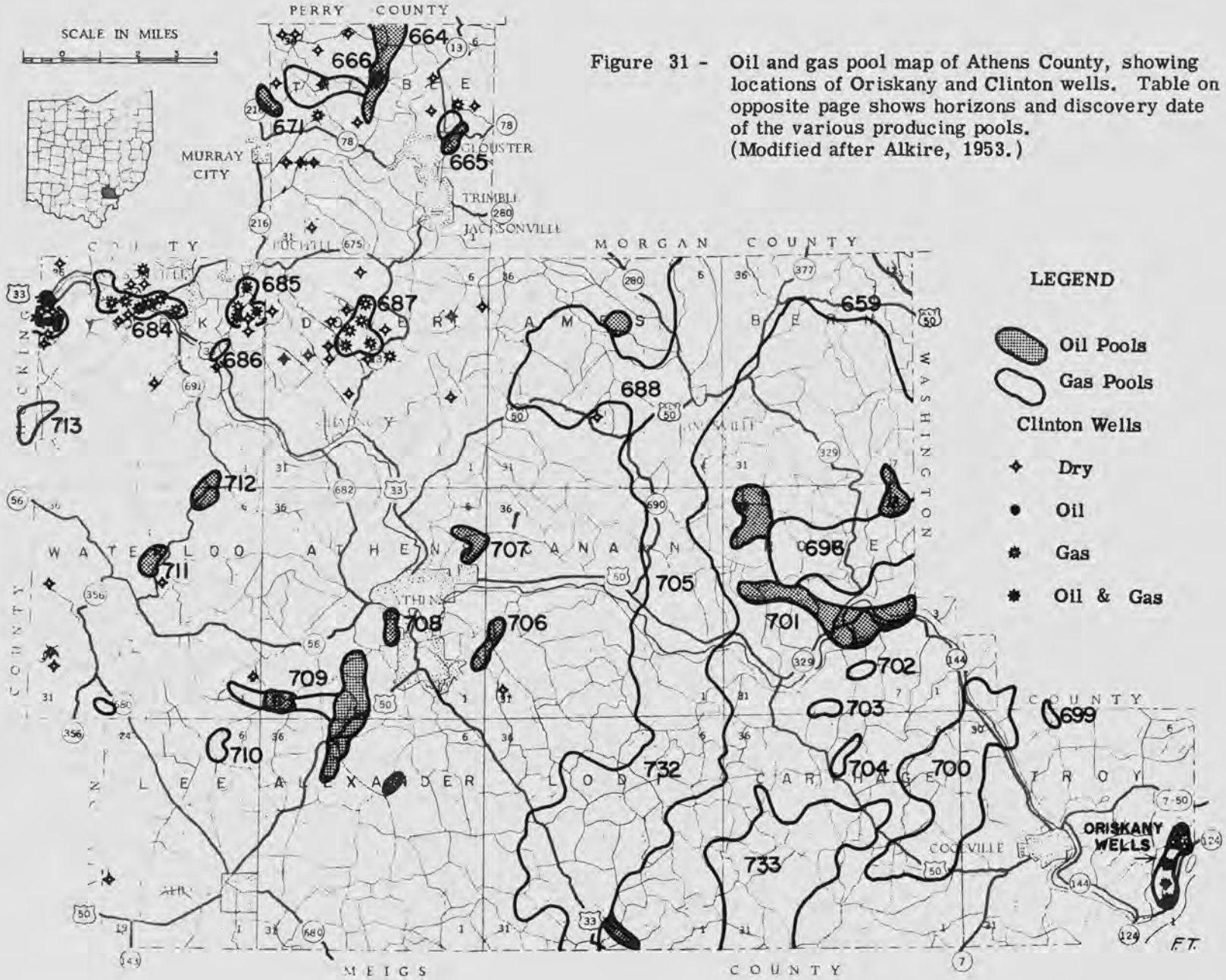


Figure 31 - Oil and gas pool map of Athens County, showing locations of Oriskany and Clinton wells. Table on opposite page shows horizons and discovery date of the various producing pools. (Modified after Alkire, 1953.)

Pool Number	Pool Name	Discovery Date		Producing Sand*		Average Depth	
659	Sharpsburg	1900	1922	CR	Max.	425	1,000
		1917	1922	SS	Be	800	1,500
		1929	1919	Br	2 Be	950	1,600
664	Corning	1891	1922	Be	Cl	1,200	3,600
665	Glouster	1898		Be		1,250	
666	McLeish	1898		Be		1,100	
671	Brenholts	1933	1926	Be	Cl	1,000	3,200
684	Nelsonville	1930		Be	Cl	850	3,450
685	Doanville	1942		Cl		3,425	
686	Floodwood	1938		Be		925	
687	Millfield	1926		Cl		3,750	
688	Amesville	1937	1928	CR	2 Be	200	1,400
696	Kilvert	1907	1918	CR	Max	500	850
		1920		Be		1,600	
699	Frost Run	1924		Ke		1,100	
700	Frost	1923	1923	CR	Inj	900	1,350
		1923	1927	Max	Be	1,100	1,800
		1922		Ke		1,250	
701	Stewart	1914	1924	CR	Max	300	1,000
702	Piper Run	1924		Be		1,600	
703	Guysville	1922		Max		900	
704	Mills	1941		Be		1,700	
705	Canaanville	1928	1928	CR	2 Be	200	1,500
706	East Athens	1913		Be		1,300	
707	North Athens	1925	1924	CR	Be	500	1,200
708	Athens	1924		Be		1,100	
709	Fisher	1900		Be		1,200	
710	West Branch	1928		Be		1,250	
711	Grass Run	1900		Be		1,150	
712	Hamley Run	1918		Be		1,025	
713	Carbondale	1941	1945	CR	M	200	450
732	Shade	1929	1929	CR	Max	700	1,200
		1924		2 Be		1,600	
733	Carthage	1923	1923	CR	Ke	550	1,050
		1923	1939	Max	Be	875	1,600

* Be - Berea
2 Be - 2nd Berea
Br - Brill
Cl - Clinton
CR - Cow Run
Inj - Big Injun
Ke - Keener
M - Macksburg
Max - Maxton
SS - Salt Sand

drilled to test the Berea sand throughout Athens County. As occurred in the earlier wells, most of these were nonproductive, and it was not until the discovery of the McLeish Pool in northwestern Trimble Township, in 1898, that substantial production was found in this county. Since 1898, an additional 27 oil and gas pools, producing from eleven different horizons, have been discovered and developed in Athens County (figure 31).

Exploration of strata lying below the Berea sand probably started as early as 1890; however, it was not until 1899 that the first known test was drilled to the Clinton sand. The drilling of this dry hole, located on the James Boden farm, section 16, Waterloo Township, was closely followed in 1900 by two additional dry Clinton test wells in section 32 of the same township. This unsuccessful early drilling resulted in a waning interest in the Clinton sand as a source of oil and gas in Athens County; and it was not until 1922, with the discovery of gas at this horizon in the Corning Pool of northern Trimble Township, that interest was revived. Since this discovery, 75 recorded wells have been drilled to the Clinton sand in Ames, Canaan, Dover, Lee, Trimble, and Troy Townships. The deepest of these wells, is located on the L. J. Ice farm, section 2, Troy Township. It was completed in February of 1954 to a depth of 5,685 feet and bottomed in the Red Medina shale.

A conservative estimate indicates that a total of approximately 3,500 wells have been drilled in the search for oil and gas in Athens County. Of this number, less than three per cent extend below the Second Berea sand; about thirty per cent are drilled to the shallow sands overlying the Berea, and the remaining sixty-seven per cent were drilled to the First or Second Berea sands. Of the 876 wells which have been drilled to the various producing horizons in Athens County from 1940 to 1956, 23 per cent recorded oil production, 42 per cent gas production, and the remaining 35 per cent are dry holes.

In general, the oil and gas production of Athens County has been secured chiefly from pool areas developed in each of the fourteen townships. The larger of these areas are found in the eastern half of the county and are dominantly gas producing pools (figure 31). Of the eleven producing horizons found in Athens County, the First and Second Berea sands are by far the most important and, although production from the latter has been more or less restricted to the larger pool areas in Ames, Bern, Canaan, Carthage, Lodi, and Rome Townships, production from the First Berea sand has been obtained in every township. Comparatively less important, the Keener*, Maxton, and Cow Run sands are, nevertheless, productive and represent the principal producing horizons above the First Berea sand. Production from these and the other shallow sands generally is restricted to the smaller pool areas in the eastern half of Athens County. The only significant production found in the deeper horizons underlying the Berea comes from the Oriskany and Clinton sands. In the Oriskany, this production has been limited to six gas wells located in sections 2 and 3 of Troy Township. Both oil and gas have been found in the Clinton sand in small areas of Dover, Trimble, and York Townships.

With the exception of five Berea gas wells, production from individual wells has not been large. The most outstanding of these five gas wells, drilled during the late 1890's in sections 22 and 29 of Trimble Township, started at 3,000,000 cubic feet per day and two years later was still producing 1,500,000 cubic feet. Of the remaining four wells, two started at 2,000,000 cubic feet per day and two at 1,000,000 cubic feet (Bownocker, 1903, p. 263).

Table 28 shows the average oil and gas production, by sands, for those single wells completed from 1951 to 1956. Although not standard, these averages are, nevertheless, in general indicative for all of Athens County and should be kept in mind during the following discussion of production by townships.

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* Since this portion of the text is of principal interest to the oil and gas well operator, and in order to eliminate as much cross references and confusion as possible, the commonly accepted drillers' terms rather than geological names have been used in this discussion. Correlation of these terms can be seen in table 27.

Table 28

Summary of Oil and Gas Production, by Sands, in Athens County From 1951 to 1956

Abbreviations: MCF - thousand cubic feet of gas at completion.
Bbls - standard 42-gallon barrels of oil in first 24 hours.

	1951				1952				1953				1954				1955				1956 *			
	Gas		Oil		Gas		Oil		Gas		Oil		Gas		Oil		Gas		Oil		Gas		Oil	
	No. Wells	Aver. MCF	No. Wells	Aver. Bbls	No. Wells	Aver. MCF	No. Wells	Aver. Bbls	No. Wells	Aver. MCF	No. Wells	Aver. Bbls	No. Wells	Aver. MCF	No. Wells	Aver. Bbls	No. Wells	Aver. MCF	No. Wells	Aver. Bbls	No. Wells	Aver. MCF	No. Wells	Aver. Bbls
Cow Run	1	80	4	4	-	-	9	4	3	208	2	7	-	-	2	4	-	-	6**	9	4	176	23	5.5
Macksburg	1	183	-	-	-	-	-	-	-	-	-	-	1	726	-	-	-	-	-	-	2	455	-	-
Stray	-	-	-	-	-	-	-	-	-	-	-	-	2	36	-	-	-	-	-	-	2	36	-	-
Salt	1	260	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	260	-	-
Maxton	2	92	-	-	2	178	-	-	2	280	1	8	-	-	-	-	3**	431	-	-	9	266	1	8
Squaw	1	75	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	75	-	-
Berea	12	172	2	5	1	325	3	4	12	203	2	15	3	490	5	6	2	134	4	3	29	222	16	8
2nd Berea	-	-	-	-	-	-	-	-	-	-	-	-	32	259	-	-	27	272	1	4	59	265	1	4
Shale	1	200	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	200	-	-
Oriskany	-	-	-	-	-	-	-	-	5	392	-	-	-	-	-	-	-	-	-	-	5	392	-	-

* Totals do not include 106 MCF and 8 Bbls from combination wells completed in the Second Berea sand in 1955.

** Indicates probable sands producing from the Conemaugh and Pottsville series.

DEVELOPMENT BY TOWNSHIP

Alexander Township

According to Bownocker (1903, p. 272), three wells were drilled to the Berea sand in the search for oil and gas in Alexander Township in 1895. One situated on the Henry Merrick farm at Hebbardsville reported a show of oil; a second near Zelda was a dry hole. The last of these early wells, drilled on the Cooley farm, two miles south of Hebbardsville, reportedly produced an initial gas flow of 1,222,000 cubic feet per day. However, this well was ruined when the dissatisfied operator, in drilling deeper, encountered a strong flow of salt water. Since 1895, a total of 140 recorded exploratory and offset wells have been drilled in Alexander Township. Of these, two-thirds have been offset Berea wells drilled within the limits of the Fisher Pool (figure 31) since 1923. The remaining 50 wells, principally scattered throughout the western half of the township, for the most part have been dry holes. One notable exception, however, occurs in the northeast quarter of section 17, where eight of the twelve Berea wells drilled in 1929 recorded oil production.

With few exceptions, the production secured in Alexander Township has come from the 80-odd wells drilled within the Fisher Pool. Production from these, with the exception of one combination well in central section 25, has been restricted entirely to small quantities of oil. The remaining production of the township has come from scattered Berea oil wells in sections 6, 20, and 28, Berea gas wells in sections 22, 26, and 36, and a single Macksburg gas well in section 7. No recorded production has come from other horizons above the Berea, nor have tests been made of lower horizons.

Ames Township

Although the earliest drill activity in the search for oil and gas probably began shortly after the discovery of the Chesterhill oil field of southern Morgan County in 1861 (Bownocker, 1903, p. 126), the first such recorded activity in Ames Township did not occur until 1900 when five oil producing wells were drilled to the Cow Run sand on the Eva Balderson farm in section 6. Later this same year, three additional Cow Run wells were drilled on the adjoining Marion Carpenter farm, section 12. Since 1900, a total of 600 recorded wells have been drilled in Ames Township. About 95 per cent of these have been offset Cow Run, Berea, and Second Berea wells drilled in the development of, and consequently located within, the Amesville Pool. Discovered in 1928, this pool covers an area of approximately 18 square miles and extends under most of eastern and west central Ames Township (figure 31). The remainder of the 600 wells, drilled to these same horizons around the outer limits of this pool, are dry holes which have accurately established the pool limits.

Three productive horizons are found within the Amesville Pool. These are the Cow Run, the First Berea, and the Second Berea sands. Foremost in importance, due to its productivity, the Second Berea sand accounts for a major portion of the township's gas production. Next in importance is the Cow Run sand, which supplies nearly all of the township's oil production. The other producing horizon of the Amesville Pool, the First Berea sand, has contributed the remainder of the gas production. Outside of the pool area, oil production has been secured from the Macksburg sand in three wells found along the eastern boundary of section 1.

Athens Township

The first drill activity in Athens Township began around 1865. Little is known concerning these early operations; however, some gas reportedly was secured from wells drilled to the Berea sand in both the Stroud's Run field, 3 miles northwest of Athens, and to the north along Sugar Creek (Bownocker, 1903, p. 269). Since 1865, the search for oil and gas in Athens Township has resulted in the recorded drilling of some 180 additional wells. As in Alexander and Ames Townships, the majority, or roughly 150 of these, have been offset wells located within the four pool areas of the township (figure 31). With the exception of nine Berea wells found in sections 28, 29, 33, and 34, all of the oil and gas production of Athens Township has come from Berea wells located within the four pool areas.

No other production has been recorded in the township. The overlying shallow sands encountered in Berea wells have proven unproductive, while those potential producing horizons underlying the Berea have not as yet been tested.

Bern Township

As in Ames Township, directly to the west, the search for oil and gas in Bern Township probably began shortly after the discovery of the Chesterhill oil field in 1861 (Bownocker, 1903, p. 126). However, it was not until 1900, when oil was discovered in the Cow Run sand that any extensive drilling activity occurred. Since 1900, a total of 260 recorded wells have been drilled within the township. Of these, about 210 have been offset wells, located within the resulting Sharpsburg Pool (figure 31). This pool, covering an area of about 13 square miles, underlies most of northern Bern Township. Tapering southward toward the township's east and west boundaries, it extends into Washington County to the east and joins the Amesville Pool to the west. Of the 50-odd wells drilled outside the limits of this pool, 22 are found in section 7 and represent the extreme northern development of the Kilvert Pool (figure 31). The remaining 28 wells are scattered throughout the undeveloped area between these two pools.

Approximately 210 of the 260 recorded wells drilled in Bern Township since 1900 have been productive. Nearly all of these are located within pool areas. The exceptions are found in sections 27, 31, and 33 where a single Macksburg and four Berea wells have recorded gas and

oil production, respectively. The rest of the township's gas production comes almost entirely, in order of importance, from the First and Second Berea, the Maxton, Brill, Salt, and Cow Run sands of the Sharpsburg Pool. The remaining and comparatively less important oil production has been restricted to the Cow Run sand of the Kilvert Pool. No other productive horizons have been established in Bern Township.

Canaan Township

According to Bownocker (1903, p. 272-273) three wells were drilled in the search for oil and gas in Canaan Township prior to 1903. The first of these, drilled in 1896, was a dry hole in the Berea sand in section 34. This was followed in 1898 by the drilling of two additional Berea wells in section 33. Of these, one produced oil from the Berea sand and the other gas from an unidentified shallower horizon. Since 1898, about 250 recorded wells have been drilled and, as in Ames Township to the north, a majority, or nearly 200 of these, have been offset Second Berea, Berea, and Cow Run wells drilled within the resulting Canaanville Pool (figure 31). Discovered in the Cow Run and Second Berea sands in 1928, this pool today extends under some 12 square miles of eastern Canaan Township. The remaining 50 wells drilled since 1898 are found scattered along the eastern edge of this pool and in the southwest quarter of the township. One notable exception, however, is found in section 33 where 9 Berea wells, producing both oil and gas, have been drilled within the East Athens Pool (figure 31).

Except for four Berea and nine Second Berea wells which are found in the East Athens Pool and scattered in sections 27, 28, 31, and 32, all of the gas production of Canaan Township comes from the Canaanville Pool. This gas production, accounting for two-thirds of all the productive wells, is primarily secured from the Second Berea sand. The remainder of the township's gas production has come from the overlying Berea sand, and in one case, in section 5, from the Keener sand. Of lesser importance, the oil production of Canaan Township is almost entirely secured from the shallow Cow Run sand. No additional recorded production has been obtained from any other shallow horizons; and in the single deep test, on the Peter K. Fagan farm, section 31, the Oriskany sand was unrecorded and the Clinton sand was reported dry.

Carthage Township

The earliest recorded drilling activity in Carthage Township occurred in 1922 with the discovery of gas in the Keener sand. Since 1922, 300 recorded wells have been drilled in the search for oil and gas. This drilling activity has resulted in the development of three pools (figure 31). The largest of these, the Carthage Pool, extends some eight square miles under central and southwestern Carthage Township before crossing into Meigs County to the south. The second of these pool areas, the Frost Pool, covers about 6 square miles along the eastern border and extends into northwestern Troy Township. The remaining small pool, or Mills Pool, is located in parts of sections 18 and 23. Of the total of 300 recorded wells drilled since 1922, approximately 250 have been offset and drilled to either the Cow Run, Maxton, Keener, Big Injun, or Berea sands of the three pool areas. The remaining 50 wells are located along the borders of these pools and for the most part have been dry holes.

Both oil and gas production are secured in Carthage Township. The oil production, coming from 40 of the 250 productive wells, has been more or less restricted to the southwest extremities of the Carthage Pool. In this area oil production comes from both oil and combination wells drilled to the Berea sand. The more important gas production, derived from the remaining 210 productive wells found within the township, on the other hand, is subject to no such restriction and is found in each of the three pool areas. The primary source of this gas production has been the Keener and Cow Run sands, which are best developed in the Frost Pool. Nearly all of the remaining gas of the township is secured from the Carthage Pool where the Keener and Cow Run sands are poorly developed as sources and overshadowed by the Berea and Maxton sands. In the smaller Mills Pool, gas production is restricted to the Berea sand. In the Frost Pool, the Big Injun sand has been developed to a limited extent.

Dover Township

In Dover Township the search for oil and gas has not been as extensive as in other areas in the county. The first wells, drilled prior to 1903, were located in sections 1 and 2 (Bownocker, 1903, p. 273) and were reportedly dry holes. Since this time only 40 additional recorded wells have been drilled within the township. In general, these wells are sparsely scattered in northern Dover Township with the exception of a single concentration found within the limits of the Millfield Pool. Centered in section 23, this small pool, discovered in the Clinton sand in 1926, covers about one square mile.

As is the case in many of the previously discussed areas of Athens County, production in Dover Township has been predominantly gas. Primarily secured from Clinton wells located in the Millfield Pool, this production has been supplemented by small quantities of gas, and occasionally oil, from scattered Berea wells in sections 5, 16, 21, and 35. No noteworthy productivity has been developed in any of the other potential producing horizons of Dover Township.

Lee Township

The extent, periods, and results of drill activity in Lee Township can be closely related to those of Dover Township. The two wells drilled prior to 1903 (Bownocker, 1903, p. 272) were located on the John Elliot farm, section 17, and in the village of Albany. Both were drilled to the Berea sand and while the first was a dry hole, the latter reportedly made a show of oil. Since this early drilling activity, an additional 28 recorded wells have been drilled in Lee Township. Among these, the only concentration is found in section 12 where six Berea wells have been drilled within the West Branch Pool. Discovered in 1928, this small pool (figure 31), covering an area of less than one-half square mile, represents the only such development within the township.

The small quantities of oil and gas which are produced in Lee Township come primarily from eight Berea wells located within the West Branch Pool. Additional oil and gas production has been obtained from five Berea wells located in sections 14, 20, and 21. Gas production has also been secured from the Macksburg sand in single wells located on the Lee Elliot farm, section 4, and the E. C. Wingett farm in section 12. No oil or gas production has been found in any other potential producing horizon. A single deep test in Lee Township, on the Martha Hammond farm, fraction 19, was a dry hole in the Clinton sand.

Lodi Township

Five wells testing the Berea sand were drilled in the search for oil and gas in section 12 of Lodi Township prior to 1903 (Bownocker, 1903, p. 273). All of these, with the exception of one from which was reported a small gas flow from an unidentified shallow sand, were dry holes. Since this early drill activity some 275 recorded wells have been drilled in Lodi Township. As has frequently been the case in Athens County, almost all of these have been offset wells. Primarily drilled to the Second Berea sand, these offset wells have resulted in development of the Shade Pool (figure 31). Originally discovered in the Second Berea sand in 1924, this pool has since undergone a lesser development in the shallower Maxton and Cow Run sands and, today, covers an area of about 13 square miles extending from northeastern to south central Lodi Township. Most of the remaining wells drilled in Lodi Township since 1903 are principally dry holes located around the perimeter of this pool, although some wells are found within the productive limits of the Carthage Pool along the township's eastern boundary (figure 31). With the exception of 22 wells which have produced oil from the Cow Run sand in section 13, all of the production of Lodi Township comes from gas wells located within pool areas.

Rome Township

The earliest reported drill acitivity in Rome Township occurred in 1900 on the S. J.

Copeland farm, section 29, and in the northeast quarter of section 31 (Bownocker, 1903, p. 273). The first of these was a dry hole, while the latter resulted in some oil and gas production from the Berea and Macksburg sands, respectively. Since 1900, a record total of 750 recorded wells have been drilled in the search for oil and gas in Rome Township. Again, these, for the most part, were offset wells drilled primarily to the Berea, Cow Run, and occasionally the Maxton sands. The remaining 75-odd wells drilled since 1900 are sparsely scattered both around the limits of the resulting four pool developments (figure 31) and throughout the remaining areas of the township.

The township's oil and gas production is almost completely restricted to those offset wells drilled within the four pool areas. The producing horizons which account for this production are, in order of their importance, the Berea, Cow Run, and Maxton sands. Of these, the Cow Run sand accounts for nearly all of the township's oil production while Berea and Maxton wells are almost exclusively gas producers. Because of the comparatively good productivity encountered in these sands to date, no interest has been shown in any of the potentially productive deeper horizone such as the Oriskany and Clinton sands. Other, shallow sands, overlying the Berea, have been repeatedly tested and, with the exception of a few gas wells producing from the Second Cow Run sand in section 30, have been found to be nonproductive.

Trimble Township

A few scattered tests were drilled in Trimble Township shortly after the discovery of the Corning Pool, immediately to the north in Perry County, in 1891. However, it was not until the discovery of gas in the Berea sand in 1898, and the subsequent development of the Glouster and McLeish Pools, that any extensive drilling was reported. Since this discovery, a total of 150 recorded wells, some 125 of which are offset and primarily extend to the Berea sand, have been drilled in development of the township's three pools (figure 31). The 25 remaining wells are sparsely scattered in the northwest portion and around the perimeters of the pool areas.

Both oil and gas production has been secured in Trimble Township. Some three-fifths of the township's 125 productive wells produce oil from the Berea sand. This production is restricted, with few exceptions, to the oil pools of the township. The less important gas production also comes primarily from Berea wells within the pool areas but has been supplemented to a certain extent by gas from the Clinton sand in sections 4 and 28.

Troy Township

A dry Berea hole on the Shepard Humphrey farm south of Coolville and another about one-half mile west of this village were drilled prior to 1903 (Bownocker, 1903, p. 273). Since 1903 some 60 additional recorded wells have been drilled. Twenty-seven of these are offset Keener and, occasionally, Maxton wells, which are concentrated in the extreme northwest corner of the township in the area of the Frost Pool (figure 31). With the exception of six additional offset Keener wells drilled in section 24 (figure 31) and six Oriskany wells located in sections 2 and 3, the remaining wells drilled since 1903 are scattered in the central portion of the township.

No oil production has been recorded in Troy Township. With the exception of single wells located in sections 9 and 21, the township's gas production has been secured from the 24 productive wells found in the three pool areas (figure 31). The principal producing horizon has been the Keener sand within the Frost and Frost Run Pools. Elsewhere in the township, this production has been limited to six Oriskany wells located in sections 2 and 3. None of the shallower sands has proven productive where encountered; and in the single Clinton test, drilled on the L. J. Ice farm, section 2, this sand was nonproductive.

Waterloo Township

A number of unsuccessful deep wells were drilled in Waterloo Township prior to 1903

(Bownocker, 1903, p. 270). These early tests, at least four of which are known to have reached the Clinton sand, were located in sections 10, 16, 17, 18, 19, and 25. During the same period a few scattered tests of the Berea sand also were made. These, in general, proved to be more successful and in 1900 led to the discovery of the small Grass Run Pool (figure 31). Since 1900, approximately 110 recorded wells have been drilled for oil and gas in Waterloo Township. This drilling activity, resulting in the development of three small pool areas, has been restricted, with the exception of a half dozen dry Clinton wells (figure 31), to the Berea sand of the pool areas.

The small quantities of oil produced in this township have come almost entirely from Berea wells within the pool limits. The remaining, almost insignificant gas production, has been taken from a few scattered Berea wells within these same pools.

York Township

Early drill activities in York Township were unsuccessful. According to Bownocker (1903, p. 272) a dry hole in section 1, another at Nelsonville, and a third near Buchtel, were drilled prior to 1903. Since these early attempts, an additional 100 recorded tests have been made in York Township. This has resulted in the discovery and development of five separate small pool areas, within the limits of which a majority of some eighty-odd Berea and Clinton offset wells have been located. The names, discovery dates, locations, and extents of these small pools in York Township are found in figure 31. The remaining 20 wells drilled since 1903 are sparsely scattered outside these pools and, for the most part, have been dry holes.

Production in York Township has been primarily gas, although small quantities of oil have been obtained from seven Berea wells in section 7 and five Clinton wells in section 35. The principal gas producing horizons have also been the Berea and Clinton sands, and a majority of the township's more important gas production has come from these sands in the Nelsonville, Doanville, and Floodwood Pools.

SUBSURFACE STRATIGRAPHY PENETRATED BY OIL AND GAS WELLS

The rocks penetrated by the drill in Athens County range in age from the Permian to the Ordovician. The deepest well in the county, located on the L. J. Ice farm in section 2, Troy Township, starts in the Dunkard group and bottoms in the Red Medina shale at a depth of 5,685 feet. Well cuttings from this well are not available for study, but examination of cuttings collected in adjacent areas and interpretation of drillers' logs give a composite stratigraphic section, shown on table 27. A discussion of this subsurface sequence of strata follows, starting with the oldest and deepest units.

Cincinnatian Series

The Cincinnatian series, of upper Ordovician age, represents the oldest strata discussed in this report. Throughout Ohio it consists of a series of shales and thin limestones which range in thickness from 650 feet in northwestern Ohio to 1,700 feet in northeastern Ohio. Three lithological subdivisions are recognized in these shales. The lower consists of a brownish black shale, called the Utica shale by the driller, which is calcareous near the base and contains thin dark beds of limestone in southern Ohio. The middle subdivision of green to dark gray calcareous shale lies conformably above the Utica shale and contains thin nodular limestone beds. The Queenston shale, or upper unit, consists of reddish-brown shale and is called Red Medina by the driller. This latter unit is known to be present throughout Athens County and is correlated to the northeast with the Queenston shale of western New York and to the west with the thin pink and

red shales of the Elkhorn in southwestern Ohio. Along the eastern edge of the Clinton production belt, running north from Lawrence County to Lorain County in Ohio, the thickness of the Queenston shale measures slightly less than 225 feet, being thinnest in southern Ohio. No production has been obtained from the Queenston in Ohio and production from the Cincinnatian series has been restricted to small scattered yields of gas in the Utica shale of western Ohio (Lamborn, 1954, p. 214-215).

In Athens County the exact thickness of the upper Ordovician or Cincinnatian series is unknown, and the maximum penetration of this series has extended only 54 feet into the Queenston shale. However, according to Lamborn, a thickness of 1,360 feet has been recorded for this series in eastern Meigs County immediately to the south, which suggests that the Cincinnatian in Athens County is probably this thick or slightly thicker.

The depth to the top of the Queenston in Athens County, as recorded in well logs, ranges from an average of 3,415 well feet, or approximately 2,500 feet below sea level, in section 36, York Township, to 5,630 well feet, or 4,940 feet below sea level, in section 2, Troy Township. This variation results in an average dip of about 83 feet per mile to the southeast.

The shales of the Queenston in Athens County have been recorded by the driller as either redrock or Red Medina and have been distinguished on the basis of their reddish-brown color and their position below the drillers' Medina sand at the base of the Silurian system.

Medina and Clinton Groups

The Medina and Clinton groups, of lower and middle Silurian age, include the sandstones, shales, limestones, and dolomites which make up the succession from the top of the Cincinnatian series to the base of the drillers' Big Lime. In ascending order, the Medina group consists of the drillers' Medina sand, a shale, and the Clinton sandstones interbedded with shales, capped by the Packer Shell. The Clinton group consists of shales, limestones, and minor amounts of sandy shales. Often the drillers refer to the limestones as Little Shells and the shales as the Green Cave. This lithologic relationship is shown diagramatically in figure 32. The top of this

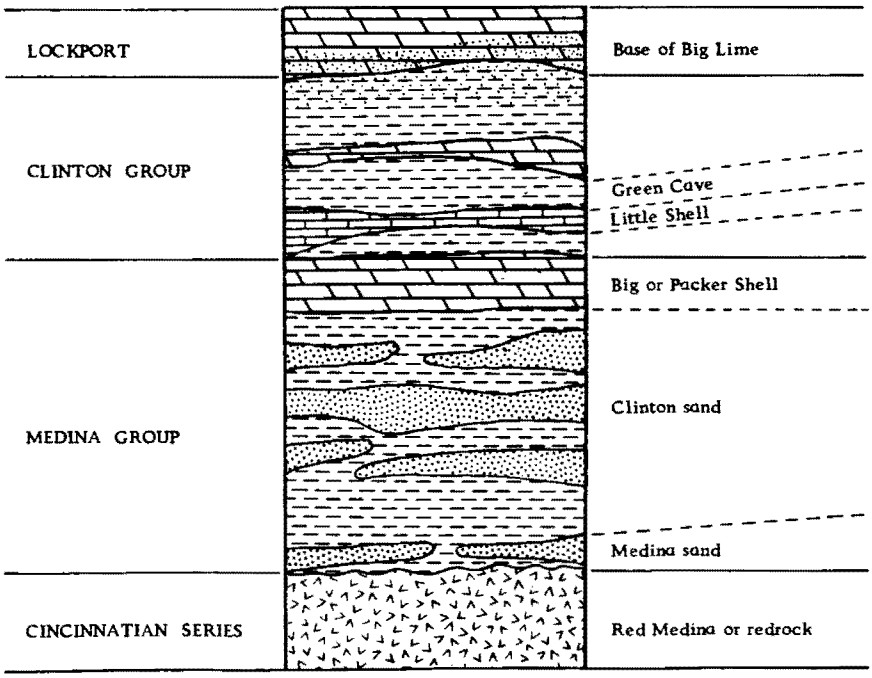


Figure 32 - Diagram of lithologic relationship of Clinton and Medina groups.

sequence, described above, is encountered at an average depth of 3,050 well feet, or 2,204 feet below sea level, in York Township, and at 5,100 well feet, or 4,429 feet below sea level, in Troy Township. The average dip is 70 feet per mile to the southwest.

In Athens County, this sequence ranges in average thickness from 300 feet in York and Trimble Townships to 500 feet in Troy Township. The sands and shales of the Medina group thin to the west from Athens County, and west of the major belt of Clinton production the sandstone bodies drop from this group while the shales become thinner and pinch out. The shales of the overlying Clinton group, which attain their greatest thickness in eastern Ohio, also tend to thin to the northwest.

Medina Group. - According to Magbee and Alkire (1954, p. 23-25) the Medina sand, as referred to in Morgan County, is a very fine-grained brown to gray sandstone formation lying 90 to 100 feet below the top of the Clinton sand and grading downward into siltstone which lies unconformably on the red shales of the Queenston formation. Less than a half-dozen deep wells have recorded this sand in Athens County. In Trimble Township, the Medina sand is encountered at an average depth of 3,770 well feet, or approximately 105 to 120 feet below the top of the Clinton sand, and ranges in thickness from 4 to 7 feet. To the southeast, in Troy Township, this sand was penetrated in the L. J. Ice No. 2 well at a depth of 5,615 well feet, or 4,924 feet below sea level. It was 15 feet thick and 125 feet below the top of the Clinton sand. No production has been obtained from the Medina sand in Athens County to date.

The Clinton sand, extending under most of eastern Ohio, is separated from the underlying Medina sand, in Athens County, by 45 to 115 feet of bluish-gray shale. The average depth to the top of this sand, described in Morgan County by Magbee and Alkire (1954, p. 19) as a "tight" fine-grained sandstone in which shale breaks are common, ranges from 3,258 well feet, or 2,385 feet below sea level, in York Township to 5,492 well feet, or 4,800 feet below sea level in Troy Township. The average dip at the top of this sand is about 79 feet per mile to the southeast and its average thickness ranges from 30 to 35 feet in Trimble and York Townships to 15 feet in Troy Township. Of the seventy-odd deep wells drilled in Athens County to date, all have recorded the presence of the Clinton sand, and approximately 35 per cent have produced or are producing either gas or oil.

The Big or Packer shell is a pinkish-gray, hard, cherty dolomite found in the subsurface throughout Athens County. On the basis of its recorded thickness and stratigraphic position, this cherty limestone, in all probability, is the equivalent of the central Ohio drillers' Packer Shell which, according to Lamborn (1954, p. 218), is represented in part by the Brassfield limestone of southwestern Ohio.

Clinton Group. - The stratigraphic sequence between the top of the Big Shell and the base of the Big Lime consists of a series of gray, greenish-gray, and reddish-brown shales, gray and brown limestones, and sandy shales, which compose the Clinton group in Athens County. They range from 100 to 235 feet thick and are found throughout the county. At the base of the group, and immediately overlying the Big Shell in eastern Athens County, are 10 to 20 feet of shale which thins to the west.

Overlying this shale is a hard limestone or dolomitic limestone which has been recorded by the drillers in Athens County as the Little Shell. Found in every deep well west of a line running from northeast Ames to southwest Lodi Townships, the Little Shell ranges from 2 to 8 feet thick and occurs from 160 to 210 feet below the base of the Big Lime. East of this line, this horizon has been recorded as a "green" shale in the single well which has penetrated to this depth. No definite correlation of this unit can be made on the basis of available information. However, it is possible that this limestone is a correlative of the Dayton limestone, or it could be just a thin local limestone of the Clinton group.

In the area of Clinton sand production, the Little Shell is overlain by soft, greenish-gray to dark gray argillaceous shale which tends to thicken to the east and south and to thin out towards

the west and northwest (Lamborn, 1954, p. 219). In Athens County this shale unit ranges in thickness from 100 feet in the northwest townships to 235 feet in Troy Township to the southeast, where it consists predominantly of reddish-brown, gray, and bluish-gray shales which are encountered at a depth of 5,120 well feet, or 4,430 feet below sea level.

Big Lime Sequence

The Big Lime of the driller in Ohio consists of the limestones and dolomites which are encountered above the Clinton group and below the Devonian shales. The outcrops of these Devonian and Silurian carbonates cover a large portion of western Ohio and range in thickness from some 200 feet in Adams County to 1,000 feet in western Erie County. The Big Lime thickens to the northeast where, in Columbiana County, over 2,000 feet is recorded (Lamborn, 1954, p. 220).

In Athens County the Big Lime ranges in thickness from an average of 810 feet in the western townships to 1,160 feet in section 2, Troy Township, thickening on the average of 11 feet per mile to the southeast. The top of this unit has been recorded at an average depth of 2,258 well feet, or 1,394 feet below sea level, in York and Trimble Townships; and 4,025 well feet, or 3,271 feet below sea level, in Troy Township, with a dip of approximately 59 feet per mile to the southeast.

Lacking well cuttings of the Big Lime in Athens County, the exact lithologic character of this unit cannot be determined. However, the following general description of well cuttings of the Big Lime, taken from the W. T. Longworth well no. 1, section 22, Olive Township, in Meigs County to the south, logged by R. E. Lamborn (Ohio Division of Geological Survey), in all probability can be accurately applied to the eastern extremities of this unit in Athens County.

	Thickness Feet
Limestone, hard gray to brown, chert and shale, becoming white and dolomitic at the base	100
Sandstone, fine- to medium-grained, Oriskany	15
Limestone and chert, hard gray to brown	155
Dolomite, gray brown to brown, traces of anhydrite	725
Newburg "sand" horizon	-
Limestone, gray to brown and drab, and dolomitic limestone	115
	1,110

Drillers in Ohio have recorded several distinct horizons. The first is a porous zone containing brines which the driller refers to as the First Water or Oriskany sand. According to Lamborn (1954, p. 220), this horizon is fairly persistent north of a line running through northern Know and southern Coshocton Counties and is found 100 to 350 feet below the top of the Big Lime. In Athens County, the Oriskany sand is present in only ten of the deep wells. Where found it ranges from 70 to 140 feet below the top of the Big Lime. In sections 23 and 27 of York Township and section 36 of Trimble Township, the Oriskany is 15 to 25 feet thick and approximately 70 to 100 feet below the top of the Big Lime. The remaining wells which record the Oriskany sand are located in sections 2 and 3 of Troy Township, where the sand is 9 to 22 feet thick and 100 to 140 feet below the top of the Big Lime. In sections 25 and 27, Trimble Township, the Oriskany is not recorded, but this horizon has been established by the presence of the First Water. In the remaining deep wells of the county, neither the Oriskany nor the First Water is recorded.

The second of these distinct horizons encountered by the driller in the Big Lime occurs 150 to 260 feet above its base and consists of a porous zone containing brines, which has been recorded in a majority of the deep wells in Athens County. This horizon, referred to by the driller as the Second Water, appears to be distributed throughout the county but has not been recorded in every well and is apparently discontinuous, a condition which, according to Lamborn (1954, p. 220), prevails throughout the belt of Clinton production. Locally, in eastern Ohio, this Second Water is closely overlain by a porous zone in the dolomite which is known to the driller as the Newburg "sand" (Lamborn, 1954, p. 220). This horizon has not been recorded by the driller in Athens County to date.

Bedford, Ohio, and Olentangy Shale Sequence

This sequence, consisting of the Bedford, Ohio, and Olentangy shales, with outcrops in central and southern Ohio, is upper Devonian and lower Mississippian in age. It ranges in thickness along its outcrop from 350 feet in Adams County to 550 feet in Erie County, thickens under cover to the east and attains a recorded thickness of about 3,400 feet in Jefferson and Washington Counties. Overlying the Big Lime and extending upward to the base of the Berea sandstone, this sequence along the outcrop is comprised of the gray, gray-black, and brown-black carbonaceous Olentangy and Ohio shales with the reddish-brown and gray shales of the Bedford formation at the top. With the exception of the disappearance of the red shale of the Bedford formation at varying distances east of the outcrop, the predominant features of this sequence undergo very little change (Lamborn, 1954, p. 223).

A number of distinct horizons have been encountered by the drill in the Bedford, Ohio, and Olentangy sequence. The foremost of these is an elongated lenticular-like sand body which is found in the Bedford shale some 15 to 75 feet below the First Berea sandstone and separated from it by the red shales of the Bedford formation. This sandstone body, designated as the Second Berea sand, is approximately 80 miles long and 3 to 15 miles wide and extends northeastward from Gallia County through Meigs, Athens, and Morgan, and into central Muskingum County. It consists of well-sorted, fine-grained, porous sandstone and has been described by DeWitt (1947) as an off-shore bar deposit. Other prominent horizons recognized by the driller are the brown-black shale zones of the Ohio shale formation, which drillers call the "Big Cinnamon" and "Little Cinnamon" shales. In addition to the above, thin siltstones are often encountered and normally reported on the drillers logs as "shells."

In section 35, York Township, the top of the Bedford, Ohio, and Olentangy shale sequence is encountered at an average depth of 1,030 well feet, or 222 feet below sea level. In sections 2 and 3 of Troy Township it is recorded at an average depth of 1,850 well feet, or 1,166 feet below sea level, maintaining a dip of about 30 feet per mile. The average thickness of these shales ranges from 1,170 feet in York to 2,105 feet in Troy Township, giving a rate of thickening of 29 feet per mile.

Both the "Little" and "Big Cinnamon" have been recorded in a majority of the deep wells drilled in Athens County. Where recorded they occur in the lower half of the series and appear to reach their maximum thickness to the south and east. The "Little Cinnamon" has a recorded range in thickness of 40 to 70 feet while the "Big Cinnamon," which is stratigraphically about 200 feet lower, ranges in recorded thickness from 200 to 400 feet.

The Second Berea sandstone, which in Athens County is found near the base of the Bedford shale, lies 40 to 65 feet below the First Berea sandstone. This unit, a porous, fine-grained, well-sorted sandstone, is found throughout Ames, Canaan, and Lodi Townships and extends into parts of Dover, Athens, Alexander, Bern, Rome, and Carthage Townships.

According to DeWitt (1947) the upward convex form of this Second Berea sand bar produces a crest east of which, by comparison to the west, the sand thins more rapidly and the typical red shales of the Bedford formation are absent. The average maximum recorded thickness of the Second Berea sandstone in Athens County is 29 feet, in Bern Township,

Production from this shale sequence in Athens County has been restricted entirely to the above discussed Second Berea sandstone and, according to DeWitt (1947), is controlled not only by thickness but also by the degree of sorting and the southeast regional dip of the subsurface strata. Production from this sand has been limited to gas, with the best producer wells in the thick sand near the crest of this deposit. A greater percentage of the wells drilled east of this crest have been dry, while to the west of the crest, production has been obtained in sands as little as ten feet thick (DeWitt, 1947).

Berea Sandstone

The Berea sandstone, of lower Mississippian age, underlies most of the eastern half of Ohio. From the outcrop, where its thickness ranges from 40 feet in southern Ohio to 200 feet in northern Ohio, it dips below the surface and extends eastward into Pennsylvania and West Virginia. The maximum depth to the Berea sandstone in Ohio is found in eastern Washington County, where it has been encountered at a depth of 2,000 feet (Lamborn, 1954, p. 224).

Locally in Athens County, the Berea sandstone reaches thicknesses of 60 to 70 feet. From York Township, where the average thickness is 38 feet, the Berea sandstone gradually thins southeastward to a line running through central Lodi, southeastern Canaan, and into northeastern Rome Township. East of this line the sand thins out rapidly, reaching an average thickness of four feet in eastern Troy Township at an average depth of 1,850 well feet, or 1,162 feet below sea level.

To the north, in Morgan County, the Berea sandstone, as described by Magbee and Alkire (1954, p. 15), consists of two feet of very fine-grained siltstone underlain by 6 to 60 feet of fine- to medium-grained, light brown sand. In Athens County the only available well cuttings of the Berea sandstone are from the L. J. Ice No. 2 well, section 3, Troy Township. Here the sandstone is six feet thick and very fine-grained. Elsewhere in Athens County it has been logged by the driller as a hard gray or white sand ranging up to 70 feet thick. Local shale lenses which occur in the lower part of the Berea sandstone in Guernsey County, Ohio (DeWitt, 1947), have also been encountered in Athens County in section 27, York Township; section 16, Alexander Township; section 11, Trimble Township; and sections 16, 18, 23, and 32 of Dover Township. Here these lenses occur up to ten feet thick, and that part of the Berea sand lying below them has been erroneously called the Second Berea by some drillers. Throughout the major gas producing area of the Second Berea sand in Athens County, salt water is generally encountered in the First Berea sandstone. Elsewhere this sand is generally free of salt water.

The regional dip to the southeast, as well as the terrace-like structure of the Berea sandstone (figure 33), has no apparent effect on the production of oil and gas in Athens County. According to DeWitt (1947) production from the Berea sandstone is principally controlled by local differences in the porosity and permeability of the sand, with the better sorted sands, commonly less than 40 feet thick, affording the best production. This appears to be the case in Athens County for there is no apparent relationship between the structure and the oil and gas pools of the county.

Mississippian Units Above the Berea Sandstone

The Mississippian units above the Berea sandstone in Ohio include the Sunbury shale, the Cuyahoga and Logan shales, siltstones and sandstones, and the overlying Maxville limestone. Their outcrop extends north from Scioto County, in southern Ohio, to southeastern Erie County and thence east into southern Ashtabula County. These units reach a maximum thickness of 870 feet in Wayne County. They thin to the north and east, and have been recorded at less than 100 feet thick in southern Mahoning County (Lamborn, 1954, p. 225).

In Athens County the sandstones and shales above the Berea sandstone range in thickness from 450 to 675 feet. This irregularity in thickness is due to post-Mississippian erosion which locally removed the overlying Maxville limestone and cut to unequal depths into the underlying shales and sandstones.

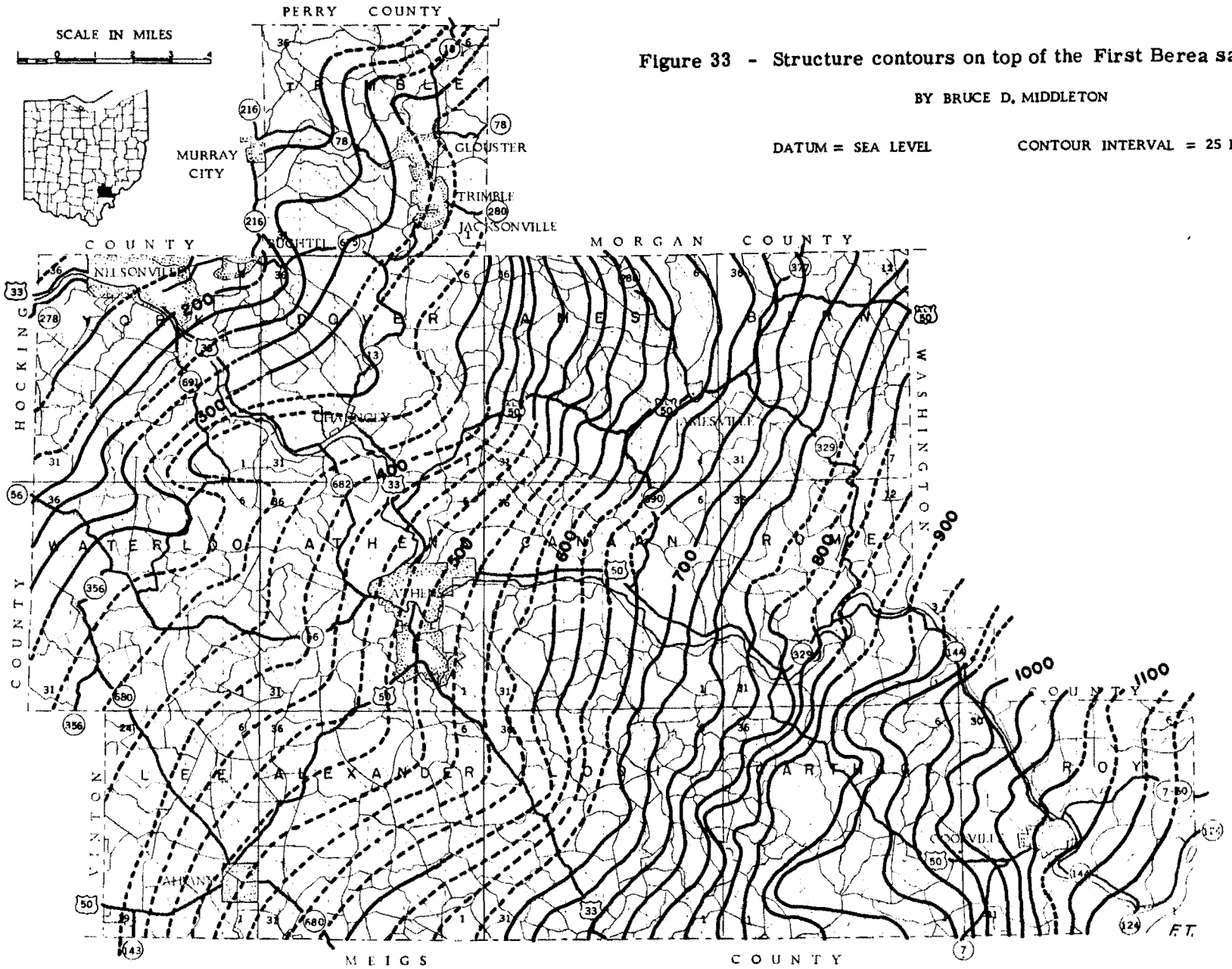


Figure 33 - Structure contours on top of the First Berea sand.

BY BRUCE D. MIDDLETON

DATUM = SEA LEVEL CONTOUR INTERVAL = 25 FEET

At the base of this series a brown-black carbonaceous shale ranging from 5 to 25 feet has been encountered by the driller in Athens County. This shale, which according to Lamborn (1954, p. 225) is widespread in eastern Ohio and generally correlated with Sunbury shale of surface outcrops, has been recorded in practically every well in the county and is an excellent marker for the underlying Berea sandstone.

Immediately overlying the Sunbury shale and extending upward 370 to 470 feet is gray to gray-black shale, interstratified with thin sands and siltstones, which have been logged in a majority of the wells in Athens County as "slate and shells." These are generally correlated with the Cuyahoga formation of surface outcrops. Overlying this shale is a gray to white conglomeratic sandstone ranging from 10 to 60 feet thick which appears to be present throughout Athens County but which is not recorded in every well and therefore probably is discontinuous. This sandstone, which is referred to by the driller as the Big Injun and has an average thickness of about 50 feet, has been correlated with the Blackhand sandstone of the outcrop and is generally considered the upper unit of the Cuyahoga formation.

Where present, the shales and sandstone which overlie the Cuyahoga formation, are generally correlated with the Logan formation at the outcrops. Study of well cuttings from the L. J. Ice Well No. 2, in Troy Township, shows these shales to be gray, brown-black, and black with thin sandy zones occurring locally. They are generally logged by the driller, in Athens County, as undifferentiated shale, and they range in thickness from 50 to 70 feet. The drillers' Keener sand, which is locally present in this shale unit in Athens County, has a range in thickness of 5 to 60 feet and is lensy and discontinuous, much the same as the previously mentioned Big Injun sand. It is a fine-grained subangular sandstone, generally occurring immediately below the Maxville limestone or separated from it by a few feet of shale. Also, it normally is separated from the underlying Big Injun sand by as much as 60 feet of the brown-black Logan shales. According to Miller (1943), when these intervening shales are not present the Keener sand is normally logged by the driller as part of the underlying Big Injun sand. This appears to be the case in a number of wells drilled in Athens County.

Overlying the shales and sandstones of the Logan formation is the Maxville limestone. This conspicuous horizon, which occurs locally throughout Athens County but is not found in every well due to the previously mentioned post-Mississippian erosion, has alternately been referred to on the drillers' log as lime or the Keener lime. It dips to the southeast at an average rate of approximately 30 feet per mile and has been encountered at elevations ranging from 300 feet above sea level in York Township to 600 feet below sea level in Troy Township. In Athens County the thickness has been recorded from 15 to 45 feet thick.

In Athens County some gas production has been obtained from the Keener and Big Injun sands. However, generally speaking, both sands contain salt water, and in most instances this production has been drowned out at an early stage.

Pennsylvanian Sands

For the purposes of this report the term "shallow sands" is restricted to the more important sands of the Pennsylvanian system which occur below the Ames limestone in Athens County. Their names, age, geologic correlation (after Magbee, 1954) and average depth below the persistent Ames limestone are shown in table 29.

A great deal of difficulty is encountered when attempting to correlate these shallow sands. According to Magbee and Alkire (1954, p. 8), to the north in Morgan County these shallow sands are generally "lenticular bodies without lateral continuity, which may be replaced by shale or siltstone within very short distances." A study of the drillers' logs in Athens County shows not only that the same condition exists in this county, but that it is not uncommon for one shallow sand to grade directly into another (figure 34). Such reports may be due to the inability of the driller to recognize the intervening units. Only by the microscopic examination of a sufficient number of well cuttings can this relationship be determined. Correlation on the

Table 29

Shallow Sands of the Pennsylvanian

Series	Geologic Name of Member	Drillers' Name	Average Feet Below Ames
Conemaugh	Cow Run sandstone	First Cow Run	55
	Buffalo sandstone	Buell Run	90
	Mahoning sandstone	Macksburg 300	160
Allegheny	Lower Freeport sandstone	Second Cow Run	275
	Clarion sandstone	Second Cow Run or Macksburg 500	375
	Homewood sandstone	Macksburg 700, 800, or Stray	445
Pottsville	Upper Massillon sandstone	Salt	500
	Lower Massillon sandstone	Brill	555
	Sharon conglomerate	Maxton	600

basis of brine horizons is believed to be unfeasible by Stout (1932, p. 20), who maintains that "with few exceptions the sandstones of the Pottsville, Allegheny, and lower Conemaugh series are more or less charged with brine," throughout southeastern Ohio. Taking the foregoing factors into consideration, and remembering that erosion at the end of Mississippian time locally removed as much as 200 to 300 feet of Mississippian strata, no lateral correlation of these shallow sands is attempted. However, as evidenced by drillers' logs, shallow sands occur throughout Athens County, and for the purposes of the following discussion their stratigraphic positions are described in relationship to certain persistent and well-known key horizons.

Sands of the Pottsville Series

Two important shallow sands are present in the Pottsville series of Athens County, and these are the Massillon sandstone and locally the Sharon conglomerate. Comparatively short-lived gas production has been obtained from both of these; however, production from the Massillong sandstone has been limited to those wells in which extra strong gas flows can be economically produced. In contrast, a majority of the wells drilled into the Sharon conglomerate have a strong initial flow, and pool areas have been developed in Carthage, Bern, Lodi, Rome, and Troy Townships. With the exception of the Cow Run sandstone, the Sharon conglomerate is the most productive of the shallow sands in Athens County.

Sharon Conglomerate. - The Sharon conglomerate, or the Maxton sand of the driller, is the oldest of the shallow sands and where present forms the base of the Pottsville series in Ohio. In Athens County it is patchy, occurring only in trough-like depressions which resulted from differential erosion at the end of Mississippian time. According to Stout (1932, p. 22), the Sharon conglomerate in southern and southeastern Ohio ranges in thickness "from 10 to 200 feet and may change either laterally or vertically from a coarse-textured conglomerate to a fine-grained sandstone." Where recorded on the drillers' logs of Athens County, the Sharon conglomerate has a thickness range from 5 to 60 feet.

Massillon Sandstone. - The Massillon sandstone is probably the most prominent sand of the Pennsylvanian system of eastern Ohio, and because of its extensive salt water content it is known to the driller as the Salt sand. It is geologically younger than the Sharon conglomerate, and its position in the Pottsville series of Ohio "is commonly about 70 feet below the Lower Mercer limestone and directly or not far above the Quakerstown coal" (Stout, 1932, p. 21). To the west in southern Hocking County, Hall (1951, p. 70) described the Massillon as medium-

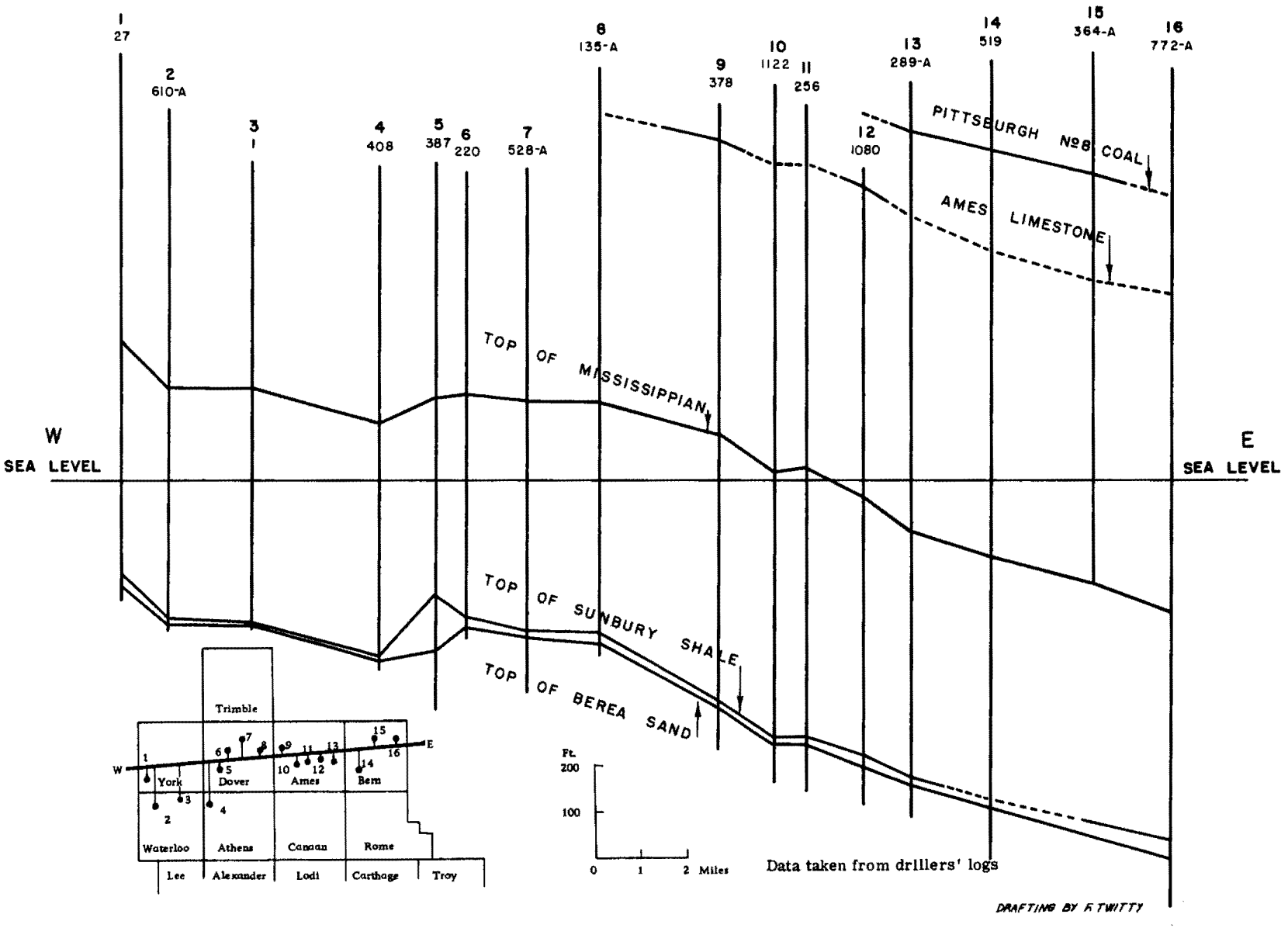


Figure 34 - Generalized cross section of subsurface geology through northern Athens County.

grained, gray to dark gray, massive sandstone which ranges in thickness from 2 to 57 feet. Locally in Athens County it directly overlies the Maxville limestone of Mississippian age, and represents the base of the Pennsylvanian system. Where this condition is found the Massillon sandstone is often erroneously called the Maxton sand by the drillers. Magbee (1954, p. 13) believes that to the north, in southern Morgan County, this sandstone laterally splits into two distinct members which are separated by a few feet of shale. He further maintains that the Brill sand of the driller is actually the lower member of the Massillon sandstone rather than a separate underlying sandstone unit. Some support for this theory is evident from the drillers' logs of Athens County, although it is apparent that the name Brill sand has often been applied to the thinner portions of both the Massillon sandstone and the Sharon conglomerate.

Sands of the Allegheny Series

Three important sandstones occur in the Allegheny series in Athens County. The oldest of these is the Homewood sandstone. The Clarion sandstone is conspicuous in the Pennsylvanian system of southeastern Ohio and known to the driller as the Macksburg 500. The youngest, the Lower Freeport sandstone, has been a good producer of oil and gas in Meigs, Noble, and Monroe Counties. None of these sandstones are of significant importance as producers of oil and gas in Athens County.

Homewood Sandstone. - The Homewood sandstone is the youngest of the shallow sands of the Allegheny series in Athens County. Stratigraphically located 70 to 90 feet below the persistent Middle Kittanning coal, it has been variously referred to by the driller as the Macksburg 700, the Macksburg 800, or the Macksburg Stray. To the west, in southern Hocking County, the Homewood is a massive, fine- to medium-grained, buff to gray sandstone which ranges from 3 to 23 feet thick (Hall, 1951, p. 70). Where identifiable on the drillers' logs of Athens County, the thickness of this sandstone is generally indicated at approximately 20 feet.

Clarion Sandstone. - The Clarion sandstone, stratigraphically located below the Clarion coal and above the Putnam Hill limestone, is known to the driller as the Macksburg 500 sand and is the basal sandstone member of the Allegheny series. As described by Stout (1932, p. 21) the Clarion sandstone is a fine-textured, light gray sandstone which varies in thickness from 5 to 50 feet in southern and southeastern Ohio. Locally in Athens County this sandstone commonly has been erroneously called the Second Cow Run sand by the drillers.

Lower Freeport Sandstone. - The medium-grained, pale-yellow to buff, micaceous Lower Freeport sandstone is easily identified from its position either directly or a few feet above the thick and persistent Middle Kittanning coal. It thickens in a southerly direction from 19 feet in Trimble and York Townships to 40 feet in Waterloo Township (Laubach, 1953, p. 27).

Sands of the Conemaugh Series

The Mahoning, Buffalo, and Cow Run sandstones constitute the important shallow sands of the Conemaugh series in Athens County. The older of these, the Mahoning and Buffalo sands, have produced some oil and gas in a few places, but in general the production is of no economic significance. The Cow Run sandstone, on the other hand, is the most prolific oil and gas producer of the Pennsylvanian shallow sands and pool areas and has been developed throughout the eastern half of Athens County. Oil is the dominant product, and although generally small in quantity and comparatively short-lived, production from this sandstone has been profitable due to the shallow depth at which the sand occurs.

Mahoning Sandstone. - In Athens County the Mahoning sandstone, or the Macksburg 300 of the driller, has an upper and a lower member separated by the Mahoning coal. However, due to

the poor development of this coal, which normally occurs only as a smut averaging less than a foot thick, and the difficulty of identifying it from well cuttings, the Mahoning sandstone for the purposes of this discussion is being considered as a single unit. Stratigraphically, this medium- to coarse-grained, gray, micaceous sandstone lies directly on or only a few feet above the Upper Freeport coal and forms the basal sandstone of the Conemaugh series. Its thickness ranges from 7 to 83 feet.

Buffalo Sandstone. - The Buffalo sandstone, or the Buell Run sand of the driller, is stratigraphically either immediately below the easily recognized Cambridge limestone or separated from it by a few feet of coal or shale. It is generally a fine- to medium-grained, gray to brown, micaceous sandstone, ranging in thickness from 5 to 30 feet.

Cow Run Sandstone. - Stratigraphically, the Cow Run sandstone lies between the Ames and Cambridge limestones. It is a clean white quartz sandstone, commonly appearing gray due to the presence of dark mica (Laubach, 1953, p. 16). Lateral variations in thickness are common, but along outcrops extending south from Trimble Township into southwestern Alexander Township, the average thickness is 14 feet.

Table 30

Deep Wells of Athens County

Township	Section* or Fraction	Property Name and Well Number	Date Drilled	Wellhead Elevation	First Berea		Big Lime		First Water (W) Oriskany		Second Water		Packer Shell		Clinton		Total Depth	Remarks
					Top	Bottom	Top	Bottom	Top	Bottom	Top	Bottom	Top	Bottom	Top	Bottom		
Alexander	24		1941	-	1,167	1,200	2,691	-	-	-	-	-	-	-	-	-	-	
Ames	20, Fr. 31	Jennie Beasley, #1A	1948	-	1,355	1,369	3,028	4,058	-	-	3,862	-	4,194	4,204	4,250	4,320	4,404	Dry
Canaan	31-32	Peter L. Fagan, #1	1926	990	1,560	1,580	3,177	4,130	-	-	3,975	-	-	-	4,388	4,422	4,442	Gas in 2nd Berea
Carthage	18	Marion Potter, #1	1940	807	1,752	1,764	3,611	-	-	-	-	-	-	-	-	-	3,823	Dry
Dover	3	Sugar Creek Coal Co., #3	1923	900±	1,247	1,282	2,828	3,818	-	-	-	-	3,994	4,004	4,077	4,117	4,137	Dry
	5	Eileen Stratton, #1	1937	-	1,045	1,089	2,472	3,295	-	-	3,140	-	3,488	3,491	3,551	3,579	3,613	Show of gas in Berea
	5	Millfield C. and M. Co., #1	1930	800	1,111	1,136	2,668	3,636	-	-	3,440	-	-	-	3,889	3,939	4,139	Dry
	16	Sunday Creek Coal Co., #114	1934	671	1,009	1,062	2,532	3,485	-	-	-	-	3,634	3,643	3,733	3,767	3,786	Gas in Clinton
	17	Sunday Creek Coal Co., #237	1944	834	1,173	1,218	2,729	3,630	-	-	3,430	-	-	-	3,881	3,905	3,932	Dry
	21, Fr. 1	New York Coal Co., #4	1938	681	1,007	1,030	2,520	3,480	-	-	-	-	3,630	3,637	3,712	3,742	3,860	Dry
	22, Fr. 30	Sunday Creek Coal Co., #101	1933	682	1,000	1,035	2,502	3,430	-	-	-	-	-	-	3,700	3,730	3,793	Show oil and gas in Berea
	22, Fr. 18	Sunday Creek Coal Co., #273	1948	824	1,150	1,173	2,650	3,603	-	-	3,383	-	-	-	3,836	3,870	3,873	Gas in Clinton
	23, Fr. ,17	Sunday Creek Coal Co., #123	1935	916	1,210	1,237	2,705	3,613	-	-	3,420	-	3,768	3,775	3,836	3,872	3,873	Gas in Clinton
	28, Fr. 35	Sunday Creek Coal Co., #128	1936	722	1,020	1,043	2,500	3,418	-	-	-	-	-	-	3,640	3,670?	3,713	Dry
	29	Sunday Creek Coal Co., #132	1936	794	1,077	1,107	2,555	3,465	-	-	3,250	-	3,605	3,611	3,674	3,710	3,773	Dry
	33, Fr. 36	New York Coal Co., #1	1935	-	1,138	1,188	2,615	3,563	-	-	-	-	3,703	3,708	3,768	3,805	3,883	Gas in Clinton
	34	New York Coal Co., #3	1937	815	1,105	1,110	2,535	3,450	-	-	-	-	-	-	3,681	3,716	3,732	Dry
	35	Eileen Stratton, #1	1937	-	1,054	1,089	2,472	3,295	-	-	3,140	-	3,488	3,491	3,551	3,579	3,613	Dry
Lee	20, Fr. 19	Martha Hammond	?	864	1,260	1,299	2,570	3,385	-	-	-	-	-	-	3,636	3,642	3,701	Oil in Berea
Trimble	4	McDonald, #1	1929	-	1,030	1,050	2,575	3,525	-	-	3,295	-	-	-	3,745	3,774	3,791	Gas in Clinton
	10, Fr. 5	Sunday Creek Coal Co., #1	1936	882	1,196	1,211	2,721	3,682	-	-	-	-	3,803	3,809	3,879	3,917	3,980	Show of gas in Berea
	11	McDonald Hrs., #2	1929	-	1,025	1,060	2,550	3,530	-	-	3,270	-	-	-	3,717	3,764	3,770	Dry
	22, Fr. 17	George M. Jones "B" Lease, #1	1948	-	1,006	1,031	2,495	3,409	-	-	3,280	-	-	-	3,623	3,885	3,745	Show of gas in Berea
	23	Republic Coal Co., #38	1948	-	975	1,062	2,465	3,398	-	-	3,200	-	3,536	3,541	3,605	3,652	3,735	Show of gas in Berea
	24	W. C. Maholm, #1	1948	179?	951	988	2,425	3,352	-	-	3,150	-	3,477	3,482	3,542	3,596	3,679	Show of gas in Clinton
	25	Buckingham & Wright, #1	1952	-	1,046	1,088	2,520	3,432	2,525W	-	-	-	3,560	3,570	3,660	3,670	3,732	Show of oil in Clinton
	27, Fr. 33	Sunday Creek Coal Co., #191	1941	955	1,200	1,218	2,653	3,552	2,733W	-	3,370	-	3,690	3,695	3,757	3,804	3,859	Dry
	28, Fr. 35	George M. Jones Co., #1	1948	-	990	1,006	2,445	3,353	-	-	3,185	-	-	-	3,571	3,613	3,831	Gas in Clinton
	29	Sunday Creek Coal Co., #72	1929	-	1,080	1,094	2,505	3,405	-	-	-	-	-	-	3,626	-	3,722	Dry
	30	Sunday Creek Coal Co., #247	1944	949	1,157	1,175	2,595	3,500	-	-	3,360	-	-	-	3,703	3,749	3,833	Dry
	33	Sunday Creek Coal Co., #104	1933	796	1,050	1,085	2,470	3,373	-	-	3,200	-	3,520	3,526	3,578	3,608	3,618	Show of oil in Clinton
	35	Sunday Creek Coal Co., #208	1942	846	1,058	1,068	2,450	3,362	-	-	3,149	-	-	-	3,558	3,575	3,668	Dry
	36	Sunday Creek Coal Co., #220	1942	909	1,111	1,139	2,510	2,590	2,570	2,590	3,210	-	-	-	3,614	3,634	3,644	Show of gas in Oriskany
Troy	2	L. J. Ice, #2	1953	691	1,871	1,874	2,989	5,120	4,120	-	-	-	-	-	5,492	5,507	5,685	Gas?
	3	W. C. Wilson, #2	1951	837	1,982	1,986	4,132	-	4,215	4,237	-	-	-	-	-	-	4,265	Gas in Oriskany
	9, Fr. 3	E. F. Story, #1	1949	-	1,901	1,904	3,925	-	-	-	-	-	-	-	-	-	4,172	Gas?
Waterloo	2	T. N. Hoover, #2	1930	-	1,261	1,281	2,709	3,543	2,761	-	3,355	-	3,713	3,715	3,805	3,825	3,950	Dry
	32	Athens-Vinton Co., #1	1899	-	1,007	1,041	2,271	3,080	-	-	-	-	-	-	3,272	3,292	3,307	Dry
	34	L. C. Hewitt,	1921	965	1,260	1,285	2,512	3,325	-	-	3,135	-	-	-	3,574	3,598	3,633	Dry
York	5	Hocking Valley Prod. Co., #220	1943	-	1,062	1,089	2,466	3,320	-	-	3,148	-	3,460	3,465	3,531	3,550	3,629	Dry
	6	Hocking Valley Prod. Co., #221	1943	-	1,044	1,080	2,426	3,287	-	-	3,110	-	3,420	3,424	3,480	3,510	3,518	Oil & gas in Berea & Clinton
	10, L-623	Homer Frank, #1	1937	-	960	990	2,340	3,120	-	-	3,020	-	-	-	3,392	3,430	3,430	Dry
	15, Fr. 6	Valley Mining Co., #1	1931	-	976	991	2,295	3,122	-	-	-	-	3,275	3,278	3,360	3,370	3,402	Dry
	17	Hocking Valley Prod. Co., #216	1931	-	1,058	1,076	2,382	3,210	-	-	2,990	-	3,348	3,351	3,416	3,441	3,448	Gas?
	23	Sunday Creek Coal Co., #96	1930	-	985	1,040	2,280	3,101	2,390W	-	2,900	-	3,228	3,235	3,325	3,376	3,392	Gas in Clinton
	24	Nelsonville Lumber Co., #1	1930	-	880	905	2,190	3,035	-	-	2,835	-	3,160	3,165	3,234	3,260	3,285	Dry
	27, Fr. 26	Sunday Creek Coal Co., #260	1945	-	1,155	1,230	2,472	3,359	2,555W	-	-	-	3,502	3,509	3,542	3,572	3,704	Dry
	28, Fr. 36	New York Coal Co., #2	1937	726	1,010	1,050	2,470	3,420	-	-	-	-	3,550	3,555	3,615	3,657	3,667	Dry
	34, Fr. 18	Stephen Arnot Est., #1	1920	-	1,125	1,148	2,330	3,140	-	-	2,940	-	-	-	3,373	3,393	3,409	Dry
	35	New York Coal Co., #5	1943	928	1,090	1,125	2,325	3,135	-	-	2,925	-	3,245	3,250	3,312	3,332	3,371	Dry
	36	E. J. and S. R. Cable, #1	1918	-	950	990	2,200	3,040	-	-	2,820	-	-	-	3,229	3,254	3,310	Dry

*For the convenience of the reader, the author has taken the liberty of assigning section numbers to those

The following plates, 9 through 11, illustrate a few of the more common invertebrate (shelled) fossils that occur in marine stratigraphic members of the Pennsylvanian system in eastern Ohio. Fossiliferous marine members in Athens County include: Putnam Hill limestone; Zaleski, Dorr Run, and Mason shales; Lower and Upper Brush Creek limestones; Cambridge limestone; Portersville shale and limestone; and Ames, Gaysport, and Skelley limestones (see tables 7 and 11).



PLATE 9. Some representative Pennsylvanian invertebrate fossils (Gastropods).

1-2. Euphemites sp. X5; 3. Platyceras (Orthonychia) parvum (Swallow), X1; 4. Donaldina stevensana (Meek & Worthen), X8; 5. Worthenia tabulata (Conrad), X1; 6. Straparobus (Amphiscapha) catilloides (Conrad), X3; 7. Glabrocingulum sp., X3; 8. Trepospira illinoiensis (Worthen), X2; 9. Strobeus regularis (Cox), X1; 10. Meekospira peracuta (Meed & Worthen), X5; 11. Shansiella carbonaria (Norwood & Pratten), X1; 12. Strobeus paludinaeformis (Hall), X3; 13-14. Cymatospira montfortianus (Norwood & Pratten), X2; 15. Pharkiodonotus percarinatus (Conrad), X5.

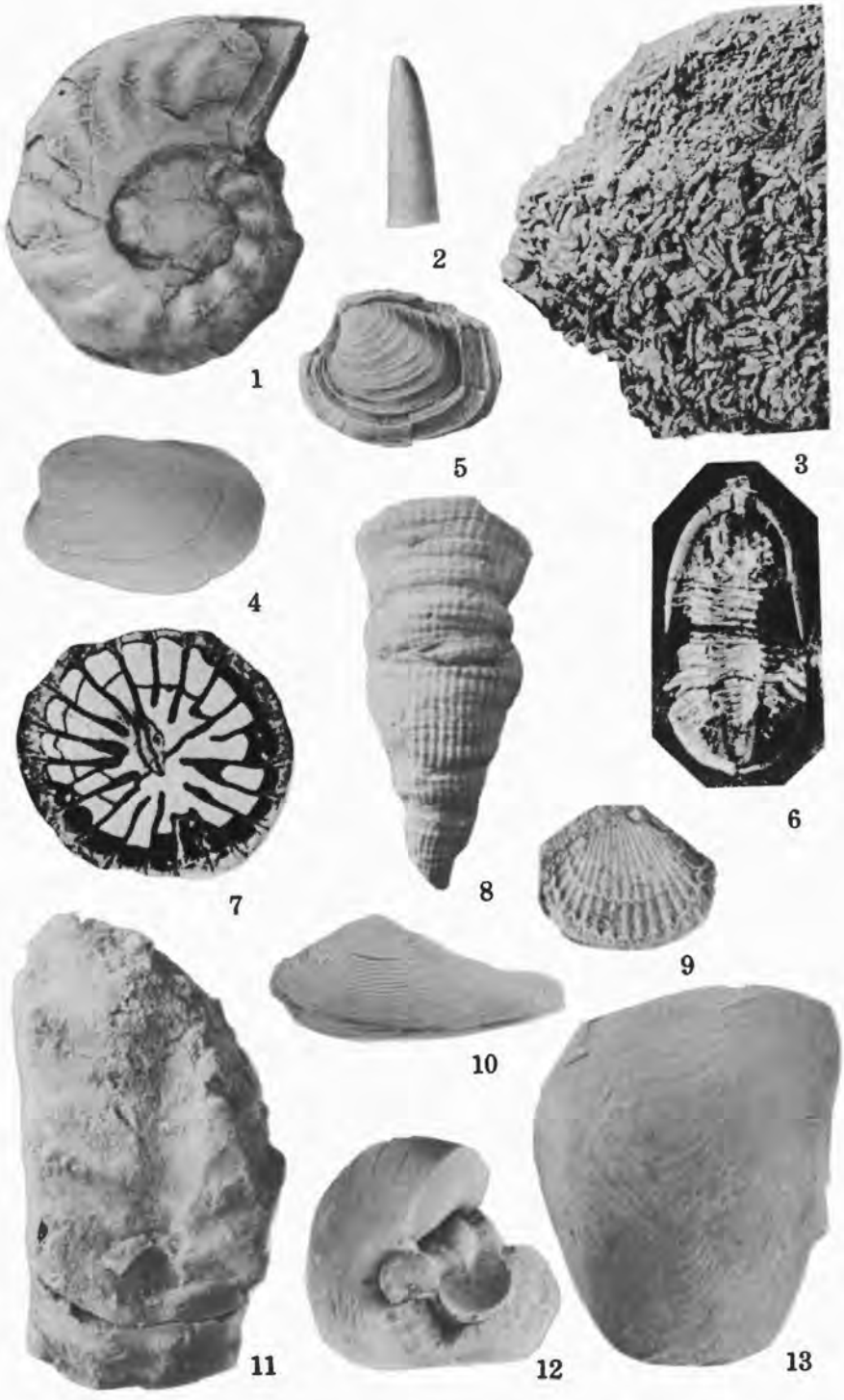


PLATE 10. Some representative Pennsylvanian invertebrate fossils: Anthozoa (coral) 7-8; Cephalopoda (cephalopods) 1-2, 11-13; Foraminifera (fusulinid protozoans) 3; Pelecypoda (clams) 4-5, 9-10; Trilobita (trilobite) 6.

1. Metacoceras perelegans Girty, X1; 2. Pseudorthoceras knoxense (McChesney), X2; 3. Triticites ? sp., X1; 4. Clinopistha sp., X2; 5. Astartella sp., X2 ?; 6. Ditomopyge sp., X2; 7-8. Stereostylus sp., 7-X5, 8-X2.5; 9. Acanthopecten sp., X2; 10. Nuculana sp., X2; 11. Tainoceras monilifer Miller, Dunbar, and Condra, X1; 12-13. Liroceras liratum (Girty), X2.

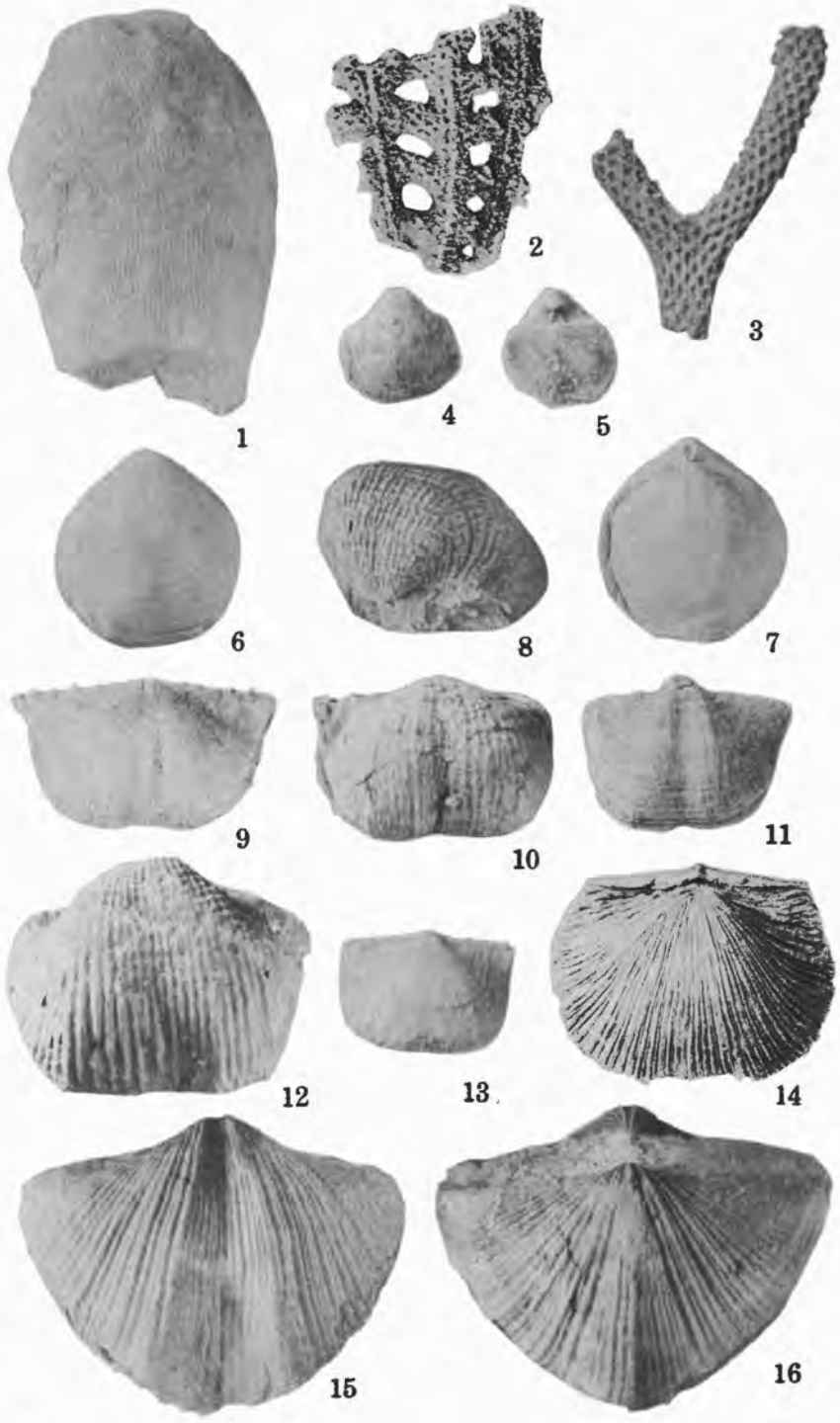


PLATE 11. Some representative Pennsylvanian invertebrate fossils: Brachiopoda (brachiopods, lamp shells) 1, 4-16; Bryozoa (moss animals) 2-3.

1. Linoproductus prattenianus ? (Norwood and Pratten), X1; 2. Septopora ? sp., X 5+; 3. Rhombopora sp., X5+ ; 4-5. Crurithyris planoconvexa (Shumard), X2; 6-7. Composita ovata Mather, X1; 8. Juresania nebrascensis? (Owen), X1; 9. Mesolobus mesolobus (Norwood and Pratten), X2; 10. Marginifera muricatina ? Dunbar and Condra, X1.5; 11. Chonetina verneuiliana (Norwood and Pratten), X2, 12. Dictyoclostus crassicostus ? Dunbar and Condra, X1+; 13. Chonetes granulifer Owen, X2; 14. Derbya ? sp., X1; 15-16. Neospirifer cameratus (Morton), X1.

GLOSSARY

A

ALLEGHENY SERIES (see also formation or group). Pennsylvanian strata between base of Brookville (No. 4) coal and top of Upper Freeport (No. 7) coal; but herein expanded to include rocks between base of Homewood sandstone below the Brookville coal and top of the Uffington shale overlying the Upper Freeport coal. Formerly called Lower Productive group.

ALLUVIAL. Pertaining to streams and stream sediments.

ANHYDRITE. A white mineral formed of calcium sulfate ($CaSO_4$), formed when salty water (for example, the seas that once covered Ohio) evaporated.

ANNELID. Segmented worm.

ANTHRACITE. A variety of coal; a hard black lustrous coal containing a large percentage of fixed carbon and little volatile (gaseous) matter. Anthracite coal is not found in Ohio.

ANTICLINE. A fold in layered (sedimentary) rocks in which the layers are bent upward into an arch.

APPALACHIAN GEOSYNCLINE. A syncline of very extensive proportions in which a thick deposit of Paleozoic sediments accumulated, that have since been raised, folded, and eroded to form the present Appalachian Mountains.

APPALACHIAN HIGHLANDS. All the highland area between the Atlantic Coastal Plain and the Interior Lowlands. See figure 3.

ARCH. A synonym for a broad, gentle anticline.

ARENACEOUS. Term used to describe a sedimentary rock that is sandy.

ARGILLACEOUS. Term applied to rocks containing appreciable amounts of clay.

AVERAGE THICKNESS. The average of all values obtained for the thickness of a cyclothem or cyclothem member. Zero measurements are not included in the average.

B

BASIN. (1) A type of syncline or downward bend of the sedimentary rock layers that is circular in plan, with the layers dipping inward on all sides. (2) Drainage basin (catchment area for a river system).

BED. Single layer of sedimentary rock.

BEDDING. Arrangement, one upon another, of layers (beds) of sedimentary rock.

BEDDING PLANE. Plane or surface separating adjacent layers, or beds, of sedimentary rock.

BEDROCK. Solid rock of the earth's crust.

BENCH. Individual layers of coal separated by thin layers of clay or shale.

BITUMINOUS COAL. Pertaining to certain varieties of coal that burn with flame and yield volatile matter when heated. Ohio's coals are of bituminous rank.

BLOSSOM (Coal). A highly weathered outcrop of coal.

BONY. Argillaceous or shaly, pertaining to coal.

BRACHIOPOD. Marine animal that lived inside two shells, similar to a clam (but, unlike clams whose two shells are similar, the shells of a brachiopod are of different shape and size). Brachiopods are among the most common fossils found in Ohio's rocks.

BRACKISH. Term applied to environment in which water is somewhat salty, but not as salty as sea water, such as may occur in estuaries adjoining, but partly separated from, the sea.

BRECCIA. Rock composed of cemented coarse angular rock fragments.

BRIGHT COAL. Coal composed primarily of vitrain.

C

CALCAREOUS. Term applied to rocks containing appreciable amounts of calcium carbonate or lime.

CALCITE. A light-colored mineral composed of calcium carbonate ($CaCO_3$); the main mineral making up the rock limestone.

CALLIPTERIS CONFERTA. Fossil plant of Permian age found in shales above the Washington coal in the Appalachian area. Used as index to establish Permian age of the Dunkard group.

CAMBRIAN. Oldest of the seven geologic periods of the Paleozoic ("ancient life") era (see table 5). Rocks of this age do not occur at the surface in Ohio, but are encountered in deep wells.

CANNEL COAL. Variety of bituminous coal that is dull, greasy, and nonbanded. There are three types: 1) boghead or algal cannel coal, 2) spore cannel coal, composed of large numbers of spore exines, and 3) humic cannel, composed of highly degraded (finely divided) plant material.

CANNELOID. Pertaining to cannel coal.

CARBONACEOUS. Containing organic matter, commonly fossil plant matter; coaly.

CARBONATE. Pertaining to materials containing or composed of carbonic acid salts, calcium carbonate, iron carbonate, etc.

CARBONIFEROUS. A general term to include the Mississippian and Pennsylvanian systems; sometimes restricted in the United States to the Pennsylvanian.

CARBONIFEROUS CONGLOMERATE. Older name for Pottsville series.

CASE-HARDENED. The extremely tight cementation of some beds in the exposed face of a massive, porous sandstone or similar rock body.

CENOZOIC. Most recent of the geologic eras; the time of "modern" life (development of mammals) (see table 5).

CERAMIC. Pertaining to pottery and allied products.

CHANNEL DEPOSIT. A deposit, usually sandstone, which fills a former stream cut or channel and generally shows a lenticular shape in an exposure.

CHERT. A dense mineral composed of finely crystalline silica (SiO_2) which, because it breaks with smooth conchoidal surfaces, was often used by the Indians for arrowheads. Synonymous with flint.

CLASTIC. Composed of fragments of rocks or minerals. Refers to rocks which are composed of such fragments as opposed to rocks that are formed by chemical precipitation.

CLAY. Deposit composed of very tiny particles, less than 1/256 mm (1/1000 of an inch) in size; clays occurring beneath coals are called underclays.

CLAYEY. Term applied to a sediment or sedimentary rock to indicate that it contains a high percentage of clay; synonymous with argillaceous.

COAL. A sedimentary rock composed of partially preserved plant material which has been changed into an adherent, compact, brown to black, dull to bright mass. Coal is also characterized by banding and cleat (joints). Usually rocks classified as coal contain at least 60% of organic matter on the dry basis.

COALESCED. The joining together of similar strata that are usually separated by strata of different lithology.

COAL MEASURES. Old term for Upper Carboniferous or Pennsylvanian system.

COBBLESTONE. A rounded rock fragment intermediate in size between a boulder and a pebble (between $2\frac{1}{2}$ and 10 inches or between 64 and 256 mm in diameter).

CONCRETION. Nodular concentrations of mineral matter, denser and usually of somewhat different composition than enclosing rock, formed by precipitation of mineral matter within the natural pore spaces of rocks.

CONEMAUGH SERIES. (See also formation or group.) Pennsylvanian strata between top of Upper Freeport (No. 7) coal and base of Pittsburgh (No. 8) coal, but herein restricted to include rocks between top of the Uffington shale or, in its absence, top of the Upper Freeport coal and the base of the Lower Pittsburgh (Bellaire) shale and sandstone. Formerly called Lower Barren group. See table 11.

CONGLOMERATE. A variety of sedimentary rock composed of cemented gravel (pebbles).

CORRELATION. Matching of the geologic age of sedimentary rocks of one area with that of another by means of fossil content, similarity in lithology, stratigraphic sequence, etc.

CROSS-BEDDING. Layers or beds of sedimentary rock which are enclosed by and inclined to adjacent layers, as a result of current action.

CROSS-LAMINATION. Cross-bedding on a small scale (see cross-bedding).

CRUST OF THE EARTH. Outer shell of the earth extending from the earth's surface (where it is called bedrock) to a depth of about 50 kilometers (31 miles).

CYCLOTHEM. A related sequence of rocks which were deposited in a single sedimentary cycle. About 60 such cycles occur in the Pennsylvanian system of Ohio. A complete cyclothem consists of the following sequence of rocks, in ascending order: sandstone, shale, fresh-water limestone, underclay, coal, black shale, marine limestone, and siltstone.

D

DENDRITIC STREAM PATTERN. The pattern made in some areas by a main stream and its tributaries, somewhat similar to the arrangement of veins in the leaf of a tree (for examples, see figure 6).

DEVONIAN. One of the seven periods of the Paleozoic ("ancient life") era (see table 5). Rocks of this age crop out as a north-south belt through central Ohio and are composed of limestone and shale (see figure 8).

DIASTEM. A minor interruption in a depositional history.

DIP OF A ROCK LAYER. The maximum amount of inclination (angle) formed with the horizontal plane by a sloping rock surface (at right angles to strike).

DISCONFORMITY. A surface of erosion or nondeposition that separates younger strata from older rocks which have not been deformed.

DIVIDE. Line separating drainage areas of two different streams. In many areas in Athens County, PREGLACIAL DIVIDES occupied different locations than do modern divides. the change having been made by a complicated series of stream changes (piracy, reversals, etc.)

DUNKARD. The group of rocks of Permian age which overlie the Pennsylvanian system and are composed of the Washington series below and the Greene series above.

E

EPOCH (geologic). Subdivisions of a geologic period.

ERA (geologic). Major subdivision of geologic time (see Paleozoic, Mesozoic, Cenozoic eras).

ESTHERIDS. An extinct form of crustacean found as fossils in rocks of Paleozoic age.

F

FACIES. In a formation the type of rock may vary from place to place; in one area the formation may be composed of sandstone while laterally the formation is composed of siltstone or shale, because of differing environmental conditions at time of deposition. Facies is the term used for one of these rock types within a formation.

FAULT. Crack in the earth's crust along which offsetting of the two sides has occurred.

FAUNA (Fossil). The sum total of all known animals that lived in a particular time and place and are now found as fossil remains in certain layers, zones, or areas of the sedimentary rocks.

FERRUGINOUS. Term applied to a sedimentary rock containing iron.

FISSILE. Term applied to a sedimentary rock, especially shale, to describe the tendency of that rock to break into thin plates or flakes.

FIXED CARBON. Solid carbon residue of coal which remains after the volatile matter has been driven off by heat.

FLINT. Synonymous with chert.

FLINT CLAY. A clay which when weathered has no plasticity.

FLOAT. Fragments of rock which have broken off from an exposure and have moved down the slope below the outcrop.

FLORA (Fossil). Kinds of plants, and their abundance, in one individual rock layer or zone.

FORMATION. An assemblage of rocks which, because they have some character in common, such as origin, age, or composition, are mapped as a single unit.

FOSSIL. The remains or traces of prehistoric animals or plants which have been preserved by natural causes in the earth's crust.

FOSSILIFEROUS. Term applied to sedimentary rocks to indicate that they contain fossils.

FUSAIN. Fossil charcoal, an inert petrographic ingredient of coal.

G

GASTROPODS. Snails.

GEOSYNCLINE. A syncline of very extensive proportions in which, characteristically, a thick deposit of sediments accumulates (see syncline; Appalachian geosyncline).

GRADED SEDIMENT. A gradual change of the constituent grain size, or rock type, in either lateral or vertical direction.

GREENE SERIES. The rocks which belong to the uppermost division of the Dunkard group (Permian), beginning at the base of the Jollytown coal bed.

GYPSUM. A white mineral,composed of hydrous calcium sulfate ($CaSO_4 \cdot 2H_2O$), which precipitates as sea water evaporates.

H

HACKLY. Pertaining to the angular character of shale upon breaking or weathering (synonymous with starch-like fracturing and irregular fracture).

HORIZON. Surface separating two adjacent rock layers and hence without thickness.

I

IGNEOUS ROCK. Rock formed by crystallization of molten mass.

INDEX FOSSIL. An individual species, genus, or group of fossils that has a broad geographic occurrence but a limited stratigraphic occurrence (i. e., generally in only one rock layer or zone), by means of which the rocks in which it occurs can be correlated.

INTERBEDDED. Expression used when two kinds of rock, for example sandstone and shale, occur in alternating sequence.

IRONSTONE. Nodules composed of the mineral siderite (see siderite).

IRREGULAR FRACTURE. See hackly.

J

JOINT. Crack in the earth's crust along which no displacement has taken place; commonly many parallel joints occur together in a SYSTEM. Joints in coal are called CLEATS and are usually closely spaced.

K

KNOT. An irregular nodule.

L

LACUSTRINE. Pertaining to lakes and their deposits and environment.

LAMINATED. Term used for rocks when beds or layers are very thin.

LANDSLIDE. The slow down-slope movement of masses of soil and rock, often soft shales, which frequently gives a hummocky appearance to the hillsides.

LENS. A rock layer that is thicker in the middle, but thins laterally to a feather edge.

LIMESTONE. Sedimentary rock composed entirely of the mineral calcite (calcium carbonate).

LIMONITE. A yellowish-brown mineral composed of hydrated iron oxide ($Fe_2O_3 \cdot nH_2O$) which is the main mineral of common rust.

LITHOLOGY. The description and classification of rocks.

LOESS. Homogeneous accumulation of silt, lacking stratification (bedding lines), deposited by the wind.

LOWER BARREN GROUP. Old and abandoned name for Conemaugh series.

LOWER PRODUCTIVE GROUP. Old and abandoned name for the combined Pottsville-Allegheny series.

M

MANTLE. The loose rock material lying on top of the bedrock.
TRANSPORTED MANTLE - Was weathered and broken from a source rock at another locality and transported to the present location by streams or glaciers, etc., and commonly has a different composition from the underlying bedrock.
RESIDUAL MANTLE - Was weathered and broken from the underlying bedrock, is therefore of the same composition as that bedrock, and grades down into it.

MARCASITE. A greenish-yellow to greenish-gray metallic mineral composed of iron sulfide (FeS_2); like pyrite, but with different molecular structure (see pyrite).

MARINE. Pertaining to sediments deposited in environments in which the water was salty, such as in oceans.

MARLY. Term applied to rocks containing relatively high percentages of both calcium carbonate and clay.

MASSIVE. A term applied to rock layers that occur in unusually thick beds.

MAUCH CHUNK. Uppermost group of the Mississippian rocks in Pennsylvania and West Virginia.

MEMBER. Subdivision of a formation; also a lithologic element of a cyclothem.

MESOZOIC. Geologic era that preceeded most recent one; the time of "Middle" development of life (the time of the dinosaurs) (see table 5).

METAMORPHIC ROCK. Rock that has been changed ("metamorphosed") by application of excessive temperatures and pressures deep within the crust of the earth.

MICA. A mineral of complex composition (aluminum silicate containing iron, magnesium, and potash) which occurs in thin sheets ("isinglass") and may be silver or black in color.

MICACEOUS. Term used to describe a rock containing mica.

MILLSTONE GRIT. Old and abandoned name for Pottsville formation.

MISSISSIPPIAN. One of the later of the seven geologic periods of the Paleozoic ("Ancient Life") era (see table 5). Rocks of this age occur in eastern Ohio (see figure 8) and are composed mostly of sandstone and shale.

MONONGAHELA SERIES. The youngest series of rocks in the Pennsylvanian system, which overlies the Conemaugh and underlies the Dunkard (Permian) group. The Monongahela series extends from the base of the Pittsburgh cyclothem up to the base of the Waynesburg cyclothem (see table 13).

MOTTLED. Term used to indicate that rock is irregularly marked with spots of different color.

MUD CRACKS. Cracks that develop in mud as it dries out and contracts, characteristically forming a somewhat hexagonal pattern. When these cracks fill with a somewhat different mud, they may be preserved in the rock.

MUDSTONE. Sedimentary rock formed by the dehydration and compaction of mud (mixture of clay, silt , and water), generally lacking bedding.

N

NODULAR. Term for rock containing small concretions (see concretion).

NODULE. Small concretion (see concretion).

O

ORDOVICIAN. Next-to-oldest of the seven geologic periods of the Paleozoic ("ancient life") era (see table 5). Rocks of this age occur in southwestern Ohio (see figure 8), are composed of limestone and shale, and are famous for the abundance and ease of collecting of their fossils.

OSTRACOD. Minute crustaceons which have small bivalve (clam-like) shells; shells are often preserved as fossils.

OUTCROP. Place where the bedrock is exposed at the surface.

P

PALEOBOTANY. Study of fossil plants.

PALEOZOIC. First of the geologic eras during which life was abundant; the time of ancient development of life (brachiopods, corals, archaic fish, etc.) (see table 5).

PARTING. Rock (shale, bone, or fusain) which separates benches of coal.

PELECYPOD. Clams.

PELLET. Like a nodule but smaller.

PENEPLAIN. A land surface worn down by erosion to a nearly flat or broadly undulating plain, which may subsequently be uplifted and dissected so that it may be recognized only in an even skyline (as in Athens County). Local spots, protected by rock resistance or remote location from being completely lowered to the general level, are called MONADNOCKS.

PENNSYLVANIAN. Next-to-youngest of the seven geologic periods of the Paleozoic ("ancient life") era (see table 5). Rocks of this age occur in eastern Ohio (see figure 8) and contain Ohio's coal.

PERIOD (geologic). Subdivision of a geologic era (for example, the Pennsylvanian period of the Paleozoic era).

PERMIAN. The youngest of the seven geologic periods of the Paleozoic ("ancient life") era (see table 5). Rocks of this age occur along the southeastern edge of Ohio (see figure 8) and are known by miners as the "Upper Barrens."

PERMO-CARBONIFEROUS. Term formerly applied to rocks of the Pennsylvania-Permian transition zone.

PETROLEUM. Unrefined oil and gas (fluid hydrocarbons) as they come from the earth.

PLASTIC. A clay or shale is said to be plastic when it can be molded or shaped when it is wet.

PLEISTOCENE. First of the two subdivisions of the youngest period (Quaternary) of the Cenozoic ("modern life") era (see table 5). This is the Ice Age which began only a million years ago.

POTTSVILLE. The oldest series of rocks in the Pennsylvanian system, extending from the eroded Mississippian surface up to the base of the Homewood sandstone.

PRE-CAMBRIAN. The general term for the first and largest interval of geologic history, for which we have very little information (see table 5). Life apparently appeared only near the end of this interval and consisted only of the simplest forms.

PYRITE. A yellow metallic mineral composed of iron sulfide (FeS_2), commonly called "fool's gold" (see also marcasite).

PYRITIFEROUS. Term used to describe a rock containing pyrite.

Q

QUARTZ. A glassy-looking mineral composed of silica (SiO_2) and forming most of the sand in Ohio's sandstones.

R

RECENT. Most recent subdivision of the youngest period (Quaternary) of the Cenozoic ("modern life") era (see table 5). This is the time since the Ice-Age and the time in which we live.

REDBEDS. A rock type common to the upper part of the Pennsylvanian and the Permian systems. Consists of soft, nonbedded to poorly bedded shale of various colors including red and purple, and gray and green, or, frequently, a mottling of these colors. When dry it is characterized by a hackly to fissile fracture and when wet is semi-plastic. These shales are commonly calcareous, with fresh-water limestone inclusions in the form of knots, nodules, and stringers.

RESIDUAL MANTLE. See mantle.

RIDER COAL BED. A coal deposit above or a split from the main coal and separated from it by a few feet of other strata.

RIPPLE MARKS. An undulating surface produced in sand by wind, currents of water, or agitation of water in wave action.

ROCK SALT. A white mineral composed of sodium chloride (NaCl) which when pure is used as common table salt and which forms as a precipitate when sea water evaporates.

ROOF. The rock overlying a coal; also the ceiling or top surface of a mine.

RUNOFF. That percentage (about a third) of rainfall which leaves an area in surface streams.

S

SANDSTONE. Sedimentary rock composed of cemented sand grains.

SEDIMENT. Deposit of clay, silt, sand, or a mixture of any of these, which usually has settled from water.

SEDIMENTARY ROCK. Rock formed of layers of sediment that have been cemented or compacted into solid bedrock.

SEPTARIA. Concretions with development of crisscrossing sets of joints filled with a material (usually calcite) different from that forming the concretion, thus giving the concretion a polygonal pattern.

SERAL CONGLOMERATE. Old and abandoned name for the Pottsville series.

SERIES. Rocks whose age span that of a single geologic epoch.

SHALE. Sedimentary rock composed of compacted silt and clay and commonly exhibiting a thin-bedded or somewhat fissile quality.

SIDERITE. A gray to brown mineral composed of iron carbonate ($FeCO_3$) formed by precipitation in anaerobic environments.

SILICEOUS. Term used to describe a rock containing a high percentage of silica.

SILT. Material composed of particles between 1/16 and 1/256 mm (between 25/1000 and 1/1000 of an inch) in diameter, i.e., not as fine as clay nor as coarse as sand.

SILTY. Term used for a rock containing silt.

SILURIAN. One of the seven periods of the Paleozoic ("ancient life") era (see table 5). Rocks of this age occur in western Ohio and are composed of magnesium limestone (see figure 8).

SLATE. A metamorphic rock which is hard, thin-bedded, and generally gray to black in color, formed by the metamorphism of shale. There is no true slate exposed in Ohio.

SLICKENSIDES. Polish or scratches on a rock surface made when movement or offsetting of the rocks (faulting) occurs.

SLUMPING. Settling of a mass of mantle or weathered bedrock when it becomes unsupported below, as often happens when a stream undercuts its bank.

SMUT. A thin zone of carbonaceous clay or shale which marks the position of a coal bed.

SOIL. That portion of the mantle or bedrock near the surface which has been altered by the effects of weathering and vegetation.

STAINING. A surface film, deposited by water percolating along bedding planes, joints, and fractures, that is of different color and/or composition than that of the host rock.

STARCH-LIKE FRACTURE . See hackly.

STIGMARIA. Rhizomes (form of root) of Pennsylvanian plants, frequently preserved in an underclay.

STRATA. Layers or beds of sedimentary rock (singular: stratum).

STRATIGRAPHER. Geologist who is concerned with the stratigraphy of the rocks.

STRATIGRAPHY. Study of the layers or beds of sedimentary rock, their individual characteristics, and their sequence and age relations.

STREAM PIRACY OR CAPTURE. Change in stream pattern caused by diversion of the upper part of a stream by headward erosion of another stream (for examples, see figures 6 and 7).

STRIKE. Direction of a horizontal line on the surface of a sloping bed or layer of sedimentary rock.

STRIP MINE. A mine which recovers coal, clay, or other valuable mineral resources, by removal of the overburden.

STRUCTURE. 1)Arrangement of the layers of sedimentary rock into anticlines, synclines, faults, etc. 2) Arrangement of the particles of a sedimentary rock into forms such as ripple marks, concretions, etc.

SYNCLINE. A fold in layered (sedimentary) rocks in which the layers are bent downward into the form of a trough.

T

TEAYS RIVER SYSTEM. The river system present in southeastern Ohio during preglacial times. Two major tributaries of this stream were located in Athens County: the Albany and Marietta Rivers. The main Teays River flowed northwest from the central Appalachians to western Ohio and thence apparently across Indiana to the Wabash River and the Mississippi River, finally reaching the Gulf of Mexico.

TERRACE. Flat land in a stream valley, occurring at a higher level than the floodplain (bottom land) and separated from the floodplain by a distinct bluff. Terraces generally represent a level of former fill in a valley.

TEXTURE. Generally refers to the size of the particles making up a sedimentary rock.

TRANSPORTED MANTLE. See mantle.

TYPE AREA. See type locality.

TYPE LOCALITY. The geographic area from which a geologic unit was named.

U

UNCONFORMITY. A surface of erosion or nondeposition that separates younger strata from older rocks which have been deformed.

UNDERCLAY. A clay deposit which occurs below a coal bed or horizon.

UPPER BARREN GROUP. Old and abandoned term for the Dunkard group.

UPPER PRODUCTIVE GROUP. Former term, no longer used, for the Monongahela series.

V

VARIEGATED. Term used to indicate that different colors are present in a sedimentary rock unit.

VITRAIN. The bright, shiny, petrographic ingredient of coal, primarily formed from wood and bark.

VOLATILE MATTER. That portion of coal other than moisture which is driven off when heated.

W

WASHINGTON SERIES. The lower of the two series of the Dunkard group (Permian), which extends from the top of the Waynesburg coal bed to the base of the Jollytown coal bed.

WEATHERING. The break-up and chemical change that takes place in rock exposed to the atmosphere (by air, rain, plants, and temperature change).

Z

ZONE. A specific subdivision of rock that is characterized by some particular rock, mineral, or fossil assemblage.

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APPENDIX

On the following pages is a large selection of measured geological sections which document conclusions and basic geologic data upon which this Athens County report is based. The measured sections are listed by township and by ascending Geological Survey file number under each township. One section (number 14263, p. 591) is from adjacent Hocking County at the Diamond Brick Plant and is frequently referred to in the text. Below is a list of included sections and the page numbers on which they appear.

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ALEXANDER TOWNSHIP

LOCATION KEY: Aal 2 FILE NUMBER: 11247 ELEVATION: 698 Base TOPO MAP: Athens

STATE: Ohio COUNTY: Athens TOWNSHIP: Alexander SECTION: SE¼ NW¼, 36 *

LOCATION: Exposure along creek southward and along road beginning at bend of road.

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
10	Conemaugh	Ames	Ames	Limestone, light gray with yellow or brown stain near surfaces, dense, with numerous crinoids, marine, in two layers, lower one more fossiliferous.			1	2	4	0	112	4
9				Sandstone, light gray to brownish or yellowish stain, fine, micaceous, friable, weathers into layers 1½ inches thick.			2	10			111	2
8		?	?	Covered interval, maroon clay-shale with fine nodules of fresh-water limestone toward top.			68	9	68	9	108	4
7		Anderson	Anderson	Coal, weathered, slumped, thickness uncertain.			0	2	0	2	39	7
6		Anderson and Wilgus ?	Bakerstown and Buffalo ?	Shale, light gray to olive drab with some limonite stain, silty, finely micaceous, poorly exposed and covered upward, probably clay upward.			31	5	31	5	39	5
5		Upper Brush Creek	Upper Brush Creek	Limestone, gray with some limonite stain, dense to partly crystalline, micaceous, sandy, fossiliferous, marine, thickness variable			1	0	8	0	8	0
4				Limestone, light gray to gray with some limonite stain, sandy, micaceous, fossiliferous, marine, nodular or irregular bedded with thin shale partings.			1	0			7	0
3				Shale, light gray to olive drab with some limonite stain, clayey, silty, sandy, and micaceous, with scattered small limestone nodules.			1	9			6	0
2				Limestone, light gray, weathers yellowish brown, sandy, micaceous, fossiliferous.			0	9			4	3
1				Clay shale, light gray with cherry red stain in lower half and some limonite stain above, silty, micaceous, exposed.			3	6			3	6

LOCATION KEY: Aal 3 FILE NUMBER: 11248 ELEVATION: 720 Base TOPO MAP: Pomeroy

STATE: Ohio COUNTY: Athens TOWNSHIP: Alexander SECTION: NW¼, 32

LOCATION: Exposure along southeast side N. Y. C. R. R. and southeast toward hilltop.

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
12	Conemaugh	Ames	Ames	Limestone, light gray, weathering purplish or yellowish brown near surfaces, mostly dense, fossiliferous, marine.			0	7	2	6	77	6
11				Clay shale, light gray with much limonite stain, silty, finely micaceous.			1	4			76	11
10				Sandstone, gray to yellowish brown, fine micaceous, single ledge showing some bedding and cross bedding on weathered surfaces.			0	7			75	7
9				Covered interval.			62	0			75	0
8		Upper Bakerstown	Cow Run	Sandstone, weathered brown, fine to medium, heavy to massive bedded, exposed, unmeasured.			?	?			-	-
7		?	Portersville?	Clay shale, chocolate to reddish brown or maroon, silty, fissile on weathering, upper part poorly exposed.			5	7	5	7	13	0
6		Anderson	Portersville	Limestone, gray to greenish gray, dense with dendrites, nodular, fossiliferous, marine, locally present.			0	7	8	5	7	5
5				Shale, gray, argillaceous, fossiliferous marine.			0	8			6	10
4			Anderson	Coal smut			-	-			6	2
3				Clay, gray to light gray with some limonite stain, micaceous, somewhat plastic. **			0	8			6	2

* In Athens County all of Alexander and Athens Townships and parts of several other townships are unsectioned, but for convenience in designating locations in this bulletin all of Athens County is treated as if it were divided into sections (see page 3).

**Clay and underclay below a coal or coal horizon are used interchangeably in descriptions of this appendix.

LOCATION: Aal 3 FILE NUMBER: 11248 - continued

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
2	Conemaugh (continued)	Anderson (continued)	Bloomfield	Clay shale, gray to gray-brown with some limonite stain, silty, very finely micaceous locally with numerous small fresh-water limestone pellets and nodules in basal part.			5	6			5	6
1			Bakerstown	Sandstone, light gray with limonite stain, fine, micaceous, exposed, unmeasured.			-	-			-	-

LOCATION KEY: Aal 7 FILE NUMBER: 11249 ELEVATION: 695 Base TOPO MAP: Athens

STATE: Ohio COUNTY: Athens TOWNSHIP: Alexander SECTION: N½ NE¼, 28 and S½ SE¼, 29

LOCATION: Along ravine - there are many hematite concretions just above Ames limestone, mostly flattened, some 8-10 inches in length, none found in place.

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
15	Conemaugh	Gaysport ?	Gaysport ?	Shale, clay shale, and limestone, olive drab, argillaceous shale, buff to purplish mottled clay shale containing nodular, light gray to buff fresh-water limestone.			4	6	11	8	85	10
14				Shale, chocolate, maroon, fissile, argillaceous.			7	2			81	4
13		Ames	Ames	Shale, light greenish gray with maroon stain, argillaceous, fossiliferous, marine, with nodular limestone in base, numerous Crurithyris specimens.			1	6	6	8	74	2
12				Limestone, light gray, partly crystalline, fossiliferous, marine.			1	2			72	8
11				Sandstone, light gray to olive drab with some limonite stain, fine, silty, micaceous, thin-bedded, some layers rippled.			2	0			71	6
10				Shale, light gray to olive drab, limonite stained, silty, micaceous			2	0			69	6
9		Harlem?	Round Knob ?	Covered interval with red to maroon soil, slumped blocks of sandstone and Ames limestone, clay shale at top			25	11	25	11	67	6
8		Upper Bakerstown	Upper Bakerstown	Clay, light gray to buff or maroon, numerous small limestone nodules in basal part.			3	0	32	6	41	7
7			Cow Run	Sandstone and shale, light gray with some limonite stain, fine, silty, micaceous, with calcareous nodular masses, shale zones interbedded, bedding somewhat irregular, heavier at top, some layers rippled.			11	6			38	7
6				Shale, light gray, weathers olive drab with some limonite stain, micaceous, silty and sandy upwards and grades into overlying sandstone, few scattered calcareous concretions in upper part.			18	0			27	1
5				Shale, dull chocolate maroon with thin irregular layers light gray to buff, argillaceous, scattered, very small concretions.			4	8	4	8	9	1
4		Anderson	Portersville	Limestone, light gray to greenish gray, dense, nodular, fossiliferous, marine, embedded in light gray, limonitic stained clay.			0	4	4	5	4	5
3				Shale, gray, with some limonite stain, argillaceous, fossiliferous, marine, exposed.			0	6			4	1
2			Anderson	Covered interval, Anderson coal blossom and slumped Portersville shale.			2	4			3	7
1				Clay and clay shale, gray to buff with some limonite stain, slightly silty, exposed.			1	3			1	3

LOCATION KEY: Aal 8 FILE NUMBER: 11250 ELEVATION: 701 Base TOPO MAP: Pomeroy

STATE: Ohio COUNTY: Athens TOWNSHIP: Alexander SECTION: SE¼ SE¼, 33

LOCATION: Exposure along ravine on east side of Margaret Creek.

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
13	Conemaugh	Elk Lick	Birmingham	Clay shale, chocolate maroon to dark red, breaks with starch-like fractures, zones of scattered ferruginous, reddish to green mottled fresh-water nodular limestone, especially at top, exposed.			24	6	32	0	125	6
12			Upper Grafton	Shale, light gray to olive drab, light gray at top, argillaceous, silty, finely micaceous, fossils.			7	6			101	0
11		Duquesne (In lower part Gaysport?)	Skelley	Limestone, greenish gray to olive drab, weathers yellowish brown, sandy, ferruginous, sparingly fossiliferous, marine.			0	5	35	11	93	6
10				Shale, olive drab to light brown, fissile, slightly micaceous, scattered small siderite-hematite concretions up to 6 inches long.			12	1			93	5
9			Duquesne (In lower part Gaysport?)	Coal, smut.			-	-			-	-
8				Underclay, light gray above, buff to olive drab below, maroon at top, calcareous, plastic. *			3	2			81	0
7				Limestone, light gray, nodular, fresh-water, embedded in mottled clay shale.			1	0			77	10
6				Clay shale, mottled maroon and buff, with scattered very small limestone nodules.			19	3			76	10
5		Ames	Ames	Shale, light gray to olive drab, argillaceous with numerous scattered nodules of light gray limestone, especially in basal part, fossiliferous, marine.			2	4	6	10	57	7
4				Limestone, light gray to greenish gray, numerous dendrites, dense to partly crystalline, fossiliferous, marine.			0	8			55	3
3				Sandstone, gray to light brown, weathers dark gray on surface, fine, micaceous, bedded to massive.			3	10			54	7
2		Harlem	Round Knob	Clay shale, chocolate maroon to mottled maroon and buff at top, numerous scattered small limestone nodules, micaceous toward base.			29	0	29	0	50	9
1		Upper Bakerstown	Ewing and Cow Run	Shale, light gray to olive drab, silty, micaceous, with scattered zones of nodular calcareous and sandy masses, partly covered, exposed.			21	9	21	9	21	9

LOCATION KEY: Aal 12 FILE NUMBER: 11251 ELEVATION: 710 (Base of Ames ls) TOPO MAP: Athens

STATE: Ohio COUNTY: Athens TOWNSHIP: Alexander SECTION: NE¼ NW¼, 16

LOCATION: Exposure on east side of road at farm pasture gate at road intersection in NE¼ NW¼, section 16.

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
4	Conemaugh	Ames	Ames	Shale and limestone, light dove gray, laminated, argillaceous shale, fossiliferous in basal part with irregular, small nodules of pale olive, dense limestone upward, exposed.			3	4	7	10	7	10
3				Limestone, light gray with slight limonite stain, dense, massive, nodular at top, fossiliferous, marine.			1	6			4	6
2				Shale, light gray to pale olive with some dark reddish brown stain, argillaceous, calcareous.			0	6			3	0
1				Shale and sandstone, light tan with some limonite stain, silty, micaceous, shale and thin-bedded similarly colored, fine, silty, micaceous sandstone, interbedded, most sandstone near middle of exposure, exposed.			2	6			2	6

* Clay and underclay below a coal or coal horizon are used interchangeably in descriptions of this appendix.

LOCATION KEY: Aal 14 FILE NUMBER: 11252 ELEVATION: 703 ± base TOPO MAP: Pomeroy

STATE: Ohio COUNTY: Athens TOWNSHIP: Alexander SECTION: NE¼ NE¼, 15 and SE¼ SE¼, 16

LOCATION: Exposure along southwest side of stream in NE¼ NE¼, section 15 and SE¼ SE¼, section 16.

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
10	Conemaugh	Elk Lick	Birmingham	Clay shale, maroon, silty, micaceous, laminated, platy, weathering to a sticky clay-like mass, exposed.			3	0	4	6	24	8
9				Clay shale, light gray with considerable limonite and maroon stain, slightly silty, finely micaceous, laminated, thickness variable.			1	6			21	8
8		Duquesne	Skelley	Limestone, greenish gray, weathering dark gray to dark brown, sandy, ferruginous, pyritiferous, a single nodular ledge, fossiliferous, marine.			0	10	20	2	20	2
7				Shale, light gray to gray with considerable limonite stain and crusts along surfaces, argillaceous, finely micaceous, breaks with irregular to starch-like fracture, greenish and silty to sandy in top several inches.			3	6			19	4
6				Clay shale, varicolored, mostly dull maroon but also greenish brown, gray, etc., laminated, rather fissile.			7	6			15	10
5				Clay shale, pale yellowish olive, silty, micaceous, laminated, breaks irregularly to semi-fissile.			0	7			8	4
4			Duquesne	Clay shale, dark gray to black, carbonaceous with thin black films, slickensided, horizon of Duquesne coal ?. Weak seep at this horizon.			0	1			7	9
3				Underclay, gray to dark gray, breaks with starch-like fracture, very slight plasticity.			0	3			7	8
2				Clay shale, pale olive to light gray, silty, finely micaceous, breaks with starch-like fracture, noncalcareous, slickensided, exposed.			0	5			7	5
1				Clay shale and limestone, variegated, mottled light gray, pale greenish, purple, and maroon, silty, finely micaceous, calcareous clay shale with starch-like fracture and with numerous irregular, freshwater limestone nodules scattered throughout but largely in basal half of exposure, exposed. Level of creek.			7	0			7	0

LOCATION KEY: Aal 19 FILE NUMBER: 11253 ELEVATION: 818 base TOPO MAP: Pomeroy

STATE: Ohio COUNTY: Athens TOWNSHIP: Alexander SECTION: SE¼ SW¼, 16 to SW¼ SE¼, 16

LOCATION: Exposure along east-west road beginning three-fourths of a mile west of Pleasanton in SE¼ SW¼, sec. 16, and continuing to church at cemetary on south side of road in SW¼ SE¼, sec. 16.

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
26	Monongahela	Sewickley ?	Lower Sewickley ?	Shale, gray, much limonite stained, very silty, micaceous, breaks irregularly, weathered, grades upward into soil.			10	11	10	11	134	6
25		Fishpot	Fishpot	Limestone, gray to tan with brown stain and crusts, micaceous, compact, impure with calcite films, nodular, embedded in shale.			1	0	24	5	123	7
24			Fishpot or Pomeroy	Sandstone and shale, light tan to pale olive with some limonite stain, fine to medium, silty, micaceous, bedded, shaly appearing sandstone with shaly zones and grading upward into shale.			15	5			122	7
23				Sandstone, light gray, much limonite stained, coarse, arkosic?, massive, somewhat friable, thickness variable, disconformable base.			8	0			107	2

LOCATION: Aal 19 FILE NUMBER: 11253 - continued

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
22	Monongahela continued	Restone	Redstone	Clay shale, light gray with some limonite stain, silty, sparingly micaceous, poorly bedded, breaks in irregular plates.			1	7	42	2	99	2
21				Limestone and shale, light gray with some limonite stain, irregular nodules 1/8 to 6 inches, compact with crystals, limestone embedded in similarly colored, silty, finely micaceous shale, nodular, rather abundant.			5	7			97	7
20			Upper Pittsburgh	Shale, light tan to olive with some limonite stain, silty, finely micaceous, bedded, breaks in platy masses.			6	2			92	0
19				Sandstone, light gray, stained by limonite near surfaces, medium to coarse below, finer near top, massive below, bedded above, micaceous, somewhat friable.			28	10			85	10
18		?	?	Covered interval.			5	0	5	0	57	0
17		Pittsburgh	Pittsburgh	Shale, light gray to gray with considerable limonite stain, argillaceous, slightly silty, numerous fossil plants, exposed.			2	6	6	0	52	0
16				Coal, very much like next coal layer below.			0	3			49	6
15				Clay shale, much like partings below, much limonite stained.			0	2			49	3
14				Coal, alternate bright and dull, thin layers, bony, shaly.			0	4			49	1
13				Clay shale, very much like two partings below but more limonite stained.			0	3			48	9
12				Coal, very similar to that between 48' 0" and 48' 1½".			0	2			48	6
11				Clay shale, very much like that between 47' 7" and 48' 0".			0	3			48	4
10				Coal, much dull and fusain with bright streaks, fossil plants at base.			0	1½			48	1
9				Clay shale, light to full gray with some limonite stain, finely micaceous, numerous fossil plants.			0	5			48	0
8				Coal, much bright with thin dull layers, thinly laminated, weathered.			1	1			47	7
7				"Clay," light tan, much limonite stained, only slightly silty, if at all, little or no lamination, breaks into irregular flattened fragments, exposed.			0	6			46	6
6		?	?	Covered interval.			11	4	11	4	46	0
5		Pittsburgh ?	Lower Pittsburgh ?	Shale, light gray, much stained yellow and brown, silty, slightly micaceous, massive, breaks with irregular fracture, becomes olive drab more micaceous and laminated upward, exposed.			13	6	13	6	34	8
	?											
4	Conemaugh	Upper Little Pittsburgh ?	Upper Little Pittsburgh ?	Limestone and clay (?) shale, irregular nodules, 6-8 inches in maximum diameter, dove gray to purplish, dense except for thin veinlets of calcite, limestone embedded in gray with some maroon, calcareous, rather massive shale, limestone mostly near top.			5	3	5	3	21	2
3		Lower Little Pittsburgh ?	Lower Little Pittsburgh ?	Clay, light gray to white with considerable limonite stain upward, soft, plastic, with numerous small bladed crystals of selenite ?			1	4	15	11	15	11
2			Connellsville ?	Shale, varicolored, light gray to yellow and maroon, mottled in part, silty, sandy, micaceous but mostly with a smooth feel, bedding apparent but not perfectly developed, breaks irregularly more or less parallel to bedding, with some thin-bedded sandstone upward, calcareous in part.			11	9			14	7
1				Sandstone, mostly stained yellow to pale brown, fine-grained, silty, micaceous, thin-bedded, exposed.			2	10			2	10

LOCATION KEY: Aal 20 FILE NUMBER: 11254 ELEVATION: 816 base TOPO MAP: Pomeroy

STATE: Ohio COUNTY: Athens TOWNSHIP: Alexander SECTION: SE¼ NW¼, 4

LOCATION: Exposure in abandoned strip mine and north along road in SE¼ NW¼, section 4.

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
23	Monongahela	?	?	Sandstone, brown to yellow, fine to medium micaceous, massive showing bedding, friable, weathered, exposed.			9	6	9	6	122	10
22				Covered interval.			18	4	18	4	113	4
21		Benwood	Fulton ?	Sandstone and shale, both olive drab with considerable limonite stain, fine, silty, micaceous, thin-bedded sandstone grading upward into silty, micaceous shale.			6	11	19	0	95	0
20			Benwood ?	Limestone and shale, nodular (small), gray with limonite stain, dense, limestone embedded in silty, micaceous calcareous shale, argillaceous near top.			7	3			88	1
19			Upper Sewickley	Sandstone, light gray stained yellow to brown or weathered gray to brown, medium to coarse, micaceous, massive, somewhat friable, becomes finer in top.			4	10			80	10
18		Sewickley	Sewickley	Covered interval with showings of sandy shale and fine-grained, thin-bedded sandstone, especially upward.			27	2	36	0	76	0
17				Limestone and clay shale, light gray with limonite stain, dendrites, dense with crystalline veins, small to large nodules embedded in light gray, calcareous clay shale, exposed.			2	0			48	10
16			Lower Sewickley	Shale and sandstone, olive drab to light gray with some limonite stain, silty to sandy, micaceous shale with few flat limonite concretions, grading upward into similar colored, fine, micaceous, bedded sandstone, thick interval along road, most of thickness above Pomeroy coal.			6	10			46	10
15		Fishpot	Fishpot	Limestone, gray, weathering light gray, dense to finely crystalline, fossiliferous (ostracodes), embedded in clay shale, weathered and slumped, exposed.			4	10	15	4	40	0
14				Limestone, gray, argillaceous, weathering yellow and spongy, weathered and slumped, thickness estimated.			1	6			35	2
13				Clay, varicolored, shades of gray, yellow, and red, tough, plastic, weathered.			0	8			33	8
12			Pomeroy	Shale, light gray to olive drab, with considerable limonite stain, very sandy, silty, micaceous, thin-bedded.			8	4			33	0
11		Redstone	Redstone	Coal, bright with dull streaks near base, mostly dull with bright streaks above, becoming bony upward.			0	6	16	4	24	8
10				Shale, dark gray to black, bony, carbonaceous, coaly.			0	2			24	2
9				Underclay, light gray to gray with some limonite stain, somewhat plastic, slickensided, slightly silty, finely micaceous.			0	5			24	0
8				Clay shale, gray to olive with some limonite stain, silty, finely micaceous, massive, soft, becomes dark gray at top.			1	5			23	7
7				Clay shale and limestone, gray to light gray with some limonite stain, silty, finely micaceous clay shale that breaks into small irregular fragments, with numerous nodules of dense limestone up to 10 inches in diameter, apparently a lens, cannot be traced laterally.			4	9			22	2
6				Shale and limestone, mottled light gray, gray, maroon, purple, silty, slightly micaceous, calcareous, massive shale, breaking irregularly, with scattered irregular nodules of variable gray, dense limestone which weathers gray and brown, limestone mostly in middle part of thickness.			6	3			17	5
5				Shale, mottled light gray and maroon, slight limonite stain, silty, micaceous, massive, breaks irregularly into small fragments.			2	10			11	2

LOCATION: Aal 20 FILE NUMBER: 11254 - continued

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
4	Monongahela - continued	Pittsburgh	Pittsburgh	Shale, light gray near base to dove gray above, with some limonite stain, clayey near base, silty, and micaceous throughout some fossil plants, rather massive, breaks into irregular platy chips.			5	0	8	4	8	4
3				Coal, bright with thin dull partings, slightly bony in part, with both pyrite and fusain.			2	0			3	4½
2				Shale, black, carbonaceous, weathers soft like fusain.			0	0½			1	4½
1				Coal, mostly bright, some flattened pyrite masses.			1	4			1	4
				Underclay, gray to dark gray, exposed			-	-				

LOCATION KEY: Aal 22 FILE NUMBER: 11255 ELEVATION: 897 base TOPO MAP: Pomeroy

STATE: Ohio COUNTY: Athens TOWNSHIP: Alexander SECTION: SE¼ NE¼, 26

LOCATION: Exposure along highwall of abandoned strip mine.

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
24	Monongahela	Fishpot	Pomeroy	Sandstone, light gray with considerable limonite stain and some case hardening, fine to medium, micaceous, friable, massive showing some bedding on weathered surfaces, exposed.			22	6	22	6	48	6
23		Redstone	Redstone (Pomeroy)	Coal, bright, blocky, weathered (6).	0	0½	1	3	19	2	26	0
22				Shale, black and gray.	0	0½						
21				Coal, bright, blocky, weathered (5).	0	2						
20				Shale, black, carbonaceous, soft.	0	0½						
19				Coal, bright, blocky (4) .	0	1						
18				Shale, black and gray, soft in part.	0	1						
17				Coal, bright, blocky (3).	0	2						
16				Shale, black, carbonaceous, soft.	0	0½						
15				Coal, bright, blocky (2).	0	5						
14				Shale, black, carbonaceous, soft.	0	0½						
13				Coal, bright, blocky (1).	0	1½						
12			Redstone	Clay shale, gray with considerable limonite stain and crust, slightly silty, micaceous, weathered soft, fossiliferous (gastropods and ostracods).			0	6			24	9
11				Shale, light gray with considerable fine limonite stain, silty, micaceous, massive, breaks irregularly, few small limestone nodules.			3	0			24	3
10				Limestone, gray, weathering light gray or yellowish or brownish, dense with small show of crystalline matter, shale, grains and pebbles show on weathered surfaces large and small nodules in shale.			1	6			21	3
9				Siltstone, light greenish gray, with considerable limonite stain, argillaceous, micaceous with calcareous, ferruginous masses, breaks irregularly.			6	7			19	9
8			Upper Pittsburgh	Sandstone and shale, gray, shaly, fine to medium, micaceous sandstone and similarly colored silty sandy micaceous shale, calcareous masses near base and near middle.			6	4			13	2
7		Pittsburgh	Pittsburgh	Shale, dark gray to black, carbonaceous, locally coaly, argillaceous and micaceous.			0	1	6	10	6	10
6				Clay shale, gray, below to light gray above, slightly silty below, finely micaceous, somewhat plastic at top, breaks irregularly to starch-like fragments.			1	8			6	9

LOCATION: Aal 22 FILE NUMBER: 11255 - continued

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
5	Monongahela - Continued	Pittsburgh - Continued	Pittsburgh - Continued	Shale, gray to dark gray, silty, finely micaceous, moderate bedding.			1	0			5	1
4				Coal, bony, some bright with some pyrite.	0	3	4	1			4	1
3				Coal, bright with numerous thin partings of dull coal and fusain, some pyrite (4)	0	9½						
2				Fusain parting.	0	1½						
1				Coal, bright, blocky, with thin partings of dull coal, fusain pyrite more abundant upwards: 13" (3); 12" (2); 12" (1).	3	1						

LOCATION KEY: Aal 23 FILE NUMBER: 11256 ELEVATION: 813 base TOPO MAP: Pomeroy

STATE: Ohio COUNTY: Athens TOWNSHIP: Alexander SECTION: NE¼ NW¼, 8

LOCATION: Exposure along roads south and west of 882 road junction, NE¼ NW¼, section 8.

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
12	Monongahela	Sewickley and Fishpot ?	?	Covered to top of hill, some evidence of mottled clay shale.			17	0	26	6	150	0
11			Sewickley	Sandstone, weathered to a dark brown, fine to medium-grained, very micaceous, calcareous in part, mostly thin-bedded and shaly appearing.			9	6			133	0
10				Clay shale, maroon to light gray, silty, slightly micaceous, calcareous in part, poorly exposed.			14	0	70	6	123	6
9			Lower Sewickley - Pomeroy ?	Sandstone, light gray, much stained yellowish or brownish, mostly coarse, micaceous massive, showing some bedding and cross-bedding.			38	0			109	6
8				Covered interval.			18	3			71	6
7		Redstone	Redstone	Underclay, light gray to gray, with considerable light limonite stain, silty?, finely micaceous, mixed with loose sand grains and bits of coal, plastic, very tough.	2	0	2	0	18	9	53	3
6			Upper Pittsburgh	Sandstone, olive to yellowish brown with limonite stain, fine to medium, very micaceous, large flakes, mostly thin-bedded except for basal 6-inche ledge below, massive above, friable.	14	9	16	9			51	3
				Clay, mostly gray, with some light gray, much limonite stain, rather plastic, tough.	1	0						
				Sandstone, light gray with limonite stain, medium-grained, micaceous, ferruginous at top with small limonite concretions which weather into pits, thickness variable.	1	0						
5		Pittsburgh	Pittsburgh	Roof shale, clay, slight gray with darker gray zones and limonite stain, local small coal masses, slightly silty, breaks irregularly.			4	0	34	6	34	6
4				Shale, black to dark gray, with coal streaks	0	1	1	10			30	6
				Coal, mostly bright with thin dull streaks and some fusain, more blocky than coal below.	1	2						
				Coal, bright, some fusain, breaks irregularly.	0	7						
3				Underclay, gray to light gray, carbonaceous, somewhat plastic.			0	6			28	8
2				Covered interval.			10	10			28	2
1				Clay shale, varicolored, maroon, mottled with purple, gray, tan, and yellow, finely micaceous, calcareous in part, laminated, breaks irregularly, somewhat plastic.			17	4			17	4

LOCATION KEY: Aal 29 FILE NUMBER: 11260 ELEVATION: 793 Base TOPO MAP: Pomeroy

STATE: Ohio COUNTY: Athens TOWNSHIP: Alexander SECTION: SE¼, 2

LOCATION: Exposure along abandoned road beginning one-half mile southwest of 893 road intersection and extending 0.3 mile west to farm house.

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
14	Monongahela	Benwood	Benwood	Clay shale, weathered, exposed			9	0	22	9	134	9
13			Upper Sewickley	Sandstone, light gray, mostly stained yellow or brown, mostly medium to coarse, micaceous, calcareous in part, massive, friable.			13	9			125	9
12		Sewickley	Sewickley	Shale, variable, tan, olive drab to red, silty or argillaceous, micaceous, thin zone of fissile maroon, poorly exposed.			15	0	28	2	112	0
11				Clay shale and limestone, light gray to yellow or olive drab with much maroon stain, silty, micaceous, calcareous, irregularly breaking shale with numerous small greenish gray limestone nodules, exposed.			4	10			97	0
10			Lower Sewickley	Sandstone, tan to olive drab with some limonite stain, fine, silty, micaceous, thin-bedded.			8	4			92	2
9		Fishpot	Fishpot	Clay shale, light gray to tan or yellow with much maroon stain, silty, finely micaceous weathers somewhat plastic.			6	5	6	5	83	10
8		Fishpot ? and Redstone	Upper Pittsburgh and Fishpot or Pomeroy	Sandstone, light gray, mostly weathered and stained yellow or brown, mostly medium to coarse, coarse at short distance below top, finest at top mostly massive bedded at top, micaceous throughout, argillaceous at top, friable.			53	4	53	4	77	5
7		Pittsburgh	Pittsburgh	Clay shale, gray, with carbonaceous streaks limonitic stained, somewhat soft.			0	3½	24	1	24	1
6				Coal, dull, with bright streaks, some fusain, bony, laminated, much weathered.			0	8			23	9½
5				Coal, bright, breaks irregularly, little dull masses.			0	4½			23	1½
4				Clay shale, gray specked with light flake-like masses, micro-breccia in appearance, sparingly micaceous and fossiliferous (clams).			0	9			22	9
3				Clay shale, gray to light gray with limonite stain and black carbonaceous streaks, silty, micaceous, only slightly plastic.			1	8			22	0
2			Upper Pittsburgh	Clay shale and limestone, light gray with yellow and brown stain, argillaceous, calcareous, with small irregular nodules of gray stained limestone, shale weathers somewhat plastic.			8	2			20	4
1			Lower Pittsburgh	Clay shale, pale yellow with brown and red stain, silty, finely micaceous, flinty in appearance, breaks irregularly to starch-like, massive, exposed.			12	2			12	2

LOCATION KEY: Aal 31 FILE NUMBER: 11262 ELEVATION: 730 base TOPO MAP: Pomeroy

STATE: Ohio COUNTY: Athens TOWNSHIP: Alexander SECTION: NW¼ SE¼, 3

LOCATION: Along east-west run in the NW¼ SE¼ of section 3, east of road junction 982.

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
6	Monongahela	Fishpot	Pomeroy	Clay shale, light gray, weathers somewhat plastic.			1	6	1	6	22	0
5		Redstone	Redstone	Coal, dull with some bright, laminated, weathered.	0	11½	1	2	17	5	20	6
				Clay, gray, soft, weathered, plastic.	0	0½						
				Coal, bony, laminated, with thin bright streaks, weathered.	0	2						
4				Clay, gray, laminated, some coal streaks, somewhat plastic.			0	3			19	4
3			Upper Pittsburgh	Shale, light gray, limonite stained, silty, sandy, micaceous, laminated, coaly streaks near base.			16	0			19	1
2		Pittsburgh	Pittsburgh	Coal, bright, blocky, with thin irregular shaly partings and some pyrite.	0	4	2	9	3	1	3	1
				Shale, dark gray, carbonaceous.	0	3						
				Clay shale.	0	3½						
				Coal, bony.	0	0½						
				Clay shale, light gray, silty, finely micaceous, with numerous fossil plants and thin irregular coal partings.	0	7						
				Coal, bright, blocky, with thin, irregular partings.	1	3						
1				Shale, dark gray, carbonaceous, light gray masses throughout, silty, micaceous, variable thickness.			0	4			0	4

LOCATION KEY: Aal 33 FILE NUMBER: 11264 ELEVATION: 758 base TOPO MAP: Athens

STATE: Ohio COUNTY: Athens TOWNSHIP: Alexander and Lodi SECTION: SW¼ SW¼, 36

LOCATION: Up dead-end road beginning at U. S. Route 33, 100 yards northwest of road junction 758 in the SW¼ SW¼, section 36, Lodi Township and continuing uphill east to the top into Alexander Township.

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
20	Monongahela	Benwood	Sewickley	Sandstone, gray to buff, limonite stained, massive, cross-bedded below, very micaceous, fine to medium-grained, friable.			31	4	39	3	192	0
19				Shale and sandstone, gray to tan, mottled maroon, sandy shale below becoming more sandy, micaceous, and shaly bedded upward.			7	11			160	8
18		Sewickley	Sewickley	Clay, light gray, plastic, limonite stained.			0	2	13	11	152	9
17				Clay shale, greenish gray, with coal flecks.			0	1			152	7
16				Clay shale, gray to dark gray, silty, micaceous.			0	6			152	6
15				Shale and clay shale, silty, some gray to maroon, calcareous, small scattered limestone knots, micaceous, sandy.			4	11			152	0
14			Lower Sewickley	Shale and sandstone, gray to tan, micaceous, argillaceous to silty, laminated, sandy at top, with sandstone ledges in upper 2 feet.			8	1			147	1
13		Fishpot	Fishpot	Clay shale, gray to tan, mottled maroon to greenish, scattered limestone and hematite masses, non-bedded, silty to sandy upwards.			5	8	28	11	139	0
12				Limestone, fresh-water, gray to light gray, limonite stained, nodular, impure.			1	0			133	4
11			Fishpot or Pomeroy	Siltstone, gray to olive gray, limonite stained, micaceous, irregular to non-bedded.			4	7			132	4
10				Shale, gray to tan, limonite stains, silty to sandy upward, poorly exposed and concealed in part.			17	8			127	9

LOCATION: Aal 33 FILE NUMBER: 11264 - continued

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
9	Monongahela - continued	Redstone	Upper Pittsburgh	Sandstone, gray to tan, limonite stained, micaceous, fine to medium, shaly to medium, shaly to massive bedded, cross-bedded.			36	8	36	8	110	1
8		Pittsburgh	Pittsburgh	Roof shale, gray, limonite stained, "soapy" feeling in lower one foot, some plant fossils and scattered carbonaceous fragments in top one foot, with pyrite.			3	6	20	9	73	5
7				Coal, bright, blocky, somewhat bony near top.			0	11			69	11
6				Clay shale, gray, silty to sandy, carbonaceous and calcareous near top.			2	0			69	0
5			Upper Pittsburgh	Limestone, light gray to gray, limonite stained, nodular, fresh-water in shales similar to next below.			11	10			67	0
4			Lower Pittsburgh	Clay shale, maroon, limonite stained, mottled gray to purple above, breaks with a starch-like fracture.			2	6			55	2
3	Conemaugh	Upper Little Pittsburgh	Upper Little Pittsburgh	Clay shale, gray, purple, silty, non-bedded, plant fossils, with coaly streaks near base and top 1 inch plastic. Coal horizon.			2	3	23	3	52	8
2				Clay shale, gray to tan below with scattered purple mottling. Mottling becomes more pronounced upward. Scattered limestone knots and nodules in top 6 feet.			21	0			50	5
1		Lower Little Pittsburgh ?	Connellsville ?	Sandstone, gray to tan, limonite stained, micaceous, fine to medium grained, forms cliffs along U. S. Route 33.			29	5	29	5	29	5

LOCATION KEY: Aal 34 FILE NUMBER: 11265 ELEVATION: 809 base TOPO MAP: Pomeroy

STATE: Ohio COUNTY: Athens TOWNSHIP: Alexander SECTION: NW¼ NE¼ and NE¼ NW¼, 3

LOCATION: Exposure along stream southeast of Pleasanton.

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
	Monongahela	Benwood ?	Sewickley ?	Spring zone across valley, change in gradual to steeper slope.								
16		Sewickley ?	Sewickley ?	Covered interval, float of fine, micaceous sandstone.			6	0	6	0	96	6
15		Sewickley	Lower Sewickley	Shale, tan to olive drab with some limonite stain, argillaceous, silty, very micaceous, exposed.			6	0	21	0	90	6
14				Shale, gray to olive drab, silty, finely micaceous, breaks irregularly to starch-like.			1	8			84	6
13				Sandstone, pale olive drab with some limonite stain, fine, silty, micaceous, thin-bedded to massive upward, limonitic zone at top.			13	4			82	10
12		Fishpot	Fishpot	Clay shale, maroon to pale yellowish, silty, finely micaceous, breaks with starch-like fracture, non-plastic.			3	6	33	9	69	6
11				Shale and sandstone, variable, light bluish gray to light gray, weathering pale olive drab, silty, sandy, micaceous, laminated shale with thin lenticular layers of light gray, limonite stained, fine, silty, micaceous sandstone, one massive ledge of fine, micaceous sandstone 3 feet thick near top.			30	3			66	0
10		Redstone	Redstone	Shale, chocolate brown to maroon, argillaceous, silty, finely micaceous, laminated, breaks into small thin plates, scattered fossil fern leaves throughout.			1	5	24	10	35	9

LOCATION: Aal 34 FILE NUMBER: 11265 - continued

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
9	Monongahela - continued	Redstone - continued	Redstone - continued	Clay, greenish gray below to dark gray above, carbonaceous matter and fossil plants in top part, silty, grainy, finely micaceous, breaks irregularly.			1	2			34	4
8				Limestone, dove gray, weathering lighter gray, dense to very finely crystalline, micaceous, massive, fossiliferous (ostracods)			1	2			33	2
7				Clay shale and limestone, olive drab, silty, very micaceous clay shale, with one local zone of chocolate red shale, weathers generally pale yellowish, calcareous with numerous flattened or irregular small nodules of gray-drab, weathering yellowish, dense, with crystalline masses of limestone, upstream layers of light gray limestone almost fill interval.			4	8			32	0
6				Shale, gray to dark gray, silty, slightly argillaceous, finely micaceous, calcareous grainy appearing, breaks irregularly.			0	10			27	4
5				Clay shale and limestone, variegated light gray, gray, greenish gray, dull, maroon, silty, finely micaceous, calcareous, irregularly bedded, yellowish dense limestone in basal part nodular, white, dense limestone above, most abundant near top.			10	5			26	6
4				Limestone, light gray, weathering drab or yellowish, dense, with few small crystals, heavy irregular bedding, weathers in irregular slabs, fossiliferous (ostracods), top uneven.			5	2			16	1
3		Pittsburgh	Pittsburgh	Clay, light and dark gray, interbedded, contacts rather sharp, between slightly silty, finely micaceous, somewhat plastic, numerous fossil plants in basal several inches, slickensided, thickness variable.			5	0	10	11	10	11
2				Coal, bright, blocky, thin-bedded at top with dull partings, some fusain.	0	2½	3	11			5	11
				Clay shale, light gray to gray, with carbonaceous streaks and fossil plants, finely micaceous, slightly silty, somewhat plastic	0	2½						
				Coal, considerable bright, much dull, numerous fossil plants, somewhat bony and laminated.	0	4						
				Clay shale, light gray with numerous coaly streaks and numerous fossil plants, laminated, weathers plastic.	1	8						
				Coal, bright, blocky with dull and fusain streaks, some small pyrite masses.	0	3						
				Fusain, a thin parting showing woody structures.	0	0¼						
				Coal, bright, blocky, with some full coal and fusain streaks, some small masses of pyrite.	0	2½						
				Fusain, a thin parting showing woody structures.	0	0¼						
				Coal, bright, blocky, with some dull streaks and some pyrite masses.	0	9						
				Shale, gray, with numerous light specks, carbonaceous with thin coal layer at bottom, more or less laminated.	0	3						
1			Upper Pittsburgh	Clay shale and limestone, light gray with some limonite stain along surfaces, silty, micaceous, massive with few slickensides, with scattered large irregular nodules of gray to light gray, dense limestone, small normal fault cutting coal and clay with a throw of almost one foot.			2	0			2	0

LOCATION KEY: Aal 35 FILE NUMBER: 11266 ELEVATION: 766 ± base TOPO MAP: Athens

STATE: Ohio COUNTY: Athens TOWNSHIP: Alexander SECTION: 6

LOCATION: Exposure up stream along abandoned road beginning 1/8 mile north of road junction 776 and running northeast up hollow from northeast corner of Alexander Township into the southeast corner of Athens Township and then into the W½ SW¼, section 31, Canaan Township.

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
13	Monongahela	Redstone	Upper Pittsburgh	Sandstone, gray to tan, limonite stained, shale below, exposed.			25	1	25	1	126	0
12		Pittsburgh	Pittsburgh	Clay, light gray, limonite stained, plastic.			0	3	44	5	100	11
11				Coal, mostly dull with some bright streaks, weathered.			0	4			100	8
10				Clay shale, gray to dark gray and carbonaceous in zones, some coaly streaks.			4	2			100	4
9				Coal, some bright, badly weathered.	0	4½	1	2			96	2
				Clay, light gray, plastic.	0	0½						
				Coal, bright, blocky, weathered.	0	9						
8				Clay shale, gray to dark gray, seemingly more clayey upward.			5	0			95	0
7			Upper and Lower Pittsburgh	Limestone and clay shale, light gray limestone, large nodules, fresh-water, weathering out of gray to tan shale, poorly exposed in part, apparently cuts out a red clay shale with hematite nodules showing further downstream.			33	6			90	0
6	Conemaugh	Upper Little Pittsburgh	Upper Little Pittsburgh	Siltstone, gray to tan, limonite stained, irregular bedded with one prominent bedded zone 2 feet from bottom.			19	2	19	2	56	6
5		Lower Little Pittsburgh ?	Connellsville ?	Clay shale, gray at base, mottled maroon to red above, starch-like fracture, silty.			6	0	14	6	37	4
4				Sandstone, gray to tan, limonite stained, micaceous, massive, very irregular, cuts out coal below and some shale above.			8	6			31	4
3		Little Clarksburg?	Little Clarksburg?	Coal, bright, blocky, quite variable in thickness due to irregular bottom of overlying sandstone from 0 to 12 inches.			0	6	22	10	22	10
2			Clarksburg ?	Clay shale, gray, micaceous, silty, somewhat laminated.			1	0			22	4
1			Morgantown ?	Sandstone, gray to tan, limonite stained, massive, fine to coarse in zones, forms ledge along lower stream, exposed.			21	4			21	4

LOCATION KEY: Aal 6 FILE NUMBER: 11435 ELEVATION: 664 base TOPO MAP: Athens

STATE: Ohio COUNTY: Athens TOWNSHIP: Alexander SECTION: S½ NE¼, 29

LOCATION: Exposure along ravine in S½ NE¼, section 29, Alexander Township, Athens County.

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
14	Conemaugh	?	?	Covered interval to top of hill with shale showing in lower portion and very coarse sandstone and fresh-water limestone near the top, unmeasured.								
13		Gaysport	Gaysport ?	Sandstone, light gray, limonite stained, fine, calcareous, micaceous, cross-bedded on weathered surface, exposed.			10	10	19	3	135	5
12				Covered interval.			8	5			124	7
11		Ames	Ames	Limestone, light gray, some limonite stain, partly crystalline, marine, fossiliferous, two thick layers.			0	11	0	11	116	2
10		Ames and Harlem	Ames, in part	Sandstone, covered in part, and shale ?, light gray, limonite and dark gray stained, fine, micaceous, calcareous, bedded variously from very thin to several inches.			43	0	43	0	115	3
9		Harlem	Saltsburg	Shale, light gray to olive drab, limonite stained, micaceous, sandy, grades upward to thin-bedded sandstone.			10	9	10	9	72	3

LOCATION: Aal 6 FILE NUMBER: 11435 - continued

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
8	Conemaugh - continued	Upper Bakerstown	Ewing	Limestone, light gray, weathers to olive drab or yellowish, dense, nodular, fresh-water.			1	0	14	6	61	6
7			Cow Run	Shale, light gray to olive, limonite stained, becomes sandy upward with some clay near top.			13	6			60	6
6		Anderson	Portersville	Shale, dark gray, marine, fossiliferous.			1	0	1	0	47	0
5			Anderson	Coal, probably slumped, with 1 foot of clay exposed below.			-	-			46	0
4		Wilgus, in part	Buffalo ?	Covered interval showing argillaceous, silty and micaceous shale, slumped coal at 24 feet.			26	5	26	5	46	0
3		Upper Brush Creek	Upper Brush Creek	Limestone, light gray to olive drab, dense, flinty, probably with shaly partings, badly weathered, poorly exposed.			3	6	19	7	19	7
2				Limestone, light gray to light bluish gray, some limonite stain, dense to partly crystalline, locally fossiliferous, marine.			1	1			16	1
1				Shale, sandstone, and siltstone, light gray, limonite stained, sandy, micaceous, shale grading into shaly sandstone and siltstone, heavy sandstone locally near top, exposed.			15	0			15	0

LOCATION KEY: Aal 9 FILE NUMBER: 11436 ELEVATION: 678 ± base TOPO MAP: Athens

STATE: Ohio COUNTY: Athens TOWNSHIP: Alexander SECTION: E½ NE¼, 22

LOCATION: Exposure along road southwest from creek.

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
8	Conemaugh	Duquesne, Gaysport, and Ames	Duquesne, Gaysport, and Ames	Clay shale, mottled buff to maroon with marine fossils in lower part, slumped, mostly poorly exposed, light plastic clay and numerous fresh-water limestone nodules.			26	10	26	10	86	8
7		Ames	Ames	Shale, light gray to olive drab with some limonite stain, argillaceous, silty, calcareous, with small limestone nodules, fossiliferous, marine.			0	5	3	1	59	10
6				Limestone, light gray to light bluish or greenish gray, dense to partly crystalline, in two massive layers, fossiliferous, marine, very fossiliferous at top with many Crurithyris sp.			1	1			59	5
5				Sandstone, and shale, olive drab, very fine silty, micaceous, thin-bedded sandstone grading upward into silty micaceous shale.			1	7			58	4
4		Harlem ?	Round Knob ?	Clay shale, mottled light gray, buff to maroon, poorly exposed.			4	7	4	7	56	9
3		Harlem and Upper Bakerstown ?	?	Covered interval			30	6	30	6	52	2
2		Upper Bakerstown?	Cow Run ?	Sandstone, light gray with considerable limonite stain, fine, silty, micaceous, bedded in flaggy, ripple-marked layers with thin shaly partings and zones, calcareous and massive above.			5	5	21	8	21	8
1				Shale, light bluish gray with considerable limonite stain, silty, sandy, and micaceous with many scattered impure limestone nodules up to 1 foot in diameter, exposed.			18	3			16	3

LOCATION KEY: Aal 13 FILE NUMBER: 11437 ELEVATION: 686 base TOPO MAP: Athens

STATE: Ohio COUNTY: Athens TOWNSHIP: Alexander SECTION: 16-17

LOCATION: Exposure beginning at bridge in SE¼, SW¼, 17, and extending up to abandoned slope mine, E. A. French farm.

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
17	Monongahela	Fishpot	Pomeroy	Sandstone, light gray, much limonite stained, fine, micaceous, bedded, poorly exposed, exposed.			13	9	13	9	235	5
16		Redstone	Redstone	Limestone, light gray to pale olive, dense, nodular, embedded in greenish to yellowish clay shale, limestone nodules decrease in number upward.			2	6	22	1	221	8
15				Limestone, tan, dense, some weathering, spongy, nodular, larger nodules at base, embedded in clay shale.			3	10			219	2
14			Upper Pittsburgh	Shale and sandstone, light gray to pale olive with considerable limonite stain, silty, sandy, micaceous shale interbedded with fine silty micaceous sandstone.			15	9			215	4
13		Pittsburgh	Pittsburgh	Clay, light gray to gray with some limonite stain, somewhat plastic, slumped, weathered.			2	4	9	4	199	7
12				Shale, black, carbonaceous.			2	6			197	3
11				Coal (see section No. 11438 for details)			4	6			194	9
10	Conemaugh	?	?	Covered interval, apparently mostly red shales with few hematite nodules.			158	3	158	3	190	3
9		Gaysport ?	Gaysport ?	Shale and covered interval, light gray, light olive and reddish clay shales, much weathered and slumpted, poorly exposed, exposed.			13	2	13	2	32	0
8		Ames	Ames	Limestone, light gray, slightly stained with traces of dendrites, dense, with crystalline masses and veins at top, fossiliferous, marine, top part very fossiliferous (good fossil collecting).			0	8	16	10	18	10
7				Shale, light gray to pale olive, silty, sandy micaceous, laminated, platy, top part covered.			5	2			18	2
6				Sandstone, light gray, weathered dark on surfaces and considerably limonite stained within, fine to medium, very micaceous, calcareous, massive ledge showing bedding on weathered surfaces, top surface irregularly rippled, few fossils, Calamites, spring zone at base.			1	6			13	0
5				Shale, and covered interval, light gray to pale olive with some limonite stain, silty, sandy, micaceous shale, covered in part.			7	10			11	4
4				Shale, pale olive drab with some slight limonite stain, silty, micaceous, laminated, somewhat fissile, exposed.			1	6			3	6
3		Harlem	Harlem	Shale, dark gray to black, carbonaceous, finely micaceous, laminated.			0	4	2	0	2	0
2				Clay, light gray to gray, somewhat plastic.			0	1			1	8
1			Round Knob	Clay shale, varicolored, light gray with maroon mottling, slightly silty, finely micaceous, breaks with starch-like fracture, exposed.			1	7			1	7

LOCATION KEY: Aal 13A FILE NUMBER: 11438 ELEVATION: 878 base TOPO MAP: Athens

STATE: Ohio COUNTY: Athens TOWNSHIP: Alexander SECTION: 3/4 mile south southeast of "n" in Alexander

LOCATION: Details of Pittsburgh coal on property of J. W. Hull, Athens, Route 1, as taken from small strip pit on hilltop 2-1/2 miles east of Hibbardsville, 3/4 mile south southeast of "n" in Alexander, (1905 ed., Athens topographic map.)

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
12	Monongahela	Redstone	Upper Pittsburgh	Sandstone, gray, micaceous, massive, exposed to hilltop.			15	0	25	10	36	5
11				Shale and sandstone, gray to tan, limonite stained, micaceous.			10	10			21	5
10		Pittsburgh	Pittsburgh	Clay shale, medium gray, micaceous, irregular bottom, much woody interval and many plant fossils, thickness variable.			2	6	10	7	10	7
9				Clay shale, gray, weathers very light gray, irregular 2-inch to 11-inch at exposure of coal below.			0	6			8	1
8				Coal, bright, blocky, varies laterally from 0 inches to 6 inches.			0	3			7	7
7				Clay shale, some plant fossils.			0	½			7	4
6				Coal, dull, somewhat shaly.			0	4½			7	3½
5				Clay shale.			0	½			6	11
4				Coal, bright blocky.			1	7			6	10½
3				Clay shale, gray, somewhat carbonaceous.			0	½			5	3½
2				Coal, bright, blocky.			1	3			5	3
1				Clay shale, gray, exposed.			4	0			4	0

LOCATION KEY: Aal 16 FILE NUMBER: 11440 ELEVATION: 685 base TOPO MAP: Athens

STATE: Ohio COUNTY: Athens TOWNSHIP: Alexander SECTION: NE¼ NW¼, 18

LOCATION: Exposure south uphill past road junction 824 to top of hill in section 18.

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
27	Monongahela	Redstone	Upper Pittsburgh	Covered interval with some sandy shales			15	4	15	4	227	0
26		Pittsburgh	Pittsburgh	Clay shale, light gray with some carbonaceous flecks, weathered.			0	3	0	8	211	8
25				Shale, carbonaceous, coaly, weathered, coal horizon.			0	1			211	5
24				Clay shale, dark gray, carbonaceous, weathered.			0	4			211	4
23	——?——	Pittsburgh and Upper Little Pittsburgh ?	?	Covered interval with many limestone boulders.			51	0	51	0	211	0
22	Conemaugh	Lower Little Pittsburg ? and Little Clarksburg ?	?	Clay shale and limestone, light gray, nodular, some septarians, dense, freshwater limestone in clayey maroon shale.			68	9	68	9	160	0
21		Little Clarksburg ?	Clarksburg or Morgantown ?	Clay shale, gray to maroon, mottled green to purple, silty, with small scattered limestone nodules, poorly exposed.			17	7	17	7	91	3
20		Elk Lick ?	Elk Lick ?	Clay shale and limestone, gray to tan clay shale containing large scattered nodules of brown-stained limestone.			7	8	28	0	73	8
19				Limestone, gray to tan, with limonite stain nodular, fresh-water, in olive drab to tan clay shale.			1	0			66	0
18			Upper Grafton ?	Covered interval, some large sandstone float blocks in nearby ravine apparently from this interval, possibly interbedded shale and sandstone.			10	0			65	0
17				Shale, gray to olive drab, clayey, sandy in zones, thin-bedded, poorly exposed at top.			9	4			55	0
16		Duquesne	Duquesne	Clay shale, light gray with scattered coaly flecks at base and somewhat carbonaceous upward.			0	7	6	5	45	8
15				Shale, carbonaceous with some coaly material, micaceous, weathered, slumped.			0	1			45	1
14				Shale, blue-gray below to olive drab above, argillaceous, silty, with scattered limestone nodules in top 3 feet and especially in top 6 inches.			5	9			45	0

LOCATION: Aal 16 FILE NUMBER: 11440 - continued

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
13	Conemaugh - continued	Gaysport	Gaysport	Limestone, blue-gray, limonite stained on surfaces, dense to partly crystalline, nodular, very hard.			0	3	6	7	39	3
12				Shale, gray to tan and olive drab at top, limonite stained, argillaceous to silty with some sandy zones, micaceous, thin-bedded			6	4			39	0
11		Ames	Ames	Limestone, gray, dense to partly crystalline, massive ledge, fossiliferous, marine			0	8	20	10	32	8
10				Clay shale, light gray, somewhat calcareous.			1	0			32	0
9				Sandstone, gray to tan, micaceous, fine, thin-bedded, shaly appearing, more massive upward.			8	7			31	0
8				Sandstone, gray, fine to medium, micaceous, massive			8	5			22	5
7				Sandstone, fine, micaceous, thin and cross-bedded.			2	2			14	0
6		Harlem ?	Harlem ?	Covered interval with some dark gray clay shale in places.			3	2	3	2	11	10
5		Harlem	Harlem	Coal, bright, platy, weathered, slumped.			0	4	8	8	8	8
4				Clay, dark gray, somewhat plastic.			0	2			8	4
3			Round Knob ?	Clay shale, gray with limonite stain, silty, finely micaceous.			5	0			8	2
2			Saltsburg	Shale and sandstone, poorly exposed, mostly float on flood plain of small stream, exposed.			3	2			3	2
1				Base of section top of southeast abutment of cement bridge.								

LOCATION KEY: Aal 18 FILE NUMBER: 11442 ELEVATION: 751 ± base TOPO MAP: Pomeroy

STATE: Ohio COUNTY: Athens TOWNSHIP: Alexander SECTION: 1 mi. west of Chase, ½ mi. north of county line

LOCATION: Section north up road from road junction 754.

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
24	Monongahela	Sewickley	Sewickley	Concealed uproad to house, some red to maroon shales weathering out.			14	0	21	4	192	0
23			Lower Sewickley	Sandstone, gray to tan, friable, weathers yellowish, limonite stained, poorly exposed.			7	4			178	0
22		Fishpot	Fishpot	Covered, appears to contain tan clay shales with some maroon mottling.			16	0	23	8	170	8
21				Clay shale and limestone, maroon to dark red shales with nodules of limestone, gray, yellow weathering limestone with a fretted surface, poorly exposed.			7	8			154	8
20		Redstone	Redstone	Coal horizon, poorly exposed, possibly slumped, clay shale, gray with carbonaceous material.			1	0	33	6	147	0
19			Upper Pittsburgh	Shale and sandstone, gray to tan, thin-bedded sandstone in gray shales, micaceous, poorly exposed.			13	10			146	0
18				Sandstone, gray to buff, limonite stained, medium, micaceous.			18	8			132	2
17		Pittsburgh	Pittsburgh	Carbonaceous shale			0	1	33	6	113	6
16				Clay shale, gray, limonite stained.			0	5			113	5
15				Carbonaceous shale.			0	1			113	0
14				Carbonaceous shale, paper thin sheets of plant matter.			0	½			112	11
13				Clay shale, light gray, much limonite staining, some coaly zones.			1	4			112	10½
12				Shale, coaly, weathered.			0	1½			111	6½

LOCATION: Aal 18 FILE NUMBER: 11442 - continued

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
11	Monongahela - continued	Pittsburgh - continued	Pittsburgh - continued	Clay shale, gray to dark gray, much limonite stain, some carbonaceous zones in upper 5 inches, plant fossils.			4	5			111	5
10				Coal, bright,blocky.	0	1½	1	10			107	0
				Carbonaceous shale.	0	0½						
				Coal, bright, blocky.	0	2						
				Coal, bony.	0	2						
				Clay shale, gray.	0	1						
				Coal, bony.	0	1						
				Clay shale, gray.	0	1						
				Coal, bright, blocky, some fusain.	0	3						
				Carbonaceous shale, black.	0	1						
				Coal, bright, blocky.	0	7						
				Carbonaceous shale, black.	0	0½						
				Coal, bright, some iron stained.	0	1½						
9				Clay shale, gray, limonite stained, silty, finely micaceous, irregular bedded, some carbonaceous zones.			2	7			105	2
8			Upper Pittsburgh	Limestone, gray to light gray, nodular in clay shale.			4	4			102	7
7				Shale, gray to tan, weathered yellow to red, sandy, much stained and iron crusted, argillaceous.			18	3			98	3
6	Conemaugh	Lower Little Pittsburgh	Connellsville	Sandstone, gray to tan, shaly, micaceous, poorly exposed.			22	0	44	8	80	0
5				Covered interval			22	8			58	0
4		Little Clarksburg	Little Clarksburg	Coal horizon, clay shale, gray, sandy, weathered and poorly exposed, has numerous coaly streaks.			1	0	35	4	35	4
3			Morgantown	Covered interval.			8	4			34	4
2				Sandstone, gray-green, micaceous, massive, exposed.			12	0			26	0
1				Covered to road junction 754.			14	0			14	0
				Note: Lower 58 feet of section concealed by brush.								

LOCATION KEY: Aal 4 FILE NUMBER: 11482 ELEVATION: 679 base TOPO MAP: Athens

STATE: Ohio COUNTY: Athens TOWNSHIP: Alexander SECTION: NE¼ NW¼, 24

LOCATION: Exposure along route 50 and east along hill.

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
14	Conemaugh	Upper Bakerstown	Cow Run	Shale, olive drab, limonite stained, silty to sandy.			5	0	15	0	51	0
13				Sandstone, light gray, limonite stained, medium, very micaceous, massive, variable.			10	0			46	0
12		?	?	Covered interval and shale, poorly exposed in part.			9	8	9	8	36	0
11		Anderson ?	Portersville ?	Shale and clay shale, light gray to olive drab, limonite stained, micaceous, silty, exposed.			3	0	3	0	26	4
10		Anderson	Anderson	Coal, badly weathered, poorly developed and exposed.			0	1	7	3	23	4
9				Clay, light gray, plastic, limonite stained.			1	6			23	3
8			Bloomfield ?	Shale, olive drab, limonite stained, scattered iron concretions and zones, silty, micaceous.			2	8			21	9
7			Bakerstown	Sandstone, light gray, limonite stained, calcareous at base, nodular appearance on surface at top.			3	0			19	1

LOCATION: Aal 4 FILE NUMBER: 11482 - continued

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
6	Conemaugh - continued	Wilgus	Cambridge	Limestone, light gray, dense to partially crystalline, fossiliferous, marine.			0	3	13	1	16	1
5			Buffalo	Shale and sandstone, olive drab, silty to sandy, micaceous shale with a few fossils at base, containing ferruginous nodules and thin-bedded, limy sandstone near top.			12	10			15	10
4		Upper Brush Creek	Upper Brush Creek	Limestone, light gray, dense, massive ledge, marine, fossiliferous.			1	6	3	0	3	0
3				Limestone, light gray, dense, flinty, weathers brown, marine, fossiliferous.			0	6			1	6
2				Limestone, dark gray, dense, nodular, marine, fossiliferous, thickness variable.			0	3			1	0
1				Shale, gray to olive drab, limonite stained, slightly silty and micaceous, fossiliferous, marine, exposed.			0	9			0	9

LOCATION KEY: Aal 10 FILE NUMBER: 11625 ELEVATION: 685 base TOPO MAP: Athens

STATE: Ohio COUNTY: Athens TOWNSHIP: Alexander SECTION: SW¼, 24

LOCATION: Exposure along ravine and along road to Buck's Speedway and at Speedway.

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
30	Conemaugh	Lower Little Pittsburgh	Connellsville	Sandstone, light gray, weathered yellowish to brownish, fine to medium, micaceous, friable, massive, showing variable bedding on weathered surfaces, base disconformable, thickness variable.			23	7	23	7	202	5
29		Little Clarksburg	Little Clarksburg	Coal, weathered.			0	1	49	3	178	10
28			Clarksburg	Underclay, light gray with some limonite stain, semi-plastic, weathers plastic, silty, calcareous, with numerous nodules of fresh-water limestone, thickness variable.			0	10			178	9
27				Limestone, mostly gray.			1	6			177	11
26				Clay shale, light gray mottled maroon with small pellets and nodules of limestone.			8	6			176	5
25				Clay shale, mottled dull maroon, purple, yellow, light gray, numerous very small limestone nodules in zones, exposed.			18	11			167	11
24			?	Covered interval.			13	7			149	0
23			Morgantown	Sandstone, brown to light tan, fine to medium, micaceous, friable, in layers up to 2 inches thick, exposed.			5	10			135	5
22		Elk Lick	Elk Lick	Clay shale, mottled dull, chocolate, maroon to purple, green, and light gray.			3	11	12	10	129	7
21				Clay shale and limestone, light gray clay shale with numerous nodules of fresh-water limestone, mostly limestone, massive ledge.			1	1			125	8
20			Birmingham ?	Clay shale mottled light greenish gray to maroon and purple, micaceous, breaks with starch-like fracture.			3	5			124	7
19				Clay shale and limestone, mottled purple below to light greenish-gray above with numerous fresh-water, brecciated limestone nodules and layers.			4	5			121	2
18		Duquesne ?	Duquesne ?	Clay shale, mottled dull chocolate maroon, purple, to light yellowish-gray.			6	4	26	5	116	9
17				Clay shale and limestone, maroon at base, light to yellow gray above clay shale with numerous fresh-water limestone nodules.			1	8			110	5
16				Clay shale, mottled purple to light greenish gray, micaceous.			3	8			108	9

LOCATION: Aal 10 FILE NUMBER: 11625 - continued

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
15	Conemaugh - continued	Duquesne - continued	Lower Grafton	Shale and sandstone, variable, light gray to olive drab with some limonite stain, argillaceous to sandy, micaceous shale with several layers of fine, silty, micaceous sandstone, few scattered limonite concretions near top.			14	9			105	1
14		Gaysport ?	Gaysport ?	Clay shale, mottled purple, green, and yellow, finely micaceous, numerous nodules of light gray fresh-water limestone in lower part.			3	8	3	8	90	4
13		Ames ?	Ames ?	Shale, dull chocolate, maroon, mottled buff and mottled green and purple at top, argillaceous, micaceous, fossil ostracods in basal part.			6	6	6	6	86	8
12		Ames	Ames	Shale, light greenish gray with some maroon stain, calcareous, fossiliferous, marine.			1	3	18	5	80	2
11				Limestone, light greenish gray, dense, partly crystalline, fossiliferous, marine, in two massive layers.			1	2			78	11
10				Shale, light gray to light olive drab with some limonite stain, silty, micaceous, nodules of fossiliferous marine limestone (slumped?) in top, breaks with starch-like fracture, thickness variable.			30	0			77	9
		Harlem ?	?						14	0		
9		Upper Bakerstown	Cow Run	Sandstone, light gray, weathers dark gray on surfaces, fine, silty, micaceous, thin flaggy layers, some ripple-marked.			6	10	18	8	47	9
8				Shale and sandstone, light gray, weathers olive drab, silty, sandy, micaceous shale interbedded with thin layers of fine, silty, micaceous sandstone.			11	10			40	11
7		Anderson ?	Portersville ?	Shale, buff to dull chocolate maroon, argillaceous, with scattered small siderite, limonite concretions.			5	6	5	6	29	1
6		Anderson	Portersville	Limestone, light greenish gray, weathers yellowish along fractures, nodular, irregular surfaces, fossiliferous, marine--thickness variable.			0	2	11	0	23	7
5				Shale, gray to dark gray, argillaceous, fossiliferous, marine.			2	0			23	5
4			Anderson	Coal smut.			-	-			21	5
3			Bloomfield	Clay shale, variable light gray to yellow, numerous nodules of fresh-water limestone up to 3 inches in diameter in basal part.			8	10			21	5
2		Wilgus ?	Cambridge ?	Sandstone, light gray, weathers yellowish to brownish, fine, silty, micaceous, small limonite masses throughout, calcareous.			0	10	12	7	12	7
1			Buffalo ?	Shale, light gray, weathers olive drab with considerable limonite stain, silty, micaceous, becomes sandy and has many small limonite nodules at top.			11	9			11	9

LOCATION KEY: Aal 11 FILE NUMBER: 11626 ELEVATION: 666 base TOPO MAP: Athens

STATE: Ohio COUNTY: Athens TOWNSHIP: Alexander SECTION: NW¼ NE¼, 24, Alexander, SW¼ SE¼, 19, Athens

LOCATION: Exposure in ravine located in SE¼, section 19, Athens Township and extending into the NE¼, section 24, Alexander Township.

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
20	Conemaugh	Ames	Ames	Limestone, light to dark gray, dense to partly crystalline, fossiliferous, marine, in two layers.			1	0	6	10	93	6
19				Sandstone, light gray to yellowish brown, fine, micaceous, thin to medium-bedded.			2	2			92	6
18				Shale, light gray with limonite stain, argillaceous, silty, finely micaceous, exposed.			3	8			90	4
17		?	?	Covered interval			14	6	14	6	86	8
16		Harlem	Saltsburg	Sandstone, light gray with brown specks on surfaces, medium to coarse, massive, somewhat friable.			12	7	12	7	72	2
15		?	?	Covered interval.			4	1	4	1	59	7
14		Upper Bakerstown	Cow Run	Clay shale, buff with red mottling, silty to sandy, micaceous, exposed.			3	5	26	0	55	6
13				Covered interval.			6	3			52	1
12				Shale, buff to olive drab, stained in dark brown blotches on surfaces, silty, finely micaceous.			11	4			45	10
11				Shale, gray to red-brown, argillaceous, micaceous, with scattered ferruginous masses.			5	0			34	6
10		Anderson	Portersville	Shale, light gray with limonite stain, argillaceous, fossiliferous, marine.			1	0	12	9	29	6
9				Limestone, gray to light gray, nodular, fossiliferous, marine.			0	3			28	6
8				Clay shale, gray to dark gray, finely micaceous, fossiliferous, marine.			2	0			28	3
7			Anderson	Coal smut.			-	-			26	3
6			Anderson and Bloomfield	Clay shale and underclay, buff to red and maroon mottled, clay shale part with starch-like fracture.			6	7			26	3
5			Bakerstown	Shale, olive drab to buff, silty, argillaceous, micaceous.			2	11			19	8
4		Wilgus	Cambridge ?	Limestone, light gray, thickness variable.			0	6	16	9	16	9
3			Buffalo	Shale, light blue-gray with some limonite stain along surfaces, argillaceous to silty, micaceous, with scattered small ferruginous masses.			5	11			16	3
2				Sandstone, light gray with limonite stained surface, fine, silty, calcareous at top, heavy to massive-bedded.			2	5			10	4
1				Shale, light gray with considerable limonite stain on surfaces, argillaceous, silty, micaceous, exposed.			7	11			7	11

AMES TOWNSHIP

LOCATION KEY: Aam 1 FILE NUMBER: 8966 ELEVATION: 722 Base of Ames limestone TOPO MAP: Athens

STATE: Ohio COUNTY: Athens TOWNSHIP: Ames SECTION: SE¼, 31, Ames Twp.; E½ NE¼, 36, Canaan Twp.

LOCATION: Exposure in creek behind house and uphill along road.

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
29	Monongahela	Redstone ?	Redstone ?	Limestone, light gray to buff, impure, dense to partly crystalline, nodular, fossiliferous, fresh-water, weathers with fretted surface in base.			15	9	15	9	227	6
28		Redstone	Redstone	Clay, light gray with some limonite stains, slightly silty, finely micaceous, calcareous with small nodules of fresh-water limestone			1	6	22	11	211	9
27				Shale and clay shale, olive drab mottled reddish to purplish with some maroon and limonite stains, clay shale with starch-like fracture.			9	2			210	3
26				Sandstone, light gray with limonite stain, fine, very micaceous, thin- to medium-bedded.			6	1			201	1
25				Shale, olive drab with some limonite staining, very argillaceous, silty, finely micaceous, scattered limonitic masses along joint planes.			6	2			195	0
24		Pittsburgh	Pittsburgh	Shale, gray to dark gray, argillaceous, silty, micaceous, with fine carbonaceous shreds, coal horizon.			0	2	37	0	188	10
23				Shale and clay shale, olive drab to yellowish brown with maroon mottling and limonite streaks, silty, finely micaceous, with scattered limonitic masses.			6	5			188	8
22			Upper Pittsburgh	Limestone, gray to dark gray, weathering light on surfaces, dense, hard, with some dendrites, somewhat nodular on weathering, fresh-water, thickness variable.			2	3			182	3
21			Lower Pittsburgh	Shale and siltstone, light gray to olive drab, with red, brown, and maroon mottling and much limonite stain at base, finely micaceous, grading upward to silty, micaceous clay shale.			8	1			180	0
20				Clay shale, mottled light gray to greenish gray with some maroon, silty, finely micaceous, calcareous in part and with scattered ferruginous zones, with starch-like fracture, poorly exposed in top.			14	6			171	11
19				Shale, olive drab to buff with limonite stain and brownish black surfaces, argillaceous to silty, finely micaceous, with scattered limonitic concretions, exposed.			5	9			157	5
18	Conemaugh	Upper Little Pittsburgh ?	Upper Little Pittsburgh ?	Covered interval.			9	9	9	9	151	8
17		Upper Little Pittsburgh	Upper Little Pittsburgh	Shale and sandstone, light gray to olive drab with some limonite stain, sandy, micaceous shale grading upward into similarly colored, fine, micaceous, thin to medium-bedded sandstone with some cross-bedding.			7	3	7	3	141	11
16		Lower Little Pittsburgh	Lower Little Pittsburgh	Clay shale and clay, light gray with yellow and maroon mottling and some limonite stain, silty, sandy, micaceous clay shale with starch-like fracture and grading upward into a plastic clay.			6	7	53	3	134	8
15			Connellsville ?	Shale, olive drab with some limonite stain, argillaceous to silty, finely micaceous, exposed.			6	5			128	1
14			Connellsville	Covered interval with slumped mottled maroon clay shale, sandstone, and fresh-water limestone nodules.			13	4			121	8
13				Shale and sandstone, olive drab, argillaceous, finely micaceous shale and argillaceous, silty, micaceous to coarse sandstone with some light clay shale at base.			21	0			108	4
12				Sandstone, light gray with considerable limonite stain, coarse in base to fine and medium above, micaceous, slightly friable, irregularly bedded to massive.			5	11			87	4
11		Little Clarksburg	Clarksburg	Underclay, light gray with some limonite stain, sandy, micaceous, somewhat plastic.			0	8	30	2	81	5

LOCATION: Aam 1 FILE NUMBER: 8966 - continued

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
10	Conemaugh - continued	Little Clarksburg - continued	Morgantown	Sandstone, light gray much stained yellow to reddish brown with some case hardening, basal 6 inches quite ferruginous, medium to coarse with zones of granules and coarse pebbles, friable, massive showing much cross-bedding, bedded at top.			29	6			80	9
9		Elk Lick ?	Upper Grafton ?	Shale, light gray to buff, limonite stained, argillaceous, silty, micaceous, with scattered limonite concretions.			5	3	5	3	51	3
8		Duquesne	Skelley	Limestone, light bluish gray weathering yellow to reddish brown, dense to partly crystalline, nodular, embedded in shale, fossiliferous, marine.			0	6	29	6	46	0
7				Shale, light gray to olive drab with limonite stain, argillaceous, sparingly and finely micaceous, calcareous near top, exposed.			13	0			45	6
6			Duquesne	Covered interval.			5	6			32	6
5				Clay shale, varicolored, mottled maroon to purple, light buff, gray, etc., nodular, fresh-water?, ferruginous limestone near top, exposed.			6	9			27	0
4			Lower Grafton	Shale, olive drab with limonite stain, argillaceous, finely micaceous, poorly exposed.			3	9			20	3
3		Gaysport ?	Gaysport ?	Covered interval			11	6	11	6	16	6
2		Ames	Ames	Limestone, light gray much weathered yellow to reddish brown, dense to partly crystalline, ledge with top weathered platy, fossiliferous, marine.			2	0	5	0	5	0
1				Sandstone, pale yellow to brownish, fine, silty, micaceous, thin-bedded, poorly exposed.			3	0			3	0

LOCATION KEY: Aam 3 FILE NUMBER: 8968 ELEVATION: 708±Base TOPO MAP: Athens

STATE: Ohio COUNTY: Athens TOWNSHIP: Ames SECTION: S½, 5, Dover Twp., SW¼, 35, Ames Twp.

LOCATION: Exposure along road east of Millfield from road junction 701 to road junction 991 and right to top of hill

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
36	Monongahela	Sewickley	Lower Sewickley	Sandstone, light gray to gray, much limonite stained on surfaces, fine, thin to medium-bedded, micaceous, grades laterally into shales. Thickness variable.			19	1	19	1	356	0
35		Fishpot	Fishpot	Coal smut, poorly exposed, possibly slumped			0	1	39	5	336	11
34				Clay, light gray, some limonite stains, plastic.			0	6			336	10
33				Clay shale, light gray to gray with maroon mottling, limonite stains, fissile on weathering, some nodules of light gray, fresh-water limestone, partly covered in center.			29	7			336	4
32				Limestone and shale, light gray to gray, weathers yellow to brown with a fretted appearance on the surfaces, irregularly bedded, dense, impure, nodular, fresh-water limestone embedded in light gray, micaceous argillaceous shales.			9	3			306	9
31		Redstone	Redstone	Clay shale and shale, light gray to buff, limonite stains, silty, micaceous, fissile on weathering, scattered small ferruginous zones and masses.			13	1	16	1	297	6
30			Upper Pittsburgh	Sandstone, light gray to buff, limonite stained on surfaces, fine, micaceous, medium-bedded.			3	0			284	5

LOCATION: Aam 3 FILE NUMBER: 8968 - continued

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
29	Monongahela -	Pittsburgh	Pittsburgh	Coal, smut streak, badly weathered.			0	1	38	8	281	5
28	continued			Clay and clay shale, light gray with some limonite stains, somewhat plastic, clay at top.			1	10			281	4
27			Upper Pittsburgh	Limestone, gray to light gray, limonite stained on surface, dense to partly crystalline, dendritic, nodular, irregularly bedded, fresh-water, embedded in argillaceous shales.			4	0			279	6
26			Lower Pittsburgh	Shale, olive drab to greenish buff, mottled red to maroon and purple, considerable limonite stains throughout, with red and yellow streaks, argillaceous, breaks with a starch-like fracture, flint clay in appearance, with small nodules of fresh-water limestone.			32	9			275	6
25	Conemaugh	Upper or Lower Little Pittsburgh ?	?	Clay shale, light gray to buff, slightly silty, micaceous, thin-bedded.			4	6	7	0	242	9
24				Sandstone, gray to olive drab, limonite stained, fine, thin to medium-bedded, micaceous, shows cross-bedding, forms prominent ledge.			2	6			238	3
23		Little Clarksburg	Clarksburg or Morgantown	Clay shale, gray to greenish gray, limonite stained, mottled red to maroon, silty, finely micaceous, breaks with a starch-like fracture, slickensided surfaces, exposed.			13	0	13	0	235	9
22		?	?	Covered interval with some sandstone and sandy shales exposed in the lower parts.			69	5	69	5	222	9
21		Duquesne	Skelley	Limestone, gray to greenish gray, limonite stains on surfaces, weathers dark brown, nodular, irregularly bedded, impure, fossiliferous, marine.			0	3	18	0	153	4
20			Duquesne and Lower Grafton	Shale, light gray to buff, red to purplish mottling, silty grading to thin-bedded sandy shales above, finely micaceous, somewhat argillaceous.			17	9			153	1
19		Gaysport	Gaysport	Limestone, light gray to greenish or bluish gray, much limonite stained, red mottled, sandy, impure, much weathered on surfaces, no fossils observed.			0	7	14	0	135	4
18				Shale and sandstone, light gray to tan, limonite stained, argillaceous, sandy shales interbedded with fine, micaceous, thin beds of sandstone.			13	5			134	9
17		Ames	Ames	Limestone, light gray to gray, limonite stains on surface, dense to mostly crystalline, massive ledge, fossiliferous, marine.			1	2	16	3	121	4
16				Shale and sandstone, light gray, limonite stained, argillaceous, sandy, shales interbedded with thin, fine, micaceous sandstone layers.			15	1			120	2
15		Hariem	Round Knob	Clay shale and shale, light gray to buff to reddish maroon, scattered fresh-water limestone nodules, poorly exposed in part.			23	1	23	1	105	1
14		Upper Bakerstown	Ewing	Limestone, gray to greenish gray with red mottling, impure, sandy, nodular, fresh-water, irregular-bedded.			0	2	32	0	82	0
13			Cow Run	Shale and sandstone, light gray to tan, limonite stains on surfaces, micaceous, silty, argillaceous in base to sandy upward, contains scattered ferruginous nodules.			21	10			81	10
12		Anderson	Portersville ?	Shale, gray to buff, with maroon mottling, contains some scattered, flat, hematite nodules, variable.			10	0			60	0
11			Portersville	Clay shale and shale, gray to dark gray with some maroon mottling, scattered fossiliferous, marine limestone nodules throughout.			4	0	14	2	50	0
10			Anderson	Coal, bright and blocky, mostly dull with some bright streaks, some thin layers of fusain, badly weathered, possibly slumped.			0	3			46	0
9			Bakerstown	Shale and clay shale, mottled maroon and tan, laterally replaced by calcareous sandstone, poorly exposed.			9	11			45	9

LOCATION: Aam 3 FILE NUMBER: 8968 - continued

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
9	Conemaugh - continued	Wilgus	Cambridge	Limestone, gray to gray-green, limonite stained, grades locally into a calcareous sandstone, impure, micaceous, medium-bedded, fossiliferous, marine.			0	10	22	4	35	10
8			Wilgus	Coal smut, very thin locally, below elevation of 743'.			-	-			-	-
7			Buffalo	Shale, gray to olive drab, limonite stained, argillaceous, silty to very sandy at top.			21	6			35	0
6		Upper Brush Creek	Upper Brush Creek	Shale, light gray to olive drab, limonite stained, argillaceous, silty, finely micaceous, fossiliferous, marine.			2	6	7	1	13	6
5				Shale, light to olive drab, limonite stained, argillaceous, finely micaceous, plant fossils in top part.			4	7			11	0
4		Lower Brush Creek	Lower Brush Creek	Shale and limestone, olive drab to light brown, limonite stained, fossiliferous, marine, shales containing thin, slabby beds of impure, fossiliferous, marine limestone.			0	5	6	5	6	5
3				Limestone, blue gray to dark blue gray, considerable limonite stain on surface, silty, micaceous at base, more pure upward, one massive ledge, fossiliferous, marine.			1	6			6	0
2				Shale, olive drab with limonite stains, silty to very sandy at top, micaceous, calcareous at top.			4	0			4	6
1				Siltstone, buff to light brown, considerably limonite stained, micaceous, fine, thin to medium-bedded, exposed.			0	6			0	6

LOCATION KEY: Aam 4 FILE NUMBER: 8969 ELEVATION: 791± base TOPO MAP: Athens

STATE: Ohio COUNTY: Athens TOWNSHIP: Ames SECTION: NE¼ SW¼, 36

LOCATION: Exposure along old road west from road junction 789.

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
10	Conemaugh	Elk Lick	Upper Grafton	Shale, light gray to olive drab, much limonite stained, argillaceous, silty at base grading upward into clay shale, exposed.			3	11	3	11	50	0
9		Duquesne	Skelley	Limestone, gray to greenish gray with limonite stains, especially at top, very sandy at base grading upward into a pure, nodular, fossiliferous, marine limestone.			1	0	20	1	46	1
8				Shale, light gray to tan, much limonite stained, argillaceous, silty to sandy and thin-bedded upward.			3	9			45	1
7				Sandstone, gray, weathering to dark brown, much limonite stain on surfaces, fine to medium, calcareous, thin to medium-bedded.			0	6			41	4
6			Duquesne	Shale, light gray to buff, red to purplish mottling, argillaceous, sandy upward.			14	10			40	10
5		Gaysport	Gaysport	Limestone, light blue gray to gray, limonite stains on surfaces, sandy, irregular bedded, fossiliferous, marine.			0	2	17	11	26	0
4				Shale, light gray to buff, limonite stained, argillaceous, silty, micaceous, thin-bedded.			17	9			25	10
3		Ames	Ames	Limestone, light gray to gray, limonite stains on surfaces, dense to partially crystalline, massive ledge, fossiliferous, marine.			1	3	8	1	8	1
2				Clay shale, light gray to gray with some limonite stains, weathers to clay, plastic, finely micaceous.			1	3			6	10
1				Sandstone, light gray to gray, limonite stains on surfaces, fine, micaceous, thin to medium heavy bedded.			5	7			5	7

LOCATION KEY: Aam 5 FILE NUMBER: 8970 ELEVATION: 653±base TOPO MAP: Chesterhill

STATE: Ohio COUNTY: Athens TOWNSHIP: Ames SECTION: SE¼ SW¼, 13

LOCATION: Exposure in bank of Mush Run.

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
9	Conemaugh	Duquesne	Skelley	Shale, gray to olive drab, limonite stained, argillaceous, fossiliferous in basal part, marine, exposed.			7	0	26	7	26	7
8				Limestone, blue-gray to olive drab, limonite stained, badly weathered, impure, sandy, irregular ledge, fossiliferous, marine.			1	4			19	7
7				Shale, gray to olive drab, limonite stained, argillaceous to sandy, thin-bedded.			2	7			18	3
6			Duquesne	Clay, light gray, limonite stained, silty, plastic.			0	5			15	8
5				Clay shale, blue, green and maroon, silty, thin-bedded.			0	6			15	3
4				Clay shale, dark gray, carbonaceous, silty, coal horizon?			0	1			14	9
3				Clay shale, maroon to purple to greenish gray in upper part, with small limestone nodules and scattered ferruginous masses.			8	6			14	8
2				Clay, light gray, limonite stained, plastic.			0	2			6	2
1				Clay shale, maroon and blue gray, limonite stained, with small fresh-water limestone nodules, exposed to creek level.			6	0			6	0

LOCATION KEY: Aam 6 FILE NUMBER: 8971 ELEVATION: 758±base TOPO MAP: Athens

STATE: Ohio COUNTY: Athens TOWNSHIP: Ames SECTION: E½ NW¼, 34

LOCATION: Exposure from stream bed and section line between sections 33 and 34, east to road junction 780 and northwest uphill.

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
21	Monongahela	Fishpot ?	Fishpot ?	Clay shale, gray to buff, limonite stains, mottled red to purple, fresh-water limestone, nodules showing, exposed to hill top.			5	4	30	0	254	0
20				Limestone in shale, light gray to gray, stained buff to yellow, weathers with a fretwork, exposed, nodular, dense, impure, fresh-water, irregular bedded in light gray, limonite stained, micaceous shale.			10	8			247	8
19		Redstone	Upper Pittsburgh	Shale and sandstone, light gray to drab, limonite stained, laterally grades into each other, sandstone locally lenticular, micaceous.			14	0	28	11	237	0
18				Sandstone, light gray to buff, limonite stained, medium, micaceous, heavy bedded to massive, somewhat friable, shows cross-bedding on weathered surfaces.			14	11			223	0
17		Pittsburgh	Pittsburgh	Clay, gray to dark gray at top, micaceous, somewhat plastic, coal horizon.			1	0	55	1	208	1
16			Upper Pittsburgh	Limestone, light gray with some limonite stains, dense, crystalline, nodular, irregular beds in shale.			20	3			207	1
15	? Conemaugh		Lower Pittsburgh and Upper Little Pittsburgh ?	Shale, gray to buff, with considerable limonite stains, reddish to purplish to green mottling, yellow to dark red streaks, breaks with starch-like fracture, flinty clay in appearance.			33	10			186	10
14		Lower Little Pittsburgh ?	Connellsville ?	Shale and clay shale, light gray to buff with red and purplish mottling, limonite stains, silty to sandy, micaceous, shale thin-bedded.			22	0	22	0	154	0
13		Little Clarksburg	Clarksburg	Clay and limestone, light gray to dark gray at top, some limonite stains, plastic clay with light gray, limonite stained, nodular fossiliferous, fresh-water limestone interbedded.			3	0			132	0

LOCATION: Aam 6 FILE NUMBER: 8971 - Continued

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
12	Conemaugh - continued	Little Clarksburg - continued	Morgantown	Shale, light gray to tan, limonite stained, silty, micaceous, thin-bedded.			8	0			129	0
11		? Elk Lick	Morgantown and/or Elk Lick	Clay shale, gray to tan, mottled red to purplish, silty, finely micaceous, poorly exposed in part.			56	1	?		121	0
10			Upper Grafton	Sandstone, gray to tan, limonite stained, medium thin to slabby bedded, variable.			3	6			64	11
9				Shale, light gray to tan, limonite stains, micaceous, silty, fissile.			7	0			61	5
8		Duquesne	Skelley	Limestone, dark blue-green with limonite stains on surface, red mottled, dense to crystalline, sandy, irregular bedded, fossiliferous, marine.			1	2	22	8	54	5
7				Sandstone and shale, light gray with much limonite stains on surface in beds up to 10 inches, sandstone interbedded in buff, micaceous, silty, shales, grade laterally into each other.			11	11			53	3
6			Lower Grafton	Shale, light gray to buff, limonite stains, reddish to purplish mottling, silty to sandy upward, micaceous, argillaceous.			9	7			41	4
5		Gaysport	Gaysport	Limestone, blue-gray with much limonite stains, weathering to dark greenish brown, sandy, impure, irregular bedded, fossiliferous, marine.			0	3	14	7	31	9
4				Shale, light gray to tan, limonite stains, argillaceous, silty, micaceous, thin-bedded.			14	4			31	6
3		Ames	Ames	Limestone, light gray to gray, limonite on surface, dense to partly crystalline, fossiliferous, marine.			1	0	16	2	17	2
2				Shale and sandstone, gray to olive drab with some limonite stains, argillaceous, interbedded with thin, micaceous sandstone beds to 2 inches thick.			15	2			16	2
1		Harlem	Round Knob	Clay shale, light gray to tan, mottled red and maroon, breaks with starch-like fracture, exposed.			1	0	1	0	1	0

LOCATION KEY: Aam 7 FILE NUMBER: 8972 ELEVATION: 735±base TOPO MAP: Athens

STATE: Ohio COUNTY: Athens TOWNSHIP: Ames SECTION: E½ SW¼, and the SW¼ SE¼, 33

LOCATION: Exposure up ravine behind old house and uphill to left.

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
19	Monongahela	Redstone	Upper Pittsburgh	Sandstone, gray to buff, some limonite stain fine to medium, micaceous, shows crop bedding on surface, medium to thick-bedded ledge on top of hill.			6	4	6	4	217	4
18		Pittsburgh	Pittsburgh	Shale, gray to dark gray, some limonite stains, argillaceous, micaceous, silty to sandy upward, coal horizon at top.			14	0	21	0	211	0
17			Upper Pittsburgh	Limestone, light gray with some limonite stains, dense to crystalline, nodular in shale, fresh-water, some dendrites.			7	0			197	0
16	? Conemaugh	Pittsburgh and Upper Little Pittsburgh ?	Lower Pittsburgh and Upper Little Pittsburgh ?	Shale and clay shale, gray to buff with maroon to purplish mottling, limonite stained, streaked with red, poorly exposed in part, much weathered on exposures.			52	0	52	0	190	0
15		Lower Little Pittsburgh	Connellsville	Shale and sandstone, gray to tan, limonite stained, sandy shale, interbedded with gray to buff, medium, thin-bedded, scattered micaceous sandstone, poorly exposed and covered in part.			25	9	27	0	138	0
14				Sandstone, gray to buff to blue-green on top, limonite stained, shaly at bottom grading to sandy, impure fresh-water limestone at top, micaceous, medium, medium-bedded, slumped somewhat.			1	3			112	3

LOCATION: Aam 7 FILE NUMBER: 8972

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
13	Conemaugh - continued	Little Clarksburg ?	Morgantown ?	Shale and sandstone, gray to tan, maroon to purplish mottling, sandy shale with interbedded scattered thin-bedded micaceous sandstone layers, poorly exposed.			47	0			111	0
		?	?									
12		Elk Lick	Upper Grafton	Shale, olive drab, limonite stained, argillaceous, silty, finely micaceous, scattered small ferruginous nodules and masses.			17	6	?		64	0
11		Duquesne	Skelley	Limestone, greenish blue, limonite stained, red and maroon mottling, weathers to dark yellow-brown and gray-black, dense to crystalline, weathers with irregular surfaces, marine, fossiliferous, numerous large pelecypods.			0	4	22	5	46	6
10				Shale, gray to buff, limonite stained, sandy to very sandy upward, micaceous, thin-bedded.			11	2			46	2
9			Duquesne	Clay shale and shale, light gray to tan with much limonite stain, mottled maroon to purplish, clay streaks, some slickensided surfaces, micaceous, fresh-water limestone nodules in base.			10	11			35	0
8		Gaysport	Gaysport	Limestone, blue-green with red mottling, brown on weathered surfaces, dense, partly crystalline, somewhat sandy, sparingly fossiliferous, marine.			0	3	13	1	24	1
7				Shale, light gray to olive drab, limonite stain maroon mottled, silty, argillaceous, finely micaceous, thin-bedded.			12	10			23	10
6		Ames	Ames	Limestone, gray to light gray, limonite stains on surface, dense, partly crystalline, massive ledge, fossiliferous, marine.			1	2	11	0	11	0
5				Shale and clay shale, light gray to tan, limonite stains, maroon streaks, sandy in base grading upward to silty, more argillaceous at top, coaly.			4	8			9	10
4				Limestone, gray to blue-gray, mostly crystalline, hard, compact, weathers with nodular surfaces, marine, fossiliferous.			1	8			5	2
3				Shale, light gray to blue-gray, limonite stained, silty, micaceous, argillaceous.			0	9			3	6
2				Sandstone, light gray to buff, some limonite stains, weathers dark brown, fine to medium, micaceous, thin to medium-bedded.			1	0			2	9
1				Clay shale, blue-gray to chocolate brown, limonite stains, slightly silty, finely micaceous, exposed.			1	9			1	9

LOCATION KEY: Aam 8 FILE NUMBER: 8973 ELEVATION: 750± base TOPO MAP: Athens

STATE: Ohio COUNTY: Athens TOWNSHIP: Ames SECTION: NW¼, 32

LOCATION: From the SW¼, to the NW¼ to the SE¼ of the NW¼, section 32, Ames Twp., Athens County, Ohio. From Ames and Dover Townships in two ravines on north side of U. S. Route 50 and up road to road junction 918, then south uphill to 1000 ' contour.

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
25	Monongahela	Sewickley ?	Lower Sewickley ?	Shale, light gray, some limonite stained, argillaceous, silty, micaceous, thin-bedded, exposed to crest of hill.			8	0	8	0	252	11
24		Fishpot	Fishpot	Limestone, light gray, some limonite stains, hard nodular fresh-water, embedded in gray to tan shale.			13	0	23	0	244	11
23				Limestone, gray, buff to yellow brownish, much limonite stains, weathers with fretted appearance, dense, irregular bedded in shale, fresh-water.			10	0			231	11
22		Redstone	Redstone	Shale and clay shale, light gray to buff, limonite stained, silty, micaceous, poorly exposed.			14	6	24	0	221	11

LOCATION: Aam 8 FILE NUMBER: 8973 - continued

No.	Series	Cyclothem	Member	Description	Beu Ft.	Beu In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
21	Monongahela - continued	Redstone - continued	Upper Pittsburgh	Sandstone, light gray to buff, limonite stains on surface, fine, micaceous, very thin to massive-bedded, grading laterally.			9	6			207	5
20	——— ? ——— Conemaugh	Pittsburgh and Upper Little Pittsburgh	Lower Pittsburgh and Upper Little Pittsburgh ?	Shale and sandstone, light gray to buff, limonite stained, sandy, micaceous, shale interbedded with thin to medium beds of shaly micaceous sandstone, poorly exposed in part, variable, much cross-bedding, disconformable base, massive but shows bedding on weathered surfaces.			63	0	63	0	197	11
19		Lower Little Pittsburgh	Connellsville	Sandstone, light gray to tan, limonite stained on surface, fine to medium, micaceous, thin to mostly massive-bedded, cross-bedding shows well on surfaces, variable.			15	3	15	3	134	11
18		Little Clarksburg	Clarksburg	Underclay, light gray, plastic.			0	1	44	8	119	8
17				Coal, impure and much weathered.			0	3			119	7
16				Shale, slate gray, weathers tan to yellowish brown, fossiliferous, soft, argillaceous.			0	3			119	4
15				Limestone, similar to that below except heavier concentrates of limestone nodules and pellets, pellets and nodules become less abundant towards top.			8	6			119	1
14				Clay shale and limestone, olive gray, calcareous with considerable limonite stain, scattered nodules and pellets arranged in layers. Limestone is gray to greenish gray dense with crystalline flakes, fossiliferous, nonmarine.			5	3			110	7
13				Clay shale, varicolored, purplish reds, browns, tans, light grays, calcareous pellets with limestone.			8	8			105	4
12			Morgantown	Sandstone, greenish gray, weathered to brown and yellowish brown, micaceous, fine-bedded, bed of coarse-grained, calcareous, conglomeratic sandstone near middle.			15	6			96	8
11				Shale, and clay shale, light gray to buff, limonite stains, mottled red to purple, silty to sandy, micaceous, exposed.			6	2			81	2
10		Elk Lick	?	Covered interval			10	0	30	3	75	0
9			Birmingham	Shale, light gray to olive drab, limonite stains, mottled red to purplish, argillaceous, silty, micaceous, exposed.			20	3			65	0
8		Duquesne	Skelley	Sandstone, gray to buff, limonite stains on surface, weathers dark brown, medium to coarse, cross-bedded, micaceous, single massive ledge.			2	8	15	10	44	9
7				Shale, gray to tan, limonite stains, micaceous, silty to sandy, upwards, thin-bedded, covered in part.			13	2			42	1
6		Gaysport	Gaysport	Limestone, dark blue-gray to blue-green, limonite stains on surface, weathers dark brown, sandy, impure, sparingly fossiliferous, marine.			0	5	12	11	28	11
5				Shale and sandstone, gray to tan with limonite stains, micaceous, grades laterally from sandy shale to shaly sandstone.			1	0			28	6
4				Shale, light gray to tan, limonite stains, argillaceous, silty, micaceous, contains small scattered limonite nodules, thin-bedded.			11	6			27	6
3		Ames	Ames	Limestone, light gray to gray, limonite stains on surface, dense to crystalline, massive, fossiliferous, marine.			1	8	12	0	16	0
2				Shale, light gray to tan with limonite stains, silty to sandy, argillaceous, micaceous, fissile.			10	4			14	4
1		Harlem	Round Knob	Clay shale and shale, light gray to buff with limonite stains, maroon mottling, silty, micaceous, exposed.			4	0	4	0	4	0

LOCATION KEY: Aam 9 FILE NUMBER: 8974 ELEVATION: 780± base TOPO MAP: Athens

STATE: Ohio COUNTY: Athens TOWNSHIP: Ames SECTION: NE¼ NE¼, 31; SE¼ SE¼, 32

LOCATION: Exposure up abandoned quarry road and along hillside.

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
16	Monongahela	Benwood	Sewickley	Sandstone, light gray to buff, limonite stained, fine, micaceous, massive ledge on hill top.			12	0	12	0	244	0
15		?	?	Covered.			31	0	31	0	232	0
14		Sewickley	Lower Sewickley	Sandstone, gray to buff, limonite stains, weathers yellow brown, micaceous, friable, coarse-grained, exposed.			16	0	16	0	201	0
13		Fishpot	Fishpot	Clay shale, light gray with deep maroon mottling, micaceous, containing fresh-water limestone nodules up to 6 inches, grading into clay at top.			8	0	20	0	185	0
12			Fishpot or Pomeroy	Shale, light gray to tan, limonite stains, sandy, micaceous, thin-bedded.			12	0			177	0
11		Redstone	Redstone	Limestone, gray to dark gray, limonite stains, weathers mottled yellowish brown, fretwork appearance, fresh-water, embedded in reddish brown shale.			7	0	31	5	165	0
10			Upper Pittsburgh	Shale and sandstone, light gray to tan, limonite stained, maroon mottled, micaceous sandy shales and fine, micaceous sandstone layers to 8 inches thick.			24	5			158	0
9		Pittsburgh	Pittsburgh	Coal smut, carbonaceous shale.			0	1	9	7	133	7
8				Clay, dark gray, somewhat plastic			1	0			133	6
7			Upper Pittsburgh	Limestone and shale, gray to dark gray, weathers light gray, some stain, nodular, fresh-water limestone, interbedded in light gray to buff, calcareous shales, nodules up to 3 feet in size, abandoned quarry.			8	6			132	6
6	Conemaugh	Pittsburgh or Upper Little Pittsburgh	Lower Pittsburgh or Upper Little Pittsburgh	Sandstone, gray to blue-green with much limonite stains on surface, fine, micaceous, calcareous, massive, exposed on top and bottom only.			17	10	17	10	124	0
5		Lower Little Pittsburgh	Lower Little Pittsburgh	Clay, light gray to gray, limonite stains, silty, somewhat plastic, micaceous, exposed.			1	0	42	5	106	2
4			Connellsville	Shale and sandstone, light gray to buff, limonite stained, sandy micaceous shales interbedded with fine, micaceous thin-bedded sandstone.			41	5			105	2
3		Little Clarksburg	Clarksburg	Shale, gray to tan, some stained, red-brown to red, argillaceous, silty, finely micaceous, poorly exposed in part.			26	9	63	9	63	9
2			Morgantown	Sandstone, light gray to tan, limonite stains on surface, weathers dark brown, medium to coarse, friable, thin-bedded, shaly top to massive base, micaceous, variable thickness.			23	0			37	0
1				Clay shale and clay, light gray to tan, limonite stained, mottled buff and maroon, micaceous, silty, exposed.			14	0			14	0

LOCATION KEY: Aam 10 FILE NUMBER: 8975 ELEVATION: 708± Base TOPO MAP: Athens

STATE: Ohio COUNTY: Athens TOWNSHIP: Ames SECTION: NE¼ SW¼ and the SE¼ NW¼, 25

LOCATION: Exposure in creek bed, along road and uphill in NE¼ SW¼ and SE¼ NW¼, section 25, Ames Township.

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
8	Conemaugh	Elk Lick	Upper Grafton	Sandstone, light gray to tan, limonite stained, weathers dark brown, coarse, micaceous, massive ledge, poorly exposed at top.			27	0	48	7	83	0
7			Birmingham	Shale, light gray to olive drab, limonite stained, mottled red, silty to argillaceous, finely micaceous, thin-bedded.			21	7			56	0
6		Duquesne	Skelley	Limestone, blue-gray to greenish blue, some red mottling, limonite stains, dense to partly crystalline, nodules and irregular masses embedded in gray to buff, limonite stained, micaceous shale, showing slickensided surfaces, fossiliferous, marine.			6	0	32	0	34	5
5				Shale and sandstone, light gray to tan, limonite stained, argillaceous, finely micaceous shale and thin bed of finely micaceous, fine sandstone in center.			13	5			28	5
4			Duquesne	Clay shale, light gray, mottled tan, blue, green, and maroon, finely micaceous, containing limonite and fresh-water limestone nodules, thin-bedded.			7	4			15	0
3				Clay shale, red to maroon, finely micaceous, thin-bedded, containing septarian, flattened, hematite nodules and masses.			5	3			7	8
2		Gaysport	Gaysport	Limestone, blue-green to greenish gray, mottled red, weathers dark brownish red, nodular and irregular bed, dense, fossiliferous, marine.			0	5	2	5	2	5
1				Clay shale, blue-green to maroon, silty, micaceous, thin-bedded, exposed.			2	0			2	0

LOCATION KEY: Aam 12 FILE NUMBER: 8977 ELEVATION: 710± Base TOPO MAP: Athens

STATE: Ohio COUNTY: Athens TOWNSHIP: Ames SECTION: E½ SE¼, 27

LOCATION: Exposure northeast along road uphill from road junction 690 in E½ SE¼, section 27.

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
14	Conemaugh	Elk Lick	Birmingham	Clay shale, maroon to red, micaceous, slightly silty, fossils.			5	0	5	0	61	0
13		Duquesne	Skelley	Limestone, greenish gray, with red mottling, limonite stained, weathers reddish brown, nodular, irregularly bedded in gray to tan, micaceous shale.			5	9	33	8	56	0
12				Shale, light gray to olive drab, limonite stained, silty to sandy, micaceous, thin-bedded.			8	3			50	3
11			Lower Grafton	Shale and sandstone, light gray to buff, limonite stained, local structure, massive sandstone lens causes slight folding of interbedded shales and thin sandstones above, micaceous.			14	0			42	0
10				Shale, light gray to tan, limonite stained, micaceous, argillaceous, silty upward, thin-bedded.			5	8			28	0
9		Gaysport	Gaysport	Limestone, blue-green, limonite stains, weathers dark brown, dense to finely crystalline, fossiliferous, marine.			0	4	8	7	22	4
8				Shale and sandstone, light gray to buff, limonite stained, micaceous, silty, shale interbedded with thin, fine, micaceous sandstone beds.			8	3			22	0
7		Ames	Ames	Limestone, light gray to gray, limonite stained, dense, hard, massive ledge, fossiliferous, marine.			2	0	5	9	13	9

LOCATION: Aam 12 FILE NUMBER: 8977 - continued

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
6	Conemaugh - continued	Ames - continued	Ames - continued	Shale, light gray to tan, limonite stains, micaceous, silty, fossiliferous, marine.			0	3			11	9
5				Limestone, light gray to gray, limonite stained, dense to partly crystalline, shaly appearing, massive ledge, fossiliferous, marine.			0	4			11	6
4				Shale and sandstone, light gray to buff, micaceous, argillaceous to silty shales, with gray to buff, fine, micaceous sandstone lens of 6 inches to 3 feet in thickness.			1	10			11	2
3				Coal, mostly dull with some bright streaks, small clay parting, poorly developed.			0	3			9	4
2				Clay, light gray to gray, limonite stains, finely micaceous, exposed.			1	1			9	1
1		?	?	Covered below			8	0	8	0	8	0

LOCATION KEY: Aam 13 FILE NUMBER: 8978 ELEVATION: 700± Base TOPO MAP: Athens

STATE: Ohio COUNTY: Athens TOWNSHIP: Ames SECTION: NW¼ NE¼ and N½ NW¼, 28

LOCATION: Exposure in creek bed and along hillside.

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
24	Monongahela	?	?	Covered to hill top			34	0	34	0	335	0
23		Fishpot ?	Fishpot?	Limestone in shale, light gray to gray, weathers light, nodular, dark.			15	0	15	0	301	0
22		Fishpot	Fishpot	Limestone in shale, light gray to buff, weathers yellow to brown with a fretted, appearance, nodular, fresh-water, scattered piece on hillside.			14	0	49	0	286	0
21			Fishpot or Pomeroy	Sandstone, light gray to buff, limonite stains, fine, thin-beded top to massive base.			35	0			272	0
20		Redstone	Redstone	Clay shale, light gray to gray, limonite stained, coal horizon?			1	0	7	0	237	0
19				Limestone and shale, gray to dark gray, limonite stained, weathered white, nodular, fresh-water limestone in gray to tan micaceous shales.			6	0			236	0
18		Pittsburgh	Pittsburgh ?	Coal horizon due here.								
17			Lower Pittsburgh	Shale and clay shale, gray to buff mottled red to purple to maroon, limonite stains, red and yellow streaks, breaks with a starch-like fracture, flint clay in appearance.			38	0	38	0	230	0
16	Conemaugh	Upper Little Pittsburgh	Upper Little Pittsburgh	Clay shale, gray to red to maroon to purple mottled, silty to sandy at top, micaceous.			17	0	17	0	192	0
15		?	?	Covered interval.			25	0	25	0	175	0
14		Little Clarksburg	Morgantown	Shale and sandstone, gray to buff, limonite stained, some maroon mottling, shales interbedded with thin micaceous sandstone.			43	10	43	10	150	0
13		Elk Lick	Upper Grafton	Shale, gray to buff, limonite stained, silty, micaceous, thin-bedded.			24	3	24	3	106	2
12		Duquesne	Skelley	Limestone, dark blue-green to olive drab, limonite stained, weathers to dark brown, very sandy and micaceous.			1	8	28	1	81	11
11			Lower Grafton	Shale and sandstone, light gray to tan, limonite stained, sandy shales, interbedded with thin, fine, micaceous sandstone, ledges covered in part.			26	5			80	3
10		Gaysport	Gaysport	Limestone, blue-green with red mottling, limonite stained, sandy, impure, thin-bedded.			0	7	14	6	53	10
9				Sandstone, gray to buff, limonite stained on surface, fine, micaceous, thin to medium-bedded, calcareous, variable.			2	0			53	3

LOCATION: Aam 13 FILE NUMBER: 8978 - continued

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
8	Conemaugh - continued	Gaysport - continued	Gaysport - continued	Shale, light gray to gran, limonite stained, argillaceous, silty, micaceous, thin-bedded.			11	11			51	3
7		Ames	Ames	Limestone, gray to dark gray, some limonite stains on surface, dense to partly crystalline, massive ledge, fossiliferous, marine.			0	10	17	6	39	4
6				Sandstone and shale, light gray to blue-gray, limonite stained, sandy, micaceous shales interbedded with fine, micaceous, thin to medium-bedded sandstone.			16	8			38	6
5		Harlem	Harlem	Shale, dark gray to gray, limonite stains, silty to sandy upward, micaceous, argillaceous.			8	6	21	10	21	10
4				Clay shale, dark gray to black, thin-bedded, with small pyrite masses and layers.			1	1			13	4
3				Coal, bright, blocky, some dull, fusain at top, contains some visible plant fossils.			0	5			12	3
2				Clay, light gray, some limonite stains, micaceous, fairly plastic.			2	6			11	10
1			Round Knob	Clay shale, gray to tan with limonite stains and maroon mottleing, breaks with a starch-like fracture, micaceous, slickensided surfaces, limonite masses and freshwater nodular limestone near top.			9	4			9	4

LOCATION KEY: Aam 14 FILE NUMBER: 8979 ELEVATION: 933 ± Base TOPO MAP: Athens

STATE: Ohio COUNTY: Athens TOWNSHIP: Ames SECTION: SW¼ NE¼ and E½ NW¼, 30

LOCATION: Composite section in abandoned strip pit and on road along ridge.

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
18	Monongahela	Benwood	Sewickley	Shale, light gray to tan with some limonite and fresh-water nodules.			6	0	6	0	107	8
17		Sewickley	Sewickley	Coal, smutty, badly weathered, poorly developed, exposed at road intersection.			0	1	26	0	101	8
16				Clay, light gray, limonite stained, somewhat plastic.			3	0			101	7
15				Shale and clay shale, light gray to tan, micaceous, silty at base, argillaceous upward.			13	8			98	7
14			Lower Sewickley	Sandstone, gray to buff, limonite stained, weathered to dark brown, micaceous, fine-grained, thin to massive-bedded.			7	3			84	11
13				Clay shale and shale, gray to olive drab, silty to sandy upward, micaceous.			2	0			77	8
12		Fishpot	Fishpot	Coal horizon, carbonaceous shale, poorly developed.			0	1	50	11	75	8
11				Clay shale, dark gray to buff, limonite stained, micaceous, thin-bedded.			1	8			75	7
10				Limestone, in shale, light gray to gray, weathering to lighter, rounded nodules in tan shale.			14	0			73	11
9				Limestone, fresh-water, in shale, gray to light gray, weathers yellow to brown with a fretted appearance, nodular, in maroon shale.			14	4			59	11
8			Fishpot or Pomeroy	Shale and sandstone, light gray to buff, limonite stained, micaceous shales interbedded with fine, thin sandstone layers.			20	10			45	7
7		Redstone	Redstone	Coal, bright, blocky, with dull streaks, and overlain by 2 inches of plastic clay.			0	5	20	9	24	9

LOCATION: Aam 14

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
6	Monongahela - continued	Redstone - Continued	Redstone - continued	Clay shale, dark gray, finely micaceous, starch-like fracture, somewhat carbonaceous.			1	4			24	4
5				Limestone, fresh-water, gray, weathers very light, nodular, dense, irregular zone in shales.			2	0			23	0
4			Upper Pittsburgh	Shale, gray to dark gray, some limonite stain, silty, calcareous with small limestone nodules.			2	0			21	0
3				Sandstone, gray to tan, fine-grained, thin-bedded, micaceous, some cross-bedding.			10	0			19	0
2				Clay shale, light gray to gray, stained, silty to sandy upward, micaceous, weathers into plastic clay, grades laterally into sandy shale or sandstone.			5	0			9	0
1		Pittsburgh	Pittsburgh	Coal, bright, blocky, with some fusain.	1	2	4	0	4	0	4	0
				Clay shale, dark gray.	0	1						
				Coal, bright blocky, with little fusain.	1	3						
				Coal, reported as above, under water, not exposed in bottom of pit.	1	6						

LOCATION KEY: Aam 15 FILE NUMBER: 8980 ELEVATION: 745±base TOPO MAP: Athens

STATE: Ohio COUNTY: Athens TOWNSHIP: Ames SECTION: NE¼ SW¼ and E½ NE¼, 29

LOCATION: Exposure northeast along road to road junction 1009, then left and to top of hill, beginning in the NE¼ SW¼ and extending through the E½ NE¼, section 29.

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
20	Monongahela	Benwood	Benwood	Limestoue in shale, gray to dark gray, some stains, weathers light, fresh-water, nodular, on hill top.			4	7	24	4	298	2
19			Sewickley	Shale, gray to tan, micaceous, contains some small, ferruginous nodules of fresh-water limestone.			19	9			293	7
18		Sewickley	Sewickley (Meigs Creek)	Coal horizon, carbonaceous shale with some dull streaks.			0	3	6	2	273	10
17				Clay shale and shale, light gray to tan, limonite stained, silty, more plastic upward.			3	0			273	7
16				Coal, mostly dull with some bright streaks, badly weathered, poorly developed.			1	11			270	7
15				Clay, light gray, limonite stained, plastic.			1	0			268	8
14		Sewickley and Fishpot	Lower Sewickley and Fishpot	Shale, clay shale, and covered, light gray to olive drab, micaceous, shales and light gray to buff, limonite stained clay.			58	4	58	4	267	8
13		Redstone	Upper Pittsburgh	Sandstone, light gray to buff with limonite stains on surface, fine, micaceous, friable, medium to massive-bedded.			28	10	28	10	209	4
12		Pittsburgh	Pittsburgh	Shale, gray to dark gray, slightly carbonaceous, coal horizon.			1	0	20	1	180	6
11			Lower Pittsburgh	Clay shale, light gray to tan, limonite stained, mottled red to purple, breaks with a starch-like fracture, flint clay in appearance.			19	1			179	6
10	Conemaugh	Upper Little Pittsburgh	Upper Little Pittsburgh	Shale, carbonaceous, silty, coal horizon.			0	1	14	2	160	5
9				Clay shale, gray to dark gray, silty, finely micaceous.			0	11			160	4
8				Limestone and shale, light gray to gray, limonite stained, nodular, fresh-water limestone in light gray, argillaceous, micaceous shales, more weathered and ferruginous at base.			13	2			159	5

LOCATION: Aam 15 FILE NUMBER: 8980 - continued

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
7	Conemaugh - Continued	Elk Lick and Little Clarksburg	Morgantown and/or Upper Grafton	Shale and sandstone, light gray to tan, limonite stained, micaceous shales interbedded with thin, fine, micaceous sandstone in layers up to one foot in thickness, ferruginous.			61	3	61	3	146	3
6		Duquesne	Birmingham ? and Duquesne	Clay shale, and shale, gray to tan, mottled maroon to purplish, micaceous, silty, poorly exposed in part, some fresh-water nodules.			42	6	47	6	85	0
5			Lower Grafton	Sandstone, light gray to buff, limonite stains, fine, micaceous, medium to massive, variable, disconformable base.			5	0			42	6
4		Gaysport	Gaysport	Shale, light gray to olive drab, limonite stained, purplish, argillaceous, finely micaceous, thin-bedded.			12	8	12	8	37	6
3		Ames	Ames	Limestone, gray to light gray, some limonite stained, dense to partially crystalline, massive ledge, fossiliferous, marine, fusulinids.			1	1	24	10	24	10
2				Shale, light gray to tan, limonite stained, micaceous, sandy to silty to argillaceous upward, thin-bedded.			11	9			23	9
1				Sandstone, light gray to buff, some limonite stains, fine, micaceous, massive base to shaly upward, exposed.			12	0			12	0

LOCATION KEY: Aam 18 FILE NUMBER: 8983 ELEVATION: 695±base TOPO MAP: Athens

STATE: Ohio COUNTY: Athens TOWNSHIP: Ames SECTION: E½ SW¼ and E½ NW¼, 22

LOCATION: Exposure along old and new road from creek to hilltop.

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
39	Monongahela	Benwood	Sewickley	Sandstone, gray to buff, limonite stained, thin to shaly bedded, grades laterally into shales, exposed.			15	0	37	10	345	0
38				Shale and sandstone, gray to buff, much limonite stains and many ferruginous zones in sandstone layers, shale somewhat argillaceous, silty, micaceous.			22	10			330	0
37		Sewickley	Sewickley	Clay shale, light gray, limonite stained, mottled maroon to purple in part, silty.			11	0	14	11	307	2
36			Lower Sewickley	Sandstone, gray to buff, limonite stains on surface, fine to medium, micaceous, medium to massive-bedded.			3	11			296	2
35		Fishpot	Fishpot	Clay shale, gray to dark tan, limonite stained, breaks with a starch-like fracture, contains nodular, fresh-water limestone.			20	3	27	3	292	3
34				Clay shale, dark gray to purple, silty, finely micaceous, poorly exposed. 967'			0	6			272	0
33				Clay, light gray to light tan, limonite stains, poorly exposed.			0	6			271	6
32				Clay shale, gray to tan, limonite stained, silty, micaceous, poorly exposed.			6	0			271	0
31		Redstone	Redstone	Limestone in shale, gray to light gray, weathers lighter, nodules dense, fresh-water, embedded in tan, micaceous, argillaceous shale.			11	0	34	3	265	0
30				Limestone in shale, gray to buff, limonite stained, weathered yellow to brown with a fretwork appearance, nodular, fresh-water in mottled maroon clay.			11	0			254	0
29			Upper Pittsburgh	Shale and sandstone, gray to buff, some limonite stains, fine micaceous sandstone layers interbedded with micaceous, argillaceous shales.			11	7			243	0
28				Clay shale, light gray to gray, limonite stained, micaceous, thin-bedded, silty.			0	8			231	5

LOCATION: Aam 18 FILE NUMBER: 8983 - continued

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
27	Monongahela - continued	Pittsburgh	Pittsburgh	Coal horizon, dark gray to black carbonaceous shale.			0	1	10	9	230	9
26				Clay shale, light gray to dark gray upwards.			2	0			230	8
25			Upper Pittsburgh	Limestone in shale, light gray to gray, limonite stained, fresh-water, nodular limestone embedded in buff, micaceous, argillaceous shale.			8	8			228	8
24	?	?	?	Covered interval.			30	0	30	0	220	0
23	Conemaugh	Lower Little Pittsburg and/or Little Clarksburg	Connellsville and/or Clarksburg	Clay shale, gray to tan, limonite stained, mottled red to maroon to yellow-brown, breaks with a starch-like fracture.			39	0	39	0	190	0
22		Little Clarksburg and/or Elk Lick	Morgantown and/or Birmingham	Shale, red to maroon, some limonite stains, silty to sandy, scattered, small, ferruginous, nodules poorly exposed in part.			49	0	58	9	151	0
21				Shale, gray to buff, limonite stained, micaceous, silty to sandy upward, thin-bedded.			9	9			102	0
20		Duquesne	Skelley	Limestone, gray to light blue-gray, limonite stained, mottled red, maroon, brown, and yellow, weathers brown on surface, nodular, irregular, marine, fossiliferous.			0	4	29	11	92	3
19				Shale and sandstone, light gray to tan, limonite stained, micaceous shales, interbedded with fine, micaceous, thin-bedded sandstone layers.			4	5			91	11
18			Duquesne	Clay shale, gray to maroon, some limonite stains, mottled red to purplish, micaceous.			4	9			87	6
17				Limestone, gray to olive drab, limonite stained, mottled red, yellow, and maroon, nodular, dense, embedded in clay shale, fresh-water.			0	6			82	9
16			Lower Grafton	Clay shale, gray to maroon, some limonite stains, mottled red to purplish, micaceous.			0	7			82	3
15				Sandstone, light gray to buff, limonite stains on surface, fine, medium to massive bedded, finely micaceous.			7	2			81	8
14				Shale and clay shale, light gray to tan with limonite stains, ferruginous zones along joints, more argillaceous upward, maroon mottling.			12	2			74	6
13		Gaysport	Gaysport	Limestone, gray to light greenish gray, limonite stained, weathers brown on surfaces, sandy, impure, fossiliferous, marine.			0	7	11	3	62	4
12				Shale, gray to olive drab, limonite stained, ferruginous zones along joint planes, some maroon mottling, argillaceous, finely micaceous.			10	8			61	9
11		Ames	Ames	Limestone, gray to light gray, limonite stained on surface, dense to finely crystalline, massive ledge, fossiliferous, marine.			1	5	11	11	51	1
10				Shale, gray to black, limonite stained, black in bottom to gray above, argillaceous, slightly silty, micaceous.			1	6			49	8
9				Clay, light gray, some limonite stains, somewhat plastic.			0	1			48	2
8				Shale and sandstone, light gray to buff, limonite stained, micaceous shales, interbedded with fine, micaceous sandstone in ledges up to one foot.			7	0			48	1
7				Shale, gray to black, some limonite stains, thin-bedded, slightly silty, finely micaceous.			1	11			41	1
6		Harlem	Harlem	Coal, dull with few bright streaks, soft, much limonite stains.			0	1	11	2	39	2
5				Clay, gray to dark gray, limonite stained, silty, somewhat plastic.			1	0			39	1
4			Saltsburg	Shale and sandstone, light gray to tan, limonite stained, micaceous, shale interbedded with fine, thin, micaceous sandstone layers.			5	1			38	1
3			Rock Riffle and Round Knob	Clay shale and limestone, gray to maroon clay shale interbedded with small light gray nodules of fresh-water limestone.			5	0			33	0

LOCATION: Aam 18 FILE NUMBER: 8983 - continued

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
2	Conemaugh - continued	Upper Bakerstown	Cow Run	Shale, light gray to tan, some limonite stains, micaceous, argillaceous, mottled maroon in base, grading to sandy shale above; top part contains some small sandstone layers.			24	0	28	0	28	0
1				Sandstone, light gray to buff, limonite stained, fine to medium, micaceous, massive, shows cross-bedding.			4	0			4	0

LOCATION KEY: Aam 19 FILE NUMBER: 8984 ELEVATION: 691± base TOPO MAP: Athens

STATE: Ohio COUNTY: Athens TOWNSHIP: Ames SECTION: W½ SE¼ NW¼, 21

LOCATION: Exposure up road and past road junction 770. Type section of Ames coal and limestone.

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
22	Conemaugh	Elk Lick	Upper Grafton	Shale and sandstone, gray, to reddish orange, limonite stained, micaceous, fine, shaly to medium-bedded sandstone in gray to olive drab, micaceous, silty shales, exposed.			15	0	29	4	105	0
21			Birmingham	Clay shale, maroon to red, limonite stained, micaceous, silty.			7	3			90	0
20				Shale, light gray to tan, with limonite stain and mottling red to purple, maroon, argillaceous, micaceous, with irregular beds of nodular fresh-water limestone.			7	1			82	9
19		Duquesne	Skelley	Limestone, gray to greenish gray, weathers yellow to dark brown, nodular and irregular-bedded, badly weathered in part, fossiliferous, marine.			0	4	33	3	75	8
18				Shale and sandstone, light gray to tan and olive drab, limonite stained, thin-bedded, micaceous sandstones in argillaceous, silty shales.			5	4			75	4
17			Duquesne	Clay shale, gray to greenish gray, mottled red to purple and maroon, silty, micaceous.			8	4			70	0
16			Lower Grafton	Sandstone, gray to buff, limonite stained on surfaces, fine, medium to massive-bedded, some cross-bedding, micaceous.			9	5			61	8
15				Shale, gray to tan, limonite stained, argillaceous to silty and sandy upward, micaceous.			3	11			52	3
14				Shale, gray to olive drab, some limonite stains, mottled maroon to purplish, argillaceous, fossiliferous, marine in base.			5	11			48	4
13		Gaysport	Gaysport	Limestone, gray to blue-gray, weathers yellow to brown, nodular, irregular, fossiliferous, marine. 734'			0	4	10	0	42	5
12				Shale, gray to olive drab, limonite stained, mottled maroon to purplish, argillaceous, silty, micaceous.			9	8			42	1
11		Ames	Ames	Limestone, light gray to gray, stained on surface, dense to partly crystalline, massive ledge, fossiliferous, marine. 723'			1	6	12	10	32	5
10				Shale, gray to dark gray, carbonaceous, grades upward to argillaceous, light gray clay shale, silty, micaceous.			1	9			30	11
9				Coal, mostly dull, some bright, limonite stained on bedding planes, shaly with free sulphur and selenite on surfaces, somewhat bony.			0	11			29	2
8				Clay shale and clay, light gray to gray, some limonite stains, micaceous, silty, somewhat plastic.			0	11			28	3
7				Shale and sandstone, light gray to buff, limonite stained, micaceous, sandstone ledges up to 1' in micaceous sandy, thin-bedded shales.			7	9			27	4

LOCATION: Aam 19 FILE NUMBER: 8984 - continued

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
6	Conemaugh - continued	Harlem ?	Harlem ?	Shale, gray to dark gray, some limonite stains, argillaceous, slightly silty, micaceous, variable.			3	0	3	0	19	7
5		Harlem	Harlem	Coal, mostly dull with some bright, soft, fusain, poorly developed.			0	4	16	7	16	7
4				Clay, dark gray to gray, limonite stained, silty, micaceous, somewhat plastic.			0	3			16	3
3			Round Knob	Clay shale, gray-green to olive drab, some limonite stains, micaceous, silty, thin-bedded, slickensided surfaces.			10	6			16	0
2			Saltsburg	Sandstone, gray to olive drab, limonite stained on surfaces, calcareous, weathers to nodule appearance, micaceous.			3	10			5	6
1				Shale, gray to buff, limonite stained, micaceous, argillaceous, silty, exposed.			1	8			1	8

LOCATION KEY: Aam 20 FILE NUMBER: 8985 ELEVATION: 640± base TOPO MAP: Athens

STATE: Ohio COUNTY: Athens TOWNSHIP: Ames SECTION: NE¼ SE¼ and SE¼ NE¼, 20

LOCATION: Exposure along road into pasture, Route 50, and uphill along new lane.

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
13	Conemaugh	Little Clarksburg ?	Morgantown ?	Shale and sandstone, gray to tan, limonite stained, silty, argillaceous shales, interbedded with light gray to buff, stained, fine, micaceous, thin-bedded sandstones, exposed.			12	3	12	3	62	4
12		Elk Lick ?	Elk Lick ?	Coal horizon, dark gray, carbonaceous shale.			0	1	3	1	50	1
11				Clay, light gray to gray, limonite stained, silty, micaceous.			0	3			50	0
10			Birmingham ?	Shale, gray to greenish gray, mottled maroon, much limonite stain, argillaceous to silty upward.			2	9			49	9
9		Duquesne	Skelley	Limestone, gray to blue-gray, much stained and weathered dark brown, nodular, irregular.			0	3	23	1	47	0
8			Duquesne	Clay shale, gray mottled, red to maroon to deep purple, silty, contains small nodules of fresh-water limestone and hematite throughout.			19	10			46	9
7				Clay shale, dark gray to maroon, much limonite stained, finely micaceous, silty, contains scattered nodules of limonite and siderite and hematite to 4", hematite also appears as joint fillings.			3	0			26	11
6		Gaysport	Gaysport	Limestone, gray to light blue-gray, limonite stained, nodular, irregular, dense, fossiliferous, marine.			0	3	12	1	23	11
5				Clay shale, dark gray to chocolate-maroon, limonite stained, finely micaceous, silty, contains many scattered, flattened limonite, siderite, and hematite nodules.			11	10			23	8
4		Ames	Ames	Limestone, light gray to gray, much limonite stains, dense to fully crystalline, massive ledge, fossiliferous, marine.			1	5	11	10	11	10
3				Clay shale, light gray to gray, limonite stained, silty, somewhat plastic, finely micaceous.			0	11			10	5
2				Sandstone, light gray to tan, limonite stained on surface, fine, micaceous, medium to massive, bedded irregular.			5	6			9	6
1				Clay shale, gray to tan, mottled maroon, limonite stained, silty to sandy to sandy upward, exposed.			4	0			4	0

LOCATION KEY: Aam 22 FILE NUMBER: 8987 ELEVATION: 648± Base TOPO MAP: Chesterhill

STATE: Ohio COUNTY: Athens TOWNSHIP: Ames SECTION: NE¼ NW¼, 13

LOCATION: Exposure in ravine behind house and to west of abandoned road.

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
8	Conemaugh	Elk Lick	Upper Grafton	Sandstone, light gray to buff, limonite stained, medium to coarse to conglomerate at base, massive at base to thin-bedded upward. Spring at contact with clay below.			39	0	39	0	83	0
7		Duquesne	Skelley ?	Clay, light gray, some limonite stains, somewhat plastic, sandy, micaceous.			3	0	27	9	44	0
6				Shale, light gray to olive drab, limonite stains on surfaces and joint planes, argillaceous, micaceous, silty to sandy upward.			12	6			41	0
5			Duquesne	Clay shale, gray to greenish gray, limonite stained, mottled maroon to purple to blue, contains many nodules, light gray, fresh-water limestone.			12	3			28	6
4		Gaysport	Gaysport	Clay shale, blue-gray to light blue, some limonite stains, micaceous, calcareous sandstone with marine fossils.			1	10	13	3	16	3
3				Clay shale, gray to green, mottled red to maroon, silty, finely micaceous.			11	5			14	5
2		Ames	Ames	Limestone, light gray to gray, limonite stained on surface, dense to partly crystalline, massive ledge, fossiliferous, marine.			1	0	3	0	3	0
1				Shale and sandstone, light gray to tan, micaceous, limonite stained, fine, slabby sandstone grading upward into shale.			2	0			2	0

LOCATION KEY: Aam 23 FILE NUMBER: 8988 ELEVATION: 836± Base TOPO MAP: Chesterhill

STATE: Ohio COUNTY: Athens TOWNSHIP: Ames SECTION: NE¼ NW¼ SE¼, 15

LOCATION: Exposure in abandoned limestone quarry located along hillside.

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
12	Monongahela	Sewickley ?	Lower Sewickley ?	Sandstone, gray to buff, limonite stained, fine, micaceous, thin to slabby bedded, exposed.			2	6	2	6	71	4
11		Fishpot ?	Fishpot ?	Limestone and shale, light gray to gray, hard, dense, nodular limestone embedded in gray to tan shales, poorly exposed and slumped.			18	10	18	10	68	10
10		?	?	Covered interval			10	0	10	0	50	0
9		Fishpot	Fishpot	Limestone, gray to tan, limonite stained, weathers yellow to brown with a fretted appearance, fresh-water, nodular.			6	6	10	2	40	0
8				Underclay and clay shale, light gray to gray, mottled maroon to tan, some limonite stains, light gray clays are plastic, contains scattered minute fresh-water limestone nodules.			3	8			33	6
7		Redstone	Redstone	Clay shale, gray to dark gray, some thin, dull, coaly streaks, locally shows multiple coal streaks. Coal horizon.			0	2	13	5	29	10
6				Underclay, light gray to gray, some limonite streak, plastic.			1	8			29	8
5			Upper Pittsburgh	Shale and sandstone, light gray to buff with some light blue limonite stained, silty shales with interbedded buff, limonite stained, micaceous sandstones in beds up to 10 inches thick.			11	7			28	0
4		Pittsburgh	Pittsburgh	Clay shale, gray to buff, limonite stained, silty, containing small ferruginous nodules.			0	6	16	5	16	5
3				Clay shale, carbonaceous, with some dull thin coaly streaks. Coal horizon.			0	3			15	11

LOCATION: Aam 23 FILE NUMBER: 8988 - continued

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
2	Monongahela - continued	Pittsburgh - continued	Pittsburgh - continued	Clay shale, light gray to gray to dark gray upward, some limonte stained, silty, finely micaceous, fossiliferous, fresh-water in upper 6 inches.			1	8			15	8
1			Upper Pittsburgh	Limestone, light gray to gray, some limonite stains on surface, hard, dense, nodular, fresh-water, irregular-bedded in light gray to tan shales, exposed.			14	0			14	0

LOCATION KEY: Aam 24 FILE NUMBER: 8989 ELEVATION: 799 ± Base TOPO MAP: Chesterhill

STATE: Ohio COUNTY: Athens TOWNSHIP: Ames SECTION: NE¼ NE¼ NE¼, 16

LOCATION: Exposure on hillside behind old house.

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
16	Monongahela	Redstone	Redstone	Limestone, gray to tan, weathering brown to yellow with fretted appearance, nodular, in shale, fresh-water, exposed.			5	0	5	0	65	10
15		Pittsburgh	Pittsburgh	Shale, dark, carbonaceous, with few dull black specks, coal horizon.			0	1	36	11	60	10
14				Underclay, light gray, stained, plastic.			0	8			60	9
13				Shale, gray to olive drab, limonite stained, argillaceous to sandy, micaceous.			2	8			60	1
12				Clay shale, carbonaceous, with small dull streaks.			0	1			57	5
11				Underclay, light gray to gray, limonite stained, somewhat plastic.			0	6			57	4
10				Clay shale, light gray to gray, limonite stained, micaceous, silty upward.			4	4			56	10
9			Upper Pittsburgh	Limestone, light gray to gray, limonite stained, nodular, irregularly bedded, in gray to tan, argillaceous shale, fresh-water.			14	3			52	6
8			Lower Pittsburgh	Clay shale, light gray to buff, mottled red to maroon, limonite stained and streaked with flint clay appearance, with interbedded thin shaly sandstone and scattered ferruginous masses.			14	4			38	3
7	Conemaugh	Upper Little Pittsburgh	Upper Little Pittsburgh	Clay shale, carbonaceous with some dull coaly streaks, coal horizon.			0	1	21	11	23	11
6				Underclay, gray to greenish gray, with limonite stains and some carbonaceous flecks at top.			3	6			23	10
5				Shale, gray to greenish gray, with limonite streaks, argillaceous upward, silty, with fresh-water limestone nodules, especially at top and bottom.			9	6			20	4
4				Sandstone, gray to buff, with some limonite stains and blotches of calcareous efflorescence on surface, micaceous, fine to medium, massive to shaly bedded.			6	4			10	10
3				Clay shale light gray with some limonite stain, silty in base to sandy upward.			2	6			4	6
2		Lower Little Pittsburgh ?	Lower Little Pittsburgh ?	Underclay, light gray, silty, plastic clay with thin carbonaceous streaks, coal horizon.			0	1	2	0	2	0
1			Connellsville ?	Clay shale, gray to buff with maroon to purplish mottling, finely micaceous, with small scattered hematite nodules, exposed.			1	11			1	11

LOCATION KEY: Aam 25 FILE NUMBER: 8990 ELEVATION: 705±base TOPO MAP: Chesterhill

STATE: Ohio COUNTY: Athens TOWNSHIP: Ames SECTION: NW¼ NE¼, 17

LOCATION: Exposure along road and hillside.

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
11	Conemaugh	Elk Lick	Upper Grafton	Shale, light gray to buff, limonite stained, micaceous, sandy, thin-bedded, showing scattered float blocks of medium-bedded sandstone in top, exposed.			10	0	14	10	60	0
10			Birmingham	Clay shale, maroon, silty, containing scattered hematite masses up to 4 inches.			1	10			50	0
9				Shale, gray to buff, limonite stained, argillaceous, silty, finely micaceous, thin-bedded.			3	0			48	2
8		Duquesne	Skelley	Limestone, greenish gray to blue green, limonite stained, much weathered, nodular irregular, fossiliferous, marine.			0	4	22	11	45	2
7				Shale, light gray to tan, limonite stained, argillaceous, silty to sandy upward, micaceous, thin-bedded.			11	4			44	10
6			Duquesne	Clay shale, maroon, silty, calcareous, darker near bottom, contains numerous fresh-water limestone nodules in bottom 2 feet.			6	6			33	6
5			Lower Grafton	Shale, gray to olive drab, limonite stain, ferruginous zones on joint planes, micaceous, thin-bedded, calcareous green sandstone at top with numerous plant fossils.			4	9			27	0
4		Gaysport	Gaysport	Limestone, blue green, much limonite stained, and weathered dark brown, nodular, irregular, fossiliferous, marine.			0	3	10	5	22	3
3				Shale, gray to olive drab, limonite stained, argillaceous, silty to sandy upward, ferruginous stains on joint planes, thin to medium-bedded upward.			10	2			22	0
2		Ames	Ames	Limestone, gray to dark gray, stained on surface, dense to partly crystalline, massive ledge, fossiliferous, marine.			1	10	11	10	11	10
1				Shale and sandstone, gray to buff, maroon mottled, limonite stained, sandy shales with sandstone ledge, gray to olive drab, fine, micaceous, medium to shaly bedded, exposed.			10	0			10	0

LOCATION KEY: Aam 26 FILE NUMBER: 8991 ELEVATION: 674±base TOPO MAP: Chesterhill

STATE: Ohio COUNTY: Athens TOWNSHIP: Ames SECTION: NW¼ NE¼, 18

LOCATION: Exposure along road from road junction 665 northeast to Morgan County line.

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
15	Conemaugh	Little Clarksburg	Morgantown	Shale and sandstone, gray to buff, limonite stained, micaceous, argillaceous shales interbedded, with fine, micaceous, thin to medium-bedded sandstone layers, exposed to crest of hill.			38	0	38	0	153	0
14		Elk Lick	Upper Grafton and Birmingham	Shale, gray to maroon with much red mottling, argillaceous, micaceous, silty to sandy upward.			31	0	39	2	115	0
13				Shale, gray to olive drab, limonite stained, micaceous, sandy, somewhat argillaceous, thin-bedded.			8	2			84	0
12		Duquesne	Skelley	Shale, olive drab, limonite stained, weathers dark brown to blue black, argillaceous, micaceous, silty, fossiliferous, marine.			0	8	28	7	75	10
11				Shale, gray to gray-green, mottled maroon in places and limonite stained, argillaceous silty, micaceous.			4	1			75	2

LOCATION: Aam 26 FILE NUMBER: 8991 - continued

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
10	Conemaugh - continued	Dusquesne - continued	Skelley continued	Clay shale, maroon, mottled darker maroon, silty, micaceous, containing small nodular fresh-water limestone.			8	10			71	1
9			Lower Grafton	Shale and sandstone, gray to tan, limonite stained, micaceous, silty, shales interbedded at top with layers of dark gray-green calcareous sandstone up to 1 inch.			6	10			62	3
8		Gaysport	Gaysport	Limestone, blue gray, weathered red brown to dark yellow brown, sandy, impure, fossiliferous, marine.			0	2	11	5	55	5
7				Shale, gray to olive drab, limonite stains, silty, argillaceous, micaceous, thin bedded.			11	3			55	3
6		Ames	Ames	Limestone, gray to dark gray, stained on surface, dense to partially crystalline, massive ledge, fossiliferous, marine.			1	5	7	0	44	0
5				Sandstone, gray to buff, limonite stained, fine, micaceous, massive below to thin, shaly bedded above.			5	7			42	7
4		Harlem ?	Harlem ?	Shale, greenish gray to olive drab, some staining, argillaceous, silty, micaceous.			18	9	18	9	37	0
3		Harlem	Round Knob	Clay shale, gray to tan and maroon mottled silty, finely micaceous, contains small nodular fresh-water limestone throughout.			12	8	18	3	18	3
2			Saltsburg	Sandstone, gray to tan, limonite stained, fine, massive bed, micaceous, somewhat friable.			2	1			5	7
1				Shale and sandstone, gray to buff, limonite stained, micaceous, shales interbedded with thin, fine sandstone layers.			3	6			3	6

LOCATION KEY: Aam 27 FILE NUMBER: 8992 ELEVATION: 661±base TOPO MAP: Chesterhill

STATE: Ohio COUNTY: Athens TOWNSHIP: Ames SECTION: NE¼ NW¼, 11

LOCATION: Exposure along Route 280 and uphill toward old house.

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
4	Conemaugh	Duquesne	Lower Grafton	Shale and sandstone, gray to tan to buff, limonite stained, silty to sandy, thin-bedded shales interbedded with fine, micaceous, thin-bedded sandstone, contains small clay ironstone nodules , exposed.			27	0	27	0	52	0
3		Gaysport	Gaysport	Facies relationship extending about 100 yards from northwest to southeast. Northwest: Clay shale, gray to tan, with maroon mottling and limonite stains, silty, micaceous with small hematite nodules. Central: Shale and sandstone, gray to buff, limonite stained, ferruginous zones on joint planes, argillaceous, micaceous layers with thin-bedded fine micaceous sandstone layers. Southeast: Sandstone, light gray to buff, limonite stained, with small nodules of hematite, fine to medium above, massive, thin shale partings.			12	7	12	7	25	0
2		Ames	Ames	Limestone, gray to dark gray, limonite stained on surface, dense to partly crystalline, massive ledge, fossiliferous, marine.			1	5	12	5	12	5
1				Shale and sandstone, light gray to blue gray to tan, micaceous, thin-bedded shales interbedded with fine micaceous, thin to medium bedded, cross-bedded sandstone ledges up to 10 feet.			11	0			11	0

LOCATION KEY: Aam 28 FILE NUMBER: 8993 ELEVATION: 834 ± Base TOPO MAP: Chesterhill

STATE: Ohio COUNTY: Athens TOWNSHIP: Ames SECTION: NW¼ NE¼, 12

LOCATION: Exposure in ravine, quarry pit, and old road, beginning in the NW¼ NE¼, section 12, Ames Twp., Athens County, and extending to the SW¼ SE¼, section 7, Homer Twp., Morgan County.

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
25	Monongahela	Little Waynesburg	Uniontown	Shale and sandstone, light gray to tan, limonite stained, micaceous shales interbedded with gray to buff, fine-grained, micaceous, thin-bedded sandstone, exposed to hill top.			15	9	15	9	206	8
24		Uniontown and/or	Uniontown	Coal horizon, carbonaceous shale.			0	1	42	11	190	11
23		Arnoldsburg	Uniontown -	Clay, light gray, somewhat plastic.			2	0			190	10
22			Arnoldsburg ?	Clay shale, with limestone, light gray, maroon shale, with small fresh-water limestone nodules.			11	4			188	10
21				Shale, light gray to buff, argillaceous to silty and sandy upward.			7	6			177	6
20				Limestone in shale, gray to red and purple shale with embedded nodular fresh-water limestone.			16	11			170	0
19				Clay shale, gray black to purplish, silty, finely micaceous, with small fresh-water limestone nodules.			0	9			153	1
18			Fulton ?	Clay shale, gray to greenish gray, limonite stained, finely micaceous, breaks with starch-like fracture			4	4			152	4
17		Benwood ?	Benwood ?	Limestone, fresh-water, light to blue gray, dense, partly crystalline, nodular, in light gray calcareous clay shale.			14	0	59	0	148	0
16				Covered interval.			39	0			134	0
15				Clay shale, gray with maroon mottling, silty, micaceous.			6	0			95	0
14		Sewickley	Sewickley	Coal, dull, soft.			0	1	43	4	89	0
13				Clay, light gray, plastic.			0	3			88	11
12				Shale and sandstone, light gray to buff, argillaceous shale with fine, micaceous thick-bedded sandstones up to 1 inch.			18	8			88	8
11				Covered interval.			14	0			70	0
10				Shale and limestone, gray to greenish gray, argillaceous, micaceous, interbedded with gray nodular fresh-water limestone.			6	3			56	0
9			Lower Sewickley	Sandstone, light gray to blue gray, fine-grained, micaceous, shaly, calcareous at base.			4	1			49	9
8		Fishpot	Fishpot	Limestone, fresh-water, gray to dark gray, limonite stained, weathers yellow to brown with fretted appearance, nodular, embedded in blue argillaceous shale.			18	10	41	2	45	8
7				Shale, light gray to tan with green mottling, silty, micaceous, argillaceous.			6	2			26	10
6				Limestone and shale, light gray, stained, nodular, fresh-water limestone in gray to buff, slightly greenish argillaceous micaceous shale.			10	5			20	8
5			Pomeroy	Sandstone, light gray to buff, limonite stained, very fine, medium-grained, irregular bedded, micaceous.			2	9			10	3
4				Clay shale, light gray to greenish gray, maroon mottled, argillaceous to silty upward, micaceous.			3	0			7	6
3		Redstone	Redstone	Coal, dull, poorly developed.	0	1	0	6	4	6	4	6
				Clay, light gray, plastic.	0	3						
				Coal, dull, with some bright.	0	2						
2				Clay, light gray, mottled blue green, plastic.			1	0			4	0
1				Clay shale, gray to tan, mottled maroon and green, silty, micaceous.			3	0			3	0

LOCATION KEY: Aam 31 FILE NUMBER: 8996 ELEVATION: 781± base TOPO MAP: Chesterhill

STATE: Ohio COUNTY: Athens TOWNSHIP: Ames SECTION: SE¼ NE¼, 9

LOCATION: Exposure up hillside.

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
11	Monongahela	Lower Sewickley or Fishpot or Pomeroy	Lower Sewickley or Fishpot or Pomeroy	Sandstone, light gray to buff, limonite stained, micaceous, fine to medium, massive, exposed.			20	0	56	7	150	0
10				Shale and sandstone, gray to buff, limonite stained, argillaceous shale with interbedded fine micaceous thin-bedded sandstone.			36	7			130	0
9		Redstone ?	Redstone ?	Limestone, light gray to gray with surface stain, nodular, fresh-water, embedded in gray to tan, argillaceous shale.			21	8	21	8	93	5
8		Redstone	Redstone	Limestone, gray to dark gray, weathering brown to yellow with fretted appearance, nodular, fresh-water, embedded in gray to tan shale.			11	3	22	5	71	9
7			Upper Pittsburgh	Shale and sandstone, light to buff, limonite stained with ferruginous stains on joints, argillaceous, silty shale interbedded with fine, thin, micaceous sandstone.			11	2			60	6
6		Pittsburgh	Pittsburgh	Clay shale, carbonaceous, with some dull specks, coal horizon.			0	1	49	4	49	4
5				Clay shale, gray to dark gray, limonite stained, silty.			1	2			49	3
4			Upper Pittsburgh	Limestone and shale, light gray to gray with limonite stained surfaces, nodular, fresh-water limestone irregularly embedded in light gray, stained, argillaceous shale.			17	8			48	1
3			Lower Pittsburgh	Clay shale, gray to buff, mottled red to yellow or maroon, greenish on fresh exposures, breaks with starch-like fracture, flinty in appearance.			13	8			30	5
2				Shale, gray to buff, limonite stained, argillaceous, silty, with scattered small nodules of fresh-water limestone.			4	5			16	9
1				Sandstone, gray to buff, limonite stained, weathering dark to yellowish brown, fine, shaly to slabby bedded, calcareous at top, exposed.			12	4			12	4

LOCATION KEY: Aam 32 FILE NUMBER: 8997 ELEVATION: 653 ± Base TOPO MAP: Chesterhill

STATE: Ohio COUNTY: Athens TOWNSHIP: Ames SECTION: NW¼ NE¼, 8

LOCATION: Exposure along hillside on Route 50A.

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
11	Conemaugh	Lower Little Pittsburgh	Connellsville	Shale and sandstone, light gray to buff, limonite stained, argillaceous, silty, micaceous, shales interbedded with fine micaceous thin to slabby bedded sandstone, exposed.			7	7	7	7	70	0
10		Little Clarksburg	Clarksburg	Clay shale, carbonaceous, with some dull streaks, badly weathered, coal horizon.			0	1	43	11	62	5
9				Clay, gray to light gray, limonite stained, somewhat plastic.			0	5			62	4
8				Limestone, gray to dark gray, limonite stained on surface, dense, nodular, fresh-water, embedded in gray to tan argillaceous shale.			2	3			61	11
7			Morgantown	Shale and sandstone, light gray to buff, limonite stained, argillaceous, silty shales with thin layers of fine micaceous thin-bedded sandstone up to 3 inches. Shale has red baked appearance at top.			21	2			59	8

LOCATION: Aam 32 FILE NUMBER: 8997 - continued

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
6	Conemaugh - continued	Little Clarksburg - continued	Morgantown - continued	Shale and limestone, gray to maroon, limonite stained and mottled red to purple, argillaceous, silty at top, contains scattered nodules of fresh-water limestone throughout. Redbed.			20	0			38	6
5		Elk Lick	Elk Lick	Shale, carbonaceous, with fine coaly specks. Coal horizon.			0	1	9	9	18	6
4				Clay shale, gray to medium gray, silty, slightly plastic.			0	5			18	5
3				Clay shale and limestone, light gray to olive drab, clay shale with two beds of blue-gray, limonite stained nodular limestone up to 4 inches thick.			9	3			18	0
2		Duquesne	Skelley	Limestone, gray to blue gray, limonite stained on surfaces, nodular, irregular, sandy, impure, fossiliferous, marine.			0	5	8	9	8	9
1				Shale and clay shale, light gray to olive drab, limonite and ferruginous stained, silty to sandy upward, fossiliferous exposed.			8	4			8	4

LOCATION KEY: Aam 33 FILE NUMBER: 8998 ELEVATION: 750± Base TOPO MAP: Chesterhill

STATE: Ohio COUNTY: Athens TOWNSHIP: Ames SECTION: NE¼ SW¼ to NW¼ SE¼, 7

LOCATION: Exposure along farm lane uphill from main road.

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
16	Monongahela	Benwood	Sewickley	Shale and sandstone, gray to tan, limonite stained, argillaceous, silty shales interbedded with thin layers of fine, micaceous sandstone, poorly exposed in part.			7	1	7	1	129	8
15		Sewickley	Sewickley	Clay shale, carbonaceous, dark gray, with small dull coaly specks. Coal horizon.			0	1	27	11	122	7
14				Clay shale and clay, light gray, limonite stained, somewhat plastic clay.			1	10			122	6
13			Lower Sewickley	Sandstone, gray to buff, limonite stains on surfaces, medium to coarse, micaceous, massive, ferruginous stains along joint planes.			5	11			120	8
12				Covered in part, poor exposures of clay shale, gray to tan, stained and thin bedded sandy shales.			17	10			114	9
11				Sandstone, gray to dark green gray, limonite stained, fine, massive ledge, micaceous.			2	3			96	11
10		Fishpot	Fishpot	Limestone, light gray to gray, weathers lighter, limonite stains on surface, nodular, fresh-water, irregular-bedded in clay shale.			10	0	35	7	94	8
9			Pomeroy	Shale, light gray to olive drab, limonite stained, silty to sandy upward, micaceous, poorly exposed in part.			25	7			85	0
8		Redstone	Redstone	Limestone, light gray to gray, limonite on surfaces, nodular, irregular, fresh-water.			1	0	24	7	59	1
7				Clay shale, light gray to olive drab, limonite stained, silty, micaceous.			7	4			58	1
6			Upper Pittsburgh	Sandstone, gray to buff, limonite stains on surfaces, fine, micaceous, thin-bedded to shaly in base to medium-bedded upward.			16	3			50	9
5		Pittsburgh	Pittsburgh	Clay shale, light gray to tan, limonite stains, silty, weathers to a light gray plastic clay.			0	11	34	6	34	6
4				Shale, carbonaceous, dark gray to black, badly weathered, poorly developed. Coal horizon.			0	1			33	7
3				Clay, gray to dark gray, limonite stained, silty, plastic.			0	4			33	6

LOCATION: Aam 33 FILE NUMBER: 8998 - continued

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
2	Monongahela - continued	Pittsburgh - continued	Upper Pittsburgh	Limestone, light gray to gray, limonite stained on surface, nodular, irregular bedded in shale, fresh-water.			17	2			33	2
1			Lower Pittsburgh	Clay shale, gray to tan, mottled red to maroon to purplish, limonite and ferruginous stained, silty, flint clay in appearance, breaks with a starch-like fracture, exposed			16	0			16	0

LOCATION KEY: Aam 34 FILE NUMBER: 8999 ELEVATION: 627± base TOPO MAP: Chesterhill

STATE: Ohio COUNTY: Athens TOWNSHIP: Ames SECTION: N½ SE¼, 4

LOCATION: Exposure in Linscott Run and east along hillside.

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
13	Monongahela	Redstone	Upper Pittsburgh	Shale and sandstone, gray to olive drab, argillaceous shales with thin-bedded, fine, micaceous sandstone, poorly exposed, badly slumped freshwater limestone nodules in place.			9	4	9	4	173	10
12		Pittsburgh	Upper Pittsburgh	Limestone, light gray to gray, limonite stains on surface, nodular, irregular, fresh-water, embedded in buff, argillaceous shales.			12	6	53	8	164	6
11			Lower Pittsburgh	Clay shale, gray to buff, mottled red to maroon, limonite stained, silty, poorly exposed in part.			34	0			152	0
10				Sandstone, gray to buff, limonite stained, very fine, micaceous, shaly to thin-bedded with some massive.			7	2			118	0
9	Conemaugh	Upper Little Pittsburgh	Upper Little Pittsburgh	Shale and sandstone, gray to buff to olive drab, limonite stained, argillaceous, silty shales with interbedded thin fine micaceous sandstone layers, exposed.			16	10	?		110	10
8		?	?	Covered interval.			20	0			94	0
7		Lower Little Pittsburgh	Lower Pittsburgh and Connellsville	Shale, gray to maroon, mottled red, limonite stains, silty, argillaceous, contains scattered small fresh-water limestone nodules and ferruginous masses, exposed.			5	0	?		74	0
6		Little Clarksburg	Clarksburg and Morgantown	Clay shale, gray to buff, mottled maroon to red and purplish, limonite stained, silty, with scattered ferruginous masses.			41	6	41	6	69	0
5		Elk Lick	Upper Grafton	Shale and sandstone, light blue-gray to greenish gray, limonite stained, argillaceous shales interbedded with fine, blue-gray, micaceous sandstone layers 1 inch to 5 inches thick.			23	8	23	8	27	6
4		Duquesne	Skelley	Limestone, gray-green to dark blue-green, limonite stains, micaceous, nodular, silty to sandy, irregular, fossiliferous, marine.			0	4	3	10	3	10
3				Shale, gray to blue-gray, limonite and hematite stains, argillaceous, silty, calcareous.			2	9			3	6
2			Duquesne	Limestone, gray to blue gray, limonite stained, ferruginous, with hematite nodules, nodular, irregular.			0	3			0	9
1				Shale, gray to blue-gray, sitly, argillaceous, micaceous, exposed in bottom of Linscott Run.			0	6			0	6

LOCATION KEY: Aam 36 FILE NUMBER: 9001 ELEVATION: 630±base TOPO MAP: Chesterhill

STATE: Ohio COUNTY: Athens TOWNSHIP: Ames SECTION: E½ SE¼, 3

LOCATION: Exposure along road and up ravine starting from Route 50.

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
11	Monongahela	Redstone	Upper Pittsburgh ?	Sandstone, gray to buff, limonite stained, fine, micaceous, thin to medium-bedded, exposed.			7	0	7	0	148	0
10		Pittsburgh	Pittsburgh ?	Shale and clay shale, gray to olive drab, with some dark gray, silty to sandy upward, no coal observed.			10	8	43	6	141	0
9			Upper Pittsburgh	Limestone, light gray to gray, limonite stains on surfaces, nodular, fresh-water, embedded in tan argillaceous shales.			12	10			130	4
8			Lower Pittsburgh	Clay shale, gray to tan, limonite stained, mottled red to maroon to purplish, silty, breaks with starch-like fracture, flint clay in appearance.			20	0			111	6
7	Conemaugh	Upper Little Pittsburgh	Upper Little Pittsburgh	Clay shale, gray to greenish gray, mottled, slightly maroon, silty, contains small, scattered, fresh-water limestone, nodular.			7	0	16	8	97	6
6				Sandstone, gray to buff, limonite stained on surfaces, fine, shaly to slabby bedded, micaceous.			9	8			90	6
5		Lower Little Pittsburgh	Connellsville	Clay shale, gray to dark gray, limonite stained, mottled red to maroon with some purplish, covered in part.			19	5	47	10	80	10
4				Sandstone, gray to olive drab, limonite stained on surfaces, fine, shaly to massive bedded, micaceous, poorly exposed in lower part.			28	5			61	5
3		Little Clarksburg	Clarksburg	Limestone, light gray to gray, limonite stained on surface, nodular, fresh-water, dense, embedded in shale.			10	6	33	0	33	0
2				Clay shale, gray to tan, limonite stained, mottled red to maroon to purplish, silty, micaceous.			18	6			22	6
1			Morgantown	Shale, gray to tan, limonite stained, argillaceous, micaceous, silty to sandy, exposed.			4	0			4	0

LOCATION KEY: Aam 37 FILE NUMBER: 9002 ELEVATION: 681± Base TOPO MAP: Chesterhill

STATE: Ohio COUNTY: Athens TOWNSHIP: Ames SECTION: SE¼ SE¼, 2

LOCATION: Exposure along road and in abandoned quarry.

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
8	Monongahela	Redstone	Redstone	Shale, gray to tan and maroon, mottled, argillaceous, finely micaceous, exposed.			5+	0	22	2	84	10
7			Upper Pittsburgh	Sandstone, gray to olive drab, limonite stains on surface, fine, micaceous, thin-bedded below to massive above.			14	2			79	10
6				Shale, gray to greenish gray, with limonite stains, argillaceous, silty to sandy upwards			3	0			65	8
5		Pittsburgh	Pittsburgh	Clay shale, limonite stained, carbonaceous, thin-bedded, coal horizon.			0	2	62	8	62	8
4				Clay shale, gray with some small black specks, argillaceous, micaceous, fossiliferous (pelecypods).			1	0			62	6
3			Upper Pittsburgh	Limestone, light gray to gray, limonite stained on surfaces, nodular, irregular in argillaceous shale, fresh-water.			14	4			61	6
2			Lower Pittsburgh	Clay shale, gray to tan, mottled red, maroon to purple and yellow, silty, micaceous flinty in appearance.			16	2			47	2
1				Shale and sandstone, gray to buff, limonite stained, argillaceous shale with fine micaceous, thin interbedded layers of sandstone, exposed.			31	0			31	0

LOCATION KEY: Aam 40 FILE NUMBER: 9005 ELEVATION: 799± base TOPO MAP: Chesterhill

STATE: Ohio COUNTY: Athens TOWNSHIP: Ames SECTION: NW¼ NW¼ SW¼, 5

LOCATION: Exposure in abandoned strip mine and uphill above.

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
17	Monongahela	Benwood	Sewickley	Sandstone, gray to tan, limonite stained, fine, micaceous, thin-bedded, exposed.			3	0	20	10	101	0
16				Shale and sandstone, gray to tan, limonite stained, argillaceous shale interbedded with thin, micaceous, fine sandstone layers.			16	0			98	0
15				Sandstone, gray to tan, limonite stained on surface, fine to medium, thin to massive.			1	10			82	0
14		Sewickley	Lower Sewickley	Shale, gray to tan, limonite stained, argillaceous, silty, micaceous, thin-bedded, exposed.			10	2	10	2	80	2
13		Fishpot, in part	Fishpot, in part	Covered, limestone, yellow to brown, fretted, seen in float.			26	8	26	8	70	0
12		Fishpot	Fishpot	Clay shale, maroon, limonite stained, mottled, maroon to purplish, exposed.			10	0	20	11	43	4
11			Fishpot or Pomeroy	Sandstone, gray to olive drab, limonite stained, fine, shaly to massive, bedded upward, micaceous.			10	11			33	4
10		Redstone	Redstone	Coal, dull, soft, badly weathered.			0	1	18	7	22	5
9				Clay shale, dark blue-gray, limonite stained, micaceous, silty.			0	6			22	4
8				Limestone, light gray to gray, limonite stains on surfaces, nodular, fresh-water, embedded in gray to tan argillaceous shale.			8	4			21	10
7				Clay shale, blue-gray to dark gray, limonite stained, micaceous, contains fresh-water limestone nodules, in erratic ledges.			4	9			13	6
6			Upper Pittsburgh	Sandstone, gray to olive drab, limonite stained, ferruginous stains on surface, fine massive ledge.			0	8			8	9
5				Clay and clay shale, light gray to gray upwards, plastic on bottom to shaly, thin-bedded above, silty to sandy upward, micaceous, contains pyrite crystals.			4	3			8	1
4		Pittsburgh	Pittsburgh	Coal, bright, blocky, some dull, free sulphur and mellanterite on surfaces, pyrite, some fusain.			0	10	3	10	3	10
3				Clay, dark gray to black, plastic.			0	1			3	0
2				Coal, bright, blocky, some dull, free sulphur and mellanterite on surfaces, pyrite, some fusain.			1	8			2	11
1				Coal, exposed, underwater.			1	3			1	3

ATHENS TOWNSHIP

LOCATION KEY: Aa 2 FILE NUMBER: 11223 ELEVATION: 668 ± base TOPO MAP: Athens

STATE: Ohio COUNTY: Athens TOWNSHIP: Athens SECTION: SW¼ NE¼ and NW¼ SE¼, 25

LOCATION: Section exposed along road 0. 15 mile south of 649 road junction and 0. 85 mile west-northwest of road junction 668.

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
26	Conemaugh	?	?	Clay shale, gray to olive grading to pale maroon above, considerable limonite stain, very finely micaceous, exposed.			4	5	4	7	60	0
25				Coal smut.			0	1			55	7
24				Clay, light gray, silty, plastic.			0	1			55	6
23		Anderson	Portersville	Shale, gray, argillaceous, calcareous, fossiliferous, marine, scattered small nodules of gray limestone.			1	11	14	2	55	5
22			Anderson	Coal, bright and dull, much fusain, shaly, weathered.			0	2			53	6
21				Underclay, light gray to gray, plastic, with numerous slickensides.			3	0			53	4
20			Bloomfield	Clay, light gray to light greenish gray or purplish, plastic, lower half with numerous small fresh-water limestone nodules and pellets.			6	0			50	4
19			Bakerstown	Shale and sandstone, light gray, with much limonite stain, silty, micaceous, with interbedded clay zones, at top 4-6 inches five, silty, micaceous, calcareous, and ferruginous sandstones.			3	1			44	4
18		Wilgus	Cambridge	Limestone, light greenish gray, weathers yellowish brown, dense, ferruginous, sparingly fossiliferous, marine, nodular, irregular in development			0	6	8	9	41	3
17			Buffalo	Shale, light gray to olive drab, with limonite stain, argillaceous, silty, finely micaceous.			6	7			40	9
16				Sandstone, light gray, weathers brown to yellowish, fine, micaceous, some case hardening, medium to heavy-bedded.			1	8			34	2
15		Upper Brush Creek	Upper Brush Creek	Shale and siltstone, light gray to olive drab, silty, sandy, micaceous, layers and scattered nodules of ferruginous limestone and limonite concretions, fossiliferous, marine			4	10	17	3	32	6
14				Limestone, light gray to olive drab, with considerable limonite stain, dense, silty, ferruginous, fossiliferous, marine.			0	7			27	8
13				Shale, light gray to olive drab, with some limonite stain, silty, micaceous, few small limonite concretions, essentially siltstone at top.			11	10			27	1
12		Lower Brush Creek	Lower Brush Creek	Shale, olive drab with some limonite stains, argillaceous, sparingly micaceous, fossiliferous, marine, 1 inch to 2 inch layer of nodular limonite near bottom.			1	3	8	7	15	3
11				Limestone, gray, weathers light gray, some limonite, weathers to soft pasty clay, dense, somewhat flinty in top part, fossiliferous, marine.			0	5			14	0
10				Limestone, light to greenish gray, some limonite stains, shaly, quite fossiliferous, marine.			1	3			13	7
9				Limestone, gray, some limonite stains on surface, dense, fossiliferous, marine, thickness variable.			1	5			12	4
8				Sandstone, light gray, much limonite stain, fine, very micaceous, thin, sandy micaceous clay zones, nodular limestone throughout.			1	11			10	11
7				Clay shale, light gray to olive drab, with some limonite stain, very micaceous, sparingly fossiliferous, marine.			1	3			9	0
6				Shale, light gray, with limonite stain, very sandy and micaceous, calcareous, with small limestone nodules, marine.			0	9			7	9
5				Limestone, light gray, weathers yellowish brown, nodular, sandy, micaceous, firm, calcite veinlets, fossiliferous, marine.			0	4			7	0

LOCATION: Aa 2 FILE NUMBER: 11223 - continued

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
4	Conemaugh - continued	Mason ?	Mason ?	Shale, light gray to olive drab, with considerable limonite stain, silty, micaceous with clayey zones and very sandy toward top.			3	5	6	8	6	8
3				Clay, light gray, with considerable limonite stain, sandy, very micaceous, somewhat plastic.			0	6			3	3
2				Coal, somewhat shaly, some fossil plants, some bright.	so		0	2			2	9
1			Upper Mahoning	Shale, light gray to olive drab, with some limonite stain, silty, finely micaceous, somewhat argillaceous toward top, exposed			2	7			2	7

LOCATION KEY: Aa 5 FILE NUMBER: 11224 ELEVATION: 681 ± base TOPO MAP: Athens

STATE: Ohio COUNTY: Athens TOWNSHIP: Athens SECTION: S½ NE¼, 34

LOCATION: Exposure in B. and O. R. R. cut 0.15 mile southeast of Brookville.

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
9	Conemaugh	Upper Brush Creek	Upper Brush Creek	Shale, light gray to olive drab, silty, sandy, micaceous, with thin zones and masses of shaly, silty, micaceous fine sandstone.			32	9	32	9	81	3
8		Lower Brush Creek	Lower Brush Creek	Shale, gray, with some limonite stain, argillaceous, quite fossiliferous, marine.			2	9	23	6	48	6
7				Clay shale, gray, much limonite stained, weathers somewhat plastic, fossiliferous, marine.			0	3			45	9
6				Shale, dark gray to black, with numerous streaks and partings of bright coal.			0	3			45	6
5				Coal, mostly bright and somewhat blocky with thin layers of dull coal and fusain.			0	5			45	3
4				Clay, light gray with considerable limonite stain and some small limonite masses, moderately plastic.			1	10			44	10
3				Clay shale, gray, mottled chocolate maroon to gray in top 15 inches, silty and micaceous, breaks with starch-like fracture.			5	1			43	0
2		? Mason	? Upper Mahoning	Shale, gray to light gray with much limonite stain, silty, sandy, and micaceous with thin layers of shaly sandstone and locally where sandstone is thinner, clay-shale, gray mottled tan, buff to maroon, very sandy especially in lower part, micaceous, silty, with scattered nodules of impure limestone and locally a layer of limestone at top.			12	11			37	11
1				Sandstone, light gray to yellowish brown, dominantly coarse but with one zone of fine or medium, micaceous, massive, showing some large cross-bedding on weathered surfaces, prominent joint planes, (Mahoning coal and clay should be present just below.)			25	0	25	0	25	0

LOCATION KEY: Aa 14 FILE NUMBER: 11226 ELEVATION: 741 ± base TOPO MAP: Athens

STATE: Ohio COUNTY: Athens TOWNSHIP: Athens SECTION: 30 and 36

LOCATION: Exposure in ravine on north side of road along line between sections 30 and 36, 0.6 mile west of road junction 739 and 0.2 mile south of Athens-Dover Township boundary line.

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
15	Conemaugh	Ames	Ames	Limestone, light gray to light greenish gray, partly crystalline, fossiliferous, including fusulinids, marine.			1	0	1	0	124	0
14		Ames, Harlem, & Upper Bakerstown?	?	Shale, and covered interval, olive drab, silty, micaceous shale poorly exposed and much covered.			61	6	61	6	123	0
13		Anderson	Portersville	Shale, gray to dark gray with some limonite stains, argillaceous, weathers plastic, fossiliferous, marine, slumped.			2	6	20	6	61	6
12			Anderson	Coal, mostly dull with some bright, much fusain, weathered, probably slumped somewhat.			0	5			59	0
11				Clay, light gray with limonite streaks, somewhat plastic, slumped, poorly exposed.			2	0			58	7
10				Covered interval.			6	4			56	7
9			Bakerstown	Sandstone, yellowish brown, fine to medium, finely micaceous, calcareous?, single massive ledge.			0	7			50	3
8				Shale, light gray to olive drab, with limonite stain, argillaceous to silty, finely micaceous.			8	8			49	8
7		Wilgus	Cambridge	Limestone, light gray, weathers yellowish brown, partly crystalline, arenaceous at base, sparingly fossiliferous, marine.			0	8	22	6	41	0
6			Buffalo	Sandstone, light gray, weathers brown, calcareous, crystalline, micaceous, fine to medium-bedded, massive ledge, ripple-marked near top.			4	5			40	4
5				Shale, light gray to buff to olive drab with some limonite stain, argillaceous to silty or in some zones sandy, finely micaceous, partly covered.			17	5			35	11
4		?	?	Covered interval.			7	3	7	3	18	6
3		Upper Brush Creek ?	Upper Brush Creek ?	Shale, gray to dark gray with some limonite stain, argillaceous to slightly silty, fossiliferous, marine, poorly exposed to 10 feet above.			5	10	6	8	11	3
2				Limestone, dark gray, carbonaceous, mostly dense, fossiliferous, marine, a single ledge.			0	10			5	5
1				Shale and sandstone, light gray with considerable limonite stain, argillaceous to silty, micaceous shale interbedded with similarly colored silty, micaceous fine sandstone, weathered soft in top 6 inches, exposed.			4	7	4	7	4	7

LOCATION KEY: Aa 15 FILE NUMBER: 11227 ELEVATION: TOPO MAP: Athens

STATE: Ohio COUNTY: Athens TOWNSHIP: Athens SECTION: NW¼, 12

LOCATION: Exposure along west side of Route 50A, 0.2 mile south of Athens-Dover Township line

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
8	Conemaugh	Wilgus	Buffalo ?	Shale, olive drab, with some limonite stain, silty, micaceous.			8	0	8	0	18	11
7		Upper Brush Creek	Upper Brush Creek	Limestone, gray to light gray with some limonite stain, shaly to very shaly, fossiliferous, marine.			0	8	10	11	10	11
6				Limestone, light gray with limonite stained surfaces, dense, compact, partly crystalline, fossiliferous, marine, thickness variable.			1	2			10	3

LOCATION: Aa 15 FILE NUMBER: 11227 - continued

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
5	Conemaugh - continued	Upper Brush Creek- continued	Upper Brush Creek- continued	Sandstone, light gray with much limonite stain, fine to medium, micaceous, calcareous, no apparent fossils.			0	6			9	1
4				Shale, very similar to that below underlying sandstone.			0	7			8	7
3				Sandstone, light gray to brown and yellow, fine to medium, micaceous, bedded in layers $\frac{1}{2}$ to several inches thick.			1	0			8	0
2				Shale, light gray with considerable limonite stain, silty, very sandy, micaceous, with thin, fine, micaceous sandstone layers			4	0			7	0
1				Shale, light bluish gray with considerable limonite stain, argillaceous to silty, micaceous.			3	0			3	0

LOCATION KEY: Aa 16 FILE NUMBER: 11228 ELEVATION: 664± base TOPO MAP: Athens

STATE: Ohio COUNTY: Athens TOWNSHIP: Athens SECTION: NW$\frac{1}{4}$, 11

LOCATION: Exposure in ravine on Francis Woodwarth property, 0.65 mile east-southeast of mouth of Sugar Creek and 1.3 miles south of Athens-Dover Township line.

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
25	Conemaugh	Elk Lick	Upper Grafton	Sandstone, light gray, stained brown and yellow, medium to coarse, slightly micaceous, massive.			24	0	24	0	139	0
24		Gaysport	Gaysport	Limestone, light bluish gray, mottled brown, yellow, purple, mostly dense, micaceous, sandy, marine.			1	2	12	2	115	0
23				Covered interval.			11	0			113	10
22		Ames	Ames	Limestone, light gray with slight limonite stain, dense to partly crystalline, massive fossiliferous, marine.			1	10	15	10	102	10
21				Clay, light gray, with limonite stain, shaly, somewhat plastic.			1	0			101	0
20				Shale and sandstone, light gray to olive or tan with some limonite stain, argillaceous to sandy, micaceous shale interbedded with fine, micaceous, thin-bedded sandstone.			13	0			100	0
19		?	?	Covered interval			2	8	2	8	87	0
18		Harlem	Rock Riffle or Round Knob	Clay shale, mottled tan and maroon, breaks with starch-like fracture, weathers plastic, nodular, tan, fresh-water limestone in base			2	8	10	4	84	4
17			Saltsburg	Shale, light gray to light tan with some limonite stain, silty, micaceous.			3	0			81	8
16				Sandstone, light gray with some limonite stain, fine, micaceous, calcareous, thin to irregularly bedded on weathered surface.			4	8			78	8
15		Upper Bakerstown	Ewing	Shale, light bluish gray, much weathered to brown and yellow, silty, sandy, and micaceous, scattered nodules of impure limestone and masses along joints.			13	0	29	0	74	0
14			Cow Run	Shale, variable, bluish gray to light gray, with considerable limonite stain, argillaceous and very finely micaceous below to silty, sandy, and micaceous upward.			14	3			61	0
13				Shale, chocolate brown to chocolate maroon, argillaceous to silty, finely micaceous, fissile, with small flattened limonite concretions.			1	9			46	9
12		Anderson	Portersville	Shale, dark gray to almost black below, light gray above, argillaceous, micaceous, fossiliferous, marine.			2	5	11	2	45	0
11			Anderson	Coal, shiny, blocky with numerous thin dull streaks, much weathered.			1	0			42	7
10				Clay, light gray to yellowish tan, starch-like fracture, lean below, more plastic above, some slickensides, small scattered calcareous nodules in lower part.			4	1			41	7

LOCATION: Aa 16 FILE NUMBER: 11228 - continued

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
9	Conemaugh - Continued	Anderson - Continued	?	Covered interval.			0	9			37	6
8			Bakerstown	Sandstone, light gray, with limonite surfaces, fine, calcareous, micaceous, no apparant fossils.			0	5			36	9
7				Shale, light gray to olive drab, silty, micaceous.			2	6			36	4
6		Wilgus	Cambridge	Limestone, light bluish gray, weathers brown and yellow, ferruginous, sandy, micaceous, nodular, fossiliferous, marine.			0	4	31	11	33	10
5			Buffalo	Shale, light gray to olive with much limonite stain, silty, micaceous, grades upward from sandstone below.			1	6			33	6
4				Sandstone, light gray to brown and yellow, fine to medium, silty, micaceous, some cross-bedding, stratified in layers $\frac{1}{2}$ to several inches thick, calcareous in part.			7	0			32	0
3				Shale and sandstone, light gray with considerable limonite stain, silty, sandy, micaceous, shale interbedded and grading upward into shaley, fine, micaceous sandstone, in top of exposure several flaggy 4-inch layers of sandstone.			23	1			25	0
2		Upper Brush Creek	Upper Brush Creek	Limestone, light gray with some limonite stain surfaces, dense, partly crystalline, slightly sandy and micaceous, massive, fossiliferous, marine.			1	0	1	11	1	11
1				Sandstone, light gray with much brown and yellow stain, fine, silty, micaceous, shows irregular bedding on weathered surfaces, grades upward rather abruptly into overlying limestone.			0	11			0	11

LOCATION KEY: Aa 17 FILE NUMBER: 11229 ELEVATION: not available TOPO MAP: Athens

STATE: Ohio COUNTY: Athens TOWNSHIP: Athens SECTION: $NW\frac{1}{4}$ $NW\frac{1}{4}$, 11

LOCATION: Detail of Harlem-Ames cyclothems exposed in ravine 0.4 mile east-northeast of mouth of Sugar Creek and 1.1 miles south of Athens-Dover Township line.

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
5	Conemaugh	Ames	Ames	Limestone, light gray with some limonite stain, dense to partly crystalline, fossiliferous, marine.			1	6	18	1	18	8
4				Clay, light gray with some limonite stain, somewhat plastic.			1	0			17	2
3				Shale and sandstone, light gray to olive drab with some limonite stain, silty, micaceous shale and fine, silty, micaceous sandstone.			15	7			16	2
2		Harlem	Harlem	Coal, some bright with thin dull partings			0	1	0	7	0	7
1				Clay, gray, with some limonite stain, silty, finely micaceous, not very plastic.			0	6			0	6

LOCATION KEY: Aa 23 FILE NUMBER: 11231 ELEVATION: 682 ± base TOPO MAP: Athens

STATE: Ohio COUNTY: Athens TOWNSHIP: Athens SECTION: $SE\frac{1}{4}$ $NW\frac{1}{4}$ and $SW\frac{1}{4}$ $NE\frac{1}{4}$, 17

LOCATION: Exposure in ravine along C. & O. RR, 0.2 mile south-southwest of mouth of Sugar Creek and 1.0 mile southeast of road junction 711.

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
20	Conemaugh	Duquesne	Skelley ?	Sandstone, light gray, much limonite stain, calcareous, ferruginous.			0	4	32	4	162	4
19			Duquesne ?	Covered interval			14	0			162	0
18			Lower Grafton	Shale, light tan to light olive with limonite stain, silty, micaceous above, argillaceous below and at top.			18	0			148	0
17		Gaysport	Gaysport	Limestone, light gray with surface limonite stain, dense, sandy, micaceous, fossiliferous, marine.			0	5	11	4	130	0
16				Limestone, light gray with considerable limonite stain, sandy, micaceous, fossiliferous (many fusulinids), marine.			0	8			129	7
15				Sandstone, olive drab with some limonite stain, fine, silty, micaceous.			1	3			128	11
14				Shale and covered interval			9	0			127	8
13		Ames	Ames	Limestone, light gray mottled purple with considerable near surface, limonite stain, partly crystalline, massive, fossiliferous, marine.			1	8	25	6	118	8
12				Shale, gray, argillaceous, soft, weathered			2	9			117	0
11				Sandstone, light gray with some limonite stain, fine, micaceous, thin-bedded with some cross-bedding.			8	9			114	3
10				Shale, light bluish gray to olive drab with some limonite stain, silty, micaceous, becomes sandy upward.			12	4			105	6
9		Harlem	Harlem	Shale, black, bony, carbonaceous, with scattered small pyrite concretions in lower part.			2	11	8	2	93	2
8				Coal, mostly dull, definitely canneloid in basal part.			0	4			90	3
7				Clay, mottled light gray, yellow, etc., silty, finely micaceous, breaks with starch-like fracture, only slight plasticity.			4	11			89	11
6		Upper Bakerstown	Cow Run	Sandstone, light gray, stained yellow to brown near surfaces, mostly medium-grained, micaceous, somewhat friable, massive, showing bedding and cross-bedding on weathered surfaces, definite calcareous zones at base and top.			52	6	52	6	85	0
5		Wilgus	Buffalo	Shale, olive drab with some limonite stain, silty, abundantly and finely micaceous, grades upward into fine sandstone.			16	4	16	4	32	6
4		Upper Brush Creek	Upper Brush Creek	Shale, olive drab with small amounts of limonite stain, silty, finely micaceous with small scattered calcareous and ferruginous nodules, fossiliferous, marine.			6	0	16	2	16	2
3				Limestone, light gray with some limonite stain along surfaces, dense, sandy, micaceous, fossiliferous, marine.			1	10			10	2
2				Sandstone, light gray to light greenish gray with considerable limonite stain, fine, silty, micaceous, bedded in thin, somewhat irregular layers.			6	8			8	4
1				Shale, light gray to olive with much limonite stain, very sandy, silty, micaceous.			1	8			1	8

LOCATION KEY: Aa 24 FILE NUMBER: 11232 ELEVATION: 670 ± base TOPO MAP: Athens

STATE: Ohio COUNTY: Athens TOWNSHIP: Athens SECTION: S½ SE¼, 17

LOCATION: Exposure of Upper Brush Creek limestone and associated strata 0.25 mile west of Armitage C & O, N. Y. C. RR. crossing and 0.8 mile south-southeast of mouth of Sugar Creek.

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
4	Conemaugh	Upper Brush Creek	Upper Brush Creek	Limestone, light gray with slight limonite stain, mostly dense, sandy, and micaceous, grades downward into underlying sandstone, fossiliferous, marine.			1	1	5	10	5	10
3				Sandstone, light gray, stained yellow and brown, fine, micaceous, calcareous, fossiliferous, marine.			0	7			4	9
2				Sandstone, light gray, much stained brown and yellow, fine, silty, micaceous, bedded in layers to several inches in thickness.			2	6			4	2
1				Shale, light gray with much limonite stain, argillaceous to sandy, micaceous, considerably weathered.			1	8			1	8

LOCATION KEY: Aa 25 FILE NUMBER: 11233 ELEVATION: 681 ± base TOPO MAP: Athens

STATE: Ohio COUNTY: Athens TOWNSHIP: Athens SECTION: SE¼, 17

LOCATION: Exposure in gravel pit and along ravine above gravel pit on Depue farm, 0.1 mile west of C & O and NYC Railroad's and 0.7 mile south-southeast of mouth of Sugar Creek.

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
20	Conemaugh	Duquesne	Lower Grafton	Shale, variable, light gray, chocolate, etc, light clay shale with small limestone nodules at top, all weathered and slumped.			4	0	4	0	104	8
19		Gaysport	Gaysport	Limestone, light greenish gray, much weathered brown and yellow, fossiliferous, marine.			0	8	7	11	100	8
18				Shale, light gray to tan with some limonite stain, argillaceous to silty, micaceous.			7	3			100	0
17		Ames	Ames	Limestone, light gray with some limonite stain, partly crystalline, massive, fossiliferous, marine.			1	7	13	11	92	9
16				Shale light gray to pale tan with slight limonite stain, argillaceous, silty, micaceous.			4	0			91	2
15				Sandstone, light gray, stained brown and yellow, fine, massive.			1	10			87	2
14				Shale, gray to light gray with some limonite stain, argillaceous below, tan, silty to sandy, micaceous above.			6	6			85	4
13		Harlem	Harlem	Coal, some bright with considerable limonite stain, sooty, much weathered.			0	1	9	0	78	10
12				Clay, light gray to gray, with yellowish stain, somewhat plastic.			1	6			78	9
11			Saltsburg	Shale, light gray to olive drab with some limonite stain, silty, micaceous.			7	5			77	3
10		Upper Bakerstown	Ewing ?	Limestone, light gray with considerable limonite stain, silty, sandy, micaceous, ripple-marked.			0	7	24	7	69	10
9				Shale and sandstone, light gray to olive with some limonite stain, silty, sandy, micaceous shale, grading upward, fine, micaceous thin-bedded sandstone.			5	2			69	3
8				Limestone and sandstone, gray to light gray with some limonite stain, silty, sandy, micaceous limestone, and fine, silty, micaceous sandstone.			1	6			64	1
7			Cow Run	Shale, light greenish gray to pale olive, silty, sandy, micaceous.			6	6			62	7
6				Shale, similar to that immediately below but more sandy and with nodules of light bluish gray with yellow-brown stain, dense limestone.			4	1			56	1
5				Shale, light gray to tan with some limonite stain, silty, micaceous, with fine sandy zones.			6	9			52	0

LOCATION: Aa 25 FILE NUMBER: 11233 - continued

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
4	Conemaugh	?	?	Covered interval			10	3	10	3	45	3
3	Pleistocene		Illinoian	Silty sand and gravel, light brown to tan, silty, sandy, fine gravel and silty sand, much weathered with soil profile at top.			21	6	35	0	35	0
2				Gravel and sand, light gray to light brownish gray, medium to coarse gravel intercolated with beds of coarse sand 8-10 inches thick, pebble various igneous, sedimentary, and metamorphic rocks up to 4 inches in maximum size, some weathered.			4	0			13	6
1				Sand, light greenish gray when damp, light gray when dry, medium to coarse with some scattered small pebbles and thin clay-silty layers, stratified, much cross-bedded.			9	6			9	6

LOCATION KEY: Aa 26 FILE NUMBER: 11234 ELEVATION: 681 ± base TOPO MAP: Athens

STATE: Ohio COUNTY: Athens TOWNSHIP: Athens SECTION: E½ NE¼, 22

LOCATION: Exposure along ravine and its tributaries, 0.7 mile north-northeast of mouth of Margaret Creek and 0.8 mile northeast of road junction 655.

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
26	Conemaugh	Elk Lick	Elk Lick	Limestone, light yellowish gray with some limonite stain, very sandy, micaceous, no apparant fossils.			0	6	18	0	162	2
25			Upper Grafton	Shale, olive drab to tan with limonite stain, silty, micaceous to sandy, weathered, poorly exposed.			14	0			161	8
24				Sandstone, light gray, much stained brown and yellow, fine to medium, micaceous, massive.			3	6			147	8
23		Duquesne	Duquesne	Clay shale, variable, mottled brown, yellow, purple, maroon, gray, etc., laminated or breaking with starch-like fracture, weathered, partly covered.			11	8	11	8	144	2
22		Gaysport	Gaysport	Limestone, light to dove gray with some limonite stain, dense, nodular, no apparent fossils, embedded in shale.			0	3	11	6	132	6
21				Shale, olive drab with some limonite stain, argillaceous to silty, finely micaceous, sandy upward, poorly exposed.			11	3			132	3
20		Ames	Ames	Limestone, light gray with some surface stain of limonite, partly crystalline, fossiliferous (fusulinids), marine.			1	8	21	4	121	0
19				Covered interval.			3	0			119	4
18				Sandstone, light gray with some limonite stain, fine to medium, micaceous, thin to heavy-bedded, some cross-bedding, some silty shale zones.			11	8			116	4
17				Shale, light gray with some limonite stain, silty, sandy, micaceous, evenly laminated, few plant fragments, exposed.			5	0			104	8
16		Harlem and Upper Bakerstown	Harlem and Upper Bakerstown	Covered interval			35	8	35	8	99	8
15		Upper Bakerstown	Cow Run	Shale, light gray to tan, with some limonite stain, silty, micaceous, locally cut out and replaced by fine, silty, micaceous sandstone.			7	3	8	9	64	0
14				Shale, chocolate, argillaceous, finely micaceous, locally replaced by fine silty micaceous sandstone.			1	6			56	9
13		Anderson	Portersville	Limestone, nodular, gray to light bluish gray, dense, fossiliferous, marine.			0	3	19	7	55	3
12				Shale, gray to tan, argillaceous, finely micaceous, fossiliferous, marine.			3	6			55	0

LOCATION: Aa 26 FILE NUMBER:11234 - continued

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
11	Conemaugh -	Anderson	Anderson	Coal, some bright, with dull streaks, some fusain.			0	9			51	6
10	continued	continued		Clay, gray to greenish gray, finely micaceous, exposed.			1	0			50	9
9			Bakerstown	Shale, light bluish gray to olive, moderate to much limonite stain, silty or sandy, micaceous, poorly exposed in upper part.			14	1			49	9
8		Wilgus	Cambridge	Limestone, light bluish gray with considerable limonite stain, silty, sandy, micaceous, ferruginous.			0	4	10	9	35	8
7			Buffalo	Sandstone, light gray to greenish gray to olive with some limonite stain, fine, micaceous, thin, irregularly bedded.			3	4			35	4
6				Shale, light gray to light blue-gray to olive with chocolate zone at base, some limonite stain, silty, micaceous, few thin, flat limonite concretions, sandy, upward, grading into fine sandstone.			7	1			32	0
5		Upper Brush Creek	Upper Brush Creek	Limestone, light gray to gray with some limonite stain, sandy, micaceous, fossiliferous, marine.			0	3	24	11	24	11
4				Shale, chocolate to olive above, argillaceous, finely micaceous, sparingly fossiliferous, marine.			6	6			24	8
3				Limestone, light gray with some limonite stain, dense, sandy, very sandy in base, micaceous, fossiliferous, marine, in two massive benches.			1	7			18	2
2				Sandstone, light gray to olive with some limonite stain, fine to very fine upward, silty, micaceous, basal 18 inches calcareous, massive in base, thin-bedded above.			10	10			16	7
1				Sandstone, light gray to olive with some limonite stain, very fine, silty, micaceous thin-bedded, exposed.			5	9			5	9

LOCATION KEY: Aa 27 FILE NUMBER: 11235 ELEVATION: 645 ± base TOPO MAP: Athens

STATE: Ohio COUNTY: Athens TOWNSHIP: Athens SECTION: $S\frac{1}{2}$ $NW\frac{1}{4}$, 15

LOCATION: Exposure along ravine on south side of Hocking River, one-half mile northwest of State Hospital buildings and located on State Hospital grounds in $S\frac{1}{2}$ $NW\frac{1}{4}$, section 15.

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
15	Conemaugh	Duquesne	Skelley	Limestone, light gray, weathering yellowish brown, partly crystalline, sandy, micaceous, fossiliferous, marine.			0	11			201	6
14				Shale, light tan to maroon, argillaceous to silty, finely micaceous, poorly exposed.			7	7			200	7
13			Lower Grafton	Sandstone, light gray, mostly stained light brown or yellow, fine, silty, micaceous, laminated.			11	8			193	0
12		? Gaysport	? Gaysport	Shale, light gray to olive and tan with considerable limonite stain, silty below becoming sandy upward, micaceous, nodular, dove gray, dense limestone in basal 5 feet, covered in part.			35	1			181	4
11		Ames	Ames	Limestone, light gray with some limonite stain near surfaces, partly crystalline, massive, fossiliferous, marine.			1	5			146	3
10				Clay shale, light gray to yellowish brown, laminated, weathers somewhat plastic.			1	6			144	10
9				Shale, light gray to olive or tan with some limonite stain, silty, sandy, and micaceous.			10	4			143	4
8		? Anderson	? Portersville and Anderson	Covered interval, coal smut, blocks of Portersville? limestone and weathered clay shale at 96 feet above base of section, coal smut at 119 feet above base, elevation of Portersville is approximately 741 feet.			60	3			133	0

LOCATION: Aa 27 FILE NUMBER: 11235 - continued

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
7	Conemaugh - continued	Anderson	Bloomfield ?	Clay shale, yellow, brown, maroon, etc., with nodules of dove-colored limonite-stained limestone, weathered, poorly exposed.			0	5			72	9
6			Bakerstown	Sandstone, light gray, mostly weathered brown and yellow, mostly fine micaceous, very calcareous, bedded and cross-bedded in layers 1/4 to 6 inches thick.			3	0			72	4
5				Shale, light bluish gray to gray-drab, with some limonite stain, silty, finely micaceous, sandy toward top.			15	4			69	4
4		Wilgus	Cambridge	Limestone, light gray with considerable limonite stain, silty, sandy, micaceous, nodular at top and bottom, marine, fossiliferous.			1	6	17	7	54	0
3			Buffalo	Shale, light bluish gray, weathered brown and yellow, silty, sandy, micaceous, few scattered plant fragments, scattered small calcareous concretions in basal part.			16	1			52	6
2		Upper Brush Creek	Upper Brush Creek	Limestone, light gray with some limonite stain, dense, sandy, micaceous, grades into sandstone below, fossiliferous, marine.			1	5	36	5	36	5
1				Sandstone and shale, light bluish gray with some limonite stain, sandy, micaceous shale and fine, micaceous sandstone, with scattered and lenses of calcareous siderite concretions up to 6 inches or more in size, dominantly sandstone and entirely sandstone in ravine.			35	0			35	0

LOCATION KEY: Aa 29 FILE NUMBER: 11236 ELEVATION: 660 ± base TOPO MAP: Athens

STATE: Ohio COUNTY: Athens TOWNSHIP: Athens SECTION: NE¼ NE¼, 21

LOCATION: Exposure along bank just south of White's Mill.

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
15	Conemaugh	Anderson ?	Bakerstown ?	Sandstone, light gray, mostly stained brown and yellow, fine, micaceous, thin-bedded, much weathered.					13	5		
14				Shale, light gray to olive, with considerable limonite stain, sandy, silty, micaceous.			13	5			68	0
13		Wilgus ?	Cambridge ?	Limestone, light gray to pale yellow and brown, almost entirely dense, nodular, fossiliferous, marine.			0	9	7	11	54	7
12			Meyersdale ?	Shale, olive drab to light tan with chocolate zones with some limonite stain, argillaceous to silty, finely micaceous.			7	2			53	10
11		Upper Brush Creek	Upper Brush Creek	Limestone, light gray, with brown and yellow stain, dense to partly crystalline, sandy, micaceous, grades into sandstone below, basal 12 inches massive, upper 10 inches irregularly bedded to massive.			1	10	39	4	46	8
10				Sandstone, light gray, much limonite stained, fine, calcareous, silty.			0	10			44	10
9				Shale, varicolored, olive drab, purple, yellow, argillaceous to silty, finely micaceous, breaks in part with starch-like fracture.			3	11			44	0
8				Coal, dark gray to black, dull, shaly, plant fossils, merely a coal horizon.			0	1			40	1
7				Shale and clay shale, light gray to olive, sandy, micaceous shale grading upward into dark gray, silty, micaceous clay shale.			3	0			40	0
6				Sandstone, light greenish gray with some limonite stain, fine, silty, micaceous, with shaly partings, bedded in layers 1/2 to several inches thick.			5	0			37	0

LOCATION: Aa 29 FILE NUMBER: 11236

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
5	Conemaugh - continued	Upper Brush Creek- continued	Upper Brush Creek- continued	Shale, gray to bluish gray with some limonite stain, silty to sandy becoming more sandy upward, micaceous, layers of nodular calcareous siderite and lenses of calcareous sandstone.			24	8			32	0
4		Lower Brush Creek	Lower Brush Creek	Shale, dark gray, argillaceous to silty, finely micaceous, with scattered and one thin layer near top of flat, calcareous siderite concretions, scattered fossil plants near top, fossiliferous, marine.			6	0	7	4	7	4
3				Limestone, dark gray, mostly dense, finely micaceous, somewhat shaly, fossiliferous, marine.			0	9			1	4
2				Coal			0	1			0	7
1				Clay, gray to light gray, finely micaceous, only moderately plastic.			0	6			0	6

LOCATION KEY: Aa 30 FILE NUMBER: 11237 ELEVATION: 642 ± base TOPO MAP: Athens

STATE: Ohio COUNTY: Athens TOWNSHIP: Athens SECTION: $SW\frac{1}{4}$ $NW\frac{1}{4}$, 9

LOCATION: Exposure along B & O Railroad at north end of Richland Avenue bridge over Hocking River in Athens.

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
4	Conemaugh	Wilgus	Buffalo	Shale and sandstone, light bluish gray, weathering olive drab to tan with limonite stain, silty, sandy, micaceous shale and fine, silty, micaceous sandstone, 3 to 4 feet of sandstone immediately over underlying limestone.			19	8	19	8	43	4
3		Upper Brush Creek	Upper Brush Creek	Limestone, light gray with little limonite stain, partly crystalline, basal 12 inches massive, upper 9 inches more irregularly bedded, fossiliferous, marine.			1	9	23	8	23	8
2				Sandstone, light gray, mostly stained brown and yellow, silty, micaceous, fine to medium, irregularly bedded.			0	9			21	11
1				Shale and sandstone, light bluish gray, weathering tan to olive drab with limonite stain, silty, sandy, micaceous shale interbedded with silty, micaceous, fine to medium sandstone, top and bottom well exposed, middle part mostly covered, some limonite-siderite concretions in basal part, exposed.			21	2			21	2

LOCATION KEY: Aa 31 FILE NUMBER: 11238 ELEVATION: 766 ± Base TOPO MAP: Athens

STATE: Athens COUNTY: Athens TOWNSHIP: Athens SECTION: $SE\frac{1}{4}$, 16

LOCATION: Exposure on Athens High School yard along W. Washington Street.

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
7	Conemaugh	Duquesne ?	Lower Grafton ?	Shale and sandstone, light gray, olive and tan with some limonite stain, silty, micaceous shale and fine, silty, micaceous sandstone, much weathered.			2	6	5	5	13	4
6				Shale, chocolate brown, argillaceous to silty, finely micaceous, fissile.			2	11			10	10
5		Gaysport ?	Gaysport ?	Limestone, light gray to light tan with some limonite stain, nodular, embedded in light olive shale, both very fossiliferous, marine.			1	3	3	7	7	11
4				Shale, light olive to light tan, with some limonite stain, silty, finely micaceous, sparingly fossiliferous.			2	4			6	8

LOCATION: Aa 31 FILE NUMBER: 11238 - continued

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
3	Conemaugh - continued	Ames	Ames	Limestone, light gray to purple, with slight limonite stain, mostly dense, massive, fossiliferous (fusulinids), marine.			1	3	4	4	4	4
2				Shale, light gray to light olive or tan with slight limonite stain, argillaceous to clayey in certain zones and at top, laminated to starch-like.			1	3			3	1
1				Shale, light olive to light tan with some limonite stain, silty, sandy, micaceous.			1	10			1	10

LOCATION KEY: Aa 33 FILE NUMBER: 11240 ELEVATION: 667 ± base TOPO MAP: Athens

STATE: Ohio COUNTY: Athens TOWNSHIP: Athens SECTION: NE¼, 10 and SE¼, 11

LOCATION: Exposure along stream and one tributary parallel to May Avenue east from East State Street to top of hill.

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
28	Conemaugh	Lower Little Pittsburgh	Lower Little Pittsburgh	Clay shale, gray to tan, mottled maroon, purple, olive, etc., silty, micaceous, breaks with starch-like fracture, scattered limestone nodules in upper part.			22	8	115	8	281	8
27			Lower Pittsburgh	Limestone, light olive drab to yellowish with dark brown stain, small nodules embedded in light gray to yellowish, calcareous clay shale.			5	4			259	0
26				Shale, light gray to tan, sandy, silty, micaceous.			3	8			253	8
25			Connellsville	Sandstone, light gray, much limonite stained, coarse to very coarse below, medium to coarse above, micaceous, massive, except for several shaly appearing and one shale parting, shows bedding and cross-bedding on weathered surfaces, base disconformable.			84	0			250	0
24		Little Clarksburg	Clarksburg	Limestone, light gray, much stained by limonite, argillaceous, micaceous, fine, breaks with coarse starch-like fracture.			4	4	8	10	166	0
23			Morgantown	Clay, mottled gray to light gray, purple, yellow, green, with some limonite stain, silty, micaceous, breaks with starch-like fracture, thickness variable.			4	6			161	8
22		Elk Lick	Elk Lick	Limestone, light gray with some limonite nodules up to several inches in diameter embedded in clay shale similar to that immediately below.			7	2	32	4	157	2
21			Upper Grafton	Shale and clay shale, light tan to light olive with some limonite stain, silty, micaceous, Skelley limestone may be in lower part or more probably in top part of underlying calcareous sandstone.			25	2			150	0
20		Duquesne	Skelley	Sandstone, light gray, mostly stained brown to yellow, fine to medium, micaceous, mostly thin-bedded, some parts shaly appearing, some parts calcareous, especially near top where nodular, calcareous zone occurs 10 feet above base.			13	6	18	4	124	10
19			Duquesne	Clay, light greenish gray, stained with limonite, semi-plastic, weathers somewhat plastic.			0	6			111	4
18				Clay shale, maroon to purple with gray mottling, with ferruginous pellets.			4	4			110	10
17		Gaysport	Gaysport	Shale, maroon with green mottling, micaceous, fissile, fossiliferous (Chonetes, Lingula, ostracods, pelecypods, fish fragments), marine.			4	0	12	6	106	6
16				Shale, olive drab to tan, silty, micaceous, no apparent fossils.			8	6			102	6

LOCATION: Aa 33 FILE NUMBER: 11240 - continued

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
15	Conemaugh - continued	Ames	Ames	Limestone, gray to light gray with some limonite stain, partly crystalline, fossiliferous, marine.			1	0	17	6	94	0
14				Shale, light bluish gray, weathered to light olive or light tan, silty, finely micaceous, poorly exposed.			8	0			93	0
13				Sandstone, light gray, stained olive or drab, silty, very fine, micaceous, mostly thin-bedded.			8	6			85	0
12		Harlem	Harlem	Shale, dark gray to black, carbonaceous, argillaceous, laminated.			0	8	28	0	76	6
11				Coal, somewhat bright and blocky below but dull, shaly with thin bright laminae above.			0	4			75	10
10				Underclay, gray to light gray with much limonite stain, weathers plastic.			0	3			75	6
9			Round Knob	Clay shale, gray to greenish gray, massive breaks with starch-like fracture, with numerous tiny grains throughout, and small ferruginous concretions toward top.			7	3			75	3
8			Saltsburg	Sandstone, light gray, weathered olive to tan with limonite stain, fine to medium, micaceous, irregular heavy bedding below to thin-bedded and shaly appearing above except for small massive lens at top, basal part somewhat friable.			19	6			68	0
7		Upper Bakerstown	Ewing	Clay shale, varicolored, tan, purple, yellow, silty, micaceous, breaks with a more or less starch-like fracture, with limestone nodules, grades into or is succeeded upward by chocolate fissile shale, poorly exposed.			16	7	29	1	48	6
6			Cow Run	Sandstone and shale, light bluish gray with some limonite stain, fine to medium, micaceous, shaly, irregularly bedded sandstone interbedded with and grading upward into light bluish gray, silty, sandy, micaceous shale which grades upward into clayey tan shale, concretions near top.			12	6			31	11
5		Anderson	Portersville	Shale, full gray with some limonite stain, argillaceous to sandy, micaceous, scattered calcareous nodules, fossiliferous, marine.			1	9	19	5	19	5
4			Anderson	Clay, gray to light gray with red mottling and some limonite stain, silty, micaceous, lean plasticity, slickensided.			1	0			17	8
3			?	Covered interval.			2	8			16	8
2			Bakerstown	Sandstone, light gray, mostly stained dull brown and yellowish brown, medium, micaceous, bedded in layers up to 6 or more inches thick, calcareous at top.			2	6			14	0
1				Shale, light blue-gray to blue-gray with some limonite stain, silty, sandy, micaceous, partly concealed.			11	6			11	6

LOCATION KEY: Aa 35 FILE NUMBER: 11242 ELEVATION: 647 ± base TOPO MAP: Athens

STATE: Ohio COUNTY: Athens TOWNSHIP: Athens SECTION: $N\frac{1}{2}$ $NW\frac{1}{4}$ $SW\frac{1}{4}$ $NE\frac{1}{4}$ and $NE\frac{1}{4}$ $SE\frac{1}{4}$, 8

LOCATION: Exposure along stream parallel to Hooper Street and extending along road to top of hill.

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
37	Monongahela	Benwood ?	Sewickley ?	Sandstone, yellowish brown, fine to medium, very micaceous, friable, showing bedding and cross-bedding on weathered surfaces, massive.			14	6	14	6	373	6

LOCATION: Aa 35 FILE NUMBER: 11242 - continued

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
36	Monongahela - continued	Sewickley	Lower Sewickley	Shale, olive drab to gray with purple below some limonite stain, silty, micaceous, breaks irregular to starch-like, small nodules of limestone in lower part, more argillaceous upward.			7	6	20	6	359	0
35				Sandstone, light gray, mostly stained yellowish to brownish, medium to coarse below, finer above, micaceous, massive below, bedded above.			13	0			351	6
34		Fishpot ?	Fishpot ?	Shale, olive drab with some limonite stain, silty, micaceous, becoming sandy upward, laminated, weathers into thin plate.			4	9	20	3	338	6
33				Shale, light tan to pale olive drab with some limonite stain, silty, finely micaceous, mostly calcareous, breaks irregularly with limestone nodules (mostly small except in upper part where they have diameters of 8-10 inches.)			15	6			333	9
32		Redstone	Redstone	Limestone, mostly gray weathering light gray, a little yellow at base, dense, nodular, embedded in clay shale, abundant nodules to 6 inches in diameter.			12	3	12	3	318	3
31	? Conemaugh	Pittsburgh and Upper Little Pittsburgh	Pittsburgh and Upper Little Pittsburgh	Covered interval, some evidence of clay shale with nodular and bedded fresh-water limestone (several limestone blocks 8-10 inches thick), (Pittsburgh) coal blossom reported at 284' above base of section.			42	9	42	9	306	0
30		Lower Little Pittsburgh	Connellsville	Sandstone, light gray, surfaces stained brown to yellow, coarse except near top where it is medium to coarse, arkosic?, micaceous, friable, massive showing some bedding and cross-bedding.			45	9	45	9	263	3
29		Little Clarksburg	Clarksburg	Clay shale, light gray with some limonite stain, somewhat plastic.			1	0	57	6	217	6
28				Covered interval, some evidence of red clay shale.			56	6			216	6
27		Elk Lick	Elk Lick	Clay shale, light gray to tan and maroon, calcareous clay shale with nodular tan to gray, dense limestone in basal part.			15	6	22	2	160	0
26			Upper Grafton	Shale, pale tan to olive drab, argillaceous, silty, finely micaceous, platy to fissile.			6	8			144	6
25		Duquesne	Skelley	Limestone, dark greenish to purplish gray, much weathered yellowish brown, dense, silty, sandy, slightly micaceous, ferruginous, fossiliferous, marine, a nodular ledge.			0	6	34	11	137	10
24				Shale and clay shale, variable tan to olive drab, silty, finely micaceous shale and variegated clay shales with float blocks of yellowish, fossiliferous, marine limestone.			6	7			137	4
23			Duquesne	Sandstone, light gray, mostly stained brown or yellow, fine to medium, mostly fine, slightly silty, micaceous, calcareous, somewhat friable, heavy bedded to massive below, shaly appearing upward.			11	10			130	9
22				Clay shale, light gray to tan below, mottled maroon and purple upward, considerable limonite stain, calcareous with very small limestone nodules, weathers plastic.			16	0			118	11
21		Gaysport	Gaysport ?	Shale, tan to chocolate brown, silty, finely micaceous, smooth, breaks into irregular platy chips, fossiliferous, marine, with few nodules of yellow, dense limestone.			7	10	7	10	102	11
20		Ames	Ames	Limestone, light gray with some limonite stain throughout and purple stain near top, mostly dense with some small crystals, fossiliferous, marine.			1	2	12	10	95	1
19				Clay shale, light olive, silty, weathers somewhat plastic, calcareous, fossiliferous.			0	4			93	11
18				Sandstone and shale, light gray to pale olive drab with some limonite stain, fine, silty, finely micaceous, bedded or shaly appearing sandstone and sandy shale.			11	4			93	7

LOCATION: Aa 35 FILE NUMBER: 11242 - continued

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
17	Conemaugh - continued	Harlem	Harlem	Clay shale, dark gray, carbonaceous with bits of woody material, finely micaceous, laminated.			0	5	26	0	82	3
16				Coal, weathered.			0	1			81	10
15				Clay, light gray to tan, somewhat plastic top and bottom.			0	10			81	9
14			?	Covered interval			19	8			80	11
13			Round Knob ?	Clay shale and limestone, varicolored, light gray, yellow, and maroon, silty, finely micaceous, calcareous clay shale with numerous small, mostly under 1 inch in size, light gray to buff limestone nodules.			5	0			61	3
12		Upper Bakerstown	Ewing	Shale and limestone, light gray to bluish gray with some limonite stain, silty, micaceous, calcareous shale with numerous, small, irregular nodules of dense, iron-stained, light bluish gray limestone, thickness variable, base uneven.			6	0	18	3	56	3
11			Cow Run	Shale and sandstone, light bluish gray with some limonite stain, silty, micaceous shale and fine, silty, micaceous, calcareous sandstone in layers up to 18 inches thick, with calcareous masses and veins, a zone of variable lithology and thickness.			12	3			50	3
10		Anderson	Portersville ?	Clay shale, chocolate brown to maroon, silty, finely micaceous, laminated, breaks into irregular chips, slightly plastic when pulverized and wet, sparingly fossiliferous with marine fossils in lower part.			3	0	6	4	38	0
9			Portersville	Clay shale and limestone, light olive with limonite stain, calcareous, fossiliferous, marine shale with nodules of light gray to greenish, ferruginous, dense, fossiliferous marine limestone to 6 inches in diameter.			0	7			35	0
8				Clay shale, bluish gray with some limonite stain, silty, calcareous, laminated, fossiliferous, marine.			1	9			34	5
7			Anderson	Coal smut.			0	$\frac{1}{2}$			32	8
6				Clay, gray in top 1 inch, light gray to pale buff below, silty, somewhat plastic at top, exposed.			1	0			32	8
5		Wilgus	Buffalo	Covered interval. Cambridge limestone probably present. See section 11243.			5	7	24	7	31	8
4				Shale and sandstone, variable light gray to pale olive or dull maroon with some limonite stain, silty, micaceous to argillaceous shale, with thin flaggy, similarly colored fine, micaceous sandstone up to 4 inches thick, exposed.			19	0			26	1
3		Upper Brush Creek	Upper Brush Creek	Limestone, gray to light gray, much weathered dull reddish brown, mostly dense, sandy, ferruginous, fossiliferous, marine.			0	2	7	1	7	1
2				Limestone, light gray with slight limonite surface stain, sandy, partly crystalline, sparingly fossiliferous, marine, a very massive ledge.			1	4			6	11
1				Sandstone, light greenish gray with some limonite stain, fine, micaceous, shaly in appearance, cross-bedded at top, covered in part.			5	7			5	7

LOCATION KEY: Aa 36 FILE NUMBER: 11243 ELEVATION: 676 base TOPO MAP: Athens

STATE: Ohio COUNTY: Athens TOWNSHIP: Athens SECTION:

LOCATION: Section up hill east up Mulligan Road beginning 100 yards east of U. S. 33, 1 mile south of hedge across Hocking River at Athens.

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
55	Monongahela	Benwood	Benwood	Clay shale, maroon, exposed to hill top, road junction.			3	4	32	0	350	0
54			Sewickley	Sandstone, gray to olive drab, micaceous, limonite stained, mostly thin bedded to shaly, some medium bedding.			21	8			346	8
53				Shale and sandstone, gray to buff, shaly sandstone and gray to maroon clay shale interbedded.			7	0			325	0
52		Sewickley	Sewickley	Clay shale, gray to greenish gray, silty, calcareous, contains scattered limestone nodules, poorly exposed.			10	8	25	0	318	0
51				Concealed.			7	4			307	4
50				Clay shale, tan to maroon, finely micaceous			5	5			300	0
49			Lower Sewickley	Sandstone, gray to tan, limonite stained, fine, thin to medium bedded, micaceous, argillaceous and silty at top.			1	7			294	7
48		Fishpot	Fishpot	Clay shale, maroon to green upward, contains small limestone nodules in base and larger nodules in green parts, varies laterally to clay shale, gray, limonite stained, finely micaceous, contains small scattered limestone nodules.			11	10	30	11	293	0
47			Pomeroy	Sandstone, gray to buff, limonite stained, micaceous, fine.			9	2			281	2
46		?	?	Clay shale, dark red to brown, containing nodules of fresh-water limestone that weather yellow and with a fretted appearance.			9	11			272	0
45		Redstone	Redstone	Clay, light gray, plastic.			0	3	27	8	262	1
44				Carbonaceous shale, dark gray to black, silty, coal horizon.			0	4			261	10
43				Clay shale, gray, limonite stained, silty.			0	10			261	6
42				Clay, light gray, plastic.			0	2			260	8
41			Upper Pittsburgh	Sandstone, gray to buff, limonite stained, fine to medium, irregularly bedded, thin to massive to shaly, base is concealed zone below.			26	3			260	6
40		Pittsburgh	Pittsburgh	Concealed, some gray clay shale over limestone below, Pittsburgh coal should be here.			5	0	23	9	234	3
39			Upper Pittsburgh	Limestone, light gray, limonite stained, hard, nodular ledge, irregular.			0	10			229	3
38			Lower Pittsburgh	Clay shale, gray to tan, mottled red to yellow and purple, covered in part.			9	5			228	5
37				Concealed, probably sandstone.			3	0			219	0
36				Sandstone, shaly, gray to tan, micaceous, fine, limonite stained, poorly exposed at top			5	6			216	0
35	Conemaugh	Lower Little Pittsburgh	Lower Little Pittsburgh	Clay, light gray, some carbonaceous flecks			0	2	25	8	210	6
34			Lower Pittsburgh	Covered, with some clay shale and limestone showing.			10	0			210	4
33			Connellsville	Shale and sandstone, gray to olive drab, fine, micaceous sandstone interbedded with gray to maroon,sandy, argillaceous shale. Limestone nodules in upper part, exposed.			4	0			200	4
32				Sandstone, gray to buff, micaceous, limonite stained, fine, thin to slabby bedded.			11	6			196	4
31		Little Clarksburg	Little Clarksburg	Coaly shale, bony streaks in shale, thin layers intermixed.			0	6	56	8	184	10
30				Coal, bony, micaceous, weathered.			0	3			184	4
29				Clay shale, gray, much limonite stained, thin carbonaceous streaks.			0	8			184	1
28				Coal, dull, bony, irregular clay partings.			0	3			183	5
27			Clarksburg	Clay shale, gray, limonite stained.			0	5			183	2
26				Clay shale, gray to medium gray, many scattered limestone nodules, some up to 1 foot in diameter, exposed.			17	9			182	9

LOCATION: Aa 36 FILE NUMBER: 11243 - continued

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
25	Conemaugh - continued	Little Clarksburg - continued	Morgantown - Elk Lick in base	Covered, appears to be gray and maroon clay shale with light gray, hard, nodular, fresh-water limestone weathering out, some small exposures show in zone.			36	10			165	0
24		Elk Lick	Elk Lick	Limestone, light gray, hard, limonite stained, nodular, in gray clay shale.			3	0	22	5	128	2
23			Birmingham	Clay shale, gray to maroon and purple, contains small scattered limestone nodules, lower contact poorly exposed.			7	10			125	2
22				Shale, gray to olive drab, some maroon zones, thin bedded, argillaceous, poorly exposed upward.			11	7			117	4
21		Duquesne	Skelley	Limestone, gray to dark gray, dense, partially crystalline, nodular, marine, fossiliferous, variable 4-6 inches.			0	5	26	9	105	9
20				Siltstone, gray to tan, limonite stained, micaceous, thin to shaly bedded, argillaceous.			14	8			105	4
19			Duquesne	Clay shale, green-gray to purple, nonbedded below becoming light gray and bedded above, sandy at top.			2	0			90	8
18				Clay shale, gray, mottled maroon and purple, contains some sandy zones and scattered, small limestone nodules.			9	8			88	8
17		?	?	Covered interval.			7	10	7	10	79	0
16		Ames	Ames	Limestone, gray, massive, limonite stained, dense to partially crystalline, fossiliferous, marine.			1	0	12	6	71	2
15				Covered interval.			1	0			70	2
14				Sandstone, gray to tan, fine, micaceous, thin to massive bedded, limonite stained, exposed.			10	6			69	2
13		Harlem	?	Covered interval.			8	8	11	8	58	8
12			Round Knob ?	Clay shale, gray to tan, mottled maroon, silty in zones, limonite stained, exposed.			3	0			50	0
11		Upper Bakerstown	Cow Run - in part	Shale and sandstone, gray to tan, limonite stained, silty shales below becoming more massive-bedded sandstone above, micaceous, limestone nodules in upper 6 feet.			34	4	34	9	47	0
10				Clay shale, maroon, nonbedded, iron stained.			0	5			12	8
9		Anderson	Portersville	Clay shale, gray to dark gray, limonite stained, some carbonaceous streaks, fossiliferous, marine.			0	6	7	8	12	3
8			Anderson	Clay shale, carbonaceous.			0	$\frac{1}{4}$			11	9
7				Clay, gray, plastic.			0	1			11	$8\frac{3}{4}$
6				Clay shale, carbonaceous.			0	$\frac{1}{4}$			11	$7\frac{3}{4}$
5				Clay, light gray, plastic.			0	$\frac{1}{2}$			11	$7\frac{1}{2}$
4				Clay shale, gray to tan, limonite stained, silty, micaceous.			6	11			11	7
3				Clay, light gray, plastic, silty.			0	1			4	8
2		Wilgus	Cambridge	Limestone, gray to tan, limonite stained, nodular, sandy, impure, fossiliferous, marine.			0	3	4	7	4	7
1			Buffalo ?	Shale, gray to tan, limonite stained, silty to sandy upward, exposed.			4	4			4	4

LOCATION KEY: Aa 38 FILE NUMBER: 11245 ELEVATION: 622 base TOPO MAP: Athens

STATE: Athens COUNTY: Athens TOWNSHIP: Athens SECTION: SE¼ NE¼, 9 to the NE¼ SE¼, 3

LOCATION: Exposure extending southeast along Rock Riffle Creek

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
41	Monongahela	Redstone ?	?	Covered interval, with blocks of fretted yellow and nodular light gray limestone and tan to olive drab, chippy shale, unmeasured			-	-			-	-
40		Pittsburgh	Pittsburgh	Coal, badly weathered, probably slumped.			0	6	19	8	281	9
39			?	Covered interval, showing some pale olive, silty, micaceous shale, clay below coal.			19	2			281	3
38	Conemaugh	Upper Little Pittsburgh	Upper Little Pittsburgh	Limestone, light gray-drab, weathered light gray with some limonite stain, nodules to 18 inches in diameter, embedded in calcareous clay shale.			5	0	12	5	262	1
37		?	?	Covered interval, showing chips of sandy shale.			15	0			257	1
36		Lower Little Pittsburgh	Lower Pittsburgh?	Shale and limestone, pale olive drab with limonite stain, silty, micaceous, massive shale with small scattered, ferruginous limestone nodules.			3	0	58	1	242	1
35			Connellsville	Sandstone, light gray with much limonite stain, medium to coarse, finer upward, micaceous, somewhat friable, massive, showing some bedding and cross-bedding, base uneven.			47	8			239	1
34		Little Clarksburg	Little Clarksburg	Coal, bony, many fossil plants.	0	2	4	8	11	4	191	5
33				Coal, bright, blocky.	1	1					191	3
32				Shale, gray to dark gray, coaly.	1	3					190	2
31				Coal, bright, blocky.	0	2					188	11
30				Shale, gray, with some limonite stain, carbonaceous streaks and plant material.	1	0					188	9
29				Coal, bright, blocky, with thin bony partings, some pyrite.	1	0					187	9
28			Clarksburg	Clay, light gray with some limonite stain, silty, micaceous, laminated above, massive with starch-like fracture below, fossil plants.			2	0			186	9
27			Morgantown ?	Covered interval			9	4			184	9
26		Elk Lick	Elk Lick - (Birmingham ?)	Limestone, pale greenish gray with considerable limonite stain, dense with few calcite veins, fossiliferous, fresh-water, nodular, probably slumped somewhat.			1	4	37	3	175	5
25			Birmingham	Clay shale, light greenish gray, mottled purplish, some limonite stain with few scattered nodules of gray limestone up to 3 inches in diameter, micaceous, silty.			11	7			174	1
24				Covered interval, with some show of clay shale and nodular limestone.			19	8			162	6
23		Duquesne	Skelley	Limestone, light greenish gray with much limonite stain and some dendrites, nodular, fossiliferous, marine.			0	4	31	0	142	10
22				Sandstone, light gray with considerable limonite stain, micaceous, fine to medium, massive to heavy-bedded below to thin-bedded above.			18	2			142	6
21				Shale and sandstone, light gray with considerable limonite stain, finely micaceous, laminated, clay shale interbedded with argillaceous, micaceous sandstone.			4	0			124	4
20			Duquesne	Shale, gray to dark gray with limonite crusts along bedding planes, finely micaceous and tiny flakes of carbon, laminated.			0	7			120	4
19				Shale, black with some limonite stain, bony, carbonaceous, fossiliferous (numerous estheriids), coaly streaks.			0	2			119	9
18				Clay, light gray with limonite stain, slightly silty, massive to poorly laminated, only slightly plastic, thin dark layer at top with tiny light specks.			0	9			119	7
17				Clay shale, light greenish gray, with considerable limonite stain, silty, finely micaceous, massive, breaks with starch-like fracture, slightly calcareous with small limestone nodules in base.			7	0			118	10

LOCATION: Aa 38 FILE NUMBER: 11245 - continued

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
16	Conemaugh - continued	Gaysport	Gaysport	Shale, light gray weathering pale olive, some limonite stain, silty, sandy, micaceous, becomes finer grained upward.			17	3	17	3	111	10
15		Ames	Ames	Limestone, light gray with considerable brown stain below, mostly dense, few crystals, massive, in two layers, lower one thicker, fossiliferous, marine.			1	8	14	7	94	7
14				Shale, light blusih gray with slight limonite stain, silty, finely micaceous, argillaceous at top, flakes of carbonaceous material.			3	6			92	11
13				Sandstone, light gray with considerable limonite stain, micaceous, fine to medium, heavy and evenly bedded, becomes shaly upward.			3	5			89	5
12				Shale, light gray to gray, much limonite stained, thin streaks and zones of carbonaceous material, fossil plants.			6	0			86	0
11		Harlem	Harlem	Shale, black, carbonaceous, laminated, fissile			1	11	29	0	80	0
10				Coal, bright, blocky with fusain layer on top, pyritized log.			0	1			78	1
9				Clay shale, similar to that below but more argillaceous, slightly plastic at top.			1	0			78	0
8				Clay shale, greenish gray with some limonite stain, silty, finely micaceous, grainy with "shot", massive, breaks irregularly.			4	5			77	0
7			Rock Riffle	Limestone, gray, weathering greenish gray, dense, heavy-bedded to nodular, embedded in greenish gray shale, fossiliferous, fresh-water.			4	6			72	7
6			Round Knob	Shale and limestone, variegated light bluish gray to purplish, silty, sandy, micaceous, massive, breaking irregularly, numerous scattered nodules of ferruginous, light bluish gray limestone containing numerous Spirorbis near base, small limestone nodules throughout.			17	1			68	1
5		Anderson	Anderson and Portersville	Shale, black and light gray interbedded, carbonaceous, fissile, fossiliferous (plants clams, fish) interbedded with light gray, argillaceous shale, grades laterally into bony coal.			3	0	21	6	51	0
4			Bloomfield	Clay shale, light bluish gray below to dark gray above, micaceous, silty, with carbonaceous streaks, massive, breaks irregularly, slickensided, with scattered ferruginous nodules.			2	3			48	0
3			Bakerstown	Sandstone, light gray with some limonite stain, medium to coarse, conglomeratic with small quartz pebbles in basal several feet, massive below, bedded above, olive and finer grained upward.			16	3			45	9
2		Wilgus	Cambridge	Limestone, light gray with limonite stained surfaces, partly crystalline, firm, sandy, fossiliferous, marine.			1	3	29	6	29	6
1			Buffalo	Shale and sandstone, light gray to light bluish gray with some limonite stain, silty, sandy, micaceous shale below, interbedded with and grading upward into fine to medium, micaceous, bedded sandstone, few siderite-limonite concretions.			28	3			28	3

LOCATION KEY: Aa 12 FILE NUMBER: 11434 ELEVATION: 702 base TOPO MAP: Athens

STATE: Ohio COUNTY: Athens TOWNSHIP: Athens SECTION: NW¼, 10

LOCATION: Exposure along route 33 on Courtney Hill at north edge of Athens and 0.75 mile west of Road Junction 642.

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
26	Conemaugh	Lower Little Pittsburgh	Connellsville	Sandstone, light gray with yellowish brown stain, micaceous, mostly medium to coarse friable, somewhat case hardened and considerable cross-bedding on surface.			10	5	10	5	220	0
25		Little Clarksburg	Clarksburg	Shale, gray with slight yellowish stain, argillaceous, calcareous, silty, with nodules and layers of light gray fresh-water limestone, exposed.			4	0	76	7	209	7
24				Covered interval			27	2			205	7
23			Morgantown	Shale and clay shale, gray with limonite stain, mottled yellow to red, maroon, micaceous, silty to sandy, contains nodular fresh-water limestone up to 2 inches in diameter.			45	5			178	5
22		Elk Lick	Upper Grafton	Sandstone, light gray to olive with limonite stain, silty, micaceous, fine-grained, thin and irregular-bedded, becomes shaly upward.			15	2	38	2	133	0
21				Sandstone, light gray, stained yellowish to brown on surfaces, fine to medium, micaceous, mostly massive, shows some bedding on surface, grades laterally into shaly zones, coarse at top, pyrite layers near base.			23	0			117	10
20		Duquesne	Duquesne	Coal horizon, local.			0	1			94	10
19				Clay shale, mostly greenish gray, mottled with yellow-buff, somewhat plastic toward top, numerous small ferruginous limestone nodules at top.			5	4			94	9
18				Shale, light greenish gray with some limonite stains, grading upward to clay shale, argillaceous.			4	2			89	5
17		? Gaysport ?	? Gaysport ?	Shale, pale greenish gray to darker gray becoming purplish gray upwards, argillaceous with small ferruginous nodules toward top, fossiliferous, marine in lower part.			3	6	?		85	3
16				Limestone, pale yellowish brown to olive drab, dense, impure, with irregular calcite veins, nodular, fossiliferous, marine, embedded in olive drab limonite stained silty shale.			1	4			81	9
15				Shale, light gray to light olive drab with limonite stain, silty, argillaceous, micaceous			4	1			80	5
14		Ames	Ames	Limestone, light gray with limonite stain near surfaces, dense to partly crystalline, fossiliferous, marine, in singly massive layer.			1	6	11	3	76	4
13				Clay shale, dark gray, with some limonite stain, finely micaceous, thin carbonaceous streaks.			1	6			74	10
12				Sandstone and shale, light olive drab, silty, finely micaceous shale grading upward into silty, fine, micaceous sandstone with thin veins of calcite and few small flattened siderite-limonite concretions.			8	3			73	4
11		Harlem	Harlem	Shale, variably colored dark gray to black, greenish gray to dull chocolate, maroon, somewhat fissile, argillaceous and/or carbonaceous, very finely micaceous.			1	0	20	6	65	1
10			Rock Riffle and Round Knob	Clay, light greenish gray to gray above, small fresh-water limestone nodules in base, somewhat silty, finely micaceous, moderately plastic.			3	2			64	1
9				Clay shale, dull, chocolate, maroon, with light yellowish gray, grades upward into greenish gray, with small limestone nodules, locally present.			16	4			60	11

LOCATION: Aa 12 FILE NUMBER: 11434 - continued

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
8	Conemaugh - continued	Upper Bakerstown	Ewing and Cow Run	Shale, light gray, silty to sandy, finely micaceous, becomes sandy upward with zones of silty, micaceous fine sandstone up to several feet thick, also with zones of thin calcite veins and impure fresh-water limestone at top, grades into chocolate maroon clay shale with small freshwater limestone nodules.			27	0	27	0	44	7
7		Anderson ?	Portersville ?	Shale, dull chocolate maroon with light greenish gray masses, argillaceous, finely micaceous, grades upward into olive drab shale.			5	0	5	0	17	7
6		Anderson	Portersville	Shale, light greenish gray with slight limonite stain, finely micaceous, fossiliferous, marine with nodules of fossiliferous marine limestone.			0	8	12	7	12	7
5				Shale, gray, argillaceous and calcareous, finely micaceous, fossiliferous especially in basal part, marine.			3	4			11	11
4			Anderson	Coal, shaly, some bright.			0	½			8	7
3			Bloomfield	Clay shale and clay, light gray, silty, sandy, micaceous shale at base, grading upward into gray, limonite stained, calcareous clay with scattered small limestone nodules, both somewhat plastic.			7	7			8	6½
2			Bakerstown ?	Sandstone, light gray to almost white, fine, silty, micaceous, slightly calcareous.			0	5½			0	11½
1				Shale, light olive gray with some limonite stain, sandy, silty, micaceous, exposed.			0	6			0	6

LOCATION KEY: Aa 1 FILE NUMBER: 11484 ELEVATION: 667 base TOPO MAP:

STATE: Ohio COUNTY: Athens TOWNSHIP: Athens SECTION: unnumbered

LOCATION: Exposures along northeast side of Route 33 about 0.3 mile northwest of junction with Route 50 (alternate) at Sugar Creek.

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
26	Conemaugh	?	?	Shale, poorly exposed, unmeasured.			-	-			-	-
25		Ames	Ames	Limestone, light gray, partly crystalline, fossiliferous, marine.			1	0	12	0	136	0
24				Covered interval.			5	0			135	0
23				Sandstone and shale, gray, medium sandstone and gray silty shale interbedded in layers 8 to 20 inches thick, exposed.			6	0			130	0
22		Ames and Harlem	?	Covered interval. Harlem coal should be in this interval.			20	3	20	3	124	0
21		Harlem	Rock Riffle, Round Knob, and Saltsburg	Shale, gray, silty, with layers of fine, silty sandstone, exposed.			3	0	11	6	103	9
20				Clay shale, full gray to lighter yellowish gray in basal 18 inches, starch-like fracture, with small scattered limestone nodules throughout.			8	6			100	9
19		Upper Bakerstown	Upper Bakerstown ?	Clay, gray to gray drab with considerable limonite stain on surfaces, flinty, numerous slickensides.			1	10	26	1	92	3
18			Ewing	Limestone and clay shale, gray, dense, nodular limestone embedded in silty and finely sandy clay shale, limestone nodules more abundant in upper half.			2	6			90	5
17			Cow Run	Shale, gray drab with small amount of limonite stain, argillaceous, rather soft.			1	0			87	11
16				Sandstone, gray, medium, micaceous, massive.			13	6			86	11
15				Shale, gray, argillaceous, with layers of medium sandstone, partly covered.			7	3			73	5

LOCATION: Aa 1 FILE NUMBER: 11484 - continued

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
14	Conemaugh -	Anderson	Anderson	Clay, dark gray.			0	2	5	5	66	2
13	continued			Clay, light gray, with nodules of ferruginous limestone, breaks with starch-like fracture.			1	6			66	0
12			Bakerstown	Sandstone, gray, drab, calcareous			0	8			64	6
11				Shale, gray, silty.			3	1			63	10
10		Wilgus	Cambridge	Limestone, gray, weathers yellowish to brownish, ferruginous, fossiliferous, marine.			0	9	27	1	60	9
9			Buffalo	Shale, gray, silty.			9	4			60	0
8				Shale, gray, silty to sandy, with numerous layers and thin lenses of fine silty sandstone.			7	5			50	8
7				Shale, gray, argillaceous to silty, with scattered siderite concretions.			9	7			43	3
6		Upper Brush Creek	Upper Brush Creek	Limestone, gray, weathers yellowish and brownish at top, granular, fossiliferous, marine.			2	0	30	4	33	8
5				Shale and sandstone, gray, silty, micaceous shale with upward gray, silty, micaceous sandstone weathering into thin layers with scattered siderite concretions.			28	4			31	8
4		Lower Brush Creek	Lower Brush Creek	Limestone, gray, ferruginous, fossiliferous, marine.			0	1	3	4	3	4
3				Shale, gray, dense, fossiliferous, marine.			0	4			3	3
2				Limestone, gray, dense, ferruginous, fossiliferous, marine.			1	2			2	11
1				Underclay, gray, starch-like fracture, exposed.			1	9			1	9

LOCATION KEY: Aa 13 FILE NUMBER: 11485 ELEVATION: 751 ± base TOPO MAP: Athens

STATE: Ohio COUNTY: Athens TOWNSHIP: Athens SECTION: SW¼ NE¼, 30 to SE¼ NW¼, 30

LOCATION: Exposure along road starting near road junction 739, 0.7 mile west of church at road junction 715 and 1.1 miles south of Beaumont.

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
18	Conemaugh	Duquesne	Duquesne	Clay shale, light gray to red, maroon at top with scattered limonite concretions, weathers to clay.			11	3	13	6	129	0
17			Lower Grafton	Shale, olive drab with much limonite stain in places, argillaceous, silty, and finely micaceous.			2	3			117	9
16		Gaysport	Gaysport	Limestone, greenish gray to light gray with much limonite stain on surfaces, finely crystalline, sparingly fossiliferous, marine			1	0	6	6	115	6
15				Shale, olive drab, some limonite stain, silty to argillaceous, very finely micaceous.			5	6			114	6
14		Ames	Ames	Limestone, light gray, considerable limonite stain on surfaces, marine, fossiliferous			1	6	18	10	109	0
13				Clay shale and shale, gray to olive drab, silty, micaceous clay shale with light gray, argillaceous, silty shale above.			17	4			107	6
12		Harlem	Harlem	Coal, badly weathered, poorly exposed, possibly slumped.			0	2	9	9	90	2
11			Saltsburg	Shale and clay shale, buff to yellowish brown, limonite stained, silty, finely micaceous, weathered, grades into clay at top.			6	3			90	0
10				Sandstone, light gray weathers brownish gray to brown, fine, micaceous, bedded in layers 1 to 4 inches thick.			3	4			83	9

LOCATION: Aa 13 FILE NUMBER: 11485 - continued

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
9	Conemaugh - continued	Upper Bakerstown	Ewing and Cow Run	Shale and siltstone, buff to olive drab, argillaceous to silty, micaceous, weathered, contains nodular fresh-water limestone.			31	11	41	5	80	5
8				Clay shale, dull, chocolate maroon to buff, weathered, poorly exposed in part.			9	6			48	6
7		Anderson	Portersville	Shale, gray with some limonite stain, argillaceous to slightly silty, fossiliferous, marine, soft, weathered, exposed.			1	0	23	0	39	0
6			Anderson	Coal, dull with some bright, much weathered and probably slumped.			1	0			38	0
5				Clay, light gray with limonite stain, plastic, slightly micaceous, slumped, exposed.			1	6			37	0
4			Bloomfield	Clay shale, dull greenish gray, calcareous, micaceous with small yellowish granules and scattered nodules of limestone, more clay-like upward.			10	4			35	6
3			Bakerstown	Sandstone, light gray, weathers pale brown to yellow, fine, micaceous, very calcareous, a single ledge.			0	8			25	2
2				Shale, olive drab with some limonite stain, argillaceous to silty, micaceous, sandy, ferruginous layer at base, becomes sandy upward.			8	6			24	6
1		Wilgus	Buffalo and Cambridge ?	Sandstone, light gray weathered brown to yellow, fine to medium, micaceous, thin-bedded to massive, top one foot calcareous, exposed.			16	0	16	0	16	0

LOCATION KEY: Aa 19 FILE NUMBER: 11487 ELEVATION: 709' ± base TOPO MAP: Athens

STATE: Ohio COUNTY: Athens TOWNSHIP: Athens SECTION: SE¼ NE¼ to NE¼ SE¼, 5

LOCATION: Section measured in gully 0.2 mile west of Athens-Canaan Township line and 0.25 mile south of Tucker Hollow Road on John Gillette property.

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
16	Monongahela	Fishpot?	Fishpot ?	Limestone, dull yellow, weathers to a state resembling decaying wood, fretted.			3	9	3	9	238	7
15	Conemaugh	?	?	Covered interval, shows slump blocks of dull yellow and light gray limestone which weathers to thin chalky white and silty olive drab soil.			24	2	24	2	234	10
14		Upper Little Pittsburgh ?	Lower Pittsburgh (Bellaire) ?	Siltstone, olive drab, micaceous, weathers to thin beds, massive when fresh.			19	8	19	8	210	8
13		?	?	Covered interval, shows maroon, calcareous soil and thinly bedded arenaceous light brown shale float.			62	6	62	6	191	0
12		Little Clarksburg	Morgantown	Sandstone, light brown, limonite stain on surface, medium to coarse-grained, massive.			23	5	23	5	128	6
11		Elk Lick	Upper Grafton and Birmingham	Covered interval, shows light brown, coarse-grained sandstone and maroon, calcareous soil float.			36	2	40	1	105	1
10			Upper Grafton	Shale, light grayish blue, finely arenaceous, fissile.			3	7			68	11
9				Sandstone, olive drab, fine-grained, calcareous.			0	4			65	4
8		Duquesne	Duquesne	Covered interval, shows light blue arenaceous shale and sandy maroon soil float.			21	4	27	0	65	0
7				Clay shale, greenish gray, lowermost 1' 7" is pure, grades upward to a light blue arenaceous shale.			5	8			43	8
6		Gaysport	Gaysport	Limestone, light blue, nodular, very arenaceous, sparingly fossiliferous, marine.			0	11	9	5	38	0
5				Shale, dark blue, irregular limonite stain, fissile, arenaceous.			0	11			37	1

LOCATION: Aa 19 FILE NUMBER: 11487 - continued

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
4	Conemaugh - continued	Gaysport - continued	Gaysport - continued	Limestone, bluish gray, weathers nodular, marine.			0	8			36	2
3				Clay shale, varies from dark blue to gray, finely arenaceous.			6	11			35	6
2		Ames	Ames	Limestone, light gray, crystalline, fossiliferous, marine.			1	11	28	7	28	7
1				Sandstone, bluish gray, finely grained, well bedded.			26	8			26	8

LOCATION KEY: Aa 39 FILE NUMBER: 11489 ELEVATION: 660 base TOPO MAP: Athens

STATE: Ohio COUNTY: Athens TOWNSHIP: Athens SECTION: unnumbered

LOCATION: Exposure on northeast side of Route 33 and about 0.5 mile northwest of junction with Route 50 (alternate).

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
7	Conemaugh	Upper Brush Creek	Upper Brush Creek	Limestone, dark bluish gray with some limonite stain, dense to finely crystalline, sandy in lower part, fossiliferous, marine.			2	8	42	6	42	6
6				Shale, gray drab with limonite stain, sandy and micaceous, no apparent fossils.			2	0			39	10
5				Sandstone, light gray, much stained yellowish to brownish, medium, micaceous, calcareous, weathering with rounded surfaces, fossiliferous, marine.			2	4			37	10
4				Shale, gray drab with considerable limonite stain, sandy and micaceous especially upward where the rock is somewhat concretionary.			14	0			35	6
3				Coal, shaly with some bright streaks and with much fusain and many fossil plants, somewhat weathered.			1	0			21	6
2				Clay, gray with limonite stain, very micaceous and sandy.			3	9			20	6
1				Shale and sandstone, gray to light brown with limonite stain, medium, micaceous, thin-bedded sandstone in layers and lenses up to 6 inches thick interbedded with and intergrading into gray, drab, argillaceous shale.			16	9			16	9

LOCATION KEY: Aa 7 FILE NUMBER: 11631 ELEVATION: 647 base TOPO MAP: Athens

STATE: Ohio COUNTY: Athens TOWNSHIP: Athens SECTION: $N\frac{1}{2}$ and $SW\frac{1}{4}$ $SE\frac{1}{4}$, 34

LOCATION: Exposure in ravine, 0.65 mile southeast of Brookville and 1.2 miles east of Luhrig.

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
28	Conemaugh	Duquesne	Duquesne and/or Birmingham	Shale and clay shale, light gray, silty and micaceous shale grading upward into red mottled, poorly exposed clay shale, contains fresh-water limestone.			30	7	55	0	295	0
27			Lower Grafton ?	Sandstone, buff to brown, limonite stained, fine, somewhat friable, finely micaceous, massive.			24	5			264	5
26				Covered interval.			13	0			240	0
25		? Ames	? Ames	Shale, light gray to buff and olive drab, much limonite stained, silty, argillaceous, finely micaceous, poorly exposed at top.			32	11	?		227	0
24		Harlem	Harlem	Coal, dull, weathered and slumped.			0	1	15	5	194	1
23			Saltsburg	Shale, olive drab, limonite stained, argillaceous, silty, ferruginous zones and scattered concretions, poorly exposed in part, expecially at top.			15	4			194	0

LOCATION: Aa 7 FILE NUMBER: 11631 - continued

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
22	Conemaugh - continued	Upper Bakerstown	Ewing	Limestone, light gray, fresh-water, nodular appearing, limonite stained at surface, variable.			0	8	24	10	178	8
21			Cow Run	Shale, tan to pale maroon, argillaceous with some slickensides, grades upward into similar light gray shale.			24	2			178	0
20		Anderson	Portersville	Shale, gray, light gray, micaceous, argillaceous, fossiliferous, with layer of ferruginous nodular limestone.			1	2	30	0	153	10
19				Shale, dark gray, argillaceous, fossiliferous, micaceous, marine (horizon of Anderson coal, reported as having been mined).			1	9			152	8
18			Anderson ?	Clay, light yellowish gray, limonite stained, slightly micaceous, plastic.			8	7			150	11
17			Bakerstown	Sandstone, with limonite stain, fine, silty, micaceous, thin-bedded to shaly, slightly calcareous at top.			18	6			142	4
16		Wilgus	Buffalo	Shale, light bluish gray, with some limonite stain, argillaceous to silty, finely micaceous, some siderite concretions.			13	8	13	8	123	10
15		Upper Brush Creek	Upper Brush Creek	Clay shale, light gray with some limonite stain, argillaceous and silty, small nodules of limestone and limonite, fossiliferous, marine.			0	9	36	4	110	2
14				Limestone, light gray, with limonite surfaces, partly crystalline, fossiliferous, marine, variable.			0	3			109	5
13				Shale, light gray, with much limonite stain argillaceous, silty, fossils?, variable.			0	4			109	2
12				Limestone, light gray to gray, partly crystalline, limonite surfaces, fossiliferous, marine, variable.			0	6			108	10
11				Sandstone, light gray, with limonite surfaces, fine to medium, micaceous, exposed laterally, grades locally into shale.			15	4			108	4
10				Shale, light gray to gray, grades from siltstone at bottom, limonite stain, with ferruginous concretions, micaceous, poorly exposed in part.			19	2			93	2
9		Lower Brush Creek	Lower Brush Creek	Limestone, gray, weathers brown, partly crystalline, fossiliferous, marine.			0	3	12	6	74	0
8				Shale, gray, fossiliferous, marine.			0	5			73	9
7				Limestone, gray, limonite surfaces, grainy, fossiliferous, marine, trace of coal below.			0	5			73	4
6				Clay and clay shale, light gray, with red mottling, sandy and micaceous, poorly exposed in part, horizon of Mason coal.			11	5			72	11
5		Mason and Mahoning	Mahoning	Sandstone, light gray to buff or brown, limonite stained, medium, micaceous, very massive, weathers in places into slabby appearing rock, calcareous at top.			54	6	60	6	61	6
4				Covered interval.			3	3			7	0
3				Shale, gray, with limonite stain, argillaceous, micaceous, with large scattered limonite nodules 15 inches from base, silty upward.			2	9			3	9
2		Upper Freeport	Upper Freeport	Shale and coal, gray with limonite stain, argillaceous, micaceous, coal, interbedded with several thin, impure layers of coal.			0	6	1	0	1	0
1				Clay, light gray to gray, mottled, with considerable limonite stain on surfaces, plastic, exposed.			0	6			0	6

LOCATION KEY: Aa 10 FILE NUMBER: 11634 ELEVATION: 709 base TOPO MAP: Athens

STATE: Ohio COUNTY: Athens TOWNSHIP: Athens SECTION: 31 and 32

LOCATION: Exposure in tributary of West Branch Creek, located in NW¼ NE¼, section 31, and extending to SW¼ SE¼, section 32.

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
12	Conemaugh	Ames	Ames	Limestone, gray to light gray, dense to partly crystalline, marine, fossiliferous.			0	9	20	5	130	9
11				Shale, olive drab to buff, silty, finely micaceous, with scattered limonite nodules.			19	8			130	0
10		Harlem	Round Knob	Clay shale, light gray to red brown or maroon, silty, finely micaceous, variable.			21	0	21	0	110	4
9		Upper Bakerstown?	Cow Run ?	Shale, gray to light gray, argillaceous, silty and sandy, finely micaceous, with scattered ferruginous concretions.			48	8	48	8	89	4
8		Wilgus	Buffalo	Sandstone, buff to brown, with black specks, medium, limonite stained, massive, variable thickness.			15	0	15	0	40	8
7		Upper Brush Creek	Upper Brush Creek	Limestone, gray, sandy in basal part, in several massive ledges, dense to partly crystalline, marine, fossiliferous.			4	11	24	9	25	8
6				Clay, light gray, silty to sandy, some limonite stain.			3	0			20	9
5				Sandstone, light to dark gray with much limonite stain, shaly in basal one foot, fine micaceous, scattered limonite-siderite concretions, bedded in layers up to several inches thick.			3	2			17	9
4				Coal, shaly, some bright with numerous shale partings, and a clay shale at base.			0	6			14	7
3				Shale, light gray to blue-gray locally, weathers olive drab with limonite stain, argillaceous, silty, finely micaceous, and some ferruginous layers.			13	2			14	1
2		Lower Brush Creek	Lower Brush Creek	Shale and limestone, gray, argillaceous, fossiliferous, marine shale containing many small layers and nodules of limestone with ferruginous zone at top.			0	5	0	11	0	11
1				Limestone, gray to dark blue-gray, dense to partly crystalline, marine, fossiliferous			0	6			0	6

LOCATION KEY: Aa 41 FILE NUMBER: 12158 ELEVATION: TOPO MAP: Athens

STATE: Ohio COUNTY: Athens TOWNSHIP: Athens SECTION: SW¼ NE¼, 21

LOCATION: Road cut on east side of Route 56 where Margaret Creek is tangent to the road. This is known as White's Mill section but actually is located about 0.4 mile south of junction of Routes 56 and 682 and an equal distance south-southwest of White's Mill.

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
13	Conemaugh	Upper Brush Creek	Upper Brush Creek	Sandstone, light gray with yellowish brown stain, fine, micaceous, shaly with thin shale layers in lower part and more massive near top, exposed, thickness estimated.			25	0	25	0	46	4
12		Lower Brush Creek	Lower Brush Creek	Shale, medium gray to lighter gray above, with numerous small flattened siderite concretions more or less arranged in layers, sparingly fossiliferous in lower part, thickness variable.			6	8	21	11	21	11
11				Shale, medium gray, with few small siderite concretions in upper part, fossiliferous, marine.			1	6			15	3
10				Limestone, medium to dark gray, impure, shaly, pyritiferous, fossiliferous, marine, thickness variable.			0	6			13	9
9				Shale, dark gray, carbonaceous, fissile, pyritiferous, with fossiliferous concretions of limestone.			0	3			13	6
8				Coal, shaly, pyritiferous, weathered.			0	2			13	0
7				Coal, bright, with shaly partings, pyrite, and fusain.			0	3			12	10
6				Underclay, dark gray, carbonaceous, plastic.			0	1			12	7

LOCATION: Aa 41 FILE NUMBER: 12158 - continued

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
5	Conemaugh - continued	Lower Brush Creek- continued	Lower Brush Creek - continued	Clay, light gray with yellowish brown stain, small siderite concretions in lower part.			0	6			12	6
4				Clay shale, medium to light gray with yellowish brown stain, argillaceous with some silt, irregular fracture, slickensided.			2	0			12	0
3				Shale, medium to dark gray with some dull reddish and yellowish brown stain, argillaceous and silty, with semi-starch to starch-like fracture.			2	0			10	0
2				Clay shale, gray-mauve, mottled, somewhat silty, with starch-like fracture.			3	0			8	0
.1				Shale, gray with dark reddish and yellowish brown stain, argillaceous and silty, grading upward into overlying clay shale, exposed.			5	0			5	0

LOCATION KEY: Aa FILE NUMBER: 13399 ELEVATION: TOPO MAP: Athens

STATE: Ohio COUNTY: Athens TOWNSHIP: Athens SECTION:

LOCATION: The shale pit of the Athens Brick Co., measured in 1912.

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
7	Conemaugh	Duquesne-Gaysport?	Lower Grafton - Gaysport?	Sandstone.			20	0	59	0	121	1
6				Shale, red and bluish-gray, changing from sandy in upper portion to calcareous near base.			39	0			101	1
5		Ames	Ames	Limestone, fossiliferous.			1	8	1	8	62	1
4		Harlem - Upper Bakerstown	Round Knob	Clay, deep red color, nodular limestone in lower portion.			24	0	57	0	60	5
3			Cow Run - Saltsburg ?	Shale, sandy, bluish gray color, with reddish-brown bands in lower portion. Fossil, ripplemarks and sun-cracks along the bedding planes.			33	0			36	5
2		Anderson	Portersville	Limestone, fossiliferous.			0	5	3	5	3	5
1				Shale, carbonaceous, many fossils.			3	0			3	0

BERN TOWNSHIP

LOCATION KEY: Ab 1 FILE NUMBER: 11267 ELEVATION: 715 ± Base TOPO MAP: Chesterhill

STATE: Ohio COUNTY: Athens TOWNSHIP: Bern SECTION: SW-1/4, 13 extending into NE-1/4, 24

LOCATION: Exposure up road to west from Broadwell, SW-1/4, 13, Bern Township, extending into NE-1/4, 24, Rome Township, Interval 11; this interval originally recorded as 23 feet 5 inches, not certain whether thickness of interval or distance above base is correct.

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
6	Washington	Little Washington Waynesburg "A"	Mannington Waynesburg	Sandstone, tan, yellow, brown, red, coarse porous, micaceous, friable, massive showing bedding and cross-bedding, some large scattered quartz pebbles and clay balls, medium to fine at top, exposed.			70	0	70	0	245	0
15	Monongahela	Waynesburg - Little Waynesburg Uniontown	Waynesburg ?	Clay shale, mottled, maroon, light gray, yellow, slumped, covered in part.			23	0	74	0	175	0
14			Gilboy - Uniontown - Arnoldsburg	Sandstone, pale brown to olive, fine to medium, micaceous, massive, poorly exposed.			51	0			152	0
13		Arnoldsburg	Arnoldsburg	Covered interval.			41	0	?		101	0
12				Clay shale, pale pink and gray, silty, contains small nodules of fresh-water limestone.			5	0			60	0
11				Covered, some sandstone showing.			33	5			55	0
10		Benwood	Benwood	Limestone, light greenish gray weathering to yellow tan, fretted weathering, contains clay balls, spongy appearing in gray clay shale.			3	0	16	9+	21	7
9			Sewickley	Shale and sandstone, gray and tan, limonite stained, fine to medium, micaceous, thin-bedded, poorly exposed.			13	9			18	7
8		Sewickley	Sewickley	Clay, light gray, mottled with limonite stains, finely micaceous, somewhat plastic, carbonaceous streaks in base.			0	5	4	10+	4	10
7				Coal, bony, shaly, mostly dull with thin bright streaks, badly weathered.			1	1			4	5
6				Shale, gray with carbonaceous flakes, micaceous, silty.			0	9			3	4
5				Coal, mostly dull with some bright streaks, shaly in part.			0	5			2	7
4				Shale, light gray to gray, with carbonaceous specks, micaceous, silty, sandy.			0	1			2	2
3				Coal, bright with thin dull streaks, blocky.			0	11			2	1
2				Shale, light gray to gray, some limonite stains, silty, micaceous, argillaceous, coaly streaks in top.			1	2			1	2
1			Fishpot	Sandstone, light gray to gray with some limonite stains, fine, silty, friable, exposed unmeasured.								

LOCATION KEY: Ab 2 FILE NUMBER: 11268 ELEVATION: 655 Base TOPO MAP: Chesterhill

STATE: Ohio COUNTY: Athens TOWNSHIP: Bern SECTION: NW-1/4 section 7 and SE-1/4, NE-1/4 section 13

LOCATION: Exposure up road 0.6 miles NE from Broadwell toward 996 triangulation station.

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
35	Washington	Washington	Lower Washington	Shale and sandstone, gray fine grained, thin-bedded sandstone in gray, silty shales zones of strong limonite staining exposed.			10	6	10	6	287	0
34		Little Washington		Clay shale, maroon, silty, finely micaceous, breaks with a starch-like fracture, weathered.			0	2	26	5	276	6
33			Little Washington	Coal horizon, maroon to gray clay shale, silty, micaceous, contains numerous patches of dull coal and plant fossils, poorly exposed.			0	6			276	4
32				Clay shale, gray to tan, limonite stained, silty, micaceous, grows sandy upward, small flecks of carbonaceous material.			2	0			275	10
31				Clay shale, gray to light gray, limonite stained, silty, micaceous, contains many thin carbonaceous streaks and excellent plant fossils, some dull coaly patches to 1/4 inch thick.			3	0			273	10
30			Mannington	Shale and sandstone, gray to buff, micaceous, finely bedded, poorly exposed.			20	9			270	10
29		Waynesburg "A"-Waynesburg		Clay shale, maroon, finely micaceous, silty.			0	3	61	11	250	1
28			Waynesburg "A"	Clay, light gray, limonite stained, silty, finely micaceous, breaks with starch-like fracture, gray carbonaceous streaks in top 1-inch.			0	8			249	10
27	Monongahela		Waynesburg - Gilboy	Sandstone, gray to yellow, limonite stained, micaceous, coarse grained, cross-bedded massive, friable, somewhat finer bedded near top.			61	0			249	2
26		Little Waynesburg		Clay shale, maroon, silty, finely micaceous, breaks with starch-like fracture, becomes tan in upper part.			5	2	23	5	188	2
25			Uniontown	Shale and sandstone, gray to olive drab, limonite stained, silty to sandy shale, interbedded with generally thin-bedded sandstone.			18	3			183	0
24		Uniontown - Arnoldsburg		Clay shale, maroon, silty, finely micaceous, plant fossils.			1	8	29	9	164	9
23			Uniontown	Coal horizon, clay shale, with small carbonaceous pieces.			0	1			163	1
22			Lower Uniontown ?	Shale, tan to olive, micaceous, silty, platy fracture, including sandstone lenses near top, becomes dark purple at top.			16	6			163	0
21				Clay shale, maroon and mottled, gray green, finely micaceous, platy to irregular fracture, contains small nodular limestone, exposed.			11	6			146	6
20		Benwood		Covered interval, some sandstone observed.			45	0	83	3	135	0
19			Benwood	Limestone, gray, dense, massive nodules, exposed in field along road, poorly exposed.			15	0			90	0
18				Poorly exposed, sandstone.			8	0			75	0
17			Sewickley	Shale, gray to tan, limonite stained, silty, finely micaceous, breaks with starch-like fracture, grades upward to thin-bedded sandstone, poorly exposed.			15	3			67	0

LOCATION: Ab 2 FILE NUMBER 11268 - continued

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
16	Monongahela continued	Sewickley	Sewickley	Coal, dull, some bright streaks, thin-bedded, badly weathered.			1	6	7	9	51	9
15				Clay shale, light gray, limonite stained, sandy to silty, thickness varies laterally.			0	6			50	3
14			Lower Sewickley	Sandstone, gray to tan, limonite stained, micaceous, fine to medium, finely and irregularly bedded.			5	9			49	9
13		Lower Sewickley	Lower Sewickley	Clay shale, like that below coal.			2	1	11	10	44	0
12				Coal horizon, clay shale, gray to dark gray, limonite stained some dull black streaks, poorly developed.			0	5			41	11
11				Clay shale, light gray to gray, limonite stained, silty, finely micaceous, showing free sulphur.			0	11			41	6
10			Pomeroy ?	Sandstone, gray to olive drab, limonite stained, micaceous, fine to medium, shaly.			4	7			40	7
9				Limestone, gray with white to light blue veinlets, greenish masses, very dense except in veinlets, massive ledge, weathering on surface to a rich brown.			0	6			36	0
8				Shale, gray to olive, mottled maroon, argillaceous, silty, finely micaceous.			3	4			35	6
7		Fishpot	Fishpot	Coal horizon, gray, mottled maroon, shale with carbonaceous fleeks, plant fossils.			0	9	13	3	32	2
6				Clay shale, gray to olive, limonite stained, silty, finely micaceous, breaks with starch-like fracture.			1	1			31	5
5				Clay shale, maroon, platy, silty, finely micaceous, fossiliferous, (ostracods).			11	5			30	4
4		Redstone	Redstone	Coal horizon, gray to black carbonaceous shale, poorly developed.			0	1	18	11	18	11
3				Clay, gray to brown, slightly plastic, small carbonaceous specks.			0	1			18	10
2				Limestone, light gray to gray, some limonite stain, dense, nodular, fresh-water, interbedded with bluish gray shale.			2	9			18	9
1				Clay shale, light pink to gray, silty, finely micaceous, small scattered nodules of limestone, exposed.			16	0			16	0

LOCATION KEY: Ab 3 FILE NUMBER: 11269 ELEVATION: 679± Base TOPO MAP: Chesterhill

STATE: Ohio COUNTY: Athens TOWNSHIP: Bern SECTION: SW part section 31

LOCATION: Exposure along road south of 673 road intersection and Wyatt Run across SW part of section 31, Bern Township, to top of hill at Bern-Rome Township line.

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
50	Washington	Waynesburg "A"	Waynesburg	Sandstone, light gray weathered tan or buff, with some limonite stain, fine to medium, micaceous, thin-bedded to massive, exposed.			14	6	14	6	303	0
49	Monongahela	Waynesburg	Waynesburg	Shale, like shale immediately below underlying coal.			0	4	6	10	288	6
48				Coal, dull, weathered, probably slumped.			0	2			288	2
47				Shale, gray with thin masses of coal, argillaceous, soft, laminated.			0	3			288	0
46			Gilboy	Sandstone, light gray to tan, yellow or brown, fine to medium, micaceous, bedded.			6	1			287	9
45		Little Waynesburg	Little Waynesburg	Coal, dull with thin bright streaks, much weathered.			0	2	31	5	281	8
44				Clay, shale, light greenish gray with some maroon, finely micaceous, weathers somewhat plastic, fossil plants present, ferruginous and hard at top.			16	6			281	6
43			Uniontown	Sandstone, light gray to olive or tan, with some limonite stain, fine to medium, silty, micaceous, bedded in layers 1/8 to 10 inches thick.			8	8			265	0
42		Uniontown	Uniontown	Shale, maroon, silty, finely micaceous, fossiliferous, small clams in base.			0	9	51	10	256	4
41				Clay, light gray, plastic, coal zone.			0	1			255	7
40				Clay shale, varicolored, light greenish gray to maroon, yellow, etc., silty, finely micaceous, breaks with starch-like fracture, brown zone at top.			3	6			255	6
39				Limestone, gray weathering yellowish and lighter gray, dense except for tiny crystalline masses and filling, nodular, embedded in clay shale.			0	6			252	0
38			Ritchie	Clay shale, light greenish gray to maroon and purple, silty, finely micaceous, somewhat weathered.			2	11			251	6
37				Shale, gray to maroon, finely micaceous, argillaceous, laminated, poorly exposed.			8	7			248	7
36				Clay shale, varicolored, light greenish gray, yellow, tan, purple, maroon, breaks with starch-like fracture, parts weather plastic.			22	11			240	0
35			Arnoldsburg	Sandstone, light gray to olive with some limonite stain, fine to medium, micaceous, calcareous, in part, somewhat massive showing bedding and cross-bedding on weathered surfaces.			12	7			217	1
34		Arnoldsburg	Arnoldsburg	Shale, gray to maroon, argillaceous, finely micaceous, silty, laminated.			0	3	16	11	204	6
33				Clay, light gray with some limonite stain, weathers somewhat plastic, carbonaceous and coaly at top.			0	4			204	3
32				Limestone, light gray to gray, mostly dense, fossiliferous (numerous astracodes), freshwater.			0	3			203	11

LOCATION: Ab 3 FILE NUMBER 11269 - continued

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
31	Monongahela - continued	Arnoldsburg - continued	Fulton ?	Sandstone, light gray to olive with some limonite stain, or red to chocolate brown, fine, silty, micaceous, mostly thin-bedded, shaly appearing, some layers to 6 inches thick.			12	2			203	8
30				Clay shale, maroon with slight gray and tan mottling, silty, micaceous, calcareous with few scattered, small limestone nodules.			2	5			191	6
29				Sandstone, light gray, weathered olive to tan, fine, silty, micaceous, thin to medium-bedded.			1	6			189	1
28		Benwood		Clay shale, maroon, breaks with starch-like fracture, much weathered.			0	8	33	1	187	7
27			Benwood	Coal smut. ?								
26				Clay and clay shale, light gray with considerable limonite stain, finely micaceous.			1	3			186	11
25				Limestone and clay shale, light gray to gray with some limonite stain, hard, dense, nodular to heavy-bedded, interbedded and embedded in purple, gray to tan, calcareous clay shale, fossiliferous.			13	0			185	8
24				Limestone, yellow to tan, dense, layers interabedded in gray to purplish, calcareous clay shale.			5	0			172	8
23				Clay shale, maroon, mottled gray, yellow, and purple, micaceous, calcareous.			7	8			167	8
22			Sewickley	Shale, light gray weathers olive, tan, or brown, silty, sandy, micaceous, tending toward sandstone, poorly bedded and breaks irregularly, ferruginous concretions scattered at top.			5	6			160	0
21		Sewickley	Sewickley	Clay, similar to that below coal smut immediately below, but with some red stain.			0	8	35	2	154	6
20				Coal smut.								
19				Clay, light gray with considerable limonite stain, micaceous, laminated, somewhat plastic.			1	8			153	10
18			Lower Sewickley	Shale and sandstone, gray to dark gray weathering olive with limonite stain, silty to sandy, micaceous, shale interbedded with fine to medium, micaceous, silty sandstone which is mostly thin-bedded but tends to be massive in two zones 5 to 8 feet thick.			32	10			152	2
17		Fishpot	Fishpot	Clay shale, mottled gray, green, maroon, and purple, silty, micaceous, calcareous with scattered small limestone nodules, layer of large nodules toward top.			18	9	24	6	119	4
16				Limestone, light gray, weathering olive to yellowish, dense, micaceous, somewhat sandy, nodular to irregular bedding.			4	0			100	7
15			Pomeroy	Sandstone, light gray, weathering to pale yellow, mostly fine grained, some medium, silty and micaceous bedded in layers 1/8 inches to several inches in thickness.			1	9			96	7

LOCATION: Ab 3 FILE NUMBER 11269 - continued

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
14	Monongahela - continued	Redstone	Redstone	Limestone, light yellow to tan, earthy, clayey, weathers to porous, spongy appearing surface, bedded to nodular, bedded with yellow clay shale.			7	6	29	9	94	10
13				Clay shale, varicolored, gray to maroon, limonite stained, finely micaceous, thin with small limestone nodules, starch-like fracture.			3	0			87	4
12				Clay shale, light gray to gray, limonite stained, somewhat silty, finely micaceous, irregular to platy fracture.			1	3			84	4
11			Upper Pittsburgh	Sandstone, light gray weathered to olive to tan with some limonite stain, fine to medium, silty and micaceous, irregular to massive bedding.			18	0			83	1
10		Pittsburgh	Pittsburgh	Shale, dark grayish brown to black with thin irregular coaly and carbonaceous layers.			0	1	47	6	65	1
9			Upper Pittsburgh	Limestone, gray to light gray weathering light gray with pale limonite stain, dark gray toward top, dense, mostly bedded in layers up to 1 foot or more in thickness, interbedded with thinner shale zones.			14	2			65	0
8				Clay shale, mottled red, brown, yellow above to light gray, yellow, flinty in appearance with starch-like fracture, calcareous in basal part and limestone nodules in top part.			22	10			50	10
7			Bellaire	Sandstone, light gray to olive, with some limonite stain, silty, micaceous, thin-bedded shaly below, massive, and calcareous toward top.			10	6			28	0
6	Conemaugh	Lower Little Pittsburgh	Lower Little Pittsburgh	Clay shale, mottled gray, pale greenish, yellow, maroon.			3	0	12	2	17	6
5			Connellsville	Shale and sandstone, light gray to olive with some limonite stain, silty, sandy, micaceous shale and similarly colored, fine, silty, micaceous sandstone.			9	2			14	6
4		Clarksburg	Clarksburg	Shale, chocolate brown to maroon, argillaceous, micaceous.			0	6	5	4	5	4
3				Clay shale, gray, micaceous, with carbonaceous specks and streaks, coal zone.			0	1			4	10
2				Clay, gray to light olive, breaks with starch-like fracture.			1	5			4	9
1				Clay shale, mottled gray, olive, maroon, breaks with starch-like fracture, calcareous with scattered limestone nodules up to 6 to 8 inches in size, exposed.			3	4			3	4

LOCATION KEY: Ab 4 FILE NUMBER: 11270 ELEVATION: 734 Base TOPO MAP: Chesterhill

STATE: Ohio COUNTY: Athens TOWNSHIP: Bern SECTION: SE-1/4, NW-1/4?, SE-1/4 ?, 36

LOCATION: Exposure in abandoned strip pit and measured at point of hill in SE NW SE, Section 36, Bern Township, Athens County, Ohio.

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
12	Monongahela	Sewickley	Lower Sewickley	Sandstone, brown to tan, medium to coarse grained, micaceous, some limonite stain, massive.			21	4	21	4	112	0
11		Fishpot - Redstone	Fishpot - Redstone	Clay shale, gray to tan, limonite stain, silty, calcareous.			5	8	65	2	90	8
10				Limestone and shale, gray, weathers tan, nodular to somewhat bedded in clay shale, tan to gray, somewhat silty.			5	0			85	0
9				Clay shale, light gray, mottled light purple, silty, with lenses of limestone nodules to 1 foot thick laterally.			12	6			80	0
8				Limestone, gray to light gray, nodular to massive, some calcareous clay shale zones laterally.			2	0			67	6
7				Limestone, gray, weathering bright yellow orange, fretted, irregular weathering surfaces, nodular to somewhat bedded.			15	0			65	6
6				Clay shale, gray to purple, silty, micaceous.			0	6			50	6
5			Upper Pittsburgh	Sandstone, gray, tan to olive drab, limonite stained, micaceous, calcareous, fine to medium grained, thin bedded to some massive zones, irregular.			17	4			50	0
4				Clay shale, gray, limonite stained, silty, thin-bedded to platy, scattered limestone nodules in upper 4 feet.			7	8			32	8
3		Pittsburgh	Pittsburgh	Coal, bright, blocky, laterally contains large algal and pyrite masses.	4	6	9	0	25	0	25	0
				Covered, contains lower bench of coal and parting.	4	6						
2			Upper Pittsburgh	Clay shale, limonite stained, silty, micaceous, weathers very light, dark at top.			3	4			16	0
1			Lower Pittsburgh	Sandstone, gray to tan, limonite stained, micaceous, medium to coarse grained, massive, much limonite at top.			12	8			12	8

LOCATION KEY: Ab 5 FILE NUMBER: 11271 ELEVATION: 750 ± Base TOPO MAP: Chesterhill

STATE: Ohio COUNTY: Athens TOWNSHIP: Bern SECTION: NW-1/4, NW-1/4, into NE-1/4, NW-1/4, 30

LOCATION: Exposure up form road and ravine extending NE from old mine, 1.0 mile North of Sharpsburg and 2.3 miles West of Plantsville.

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
30	Monongahela	Waynesburg	Waynesburg	Clay shale and limestone, maroon clay shale and small limestone nodules, exposed.			3	0	16	9	239	0
29			Gilboy	Sandstone, gray to tan, limonite stained, fine to medium above, thin to platy bedded, weathers somewhat shaly.			13	9			236	0

LOCATION: Ab 5 FILE NUMBER 11271 - continued

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
28	Monongahela continued	Little Waynesburg	Little Waynesburg	Clay, light gray, plastic, small scattered flecks of carbonaceous matter.			0	2	26	9	222	3
27			Waynesburg	Limestone and shale variegated shales below to greenish above with more massive limestone nodules in top 1 foot.			5	5			222	1
26				Clay shale, maroon.			8	8			216	8
25			Uniontown	Siltstone, gray to olive drab, limonite stained, thin-bedded, poorly exposed.			12	6			208	0
24		Uniontown	Uniontown	Clay shale, maroon, platy to chippy bedded, poorly exposed.			0	3	25	2	195	6
23				Clay shale, gray, weathers somewhat plastic, silty.			0	3			195	3
22				Limestone and shale, variegated gray to red and purple shales and nodules of light gray limestone, chippy shales above, poorly exposed.			4	0			195	0
21				Clay shale, maroon, weathered, poorly exposed.			12	2			191	0
20				Limestone and shale, variegated gray to red and purple, argillaceous shale with small nodules of light gray limestone, poorly exposed.			4	6			178	10
19			Arnoldsburg	Siltstone, gray to olive drab, limonite stained, thin-bedded to chippy, more sandy upward.			4	0			174	4
18		Benwood - Arnoldsburg	Benwood	Clay shale, gray to maroon, poorly exposed but with some small limestone nodules weathering out.			14	11	85	0	170	4
17				Limestone, light gray to gray, somewhat conglomeratic, massive ledge, some ostracod			1	3			155	5
16				Limestone and shale, gray weathering yellow, nodular, somewhat conglomeratic limestone weathering out of reddish tan to maroon clay shale, limestone masses from 1 inch to many feet.			36	6			154	2
15			Sewickley	Sandstone, light gray, limonite stained, medium to coarse, very micaceous, generally massive showing cross-bedding in lower part, somewhat friable.			32	4			117	8
14		Sewickley - Fishpot - Redstone	Sewickley	Clay shale, light gray to gray, some limonite stain, micaceous, laminated, weathers plastic, more clayey on top of thicker zones, thickness variable.			1	4	78	0	85	4
13			Fishpot ?	Limestone, light gray to gray, massive, dense, hard, bedded below and nodular in upper 4 inches.			3	9			84	0
12			?	Clay shale, light gray, limonite stained, calcareous, irregularly bedded, darker at top.			4	5			80	3
11				Clay shale, tan, mottled maroon to dark brown, scattered, small limestone nodules, poorly exposed in part.			45	10			75	10
10			Upper Pittsburgh	Sandstone, light gray, medium to coarse, micaceous, massive, arkosic, friable, irregular base cutting into coal at north.			22	8			30	0

LOCATION: Ab 5 FILE NUMBER 11271 - continued

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
9	Monongahela continued	Pittsburgh	Pittsburgh	Shale, clayey, light gray, pale limonite stain, finely micaceous, laminated, irregular 3 inches to 10 inches.			0	6	7	4	7	4
8				Coal, bony, some bright streaks.			0	2			6	10
7				Coal, bright, blocky, irregular shaly partings to 1 inch.			1	7			6	8
6				Coal, bony, shaly near top.			0	6			5	1
5				Coal, bright, blocky, thin, shaly streaks.			0	5			4	7
4				Clay, gray, limonite stained.			1	0			4	2
3				Coal, bright, blocky.			0	9			3	2
2				Clay shale.			0	1			2	5
1				Coal, bright, blocky.			2	4			2	4
				Clay, light gray, plastic.								

LOCATION KEY: Ab 12 FILE NUMBER: 11275 ELEVATION: 629 Base TOPO MAP: Chesterhill

STATE: Ohio COUNTY: Athens TOWNSHIP: Bern SECTION: W-1/2, NW-1/4, 20

LOCATION: Exposure North uphill from Utley to crossing of Texas Eastern pipeline, all in the W-1/w, NW-1/4, section 20, Bern Township, Athens County, Ohio.

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
28	Washington	Little Washington	Mannington	Sandstone, gray to buff, limonite stained, fine to medium, some coarse zones, micaceous, friable, massive, exposed to top of hill.			14	0	14	0	314	0
27		Waynesburg "A"	Waynesburg	Clay shale, gray, mottled maroon to purple, slightly calcareous at base, silty, non-bedded.			19	4	28	0	300	0
26				Sandstone, gray to olive drab, limonite stained, very fine, micaceous, thin-bedded, cross-bedded.			8	8			280	8
25	Monongahela	Waynesburg	Waynesburg	Clay, gray to olive green, soft, grainy, no carbonaceous streak evident, coal horizon.			1	6	28	8	272	0
24			?	Limestone, light gray, nodular.			0	4			270	6
23			?	Covered, mostly red shales, containing a slumped (3' - 8') sandstone in interval.			26	10			270	2
22		Little Waynesburg	Little Waynesburg	Covered, soft red clay shale showing grades upward to (3' - 4') green gray grainy clay.			21	4	35	9	243	4
21			Uniontown	Sandstone, gray to tan, limonite stained, micaceous, fine, thin to shaly bedded to medium and massive upward.			14	5			222	0
20		Uniontown	Uniontown	Clay shale, gray to olive drab, limonite stained, silty.	0	2	0	5	14	4	207	7
				Clay shale, dark gray, carbonaceous in zones, coal horizon.	0	3						
19				Shale, gray to olive drab, limonite stained, silty, bedded to almost a siltstone, some maroon mottling, a 4 inch to 6 inch nodular dark limestone lies directly beneath the coal.			3	11			207	2

LOCATION: Ab 12 FILE NUMBER 11275 - continued

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
18	Monongahela continued	Uniontown - continued	Uniontown - continued	Clay shale, poorly exposed in part, lower three feet contains much thin-bedded yellow weathering limestone in 2 to 4 inch beds.			10	0			203	3
17		Lower Uniontown	Lower Uniontown	Carbonaceous shale streak in gray clay, well shown, conspicuous.			0	1	13	1	193	3
16				Clay shale, tan, pink, silty.			2	6			193	2
15			Uniontown	Limestone, dove gray, very dense, single prominent bed.			1	0			190	8
14				Limestone gray, nodular, more impure than overlying bed and more nodular.			2	0			189	8
13			?	Covered, red clay shales showing very soft, somewhat slumped.			5	6			187	8
12			Arnoldsburg	Siltstone, greenish, hard, a conspicuous hard massive bed.			2	0			182	2
11		Arnoldsburg - Benwood	?	Covered interval.			6	5	64	11	180	2
10			Benwood ?	Limestone, gray, weathering yellow to tan, nodular in clay shale, weathering yellow to dark red.			5	5			173	9
9			Sewickley ?	Sandstone, gray to buff and tan, fine, micaceous, irregularly bedded below becoming more coarse and massive upwards, some calcareous lenses.			53	1			168	4
8		Sewickley - Fishpot ?	Sewickley	Clay shale, maroon above and gray to tan below, platy, silty, micaceous.			0	8	56	7	115	3
7				Clay, carbonaceous, coal horizon.			0	1/2			114	7
6				Clay, light gray.			0	1/2			114	6-1/2
5				Clay shale, gray to greenish gray, silty, finely micaceous, breaks irregularly.			0	5			114	6
4				Limestone, light gray, hard, dense, nodular in gray to tan, non-bedded shale.			2	11			114	1
3			Lower Sewickley - Pomeroy	Shale and sandstone, gray to tan and maroon shales with thin interbedded sandstone layers in the upper part.			52	6			111	2
2		?	?	Sandstone, gray to tan, limonite stained, micaceous, fine to medium, massive to thin-bedded above.			14	6	14	6	58	8
1		?	?	This interval is badly slumped but is known to contain both benches of the Pittsburgh coal or about 8 feet of coal with partings. The coal was observed but not measured when the pipeline about 100 yds. west was laid in 1952.			44	2	44	2	44	2

LOCATION KEY: Ab 14 FILE NUMBER: 11278 ELEVATION: 695 Base TOPO MAP: Chesterhill

STATE: Ohio COUNTY: Athens TOWNSHIP: Bern SECTION: NW-1/4, NE-1/4, 28

LOCATION: Exposure in south side of abandoned strip mine 1/4 mile SE of Lathrop in the NW-1/4, NE-1/4, section 28, Bern Township, Athens County, Ohio.

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
9	Monongahela	Fishpot	Fishpot	Sandstone, gray to tan, limonite stained, very micaceous, fine to medium grained, coarse in zones.			5	7	15	7	56	0
8				Limestone and shale, gray, weathering yellow, nodular limestones in bed to 1 foot 6 inches with gray clay shale partings to 6 inches.			7	0			50	5
7				Clay shale, gray to blue gray, silty to sandy, more tan laterally, somewhat bedded.			3	0			43	5
6		Redstone	Redstone	Shale, carbonaceous, coal horizon.			0	1	31	4	40	5
5				Clay, gray, plastic, irregular			0	1			40	4
4				Clay shale, blue gray, limonite stained, silty, non-bedded.			3	0			40	3
3			Upper Pittsburgh	Sandstone, gray to light blue gray, limonite stained, very shaly in part, fine to medium grained, micaceous, varies laterally to tan sandstone.			11	0			37	3
2				Shale, light blue gray, limonite stained, silty to sandy upward, thin-bedded.			17	2			26	3
1		Pittsburgh	Pittsburgh	Coal, bright, blocky, thickness extends to coal below if nodules are absent.	2	11	9	1	9	1	9	1
				Nodules of pyrite and "bog-head" appear in this zone laterally, up to 1 foot thick in places, variable.	0	6						
				Coal, bright, blocky.	1	2						
				Coal, bony.	0	5						
				Coal, blocky.	0	3						
				Clay shale, light gray, variable.	0	10						
				Coal, bright, blocky, exposed to water level in mine, probably 1 foot more under water.	3	0						

LOCATION KEY: Ab 15 FILE NUMBER: 11279 ELEVATION: 706 Base TOPO MAP: Chesterhill

STATE: Ohio COUNTY: Athens TOWNSHIP: Bern SECTION: NE-1/4, NW-1/4 to the NW-1/4, NE-1/4, 9

LOCATION: Exposure on abandoned E-W road uphill (west) from the NE-1/4, NW-1/4 into the NW-1/4, NE-1/4, section 9, Bern Township, Athens County, Ohio.

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
18	Washington	Washington - Waynesburg "A"	Mannington - Waynesburg	Sandstone and clay shale, the section up the road shows mostly sandstone, but the next hollow to the west shows red to maroon clay shales in part of the interval. The bottom 30 feet is, however, massive sandstone.			105	0	105	0	269	0
17				Covered, probably sandstone.			5	0			164	0

LOCATION: Ab 15 FILE NUMBER 11279 - continued

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
16	Monongahela	Waynesburg	Waynesburg	Clay, gray, plastic when weathered.			1	4	53	4	159	0
15				Clay shale, gray mottled maroon, silty, non-bedded, dries yellow to red, has starch-like fracture.			10	8			157	8
14				Limestone, gray, weathering greenish gray, brecciated, bedded, weathering nodular, much staining.			1	0			147	0
13			Gilboy	Sandstone, gray to tan and massive below to more shaly upward, micaceous, poorly exposed in part, 2 feet calcareous siltstone zone 1 foot 6 inches from top.			40	4			146	0
12		Little Waynesburg	Little Waynesburg	Coal shale, weathered, poorly exposed.			0	1	13	8	105	8
11				Clay, light gray, plastic.			0	1			105	7
10				Clay shale, gray to maroon, silty, micaceous, slightly calcareous, limonite stained.			6	2			105	6
9			Uniontown	Sandstone, gray to tan, limonite stained, micaceous, medium to coarse grained, massive, friable.			7	4			99	4
8		Uniontown ?	Uniontown	Clay shale, poorly exposed, badly weathered and slumped, small carbonaceous flecks, coal horizon.			2	0	29	1	92	0
7			?	Covered, sandstone ?			9	0			90	0
6			?	Clay shale, gray, mottled maroon and purple, weathered and somewhat slumped, concealed at top.			6	4			81	0
5			Arnoldsburg ?	Sandstone, gray to tan, limonite stained, micaceous, fine to medium grained, some coarse zones, thin-bedded.			11	9			74	8
4		Arnoldsburg ?	Arnoldsburg ?	Clay shale, gray to tan, some maroon mottling, silty, poorly exposed.			1	5	62	11	62	11
3				Limestone, light gray with some weathering yellow, dense, hard, in gray to maroon clay shales.			25	2			61	6
2				Clay shale, tan, mottled maroon, silty, calcareous with scattered limestone, poorly exposed.			12	4			36	4
1			Benwood ?	Sandstone, gray to olive drab, micaceous, fine, thin to massive bedded below to quite shaly upward.			24	0			24	0

LOCATION KEY: Ab 16 FILE NUMBER: 11281 ELEVATION: 680 ± base TOPO MAP: Chesterhill

STATE: Ohio COUNTY: Athens TOWNSHIP: Bern SECTION: NE-1/4, SW-1/4, to NW-1/4, NE-1/4, 7

LOCATION: Exposure up old road to Joes Hollow (Joes Run) beginning in creek in NE-1/4, SW-1/4, and extending N to old road intersection in NW-1/4, NE-1/4, section 7. NOTE: Well being drilled near base of section indicates Pittsburgh horizon with little coal at 580 feet and Ames limestone at 404 feet.

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
33	Washington	Little Washington	Mannington	Sandstone, gray to tan, limonite stained, micaceous, fine to medium, exposed to old trail intersection.			5	0	7	4	261	0
32				Clay shale, maroon, chippy, slightly silty.			2	4			256	0

LOCATION: Ab 16 FILE NUMBER 11281 - continued

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
31	Washington - continued	Waynesburg "A" Waynesburg - Little Waynesburg	Waynesburg "A"	Clay shale, carbonaceous, plastic where weathered, coal horizon.			0	1	136	4	253	8
30				Clay shale, gray, limonite stained, some scattered carbonaceous material.			0	11			253	7
29			Mt. Morris	Clay shale, maroon, silty, small scattered limestone nodules, mottled gray and purple near top.			18	0			252	8
28				Limestone and shale, gray, weathering yellow, limestone nodules to 6 inches in gray to greenish gray clay shale, limestone weathers rough.			7	8			234	8
27			Waynesburg - Gilboy - Uniontown	Siltstone, gray, limonite stained, very micaceous, non-bedded, exposed.			3	0			227	0
26	Monongahela			Shale and sandstone, gray, limonite stained shales with thin-bedded sandstone, poorly exposed.			26	8			224	0
25				Sandstone, gray to tan, massive, cliff to 20 feet in places, cross-bedded, conglomeratic in lower part, coarse, micaceous.			32	0			197	4
24				Sandstone, gray to tan, limonite stained, fine below to coarse above, thin-bedded, poorly exposed in upper part, may be broken.			48	0			165	4
23		Uniontown - Arnoldsburg		Covered, some maroon to gray clay shale and limestone is seen mixed with much sandstone, badly slumped.			32	0	59	8	117	4
22			?	Sandstone, gray to tan, limonite stained, fine, micaceous, shaly, bedded below to medium, coarse, friable, massive above, exposed.			27	8			85	4
21		Benwood	Benwood	Clay shale, gray, limonite stained, more silty upward, somewhat bedded, weathered.			1	1	42	0	57	8
20				Coal horizon, clay shale, dark gray to purple, some carbonaceous material.			0	1			56	7
19				Shale, gray, sandy to silty, calcareous, breaks with starch-like fracture, slickensided surfaces.			0	8			56	6
18				Limestone and clay shale, gray, limonite stained clay shale with scattered limestone nodules to 2 inches.			2	6			55	10
17			Tyler Reds	Clay shale, gray to tan, mottled maroon with numerous, scattered limestone nodules, poorly exposed in part.			8	8			53	4
16				Covered with numerous greenish sandstone blocks in top 10 feet.			19	8			44	8
15				Clay shale, gray mottled maroon, exposed.			1	0			25	0
14			Sewickley	Sandstone, gray to blue gray, shaly below to tan and more massive above, fine to medium, micaceous.			5	1			24	0
13				Clay shale, gray to tan, limonite stained, micaceous, silty, sandy.			3	3			18	11
12		Sewickley	Sewickley	Shale, carbonaceous, some gray streaks, silty, more weathered upward.			0	10	15	8	15	8
11				Coal, bright, blocky, scattered fusain partings.	2	8	9	11			14	10

LOCATION: Ab 16 FILE NUMBER 11281 - continued

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
10	Monongahela continued	Sewickley - continued	Sewickley - continued	Clay shale, gray, limonite stained, silty, irregular bedded.	1	5	9	11			12	2
9				Coal, bright, thin-bedded.	1	0					10	9
8				Coal, bright, blocky.	2	0					9	9
7				Coal, bony, shaly, micaceous.	1	6-1/2					7	9
6				Clay shale, gray variable.	0	3-1/2					6	2-1/2
5				Coal, bright, blocky.	1	0					5	11
4				Shale, carbonaceous, sandy to silty, laminated, variable with sandstone lenses, gray, hard, much quartz to 2 inches. 684'			0	11			4	11
3				Clay shale and clay, gray to blue gray, some plastic clay, scattered, siderite nodules up to 6 inches at top, dark gray below.			2	0			4	0
2				Limestone, light gray, massive, weathering nodular.			1	0			2	0
1				Clay shale, gray, silty, exposed.			1	0			1	0

LOCATION KEY: Ab 17 FILE NUMBER: 11282 ELEVATION: 690 Base TOPO MAP: Chesterhill

STATE: Ohio COUNTY: Athens TOWNSHIP: Bern SECTION: NW-1/4, section 10 and SW-1/4, section 11

LOCATION: Exposure along stream beginning at log house on west side of stream SE-1/4, NW-1/4, section 10, extending northward along Marietta Run to and along tributary south of road junction 963 and along road to junction 963 and west along Rt. 50A to hill on south side in SW-1/4, NW-1/4, section 11, Bern Township, Athens County, Ohio.

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
36	Washington	Washington "A"	Lower Marietta	Sandstone, yellow to dark brown, medium to coarse, micaceous, friable, massive, much weathered, poorly exposed upward.			29	5	29	5	312	8
35		Washington		Clay shale, maroon to light gray with some mottling, massive to laminated, parts weather somewhat plastic.			25	0	30	9	283	3
34			Washington	Sandstone, tan to dark brown, fine, slightly micaceous, somewhat friable, mostly thin-bedded.			5	9			258	3
33		Little Washington		Clay shale and covered interval, maroon and light gray, massive and laminated, weathers somewhat plastic, basal part covered and poorly exposed throughout.			36	6	42	6	252	6
32			Upper Mannington	Sandstone, light gray mostly weathered tan to yellow, medium, very micaceous, massive, friable, base uneven.			6	0			216	0
31		Upper Waynesburg "A"	Upper Bench Waynesburg "A"	Coal horizon.			-	-	13	3	210	0
30				Shale and clay shale, tan to olive drab, silty, micaceous shale interbedded with light gray, somewhat plastic clay shale all with some limonite stain, locally with coal zone at top.			3	0			210	0
29			Lower Mannington	Sandstone, light gray with limonite stain, fine, micaceous, rather thin-bedded, with fossil plants in lower part.			10	3			207	0

LOCATION: Ab 17 FILE NUMBER 11282 - continued

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
28	Washington - continued	Lower Waynesburg "A"	Lower Bench Waynesburg "A"	Clay shale, light gray weathers tan to olive, silty, with fossil plants and coal streaks, coal horizon.			1	0	50	11	196	9
27				Covered interval.			15	9			195	9
26			Waynesburg	Sandstone, light gray or greenish gray, weathering dull brown, medium, micaceous, well cemented, massive.			34	2			180	0
25	Monongahela	Waynesburg	Waynesburg	Covered interval.			2	0	40	2	145	10
24				Limestone and clay shale, gray, nodular and bedded, dense, fossiliferous (Spirorbis) interbedded in light gray clay shale.			3	0			143	10
23				Covered interval.			12	10			140	10
22				Shale and limestone, light bluish to greenish gray, shale grading upward into light gray and maroon clay shale upward, small nodules of siderite limestone in basal part, covered in part.			19	4			128	0
21			Gilboy	Sandstone and shale, light bluish gray weathering olive, with some limonite stain, silty, finely micaceous shale interbedded with fine sandstone, thickness variable.			3	0			108	8
20		Little Waynesburg ?	Little Waynesburg ?	Shale, chocolate brown to maroon, slightly silty, finely micaceous, laminated, fossil clams, thicker short distance away and with fossil plants.			0	10	10	6	105	8
19				Clay shale, light yellowish gray, calcareous, finely micaceous, weathers somewhat plastic.			0	3			104	10
18			Uniontown	Sandstone and shale, light gray to olive or tan with little limonite stain, micaceous, silty shale and similar, fine, thin-bedded sandstone.			9	5			104	7
17		Uniontown ?	Uniontown ?	Clay, light gray with some limonite stain, micaceous, weathers somewhat plastic.			0	2	28	6	95	2
16				Clay, gray, silty and argillaceous, finely micaceous, breaks with blocky fracture coal streaks, coal horizon.			0	1			95	0
15				Shale, gray to greenish gray, silty, finely micaceous, massive, breaks irregularly.			0	1			94	11
14				Limestone and clay shale, massive or heavy-bedded, light gray to gray, dense or brecciated limestone, interbedded with light gray to varicolored clay shale.			27	7			94	10
13			Arnoldsburg ?	Siltstone, pale olive with some limonite stain, finely micaceous, breaks irregularly in small blocks.			0	7			67	3
12		Arnoldsburg - Benwood ?	Arnoldsburg - Benwood ?	Limestone and clay shale, dull yellow or buff, dense limestone layers in light gray to light yellow clay shale, some of which weathers plastic, basal part poorly exposed.			19	11	44	8	66	8
11				Clay shale, light gray to light greenish gray with some purple mottling, massive, slickensided, breaks irregularly.			7	0			46	9

LOCATION: Ab 17 FILE NUMBER 11282 - continued

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
10	Monongahela continued	Arnoldsburg - Benwood ? continued	Sewickley	Sandstone, light greenish gray with slight limonite stain, fine, very micaceous, slightly calcareous, mostly thin-bedded, some shale with some shaly appearing zones near base.			17	9			39	9
9		Sewickley	Sewickley	Clay shale, gray with some limonite stain slightly silty, finely micaceous, slickensided, poorly laminated, breaks irregularly.			0	7	19	8	22	0
8				Clay shale, gray, silty, laminated with carbonaceous streaks and 1/4 inch coaly streaks at top and bottom, coal horizon.			0	3			21	5
7				Clay shale, gray with slight limonite stain, silty, finely micaceous, breaks irregularly.			2	0			21	2
6				Shale and limestone, light bluish gray with some limonite stain, silty, micaceous bedded shale with one 5 inch layer of dove gray, dense, nodular limestone.			2	5			19	2
5			Lower Sewickley	Sandstone, light gray to light greenish gray with some limonite stain, very micaceous, medium to fine, finer upward, slightly calcareous, massive at base, some heavy layers above, mostly thin-bedded, base uneven.			14	5			16	9
4		Fishpot	Fishpot	Clay, light gray with some limonite stain, silty, finely micaceous, with thin, dark, calcareous streak, thickness variable.			1	0	2	4-1/4	2	4
3				Coal streak.			0	1/4			1	4
2				Clay shale, gray with slight limonite stain, slightly silty, finely micaceous, breaks irregularly.			0	4			1	4
1				Limestone, gray to light gray, weathers pale tan, dense, a single layer.			1	0			1	0

LOCATION KEY: Ab 8 FILE NUMBER: 11448 ELEVATION: 695 ± Base TOPO MAP: Chesterhill

STATE: Ohio COUNTY: Athens TOWNSHIP: Bern SECTION: N-1/2, SE-1/4, 24 and NW-1/4, 18

LOCATION: Exposure along valley and abandoned road in N-1/2, SE-1/4, section 24, and NW-1/4, section 18, ending at road junction 998 at SW edge of Plantsville, Bern Township, Athens County, Ohio.

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
26	Washington	Waynesburg "A"	Mannington - Waynesburg	Sandstone, gray to buff, some dark brown, medium to coarse, friable, micaceous in zones.			71	8	71	8	310	0
25	Monongahela	Waynesburg		Clay shale variegated, gray to maroon, dark red, silty, non-bedded, some gray streaks.			3	4	13	0	238	4
24			Gilboy	Sandstone, gray to olive, fine, micaceous, thin-bedded, shaly in appearance.			7	8			235	0
23				Clay shale, variegated, gray to maroon, platy, silty.			2	0			227	4
22		Little Waynesburg	Little Waynesburg	Clay horizon, clay with some carbonaceous bits.			0	1	34	1	225	4
21				Clay shale, gray to maroon with some gray streaks and scattered limestone nodules, silty, non-bedded.			3	3			225	3

LOCATION: Ab 8 FILE NUMBER 11448 - continued

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
20	Monongahela - continued	Little Waynesburg - continued	Uniontown	Sandstone, light greenish gray to olive drab with some surface limonite stain, fine, micaceous, mostly thin-bedded.			21	9			222	0
19				Shale and clay shale, dull greenish gray with dull reddish stain, silty, finely micaceous, breaks irregularly, clay shale succeeded upward by chocolate brown, silty, finely micaceous, laminated shale, contact not exposed.			9	0			200	3
18		Uniontown	Uniontown	Clay, light gray with some limonite stain, somewhat plastic			0	1	31	5	191	3
17				Coal smut.			0	1/2			191	2
16				Clay shale and limestone, variegated maroon, light greenish gray, massive, breaking irregularly shale with scattered irregular nodules of light gray limestone, limestone mostly top and bottom.			17	2			191	2
15			Arnoldsburg	Shale, variable, light olive drab, maroon, chocolate brown, interbedded, silty, finely micaceous, laminated, some layers somewhat fissile.			14	2			174	0
14		Arnoldsburg	Arnoldsburg	Limestone and clay shale, light gray to gray and yellow, dense, heavy-bedded limestone interbedded with greenish gray, laminated clay shale.			13	6	32	10	159	10
13				Shale, greenish gray with some limonite stain, argillaceous, poorly laminated, breaks irregularly.			7	2			146	4
12				Limestone and clay shale, light gray, heavy bedded or nodular, dense or brecciated limestone and light gray or light greenish gray, calcareous clay shale.			11	5			139	2
11				Siltstone, light greenish gray to olive drab with some surface stain, compact, dense with grainy appearance.			0	9			127	9
10		Benwood	Benwood	Limestone and clay shale, yellow fretted limestone at base, light gray, bedded or nodular above, dense, interbedded with variegated (mostly light gray), silty, calcareous clay shale.			18	2	48	7	127	0
9			Sewickley	Sandstone, light greenish gray, weathering light gray to olive, with some limonite stain, fine, silty, micaceous, calcareous at top, shaly in appearance.			18	10			108	10
8				Sandstone, light gray to light greenish gray with some limonite stain, micaceous, calcareous, mostly medium grained, massive.			11	4			89	3
7		Sewickley	Sewickley	Clay shale, light gray with some limonite stain, soft, bedded.			1	6	41	8	77	8
6				Coal smut.			0	1/4			76	2
5				Clay shale and limestone, variegated, light gray, light greenish gray, purple, mostly light gray upward, silty, finely micaceous, laminated with layers of gray or light greenish gray limestone in layers to 1 foot thick or with small nodules of limestone.			28	1-1/2			76	1-1/2

LOCATION: Ab 8 FILE NUMBER 11448 - continued

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
4	Monongahela - continued	Sewickley - continued	Pomeroy	Sandstone, light gray with little limonite stain, medium grained, very micaceous including biotite, slightly calcareous, mostly thin irregularly bedded, base uneven.			12	0			48	0
3		Fishpot ? or Redstone	?	Clay shale, maroon mottled with greenish gray below and gray to light gray above, silty, finely micaceous, with scattered large quartz grains, slightly calcareous, with few small limestone nodules near top, massive, breaks irregularly, slickensided.			5	5	31	0	36	0
2			Upper Pittsburgh ?	Sandstone, light gray with some limonite stain, mostly coarse becoming finer upward, micaceous, calcareous zones with few scattered siderite nodules, massive throughout.			25	7			30	7
1		Pittsburgh	Pittsburgh	Shale, light gray to light bluish gray with some limonite stain, argillaceous, silty, finely micaceous, soft, with large scattered siderite concretions.			5	0	5	0	5	0
				Top of upper bench of PITTSBURGH Coal.								

LOCATION KEY: Ab 11 FILE NUMBER: 11449 ELEVATION: 640± Base TOPO MAP: Chesterhill

STATE: Ohio COUNTY: Athens TOWNSHIP: Bern SECTION: NW-1/4, NW-1/4, 28 to SE-1/4, SE-1/4, 35

LOCATION: Exposure up old strip and quarry road W. from US 50A and 1/4 mile W. of Lathrop. Beginning at Route 50 A to top of hill.

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
24	Monongahela	Arnoldsburg ?	Benwood ?	Sandstone, gray to tan, limonite stained, weathered shaly, exposed to hilltop.			16	4	16	4	251	0
23		Benwood	Benwood	Limestone and shale, gray, weathering yellow, nodular to massive, limestone, in gray to dark red and brown clay shales prominent horizon, much slumping, some limestone dove gray and conglomerate in appearance.			48	0	48	0	234	8
22		Sewickley	Lower Sewickley	Sandstone, gray to tan, limonite stained, fine to medium, micaceous, massive above to shaly below and laterally, coarse grained in zones above. Top poorly exposed due to slumping of beds above.			31	0	31	0	186	8
21		Fishpot	Fishpot	Clay shale, gray silty, limonite stained.			0	5-1/2	35	10	155	8
20				Clay, light gray with much carbonaceous matter.			0	0-1/2			155	2-1/2
19				Clay shale, gray, silty, limonite stained.			0	6			155	2
18				Limestone and shale, light gray, nodular, yellow crack filled limestone ledges to 1 foot in gray to tan, silty, micaceous shales.			13	2			154	8
17				Clay shale, gray to purple, with numerous very small knots of fresh-water limestone.			2	5			141	6

LOCATION: Ab 11 FILE NUMBER 11449 - continued

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
16	Monongahela - continued	Fishpot - continued	Fishpot - continued	Limestone, gray to light gray, limonite stained, bedded, weathering nodular, poorly exposed in part.			11	1			139	1
15			Pomeroy	Covered, with fine-grained sandstone weathering out in places, badly slumped.			7	0			128	0
14				Clay shale, gray, mottled red and maroon, silty to sandy, exposed.			1	2			121	0
13		Redstone	Redstone	Clay shale, dark gray, scattered, small, thin, carbonaceous material, light gray, plastic clay in upper 1 inch locally.			0	3	26	9	119	10
12				Clay shale, gray to greenish gray, irregular fracture, silty, non-bedded.			1	3			119	7
11				Limestone, gray to buff, weathers yellowish, large, bedded, weathers slabby.			4	4			118	4
10				Limestone and shale, gray to light gray clay shales with small gray limestone nodules.			2	0			114	0
9				Limestone, gray weathering, buff to yellow, slabby to massive bedded, impure , fresh-water, irregular fracture.			6	10			112	0
8				Clay shale, gray to dove gray, some limonite stain, silty, weathers irregular, poorly exposed below.			1	6			105	2
7				Covered, some impure limestone nodules at top.			6	2			103	8
6			Upper Pittsburgh	Sandstone, gray to olive drab, limonite stained, fine, micaceous, calcareous in part, poorly exposed above.			3	0			97	6
5				Clay shale, gray to olive drab, some limonite stained, silty to sandy, micaceous.			1	5			94	6
4		Pittsburgh	Pittsburgh	Coal, weathered, some bright and blocky, irregular, thin partings of fusain and pyrite.			1	5	5	1	93	1
3				Clay shale, gray, limonite stained, silty, light gray and somewhat plastic upwards.			1	0			91	8
2			Upper Pittsburgh	Limestone and shale, gray to light gray, limestone nodules in gray and tan shales, exposed.			2	8			90	8
1		?	?	Concealed below to Route 50 A.			88	0			88	0

LOCATION KEY: Ab 20 FILE NUMBER: 11451 ELEVATION: 736 Base TOPO MAP: Chesterhill

STATE: Ohio COUNTY: Athens TOWNSHIP: Bern SECTION: W-1/2, NW-1/4, 25

LOCATION: Exposure along road south of J. D. Parmiter farmhouse in W-1/2, NW-1/4, section 25, Athens County, Ohio

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
21	Washington	Waynesburg "A"	Waynesburg	Sandstone, brown, tan, buff, medium to coarse grained, conglomeratic at base in local area, micaceous, massive.			17	6	17	6	213	0
20	Monongahela	Waynesburg - Little Waynesburg	Waynesburg	Coal was reported at this horizon in nearby well.			-	-	52	0	195	6

LOCATION: Ab 20 FILE NUMBER 11451 - continued

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
19	Monongahela - continued	Waynesburg - Little Waynesburg - continued	Waynesburg - Little Waynesburg	Clay shale, maroon, tan, buff, breaks irregularly, silty, micaceous, poorly exposed, weathered, calcareous in upper part.			45	6			195	6
18				Shale, tan, buff, maroon, argillaceous, micaceous, poorly exposed, weathered.			6	6			150	0
17		Uniontown	Uniontown	Coal smut ?			-	-	43	6	143	6
16				Clay shale, brown, buff, yellow, gray, sandy, micaceous, poorly exposed, badly weathered.			15	6			143	6
15			Arnoldsburg	Sandstone, tan to buff, gray to dark greenish-gray, fine to medium grained, massive at base and top, thin-bedded in center, becomes very friable at top and intermixed with gray clay?			23	4			128	0
14				Clay shale, tan to olive, slightly laminated, silty, micaceous, becomes sandy upward.			2	8			104	8
13				Clay shale, maroon to red, chippy fracture, laminated, slightly silty, slightly micaceous, thickness irregular.			2	0			102	0
12		Arnoldsburg - Benwood	Arnoldsburg	Coal smut.			0	1/4	48	11	100	0
11				Clay shale, gray, brown, buff, breaks irregularly, calcareous, micaceous, silty.			14	2			100	0
10			Arnoldsburg - Benwood	Limestone and clay shale: shale, variegated, brown, maroon, purple, yellow, breaks irregularly, silty, micaceous; limestone, white, gray, yellow, some nodules and other ledges, fresh-water, massive, some brecciated, ledges become more massive at top with 5 foot ledge at top.			34	6			85	10
9				Clay shale, chocolate to maroon, laminated, silty, micaceous.			0	3			51	4
8		Sewickley	Sewickley	Coal smut -- this coal was reported as being 3 feet 9 inches in nearby mine 90 years old.			0	1/4	42	0	51	1
7				Clay, light gray with some pale yellow stain, silty and sandy, laminated, semi-plastic, micaceous.			0	10			51	1
6			Lower Sewickley	Shale and sandstone, light greenish-gray to olive, fine to medium grained, micaceous, generally irregularly bedded but some massive ledges.			39	3			50	3
5				Clay shale, light maroon, olive brown, dark gray at top, silty, micaceous, breaks irregularly at bas, massive at top.			1	11			11	0
4		Fishpot	Fishpot	Coal streak, dark carbonaceous material.			0	1/4	9	1	9	1
3				Shale, dark gray, grainy, silty, micaceous, breaks irregularly.			0	9			9	1
2				Limestone, dark gray, weathers light gray, massive, nodular in parts.			2	10			8	4
1				Clay shale, light greenish gray with purplish mottling, breaks irregularly, silty, micaceous, contains limestone nodules, greenish gray with purple stain, massive, micaceous.			5	6			5	6

LOCATION KEY: Ab 21 FILE NUMBER: 11635 ELEVATION: TOPO MAP: Chesterhill

STATE: Ohio COUNTY: Athens TOWNSHIP: Bern SECTION: NE-1/4, 29

LOCATION: Exposure east along Route 50A east from 653 road junction up Sharpsburg Hill.

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
40	Washington	Waynesburg "A"	Waynesburg	Sandstone, coarse below to medium above, massive, exposed to hilltop.			7	1	7	1	271	0
39	Monongahela	Waynesburg	Cassville ?	Shale, medium, argillaceous, thin-bedded.			1	11	33	9	263	11
38			Waynesburg	Coal, shaly or shale, coaly			0	1			262	0
37			Gilboy	Shale, variable reddish to olive gray above and olive brown to olive gray, silty below.			29	5			261	11
36				Shale, variegated red to gray, platy above, clayey below.			2	4			232	6
35		Little Waynesburg	Little Waynesburg	Shale, carbonaceous, coaly smut.			0	1	25	3	230	2
34			Waynesburg	Shale, dusky red, massive, with zones of limestone nodules and pellets.			10	9			230	1
33			Uniontown	Shale and sandstone, varying shades of gray, brown, reddish, bedded.			14	5			219	4
32		Uniontown	Uniontown	Shale, carabonaceous, coal zone.			0	1	28	2	204	11
31				Shale, gray below and dusky red to olive gray above, with numerous limestone nodules and pellets throughout.			19	10			204	10
30			Arnoldsburg	Sandstone and shale, gray to brown, fine to medium, with shaly partings.			8	2			185	0
29				Shale, reddish to olive gray interbedded, silty to sandy upward, gray clay shale at base.			12	4			176	10
28		Arnoldsburg and Benwood	Arnoldsburg ?	Shale, coaly, smut streak.			0	1	68	2	176	9
27			Arnoldsburg and Benwood	Shale and limestone, variegated (gray, red, brown, yellow, purple) shale interbedded with light to dark gray, variable (dense, brecciated, etc.) limestone beds or nodular zones in layers 4 inches to several feet thick, shale zones with or without limestone nodules and pellets, middle part weathers predominantly white, lower and upper parts weather red, brown, or yellow, some beds with non-marine gastropods, ostracodes, and Spirorbis.			61	3			176	8
26			Sewickley	Sandstone, olive brown, micaceous, somewhat lenticular, massive with some shaly sandstone zones above and below, conspicuous ledge.			5	2			115	5
25				Shale and clay shale, gray to olive gray with considerable limonite stain in base.			1	8			110	3
24		Sewickley	Sewickley	Shale and clay shale, carbonaceous.			0	1	16	1	108	7
23			?	Shale, olive to medium gray above to varicolored with limestone nodules below, massive, prominent limonite crust at top, transitional into bed below.			3	11			108	6
22				Sandstone, siltstone, and shale, shades of brown to gray, silty, micaceous, bedded, some interbedded, thin zones.			12	1			104	7
21		Lower Sewickley	Lower Sewickley	Clay shale, olive gray to olive brown, poorly bedded.			0	10	16	5	92	6

LOCATION: Ab 21 FILE NUMBER 11635 - continued

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
20	Monongahela - continued	Lower Sewickley - continued	Lower Sewickley - continued	Shale, olive gray, dark purplish zone at top.			0	3			91	8
19				Limestone and shale: limestone pale yellow to pale olive gray, poor conchoidal to irregular clay fracture, hard; shale, olive gray, laminated.			7	2			91	5
18				Siltstone, calcareous, medium gray, irregular.			1	8			84	3
17				Limestone, pale olive gray, weathers white to yellowish several irregular bouldery beds with some shaly partings, some ostracodes in shale.			5	10			82	7
16				Shale, light gray, clayey, partially calcareous.			0	8			76	9
15		Fishpot	Fishpot	Shale, olive gray above, dusky red below, weathers to purplish dust, considerable limy flakes and knots with a few large knots.			7	9	23	10	76	1
14				Limestone, bouldery, gray to pale yellowish gray in gray to olive gray shale matrix.			4	9			68	4
13			Pomeroy ?	Sandstone, highly calcareous, or limestone, silty, olive brown to gray, almost pure limestone above, micaceous.			1	8			63	7
12				Shale and sandstone, interbedded, 1 inch to 3 feet, gray to olive gray, fine sandstone in like shale.			1	0			61	11
11			Fishpot	Limestone, pale yellow orange, fretted, weathers slabby in zones.			3	0			60	11
10				Shale, olive gray to yellowish when weathered, fretted pale yellow orange limestone included, weathers to dust.			0	10			57	11
9				Limestone, light yellowish orange to pale yellow, nodular or lumpy below, spalling in sharp slabs in upper layer.			3	0			57	1
8				Shale, light gray, weathers yellowish, highly calcareous.			1	4			54	1
7				Clay shale, dark gray.			0	2-3/4			52	9
6				Clay shale, gray, weathers brown with white on surfaces.			0	3			52	6
5		Redstone	Redstone	Shale, carbonaceous, coal zone.			0	1	51	7	52	3
4			Redstone	Shale and limestone, varicolored (red, green, gray) calcareous, massive shale, in part with nodules and pellets of limestone, and light gray to olive gray, silty, nodular limestone (may in part represent a sandstone).			20	0			52	2
3			Upper Pittsburgh	Shale in two zones, an upper olive green weathering to various shades of red, brown, and yellow, silty to sandy, much distorted, rolled, etc., and a varicolored lower zone, mostly red, massive, crumbly with irregular to conchoidal fracture.			31	6			32	2
2		Pittsburgh	Pittsburgh	Coal zone.			0	1	0	8	0	8
1				Clay shale, greenish gray, bluish cast when wet, exposed.			0	7			0	7

CANAAN TOWNSHIP

LOCATION KEY: Acn FILE NUMBER: 3198 ELEVATION: TOPO MAP: Chesterhill

STATE: Ohio COUNTY: Athens TOWNSHIP: Canaan SECTION: NW¼, 9

LOCATION: Shaft of Canaan Coal Company and in adjacent small valley on north side of Hocking River. Modified from stratigraphic section by Stout (1954, p. 64-65).

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
59	Monongahela	Redstone	Upper Pittsburgh	Sandstone, massive to shaly, fine-grained, drab.			15	0	18	9	577	6½
58				Shale, gray, siliceous.			3	9			562	6½
57		Pittsburgh	Pittsburgh	Shale, dark gray.			0	3	0	9½	558	9½
56				Shale, coaly, coal horizon.			0	6½			558	6½
55	Monongahela & Conemaugh	?	?	Covered interval.			101	1	101	1	558	0
54		Recent	Recent	Top of shaft			-	-	7	0		
53				Soil			3	0			456	11
52				Sand and gravel.			4	0			453	11
51	Conemaugh	Elk Lick	Elk Lick ?	Clay shale.			11	0	42	0	449	11
50			Upper Grafton	Sandstone.			26	0			438	11
49			Birmingham	Shale, blue.			3	0			412	11
48				Shale, red			2	0			409	11
47		Duquesne and Gaysport.	Skelley ?	Sandstone, limy			4	0	51	0	407	11
46			Skelley and	Shale, blue.			5	0			403	11
45			Gaysport	Sandstone.			12	0			398	11
44				Shale.			30	0			386	11
43		Ames	Ames	Limestone, fossiliferous,			3	0	14	0	356	11
42				Shale.			3	0			353	11
41				Sandstone.			8	0			350	11
40		Harlem	Saltsburg	Shale			14	0	23	0	342	11
39				Shale, blue, siliceous.			9	0			328	11
38		Upper Bakerstown	Ewing	Shale, siliceous, with some limestone.			9	0	25	0	319	11
37			Cow Run	Shale, blue.			16	0			310	11
36		Anderson	Portersville	Shale, black			6	0	16	0	294	11
35			Anderson	Coal			2	0			288	11
34				Clay, impure			3	0			286	11
33			Bakerstown	Sandstone			5	0			283	11
32		Wilgus	Cambridge	Limestone			4	0	36	0	278	11
31			Buffalo	Shale			16	0			274	11
30		?	?	Sandstone, blue.			16	0			258	11
29		Upper Brush	Upper Brush	Shale, hard			26	0	48	0	242	11
28		Creek	Creek	Coal			1	0			216	11
27				Shale and clay			11	0			215	11
26				Sandstone and hard shale			10	0			204	11
25		Lower Brush	Lower Brush	Flint, red			2	0	29	0	194	11
24		Creek	Creek	Limestone			3	0			192	11
23				Shale, siliceous.			24	0			189	11
22		Mason	Mason ?	Shale, light, soft.			9	0	27	0	165	11
21			Upper Mahoning	Shale, siliceous.			2	0			156	11
20				Sandstone			4	0			154	11
19				Shale			12	0			150	11
18		?	?	Sandstone			1	0			138	11
17		Mahoning	Lower Mahoning	Shale			30	0	31	0	137	11
	Allegheny	Upper Freeport and Bolivar	Upper Freeport and Bolivar	Coal horizon, approximate			0	0	50	0	104	11
16				Sandstone, massive			50	0	50	0	104	11
15		Lower Freeport	Lower Freeport	Shale			1	0	36	0	54	11
14				Coal			4	0			53	11
13				Clay, impure			3	0			49	11
12				Sandstone			28	0			46	11
11		Upper Kittanning	Upper Kittanning	Shale, with thin coal bands			1	0	13	0	18	11
10				Sandstone			4	0			17	11
9		?	?	Shale, coal, and clay			8	0			13	11

LOCATION: Acn FILE NUMBER: 3198

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
8	Allegheny	Middle Kittanning	Middle Kittanning	Coal			0	10	5	11	5	11
7				Shale			9	3			5	1
6				Coal			1	7			4	10
5				Shale			0	3			3	3
4				Coal			0	6½			3	0
3				Coal, bony			0	1½			2	5½
2				Coal			2	4			2	4
1				Underclay, unmeasured			-	-				

LOCATION KEY: Acn 4 FILE NUMBER: 11285 ELEVATION: 660 ± Base TOPO MAP: Athens

STATE: Ohio COUNTY: Athens TOWNSHIP: Canaan SECTION: NW¼, 34 and SW¼, 35

LOCATION: Composite exposure along tributary valley north of Route 50.

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
25	Monongahela	Redstone	Upper Pittsburgh	Shale, light gray weathered olive to tan with some limonite stain, silty, sandy, micaceous, with layers up to 6 inches or more of fine, thin-bedded micaceous sandstone, exposed.			10	0	10	0	273	3
24		Pittsburgh	Pittsburgh	Coal, much bright in rather thin layers separated by about equal thicknesses of dull coal, basal part shaly and micaceous.			3	8	20	3	263	3
23			?	Covered interval.			16	7			259	7
22	Conemaugh	Lower Little Pittsburgh	Connellsville	Sandstone, light gray, much limonite stained, medium to coarse with very coarse zones, arkosic?, micaceous, somewhat friable with case hardened surfaces, massive, showing much bedding and cross-bedding on weathered surfaces.			78	4	78	4	243	0
21		?	?	Covered interval			59	10	59	10	164	8
20		Little Clarksburg or Elk Lick	Morgantown or Upper Grafton	Shale and sandstone, light gray mostly weathered light olive to tan, silty, sandy, micaceous shale interbedded with thin-bedded somewhat limonite-stained, fine, silty, micaceous sandstone.			17	5	17	5	104	10
19		Duquesne	Duquesne	Shale, dull gray to brown with some maroon stain, silty to argillaceous, finely micaceous with thin coal lenses in base, and also some fossil clams (estherids?)			0	3	9	9	87	5
18				Clay shale and limestone, mottled various shades of gray, yellow, purple, breaks with starch-like fracture, calcareous with numerous very small limestone nodules at base			4	11			87	2
17			Lower Grafton	Shale, light gray weathering pale olive or tan, silty, micaceous, platy.			4	7			83	1
16		Gaysport	Gaysport	Shale and limestone, chocolate with dull greenish and yellow mottling, silty, finely micaceous, fissile, with light gray-drab, dense, nodular limestone which weathers tan, yellow or brown at top, bottom, and possibly throughout, fossiliferous, marine			5	2	11	0	78	6
15				Shale, light gray weathering pale buff to tan, with some limonite stain, silty to finely sandy, micaceous, no apparent fossils.			5	10			73	4
14		Ames	Ames	Limestone, light gray with slight limonite stain, mostly dense, fossiliferous, marine			1	6	25	2	67	6
13				Clay, light gray with limonite stain, breaks with starch-like fracutre, weathers somewhat plastic.			0	9			66	0
12				Sandstone, light gray stained pale brown and yellow, fine, silty, micaceous, massive layers near top and bottom thin-bedded, shaly between and above shale at top.			4	11			65	3
11				Shale and sandstone, light gray to pale olive or tan, silty, sandy, micaceous shale with thin beds of light gray, limonite stained, fine, silty, micaceous sandstone.			18	0			60	4

LOCATION: Acn 4 FILE NUMBER: 11285 - continued

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
10	Conemaugh - continued	Harlem	Harlem	Shale, black, bony, carbonaceous, fissile			2	2½	10	4	42	4
9				Coal, bright, bands interbedded with dull, carbonaceous shale partings.			0	1½			40	1½
8			Round Knob	Clay, gray to light gray, silty, micaceous, sandy in base, breaks with starch-like fracture, little or no plasticity.			1	2			40	0
7			Saltsburg	Shale, light gray to pale olive or tan with some limonite stain, silty, sandy, micaceous.			6	10			38	10
6		Upper Bakerstown	Ewing	Limestone and shale, gray to light gray with some limonite stain, sandy, silty, micaceous, nodules (up to 8 inches in size) or veinlets in silty shale similar to that immediately below, becomes sandy upward.			10	6	22	10	32	0
5			Cow Run	Shale, light gray to pale olive or tan with little limonite stain, silty, finely micaceous			12	4			21	6
4		Anderson	Portersville	Shale, chocolate, argillaceous, silty, somewhat fissile with few small, scattered yellow concretions, few or no fossils.			5	11	9	2	9	2
3				Shale, dark chocolate mottled with dull green, some limonite stain, compact, argillaceous, silty, fossiliferous, especially in lower part, marine.			1	0			3	3
2				Limestone and shale, nodular, dark greenish gray, dense, fossiliferous, limestone, embedded in light greenish gray, slightly limonitic stained, argillaceous to silty, calcareous shale, fossiliferous, marine.			0	5			2	3
1				Shale, full gray with slight limonite stain, argillaceous, silty, micaceous, fossiliferous, marine, exposed.			1	10			1	10

LOCATION KEY: Acn 5 FILE NUMBER: 11287 ELEVATION: 637± Base TOPO MAP: Athens

STATE: Ohio COUNTY: Athens TOWNSHIP: Canaan SECTION: E½ NW¼, 28

LOCATION: Composite of exposure on Hope farm.

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
30	Monongahela	Benwood ?	Sewickley ?	Covered to top of hill, some sandstone float (well developed 10-15 ft. thick on adjacent hill tops).			31	6	31	6	349	9
29		Sewickley	Sewickley	Limestone, gray to olive drab with some limonite stain, dense, nodular, loose pieces on surface, exposed.			3	0	11	2	318	3
28			Lower Sewickley	Shale and sandstone, pale olive to tan with some limonite stain, silty, micaceous shale and finer, silty, micaceous, thin-bedded, sandstone, covered upward.			7	6			315	3
27				Shale, chocolate brown to maroon, argillaceous, finely micaceous, with numerous fossil plants.			0	8			307	9
26		?	?	Covered interval, showing at top olive to drab, silty, sandy, micaceous shale and thin-bedded, fine, silty, micaceous sandstone.			18	4			307	1
25		Redstone	Redstone	Limestone, gray, weathered to light gray, dense, nodular, apparently bedded in red clay shale, poorly exposed.			6	4	24	0	288	9
24				Limestone, light yellow to tan with some brown, dense to chalky, with numerous, calcareous, clay masses which weather out giving a pitted spongy surface, not well developed.			8	2			282	5
23			Upper Pittsburgh	Shale and sandstone, light gray, weathered pale olive with some limonite stain, silty, sandy, micaceous shale with zones of similarly colored, fine, silty, micaceous, thin-bedded sandstone, massive layer of coarser sandstone at top.			8	6			274	3

LOCATION: Acn 5 FILE NUMBER: 11287 - continued

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
22	Monongahela - continued	Redstone - continued	Upper Pittsburgh - continued	Shale, gray, with some limonite stain, silty to argillaceous, breaks up, starch-like fracture, exposed.			4	0			265	9
21		?	?	Covered interval, light gray to tan, mottled red, flinty appearing, clay shale at 240 feet above base, not certain in place, sweet clover abundant between 250-260 feet.			29	8			261	9
20	Conemaugh	Lower Little Pittsburgh	Connellsville	Sandstone, light gray to pale tan or buff, with slight limonite stain, mostly coarse to very coarse, micaceous, friable, porous, massive, showing some evidence of bedding and cross-bedding on weathered surfaces, at 157 feet irregular lenses of bright coal 5 inches thick scattered in a zone 18 inches thick.			102	6	102	6	232	1
19		?	?	Covered interval			39	1	51	0	130	7
18		Elk Lick	Elk Lick	Limestone conglomerate, dull greenish gray with purple and yellow surface, pebbles of various dense limestones, mostly under 1 inch diameter, matrix grainy, sandy, micaceous, calcareous, apparently a lens.			1	6			91	6
17				Clay shale and limonite, red, maroon, or light bluish gray with some limonite, silty, finely micaceous, calcareous, breaks with starch-like fracture, small limonite nodules in top of top exposure, only top 18 inches of interval exposed.			3	9			90	0
16			Upper Grafton	Sandstone, light gray to olive with considerable brown stain, mostly fine, micaceous, in layers mostly 1/2 to 8 inches, some cross-bedding.			2	0			86	3
15				Shale and sandstone, light bluish gray and some limonite stain, silty, sandy, micaceous shale grading upward into similarly colored, fine, silty, micaceous sandstone, most of interval shaly appearing.			4	8			84	3
14		Duquesne	Skelley	Limestone, light greenish gray with whitish masses and pale yellow stain, dense with crystalline masses, fossiliferous?, marine			0	3	28	10	79	7
13				Shale, maroon to dark greenish gray, silty, micaceous, irregular fracture to almost fissile, fossiliferous, marine.			1	5			79	4
12			Duquesne	Siderite, bluish to greenish gray with light gray masses, some limonite stain, micaceous, silty, sandy, nodular, thickness variable.			0	4			77	11
11				Shale, light bluish gray weathering olive to tan with small amounts of limonite, silty, sandy, micaceous with zones of fine, silty, micaceous sandstone, not all well exposed.			14	10			77	7
10				Covered interval			12	0			62	9
9		Gaysport	Gaysport	Shale and limestone, gray to chocolate with considerable limonite stain, with scattered nodules of gray, granular or brown to tan, dense, fossiliferous limestone, marine, exposed.			3	8	4	5	50	9
8				Shale, light bluish gray with small amounts of limonite stain, silty, micaceous, fossiliferous, marine.			0	9			47	1
7		Ames	Ames	Shale, light gray to light tan at base but most above chocolate brown with some green mottling, silty, finely micaceous, fissile, marine fossils in base.			3	8	45	0	46	4
6				Limestone, light gray with tints of pink and green, with some limonite stains, partly crystalline, massive, fossiliferous (fusulinids) and abundant Crurithyris), marine.			1	2			42	8
5				Shale, gray with some limonite stain, argillaceous, silty, micaceous, slightly plastic.			1	2			41	6
4				Shale, tan, silty, micaceous, exposed.			2	4			40	4
3				Sandstone, light gray with considerable limonite stain, fine, micaceous, thin-bedded, ripple-marked, exposed.			6	0			38	0

LOCATION: Acn 5 FILE NUMBER: 11287 - continued

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
2	Conemaugh - continued	Upper Bakerstown and Harlem	?	Covered interval.			23	0	23	0	32	0
1			Cow Run ?	Shale and sandstone, light gray to pale greenish gray, somewhat limonitic, stained, silty, sandy, micaceous shale with calcareous concretions, grading upward, similarly colored, fine, silty, micaceous, calcareous, sandstone which is nodular at base and thin-bedded above, exposed.			9	0			9	0

LOCATION KEY: Acn 10 FILE NUMBER: 11292 ELEVATION: 990 ± Base TOPO MAP: Athens

STATE: Ohio COUNTY: Athens TOWNSHIP: Canaan SECTION: NW¼ SE¼, 24

LOCATION: Exposure in ravine and along slope south of abandoned school.

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
33	Monongahela	Arnoldsburg - Benwood	Arnoldsburg - Benwood	Shale, varicolored, tan with maroon zones, argillaceous to silty, finely micaceous, platy to fissile, covered in top part.			22	4	66	3	241	0
32				Clay shale and limestone, light gray to maroon above, calcareous clay shale with gray greenish nodules of dense limestone			6	8			218	8
31				Limestone, light gray with faint yellowish stain, dense, except for small crystalline masses and fillings, fossiliferous, freshwater, single massive ledge.			0	6			212	0
30				Clay and limestone, maroon below to tan above, calcareous clay shale with numerous nodules of gray to light gray dense limestone.			10	8			211	6
29			?	Covered interval.			24	4			200	10
28			Sewickley	Sandstone, light gray to olive with some limonite stain, fine to medium, micaceous, thin-bedded.			1	3			176	6
27		Sewickley	Sewickley	Clay shale, yellow, weathered			0	6	37	3	175	3
26				Clay, light gray, weathered.			0	2			174	9
25				Coal smut, weathered			0	1			174	7
24				Covered interval, apparently light gray to olive or tan, silty, micaceous, shale.			16	6			174	6
23				Shale, gray to olive with considerable limonite stain, platy, silty, micaceous, exposed			1	0			158	0
22				Shale, varicolored, maroon, yellow, gray, fissile to starch-like fracture, small nodules of hematite towards base, gray plastic clay zone at top.			7	7			157	0
21				Sandstone, light greenish gray with some limonite stain, silty, micaceous, fine-grained calcareous.			1	0			149	5
20				Shale, varicolored, light greenish gray, chocolate, maroon, argillaceous, slightly micaceous.			4	7			148	5
19			Lower Sewickley	Sandstone, gray to light gray with limonite surface stains, fine to medium, arkosic?, calcareous, micaceous, bedded in 4" layers			1	4			143	10
18				Shale, light gray to olive, with some limonite stain, silty, with sandy zones upward.			5	5			142	6
17		Fishpot and Redstone ?	Fishpot	Shale, gray with limonite stain below to maroon above, argillaceous, platy to fissile, fossiliferous (clams)			0	9	37	1	137	1
16				Clay shale and limestone, light gray mottled maroon, purple, greenish-gray, breaks with starch-like fracture and small nodules of light gray limestone, gray at top with ostracods, Spirorbis.			11	2			136	4
15				Limestone, light gray, weathered with white surfaces, nodular, embedded in light gray, calcareous shale.			6	6			125	2

LOCATION: Acn 10 FILE NUMBER: 11292 - continued

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
14	Monongahela - continued	Fishpot & Redstone continued	Fishpot or Redstone ? continued	Limestone, yellow to tan, dense, argillaceous, weathers with porous spongy surfaces, embedded in light gray, clay shale.			5	9			118	8
13			Upper Pittsburgh	Shale, light gray to tan, silty, sandy, micaceous, slumped over by maroon clay, clay shale.			12	11			112	11
12		Pittsburgh ?	Pittsburgh ?	Shale, light gray to tan, with some limonite stain, fine, very micaceous, thin-bedded, thickness variable.			8	0	15	0	100	0
11				Shale, light gray to olive with some limonite stain, argillaceous, finely micaceous, fissile, no trace of Pittsburgh coal.			7	0			92	0
10	Conemaugh	Pittsburgh ?	Upper Pittsburgh ?	Limestone, light gray to yellow or tan, dense, coarsely nodular, with numerous dendrites interbedded with clay shale.			4	0	4	0	85	0
9		Lower Little Pittsburgh ?	Lower Pittsburgh?	Clay shale, gray to tan, mottled bright red to yellow, breaks with starch-like fracture, flint clay in appearance.			4	10	76	6	81	0
8				Clay shale, mottled light green to maroon, very finely micaceous, breaks with starch-like fracture, small scattered limestone nodules.			6	2			76	2
7				Limestone, greenish gray with some limonite stains, impure, nodular, embedded in similarly colored shales.			2	4			70	0
6			Connellsville	Sandstone, light gray, much yellow-brown stain, mostly medium fine to coarse.			53	2			67	8
5		Little Clarksburg	Clarksburg	Shale, light greenish gray with much limonite stain, finely micaceous.			0	5	14	6	14	6
4				Limestone, light greenish to yellowish gray, with numerous brown specks, styolites, single massive ledge, uneven thickness.			0	6			14	1
3				Shale and clay shale, interbedded, mottled gray to tan-gray, shale and light bluish gray with considerable limonite stain, silty to sandy, micaceous shale.			9	4			13	7
2				Clay, gray to light gray with some limonite stains, breaks with a starch-like fracture, finely micaceous, some slickensides, nodular gray limestone at top.			1	5			4	3
1				Clay shale, mottled gray and dull maroon, silty, breaks with starch-like fracture, scattered small gray limestone nodules, exposed.			2	10			2	10

LOCATION KEY: Acn 12 FILE NUMBER: 11294 ELEVATION: 740 ± Base TOPO MAP: Chesterhill

STATE: Ohio COUNTY: Athens TOWNSHIP: Canaan SECTION: $S\frac{1}{2}$ $NW\frac{1}{4}$, 4

LOCATION: Exposure up hill along road.

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
20	Monongahela	Benwood	Benwood	Limestone, light gray to gray, hard, dense massive, in tan shales.			3	4	55	9	166	11
19				Shale, maroon, silty, argillaceous, finely micaceous, with small limestone nodules.			3	4			163	7
18				Shale and limestone, gray to tan shales, limestone nodules throughout.			2	0			160	3
17			Sewickley	Sandstone, gray to buff, limonite stained, fine, micaceous, massive below to slabby upward.			10	2			158	3
16			Tyler	Shale, gray to tan, limonite stained, silty to sandy upward, micaceous, thin-bedded.			4	0			148	1
15				Shale, maroon to dark red, silty, argillaceous, with small limestone nodules.			17	10			144	1
14				Shale, gray to greenish gray, many scattered limestone nodules.			2	0			126	3
13			Sewickley	Sandstone, gray to buff, limonite stain, fine-grained, slabby to massive, micaceous.			13	1			124	3

LOCATION: Acn 12 FILE NUMBER: 11294 - continued

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
12	Monongahela - continued	Sewickley	Sewickley	Shale, gray to olive drab, silty to sandy upwards, micaceous.			1	7	46	3	111	2
11				Clay shale, light gray, silty, finely micaceous, breaks with a starch-like fracture.			0	9			109	7
10				Shale, chocolate to maroon, argillaceous, finely micaceous, breaks with a starch-like fracture.			6	7			108	10
9				Shale and limestone, gray mottled purple, with scattered limestone nodules up to 8 in.			26	3			102	3
8				Limestone, light gray, lense, hard, nodular			1	0			76	0
7				Shale, gray to tan, mottled maroon, with small scattered limestone nodules.			6	0			75	0
6			Lower Sewickley	Sandstone, gray to tan, fine-grained, poorly exposed.			20	2			69	0
5		Fishpot	Fishpot	Limestone, gray to light gray, some limonite stain, nodular, dense, hard, upper part weathers yellow with slight fretted appearance.			12	10	31	5	47	10
4			Fishpot or Pomeroy	Sandstone, gray to greenish gray, fine, very micaceous, massive to thin-bedded, cross-bedded, irregular thickness.			16	1			35	0
3				Siltstone, gray to greenish gray, micaceous, fissile, becomes sandy upward, irregular thickness.			2	6			18	11
2		Redstone	Redstone	Clay shale, maroon to light blue, silty to sandy, micaceous, contains plant fossils.			0	5	16	5	16	5
1				Shale, blue-gray to blue, silty, finely micaceous, with scattered limestone nodules up to 6 inches.			16	0			16	0

LOCATION KEY: Acn 13 FILE NUMBER: 11295 ELEVATION: 662 ± Base TOPO MAP: Chesterhill

STATE: Ohio COUNTY. Athens TOWNSHIP: Canaan SECTION: NE¼, 12

LOCATION: Exposure at the Paul Kinnen farm along tributary to Sugar Run.

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
23	Monongahela	Arnoldsburg - Benwood	?	Sandstone, light gray to pale olive with some limonite stain, fine, micaceous, calcareous in part, thin bedded, poorly exposed.			27	1	90	9	229	4
22			Benwood	Limestone, gray to light gray with yellowish stain, dense, one bedded layer 6"-8" thick, bedded in gray calcareous clay shale, basal contact not certain, fossiliferous, freshwater up to 30 ' thick.			4	3			202	3
21				Clay shale, varicolored, brown, red, yellow, etc., silty, finely micaceous, breaks with starch-like fracture, rather firm not hard, numerous limestone nodules.			37	0			198	0
20			Sewickley	Sandstone, light olive to tan or brown, fine, fine, silty, micaceous, thin-bedded, sandstone, probably with shaly zones, not well exposed.			22	5			161	0
19		Sewickley	Sewickley	Clay shale and coal, gray to dark gray, soft laminated clay shale, with several thin streaks of coal.			2	5	21	1	138	7
18				Clay shale, dark greenish gray to dark gray, silty, micaceous, carbonaceous toward top, breaks with starch-like fracture.			2	6			136	2
17				Limestone, tan to yellow with some brown stain, argillaceous, dense, nodular, weathered.			0	4			133	8
16				Clay shale, varicolored light gray, tan to yellow, maroon, micaceous, breaks with starch-like fracture.			7	6			133	4
15			Lower Sewickley	Sandstone, light gray to pale olive gray or tan with small amounts of limonite stain, fine, silty, very micaceous, in layers 1/4 to 8 inches thick.			8	4			125	10

LOCATION: Acn 13 FILE NUMBER: 11295 - continued

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
14	Monongahela - continued	Fishpot-Redstone	Fishpot-Redstone	Shale, variable, chocolate brown to olive or tan, with some limonite stain, silty in part, argillaceous at top, laminated below with starch-like fracture at top, fossil ostracods at base of chocolate shale.			1	8	67	3	117	6
13				Clay shale, varicolored light to greenish gray, maroon, very finely micaceous, breaks with starch-like fracture, some slickensides.			1	9			115	10
12				Limestone, light gray to gray, dense, sparingly to finely micaceous.			2	1			114	1
11				Clay shale, varicolored, gray to light gray, maroon, yellow, finely micaceous, silty?, breaks with starch-like fracture.			8	2			112	0
10				Covered interval			16	10			103	10
9				Limestone, light tan to yellow, argillaceous, dense, porous and spongy			3	6			87	0
8				Clay shale and limestone, mottled maroon, purple, yellow and gray, calcareous clay shale which breaks with starch-like fracture, contains many small limestone nodules.			5	6			83	6
7			Upper Pittsburgh	Shale, light gray to pale olive with limonite stain, sandy in basal part, silty, finely micaceous, mostly laminated zones upward of irregular laminae fracture.			8	4			78	0
6				Shale and sandstone, light gray to pale olive, silty, sandy, micaceous shale below, grading upward into similarly colored, fine, silty, shale below, thin bedded sandstone.			19	5			68	9
5		Pittsburgh	Pittsburgh	Coal, mostly dull, thin lenses of bright coal			0	3	19	1	50	3
4				Clay shale, light gray at top, olive gray below, some limonite stain, finely micaceous, with lenses of coal shale.			0	8			50	0
3			Upper Pittsburgh	Limestone, light gray to gray or greenish gray, weathered almost white with little limonite stain, dense, irregularly bedded, interbedded with thinner layers of gray to light gray calcareous, fossiliferous, fresh-water.			18	2			49	4
2	Conemaugh	Lower Little Pittsburgh	Lower Little Pittsburgh	Clay shale, tan to yellow with red and brown mottling, flinty to irregular fracture, sparingly micaceous.			13	2	31	2	31	2
1			Connellsville	Shale, light gray to pale olive or tan with little limonite stain, finely micaceous, laminated, poorly exposed.			18	0			18	0

LOCATION KEY: Acn 14 FILE NUMBER: 11296 ELEVATION: 690± base TOPO MAP: Chesterhill

STATE: Ohio COUNTY: Athens TOWNSHIP: Canaan SECTION: NW¼ NW¼, 5

LOCATION: Exposure in ravine and abandoned limestone quarry on hill behind house of R. E. Poston

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
11	Monongahela	Redstone	Redstone	Shale, gray to tan with limonite stain.			17	0	24	2	82	5
10				Shale, gray to maroon with limonite stain, argillaceous, platy, silty.			1	9			65	5
9			Upper Pittsburgh	Sandstone, gray to tan, limonite stained, micaceous, shaly below to massive above.			5	4			63	8
8		Pittsburgh	Pittsburgh	Clay shale, light gray to gray with limonite stain, thin-bedded, finely micaceous.			0	4			58	4
7				Coal, mostly dull with some bright streaks, weathers in thin sheets, fish fossils.			0	3			58	0
6				Clay, gray to brown with limonite stain, somewhat plastic.			0	4			57	9
5				Clay shale, gray to medium gray, with limonite stain, some carbonaceous specks.			0	9			57	5
4			Upper Pittsburgh	Limestone, gray to light gray with limonite stain, dense, massive nodules, fresh-water in gray to tan argillaceous shales.			7	2			56	8

LOCATION: Acn 14 FILE NUMBER: 11296 - continued

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
3	Monongahela - continued	Pittsburgh - continued	Lower Pittsburgh	Clay shale, gray to tan, mottled red to yellow, silty, with a starch-like fracture and traces of bedding, flinty in appearance.			10	6			49	6
2				Sandstone, gray to olive drab, limonite stained, very fine, micaceous, thin to shaly bedded below to massive above.			3	0			39	0
1	Conemaugh	Upper Little Pittsburgh	Upper Little Pittsburgh	Shale, gray to olive drab with limonite stain, and some maroon mottling, silty to sandy, micaceous, somewhat bedded, exposed.			36	0	36	0	36	0

LOCATION KEY: Acn 15 FILE NUMBER: 11473 ELEVATION: 693 ±base TOPO MAP: Chesterhill

STATE: Ohio COUNTY: Athens TOWNSHIP: Canaan SECTION: 11

LOCATION: Exposure along creek and up hill south in the $E\frac{1}{2}$ $NW\frac{1}{4}$, section 11, and the $W\frac{1}{2}$ $SE\frac{1}{4}$, section 11.

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
41	Monongahela	Uniontown ?	Uniontown ?	Limestone, gray, dense, large boulders in gray to tan and brown clay shales, exposed.			11	0	22	2	267	0
40			Ritchie ?	Clay shale, gray to light maroon or pink, silty, finely micaceous, contains very small scattered nodules of fresh-water limestone			4	0			256	0
39				Clay shale, gray to tan, limonite stain, silty, calcareous, contains nodules (small) fresh-water limestone.			4	8			252	0
38			Arnoldsburg ?	Sandstone, gray to buff or olive drab, limonite stained, fine to medium, massive, calcareous			1	6			247	4
37		Arnoldsburg ?	Arnoldsburg ?	Clay shale, gray to olive drab, limonite stained.			1	0	26	11	245	10
36				Clay shale, gray to olive below, to maroon above, silty, finely micaceous, calcareous contains small scattered nodules of fresh-water limestone.			19	2			244	10
35			Fulton ?	Sandstone and shale, gray to buff, micaceous, silty shale, sandstone ledges 4"			6	9			225	8
34		Benwood ?	Tyler ?	Clay shale, gray to chocolate maroon, platy, slightly carbonaceous, contains scattered nodules of fresh-water limestone, shale becomes light gray at top.			3	4	74	11	218	11
33				Clay shale, gray to tan below to maroon above, silty, finely micaceous, contains scattered nodules of fresh-water limestone, shale becomes light gray at top.			21	3			215	7
32				Clay shale, chocolate maroon, silty, contains plant fossils, laminated.			1	10			194	4
31				Clay shale, light gray, silty, slightly plastic in base, upper 6 inches calcareous			1	0			192	6
30				Clay shale, variable, gray to light maroon, silty, contains scattered nodules of small fresh-water limestone.			11	6			191	6
29			Sewickley	Sandstone and shale, gray to buff, micaceous, poorly exposed.			20	0			180	0
28				Sandstone, light gray to olive, limonite stained, fine, micaceous, laminated.			16	0			160	0
27		Sewickley ?	Sewickley	Clay shale, maroon to gray below, silty, finely micaceous.			19	6	25	8	144	0
26			Lower Sewickley	Shale and sandstone, gray to tan, limonite stained, micaceous and silty shales grading upward into fine, micaceous, slabby sandstone.			6	2			124	6
25		Fishpot	Fishpot	Clay shale, gray to maroon, finely micaceous, silty.			0	6	18	9	118	4
24				Clay shale, gray, carbonaceous streaks			0	1			117	10
23				Clay shale, gray, silty, finely micaceous, breaks with starch-like fracture.			0	3			117	9

LOCATION: Acn 15 FILE NUMBER: 11473 - continued

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
22	Monongahela - continued	Fishpot - continued	Fishpot - continued	Limestone, gray, limonite stained, nodular, dense, embedded in gray calcareous shale, fresh-water.			3	6			117	6
21				Clay shale, variable, gray to maroon, silty, very finely micaceous, breaks with a starch-like fracture, contains scattered fresh-water limestone nodules.			8	0			114	0
20			Pomeroy	Sandstone, light gray to gray, some limonite stained, fine to medium, very micaceous, calcareous, massive.			6	5			106	0
19		Redstone	Redstone	Limestone, gray to yellow, limonite stained, weathers with a fretted appearance, fresh-water, embedded in shales as described below.			3	7	23	10	99	7
18				Clay shale, gray to tan, some maroon mottling, silty, finely micaceous, thin-bedded sandstone.			3	10			96	0
17			Upper Pittsburgh	Shale and sandstone, gray, argillaceous to silty, finely micaceous shales grading laterally and upward into fine-grained, micaceous, thin-bedded sandstone.			16	5			92	2
16		Pittsburgh	Pittsburgh "Rider"	Shale, dark gray to black, carbonaceous, some fossil plants, coal horizon ?			0	1	17	1	75	9
15			Pittsburgh	Shale, olive drab with some limonite stain, laminated, finely micaceous, argillaceous.			0	6			75	8
14				Limestone, gray, limonite stains on surfaces, dense, flattened nodules in shales.			0	1			75	2
13				Shale, light greenish gray, with some limonite stain, argillaceous, becoming sandy and silty upward, micaceous, irregularly laminated.			2	7			75	1
12				Shale, dark to black, carbonaceous, with thin coaly streaks, micaceous, coal horizon			0	2			72	6
11			Upper Pittsburgh	Shale, dull yellow brown, argillaceous to silty, micaceous, abundant fauna of ostracods, Spirorbis, gastropods, pelecypods, breaks irregularly.			0	5			72	4
10				Limestone, gray, weathering light gray to pale yellow on weathered surface, mostly dense, some slickensides, mostly heavy, irregularly bedded, some small nodules in light greenish gray, grainy shale partings, about 2 feet of shale and few nodules at top.			13	3			71	11
9	Conemaugh	Upper Little Pittsburgh	Upper Little Pittsburgh	Clay shale, bluish gray, weathering brown, tan, and yellow, silty, micaceous, breaks with irregular to starch-like fracture, slickensided, few scattered limestone nodules.			8	8	23	2	58	8
8				Sandstone and shale, gray to tan, limonite stained, fine to medium, thin-bedded sandstone and gray to tan, silty micaceous shale.			16	6			50	6
7		Lower Little Pittsburgh	Lower Little Pittsburgh	Coal smut, carbonaceous shale, very thin.			0	0	23	0	33	6
6			Lower Pittsburgh	Shale, gray to tan, mottled maroon, some limonite stains, silty, contains some scattered nodules of limestone to 4 inches.			6	6			33	6
5			Connellsville	Sandstone, gray to blue gray, limonite stained, micaceous, fine, irregular bedded, mostly shaly.			16	6			27	0
4		Little Clarksburg	Little Clarksburg	Clay shale, medium gray, limonite stained, some maroon, finely micaceous, carbonaceous specks, silty, more clayey basal 3"			1	8½	10	6	10	6
3				Coal, mostly dull, some bright streaks and clay streaks, poorly developed.			0	0½			8	9½
2			Clarksburg	Clay, greenish gray to gray, finely micaceous, silty, slickensided near top.			0	6			8	9
1				Clay shale, variable, gray to maroon, red, and yellow upward, micaceous, silty, small nodules of fresh-water limestones, exposed			8	3			8	3

LOCATION KEY: Acn 1 FILE NUMBER: 11490 ELEVATION: 724± base TOPO MAP: Athens

STATE: Ohio COUNTY: Athens TOWNSHIP: Canaan SECTION: SE¼ SW¼, 36, Canaan Twp., to SE¼ NE¼, 6, Athens Twp.

LOCATION: This section was run on the outcrop along the stream which flows through Tucker Hollow proper to the rear of the Otis Blair house on Peach Ridge.

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
21	Monongahela	?	?	Covered interval, shows light gray limestone, olive drab, fine to coarse-grained sandstone.			99	9	99	9	358	6
20		Fishpot ?	Fishpot ?	Limestone, dull yellow, weathers to a state resembling decaying wood, fretted surface.			1	8	1	8	258	9
19		?	?	Covered interval.			92	4	92	4	257	1
18		Little Clarksburg - Elk Lick	Morgantown - Upper Grafton	Sandstone, light gray, weathers to a light brown, massive, very micaceous, 3" to 4" nodules of limonite, case hardening along the surfaces.			116	11	119	6	164	9
17				Clay shale, maroon with bluish gray in blotches, limonite stain throughout, scattered limestone nodules with pyrite mottling.			2	7			47	10
16		Duquesne	Skelley	Folded Rock Layers: Limestone, bluish gray, shows mottling of pyrite			0	7	36	10	45	3
15				Shale, light gray, slightly arenaceous, very fissile, the uppermost 1 inch shows limonite stain.			3	2				
14				Limestone, light gray, maroon, nodular, dense.			1	6				
13				Clay shale, maroon with gray blotches, shows scattered maroon nodular limestone.			0	2				
12				Limestone, light gray, highly arenaceous.			1	0				
11				Shale, maroon, siliceous, contains scattered gray limestone			4	0				
10				Limestone, light blue, shows streaking of pyrite, arenaceous, fossiliferous, marine.			1	0				
9				Shale, olive drab, weathers into red soil, silty.			4	0				
				NOTE: The above unit thicknesses are taken at right angles to the plane of bedding. The limbs of this fold are inclined 30° toward the southeast.								
8			Duquesne	Clay shale, light blue to gray, slightly arenaceous, uppermost 1 foot shows limonite stain			4	2			40	1
7				Covered interval, shows weathered sandstone and arenaceous shale.			13	9			35	11
6				Clay shale, maroon, fissile.			3	6			22	2
5		Gaysport	Gaysport	Limestone, olive drab, nodular, fossiliferous, marine.			0	8	8	4	18	8
4				Shale, olive drab, weathers into maroon soil, fissile.			1	11			18	0
3				Covered interval, shows sandstone, arenaceous, shale and red soil float.			5	9			16	1
2		Ames	Ames	Limestone, gray, crystalline, fossiliferous marine.			2	0	10	4	10	4
1				Sandstone, olive drab, shows limonite stain micaceous, thinly bedded.			8	4			8	4

LOCATION KEY: Acn 3 FILE NUMBER: 11492 ELEVATION: 705 ± base TOPO MAP: Athens

STATE: Ohio COUNTY: Athens TOWNSHIP: Canaan SECTION: SE¼ NE¼, 36 and SW¼ NW¼, 30

LOCATION: Section was measured from concrete bridge 1/4 mile southeast of Fred Heavener's house on Stroud Run road to road near the crest of the hill.

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
19	Monongahela	Sewickley ?	Lower Sewickley ?	Sandstone, light brown, fine to medium-grained, massive showing cross-bedding.			19	3	19	3	255	8
18		Fishpot - Redstone	Fishpot - Redstone	Limestone, greenish gray, weathers to a chalky white, dense. The top 1 foot is bluish gray, fresh-water, and fossiliferous.			15	6	44	2	236	5

LOCATION: Acn 3 FILE NUMBER: 11492 - continued

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
17	Monongahela - continued	Fishpot - Redstone continued	Fishpot - Redstone continued	Limestone, dull yellow, weathers into a state that has the appearance of rotting wood			9	6			220	11
16				Covered interval, shows olive drab, silty, and siliceous shale and slump blocks of light drab fine-grained sandstone.			19	2			211	5
15		Pittsburgh	Upper Pittsburgh	Limestone, brownish gray, weathers to a chalky white or a dull yellow, dense, conchoidal fracture, scattered black carbonaceous material.			5	5	11	11	192	3
14	?		Lower Pittsburgh	Siltstone, olive drab, weathers into thin fissile sheets.			6	6			186	10
13	Conemaugh	?	?	Covered interval, shows slabs of dark drab fine-grained sandstone and yellow and gray to chalky, weathered limestone.			36	3	36	3	180	4
12		Lower Little Pittsburgh	Connellsville	Siltstone, light drab with limonite stain, micaceous, weathers into thin beds.			9	8	9	8	144	1
11		Little Clarksburg ?	Clarksburg ?	Clay shale, light drab, scattered calcareous concretions, blotches of case hardening by limonite.			11	3	11	3	134	5
10		?	?	Covered interval, shows blocks of buff, coarse-grained, sandstone and light brown siliceous shale.			37	7	37	7	123	2
9		Elk Lick ?	Elk Lick ?	Clay shale, light gray, mottled by limonite stain, arenaceous.			1	3	52	1	85	7
8				Shale, yellowish brown, siliceous, thinly bedded.			5	6			84	4
7			Upper Grafton ?	Sandstone, light brown, coarse to medium-grained, micaceous, massive, weathers into thin limonite stained layers.			45	4			78	10
6		Duquesne ?	Duquesne ?	Underclay, light gray, top 6 inches shows yellow limonite stain, contains scattered 6-inch diameter limestone nodules.			2	11	10	4	33	6
5			Lower Grafton	Sandstone, dark drab, fine-grained, micaceous.			1	2			30	7
4				Shale, greenish to light blue, finely arenaceous, fissile, friable.			4	7			29	5
3				Sandstone, bluish gray, fine-grained, calcareous, lowermost 6 inches well jointed perpendicular to bedding planes in two directions			1	8			24	10
2		?	?	Covered interval, shows fragments of fine-grained weathered sandstone and yellow clay shale.			20	11	20	11	23	2
1		Ames	Ames	Limestone, light gray, crystalline, fossiliferous, marine.			2	3	2	3	2	3

LOCATION KEY: Acn 17 FILE NUMBER: 11637 ELEVATION: 654±base TOPO MAP: Chesterhill

STATE: Ohio COUNTY: Athens TOWNSHIP: Canaan SECTION: 7

LOCATION: Exposure in abandoned limestone quarry in the SE¼ NE¼, section 7, on north side of Lick Run, Kincade farm.

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
21	Monongahela	Benwood	Sewickley	Shale and sandstone, interbedded, fine			15	6	15	6	133	0
20		Sewickley	Sewickley	Clay shale, dusky red and tan, thin-bedded, silty.			2	0	18	4	117	6
19				Clay, light gray, plastic, thin carbonaceous film at top.			0	1			115	6
18				Clay shale, gray mottled purple, green-gray and dusky red, few scattered limestone knots.			4	9			115	5
17			Lower Sewickley	Sandstone, olive-gray to tan, fine, micaceous, some bedded, some irregular, clay shale breaks.			11	6			110	8
16		Fishpot	Fishpot	Clay shale, dusky red, weathering micaceous, thin-bedded, some gray shale in top			2	5			99	2
15				Clay shale, dusky red weathering to purple and olive green dust, small scattered limestone knots.			3	9			96	9

LOCATION: Acn 17 FILE NUMBER: 11637 - continued

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
14	Monongahela - continued	Fishpot - continued	Fishpot - continued	Limestone and shale, dusky red mottled gray-green and purple, clay shales with numerous small white limestone nodules, weathering out.			5	4			93	0
13			Fishpot or Pomeroy	Sandstone, pale olive-gray, weathering yellowish-tan, fine, poorly bedded, becomes calcareous upward.			7	8			87	8
12		?	?	Covered interval, tan and maroon clay shales, slumped masses of light gray limestone.			27	3	?		80	0
11		Redstone	Upper Pittsburgh	Sandstone, pale olive gray, fine to medium, medium-bedded, prominent ledge around hill.			4	0			52	9
10				Shale, light olive gray, silty, finely micaceous, thinly laminated.			2	1			48	9
9				Clay shale, dark olive drab, upper pelecypod zone. ?			0	1			46	8
8				Siltstone, pale olive-gray, micaceous, thin-bedded, some massive zones.			12	1			46	7
7		Pittsburgh	Pittsburgh	Clay shale, carbonaceous	0	6½	1	1	16	3	34	6
				Coal, bony, some bright bands	0	5⅓						
				Clay shale	0	0¼						
				Coal, bony	0	0⅓						
6			Upper Pittsburgh	Limestone in clay shale, hard, dense nodules forming layers in like-colored clay shales, nodules becoming more massive upwards, pelecypods at top.			15	2			33	5
5	Conemaugh	Lower Little Pittsburgh	Connellsville	Clay shale, gray, mottled bright red, yellow, and orange, breaks with starch-like fracture, flint clay.			12	9	18	3	18	3
4				Limestone, blue gray, nodular, weathers dark gray to red.			1	0			5	6
3				Covered interval			3	0			4	6
2				Sandstone, gray to tan, massive.			1	6			1	6
1				Ledge in creek.			-	-				

LOCATION KEY: Acn 19 FILE NUMBER: 11639 ELEVATION: 660 ±base TOPO MAP: Athens

STATE: Ohio COUNTY: Athens TOWNSHIP: Canaan SECTION: 29

LOCATION: Details of Ames limestone along Stroud Run road located in NE¼ NW¼ SE¼, section 29.

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
2	Conemaugh	Gaysport	Gaysport	Shale, light gray to olive drab and reddish, limonite stained, silty to sandy, finely micaceous, becomes sandy upwards, exposed.			6	0	6	0	7	6
1		Ames	Ames	Limestone, gray to light gray, dense to partly crystalline, marine, very fossiliferous, massive ledge.			1	6	1	6	1	6

LOCATION KEY: Acn 20 FILE NUMBER: 11640 ELEVATION: 762 ± base TOPO MAP: Athens

STATE: Ohio COUNTY: Athens TOWNSHIP: Canaan SECTION: 25

LOCATION: Exposure from Long Run through Quince Carsey farm and strip mine in the SE¼, NW¼ of section 25.

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
37	Monongahela	Benwood	Sewickley	Covered to flat on hill top.			13	4	19	4	160	0
36				Sandstone, pale olive gray, fine, thin-bedded, exposed to grass level.			6	0			146	8
35		Sewickley	Sewickley	Clay, gray, somewhat plastic, some carbonaceous flecks, limonite stained, coal horizon.			0	2	18	8	140	8
34				Clay shale, olive gray, sandy, non-bedded hard.			1	1			140	6
33				Clay shale, dusky red, nonbedded			1	3			139	5
32			?	Sandstone, pale olive gray, medium below to fine above, massive in lower 1 foot.			5	2			138	2
31				Sandstone, dark olive gray, weathers dark brown, calcareous.			1	0			133	0
30				Clay shale, dusky red, non bedded to slightly bedded.			0	5			132	0
29				Sandstone, pale olive gray, some maroon zones, fine to silty, thin-bedded, one massive ledge of 1' at 3 feet up from bottom.			9	4			131	7
28				Clay shale, dusky red, thin-bedded.			0	3			122	3
27		Lower Sewickley	Lower Sewickley	Clay shale, light gray, plastic when weathered, coal horizon.			0	2	11	1	122	0
26				Clay shale, olive gray, non bedded, sandy			1	8			121	10
25				Limestone and shale, dusky red mottled gray with nodules of light gray limestone to 5 ", purple mottling and smaller limestone knots at top.			7	8			120	2
24				Sandstone, light olive gray, fine, micaceous, thin-bedded to shaly.			1	7			112	6
23		Fishpot	Fishpot	Clay shale, dusky red, some thin-bedded, mostly poorly bedded, plant fossils.			0	3	12	5	110	11
22				Clay shale, gray, mottled dusky red, non-bedded.			3	4			110	8
21				Limestone and shale, light gray, nodular limestone in gray and dusky red clay shales.			2	4			107	4
20				Covered interval, appears to be mostly sandstone in pasture field.			6	6			105	6
19		Redstone	Redstone	Limestone and shale, gray, nodular, weathers yellow and fretted, in gray to tan clay shales			1	10	23	5	98	6
18			Upper Pittsburgh	Sandstone, gray to buff, thin-bedded, fine, micaceous, poorly exposed in part.			15	4			96	8
17				Clay shale, pale olive gray, scattered siderite nodules, weathers to a porminent brown zone.			2	0			81	4
16				Clay, light gray, some carbonaceous streaks			0	1			79	4
15				Clay shale, light gray, limonite stained, somewhat plastic.			1	6			79	3
14				Siltstone, light olive gray, micaceous, many hematite nodules up to 4 inches weathering out.			2	8			77	9
13		Pittsburgh "Rider"?	Pittsburgh "Rider"?	Clay shale, gray, non-bedded, silty.			0	9	12	7	75	1
12				Clay shale, gray, thin-bedded, with carbonaceous zones.			0	2			74	4
11				Clay shale, gray, massive, slickensided faces, some carbonaceous flecks.			0	8			74	2
10				Limestone and shale, scattered nodules in light olive clay shale.			1	3			73	6
9				Sandstone, light olive gray, shaly, bedded, micaceous, more massive in upper 1 foot, calcareous at top.			7	5			72	3
8				Clay shale, light gray, limonite stained, sandy.			2	4			64	10
7		Pittsburgh	Pittsburgh	Coal, bony	0	2½	5	1	62	6	62	6
				Clay shale, gray	0	1½						
				Coal, bony	0	9						
				Coal, bright, blocky.	0	5						

LOCATION: Acn 20 FILE NUMBER: 11640 - continued

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
7	Monongahela - continued	Pittsburgh - continued	Pittsburgh - continued	Clay shale parting, gray, plastic when wet, thin coaly streaks.	0	11						
				Coal, bony	0	1						
				Coal, bright, blocky	0	6						
				Shale and pyrite.	0	0½						
				Coal, bright, blocky.	0	9						
				Fusain.	0	0¼						
				Coal, bright, blocky	0	7						
				Shale and pyrite	0	0¼						
				Coal, bright, blocky	0	9						
6				Clay, gray, plastic			0	11			57	4
5			Upper Pittsburgh	Clay shale, light gray, silty, micaceous some scattered limestone nodules to 2 inches in diameter.			1	0			56	5
4				Clay shale, dark gray, plastic below, some carbonaceous material in upper 3 inches.			0	8			55	5
3				Clay, light gray, sandy			2	3			54	9
2				Shale, olive-gray, sandy, varies laterally from 3 feet to nothing			1	6			52	6
1			Lower Pittsburgh	Sandstone, light olive gray weathering buff, massive, medium to coarse, ledge along Long Run road, exposed to creek level.			51	0			51	0
				Sandstone reported in well with "Blue Mud" below								

LOCATION KEY: Acn 30 FILE NUMBER: 14305 ELEVATION: TOPO MAP: Athens

STATE: Ohio COUNTY: Athens TOWNSHIP: Canaan SECTION: $SW\frac{1}{4}$ $NW\frac{1}{4}$, 8

LOCATION: Exposure on north side of Route 50 immediately west of J. G. Hope farm buildings, base of section is 18 inches below highway survey station 912. +00

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
22	Conemaugh	Lower Little Pittsburgh	Connellsville	Sandstone, light gray to tan and light olive, much limonite stained, ferruginous, friable, medium to coarse, massive showing bedding and cross-bedding on weathered surfaces, base congomeratic with fossil plants, disconformable, thickness approximate.			68	0	68	0	192	6
21		Little Clarksburg and Elk Lick	Morgantown	Clay shale, olive drab mottled maroon and reddish brown with purplish, greenish and gray zones, starch-like fracture, with some clayey and zones of ferruginous pellets and bluish-greenish gray dense limestone nodules at base and of white nodular limestone near top.			41	0	48	0	124	6
20			Morgantown and/or Upper Grafton	Shale and sandstone, light greenish-blue, silty, micaceous shale with interbedded olive drab, stained, fine-grained, micaceous, thin-bedded sandstone with 1 foot calcareous sandstone at top, thickness varies			7	0			83	6
19		Duquesne	Skelley	Limestone, pale bluish gray stained brown and yellow, ferruginous, arenaceous, nodular, fossiliferous, marine.			0	4	19	7	76	6
18				Shale and sandstone, bluish gray, silty, micaceous, pyritiferous, well bedded shale with interbedded olive drab, much stained, fine-grained, bedded sandstone, weak spring zone at base.			13	0			76	2
17			Duquesne	Clay shale, olive drab, mottled chocolate brown and maroon with much limonite stain, full gray at top, massive, argillaceous, breaks irregularly, with zone of impure limestone pellets near top.			3	9			63	2
16			Lower Grafton	Shale, light gray to light bluish gray, or light olive, silty, micaceous, well-bedded			1	0			59	5
15				Sandstone, olive drab to light greenish tan with much limonite stain, silty, fine grained, thin-bedded, grading laterally into olive drab massive clay shale.			1	6			58	5

LOCATION: Acn 30 FILE NUMBER: 14305 - continued

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
14	Conemaugh - continued	Gaysport ?	Gaysport ?	Shale, olive drab and reddish brown, stained, platy, fissile, argillaceous, slightly silty, sparingly to very fossiliferous, marine.			2	3	2	6	56	11
13				Limestone, dark reddish brown, weathering yellow, dense, ferruginous, septarian with calcite veinlets, sparingly fossiliferous, marine.			0	3			54	8
12		Ames	Ames	Shale, chocolate brown to maroon, limonite stained, argillaceous, slightly silty, platy, fissile, fossiliferous, marine.			3	9	15	4	54	5
11				Shale, olive drab to light bluish gray, lighter gray below with some limonite stain, silty, with ferruginous limestone pellets, top gradational into shale above, fossiliferous, (ostracods), marine.			5	6			50	8
10				Limestone, gray to light gray, dense, pure, a massive ledge, fossiliferous, marine.			1	6			45	2
9				Shale, olive to gray, much stained, silty, micaceous, massive with irregular fracture			0	6			43	8
8				Carbonaceous zone, coaly			-	-			43	2
7				Siltstone, light olive to light gray, stained, silty, finely micaceous, laminated.			3	7			43	2
6				Shale, dark olive to dark brown with considerable yellow-brown stain, argillaceous, becoming silty upward and grading into siltstone above, laminated, with some slickensides.			0	6			39	7
5		Harlem	Harlem	Underclay, gray to dark gray with stain at top, massive, with some plasticity, slickensided, and small pellets.			0	3	36	1	39	1
4			Round Knob and Rock Riffle ?	Clay shale, olive drab mottled maroon, reddish-brown, and purple, grayish above, argillaceous to somewhat silty, zones of stained light gray clayey material, massive, starch-like fracture, weathering somewhat plastic, with scattered irregular ferruginous limestone pellets and nodules up to 2 inches in size.			14	6			38	10
3			Saltsburg	Sandstone and shale, pale greenish gray with some limonite stain, fine, silty, micaceous, thin-bedded sandstone with zones of similarly colored silty, sandy, micaceous shale, calcareous and more silty toward top with a few scattered concretions.			21	4			24	4
2		?	?	Covered interval			1	0			3	0
1		Upper Bakerstown	Ewing ?	Shale, olive to chocolate brown, silty, micaceous, poorly laminated, with a few small elongate or flattened nodules of septarian limestone, exposed.			2	0	2	0	2	0

LOCATION KEY: Acn 23 FILE NUMBER: 14512 ELEVATION: 707 ± base TOPO MAP: Athens

STATE: Ohio COUNTY: Athens TOWNSHIP: Canaan SECTION: SW¼, 21

LOCATION: Exposure along Texas Eastern Pipe line from Wildcat Hollow to Coolville Ridge Road, just east of Dana Williams' building. Top of section is 2 feet 6 inches above casing head of Dana Williams' gas well. Elevation of Dana Williams' gas well head: 946'.

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
28	Monongahela	Arnoldsburg	Arnoldsburg	Clay shale and limestone, variegated purples, reds, pale greens, browns, breaks with starch-like fracture, grades into similar clay shale, contains limestone knots and nodules at top - nodules up to 6 " in diameter. Limestone is light gray, impure, hard, exposed.			22	4	46	10	242	0
27			Fulton ?	Sandstone and sandy shale, mainly sandstone, olive green, micaceous, shaly, massive beds, fine-grained, weathers brown on surface, bottom 18 inches is clayey and silty.			24	6			219	8

LOCATION: Acn 23 FILE NUMBER: 14512 - continued

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
26	Monongahela - continued	Benwood	Benwood	Coal zone, clay, gray, with yellow-brown stain, slightly plastic, calcareous.			0	2	72	4	195	2
25				Clay shale, dusky red, bedded, some slickensides.			6	8			195	0
24			Sewickley ?	Sandstone, medium-grained, olive green to tan, micaceous, weathers tan, fairly well cemented, massive-bedded, slumped at bottom, exposed.			25	10			188	4
23			?	Covered interval, appears slumped, sandstone toward top.			21	8			162	6
22			Benwood	Limestone and clay shale, nodular, tan to buff, in variegated red, brown, gray clay shale. Limestone is fairly dense and hard, exposed.			5	5			140	10
21				Clay shale, variegated, grays, greens, purples, reds, breaks with starch-like fracture			4	7			135	5
20				Limestone, brown to tan, nodular bed, dense, hard, nodules up to 5" diameter in bottom, upper part yellow, weathers spongy, impure, clayey.			5	5			130	10
19				Clay shale, interbedded, variecolored reds and grays. Zone of medium gray clay at top			2	7			125	5
18		Sewickley	Sewickley	Coal, shaly, bony, weathered			0	1	17	3	122	10
17				Limestone, dark gray, dense, hard, red and green streaked.			0	$0\frac{1}{2}$			122	9
16				Clay, light gray to white, some olive green layers.			0	$6\frac{1}{2}$			122	$8\frac{1}{2}$
15			Lower Sewickley	Siltstone and shale, olive green, somewhat bedded, grades into clay above, sparingly micaceous.			1	5			122	2
14				Sandstone, dark olive green, slightly micaceous, firm, fine-grained, stained brown on on surface, one bed.			0	10			120	9
13				Shale, olive-green, silty, well bedded, considerable brown stain on jointing planes and bedding, film of white clay on top.			14	4			119	11
12		Fishpot	Fishpot	Coal, shaly to shale, coaly, carbonaceous			0	6	19	4	105	1
11				Limestone, dark gray, nodular red, rather impure, fossiliferous.			1	0			104	7
10				Clay shale, gray to greenish gray, massive, slightly silty, breaks with starch-like fracture.			4	1			103	7
9				Limestone, light to dark gray, hard, dense, nodular, up to 12 inches diameter, interbedded with clay layers up to 15 inches.			3	6			99	6
8				Clay shale, olive green to tan to yellowish, somewhat bedded, silty in certain layers, breaks with starch-like fracture.			10	3			96	0
7		Redstone	Redstone	Underclay, light gray, plastic.			1	6	38	3	85	9
6				Clay shale, interbedded and mottled, reds, purples, olive green, yellows, and browns, fractures with a starch-like fracture.			3	0			84	3
5			Upper Pittsburgh	Siltstone, shaly to shale, silty, olive-green to tan, weathers brown, fine-bedded, sparingly micaceous.			8	3			81	3
4				Sandstone, medium gray, weathers tan, medium grained, highly micaceous, especially along bedding pales, considerable biotite, friable, limonite stain and deposits along some joint planes, coarser grained near top exposed.			25	6			73	0
3		?	?	Covered interval.			43	6			47	6
2	Conemaugh	?	?	Alluvium, sand and gravel, mostly gravel, pebbles and cobbles, gravel composed mainly of sandstone pebbles, exposed.			2	0	4	0	4	0
1			?	Clay shale, variegated, purplish reds, gray greens, olive green, somewhat plastic, breaks with a starch-like fracture, some slickensides, exposed.			2	0			2	0

LOCATION KEY: Acn 24 FILE NUMBER: 14513 ELEVATION: 861 ± base TOPO MAP: Athens

STATE: Ohio COUNTY: Athens TOWNSHIP: Canaan SECTION: East center, 26

LOCATION: Section along Texas Eastern Pipeline, east of west extendin g secondary road.

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
17	Monongahela	Arnoldsburg	Arnoldsburg	Clay shale, dusky red, light gray, breaks with starch-like fracture, calcareous, very clayey.			18	2	40	6	159	0
16			Fulton	Sandstone, olive green, sandy, calcareous, micaceous, shaly partings, massive.			2	6			140	10
15				Sandstone and shale, sandstone is silty, fine-grained, micaceous on bedding planes, olive green. Shale, silty, tan to olive-green, bedded, becomes more shaly near top.			19	10			138	4
14		Benwood	Benwood	Coal, weathered, thickness variable,			0	3	60	4	118	6
13				Clay shale, variegated, reds, grays, greens, starch-like fracture, contains abundant irregular knots of limestone, calcareous, crumbly in upper part.			34	9			118	3
12				Limestone, olive-green, nodular bed, nodules up to 18" diameter, impure, sandy.			2	6			83	6
11			Sewickley	Siltstone, shaly to shale, silty, olive-green, finely bedded, lower few inches contains plant fossils and becomes more clayey, becomes more sandy and massive toward top.			22	10			80	0
10		Sewickley	Sewickley	Coal horizon.			0	0	24	8	57	2
9				Ironstone, nodules, calcareous, dark gray, stained red to brown.			0	1			57	2
8				Clay shale, dusky red and gray greens, starch-like fracture, massive, impure, red bed			4	4			57	1
7			Lower Sewickley	Siltstone, shaly to shale, silty, olive-green, to gray-brown, thin-bedded, stained brown along joints, 28-inch zone of red material, similar at 4'8" above bottom.			20	3			52	9
6		Fishpot	Fishpot	Clay, light gray, plastic, shaly, some interbedded red material, possible coal horizon.			0	2	32	6	32	6
5				Limestone, dark gray, nodular, interbedded with calcareous shale, impure, olive green color.			1	10			32	4
4				Covered interval.			14	0			30	6
3				Limestone, light gray, nodules up to 10" in diameter, dense, hard, stained brown on surface, embedded in variegated clay shale			3	6			16	6
2				Redbed, poorly exposed and probably slumped, variegated reds, greens, grays, purple			11	0			13	0
1			Fishpot or Pomeroy	Siltstone, shaly to shale, silty, olive-green, bedded, finely micaceous, exposed.			2	0			2	0

LOCATION KEY: Acn 25 FILE NUMBER: 14514 ELEVATION: 869 ± base TOPO MAP: Athens

STATE: Ohio COUNTY: Athens TOWNSHIP: Canaan SECTION: West central, 26

LOCATION: Exposure along Texas Eastern pipeline, along secondary road in west central part of section 26.

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
23	Monongahela	Arnoldsburg	Arnoldsburg	Clay shale, dusky red in the top portion and silty, pale olive green in bottom.			14	6	30	4½	146	0
22			Fulton	Sandstone, calcareous, considerably weathered, see section 14513 for description.			6	6			131	6
21				Clay shale, brown, bedded, clay zone, gray, 1 foot above base			9	2			125	0
20				Clay, light gray, weathers somewhat plastic			0	2½			115	10
19		Benwood	Benwood	Coal zone, gray clay shale with carbonaceous films.			0	1½	57	3½	115	7½
18				Clay shale, olive-green, stained red-brown on surfaces, breaks with starch-like fracture, weathers yellow-brown.			I	0			115	6
17				Limestone, greenish gray, fossiliferous, dense, hard, some calcite crystals, weathers white, yellow, or brown.			1	6			114	6

LOCATION: Acn 25 FILE NUMBER: 14514 - continued

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
16	Monongahela - continued	Benwood - continued	Benwood - continued	Clay shale, green, stained brown and yellow, variegated, with small limestone pellets, thickness approximate, affected by dip of beds into hill.			4	6			113	0
15				Limestone, two nodular beds, dark gray, hard, dense, much weathered in top portion to soft crumbly yellow and gray limestone.			2	6			108	6
14				Clay shale, variegated maroon and light olive-green, mottled, grades into purplish pink clay shale at top containing abundant calcareous, irregular, limestone knots, crumbly.			27	8			106	0
13			Sewickley	Sandstone, olive-green to brown, micaceous, rather fine-grained, fairly well bedded, both biotite and muscovite on bedding planes, 2-foot zone of argillaceous, sandy material similar in color, five feet above base.			18	4			78	4
12				Shale, light gray to brown, very silty, stained dark brown to black on bedding and joint planes, thickness approximate.			1	9			60	0
11		Sewickley	Sewickley	Coal zone, carbonaceous shale, micaceous, argillaceous, slopes into hill.			0	1	30	9	58	3
10				Clay shale, maroon below to olive-green above, becomes more clayey towards top, breaks with a starch-like fracture.			2	0			58	2
9			Lower Sewickley	Siltstone, shaly to shale, silty, olive-green, bedded, stained brown on surface of bedding and joint planes. A 24" red zone near middle with more red stringers near top. More sandy at top. 24" red zone is 6' 6" from bottom of bed. A lensing 12" limestone layer at 13' 6" from bottom of bed, it is similar to 4'0" bed of limestone below coal horizon, unit grades from bedded to nonbedded material at top.			27	8			56	2
8		Fishpot	Fishpot	Clay films and fossil plants in clay shale, bedded, coal horizon.			0	0	30	6	30	6
7				Limestone, dark gray, dense, some crystalline to olive-green, dense, massive, in nodular beds, bottom part rather impure.			4	0			30	6
6				Clay shale, maroon and light olive-green, interbedded, breaks with a starch-like fracture, tending toward bedding in bottom 8", top part grades into limestone above.			11	3			26	6
5				Clay, light gray, plastic, some yellow streaks in it.			0	1			15	3
4				Clay shale, maroon, and light olive-green above, hackly fracture, red bed type			1	0			15	2
3				Limestone, yellowish brown, soft, weathered, nodular bed, larger nodules in bottom, smaller at top.			2	4			14	2
2				Limestone, nodular bed, medium gray to tan, dense, hard, some clay shale, green-gray, as matrix in upper part.			1	10			11	10
1				Clay shale, silver-gray, with limestone nodules, clay shale is silty, bedded. Limestone is medium gray, dense, very hard, in nodules up to 8-9-inch diameter, weathers brown, 6 feet above bottom is 6' 8" zone of sandy, calcareous, nodular layer, top 3 feet are variegated red, green clay shale.			10	0			10	0

LOCATION KEY: Acn 26 FILE NUMBER: 14515 ELEVATION: 829 ± base TOPO MAP: Athens

STATE: Ohio COUNTY: Athens TOWNSHIP: Canaan SECTION: NE¼ NE¼, 31

LOCATION: Section along Texas Eastern Pipeline to top of first ridge east of Long Run.

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
27	Monongahela	Benwood	?	Sandstone, shaly, micaceous, medium brown, thin-bedded, exposed.			3	0	14	0	138	7
26			Stray ?	Clay, light gray, plastic, coal horizon.			0	1			135	7
25				Clay shale, silty, brown, hackly fracture.			0	10			135	6
24			Sewickley	Sandstone, light brown, fine-grained, slightly micaceous, somewhat friable, massive bedded			8	11			134	8
23				Shale, argillaceous and silty, brown to olive-green.			4	2			125	9
22		Sewickley	Sewickley	Clay, light greenish gray, plastic. (Sewickley Rider horizon ?)			0	1	20	0	121	7
21				Shale, argillaceous and silty, light olive-green, stained dark brown on surface.			2	6½			121	6
20				Underclay, medium grain, stained yellow in places, thin film interbedded laminae of coaly material.			0	0½			118	11½
19				Clay shale, maroon, gray, green, variegated and interbedded, breaks with starch-like fracture			5	2			118	11
18			Lower Sewickley	Siltstone, shaly to shale, silty, light gray to pale olive drab, clayey, thin-bedded, stained brown, red platy zone 5 feet above base of unit. Contact is gradational with unit above.			12	2			113	2
17		Fishpot	Fishpot	Clay, light gray to greenish gray, possible plant fossils, coal horizon.			0	1	39	3	101	7
16				Limestone, medium gray, nodular bed, hard, dense, upper 2 inches is yellow-brown non-calcareous layer.			4	0			101	6
15				Clay shale, interbedded maroon and greens, grays; dark purple clay zone at bottom; zone of nodular, tan-colored limestone at 7 feet above base of unit.			22	1			97	6
14			Fishpot or Pomeroy	Sandstone, olive-green, finely micaceous, generally thin-bedded and shaly appearing, fine-grained.			10	7			75	5
13				Shale, varicolored, clayey, somewhat bedded, contains gray clay stringers 20" and 26" above base.			2	6			64	10
12		Redstone	Redstone	Clay, medium gray and carbonaceous material.			0	3	26	5	62	4
11				Coal, much weathered			0	4			62	1
10				Clay shale, light gray, mottled and weathered yellowish brown, very sandy, becomes more clayey upward.			3	9			61	9
9			Upper Pittsburgh	Sandstone, greenish gray, dense, hard, quite calcareous, weathers round (limestone horizon?) nodules up to 7 inches diameter.			3	0			58	0
8				Sandstone, olive-green to brown, slightly micaceous, fine-grained, silty, thin-bedded, stained red-brown on jointing and bedding planes. Layer of sideritic nodules 8 feet above base.			19	1			55	0
7		Pittsburgh	Pittsburgh	Clay shale, light gray, stained yellow-brown, sandy, carbonaceous streaks in bottom 6"			1	1	35	11	35	11
6				Coal, weathered, shaly.	2	0	5	5			34	10
5				Clay parting, gray mottled yellowish brown, lighter colored gray than that below, thickness variable.	0	10						
4				Coal, much weathered, some bright and blocky. small clay parting 6" from top.	2	7						
3				Underclay, light gray at bottom to dark gray at top, plastic, becomes quite dark and carbonaceous at top, not calcareous.			5	0			29	5
2			Lower Pittsburgh	Sandstone, greenish gray, very well cemented, very calcareous, less micaceous than that below, heavily bedded.			13	7			24	5
1				Sandstone, light gray weathers brown and tan, very micaceous, especially along bedding planes, calcareous.			10	10			10	10

CARTHAGE TOWNSHIP

LOCATION KEY: Act | FILE NUMBER: 3168 | ELEVATION: 731 base | TOPO MAP: Keno

STATE: Ohio | COUNTY: Athens | TOWNSHIP: Carthage | SECTION: NW¼, 20

LOCATION: Section exposed along road one mile southwest of Lottridge and 1.3 miles northwest of road junction 706.

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
17	Washington	Upper Waynesburg "A"	Upper bench Waynesburg "A"	Shales, dark, coal zone?			0	5	12	2	118	5-3/8
16				Bone shale, hard.			0	3			118	0-3/8
15				Shale, gray, and covered.			11	6			117	9-3/8
14		Lower Waynesburg	Lower Bench Waynesburg "A"	Coal smut.			0	0⅛	37	3⅛	106	3-3/8
13				Clay, light and grainy.			1	0			106	3-1/4
12			Waynesburg	Shale, gray and shaly sandstone.			18	3			105	3-1/4
11				Shale, pink and gray, siliceous, soft.			9	6			87	0-1/4
10				Shale, gray and shaly sandstone			8	6			77	6-1/4
9	Monongahela	Waynesburg		Clay shale, pink, soft.			21	0	35	0	69	0-1/4
8			Gilboy	Sandstone, shaly, gray, fine grained, silty.			14	0			48	0-1/4
7		Little Waynesburg		Shales, gray and pink.			4	0	18	0	34	0-1/4
6			Uniontown	Sandstone, shaly, gray, fine-grained.			10	0			30	0-1/4
5				Shale, gray, siliceous.			4	0			20	0-1/4
4		Uniontown		Shale, soft.			0	10	16	0¼	16	0-1/4
3			Uniontown	Coal, smut.			0	0¼			15	2-1/4
2				Clay			0	2			15	2
1			Uniontown ?	Limestone and covered.			15	0			15	0

LOCATION KEY: Act 1 | FILE NUMBER: 11452 | ELEVATION: 664 base | TOPO MAP: Chesterhill

STATE: Ohio | COUNTY: Athens | TOWNSHIP: Carthage | SECTION: SE¼, 12

LOCATION: Exposure extending along road south of road junction 664 to west of church.

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
8	Washington	Washington - Little Washington	Washington - Mannington	Sandstone, light gray to tan, fine-grained, micaceous, thin-bedded.			9	7	58	11	173	7
7				Sandstone, mostly yellow or brown, very coarse at base with scattered pebbles of quartz and sandstone, massive, showing some bedding and cross-bedding, friable.			49	4			164	0
6		Waynesburg "A"		Clay shale, light gray with considerable limonite stain, finely micaceous, massive, breaks irregularly, slightly plastic becomes silty and sandy below, grading downward into sandstone.			1	0	19	8	114	8
5			Waynesburg	Sandstone, light gray, much limonite stain, silty, finely micaceous shale grading upward into fine, micaceous, thin-bedded sandstone.			18	8			113	8
4	Monongahela	Waynesburg - Little Waynesburg		Clay shale, light yellowish gray to maroon, silty, finely micaceous, breaks irregularly into starch-like.			16	4	67	8	95	0
3			Gilboy - Uniontown coalesced	Sandstone, light gray, much limonite stain, fine to medium grained, micaceous, thin-bedded, few heavy massive ledges, coaly streaks in bottom few inches.			51	4			78	8
2		Uniontown	Uniontown	Clay shale and coal, light gray to gray with some limonite stain, laminated clay shale with dark carbonaceous coaly zone.			0	4	27	4+	27	4
1				Limestone and clay shale, light gray to gray, some dull yellowish brown, weathering dense with small crystalline masses, nodular or bedded, fossiliferous limestone in variegated clay shale, poorly exposed.			27	0			27	0

LOCATION KEY: Act 2 FILE NUMBER: 11453 ELEVATION: 677 base TOPO MAP: Keno

STATE: Ohio COUNTY: Athens TOWNSHIP: Carthage SECTION: SE¼ SW¼, 11

LOCATION: Exposure along abandoned road extending west from road junction 677 for 1/4 mile, then north and west along zig-zagged abandoned road to just west of farm house.

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
24	Washington	Little Washington?		Clay shale, maroon, silty, finely micaceous breaks irregularly, weathered.			6	5	22	6	194	8
23				Shale, tan, silty, finely micaceous, laminated.			3	11			188	3
22				Clay shale, maroon, silty, finely micaceous, breaks irregularly.			4	7			184	4
21			Mannington	Sandstone, mostly tan to olive drab with some limonite stain, fine-grained, silty, finely micaceous, thin-bedded, shaly.			7	7			179	9
20		Waynesburg "A"	Waynesburg "A"	Shale, chocolate brown, silty, finely micaceous, laminated, some fossil plant material, coal horizon.			0	4	72	10	172	2
19			Mount Morris ?	Clay shale, maroon and light gray below with small nodules of light gray, dense limestone.			12	0			171	10
18			Waynesburg	Sandstone, variable, light gray, mostly weathered tan to brown, thinly laminated at base and top, coarse-grained, massive, friable above, micaceous throughout, poorly exposed at top.			59	0			159	10
17				Shale, light gray to gray with some limonite stain, silty to argillaceous, finely micaceous, laminated.			1	6			100	10
16		Elm Grove	Elm Grove	Coal, carbonaceous, coaly material in dark gray clay.			0	1	10	8	99	4
15				Clay shale, variegated maroon, light gray, gray, silty, finely micaceous, hackley, weathers plastic.			4	3			99	3
14			Elm Grove	Sandstone, light greenish gray, weathers tan to olive drab, very silty, micaceous, fine-grained, thin-bedded, shaly.			6	4			95	0
13	Monongahela	Waynesburg	Cassville	Shale, chocolate brown, with thin black surface crusts, silty, finely micaceous, poorly laminated.			0	4	24	4	88	8
12			Waynesburg	Clay, light gray with some limonite stains, finely micaceous, slightly carbonaceous, semi-plastic, coal horizon.			0	2			88	4
11				Clay shale, variegated maroon and gray, silty, finely micaceous, breaks irregularly.			1	9			88	2
10			Gilboy	Sandstone, light greenish gray, mostly weathered tan to olive drab, fine-grained to silty, micaceous, thin-bedded, shaly.			22	1			86	5
9		Little Waynesburg	Little Waynesburg	Shale, chocolate brown, silty, finely micaceous, poorly laminated, few fossil plants.			0	8	45	2	64	4
8				Clay, light gray with some limonite stains, micaceous, carbonaceous in part, semi-plastic, coal horizon.			0	10			63	8
7				Clay shale, maroon to gray, silty, finely micaceous, irregular starch-like fracture and some lamination.			4	2			62	10
6				Covered interval, probably shale			10	8			58	8
5			Uniontown	Sandstone, light gray to light greenish gray with some limonite stain, fine to medium grained, micaceous, thin-bedded to massive, becomes shaly upward, few ripple marked layers.			21	4			48	0
4				Shale, light greenish gray with some limonite stain, silty to sandy, micaceous, laminated and platy.			7	6			26	8
3		Uniontown	Uniontown	Shale, chocolate brown, finely micaceous, laminated smooth, sparingly fossiliferous (clams), few slickensides.			1	0	19	2	19	2
2				Shale, greenish gray to gray, and black, silty, finely micaceous, carbonaceous in part, smooth and argillaceous, coal horizon.			0	6			18	2
1				Limestone and shale, light gray to gray or yellow, dense, heavy bedded or nodular, fossiliferous (ostracods) limestone interbedded with variegated silty shale.			17	8			17	8

LOCATION KEY: Act 11 FILE NUMBER: 11455 ELEVATION: 650 base TOPO MAP: Keno

STATE: Ohio COUNTY: Athens TOWNSHIP: Carthage SECTION: SW¼, 3 and SE¼, 9

LOCATION: Section measured along U. S. Route 50. Base of section is 8.2 miles west and continues up hill to 8.6 miles west of the road junction of Ohio route 7 and U. S. Route 50.

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
17	Washington	Washington Rider "B"	Upper Washington	Sandstone, gray, weathers to yellow-orange poorly exposed, caps hill.			5	1	17	1	176	0
16				Clay and sandstone, light gray, plastic, sandy clay with thin sandstone layers, much iron staining and abundant fossil plants throughout, variable.			12	0			170	11
15		Washington	Washington	Clay, gray to light gray, sandy, many carbonaceous bands.			0	2	16	2	158	11
14				Coal, very bright, weathers to paper-thin layers, much woody material.			0	1			158	9
13			Lower Washington	Sandstone, blue-gray, very micaceous, fine-grained, much cross-bedding in lower 5 feet with conglomeratic zones in this lower part. Coal develops below this unit 0.4 mile to the west.			15	11			158	8
12		Little Washington		Clay shale, blue-gray, mottled purple and maroon, develops a limestone to the west, zone thickens splitting two sandstones from 1 inch to 3 feet seen.			3	0	32	6	142	9
11			Mannington	Sandstone, gray to blue-gray, fine-grained, micaceous, massive below becoming bedded above, large mica flakes in bedded top.			29	6			139	9
10		Waynesburg "A"	Upper and Lower Bench development of Waynesburg "A"	Shale, gray to dark gray, some carbonaceous zones, much slickensided and disturbed.			1	0	19	3	110	3
9				Shale and sandstone, much like second unit below and joins laterally with carbonaceous shale missing.			2	0			109	3
8				Shale, carbonaceous, plastic when weathered			0	1			107	3
7				Sandstone, pale olive-green, irregular, appears to change in zone below.			2	2			107	2
6				Shale and sandstone, blue-gray, silty shales and interbedded sandstones that grade into each other laterally, plant fossils in shale.			2	11			105	0
5			Mount Morris	Clay shale, blue-gray, some maroon mottling, micaceous, scattered limestone knots to 3 inches.			5	1			102	1
4			Waynesburg	Sandstone, light gray, fine-grained, micaceous, massive.			6	0			97	0
3				Covered interval, some shales both red and gray exposed.			71	0	71	0	91	0
2	Monongahela	Waynesburg	Gilboy ?	Sandstone, massive, fine-grained, irregular			10	0	10	0	20	0
1		Little Waynesburg	Waynesburg ?	Limestone and shale, deep purple mottled			10	0	10	0	10	0

LOCATION KEY: Act 3 FILE NUMBER: 11577 ELEVATION: 834 base TOPO MAP: Keno

STATE: Ohio COUNTY: Athens TOWNSHIP: Carthage SECTION: SE¼ NE¼, 34

LOCATION: Section exposed along abandoned road 0.7 mile north of Jasper Hill School and 0.8 mile east southeast of Road Junction 943.

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
15	Washington	Little Washington ?	Mannington	Shale and sandstone, olive gray to tan, laminated, micaceous, iron stained, fine-grained.			25	6	25	6	86	1
14		Waynesburg "A"		Clay shale, red, weathers somewhat plastic			3	1	50	4	60	7
13			Waynesburg	Sandstone, light gray to tan, limonite stained, medium to coarse-grained, micaceous.			45	7			57	6
12				Shale, tan, silty, argillaceous near base.			1	8			11	11

LOCATION: Act 3 FILE NUMBER: 11577 - continued

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
11	Monongahela	Waynesburg	Waynesburg	Coal smut, badly weathered, irregular.			0	1	6	10	10	3
10				Clay shale, much like that below.			0	4			10	2
9				Coal, shaly, some bright streaks, soft, weathered, thin shaly partings.			0	3			9	10
8				Clay shale, light gray to gray, limonite stained, finely micaceous, carbonaceous streaks.			0	1			9	7
7				Coal, bony, weathered, somewhat bright.			0	2			9	6
6				Clay shale, light gray to gray, limonite stained, finely micaceous, laminated, weathers plastic.			0	4			9	4
5			Gilboy	Shale and sandstone, gray to light gray, micaceous, silty to sandy shale grading upward into medium to fine grained sandstone, traces of fossil plants.			5	7			9	0
4		Little Waynesburg	Little Waynesburg	Clay shale, gray to light gray, laminated, soft, limonite stained, micaceous, well preserved plant fossils.			1	1	3	5	3	5
3				Coal, bony, shaly, some bright bands, some fusain.			0	2			2	4
2				Shale, dark to olive gray, silty, massive, carbonaceous streaks, traces of fossil plants, breaks with coarse fracture than unit below.			0	2			2	2
1				Clay shale, light olive gray, some limonite stains, silty, massive, breaks irregularly to a fine powder.			2	0			2	0

LOCATION KEY: FILE NUMBER: 11608 ELEVATION: 788 base TOPO MAP: Keno

STATE: Ohio COUNTY: Athens TOWNSHIP: Carthage SECTION: 16

LOCATION: Section exposed along U. S. Route 50 between Guysville and Coolville, base of section is 1.2 miles northeast of Lottridge in road cut opposite roadside park along route 50.

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
9	Washington	Washington	Washington	Coal horizon, well shown.			0	1	20	1	106	3
8				Covered interval, red shale showing.			10	0			106	2
7				Clay shale, red, badly weathered.			10	0			96	2
6		Little Washington	Little Washington	Clay, gray, plastic, possibly a coal horizon			0	1	86	1	86	2
5				Clay, sandy.			3	6			86	1
4				Shale, clayey, tan.			2	6			82	7
3			Mannington - Waynesburg	Sandstone, massive.			77	0			80	1
2				Shale, sandy, platy.			3	0			3	1
1	Monongahela	Waynesburg	Waynesburg	Clay shale, non-bedded, contact shows no coal though a horizon (contact zone) is evident.			0	1	0	1	0	1

LOCATION KEY: Act 12 FILE NUMBER: 14236 ELEVATION: 641 base TOPO MAP: Keno

STATE: Ohio COUNTY: Athens TOWNSHIP: Carthage SECTION: SE¼, 3

LOCATION: Details of Washington coal and associated strata exposed along U. S. Route 50, 1.25 miles northeast of Vanderhoof and 2.5 miles west-southwest of Coolville.

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
10	Washington	Washington "A"	Lower Marietta	Shale and sandstone, pale olive green, very fine grained, massive in upper 5 feet, may have a calcareous zone at base, top poorly exposed.			12	5	25	10	41	1
9				Sandstone, gray to olive, micaceous, fine-grained, cross-bedded below to massive at top, thickness varies laterally.			10	5			28	8
8				Shale, silty to sandy to siltstone, sandy to shaly, medium gray, limonite stained.			3	0			18	3
7		Washington	Washington	Interbedded carbonaceous shale and bony coal stringers with medium to light gray clay shale.			1	10	15	3	15	3
6				Coal, blocky, bright, gob pile from old mine nearby.			1	2			13	5
5				Interbedded medium gray clay shale and bone coal in stringers up to ½ inch thick.			1	10			12	3
4				Coal, bony to shaly.			0	3			10	5
3			Washington fire clay shale	Clay shale, medium gray, limonite-stained.			2	2			10	2
2			Bristol	Limestone, light gray, weathering almost white, nodular but somewhat bedded, irregular thickness.			3	3			8	0
1				Limestone and shale, deep purple, mottled red and maroon, clay shale with scattered limestone knots.			4	9			4	9

DOVER TOWNSHIP

LOCATION KEY: Ad 2 FILE NUMBER: 6715 ELEVATION: 911 Base TOPO MAP: Athens

STATE: Ohio COUNTY: Athens TOWNSHIP: Dover SECTION: NE-1/4 SE-1/4, 33

LOCATION: The measured section is along road and to top of small hill on south side of the road.

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
4	Conemaugh	Ames	Ames	Limestone, light gray with pinkish mottling, weathers dark gray to brownish, partly crystalline, very fossiliferous.			2	0	17	3	31	0
3				Covered interval.			15	3			29	0
2		Harlem	Round Knob	Clay shale, maroon, calcareous, with few, scattered, small limestone nodules, exposed.			11	9	13	9	13	9
1				Clay shale and limestone, mottled maroon and light buffish gray, calcareous clay shale, with numerous, small nodules of greenish gray limestone.			2	0			2	0

LOCATION KEY: Ad 4 FILE NUMBER: 6718 ELEVATION: 823 ± Base TOPO MAP: Athens

STATE: Ohio COUNTY: Athens TOWNSHIP: Dover SECTION: NE-1/4 SW-1/4, 35

LOCATION: Exposures along small ravine west of 987 road intersection.

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
25	Conemaugh	Duquesne	Skelley	Sandstone, light gray to yellowish brown, medium, micaceous, friable, massive to bedded, exposed.			18	9	24	4	168	0
24			Duquesne	Clay shale, maroon mottled with some light yellowish, numerous small (to 1") nodules of limestone in basal foot.			3	11			149	3
23			Lower Grafton	Sandstone, gray stained yellowish to brownish, fine, micaceous, thin bedded below and heavy bedded above.			1	8			145	4
22		Gaysport ?	Gaysport ?	Covered interval.			19	6	19	6	143	8
21		Ames	Ames	Limestone, light gray, weathers brownish on surfaces, partly crystalline, fossiliferous, massive.			1	4	20	10	124	2
20				Covered interval, light gray clay shale at base, mantle indicates sandy and silty shale above.			19	6			122	10
19		Harlem	Harlem	Coal smut, badly weathered.			0	1	4	10	103	4
18				Underclay, mottled light gray, gray and yellow, much limonite stained, slightly calcareous, plastic.			3	4			103	3
17			Rock Riffle	Limestone, nodular, ferruginous, embedded in sandy clay shale, fresh-water.			1	5			99	11
16		Upper Bakerstown	Cow Run	Shale and sandstone, olive drab with limonite stain, silty and sandy shale interbedded with fine to medium, micaceous (some calcareous) sandstones.			32	6	32	6	98	6
15		Anderson	Portersville	Shale, dark gray to black, argillaceous, calcareous, fossilliferous limestone, weathered.			3	4	23	11	66	0

LOCATION: Ad 4 FILE NUMBER 6718 - continued

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
14	Conemaugh	Anderson - continued	Anderson	Coal, blocky, some bright with numerous dull partings, shaly in upper part, considerably weathered.			1	3			62	8
13				Underclay, light gray mottled yellowish, plastic, exposed.			1	0			61	5
12			Bakerstown	Shale, olive drab, argillaceous, poorly exposed and covered, with some loose sandstone blocks above.			10	11			60	5
11				Sandstone, much stained by limonite to yellowish or brownish, fine to medium, micaceous.			1	6			49	6
10				Shale, olive drab with limonite stain, argillaceous, silty, sandy.			3	4			48	0
9				Sandstone, weathers brownish, fine to medium, micaceous, medium to heavy-bedded.			2	7			44	8
8		Wilgus	Cambridge	Sandstone, gray to light gray, weathers yellowish to brownish, calcareous, micaceous, shows bedding on weathering, probably represents the Cambridge limestone.			1	6	28	7	42	1
7			Buffalo	Shale and sandstone, olive drab, silty, sandy, micaceous shale interbedded with fine, micaceous, thin-bedded sandstone.			18	3			40	7
6				Covered interval.			8	10			22	4
5		Upper Brush Creek	Upper Brush Creek	Limestone, dark bluish gray, dense, weathers shaly with rounded surfaces, fossiliferous, thickness variable.			0	6	12	1	13	6
4				Coal, shaly, weathered.			0	8			13	0
3				Underclay, light gray to gray with limonite stain, carbonaceous, coaly streaks and masses throughout.			4	3			12	4
2				Shale, olive drab with limonite stain, silty, sandy, micaceous, with layers of shaly sandstone upward.			6	8			8	1
1		Lower Brush Creek	Lower Brush Creek	Limestone, light gray with limonite stain near surfaces, mostly crystalline, some dark inclusions fossiliferous especially crinoids massive.			1	5	1	5	1	5
				Patches of olive drab shale exposed downstream below.								

LOCATION KEY: Ad 6 FILE NUMBER: 6720 ELEVATION: 670 ± Base TOPO MAP: Athens

STATE: Ohio COUNTY: Athens TOWNSHIP: Dover SECTION: SW-1/4 SE-1/4, 26

LOCATION: Exposures along northwest side of Route 33 and in nearly driveway.

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
3	Conemaugh	Mason	Upper Mahoning	Sandstone, light gray but much stained yellowish to brownish, medium to coarse, micaceous, friable with some case hardening, massive showing bedding and cross bedding on weathered surfaces.			27	11	27	11	36	0
2		Mahoning	Thornton	Underclay, light gray with some limonite stain, arenaceous and micaceous in lower part, dark gray, carbonaceous streaks in middle part (somewhat carbonaceous), plastic.			4	1	8	1	8	1
1			Lower Mahoning	Shale, olive drab much stained by limonite, silty, finely micaceous, with scattered small limonite concretions, becomes argillaceous upward and grades into overlying gray plastic clay, exposed.			4	0			4	0

LOCATION KEY: Ad 7 FILE NUMBER: 6721 ELEVATION: 737 ± Base TOPO MAP: Athens

STATE: Ohio COUNTY: Athens TOWNSHIP: Dover SECTION: S-1/2 NW-1/4, 33

LOCATION: Exposures along secondary road between Floodwood Hollow and 917 road intersection.

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
20	Conemaugh	Ames	Ames	Limestone, light gray, partly crystalline, fossiliferous.			1	0	33	8	216	0
19		?	?	Clay shale and shale, maroon clay shale, olive drab argillaceous or silty, sandy, micaceous shale, poorly exposed and partly covered.	16	0	32	8			215	0
		Harlem ?	Round Knob		16	8						
18		Upper Bakerstown	Cow Run	Shale and sandstone, olive drab with limonite stain, silty, sandy, micaceous shale interbedded with dull gray, iron oxide stained, fine, micaceous sandstone in layers 1" to several inches thick.			15	10	32	7	182	4
17				Shale, olive drab with limonite stain, silty, sandy, micaceous.			16	9			166	6
16		Anderson	?	Covered interval.			16	5	16	5	149	9
15		Wilgus	Cambridge	Limestone, nodular, ferruginous, fossiliferous.			0	4	28	10	133	4
14			Buffalo	Shale, olive drab with some limonite stain, argillaceous to silty, with some scattered ferruginous nodules.			4	7			133	0
13				Shale and sandstone, olive drab with some limonite stain, silty to sandy shale interbedded with gray to yellowish brown, fine to medium, bedded with some ripples, micaceous sandstone in layers 1/4 to 15" thick.			6	5			128	5

LOCATION: Ad 7 FILE NUMBER 6721 - continued

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
12	Conemaugh - continued	Wilgus - continued	Buffalo - continued	Shale, olive drab with some limonite stain, argillaceous to silty, with fine sandy zones and with few thin ferruginous layers, micaceous.			17	6			122	0
11		Upper Brush Creek	Upper Brush Creek	Limestone, gray with reddish mottling, weathers dark gray with some limonite stain, partly crystalline, ferruginous, fossiliferous, mostly weathered to a limonite zone with fossil impressions.			1	0	20	7	104	6
10				Shale and sandstone, olive drab with limonite stain, argillaceous to sandy, micaceous shale, with thin layers of medium, micaceous sandstone and one zone of shaly micaceous sandstone 3 to 4' thick.			19	7			103	6
9		Lower Brush Creek	Lower Brush Creek	Limestone, gray mottled reddish, weathers yellowish brown, dense, partly crystalline, fossiliferous, thickness variable.			0	6	4	3	83	11
8				Shale and sandstone, olive drab with limonite stain, sandy, micaceous shale, with layers and lenses of fine micaceous sandstone.			3	9			83	5
7		Mason	Upper Mahoning	Sandstone, light gray with some limonite stain, fine to medium, very micaceous, bedded, cross-bedded or massive, especially massive in upper half, calcite in joints near top, somewhat friable.			24	8	36	8	79	8
6				Covered interval.			12	0			55	0
5		Mahoning	Thornton	Underclay, light gray to maroon, somewhat plastic.			4	0	39	3	43	0
4			Lower Mahoning	Shale, olive drab to light gray above with limonite stain, sandy and micaceous becoming argillaceous upward, with numerous tiny limonite concretions in certain layers (also piece of float freshwater limestone with similar tiny limonite concretions).			3	0			39	0
3				Sandstone, light gray with much limonite stain, medium to coarse, micaceous, porous, friable, massive, (mostly covered except at top and bottom).			32	3			36	0
2	Allegheny	Upper Freeport	Upper Freeport	Clay, light gray with limonite stain, sandy and micaceous upward.			1	3	3	9	3	9
1				Underclay, dark gray, carbonaceous, shaly, with two thin (1+ "), shaly coaly streaks.			2	6			2	6

LOCATION KEY: Ad 9 FILE NUMBER: 6723 ELEVATION: 758 ± Base TOPO MAP: Athens

STATE: Ohio COUNTY: Athens TOWNSHIP: Dover SECTION: NE-1/4 ; 14

LOCATION: Composite section in ravines and along road for a short distance southeast, south, and southwest of 991 road intersection.

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
18	Conemaugh	Lower Little Pittsburgh and Upper Little Pittsburgh	Connellsville and Upper Little Pittsburgh	Sandstone, light gray to yellowish brown with local ferruginous zones, medium to coarse, micaceous, friable, massive but shows bedding and cross-bedding on weathered surfaces, porous, partly covered upward.			67	0	67	0	232	4
17		Little Clarksburg	?	Covered interval.			9	4	66	10	165	4
16			Clarksburg ?	Limestone, light gray, nodular, embedded in clay shale, poorly exposed, thickness estimated.			5	0			156	0
15		? Elk Lick	Morgantown ? ? Upper Grafton	Shale and sandstone, mostly covered, boulder of conglomeratic limestone near middle.			52	6			151	0
14		Duquesne ?	Skelley ?	Limestone, gray to yellowish brown, ferruginous, nodular, conglomeratic and dendritic (in a nearby tributary valley a similar lithologic limestone is bedded in massive or irregular beds and is somewhat ferruginous. There it is 38" thick and lies 41' above the Ames limestone).			6	6	6	6	98	6
13		Duquesne and Gaysport	Lower Grafton and Gaysport	Shale, gray or olive drab with slight limonite stain, argillaceous, silty, with scattered small ferruginous concretions, grades upward into fine, shaly, micaceous sandstone.			18	3	18	3	92	0
12		Ames	Ames	Limestone, light gray, partly crystalline, shows some differential weathering, fossiliferous, thickness somewhat variable.			1	6	20	0	73	9
11				Clay shale, light gray to gray with limonite stain, carbonaceous particles in basal part.			1	10			72	3
10				Coal, shaly with few thin bright streaks and some fossil plants, weathered.			0	2			70	5
9				Shale, light gray with some limonite stain, silty, finely micaceous, sandy downward.			2	6			70	3
8				Shale and sandstone, light gray or olive drab, varies from clay shale at base to a micaceous arenaceous shale upward, with some thin sandstone layers which at top becomes several feet of heavy bedded sandstone.			14	0			67	9
7		Harlem	Harlem	Coal, shaly, some bright, weathered.			0	3	23	3	53	9
6				Clay shale, olive drab with limonite stain, darker in upper part, arenaceous, micaceous.			0	6			53	6
5			Saltsburg	Sandstone and shale, gray to olive drab with some limonite stain, fine, micaceous, bedded to irregularly bedded sandstone interbedded with gray limonite stained, argillaceous, silty, finely micaceous shale, with small (4^{+}") ferruginous concretions, covered in part.			22	6			53	0

LOCATION: Ad 9 FILE NUMBER 6723 - continued

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
4	Conemaugh	Upper Bakerstown	Ewing ?	Ironstone, gray weathered to yellowish and brownish, calcareous, more or less in a layer embedded in shale.			0	6	29	0	30	0
3			Cow Run	Sandstone and shale, basal sandstone is similar to that below black shale but with more limonite stain, fine to medium, friable, some massive but mostly cross-bedded and interbedded with gray, sandy, slightly carbonaceous shale. Basal sandstone with few scattered coal masses; shale one thin lenticular coal layer and numerous large ferruginous concretions in upper part.			28	6			30	0
2		Anderson	Anderson	Shale, black carbonaceous, arenaceous, micaceous, with numerous fossil plants, lenticular, thickness variable.			1	6	1	6	1	6
1			Bakerstown	Sandstone, gray to yellowish brown, fine, micaceous, with fossil plants, exposed, unmeasured.			-	-			-	-

LOCATION KEY: Ad 10 FILE NUMBER: 6724 ELEVATION: 665 ± Base TOPO MAP: Athens

STATE: Ohio COUNTY: Athens TOWNSHIP: Dover SECTION: NW-1/4, 14

LOCATION: Exposures along ravine west of 991 road intersection.

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
25	Conemaugh	Lower Little Pittsburgh and Upper Little Pittsburgh ?	Connellsville and Upper Little Pittsburgh	Sandstone, light gray to yellowish brown with local ferruginous zones, medium to coarse, micaceous, friable, massive but shows bedding and cross-bedding on weathered surfaces, porous, partly covered upward.			67	0	67	0	326	7
24		Little Clarksburg ?	Morgantown ?	Covered interval, probably mostly sandstone, spring zone at 218' above base.			54	5	54	5	259	7
23		Gaysport ?	Gaysport ?	Shale and sandstone, poorly exposed, mostly covered.			25	5	25	5	205	2
22		Ames	Ames	Limestone, light gray with some iron oxide stain, partly crystalline, ferruginous, some differential weathering.			1	6	22	8	179	9
21				Shale, olive drab with limonite stain, silty, micaceous, with zones of fine sandstone, poorly exposed in part.			21	2			178	3
20		?	?	Covered interval.			17	6	17	6	157	1
19		Anderson	Portersville	Shale and sandstone, olive drab with limonite stain, sandy micaceous, shale with some fossil plants and fine, micaceous, thin-bedded sandstone, poorly exposed, slumped, weathered masses of Portersville dark gray shale.			4	6	18	8	139	7
18			Bakerstown	Sandstone, gray weathers light brown, fine to medium, micaceous, somewhat friable, massive, base disconformable.			10	0			135	1

LOCATION: Ad 10 FILE NUMBER 6724 - continued

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
17	Conemaugh	Anderson - continued	Bakerstown - continued	Clay shale, olive drab with dull reddish brown stain, silty, micaceous, breaks with coarse, starch-like fracture, with scattered ferruginous concretions, thickness variable.			4	2			125	1
16		Wilgus	Cambridge	Limestone, light greenish gray, mostly dense, with ferruginous zones and masses, very fossiliferous, basal part arenaceous.			1	0	26	10	120	11
15			Wilgus	Clay shale, olive drab to light gray, sandy, micaceous layers in upper part.			3	7			119	11
14			Buffalo	Sandstone, gray to brown, fine to medium, micaceous, thin to medium bedded.			7	1			116	4
13				Shale, olive drab to gray with some limonite stain throughout, scattered ferruginous nodules especially in basal 6" basal 2 feet with marine fossils, sandy and micaceous upward.			15	2			109	3
12		Upper Brush Creek	Upper Brush Creek	Limestone, gray mottled with dull iron oxide stain, partly crystalline, arenaceous, fossiliferous.			0	6	16	4	94	1
11				Shale and sandstone, olive drab, sandy, micaceous shale in lower part, light gray, fine, micaceous, thin-bedded sandstone above with massive calcareous layer at top.			15	10			93	7
10		Lower Brush Creek	Lower Brush Creek	Limestone, gray with ferruginous streaks, weathers brown on surface, partly crystalline, fossiliferous.			0	6	9	9	77	9
9				Sandstone, light gray with considerable iron oxide stain, weathers brown, fine to medium, very micaceous, somewhat friable, thin to medium or cross-bedded, shaly upward.			9	3			77	3
8		Mason	Mason and Upper Mahoning	Clay, mottled buff and maroon, plastic, becomes light gray and very plastic upward, carbonaceous and coaly fragment at very top.			13	0	46	8	68	0
7			Upper Mahoning	Shale, light gray, much iron stained, sandy, micaceous, with thin layers of shaly sandstone, poorly exposed in upper part.			7	9			55	0
6				Sandstone, light gray with slight limonite stain, medium, micaceous, somewhat friable, massive but shows cross-bedding on surfaces, exposed.			15	9			47	3
5				Covered interval			10	2			31	6
4		Mahoning	Thornton	Underclay, mottled buff and maroon, plastic, exposed.			1	0	21	4	21	4
3			Lower Mahoning	Covered interval			7	4			20	4
2				Sandstone and shale, variable sandstone, fine, micaceous, shaly or medium, micaceous interbedded with olive drab, silty, micaceous shale.			10+	0			13	0
1				Sandstone, light gray with some limonite stain, medium, micaceous, friable, massive but shows bedding and cross-bedding on weathered surfaces, exposed.			3	0			3	0
				Covered interval to level of Sunday Creek			0	0			0	0

LOCATION KEY: Ad 22 FILE NUMBER: 11297 ELEVATION: 670 Base TOPO MAP: Athens

STATE: Ohio COUNTY: Athens TOWNSHIP: Dover SECTION: SE-1/4 NW-1/4, 18

LOCATION: Details of Upper Freeport Coal in mine of Green Run Coal Co.

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
8	Conemaugh	Mahoning	Lower Mahoning	Sandstone, unmeasured, exposed.			-	-	-	-	-	-
7	Allegheny	Upper Freeport	Uffington	Shale, light bluish gray, numerous fossil plant impressions, generally a good roof.			6	0	10	10	10	10
6			Upper Freeport	Coal, bright, some dull coal, considerable fusain, little pyrite, softer coal than in benches below.			0	5			4	10
5				Coal, dull with some bright and bony bands, some pyrite.			0	7			4	5
4				Coal, bright, blocky, some dull streaks, some fusain, less pyrite than in lower benches.			1	1			3	10
3				Clay, gray to dark gray, few thin coal streaks, slickensides, stigmaria rootlets, thickness variable.			0	4			2	9
2				Coal, bright, blocky, a few thin dull streaks, some fusain streaks, some pyrite bands.			2	5			2	5
1			Upper Freeport	Underclay, light gray, considerable pyrite, somewhat plastic.			-	-			-	-

LOCATION KEY: Ad 23 FILE NUMBER: 11298 ELEVATION: 680 ± Base TOPO MAP: Athens

STATE: Ohio COUNTY: Athens TOWNSHIP: Dover SECTION: SW-1/4 SE-1/4, 11

LOCATION: Exposure along east-west road and northeastward from west end of road exposure along ravine to top of hill.

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
22	Conemaugh	Gaysport	Gaysport	Limestone, light greenish gray, weathers buff to tan with some limonite stain, sandy, micaceous, fossiliferous, marine, may not be exactly in place.			0	6	15	10	162	6
21				Shale, poorly exposed.			15	4			162	0
20		Ames	Ames	Limestone, light gray with slight limonite stain, especially at top, partly crystalline, quite fossiliferous (fusulines), massive ledges.			2	8	6	0	146	8
19				Shale, light olive drab to tan with some limonite stain, argillaceous, micaceous, poorly exposed.			1	6			144	0
18				Sandstone, light tan to light olive, drab, fine, argillaceous, silty, micaceous, thin-bedded, exposed.			1	10			142	6
17		Ames and Harlem	Harlem (in part)	Covered interval, apparently shale and clay shale, one slumped blossom of Harlem coal.			23	2	23	2	140	8
16		Harlem	Round Knob	Clay shale, mottled light gray, greenish purple, maroon, etc., weathers somewhat plastic, with numerous small limestone nodules.			12	6	12	6	117	6

LOCATION: Ad 23 FILE NUMBER 11298 - continued

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
15	Conemaugh	Upper Bakerstown	Cow Run	Shale and sandstone, mostly light olive drab or tan with some limonite stain, silty, sandy, micaceous shale interbedded with fine, silty, micaceous sandstone, top four feet argillaceous shale.			21	6	25	0	105	0
14				Sandstone, light gray, mostly stained pale to dark brown or yellow, fine, micaceous, somewhat friable, irregularly thin to heavy -bedded.			3	6			83	6
13		Anderson	Anderson	Coal, badly weathered, with clay streaks.			0	3	13	11	80	0
12				Underclay, light gray with some limonite stain, poorly exposed, weathered, somewhat plastic, exposed.			1	0			79	9
11			Bakerstown and/or Bloomfield ?	Covered interval.			12	8			78	9
10		Wilgus	Cambridge	Limestone, light greenish gray, much weathered and stained by limonite, marine, not positively in place.			0	10	28	3	66	1
9			?	Covered interval.			2	5			65	3
8			Buffalo	Sandstone, mostly stained light dull brownish to yellowish, fine, micaceous, slightly friable, ledges weathering into layers 1 to 6 inches thick, exposed.			1	6			62	10
7				Covered interval.			7	10			61	4
6				Shale, light gray to light olive drab with some limonite stain, argillaceous, micaceous, exposed.			15	8			53	6
5		Upper Brush Creek	Upper Brush Creek	Limestone, light gray to gray, mostly stained yellowish to brown sandy, dense to partly crystalline, fossiliferous, marine, thickness variable.			0	12	12	10	37	10
4				Shale, light gray to olive drab with some limonite stain, silty to finely sandy, micaceous.			11	10			36	10
3		Lower Brush Creek	Lower Brush Creek	Limestone, light gray with some maroon to purplish mottling and some limonite stain, partly crystalline, marine, fossiliferous.			0	10	17	0	25	0
2				Shale and sandstone, light gray to olive drab with some limonite stain, argillaceous to sandy, micaceous shale interbedded with layers and lenses of similarly colored, fine to medium, micaceous sandstone up to 4 feet thick.			16	2			24	2
1		?	?	Covered interval.			8	0	8	0	8	0

LOCATION KEY: Ad 26 FILE NUMBER: 11300 ELEVATION: 704 ± Base TOPO MAP: Athens

STATE: Ohio COUNTY: Athens TOWNSHIP: Dover SECTION: SW-1/4 SW-1/4, 10

LOCATION: Exposure along west-flowing creek and small tributary from south.

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
26	Conemaugh	Elk Lick ?	Elk Lick ?	Shale, chocolate, argillaceous, platy.			1	3	1	3	151	11-1/2
25				Clay shale, tan, soft, finely micaceous.			1	0	6	6	150	8-1/2
24				Limestone, light olive with limonite stain.			0	3			149	8-1/2
23			Upper Grafton ?	Shale, greenish tan, platy, argillaceous, silty, micaceous.			5	3			149	5-1/2
22		Duquesne	Skelley	Limestone, nodular, ferruginous, fossiliferous, marine limestone embedded in calcareous shale.			0	10	15	6-1/2	144	2-1/2
21				Shale, pale olive with limonite stain, argillaceous, silty, micaceous.			6	3			143	4-1/2
20			Duquesne	Underclay, light gray with iron oxide stain, weathers plastic.			0	3			137	1-1/2
19				Shale, mottled light gray, yellow, tan, argillaceous, silty.			0	5			136	10-1/2
18				Shale, maroon to reddish brown, argillaceous, thin, carbonaceous laminations, coal.			0	1/2			136	5-1/2
17				Clay, medium gray with yellow stain.			0	3			136	5
16				Clay, similar to that immediately below but tan in color, softer and with slickensides.			0	10			136	2
15				Clay, light gray to gray with considerable limonite stain, silty, finely micaceous, breaks with starch-like fracture.			2	4			135	4
14				Limestone, pinkish, nodular, embedded in mottled, maroon, marly clay shale.			2	0			133	0
13				Limestone, light gray, stained, nodular, embedded in clay shale, poorly exposed.			2	4			131	0
12		Gaysport	Gaysport	Sandstone, light gray with some limonite stain, fine, micaceous, calcareous, no apparent fossils.			2	2	16	3	128	8
11				Shale, light gray to light olive drab with some limonite stain, argillaceous, micaceous.			14	1			126	6
10		Ames	Ames	Limestone, light gray to gray and purple with some limonite stain, mostly dense, massive, fossiliferous, marine.			1	3	21	5	112	5
9				Shale and sandstone, light gray to light olive drab with some limonite stain, silty, micaceous shale interbedded with layers of fine micaceous sandstone, which becomes a ledge of considerable thickness in next ravine east.			20	2			111	2
8		Harlem and Upper Bakerstown	?	Covered interval.			34	3	34	3	91	0
7		Upper Bakerstown	Cow Run ?	Sandstone, light gray with much brown and yellow stain, some case hardening, fine to medium, micaceous, massive.			4	3	4	3	56	9
6		Anderson ?	?	Covered interval.			17	2	17	2	52	6

LOCATION: Ad 26 FILE NUMBER 11300 - continued

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
5	Conemaugh	Wilgus	Buffalo ?	Shale, light gray to light olive drab with some limonite stain, argillaceous, micaceous, becomes silty and sandy upward with calcareous, micaceous layers of fine sandstone, exposed.			15	4	20	4	35	4
4				Covered interval.			2	0			20	0
3				Sandstone, light gray considerably stained yellow and brown, fine to medium, micaceous, somewhat friable bedded in layers up to 4 inches thick.			3	0			18	0
2		Upper Brush Creek	Upper Brush Creek	Shale, much weathered, poorly exposed, mostly covered.			12	0	15	0	15	0
1				Shale, light gray to gray with considerable limonite stain, soft, argillaceous, micaceous, fossiliferous (ostracodes), marine, (blocks of dark blue fossiliferous limestone along bank), exposed.			3	0			3	0

LOCATION KEY: Ad 34 FILE NUMBER: 11307 ELEVATION: 731 Base TOPO MAP: Athens

STATE: Ohio COUNTY: Athens TOWNSHIP: Dover SECTION: E - Center and NE-1/4, 8

LOCATION: Exposure along tributary to Mill Creek on north side and relocated road in E - Center and NE-1/4, Section 8.

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
22	Conemaugh	?	?	Covered interval, U. S. Coast & Geodetic BM on Mt. Nebo.			90	2	90	2	312	8
21		Upper Little Pittsburgh and Lower Little Pittsburgh	Upper Little Pittsburgh and Connellsville	Shale and sandstone, light drab to tan with some limonite stain, silty, sandy, micaceous shale interbedded with fine, micaceous sandstone.			9	2	68	10	222	6
20				Sandstone, light gray, much stained dark brown and yellow, coarse to medium, fine to medium toward top, mostly massive, bedded toward top, micaceous, friable, with ferruginous limonitic zones.			59	8			213	4
19		Little Clarksburg	Clarksburg	Clay shale, mottled red, purplish, and light with scattered, mostly small, nodules of light gray to yellow freshwater limestone, lighter gray at top.			5	10	63	0	153	8
18				Clay shale, mottled red and light, poorly exposed.			17	4			147	10
17				Limestone, light gray to almost white, small nodules embedded in clay shale.			2	6			130	6
16			Morgantown ?	Sandstone, light gray to brown, red and yellow, coarse or medium and coarse, micaceous, friable, mostly massive, bedded at top.			37	4			128	0
15		Elk Lick	Elk Lick	Clay, gray to light gray with considerable limonite stain, rather plastic, especially light gray part.			1	3	31	2	90	8

LOCATION: Ad 34 FILE NUMBER 11307 - continued

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
14	Conemaugh	Elk Lick - continued	Birmingham ?	Clay shale, mottled maroon and yellow, somewhat plastic, with nodular ferruginous limestone nodules, exposed.			3	11			89	5
13				Covered interval.			16	2			85	6
12				Shale, similar to that below but without limestone nodules, exposed.			7	6			69	4
11				Shale, olive drab with some limonite stain, argillaceous, silty, micaceous, with scattered, dense, bluish, ferruginous limestone nodules.			2	4			61	10
10		Duquesne	Skelley	Limestone, greenish gray weathering brown and yellow, dense with conspicuous crystalline masses, sandy, micaceous, fossiliferous, marine.			0	8	20	2	59	6
9				Shale, light gray to light olive drab with considerable limonite stain, silty, micaceous, poorly exposed, details of middle part of this interval unknown.			19	6			58	10
8		Gaysport	Gaysport	Limestone, light bluish gray, weathers yellow and brown, dense to partly crystalline, sandy, micaceous, fossiliferous (fusulines), marine.			1	0	19	6	39	4
7				Shale, light gray to light olive drab with some limonite stain, silty to sandy, micaceous, with thin layers of fine sandstone.			18	6			38	4
6		Ames	Ames	Limestone, light gray with some limonite stain and green specks, dense to finely crystalline, fine pits on weathered surfaces, massive, fossiliferous, marine.			2	0	19	10	19	10
5				Coal smut, carbonaceous, clay shale, with coaly masses and streaks.			0	1			17	10
4				Underclay, light gray to olive, breaks with starch-like fracture, somewhat plastic.			0	8			17	9
3				Shale, olive to tan and brown, argillaceous to silty, micaceous.			4	1			17	1
2				Sandstone, light gray, mostly stained brown and yellow, medium to fine, micaceous, massive ledge.			0	5			13	0
1				Shale, light gray to olive drab with some limonite stain, silty, micaceous, laminated.			12	7			12	7

LOCATION KEY: Ad 35 FILE NUMBER: 11308 ELEVATION: 670 Base TOPO MAP: Athens

STATE: Ohio COUNTY: Athens TOWNSHIP: Dover SECTION: NE-1/4 SE-1/4, 7

LOCATION: Exposure along east bank of Sugar Creek 150 yards SE Poston ME Church and along west side of Route 50A west and northwest of church to hilltop.

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
17	Conemaugh	Duquesne ?	?	Top of ridge. Shale and sandstone, weathered, poorly exposed, no description.			23	1	23	1	145	0
16		Gaysport	Gaysport	Sandstone, light gray, much stained brown and yellow, fine, micaceous, calcareous, dense, and firm, no apparent fossils.			0	9	16	11	121	11
15				Shale, light tan, silty, micaceous, poorly exposed, mostly covered.			16	2			121	2
14		Ames	Ames	Limestone, light gray with some limonite stain and pale green specks, dense to partly crystalline, massive ledge, fossiliferous, marine.			1	6	11	4	105	0
13				Shale, light tan to olive drab, silty, argillaceous, micaceous, with 3-inch layer of light gray plastic clay, somewhat slumped, poorly exposed.			3	0			103	6
12				Sandstone and shale, light gray with limonite stain, fine to medium, micaceous, sandstone in massive layers 12 to 16 inches thick, interbedded with like colored silty, sandy, micaceous shale, massive sandstone layers show bedding and cross-bedding on weathered surfaces.			6	10			100	6
11		Harlem	Saltsburg ?	Shale, light gray to light olive drab with limonite stain, silty, sandy, micaceous, with zones of fine micaceous sandstone, poorly exposed.			32	0	32	0	93	8
10		Upper Bakerstown	Cow Run	Sandstone, weathered tan to brown, fine, micaceous, massive showing some bedding not well exposed, much better exposed downstream on west side of Sugar Creek valley.			16	8	27	2	61	8
9				Shale and covered interval.			7	8			45	0
8				Shale, chocolate to maroon, argillaceous, slumped, thickness estimated.			1	6			37	4
7				Shale and covered interval.			1	4			35	10
6		Anderson	Portersville	Limestone, light bluish gray, much limonite stained, nodular fossiliferous, marine, slumped, thickness estimated.			0	6	11	11	34	6
5			Bakerstown	Shale, weathered, badly slumped mostly covered.			11	5			34	0
4		Wilgus	Cambridge	Limestone, light gray-drab with much brown and yellow stain and numerous dendrites, dense, sandy, micaceous, fossiliferous, marine.			0	8	21	7	22	7
3			Buffalo	Sandstone, light gray, weathers brown to yellow, dense, very firm, micaceous, calcareous.			0	7			21	11
2				Shale and sandstone, light olive drab with some limonite stain, silty, sandy, micaceous shale with zones of fine, silty, micaceous sandstone, poorly exposed.			20	4			21	4
1		Upper Brush Creek	Upper Brush Creek	Limestone, light gray with some limonite stain, dense with few visible crystals, micaceous, fossiliferous, marine.			1	0	1	0	1	0

LOCATION KEY: Ad 36 FILE NUMBER: 11309 ELEVATION: 634 Base TOPO MAP: Athens

STATE: Ohio COUNTY: Athens TOWNSHIP: Dover SECTION: S-1/2 SW-1/4, 7

LOCATION: Exposure in well (reported) and along small stream west of and above farm buildings on Henry Augustine farm.

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
16	Conemaugh	Ames	Ames	Shale, light to pale buff, argillaceous fossiliferous, marine, nodules of marine limestone in base.			1	0	11	8	146	8
15				Limestone, light gray to gray with some limonite stain near surfaces, dense, with few small crystals, nodular, ferruginous at top, fossiliferous (fusulines), marine.			1	10			145	8
14				Underclay, gray to light gray with some limonite stain, carbonaceous toward top, somewhat plastic.			2	6			143	10
13				Shale and sandstone, light gray to light olive drab, with considerable limonite stain, silty, sandy, micaceous shale interbedded with layers of fine, micaceous, rippled sandstone, exposed.			6	4			141	4
12		? Harlem	? Harlem	Covered interval, float of shale, fine, sandstone, coal smut at 125 feet, 8 inches above base, exposures of weathered shale toward top.			35	6	35	6	135	0
11		Upper Bakerstown	Cow Run	Shale and sandstone, light gray to light olive drab with some limonite stain, sandy, micaceous shale and shaly, fine, micaceous sandstone, numerous limonite-siderite concretions.			25	10	25	10	99	6
10		Anderson	Portersville and Anderson	Shale, dark gray to black, carbonaceous, sandy, micaceous, with thin streaks of coal.			2	4	8	8	73	8
9			Bakerstown	Sandstone, light gray to brown and yellow, medium to coarse, micaceous, massive, showing some traces of bedding on weathered surfaces.			6	4			71	4
8		Wilgus	Buffalo	Shale, light bluish gray to light olive drab with some limonite stain, argillaceous to silty and sandy, micaceous, layers of iron carbonate concretions, exposed.			6	6	22	7	65	0
7				Covered interval.			14	7			58	6
6				Shale, light gray to olive drab, argillaceous to silty, micaceous, exposed.			1	6			43	11
5		Upper Brush Creek	Upper Brush Creek	Limestone, light gray with considerable limonite stain, micaceous, sandy, dense and firm, fossiliferous, marine.			0	9	41	5	42	5
4				Sandstone, light gray with limonite stain, micaceous, calcareous.			0	3			41	8
3				Shale, light gray with some limonite stain, silty, sandy, micaceous, exposed.			1	0			41	5
2				Covered interval, probably shale.			39	5			40	5
1		Lower Brush Creek	Lower Brush Creek	Limestone, reported to be bluish and hard in bottom of Henry Augustine's well at depth of 30 feet. (thickness estimated).			1	0	1	0	1	0

LOCATION KEY: Ad 37 FILE NUMBER: 11310 ELEVATION: 700 Base TOPO MAP: Athens

STATE: Ohio COUNTY: Athens TOWNSHIP: Dover SECTION: NE-1/4 SW-1/4, 2

LOCATION: Exposure along east side of Route 50 A

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
6	Conemaugh	Wilgus	Cambridge	Shale and limestone, light olive drab to tan with limonite stain, argillaceous, silty, micaceous, sparingly fossiliferous, marine shale with nodules of ferruginous limestone, exposed.			2	0	12	8	12	8
5				Limestone, light bluish to greenish weathering brown and yellow, ferruginous, partly dense and partly crystalline, very fossiliferous, marine.			0	3			10	8
4				Shale, light tan to olive drab with limonite stain, argillaceous, silty, finely micaceous, no apparent fossils.			0	11			10	5
3				Limestone, light bluish gray, weathering brown and yellow, ferruginous, sandy, micaceous, dense, fossiliferous, marine.			0	7			9	6
2			Buffalo	Shale, light gray weathered olive drab with some limonite stain, silty, sandy, micaceous.			2	5			8	11
1				Sandstone, light gray with much limonite stain, fine, silty, micaceous, in layers 1/4 to several inches thick, with thin layers of light bluish gray shale, exposed.			6	6			6	6

LOCATION KEY: Ad 38 FILE NUMBER: 11311 ELEVATION: 721± Base TOPO MAP: Athens

STATE: Ohio COUNTY: Athens TOWNSHIP: Dover SECTION: NW-1/4 NE-1/4, 2

LOCATION: Exposure northward from 706 road junction in north-center, Section 2, Dover Township, section continues to hilltop in NW-1/4, NE-1/4, Section 2.

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
45	Monongahela	Fishpot ?	Fishpot ?	Limestone and clay shale, variable light gray or yellow, nodular with lesser amounts of bedded, dense, some brecciated limestone, in part fossiliferous, fresh-water limestone embedded in light gray clay shale, poorly exposed.			22	0	22	0	313	0
44		Redstone	Upper Pittsburgh	Shale, light olive to tan with some limonite stain, silty, micaceous.			4	0	22	3	291	0
43				Sandstone, light tan with brown and yellow streaks, fine, finely micaceous, some stratigication.			0	4			287	0
42				Shale, light olive to tan with some limonite stain, silty, sandy, micaceous.			14	10			286	8
41				Sandstone, light olive to tan with some limonite stain, fine, silty, micaceous, thin, somewhat irregularly bedded.			0	10			271	10
40				Shale, light olive to tan, silty, finely micaceous.			1	5			271	0

LOCATION: Ad 38 FILE NUMBER 11311 - continued

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
39	Monongahela - continued	Redstone - continued	Upper Pittsburgh - continued	Sandstone, tan with limonite stain, fine, micaceous, thin and cross-bedded.			0	3			269	7
38				Shale, olive to tan, silty, finely micaceous.			0	7			269	4
37		Pittsburgh	Pittsburgh	Shale, dark gray to black, carbonaceous, silty, micaceous, a coal horizon.			0	1	13	2	268	9
36				Clay shale, gray to dark olive gray, silty, finely micaceous, breaks with starch-like fracture.			1	0			268	8
35			Upper Pittsburgh	Limestone, light gray to yellowish tan, dense, irregularly broken, thickness uncertain.			1	0			267	8
34			Lower Pittsburgh	Shale, poorly exposed.			8	8			266	8
33				Clay shale and limestone, light gray, much stained pale yellow, nodular limestone in lower part, somewhat plastic and clay-like above.			2	5			258	0
32	Conemaugh	Upper Little Pittsburgh	Upper Little Pittsburgh	Limestone, yellow brown, silty, sandy, micaceous, irregularly thin-bedded.			0	8	15	7	255	7
31				Clay shale, mottled gray to greenish with much yellow stain upward, with scattered yellow, dense, fresh-water limestone nodules, poorly exposed.			11	5			254	11
30				Shale and sandstone, white to tan with some limonite stain, silty, micaceous shale and fine, micaceous thin-bedded sandstone.			3	6			243	6
29		Upper and Lower Little Pittsburgh	Upper Little Pittsburgh and Connellsville	Sandstone, light gray much stained brown and yellow, coarse to medium, medium upward, micaceous, friable, mostly massive, shows some bedding and cross-bedding, base uneven.			75	2	75	2	240	0
28		Little Clarksburg	Little Clarksburg	Coal smut, local.			0	1/8	10	10	164	10
27			Clarksburg	Clay, light gray with some yellow stain, little darker gray toward base, moderately plastic, thickness variable.			2	8			164	10
26			Morgantown	Clay shale, mottled maroon, green gray, breaks with starch-like fracture, with small fresh-water limestone nodules throughout.			8	2			162	4
25		Elk Lick	Morgantown ? and Upper Grafton	Sandstone, light greenish gray with some limonite stain, fine, micaceous, shaly appearing, calcareous with numerous, calcareous concretionary masses.			7	6	43	8	154	2
24				Sandstone, light gray with considerable brown and yellow stain, coarse to medium micaceous, friable, massive, becomes fine grained and bedded upward.			30	10			146	8
23			Birmingham	Clay shale, mottled maroon, purple gray, breaks with starch-like fracture, with scattered, small, fresh-water limestone nodules.			5	4			115	10
22		Duquesne	Skelley	Shale, light olive drab to light tan with some limonite stain, silty, micaceous, with sandy zones in basal part, breaks irregularly toward top.			15	9	27	2	110	6

LOCATION: Ad 38 FILE NUMBER 11311 - continued

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
21	Conemaugh - continued	Duquesne - continued	Duquesne	Underclay, light gray, plastic.			0	1			94	9
20				Clay shale, mottled purple green and yellow becoming grayish green at top, small, nodules of fresh-water limestone scattered throughout, breaks with starck-like fracture.			11	4			94	8
19		Gaysport	Gaysport	Shale, light gray to light olive drab with considerable limonite stain in basal few inches and along joints in lower part, silty, micaceous.			11	10	11	10	83	4
18		Ames	Ames	Limestone, light gray with some limonite surface stain, partly crystalline, fossiliferous, marine.			1	3	13	10	71	6
17				Shale, light olive drab to light tan, with some limonite stain, silty, micaceous.			9	9			70	3
16				Clay, light gray, somewhat plastic.			0	2			60	6
15				Shale, chocolate brown, similar to that above coal smut below, light gray in top several inches.			1	6			60	4
14				Shale, light gray to pale olive with some limonite stain, silty to sandy, micaceous.			0	6			58	10
13				Shale, chocolate brown, argillaceous to silty, micaceous, fissile.			0	8			58	4
12		Harlem	Harlem	Coal smut.			0	1/8	32	8	57	8
11				Underclay, light gray with some pale yellow stain, some very small mica flakes, moderately plastic.			0	8			57	8
10			Rock Riffle and Round Knob	Clay shale, chocolate maroon below mottled greenish, gray and yellow upward, scattered small nodules of gray to whitish fresh-water limestone, breaks with starch-like fracture.			16	4			57	0
9				Limestone, light gray to light greenish gray with some limonite stain, nodular, silty, micaceous, embedded in similarly colored, silty, micaceous shale.			3	4			40	8
8			Saltsburg	Sandstone, light gray to light tan with some limonite stain, fine, silty, micaceous, bedded in layers 1/8 to several inches thick, interbedded with irregular thickness of similarly colored, silty, micaceous shale and nodular impure limestone, top surface irregular.			12	4			37	4
7		Upper Bakerstown	Ewing	Shale, similar to that below, shale and limestone but with light tan limestone nodules.			6	1	14	6	25	0
6			Cow Run ?	Shale and limestone, shale light greenish gray or chocolate brown with some limonite stain, argillaceous, silty, micaceous, with nodules of impure mottled similarly colored, fossiliferous (chonetid brachiopods) limestone up to 6 inches across.			2	0			18	11
5				Shale, light gray to pale tan, silty to sandy, micaceous.			6	5			16	11
4		Anderson	Portersville ?	Shale, light gray to pale olive or chocobrown with some stain, argillaceous to silty, finely micaceous, fissile, interbedded with 18 inch chocolate layer with few impure limestone nodules at top.			7	2	10	6	10	6

LOCATION: AD 38 FILE NUMBER 11311 - continued

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
3	Conemaugh - continued	Anderson - continued	Portersville - continued	Shale, gray to dark gray with some limonite stain, argillaceous to slightly silty, finely, micaceous, soft, fossiliferous, marine, with nodular, fossiliferous limestone at top.			2	9			3	4
2			Anderson	Coal smut.			0	1			0	7
1				Underclay, gray to light gray, tough, plastic, exposed.			0	6			0	6

LOCATION KEY: Ad 42 FILE NUMBER: 11313 ELEVATION: 684± Base TOPO MAP: Athens

STATE: Ohio COUNTY: Athens TOWNSHIP: Dover SECTION: SW-1/4, 1

LOCATION: Exposure beginning along small creek on Joe Chiki's farm, and continuing south along abandoned road between sections 6 and 12, and ending just south of school (now gone) south of 977 road junction at hilltop in SW-1/4, section 6, Athens Township.

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
29	Monongahela	Fishpot ?	Fishpot ?	Limestone, yellowish tan below and light gray above, tan has considerable limonite, bedded or nodular with clay shale matrix, thickness variable, apparently a lens, not seen on adjacent hilltop, numerous ostracodes.			4	4	8	4	309	10
28			Pomeroy ?	Sandstone, light gray to tan, fine, micaceous, mostly thin-bedded at top and bottom, entire thickness of sandstone and that in two intervals below is variable in bedding and may be shale.			4	0			305	6
27		Redstone ?	?	Covered interval, probably sandstone, all sandstone on opposite side of hilltop.			11	6	11	6	301	6
26		Redstone	Upper Pittsburgh	Sandstone, light gray mostly stained yellowish brown, medium to coarse, micaceous, somewhat friable.			11	7	19	0	290	0
25				Shale mostly covered.			7	5			278	5
24		Pittsburgh	Pittsburgh	Underclay, light gray to gray at top with some limonite stain, rather tough and plastic.			1	0	4	6	271	0
23				Coal, somewhat limonite stained, soft, sooty, much weathered.			0	11			270	0
22				Underclay, gray, somewhat limonite stained, somewhat plastic, not fully exposed.			1	3			269	1
21			Lower ? Pittsburgh	Clay or clay shale, light gray with considerable limonite stain, silty, finely micaceous, only slightly plastic.			1	4			267	10
20	Conemaugh	Upper Little Pittsburgh ?	Upper Little Pittsburgh ?	Shale, light gray much stained yellow and brown, silty, sandy, micaceous.			3	0	3	0	266	6
19		Lower Little Pittsburgh and Upper Little Pittsburgh ?	Connellsville and Upper Little Pittsburgh ?	Sandstone, light gray much weathered yellow with lesser brown and some red, medium to coarse, micaceous, friable, massive, showing some bedding.			71	6	71	6	263	6

LOCATION: Ad 42 FILE NUMBER 11313 - continued

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
18	Conemaugh - continued	Little Clarksburg	Morgantown ?	Shale and/or clay shale, silty, sandy, poorly exposed.			24	6	24	6	192	0
17		Elk Lick	Upper Grafton	Sandstone, light gray much stained yellow and brown, coarse to medium, micaceous, somewhat friable, massive show some bedding and cross-bedding on weathered surfaces.			41	10	50	8	167	6
16			Birmingham ?	Shale, light gray olive to tan with some limonite stain, silty, sandy, micaceous, clay or clay shale at top, exposed.			8	10			125	8
15		Duquesne	?	Covered interval, apparently clay or clay shale near top.			28	1	28	1	116	10
14		Gaysport	Gaysport	Limestone, gray with considerable limonite stain, sandy, micaceous, fossiliferous, marine.			0	5	14	5	88	9
13				Shale and sandstone, light gray weathered olive to tan, silty, micaceous, poorly exposed.			14	0			88	4
12		Ames	Ames	Limestone, light gray with considerable limonite stain near surfaces, dense to partly crystalline, massive, fossiliferous, marine.			2	0	14	2	74	4
11				Underclay, gray to light gray with some limonite stain, silty, finely micaceous, exposed.			1	0			72	4
10				Shale and sandstone, interbedded light gray to olive and tan with some limonite stain, silty, sandy, micaceous shale and similarly colored fine, silty, micaceous sandstone, poorly exposed.			3	2			71	4
9				Sandstone, light gray to tan with considerable limonite stain, fine, micaceous, bedded in thin to moderately massive layers, some cross-bedding apparent on weathered surfaces.			8	0			68	2
8		Harlem	Saltsburg	Shale, light gray to olive or tan with some limonite stain, sandy, silty, micaceous, poorly exposed.			14	1	14	1	60	2
7		Upper Bakerstown	Ewing ?	Sandstone, light gray to olive with some limonite stain, fine, micaceous, calcareous.			0	5	36	4	46	1
6			Cow Run	Shale, light gray to olive drab or tan with some limonite stain, silty, sandy, micaceous, poorly exposed.			35	11			45	8
5		Anderson	Portersville ?	Shale, pale chocolate brown with some limonite stain, silty, micaceous, chippy fracture, exposed.			1	8	9	9	9	9
4			Portersville	Shale and limestone, gray with some limonite stain, silty, micaceous, fossiliferous, marine with nodular fossiliferous limestone.			0	11			8	1
3				Shale, gray to light bluish gray with slight limonite stain, argillaceous, fossiliferous, marine, silty, micaceous, calcareous.			4	0			7	2
2			Anderson	Coal smut mixed in top two inches of clay; coal is reported to have been mined in the valley flat and to have attained a maximum thickness of 18 inches.			0	2			3	2
1				Underclay, light gray to light bluish gray, somewhat plastic, scattered small limestone nodules in lower part, exposed.			3	0			3	0

LOCATION KEY: Ad 43 FILE NUMBER: 11314 ELEVATION: 635 ± Base TOPO MAP: Athens

STATE: Ohio COUNTY: Athens TOWNSHIP: Dover SECTION: NE-1/4, 25

LOCATION: Exposure along C.&O. R.R. on SE side of Hocking River and east of Rt. 682 just NW of Beaumont.

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
18	Conemaugh	Wilgus	Buffalo	Shale, light gray to light greenish gray or olive with some limonite stain, silty, micaceous with sandy zones, exposed.			7	0	7	0	109	2
17		Upper Brush Creek	Upper Brush Creek	Limestone, light gray with brownish near surface stain, partly crystalline, micaceous, sandy, fossiliferous, marine.			0	11	12	9	102	2
16				Sandstone, light gray with considerable limonite stain, fine, micaceous, thin-bedded.			3	0			101	4
15				Sandstone, light gray with considerable limonite stain, medium to coarse micaceous, somewhat friable, massive, formerly quarried, exposed.			8	10			98	4
14		Upper and Lower Brush Creek	Upper and Lower Brush Creek	Covered interval showing slumped silty, micaceous shale, varicolored clay shale, and fragments of sandstone.			37	8	37	8	89	6
13		Lower Brush Creek	Lower Brush Creek	Sandstone, light gray, mostly stained yellowish brown, fine, silty, micaceous, finely laminated but holding together in blocks up to 8 inches thick, thickness variable.			4	0	13	3	51	10
12				Shale, light greenish gray to olive with considerable limonite stain, silty, finely micaceous.			9	3			47	10
11		Mason	Mason	Underclay, light gray with considerable limonite stain, somewhat shaly and plastic, small water seeps occur at this horizon.			0	1	12	3	38	7
10			Upper Mahoning	Shale, light bluish to light greenish gray with some limonite stain, silty, sandy, micaceous.			2	0			38	6
9				Sandstone and shale, light gray with some limonite stain, fine, silty, very micaceous sandstone with shaly partings and grading upward into shale, thickness variable.			4	6			36	6
8				Shale, light gray to light bluish gray with considerable limonite stain, silty, sandy, micaceous, with scattered, flat, calcareous sandstone near bottom.			5	8			32	0
7		Mahoning	Mahoning	Coal, bright with considerable limonite stain and numerous dull streaks.	0	2	0	8	18	0	26	4
6				Clay shale, gray to light gray, finely micaceous.	0	3					26	2
5				Coal, bright with much dull coal including considerable fusain and some pyrite.	0	3					25	11
4			Thornton	Underclay, gray to light gray at top with considerable limonite stain, silty, micaceous, shaly below with thin streaks of bright coal, somewhat plastic below to quite plastic at top.			1	8			25	8
3			Lower Mahoning	Covered interval, apparently shale in top part.			10	8			24	0

LOCATION: Ad 43 FILE NUMBER 11314 - continued

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
2	Conemaugh continued	Mahoning continued	Lower Mahoning continued	Sandstone, light gray with considerable limonite stain, medium to coarse, micaceous, somewhat friable, massive showing thin and irregular bedding with thin irregular lenses of coal, exposed.			5	0			13	4
1	Allegheny	Upper Freeport	Upper Freeport	Covered interval, coal reported in this interval and to have been formerly mined, not over 2 feet thick. Base level of Hocking River.			8	4	8	4	8	4

LOCATION KEY: Ad 45 A FILE NUMBER: 11316 ELEVATION: TOPO MAP: Athens

STATE: Ohio COUNTY: Athens TOWNSHIP: Dover SECTION: 14 - 15

LOCATION: Detail of Middle Kittanning No. 6 Coal in Chauncy Mine No. 25, New York Coal Company. 13th East off Main South Entry.

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
8	Allegheny	Lower Freeport	Lower Freeport	Sandstone.			-	-			-	-
				Shale, light gray, sandy, finely micaceous, with some limonite stain, soft clay leaches out of shale and sandstone above.			3	6	3	6	12	2
7		Middle Kittanning	Middle Kittanning	Coal, bony, interbedded with shale, fusain, pyrite and fossil plants.			2	6	8	8	8	8
6				Coal, bony, interbedded with bright coal, brighter at top, considerable fusain.			0	10			6	2
5				Coal, bright with dull layers and thin streaks and masses of pyrite, bony toward top.			1	10			5	4
4				Clay shale, gray to dark gray, weathering light gray with thin coaly streaks, soft.			0	3			3	6
3				Coal, bright, blocky, some dull streaks.			1	2			3	3
2				Shale, dark gray with bright streaks of coal.			0	1			2	1
1				Coal, bright, blocky, with dull coal in streaks, hard.			2	0			2	0
				Underclay, light gray, plastic.			-	-			-	-

LOCATION KEY: Ad 11 FILE NUMBER: 11454 ELEVATION: 714 Base TOPO MAP: Athens

STATE: Ohio COUNTY: Athens TOWNSHIP: Dover SECTION: NW-1/4, NE-1/4, 27

LOCATION: Exposure along road west of 714 road intersection.

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
10	Conemaugh	Mason	Upper Mahoning	Shale, gray-drab with limonite stain, sandy with thin beds of laminated sandstone throughout, with several float blocks of dark bluish marine limestone, exposed.			15	0	42	3	73	10
9				Sandstone, light gray with considerable limonite stain especially along joints and bedding planes, medium to coarse, micaceous, massive showing some bedding on weathered surfaces, friable, base disconformable, thickness variable.			22	10			58	10
8				Shale, light gray to drab with some limonite stain, argillaceous with thin sandy layers, thickness variable.			4	5			36	0
7		Mahoning	Lower Mahoning	Coal, shaly with some bright streaks, reported to thicken to 18 inches and to be mined locally for house coal.			0	4	31	7	31	7
6			Thornton	Underclay, light gray with yellow, brown, or maroon mottling, somewhat plastic.			5	0			31	3
5			Lower Mahoning	Clay shale and clay, color variegated light greenish gray to purple or maroon breaks with a starch-like fracture, somewhat plastic, with small nodules of limestone in lower part.			15	2			26	3
4				Limestone, light gray to buff, nodular, argillaceous, impure, fresh-water, thickness variable.			1	6			11	1
3				Shale, gray-drab, argillaceous, finely micaceous, with thin zones of thin-bedded sandstone, exposed.			5	7			9	7
2				Covered interval.			4	0			4	0
1				714 road intersection.								

LOCATION KEY: Ad 19 FILE NUMBER: 11460 ELEVATION: 656 ± Base TOPO MAP: Athens

STATE: Ohio COUNTY: Athens TOWNSHIP: Dover SECTION: NE-1/4, SE-1/4 , 31

LOCATION: Exposure in small ravine on south side of Hocking River.

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
16	Conemaugh	Ames	Ames	Limestone, loose blocks of light gray, partly crystalline, fossiliferous with fusulines, marine.			0	8	0	8	218	8
15		?	?	Covered interval, blocks of brown, fine sandstone at 206 feet above base.			29	0	29	0	218	0
14		Upper Bakerstown	Cow Run	Shale, light olive drab with some limonite stain, silty, finely micaceous, few scattered siderite-limonite concretions, exposed.			28	6	28	6	189	0
13		Anderson	?	Covered interval.			23	10	23	10	160	6

LOCATION: Ad 19 FILE NUMBER 11460 - continued

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
12	Conemaugh - continued	Wilgus	Cambridge	Limestone, light gray with limonite stain, mostly crystalline, sandy, fossiliferous, marine, single ledge (good collecting for compositas).			1	0	7	2	136	8
11			Buffalo	Sandstone, light gray with some limonite stain, fine, micaceous, bedded in layers up to several inches thick.			6	2			135	8
10		Wilgus and Upper Brush Creek	Buffalo ?	Covered interval, apparently mostly olive-drab, limonite stained, silty to sandy, micaceous, shale.			33	0	33	0	129	6
9		Lower Brush Creek	Lower Brush Creek	Limestone, dark slaty to bluish gray, mostly dense but some fine crystals, fossiliferous, marine, massive except shaly appearing top and bottom.			1	6	18	8	96	6
8				Shale, light gray to olive-drab with some limonite stain, argillaceous to very sandy and micaceous, poorly exposed.			17	2			95	0
7		Mason	Mason ?	Coal, some bright, shaly being fissile and brittle, full thickness uncertain.			0	6	45	4	77	10
6				Underclay, gray, quite plastic.			0	1			77	4
5				Shale, gray to black with limonite stain, argillaceous to silty, micaceous, carbonaceous, with fossil plants.			1	9			77	3
4				Shale, light gray with limonite stain, argillaceous, silty, and very sandy and micaceous, with thin coaly and carbonaceous masses.			1	0			75	6
3			Upper Mahoning	Sandstone, light gray with some limonite stain, medium to coarse, micaceous, friable, massive showing some bedding on weathered surfaces, with included masses of clay shale up to 2 feet across.			42	0			74	6
2		Mahoning	Lower Mahoning	Covered interval.			31	0	32	6	32	6
1				Shale, bluish gray with some limonite stain, argillaceous to sandy, micaceous, exposed.			1	6			1	6

LOCATION KEY: Ad 25 FILE NUMBER: 11461 ELEVATION: 799 Base TOPO MAP: Athens

STATE: Ohio COUNTY: Athens TOWNSHIP: Dover SECTION: NE-1/4, SE-1/4, 9

LOCATION: Exposure along ravine beginning at Ames limestone above Carl Smathers house in NE-1/4, SE-1/4, 9, Dover Township, Athens Co., Ohio. Exposure continues 1/4 mile N. along right fork of stream and top of section was measured along Smathers lane and to U.S.C. & G. BM on top of Mt. Nebo.

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
17	Conemaugh	?	?	Covered to top of Mt. Nebo.			40	10	40	10	243	9
16		Pittsburgh ?	Lower Pittsburgh ?	Clay shale, mottled yellow, brown, red, gray, etc., micaceous, flinty appearing in part, weathered, poorly exposed.			8	0	8	0	202	11
15		Upper Little and Lower Little Pittsburgh	Upper Little Pittsburgh and Connellsville	Covered interval.			10	0	90	8	194	11
14				Sandstone, light gray, much stained yellow and brown, fine to medium, very micaceous, rather friable, massive showing bedding and cross-bedding on weathered surfaces, becomes fine and shaly appearing at top.			80	8			184	11

LOCATION: Ad 25 FILE NUMBER 11461 - continued

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
13	Conemaugh - continued	Little Clarksburg	Clarksburg and/or Morgantown	Clay shale, mottled light gray, greenish, purplish to maroon, poorly exposed at most places.			32	0	32	0	104	3
12		Elk Lick	Upper Grafton	Sandstone, light gray weathered yellow, brown, and red, coarse with conglomerate zones, friable in part, micaceous, massive showing bedding and cross-bedding on weathered surfaces, base uneven, thickness variable.			24	0	33	11	72	3
11			Birmingham	Clay shale, exposed only in basal few inches, remainder of interval covered.			9	11			48	3
10		Duquesne	Skelley	Limestone, light greenish gray, weathers yellow to brown, nodular, fossiliferous, marine.			0	4	18	4	38	4
9				Shale, similar to that below underlying thin calcareous sandstone, top part poorly exposed.			3	0			38	0
8				Sandstone, light bluish gray with considerable limonite stain, fine, silty, micaceous, calcareous.			0	3			35	0
7				Shale, light gray to light bluish gray with considerable limonite stain, silty, micaceous.			3	3			34	9
6			Duquesne	Underclay, light gray with considerable limonite stain, somewhat plastic, several streaks of coal in upper part, exposed.			3	6			31	6
5			Lower Grafton	Shale, light gray to light greenish gray with some limonite stain, argillaceous, micaceous, upper part poorly exposed.			8	0			28	0
4		Gaysport	Gaysport	Limestone, light gray to gray with limonite surface stain, dense to finely crystalline, fossiliferous, marine.			0	5	10	3	20	0
3				Shale, light gray with some limonite stain, argillaceou to silty, micaceous, becomes sandy toward top.			9	10			19	7
2		Ames	Ames	Limestone, light gray with slight surface limonite stain and with inconspicuous pale green flakes, dense, partly crystalline, fossiliferous (numerous fusulines), marine.			1	4	9	9	9	9
1				Shale and sandstone, light gray with some limonite stain, argillaceous to silty, micaceous shale with layers of like-colored, fine, silty, micaceous sandstone in layers up to 6 inches thick, exposed.			8	5			8	5

LOCATION KEY: Ad 32 FILE NUMBER: 11462 ELEVATION: 645 Base TOPO MAP: Athens

STATE: Ohio COUNTY: Athens TOWNSHIP: Dover SECTION: NE-1/4, NW-1/4, NE-1/4 and NE-1/4, SE-1/4, 15

LOCATION: Exposure along valley and tributary valley.

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
36	Conemaugh	?	?	Covered to top of hill.			10	0	10	0	345	0
35		Lower Little Pittsburgh	Connellsville	Sandstone, light gray to yellow, brown, etc., medium to coarse, micaceous, friable, poorly exposed in most part.			50	8	50	8	335	0
34		Little Clarksburg	Clarksburg ? or Morgantown	Clay shale, light tan below, dark maroon above, breaks with a starch-like fracture, weathers plastic.			3	8	3	8	284	4
33		Elk Lick	Elk Lick	Limestone, light gray to light tan with some limonite stain, dense, nodular, embedded in light clay shale.			1	0	54	4	280	8
32				Shale, light gray to light tan, silty, micaceous, with thin zones of fine, silty sandstone.			8	0			279	8
31			Upper Grafton	Sandstone, light gray mostly weathered			39	4			271	8
30			Birmingham	Clay shale, dark maroon, with nodular, light gray, fresh-water limestone.			6	0			232	4
29		Duquesne	Duquesne	Clay shale, maroon, shale, light olive to tan, sandstone?, mostly poorly exposed.			30	4	32	8	226	4
28				Limestone, light gray to dark green, tan, etc., nodular, embedded in light gray clay shale, fresh-water.			2	4			196	0
27		Gaysport	Gaysport	Limestone, light gray to yellowish or brownish and purplish, dense, sandy, micaceous, conglomeratic, fossiliferous, marine, possibly reworked Skelley limestone.			1	0	24	0	193	8
26				Shale, light olive drab to light tan, silty, micaceous, basal part not very well exposed.			23	0			192	8
25		Ames	Ames	Limestone, light gray with considerable iron stain, dense to partly crystalline, fossiliferous, marine, a massive ledge, fusulines.			1	6	6	6	169	8
24				Clay, yellow-brown, plastic, probably represents weathered limestone.			0	3			168	2
23				Coal smut, dark gray to black, carbonaceous clay with coaly streaks.			0	1			167	11
22				Underclay, light gray to light olive drab, breaks with starch-like fracture, somewhat plastic.			0	4			167	10
21				Shale, light gray to light olive drab, with some limonite stain, silty, sandy, and micaceous below becoming argillaceous upward.			2	2			167	6
20				Sandstone, light gray with considerable limonite stain, fine, micaceous, bedded in layers to several inches thick.			2	2			165	4
19		Harlem	?	Covered interval, apparently shale and clay shale.			33	2	33	2	163	2
18		Upper Bakerstown	Upper Bakerstown ?	Clay shale, light gray with considerable iron oxide stain, breaks with starch-like fracture, weathers somewhat plastic, poorly exposed upward, exposed.			5	0	26	2	130	0

LOCATION: Ad 32 FILE NUMBER 11462 - continued

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
17	Conemaugh - continued	Upper Bakerstown - continued	Cow Run	Shale, light gray to light olive drab with some limonite stain, silty, micaceous, sandy in basal part.			7	6			125	0
16				Sandstone, much stained brown and yellow, fine to medium, micaceous, massive apparently grades laterally into thin-bedded sandstone and shale.			12	0			117	6
15				Conglomerate, gray with considerable limonite stain, pebbles up to 2 inches in size, consisting of quartz, limestone, limonite concretions, etc., matrix medium to coarse sand, very calcareous, reworked.			1	8			105	6
14		Anderson	Anderson and Bloomfield	Underclay, light gray with considerable yellow and brown stain, plastic, nodules of fresh-water limestone in base, much weathered and slumped.			7	9	14	3	103	10
13			Bakerstown	Shale, light gray to light olive drab, with considerable limonite stain, argillaceous to silty, micaceous.			6	6			96	1
12		Wilgus	Cambridge	Limestone, gray to light gray with considerable limonite stain, dense with few crystals, fossiliferous, marine.			0	9	7	4	89	7
11				Shale, light gray to olive gray, with some limonite stain, silty, finely micaceous, grades upward into fine, shaly sandstone.			6	7			88	10
10		Upper Brush Creek	Upper Brush Creek	Limestone, gray, weathering brown to yellow, dense, sandy, micaceous, nodular at top, fossiliferous, marine.			2	3	24	5	82	3
9				Shale, gray, silty, sandy, micaceous, evenly laminated with sandy layers 2 to 3 inches thick, few scattered sideritic concretions, grades upward fine shaly sandstone.			22	2			80	0
8		Lower Brush Creek	Lower Brush Creek	Shale, dark bluish gray becoming lighter upward, silty, finely micaceous, evenly laminated with thin even layers of iron carbonate nodules or concretions, fossiliferous, marine in basal part.			7	5	10	2	57	10
7				Limestone, dark bluish, very shaly, fossiliferous, marine.			0	5			50	5
6				Shale, dark bluish gray, silty, micaceous, fossiliferous, marine.			0	8			50	0
5				Limestone, dark bluish gray, dense, silty, sandy, and micaceous, shaly parting 4 inches above base and 6 inches below top, fossiliferous, marine.			1	8			49	4
4		Mason	Mason	Shale, dark bluish gray, silty, sandy, and micaceous with scattered nodules of dark bluish gray limestone, fossiliferous, marine, base at 37 feet 6 inches.			10	2	34	4	47	8

LOCATION: Ad 32 FILE NUMBER 11462 - continued

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
3	Conemaugh - continued	Mason - continued	Upper Mahoning	Sandstone, light gray, much stained brown and yellow, medium to coarse, micaceous, somewhat friable, mostly massive but some blocks show bedding and cross-bedding, 32 feet 8 inches measured, thickness variable. (Some distance up the valley at 32 feet above the base of the section is mottled maroon to yellow clay shale with starch-like fracture below and chocolate, fissile, argillaceous shale above are exposed in a thickness of 8 feet. Still farther upstream at the same distance above base (30 feet) there is light gray, considerably stained by limonite, silty, micaceous shale, which continues upward to the base of the Lower Brush Creek limestone).			22	2			37	6
2		Mahoning	Thornton	Underclay, gray above to light gray below with some limonite stain, silty, micaceous, only slightly plastic.			3	0	15	4	15	4
1			Lower Mahoning	Sandstone, light gray with some limonite stain, fine to medium, micaceous, bedded in layers one to several inches thick, exposed.			12	4			12	4

LOCATION KEY: Ad 13 FILE NUMBER: 11493 ELEVATION: 778 Base TOPO MAP: Athens

STATE: Ohio COUNTY: Athens TOWNSHIP: Dover SECTION: NW-1/4, NE-1/4, 35

LOCATION: Composite section on north side of tributary valley to Bailey Run.

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
20	Conemaugh	?	?	Covered interval.			3	1	3	1	185	9
19		Duquesne	Duquesne ?	Clay shale, dull maroon, with numerous, small, light gray, limestone nodules.			5	6	6	0	182	8
18			Lower Grafton	Sandstone, olive drab to brown, fine, micaceous, ferruginous.			0	6			177	2
17		Gaysport	Gaysport	Shale, olive drab, mostly covered.			17	10	17	10	176	8
16		Ames	Ames	Limestone, light gray with limonite streaks near surfaces, mostly dense and compact, very fossiliferous, marine.			1	4	1	4	158	10
15		?	?	Covered interval.			19	3	19	3	157	6
14		Upper Bakerstown	Ewing	Shale, weathers light buff to yellowish, nodular, ferruginous limestone in basal part, poorly exposed.			16	0	41	0	138	3
13			Cow Run	Shale, olive drab, argillaceous, sandy and micaceous, partly covered.			25	0			122	3
12		Anderson	Portersville	Shale, dark gray, argillaceous, calcareous, fossiliferous, marine.			1	6	21	2	97	3
11			Anderson	Coal, bright, with some clay-like partings and considerable fusain, weathered.			1	6			95	9
10			Anderson and Bloomfield	Underclay, light gray with some limonite stain, darker gray upward, micaceous sandy, with small, calcareous nodules at base, somewhat plastic, exposed.			5	6			94	3

LOCATION: Ad 13 FILE NUMBER 11493 - continued

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
9	Conemaugh - continued	Anderson - continued	Bakerstown	Shale, olive drab to brown and maroon, argillaceous, sandy in part, micaceous, with ferruginous concretions up to 2 inches in size.			12	8			89	9
8		Wilgus	Cambridge ?	Sandstone, light bluish gray with limonite stain near surfaces, medium, micaceous, calcareous.			1	0	38	1	76	1
7			Buffalo	Sandstone, light gray with some limonite stain, fine to medium, micaceous, in layers 1/4 to 6 inches thick.			9	6			75	1
6				Shale, light gray or olive drab with some limonite stain, micaceous, sandy becoming very sandy upward.			27	7			65	7
5		Upper Brush Creek	Upper Brush Creek	Limestone, dark gray with dull reddish and whitish mottling and yellowish surfaces, dense, moderately fossiliferous, marine.			1	0	12	6	39	0
4				Shale, light gray to olive drab with some limonite stain, sandy, micaceous.			11	6			38	0
3		Lower Brush Creek	Lower Brush Creek	Limestone, light gray, partly coarse crystalline, fossiliferous, with few glauconite grains, marine.			1	0	26	6	26	6
2				Sandstone, light gray to olive drab with some limonite stain, fine to medium, micaceous, thin bedded shaly appearing, grades upward into sandy, micaceous shale at top.			25	6			25	6
1				Base of section.								

LOCATION KEY: Ad 17 FILE NUMBER: 11459 ELEVATION: 562 Base TOPO MAP: Athens

STATE: Ohio COUNTY: Athens TOWNSHIP: Dover SECTION: NW-1/4, SE-1/4, 23

LOCATION: Mine 255-1/2, Drydock Coal Co., along North Branch of Bailey Run.

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
11	Allegheny	Upper Freeport	Upper Freeport	Coal, thickness reported .			4	0	4	0		
10		Upper Freeport, Bolivar ? and Lower Freeport ?	Upper Freeport, Bolivar ? and Lower Freeport	Underclay and shale, unmeasured.			-	-				
9		Lower Freeport	Lower Freeport	Sandstone, light gray, medium to coarse, micaceous, thickness estimated.			35	0	35	0	45	1
8		Middle Kittanning	Middle Kittanning	Shale, light gray, sandy, micaceous, with thin layer of plastic underclay at top, and locally with fossil plants, thickness variable.			2	6	10	1	10	1
7				Coal, bony with some bright, shaly in part with alternating shale and coal.			1	8			7	7
6				Coal, bright, blocky, with much fusain especially in lower 6 inches and with scattered irregular lenses of pyrite up to 1/2 thick.			2	5			5	11
5				Clay shale, dark gray, sandy, slickensided, with fossil plants and fine streaks of coal.			0	3			3	6
4				Coal, bright, blocky, with some fusain, and locally with traces of pyrite.			1	2			3	3

LOCATION: Ad 17 FILE NUMBER 11459 - continued

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
3	Allegheny - continued	Middle Kittanning - continued	Middle Kittanning - continued	Shale, black, carbonaceous, with thin streaks of coal.			0	1			2	1
2				Coal, bright, blocky, with thin dull partings and some fusain.			2	0			2	0
1				Underclay, unmeasured, reported to be several feet thick.								

LOCATION KEY: Ad 20 FILE NUMBER: 11573 ELEVATION: 727 Base TOPO MAP: Athens

STATE: Ohio COUNTY: Athens TOWNSHIP: Dover SECTION: NW-1/4, SW-1/4, 12

LOCATION: Exposures along east-west road east of cross road 1-1/2 mile east of 675 R.R. grade crossing.

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
14	Conemaugh	Ames	Ames	Limestone, light gray with some limonite stain, especially in base, dense to partly crystalline, fossiliferous marine, one massive ledge.			1	10	18	8	130	8
13				Underclay, very light gray with some limonite stain, calcareous.			0	10			128	10
12				Clay shale, olive drab with some yellow or brown stain, argillaceous, finely micaceous.			8	4			128	0
11				Sandstone, stained yellowish to brownish, fine to medium, micaceous, massive to heavy-bedded, poorly exposed in basal part.			7	8			119	8
10		Harlem	Round Knob and/or Saltsburg	Clay shale, light gray to olive drab, with some limonite stain, micaceous, bedded, more argillaceous and with starch-like fracture in basal 1 foot few scattered small limonite concretions, scattered fossil plants, poorly exposed upward.			15	9	15	9	112	0
9		Upper Bakerstown ?	Ewing ?	Limestone, light greenish gray to olive with some limonite stain, small nodules embedded in compact clay shale.			0	6	37	3	96	3
8			?	Shale, light olive drab weathering buff to yellowish or brownish argillaceous to silty micaceous few, scattered, small, limonite concretions.			14	1			95	9
7			Cow Run ?	Sandstone, mostly stained brown and yellow, medium to coarse, ferruginous conglomerate layer at base, micaceous, friable, massive becoming bedded upward and fine and thick-bedded near top.			22	8			81	8
6		Wilgus	Buffalo	Shale, gray with limonite stain, silty, micaceous, few plant fragments, numerous, small, limonite concretions, becomes sandy with layers of fine sandstone upward.			37	8	37	8	59	0
5		Upper Brush Creek ?	Upper Brush Creek ?	Shale, gray with some limonite stain, argillaceous slightly micaceous, fossiliferous, marine.			5	1	6	0	21	4
4				Underclay, gray, micaceous, somewhat plastic.			0	11			16	3
3		Lower Brush Creek	Lower Brush Creek	Limestone, dark gray to black, somewhat shaly, sandy, and micaceous, a single ledge, fossiliferous, marine.			0	8	15	4	15	4

LOCATION: Ad 20 FILE NUMBER 11573 - continued

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
2	Conemaugh continued	Lower Brush Creek - continued	Lower Brush Creek - continued	Shale, gray with considerable limonite stain, silty, argillaceous and micaceous, becoming somewhat sandy upward, fossiliferous, marine.			9	4			14	8
1				Shale, mostly stained yellowish to brownish, silty, sandy, micaceous with scattered limonite concretions, sparingly fossiliferous (ostracods) in top part; exposed.			5	4			5	4

LOCATION KEY: Ad 21 FILE NUMBER: 11574 ELEVATION: 708 Base TOPO MAP: Athens

STATE: Ohio COUNTY: Athens TOWNSHIP: Dover SECTION: NW-1/4, 6 and NE-1/4, 12

LOCATION: Exposure up steep hill along abandoned farm road.

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
11	Conemaugh	Ames	Ames	Limestone, light gray with purple mottling dense, fossiliferous, marine, float, approximate level of outcrop.			1	0	1	0	121	0
10		?	?	Covered interval			31	0	31	0	120	0
9		Upper Bakerstown	Cow Run ?	Clay shale, gray, some dull maroon near base, grades upward into silty, sandy, micaceous shale with thin layers of fine sandstone, much weathered, poorly exposed.			25	8	25	8	89	0
8		Anderson	Portersville	Shale, dark gray, with some limonite stain, argillaceous, fossiliferous, marine, much softened by weathering.			4	9	11	0	63	4
7			Anderson	Coal, some bright, weathers into thin angular chips, some fusain, much weathered.			2	0			58	7
6				Underclay, light gray with considerable limonite stain, only moderately plastic, finely micaceous, grades into clay shale below.			4	3			56	7
5		Wilgus and Anderson ?	Buffalo and Bakerstown ?	Shale and clay shale, light gray but mostly with limonite stain, silty, sandy and micaceous, top part breaks with starch-like fracture, much weathered, poorly exposed.			26	8	26	8	52	4
4		Upper Brush Creek	Upper Brush Creek	Limestone, light gray with maroon mottling and limonite stain near surfaces, dens, fossiliferous, marine.			0	8	15	0	25	8
3				Shale, light olive drab with some limonite, argillaceous, sparingly micaceous with very fine mica flakes, apparently no fossils.			14	4			25	0
2		Lower Brush Creek	Lower Brush Creek	Limestone, gray to light gray with purplish mottling, dense to partly crystalline, fossiliferous, marine, one ledge except for thin layers in top several inches.			1	8	10	8	10	8
1				Shale and sandstone, light olive drab with limonite stain, silty, micaceous shale with lenses and layers of fine silty, micaceous sandstone, exposed.			9	0			9	0

LOCATION KEY: Ad 12 FILE NUMBER: 11594 ELEVATION: TOPO MAP: Athens

STATE: Ohio COUNTY: Athens TOWNSHIP: Dover SECTION: N-1/2, NW-1/4 and W-1/2, NE-1/4, 36

LOCATION: Exposure at mine entrances, in strip mine and along road.

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
38	Conemaugh	Gaysport	Gaysport	Shale, olive drab, argillaceous, sandy, micaceous, exposed.			5	0	5	0	258	11
37		Ames	Ames	Limestone, light gray, with iron oxide stain near surfaces, dense to finely crystalline, fossiliferous, marine.			1	2	4	2	253	11
36				Shale, olive drab, sandy, micaceous.			3	0			252	9
35		Harlem	Round Knob	Shale, red, dark to maroon, argillaceous, calcareous nodules, exposed.			13	6	13	6	249	9
34		Upper Bakerstown	Ewing	Shale, olive drab, silty, argillaceous, with fine sand and tiny mica flakes, with many scattered impure calcareous nodules.			7	0	33	9	236	3
33			Cow Run	Shale, olive drab, sandy, micaceous, becoming silty upward.			9	6			229	3
32				Sandstone, stain yellowish to brownish fine micaceous, friable, irregularly bedded.			17	3			219	9
31		Anderson	Portersville	Shale, light gray to olive drab with some limonite stain, argillaceous, chocolate color.			2	0	10	4	202	6
30				Shale, gray to dark gray with considerable limonite stain, fossiliverous, marine, much weathered.			0	8			200	6
29			Anderson	Coal badly weathered.			1	0			199	10
28			? Bloomfield	Underclay, light olive drab, with some limonite stain, numerous small calcareous concretions in lower part, upper part poorly exposed.			6	8			198	10
27		Wilgus and Anderson	Buffalo and Bakerstown	Shale with much limonite stain, sandy and micaceous, some parts very sandy, become argillaceous at top, much of thickness covered.			40	2	40	2	192	2
26		Upper Brush Creek	Upper Brush Creek	Sandstone, light gray with considerable limonite stain, fine to medium micaceous, with very thin, small clay masses, friable, bedded in layers to 12 or more inches in thickness.			20	2	34	10	152	0
25				Shale, light gray with limonite stain, micaceous, sandy, interbedded with layers of similarly colored sandstone, medium-grained, micaceous, poorly exposed.			14	8			131	10
24		Mason	Mason	Coal, bright and dull, with considerable fusain, shaly in top part, much weathered.			0	10	22	11	117	2
23				Underclay and limestone, gray to light gray, plastic, apparently nodular ferruginous, limestone in lower part, poorly exposed, limestone known only from slump blocks on the surface.			9	0			116	4
22			Upper Mahoning	Sandstone, light gray with considerable limonite stain, coarse, friable, micaceous.			2	6			107	4
21				Shale, gray to light gray, micaceous and very sandy, somewhat argillaceous, poorly exposed.			9	3			104	10
20				Sandstone, light gray, with fine dark specks, medium to coarse, micaceous, somewhat friable, massive.			1	4			95	7

LOCATION: Ad 12 FILE NUMBER 11594 - continued

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
19	Conemaugh - continued	Mahoning	Thornton	Underclay, light gray with some limonite stain, sandy, grading upward into sandstone, micaceous, somewhat plastic, base poorly exposed, coal slumped on side of road but apparently not in place; in strip mine high wall there is exposed light gray mottled with purple tough, plastic, with scattered small limonite concretions, weathered and slumped, poorly exposed.			7	5	31	2	94	3
18			Lower Mahoning	Sandstone, and shale, light gray, with some limonite stain, reddish at top, medium to fine, micaceous massive above, interbedded with light gray to olive drab, sandy, micaceous shale.			21	9			86	10
17				Shale, light gray with some limonite stain, arenaceous, micaceous, with scattered, siderite-limonite concretions up to 4 inches in size.			2	0			65	1
16	Allegheny	Upper Freeport	Upper Freeport	Clay shale, light to dark gray with considerable limonite stain, dark gray 3-inch, carbonaceous layer near base.			1	3	25	7	63	1
15				Coal, bright, blocky, with some limonite stain and free sulphur on weathered surfaces, fusain, pyrite, and dull coal present, shaly upward.			1	10			61	10
14				Shale, gray, argillaceous, with fossil plants and with melanterite on weathered surfaces, thickness variable.			0	3			60	0
13				Coal, bright with thin dull streaks and streaks of pyrite, some fusain, shows sulphur and limonite on weathered surfaces.			2	0			59	9
12				Underclay, gray, somewhat sandy, micaceous, with fossil plants and thin streaks of coal, exposed.			0	6			57	9
11				Covered interval.			19	9			57	3
10		Bolivar	Shawnee	Limestone, light gray with limonite stain on surfaces, dense, nodular appearing fresh-water.			0	8	10	4	36	10
9			Bolivar	Shale, light gray to olive drab, with considerable limonite zones, with zones of clay shale and light gray, fine to medium, micaceous sandstone.			9	8			36	10
8		Lower Freeport	Lower Freeport	Underclay, light gray with some limonite stain, carbonaceous fragments in basal part.	0	10	4	2	27	2	27	2
7				Coal, some bright, considerable fusain and limonite stain, shaly, weathered.	1	1					26	4
6				Shale, gray to dark gray with limonite stain, argillaceous.	0	2					25	3
5				Coal, bright with dull streaks and some fusain and pyrite.	1	1					25	1
4				Underclay, light gray, silty, with traces of fossil plants, plastic exposed.	1	0					24	0
3				Covered interval.			15	6			23	0

LOCATION: Ad 12 FILE NUMBER 11594 - continued

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
2	Allegheny - continued	Lower Freeport - continued	Lower Freeport - continued	Sandstone, light gray with much limonite stain and ferruginous streaks, medium, micaceous, exposed.			2	0			7	6
1				Shale, light gray to olive drab with limonite stain, sandy, especially upward, thin argillaceous layer at bottom.			5	6			5	6
				Top of Middle Kittanning Coal (No. 6)								

LOCATION KEY: Ad 18 FILE NUMBER: 11643 ELEVATION: TOPO MAP: Athens

STATE: Ohio COUNTY: Athens TOWNSHIP: Dover SECTION: S-1/2, NE-1/4, 36

LOCATION: Exposure along roads.

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
20	Conemaugh	Elk Lick	Upper Grafton	Sandstone, yellowish to brownish, very coarse, friable, massive, exposed.			1	0	7	6	192	0
19			Birmingham	Clay shale?, mottled yellow and maroon, weathered and slumped.			6	6			191	0
18		Duquesne	Skelley	Shale, olive drab, some limonite stain, sand, micaceous, grading upward into fine, shaly sandstone.			19	6	26	6	184	6
17			Duquesne	Clay shale, mottled olive drab, yellow, brown, and maroon, calcareous, with numerous small limestone nodules, poorly exposed above.			5	0			165	0
16			Lower Grafton	Sandstone, olive drab to pale greenish with limonite stain, with many dendrites, calcareous, especially in lower part, thin irregular bedding.			2	0			160	0
15		Gaysport	Gaysport	Shale, olive drab with some limonite stain, argillaceous, finely micaceous, few scattered limestone nodules near top.			21	6	21	6	158	0
14		Ames	Ames	Limestone, gray with limonite streaks and stain near top, partly crystalline, fossiliferous, marine.			1	0	6	6	136	6
13				Underclay, light gray with limonite stain and dark streaks, semi-plastic.			0	6			135	6
12				Sandstone and shale, light gray to olive drab with some limonite stain, sandy, micaceous, fine sandstone grading upward into shale.			5	0			135	0
11		Harlem	?	Shale, olive drab to dark gray, mostly covered.			23	S	23	5	130	0
10		Upper Bakerstown	Cow Run	Sandstone, light gray with some limonite stain, fine, micaceous, bedded in layers 1 to 6 inches thick.			6	0	52	10	106	7
9		?	?	Covered interval.			39	2			100	7
8		Anderson	?	Shale, olive drab, argillaceous, silty, finely micaceous.			7	8			61	5
7		Wilgus	Cambridge	Limestone, light bluish gray, micaceous, ferruginous, very sandy, no apparent fossils.			0	8	35	2	53	9

LOCATION: Ad 18 FILE NUMBER 11643 - continued

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
6	Conemaugh - continued	Wilgus - continued	Buffalo	Sandstone, light gray with much limonite stain, fine, finely micaceous, friable, heavy-bedded to massive, calcareous near top.			5	9			53	1
5				Shale, mostly covered.			28	9			47	4
4		Upper Brush Creek	Upper Brush Creek	Limestone, dark bluish gray with much dull reddish-brown stain, especially on surfaces, dense, fossiliferous, marine.			0	4	8	10	18	7
3				Shale, olive drab with limonite stain, argillaceous, silty, finely micaceous, partly covered.			8	6			18	3
2		Lower Brush Creek	Lower Brush Creek	Limestone, light gray to gray, largely crystalline, fossiliferous with crinoid stems, marine.			1	0	9	9	9	9
1				Sandstone and shale, light gray to brown, fine, micaceous, thin-bedded sandstone and light gray, limonite-stained, sandy, micaceous shale with numerous, large, flattened siderite concretions up to 2 feet across, exposed.			8	9			8	9
				Base of exposure.								

LEE TOWNSHIP

LOCATION KEY: Ale 1 FILE NUMBER: 11542 ELEVATION: 702 ± base TOPO MAP: Athens

STATE: Ohio COUNTY: Athens TOWNSHIP: Lee SECTION: NE¼, 6

LOCATION: Exposure along ravine.

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
26	Conemaugh			Shale, sandstone and covered interval.			18	11	18	11	143	10
25		Ames	Ames	Limestone, light gray, dense to partially crystalline, fossiliferous, marine, especially crinoid fragments, a single layer.			0	8	31	7	124	11
24				Covered interval.			1	8			124	3
23				Sandstone, light gray to faintly yellowish, fine, micaceous, a single ledge showing layers on weathered surface.			0	8			122	7
22				Covered interval.			28	7			121	7
21		Harlem ?	Harlem ?	Coal, smut streak, weathered, possibly slumped.			0	1	8	8	93	4
20				Clay, light gray to brick or cherry red in basal part, plastic.			2	9			93	3
19			Saltsburg	Shale, gray-drab with limonite stain, silty, sandy, micaceous.			1	6			90	6
18				Sandstone, light gray-drab with some limonite stain, fine, silty, micaceous, layers 6-8 inches thick.			4	4			89	0
17		Upper Bakerstown	Cow Run	Sandstone and shale, light gray-drab with some limonite stain, fine, silty, thin-bedded, shaly appearing sandstone with partings of silty and sandy shale, exposed.			13	10	35	0	84	8
16				Covered interval.			17	4			70	10
15				Shale, silty, ferruginous, micaceous with limonite concretions, exposed.			3	10			53	6
14		Anderson	Portersville	Shale, light bluish to greenish gray with slight limonite stain, argillaceous, fossiliferous.			0	4	20	7	49	8
13				Limestone, gray to light gray, dense, fossiliferous, single layer with a nodular top surface.			0	4			49	4
12				Shale, dark gray below to full and light gray above, argillaceous, fossiliferous.			3	1			49	0
11			Anderson.	Coal, shaly, weathered.			0	5			45	11
10				Clay, light gray mottled with yellow and brown, plastic.			3	4			45	6
9			Bloomfield	Clay shale, light gray weathering yellowish to brownish, numerous scattered ferruginous and calcareous nodules.			5	5			42	2
8			Bakerstown	Shale, light bluish gray, silty and clayey, scattered nodules of light bluish to greenish gray limestone in upper part.			7	8			36	9
7		Wilgus	Cambridge	Sandstone, heavily limonite stained, fine, micaceous, sparingly fossiliferous, single ledge at junction of two tributaries, grades laterally into light greenish gray, sandy, fossiliferous, marine limestone containing large clams.			0	6	15	3	29	1
6			Buffalo	Shale and sandstone, light gray, silty, sandy and micaceous shale, interbedded with thinner layers of fine micaceous sandstone, covered in part.			3	10			28	7
5				Shale, light gray with limonite stain, clayey, silty and micaceous.			10	11			24	9
4		Upper Brush Creek	Upper Brush Creek	Limestone, light gray to gray, dense, compact, in layers 8-10 inches thick, cherty nodular masses, fossiliferous, marine, weathers to rough pitted or nodular surfaces.			1	10	13	10	13	10
3				Shale, light bluish gray with some limonite stain, sandy, fossiliferous, scattered limestone nodules, exposed.			1	0			12	0
2				Covered interval.			5	0			11	0
1				Shale and sandstone, light gray, limonite stain, sandy, micaceous shale and shaly fine, micaceous sandstone, few limonite concretions, partly covered.			6	0			6	0
				Base of exposure in channel at fence and pipeline.								

LOCATION KEY: Ale 2 FILE NUMBER: 11543 ELEVATION: 728 ± base TOPO MAP: Athens

STATE: Ohio COUNTY: Athens TOWNSHIP: Lee SECTION: SE¼ and NW¼, 4

LOCATION: Exposures along creek and tributary.

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
11	Conemaugh	Ames	Ames	Limestone, light gray, dense to partly crystalline, quite fossiliferous, loose blocks.			0	6	0	6	116	9
10		?	?	Covered interval.			49	3	49	3	116	3
9		?	Anderson ?	Spring, perhaps horizon of Anderson coal and underclay, covered and shale in part, mostly covered.			37	11	37	11	67	0
8		Upper Brush Creek ?	Upper Brush Creek ?	Limestone, light gray to olive drab, dense, flinty, fossiliferous in layers up to 5" thick.			5	0	27	2	29	1
7				Clay and clay shale, light gray with limonite stain, silty, micaceous, scattered layers of small ferruginous limestone concretions, poorly exposed in top part.			6	0			24	1
6				Covered interval, nearby exposures indicate this interval is bluish gray, sandy, micaceous shale which apparently replaces the underlying sandstone.			0	11			18	1
5				Sandstone, weathered brown to buff, micaceous, bedded to heavy bedded or massive, exposed.			9	0			17	2
4		Lower Brush Creek	Lower Brush Creek	Clay shale, light gray with limonite stain, finely micaceous, weathers soft and somewhat plastic (laterally replaced by sandstone and sandy shale).			6	3	6	3	8	2
3		Mason	Mason	Coal, dull with thin bright streaks, shaly, brown plant material.			0	7	1	11	1	11
2				Clay, medium gray with black masses and some limonite stain, sandy, micaceous, somewhat plastic, thin coal streaks in top part.			0	10			1	4
1				Shale, gray to black, sandy, micaceous, carbonaceous with fragmental fossil plants, exposed.			0	6			0	6
				Level of creek.								

LOCATION KEY: Ale 3 FILE NUMBER: 11544 ELEVATION: 698 ± base TOPO MAP: Athens

STATE: Ohio COUNTY: Athens TOWNSHIP: Lee SECTION: NW¼ SE¼, 4

LOCATION: Details of Brush Creek limestone(s) along creek.

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
10	Conemaugh	Upper and/or Lower Brush Creek	Upper and/or Lower Brush Creek	Limestone, olive drab to gray, dense, hard, flinty in top part, in two layers which, upon weathering, show thin, irregular layers, fossiliferous, marine.			0	10	13	8	13	8
9				Limestone, olive drab to dark gray, nodular to irregular bedded, dense, hard, fossiliferous.			1	7			12	10
8				Shale, light greenish gray, some reddish to brownish stain, calcareous, fossiliferous, with scattered limestone nodules, marine.			2	0			11	3
7				Limestone, gray to dark gray, dense, fossiliferous, marine.			0	8			9	3
6				Shale, gray to light gray, slightly limonite stained, sandy, micaceous, calcareous, fossiliferous with numerous chonetid brachiopods, marine.			0	3			8	7
5				Limestone, light gray with slight limonite stained surfaces, sandy, fossiliferous, marine, weathers into hourglass shapes.			0	11			8	4
4				Shale, light gray with some limonite stain, sandy, micaceous, clayey and calcareous with nodular layers of calcareous sandstone, fossiliferous, marine.			1	6			7	5

LOCATION: Ale 3 FILE NUMBER: 11544 - continued

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
3	Conemaugh - continued	Upper? and Lower? Brush Creek - continued	Upper? and Lower? Brush Creek - continued	Sandstone, light gray, calcareous, micaceous with thin shaly partings, thickens laterally and dips rather strongly.			1	0			5	11
2				Sandstone and shale, light gray with much limonite stain, interbedded dense calcareous and ferruginous micaceous sandstone and shale similar to shale below.			1	5			4	11
1				Shale, light gray with considerable limonite stain, sandy, argillaceous and micaceous, rather soft and friable, exposed.			3	6			3	6

LOCATION KEY: Ale 4 FILE NUMBER: 11545 ELEVATION: 716 ± base TOPO MAP: Athens

STATE: Ohio COUNTY: Athens TOWNSHIP: Lee SECTION: NW¼ NE¼, 5

LOCATION: Exposure along creek and road in NW¼ NE¼, section 5.

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
9	Conemaugh	Ames	Ames	Limestone, light gray with pink mottling, partly crystalline, fossiliferous, marine, weathers with dark gray blotches on surface.			0	8	39	9	108	6
8		?	?	Covered interval and shale.			39	1			107	10
7		Anderson	Portersville	Shale, gray to dark gray, clayey, micaceous, fossiliferous, marine, weathered and slumped.			0	4	26	7	68	9
6			Anderson	Coal, badly weathered, probably slumped.			0	7			68	5
5			?	Covered interval			13	8			67	10
4			Bakerstown ?	Shale, light gray to olive drab, silty, sandy, micaceous, with scattered limonite concretions, covered in part.			12	0			54	2
3		Wilgus	Cambridge	Limestone, light gray to drab, shaly, bedded in layers up to 8 inches thick, flinty near top, fossiliferous, marine.			5	8	35	2	35	2
2			Wilgus	Clay, light gray with limonite stain, finely sandy and micaceous, silty, quite plastic, starch-like fracture, coaly streak near base, grades downward into sandstone with small nodules on uneven surface.			2	6			29	6
1			Buffalo	Sandstone, light gray with some limonite stain and surfaces weathering dark gray, fine to medium, calcareous in part, micaceous throughout, massive grading upstream into thin-bedded shaly appearing sandstone, thickness variable, exposed.			27	0			27	0

LOCATION KEY: Ale 6 FILE NUMBER: 11547 ELEVATION: 837 ± base TOPO MAP: Athens

STATE: Ohio COUNTY: Athens TOWNSHIP: Lee SECTION: NW¼ NE¼, 11

LOCATION: Exposure in ravine southwest of 777 road intersection.

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
10	Conemaugh	Ames	Ames	Limestone, light gray, dense to partly crystalline, marine, fossiliferous, especially crinoids.			0	8	18	1	37	11
9				Shale, light gray to drab or yellow-brown, silty to sandy, micaceous with thin layers of sandstone.			8	9			37	3
8				Sandstone, light gray, weathers yellow-brown to dark gray, fine-grained, micaceous, bedded in layers 2-6 inches thick.			3	6			28	6
7				Covered interval			5	2			25	0

LOCATION: Ale 6 FILE NUMBER: 11547 - continued

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
6	Conemaugh - continued	Harlem	Harlem	Shale, gray, slightly carbonaceous, argillaceous.			2	8	19	10	19	10
5				Shale, dark gray, carbonaceous, finely micaceous, argillaceous.			0	3			17	2
4				Coal, dull, shaly with bright streaks.			0	3			16	11
3				Clay, light gray, limonite stained, plastic.			2	3			16	8
2			Rock Riffle	Clay shale, light gray with some limonite stain, numerous small dense limestone nodules 5 inches long.			1	6			14	5
1			Saltsburg	Shale and sandstone, light gray to olive drab, silty, sandy, and micaceous sandstone, zones 2 feet in thickness.			12	11			12	11

LOCATION KEY: Ale 7 FILE NUMBER: 11548 ELEVATION: 708 ± base TOPO MAP: Athens

STATE: Ohio COUNTY: Athens TOWNSHIP: Lee SECTION: SE¼ NE¼, 16

LOCATION: Exposure from five points road intersection in SE¼ NE¼, section 16 and along ravine on south side of Onion Creek in N½ SE¼, section 16.

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
17	Conemaugh	Anderson	Portersville	Shale, dark gray, carbonaceous and argillaceous, fossiliferous, marine, exposed.			1	0	22	1	128	9
16			Anderson	Coal, mostly dull, some bright and shaly, weathered.			1	0			127	9
15				Clay, shale, and covered interval.			5	7			126	9
14			Bakerstown	Sandstone, light gray with much limonite stain, silty, micaceous, massive, fine to medium.			14	6			121	2
13		Wilgus	Buffalo	Shale, light gray with much limonite stain, fine to medium, micaceous, massive, sandy upwards.			11	2	16	7	106	8
12				Sandstone, light gray with much limonite stain, fine to medium, micaceous, massive, covered in part.			5	5			95	6
11		Upper Brush Creek	Upper Brush Creek	Shale and limestone, gray to dark gray, calcareous shale interbedded with nodular and bedded limestone, marine, fossiliferous.			5	1	15	8	90	1
10				Limestone, dark gray, hard, dense, massive, cherty, fossiliferous, marine.			3	0			85	0
9				Limestone, dark gray, nodular layers up to 4 inches thick interbedded with thinner layers of calcareous shale, marine, fossiliferous.			2	10			82	0
8				Shale, light gray, sandy, micaceous, calcareous with scattered small nodules of limestone.			1	6			79	2
7				Shale, dark gray with slight limonite stain, argillaceous, sandy, and micaceous, exposed.			3	4			77	8
6		?	?	Covered interval.			20	4	20	4	74	4
5		Lower Brush Creek	Lower Brush Creek	Sandstone, light gray with limonite stain and gray weathered surfaces, medium to coarse, micaceous, friable, with shaly partings.			10	5	10	5	54	0
4		Mason	Mason	Shale, gray to black, carbonaceous with thin streaks of coal, soft, argillaceous, weathered			1	2	43	7	43	7
3				Clay, light gray, mottled, pink to red, plastic, exposed.			0	6			42	5
2			Upper Mahoning ?	Covered interval (in ravine south of Onion Creek conglomerate and 2 inches coal in sandstone at 33 feet above base).			19	9			41	11
1			Upper ? Mahoning	Sandstone, light gray with a slight limonite stain, weathers dark gray on surfaces, medium to coarse, micaceous, friable, massive, showing some bedding and cross-bedding on weathered surfaces, exposed.			22	2			22	2

LOCATION KEY: Ale 9 FILE NUMBER: 11550 ELEVATION: 726± base TOPO MAP: Pomeroy

STATE: Ohio COUNTY: Athens TOWNSHIP: Lee SECTION: NE¼ SE¼, 22

LOCATION: Exposure in ravine.

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
22	Conemaugh	?	?	Shale to top of section (unmeasured).			-	-			-	-
21		Anderson	Portersville ?	Shale, chocolate brown, weathers to dark red, argillaceous.			2	0	11	6	135	6
20			Anderson	Coal, black, mostly dull, weathered, thickens and thins laterally.			0	5			133	6
19				Clay, medium to dark gray, plastic.			0	6			133	1
18			?	Shale, light gray, micaceous, arenaceous.			6	7			132	7
17			Bloomfield	Limestone, nodular, fossiliferous (ostracods)			2	0			126	0
16		Wilgus	Wilgus	Shale, light gray, micaceous, arenaceous, covered in part.			9	6	23	6	124	0
15				Sandstone, fine, micaceous.			14	0			114	6
14		Upper Brush Creek	Upper Brush Creek	Shale and limestone, light gray to olive drab, dense, calcareous, fossiliferous, marine, shale with thin layers of shaly, siliceous limestone.			4	1	32	7	100	6
13				Limestone, light gray, dense, siliceous, flinty, heavy-bedded, fossiliferous, marine, surfaces show differential weathering.			2	4			96	5
12				Covered interval			6	5			94	1
11				Shale, dark gray at base to full gray above, argillaceous, finely micaceous, grading upward into gray, calcareous, fine micaceous sandstone.			19	9			87	8
10		Lower Brush Creek	Lower Brush Creek	Limestone, dark gray, dense to shaly, fossiliferous, marine.			0	11	16	7	67	11
9				Clay shale, medium gray, carbonaceous streaks, becoming carbonaceous upward, covered in part.			15	8			67	0
8		Mason	Mason	Coal, bright and dull, hard, some fusain, lenticular, thickens and thins laterally, pinches out in short distances.			0	5	41	11	51	4
7				Clay, light gray with yellowish stain, plastic to very plastic at top.			1	10			50	11
6			Upper Mahoning	Shale, light gray with limonite stain, sandy, micaceous or argillaceous, micaceous, weathers somewhat plastic, lensing partings of fine sandstone.			10	7			49	1
5				Sandstone and shale, light gray with limonite stain, fine, micaceous, thin-bedded shaly sandstone with layers of shale up to 4 inches thick and grading upward into sandy, micaceous shale.			13	0			38	6
4				Sandstone, light gray with yellowish and brownish stain, fine to medium, micaceous, friable, massive.			16	1			25	6
3		Mahoning	Thornton	Clay, dark gray, carbonaceous with coaly streaks, may represent the Mahoning coal.			1	0	9	5	9	5
2				Clay, light gray with limonite stain, sandy, micaceous, somewhat plastic.			2	8			8	5
1			Lower Mahoning	Shale, light gray to light bluish gray with considerable limonite stain, silty, sandy, and micaceous, scattered siderite-limonite concretions at top and bottom, exposed.			5	9			5	9

LOCATION KEY: Ale 12 FILE NUMBER: 11552 ELEVATION: 731±base TOPO MAP: Zaleski

STATE: Ohio COUNTY: Athens TOWNSHIP: Lee SECTION: SW¼, 23

LOCATION: Composite exposure in two ravines on north side of tributary to Onion Creek.

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
12	Conemaugh	Upper Brush Creek ?	Upper Brush Creek ?	Limestone, light gray to drab with some dark gray and limonite stain, flinty, weathers irregularly, fossiliferous, massive, poorly exposed.			5	10	30	10	141	10
11				Shale and sandstone, light gray to drab, somewhat limonite stained, sandy, micaceous shale interbedded with silty, micaceous, fine sandstone, poorly exposed.			25	0			136	0
10		Lower Brush Creek ?	Lower Brush Creek ?	Covered interval.			30	5	35	7	111	0
9				Shale, light gray or dull maroon, much limonite stain, silty, argillaceous, micaceous, with zones of fine shaly sandstone, exposed.			5	2			80	7
8		Mason and Mahoning	Mason ?	Limestone, yellowish to brownish, impure, embedded in clay shale.			0	8	69	6	75	5
7				Shale, light gray, much limonite stained, sandy, micaceous.			2	9			74	9
6				Clay shale, dark gray, slightly carbonaceous, may represent a coal horizon, thickness variable.			0	3			72	0
5			Upper and/or Lower Mahoning	Clay, light gray, much mottled by purple, maroon and yellow, silty, micaceous, calcareous with small particles of limestone especially in lower part.			4	9			71	9
4				Clay shale, light gray, weathers tan, silty, sandy, micaceous, slightly plastic.			4	9			67	0
3				Sandstone, light gray with some limonite stain, fine to medium, friable, massive, becoming thin-bedded and shaly toward top.			58	4			62	3
2	Allegheny	Upper Freeport ?	Upper Freeport ?	Shale, light gray to gray, argillaceous, micaceous, scattered siderite concretions, upper 2/3 weathers more readily.			2	11	3	11	3	11
1				Clay shale, gray to light gray, some limonite stain, sandy, micaceous, some slickensides, exposed.			1	0			1	0

LOCATION KEY: Ale 11 FILE NUMBER: 11554 ELEVATION: 693± base TOPO MAP: Zaleski

STATE: Ohio COUNTY: Athens TOWNSHIP: Lee SECTION: NW¼, 29

LOCATION: Exposure along road northeast from 694 road intersection in NW¼, section 29 and extending through NW¼ NE¼, section 29 into southern half of SE¼, section 30, Knox Township, Vinton County, Ohio, and into SW¼ SW¼ section 24, Lee Township, Athens County.

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
15	Conemaugh	Wilgus ?	Buffalo ?	Sandstone, yellowish to brown, fine to medium, thin to heavy-bedded, shaly layers.			17	0	17	0	211	0
14		Upper Brush Creek	Upper Brush Creek	Shale and sandstone, light gray to tan or olive drab with limonite stain, silty, sandy, micaceous shale interbedded with similar colored fine, silty, micaceous sandstone.			21	2	21	2	194	0
13		Lower Brush Creek	Lower Brush Creek	Limestone, light gray to tan, dense, flinty, much weathered, fossiliferous, marine.			0	7	26	7	172	10
12				Shale, tan to olive drab with some limonite stain, silty, sandy, micaceous, some layers more sandy than others, scattered small limonite concretions.			26	0			172	3
11		?	?	Covered interval			16	3	16	3	146	3
10		Mason	Upper Mahoning	Shale and clay shale, tan to olive drab, silty, finely micaceous shale and silty, sandy, micaceous clay shale, poorly exposed in parts.			15	3	15	3	130	0
9		Mason and/or Mahoning	Upper and/or Lower Mahoning	Sandstone, light gray with some limonite stain, medium to coarse, micaceous, friable, massive below to bedded and cross-bedded above, grading into shale at top, base uneven, locally cutting out Upper Freeport coal.			50	5	50	5	114	9

LOCATION: Ale 11 FILE NUMBER: 11554 - continued

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
8	Allegheny	Upper Freeport	Upper Freeport	Underclay, light gray to gray with some yellowish stain, finely micaceous, sandy toward base grading downward into sandstone.			2	1	19	1	64	4
7				Shale and sandstone, light gray with some limonite stain, silty, sandy, micaceous shale and silty, micaceous, fine sandstone interbedded, few scattered siderite-limonite concretions.			17	0			62	3
6		Bolivar and/or Lower Freeport	Bolivar and/or Lower Freeport	Sandstone, light gray with limonite stain, coarse to medium, micaceous, fine-bedded to layers less than 1 inch to several inches thick to massive layers, cross-bedded in certain layers, especially near top.			42	2	42	2	45	3
5		Upper Kittanning?	Upper Kittanning?	Coal, very badly weathered.			0	5	3	1	3	1
4				Clay shale, gray, limonite stained, with fossil plant fragments.			0	1			2	8
3				Coal, shaly, very badly weathered.			0	4			2	7
2				Underclay, light gray with some limonite stain, finely micaceous, plastic.			1	1			2	3
1				Sandstone, tan to drab, fine, much fine mica and clay with fragments of fossil plants, exposed.			1	2			1	2

LOCATION KEY: Ale 14 FILE NUMBER: 11555 ELEVATION: 744± base TOPO MAP: Zaleski

STATE: Ohio COUNTY: Athens TOWNSHIP: Lee SECTION: W½ SW¼, 22

LOCATION: Exposure along stream, along road, and across field to crest of hill on north side of hill in W½ SW¼, section 22, Lee Township, Athens County, and extending across the line into section 28, Knox Township, Vinton County.

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
18	Conemaugh	Upper Brush Creek	Upper Brush Creek	Limestone, loose blocks of flinty, fossiliferous, marine limestone.			0	6	0	6	92	7
17		Upper and Lower Brush Creek	Upper and Lower Brush Creek	Shale and covered interval, mostly covered.			40	2	40	2	92	1
16		Mason	Mason	Clay and coal, light gray to gray with limonite stains, shaly and darker below, fairly plastic at top, fine coaly partings 1/2 to 1 inch thick.			3	7	16	3	51	11
15			Upper Mahoning	Shale, light gray with slight limonite stain, silty with sandy layers, sparingly and finely micaceous, few fossil plants.			12	8			48	4
14		Mahoning	Mahoning	Clay, gray to dark gray with limonite stain, somewhat plastic.			0	3	35	8	35	8
13				Coal, dull, shaly, numerous shale partings, much weathered.			0	2			35	5
12				Clay, gray to dark gray, limonite stain, somewhat plastic.			0	4			35	3
11				Coal, dull, some bright, somewhat shaly, weathered.			0	3			34	11
10			Thornton	Clay, dark gray, silty, lean plasticity.			1	5			34	8
9				Clay, gray to dark gray, silty, finely micaceous, lean plasticity.			2	0			33	3
8			Lower Mahoning ?	Shale, light gray with limonite stain, sandy, micaceous, poorly exposed.			4	3			31	3
7				Sandstone, light gray with some limonite stain, fine, micaceous, calcareous, bedded in several thick layers, bottom of one near middle has numerous fucoid structures, thickness variable.			5	0			27	0
6				Shale, light gray to gray with some limonite stain, silty, slightly argillaceous, finely micaceous, thickness variable.			4	6			22	0
5			Piedmont ?	Shale, dark gray to black, slightly carbonaceous, massive below and bedded, fissile above, thickness apparently variable, coal horizon.			1	11			17	6

LOCATION: Ale 14 FILE NUMBER: 11555 - continued

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
4	Conemaugh - continued	Mahoning - continued	Lower Mahoning	Shale, gray with some limonite stain, argillaceous to silty, finely micaceous, massive to irregular bedding, exposed.			1	0			15	7
3				Covered interval, probably shale.			9	1			14	7
2				Shale, light bluish gray with some limonite stain, variable clayey to sandy, micaceous, many scattered siderite concretions up to 1 foot in maximum dimension, exposed.			5	6			5	6
1				Sandstone, and shale, light gray with considerable limonite stain, fine to medium, silty, micaceous, friable, bedded or cross-bedded, sandstone and clayey silty, or sandy micaceous shale, few scattered siderite-limonite concretions, unmeasured.			-	-			-	-

LOCATION KEY: Ale 16 FILE NUMBER: 11557 ELEVATION: 688 ± base TOPO MAP: Wilkesville

STATE: Ohio COUNTY: Athens TOWNSHIP: Lee SECTION: $SE\frac{1}{4}$ $NE\frac{1}{4}$, 20, and $NE\frac{1}{4}$ $SE\frac{1}{4}$, 26, Knox Twp., Vinton County and section 20, Lee Township, Athens County.

LOCATION: Exposure in ravine in $SE\frac{1}{4}$ $NE\frac{1}{4}$, 20, and $NE\frac{1}{4}$ $SE\frac{1}{4}$, section 26, Knox Township, Vinton County, and extending in section 20 Lee Township, Athens County.

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
3	Conemaugh	Mason and Mahoning	Upper and Lower Mahoning	Sandstone, light gray with limonite stain, medium to coarse, friable, massive, showing irregular and some cross-bedding, less micaceous than usual sandstone, numerous fossil plants in basal part, calcareous zones, covered in part, exposed.			80	11	80	11	136	8
2	Allegheny	Upper Freeport	Upper Freeport	Sandstone and shale, light gray with some limonite stain, medium to fine, micaceous, thin-bedded sandstone with sandy, micaceous shale zones, a few heavier bedded sandstone layers and lenses, becomes thin-bedded sandstone upward, clay shale lenses at top (probably the No. 7 coal horizon).			17	9	17	9	55	9
1		Lower Freeport	Lower Freeport	Sandstone, light gray with considerable limonite stain, micaceous, medium to coarse, massive with considerable cross-bedding and thin-bedded zones upward, a few fossil plant stems, shaly lenses and limey nodules toward top.			38	0	38	0	38	0

LOCATION KEY: Ale 18 FILE NUMBER: 11559 ELEVATION: 765 ± base TOPO MAP: Pomeroy

STATE: Ohio COUNTY: Athens TOWNSHIP: Lee SECTION: $E\frac{1}{2}$ $NW\frac{1}{4}$, 13

LOCATION: Dickson Brothers' Quarry. Located 0.15 mile north of Route 50, (now Shamrock quarry).

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
8	Conemaugh	Wilgus	Buffalo	Sandstone, light gray, mostly weathered yellowish to brownish, medium, micaceous, friable, disconformable base, thickness variable.			6	0	6	0	23	11
7		Upper and/or Lower Brush Creek	Upper and/or Lower Brush Creek	Clay, light gray, much limonite stain, finely micaceous, somewhat plastic.			0	2	17	11	17	11
6				Clay shale, gray to olive drab, much limonite stained, silty and micaceous, sparingly fossiliferous.			3	9			17	9
5				Shale and limestone, olive drab to gray, weathered, interbedded with flinty limestone similar to that below, fossiliferous, marine, locally massive, very fossiliferous limestone at top.			1	8			14	0

LOCATION: Ale 18 FILE NUMBER: 11559 - continued

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
4	Conemaugh - continued	Upper and/or Lower Brush Creek	Upper and/or Lower Brush Creek	Limestone, light gray to gray, dense, very flinty, locally pure flint, heavy-bedded, weathers irregularly with honeycomb appearance, fossiliferous, marine.			4	0			12	4
3				Limestone and shale, gray, dense to finely crystalline, flinty limestone in layers 2-6 inches thick, interbedded with gray, silty, micaceous shale, fossiliferous, marine.			4	6			8	4
2				Shale, gray, argillaceous, silty, finely micaceous, fossiliferous, limestone nodules.			3	2			3	10
1				Shale, dark gray, argillaceous, silty, micaceous, sparingly fossiliferous, exposed.			0	8			0	8

LOCATION KEY: Ale 19 FILE NUMBER: 11560 ELEVATION: 712±base TOPO MAP: Pomeroy

STATE: Ohio COUNTY: Athens TOWNSHIP: Lee SECTION: N½ NE¼, 7

LOCATION: Stinson quarry and exposures along driveway to crusher and tipple.

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
10	Conemaugh	Harlem	Round Knob	Clay shale, mottled gray, buff, maroon, with zones of interbedded nodular freshwater limestone.			15	0	15	0	105	0
9		?	?	Covered interval.			10	9	10	9	90	0
8		Upper Bakerstown?	Cow Run?	Shale and sandstone, olive drab, micaceous, shale with layers up to 2½ inches thick of drab, silty, micaceous, fine, friable sand stone, becomes almost entirely shale above base.			8	10	8	10	79	3
7		Anderson ?	Bakerstown ?	Shale, mottled light gray to yellowish brown or reddish clay and olive drab, poorly exposed and covered in part.			33	5	33	5	70	5
6		Wilgus	Buffalo	Sandstone, light gray, but mostly weathered yellow to buff, medium, micaceous, friable, massive.			22	6	30	0	37	0
5		?	?	Shale, light gray to olive drab, micaceous, fossiliferous in lower part.			7	6			14	6
4		Upper and/or Lower Brush Creek	Upper and/or Lower Brush Creek	Limestone, light gray with pale green specks, dense to partly crystalline, fossiliferous, marine.			0	10	7	0	7	0
3				Shale, light gray with much limonite stain, micaceous, with limestone nodules, fossiliferous, marine.			0	8			6	2
2				Limestone, gray with limonite stain, massive, flinty, fossiliferous, marine, bedded planes appear to show some effects of stylatic solution.			2	0			5	6
1				Limestone and shale, gray, medium, hard, dense, in layers up to 4 inches thick, interbedded with thin layers of light gray to gray, calcareous, silty shale, both fossiliferous, marine, some layers with abundant bryozoa.			3	6			3	6

LOCATION KEY: Ale 21 FILE NUMBER: 11562 ELEVATION: 692± base TOPO MAP: Pomeroy

STATE: Ohio COUNTY: Athens TOWNSHIP: Lee SECTION: E½ SE¼ SW¼, 1

LOCATION: Exposure in abandoned quarry. Details of Brush Creek limestone.

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
6	Conemaugh	Wilgus ?	Buffalo ?	Sandstone, light gray with some limonite stain, fine to medium, micaceous, friable, grades downward into shale below, thickness variable.			3	0	16	10	29	0
5				Shale, light bluish gray, weathers olive drab with much limonite stain, silty, argillaceous, very finely micaceous, 1 thin layer of fine sandstone, becomes sandy upward.			13	10			26	0

LOCATION: Ale 21 FILE NUMBER: 11562 - continued

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
4	Conemaugh - continued	Upper and/or Lower Brush Creek	Upper and/or Lower Brush Creek	Shale, light bluish gray, argillaceous, silty, finely micaceous, limestone nodules in base, fossiliferous, marine, thickness variable.			5	0	12	2	12	2
3				Limestone and shale, gray with limonite stain, flinty, limestones interbedded with light bluish gray shale, fossiliferous, marine, dendrites present.			1	8			7	2
2				Limestone, light gray drab, dense, flinty, massive limestone, fossiliferous, marine.			1	4			5	6
1				Limestone, gray with some limonite stain, dense, locally flinty, fossiliferous, marine, very thin, irregular shale partings.			4	2			4	2

LOCATION KEY: Ale 22 FILE NUMBER: 11563 ELEVATION: 661±base TOPO MAP: Pomeroy

STATE: Ohio COUNTY: Athens TOWNSHIP: Lee SECTION: 6 and 1

LOCATION: Exposure in ravine located in NW¼ NE¼, section 6, Columbia Township, Meigs County and SE¼ SE¼, section 1, Lee Township, Athens County.

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
15	Conemaugh	Duquesne	Lower Grafton	Sandstone, light gray to pale brown, fine to very coarse and pebbly, friable, micaceous, massive, showing bedding and cross-bedding on weathered surfaces, exposed.			24	6	24	6	164	6
14		?	?	Covered interval			17	4	17	4	140	0
13		Ames	Ames	Limestone, light gray, dense to partly crystalline, dendrites, fossiliferous, marine.			0	10	0	10	122	8
12		?	?	Covered interval.			25	5	25	5	121	10
11		Harlem	Round Knob	Clay shale and clay, light gray to olive drab, with limonite stain, silty, micaceous clay shale below and plastic, maroon-tinted clay with nodular fresh-water limestone above.			5	11	11	1	96	5
10			Saltsburg	Sandstone, light gray with some limonite stain, fine, micaceous, grades from shaly to slabby upward, calcareous in base, covered in upper part.			5	2			90	6
9		Upper Bakerstown	Ewing and Cow Run	Shale and clay shale, light gray, silty to sandy at top surface, stained, red, nodular, blue-gray limestone in upper part.			24	9	24	9	85	4
8		Anderson	Portersville	Clay shale, brown to chocolate brown, containing bluish-green nodules of septarian limestone.			2	0	11	4	60	7
7				Covered interval, probably clay shale.			4	10			58	7
6				Clay shale, weathered drab to brownish, finely micaceous, some slickensides, fossiliferous, marine.			1	0			53	9
5			Anderson	Coal, dull, some bright, much fusain, badly weathered and possibly slumped.			0	2			52	9
4				Clay, light gray, limonite stained, plastic.			0	10			52	7
3			Bloomfield	Clay shale, olive drab to yellow-brown with small nodules of fresh-water limestone in top half, weathers somewhat plastic.			2	6			51	9
2		Wilgus	Buffalo	Sandstone, light gray weathered by much limonite stain, especially brown, fine to medium, micaceous, massive, shows some bedding on weathered surfaces.			31	3	31	3	49	3
1		Upper and/or Lower Brush Creek	Upper and/or Lower Brush Creek	Limestone, light gray to gray, dense to finely crystalline, flinty in part, fossiliferous, marine, weathered surfaces, pitted, covered in part, exposed.			18	0	18	0	18	0

LOCATION KEY: Ale 25 FILE NUMBER: 11566 ELEVATION: 717± base TOPO MAP: Pomeroy

STATE: Ohio COUNTY: Athens TOWNSHIP: Lee SECTION: NE¼, 21

LOCATION: Exposure from stream bed along road on right side.

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
8	Conemaugh	Lower Brush Creek ?	Lower Brush Creek ?	Limestone, blue-gray, containing corals, grades upward to flinty material, slumped coal appears below the limestone, unmeasured.			-	-	20	0	-	-
7				Covered interval.			16	6			50	0
6				Shale and sandstone, light gray with limonite stain, sandy, silty, micaceous shale grading downward at base into fine sandstone, exposed.			3	6			33	6
5		Mason	Mason	Clay shale, gray with some limonite stain, soft, slick, weathers plastic, slickensided.			1	1	30	0	30	0
4				Coal, dull with bright streaks, shaly, weathered.			0	2			28	11
3				Clay, light gray above and gray below, slightly carbonaceous, plastic.			1	4			28	9
2			Upper Mahoning	Shale, light gray to olive drab with some limonite stain, silty, sandy, micaceous, breaks with a starch-like fracture.			5	9			27	5
1				Sandstone, light gray with considerable limonite stain, medium to coarse, micaceous, friable, massive, showing some bedding on weathering, siderite-limonite concretions in top few feet, shaly zones near top, exposed.			21	8			21	8

LOCATION KEY: Ale 26 FILE NUMBER: 11567 ELEVATION: 805± base TOPO MAP: Pomeroy

STATE: Ohio COUNTY: Athens TOWNSHIP: Lee SECTION: NE¼, 21 and NW¼, 15

LOCATION: Exposure up ravine.

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
16	Conemaugh	Upper Brush Creek ?	Upper Brush Creek?	Sandstone, light gray to pale brownish, fine to medium, massive, friable, exposed.			2	5	2	5	102	11
15		Lower Brush Creek	Lower Brush Creek	Covered interval showing numerous fragments, blocks, and nodules of gray, flinty, fossiliferous, marine limestone.			15	3	47	1	100	6
14				Shale, gray with considerable limonite stain, silty, sandy, micaceous, with thin layers of micaceous, fine sandstone.			20	3			85	3
13				Shale, dark gray to gray, considerable limonite stain, argillaceous, very finely micaceous, sparingly fossiliferous in lower few inches (Lingula) and becoming micaceous and silty toward top.			11	7			65	0
		Mason	Mason				0	6	39	11	53	5
12				Coal, shaly, some bright streaks, somewhat weathered.			0	2			52	11
11				Clay, light gray, considerable limonite stains, some fossil plants, fairly plastic.			0	8			52	9
10				Coal, shaly at top, some bright streaks, more bright in base.			0	9			52	1
9				Clay, light gray to gray, limonite stains, fossil plants, carbonaceous particles, somewhat plastic.			0	2			51	4
8				Coal, some bright, numerous, dull shaly zones.			0	5			51	2
7				Clay shale, gray to dark gray with some limonite stain, thin coaly streaks and some fossil plants.			0	5			50	9
6				Coal, bright with numerous thin dull streaks, some fusain, becomes shaly toward top.			0	7			50	4
5				Clay, light gray with some limonite stain, silty, plastic.			3	1			49	9

LOCATION: Ale 26 FILE NUMBER: 11567 - continued

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
4	Conemaugh - continued	Mason - continued	Upper Mahoning	Shale, light gray, weathering olive drab with some limonite stain, micaceous, silty, sandy below, becoming argillaceous upward			11	11			46	8
3				Sandstone, light gray with limonite stain, micaceous, firm, medium to coarse, massive, showing some bedding and cross-bedding on weathered surfaces, base disconformable.			21	3			34	9
2		Mahoning	Thornton	Clay, light gray below to dark gray above, with some limonite stain, finely micaceous, numerous slickensides, limonite concretions in basal part, two thin layers of coal in top, one foot and two inches layer of soft very plastic clay at top.			5	10	13	6	13	6
1			Lower Mahoning	Shale, light gray weathering olive drab with considerable limonite stain, clayey, silty, finely micaceous, sandy at top with scattered limonite concretions, especially in top part where they are arranged in irregular layers, exposed.			7	8			7	8

LODI TOWNSHIP

LOCATION KEY: Alo 9A FILE NUMBER: 3098 ELEVATION: 905 base TOPO MAP: Keno

STATE: Ohio COUNTY: Athens TOWNSHIP: Lodi SECTION: SW¼ SE¼, 9

LOCATION: The section begins near section line in SW¼ SE¼, section 9 and continues up road for about 0.2 mile in same area of Lodi Township.

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
8	Washington	Waynesburg "A"	Waynesburg	Sandstone, yellowish-brown to gray, massive except for highly cross-bedded areas which are thin-bedded, fine to coarse-grained, micaceous.			4	0	5	8½	30	6
7		Waynesburg	Cassville	Shale, light gray, laminated to poorly bedded, weathers semi-plastic in part, silty.			1	8½			26	6
6	Monongahela	Waynesburg	Waynesburg	Clay shale, carbonaceous, semi-plastic, weathered.	0	4½	0	10½	17	11	24	9½
				Clay, light to dark gray, weathers semi-plastic, carbonaceous.	0	3						
				Coal, dull, weathered.	0	2						
				Shale, dark gray, weathers semi-plastic, thinly laminated.	0	0½						
				Coal, dull, weathered.	0	0½						
5				Clay shale, light to dark gray, non-bedded semi-plastic, slightly silty.			1	4			23	11
4			Gilboy	Shale and sandstone; shale, light to dark olive green, laminated to poorly bedded, silty to sandy, micaceous; sandstone, olive green, occurs interbedded in the shale.			14	0			22	7
3		Little Waynesburg	Little Waynesburg	Shale, maroon, dark olive green, laminated to poorly bedded, silty, micaceous.			0	11	8	7	8	7
2				Clay, dark gray, weathers plastic, carbonaceous.			0	1			7	8
1				Clay shale, maroon, non-bedded, breaks irregularly, silty, micaceous, limestone nodules.			7	7			7	7

LOCATION KEY: Aal 33 FILE NUMBER: 11264 ELEVATION: 758 base TOPO MAP: Athens

STATE: Ohio COUNTY: Athens TOWNSHIP: Alexander & Lodi SECTION: SW¼ SW¼, 36

LOCATION: Exposure up dead-end road beginning at U. S. Route 33 about 100 yards northwest of road junction 758 in SW¼ SW¼, section 36, Lodi Township, and extending up hill east to hill top in Alexander Township.

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
23	Monongahela	Benwood	Sewickley	Sandstone, gray to buff with limonite stain, massive showing cross-bedding below, very micaceous, fine to medium, very friable, exposed.			31	4	39	3	192	0
22				Shale and sandstone, gray to tan mottled maroon, sandy shale below becoming more sandy, micaceous, and shaly bedded upwards			7	11			160	8
21		Sewickley	Sewickley	Underclay, light gray with limonite stain, plastic.			0	2	13	9	159	9
20				Clay shale, greenish gray with coaly flecks.			0	1			152	7
19				Clay shale, gray to dark gray, silty, micaceous.			0	6			152	6
18				Shale and clay shale, weathering gray to maroon, silty, sandy, micaceous, calcareous with small scattered limestone knots.			4	11			152	0
17			Lower Sewickley	Shale and sandstone, gray to tan, limonite stained, argillaceous to silty, laminated, sandy upward with sandstone ledges in top 2 feet.			8	1			147	1
16		Fishpot	Fishpot	Clay shale, gray to tan mottled maroon to greenish, silty to sandy upward, massive, with scattered limestone and hematite masses			5	8	29	5	139	0
15				Limestone, gray to light gray with limonite stain, impure, nodular, fresh-water.			1	0			133	4
14			Fishpot or Pomeroy	Siltstone, gray to olive drab with limonite stain, micaceous, irregularly bedded to massive.			4	7			132	4

LOCATION: Aal 33 FILE NUMBER: 11264

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
13	Monongahela - continued	Fishpot - continued	Fishpot or Pomeroy continued	Shale, gray to tan, limonite stained, silty to sandy upward, poorly exposed.			17	8			127	9
12		Redstone	Upper Pittsburgh	Sandstone, gray to tan with limonite stain, micaceous, fine to medium, shaly to massive bedded or cross-bedded.			36	8	36	8	110	1
11		Pittsburgh	Pittsburgh	Clay shale, gray with limonite stain "soapy" feel in lower 1 foot, with scattered carbonaceous fragments in top 1 foot, with some pyrite.			3	6	20	9	73	5
10				Coal, bright, blocky, somewhat bony near top.			0	11			69	11
9				Shale, dark?, carbonaceous, hard, with numerous small calcareous masses, brecciated in appearance.			0	10			69	0
8				Clay shale, gray with limonite stain, silty to sandy.			1	2			68	2
7			Upper Pittsburgh	Limestone, light gray to gray, limonite stained, nodular, fresh-water, embedded in clay shale similar to next below.			11	10			67	0
6			Lower Pittsburgh	Clay shale, maroon mottled gray to purple above, limonite stained, with starch-like fracture.			2	6			55	2
5	Conemaugh	Upper Little Pittsburgh ?	Upper Little Pittsburgh ?	Clay, light gray, plastic.			0	1	23	3	52	8
4				Clay shale, gray with limonite stain, massive, silty, with fossil plants and thin carbonaceous film at top.			1	10			52	7
3				Clay shale, deep purple with carbonaceous coaly streaks in top 1 inch.			0	4			50	9
2				Clay shale, gray to tan below with some scattered maroon to purple mottling olive drab with more mottling above, with scattered pellets and nodules of limestone in top 6 feet.			21	0			50	5
1		Lower Little Pittsburgh ?	Connellsville ?	Sandstone, gray to tan, limonite stained, micaceous, fine to medium or massive, cliff-former along Route 33, exposed.			29	5	29	5	29	5

LOCATION KEY: Alo 30 FILE NUMBER: 11496 ELEVATION: 745 base TOPO MAP: Athens

STATE: Ohio COUNTY: Athens TOWNSHIP: Lodi SECTION: $NW\frac{1}{4}$, 30

LOCATION: The section begins in the $NE\frac{1}{4}$ $NW\frac{1}{4}$, section 30, at creek bottom, and continues up road (road has been built since the topographic map was made) to the $NW\frac{1}{4}$ $NW\frac{1}{4}$, section 24, Lodi Township.

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
32	Monongahela	Uniontown ?	Arnoldsburg	Sandstone, tan, light olive-green, yellowish-tan, fine to medium-grained, thin-bedded to shaly at base, massive upward, friable.			14	4	19	1	217	8
31				Shale, dark gray, dark olive-green, maroon, silty, non-bedded to thinly laminated.			4	9			203	4
30		Arnoldsburg , Benwood, and Sewickley?	Arnoldsburg	Clay, light gray, plastic, some limonite stain.			0	2	90	9	198	7
29				Clay, light gray, weathers plastic, contains two carbonaceous streaks, one at the top and one at the bottom, coal horizon.			0	3			198	5
28			Ritchie ?	Clay shale, dark olive-green, silty to sandy, non-bedded, breaks with a starch-like fracture.			2	6			198	2
27				Clay shale and limestone; clay shale, gray, tan, silty, non-bedded, breaks irregularly, calcareous; limestone, gray to grayish-white, occurs as nodules in clay shale.			2	8			195	8
26				Covered interval.			14	3			193	0
25			Tyler Reds ?	Clay shale, gray, red, light olive-green, maroon, purple, silty, non-bedded, breaks irregularly, calcareous, with veinlets and nodules of limestone.			16	3			178	9
24			Sewickley - Lower Sewickley	Sandstone, brown, light olive-green, tan to yellow, fine to medium-grained, thin-bedded, becoming massive upward, friable.			54	6			162	6

LOCATION: Alo 30 FILE NUMBER: 11496 - continued

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
23	Monongahela - continued	Fishpot	Fishpot	Shale, maroon, thinly laminated, silty, chippy fracture, contains thin plastic clay, unit may be slumped.			0	4	26	0	108	0
22				Clay shale, maroon, tan, brown, non-bedded, silty, breaks irregularly.			9	2			107	8
21				Limestone, and clay shale; limestone, light gray to yellow, occurs as nodules and ledges; clay shale, tan, brown, gray, silty, non-bedded, calcareous.			6	5			98	6
20			Pomeroy	Sandstone, light olive-green, tan, fine to medium-grained, thin to massive-bedded, limonite stained.			10	1			92	1
19		Redstone	Redstone	Clay, light gray, weathers plastic, contains 1/8 inch streak of coal.			0	2	18	0	82	0
18				Clay shale, light to dark gray, silty, breaks irregularly, limonite stained.			0	4			81	10
17				Clay, light to dark gray, weathers plastic, limonite stained, contains 1/8 inch streak of coal.			0	1			81	6
16				Clay shale, medium to dark gray, silty, non-bedded, breaks irregularly, carbonaceous streaks at top.			0	5			81	5
15				Clay, gray, weathers plastic.			0	2			81	3
14			Upper Pittsburgh	Sandstone, gray to bluish-gray, fine to medium-grained, thin to massive-bedded.			13	10			80	10
13				Shale, dark gray to grayish-black, silty, laminated in part, contains limestone nodules, dark gray, 5 to 8 inches in diameter.			3	0			67	0
12		Pittsburgh	Pittsburgh	Shale, light gray, silty, laminated in part, contains small carbonaceous inclusions.			2	1	64	0	64	0
11				Clay, gray to dark gray, partly laminated, contains thin coaly streaks.			0	2			61	11
10				Coal, bony, irregular.			0	2			61	9
9				Coal, bright, blocky, thin irregular partings			2	4½			61	7
8				Carbonaceous shale.			0	0½			59	2½
7				Coal, bony.			0	11			59	2
6				Coal, bright, blocky.			0	4			58	3
5				Shale, light to dark gray, silty, breaks with irregular to flake-like fracture, thickness variable.			0	11			57	11
4				Coal, bright, blocky, poorly exposed.			2	7			57	0
3			Lower Pittsburgh	Clay shale, dark gray to grayish black, silty, non-bedded, breaks irregularly, carbonaceous.			2	3			54	5
2				Clay shale, light gray to grayish-white, non-bedded, breaks irregularly, limonite stained			2	5			52	2
1				Sandstone, brown to tan, fine to medium grained, massive to thin-bedded in upper 10 feet, exposed to creek bottom.			48	9			48	9

LOCATION KEY: Alo 19 FILE NUMBER: 11498 ELEVATION: 724 base TOPO MAP: Pomeroy

STATE: Ohio COUNTY: Athens TOWNSHIP: Lodi SECTION: $SE\frac{1}{4}$ $SW\frac{1}{4}$, 19

LOCATION: The section begins in the $SE\frac{1}{4}$ $SW\frac{1}{4}$, section 19, on the road near the Athens-Meigs County line and continues north to the crossroad, then west to the next crossroad, then north up the Pratts Run road to the $NW\frac{1}{4}$ $SW\frac{1}{4}$ of section 19, Lodi Township.

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
12	Monongahela	Fishpot	Pomeroy	Sandstone, brown to yellowish-tan, medium to coarse-grained, massive, micaceous, limonite stained, cross-bedded in part.			4	0	32	3	52	4
11				Clay shale, gray, brown, marron, limonite stained, limestone nodules 1 inch in diameter, poorly exposed.			6	3			48	4
10				Sandstone, tan to brown, medium to coarse-grained, massive, thin-bedded in part, cross-bedded, friable, base unconformable.			22	0			42	1

LOCATION: Alo 19 FILE NUMBER: 11498 - continued

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
9	Monongahela - continued	Redstone	Redstone	Carbonaceous shale, thinly laminated, zones of coal present.			0	2	16	10	20	1
8				Shale, bluish-gray to black, thinly laminated to non-bedded, contains zones of carbonaceous material.			0	11			19	11
7				Coal, dull.	0	1	0	4			19	0
				Clay, bluish gray, semi-plastic, carbonaceous.	0	0½						
				Coal, bright, thinly laminated, some fusain	0	1						
				Clay, bluish-gray, semi-plastic, carbonaceous.	0	0½						
				Coal, bright and dull.	0	1						
6			Upper Pittsburgh	Shale, bluish gray, thinly laminated, slightly silty, micaceous, plant fossils.			0	7			18	8
5				Shale, light gray to olive-green and brownish-tan, silty to sandy, thinly laminated to massive, micaceous, plant fossils.			14	10			18	1
4		Pittsburgh	Pittsburgh "Rider"	Coal, dull, some bright zones, poorly developed.			0	1	3	3	3	3
3			Pittsburgh	Shale, light gray to bluish gray, nonbedded to thinly laminated, semi-plastic, plant fossils, carbonaceous.			1	6			3	2
2				Coal, bright, blocky, irregular fusain partings.	0	11	1	2			1	8
				Clay, light gray, silty, semi-plastic, micaceous, limonite stained, carbonaceous.	0	2¾						
				Coaly material, lithology indefinite.	0	0¼						
1				Clay shale, dark gray to grayish black, nonbedded, breaks irregularly, carbonaceous.			0	6			0	6

LOCATION KEY: Alo 29 FILE NUMBER: 11499 ELEVATION: 725 base TOPO MAP: Athens

STATE: Ohio COUNTY: Athens TOWNSHIP: Lodi SECTION: NE¼ NE¼, 29

LOCATION: The section begins in the NE¼ NE¼, section 29, at the bridge north of the church and continues west to road junction 743, then south to farm lane and up farm lane to house in NE¼ SE¼, section 29.

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
20	Monongahela	Benwood	Sewickley	Sandstone, tan to brownish yellow, medium to coarse-grained, massive, calcareous upward, micaceous, friable.			26	6	26	6	185	0
19		Sewickley	Sewickley	Clay shale, dark gray, tan, silty, non-bedded, breaks irregularly, micaceous.			6	10	19	0	158	6
18				Clay shale, gray-green, brown to tan, nonbedded, breaks irregularly, micaceous, calcareous, limestone nodules.			3	7			151	8
17			Lower Sewickley	Siltstone, pale green to tan, thin bedded, micaceous, some sandy zones.			8	7			148	1
16		Fishpot	Fishpot	Shale, red, slightly silty, thinly laminated, chippy fracture, micaceous.			1	3	14	2	139	6
15				Clay shale, tan to brown, mottled maroon, silty, breaks irregularly, weathers semi-plastic.			4	3			138	3
14				Clay shale and limestone; clay shale, light olive-green, slightly silty, breaks irregularly, micaceous; limestone, grayish green, nodular and lenticular, massive, finely crystalline.			3	2			134	0
13			Pomeroy	Siltstone and sandstone, olive-green to light greenish-tan, medium-grained at base becoming silty upward, thin-bedded at base becoming massive upward.			5	6			130	10
12		Redstone	Redstone	Shale, red to maroon, thinly laminated, chippy fracture, some plant fossils.			1	6	43	6	125	4
11				Clay, gray to bluish gray, plastic, micaceous, carbonaceous material, coal horizon.			0	2			123	10

LOCATION: Alo 29 FILE NUMBER: 11499 - continued

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
10	Monongahela continued	Redstone - continued	Redstone - continued	Clay shale, light olive-tan, dark gray, slightly silty, non-bedded, breaks irregularly, micaceous.			0	8			123	8
9				Clay shale, maroon, silty, non-bedded, a starch-like fracture, micaceous.			1	2			123	0
8				Limestone and clay shale; limestone, light olive-green, massive, occurs as nodules and lenses; clay shale, tan, green, maroon, silty, non-bedded, breaks irregularly, calcareous.			11	6			121	10
7			Upper Pittsburgh	Sandstone, olive-green, weathers yellowish-brown, fine to medium-grained, massive at base becoming thin-bedded upward, limonite stained, micaceous, varying thickness, base unconformable.			28	$5\frac{3}{4}$			110	4
6		Pittsburgh	Pittsburgh	Carbonaceous shale, thinly laminated, some thin bright coal streaks.	0	$0\frac{1}{4}$	0	$10\frac{1}{4}$	13	2	81	$10\frac{1}{4}$
				Coal, bright, blocky, thin fusain partings.	0	10						
5			Upper Pittsburgh	Clay shale, bluish gray, silty, non to irregular bedding, breaks irregularly, carbonaceous in zones.			2	6			81	0
4				Limestone and clay shale; limestone, dark gray, weathers grayish-white, nodular to lenticular; clay shale, gray, purple, yellow, red, mottled, silty, non-bedded, breaks irregularly.			9	10			78	6
3	Conemaugh	Lower Little Pittsburgh	Lower Little Pittsburgh	Shale, carbonaceous, bluish-gray, black, thinly laminated, semi-plastic, coal horizon			0	3	68	8	68	8
2			Lower Pittsburgh	Clay shale, gray, tan, yellowish-brown, silty, non-bedded, breaks irregularly, micaceous.			4	5			68	5
1			Connellsville	Sandstone, light greenish-gray, weathers yellowish-tan to brown, coarse to medium-grained at base, massive at base becoming thin-bedded near top, limonite stained, micaceous, cross-bedded in part, cliff-forming at base.			64	0			64	0

LOCATION KEY: Alo 35 FILE NUMBER: 11501 ELEVATION: 736 base TOPO MAP: Athens

STATE: Ohio COUNTY: Athens TOWNSHIP: Lodi SECTION: $NE\frac{1}{4}$ $SE\frac{1}{4}$, 35

LOCATION: Section begins in the creek bottom in the $NW\frac{1}{4}$ $SE\frac{1}{4}$, section 35, and continues west up the stream to the top in the $SE\frac{1}{4}$ $SW\frac{1}{4}$, section 35, Lodi Township.

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
21	Monongahela	Fishpot	?	Covered interval, some outcropping of tan sandstone and shale.			38	0	48	0	157	5
20				Covered interval, evidence of limestone that weathers yellow.			10	0			119	5
19		Redstone	Redstone	Shale, red, thinly laminated, breaks with a chippy fracture.			0	6	35	9	109	5
18				Clay, light gray, semi-plastic, containing streaks of carbonaceous material.			0	1			108	11
17				Clay, gray to tan, plastic, some carbonaceous material, slightly micaceous, coal horizon.			0	2			108	10
16				Clay shale, olive-tan to green, thickly laminated, silty, slightly micaceous.			4	10			108	8
15			Upper Pittsburgh	Sandstone, tan, olive-green and brown, grayish-tan, fine to medium-grained, shaly to massive, micaceous, variable thickness, upstream the unit is a massive cliff-former.			30	2			103	10
14		Pittsburgh	Pittsburgh	Coal, bright, blocky, some small fusain partings.			0	9	22	0	73	8
13				Clay, dark gray, weathers semi-plastic, micaceous, containing carbonaceous material			0	3			72	11

LOCATION: Alo 35 FILE NUMBER: 11501 - continued

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
12	Monongahela -	Pittsburgh -	Pittsburgh -	Coal, dull, fusain, weathered.			0	1			72	8
11	continued	continued	continued	Clay shale, dark gray to grayish-black, non-bedded, breaks irregularly, highly carbonaceous.			0	6			72	7
10				Clay shale, tan, brown, gray to bluish-gray, non-bedded, breaks irregularly, containing zones of carbonaceous material.			2	6			72	1
9			Upper Pittsburgh	Limestone and clay shale; limestone, gray to bluish-gray, weathering grayish-white, occurring as lenses and nodules in lower part; clay shale, tan, brown, gray, non-bedded, breaks irregularly, silty, micaceous.			15	7			69	7
8			Lower Pittsburgh	Clay shale, dark gray, grayish-black, mottled maroon in part, non-bedded, breaks irregularly, silty, micaceous.			2	6			54	0
7		Lower Little Pittsburgh ?		Carbonaceous shale, black, thinly laminated, to fissile, containing zones of dull fusain			0	1	38	0	51	6
6				Clay shale, light, bluish-gray to dark gray, non-bedded, breaks irregularly, silty, micaceous.			1	11			51	5
5			Connellsville	Clay shale and limestone; clay shale olive-tan, purple, dark gray, bluish-gray upward, non-bedded, breaks irregularly, silty, calcareous, micaceous; containing limestone nodules and lenses, bluish-gray to green weathers yellow.			8	7			49	6
4				Sandstone, bluish gray to light olive-tan, fine to medium-grained, shaly bedded at base, fine-grained upward, zones of calcareous sandstone and shale with limestone nodules.			24	11			40	11
3		Little Clarksburg?	Little Clarksburg?	Clay shale, gray, silty, micaceous, non-bedded, breaks irregularly, and ½-inch zone of sandy shale at base.			0	2	16	0	16	0
2			Clarksburg ?	Clay shale, medium to dark bluish-gray, thinly laminated, silty, micaceous, containing streaks and zones of carbonaceous material, coal horizon.			1	6			15	10
1			Morgantown ?	Sandstone, brown to yellowish-tan, fine to coarse grained, massive to shaly, micaceous, cross-bedded, in part, massive cliff-former at base becoming thinner bedded at top with few shaly zones.			14	4			14	4

LOCATION KEY: Alo 34 FILE NUMBER: 11502 ELEVATION: 766 base TOPO MAP: Pomeroy

STATE: Ohio COUNTY: Athens TOWNSHIP: Lodi SECTION: NW¼ NE¼, 34

LOCATION: The base of the section begins in the creek bottom in the NW¼ NE¼, section 34 and continues west to fork in creek, then up northwest branch of stream to the top in Lodi Township. This is a composite section measured in the immediate area of the above description.

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
22	Monongahela	Benwood	Sewickley	Sandstone and shale, brown, tan, grayish-blue, yellowish-brown, fine to medium-grained, shaly at the base becoming massive upward, friable.			15	2¼	15	2½	160	8
21		Sewickley	Sewickley	Clay, bluish-gray, plastic, with a thin coal streak.	0	0½	1	1½	16	7	144	5½
				Shale, bluish-gray, thinly laminated, slightly silty, micaceous, carbonaceous, plant fossils.	0	11						
				Clay shale, bluish-gray, plastic, carbonaceous.	0	0½						
				Shale, carbonaceous, non-bedded, breaks irregularly.	0	1½						
20				Clay shale, dark grayish-black, grayish-blue, mottled maroon, non-bedded, breaks irregularly, silty, micaceous.			4	0			144	4
19				Clay, light gray, plastic, limonite stained			1	0			140	4

LOCATION: Alo 34 FILE NUMBER: 11502 - continued

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
18	Monongahela - continued	Sewickley continued	?	Sandstone and shale, olive tan to olive green, fine to medium-grained sandstone interbedded with shale.			10	6			139	4
17		Lower Sewickley	Lower Sewickley	Shale, red, thinly laminated, chippy fracture, slightly micaceous.			0	3	18	8	128	10
16				Shale, tan, thinly laminated, weathers semi-plastic.			0	2			128	7
15				Clay, bluish-gray, semi-plastic, some carbonaceous material			0	0½			128	5
14				Clay shale, gray, tan, red, non-bedded, breaks irregularly, silty, micaceous.			6	4½			128	4½
13				Sandstone and siltstone, pale olive-green, tan, fine to medium-grained, micaceous, thin-bedded to shaly, with a few massive zones.			10	10			122	0
12		Fishpot-Redstone	Fishpot ?	Shale, red, thinly laminated, chippy fracture, with ¼-inch streak of gray semi-plastic clay at base.			0	2	57	8	111	2
11				Clay shale, dark gray, non-bedded, silty, micaceous.			1	0			111	0
10			?	Covered interval.			7	0			110	0
9			Upper Pittsburgh	Sandstone, light olive-green to olive-tan, medium to coarse-grained, massive cliff-former at base becoming thin-bedded upward, contains zones of bluish-gray, sandy shale, micaceous.			45	6			103	0
8				Clay shale, light to dark gray, thinly laminated in part to non-bedded, contains carbonaceous material in streaks at base.			4	0			57	6
7		Pittsburgh	Pittsburgh	Coal, bright, blocky.	0	2½	1	6	52	3	53	6
				Shale, dark gray, streaks of carbonaceous material	0	0½						
				Coal, bright, blocky, some fusain partings.	0	7½						
				Clay, dark gray, plastic.	0	1½						
				Coal, bright, thinly laminated, zones of dull fusain.	0	8						
6				Shale, carbonaceous, thinly laminated	0	9	3	2			52	0
				Shale, bluish-gray, thinly laminated, carbonaceous, thickness varies.	1	0						
				Carbonaceous shale, thin laminae of bright coal.	0	5						
				Shale, dark gray, laminated, carbonaceous.	1	0						
5			Upper Pittsburgh	Limestone and clay shale; limestone, greenish gray to grayish-white, nodules and ledges; clay shale, bluish-gray, tan, non-bedded, breaks irregularly, calcareous, silty.			21	0			48	10
4				Clay shale, dark to light gray, mottled maroon to red, non-bedded, breaks irregularly			2	0			27	10
3			Lower Pittsburgh	Sandstone, bluish-gray to olive-green, fine to medium-grained, thin-bedded to massive, cliff-forming in part, thickness varies.			24	7			25	10
2	Conemaugh	Lower Little Pittsburgh	Lower Pittsburgh	Clay, grayish-white to tan, weathers semi-plastic, contains thin coal streaks.			0	7	1	3	1	3
1				Clay shale, bluish-gray, non-bedded, breaks irregularly, silty, micaceous, contains small limestone nodules.			0	8			0	8

LOCATION KEY: Alo 33 FILE NUMBER: 11504 ELEVATION: 772 base TOPO MAP: Pomeroy

STATE: Ohio COUNTY: Athens TOWNSHIP: Lodi SECTION: NE¼ SW¼ 33

LOCATION: The section begins on section line in SE¼ SW¼, section 33, and runs north up gulley to last exposure in gully just west of house in NE¼ SW¼, section 33.

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
12	Monongahela	Fishpot	Pomeroy	Sandstone, light olive-green, tan, grayish-green, fine to medium-grained, massive to shaly bedded, micaceous.			21	2	21	2	77	0
11		Redstone	Redstone	Clay shale, red, thinly laminated, breaks with chippy fracture, coal horizon.			0	3	15	7	55	10
10				Clay shale, grayish-black, non-bedded, breaks irregular, silty.			1	6			55	7
9				Limestone and clay shale; limestone, gray, occurs as ledges and nodules; clay shale, gray, tan, red at base, silty, non-bedded, micaceous.			4	1			54	1
8			Upper Pittsburgh	Sandstone, grayish-blue, olive-green, fine to medium-grained, massive to thin-bedded, varies laterally.			10	9			50	1
7		Pittsburgh	Pittsburgh "Rider"	Coal, weathered, thickness variable.			0	3	38	0	39	4
			Pittsburgh	Clay shale, like unit 7.			6	0				
				Coal, bright, blocky, weathered.	0	2	4	0				
				Clay shale, like unit 7.	0	5						
				Coal, bright, blocky, weathered.	0	4						
				Clay shale, like unit 7.	1	7/8						
				Coal, weathered.	0	1/8						
				Clay shale, light to medium gray, non-bedded to thinly laminated, micaceous, plant fossils and carbonaceous material.	1	1						
				Coal, bright, blocky, weathered.	0	11						
6				Clay shale, light to dark gray, non-bedded, breaks irregularly, contains carbonaceous material.	3	4	3	5			29	1
				Coal, weathered.	0	1						
5			Upper Pittsburgh	Clay shale, gray to grayish-white, non-bedded, breaks irregularly, slightly silty, micaceous, top part weathers plastic.			2	4			25	8
4				Limestone and clay shale; limestone, gray to bluish-gray, partly crystalline, brecciated in part, occurs as ledges 1 to 2 feet thick and nodules; clay shale, dark to light gray, non-bedded, breaks irregularly, silty, thickness varies laterally.			16	8			23	4
3			Lower Pittsburgh	Clay shale, gray, mottled purplish red in part, non-bedded, breaks with flint-clay fracture, silty, weathers semi-plastic, contains streaks of carbonaceous material and zones of fire red clay shale.			5	4			6	8
2	Conemaugh	Upper Little Pittsburgh ?	Upper Little Pittsburgh ?	Coal, bright, blocky.			0	8	1	4	1	4
1				Clay shale, grayish-black to black, non-bedded, breaks irregularly, silty, highly carbonaceous, speckled in part with gray spots.			0	8			0	8

LOCATION KEY: Alo 20 FILE NUMBER: 11505 ELEVATION: 686 base TOPO MAP: Pomeroy

STATE: Ohio COUNTY: Athens TOWNSHIP: Lodi SECTION: SE¼ SW¼ SE¼, 20

LOCATION: The section begins at stream fork in the SW¼ SE¼ SE¼ section 20 and continues up the west fork to cut bank in SE¼ SW¼ SE¼, section 20.

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
8	Monongahela	Fishpot	Pomeroy	Shale, light to dark olive-green, very sandy medium-bedded, micaceous, with interbedded lenses of medium-grained, massive sandstone.			10	0	10	0	51	9

LOCATION: Alo 20 FILE NUMBER: 11505 - continued

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
7	Monongahela -	Redstone	Redstone	Clay, light gray, weathers plastic.			0	3	16	8	41	9
6	continued			Carbonaceous shale, dark gray to black, thinly laminated, with streaks of bright, blocky coal, and some shale.			1	0			41	6
5				Coal, bright, blocky.	0	1	3	6			40	6
				Carbonaceous shale, dark gray to black, thinly laminated, some coal streaks.	1	5						
				Clay, light to dark gray, plastic, with a thin coal streak.	0	1						
				Carbonaceous shale, dark gray to black, thinly laminated, with some interbedded coal and shale.	0	2½						
				Clay, light to dark gray, plastic, with a th thin coal streak.	0	0½						
				Clay shale, bluish-gray to grayish-black, silty, non-bedded, micaceous, carbonaceous	0	6						
				Coal, bright.	0	0¼						
				Clay shale, bluish-gray to dark grayish black, silty, non-bedded, micaceous, carbonaceous.	0	8						
				Coal, bright, blocky.	0	2						
				Clay shale, bluish-gray, non-bedded, breaks irregularly, weathers semi-plastic, carbonaceous, with some plant fossils.	0	1¾						
				Coal, bright, blocky.	0	2						
4			Upper Pittsburgh	Shale and sandstone; shale, bluish-gray to gray, silty, thinly laminated, fossiliferous, concretionary, interbedded with light olive-tan to olive-green, and gray, fine-grained, thinly bedded sandstone, with some fossil plants.			11	11			37	0
3		Pittsburgh	Pittsburgh	Coal, bright, blocky			0	10	25	1	25	1
2				Clay shale, bluish-gray to gray, non-bedded, weathers semi-plastic in part, some carbonaceous zones.			0	6			24	3
1			Upper Pittsburgh	Limestone and clay shale; limestone, bluish gray to gray, very sandy at base becoming purer upward, also brecciated, conglomeratic and fossiliferous upward, the limestone occurs as nodules and ledges in a variegated silty, non-bedded, calcareous clay shale.			23	9			23	9

LOCATION KEY: Alo 24 FILE NUMBER: 11508 ELEVATION: 780 base TOPO MAP: Athens

STATE: Ohio COUNTY: Athens TOWNSHIP: Lodi SECTION: NE¼ SW¼, 24

LOCATION: The section begins at the creek bottom northwest of the church in the NE¼ SW¼, section 24, and continues upstream to fork in creek, then up the right-hand branch to the road in the SW¼ NE¼, section 24, Lodi Township.

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
21	Monongahela	Uniontown	Uniontown	Shale, olive green, red, thinly laminated, chippy fracture, silty, calcareous, micaceous, limestone nodules up to 6 inches, some small clay zones.			38	8	40	2	192	0
20			Arnoldsburg	Shale, gray, brown, purple, mottled, thinly laminated, silty, micaceous.			1	6			153	4
19		Arnoldsburg - Benwood	Arnoldsburg	Coal, with clay, gray, plastic.	0	0¼	0	3	64	10	151	10
				Clay, grayish-white, plastic.	0	1¾						
				Coal, weathered, with gray plastic clay.	0	1						
18			Arnoldsburg - Benwood	Siltstone, olive-green, olive-drab, irregularly bedded, irregular fracture, micaceous, with nodules of limestone, gray, massive, crystalline.			6	4			151	7
17				Limestone and clay shale; limestone, dark gray, massive, weathers grayish-white, conglomeratic, fossiliferous (Ostracods), nodular to lenticular; clay shale, red, purple, tan, gray, mottled, breaks irregularly, calcareous, silty, micaceous.			38	7			145	3

LOCATION: Alo 24 FILE NUMBER: 11508 - continued

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
16	Monongahela - continued	Arnoldsburg - Benwood - continued	Sewickley	Sandstone, siltstone, and shale, gray, light olive-green, yellowish-brown, fine to medium-grained, shaly to massive; these three lithologies are gradational and interbedded; upward, the sandstone is massive and friable, and the shale is sandy.			19	8			106	8
15		Sewickley	Sewickley	Shale, red, thinly laminated, chippy fracture, silty, micaceous.			0	3	29	10	87	0
14				Clay shale, dark gray to dark olive-green, irregular fracture, silty.			0	5			86	9
13				Clay, tan to gray, semi-plastic, carbonaceous, coal horizon.			0	1			86	4
12				Clay shale, gray to dark gray, non-bedded, breaks irregularly, silty, micaceous.			2	11			86	3
11				Limestone and clay shale; limestone, gray, massive, crystalline, weathers yellowish-brown, occurs as ledges and nodules; clay shale, tan to yellowish-brown, non-bedded, calcareous, silty, micaceous.			2	0			83	4
10			Lower Sewickley	Siltstone and shale, light olive-tan to olive-green, bluish-gray, fine-grained, micaceous, thin-bedded to shaly, with a few massive lenses, and upward becomes thin-bedded siltstone with sandy limestone nodules.			24	2			81	4
9		Fishpot-Redstone	Fishpot	Shale, red, thinly laminated, chippy fracture, silty, micaceous, clay at base, coal horizon.			0	8	51	4	57	2
8			Fishpot-Redstone	Clay shale, olive-green to dark grayish-black, non-bedded, breaks irregularly, calcareous, silty, limestone knots.			1	1			56	6
7				Clay shale, red to reddish-purple, non-bedded, breaks irregularly, calcareous, silty, limestone knots.			1	1			55	5
6				Limestone and clay shale; limestone, grayish-white, massive, partly crystalline, occurs as ledges and nodules; clay shale, tan, maroon, gray, non-bedded, calcareous, silty, micaceous.			3	6			54	4
5			Pomeroy ? - Upper Pittsburgh	Sandstone, siltstone, and shale; sandstone, light olive-green, fine to medium-grained, massive to thin-bedded, micaceous, cross-bedded; siltstone, gray, green, thin-bedded; shale, gray, calcareous with limestone nodules, irregularly bedded, sandy, plant fossils. The three lithologies are interbedded and gradational.			45	0			50	10
4		Pittsburgh	Pittsburgh	Clay, bluish gray, weathers plastic with plant fossils, 2-inch carbonaceous zone at base.			0	7	5	10	5	10
3				Shale, carbonaceous, thinly laminated with interbedded streaks of bright coal, fossil plants.			1	3			5	3
2				Coal, bright, blocky.	0	4	3	10			4	0
				Clay shale, light to medium gray, non-bedded, silty, micaceous, carbonaceous shale at base.	1	0						
				Coal, bright, blocky, thickness varies laterally.	1	2½						
				Fusain parting.	0	0½						
				Coal, bright, blocky, thickness varies laterally.	1	3						
1				Shale, dark grayish-black, thinly laminated, carbonaceous.			0	2			0	2

LOCATION KEY: Alo 14 FILE NUMBER: 11512 ELEVATION: 710 base TOPO MAP: Pomeroy

STATE: Ohio COUNTY: Athens TOWNSHIP: Lodi SECTION: NE¼ SW¼, 14

LOCATION: Base of the section begins south of road junction in stream bottom in NE¼ SW¼, section 14, and continues up road to junction 819, section 15, Lodi Township.

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
21	Monongahela	Benwood	?	Covered interval, some evidence of sandstone.			18	3	35	0	114	2
20			Sewickley	Sandstone and shale; sandstone, olive green to olive tan, fine to medium-grained, massive to shaly bedded, micaceous, very friable upward; shale, olive green, fine-grained, non-bedded in part, this shale grades into the sandstone.			16	9			95	11
19		Sewickley	Sewickley	Shale, red, thinly laminated, breaks with "chippy" fracture, silty, micaceous.			0	8	32	4	79	2
18				Clay shale, grayish-blue, weathers semi-plastic, carbonaceous, coal horizon.			0	2			78	6
17			Fishpot	Clay shale, olive green, non-bedded to thinly laminated, silty, micaceous, limonite stained.			1	3½			78	4
16				Clay, light gray, weathers semi-plastic, limonite stained.			0	3½			77	0½
15				Clay shale, deep olive-green, irregularly bedded, silty, micaceous, thinly bedded in part.			2	2			76	9
14				Clay shale, olive-green, maroon, mottled maroon in part, non-bedded, silty, micaceous.			7	7			74	7
13			Lower Sewickley	Sandstone, olive-green to olive-tan, fine to medium-grained, massive to shaly, micaceous, limestone nodules upward, thickness varies.			20	2			67	0
12		Fishpot	Fishpot	Shale, red, thinly laminated, breaks with "chippy" fracture, silty, micaceous.			0	6	12	1	46	10
11				Clay shale, tan to gray, non-bedded, weathers semi-plastic, silty, micaceous, contains carbonaceous streaks at top, coal horizon.			0	2			46	4
10				Clay shale, maroon, olive green, red, mottled olive-green in part, non-bedded, calcareous, silty, micaceous, contains a few limestone nodules.			4	10			46	2
9			Pomeroy	Siltstone, pale olive-green, fine-grained, massive, micaceous, limestone nodules in upper part.			3	9			41	4
8				Clay shale, olive-green, maroon, tan, non-bedded, silty, micaceous, contains limestone nodules and knots.			2	10			37	7
7		Redstone	Redstone	Shale, olive-green, thinly laminated, silty, micaceous, limonite stained.			0	3	32	9	34	9
6				Clay shale, light to dark gray, non-bedded, breaks irregularly, weathers semi-plastic in zones, silty, micaceous, carbonaceous, coal horizon.			0	10			34	6
5				Limestone and clay shale; limestone, gray, occurs as nodules; clay shale, tan, non-bedded, calcareous, silty, micaceous.			0	4			33	8
4				Covered interval.			3	3			33	4
3			Upper Pittsburgh	Sandstone, brown, olive-green, massive at base, thin-bedded at top, fine to medium-grained, micaceous, calcareous laterally with limestone nodules.			28	1			30	1
2		Pittsburgh	Pittsburgh	Shale, bluish-gray to gray, thinly laminated in part, micaceous, plant fossils.			0	11	2	0	2	0
1				Coal, bright, blocky.			1	1			1	1

LOCATION KEY: Alo 13 FILE NUMBER: 11514 ELEVATION: 692 base TOPO MAP: Pomeroy

STATE: Ohio COUNTY: Athens TOWNSHIP: Lodi SECTION: SE¼ NW¼, 13

LOCATION: The section begins at creek bottom in the SE¼ NW¼ of section 13, and continues up the road to Pratts Fork in section 13 of Lodi Township.

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
11	Monongahela	Benwood	Sewickley	Sandstone, yellowish-brown, tan, fine to medium-grained, thin-bedded to massive, micaceous.			6	0	6	0	113	2
10		Sewickley	Sewickley	Shale, red, thinly laminated, chippy fracture silty, micaceous, concretionary, coal smut at base.			2	2	20	6	107	2
9				Clay shale and limestone, shale, red, maroon, olive-green, non-bedded, calcareous, silty, micaceous; limestone, dark gray, weathers grayish white, occurring as nodules, poorly exposed in part.			12	11			105	0
8			Lower Sewickley?	Siltstone, green to grayish-green, thinly bedded, highly micaceous, local silty limestone nodules.			5	5			92	1
7		Fishpot - Redstone ?	Fishpot	Clay shale, green to olive-green, non-bedded, calcareous, micaceous, silty, containing limestone nodules up to 6 inches in diameter.			1	0	76	4	86	8
6			?	Covered interval.			13	2			85	8
5			Upper Pittsburgh	Sandstone, light gray to tan, medium to coarse-grained, massive cliff-former, micaceous, containing a few thinly bedded zones, cross-bedded.			62	2			72	6
4		Pittsburgh	Pittsburgh	Coal, bright, thinly laminated.	0	3¾	1	3	10	4	10	4
				Fusain.	0	0¼						
				Coal, bright, blocky.	0	11						
3				Shale, carbonaceous, black, thinly laminated in part, becoming carbonaceous clay at top and base.			0	7			9	1
2			Lower Pittsburgh	Clay shale, bluish-gray to grayish-black, non-bedded, breaks irregularly, silty, micaceous, carbonaceous.			1	6			8	6
1				Clay shale and limestone; shale, gray, greenish-gray, bluish-gray, non-bedded, breaks irregularly, calcareous, silty, micaceous; limestone, dark gray, occurring as nodules.			7	0			7	0

LOCATION KEY: Alo 9 FILE NUMBER: 11517 ELEVATION: 685 base TOPO MAP: Keno

STATE: Ohio COUNTY: Athens TOWNSHIP: Lodi SECTION: SW¼ SW¼, 9

LOCATION: Base of section at road junction 685 in section 9, and continues northeast up road to junction 947 in Lodi Township.

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
28	Monongahela	Little Waynesburg	Gilboy	Sandstone, gray to tan, weathers yellowish-brown, fine to coarse-grained, massive, very friable, limonite stained, highly micaceous.			22	0	34	7	260	5
27				Covered interval.			7	1			238	5
26				Shale, light olive-green to olive-brown, thin-bedded, silty to sandy, micaceous.			5	0			231	4
25			Little Waynesburg ?	Shale, red, thinly laminated, "chippy" fracture, silty, micaceous, position of coal ?			0	6			226	4
24		Uniontown	Uniontown	Clay shale, dark olive green, gray, non-bedded to irregularly bedded, calcareous, silty, micaceous, with limestone knots.			0	7	18	5	225	10
23				Clay shale, red, olive-green, gray, non-bedded to irregularly bedded, calcareous, silty, micaceous, contains knots of limestone.			12	2			225	3
22			Lower Uniontown	Shale and sandstone, olive-green to olive-drab, fine to medium-grained, thin-bedded with some massive zones, highly micaceous. The sandstone occurs as lens in the shale.			5	8			213	1

LOCATION: Alo 9 FILE NUMBER: 11517 - continued

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
21	Monongahela - continued	Lower Uniontown	Ritchie	Shale, red, olive-green, thinly laminated, silty, micaceous, poorly exposed.			12	0	30	0	207	5
20				Clay shale, maroon, mottled gray and purple, non-bedded, silty, calcareous, micaceous, contains small limestone nodules.			4	6			195	5
19			Arnoldsburg	Sandstone and siltstone, light to dark olive-green, fine-grained, massive becoming irregularly bedded upward, micaceous.			13	6			190	11
18		Arnoldsburg - Benwood	Arnoldsburg	Clay shale, gray, semi-plastic, carbonaceous, coal horizon.			0	1	84	9	177	5
17			Arnoldsburg - Tyler Reds	Clay shale and limestone; clay shale, tan, maroon, gray, olive-green, non-bedded with some thin-bedded zones, silty, micaceous, calcareous; limestone, dark gray, weathers grayish-white, ledges and nodular, crystalline in part, poorly exposed.			65	2			177	4
16			Sewickley	Sandstone, light olive-green, yellowish-brown, tan, fine to medium-grained, massive to shaly bedding, very friable in zones, highly micaceous, limonite stained.			19	6			112	2
15		Sewickley ?	Sewickley ?	Shale, olive drab, thinly laminated, chippy, silty, coal zone?			0	8	11	5	92	8
14				Clay shale, dark olive-green, non-bedded, starch-like fracture, silty, micaceous, limonite stained.			1	5			92	0
13			Lower Sewickley ?	Sandstone, light olive-green to tan, fine to medium-grained, massive, very friable, micaceous, highly stained with limonite, varies laterally to a siltstone.			9	4			90	7
12		Fishpot	Fishpot	Clay shale and limestone; clay shale, light olive-green, gray, maroon, mottled maroon in part, non-bedded, calcareous, silty, micaceous; limestone, gray, weathers grayish-white and yellow, occurs as ledges in lower part, and nodules in upper part, partly crystalline.			11	7	26	7	81	3
11			Pomeroy	Sandstone and shale; sandstone, light olive-green, fine to medium-grained, massive to shaly bedded, micaceous; becomes shale, olive green, silty, micaceous, non-bedded, upward.			15	0			69	8
10		Redstone	Redstone	Clay shale and limestone, clay shale, gray, maroon, tan, non-bedded, weathers semi-plastic in part, calcareous, silty, micaceous; limestone, dark gray, weathers grayish-white and yellow, occurs as nodules.			5	5	39	0	54	8
9			Upper Pittsburgh	Sandstone, light olive-green, darker upward, fine to medium-grained, massive below, thin-bedded above.			28	3			49	3
8				Shale, gray to bluish-gray, irregularly bedded, sandy, micaceous, poorly exposed.			5	4			21	0
7		Pittsburgh	Pittsburgh	Coal, dull.	0	0½	1	3½	15	7	15	7
				Clay, light gray, semi-plastic.	0	7⅓						
				Coal, weathered.	0	7½						
6				Clay shale, grayish-black to black, massive well indurated, silty, micaceous, fossils?			0	0⅔			14	5
5				Clay, light gray, semi-plastic.			0	4½			14	4⅓
4				Clay shale, bluish black, carbonaceous, irregularly bedded, silty, micaceous, semi-plastic.			0	1¾			14	0
3				Clay, light gray, weathers plastic.			0	0¼			13	10¼
2			Upper Pittsburgh	Clay shale, grayish-green, non-bedded, breaks irregularly, silty, micaceous.			2	7			13	10
1				Limestone and clay shale; limestone, dark gray, weathers grayish-white, occurs as nodules and ledges, partly crystalline, fossiliferous; clay shale, gray, tan, bluish-gray, mottled maroon in part, non-bedded, calcareous, silty, micaceous.			11	3			11	3

LOCATION KEY: Alo 2 FILE NUMBER: 11521 ELEVATION: 682 base TOPO MAP: Keno

STATE: Ohio COUNTY: Athens TOWNSHIP: Lodi SECTION: NE¼ SW¼, 2

LOCATION: The section begins at sharp bend in road in the NE¼ SW¼, section 2, and continues up ridge to SW¼ NE¼, section 2.

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
21	Monongahela	Waynesburg ?	Waynesburg ?	Clay shale, red, non-bedded, breaks irregularly, silty, micaceous.			5	0	18	8	184	6
20			Gilboy ?	Siltstone and shale, olive tan, tan, gray, fine-grained, silty, thin-bedded to irregularly bedded, micaceous, contains limestone nodules up to 2 inches in diameter.			8	8			179	6
19				Sandstone and siltstone, tan, olive, brown, fine-grained, massive to thin-bedded. About 5 feet below this base is a spring zone.			5	0			170	10
18		?	?	Covered interval.			31	6	31	6	165	10
17		Uniontown ?	Arnoldsburg ?	Sandstone, tan, fine to medium-grained, massive to shaly bedded, micaceous, some limonite staining.			12	4	22	4	134	4
16			?	Covered interval, clay shale and limestone?			10	0			122	0
15		Arnoldsburg - Benwood	Arnoldsburg	Clay, gray, non-bedded, carbonaceous.			0	2	72	4	112	0
14				Coal, weathered, mixed with clay.			0	1			111	10
13				Clay, gray, non-bedded, semi-plastic, micaceous.			0	1			111	9
12			Arnoldsburg - Benwood	Siltstone, olive green to tan, fine-grained, thin-bedded to massive, highly micaceous.			2	5			111	8
11				Shale, red, laminated, chippy fracture, silty, micaceous.			1	2			109	3
10				Clay shale and limestone; clay shale, gray, maroon, purple, tan, olive-green, red, non-bedded to poorly laminated, calcareous in part, silty, micaceous; limestone, dark gray, weathers grayish-white to gray, nodular and lenticular, calcite veins.			46	6			108	1
9			Sewickley	Siltstone, sandstone, shale; siltstone, fine-grained, thin-bedded with some massive zones; sandstone, fine to medium-grained, massive lenses; shale, slightly silty, thin-bedded; all three types are interbedded and gradational.			21	11			61	7
8		Sewickley	Sewickley	Clay, bluish-gray, weathers semi-plastic, silty, micaceous.			1	0	12	0	39	8
7				Clay shale, olive drab, irregularly bedded, silty, slightly micaceous, poorly exposed.			1	9			38	8
6			Lower Sewickley	Sandstone and siltstone; sandstone, olive-green, fine to medium-grained, massive to thin-bedded, micaceous; siltstone, thin-bedded, micaceous.			9	3			36	11
5		Fishpot	Fishpot	Shale, olive green, thinly laminated, silty, micaceous, some iron stain.			0	3½	27	8	27	8
4				Clay, gray, weathers semi-plastic, carbonaceous, coal horizon.			0	0½			27	4½
3				Shale, olive green, stained red in part, poorly laminated, silty, micaceous.			4	8			27	4
2				Clay shale and limestone, olive green, gray, dark gray, non-bedded, breaks irregularly, silty, micaceous, calcareous; limestone, dark gray, weathers grayish white, occurs as large nodules.			11	4			22	8
1			Pomeroy	Sandstone, light olive green, fine to medium grained, massive with some shaly bedded zones, micaceous.			11	4			11	4

LOCATION KEY: Alo 7 FILE NUMBER: 11524 ELEVATION: 693 base TOPO MAP: Keno

STATE: Ohio COUNTY: Athens TOWNSHIP: Lodi SECTION: SE¼ NW¼, 13

LOCATION: The section begins in stream bottom on Pratts Fork and continues northeast up hill road to top in SE¼ SW¼, of section 8.

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
37	Monongahela	Waynesburg	Gilboy	Sandstone and shale, than to yellowish-tan, shaly to massive bedding, fine-grained, micaceous.			16	3	16	3	226	4
36		Little Waynesburg	Little Waynesburg	Coal, zone, clay shale, gray to greenish-gray, irregularly bedded to laminated, silty micaceous, contains many zones of carbonaceous material.			0	4	30	1	210	1
35				Clay shale, gray to greenish-gray, irregular bedding, breaks irregularly, silty, micaceous.			0	10			209	9
34			Waynesburg	Limestone, dark gray, nodular ledge.			0	3			208	11
33			Little Waynesburg	Clay shale, maroon, gray, mottled purple and maroon, non-bedded, silty, calcareous, micaceous, with limestone nodules up to 6"			10	3			208	8
32			Uniontown	Sandstone and shale, light to olive-tan, fine-grained at base becoming medium-grained upward, thin-bedded to massive, micaceous, limonite stained.			15	8			198	5
31				Shale, light gray, poorly to well laminated, weathers with a soapy surface, slightly silty, micaceous, contains zones of concentrated limonite.			2	2			182	9
30		Uniontown - Lower Uniontown ?	Uniontown ?	Shale, olive drab, laminated in part, silty, slightly micaceous, coal zone.			0	1	13	6	180	7
29				Limestone, grayish-green, nodular, fossiliferous.			0	7			180	6
28			Ritchie ?	Clay shale, green, non-bedded, breaks irregularly, calcareous, silty, micaceous.	1	4	7	4			179	11
27				Clay shale, red, non-bedded, breaks irregularly, silty, micaceous.	6	0					178	7
26				Covered interval.			1	6			172	7
25				Shale, light olive-green, poorly laminated, silty, micaceous, iron-stained.			4	0			171	1
24		Arnoldsburg - Benwood ?	Arnoldsburg	Clay, gray, weathers semi-plastic, laminated, silty, micaceous, carbonaceous, coal zone.			0	2	70	3	167	1
23				Clay shale, greenish-gray to olive-green, non-bedded, breaks irregularly, silty, micaceous, limonite stained.			2	7			166	11
22				Covered interval.			6	5			164	4
21			Arnoldsburg - Tyler Reds ?	Clay shale, olive-green, red, gray, mottled maroon, bedded, breaks in small slabs, silty, micaceous.	3	4	42	1			157	11
20				Marly lime, grayish-white to white, non-bedded, breaks irregularly, highly calcareous, micaceous, fossiliferous?	8	10					154	7
19				Clay shale, maroon, gray, grayish-white, non-bedded, breaks irregularly, calcareous in part, silty, micaceous, contains limestone nodules up to 6 inches.	29	11					145	9
18			Sewickley	Sandstone, tan to yellowish-brown, gray, fine to coarse-grained, massive with a few thin-bedded zones, stained with limonite, micaceous, cross-bedded, friable.			19	0			115	10
17		Sewickley	Sewickley	Clay, "roof shale", gray, irregularly bedded, breaks irregularly, silty, micaceous.			0	8	22	0	96	10
16			?	Sandstone, gray to grayish-tan, fine to coarse grained, massive with some thin-bedded zones at base, friable, micaceous, limonite stained.			21	4			96	2
15		Lower Sewickley	Lower Sewickley	Clay shale, gray, some bedding, breaks irregularly, silty, micaceous, carbonaceous? coal zone.			0	6	19	3	74	10
14				Clay shale, dark olive-green, non-bedded, breaks irregularly, silty, micaceous.	1	2	10	0			74	4
13				Clay shale, maroon, olive green, non-bedded breaks irregularly, silty, calcareous in part, contains limestone nodules up to 3 inches in diameter.	8	10					73	2
12				Sandstone and siltstone, olive-green, fine-grained at base becoming sandy upward, massive to shaly bedded, micaceous, with calcareous nodules in upper 2 feet.			8	9			64	4

LOCATION: Alo 7 FILE NUMBER: 11524 - continued

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
11	Monongahela - continued	Fishpot - Redstone	Fishpot-Redstone	Shale, olive-green, laminated to non-bedded, silty, micaceous, limonite stained, contains a few lenses of siltstone mottled red in part.			9	11	51	2	55	7
10			Upper Pittsburgh ?	Sandstone, gray, tan, fine to coarse-grained, massive at base, becoming shale-bedded in upper 10 feet, cross-bedded, micaceous, forms conspicuous cliff at base, most of underlying covered interval is probably sandstone ?			36	10			45	8
9				Covered interval.			4	5			8	10
8		Pittsburgh	Pittsburgh "Rider"	Carbonaceous shale, black, thinly laminated, silty, micaceous, carbonaceous.			0	2	4	5	4	5
7			Pittsburgh	Shale, light olive-green to gray, laminated in part, silty, micaceous, contains many plant fossils, highly stained with limonite.			2	5			4	3
6				Coal, bright, blocky to thinly laminated	0	10	1	3			1	10
5				Clay, weathers mucky.	0	1					1	0
4				Coal, bright, blocky.	0	4					0	11
3				Clay shale, bluish-gray, poorly bedded, breaks irregularly, silty, micaceous, carbonaceous.			0	3			0	7
2				Clay shale, black, carbonaceous, non-bedded, breaks irregularly, silty, micaceous, highly carbonaceous.			0	1			0	4
1			Lower Pittsburgh	Clay shale, gray to grayish-black, non-bedded to irregular, silty, micaceous, carbonaceous.			0	3			0	3

LOCATION KEY: Alo 1 FILE NUMBER: 11528 ELEVATION: 657 base TOPO MAP: Keno

STATE: Ohio COUNTY: Athens TOWNSHIP: Lodi SECTION: SE¼ NW¼, 1

LOCATION: The section begins at water level on Pratts Fork in SE¼ NW¼, section 1, and continues uphill to top in SW¼ SW¼, section 1.

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
20	Washington	Waynesburg "A"	Mannington-Waynesburg ?	Sandstone, gray to yellowish-brown, fine to coarse grained, massive, friable, micaceous, highly stained with limonite.			27	3	27	3	268	0
19		Waynesburg	Cassville	Shale, greenish-gray, poorly laminated, slightly silty, weathers semi-plastic, micaceous, limonite stained.			0	9	20	8	240	9
18	Monongahela		Waynesburg	Clay shale, grayish-purple, badly weathered, carbonaceous, coal horizon.			0	4			240	0
17				Clay shale, maroon, yellowish-tan, non-bedded, breaks irregularly, silty, micaceous			8	9			239	8
16			Gilboy	Sandstone, light olive-green to olive-tan, massive with a few thin-bedded zones, fine to medium-grained, micaceous.			10	10			230	11
15		Little Waynesburg	Little Waynesburg	Shale, gray, pink, laminated to poorly bedded, weathers semi-plastic, slightly silty, micaceous.			1	0	44	9	220	1
14				Clay shale, purplish-gray, carbonaceous, bedded, weathers soft, coal horizon.			0	1			219	1
13				Clay shale, grayish-green, purple, maroon, non-bedded, breaks irregularly, calcareous, silty, micaceous, contains limestone knots and nodules.			13	8			219	0
12			Waynesburg	Limestone, sandy, light olive-green, partly crystalline.			4	4			205	4
11			Uniontown	Sandstone and shale; sandstone, gray, tan, fine to medium-grained, massive, to shaly, micaceous; shale, pink, olive-green, tan, shaly bedded to laminated, argillaceous, micaceous, grades upward into sandstone.			25	8			201	0
10		Uniontown	Uniontown	Shale, red, greenish-gray, laminated, silty, micaceous, carbonaceous.			0	4	17	3	175	4

LOCATION: Alo 1 FILE NUMBER: 11528 - continued

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
9	Monongahela - continued	Uniontown - continued	Uniontown - continued	Shale, dark gray, laminated, silty, micaceous, carbonaceous, coal horizon.			0	1			175	0
8				Clay shale, maroon, gray, olive-green, non-bedded, breaks irregularly, calcareous, silty, micaceous, contains limestone nodules			3	0			174	11
7			?	Covered interval.			13	10			171	11
6		?	?	Shale, dark olive-green, laminated, becomes s siltstone upward, micaceous.			3	0	158	1	158	1
5				Clay shale, gray, maroon, gray, non-bedded, breaks irregularly, silty, micaceous, calcareous, contains some limestone nodules.			49	0			155	1
4				Covered interval.			21	4			106	1
3				Shale, olive tan to green, argillaceous, thin-bedded, micaceous, sandstone lenses.			5	0			84	9
2				Covered interval, with some clay shale exposed.			25	1			79	9
1				Sandstone, tan to yellowish-brown, fine to coarse grained, massive with some shaly bedded zones, micaceous, cliff-forming unit.			54	8			54	8

LOCATION KEY: Alo 25 FILE NUMBER: 11534 ELEVATION: 742 base TOPO MAP: Pomeroy

STATE: Ohio COUNTY: Athens TOWNSHIP: Lodi SECTION: $N\frac{1}{2}$ $SE\frac{1}{4}$ $SE\frac{1}{4}$, 25

LOCATION: Section begins in stream bottom in $N\frac{1}{2}$ of $SE\frac{1}{4}$ $SE\frac{1}{4}$, and continues up road to road junction in $SW\frac{1}{4}$ $SE\frac{1}{4}$, and then south up hill road to top in $SW\frac{1}{4}$ $SE\frac{1}{4}$, section 25, Lodi Township.

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
10	Monongahela	Benwood	Tyler Reds	Clay shale, dark to light gray, purple, maroon, non-bedded, breaks irregularly, calcareous in part, silty, micaceous, contains limestone nodules.			26	11	42	8	148	9
9			Sewickley	Sandstone, yellowish-brown to gray, medium to coarse-grained, massive, thin-bedded in the cross-bedded zones, friable, micaceous, limonite stained, base not well exposed.			15	9			121	10
8		Sewickley	Sewickley	Clay shale, gray, maroon, olive-brown, non-bedded, breaks irregularly, silty, micaceous, covered in part.			22	4	37	7	106	1
7			Lower Sewickley	Sandstone, yellowish-tan, fine to medium-grained, massive to shaly bedded, highly micaceous, friable, limonite stained.			15	3			83	9
6		Fishpot	Fishpot	Clay shale, gray, laminated, micaceous, carbonaceous, coal zone.			0	4	67	0	68	6
5				Clay shale, gray, maroon, tan, dark olive-green, non-bedded, breaks irregularly, silty, micaceous, contains knots of gray limestone, weathering to white.			9	0			68	2
4			Pomeroy	Sandstone, grayish-tan, olive-green, fine to medium-grained, massive to shaly bedded, micaceous, base unconformable, covered in part.			57	8			59	2
3		Redstone	Redstone	Clay shale, dark gray, poorly laminated, weathers semi-plastic, silty, micaceous, variable thickness.			0	3	1	6	1	6
2				Coal, bright, blocky to thinly laminated, much fusain, thickness varies, cut-out in part by overlying sandstone.			0	4			1	3
1				Clay shale, bluish-gray, laminated, silty to sandy at base, becoming shaly upward, micaceous, carbonaceous, with plant fossils.			0	11			0	11

LOCATION KEY: Alo 21 FILE NUMBER: 11536 ELEVATION: 757 base TOPO MAP: Pomeroy

STATE: Ohio COUNTY: Athens TOWNSHIP: Lodi SECTION: E½ NE¼, 21

LOCATION: Section begins in stream bottom in E½ of NE¼, section 21 and continues upstream in NW¼, section 21, Lodi Township.

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
7	Monongahela	Redstone	Upper Pittsburgh	Sandstone and shale, tan to light olive-brown, fine to medium-grained, shaly to massive-bedded, micaceous, becomes massive sandstone upward.			11	5	11	5	18	0
6		Pittsburgh	Pittsburgh	Clay shale, medium gray, poorly bedded to laminated, slightly silty, some plant fossils, carbonaceous at base.			2	2	6	7	6	7
5				Fusain	0	1	2	5			4	5
				Coal, bright, blocky	0	3						
				Carbonaceous shale, some small zones of bright coal.	2	0½						
				Coal, bright, blocky.	0	0½						
4				Clay shale, dark gray to greenish-black, poorly bedded, silty, carbonaceous.			0	6			2	0
3			Lower Pittsburgh	Clay shale, gray, olive-green, non-bedded, breaks irregularly, silty, micaceous, contains nodular zone of limestone, dark grayish-black, thickness varies.			0	4			1	6
2				Clay shale, dark gray to greenish-black, poorly bedded, slightly silty, micaceous, carbonaceous.			0	8			1	2
1				Clay shale, light to dark gray, mottled, maroon in part, non-bedded, breaks irregularly, calcareous, silty, micaceous with abundant limestone nodules gray to greenish-gray, fossiliferous (ostracods).			0	6			0	6

ROME TOWNSHIP

LOCATION KEY: Ar 1 FILE NUMBER: 11318 ELEVATION: 699 base TOPO MAP: Chesterhill

STATE: Ohio COUNTY: Athens TOWNSHIP: Rome SECTION: SE¼, 16

LOCATION: Exposure in abandoned quarry, near center, SE¼, section 16.

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
14	Monongahela	Little Waynesburg	Little Waynesburg	Clay shale, chocolate maroon, slightly limonite stained, very finely micaceous, laminated.			1	3	1	9	43	9
13				Shale, gray to tan, limonite stained, finely micaceous, silty.			0	6			42	6
12		Uniontown	Uniontown	Coal, soft, dull, much weathered, some bright streaks.			0	5	12	0	42	0
11				Clay shale and limestone, gray to olive drab, much limonite staining and ferruginous staining at top, silty, calcareous below to non-calcareous above, becomes somewhat clay-like at the top.			6	1			41	7
10				Limestone and shale, gray to medium gray, dense, nodular, sulphurous, fresh-water limestone embedded in gray to tan, limonite stained, argillaceous, micaceous, silty shales.			5	6			35	6
9		Arnoldsburg - Benwood	Arnoldsburg ?	Carbonaceous shale, coal horizon.			0	0½	30	0	30	0
8				Sandstone, light greenish gray with considerable limonite stain, very fine, argillaceous, silty, micaceous, poorly stratified, thickness variable.			5	0			29	11
7			Arnoldsburg - Benwood	Clay shale, greenish gray with light purple mottling, argillaceous to slightly silty, calcareous with small limestone nodules, breaks with starch-like fracture.			1	0			24	11
6				Limestone and shale, limestone nodules and beds similar to limestone immediately below, embedded in bluish to greenish gray with purple mottling, argillaceous, finely micaceous shale with starch-like fracture.			4	4			23	11
5				Limestone, gray to light gray, dense, massive to irregularly bedded, locally shaly lenses.			5	4			19	7
4				Limestone and shale, gray to blue gray with limonite stain, argillaceous, finely micaceous, with many nodules of gray, dense limestone containing many small calcite crystals, thickness variable.			2	6			14	3
3				Shale and limestone, gray to light greenish gray, mottled purple and maroon with numerous rounded nodules of dense limestone, breaks with starch-like fracture.			4	3			11	9
2				Limestone, gray, weathering light gray with some limonite stain, mostly dense, heavy bedded to nodular, with scattered, irregular shale partings, slickensided.			6	6			7	6
1				Shale and limestone, dark gray to greenish gray with some limonite stain, silty, micaceous, with numerous, small nodules of dark gray, dense limestone.			1	0			1	0

LOCATION KEY: Ar 4 FILE NUMBER: 11320 ELEVATION: 620 base TOPO MAP: Chesterhill

STATE: Ohio COUNTY: Athens TOWNSHIP: Rome SECTION: NE¼ SE¼, 32

LOCATION: Exposure along road improvement, U. S. Route 50, west of Guysville.

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
6	Monongahela	Redstone	Upper Pittsburgh	Sandstone, gray to tan with some limonite stain, fine to medium, micaceous, massive to bedded above.			27	0	27	0	58	3
5		Pittsburgh	Pittsburgh	Clay shale, gray to dark gray or tan, limonite stained, with some plant fossils.			0	4½	31	3	31	3
4				Coal, dull, platy, soft, poorly developed.			0	2½			30	10½

LOCATION: Ar 4 FILE NUMBER: 11320 - continued

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
3	Monongahela - continued	Pittsburgh - continued	Upper Pittsburgh	Limestone, gray to medium gray with some limonite stain, dense, massive, fresh-water, in gray to tan argillaceous shale.			14	3			30	8
2			Lower Pittsburgh	Clay shale, gray to tan, mottled red to yellow, with a starch-like fracture and traces of bedding, flinty in appearance.			10	5			16	5
1				Clay shale, gray to greenish gray with some maroon mottling and limonite stain, argillaceous, silty, massive, exposed.			6	0			6	0

LOCATION KEY: Ar 5 FILE NUMBER: 11321 ELEVATION: 621 base TOPO MAP: Chesterhill

STATE: Ohio COUNTY: Athens TOWNSHIP: Rome SECTION: NW¼ NE¼, 32

LOCATION: Exposure along road improvement of U. S. Route 50 west of Guysville. Upper Monongahela (69'9" to 221' 5") poorly exposed sandstone, limestone and maroon shale.

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
8	Monongahela	Redstone	Upper Pittsburgh	Sandstone, gray to tan, limonite stained, fine to medium, massive below to thin-bedded above, micaceous, exposed.			27	1	28	3	69	9
7				Shale, gray to olive, limonite stained, silty to sandy, finely micaceous.			1	2			42	8
6		Pittsburgh	Pittsburgh	Coal, blocky, some bright, weathered, carbonaceous shale in upper 2 inches.			0	7	41	6	41	6
5				Clay shale, chocolate brown, somewhat plastic with limonite stain.			0	7			40	11
4			Upper Pittsburgh	Limestone, light gray to gray with some limonite stain, dense, hard, massive nodules, fresh-water, in gray argillaceous shales.			11	0			40	4
3				Shale, gray to tan with red to maroon to yellow mottling, with starch-like fracture, some bedding, flinty in appearance.			15	6			29	4
2				Shale, gray to greenish gray, limonite stained, some maroon mottling, silty to sandy, argillaceous, micaceous.			12	4			13	10
1				Shale, gray to tan, limonite stained, silty to sandy, exposed.			1	6			1	6

LOCATION KEY: Ar 7 FILE NUMBER: 11323 ELEVATION: 615 base TOPO MAP: Chesterhill

STATE: Ohio COUNTY: Athens TOWNSHIP: Rome SECTION: SE¼ SW¼, 26

LOCATION: Exposures along B. & O. Railroad and relocation of Route 50 in SE¼ SW¼, section 26.

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
21	Monongahela	Benwood	Sewickley	Sandstone, light gray, weathers to pale olive and tan, fine to medium-grained, micaceous, including biotite with calcareous zones, mostly massive though stratified in part in thin zones, exposed.			20	0	20	0	112	0
20		Sewickley	Sewickley	Shale, light gray to light tan with limonite stain throughout with purple mottling in basal two feet, silty, sandy, micaceous, calcareous, with scattered limestone nodules, breaks with starch-like fracture except near top where it becomes fissile.			8	9	22	4	92	0
19				Clay shale, maroon mottled yellow and gray, silty, micaceous, calcareous, with some limestone nodules, breaks with starch-like fracture.			3	3			83	3
18				Shale, light bluish gray, weathering olive drab with considerable limonite stain in joints, silty, with few small limestone nodules, few slickensides, becomes more calcareous upward.			10	4			80	0

LOCATION: Ar 7 FILE NUMBER: 11323 - continued

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
17	Monongahela - continued	Fishpot	Fishpot	Clay shale, mottled gray, yellow, maroon, with some slickensides and numerous fossil plants in basal part.			0	8	17	8	69	8
16				Clay, gray to light gray with thin lensing streaks of coal and carbonaceous material.			0	1			69	0
15				Clay shale, light greenish gray to purple and maroon, with some yellow stains, finely micaceous in part, sandy in basal part, calcareous in basal part, with limestone nodules, breaks with a starch-like fracture.			4	10			68	11
14				Sandstone, light gray, fine, micaceous.			1	0			64	1
13				Shale, light greenish gray, silty, sandy, micaceous, calcareous, with numerous small limestone nodules.			1	3			63	1
12				Limestone, light gray, weathers to pale yellow or brown with an irregular spongy appearance, massive, dense, except basal 10 inches which has numerous ostracods.			5	9			61	10
11				Limestone and clay shale, gray to drab flat nodules of dense limestone embedded in greenish gray, soft clay shale with slight purplish streaks.			1	7			56	1
10				Clay shale, mottled pink, maroon, purple, yellow and gray, slightly micaceous, with numerous slickensides, somewhat fissile in basal inch or two.			2	6			54	6
9		Redstone	Redstone	Coal, thin coaly streaks and carbonaceous streaks irregularly interbedded in gray clay, which has numerous slickensides.			0	2	37	11	52	0
8				Clay, gray, silty, finely micaceous, breaks with starch-like fracture, very slightly plastic upon weathering.			0	10			51	10
7				Clay shale, greenish gray with some purplish to maroon mottling, finely micaceous, breaks with starch-like fracture, impure calcareous nodules in basal part.			2	0			51	0
6			Upper Pittsburgh	Shale-sandstone, light bluish gray, weathering pale olive with limonite stain, silty, sandy, micaceous shale interbedded with fine, silty, micaceous sandstone, base of this zone locally has clay and coal, thickness variable, grades laterally into sandstone, some small scattered calcareous siderite concretions, becomes entirely silty shale toward top.			15	6			49	0
5				Sandstone, light gray, weathering pale greenish to yellowish, fine, micaceous, massive, showing bedding and cross-bedding on weathering surfaces, calcite fillings in some joints, thickness variable. Base disconformable at west end - a lense cutting out bluish gray shale and bedded sandstone.			15	3			33	6
4				Shale, gray with very little limonite stain, silty, micaceous, thickness variable.			4	2			18	3
3		Pittsburgh	Pittsburgh	Shale, dark gray, slightly carbonaceous to bony at base, somewhat fissile, numerous fossil ostracods and fish remains.			0	6	14	1	14	1
2				Coal, some bright and blocky, with dull and shaly partings, weathers yellow, brown, or whitish, with some pyrite.			0	3			13	7
1			Upper Pittsburgh	Limestone, gray to light greenish gray, weathered light gray to yellow, some limonite stain, dense, nodular to irregularly bedded with thin shaly partings in top and bottom. Exposed zones of flinty appearing yellowish to brownish clay shale, exposed.			13	4			13	4

LOCATION KEY: Ar 8 FILE NUMBER: 11324 ELEVATION: 639 base TOPO MAP: Chesterhill

STATE: Ohio COUNTY: Athens TOWNSHIP: Rome SECTION: SW¼ SE¼, 12 through W½ NE¼ into the NE¼ SW¼, 11

LOCATION: Composite exposure south down road and in bed of Nell's Run, beginning 1/4 mile south of Big Run and continuing through abandoned road intersection 823 to top of hill from the SW¼ SE¼, section 12, through the W½ NE¼, into the NE¼ SW¼, section 11.

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
32	Washington	Little Washington	Mannington ?	Sandstone, gray to tan, exposed to hilltop.			3	2	14	3	270	0
31				Clay shale, maroon, irregularly bedded, breaks with starch-like fracture.			11	1			266	10
30		Waynesburg "A" - Waynesburg	Waynesburg "A"	Clay, light gray, limonite stained, plastic, carbonaceous streaks, micaceous.			0	2	74	1	255	9
29	Monongahela		Waynesburg - Gilboy	Sandstone, gray to tan, massive, fine to coarse-grained, limonite stained, micaceous exposed			73	11			255	7
28		Little Waynesburg		Clay shale, maroon, irregularly bedded.			1	11	23	2	181	8
27			Uniontown	Sandstone, gray to tan, massive, fine to coarse, limonite stained, micaceous.			20	3			179	9
26				Clay shale, maroon, thin-bedded, finely micaceous, silty.			1	0			159	6
25		Uniontown	Uniontown	Coal smut, weathered	0	0	0	2	41	3		
24				Clay, light gray, plastic.	0	1					158	6
23				Coal, much weathered.	0	1					158	5
22				Clay, light gray, limonite stained, somewhat plastic.			0	4			158	4
21			Arnoldsburg	Sandstone, gray to tan, massive to thin-bedded, limonite stained, micaceous.			4	10			158	0
20				Clay shale, maroon, irregularly bedded.			3	3			153	2
19				Sandstone, gray to tan, massive, limonite stained, base poorly exposed, micaceous.			15	4			149	11
18				Clay shale, tan to maroon, irregularly bedded to regular, slickensided, finely micaceous.			7	4			134	7
17		Arnoldsburg-Benwood	Arnoldsburg	Clay, light gray, limonite stained, somewhat plastic.			0	4	83	2	127	3
16				Coal, mostly dull, some bright, weathered.			0	5			126	11
15			Ritchie	Shale, gray to olive drab, mottled maroon, irregular bedded, slickensided, silty, starch like fracture.			19	2			126	6
14			Benwood	Limestone and shale, gray to tan, some mottled maroon, calcareous shales interbedded, limestone nodules up to 8 inches in diameter.			21	4			107	4
13			Sewickley	Sandstone, brown to tan, massive, coarse in part, micaceous, red zone.			29	10			86	0
12				Covered interval, much slumping, appears to contain mostly sandstone with some maroon shales in bottom part.			12	1			56	2
11		Sewickley	Sewickley	Shale, gray-green, sandy, some carbonaceous zones in lower 1 foot, exposed.			3	0	43	0	44	1
10				Clay, gray, plastic.	0	1½	4	3			41	1
				Coal, bony, some bright bands.	0	1½						
				Coal, bright, blocky.	1	5						
				Pyrite and boghead masses, irregular, hard	0	3						
				Coal, bright, blocky.	0	2						
				Clay shale, gray to dark gray with thin carbonaceous zones.	1	2						
				Coal, bright, blocky, underwater, reported to 2 feet, observed.	1	0						
9				Covered, limestone nodules found in slump but none in place.			3	10			36	10
8			Lower Sewickley	Sandstone, gray to blue-gray, fine, may be sandy lens in shale below, exposed.			1	0			33	0
7				Clay shale, blue to blue-gray, with some maroon mottling, silty, with scattered limestone nodules to 6 inches, nonbedded, more sandy upward.			26	5			32	0
6				Covered interval			1	9			5	7
5				Siltstone, gray to tan, limonite stained, thin to slabby bedded, micaceous, grades into shales below.			1	0			3	10

LOCATION: Ar 8 FILE NUMBER: 11324 - continued

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
4	Monongahela-continued	Sewickley - continued	Lower Sewickley - continued	Clay shale, maroon to greenish gray, irregular to regular bedded, sequence thus far very irregular, silty, sandy upward.			1	6			2	10
3		Fishpot	Fishpot	Clay shale, greenish gray, mottled with red, brecciated			0	3	1	4	1	4
2				Carbonaceous shale, dark gray to black, irregular bedded, weathered, coal horizon.			0	1			1	1
1				Limestone and shale, gray to blue-gray, interbedded, hard, dense, nodular limestone in greenish gray, calcareous shale, exposed.			1	0			1	0

LOCATION KEY: Ar 9 FILE NUMBER: 11325 ELEVATION: 588 base TOPO MAP: Chesterhill

STATE: Ohio COUNTY: Athens TOWNSHIP: Rome SECTION: SE¼, SW¼ and S½ SE¼, 32E

LOCATION: Exposure up road on southeast side of Lead Run, 0.55 mile east-northeast of mouth of Lead Run and 0.9 mile north-northeast of Frost.

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
16	Washington	Washington "A"	Lower Marietta	Sandstone and shale, light tan, fine-grained, silty, micaceous sandstone with heavy ledge at base but thin-bedded and shaly above with zone of tan and maroon shale near base.			25	4	44	9	306	0
15				Shale, variable, mostly chocolate brown below to light tan above, silty to sandy, micaceous, mostly laminated, poorly exposed toward base.			19	5			280	8
14		Washington - Waynesburg "A"	Washington	Shale, gray, silty, micaceous, laminated, carbonaceous, coaly streak at base, coal horizon.			0	3	119	8	261	3
13				Shale, clayey, variegated maroon, gray, green, purple, yellow, silty, massive, breaks irregularly, slickensided with small irregular impure limestone nodules scattered in basal part.			25	4			261	0
12				Shale, light tan with some limonite stain, silty, micaceous somewhat laminated, breaks irregularly.			3	6			235	8
11			Mannington - Waynesburg	Sandstone, variable, light gray to greenish gray, mostly weathered tan to olive or yellowish brown, medium to coarse-grained below, fine to medium upward, micaceous, calcareous near top, massive below, bedded above.			90	7			232	2
10	Monongahela	Waynesburg		Clay shale, variegated maroon, greenish gray, poorly laminated, silty, finely micaceous, weathers somewhat plastic, light gray clay at top.			6	10	24	2	141	7
9			Gilboy	Shale and sandstone, mostly olive drab with some limonite stain, silty, micaceous, laminated,shaly with several layers one foot thick of maroon shale and with fine silty, calcareous sandstone near top, poorly exposed in part.			17	4			134	9
8		Little Waynesburg	Little Waynesburg	Clay shale, gray, silty, finely micaceous, weathers somewhat plastic, carbonaceous, coaly streaks at top, coal horizon.			0	4	44	6	117	5
7				Clay shale, maroon to greenish gray, silty, finely micaceous, breaks irregularly to starch-like fracture.			4	11			117	1
6			Uniontown	Sandstone, light greenish gray with some limonite stain, fine-grained, silty, micaceous, ledges to several feet thick alternating with shaly zones, all show thin bedding on weathered surfaces and some cross-bedding, calcareous at top.			37	9			112	2
5				Shale, chocolate brown to maroon below, olive drab above, silty, micaceous, laminated			1	6			74	5

LOCATION: Ar 9 FILE NUMBER: 11325 - continued

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
4	Monongahela - continued	Uniontown	Uniontown	Clay, light gray to gray, silty, finely micaceous, somewhat plastic.			0	1	32	3	72	1
				Shale, gray, weathering tan, silty, argillaceous, fossiliferous (ostracods), coaly and carbonaceous at top.			0	3			72	10
3				Limestone and clay shale, light gray with some limonite stain, dense, brecciated, heavy bedded limestone in maroon variegated clay shale, covered in part.			29	6			72	7
2			Arnoldsburg	Shale, olive drab to tan with some limonite stain, silty, micaceous, laminated, breaks irregularly.			2	5			43	1
1		Arnoldsburg - Benwood	Arnoldsburg - Benwood	Limestone and clay shale, light gray to gray, or dull pale yellow, dense to partly crystalline, heavy bedded, limestone interbedded with varicolored clay shale, some limestone layers fossiliferous, freshwater.			40	8	40	8	40	8

LOCATION KEY: Ar 12 FILE NUMBER: 11326 ELEVATION: 691 ± base TOPO MAP: Chesterhill

STATE: Ohio COUNTY: Athens TOWNSHIP: Rome SECTION: SE¼ SE¼ through the SW¼ SE¼, 7

LOCATION: Exposure beginning in Rowell Run and extending south to cross roads then west up hill past Bethany Church.

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
17	Washington	Washington "A"	Lower Marietta ?	Sandstone, gray to tan, limonite stained, micaceous, massive, much bedding showing on weathered surfaces, exposed to hill top.			23	6	23	6	227	0
16		Washington	Washington	Clay shale, maroon, chippy.			0	0½	51	10	203	6
15				Clay, gray, plastic.			0	2½			203	5½
14				Clay shale, gray with maroon mottling, irregular, weathers somewhat plastic.			0	5			203	3
13			Mannington	Shale and sandstone, gray with much red, limonite stained and some small masses weathering out, sandstone is fine, quite micaceous, and irregular.			42	10			202	10
12				Sandstone, gray to olive drab, limonite stained, fine, micaceous, irregularly bedded.			8	4			160	0
11				Covered interval			16	3	16	3	151	8
10		Waynesburg "A"	Waynesburg	Sandstone, gray to buff, coarse below to fine above, massive ledge along road and in field, more shaly in zones above.			50	8	50	8	135	5
9	Monongahela	Waynesburg	Waynesburg	Coal horizon, gray clay shale with some calcareous zones, badly weathered.			0	1	34	3	84	9
8				Clay shale, gray to maroon, badly slumped, poorly exposed.			6	10			84	8
7			Gilboy	Sandstone, gray to buff, limonite stained, fine, almost a siltstone at the top, poorly exposed in part.			27	4			77	10
6		Little Waynesburg		Clay shale, gray and maroon, silty, badly slumped and poorly exposed at top.			10	6	43	11	50	6
5			Uniontown	Sandstone, gray to tan and olive drab, fine, micaceous, mostly thin or shaly bedded but some massive ledges to 1 foot and massive conglomeratic zones at top.			33	5			40	0
4		Uniontown	Uniontown	Clay shale, gray and maroon, platy below to more thick-bedded above, grades into sandstone above, some fossil plant impressions.			1	0	6	7	6	7
3				Clay, gray, somewhat plastic.			0	0½			5	7
2				Carbonaceous shale, black, argillaceous, some very thin coaly streaks.			0	1½			5	6½
1			Uniontown ?	Limestone and shale, gray, limonite stained, dense, fresh-water limestone in ledges up to 1 foot 6 inches in gray to tan clay shales exposed.			5	5			5	5

LOCATION KEY: Ar 16 FILE NUMBER: 11328 ELEVATION: 719 ± base TOPO MAP: Chesterhill

STATE: Ohio COUNTY: Athens TOWNSHIP: Rome SECTION: NE¼ SE¼, 29 to NW¼ SE¼, 30

LOCATION: This section begins just south of where stream crosses road in NE¼ SE¼, sec. 29, and continues up stream for 1/4 mile, then up road to road junction in NW¼ SE¼, section 30.

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
30	Monongahela	Waynesburg ?		Covered interval.			26	6	40	2	197	2
29				Clay shale, light greenish yellow to tan, some laminations, generally irregularly bedded, silty, micaceous, limonite stain.			4	4			170	8
28				Covered interval, evidence of some clay shales and sandstone.			9	4			166	4
27		Little Waynesburg		Clay shale, tan, brown, maroon, silty, breaks irregular, micaceous, these rock units are interbedded and gradational.			12	0	27	3	157	0
26			Uniontown	Sandstone and siltstone; sandstone, olive green, tan, massive, fine-grained, micaceous; siltstone, greenish-brown, tan, thin-bedded, micaceous, almost shaly in appearance.			14	0			145	0
25				Clay shale, light gray to tan, maroon, breaks irregular, silty, semi-plastic, micaceous, some limonite stain.			1	3			131	0
24		Uniontown	Uniontown	Coal, dull, badly weathered, probably fusain.	0	2	1	1	34	7	129	9
				Clay, gray to tan, semi-plastic, contains plant material, micaceous, slightly silty, in the middle of this unit there is a 1/4-inch bed of limonite.	0	4						
				Coal, dull and bright, blocky, some fusain near top, 1/2-inch clay parting 4 inches above bottom.	0	7						
23				Clay shale, gray to dark gray, breaks irregularly, silty, contains carbonaceous material, exposed.			0	8			128	8
22				Covered interval, in this interval there is some small outcrops of clay shale, maroon, tan, silty, micaceous.			18	0			128	0
21				Clay shale, maroon, tan, grayish-white, silty, micaceous, these rock types are all interbedded and gradational.			11	10			110	0
20			Arnoldsburg	Sandstone and siltstone, sandstone greenish yellow to olive green, fine-grained, massive, micaceous. Siltstone, greenish yellow to pale olive green, thinly bedded, very fine-grained, almost shaly, weatheres in a nodule-like form.			3	0			98	2
19		Arnoldsburg - Benwood	Arnoldsburg	Clay shale, light to dark gray with carbonaceous material, silty, micaceous, coal horizon.			0	2	92	8	95	2
18			Arnoldsburg - Benwood	Siltstone, greenish-yellow to light olive green, fine-grained, breaks irregular, non-bedded, micaceous, weathers in a nodule-like form.			4	4			95	0
17				Siltstone, olive green to greenish-tan, fine to medium-grained, thinly bedded at base becomes massive upward, micaceous.			4	6			90	8
16				Clay shale, maroon to red, breaks with chippy fracture, slightly silty, finely micaceous, fossiliferous ?			1	9			86	2
15				Siltstone, dark green to olive green, breaks into irregular 2-inch block, nonbedded, finely micaceous, fine-grained.			1	0			84	5
14				Limestone and clay shale; limestone, gray to grayish-white, yellow, mottled gray. (The yellow limestone is fretted and fossiliferous-ostracods, some of the gray limestone is conglomeratic), massive, crystalline in part. Clay shale, maroon, gray, tan, purple, calcareous, silty, some limestone nodules. These rock types are interbedded.			9	2			83	5
13				Siltstone, olive green to olive drab, breaks with irregular fracture, nonbedded, non-calcareous, highly micaceous, contains some limestone nodules.			4	0			74	3
12				Limestone and clay shale, gray to grayish white and yellow mottled gray, massive, partly crystalline (some of the yellow limestone is fretted), (some of the gray limestone is conglomeratic). The limestone occurs as 1 foot to 4 foot ledges. Clay shale, maroon, tan, gray, dark grayish black, calcareous, micaceous, silty.			28	3			70	3

LOCATION: Ar 16 FILE NUMBER: 11328 - continued

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
11	Monongahela - continued	Arnoldsburg - Benwood - continued	Arnoldsburg - Benwood - continued	Limestone, yellow, mottled gray, massive, contains many crystalline fillings, ledge-former, weathers a conspicuous yellow.			0	6			42	0
10				Clay shale, maroon, tanish-yellow, gray, breaks irregularly, calcareous, silty, micaceous, contains nodules of limestone, greenish-gray, massive, partly crystalline.			4	4			41	6
9			Sewickley	Sandstone and siltstone; sandstone, tan to olive green, fine to medium-grained, highly micaceous, massive to thin-bedded; siltstone, tan to olive green, thin-bedded, micaceous. These rock types are interbedded and gradational.			12	4			37	2
8				Clay shale, gray to light gray, breaks irregularly, calcareous, slightly micaceous, some limonite stain, weathers semi-plastic.			1	6			24	10
7				Sandstone, siltstone, shale; sandstone, gray, tan to olive green, medium to fine-grained, micaceous, forms ledge at base of unit; siltstone, tan to olive green, some gray, fine-grained, micaceous; shale, tan to gray, laminated, sandy, micaceous. All three rock types grade into each other and occur interbedded.			17	10			23	4
6				Shale and sandstone; shale, olive drab to olive green, sandy, micaceous, bedded to nonbedded; sandstone, olive drab to tan, medium-grained, thin-bedded, micaceous.			3	0			5	6
5		Sewickley	Sewickley	Clay shale, maroon, breaks in thin laminae, micaceous, slightly silty.			0	10	2	6	2	6
4				Clay shale, tan to gray, breaks irregularly, calcareous, micaceous, silty, weathers semi-plastic, some limonite stain.			0	3			1	8
3				Coal horizon.			-	-				
2				Clay shale, gray to dark grayish black, breaks irregularly, slightly silty, slightly micaceous.			0	3			1	5
1				Clay shale, maroon, mottled gray, with some gray layers, breaks with irregular fracture, silty, slightly micaceous, exposed.			1	2			1	2

LOCATION KEY: Ar 19 FILE NUMBER: 11331 ELEVATION: 643 ± base TOPO MAP: Chesterhill

STATE: Ohio COUNTY: Athens TOWNSHIP: Rome SECTION: 17

LOCATION: Exposure up nose of ridge past abandoned limestone quarry southeast side of Federal Creek and beginning just southwest of bridge over Federal Creek about 0.3 mile south of Kilvert, section 17, Rome Township.

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
56	Washington	Waynesburg "A"	Waynesburg	Sandstone, yellowish brown, medium to coarse, micaceous, friable, conglomeratic in part with quartz and feldspar pebbles, exposed.			13	6	13	6	238	4
55	Monongahela	Waynesburg - Little Waynesburg	Cassville	Shale, gray to dark gray, weathers yellowish brown, silty, micaceous, laminated, good fossil plants in part of thickness.			2	3	57	10	225	10
54			Waynesburg	Coal, smutty, weathered.			0	1			223	7
53				Clay shale, light gray to brownish yellow, weathers somewhat plastic.			3	3			223	6
52				Limestone, light gray to gray, dense, impure, nodular, nodules mostly less than 3 inches in diameter.			1	0			220	3
51				Clay shale, variegated, silty, breaks with starch-like fracture, poorly exposed.			4	0			219	3
50			Uniontown-Gilboy	Shale and sandstone, light olive gray to brownish yellow, silty, micaceous shale interbedded with layers of fine, silty, micaceous sandstone, possibly red shale layers near top, covered in part.			47	3			215	3

LOCATION: Ar 19 FILE NUMBER: 11331 - continued

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
49	Monongahela - continued	Uniontown	Uniontown	Clay shale, light gray to brownish yellow, weathered, somewhat plastic.			0	10	9	2	168	0
48				Coal, bony to shaly, thin bright streaks, weathered and slumped.			0	0½			167	2
47				Clay shale, gray to brownish yellow, somewhat plastic, micaceous, weathered.			0	2			167	1½
46				Coal, shaly to bony, some bright, weathered and slumped.			0	2½			166	11½
45				Clay shale, light gray to yellowish brown, slightly plastic, somewhat weathered.			0	3			166	9
44			Lower Uniontown	Shale, olive gray to brownish yellow, silty, micaceous, breaks into irregular flakes, poorly exposed.			7	10			166	6
43		?	?	Covered interval.			4	4	4	4	158	8
42		Lower Uniontown	Lower Uniontown	Shale, pale brown to dusky red, silty, micaceous, few fossil plants, laminated, exposed.			1	6	23	4	154	4
41				Clay shale, light gray to pale yellowish gray, slightly carbonaceous?, weathers somewhat plastic.			0	10			152	10
40				Limestone, light to dove gray, dense with crystalline masses, fossiliferous, a massive ledge.			0	9			152	0
39				Covered interval.			16	3			151	3
38			Arnoldsburg	Shale, dark red to chocolate brown, argillaceous to silty, micaceous, laminated to poorly laminated, nonbedded at base, some fossil plants, coal horizon.			4	0			135	0
37		Arnoldsburg - Benwood	Arnoldsburg	Covered interval, presumably variegated clay shale and small nodules of limestone, larger nodules on surface at 126 feet above base of exposure.			11	5	67	10	131	0
36				Limestone, olive gray to pale yellow, dense with some crystalline masses, nodular to bouldery.			1	7			119	7
35				Clay shale and limestone, variegated, calcareous clay shale and small nodules of limestone, poorly exposed.			5	2			118	0
34				Limestone, olive gray to pale olive gray, dense showing crystalline surfaces, silty, nodular.			0	7			112	10
33			Benwood	Clay shale and limestone, variegated, calcareous, clay shale and small nodules of limestone, poorly exposed.			9	3			112	3
32				Limestone, light gray, dense with crystalline masses, fossiliferous (ostracodes), nodular layers in shale.			7	10			103	0
31				Limestone, light yellow with light gray masses, crumbly, dense with calcite veinlets and masses, somewhat clayey, fossiliferous (ostracodes), heavy to massive-bedded, nodules at top, light olive shale partings, formerly quarried.			15	2			95	2
30				Clay shale, variegated light gray to red, calcareous, massive, breaks irregular to starch-like.			2	8			80	0
29				Clay, light gray to gray, with coaly masses and streaks, silty, crumbly.			0	1			77	4
28				Shale, light olive gray, silty, micaceous, massive, breaks with irregular starch-like fracture.			2	1			77	3
27			Sewickley	Sandstone, similar color to shale below but more olive, fine or fine to medium, silty, heavy bedded, showing thinner bedding on weathered surfaces.			5	2			75	2
26				Shale, pale olive to light yellowish brown, silty, finely micaceous, laminated.			6	10			70	0

LOCATION: Ar 19 FILE NUMBER: 11331 - continued

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
25	Monongahela - continued	Sewickley	Sewickley	Clay, light to pale olive or pale yellowish olive mixed with carbonaceous and coaly material.			0	2	21	8	63	2
24				Clay shale, light to olive gray and brownish yellow, silty, micaceous, massive, breaks with starch-like to irregular fracture.			1	0			63	0
23				Clay shale, dusky to brownish red, silty, micaceous, massive, breaks irregular to starch-like.			6	0			62	0
22			Lower Sewickley	Shale and sandstone, pale olive to olive or yellow, fine, silty, micaceous, bedded sandstone and silty to sandy, micaceous, laminated shale.			14	6			56	0
21		Fishpot	Fishpot	Shale, dusky to chocolate brown, silty, micaceous, fossiliferous (clams), laminated.			0	10	31	6	41	6
20				Clay, light gray to light yellowish gray, slightly plastic, coal horizon.			0	1			40	8
19				Clay, light gray to pale olive, slightly carbonaceous, coal horizon.			0	1			40	7
18				Clay shale, yellowish olive gray, silty, finely micaceous, massive, breaks irregular to starch-like.			1	2			40	6
17				Limestone, light gray to gray, weathering light gray, dense, fossiliferous (ostracods), nodular, nodules mostly less than 2-3 inches in size, embedded in clay shale, light gray above and red below.			3	4			39	4
16				Covered interval.			13	6			36	0
15				Limestone, pale yellowish gray, weathering light gray, dense, with small crystalline masses, nodular to bouldery.			2	8			22	6
14				Sandstone, pale olive with some brownish yellow stain, fine to medium, silty, micaceous, heavy bedded, 4-5-inch "fucoid" layer			0	10			19	10
13				Shale, pale olive to tan, silty, sandy, micaceous, weathered.			1	0			19	0
12				Covered interval			2	9			18	0
11				Limestone, light yellowish orange to moderate yellowish brown, dull clayey, nodular layers, fretted appearance on weathering.			2	0			15	3
10			Pomeroy	Shale, light olive gray to dull reddish brown at base, argillaceous to silty, finely micaceous, laminated.			3	3			13	3
9		Redstone		Clay shale, light gray to very pale yellow.			0	1	10	0	10	0
8			Redstone Rider ?	Clay shale, gray, slightly carbonaceous, micaceous.			0	0½			9	11
7			?	Clay shale, light olive gray, argillaceous, finely micaceous, poorly laminated, breaks irregularly.			0	8			9	10½
6				Sandstone, light olive to brownish yellow, fine, silty, micaceous, thin-bedded.			3	2			9	2½
5			Redstone "roof shale"	Shale, reddish brown, laminated, platy, fossil plants, locally present.			0	3			6	0½
4			Redstone	Clay, gray to brownish yellow, micaceous, carbonaceous, slightly plastic, coal horizon.			0	1½			5	9½
3				Clay shale, light olive gray mottled with dusky red to dusky brown, silty, micaceous, massive, breaks with irregular fracture, starch-like			3	0			5	8
2				Limestone, light brownish yellow, impure with thin calcite veins, nodular, some fretted appearance on weathering.			1	0			2	8
1				Shale, pale olive to dull yellowish brown, silty, micaceous, massive, tends to break in flattened irregular chips.			1	8			1	8

LOCATION KEY: Ar 2 FILE NUMBER: 11465 ELEVATION: 628 base TOPO MAP: Chesterhill

STATE: Ohio COUNTY: Athens TOWNSHIP: Rome SECTION: E. near center, 10

LOCATION: Section exposed along road, 1.3 miles northwest of Beebe and 1.5 miles northeast of Stewart.

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
24	Washington	Washington – Little Washington		Shale, gray to tan, some maroon mottling, argillaceous, exposed to hill top.			9	0	79	1	300	0
23			Lower Washington-Mannington	Sandstone, gray to tan, limonite stained, coarse, massive, shows some bedded on weathering, micaceous, finer at top.			70	1			291	0
22		Waynesburg "A"		Clay shale, light gray, limonite stained, silty, some sandy zones up to 1/4 inch.			1	3	51	0	220	11
21			Waynesburg "A"	Carbonaceous shale, some thin bright streaks, weathered.			0	1			219	8
20				Clay shale, gray, limonite stained, silty.			1	6			219	7
19			Waynesburg	Sandstone, gray to greenish, limonite stained, medium to coarse, massive.			6	1			218	1
18				Shale, gray to olive drab, limonite stained, micaceous, silty to sandy, thin-bedded.			12	0			212	0
17				Shale, maroon, limonite stained, argillaceous, many small nodules of fresh-water limestone in lower 2 feet.			10	0			194	0
16				Sandstone, gray to tan, limonite stained, fine, micaceous, thin to slabby bedded.			20	1			184	0
15	Monongahela	Waynesburg	Cassville	Clay shale, maroon, slightly silty, micaceous			0	6	25	11	163	11
14			Waynesburg	Coal horizon, carbonaceous, coaly shale, dull, poorly developed.			0	1			163	5
13				Clay shale, gray to light gray, silty, some carbonaceous specks.			0	5			163	4
12			Gilboy	Shale, gray to greenish gray with maroon mottling and limonite stains, silty to sandy, micaceous.			5	11			162	11
11				Sandstone, red to brown, coarse, friable, quartz pebbles in base, fine grained, massive above, coal smut at base.			19	0			157	0
10		Little Waynesburg	Uniontown	Shale, varicolored, tan, red, chocolate, micaceous, platy or fissile, weathered.			14	10	14	10	138	0
9		Uniontown	Uniontown	Coal, bright and dull, interbedded in thin laminae, weathered, soft.			0	6	18	4	123	2
8				Clay shale, gray to dark gray, silty, micaceous, soft and almost plastic, fossiliferous (ostracods, gastropods).			0	6			122	8
7			Uniontown	Clay shale and limestone, light gray to varicolored with brown and yellow stain, breaks with starch-like fracture, with nodular light gray limestone, poorly exposed.			12	6			122	2
6			Arnoldsburg	Sandstone, light greenish gray to green with some limonite stain, fine, silty, micaceous, massive at top, thin below.			4	10			109	8
5		Benwood – Arnoldsburg	Benwood – Arnoldsburg	Limestone and clay shale, light gray to tan, dense limestone, nodular at top and bottom, embedded in varicolored clay shale with starch-like fracture, middle part massive to irregularly bedded, formerly quarried.			44	8	52	2	104	10
4				Shale, bluish gray to greenish gray with limonite stains, silty, micaceous to sandy shale, few fossil plants in base.			7	8			60	2
3		Sewickley ?	Sewickley ?	Clay shale, varicolored, gray to light gray mottled maroon, purple, tan, silty, micaceous, breaks with starch-like fracture, slickensided, exposed.			9	4	42	10	52	8
2			Lower Sewickley ?	Sandstone, light bluish gray, weathering to tan, with some limonite stain, fine, silty, micaceous, calcareous in lower part, thin-bedded throughout, shaly in part.			33	6			42	4
1		Fishpot ?	Fishpot ?	Limestone, light gray or gray, weathering pale tan, dense, silty, sparingly and finely micaceous, bedded in layers 1 to 6 inches thick, interbedded with light gray to tan, argillaceous to silty, micaceous shale zones.			8	10	8	10	8	10

LOCATION KEY: Ar 13 FILE NUMBER: 11467 ELEVATION: 744 base TOPO MAP: Chesterhill

STATE: Ohio COUNTY: Athens TOWNSHIP: Rome SECTION: NW¼ NW¼, 30 to NE¼ SE¼, 25

LOCATION: Exposure along road (mostly abandoned) beginning at road junction in NW¼ NW¼, section 30 and extending east and northeast to 936 road junction in NE¼ SE¼, section 25, Bern Township. 85 feet of sandstone east of 936 road junction with 10 feet of maroon clay shale at 30 feet above base, soil sandy.

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
20	Washington	Waynesburg "A"	Waynesburg	Sandstone, light gray, mostly limonite stain, fine to medium, micaceous, coaly streaks in base, bedded at base, massive above showing some bedding on weathered surfaces, friable.			40	0	40	0	202	9
19	Monongahela	Waynesburg	Waynesburg	Coal, bony, shaly, thin, bright, somewhat weathered, thickness variable.	0	1	1	0	24	6	162	9
				Sandstone, mostly limonite stained, medium micaceous, carbonaceous.	0	2						
				Clay shale, dove gray with limonite stains, somewhat silty, fine micaceous, laminated, numerous fossil plants, thin coal lenses.	0	8						
				Coal, bony, shaly, some bright streaks, somewhat weathered.	0	1						
18				Clay shale, light gray with considerable limonite stain, somewhat silty, finely micaceous, non-plastic, somewhat plastic at top.			6	3			161	9
17				Clay shale, maroon, silty, micaceous, breaks irregularly.			6	4			155	6
16			Gilboy	Sandstone, light gray mostly, somewhat limonite stained, fine to medium, silty in part, micaceous, thin to heavy bedded.			7	2			149	2
15				Shale, chocolate brown to maroon, interbedded with olive drab, some limonite stain, silty, micaceous, mostly laminated but st breaks irregularly near base.			3	9			142	0
14		Little Waynesburg	Little Waynesburg	Clay shale, gray with black carbonaceous fragments, silty, micaceous, breaks irregularly, coal horizon.			0	1	33	7	138	3
13				Clay shale, mottled yellow, gray, maroon, mostly yellowish gray at top, silty, micaceous, breaks irregularly.			10	2			138	2
12			Uniontown	Siltstone, tan to olive, sandy, micaceous, grades upward into massive sandstone.			23	4			128	0
11		Uniontown	Uniontown	Clay, light gray with limonite stain, somewhat plastic.			0	2	31	0	104	8
10				Coal, dull, with bright streaks, weathered.			0	0½			104	6½
9			Ritchie	Clay shale and limestone, light gray, silty, micaceous, poorly laminated with 4-6-inch nodular layer of dense, dove gray limestone.			2	0			104	6
8				Sandstone, tan to olive, silty, fine, micaceous, massive showing bedding.			2	2			102	6
7				Clay shale, maroon, mottled greenish or grayish, silty, micaceous, weathers somewhat plastic.			13	0			100	4
6			Arnoldsburg	Sandstone, light greenish gray with some limonite stain, fine to medium, micaceous, thin-bedded.			12	4			87	4
5				Shale, chocolate brown to maroon, laminated, silty, finely micaceous, somewhat limonite stained.			1	1			75	0
4				Clay shale, light gray, laminated, finely micaceous, semi-plastic.			0	2			73	11
3		Arnoldsburg - Benwood	Arnoldsburg	Shale, gray to dark gray, laminated, argillaceous, finely micaceous, carbonaceous fragments, limonite stained, coal horizon.			0	1	73	9	73	9
2			Arnoldsburg - Benwood	Limestone and clay shale, gray to light gray, dense with small crystalline masses, fossiliferous, nodular or heavy-bedded limestone in variegated clay shale, some zones mostly clay shale locally with zones of greenish silty shale.			35	2			73	8
1			Sewickley	Sandstone and shale, light greenish gray with some limonite stain, fine to medium, micaceous, calcareous, bedded sandstone interbedded with lenses and layers of light greenish to bluish, sandy, silty, micaceous shale, few fossil plants, exposed.			38	6			38	6

LOCATION KEY: Ar 23 FILE NUMBER: 11470 ELEVATION: 617 base TOPO MAP: Chesterhill

STATE: Ohio COUNTY: Athens TOWNSHIP: Rome SECTION: NW¼, 22

LOCATION: Composite section beginning at bridge east of 651 road intersection and extending northeast along second order tributary to Sharps Run in NW¼, section 22.

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
37	Washington	Waynesburg "A"	Waynesburg	Sandstone and conglomerate, light brown to dark yellowish brown to pale yellowish or grayish orange, coarse, micaceous, friable, coarse to medium, conglomeratic near base, quartz and feldspar pebbles to 2 inches, mostly less than 1 inch.			35	0	36	6	300	8
36				Clay shale, light gray to light yellowish brown, silty, micaceous, sandy, breaks irregular to starch-like, slightly plastic.			1	6			265	8
35	Monongahela	Waynesburg	Waynesburg	Coal, smutty, weathered, mixed with clay shale.			0	1	18	10	264	2
34				Clay shale and limestone, dusky yellow to pale olive to pale brown, silty, micaceous, starch-like clay shale and small nodules of dense, sandy, micaceous limestone.			3	7			264	1
33			Gilboy	Siltstone and sandstone, pale olive to dusky yellow or grayish brown, micaceous, thin-bedded siltstone interbedded upward with thin zones of similarly colored silty, micaceous, fine sandstone.			15	2			260	6
32		Little Waynesburg	Little Waynesburg	Shale, moderate brown to dark reddish brown, silty, finely micaceous, laminated, coal horizon at base?			0	6	43	5	245	4
31			Waynesburg	Clay shale and limestone, varicolored, moderate greenish yellowish to moderate yellow and moderate brown, calcareous, finely micaceous clay shale with nodular, pale olive to yellowish brown, dense, fossiliferous limestone in base.			5	10			244	10
30			Uniontown	Sandstone, pale olive to dark yellowish brown, fine, silty, micaceous, mostly thin-bedded and shaly appearing.			32	0			239	0
29				Siltstone, moderate olive brown to grayish olive, micaceous, sandy, laminated, grades upward into sandstone.			5	1			207	0
28		Uniontown	Uniontown	Clay. Coal horizon?			0	1	26	11	201	11
27			Ritchie	Clay shale, varicolored, grayish olive, dark reddish brown, silty, very slightly micaceous, massive, breaks irregular to starch-like shale with small nodules of pale red to moderate reddish orange, dense limestone.			21	5			201	10
26			Arnoldsburg	Shale, similar to that between and below sandstone.			1	2			180	5
25				Sandstone, light olive gray to pale olive, fine, silty, micaceous, calcareous with calcite masses with embedded septaria of light olive, gray, dense limestone, flattened and rounded to 8-10 inches in length.			1	0			179	3
24				Shale, dark yellowish brown to dark yellowish orange, sandy, silty, finely micaceous, laminated.			0	10			178	3
23				Sandstone, like that second above but lacking septaria.			0	9			177	5
22				Shale, like that between sandstones above but only silty.			1	8			176	8
21		Arnoldsburg	Arnoldsburg	Shale, grayish brown to pale red, silty, micaceous, laminated, fossiliferous.			0	5	15	5	175	0
20				Clay shale, pale olive to light olive gray, finely micaceous, slightly carbonaceous at top, laminated, coal horizon.			0	1			174	7
19				Shale, light olive gray to grayish olive, weathering to moderate brown, silty, micaceous, massive, weakly laminated.			0	4			174	6
18			Arnoldsburg	Limestone and clay shale, varicolored yellowish orange to grayish orange, pale yellowish brown, pale olive, etc., nodular except for 3-4-inch layer at base, dense limestone in pale red, silty, very finely micaceous clay shale, breaking irregularly to starch-like.			12	3			174	2
17			Fulton ?	Siltstone, grayish olive, weathering to pale brown, finely micaceous, poorly laminated, noncalcareous.			2	4			161	11

LOCATION: Ar 23 FILE NUMBER: 11470 - continued

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
16	Monongahela - continued	Benwood	Benwood	Clay shale and limestone, varicolored, grayish yellow to yellowish gray, grayish red to pale red or pale brown, calcareous, very finely micaceous, massive breaking irregularly, mostly nonplastic clay shale with scattered small nodules of pale yellowish brown, dense limestone.			17	0	72	0	159	7
15				Limestone, light yellowish gray to pale yellowish brown, dense with small crystalline masses, heavy to massive bedded.			4	2			142	7
14			Sewickley	Siltstone and sandstone, light olive gray, weathering pale to light brown, micaceous, shaly siltstone with layers up to 3 feet thick of similarly colored, silty, micaceous, bedded sandstone.			20	10			131	5
13				Shale, olive gray weathering moderate brown to dark yellowish orange, becomes clayey at top, massive, breaks irregularly to starch-like, darker thin zone at top.			5	3			110	7
12				Siltstone, pale olive to olive gray, weathering pale yellowish brown to brown, sandy, micaceous, massive, breaks irregularly (possible coal horizon near base in next ravine to north).			11	6			105	4
11				Sandstone, light gray to pale olive, fine to medium, micaceous, massive, showing some bedding on weathered faces.			6	3			93	10
10		Sewickley	Sewickley	Shale, olive gray to light olive gray, silty, finely micaceous, massive, breaking with an irregular starch-like fracture.			1	9	47	9	87	7
9				Limestone and shale, light olive gray to pale olive, dense, small nodular limestone weathering moderate brown to yellowish brown and embedded in similarly colored, silty, micaceous shale.			3	1			85	9
8				Clay shale, very dusky red to light olive gray, weathering to brownish gray, silty, finely micaceous, calcareous, breaks with coarse starch-like fracture.			9	5			82	8
7				Limestone, light olive to pale olive gray, dense, with very small crystalline masses, nodular to bouldery limestone in pale olive, calcareous shale.			4	0			73	3
6			Lower Sewickley	Sandstone, pale olive gray to light brown, calcareous, micaceous, fine to medium, a single massive ledge.			0	8			69	3
5				Covered interval.			8	7			68	7
4				Sandstone, yellowish gray to moderate greenish yellow or pale to grayish olive, medium to coarse, calcareous, micaceous, cross-bedded near base, massive or bedded above.			20	3			60	0
3		Fishpot	Fishpot	Shale, dark olive gray, grainy, silty, coal horizon at top.			1	6	39	9	39	9
2				Clay shale and limestone, varicolored, light gray to yellowish clay shale, containing nodules and small boulders of light olive gray or yellowish, dense limestone.			16	9			38	3
1			Pomeroy	Sandstone, light yellowish to light brownish gray to moderate yellowish brown, coarse below to medium above, massive to bedded above, micaceous below to very micaceous upward, thickness apparently variable, exposed.			21	6			21	6
				Level of creek.								

LOCATION KEY: Ar FILE NUMBER: 11607 ELEVATION: 637 base TOPO MAP: Chesterhill

STATE: Ohio COUNTY: Athens TOWNSHIP: Rome SECTION: SE¼ SW¼, 9

LOCATION: Section is measured south up ravine.

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
18	Washington	Little Washington	Mannington	Sandstone, coarse, conglomeratic, exposed in vertical cliff and shelter cave.			20	0	29	0	189	10
17				Covered.			9	0			169	10
16				Shale, gray, bedded.			2	0			160	10
15		Waynesburg "A"	Waynesburg "A"	Clay, gray, plastic, pinches out in exposure 10 feet long. Coal horizon.			0	0½	41	6	158	10
14				Shale, red, mottled purple, gray at top, nonbedded.			5	0			158	9
13				Covered.			23	9			153	9
12			Waynesburg	Shale and siltstone, gray, evenly thin bedded			11	0			130	0
11				Shale, blue-gray, thin-bedded, less silty than above.			1	8			119	0
10	Monongahela	Waynesburg	Waynesburg	Shale, coaly, clayey, coal horizon.			0	6	16	8	117	4
9				Clay shale, dark gray.			4	1			116	10
8			Gilboy	Sandstone, lower 2 feet massive, upper part irregularly bedded, fine-grained, silty.			6	3			112	9
7				Sandstone, shaly, gray to greenish gray, platy.			5	10			106	6
6		Little Waynesburg		Clay, blue-gray, smut.			0	2	30	8	100	8
5				Shale, red, blocky.			9	6			100	6
4			Uniontown	Shale, blue-gray, even-bedded, and sandstone, blue-gray, shaly, approximately 5 feet.			21	0			91	0
3		Uniontown, Arnoldsburg - Benwood - undifferentiated	Uniontown	Coal, good, reported to have been worked locally.			1	0	70	0	70	0
2			Arnoldsburg - Benwood	Limestone and calcareous shale, mottled.			39	0			69	0
1			Sewickley	Sandstone, medium to massive bedded, medium-grained, partly covered.			30	0			30	0

LOCATION KEY: Ar 21 FILE NUMBER: 11645 ELEVATION: 622 base TOPO MAP: Chesterhill

STATE: Ohio COUNTY: Athens TOWNSHIP: Rome SECTION: SW¼, 31

LOCATION: Exposure in bed of Butts Run and up hill across from farm house.

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
21	Monongahela	Benwood	Sewickley	Shale and sandstone, exposed to top of first nose on hill above sandstone ledge in creek.			15	0	15	0	140	0
20		Sewickley	Sewickley	Clay shale, dusky red, weathers to dust, slightly calcareous.			5	0	24	1	125	0
19			Lower Sewickley	Shale and sandstone, olive gray to tan, fine micaceous, sandstone in irregular ledges to 1' 8", irregular bedding.			19	1			120	0
18		Fishpot	Fishpot	Clay shale, dusky red, mottled gray and purple, weathers to dust, small scattered limestone knots, massive.			7	6	19	8	100	11
17				Limestone, olive gray, nodular, impure, weathers deep purple and red.			1	0			93	5
16			Fishpot or Pomeroy	Sandstone, olive gray, fine to medium, shaly-bedded, some massive near top, calcareous in upper foot.			11	2			92	5
15		?	Redstone ?	Covered interval, with some nodules of yellow fretted limestone below and light gray nodules above.			11	3	11	3	81	3
14		Redstone	Redstone	Limestone and shale, light gray shales with small irregular nodules of light gray limestone exposed.			3	6	37	9	70	0
13			Upper Pittsburgh	Sandstone, light olive gray to tan, fine to medium, massive ledge in creek, shaly and calcareous near top.			33	10			66	6

LOCATION: Ar 21 FILE NUMBER: 11645 - continued

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
12	Monongahela - continued	Redstone - continued	Upper Pittsburgh - continued	Shale, light olive, weathering light yellowish brown, argillaceous to sandy, micaceous, sandy zones (varies laterally due to uneven sandstone above.)			0	5			32	8
11		Pittsburgh	Pittsburgh	Shale, dark gray to black, carbonaceous, micaceous.			0	2	26	0	32	3
10				Coal, bright, blocky, dull partings.			0	4			32	1
9			Upper Pittsburgh	Limestone and shale, olive gray to dark olive gray, weathering yellowish brown, dense, impure, nodular limestone with shaly and coaly parting and lenses.			0	9			31	9
8				Shale, olive gray to yellowish brown at top, silty, micaceous, poorly laminated, breaks irregularly.			1	2			31	0
7				Limestone and shale, gray to dark gray, dense, massive, heavy-bedded limestone interbedded with layers of light olive green to olive green, silty, micaceous, grainy or smooth, laminated to poorly laminated shale			3	2			29	10
6				Limestone, gray to dark gray weathering lighter gray, dense, heavy-bedded in layers 1 foot or more thick with few irregular shaly partings.			4	2			26	8
5				Shale and limestone, light olive gray to olive gray with yellowish brown stain, silty, sandy, micaceous shale, breaks with irregular starch-like fracture, and with nodular impure limestone layer 3 to 4 inches thick and small limestone nodules in top part.			2	3			22	6
4			Lower Pittsburgh	Sandstone and shale, olive gray to yellowish brown, fine, silty, micaceous, irregularly bedded sandstone with lenses and zones of similarly colored, silty, micaceous shale and nodular masses of ferruginous limestone scattered along fractures and bedding planes, base uneven.			7	6			20	3
3				Clay shale, variegated, gray, yellowish-brown, light yellowish-orange to shades of red, dense, flinty appearing, slickensided, massive, breaks with starch-like fracture, few scattered ferruginous limestone nodules in base, thickness variable.			6	6			12	9
2	Conemaugh	Upper Little Pittsburgh	Upper Little Pittsburgh	Shale, dark gray and black, micaceous, silty, carbonaceous?, breaks irregularly, coal horizon?			0	1	6	3	6	3
1				Clay shale and limestone, variegated, mottled dark gray, gray, olive gray, purple, yellowish brown, etc., silty, micaceous, grainy, massive, clay shale breaking with a starch-like fracture and containing scattered nodules and veinlets of pyritiferous, gray limestone, slickensided, exposed.			6	2			6	2

LOCATION KEY: Ar 22 FILE NUMBER: 11646 ELEVATION: TOPO MAP: Chesterhill

STATE: Ohio COUNTY: Athens TOWNSHIP: Rome SECTION: 14

LOCATION: Exposure along road beginning at 615 road junction and extending southeast to vicinity of Evergreen Grocery near top of hill .

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
29	Washington	Little Washington-Waynesburg "A"	Waynesburg - Mannington	Sandstone, light gray to tan or pale yellowish, coarse below becoming finer upward, micaceous, friable, with conglomeratic zones in coarse part, massive below, bedded upward, Waynesburg.			66	6	87	8	232	2
28				Sandstone, tan to yellowish brown, fine, micaceous, silty and argillaceous, bedded, not well exposed, spring zone at base.			21	2			211	0
27	Monongahela	Waynesburg	Waynesburg	Clay shale, mottled red, yellow, and light gray, poorly exposed.			5	3	25	9	205	9

LOCATION: Ar 22 FILE NUMBER: 11646 - continued

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
27	Monongahela - continued	Waynesburg - continued	Gilboy	Shale and sandstone, light greenish gray weathering olive to drab, silty, micaceous shale, or siltstone with layers of fine, silty micaceous sandstone.			20	0	25	9	185	9
26				Shale, dusky red to reddish brown, silty, micaceous, poorly laminated.			0	6			185	3
25		Little Waynesburg	Little Waynesburg	Coal, smutty, in carbonaceous clay shale.			0	1	23	1	185	2
24				Clay, greenish to dark gray, fractures irregularly, slickensided, weathers somewhat plastic.			0	3			184	11
23				Clay shale, mottled light greenish gray and reddish, silty, micaceous, massive, breaks irregularly to starch-like fracture.			2	4			182	7
22			Uniontown	Sandstone, olive gray, fine, silty, micaceous, calcareous at top, massive.			20	5			162	2
21		Uniontown	Uniontown	Shale, dusky red to reddish brown, silty, micaceous, laminated, with fossil plants.			0	8	31	9	161	6
20				Clay, light gray, slightly plastic, coal horizon.			0	2			161	4
19			Ritchie	Clay shale and limestone, dusky red below to olive gray above, some mottling, massive shale, with starch-like fracture and few small scattered ferruginous and limestone nodules toward top.			9	0			152	4
18			Arnoldsburg	Sandstone and shale, light olive to greenish gray, silty to sandy, micaceous shale and like-colored silty, micaceous, thin-bedded sandstone, heavy-bedded upward.			21	11			130	5
17		Arnoldsburg	Arnoldsburg	Clay, light gray with much limonite stain, laminated, micaceous, smooth.			0	9	14	3	129	8
16				Coal, shaly with numerous bright streaks, slumped and weathered.			0	2			129	6
15				Clay, light gray with some yellowish brown stain, micaceous, slightly plastic.			0	4			129	2
14				Shale, gray, argillaceous to silty, micaceous, massive, exposed.			0	3			128	11
13				Covered interval			10	3			118	8
12			Arnoldsburg ?	Shale, light olive to tan with some yellowish brown stain, argillaceous to silty, micaceous, massive, breaks irregularly.			2	6			116	2
11		Benwood ?	Tyler Reds	Clay shale and limestone, variegated, various shades of gray and red with small scattered limestone nodules, weathers soft to semi-plastic, poorly exposed.			21	6	67	7	94	8
10				Limestone, light gray to yellowish, dense, bedded in layers 6 to 8 inches thick, poorly exposed.			9	0			85	8
9			Sewickley	Sandstone and shale, light greenish gray to pale olive, with considerable limonite stain, fine to medium, micaceous, bedded to heavy bedded sandstone and argillaceous, micaceous shale, massive sandstone near top.			31	6			54	2
8				Shale, dusky red, platy, silty, micaceous, fossiliferous (estheria)			5	7			48	7
7		Sewickley	Sewickley	Clay, light greenish gray, carbonaceous, weathers somewhat plastic, coal horizon.			0	1	24	1	48	6
6				Clay shale and limestone, mottled red to greenish or yellowish gray, massive clay shale with small scattered nodules of light gray limestone, covered in part.			24	0			24	6
5		Fishpot	Fishpot	Limestone and shale, both light gray, nodular to bouldery, dense, fossiliferous (ostracods) limestone in silty, micaceous bedded shale.			2	11	21	7	21	7
4				Sandstone, light gray, fine, calcareous, micaceous, heavy-bedded.			0	10			20	9
3				Limestone, light to pale yellowish-gray dense, in layers 3 to 4 inches thick, fossiliferous (ostracods), exposed.			0	6			20	3
2				Covered interval.			11	9			8	6
1			Pomeroy	Sandstone and shale, both light greenish gray, argillaceous, micaceous, bedded shale below overlain by fine, silty, micaceous, bedded sandstone, exposed.			8	6			8	6

TRIMBLE TOWNSHIP

LOCATION KEY: At 2 FILE NUMBER: 6674 ELEVATION: 693 base TOPO MAP: New Lexington

STATE: Ohio COUNTY: Athens TOWNSHIP: Trimble SECTION: N½, 6

LOCATION: Exposures in northeast-trending gully, east of Burr Oak

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
17	Conemaugh	Duquesne	Skelley	Sandstone, gray, fine to medium-grained, ferruginous, micaceous, calcareous, weathers yellowish-brown, some arenaceous limestone, sparingly fossiliferous.			1	2	2	2	236	9
16			Duquesne ?	Clay, light gray, plastic, exposed			1	0			235	7
15		?	?	Covered interval.			30	7	30	7	234	7
14		Gaysport	Gaysport	Shale, gray, weathers buff, finely micaceous, becomes sandy upward, poorly exposed in part.			26	2	26	2	204	0
13		Ames	Ames	Limestone, light gray with pinkish mottling and small green spots, weathers brownish, dense with crystalline flakes, massive, single layer, fossiliferous, marine.			1	6	3	10	177	10
12				Shale, gray, argillaceous, weathered.			1	3			176	4
11				Clay, light gray to buff, thin black carbonaceous streak at top.			0	3			175	1
10				Shale, black, carbonaceous, weathered.			0	4			174	10
9				Clay shale, gray to buff, weathered, exposed.			0	6			174	6
8		Harlem and Upper Bakerstown and Anderson	?	Slumped and covered interval, light gray to buff, red or dark gray clay shale, sandstone slumped to a sharp degree, scattered nodules of rough appearing, fossiliferous, marine limestone, not Ames.			76	6	76	6	174	0
7		Anderson	Bakerstown	Shale, light gray with ferruginous stain, micaceous, arenaceous, poorly exposed in part.			12	3	12	3	97	6
6		Wilgus and Brush Creek	Cambridge ?	Limestone, greenish gray, weathers buff to brownish, nodular to massive, sparingly fossiliferous, marine.			0	4	38	6	85	3
5			?	Shale and sandstone, gray, stained somewhat yellowish to brownish, shale with zones of interbedded fine, micaceous and shaly sandstone, basal part poorly exposed and with fossil plants and thin irregular partings of coal.			38	2			84	11
4		Mason ?	Mason ?	Clay, light gray, stained buff in part, plastic, exposed.			1	6	1	6	46	9
3		?	?	Covered interval.			18	3	18	3	45	3
2		Mahoning	Lower Mahoning	Sandstone, light gray, stained yellowish to brownish, massive showing bedding and cross-bedding on weathered faces, coarse with fine and medium-grained (graded), micaceous, friable, becomes finer grained and shaly upward.			25	6	25	6	27	0
1	Allegheny	Upper Freeport	Upper Freeport	Shale, weathered buff to brownish, micaceous, arenaceous, thin layer of plastic clay at top, thickness variable, exposed. Creek level.			1	6	1	6	1	6

LOCATION KEY: At 3 FILE NUMBER: 6675 ELEVATION: 707 base TOPO MAP: New Lexington

STATE: Ohio COUNTY: Athens TOWNSHIP: Trimble SECTION: NW¼, 4

LOCATION: Exposures along road from house east of 711 road intersection toward Bishopville. Measured section extends for 0.5 mile along road.

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
18	Conemaugh	?	?	Soil and weathered shale.			3	0	3	0	161	10
17		Ames	Ames	Limestone, light gray, dense, massive, fossiliferous, marine, single layer			1	6	23	5	158	10
16				Underclay, light gray, mottled with buff and pink.			0	6			157	4
15				Shale, gray to buff, argillaceous toward top and arenaceous toward bottom.			3	2			156	10

LOCATION: At 3 FILE NUMBER: 6675 - continued

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
14	Conemaugh - continued	Ames - continued	Ames - continued	Sandstone, gray weathered yellowish to brownish, fine to medium-grained, micaceous, thin and cross-bedded.			5	5			153	8
13				Shale, gray to buff, argillaceous, slightly micaceous and arenaceous, possibly some macerated fossil plants.			12	10			148	3
12		Harlem	Harlem ?	Coal, shaly, weathered.			0	1	11	8	135	5
11				Shale, gray to buff, argillaceous, slightly sandy and micaceous in part.			11	7			135	4
10		Upper Bakerstown and Anderson	Ewing ?	Clay shale, maroon and buff, calcareous, with numerous small, irregular limestone concretions.			8	0	51	2	123	9
9				Clay shale, gray to buff.			7	6			115	9
8			Cow Run (in part)	Shale and sandstone, gray to buff or chocolate brown, argillaceous shale and lenses of shaly calcareous, micaceous sandstone up to 3 feet thick.			35	8			108	3
7		Wilgus	Cambridge	Limestone, variable, greenish gray, ferruginous, arenaceous, shaly, nodular limestone in shale and shaly calcareous sandstone.			5	7	36	5	72	7
6			Buffalo	Shale, gray to buff, sandy and micaceous in part, clay shale in basal part, scattered, small limonite concretions.			31	10			67	0
5		Upper and/or Lower Brush Creek	Upper and/or Lower Brush Creek	Limestone, dark gray, dense to crystalline, shaly at top and bottom, fossiliferous (excellent small gastropods), marine.			1	2	21	11	35	2
4				Shale, gray to buff, weathered, fossiliferous in upper part (3 feet approximately) scattered small limonite concretions.			20	9			34	0
3		Mason ?	Mason ?	Coal, shaly, weathered.			1	0	13	3	13	3
2				Underclay, shale, light gray to buff, slightly micaceous and arenaceous.			1	0			12	3
1			Upper Mahoning ?	Shale, gray, with slight iron oxide stain, arenaceous, micaceous, silty, exposed.			11	3			11	3

LOCATION KEY: At 4 FILE NUMBER: 6676 ELEVATION: 796 base TOPO MAP: New Lexington

STATE: Ohio COUNTY: Athens TOWNSHIP: Trimble SECTION: NE$\frac{1}{4}$ NE$\frac{1}{4}$, 4

LOCATION: Railroad cut (formerly a tunnel) on Marietta, Columbus, and Cleveland (N. Y. C.) Railroad .

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
13	Conemaugh	Harlem ?	Harlem ?	Shale, weathered buff, with layers of sandstone to 6 inches, exposed.			5	0	13	1	61	10
12				Sandstone, weathered yellowish to brownish, fine to medium-grained, micaceous, in layers to 1.5 feet thick, base disconformable, thickness variable.			8	1			56	10
11		Upper Bakerstown	Cow Run	Shale and sandstone, weathered buff to brownish, thickness variable.			3	1	9	1	48	9
10				Shale, dark to light gray, flattened iron concretions in upper third.			5	11			45	1
9				Sandstone, light gray, iron oxide stained, fine-grained, silty, slightly micaceous.			0	1			39	2
8		Anderson	Portersville	Shale, full gray, fossiliferous (decreasing upward), scattered layers of iron ore concretions in lower half.			10	1	27	9	39	1
7				Shale, gray, calcareous, very fossiliferous			0	2			29	7
6				Shale, dark gray, calcareous, fossiliferous, with high abundance of fossils in thin layers, marine.			3	9			28	10
5			Anderson	Coal, mixed dull and bright, with considerable fusain and some pyrite.			0	11			25	1
4			Bloomfield	Clay shale, gray to greenish mottled, limonitic, calcareous, plant fossils in upper part, with nodular ferruginous and calcareous concretions.			7	11			24	2
3			Bakerstown	Shale, mottled maroon and gray, ferruginous, sandy, micaceous.			4	11			16	3

LOCATION: At 4 FILE NUMBER: 6676 - continued

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
2	Conemaugh - continued	Wilgus	Cambridge	Sandstone, light gray, weathers yellowish to brownish, silty, micaceous, calcareous, massive but weathers irregularly, fine-grained, ferruginous in upper part, very sparingly fossiliferous, marine.			7	11	11	11	11	11
1			Buffalo	Shale, gray, weathers to buff and brown, slightly arenaceous, micaceous, with sandstone layers and lenses, thickness variable, exposed.			4	0			4	0

LOCATION KEY: At 6 FILE NUMBER: 6678 ELEVATION: 711 base TOPO MAP: New Lexington

STATE: Ohio COUNTY: Athens TOWNSHIP: Trimble SECTION: SW¼ SE¼, 4

LOCATION: In this section coal due below the Brush Creek limestone was absent but reported in a slightly larger gully just to the west.

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
19	Conemaugh	Ames	Ames	Limestone, tan with maroon mottling, dense, massive, fossiliferous, with many fusulinids in the top 4 inches.			1	6	8	8	134	6
18				Shale, gray, weathers buff, sandy, micaceous.			1	4			133	0
17				Sandstone, weathered buff, fine-grained, slightly micaceous, flaggy, ripple marked at top.			5	10			131	8
16		?	?	Covered interval.			2	0	8	4	125	10
15				Shale, weathered buff, silty, micaceous.			6	4			123	10
14		Harlem	Harlem	Shale, drab gray, clayey, with thin, carbonaceous and weathered coal streaks.			0	8	32	1	117	6
13			Round Knob	Clay shale, maroon and gray, with ferruginous limestone concretions, possibly slumped, covered in part.			31	5			116	10
12		?	?	Covered interval.			5	0	5	0	75	5
11		Upper Bakerstown ?	Cow Run ?	Shale, greenish gray, weathered buff to drab gray, micaceous, arenaceous with lenses and layers of calcareous, fine-grained, gray, micaceous sandstone to 1 foot thick.			12	9	20	2	70	5
10				Sandstone, weathered buff, fine-grained, flaggy, micaceous.			7	5			67	8
9		Anderson ?	Bakerstown ?	Clay shale, weathered gray to buff.			8	0	8	0	60	3
8		Wilgus	Cambridge	Limestone, greenish gray, weathers buff, arenaceous, massive, dense, sparingly fossiliferous.			1	0	23	2	52	3
7			Wilgus ?	Clay shale, light gray, stained buff to brown, slightly arenaceous.			0	8			51	3
6			Buffalo	Shale, gray-drab, iron-stained, silty, with thin scattered clay shale layers and a few sandstone layers to 6 inches thick.			21	6			50	7
5		Upper Brush Creek ?	Upper Brush Creek ?	Clay shale, stained yellowish to brownish with a layer of limonite concretions			0	8	19	1	29	1
4				Limestone, greenish-gray, mottled maroon, sandy, fossiliferous, weathers gray to buff, massive, dense, fossiliferous single layer.			0	6			28	5
3				Shale, gray, weathers maroon to buff, micaceous, sandy.			7	8			27	11
2				Sandstone, greenish gray, fine-grained, flaggy (1 to 6 inch flags), micaceous, becomes more massive and heavy-bedded (to 18 inches) upward, cross-bedded.			10	3			20	3
1		?	?	Shale, light bluish gray, iron stained, micaceous, arenaceous, with small flattened limonitic concretions near top, thickness of exposure estimated.			10	0	10	0	10	0

LOCATION KEY: At 10 FILE NUMBER: 6681 ELEVATION: 682 base TOPO MAP: New Lexington

STATE: Ohio COUNTY: Athens TOWNSHIP: Trimble SECTION: NW¼, 5

LOCATION: Section measured in a tributary ravine of Sunday Creek.

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
13	Conemaugh	Ames	Ames	Limestone, light gray variegated with green and pink, dense to finely crystalline, fossiliferous, marine.			1	6	1	6	205	10
12		Harlem and Upper Bakerstown	?	Shale, light gray, weathers buff, sandy, mostly covered.			50	8	50	8	204	4
11		Upper Bakerstown	Cow Run	Sandstone, gray, somewhat iron oxide stained, medium to coarse, slightly micaceous, massive showing some bedding and cross-bedding on weathered surfaces, basal 2 feet very calcareous and conglomeratic with small Portersville limestone pebbles.			19	6	19	6	153	8
10		Anderson	Bakerstown	Shale, gray to buff, argillaceous, sandy and slightly micaceous.			3	8	3	8	134	2
9		Wilgus	Cambridge	Limestone, gray, weathers yellowish brown, ferruginous, arenaceous, dense and hard.			0	4	27	7	130	6
8			Buffalo	Sandstone, gray, weathers yellowish to brownish, medium to fine, slightly micaceous, grades downward into sandy shale.			5	0			130	2
7				Shale, light gray, arenaceous and micaceous			22	3			125	2
6		Upper Brush Creek?	Upper Brush Creek ?	Limestone, greenish gray, weathers yellowish brown, dense, ferruginous, sparingly fossiliferous, marine.			0	6	0	6	102	11
5		Lower Brush Creek	Lower Brush Creek	Shale, gray, micaceous, sandy, apparently unfossiliferous.			3	9	5	9	102	5
4				Limestone, gray-drab, crystalline, massive, fossiliferous, marine.			2	0			98	8
3		Mason	Upper Mahoning	Shale and sandstone, gray to light gray, slightly iron-stained, sandy, micaceous shale and fine to medium micaceous to shaly sandstone interbedded in thin layers up to several feet thick, few scattered siderite-limonite concretions.			31	8	31	8	96	8
2		Mahoning	Lower Mahoning	Covered interval.			20	0	65	0	65	0
1				Sandstone, light gray, medium to coarse, micaceous, friable, massive, showing some bedding and cross-bedding on weathered surfaces, covered in part.			45	0			45	0

LOCATION KEY: At 19 FILE NUMBER: 6689 ELEVATION: 731 base TOPO MAP: New Lexington

STATE: Ohio COUNTY: Athens TOWNSHIP: Trimble SECTION: NE¼ NW¼, 24

LOCATION: Exposure in second ravine on north side of road along Johnson's Run and 0.1 mile east of 734 road intersection.

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
8	Conemaugh	Mason	Upper Mahoning	Sandstone, light gray, weathers yellowish to brownish, medium to coarse, micaceous, friable, massive, exposed.			19	4	19	4	70	0
7		Mahoning	Mahoning	Clay, light gray to yellowish brown, plastic			0	4	40	11	50	8
6				Coal, weathered.			0	1			50	4
5			Thornton	Underclay, light gray to buff, plastic, exposed.			1	6			50	3
4			Lower Mahoning	Shale, light gray, sandy, micaceous, interbedded with fine to medium, silty, micaceous sandstone, covered in upper part.			10	10			48	9
3				Sandstone, light gray but weathered to yellowish brownish, graded but mostly medium grained, lower part coarse, micaceous, massive, bedded or cross-bedded, base uneven.			28	2			37	11

LOCATION: At 19 FILE NUMBER: 6689 - continued

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
2	Allegheny	Upper Freeport	Upper Freeport	Clay and limestone, light gray to yellowish brown clay and clay shale with nodular and bedded gray to dark gray, ferruginous, fossiliferous, fresh-water limestone which grades downward through shaly, micaceous phase into sandstone.			5	5	9	9	9	9
1				Sandstone, light gray weathering yellowish to brownish, fine, silty, micaceous and calcareous, irregularly bedded, exposed.			4	4			4	4

LOCATION KEY: At 38 FILE NUMBER: 6692 ELEVATION: 696 base TOPO MAP: New Lexington

STATE: Ohio COUNTY: Athens TOWNSHIP: Trimble SECTION: NW¼ SE¼, 16

LOCATION: Leased from George M. Jones Coal Company. Mr. Blackburn of Jones Coal Co. gave elevation of coal at mine entrance: 696 feet.

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
7	Conemaugh	Mahoning	Lower Mahoning	Sandstone, light gray to yellowish brown, micaceous, thin-bedded, medium-grained, joints case hardened by limonite, exposed.			2	0	8	6	13	0
6				Shale, gray to light gray with some limonite stain, argillaceous, silty upwards.			6	6			11	0
5	Allegheny	Upper Freeport	Upper Freeport	Shale, gray to light gray, argillaceous, some small carbon fragments, some fossil plants, thin coaly partings in lower part.			0	4	4	6	4	6
4				Coal, bright, blocky, with some thin dull partings.			1	0			4	2
3				Shale, gray to dark gray, argillaceous, carbonaceous, fragments, fossil plants.			0	5			3	2
2				Coal, bony and bright or shaly interbedded with clay shale.			0	3			2	9
1				Coal, bright with some thin dull fusain partings, very little pyrite in thin irregular partings.			2	6			2	6
				Clay, gray, plastic, unmeasured.								

LOCATION KEY: At 40 FILE NUMBER: 6693 ELEVATION: 685 ± base TOPO MAP: New Lexington

STATE: Ohio COUNTY: Athens TOWNSHIP: Trimble SECTION: South-central 10

LOCATION: Exposures along ravine north of Glouster, northwest of sharp turn in road.

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
19	Conemaugh	Gaysport	Gaysport	Shale and sandstone, unmeasured to top of hill.			20±	0	20	0	231±	3
18		Ames	Ames	Limestone, light gray, partly crystalline, very fossiliferous, with long irregular ferruginous masses or stringer.			2	0	21	7	211	3
17				Shale, light gray, weathers to yellowish-brown and buff, silty, arenaceous, micaceous, covered in upper part with thin, fine to medium sandstone just below the Ames.			19	7			209	3
16		Harlem	Harlem	Coal, smut.			0	1	11	4	189	8
15			Saltsburg	Shale, light gray, weathered yellowish to buff, silty, arenaceous, micaceous.			11	3			189	7
14		Upper Bakerstown	Ewing	Limestone, nodular, greenish mottled, weathers reddish-brown, embedded in clay shale.			1	0	35	6	178	4
13			Cow Run ?	Shale, light gray, weathers buff, sandy, micaceous.			4	0			177	4

LOCATION: At 40 FILE NUMBER: 6693 - continued

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
12	Conemaugh - continued	Upper Bakerstown- continued	Cow Run? - continued	Sandstone, light gray, weathering yellowish-brown, medium, slightly micaceous, massive showing some bedding on weathered faces.			30	6			173	4
11		Anderson	Bakerstown ?	Shale and sandstone, partly covered in upper part, light gray with considerable iron oxide stain, sandy, micaceous shale and fine to medium, micaceous sandstone, some of which is calcareous.			29	1	29	1	142	10
10		Wilgus	Buffalo	Shale, gray, weathers to yellowish to brown, silty, becomes slightly sandy and micaceous upward, arenaceous and micaceous at top.			19	3	19	3	113	9
9		Upper Brush Creek	Upper Brush Creek	Shale, gray, weathers brown, silty, fossiliferous, marine.			0	2	21	11	94	6
8				Limestone, light bluish gray, sandy, micaceous, ferruginous, marine, fossiliferous.			1	2			94	6
7				Sandstone, medium gray, weathers yellowish brown, fine, micaceous, calcareous in part, thinly bedded.			1	3			93	2
6				Shale, light gray, weathers yellowish brown, micaceous, sandy.			6	10			91	11
5				Sandstone, light gray, weathers yellowish brown, fine to medium, micaceous, calcareous in part, thin to irregularly bedded.			9	3			85	1
4				Covered interval			3	3			75	10
3		Lower Brush Creek	Lower Brush Creek.	Limestone, dark bluish gray, dense, fossiliferous, marine.			1	4			72	7
2		?	?	Covered interval.			59	3	59	3	71	3
1		Mahoning	Lower Mahoning	Sandstone, light gray to yellowish to brownish stain, medium to coarse, micaceous, friable, massive tending to thin cross-bedding at top, exposed.			12	0	12	0	12	0

LOCATION KEY: At 41 FILE NUMBER: 6694 ELEVATION: 696 ± Base TOPO MAP: New Lexington

STATE: Ohio COUNTY: Athens TOWNSHIP: Trimble SECTION:

LOCATION: Exposure in Glouster Coal Company's mine along road between map elevation 709' and 987' road intersections north of Hollister.

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
26	Conemaugh	Elk Lick ?	Upper Grafton ?	Sandstone, buff to yellow-brown, medium grained, micaceous, silty, probably massive at one time, bedding on weathered surface.			16	3	16	3	276	9
25		Duquesne	Duquesne	Clay, mottled gray and red, plastic.			26	0	26	0	260	3
24		Gaysport ?	Gaysport ?	Sandstone, tan, fine-grained, silty, micaceous, thin, bedded.			3	0	15	10	234	6
23				Shale, drab to buff, micaceous, slightly arenaceous.			12	10			231	6
22		Ames	Ames	Limestone, light gray, partly crystalline, very fossiliferous, possibly shale at bottom, above coal.			1	0	7	8	218	8
21				Coal, black, shaly, highly weathered			0	2			217	8
20				Clay, light gray to yellow brown, plastic.			1	0			217	6
19		?		Sandstone and shale, yellow to brown, fine to medium, micaceous, thin irregular beds			5	6			216	6
18		Harlem	Saltsburg	Shale, drab to buff, argillaceous, micaceous, limonite concretions.			36	6	39	6	211	0
17				Sandstone, drab, micaceous, fine-grained, shaly.			3	0			174	6
16		Upper Bakerstown	Cow Run	Shale, drab to tan, highly iron-stained, arenaceous, micaceous, limonite concretions, more arenaceous upward.			14	6	17	6	171	6

LOCATION: At 41 FILE NUMBER: 6694 - continued

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
15	Conemaugh - continued	Upper Bakerstown continued	Cow Run - continued	Conglomerate, gray to light gray, highly iron stained, concretions: ½ to 1½ inch limestone pebbles, ½ to 4 inch concretions, ½ to ¼ inch quartz pebbles, matrix is medium to coarse, calcareous sandstone, fossil tooth.			3	0			157	0
14		Anderson	Bakerstown	Shale, buff to drab, argillaceous, arenaceous, thin interbedded sandstone.			7	2	10	2	154	0
13				Sandstone, massive, dull brown, medium-grained, micaceous, iron stained, thickness varies.			3	0			146	10
12		"Ilgus	Cambridge	Limestone, drab to buff, micaceous, weathers nodular, fossiliferous, heavy iron content, top tends to shaly drab sandstone.			3	6	25	2	143	10
11			Buffalo	Sandstone, thin-bedded, tan, medium grained, iron stained, micaceous.			6	8			140	4
10				Shale, and sandstone, upper part micaceous and argillaceous sandstone, olive drab to green, shale is interbedded with thin sandstone, drab to brown, numerous plants.			15	0			133	8
9		Upper Brush Creek	Upper Brush Creek	Shale, gray, arenaceous upward, weathers drab, plant fragments, marine fossils.			21	2	21	2	118	8
8		Lower Brush Creek	Lower Brush Creek	Clay shale, gray to dark gray, silty to argillaceous, weathers drab, contains fossils.			10	9	33	5	97	6
7				Limestone, dark gray, dense, fossiliferous			0	9			86	9
6				Limestone, dark gray, shaly, fossiliferous			0	6			86	0
5				Clay shale, light gray, slightly arenaceous, highly weathered, base uncertain.	2	0	2	11			85	6
				Coal, shaly, some bright streaks, weathered	0	10						
				Clay, light gray.	0	1						
4				Shale, light buff, micaceous, argillaceous, yellow iron stained, arenaceous upward, shale, carbonaceous clayey.			18	6			83	6
3		Mahoning-Mason	?	Covered interval.			55	9	55	9	65	0
2	Allegheny	Upper Freeport	Uffington	Shale light gray, sandy, micaceous, few plants, poor roof near mine entrance, numerous slickensides exposed, numerous layers of flattened siderite-limonite concretions.			5	0	9	3	9	3
1			Upper Freeport	Coal, bright, thin basal partings of dull coal, numerous thin partings of pyrite and small pyrite masses, slickensides, small normal fault.			4	3			4	3
				Note: Underclay, light gray, micaceous, sandy, plastic, fossil plants.								
				Sandstone, light gray, fine to medium, silty, micaceous, unmeasured.								

LOCATION KEY: At 42 FILE NUMBER: 6695 ELEVATION: 696± base TOPO MAP: New Lexington

STATE: Ohio COUNTY: Athens TOWNSHIP: Trimble SECTION: 16

LOCATION: Exposures in NYC Railroad cut and along abandoned road that extends westward to 987 road intersection. The exposed and measured rocks extend for less than 1/4 mile and do not reach top of hill. A thin coal smut was also seen at about 1/2 mile west of the railroad.

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
33	Conemaugh	Upper Bakerstown	Cow Run	Sandstone, weathered buff to brownish, fine to medium, micaceous, poorly exposed, unmeasured.								
32		Anderson	Portersville ?	Clay and clay shale, weathered			1	5	38	2	185	6
31			Anderson	Coal smut.			0	1			184	1
30				Clay shale, light gray with iron oxide stain, becomes plastic on weathering.			1	2			184	0
29			Bloomfield	Limestone, light gray to olive drab, mottled, ferruginous in part, nodular, sparingly fossiliferous, fresh-water.			0	10			182	10
28				Clay shale, light gray to olive drab, weathers to a plastic clay.			2	2			182	0

LOCATION: At 42 FILE NUMBER: 6695 - continued

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
27	Conemaugh -	Anderson -	Bakerstown	Shale, light gray to buff, sandy and micaceous, becoming silty upwards.			17	6			179	10
26	continued	continued		Sandstone, light gray but mostly stained yellowish brown to dark brown, coarse to medium upward, micaceous, friable, massive to bedded, 1-foot ledge with limonite at base and shaly at top.			15	0			162	4
25		Wilgus	Wilgus ?	Clay shale, light gray stained yellowish to brownish, becoming plastic on weathering.			1	6	9	6	147	4
24			Buffalo	Shale, light gray, mostly weathered buff, silty and argillaceous.			4	6			145	10
23				Sandstone, once light gray but weathered yellowish brown, fine to medium, finely micaceous, bedded in layers up to 10 inches thick			3	6			141	4
22		Upper Brush Creek	Upper Brush Creek	Shale and limestone, light gray shale, stained by iron oxide, arenaceous, fossiliferous, marine, and a dense, greenish gray, ferruginous, fossiliferous, nodular, marine limestone near the center.			2	0			137	10
21				Shale and sandstone, light gray, stained by iron oxide, arenaceous, micaceous shale interbedded by fine micaceous sandstone.			10	0			135	10
20		?	?	Shale, light gray to drab with yellowish brown stain, silty and micaceous becoming sandy upward, very few small scattered limonite concretions, marine fossils in much of lower part.			36	4	?		125	10
19		Lower Brush Creek	Lower Brush Creek	Limestone, dark gray to black, slightly ferruginous, fossiliferous, marine, much weathered, possilby some slump (18-inch blocks found across road to south).			0	8			89	6
18				Shale, gray to light gray with yellowish brown stain, silty, micaceous, with marine fossils upward, partly covered at top.			16	6			88	10
17				Covered interval.			4	6			72	4
16				Shale, light gray to drab with some yellow to brown stain, variable, silty, grading upward into micaceous, sandy shale and shaly micaceous sandstone, few flattened disc-shaped ferruginous concretions, exposed.			9	6			67	10
15		Mason or Mahoning	Mason or Mahoning	Underclay, gray to light gray, plastic.			0	8	5	2	58	4
14				Coal, shaly, weathered.			0	1			57	8
13			Mason or Thornton	Underclay, gray to light gray, yellow stained, plastic.			0	7			57	7
12			Upper or Lower Mahoning.	Clay and limestone, light gray with yellowish brown stain, plastic clay containing numerous small ferruginous nodules of limestone.			3	10			57	0
11		?	?	Covered interval, mantle dull reddish color in upper part.			10	2	10	2	53	2
10		Mahoning	Lower Mahoning	Sandstone, light gray with yellow brown stain, medium and coarse to very coarse, micaceous, arkosic, massive showing bedding and cross-bedding on large scale.			22	1	28	1	43	0
9				Shale, variable, light gray to gray, iron oxide stained, sandy and micaceous in part.			6	0			20	11
8	Allegheny	Upper Freeport	Upper Freeport	Underclay, light gray with yellow iron stain, plastic.			0	2	14	11	14	11
7				Shale, black, carbonaceous, with much pyrite.			0	1			14	9
6				Underclay, light gray, plastic.			0	1			14	8
5				Coal, bright with many thin, dull partings of fusain or weathered pyrite shaly at top and bottom.			1	9			14	7
4				Underclay, gray to light gray, with small amount of iron oxide stain, few scattered fossil plants, plastic.			1	6			12	10
3				Underclay, gray, brownish iron oxide stain, shaly in lower part with small iron oxide concretions, plastic.			2	0			11	4
2				Ironstone, gray stained brownish, nodular, calcareous, siderite-limonite.			0	8			9	4
1				Shale and sandstone, light gray with some iron oxide stain, silty, sandy, and micaceous shale with lenses and layers of shaly sandstone in lower part, some small siderite-limonite concretions, exposed.			8	8			8	8

LOCATION KEY: At 44 FILE NUMBER: 6697 ELEVATION: TOPO MAP: Athens

STATE: Ohio COUNTY: Athens TOWNSHIP: Trimble SECTION: SW¼, 15 (unnumbered)

LOCATION: Small mine just southwest of 692 road intersection on west side of road, railroad (shown on map but no longer present on ground), and creek. Mine survey map shows the base of the coal to vary between 694' and 701'.

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
9	Conemaugh	Mahoning	Lower Mahoning	Sandstone, light gray to white, weathers with small brown spots, coarse, porous, friable, sparingly micaceous, apparently originally arkosic, exposed.			8±	0	8±	0	24±	6
8	Allegheny	Upper Freeport	Uffington ?	Shale, gray, with some slickensides and many large Sigillaria "pots" or stumps, fossil ferns reported locally, becomes sandy and micaceous upward.			12	0	16	6	16	6
7			Upper Freeport	Coal, bright, with very thin dull layers, massive, breaks more easilty and into smaller pieces than lower level.			0	8			4	6
6				Pyrite and shale.			0	1			3	10
5				Coal, bony with some bright coal in lower part and considerable fusain in upper part.			0	10			3	9
4				Shale, gray, silty and sandy, micaceous, some fossil plants, thickness varies from 2½ to 4 inches			0	3			2	1
3				Coal, bright, with considerable pyrite in streaks and joints, some fusain, cannel-like thin layer in bottom locally.			2	8			2	8
2				Pyrite			0	0½			-	-
1				Underclay, gray, plastic, unmeasured			-	-				

LOCATION KEY: At 45 (composite) FILE NUMBER: 6698 ELEVATION: 715 ± base ? TOPO MAP: Athens

STATE: Ohio COUNTY: Athens TOWNSHIP: Trimble SECTION: 2 and 8 (?)

LOCATION: Exposure along Route 280 along Trimble Hill at southeast edge of Trimble, including abandoned shale pit of the Trimble Brick Manufacturing Company and to top at the high hill in the south-central part of section 2.

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
37	Conemaugh	Upper Little Pittsburgh ?	Lower Pittsburgh ?	Sandstone, yellowish brown, ferruginous, fine, slightly micaceous, exposed.			5	0	5	0	341	0
36		Lower Little Pittsburgh	Lower Pittsburgh	Shale and limestone, poorly exposed and base uncertain, lower part is drab and maroon shale containing nodular fresh-water limestone. Upward the limestone appears to be in layers and the nature of the shale is not well shown.			48	2	56	0	336	0
35			Connellsville	Sandstone, drab, medium to fine, very micaceous, calcareous with calcite filled joints up to 1 inch thick, massive to bedded, exposed.			7	10			287	10
34		Little Clarksburg	?	Covered interval.			46	4	46	4	280	0
33		Elk Lick ?	Elk Lick ?	Clay shale, drab mottled reddish brown, nodular, fresh-water limestone in part (nearby dug well is reported to have shown sandstone in this interval.)			21	8	51	8	233	8
32				Shale, light gray to drab, silty, micaceous, exposed.			2	0			212	0
31				Covered interval, showing shale and sandstone in small patches at intervals.			24	0			210	0
30				Sandstone, light gray mottled with fine brown specks, medium, massive, exposed.			4	0			186	0
29		?	?	Covered interval.			11	0	11	0	182	0
28		Duquesne	Duquesne	Clay shale, light gray to drab, mottled greenish or maroon, nodular fresh-water limestone within, exposed.			2	0	18	1	171	0
27				Sandstone, light gray with yellowish brown stain, fine to medium, massive to heavy bedded.			12	2			169	0
26				Shale, light gray to buff, silty, finely micaceous.			3	11			156	10

LOCATION: At 45 FILE NUMBER: 6698 - continued

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
25	Conemaugh - continued	Ames	Ames	Limestone, light gray mottled pinkish, partly crystalline, fossiliferous, marine, apparently cut out by sandstone locally.			1	6	12	4	152	11
24				Shale, light gray to drab with brownish stain, finely arenaceous and micaceous.			10	10			151	5
23		Harlem	Round Knob	Shale, drab mottled maroon, clayey, slumped			17	3	17	3	140	7
22		Upper Bakerstown	Ewing	Shale, light gray weathers yellowish to drab, with nodular fresh-water limestone.			15	3	24	7	123	4
21			Cow Run	Sandstone and shale, light gray to drab, fine, micaceous sandstone interbedded with silty, finely micaceous shale, grades upward and laterally into shale. 50 feet thick in nearby abandoned shale pit and lenses out uphill toward east, thickness approximate.			9	4			108	1
20		Anderson	Portersville	Limestone, light gray, nodular, dense, fossiliferous, marine.			0	6	12	2	98	9
19				Shale, dark gray at base to gray or olive tan above, clayey, calcareous, fossiliferous, marine.			1	0			98	3
18			Anderson	Shale, black except for 1/2 light gray clay seam at base, carbonaceous with few tiny coal lenses, moderately well bedded.			0	5			97	3
17				Coal, bright with dull partings including fusain, much weathered.			0	9			96	10
16				Underclay, gray with limonite stain, with small pellets, massive, moderately plastic.			0	6			96	1
15			Bloomfield	Clay shale and limestone, olive to gray, much stained by limonite, calcareous, with pellets and small nodules of fresh-water limestone in lower part, massive with starch-like fracture.			6	0			95	7
14			Bakerstown	Shale, light bluish gray, silty, micaceous, sandy, calcareous and ferruginous toward base.			3	0			89	7
13		Wilgus	Cambridge	Limestone, similar to sandstone below but an impure sandy, sparingly fossiliferous, marine limestone.			0	6	6	6	86	7
12				Sandstone, light gray, much stained yellow and brown, fine, silty, micaceous, calcareous.			2	0			86	1
11			Buffalo	Shale and sandstone, light gray, weathers reddish to yellowish brown, sandy, micaceous shale grading upward into similarly colored, fine, micaceous, shaly-appearing sandstone, exposed.			4	0			84	1
10		Wilgus and Upper Brush Creek	Buffalo and Upper Brush Creek	Covered interval.			36	1	36	1	80	1
9		Lower Brush	Lower Brush	Shale, gray, silty, fossiliferous, marine, exposed.			4	8	29	4	44	0
8				Shale, gray, sandy, micaceous, fossiliferous, marine.			0	5			39	4
7				Limestone, gray, sandy, micaceous, fossiliferous, marine.			1	6			38	11
6				Shale, light gray, weathers yellowish to tan, silty, micaceous, with some scattered limonite concretions, upper part partially covered.			22	9			37	5
5		Mason	Mason	Shale, black, carbonaceous, weathered.			0	3	14	8	14	8
4				Coal, bright, weathered.			0	2			14	5
3				Underclay, gray, sandy, micaceous.			1	3			14	3
2			Upper Mahoning	Shale, light gray, sandy, micaceous, with thin layers of fine micaceous sandstone, becomes silty near top.			11	3			13	0
1				Sandstone, light gray with yellowish brown stain; medium to fine, micaceous with plant fossils, exposed.			1	9			1	9

LOCATION KEY: At 47 FILE NUMBER: 6699 ELEVATION: 761 base TOPO MAP: New Lexington

STATE: Ohio COUNTY: Athens TOWNSHIP: Trimble SECTION: NE¼ 36

LOCATION: Abandoned strip mine on north nose of hill just west of 762 road intersection in Johnson Run Valley.

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
6	Conemaugh	Mahoning	Lower Mahoning	Sandstone, light gray with considerable limonite stain, medium to very coarse, micaceous, friable, massive to thin-bedded at top, thickness variable.			8	0	8	0	72	1
5	Allegheny	Upper Freeport		Shale, light to full gray, with thin yellow bands and limonite stains, argillaceous, scattered and one or two layers of ferruginous nodules up to one foot or more in maximum size.			15	0	64	1	64	1
4			Upper Freeport	Coal, mostly bright, with some dull coal, fusain and pyrite, shaly and pyritiferous in basal few inches, floor of mine rises to the west and coal becomes thinner up the rise.			3	9			49	1
3				Covered interval, underclay, exposed in west end of pit, slightly thicker than 11", sandy and micaceous.			0	11			45	4
2				Sandstone, light gray with limonite stain, medium to coarse, micaceous, friable, bedded to massive.			40	8			44	5
1				Covered interval.			3	9			3	9

LOCATION KEY: At 49 FILE NUMBER: 6701 ELEVATION: 685 base TOPO MAP: Athens

STATE: Ohio COUNTY: Athens TOWNSHIP: Trimble SECTION: SE¼, 19

LOCATION: Exposure along road from road intersection near Greens Run in the southeast corner of section 19, northwest toward the central part of section 19 at the top of the hill.

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
26	Conemaugh	?	?	Shale, weathered and mantle.			18	0	18	0	227	1
25		Ames	Ames	Limestone, gray mottled pinkish to greenish, partly crystalline, massive, fossiliferous, marine.			1	3	19	3	209	1
24				Shale and sandstone, light yellowish to brownish, sandy and micaceous shale with interbedded layers of fine to medium, micaceous sandstone.			12	5			207	10
23				Sandstone, yellowish brown, medium to coarse, micaceous, bedded and cross-bedded, layers 1 to 6 inches thick.			5	7			195	5
22		Harlem		Shale, light gray with much limonite stain, very sandy, micaceous.			11	2	20	1	189	10
21				Sandstone, yellowish to brownish, fine to medium, micaceous, bedded to thin-bedded, shaly appearing upward.			8	11			178	8
20		Upper Bakerstown	Cow Run	Clay shale, yellowish to brownish, argillaceous, plastic.			1	3	12	9	169	9
19				Coal, merely a smut streak			0	¼			168	6
18				Shale, gray to yellowish tan, silty and micaceous below with siderite-limonite concretions and clay shale above.			6	7			168	6
17				Sandstone, light gray mostly yellowish stained medium to fine, micaceous, friable, variously bedded.			4	11			161	11
16		Anderson	Bakerstown ?	Shale, light gray to gray but mostly stained by limonite, silty, sandy and micaceous, becomes more sandy upward and grades into overlying sandstone.			10	10	23	8	157	0
15				Sandstone, light gray with much limonite stain, medium to coarse, micaceous, calcareous in part, friable, conglomeratic and ferruginous in base, heavy to massive bedding.			12	10			146	2

LOCATION: At 49 FILE NUMBER: 6701 - continued

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
14	Conemaugh - continued	Wilgus	Buffalo	Shale, light yellowish to brownish, sandy, silty, micaceous.			4	11	60	9	133	4
13				Sandstone, light gray with much limonite stain, coarse to medium in base, medium above, friable except in top which is well cemented calcareous sandstone.			11	11			128	5
12				Shale, light yellow to brown, silty, finely micaceous, thin layer of light gray clay shale near top.			4	4			116	6
11				Sandstone, light yellow to brown, fine to medium, micaceous, bedded in layers ½ to 4 or more inches thick.			11	8			112	2
10				Shale, light gray, mostly stained by limonite sandy, silty, and micaceous with thin layers of fine micaceous sandstone, especially in top part which grades upward into overlying sandstone.			27	11			100	6
9		Upper Brush Creek	Upper Brush Creek	Covered interval, probably the lower part is dark gray, fossiliferous, marine shale with nodular marine limestone			9	8	49	0	72	7
8				Limestone, dark gray, compact, fossiliferous, marine.			0	6			62	11
7				Shale, poorly exposed.			4	6			62	5
6				Clay, light gray to yellowish, plastic.			0	4			57	11
5				Coal, badly weathered.			0	1			57	7
4				Underclay, light gray to yellow, plastic.			0	9			57	6
3				Shale and sandstone, light gray, largely stained by limonite, sandy micaceous shale with layers and zones of ferruginous micaceous, medium , some scattered siderite limonite concretions.			33	2			56	9
2		Lower Brush Creek	Lower Brush Creek	Sandstone, light yellowish brown, medium micaceous with ferruginous bands, bedded in layers ¼ to 3 inches thick, exposed.			12	5	23	7	23	7
1				Covered interval.			11	2			11	2

LOCATION KEY: At 50 FILE NUMBER: 6702 ELEVATION: 789 base TOPO MAP: New Lexington

STATE: Ohio COUNTY: Athens TOWNSHIP: Trimble SECTION: NW¼, 35 and SW¼, 36

LOCATION: East of Athens-Hocking County line to top of first hill west of 981 road intersection .

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
22	Conemaugh	?	?	Mantle, apparently weathered shale with an occasional sandstone fragment.			14	8	14	8	249	2
21		? Upper Bakerstown	? Cow Run ?	Shale, light gray to yellowish, silty, with scattered nodular sandy and calcareous masses, micaceous, occasional layer of fine, micaceous sandstone 4" to 6" thick.			50	3	86	6	234	6
20		?	?	Shale, variable, light gray to pale yellowish with maroon layers in lower part, argillaceous, partly covered in lower part.			36	3			184	3
19		Anderson	Bakerstown	Sandstone, yellowish to brownish, fine to medium bedded to heavy bedded, micaceous.			14	6	14	6	148	0
18		Wilgus	Cambridge	Shale, light blue-gray, 8 inch ferruginous layer limestone at base, scattered limestone nodules, irregular layer, fossiliferous, marine limestone at top.			7	0	24	5	133	6
17			Buffalo	Shale, light gray with limonite stain, silty, finely micaceous, scattered siderite concretions and several nodular layers of siderite, one at 6 inches below top is 8 to 10 inches thick.			17	5			126	6
16		Upper Brush Creek	Upper Brush Creek	Limestone, gray to dark gray, dense to partly crystalline, somewhat ferruginous, fossiliferous, marine.			1	0	18	4	109	1
15				Shale, gray to light gray, micaceous, silty below to very sandy on top, few scattered siderite concretions.			17	4			108	1

LOCATION: At 50 FILE NUMBER: 6702 - continued

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
14	Conemaugh continued	Lower Brush Creek	Lower Brush Creek	Limestone, drab to gray, weathers brownish, partly crystalline, sandy in basal part, fossiliferous, marine, variable thickness			2	6	11	9	90	9
13				Shale and sandstone, light gray, stained yellow to brown, fine to medium, micaceous sandstone and arenaceous shale, calcareous at top, ferruginous throughout.			9	3			88	3
12		Mason	Upper Mahoning	Shale, gray to dark gray or black, argillaceous and silty shale with carbonaceous layers, micaceous layers, top part light gray			48	7	48	7	79	0
11		Mahoning	Mahoning	Shale, black, bony, carbonaceous.			0	4	20	3	30	5
10				Coal, shaly.			0	4			30	1
9			Lower Mahoning	Shale, gray to light gray some yellow iron oxide stain, micaceous, quite friable, massive.			2	3			29	9
8				Covered interval.			8	0			27	6
7				Sandstone, gray to light gray, some iron stain, yellow, micaceous, quite friable, massive.			9	4			19	6
6	Allegheny	Upper Freeport	Upper Freeport	Shale, gray, to light gray, argillaceous, scattered carbonaceous fragments.			3	8	10	2	10	2
5				Coal, good.			0	5			6	6
4				Shale, black, bony, carbonaceous, cannel-oid, base not seen.			1	0			6	1
3				Underclay, light gray , plastic.			2	5			5	1
2				Limestone, gray, weathers to yellowish to brownish, very dense, fresh-water.			0	10			2	8
1				Shale, light gray stained by limonite, sandy, micaceous and argillaceous, exposed.			1	10			1	10

LOCATION KEY: At 53 FILE NUMBER: 6705 ELEVATION: 843 base TOPO MAP: New Lexington

STATE: Ohio COUNTY: Athens TOWNSHIP: Trimble SECTION: N½ SE¼, 34

LOCATION: Exposures along new road.

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
25	Conemaugh	Harlem ?	Harlem ?	Shale, greenish to brown, silty to sandy, becomes more sandy upward.			20	6	20	6	150	9
24		Upper Bakerstown	Ewing	Limestone, gray, weathers pale buff, sandy, nodular, fresh-water?			0	3	14	6	130	3
23			Cow Run	Shale, greenish to brownish, mottled maroon in lower part, silty.			14	3			130	0
22		Anderson	Portersville	Shale, gray to dark gray, calcareous, fossiliferous, containing nodular, greenish gray, dense to finely crystalline limestone, very fossiliferous, marine.			1	6	24	1	115	9
21			Anderson	Coal, bright and dull, shaly in top, weathered			1	0			114	3
20				Underclay, light gray with buff stain, plastic			3	6			113	3
19			Bakerstown	Shale, brown, clayey.			2	9			109	9
18				Clay, gray stained by limonite, plastic, limonite concretions 1 inch in size.			0	4			107	0
17				Sandstone, light gray, stained brown to medium, friable, thin to medium-bedded, beds up to 1 foot, ferruginous specks throughout			5	0			106	8
16				Shale, olive drab, slightly silty.			10	0			101	8
15		Wilgus	Cambridge	Limestone, light gray, mottled reddish to purplish, dense to finely crystalline, fossiliferous, marine, crinoids, brachiopods.			0	8	26	8	91	8
14			Buffalo	Sandstone and shale, gray to buff, fine-grained, micaceous, thin-bedded sandstone, becoming heavier bedded upward with thin interbedded light blue-gray shale, with scattered ferruginous nodules, one prominent lens of sandstone at top 2 feet thick.			16	0			91	0
13				Shale, gray to blue-gray, weathers yellowish sandy, micaceous with siderite-limonite concretions 2" in diameter, interbedded with buff fine-grained sandstone.			10	0			75	0

LOCATION: At 53 FILE NUMBER: 6705 - continued

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
12	Conemaugh - continued	Upper Brush Creek	Upper Brush Creek	Shale, sandy, fossiliferous, at least one layer of pecten-like clams.			0	1	25	2	65	0
11				Shale, olive drab, sandy, with layers of buff shaly fine-grained sandstone.			5	2			64	11
10				Shale, olive drab, clayey and sandy upward, many carbonaceous plant fragments.			19	11			59	9
9		Lower Brush Creek	Lower Brush Creek	Shale, gray, with lower foot being darker gray, argillaceous, ferruginous at top, fossiliferous, marine.			3	8	10	2	39	10
8				Limestone, gray, nodular, dense to finely crystalline, fossiliferous, finely disseminated pyrite, marine.			0	4			36	2
7				Underclay, gray, plastic.			0	1			35	10
6				Clay shale, gray, micaceous, pinches out between clay below and limestone above, 50 feet to the west, thickens to east.			5	0			35	9
5				Clay, gray, plastic.			1	1			30	9
4		Mason	Mason	Coal, blossom, thins and is missing from section 100 feet westward.			0	1	29	8	29	8
3				Underclay, light gray, stained by limonite, plastic.			0	7			29	7
2			Upper Mahoning	Shale, greenish gray with iron oxide stain, iron oxide concretions 3 inches in diameter, less abundant upward, more argillaceous upward, becomes sandy laterally, thickens top rising in section with some calcareous layers added.			15	5			29	0
1				Shale, and sandstone, gray to yellowish brown, micaceous, sandy shale and shaly sandstone with scattered ironstone concretions, poorly exposed in lower part with prominent 3 foot layer at top consisting of sandstone, exposed.			13	7			13	7

LOCATION KEY: At 55 FILE NUMBER: 6707 ELEVATION: 786 ± base of coal TOPO MAP: New Lexington

STATE: Ohio COUNTY: Athens TOWNSHIP: Trimble SECTION: NW¼, 35

LOCATION: Exposures in tributary ravine to Snow Fork.

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
7	Conemaugh	Mahoning	Lower Mahoning	Sandstone, gray, medium to coarse, thin-bedded, possibly cross-bedded in lower part, unmeasured.			-	-				
6	Allegheny	Upper Freeport	Upper Freeport	Coal, bony to shaly, sandy with thin sandstone partings.			0	4	5	6	5	6
5				Sandstone, light gray with much limonite stain, expecially at bottom, coarse, many carbonaceous particles, some carbonaceous streaks, disconformable at base.			1	2			5	2
4				Coal, bright to bony, blocky to shaly, irregular at top.			1	2			4	0
3				Shale, black, carbonaceous.			0	4			2	10
2				Clay, gray to light gray, sandy, ferruginous nodules, especially in top part, plastic.			2	0			2	6
1				Limestone, light gray to gray with greenish spots, fossiliferous, fresh-water.			0	6			0	6

LOCATION KEY: At 56-A FILE NUMBER: 6708 ELEVATION: 760 ± base TOPO MAP: New Lexington

STATE: Ohio COUNTY: Athens TOWNSHIP: Trimble SECTION: NE¼ NE¼, 4, Ward Twp., Hocking Co., NE¼ NW¼, 34, Trimble Twp., Athens Co.

LOCATION: Exposures along ravine tributary to Snow Fork

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
25	Conemaugh	?	?	Covered interval to road level.			15	3	15	3	218	0
24		Wilgus ?	Buffalo ?	Sandstone, gray to brown, fine, ferruginous, micaceous, in layers 1" to 12" thick, exposed.			4	4	43	2	202	9
23				Shale, gray, greenish to brownish, argillaceous, silty, clay-like fracture in part becomes sandy upward, with scattered nodules and layers of siderite.			38	10			198	5
22		Upper Brush Creek?	Upper Brush Creek?	Limestone, dark gray to black, ferruginous, weathers to a nodular surface, contains irregular shale pebbles.			1	4	1	4	159	7
21		Lower Brush Creek	Lower Brush Creek	S hale, light gray, clayey, silty.			3	9	15	3	158	3
20				Limestone, gray to reddish, crystalline, fossiliferous, marine.			1	6			154	6
19				Sandstone, gray stained brown to buff, fine to medium, micaceous, bedded in layers 1/2 to 6 inches thick.			10	0			153	0
18		Mason	Upper Mahoning	Shale, sandstone, and covered interval, gray to dark gray shale, weathers brownish, argillaceous and silty, some limonite layers with brown to buff, fine to medium, micaceous sandstone.			46	7	46	7	143	0
17		Mahoning	Lower Mahoning	Sandstone, gray to brown, coarse, many carbonaceous grains in base, micaceous, massive with some cross-bedding.			26	10	26	10	96	5
16	Allegheny	Upper Freeport	Upper Freeport	Clay, light gray, plastic, slight ferruginous stain.			0	10	19	9	69	7
15				Shale, black, carbonaceous, bony.			0	1			68	9
14				Shale, gray with limonite stain, clayey, poorly exposed in part.			1	6			68	8
13				Shale, black, carbonaceous, bony.			0	2			67	2
12				Underclay, gray to dark gray, plastic.			0	2			67	0
11				Coal, bright to bony, blocky, some shaly layers in upper part, middle and lower part poorly exposed.			2	0			66	10
10				Shale, dark gray to black, carbonaceous, bony, bright coal streaks.			0	3			64	10
9				Underclay, gray to light gray, silty, iron oxide stained.			1	3			64	7
8				Covered interval.			13	6			63	4
7		Bolivar	Bolivar	Underclay, gray, silty, micaceous, with some carbonaceous fragments, somewhat plastic.			2	6	14	6	49	10
6				Shale and clay shale, gray with some limonite stain, micaceous and argillaceous, scattered siderite-limonite concretions, top poorly exposed.			12	0			47	4
5		Lower Freeport	Lower Freeport	Sandstone, gray to light gray, heavily limonitic stained, medium to coarse, micaceous, somewhat friable, mostly massive, some exfoliation on weathered surfaces.			32	2	32	9	35	4
4				Clay shale, gray, somewhat ferruginous along joints.			0	7			3	2
3		Middle Kittanning	Middle Kittanning	Coal, bright to bony, grading upward to shale, carbonaceous and clayey, free sulphur on surface.			1	7	2	7	2	7
2				Clay shale, dark gray, carbonaceous.			0	3			1	0
1				Coal, bright, blocky, exposed.			0	9			0	9

LOCATION KEY: At 58 FILE NUMBER: 6711 ELEVATION: 632 ± base TOPO MAP: New Lexington

STATE: Ohio COUNTY: Athens TOWNSHIP: Trimble SECTION: NW¼ NW¼, 33

LOCATION: Elevation of coal at mine entrance shows the maximum elevation of 711 feet, and the minimum elevation of coal is to the east and southeast at 632 feet in SW¼ section 27. Mine produces an average of 275 tons of coal a day. Mine 5, Murray Company, Murray City.

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
9	Allegheny	Lower Freeport	Lower Freeport	Sandstone, gray, with some limonite stain, coarse, micaceous, massive, friable, carbonaceous particles, disconformable at base with about 5 feet relief, unmeasured.			-	-				
8		Middle Kittanning	Middle Kittanning	Shale, gray, with some iron oxide stain on joints, argillaceous, somewhat silty, clay layer at top.			4	6	15	2	15	2
7				Coal, bright, blocky, many fusain partings			1	6			10	8
6				Coal, bright, blocky at base, bony upward, surface well coated with melanterite, disseminated pyrite, bony layer at top.			4	6			9	2
5				Clay shale, dark gray, carbonaceous, coaly			0	3			4	8
4				Coal, bright and blocky, free sulphur on surface.			1	2			4	5
3				Underclay, dark gray, carbonaceous and coaly, some bone with bright coal streaks.			0	1			3	3
2				Coal, bright, blocky, some surface sulphur, few thin bony layers.			2	2			3	2
1				Clay, light gray, plastic, few fossil plants, exposed.			1	0			1	0

LOCATION KEY: At 59 FILE NUMBER: 6712 ELEVATION: 854 ± base TOPO MAP: New Lexington

STATE: Ohio COUNTY: Athens TOWNSHIP: Trimble SECTION: SW¼ NW¼, 27

LOCATION: Composite exposure along road and tributary to Mud Fork Creek.

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
21	Conemaugh	Duquesne	Lower Grafton	Shale, similar to shale below, nodular limestone, exposed.			5	0	5	0	158	8
20		Gaysport	Gaysport ?	Limestone, light gray to drab with some brown stain, dense, nodular with dendrites, embedded in shale.			0	4	10	4	153	8
19				Shale, gray drab with some limonite stain, silty, argillaceous, finely micaceous, poorly exposed in lower part.			10	0			153	4
18		Ames	Ames	Limestone, dull, pink mottled with light greenish-gray, dense, partly crystalline, fossiliferous, marine.			1	0	1	0	143	4
17		Ames and Harlem	Ames and Harlem	Covered interval, apparently gray-green shale, red shale, and calcareous sandstone			36	3	36	3	142	4
16		Upper Bakerstown	Cow Run	Shale and sandstone, yellowish to brown, micaceous, arenaceous shale interbedded with yellow-brown, medium, argillaceous, micaceous, calcareous sandstone, bedded in layers 1/4 to 6 inches thick with scattered ferruginous nodules.			16	9	33	0	106	1
15				Shale, gray drab with limonite stain, argillaceous and silty, becomes sandy upward, scattered siderite-limonite concretions in top several feet.			16	3			89	4
14		Anderson	Portersville	Shale, gray, argillaceous, breaks with hackly fracture, somewhat fossiliferous in lower part, marine, weathered, scattered calcareous ferruginous nodules upward.			10	0	30	0	73	1
13				Shale, gray, calcareous, fossiliferous, marine, becomes lighter gray upward with 3" nodular, fossiliferous limestone at top.			2	0			63	1
12				Shale, black, carbonaceous, argillaceous, pyritiferous, fossiliferous, marine.			0	8			61	1
11			Anderson	Coal, weathered.			1	0			60	5
10				Clay shale and clay, weathered and slumped, plastic clay at top beneath coal.			4	0			59	5

LOCATION: At 59 FILE NUMBER: 6712 - continued

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
9	Conemaugh - continued	Anderson - continued	Bakerstown	Sandstone, light gray with limonite stain, medium, micaceous, thin-bedded in lower half, heavy-bedded above.			6	0			55	5
8				Shale, light gray with limonite stain, silty, sandy and micaceous.			6	4			49	5
7		Wilgus	Cambridge	Limestone, light gray to greenish gray, weathers yellow to brownish, dense with small amount of crystalline, slightly ferruginous and arenaceous, fossiliferous, marine.			0	8	16	1	43	1
6			Buffalo	Shale, light gray with limonite stain, silty, sandy and micaceous with layers of fine sandstone grading upward into shaly sandstone, 2-inch layer of nodular, ferruginous limestone at base, scattered nodules of ferruginous limestone in lower part.			9	3			42	5
5				Shale, light gray with some limonite stain, silty, micaceous, with thin fine sandy layers			6	2			33	2
4		Upper Brush Creek	Upper Brush Creek	Shale, gray, silty, micaceous, with nodules in ferruginous, fossiliferous, calcareous nodule layers.			1	0	25	4	27	0
3				Shale, poorly exposed, dark gray with carbonaceous fragments of plant fossils in lower part, micaceous, lighter gray sandy upward			24	4			26	0
2		Lower Brush Creek	Lower Brush Creek	Limestone, dark bluish gray, fossiliferous, marine.			0	8	1	8	1	8
1				Clay, gray, stained with limonite stain, silty, micaceous, only moderately plastic, exposed			1	0			1	0

LOCATION KEY: At 60 FILE NUMBER: 6713 ELEVATION: 710 ± base TOPO MAP: New Lexington

STATE: Ohio COUNTY: Athens TOWNSHIP: Trimble SECTION: 21 (unnumbered)

LOCATION: Mine at south side of Mud Fork Creek at the south edge of Hollister.

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
7	Conemaugh	Mahoning	Lower Mahoning	Sandstone, reported by mine operator			-	-				
6				Shale, light gray to dark bluish gray, argillaceous with scattered ferruginous concretions, shale reported to be 15 to 20 feet thick.			4	0	4	0	14	5
5	Allegheny	Upper Freeport	Upper Freeport	Shale, gray to dark gray, argillaceous, slightly carbonaceous, hackly fracture.			5	6	10	5	10	5
4				Shale, gray to dark, argillaceous, slightly carbonaceous, free sulphur on surface.			0	3			4	11
3				Coal, bright, blocky, with numerous partings throughout, pyrite in thin irregular masses, numerous in top 2 inches, with lesser amounts in lower 2 inches, 50 to 60 inches thick, free sulphur and melanterite on weathered surfaces.			4	6			4	8
2				Shale, black to dark gray, carbonaceous, bony.			0	2			0	2
1				Clay, gray, somewhat carbonaceous, unmeasured.			-	-				

LOCATION KEY: At 62 FILE NUMBER: 11494 ELEVATION: 695± base TOPO MAP: Athens

STATE: Ohio COUNTY: Athens TOWNSHIP: Trimble SECTION: NE¼ SE¼, 8

LOCATION: Exposure along Route 13 between Jacksonville and Trimble.

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
11	Conemaugh	Upper Brush Creek	Upper Brush Creek	Shale, gray-drab, silty, sandy, micaceous, exposed.			8	0	8	0	45	11
10		Lower Brush Creek	Lower Brush Creek	Limestone, light gray to pinkish, weathers brownish, finely crystalline, glauconitic, fossiliferous (crinoidal), one or 2 massive layers, thickness 1 to 2½ feet.			2	0	26	8	37	11
9				Sandstone, light gray with much limonite stain, coarse, micaceous, friable, bedded to heavy bedded, base disconformable, becomes finer and is covered in part upward.			16	7			35	11
8				Shale, light gray to drab with considerable limonite stain on surfaces, silty especially upward, finely micaceous.			8	1			19	4
7		Mason	Mason	Shale, black with limonite stain on surfaces argillaceous, carbonaceous, finely micaceous, fissile, fossiliferous and marine at top.			7	10	11	3	11	3
6				Coal, alternating thin, bright, and dull shaly streaks.	0	3½	1	11			3	5
5				Clay shale, gray to light gray with carbonaceous coaly streaks.	0	0½					3	1½
4				Coal, bright with numerous shaly partings, very shaly at top.	0	2					3	1
3				Shale, gray, argillaceous (light gray clay at top), with thin coaly partings and numerous fossil plants.	0	8					2	11
2				Coal, bright with numerous thin, dull, shaly partings, especially shaly at top, some fusain.	0	9					2	3
1				Underclay, gray (dark gray at top) with some limonite stain, small, scattered, calcareous concretions, plastic, exposed.			1	6			1	6

LOCATION KEY: At 63 FILE NUMBER: 11575 ELEVATION: 704± base TOPO MAP: New Lexington

STATE: Ohio COUNTY: Athens TOWNSHIP: Trimble SECTION: SW¼ SW¼, 6

LOCATION: Section in borrow pit for Burr Oak Dam, west side of Route 13.

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
18	Conemaugh	?	?	Shale, badly weathered, exposed			5	0	5	0	145	0
17		Anderson? and Wilgus	Cow Run? and Buffalo	Sandstone, light gray, weathers yellowish to brown, massive, showing bedding and cross-bedding on weathered surfaces, medium to coarse, micaceous, friable, several distinct coaly bands up to 6 inches (1"-6") thick in basal third of exposure, slightly calcareous near top, Buffalo, locally ferruginous and conglomerate at base, base uneven.			42	9	42	9	140	0
16		Upper Brush Creek	Upper Brush Creek	Clay, light gray, sandy, micaceous, thickness uncertain.			0	6	5	0	97	3
15				Shale, light gray to light greenish-gray, with some limestone stain, silty to finely sandy, micaceous.			4	6			96	9
14		Lower Brush Creek	Lower Brush Creek	Limestone, light gray to pinkish gray, massive, weathers to yellowish brown, especially at top, dense to partly crystalline, very fossiliferous, marine, thickness varies			2	0	29	4	92	3
13				Shale, light gray to light greenish gray with some limonite stain, argillaceous, silty, micaceous.			2	1			90	3
12				Sandstone, light gray with some limonite stain, fine to medium, mostly fine, micaceous, bedded in layers ½ to 8 inches thick, some layers with well-developed wave ripple marks.			8	2			88	2

LOCATION: At 63 FILE NUMBER: 11575

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
11	Conemaugh - continued	Lower Brush Creek -continued	Lower Brush Creek - continued	Shale, light blue-gray to bluish gray with some maroon stain, argillaceous, very micaceous.			17	1			80	0
10		Mason	Mason	Coal, mostly bright, some limonite stain, considerable fusain, much weathered, thickness variable.			0	6	8	8	62	11
9				Underclay, light gray with limonite stain in base, micaceous, shaly downward, plastic.			0	1			62	5
8			Upper Mahoning	Sandstone, light gray with considerable yellow and brown stain, fine to medium, micaceous, bedded in thin shaly to 5-inch layers.			3	7			62	4
7				Shale, dark gray, argillaceous to silty, micaceous, thin layers of iron carbonate nodules in basal part, thin layers of fine sandstone in top part.			4	6			58	9
6		Mahoning	Mahoning	Coal horizon, dark gray to black, carbonaceous shale grading laterally into lenses of bright blocky coal.			0	1	54	3	54	3
5			Thornton	Underclay, light gray, plastic.			0	2			54	2
4				Underclay, gray to light gray, limonite stain, micaceous, varies from poorly laminated to starch-like fracture, nodular iron-carbonate layer 4 inches thick at base, small calcareous nodules scattered throughout, base and top uneven			3	6			54	0
3			Lower Mahoning	Clay, mottled light gray, purple, yellow, and brown, massive, breaks with starch-like fracture.			7	0			50	6
2				Sandstone and shale, light gray to olive-drab, limonite stain, fine, thin-bedded, micaceous sandstone and sandy silty micaceous shale, few large limonite concretions, more shaly toward top.			10	4			43	6
1				Sandstone, light gray, mostly weathered to yellow, tan, or brown, medium to coarse, massive with some traces of cross bedding on weathered surfaces, micaceous, exposed			33	2			33	2

LOCATION KEY: At - 1 FILE NUMBER: 11647 ELEVATION: 938 base TOPO MAP: New Lexington

STATE: Ohio COUNTY: Athens TOWNSHIP: Trimble SECTION: 6

LOCATION: Exposures along diagonal road in the NE¼ NE¼, section 6.

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
14	Conemaugh	Elk Lick	Birmingham	Clay shale and soil, deeply weathered .			9	8	9	8	89	8
13		Duquesne	Skelley	Limestone, impure, arenaceous, nodular in shale, fossiliferous, marine.			2	2	6	5	80	0
12				Sandstone, shaly, calcareous			3	1			77	10
11			Duquesne	Clay, light gray to buff, arenaceous, plastic, 1" coal on opposite side of hill.			1	2			74	9
10		?	?	Covered interval and poorly exposed, weathered shale.			8	7	8	7	73	7
9		Gaysport	Gaysport	Sandstone, gray to buff, shaly, micaceous, fine-grained.			5	0	22	6	65	0
8				Shale, gray to buff, sandy, micaceous, grades upward into shaly, fine-grained sandstone.			17	6			60	0
7		Ames	Ames	Limestone, pinkish gray, mottled, crystalline in part, fossiliferous, massive, marine.			1	6	15	10	42	6
6				Covered interval.			3	0			41	0
5				Shale, gray, arenaceous in part, micaceous, scattered plant fossils, especially in lower part.			11	4			38	0
4		Harlem	Harlem	Shale, black, carbonaceous, soft, possibly with fossil fish scales, slumped slightly?			4	4	26	8	26	8
3				Coal, shaly, weathered.			0	1			22	4

LOCATION: At 1 FILE NUMBER: 11647 - continued

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
2	Conemaugh - continued	Harlem - continued	Harlem - continued	Clay, light gray to light buff, plastic, some small limonite concretions near top; exposed.			3	9			22	3
1			Round Knob	Clay shale, red to light gray or buff, poorly exposed.			18	6			18	6

LOCATION KEY: At 64 FILE NUMBER: 11648 ELEVATION: 714 ± base TOPO MAP: Athens

STATE: Ohio COUNTY: Athens TOWNSHIP: Trimble SECTION: SW¼, 1

LOCATION: Exposure along east-west ravine and east along east-west road north of above ravine to top of hill at Athens-Morgan County line.

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
36	Monongahela	Pittsburgh	Lower Pittsburgh	Shale and clay shale, varicolored buff, yellow, red, brown, etc., argillaceous, flinty-appearing, much breaks with starch-like fracture, locally coarser and micaceous, with few limestone nodules 8 to 10 inches across; exposed.			11	0	11	0	265	6
35	Conemaugh	?	?	Covered interval			53	6	53	6	254	6
34		Elk Lick ?	Elk Lick ?	Clay shale, mottled light yellowish gray and maroon, with embedded nodules, light gray dense, fossiliferous (ostracods), freshwater limestone, which shows some limonite stain and dendrites, exposed			6	0	22	1	201	0
33			Upper Grafton ?	Sandstone, light gray, much stained, brown and yellow, fine, micaceous, calcareous in part, bedded.			4	0			195	0
32				Shale, light olive drab to tan with one 18" layer of purple, with some limonite stain, argillaceous, micaceous.			12	1			191	0
31		Duquesne	Skelley	Limestone, olive weathering yellow and brown, dense, with few crystals, nodular, fossiliferous, marine.			0	8	0	8	178	11
30		Duquesne and Gaysport	Lower Grafton and Gaysport	Covered interval, small exposures of olive drab, argillaceous, micaceous shale.			30	6	30	6	178	3
29		Ames	Ames	Limestone, light gray with limonite stain, dense to partly crystalline, fossiliferous, fusulinids, marine.			1	6	8	4	147	9
28				Shale and sandstone, light gray, weathered olive drab with some limonite stain, micaceous, silty shale and fine micaceous sandstone, poorly exposed.			4	10			146	3
27				Sandstone, light gray, weathered, micaceous, fine, brown.			0	9			141	5
26				Shale, light gray, weathered to olive, brown stain, argillaceous, silty, micaceous, exposed			1	3			140	8
		?	?									
25		Harlem	Round Knob	Covered interval, numerous blocks of slabby sandstone and slumped coating of red to maroon clay shale.			29	11	29	11	139	5
24		Upper Bakerstown	Ewing (in part)	Shale and sandstone, light gray, weathered to olive drab, limonite stain, sandy, micaceous shale interbedded with fine, micaceous rippled sandstone, calcareous in part, nodules and veins of impure limestone in lower part.			14	6	33	1	109	6
23			Cow Run	Shale, light blue-gray, much limonite stain, argillaceous, becoming silty and sandy upwards, micaceous.			18	7			95	0
22		Anderson	Portersville	Shale, dark gray, argillaceous and carbonaceous, fossiliferous, marine, nodular, fossil limestone in top 6-8 inches.			4	10	22	5	76	5
21			Anderson	Coal, bright, shaly to bony			0	5			71	7
20				Coal, bright, numerous thin dull partings, fusain.			1	9			71	2
19				Underclay, dark gray, limonite stain, carbonaceous, micaceous, few fossil plants, variable thickness.			0	8			69	5

LOCATION: At 64 FILE NUMBER: 11648 - continued

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
18				Underclay, light gray, limonite stain, small calcareous and ferruginous nodules, plastic breaks with starch-like fracture.			2	11			68	9
17			?	Covered interval.			3	5			65	10
16			Bakerstown	Sandstone and shale, light gray, limonite stain, fine, micaceous, bedded sandstone at bottom and top, separated by similar silty micaceous shale.			8	5			62	5
15		Wilgus	Cambridge	Sandstone, light gray, weathers to yellow or brown, calcareous, micaceous, few fossils, marine.			1	4	18	4	54	0
14			Buffalo	Sandstone, light gray, fine, micaceous, calcareous, brown stain.			3	3			52	8
13				Shale, light blue-gray, weathers to olive-drab, some limonite stain, silty becoming sandy upwards, micaceous, limonite concretions and calcareous nodules near top.			13	9			49	5
12		Upper Brush Creek	Upper Brush Creek	Shale, olive drab, limonite stained, micaceous, fossiliferous, marine.			1	10	15	6	35	8
11				Limestone, light gray, purple mottling and limonite stain, fine, sandy, micaceous, fossiliferous, marine.			1	0			33	10
10				Shale, light gray, limonite stain, silty, sandy, micaceous.			0	6			32	10
9				Covered interval.			4	4			32	4
8				Sandstone, light gray, limonite stained, fine, micaceous, calcareous layers, bedded, thickness variable, base uneven.			7	10			28	0
7		Lower Brush Creek	Lower Brush Creek	Limestone, light gray, considerable limonite stain, dense, partly crystalline blocks and nodules embedded in light blue-gray shale, marine, fossiliferous.			0	8			20	2
6				Shale, light olive drab, much limonite stain, silty, micaceous, scattered small limonite concretions, thickness variable.			3	1			19	6
5		? Mason	? Mason	Shale, dark gray-black, limonite stain, micaceous, carbonaceous, few marine and plant fossils.			10	6	?		16	5
4				Coal, bright, bony, limonite along joints.			0	3			5	11
3				Shale, black, carbonaceous, fissile, variable thickness.			0	1			5	8
2				Coal, bright, much limonite stain, blocky, some thin, irregular pyrite films.			0	9			5	7
1				Underclay, gray, light gray on top, limonite stain, breaks with starch-like fracture, small calcareous nodules scattered throughout, slickensides, plastic.			4	10			4	10

TROY TOWNSHIP

LOCATION KEY: FILE NUMBER: 3146 ELEVATION: TOPO MAP: Chesterhill

STATE: Ohio COUNTY: Athens TOWNSHIP: Troy SECTION: NW corner, 36

LOCATION: Cut of B. & O. Railroad, in the northwest corner of section 36, Troy Township.

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
7	Monongahela	Waynesburg - Waynesburg "A"	Waynesburg - Mannington	Sandstone, massive, pebbly to fine.			40	0	108	0	175	0
6				Shale, sandstone, and covered.			68	0			135	0
5		Little Waynesburg ?	Uniontown ?	Shale, gray, and shaly sandstone.			25	5	25	5	67	0
4		Uniontown	Uniontown	Shale, coaly.			0	0¼	41	7	41	7
3				Shale, calcareous.			0	2			41	7
2				Limestone, massive, irregular	0	9	34	11			41	5
				Shale, calcareous, marly	1	7						
				Limestone, light, irregular.	0	7						
				Limestone, light, irregular	0	5						
				Shale, calcareous, marly.	2	11						
				Limestone, nodular, irregular	0	6						
				Shale, calcareous, light, marly	5	2						
				Shale, calcareous, with nodular limestone.	1	11						
				Limestone, light.	0	7						
				Limestone, yellowish, soft.	1	3						
				Limestone, thin, nodular.	2	9						
				Shale, marly.	1	2						
				Shale, pink.	7	3						
				Limestone, marly.	1	2						
				Shale, gray, calcareous.	4	10						
				Limestone, irregular, light.	0	9						
				Shale, gray, calcareous.	0	10						
				Limestone, marly.	0	6						
1				Shale, calcareous, gray, drab, pink.			6	6			6	6
				Top of track level, B. & O. Railroad.								

LOCATION KEY: FILE NUMBER: 3152 ELEVATION: 610 base TOPO MAP: Keno

STATE: Ohio COUNTY: Athens TOWNSHIP: Troy SECTION: SE¼, 33

LOCATION: Exposure up ravine along road, 2.0 miles southwest of Coolville and 1.1 miles northwest of mouth of East Fourmile Creek.

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
22	Washington	Washington	Mannington	Sandstone, soft, coarse			63	0	63+		172	0½
21				Covered interval.			3	0			109	0½
20		Waynesburg "A"	Waynesburg	Sandstone, shaly			11	0	36	11+	106	0½
19				Shale, pink and gray, soft.			4	10			95	0½
18				Sandstone, shaly			3	2			90	2½
17				Shale, pink and gray, soft.			5	11			87	0½
16				Sandstone and covered			3	0			81	1½
15				Shale, pink, siliceous.			9	0			78	1½
14	Monongahela	Waynesburg	Waynesburg	Coal, smut.			0	0½	15	6½	69	1½
13				Shale, soft, light.			0	1			69	1½
12				Shale, pink, soft.			8	0			69	0½
11			Gilboy	Shale, gray, siliceous			5	9			61	0½
10				Shale, pink, somewhat siliceous.			1	8			55	3½
9		Little Waynesburg	Little Waynesburg	Shale, coaly.			0	0½	46	0½	53	7½

LOCATION: SE¼, 33 FILE NUMBER: 3152 - continued

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
8	Monongahela -	Little Waynesburg -		Clay, light.			0	1			53	7
7	continued	continued		Shale, pink, soft.			2	6			53	6
6				Shale, gray, siliceous, ore balls.			7	0			51	0
5			Uniontown	Sandstone, shaly.			7	6			44	0
4				Sandstone, massive, drab, gray.			8	0			36	6
3				Shale, gray, and shaly sandstone.			20	11			28	6
2		Uniontown	Uniontown	Clay, with thin coaly bands.			0	3	7	7	7	7
1				Limestone and covered.			7	4			7	4

LOCATION KEY: Atr 2 FILE NUMBER: 11459 ELEVATION: 599 base TOPO MAP: Belleville

STATE: Ohio COUNTY: Athens TOWNSHIP: Troy SECTION: SE¼, 3

LOCATION: Exposure up old road northwest from Ohio River at road junction 599, 0.45 miles southwest of Washington-Athens County line.

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
24	Greene	Dunkard ?	Dunkard ?	Sandstone, gray to tan, weathering dark brown, massive to medium-bedded, micaceous.			23	9	23	9+	298	0
23				Covered interval, appears to be fine-grained sandstone with some red zones, contact with red zone below not distinct.			19	8	19	8	274	3
22	Washington	Jollytown	Upper Washington ?	Clay shale, maroon, nonbedded, poorly exposed in upper part.			18	9	50	1	254	7
21				Clay shale and limestone, gray to olive shales, mottled maroon and containing scattered nodules of light gray, impure limestone, getting more numerous upward.			6	0			235	10
20			Hundred	Sandstone, gray to tan and olive drab, fine-grained, massive below to more nodular above, grades upward into silty shale.			24	8			229	10
19		Hundred ?	Hundred ?	Clay shale, maroon, thin bedded, contains plant fossils and has a thin clay streak at the bottom.			0	4	11	3	205	2
18			Creston "Reds"	Clay shale, maroon to dusky red, non-bedded, some mottling.			9	5			204	10
17			Davistown ?	Sandstone, gray to olive, thin-bedded, fine-grained, very micaceous.			1	6			195	5
16		Jollytown "A"	Jollytown "A"	Clay shale, maroon, platy to thin-bedded, some plant fossils.			1	1	41	5	193	11
15				Clay shale, maroon, poorly exposed in center.			20	4			192	10
14			Upper Marietta	Sandstone (This zone 152' 6" to 192' 10" is poorly exposed and not detailed).			20	0			172	6
13		Washington "A"	Middle Washington ?	Clay shale, maroon to dusky red, nonbedded, poorly exposed.			3	6	19	4	152	6
12				Clay shale and limestone, gray to olive drab, nonbedded, clay shale with scattered white limestone nodules, more numerous at top.			3	10			149	0
11			Lower Marietta (upper bench)	Sandstone, gray to olive drab, fine-grained, almost a siltstone, massive, weathers somewhat nodular.			12	0			145	2
10		Washington Rider "C"	Washington Rider "C"	Clay shale, maroon to dusky red, thin-bedded to platy, contains numerous plant fossils.			1	2	14	2	133	2
9			Lower Marietta (lower bench)	Sandstone, gray to olive drab, fine-grained, almost a siltstone, massive, weathers nodular.			13	2			132	0
8		Washington Rider "B"		Clay shale, maroon, thin-bedded, poorly exposed in part.			2	9	20	9	119	0
7			Washington Rider "B" horizon	Clay, light gray, plastic.			0	1			116	3
6				Clay shale, maroon, non bedded poorly exposed in part.			17	11			116	2

LOCATION: Atr 2 FILE NUMBER: 11459 - continued

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
5	Washington - continued	Washington - Waynesburg "A"	Washington	Coal horizon, light gray clay with some darker zones and scattered carbonaceous debris.			0	2	98	3	98	3
4			Bristol ?	Limestone and shale, similar to unit below but with much more limestone in larger nodules, dark green at top.			10	0			98	1
3				Shale and limestone, gray to olive, mottled red and purple, nonbedded, contains small white scattered limestone nodules.			7	4			88	1
2			Mannington Waynesburg, coalesced	Siltstone, gray to dark tan, micaceous, irregular thickness and contact with sandstone below.			6	3			80	9
1				Sandstone, gray to tan, fine-grained, micaceous, cross-bedded at base with conglomeratic zones appearing at irregular intervals, mostly massive with some thin bedding in upper 10 feet.			74	6			74	6

LOCATION KEY: FILE NUMBER: 11604 ELEVATION: 626 base TOPO MAP: Keno

STATE: Ohio COUNTY: Athens TOWNSHIP: Troy SECTION: SE¼ SW¼, 29

LOCATION: Section up a ravine west of Hocking River, 1.2 miles due west of Coolville Station and 2.6 miles north-northwest of mouth of Fourmile Creek.

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
8	Washington	Washington		Shale, red, blocky.			20	0	86	0	170	0½
7			Mannington	Sandstone, coarse, conglomeratic, massive, thin-bedded at top.			66	0			150	0½
6		Waynesburg "A"		Shale, red, blocky.			8	0	25	0	84	0½
5			Waynesburg	Sandstone, massive to medium-bedded, medium grained.			17	0			76	0½
4	Monongahela	Waynesburg / Little Waynesburg		Shale, red, soft to sandy, and covered.			15	0	59	0	59	0½
3			Gilboy-Uniontown	Sandstone, massive at base, medium-grained.			25	0			44	0½
2				Shale, gray, even-bedded.			19	0			19	0½
1		Uniontown	Uniontown	Coal.			0	0½	0	0½	0	0½

LOCATION KEY: FILE NUMBER: 11609 ELEVATION: 594 base TOPO MAP: Chesterhill

STATE: Ohio COUNTY: Athens TOWNSHIP: Troy SECTION: NW¼, 29

LOCATION: Section up hill from valley of Hocking River at road junction 594 from NW¼, section 29 to hilltop.

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
11	Monongahela	Waynesburg ?	Waynesburg ?	Sandstone, massive, thick-bedded, mostly poorly exposed, may not be continuous, apparently 60 to 90 feet thick.			60	0	65	6	155	8
10				Shale, red, very badly weathered.			5	6			95	8
9				Clay, very weathered and poorly exposed with some slumping.			-	-			90	2
8		Little Waynesburg	Little Waynesburg?	Covered, red and tan shale evident, clay smut overlain by sandy platy shale, coal horizon?			13	0	43	6	90	2
7				Clay or clay shale, red, badly weathered.			3	0			77	2
6			Uniontown	Sandstone, even bedded, shaly partings, upper part partly covered.			24	6			74	2
5				Shale, tan, silty, massive.			3	0			49	8

LOCATION: NW¼, 29 FILE NUMBER: 11609 - continued

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
4	Monongahela - continued	Uniontown	Uniontown	Shale, red, chippy, silty, grades upward to tan shale.			1	6	8	8	46	8
3				Carbonaceous clay shale, varies 1 to 3 inches, rests directly on limestone.			0	2			45	2
2				Limestone, in several massive bouldery beds up to 2 feet thick, interbedded with green-gray claystone, formerly quarried in a small way.			7	0			45	0
1		?	?	Covered interval.			38	0	38	0	38	0

LOCATION KEY: Atr 1 FILE NUMBER: 11654 ELEVATION: 603 base TOPO MAP: Keno

STATE: Ohio COUNTY: Athens TOWNSHIP: Troy SECTION: NW¼, 26

LOCATION: Composite section from series of road cuts along Ohio Route 7, 1.2 miles southwest of Coolville.

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
32	Washington	Washington Rider "B"	Lower Marietta ?	Sandstone, light gray to tan, fine to medium-grained, massive with cross-bedding, appears as a lens in road cut and cuts out second and third units below, about 900 feet wide.			10	6	16	0	205	0
31				Shale, gray mottled varicolored, bright red orange and yellow at top, flint clay in appearance, sideritic masses, breaks with a starch-like fracture, variable.			5	6			194	6
30		Washington	Washington	Clay shale, dark gray, coal horizon.			0	1	43	2	189	0
29				Clay shale, dusky red, mottled purple, blue-gray, and some yellow, non-bedded, contains small scattered limestone knots, more gray-green in top part.			15	0			188	11
28			Mannington	Sandstone, olive-gray, some blue-gray on fresh surfaces, shaly in zones and at top 3 feet, fine to medium-grained, poorly bedded in part.			23	1			173	11
27				Clay shale, dusky red, silty, fissile below becoming more sandy and blue-gray upward, some hematite and siderite nodules, more bedded upward, irregular top.			5	0			150	10
26		Waynesburg "A"	Waynesburg "A"	Clay shale, dark greenish gray, some carbon flecks, coal horizon.			0	0½	56	10	145	10
25				Clay shale, dark dusky red, some blue-gray mottling in bottom and top, weathers to dust.			6	9½			145	9½
24			Waynesburg	Sandstone, olive gray, weathering tan, massive, fine to medium-grained, some coarse zones.			50	0			139	0
23		Elm Grove	Elm Grove	Clay, blue-gray, weathering very light.			0	6	12	10	89	0
22				Sandstone, blue-gray, fine to medium-grained, thin-bedded, with shaly partings to 3 inches.			12	4			88	6
21	Monongahela	Waynesburg	Cassville ?	Shale, dusky red, chippy, clayey, irregular, 0 - 6 inches.			0	3	13	7	76	2
20			Waynesburg	Clay shale, dark gray, coal horizon.			0	1			75	11
19			Waynesburg	Clay shale, dusky red, mottled blue-gray, poorly bedded.			5	2			75	10
18			Upper Gilboy	Sandstone, olive gray, fine to medium-grained, poorly bedded in part, massive in zones, irregular.			7	5			70	8
17				Shale, dusky red, mottled blue-gray with buff siltstone layers to 3 inches.			0	8			63	3
16		Little Waynesburg	Little Waynesburg Rider	Clay shale, with carbonaceous film, coal horizon.			0	1	18	10	62	7

LOCATION: Atr 1 FILE NUMBER: 11654 - continued

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
15	Monongahela - Continued	Little Waynesburg - Continued		Clay shale, dusky red, mottled blue-gray, nonbedded, sandy.			1	8			62	6
14			Lower Gilboy	Sandstone, olive gray, fine to medium-grained, micaceous, irregular lens disappearing to the west.			3	8			60	10
13				Shale, dusky red, mottled blue-gray, bedded, clayey to silty, to sandy upward with some sandstone lenses at top.			7	7			57	2
12			Little Waynesburg	Clay shale, dark gray, coal horizon ?			0	1			49	7
11				Clay shale, dusky red, silty, nonbedded.			1	3			49	6
10			Uniontown	Sandstone, olive gray to blue-gray, fine grained, irregular bedding.			2	6			48	3
9				Shale, dusky red, clayey to silty, chippy, micaceous, some blue-gray at top.			2	0			45	9
8		Uniontown	Uniontown	Carbonaceous clay, some coaly streaks.			0	0½	9	3+	43	9
7				Clay, light gray, plastic.			0	0½			43	8½
6				Clay shale and limestone, greenish gray clay shale with nodules of white limestone to 6 inches, nonbedded, maroon mottling.			1	6			43	8
5				Carbonaceous clay shale (laterally these coal streaks come together and the limestone goes out.)			0	1			42	2
4				Clay, gray, plastic.			0	2			42	1
3			Uniontown	Clay shale and limestone, dusky red and mottled purple and blue-gray with scattered small limestone knots.			7	5			41	11
2				Covered interval, probably red shale			14	6	14	6	34	6
1		Lower Uniontown	Arnoldsburg ?	Sandstone, light olive to brownish yellow, fine-grained, micaceous, bedded, calcareous in zones.			20	0	20	0	20	0

WATERLOO TOWNSHIP

LOCATION KEY: Aw 1 FILE NUMBER: 7570 ELEVATION: 761 Base TOPO MAP: Zaleski

STATE: Ohio COUNTY: Athens TOWNSHIP: Waterloo SECTION: NE-1/4 NE-1/4 30

LOCATION: Exposure in strip mine along north side of road east from Carbondale.

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
5	Allegheny	Bolivar	Bolivar	Sandstone, light gray, limonite stained, thin to massive-bedded, medium to coarse, friable, micaceous, with numerous fossil plants, scattered masses of ferruginous material and shale, and interbedded coal masses.			18	0	22	0	28	10
4				Shale, gray-light gray, limonite stained, sandy upward with scattered limonite-siderite concretions, variable thickness.			4	0			10	10
3		Lower Freeport	Dorr Run	Shale, black, carbonaceous, grades up to dark gray shale, sparingly fossiliferous in lower part, marine, argillaceous at top with limonite.			3	6	6	10	6	10
2			Lower Freeport	Coal, bright, blocky, with dull partings of fusain, pyrite towards top, melanterite on weathered surfaces.	1	6	2	10			3	4
				Clay shale, gray to dark gray, with thin seams of coal scattered throughout.	0	1-1/2						
				Coal, bright, blocky, with fine thin, dull masses of pyrite, much limonite stained on weathered surfaces.	1	2-1/2						
1				Clay, light gray to dark gray, many fossil plants, somewhat plastic, fine muscovite throughout.			0	6			0	6

LOCATION KEY: Aw 2 FILE NUMBER: 7571 ELEVATION: 788 Base TOPO MAP: Zaleski

STATE: Ohio COUNTY: Athens, Vinton TOWNSHIP: Brown, Waterloo SECTION: 6 Brown Twp., Vinton Co. 36 Waterloo Twp., Athens Co.

LOCATION: Exposure in slope mine and at entrance of same mine on north side of Route 56 west out of Carbondale and nearly at Athens–Vinton County line. Operated by J. R. McDaniels. (abandoned)

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
14	Allegheny	Lower Freeport	Lower Freeport	Shale, light gray to olive drab, limonite stained, with scattered ferruginous masses.			10	0	10	0	28	3
13		Upper Kittanning	Upper Kittanning	Shale, black, carbonaceous, weathered.			1	0	12	11	18	3
12				Coal, dull, badly weathered.			0	5			17	3
11				Underclay, light gray, limonite stained.			0	6			16	10
10				Shale, gray to light gray, several coaly streaks at top, some limonite stained, scattered iron concretions, shaly coal parting near base.			11	0			16	4
9		Middle Kittanning	Middle Kittanning	Coal, bony and shaly with thin bright streaks, some fusain, some pyrite.			0	5	5	4	5	4
8				Shale, gray to dark gray, pyrite irregular bedded, micaceous, fossil plants.			0	3			4	11
7				Coal, bright and dull, bony, much fusain, some sulphur.			0	7			4	8
6				Coal, bright, some dull streaks of much fusain, some bone coal scattered throughout.			0	10			4	1
5				Clay shale, gray to dark gray, thin coaly streaks and some fossil plants.			0	3			3	3
4				Coal, mostly bright with beds of dull coal interbedded, some irregular masses of pyrite, calcareous along some joint surfaces.			2	3			3	0
3				Shale, gray to dark gray, argillaceous with thin irregular streaks of coal.			0	2			0	9
2				Coal, bright, blocky, some pyrite, and some dull streaks.			0	7			0	7
1				Underlay, gray to light gray, plastic exposed, unmeasured.			-	-			-	-

LOCATION KEY: Aw 3 FILE NUMBER: 7572 ELEVATION: 759 ± Base TOPO MAP: Zaleski

STATE: Ohio COUNTY: Athens TOWNSHIP: Waterloo SECTION: E-1/2, NE-1/4, 30

LOCATION: Composite exposure in ravine and along North-South road.

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
37	Conemaugh	Upper Bakerstown	Cow Run	Shale, olive drab, sandy, limonite stained, argillaceous and finely micaceous, scattered iron concretions and masses.			22	5	22	5	224	7
36		Anderson	Portersville	Shale, gray, somewhat limonite stained, argillaceous, no apparent fossils, weathered.			0	8	7	11	202	2
35			Anderson	Coal, weathered, shaly.			0	3			201	6
34				Underclay, light gray, limonite stained, somewhat stained.			0	8			201	3
33			Bakerstown ?	Covered, with some shale exposed.			6	4			200	7

LOCATION: . Aw 3 FILE NUMBER 7572 - continued

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
32	Conemaugh - continued	Wilgus	Cambridge	Limestone, gray mottled with iron stain, sandy, micaceous, calcareous and nodular.			0	6	37	6	194	3
31			Buffalo	Shale, olive drab, limonite stained, sandy, micaceous with ferruginous zones.			2	8			193	9
30				Sandstone, gray to olive drab, limonite stained, thin-bedded, fine, micaceous.			10	0			191	1
29				Shale, olive drab, sandy upwards, micaceous with ferruginous zone and scattered sideritic concretions.			24	4			181	1
28		Upper Brush Creek	Upper Brush Creek	Limestone, dark bluish gray, dense, fossiliferous, marine.			0	9	23	9	156	9
27				Shale, dark bluish gray, dense, weathers to yellowish color, fossiliferous, marine, secondary calcite.			0	6			156	0
26				Shale and shaly sandstone, olive drab, limonite stained, sandy, micaceous, scattered ferruginous zones and concretions.			22	6			155	6
25		Lower Brush Creek	Lower Brush Creek	Limestone, gray mottled, limonote stained, lower part quite fossiliferous.			0	8	8	9	133	0
24				Shale, olive drab, limonite stained, sandy, micaceous, with scattered ferruginous concretions, grades up to sandstone at top.			8	1			132	4
23		Mason	Mason	Clay shale, light gray, limonite stained, with dark streaks.			0	3	30	11	124	3
22				Coal, smut streak, with some coaly fragments, badly weathered.			0	1			124	0
21				Underclay, light gray.			0	3			123	11
20			Upper Mahoning	Shale, light gray to olive drab, limonite stained, clay shale zones throughout, sandy and micaceous, becomes more sandy at top, ferruginous zones.			30	4			123	8
19		Mahoning	Lower Mahoning	Clay shale and variegated clay with nodular ferruginous zones of fresh-water limestone near base.			4	6	49	0	93	4
18				Shale, olive drab, sandy at base to argillaceous at top, limonite stained.			1	10			88	10
17				Sandstone, light gray, limonite stained, medium to fine grained upward, micaceous, massive, variable thickness (in hollow was thinner).			42	8			87	0
16	Allegheny	Upper Freeport	Upper Freeport	Coal, shaly, badly weathered.			0	1	16	11	44	4
15				Underclay, light gray, some limonite stained, plastic.			1	1			44	3
14				Shale, gray, sandy, micaceous, interbedded with clay shale and sandstone, ferruginous zones and nodules.			15	9			43	2
13		Bolivar	Shawnee	Limestone, light gray, limonite stained on surface, dense, locally brecciated, fossiliferous, fresh-water			0	8	19	3	27	5
12			?	Covered mostly, probably shale and clay shale.			7	1			26	9

LOCATION: Aw 3 FILE NUMBER 7572 - continued

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
11	Allegheny - continued	Bolivar - continued	Shawnee ?	Ironstone, sideritic and limonitic, nodular.			0	6			19	8
10			Bolivar ?	Clay and clay shale, light gray to olive drab, limonite stained, ferruginous zones.			6	0			19	2
9				Shale, light gray to olive drab, limonite stained, sandy and micaceous upward.			4	0			13	2
8				Clay shale, light gray, silty, finely micaceous, limonite stained at top, becomes shaly upward.			1	0			9	2
7		Lower Freeport	Dorr Run	Shale, dark gray to black, carbonaceous, fossiliferous.			2	0	8	2	8	2
6			Lower Freeport	Coal, some bright, mostly dull, shaly, weathered.			1	4			6	2
5				Clay shale, gray to dark gray, thin coaly streaks?, weathered.			0	2			4	10
4				Coal, bright, dull streaks, some fusain, weathered.			1	4			4	8
3				Underclay, light gray, limonite stained, plastic.			0	8			3	4
2				Sandstone, light gray with limonite stain, fine, micaceous, traces of fossil plants.			0	4			2	8
1				Clay shale, light gray to olive drab, some limonite stain, finely micaceous, somewhat plastic when wet, exposed.			2	4			2	4

LOCATION KEY: Aw 5 FILE NUMBER: 7574 ELEVATION: 728 ± Base TOPO MAP: Zaleski

STATE: Ohio COUNTY: Athens TOWNSHIP: Waterloo SECTION: NW-1/4, NW-1/4, 22

LOCATION: Exposure in mine and along road of No. 6 Coal (Goldbrick Mine) located on east side of Route 56, south of Carbondale.

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
15	Conemaugh	Lower Brush Creek	Lower Brush Creek	Sandstone, light gray, limonite stained, coarse, very friable, micaceous and massive, some bedding on weathered surface.			22	0	22	0	180	0
14		Mason ?	Mason ?	Covered interval.			9	9	9	9	158	0
13		Mason ? and Mahoning	Upper and Lower Mahoning	Clay, light gray, maroon, varicolored, somewhat plastic, zone of sandy shale near center, exposed. Possibly Mason cyclothem above sandy shale.			22	0	52	3	148	3
12				Sandstone, light gray, with variable limonite stain, one zone of calcareous material near top.			1	9			126	3
11				Shale, olive drab, limonite stained, sandy and micaceous at base, grading into argillaceous with ferruginous concretions at top, covered in part.			9	0			124	6
10				Sandstone, light gray, limonite stained with ferruginous bands, medium to coarse, friable, massive.			19	6			115	6
9	Allegheny	Upper Freeport	Upper Freeport	Covered with showing of light gray plastic clay, probably Upper Freeport.			10	6	25	6	96	0
8				Shale, olive drab, limonite stained with ferruginous zones and masses, sandy, micaceous with some gray clay shale interbedded.			15	0			85	6

LOCATION: Aw 5 FILE NUMBER 7574 - continued

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
7	Allegheny	Lower Freeport	Lower Freeport	Sandstone, light gray, limonite stained, very massive, medium, somewhat friable, very micaceous, disconformable			64	3	66	9	70	6
6				Shale, gray to dark gray, sandy, micaceous, locally replaced by 6-8 inch "false" rock, thickness variable.			2	6			6	3
5		Middle Kittanning	Middle Kittanning	Coal, bright and dull, with some fusain and bone, lenses and masses of pyrite.	0	8	3	9	3	9	3	9
4				Clay shale, gray to dark gray with thin partings and seams of coal.	0	5					3	1
3				Coal, bright, blocky, with some fusain and thin lenses and masses of pyrite.	1	11					2	8
2				Clay shale, light gray, hard and compact.	0	1					0	9
1				Coal, bright, blocky with some dull streaks.	0	8					0	8
				Underclay, light gray.							0	0

LOCATION KEY: Aw 7 FILE NUMBER: 7576 ELEVATION: 735 ± Base TOPO MAP: Zaleski

STATE: Ohio COUNTY: Athens TOWNSHIP: Waterloo SECTION: SW-1/4 and NE-1/4 of NE-1/4, 29

LOCATION: Brush Creek at 917 feet to west: exposure in ravines and along road.

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
25	Conemaugh	Wilgus	Buffalo	Sandstone, light gray, limonite stained, massive, friable, shaly appearing on weathered surfaces, fine, exposed.			15	9			216	0
24		?	?	Covered with many blocks of sandstone float.			26	9	?		201	0
23		Upper Brush Creek ?	Upper Brush Creek ?	Shale, olive drab, limonite stained, sandy and micaceous, exposed (float of Lower Brush Creek found here).			26	0	?		174	3
22		Lower Brush Creek	Lower Brush Creek	Sandstone, light gray with limonite stain, medium to coarse, micaceous, massive, showing some bedding on weathered surface.			22	7			148	3
21		Mason	Mason	Clay, light gray, plastic, some shaly layers.			0	8	21	5	125	8
20				Coal and clay interbedded with 3 to 4 coal streaks, fossil plants, coal badly weathered and shaly.			1	0			125	0
19				Underclay, light gray, yellow stained, plastic, poorly exposed.			2	0			124	0
18			Upper Mahoning	Sandstone and shale, light gray with limonite stain, micaceous, calcareous sandstone interbedded with similarly colored clay shale and shale.			17	9			122	0
17		Mahoning	Thornton	Clay and clay shale, light gray mottled yellowish, purplish, and maroon.			5	3	32	5	104	3
16			Lower Mahoning	Covered in part, some clay and clay shale exposed.			1	0			99	0

LOCATION: Aw 7 FILE NUMBER 7576 - continued

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
15	Conemaugh - continued	Mahoning - continued	Lower Mahoning - continued	Sandstone, light gray, limonite stained, medium, micaceous, somewhat friable, massive.			26	2			98	0
14	Allegheny	Upper Freeport	Upper Freeport	Coal, shaly, badly weathered.			0	1	8	11	71	10
13				Underclay, light gray, limonite stained, plastic.			2	0			71	9
12				Sandstone, light gray, limonite stained, thin-bedded with shaly appearance on surface, argillaceous towards top.			2	8			69	9
11				Shale, olive drab, limonite stained, argillaceous at base becoming sandy upward.			4	2			67	1
10		Bolivar	Bolivar	Clay, light gray, limonite stained.			1	2	13	2	62	11
9			Shawnee	Limestone, gray to red mottled appearance on surface, ferruginous.			1	10			61	9
8			Bolivar	Clay, light gray, limonite stained, plastic.			0	9			59	11
7				Flint clay, gray, limonite stained, brecciated appearance with ferruginous zones.			2	1			59	2
6				Shale and shaly sandstone, olive drab, limonite stained, sandy and micaceous, ferruginous zones becoming argillaceous at top.			7	4			57	1
5		Lower Freeport	Lower Freeport	Clay, light gray, limonite stained, plastic.			0	5	49	9	49	9
4				Coal, badly weathered, shaly.			0	1			49	4
3				Underclay, light gray to gray, limonite stained at base, sandy and micaceous.			2	11			49	3
2				Shale, olive drab, limonite stained, sandy and micaceous, becoming argillaceous, scattered siderite and limy concretions, calcareous.			2	10			46	4
1				Sandstone, light gray, limonite stained, medium, friable, exposed.			43	6			43	6

LOCATION KEY: Aw 8 FILE NUMBER: 7577 ELEVATION: 765± Base TOPO MAP: Zaleski

STATE: Ohio COUNTY: Athens TOWNSHIP: Waterloo SECTION: N-1/2, NE-1/4, 36

LOCATION: Exposure along roads in the N-1/2 of NE-1/4 of section 36 along south of Tributary and west of Carbondale.

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
20	Conemaugh	Mahoning	Lower Mahoning	Sandstone, light gray with calcareous (Mahoning's) sandstone, massive, friable, limonite stained, micaceous, poorly exposed at base and top, shaly appearing, probably coalesced with Upper Mahoning member.			84	6	84	6	183	6
19	Allegheny	Upper Freeport	Upper Freeport	Shale, blue drab, limonite stained, micaceous and sandy.			4	5	28	11	99	0
18				Flint clay, gray with much limonite stain, breaks with starch-like fracture.			1	4			94	7
17				Shale and clay shale, covered in part, ferruginous, nodular zone at top.			17	5			93	3

LOCATION: Aw 8 FILE NUMBER 7577 - continued

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
16	Allegheny - continued	Upper Freeport - continued	Upper Freeport - continued	Clay shale and clay, light gray, limonite stained with limonite concretions.			5	9			75	10
15		Bolivar	Bolivar	Coal, poorly developed.			0	1	13	0	70	1
14				Clay shale and shale, poorly exposed in part, micaceous, sandy, limonite stained.			1	6			70	0
13			Shawnee	Limestone, light gray, surface limonite stained, nodular.			2	10			68	6
12			Bolivar	Shale and clay shale, olive drab, micaceous, limonite stained on joint surfaces.			3	4			65	8
11				Sandstone, light gray, thin-bedded, fine to medium, micaceous.			1	4			62	4
10				Shale, olive drab, limonite stained, argillaceous, sandy and micaceous, more sandy at top and poorly exposed.			3	11			61	0
9		Lower Freeport	Lower Freeport	Clay shale, light gray with some limonite stain, plastic.			0	10	57	1	57	1
8				Clay shale, dark gray, carbonaceous.			0	6			56	3
7				Coal, badly weathered.			0	1			55	9
6				Underclay, light gray, plastic.			0	9			55	8
5				Clay shale, light gray to gray to yellowish, streaks and concretions of limonite.			2	11			54	11
4				Limestone, light gray, limonite stained on surface, many dendrites, dense, freshwater, some crystalline areas, nodular and lensing.			1	0			52	0
3				Clay shale, light gray, streaks of limonite stain with ferruginous concretions.			3	0			51	0
2				Sandstone, light gray, limonite stained, shaly bedded, micaceous to sandy shale at top.			21	0			48	0
1				Sandstone, light gray, limonite stained, massive to medium with brown ferruginous zones.			27	0			27	0
		Middle Kittanning	Middle Kittanning	Top of Middle Kittanning No. 6 coal.							0	0

LOCATION KEY: Aw 10 FILE NUMBER: 7579 ELEVATION: 714 ± Base TOPO MAP: Zaleski

STATE: Ohio COUNTY: Athens TOWNSHIP: Waterloo SECTION: E-1/2, SE-1/4, 26 into Section 20

LOCATION: Exposure along road east from intersection of state routes 356 and 680 and along first road, east to the north of this intersection

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
23	Conemaugh	Lower Brush Creek ?	Lower Brush Creek ?	Clay shale and shale, partially exposed, mostly covered.			16	6	16	6	167	6
22		Mason	Mason	Coal, shaly and weathered.			0	4	10	2	151	0
21				Clay, light gray plastic.			0	8			150	8
20			Upper Mahoning	Shale and clay shale, olive drab, limonite stained, micaceous, sandy.			3	9			150	0
19				Sandstone, light gray, limonite stained, massive.			5	5			146	3

LOCATION: Aw 10 FILE NUMBER 7579 - continued

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
18	Conemaugh - continued	Mahoning	Lower Mahoning	Covered interval.			2	10	45	10	140	10
17				Clay shale, varicolored, ferruginous nodular limestone layers throughout, poorly exposed.			16	8			138	0
16				Covered interval			8	4			121	4
15				Sandstone, light gray, limonite stained, micaceous, bedded, poorly exposed in part.			18	0			113	0
14	Allegheny	Upper Freeport	Upper Freeport	Coal, shaly and clayey, weathered streaks of coal.			0	1	25	8	95	0
13				Underclay, light gray, plastic, dark at top.			1	7			94	4
12				Sandstone, light gray, fine to medium, massive, bedded, shaly.			24	0			93	4
11		Bolivar	Bolivar	Clay, light gray to dark gray, plastic, limonite stained, upper part light gray.			4	10	20	6	69	4
10			Shawnee	Limestone, buff to brown weathered, dense, ferruginous, numerous dendrites, fresh-water, nodular.			1	6			64	6
9			Bolivar	Shale and clay shale, olive drab to light gray, limonite stained, iron concretions scattered.			3	6			63	0
8				Sandstone, light gray, limonite stained, micaceous, thin-bedded when weathered.			8	2			59	6
7				Shale, olive drab, argillaceous to sandy and micaceous, concretionary masses at top.			2	6			51	4
6		Lower Freeport	Dorr Run	Clay shale, light gray to dark gray, slightly carbonaceous at the base, no apparent fossils.			0	6	36	10	48	10
5			Lower Freeport	Coal, shaly, badly weathered, clay partings.			1	2			48	4
4				Underclay, light gray, plastic, limonite stained in streaks, grades to clay shale at base.			2	4			47	2
3				Shale, olive drab, limonite stained, sandy and micaceous, becomes argillaceous at top.			6	10			44	10
2				Sandstone, light gray, limonite stained, medium to coarse, micaceous, somewhat friable, case hardened along joint and bedding planes, cross-bedded, massive, variable thickness.			26	0			38	0
1		Middle Kittanning	Middle Kittanning	Covered interval (Top of No. 6 coal exposed at elevation of 726 feet).			12	0	12	0	12	0

LOCATION KEY: Aw 12 FILE NUMBER: 7581 ELEVATION: 705 ± Base TOPO MAP: Zaleski

STATE: Ohio COUNTY: Athens TOWNSHIP: Waterloo SECTION: 32 - Waterloo Twp.
Brown 2 - Brown Twp.

LOCATION: Exposure along cut of B. & O. main line railroad, 1,000 feet west of Athens County, Waterloo Township and Vinton County, Brown Township lines; in SE-1/4, SE-1/4, section 2 Brown Township, Vinton County, Ohio.

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
12	Allegheny	Middle Kittanning	Middle Kittanning and Snow Fork	Shale with calcareous sandstone and ferruginous concretionary masses, including a very thin coal and clay above sandstone.			14	6	14	6	39	10
11		Strasburg	Oak Hill	Clay, gray to light gray, plastic zones of ferruginous and calcareous material at top.			4	6	16	5	25	4
10			Strasburg	Shale and sandstone interbedded with small scattered limonite concretions.			7	7			20	10
9				Sandstone, light gray, buff, limonite stained, case hardened fine to medium, micaceous, variable thickness, thin-bedded with shaly partings, friable.			2	0			13	3
8				Shale gray to light gray, limonite stained, small flat ferruginous concretions, argillaceous and sandy at top, grading into thin sandstone layers.			2	4			11	3
7		Lower Kittanning	Lower Kittanning	Shale, black, bony, carbonaceous, fossil fish scales and plants, limonite stained on joint and bedding planes.			0	6	8	11	8	11
6				Shale, dark gray, argillaceous, finely micaceous, traces of fossil plants.	0	3	1	5			8	5
5				Coal bright with much dull shaly material, some pyrite and fusain, fossil plants.	0	10					8	2
4				Shale, light gray to green carbonaceous, sandy, thin coaly streaks.	0	1					7	4
3				Coal, bright and dull, some fusain and pyrite.	0	3					7	3
2				Underclay, light gray to dark gray at top, some limonite stain, micaceous, more sandy at base.			5	0			7	0
1				Sandstone, white to light gray, limonite stained, micaceous, friable, exposed.			2	0			2	0

LOCATION KEY: Aw 13 FILE NUMBER: 7582 ELEVATION: 721 Base TOPO MAP: Zaleski

STATE: Ohio COUNTY: Athens TOWNSHIP: Waterloo SECTION: SE-1/4, NW-1/4, 32

LOCATION: Exposure in rock cut along B. & O. RR, 150 ft. west of plank crossing.

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
8	Allegheny	Lower Freeport	Lower Freeport	Sandstone, light gray with much limonite stain, friable, micaceous streaks.			55	5	55	5	87	0
7		Middle Kittanning	Middle Kittanning	Coal, bright and dull, shaly with some fusain.			0	9	28	7	31	7
6				Clay shale, dark gray to gray with carbonaceous streaks.			0	1			30	10
5				Coal, bright with some dull and some fusain.			0	7			30	9
4				Clay, light gray, plastic, very sandy at bottom.			1	6			30	2

LOCATION: Aw 13 FILE NUMBER 7582 - continued

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
3	Allegheny - continued	Middle Kittanning - continued	Middle Kittanning - continued	Shale and sandstone, olive drab to gray shale, sandy and micaceous, concretions scattered throughout, locally replaced by lenticular masses of cross-bedded sandstone up to 6 - 8 feet thick and 100 feet long.			23	8			28	8
2				Shale, gray to light gray, sandy and micaceous, argillaceous concretions.			2	0			5	0
1		Strasburg	Oak Hill	Clay, light gray to gray, upper plastic, finely micaceous with fine to 1 inch size ferruginous concretions, lower part exposed.			3	0	3	0	3	0

LOCATION KEY: Aw 14 FILE NUMBER: 7583 ELEVATION: 719 ± Base TOPO MAP: Zaleski

STATE: Ohio COUNTY: Athens TOWNSHIP: Waterloo SECTION: 32

LOCATION: Exposure in cut at west portal of Kings Tunnel #4 along B. & O. Railroad.

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
9	Allegheny	Lower Freeport	Lower Freeport	Sandstone, light gray, limonite stained, case hardened on surface, medium to coarse, micaceous, very massive.			46	0	47	3	68	11
8				Shale, gray, argillaceous, limonite stained, finely micaceous, selenite on surface, variable thickness.			1	3			22	11
7		Middle Kittanning	Middle Kittanning	Coal, bright, much fusain and some pyrite, free sulfur and melanterite on weathered surfaces.			0	6	21	8	21	8
6				Shale, gray, argillaceous, slickensides, surface stained, thin coal partings.			0	3			21	2
5				Coal, bright with thin dull partings, some pyrite and fusain, much melanterite and sulfur			2	0			20	11
4				Shale, gray, bony at top, thin carbonaceous streaks, argillaceous, free sulfur on surface.			0	1			18	11
3				Coal, bright with minor amount of dull coal, some pyrite and fusain, free sulfur on weathered surface.			0	7			18	10
2				Underclay, gray, some limonite stain, dull carbonaceous thin partings, silty, micaceous, plastic, traces of fossil plants.			1	0			18	3
1				Sandstone and shale, the sandstone is light gray, limonite stained, shaly appearing and interbedded in lenticular masses with the sandy shale, gray to light gray.			17	3			17	3

LOCATION KEY: Aw 15 FILE NUMBER: 7584 ELEVATION: 784 ± Base TOPO MAP: Zaleski

STATE: Ohio COUNTY: Athens TOWNSHIP: Waterloo SECTION: 35

LOCATION: Exposure in ravine and to 1009 feet road intersection.

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
12	Conemaugh	Mason and Mahoning	Upper and Lower Mahoning	Sandstone, light gray, limonite stained, coarse, massive, thin, light gray clay shale interbedded.			85	8	85	8	168	0
11	Allegheny	Upper Freeport	Upper Freeport	Clay, light gray, limonite stained, becomes clay shale in spots and represents Upper Freeport No. 7 coal horizon.			3	2	12	10	82	4
10				Shale and sandstone, micaceous, olive drab thin-bedded sandstone shale becomes argillaceous at top.			9	8			79	2
9		Bolivar	Shawnee	Limestone, light gray, limonite stained on surface, dense fresh-water, sand at base, nodular appearance on weathering.			0	9	0	9	69	6
8		Lower Freeport	Lower Freeport	Sandstone, light gray, limonite stained micaceous, fine to medium, cross-bedded, massive to laminated and shaly appearing in top 6 - 8 feet.			60	9	60	9	68	9
7		Middle Kittanning	Middle Kittanning	Coal, shaly, bony, some bright, much fusain badly weathered.	0	6	3	10	8	0	8	0
6				Shale, gray to dark gray argillaceous with thin coaly streaks.	0	S					7	6
5				Coal, bright, weathered with limonite stain, dull partings, some fusain.	2	4					7	1
4				Shale, dark gray, carbonaceous, argillaceous, weathered.	0	1					4	9
3				Coal, bright, limonite stained, weathered thin streaks dull coal and fusain.	0	6					4	8
2				Underclay, light gray with much limonite stain, sandy, silty, micaceous, many stigmaria.			0	8			4	2
1				Sandstone, light gray with much limonite stain fine to medium, stigmaria, micaceous, grades into shale locally, exposed.			3	6			3	6

LOCATION KEY: Aw 18 FILE NUMBER: 7587 ELEVATION: 761± Base TOPO MAP: Zaleski

STATE: Ohio COUNTY: Athens TOWNSHIP: Waterloo SECTION: SW-1/4, SE-1/4, 34

LOCATION: Exposure in north side of ravine of Pine Run.

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
8	Allegheny	Lower Freeport	Lower Freeport	Sandstone, light gray, limonite stained, very massive with laminated zones, micaceous, medium to coarse, exposed.			66	0	66	0	69	0
7		Middle Kittanning	Middle Kittanning	Coal, shaly, bony, and weathered.			0	2	3	0	3	0
6				Clay shale, light gray to gray with some carbonaceou shaly material and some coaly shale.			0	3			2	10
5				Coal, bright, blocky, with some dull streaks and fusain.			2	0			2	7
4				Clay shale, light gray to gray.			0	1			0	7
3				Coal, bright, blocky with some fusain.			0	6			0	6
2				Clay light gray, plastic, unmeasured.			-	-			-	-
1				Sandstone exposed, unmeasured.			-	-			-	-

LOCATION KEY: Aw 19 FILE NUMBER: 7588 ELEVATION: 730 ± Base TOPO MAP: Zaleski

STATE: Ohio COUNTY: Athens TOWNSHIP: Waterloo SECTION: E-1/2, NE-1/4, 28

LOCATION: Exposure along main road of Waterloo Game Area.

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
10	Conemaugh	Lower Brush Creek	Lower Brush Creek	Limestone, dark bluish gray, dense, fossiliferous.			0	4	0	4	149	10
9		? Mahoning	? Lower Mahoning Thornton ?	Covered interval, usually contains MAHONING coal, clay and sandstone, red clay shale at top.			43	6	?		149	6
8			Lower Mahoning	Sandstone, light gray, limonite stained, coarse, friable, massive.			25	9			106	0
7	Allegheny	Upper Freeport	Upper Freeport	Clay, light gray, plastic, limonite stained with nodular ferruginous masses embedded, exposed.			1	3	7	1	80	3
6				Shale and sandstone, limonite stained, micaceous, sandstone bedded in layers 6 inches thick, poorly exposed.			5	10			79	0
5		Bolivar	Shawnee	Limestone, gray, yellow to buff to red stained by limonite, nodular and impure.			0	8	11	0	73	2
4			Bolivar	Shale, light gray to olive drab, limonite stained with ferruginous zones, argillaceous at base grading to sandy at top.			10	4			72	6
3		Lower Freeport	Lower Freeport	Clay, light gray with limonite streaks, plastic.			1	0	62	2	62	2
2				Shale, light gray to olive drab, limonite stained, sandy and micaceous, clay zones.			2	2			61	2
1				Sandstone, light gray, limonite streaks, friable, massive, micaceous, exposed.			59	0			59	0
				B. & O. railroad at Waterloo Game Farm.								

LOCATION KEY: Aw 20 FILE NUMBER: 7589 ELEVATION: 749±Base TOPO MAP: Zaleski

STATE: Ohio COUNTY: Athens TOWNSHIP: Waterloo SECTION: NE-1/4, SW-1/4, 33

LOCATION: Exposure in ravine.

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
10	Conemaugh	Mahoning	Lower Mahoning	Sandstone and shale, very poorly exposed except at top and base, shale probably in center.			76	1	76	1	161	0
9	Allegheny	?	?	Covered, adjacent hollow shows underclay and shale in this interval.			10	0	10	0	84	11
8		Bolivar ?	Shawnee ?	Limestone, gray, limonite stained on surface, nodular, slightly ferruginous.			0	10	0	10	74	11
7		Lower Freeport	Lower Freeport	Shale, light gray to olive drab, limonite stained, sandy and micaceous, poorly exposed.			5	3	62	3	74	1
6				Sandstone, light gray, limonite stained, containing shaly partings, cross-bedded, micaceous, massive, disconformable at base.			57	0			68	10
5		Middle Kittanning	Middle Kittanning	Coal, bright and dull, grading into shaly at base, bony material at top, badly weathered.			1	11	11	10	11	10

LOCATION: Aw 20 FILE NUMBER 7589 - continued

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
4	Allegheny - continued	Middle Kittanning - continued	Middle Kittanning - continued	Clay shale, gray to dark gray, fossil plants.			0	1			9	11
3				Coal, bright, blocky, some dull streaks and fusain.			0	7			9	10
2				Clay, light gray, limonite stained, plastic, grades into clay shale at base.			1	9			9	3
1			Snow Fork	Shale, light gray, much limonite stained on surface, sandy and micaceous, more argillaceous at top with ironstone concretions 6 inches in diameter.			7	6			7	6

LOCATION: KEY: Aw 20-A FILE NUMBER: 7590 ELEVATION: 816 Base TOPO MAP: Zaleski

STATE: Ohio COUNTY: Athens TOWNSHIP: Waterloo SECTION: 33

LOCATION:

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
4	Conemaugh	Mahoning	Lower Mahoning	Sandstone, light gray, limonite stained, coarse, micaceous, friable, case hardened.			70	3	70	3	95	3
3	Allegheny	Upper Freeport	Upper Freeport	Clay, light gray, plastic, represents No. 7 coal horizon.			3	1	25	0	25	0
2				Limestone, gray, buff, stained on surface by limonite.			0	8			21	11
1				Shale, and shaly sandstone, olive drab, limonite stained.			21	3			21	3

LOCATION KEY: Aw 21 FILE NUMBER: 7591 ELEVATION: 748 Base TOPO MAP: Zaleski

STATE: Ohio COUNTY: Athens TOWNSHIP: Waterloo SECTION: E-1/2, SW-1/4, 33

LOCATION: Details of Middle Kittanning coal in abandoned mine located in ravine.

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
7	Allegheny	Lower Freeport	Lower Freeport	Sandstone, light gray, limonite stained, friable, case hardened, micaceous, exposed.			30	0	30	0	34	0
6		Middle Kittanning	Middle Kittanning	Coal, shaly with bright streaks, much fusain and some bone, variable thickness.			0	4	4	0	4	0
5				Clay shale, light to dark gray with coaly streaks, soft, weathered.			0	4			3	8
4				Coal, bright with thin dull streaks and fusain, considerable melanterite and some limonite on weathered surface, pyrite.			2	1			3	4
3				Clay shale, gray to gray drab with thin, irregular, coaly streaks, compact.			0	2			1	3
2				Coal, bright with thin dull streaks, some fusain and pyrite.			0	7			1	1
1				Clay, light gray, limonite stained, plastic, exposed.			0	6			0	6

LOCATION KEY: Aw 22 FILE NUMBER: 7592 ELEVATION: 776 ± Base TOPO MAP: Zaleski

STATE: Ohio COUNTY: Athens TOWNSHIP: Waterloo SECTION: 25

LOCATION: Exposure along Route 356 starting at a cut of No. 6 Coal directly opposite of headquarters of the Waterloo State Forest and continuing up the hill to the south.

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
22	Conemaugh	Lower Brush Creek	Lower Brush Creek	Shale, fossiliferous.			2	0	7	0	174	0
21				Limestone, light gray, limonite stained, marine fossiliferous, flinty, weathered nearly nodular limestone.			1	0			172	0
20				Clay shale, mottled yellow and red, micaceous.			2	6			171	0
19				Sandstone, much stained yellow and brown, fine micaceous, cavities 2 - 6 inches in diameter.			1	6			168	6
18		Mason	Mason	Shale, light gray, micaceous and sandy, limonite stained and ferruginous at top.			10	0	16	3	167	0
17				Coal shaly with some bright streaks, considerably weathered, undulating base, rising 8 feet in short space.			0	9			157	0
16			Upper Mahoning	Shale, gray to light gray, sandy, micaceous, stigmaria roots at top.			5	6			156	3
15		Mason and Mahoning	Upper and Lower Mahoning	Sandstone, light gray, massive, medium to coarse, micaceous, friable, ferruginous and shaly zones, poorly exposed in center.			83	6	83	6	150	9
14	Allegheny	Upper Freeport	Upper Freeport	Coal, weathered, shaly.			0	6	7	0	67	3
13				Underclay, light gray, streaked with limonite stain, plastic (in branch to southwest no clay is present).			1	6			66	9
12				Shale, light gray, micaceous, sandy, argillaceous.			5	0			65	3
11		Bolivar	Shawnee	Limestone, sideritic, nodular.			0	3	14	3	60	3
10			Bolivar	Shale, light gray, much limonite stained on surface, argillaceous to sandy.			3	0			60	0
9				Sandstone, light gray, limonite stained, fine to medium, numerous fossil plants near bottom, micaceous, thin-bedded to massive.			11	10			57	0
8		Lower Freeport	Lower Freeport	Limestone, gray, dense to crystalline in spots and in veinlets, nodular, micaceous, ferruginous, sandy, interbedded in gray clay, shale with one predominant 30-inch ledge near top of shale.			8	0	41	4	46	0
7				Sandstone, light gray, limonite stained, micaceous, coarse, massive.			33	4			38	0
6		Middle Kittanning	Middle Kittanning	Shale, gray, sandy, limonite stained, micaceous, some fossil plants.			1	0	4	8	4	8
5				Coal, some bright with large amounts of fusain fossil plants.			0	7			3	8
4				Clay shale, gray, micaceous with coaly streaks, numerous stigmaria rootlets, much much limonite stained.			0	5			3	1
3				Coal, bright with numerous thin dull streaks, sulfur on surface much fusain.			2	0			2	8
2				Shale, dark gray, argillaceous micaceous, carbonaceous.			0	1			0	8
1				Coal, bright, some fusain and pyrite.			0	7			0	7
				Underclay, light gray, plastic, exposed.			-	-			-	-

LOCATION KEY: Aw 23 FILE NUMBER: 7593 ELEVATION: 755± Base ? TOPO MAP: Zaleski

STATE: Ohio COUNTY: Athens - Vinton TOWNSHIP: Knox, Waterloo SECTION: 36 Knox, NE-1/4, NW-1/4; 31 Waterloo, E-1/2, SW-1/4

LOCATION: Exposure in ravine and along road starting in the NE-1/4 of the NW-1/4 of section 36, Knox Township, Vinton County, and continuing in the E-1/2. SW-1/4, section 31, Waterloo Township, Athens County, Ohio.

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
8	Conemaugh	Brush Creek ?	Brush Creek ?	Sandstone, light gray, mottled dark brown to red brown, probably fossiliferous.			3	0	11	0	219	8
7				Sandstone, light gray, very friable, limonite stained, ferruginous zones.			8	0			216	8
6		?	?	Covered interval.			55	8	55	8	208	8
5		Mason and Mahoning	Upper and Lower Mahoning	Sandstone, light gray, limonite stained, coarse to medium, micaceous, friable, zone of limonite and ferruginous material at base, Mahoning coal fragments in matrix.			70	7	70	7	153	0
4	Allegheny	Upper Freeport	Upper Freeport	Clay, light gray, limonite stained, plastic.			3	0	29	11	82	5
3				Limestone, light gray, mottled yellow or red by limonite and ferruginous material, nodular, interbedded with clay and sandstone.			2	9			79	5
2				Shale, light gray, limonite stained, micaceous and sandy, grades upward into shaly sandstone.			24	2			76	8
1		Lower Freeport	Lower Freeport	Sandstone with clay shale at top, light gray, medium to fine, micaceous, massive, limonite stained and streaked, especially along bedding planes, shows jointing, exposed.			52	6	52	6	52	6

LOCATION KEY: Aw 24 FILE NUMBER: 7594 ELEVATION: 727± Base TOPO MAP: Zaleski

STATE: Ohio COUNTY: Athens TOWNSHIP: Waterloo SECTION: SW-1/4, NW-1/4, 21

LOCATION: Exposure along road and in ravine.

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
13	Conemaugh	Wilgus and Upper Brush Creek	Cambridge	Limestone, light gray, limonite stained.			0	6	1	2	202	11
12			Buffalo	Sandstone, calcareous gray to light gray.			0	8			202	5
11			Buffalo and Upper Brush Creek	Shale and sandstone, gray limonite stained, fossiliferous at base.			44	8	44	8	201	9
10		Lower Brush Creek	Lower Brush Creek	Limestone, gray, weathered, slabby, fossiliferous, marine.			1	0	33	6	157	1
9				Shale and sandstone, gray to light gray interbedded.			32	6			156	1
8		Mason	Upper Mahoning	Sandstone, light gray, limonite stained, very massive, cross-bedded.			26	0	26	0	123	7
7		Mahoning	Lower Mahoning	Sandstone, light gray, limonite stained, thin-bedded to massive.			16	8	16	8	97	7
6	Allegheny	?	?	Covered interval, (fresh-water limestone in next ravine).			17	0	17	0	80	11
5		Upper Freeport	Upper Freeport	Sandstone, light gray, limonite stained, fine to medium slabby, layer exposed.			3	6	5	6	63	11
4				Shale, olive drab, micaceous, argillaceous at base, grading to sandy above.			2	0			60	5
3		Bolivar	Bolivar	Clay, light gray, plastic, weathered, becomes shaly in places.			3	8	4	11	58	5
2			Shawnee	Limestone, light gray, much stained, buff to yellow by limonite, sandy, micaceous shaly appearing.			1	3			54	9
1		Lower Freeport	Lower Freeport	Sandstone, light gray, limonite stained, weathers dark on surface, very massive, fine to medium, micaceous, exposed (natural bridge formed from differential weathering along joints.			53	6	53	6	53	6
				Water level of Grass Run beside B.&O.RR								

LOCATION KEY: Aw 26 FILE NUMBER: 7596 ELEVATION: 806± Base TOPO MAP: Zaleski

STATE: Ohio COUNTY: Athens TOWNSHIP: Waterloo SECTION: N-1/2, SW-1/4, 20

LOCATION: Exposure in ravine tributary of Coal Run.

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
11	Conemaugh	?	?	Shale, badly weathered, red mottled, unmeasured.			-	-	-	-	-	-
10		Upper Bakerstown ?	Cow Run ?	Sandstone, light gray, limonite stained, micaceous, coarse, friable.			25	0	25	0	116	10
9		Wilgus ?	Buffalo ?	Shale, olive drab, micaceous and sandy, ferruginous zones along joints.			21	0	35	8	91	10
8				Covered interval, probably shale.			14	8			70	10
7		Upper Brush Creek	Upper Brush Creek	Limestone, gray, compact, dense, marine fossiliferous, surface weathers with rounded appearance.			0	8	20	8	56	2
6				Shale, olive drab, micaceous and sandy with ferruginous concretions, thin-bedded sandstone at top, calcareous at base.			20	0			55	6

LOCATION: Aw 26 FILE NUMBER 7596 - continued

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
5	Conemaugh - continued	Lower Brush Creek	Lower Brush Creek	Limestone and shale, gray to dark gray, calcareous, fossiliferous, marine, 1 foot limestone layer.			6	1	35	6	35	6
4				Coal, badly weathered with several clay partings.			1	3			29	5
3				Underclay, light gray, limonite stained.			2	0			28	2
2				Clay and clay shale, red mottled, gray, micaceous and sandy.			11	2			26	2
1				Covered in part, some shale.			15	0			15	0
				Top of Upper Mahoning sandstone.								

LOCATION KEY: Aw 28 FILE NUMBER: 7598 ELEVATION: 728± Base TOPO MAP: Zaleski

STATE: Ohio COUNTY: Athens TOWNSHIP: Waterloo SECTION: NW-1/4, NW-1/4, 19

LOCATION: Exposure in ravine.

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
23	Conemaugh	Upper Bakerstown ?	Upper Bakerstown ?	Sandstone, conglomerate, limestone, and flint, grading upward to the sandstone (on hill to west, much flint material shown).			52	0	52	0	225	0
22		Anderson ?	Portersville ?	Shale, olive drab to greenish, fissile.			1	0	2	0	173	0
21			Bloomfield ?	Limestone, much limonite stained, fresh-water.			1	0			172	0
20		Wilgus ?	Buffalo ?	Shale, olive drab, fissile in places, limonite stained along joints, siderite concretions scattered throughout, greenish and finer upward.			36	6	39	6	171	0
19				Conglomerate, fine to coarse, quartz pebbles and fossiliferous limestone pebbles.			3	0			134	6
18		Lower Brush Creek ?	Lower Brush Creek ?	Clay and clay shale, gray to light gray, limonite stained.			1	0	1	0	131	6
17		Mason	Mason	Coal, badly weathered, some bright clay seams.			0	10	13	0	130	6
16				Underclay, light gray, plastic, nodules of fresh-water limestone at base, exposed.			2	0			129	8
15				Shale, olive drab, micaceous and sandy.			7	10			127	8
14			Upper Mahoning	Sandstone, light gray, thin-bedded, fucoids on bottom.			2	4			119	10
13		Mahoning	Lower Mahoning	Shale, olive drab, limonite stained, micaceous, fossil plants.			7	6	56	10	117	6
12				Clay and limestone, red mottled clay with limestone nodules at the base, ferruginous nodules in top.			21	4			110	0
11				Sandstone, light gray, limonite stained, micaceous, medium, thin-bedded to massive, calcareous layers.			28	0			88	8
10	Allegheny	Upper Freeport	Upper Freeport	Clay shale, dark gray, light gray at bottom, No. 7 Coal horizon.			0	1	16	1	60	8
9				Underclay, light gray, plastic.			0	6			60	7
8				Shale, olive drab, micaceous, limonite stained, sandy, iron concretions scattered throughout.			15	6			60	1

LOCATION: Ad 28 FILE NUMBER 7598 - continued

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
7	Allegheny - continued	Bolivar	Shawnee	Limestone, gray, limonite stained, buff, nodular appearing.			1	3	14	11	44	7
6			Bolivar	Shale, olive drab, limonite stained, sandy, nodular appearing.			13	8			43	4
5		Lower Freeport	Dorr Run	Clay shale, gray to dark gray, no apparent fossils.			0	6	29	8	29	8
4			Lower Freeport	Coal, badly weathered, shaly with some bright streaks.			0	4			29	2
3				Underclay, light gray, plastic, much stained by limonite, exposed.			1	0			28	10
2				Shale, olive drab, limonite stained, micaceous, sandy to argillaceous.			7	10			27	10
1				Sandstone, light gray, limonite stained, fine to medium, micaceous, massive, becomes slabby at top.			20	0			20	0
				Middle of culvert.								

LOCATION KEY: Aw 32 FILE NUMBER: 7602 ELEVATION: 720 ± Base TOPO MAP: Athens

STATE: Ohio COUNTY: Athens TOWNSHIP: Waterloo SECTION: SE-1/4, NE-1/4, 21

LOCATION: Details of Upper Freeport limestone and No. 7 Coal in B. & O. R. R.

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
7	Conemaugh	Mahoning	Lower Mahoning	Sandstone, light gray, medium to coarse, micaceous, very friable, massive, exposed formerly quarried along road.			15	0	15	0	28	11
6	Allegheny	Upper Freeport	Upper Freeport	Underclay, light gray, plastic, limonite stained.			0	2-1/2	13	11	13	11
5				Coal, mostly coaly streaks at top of clay.			0	0-1/2			13	8-1/2
4				Underclay, light gray to gray, plastic, limonite stained, variable thickness.			2	6			13	8
3				Underclay and clay shale, gray to dark gray, starch-like fracture, scattered siderite concretions and lenses, somewhat plastic.			6	6			11	2
2				Limestone, gray, dense, small veinlets of calcite, weathered surface limonite stained, nodular ferruginous concretions at layers of varying thickness.			1	8			4	8
1				Shale, gray to light gray, silty, sandy and micaceous, exposed.			3	0			3	0

LOCATION KEY: Aw 33 FILE NUMBER: 7603 ELEVATION: 754 ± Base TOPO MAP: Athens

STATE: Ohio COUNTY: Athens TOWNSHIP: Waterloo SECTION: SE-1/4, SE-1/4, 22 W-1/2, SW-1/4, 16

LOCATION: Exposure along Route No. 56 to E - W road to right, on up to top of hill located in the SE-1/4 of the SE-1/4, of section 22, and the W-1/2 of the SW-1/4 of section 16.

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
11	Conemaugh	?	?	Sandstone, light gray, limonite stained, unmeasured.			-	-	-	-	-	-
10		?	?	Covered.			-	-	-	-	-	-
9		Wilgus and Upper Brush Creek	Buffalo and Upper Brush Creek	Shale, olive drab, limonite stained, sandy, micaceous, some clay zones, poorly exposed in part.			47	6	47	6	154	0
8		Lower Brush Creek	Lower Brush Creek	Shale, light to gray, limonite stained, micaceous and silty, somewhat weathered, fossiliferous.			2	10	29	2	106	6
7				Limestone, dark blue gray, fossiliferous, marine, shaly appearance on weathered surfaces.			0	8			103	8
6				Shale, olive drab, limonite stained, poorly exposed in part, silty, sandy.			25	8			103	0
5		Mason	Mason	Clay and clay shale, gray, mottled red, buff and yellowish, poorly exposed in lower 15 feet.			22	4	22	4	77	4
4		Mason ? and Mahoning	Upper ? and Lower Mahoning	Sandstone, light gray, limonite stained, very coarse at base, becoming finer upwards, micaceous, friable, massive.			53	2	53	2	55	0
3	Allegheny	Upper Freeport	Upper Freeport	Clay shale, dark gray to light gray, fossil plants, slickensided.			0	4	1	10	1	10
2				Coal, dull with some bright streaks, some fusain, shaly.			0	2			1	6
1				Underclay, gray to light gray, limonite stained, micaceous, plastic.			1	4			1	4
				Shale, light gray, limonite stained, micaceous, sandy, silty.							-	-

LOCATION: Aw 34 FILE NUMBER: 7604 ELEVATION: 765 ± Base TOPO MAP: Athens

STATE: Ohio COUNTY: Athens TOWNSHIP: Waterloo SECTION: S-1/2, NE-1/4, 23

LOCATION: Exposure in ravine between Grass Run road and ridge road.

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
29	Conemaugh	Upper Bakerstown	Cow Run	Shale, olive drab, sandy, micaceous.			42	10	42	10	180	4
28		Anderson	Anderson	Coal, badly weathered.			0	6	0	6	137	6
27		?	?	Covered interval.			8	4	8	4	137	0
26		Wilgus and Upper Brush Creek	Buffalo and Upper Brush Creek	Siltstone and sandstone, thin-bedded, becoming more sandy upward to beds 6 - 8 inches thick.			12	0	32	0	128	8
25				Shale, olive drab, limonite stained, micaceous and sandy upward, ferruginous concretions, exposed.			20	0			116	8
24		Lower Brush Creek	Lower Brush Creek	Limestone, dark blue-gray, weathers dirty gray, marine fossiliferous, shaly in places.			2	8	32	11	96	8

LOCATION: Aw 34 FILE NUMBER: 7604 - continued

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
23	Conemaugh	Lower Brush Creek - continued	Lower Brush Creek - continued	Clay shale, starch-like fracture, plastic.			0	8			94	0
22	- continued			Sandstone, light gray, much limonite stained, single ledge, fine to medium, micaceous.			2	6			93	4
21				Shale, olive drab, limonite stained, micaceous, sandy upward.			27	1			90	10
20		Mason	Mason	Limestone, light blue-gray, limonite stained on surface, weathered, marine ?			1	0	16	11	63	9
19				Shale, gray to dark gray, some carbonaceous material, partially micaceous.			1	3			62	9
18				Coal, shaly, weathered.			0	6			61	6
17			Upper Mahoning	Clay and clay shale, mottled red, green, and buff, with several fissile interbedded layers of ferruginous, nodular limestone and thin beds of sandstone.			13	2			61	0
16				Sandstone, olive-drab, very micaceous, single ledge, fine.			1	0			47	10
15		Mahoning	Mahoning	Limestone, ferruginous nodular layers, mottled appearance on weathering, fresh-water, embedded in shales.			3	2	25	0	46	10
14				Shale, olive drab, micaceous, sandy with scattered sideritic and ferruginous concretions.			7	8			43	8
13			Lower Mahoning	Sandstone, light gray, limonite stained, cross-bedded; massive, irregular on top and bottom, lenticular in places.			8	8			36	0
12				Shale and sandstone, poorly exposed.			5	6			27	4
11	Allegheny	Upper Freeport	Upper Freeport	Clay, light gray, plastic, limonite stained.			2	0	11	4	21	10
10				Clay, much limonite stained with ferruginous, calcareous material throughout.			2	2			19	10
9				Shale, light gray, limonite stained, clay zones and ferruginous masses scattered throughout.			2	10			17	8
8				Sandstone, light gray, fine to medium, very micaceous, weathers thin-bedded, ripple marked at top.			2	0			14	10
7				Shale, light gray, argillaceous, micaceous, silty.			2	4			12	10
6		Bolivar	Bolivar	Clay, greenish gray, micaceous, limonite stained, numerous siderite concretions throughout, thickness variable.			1	6	9	2	10	6
5			Shawnee	Limestone, gray, dense with small veinlets of calcite, limonite stained on surface, nodular and lenticular, fresh-water.			1	0			9	0
4			Bolivar	Shale and sandstone, olive drab, sandy shale and thin-bedded micaceous sandstone, limonite stained.			6	8			8	0
3		Lower Freeport	Dorr Run	Clay shale, dark gray to gray, carbonaceous at base, micaceous.			0	3-1/2	1	4	1	4
2			Lower Freeport	Coal, smut streak, shaly, poorly developed.			0	1/2			1	1/2
1				Clay and clay shale, light gray to dark gray at bottom, starch-like fracture, plastic when wet, exposed.			1	0			1	0

LOCATION KEY: Aw 35 FILE NUMBER: 7605 ELEVATION: 788± Base TOPO MAP: Athens

STATE: Ohio COUNTY: Athens TOWNSHIP: Waterloo SECTION: 18 and 24

LOCATION: Exposure along road and adjacent parallel creek SW-1/4 of the NW-1/4 of section 18 and E-1/2 of SE-1/4 of section 24.

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
21	Conemaugh	Upper Bakerstown	Cow Run	Shale, light gray to reddish micaceous, sandy.			5	5	18	6	190	3
20				Sandstone, light gray, limonite stained, thin-bedded to massive, fine micaceous.			13	1			184	10
19		Anderson	Portersville	Shale, olive drab.			2	3	39	3	173	9
18				Clay shale, gray starch-like fracture, fossiliferous, marine.			0	6			171	6
17			Anderson	Coal, badly weathered.			0	2			171	0
16			Bakerstown	Sandstone and shale, mostly friable, micaceous sandstone with some shaly zones and micaceous sandy shale, poorly exposed.			36	4			170	10
15		Wilgus	Buffalo	Shale and sandstone, light gray, limonite stained shale with interbedded thin beds of micaceous fine, limonite stained sandstone, ferruginous nodular zones. (Cambridge horizon approximately 34 feet above Upper Brush Creek.)			41	0	41	0	134	6
14		Upper Brush Creek	Upper Brush Creek	Shale, light gray, nodular, concretion zones, micaceous, sandy, and fossiliferous.			7	1	35	4	93	6
13				Limestone, dark blue-gray, dense, marine fossiliferous, lower part more sandy and lighter.			1	2			86	5
12				Sandstone, light gray, fine micaceous, shaly at base calcareous at top, thin-bedded.			7	6			85	3
11				Shale, light gray, limonite stained, sandy micaceous ferruginous concretions.			19	7			77	9
10		Lower Brush Creek	Lower Brush Creek	Shale, dark gray, argillaceous, fossiliferous, streaks of limonite stain along bedding and joint planes.			4	0	38	4	58	2
9				Limestone, dark blue-gray to gray, mottled, fine disseminated pyrite, fossiliferous, marine.			0	8			54	2
8				Shale, light gray, limonite stained, fossil in part, carbonaceous, fossiliferous calcareous.			0	3			53	6
7				Coal, shaly, some bright, mostly dull, partly weathered.			0	6			53	3
6				Underclay, light gray plastic, limonite stained.			0	9			52	9
5		? Mason ?	? Upper Mahoning?	Shale, light gray, limonite stained, micaceous, sandy, ferruginous along bedding and joint planes, possibly Mason cyclothem in part.			32	2	?		52	0
4		Mason ? and Mahoning	Mahoning	Clay shale, light gray, limonite stained, sandy, limonite stained, sandy, numerous fossil plants.			1	6	19	10	19	10
3				Coal, bright, thin-bedded, much fusain, shaly at top.			1	9			18	4
2			Thornton	Underclay, light gray to gray, plastic.			1	0			16	7
1			Lower Mahoning	Shale, light gray, limonite stained, sandy, micaceous, poorly exposed.			15	7			15	7
				Top of Lower Mahoning sandstone.								

LOCATION KEY: Aw 37 FILE NUMBER: 7607 ELEVATION: 701 ± base TOPO MAP: Athens

STATE: Ohio COUNTY: Athens TOWNSHIP: Waterloo SECTION: N½ NW¼ SW¼, 4, 10, and SW¼ NE¼, 16

LOCATION: Exposure along road northwest from 696 road intersection.

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
25	Conemaugh	Ames	Ames	Limestone, gray to pinkish gray, top weathers thin-bedded, marine, very fossiliferous			1	10	18	10	244	10
24				Shale, olive drab, limonite stained, sandy and micaceous.			5	3			243	0
23				Sandstone, limonite stained, fine, micaceous, bedded in 4-6-inch layers.			2	9			237	0
22				Shale, light gray, limonite stained along joints and bedding planes, micaceous, grades from clay shale below.			9	0			235	0
21		Harlem	Round Knob	Shale, gray, mottled red, maroon.			17	0	17	0	226	0
20		?	?	Covered interval			15	6	15	6	209	0
19		Upper Bakerstown	Cow Run	Sandstone, light gray, fine, thin-bedded, poorly exposed, exposed.			5	0	5	0	193	6
18		Anderson	Portersville ?	Covered interval, probably shale, including Portersville member.			3	8	25	10	188	6
17			Anderson	Coal, badly weathered, shaly appearing, interbedded with clay.			0	8			184	10
16				Clay shale, light gray to gray, limonitic streaks, weathered along joints.			3	0			184	2
15			Bloomfield	Limestone, gray, limonite stained on surface, nodular, fresh-water.			0	8			181	2
14			Bakerstown	Shale, light gray to gray, limonite stained buff and reddish, sandy and micaceous, some clay shale interbedded limonite-siderite concretions.			16	2			180	6
13				Sandstone, light gray, limonite stained, fine, micaceous, bedded in 6-inch layers.			1	8			164	4
12		Wilgus	Buffalo	Shale, light gray , limonite stained, sandy to very sandy in places, micaceous.			17	0	27	6	162	8
11				Sandstone, light gray, limonite stained, calcareous and limy, nodular to concretionary, weathered.			0	6			145	8
10				Sandstone, light gray, fine, mostly massive thinner bedded at top and bottom.			10	0			145	2
9		Upper Brush Creek ?	Upper Brush Creek ?	Shale and sandstone, light gray, micaceous shale interbedded with thin-bedded, fine micaceous sandstone.			9	2	22	6	135	2
8				Shale, light gray, limonite stained, no apparent fossils, micaceous, sandy, ferruginous along joints and bedding planes.			13	4			126	0
7		Lower ? Brush Creek	Lower ? Brush Creek	Shale, gray to dark gray, argillaceous, fossiliferous with numerous scattered limonitic nodules and concretions containing microfossils, marine.			19	0	19	0	112	8
6		Lower Brush Creek	Lower Brush Creek	Limestone, dark blue-gray, weathers gray, marine, fossiliferous, shaly at base.			1	2	28	7	93	8
5				Shale and clay shale, with a 3-inch coal seam (4feet below Brush Creek limestone) in places, at least 2 beds of fresh-water limestone, fossiliferous shale.			13	1			92	6
4				Sandstone, light gray, fine, micaceous, shaly at base to massive above.			14	4			79	5
3		Mason	Mason	Shale, dark, carbonaceous, fossil plants, sandy and micaceous upwards.			10	5	65	1	65	1
2				Coal, shaly, some bright, much fusain thickness variable.			0	8			54	8
1			Upper Mahoning	Clay and clay shale, interbedded gray to light gray, mottled red, green, buff, with a fresh-water, nodular ferruginous limestone at base, scattered ferruginous masses and lenses, poorly exposed in part, includes part of Lower Mahoning cyclothem.			54	0			54	0

LOCATION KEY: Aw 38 FILE NUMBER: 7608 ELEVATION: 770±base TOPO MAP: Athens

STATE: Ohio COUNTY: Athens TOWNSHIP: Waterloo SECTION: SW¼ NE¼, to W½ SE¼, 17

LOCATION: Exposure along north road from 965 road intersection in the SW¼ of the NE¼ to the W½ of the SE¼ of section 17.

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
14	Conemaugh	Ames	Ames	Limestone, gray, pinkish, mottled, marine, fossiliferous, dense to partly crystalline.			1	5	17	11	190	5
13				Covered interval.			16	6			189	0
12		Harlem	Round Knob	Shale, light gray, mottled maroon and red, covered and poorly exposed in part.			10	0	10	0	172	6
11		Upper Bakerstown	Cow Run	Shale and sandstone, olive-drab, limonite stained, micaceous, covered in part, sandstone layers up to 8 inches thick.			35	6	35	6	162	6
10		Anderson	Portersville	Clay shale, gray, much weathered			0	6	26	2	127	0
9			Anderson	Coal, smut streak, badly slumped and poorly developed.			0	1			126	6
8				Underclay, light gray, streaked by limonite stain, plastic.			4	5			126	5
7			Bloomfield	Limestone, gray to buff-colored on surface, nodular, sandy in places, variable thickness, fresh-water.			3	10			122	0
6			Bakerstown	Shale, olive-drab, limonite stained, silty to sandy, micaceous.			9	10			118	2
5				Sandstone, light gray, limonite stained, micaceous, bedded in 6 to 8-inch layers at top and bottom, shaly in middle, ripple-marked.			7	6			108	4
4		Upper Brush Creek ?	Upper Brush Creek ?	Shale, olive drab, limonite stained, silty to sandy, fossil plants at base.			29	10	29	10	100	10
3		Lower Brush Creek	Lower Brush Creek	Shale, olive-drab, silty, argillaceous, micaceous and fossiliferous.			17	11			71	0
2				Limestone, light gray to pinkish gray in places, marine, fossiliferous, shaly appearance when it becomes weathered.			0	11			53	1
1		? Mason ?	? Mason ?	Shale, light gray, limonite stained, micaceous and sandy, poorly exposed in part.			52	2	?		52	2
				Top of Lower Mahoning sandstone in creek bottom.								

LOCATION KEY: Aw 39 FILE NUMBER: 7609 ELEVATION: 719±base TOPO MAP: Athens

STATE: Ohio COUNTY: Athens TOWNSHIP: Waterloo SECTION: SW¼ SW¼, 12

LOCATION: Details of exposure of Upper Freeport coal located along road northwest 300 feet from 722 road intersection located in center of SW¼ SW¼, section 12.

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
5	Conemaugh	Mahoning	Lower Mahoning	Sandstone, light gray, some limonite stain, medium to coarse, micaceous, massive, disconformable at base.			15	0	15	0	18	5
4	Allegheny	Upper Freeport	Upper Freeport	Clay shale, gray, limonite stained, somewhat plastic, variable thickness.			0	2	3	5	3	5
3				Coal, some bright, much fusain and pyrite, bony bands top and bottom, melanterite and free sulphur? on weathered surfaces, variable thickness.			0	10			3	3
2				Underclay, light gray, limonite stained, with ferruginous nodules, plastic.			2	5			2	5
1				Clay shale, exposed.			-	-			-	-

LOCATION KEY: Aw 40 FILE NUMBER: 7610 ELEVATION: 730 ± base TOPO MAP: Athens

STATE: Ohio COUNTY: Athens TOWNSHIP: Waterloo SECTION: S½ SE¼, 11

LOCATION: Exposure along road.

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
13	Conemaugh	Harlem	Saltsburg	Shale and sandstone, mostly covered.			10	9	10	9	177	9
12		Upper Bakerstown	Ewing	Limestone, gray to buff, mottled reddish, nodular and ferruginous in part, fresh-water, variable thickness, embedded in shale.			7	8	47	11	167	0
11			Cow Run	Shale, olive-drab, micaceous, sandy, poorly exposed in part.			40	3			159	4
10		Anderson	Anderson	Coal, smut streak, poorly developed.			0	1	23	2	119	1
9				Underclay, light gray to gray, limonite stained, plastic.			0	6			119	0
8				Shale and clay shale, limonite stained, sandy, micaceous.			3	9			118	6
7			Bloomfield	Limestone, gray, weathers buff on surface, nodular, fresh-water, variable thickness.			2	0			114	9
6			Bakerstown	Shale and sandstone, olive drab, limonite stained, sandy, micaceous, ferruginous zones and nodules.			16	10			112	9
5		Wilgus	Cambridge	Limestone, gray, crystalline, very sandy, no apparent fossils.			0	7	23	11	95	11
4			Buffalo	Shale and sandstone, olive drab, micaceous and sandy, interbedded thin layers of sandstone.			23	4			95	4
3		Upper Brush Creek ?	Upper Brush Creek ?	Shale, olive drab, limonite stained with numerous scattered limonite concretions, sandy, much stained along joints and bedding planes, fossiliferous.			16	1	16	1	72	0
2		Lower Brush Creek ?	Lower Brush Creek ?	Limestone, dark bluish gray, weathers shaly, marine, fossiliferous with fossil plants.			0	11	0	11	55	11
1		Mason and Mahoning	Upper and Lower Mahoning ?	Shale and sandstone, olive drab, thin-bedded limonite stained, sandy, micaceous, scattered ferruginous concretions, exposed.			55	0	55	0	55	0

LOCATION KEY: Aw 41 FILE NUMBER: 7611 ELEVATION: 698± base TOPO MAP: Athens

STATE: Ohio COUNTY: Athens TOWNSHIP: Waterloo SECTION: NE¼ SE¼, 6

LOCATION: Exposure along creek bottom and along roads in NE¼ SE¼ of section 6, Waterloo Township, Athens County and from 817 road intersection east to center of W½ of the SW¼ of section 36, Athens Township, Athens County, Ohio.

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
20	Conemaugh	Upper Bakerstown	Cow Run	Shale, olive drab, limonite stained, micaceous, silty and argillaceous (top of hill).			1	3	1	3	161	6
19		Anderson	Portersville	Clay shale, light gray to gray, marine, fossiliferous.			1	0	9	1	160	3
18			Anderson	Coal, shaly and clayey, badly weathered, poorly exposed.			0	2			159	3
17				Underclay, light gray, limonite stained, weathered, plastic, exposed.			1	0			159	1
16			Bakerstown	Shale, light gray, sandy, micaceous, grading into light gray clay shale at top, poorly exposed.			6	11			158	1
15		Wilgus	Cambridge	Sandstone, light gray with buff limonite stain, small greenish gray limy patches, single ledge, more nodular and limy on other side of hill.			1	2	20	2	151	2
14			Buffalo	Shale and sandstone, olive drab, limonite stained, shale becoming more sandy upward, thin-bedded, micaceous and fine sandstone.			19	0			150	0
13		Upper Brush Creek	Upper Brush Creek	Covered interval (cross-roads 119' above base.			13	9	18	10	131	0
12				Shale, olive drab, sandy, micaceous, fossiliferous, scattered limonite concretions, exposed.			5	1			117	3

LOCATION: Aw 41 FILE NUMBER: 7611 - continued

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
11	Conemaugh - continued	Lower Brush Creek	Lower Brush Creek	Limestone, dark blue-gray, marine, fossiliferous.			1	0	28	0	112	2
10				Sandstone, light gray, fine to medium, reddish stained, single ledge.			0	10			111	2
9				Shale, olive drab, sandy, micaceous, poorly exposed.			26	2			110	4
8		Mason	Mason	Coal, badly weathered.			0	7	37	2	84	2
7			Upper Mahoning	Shale and sandstone, olive drab, limonite stained shale with 4 to 6-inch layers of interbedded, micaceous sandstone.			36	7			83	7
6		Mahoning	Lower Mahoning	Sandstone, light gray, medium to coarse, friable, micaceous, shaly at base, massive.			37	10	40	10	47	0
5				Shale, olive drab, limonite stained, sandy and ferruginous.			3	0			9	2
4	Allegheny	Upper Freeport	Upper Freeport	Coal, badly weathered, poorly developed.			0	5	6	2	6	2
3				Underclay, gray to dark gray, breaks with starch-like fracture, somewhat plastic.			2	0			5	9
2				Clay, light gray, limonite stained, ferruginous nodules at top.			1	3			3	9
1				Shale and sandstone, light gray, limonite stained, micaceous, shale and shaly sandstone at base, exposed.			2	6			2	6

LOCATION KEY: Aw 43 FILE NUMBER: 7613 ELEVATION: 690±base TOPO MAP: Athens

STATE: Ohio COUNTY: Athens TOWNSHIP: Waterloo SECTION: NE¼ NE¼, 12

LOCATION: Details of section in NE¼ NE¼, section 12.

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
13	Conemaugh	Mahoning	Lower Mahoning	Clay shale, gray, red mottled with limonite stain.			6	9	28	9	54	5
12				Sandstone, light gray, limonite stained, micaceous, massive, 13-foot massive, remainder useful for molding sand.			22	0			47	8
11	Allegheny	Upper Freeport	Uffington ?	Clay shale, light gray, much limonite stained, some finely micaceous, trace of fossil plants.			2	7	23	8	25	8
10			Upper Freeport	Coal, shaly, some bright streaks, many fossil plants, shaly upward.			1	3			23	1
9				Shale, gray, limonite stained, micaceous, silty, traces of fossil plants.			1	6			21	10
8				Coal, bright and dull, becomes more bony upwards with bright streaks and fusain.			0	11			20	4
7				Clay shale, gray, traces of fossil plants, coaly streaks.			0	3			19	5
6				Coal, bright, dull streaks of fusain, streaks of pyrite near base, 1-inch band of fusain 6 inches from bottom.			2	4			19	2
5				Underclay, gray to dark gray, micaceous, plastic, fossil plant fragments, bottom partly covered.			0	7			16	10
4				Shale and sandstone.			5	0			16	3
3				Shale, gray at base to much limonite stained above, an 8-inch band of ferruginous nodules at base and near top, sandy upwards.			9	3			11	3
2		Bolivar	Shawnee	Limestone, gray, dense, sandy, and micaceous in lower part, nodular erosion surface			2	0	2	0	2	0
1			Bolivar	Clay, light gray, plastic, exposed, unmeasured.			-	-			-	-

LOCATION KEY: Aw 44 FILE NUMBER: 7614 ELEVATION: 716±base TOPO MAP: Athens

STATE: Ohio COUNTY: Athens TOWNSHIP: Waterloo SECTION: N½ SW¼, 6

LOCATION: Exposure in abandoned strip mine, along road and in ravine.

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
11	Conemaugh	?	?	Shale, light gray, limonite stained, unmeasured.			-	-			-	-
10		Wilgus	Cambridge ?	Sandstone, greenish-gray with calcareous appearance and limy patches, micaceous.			1	0	29	6	135	0
9			Buffalo	Sandstone, light gray, fine to medium, bedded to very thick-bedded, micaceous, some interbedded shale.			11	6			134	0
8				Shale, light gray to olive drab, limonite stained, argillaceous and silty at base to sandy at top, traces of fossil plants.			17	0			122	6
7		Upper ? and Lower Brush Creek	Upper? and Lower Brush Creek	Shale, light gray to gray, limonite stained, argillaceous and silty, micaceous, fossiliferous (gastropods).			15	6	37	1	105	6
6				Limestone, dark blue-gray, dense, marine, fossiliferous.			1	1			90	0
5				Covered interval, probably shale.			20	6			88	11
4		Mason	Upper Mahoning	Shale, light gray, limonite stained, small scattered limonite concretions.			18	0	28	0	68	5
3				Sandstone, light gray, limonite stained, fine to medium, micaceous, massive to thin-bedded, lensing laterally composed of red clay shale and carbonaceous material.			10	0			50	5
2		Mahoning	Lower Mahoning	Shale, light gray, limonite stained, silty to more sandy upward, scattered ferruginous nodules and concretions.			36	11	40	5	40	5
1				Shale, dark gray to gray, carbonaceous, argillaceous, with bright coaly streaks, especially at top, traces of fossil plants.			3	6			3	6
				Top of Upper Freeport coal								

LOCATION KEY: Aw 46 FILE NUMBER: 7616 ELEVATION: 700±base TOPO MAP: Athens

STATE: Ohio COUNTY: Athens TOWNSHIP: Waterloo SECTION: E½ SE¼, 4

LOCATION: Exposure along road and in ravine.

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
13	Conemaugh	Gaysport ?	Gaysport ?	Covered interval to top of hill with a few blocks of sandstone in place between 200 and 210 feet.			28	6	28	6	211	2
12		Ames	Ames	Limestone, green-gray, dense to partly crystalline on top, fossiliferous, marine.			0	8	0	8	182	8
11		?	?	Covered interval with some shaly sandstone? exposed and sandstone float (interval of Cow Run member).			79	6	79	6	182	0
10		Anderson	Anderson	Coal, badly weathered, poorly exposed and badly slumped.			0	6	15	0	102	6
9				Underclay and clay shale, gray to light gray, limonite stained.			1	10			102	0
8			Bloomfield	Limestone, gray to greenish gray, reddish mottled, fresh-water.			0	6			100	2
7			Bakerstown	Shale and sandstone, olive drab, micaceous, sandy shale interbedded with thin, micaceous sandstone, poorly exposed in part.			12	2			99	8
6		Wilgus	Buffalo	Sandstone, light gray, limonite stained, case hardened on weathered surface, fine to medium, micaceous, massive, disconformable at base to thin-bedded at top and calcareous.			17	0	17	0	87	6
5		Upper Brush Creek	Upper Brush Creek	Shale, olive drab, limonite stained, very sandy and interbedded with fine, micaceous, shaly sandstone.			2	6	22	6	70	6
4				Shale, light gray to gray, argillaceous with small limonite concretions, marine, fossiliferous.			20	0			68	0

LOCATION: Aw 46 FILE NUMBER: 7616 - continued

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
3	Conemaugh - continued	Lower Brush Creek	Lower Brush Creek	Limestone, gray to dark blue-gray, dense, marine, fossiliferous.			1	5	45	0	48	0
2				Shale, light gray, limonite stained, sandy, micaceous and red mottled clay shale with some thin-bedded sandstone near top, poorly exposed.			43	7			46	7
1		Mason ?	Upper Mahoning ?	Sandstone, light gray, streaked with limonite stain, coarse, friable, micaceous, massive, exposed.			3	0	3	0	3	0

LOCATION KEY: Aw 47 FILE NUMBER: 7617 ELEVATION: 768± base TOPO MAP: Athens

STATE: Ohio COUNTY: Athens TOWNSHIP: Waterloo SECTION: NW¼ SW¼, 9

LOCATION: Exposure along B. and O. Railroad cut northeast of New Marshfield.

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
9	Conemaugh	Wilgus	Buffalo	Sandstone, light gray, limonite stained, fine, micaceous, friable at top, massive, exposed.			14	7	28	8	70	0
8				Shale, light gray with thin beds of sandstone, siderite concretions.			14	1			55	5
7		Upper Brush Creek	Upper Brush Creek	Limestone, light gray, sideritic and limonitic on surface, fossiliferous.			0	2	9	3	41	4
6				Shale, light gray with numerous layers and nodules of sideritic concretions containing marine fossils.			9	1			41	2
5		Lower Brush Creek	Lower Brush Creek	Limestone, dark blue-gray, surface limonite stained a reddish color, marine, fossiliferous.			1	1	27	1	32	1
4				Shale, light gray to gray, limonite stained, micaceous, silty, argillaceous, marine fossils.			2	2			31	0
3				Sandstone, light gray, single massive ledge grading laterally into thinner beds and shale, micaceous, marine fossils at top.			1	7			28	10
2				Shale and sandstone, olive drab, limonite stained, micaceous, shale interbedded with thin layers of fine, micaceous sandstone. Mason cyclothem possibly included.			22	3			27	3
1		Mason	Upper Mahoning	Sandstone, light gray, streaked by limonite stain, medium to coarse, very micaceous, massive, exposed.			5	0	5	0	5	0

LOCATION KEY: Aw 48 FILE NUMBER: 7618 ELEVATION: 729 ± base TOPO MAP: Athens

STATE: Ohio COUNTY: Athens TOWNSHIP: Waterloo SECTION: N½ SW¼, 3

LOCATION: Exposure in ravine in N½ of the SW¼ of section 3.

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
19	Conemaugh	Harlem	Round Knob (in part)	Shale, light gray to buff and red mottled, fissile, micaceous, and silty, poorly exposed at top.			18	0	18	0	141	0
18		Upper Bakerstown	Ewing	Limestone, gray to greenish gray, red mottled, nodular, fresh-water.			0	6	16	11	123	0
17			Cow Run	Shale, reddish brown to a greenish gray, fissile, micaceous, silty.			16	5			122	6
16		Anderson	Portersville	Shale and limestone, gray, marine, fossiliferous shale with scattered pieces of weathered, gray, fossiliferous limestone.			2	6	34	10	106	1
15			Anderson	Shale, black to dark gray at top, carbonaceous with thin, bright, coaly streaks.			2	0			103	7
14				Shale, light gray to greenish gray, limonite stained, argillaceous and sandy.			8	1			101	7

LOCATION: Aw 48 FILE NUMBER: 7618 - continued

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
13	Conemaugh - continued	Anderson - continued	Bloomfield	Limestone, greenish gray, very sandy, fresh-water.			0	3			93	6
12			Bakerstown	Sandstone, light gray, fine, micaceous, calcareous at top, some shale partings at top.			6	10			93	3
11				Sandstone and shale, light gray, fine, micaceous, sandstone interbedded with light gray sandy shale.			10	7			86	5
10				Shale, olive drab, limonite stained, micaceous and sandy.			4	7			75	10
9		Wilgus	Cambridge	Limestone, light gray, limonite stained on surface, sideritic in part, nodular.			0	3			71	3
8			Buffalo	Shale, olive drab to gray, limonite stained, sandy, micaceous with ferruginous nodules scattered throughout.			6	0			71	0
7		?	?	Shale, gray to dark gray, limonite stained, argillaceous and silty, micaceous, marine, fossils in bottom one foot.			10	4	?		65	0
6		Upper Brush Creek	Upper Brush Creek	Limestone, gray to dark blue-gray, nodular on weathered surface, massive, fossiliferous, to very fossiliferous.			0	9			54	8
5				Shale, dark gray to light gray, finely micaceous, argillaceous and silty.			24	11			53	11
4		Lower Brush Creek	Lower Brush Creek	Limestone, gray to dark blue-gray, dense to crystalline, marine, fossiliferous.			0	6	10	5	29	0
3				Shale, dark gray to gray, micaceous and sandy, at top 3 feet less sandy and argillaceous, containing marine fossils.			9	11			28	6
2		Mason	Mason	Coal, some bright, mostly dull, shaly and bony throughout.			1	2	18	7	18	7
1			Upper Mahoning	Clay shale, light gray, red, and buff mottled, finely micaceous and silty, plastic when wet, exposed.			17	5			17	5

LOCATION KEY: Aw 49 FILE NUMBER: 7619 ELEVATION: 708 ± base TOPO MAP: Athens

STATE: Ohio COUNTY: Athens TOWNSHIP: Waterloo SECTION: $N\frac{1}{2}$ $S\frac{1}{2}$, 2

LOCATION: Exposure along road west of 696 road intersection located in the $N\frac{1}{2}$ of the $S\frac{1}{2}$ of section 2.

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
19	Conemaugh	Gaysport ?	Gaysport ?	Limestone, light gray, nodular, ferruginous, impure.			0	6	20	8	179	2
18				Shale and sandstone, light gray, micaceous.			20	2			178	8
17		Ames	Ames	Limestone, greenish gray, partly crystalline, very fossiliferous, marine.			0	5	0	5	158	6
16		Upper Bakerstown	Cow Run	Shale, light gray, olive drab stained, silty, micaceous, weathered along joints, clay shale at top.			30	0	30	0	158	1
15		Anderson	Portersville	Clay shale, gray to light gray, marine, fossiliferous.			0	4	16	6	128	1
14			Anderson	Coal, shaly and clayey, badly weathered, poorly developed.			0	3			127	9
13			Bakerstown	Shale and clay shale, gray to light gray, limonite stained, micaceous, grading into clay shale and clay at top.			15	11			127	6
12		Wilgus	Buffalo	Shale and sandstone, light gray, limonite stained, very sandy and micaceous at base, grading into a shaly sandstone at top. Cambridge ought to be in here at or near top			19	7	47	3	111	7
11				Sandstone, light gray, much stained, very fine to medium, micaceous, massive to thin-bedded at top, very friable, exposed.			7	0			92	0
10				Covered interval, probably sandstone and shale.			14	0			85	0
9				Sandstone, light gray, limonite stained, case hardened at base, medium, grading to coarse at top, friable, weathered brown to buff.			6	8			71	0

LOCATION: Aw 49 FILE NUMBER: 7619 - continued

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
8	Conemaugh - continued	Upper Brush Creek	Upper Brush Creek	Shale, olive drab, limonite stained, sandy and micaceous with limonite concretions.			9	1	33	0	64	4
7				Sandstone, light gray, limonite stained buff and brown, single massive ledge.			1	0			55	3
6				Limestone, gray, dense, partly crystalline and somewhat knotty, reddish stained in part.			0	7			54	3
5				Shale, gray to olive drab, limonite stained, argillaceous, very sandy and micaceous at top with scattered limonite concretions, bottom 1 foot fossiliferous.			22	4			53	8
4		Lower Brush Creek	Lower Brush Creek	Limestone, gray, dense to crystalline at top, knotty at base, possibly weathering to flint which is seen as float.			1	7	31	-	31	4
3				Shale, olive drab, limonite stained, marine, fossiliferous, argillaceous, silty, and micaceous.			6	1			29	9
2				Sandstone, light gray, fine to medium, limonite stained, micaceous, single lensing massive ledge, calcareous and fossiliferous at top.			3	0			23	8
1				Shale, olive drab, limonite stained, especially along the joints and bedding planes, sandy and micaceous, grades into thin sandstone at top, exposed.			20	8			20	8

LOCATION KEY: Aw 51 FILE NUMBER: 7621 ELEVATION: 725±base TOPO MAP: Athens

STATE: Ohio COUNTY: Athens TOWNSHIP: Waterloo SECTION: NE¼ NE¼, 7 and NW¼ NW¼, 1

LOCATION: Exposure in ravine.

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
12	Conemaugh	Ames	Ames	Limestone, light gray to greenish gray with a pinkish cast, mostly crystalline, marine, fossiliferous.			0	10	18	3	149	1
11		? Harlem	? Saltsburg ?	Shale and sandstone, light gray, limonite stained, micaceous, poorly exposed in part.	17 20	5 0	37	5	20	0	148	3
10		Upper Bakerstown	Ewing	Limestone, gray, dense, yellowish stained on surface, brecciated in part, fresh-water fossiliferous, ostracods, Spirorbis?			0	9	24	2	110	10
9			Cow Run	Shale, light gray, limonite stained, sandy to very sandy and micaceous, poorly exposed in part (spring at this horizon.)			23	5			110	1
8		Anderson ?	Bakerstown ?	Sandstone, light gray, medium, friable, much stained by limonite, massive, micaceous.			13	8	13	8	86	8
7		Wilgus	Buffalo	Shale, light gray, very argillaceous, limonite stained with small scattered limonite concretions, sandy upwards with thin layers of calcareous sandstone.			24	3	24	3	73	0
6		Upper Brush Creek	Upper Brush Creek?	Limestone, light gray, dense, knotty, sparingly fossiliferous, in bottom part with marine fossils at top, weathered flinty layers all embedded in gray argillaceous shale.			6	3	35	6	48	9
5				Shale and iron ore, light gray to gray, argillaceous silty shale with several interbedded layers of limonite-siderite concretions up to 5 inches thick.			5	6			42	6
4				Shale, olive drab, argillaceous, silty, micaceous, few scattered limonite concretions and thin beds of sandstone, fossils in 1-foot bed at base.			23	9			37	0
3		Lower Brush Creek	Lower Brush Creek	Limestone, gray, crystalline, some reddish stain, marine, fossiliferous.			1	0	11	6	13	3
2				Shale, light gray, clayey and argillaceous at base, stained red in streaks, becomes silty and micaceous upwards.			10	6			12	3
1		Mason	Mason	Coal, some bright, mostly dull, shaly, some fusain.			1	9	1	9	1	9
				Underclay, light gray, exposed.			-	-			-	-

LOCATION KEY: Aw 52 FILE NUMBER: 7622 ELEVATION: 765±base TOPO MAP: Athens

STATE: Ohio COUNTY: Athens TOWNSHIP: Waterloo SECTION: SE¼ NE¼ and NE¼ SE¼, 13

LOCATION: Exposure in ravines.

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
14	Conemaugh	Ames	Ames	Limestone, greenish gray, crystalline, marine, fossiliferous.			0	10	0	10	139	4
13		Harlem and Upper Bakerstown	Cow Run ?	Shale, gray to reddish and brownish, micaceous, poorly exposed.			37	3	37	3	138	6
12		Anderson	Portersville	Clay shale, argillaceous, marine, fossiliferous, very poorly exposed.			0	4	15	8	101	3
11			Anderson	Coal, smut streak, badly slumped and poorly developed.			0	1			100	11
10			Bakerstown	Shale, olive drab, limonite stained, some clay at top, poorly exposed.			15	3			100	10
9		Wilgus	Buffalo	Sandstone, light gray, very coarse at base to medium, well cemented, bedded to very massive, Cambridge horizon at top.			32	5	39	0	85	7
8				Shale, gray to light gray, argillaceous to sandy, micaceous.			6	7			53	2
7		Upper Brush Creek	Upper Brush Creek	Limestone, gray, sideritic, ferruginous, and nodular concretions embedded in gray argillaceous shale.			3	5			46	7
6				Shale, gray to light gray, argillaceous, silty and micaceous, some scattered limonite and siderite concretions.			4	3			43	2
5				Limestone and shale, gray, knotty, dense limestone that becomes flint near the top, embedded in gray argillaceous shale, marine, fossiliferous.			6	5			38	11
4				Limestone, dark blue-gray, dense at top, shaly and weathered at base.			1	8			32	6
3		——?——	——?——	Shale and shaly sandstone, gray with limonite stain, argillaceous to silty, micaceous, small siderite concretions, sparingly fossiliferous, poorly exposed.			28	10	——?——		30	10
2		Lower Brush Creek	Lower Brush Creek	Limestone, gray, crystalline, shaly at top, marine, fossiliferous.			1	8			2	0
1				Clay, light gray to gray with carbonaceous and coaly streaks, exposed.			0	4			0	4

YORK TOWNSHIP

LOCATION KEY: Ay 3 FILE NUMBER: 6727 ELEVATION: 760± base of coal TOPO MAP: Athens

STATE: Ohio COUNTY: Athens TOWNSHIP: York SECTION: NE¼ SW¼, 6

LOCATION: Exposure in abandoned slope or drift mine entrance near ravine head.

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
8	Conemaugh	Mahoning	Lower Mahoning	Shale, light gray stained by oxide, arenaceous, micaceous, more sandy upward, exposed.			7	0	7	0	14	8
7	Allegheny	Upper Freeport	Upper Freeport	Shale, dark gray to black, with coaly streaks, thickness variable.			1	0	7	8	7	8
6				Coal.			0	6			6	8
5				Shale, black, carbonaceous, with streaks of coal.			0	6			6	2
4				Coal.			2	8			5	8
3				Shale, dark gray, carbonaceous, thickness variable.			0	2			3	0
2				Coal, with 1 inch pyrite layer near base.			2	8			2	10
1				Shale, dark gray, exposed.			0	2			0	2

LOCATION KEY: Ay 4 FILE NUMBER: 6728 ELEVATION: 682 ± base TOPO MAP: Athens

STATE: Ohio COUNTY: Athens TOWNSHIP: York SECTION: Central and South-central 6

LOCATION: Exposure along north-south road and entrances of abandoned mines on east side of road.

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
30	Conemaugh	Mahoning	Lower Mahoning	Shale, gray, stained somewhat by oxide, arenaceous, micaceous, exposed.			8	0	8	0	91	4
29	Allegheny	Upper Freeport	Upper Freeport	Coal, weathered in several benches and with partings.			6	11	18	5	83	4
28				Underclay, gray, plastic.			1	5			76	5
27				Shale, gray, stained somewhat by iron oxide, arenaceous and micaceous, not well exposed, top part possibly plastic clay.			10	1			75	0
26		Bolivar	Shawnee	Limestone, gray, nodular, fossiliferous, fresh-water.			0	8	11	6	64	11
25			Bolivar	Shale, gray, stained by iron oxide, arenaceous and argillaceous, covered in part, possibly with some limestone nodules in upper part.			3	7			64	3
24				Underclay, light gray with a thin dark flinty layer 3 inches above base, plastic.			1	6			60	8
23				Shale, gray, stained somewhat by iron oxide, arenaceous and micaceous, with thin layers of fine shaly sandstone.			5	9			59	2
22		Lower Freeport	Lower Freeport	Shale, gray, clayey.			0	3	24	7	53	5
21				Underclay, light gray, plastic.			0	2			53	2
20				Coal.			0	2			53	0
19				Underclay, gray, plastic, carbonaceous.			0	1			52	10
18				Coal			0	2			52	9
17				Underclay, gray and light gray, plastic, arenaceous.			1	4			52	7
16				Shale and sandstone, gray, arenaceous and micaceous, shale with fine shaly sandstone layers up to 12 inches thick, top and bottom largely shale, fossil plants on top.			22	5			51	3
15		Middle Kittanning	Middle Kittanning	Shale, dark gray, stained somewhat by iron oxide.			0	4	20	6	28	10
14				Shale, gray, somewhat stained by iron oxide, with fossil plants.			2	8			28	6
13				Coal, bony and shaly, weathered			2	3			25	10
12				Shale, gray, weathered.			0	2			23	7
11				Coal, bony, weathered.			0	11			23	5

LOCATION: Ay 4 FILE NUMBER: 6728 - continued

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
10	Allegheny -	Middle Kittanning -	Middle Kittanning -	Coal, somewhat weathered.			2	3			22	6
9	continued	continued	continued	Shale, gray, weathered, with thin partings of coal.			0	3			20	3
8				Coal, good.			1	8			20	0
7				Shale, gray, weathered.			0	1			18	4
6				Coal, good.			1	8			18	3
5				Underclay, light gray, plastic.			1	0			16	7
4				Shale, gray, stained by iron oxide, very few small scattered siderite-limonite concretions			7	3			15	7
3		Strasburg	Strasburg	Coal smut.			-	-	8	4	-	-
2			Oak Hill	Underclay and clay shale, light gray, plastic			0	11			8	4
1			Strasburg	Shale, gray, slightly stained by iron oxide, arenaceous and micaceous, with many small siderite-limonite concretions, especially in lower part, exposed.			7	5			7	5

LOCATION KEY: Ay 5 FILE NUMBER: 6729 ELEVATION: 711± base ? TOPO MAP: Athens

STATE: Ohio COUNTY: Athens TOWNSHIP: York SECTION: NW¼, 6

LOCATION: Exposures in gullies and abandoned mine cave-in on west side of hill south of Buchtel School.

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
18	Conemaugh	Mason	Upper Mahoning	Shale and clay, ferruginous, partially covered.			10	0	42	6	129	7
17				Sandstone, light gray, stained yellowish to brownish, coarse, micaceous, argillaceous, friable, massive-bedded or cross-bedded, formerly quarried.			32	6			119	7
16		Mahoning	Thornton	Clay, light gray, plastic.			4	1	18	8	87	1
15				Clay, gray, plastic.			3	0			83	0
14			Lower Mahoning	Shale, gray, somewhat stained by iron oxide, arenaceous, micaceous, nodular, ferruginous layer at top.			11	7			80	0
13	Allegheny	Upper Freeport	Upper Freeport	Coal, weathered, with several partings.			4	0	23	4	68	5
12				Underclay, light gray, arenaceous and micaceous, plastic.			1	6			64	5
11				Shale, poorly exposed.			17	10			62	11
10		Bolivar	Shawnee	Limestone, gray to dark gray, massive, brecciated, fossiliferous, fresh-water.			1	6	10	4	45	1
9			Bolivar	Shale, poorly exposed.			1	8			43	7
8				Clay, light gray to gray, thin dark streak at bottom, flinty.			1	0			41	11
7				Shale, gray, arenaceous, micaceous, with ferruginous sandstone 1 inch thick.			6	2			40	11
6		Lower Freeport	Lower Freeport	Clay, gray to light gray, shaly and plastic.			1	0	34	9	34	9
5				Shale.			3	11			33	9
4				Coal, weathered, thickness variable.			1	0			29	10
3				Clay, gray, breaking with starch fracture, plastic.			4	0			28	10
2				Shale, gray, arenaceous, micaceous, 1 inch plastic clay at base, covered in part, complete interval exposed but not at any one place.			24	10			24	10
1		Middle Kittanning	Middle Kittanning	Top of Middle Kittanning coal.			-	-			-	-

LOCATION KEY: Ay 6 FILE NUMBER: 6730 ELEVATION: 670 ± base TOPO MAP: Athens

STATE: Ohio COUNTY: Athens TOWNSHIP: York SECTION: NW¼, 6

LOCATION: Exposure along gully on southeast corner of ridge south of Buchtel School.

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
20	Conemaugh	Mason		Shale and covered interval.			16	4	43	6	137	3
19			Upper Mahoning	Sandstone, light gray with some yellowish brown stain, coarse, micaceous, argillaceous, friable, massive, bedded or cross-bedded, formerly quarried.			27	2			120	11
18		Mahoning	Thornton	Clay, gray to light gray, plastic.			4	10	23	0	93	9
17			Lower Mahoning	Clay shale, gray to purplish.			2	0			88	11
16				Shale, light gray, slightly stained, arenaceous, micaceous, with scattered limonite concretions.			14	2			86	11
15				Shale, gray and light gray, stained by iron oxide, argillaceous and micaceous.			2	0			72	9
14	Allegheny	Upper Freeport	Upper Freeport	Coal, weathered with several partings.			4	10	17	11	70	9
13				Underclay, gray to light gray, plastic.			2	3			65	11
12				Shale, gray to light gray, arenaceous, micaceous, ferruginous, with thin layers and scattered concretions of limonite including a 1 to 2-inch layer of limonite at the top.			10	10			63	8
11		Bolivar	Bolivar	Iron ore, black, sooty.			0	4	19	6	52	10
10				Clay and clay shale, gray.			2	9			52	6
9			Shawnee	Limestone, gray to yellowish-brown, ferruginous, fossiliferous, nodular, fresh-water.			1	0			49	9
8			Bolivar	Clay, gray, ferruginous at top and bottom.			2	1			48	9
7				Shale, light gray, somewhat stained by iron oxide, arenaceous, micaceous, with few very small limonite concretions.			2	10			46	8
6				Sandstone, gray stained by iron oxide, fine to medium, micaceous, ferruginous, with concretions of limonite in upper part.			1	8			43	10
5				Shale, gray to light gray, stained by iron oxide, with siderite-limonite concretions, micaceous.			8	10			42	4
4		Lower Freeport	Lower Freeport	Coal, thickness variable.			1	6	33	6	33	6
3				Clay, gray to light gray, plastic, with 2-inch iron calcareous layer at 6 inches above the base.			4	0			32	0
2				Shale, gray to light gray, arenaceous and micaceous, with some thin layers of medium micaceous sandstone in layers up to several inches in thickness (evidence of caving over mine works below).			28	0			28	0
1		Middle Kittanning	Middle Kittanning	Top of Middle Kittanning coal			-	-			-	-

LOCATION KEY: Ay 7 FILE NUMBER: 6731 ELEVATION: 720 ?base TOPO MAP: Athens

STATE: Ohio COUNTY: Athens TOWNSHIP: York SECTION: NW¼, 18

LOCATION: Exposure along small stream and in sealed mine entrance.

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
13	Allegheny	Lower Freeport	Lower Freeport	Sandstone, gray, arenaceous and micaceous, medium, friable, massive, iron stained yellow-brown, exposed.			3	9	10	0	37	7
12				Shale, gray, arenaceous and micaceous, with thin layers of sandstone.			6	3			33	10
11		Middle Kittanning	Middle Kittanning	Shale, gray to dark gray.			0	7	27	7	27	7
10				Coal, good.			1	9			27	0

LOCATION: Ay 7 FILE NUMBER: 6731 - continued

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
9	Allegheny -	Middle Kittanning -	Middle Kittanning -	Underclay, shale, gray			1	0			25	3
8	continued	continued	continued	Shale, dark gray, carbonaceous.			0	8			24	3
7				Coal, good.			2	7			23	7
6				Shale, dark gray, carbonaceous.			0	9			21	0
5				Coal, good.			3	0			20	3
4				Underclay, gray, plastic.			1	6			17	3
3				Covered interval.			3	8			15	9
2			Snow Fork	Ironstone, numerous large siderite concretions, with limonite, 8 to 12 inches or more in size, scattered in gray clay shale. Many loose concretions in stream channel.			2	6			12	1
1			Middle Kittanning	Shale and sandstone, gray stained by iron oxide, arenaceous and micaceous shale with interbedded micaceous shaly sandstone, exposed.			9	7			9	7

LOCATION KEY: Ay 8 FILE NUMBER: 6732 ELEVATION: 710 ± base TOPO MAP: Athens

STATE: Ohio COUNTY: Athens TOWNSHIP: York SECTION: South central 16

LOCATION: Exposure in abandoned strip mine and in prospect cut along slope on the south side of Minker's Run.

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
29	Conemaugh	Mahoning	Lower Mahoning	Shale, gray stained by iron oxides, arenaceous and micaceous with scattered ferruginous concretions, exposed.			7	0	7	0	93	5
28	Allegheny	Upper Freeport	Upper Freeport	Shale, gray to light gray, somewhat carbonaceous.			1	7	33	1	86	5
27				Shale, dark gray, carbonaceous.			0	9			84	10
26				Coal, weathered			0	8			84	1
25				Coal and shale, interbedded coal and gray shale.			1	5			83	5
24				Shale, gray, argillaceous, with fossil plants			1	8			82	0
23				Coal, weathered.			2	0			80	4
22				Underclay, light gray stained by iron oxides, plastic, with limonitic concretions in basal part.			4	2			78	4
21				Sandstone, light gray stained by iron oxides, fine to medium, micaceous and argillaceous, massive to bedded.			2	2			74	2
20				Shale, and clay shale, light gray to gray, arenaceous and micaceous in part.			18	8			72	0
19		Bolivar	Bolivar and Shawnee	Ironstone, limonitic concretionary layer.			0	2	20	7	53	4
18				Underclay, gray to light gray, micaceous, with thin layer of thin fossiliferous limestone and dark shale near middle.			0	8			53	2
17				Limestone, gray stained by limonite, ferruginous, fossiliferous, fresh-water.			0	6			52	6
16				Underclay and clay shale, light gray stained by limonite, with several thin layers of irregular, nodular limonite.			2	0			52	0
15				Limestone, light to drab gray, dense, heavy bedded, fossiliferous, fresh-water.			1	10			50	0
14				Underclay, light gray, plastic.			0	10			48	2
13				Limestone, gray, somewhat limonite stained ferruginous, nodular or shaly, fossiliferous, fresh-water.			0	8			47	4
12				Underclay, light gray, plastic, with scattered ferruginous limestone nodules.			2	7			46	8
11				Limestone, gray, weathering yellowish brown ferruginous, fresh-water, nodular, thickness variable.			0	5			44	1
10				Underclay, light gray, shaly, plastic.			0	3			43	8

LOCATION: Ay 8 FILE NUMBER: 6732 - continued

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
9	Allegheny - continued	Bolivar - continued	Bolivar	Shale and sandstone, gray stained by limonite, arenaceous and micaceous shale and shaly micaceous sandstone, ferruginous in lower part and locally with 6 to 8-inch layer of siderite-limonite ironstone.			10	8			43	5
8		Lower Freeport	Dorr Run	Shale, black, carbonaceous.			4	10	25	7	32	9
7				Shale, black, bony, fossiliferous, marine, (Lingula).			1	1			27	11
6				Shale, gray, fossiliferous?			0	11			26	10
5			Lower Freeport	Coal.			3	1			25	11
4				Underclay, light gray to gray, plastic.			1	2			22	10
3				Shale, gray, somewhat stained by limonite especially in upper part with an irregular zone of limonite about 1 inch thick, micaceous and arenaceous.			14	6			21	8
2		Middle Kittanning	Middle Kittanning	Shale, gray to dark gray, carbonaceous,			2	8	7	2	7	2
1				Coal, exposed above water level.			4	6			4	6

LOCATION KEY: Ay 11 FILE NUMBER: 6733 ELEVATION: 681± base TOPO MAP: Athens

STATE: Ohio COUNTY: Athens TOWNSHIP: York SECTION: SW¼, 24 and NW¼, 23

LOCATION: Exposures along road on south side of Hocking Valley to crest of ridge between Hocking Valley and valley of Minker's Run and in abandoned clay mine on Baird property just above Hocking Valley flood plain.

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
51	Conemaugh	Lower Brush Creek	Lower Brush Creek	Clay shale, light gray to maroon and purplish, exposed.			5	0	16	9	252	10
50				Sandstone, shaly			1	0			247	10
49				Shale, gray, stained by limonite, arenaceous, micaceous, with thin layers of shaly sandstone.			10	9			246	10
48		Mason	Upper Mahoning	Clay shale, light gray to purple or maroon.			4	6	12	0	236	1
47				Shale, gray, stained by limonite, arenaceous, micaceous, almost grades in part into shaly sandstone.			7	6			231	7
46		——— ? ——— Mahoning	Upper? and Lower Mahoning	Sandstone, gray, coarse, micaceous, argillaceous, very friable, massive to bedded toward top, base uneven.			67	4	67	4	224	1
45	Allegheny	Upper Freeport	Upper Freeport	Coal, weathered, poorly exposed.			1	0	27	2	156	9
44				Clay, gray to light gray, stained by limonite ferruginous, plastic.			3	1			155	9
43				Shale, gray, stained by limonite, arenaceous, micaceous, ferruginous, with many crusts and small concretions of limonite.			7	7			152	8
42				Shale and sandstone, gray, stained by limonite, arenaceous shale and medium micaceous sandstone.			15	6			145	1
41		Bolivar	Shawnee	Limestone, gray to buff, nodular, fossiliferous, fresh-water.			1	0	6	0	129	7
40			Bolivar	Shale, light gray, ferruginous, with one thin layer of sandstone.			2	6			128	7
39				Sandstone, gray to yellowish brown, fine to medium, shaly, ferruginous.			2	6			126	1
38		Lower Freeport	Dorr Run	Shale, dark gray to black, with several layers of light gray, argillaceous clay shale, carbonaceous.			11	6	30	10	123	7
37				Shale, gray with limonite stain, argillaceous, sparingly fossiliferous.			0	5			112	1
36				Shale, gray to dark gray with limonite stain, argillaceous, carbonaceous, fossiliferous.			1	1			111	8
35			Lower Freeport	Coal, weathered			1	2			110	7
34				Shale, gray with limonite stain.			0	3			109	5

LOCATION: Ay 11 FILE NUMBER: 6733 - continued

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
33	Allegheny -	Lower Freeport -	Lower Freeport -	Coal, weathered.			0	11			109	2
32	continued	continued	continued	Clay, gray stained by limonite, slightly ferruginous, shaly.			3	6			108	3
31				Shale, ferruginous with considerable limonite, mostly as crusts along joints, weathered fresh-water limestone.			4	6			104	9
30				Shale, gray stained by limonite, arenaceous, micaceous, poorly exposed in part.			7	6			100	3
29		Upper Kittanning	Upper Kittanning	Coal, smutty, about 2 inches thick, nodular sandy, limonite stained shale with coal.			0	3	14	3	92	9
28				Shale, gray, limonite stained in places.			14	0			92	6
27		Middle Kittanning	Middle Kittanning	Coal, shaly, thin-bedded, smutty at top. Becomes thicker downward. Blocky and shiny at bottom. Has 4 clay partings.			4	0	27	4	78	6
26				Clay, light gray, plastic.			0	6			74	6
25				Shale, gray stained by limonite, arenaceous, micaceous, with some scattered ferruginous nodules (Sugar Fork?) up to 10 inches in size, covered in part.			22	10			74	0
24		Strasburg	Strasburg	Coal, impure, badly weathered.			0	11	12	5	51	2
23			Oak Hill and Hamden	Clay, light gray, considerable limonite stain, weathered, slumped, moderately plastic.			0	9			50	3
22				Shale, gray, considerable limonite stain, argillaceous, silty, micaceous, numerous clay ironstone nodules, bedded iron concretions run out at top, shale continues up.			5	6			49	6
21				Clay, dark gray, black, silty, micaceous, carbonaceous, breaks with starch-like fracture, slightly plastic.			1	5			44	0
20				Clay, silty, ferruginous (shot), finely micaceous, plastic, massive, breaks with starch-like fracture.			1	8			42	7
19			Strasburg	Shale, gray, light gray, yellow-brown stain, finely micaceous, laminated, weathers somewhat plastic.			0	4			40	11
18				Shale, black, carbonaceous, argillaceous in lower part, finely micaceous, upper part fissile.			1	6			40	7
17				Sandstone, carbonaceous, micaceous, shaly lower part, numerous plant fragments, irregular bedding.			0	4			39	1
16		Lower Kittanning	Lower Kittanning	Shale, black, carbonaceous, with coal streaks, fusain, and pyrite.			0	1	6	6	38	9
15				Coal, bright, blocky, with much dull, fusain and pyrite flat masses.			0	9			38	8
14				Shale, black, carbonaceous, bony, canneloid, some fusain and thin streaks of weathered coal, selenite rosettes.			0	1			37	11
13				Coal, bright, shiney, cubic break, numerous thin dull partings including much fusain and some pyrite, weathered sulphur? and melanterite.			1	6			37	10
12				Clay, dark gray, traces of fossil plants, few slickensides, slightly plastic, starch-like fracture, grows gray downward.			1	0			36	4
11				Clay, light gray, limonite stain on surface, finely micaceous, somewhat silty, moderately plastic below, grades into overlying dark gray, starch-like fracture.			2	0			35	4
10				Clay, shaly, balls of pyrite, light gray limonite stain, somewhat laminated, partly silty, numerous scattered shot.			1	1			33	4
9		Lawrence	Lawrence	Coal smut.			0	0	4	10	32	3
8				Clay, light gray, medium, limonite stain, micaceous, silty, sandy downward			4	10			32	3

LOCATION: Ay 11 FILE NUMBER: 6733 - continued

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
7	Allegheny -	Scrubgrass	Ferriferous	Shale, gray to yellowish brown, with small ironstone "shot".			3	11	7	5	27	5
6	continued		Scrubgrass	Sandstone and shale, gray, stained by limonite, medium, ferruginous, micaceous sandstone and arenaceous shale.			3	6			23	6
5		?	?	Covered interval			10	0	10	0	20	0
4		Clarion	Clarion	Shale, gray, stained by limonite, arenaceous, exposed.			1	0	10	0	10	0
3				Shale and clay shale, dark gray, carbonaceous shale and light gray clay shale, coal horizon?			0	9			9	0
2				Clay, light gray to gray, stained by limonite, plastic.			0	3			8	3
1				Shale, gray, arenaceous, micaceous, with thin layers of shaly sandstone, exposed.			8	0			8	0

LOCATION KEY: Ay 12 FILE NUMBER: 6734 ELEVATION: 697±base TOPO MAP: Athens

STATE: Ohio COUNTY: Athens TOWNSHIP: York SECTION: North central 5

LOCATION: Exposure in strip mine.

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
26	Conemaugh	Mason	Upper Mahoning	Sandstone, gray stained yellowish brown, medium to coarse, argillaceous, micaceous, friable, massive with scattered flattened spheroidal masses, weathered, 6 to 8 feet in diameter, exposed.			30	0	30	0	114	8
25		Mahoning	Mahoning	Shale, dark gray, carbonaceous.			0	1	35	7	84	8
24			Thornton	Clay, light gray to gray, plastic.			2	6			84	7
23			Lower Mahoning	Clay shale, gray to purple or maroon.			1	0			82	1
22				Clay shale, greenish-gray to yellowish on top.			5	0			81	1
21				Shale, gray, arenaceous, with small scattered siderite-limonite concretions, and locally with 5 or more feet of sandstone immediately above the coal (channel fill that cuts out coal).			27	10			76	1
20	Allegheny	Upper Freeport	Upper Freeport	Coal, pyrite in base with partings.			5	4	20	8	48	3
19				Underclay, light gray, stained somewhat by iron oxide, with few small limonite concretions.			4	6			42	11
18				Shale, gray, stained by iron oxide, expecially along joints, arenaceous in part.			10	10			38	5
17		Bolivar	Bolivar ?	Iron ore, siderite-limonite, nodular, calcareous.			0	8	24	10	27	7
16				Clay, gray, plastic.			2	0			26	11
15				Shale, gray, arenaceous with scattered siderite-limonite concretions.			6	5			24	11
14			Shawnee ?	Limestone, gray, ferruginous, fossiliferous, nodular, embedded in clay shale.			1	3			18	6
13			Bolivar	Shale, dark gray, carbonaceous.			0	2			17	3
12				Underclay, gray with several layers of calcareous siderite-limonite concretions 2 to 3 inches thick.			3	0			17	1
11				Shale, poorly exposed.			2	0			14	1
10			Shawnee ?	Limestone, gray, ferruginous, fossiliferous, nodular, embedded in clay shale.			1	8			12	1
9				Clay, gray to light gray, plastic.			1	0			10	5
8				Shale, gray stained yellowish to brownish, arenaceous, micaceous, grading into shaly sandstone.			4	1			9	5

LOCATION: Ay 12 FILE NUMBER: 6734 - continued

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
7	Allegheny - continued	Bolivar - continued	Bolivar - continued	Sandstone, gray, stained by iron oxide, coarse, ferruginous.			0	3			5	4
6				Shale, gray to light gray at base.			2	4			5	1
5		Lower Freeport	Lower Freeport	Coal, weathered.			0	2	2	9	2	9
4				Shale, gray, argillaceous and carbonaceous			0	4			2	7
3				Coal, weathered.			1	0			2	3
2				Underclay, light gray stained by iron oxide, plastic.			1	0			1	3
1				Sandstone, gray, stained, slightly ferruginous, with Stigmaria rootlets.			0	3			0	3

LOCATION KEY: Ay 14 FILE NUMBER: 6736 ELEVATION: 685 ± base TOPO MAP: Athens

STATE: Ohio COUNTY: Athens TOWNSHIP: York SECTION: SE¼, 17 and SW¼, 11

LOCATION: Exposure along Happy Hollow road just north of Route 33.

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
19	Conemaugh	Mahoning	Lower Mahoning	Sandstone, light gray, stained slightly by iron oxide, medium to coarse, friable, micaceous, exposed.			10	0	10	0	114	11
18				Covered interval.			15	3	41	1	104	11
17	Allegheny	Upper Freeport	Upper Freeport	Coal, weathered slightly, possibly slumped			1	0			89	8
16				Underclay, light gray, plastic.			1	3			88	8
15				Shale, yellowish-brown, with numerous small limonite concretions.			1	0			87	5
14				Shale, gray, stained by iron oxide, arenaceous or argillaceous, with thin lensing layers of fine to medium micaceous sandstone.			22	7			86	5
13		Bolivar	Shawnee	Limestone, gray, weathers buff to yellowish-brown, ferruginous, fossiliferous, nodular.			0	8	8	2	63	10
12			Bolivar	Shale, gray with limonite stain on top, argillaceous, micaceous, calcareous.			4	4			63	2
11				Sandstone, gray, stained by iron oxide, fine micaceous, shaly, with scattered siderite-limonite concretions.			3	2			58	10
10		Lower Freeport	Dorr Run	Shale, gray todark gray, carbonaceous, argillaceous, fossiliferous in basal few inches.			6	11	30	8	55	8
9			Lower Freeport	Coal, good.			1	5			48	9
8				Shale, gray to dark gray			0	2			47	4
7				Coal, good.			1	8			47	2
6				Clay, gray, micaceous, plastic.			0	7			45	6
5				Shale, gray, stained by iron oxide, arenaceous, micaceous, ferruginous in part, exposed.			11	2			44	11
4				Covered interval.			8	9			33	9
3		Middle Kittanning	Middle Kittanning	Coal, covered at entrance to small mine, thickness recorded as approximate.			6	0	25	0	25	0
2				Covered interval.			10	6			19	0
1				Sandstone, gray, fine, micaceous, with small scattered limonite concretions, thin-bedded, shaly in appearance, exposed.			8	6			8	6

LOCATION KEY: Ay 15 FILE NUMBER: 6737 ELEVATION: 683 ± base TOPO MAP: Athens

STATE: Ohio COUNTY: Athens TOWNSHIP: York SECTION: NE¼ SE¼, 18

LOCATION: Exposure along road and in strip mine north side of Route 216 west of Monday Creek.

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
45	Conemaugh	Mahoning	Lower Mahoning	Shale, olive drab with iron oxide stain, argillaceous and silty, finely micaceous, sandy upward with interbedded sandstone layers 1 inch thick, exposed.			20	0	25	0	148	9
44				Sandstone, light gray with small amount of limonite stain, mostly coarse, some medium, porous, friable, impure, massive, thickness variable, base disconformable			5	0			128	9
43	Allegheny	Upper Freeport	Upper Freeport	Shale, gray with some limonite stain, argillaceous, thickness variable.			0	2	10	3	123	9
42				Shale, dark gray to black, argillaceous and carbonaceous, with thin coaly partings.			0	6			123	7
41				Coal, shaly, with some pyrite.	0	1	3	1			123	1
40				Shale, gray to dark gray, argillaceous, carbonaceous in upper part.	0	5						
39				Coal, dull and bright, somewhat shaly and bony, with some pyrite.	0	2						
38				Clay shale, gray to dark gray, somewhat carbonaceous and plastic.	0	2						
37				Coal, bright, blocky, with much limonite stain on joints and faces, some pyrite, dull coal at top.	2	3						
36				Shale, dark gray to black, carbonaceous, pyritiferous, thickness uncertain.			0	1			120	0
35				Clay, light gray with some limonite stain, plastic.			0	6			119	11
34				Clay shale, light gray with much limonite stain, silty, sandy, micaceous clay shale with interbedded layers of nodular limonite and several thin layers of fine, silty, micaceous sandstone in lower part.			5	11			119	5
33		?	?	Covered interval			6	9	6	9	113	6
32		Bolivar	Shawnee	Clay and limestone, light gray with limonite stain, calcareous, plastic, interbedded with gray, nodular limestone in nodules up to 8 inches in diameter, exposed.			2	6	13	2	106	9
31			Bolivar	Shale, olive drab to gray with limonite stain, sandy, micaceous, interbedded with thin micaceous sandstone, grading upward into shaly sandstone.			8	0			104	3
30				Clay shale, gray to brown with much limonite stain and one layer of nodular limestone			2	8			96	3
29		Lower Freeport	Lower Freeport	Underclay, light gray, plastic.			0	4	54	4	93	7
28				Coal, shaly, weathered.			0	1			93	3
27				Underclay, gray at top to light gray below, plastic.			1	3			93	2
26				Shale, gray to olive drab with some limonite stain, very sandy, micaceous, some zones almost shaly sandstone, grades upward into fine shaly sandstone and back to shale at very top.			24	8			91	11
25				Shale and sandstone, gray with dark gray, limonite stain especially on surfaces, with some ferruginous concretions; shale sandy and micaceous, sandstone medium to fine, micaceous, in layers 2 inches to 2 feet thick, replaced locally by massive coarse sandstone.			28	0			67	3
24		Middle Kittanning	Middle Kittanning	Shale, dark gray to black, carbonaceous, with some thin coaly streaks.			0	10	19	8	39	3
23				Coal, black, some bright, some dull, with limonite stain, with some fusain and free sulphur, latter on surfaces.	1	0	8	11			38	5
22				Shale, gray, argillaceous, carbonaceous, with some silt.	0	4					37	5
21				Shale, black, carbonaceous, bony, with limonite stain on bedding planes.	0	10					37	1

LOCATION: Ay 15 FILE NUMBER: 6737 - continued

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
20	Allegheny - continued	Middle Kittanning - continued	Middle Kittanning - continued	Coal, bright with some dull and with heavy limonite on joint planes, blocky.	2	6					36	3
19				Shale, gray to black with limonite stain, argillaceous, with fossil megaspores.	0	4					33	9
18				Coal, bright, with some dull streaks and some fusain; melanterite and free sulphur on surfaces, blocky.	2	0					33	5
17				Shale, gray, argillaceous, silty.	0	2					31	5
16				Coal, bright with some dull streaks, melanterite and free sulphur on surfaces, blocky.	1	9					31	3
15				Underclay, light gray to gray, sandy, micaceous, some carbonaceous fragments.			0	4			29	6
14				Sandstone, gray with limonite stain, clayey and shaly, micaceous, with carbonaceous fragments.			1	1			29	2
13				Clay shale, gray with some limonite stain, layers of well-preserved fossil plants.			5	7			28	1
12				Shale, gray to dark gray or black, some limonite stain, argillaceous and carbonaceous with coaly streaks in lower part, some fossil plants.			0	6			22	6
11				Shale, gray to light gray with some limonite stain, silty, argillaceous, finely micaceous, somewhat plastic at top.			1	9			22	0
10			Snow Fork	Shale and iron ore, gray, argillaceous shale and gray, slightly calcareous, fossiliferous (plants) ironstone concretions.			1	6			20	3
9		Strasburg	Strasburg	Coal, bright and ull with much pyrite in layers, shaly.			0	1	13	0	18	9
8			Oak Hill	Underclay, light gray to gray with some limonite stain, somewhat plastic, with several thin coaly carbonaceous partings.			0	9			18	8
7				Clay shale, gray with much yellowish brown stain, argillaceous.			1	3			17	11
6			Strasburg	Sandstone, light gray with much limonite stain, fine to medium, silty, finely micaceous, shaly in appearance.			1	0			16	8
5				Shale and covered interval, olive drab, argillaceous, silty shale becoming sandy upward, with some small scattered limonite concretions, covered in part.			9	11			15	8
4		Lower Kittanning	Lower Kittanning	Coal, weathered to a dark macerated material.			1	3	5	9	5	9
3				Underclay, light gray to gray with some limonite stain, stlty, plastic.			0	10			4	6
2				Clay shale, light gray with layers and irregular layers of limonite stain, semiplastic.			2	11			3	8
1				Sandstone, light gray with limonite stain, fine, silty, micaceous, exposed.			0	9			0	9

LOCATION KEY: Ay 18 FILE NUMBER: 6740 ELEVATION: 749± base TOPO MAP: Athens

STATE: Ohio COUNTY: Athens TOWNSHIP: York SECTION: SW¼ SE¼, 6

LOCATION: Exposure in strip mine one-half mile south of Buchtel.

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
14	Conemaugh	Mason	Upper Mahoning	Sandstone, yellowish to brownish, coarse, porous, micaceous, very friable, disconformable base, top is top of hill, exposed.			8	0	8	0	39	4

LOCATION: Ay 18 FILE NUMBER: 6740 - continued

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
13	Conemaugh -	Mahoning	Thornton	Clay, light gray, pinkish in lower part, slightly silty, plastic.			3	0	23	1	31	4
12	continued		Lower Mahoning	Clay shale, olive gray, nodular layer of calcareous, ferruginous masses in basal foot.			2	0			28	4
11				Shale, variable, gray to light gray, surfaces with limonite stain, especially upward, clayey in lower part, more silty to sandy upward grading upward into shaly sandstone, ferruginous concretions throughout.			18	1			26	4
10	Allegheny	Upper Freeport	Upper Freeport	Shale, gray to black, carbonaceous, especially in lower part argillaceous, laminated.			0	9	8	3	8	3
9				Coal, bright, blocky, some dull with pyrite partings.			0	9			7	6
8				Shale, gray to black, carbonaceous, argillaceous.			0	4			6	9
7				Coal, bright, blocky, with dull partings, top 2 inches shaly and bony.			1	2			6	5
6				Coal, bony, with bright layers and shaly top			0	5			5	3
5				Coal, bright, blocky, with dull partings,			0	10			4	10
4				Clay shale, light gray to gray with coaly and carbonaceous streaks, variable thickness.			0	2			4	0
3				Coal, bright, blocky, some thin dull partings, some conchoidal fracture, scattered masses of pyrite up to 1 inch thick in upper part.			2	8			3	10
2				Coal and pyrite, coal is dull, shaly with numerous thin layers and flat nodular masses of pyrite, 750'.			0	2			1	2
1				Clay, light gray with slickensides, macerated fossil plants.			1	0			1	0

LOCATION KEY: Ay 21 FILE NUMBER: 6743 ELEVATION: 813 ± base TOPO MAP: Athens

STATE: Ohio COUNTY: Athens TOWNSHIP: York SECTION: SE¼ NE¼, 4 (unnumbered)

LOCATION: Exposures up hill along road just west of 926 road intersection along road north from 926 road intersection.

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
22	Conemaugh	Ames	Ames	Limestone, light gray with faint limonite stain near surfaces, partly crystalline, some pyrite inclusions, fossiliferous, (zone of loose blocks).			1	0	1	0	157	4
21		?	?	Covered interval.			39	1	39	1	156	4
20		Upper Bakerstown	Cow Run	Shale, olive drab, with some limonite stain, silty, sandy, micaceous, with thin zones of shaly sandstone.			15	3	31	9	117	3
19				Covered interval.			16	6			102	0
18		Anderson	Portersville	Shale, gray to dark gray, somewhat limonite stained, argillaceous, fossiliferous, weathered.			0	6	13	6	85	6
17			Anderson	Coal, mostly dull, shaly, much fusain, some bright streaks, top very shaly, weathered.			1	0			85	0
16			? Bloomfield	Underclay, light gray to greenish with some limonite stain, plastic, small limestone nodules in base.			6	10			84	0
15			? Bakerstown	Sandstone and limestone, gray to olive drab, limonite stained, fine, micaceous sandstone, with and underlain by nodular, freshwater limestone. Sandstone is bedded in layers to 4 inches thick, thickness variable.			1	10			77	2

LOCATION: Ay 21 FILE NUMBER: 6743 - continued

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
14	Conemaugh - continued	Anderson - continued	Bakerstown - continued	Shale, olive drab with limonite stain, silty, sandy, finely micaceous, with fine zones of fine shaly sandstone.			3	4			75	4
13		Wilgus	Cambridge	Limestone, gray weathering brown, surface somewhat pitted, very sandy part being sandstone, micaceous, ferruginous, fossiliferous, massive to heavy-bedded.			3	6	29	5	72	0
12			Wilgus	Clay shale, light gray with limonite stain, starch-like fracture, grading toward plastic clay.			1	0			68	6
11			Buffalo	Shale, olive drab with some limonite stain, sandy, silty, micaceous, with scattered small ferruginous nodules.			2	2			67	6
10				Sandstone, light olive drab with limonite stain, fine, micaceous, bedded in layers ¼ to 3 inches thick.			6	0			65	4
9				Shale, olive drab with limonite stain, silty, sandy, micaceous.			6	11			59	4
8				Shale, gray to dark gray with limonite stain, silty, with scattered carbonaceous fragments and macerated plants.			9	10			52	5
7		Upper and Lower Brush Creek ?	Upper and Lower Brush Creek ?	Shale, gray to olive drab with limonite stain, silty, finely micaceous, sparingly fossiliferous, with scattered, ferruginous, small, fossiliferous nodules.			6	6	20	3	42	7
6				Limestone, dark gray with surface weathering to brown, mostly dense, fossiliferous, (mostly weathered to a 5-inch dark brown, clayey layer).			0	5			36	1
5				Clay, light gray with limonite stain, slightly silty, somewhat plastic.			0	3			35	8
4				Shale, olive drab with some limonite stain, silty, sandy, finely micaceous, some zones almost shaly sandstone.			13	1			35	5
3		Lower Brush Creek	Lower Brush Creek	Sandstone and shale, yellowish to brownish, fine, very micaceous, bedded and cross-bedded sandstone succeeded upward and interbedded with olive drab, limonite stained, sandy, micaceous shale.			19	9	19	9	22	4
2		Mason	Mason	Coal, shaly, badly weathered.			0	1	2	7	2	7
1				Underclay, light gray, limonite mottling throughout, plastic, exposed.			2	6			2	6

LOCATION KEY: Ay 22 FILE NUMBER: 6744 ELEVATION: 672 ± base TOPO MAP: Athens

STATE: Ohio COUNTY: Athens TOWNSHIP: York SECTION: NW¼ NE¼, 18

LOCATION: Exposure in strip mine (Middle Kittanning) north of Buchtel-Nelsonville road and south of ridge south of Snake Hollow.

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
34	Allegheny	Bolivar ?	Bolivar ?	Shale, gray to olive drab, exposed.			9	5	9	5	129	0
33		Lower Freeport	Dorr Run	Shale, gray, argillaceous, sparingly fossiliferous (Lingula) in basal 2 inches.			0	8	23	8	119	7
32			Lower Freeport	Coal, bright, blocky, with numerous, thin, irregular partings, including much fusain.	1	0	1	7			118	11
31				Shale, dark gray to black, carbonaceous, numerous fossil megaspores and thin coaly streaks.	0	2					117	11
30				Coal, bright, blocky, with numerous dull partings of fusain and/or pyrite, some thin shaly partings, coatings of melanterite on joint faces and bedding planes.	0	5					117	9
29				Underclay, gray, ferruginous, silty, sandy micaceous, with scattered small masses of limonite and pyrite.			5	10			117	4
28				Limestone, greenish gray, nodular, ferruginous with network of thin, irregular, limonite partings, containing pyrite, embedded in light gray, clay shale.			2	0			111	6

LOCATION: Ay 22 FILE NUMBER: 6744 - continued

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
27	Allegheny - continued	Lower Freeport - continued	Lower Freeport - continued	Shale, gray to olive drab, some limonite stain, argillaceous, silty, finely micaceous, with scattered small limonite concretions and limonite concentrated along joints.			13	7			109	6
26		Lower Freeport ?	Lower Freeport ?	Covered interval.			5	5	19	5	95	11
25				Shale, gray, argillaceous to silty, finely micaceous, with layers of fine micaceous sandstone which are more numerous and thicker upward.			14	0			90	6
24		Middle Kittanning	Middle Kittanning	Shale, gray to dark gray, carbonaceous, argillaceous.			0	8	19	0	76	6
23				Coal, bright, blocky, with numerous, thin, dull partings including bone, fusain, and pyrite, becomes canneloid and bony upward.	1	7	10	2			75	10
22				Shale, dark gray to black, carbonaceous, argillaceous, with traces of fossil plants, lower 7 inches bony and coaly.	1	6					74	3
21				Coal, bright, blocky, with numerous bony partings, some fusain.	2	9					72	9
20				Shale, dark gray, argillaceous, with very thin coal partings, thickness variable.	0	4					70	0
19				Coal, bright, blocky, with thin dull partings containing fusain, becomes bony upward.	2	1					69	8
18				Shale, dark gray to gray, with numerous very thin coal partings.	0	1					67	7
17				Coal, bright blocky, with very thin dull partings containing fusain and pyrite.	1	10					67	6
16				Underclay, light gray, much stained by limonite, with fossil plants, plastic.			0	11			65	8
15			Snow Fork	Shale, light gray with considerable limonite stain on surfaces, argillaceous to silty, contains layers and scattered nodules of calcareous siderite now largely weathered to limonite, numerous fossil plants in shale and nodules.			7	11			64	9
14		?	?	Covered interval			6	8	6	8	56	10
13		Strasburg ?	Oak Hill ?	Clay or clay shale, weathered light gray with some limonite stain, with limonite masses up to 8 inches in size.			2	0	2	0	50	2
12		?	?	Covered interval.			4	1	4	1	48	2
11		Lower Kittanning	Lower Kittanning	Coal, bright and ull, some fusain, shaly in top several inches, badly weathered.			1	7	38	7	44	1
10				Underclay, light gray to dark gray at top, with considerable limonite stain, lower part very sandy and micaceous, less sandy above where it is massive and quite plastic, exposed.			4	0			42	6
9				Covered or poorly exposed interval, calcareous sandstone overlain by clay shale between 14' 6" and 18' 9".			33	0			38	6
8		Scrubgrass	Ferriferous	Shale, gray with some limonite stain on surfaces, argillaceous to silty, finely micaceous, quite sandy in lower 2 inches, with carbonaceous fragments, numerous ferruginous zones and several layers of flattened ferruginous nodules.			2	1	2	1	5	6
7		Clarion - Scrubgrass	Scrubgrass ?	Clay, light gray with limonite stain on surfaces, somewhat silty and plastic, with scattered small ferruginous nodules and irregular lensing streaks (some nearly vertical) of coal, top 2 inches shaly with two thin layers of coal.			0	9	3	5	3	5
6			Clarion	Shale, dark gray to black, carbonaceous, with coaly streaks.			0	1			2	8
5				Coal, bright to bony, with black to gray shaly partings and disseminated pyrite.			0	3			2	7
4				Shale, dark gray to black, carbonaceous, coaly, with thin coal streaks.			0	1			2	6

LOCATION: Ay 22 FILE NUMBER: 6744 - continued

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
3	Allegheny continued	Clarion - Scrubgrass - continued	Clarion - continued	Underclay, gray to light gray, with numerous thin carbonaceous fragments, shaly appearing, quite plastic.			0	2			2	3
2				Shale, gray, with some limonite stain on surfaces, argillaceous to sandy, micaceous, with traces of fossil plants.			1	1			2	1
1				Sandstone, gray to light gray, with some limonite stain on surfaces, fine-grained, micaceous, thin-bedded, compact, exposed.			1	0			1	0

LOCATION KEY: Ay 23 FILE NUMBER: 6745 ELEVATION: 781 ± base TOPO MAP: Athens

STATE: Ohio COUNTY: Athens TOWNSHIP: York SECTION: NW¼ NW¼, 18

LOCATION: Exposures along road east and southeast of 871 road intersection for a distance of 0.3 mile NW¼ NW¼, section 18, York Twp., Athens County. The exposures extend for a short distance into the southwest corner of section 13 and the southeast corner of section 19, Ward Township, Hocking County.

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
11	Conemaugh	Mahoning	Lower Mahoning	Sandstone, light gray with limonite stain, medium to coarse, micaceous, friable, mostly massive but with some shaly zones bearing ferruginous nodules.			21	9	21	9	95	0
10	Allegheny	Upper Freeport	Upper Freeport	Coal, slumped, badly weathered.			0	8	23	6	73	3
9				Shale and plastic underclay at top, mostly covered.			22	10			72	7
8		Bolivar	Bolivar and Shawnee	Underclay and limestone, light gray mottled maroon with limonite stain, plastic clay with embedded nodular, olive to brownish, dendritic, arenaceous limestone, exposed.			3	0	12	9	49	9
7			Bolivar	Shale and sandstone, light gray to olive drab, with limonite stain, silty, sandy, micaceous shale and fine-grained micaceous sandstone above.			9	9			46	9
6		Lower Freeport	Lower Freeport	Clay shale, gray with some limonite stain on surfaces, carbonaceous fragments in lower part.			0	6	37	0	37	0
5				Coal, mostly dull with some bright streaks, with fusain and fossil plants, weathered, thins rapidly in short lateral distances, weathered.			0	6			36	6
4				Underclay, light gray with considerable limonite stain, moderately plastic.			2	6			36	0
3				Underclay and clay shale, gray to light gray or olive drab with limonite stain in most part, silty, slightly sandy in part, micaceous, with scattered ferruginous nodules, breaks with starch-like fracture.			6	6			33	6
2				Shale and sandstone, light gray with limonite stain, sandy, micaceous shale and a lense of light gray limonite stained, fine, micaceous, calcareous sandstone 2+ feet thick in upper part.			15	0			27	0
1				Sandstone, gray to light gray with limonite stain, medium, micaceous, friable, mostly massive, exposed.			12	0			12	0

LOCATION KEY: Ay 25 FILE NUMBER: 6747 ELEVATION: 680 ± base TOPO MAP: Athens

STATE: Ohio COUNTY: Athens TOWNSHIP: York SECTION: NE¼ NW¼, 10 (unnumbered)

LOCATION: Exposures along north side of Route 33 and in prospect pits up hillside.

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
20	Conemaugh	Mahoning	Lower Mahoning	Sandstone, light gray with limonite streaks, medium to coarse, micaceous, massive, showing bedding and cross bedding on weathered surfaces.			5	10	5	10	109	7
19	Allegheny	Upper Freeport	Upper Freeport	Clay, light gray, with coaly streaks, plastic			1	0	30	9	103	9
18				Coal, badly weathered.			0	3			102	9
17				Clay, light gray, plastic.			0	3			102	6
16				Coal, weathered.			2	6			[illegible]	3
15				Clay, gray to light gray, plastic, exposed.			0	2			99	9
14				Shale and covered, olive drab, limonite stained, with many limonite nodules more or less in layers.			26	7			99	7
13		Bolivar	Bolivar	Clay, light gray, plastic, few scattered limonite concretions.			3	6	10	0	73	0
12			Shawnee	Limestone, nodular, light gray to gray, basal 6 inches very ferruginous, fossiliferous, embedded in clay.			1	6			69	6
11			Bolivar	Clay, gray, plastic.			2	6			68	0
10				Sandstone, olive drab with limonite stain on surface, fine, silty, micaceous, shaly.			2	6			65	5
9		Lower Freeport	Lower Freeport	Clay shale, gray to olive drab, with limonite stain and scattered ferruginous nodules up to 6 inches in size, micaceous.			6	11	9	10	63	0
8				Clay, light gray, much limonite stained, plastic.			2	0			56	1
7				Coal, badly weathered.			0	9			54	1
6				Clay, gray, plastic, weathered, exposed.			0	2			53	4
5		Lower Freeport and Middle Kittanning	Lower Freeport and Middle Kittanning	Covered interval, Middle Kittanning coal near base, elevation 702±', estimated.			41	0	41	0	53	2
4		Middle Kittanning	Middle Kittanning	Clay shale, olive drab with limonite stain, finely micaceous, some silt, exposed.			1	0	12	2	12	2
3			Snow Fork	Iron ore, nodular, yellowish to dark reddish brown, weathered to limonite.			0	4			11	2
2			Middle Kittanning	Shale, light gray to olive drab with limonite stain on surfaces, silty, sandy, micaceous, with small scattered limonite nodules.			3	2			10	10
1				Sandstone, light gray with dark limonite streaks and sports, fine, micaceous, massive showing cross-bedding and lamination on weathered surfaces.			7	8			7	8

LOCATION KEY: Ay 27 FILE NUMBER: 6749 ELEVATION: 730 ± base TOPO MAP: Athens

STATE: Ohio COUNTY: Athens TOWNSHIP: York SECTION: SE¼ SE¼, 17 (unnumbered)

LOCATION: Exposure on south slope along north side of Route 33, east of mouth of Coe Hollow.

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
18	Conemaugh	Mahoning	Lower Mahoning	Sandstone, light gray with some limonite stain, some fine, micaceous, friable, massive.			13	0	13	0	72	6
17	Allegheny	Upper Freeport	Upper Freeport	Shale, dark gray to black, argillaceous and somewhat carbonaceous.			0	4	35	0	59	6
16				Clay shale, light gray to dark gray, argillaceous.			0	10			59	2
15				Coal, badly weathered.			0	8			58	4
14				Underclay, gray to dark gray, traces of fossil plants, plastic.			0	4			57	8
13				Coal, weathered, shale in top part, some bright.			2	0			57	4

LOCATION: Ay 27 FILE NUMBER: 6749 - continued

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
12	Allegheny - continued	Upper Freeport - continued	Upper Freeport - continued	Underclay, light gray, with considerable limonite stain in masses and on surface, silty, plastic, traces of fossil plants.			2	7			55	4
11				Shale and sandstone, partly covered, fine, micaceous sandstone and micaceous shale, some clay shale.			28	3			52	9
10		Bolivar	Shawnee	Limestone, light gray, limonite stained at top, dense, small cracks filled with calcite, fossiliferous, non-marine.			1	0	13	3	24	6
9			Bolivar	Shale, olive drab to light brown, arenaceous, micaceous, limonite stained, scattered small ferruginous nodules.			2	6			23	6
8				Sandstone, light gray, mostly stained yellowish to brown, fine to medium, micaceous, massive to bedded and cross-bedded shale towards top.			9	9			21	0
7		Lower Freeport	Dorr Run	Shale, dark gray to black, carbonaceous, somewhat limonite stained.			6	6	11	3	11	3
6				Shale, gray to dark gray to black lower part, argillaceous, pyritiferous and fossiliferous in lower part, marine.			0	8			4	9
5			Lower Freeport	Coal, bright, blocky, some bone and fusain considerably weathered.			1	7			4	1
4				Clay shale, gray with very thin small lensing coal partings, micaceous.			0	2			2	6
3				Coal, bright, blocky, some thin dull partings including fusain.			1	7			2	4
2				Shale, black, coaly, carbonaceous with gray clayey parting.			0	3			0	9
1				Underclay, gray, plastic, exposed.			0	6			0	6

LOCATION KEY: Ay 28 FILE NUMBER: 6750 ELEVATION: 703 ± base TOPO MAP: Athens

STATE: Ohio COUNTY: Athens TOWNSHIP: York SECTION: 17 (unnumbered)

LOCATION: Exposure in ravine on north side of Route 33 near east edge of Nelsonville.

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
12	Conemaugh	Mahoning	Lower Mahoning	Sandstone, gray to light gray, medium to coarse, limonite stained, micaceous, friable, massive, base very disconformable, base may cut No. 7 coal out.			20	0	20	0	100	8
11	Allegheny	Upper Freeport	Upper Freeport	Shale, black, carbonaceous, much weathered and stained, 4-inch light clay at base.			1	5			80	8
10				Coal, bright, blocky, with very thin partings.			4	0			79	3
9				Clay, gray, plastic.			0	2			75	3
8				Shale, olive drab with limonite, argillaceous, silty, micaceous, scattered ferruginous nodules, poorly exposed.			23	11			75	1
7		Bolivar ?	Shawnee ?	Limestone, light gray, dense, fossiliferous, fresh-water.			3	0	9	0	51	2
6			?	Covered interval.			6	0			48	2
5		Lower Freeport	Lower Freeport	Sandstone, gray to brown, medium limonite stained, micaceous, massive, friable.			12	0	35	4	42	2
4				Shale, gray to dark gray or black, argillaceous, becomes silty upward, some carbonaceous material at base.			23	4			30	2
3		Middle Kittanning	Middle Kittanning	Shale, black, carbonaceous, streaked with yellow-brown limonite.			0	6	6	10	6	10
2				Coal, some bright, blocky, considerable fusain throughout, shaly at top.	2	0	6	2			6	4
				Shale, gray to dark gray or black, carbonaceous, with some very thin bright coal streaks.	0	3						
				Coal, bright, blocky, some very thin dull partings.	2	3						

LOCATION: Ay 28 FILE NUMBER: 6750 - continued

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
	Conemaugh - continued	Middle Kittanning - continued	Middle Kittanning - continued	Shale, dark gray to black, carbonaceous, with bright coaly streaks.	0	1						
				Coal, bright, blocky, some dull, some free sulphur on surfaces.	1	7						
1				Clay, light gray, silty, finely micaceous, exposed.			0	2			0	2

LOCATION KEY: Ay 30 FILE NUMBER: 6752 ELEVATION: 715± base TOPO MAP: Athens

STATE: Ohio COUNTY: Athens TOWNSHIP: York SECTION: NW¼ SE¼, 14

LOCATION: Exposure along ravine at farm buildings south from house in bed and banks of creek channel.

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
17	Conemaugh	Mahoning	Lower Mahoning	Sandstone, gray, coarse, massive, irregular base.			13	0	13	0	56	2
16	Allegheny	Upper Freeport	Upper Freeport	Coal, (50 inches reported from nearby mine).			2+	0	24	0	43	2
15				Clay, gray, plastic.			1	8			41	2
14				Sandstone, gray, thin-bedded, shaly, with shaly layers to 12 inches.			10	2			39	6
13				Shale, gray, silty, micaceous, with layers of fine micaceous sandstone to 6 inches with scattered siderite concretions.			10	2			29	4
12		Bolivar	Shawnee	Limestone, gray, brecciated in part, ferruginous in upper part particularly, fossiliferous, nonmarine.			1	3	10	8	19	2
11			Bolivar	Clay, gray, plastic, impure and ferruginous near base, with septarian siderite nodules.			2	1			17	11
10				Shale, siliceous to sandy, gray with thin layers of sandstone, with scattered siderite concretions.			6	2			15	10
9				Sandstone, gray, thin-bedded, flaggy.			1	2			9	8
8		Lower Freeport	Dorr Run ?	Shale, blue gray, silty.			3	9	7	6	7	6
7				Shale, dark gray, carbonaceous.			0	5			3	9
6				Limestone, light gray, very hard, shaly with ostracods.			0	9			3	4
5				Shale, gray, silty.			0	3			2	7
4				Shale, gray, silty.			0	6			2	4
3			Lower Freeport	Shale, black, carbonaceous, fissile, hard, Lower Freeport (No. 6a) coal horizon.			0	6			1	10
2				Limestone, blue-gray, massive.			0	8			1	4
1				Shale, blue, calcareous.			0	8			0	8

LOCATION KEY: Ay 31 FILE NUMBER: 6753 ELEVATION: TOPO MAP: Athens

STATE: Ohio COUNTY: Athens TOWNSHIP: York SECTION: NW¼, 9

LOCATION: C. D. Shafer property, exposure in strip mine on west side of road.

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
23	Conemaugh	Mason	Upper Mahoning	Sandstone, weathered and covered.			3	0	3	0	45	5
22		Mahoning	Mahoning	Clay, gray, weathered.			0	6	35	8	42	5
21				Coal, shaly.			0	1			41	11
20			Thornton	Underclay, gray to dark gray, red stained, plastic.			1	8			41	10
19			Lower Mahoning	Shale, fine-grained, maroon.			2	0			40	2
18				Clay, light, very sandy and micaceous.			1	3			38	2

LOCATION: Ay 31 FILE NUMBER: 6753 - continued

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
17	Conemaugh - continued	LoMahoning - continued	Lower Mahoning - continued	Shale, olive with iron oxide along joints, silty to sandy.			1	10			36	11
16				Clay shale, drab gray with few small ironstone kidneys and calcareous nodules.			4	10			35	1
15				Shale, drab and maroon, mottled, irregular fracture.			6	6			30	3
14				Clay shale, olive.			3	7			23	9
13				Shale, gray, with carbonaceous streaks			0	1			20	2
12				Shale, olive, fine-grained, with few large ore knots, ore along joints.			4	10			20	1
11				Sandstone, gray, fine, silty.			5	7			15	3
10				Shale, blue-gray, sandy to silty, carbonaceous near top.			2	11			9	8
9	Allegheny	Upper Freeport	Upper Freeport	Shale, black, carbonaceous with coaly streaks.			1	5	6	9	6	9
8				Clay shale, gray, micaceous, locally with lens of gray, coarse, arkosic, micaceous sandstone cutting out overlying carbonaceous shale.			1	7			5	4
7				Coal, bony.	0	1	3	9			3	9
6				Coal, somewhat bony in upper part.	0	6½					3	8
5				Shale, black, carbonaceous	0	0¼					3	2¾
4				Coal, bright, blocky.	0	8½					3	2½
3				Shale, dark gray.	0	3					2	6
2				Coal, very bright and hard, with dull laminae, pyrite and fusain.	2	0					2	3
1				Coal, with pyrite layers to 1½ inches thick.	0	3					0	3

LOCATION KEY: Ay 32 FILE NUMBER: 6754 ELEVATION: 826± base TOPO MAP: Athens

STATE: Ohio COUNTY: Athens TOWNSHIP: York SECTION: NW¼ NE¼, 17 (unnumbered)

LOCATION: Up ravine in NW¼ NE¼, section 17.

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
7	Conemaugh	Lower Brush Creek	Lower Brush Creek	Limestone, light gray with green specks, weathers dark gray to yellowish with some dull purple, dense to partly crystalline, massive, fossiliferous, marine.			1	0	12	0	13	4
6				Covered interval			10	0			12	4
5				Shale, olive drab with some limonite stain, silty, sandy, micaceous, exposed.			1	0			2	4
4		Mason	Mason	Coal, bright with dull partings, possibly shaly upward, weathered.			1	0	1	4	1	4
3				Underclay, light to dark gray with some limonite stain, plastic.			0	1½			0	4
2				Coal, shaly, weathered			0	0½			0	2½
1				Underclay, light gray to yellowish, plastic, exposed.			0	2			0	2

LOCATION KEY: Ay 10 FILE NUMBER: 11474 ELEVATION: 780' base of No. 6 coal TOPO MAP: Athens

STATE: Ohio COUNTY: Athens TOWNSHIP: York SECTION: SE¼, 29

LOCATION: Exposure at mine drain on south side of Minker's Run.

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
11	Allegheny	Lower Freeport	Lower Freeport	Sandstone, gray, medium to fine, argillaceous, micaceous, irregularly bedded, exposed.			4	0	4	0	21	9
10		Middle Kittanning	Middle Kittanning	Shale, variable, gray to dark gray stained by iron oxide, carbonaceous in part.			4	6	15	9	17	9
9				Coal, good			1	9			13	3
8				Shale, dark gray.			0	4			11	6
7				Coal, good.			2	3			11	2
6				Shale, dark gray to black, carbonaceous.			0	1			8	11
5				Coal, good.			1	6			8	10
4				Underclay, light gray, plastic.			0	10			7	4
3			Snow Fork ?	Shale, gray stained by iron oxide with scattered small limonite concretions.			4	6			6	6
2		Strasburg ?	Strasburg ?	Shale, dark gray, carbonaceous			0	6	2	0	2	0
1			Oak Hill ?	Clay shale, light gray with some iron oxide stain, exposed.			1	6			1	6

LOCATION KEY: Ay 34 FILE NUMBER: 11476 ELEVATION: 840± base TOPO MAP: Zaleski

STATE: Ohio COUNTY: Athens TOWNSHIP: York SECTION: N½ NW¼, 27

LOCATION: Exposure along road west of bridge over tributary to Hewett Fork.

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
10	Conemaugh	Lower Brush Creek?	Lower Brush Creek?	Shale, gray drab, silty, finely micaceous, poorly exposed in upper part.			20	0	20	0	114	0
9		Mason	Upper Mahoning	Sandstone, light gray weathered yellowish to brownish, medium to coarse, micaceous, friable, massive below becoming bedded upward.			39	0	39	0	94	0
8		Mahoning	Lower Mahoning	Sandstone and shale, light gray weathered yellowish to brownish, fine micaceous sandstone interbedded with sandy micaceous shale, covered in upper part.			20	2	33	10	55	0
7				Sandstone, weathered yellowish to brownish, coarse, micaceous, friable, massive, few scattered pebbles throughout.			13	8			34	10

LOCATION: Ay 34 FILE NUMBER: 11476 - continued

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
6	Allegheny	Upper Freeport	Upper Freeport	Shale, dark gray, carbonaceous, badly weathered.			0	6	21	2	21	2
5				Coal, much weathered, bright with numerous streaks of dull coal, and with some fusain and pyrite, becomes shaly upward.			0	10			20	8
4				Underclay, dark gray, carbonaceous, shaly, plastic.			0	2			19	10
3				Clay, light gray, micaceous and sandy, grades downward into sandstone.			1	6			19	8
2				Sandstone, light gray with some limonite stain, fine, micaceous, shaly and ferruginous in part.			1	6			18	2
1				Shale, weathered yellowish to brownish, argillaceous below, sandy and micaceous upward, poorly exposed, base not seen.			16	8			16	8

LOCATION KEY: Ay 37 FILE NUMBER: 11479 ELEVATION: 799± base TOPO MAP: Zaleski

STATE: Ohio COUNTY: Athens TOWNSHIP: York SECTION: NW¼, 32

LOCATION: Exposures in strip mine formerly operated by Sunday Creek Coal Co. along tributary to Hewett Fork.

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
27	Allegheny	Upper Freeport	Upper Freeport	Shale, light gray with limonite stain, argillaceous, grades upward into soil, exposed.			5	0	5	0	76	10
26		Bolivar	Bolivar and Shawnee	Clay shale, gray weathering yellowish brown, ferruginous, fossiliferous.			0	11	19	8	71	10
25				Limestone, light gray to yellowish or brownish, dense, nodular, fossiliferous, freshwater.			1	9			70	11
24				Clay, light gray to gray, with ferruginous layers and small scattered limestone concretions.			3	2			69	2
23				Clay, light gray, flinty, with much limonite stain, ferruginous.			1	10			66	0
22			Bolivar	Shale, light gray to olive drab with limonite stain, sandy, micaceous.			4	0			64	2
21				Sandstone, light gray, medium, micaceous, a single ledge showing bedding on weathered surfaces			5	0			60	2
20				Shale, gray to light gray with limonite stain, silty, argillaceous, micaceous, with layer of ferruginous concretions in basal part and some scattered throughout.			3	0			55	2
19		Lower Freeport	Dorr Run	Shale, black, bony, carbonaceous, fissile, sparingly fossiliferous in basal part, marine.			4	0	43	11	52	2
18			Lower Freeport	Shale, gray to dark gray with limonite stain, argillaceous.			1	8			48	2
17				Coal, bright with thin partings of fusain.			1	3			46	6
16				Shale, dark gray, argillaceous.			0	2			45	3
15				Coal, bright with thin partings of fusain and pyrite.			1	3			45	1
14				Underclay, light gray with limonite stain, micaceous, very sandy, plastic.			1	0			43	10
13				Shale, light gray to gray drab, limonite stained, sandy, micaceous, with scattered ferruginous concretions.			6	8			42	10
12				Sandstone, light gray with some iron oxide stain, fine, micaceous, calcareous.			0	8			36	2
11				Shale, light gray with some limonite stain near top, silty, argillaceous, micaceous.			8	6			35	6
10				Sandstone, light gray with some limonite stain, fine to coarse, mostly medium to coarse, micaceous, massive showing bedding on weathered surfaces, lenticular, thickness variable.			10	9			27	0

LOCATION: Ay 37 FILE NUMBER: 11479 - continued

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
9	Allegheny - continued	Lower Freeport continued	Lower Freeport - continued	Shale, light gray to gray (basal 2 inches dark gray) with considerable limonite stain on surfaces, argillaceous in lower part becoming silty and sandy upward, micaceous.			8	0			16	3
8		Middle Kittanning	Middle Kittanning	Coal, bright, with dull streaks and fusain, becomes shaly upward.			1	1	8	3	8	3
7				Shale, dark gray, micaceous, with coaly masses, fusain, and stigmaria.			0	4			7	2
6				Coal, bright with much fusain and some dull or canneloid layers.			3	0			6	10
5				Shale, dark gray with thin layers of bright coal and numerous megaspores.			0	4			3	10
4				Coal, bright with numerous thin layers of dull coal, few masses and some thin layers of fusain or pyrite.			2	5			3	6
3				Shale, dark gray, finely micaceous, with slickensides and traces of fossil plants.			0	1			1	1
2				Coal, bright, hard, with numerous thin layers and masses of fusain.			1	0			1	0
1				Underclay, light gray to gray, micaceous, plastic, exposed.			0	0			0	0

LOCATION KEY: Ay 38 FILE NUMBER: 11480 ELEVATION: 771± base TOPO MAP: Zaleski

STATE: Ohio COUNTY: Athens TOWNSHIP: York SECTION: NW¼ and SE¼'s, SW¼, 26

LOCATION: Deep and strip mines and exposure along road to southeast.

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
27	Conemaugh	?	?	Sandstone, light brown, micaceous, bedded in layers 1 to 3 inches thick, exposed.			3	0	3	0	185	1
26		Upper Brush Creek and Wilgus ?	Upper Brush Creek and Wilgus ?	Shale, gray, weathering ferruginous, argillaceous grading upward into sandy shale, with ferruginous nodules, poorly exposed in top part.			43	5	43	5	182	1
25		Lower Brush Creek	Lower Brush Creek	Limestone, gray to dark gray, fossiliferous, marine, weathered, poorly exposed.			1	0	10	2	138	8
24				Covered interval showing weathered shale and some pieces of sandstone.			9	2			137	8
23		Mason	Mason	Coal, badly weathered streak			0	1	25	9	128	6
22			Upper Mahoning	Shale and sandstone, ferruginous and micaceous, becomes argillaceous upward.			9	5			128	5
21				Covered interval.			16	3			119	0
20		Mahoning	Lower Mahoning	Sandstone, gray with limonite stain, medium grained, micaceous, rather ferruginous at base, with included chips of clay and a few fossil plants .			28	1	28	1	102	9
19	Allegheny	Upper Freeport	Upper Freeport	Clay and argillaceous shale, ferruginous.			15	3	23	11	74	8
18				Sandstone, very poorly exposed.			8	8			59	5
17		Bolivar	Shawnee	Limestone, light blue-gray, sandy, micaceous, ferruginous, fresh-water.			1	0	10	10	50	9
16			Bolivar	Shale, sandy, micaceous, thickness variable (locally replaced by underlying sandstone).			2	6			49	9
15				Sandstone, light gray with some limonite stain, very micaceous along bedding planes, medium-grained, massive showing bedding on weathered surfaces, lenticular, thickness variable, base disconformable.			5	0			47	3
14				Shale, light gray with limonite stain on surfaces, argillaceous, finely micaceous, with scattered ferruginous concretions, thickness variable.			2	4			42	3

LOCATION: Ay 38 FILE NUMBER: 11480 - continued

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
13	Allegheny - continued	Lower Freeport	Dorr Run	Shale, black, carbonaceous, weathers fissile with some limonite stain on surfaces, pyritiferous in basal part and with scattered ferruginous concretions in top part, fossiliferous especially in basal part where there is a thin zone of Lingula.			3	6	30	7	29	11
12				Shale, argillaceous, sparingly fossiliferous			0	9			36	5
11			Lower Freeport	Coal, bright with dull partings and considerable fusain, becomes shaly upward.			1	6			35	8
10				Clay shale, gray to dark gray, with thin coaly streaks, fossil plants, and scattered pyrite masses.			0	2			34	2
9				Coal, bright, with some thin dull partings and some pyrite.			0	8			34	0
8				Clay shale, light gray with limonite stain, micaceous, with thin irregular bands of coal.			4	4			33	4
7				Sandstone and shale, light gray with much limonite stain, fine to medium sandstone, shaly in basal part and grades upward into more massive sandstone, with scattered ferruginous concretions, thickness variable			19	8			29	0
6		Middle Kittanning	Middle Kittanning	Shale, gray to dark gray, argillaceous, micaceous, somewhat carbonaceous, layers of dark shale at top and bottom with numerous megaspores and some fossil plants.			1	4	9	4	9	4
5				Coal, alternate bands of bright and dull coal with much fusain and pyrite.			1	0			8	0
4				Shale, dark gray to black, carbonaceous, micaceous.			0	2			7	0
3				Coal, bright, with dull partings and some fusain.			3	2			6	10
2				Shale, dark gray, argillaceous, soft.			0	3			3	8
1				Coal, bright.			3	5			3	5
				Top of underclay								

LOCATION KEY: Ay 39 FILE NUMBER: 11481 ELEVATION: TOPO MAP: Athens

STATE: Ohio COUNTY: Athens TOWNSHIP: York SECTION: 6

LOCATION: Exposures in strip mine and prospect pit on east side of north-flowing tributary to Snow Fork in the $SE\frac{1}{4}$ $NE\frac{1}{4}$, section 6.

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
22	Conemaugh	Mahoning	Lower Mahoning	Sandstone, light gray with limonite stain and ferruginous zones, coarse, friable, exposed.			5	0	8	0	83	7
21				Clay shale, light gray to olive drab, limonite stained, arenaceous, micaceous.			3	0			78	7
20	Allegheny	Upper Freeport	Upper Freeport	Coal and clay, interbedded.			0	6	38	6	75	7
19				Clay, light gray with zone of nodular limonite at base.			2	0			75	1
18				Covered interval.			12	2			73	1
17				Shale, light gray to olive drab, sandy and micaceous, with scattered ferruginous nodules, exposed.			8	0			60	11
16				Limestone, light gray to gray with limonite stained surfaces, fossiliferous, fresh-water.			1	0			52	11
15				Clay shale, gray to light olive drab, ferruginous at bottom, starch-like fracture, fossiliferous especially in top several inches.			3	0			51	11
14				Limestone, olive drab with iron oxide stained surfaces, with crystalline masses and veins, fossiliferous, fresh-water.			0	10			48	11

LOCATION: Ay 39 FILE NUMBER: 11481 - continued

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
13	Allegheny - continued	Upper Freeport - continued	Upper Freeport - continued	Shale and clay shale, gray to light gray or olive drab with some limonite stain, micaceous and sandy, interbedded with thin layers of micaceous sandstone and calcareous ferruginous nodules.			6	0			48	1
12				Sandstone, light gray, much iron oxide stained, very ferruginous in base, thin bedded, shaly in part, lenticular variable thickness.			5	0			42	1
11		Lower Freeport	Dorr Run	Shale, dark gray to gray with some limonite stain, carbonaceous, argillaceous, somewhat fissile, micaceous, with layer of calcareous ferruginous nodules near middle, marine fossils in basal part.			5	0	37	1	37	1
10			Lower Freeport	Coal, bright with some dull streaks, much fusain, some pyrite, shaly at top.	1	3	2	10			32	1
				Shale, dark gray, argillaceous, finely micaceous, with many megaspores and some fossil plants.	0	2						
				Coal, bright with numerous thin dull partings, much fusain and some pyrite.	1	4						
				Shale, dark gray, carbonaceous, with thin coal streaks.	0	1						
9				Clay, gray to light gray, micaceous, with thin scattered carbonaceous masses and fossil plants.			1	9			29	3
8				Sandstone, light gray with limonite stain, fine to medium, micaceous, thin-bedded, exposed.			3	0			27	6
7				Clay shale, gray mottled yellowish to reddish, starch-like fracture, micaceous, thickness variable.			2	0			24	6
6				Shale, light gray to olive drab with considerable limonite stain, sandy, micaceous, thickness variable.			1	6			22	6
5				Limestone, gray, weathers light gray with a mottled and brecciated appearance and little crystalline masses and veins, ferruginous, fossiliferous, fresh-water, a nodular layer of variable thickness.			1	0			21	0
4				Shale, light gray to olive drab with limonite stain, sandy and micaceous, ferruginous, thickness variable.			1	6			20	0
3				Sandstone, light gray with some limonite stain, fine, micaceous, thin-bedded to massive, lenticular with irregular shaly layers.			7	4			18	6
2				Shale, light gray with slight iron oxide stain, sandy, micaceous, with thin lensing layers of light gray, fine, micaceous sandstone and scattered, small, siderite concretions.			11	2			11	2
1		Middle Kittanning	Middle Kittanning	Top of Middle Kittanning (No. 6) coal.			-	-			-	-

LOCATION KEY: Ay 44 FILE NUMBER: 11495 ELEVATION: 886± base TOPO MAP: Zaleski

STATE: Ohio COUNTY: Athens TOWNSHIP: York SECTION: NW¼ NW¼, 33

LOCATION: Exposure along extending northwest toward 990 road intersection which is in SW¼ of section 34.

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
21	Conemaugh	?	?	Covered interval with few exposures of shale			16	2	16	2	118	9
20		Lower Brush Creek	Lower Brush Creek	Limestone, blocks of dark gray to black, carbonaceous, fossiliferous, marine.			1	0	28	6	102	7
19				Covered interval.			5	5			101	7
18				Coal, weathered.			0	1			96	2
17				Underclay, light gray, plastic.			1	0			96	1
16				Covered interval with few exposures of shale.			21	0			95	1
15		Lower Brush Creek ?	Lower Brush Creek ?	Sandstone, yellow to buff, medium to fine, micaceous, shaly upward, ferruginous in basal 18 inches, exposed.			8	0	8	0	74	1

LOCATION: Ay 44 FILE NUMBER: 11495 - continued

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
14	Conemaugh -	Mason	Mason ?	Clay, light gray with limonite stain, plastic			1	0	29	0	66	1
13	continued		Upper Mahoning	Shale, light gray stained yellowish to brownish, sandy, micaceous.			5	6			65	1
12				Sandstone, yellowish to buff, coarse to medium becoming finer upward, micaceous, ferruginous, friable, sparingly pebbly in basal part, massive but shows some cross-bedding on weathered surfaces.			22	6			59	7
11		Mahoning	Mahoning	Coal and light gray plastic clay, interbedded			0	3	20	10	37	1
10			Thornton	Clay, light gray with iron oxide stain, especially in lower part, plastic.			1	10			36	10
9			Lower Mahoning	Shale, light gray with limonite stain along bedding and joints and especially in top 18 inches, silty, sandy, micaceous, poorly exposed in lower part.			18	9			35	0
8	Allegheny	Upper Freeport	Upper Freeport	Shale, dark gray, somewhat carbonaceous, argillaceous, weathers plastic.			2	3	9	9	16	3
7				Clay, light gray with some limonite stain, shaly, plastic.			0	3			14	0
6				Shale, yellowish to brownish, somewhat iron oxide stained, argillaceous.			1	2			13	9
5				Coal, badly weathered.			1	10			12	7
4				Shale, gray to black, sandy, micaceous, somewhat carbonaceous, some fossil plants			0	9			10	9
3				Underclay, gray to light gray with considerable limonite stain, silty, slightly micaceous, top several inches heavily impregnated with limonite.			3	6			10	0
2		Bolivar or Upper Freeport ?	Upper Freeport or Shawnee ?	Limestone, light gray to buff, nodular, thickness variable, slightly ferruginous at top, fossiliferous.			1	0	6	6	6	6
1		Bolivar ?	Bolivar ?	Underclay and shale, gray to olive drab with some iron oxide stain, silty, sandy, micaceous, somewhat plastic, more shaly below, exposed.			5	6			5	6

LOCATION KEY: Ay 9 FILE NUMBER: 11576 ELEVATION: 781± base TOPO MAP: Athens

STATE: Ohio COUNTY: Athens TOWNSHIP: York SECTION: NE¼, 29 and NW¼, 23

LOCATION: Exposure along road on north side of Minker's Run.

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
35	Conemaugh	Lower Brush Creek	Lower Brush Creek	Clay shale, light gray to brown and maroon, exposed.			5	0	7	0	158	8
34				Sandstone and shale, gray, fine to medium, micaceous sandstone and arenaceous, micaceous shale.			2	0			153	8
33		Mason	Upper Mahoning	Clay shale, maroon to purplish and dark gray.			6	2	19	7	151	8
32				Clay shale, gray drab to light gray stained by iron oxides.			1	4			145	6
31				Shale, gray stained by iron oxides, arenaceous, micaceous.			7	0			144	2
30				Sandstone and shale, gray, medium, micaceous, bedded and cross-bedded sandstone and arenaceous micaceous shale.			5	1			137	2
29		——— ? ——— Mahoning	Upper ? and Lower Mahoning	Sandstone, gray, medium to coarse, micaceous, argillaceous, friable, massive with 4 to 5 feet of gray drab, arenaceous and micaceous shale about 20 feet above base, with irregular calcareous zones or masses, base disconformable.			54	3	54	3	132	1

LOCATION: Ay 9 FILE NUMBER: 11576 - continued

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
28	Allegheny	Upper Freeport	Upper Freeport	Coal, weathered, thickness variable.			1	8	16	4	77	10
27				Underclay, light gray with limonite stain, with limonite concretions in basal part, plastic.			3	8			76	2
26				Shale and sandstone, gray stained by limonite, micaceous, arenaceous.			11	0			72	6
25		Bolivar	Bolivar and Shawnee	Underclay or clay shale, light gray.			1	6	14	7	61	6
24				Limestone, gray to buff, nodular, embedded in gray clay shale, fossiliferous, freshwater.			2	0			60	0
23			Bolivar	Shale and sandstone, gray stained by iron oxides, micaceous, sandy shale and thin bedded, micaceous sandstone.			11	1			58	0
22		Lower Freeport	Dorr Run	Shale, light gray, argillaceous.			0	3	21	2	47	11
21				Shale, dark gray to black with some limonite stain, carbonaceous and argillaceous.			7	0			47	8
20				Shale, gray to dark gray, argillaceous, carbonaceous, with scattered limonite concretions.			1	0			40	8
19				Shale, dark gray to black with surfaces stained by limonite, argillaceous, carbonaceous, fossiliferous, marine.			1	6			39	8
18			Lower Freeport	Coal, canneloid, shaly at top, some bright.			0	6			38	2
17				Shale, dark gray to black, argillaceous, carbonaceous with thin streaks of coal.			0	3			37	8
16				Coal, canneloid, shaly, some bright.			0	7			37	5
15				Underclay, light gray, plastic.			0	10			36	10
14				Shale, gray, arenaceous, micaceous.			8	3			36	0
13				Sandstone, yellowish to brownish, fine to medium, micaceous, thickness variable.			1	0			27	9
12		Upper Kittanning	Upper Kittanning	Shale, gray stained by iron oxides, argillaceous.			0	4	17	4	26	9
11				Shale, dark gray, carbonaceous, arenaceous, coal horizon.			0	3			26	5
10				Underclay, gray, micaceous, plastic.			1	0			26	2
9				Shale, gray stained by iron oxides, micaceous, arenaceous, with scattered flat limonite concretions.			15	2			25	2
8				Shale, gray.			0	7			10	0
7		Middle Kittanning	Middle Kittanning	Coal, weathered.			1	0	9	5	9	5
6				Shale, gray.			0	3			8	5
5				Coal, weathered.			3	6			8	2
4				Shale, gray.			0	1			4	8
3				Coal, weathered.			1	1			4	7
2				Underclay, light gray stained by iron oxide, plastic.			I	0			3	6
1			Snow Fork ?	Shale, gray, stained by iron oxides, arenaceous, micaceous, with small limonite concretions, exposed.			2	6			2	6

LOCATION KEY: Ay 51 FILE NUMBER: 11595 ELEVATION: 688± base TOPO MAP: Athens

STATE: Ohio COUNTY: Athens TOWNSHIP: York SECTION: SE¼ NE¼, 30

LOCATION: Exposure beginning on north side of Route 33 about 750 feet west of Daugherty Drive in Nelsonville and directlybelow St. Mary Hospital and continues up road west of hospital to cliff back of hospital.

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
31	Allegheny	Middle Kittanning	Middle Kittanning	Sandstone, light gray with limonite stain, micaceous, fine-grained, thin-bedded throughout, exposed.			3	0	5	6	102	11
30				Shale, gray, silty, sandy, micaceous, with scattered limonite nodules.			2	6			99	11

LOCATION: Ay 51 FILE NUMBER: 11595 - continued

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
29	Allegheny - continued	Strasburg	Oak Hill	Clay shale, gray weathers plastic and with limonite stain, micaceous, scattered fossil plants and limonite nodules, thin coal at base.			4	6			97	5
28			Strasburg	Sandstone, similar to unit 26 below but more massive.			7	6			92	11
27				Shale, pale greenish gray, micaceous with scattered limonite nodules, thickness variable.			2	6			85	5
26				Sandstone, light gray, fine-grained, micaceous, bedded and cross-bedded.			3	6			82	11
25				Shale, light yellow, silty, sandy, micaceous, with small scattered limonite nodules, zone of plastic clay at top.			1	0			79	5
24				Shale, light gray.			1	1			78	5
23		Lower Kittanning	Lower Kittanning	Clay shale, dark gray, carbonaceous.			0	3	12	2	77	4
22				Clay, gray with limonite stain, silty, micaceous.			1	6			77	1
21				Clay, light gray with slight limonite stain, plastic.			1	3			75	7
20				Clay, gray to dark gray, breaks irregularly			1	0			74	4
19				Clay shale, dark gray to black.			0	6			73	4
18				Clay shale, dark gray with light limonite stain, micaceous, soft, weathers plastic.			1	10			72	10
17				Coal, bright and dull, some fusain.	0	4	2	2			71	0
16				Clay shale, gray to dark gray.	0	1					70	8
15				Coal, bright with dull streaks, dull upward.	1	9					70	7
14				Underclay, light gray, plastic, mostly covered.			5	10			68	10
13		Lawrence and Scrubgrass	Scrubgrass (Ferriferous)	Shale, light greenish gray with some limonite stain, silty, micaceous, more silty and also sandy toward top, grainy, nodular ironstone at top.			8	10	8	10	63	0
12		Clarion	Clarion	Clay and clay shale, light gray with limonite stain, silty, sandy, micaceous, bedded, weathers somewhat plastic.			1	10	26	0	54	2
11			Canary ?	Ironstone, nodular limonite with grainy texture embedded in clay shale.			2	3			52	4
10			Clarion	Shale, similar to that between clays below, unit 8, less ferruginous, thickness variable			0	6			50	1
9				Clay, light gray with yellowish stain, plastic			0	2			49	7
8				Shale, light greenish gray, argillaceous, ferruginous upward, micaceous, poorly laminated.			1	4			49	5
7				Underclay, light gray with some limonite stain and some coaly material, plastic.			0	3			48	1
6				Sandstone, light gray mostly weathered yellowish brown, micaceous, fine-grained, bedded in layers 1/8 to several inches thick, one calcareous zone, upper layers somewhat heavier and lenticular but shaly at extreme top.			18	10			47	10
5		Ogan ?	Ogan ?	Covered interval.			13	10	21	0	29	0
4				Sandstone, dull, yellowish brown, micaceous, fine-grained, massive, showing irregular bedding on weathered surfaces, exposed, possibly float boulder.			1	6			15	2
3				Shale, similar to that below but more silty and apparently without fossils, with small scattered limonite nodules, becomes sandy upward, exposed.			5	8			13	8
2		Brookville	Putnam Hill	Shale, gray, mostly weathered yellowish or brownish, micaceous, base sandy, remainder clayey and silty, few scattered ferruginous nodules fossiliferous, marine.			3	10	8	0	8	0
1			Homewood	Sandstone, light gray to white with slight limonite stain, fine-grained, micaceous, thin somewhat irregularly bedded, weathers into small thick plates, base not exposed and top rises westward along Route 33, exposed.			4	2			4	2

LOCATION KEY: Ay 41 FILE NUMBER: 11650 ELEVATION: 748± base TOPO MAP: Athens

STATE: Ohio COUNTY: Athens TOWNSHIP: York SECTION: 7

LOCATION: Exposure up road from township line into York Township, section 7, from 726 road intersection.

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
20	Conemaugh	Anderson	Portersville	Clay shale, gray,and limestone, fossiliferous.			2	0	54	0	174	2
19			Anderson	Coal, shaly, with fusain, badly weathered.			0	10			172	2
18			Anderson ?	Covered interval.			14	2			171	4
17				Sandstone and shale, light gray, micaceous, interbedded.			10	0			157	2
16				Shale, light gray, micaceous, sandy, limonite stain.			4	5			147	2
15			Bloomfield ?	Limestone, gray, with reddish ferruginous patches, nodular, fresh-water.			0	6			142	9
14			Bakerstown	Shale and sandstone, buff and reddish, mottled shale with lenses of massive sandstone poorly exposed.			8	3			142	3
13				Sandstone, light gray, limonite stained, friable, micaceous, thin-bedded, weathered			6	0			134	0
12				Shale, olive drab, weathered, poorly exposed.			7	10			128	2
11		Wilgus	Cambridge	Limestone, greenish gray to red, mottled, sandy and micaceous, thin-bedded.			1	2	38	2	120	2
10			Buffalo	Shale, light gray, limonite stained, micaceous			12	0			119	0
9				Sandstone, light gray, limonite stained on surface, calcareous, rounded appearance, with limy patches.			1	10			107	0
8				Sandstone, light gray, limonite stained, with shale partings, micaceous, massive.			13	2			105	2
7				Shale and sandstone, olive drab, limonite stained, shale with thin bedded micaceous sandstone.			10	0			92	0
6		Upper Brush Creek	Upper Brush Creek	Shale, gray to light gray, limonite stained, with scattered ferruginous masses, fossiliferous.			20	4	20	4	82	0
5		Lower Brush Creek	Lower Brush Creek	Limestone, dark blue-gray, shaly at top, with some coalified plant material enclosed			0	8	17	8	61	8
4				Shale, olive drab, limonite stained, micaceous, sandy, poorly exposed.			17	0			61	0
3		Mason	Mason	Coal, shaly, badly weathered, poorly developed.			0	5			44	0
2		——?——	Upper Mahoning	Covered in part, with exposure of slumped Thornton clay.			30	5	——?——		43	7
		Mahoning	Thornton									
1			Lower Mahoning	Sandstone, light gray, limonite stained, medium, micaceous, massive, grades to shaly sandstone at top, exposed.			13	2			13	2

LOCATION KEY: Ay 43 FILE NUMBER: 11652 ELEVATION: 739± base TOPO MAP: Athens

STATE: Ohio COUNTY: Athens TOWNSHIP: York SECTION: NW¼ NE¼, 2 and SW¼ SE¼, 3

LOCATION: Exposures in strip mine of Wharton Coal Co., north side of Route 33.

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
17	Conemaugh	Mason	Upper Mahoning	Sandstone, gray to tan, limonite stained, fine to medium, exposed at top of high wall.			3	0	3	0	33	3
16		Mahoning	Thornton	Clay, light gray, mottled purplish, somewhat plastic.			4	6	24	6	30	3
15			Lower Mahoning	Sandstone, gray to tan, limonite stained, micaceous, fine to medium, somewhat bedded.			18	0			25	9
14				Clay shale, gray to blue-gray, silty to sandy upward, micaceous, variable.			2	0			7	9

LOCATION: Ay 43 FILE NUMBER: 11652 - continued

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
13	Allegheny	Upper Freeport	Upper Freeport	Coal, quite variable in short distance, bright to shaly, numerous pyrite lenses and thin irregular shale partings.	1	3	5	9	5	9	5	9
12				Coal, mostly bony, some bright streaks.	0	4					4	6
11				Shale, coaly, some scattered bright zones.	0	0½					4	2
10				Coal, bright, crumbly.	1	0½					4	1½
9				Clay shale, gray, slightly silty, variable.	0	3					3	1
8				Coal, bright, blocky.	0	1½					2	10
7				Shale, parting, irregular.	0	0¼					2	8½
6				Coal, bright, blocky.	0	1½					2	8¼
5				Fusain parting.	0	0¼					2	6¾
4				Coal, bright, blocky, some scattered pyrite masses.	0	11					2	6½
3				Fusain parting.	0	0½					1	7½
2				Coal, bright, blocky.	1	1					1	7
1				Clay shale, dark to light gray, exposed.	0	6					0	6

LOCATION KEY: Ay 60 FILE NUMBER: 12478 ELEVATION: 703 ± base TOPO MAP: Zaleski

STATE: Ohio COUNTY: Athens TOWNSHIP: York SECTION: SW¼ SW¼, 36

LOCATION: Vaughn strip mine on Parsons farm north of Route 33 and east side of tributary valley.

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
39	Allegheny	?	?	Clay shale, much weathered, somewhat plastic, exposed.			1	0			181	6
38		Lower Freeport	Dorr Run	Shale, black, fissile, fossiliferous, marine, thickness estimated			0	3	53	8	180	6
37			Lower Freeport	Coal, almost completely weathered, black and sooty, thickness estimated.			0	5			180	3
36				Clay, light to dark gray at top, silty, micaceous, moderately plastic.			4	0			179	10
35				Zone of shale and ironstone nodules. Shale is light gray, bedded, slightly micaceous, nodules of ironstone less abundant than below.			9	0			175	10
34				Zone of shale, clay, and ironstone, nodules with calcareous veins, rather massive.			11	6			166	10
33				Sandstone, light gray, weathers tan, fine-grained, micaceous, massive to thin-bedded, irregular limonite deposits along joints and bedding planes. Thickness is variable with irregular top.			15	6			155	4
32		Upper Kittanning ?	Upper Kittanning ?	Shale, tan to light gray, massive, breaks with starch-like fracture, has the appearance of flint-clay, considerable limonite stain on surface, limonite deposit along bedding and joint planes, light gray zone at top 6 inches thick, does not effervesce.			13	0	13	0	139	8
31		Middle Kittanning	Middle Kittanning	Clay shale, medium gray, slightly silty, contains plant fragments, stained brown along bedding planes			2	0	9	4	121	8
30				Coal, much weathered, coal and clay interbedded, shaly weathered coal, some bright coal.			0	4			119	8
29				Underclay, light gray to gray with considerable limonite stain, some carbonaceous fragments, very plastic.			1	0			119	4
28				Shale and sandstone, variable shale ranging from gray and finely micaceous in basal two feet to tan and buff shale and fine sandstone above, thickness varies from 5 to 8 feet.			6	0			118	4

LOCATION: Ay 60 FILE NUMBER: 12478 - continued

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
27	Allegheny -	Strasburg	Strasburg	Coal, shaly, some bright, locally present.			0	2	16	2	112	4
26	continued		Oak Hill and Hamden	Underclay and limestone, clay variably dark gray to light gray, massive with numerous slickensides with irregular starch-like fracture, thickness of clay variable, ranging from 7 feet to 12 feet, locally with lenses of gray to light gray, dense to partly crystalline limestone, limestone lenses occur where clay is thickest and in upper half of clay.			8	0			112	2
25			Strasburg	Sandstone and shale, light gray, fine grain, very micaceous, bedded to irregularly interbedded sandstone with beds of gray sandy shale, thickness of this zone and overlying clay is variable, where one thickens, the other thins and visa-versa .			8	0			104	2
24		Lower Kittanning	Lower Kittanning	Shale, dark gray to black, similar to shale below except lighter in color and irregular layers of flattened ironstone nodules; sometimes cut out by overlying sandstone.			1	3	18	7	96	2
23				Shale, black, bony, carbonaceous, fissile, either selenite crystals or mica flakes are present on bedding planes, thickness variable.			0	5			94	11
22				Coal, bright, blocky, with thin irregular partings including fusain and considerable pyrite, local irregular partings of shale.			2	3			94	6
21				Underclay, light gray and sandy below, becoming darker and carbonaceous above.			9	10			92	3
20				Sandstone, light gray, with some limonite stain, shaly appearing, fine, micaceous, massive, shows bedding on weathering, exposed, scattered grainy ironstone masses at top represents Ferriferous.			4	10			82	5
19		Clarion ?	Clarion ?	Covered interval.			7	10	16	9	77	7
18				Sandstone, similar to sandstone beneath underlying underclay, exposed.			3	6			69	9
17				Underclay, light gray with some limonite stain, micaceous, plastic.			2	1			66	3
16				Sandstone, similar to sandstone below underlying shale, slightly more micaceous, shaly towards top.			3	4			64	2
15		Winters ?	Winters ?	Shale, gray, much stained yellowish brown, slightly sandy below and carbonaceous and clayey at top, a coal zone ?			1	9	3	2	60	10
14				Sandstone, light gray with buff limonite stain, fine, micaceous, heavily bedded.			1	5			59	1
13		Ogan	Zaleski	Shale, medium gray with much limonite stain, micaceous, with several zones of flattened ferruginous concretions, very sparingly fossiliferous, marine.			1	4	22	8	57	8
12			Ogan	Shale and sandstone, gray, sandy, silty, micaceous shale with considerable limonite stain especially along joints, shale grades upward through shaly sandstone into similarly colored medium-grained, micaceous, arkosic, heavy-bedded sandstone at top.			21	4			56	4
11		?	?	Covered interval.			17	3	17	3	35	0
10		Brookville	Putnam Hill	Clay shale, gray with some limonite stain, much weathered and probably slumped, exposed.			1	0	6	2	17	9
9			Brookville	Coal, badly weathered, slumped.			0	2			16	9
8				Underclay, dark gray below to light gray above, sandy, micaceous, carbonaceous below but becomes less so above, shaly in bottom, becomes more plastic upward.			3	0			16	7
7			Homewood	Sandstone, very light gray, stained yellow to brown on surface, few plant fragments, medium to coarse-grained, sparingly micaceous, one massive bed, powdered kaolin between quartz grains ?			2	0			13	7

LOCATION: Ay 60 FILE NUMBER: 12478 - continued

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
6	Pottsville	Tionesta ?	Tionesta ?	Underclay, gray to light gray, silty, slightly sandy, micaceous, moderately plastic, dark carbonaceous zone in basal 6 inches.			1	3	11	7	11	7
5				Shale, black, fissile, carbonaceous, scattered plant fragments, finely micaceous.			2	9			10	4
4				Sandstone, gray with some limonite stain, shaly appearing, fine to medium, mostly fine, micaceous, silty, many plant fragments, 1-2-inch layer of heavier sandstone at top.			0	10			7	7
3				Shale, dark gray to black, carbonaceous, finely micaceous, silty and clayey.			0	2			6	9
2				Underclay, gray to light gray, silty, micaceous, and sandy toward base, slickensided, only moderately plastic, somewhat bedded.			1	5			6	7
1				Sandstone, very light gray with much limonite stain, fine to medium, micaceous, bedded in alternate zones of fine, silty, shaly appearing zones up to one foot thick and of fine to medium zones up to 18 inches thick, few ripple marks and plant fossils, exposed. Base of exposure.			5	2			5	2

LOCATION KEY: Ay 52 FILE NUMBER: 14264 ELEVATION: 696 ± base TOPO MAP: Zaleski

STATE: Ohio COUNTY: Athens TOWNSHIP: York SECTION: SW¼ NW¼, 30

LOCATION: Exposure up steep slope on north side of Route 33 and below abandoned No. 6 coal mines about 0.6 mile west of Dorr Run.

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
13	Allegheny	Lower Freeport	Lower Freeport	Sandstone, mostly weathered yellowish to brownish with some reddish at base, medium-grained, micaceous, ferruginous, massive showing bedding on weathered surfaces, shale parting 15 inches above base, exposed.			20	11	20	11	164	0
12		Middle Kittanning	Middle Kittanning	Coal, bright, blocky, thin dull partings including fusain and pyrite, exposed.			1	0	23	10	143	1
11				Covered interval.			22	10			142	1
10		Strasburg	Oak Hill	Underclay, light gray with some limonite stain, ferruginous base, plastic.			5	5	20	2	119	3
9			Strasburg	Shale, sandstone, and covered interval; shale, light gray with some limonite stain, silty, micaceous and fine-grained, micaceous, bedded sandstone, poorly exposed.			14	9			113	10
8		Lower Kittanning	Lower Kittanning	Coal, badly weathered.			1	2	16	1	99	1
7				Underclay, light gray with some limonite stain, sandy, plastic, slumped, base uncertain and thickness may be less than indicated.			10	3			97	11
6		?		Shale, light gray mostly stained yellowish to brownish or reddish, sandy, and micaceous with sandstone zones below, becomes clayey upward.			4	8	?		87	8
5		Clarion ?	Clarion ?	Sandstone, variable, light gray, mostly weathered yellowish to brownish, fine below and fine to medium above, micaceous, massive in upper and lower parts, thin-bedded or cross-bedded in middle, zone of small ferruginous concretions and shale pebbles near middle, friable in part.			36	5	36	5	83	0
4		?	?	Covered interval			8	9	8	9	46	7
3		Brookville	Putnam Hill	Clay shale, gray with some limonite stain, silty, sandy, micaceous, laminated, fossiliferous, marine, exposed.			0	5	37	10	37	10
2			Brookville	Underclay, light gray with some dark gray scattered near base of exposure and with some limonite stain, micaceous, sandy toward base, possibly somewhat slumped, exposed.			6	5			37	5
1	?	?	?	Covered interval			31	0			31	0

LOCATION KEY: Ay 54 FILE NUMBER: 14266 ELEVATION: 693 ± base TOPO MAP: Zaleski

STATE: Ohio COUNTY: Athens TOWNSHIP: York SECTION: NW¼ NW¼, 35

LOCATION: Exposure on north side of Hocking Valley and of Route 33 just east of Athens-Hocking County line.

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
4	Allegheny	Brookville	Homewood	Sandstone, light gray with limonite stain, micaceous, massive, medium to fine-grained, not well exposed, unmeasured.			-	-			-	-
3	Pottsville	Tionesta	Tionesta	Shale, black, carbonaceous, thin-bedded.			1	1	13	8	13	8
2				Underclay, light gray to gray with limonite stain, micaceous, plastic.			1	2			12	7
1				Sandstone, light greenish gray with limonite stain, micaceous, thin-bedded to blocky, argillaceous at top, base not exposed.			11	5			11	5

LOCATION KEY: Ay 46 FILE NUMBER: 14268 ELEVATION: 795± base TOPO MAP: Athens

STATE: Ohio COUNTY: Athens TOWNSHIP: York SECTION: SW¼ NW¼, 24

LOCATION: Exposure about 1/8 mile northeast of St. Mary Hospital and just northeast of small reservoir. Exposure is recently graded hillside on north side of Pine Drive, Nelsonville, Ohio.

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
22	Allegheny	Bolivar	Shawnee	Limestone, light gray with some faint limonite stain, massive blocks with brecciation apparent on some weathered surfaces, fossiliferous (Spirorbis). Slope steepens above Upper Freeport limestone and Lower Mahoning sandstone exposed in freshly exposed roadway short distance to northwest.			1	3	21	5	61	10
21			Bolivar and Shawnee	Underclay, light gray with some limonite stain, few large nodules of ferruginous limestone at top, somewhat slumped and weathered, rather plastic.			4	6			60	7
20			Bolivar	Shale, limonite stained, micaceous, sandy toward top; ferruginous in base.			4	9			56	1
19				Underclay and clay shale, limonite crusts and stain and limonite nodules.			4	1			51	4
18				Shale and clay shale, slightly carbonaceous, thin zone of light plastic clay, limonite stain.			3	3			47	3
17				Shale and clay shale, limonite stained.			3	7			44	0
16		Lower Freeport	Dorr Run	Shale, gray to dark gray, argillaceous, carbonaceous, fossiliferous, marine.			0	6	18	3	40	5
15			Lower Freeport	Coal, some bright, much fusain, some pyrite, badly weathered.	1	0	1	5			39	11
14				Clay shale, dark gray, carbonaceous, micaceous.	0	1					38	11
13				Coal, shaly, some bright, much weathered	0	4					38	10
12				Underclay, gray, with some limonite stain and crusts, slightly plastic.			4	2			38	6
11				Limestone, light gray, much limonite stained, impure, ferruginous, nodular, embedded in matrix of light gray to gray impure clay.			1	10			34	4
10				Shale, light gray with considerable limonite stain, finely micaceous, scattered calcareous ferruginous nodules which are more abundant upward.			5	8			32	6
9				Shale, light gray to gray, argillaceous below and silty upward, with scattered limonite nodules up to 4 to 5 inches in diameter.			4	8			26	10
8		Upper Kittanning	Upper Kittanning	Underclay and ironstone, gray to dark gray impure clay with coaly laminae and very few scattered, flattened, ferruginous nodules			0	6	14	2	22	2
7				Underclay and ironstone, light gray to gray impure clay with scattered limonite nodules			0	10			21	8
6				Underclay, light and dark gray, sharply separated in irregular masses and streaks, flinty, impure.			0	10			20	10
5				Shale and sandstone, gray to light gray, sandy, silty shale (more silty upward), micaceous shale interbedded with lighter gray, silty, micaceous sandstone.			12	0			20	0

LOCATION: Ay 46 FILE NUMBER: 14268 - continued

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
4	Allegheny - continued	Middle Kittanning	Middle Kittanning	Shale, gray with some limonite stain, black carbonaceous fragments and fossil plants, silty, micaceous.			5	6	8	0	8	0
3				Shale, black, bony, carbonaceous			0	10			2	6
2				Coal, bright and dull interbedded, shaly and bony upward with only bright streaks exposed (upper bench or supplemental bench).			1	8			1	8
1				Clay shale, dark gray, unmeasured.			-	-				

LOCATION KEY: Ay 49 FILE NUMBER: 14269 ELEVATION: 709 ± base TOPO MAP: Athens

STATE: Ohio COUNTY: Athens TOWNSHIP: York SECTION: SW¼ NE¼, 30

LOCATION: Exposure in small pit on east side of Dorr Run Valley road about 0.15 mile northwest from junction with abandoned part of Route 33.

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
6	Allegheny	Clarion ?	Clarion ?	Sandstone, weathered yellowish brown, silty, micaceous, shaly appearing below to thin bedded in layers up to 2 inches above, fine to medium grained, grades into shale below, exposed.			5	0	9	10	21	3
5				Shale, mostly weathered yellowish brown, silty, sandy, micaceous, grades upward into sandstone, with few scattered limonite nodules.			4	10			16	3
4		Brookville	Putnam Hill ?	Shale, gray, weathering light yellowish to grayish brown, argillaceous at base, similar to marine shale below but without apparent fossils, more silty and micaceous upward, no sharp top or bottom limits, with few scattered limonite nodules.			6	0	11	5	11	5
3			Putnam Hill	Clay shale, gray with some limonite stain, with few small scattered limonite nodules, sparingly fossiliferous, marine.			1	0			5	5
2			Brookville	Clay, light gray, micaceous, sandy, plastic, more sandy downward and grades sharply into underlying sandstone.			0	5			4	5
1			Homewood	Sandstone, light gray to almost white, weathers gray with slight limonite stain, fine to medium-grained, micaceous, massive, weathering into thin layers, especially toward top, exposed.			4	0			4	0

LOCATION KEY: Ay 50 FILE NUMBER: 14272 ELEVATION: 705 ± base TOPO MAP: Athens

STATE: Ohio COUNTY: Athens TOWNSHIP: York SECTION: NE¼ NW¼, 24

LOCATION: Composite exposed section from several small gullies and in mine entrance to Middle Kittanning (No. 6) coal near north edge of Nelsonville on opposite sides of William Street.

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
18	Allegheny	Lower Freeport	Lower Freeport	Sandstone, light gray with considerable limonite stain, fine to medium-grained, micaceous, exposed thickness estimated.			15	0	15	0	100	8
17		Upper Kittanning	Upper Kittanning	Coal, shaly appearing, limonite stained somewhat weathered.			0	8	6	10	85	8
16				Underclay, light gray, somewhat plastic.			0	2			85	0
15				Shale, dark gray, lighter gray above, carbonaceous below.			6	0			84	10
14		Middle Kittanning	Middle Kittanning	Coal, bright, blocky, interlaminated with dull streaks containing fusain.	2	6	6	9			78	10
				Clay shale, dark gray, carbonaceous.	0	3						
				Coal, bright, blocky, with some fusain and pyrite shaly and bony upward.	2	1						
				Shale, dark gray to black, carbonaceous	0	3						
				Coal, bright, blocky, few dull streaks.	1	8						
13				Underclay, light gray, plastic, exposed.			0	3			72	1

LOCATION: Ay 50 FILE NUMBER: 14272 - continued

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
12	Allegheny -	?	?	Shale and covered interval.			29	8	29	8	71	10
11	continued	Lower Kittanning and Lawrence ?	Lower Kittanning	Coal, badly weathered, slumped.			1	2	5	8	42	2
10			Lower Kittanning - Lawrence ?	Underclay, light gray to somewhat darker at top, plastic, exposed.			4	6			41	0
9		Scrubgrass ?	Scrubgrass ?	Clay shale and covered interval, light gray mostly stained yellowish to brownish, finely micaceous, irregularly laminated, ferruginous zone (Ferriferous ?) toward top near base of overlying clay.			8	6	8	6	36	6
8		Clarion ?	Clarion ?	Coal smut.			-	-	19	11	28	0
7				Underclay, light gray with considerable limonite stain, gray in top few inches, micaceous, silty, sandy in base, plastic.			5	4			28	0
6				Sandstone and shale, light greenish to yellowish or brownish, fine to medium-grained, micaceous, clayey, thin-bedded sandstone with zones of argillaceous shale, grades upward into overlying clay.			8	10			22	8
5				Shale, light gray to light greenish gray, weathering pale yellowish brown, silty, micaceous, with argillaceous zones, bedded, with few scattered limonite masses, sandy upward.			5	9			13	10
4		Ogan ?	Zaleski ?	Ironstone, dove gray, siderite nodules up to 1 foot in maximum diameter, weathered near surface to yellowish brown limonite with few small veins of calcite.			0	6	8	1	8	1
3			Ogan ?	Shale, gray with limonite stain along joints and bedding planes, argillaceous, silty, and micaceous, laminated, rather firm, sandy at top.			6	3			7	7
2				Coal, bright, blocky, with thin laminae of fusain and pyrite, more fusain than pyrite.	0	1½	0	4			1	4
				Coal and underclay, thin laminae of shaly and bright coal interbedded with light gray clay.	0	2½						
1				Underclay, light gray with carbonaceous laminae at top, finely micaceous, laminated, not very plastic, exposed.			1	0			1	0

LOCATION KEY: Ay 48 FILE NUMBER: 14274 ELEVATION: 703±base TOPO MAP: Zaleski

STATE: Ohio COUNTY: Athens TOWNSHIP: York SECTION: SW¼ NW¼, 35

LOCATION: Exposure south of Hocking River on south side of Route 278 in gully about 0.375 mile northeast of Athens-Hocking line. Measured section starts in gully at south end of culvert - gully is at top of small rise along Route 278.

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
7	Allegheny	Brookville	Homewood	Sandstone, stained yellowish to brownish, micaceous, fine, heavy-bedded to massive, exposed.			1	6	1	6	11	2
6	Pottsville	Tionesta	Tionesta	Shale, dark gray to black, carbonaceous and coaly, clayey, weathered film of light gray, sandy clay at top.			0	1	9	8	9	8
5				Underclay, light gray to gray, slightly silty, somewhat plastic.			0	7			9	7
4				Coal, shaly, with considerable bright coal, weathered.			0	2			9	0
3				Shale, dark gray to black, argillaceous and carbonaceous, more carbonaceous upward, weathers soft.			2	8			8	10
2				Clay, light gray to gray, silty, micaceous, massive, only moderately plastic, more plastic at top.			1	8			6	2
1				Sandstone, light gray with considerable limonite stain, micaceous, fine-grained, bedded, weathers slabby, exposed.			4	6			4	6

LOCATION KEY: Ay 56 FILE NUMBER: 14301 ELEVATION: 693 ± base TOPO MAP: Zaleski

STATE: Ohio COUNTY: Athens TOWNSHIP: York SECTION: SE¼ SW¼, 36

LOCATION: Exposure along northwest side of Route 33 about 0.225 mile east of Athens-Hocking County line.

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
6	Allegheny	Brookville	Putnam Hill	Limestone, gray, dense to shaly, impure, silty, micaceous, with some septarian development, fossiliferous, marine.			0	5	14	10	14	10
5				Clay shale, gray to tan, calcareous toward top, micaceous, with fine carbon fragments, laminated, fossiliferous, marine.			2	8			14	5
4			Brookville	Underclay, light gray with much yellow stain, weathered.			0	2			11	9
3				Coal, shaly, some bright, bony toward top, much weathered.			1	0			11	7
2				Underclay, gray to dark gray, carbonaceous, soft, weathered.			0	1			10	7
1			Homewood	Sandstone, light gray with some limonite stain, medium-grained with some fine and coarse grains, micaceous, moderately porous and rather clean, with few shale pebbles, rather massive but upon weathering shows much irregular and lenticular bedding, exposed.			10	6			10	6

LOCATION KEY: Ay 57 FILE NUMBER: 14302 ELEVATION: 748 ± Base ? TOPO MAP: Athens

STATE: Ohio COUNTY: Athens TOWNSHIP: York SECTION: NE¼, 30

LOCATION: Abandoned strip mine at first tributary valley above mouth of Dorr Run on east side of Dorr Run valley. Athens County, Ohio.

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
38	Allegheny	Bolivar	Bolivar and Shawnee	Underclay and limestone, light gray, plastic clay and light nodular to massive ledge of limestone, exposed.			2	4	18	6	114	9
37			Shawnee	Limestone, light gray with limonite stain and zones, dense, partly crystalline.			0	6			112	5
36			Bolivar	Shale, olive drab, with some medium-grained sandstone, covered in part.			15	8			111	11
35		Lower Freeport	Lower Freeport	Coal, badly weathered, thickness only approximate.			1	0	22	1	96	3
34				Underclay, full gray below and lighter above but with carbonaceous streaks in upper half and much limonite stain in base, massive, plastic, more so upwards.			4	4			95	3
33				Clay shale, full gray with limonite stain and nodules, massive.			2	1			90	11
32				Ironstone, clay ironstone-limonite nodules 4-6 inches in size embedded in clay shale matrix.			1	6			88	10
31				Clay shale, light olive to gray with limonite stain and some ironstone nodules near top, well bedded.			4	0			87	4
30				Shale, olive drab with yellow limonite stain and limonite nodules, silty, thin-bedded.			10	2			83	4
29		Upper Kittanning	Upper Kittanning	Underclay, light gray, plastic.			0	0½	13	7	73	2
28				Coal, dull, shaly.			0	2½			73	1½
27				Underclay, light gray to gray with limonite stain and many carbonaceous zones, plastic at top.			0	9			72	11
26				Coal, bright, blocky.			0	5			72	2
25				Coal, dull, shaly, with much pyrite.			0	1½			71	9
24				Clay shale, full gray with limonite stain and some carbonaceous streaks, somewhat bedded with angular fracture.			1	7			71	7½
23				Shale, olive drab to gray with limonite stain, thin-bedded with zones of coaly material, plant fossils and sandstone, excellent plant fossils 8 feet from top in slightly clayey zone.			10	5			70	0½

LOCATION: Ay 57 FILE NUMBER: 14302 - continued

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
22	Allegheny - continued	Middle Kittanning	Middle Kittanning	Shale, black, carbonaceous, thin-bedded, with few plant fossils and some melanterite.			0	11	19	4	59	7½
21				Coal, some bright and blocky, shaly in part.			1	10			58	8½
20				Underclay, carbonaceous, breaks with angular fracture.			0	4½			56	10½
19				Coal, similar to that below.			2	9			56	6
18				Clay shale, firm, carbonaceous.			0	2			53	9
17				Coal, mostly bright, blocky.			1	4			53	7
16				Clay shale, light bluish gray with some limonite stain, mostly bedded, some massive and plastic.			1	0			52	3
15				Shale, light gray to olive drab with much limonite stain, silty, well bedded, similar to shale below but lacking ironstone and fossils.			3	6			51	3
14			Snow Fork	Shale, olive drab with some limonite stain, well bedded, numerous good plant fossils, carbonaceous streaks and several clay ironstone-limonite nodular layers.			1	8			47	9
13			?	Coal zone, two 1/4-inch dull, irregular coal streaks separated by clay shale.			0	5			46	1
12			Middle Kittanning	Clay shale, light gray, much stained and mottled yellow and orange, massive, somewhat plastic.			2	7			45	8
11				Sandstone, olive drab to brownish gray, heavily stained, especially at top, slightly micaceous, mostly fine, bedded to massive, ironstone nodules near top.			2	10			43	1
10		Strasburg	Oak Hill	Underclay and clay shale, similar to that above sandstone in color, massive except near top, with starch-like fracture, plastic and carbonaceous zones, grades in coal zone below.			9	6	13	5	40	3
9				Coal zone, dark gray, very carbonaceous, slickensided, starch-like fracture.			0	7			30	9
8				Underclay, gray stained in zones, expecially near base, silty, massive, starch-like fracture, plastic at top.			0	11			30	2
7			Strasburg	Sandstone, light gray weathers yellow, fine to medium, massive, micaceous, a prominent layer.			2	5			29	3
6		Lower Kittanning	Lower Kittanning	Shale dark gray to black with limonite stain especially toward top, lighter and more silty upward, carbonaceous with fossil plants and one upright tree stump, bedded, slickensided, with nodules of clay ironstone.			5	9	?		26	10
5				Coal, bright and blocky with thin dull partings, with traces of fossil plants, pyrite, and prominent limonite stain.			2	0			21	1
4		?	?	Underclay, full gray at top to lighter gray below, massive, breaks with starch-like fracture, slickensided, plastic.			18	1	?		19	1
3		Lawrence	Lawrence	Underclay and clay shale, clay grading downward light olive gray, bedded, shale somewhat limonite-stained.								
2				Shale and sandstone, olive drab with much limonite stain, silty, sandy shale with thin layers of micaceous, medium-grained sandstone.			1	0			1	0
1		?	?	Sandstone, olive drab, limonite stained, more stain toward top, massive below and bedded above, fine, micaceous, partly covered, unmeasured.			-	-			-	-

LOCATION KEY: Ay 59 FILE NUMBER: 14303 ELEVATION: 849 ± base TOPO MAP: Zaleski

STATE: Ohio COUNTY: Athens TOWNSHIP: York SECTION: Center NW¼, 36

LOCATION: Prospect pit above high wall of strip mine on northwest side of ridge.

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
10	Allegheny	Bolivar	Shawnee	Limestone float blocks			1	0	20	9	37	0
9				Covered interval			7	6			36	0
8			Bolivar	Sandstone, silty, buff, slightly micaceous, medium to coarse, exposed.			12	3			28	6
7		Lower Freeport	Dorr Run	Clay shale, buff to gray, weathered brown, clayey base, breaks with hackly fracture.			1	1	16	3	16	3
6				Shale, dark gray, carbonaceous, fossiliferous, marine.			11	8			15	2
5				Shale, black, bony, carbonaceous, fossiliferous, marine.			1	4			3	6
4			Lower Freeport	Coal, shaly.			0	5			2	2
3				Shale, black, carbonaceous.			0	2			1	9
2				Coal, bright, with dull partings, somewhat weathered.			1	7			1	7
1				Underclay, light gray, plastic, exposed, unmeasured.			-	-				

LOCATION KEY: Ay 58 FILE NUMBER: 14507 ELEVATION: 757 ± base TOPO MAP: Zaleski

STATE: Ohio COUNTY: Athens TOWNSHIP: York SECTION: 36

LOCATION: Section from floor of strip pit up high wall and to top of ridge in the SE¼ NW¼, section 36.

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
29	Conemaugh	Upper Freeport	Upper Freeport	Sandstone, tan to yellow, friable, coarse-grained, arkosic?, porous, thickness estimated.			10	0	22	0	138	0
28				Covered interval, float of fine-bedded, silty sandstone.			9	0			128	0
27				Limestone, loose, layer of large flattened nodules, medium to light gray, hard, dense, brecciated.			1	0			119	0
26				Covered interval.			2	0			118	0
25		Bolivar ?	Bolivar ?	Flint clay, white, with ferruginous zone of nodules in lower part.			1	9	14	6	116	0
24				Coal zone, dark gray to purple clay.			0	3			114	3
23				Sandstone, light olive green to buff, fine to medium grained, micaceous, shaly appearing bedding.			12	6			114	0
22		Lower Freeport	Lower Freeport	Shale, black, and weathered coal, exposed.			0	1	33	4	111	6
21				Shale, covered in part.			24	1			111	5
20				Covered interval.			9	2			87	4
19		Upper Kittanning ?	Upper Kittanning ?	Clay, light gray to dark buff, slightly plastic, exposed.			2	4	6	0	78	2
18				Sandstone, silty, shaly appearing, light olive green, slightly micaceous.			3	8			75	10
17		Middle Kittanning	Middle Kittanning	Underclay, light to medium gray, contains plant fossils in upper part, plastic toward top.			1	6	30	3	72	2
16			Snow Fork (Salem)	Limestone nodules and silty clay shale interbedded, greenish gray to dark gray, hackly fracture, limestone weathers yellow.			6	4			70	8
15			Middle Kittanning	Zone of interbedded silty sandstone and flint clay, sandstone is light olive green and flint clay is light to medium gray.			17	3			64	4
14				Sandstone, light olive green, slightly micaceous, fine-grained, shlay and contains many plant fossils in lower few inches.			5	2			47	1
13		Strasburg	Strasburg	Coal smut.			0	1	26	9	41	11
12				Underclay, light gray, plastic, contains coaly material.			0	1			41	10
11				Shale, medium gray, clayey, contains abundant small ironstone nodules, stained red.			2	9			41	9
10				Coal, shaly, weathered.			0	2			39	0

LOCATION: Ay 58 FILE NUMBER: 14507 - continued

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
9	Conemaugh -	Strasburg -	Oak Hill	Underclay, light to medium gray, plant fossils in upper part.			1	6			38	10
8	continued	continued		Sandstone, light olive green, silty, micaceous, shaly bedded, stained black on surface, becomes clayey upward, gradational contact with unit above. Contains ironstone nodules.			3	2			37	4
7				Underclay, light to medium gray, sandy in lower part, becomes darker and more clayey upward. A pinkish-colored layer through center of bed.			4	0			34	2
6			Strasburg	Shale, clayey, and quite sandy, light gray, ferruginous stain on surface, gradational with unit above.			13	6			30	2
5				Sandstone, light gray, fine-grained, micaceous, contains fossil plants, has shaly appearing beds, thin zones of ferruginous "shot", carbonaceous, some nodular appearing ferruginous zones, lenticular, thickness variable.			1	6			16	8
4		Lower Kittanning	Lower Kittanning	Shale, black, very fissile, carbonaceous, thickness quite variable.			1	6	15	2	15	2
3				Coal, blocky, thickness varies slightly, parting rather persistent about 15 inches from base of unit, some copiapite deposited on surface.			2	0			13	8
2				Clay, medium to light gray, sandy, gradational contact with unit below, becomes darker toward the top, dark gray at top. Thickness varies, approximately 8 feet at a distance 200 feet to the northeast.			4	8			11	8
1				Sandstone, white to light gray, fine to medium grained, very argillaceous, becomes more clayey towards top, micaceous, stained yellow and orange, massive appearing, 7-inch clay zone $4\frac{1}{2}$ feet from base of unit, exposed.			7	0			7	0

HOCKING COUNTY

LOCATION KEY: Hs 1 FILE NUMBER: 14263 ELEVATION: 715 base TOPO MAP: Zaleski

STATE: Ohio COUNTY: Hocking TOWNSHIP: Starr SECTION: SW¼ SE¼, 6

LOCATION: Exposure up hillside and in very small ravine, just east of National Fire Proofing Brick and Tile Plant at Diamond and above Norman's house on north side of Route 33. Base of exposure at spring 100'+ east of Norman's house.

No.	Series	Cyclothem	Member	Description	Bed Ft.	Bed In.	Member Ft.	Member In.	Cycle Ft.	Cycle In.	Total Ft.	Total In.
11	Allegheny	Clarion ?	Clarion ?	Shale, similar in appearance to shale below Zaleski marine member, no apparent marine fossils.								
10		Ogan	Zaleski	Shale, gray with considerable stain, silty micaceous, with small scattered ferruginous, fossiliferous, marine.			0	8	29	6	69	3
9			Ogan	Shale, gray, silty, sandy, micaceous, rather evenly bedded, poorly exposed.			28	10			68	7
8		Brookville	Putnam Hill	Shale and limestone, gray, bedded, fossiliferous, marine shale with laterally gray, shaly, fossiliferous, marine, locally septarian limestone.			1	0	36	9	39	9
7			Brookville	Coal, weathered.			0	3			38	9
6				Underclay, gray to light gray, plastic.			2	7			38	6
5			Homewood	Sandstone, light gray, medium to fine-grained, micaceous, thin-bedded on weathered surfaces.			14	8			35	11
4				Sandstone, light gray with some limonite stain, medium-grained, micaceous, massive showing some bedding and cross-bedding on weathered surfaces.			18	3			21	3
3	Pottsville	Tionesta	Tionesta	Clay shale, gray to dark gray with some limonite stain, weathered, soft.			0	5	3	0	3	0
2				Coal, dull, shaly, with some bright streaks			1	2			2	7
1				Coal, mostly bright, much weathered.			1	5			1	5

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BASE COMPILED FROM
THE FOLLOWING U.S. GEOLOGICAL SURVEY
TOPOGRAPHIC MAPS:

ATHENS
BELLEVILLE
CHESTERHILL
KENO
NEW LEXINGTON
PARKERSBURG
POMEROY
WILKESVILLE
ZALESKI



LOCATION OF ATHENS COUNTY, OHIO

STATE OF OHIO
C. WILLIAM O'NEILL, GOVERNOR
DEPARTMENT OF NATURAL RESOURCES
HERBERT B. EAGON, DIRECTOR
DIVISION OF GEOLOGICAL SURVEY
RALPH J. BERNHAGEN, CHIEF

GEOLOGIC MAP OF ATHENS COUNTY, OHIO

GEOLOGY BY
MYRON T. STURGEON
AND ASSOCIATES

1958

GEOLOGIC MAP COMPILED BY
GILBERT E. SMITH AND OTHERS

DRAFTING BY HAROLD J. FLINT

10,000 FOOT GRID BASED ON
OHIO COORDINATE SYSTEM,
SOUTH ZONE

LEGEND

QUATERNARY SYSTEM

RECENT

Qal — Alluvium

PLEISTOCENE

Ql — Wisconsin Lake Silts

Qtw — Wisconsin Terrace

Qti — Illinoian Terrace

PERMIAN SYSTEM

Pd — Dunkard Group (Washington-Greene Series)

PENNSYLVANIAN SYSTEM

Pm — Monongahela Series

Pc — Conemaugh Series

Pa — Allegheny Series

Pp — Pottsville Series

ADDITIONAL OUTCROP DATA

A — Outcrop of Ames limestone

M — Outcrop of Middle Kittanning coal

Scale of Miles

Contour interval 20 feet
Datum is mean sea level

GENERALIZED COLUMNAR SECTION

SERIES LITHOLOGY — NAMED MEMBERS

PLEISTOCENE

Recent Alluvium
Wisconsin Gravel Terrace and Lake Silts
Illinoian Gravel Terrace

GREENE

Dunkard Coal
Jollytown Sandstone
Jollytown Coal
Upper Washington Limestone
Hundred Sandstone
Hundred Coal
Creston Rods
Jollytown "A" Coal
Upper Moriotta Sandstone
Washington "A" Coal
Middle Washington Limestone (Upper bench)
Middle Washington Limestone (Lower bench)
Washington Rider "C" Coal
Lower Moriotta Sandstone
Washington Rider "B" Coal
Lower Washington Limestone
Washington Rider "A" Coal
Washington No. 11 Coal
Washington Clay
Washington Sandstone and Shale
Little Washington Coal
Mennington Shale and Sandstone
Upper Bench Waynesburg-A-Coal
Mt. Morris Limestone
Lower Bench Waynesburg-A-Coal
Waynesburg Shale and Sandstone
Cassville Shale
Waynesburg No. 11 Coal
Waynesburg Red Bed
Gilboy Shale and Sandstone
Little Waynesburg Coal
Waynesburg Limestone
Little Waynesburg Red Bed
Uniontown Shale and Sandstone

WASHINGTON

Uniontown No. 10 Coal
Uniontown Shale and Sandstone
Lower Uniontown Coal
Uniontown Limestone
Ditsky Red Bed
Arnoldsburg Shale and Sandstone
Arnoldsburg Coal
Arnoldsburg Limestone
Fulton Shale
Fulton Coal
Benwood Limestone and Shale
Tyler Red Bed
Sewickley Shale and Sandstone
Sewickley (Meigs Creek No. 9 Coal)
Lower Sewickley Shale and Sandstone
Lower Sewickley Coal
Fishpot Coal
Fishpot Limestone
Fishpot Red Bed
Pomeroy Shale and Sandstone
Redstone (Pomeroy) No. 8 Coal
Redstone Limestone
Redstone Red Bed

MONONGAHELA

Upper Pittsburgh Shale and Sandstone
Pittsburgh No. 8 Coal
Upper Pittsburgh Limestone
Lower Pittsburgh Shale and Sandstone
Upper Little Pittsburgh Coal
Upper Little Pittsburgh Shale and Sandstone
Lower Little Pittsburgh Limestone
Connellsville Red Bed
Connellsville Shale and Sandstone
Little Clarksburg Coal
Clarksburg Limestone
Clarksburg Red Bed
Morgantown Sandstone and Shale
Elk Lick Red Bed
Elk Lick Coal
Elk Lick Limestone
Upper Grafton Shale and Sandstone
Birmingham Red Bed
Shelley Limestone (Marine)
Duquesne Coal
Duquesne Red Bed
Lower Grafton Shale and Sandstone
Grayport Limestone (Marine)
Grayport Shale and Sandstone
Ames Limestone (Marine)
Ames Coal
Ames Shale and Sandstone
Harlem Coal
Round Knob Red Bed
Upper Pikestown Shale and Sandstone
Upper Pikestown Underclay
Ewing Limestone
Cow Run Shale and Sandstone
Woodmansee Shale and Sandstone (Marine)
Andrews Coal
Bloomfield Limestone
Dolerites Shale and Sandstone
Cambridge Limestone (Marine)
Wilgus Underclay and Coal
Buffalo Shale and Sandstone
Upper Brush Creek Limestone (Marine)
Upper Brush Creek Coal
Upper Brush Creek Shale and Sandstone
Lower Brush Creek Limestone (Marine)
Lower Brush Creek Coal
Lower Brush Creek Shale and Sandstone
Mason Shale (Marine)
Mason Coal
Upper Mahoning Red Bed
Upper Mahoning Shale and Sandstone
Mahoning Coal
Thurston Underclay
Lower Mahoning Red Bed
Lower Mahoning Shale and Sandstone
Uffington Shale
Upper Freeport No. 7 Coal
Upper Freeport Limestone
Upper Freeport Shale and Sandstone
Saltzer Underclay and Coal
Shawnee Limestone
Dorr Run Shale (Marine)
Lower Freeport No. 6A Coal
Lower Freeport Limestone
Lower Freeport Shale and Sandstone
Upper Kittanning Coal
Middle Kittanning No. 6 Coal
Snow Fork Ironstone
Strasburg Coal
Oak Hill Underclay
Oak Hill Limestone
Lower Kittanning No. 5 Coal
Lower Kittanning and Laurence Underclay
Ferriferous Ironstone
Clarion No. 4A Coal
Clarion Shale and Sandstone
Winter's Coal (?)
Zaleski Shale (Marine)
Upper Coal
Putnam Hill Limestone or Shale (Marine)
Brookville No. 4 Coal
Homewood Shale and Sandstone
Tionesta Shale
Tionesta Coal
Tionesta Underclay
Tionesta Shale and Sandstone

CONEMAUGH

ALLEGHENY

POTTSVILLE