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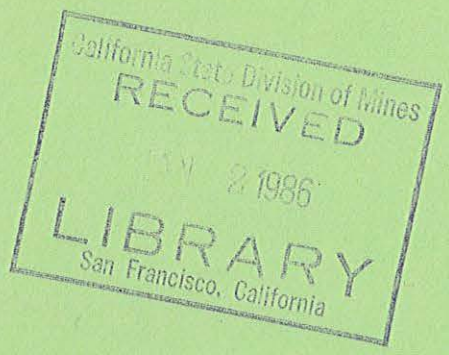
Report of Investigations No. 129



GLACIAL GEOLOGY OF COLUMBIANA COUNTY, OHIO

by
George W. White
and
Stanley M. Totten

Columbus
1985

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ABSTRACT

The northern part of Columbiana County lies in the Glaciated Plateau Section of the Allegheny Plateau, and the southern part is in the Unglaciated Plateau Section. Thus the county exhibits striking topographic contrasts from north to south. The topography ranges from a gently rolling surface at 1,100 to 1,200 feet in the north to an extensively dissected upland at 1,200 to 1,300 feet in the south.

Glaciation in Columbiana County resulted from southward expansion of ice in the Grand River sublobe of the Erie lobe. At least four ice sheets invaded the county in later Pleistocene time and an unknown number of advances occurred in earlier Pleistocene time. Early Pleistocene deposits include scattered erratics at the glacial boundary, extremely weathered till below later tills in strip mines, outwash material in terrace remnants more than 300 feet above the level of the present Ohio River at East Liverpool, and the lacustrine Calcutta Silt, which was deposited in a large proglacial lake prior to the formation of the Ohio River.

Meager deposits of Mapledale Till and outwash are referred to the Illinoian Stage of glaciation. The Mapledale Till is silty and sandy and has been deeply weathered. It is overlain by till of Wisconsinan age.

The Titusville Till of Early Wisconsinan (Altonian) age is the oldest till on the surface in Columbiana County. The southern margin of this till is the glacial boundary. Titusville Till typically is dense, stony, and sandy and oxidizes to an olive-brown color, with darker stains along joints and around pebbles. Its depth of leaching is variable, but averages 8 feet 8 inches.

North of the area of outcrop the Titusville Till generally consists of two or more units separated in most places by sand and gravel, sometimes of considerable thickness. The Kent Moraine is the zone along which the Titusville Till sheets stacked up to form the major volume of the moraine.

The Kent Till, the earliest till of Woodfordian age, is at the surface in an east-west belt 1 to 6 miles wide across the county north of the outcrop of Titusville Till. Although the younger Lavery Till overlies the Kent Till in the northern part of the county, the Kent Till is the surface till over much of the northern half of Columbiana County owing to the discontinuous nature of Lavery Till. Kent Till is sandy and pebbly, oxidizes to a yellow-brown color, and is not nearly as dense as the Titusville Till. It is leached to a depth generally between 5 and 6 feet. The Lavery Till is silty, moderately clayey, and sparingly pebbly, oxidizes to a drab-brown color, and is leached to a depth of about 4 feet. It occurs at the surface in the northern part of the county. In most places the Lavery Till is present only as isolated small patches; elsewhere the Lavery Till is either absent or so thin it is incorporated into the present soil and the surface drift appears to be Kent Till.

The major glacial landform in Columbiana County is the Kent Moraine, a wide belt of knolls 10 to 30 feet high, which extends east-west across the northern third of the county. The bulk of the material in the moraine is till or gravel of Titusville age, with a veneer of Kent Till and, in the northern part of the county, of Lavery Till as well. Prominent kames of Titusville age are present near the glacial boundary and within the Kent Moraine.

Kame terraces are well developed in many of the valleys in the glaciated portion of the county. In some valleys the terraces are at two or more levels and presumably are of more than one age. Particularly fine examples of outwash terraces are present in the valleys of Middle Fork and North Fork Little Beaver Creek, Bull Creek, and Sandy Creek.

Sand and gravel are plentiful in the northern half of the county. Most large supplies of gravel are in the kame terraces. The gravel of the kame terraces is variable in texture and composition and in some places has a covering of till which may reach many feet in thickness.

Glacial sand and gravel are important aquifers where they have sufficient extent and thickness. Areas with the greatest potential yield of ground water are the preglacial and interglacial drainage channels, which are now wholly or partially filled with glaciofluvial deposits of varying thickness.

INTRODUCTION

Columbiana County is located in central-eastern Ohio (fig. 1) and is the most northerly Ohio county to have the Ohio River as part of its boundary. The county is bounded on the north by Mahoning County, on the west by Stark County, on the south by Carroll and Jefferson Counties, on the east by Pennsylvania, and on the southeast, across the Ohio River, by West Virginia. The county lies between 80°31′ and 81°06′ west longitude and 40°35′ and 40°55′ north latitude. Columbiana County has an area of 535 square miles. Its population, according to the 1980 census, was 113,572 (Celebrezze, 1980). The largest city is East Liverpool, but Lisbon is the county seat. Other cities are Columbiana, East Palestine, Salem, and Wellsville; other municipalities are Leetonia, Salineville, and Washingtonville.

PURPOSE AND SCOPE

This report describes the glacial drift—the surface material overlying the bedrock—in the northern half of Columbiana County (pl. 1). Stratigraphy of the deposits and morphology of the landforms are described and correlated with deposits and morphologic features of bordering counties. Economic resources of the glacial drift are considered, and suggestions are made on their utilization and conservation.

This report will be of interest to various groups and individuals: geologists, highway engineers, construction firms, sand and gravel operators, architects, city planners, soil scientists, and landowners. Citizens who are or will be responsible for planning and shaping the future of Columbiana County for agriculture, urbanization, recreation, and industrialization will find this report useful in making their decisions.

PREVIOUS INVESTIGATIONS

The first report specifically on Columbiana County was by Newberry in 1878 and dealt almost entirely with the bedrock, with only a very few words on the glacial drift. Also in 1878, Stevenson, in his report on Carroll County,

FIGURE 1.—Location of Columbiana County, Ohio.

noted erratics to the north or northeast of Carroll County, that is, in Columbiana County. Earlier, Newberry (1874, map, p. 76) had shown the "margin of the area of northern drift" from Kansas to New Jersey by a line passing through Columbiana County, although the county was not specifically named. Even earlier, Whittlesey (1866) had shown the "Limits of Glacier Drift of North America" on a map of the eastern United States by a line passing across eastern Ohio just north of the Ohio River in the region of Columbiana County. This is one of the earliest maps to attempt to show the extent of glaciation in the United States (White, 1973b, p. 9).

The first detailed discussion of glacial drift in Columbiana County was in a series of papers by Wright (1884a, 1884b, 1890), who traced the glacial boundary in considerable detail and with remarkable precision across the county (Wright, 1884a, p. 227-230, pl. 8). He did note (p. 229) that "one boulder was found in the northwestern corner of Augusta Township, Carroll County," but no others were found south of the line as drawn. Chamberlin (1883, p. 341, pls. 28 and 31) showed that the glacial boundary crossed Columbiana County and that a wide end moraine (now called the Kent Moraine) marked the boundary in the western part of the county, but that "farther east, however, drift was observed from three to four miles south of . . . the moraine." Chamberlin was not sure if this outer drift was the same age as the moraine, or was earlier, but by 1890 (Chamberlin, *in* Wright, 1890, p. 34) he had come to the conclusion that the "extra moraine," or fringe drift, was indeed older than that to the north.

Leverett, in his great monograph of 1902 (fig. 15), shows the drift border passing through Lisbon, several miles north of its actual position, which had already been mapped accurately by Wright (1884a, pl. 8). Leverett mentioned the "extramorainic drift," and thought it might be of "early Wisconsin" age (p. 351). He had only general remarks elsewhere (p. 438, 451) on Columbiana County.

The comprehensive report on Columbiana County by Stout and Lamborn (1924) has a chapter on physiography that deals in great detail with present and ancient drainage lines (Map 2). Stout and Lamborn discussed erosion levels in detail (p. 36-45) and briefly discussed (p. 45-48) the glacial drift, mainly in appropriate quotations from Leverett's monograph. They considered the age of the fringe drift to be "early Wisconsin." The glacial boundary is shown very precisely on the bedrock geology map (Map 8), and the location of the boundary is described very briefly in the text (p. 46).

In a later publication (Stout, Ver Steeg, and Lamb, 1943, p. 23; map, p. 20), Stout was so impressed by the greater age of the fringe drift that he assigned it a "Kansan or pre-Kansan" age.

Field investigation by White from 1941 to 1946, but mainly in 1941, resulted in a map and report (White, 1951) of an area which included the glaciated part of Columbiana County. The borders of the older and younger drifts in eastern Ohio were mapped in detail. The younger drift was called "Wisconsin," and the older drift "Illinoian," on the basis of degree of weathering and erosion of the tills. Kame areas were described in the "Illinoian" drift, and kames and kame terraces in the "Wisconsin" drift. The belt of moraine, formerly mapped as continuous (Leverett, 1902, fig. 15), was shown as separate linear areas, but in what is now known to be a too restricted area. It was this mapping which was shown on the glacial map of the United States (Flint and others, 1945). Investigation in adjacent Pennsylvania discovered that in Pennsylvania the "Illinoian" area became wider and could be separated into two belts of differing ages, called "Inner Illinoian" and "Outer Illinoian," based on intensity of weathering and erosion of the till (Shepps and others, 1959). The "Inner Illinoian" was traced into the "Illinoian" area of Columbiana County, Ohio. Later, wood associated with "Inner Illinoian" till at Titusville, Pennsylvania, was discovered and carbon-14 analysis showed it to be about 40,000 years old. The till, therefore, could not be Illinoian in age, but was early Wisconsinan—Altonian in the Mississippi Valley terminology (White, Totten, and Gross, 1969, p. 30).

A summary report on the glacial deposits of the Allegheny Plateau (White, 1969) showed for Columbiana County and the rest of the plateau for the first time the division of late Wisconsinan till into two units, Kent and Lavery, and the "Illinoian" area as early Wisconsinan Titusville Till and Illinoian Mapledale Till. The present study shows that the area shown as Mapledale Till in the 1969 report is too wide, and indeed that the Mapledale Till is present at the surface in only a few very restricted areas. The summary report on the glacial geology of northeastern Ohio by White (1982) includes Columbiana County.

Very detailed studies of the soils of Columbiana County are reported in Lessig, Hale, and Yohn (1968) and include a summary map of the county and 93 detailed maps. The geological controls and parent materials of the soils are emphasized. The complex series of terraces on which different soils have developed have been studied in detail by Lessig (1959, 1961a, 1961b, 1964). An upland silt (Calcutta Silt) of early Pleistocene age was discovered and described by Lessig (1963). A riftlike structure at Elkton that involves bedrock and early tills has been described by Lessig and Rice (1962).

ACKNOWLEDGMENTS

This report is an outgrowth of an investigation by George W. White of the glacial geology and water resources of northeastern Ohio by the U.S. Geological Survey in cooperation with the Ohio Department of Natural Resources, Division of Water. Study of the petrography and stratigraphy of the tills was supported by grants from the National Science Foundation and the University of Illinois Research Board. Generous sharing by Heber Lessig in office conferences, in correspondence, and in field conferences of his intimate knowledge of the soils and the geological controls is gratefully acknowledged. William A. Rice gave helpful information, and Stephen R. Moran gave effective assistance to Stanley M. Totten in the field season of 1967, in which the stratigraphy of older tills was investigated.

PHYSIOGRAPHY

An excellent detailed description of the topography and relief of Columbiana County can be found in Stout and Lamborn (1924, p. 9-12); only a brief summary is given here.

Columbiana County lies in two sections of the Allegheny Plateau. The northern part is in the Glaciated Plateau Section, and the southern part is in the Unglaciated Plateau Section (fig. 2). The county is thus an area of topographic contrasts. The northern row of townships ranges from a very gently rolling surface at 1,100 to 1,200 feet with slopes of less than 20 to about 50 feet per mile to smoothly rounded hills and rolling upland at 1,200 to 1,300 feet with a local relief of 100 feet or more within a mile in the central-northern and northeastern part of the county. The valleys of Little Beaver Creek and its tributaries are cut more than 200 feet below the upland. The row of townships south of the northern tier is covered in large part by older drift, and the hills are sharper, some rising to almost 1,400 feet.

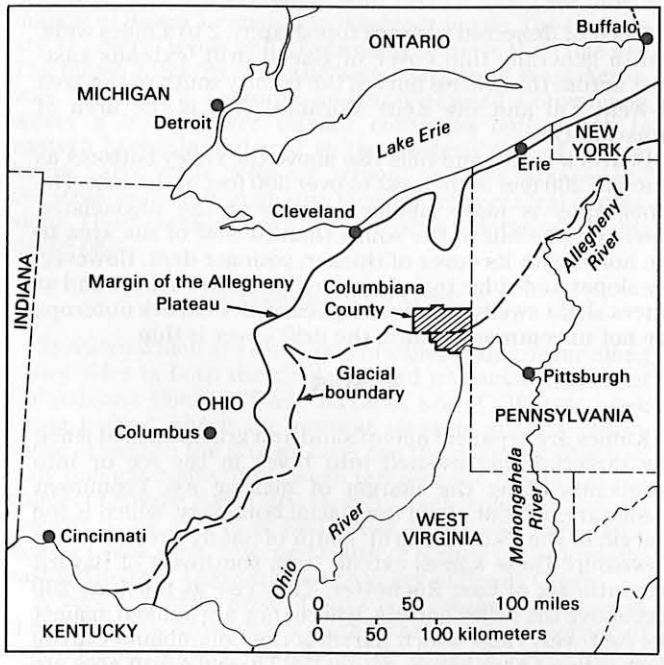


FIGURE 2.—Location of margin of Allegheny Plateau and glacial boundary in Ohio and Pennsylvania and position of Columbiana County (modified from White, 1969, fig. 1).

The southern half of the county is a dissected plateau with varying amounts of gently rolling uplands, which decrease in proportion near the Ohio River. The uplands range from about 1,200 to 1,300 feet, but the highest hill, Round Knob, in Madison Township, is 1,446 feet in elevation. The lowest elevation is where the Ohio River leaves the county, at an elevation of 665 feet (normal pool elevation of Ohio River).

"The ridges, broad and flat, rise to a rather uniform height of about 1,270 feet above tide" (Stout and Lamborn, 1924, p. 38-40). This upland level was interpreted as the remnants of the Harrisburg peneplain, which formerly extended across this and adjacent counties. Small areas, with a combined area for the whole county of 22 square miles, rising above this level were interpreted as unconsumed areas of an even earlier erosion level. Below the Harrisburg peneplain, a less well developed erosion level at about 1,120 to 1,140 feet was identified as the Worthington peneplain (Stout and Lamborn, 1924, p. 41-42). Valleys as much as a mile wide were cut from 100 to 150 feet below the Worthington level. These wide valleys were interpreted as the Parker Strath (a very incomplete peneplain). Present streams now flow from a few feet below the strath level in the headwater areas to over 200 feet below in their lower courses. The best examples of relatively undissected Parker Strath are in the valley of West Fork Little Beaver Creek in Wayne and Madison Townships. It is probable that the wide part of the Mahoning River valley in Knox Township, the headwater area of Bull Creek east of Columbiana, the headwater area of North Fork Little Beaver Creek in Unity Township, the wide valley at East Palestine, the valley of Middle Fork Little Beaver Creek downstream from Elkton, and the wide valley at the confluence of North Fork Little Beaver Creek and Bull Creek at Negley and for 2 miles south are Parker Strath areas now more or less thickly covered by glacial deposits.

BEDROCK

The bedrock of Columbiana County is composed of essentially flat-lying strata of the Pennsylvanian System. The uppermost part of the Pottsville Group, all of the Allegheny Group, and much of the Conemaugh Group are represented above drainage. The strata are mainly sandstone and shale, but include a few thin limestone beds, some very important clay members, and important coal beds. These strata and their economic importance have already been described in great detail by Stout and Lamborn (1924, p. 49-355).

MODERN DRAINAGE

All of the drainage from Columbiana County finds its way, directly or indirectly, to the Ohio River. The stream courses are described in detail by Stout and Lamborn (1924, p. 12-18). The Mahoning River drains the northwestern part of the county. The headwaters of Sandy Creek drain the southwestern part. The extreme southern part is drained by North Fork Yellow Creek and Brush Creek. The remainder and the largest part of the county is drained by the West, Middle, and North Forks of Little Beaver Creek, which join in the southeastern part of the county to flow south to the Ohio River near the southeastern corner of the county.

EARLY DRAINAGE SYSTEMS

The advent of glaciation during the Pleistocene Epoch disrupted the drainage by damming streams, filling valleys with drift, and diverting water across divides into other drainage systems. Each glacial advance caused new diversions, and the modern drainage is a composite of the successive diversions. The sequences of drainage changes are difficult to discuss on the basis of a single county. The changes in Columbiana and adjacent counties, as well as in bordering Pennsylvania, have been discussed in great detail and illustrated on a map by Stout and Lamborn (1924, p. 18-36), so that only a general summary will be given here.

At the onset of the Pleistocene, after the wide Parker Strath valleys had been cut, a very early divide passed east-west across the northern part of the county, so that the streams flowed north from the northern townships. South of the divide, early streams flowed west-southwest from the southwestern part, and generally east-southeast and east from the central and southeastern parts. Diversions at various times reversed the northward-flowing streams, which cut across the divide and now flow southward in valleys of varying widths, attesting to the different lengths of time the streams have been flowing across the old divide. At least one stream course across the old divide is not now occupied by a stream. This is the spectacular double gorge south of Chambersburg in secs. 9 and 16, West Township. Sandy Creek has the widest valley, and was probably diverted in early Pleistocene time. The valleys of West Fork Little Beaver Creek, Bull Creek, Cold Run, and Leslie Run are gorges across the divide and represent later diversions. The early Ohio River itself flowed northward, then eastward, and again northward to the Lake Erie basin, but was diverted to a southerly course when dammed by a very early ice sheet (Leverett, 1902, p. 88-98; Stout and Lamborn, 1924, p. 19-23; Stout, Ver Steeg, and Lamb, 1943, p. 73, 94).

Some of the ancient valleys in the northern part of the county were partly or wholly filled with drift. The bedrock contours on the accompanying map show well these partly or wholly buried valleys. The Mahoning River flows in an ancient valley now filled by 150 feet or more of glacial deposits. Several buried valleys are present from Columbiana west to beyond Leetonia. The old valley from Lisbon to Guilford Lake is almost completely filled with drift in places, and West Fork Little Beaver Creek and Cold Run flow across it. These filled valleys are important economic assets as sources of ground water, and large supplies may be obtained from them where the material has suitable permeability and porosity. The filled valleys receive recharge not only from direct rainfall, but also from infiltration from streams flowing along or across them.

GLACIAL GEOMORPHIC FEATURES

The surface expression of the drift of the glaciated part of Columbiana County is not the result of a single advance or retreat of the ice, but has been produced by two to four or more ice advances. Most of the separate constructional features owe their origin to deposition by more than one ice sheet, so that the geomorphology of the drift surface is best described separately, rather than in connection with the character and arrangement of the material.

KENT MORAINE

The major glacial landform in Columbiana County is the wide Kent Moraine, which lies east-west across the northern third of the county and extends north into Mahoning County. The Kent Moraine has been traced around the margin of the Grand River lobe from Ohio across Pennsylvania into New York as an irregular and diffuse belt of hummocky topography as much as 10 miles wide.

The moraine has a hummocky surface composed of knolls and swells rising from 10 to 30 feet above their bases. Shallow kettle holes are present in places. In the southern part of the moraine the underlying bedrock hills, with a relief of as much as 200 feet, influence the topography so that there the moraine is composed of irregular swells superimposed upon the bedrock hills.

As shown on the glacial map (pl. 1), the moraine consists of somewhat hummocky areas of till and of more pronounced hummocky areas of gravelly till or gravel. The boundary between these two is transitional rather than sharp.

Interspersed within the Kent Moraine are flatter areas on uplands and smoother areas on some bedrock hills which represent ground moraine. In these areas the drift is generally thinner than in the hummocky moraine.

The Kent Moraine is composed of several till units. The bulk of the material is Titusville till or gravel, with a veneer of Kent Till and, in the northern part of the county, of Lavery Till as well (see fig. 12). The end moraines in the Allegheny Plateau are composed of several units of different ice advances; the great bulk of the moraines is made up of drift of an early ice advance, generally of Titusville or correlative age (White, 1962; Totten, 1969).

Although the southern margin of the Kent Moraine marks the southern margin of the Kent ice advance, the moraine was already present in Kent time and was the factor which controlled the farthest advance of the Kent ice. The Kent Till is actually quite thin in most places in the moraine and may even be missing (fig. 12).

GROUND MORAINE BEYOND THE KENT MORAINE

A belt of dissected bedrock topography, 2 to 4 miles wide, with a generally thin cover of glacial drift, extends east-west across the central part of the county south of the area of Kent Till and the Kent Moraine. This is the area of Titusville Till.

Bedrock ridges and hills rise above the valley bottoms as much as 200 feet in the west to over 300 feet in the east. The topography is more similar to that of the unglaciated dissected plateau to the south than to that of the area to the north with its cover of thicker, younger drift. However, the slopes and ridge tops do have a smoother aspect and at places slight swells because of glaciation. Bedrock outcrops are not uncommon because the drift cover is thin.

KAMES

Kames are separate hills of sand and gravel formed when the material was washed into holes in the ice or into reentrants along the margin of melting ice. Prominent kames are present along the glacial boundary, which is the margin of the Titusville drift, south of Sandy Creek in West Township. These kames extend from southwest of Bayard to southeast of East Rochester. They rise as much as 200 feet above the valley bottom, where they are banked against the east-west ridge which parallels the Columbiana-Carroll County line. Other kames within the Titusville drift area are along the valley sides south and southeast of Hanoverton, in Hanover Township; and south and east of Rogers, in Middleton Township.

Within the Kent Moraine, kames are associated with

other drift knolls from place to place. The most prominent kames are in secs. 20, 29, and 30, Salem Township. Within the Kent Moraine, the areas shown as "gravelly moraine" also include some kames. Other parts of these "gravelly moraine" areas are probably kames under a thin covering of later till.

KAME TERRACES

Kame terraces consist of sand and gravel deposited by meltwater flowing along valley sides between the valley wall and ice masses which remained after the main mass of ice had melted from the uplands. The kame terraces are now 20 to more than 100 feet above the valley bottoms. They have an irregular inner margin, which is the cast of the ice edge. When the ice finally disappeared, the sand and gravel deposited along the melting ice edge formed knolls, which are now kames. Some terraces are very hummocky because they are made up of massed kames with kettle holes between. These depressions are now swampy hollows if the water table is at or above their bottoms. Where kames within the terraces are low or absent, the terraces are much smoother and resemble terrace remnants of valley trains. Particularly fine examples of hummocky kame terraces are present in the Washingtonville-Leetonia-Franklin Square segment of the valley of Middle Fork Little Beaver Creek. Other fine examples of kame terraces, as shown on plate 1, are in the valley of the Mahoning River and in the complex of valleys tributary to it in the North Georgetown area in western Knox and eastern Butler Townships.

In the northeastern part of Columbiana County excellent examples of kame terraces are present in the valleys of Little Bull Creek, Bull Creek, Leslie Run, and North Fork Little Beaver Creek.

High kame terraces are present on either side of the valley of Middle Fork Little Beaver Creek from the Columbiana-Mahoning County line northeast of Salem, across a corner of Mahoning County, and thence along the north margin of Salem Township to Washingtonville. The terraces are at several levels and presumably of more than one age. The higher terraces continue both south from Washingtonville to western Leetonia and east toward Columbiana, where a broad lower terrace continues both south to eastern Leetonia and east to the western part of Columbiana. Large kettle holes are present on these terraces and the streams flow through very large swampy central depressions. These terraces have been the sites of large gravel pits in the past.

OUTWASH TERRACES

Terraces which are remnants of valley trains occur along valley sides in both the glaciated and unglaciated parts of Columbiana County. These terraces are of different ages; those highest above the present streams are the oldest, those closest to the stream level are the youngest. Particularly fine examples of outwash terraces are present in the valleys of Middle Fork Little Beaver Creek from Lisbon to its mouth; in the valleys of Bull Creek and North Fork Little Beaver Creek west, east, and south of Negley; in the lowland east of Guilford Lake; and in the valley of Sandy Creek.

A very extensive area of outwash terrace is present in the Mahoning River valley in the northwestern corner of Columbiana County, southeast of Alliance. This flat is almost 2 miles wide and rises from 10 to 40 feet above the river. It is probably a composite feature, composed of outwash sand and fine gravel deposited when meltwater escaped southward through the now-abandoned gorge across the divide at Chambersburg, and, at lower levels, of fine sand and silt deposited in a lake which later formed in the depression, before glacial ice melted northward far enough to allow escape of water northward and then eastward by way of the present Mahoning River.

PLEISTOCENE STRATIGRAPHY

The glacial deposits of Ohio are the result of several ice advances during the Pleistocene or Glacial Epoch. Ice accumulated far to the northeast in eastern Canada in the general area of Labrador and spread out laterally in all directions. A portion of this ice advanced southwestward into the Lake Erie basin as a major tongue known as the Erie lobe. As the Erie lobe advanced into northern Ohio and northwestern Pennsylvania, it spread southward into lowlands and subdivided, from east to west, into the Grand River, Cuyahoga, Killbuck, Scioto, and Miami sublobes (fig. 3), hereafter referred to as lobes.

Glaciation in Columbiana County resulted from southward expansion of the Grand River lobe. At least four ice sheets invaded the county in later Pleistocene time and an unknown number of advances occurred in earlier Pleistocene time, but no ice sheet advanced farther than about halfway into the county. The presence of till of four distinct ice advances and the margins of three of these in the county make Columbiana County a critical area for investigation of these marginal drifts of different ages, as they can be studied at the surface, and then traced northward beneath younger drift sheets. Figure 3 shows the margin of the various tills in three lobes in northeastern Ohio and shows the relation of the tills and their boundaries in Columbiana County to those in nearby areas. The general southward and southeastward rise of the land surface from the Grand River lowland northwest of Columbiana County controlled the pattern of each successive ice advance. The ice advances reached successively less far south in the later glaciations, so that, with the exception of the earliest

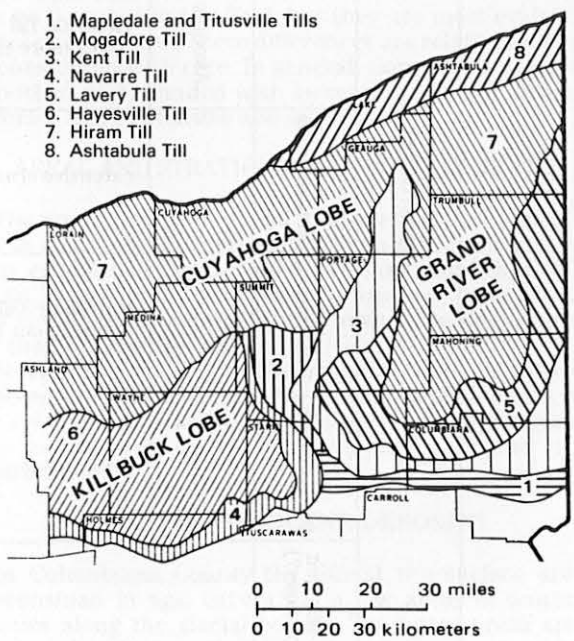


FIGURE 3.—Glacial lobes and tills in northeastern Ohio.

advance, belts of older drift are encountered in passing from north to south.

CLASSIFICATION

Four major glacial stages of the Pleistocene Epoch, separated by warmer interglacial intervals, are generally recognized in the central United States:

Wisconsinan Stage	*Sangamonian Interglacial Stage*
Illinoian Stage	*Yarmouthian Interglacial Stage*
Kansan Stage	*Aftonian Interglacial Stage*
Nebraskan Stage	

Ice moved into Columbiana County several times during at least two glacial stages, the Illinoian and the Wisconsinan, and also may have advanced into the county during one or both of the earlier glacial stages. Conclusive proof of age of the older deposits in the form of direct interregional correlation is not yet possible.

As ice moved over Columbiana County, it deposited till—an unsorted, unstratified mixture of clay, silt, sand, and gravel. Meltwater flowing on, within, beneath, and away from the ice deposited outwash—sorted and stratified sand and gravel. Deposits of silt and clay accumulated in glacial lakes. During longer periods of ice retreat (interglacials or interstadials), the climate ameliorated, vegetation flourished, the deposits weathered, and soils were formed.

Each major ice advance into northern Ohio carried material of slightly different texture and composition from that of the preceding advance. It is possible therefore to differentiate tills and to trace them for several hundreds of square miles through parts of several counties. These tills are rock-stratigraphic units or formations and are assigned names for purposes of mapping and discussion (table 1).

CRITERIA FOR IDENTIFYING AND CORRELATING TILLS

Identification and correlation of tills are based upon field criteria and laboratory analyses. Factors considered are (1) weathering characteristics, (2) texture, (3) mineral composition, (4) color, (5) structure, (6) topography and drainage, and (7) areal and stratigraphic position of the till with respect to other tills.

TABLE 1.—*Glacial stages and deposits in Columbiana County*

Epoch	Stage	Substage	Unit or interval	Deposit in Columbiana County
PLEISTOCENE	Wisconsinan	Woodfordian	Late-glacial and postglacial	alluvium, peat, lacustrine silt and clay, loess
			Lavery Till	dark-brown silty till
			Kent Till	yellow-brown sandy till
		Farmdalian	weathering	paleosol (generally removed by erosion)
		Altonian	Titusville Till (3 or more sheets)	olive-brown sandy till
	Sangamonian		extensive erosion	paleosol
	Illinoian		Mapledale Till (more than 1 sheet?)	yellow-brown silty-sandy till
	Yarmouthian		extensive erosion	paleosol(?) at Elkton
	Pre-Illinoian (two stages?)			weathered till, rare erratics, gravel in high terraces; Calcutta Silt on uplands

WEATHERING CHARACTERISTICS

The weathering of till produces a soil profile that may be subdivided vertically into several horizons (White, 1963, 1967; Totten, 1973).

Horizon 5 is the unaltered till, which is some shade of dark gray. This horizon is typically 10 to 15 feet below the surface; many exposures are too shallow to reveal gray till.

Horizon 4 is calcareous till, which differs from horizon 5 primarily in that the gray till has been oxidized to a shade of brown that is different for each till. The oxidized color is a useful field-identification criterion. Gray veins of secondary carbonate enrichment are found in some places in the upper part of this horizon.

Horizon 3 is composed of brown till from which the carbonate minerals have been leached by the percolation of ground water. Dark rusty-brown and black stains of iron and manganese oxides may occur along joint and fracture surfaces, particularly in the sandy tills. The contact between horizons 3 and 4 is known as the depth of leaching, which ranges from as little as 3 feet below the surface in the youngest tills to over 12 feet in the oldest tills. This depth is an aid in distinguishing different tills. The depth of leaching is dependent on many variables, including age of the till, topography, drainage, and parent material. Within a single till sheet of sufficient thickness these variables are at a minimum, and depth-of-leaching measurements are generally consistent enough to be of value.

One of the biggest problems concerning the depth of leaching, and one that has been often overlooked, is correct interpretation of leaching depths when till sheets are thin and discontinuous. Depth-of-leaching values may be significant only for till deposited by the last ice sheet to cover a particular area and only then if the till is sufficiently thick that leaching has not proceeded into or has not been influenced by material underlying the till. There are many places in Columbiana County where an older till is at or near the surface in an area of a younger till. In some places the older till has been partially eroded, exposing fresh calcareous till. In such places the amount of leaching of the older till cannot be expected to be greater than the amount of leaching of the till deposited by the last ice advance.

Horizon 2 is composed of thoroughly weathered till in which some pebbles and cobbles have decomposed. Clay coatings are present, and dark stains of iron and manganese oxides are found along joints in many places.

Horizon 1 is the soil of soil scientists, and generally is divisible into an upper gray-brown to dark-brown topsoil (A) and a lower yellow-brown subsoil (B).

Different tills give rise to different soil types. In addition to the length of time a till has been weathered, till texture and mineralogy also influence soil types. The different soils of Columbiana County have been described and mapped in great detail by Lessig, Hale, and Yohn (1968). Typical weathering horizons of tills in Columbiana County are shown in figure 4.

TEXTURE

The texture or size of the grains composing a till has been an important criterion in till identification in northeastern Ohio and northwestern Pennsylvania (Shepps and others, 1959; White, 1963, 1967; White, Totten, and Gross, 1969). Tills in Columbiana County range from quite sandy tills with a quite low clay content to silty clayey tills with a low sand content. The stoniness of tills also is a useful criterion in till identification.

MINERAL COMPOSITION

Tills in Columbiana County consist of a large variety of minerals, the most abundant of which are quartz, feldspar, clay minerals (illite, chlorite, kaolinite), and carbonate minerals (calcite, dolomite). Studies of till samples from northeastern Ohio (Totten, 1960; Heath, 1963) indicate that individual tills vary in mineral content. The statistical studies of Gross and Moran (1971) show the general composition and texture of the tills of the Grand River lobe in Ohio and Pennsylvania and the lateral variation of each till. Columbiana County is included in these analyses and the interested reader is referred to that report for details.

COLOR

The color of the different tills is a subtle but very useful physical characteristic in till identification. All tills, where sufficiently thick, display two dominant colors: gray where unaltered and brown where oxidized; the color change in Columbiana County is commonly 5 to 15 feet below the surface. The original gray color is due primarily to ferrous iron; oxidation to ferric iron gives the till a brown color, the shade of which is characteristic and consistent for each till.

STRUCTURE

Structure refers to the size and shape of the individual pieces that result when till fractures or breaks. Unweathered till commonly appears structureless, but weathered till may exhibit a variety of fracture patterns. It is not known how these patterns are produced, but they are of use in distinguishing tills.

TOPOGRAPHY AND DRAINAGE

The surfaces of different till sheets in many cases show differences in topography and drainage that aid in distinguishing one till from another. Sometimes these differences can be detected in the field, but they are most evident on aerial photographs. These differences are relative and must be considered with care. In general, slopes tend to become smoothed and rounded with increasing age, and drainage becomes more extensive and integrated.

AREAL AND STRATIGRAPHIC POSITION OF TILL

The approximate areal and stratigraphic positions of the tills in neighboring counties in Ohio and Pennsylvania have been established (White, 1963; Winslow and White, 1966; White, Totten, and Gross, 1969). It has been demonstrated that the older tills extend farther toward the glacial boundary than the younger tills.

Stratigraphic sections showing more than one till are of importance in determining the sequence of deposits, and the relative age relationships between tills in a sequence may be inferred by intercalated paleosols and other deposits.

EARLY PLEISTOCENE DEPOSITS

In Columbiana County the tills at the surface are all Wisconsinan in age, except for a few areas of scattered erratics along the glacial border. The latter areas are so small and indistinct that no attempt has been made to show them on the glacial map.

The pre-Wisconsinan drift is possibly of two ages. In

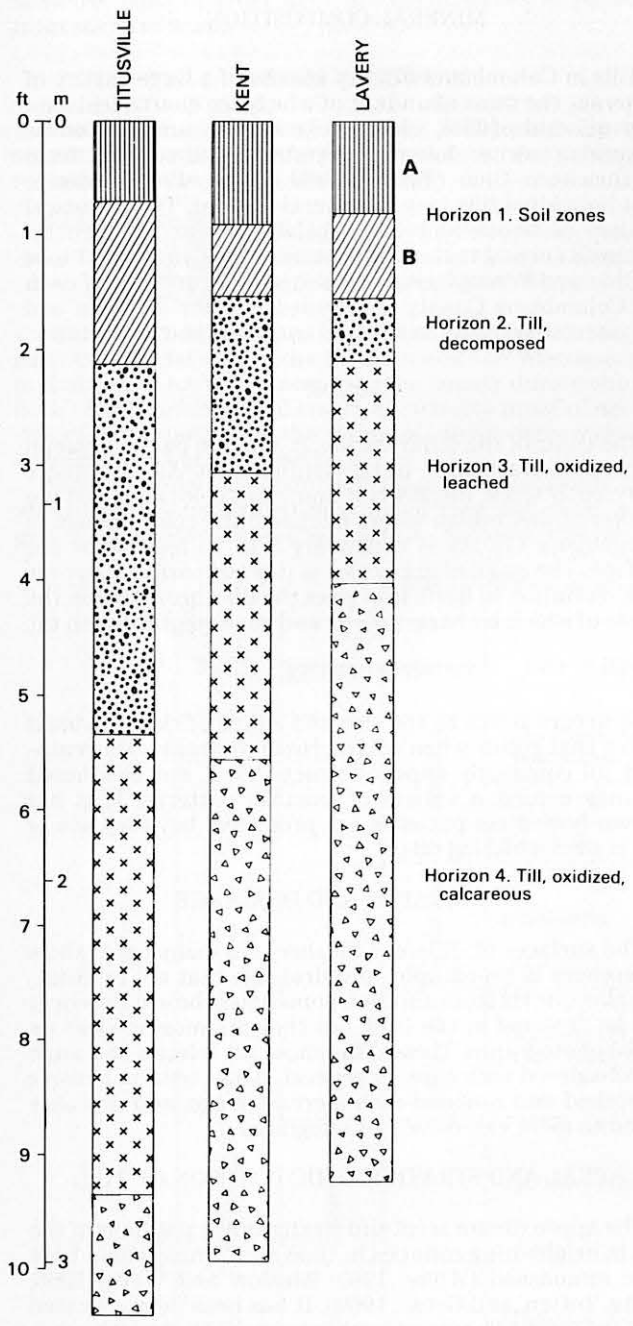


FIGURE 4.—Representative sections showing weathering horizons of tills in Columbiana County. Titusville section from SE¼SW¼ sec. 29, Elk Run Township; Kent section from ½ mile south of Lisbon in SE¼NE¼ sec. 23, Center Township; Lavery section from NW¼SE¼ sec. 19, Knox Township.

addition to the ice-laid deposits, some gravels in high terraces along the Ohio River valley and very extensive silts on the uplands in the southern part of the county are partly or wholly deposits of glacial meltwater beyond the limit of early Pleistocene ice advances. Meager deposits in some of the valleys are early Pleistocene in age but are derived from local bedrock sources, rather than from glacial outwash.

In the subsurface, below the tills of Wisconsinan age, remnants of earlier tills are revealed in deep excavations. At Elkton, in the SW¼NW¼ sec. 21, Elk Run Township, the lowest till exposed in a strip pit has a paleosol with plinthitic zones so well developed that they may have been formed upon till of Kansan age during the Yarmouthian Interglacial Stage. This occurrence has been described in detail by Lessig and Rice (1962).

From time to time one or two scattered boulders and cobbles of crystalline rocks have been reported south of the glacial boundary as mapped. Wright (1884a, p. 229) noted a boulder in the northwestern corner of Augusta Township, Carroll County, which would be a mile or more south of the boundary. Stevenson (1878, p. 179), in his report on Carroll County, stated that he had made "diligent examination" to determine "the presence or absence of true drift, but as none was found, excepting a few doubtful specimens in the north-east, it is probable that the boundary line of drift influence lies to the north or north-east of the county." It is tempting to speculate that Stevenson's "doubtful specimens" were quartzite erratics in Augusta and East Townships. The present authors noted a quartzite cobble on the upland at an elevation of 1,260 feet in the NE¼NE¼ sec. 5, East Township, Carroll County, and a similar pebble 1½ miles east in the NE¼NW¼ sec. 10, Franklin Township, Columbiana County. These erratics are 1 to 2 miles south of the glacial boundary. More recently Jackson and Bain (1974) reported erratic boulders several miles south of the glacial boundary in Stark County, west of Columbiana County.

Until more evidence is at hand, it is impossible to determine the origin of these erratics. They may be the last remnants of a very early Pleistocene drift sheet, now essentially completed eroded. If actually glacial in origin, these erratics are probably pre-Illinoian, for to the northeast in Pennsylvania, the Mapledale Till of Illinoian age is at the surface and a much higher proportion of that drift is preserved, although it is attenuated. In northwestern Pennsylvania, similar rare erratics beyond the Illinoian boundary have been reported (White, Totten, and Gross, 1969, p. 14-15).

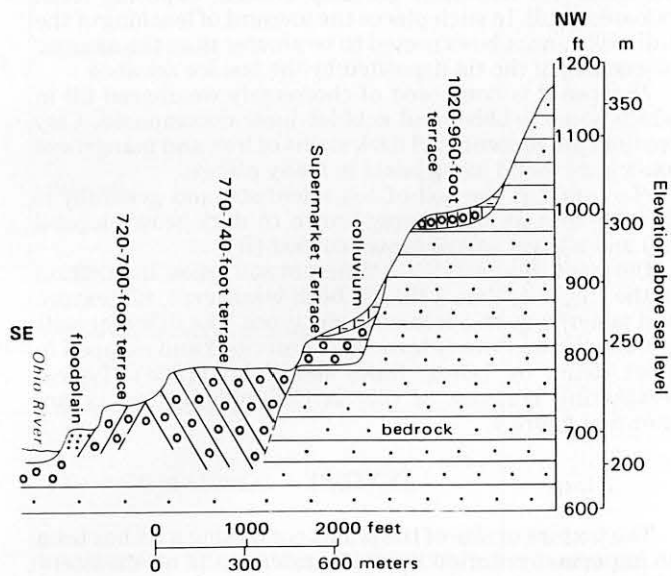


FIGURE 5.—Profile of terraces on the north side of the Ohio River valley at East Liverpool (modified from Lessig, 1959). The 720-700-foot terrace is Kent (Woodfordian) in age; the 770-740-foot terrace is Titusville (Altonian) in age; the Supermarket Terrace is probably Illinoian in age; the 1020-960-foot terrace is pre-Illinoian in age (age assignments made by White and Totten).

TILL DEPOSITS

Extremely weathered till below later tills in a strip mine in the SE¼NE¼ sec. 1, Center Township (see fig. 9), may be of pre-Illinoian age and may be related to the Slippery Rock Till of Pennsylvania (White, Totten, and Gross, 1969, p. 11). Other rare exposures in deep excavations of deeply weathered remnants of till may be of pre-Illinoian age. At no place was enough of this till present to preserve unweathered material for characterization. It is probable that lower deposits both of till and outwash in partly filled deep valleys in Columbiana County are pre-Illinoian.

OUTWASH DEPOSITS

Outwash material, generally gravelly, was deposited by meltwater from early ice sheets in at least two episodes. This material partly filled the valleys of Middle Fork Little Beaver Creek and the Ohio River. Later erosion dissected these valley trains, leaving only remnants now preserved as terraces along the valleys.

Terrace remnants are present more than 300 feet above the level of the present Ohio River in the eastern part of East Liverpool and in the western and southwestern part of Wellsville, as shown on the map. The largest area of these early outwash deposits is at an elevation of 960 to about 1,000 feet. The lower terrace remnant at about 850 feet at East Liverpool was called the Supermarket Terrace by Lessig (1959) and is probably Illinoian in age. These terraces and their soils have been studied in detail by Lessig (1959, 1961a, 1961b) and Lessig, Hale, and Yohn (1968). Lessig's (1959, fig. 3) illustration of these terraces at East Liverpool is reproduced here as figure 5.

The material of the upper terraces is complex, consisting of a basal silt, overlain by gravel, which in turn is overlain by alluvial or lacustrine material and colluvium (Lessig, 1961b, p. 32). The gravel is medium grained, but is so severely weathered to a depth of at least 18 feet that the pebbles, except quartzites, are disintegrated and the whole mass is clayey.

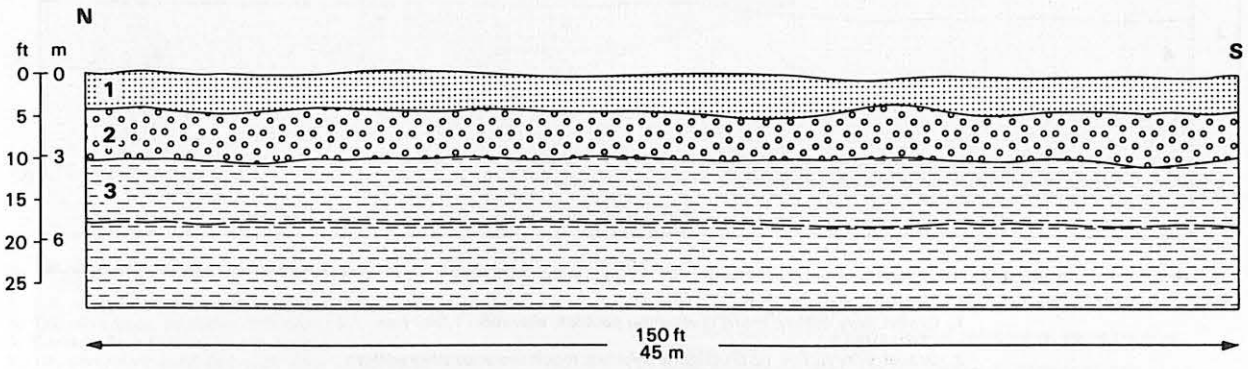
Similar much smaller terrace remnants are present high above the stream in the valley of Little Beaver Creek for about 5 miles upstream from the Ohio River. Most of these terrace remnants are so small that they have not been mapped on plate 1. (See detailed soil maps of Lessig, Hale, and Yohn, 1968; also Lessig, 1961b, fig. 1.).

These terraces are remnants of valley trains of at least two early Pleistocene ice sheets, whose margins were at unknown locations to the north. One of these may have been the ice sheet which deposited the early Pleistocene Slippery Rock Till in Pennsylvania (White, Totten, and Gross, 1969, p. 11). The lower (860-foot) outwash may be from the meltwater of the ice sheet which deposited the Mapledale Till of probable Illinoian age. The "Illinoian" terraces of Lessig are now interpreted as Titusville (early Wisconsinan) in age, and not as Illinoian.

CALCUTTA SILT

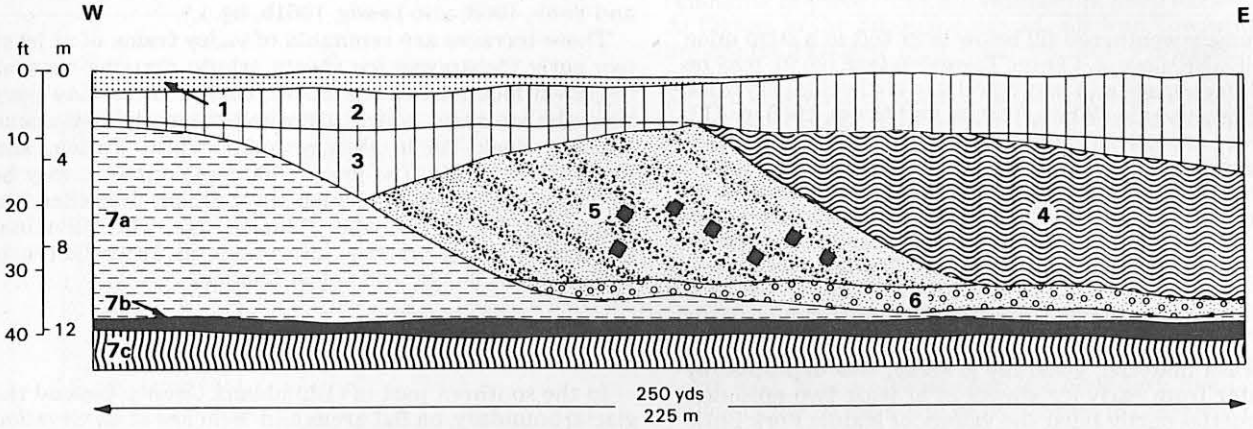
In the southern part of Columbiana County, beyond the glacial boundary, on flat areas and "benches at an elevation of 1080-1180 feet . . . silty, laminated materials were discovered" by Lessig (1963, p. 129) and named the Calcutta Silt, for the village in St. Clair Township. The Calcutta Silt is a water-laid deposit with "thin sandy layers and pebbles from local sedimentary rocks. Cobbles and pebbles of very resistant crystalline rocks occur at places on the surface" (Lessig, 1963, p. 129). The Calcutta Silt ranges from 2 to 10 feet in thickness and overlies bedrock. The Calcutta Silt areas are not shown on plate 1. These areas are mapped in great detail by Lessig, Hale, and Yohn (1968) and correspond to areas of Allegheny and Monongahela soils. In general, the flat to rolling uplands between 1,080 and 1,180 feet in the unglaciated area are mantled with this material, but the Calcutta Silt is not preserved on adjacent steep valley sides. The Calcutta Silt is particularly widespread in the area north and south of Cannons Mills and Longs Run northeast of Calcutta, extending to the valley of Little Beaver Creek (Lessig, Hale, and Yohn, 1968, general map and Map 76).

The Calcutta Silt is interpreted as a very early Pleistocene lacustrine deposit laid down in waters of a lake ponded between ice to the north and an early divide, now cut through to the south. The presence of similar upland silts south of Columbiana County indicates that the divide which formed the southern margin of the ancient lake was far to the south. The Calcutta Silt is older than the oldest



1. Silt, yellow; coarse and sandy in basal part
2. Gravel, medium; no crystalline pebbles; nonglacial. EARLY PLEISTOCENE
3. Bedrock, carbonaceous shale; upper 8 feet weathered

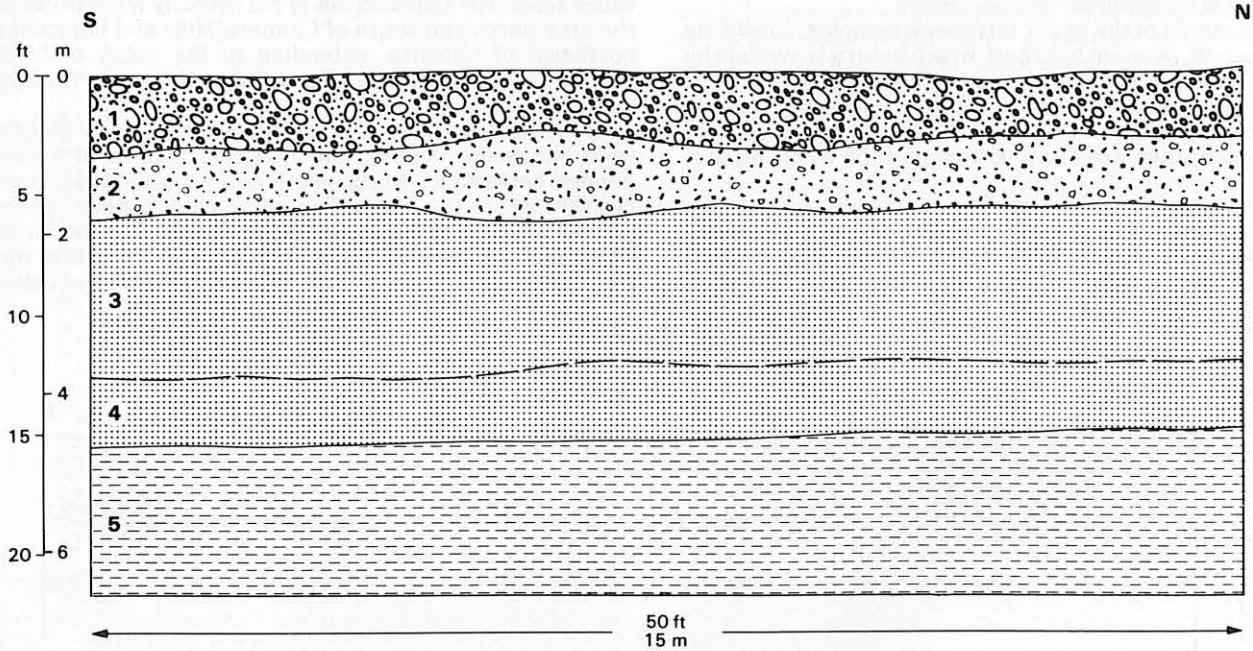
FIGURE 6.—Sketch of east wall of excavation on north side of U.S. Route 30, 300 yards west of West Point interchange of U.S. Route 30 and Ohio Route 11, NE¼ sec. 9, Madison Township, showing early Pleistocene nonglacial deposits on ancient Parker Strath surface.



1. Silt and fine sand, yellow-brown
2. Till, olive-brown, sandy, stony, hard; leached 8 feet. TITUSVILLE
3. Till, olive-gray, sandy, stony, hard, calcareous. TITUSVILLE
4. Clay, gray; basal part has 2-mm laminations (varves)
5. Sand, yellow, clean; beds steeply dipping; a few "floating" sandstone slabs, no crystalline pebbles
6. Gravel, brown, very dirty, alluvial(?); no crystalline pebbles
7. Bedrock, shale (7a), coal (7b), and clay (7c)

NOTE: Elsewhere in this extensive strip mine, bedrock is generally 5 to 10 feet below the surface, as at west end of this section.

FIGURE 7.—Sketch of wall of clay pit of Negley Clay Co., SE¼NE¼ sec. 13, Middleton Township, 1 mile south-southeast of Negley.



1. Gravel, very cobbly; many crystalline pebbles; elevation 1,040 feet. TITUSVILLE
2. Gravel, very rubbly; no crystalline pebbles; much more weathered than unit 1; resembles colluvium
3. Silt, brown; nonglacial. EARLY PLEISTOCENE
4. Silt, gray; nonglacial. EARLY PLEISTOCENE
5. Bedrock, shale and siltstone

FIGURE 8.—Sketch of material exposed in slump face in deep cut on west side of Ohio Route 11, NE¼SW¼ sec. 20, Elk Run Township.

terraces, because it occurs below the gravel of the highest terrace near Wellsville (Lessig, 1961a, p. 33; 1963).

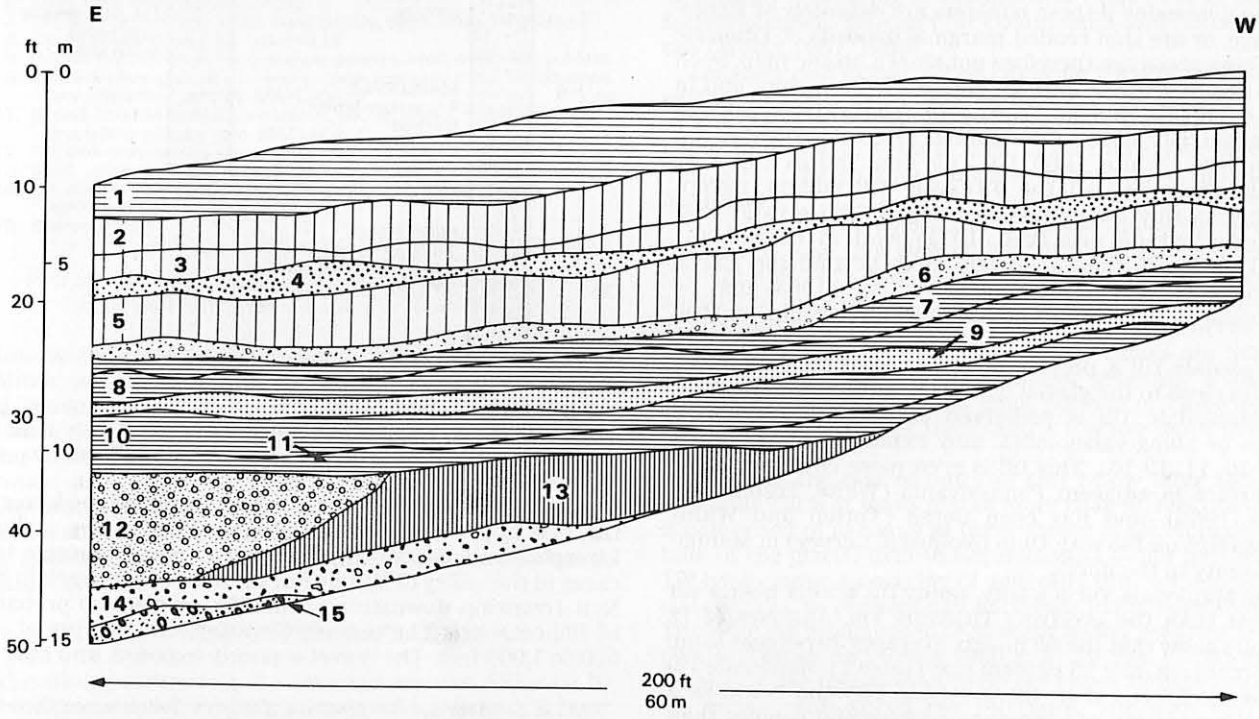
NONGLACIAL EARLY PLEISTOCENE DEPOSITS

The valleys of Brush Creek and West Fork Little Beaver Creek for a distance of about 15 miles from near Millport to the junction with Middle Fork are a wide Parker Strath valley ranging in width from ½ to 1 mile. The present stream at Millport is flowing only a very few feet below the ancient valley, but downstream the stream has cut progressively lower below the ancient surface, so that at the mouth of West Fork the stream is flowing in a gorge almost 150 feet below the ancient valley surface. The slope of the ancient valley grades from 1,060 feet at Millport to 1,000 feet at the mouth, or about 60 feet in 15 miles, whereas the present stream falls about 180 feet in the same distance.

Aside from the floodplain of the present stream and several narrow outwash terraces bordering it, the ancient valley has a veneer of alluvium, generally only a few feet thick. Exposures are poor, but a deep cut of U.S. Route 30 through a spur about ¼ mile east of West Point exposed medium gravel overlain by sandy silt, with a total thickness of 10 feet, overlying weathered shale (fig. 6). The gravel contains no crystalline pebbles, but only material from the local Paleozoic rocks. Similar material is exposed along the road leading up from the valley bottom at Williamsport to the flat upon which Leslie Airport is located.

This material is interpreted as alluvium and slack-water sand and silt deposited in West Fork when Middle Fork Little Beaver Creek and Little Beaver Creek itself were filled with outwash of an early ice sheet to the level of about 1,020 feet. West Fork became an aggrading stream and became less and less competent, and sand and silt were deposited in the slack water behind the rising valley-train deposit at its mouth. Later, the deposits in West Fork and the glacial outwash in Middle Fork were dissected and the streams flowed at lower and lower levels. The extent of the remaining early Pleistocene nonglacial deposits in West Fork is shown on plate 1 and in great detail on the soil maps of Lessig, Hale, and Yohn (1968, Maps 63-68, 70).

Similar very early Pleistocene nonglacial deposits exist north of the glacial boundary beneath later glacial deposits. In the pit of the Negley Clay Co., 1 mile south-southeast of Negley, a deposit of sand and clay containing no glacially derived particles underlies Titusville Till (fig. 7). Nonglacial silt and rubbly gravel beneath glacial gravel of Titusville age were exposed in a slump face of a cut of Ohio Route 11 in sec. 20, Elk Run Township (fig. 8).



1. Till, olive-brown to yellow-brown, sandy; lower 1 foot calcareous. KENT
2. Till, olive-brown, stained, hard, calcareous. TITUSVILLE
3. Till, olive-gray, as above. TITUSVILLE
4. Sand, yellow-brown, fine to coarse
5. Till, dark-olive-gray, compact, silty. TITUSVILLE
6. Sand, silt, and gravel, yellow-brown to gray, thin-bedded
7. Till, yellow-brown to light-olive-brown, pebbly, silty, hard, noncalcareous. MAPLEDALE
8. Till, olive-gray, hard, quite pebbly; many bedrock inclusions; upper 1 foot noncalcareous. MAPLEDALE
9. Silt, steel-blue-gray, homogeneous, calcareous
10. Till, olive-gray to olive, silty, very pebbly, oxidized and noncalcareous in upper part. MAPLEDALE
11. Till, dark-olive-gray, tough, pebbly, calcareous; some pebbles weathered. MAPLEDALE
12. Sand and gravel, gray, noncalcareous. SLIPPERY ROCK?
13. Till, variegated, very dark gray and maroon, stony, hard, calcareous. SLIPPERY ROCK
14. Colluvium, greenish-olive to gray
15. Gravel and sand, strong brown, rusty, much-weathered. SLIPPERY ROCK?

FIGURE 9.—Sketch of material exposed in strip-mine highwall in SE¼NE¼ sec. 1, Center Township.

ILLINOIAN STAGE

Meager deposits of till and outwash are referred to the Illinoian Stage of glaciation. A till which is seen in a few deep excavations in strip mines, generally much weathered and overlain by fresh till of Wisconsinan age, is interpreted as Mapledale Till of Illinoian age. It may overlie a still more weathered Slippery Rock Till of presumed pre-Illinoian age. Deeply weathered gravel in a few high terraces is probably of Illinoian age.

MAPLEDALE TILL

The Mapledale Till is named for exposures at Mapledale, a southwestern suburb of Franklin, Pennsylvania (White, Totten, and Gross, 1969, p. 15). This till was shown as "outer Illinoian" on an earlier map and report (Shepps and others, 1959) on northwestern Pennsylvania. From Slippery Rock, Pennsylvania, southwest to the Ohio-Pennsylvania state line the belt of Mapledale Till at the surface becomes narrower, and as the state line is approached the younger Titusville Till overlaps the Mapledale Till at more and more localities (Shepps and others, 1959, map; White, Totten, and Gross, 1969, fig. 2). Across Columbiana County, the Titusville Till extends to the glacial boundary almost everywhere. A few very small tracts, a fraction of a mile in width, have on their surface only rare scattered boulders, which may represent eroded Mapledale Till. It is not possible to determine if these boulders are definitely of Mapledale age, or are thin eroded marginal deposits of Titusville Till. These areas are therefore not shown on the map. Such areas are in secs. 25 and 26, Middleton Township, and in secs. 4 and 5, Madison Township. The narrow area of Mapledale Till across Columbiana County shown on an earlier map (White, 1969, fig. 2) is now known not to be present there beyond the Titusville Till margin, except possibly as tiny tracts just mentioned. The erratics discovered (Jackson and Bain, 1974) west of Columbiana County in Stark County several miles beyond the glacial boundary as originally mapped by White (1963) may be remnants of Mapledale Till, although they could be even older.

Mapledale Till is present at some places beneath Titusville Till close to the glacial boundary, as shown in figure 9. The Mapledale Till is preserved as remnants in buried valleys or along valley sides, now exposed in strip mines (figs. 10, 11, 13-16). This till is even more common in the subsurface in adjacent Pennsylvania (White, Totten, and Gross, 1969), and has been noted (Totten and White, manuscript on file with Ohio Geological Survey) in Mahoning County to the north.

The Mapledale Till is a silty, sandy till, with a higher silt content than the overlying Titusville Till. Analyses of 12 samples show that the till matrix averages 39 percent sand, 36 percent silt, and 25 percent clay (table 2). Mapledale Till is less calcareous than the overlying tills and contains a higher proportion of sandstone pebbles and cobbles than the later tills. In Pennsylvania the Mapledale Till occurs in two units, the lower of which is more calcareous than the upper. The multiple character is also present in Columbiana County, as shown in figures 9 and 11, where two layers of Mapledale Till are present, separated by silt, sand, or gravel.

ILLINOIAN OUTWASH

The terrace at about 850 feet in elevation, called the Supermarket Terrace by Lessig (1959), is present in the East End area of East Liverpool. This terrace is the lower of the two upper terraces in the Ohio River valley at East Liverpool and is probably Illinoian in age. Extensive terraces in the valley of Middle Fork Little Beaver Creek in Elk Run Township downstream from Elkton are also probably of Illinoian age. The terrace elevation ranges from about 990 to 1,000 feet. The gravel is poorly exposed, and may be

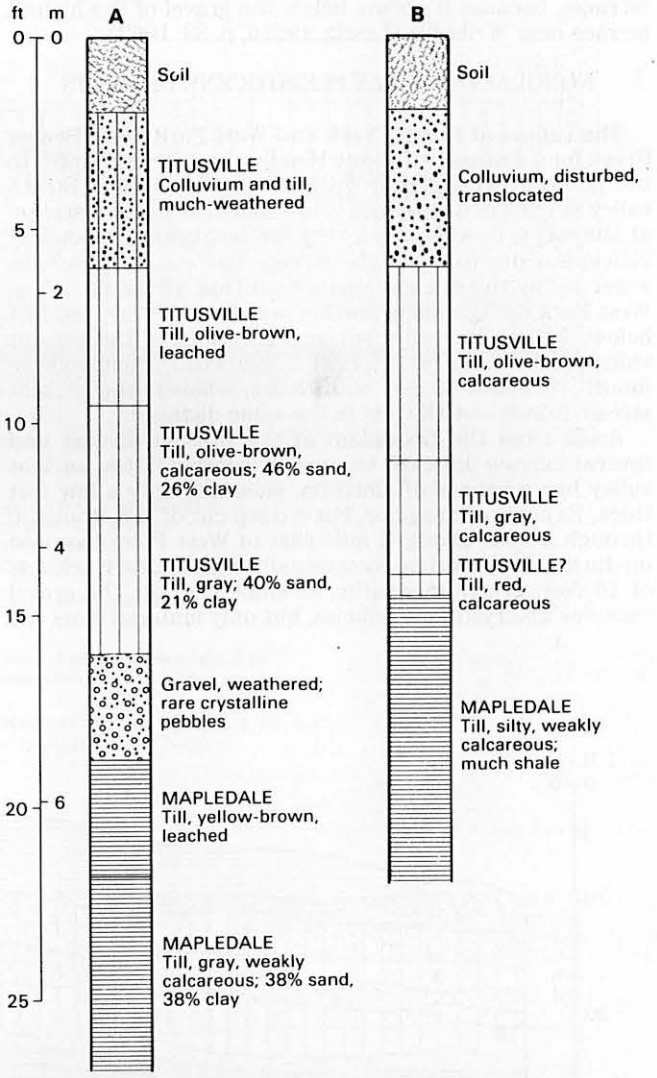
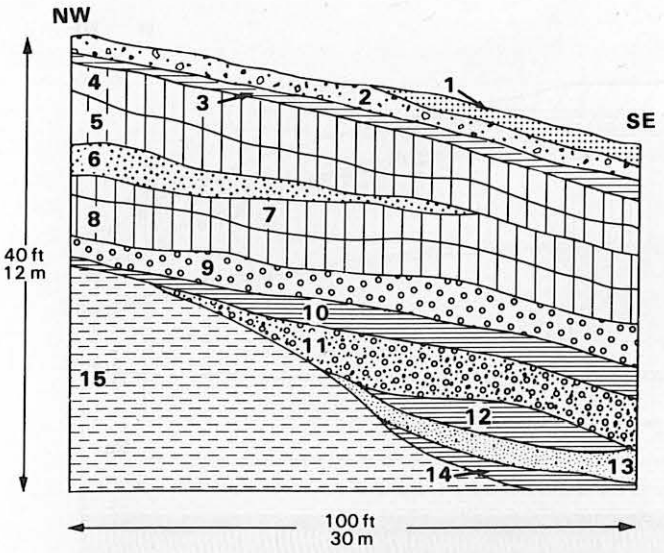


FIGURE 10.—Sections of Titusville and Mapledale Tills exposed in strip mines. A, ½ mile east-southeast of Guilford, SW¼ sec. 7, Center Township; B, SW¼NE¼SW¼ sec. 22, Center Township.

TABLE 2.—*Average composition of tills in Columbiana County*

Till	No. of samples	Grain size (percent)			Mineralogy (percent)	
		Sand	Silt	Clay	Quartz	Feldspar
Lavery	5	26	45	29	80	20
Kent	15	43	30	27	87	13
Titusville	46	49	32	19	93	7
Mapledale	12	39	36	25		



1. Silt, bedded, light-yellow-brown to dark-brown
2. Gravel, reddish-brown, very poorly sorted; pebbles fresh
3. Till, yellow-brown to olive-brown, pebbly, sandy, noncalcareous. KENT
4. Till, olive-brown, hard, compact, pebbly, calcareous almost to top. TITUSVILLE
5. Till, olive-gray, hard, pebbly; some sand lenses. TITUSVILLE
6. Sand, yellow-brown, calcareous
7. Till, olive-brown, very rusty, hard, pebbly, calcareous. TITUSVILLE
8. Till, as above, olive gray. TITUSVILLE
9. Gravel, reddish-brown, calcareous, poorly sorted; many soft pebbles
10. Till, dark-olive-gray, calcareous; pebbles primarily shale and siltstone, few crystalline pebbles. MAPLEDALE
11. Gravel, reddish-brown, calcareous, poorly sorted, much-weathered; crystalline pebbles rare. MAPLEDALE
12. Till, dark-gray-brown, calcareous, massive. MAPLEDALE
13. Sand, yellow-brown and gray-brown, silty, calcareous
14. Till, olive-gray, slowly calcareous, moderately pebbly, tough. MAPLEDALE
15. Bedrock, shale

FIGURE 11.—Sketch of material exposed in strip mine in SW¼SW¼NW¼ sec. 14, Elk Run Township.

a thin veneer upon a wide Parker Strath bedrock valley.

Minor terrace remnants in the valleys of Brush Creek and West Fork Little Beaver Creek and its tributaries, Williard and Rowley Runs, below the level of the higher, wider early Pleistocene alluvial terrace, are probably of Illinoian age. These terraces appear to be remnants of valley trains deposited by meltwater from ice at some location not far north of the boundary of later Titusville Till. The gravel is poorly exposed, but appears to be fine to medium grained.

SANGAMONIAN INTERGLACIAL STAGE

The disappearance of the Illinoian ice was followed by the Sangamonian Interglacial Stage, which lasted at least several tens of thousands of years. During the warmer climate of the Sangamonian, erosion and weathering took place. Valleys were cut or deepened, much of the Illinoian drift was removed, and deep soils formed. The Wisconsinan ice advances later removed much, or all, of the Sangamonian soil, so that all that is preserved may be the basal part of the weathered zone of Illinoian till. In the outwash deposits beyond the later ice advances, the Sangamonian soil continued to be weathered throughout the Wisconsinan Stage and in post-Wisconsinan time so that distinctive very deep soils now exist on the Illinoian outwash. These soils are assigned to the Parke Series (Lessig, Hale, and Yohn, 1968, p. 92, 81, 110).

WISCONSINAN STAGE

The ice-laid glacial deposits at the surface in Columbiana County are all of Wisconsinan age, except possibly for extremely small areas already noted. The early Wisconsinan ice advanced farther (but only a very little farther) than any earlier ice sheet yet positively known. The surface drift in a belt 2 to 4 miles wide in the central part of the county is Early Wisconsinan (Altonian) in age, and the remainder of the glaciated part of Columbiana County has Late Wisconsinan (Woodfordian) drift at the surface.

ALTONIAN SUBSTAGE

Titusville Till

The Titusville Till is the oldest till on the surface in Columbiana County. It is present in the subsurface throughout most of Columbiana County beneath younger drift. The Titusville Till is named for the type locality at Titusville, Pennsylvania (White and Totten, 1965; White, Totten, and Gross, 1969, p. 23-32), from where it has been traced at the surface into Ohio across Columbiana and Stark Counties; the Titusville Till is present in the subsurface in the counties north and northwest of Columbiana County. It is the till formerly called "Illinoian" in Columbiana and Stark Counties (White, 1951, 1963).

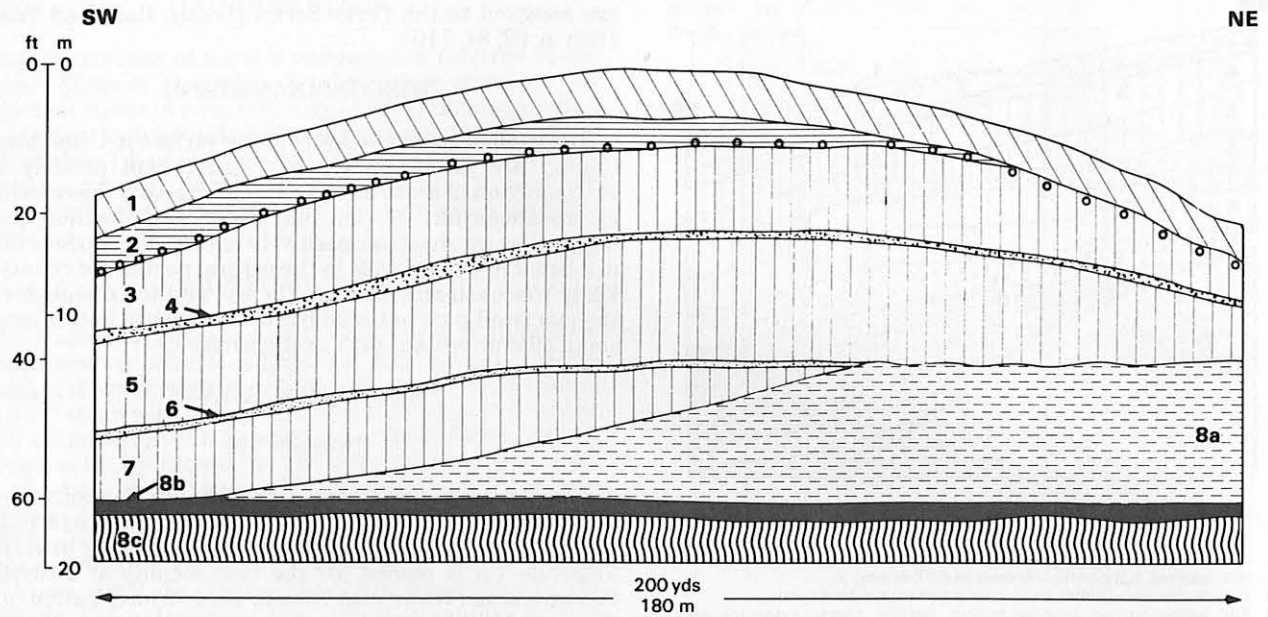
Location and extent.—The Titusville Till is present at the surface in a belt 2 to 4 miles wide across the southern part of West, Hanover, Center, Elk Run, and Middleton Townships, and in a very small area in northernmost Madison Township. The southern margin of this till is the glacial boundary.

At some places where the Titusville Till is the surface material it is so thin that all the till is incorporated in the present soil, with only a few pebbles and cobbles on the surface to indicate the presence of some glacial material. This is particularly the case in the outer margin of the belt, except in West Township, where large kames are massed along the boundary. At other places, generally a mile or more north of the southern limit, pockets of Titusville Till are as much as 10 feet thick, and a few are more than 20 feet thick.

North of the belt of outcrop and below later tills, the Titusville Till is at many places more than 20 feet thick and is composed of as many as three sheets of till. Actually, the bulk of the glacial drift in Columbiana County is Titusville Till lying under a covering of generally thin younger material (fig. 12). To the east and northeast in Pennsylvania, the Titusville Till is composed of as many as five separate sheets (White, Totten, and Gross, 1969, p. 27-29, figs. 17-30). These till sheets are interpreted to be the result of deposition by ice which readvanced several times, but with each readvance reaching less far than the earlier ones. The Kent Moraine is believed to be the zone along which the Titusville Till sheets "stacked up" to form the major volume of this feature.

Color and composition.—The unweathered Titusville Till is olive gray. The upper part of the gray till has been oxidized along joints and horizontal partings; these oxidized areas become somewhat harder at an outcrop and present a characteristic reticulated appearance.

The oxidized till is olive brown, with heavy darker stains



1. Till, dark-brown, silty, sparingly pebbly; leached 4 feet. LAVERY
2. Till, yellow-brown, sandy, pebbly; boulder zone at base. KENT
3. Till, olive-brown (top) to gray (base), sandy, stony, very hard. TITUSVILLE I
4. Sand and gravel, ½ to 3 feet
5. Till, olive-gray, sandy, stony. TITUSVILLE II
6. Sand, 0 to ½ foot
7. Till, olive-gray, sandy, stony. TITUSVILLE III
8. Bedrock, shale (8a), coal (8b), and clay (8c)

FIGURE 12.—Sketch of tills exposed in clay pit of Whitacre-Greer Co. in SW¼NE¼ sec. 7, Knox Township.

along joints and around pebbles. This till is hard, compact, dense, and picks with some difficulty, and the matrix retains the imprint of pebbles after they are removed.

The Titusville Till is coarse, sandy, and stony. The mean texture of the matrix is 49 percent sand, 32 percent silt, and 19 percent clay (table 2). The feldspar content ranges from 4 to 10 percent and the quartz content from 90 to 96 percent. The mean feldspar content (based on 14 samples) is 7 percent. The general southward decrease in feldspar content in the Titusville Till in the Grand River lobe has been investigated in detail by Gross and Moran (1971, fig. 2). Only a small number of determinations of carbonate content have been made on Titusville Till in Columbiana County, but in adjacent Pennsylvania the mean carbonate content is 2.4 percent (White, Totten, and Gross, 1969, p. 44). The till reacts visibly to hydrochloric acid.

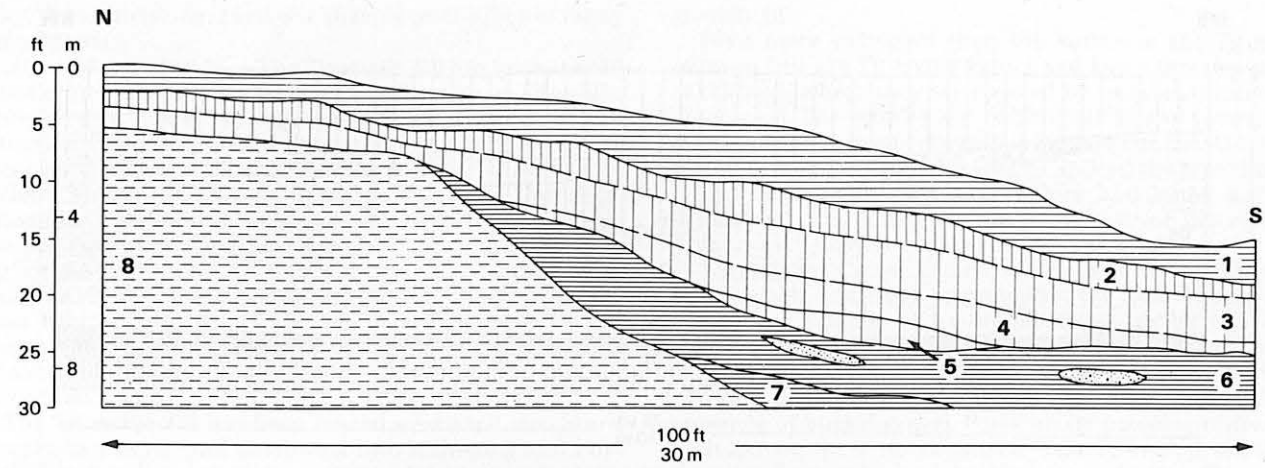
Weathering character.—In the belt where Titusville Till is at the surface, there are only a few outcrops of till thick enough to preserve unweathered gray till, but at those few places the gray till has an average depth of 12 feet 6 inches. The weathering horizons are shown in figure 4. The olive-brown color of the oxidized Titusville Till contrasts with the yellow-brown color of the younger Kent Till. The upper part of the Titusville generally shows disturbance and colluviation, and the soil may be formed in colluvium rather than in till (fig. 4). The depth of leaching, therefore, is variable, but averages 8 feet 8 inches.

Weathering of the Titusville Till yields a well-drained friable soil mapped as Hanover on drift-mantled slopes or as Loudonville on steeper slopes or other areas where little drift remains. Some small areas of moderately drained soils are mapped as Titusville Series (Lessig, Hale, and Yohn, 1968).

North of the belt of surface outcrop, where later tills overlie Titusville Till, truncated weathering profiles are present in some places (figs. 13, 14). No complete paleosol has been discovered, because at all exposures at least some of the upper part has been removed. At a few places, that part of the paleosol preserved is a very hard dark-reddish-brown clay loam, the lower part of which contains many fragments of angular sandstone and siltstone (channers) as much as 3 inches in length. Such material is ascribed to translocation, colluviation, and pedisediment action where seen elsewhere in Pennsylvania and Ohio (White, 1967, p. 21; White, Totten, and Gross, 1969, p. 27).

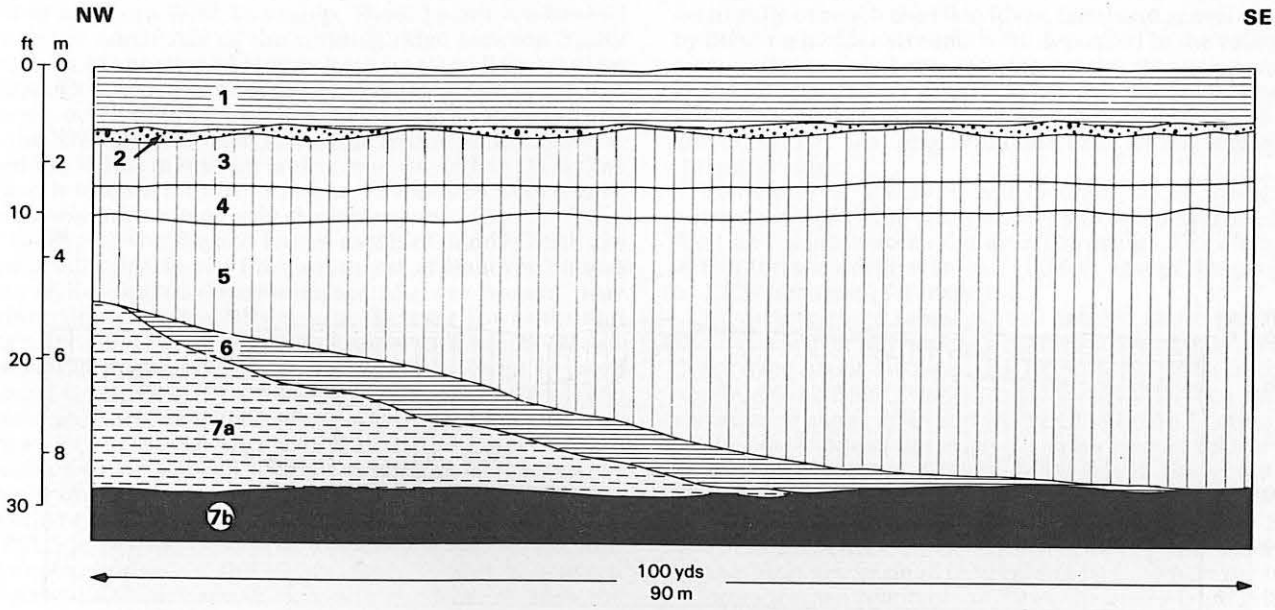
Stratigraphic position.—The Titusville Till is underlain by weathered Mapledale Till in a few places (figs. 9-11, 13-16) or by bedrock (figs. 7, 12, 15, 16). North of the Kent Till margin the Titusville Till is overlain by Kent Till, but in some places the Kent Till is missing, and Lavery Till lies directly on the Titusville Till (fig. 12).

Where it is at the surface the Titusville Till appears to consist of a single sheet. North of the area of outcrop the Titusville Till generally consists of two or more units (figs. 7, 9-16). The units are separated in most places by sand and gravel, sometimes of considerable thickness. These intertill layers may be water bearing, and thus the stability of slopes in strip mines and along highway and other deep cuts may be affected. The divisions of the Titusville Till may be indicated not only by the presence of the sand and gravel layers, but by a change in color from olive gray to a brighter



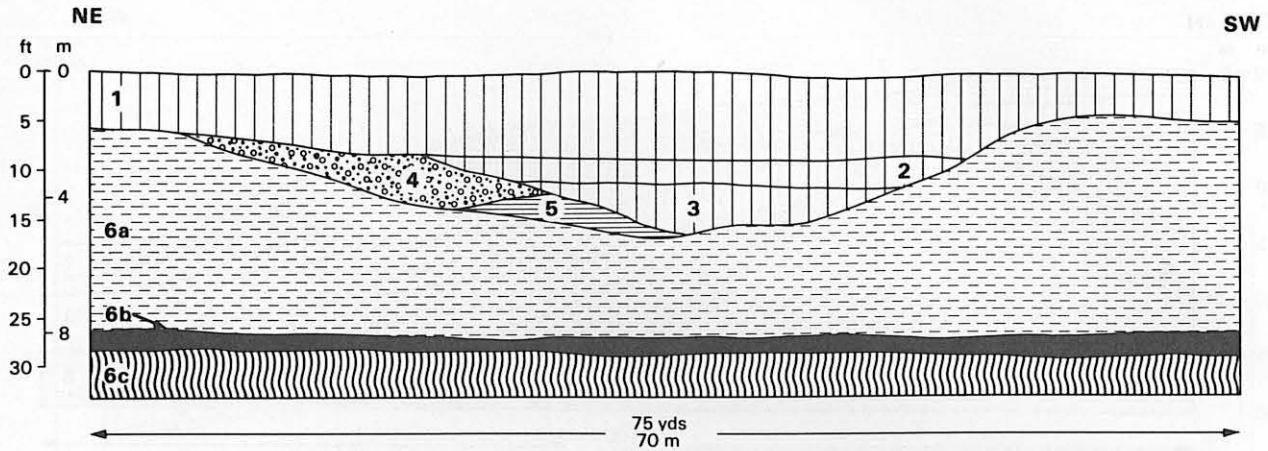
1. Till, yellowish-brown, silty, sandy, weathered. KENT
2. Till, strong brown, severely weathered; paleosol. FARMDALE
3. Till, olive-brown, weathered; heavy manganese staining. TITUSVILLE
4. Till, olive-brown, calcareous, pebbly. TITUSVILLE
5. Till, as above, olive gray. TITUSVILLE
6. Till, dark-olive-brown, rusty, weakly calcareous, very pebbly; contains sand streaks. MAPLEDALE
7. Till, as above, dark gray brown. MAPLEDALE
8. Bedrock, shale

FIGURE 13.—Sketch of material exposed in a strip mine 1 mile southeast of East Palestine, SW¼NE¼ sec. 36, Unity Township.



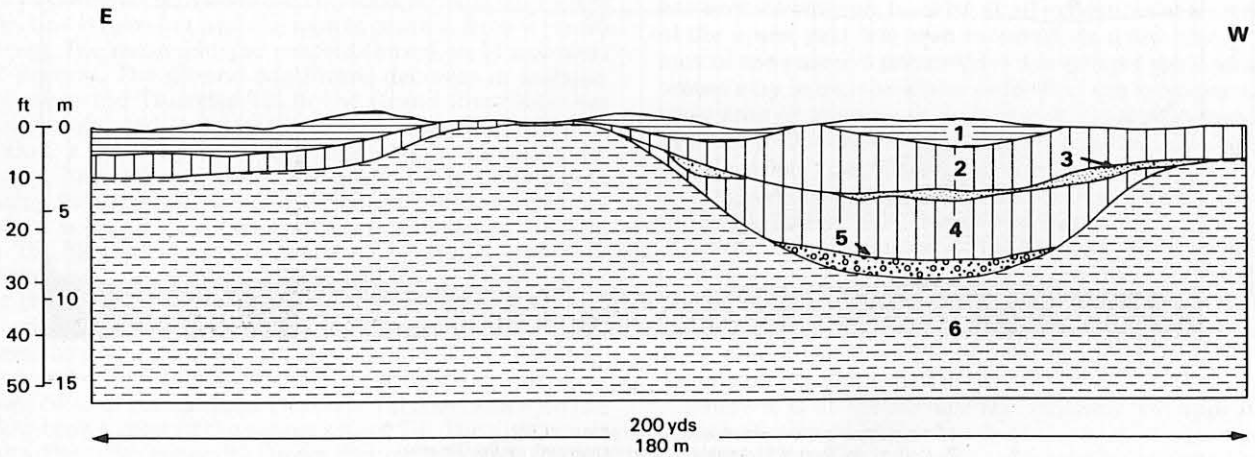
1. Till, yellow-brown, much weathered at top. KENT
2. Colluvium, stones and pebbles, iron-cemented; pedisediment. FARMDALE
3. Till, olive-brown, sandy, stony, noncalcareous. TITUSVILLE
4. Till, olive-brown, sandy, stony, calcareous. TITUSVILLE
5. Till, olive-gray, sandy, stony, calcareous; 47 percent sand, 20 percent clay. TITUSVILLE
6. Till, much-weathered, hard, noncalcareous, mixed with colluvium. MAPLEDALE
7. Bedrock, shale (7a) and coal (7b)

FIGURE 14.—Sketch of tills in strip mine 2 miles north-northeast of Lisbon, SE¼SW¼ sec. 1, Center Township.



1. Till, olive-brown, sandy, stony, leached, much weathered at top; overlain by 1 to 2 feet of silt. TITUSVILLE
2. Till, olive-brown, sandy, stony, calcareous at 10 feet; 43 percent sand, 19 percent clay. TITUSVILLE
3. Till, olive-gray, sandy, stony, calcareous; 47 percent sand, 20 percent clay. TITUSVILLE
4. Gravel, very coarse, stony, rubbly (mainly sandstone), noncalcareous. MAPLEDALE
5. Till, brown, coarse, noncalcareous, little-weathered. MAPLEDALE
6. Bedrock, shale (6a), coal (6b), and clay (6c)

FIGURE 15.—Sketch of strip-mine wall south of Achor Church in SW¼SW¼ sec. 13, Middleton Township.



1. Till, yellow-brown, sandy. KENT
2. Till, olive-brown, sandy. TITUSVILLE
3. Sand
4. Till, gray. TITUSVILLE
5. Gravel, brown, dirty, weathered. MAPLEDALE
6. Bedrock, shale and sandstone

FIGURE 16.—Sketch of strip-mine wall ½ mile south of Signal in NE¼SW¼ sec. 11, Elk Run Township.

gray. These divisions stand out sharply on the face of many excavations.

Age and correlation.—The Titusville Till has been traced into Columbiana County from its type locality at Titusville, Pennsylvania, about 80 miles northeast. The age of the Titusville Till, determined from carbon-14 analyses of peat associated with the till at Titusville, is about 40,000 years (White, Totten, and Gross, 1969, p. 30). It is, therefore, Altonian—Early Wisconsinan—in age, in terms of the Mississippi Valley classification (Frye and Willman, 1960). The earlier assignment of an Illinoian age (White, 1951) was based on degree of weathering and erosion, which is greater than that of the tills to the north, which were of unquestioned Wisconsinan age. The existence of an Early Wisconsinan till was not realized at that time, so any till older than that to the north was perforce "Illinoian."

The Titusville Till has been traced westward into Stark County and north and northwest into Mahoning and Portage Counties. It is correlative with the Mogadore Till of the Cuyahoga lobe (White, 1960), the Millbrook Till of the Killbuck lobe (White, 1967; Totten, 1973), and the Jelloway Till of the Scioto lobe (Totten, 1973).

Titusville kames

Associated with the Titusville Till in many places are deposits of gravel in the form of kames, some of them large and extensive. Some Titusville kames are in the area of outcrop and others are buried, in whole or in part, beneath later till north of the outcrop belt.

The most impressive group of kames are those south of Bayard along the south boundary of the Titusville outcrop belt in southern West Township. These kames are banked along the north side of the dividing ridge between Sandy Creek on the north and Muddy Fork (in Carroll County) on the south. Large pits have been excavated in some of these kames; much of the gravel has been removed from the one in the NW¼ sec. 32, West Township. In this pit the gravel is medium to fine in texture and as much as 40 feet thick. The gravel is leached only 5 to 8 feet and is oxidized from 6 to 12 feet; these are anomalously shallow values.

Related to the Bayard kames south of Sandy Creek are two smaller tracts of kames southeast of Hanoverton and east of Kensington. Smaller kames also are present near Trinity Church, in the NE¼ sec. 25, Hanover Township, and NW¼ sec. 30, Center Township. Gravel as much as 50 feet thick was exposed in a large kame discovered in strip mining in the NE¼SE¼ sec. 20, Center Township. Below the gravel as much as 20 feet of silt was exposed, which was brown in the upper part and gray in the lower. We are indebted to Mr. Heber Lessig for guiding us to this feature he discovered in soil surveying. The character of the unweathered gravel and the soil upon it are described by him (1961b, p. 291-292). Material in kames in sec. 13, Elk Run Township, and secs. 7 and 18, Middleton Township, between Rogers and East Carmel, is poorly exposed, so that the thickness and character of the gravel is not known, but considerable till appears to be mixed with the gravel.

A large tract of kames is present in the valley of an unnamed northward-flowing tributary to Bull Run in secs. 8, 9, and 16, Middleton Township, south of Mill Rock. No pits are present, but gravel is reported to be at least 60 feet thick in sec. 16 (Heber Lessig, personal communication). Smaller areas of kames of uncertain extent are present in central and northeastern Middleton Township. Limited exposures show the material is in part gravel and in part gravelly till.

Even more extensive than the kames in the Titusville outcrop belt are Titusville kames and kame terraces north of this belt, where they are covered by variable thicknesses of later till. The wide extent of Titusville gravel beneath till of later age has been recognized throughout the Allegheny Plateau (White, 1963, 1967, 1973a). Indeed the great bulk of gravel in commercial pits in kames and kame terraces throughout the plateau is not of the age of the surficial drift, but is Titusville (or its correlative) in age.

Throughout Columbiana County north of the Titusville outcrop belt, extensive areas within the Kent Moraine are mapped as gravelly end moraine. Many, perhaps most, of these areas are Titusville kames, with gravel exposed at the surface or with only a thin covering of later drift. Where the covering is thicker, borings and well records reveal the presence of buried gravel. Particularly prominent areas of such kames are in northeastern West Township, northern Hanover Township, and northwestern Center Township. The kames within the Kent Moraine are probably Titusville in age, without any cover of later till or with a very thin cover. The kame terraces in the valleys of the Mahoning River and its tributaries in the North Georgetown area of Knox Township, Middle Fork Little Beaver Creek and its tributaries in Perry and Salem Townships, and North Fork Little Beaver Creek in northeastern Unity Township are mainly composed of gravel of Titusville age with a very thin cover of later till.

Titusville outwash

Meltwater flowed away from the melting Titusville ice, eventually to reach the Ohio River. Sand and gravel carried by these meltwater streams were deposited in the valleys to form valley trains. Later, erosion by the streams, now no longer overloaded by glacial debris, cut floodplains below the valley-train levels and removed much of the sand and gravel, so that now only remnants exist as terraces along the valley sides.

Remnants of Titusville valley train occur along the narrow portion of the valley of Sandy Creek in southeastern West and southwestern Hanover Townships. The elevation of this terrace declines from 1,190 feet east of Hanoverton to 1,120 feet west of Kensington.

Titusville terrace remnants are present above the lower Kent terrace in the valley of Middle Fork Little Beaver Creek from about 1½ miles upstream from Elkton to about a mile downstream from that village. The terrace has an elevation of about 1,040 feet where Ohio Route 11 crosses it on the south side of the valley 1½ miles west of Elkton (fig. 8), and an elevation of about 1,020 feet in the vicinity of Elkton. Downstream from a point 1 mile below Elkton, Titusville terrace remnants in the valleys of Middle Fork and of Little Beaver Creek all the way to the Ohio River are sparse. Most are so small they cannot be shown on the map.

Large terrace remnants of Titusville valley-train gravels are excellently preserved in the valley of North Fork Little Beaver Creek at Negley; most of the village is built upon these terrace remnants. The elevation of the terrace declines from 900 feet at the state line to 880 feet at Negley and Achor. Below Achor the valley narrows and no remnants are preserved south to Fredericktown (formerly St. Clair), at the junction with Little Beaver Creek. From Fredericktown south to the Ohio River the valley is a gorge and only very small Titusville terrace remnants are preserved; these are not shown on the map.

It is curious that such a very small amount of Titusville outwash is present in the valleys of West Fork Little Beaver Creek and Brush Creek and its tributary, Williard Run, which heads within the Titusville outcrop belt. The amount of Titusville outwash in West Fork and Brush Creek appears originally to have been very small, and most of what was deposited has been removed, so that only the most meager remnants are left. Interestingly enough, some of the gravel in these remnants is very coarse; just north of Wayne School east of Gavers in sec. 10, Wayne Township, boulders as large as 1 foot in diameter are scattered on the surface.

In the Ohio River valley near East Liverpool, below the two higher early Pleistocene terraces already described, are two extensive lower terraces (fig. 5). The Titusville terrace is the higher of these two terraces. A terrace remnant about ¼ mile wide and more than ½ mile long is preserved in the East End section of East Liverpool, and much of the central part of that city is built upon another terrace of about equal size. This is the terrace Lessig (1959, fig. 3) illustrated as the "770-740 foot terrace" and called "Illinoian" (1961b, fig. 1). The terrace remnants have an elevation of about 760 feet, some 50 or 60 feet above the lower Kent (Woodfordian) terrace. Equally large remnants of Titusville terrace are present across the Ohio River at Georgetown, Pennsylvania, which is the site of a very large gravel pit; at Newell, West Virginia; and at Waterford Park, West Virginia.

The soil of the terraces has been studied in great detail by Lessig (1961b) and Lessig, Hale, and Yohn (1968). Lessig (1961b, p. 294) found that the soils developed on the Titusville ("Illinoian-age") terraces and on the Kent ("Wisconsin-age") terraces "have similar profiles" but that the latter soils "are not as strongly formed and as deeply weathered." Later, the soils on the Titusville terraces were given the name Negley Series, and those on the Kent terraces, Chili Series (Lessig, Hale, and Yohn, 1968, p. 68-70, 79-80). The Titusville gravels generally are leached 17 feet or more, the Kent gravels about 6 to 7 feet (Lessig, 1961b, p. 289, 291).

FARMDALIAN SUBSTAGE

After the deposition of the Titusville Till the ice retreated, and a period of weathering and erosion, known as the Farmdalian Substage, followed. In Illinois the stage has a carbon-14 date of about 27,000 to 21,000 years B.P. (Willman and Frye, 1970, p. 87). Presumably the period of erosion in Columbiana County was at least that long. A part of the soil on the Titusville Till in the area of outcrop was formed during Farmdalian time. The character of the weathered material preserved at some places below later till has already been described.

WOODFORDIAN SUBSTAGE

Kent Till

The Kent Till has been traced from its type locality at Kent in Portage County, Ohio (White, 1960, p. 5), around the marginal part of the Grand River lobe into Columbiana County.

Location and extent.—The Kent Till is present at the surface in an east-west belt across the county north of the outcrop of Titusville Till. It is present below younger Lavery Till in the northern part of the county. However, the Lavery Till in much of its extent is very discontinuous and patchy, and the Kent Till actually is the surface till over much of the northern half of Columbiana County. The southern margin of the Kent Till, as shown on plate 1, extends across the central parts of West, Hanover, Center, and Elk Run Townships and across the northern part of Middleton Township to the Ohio-Pennsylvania state line.

The Kent Till is generally thin and not everywhere present, so at places the underlying Titusville Till is at or very close to the surface. This is particularly true in many parts of the Kent Moraine, where gravelly Titusville Till or Titusville kames are at or very close to the surface.

Color and composition.—The unweathered Kent Till is gray, but the upper part is oxidized to yellow brown. The till is compact, but not nearly so hard and dense as the Titusville Till. It is mealy and picks more easily than the Titusville Till.

The Kent Till is a sandy, pebbly to stony till with a mean composition of 43 percent sand, 30 percent silt, and 27 percent clay (table 2). The feldspar content ranges from 8 to 25 percent, but the mean of 15 samples is 13 percent, which contrasts with the mean feldspar content of 7 percent for the Titusville Till. (For discussion of the general southward decrease in feldspar content of the Kent Till see Gross and Moran, 1971.)

Weathering character.—As the Kent Till is generally thin, weathering at many places has extended through the Kent Till into the underlying Titusville Till. Kent Till thick enough to preserve unweathered, unoxidized gray till is rarely seen. The upper part of the Kent Till is oxidized to a yellow brown, in contrast to the olive-brown Titusville Till. The depth of leaching is generally between 5 and 6 feet. The weathered horizons at a typical exposure are shown in figure 4.

Weathering of the Kent Till yields a well-drained soil of the Wooster-Canfield Series (Lessig, Hale, and Yohn, 1968, general map). Where the Kent Till is more sandy and gravelly, including the areas of gravelly moraine, the soils are of the Chili Series.

Stratigraphic position.—The Kent Till is underlain by the Titusville Till. North of the margin of thin Lavery Till the Kent Till is discontinuously overlain by thin Lavery Till. In Knox and northern Perry Townships north of the margin of thicker Lavery Till the Kent Till is generally concealed by the younger till.

Age and correlation.—The Kent Till has been traced from its type locality near Kent, Ohio, across Portage and Stark Counties to Columbiana County. It is correlated with the Navarre Till of the Killbuck lobe (White, 1963, p. 122; 1967, p. 23). The Kent Till has a probable age of about 24,000 years at Cleveland (White, 1968, p. 750), so the age of the Kent Till in Columbiana County is less than this by the amount of time it took the ice to advance from Cleveland to the margin. Perhaps a figure of 21,000 years for the Kent Till in Columbiana County is within reason.

Kent kames and kame terraces

Kame terraces are prominent in the valley of the Mahoning River and its tributaries entering the valley near North Georgetown in Knox Township; in the valleys of Middle Fork and East Branch of Middle Fork, principally in Salem Township; in the valley of Little Bull Creek in northeastern Elk Run and northwestern Middleton Townships; in the valley of Bull Creek in Unity Township; and in the valley of North Fork Little Beaver Creek in northeastern Unity Township.

Although many of these kame terraces are within the area over which Lavery ice advanced, they were not formed

by that ice, which at some places deposited discontinuous, very thin Lavery Till over the gravel of the terraces. Many of the terraces have elements of Titusville gravel in them, and it is difficult to determine just what part of a terrace is Titusville in age and what part is Kent. In the large gravel pits in the valley of Middle Fork on either side of the Columbiana-Mahoning County line, the gravel has a cover of several feet of Kent Till, with very thin and discontinuous Lavery Till overlying this till at places. This shows that in this locality the bulk of the gravel is Titusville in age.

These terraces provide a large source of sand and gravel and many pits have been opened in them, although, except in the Middle Fork valley, most are small or abandoned. The gravel ranges from sandy gravel to coarse, cobbly, or even bouldery material, a characteristic of kame gravels.

In addition to the kames that are part of the terraces, separate kames occur within the Kent Moraine. Such kames are present in secs. 11, 14, and 35 of Perry Township and secs. 20, 29, and 30 of Salem Township. They may be kames of Kent age, or they may be kames of Titusville age projected through a thin cover of Kent Till. Kames are present at the Kent margin in the NE¼ sec. 19, Elk Run Township, at the Ohio Routes 11 and 154 interchange 2 miles east of Lisbon. In the pits there, coarse, cobbly Kent gravel interfingering with Kent Till overlies gravel of Titusville age (fig. 17).

Kent outwash

At levels below the kame terraces in some of the valleys are valley trains or their remnants which were deposited by meltwater streams flowing from Kent ice upstream. Later, when the supply of sand and gravel ceased because of retreat of the ice to the north, the stream changed from depositing to eroding, and the valley trains were dissected and floodplains formed.

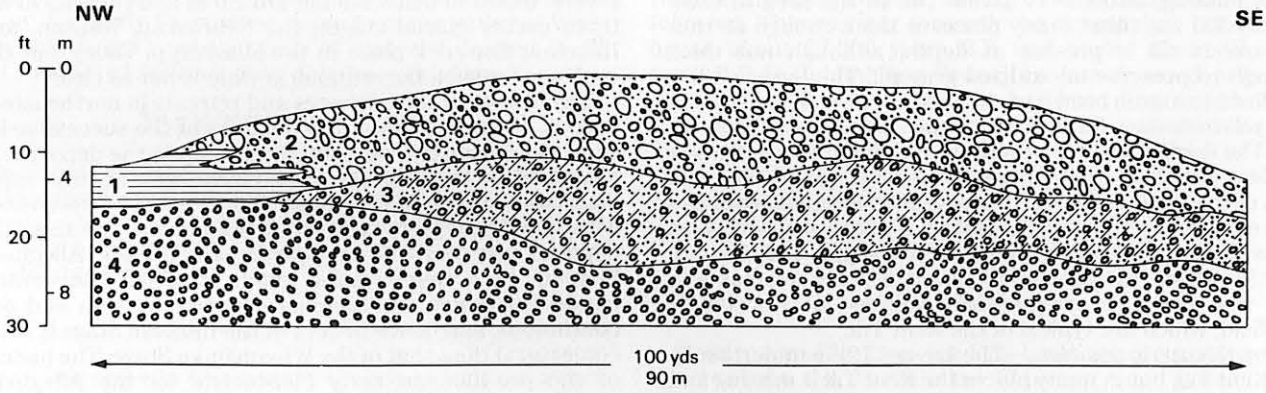
Such valley-train remnants, now low terraces, are especially prominent in the valley of Conser Run from sec. 18, West Township, at an elevation of 1,180 feet, to its junction with Sandy Creek at East Rochester, where its elevation is 1,100 feet. The terrace continues down Sandy Creek to Minerva at the Columbiana-Carroll County line at an elevation of 1,060 feet, and thence as a massive valley train across Stark and Carroll Counties. Farther upstream in the Sandy Creek valley in West Township, where the valley becomes wider, remnants of a Kent valley train are preserved. This terrace, which has a relatively low gradient, ranges in elevation from 1,100 feet at the West-Hanover Township line to 1,080 feet at Bayard.

The Kent valley train in the valley of Middle Fork extends as a terrace below the higher Titusville terrace from Lisbon, at an elevation of about 980 feet, 4 miles downstream to Elkton, at an elevation of about 920 feet. The business section of Lisbon is built on this terrace. Downstream from Elkton to the junction of West Fork and Middle Fork to form Little Beaver Creek the Kent terrace is poorly preserved. (The profile of this terrace is shown in Lessig, 1961b, fig. 2.) In the valley of Little Beaver Creek, only small terrace remnants of the Kent valley train are preserved.

The large valley train in the valley of North Fork Little Beaver Creek in Pennsylvania enters Ohio at Negley, where its elevation is about 860 feet, and continues south for 2 miles, at an elevation of about 840 feet. South of Achor the valley becomes constricted and only very small remnants of the valley train remain. The Kent terrace is the lower of the two terraces on which Negley is built, the upper one being Titusville in age.

The Kent terrace in the Ohio River valley consists of remnants of a great outwash plain at 700-720 feet, some 50 to 60 feet below the higher Titusville terrace and about 50 feet above river level (fig. 5). The terrace is generally continuous from the Ohio-Pennsylvania state line to East Liverpool, where it is as much as ¼ mile wide in places. It is very narrow in the central part of East Liverpool, but is much wider across the river in Chester, West Virginia. Most of Wellsville is built on the Kent terrace, which is about ¼ mile wide and about 2 miles long (Lessig, 1961b, fig. 1).

The material of the Kent terrace is sandy to medium gravel with some cobbles. The lithology of the unweathered material of the terrace near Elkton has been described by Lessig (1961b, p. 289) as "41% sandstone, 17% limestone, 12% quartzite, 9% chert, 9% granite, 8% concretions, 4% quartz." The soil developed on the Kent outwash terraces is generally of the Chili Series (Lessig, 1961b, p. 290; Lessig, Hale, and Yohn, 1968, p. 68).



1. Till, yellow-brown, sandy; leached 5 feet. KENT
2. Gravel, coarse, cobbly, brown; leached 6 feet. KENT
3. Colluvium, rubbly (angular sandstone and shale); much clay; exceedingly rare igneous pebbles. FARMDALE
4. Gravel, brown and gray, distinctly cross-bedded. TITUSVILLE

FIGURE 17.—Sketch of wall of gravel pit at interchange of Ohio Routes 11 and 154 in NE¼ sec. 19, Elk Run Township.

Lavery Till

The Lavery Till has been traced from its type locality at the hamlet of Lavery in Erie County, Pennsylvania, 4½ miles west of Edinboro (Shepps and others, 1959, p. 38), across northeastern Pennsylvania into Ohio.

Location and extent.—The Lavery Till in both Pennsylvania and Ohio exists in a thin phase and a thick phase (White, Totten, and Gross, 1969, p. 36). Most of the area of Lavery Till in Columbiana County is in the thin phase. Only a very small area north of Salem and a larger area which includes most of Knox Township exhibit the thick phase. The outer margin of the Lavery Till (thin phase) extends across northern West Township, northern Hanover Township, northwestern Center Township, southeastern Salem Township, northwestern Fairfield Township, and northern Unity Township.

Within the thin-phase area the Lavery Till is present only as isolated small patches, between which the Lavery Till is either absent or so thin it is incorporated into the present soil and the surface drift appears to be Kent Till. Indeed, many square miles of the thin-phase area show no signs of the presence of Lavery ice until fortuitous roadcuts or repeated augerings discover patches of Lavery Till that show the Lavery ice indeed extended over the region.

The extent of Lavery Till in the thick-phase area is more obvious, as the surface material is recognizably Lavery Till and has characteristic soil formed upon that till. In this area the thickness may be as much as 10 feet, but is generally not more than 5 feet and commonly is less.

Color and composition.—The unweathered Lavery Till is gray, but in Columbiana County it was not seen in any exposure of sufficient thickness to preserve unoxidized till. The Lavery Till is compact and has a tendency to break into roughly prismatic, nutsize fragments, quite in contrast to the mealy Kent Till or the hard, dense, tough Titusville Till.

The Lavery Till is sparingly pebbly, silty, and noticeably less pebbly and stony than the Kent or Titusville Tills. The average of five calcareous samples is 26 percent sand, 45 percent silt, and 29 percent clay. The average feldspar content is 20 percent and the average quartz content is 80 percent (table 2).

Weathering character.—In almost all the Lavery Till exposures in the thin-phase area, weathering has extended through that till into the underlying Kent Till, or where that till is missing, into the Titusville Till. In the area of thick Lavery Till the till at many places is thick enough so that calcareous till is present at depth, although not thick enough to preserve unoxidized gray till. The Lavery Till is oxidized to a drab brown to chocolate brown, in contrast to the yellow-brown Kent Till and the olive-brown Titusville Till. The depth of leaching is generally about 4 feet (fig. 4).

Weathering of thick-phase Lavery Till yields silt loam soils of the Rittman Series on moderately drained areas and of the Wadsworth Series on somewhat poorly drained areas (Lessig, Hale, and Yohn, 1968, general map, p. 112, 115). In the thin phase the patches of Lavery Till are so small and thin that the soils are generally mapped as Wooster or Canfield, which are typical of the Kent Till.

Stratigraphic position.—The Lavery Till is underlain by the Kent Till, but in many places the Kent Till is missing and the underlying material is Titusville Till (fig. 12). The Lavery Till is the youngest in the region, so where it is present it is the surface till.

Age and correlation.—The Lavery Till has been traced from its type locality in Pennsylvania (White, Totten, and Gross, 1969) into Ohio. It is correlated with the Hayesville Till of the Killbuck lobe. No wood or other organic matter which could provide a carbon-14 date has been found in association with the Lavery Till in Columbiana County. However, it seems reasonable to consider a figure of about 17,000 to 19,000 years B.P. for the age of the Lavery Till in Columbiana County.

Lavery kames and outwash

No kames or kame terraces of Lavery age have been identified in Columbiana County. The large kame terraces within the Lavery area on plate 1 are all pre-Lavery in age, and in some places Lavery Till can be seen to overlie the gravel of the terraces. The areas of kames and gravelly moraine on plate 1 are all pre-Lavery, for Lavery Till is seen at places to overlie these areas; indeed at many places Kent Till also overlies the kame gravels, which are primarily of Titusville age.

No valley trains of Lavery age have so far been identified. It is possible that a small upper portion of the terraces described as Kent may be Lavery outwash, but there is no proof of this. If any Lavery outwash is present it is most likely part of the silty, sandy outwash in the low wide depression of the Mahoning River valley in northern Knox Township.

PLEISTOCENE HISTORY

The Paleozoic sedimentary rocks of northeastern Ohio were uplifted at the end of that era and erosion took place for about 200 million years, during the whole of Mesozoic and Tertiary time. At the end of the Tertiary Period, lowered temperature and persistence of snow ushered in the Pleistocene or Glacial Epoch. The Pleistocene began possibly as much as 2 million years ago. At least four times during the Pleistocene, ice sheets formed over Labrador and spread out from this center. Ice flowed southwest into the basin of the Great Lakes and spread south into northeastern Ohio from the Erie basin.

Between each of the glacial stages the ice completely disappeared as the climate warmed, and weathering and erosion of the glacial deposits took place. During the last glacial stage, the Wisconsinan, the ice front fluctuated, advancing and retreating for distances of a few miles to several hundred miles. Similar advances and retreats in the three earlier glacial stages, the Nebraskan, Kansan, and Illinoian, also took place in the Mississippi Valley, but the evidence for such fluctuations in Ohio is not as clear.

The history of the advances and retreats in northeastern Ohio is determined from the deposits of the successive ice sheets and from the weathered zones upon the deposits, as described in this report. Later Pleistocene history, especially that of the Wisconsinan Stage, can be determined with a considerable degree of confidence because the deposits are more or less preserved. On the Allegheny Plateau, to a much lesser extent than in the central Mississippi Valley, the Illinoian deposits are thin and discontinuous, and hence history of the Illinoian Stage is more conjectural than that of the Wisconsinan Stage. The history of the pre-Illinoian early Pleistocene on the Allegheny Plateau in Ohio and Pennsylvania is not at all clear and is mainly conjectural. In contrast, in the central Mississippi Valley, early Pleistocene deposits separated by interglacial deposits are preserved in some amount, and the history there is much firmer, although still not as detailed and secure as that of the later Pleistocene. On the Allegheny

Plateau, of which Columbiana County is a part, the early ice advanced into an area of considerable relief. After deposition of the earliest deposits, a great deal of erosion took place, removing much of the material and leaving only the most meager remnants. These remnants cannot be traced continuously as can deposits of the later Pleistocene. The discussion of the earlier Pleistocene stages for Columbiana County can therefore only be tentative, based on the materials and observations in the county as well as in adjacent Pennsylvania (White, Totten, and Gross, 1969, p. 54-59; White, 1982).

NEBRASKAN STAGE

No firm, unequivocal evidence of the advance of Nebraskan ice into Columbiana County exists, but the few very sparse erratics in Columbiana County and Carroll County beyond the glacial boundary as mapped may be the remnants of drift of an early ice advance, which may have been Nebraskan. The Calcutta Silt, which is present on uplands at elevations as high as 1,180 feet, records damming of northward-flowing streams then flowing at a much higher level than the present drainage. The ice which dammed these streams was certainly very early Pleistocene, as early as Nebraskan (and possibly even earlier?). In the Ohio River valley the highest outwash deposits, now preserved in small terrace remnants at an elevation of about 1,000 feet at Wellsville, are very old, but not as old as the Calcutta Silt. They may represent outwash deposits of melting Nebraskan ice someplace to the north after drainage was established in a southerly direction in the Ohio River valley.

AFTONIAN STAGE

During the Aftonian Interglacial Stage, weathering and erosion took place for a long time, as known from evidence in states farther west. It is possible that the beginning of deep weathering of the outwash at Wellsville dates from this time.

KANSAN STAGE

Direct evidence for a pre-Illinoian glaciation, which may have been Kansan in age, is the occurrence of deeply weathered till in several places, most prominently near Elkton. The early Pleistocene deposits in the valley of West Fork, which are made up only of material derived from local weathered bedrock, may date from this time.

YARMOUTHIAN STAGE

The intense weathering horizon developed in the Kansan till at Elkton presumably represents interglacial weathering during the Yarmouthian Interglacial Stage. The intensity of this weathering indicates that the period involved was of considerable length.

ILLINOIAN STAGE

Ice advanced into Columbiana County at least once and probably more than once during the Illinoian Stage. In a few exposures in strip mines, deeply weathered Mapledale Till overlain by younger deposits is evidence of the advance of this ice. This ice sheet advanced to essentially the same position as that of the earliest Wisconsinan ice, and in some places may have advanced as much as a mile or so beyond the farthest Wisconsinan boundary. Farther east in Pennsylvania the Illinoian ice which deposited the Mapledale Till did advance a mile to several miles beyond the Wisconsinan boundary. Outwash from the melting Illinoian ice was deposited in stream valleys beyond the ice; some of the higher outwash remnants in the valleys of Little Beaver Creek and its tributaries are probably of Illinoian age. In the Ohio River valley, outwash now preserved as small terrace remnants at elevations of about 850 feet may be the meltwater deposit of an Illinoian ice sheet farther to the north.

SANGAMONIAN STAGE

A long period of warmer climate, known as the Sangamonian Interglacial Stage, followed the retreat of the Illinoian ice. This interglaciation is represented by weathering developed on the Mapledale Till and associated deposits, as well as by colluviation of valley sides, as shown by the presence of deep colluvium over the outwash deposits in the eastern part of East Liverpool. The length of the interglacial interval is indicated by the erosion of a large part of the Illinoian deposits before the next ice advance. No interglacial deposits, such as lacustrine silt and peat, have been discovered in Columbiana County.

WISCONSINAN STAGE

ALTONIAN SUBSTAGE

The Titusville Till of the Grand River lobe was deposited during a major and long-continued advance which consisted of several pulses. It was this advance which deposited the great bulk of the drift in the glaciated part of Columbiana County. Large amounts of sand and gravel were deposited on top of and beside melting masses of ice. These deposits still remain as kames in the area where Titusville drift is at the surface, or as buried kames (gravelly moraine) in the area farther north, where later Wisconsinan till is the surface material. The Titusville ice probably disappeared from Columbiana County about 30,000 years ago.

FARMDALIAN SUBSTAGE

After the retreat of the Titusville ice sheet, a period of weathering and erosion lasting several thousand years followed. This warmer interval, the Farmdalian Substage, began about 27,000 years B.P. and ended about 21,000 years B.P. In Columbiana County no datable wood, organic silt, or peat from this interval has been discovered. The evidence for a period of warmer climate after the disappearance of the ice is the weathered upper surface of the Titusville Till, preserved in part in some places where covered by later deposits.

WOODFORDIAN SUBSTAGE

Kent advance

Readvance of ice from the Erie basin about 24,000 years ago brought the Farmdalian Substage to a close. Late Wisconsinan ice advanced into Columbiana County to a line only a few miles north of the limit of Titusville deposits and deposited the Kent Till. The deposits of this advance are generally thin and the hummocky (morainic) character of the surface of this till is in large part a reflection of the underlying irregular surface of the Titusville Till. As the Kent ice dissipated, meltwater draining along the sides of

remaining ice masses in valleys deposited small amounts of gravel and sand, the remnants of which are associated with the much larger kames and kame terraces of earlier Titusville age. The Kent ice disappeared about 20,000 years ago, retreating at least as far as the Erie basin.

Lavery advance

The time of advance of Lavery ice into Columbiana County is not known, but it may have taken place about 19,000 years ago. The Lavery ice stopped 1 to 4 miles short of the previous Kent advance and deposited a thin discontinuous layer of till over a marginal belt several miles wide. Farther north, however, in the northern part of the county, Lavery Till is thicker and more continuous. No extensive outwash deposits were formed in the dissipation of the Lavery ice, presumably because the till, which would have supplied the gravel, was not very pebbly. Following the melting of the Lavery ice in Columbiana County, perhaps 17,000 years ago, ice did not again invade Columbiana County, although the later Hiram ice advanced across much of Mahoning County to reach almost to the Mahoning-Columbiana County line in the area east of Alliance. A minimum radiocarbon age for the Hiram advance is 14,290 ± 130 years B.P. in Richland County, determined from wood in silt overlying Hiram Till (Totten, 1973, p. 47).

POSTGLACIAL HISTORY

Following the retreat of the ice, the climate in Ohio and in Columbiana County ameliorated. During the postglacial period, vegetation and animal life gradually migrated back into former habitats as climatic and ecological conditions permitted. Alluvium, consisting mainly of silt and clay, was deposited in most of the valleys, and organic silt and peat accumulated in the kettle holes. Postglacial erosion has removed some drift from hillsides, although much of the erosion which removed the earlier drift beyond the Woodfordian boundary took place during the Pleistocene itself. Weathering and soil-forming processes have formed the present soils on the glacial drift during the postglacial period.

MINERAL RESOURCES

Columbiana County is rich in mineral resources. The great coal, clay, and shale formations have long been important in the economic life of the county. In earlier years iron ore and limestone have been important resources. Oil and gas are produced in relatively small amounts. The bedrock resources have been described in detail in Bulletin 28 (Stout and Lamborn, 1924) and in later publications of the Ohio Geological Survey.

The glaciation of Columbiana County has resulted in several valuable natural resources, of which sand and gravel deposits are among the most important. Gravel deposits not only provide industrial aggregate, but also are aquifers containing large supplies of ground water. Peat, which has accumulated in kettle holes, is another potential resource. The rich soils are derived largely from the glacial drift which covers the northern half of the county.

The map, descriptions, and discussions in this report indicate the location of promising areas for development of sand and gravel, peat, and ground-water resources as well as areas of little or no promise. This report provides a guide or basis for detailed examination or exploration of any given site being considered for development. No report covering an area as large as a county can be considered a detailed site study; this report is intended to be a guide for such detailed studies and to provide a geological framework of reference for landowners, mineral producers, land-use planners, and others so they may know what general geological situations and constraints may be expected in any given area.

SAND AND GRAVEL

Sand and gravel are plentiful in the northern half of the county. Some large pits have operated in the past and a number of smaller pits are operated intermittently, primarily for township road surfacing and other local uses.

The most evident large supplies of sand and gravel are in the kames terraces, as shown on plate 1, in the valleys of Sandy Creek, Conser Run, the Mahoning River and the tributaries entering it near North Georgetown, Middle Fork Little Beaver Creek from the Columbiana-Mahoning County line to Teegarden, East Branch of Middle Fork from Columbiana past Leetonia, Bull Creek from the Columbiana-Mahoning County line past New Waterford, Leslie Run and its tributaries near East Palestine, and North Fork Little Beaver Creek in the extreme northeast corner of the county.

Much of the sand and gravel of the kame terraces is above the water table, in places tens of feet above. The deposit may be many tens of feet thick and extend below the water table, so that dragline scrapers must be used to excavate the lower part. Dredges have been used elsewhere in Ohio for very large operations below the water table.

The sand and gravel in some parts of the kame terraces have a covering of till which may be many feet thick. The texture and composition of the gravel in the kame terraces is variable and may depend on the age of the deposit. The gravel in the valleys west of Salem is coarse and even bouldery; elsewhere the gravel ranges from cobbly to sandy. Although no detailed analysis of hardness and durability have been made in this study, it is known that gravels of later age are generally of lower quality.

Because texture and composition may differ greatly over short distances, careful investigation is wise before planning extensive operations. Any large-scale sand and gravel operation must produce a finished product that will meet state requirements. Finishing may include crushing, washing, and screening. If gravels of markedly different quality occur within an area, beneficiating low-quality gravel and blending it with high-quality gravel may produce a product that meets specifications. The occurrence of masses of very high quality gravel in a region of lower quality material is known elsewhere in the Allegheny Plateau. The cause of the pockets or areas of exceptionally good gravel is not clear, but age differences may play a part.

In addition to the kame terraces, there are individual kames, as shown on the map, both within the area of Titusville Till and within the area covered by the ice that deposited the Kent Till. Within the Titusville Till area, the large kames south of Bayard have supported large pits in the past and much sand and gravel have been removed. The kame area south of Mill Rock in Middleton Township is reported to contain at least 60 feet of gravel in places.

The kames north of the Kent boundary seem to be the tops of larger buried kames. The areas mapped as gravelly moraine within the Kent Moraine may include kames close to the surface. A large area of such gravelly moraine covers many square miles west and southwest of Guilford Lake.

The areas mapped as gravelly moraine in secs. 8, 9, 15, 16, and 17 of Center Township are promising sites for exploration for gravel below a till cover. By study of water-well records, exploratory drilling, and geophysical exploration, areas of promising sand and gravel supplies might be delineated.

The outwash terraces in Columbiana County contain considerable sand and gravel supplies. Some terraces, such as those in the Mahoning River valley southeast of Alliance, are silty rather than gravelly and are close to the water table, as are those east of Guilford Lake. The terraces at Lisbon have been built upon and the gravel is unavailable. The terraces at two levels at and near Negley and Achor contain much gravel, but buildings are on part of them.

Large deposits of sand and gravel exist in the terraces of the Ohio River valley, but at East Liverpool and Wellsville the two lower terraces have been built upon. The upper terraces are more suburban, but are densely enough built upon to make excavation now unlikely. In addition, the upper terraces are so deeply weathered that it would be necessary to remove as much as 20 feet of weathered sand and gravel to reach reasonably fresh material. The large terrace at Georgetown, Pennsylvania, just across the Ohio River, contained a large amount of high-quality gravel. A very large gravel operation is rapidly removing this material. The Titusville terrace in the East End area of East Liverpool and in the downtown section of East Liverpool must be gravel of the same high quality.

GROUND WATER

Ground water is a valuable natural resource in Columbiana County. Many municipalities, industries, and rural dwellers depend on wells for their water supply. Ground water is generally available everywhere, though in widely differing amounts and at various depths, from two contrasting types of aquifers—the sandstone bedrock and the Pleistocene glaciofluvial sand and gravel deposits. The water resources of the bedrock are dealt with in Stout and Lamborn (1924) and Stout, Ver Steeg, and Lamb (1943).

Sand and gravel deposits are important aquifers where they have sufficient extent and thickness. Areas with the greatest potential yield of ground water are the preglacial and interglacial drainage channels, which are now wholly or partially filled with glaciofluvial deposits of varying thickness. The greatest yields are from gravel and sand filling the valleys of Sandy Creek, Conser Run, and the Mahoning River and its tributaries in the North Georgetown area. The complex of valleys of Stone Mill Creek, Middle Fork Little Beaver Creek, and East Branch of Middle Fork, chiefly in Salem Township, have large sand and gravel deposits which contain water. The valley of Bull Creek and the valleys that join it from the east near East Palestine contain gravel and sand, and the streams that flow over these provide recharge. The valley of North Fork Little Beaver Creek in the extreme northeast corner of Columbiana County may be an area of potential interest for ground-water development.

The valleys of Little Beaver Creek and its tributaries south of the glacial boundary contain some sand and gravel from place to place, but these valleys are generally narrow and the amount of gravel very restricted. A few of the lower terraces may deserve investigation as ground-water aquifers.

In the Ohio River valley, the two outwash terraces nearest the level of the Ohio River offer potential for water supply, as at some determinable depth below the land surface the water table is recharged from the river, if pumping is sufficient. Large supplies have been developed in outwash gravels in the Ohio River valley in all the states through or past which the river flows.

A possible important source of ground water in the glaciated part of Columbiana County is actually little known—the areas of kames and gravelly moraine within the Kent Moraine in places may consist of sizeable bodies of permeable material. Some areas near streams may actually be kame terraces of Titusville age with a covering of till of later age. These areas deserve to be considered for exploration, at least for wells for domestic water supply.

The Ohio Department of Natural Resources, Division of Water has on file much information which is available for examination by citizens. These data are useful as a basis for indicating areas of favorable possibilities. A map of the ground-water resources of Columbiana County has been published (Crowell, 1978) by the Division of Water.

PEAT

Peat, which for commercial use is commonly known as peat moss, forms by the accumulation of plants in a swamp or bog. In Columbiana County, numerous poorly drained depressions and kettle holes were left by the wasting ice sheet, primarily in the northern portion of the county. These areas of standing water were sites of peat and silt accumulation until the bogs became filled or were drained. Nearly all the bogs in the county are filled, though a few large bogs still contain water.

It is likely that peat from several localities in the county has found local uses in farm gardens and in nurseries. All of the peat deposits examined in Columbiana County have accumulated since the disappearance of Lavery ice about 17,000 years ago.

Peat occurs in the swampy depressions in secs. 5 and 6, Fairfield Township, west of Columbiana, in sec. 6, Unity Township, and in sec. 14, Salem Township, but the thickness and quality are not known. The swampy depression northeast of Salem in sec. 29, Perry Township, and continuing southeast into adjacent Mahoning County contains peat, but the thickness is not known.

Dachnowski (1912, p. 44-45) investigated the peat in the swamp 2 miles east of Damascus in secs. 3 and 4, Butler Township, and reported that it was very thin. He reported that peat in Watercress Marsh in secs. 33 and 34, Butler Township, had "sandy layers," but did not record the thickness. The deposit in the "Guilford Bog" in secs. 7 and 8, Center Township, was reported to average 6 feet in thickness.

PLANNING FOR THE FUTURE

The expansion of population and the growth of industry in Columbiana County have been accompanied by problems in land use. The realization that natural resources such as soil, water, minerals, forests, and even space for building sites are limited, exhaustible, and susceptible to pollution has led to increased emphasis on land-use planning.

Glacial deposits form the surficial materials in the northern half of the county, and this study provides the data concerning surficial deposits necessary for general recommendations for land-use planning. Topics of concern include use of mineral and water resources, potential pollution hazards, and the competition for urban, agricultural, industrial, and recreational land uses.

RESOURCES

SAND AND GRAVEL

The sand and gravel deposits of Columbiana County are extensive and are located near numerous potential markets. Conservation of sand and gravel resources should receive priority in planning: zoning regulations should permit the mining of these deposits, but at the same time should require that it be done wisely. In some parts of the county, regulations may be needed to protect the kame-terrace deposits from being engulfed by urban development. Areas underlain by sand and gravel may be used for agriculture or woodland until needed. At that point, a planned excavation procedure is essential in order to extract the maximum amount of sand and gravel with the minimum amount of disturbance and to provide return of the worked-out pits to agricultural, recreational, or other uses.

GROUND WATER

Underground sources provide water for the municipal, industrial, urban-domestic, and agricultural needs of most of Columbiana County. The major aquifers are the Pennsylvanian sandstones and the thick, extensive, and highly permeable sand and gravel deposits along the major drainage lines. These glacial deposits contain water in sufficient quantities to provide an ample supply for the county, but also, because of their permeability and accessibility, have a high susceptibility for pollution from waste disposal and agricultural or urban activity.

PEAT

Peat deposits are a resource of possible value. Some of the excavation problems must be overcome before the full potential of peat as a mineral resource can be realized. The undrained depressions or bogs in which peat deposits collect do not make suitable industrial or home sites, and conflicts in land use are likely to be less critical than for sand and gravel deposits.

WASTE DISPOSAL

In a populous area underlain by a variety of glacial materials, improper waste disposal may pose a serious pollution problem. Refuse disposal sites and sanitary landfills should be situated in dry impervious materials, such as till, located above the water table. Care should be taken that refuse is not dumped in valley bottoms, where the water table is near the surface, or in tributary valleys, where runoff will wash the waste into the streams. More and more detailed specifications for sanitary landfills are being promulgated, and this report provides information on areas that are more suited than others for such use.

Sewage effluent and liquid wastes present a more hazardous problem than solid waste because these materials find their way quickly into the major drainage lines. Many streams contain too little water flowing too slowly to adequately dilute the waste to an acceptable concentration. A concerted effort by many will be required before the streams of Columbiana County can be considered clean natural resources.

Effluent from septic tanks presents a problem where the tanks are closely spaced, such as in subdivisions; in areas underlain by clayey soil; or in flat, poorly drained areas. The portion of northwestern Columbiana County overlain by thick Lavery Till and the flat areas of silty outwash deposits southeast of Alliance are more poorly suited for septic tanks than most of the rest of the glaciated area.

LAND-USE RECOMMENDATIONS

AGRICULTURE

Columbiana County has long been an important agricultural county, and its location convenient to the markets of heavily populated northeastern Ohio is certain to add to its importance in the future. Although nearly all parts of the county have contributed to agricultural production in the past, conditions of slope, drainage, and soil make certain areas more desirable than others for this purpose. The glaciated part of the county is generally well suited for general farming. Restrictions on urban development in prime agricultural regions may be necessary to protect these valuable soil resources. General farming, including dairying and beef-cattle raising, could be important in the more hilly parts of the glaciated area. The steeper slopes should be kept in pasture, orchards, or woodland to protect the soil from serious erosion.

URBAN DEVELOPMENT

Urban development is a serious problem because it involves accelerated use of ground water, sand, gravel, and agricultural land, and because it pollutes or makes unusable the very resource on which growth depends. Urban development should be carefully planned with respect to other land uses. Development should not be allowed to take over prime farmland, nor should housing on a wide scale be permitted in heavily wooded land or on steep slopes. Many areas within the glaciated part of the county are scenic, but not too steep for safe development. These areas have adequate supplies of ground water from sandstone bedrock or from gravel in buried valleys and can be developed at reasonable cost. The topography is rolling and scenic, but not steep enough that erosion would be a serious problem. Although individual septic tanks may work quite satisfactorily for widely spaced rural homes, septic-tank systems are unsuitable for urban developments. Modern sewage-treatment plants should service all homes in this urban area to minimize pollution.

INDUSTRIAL DEVELOPMENT

The requirements for industrial development are similar to those for urban development. The availability of abundant ground water and construction materials, the nearness to major highways and railroads, a location near large urban markets, and the proximity of cultural, educational, and recreational opportunities make Columbiana County an attractive site for industry. Waste disposal could present a major problem for those industries producing large quantities of solid or liquid wastes.

RECREATION

Recreational uses of land are often considered last, and then only when land is unusable for other purposes. In the future, as the population of northeastern Ohio increases and as a proportionally greater expanse of land is used for urban development, recreational land is almost certain to become a high-priority item. With leisure time increasing, facilities for camping, hiking, picnicking, and other outdoor

recreational activities will be required and should be provided by state, county, or municipal authorities. Such designated areas would also serve as nature and wildlife preserves, protecting the flora and fauna native to Columbiana County. Future development will demand additional facilities, and certain areas should be designated park or forest land before they are appropriated for other uses.

The steep narrow valleys of the unglaciated southern part of the county are the most obvious possibilities for large areas for park use. The valley of North Fork Little Beaver Creek, parts of the valley of Middle Fork, and the valley of Little Beaver Creek below the confluence of the two forks, together with their tributary valleys and ravines, make up an area of high scenic and natural quality. Little Beaver Creek has been designated a wild and scenic river by the State of Ohio and is the site of a state park. There is also a state park at Guilford Lake and state wildlife areas at Highlandtown Lake and Zepernick Lake.

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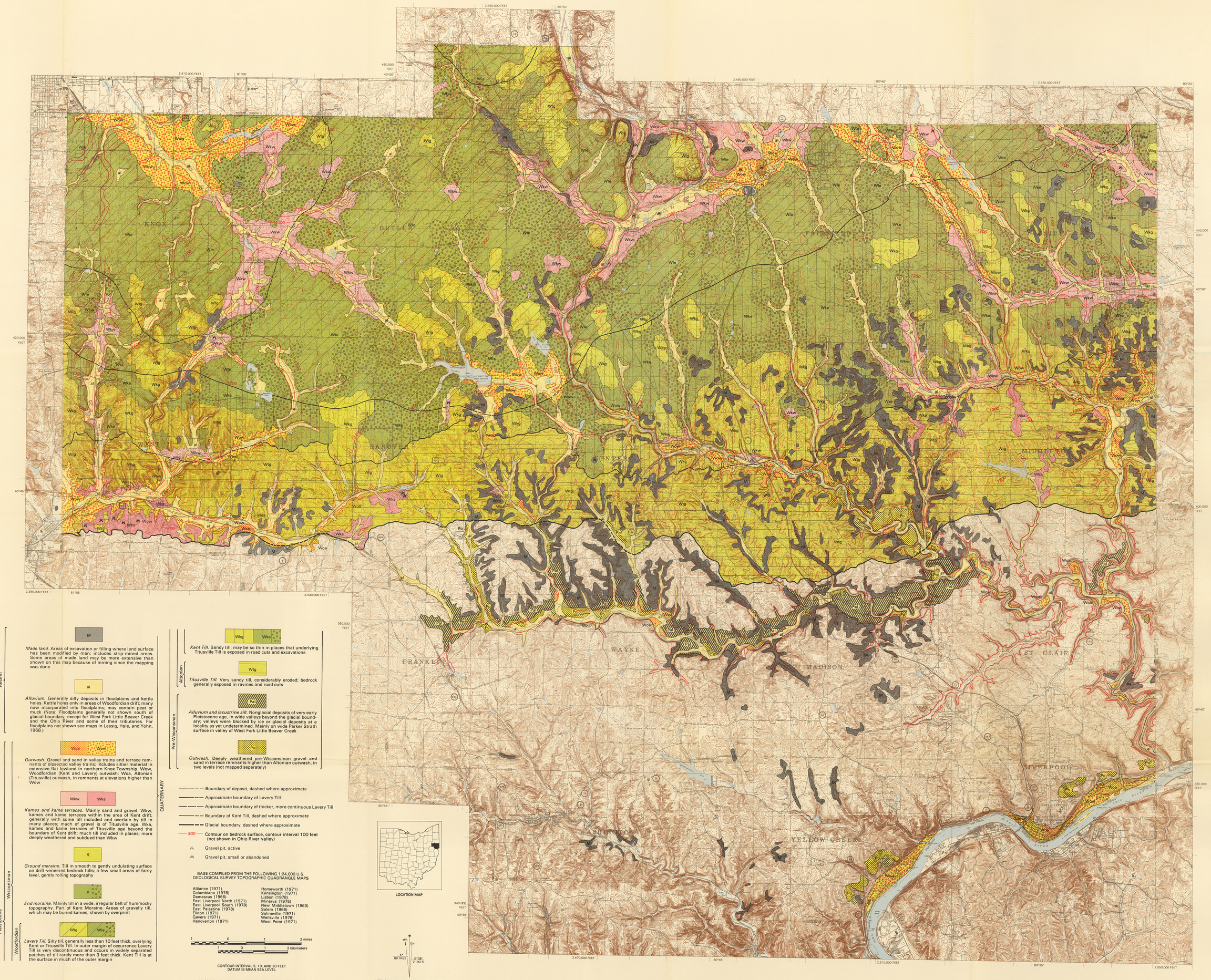
STATE OF OHIO
Richard F. Celeste, Governor
DEPARTMENT OF NATURAL RESOURCES
Joseph J. Sommer, Director
DIVISION OF GEOLOGICAL SURVEY
Horace R. Collins, Chief

DIVISION OF GEOLOGICAL SURVEY
REPORT OF INVESTIGATIONS NO. 129
GLACIAL GEOLOGY OF COLUMBIANA COUNTY, OHIO



Recent

M

Made land. Areas of excavation or filling where land surface has been modified by man; includes strip-mined areas. Some areas of made land may be more extensive than shown on this map because of mining since the mapping was done

al

Alluvium. Generally silty deposits in floodplains and kettle holes. Kettle holes only in areas of Woodfordian drift; many now incorporated into floodplains; may contain peat or muck (Note: Floodplains generally not shown south of glacial boundary, except for West Fork Little Beaver Creek and the Ohio River and some of their tributaries. For floodplains not shown see maps in Lessig, Hale, and Yohn, 1968.)

Pleistocene — Wisconsinan — Woodfordian

Woa | Wow

Outwash. Gravel and sand in valley trains and terrace remnants of dissected valley trains; includes siltier material in extensive flat lowland in northern Knox Township. Wow, Woodfordian (Kent and Lavery) outwash; Woa, Altonian (Titusville) outwash, in remnants at elevations higher than Wow

Wkw | Wka

Kames and kame terraces. Mainly sand and gravel. Wkw, kames and kame terraces within the area of Kent drift; generally with some till included and overlain by till in many places; much of gravel is of Titusville age. Wka, kames and kame terraces of Titusville age beyond the boundary of Kent drift; much till included in places; more deeply weathered and subdued than Wkw

g

Ground moraine. Till in smooth to gently undulating surface on drift-veneered bedrock hills; a few small areas of fairly level, gently rolling topography

e

End moraine. Mainly till in a wide, irregular belt of hummocky topography. Part of Kent Moraine. Areas of gravelly till, which may be buried kames, shown by overprint

Wlg | Wle

Lavery Till. Silty till, generally less than 10 feet thick, overlying Kent or Titusville Till. In outer margin of occurrence Lavery Till is very discontinuous and occurs in widely separated patches of till rarely more than 3 feet thick. Kent Till is at the surface in much of the outer margin

QUATERNARY

Pre-Wisconsinan

Pou

Alluvium and lacustrine silt. Nonglacial deposits of very early Pleistocene age, in wide valleys beyond the glacial boundary; valleys were blocked by ice or glacial deposits at a locality as yet undetermined. Mainly on wide Parker Strath surface in valley of West Fork Little Beaver Creek

Po

Outwash. Deeply weathered pre-Wisconsinan gravel and sand in terrace remnants higher than Altonian outwash, in two levels (not mapped separately)

Altonian

Wkg | Wke

Kent Till. Sandy till; may be so thin in places that underlying Titusville Till is exposed in road cuts and excavations

Wlg

Titusville Till. Very sandy till, considerably eroded; bedrock generally exposed in ravines and road cuts

Boundary of deposit, dashed where approximate

Approximate boundary of Lavery Till

Approximate boundary of thicker, more continuous Lavery Till

Boundary of Kent Till, dashed where approximate

Glacial boundary, dashed where approximate

900 Contour on bedrock surface, contour interval 100 feet (not shown in Ohio River valley)

Gravel pit, active

Gravel pit, small or abandoned

BASE COMPILED FROM THE FOLLOWING 1:24,000 U.S. GEOLOGICAL SURVEY TOPOGRAPHIC QUADRANGLE MAPS

Alliance (1971)
Columbiana (1978)
Damascus (1966)
East Liverpool North (1971)
East Liverpool South (1978)
East Palestine (1978)
Elkton (1971)
Gavers (1971)
Hanoverton (1971)
Homeworth (1971)
Kensington (1971)
Lisbon (1978)
Minerva (1975)
New Middletown (1963)
Salem (1966)
Salineville (1971)
Wellsville (1978)
West Point (1971)

1 0 1 2 miles
1 0 1 2 kilometers

CONTOUR INTERVAL 5, 10, AND 20 FEET
DATUM IS MEAN SEA LEVEL

10,000-ft grid based on Ohio coordinate system, north zone

CONTOURS ON BEDROCK SURFACE BY MICHELE L. RISSER; MODIFIED BY JOEL D. VORMELKER AND GLEN E. LARSEN

JAMES A. BROWN, CARTOGRAPHER

LOCATION MAP

UTM GRID AND 1978 MAGNETIC NORTH DECLINATION AT CENTER OF SHEET

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by George W. White and Stanley M. Totten

1985