STATE OF OHIO
DEPARTMENT OF NATURAL RESOURCES
DIVISION OF GEOLOGICAL SURVEY

REPORT OF INVESTIGATIONS NO. 31

COAL RESOURCES
Of
The Lower Part Of The
ALLEGHENY FORMATION
In Ohio

BY

Richard M. DeLong

COLUMBUS
1957

STATE OF OHIO

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ABSTRACT

This study of the coal resources of the lower part of the Allegheny formation in Ohio considers all coal horizons from the base of the series to the underclay of the Lower Kittanning No. 5 coal bed, but is devoted mainly to the Brookville No. 4 and Clarion No. 4A coal beds. Other coal beds in the lower part of the Allegheny formation are the Ogan, Winters, Scrubgrass, and Lawrence. The Lawrence coal bed which underlies the underclay of the Lower Kittanning coal bed is thin and contributes no reserves anywhere in the state. In southern Ohio all of the other subject coal beds are represented and are of varying economic importance over an area that is generally centered around Vinton County. In northern Ohio the Brookville coal bed is the only one of the subject coal beds that contains reserves.

The Brookville coal bed which is the basal unit of the Allegheny formation contains an estimated 446,215,000 tons of original coal reserve. Of this reserve 338,034,000 tons are confined to the northern field which centers around southern Stark and northern Tuscarawas Counties; the balance occurs in Vinton County. It is a high-volatile B bituminous rank coal suitable for domestic and steam generating purposes.

The stratigraphic position of the Clarion coal bed is approximately midway between the Brookville and Lower Kittanning coal beds. The original Clarion coal reserve is estimated at 715,637,000 tons and is classified as a high volatile B bituminous rank coal.

The Ogan and Winters coal beds occupy positions between the Brookville and Clarion coal beds; the Scrubgrass overlies the Clarion coal bed. The thicker portion of these beds is limited almost exclusively to Vinton County where they have been mined for local use. Throughout their extent these coal beds are variable in thickness and structure and do not constitute an important segment of Ohio's coal reserve.

CHAPTER 1

INTRODUCTION

This, the fifth of a series of reports on the reserves of the Ohio coal beds, includes all coal horizons in the lower part of the Allegheny formation. Of the six coal beds treated in this report two, the Brookville No. 4 and Clarion No. 4A, are of major importance, the other four are of minor or no economic importance.

Previous reports on Ohio coal beds include: The Meigs Creek No. 9 Coal Bed in Ohio, 1952, Division Geol. Survey Rept. Inv. No. 17; The Lower Kittanning No. 5 Coal Bed in Ohio, 1954, Division Geol. Survey Rept. Inv. No. 21; The Pittsburgh No. 8 and Redstone No. 8A

Coal Beds in Ohio, 1955, Division Geol. Survey Rept. Inv. No. 26; and The Coal Resources of the Upper Allegheny Formation in Ohio, 1956, Division Geol. Survey Rept. Inv. No. 29. Three other reports in preparation will evaluate the coal beds of the Pottsville and Conemaugh formations of the Pennsylvanian system and the coal beds of the Permian system in Ohio.

PURPOSE

The purpose of this investigation is to determine, within the limits of available data, the coal reserves in the lower part of the Allegheny formation in Ohio. The tabulations and descriptions of these reserves should serve as guides in prospecting for coal, as a preliminary evaluation of land for owners and coal operators, and as a contribution to the understanding of the solid fuel reserves not only of Ohio but within the United States.

ACKNOWLEDGMENTS

The writer wishes to acknowledge the contributions of the following people who actively assisted and gave encouragement in many phases of this report: Russell A. Brant, Head of Coal Section, and Ralph J. Bernhagen, Chief of the Ohio Division of Geological Survey, both of whom gave many constructive criticisms and valuable assistance in the preparation of this report; to student assistants, especially Jack Hyde, who gave invaluable service in the preparation of maps and illustrations; to Marian S. Klein, who prepared the tabulations of reserves; to many who contributed information about particular areas, and to others who gave active assistance.

APPROACH TO THIS RESERVE STUDY

Two approaches are used in this study of the coal reserves of the lower part of the Allegheny formation : (1) A qualitative discussion in which only a description of the areal distribution of a coal bed is given and (2) a quantitative study in which the outcrops of the coal beds are mapped, isopachous lines drawn, and original tonnage estimated. The extent and economic importance are the factors in determining which approach to use on each coal bed.

The Ogan, Winters, Scrubgrass, and Lawrence coal beds have greater stratigraphic interest than economic importance. The information related herein regarding extent and character of these minor coal beds is gleaned entirely from previous publications.

The methods and definitions used in the study of the Brookville and Clarion coal beds are identical with those followed in previous resource studies made by the Ohio Division of Geological Survey and adopted from the Illinois Geological Survey (Cady, 1952, pp. 14-20). The coal reserves are classified into categories of thickness and reliability, both of which are arbitrarily selected for convenience of work and presentation of reserve figures in a practical manner.

Estimates of coal reserves within a single thickness category include all coal between two isopachous (equal thickness) lines. The coal within the 14-inch and 28-inch isopachous lines may be referred to 14" to 28" or 21-inch average category, and coal between the 28-inch and 42-inch isopachous lines may be referred to as 28" to 42" or 35-inch average thickness category. The area of the coal bed between isopachous lines is assumed to increase or decrease in thickness uniformly and this use of an average thickness makes it possible to

calculate coal reserves by tonnage. In this report coal less than 14 inches thick is not considered a reserve.

DEFINITIONS AND PREMISES

Reliability categories indicate the relative certainty of the presence of minable coal and are established by radii from a point of known coal thickness such as a mine, drill core, or an outcrop. Coal blossom and thickness reported by local residents and coal operators are used in a general way to supplement measured coal but are not considered as definite information.

Proven Reserves

All reserves that lie within a $\frac{1}{2}$-mile radius of a point of definitely known coal thickness are termed proven reserves. This is the highest coal reserve reliability category and is considered to be within 20 percent of the true tonnage.

Probable Reserves

This class of reserve lies outside the proven area and extends to two miles from the point of definite information, and thus occupies a band $1\frac{1}{2}$ miles wide around the boundary of the proven coal.

Strongly Inferred Reserves

The reserves in this category include all coal in the area beyond the outer margin of the probable reserves to a radius of 4 miles beyond the point of known thickness. Thus this category is a belt 2 miles wide around the probable reserves category.

Weakly Inferred Reserves

This category includes all coal that lies beyond the 4 mile radius of the point of information and is the weakest reliability category in the classification. This report does not contain any reserves in this category.

OVERBURDEN

Overburden is the material from the surface of the ground down to the coal bed and is usually reported in steps of 1,000 feet as 0-1,000 feet, 1,000-2,000 feet, and 2,000-3,000 feet in regional resources studies. However, the estimated reserves of the Brookville and Clarion coal beds do not lie at a depth greater than 1,000 feet; therefore overburden figures are not included in this report.

METHODS OF PREPARATION

The methods used in this study are identical with those used in previous coal-bed investigations of Ohio. First a series of base maps 1^{o} longitude by $\frac{1}{2}^{o}$ latitude (commonly called

O'Neill areas) were drawn from U. S. G. S. topographic maps at a scale of 1 : 62,500. On these maps the outcrop of the coal bed was traced and a copy of the map was then made for a work map. All localities and file numbers of the available data were accurately plotted and thickness information was placed on the work map. Any partings exceeding 3/8 inch in thickness were excluded from the measurements of thickness data. After the data were properly plotted at appropriate locations, isopachous (equal thickness) lines were drawn to connect points of equal thickness. The line values used were 14", 28", 42", and 54". The average thickness for the block of coal between two isopachous lines was determined by taking the average of the two lines. All localities, file numbers, and isopachous lines were then copied onto the original map for publication.

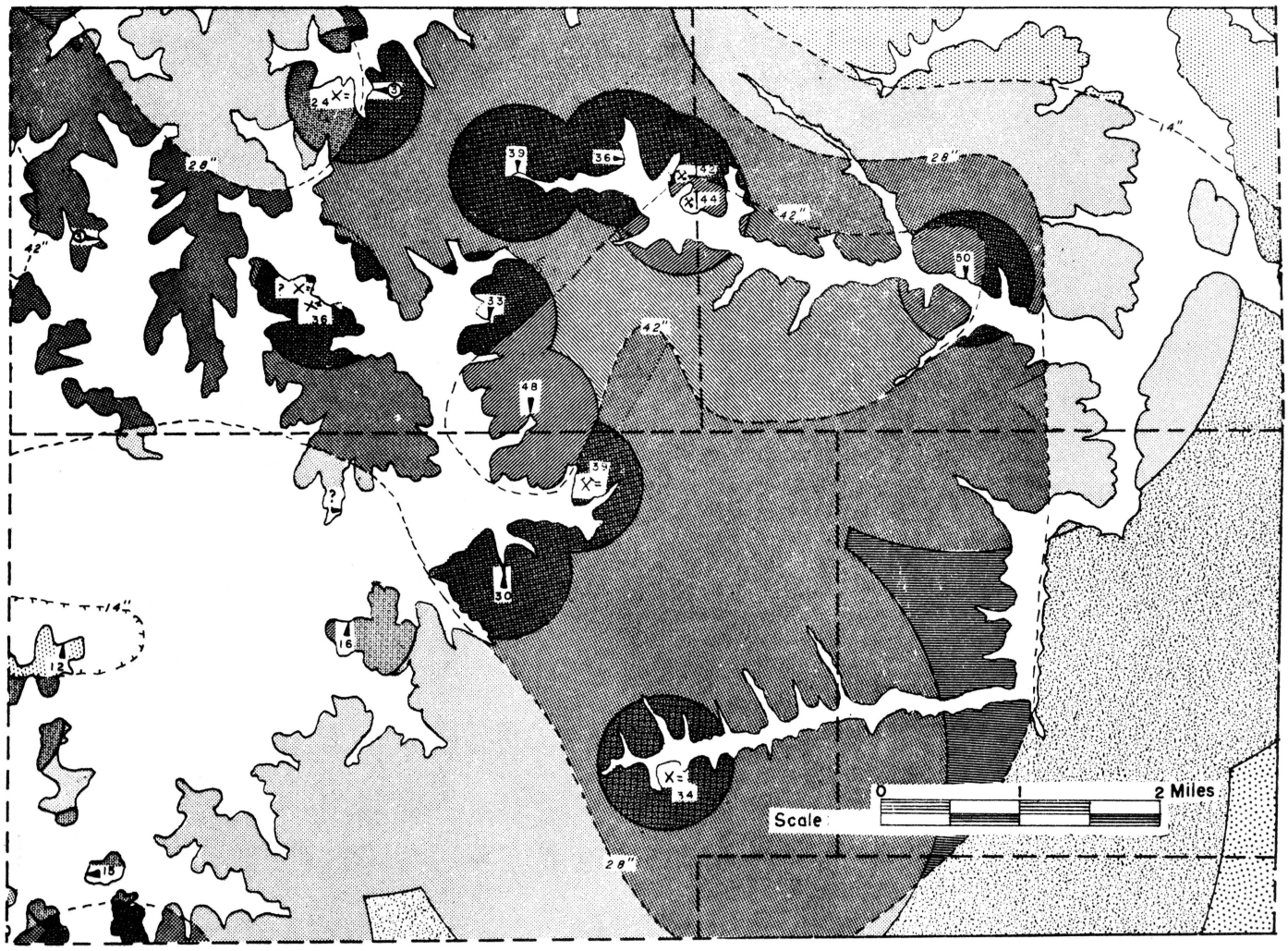
After the thickness lines were established, arcs were made around each point of definite data to determine the different categories of reliability, as described under Definitions and Premises. Certain data could not be used except to confirm, to a small extent, deductions made from other points. Such data include "reported" thickness of coal (thus not seen and not measured), and coal blossom (not definite; actual thickness of bed questionable). Figure 1 is an actual sample map made in the study of the reserves of the Lower Kittanning coal bed.

METHOD OF CALCULATION

In order to calculate the amount of coal contained in a given bed in a given area it is necessary to find two factors, namely the volume and the density of the coal. The volume is determined by measuring the area and multiplying the result by the average thickness; the density is determined from the specific gravity and is equivalent to 96,000 tons per square mile inch.

The volume in square mile inches is multiplied by the density (96,000 tons per square mile inch) to determine the tons for a given area. Eighteen hundred tons per acre foot (one acre in area by one foot thick) is frequently used as a convenient density factor in estimating small areas.

In calculation of the estimate, the areas of the different categories and thicknesses of the coal were measured with a planimeter and the value placed on a special form for tabulating the data.



This map is a copy of a portion of one of the work maps for the Lower Kittanning coal bed (Resources Map, Area 16). The shading has been added to show how the various limits of reliability and thickness are made from the definitions that appear in this report and from the data that are available.

Figure 1. - Sample work map.

CHAPTER 2

GENERAL GEOLOGY

PHYSIOGRAPHY

The lower half of the Allegheny formation lies within the Appalachian Plateau region, partly in the glaciated and partly in the unglaciated portions (Fenneman, 1938, p. 283). The northern area of Brookville coal bed reserve lies in both the glaciated and unglaciated portions. In southeastern Ohio the reserves of the Brookville, Clarion, Ogan, Winters, and Scrubgrass coal beds are confined entirely to the unglaciated section.

The unglaciated section is moderate to strong in relief with narrow sinuous ridges, and is maturely dissected. The dendritic stream pattern has suffered some modification which is most pronounced at the glacial boundary. Outwash materials from the glacier fill some of the valleys but outcrops in this section are common.

The topography of the glaciated section in contrast to the unglaciated section is one of subdued relief as a result of the glacial deposits which vary from a few feet to 300 feet in thickness. This cover of glacial drift has created a low ill-defined and sinuous divide between the Gulf of Mexico and Atlantic seaboard drainage and consequent streams that have erratic directions of flow. Because of the glacial drift outcrops in this section are few.

STRUCTURE

The area underlain by the Pennsylvanian series of rock in Ohio (see Fig. 2) is on the western side of the northern Appalachian Coal Basin and normally has a gentle but steady dip to the south and east. Local flexures as the Cambridge anticline and the Cow Run uplift interrupt the regional trend and result in reversals in dip. However, none of the minor structures has affected the reserve areas of the Brookville or Clarion coal beds.

In southeastern Ohio where all of the Clarion coal and some Brookville coal reserves occur, the rock shows a normal and uninterrupted dip or tilt of 30 to 40 feet per mile to the southeast. In northeastern Ohio where the bulk of the Brookville coal reserves lie the structure has some variability as shown by a normal dip to the southeast to one that is extremely flat with only a slight component to the east and south.

STRATIGRAPHIC RELATIONS

The portion of Ohio's rock column reported here extends from the base of the Brookville coal bed, which is the arbitrary lower boundary of the Allegheny formation, to the base of the

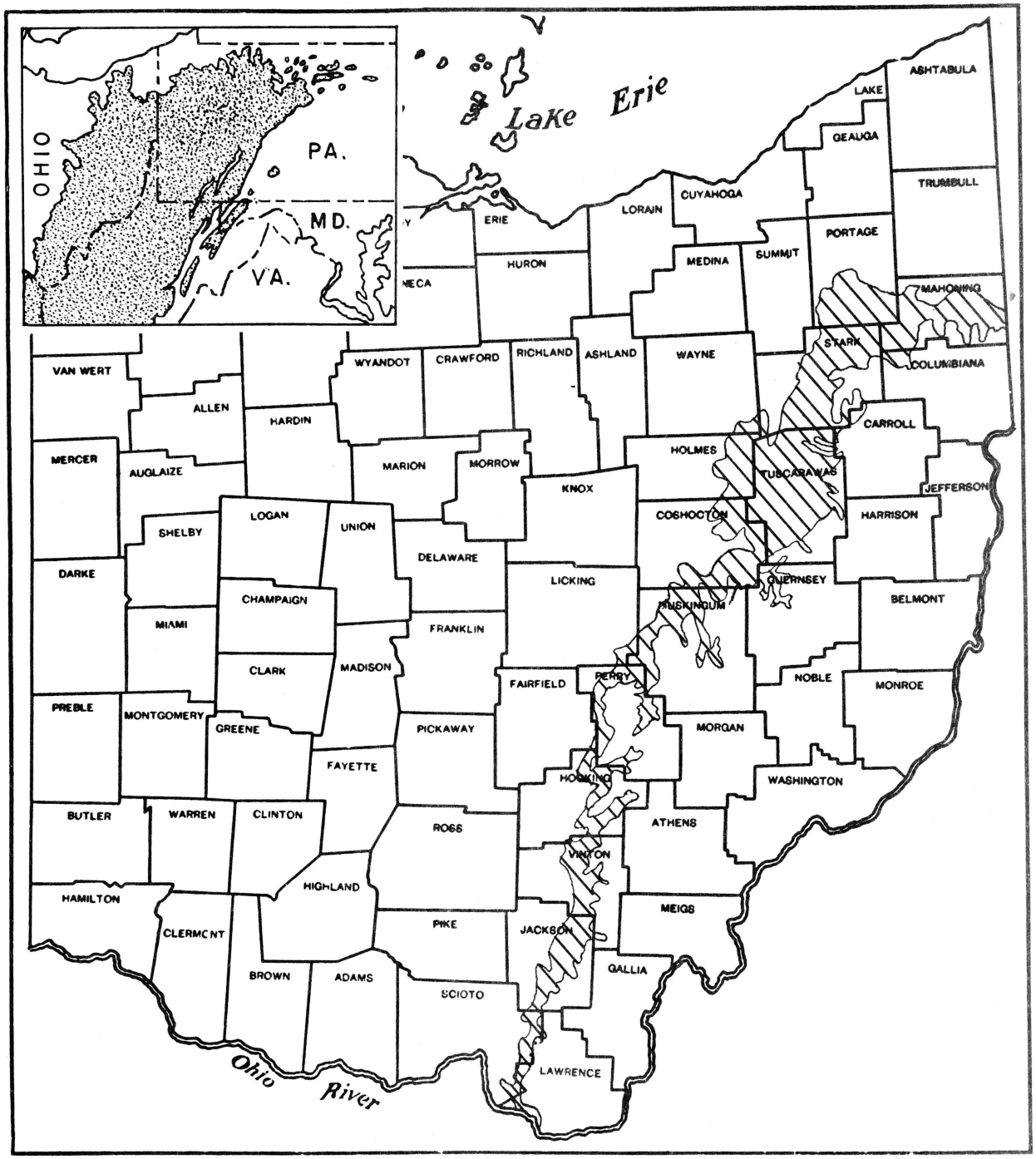


Figure 2. - Generalized map showing the outcrop extent of the lower part of the Allegheny formation in Ohio.

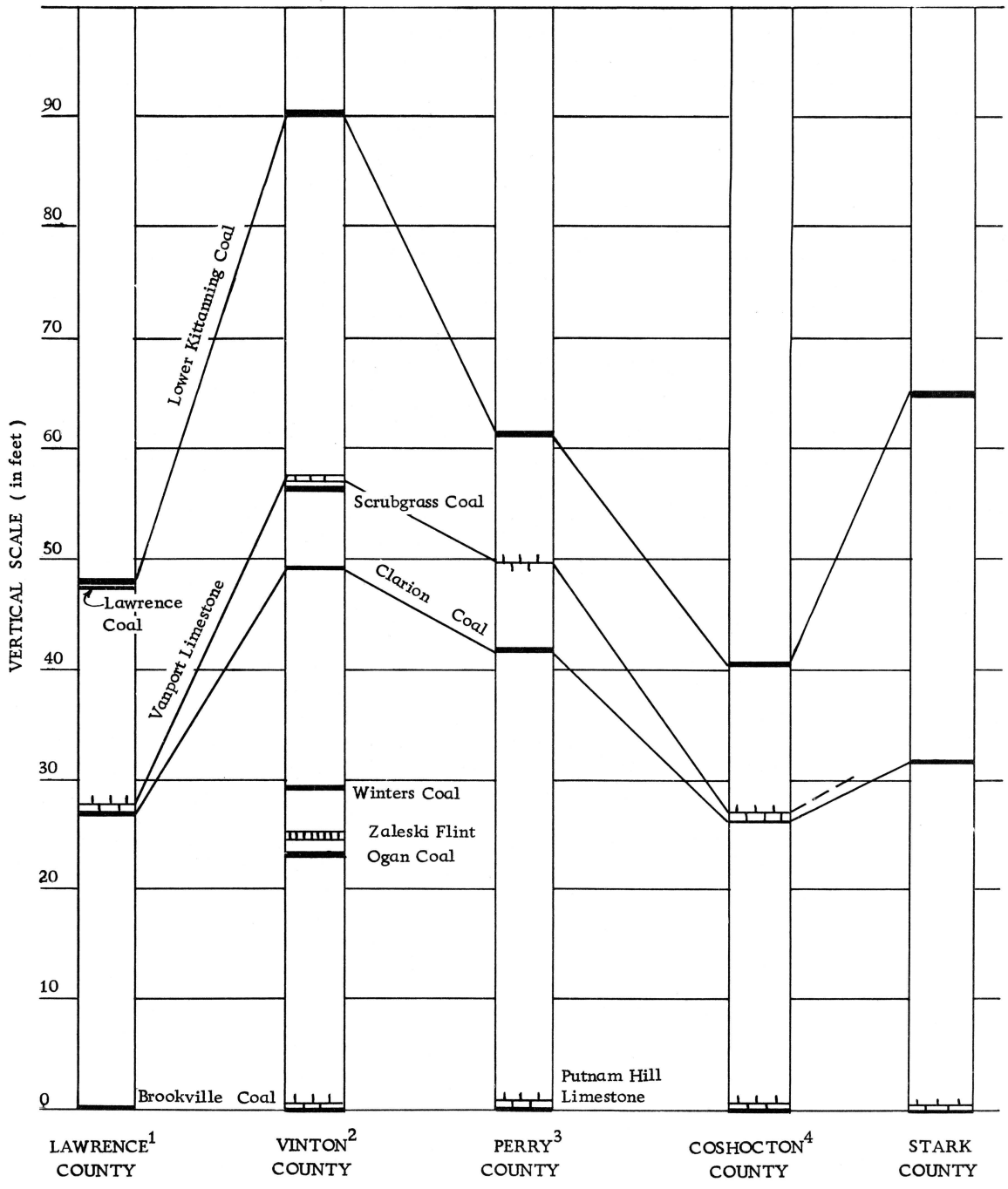
Lower Kittanning coal bed, which is about in the middle of the Allegheny formation. Cyclical sedimentation within this 50 to 100 foot interval has resulted in a vertical repetition of rocks that include coal, marine limestone, shale, sandstone, and underclay. This relationship is shown on the stratigraphic sequence listed below and in Figure 3.

Formation	Member	Kind of material	Ft.	In.
Allegheny	Oak Hill	Clay, flint and plastic	4	0
		Shales, siliceous	3	0
	Hamden	Limestone, unsteady, marine	4	0
	Lower Kittanning No. 5	Coal	2	4
		Clay, plastic	5	0
	Lawrence	Coal, shaly, local	-	4
		Clay, flint and plastic	6	0
	Kittanning	Shale and sandstone	8	2
	Ferriferous	Ore, irregular	-	8
	Vanport	Limestone, marine	6	0
	Scrubgrass	Coal, seldom present	-	6
		Shale, carbonaceous	5	0
	Clarion No. 4a	Coal, patchy	4	0
		Clay, flint and plastic	5	0
	Canary	Ore, very local	-	6
	Clarion	Sandstone, irregular	10	6
	Winters	Coal, very local	1	0
	Zaleski	Flint, impure, marine	1	0
	Ogan	Coal, local	1	0
		Shale and sandstone	25	0
	Putnam Hill	Limestone, marine	4	0
	Brookville No. 4	Coal, steady	2	0

The Putnam Hill limestone directly overlies the Brookville coal, or at some places is separated by a thin carbonaceous shale. This limestone is a widely useful bench for reference because it is found to extend from Lawrence County to approximately the Stark-Columbiana County boundary, where it disappears and can no longer be identified.

About midway between the Brookville and Clarion coal beds are two thin and discontinuous coal beds named the Ogan and Winters. Because of their proximity and discontinuous character these two beds were incorrectly interpreted for many years and both were referred to as the Winters coal bed. However, normally between them there occurs the Zaleski flint, which contains fossils, and the thin underclay of the Winters coal bed. Regarding their depositional relationship Stout states (1927, p. 176): "Although closely spaced, the two coal beds are not depositionally related as they were laid down, not during one continuous period, but during two periods which were separated by the marine invasion that gave rise to the flint stratum." The areal extent of the Ogan and Winters coal beds is confined to southern Vinton and northern Jackson Counties.

The Clarion coal bed lies about midway between the Brookville and Lower Kittanning coal beds. Overlying and closely associated with this coal bed is the Vanport limestone, named for its occurrence at Vanport, Pennsylvania. Although the type area for the Vanport limestone is in close proximity to Ohio this stratum thins and disappears from the section over much of northeastern Ohio. From northeastern Ohio to Hocking County the Clarion coal bed and Vanport limestone are of stratigraphic interest only, but in southeastern Ohio both thicken and are prominent economically and stratigraphically.



[1]Adopted from Stout, W., Geol. Sur. of Ohio, Bull. 20, 1916.

[2]Adopted from Stout, W., Geol. Sur. of Ohio, Bull. 31, 1927.

[3]Adopted from Flint, N. K., Geol. Sur. of Ohio, Bull. 48, 1951.

[4]Adopted from Lamborn, R., Geol. Sur. of Ohio, Bull. 53, 1954.

Figure 3. - Average intervals of coal and limestone beds for the lower part of the Allegheny formation in Ohio.

Tracing the horizon of the Brookville and Clarion coal beds westward from the Pennsylvania-Ohio boundary is difficult and somewhat uncertain because of the glacial drift and the lack of diagnostic features in this part of the section. Both coal beds are too thin and unsteady throughout Mahoning, Columbiana, and Portage Counties to be of economic value or stratigraphic markers. Because of these conditions the stratum which J. S. Newberry (1878, p. 795) erroneously described as the No. 4 or "Leetonia seam" in Mahoning County is actually the Lower Kittanning No. 5 coal bed (Orton, 1884, p. 187; and Bownocker, 1908, p. 186). The impoverished character of the lower part of the Allegheny formation continues to the west as far as central Stark County where the Brookville coal bed is found in its best development in Ohio and is overlain by the Putnam Hill limestone. From here southwest to the Ohio River identification of lower Allegheny members is made with more ease and certainty because of better outcrops and prevalence of the Putnam Hill limestone. From the main field of Brookville coal in Stark and Tuscarawas Counties southwest to Vinton County the Brookville and Clarion coal beds are thin and unsteady, and reserves occur only in small isolated areas. In Vinton County both coal beds are developed, the Clarion to a much greater extent than the Brookville. The Clarion coal field in southeastern Ohio is located in Vinton, Jackson, and adjacent parts of Lawrence, Scioto, Meigs, and Gallia Counties.

The term Scrubgrass was first used by H. D. Rogers (1858, p. 573) to designate a coal bed interposed between the Clarion coal bed and the Vanport limestone. In Ohio the Scrubgrass coal bed is confined to Vinton County where it directly underlies the Vanport limestone and overlies the Clarion coal bed by as much as 30 feet. Where the Scrubgrass coal bed is not present the interval from the Clarion coal bed to the Vanport limestone is much less and the Clarion coal bed is commonly directly beneath the limestone. Stout (1927, p. 249) states that "The Scrubgrass bed is not a split from the Clarion coal but is a distinct unit formed in small local basins not long after Clarion time. At no place does it combine directly with the Clarion member nor in any way is it responsible for the thickening or the thinning of the underlying stratum."

In 1926 Stout (Stout, et al., 1926, p. 269) designated a thin coal horizon that occurs immediately below the Lower Kittanning clay as the Lawrence coal bed for Lawrence County, Ohio, where it is best represented. The Lawrence coal bed is also present in the section in Columbiana and Jefferson Counties but between the two areas this horizon if present at all is marked only by a carbonaceous clay or flint clay. Nowhere has the coal been observed to be more than a few inches thick.

A high quality underclay is found below the Lawrence coal bed and where the coal is missing the two clay beds are considered as one. For economical purposes the two clay beds are mined and considered as the Lower Kittanning clay.

CHAPTER 3

THE BROOKVILLE NO. 4 COAL BED

The Brookville (or No. 4) coal bed, first described and named by Henry D. Rogers (1858, p. 490) for exposures around Brookville, Pennsylvania, crops out westward from the Ohio-Pennsylvania boundary to Stark County, then southwest to the Ohio River. Although its outcrop crosses several counties, only rarely is the coal found thick enough to be commercially important (see Fig. 4); indeed it is not one of Ohio's major coal producing beds. It is, however, important locally, particularly in Stark and Tuscarawas Counties, wherein occurs Ohio's largest field of Brookville coal. In this area mining has been carried on for a long period of time and strip mining in recent years has made this area increasingly important.

The Brookville coal reserves in Wayne and Holmes Counties occur in small thin deposits near the Stark County boundary. From Tuscarawas to Vinton County this coal bed is virtually barren; only minor amounts of reserves in widely separated deposits occur in Coshocton and Muskingum Counties. The Vinton County field is important locally, and it is second in size to the northern field.

The underclay of the Brookville coal bed is usually plastic, siliceous, and fine-grained. The most valuable field of the Brookville clay is in Muskingum, Coshocton, Holmes, Tuscarawas, Wayne, and Stark Counties (Stout, W. et al., 1923, p. 216).

MINING HISTORY

Mining of the Brookville coal bed when reported by Newberry (1878, p. 169) had been active for a number of years in both the northern and southern parts of Stark County. At that time and at present this coal bed is mined in connection with the overlying Putnam Hill limestone. Mining activity continued in this field well into the 20th century but in some years (see Table 1) no production was reported. At present (1956) there are several important stripping operations in this field.

In the southern field the Brookville coal bed was reported by Orton (1884, p. 996) to be mined at an early date. Although reports on this bed have been infrequent they indicate a small but steady production from the earliest mining dates to the present time.

Approximate production of the Brookville coal bed in recent years (shown in Table 1) is adapted from the Annual Coal and Non-metallic Mineral Reports prepared by the Ohio Department of Industrial Relations. There is good reason to believe that many operators reporting to the Department of Industrial Relations have misidentified the coal seam they are mining; whenever possible this miscorrelation has been corrected and hence the production as shown in Table 1 is not identical in every case with the reports by the Department of Industrial Relations.

Figure 4. - Distribution of Brookville No. 4 coal reserves in Ohio.

TABLE 1

Production of Brookville Coal in Ohio by County, 1946 - 1955[1]

(In short tons)

County	1946		1947		1948		1949		1950		1951	
	Total	Strip	Total	Strip	Total	Strip	Total	Strip	Total	Strip	Total	Strip
Coshocton	25,876	19,983	5,513	-	6,005	-	5,253	-	3,497	-	5,509	-
Jackson	-	-	-	-	-	-	-	-	-	-	-	-
Lawrence	24,895	-	15,548	-	-	-	-	-	-	-	-	—
Muskingum	426	-	-	-	-	-	-	-	-	-	-	—
Stark	-	-	-	-	-	2,779	-	35,416	-	103,920	-	115,855
Tuscarawas	-	-	-	-	-	-	-	-	-	-	-	1,843
Vinton	-	6,047	4,159	19,574	23,290	19,457	9,339	58,131	34,848	11,407	3,995	10,815

County	1952		1953		1954		1955	
	Total	Strip	Total	Strip	Total	Strip	Total	Strip
Coshocton	553	-	-	-	-	-	-	-
Jackson	-	-	-	-	-	-	-	-
Lawrence	-	-	-	-	-	-	-	-
Muskingum	149	-	-	-	-	-	-	-
Stark	-	194,758	-	118,203	-	94,901	95,096	95,096
Tuscarawas	-	62,133	-	7,290	-	69,794	-	-
Vinton	12,706	12,626	—	15,695	-	623	-	-

[1] Source : Ohio Department of Industrial Relations Annual Coal and Non-metallic Mineral Reports, 1946-55. Some changes in seam identification made by the author of this report have served to modify the county totals by seam published in some of these reports.

CLASSIFICATION AND CHARACTERISTICS

Classification of bituminous coal by rank as set forth by the American Society for Testing Materials is determined by the dry-fixed-carbon and the B. t. u. value on a "moist," mineral-matter-free basis. Coal with a heat value of more than 14,000 B. t. u. (rank index 140) and fixed carbon of less than 69% is classified as high-volatile A bituminous coal; coal with heat value of 13,000 to 14,000 B. t. u. (rank index 130 to 140) is classified as high-volatile B bituminous coal. It is in the latter classification that the Brookville coal falls as illustrated in the analyses given below.

OHIO GEOLOGICAL SURVEY COAL ANALYSIS FILE NO. 376
Section 35, Canton Township, Stark County

Air-Dry Loss: 2.06%		As Received	Moisture Free	Moist. and Ash Free	Unit Coal Dry	Unit Coal Moist
Proximate Analysis	Mositure	5.18	-	-	-	6.04
	Volatile matter	39.90	42.09	47.78	46.57	43.76
	Fixed carbon	43.62	46.01	52.22	53.43	50.20
	Ash	11.30	11.90	-	-	-
	Total	100.00	100.00	100.00	100.00	100.00
Ultimate Analysis	Hydrogen	5.21	4.90	5.56		
	Carbon	65.29	68.88	78.18		
	Nitrogen	1.19	1.26	1.43		
	Oxygen	13.39	9.24	10.49		
	Sulfur	3.62	3.82	4.34		
	Ash	11.30	11.90	-		
	Total	100.00	100.00	100.00		
Calorific Value Determined	Calories per gram	6,593	6,953	7,892	8,051	7,566
	B. t. u. per lb.	11,867	12,515	14,205	14,491	13,619

The following analyses illustrate the quality of the Brookville coal in the southern or Vinton field:

OHIO GEOLOGICAL SURVEY COAL ANALYSIS FILE NO. 374
Section 17, Elk Township, Vinton County

		As Received	Moisture Free	Mosit. and Ash Free	Unit Coal Dry	Unit Coal Moist
Proximate Analysis	Moisture	6.95	-	-	-	7.76
	Volatile matter	38.49	41.36	45.65	44.86	41.39
	Fixed carbon	45.81	49.24	54.35	55.14	50.85
	Ash	8.75	9.40	-	-	-
	Total	100.00	100.00	100.00	100.00	100.00
Ultimate Analysis	Hydrogen	4.94	4.48	4.94		
	Carbon	68.03	73.11	80.69		
	Nitrogen	1.23	1.32	1.46		
	Oxygen	15.21	9.71	10.72		
	Sulfur	1.84	1.98	2.19		
	Ash	8.75	9.40	-		
	Total	100.00	100.00	100.00		
Calorific Value Determined	Calories per gram	6,684	7,183	7,928	8,031	7,408
	B. t. u. per lb.	12,031	12,930	14,272	14,456	13,334

OHIO GEOLOGICAL SURVEY COAL ANALYSIS FILE NO. 375
Section WC2, Elk Township, Vinton County

		As Received	Moisture Free	Moist. and Ash Free	Unit Coal Dry	Unit Coal Moist
Proximate Analysis	Moisture	6.08	-	-	-	7.09
	Volatile matter	36.75	39.13	45.08	44.08	40.96
	Fixed carbon	44.77	47.67	54.92	55.92	51.95
	Ash	12.40	13.20	-	-	-
	Total	100.00	100.00	100.00	100.00	100.00
Ultimate Analysis	Hydrogen	4.83	4.42	5.09		
	Carbon	66.45	70.75	81.51		
	Nitrogen	1.16	1.23	1.42		
	Oxygen	13.51	8.64	9.95		
	Sulfur	1.65	1.76	2.03		
	Ash	12.40	13.20	-		
	Total	100.00	100.00	100.00		
Calorific Value Determined	Calories per gram	6,460	6,878	7,924	8,056	7,484
	B. t. u. per lb.	11,628	12,381	14,264	14,501	13,472

OHIO GEOLOGICAL SURVEY COAL ANALYSIS FILE NO. 373
Section NW 32, Madison Township, Vinton County

		As Received	Moisture Free	Moist. and Ash Free	Unit Coal Dry	Unit Coal Moist
Proximate Analysis	Moisture	4.37	-	-	-	5.19
	Volatile matter	37.99	39.73	46.32	45.22	42.87
	Fixed carbon	44.04	46.05	53.68	54.78	51.94
	Ash	13.60	14.22	-	-	-
	Total	100.00	100.00	100.00	100.00	100.00
Ultimate Analysis	Hydrogen	4.85	4.56	5.32		
	Carbon	66.01	69.03	80.47		
	Nitrogen	1.21	1.27	1.48		
	Oxygen	12.32	8.82	10.28		
	Sulfur	2.01	2.10	2.45		
	Ash	13.60	14.22	-		
	Total	100.00	100.00	100.00		
Calorific Value Determined	Calories per gram	6,474	6,771	7,893	8,040	7,622
	B. t. u. per lb.	11,654	12,187	14,207	14,472	13,720

The above analyses have been previously published (Bownocker and Dean, p. 33, 1929) in Bulletin 34, 4th Series, Ohio Geological Survey.

Nowhere in Ohio does the Brookville coal bed have a distinct or unique structure. In the northern field the coal may consist of a solid block or with indiscriminate partings that are not persistent. The southern field is also erratic in structure for in places it is represented by a single stratum of coal, elsewhere by two, three, or even more benches of coal separated by bone shale, clay, or pyrite partings. (Stout, 1927, p. 161.)

The coal is mainly trucked to nearby markets where it is used for domestic and steam generating purposes.

RESERVES

In the past the coal beds in the lower Allegheny formation have not received the attention from geologists as have the better known coal beds, the Pittsburgh and Middle Kittanning. This is especially true in the northeastern part of the State where outcrops are few and the geology is not clearly understood, resulting in inadequate maps and data. A modern study of Stark, Mahoning, or Portage Counties has not been completed to this date.

A definite limitation to the accuracy of this report is the thick mantle of glacial drift in these three counties and only by core-drill or similar subsurface methods will a completely satisfactory estimate of reserves be made. Therefore the maps illustrating the extent of minable coal should not be considered conclusive because the isopachous lines (denoting estimated limits of minable coal) have been intentionally drawn conservatively and do not necessarily condemn all apparent non-minable-coal areas shown in the illustrations. Because of the greater amount of data available in the unglaciated area the estimate for this area should be less subject to change than in the glaciated section.

TABLE 2

Comparison by Counties of Estimated Original Brookville Coal Reserves

(In short tons)

County	Author		
	Clark	Ray	DeLong
Carroll	306,000,000	-	2,056,000
Columbiana	-	33,600,000	-
Coshocton	492,000,000	-	15,856,000
Guernsey	97,000,000	-	-
Hocking	23,000,000	-	203,000
Holmes	46,000,000	-	13,858,000
Jackson	12,000,000	-	5,167,000
Mahoning	-	16,800,000	-
Muskingum	35,000,000	-	7,234,000
Portage	52,000,000	-	-
Stark	446,000,000	-	198,764,000
Tuscarawas	337,000,000	-	91,544,000
Vinton	346,000,000	13,440,000	102,811,000
Wayne	-	-	8,722,000
Total	2,192,000,000	63,840,000	446,215,000

The original estimated reserves tabulated by county and township for this coal bed, as determined by the author, are shown on Table 22, page 39.

The estimate of 446,215,000 tons of original reserves differs markedly from earlier estimates by Clark and Ray (see Table 2). The approach to the reserve estimate used by Clark and Ray was to multiply an average thickness from all measurements in a county by the coal-bearing area within that county and a weight factor. This method has evidently resulted in an over-estimate by Clark. The current estimate and that of Clark used 14 inches thickness as a lower limit of measurable coal reserves; Ray on the other hand considered as a lower limit a thickness of 2.7 feet, thus eliminating much of what this and Clark's report considered coal

reserves. Ray's generous estimate of No. 4 coal reserves in Columbiana and Mahoning Counties is probably a miscorrelation of coal beds as indicated above. Regarding the Brookville coal bed in Columbiana County Stout and Lamborn (1924, p. 56) state: "It is lacking in both persistency and development in Columbiana County. It is present only in local areas and in them it is too impure and too thin for economic use."

DISCUSSION OF RESERVES BY COUNTY

CARROLL COUNTY

The small amount of estimated reserves as illustrated in Figure 5 occurs below drainage in the west central part of Rose Township, Carroll County and is an extension from Tuscarawas County of the northern Brookville coal field. This reserve is small and is in the probable category of reliability as shown in Table 3 below.

There is no record of the Brookville coal having been observed in Carroll County.

TABLE 3

Estimated Original Reserves of the Brookville Coal Bed in Carroll County

(In thousands of short tons)

Reliability Category	Thickness				
	14" - 28"	28" - 42"	42" - 54"	54" - 66"	Total
Proven	-	-	-	-	-
Probable	2,056	-	-	-	2,056
Strongly inferred	-	-	-	-	-
Total	2,056	-	-	-	2,056

STARK COUNTY

The large reserves in Stark County have long made the Brookville coal bed of recognized importance in Ohio. As shown in Figure 5, most of the reserve is concentrated in the south-central part of the county where the greatest thickness of this coal bed is attained. Pike, Bethlehem, Perry, and Canton Townships contain the main portion of the coal and some reserves occur in the hilltops of Sugar Creek Township. The rest of the reserves in Stark County occur in small isolated areas of coal in Lexington, Lake, and Jackson Townships. As little is known about these areas, their extent has been interpreted conservatively. Table 4 illustrates the Brookville coal reserves in Stark County.

TABLE 4

Estimated Original Reserves of the Brookville Coal Bed in Stark County

(In thousands of short tons)

Reliability Category	Thickness				
	14" - 28"	28" - 42"	42" - 54"	54" - 66"	Total
Proven	7,258	5,040	23,179	1,383	36,860
Probable	25,542	18,312	102,988	-	146,842
Strongly inferred	5,826	4,536	4,700	-	15,062
Total	38,626	27,888	130,867	1,383	198,764

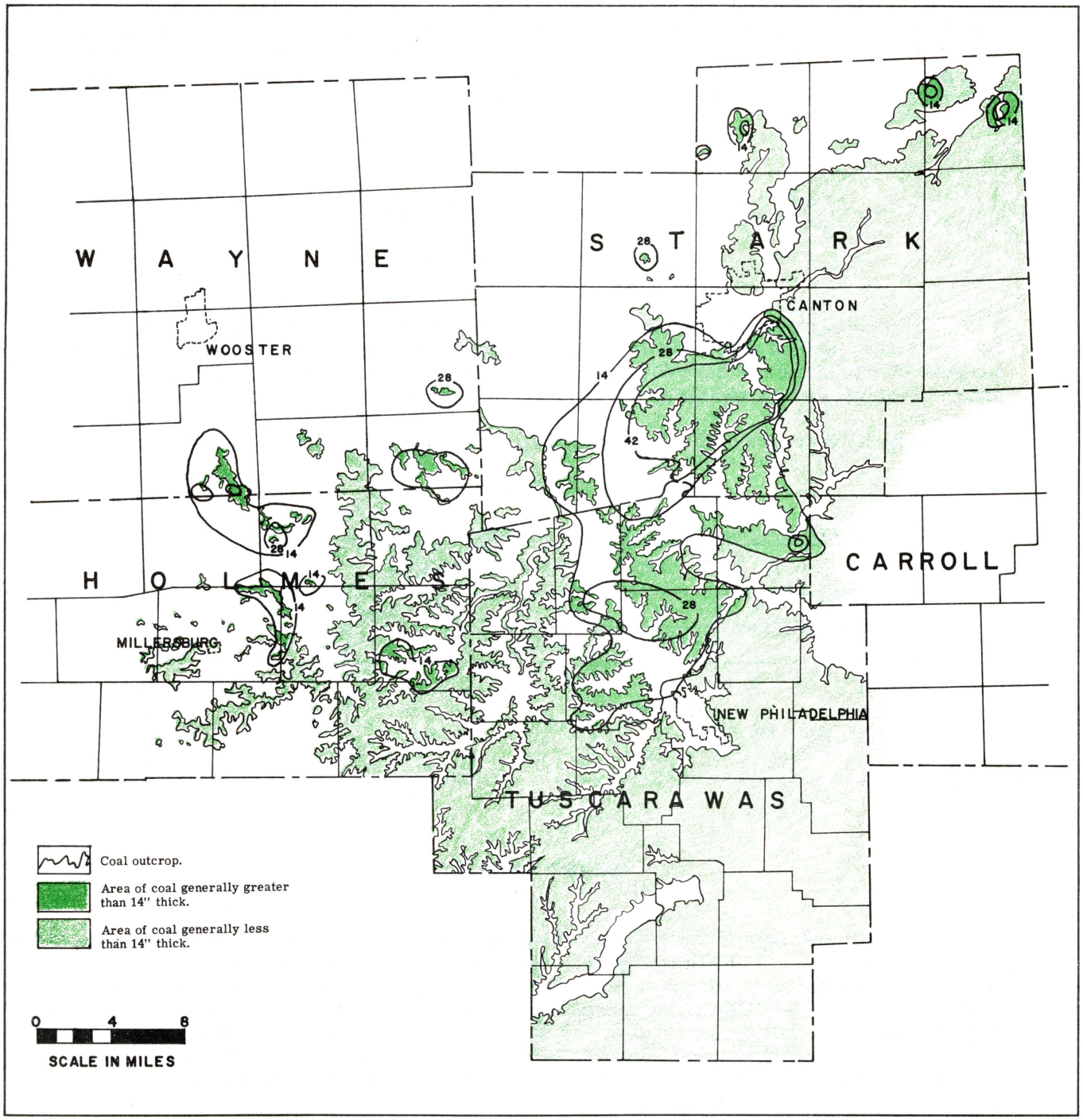


Figure 5. - The Brookville coal bed in Stark, Tuscarawas, Wayne, Holmes, and Carroll Counties.

TUSCARAWAS COUNTY

Tuscarawas County ranks third in Brookville coal reserves, following Stark and Vinton Counties. As shown in Figure 5, the coal in Tuscarawas County occurs in a north-south linear belt that is continuous with the main body of the coal in south-central Stark County. Dover, Lawrence, and Sandy Townships contain most of the reserves with minor amounts in Franklin and Fairfield Townships. Table 5 given below lists the reserves for this county.

TABLE 5

Estimated Original Reserves of the Brookville Coal Bed in Tuscarawas County

(In thousands of short tons)

Reliability Category	Thickness				
	14" - 28"	28" - 42"	42" - 54"	54" - 66"	Total
Proven	6,310	6,183	1,060	576	14,129
Probable	44,393	21,740	-	-	66,133
Strongly inferred	11,047	235	-	-	11,282
Total	61,750	28,158	1,060	576	91,544

WAYNE COUNTY

The Brookville coal reserves in Wayne County shown in Table 6 occur in the hilltops of the southern and southeastern corner of the county. The coal has been mined in a small way in Franklin Township but in recent years there has been no report of mining activity in this or Paint and Sugar Creek Townships. The distribution of minable reserves is illustrated in Figure 5.

TABLE 6

Estimated Original Reserves of the Brookville Coal Bed in Wayne County

(In thousands of short tons)

Reliability Category	Thickness				
	14" - 28"	28" - 42"	42" - 54"	54" - 66"	Total
Proven	3,710	940	-	-	4,650
Probable	4,072	-	-	-	4,072
Strongly inferred	-	-	-	-	-
Total	7,782	940	-	-	8,722

HOLMES COUNTY

Brookville coal reserves are widely dispersed in the north and eastern parts of Holmes County. The best development of the coal occurs in Prairie and Salt Creek Townships; the isolated deposits of coal in other townships are thin and of little economic importance. Table 7 and Figure 5 illustrate the quantity and distribution of reserves in this county.

TABLE 7

Estimated Original Reserves of the Brookville Coal Bed in Holmes County
(In thousands of short tons)

Reliability Category	Thickness				
	14" - 28"	28" - 42"	42" - 54"	54" - 66"	Total
Proven	6,513	1,377	-	-	7,890
Probable	5,968	-	-	-	5,968
Strongly inferred	-	-	-	-	-
Total	12,481	1,377	-	-	13,858

COSHOCTON COUNTY

The two areas of minable Brookville coal (see Figure 6) are widely separated, the largest and most important of which lies in Bedford and Jefferson Townships where the coal has been worked. Table 8 shows the total tonnage for this area and the smaller pocket of minable coal in Adams and White Eyes Townships.

TABLE 8

Estimated Original Reserves of the Brookville Coal Bed in Coshocton County
(In thousands of short tons)

Reliability Category	Thickness				
	14" - 28"	28" - 42"	42" - 54"	54" - 66"	Total
Proven	4,940	2,049	1,474	-	8,463
Probable	6,653	740	-	-	7,393
Strongly inferred	-	-	-	-	-
Total	11,593	2,789	1,474	-	15,856

MUSKINGUM COUNTY

Muskingum County with only 7,234,000 tons is a minor contributor to Brookville coal reserves. A reported thickness of two feet of coal occurs in eastern Madison Township where this bed dips below drainage. The other area of minable coal is in central Hopewell Township where a 54-inch seam has been reported. Figure 6 and Table 9 illustrate the area and quantity of Brookville coal reserve.

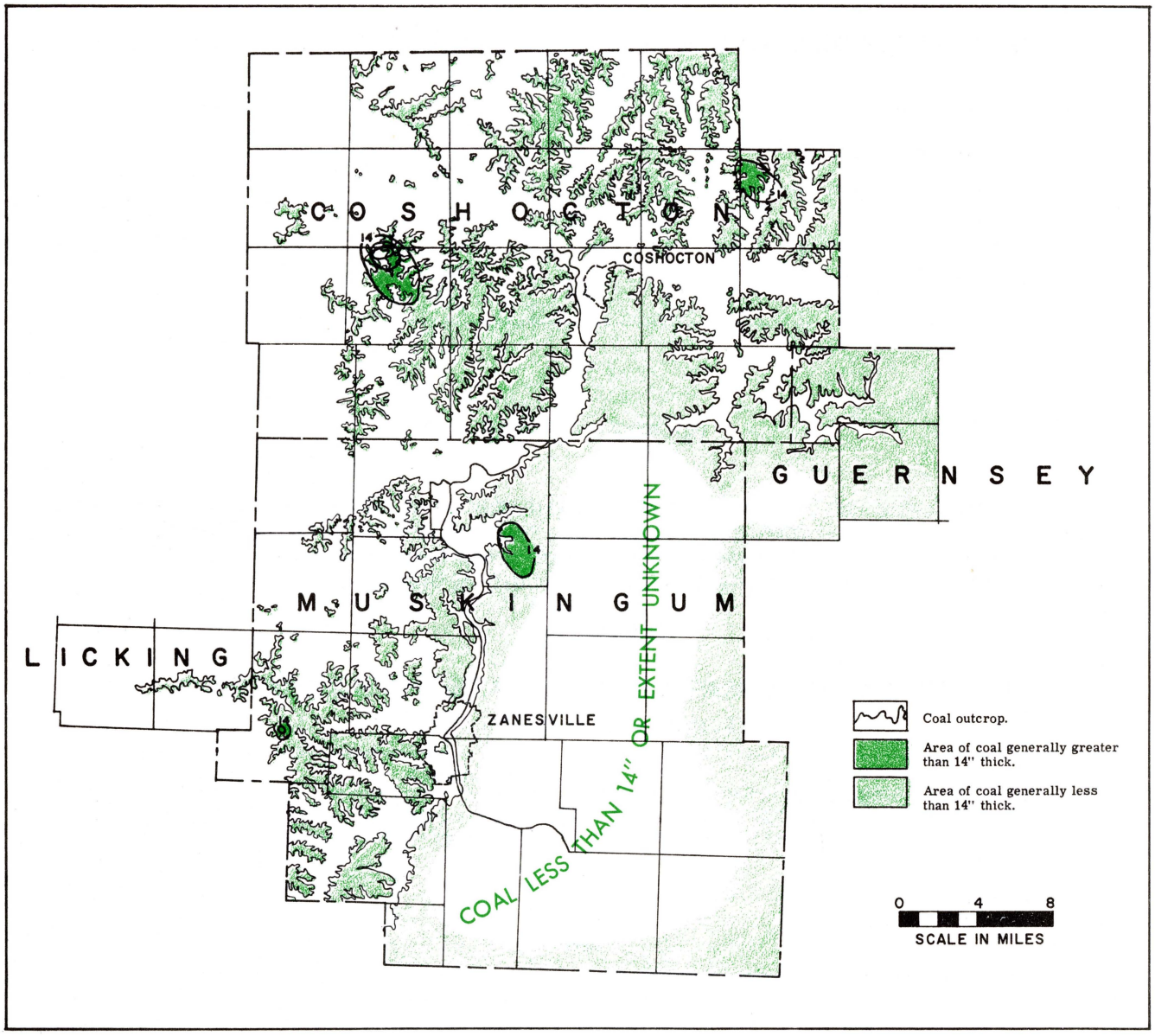


Figure 6. - The Brookville coal bed in Coshocton and Muskingum Counties.

TABLE 9

Estimated Original Reserves of the Brookville Coal Bed in Muskingum County

(In thousands of short tons)

Reliability Category	Thickness				
	14" - 28"	28" - 42"	42" - 54"	54" - 66"	Total
Proven	2,721	67	92	-	2,880
Probable	4,354	-	-	-	4,354
Strongly inferred	-	-	-	-	-
Total	7,075	67	92	-	7,234

HOCKING COUNTY

Hocking County has the lowest Brookville coal reserve of all counties considered in this report. The only locality where the coal has been reported to be of minable thickness is in the northwest corner of Washington Township where it has been strip mined (Hall, 1951, p. 83). Table 10 and Figure 7 illustrate the tonnage and locality of this area.

TABLE 10

Estimated Original Reserves of the Brookville Coal Bed in Hocking County

(In thousands of short tons)

Reliability Category	Thickness				
	14" - 28"	28" - 42"	42" - 54"	54" - 66"	Total
Proven	-	203	-	-	203
Probable	-	-	-	-	-
Strongly inferred	-	-	-	-	-
Total	-	203	-	-	203

VINTON COUNTY

The Brookville coal reserve in Vinton County, second only to that of Stark County, has been for many years an important economic asset. The coal-bearing area of west central Vinton County comprises most of the reserves tabulated in Table 11. This area includes most of Elk, the western part of Madison, and parts of the southern edge of Swan and Brown Townships. Separated from this main body of coal in the southeastern corner of Clinton Township is another area of thick coal. These two fields may possibly be connected with minable coal under deep cover. Figure 7 shows the distribution of minable Brookville coal in Vinton County.

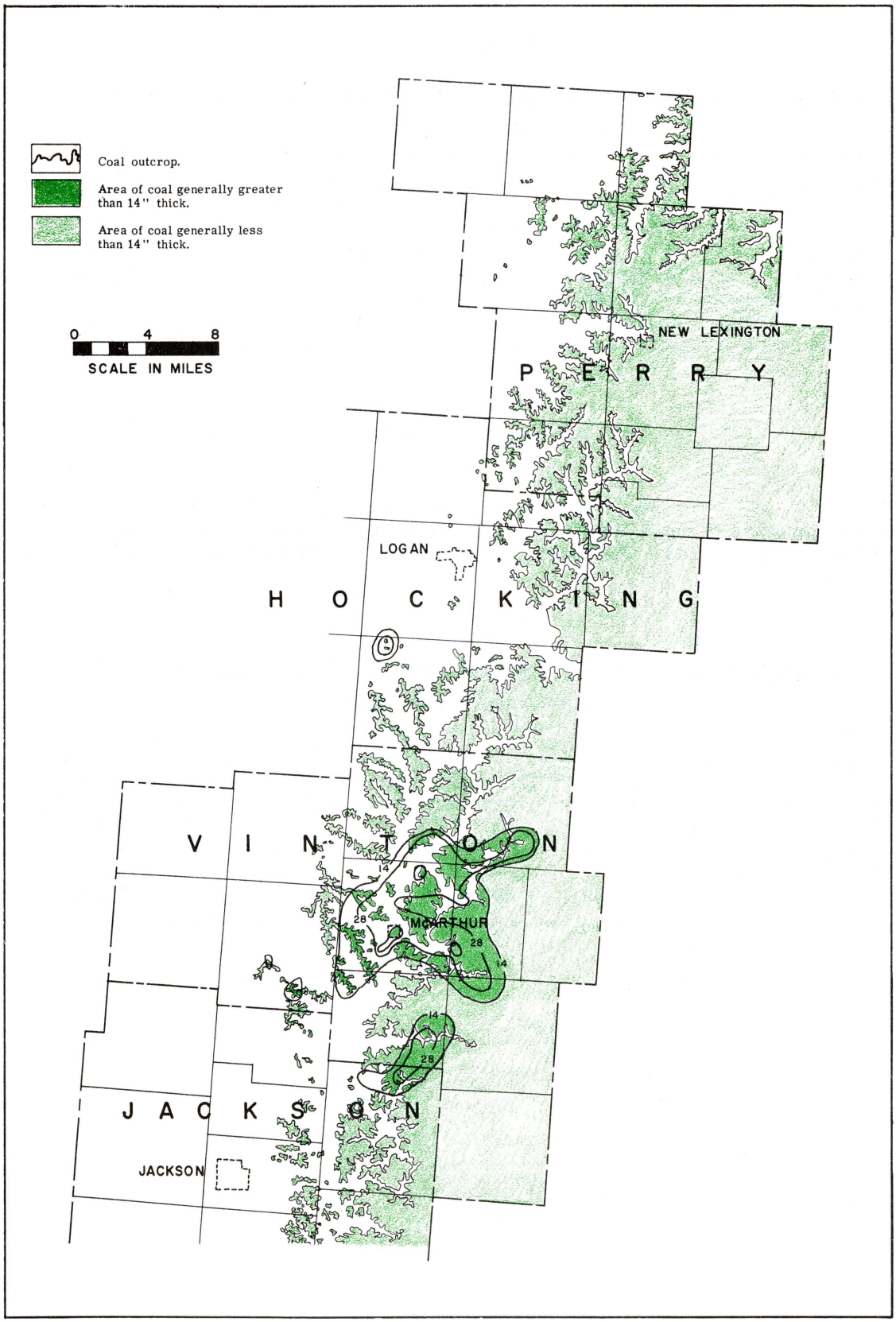


Figure 7. - The Brookville coal bed in Hocking, Vinton, and Jackson Counties.

TABLE 11

Estimated Original Reserves of the Brookville Coal Bed in Vinton County

(In thousands of short tons)

Reliability Category	Thickness				
	14" - 28"	28" - 42"	42" - 54"	54" - 66"	Total
Proven	9,112	15,455	2,258	-	26,825
Probable	31,834	41,530	-	-	73,364
Strongly inferred	2,622	-	-	-	2,622
Total	43,568	56,985	2,258	-	102,811

JACKSON COUNTY

The Brookville coal reserve in Jackson County is limited to the northern edge of Milton Township where there is found minable coal that is continuous with that of southeastern Clinton Township, Vinton County. The extent and tonnage of this reserve are shown in Figure 7 and Table 12.

TABLE 12

Estimated Original Reserves of the Brookville Coal Bed in Jackson County

(In thousands of short tons)

Reliability Category	Thickness				
	14" - 28"	28" - 42"	42" - 54"	54" - 66"	Total
Proven	1,169	1,747	-	-	2,916
Probable	1,814	437	-	-	2,251
Strongly inferred	-	-	-	-	-
Total	2,983	2,184	-	-	5,167

CHAPTER 4

THE CLARION NO. 4A COAL BED

The Clarion or No. 4A coal, named by H. D. Rogers (1858, pp. 474-477), is coexistent with the Brookville No. 4 coal bed in Ohio. Like the Brookville coal bed in the glaciated section of the Allegheny Plateau, drift has created difficulty in identification and economic evaluation of the Clarion coal bed in the northeastern part of Ohio. Although the Clarion horizon can be followed southwest across Ohio, only in the southeastern part of the State is this coal bed developed to economic proportions (See Figure 8). Here the field of minable Clarion coal centered in Jackson and Vinton Counties is of such extent that its reserve is almost double that of the Brookville coal.

The large Clarion coal reserve in Columbiana and Mahoning Counties reported in earlier publications (see Table 13, p. 27) is in error. The Columbiana and Mahoning County reserve previously reported under the name Clarion or Canfield Cannel coal by Orton (1884, p. 194) is considered by Stout and Lamborn (1924, p. 105) to be the Lower Kittanning or No. 5 coal bed. Regarding the Clarion coal bed in Columbiana County Stout and Lamborn (1924, p. 65) state: "It nowhere thickens sufficiently to be mined even in a small way. Moreover, it is usually shaly in character or is divided by bony partings."

The underclay of the Clarion coal bed is of value in two areas, one near the Ohio-Pennsylvania boundary and the other in southeastern Ohio from Lawrence to Vinton Counties. Between these two areas the clay at the Clarion horizon is of no known value.

MINING HISTORY

Little has been recorded of the early mining operations of this coal seam. Undoubtedly it was mined for domestic use and tried in our early iron manufacturing industry but for the latter purpose it was overshadowed by the famous Sharon or "Jackson shaft" coal. Although this coal bed contains more reserve than any other in Vinton County, mining has developed slowly, perhaps due to its inferior quality. In 1927 Stout (p. 224) stated that as a whole this coal bed was little depleted in Vinton County. Table 13 would seem to indicate that only within recent years has there been production of significant proportions.

CLASSIFICATION AND CHARACTERISTICS

In the classification of coal as defined and described previously on page 14 the Clarion coal falls into the high-volatile B bituminous coal group. Its principal use is for domestic and steam generating purposes.

Figure 8. - Distribution of Clarion No. 4A Coal reserves in Ohio.

TABLE 13

Production of Clarion Coal in Ohio by County, 1946 - 1955[1]

(In short tons)

County	1946		1947		1948		1949		1950	
	Total	Strip	Total	Strip	Total	Strip	Total	Strip	Total	Strip
Jackson	15,094	8,940	39,334	1,864	23,316	1,961	53,015	31,124	49,254	23,616
Vinton	-	5,857	6,484	627	27,012	26,356	5,261	-	15,774	-
Lawrence	24,895	-	15,548	-	52,013	-	15,092	-	6,940	-

County	1951		1952		1953		1954		1955	
	Total	Strip	Total	Strip	Total	Strip	Total	Strip	Total	Strip
Jackson	190,309	166,620	510,536	496,096	440,555	404,770	392,960	354,551	482,454	462,012
Vinton	8,740	-	6,320	-	1,978	-	-	-	-	-
Lawrence	64,417	40,728	7,337	-	2,483	-	353	-	4,126	-

Analyses given below illustrate the quality of this coal.

OHIO GEOLOGICAL SURVEY COAL ANALYSIS FILE NO. 358
Section 28, Madison Township, Vinton County

		As Received	Moisture Free	Moist. and Ash Free	Unit Coal	
					Dry	Moist
Proximate Analysis	Moisture	4.80	-	-	-	5.67
	Volatile matter	40.56	42.60	49.00	47.79	45.08
	Fixed carbon	42.21	44.34	51.00	52.21	49.25
	Ash	12.43	13.06	-	-	-
	Total	100.00	100.00	100.00	100.00	100.00
Ultimate Analysis	Hydrogen	4.96	4.65	5.35		
	Carbon	65.56	68.87	79.22		
	Nitrogen	1.21	1.27	1.46		
	Oxygen	12.33	8.46	9.73		
	Sulfur	3.51	3.69	4.24		
	Ash	12.43	13.06	-		
	Total	100.00	100.00	100.00		
Calorific Value Determined	Calories per gram	6,567	6,898	7,934	8,103	7,643
	B. t. u. per lb.	11,821	12,417	14,282	14,586	13,758

[1] Source: Ohio Department of Industrial Relations Annual Coal and Non-Metallic Mineral Reports, 1946-55. Some changes in seam identification made by the author of this report have served to modify the county totals by seam published in some of these reports.

OHIO GEOLOGICAL SURVEY COAL ANALYSIS FILE NO. 352
Section 27, Wilkesville Township, Vinton County

		As Received	Moisture Free	Moist. and Ash Free	Unit Coal	
					Dry	Moist
Proximate Analysis	Moisture	4.52	-	-	-	5.13
	Volatile matter	40.10	42.00	46.29	45.10	42.78
	Fixed carbon	46.53	48.73	53.71	54.90	52.09
	Ash	8.85	9.27	-	-	-
	Total	100.00	100.00	100.00	100.00	100.00
Ultimate Analysis	Hydrogen	5.44	5.17	5.70		
	Carbon	67.17	70.35	77.54		
	Nitrogen	1.28	1.34	1.48		
	Oxygen	13.03	9.44	10.40		
	Sulfur	4.23	4.43	4.88		
	Ash	8.85	9.27	-		
	Total	100.00	100.00	100.00		
Calorific Value Determined	Calories per gram	6,904	7,231	7,970	8,118	7,702
	B. t. u. per lb.	12,427	13,015	14,345	14,612	13,863

OHIO GEOLOGICAL SURVEY COAL ANALYSIS FILE NO. 371
Section 32, Bloomfield Township, Jackson County

		As Received	Moisture Free	Moist. and Ash Free	Unit Coal	
					Dry	Moist
Proximate Analysis	Moisture	5.31	-	-	-	6.47
	Volatile matter	37.33	39.42	46.00	44.07	41.22
	Fixed carbon	43.82	46.28	54.00	55.93	52.31
	Ash	13.54	14.30	-	-	-
	Total	100.00	100.00	100.00	100.00	100.00
Ultimate Analysis	Hydrogen	4.98	4.64	5.41		
	Carbon	62.05	65.53	76.47		
	Nitrogen	1.23	1.30	1.52		
	Oxygen	12.12	7.81	9.11		
	Sulfur	6.08	6.42	7.49		
	Ash	13.54	14.30	-		
	Total	100.00	100.00	100.00		
Calorific Value Determined	Calories per gram	6,394	6,753	7,880	8,113	7,588
	B. t. u. per lb.	11,509	12,154	14,182	14,604	13,659

OHIO GEOLOGICAL SURVEY COAL ANALYSIS FILE NO. 363
Section 15, Decatur Township, Lawrence County

		As Received	Moisture Free	Moist. and Ash Free	Unit Coal Dry	Unit Coal Moist
Proximate Analysis	Moisture	6.11	-	-	-	7.00
	Volatile matter	38.43	40.93	45.78	44.59	41.47
	Fixed carbon	45.52	48.48	54.22	55.41	51.53
	Ash	9.94	10.59	-	-	-
	Total	100.00	100.00	100.00	100.00	100.00
Ultimate Analysis	Hydrogen	5.42	5.05	5.65		
	Carbon	65.53	69.79	78.05		
	Nitrogen	1.22	1.30	1.45		
	Oxygen	14.28	9.42	10.54		
	Sulfur	3.61	3.85	4.31		
	Ash	9.94	10.59	-		
	Total	100.00	100.00	100.00		
Calorific Value Determined	Calories per gram	6,643	7,075	7,913	8,061	7,496
	B. t. u. per lb.	11,957	12,735	14,243	14,509	13,493

These and other analyses of the Clarion coal are given in Bulletin 34, Analyses of the Coals of Ohio, Geological Survey of Ohio, fourth series, pages 38-53.

The Clarion coal bed normally occurs in three benches of coal separated by two thin clay partings. Locally and especially near the borders of the basin this typical structure becomes varied or changed. The upper bench commonly contains more mineral impurities than the lower and middle bench. The lower parting has a high content of pyrite for which reason it is called the "sulphur band" by miners, whereas the upper parting is clay with carbonaceous matter (Stout, 1927, p. 223).

TABLE 14

Comparison by Counties of Estimated Original Clarion Coal Reserves

(In short tons)

County	Author		
	Clark	Ray	DeLong
Columbiana	449,000,000	-	-
Gallia	312,000,000	19,200,000	22,262,000
Hocking	14,000,000	-	28,842,000
Jackson	330,000,000	15,360,000	234,621,000
Lawrence	178,000,000	-	72,276,000
Mahoning	192,000,000	-	-
Meigs	150,000,000	-	5,522,000
Perry	131,000,000	-	-
Scioto	41,000,000	7,680,000	5,178,000
Vinton	412,000,000	19,200,000	346,936,000
Total	2,209,000,000	61,440,000	715,637,000

RESERVES

The reserves of the Clarion coal bed occur in a north trending basin extending from northern Lawrence County to southern Hocking County. This estimate of 715,637,000 tons of original reserve is in marked disagreement with estimates of Clark and Ray (see Table 14, p. 29). To calculate the tonnage in their estimates Clark and Ray multiplied an average thickness of all measurements within a county by the coal-bearing area and a weight factor. Ray considered 2.7 feet thickness of clean coal as the minimum reserve thickness, hence his comparatively low estimate of reserves; Clark used 14 inches of clean coal as the lower limit of minable coal. Clark's extremely large reserve figure is due partly to the apparent miscorrelation in Columbiana and Mahoning Counties as explained previously. Clark's estimate of Clarion coal reserves for Perry County is now considered to be far in excess because only one measurement records the coal in excess of one foot in thickness. Flint (1951, p. 44) states that in this county the coal generally does not exceed six inches in thickness.

Data are plentiful along the outcrop of the reserve area but there is no core-hole information available on this coal bed below drainage. The eastern margin of the basin, therefore, has been drawn relatively close to the line of outcrop.

The original estimated reserves tabulated by county and township for this coal bed, as determined by the author, are shown on Table 23, page 40.

DISCUSSION OF RESERVES BY COUNTY

GALLIA COUNTY

Only a small part of the minable Clarion coal is found to extend into Gallia County (see Figure 9). Most of the 22,262,000 tons of estimated original reserves occurs in Greenfield Township and the balance in Huntington Township. Table 15 illustrates the reserves for this county.

TABLE 15

Estimated Original Reserves of the Clarion Coal Bed in Gallia County

(In thousands of short tons)

Reliability Category	Thickness				
	14" - 28"	28" - 42"	42" - 54"	54" - 66"	Total
Proven	1,310	874	-	-	2,184
Probable	8,063	10,684	-	-	18,747
Strongly inferred	726	605	-	-	1,331
Total	10,099	12,163	-	-	22,262

HOCKING COUNTY

Washington and Starr Townships of Hocking County contain the most northerly extent of the Clarion coal basin. Although the coal is of moderate extent in these two townships (see Figure 9), it is generally thin. Only in south central Washington Township does the thickness exceed 26 inches. The estimate of original reserves is shown in Table 16.

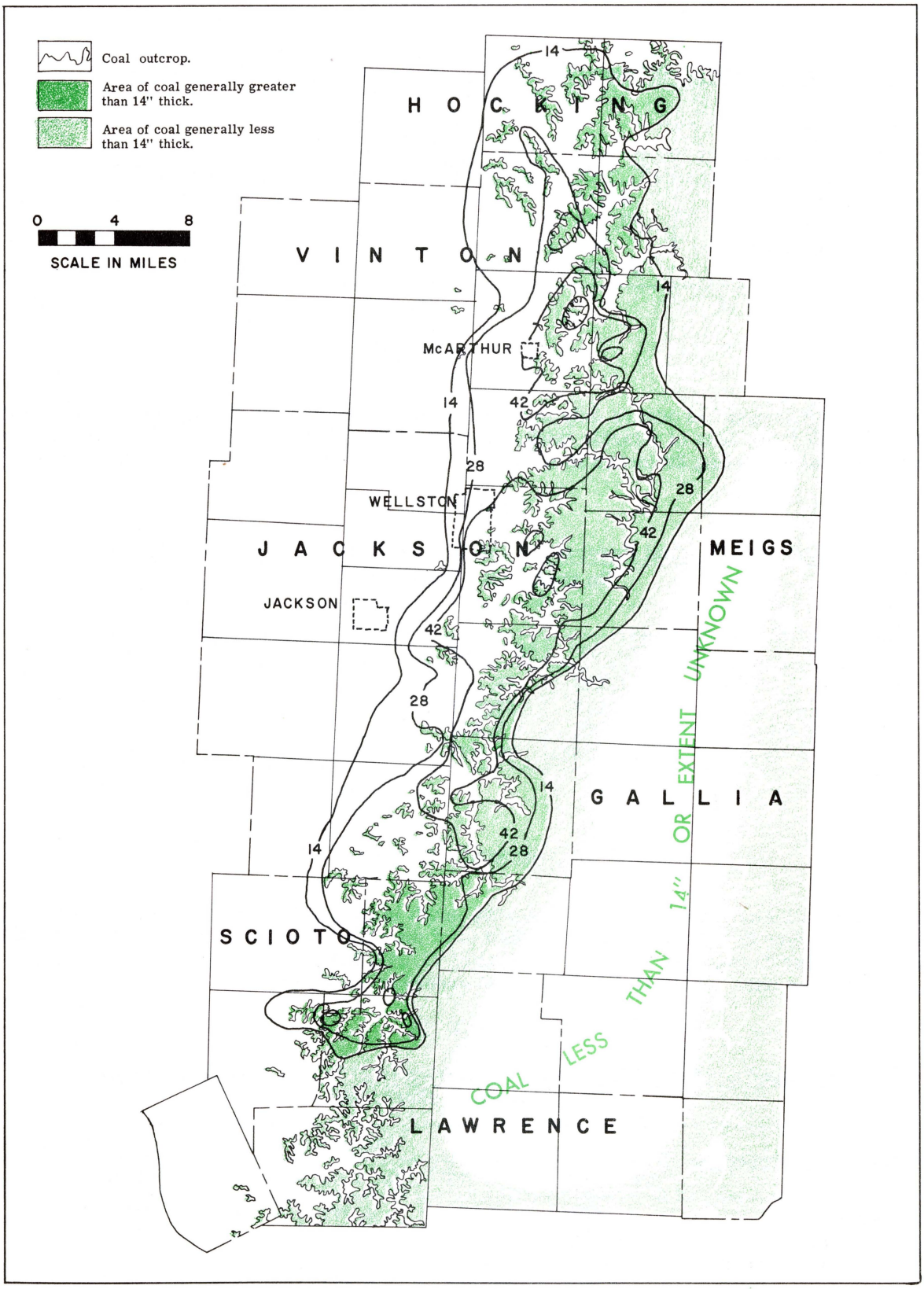


Figure 9. - The Clarion coal bed in Hocking, Vinton, Jackson, Scioto, Lawrence, Meigs, and Gallia Counties.

TABLE 16

Estimated Original Reserves of the Clarion Coal Bed in Hocking County
(In thousands of short tons)

Reliability Category	Thickness				
	14" - 28"	28" - 42"	42" - 54"	54" - 66"	Total
Proven	4,818	941	-	-	5,759
Probable	22,780	-	-	-	22,780
Strongly inferred	303	-	-	-	303
Total	27,901	941	-	-	28,842

JACKSON COUNTY

The Clarion coal bed occurs only in the eastern part of Jackson County and almost everywhere that it is found it is of minable thickness (see Figure 9). More than 90% of the reserves consists of coal exceeding 28 inches in thickness. Table 17 shows the reserves for this county.

TABLE 17

Estimated Original Reserves of the Clarion Coal Bed in Jackson County
(In thousands of short tons)

Reliability Category	Thickness				
	14" - 28"	28" - 42"	42" - 54"	54" - 66"	Total
Proven	1,673	22,881	73,033	-	97,587
Probable	9,213	36,523	77,688	-	123,424
Strongly inferred	7,983	5,443	184	-	13,610
Total	18,869	64,847	150,905	-	234,621

LAWRENCE COUNTY

Minable Clarion coal is terminated on the south in part in Decatur Township, Lawrence County (see Figure 9). Although this coal bed is of minable thickness only in Washington and northern Decatur Townships, the reserve total of 72,276,000 tons of estimated original coal is a rather large one. Table 18 illustrates the reserves in this county.

TABLE 18

Estimated Original Reserves of the Clarion Coal Bed in Lawrence County
(In thousands of short tons)

Reliability Category	Thickness				
	14" - 28"	28" - 42"	42" - 54"	54" - 66"	Total
Proven	947	23,788	3,271	115	28,121
Probable	6,289	37,866	-	-	44,155
Strongly inferred	-	-	-	-	-
Total	7,236	61,654	3,271	115	72,276

MEIGS COUNTY

Meigs County, like Gallia, is on the eastern edge of the known Clarion coal area and only one township, Columbia, contains reserves. The Clarion coal bed in Meigs County is entirely under drainage (see Figure 9) and only by core-drilling can the exact extent of the reserves be determined. Table 19 shows the estimated original reserves as determined to this date.

TABLE 19

Estimated Original Reserves of the Clarion Coal Bed in Meigs County

(In thousands of short tons)

Reliability Category	Thickness				
	14" - 28"	28" - 42"	42" - 54"	54" - 66"	Total
Proven	302	67	-	-	369
Probable	4,979	134	-	-	5,113
Strongly inferred	40	-	-	-	40
Total	5,321	201	-	-	5,522

SCIOTO COUNTY

The minable Clarion coal in northeastern Scioto County is on the southern fringe of the so-called Clarion coal field. The small amount of reserve illustrated in Figure 9 in this county occurs in the hilltops of eastern Vernon and Bloom Townships. Table 20 shows the estimated original reserves for Scioto County.

TABLE 20

Estimated Original Reserves of the Clarion Coal Bed in Scioto County

(In thousands of short tons)

Reliability Category	Thickness				
	14" - 28"	28" - 42"	42" - 54"	54" - 66"	Total
Proven	-	1,075	138	-	1,213
Probable	1,310	2,554	-	-	3,864
Strongly inferred	101	-	-	-	101
Total	1,411	3,629	138	-	5,178

VINTON COUNTY

Vinton County's 346,936,000 tons of estimated original reserve is the largest Clarion coal reserve of any county in Ohio. The coal is of minable thickness along its area of outcrop throughout Vinton County but the bed attains a greater thickness in the southern and central part of the county than in the northern part. The maximum thickness is in Madison Township where 60 inches of coal has been observed. The extent and amount of reserve in this county are illustrated in Figure 9 and Table 21.

TABLE 21

Estimated Original Reserves of the Clarion Coal Bed in Vinton County

(In thousands of short tons)

Reliability Category	Thickness				
	14" - 28"	28" - 42"	42" - 54"	54" - 66"	Total
Proven	11,128	33,264	73,495	2,707	120,594
Probable	59,348	73,245	84,047	288	216,928
Strongly inferred	9,414	-	-	-	9,414
Total	79,890	106,509	157,542	2,995	346,936

CHAPTER 5

MINOR COAL BEDS

OGAN COAL BED

The Ogan coal bed is very erratic in character and continuity throughout its extent in southern Vinton and northern Jackson Counties. Patches of minable Ogan coal have been found and worked in a small way in Elk, southwestern Brown, eastern Jackson, eastern Richland, western Madison, and western Clinton Townships, Vinton County (see Figure 10). Here, as wherever this coal bed is found, the structure of the seam is erratic, varying from a solid block of coal to a seam of several benches separated by thin partings. Locally where the overlying Zaleski flint thins or gives way to a few inches of shale, the Ogan and Winters coal beds appear to be only separate benches of the same coal deposit and are mined together. (Stout, 1927, p. 176.)

WINTERS COAL BED

The Winters coal bed and the Ogan coal bed occupy approximately the same area in southern Vinton and northern Jackson Counties. The total area of the Winters coal basin is approximately 180 square miles, of which 130 is found in Vinton County (Stout, 1927, p. 186). Measurements of minable thicknesses of coal have been reported in Elk, Clinton, Jackson, Richland, Madison, and Vinton Townships, Vinton County, and Milton Township of Jackson County (see Figure 10). Its greatest known thickness is in Elk Township where mining has been most extensive.

The coal bed is highly erratic in both continuity and structure. Thicknesses range from a mere streak to four feet; the structure varies from a solid block of coal to one containing many partings.

The following analyses of Winters coal by the Ohio Geological Survey have been previously published in Bulletin 34, pp. 36-37.

Figure 10. - General distribution of minable Ogan, Winters, and Scrubgrass coal beds in Ohio.

OHIO GEOLOGICAL SURVEY COAL ANALYSIS FILE NO. 200

Section 33, Madison Township, Vinton County

		As Received	Moisture Free	Moist and Ash Free	Unit Coal	
					Dry	Moist
Proximate Analysis	Moisture	6.06	-	-	-	6.77
	Volatile matter	38.74	41.24	45.51	44.73	41.70
	Fixed carbon	46.38	49.37	54.49	55.27	51.53
	Ash	8.82	9.39	-	-	-
	Total	100.00	100.00	100.00	100.00	100.00
Ultimate Analysis	Hydrogen	5.12	4.74	5.23		
	Carbon	68.54	72.96	80.52		
	Nitrogen	1.25	1.33	1.47		
	Oxygen	14.46	9.66	10.66		
	Sulfur	1.81	1.92	2.12		
	Ash	8.82	9.39	-		
	Total	100.00	100.00	100.00		
Calorific Value Determined	Calories per gram	6,750	7,185	7,930	8,032	7,488
	B. t. u. per lb.	12,151	12,935	14,275	14,458	13,479

OHIO GEOLOGICAL SURVEY COAL ANALYSIS FILE NO. 203

Section 34, Milton Township, Jackson County

Air - Dry Loss: 4.9%		As Received	Moisture Free	Moist and Ash Free	Unit Coal	
					Dry	Moist
Proximate Analysis	Moisture	9.31	-	-	-	10.09
	Volatile matter	36.78	40.56	43.50	42.78	38.46
	Fixed carbon	47.78	52.68	56.50	57.22	51.45
	Ash	6.13	6.76	-	-	-
	Total	100.00	100.00	100.00	100.00	100.00
Ultimate Analysis	Hydrogen	5.70	5.14	5.51		
	Carbon	67.80	74.76	80.18		
	Nitrogen	1.27	1.40	1.50		
	Oxygen	17.10	9.73	10.44		
	Sulfur	2.00	2.21	2.37		
	Ash	6.13	6.76	-		
	Total	100.00	100.00	100.00		
Calorific Value Determined	Calories per gram	6,976	7,692	8,250	8,341	7,499
	B. t. u. per lb.	12,557	13,846	14,850	15,014	13,499

OHIO GEOLOGICAL SURVEY COAL ANALYSIS FILE NO. 201

Section 26, Elk Township, Vinton County

		As Received	Moisture Free	Moist. and Ash Free	Unit Coal	
					Dry	Moist
Proximate Analysis	Moisture	6.69	-	-	-	7.93
	Volatile matter	35.56	38.11	44.72	43.67	40.21
	Fixed carbon	43.95	47.10	55.28	56.33	51.86
	Ash	13.80	14.79	-	-	-
	Total	100.00	100.00	100.00	100.00	100.00
Ultimate Analysis	Hydrogen	4.98	4.54	5.33		
	Carbon	64.04	68.63	80.54		
	Nitrogen	1.21	1.30	1.53		
	Oxygen	14.63	9.30	10.91		
	Sulfur	1.34	1.44	1.69		
	Ash	13.80	14.79	-		
	Total	100.00	100.00	100.00		
Calorific Value Determined	Calories per gram	6,250	6,698	7,861	8,000	7,366
	B. t. u. per lb.	11,251	12,058	14,151	14,400	13,258

SCRUBGRASS COAL BED

The Scrubgrass, like the Ogan and Winters coal beds, is present only in a small area in Vinton County (See Figure 10). It has been mined for local use in Brown and Madison Townships where its greatest thickness is known. Even here, or wherever this stratum is found, the thickness is variable and the coal shaly in character and poor in quality. The maximum thickness reported is one foot seven inches (Stout, 1927, p. 254).

LAWRENCE COAL BED

The Lawrence coal bed is of stratigraphic interest only. In Lawrence and Columbiana Counties where it is best developed it never exceeds a few inches and therefore contains no coal reserve.

TABLE 22

Estimated Original Reserves of the Brookville Coal Bed in Ohio

(In thousands of short tons. To obtain total tonnage add three zeros to end of each figure.)

County and Township	Proven					Probable					Strongly inferred					Total				
	14"-28"	28"-42"	42"-54"	54"-66"	Total	14"-28"	28"-42"	42"-54"	54"-66"	Total	14"-28"	28"-42"	42"-54"	54"-66"	Total	14"-28"	28"-42"	42"-54"	54"-66"	Total
CARROLL																				
Rose	-	-	-	-	-	2,056	-	-	-	2,056	-	-	-	-	-	2,056	-	-	-	2,056
COSHOCTON																				
Adams	2,097	403	184	-	2,684	2,379	-	-	-	2,379	-	-	-	-	-	4,476	403	184	-	5,063
Bedford	2,339	1,310	1,060	-	4,709	4,052	706	-	-	4,758	-	-	-	-	-	6,391	2,016	1,060	-	9,467
Jefferson	323	336	230	-	889	141	34	-	-	175	-	-	-	-	-	464	370	230	-	1,064
White Eyes	181	-	-	-	181	81	-	-	-	81	-	-	-	-	-	262	-	-	-	262
Total	4,940	2,049	1,474	-	8,463	6,653	740	-	-	7,393	-	-	-	-	-	11,593	2,789	1,474	-	15,856
HOCKING																				
Washington	-	203	-	-	203	-	-	-	-	-	-	-	-	-	-	-	203	-	-	203
HOLMES																				
Berlin	403	-	-	-	403	1,270	-	-	-	1,270	-	-	-	-	-	1,673	-	-	-	1,673
Clark	161	-	-	-	161	81	-	-	-	81	-	-	-	-	-	242	-	-	-	242
Hardy	1,331	-	-	-	1,331	464	-	-	-	464	-	-	-	-	-	1,795	-	-	-	1,795
Paint	464	-	-	-	464	40	-	-	-	40	-	-	-	-	-	504	-	-	-	504
Prairie	444	302	-	-	746	363	-	-	-	363	-	-	-	-	-	807	302	-	-	1,109
Salt Creek	1,472	1,075	-	-	2,547	282	-	-	-	282	-	-	-	-	-	1,754	1,075	-	-	2,829
Walnut Creek	2,238	-	-	-	2,238	3,468	-	-	-	3,468	-	-	-	-	-	5,706	-	-	-	5,706
Total	6,513	1,377	-	-	7,890	5,968	-	-	-	5,968	-	-	-	-	-	12,481	1,377	-	-	13,858
JACKSON																				
Milton	1,169	1,747	-	-	2,916	1,814	437	-	-	2,251	-	-	-	-	-	2,983	2,184	-	-	5,167
MUSKINGUM																				
Hopewell	60	67	92	-	219	40	-	-	-	40	-	-	-	-	-	100	67	92	-	259
Madison	2,661	-	-	-	2,661	4,314	-	-	-	4,314	-	-	-	-	-	6,975	-	-	-	6,975
Total	2,721	67	92	-	2,880	4,354	-	-	-	4,354	-	-	-	-	-	7,075	67	92	-	7,234
STARK																				
Bethlehem	988	1,042	1,935	-	3,965	2,278	1,277	24,054	-	27,609	40	202	-	-	242	3,306	2,521	25,989	-	31,816
Canton	968	403	7,788	-	9,159	3,689	6,518	43,868	-	54,075	20	-	184	-	204	4,677	6,921	51,840	-	63,438
Jackson	-	-	-	-	-	-	605	-	-	605	-	-	-	-	-	-	605	-	-	605
Lake	746	1,109	1,014	634	3,503	544	302	138	-	984	-	-	-	-	-	1,290	1,411	1,152	634	4,487
Lexington	1,109	2,352	3,041	-	6,502	2,278	605	46	-	2,929	-	-	-	-	-	3,387	2,957	3,087	-	9,431
Perry	-	-	415	-	415	-	4,133	11,566	-	15,699	5,766	4,334	4,516	-	14,616	5,766	8,467	16,497	-	30,730
Pike	2,782	134	8,986	749	12,651	13,044	4,872	23,316	-	41,232	-	-	-	-	-	15,826	5,006	32,302	749	53,883
Sugar Creek	665	-	-	-	665	3,709	-	-	-	3,709	-	-	-	-	-	4,374	--	-	-	4,374
Total	7,258	5,040	23,179	1,383	36,860	25,542	18,312	102,988	-	146,842	5,826	4,536	4,700	-	15,062	38,626	27,888	130,867	1,383	198,764
TUSCARAWAS																				
Dover	1,895	2,050	-	-	3,945	14,455	17,304	-	-	31,759	5,806	-	-	-	5,806	22,156	19,354	-	-	41,510
Fairfield	968	-	-	968	1,835	-	-	-	1,835	-	-	-	-	-	2,803	-	-	-	2,803	
Franklin	1,169	2,184	-	-	3,353	3,407	605	-	-	4,012	161	-	-	-	161	4,737	2,789	-	-	7,526
Lawrence	202	1,210	-	-	1,412	11,773	3,461	-	-	15,234	5,080	235	-	-	5,315	17,055	4,906	-	-	21,961
Sandy	2,076	739	1,060	576	4,451	12,923	370	-	-	13,293	-	-	-	-	-	14,999	1,109	1,060	576	17,744
Total	6,310	6,183	1,060	576	14,129	44,393	21,740	-	-	66,133	11,047	235	-	-	11,282	61,750	28,158	1,060	576	91,544
VINTON																				
Brown	1,048	3,461	-	-	4,509	4,919	3,763	-	-	8,682	-	-	-	-	-	5,967	7,224	-	-	13,191
Clinton	504	1,310	-	-	1,814	6,552	5,107	-	-	11,659	343	-	-	-	343	7,399	6,417	-	-	13,816
Elk	3,992	5,174	1,475	-	10,641	7,883	14,986	-	-	22,869	-	-	-	-	-	11,875	20,160	1,475	-	33,510
Madison	2,298	3,528	783	-	6,609	7,883	11,491	-	-	19,374	1,331	-	-	-	1,331	11,512	15,019	783	-	27,314
Richland	484	-	-	-	484	-	-	-	-	-	-	-	-	-	-	484	-	-	-	484
Swan	403	1,814	-	-	2,217	968	3,797	-	-	4,765	-	-	-	-	-	1,371	5,611	-	-	6,982
Vinton	383	168	-	-	551	3,629	2,386	-	-	6,015	948	-	-	-	948	4,960	2,554	-	-	7,514
Total	9,112	15,455	2,258	-	26,825	31,834	41,530	-	-	73,364	2,622	-	-	-	2,622	43,568	56,985	2,258	-	102,811
WAYNE																				
Franklin	1,976	806	-	-	2,782	1,250	-	-	-	1,250	-	-	-	-	-	3,226	806	-	-	4,032
Paint	1,411	134	-	-	1,545	2,822	-	-	-	2,822	-	-	-	-	-	4,233	134	-	-	4,367
Sugar Creek	323	-	-	-	323	-	-	-	-	-	-	-	-	-	-	323	-	-	-	323
Total	3,710	940	-	-	4,650	4,072	-	-	-	4,072	-	-	-	-	-	7,782	940	-	-	8,722
State Total	41,733	33,061	28,063	1,959	104,816	126,686	82,759	102,988	-	312,433	19,495	4,771	4,700	-	28,966	187,914	120,591	135,751	1,959	446,215

TABLE 23

Estimated Original Reserves of the Clarion Coal Bed in Ohio

(In thousands of short tons. To obtain total tonnage add three zeros to end of each figure.)

County and Township	Proven					Probable					Strongly inferred					Total				
	14"-28"	28"-42"	42"-54"	54"-66"	Total	14"-28"	28"-42"	42"-54"	54"-66"	Total	14"-28"	28"-42"	42"-54"	54"-66"	Total	14"-28"	28"-42"	42"-54"	54"-66"	Total
GALLIA																				
Greenfield	1,250	437	-	-	1,687	5,221	9,508	-	-	14,729	726	605	-	-	1,331	7,197	10,550	-	-	17,747
Huntington	60	437	-	-	497	2,842	1,176	-	-	4,018	-	-	-	-	-	2,902	1,613	-	-	4,515
Total	1,310	874	-	-	2,184	8,063	10,684	-	-	18,747	726	605	-	-	1,331	10,099	12,163	-	-	22,262
HOCKING																				
Starr	2,258	-	-	-	2,258	13,547	-	-	-	13,547	202	-	-	-	202	16,007	-	-	-	16,007
Washington	2,560	941	-	-	3,501	9,233	-	-	-	9,233	101	-	-	-	101	11,894	941	-	-	12,835
Total	4,818	941	-	-	5,759	22,780	-	-	-	22,780	303	-	-	-	303	27,901	941	-	-	28,842
JACKSON																				
Bloomfield	423	4,435	18,846	-	23,704	3,488	5,544	22,855	-	31,887	-	-	-	-	-	3,911	9,979	41,701	-	55,591
Franklin	121	840	138	-	1,099	806	2,419	92	-	3,317	-	-	-	-	-	927	3,259	230	-	4,416
Hamilton	-	-	-	-	-	--	101	-	-	101	-	-	-	-	-	-	101	-	-	101
Jefferson	-	3,629	2,534	-	6,163	--	6,451	2,350	-	8,801	-	-	-	-	-	-	10,080	4,884	-	14,964
Lick	-	-	1,106	-	1,106	81	101	783	-	965	-	-	-	-	-	81	101	1,889	-	2,071
Madison	544	10,651	8,432	-	19,627	4,838	20,193	22,348	-	47,379	7,983	5,443	184	-	13,610	13,365	36,287	30,964	-	80,616
Milton	585	3,326	41,977	-	45,888	-	1,714	29,260	-	30,974	-	-	-	-	-	585	5,040	71,237	-	76,862
Total	1,673	22,881	73,033	-	97,587	9,213	36,523	77,688	-	123,424	7,983	5,443	184	-	13,610	18,869	64,847	150,905	-	234,621
LAWRENCE																				
Decatur	665	9,105	2,995	115	12,880	4,213	8,534	-	-	12,747	-	-	-	-	-	4,878	17,639	2,995	115	25,627
Washington	282	14,683	276	-	15,241	2,076	29,332	-	-	31,408	-	-	-	-	-	2,358	44,015	276	-	46,649
Total	947	23,788	3,271	115	28,121	6,289	37,866	-	-	44,155	-	-	-	-	-	7,236	61,654	3,271	115	72,276
MEIGS																				
Columbia	302	67	-	-	369	4,979	134	-	-	5,113	40	-	-	-	40	5,321	201	-	-	5,522
SCIOTO																				
Bloom	-	941	-	-	941	242	773	-	-	1,015	20	-	-	-	20	262	1,714	-	-	1,976
Vernon	-	134	138	-	272	1,068	1,781	-	-	2,849	81	-	-	-	81	1,149	1,915	138	-	3,202
Total	-	1,075	138	-	1,213	1,310	2,554	-	-	3,864	101	-	-	-	101	1,411	3,629	138	-	5,178
VINTON																				
Brown	5,161	2,050	-	-	7,211	11,430	571	-	-	12,001	-	-	-	-	-	16,591	2,621	-	-	19,212
Clinton	2,842	7,896	1,659	-	12,397	4,354	13,271	2,442	-	20,067	-	-	-	-	-	7,196	21,167	4,101	-	32,464
Elk	-	1,949	15,160	-	17,109	60	907	11,427	-	12,394	81	-	-	-	81	141	2,856	26,587	-	29,584
Madison	2,097	5,107	8,985	2,707	18,896	15,039	4,704	13,916	288	33,947	1,935	-	-	-	1,935	19,071	9,811	22,901	2,995	54,778
Richland	-	-	-	-	-	161	-	-	-	161	-	-	-	-	-	161	-	-	-	161
Swan	927	4,065	4,331	-	9,323	4,838	4,805	2,212	-	11,855	1,955	-	-	-	1,955	7,720	8,870	6,543	-	23,133
Vinton	101	9,912	20,413	-	30,426	14,656	32,490	27,140	-	74,286	3,508	-	-	-	3,508	18,265	42,402	47,553	-	108,220
Wilkesville	-	2,285	22,947	-	25,232	8,810	16,497	26,910	-	52,217	1,935	-	-	-	1,935	10,745	18,782	49,857	-	79,384
Total	11,128	33,264	73,495	2,707	120,594	59,348	73,245	84,047	288	216,928	9,414	-	-	-	9,414	79,890	106,509	157,542	2,995	346,936
State Total	20,178	82,890	149,937	2,822	255,827	111,982	161,006	161,735	288	435,011	18,567	6,048	184	-	24,799	150,727	249,944	311,856	3,110	715,637

TABLE 24

List of U. S. G. S. Topographic Quadrangle Maps on Which Coal Outcrops Have Been Plotted[1]

Brookville #4 Coal Bed

Brinkhaven
Zaleski
Jackson
Logan
Thornville
Uhrichsville
Cambridge
Coshocton
Canton
Navarre
Frazeysburg
Wilkesville
Laurelville
New Lexington
Zanesville
Newcomerstown
Conesville
Alliance
Dover
Millersburg

Clarion #4A Coal Bed

Wilkesville
Jackson
Bidwell
Zaleski
Laurelville
Oak Hill
Ironton

[1]Coal outcrop maps, in photostat form, are available on topographic quadrangle base from the Ohio Division of Geological Survey.

Figure 11. - Index to coal resources (O'Neill Areas) maps. Each O'Neill area measures 1^{o} longitude by $\frac{1}{2}^{o}$ latitude at a scale of 1 : 62,500. O'Neill areas containing Brookville #4 and Clarion #4A coal reserves are identified by bold numbers. Brookville #4 coal reserves occur in Areas 8, 9, 15, and 16 (as indicated on this map); Clarion #4A coal reserves occur in Areas 14 and 15. These maps are available at cost through the Ohio Division of Geological Survey.

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