GEOLOGICAL SURVEY CIRCULAR 363

COAL RESERVES OF THE PITTSBURGH (NO. 8) BED IN BELMONT COUNTY OHIO

Prepared in cooperation with
the Ohio Geological Survey

UNITED STATES DEPARTMENT OF THE INTERIOR
Douglas McKay, Secretary

GEOLOGICAL SURVEY
W. E. Wrather, Director

GEOLOGICAL SURVEY CIRCULAR 363

COAL RESERVES OF THE PITTSBURGH (NO. 8) BED IN BELMONT COUNTY, OHIO

By Henry L. Berryhill, Jr.

Prepared in cooperation with
the Ohio Geological Survey

Washington, D. C., 1955

Free on application to the Geological Survey, Washington 25, D. C.

CONTENTS

ILLUSTRATIONS

TABLES

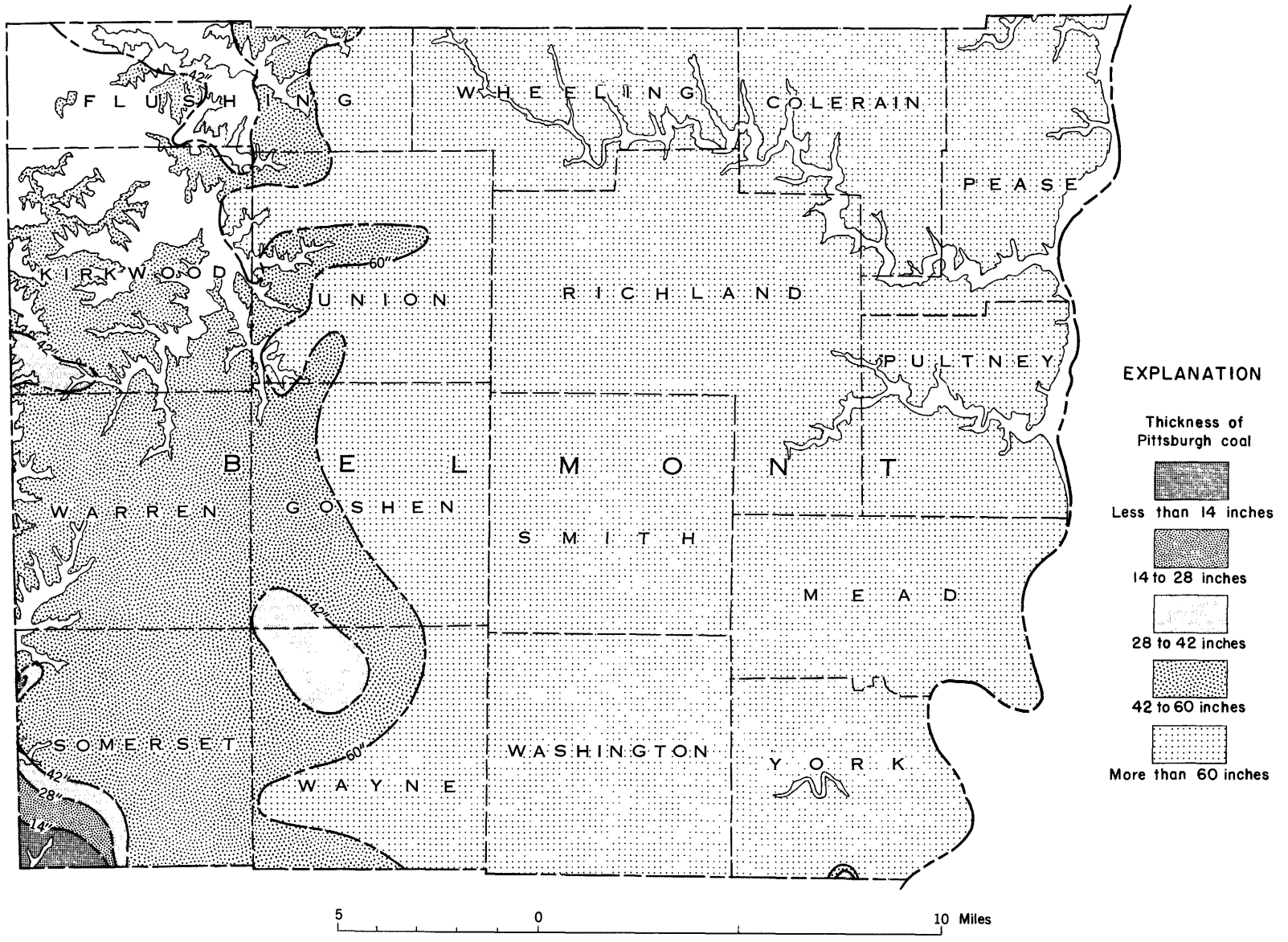


Figure 1.—Map of Belmont County, Ohio, showing the outcrop and the probable thickness range in inches of the Pittsburgh coal bed.

COAL RESERVES OF THE PITTSBURGH (NO. 8) BED IN BELMONT COUNTY, OHIO

By Henry L. Berryhill, Jr.

ABSTRACT

Remaining coal reserves totaling 1,929 million tons have been appraised in the Pittsburgh (No. 8) coal bed in Belmont County, Ohio. Of these, 508 million tons are classified as measured and 1,421 million tons are classified as indicated. All the coal has less than 1,000 feet of overburden, and most of it is of high volatile A bituminous rank.

This estimate is based on field work by the United States Geological Survey, supplemented by data from the files of the Ohio Geological Survey and from mine and drill-hole records provided by mining companies.

INTRODUCTION

The U. S. Geological Survey and the Ohio Geological Survey have cooperated in preparing this appraisal of coal reserves of the Pittsburgh (No. 8) bed in Belmont County, Ohio. The appraisal is based on field work by the U. S. Geological Survey, supplemented by a study of data on the Pittsburgh coal bed available from the publications and files of the two organizations and from mine and drill-hole records provided by mining companies and individuals. A forthcoming report, Geology and Coal Resources of Belmont County, will contain more detailed information on the Pittsburgh coal bed than is included herein, and will describe all other coal beds in the county.

In terms of quality and quantity of reserves, the Pittsburgh bed is the most important coal bed in Belmont County. The presence of comparatively large reserves of coal in the Pittsburgh bed makes Belmont one of the most important coal-bearing counties in the State. This report is designed to make information on the reserves of coal in the Pittsburgh bed available as quickly as possible.

A total of 300 measured coal sections were used in the preparation of the coal-bed thickness map (fig. 1). The writer measured 221 sections from outcrops and mines during field investigations and obtained descriptions of 79 sections from the files and publications of the U. S. Geological Survey and the Ohio Geological Survey.

A map showing mined-out areas and mine elevations of the Pittsburgh coal bed in Belmont County was prepared by the Ohio Geological Survey. The use of this map in preparing the estimate of reserves increases the reliability of the figures for remaining reserves as calculated for the report.

The writer appreciates the cooperation of the members of the Ohio Geological Survey, particularly William H. Smith, chief of the Coal Resources section, who gave freely of his personal knowledge of the Pittsburgh coal bed; and Russell A. Brant, J. A. Fagerstrom, and Russell Lehmann, who compiled the map of the mined-out areas. Most of the 63 coal sections taken from the files of the Ohio Geological Survey were measured by Wilbur Stout,[1] former chief of the Ohio Geological Survey. Acknowledgement is hereby extended to Mr. Stout and others for the use of data collected by them. Thanks are also due to the officers and representatives of the various coal companies in Belmont County for permitting the collecting of data from their mines and for the use of mine maps. Without their aid, preparation of this report would have been severely hampered.

Many individuals kindly contributed data which materially assisted in preparing this report.

SUMMARY OF RESERVES

The original reserves of coal in the Pittsburgh bed in Belmont County totaled 2,756 million tons, of which 1,335 million tons is classified as measured and 1,421 million tons as indicated (table 2). Included in the 1,335 million tons of measured coal is 827 million tons of coal mined out and lost in mining, leaving remaining reserves of 508 million tons as of January 1, 1953.

Remaining measured reserves of 508 million tons plus the indicated reserves of 1,421 million tons give total remaining reserves of 1,929 million tons as of January 1, 1953.

METHODS OF PREPARING ESTIMATES OF RESERVES

Any estimate of the coal reserves of an area must be based on assumptions as to thickness, areal extent, correlation of the coal beds, and weight of the coals.

[1]Stout, Wilbur, The Monongahela Series in eastern Ohio: Ohio Geol. Survey Open File Report No. 1., 1953.

Table 1 - Classification of coals by rank[a]

Legend: F.C. = Fixed Carbon. V.M. = Volatile Matter. Btu. = British thermal units.

Class	Group	Limits of Fixed Carbon or Btu. Mineral-Matter-Free Basis	Requisite Physical Properties
I. Anthracitic	1. Meta-anthracite	Dry F.C., 98 per cent or more (Dry V.M., 2 per cent or less)	
	2. Anthracite	Dry F.C., 92 per cent or more and less than 98 per cent (Dry V.M., 8 per cent or less and more than 2 per cent)	
	3. Semianthracite	Dry F.C., 86 per cent or more and less than 92 per cent (Dry V.M., 14 per cent or less and more than 8 per cent)	Nonagglomerating[b]
II. Bituminous[d]	1. Low volatile bituminous coal	Dry F.C., 78 per cent or more and less than 86 per cent (Dry V.M., 22 per cent or less and more than 14 per cent)	
	2. Medium volatile bituminous coal	Dry F.C., 69 per cent or more and less than 78 per cent (Dry V.M., 31 per cent or less and more than 22 per cent)	
	3. High volatile *A* bituminous coal	Dry F.C., less than 69 per cent (Dry V.M., more than 31 per cent); and moist[c] Btu., 14,000[e] or more	
	4. High volatile *B* bituminous coal	Moist[c] Btu., 13,000 or more and less than 14,000[e]	
	5. High volatile *C* bituminous coal	Moist Btu., 11,000 or more and less than 13,000[e]	Either agglomerating or nonweathering[f]
III. Subbituminous	1. Subbituminous *A* coal	Moist Btu., 11,000 or more and less than 13,000[e]	Both weathering and nonagglomerating
	2. Subbituminous *B* coal	Moist Btu., 9500 or more and less than 11,000[e]	
	3. Subbituminous *C* coal	Moist Btu., 8300 or more and less than 9500[e]	
IV. Lignitic	1. Lignite	Moist Btu., less than 8300	Consolidated
	2. Brown coal	Moist Btu., less than 8300	Unconsolidated

[a] This classification does not include a few coals which have unusual physical and chemical properties and which come within the limits of fixed carbon or Btu. of the high-volatile bituminous and subbituminous ranks. All of these coals either contain less than 48 per cent dry, mineral-matter-free fixed carbon or have more than 15,500 moist, mineral-matter-free Btu.

[b] If agglomerating, classify in low-volatile group of the bituminous class.

[c] Moist Btu. refers to coal containing its natural bed moisture but not including visible water on the surface of the coal.

[d] It is recognized that there may be noncaking varieties in each group of the bituminous class.

[e] Coals having 69 per cent or more fixed carbon on the dry, mineral-matter-free basis shall be classified according to fixed carbon, regardless of Btu.

[f] There are three varieties of coal in the high-volatile C bituminous coal group, namely, Variety 1, agglomerating and nonweathering; Variety 2, agglomerating and weathering; Variety 3, nonagglomerating and nonweathering.

An estimate, therefore, is of value only to the extent that the definitions and procedures used in its preparation are explained and understood. In addition, estimates of coal reserves, in order to have maximum usefulness, must be arranged into categories based on the characteristics of the coal and on the abundance and reliability of the information used in preparing the estimate. The criteria used in preparing this report and the categories into which the estimate is divided are described below.

Classification according to characteristics of the coal

Characteristics considered in calculating coal reserves are the rank of the coal, the thickness of beds, and the thickness of the overburden. The weight of the coal, an essential factor in computing tonnages, is largely a function of the rank and ash content.

Rank

American coals are ranked in accordance with the standard classification of the American Society for Testing Materials (reproduced as table 1). Most of the coal in the Pittsburgh bed in Belmont County is high volatile A bituminous in rank. At a few places in western Belmont County, the coal is high volatile B bituminous in rank.

Weight

The average weight of bituminous coal of low to medium ash content, as determined by many specific gravity determinations, is 1,800 tons per acre-foot (Averitt, Berryhill, and Taylor 1953). This weight has been used in calculating the reserves of coal in the Pittsburgh bed.

Thickness

In order to provide as much information as possible on the distribution of reserves, the estimates prepared by the U. S. Geological Survey are usually divided into three categories according to the thickness of the coal. These categories are termed "thin," "intermediate," and "thick." Coal classified as thin is 14 to 28 in thick; coal classified as intermediate is 28 to 42 in thick; and coal classified as thick is more than 42 in thick. These thickness categories are based primarily on the following mining practices: 14 in is approximately the minimum thickness of coal mined by hand methods; 28 in is the minimum usually considered for machine mining and hand loading; and 42 in is the approximate minimum thickness required at present for completely mechanized mining. Results of this study show that throughout much of Belmont County, the Pittsburgh coal bed is either just a little more or less than 60 in thick. Therefore, another category was added in order to show the reserves of coal in the Pittsburgh bed in Belmont County more than 60 in thick.

Overburden

The usual procedure followed by the U. S. Geological survey in classifying reserves is to separate the coal into categories based on the depth of burial or amount of overburden. The thicknesses of overburden considered are: surface to 1,000 ft, 1,000 to 2,000 ft, and 2,000 to 3,000 ft. Nowhere in Belmont County is the Pittsburgh coal buried as deeply as 1,000 ft. Indeed, the Pittsburgh coal bed can be mined by stripping methods throughout much of the western part of Belmont County.

Classification according to abundance and reliability of data

According to the abundance and reliability of data upon which the estimates are based, estimates of coal reserves prepared by the U. S. Geological Survey are divided into three categories termed "measured," "indicated," and "inferred."

Measured reserves

Measured reserves are those for which tonnage is computed from coal-bed thicknesses revealed in outcrops, trenches or prospect openings, mine workings, and drill holes. The points of observation are so closely spaced and the thickness and extent of the coal so well defined that the computed tonnage may be considered to be within 20 percent of the true tonnage. Although the spacing of points of observation necessary to demonstrate continuity of coal varies in different regions according to the character of the coal beds, geologic structure conditions, and other factors, the points of observation are, in general, about half a mile apart.

Indicated reserves

Indicated reserves are those for which tonnage is computed partly from specific measurements and partly from projection of visible data for a reasonable distance on geologic evidence. In general, the points of observation are about 1 mile apart, but they may be as much as 1-1/2 miles apart in beds of known geologic continuity.

Inferred reserves

Inferred reserves are those for which quantitative estimates are based on a broad knowledge of the character of the bed or region and for which there are few, if any, measurements. The estimates are based on an assumed continuity for which there is good geologic evidence. In general, inferred coal lies more than 2 miles from points of observed thickness. The many data on the Pittsburgh coal bed in Belmont County clearly show the continuity and uniformity of thickness of the coal. Therefore, none of the reserves of coal in the Pittsburgh bed in Belmont County are classed as inferred.

Distinction between original, remaining, and recoverable reserves

Coal reserves are further classified as original, remaining, and recoverable. Original reserves are the reserves in the ground before the beginning of mining operations.

Remaining reserves are the reserves in the ground as of the date of appraisal, and for large areas such as States, these figures are usually obtained by

Table 2.—Estimated reserves of bituminous coal in the Pittsburgh bed[1] in Belmont County (in millions of short tons)

Township	Original measured reserves: In beds 14 to 28 in thick	In beds 28 to 42 in thick	In beds 42 to 60 in thick	In beds over 60 in thick	Total A	Original indicated reserves: In beds 14 to 28 in thick	In beds 28 to 42 in thick	In beds 42 to 60 in thick	In beds over 60 in thick	Total B	Total original reserves C	Mined and lost in mining D[2]	Total remaining reserves E
Colerain				137.20	137.20						137.20	104.21	32.99
Flushing		13.79	32.26		46.05		3.70	33.72		37.42	83.47	8.85	74.62
Goshen		.43	5.48	1.45	7.36		4.73	67.47	120.72	192.92	200.28	1.33	198.95
Kirkwood		.57	19.27		19.84		4.50	69.52		74.02	93.86	1.63	92.23
Mead				160.94	160.94				30.17	30.17	191.11	126.90	64.21
Pease				145.52	145.52						145.52	82.60	62.92
Pultney				143.81	143.81						143.81	118.11	25.70
Richland			14.15	219.54	233.69			5.80	100.16	105.96	339.65	167.99	171.66
Somerset			6.62		6.62	4.19	6.24	124.06		134.49	141.11	.14	140.97
Smith			30.99		30.99			43.72	138.76	182.48	213.47	11.40	202.07
Union			78.96	2.02	80.98			109.43		109.43	190.41	37.14	153.27
Warren			28.94		28.94			124.50		124.50	153.44	6.03	147.41
Washington				26.98	26.98				194.35	194.35	221.33	5.19	216.14
Wayne		.43		.75	1.18		14.86	63.29	112.66	190.81	191.99		191.99
Wheeling			137.74		137.74			13.85		13.85	151.59	68.19	83.40
York				126.93	126.93				31.13	31.13	158.06	87.07	70.99
Bed total		15.22	354.41	965.14	1,334.77	4.19	34.03	655.36	727.95	1,421.53	2,756.30	826.78	1,929.52

[1]All tonnage estimates based on lower bench; upper bench, or "roof coal," excluded from estimate. [2]Included in total original measured reserves in column A.

subtracting recorded production plus an allowance for mining losses from original reserves. However, in appraising the reserves of coals in the Pittsburgh bed in Belmont County, sufficient mine information was available to make it possible to plot on the work map both the coal bed and the mined-out areas, and to measure separately the remaining coal and the mined-out areas. This made it possible to present a direct estimate of coal remaining in the ground as of January 1, 1953. It is believed that the accuracy of the measurements of the mined-out areas is such that the tonnages for mined-out areas are within 20 percent of the actual tonnages, and may, therefore, be placed in the measured category.

Recoverable reserves are the reserves in the ground, as of the date of appraisal, that can actually be produced in the future; the amount of these reserves is obtained by subtracting estimated future losses in mining from remaining reserves. Recoverability of coal from any property is essentially an engineering problem having many variable factors such as location, accessibility, geologic structure, thickness, and quality. Consequently, the percentage of recoverability usually differs from one area to another. Reported production from the Pittsburgh bed in Belmont County from 1816 to 1953 is 386,548,799 tons. Total coal mined and lost in mining as calculated from mine maps amounts to 826.8 million tons. This gives a recoverability factor of 47 percent for the Pittsburgh coal bed in Belmont County, which is comparable to the nationwide average of 50 percent recoverability (Averitt, Berryhill, and Taylor, 1953). Assuming 47 percent recoverability, the estimated recoverable reserves of coal in the Pittsburgh bed in Belmont County, as of January 1, 1953, is estimated to be 907 million tons. Technological advances that result in greater mining efficiency will doubtlessly raise the percentage of recoverability. An increase in strip mining where recoverability may, under favorable conditions, be as high as 90 percent of the coal originally in the ground (Koenig, 1950, p. 28), will also raise the percentage of recoverability.

Methods of recording data and making calculations

The exposures of the Pittsburgh coal bed were located in the field by planetable and alidade, surveying altimeter, or hand level and tape; and the locations were plotted on topographic maps covering Belmont County. The lateral extent of the coal was determined by the outcrop and by drill-hole and mine data. A work map was prepared from the topographic maps. All measured sections, drill holes, mine information, and other data pertinent to the bed were plotted on the work map, and the outcrop of the bed was drawn. Isopach lines were then drawn on the basis of the plotted information, dividing the coal into four categories according to the probable thickness: 14 to 28 in, 28 to 42 in, 42 to 60 in, and more than 60 in. Other lines were drawn, dividing the bed into measured and indicated categories on the basis of the spacing of the data.

Within each of the thickness categories shown on the map (fig. 1), a weighted average thickness for the coal was obtained by using all measurements from outcrops, mines, and drill holes. The figures used are the actual thicknesses of the coal minus partings,

except where the partings exceed half the total thickness of the coal bed. Where this occurs, the coal is not considered to be of commercial value and, therefore, is not included in the estimate.

The areas outlined on the map were measured with a planimeter to obtain the acreage underlain by coal in the different thickness and reliability categories. The tonnage was calculated by multiplying the number of acres by the weighted average thickness of the coal to the nearest tenth of a foot by 1,800 (the weight of bituminous coal in tons per acre-foot). The figures were then tabulated by townships and placed in categories according to thickness and reliability of information (table 2). For convenience in arranging the table, the tonnages are listed in millions of short tons.

COMPARISON OF PAST AND PRESENT ESTIMATES

Two previous estimates of the coal reserves in the Pittsburgh bed in Belmont County have been made. Clark (1917) estimated that the original reserves of coal in the Pittsburgh bed in Belmont County totaled 2,690,000,000 tons. In preparing his estimate, Clark used 59 inches as the average thickness for the bed, and he assumed that 475 square miles in Belmont County was underlain by the Pittsburgh coal bed.

Ray (1927) estimated that the original reserves of the Pittsburgh coal bed in Belmont County totaled 2,191,200,000 tons. For his estimate, Ray used an average thickness of 66 inches for the bed and assumed that 415 square miles in the county was underlain by the Pittsburgh coal bed. Ray excluded all coal less than 32 inches thick and used an assumed weight of 1,500 tons per acre-foot for the coal. This weight is very low for bituminous coal in the ground.

In the field study made preliminary to the preparation of this report, 491 square miles in Belmont County was found to be underlain by Pittsburgh coal having a thickness greater than 14 inches. Instead of assuming an overall average thickness, as was done in preparing past estimates, four different thickness categories, and a number of additional categories were employed as previously discussed to increase the accuracy of the work. The present estimate of original reserves is larger than either of the two previous estimates. Clark's estimate was smaller primarily because he assumed a smaller area underlain by the Pittsburgh coal bed. Ray's estimate is smaller for two reasons: he assumed a smaller area underlain by the Pittsburgh coal bed, and he assumed a weight of only 1,500 tons per acre-foot for the coal.

LOCATION OF BELMONT COUNTY

Belmont County is on the eastern edge of Ohio midway between the northern and southern boundaries of the State and comprises a rectangular area of 535 square miles distributed over sixteen townships (fig. 2). The greatest linear dimensions of the county are 27.65 miles from east to west along the northern boundary of the county, and 21.15 miles from north to south at a point midway between the east and west boundaries.

The County is bounded on the east by the Ohio River, which separates it from West Virginia, on the west by Guernsey and Noble Counties, on the north by Harrison and Jefferson Counties, and on the south by Monroe County (fig. 3).

TOPOGRAPHY AND DRAINAGE

Belmont County is in the Kanawha section of the Appalachian Plateaus physiographic province (Fenneman, 1938). The surface of the county is hilly and consists of broad, rounded ridges and V-shaped valleys. The valleys are deep and narrow along the Ohio River and its tributaries, but become shallower headward near the drainage divides. Slopes that are steep and precipitous along the main streams become gentle and rounded in the divide areas.

The streams of Belmont County are a part of the Ohio River drainage system. The eastern three-fourths of the county is drained mainly by Wheeling, McMahon, and Captina Creeks which flow eastward into the Ohio River. The drainage of the western fourth of the county follows a circuitous route west and northwestward along Stillwater Creek and the tributaries of Wills Creek into the drainage systems of the Tuscarawas and Muskingum Rivers before entering the Ohio River. The streams flowing east are separated from those flowing west and northwest by a divide which follows a sinuous course across the western part of the county (fig. 3).

TRANSPORTATION FACILITIES

A well-developed network of Federal, State, and county highways makes all parts of Belmont County accessible by motor vehicles. Rail outlet to most of the northern half of Belmont County and to all of the eastern part of the county along the Ohio River is afforded by the lines of three railroads: Baltimore and Ohio, Pennsylvania, and New York, Chicago, and St. Louis (Nickel Plate Road). Water transportation is possible on the Ohio River, which flows along the eastern edge of the county.

SETTLEMENT AND INDUSTRY

In 1950, Belmont County had 87,740 inhabitants. Density of population is greatest in the Ohio River valley along the eastern edge of the county. The principal towns in the county are Martins Ferry, Bellaire, Barnesville, Bridgeport, Shadyside, and St. Clairsville, the county seat.

The economy of Belmont County is based principally on agriculture, coal mining, and manufacturing. Agriculture is the leading activity in terms

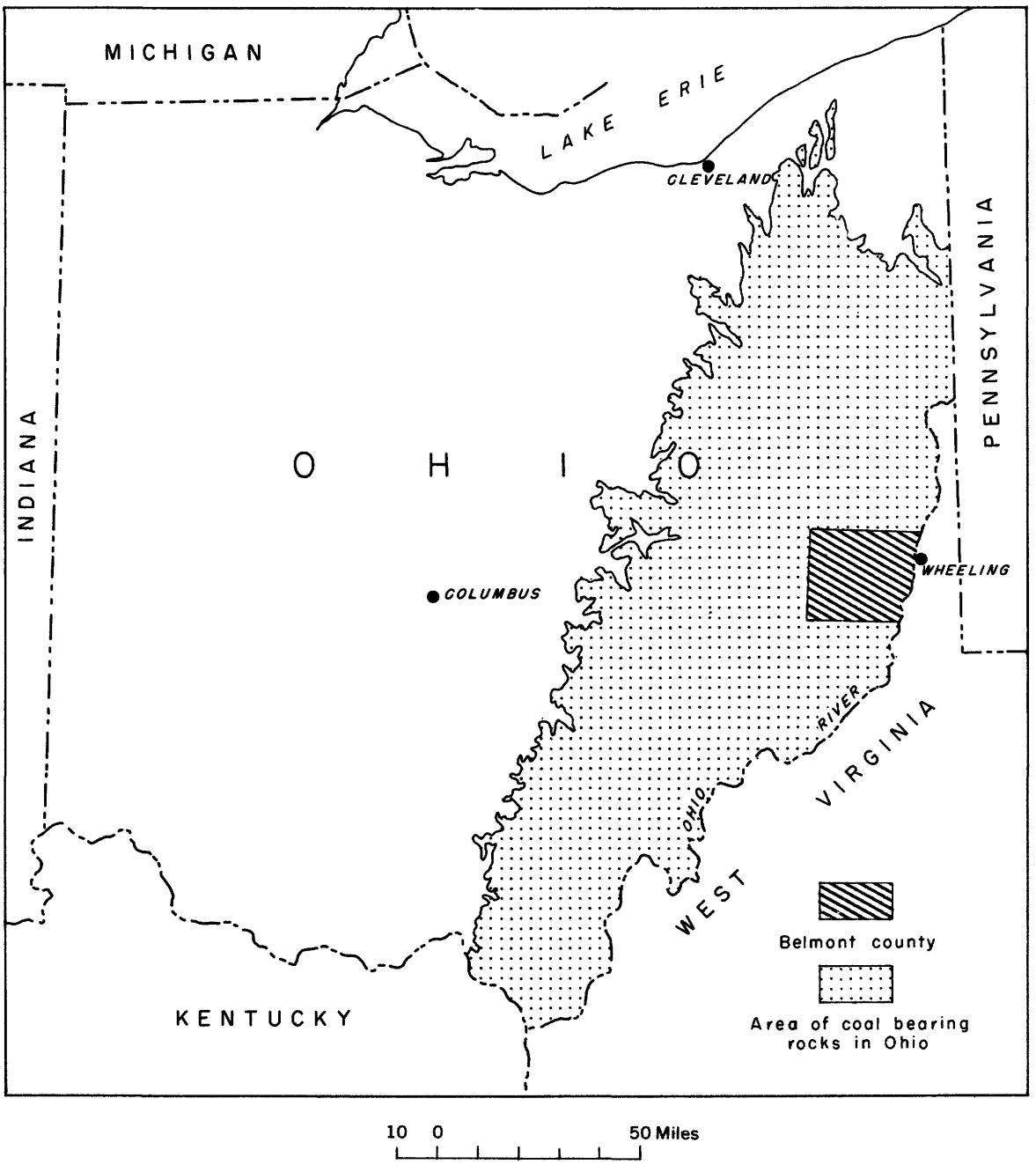


Figure 2.—Index map of Ohio showing the location of Belmont County and the area of coal-bearing rocks.

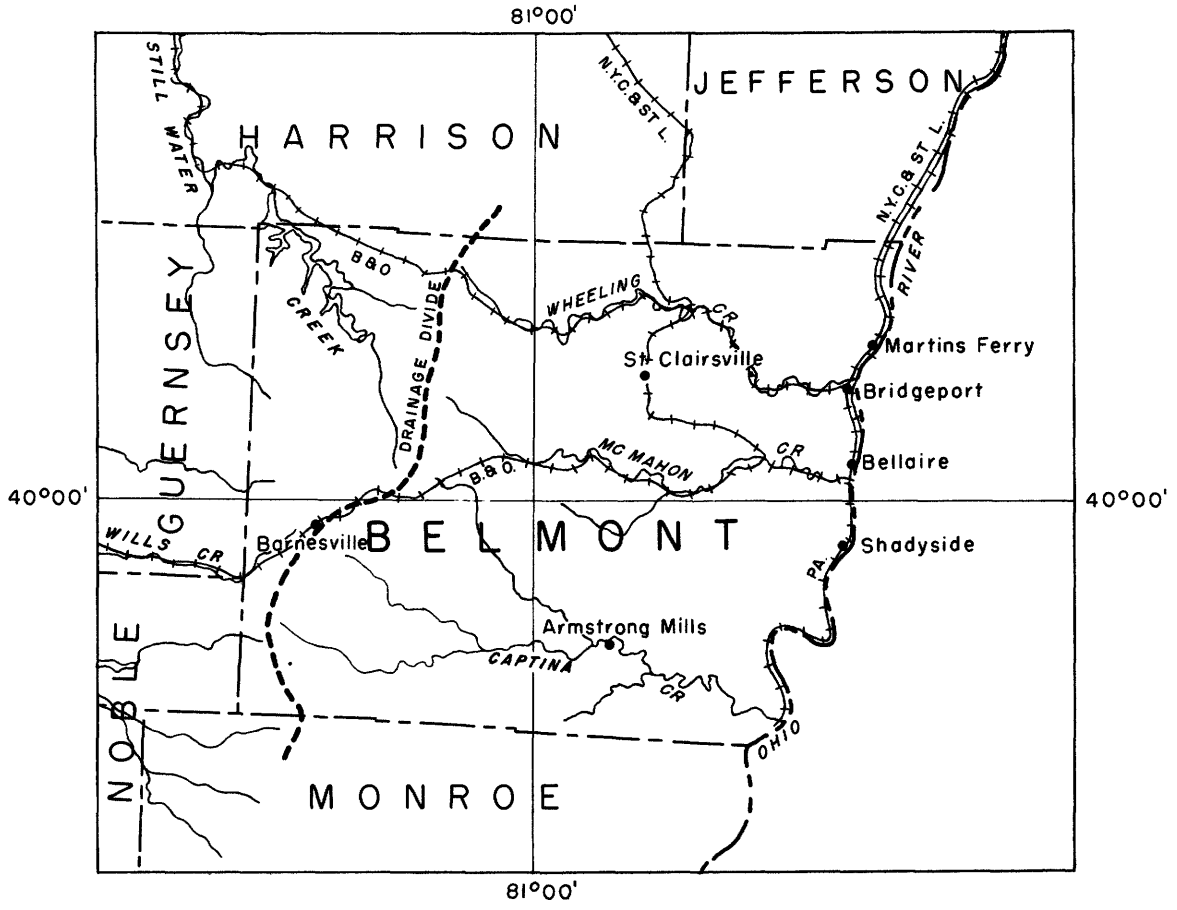


Figure 3.—Index map of Belmont County, Ohio, showing the location of main towns, streams, and railroads.

of numbers of persons engaged; but coal mining, in terms of income from sales, exceeds both manufacturing and agriculture combined.

DESCRIPTION OF THE PITTSBURGH COAL BED IN BELMONT COUNTY

Areal extent

The Pittsburgh coal bed crops out along the valleys of Stillwater Creek and the tributaries of Wills Creek in the western part of Belmont County. It is above drainage along Wheeling Creek from the northwest corner of Wheeling Township to the Ohio River and along McMahon Creek from southeastern Richland Township to the Ohio River. It is exposed along the Ohio River from the northeast corner of Pease Township to the northeast corner of Mead Township where it dips below the level of the Ohio River. A slight doming of the rocks brings the coal bed above drainage for a short distance along Captina Creek in central York Township.

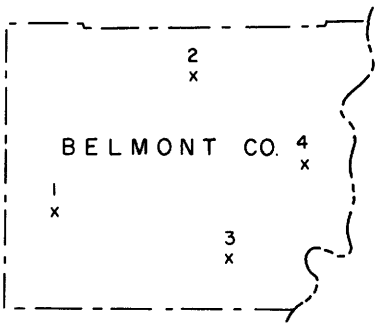
Stratigraphy

The Pittsburgh coal bed was originally named and described by H. D. Rogers in 1839 from its exposures at Pittsburgh, Pennsylvania. In Belmont County, the Pittsburgh coal bed was locally known as the Bellaire coal bed along the Ohio River and as the Lower Barnesville coal bed in the southwestern part of the County until 1878 when John J. Stevenson (1878) correctly correlated it with the Pittsburgh coal bed of Pennsylvania. The name has been in use by the Ohio Geological Survey since that time.

The Pittsburgh coal bed is the basal unit of the Monongahela formation of Pennsylvanian age. The Monongahela formation consists of sandstone, siltstone, shale, clay, limestone, and coal and ranges from 230 to 260 feet in thickness in Belmont County. It overlies the Conemaugh formation of Pennsylvanian age and is overlain by strata of Permian age.

Regional structure

The strata comprising the Monongahela formation lie nearly flat. They dip to the southeast at an average of 18 feet per mile. Locally, however, the dip increases to as much as 70 feet per mile, where small flexures or rolls cause slight variations in the regional southeast dip. The base of the Pittsburgh coal bed is 1,220 feet above sea level near the northwest corner of



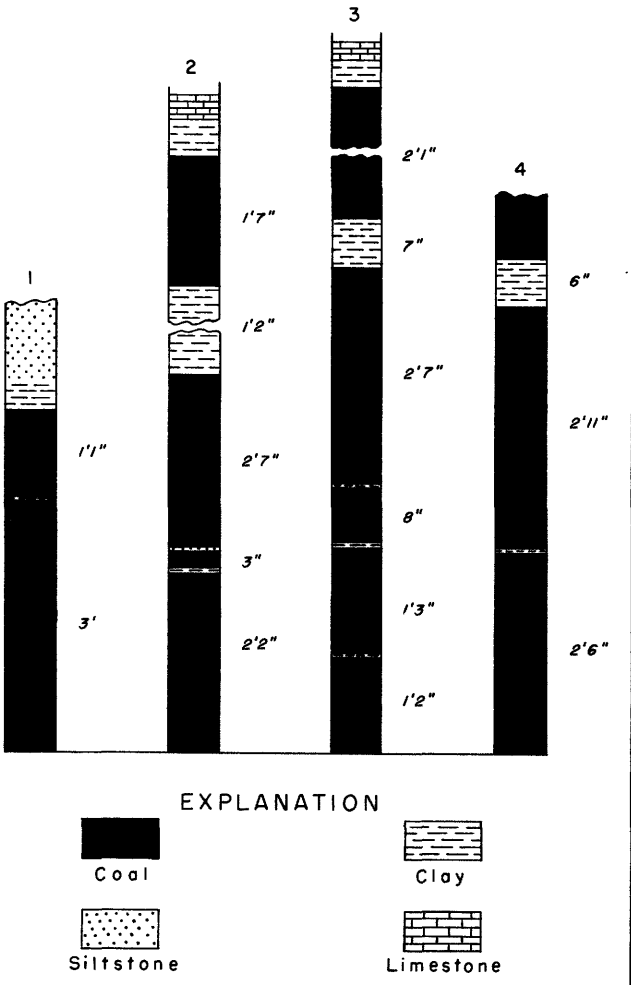


Figure 4.—Diagrammatic sections showing the character of the Pittsburgh coal bed in Belmont County, Ohio.

Belmont County in sec. 31, Flushing Township. In sec. 7, York Township, 37 miles to the southeast, the base of the Pittsburgh bed is 545 feet above sea level at the bottom of the slope to the Powhatan No. 1 mine.

Thickness

Uniformity in thickness and regularity in occurrence of certain partings characterize the Pittsburgh coal bed over most of Belmont County (fig. 4). In the eastern two-thirds of the county, the bed averages 60 to 64 in. in thickness, with only a few local variations. In northeastern Washington Township the bed is more than 72 in thick and is reported by mine operators to be 84 in thick in a narrow belt trending northeastward through Pultney and Pease Townships. At a few localities, mainly along Wheeling Creek in Wheeling and Colerain Townships, the bed is slightly less than 60 in thick.

In the western third of Belmont County, however, the Pittsburgh coal bed is more variable in thickness, ranging from 8 to 60 in. The part of the bed shown on figure 1 in the 42- to 60-in thickness category was found to average about 50 in. in thickness, and that part in the 28- to 42-in thickness category was found to average 38 in. Core-hole drillings in southwestern Goshen and northwestern Wayne Townships indicate an area of coal less than 42 in thick. In the southwest corner of Belmont County in Somerset Township, the bed thins abruptly from 42 to less than 12 in. This is the only area in Belmont County where the Pittsburgh coal bed is too thin to be mined.

The above thicknesses do not include the upper bench, or "roof coal," of the Pittsburgh coal bed.

Character

Generally, there are three to five clay stone, bone, or pyrite partings present in the Pittsburgh coal bed (fig. 4). In the eastern three-fourths of the county, the most extensive parting is a clay stone commonly termed "draw slate" by miners. This parting, which ranges from a few inches to as much as 3 feet in thickness, separates the bed into two benches. In a few isolated localities the parting is absent. The two benches of the Pittsburgh coal bed are dissimilar in character. The lower of the two benches forms the main part of the bed and contains all of the mineable coal. The reserve tonnages and bed thicknesses in this report are based entirely on the lower bench. The upper bench of the Pittsburgh coal bed is usually thin, variable in thickness, and poor in quality.

At most places the lower bench of the bed contains two or three thin partings of clay stone, pyrite, and bone which are remarkable for their regularity of occurrence. Two of these partings, which are usually spaced from 2-1/2 to 6 in apart, are almost always present near the center of the lower bench of the bed (fig. 4, no. 2). They are usually from 1/2 to 1-3/4 in thick and consist of carbonaceous claystone impregnated with pyrite (FeS_2). In some places, the lower of the two closely spaced partings is a paper-thin layer of pyrite. The two partings locally consist of bone or impure coal. A third parting is often found from 12 to 18 inches above the base of the lower bench. The third parting is generally a pyrite layer ranging from 1/8 to 3/4 in. in thickness. In a few places, a zone of pyrite discs as much as 18 in. in diameter and 6 in thick are found at the position of the third parting. Occasionally, a 1/4- to 1/2-in bone layer is present about 12 in below the top of the lower bench.

In addition to the extensive partings, "clay veins" are present in the lower bench of the Pittsburgh coal bed. Clay veins occur where the clay stone separating the Pittsburgh coal bed into benches thickens downward and takes the place of the upper part of the lower bench. Locally the entire lower bench is replaced. The clay veins range from a few feet to a few tens of feet in width. Their presence may be a result of differential settling or they may indicate the position of stream channels which traversed the coal swamp during the period of plant accumulation. Many of the clay veins are fillings of vertical cracks in the coal bed. The lower bench of the Pittsburgh coal bed is underlain by impure clay stone which grades to a plastic clay at some places.

In the past when hand cutting tools were used, the following terminology, based on the partings just described, was applied to the Pittsburgh coal bed:

roof coal	Upper bench
draw slate breast coal parting bearing-in-coal parting brick coal parting bottom coal	Lower bench

The upper bench of the Pittsburgh coal bed is usually 14 to 18 in thick but ranges from a fraction of an inch to 30 in. in thickness. Several irregular clay and shale partings ranging from a fraction of an inch to several inches in thickness are commonly present. The upper bench of the Pittsburgh coal bed is absent in the western fourth of Belmont County.

Roof rock

Clay stone several feet thick overlain by argillaceous limestone forms the roof of the Pittsburgh coal bed throughout the eastern two-thirds of Belmont County. The clay stone, which softens very quickly upon exposure to air, is a poor roof material. At most places the upper bench of the Pittsburgh bed is left in place as the roof support; hence its common designation as the Pittsburgh "roof coal." At some places, the upper bench of the coal bed is absent, which increases both the hazard and expense of mining.

Clay, sandstone, and shaly siltstone overlie the Pittsburgh coal bed in the western third of the county. The upper bench is absent, and the overlying rock lies directly on the lower bench. In most places, the coal is overlain by a few inches to several feet of soft shaly clay or shaly siltstone, which is in turn overlain by more massive siltstone or sandstone. In the western part of the county sandstone cuts out all of the upper bench of the Pittsburgh coal bed and in places also cuts into the lower bench. Where the sandstone replaces a part of or all of the lower bench, it forms what miners call "horsebacks" or "faults."

In strip mining, the clay and limestone overburden is easier to remove than the sandstone, which locally forms a massive stratum as thick as 30 feet.

Quality

Coal from the Pittsburgh bed is high volatile A bituminous in rank throughout most of Belmont County. There is some variation in rank, however, from east to west across the county, the coal from the east being slightly higher in British thermal units, or heating value, and slightly lower in ash content. Some of the coal in western Belmont County is high volatile B bituminous in rank. The average "as-received" value for the Pittsburgh coal bed in eastern Belmont County, based on 17 analyses, is 13,081 Btu. The average "as-received" value for the coal in western Belmont County, based on 12 analyses, is 12,659 Btu.

The following analyses represent the typical chemical characteristics of the Pittsburgh coal bed in the eastern and western parts of the county:

Analysis from the D. E. McIntyre mine, SE 1/4, sec. 21, York Township (Bownocker and Dean, 1930, p. 221-222):

Proximate analysis

	As received	Moisture free
Moisture	3.11	0.00
Volatile matter	41.81	43.15
Fixed carbon	47.74	49.28
Ash	7.34	7.57
	100.00	100.00
Sulfur	3.45	3.56
Btu	13,152	13,574

Analysis by the U. S. Bureau of Mines of a sample from the H. E. Tickhill mine, NW 1/4, sec. 20, Warren Township:

Proximate analysis

	As received	Moisture free
Moisture	2.50	0.00
Volatile matter	41.20	42.30
Fixed carbon	45.90	47.00
Ash	10.40	10.70
	100.00	100.00
Sulfur	4.60	4.70
Btu	12,950	13,280

History of mining

Exposures of the Pittsburgh coal bed are so numerous throughout Belmont County that its presence doubtlessly was known to the earliest settlers. Early mining was confined to small openings and stripping operations along the coal outcrops and was carried on mainly by local land owners who dug the coal for home use.

Coal from the Pittsburgh bed was first shipped out of Belmont County about 1830, when an underground mine was opened by John Fink on the south bank of

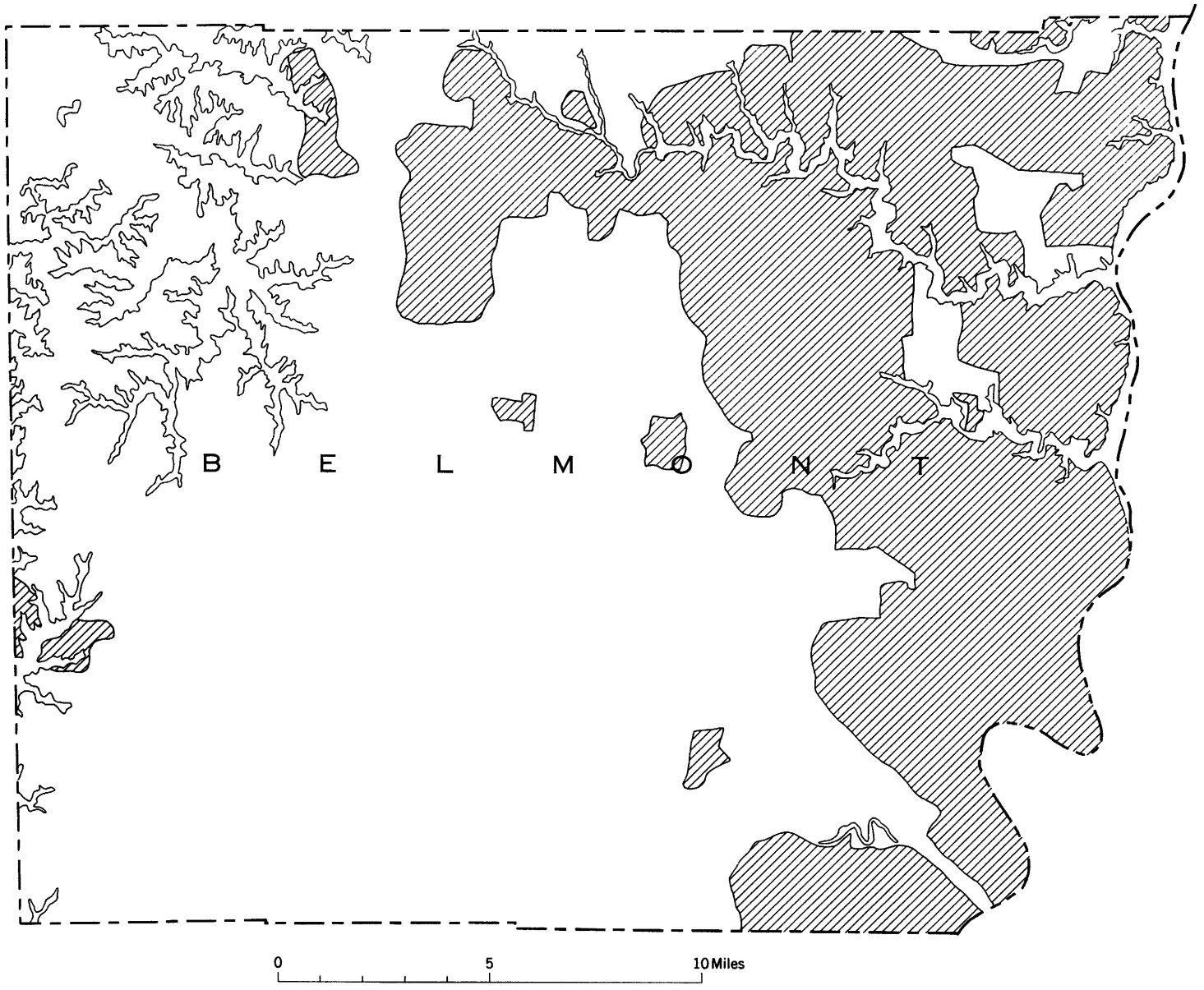


Figure 5.—Outline map of Belmont County, Ohio, which shows by line pattern the generalized areas in which the Pittsburgh coal has been largely mined out.

McMahon Creek at Bellaire (Winegerter 1912). Between 1835 and 1840, other mines were opened in the vicinity of Bellaire by Heatherington, O'Neil, Lake, and others; and by 1845, river shipment of coal had become an active enterprise (Bownocker, 1908).

The first railroad mine in the county opened on McMahon Creek one mile west of Bellaire about 1858. About 10 years later another railroad mine was opened at Franklin Station, 8 miles west of Bellaire (Bownocker, 1908).

Completion of the Cleveland, Lorain, and Wheeling Railroad in 1876, and extension of this railroad to Bellaire and Martins Ferry in 1888 opened all of northeastern Belmont County to direct rail connections with lake ports and markets to the northwest. Consequently, mining of the Pittsburgh coal bed in the Wheeling Creek field developed rapidly. The Cleveland, Lorain, and Wheeling Railroad is now a part of the Baltimore and Ohio Railroad.

By 1888, the Pittsburgh coal bed was mined for locomotive fuel along Leatherwood Creek southwest of Barnesville. The Captina mine, located on Captina Creek three-fourths of a mile east of Armstrong Mills, produced coal from the Pittsburgh bed for shipment along the narrow gauge Bellaire, Zanesville, and Columbus Railroad, later called the Ohio River and Western Railroad. This railroad is now abandoned.

Mining of the Pittsburgh coal bed increased steadily after 1888, and by 1905 Belmont was the leading coal-producing county in Ohio. With the exception of 1914, it has maintained first place in Ohio coal production.

Mining activity in the Pittsburgh bed has been concentrated mainly in eastern Belmont County. As a result, the Pittsburgh coal bed is largely mined out in this area (fig. 5). Considering the county as a whole, however, it is noteworthy that even though commercial mining of the Pittsburgh coal bed began more than 100 years ago, 1,929 million tons or 68 percent of the original reserves of the bed still remain to be mined. Most of the remaining coal is present in the southwestern half of the county where comparatively little mining has been done. In addition, blocks of unmined coal still remain within the mined-out area shown on figure 5.

Total reported production from the Pittsburgh coal bed in Belmont County to January 1, 1953, was 326,548,799 tons.

Before World War II, Practically all of the coal from the Pittsburgh bed was removed by underground mining methods; strip mining, the digging of coal by first removing the overburden, was confined to very small operations. Since World War II, however, strip mining has increased yearly. With large acreages of strippable coal present in the northern and western parts of the county, removal of the coal from the Pittsburgh bed by stripping methods doubtlessly will continue at an increased rate.

SELECTED BIBLIOGRAPHY

Averitt, Paul, Berryhill, L. R., and Taylor, D. A., 1953, Coal resources of the United States—A progress report: Oct. 1, 1953, U. S. Geol. Survey Circ. 293.

Bownocker, J. A., 1908, Coals of the Monongahela formation of upper productive coal measures: Ohio Geol. Survey, 4th ser., Bull. 9, p. 13-43.

Bownocker, J. A., and Dean, E. S., 1930, Analyses of the coals of Ohio: Ohio Geol. Survey, 4th ser., Bull 34, p. 204-224.

Brown, C. N., 1888, The Pittsburgh coal seam in Jefferson, Belmont and Guernsey Counties, in Report of the Geol. Survey of Ohio, v. 6, Economic geology, p. 605-623.

Clark, F. R., 1917, Original coal content of the fields, in Bownocker, J. A., The coal fields of Ohio: U. S. Geol. Survey Prof. Paper 100, p. 88-96. (Reprinted, 1929.)

Condit, D. D., 1912, Conemaugh formation in Ohio: Ohio Geol. Survey, 4th ser., Bull. 17.

_____1923, Economic geology of the Summerfield and Woodsfield quadrangles, Ohio: U. S. Geol. Survey Bull. 720.

Eavenson, H. N., 1942, The first century and a quarter of American coal industry, Pittsburgh, privately printed.

Fenneman, N. M., 1938, Physiography of the eastern United States, p. 279, New York, McGraw-Hill Book Co.

Fieldner, A. D., Campbell, M. R., Cooper, H. M., and others, 1923, Analyses of Ohio coals: U. S. Bureau Mines Tech. Paper 344.

Fieldner, A. C., Taylor, D. A., Toenges, A. L., and others, 1952, Analyses of Ohio coals: U. S. Bureau Mines Bull. 499.

Koenig, R. P., 1950, Economics and technique of strip coal mining in coal and metal mining: Colorado School of Mines Quart., v. 45, no, 2B, p. 27-39.

Ray, F. A., 1929, The Ohio coal supply and its exhaustion, in Bownocker, J. A., and Dean, E. S., Analyses of the coal of Ohio: Ohio Geol. Survey, 4th ser., Bull 34, p. 329-341.

Rogers, H. D., 1839, Third annual report on the geological exploration of the state of Pennsylvania.

Stauffer, C. R., and Schroyer, C. R., 1920, The Dunkard series of Ohio: Ohio Geol. Survey 4th ser., Bull. 22.

Stevenson, J. J., 1878, Geology of Belmont County, in Report of the Geol. Survey of Ohio, v. 3, Geology and paleontology, pt. 1, Geology.

Winegerter, C. A., 1912, History of greater Wheeling and vicinity, p. 352-353, Chicago and New York, Lewis Publishing Co.

INT.-DUP. SEC., WASH., D.C. 80863