STATE OF OHIO
MICHAEL V. DISALLE, Governor
DEPARTMENT OF NATURAL RESOURCES
HERBERT R. EAGON, Director
DIVISION OF GEOLOGICAL SURVEY
RALPH J. BERNHAGEN, Chief

REPORT OF INVESTIGATIONS NO. 38

COAL RESOURCES OF THE UPPER PART OF THE MONONGAHELA FORMATION AND THE DUNKARD GROUP IN OHIO

BY

George H. Denton

COLUMBUS
1960

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PREFACE

This report is the eighth of a series by the Division of Geological Survey dealing with coal resources of Ohio. A bulletin summarizing all eight reports is soon to be published.

The purpose of this investigation is to summarize the known information concerning the coal reserve of the upper Monongahela formation and Dunkard group in Ohio. The geologic data upon which this report is based have been accumulated in open file or in published reports of the Division of Geological Survey over a period of more than 70 years. Although the recognition and correlation of many of the minor coal beds, especially those of the Dunkard group, is still a controversial geologic problem, no attempt is made to resolve the problem in this report.

This report is intended specifically for use by the coal producer, miner, prospector, and owner of coal-bearing land.

Previous reports of the Division of Geological Survey in the series concerned with the estimated original reserve of Ohio coal are listed below:

Brant, R. A., 1954, The Lower Kittanning No. 5 coal bed in Ohio: Ohio Division of Geological Survey Report of Investigations 21.

Brant, R. A., 1956, Coal resources of the upper part of the Allegheny formation in Ohio: Ohio Division of Geological Survey Report of Investigations 29.

DeBrosse, T. A., 1957, Coal beds of the Conemaugh formation in Ohio: Ohio Division of Geological Survey Report of Investigations 34.

DeLong, R. M., 1955, The Pittsburgh No. 8 and Redstone No. 8a coal beds in Ohio: Ohio Division of Geological Survey Report of Investigations 26.

DeLong, R. M., 1957, Coal resources of the lower part of the Allegheny formation in Ohio: Ohio Division of Geological Survey Report of Investigations 31.

Granchi, J. A., 1958, Coal resources of the Pottsville formation: Ohio Division of Geological Survey Report of Investigations 36.

Smith, W. H., and others, 1952, The Meigs Creek No. 9 coal bed in Ohio, part I, Geology and reserves: Ohio Division of Geological Survey Report of Investigations 17.

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FIGURES

ABSTRACT

An estimated 3,902,396,000 short tons of original coal reserve of the upper Monongahela and Dunkard strata is distributed principally in Belmont, Monroe, and Washington Counties. The Monongahela coal beds contain an estimated original reserve of 2,511,668,000 short tons, distributed as follows:

Fishpot coal	440,746,000 tons
Uniontown (No. 10) coal	1,380,168,000 tons
Waynesburg (No. 11) coal	690,754,000 tons

The Dunkard coal beds contain an estimated 1,390,728,000 short tons, which is distributed as follows:

Waynesburg "A" (No. 11a) coal	490,686,000 tons
Washington (No. 12) coal	900,042,000 tons

Most chemical analyses of these coal beds reveal a high ash and sulfur content and a correspondingly low Btu content. Most of these coal beds are easily accessible and have been mined on a small scale for local use. Because of the general thinness and low heating value of the coal, increased utilization of these beds will probably await the development of highly efficient preparation plants or coal-burning equipment that can utilize low-grade coal. As the better quality and thicker coal beds are depleted, the upper Monongahela-Dunkard coals will play an increasingly important role as a future source of energy in Ohio.

Chapter I

GEOLOGIC DESCRIPTION OF THE UPPER MONONGAHELA FORMATION AND THE DUNKARD GROUP

For the purposes of this report the upper portion of the Monongahela formation is defined as those strata present in the interval between the base of the Fishpot coal and the top of the Waynesburg (No. 11) coal. All strata exposed in Ohio above the top of the Waynesburg coal belong to the Dunkard group, which is divided into the Washington and the Greene formations. The Washington formation extends from the top of the Waynesburg coal to the top of the Upper Washington limestone; the Greene formation extends from the top of the Upper Washington limestone to the top of the youngest rocks exposed in Ohio.

The geologic classification of these groups of strata has an interesting history. H. D. Rogers (1839, p. 87) made the first attempt to classify the rocks that now are known as the Monongahela formation. He termed them the "Pittsburgh series" and stated that this grouping included all the strata above the level of the Ohio River at Pittsburgh, Pa. Thus, in the Pittsburgh series Rogers incorporated what is now the upper part of the Conemaugh formation, all of the Monongahela formation, and the Washington and Greene formations of the Dunkard group. In subsequent studies, Rogers (1840, p. 149-150) applied the name "Monongahela series" to his original Pittsburgh series, but did not change the limits. Later, Rogers (1858, v. 1, p. 109 and v. 2, p. 16, 20, and 477) again classified what now is known as the Pennsylvanian and Permian systems into the Seral conglomerate, the Lower Productive Measures, the Lower Barren Measures, the Upper Productive Measures, and the Upper Barren Measures. The Upper Productive Measures were the same as the presently defined Monongahela formation and the Upper Barren Measures were equivalent to the present Permian or Dunkard rocks. Franklin Platt (1874, p. 8) in his report on the Clearfield and Jefferson district, Pennsylvania, used the term "Monongahela series" as originally proposed by Rogers in 1840. However, he fixed the limits in accordance with Roger's definition of the Upper Productive Measures. Platt's Monongahela series included the Pittsburgh coal, Redstone (Pomeroy) coal, Sewickley (Meigs Creek) coal, Waynesburg coal, and the Washington coal. Platt's boundaries of the Monongahela series remained unchanged until I. C. White (1891, p. 20) placed the beds lying above the Waynesburg coal in the Dunkard series of the Permian system. This grouping of beds is used presently in the Appalachian area. In the present report the term "Dunkard group" is used for areas of the Permian in which the Washington and the Greene formations are undifferentiated.

In Ohio, the upper Monongahela formation is composed primarily of sandstone, shale, limestone, clay and coal strata, which are exposed in the southeastern part of the State, in a narrow band 10 to 15 miles wide and roughly parallel to the Ohio River, from southern Jefferson County south to Gallia County (fig. 1). The Permian or Dunkard rocks of Ohio are exposed in a band about 30 miles wide, also parallel to the Ohio River, extending from southern Jefferson County to the southern tip of Meigs County (fig. 1). The area of the Dunkard rocks is approximately 1,213 square miles (Stouffer and Schroyer, 1920, p. 12).

Smith and others (1952) and DeLong (1955) have reported previously on the original reserve of the Pittsburgh (No. 8), Redstone (No. 8a), and Meigs Creek (No. 9) coal beds of the Monongahela formation. The other coal beds of the Monongahela formation--the

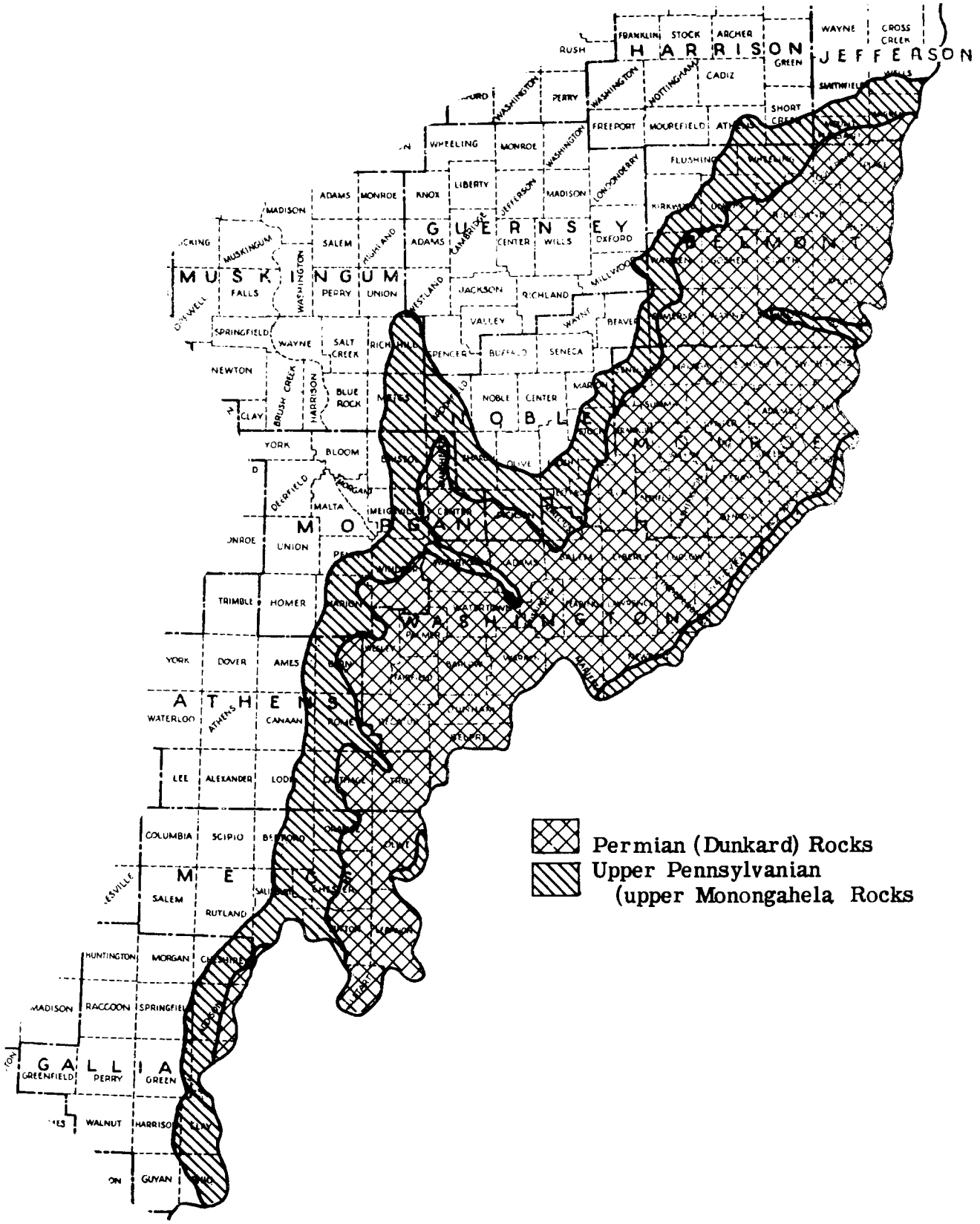
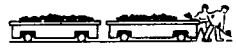


Figure 1. - Generalized map of areas underlain by rocks of upper Pennsylvanian-Permian age in Ohio. Small isolated areas underlain by rocks of this age are not shown.

Fishpot, Uniontown (No. 10), and Waynesburg (No. 11) coals, as well as the Waynesburg "A" (No. 11a) and Washington (No. 12) coals of the Dunkard group, are quite variable in occurrence, thickness, and chemical and physical nature. Although these beds are not greatly different from the older Pennsylvanian coals, they are generally less pure, less persistent, and less uniform in thickness and composition than are the older coal beds. The mining history shows only local production of these coals for domestic use. The coal beds, which thicken or thin quite rapidly over short distances and which in places become quite shaly, grade laterally into beds with numerous bony partings of high ash content. These variable and undesirable characteristics have discouraged large-scale mining. However, as the higher quality and thicker coal beds are depleted, these younger coals will play an increasingly important role as a future source of energy in Ohio.



Chapter 2

PRINCIPAL COAL BEDS

More than 32 coal beds or coal zones occur in the interval between the Fishpot coal and the Gilmore coal, the youngest recognized coal horizon in Ohio. Five of these coal beds are thick enough for a consideration of their reserve. The remaining coal beds, although characteristically thin and lacking in areal extent, are important to the geologist as a basis for the identification and correlation of more than 700 feet of strata above the Washington (No. 12) coal bed. Figure 2 is a generalized geologic columnar section of these strata. The average thickness of intervals between the Meigs Creek (Sewickley) (No. 9) coal bed and the Fishpot, Uniontown (No. 10), Waynesburg (No. 11), Waynesburg "A" (No. 11a), and Washington (No. 12) coal beds is shown in figure 3.

FISHPOT COAL

Two distinct coal zones in the interval between the Pittsburgh (No. 8) coal and the Meigs Creek (Sewickley) (No. 9) coal are found over a wide area of the Monongahela formation in Ohio. The Redstone (Pomeroy) (No. 8a) coal occurs from 25 to 30 feet above the Pittsburgh coal and has been described in an earlier report of the Survey (DeLong, 1955). The next higher coal bed in this interval, the Fishpot coal, is considered in the present report. This coal occurs from 60 to 70 feet above the Pittsburgh coal and from 19 to 35 feet below the Meigs Creek (Sewickley) coal (fig. 3). The Fishpot coal was described by W. B. Clark and G. C. Martin (1905, p. 311), who applied the name "Lower Sewickley coal" to this stratum. It was recognized and recorded in the measured rock sections of Ohio by such early geologists as E. B. Andrews, J. J. Stevenson and C. N. Brown. No name was assigned to the coal bed in Ohio, however, until D. D. Condit (1916, p. 221-222) named it the Lower Meigs Creek coal. Wilber Stout (1954, p. 31) assigned the name "Fishpot coal" to the member in order to prevent confusion from the use of the terms "Sewickley coal" or "Meigs Creek coal". Another thin coal zone, which occurs 10 to 15 feet below the Meigs Creek (Sewickley) coal, is actually the Lower Sewickley coal. The Fishpot coal is quite extensive throughout eastern Ohio (fig. 4), where it ranges in thickness from a few inches to more than 4 feet. The character is quite variable as the coal changes laterally from relatively pure coal to shaly coal to bony coal to a thin carbonaceous smut streak.

UNIONTOWN (No. 10) COAL

The Uniontown (No. 10) coal first was described and named by Rogers (1858, v. 2, p. 501, 506) for exposures near Uniontown, Fayette County, Pa. In Ohio, E. B. Andrews (1874a p. 462, 463) described this member and called it the Hobson coal, from the town of Hobson in Washington County, where it was mined. Condit (1916, p. 221, 236-237) corre-

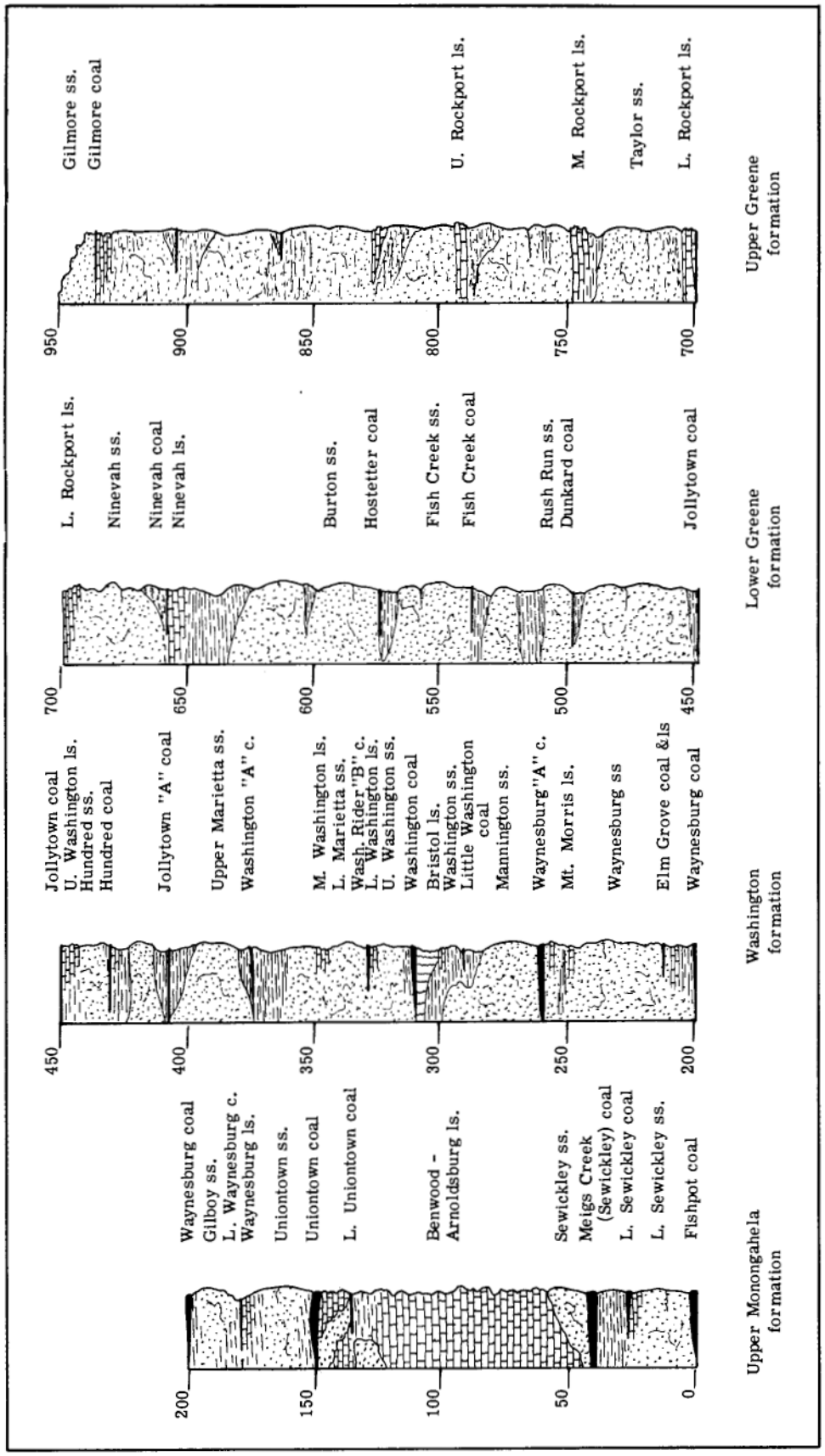


Figure 2. - Generalized geologic rock column of upper Monongahela and Dunkard strata in Ohio.

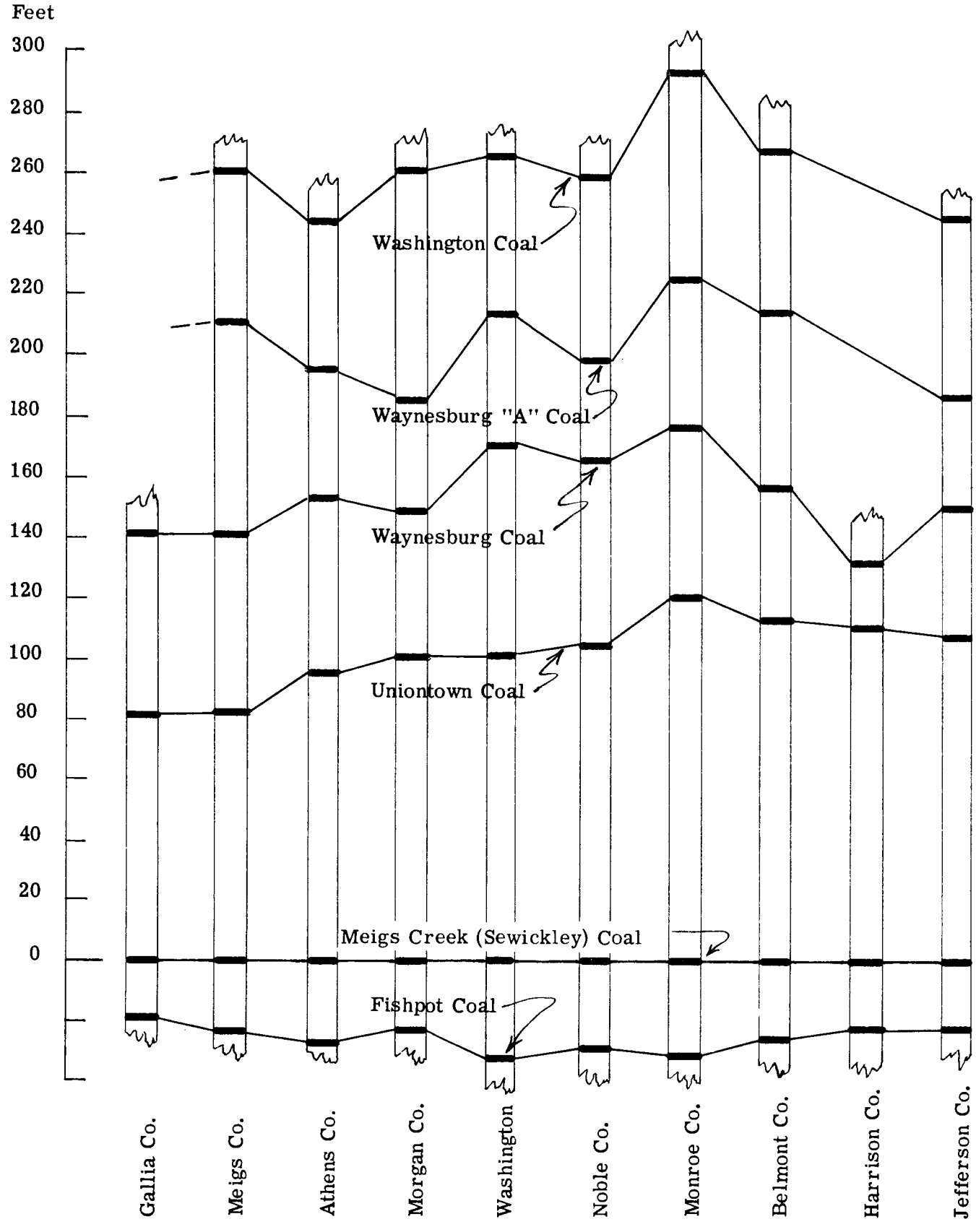


Figure 3. - Average intervals between coal beds of upper Monongahela and Permian strata in Ohio. Scale shows distance above or below the Meigs Creek (Sewickley) coal bed.

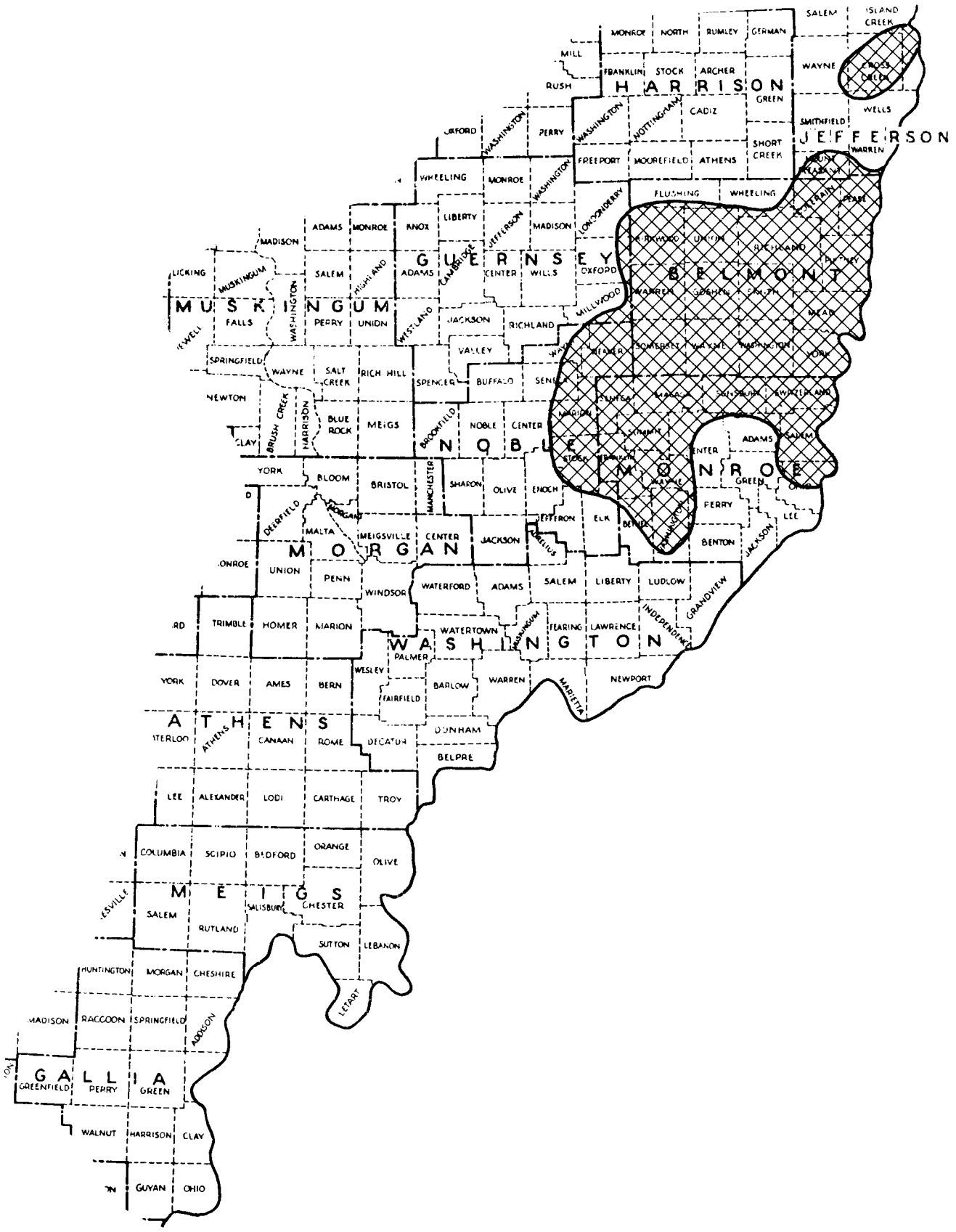


Figure 4. - Areal extent of Fishpot coal more than 14 inches thick in Ohio.

lated the Hobson coal with the Uniontown coal of Pennsylvania and correctly placed the name "Uniontown coal" in the Ohio geologic column.

The Uniontown is one of the most extensive coal beds in the upper Monongahela formation of Ohio; it is present in most of the bedrock exposures from southern Jefferson County southwestward into Gallia County. Figure 5 shows the distribution of this coal where it is more than 14 inches thick in Ohio. This coal bed occurs from 90 to 120 feet above the Meigs Creek (Sewickley) (No. 9) coal and shows considerable variation in thickness, lithologic character, and structure. It varies in thickness from a carbonaceous smut streak to a minable bed of coal more than 48 inches thick. In lithologic character the Uniontown coal varies much laterally; in the short distance of only a few hundred feet a good blocky coal in this bed may grade into shale. Structurally this coal bed is variable in that it has in some areas 1, 2, 3, or 4 benches of coal separated by partings of sandstone, limestone, clay, or bony shale.

WAYNESBURG (No. 11) COAL

Considerable geologic controversy has centered on the Waynesburg (No. 11) coal bed and its associated strata, for it is at the top of this coal bed that the Pennsylvanian-Permian boundary has been placed. In the past, the top of this coal bed, the base of the overlying Waynesburg sandstone, and the partings in the coal bed have all been used to mark the division between the two geologic systems. The Pennsylvanian-Permian boundary has been established on the basis of several criteria, but primarily on the basis of the nature of the fossil plants in the partings in this coal and the overlying Cassville roof shale. I. C. White (1891, p. 20) placed the Monongahela-Dunkard boundary at the top of the Waynesburg coal, due to the Permian affinity of the fossil plants in the Cassville roof shale. Recent investigations, however, raise some doubt as to the Permian nature of the roof-shale flora, and today, more than six decades later, there is still controversy as to the presence of Permian rocks in the Appalachian coal fields.

The Waynesburg (No. 11) coal was described first by Rogers (1858, v. 2, p. 19) from exposures along Laurel Run, near the town of Waynesburg, in Greene County, Pa. In Ohio, Andrews (1874b) first recognized this coal bed as a definite stratigraphic unit. However, miscorrelations of this coal with the overlying Washington (No. 12) coal bed and the underlying Uniontown (No. 10) coal bed were made by early Ohio geologists, and it was not until 1916 that the currently accepted correlation of the Waynesburg coal in Ohio was made by Condit.

The Waynesburg coal occurs from 145 to 175 feet above the Meigs Creek (Sewickley) (No. 9) coal (fig. 3) and ranges in thickness from a mere smut streak to a bed more than 5 feet thick. It has been mined in some areas of Jefferson County and to a considerable extent in Belmont County. Figure 6 shows the extent of minable Waynesburg coal in Ohio, West Virginia, and Pennsylvania.

WAYNESBURG "A" (No. 11a) COAL

The Waynesburg "A" (No. 11a) coal bed lies from 45 to 60 feet above the Waynesburg (No. 11) coal and from 180 to 225 feet above the Meigs Creek (Sewickley) (No. 9) coal (fig. 3). It was described first by J. J. Stevenson (1875, p. 56) from exposures in Greene and Washington Counties, Pa. In Ohio, this coal bed, which is much thinner than the other coal beds considered in this report, ranges in thickness from a few inches to more than 40 inches. The quality of the Waynesburg "A" coal is poor over much of its extent in Ohio. In places it is

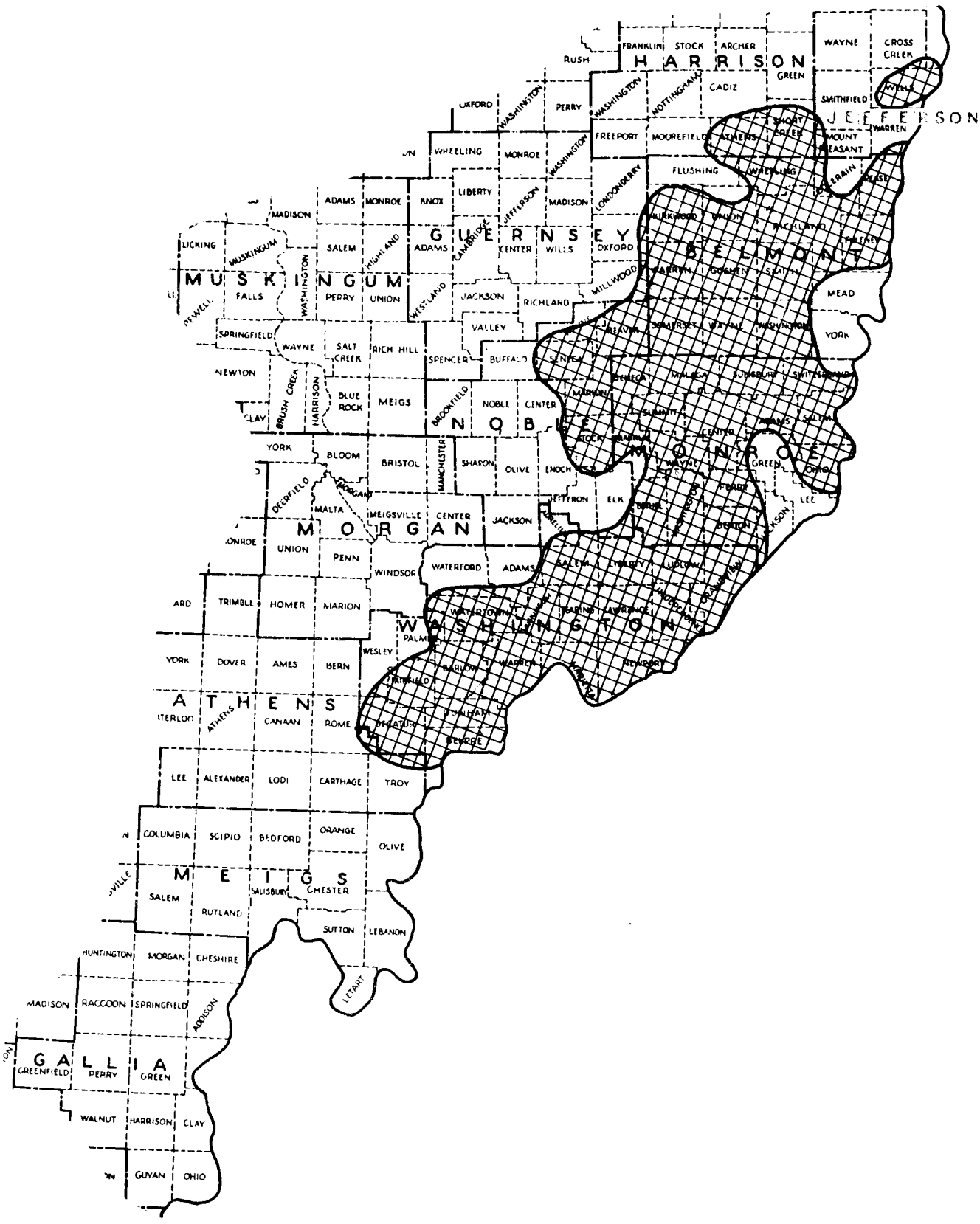


Figure 5. - Areal extent of Uniontown (No. 10) coal more than 14 inches thick in Ohio.

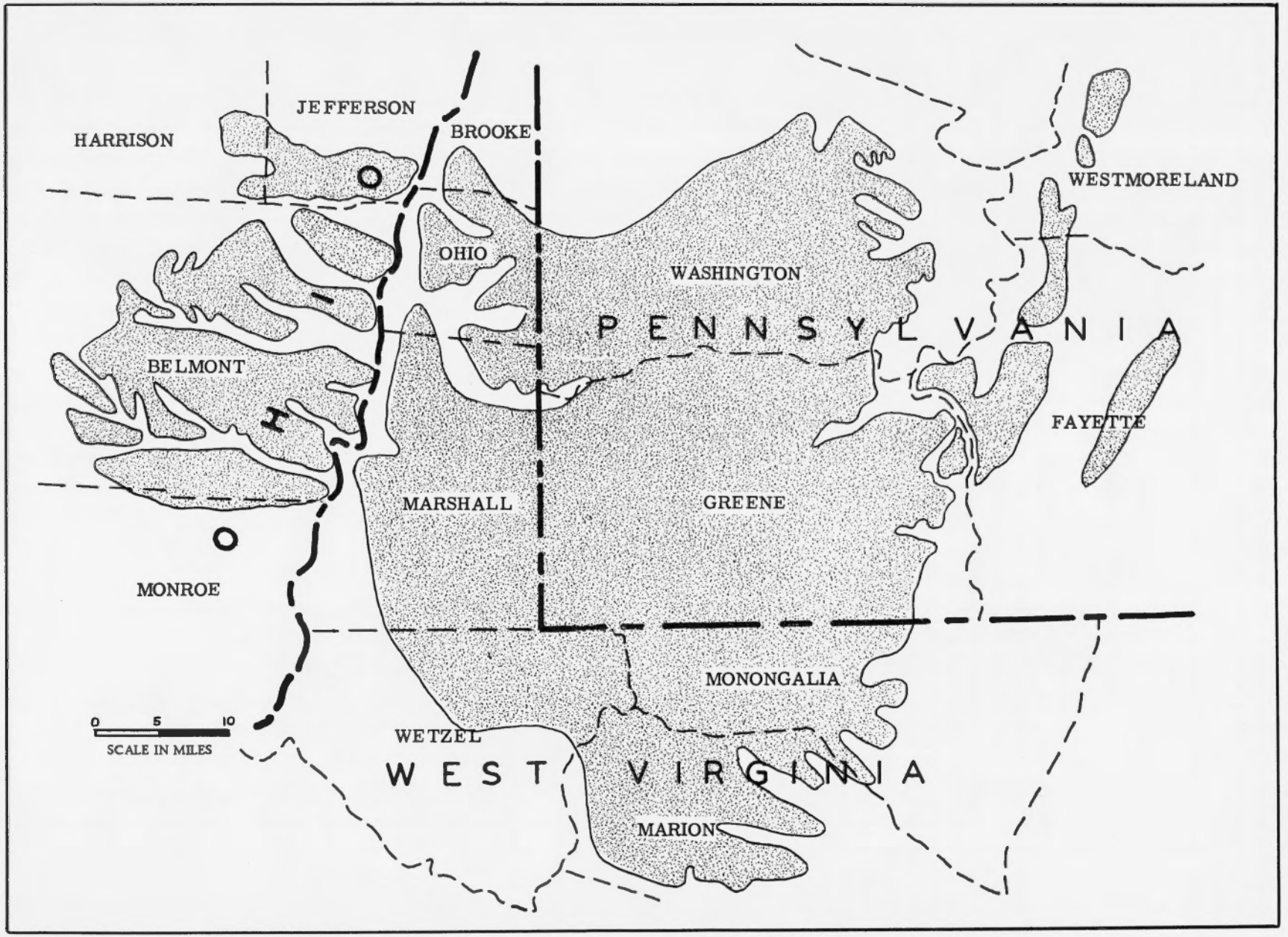


Figure 6. - Areal extent of minable Waynesburg (No. 11) coal in Ohio, West Virginia, and Pennsylvania.

missing entirely from the geologic column, especially where channel deposits of the Mannington sandstone have replaced the coal or have coalesced with the underlying Waynesburg sandstone. However, because locally it is thick enough to have been mined in the past for domestic fuel, the Waynesburg "A" coal is considered in this report as part of the coal reserve. Figure 7 shows the areal extent of Waynesburg "A" coal more than 14 inches thick.

WASHINGTON (No. 12) COAL

The Washington (No. 12) coal was named by Stevenson (1875, p. 51) for exposures in the vicinity of Washington, in Washington County, Pa. White (1903, p. 113) described this coal as "...the thickest and most important and widely extended coal of the Dunkard series. It is generally a multiple seam having several alternate layers of coal and slate in its upper half, and generally 18-20 inches of fairly good coal in the lower portion, the entire seam often obtaining a thickness of 10 feet." In Ohio, the character of this coal bed is much the same as White described it. This coal zone or its horizon has been traced throughout most of the area of Dunkard strata in Ohio and is the most important stratigraphic marker in the entire Dunkard group. The extent of Washington coal more than 14 inches thick is shown in figure 8. The coal, which has locally been called the Upper Six-Foot seam, occurs from 250 to 300 feet above the Meigs Creek (Sewickley)(No. 9) coal (fig. 3) and ranges in thickness from a few inches to more than 6 feet.

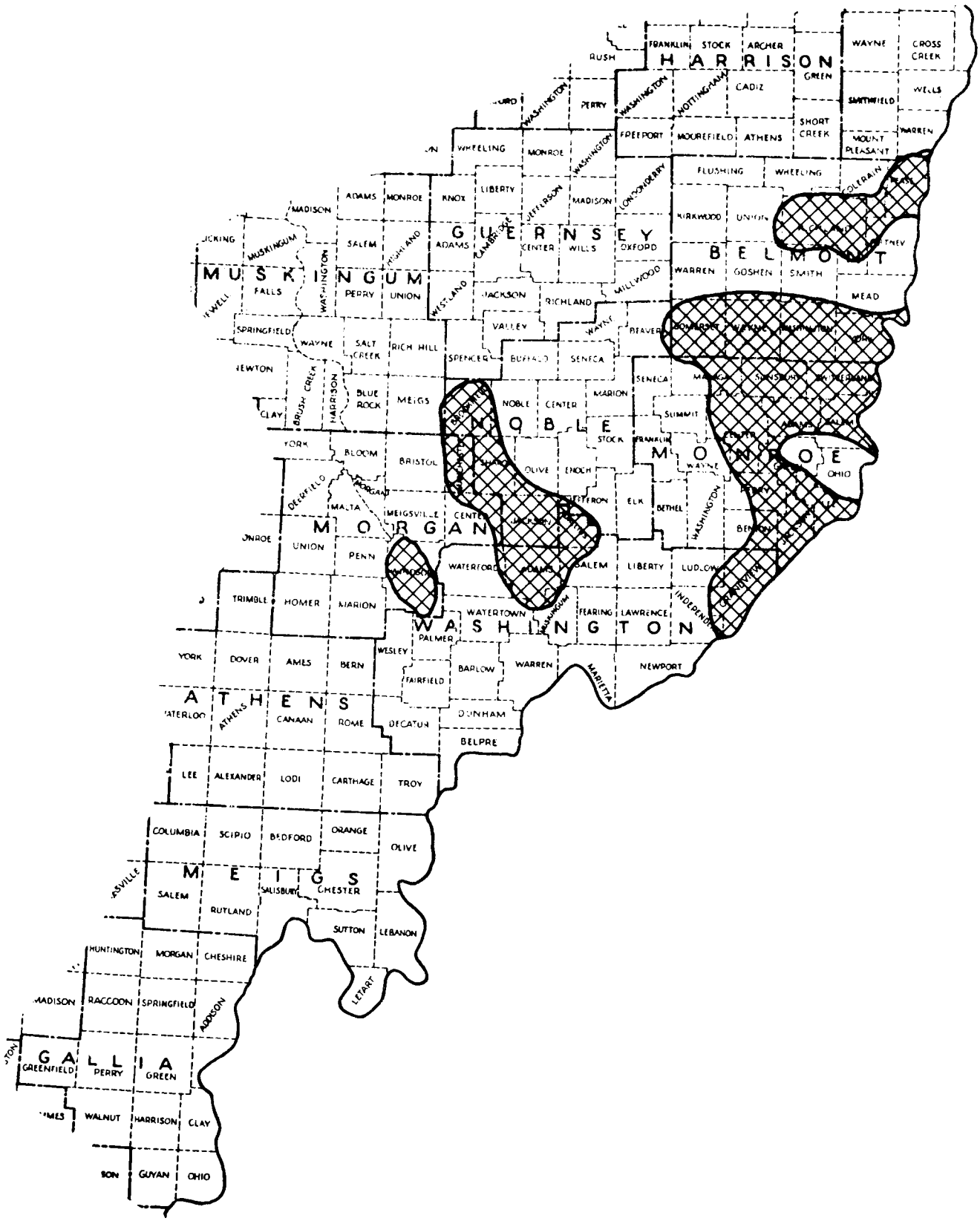


Figure 7. - Areal extent of Waynesburg "A" (No. 11a) coal more than 14 inches thick in Ohio.

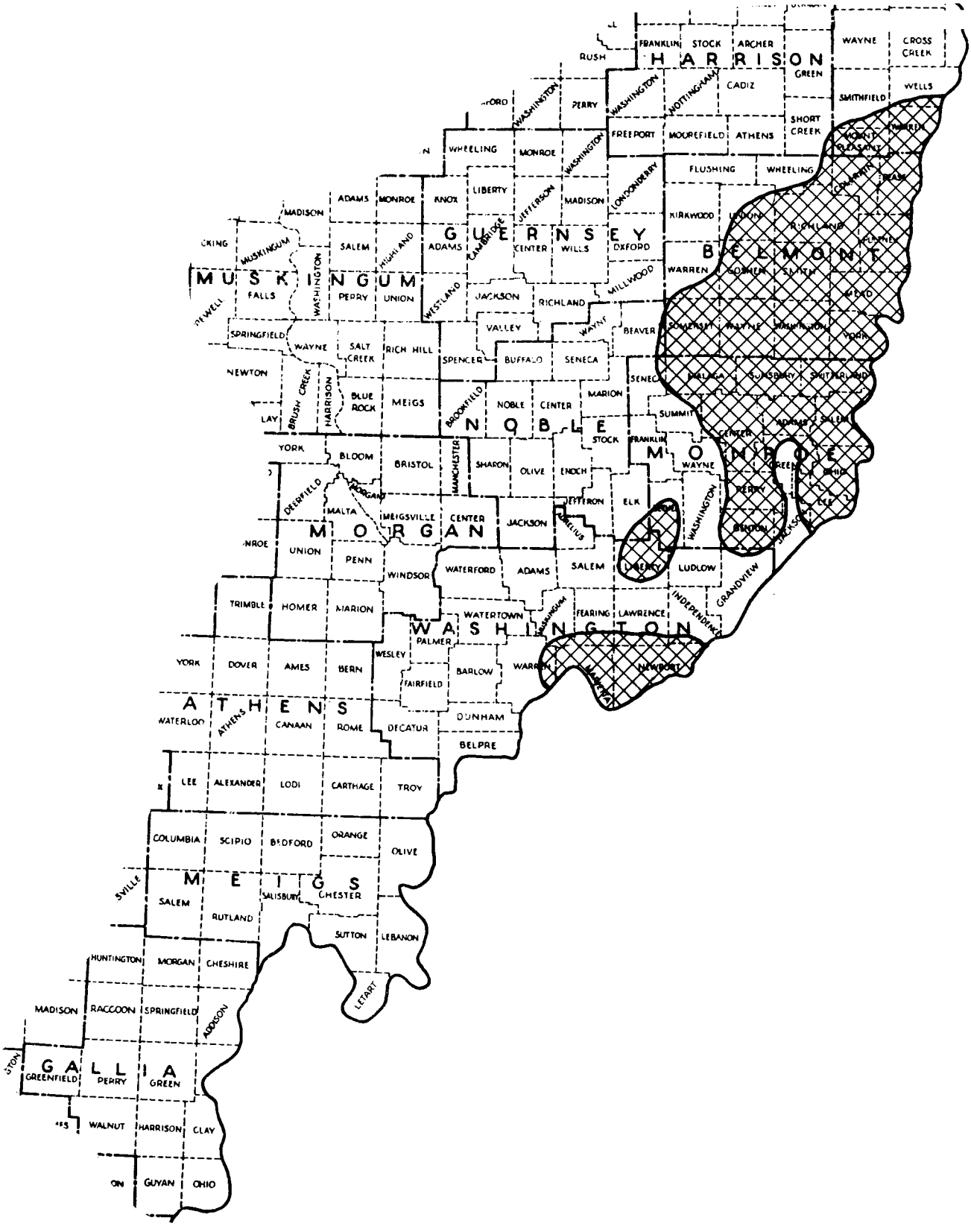
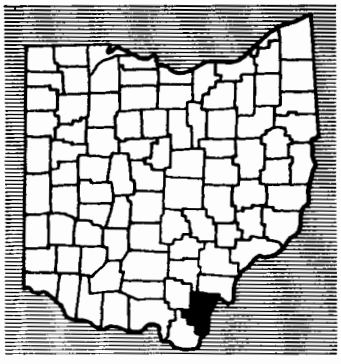


Figure 8. - Areal extent of Washington (No. 12) coal more than 14 inches thick in Ohio.

Chapter 3

AREAL DESCRIPTION

GALLIA COUNTY



Gallia County is the southernmost county in Ohio which contains upper Monongahela and Permian strata (fig. 1). These strata occur in the eastern portion of the county in Guyan, Ohio, Harrison, Clay, Green, Gallipolis, Addison, and Cheshire Townships.

Erosion has removed the Washington (No. 12) and Waynesburg "A" (No. 11a) coal beds from Gallia County, and of the coals under investigation only the Waynesburg (No. 11), Uniontown (No. 10), and Fishpot remain. All these beds are thin and lacking in extent throughout Gallia County. They occur generally as clayey streaks or coal smuts less than 1 inch in thickness.

MEIGS COUNTY

Meigs County lies well within the outcrop belt of the upper part of the Monongahela formation and the Dunkard group. Only Columbia and Salem Townships do not contain these strata. Upper Pennsylvanian and Permian rocks in Meigs County are characterized by massive sandstone units, which throughout most of their extent in the county have replaced the coal beds considered in this report.

Fishpot coal. - The Fishpot coal throughout most of its outcrop area in western Meigs County appears to have been replaced almost entirely by the massive underlying Pomeroy sandstone. This coal is local in occurrence and commonly is represented by a clayey carbonaceous shale zone averaging less than 2 inches in thickness.

Uniontown (No. 10) coal. - Throughout its outcrop area in Meigs County, the Uniontown (No. 10) coal is a zone of carbonaceous shale or coaly smut averaging about 1 inch in thickness. Even though this coal bed is poorly developed in Meigs County, it exhibits the double- or multiple-bench structure characteristic of the coal in areas of greater thickness to the north.

The Uniontown horizon is present near the ridgetops of Bedford and Salisbury Townships, about midway on the hillsides of Orange, Chester, and Sutton Townships, and near drainage level in western Olive and northern Lebanon Townships.

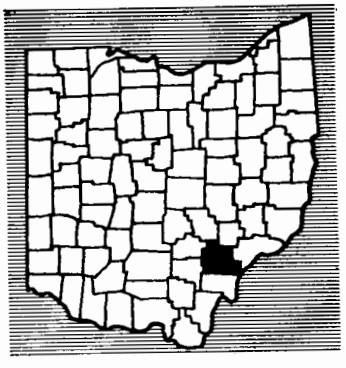
Waynesburg (No. 11) coal. - The Waynesburg (No. 11) coal is generally less than 14 inches thick throughout its extent in Meigs County, but it is marked by local areas of thickening. A thickness of 30 inches of Waynesburg coal was measured at a former strip mine in the NW$\frac{1}{4}$ of section 6, Orange Township.

The Waynesburg coal horizon is present along the ridges and hilltops of Bedford and Salisbury Townships. Regional dips to the east and south cause the coal bed to be near drainage level throughout Orange, Chester, Sutton, Olive, Lebanon, and Letart Townships.

Waynesburg "A" (No. 11a) coal. - The Waynesburg "A" (No. 11a) coal bed is confined to the eastern third of Meigs County, in Orange, Chester, Sutton, Olive, Lebanon, and Letart Townships. The coal is generally a zone of coaly debris or smut in clay shale, but locally it grades into a bright blocky coal with numerous thin irregular pyritic shale partings. One measurement in section 3, Orange Township, (Geological Survey file number 11623), records 28 inches of coal in two benches which have been strip mined around the hillsides. This coal bed commonly is replaced in Meigs County by the overlying massive Mannington sandstone, which has coalesced with the underlying Waynesburg sandstone.

Washington (No. 12) coal. - The Washington (No. 12) coal, like the Waynesburg and Waynesburg "A" coals, generally is thin and of poor quality throughout its extent in Meigs County. However, the coal thickens locally to as much as 18 inches. The coal and associated underclay are widespread and provide excellent geologic markers throughout their extent in Orange, Olive, Chester, Sutton, Lebanon, and Letart Townships.

ATHENS COUNTY



Upper Monongahela and Permian rocks occur in the eastern half of Athens County in Alexander, Ames, Athens, Bern, Canaan, Carthage, Dover, Lodi, Rome, and Troy Townships. The coal beds of this sequence of rocks are rather widespread, but are generally thin. The whole rock series consists primarily of fresh-water limestone, calcareous red shale, and massive sandstone.

Fishpot coal. - The Fishpot coal has been recognized in all the townships containing upper Monongahela strata except Troy Township, where the coal is several hundred feet below drainage level. The coal is thickest in Alexander Township, where a 14-inch measurement was recorded; however, its average thickness in the county

is less than 2 inches. In Athens County, the Fishpot coal is usually represented by a thin zone of carbonaceous or clayey debris scattered throughout a clay shale.

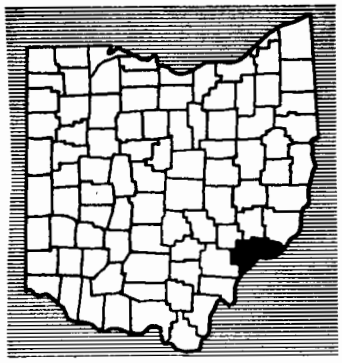
Uniontown (No. 10) coal. - The Uniontown (No. 10) coal is rather widespread in eastern Athens County, being present over large areas of Bern, Rome, Carthage, and Troy Townships. It crops out on hilltop and ridge areas in Canaan, Lodi, and Alexander Townships. The character of this coal in Athens County is quite variable, ranging from bright blocky coal to carbonaceous bony shale to coaly smut in clay shale. It is rather thin throughout its extent, averaging about 2 inches for the county. However, in Rome Township, where it was mined at one time, several 13- and 14-inch measurements have been recorded. Unfortunately, in spite of this small area of local thickening, the coal has an average thickness of only 6 inches throughout the township.

Waynesburg (No. 11) coal. - In Athens County the Waynesburg (No. 11) coal is present over large areas of Bern, Rome, Troy, and Carthage Townships. It is also present in small areas of Canaan and Lodi Townships, high on the hilltops and ridges. This stratum in Athens County in most places is marked by a zone of carbonaceous shale or clay containing stringers or lenses of coaly material. The thickness of the coal in the county averages only 4 inches, although a maximum thickness of 26 inches for this zone has been observed in Lodi Township. The Waynesburg coal zone, which generally is missing in the geologic column, is replaced by the overlying massive Waynesburg sandstone at many localities. This coal zone is important in Athens County primarily as a stratigraphic marker separating the Pennsylvanian and Permian Systems.

Waynesburg "A" (No. 11a) coal. - The Waynesburg "A" (No. 11a) coal bed is thin and has a low Btu content and high ash and high sulfur content in Athens County. Its outcrop is confined to the eastern tier of townships: Bern, Rome, Carthage, and Troy. The Waynesburg "A" coal zone is marked by layers of carbonaceous clay shale containing coaly debris. In areas throughout the county where the Mannington sandstone is massive, the Waynesburg "A" coal generally is replaced by this sandstone stratum. The average thickness of the coal bed in Athens County is less than 1 inch.

Washington (No. 12) coal. - Outcrops of the Washington (No. 12) coal are confined primarily to Troy Township in Athens County. However, there are a few ridges and hilltops in Bern, Rome, and Carthage Townships which contain this coal. Although the Washington coal is thin in Athens County, it is quite widespread, and the coal zone and underclay are good stratigraphic markers in the townships where they occur. This coal in Athens County generally is represented by a thin smut streak of carbonaceous shale or clay containing occasional bright coaly stringers. The average thickness of the Washington coal is only 2 inches, but locally the coal grades into bright blocky coal of greater thickness. In an abandoned drift mine along U. S. Route 50, in section 3 of Carthage Township, the coal zone is 3 feet thick and contains 14 inches of good bright blocky coal.

WASHINGTON COUNTY



All of Washington County lies within the outcrop area of the upper Monongahela-Dunkard sequence of rocks (fig. 1). Washington County is largely a transitional area of sedimentation in which massive terrestrial sandstone and red shale, which typically dominate the section to the south, grade northward into predominately fresh-water limestone and calcareous red shale and siltstone.

Fishpot coal. - The Fishpot coal zone is rather erratic in its extent in Washington County and in some areas fails to develop even a smut streak. This is due primarily to replacement by the massive limestone and calcareous shale units in the interval between the Redstone and Meigs Creek (Sewickley) (No. 9) coal beds. At the Fishpot horizon in Washington County, generally nothing more is present than a coaly smut streak or a zone of carbonaceous debris scattered throughout clay. The average thickness of the Fishpot coal in Washington County is less than 2 inches, although in Adams Township the coal attains a maximum thickness of 11 inches.

Uniontown (No. 10) coal. - The Uniontown (No. 10) coal bed or its horizon is found in all 22 townships of Washington County. Although it is quite widespread throughout the county, the coal is variable in thickness and quality. The member has been mined in Belpre, Decatur, Fairfield, Fearing, Grandview, Muskingum, Newport, and Wesley Townships (table 15).

The Uniontown coal is represented locally by carbonaceous, coaly smut streaks less than 1 inch in thickness, or by a bony carbonaceous shale stratum, or by a zone of alternating beds of shale and coal. Figure 9 illustrates the lithologic character of this unit in areas of Washington County where it attains minable thickness. The Uniontown coal in Washington County formerly was called the Hobson coal; the type locality is on the Stephen Hobson farm in section 36, Wesley Township, where the coal was mined for local use. The reserve of this coal in Washington County is shown in table 1.

Waynesburg (No. 11) coal. - The Waynesburg (No. 11) coal has little or no economic value in Washington County. Stout (1954, p. 282) reports that this coal is present at the surface in all but two townships, Warren and Dunham. Although widely distributed throughout Washington County, this stratum varies from a thin bed of coal to a few inches of bony shale to a thin layer of carbonaceous clay or smut. In places, the member thickens to several feet of bony coal interbedded with layers of carbonaceous shale. One such zone is 73 inches thick in Ludlow Township. The average thickness of the Waynesburg coal for the county is only 7 inches, but preliminary fieldwork has indicated there may be certain areas in Ludlow, Marietta, and Waterford Townships where the coal has sufficient thickness to be a potential reserve. Estimates based on a very few control points indicate that about 73 million tons of original reserve of Waynesburg coal may be present in these three townships.

Waynesburg "A" (No. 11a) coal. - The Waynesburg "A" (No. 11a) coal is rather widespread, but thin, in Washington County. The bed has an average thickness of only 7

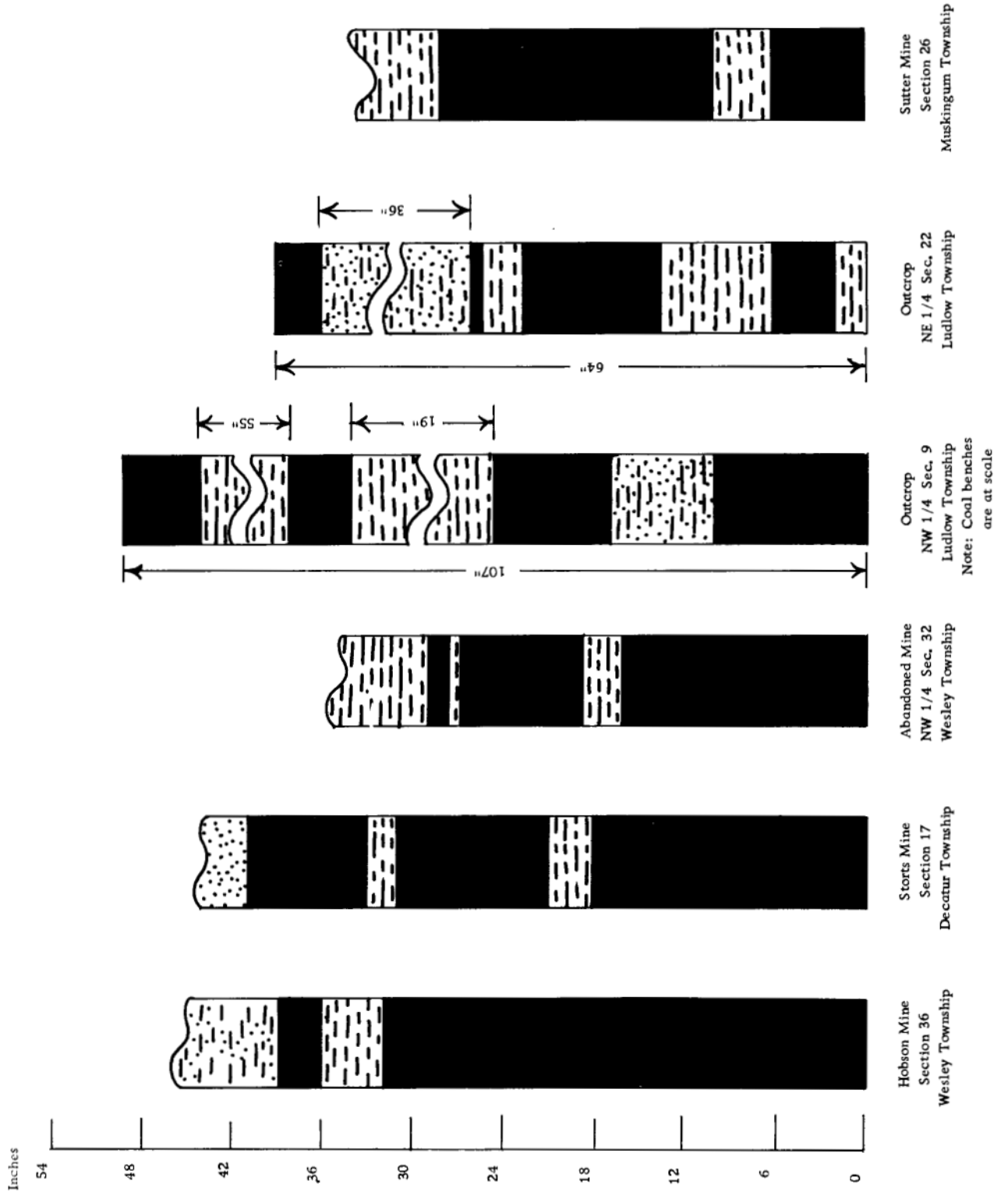


Figure 9. - Graphic sections of minable Uniontown (No. 10) coal in Washington County. Coal is shown by solid black, sandstone by irregularly spaced dots, and shale by broken parallel lines.

Table 1. - Original reserve of Uniontown (No. 10) coal in Washington County

Township	Average thickness (inches)	Area (acres)	Tonnage
Barlow	24	18,800	67,980,000
Belpre	14	14,320	30,072,000
Decatur	14	5,360	11,250,000
Dunham	18	14,880	40,176,000
Fairfield	20	8,880	26,640,000
Fearing	14	9,920	20,832,000
Grandview	20	16,120	48,360,000
Independence	21	2,360	7,434,000
Lawrence	18	9,080	24,516,000
Liberty	18	4,280	11,556,000
Ludlow	24	8,960	32,256,000
Muskingum	22	3,040	10,032,000
Newport	26	8,040	31,356,000
Salem	14	4,680	9,828,000
Warren	18	23,240	62,748,000
Watertown	32	14,080	67,584,000
Total	--	166,040	502,620,000

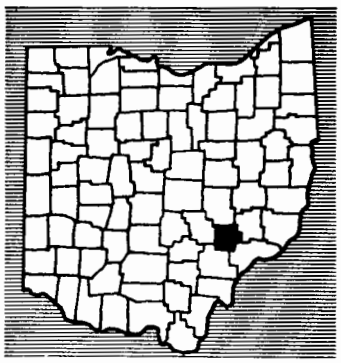
inches throughout most of the county, although in Grandview Township it attains an average thickness of 22 inches and formerly was strip mined in section 18. In this township the Waynesburg "A" coal grades from a smut streak or carbonaceous shale layer into a bright blocky coal. In Washington County, the estimated original reserve of the Waynesburg "A" coal totals 35,640,000 tons and covers 10,800 acres, all in Grandview Township.

Washington (No. 12) coal. - The Washington (No. 12) coal attains minable thicknesses in Marietta, Newport, and Liberty Townships in Washington County. Where minable, it is a soft bright blocky coal of reportedly high ash content. Smith (1948, p. 89) states that the coal has been mined for local use in the southwestern part of Newport Township. The Washington coal is rather widespread in other areas of Washington County where it has not been removed by erosion. It occurs as a thin carbonaceous clay and as layers of bony shale or coaly smut. The coal zone averages 20 inches in thickness in Newport and Liberty Townships and 19 inches in Marietta Township (table 2); however, the average for the county is less than 10 inches.

Table 2. - Original reserve of Washington (No. 12) coal in Washington County

Township	Average thickness (inches)	Area (acres)	Tonnage
Marietta	19	4,640	13,224,000
Newport	20	2,640	7,920,000
Liberty	20	2,440	7,320,000
Total	--	9,720	28,464,000

MORGAN COUNTY

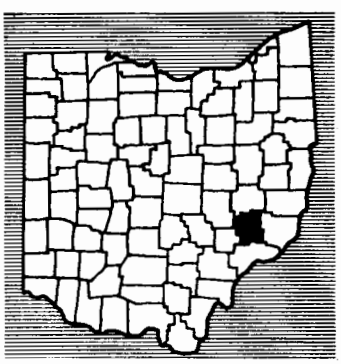


Rocks of the upper Monongahela formation and Dunkard group crop out in all of Morgan County, except York and Deerfield Townships. These strata are similar in nature and extent to those in Washington County and neighboring counties already discussed. The Washington (No. 12) coal has been removed by erosion throughout much of the county, and the Fishpot, Uniontown (No. 10), and Waynesburg (No. 11) coal beds are thin and lack persistence throughout their areal extent. Only the Waynesburg "A" (No. 11a) coal is a potential reserve in Morgan County. Norling (1958, p. 92) recognized this coal on some high hills and ridges in Manchester, Center, and Windsor Townships. Thicknesses of as much as 31 inches have been measured in Manchester and Windsor Townships; the average thicknesses are 15 and 20 inches, respectively, for the two townships. The Waynesburg "A" (No. 11a) coal has been mined near Brokaw in Windsor Township, where the coal measures 31 inches in thickness. The original reserve of the Waynesburg "A" coal is estimated at 11,490,000 tons for Morgan County (table 3).

Table 3. - Original reserve of Waynesburg "A" (No. 11a) coal in Morgan County

Township	Average thickness (inches)	Area (acres)	Tonnage
Manchester	15	1,640	3,690,000
Windsor	20	2,600	7,800,000
Total	--	4,240	11,490,000

NOBLE COUNTY



Upper Monongahela and Dunkard strata in Noble County are confined to the central, southern, and eastern parts of the county. The character of these rocks shows little change from that of rocks in adjacent counties to the east and south. The influence of the Cambridge arch in Noble County has resulted in the erosion of the younger coal beds; only the Washington (No. 12) and Waynesburg "A" (No. 11a) coal beds, which occur on higher ridges and hilltops, are present.

Fishpot coal. - The Fishpot coal is widely distributed in every township of Noble County except Wayne and Buffalo Townships, where the coal is confined to a few high knobs.

Stout (1954, p. 204) points out that the Fishpot coal "...is more definitely defined than the better known Pittsburgh coal." The coal, however, is quite variable in thickness and structure. Average thicknesses in Beaver, Marion, and Stock Townships are recorded as 28, 17, and 14 inches, respectively (table 4). Thickness of the Fishpot coal ranges from less than 1 inch to more than 50 inches, but averages about 10 inches for the county. Locally, the Fishpot coal offers sufficient fuel for domestic consumption.

Table 4. - Original reserve of Fishpot coal in Noble County

Township	Average thickness (inches)	Area (acres)	Tonnage
Beaver	28	4,640	19,488,000
Marion	17	7,920	20,196,000
Stock	14	7,920	16,632,000
Total	--	20,480	56,316,000

Uniontown (No. 10) coal. - The Uniontown (No. 10) coal or its horizon is present in every township in Noble County except Wayne and Buffalo. The character of the coal throughout Noble County is much the same as it is throughout its general extent in Ohio. The stratum generally occurs as a smut streak of carbonaceous matter, or as a single layer of coal, or as multiple benches of coal separated by shale partings. The coal attains minable thickness in Beaver, Marion, and Stock Townships, where the average thickness is 20, 37, and 17 inches, respectively (table 5). In Marion Township the Uniontown coal has been mined for local use.

Table 5. - Original reserve of Uniontown (No. 10) coal in Noble County

Township	Average thickness (inches)	Area (acres)	Tonnage
Beaver	20	1,400	3,780,000
Marion	37	1,920	10,656,000
Stock	17	1,980	5,049,000
Total	--	5,300	19,485,000

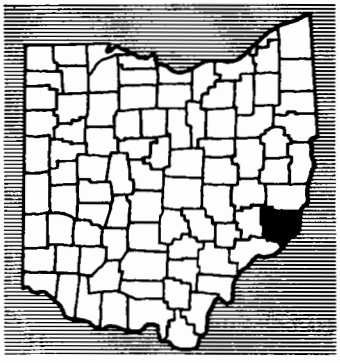
Waynesburg (No. 11) coal. - The Waynesburg (No. 11) coal is confined to the southeastern and southwestern portions of Noble County. The coal bed is widespread throughout the county, except in local areas where it has been replaced by the overlying Waynesburg sandstone. The Waynesburg coal is present in the county as a thin layer of coal, coaly shale, or carbonaceous smut. The coal is fairly thick in Beaver Township, where it averages 28 inches in thickness and occurs on the high knobs and ridges in the eastern part of the township. In Sharon Township the Waynesburg coal, although quite variable in thickness, locally thickens to as much as 36 inches and averages 14 inches for the township. The reserve of this coal in Noble County is shown in table 6.

Table 6. - Original reserve of Waynesburg (No. 11) coal in Noble County

Township	Average thickness (inches)	Area (acres)	Tonnage
Beaver	28	1,480	6,216,000
Sharon	14	4,400	9,240,000
Total	--	5,880	15,456,000

Waynesburg "A" (No. 11a) coal. - The Waynesburg "A" (No. 11a) coal in Noble County is confined generally to the high knobs and ridges in the southeastern and southwestern parts of the county. The coal crops out as a weathered blossom of bright blocky coal and also occurs as a zone of carbonaceous clay and shale containing coaly stringers. In Sharon Township this bed varies from 12 to 30 inches in thickness, but averages 21 inches. In this township, 2,440 acres contribute 7,686,000 tons to the original reserve of Waynesburg "A" coal in Noble County.

MONROE COUNTY



More than two-thirds of the surface rocks of Monroe County belong to the Dunkard group (fig. 1). The remaining third belongs to the Monongahela formation, except in the deeper valleys of the northwestern corner of the county, where Conemaugh rocks are exposed. The 18 townships of Monroe County contain the largest reserve of upper Monongahela-Dunkard coal in the State.

Fishpot coal. - The Fishpot coal is present in the northwestern third of Monroe County in Bethel, Franklin, Malaga, Seneca, Summit, and Wayne Townships. Because of the regional dip to the southeast the coal is below drainage in the remaining two-thirds of the county. The Fishpot coal is erratic in thickness in Monroe County, but locally it is thick enough to be mined on a small scale. It has been mined for domestic purposes in Malaga, Perry, Summit, and Washington Townships. The Fishpot coal is known locally as the Rich Fork coal from exposures along Rich Fork Creek in Wayne Township. The reserve of the coal in Monroe County is shown in table 7.

Table 7. - Original reserve of Fishpot coal in Monroe County

Township	Average thickness (inches)	Area (acres)	Tonnage
Franklin	23	13,560	46,782,000
Malaga	27	18,000	72,900,000
Seneca	14	3,400	7,140,000
Summit	30	11,480	51,660,000
Sunsbury	40	18,176	109,056,000
Switzerland	28	17,280	72,576,000
Wayne	14	11,560	24,316,000
Total	--	93,456	384,430,000

Uniontown (No. 10) coal. - Although the most important area of the Uniontown (No. 10) coal in Monroe County is in the valley of Sunfish Creek, where the coal maintains sufficient continuity and thickness for local mining, the member has been observed in every township of the county. The coal zone generally occurs as layers of blocky coal, bony coal, and carbonaceous shale, alternating with layers of clay shale. Thicknesses for the county range from smut streaks of less than 1 inch to coaly zones of 10 feet or more. The average thickness for the county is 20 inches. Graphic sections of the Uniontown coal in Monroe County are presented in figure 10, and the reserve is shown in table 8.

Table 8. - Original reserve of Uniontown (No. 10) coal in Monroe County

Township	Average thickness (inches)	Area (acres)	Tonnage
Adams	34	11,960	60,996,000
Benton	14	2,320	4,872,000
Bethel	24	11,720	42,192,000
Center	30	23,560	105,975,000
Malaga	38	15,920	90,744,000
Ohio	24	13,360	48,096,000
Perry	30	12,800	57,600,000
Salem	30	15,760	70,920,000
Seneca	22	5,160	17,028,000
Summit	15	9,600	21,600,000
Sunsbury	22	17,720	58,470,000
Washington	20	13,120	39,360,000
Wayne	20	4,920	14,760,000
Total	--	157,920	632,613,000

Waynesburg (No. 11) coal. - The Waynesburg (No. 11) coal has been observed in every township in Monroe County. Despite its wide distribution, the Waynesburg coal generally is thin and in some areas is represented only by a coaly smut streak. The Waynesburg coal occurs at minable thicknesses in Switzerland and Wayne Townships. In Switzerland Township the coal crops out along the Ohio River and in the valleys and along the tributaries of Cat Run and Paine Run. It ranges in thickness from 6 to 35 inches, and averages about 19 inches in Switzerland Township (table 9). In Wayne Township, the Waynesburg coal occurs along the hillsides just below the crests of the main ridges, where it ranges from 1 to 26 inches in thickness and averages about 14 inches.

Table 9. - Original reserve of Waynesburg (No. 11) coal in Monroe County

Township	Average thickness (inches)	Area (acres)	Tonnage
Switzerland	19	16,120	45,942,000
Wayne	14	6,680	14,028,000
Total	--	22,800	59,970,000

Waynesburg "A" (No. 11a) coal. - The Waynesburg "A" (No. 11a) coal attains minable thickness in the eastern townships of Monroe County, where at a number of places thicknesses of 36 to 60 inches have been recorded for the coal. The coal usually occurs in two or three benches (fig. 11), the lower and middle benches of which contain the best coal. The Waynesburg "A" coal in eastern Monroe County is fairly widespread and varies from 6 to more than 60 inches in thickness; it averages about 27 inches for the field as a

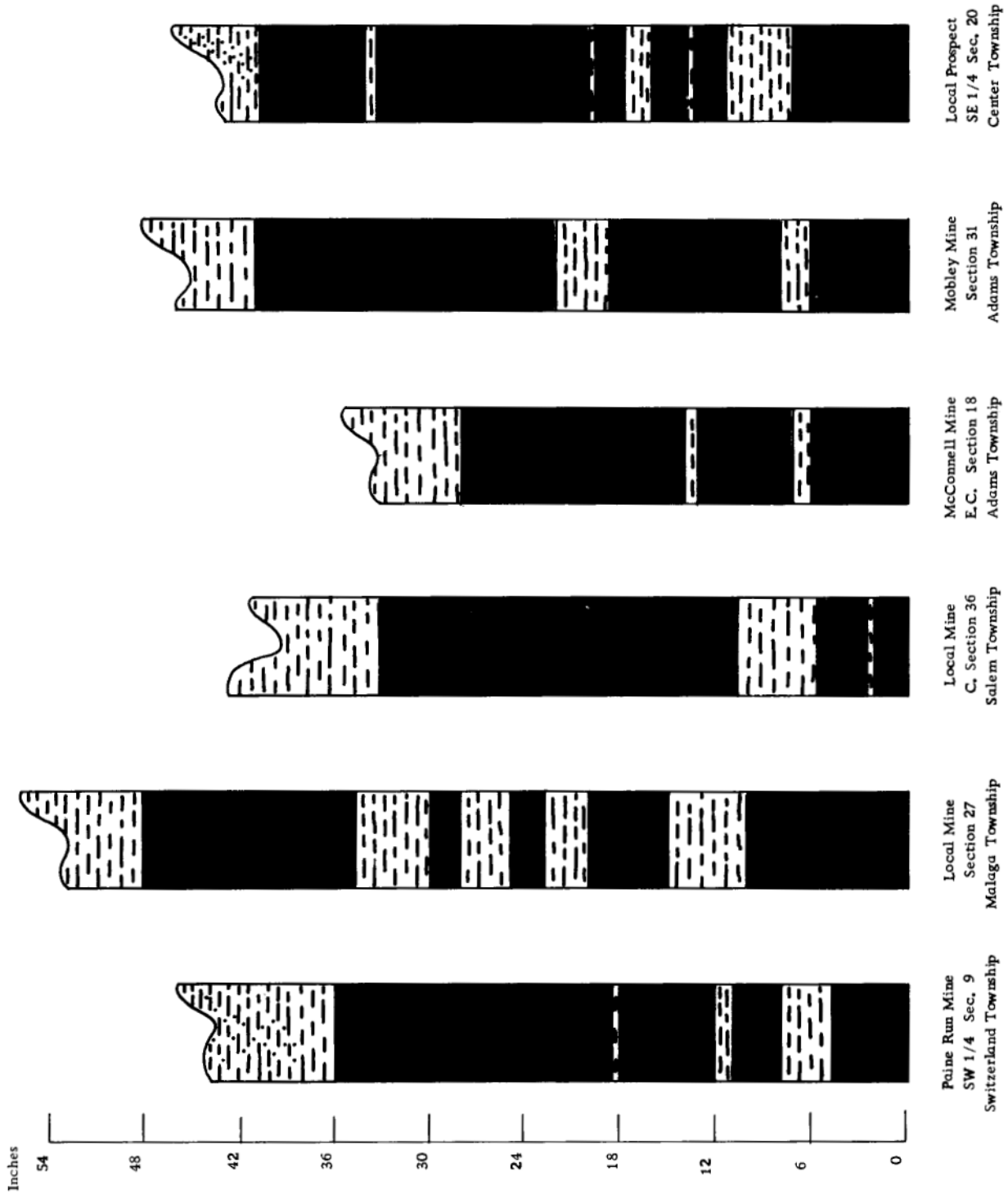


Figure 10. - Graphic sections of minable Uniontown (No. 10) coal in Monroe County. Coal is shown by solid black, sandstone by irregularly spaced dots, and shale by broken parallel lines.

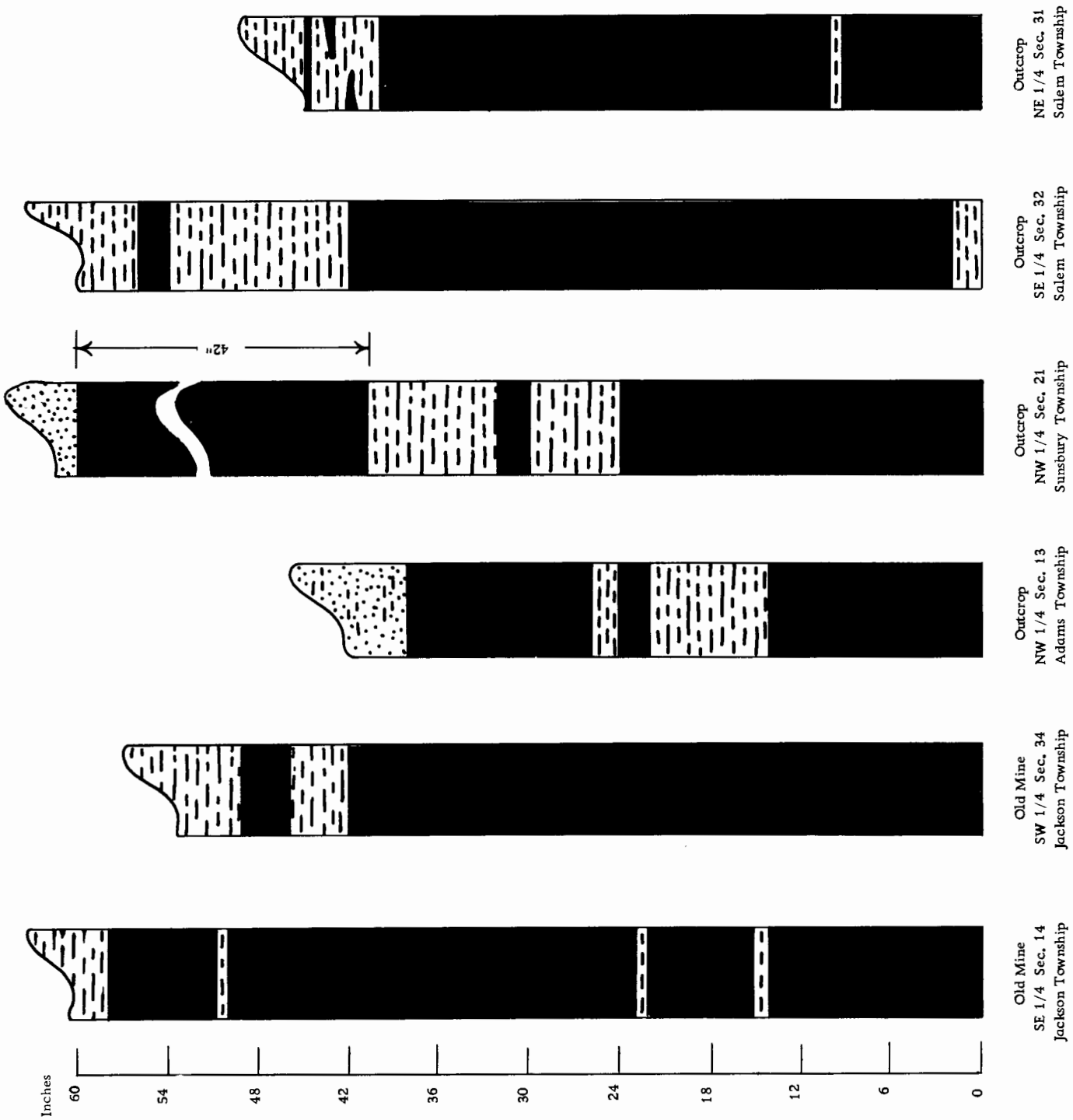


Figure 11. - Graphic sections of minable Waynesburg "A" (No. 11a) coal in Monroe County. Coal is shown by solid black, sandstone by irregularly spaced dots, and shale by broken parallel lines.

whole. In the western portion of Monroe County, where the Waynesburg "A" coal grades laterally into carbonaceous shale and zones of clay shale, the coal thins to less than 2 feet in thickness, and averages only 7 inches. The overlying massive Mannington sandstone locally replaces the coal at many localities in the County. The reserve of this coal in Monroe County is shown in table 10.

Table 10. - Original reserve of Waynesburg "A" (No. 11a) coal in Monroe County

Township	Average thickness (inches)	Area (acres)	Tonnage
Adams	20	11,900	35,700,000
Center	16	16,920	40,608,000
Jackson	32	11,120	53,376,000
Lee	28	9,480	39,816,000
Salem	26	10,600	41,340,000
Sunsbury	30	16,600	74,700,000
Switzerland	39	15,800	92,430,000
Total	--	92,420	377,970,000

Washington (No. 12) coal. - The Washington (No. 12) coal bed or its horizon has been observed in every township in Monroe County, except Seneca, where the coal has been removed by erosion. In the eastern half of the county, where the bed constitutes a large reserve, the coal is split into two benches (fig. 12); the lower bench is a relatively pure bright blocky coal, and the upper bench is somewhat shaly and bony. The thickness is erratic throughout the eastern Monroe County field, where it varies from 12 inches to a zone of alternating shale and coal more than 11 feet thick; the average thickness is about 30 inches in eastern Monroe County. The Washington coal was mined formerly in Adams, Center, Green, Malaga, Ohio, Salem, Sunsbury, and Switzerland Townships (table 15). In the western half of Monroe County, the Washington coal grades rapidly into a zone of carbonaceous clay and shale and has little or no economic value as a source of fuel. The reserve of this coal in Monroe County is shown in table 11.

Table 11. - Original reserve of Washington (No. 12) coal in Monroe County

Township	Average thickness (inches)	Area (acres)	Tonnage
Adams	20	8,080	24,240,000
Benton	15	9,440	21,240,000
Center	15	15,080	33,930,000
Lee	15	9,320	20,970,000
Malaga	21	12,480	39,312,000
Ohio	25	12,440	46,650,000
Salem	50	11,640	87,300,000
Sunsbury	27	16,680	67,554,000
Switzerland	57	14,840	126,982,000
Total	--	110,000	468,178,000

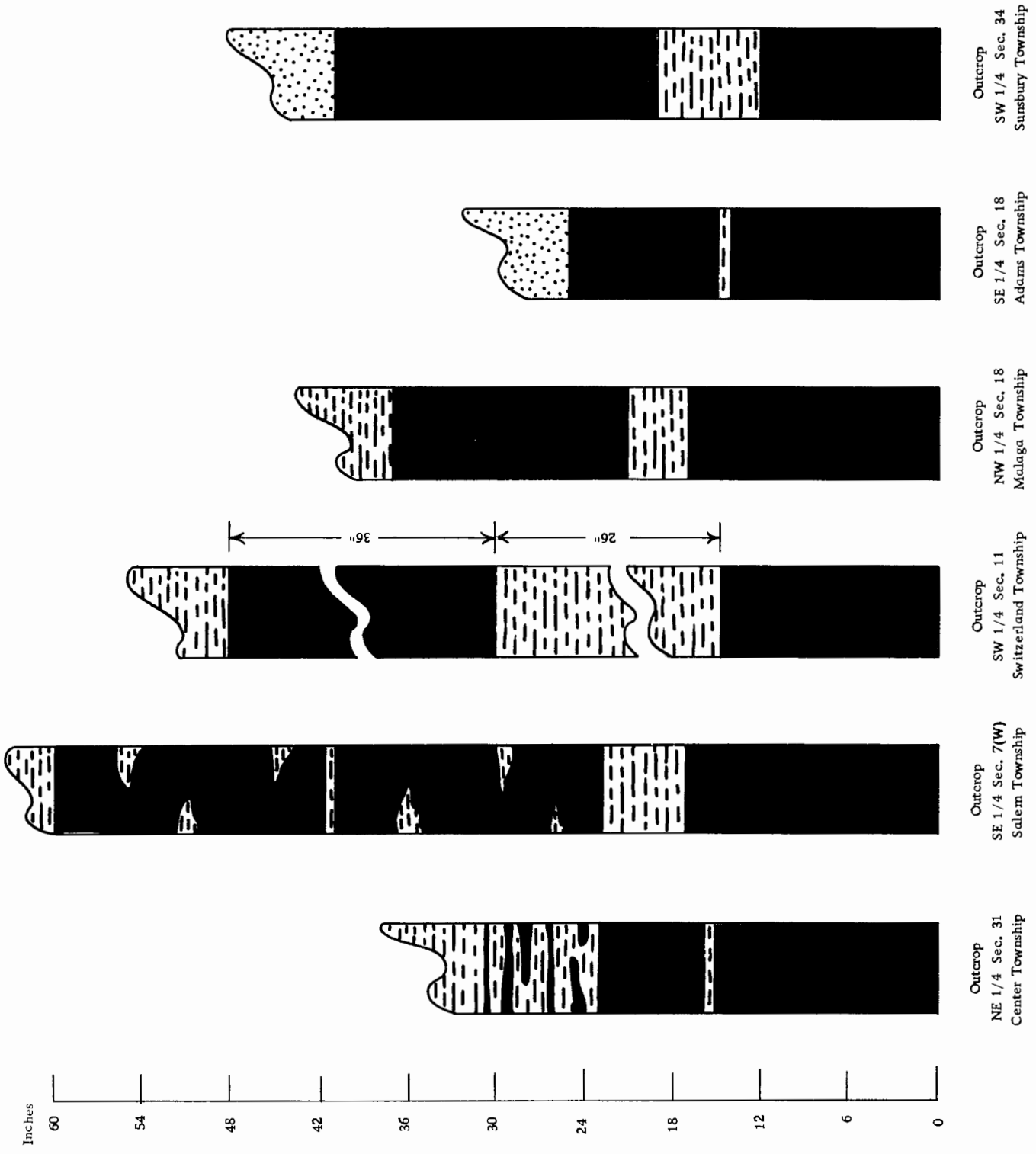
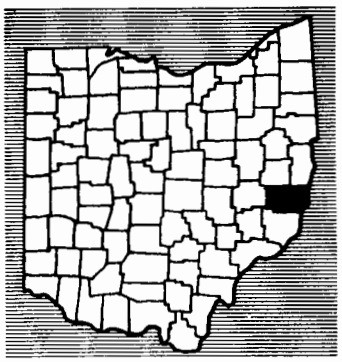


Figure 12. - Graphic sections of minable Washington (No. 12) coal in Monroe County. Coal is shown by solid black, sandstone by irregularly spaced dots, and shale by broken parallel lines.

BELMONT COUNTY



More than 90 percent of the surface area of Belmont County contains exposures of upper Monongahela and Dunkard strata (fig. 1). The Fishpot, Uniontown (No. 10), and Waynesburg (No. 11) coal beds have been observed in every township of the county. The Waynesburg "A" (No. 11a) and Washington (No. 12) coals have been removed by erosion in Flushing, Kirkwood, and Wheeling Townships, where only lower Monongahela and Conemaugh rocks are exposed. Beds of limestone and calcareous shale of the Monongahela formation dominate the rock section of Belmont County. All five coal beds, particularly the Waynesburg coal, have been mined at some time in the past (table 15).

A report on the geology of the county has been prepared by Henry L. Berryhill, Jr., of the U. S. Geological Survey, and will be published in the near future. With the exception of the Fishpot coal, Berryhill has estimated the original reserve of the coal beds of the county. His data are used in this summary.

Fishpot coal. - The Fishpot coal occurs to some extent in every township of Belmont County, and varies in thickness from less than 2 inches to more than 60 inches. The coal is marked generally by alternating layers of coal and clay shale; it may contain as many as five benches of coal separated by shale layers 2 or 3 inches thick. In the past the coal was mined in Belmont County for local use.

Uniontown (No. 10) coal. - The Uniontown (No. 10) coal occurs in every township of Belmont County and is exposed best along Captina Creek and its tributaries in Goshen, Smith, Washington, and Wayne Townships. The Uniontown coal in Belmont County shows great lateral variation in composition; it ranges from a smut streak to coaly or bony shale to bright blocky coal. Berryhill has calculated 216,100,000 tons of original reserve of the Uniontown coal in Belmont County.

Waynesburg (No. 11) coal. - Belmont County is the only county in Ohio in which the Waynesburg (No. 11) coal is persistently thick enough to define a coal field. The coal occurs in minable thicknesses in every township and has been mined in the past in every township except Flushing, Kirkwood, and Warren Townships. Representative graphic sections of the Waynesburg coal in northern Belmont County are shown in figure 13. The Waynesburg coal in the county is fairly uniform in thickness, which averages 27 inches. G. W. White (1947, p. 58) reports that in much of Belmont County the roof material of the Waynesburg coal is shale that grades upward into shaly sandstone. In the eastern margin of the field, 1 foot to several feet of clay shale overlies the coal. The shale, in turn, is overlain by the dense Elm Grove limestone (fig. 2), which is replaced by sandstone at some localities. White (1947, p. 58) further states that "on the whole, roof conditions for mining may be considered fair to good except where the coal is under shallow covering, and weathering has affected the roof strata."

Berryhill has calculated the original reserve of Waynesburg coal in Belmont County to be 581,200,000 tons.

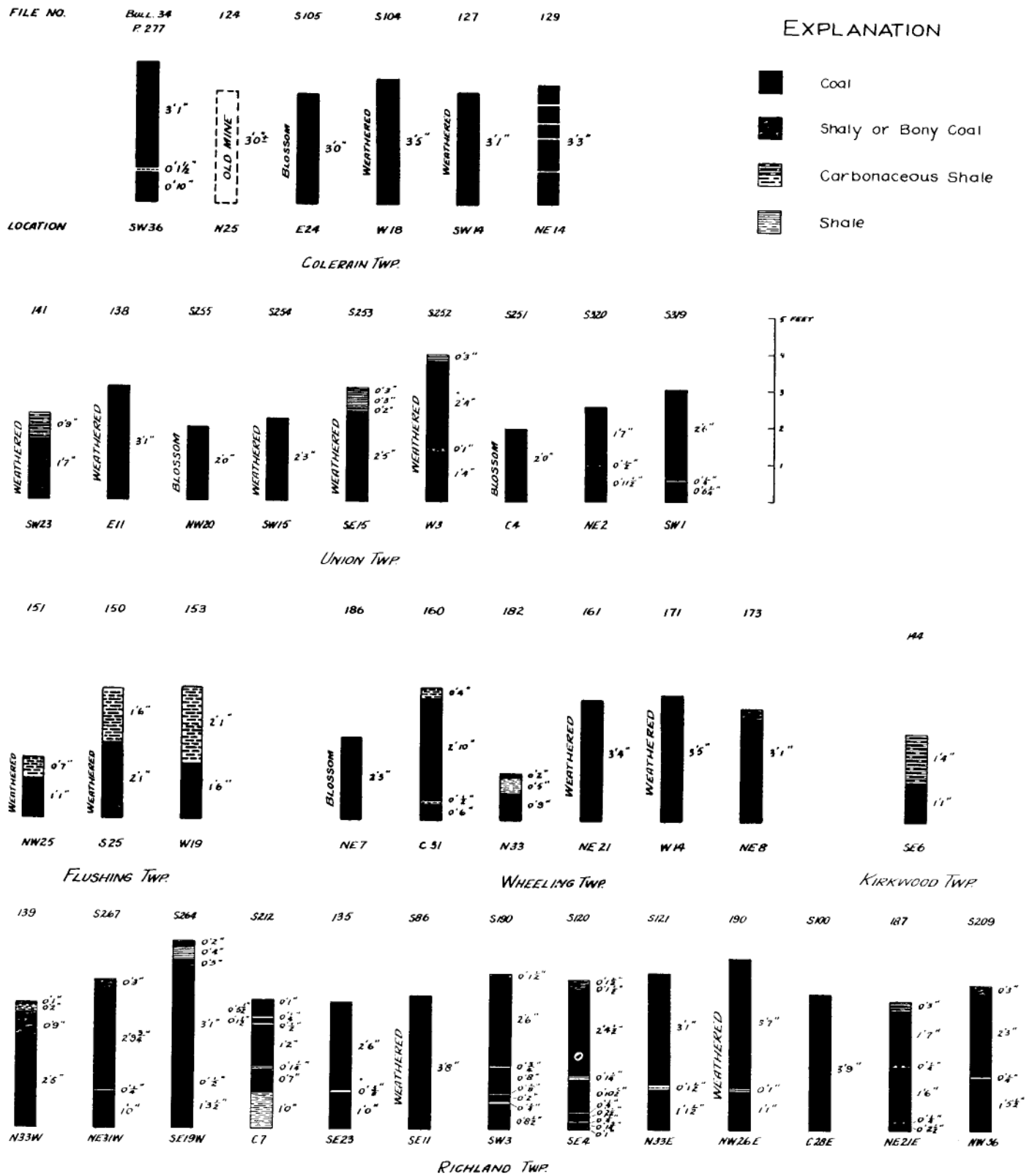
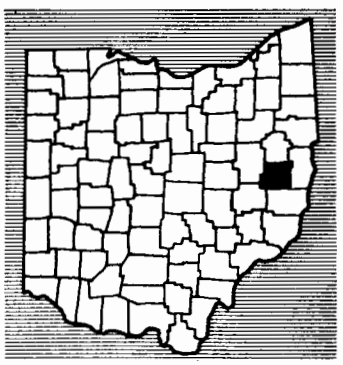


Figure 13. - Graphic sections of Waynesburg (No. 11) coal in northern Belmont County. The file number refers to the location of the section given by White (1947, pl. 1). The location refers to the section number and fraction of section within the township named.

Waynesburg "A" (No. 11a) coal. - The Waynesburg (No. 11a) coal bed has been observed in every township of Belmont County, except Flushing, Kirkwood, and Wheeling Townships. The coal occurs in the county principally in the southern tier of townships--Somerset, Wayne, Washington, and York. The coal was mined formerly in the vicinity of Alledonia, in Washington Township. The bed ranges in thickness from a smut streak less than 1 inch thick to a zone of alternating coal and clay shale more than 5 feet thick. The average thickness of the coal in the county is about 17 inches. Berryhill has calculated the original reserve of Waynesburg "A" coal in Belmont County to be 57,900,000 tons.

Washington (No. 12) coal. - The Washington (No. 12) coal in Belmont County has been observed in every township except Flushing, Kirkwood, Warren, and Wheeling Townships. The coal occurs at minable thickness in Colerain, Mead, Pease, and Washington Townships and is very persistant in areal extent in Belmont County. The coal occurs as two benches separated by a clay-shale parting. It commonly occurs as a 3- or 4-foot zone consisting of good blocky coal with many paper-thin clay laminae, but in places it varies from a zone 3 or 4 inches thick to a zone of alternating shale and coal 10 feet thick. The average thickness of the coal in the county is 40 inches. Berryhill has calculated the original reserve of Washington coal in Belmont County to be 403,400,000 tons.

HARRISON COUNTY



The eastern edge and southeastern corner of Harrison County contain strata of upper Monongahela-Dunkard age. These rocks are present to some extent in Archer, Athens, Cadiz, German, Green, and Short Creek Townships. The Waynesburg "A" (No. 11a) and Washington (No. 12) coal beds are not present in Harrison County, for they have been removed by erosion. The Fishpot, Uniontown (No. 10), and Waynesburg (No. 11) coals are all present, but only the last two thicken sufficiently to contribute to the original coal resources of the county.

Fishpot coal. - The Fishpot coal is present in Archer, Athens, Cadiz, German, Green, and Short Creek Townships. However, the coal is thin and commonly is represented by only a zone of black fissile carbonaceous shale containing little coal. In many places throughout these townships the Fishpot coal zone is lacking entirely and is replaced by siliceous or calcareous shale and limestone. The coal has no economic value in Harrison County.

Uniontown (No. 10) coal. - The Uniontown (No. 10) coal occurs as a bright blocky coal in Athens and Short Creek Townships, where it crops out near the crests of the ridges and high on the hillsides. The coal ranges in thickness from less than 2 inches to more than 49 inches, and averages about 22 inches for the county. The coal has been mined in Short Creek township. The reserve of Uniontown coal in Harrison County is shown in table 12.

Table 12. - Original reserve of Uniontown (No. 10) coal in Harrison County

Township	Average thickness (inches)	Area (acres)	Tonnage
Athens	15	680	1,530,000
Short Creek	30	1,960	7,820,000
Total	--	2,640	9,350,000

Waynesburg (No. 11) coal. - The Waynesburg (No. 11) coal crops out on the high ridges and hilltops of Athens and Short Creek Townships. The coal, which White (1947, p. 55-58) reports to be of fair quality and thickness, averages 36 inches in thickness, but varies from 16 to 47 inches. Figure 14 illustrates some graphic sections of the Waynesburg coal in Athens and Short Creek Townships. The original reserve of Waynesburg coal in Harrison County is calculated to be 7,128,000 tons and to cover 1,320 acres.

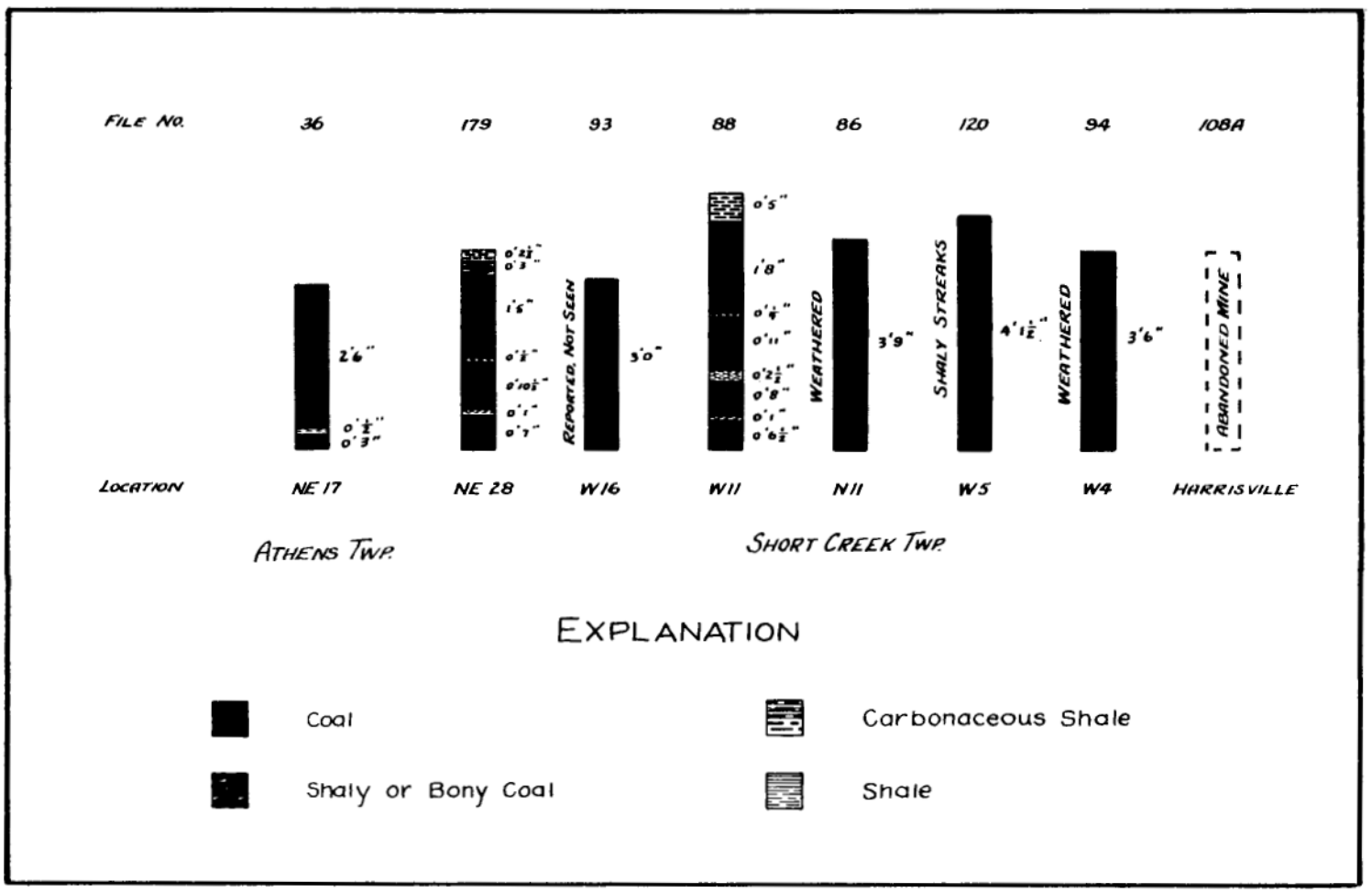
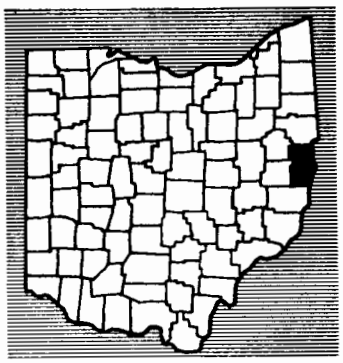


Figure 14. - Graphic sections of Waynesburg (No. 11) coal in Harrison County. The file number refers to the location of the section given by White (1947, pl. 1). The location refers to the section number and fraction of section within the township named.

JEFFERSON COUNTY



Jefferson County is the northernmost county of Ohio containing coal beds of the upper Monongahela formation and Dunkard group. These rocks are exposed in the southern half of the county in Cross Creek, Mount Pleasant, Smithfield, Warren, and Wells Townships. Lamborn (1930, p. 254) reports that only the lower 130 feet of the Washington formation of the Dunkard group is present in Jefferson County.

Fishpot coal. - The Fishpot coal in Jefferson County is represented by black carbonaceous shale containing thin coaly bands, or by a few inches of bony shale. Lamborn (1930 p. 233) reports that the thickness ranges from less than 1 inch to 56 inches, and averages about 12 inches. The coal is too thin and of too poor quality to contribute to the coal resources of Jefferson County.

Uniontown (No. 10) coal. - In Jefferson County, the Uniontown (No. 10) coal occurs as thin blossoms of weathered coal in Mount Pleasant, Smithfield, Warren, and Wells Townships. The coal which varies from 3 to 24 inches in thickness and averages about 10 inches, formerly was mined in Mount Pleasant Township as a local source of fuel. No estimates have been made of the reserve of this coal in Jefferson County.

Waynesburg (No. 11) coal. - The Waynesburg (No. 11) coal has been observed in Mount Pleasant, Warren, and Wells Townships in Jefferson County. Lamborn (1930, p. 251) reports that the coal varies in thickness from 24 inches to 40 inches and averages 30 inches. The coal generally does not contain conspicuous shale partings, but in some areas in Jefferson County the coal bed grades laterally into a coaly shale. The coal has been mined in Mount Pleasant Township, where the bed averages 34 inches in thickness. An original reserve of 27 million tons of coal covering 5,360 acres has been calculated for Jefferson County (table 13).

Table 13. - Original reserve of Waynesburg (No. 11) coal in Jefferson County

Township	Average thickness (inches)	Area (acres)	Tonnage
Mount Pleasant	34	4,240	21,624,000
Warren	32	1,120	5,376,000
Total	--	5,360	27,000,000

Waynesburg "A" (No. 11a) coal. - The Waynesburg "A" (No. 11a) coal in Jefferson County occurs as a thin carbonaceous shaly smut in a zone of clay shale overlying the Mount Morris limestone. This zone has been observed in Mount Pleasant and Wayne Townships. The coal has no economic value in Jefferson County.

Washington (No. 12) coal. - The Washington (No. 12) coal crops out near the top of a few high knobs in Mount Pleasant and Warren Townships. Measurements of the thickness of Washington coal in Jefferson County average 36 inches, but they are too few and too isolated to make a calculation of the reserve of this coal bed.

Chapter 4

SUMMARY OF THE COAL RESERVE

A summary of the estimated original reserve of the coal beds of the upper Monongahela and Dunkard strata in Ohio is shown in table 14. Estimates have been made only for those beds and in those areas where enough data were available for a reasonable evaluation. Table 14, therefore, does not include all the reserve of these coal beds or of this group of rocks. The estimates of reserve are for the 5 major coal beds of the 32 present in the upper Monongahela and Dunkard strata. Some of the other 27 coal beds also have sufficient thickness and extent in local areas of eastern Ohio for appraisal of their reserve, but such estimates are not covered in this report.

Table 14. - Summary of original reserve of upper Monongahela-Dunkard coal beds in Ohio
(In short tons)

Coal bed, county and township	Tonnage	Area (acres)	Average thickness (inches)
Fishpot	440,746,000	113,936	--
Monroe	384,430,000	93,456	--
Franklin	46,782,000	13,560	23
Malaga	72,900,000	18,000	27
Seneca	7,140,000	3,400	14
Summit	51,660,000	11,480	30
Sunsbury	109,056,000	18,176	40
Switzerland	72,576,000	17,280	28
Wayne	24,316,000	11,560	14
Noble	56,316,000	20,480	--
Beaver	19,488,000	4,640	28
Marion	20,196,000	7,920	17
Stock	16,632,000	7,920	14
Uniontown (No. 10)	1,380,168,000	331,900[a]	--
Belmont	216,100,000	--	--
Harrison	9,350,000	2,640	--
Athens	1,530,000	680	15
Short Creek	7,820,000	1,960	30
Monroe	632,613,000	157,920	--
Adams	60,996,000	11,960	34
Benton	4,872,000	2,320	14
Bethel	42,192,000	11,720	24
Center	105,975,000	23,560	30
Malaga	90,744,000	15,920	38
Ohio	48,096,000	13,360	24
Perry	57,600,000	12,800	30
Salem	70,920,000	15,760	30
Seneca	17,028,000	5,160	22
Summit	21,600,000	9,600	15
Sunsbury	58,470,000	17,720	22
Washington	39,360,000	13,120	20
Wayne	14,760,000	4,920	20
Noble	19,485,000	5,300	--
Beaver	3,780,000	1,400	20
Marion	10,656,000	1,920	37
Stock	5,049,000	1,980	17
Washington	502,620,000	166,040	--
Barlow	67,980,000	18,800	24
Belpre	30,072,000	14,320	14
Decatur	11, 250,000	5,360	14
Dunham	40,176,000	14,880	18
Fairfield	26,640,000	8,880	20
Fearing	20,832,000	9,920	14

Table 14. - Summary of original reserve of upper Monongahela-Dunkard coal beds in Ohio (In short tons) (cont.)

Coal bed, county, and township	Tonnage	Area (acres)	Average thickness (inches)
Washington (cont.)			
Grandview	48,360,000	16,120	20
Independence	7,434,000	2,360	21
Lawrence	24,516,000	9,080	18
Liberty	11,556,000	4,280	18
Ludlow	32,256,000	8,960	24
Muskingum	10,032,000	3,040	22
Newport	31,356,000	8,040	26
Salem	9,828,000	4,680	14
Warren	62,748,000	23,240	18
Watertown	67,584,000	14,080	32
Waynesburg (No. 11)	690,754,000	35,360[a]	--
Belmont	581,200,000	--	--
Harrison	7,128,000	1,320	36
Short Creek	7,128,000	1,320	36
Jefferson	27,000,000	6,680	--
Mt. Pleasant	21,624,000	4,240	34
Warren	5,376,000	1,120	32
Monroe	59,970,000	22,800	--
Switzerland	45,942,000	16,120	19
Wayne	14,028,000	6,680	14
Noble	15,456,000	5,880	--
Beaver	6,216,000	1,480	28
Sharon	9,240,000	4,400	14
Waynesburg "A" (No. 11a)	490,686,000	109,900[a]	--
Belmont	57,900,000	--	--
Monroe	377,970,000	92,420	--
Adams	35,700,000	11,900	20
Center	40,608,000	16,920	16
Jackson	53,376,000	11,120	32
Lee	39,816,000	9,480	28
Salem	41,340,000	10,600	26
Sunbury	74,700,000	16,600	30
Switzerland	92,430,000	15,800	39
Morgan	11,490,000	4,240	--
Manchester	3,690,000	1,640	15
Windsor	7,800,000	2,600	20
Noble	7,686,000	2,440	21
Sharon	7,686,000	2,440	21
Washington	35,640,000	10,800	22
Grandview	35,640,000	10,800	22

Table 14. - Summary of original reserve of upper Monongahela-Dunkard coal beds in Ohio (In short tons)(cont.)

Coal bed, county, and township	Tonnage	Area (acres)	Average thickness (inches)
Washington (No. 12)----------	900,042,000	119,720[a]	--
Belmont----------	403,400,000	--	--
Monroe----------	468,178,000	110,000	--
Adams----------	24,240,000	8,080	20
Benton----------	21,240,000	9,440	15
Center----------	33,930,000	15,080	15
Lee----------	20,970,000	9,320	15
Malaga----------	39,312,000	12,480	21
Ohio----------	46,650,000	12,440	25
Salem----------	87,300,000	11,640	50
Sunsbury----------	67,554,000	16,680	27
Switzerland----------	126,982,000	14,840	57
Washington----------	28,464,000	9,720	--
Manetta----------	13,224,000	4,640	19
Newport----------	7,920,000	2,640	20
Liberty----------	7,320,000	2,440	20

a - Does not include acreage in Belmont County.

METHOD USED TO ESTIMATE THE RESERVE

The method used in this report to estimate the coal reserve represents a departure from previous methods used by the Ohio Division of Geological Survey. In previous studies of coal reserve the area of occurrence of a coal and the measurements of coal thickness were plotted on a map, and isopachous lines were drawn from these data to show areas of equal coal thickness. The area was measured on the map by a planimeter, and the result multiplied by the coal thickness to get the volume, which then was multiplied by the density factor of the coal to get the total tonnage. This method is accurate, but requires many well-distributed measurements of coal thickness and much time for making the isopachous map.

In this report the total area of the coal was calculated by a dot-count method similar to that used by the U. S. Forest Service in making tree inventories. This method is fairly simple and is an easy way to determine close approximations of areas underlain by coal, especially areas in which measurements of coal thickness are not numerous. In the dot-count method a transparent grid containing 16 dots per square mile is superimposed on a geologic outcrop map (scale: 1 inch = 1 mile) of the coal bed in question (fig. 15). Each dot represents the center of a quarter of a quarter section of land and has a value of 40 acres. The area of coal then is determined by simply counting the number of dots within the area underlain by coal and multiplying the number by 40 to compute the number of acres of coal. The area of the coal in each township then is multiplied by the average thickness of the coal in that township to get the volume, which is multiplied by a coal-density factor to get the total tonnage. Coal-density factors that can be used in this method are 150 tons per acre-inch or 1800 tons per acre-foot. Only coal of average thickness of 14 inches or more was considered as a reserve in these estimates.

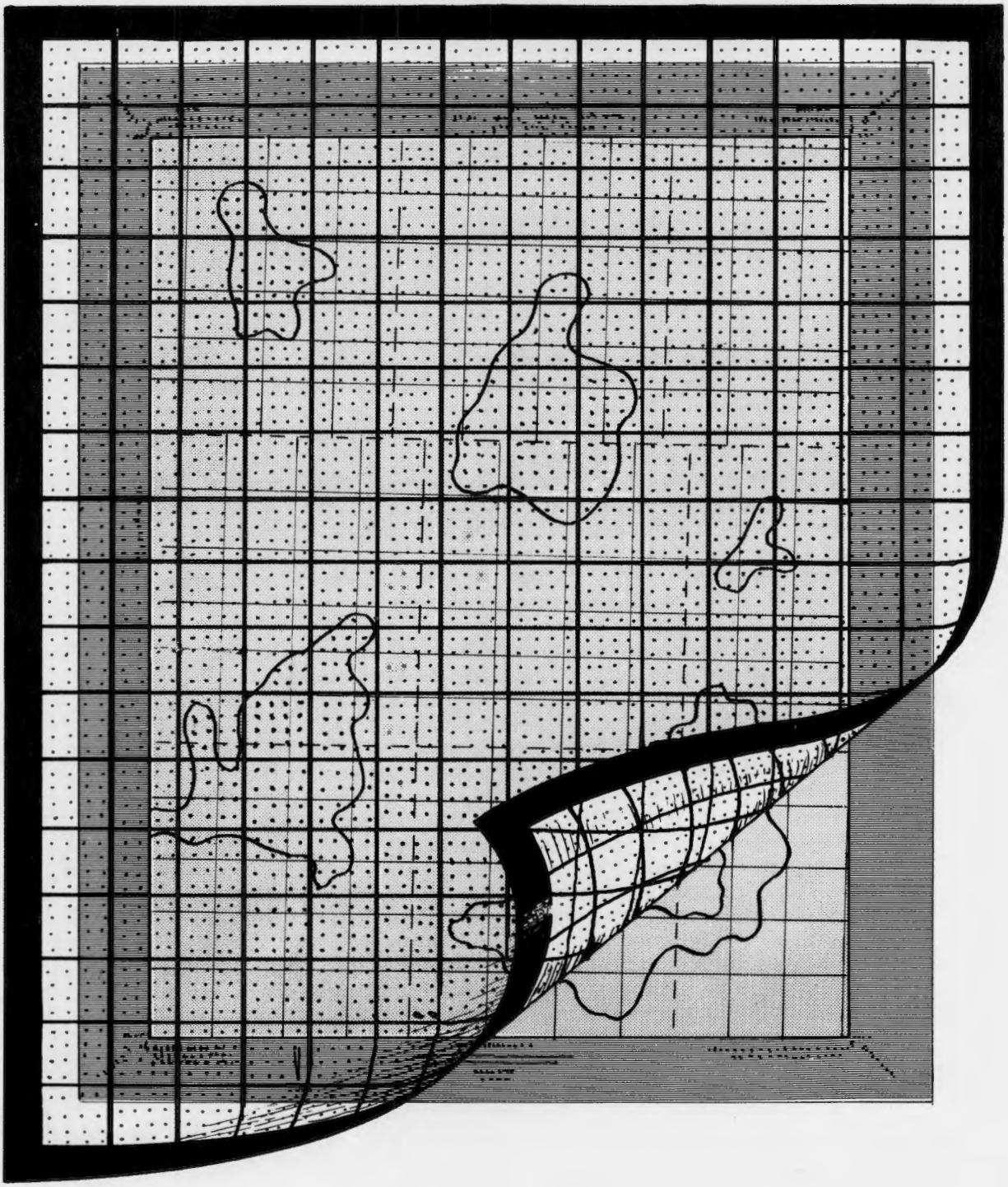


Figure 15. - Illustration of the dot-count method used in estimating area of coal reserve. The heavy lines on the overlying grid enclose squares 1 mile on a side. The 16 dots in each square represent 40 acres each in computing the total area underlain by the coal. Irregularly shaped areas shown on the map are areas underlain by coal. Explanation of the dot-count method is given in text.

LIMITATIONS OF THE INVESTIGATION

The coal beds of the upper Monongahela and Dunkard rocks change considerably in lithologic character and in quality of the coal, as well as in thickness, over short distances. For this reason, the information contained herein is restricted to an evaluation of only those areas in which information is sufficient, in the author's judgement, to warrant an estimate of the reserve. The use of average thicknesses is undesirable in that it implies a uniform thickness of a coal bed throughout a township. This study, however, is intended merely to point out areas in Ohio where these coal beds occur in sufficient thickness to be considered as a coal reserve. In light of the definitions and premises relating to reliability and thickness categories, and in consideration of the results of previous investigations of coal resources by the Ohio Division of Geological Survey, the estimates set forth herein can be placed only in an unclassified category. However, it is believed that the estimates presented in this report closely approximate the original reserve of these coal beds and generally represent the remaining reserve, since coal depletion due to mining in these coals is negligible.

Chapter 5

MINING HISTORY

The upper Monongahela and Dunkard coal beds were among the first coal beds to be mined in Ohio. None of these coal beds has ever been developed as extensively as the Pittsburgh (No. 8), Upper Freeport (No. 7), Middle Kittanning (No. 6), and Lower Kittanning (No. 5) coal beds; however, they have played an important role in the early mining history of Ohio. Many farms and communities in eastern Ohio in the mid-nineteenth century were dependent upon these coal beds for fuel supplies to heat their homes and to fire industrial boilers. Numerous mines were opened in the Uniontown (No. 10), Waynesburg (No. 11), and Washington (No. 12) coal beds to satisfy local fuel requirements as the forest resources were depleted.

The Uniontown and Waynesburg coals were used rather extensively to fire the boilers of the oil and gas drilling rigs during the early development of the oil and gas fields of Washington and Monroe Counties. These coal beds were used also to supply fuel to the salt works in the Ohio River valley. Many of the early blacksmiths also used these coals. Because of better transportation facilities and large-scale production of the better quality coals, coal beds such as the Pittsburgh (No. 8) and Middle Kittanning (No. 6) almost entirely replaced the upper Monongahela-Dunkard coal beds as a source of domestic and industrial fuel by 1900. There are no production figures available for these coal beds.

Table 15 presents a general summary of the number of abandoned coal mines observed by the Division of Geological Survey in the upper Monongahela-Dunkard strata.

Table 15. - Distribution of abandoned coal mines in upper Monongahela-Dunkard strata in Ohio

County	Township	Number of observed mines				
		Washington	Waynesburg "A"	Waynesburg	Uniontown	Fi shpot
Athens	Rome	1	-	-	1	-
	Troy	1	-	-	-	-
Belmont	Colerain	1	-	4	-	-
	Flushing	-	-	-	2	-
	Goshen	-	-	10	12	-
	Kirkwood	-	-	-	1	-
	Mead	-	-	7	-	1
	Pease	1	-	10	1	-
	Pultney	1	-	6	-	-
	Richland	1	-	21	4	1
	Smith	-	-	13	2	-
	Somerset	-	-	11	-	3
	Union	-	-	3	3	1
	Warren	-	-	-	-	2
	Washington	3	4	9	2	-
	Wayne	2	-	18	5	1
	Wheeling	-	-	2	2	-
	York	-	-	3	-	-
Harrison	Short Creek	-	-	2	2	-
Jefferson	Mt. Pleasant	-	-	1	1	-
Meigs	Orange	-	-	1	1	-
Monroe	Adams	2	-	-	13	-
	Center	2	-	-	3	-
	Green	1	-	-	1	-
	Jackson	1	5	-	1	-
	Lee	-	3	-	-	-
	Malaga	3	-	-	3	3
	Ohio	4	-	-	3	-
	Perry	-	1	-	2	-
	Salem	3	-	-	9	-
	Summit	-	-	-	-	1
	Sunsbury	4	-	-	-	-
	Switzerland	1	2	-	1	-
	Washington	-	-	-	-	1
	Wayne	-	-	1	-	-
Morgan	Manchester	-	1	-	-	-
	Windsor	-	1	-	-	-
Noble	Marion	-	-	-	1	-
Washington	Belpre	-	-	-	1	-
	Decatur	-	-	-	4	-
	Fairfield	-	-	-	1	-

Table 15. - Distribution of abandoned coal mines in upper Monongahela-Dunkard strata in Ohio (cont.)

County	Township	Number of observed mines				
		Washington	Waynesburg "A"	Waynesburg	Uniontown	Fishpot
Washington (cont.)	Fearing	-	-	-	1	-
	Grandview	-	1	-	1	-
	Muskingum	-	-	-	4	-
	Newport	1	-	-	1	-
	Wesley	-	-	-	3	-
Total		33	18	122	92	14

Chapter 6

CHEMICAL CHARACTERISTICS OF THE COAL

The chemical constitution of coal is shown by three types of analyses. An ultimate analysis shows the percentage of each of the elements contained in the coal. A proximate analysis shows the percentage of a coal that will pass off as gas when the coal is heated to various temperatures. The third type of analysis shows the percentage of the coal that is selectively dissolved by certain solvents.

Several analyses, both proximate and ultimate, have been tabulated for the coal beds under investigation (table 16). The variation in analyses of coal from a single bed is often very great, even locally. The method of sampling, the degree of weathering of the coal, and the variation in laboratory procedures and records all mitigate against an integrated comparative study. Chemical analyses of coal aid in determining the value of the coal but usually fail to disclose the physical differences which may have an important bearing on its use, minability, and economic value.

The high ash content of coal from upper Monongahela and Dunkard beds makes it undesirable as a commercial fuel, and the high content of sulfur renders it useless for making metallurgical coke. At present, coal from these beds is of value only as domestic fuel or as fuel for electric generating plants using modern coal-burning equipment that will handle coal of high ash and sulfur content.

However, as coal technology advances, these poor quality and relatively thin coal beds ultimately may be useful for gasification, hydrogenation, and other purposes.

Table 16. - Selected chemical analyses of coal from upper Monongahela-Dunkard strata in Ohio

County	Township	File number	Kind	Source	Condition	Proximate analysis				Ultimate analysis					Heat value		Year
		1	2	3	4	Moisture	Volatile	Fixed carbon	Ash	Sulphur	Hydrogen	Carbon	Nitrogen	Oxygen	Calories	B. t. u	
									WASHINGTON								
BELMONT	WASHINGTON	152	1	1	1	408	3369	4123	2100	286	476	5993	109	1036	6012	10822	14
					2		3512	4298	2190	298	449	6248	114	701	6268	11282	
					3		4497	5503		382	575	8000	146	897	8026	14446	
					4		4307	5693							8279	14902	
					5	539	4075	5386							7833	14098	
									WAYNESBURG A								
MORGAN	WINDSOR	499	1	2	1	408	3854	5026	712	445	630	5840	108	2265	6197	11154	29
					2		4018	5240	742	464	610	6088	113	1983	6460	11628	
					3		4340	5660		501	659	6576	122	2142	6978	12560	
					4		4219	5781							7079	12742	
					5	454	4027	5519							6758	12165	
									WAYNESBURG								
BELMONT	COLERAIN	214	1	2	1	587	3742	4261	1470	219	497	6445	144	1225	6434	11581	27
					2		3950	4498	1552	231	462	6804	152	799	6792	12225	
					3		4676	5324		273	547	8054	180	946	8040	14471	
					4		4555	5445							8207	14773	
					5	636	4265	5099							7686	13835	
"	GOSHEN	213	1	1	1	431	3532	4415	1622	353	498	6410	120	997	6447	11605	14
					2		3691	4614	1695	369	470	6698	125	643	6737	12127	
					3		4484	5556		444	566	8065	151	774	8112	14602	
					4		4278	5722							8328	14991	
					5	535	4049	5416							7883	14190	
"	MEAD	212	1	2	1	351	3768	4194	1687	359	470	6318	125	1041	6320	11377	27
					2		3905	4347	1748	372	487	6548	129	756	6550	11791	
					3		4732	5268		461	542	7935	156	916	7937	14289	
					4		4573	5427							8153	14676	
					5	440	4372	5188							7795	14031	
"	RICHLAND	211	1	2	1	358	3736	4589	1307	175					6678	12020	27
					2		3878	4765	1357	182					6933	12479	
					3		4487	5513		211					8022	14438	
					4		4383	5617							8160	14688	
					5	433	4194	5373							7806	14051	
"	SMITH	209	1	2	1	178	3916	4365	1541	268	487	6515	118	1071	6505	11709	26
					2		3987	4444	1569	273	475	6633	120	930	6623	11921	
					3		4729	5271		324	563	7868	142	1103	7856	14139	
					4		4601	5399							8028	14450	
					5	217	4501	5282							7853	14136	
"	"	210	1	2	1	572	3586	4431	1411	250					6439	11590	27
					2		3803	4701	1496	265					6830	12293	
					3		4472	5528		312					8032	14456	
					4		4342	5658							8200	14760	
					5	686	4045	5269							7638	13749	
"	SOMERSET	153	1	1	1	446	3660	4419	1475	302	510	6532	116	1065	6553	11795	14
					2		3831	4685	1544	316	481	6837	121	701	6859	12346	
					3		4531	5469		374	569	8085	143	829	8111	14600	
					4		4389	5611							8299	14939	
					5	541	4152	5307							7850	14130	
"	UNION	619	3	3	1	42	349	447	162	30					6430	11574	57
					2		364	467	169	31					6712	12081	
					3		438	562		37					8077	14538	
					4		422	578							8277	14899	
					5	52	401	547							7849	14129	
"	WASHINGTON	184	1	1	1	457	3681	4417	1445	259					6574	11833	14
					2		3857	4629	1514	271					6889	12400	
					3		4545	5455		319					8118	14612	
					4		4415	5585							8293	14928	
					5	551	4172	5277							7837	14106	
"	WAYNE	154	1	1	1	440	3710	4306	1544	290					6476	11657	14
					2		3881	4504	1615	303					6774	12193	
					3		4629	5371		361					8079	14541	
					4		4488	5512							8270	14886	
					5	538	4247	5215							7825	14085	
"	"	208	2	2	1	559	3838	3970	1633	320					6110	10999	26
					2		4066	4205	1729	339					6472	11650	
					3		4916	5084		410					7825	14085	
					4		4772	5228							8027	14448	
					5	694	4440	4866							7471	13447	

Table 16. - Selected chemical analyses of coal from upper Monongahela-Dunkard strata in Ohio (cont.)

County	Township	File number 1	Kind 2	Source 3	Condition 4	Proximate analysis: Moisture	Volatile	Fixed carbon	Ash	Ultimate analysis: Sulphur	Hydrogen	Carbon	Nitrogen	Oxygen	Heat value: Calories	B.t.u.	Year
BELMONT	YORK	207	1	2	1	284	4007	4375	1334	491					6526	11746	26
					2		4124	4503	1373	506					6716	12089	
					3		4780	5220		587					7785	14013	
					4		4627	5373							7981	14366	
					5	343	4468	5189							7708	13874	
									UNIONTOWN								
BELMONT	GOSHEN	155	1	1	1	470	3421	4575	1534	285	495	6371	133	1182	6479	11662	14
					2		3590	4800	1610	299	465	6685	140	801	6799	12238	
					3		4279	5721		356	554	7968	167	955	8104	14586	
					4		4127	5873							8294	14930	
					5	574	3890	5536							7817	14071	
"	"	216	1	2	1	83	4121	4429	1367	259					6747	12145	26
					2		4156	4466	1378	261					6803	12246	
					3		4820	5180		303					7890	14203	
					4		4710	5290							8043	14478	
					5	99	4663	5238							7964	14336	
MONROE	ADAMS	156	1	1	1	485	3593	4390	1532	396	487	6359	119	1107	6412	11542	14
					2		3776	4614	1610	416	455	6683	125	711	6739	12130	
					3		4501	5499		496	542	7966	149	847	8032	14458	
					4		4333	5667							8246	14842	
					5	597	4075	5328							7754	13957	
"	"	215	1	2	1	257	4087	4282	1374	306	483	6596	137	1104	6573	11831	26
					2		4195	4394	1411	315	473	6768	140	893	6746	12143	
					3		4884	5116		367	551	7879	163	1040	7854	14138	
					4		4765	5235							8019	14435	
					5	308	4617	5075							7772	13989	
									MEIGS CREEK								
BELMONT	FLUSHING	149	1	1	1	463	3384	5250	903	218							6
					2		3548	5505	947	229							
					3		3919	6081		253							
					4		3819	6181									
					5	520	3621	5859									
"	"	177	1	1	1	551	3595	4989	865	231							6
					2		3805	5280	915	244							
					3		4188	5812		269							
					4		4094	5906									
					5	616	3841	5543									
"	"	423	1	2	1	498	3330	4890	1282	241	495	6631	119	1232	6652	11974	7
					2		3505	5146	1349	253	463	6979	125	831	7001	12602	
					3		4052	5948		292	535	8068	144	961	8093	14567	
					4		3922	6078							8247	14845	
					5	587	3691	5722							7763	13973	
"	GOSHEN	148	1	1	1	423	3641	4791	1145	316							6
					2		3802	5002	1196	330							
					3		4318	5682		375							
					4		4192	5808									
					5	492	3986	5522									
"	"	422	1	2	1	340	3572	4594	1494	439	486	6477	108	996	6578	11840	7
					2		3698	4756	1546	454	464	6705	112	719	6809	12256	
					3		4374	5626		537	549	7932	132	850	8054	14497	
					4		4199	5801							8270	14886	
					5	417	4024	5559							7926	14267	
"	PEASE	421	1	2	1	455	3609	4297	1619	313	472	6263	126	1207	6265	11278	27
					2		3795	4507	1698	328	441	6568	132	833	6571	11828	
					3		4571	5429		395	531	7912	159	1003	7915	14247	
					4		4418	5582							8114	14606	
					5	576	4164	5260							7647	13765	
"	PULTNEY	419	1	2	1	388	3884	4396	1332	271					6643	11958	27
					2		4041	4573	1386	282					6911	12441	
					3		4691	5309		327					8023	14443	
					4		4573	5427							8186	14734	
					5	461	4362	5177							7808	14054	
"	"	420	1	2	1	413	3958	4247	1382	338	503	6561	121	1095	6584	11852	27
					2		4129	4430	1441	362	477	6844	126	760	6868	12363	
					3		4824	5176		411	557	7997	147	888	8024	14444	
					4		4694	5306							8207	14772	
					5	496	4461	5043							7799	14039	
"	RICHLAND	417	1	2	1	551	3818	4401	1280	260					6642	11956	27
					2		4041	4657	1302	275					7029	12653	
					3		4646	5354		316					8081	14547	
					4		4533	5467							8236	14824	
					5	646	4239	5115							7703	13866	

Table 16. - Selected chemical analyses of coal from upper Monongahela-Dunkard strata in Ohio (cont.)

County	Township	File number [1]	Kind [2]	Source [3]	Condition [4]	Proximate analysis			Ultimate analysis						Heat value		Year
						Moisture	Volatile	Fixed carbon	Ash	Sulphur	Hydrogen	Carbon	Nitrogen	Oxygen	Calories	B. t. u	
NOBLE	STOCK	288	1	2	1	2.55	38.40	47.54	11.41	5.79	5.11	67.50	.92	9.27	6952	12514	7
					2		39.40	48.89	11.71	5.94	4.96	69.26	.94	7.19	7134	12841	
					3		44.63	55.37		6.73	5.62	78.45	1.06	8.14	8080	14544	
					4		42.92	57.08							8288	14918	
					5	3.02	41.62	55.36							8038	14468	
"	"	394	1	2	1	4.08	43.49	41.56	10.87	5.39	5.19	66.70	1.02	10.83	6831	12296	27
					2		45.34	43.33	11.33	5.62	4.95	69.54	1.06	7.50	7122	12820	
					3		51.13	48.87		6.34	5.58	78.42	1.20	8.46	8032	14458	
					4		49.82	50.18							8227	14809	
					5	4.78	47.44	47.78							7833	14100	
WASHINGTON	ADAMS	287	1	2	1	2.95	37.47	46.69	12.89	5.55	5.05	65.88	.92	9.71	6803	12245	4
					2		38.61	48.11	13.28	5.72	4.86	67.88	.95	7.31	7010	12617	
					3		44.62	55.48		6.60	5.60	78.27	1.10	8.43	8083	14549	
					4		42.73	57.27							8303	14945	
					5	3.55	41.22	55.23							8008	14414	
"	"	496	1	2	1	2.72	41.16	44.57	11.55	4.48	6.83	67.07	1.04	9.03	6850	12330	29
					2		42.31	45.82	11.87	4.61	6.71	68.95	1.07	6.79	7042	12675	
					3		48.01	51.99		5.23	7.61	78.25	1.21	7.70	7990	14382	
					4		46.68	53.32							8168	14702	
					5	3.20	45.19	51.61							7907	14232	
"	AURELIUS	286	1	2	1	3.40	37.95	49.07	9.58	5.03	5.31	68.33	.90	10.85	7083	12749	7
					2		39.28	50.80	9.92	5.21	5.10	70.73	.93	8.11	7332	13198	
					3		43.61	56.39		5.78	5.66	78.53	1.03	9.00	8139	14651	
					4		42.12	57.88							8317	14970	
					5	3.91	40.48	55.61							7991	14384	
									FISHPOT								
BELMONT	MEAD	351	2	2	1	2.54	40.81	40.92	15.73	5.00					6522	11739	26
					2		41.87	41.99	16.14	5.13					6692	12045	
					3		49.93	50.07		6.12					7980	14363	
					4		48.31	51.69							8212	14782	
					5	3.16	46.79	50.05							7952	14314	
MONROE	MALAGA	350	1	2	1	5.16	37.73	37.49	19.62	5.19	5.02	59.61	.95	9.61	6068	10922	27
					2		39.78	39.53	20.69	5.48	4.70	62.85	1.00	5.28	6398	11516	
					3		50.16	49.84		6.91	5.93	79.24	1.26	6.66	8067	14520	
					4		48.14	51.86							8367	15061	
					5	6.79	44.88	48.33							7799	14038	

1. Ohio Division of Geological Survey number.
2. 1, channel (mine); 2, channel (outcrop); 3, column or core.
3. 1, U. S. Bureau of Mines and (or) U. S. Geological Survey; 2, Ohio Division of Geological Survey; 3, Engineering Experiment Station, Ohio State University.
4. 1, as received; 2, moisture free; 3, moisture and ash free; 4, dry unit coal; 5, moist unit coal.

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