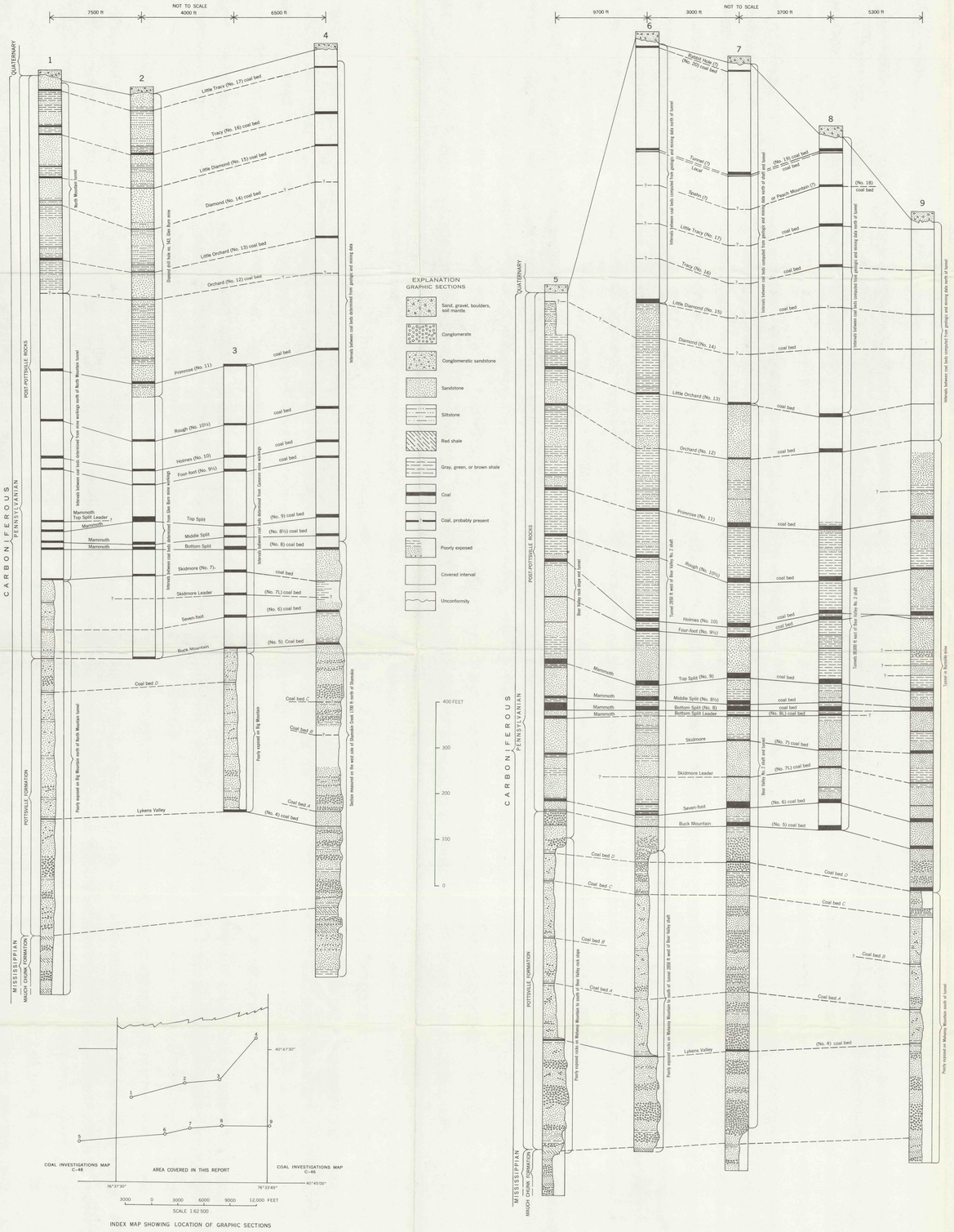
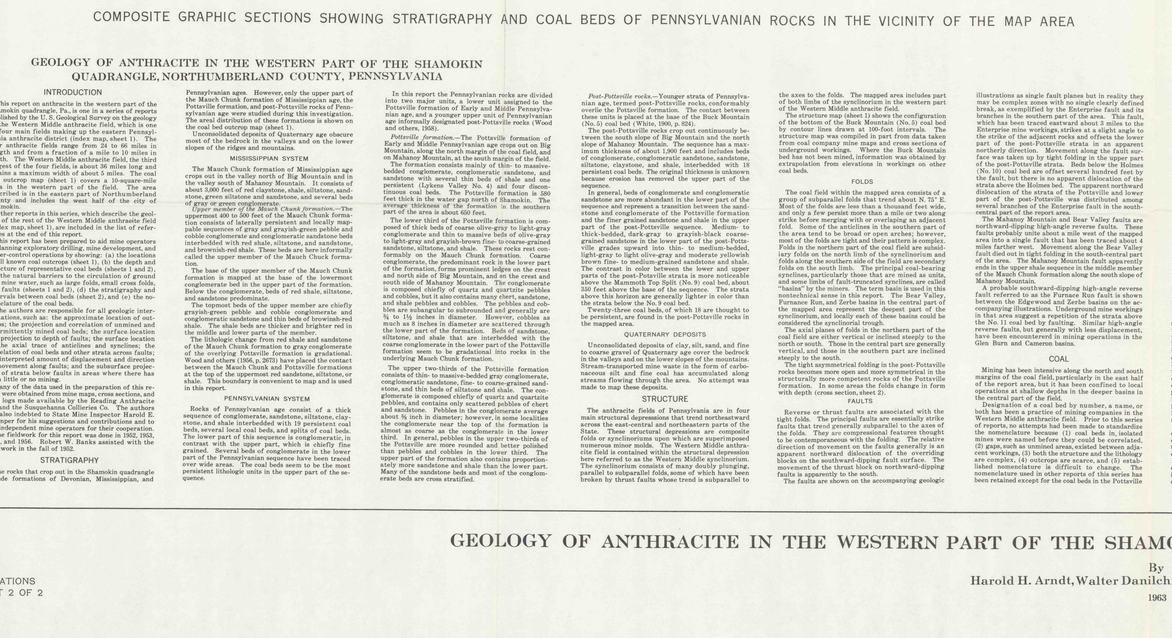
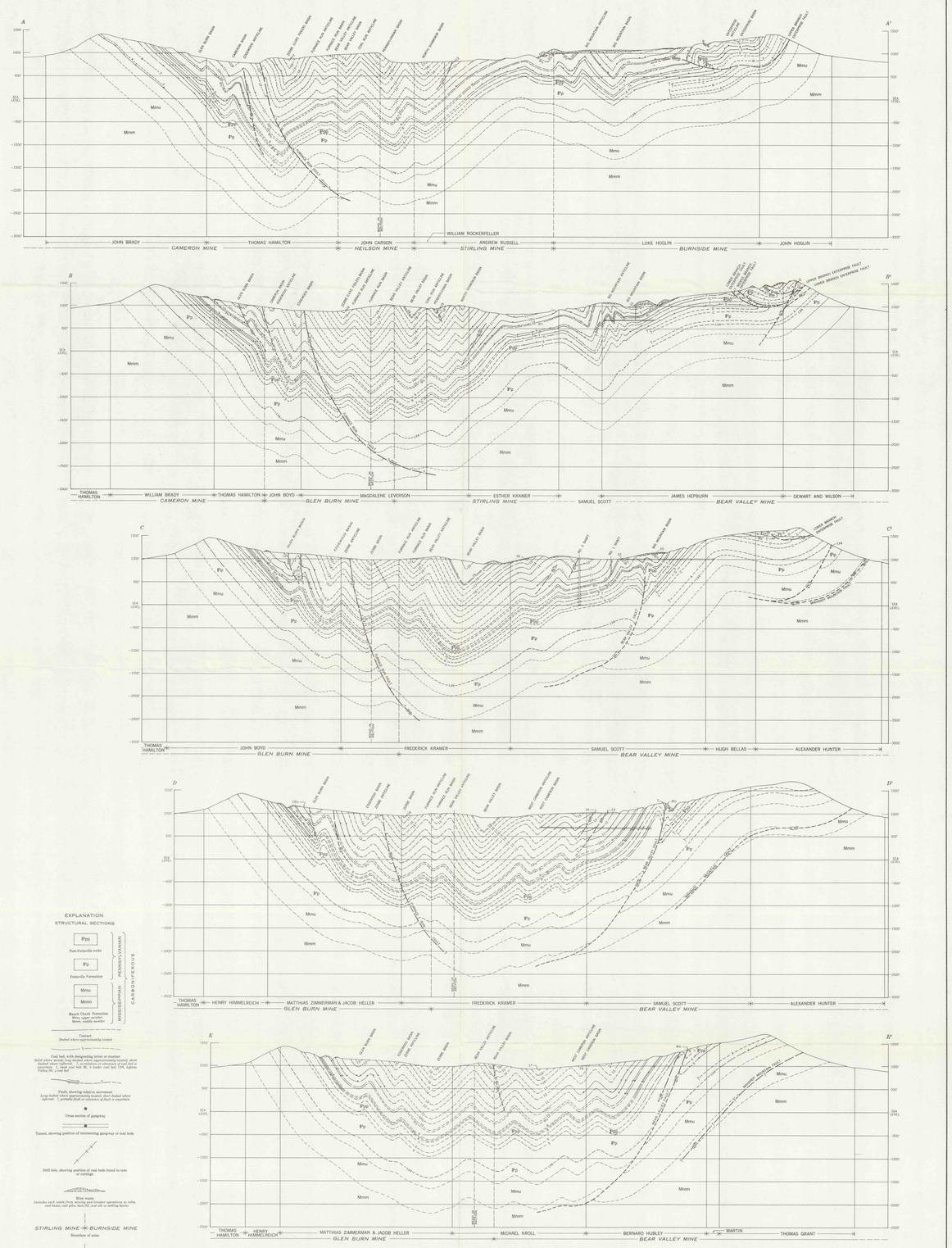




COMPOSITE GRAPHIC SECTIONS SHOWING STRATIGRAPHY AND COAL BEDS OF PENNSYLVANIAN ROCKS IN THE VICINITY OF THE MAP AREA



Prepared in 1958 from data supplied by the Reading Anthracite Co. and the Susquehanna Collieries Co. with modifications by the U. S. Geological Survey

GEOLOGY OF ANTHRACITE IN THE WESTERN PART OF THE SHAMOKIN QUADRANGLE, NORTHUMBERLAND COUNTY, PENNSYLVANIA

INTRODUCTION

This report on anthracite in the western part of the Shamokin quadrangle, Pa., is one in a series of maps published by the U. S. Geological Survey on the geology of the Western Middle anthracite field, which is one of four main fields making up the eastern Pennsylvania anthracite district (index map, sheet 1). The four anthracite fields range from 24 to 66 miles in length and from a fraction of a mile to 10 miles in width. The Western Middle anthracite field, the third largest of the four fields, is about 36 miles long and attains a maximum width of about 5 miles. The coal bed outcrop map (sheet 1) covers a 10-square-mile area in the western part of the field. The area described is in the western part of Northumberland County and includes the west half of the city of Shamokin.

Other reports in this series, which describe the geology in the rest of the Western Middle anthracite field (index map, sheet 1), are included in the list of references at the end of this report.

This report has been prepared to aid mine operators in planning exploratory drilling, mine development, and water-control operations by showing: (a) the location of all known coal outcrops (sheet 1), (b) the depth and structure of representative coal beds (sheets 1 and 2), (c) the natural barriers to the circulation of ground and mine water, such as large folds, small cross folds, and faults (sheets 1 and 2), (d) the stratigraphy and intervals between coal beds (sheet 2), and (e) the nomenclature of the coal beds.

The authors are responsible for all geologic interpretations, such as: the approximate location of outcrops; the projection and correlation of unmined and intermittently mined coal beds; the surface location and projection to depth of faults; the surface location of the axial trace of anticlines and synclines; the correlation of coal beds and other strata across faults; the interpreted amount of displacement and direction of movement along faults; and the subsurface projection of strata below faults in areas where there has been little or no mining.

Many of the data used in the preparation of this report were obtained from mine maps, cross sections, and drill logs made available by the Reading Anthracite Co. and the Susquehanna Collieries Co. The authors are also indebted to State Mine Inspector Harold E. Shomper for his suggestions and contributions and to the independent mine operators for their cooperation.

The fieldwork for this report was done in 1952, 1955, and 1956. Robert W. Banks assisted with the fieldwork in the fall of 1952.

STRATIGRAPHY

The rocks that crop out in the Shamokin quadrangle include formations of Devonian, Mississippian, and Pennsylvanian ages. However, only the upper part of the Mauch Chunk formation of Mississippian age, the Pottsville formation, and post-Pottsville rocks of Pennsylvanian age were studied during this investigation. The areal distribution of these formations is shown on the coal bed outcrop map (sheet 1).

Unconsolidated deposits of Quaternary age obscure most of the bedrock in the valleys and on the lower slopes of the ridges and mountains.

MISSISSIPPIAN SYSTEM

The Mauch Chunk formation of Mississippian age crops out in the valley north of Big Mountain and in the valley south of Mahanoy Mountain. It consists of about 3,000 feet of red claystone, shale, siltstone, sandstone, green siltstone and sandstone, and several beds of gray or green conglomerate.

Upper member of the Mauch Chunk formation.—The uppermost 400 to 500 feet of the Mauch Chunk formation consists of laterally persistent and locally mappable sequences of gray and grayish-green pebble and cobble conglomerate and conglomeratic sandstone beds interbedded with red shale, siltstone, and sandstone, and brownish-red shale. These beds are here informally called the upper member of the Mauch Chunk formation.

The base of the upper member of the Mauch Chunk formation is mapped at the base of the lowermost conglomerate bed in the upper part of the formation. Below the conglomerate, beds of red shale, siltstone, and sandstone predominate.

The topmost beds of the upper member are chiefly grayish-green pebble and cobble conglomerate and conglomeratic sandstone and thin beds of brownish-red shale. The shale beds are thicker and brighter red in the middle and lower parts of the member.

A lithologic change from red shale and sandstone of the Mauch Chunk formation to gray conglomerate of the overlying Pottsville formation is gradational (Wood and others (1956, p. 2073) but takes place between the beds in the Mauch Chunk and Pottsville formations at the top of the uppermost red sandstone, siltstone, or shale. This boundary is convenient to map and is used in this report.

PENNSYLVANIAN SYSTEM

Rocks of Pennsylvanian age consist of a thick sequence of conglomerate, sandstone, siltstone, claystone, and shale interbedded with 19 persistent coal beds, several local coal beds, and several silts of coal beds. The lower part of this sequence is conglomeratic, in contrast with the upper part, which is chiefly fine grained. Several beds of conglomerate in the lower part of the Pennsylvanian sequence have been traced over wide areas. The coal beds seem to be the most persistent lithologic units in the upper part of the sequence.

In this report the Pennsylvanian rocks are divided into two units, a lower unit assigned to the Pottsville formation of Early and Middle Pennsylvanian age, and a younger upper unit of Pennsylvanian age informally designated post-Pottsville rocks (Wood and others, 1956).

Pottsville formation.—The Pottsville formation of Early and Middle Pennsylvanian age crops out on Big Mountain, along the north margin of the coal field, and on Mahanoy Mountain, at the south margin of the field.

The formation consists mainly of thin- to massive-bedded conglomerate, conglomeratic sandstone, and sandstone with several thin beds of shale and one persistent coal (Lykens Valley No. 4) and four discontinuous coal beds. The Pottsville formation is 280 feet thick in the water gap north of Shamokin. The average thickness of the formation in the southern part of the area is about 650 feet.

The lower third of the Pottsville formation is composed of thick beds of coarse olive-gray to light-gray conglomerate and thin lenses and beds of olive-gray to light-gray and grayish-brown fine- to coarse-grained sandstone, siltstone, and shale. These beds are informally on the Mauch Chunk formation. The conglomerate, the predominant rock in the lower part of the formation, forms prominent ledges on the crest and north side of Big Mountain, and on the crest and south side of Mahanoy Mountain. The conglomerate is composed chiefly of quartz and quartzite pebbles and cobbles, but it also contains many chert, sandstone, and shale pebbles and cobbles. The pebbles and cobbles are subangular to subrounded and generally are ¾ to 1½ inches in diameter. However, cobbles as much as 8 inches in diameter are scattered through the lower part of the formation. Beds of sandstone, siltstone, and shale that are interbedded with the coarse conglomerate in the lower part of the Pottsville formation seem to be gradational into rocks in the underlying Mauch Chunk formation.

The upper two-thirds of the Pottsville formation consists of thin- to massive-bedded gray conglomerate, conglomeratic sandstone, fine- to coarse-grained sandstone, and thin beds of siltstone and shale. The conglomerate is composed chiefly of quartz and quartzite pebbles, and contains only scattered pebbles of chert and sandstone. Pebbles in the conglomerate average about ⅝ inch in diameter; however, in some localities the conglomerate near the top of the formation is almost as coarse as the conglomerate in the lower third. In general, pebbles in the upper two-thirds of the Pottsville formation are more rounded and better polished than pebbles and cobbles in the lower third. The upper part of the formation also contains proportionately more sandstone and shale than the lower part. Many of the sandstone beds and most of the conglomerate beds are cross stratified.

Post-Pottsville rocks.—Younger strata of Pennsylvanian age, termed post-Pottsville rocks, conformably overlie the Pottsville formation. The contact between these units is placed at the base of the Buck Mountain (No. 5) coal bed (White, 1900, p. 824).

The post-Pottsville rocks crop out continuously between the south slope of Big Mountain and the north slope of Mahanoy Mountain. The sequence has a maximum thickness of about 1,900 feet and includes beds of conglomerate, conglomeratic sandstone, sandstone, siltstone, claystone, and shale, interbedded with 18 persistent coal beds. The original thickness is unknown because erosion has removed the upper part of the sequence.

In general, beds of conglomerate and conglomeratic sandstone are more abundant in the lower part of the sequence and represent a transition between the sandstone and conglomerate of the Pottsville formation and the finer grained sandstone and shale in the upper part of the post-Pottsville sequence. Medium- to thick-bedded, dark-gray to grayish-black coarse-grained sandstone in the lower part of the post-Pottsville grades upward into thin- to medium-bedded, light-gray to light olive-gray and moderate yellowish brown fine- to medium-grained sandstone and shale. The contrast in color between the lower and upper parts of the post-Pottsville strata is more noticeable above the Mammoth Top Split (No. 9) coal bed, about 350 feet above the base of the sequence. The strata above this horizon are generally lighter in color than the strata below the No. 9 coal bed.

Twenty-three coal beds, of which 18 are thought to be persistent, are found in the post-Pottsville rocks in the mapped area.

QUATERNARY DEPOSITS

Unconsolidated deposits of clay, silt, sand, and fine to coarse gravel of Quaternary age cover the bedrock in the valleys and on the lower slopes of the mountains. Stream-transported mine waste in the form of carbonaceous silt and fine coal has accumulated along streams flowing through the area. No attempt was made to map these deposits.

STRUCTURE

The anthracite fields of Pennsylvania are in four main structural depressions that trend northeastward across the east-central and northeastern parts of the State. These structural depressions are composite folds or synclinoriums upon which are superimposed numerous minor folds. The Western Middle anthracite field is contained within the structural depression here referred to as the Western Middle synclinorium. The synclinorium consists of many doubly plunging, parallel to subparallel folds, some of which have been broken by thrust faults whose trend is subparallel to the axes to the folds. The mapped area includes part of both limbs of the synclinorium in the western part of the Western Middle anthracite field.

The structure map (Sheet 1) shows the configuration of the base of the Buck Mountain (No. 5) coal bed by contour lines drawn at 100-foot intervals. The structure map was compiled in part from data taken from coal company mine maps and cross sections of underground workings. Where the Buck Mountain bed has not been mined, information was obtained by extrapolation from elevations in workings on other coal beds.

FOLDS

The coal field within the mapped area consists of a group of subparallel folds that trend about N. 75° E. Most of the folds are less than a thousand feet wide, and only a few persist more than a mile or two along strike before merging with or overlaping an adjacent fold. Some of the anticlines in the southern part of the area tend to be broad or open arches; however, most of the folds are tight and their pattern is complex. Folds in the northern part of the coal field are subsidiary folds on the north limb of the synclinorium and folds along the southern side of the field are secondary folds on the south limb. The principal coal-bearing synclines, particularly those that are mined as units, and some limbs of fault-truncated synclines, are called "basins" by the miners. The term basin is used in this nontechnical sense in this report. The Bear Valley, Furnace Run, and Zerbe basins in the central part of the mapped area represent the deepest part of the synclinorium, and locally each of these basins could be considered the synclinorial trough.

The axial planes of folds in the northern part of the coal field are either vertical or inclined steeply to the north or south. Those in the central part are generally vertical, and those in the southern part are inclined steeply to the south.

The tight symmetrical folding in the post-Pottsville rocks becomes more open and more symmetrical in the structurally more competent rocks of the Pottsville formation. In some areas the folds change in form with depth (cross section, sheet 2).

FAULTS

Reverse or thrust faults are associated with the tight folds. The principal faults are essentially strike faults that trend generally subparallel to the axes of the folds. They are compositional features thought to be contemporaneous with the folding. The relative direction of movement on the faults generally is apparent northward dislocation of the overriding blocks on the southward-dipping limbs. The movement of the thrust block on northward-dipping faults is apparently to the south.

The faults are shown on the accompanying geologic illustrations as single fault planes but in reality they may be complex zones with no single clearly defined break, as exemplified by the Enterprise fault and its branches in the southern part of the area. This fault, which has been traced eastward about 3 miles to the Enterprise mine workings, strikes at a slight angle to the trend of the adjacent rocks and offsets the lower part of the post-Pottsville strata in an apparent northerly direction. Movement along the fault surface was taken up by tight folding in the upper part of the post-Pottsville strata. Beds below the Holmes (No. 10) coal bed are offset several hundred feet by the fault, but there is no apparent dislocation of the strata above the Holmes bed. The apparent northward dislocation of the strata of the Pottsville and lower part of the post-Pottsville was distributed among several branches of the Enterprise fault in the southern part of the report area.

The Mahanoy Mountain and Bear Valley faults are northward-dipping high-angle reverse faults. These faults probably unite about a mile west of the mapped area into a single fault that has been traced about 4 miles farther west. Movement along the Bear Valley fault fold out in tight folding in the south-central part of the area. The Mahanoy Mountain fault apparently ends in the upper shale sequence in the middle member of the Mauch Chunk formation along the south slope of Mahanoy Mountain.

A probable southward-dipping high-angle reverse fault referred to as the Furnace Run fault is shown between the Edgewood and Zerbe basins on the accompanying illustrations. Underground mine workings in that area suggest a repetition of the strata above the No. 11 coal bed by faulting. Similar high-angle reverse faults, but generally with less displacement, have been encountered in mining operations in the Glen Burn and Cameron basins.

COAL

Mining has been intensive along the north and south margins of the coal field, particularly in the east half of the report area, but it has been confined to local operations at shallow depths in the deeper basins in the central part of the field.

Designation of a coal bed by number, a name, or both has been a practice of mining companies in the Western Middle anthracite field. Prior to this series of reports, no attempts had been made to standardize the nomenclature because (1) coal beds in, isolated mines were named before they could be correlated, (2) gaps, such as unmined areas, existed between adjacent workings, (3) both the structure and the lithology are complex, (4) outcrops are scarce, and (5) established nomenclature is difficult to change. The nomenclature used in other reports of this series has been retained except for the coal beds in the Pottsville formation. The Lykens Valley No. 2 coal bed of miners in the Western Middle field, and of earlier reports in this series, is called the Lykens Valley No. 4 coal bed in this report because it is probably a correlative of the Lykens Valley No. 4 coal of the Southern anthracite field, according to White (1900, p. 811-812). The four other coal beds in the Pottsville formation in this area are designated in this report as beds *A*, *B*, *C*, and *D*, in ascending order, because their correlation is uncertain. The nomenclature of the coal beds in this report does not agree in some cases with the nomenclature used by the Second Geological Survey of Pennsylvania (Ashburner, 1883, p. 84-88), nor in some cases with the nomenclature used by the mining companies.

THICKNESS AND DESCRIPTION OF COAL BEDS

The table below shows the average thickness and range of thickness of coal beds in the mapped area. Figures on the right side of the table show the total thickness of coal only in each coal bed. Figures on the left side show the combined thickness of coal and shale partings in each bed. Many of the thicknesses were obtained from mine company data and are an average of many underground observations. Thicknesses shown in the table also include a number of measurements taken during the course of the present investigation. These were obtained from mine tunnels, at working faces in mines, from drill cores, and at surface exposures. Measurements thought to reflect an abnormal amount of deformation are not included.

A coal bed may be described as persistent, nonpersistent, local or leader. A persistent coal bed can be traced throughout a basin and can be correlated between adjacent basins. A nonpersistent coal bed can be recognized and correlated in more than one basin, but it is known to be discontinuous locally. A local coal bed cannot be correlated between adjoining basins or within a basin, and generally cannot be traced for more than three or four miles. A leader coal bed which may be widespread, and at surface because it is near a well-known or economically important coal bed and thus serves as a guide or marker for that bed. It may or may not merge with the principal coal bed and in some places may be separated from the principal bed by a stratigraphic interval of as much as 100 feet.

Coal beds in the Pottsville formation.—Of the five coal beds present in the Pottsville formation, only the coal bed about 200 feet above the base of the formation seems to be persistent throughout the area. This coal bed, generally referred to as the Lykens Valley No. 2 by the miners in the Western Middle field, is called the Lykens Valley No. 4 coal in this report as it is probably a correlative of the Lykens Valley No. 4 coal of the Southern anthracite field (White, 1900, p. 811-812).

The quality of the coal is very good, but in most workings mining is hampered by numerous pinches and small faults. In the southwestern part of the mapped area the bed contains a 3-inch clay parting near the top. It is underlain by medium-bedded sandstone, which grades downward into the coarse cobble and pebble conglomerate in the lower 200 feet of the Pottsville formation. The roof rock is generally sandstone or fine conglomerate. The No. 4 coal has been mined on the north limb of the Cameron basin in the southeastern part of the area, and in a few scattered independent mining operations on the south side of Mahanoy Mountain.

The four other coal beds in the Pottsville formation are designated, in ascending order, as beds *A*, *B*, *C*, and *D* because their correlation is uncertain. They are known to be local in extent and have been mined in many places by the miners in the tunnels and benches, where the coal is either too thin or too impure for profitable mining.

Coal beds in post-Pottsville rocks.—All of the 23 coal beds in the post-Pottsville, listed in the table are thought to be persistent except the Mammoth Middle Split (No. 8½), and the leader and local coal beds.

The Buck Mountain (No. 5) coal bed, at the base of the post-Pottsville rocks, is 150 to 200 feet above the Lykens Valley No. 4 coal bed. The quality of the coal is good, but in many places the bed includes several claystone or siltstone partings, which must be mined with the coal. The coal is underlain by conglomeratic sandstone or conglomerate in the northern part of the mapped area. The roof rock is carbonaceous shale. The coal has been strip-mined over much of its outcrop and has been extensively mined underground for several hundred feet from the outcrop (structure contour map, sheet 1).

The Seven-Foot (No. 6) coal bed is 25 to 90 feet above the Buck Mountain (No. 5) coal bed. The rocks in the interval between the two beds consist chiefly of sandstone and fine conglomerate. The Seven-Foot coal bed is overlain by carbonaceous shale which locally includes thin stringers of hard coal. It has been mined in the Cameron mine on the south flank of Big Mountain and in the Bear Valley and Bear Valley mines in the southern part of the field.

The Skidmore (No. 7) coal bed is about 100 feet above the Seven-Foot (No. 6) coal bed. Locally the Skidmore Leader (No. 7L) coal bed, which is generally thinner than the Skidmore coal bed and contains numerous small partings of bone and shale, is present about 40 feet below the Skidmore coal bed. The Skidmore coal bed has been most extensively mined along the north margin of the field.

The Mammoth coal zone, the most persistent of the coals in this area, generally consists of three coal beds, the Bottom Split (No. 8), Middle Split (No. 8½), and Top Split (No. 9). In addition to these principal beds, two leader coals, the Bottom Split Leader (No. 8L) about 25 feet below the Bottom Split, and the Top Split Leader (No. 9L) about 30 feet above the Top Split, occur locally in the Mammoth coal zone.

The Mammoth Bottom Split (No. 8) coal bed is 30 to 100 feet above the Skidmore (No. 7) coal bed. Generally claystone and siltstone 25 to 50 feet thick separate it from the overlying Mammoth Middle Split (No. 8½) coal bed; however, in the southeastern part of the area, this interval is so thin that it can nearly be recognized. There the coal is of considerable thickness and the two splits are mined as one bed. The floor of the Mammoth Bottom Split coal bed is carbonaceous claystone that in places contains many elliptical concretions of siltstone and iron carbonates.

The Mammoth Top Split (No. 9) coal bed is about 25 feet above the Mammoth Middle Split (No. 8½) coal bed; however, the interval is much less in some areas (as greater than 75 feet. The roof rock in some areas is claystone, siltstone, and fine-grained sandstone. In the mapped area the Middle Split and Top Split coal beds generally are thicker than the Bottom Split coal, but all three coal beds have been mined extensively along the north and south margins of the coal field for a considerable distance from the outcrop. Most of the Mammoth coal that was accessible at shallow depth has been mined out either on the surface or underground.

The Four-Foot (No. 9½) coal bed is 75 to 100 feet above the Mammoth Top Split (No. 9) coal. The intervening rocks are fine grained and lighter in color than the rocks below the Mammoth coal zone. The Four-Foot coal varies in thickness and includes numerous partings and benches of dirty coal. It has been mined in the northern, eastern, and southern part of the mapped area.

The Holmes (No. 10) coal bed is about 20 feet above the Four-Foot (No. 9½) coal bed. It is thicker than the Four-Foot bed and contains a relatively small amount (9.8 percent) of bone or shale partings, and is more extensively mined than the Four-Foot. The Holmes has been mined in the northern, eastern, and southern parts of the mapped area.

The Rough (No. 10½) coal bed, 60 to 140 feet above the Holmes (No. 10), and the Primrose (No. 11), about 100 feet above the Rough, are both mined extensively along the north and south margins of the coal field.

The coal beds numbered 12 through 20 overlying the Primrose (No. 11) coal bed are mined locally in the central part of the coal field. Most of these beds contain a high percentage of waste, and mining is restricted to shallow depths.

ADVICE TO MINERS

Coal beds are rarely exposed in natural outcrops because of the cover of soil. The outcrops shown on sheet 1 are in the position they would occupy if the coal were projected through the soil to the surface of the ground. These outcrops can be found with the bloom of the weathered coal which, because of soil creep, is generally found at a lower elevation than the outcrop. Exploration for coal should therefore start at the outcrop, shown on the coal bed outcrop map, and extend in the direction of the dip of the coal bed.

The outcrops of some coal beds have been projected on the map beyond the last known points of occurrence of the coal in order to show the estimated extent of these particular coal beds; however, the coal is not necessarily present in the indicated extent. Local or leader coal beds thinner than 14 inches are generally not shown on the coal bed outcrop map (sheet 1) and structural cross sections (sheet 2).

Mining can be impeded by (1) faults, called rock faults by miners, with displacements greater than the thickness of the offset coal bed; (2) small folds, called rolls that have sheared, thinned, or thickened the coal beds; (3) pinches—areas in which coal has been squeezed from between the roof and the floor rock; and (4) shear zones—areas in which the coal is so macerated or fractured by differential movement and extreme pressure that it cannot be mined profitably.

Direction of displacement along all faults in a given area is nearly always the same. Therefore, it would be advantageous for the miner trying to locate a fault-displaced coal bed to ascertain the characteristics of the faults in his area. This can be done by studying the fault pattern shown on the cross section (sheet 2) nearest to the workings in question.

Some of the faults shown on the cross sections are inferred. They are drawn on the basis of similarity to known faults and on the basis of surface observations, analysis of related structure, and interpretations of deformational history. Inferred faults shown in the unmined parts of the coal field are intended to suggest the direction and amount of displacement along faults that may be encountered in these areas.

Pinches and shear zones in the coal beds are, in many places, associated with faults that have relatively small displacements. Most of the shear zones are elongate, oblique to the axes of the folds, and show little or no apparent vertical displacement. They may represent transverse faults arrested in an early stage of development; however, some of the shear zones apparently have no regular orientation.

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Average thickness and range in thickness of coal beds in the western part of the Shamokin quadrangle

[. . . Indicates no data available; one measurement was available]

Coal bed Name	No.	Bed coal plus shale partings Avg	Bed coal plus shale partings Max	Bed coal plus shale partings Min	Coal Avg	Coal Max	Coal Min	Average percent age of waste
Post-Pottsville rocks								
Rabbit Hole	29	4.6	5.0	3.5				
Tunnel	28	5.5	11.5	3.0				
Local	27				4.5			
Sunset or Peach Mountain	26	6.2			6.2			
Little Tracy	25	4.6			4.6			
Tracy	24	5.5	8.0	3.0	4.1	7.5	2.5	21.3
Little Diamond	23	5.7	5.9	3.8	3.8	4.5	1.5	33.1
Diamond	22	5.7			2.5			
Little Orchard	21	7.9	7.9	3.9	4.1	5.6	2.5	21.1
Orchard	20	5.1	5.7	3.5	3.3	4.5	1.5	35.8
Primrose	19	6.6	10.2	2.5	6.1	10.0	2.5	7.6
Rough	18	5.2	6.0	1.5	5.1	5.9	1.5	2.0
Holmes	16	5.2	5.9	2.5	4.9	5.5	2.5	5.8
Four-foot	15	5.0	5.8	3.5	4.4	5.0	3.5	12.0
Mammoth Top Split Leader	14	7.5	11.6	3.0	3.7	6.0	1.0	50.7
Mammoth Top Split	9	8.3	15.5	1.2	7.8	15.0	1.2	6.0
Mammoth Middle Split	8½	5.7	12.0	2.0	5.5	12.0	2.0	3.5
Mammoth Bottom Split	8	5.7	12.9	2.7	4.3	12.4	2.2	15.0
Mammoth Bottom Split Leader	8L	4.0			4.0			
Skidmore	7	4.2	9.6	2.4	3.4	5.1	1.0	38.9
Skidmore Leader	7L	3.0	4.0	1.5	2.5	3.5	1.0	16.7
Seven-Foot	6	8.0	14.7	3.8	5.0	9.0	2.0	37.5
Buck Mountain Bottom Split	5	5.2	8.5	2.7	3.8	5.7	1.7	26.9
Post-Pottsville formation								
D		2.5			2.5			
C		3.0			3.0			
B					2.5			
A					2.5			
Lykens Valley No. 4		6.6	9.0	3.1	5.4	9.0	1.8	18.2

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GEOLOGY OF ANTHRACITE IN THE WESTERN PART OF THE SHAMOKIN QUADRANGLE, NORTHUMBERLAND COUNTY, PENNSYLVANIA

By
Harold H. Arndt, Walter Danilchik, and Gordon H. Wood, Jr.

1963

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