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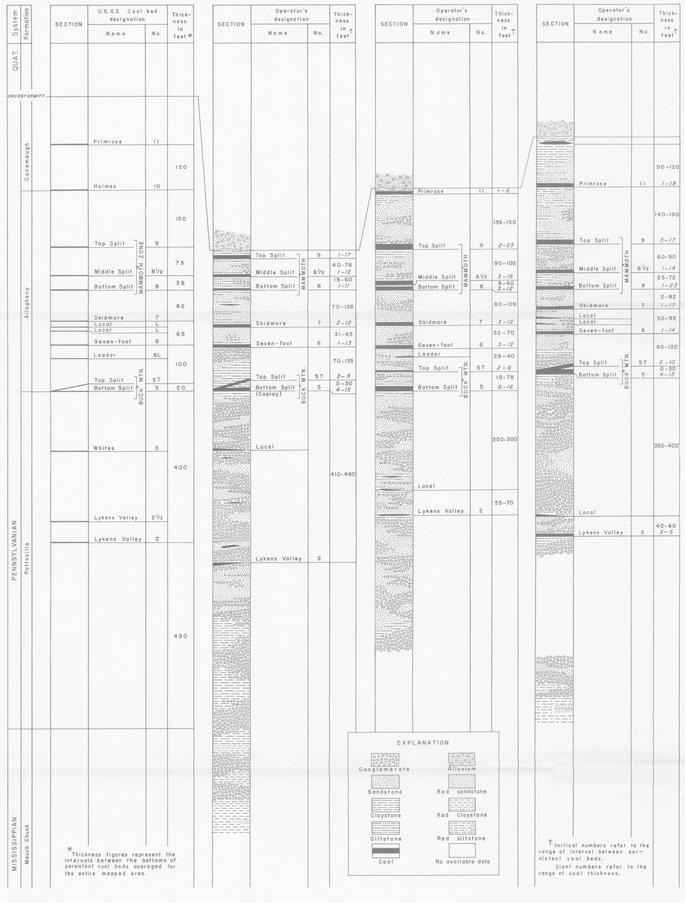


## COLUMNAR SECTIONS

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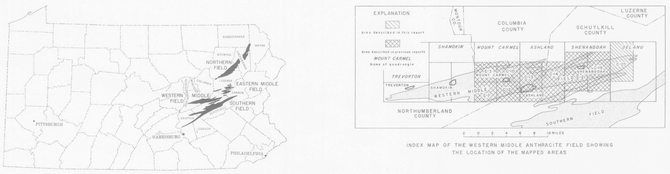
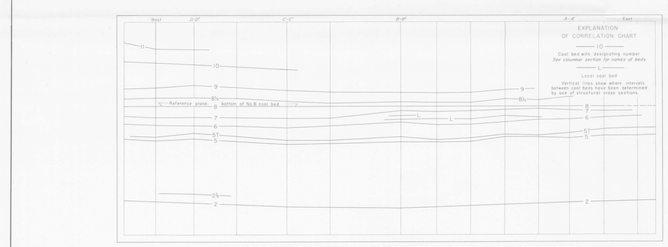



INDEX MAP OF PENNSYLVANIA SHOWING THE LOCATION OF THE ANTHRACITE FIELDS

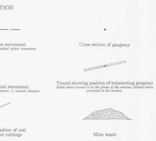


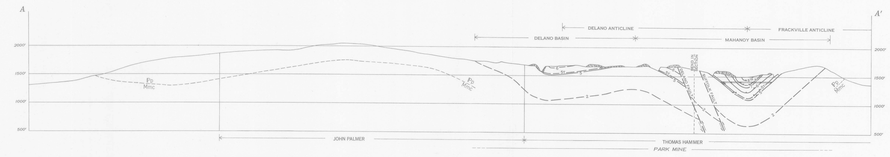

INDEX MAP OF THE WESTERN MIDDLE ANTHRACITE FIELD SHOWING THE LOCATION OF THE MAPPED AREAS

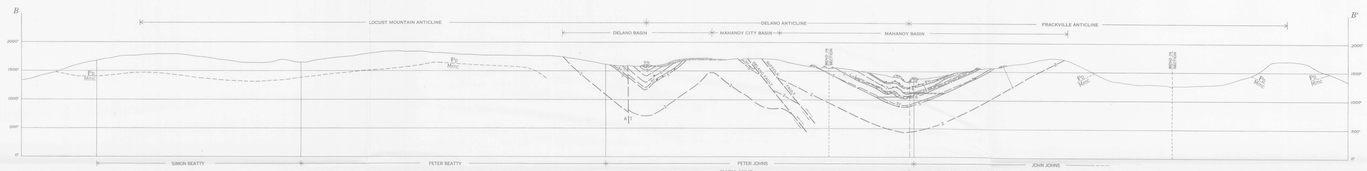


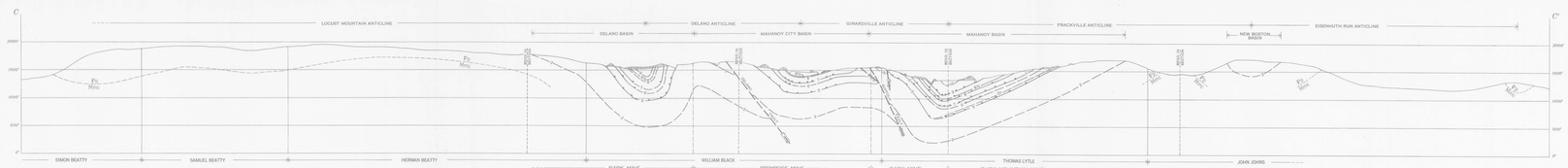

CORRELATION CHART SHOWING THE EAST-WEST LATERAL VARIATION IN THE INTERVALS BETWEEN COAL BEDS IN THE SOUTH LIMB OF THE MAHANOY BASIN

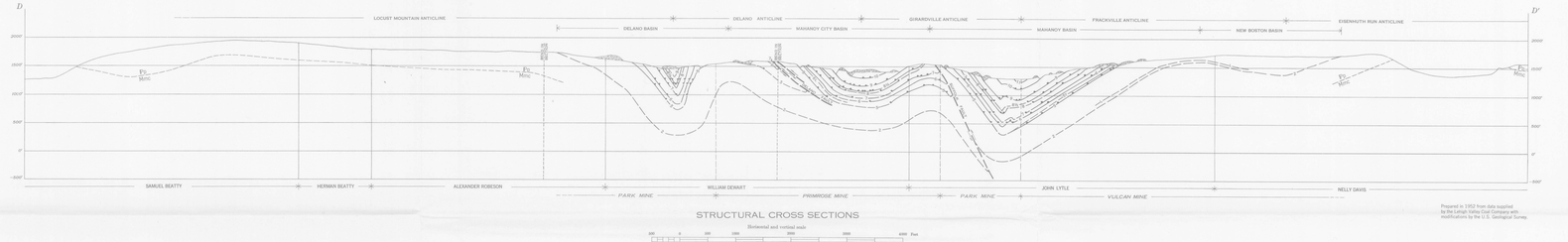
HORIZONTAL SCALE 1000 0 1000 2000 3000 FEET
VERTICAL SCALE 100 0 200 400 600 800 1000 FEET




## STRUCTURAL CROSS SECTIONS

Horizontal and vertical scale
1000 0 1000 2000 3000 4000 Feet
Datum is mean sea level

Prepared in 1952 from data supplied by the Lehigh Valley Coal Company with modifications by the U.S. Geological Survey.

# GEOLOGY OF ANTHRACITE IN THE WESTERN PART OF THE DELANO QUADRANGLE, PENNSYLVANIA

By
John A. Maxwell and Howard E. Rothrock

1955

## GEOLOGY OF ANTHRACITE IN THE WESTERN PART OF THE DELANO QUADRANGLE, PENNSYLVANIA

### INTRODUCTION

The Western Middle anthracite field is one of four structural basins in eastern Pennsylvania containing anthracite. This report describes the geology of the eastern end of the Western Middle field, which lies in the western part of the Delano quadrangle (see index map, sheet 2). The mapped area covers about 19 square miles in Schuylkill County, Pa. The town of Delano is in the east-central part of the area.

This is the ninth in a series of reports describing different parts of the Western Middle field. Previous reports, which have been prepared by several different authors, are listed under Literature cited; areas covered by these reports are shown on the index map of the Western Middle field, sheet 2.

This report has been prepared to aid in planning exploratory, developmental, 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 (sheet 1), (c) the natural and artificial barriers between mines and the structural relationships between the basins (sheets 1 and 2), (d) the stratigraphy and intervals between coal beds (sheet 2), and (e) the nonstructure of the coal beds.

Information presented in this report was obtained, in part, from data shown on mine maps, cross sections, drill logs, and other records made available by the Lehigh Valley Coal Co. The cooperation of this organization is appreciated.

Boyd R. Haley, Harold H. Arndt, Holly C. Wagner, Walter Danilchik, and Thomas M. Kehn, of the U. S. Geological Survey, aided in the field mapping of this area and the preparation of this report.

### STRATIGRAPHY

Rocks of late Paleozoic and Cenozoic ages crop out in the mapped area. The rocks of late Paleozoic age here comprise the Mississippian Mauch Chunk formation and the Pennsylvanian Pottsville, Allegheny, and Conemaugh formations. The Cenozoic rocks are assigned to the Quaternary system and consist of unconsolidated stream deposits that are composed of clay, silt, sand, and gravel; talus deposits that occur at the bases of the steeper mountain slopes; and deposits of stream-transported mine waste that include varying quantities of detrital coal. These deposits of mine-transported mine waste are in many localities the sites of valuable accumulations of detrital coal, and those large enough to be economically important are therefore shown on the outcrop map (sheet 1).

### MISSISSIPPIAN ROCKS

The Mauch Chunk formation crops out in the northern part of the mapped area on the north flank of Locust Mountain and in the valley occupied by Messers Run. In the southern part of the area the formation crops out on the crests of Frackville and Eisenhuth Run anticlines in the valleys occupied by Hosensack and Codorus Creeks, respectively. Approximately 1,500 feet of the upper part of the formation is exposed in the mapped area.

The strata that comprise the Mauch Chunk formation consist mainly of red claystone, shale, siltstone, and fine-grained sandstone; but green siltstone and fine-grained sandstone, red or green medium- to coarse-grained sandstone, and scattered lenses of gray or green conglomerate are also present. Some of the beds locally appear to be lenticular. The contact between the Mauch Chunk formation and the overlying Pottsville formation is gradational, and is mapped at that horizon below which the beds are predominantly red and above which they are predominantly gray, green, or brown.

### PENNSYLVANIAN ROCKS

Rocks of Pennsylvanian age consist of lenticular beds of conglomerate, sandstone, siltstone, claystone, and shale interbedded with nine persistent coal beds and several local coal beds. The lower part of the Pennsylvanian in the mapped area is predominantly conglomeratic, and the upper part is chiefly fine grained. The coal beds probably are the most persistent lithologic unit.

*Pottsville formation.*—The Pottsville formation, which comprises the oldest Pennsylvanian rocks in the area, overlies the Mauch Chunk formation and underlies the Allegheny formation. It consists mainly of resistant conglomerate and sandstone, which form all of the mountain as well as most of the major ridges in the mapped area. The formation is approximately 900 feet thick over the entire area.

The lower 100 feet of the Pottsville formation is composed of beds of gray conglomerate, gray, green, brown, and red sandstone and siltstone, and scattered lenses of gray or red claystone. The rest of the formation consists mainly of gray conglomerate, conglomeratic sandstone, coarse- to fine-grained sandstone, and scattered lenses of siltstone and claystone. The Lykens Valley (No. 2 and No. 2-½) coal beds are near the middle of the formation.

*Allegheny formation.*—The Allegheny formation, at the base of which is the Buck Mountain (No. 5) coal bed (White, 1900, p. 824), overlies the Pottsville formation and underlies the Conemaugh formation. The formation maintains a uniform thickness of approximately 500 feet throughout the mapped area. It is composed of conglomerate, sandstone, siltstone, claystone, and coal. In general, beds of conglomerate and sandstone are more abundant in the lower part of the formation than in the upper part.

The Allegheny formation is the source of most of the coal mined in the mapped area. Six persistent coal beds—the Buck Mountain (No. 5) Seven-foot (No. 6), Skidmore (No. 7), and three beds in the Mammoth zone (No. 8, No. 8-½, and No. 9)—are present in the Allegheny formation. The Buck Mountain and the three Mammoth coal beds are mined more extensively than other coals of the area.

*Conemaugh formation.*—The Conemaugh formation, at the base of which is the Holmes (No. 10) coal bed (Lohman, 1937, p. 46), overlies the Allegheny formation. Erosion has removed all of the formation in the northern part of the mapped area, but about 200 feet of the Conemaugh remains in the Mahanoy basin in the western part of the area. The formation is composed of gray or brown sandstone, siltstone, claystone, scattered lenses of conglomerate, and coal.

Two coal beds of economic importance are present in the portion of the Conemaugh that is exposed in the mapped area. These are the Holmes (No. 10) and Primrose (No. 11) coal beds.

### STRUCTURE

The anthracite fields of Pennsylvania are northeast-trending composite synclines that 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, one of the larger of these composite synclines, is about 36 miles long and attains a width of about 5 miles. This field consists of several overlapping anticlinal and synclinal folds, some of which have been broken by longitudinal thrust faults that trend northeast, usually subparallel to the axes of the folds. The component anticlines and synclines are best developed along the southern margin of the field, where they range from 10 to 20 miles in length. In contrast, flexures in the northern part of the field are generally only a few miles long.

The principal synclines that contain coal and some limbs of such synclines that are truncated by thrust faults are called basins by the miners, a practice that is followed in this report.

The structure contour map (sheet 1) shows the structure of the Buck Mountain (No. 5) coal bed by contour lines drawn at 100-foot intervals on the bottom of the coal bed. The structure contour map was compiled chiefly from data plotted from coal company mine maps. In those areas where the Buck Mountain coal bed is not known to have been mined the structure contours are shown as dashed lines.

### FOLDS

From north to south the major folds of the Western Middle anthracite field within the map area are the Delano, Mahanoy City, Mahanoy, and New Boston basins or synclines, and the Delano, Girardville, and Frackville anticlines.

These major folds trend N. 55°-80° E., and the dips of their axial planes range from 70° N. to 55° S. The folds are asymmetric and their limbs subtend angles ranging from 60° to 140°. The axes of the folds plunge to the southwest in the western part of the Delano quadrangle. The basins become shallower and the anticlines more prominent toward the eastern end of the Western Middle anthracite field.

The Delano syncline, the northernmost coal basin, is a relatively narrow flexure that trends east-northeast across the area to the eastern end of the field. The fold is asymmetric, having a steeply dipping southern limb and a moderately dipping northern limb. The Delano anticline, which closely parallels the Delano syncline on the south, also extends across the area.

The Mahanoy City basin or syncline, which is separated from the Delano syncline by the Delano anticline, is subparallel to both of these folds. The dips of the limbs of the Mahanoy City syncline generally are 50° or less. The syncline is almost completely truncated near the central part of the mapped area by the east-northeast-trending Suffolk thrust fault. On the south the Mahanoy City syncline is flanked by the Girardville anticline. In the eastern part of the map area the southern limb of the Girardville anticline is broken near the crest by the Suffolk thrust fault. The subsurface extensions of the Mahanoy City syncline and Girardville anticline are believed to die out eastward beneath the plate of the Suffolk fault.

The southernmost major syncline in the mapped area is the Mahanoy basin. This is one of the larger and more continuous synclines in the Western Middle field. It extends eastward from the central part of the field to a point a little beyond the eastern limit of the mapped area. The dips along the limbs of the syncline range between 25° and 50°.

The Frackville anticline, which separates the Mahanoy and New Boston synclines, also trends east-northeast across the area. It trends subparallel to the Mahanoy basin and is probably the major structural feature separating the Western Middle and Southern anthracite fields. Although coal beds locally are mined across the top of the anticline, it is in a regional sense the major anticlinal feature of this part of Pennsylvania. The New Boston basin or syncline, which lies to the south of the Frackville anticline, extends into the southwestern part of the map area. The Eisenhuth Run anticline flanks the New Boston syncline on the south. It extends across the southern part of the area, and it is the only anticline over which the coal-bearing strata of the Western Middle and Southern anthracite fields are not connected.

### FAULTS

The principal faults in the area, the Delano and Suffolk faults, are thrust faults that generally parallel the axes of the folds and are the result of compression. The Delano fault trends east-northeast across the central part of the area. In the western part of the area it fractures the southern flank of the Delano anticline. Near the eastern border of the map area it joins the Suffolk fault. The Delano fault dips southeastward at angles of 35° to 60°. The stratigraphic displacement in most places is less than 200 feet; however, the actual amount of movement is not known.

The Suffolk fault trends east-northeast in the western part of the map area, breaking the southern limb of the Girardville anticline near the crest of the fold. Near the central part of the area the strike of the fault changes to north-northeast and the fault truncates the Girardville anticline and the south limb of the Mahanoy City syncline. The strike of the fault then swings back to its original east-northeast direction and from this point the fault displaces beds on the southern flank of the Delano anticline. Near the eastern edge of the mapped area the Suffolk and Delano faults join. East of the junction the Suffolk fault continues to strike east-northeast. The fault dips south-southeast in the western part of the map area, east-southeast in the central part, and south-southeast in the eastern part of the area. In general, the dip does not exceed 65°. The stratigraphic displacement in most localities is about 250 feet. The actual movement and displacement, however, are not known.

A tear fault in the vicinity of Park Place offsets the north limb of the Delano syncline. This tear fault and other transverse or oblique faults in the area have relatively small displacements that range from a few feet to a few tens of feet and are in many places associated with shear zones in the coal beds. Most of the shear zones are elongate, oblique to the axes of the folds, have little or no apparent vertical displacement, and are thought to represent transverse faults in an early stage of development. Other shear zones apparently have no regular orientation.

Mining is adversely affected by (1) faults with displacements greater than the thickness of the respective coal bed, called "rock faults" by miners; (2) areas in which the coal has been squeezed from between the roof and floor rock, called "pinches"; (3) small folds that have sheared, thinned, or thickened the coal, called "rolls"; 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.

A fault may increase or decrease the thickness of the coal bed by thrusting or dragging one part of the bed over another. In some places the thickness of the coal is decreased by squeezing as a result of differential movement of the floor and roof rocks.

### COAL BEDS

In the Western Middle anthracite field it has been a practice of the mining companies to designate a coal bed by a number, a name, or both. No attempt has been made prior to this series of reports to standardize the nomenclature between the different mines because (1) coal beds in isolated mines were named before they could be correlated, (2) gaps exist between adjoining workings, (3) both the structure and the lithology are complex, (4) outcrops are scarce, and(5) it is difficult to change established mining records.

The names of the coal beds used in this report conform with the nomenclature used by the authors in previous reports. These names do not agree in some cases with those used in the Second Geological Survey of Pennsylvania (Ashburner, 1883, p. 84-88), and they do not agree in some cases with the nomenclature used by the mining companies in the mapped area.

In this report a coal bed is described as persistent, nonpersistent, local, or as a leader. A persistent coal bed can be traced laterally throughout a basin and can be correlated with a bed in the same stratigraphic position in adjoining basins in the Western Middle field. A nonpersistent coal bed is recognized and correlated in several of the basins, but it is not continuous. A local coal bed cannot be correlated across a basin or between adjoining basins, and generally cannot be traced for more than 3 or 4 miles. A leader coal bed is present in only a small area, and where first named was so near a well-known or economically important coal bed that it served as a guide or marker for that bed. It may or may not merge into the persistent coal bed and may be separated in some places from the persistent bed by a stratigraphic interval of as much as 40 feet.

Coal beds are rarely exposed in natural outcrops, owing to the cover of soil. The outcrops as shown on sheet 1 are in the position that they would occupy if the coal were projected through the soil to the surface of the ground. These positions may not agree with the blooms of weathered coal which, because of soil creep, are generally found lower on the slope than the original outcrop. Explorations for coal outcrops should start where beds are shown on the map and be extended in the direction of the dip of the coal.

It was necessary to project some coal beds beyond their last known points of occurrence. This has been done to show the authors' estimate of the extent of that particular coal bed and does not mean that the coal is of minable thickness throughout its indicated extent. Local or leader coal beds less than 18 inches thick were not mapped.

### THICKNESS OF COAL BEDS

Listed below are the average thicknesses and range in thicknesses of coal beds in the area covered by this report. Figures on the right side of the table show thickness of all coal in each bed; figures on the left side of the table show total thickness of all coal and all shale partings in each bed.

Most of the coal and bed thicknesses were obtained from mine company data and were chosen to show an average of many underground observations. Measurements that may have been abnormally affected by deformation were not recorded. The maximum and minimum thicknesses shown in this table and in the columnar sections (sheet 2) are from all observed measurements along tunnels, mined coal measurements, drill cores, or sections measured by U. S. Geological Survey personnel. Thickness figures have been omitted from the table where few reliable data are available.

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

| Bed number | Thicknesses | | | | | | | | Percentage of refuse |
|---|---|---|---|---|---|---|---|---|---|
| | Bed | | | | Coal | | | | |
| | Average | Range | | | Average | Range | | | |
| | Ft In | Ft In | | Ft In | Ft In | Ft In | | Ft In | |
| 11 | No data available | | | | | | | | |
| 10 | 7 5 | 1 7 | 10 | 0 | 5 11 | 0 | 2 13 | 0 | 20.2 |
| 9 | 10 1 | 1 0 | 22 | 6 | 8 7 | 1 | 0 20 | 0 | 14.9 |
| 8½ | 5 2 | 1 2 | 15 | 5 | 4 4 | 0 | 6 12 | 11 | 16.1 |
| 8 | 5 7 | 0 7 | 22 | 6 | 4 8 | 0 | 6 19 | 10 | 16.4 |
| 7 | 5 11 | 1 0 | 16 | 7 | 4 11 | 1 | 0 12 | 0 | 16.9 |
| L | No data available | | | | | | | | |
| L | No data available | | | | | | | | |
| 6 | 4 4 | 1 2 | 14 | 2 | 3 6 | 1 | 2 12 | 0 | 19.2 |
| 5T | 5 5 | 1 6 | 10 | 1 | 4 7 | 1 | 6 9 | 0 | 15.4 |
| 5 | 11 0 | 4 1 | 25 | 0 | 8 9 | 3 | 0 14 | 7 | 20.4 |
| 3 | No data available | | | | | | | | |
| 2½ | No data available | | | | | | | | |
| 2 | 4 6 | 3 10 | 5 | 2 | 2 2 | 0 | 8 3 | 8 | 51.8 |

### COAL BEDS MINED IN THE AREA

There are nine coal beds that are mined in the mapped area; these are, in ascending order, the Lykens Valley (No. 2), Buck Mountain Bottom Split (No. 5), Buck Mountain Top Split (No. 5T), Seven-foot (No. 6), Skidmore (No. 7), Mammoth Bottom Split (No. 8), Mammoth Middle Split (No. 8-½), Mammoth Top Split (No. 9), and the Holmes (No. 10). Of these the two splits of the Buck Mountain coal and the three splits in the Mammoth coal zone are most extensively mined.

The Lykens Valley No. 2 coal bed is near the middle of the Pottsville formation. There has been little mining of the No. 2 coal in the mapped area. The coal constitutes only 50 percent of the total thickness of the bed in some areas, and generally the bed in the principal synclines is at depths unfavorable for mining. The minable coal ranges in thickness from a few inches to almost 4 feet.

The Buck Mountain coal bed, considered to be the basal bed of the Allegheny formation, overlies the resistant rocks of the Pottsville formation and underlies the less resistant rocks of the Allegheny formation. The resultant topographic bench generally identifies and is an aid in locating the Buck Mountain coal bed. Two splits of the Buck Mountain coal are present in this area; they are known as the Bottom Split (No. 5) and the Top Split (No. 5T). The rock between these two splits is carbonaceous claystone or siltstone containing scattered lenses of sandstone, conglomeratic sandstone, and conglomerate. The maximum interval between the splits is 80 feet in the Mahanoy City basin. The Buck Mountain coal is mined extensively, and both splits can be seen in the faces of the many strip pits in the area.

The Seven-foot (No. 6) and Skidmore (No. 7) coal beds are present in the lower part of the Allegheny formation. They are about 120 feet and 185 feet, respectively, above the base of the Allegheny. Both beds are mined in the area. The average thickness of the Seven-foot coal bed in mined areas is 4 feet 4 inches, of which 3 feet 6 inches is coal. The Skidmore coal bed averages 5 feet 11 inches, of which 4 feet 11 inches is coal.

The Mammoth coal zone is economically the most important group of coals in the Allegheny formation. In the mapped area the Mammoth zone is composed of the Bottom Split (No. 8), Middle Split (No. 8-½), and Top Split (No. 9). The Top Split may occur more than 100 feet above the Bottom Split; the stratigraphic interval between the Bottom Split and the Middle Split ranges from 9 to 72 feet. All the coal beds in the Mammoth zone are mined extensively in this area and are characterized by a rather low percentage (about 16 percent) of refuse.

In the mapped area all of the coals of the Conemaugh formation, except the Holmes (No. 10) coal bed and the Primrose (No. 11) coal bed, have been removed by erosion, and only the Holmes coal has been mined. The Holmes coal bed is present in the southwestern part of the area in the Mahanoy City and Mahanoy basins. The coal bed ranges in thickness from about 2 feet to 19 feet in this area.

### LITERATURE CITED

Ashburner, C. A., 1883, First report of progress in the anthracite coal region: Pennsylvania 2d Geol. Survey Rept. AA, 407 p.

Danilchik, Walter, Rothrock, H. E., and Wagner, H. C., 1955, Geology of anthracite in the western part of the Shenandoah quadrangle, Pa.: U. S. Geol. Survey Coal Inv. Map C 21.

Haley, B. R., Arndt, H. H., Rothrock, H. E., and Wagner, H. C., 1953, Geology of anthracite in the western part of the Ashland quadrangle, Pa.: U. S. Geol. Survey Coal Inv. Map C 13.

Haley, B. R., Arndt, H. H., Rothrock, H. E., and Wagner, H. C., 1954, Geology of anthracite in the eastern part of the Ashland quadrangle, Pa.: U. S. Geol. Survey Coal Inv. Map C 14.

Kehn, T. M., and Wagner, H. C., 1955, Geology of anthracite in the eastern part of the Shenandoah quadrangle, Pa.: U. S. Geol. Survey Coal Inv. Map C 19.

Lohman, S. W., 1937, Ground water in northeastern Pennsylvania: Pennsylvania Topog. and Geol. Survey Bull. W-4, 312 p.

Rothrock, H. E., Wagner, H. C., and Haley, B. R., 1950, Geology of anthracite in the west-central part of the Mount Carmel quadrangle, Pa.: U. S. Geol. Survey Coal Inv. Map C 5.

Rothrock, H. E., Wagner, H. C., Haley, B. R., and Arndt, H. H., 1951, Geology of anthracite in the southwestern part of the Mount Carmel quadrangle, Pa.: U. S. Geol. Survey Coal Inv. Map C 7.

Rothrock, H. E., Wagner, H. C., Haley, B. R., and Arndt, H. H., 1951, Geology of anthracite in the east-central part of the Mount Carmel quadrangle, Pa.: U. S. Geol. Survey Coal Inv. Map C 10.

Rothrock, H. E., Wagner, H. C., Haley, B. R., and Arndt, H. H., 1953, Geology of anthracite in the southeastern part of the Mount Carmel quadrangle, Pa.: U. S. Geol. Survey Coal Inv. Map C 12.

White, David, 1900, The stratigraphic succession of the fossil floras of the Pottsville formation in the southern anthracite coal field, Pennsylvania: U. S. Geol. Survey 20th Ann. Rept., Part 2 (1898-99), p. 749-930.

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