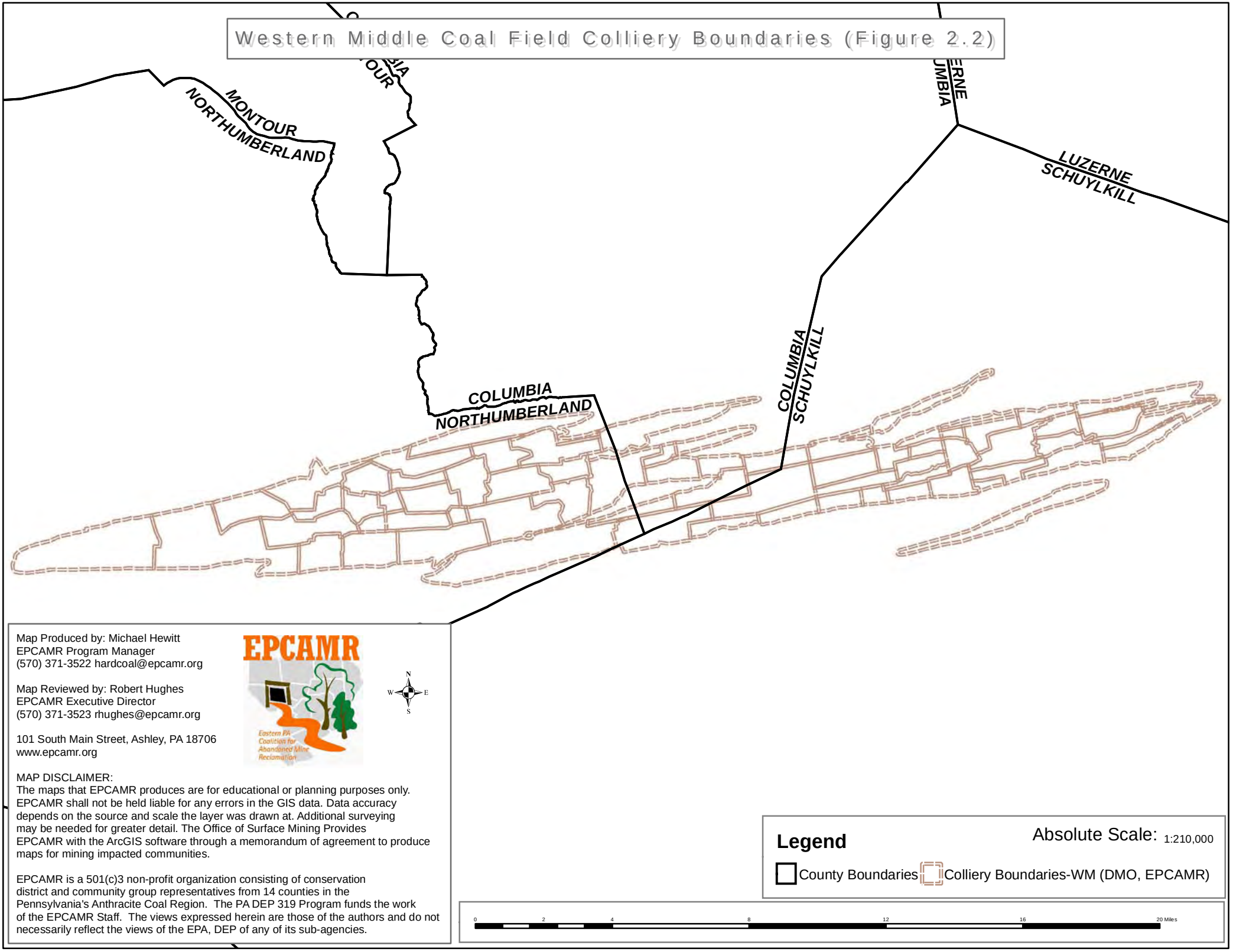
Western Middle Coal Field Colliery Boundaries (Figure 2.2)



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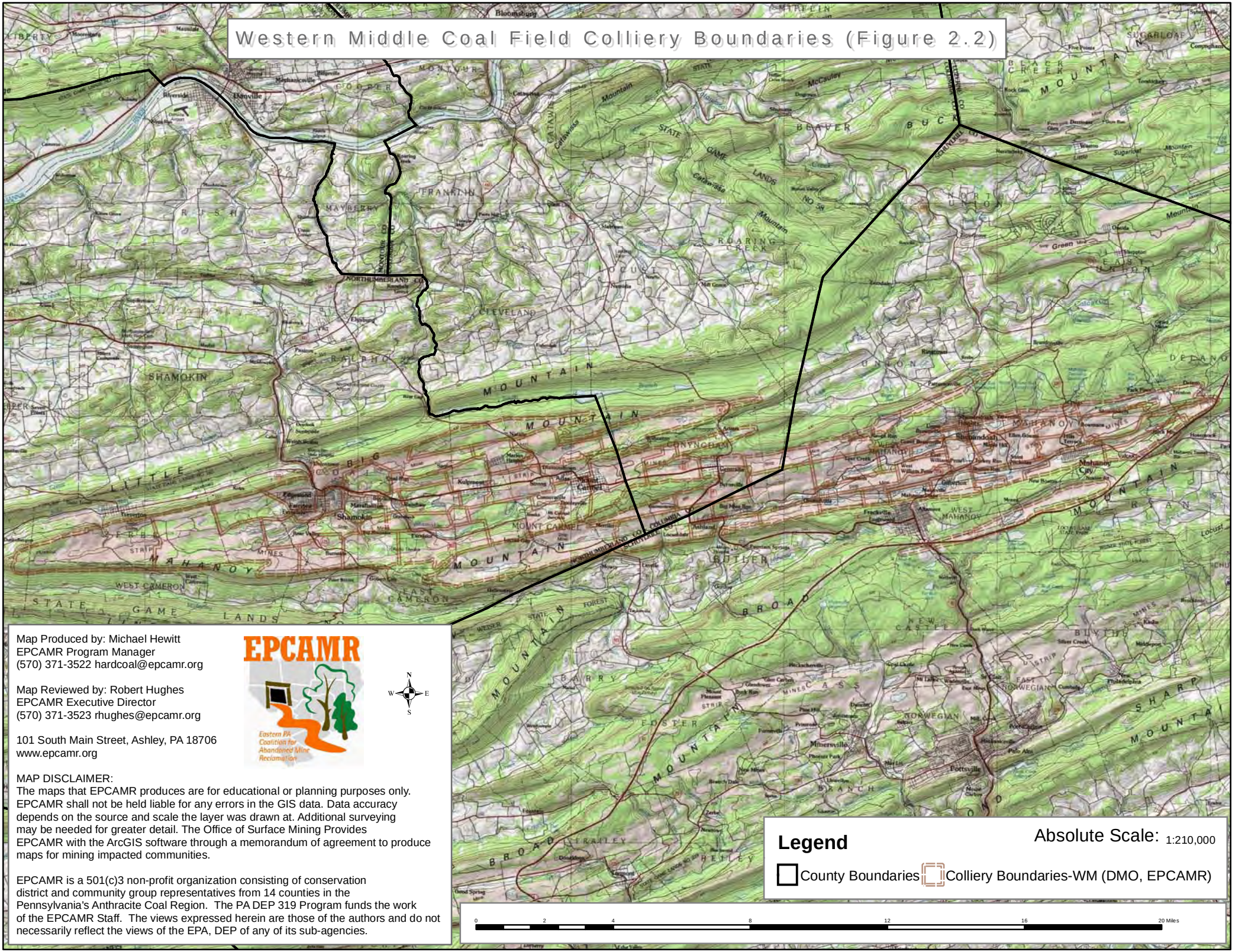
Legend

Absolute Scale: 1:210,000

County Boundaries
Colliery Boundaries-WM (DMO, EPCAMR)

0 2 4 8 12 16 20 Miles

Western Middle Coal Field Colliery Boundaries (Figure 2.2)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Nanticoke
Hanover
Wilkes-Barre
Pittston
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Shamokin
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Coaldale
Jim Thorpe
Stockton
Weatherly
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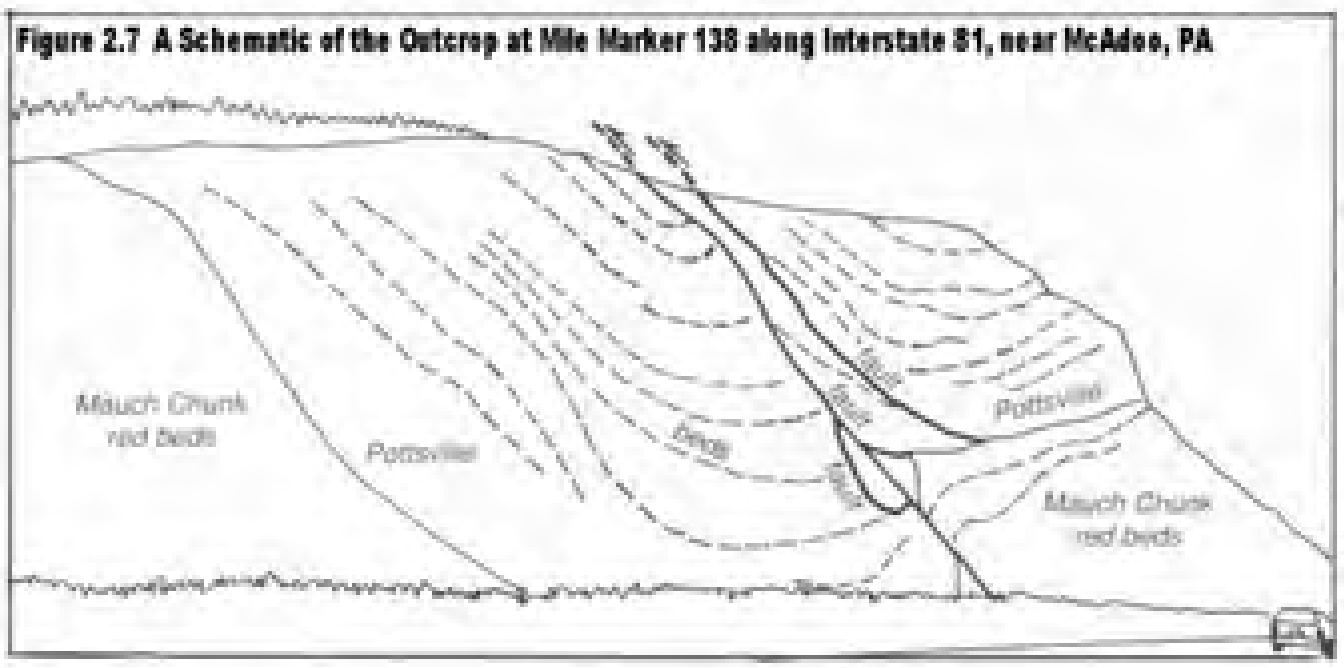
Figure 2.7 A Schematic of the Outcrop at Mile Marker 138 along Interstate 81, near McAdoo, PA



The enormous Spring Mountain cut at mile 138 of I-81 exposes a faulted syncline in Pennsylvanian Pottsville sandstones and conglomerates, above Mississippian Mauch Chunk redbeds.

DEPARTMENT OF THE INTERIOR
UNITED STATES GEOLOGICAL SURVEY

MISCELLANEOUS GEOLOGICAL INVESTIGATIONS
MAP I-528 (SHEET 1 OF 6)

Base from U.S. Geological Survey 1:24,000, 1955

Northern half of the Minersville quadrangle and part of the northern half of the Tremont quadrangle

See sheet 2 for geologic explanation and index and sheet 5 for structure sections A-A'—H-H'

GEOLOGIC MAPS OF ANTHRACITE-BEARING ROCKS IN THE WEST-CENTRAL PART OF THE SOUTHERN ANTHRACITE FIELD, PENNSYLVANIA, EASTERN AREA

By

Gordon H. Wood, Jr., J. Peter Trexler, and Thomas M. Kehn

SCALE 1:12 000

CONTOUR INTERVAL 20 FEET
DATUM IS MEAN SEA LEVEL

1968

Geology by Gordon H. Wood, Jr., J. Peter Trexler, Andy Yelenosky, and Julian Soren, 1953–58

DONALDSON SYNCLINE
BRANCHDALE ANTICLINE

For sale by U. S. Geological Survey, price $2.50 per set

DEPARTMENT OF THE INTERIOR
UNITED STATES GEOLOGICAL SURVEY

MISCELLANEOUS GEOLOGICAL INVESTIGATIONS
MAP I-528 (SHEET 2 OF 6)

Southern half of the Minersville quadrangle and part of the northern half of the Swatara Hill quadrangle

See sheet 5 for structure sections B''–B'''–F''–F''' and G''–G'''–H''–H'''

GEOLOGIC MAPS OF ANTHRACITE-BEARING ROCKS IN THE WEST-CENTRAL PART OF THE SOUTHERN ANTHRACITE FIELD, PENNSYLVANIA, EASTERN AREA

By

Gordon H. Wood, Jr., J. Peter Trexler, and Thomas M. Kehn

SCALE 1:12 000

½ 0 ½ 1 MILE

.5 0 .5 1 KILOMETER

CONTOUR INTERVAL 20 FEET
DATUM IS MEAN SEA LEVEL

1968

Base from U.S. Geological Survey
1:24,000, 1955

APPROXIMATE MEAN DECLINATION, 1968

PENNSYLVANIA

LOCATION OF THIS REPORT

EXPLANATION

Qt	Talus		QUATERNARY
	UNCONFORMITY		
Middle and Upper Pennsylvanian	Pl	Llewellyn Formation	PENNSYLVANIAN
Middle Pennsylvanian	Pps	Pottsville Formation Pps, *Sharp Mountain Member* Ppc, *Schuylkill Member* Ppt, *Tumbling Run Member*	
Lower Pennsylvanian	Ppc		
	Ppt		
Upper Mississippian and Lower Pennsylvanian	PMm	Mauch Chunk Formation	MISSISSIPPIAN AND PENNSYLVANIAN

CARBONIFEROUS

LINE SYMBOLS FOR MAPS

Geologic features such as coal beds, contacts, faults, and fold lines whose traces are shown on the coal maps are classified according to the accuracy of location and the relative certainty of existence.

The traces of geologic features are shown by solid lines where accurately located, by long dashes where approximately located, and by short dashes where indefinitely located. The traces of geologic features, if concealed by an overlying mapped geologic unit, are shown by sequences of four dots where approximately located, and by sequences of two dots where indefinitely located.

The existence of geologic features in some localities is uncertain to varying degrees because of cover and heavy vegetation. They are classified as probable if there is little uncertainty and as doubtful or inferred if there is considerable uncertainty or if an alternate interpretation is possible. The traces of geologic features are shown by sequences of long dashes separated by queries where probable and by sequences of short dashes separated by queries where doubtful or inferred. The traces of geologic features, if concealed by an overlying mapped geologic unit, are shown by sequences of four dots separated by queries where probable.

Coal bed

Solid where accurately located by underground mining. Solid with hachures where accurately located from strip mining: hachures on one side indicate direction of dip of bed; on both sides, vertical bed. Number designates coal bed; L, leader coal bed; R, rider coal bed; T, top split; B, bottom split; LV, Lykens Valley

Contact

Fault, showing relative horizontal movement

Reverse fault

R, *upthrown side. Angle of dip interpreted to be greater than 45° at time of faulting*

Thrust fault, showing dip

T, *upper plate. Angle of dip interpreted to be less than 45° at time of faulting*

Underthrust fault

UT, *underthrust plate. Angle of dip interpreted to be less than 45° at time of faulting*

Anticline
Showing trace of crestline

Geology mapped in 1953–60

Syncline
Showing trace of troughline

Overturned anticline
Showing trace of crestline

Overturned syncline
Showing trace of troughline

LINE SYMBOLS FOR CROSS SECTIONS

Unmined coal bed

Mined coal bed

Contact

Thrust fault

Underthrust fault

Reverse fault

Horizontal movement on fault
T, *towards observer;* A, *away from observer*

Shaft

Tunnel

Slope

Trench

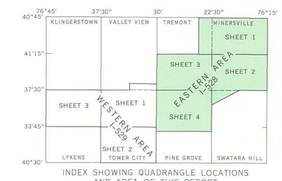
Trench
Tick marks place coal found

Prospect

Prospect, coal found

Sand or gravel pit

Drill hole



INDEX SHOWING QUADRANGLE LOCATIONS AND AREA OF THIS REPORT

INTERIOR—GEOLOGICAL SURVEY, WASHINGTON, D.C.—1968—667350

DEPARTMENT OF THE INTERIOR
UNITED STATES GEOLOGICAL SURVEY

MISCELLANEOUS GEOLOGICAL INVESTIGATIONS
MAP I-528 (SHEET 3 OF 6)

Base from U.S. Geological Survey
1:24,000, 1954

Southern half of the Tremont quadrangle

See sheet 2 for geologic explanation and index, sheet 5 for structure sections G'-G''—H'-H'' and sheet 6 for I-I'—O-O'

GEOLOGIC MAPS OF ANTHRACITE-BEARING ROCKS IN THE WEST-CENTRAL PART OF THE SOUTHERN ANTHRACITE FIELD, PENNSYLVANIA, EASTERN AREA

By

Gordon H. Wood, Jr., J. Peter Trexler, and Thomas M. Kehn

SCALE 1:12 000

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CONTOUR INTERVAL 20 FEET
DATUM IS MEAN SEA LEVEL

1968

Geology by Gordon H. Wood, Jr., J. Peter Trexler, Andy Yelenosky, Thomas M. Kehn, and Julian Soren, 1953–60

INTERIOR—GEOLOGICAL SURVEY, WASHINGTON, D.C.—1968—G67350

DEPARTMENT OF THE INTERIOR
UNITED STATES GEOLOGICAL SURVEY

MISCELLANEOUS GEOLOGICAL INVESTIGATIONS
MAP I-528 (SHEET 4 OF 6)

George R. Stuebing
Dept. Environmental Resources
108 S. Claude A. Lord Blvd.
Pottsville, PA
17901

Northern half and part of the southern half of the Pine Grove quadrangle

See sheet 2 for geologic explanation and index, and sheet 6 for structure sections *I-I'*–*O-O'* and *P-P'*

GEOLOGIC MAPS OF ANTHRACITE-BEARING ROCKS IN THE WEST-CENTRAL PART OF THE SOUTHERN ANTHRACITE FIELD, PENNSYLVANIA, EASTERN AREA

By

Gordon H. Wood, Jr., J. Peter Trexler, and Thomas M. Kehn

SCALE 1:12 000

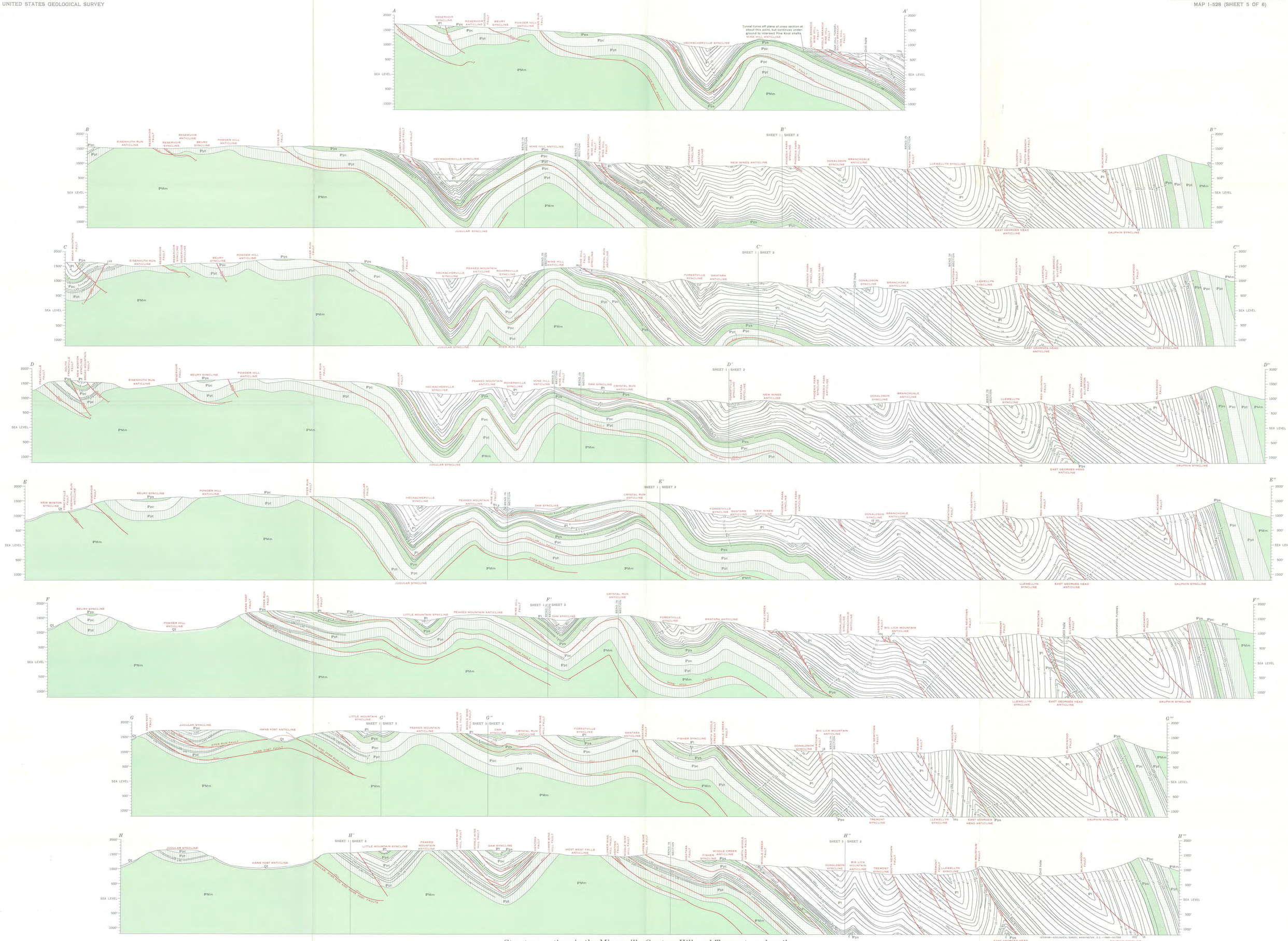
CONTOUR INTERVAL 20 FEET
DATUM IS MEAN SEA LEVEL

1968

Base from U.S. Geological Survey
1:24,000, 1954

Geology by Gordon H. Wood, Jr.,
and Thomas M. Kehn, 1954–59

INTERIOR—GEOLOGICAL SURVEY, WASHINGTON, D.C.—1968—G61350



Structure sections in the Minersville, Swatara Hill, and Tremont quadrangles

See sheet 2 for geologic explanation and index, and sheet 6 for structure sections *I–I'—O–O'* and *P–P'*

GEOLOGIC MAPS OF ANTHRACITE-BEARING ROCKS IN THE WEST-CENTRAL PART OF THE SOUTHERN ANTHRACITE FIELD, PENNSYLVANIA, EASTERN AREA

By

Gordon H. Wood, Jr., J. Peter Trexler, and Thomas M. Kehn

SCALE 1:12 000

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DATUM IS MEAN SEA LEVEL

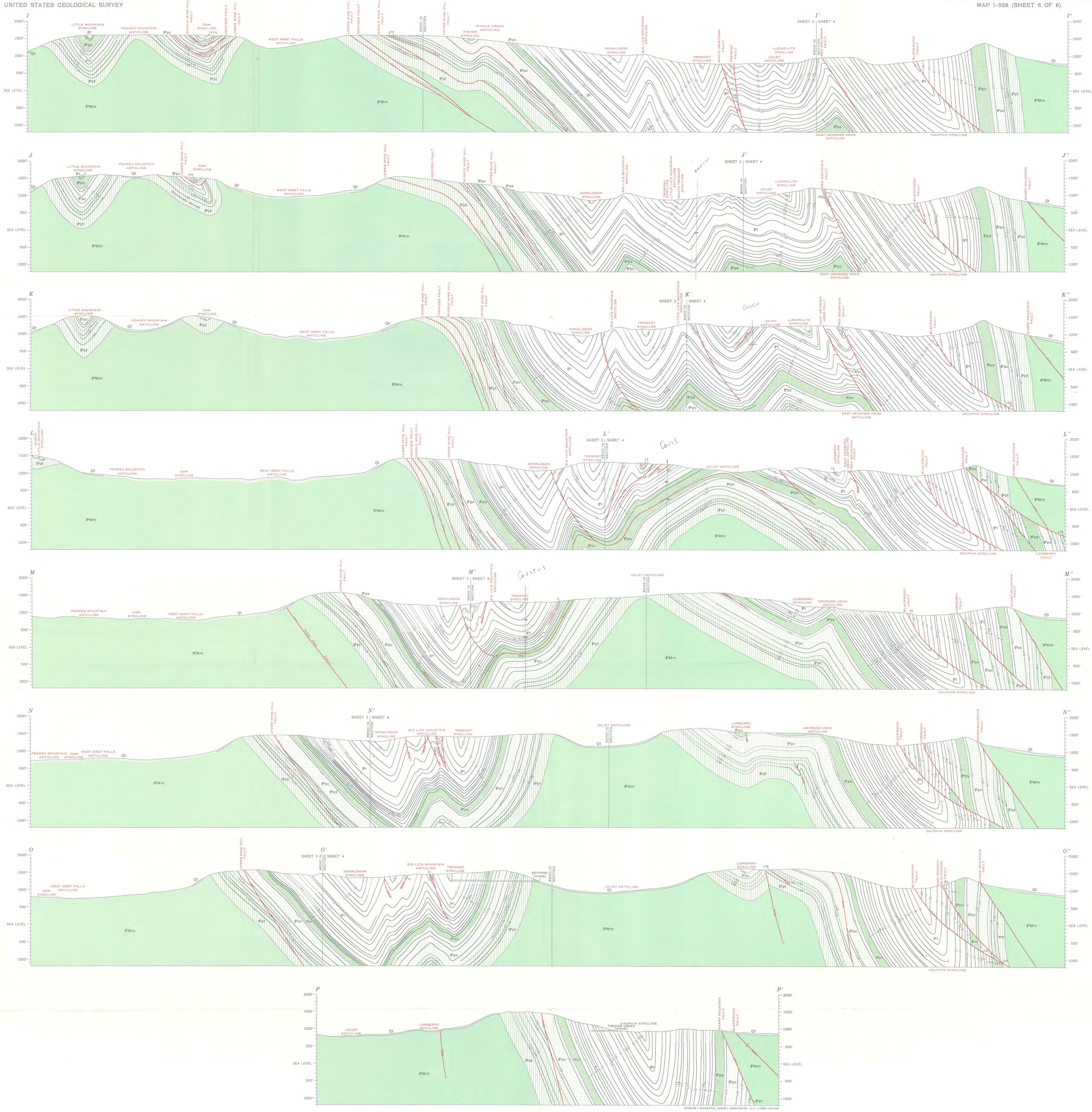
1968

INTERIOR—GEOLOGICAL SURVEY, WASHINGTON, D.C.—1968—G47300

Geology by Gordon H. Wood, Jr., J. Peter Trexler, Thomas M. Kehn, Andy Yelenosky, and Julian Soren, 1953–60

DEPARTMENT OF THE INTERIOR
UNITED STATES GEOLOGICAL SURVEY

MISCELLANEOUS GEOLOGICAL INVESTIGATIONS
MAP I-528 (SHEET 6 OF 6)



Structure sections in the Pine Grove and Tremont quadrangles

See sheet 2 for geologic explanation and index and sheet 5 for structure sections *A–A'*, *B–B''*—*F–F''* and *G–G'''*—*H–H'''*

Geology by Gordon H. Wood, Jr., J. Peter Trexler, Thomas M. Kehn, Andy Yelenosky, and Julian Soren, 1953–60

GEOLOGIC MAPS OF ANTHRACITE-BEARING ROCKS IN THE WEST-CENTRAL PART OF THE SOUTHERN ANTHRACITE FIELD, PENNSYLVANIA, EASTERN AREA

By

Gordon H. Wood, Jr., J. Peter Trexler, and Thomas M. Kehn

SCALE 1:12 000

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DATUM IS MEAN SEA LEVEL

1968

INTERIOR—GEOLOGICAL SURVEY, WASHINGTON, D.C.—1968—GS7350

DEPARTMENT OF THE INTERIOR
UNITED STATES GEOLOGICAL SURVEY

MISCELLANEOUS GEOLOGIC INVESTIGATIONS
MAP I-529 (SHEET 1 OF 4)

Northern half of the Tower City quadrangle and part of the southern half of the Valley View Quadrangle

See sheet 4 for structure sections, explanation, and index

GEOLOGIC MAPS OF ANTHRACITE-BEARING ROCKS IN THE WEST-CENTRAL PART OF THE SOUTHERN ANTHRACITE FIELD, PENNSYLVANIA, WESTERN AREA

By
Gordon H. Wood, Jr., and J. Peter Trexler

Base from U.S. Geological Survey 1:24,000, 1947

SCALE 1:12 000

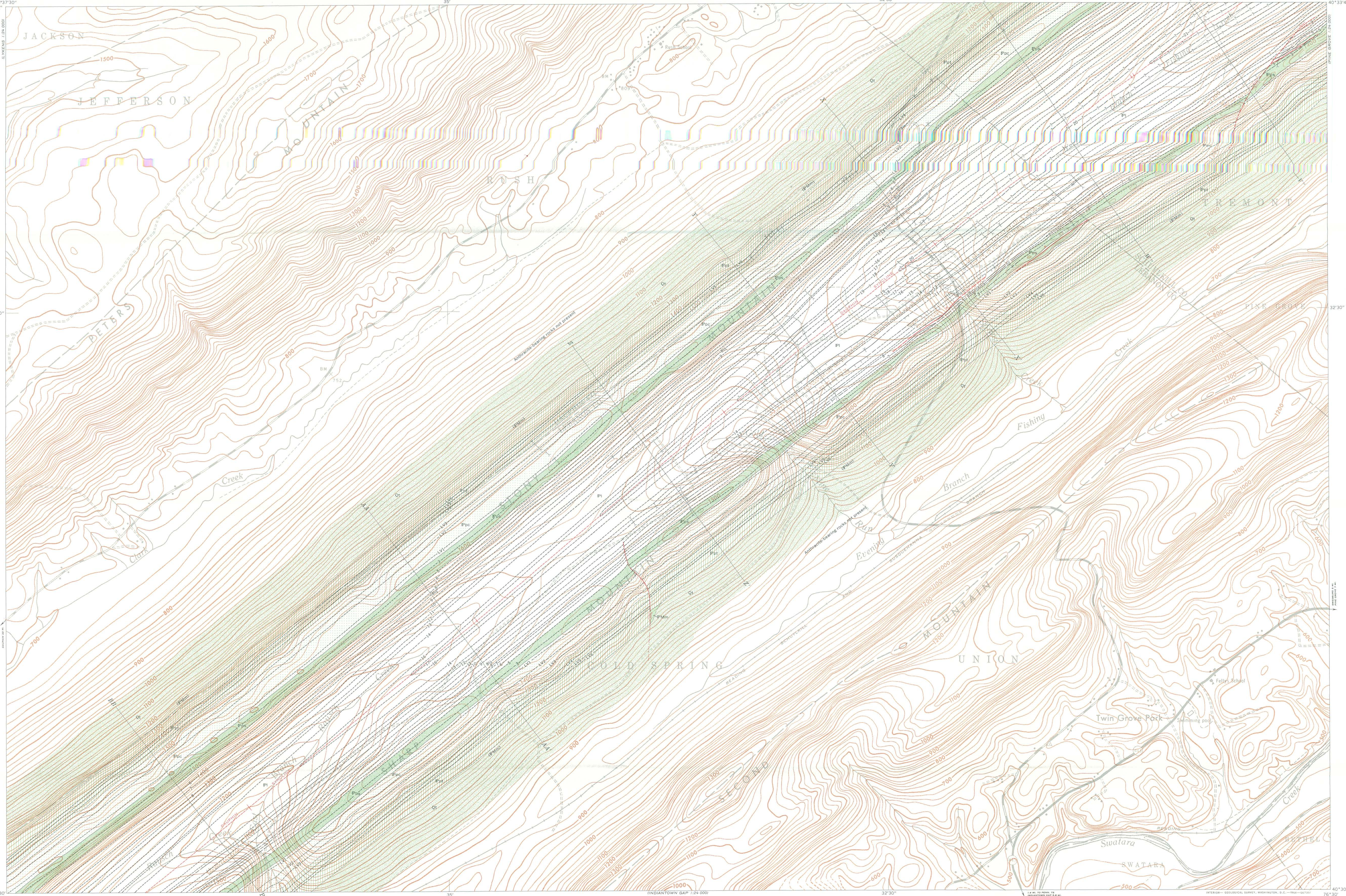
CONTOUR INTERVAL 20 FEET
DATUM IS MEAN SEA LEVEL

1968

Geology by J. Peter Trexler, Julian Soren, and Gordon H. Wood, Jr., 1957–58

INTERIOR—U.S. GEOLOGICAL SURVEY, WASHINGTON, D.C.—1968—GS7331

For sale by U.S. Geological Survey, price $2.00 per set



Base from U.S. Geological Survey 1:24,000, 1947

Geology by Gordon H. Wood, Jr., 1958

Southern half of the Tower City quadrangle

See sheet 4 for structure sections, explanation, and index

GEOLOGIC MAPS OF ANTHRACITE-BEARING ROCKS IN THE WEST-CENTRAL PART OF THE SOUTHERN ANTHRACITE FIELD, PENNSYLVANIA, WESTERN AREA

By
Gordon H. Wood, Jr., and J. Peter Trexler

APPROXIMATE MEAN DECLINATION, 1968

SCALE 1:12 000

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CONTOUR INTERVAL 20 FEET
DATUM IS MEAN SEA LEVEL

1968

DEPARTMENT OF THE INTERIOR
UNITED STATES GEOLOGICAL SURVEY

MISCELLANEOUS GEOLOGIC INVESTIGATIONS
MAP I-529 (SHEET 3 OF 4)

Base from U.S. Geological Survey 1:24,000, 1947

Geology by J. Peter Trexler, 1956–58

Northern half of the Lykens quadrangle

See sheet 4 for structure sections, explanation, and index

GEOLOGIC MAPS OF ANTHRACITE-BEARING ROCKS IN THE WEST-CENTRAL PART OF THE SOUTHERN ANTHRACITE FIELD, PENNSYLVANIA, WESTERN AREA

By
Gordon H. Wood, Jr., and J. Peter Trexler

SCALE 1:12 000

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CONTOUR INTERVAL 20 FEET
DATUM IS MEAN SEA LEVEL

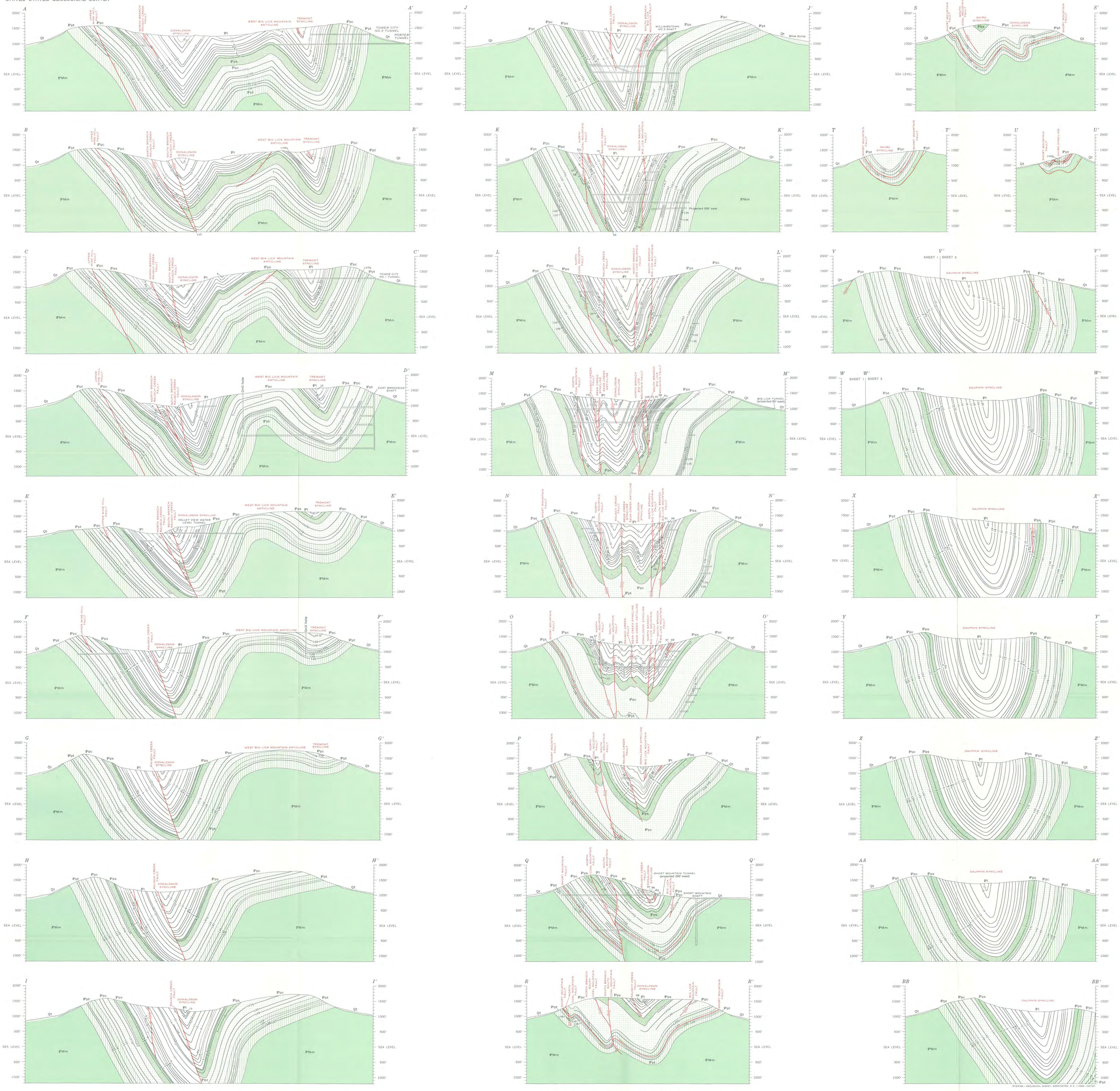
APPROXIMATE MEAN DECLINATION, 1968

1968

INTERIOR—GEOLOGICAL SURVEY, WASHINGTON, D.C.—1968—GS7351

DEPARTMENT OF THE INTERIOR
UNITED STATES GEOLOGICAL SURVEY

MISCELLANEOUS GEOLOGIC INVESTIGATIONS
MAP I-529 (SHEET 4 OF 4)



EXPLANATION

- Qt — Talus — QUATERNARY
- UNCONFORMITY
- Middle and Lower Pennsylvanian — Pl — Llewellyn Formation
- Middle Pennsylvanian — Ppts — Ppc — Ppt — Pottsville Formation: Ppts, *Sharp Mountain Member*; Ppc, *Schuylkill Member*; Ppt, *Tumbling Run Member*
- Upper Mississippian and Lower Pennsylvanian — PPm — Mauch Chunk Formation — MISSISSIPPIAN AND PENNSYLVANIAN
- PENNSYLVANIAN
- CARBONIFEROUS

LINE SYMBOLS FOR MAPS

Geologic features such as coal beds, contacts, faults, and fold lines whose traces are shown on the coal maps are classified according to the accuracy of location and the relative certainty of existence.

The traces of geologic features are shown by solid lines where accurately located, by long dashes where approximately located, and by short dashes where indefinitely located. The traces of geologic features, if concealed by an overlying mapped geologic unit, are shown by continuous dots where accurately located, by sequences of four dots where approximately located, and by sequences of two dots where indefinitely located.

The existence of geologic features in some localities is uncertain to varying degrees because of cover and heavy vegetation. They are classified as probable if there is little uncertainty and as doubtful or inferred if there is considerable uncertainty or if an alternate interpretation is possible. The traces of geologic features are shown by sequences of long dashes separated by queries where probable and by sequences of short dashes separated by queries where doubtful or inferred. The traces of geologic features, if concealed by an overlying mapped geologic unit, are shown by sequences of two dots separated by queries where doubtful or inferred.

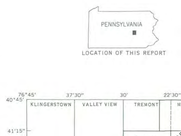
LV1 — Coal bed

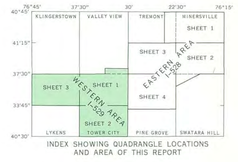
Solid where accurately located by underground mining. Solid with hachures where accurately located from strip mining; hachures on one side indicate direction of dip of bed; on both sides, vertical bed. Number designates coal bed; L, leader coal bed; R, rider coal bed; T, top split; B, bottom split; LV, Lykens Valley

- Contact
- Fault, showing relative horizontal movement
- Reverse fault
  R, *upthrown side. Angle of dip interpreted to be greater than 45° at time of faulting*
- Thrust fault
  T, *upper plate. Angle of dip interpreted to be less than 45° at time of faulting*
- Underthrust fault
  UT, *underthrust plate. Angle of dip interpreted to be less than 45° at time of faulting*
- Anticline
  Showing trace of crestline
- Syncline
  Showing trace of troughline
- Overturned anticline
  Showing trace of crestline
- Overturned syncline
  Showing trace of troughline

LINE SYMBOLS FOR CROSS SECTIONS

- Unmined coal bed
- Mined coal bed
- Contact
- Thrust fault
- Underthrust fault
- Reverse fault
- Horizontal movement on fault
  T, towards observer; A, away from observer
- Shaft
- Tunnel
- Slope
- Trench
  Tick marks place coal found
- Prospect
- Prospect, coal found
- Drill hole





INDEX SHOWING QUADRANGLE LOCATIONS AND AREA OF THIS REPORT

Structure sections, explanation, and index

GEOLOGIC MAPS OF ANTHRACITE-BEARING ROCKS IN THE WEST-CENTRAL PART OF THE SOUTHERN ANTHRACITE FIELD, PENNSYLVANIA, WESTERN AREA

By
Gordon H. Wood, Jr., and J. Peter Trexler

SCALE 1:12 000

½ 0 ½ 1 MILE

.5 0 .5 1 KILOMETER

1968

DEPARTMENT OF THE INTERIOR
UNITED STATES GEOLOGICAL SURVEY

MISCELLANEOUS GEOLOGIC INVESTIGATIONS
MAP I-681 (SHEET 1 OF 2)

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D'
E'
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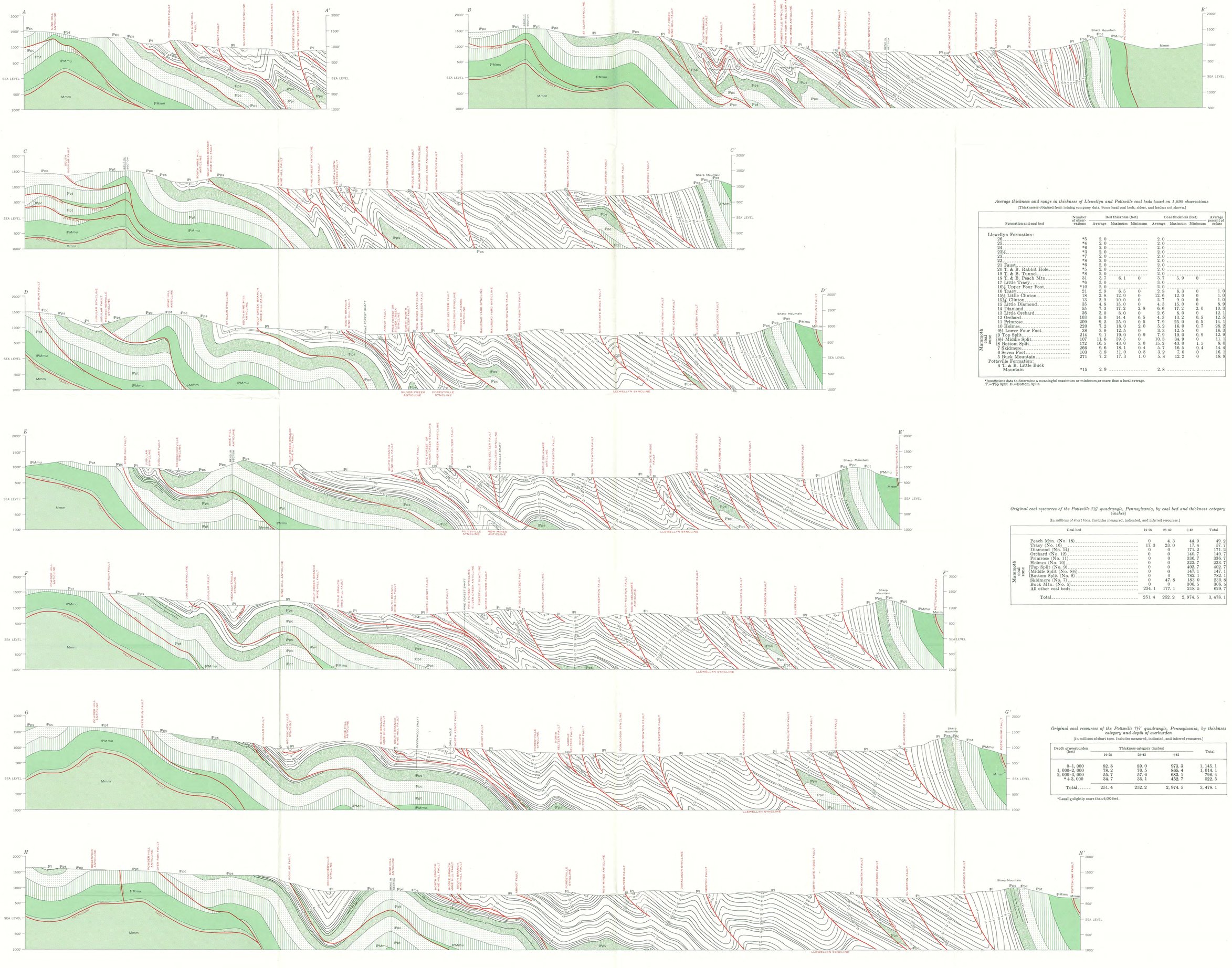
(Mineral City)
(Frackville)
(Tamaqua)
New Castle
Mt. Claire
Middle Creek
Silver Creek
Swatara
Tumbling Run
Sharp Mountain
Buck Mountain
Locust Gap
Mahanoy City
Pottsville
Mahanoy Creek
Broad Mountain
Big Mine Run
Mine Hill
Wolf Creek
Walker Creek
Bear Ridge
Yorkville
Yorkville Gap
Yorkville Water Level Drainage Tunnel
Reppler Rock Tunnel
Reppler Water Level Tunnel
St. Clair No. 40 Slope (Destroyed)
Pine Forest Shaft
Eagle Hill Shaft
Eagle Hill Water Level Drift
Eagle Hill Diamond Vein Water Level Drift
Pottsville Shaft
Pottsville Shaft Mine Water Overflow
Pottsville Shaft Mine Water Overflow
Green Parry Slope
Mine Water Overflow
Mahoney Slope
Ruhlin's Slope
Yorkville Slope
White's Slope
Lewis Slope
Snyder's Water Level Drift
Wallaroo and Rothermel Slope
Belfast Tunnel
Lucinda Tunnel
Hubleyville Tunnel
Palmer Vein Slope
Randolph Tunnel
Balem Hill Drainage Tunnel
Greenwood Slope (Destroyed)
Pottsville Gap Slope (Destroyed)
Buck Mountain Slope
Sharp Mountain Colliery (Destroyed)
Llewellyn Slope (Destroyed)
Fork Farm Slope
Bear Ridge Slope
Bellman Vein Slope
Bellman Water Level Tunnel
Lucinda Tunnel
Drill hole
Mine Water Overflow
Mine Water Overflow
Mine Water Overflow



Average thickness and range in thickness of Llewellyn and Pottsville coal beds based on 1,986 observations

[Thicknesses obtained from mining company data. Some local coal beds, riders, and leaders not shown.]

	Formation and coal bed	Number of observations	Bed thickness (feet) Average	Maximum	Minimum	Coal thickness (feet) Average	Maximum	Minimum	Average percent of refuse
	Llewellyn Formation:								
	26	*5	2.0			2.0			
	25	*4	2.0			2.0			
	24	*6	2.0			2.0			
	23½	*3	2.0			2.0			
	23	*7	2.0			2.0			
	22	*8	2.0			2.0			
	21 Faust	*6	2.0			2.0			
	20 T. & B. Rabbit Hole	*5	2.0			2.0			
	19 T. & B. Tunnel	*8	2.0			2.0			
	18 T. & B. Peach Mtn.	31	3.7	6.1	0	3.7	5.9	0	
	17 Little Tracy	*6	3.0			3.0			
	16½ Upper Four Foot	*10	2.0			2.0			
	16 Tracy	21	2.9	6.5	0	2.8	6.3	0	1.0
	15½ Little Clinton	18	2.8	12.0	0	12.6	12.0	0	1.0
	15½ Clinton	13	2.9	10.0	0	2.7	9.0	0	1.0
	15 Little Diamond	35	4.8	15.0	0	4.3	15.0	0	8.9
	14 Diamond	55	7.3	17.2	2.8	6.6	17.2	2.0	10.3
	13 Little Orchard	36	3.0	8.0	0	2.6	8.0	0	12.1
	12 Orchard	103	5.0	14.4	0.5	4.3	13.2	0.5	12.5
	11 Primrose	209	9.2	25.0	0.5	7.9	25.0	0.5	14.1
	10 Holmes	220	7.2	18.0	2.0	5.2	16.0	0.7	28.2
	9½ Lower Four Foot	38	3.9	12.5	0	3.3	12.5	0	16.3
Mammoth coal zone	(9 Top Split	214	9.1	19.0	0.9	7.9	19.0	0.9	12.9
	8½ Middle Split	107	11.6	39.5	0	10.3	34.9	0	11.1
	8 Bottom Split	172	16.5	43.0	3.0	15.2	43.0	1.5	8.0
	7 Skidmore	266	6.6	18.1	0.4	5.7	16.5	0.4	14.4
	6 Seven Foot	103	3.8	11.0	0.8	3.2	7.0	0	16.1
	5 Buck Mountain	271	7.2	17.3	1.0	5.8	12.2	0	18.9
	Pottsville Formation:								
	4 T. & B. Little Buck Mountain	*15	2.9			2.8			

*Insufficient data to determine a meaningful maximum or minimum,or more than a local average.
T.=Top Split B.=Bottom Split.

Original coal resources of the Pottsville 7½′ quadrangle, Pennsylvania, by coal bed and thickness category (inches)

[In millions of short tons. Includes measured, indicated, and inferred resources.]

	Coal bed	14-28	28-42	+42	Total
Mammoth coal zone	Peach Mtn. (No. 18)	0	4.3	44.9	49.2
	Tracy (No. 16)	17.3	23.0	17.4	57.7
	Diamond (No. 14)	0	0	171.2	171.2
	Orchard (No. 12)	0	0	140.7	140.7
	Primrose (No. 11)	0	0	336.7	336.7
	Holmes (No. 10)	0	0	223.7	223.7
	Top Split (No. 9)	0	0	402.7	402.7
	Middle Split (No. 8½)	0	0	147.1	147.1
	Bottom Split (No. 8)	0	0	782.1	782.1
	Skidmore (No. 7)	0	47.8	183.0	230.8
	Buck Mtn. (No. 5)	0	0	306.5	306.5
	All other coal beds	234.1	177.1	218.5	629.7
	Total	251.4	252.2	2,974.5	3,478.1

Original coal resources of the Pottsville 7½′ quadrangle, Pennsylvania, by thickness category and depth of overburden

[In millions of short tons. Includes measured, indicated, and inferred resources.]

Depth of overburden (feet)	Thickness category (inches) 14-28	28-42	+42	Total
0-1,000	82.8	89.0	973.3	1,145.1
1,000-2,000	78.2	70.5	865.4	1,014.1
2,000-3,000	55.7	57.6	683.1	796.4
*+3,000	34.7	35.1	452.7	522.5
Total	251.4	252.2	2,974.5	3,478.1

*Locally slightly more than 6,000 feet.

INTERIOR—GEOLOGICAL SURVEY, WASHINGTON, D.C.—1972—670476

Geology mapped in 1966–67

Structure sections of part of the Pottsville quadrangle

See sheet 1 for geologic explanation and index

GEOLOGIC MAP OF ANTHRACITE-BEARING ROCKS IN THE POTTSVILLE QUADRANGLE, SCHUYLKILL COUNTY, PENNSYLVANIA

By
Gordon H. Wood, Jr.

SCALE 1:12 000

1 ½ 0 1 MILE

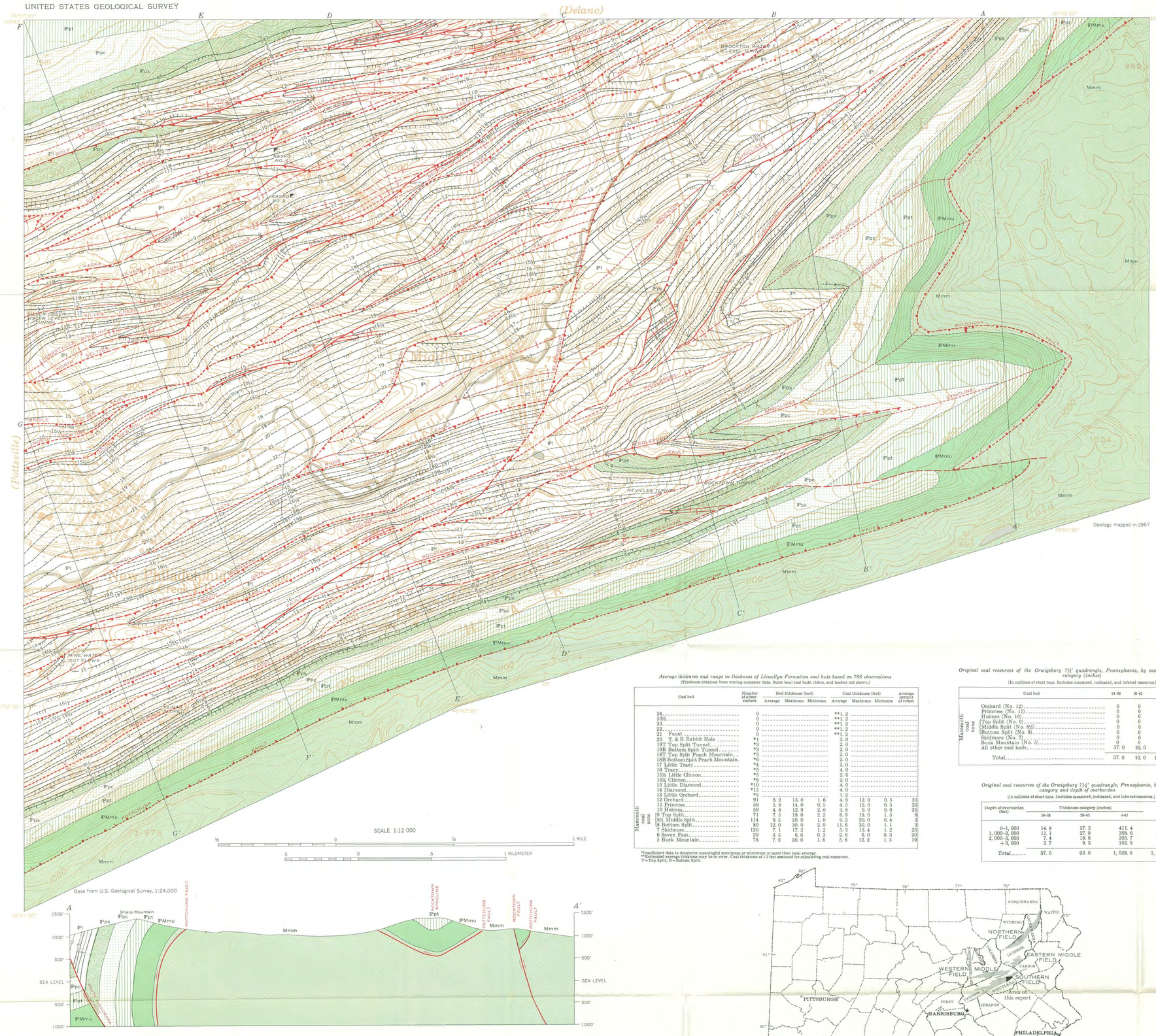
1 5 0 1 KILOMETER

DATUM IS MEAN SEA LEVEL

1972

DEPARTMENT OF THE INTERIOR
UNITED STATES GEOLOGICAL SURVEY

MISCELLANEOUS GEOLOGIC INVESTIGATIONS
MAP I-689



EXPLANATION

- Middle and Upper Pennsylvanian — Llewellyn Formation — PPl
- Middle Pennsylvanian to Lower Pennsylvanian — Pottsville Formation — PPps, Sharp Mountain Member; PPpc, Schuylkill Member; PPpt, Tumbling Run Member
- Upper Mississippian to Upper Pennsylvanian — Mauch Chunk Formation — PPMmu, upper member; Mmm, middle member

PENNSYLVANIAN; MISSISSIPPIAN AND PENNSYLVANIAN; MISSISSIPPIAN

LINE SYMBOLS FOR MAP

Geologic features such as coal beds, contacts, faults, and fold lines whose traces are shown on the coal map are classified according to the accuracy of location and the relative certainty of existence.

The traces of geologic features are shown by solid lines where accurately located, by long dashes where approximately located, and by short dashes where indefinitely located.

The existence of geologic features in some localities is uncertain to varying degrees because of cover and heavy vegetation. They are classified as probable if there is little uncertainty and as doubtful or inferred if there is considerable uncertainty or if an alternate interpretation is possible. The traces of geologic features are shown by sequences of long dashes separated by queries where probable and by sequences of short dashes separated by queries where doubtful or inferred.

Coal bed
Solid where accurately located by underground mining. Solid with hachures where accurately located from strip mining; hachures on one side indicate direction of dip of bed; on both sides vertical bed. Numbers designate coal beds. T, top split; B, bottom split; LV Lykens Valley

Contact

Fault, showing dip
U, *upthrown side*; D, *downthrown side. Angle of dip inferred to be more than 45° at time of faulting*

Thrust fault
Sawteeth on upper plate

Anticline
Showing trace of crestline

Overturned anticline
Showing trace of crestline

Syncline
Showing trace of troughline

Overturned syncline
Showing trace of troughline

Shaft

Tunnel

Slope

Trench

Trench
Tick marks place coal found

Prospect

Prospect, coal found

LINE SYMBOLS FOR CROSS SECTIONS

Unmined coal bed

Mined coal bed

Contact

Fault, showing relative movement

Thrust fault

Mine tunnels

COMPOSITE STRATIGRAPHIC SECTION SHOWING AVERAGE THICKNESS AND LITHOLOGY BETWEEN COAL BEDS

SYSTEM	SERIES	FORMATION	MEMBER	ROCK TYPE	COAL BED DESIGNATION
PENNSYLVANIAN	Middle and Upper Pennsylvanian	Llewellyn			No. 24
					No. 23½
					No. 23
					No. 22
					Faust (No. 21)
					Rabbit Hole (No. 20)
					No. 19T
					Tunnel (No. 19 or No. 19B)
					(No. 18T)
					Peach Mountain (No. 18 or No. 18B)
					Little Tracy (No. 17)
					Upper Four Foot (No. 16½)
					Tracy (No. 16)
					Little Clinton (No. 15½)
					Clinton (No. 15½)
					Little Diamond (No. 15)
					Diamond (No. 14)
					Little Orchard (No. 13)
					Orchard (No. 12)
					No. 11T
					Primrose (No. 11 or No. 11B)
					Holmes (No. 10)
					Top Split (No. 9)
					Middle Split (No. 8½)
					Bottom Split (No. 8)
					Skidmore (No. 7)
					Seven Foot (No. 6)
					Buck Mountain (No. 5)
					Little Buck Mountain (No. 4)
		Pottsville	Sharp Mountain		Lykens Valley (No. 1)
			Schuylkill		
			Tumbling Run		Uppermost red bed
MISSISSIPPIAN AND PENNSYLVANIAN	Upper Mississippian and Lower Pennsylvanian	Mauch Chunk	Upper member		Pottchunk fault
MISSISSIPPIAN	Upper Mississippian		Middle member		

Mammoth coal zone

Average thickness and range in thickness of Llewellyn Formation coal beds based on 766 observations
[Thickness obtained from mining company data. Some local coal beds, riders, and leaders not shown.]

	Coal bed	Number of observations	Bed thickness (feet) Average	Maximum	Minimum	Coal thickness (feet) Average	Maximum	Minimum	Average percent of refuse
	24	0				**1.2			
	23½	0				**1.2			
	23	0				**1.2			
	22	0				**1.2			
	21 Faust	0				**1.2			
	20 T. & B. Rabbit Hole	*1				2.0			
	19T Top Split Tunnel	*3				2.0			
	19B Bottom Split Tunnel	*3				2.0			
	18T Top Split Peach Mountain	*3				2.0			
	18B Bottom Split Peach Mountain	*6				3.0			
	17 Little Tracy	*4				3.0			
	16 Tracy	*5				4.0			
	15½ Little Clinton	*5				2.6			
	15 Clinton	*6				2.0			
	15 Little Diamond	*10				4.0			
	14 Diamond	*15				4.0			
	13 Little Orchard	*5				1.2			
Mammoth coal zone	12 Orchard	91	6.2	13.0	1.6	4.9	12.9	0.5	21
	11 Primrose	58	5.8	14.0	0.5	4.5	12.0	0.5	22
	10 Holmes	59	4.8	12.9	2.0	3.8	9.0	0.6	21
	9 Top Split	71	7.5	19.0	2.2	6.9	18.0	1.5	8
	8½ Middle Split	114	9.5	20.0	1.0	9.2	20.0	0.4	3
	8 Bottom Split	80	12.0	30.0	2.0	11.6	30.0	1.1	3
	7 Skidmore	120	7.1	17.2	1.2	5.3	13.4	1.2	25
	6 Seven Foot	29	3.5	6.6	0.3	2.8	6.0	0.3	20
	5 Buck Mountain	78	7.2	20.0	1.6	5.8	12.2	1.5	19

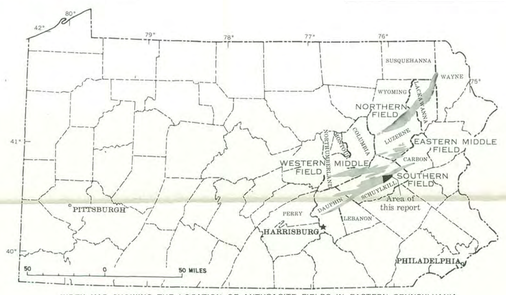
*Insufficient data to determine meaningful maximum or minimum or more than local average.
**Estimated average thickness may be in error. Coal thickness of 1.2 feet assumed for calculating coal resources.
T—Top Split, B—Bottom Split.

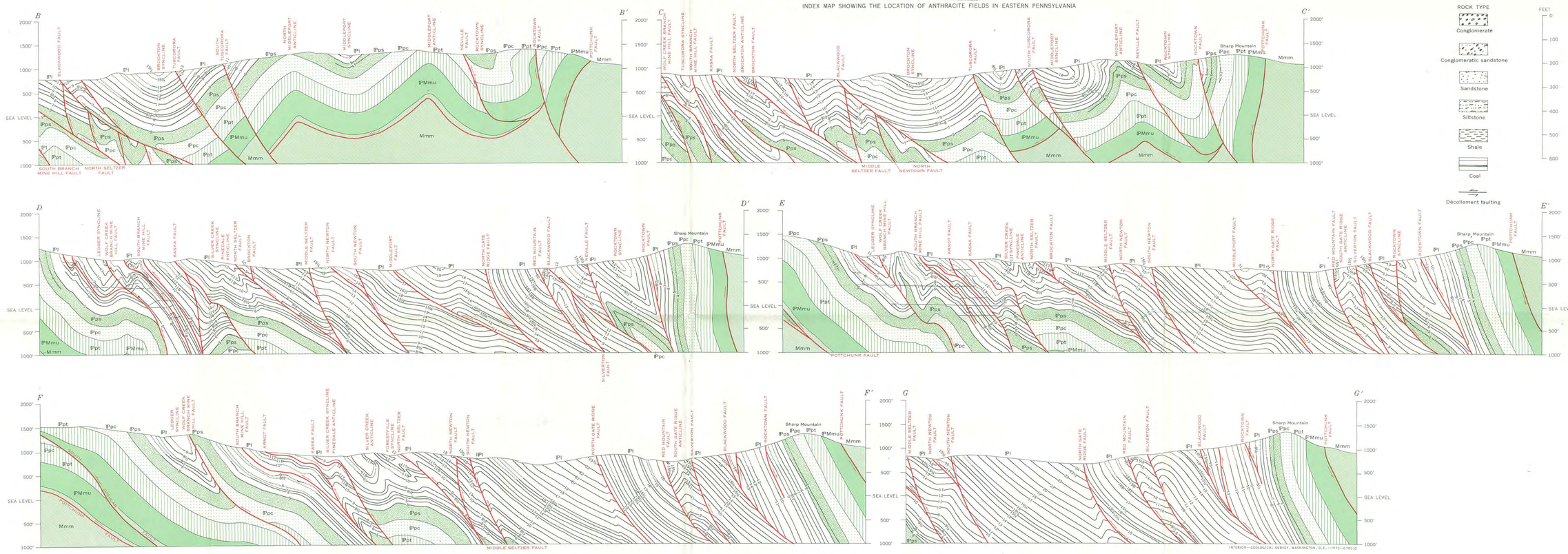
Original coal resources of the Orwigsburg 7½′ quadrangle, Pennsylvania, by coal bed and thickness category (inches)
[In millions of short tons. Includes measured, indicated, and inferred resources.]

	Coal bed	14-28	28-42	+42	Total
Mammoth coal zone	Orchard (No. 12)	0	0	55.6	55.6
	Primrose (No. 11)	0	0	62.3	62.3
	Holmes (No. 10)	0	0	60.6	60.6
	Top Split (No. 9)	0	0	116.1	116.1
	Middle Split (No. 8½)	0	0	179.9	179.9
	Bottom Split (No. 8)	0	0	233.7	233.7
	Skidmore (No. 7)	0	0	111.3	111.3
	Buck Mountain (No. 5)	0	0	124.8	124.8
	All other coal beds	37.0	93.0	84.3	214.3
	Total	37.0	93.0	1,028.6	1,158.6

Original coal resources of the Orwigsburg 7½′ quadrangle, Pennsylvania, by thickness category and depth of overburden
[In millions of short tons. Includes measured, indicated, and inferred resources.]

Depth of overburden (feet)	Thickness category (inches) 14-28	28-42	+42	Total
0–1,000	14.8	37.2	411.4	463.4
1,000–2,000	11.1	27.9	308.6	347.6
2,000–3,000	7.4	18.6	205.7	231.7
+3,000	3.7	9.3	102.9	115.9
Total	37.0	93.0	1,028.6	1,158.6



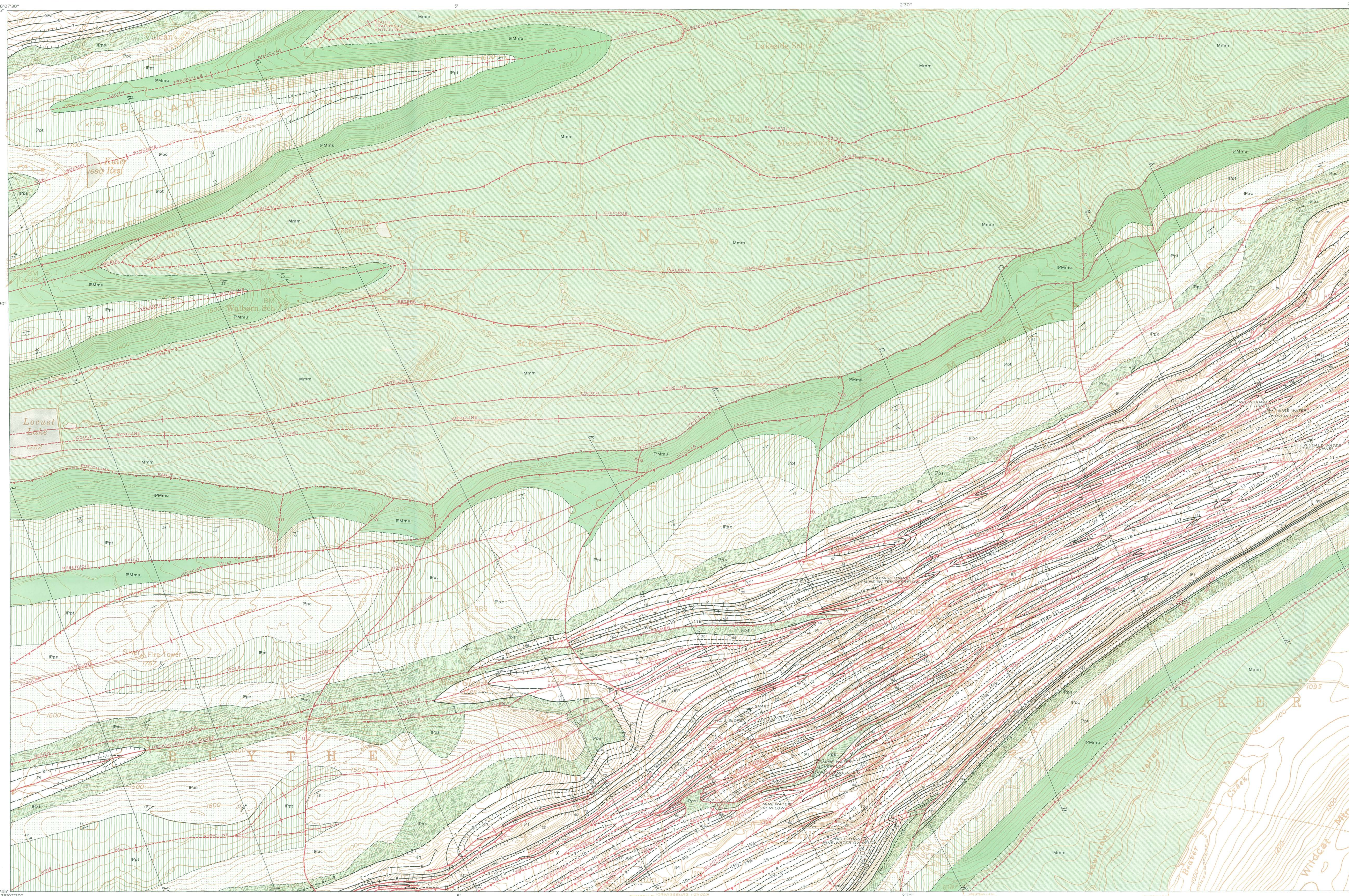


GEOLOGIC MAP OF ANTHRACITE-BEARING ROCKS IN THE NORTH PART OF THE ORWIGSBURG QUADRANGLE, SCHUYLKILL COUNTY, PENNSYLVANIA

By
Gordon H. Wood, Jr.
1972

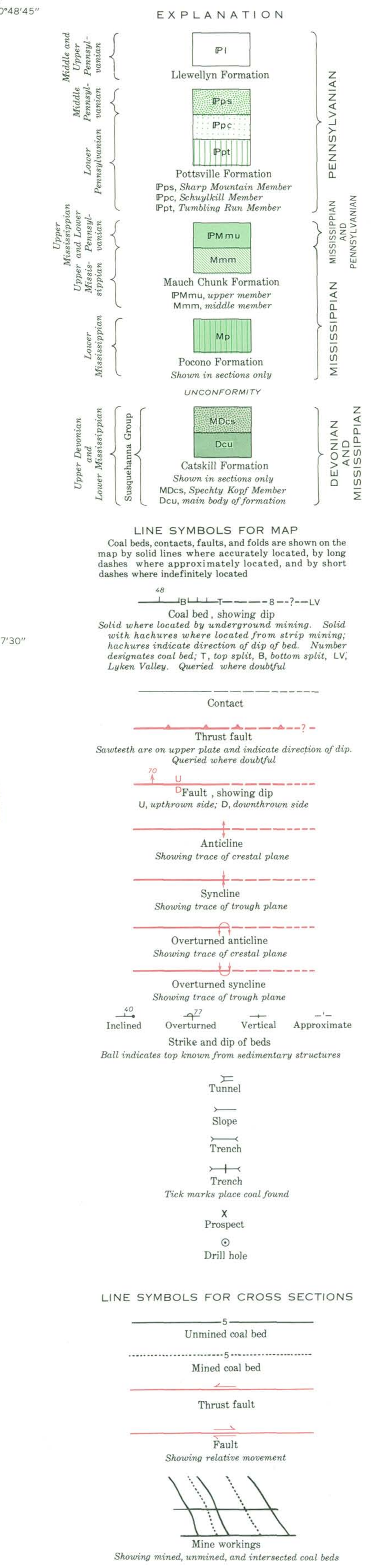
INTERIOR—GEOLOGICAL SURVEY, WASHINGTON, D.C.—1972—G70512

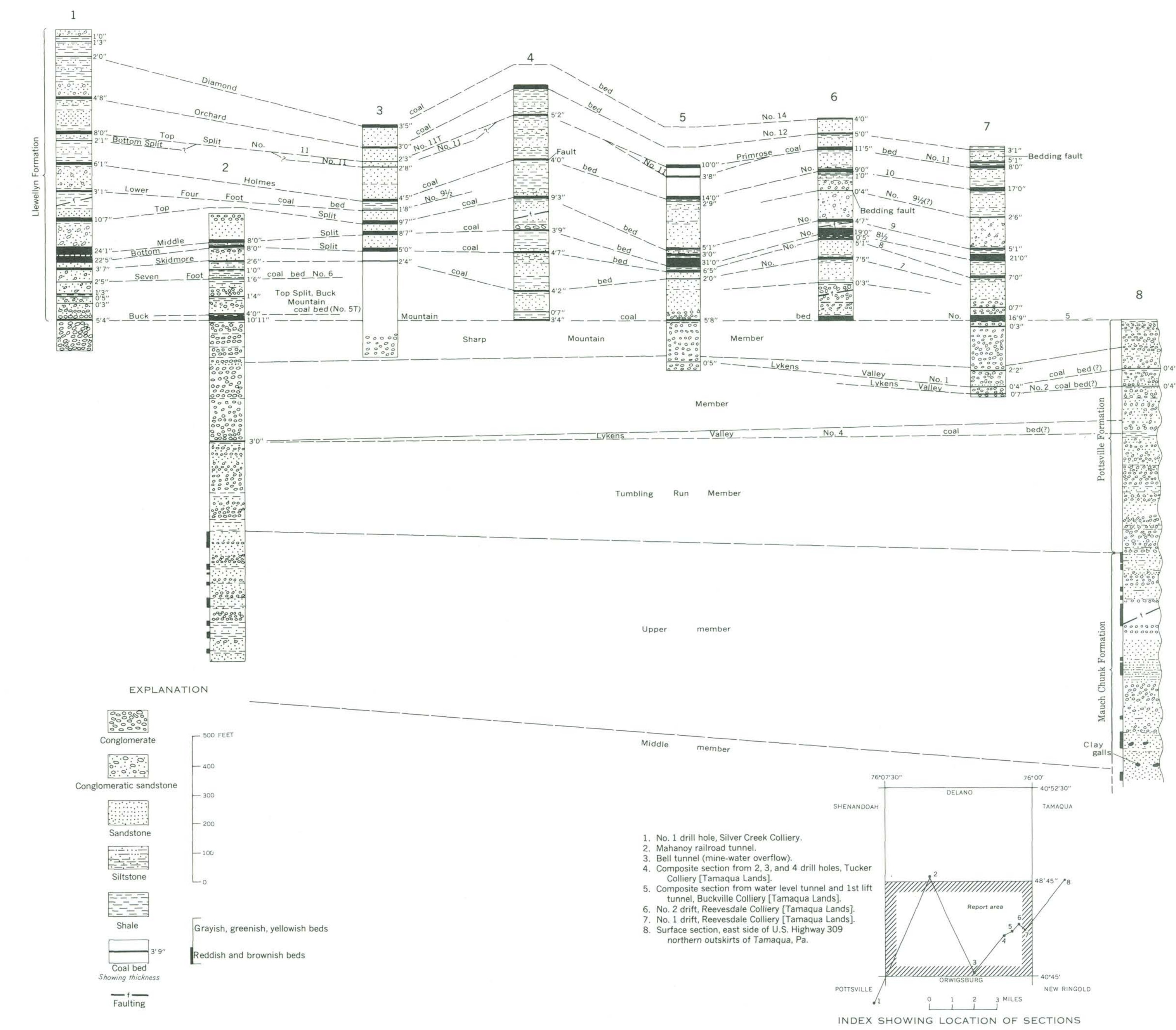
For sale by U.S. Geological Survey, price $1.00



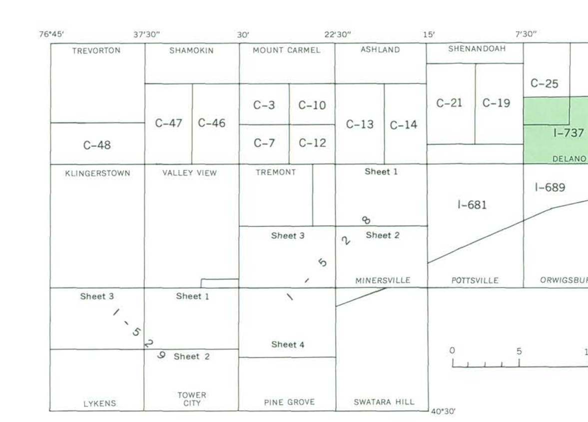
Base from U.S. Geological Survey 1:24,000, 1954

Geology mapped in 1967-68

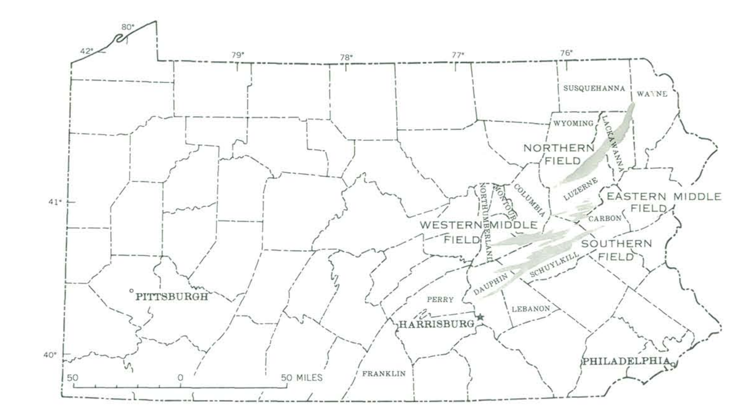




COLUMNAR SECTIONS OF PENNSYLVANIAN AND UPPER MISSISSIPPIAN ROCKS



INDEX MAP SHOWING LOCATION OF THIS MAP AND NEARBY PUBLISHED COAL MAPS (C) AND MISCELLANEOUS GEOLOGIC INVESTIGATION MAPS (I)



INDEX MAP SHOWING THE LOCATION OF ANTHRACITE FIELDS IN EASTERN PENNSYLVANIA

Original coal resources of the southern half of the Delano quadrangle, Pennsylvania, by thickness category and depth of overburden

[Includes measured, indicated, and inferred coal.]

Depth of overburden (feet)	Thickness category (inches)			Total
	14-28	28-42	+42	
	Millions of net tons			
0-1,000	8.0	0.3	502.1	510.4
1,000-2,000	2.1	.3	118.3	120.7
2,000-3,000	1.0	.0	37.5	38.5
Total	11.1	0.6	657.9	669.6

Original coal resources of the southern half of the Delano quadrangle, by coal bed and thickness category

[Includes measured, indicated, and inferred coal.]

Coal bed	Thickness category (inches)			Total
	14-28	28-42	+42	
	Millions of short tons			
Orchard (No. 12)	0.0	0.0	7.7	7.7
Primrose (No. 11)	.0	.0	27.6	27.6
Holmes (No. 10)	.0	.0	50.6	50.6
Top Split (No. 9)	.0	.0	55.1	55.1
Middle Split (No. 8½)	.0	.0	133.2	133.2
Bottom Split (No. 8)	.0	.0	161.7	161.7
Skidmore (No. 7)	.0	.0	81.1	81.1
Buck Mountain (No. 5)	.0	.0	137.7	137.7
All other coal beds	11.1	.6	3.2	14.9
Total	11.1	0.6	657.9	669.6

Average thickness and range in thickness of Llewellyn Formation coal beds based on 420 observations, south half of Delano quadrangle

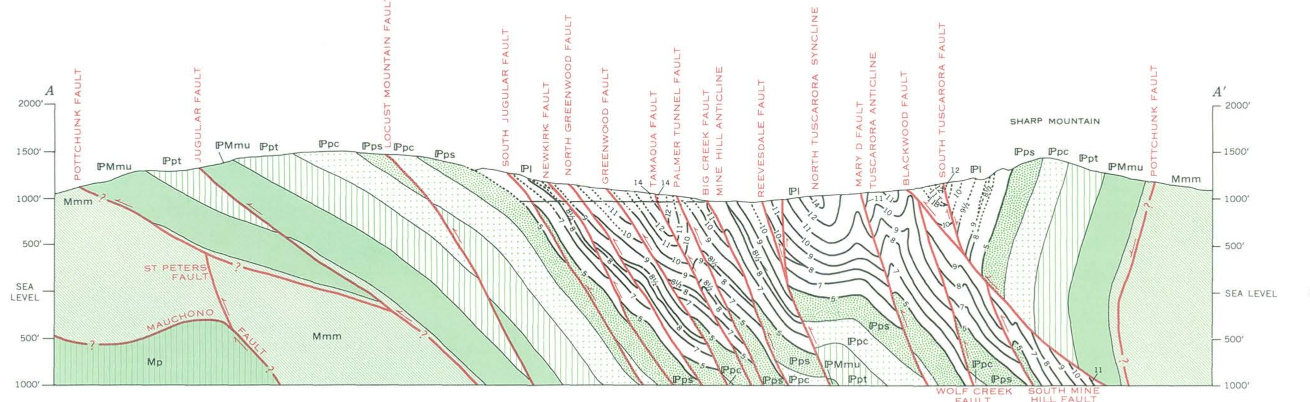
[Thickness data from mining company information. See Wood and others (1969)[1] for procedure for calculation of coal reserves.]

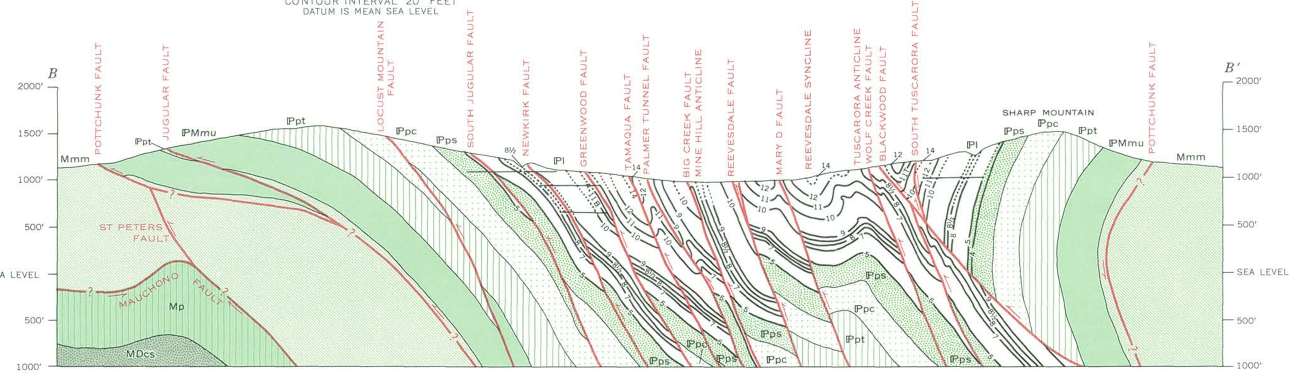
Coal bed	Number of observations	Bed thickness (feet)			Coal thickness (feet)			Average percent of refuse
		Average	Maximum	Minimum	Average	Maximum	Minimum	
15½, Little Clinton	0	--	--	--	2.0[3]	--	--	--
15¼, Clinton	0	--	--	--	2.0[3]	--	--	--
15, Little Diamond	0	--	--	--	2.0[3]	--	--	--
14, Diamond	4[2]	--	--	--	4.0	--	--	--
12, Orchard	26	5.9	16.7	2.1	5.1	16.6	1.1	13.5
11T, Primrose Top Split	5[2]	--	--	--	6.0	--	--	--
11B, Primrose Bottom Split	4[2]	--	--	--	4.0	--	--	--
11, Primrose	43	6.8	13.4	0.7	6.0	13.4	0.7	11.8
10, Holmes	78	10.2	22.0	2.0	9.2	21.0	1.3	9.8
9½, Lower Four Foot	0	--	--	--	--	--	--	--
9, Mammoth Top Split	31	7.2	25.2	3.5	6.3	25.2	2.5	12.5
8½, Mammoth Middle Split	34	14.2	45.0	1.6	13.4	45.0	1.6	5.9
8, Mammoth Bottom Split	79	8.2	57.4	1.8	7.6	50.8	1.5	7.7
7, Skidmore	44	7.5	15.5	0.2	5.8	10.6	0.2	22.7
6, Seven Foot	5[2]	--	--	--	2.0	--	--	--
5, Buck Mountain	67	11.3	18.4	1.8	9.0	15.4	1.0	20.3

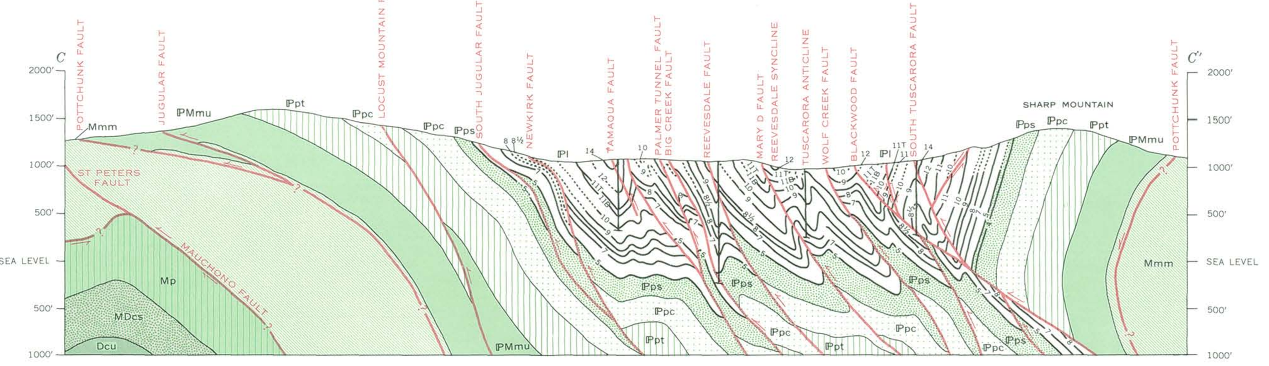
[1] Wood, G. H., Jr., Trexler, J. P., and Kehn, T. M., 1969, Geology of the west-central part of the Southern Anthracite Field and adjoining areas, Pennsylvania: U.S. Geol. Survey Prof. Paper 602, 149 p.

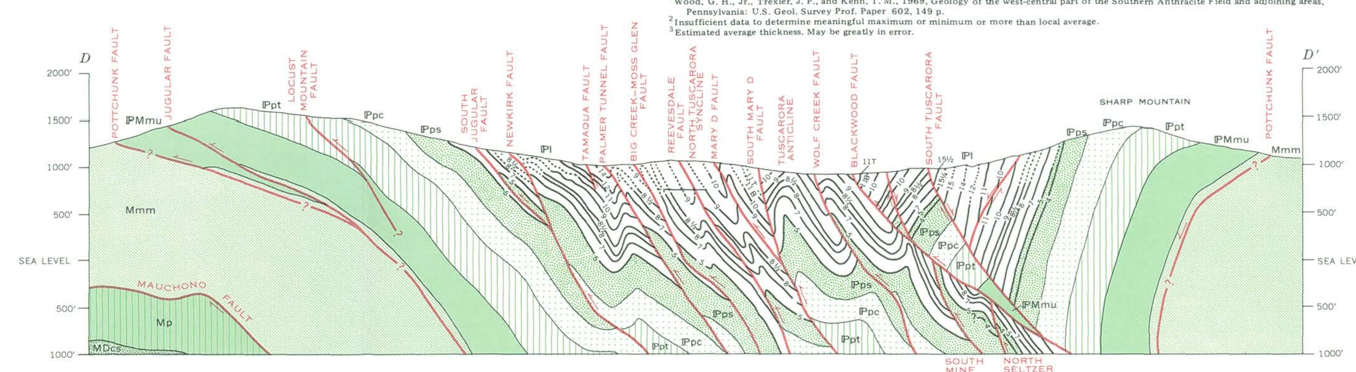
[2] Insufficient data to determine meaningful maximum or minimum or more than local average.

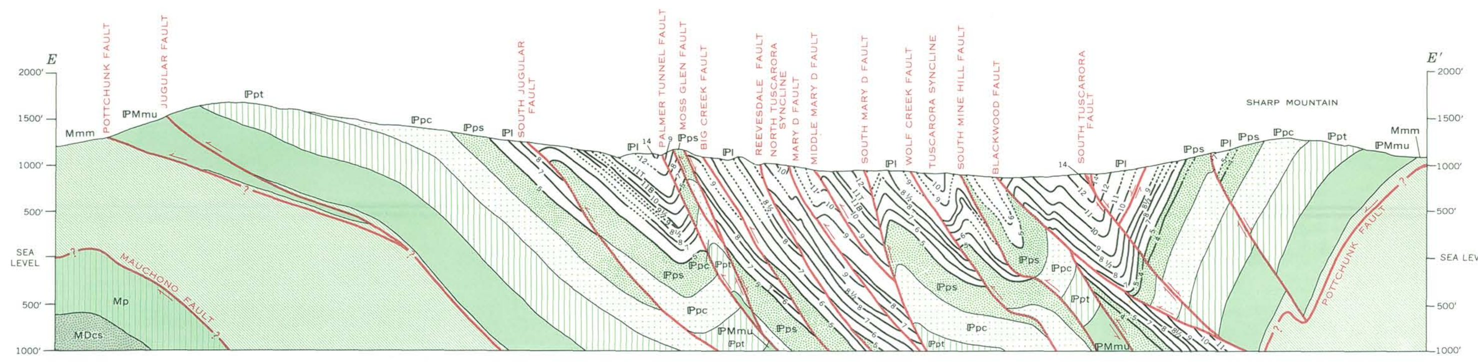
[3] Estimated average thickness. May be greatly in error.

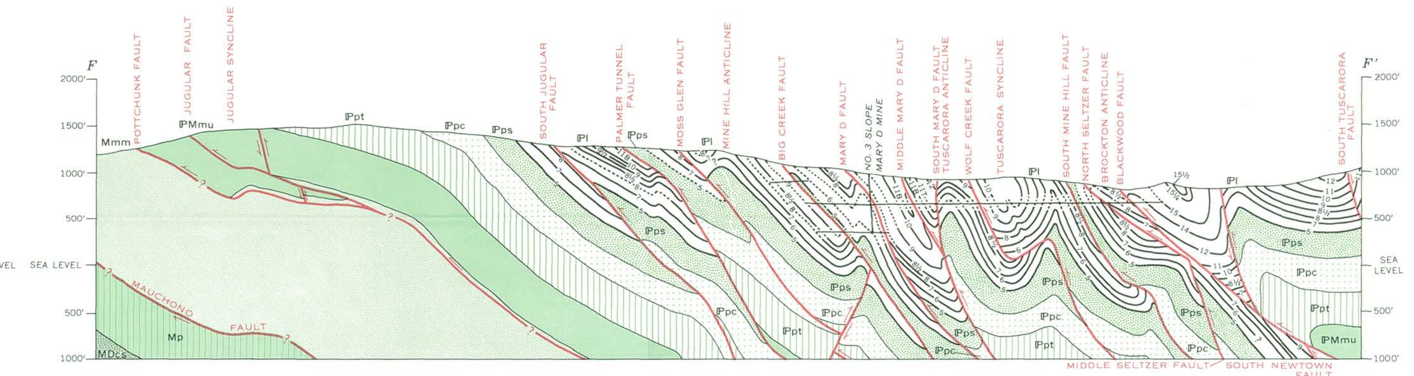


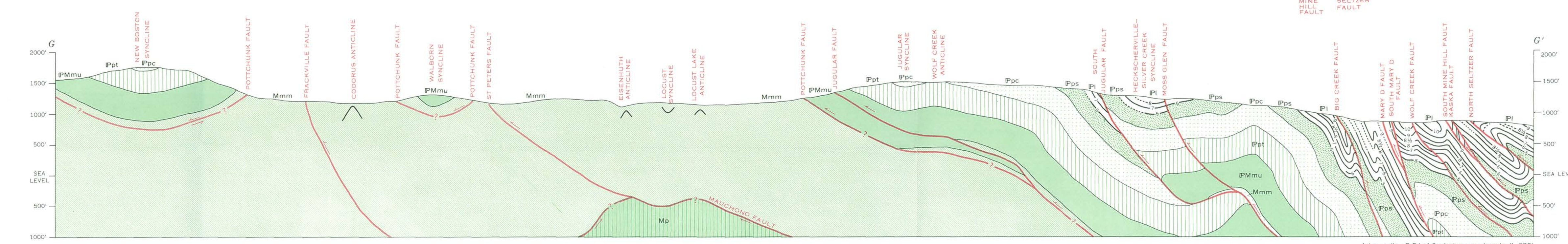


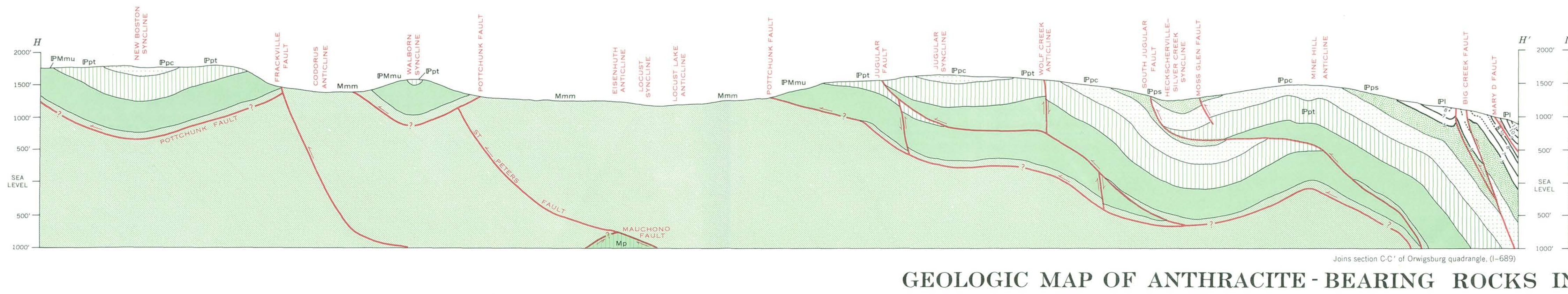


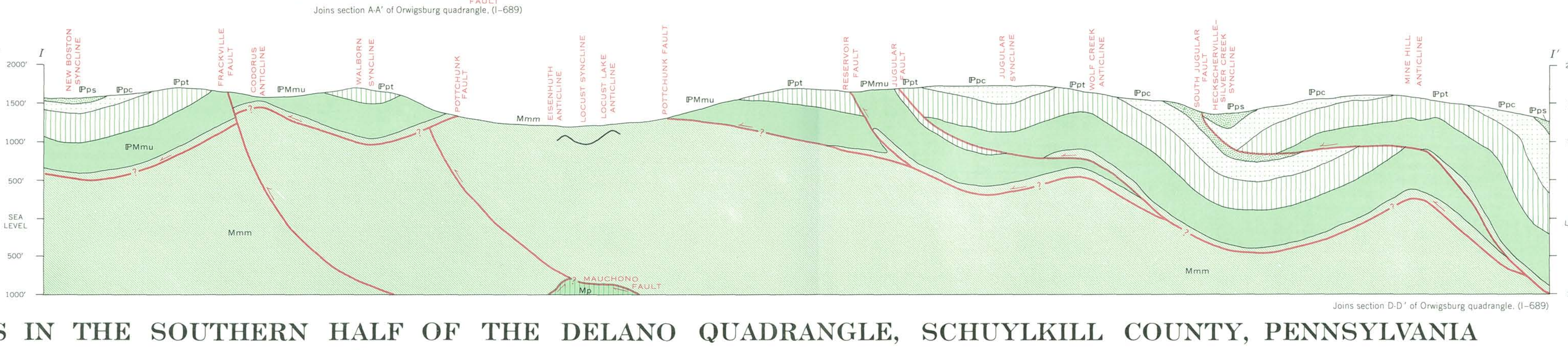


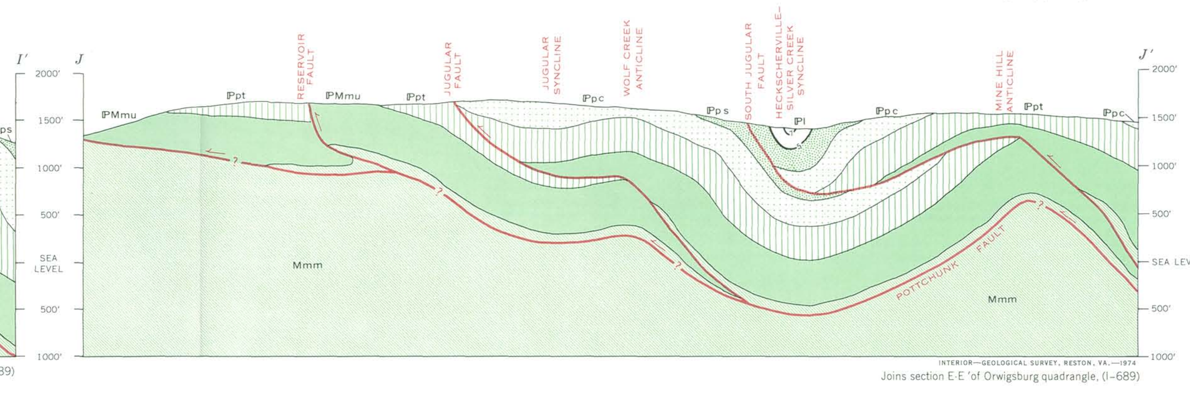










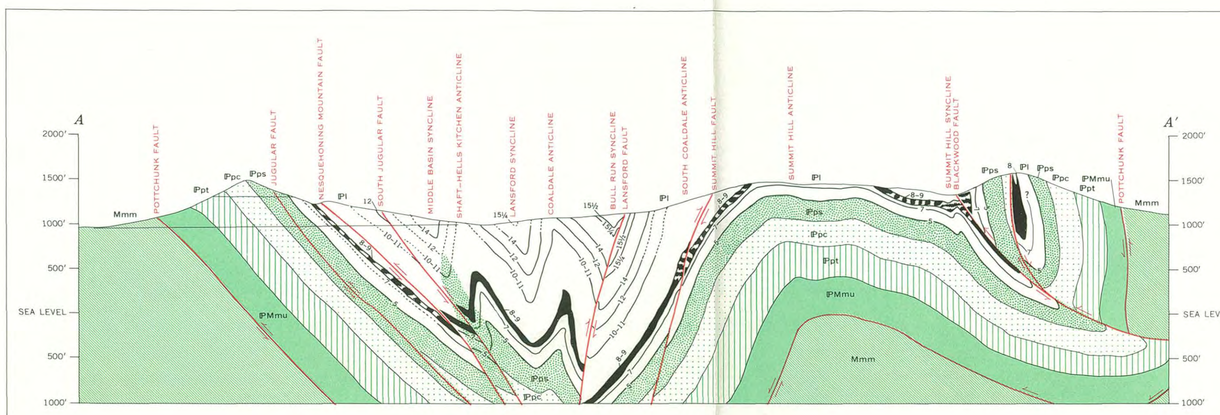


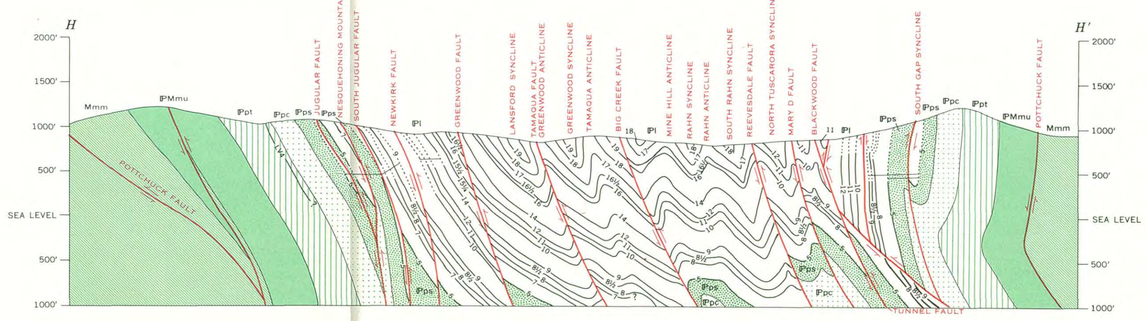
INTERIOR—GEOLOGICAL SURVEY, RESTON, VA.—1974

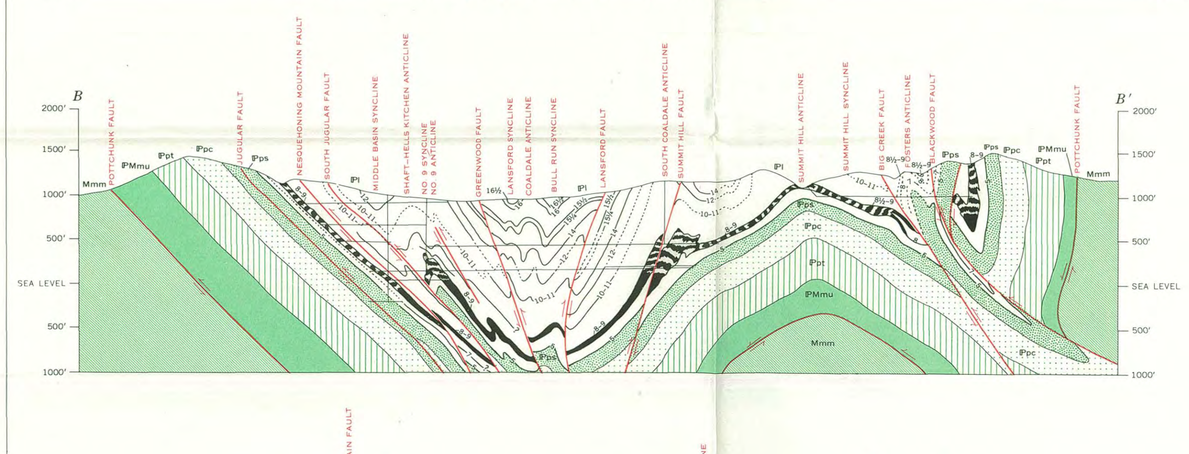
GEOLOGIC MAP OF ANTHRACITE-BEARING ROCKS IN THE SOUTHERN HALF OF THE DELANO QUADRANGLE, SCHUYLKILL COUNTY, PENNSYLVANIA

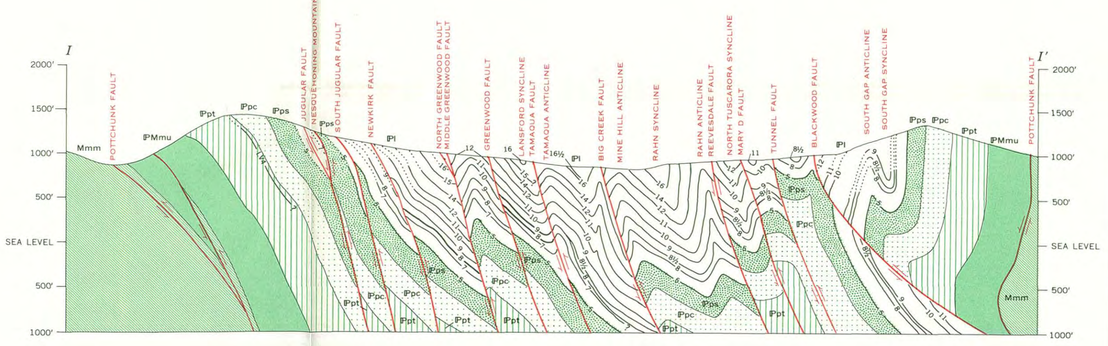
By
Gordon H. Wood, Jr.
1974

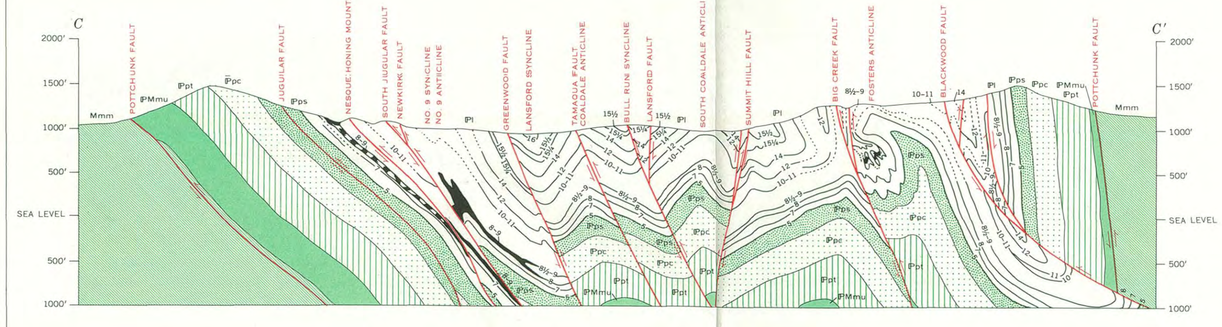
For sale by U.S. Geological Survey, Reston, Va. 22092, price $1.00

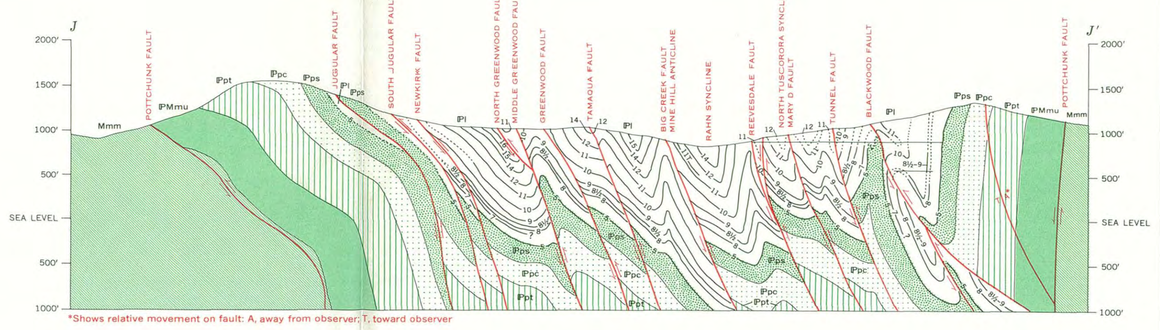




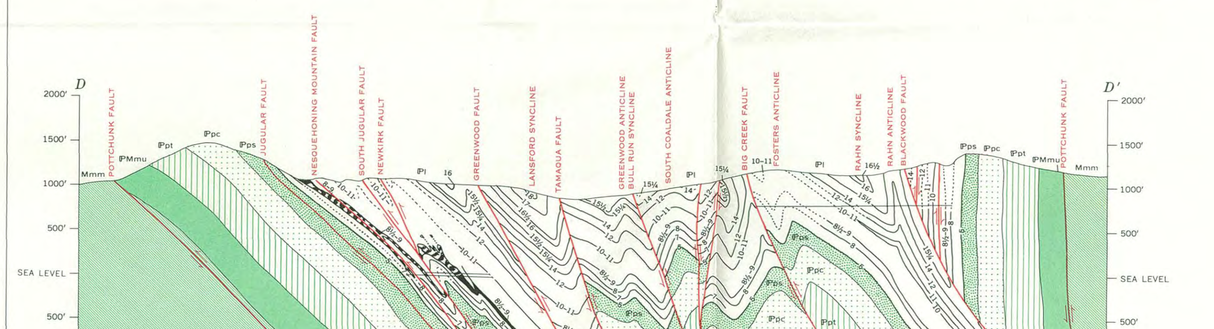


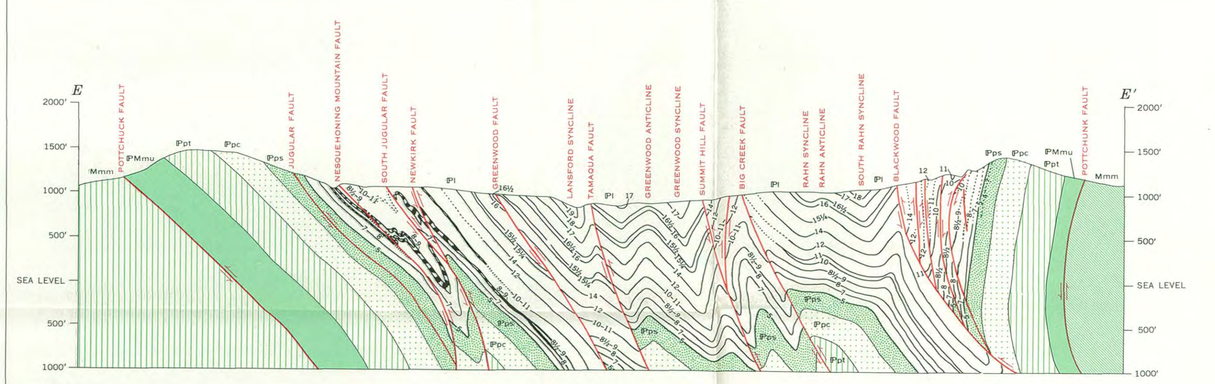


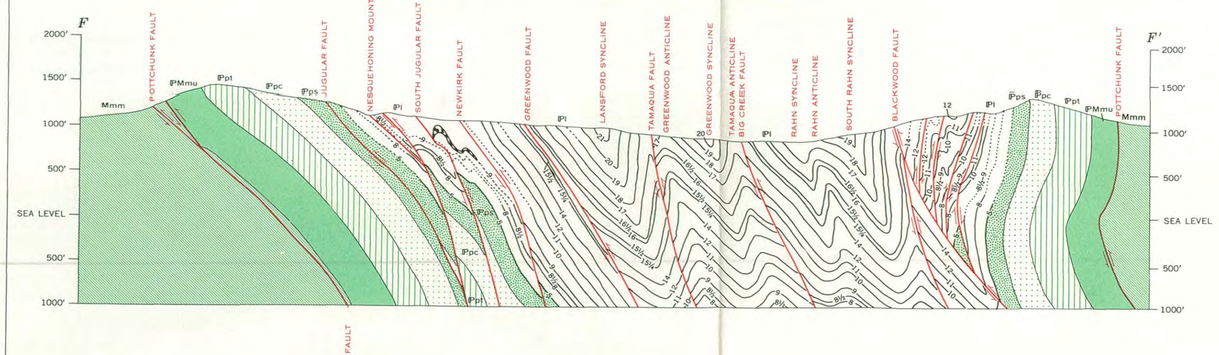


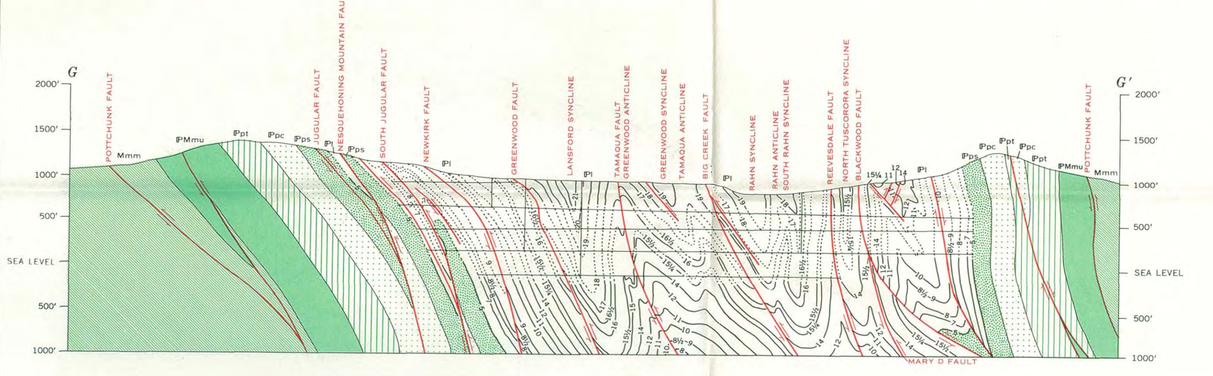


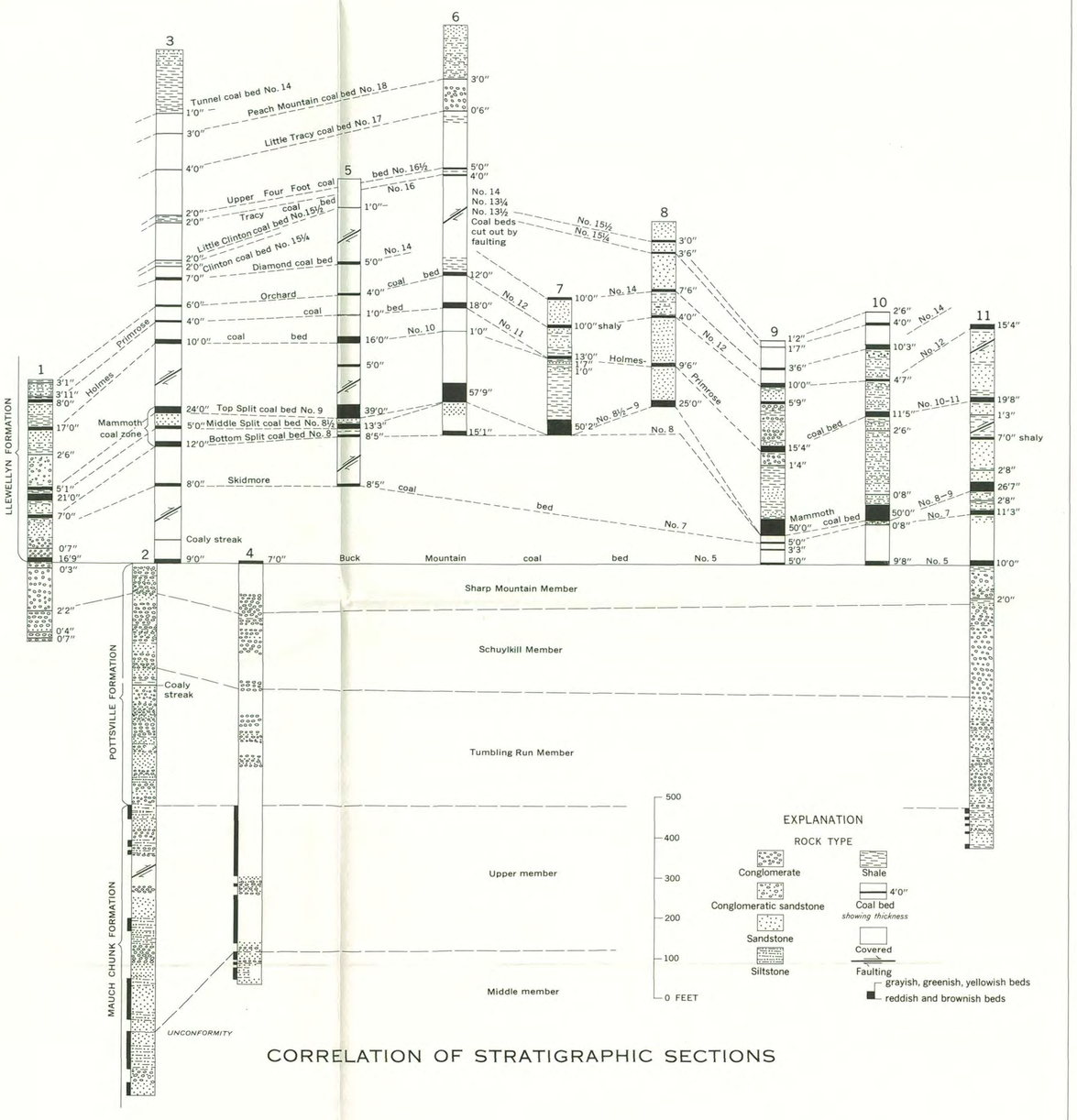
*Shows relative movement on fault: A, away from observer; T, toward observer



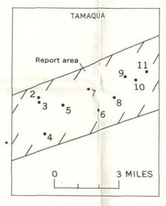








CORRELATION OF STRATIGRAPHIC SECTIONS



INDEX SHOWING LOCATION OF SECTIONS AND SOURCES OF DATA

SOURCES OF DATA

1. Compiled from company data, No. 1 Drift, Reevesdale Colliery.
2. Surface section east side of U.S. Highway 309, northern outskirts of Tamaqua.
3. Compiled from company data, Levan's Slope and Tunnels.
4. Surface section west side of highway crossing Sharp Mountain between Tamaqua and New England School.
5. Compiled from company data, Greenwood Water Level Tunnel.
6. Compiled from company data, tunnels connecting to No. 11 Shaft.
7. Compiled from company data, No. 10 Shaft, Water Level Tunnel, and connecting tunnels.
8. Compiled from company data, Foster's Tunnel.
9. Compiled from company data, No. 8 Water Level Tunnel, and Tunnel 498.
10. Compiled from company data, No. 9 Tunnel.
11. Compiled from company data, Hauto Railroad Tunnel.

INTERIOR—GEOLOGICAL SURVEY RESTON VIRGINIA—1974

Structure sections of part of the Tamaqua quadrangle

See sheet 1 for geologic explanation and index

Geology mapped in 1969–70

GEOLOGIC MAP OF ANTHRACITE-BEARING ROCKS IN THE TAMAQUA QUADRANGLE, CARBON AND SCHUYLKILL COUNTIES, PENNSYLVANIA

By
Gordon H. Wood, Jr.

SCALE 1:12 000

½ 0 ½ 1 MILE

.5 0 .5 1 KILOMETER

DATUM IS MEAN SEA LEVEL

1974

DEPARTMENT OF THE INTERIOR
UNITED STATES GEOLOGICAL SURVEY

MISCELLANEOUS INVESTIGATIONS SERIES
MAP I-809 (SHEET 1 OF 2)

Original coal resources of the Tamaqua 7½-minute quadrangle, Pennsylvania, by county, thickness category (inches), and depth of overburden

[In millions of short tons, includes measured, indicated, and inferred resources]

Depth of Overburden (ft)	Carbon County				Schuylkill County				Quadrangle			
	14-28	28-42	+42	Total	14-28	28-42	+42	Total	14-28	28-42	+42	Total
0-1000	2.0	6.4	152.5	160.9	20.2	24.0	728.1	772.3	22.2	30.4	880.6	933.2
1000-2000	—	2.3	55.3	57.6	14.1	13.2	410.6	437.9	14.1	15.5	465.9	495.5
2000-3000	—	—	—	—	8.3	5.8	152.7	166.8	8.3	5.8	152.7	166.8
Total	2.0	8.7	207.8	218.5	42.6	43.0	1291.4	1377.0	44.6	51.7	1499.2	1595.5

Original coal resources of the Tamaqua 7½-minute quadrangle, Pennsylvania, by county, coal bed, and thickness category (inches)

[In millions of short tons, includes measured, indicated, and inferred resources]

Coal bed	Carbon County				Schuylkill County				Quadrangle			
	14-28	28-42	+42	Total	14-28	28-42	+42	Total	14-28	28-42	+42	Total
Orchard (No. 12)	—	—	15.1	15.1	—	—	95.8	95.8	—	—	110.9	110.9
Holmes-Primrose (No. 10-11, No. 11)	—	—	22.7	22.7	—	—	149.3	149.3	—	—	172.0	172.0
Holmes (No. 10)	—	—	—	—	—	—	109.2	109.2	—	—	109.2	109.2
Top Split (No. 9) Mammoth coal zone	—	—	—	—	—	—	104.2	104.2	—	—	104.2	104.2
Middle Split (No. 8½) Mammoth coal zone	—	—	—	—	—	—	293.5	293.5	—	—	293.5	293.5
Bottom Split (No. 8) Mammoth coal zone	—	—	—	—	—	—	226.1	226.1	—	—	226.1	226.1
Undifferentiated coal beds of Mammoth coal zone (No. 8-8½, No. 8-9, No. 8½-9)	—	—	145.9	145.9	—	—	26.4	26.4	—	—	172.3	172.3
Skidmore (No. 7)	—	8.7	—	8.7	—	12.0	38.2	50.2	—	20.7	38.2	58.9
Buck Mountain (No. 5)	—	—	16.0	16.0	—	—	204.1	204.1	—	—	220.1	220.1
All other coal beds	2.0	—	8.1	10.1	42.6	31.0	44.6	118.2	44.6	31.0	52.7	128.3
Total	2.0	8.7	207.8	218.5	42.6	43.0	1291.4	1377.0	44.6	51.7	1499.2	1595.5

Average thickness and range in thickness of Llewellyn coal beds based on 956 observations

[Thicknesses obtained from mining company data. Local coal beds and riders not shown]

	Coal bed	Number of observations	Bed thickness (ft) Average	Bed thickness (ft) Maximum	Bed thickness (ft) Minimum	Coal thickness (ft) Average	Coal thickness (ft) Maximum	Coal thickness (ft) Minimum	Average percent of refuse
	Faust (No. 21)	0	—	—	—	—	—	—	—
	Rabbit Hole (No. 20)	2	—	—	—	—	—	—	—
	Tunnel (No. 19)	7*	4.8	9.5	0.8	4.8	9.5	0.8	—
	Peach Mountain (No. 18)	12*	2.6	7.9	0.5	2.6	7.9	0.5	—
	Little Tracy (No. 17)	6*	4.6	6.4	0.8	4.6	6.4	0.8	—
	Upper Four Foot (No. 16½)	0	—	—	—	—	—	—	—
	Tracy (No. 16)	6*	2.2	2.6	0.6	2.2	2.6	0.6	—
	Little Clinton (No. 15½)	11*	2.3	8.0	0.5	2.3	8.0	0.5	—
	Clinton (No. 15¼)	18*	2.6	5.0	0.5	2.6	5.0	0.5	—
	Little Diamond (No. 15)	0	—	—	—	—	—	—	—
	Diamond (No. 14)	46	3.9	10.3	0.9	3.8	10.3	0.8	4.2
	Orchard (No. 12)	133	8.8	28.0	2.0	8.1	20.1	2.0	8.3
	Holmes-Primrose (No. 10-11)	202	10.8	30.0	1.9	10.0	30.0	1.9	7.8
	Holmes (No. 10)	21	9.4	37.1	1.0	9.3	37.1	1.0	1.8
Mammoth coal zone	Top Split (No. 9)	41	16.4	51.0	1.5	15.6	51.0	1.5	5.0
	Middle Split (No. 8½)	80	25.9	144.0	4.0	24.9	126.5	3.6	4.1
	Bottom Split (No. 8)	151	17.7	103.8	1.0	16.8	103.5	1.0	5.1
	Skidmore (No. 7)	115	4.5	17.7	0.4	4.0	17.7	0.4	12.1
	Buck Mountain (No. 5)	105	11.1	27.0	0.8	9.7	27.0	0.8	11.8

* Observations are in local areas and are not indicative of more than local average, maximum, and minimum. Data not adequate for determining average percent of refuse.

INDEX MAP SHOWING LOCATION OF THIS MAP AND NEARBY PUBLISHED U.S. GEOL. SURVEY COAL MAPS (C) AND MISCELLANEOUS INVESTIGATIONS SERIES (I)

75°52'30"
40°50'
57'30"
76°00'
40°47'30"
55'
Greenwood Dam
Tamaqua Reservoir
Hometown
Skyview Memorial Park
Haupt Dam
Mauch Chunk Ridge
Locust Mountain
Sharp Mountain
Pisgah Hill
Broad Mountain
Little Schuylkill River
Big Creek
Lower Creek
White Bear Creek
Little Creek
Panther Creek
Mmm
PPmmu
PPps
PPpc
PPpt
PPl
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B
B'
C
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D
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F
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J
J'
X
Y
R
Z
HAUTO RAILROAD TUNNEL
NORTH NO. 9 SHAFT
SOUTH NO. 9 SHAFT
NO. 8 EAST TUNNEL
NO. 8 WEST TUNNEL
NO. 9 TUNNEL
NO. 10 SHAFT
NO. 15 SHAFT
NO. 14 SHAFT
NO. 17 SHAFT
FOSTERS TUNNEL
GREENWOOD WATER LEVEL TUNNEL
NEWKIRK SLOPE
NEWKIRK WATER LEVEL TUNNEL
NEWKIRK TUNNEL
MIDDLE MOUNTAIN SYNCLINE
SOUTH MOUNTAIN SYNCLINE
SOUTH COALDALE ANTICLINE
NORTH COALDALE ANTICLINE
FOSTERS ANTICLINE
SUMMIT HILL SYNCLINE
LANSFORD ANTICLINE
PANTHER CREEK SYNCLINE
BUCK MOUNTAIN SYNCLINE
BUCK MOUNTAIN ANTICLINE
BOTTOM SYNCLINE
BOTTOM ANTICLINE
NORTH MOUNTAIN SYNCLINE
NORTH MOUNTAIN ANTICLINE
BROAD MOUNTAIN SYNCLINE
BROAD MOUNTAIN ANTICLINE
LOCUST MOUNTAIN ANTICLINE
LOCUST MOUNTAIN SYNCLINE
SHARP MOUNTAIN ANTICLINE
SHARP MOUNTAIN SYNCLINE
PISGAH HILL SYNCLINE
PISGAH HILL ANTICLINE
BROAD MOUNTAIN FAULT
LOCUST MOUNTAIN FAULT
SUMMIT FAULT
LANSFORD FAULT
LANDINGS FAULT
BLACKWOOD FAULT
GREENWOOD FAULT
NEWKIRK TUNNEL FAULT
MINE HILL FAULT
PANTHER CREEK FAULT
BOTTOM FAULT
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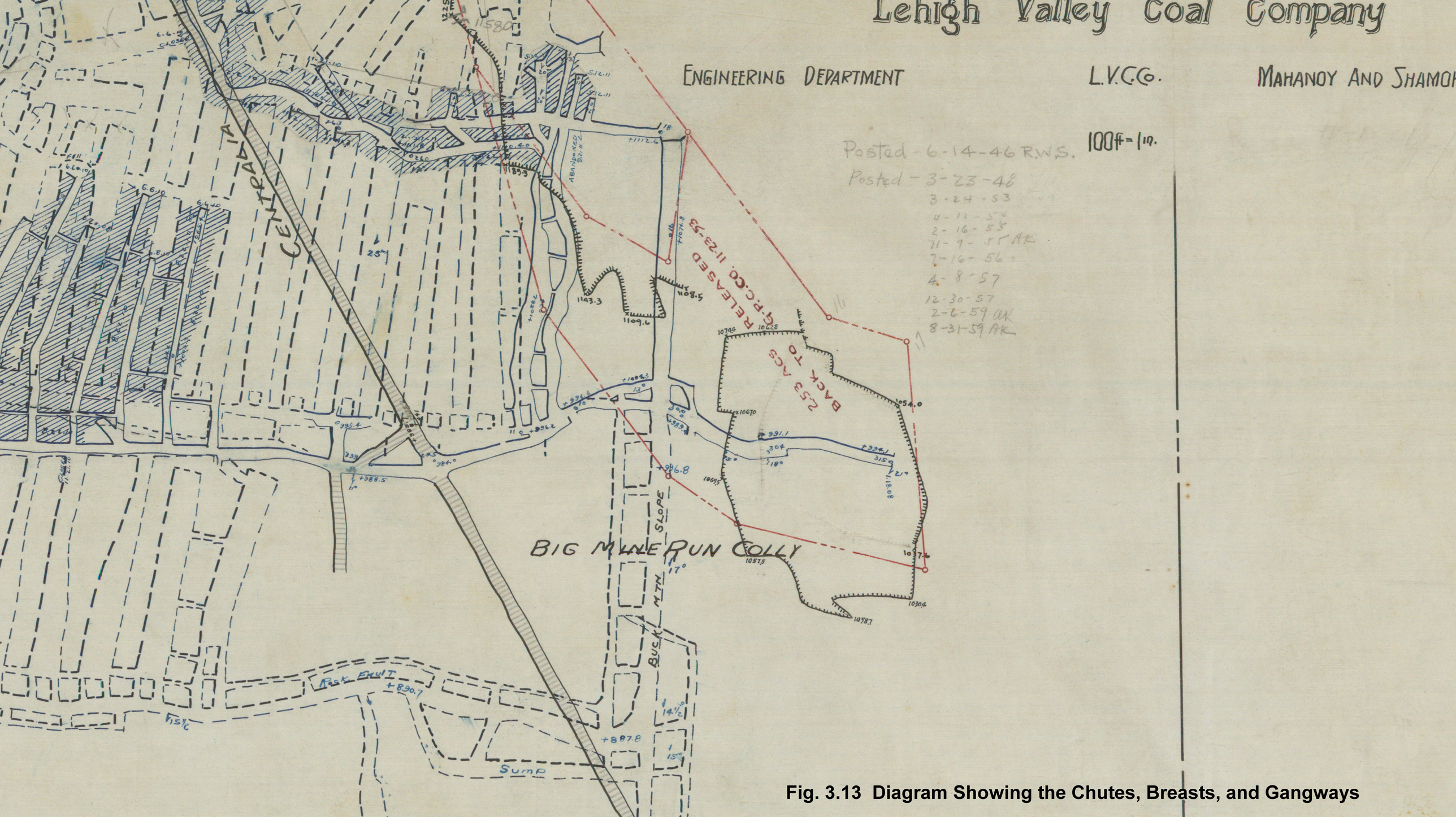


Fig. 3.13 Diagram Showing the Chutes, Breasts, and Gangways

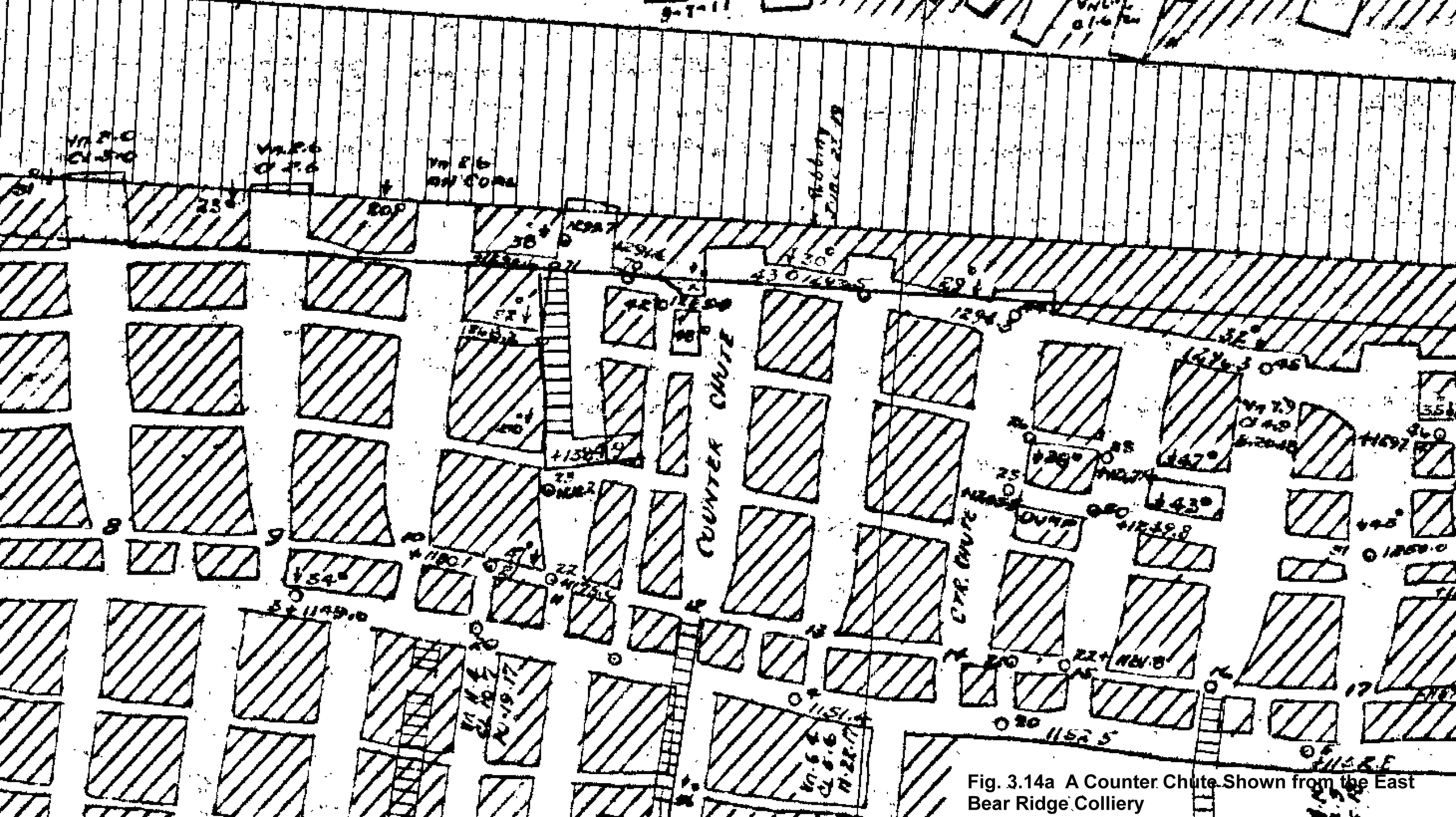


Fig. 3.14a A Counter Chute Shown from the East Bear Ridge Colliery

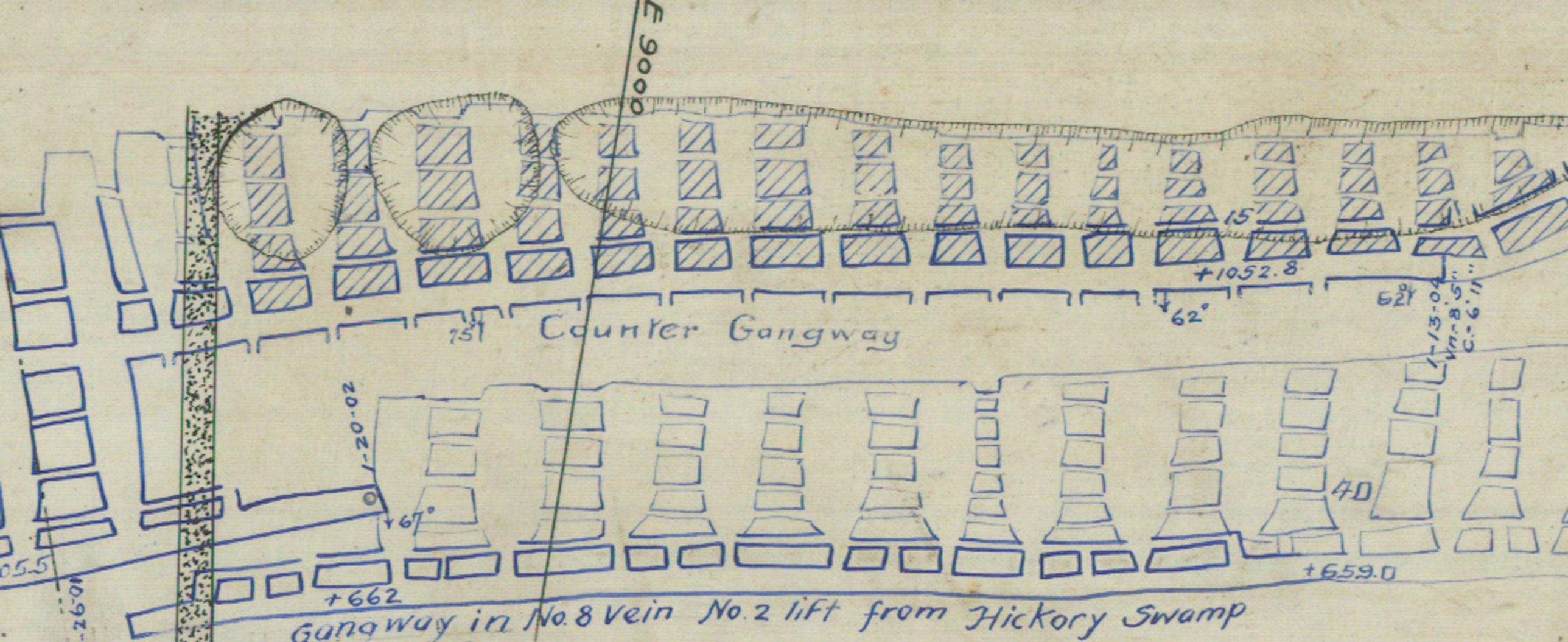


Fig. 3.14b A Counter Gangway Used to Transport Coal from the Upper Chutes and Breasts Westward within the Richards Colliery

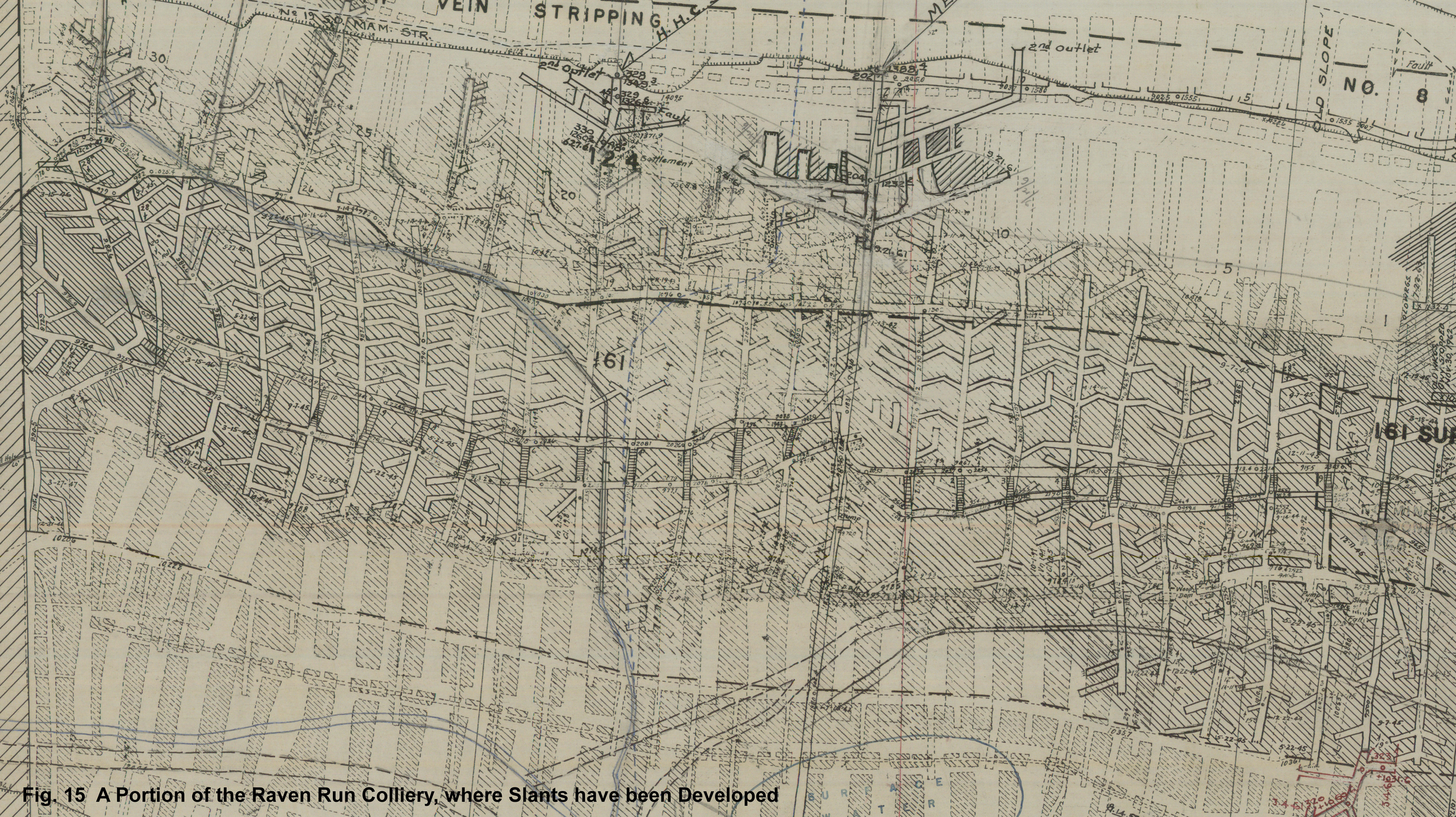


Fig. 15 A Portion of the Raven Run Colliery, where Slants have been Developed

Fig. 16a Another Example of Slants from the William Penn Colliery

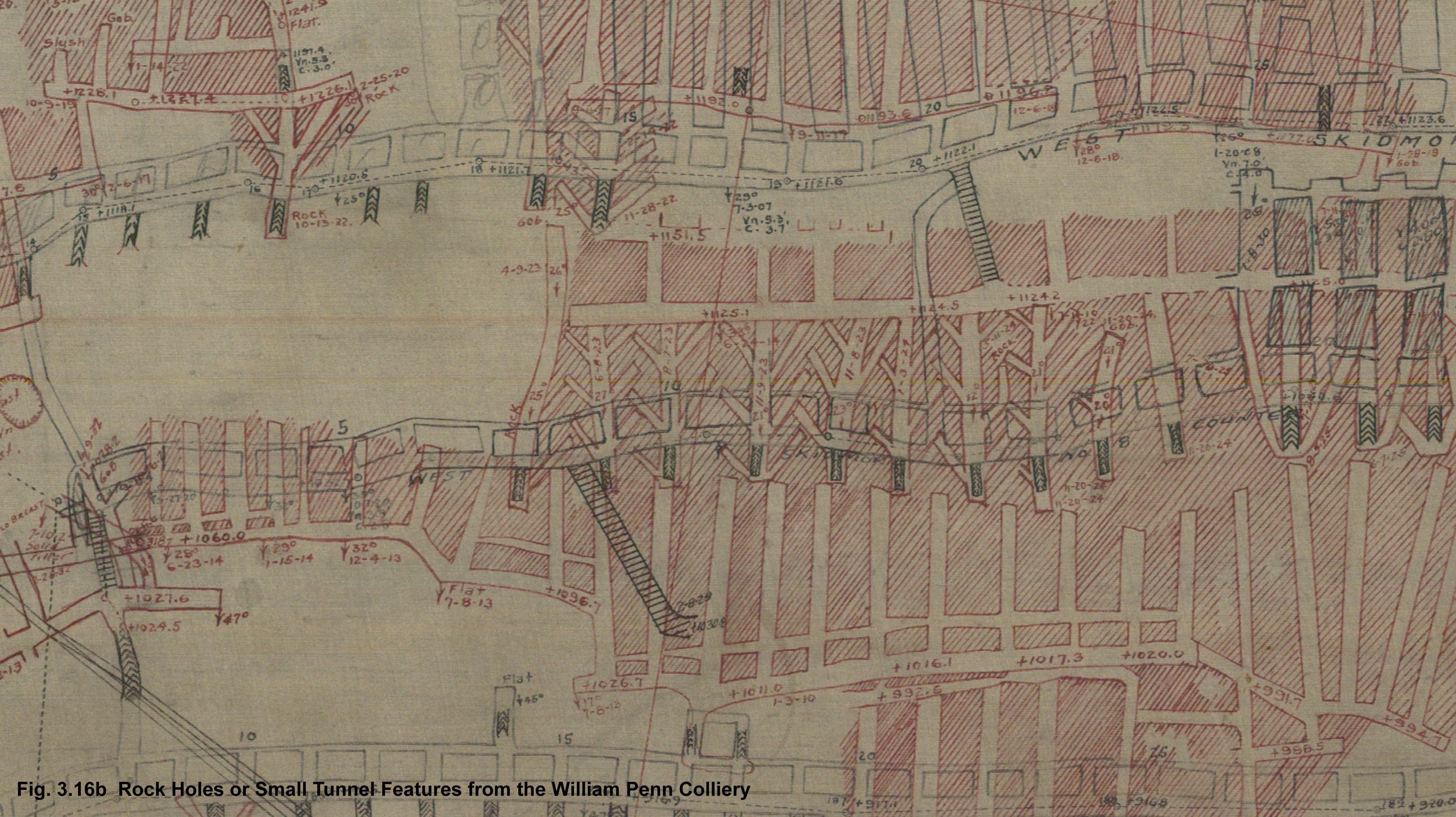


Fig. 3.16b Rock Holes or Small Tunnel Features from the William Penn Colliery

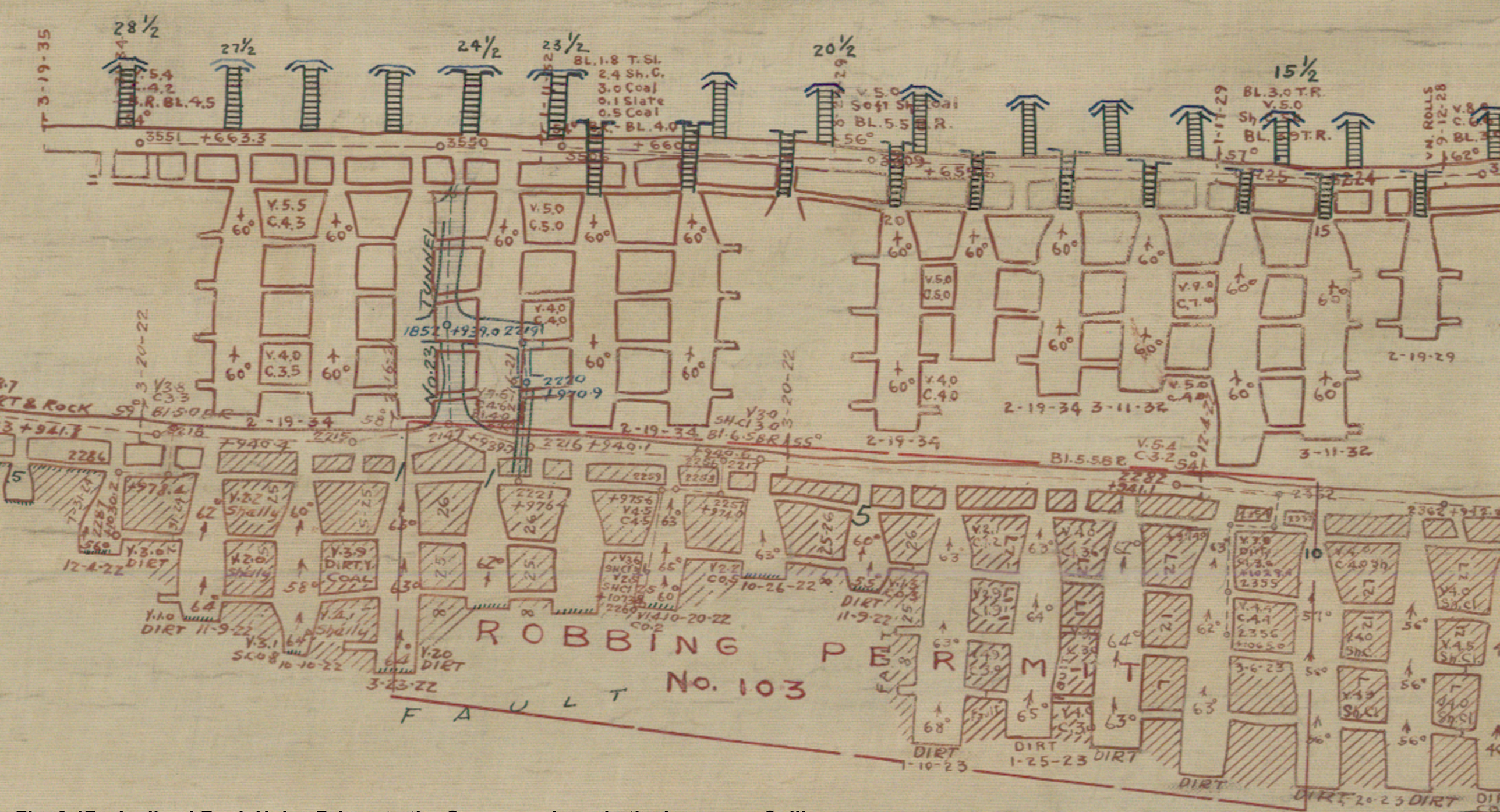


Fig. 3.17a Inclined Rock Holes Driven to the Gangway above in the Lawrence Colliery

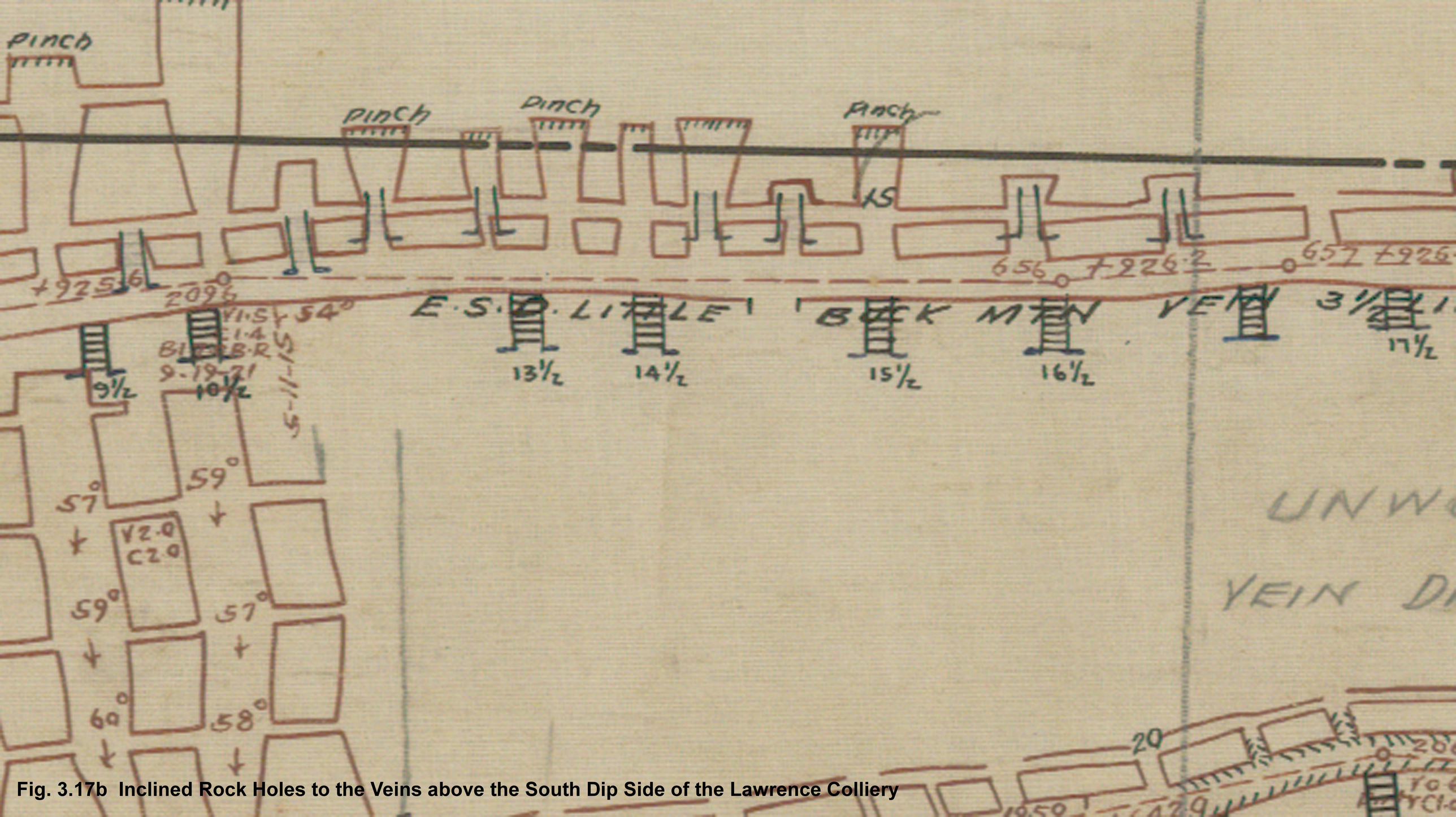


Fig. 3.17b Inclined Rock Holes to the Veins above the South Dip Side of the Lawrence Colliery

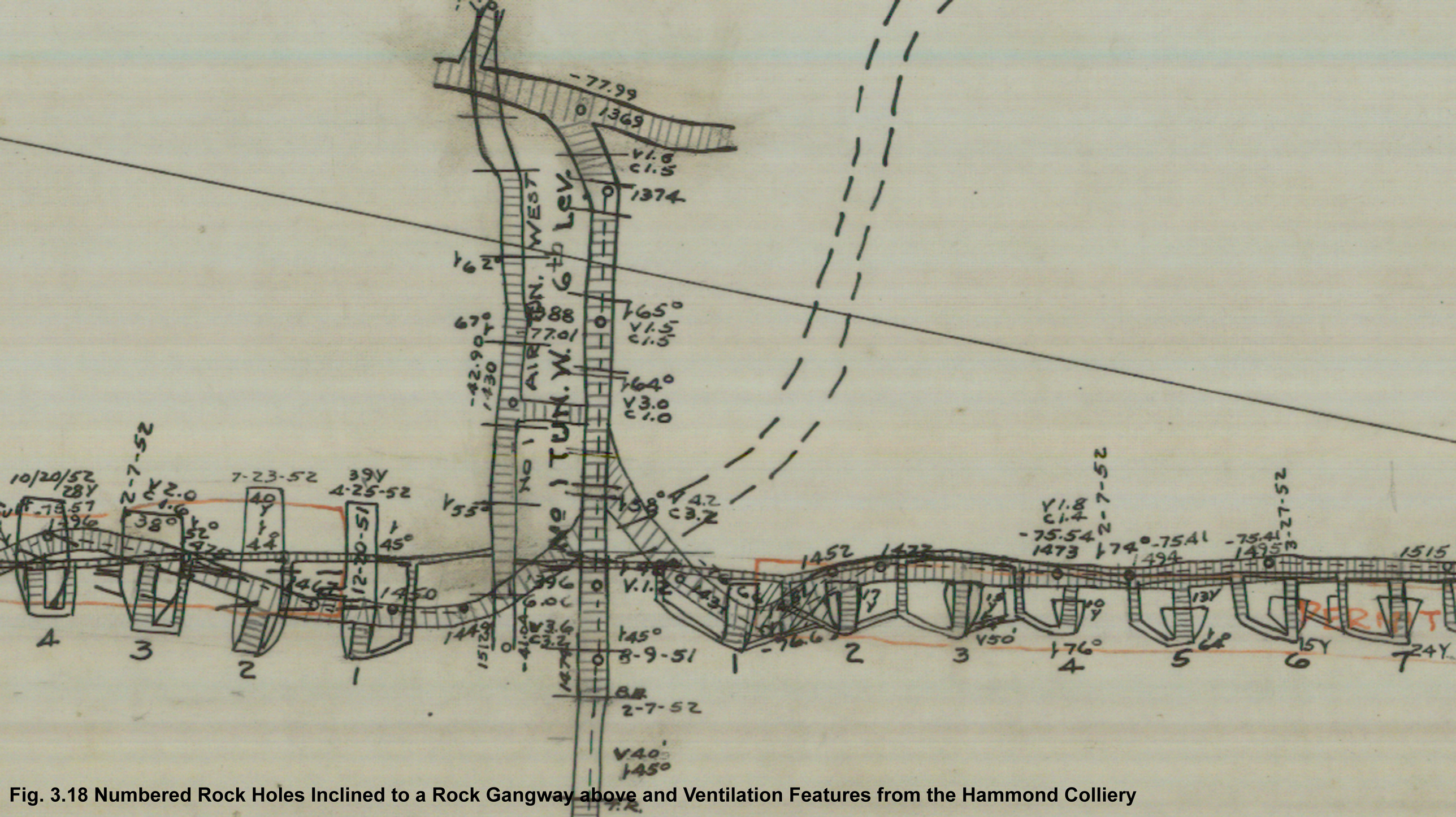


Fig. 3.18 Numbered Rock Holes Inclined to a Rock Gangway above and Ventilation Features from the Hammond Colliery

Fig. 3.19 3 Levels of Anthracite Mining on the Top Split of the Mammoth Coal Vein form the Locust Gap Colliery

Fig. 3.2 A Typical 4-Compartment Shaft in the Gilberton Colliery

Fig. 3.20a Barrier Pillars in the Kohinoor and Keehley Run Colliery

Fig. 3.20b A More Complex Barrier Pillar Configuration in the Mahanoy City Colliery

Fig. 3.20c A Longitudinal Barrier Basin Pillar Maintained along the Strike in the Base of the Syncline from the Hammond and Packer #5 Collieries

Fig. 3.21 A "Stopped" Date Mining Development of Gangways and Breasts at the Edge of a Barrier Pillar

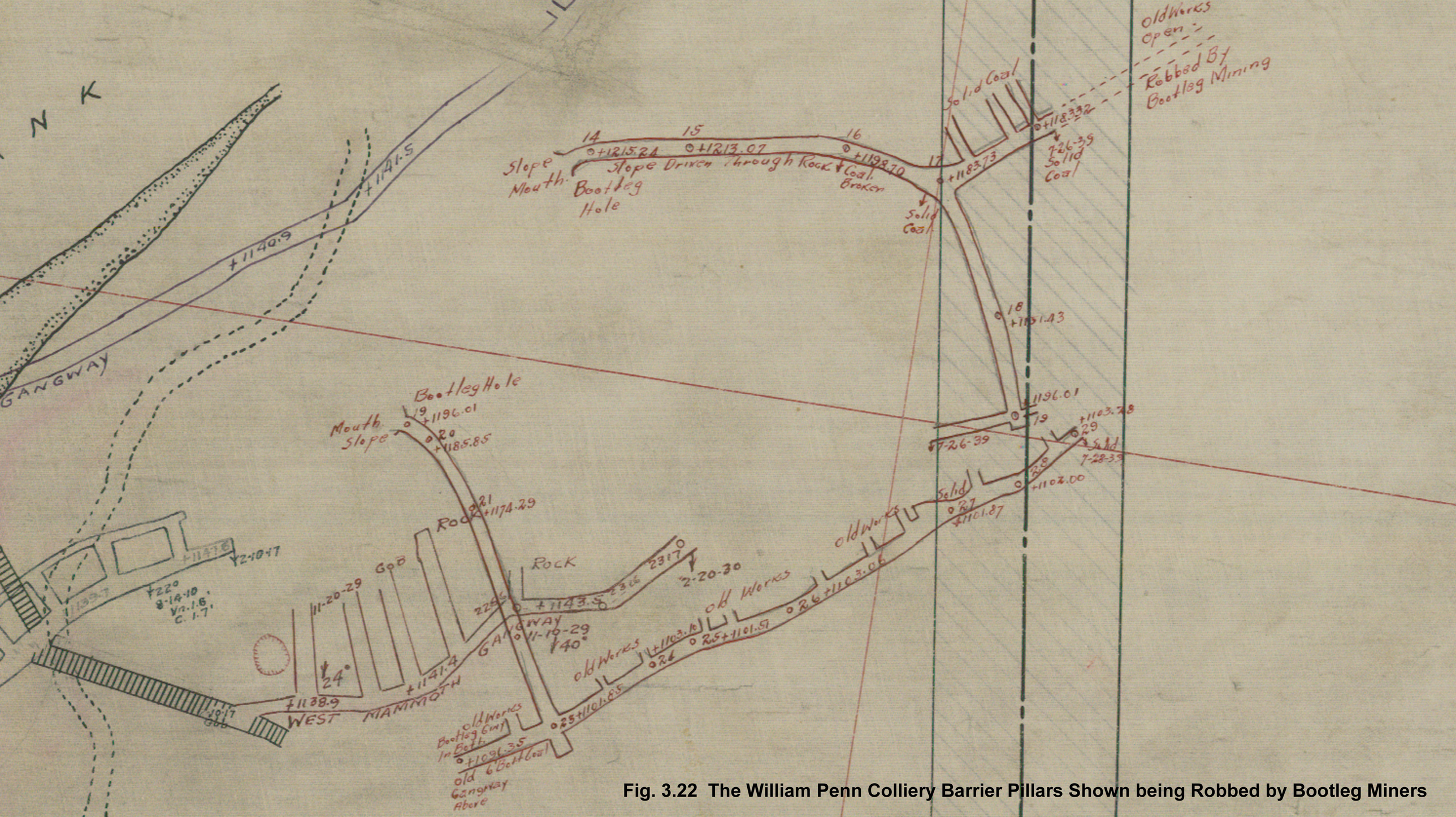


Fig. 3.22 The William Penn Colliery Barrier Pillars Shown being Robbed by Bootleg Miners

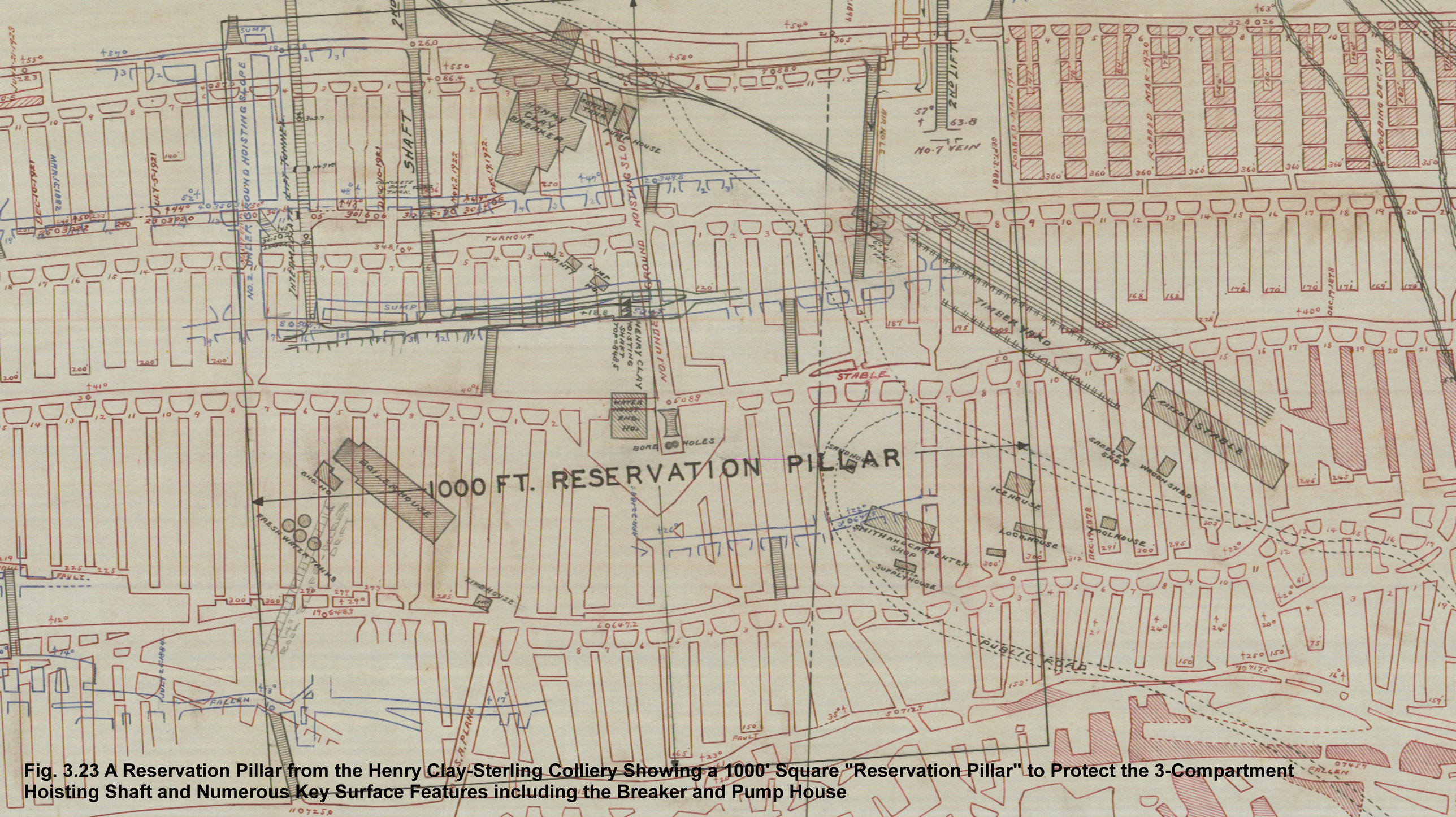


Fig. 3.23 A Reservation Pillar from the Henry Clay-Sterling Colliery Showing a 1000' Square "Reservation Pillar" to Protect the 3-Compartment Hoisting Shaft and Numerous Key Surface Features including the Breaker and Pump House

Fig. 3.24 A Large Circulation Reservation Pillar surrounding the 3-Compartment Indian Ridge Shaft from the Indian Ridge Colliery

Fig. 3.25a A Plunging Synclinal Basin from the Richards Colliery

Fig. 3.25b A Pattern of Curving Gangways in a Plunging Syncline from the Pennsylvania Colliery

Fig. 3.26a A Gently Dipping Longitudinal Barrier Pillar of Coal Located North of the Barrier Pillar in the Scott Colliery

Fig. 3.26b A Different Configuration of the Barrier Pillar from the Scott Colliery, adjacent to the Pennsylvania Colliery

Fig 3.3a Two Shafts from the Kohinoor Colliery on the Little Buck Vein

Fig 3.3a Two Shafts from the Kohinoor Colliery on the Little Buck Vein

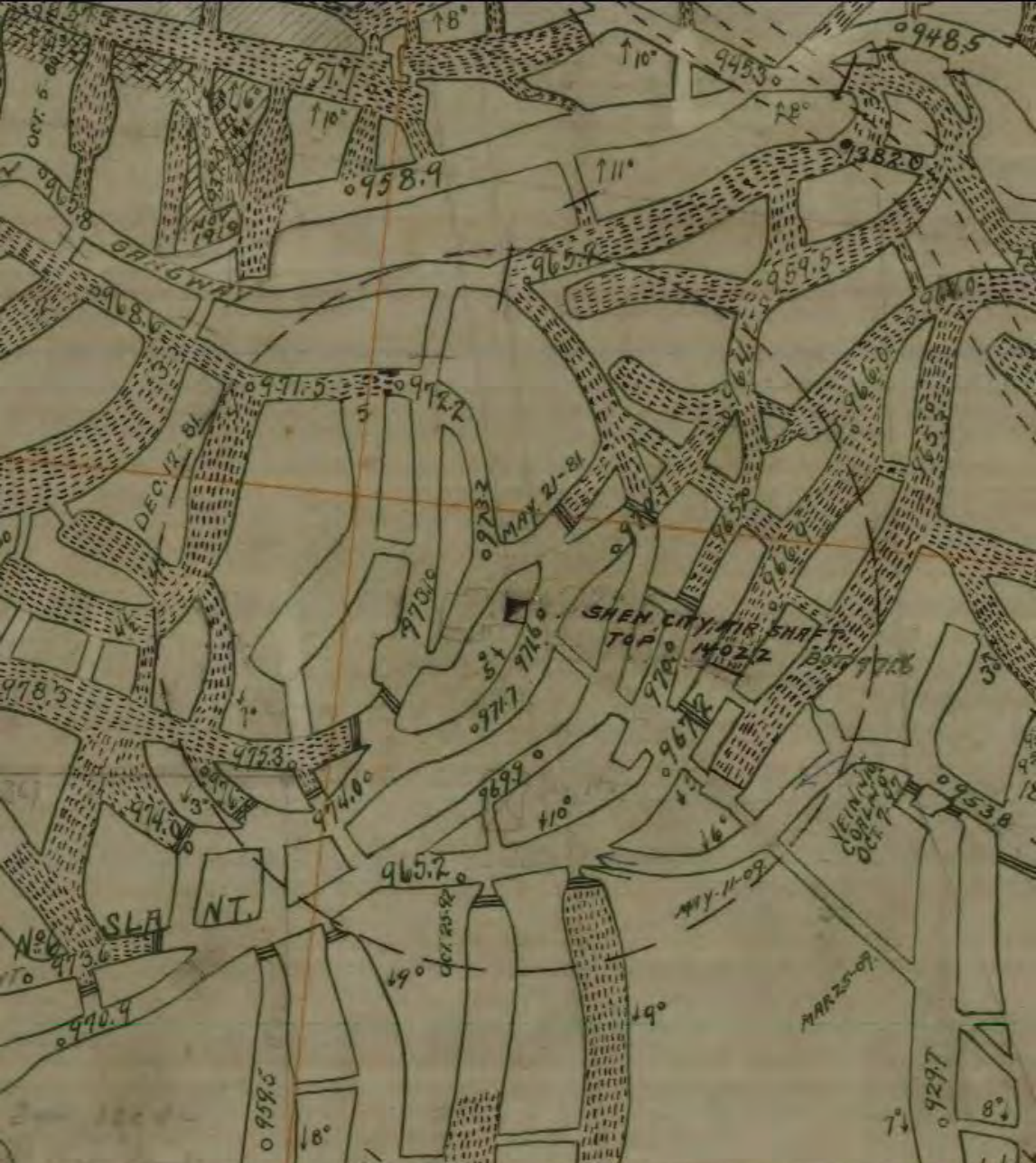


Fig 3.3b Two Shafts from the Maple Hill Colliery

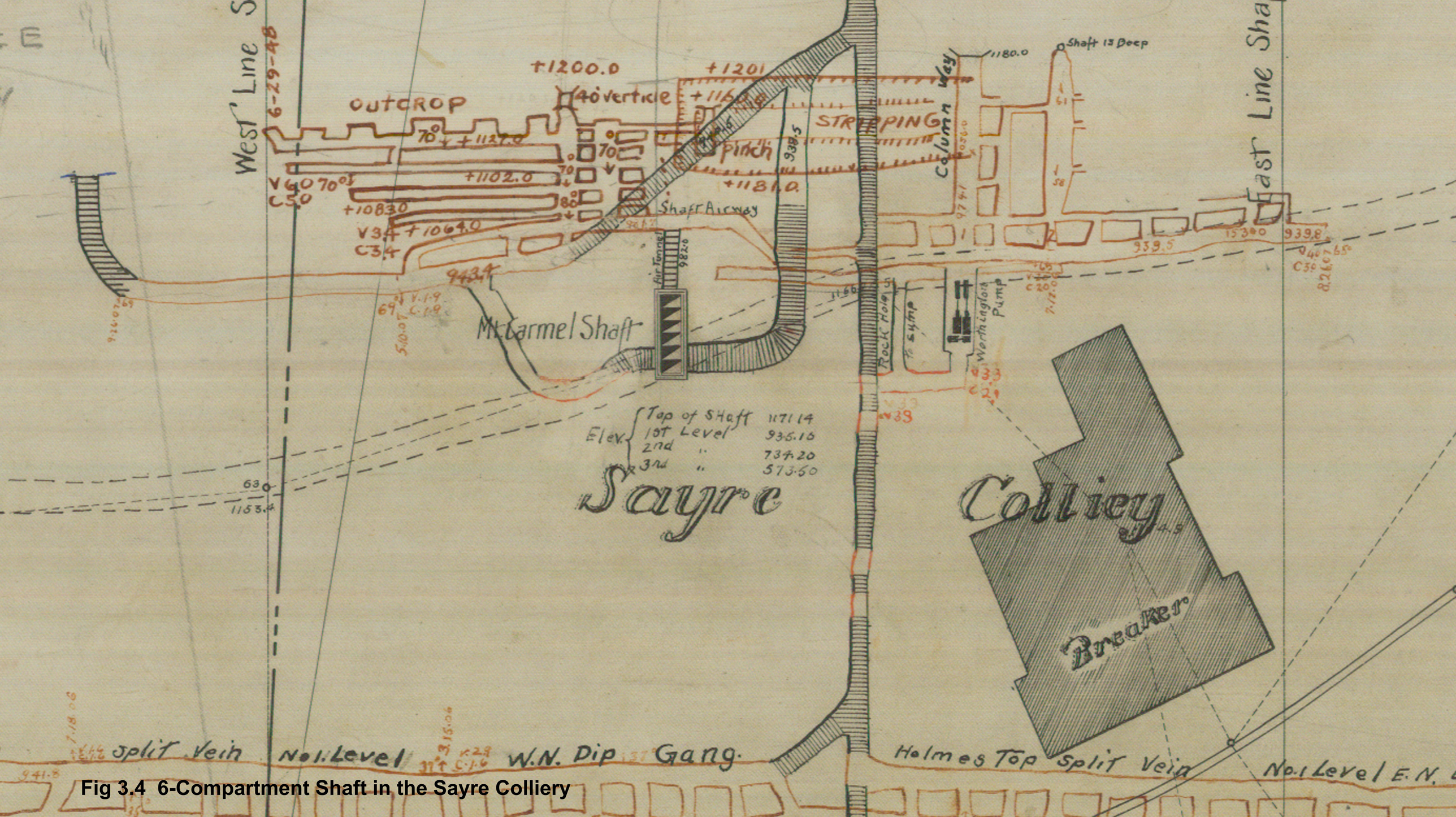


Fig 3.4 6-Compartment Shaft in the Sayre Colliery

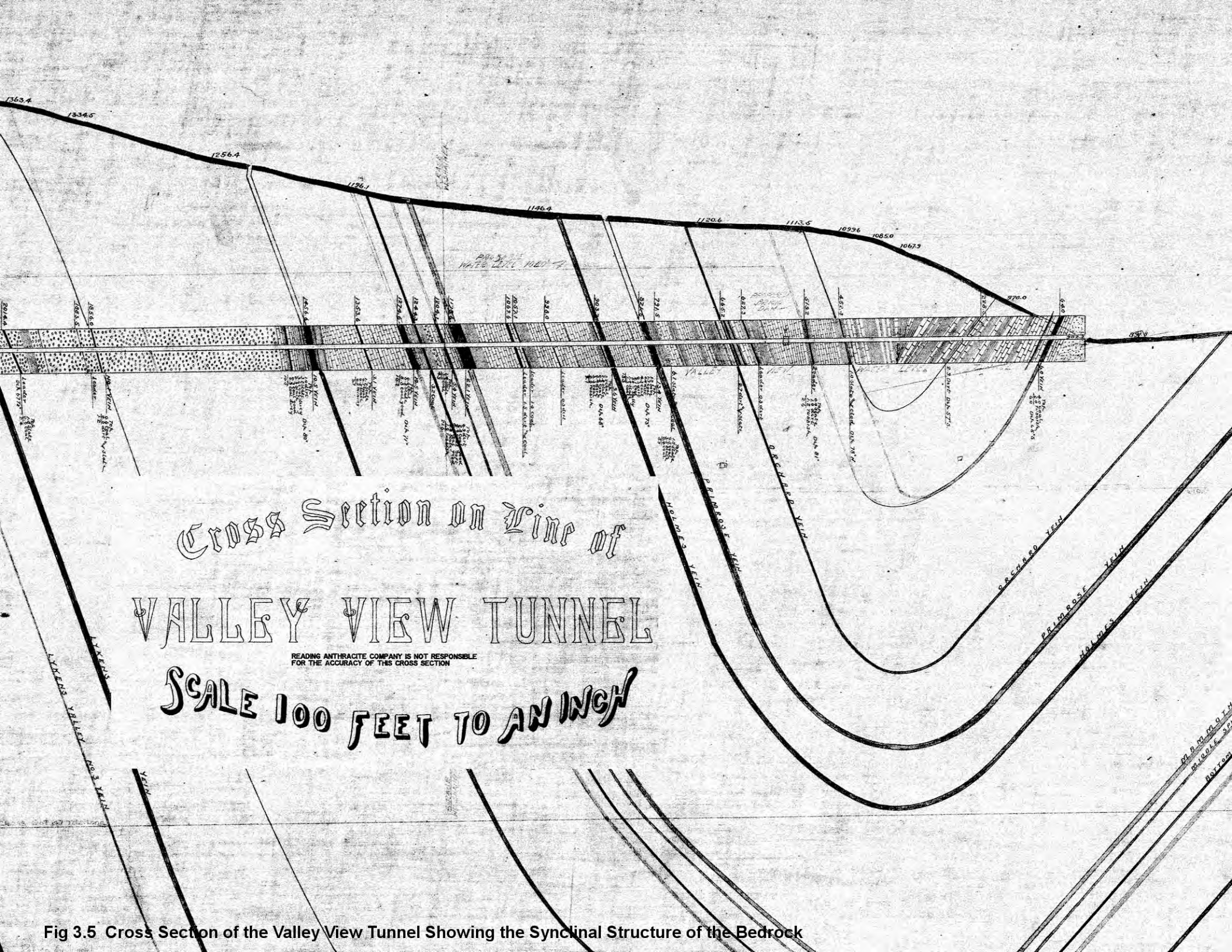


Fig 3.5 Cross Section of the Valley View Tunnel Showing the Synclinal Structure of the Bedrock

Figure 3.6 Photo of the R & S Drift Entry, Pottsville, PA

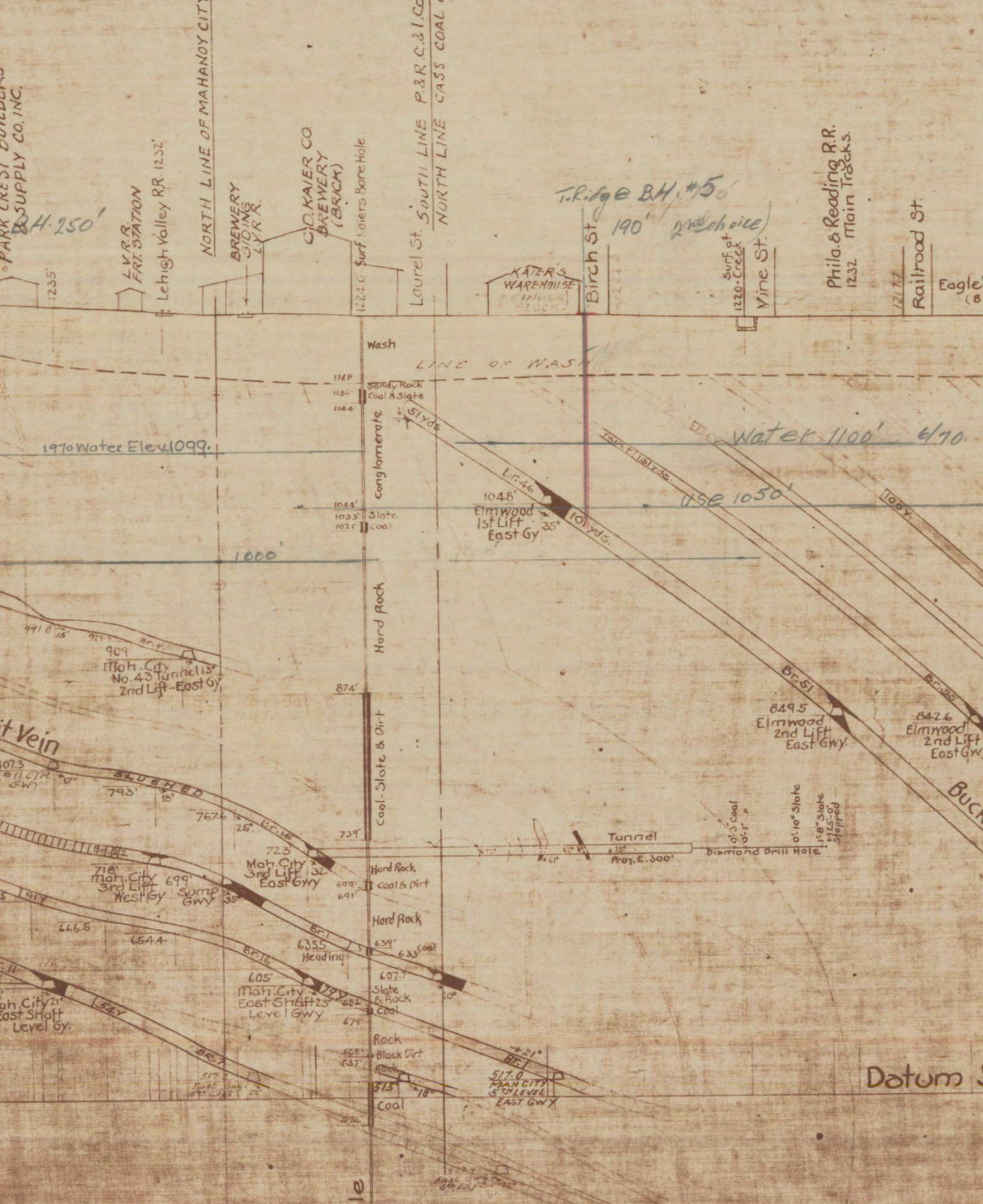


Fig 3.7 A Portion of the Kaiers Mine Workings near the Kaiers Borehole

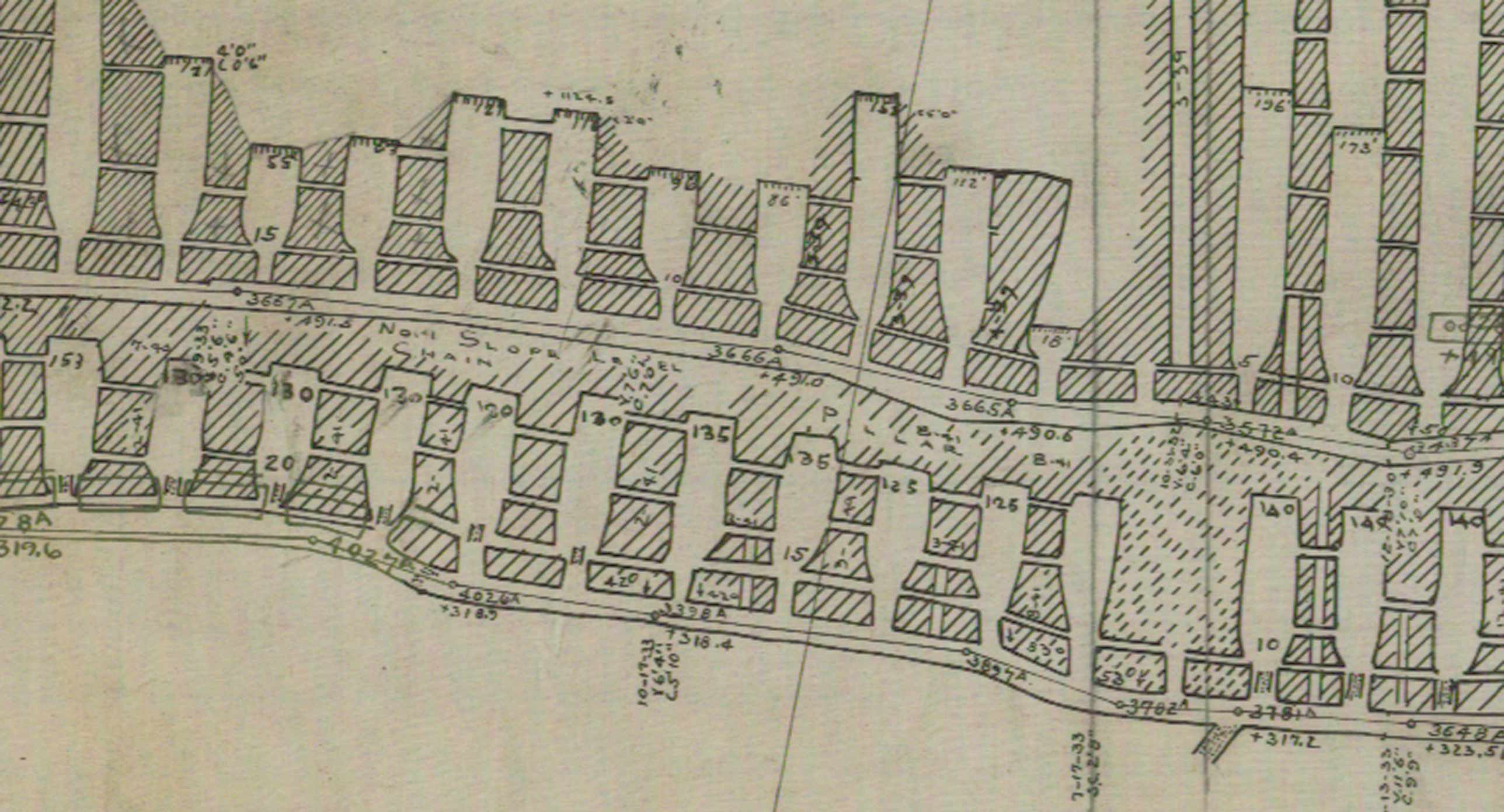


Fig. 3.8 Gangways on Two Lifts, with Chutes, Breasts, and Cross-Hatched Pillars in the Glen Burn Colliery, near Shamokin, PA

Fig. 3.9a Drawing of the Saint Nicholas and Suffolk Collieries

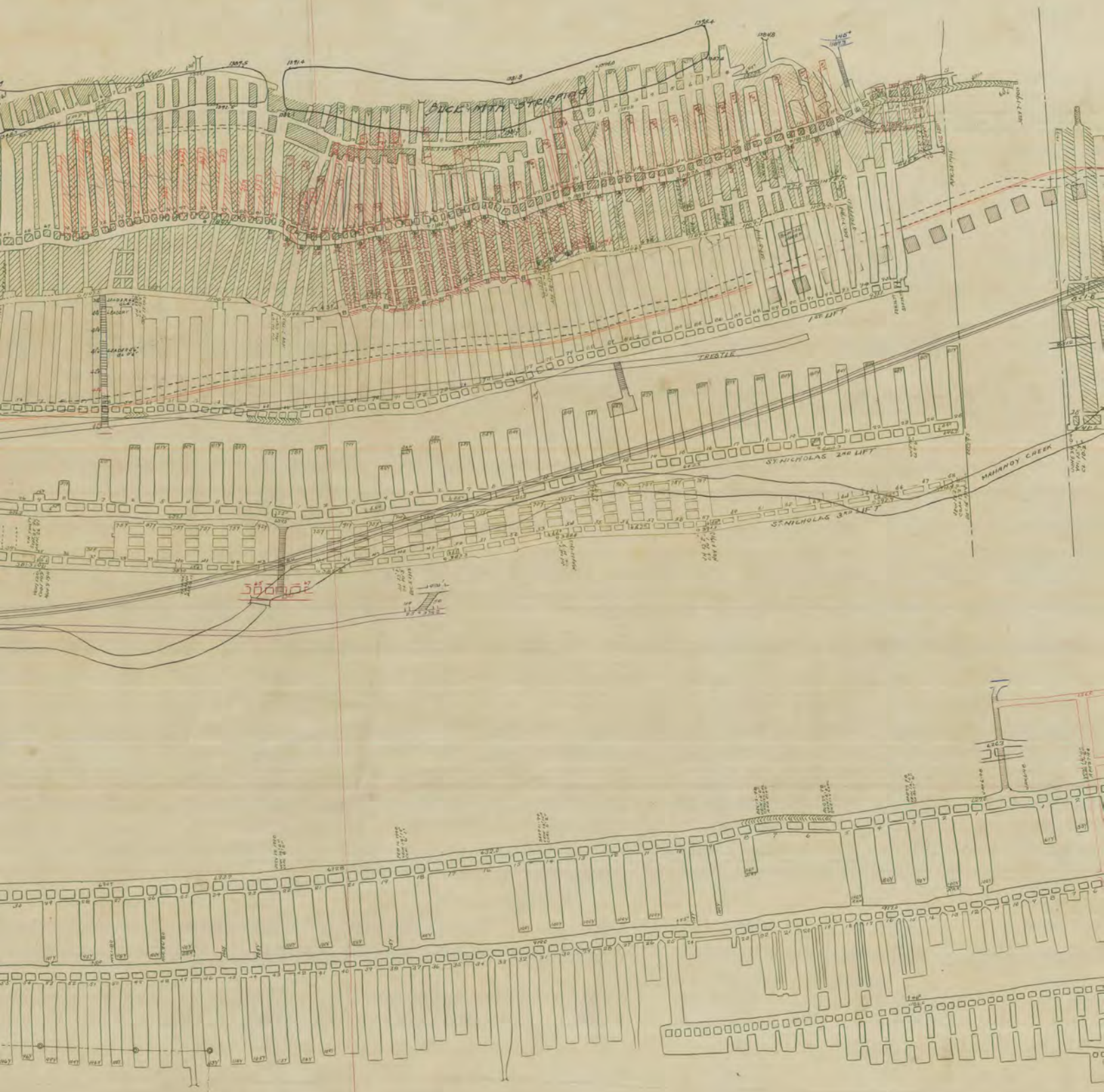


Fig. 3.9b Eastern Portion of the Saint Nicholas Colliery in the Buck Mountain Coal Bed with the Bottom Split of the Mammoth Coal Bed Overlaying the Buck Mountain Workings

Fig. 13 A Portion of the Germantown or Locust Run Colliery Showing the Centralia Drainage Tunnel Running Diagonally Across the South Dip Workings from the Centralia Colliery to the North

COLUMBIA COUNTY
SCHUYLKILL COUNTY

"B"

"A"

GERMANTOWN MINE
LOCUST RUN SECTION

BIG MINE RUN COLLIERY

E 21000

S 5000

STRIPPING

SKIDMORE

HERMIT NO 412

MAMMOTH SLOPE

WATERWAY
LDR. VEIN

SLOPE

FIRST LIFT GANGWAY.
+7560

PRIMROSE GWY.

WEST GWY. FROM BAST COLLIERY

PRIMROSE DRIFT

SOLID LINES L.V.C.CO'S SURVEYS
DOTTED " COPIED FROM P&R MAPS.

Table 1. Historic (Ash), Scarlift and Current Mine Pool Extents and Mulit-Colliery Hydrologic Units

	Extents in Acres				
Colliery / Pool Name	Historic (1950's [1])	Scarlift (1970's [2])	Current (2000's[3])	Multi-Colliery Unit	Watershed
Park #1 Pool (1)	64.48	135.54	225.53	Packer	Mahanoy
North Mahanoy (2)	66.12	288.57	404.56	Packer	Mahanoy
Knickerbocker Pool (3)	68.71	211.04	130.62	Packer	Mahanoy
Shenandoah City Pool (4)	150.48	233.87	967.61	Packer	Mahanoy
Indian Ridge Pool (5)	151.97	209.66	see pool 4	Packer	Mahanoy
Kehley Run Pool (6)	28.71	76.51	"	Packer	Mahanoy
Kehley Run Pool (6A)	10.62	see pool 6	"	Packer	Mahanoy
Kohinoor Pool (7)	62.23	184.91	"	Packer	Mahanoy
West Shenandoah Pool (7)	55.44	266.77	"	Packer	Mahanoy
Wm. Penn Pool (7A)	24.49	189.56	157.95	Packer	Mahanoy
- Hammond	0.00	409.25	166.30	Packer	Mahanoy
- Packer #5	0.00	420.44	130.50	Packer	Mahanoy
- Packer #2	0.00	487.33	398.85	Packer	Mahanoy
East Bear Ridge Pool (8)	133.91	140.68	n.d.	Packer	Mahanoy
Maple Hill Pool (9)	30.65	882.13	859.71	Packer	Mahanoy
Mahanoy City Pool (10)	43.13	337.54	see pool 2	Packer	Mahanoy
Primrose Pool (11)	117.07	184.91	291.27	Packer	Mahanoy
Vulcan - Buck Mtn Pool (12)	368.10	454.45	513.20	Vulcan	Mahanoy
Tunnel Ridge Pool (13)	298.08	278.15	282.26	Gilberton	Mahanoy
St. Nicholas Pool (14)	191.71	228.10	182.45	Gilberton	Mahanoy
Boston Run Pool (15)	107.62	98.72	92.67	Gilberton	Mahanoy
Gilberton Pool (16) / Draper	312.43	319.57	224.83	Gilberton	Mahanoy
Lawrence Pool (17)	215.23	218.44	64.06	Gilberton	Mahanoy
West Bear Ridge Pool (18)	98.24	102.60	22.68	Girard	Mahanoy
Girard Pool (19)	142.10	148.57	45.95	Girard	Mahanoy
Preston #3 Pool (20)	94.78	149.01	73.46	Preston	Mahanoy
Tunnel Pool (21)	84.73	171.37	72.67	Potts & Tunnel	Mahanoy
Bast Pool (22)	431.56	664.62	364.48	Bast	Mahanoy
Big Mine Run (23) / Germantown	63.60	382.98	220.71	Bast	Mahanoy
Cambria Pool (24)	5.83	see pool 25	see pool 25	Potts & Tunnel	Mahanoy
Potts Pool (25)	5.40	899.44	342.78	Potts & Tunnel	Mahanoy
Lavelle Mine Pool (26)	9.08	n.d.	n.d.	Lavelle	Mahanoy
Helfenstein (27)	16.60	n.d.	n.d.	Helfenstein	Mahanoy
- Morea	n.d.	n.d.	224.40	Morea	Schuylkill
- Weston	n.d.	487.33	8.55	Weston	Mahanoy
Raven Run Pool (28)	182.07	191.93	n.d.	Raven Run	Mahanoy
Centralia Pool (29)	267.06	360.59	260.88	Centralia	Mahanoy
- Continental	0.00	177.00	see pool 29	Centralia	Mahanoy
- Locust Gap / Locust Spring	0.00	1316.74	111.35	Locust Gap	Mahanoy
Midvalley #11 Pool (30)	11.00	see pool 49	see pool 49	Midvalley	Shamokin
Midvalley #3 Pool (31)	32.28	"	26.05	Midvalley	Shamokin
Sayre-Sioux Pool (32)	788.44	see pool 34	29.92	Scott	Shamokin
Pennsylvania Pool (33)	760.88	"	see pool 34	Scott	Shamokin
Scott Ridge Pool (34)	544.49	4410.02	663.67	Scott	Shamokin
Excelsior #3 Slope Pool (35)	68.37	see pool 36	see pool 36	Maysville-Corbin	Shamokin
- Maysville	0.00	337.63	n.d.	Maysville-Corbin	Shamokin
Enterprise Pool (36)	358.74	3061.38	296.43	Maysville-Corbin	Shamokin
- Reliance	0.00	see pool 36	109.32	Maysville-Corbin	Shamokin
- Alaska	0.00	see pool 36	726.19	Maysville-Corbin	Shamokin
Corbin Pool (37)	156.60	372.65	132.05	Maysville-Corbin	Shamokin
Buck Ridge #2 Pool (38)	153.27	287.03	n.d.	Maysville-Corbin	Shamokin
Greenback Pool (39)	102.30	see pool 48	40.38	Maysville-Corbin	Shamokin
Neilson Pool (40)	175.70	204.60	n.d.	Cameron	Shamokin
Henry Clay - Sterling Pool (41)	752.91	2316.70	n.d.	Sterling	Shamokin
Big Mountain Pool (42)	495.44	789.36	n.d.	Big Mountain	Shamokin
Burnside Pool (43)	415.24	see pool 41	71.35	Sterling	Shamokin
Bear Valley Pool (44)	548.66	see pool 41	77.30	Sterling	Shamokin

North Franklin Pool (45)	886.81	784.58	119.79	Maysville-Corbin	Mahanoy
Royal Oak Pool (46)	92.93	229.74	n.d.	Maysville-Corbin	Shamokin
Excesior No.1 Under SIope (47)	133.02	see pool 36	n.d.	Maysville-Corbin	Shamokin
Buck Ridge #1 Pool (48)	38.80	70887.04	287.03	Maysville-Corbin	Shamokin
Midvalley #1-2 Pool (49)	235.31	820.71	180.24	Maysville-Corbin	Shamokin
Richards Shaft (50)	452.82	see pool 34	231.90	Scott	Shamokin
Richards Water Lvl.Tunl. Pool (51)	173.91	"	see pool 50	Scott	Shamokin
Greenough Pool (52)	200.27	"	62.75	Scott	Shamokin
Hickory Ridge Pool (53)	58.16	see pool 57	154.52	Cameron	Shamokin
Hickory Swamp Pool (54)	233.59	"	see pool 53	Cameron	Shamokin
Coalbert Pool (55)	217.02	"	113.35	Cameron	Shamokin
Luke Fidler Pool (56)	489.31	"	311.09	Cameron	Shamokin
Cameron Pool (57)	380.26	3055.54	123.96	Cameron	Shamokin
Natalie Pool (58)	600.43	see pool 34	5.58	Cameron	Shamokin
Totals	13459.20	98865.30	10603.16	19	3

1.Bureau of Mines Reports (Ash et. al. 1949) (Ash et. al. 1953)

2. Scarlift Reports: SL-197 Mahanoy (Sanders & Thomas, 1975) & SL-113 Shamokin (Gannett Fleming Corddry and Carpenter, 1972) - Shamokin Scarlift Mine Pool extents are actually Geobasin extents exaggerating area.

3. Current Mine pools were determined based on underground mined out areas on the Buck Mountain Vein from the C-Series Maps at and below the average borehole water levels (or discharges) for the particular mine.

n.d. - not determined due to lack of data

Isolated pools

UNITED STATES DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

COAL INVESTIGATIONS
MAP C10 (IN 3 SHEETS) SHEET 1

GEOLOGY OF ANTHRACITE IN THE EAST-CENTRAL PART OF THE MOUNT CARMEL QUADRANGLE, PENNSYLVANIA

By
Howard E. Rothrock, Holly C. Wagner, Boyd R. Haley and Harold H. Arndt

1951

COAL OUTCROP MAP

SCALE 1:6,000

500 0 500 1000 2000 3000 Feet

Contour interval is 20 feet
Datum is mean sea level

EXPLANATION

- Boundary of mine
- I. MILLER — Warranty tract. *Boundaries are indicated for general orientation and identification but are not authenticated for legal purposes.*
- 2 — Barrier pillar. *Area reserved for barrier pillar in one bed only. Number designates the coal bed.*
- Barrier pillar. *Area reserved for barrier pillar in more than one coal bed.*
- 5 — Coal outcrop. *Solid where location is known, long dashes where uncertain. In areas covered by mine waste, short dashes indicate known locations, dots approximate locations. Number designates coal bed; L, local bed; T, top split.*
- Fault showing dip and relative position of sides. *Real direction of movement not necessarily known; U, upthrown side; D, downthrown side; ⊢ overthrust plate. Fault trace is solid line where accurately known, long dashes where approximately located. In areas covered by mine waste, short dashes indicate known locations, dots approximate locations.*
- Anticline. *Showing crest line*
- Syncline. *Showing trough line*
- Surface opening on a coal bed
- Strip-mined area
- Back-filled stripping
- Exploratory trench. *Bar shows where coal was found.*
- Crop fall. *Collapsed area where coal has fallen into underground workings.*
- Mine waste. *Includes such refuse from mining and breaker operations as culm, rock banks, cast piles, back fill, and silt in settling basins.*
- Stream-transported waste
- A——A′ Structural cross section

Base: U. S. Geological Survey topographic map.
Polyconic projection. 1927 North American datum.

Topography was contoured from aerial photographs made in 1942. Correction has generally not been made for topographic changes resulting from strip mining or alteration of mine refuse banks since 1942.

APPROXIMATE MEAN DECLINATION, 1944

DIAGRAM OF A TOPOGRAPHIC QUADRANGLE SHOWING THE AREA INCLUDED IN THIS MAP

Prepared in 1950 from data supplied by the Hazle Brook Coal Company, Lehigh Valley Coal Company, Natalie Coal Corporation, Philadelphia and Reading Coal and Iron Company, and the Susquehanna Collieries Company, with modifications by the U. S. Geological Survey, Department of the Interior.

Drafted by John T. Howells and Robert W. Banks

COAL INVESTIGATIONS
MAP C10 (IN 3 SHEETS) SHEET 1

For sale by U. S. Geological Survey, price $1.50 per set

UNITED STATES DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

COAL INVESTIGATIONS
MAP C10 (IN 3 SHEETS) SHEET 2

GEOLOGY OF ANTHRACITE IN THE EAST-CENTRAL PART OF THE MOUNT CARMEL QUADRANGLE, PENNSYLVANIA

By
Howard E. Rothrock, Holly C. Wagner, Boyd R. Haley and Harold H. Arndt

1951

STRUCTURE MAP OF THE BUCK MOUNTAIN COAL BED

SCALE 1:6,000

500 100 0 500 1000 2000 3000 Feet

Contour interval is 100 feet
Datum is mean sea level

Polyconic projection. 1927 North American datum.

9° TRUE NORTH / MAGNETIC NORTH
APPROXIMATE MEAN DECLINATION, 1944

DIAGRAM OF A TOPOGRAPHIC QUADRANGLE SHOWING THE AREA INCLUDED IN THIS MAP

Prepared in 1950 from data supplied by the Hazle Brook Coal Company, Lehigh Valley Coal Company, Natalie Coal Corporation, Philadelphia and Reading Coal and Iron Company, and the Susquehanna Collieries Company, with modifications by the U. S. Geological Survey, Department of the Interior.

EXPLANATION

Boundary of mine

I. MILLER

Warranty tract
Boundaries are indicated for general orientation and identification but are not authenticated for legal purposes.

Outcrop of coal bed

700 400 600 300 500

Contours on the bottom of the contoured coal bed
Solid in mined areas; long dashes in unmined areas; in those places when a part of the bed lies beneath another part of the same bed short dashes are used in mined areas, and very short dashes in unmined areas.

Fault cutting contoured bed showing dip of fault plane, relative position of faulted segments, and overthrust segment.
Fault trace is solid where accurately located, long dashes where approximately located. Fault trace on underlying plate is indicated by short dashes where accurately located and data where approximately located. U, upthrown segment; D, downthrown segment; ¬, overthrust segment.

Shear zone

Anticline
Showing crest line; solid where location is known, dashed where location is uncertain.

Syncline
Showing trough line; solid where location is known, dashed where location is uncertain.

Barrier pillar in contoured bed

34

Cross section from which stratigraphic column 34 of the coal interval diagram was made.

A——A'

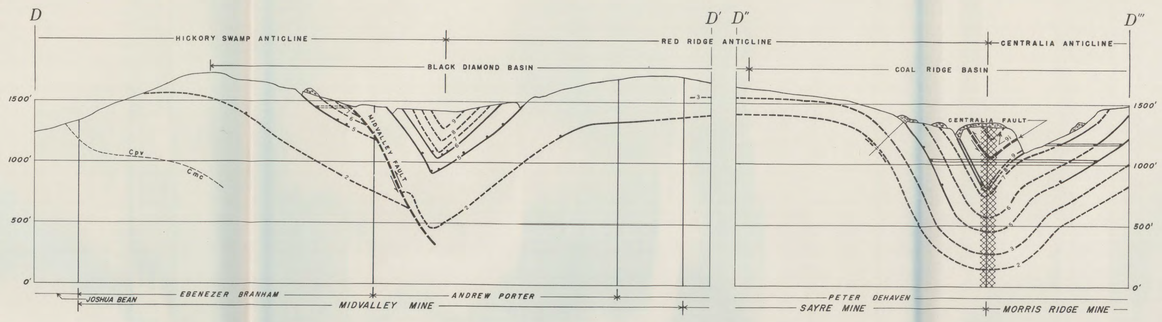
Structural cross section

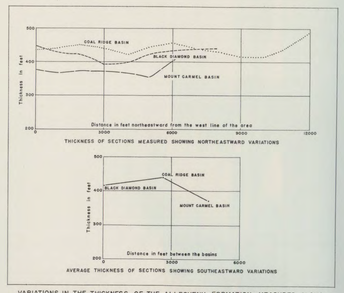
Drafted by John T. Howells and Robert W. Banks

INTERIOR—GEOLOGICAL SURVEY, WASHINGTON, D. C.

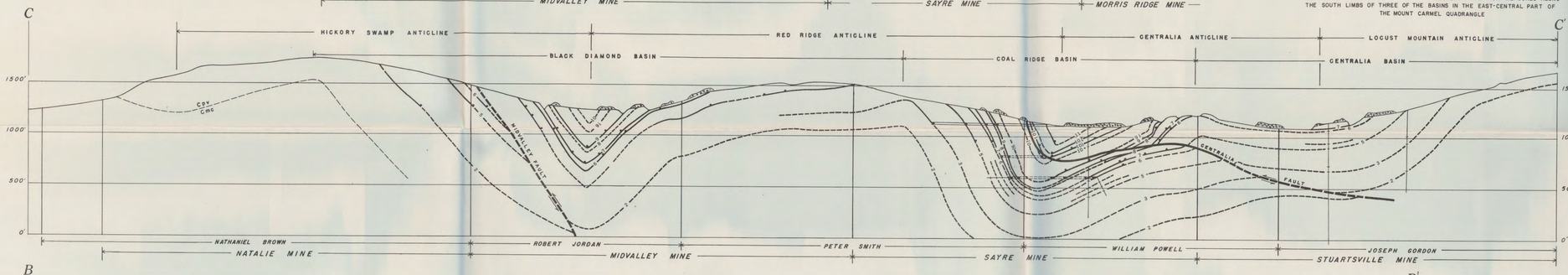
COAL INVESTIGATIONS
MAP C10 (IN 3 SHEETS) SHEET 2

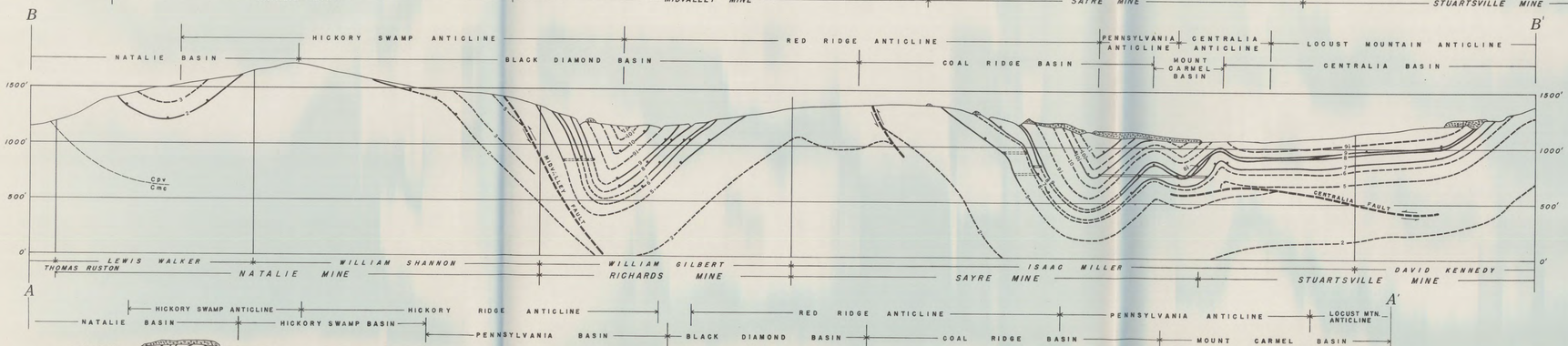
For sale by U. S. Geological Survey, price $1.50 per set

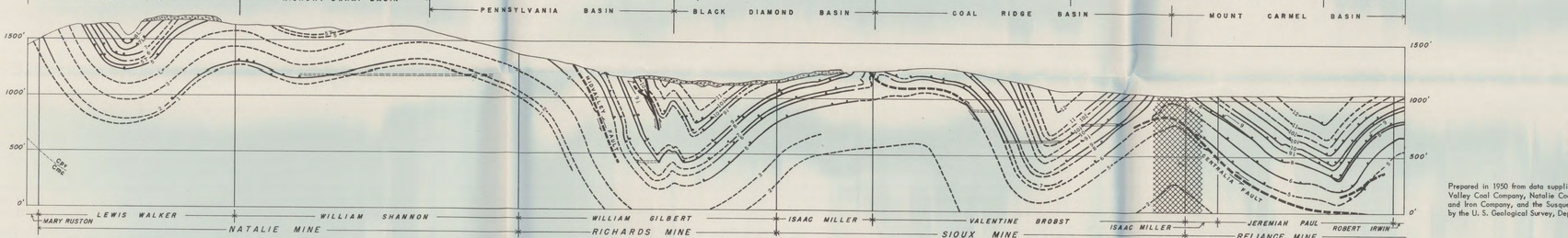




VARIATIONS IN THE THICKNESS OF THE ALLEGHENY FORMATION MEASURED ALONG THE SOUTH LIMBS OF THREE OF THE BASINS IN THE EAST-CENTRAL PART OF THE MOUNT CARMEL QUADRANGLE







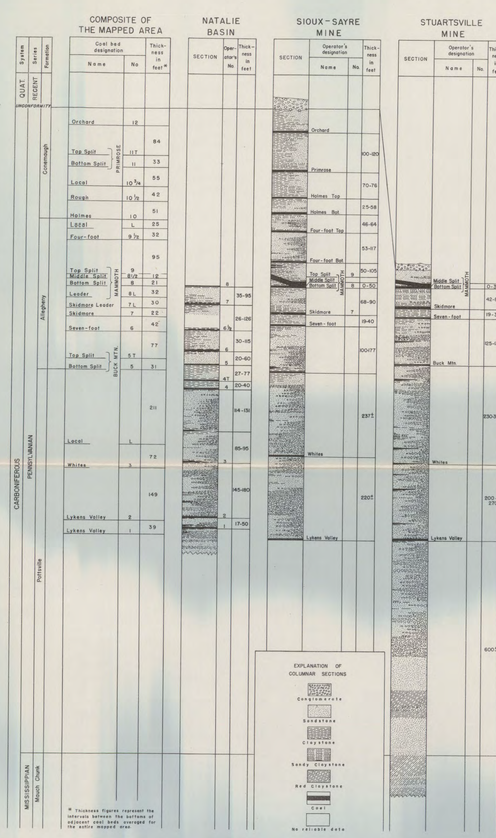
CROSS SECTIONS SHOWING THE STRUCTURE OF THE COAL BEDS IN THE EAST-CENTRAL PART OF THE MOUNT CARMEL QUADRANGLE

SCALE 1:6,000

500 100 0 500 1000 2000 3000 Feet

Datum is mean sea level

GEOLOGY OF ANTHRACITE IN THE EAST-CENTRAL PART OF THE MOUNT CARMEL QUADRANGLE, PENNSYLVANIA



EXPLANATION OF CROSS SECTIONS

Cpv / Cmc — Contact between the Mauch Chunk shale (Cmc) and the Pottsville formation (Cpv)

5 — Coal bed with designating number. *Solid where mined, dashed where unmined.*

Fault showing relative movement. *Solid where location is known, dashed where uncertain.*

Drill hole showing position of coal beds found in core or cuttings. *Solid where hole is in the plane of the section, dashed where projected to the section.*

Cross section of gangway

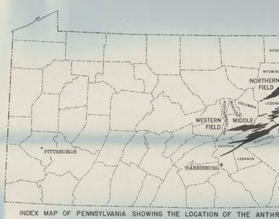
Tunnel showing position of intersecting gangway. *Solid where tunnel is in the plane of the section, dashed where projected to the section.*

Mine waste

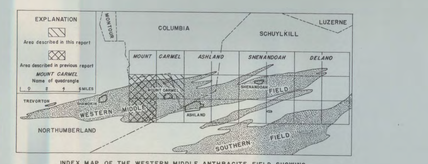
Area reserved for barrier pillar

COLUMNAR SECTIONS

0 100 200 300 400 500 VERTICAL SCALE



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

Prepared in 1950 from data supplied by the Hazle Brook Coal Company, Lehigh Valley Coal Company, Natalie Coal Corporation, Philadelphia and Reading Coal and Iron Company, and the Susquehanna Collieries Company, with modifications by the U. S. Geological Survey, Department of the Interior.

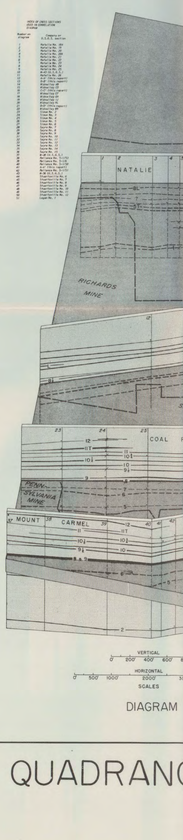


DIAGRAM SHOWING THE INTERVALS BETWEEN COAL BEDS

INTRODUCTION

The Pennsylvania anthracite fields, the principal source of anthracite in North America, are in the eastern part of the Commonwealth of Pennsylvania. (See Index map of Pennsylvania, sheet 3.) The fields are divided into three areas—the Northern, Middle, and Southern fields—that trend northeastward and lie in echelon arrangement. The fields range in length from 25 to 66 miles and in width from a fraction of a mile to 10 miles, and include about 484 square miles of coal-bearing land (Smith, 1892, p. 59). The area covered by this report is in the Western Middle field.

The boundaries of the coal-bearing areas that constitute the anthracite fields are considered to be the outcrops of the oldest of the Lykens Valley coal beds. Much of the fields has a boundary that is a single continuous line, except the Eastern Middle field, which is split by a synclinal spoon but disconnected coal-bearing areas. The approximate boundaries of the fields are generally indicated by outcrops of the resistant rocks at the base of the division or of the red rocks of the Mauch Chunk shale below the Pottsville.

The mapped area here described is near the middle of the Western Middle field and includes all or parts of seven of the area included in the U. S. Geological Survey's standard topographic quadrangle. (See index map of the Western Middle field, sheet 3.) This part of the quadrangle is between latitudes 40°47'30" and 40°50'00" N., a distance of 2.87 miles, and longitudes 76°52'30" and 76°55'00" W., a distance of 3.06 miles, in Northumberland and Columbia Counties. The borough of Mount Carmel is in the southwestern part of the area.

This report is the third of a series on the anthracite fields inaugurated by the Federal Geological Survey with the approval of the Bureau of Topographic and Geologic Surveys of the Commonwealth of Pennsylvania. The first report of the series described the northeastern part of the Mount Carmel quadrangle (Rothrock et al., 1950), and the second described the Shamokin quadrangle (Arndt et al., 1951). Other units of the series will be published as they are completed. Information in these reports includes (1) the location of coal outcrops (sheet 1), (2) the depth, pitch, and other structural features of representative coal beds, (3) the natural and artificial barriers (sheet 2) that limit the lateral extent of the Pottsville formation (sheets 1 and 2), (4) the stratigraphic intervals between the coal beds, (5) a standard columnar section of the coal beds, (6) the thickness, continuity, and other physical characteristics of the coal beds (sheet 3). The reports will bring up to date and amplify the Grand Atlas of the Anthracite Fields published by the Second Geological Survey of Pennsylvania in 1876-83, and the reports that have been published by the Bureau of Mines since 1883. The new and current series will aid operators who are mining either at the surface or underground, and who are formulating plans for control of mine water. It is hoped that these reports will also direct attention to overlooked or neglected reserves of coal.

Acknowledgments. Much of the information comprising this report was obtained from the following coal companies and their engineering staffs: Hazle Brook Coal Co., Lehigh Valley Coal Co., Natalie Coal Corp., Philadelphia and Reading Coal and Iron Co., and the Susquehanna Collieries Co. The cooperation of the companies' officials who made available this indispensable information and the aid given by John F. Brophy, State Mine Inspector, is deeply appreciated.

STRATIGRAPHY

The rocks that crop out in the mapped area belong to the Carboniferous and Quaternary systems. The Carboniferous rocks include the top of the Mauch Chunk shale (Mississippian), and the Pottsville, Allegheny, and lower part of the Conemaugh formations (Pennsylvanian). The Quaternary rocks are the glacial deposits of Wisconsin age and Recent alluvium. (See columnar sections, sheet 3.) Data for the following stratigraphic descriptions were obtained from the study of mine cross sections, core drill records, and sections taken along mine tunnels, slopes, and shafts by company engineers, and from field observations.

Mississippian rocks

Mauch Chunk shale. The Mauch Chunk shale crops out on the north ridge of Red Mountain, but no exposure of it was found because of the cover of talus from the overlying Pottsville formation. A water drill hole in the Stuartsville mine penetrated the shale approximately 1,100 ft. Thick red claystone with thin interbedded sandstone and siltstone layers is characteristic of the Mauch Chunk shale in accordance with the practice of placing the top of this formation at the horizon below which the rocks are predominantly red and below the gray, greenish Mauch Chunk and which they predominantly weather gray or brown and are coarse grained (Pottsville).

Pennsylvanian rocks

The Pennsylvanian (Carboniferous) rocks are of continental origin and consist of lenticular beds of evanescent and argillaceous rocks, interbedded with 15 persistent beds and several local beds of anthracite. The lithologic character of the rocks is predominantly conglomeratic, the upper part is argillaceous and sandy. The individual beds, however, exhibit such abrupt changes in lithology that the type of rock of which an outcrop is composed is seldom indicative of a definite stratigraphic position. The coal beds are the most persistent of the rock types, most of the principal beds being found throughout the coal-bearing area.

Pottsville formation. The Pottsville formation, the oldest of the Pennsylvanian rocks, overlies the Mauch Chunk shale and underlies the Allegheny formation. The thickness of the Pottsville formation ranges from approximately 910 ft. in the adjoining area on the west to about 1,310 ft. in the Stuartsville mine area. As the formation consists of resistant conglomerates and sandstones, it underlies the high ridges and mountains and forms the most prominent ridges in the mapped area. The base of the Pottsville is not exposed in the mapped area, but a core drill record in the Stuartsville mine indicates that the lower 175 ft. of the formation consists chiefly of sandstone with a bed of red claystone near the middle. This claystone corresponds to a similar zone of gray and red fine grained clastics in the lower part of the Pottsville in the west-central part of the Mount Carmel quadrangle. The Pottsville formation above the red claystone zone consists of lenticular conglomerates interbedded with thinner beds of sandstone and, in the upper 400 to 500 ft., with coal beds and their associated claystones. Conglomerates, which are the most persistent ridge-forming rocks, and quartzite in a quartz sand matrix cemented by siliceous quartz ridges or cliffs in many places but none form such a ridge throughout the area of outcrop. One of the most persistent ridge-forming conglomerates occurs near the middle of the formation and is overlain by the No. 2 bed of the Lykens Valley coal zone. In the eastern part of the Natalie mine area this resistant conglomerate forms a small cliff on the mountain slope and is one of the outstanding characteristics that are helpful in identifying the No. 2 coal bed in some places. In the southwestern and southeastern parts of the Mount Carmel quadrangle, however, the conglomerate above the No. 2 coal usually makes a more prominent cliff than the one below the coal. The upper part of the Pottsville is the Tuscarora member, which crops out across the northern part of the mapped area. It is a topographic feature on the north slope of Red Mountain (sheet 1, No. 5) coal, which overlies the conglomerate. The Pottsville formation contains three coal beds that have been mined—the No. 1 and No. 2 beds of the Lykens Valley coal zone, the Wilnes (No. 3) coal bed, and several beds that are of little importance.

Allegheny formation. On the mapped area the Allegheny formation extends from the base of the Buck Mountain (No. 5) coal bed to the base of the Holmes (No. 10) coal bed, which is the basal bed of the Conemaugh formation. The formation is 365 ft. to 405 ft. thick. The sharp change in sheet 3, showing variations in the thickness of the Allegheny formation which were made from sections measured along the south limbs of the basins in the east-central part of the quadrangle, is a result of thinning and unidentified conformity between the lower chart indicates that the formation thins both northward and southward from the Coal Ridge basin. The manner of this variation in depositional and how much deformational is not apparent. The following table, however, records the known facts.

Table showing the thickness of the Allegheny formation and the No. 2 coal bed in the mapped area

Basin	Measured average thickness of formation	Average dip of bottom of No. 2 coal bed
Black Diamond	417 ft.	35°
Coal Ridge	440 ft.	30°
Mount Carmel	371 ft.	36°

The Allegheny formation consists of interbedded conglomerate, sandstone, siltstone, claystone, and coal. In the lower part of the formation arenaceous rocks predominate. In the upper part claystones and siltstones occur more frequently and conglomerate becomes a less prominent rock. The bottom rock of the Bottom Split (No. 8) of the Mammoth coal zone contains ovoid ironstone concretions that are characteristic of the Allegheny and are helpful because of their approach in composition and their consistent presence of similar concretions elsewhere in the section, the conglomerate is not useful in the correlation of the Bottom Split in this area. Sandstones are in the southwestern part of the Mount Carmel quadrangle. The Allegheny formation is the source of most of the coal that is mined in the area. It contains the Buck Mountain (No. 5) coal at its base, the Mammoth (No. 9) bed near the top, and the Seven-Foot (No. 6), Skidmore (No. 7), and the Mountain coals in the intervening zone.

Conemaugh formation. Only the lower 490 ft. of the Conemaugh formation is exposed in the area. It includes the Holmes (No. 10) coal bed at the base, then the Primrose (No. 11) and Orchard (No. 12) coals, and the Rough (No. 10½) coal bed near the top. Sandstone overlying the Orchard coal bed rocks are lenticular sandstones, siltstones, and claystones, with lenses of conglomerate in the lower part of the formation.

Recent deposits

Recent deposits consist of boulders, gravel, sandy silt, and water-borne clay and silt. Some deposits, covered in many places by alluvial mine waste, are generally found in the valleys. In a previously mapped area to the southwest, deposits indicative of glacial origin were found (Rothrock et al., 1950, sheet 3). Although glacial deposits were not noted in the area studied, it is possible that they are present but covered with subsequent alluvium.

DESCRIPTION OF THE COAL BEDS

Age of the coals and location of outcrops

The coal beds in the mapped area occur in the upper half of the Pottsville formation, throughout the Allegheny formation, and in the lower part of the Conemaugh formation. (See columnar sections, sheet 3.) The younger coal beds that occur elsewhere in the anthracite fields have been removed by erosion from this area.

The coal beds are rarely exposed in natural outcrops because they are generally covered with a mantle of soil. The outcrop lines shown on sheet 2 indicate the positions on the surface of the projected beds. The position of the outcrop if it were projected through the soil mantle. This position may not agree with blooms of weathered coal that are occasionally found on the hillsides because of coal outcrops down the slope from their original position as a result of creep of the weathered soil. Exploration for the unweathered coal, therefore, should be started at the position of the outcrop shown on the map and extended in the direction of dip of the stratum.

Intervals between coal beds

The intervals between the coal beds, or the distances between any two beds measured at right angles to the bedding, are shown graphically in the fence diagram in sheet 3, where they have been arranged as distances above or below an arbitrarily chosen reference bed, the bottom of the Bottom Split of the Mammoth (No. 8) coal bed. The diagram was prepared to aid the operator in computing tunnel distances and "rock bolt" distances from mined to unmined beds in any locality within the mapped area. The length of a proposed tunnel can be obtained by dividing the interval shown on the diagram, or the interval as plotted between the nearest sections, by the sine of the angle of dip of the beds. The rock bolt can also be computed mathematically, but generally it can be more easily determined by plotting the positions of the beds and the proposed rock bolt.

The intervals between coal beds differ considerably from place to place, especially in the beds below the Bottom Split of the Mammoth coal bed. These variations have no regular trend but the interval between the No. 9 bed and the Buck Mountain (No. 5) bed thickens northward, and the one between the No. 8 and the Lykens Valley No. 2 bed thickens southward. The greatest percentage of variation is in the partings or "dividers" between the splits of the Mammoth coal bed, which in some places are so thin as to be recognized in mining to thicknesses as great as 50 ft.

Thicknesses of the coal beds

The coal thicknesses shown in this report were obtained chiefly from underground measurements made by the operators. These measurements, selected from a great number, are believed to be chosen so as to reflect the normal thickness of the bed and its included coal in unit areas 1,000 ft. square. Wherever possible, at least four measurements were averaged for each unit area. Measurements that were considered to be abnormally affected by structural features, such as faulting, pinching, or swelling, were not used; hence, more than a maximum of a bed are not included. The following table shows the average ranges and ranges of maximum thicknesses in the mapped area.

Average thicknesses and ranges in thickness of coal beds mined in the east-central part of the Mount Carmel quadrangle

Bed No.	Bed				Coal				Percentage of refuse
	Average		Range		Average		Range		
	Ft.	In.	Ft.	In.	Ft.	In.	Ft.	In.	
12	7	8	4	4 to 10	6	5	2	8 to 9	0	28.2
11	5	2	2	0 to 11	10	3	1	11 to 10	11	28.2
10½	5	6	1	11 to 6	6	2	1	11 to 4	6	16.6
10	4	8	1	0 to 8	4	4	2	0 to 8	10	7.1
10	4	8	1	0 to 12	0	3	11	1 0 to 11	0	16.0
9½	4	1	1	1 to 12	0	3	4	1 1 to 12	0	18.3
9	7	6	2	0 to 15	9	6	7	1 3 to 15	4	12.2
8½	7	7	3	0 to 21	0	6	10	2 0 to 21	0	9.9
8	6	2	1	0 to 16	0	5	4	1 0 to 16	0	13.5
8	5	6	1	1 to 10	6	5	0	1 0 to 10	5	3.2
TL	2	5	1	0 to 4	0	2	0	1 0 to 4	0	0.0
7	6	10	1	2 to 30	6	5	10	1 2 to 30	6	14.6
7	4	4	1	0 to 14	0	3	6	0 11 to 9	0	19.2
5?	7	5	2	8 to 13	0	5	3	2 3 to 9	0	29.2
5	5	6	0	11 to 14	6	4	7	0 4 to 14	6	16.6
5					2	4	1	6 to 4	0	
2	4	11	1	0 to 10	6	4	6	1 0 to 10	6	8.4
1	3	8	1	2 to 7	8	2	8	1 0 to 5	7	27.2

Coal beds less than 1½ ft. (18 in.) thick are generally not reported in the mine reports. Unmined coal beds that have thicknesses of 18 in. or more do not occur within a relatively small area, and are not branches or splits of thicker beds. Coal beds that are 18 in. thick or more and are 2 ft. or more apart occur only within the area of outcrop. Outcrops of the more persistent beds are shown in some instances for long distances beyond any known point of occurrence. They indicate the authors' estimate of the position of the horizon of the bed in order to serve as a guide for prospecting, but they do not signify that the bed is necessarily minable throughout this extent.

Lykens Valley coal zone

In the northwestern part of the area the Lykens Valley coal zone is represented by two coal beds, called the No. 1 and No. 2 beds, separated by a parting of 0 to 30 ft. Several coal beds have been found in the Natalie mine. The younger coal beds that occur elsewhere in the anthracite fields have been removed by erosion from this area.

The coal beds are rarely exposed in natural outcrops because they are generally covered with a mantle of soil. The outcrop lines shown on sheet 2 indicate the positions on the surface of the projected beds. The position of the outcrop if it were projected through the soil mantle. This position may not agree with blooms of weathered coal that are occasionally found on the hillsides because of coal outcrops down the slope from their original position as a result of creep of the weathered soil. Exploration for the unweathered coal, therefore, should be started at the position of the outcrop shown on the map and extended in the direction of dip of the stratum.

Lykens Valley No. 1 coal bed. The Lykens Valley No. 1 coal, the oldest stratigraphically in the area, occurs about in the middle of the Pottsville formation. It was mined in the Natalie mine in the Hickory Swamp basin and was correlated with beds in the Red Ridge anticline. The average thickness of 5 beds is 2 ft. 8 in., of which 2 ft. 0 in. was coal.

Lykens Valley No. 2 coal bed. The Lykens Valley No. 2 coal lies from 95 to 97 ft. above the Lykens Valley No. 1 coal. The No. 2 bed was mined at relatively shallow depths in the Natalie and Richards mines in the northwestern part of the area and in the Midvalley mine in the northeastern part. In the southwestern part of the area, however, the bed has been mined almost to sea level in the Reliance workings. Although the bed in the principal synclinal basins is generally unworkable for mining, it is above the plus 500-ft. level in many of the Red Ridge anticlines. In the northwestern part of the area the average thickness of the coal in the unit areas ranged from 1 to almost 7 ft., but eastward these thicknesses ranged from 2 to 4 ft. In the southwestern part of the area the averages were from 2 to 5 ft. The coal from the mined areas contained a very low proportion of refuse, 0.3 percent.

Isopachs of the No. 2 coal tend to be parallel with the structural features in their relationship between the thicknesses of the coal and the location of anticlines and synclines is evident.

Wilnes (No. 3) coal bed

The Wilnes (No. 3) coal bed occurs about 200 ft. above the Lykens Valley (No. 2) coal in the northwestern and southeastern parts of the area, and about 300 ft. between. It was mined locally in the Hickory Swamp and Coal Ridge basins and was cut by the Natalie, Midvalley, and Natalie tunnels. The records indicate that it is a single bed of coal about 2 ft. thick containing little refuse.

Buck Mountain (No. 5) coal bed

In most of the area the Buck Mountain (No. 5) coal is a single bed; but in the northwestern part, in the Hickory Swamp and Hickory Swamp basins, and in the Natalie mine, it splits into two beds. In the Morris Ridge mine it contains a divider that separates it into the Bottom Split (No. 5) and Top Split (No. 5?). The Buck Mountain (No. 5) is considered to be the basal member of the Allegheny formation, but the top of the coal is not known. It was called by miners the "bottom slate" and "top slate," respectively; but the "slate" is a fine sandstone. The Buck Mountain coal is soft-coal. The massive sandstone that overlies the coal in cliff-forming outcrops in the northern part of the area, whereas the one above is generally much less resistant. The interval between the No. 5 and No. 5? coal is composed of fine-grained clastic rocks that may be as thick as 35 ft.

The Buck Mountain coal has been mined extensively in the area both by underground mining and by stripping. The thickness of exposures of the coal in the unit areas generally ranged from 4 to 8 ft. for each split. In the northeastern part of the area, where both splits were mined together, the thickness of the coal in the unit areas was 13 ft. were recorded.

Two local coal beds, one 50 and the other 100 ft. above the Buck Mountain coal, were cut in core drill holes in the Coal Ridge and Centralia basins. The thicknesses ranged from 1 ft. 11 in. to 2 ft. thickness of the lower bed averaged 6 ft. 5 in., but the coal was small. The upper bed averaged 2 ft. in thickness.

Seven-foot (No. 6) coal bed

The Seven-foot (No. 6) coal bed is separated from the Buck Mountain (No. 5) coal in most of the area by 60 to 170 ft. of conglomerate and finer-grained clastics. In the northern part, however, the conglomeratic member is missing and the interval decreases to about 50 ft. The Seven-foot coal was worked extensively in all of the basins except the Natalie and Hickory Swamp basins, and was mined in the Natalie, Midvalley, Sayre, and Stuartsville mines. In most of these workings the average thickness in the unit areas ranged from 5 ft. 7 in. to 6 ft. 6 in. The eastern part of the Richards mine's maximum of 8 ft. 6 in. was recorded.

Rough (No. 6) coal bed

The Rough (No. 10½) coal bed crops out in the Black Diamond basin and the basins to the south. It is 10 to 70 ft. above the Holmes (No. 10) coal in the southern part of the area and 50 to 90 ft. above it in the northern part of the area of its occurrence. The youngest conglomerate in the stratigraphic section occurs locally within this interval. The Rough coal was mined extensively within its area of occurrence. In these workings it was relatively uniform in thickness and contained a low proportion of 7.7 percent of refuse. This percentage is in sharp contrast with 27 and 29 percent of waste in the bed in the adjoining Holmes and Primrose coals, respectively. The average thickness of the coal in the unit areas ranged from 5 ft. to 5 ft., with the greater thickness occurring in the Coal Ridge basin.

Local (No. 10?) coal bed

A local coal bed, called the No. 10? in this report, occurs 20 to 60 ft. above the Rough coal in the Coal Ridge and Mount Carmel basins. It was mined as the Top Split of the Holmes bed in the Sayre mine. The coal averages 4 ft. in thickness but ranges from 2 ft. to 12 ft.

Primrose (Nos. 11 and 11?) coal zone

The Primrose coal zone occurs in the Mount Carmel, Coal Ridge, and Black Diamond basins. In the first two of these basins it consists of a single bed, the Primrose (No. 11), and in the Top Split of the Primrose (No. 11?), which is mined locally. In the Black Diamond basin only the Primrose (No. 11) bed has been recognized.

The Primrose coal is about 190 ft. above the Holmes (No. 10) coal in the Mount Carmel basin and 120 ft. above it in the Coal Ridge basin. Little information regarding its stratigraphic position in the Black Diamond basin is available. The bed, mined in the Wilnes, Richards, and Sioux mines, averaged 5 ft. 2 in. in thickness and ranged from 4 ft. 11 in. to 6 ft.

Orchard (No. 12) coal bed

The Orchard (No. 12) coal bed, the youngest coal mined in the area, crops out in the Black Diamond basin and in the Mount Carmel basin to the south. It is 20 ft. above the Holmes (No. 10) bed. In the Reliance mine the average of 3 ft. 2 in. in the unit areas ranged from 3 ft. 2 in. to 6 ft. 4 in., 20 percent of which was refuse.

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INTERIOR—GEOLOGICAL SURVEY, WASHINGTON, D. C.

Drafted by John T. Howells and Robert W. Banes

GEOLOGY OF ANTHRACITE IN THE EAST-CENTRAL PART OF THE MOUNT CARMEL QUADRANGLE, PENNSYLVANIA

By
Howard E. Rothrock, Holly C. Wagner, Boyd R. Haley and Harold H. Arndt

1951

COAL INVESTIGATIONS
MAP C 10 (IN 3 SHEETS) SHEET 3

For sale by U. S. Geological Survey, price $1.50 per set

UNITED STATES DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

COAL INVESTIGATIONS
MAP C 12 (IN 3 SHEETS) SHEET 1

EXPLANATION

- Boundary of mine
- E. HUFF — Warranty tract. *Boundaries are indicated for general orientation and identification but are not authenticated for legal purposes.*
- Borough line
- Strip-mined area
- Back-filled stripping
- Exploratory trench. *Tick shows where coal was found.*
- Crop fall. *Collapsed area where surface has fallen into underground workings.*
- Mine waste. *Includes such refuse from mining and breaker operations as culm, rock banks, coal piles, back fill, and silt in settling basins.*
- Stream-transported waste
- A ——— A' Structural cross section
- Y Surface opening on coal bed
- 10 Coal outcrop. *Solid where location is known, long dashes where uncertain. In areas covered by mine waste, short dashes indicate known locations, very short dashes indicate approximate locations. Number designates coal bed; L, local bed; T, top split; M, middle split; B, bottom split; 21, Lykens Valley leader.*
- Fault showing dip and relative position of sides. *Real direction of movement not necessarily known; U, upthrown side; D, downthrown side; ⊢, overthrust plate. Fault trace is solid line where accurately known, long dashes where approximately located. In areas covered by mine waste, short dashes indicate known locations, dots indicate approximate locations.*
- Anticline. *Showing crest line*
- Syncline. *Showing trough line*
- Overturned anticline. *Showing crest line and direction of dip of the limbs.*
- Overturned syncline. *Showing trough line and direction of dip of the limbs.*

Base: U. S. Geological Survey topographic map. Polyconic projection. 1927 North American datum. Topography was contoured from aerial photographs made in 1942. Correction has generally not been made for topographic changes resulting from strip mining or alteration of mine refuse banks since 1942. In those areas extensively strip-mined the contours have been deleted.

APPROXIMATE MEAN DECLINATION, 1944.

COAL OUTCROP MAP

SCALE 1:6,000

500 0 500 1000 2000 3000 Feet

Contour interval is 20 feet.
Datum is mean sea level.

DIAGRAM OF A TOPOGRAPHIC QUADRANGLE SHOWING THE AREA INCLUDED IN THIS MAP

Prepared in 1950 from data supplied by the Raven Run Coal Co., Lehigh Valley Coal Co., and the Philadelphia and Reading Coal and Iron Co., with modifications by the U. S. Geological Survey.

INTERIOR—GEOLOGICAL SURVEY, WASHINGTON, D. C.

GEOLOGY OF ANTHRACITE IN THE SOUTHEASTERN PART OF THE MOUNT CARMEL QUADRANGLE, PENNSYLVANIA

By
Howard E. Rothrock, Holly C. Wagner, Boyd R. Haley, and Harold H. Arndt

1953

COAL INVESTIGATIONS
MAP C 12 (IN 3 SHEETS) SHEET 1
For sale by U. S. Geological Survey, price $1.50 per set

UNITED STATES DEPARTMENT OF THE INTERIOR
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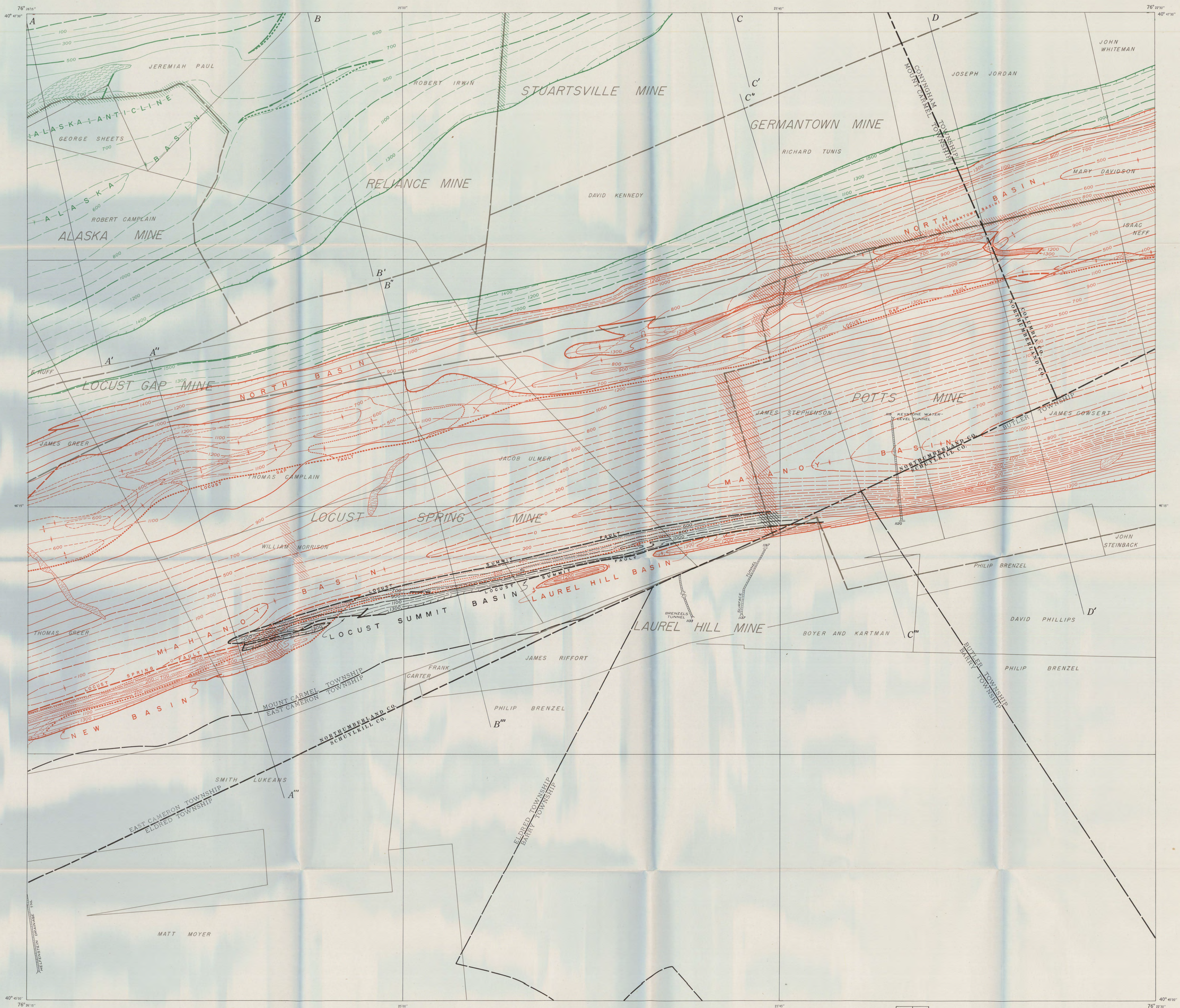
COAL INVESTIGATIONS
MAP C12 (IN 3 SHEETS) SHEET 2



EXPLANATION

Boundary of mine

E. HUFF

Warranty tract

Boundaries are indicated for general orientation and identification but are not authenticated for legal purposes.

A ——— A'

Structural cross section

Note: Green structure and outcrop symbols apply to the Buck Mountain coal bed. Red structure and outcrop symbols apply to the bottom split of the Mammoth coal bed. Where segments of bottom split of the Mammoth coal bed are superposed by thrust faulting, structure contours on the upper plates of the bottom split of the Mammoth coal bed are shown in black.

Outcrop of coal bed

Fault cutting contoured bed showing dip of fault plane, relative position of faulted segments, and overthrust segment.

Fault trace is solid where accurately located, long dashes where approximately located. Fault trace on underlying plate is indicated by short dashes where accurately located and dots where approximately located. U, upthrown segment; D, downthrown segment; ⊢, overthrust segment.

Contours on the bottom of the contoured coal bed

Solid in mined areas; long dashes in unmined areas; in those places where a part of the bed lies beneath another part of the same bed short dashes are used in mined areas, and very short dashes in unmined areas.

Shear zone

Anticline

Showing crest line; solid where location is known, dashed where location is uncertain.

Syncline

Showing trough line; solid where location is known, dashed where location is uncertain.

Overturned syncline

Showing trough line and direction of dip of the limbs.

Drainage tunnel

Barrier pillar in contoured bed

Polyconic projection. 1927 North American datum.

APPROXIMATE MEAN DECLINATION, 1944.

STRUCTURE MAP OF THE BUCK MOUNTAIN AND MAMMOTH COAL BEDS

SCALE 1:6,000

500 0 500 1000 2000 3000 Feet

Contour interval is 100 feet

Datum is mean sea level.

DIAGRAM OF A TOPOGRAPHIC QUADRANGLE SHOWING THE AREA INCLUDED IN THIS MAP

Prepared in 1950 from data supplied by the Raven Run Coal Co., Lehigh Valley Coal Co., and the Philadelphia and Reading Coal and Iron Co., with modifications by the U. S. Geological Survey.

INTERIOR—GEOLOGICAL SURVEY, WASHINGTON, D. C.

GEOLOGY OF ANTHRACITE IN THE SOUTHEASTERN PART OF THE MOUNT CARMEL QUADRANGLE, PENNSYLVANIA

By
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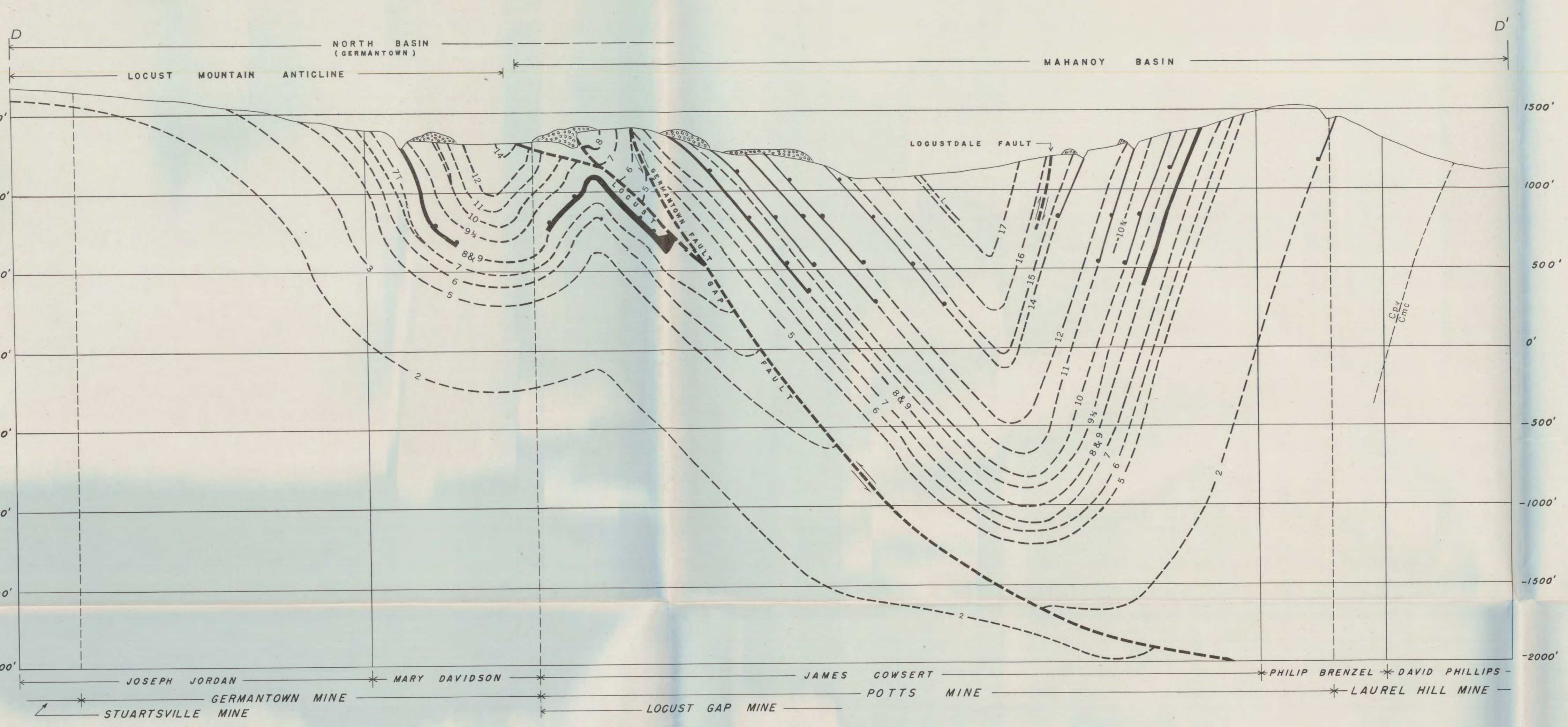
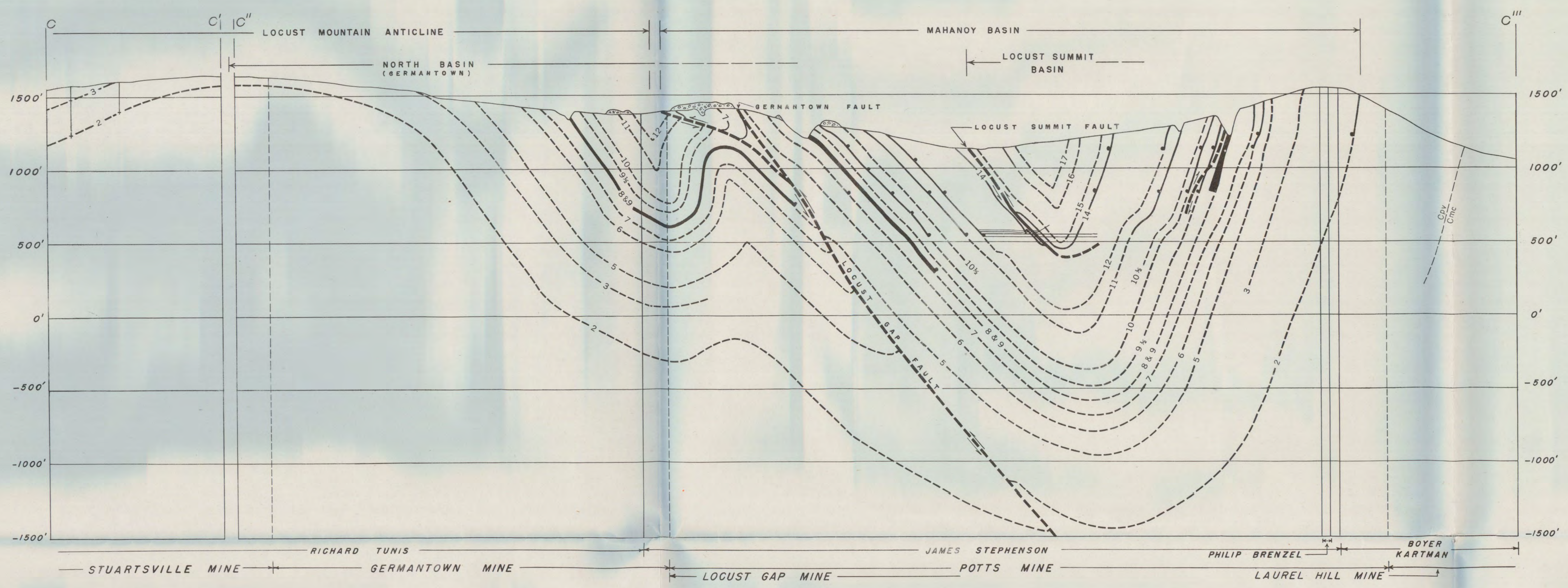
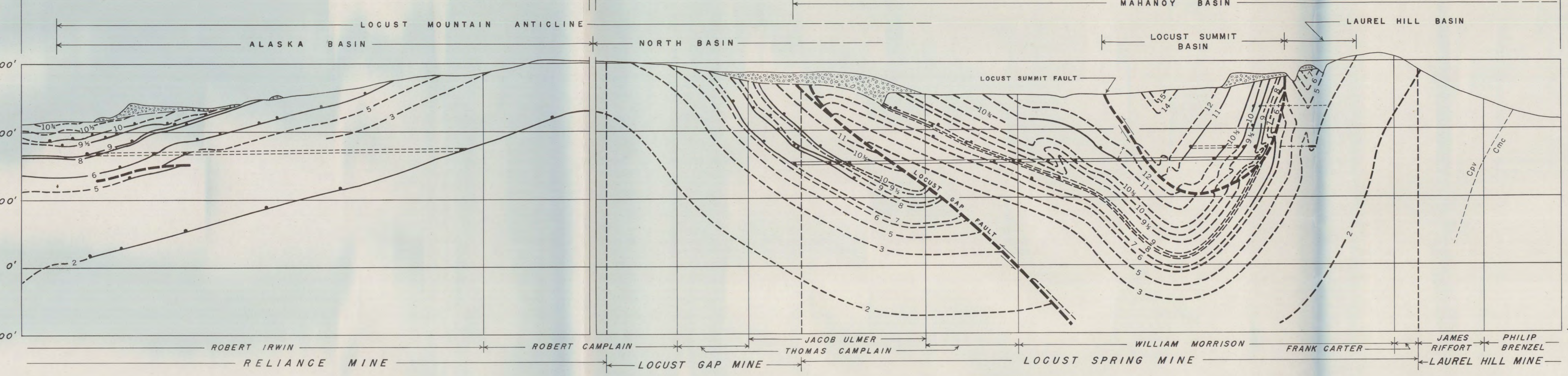
1953

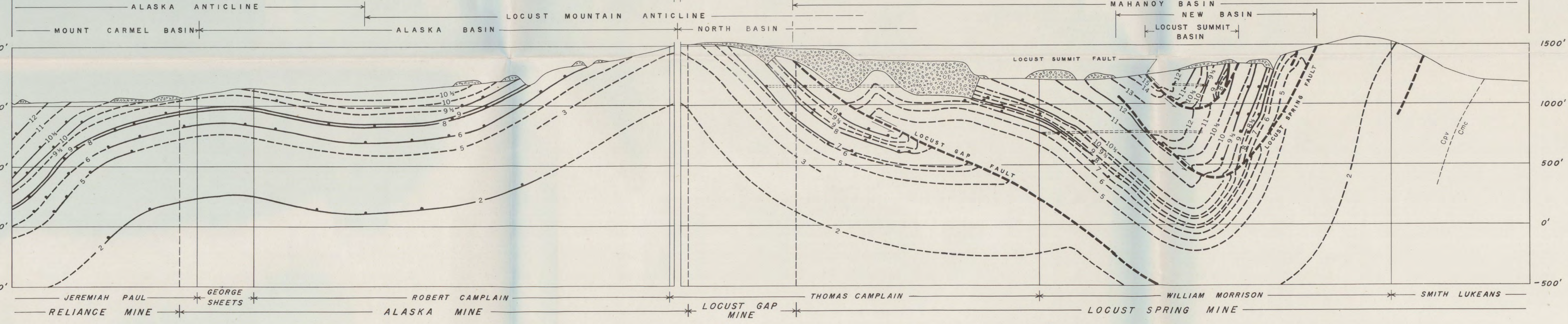
COAL INVESTIGATIONS
MAP C12 (IN 3 SHEETS) SHEET 2
For sale by U. S. Geological Survey, price $1.50 per set

UNITED STATES DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY







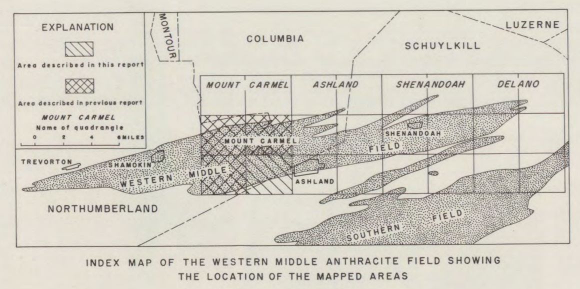


CROSS SECTIONS SHOWING THE STRUCTURE OF THE COAL BEDS IN THE SOUTHEASTERN PART OF THE MOUNT CARMEL QUADRANGLE

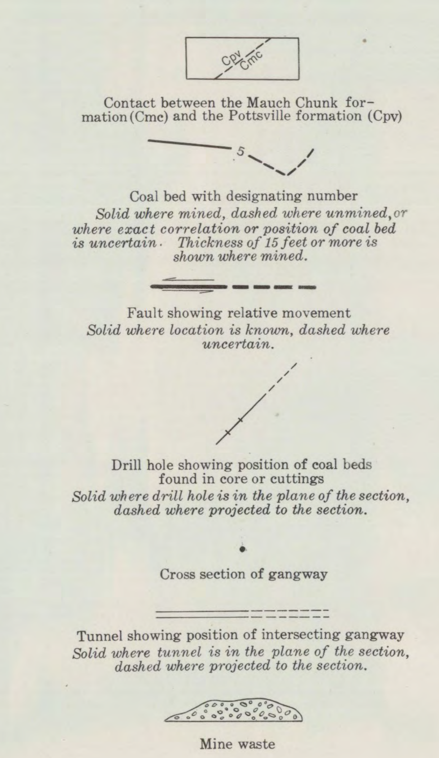
SCALE 1:6000

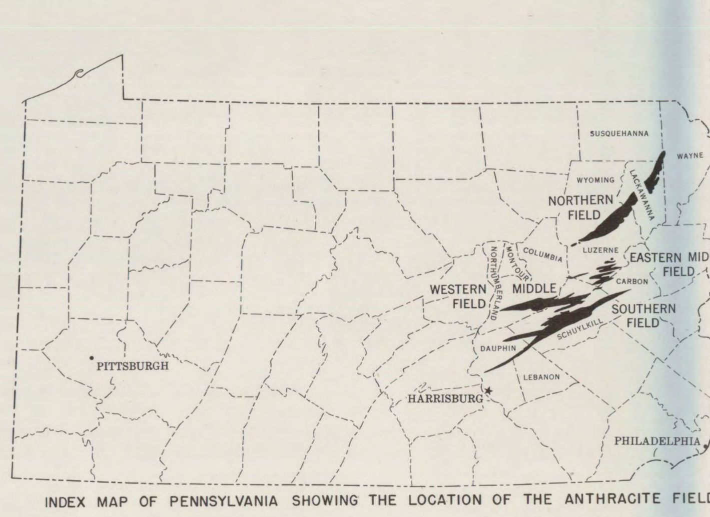
Datum is mean sea level.

Prepared in 1950 from data supplied by the Raven Run Coal Co., Lehigh Valley Coal Co., and the Philadelphia and Reading Coal and Iron Co., with modifications by the U. S. Geological Survey.



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





INDEX MAP OF PENNSYLVANIA SHOWING THE LOCATION OF THE ANTHRACITE FIELDS

GEOLOGY OF ANTHRACITE IN THE SOUTHEASTERN PART OF THE MOUNT CARMEL QUADRANGLE, PENNSYLVANIA

INTRODUCTION

This report is the fourth in a series describing the coal deposits of the anthracite fields of Pennsylvania. The three previous reports—Maps C3, C7, and C10 (Rothrock et al., 1950, 1951a, 1951b)—and this report of the U. S. Geological Survey's Coal Investigation series complete the general description of the anthracite fields in the Mount Carmel quadrangle.

The Mount Carmel quadrangle is near the center of the Western Middle Anthracite field in the Appalachian Mountains in the east-central part of Pennsylvania. (See index maps of Pennsylvania and the Western Middle field, sheet 3.) The southeastern part of the Mount Carmel quadrangle contains about 9¼ square miles, most of which is in Northumberland County; the remainder is in Columbia and Schuylkill Counties. The town of Mount Carmel is at the northern boundary of the area; Locust Gap and Locustdale are near the western and eastern boundaries, respectively.

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, pitch, and other structural features of representative coal beds (sheet 2), (c) the natural and artificial barriers between mines, and the structural relationships between the various basins (sheets 1, 2, and 3), (d) the stratigraphy and intervals between coal beds (sheet 3), and (e) a standard nomenclature of the coal beds (sheet 3).

The information presented in this report was obtained in part from actual and theoretical data shown on mine maps, cross sections, core drill records, and other information made available by the Philadelphia and Reading Coal and Iron Co., the Raven Run Coal Co., the Lehigh Valley Coal Co., and by John P. Brophy, State Mine Inspector.

STRATIGRAPHY

Rocks of the Carboniferous and Quaternary systems crop out in the mapped area. The Carboniferous rocks are, in ascending order, the upper part of the Mauch Chunk formation (Mississippian series), the Pottsville, Allegheny, and the lower part of the Conemaugh formations (Pennsylvanian series). Alluvium has been deposited along streams upon the eroded surface of these Carboniferous rocks. (See columnar sections, sheet 3.)

MISSISSIPPIAN SERIES

Mauch Chunk formation

The Mauch Chunk formation consists predominantly of lenticular fine-grained red sandstone and red siltstone with occasional thin beds of red claystone. Along Big Run, about a quarter of a mile east of the area, the upper 1,864 ft of the Mauch Chunk is exposed; red sandstone and siltstone make up 80 percent of the exposure and red claystone the remainder.

The Mauch Chunk formation crops out in the southern part of the area only, its northern limit being in the south side of Mahanoy Mountain. The base is not exposed in the mapped area, consequently the total thickness of the formation is not known. The top of the formation is gradational with the overlying Pottsville formation, and the contact is mapped at that horizon below which the beds are predominantly red and above which they are predominantly gray, green, or brown.

PENNSYLVANIAN SERIES

The Pennsylvanian rocks are composed of conglomerate, sandstone, siltstone, claystone, and coal. The coal beds are the most persistent of these rock types. The other rocks vary rapidly in lithology both vertically and laterally.

Pottsville formation

The Pottsville formation, which conformably overlies the Mauch Chunk formation, includes the oldest Pennsylvanian rocks in the area. This formation is composed mainly of conglomerate, interbedded with subordinate amounts of gray, green, or brown siltstone and sandstone. Siltstone and sandstone are most abundant in the lower part of the formation. The conglomerate pebbles consist mainly of milky quartz, quartzite, black and dark-green chert, black and brown claystone, and gray or green sandstone in a well-indurated, medium-grained sand matrix. Red siltstone and sandstone pebbles are common in the lower part of the formation. The formation is characterized by abrupt lateral changes both in lithology and in thickness. It is very resistant to erosion and forms high prominent ridges. The thickness of the Pottsville formation in the mapped area ranges from 900 to 1,000 ft.

The Lykens Valley No. 2 coal is the only persistent coal bed in the Pottsville formation within the mapped area. Two coal beds of local importance occur above the Lykens Valley No. 2 coal.

Allegheny formation

The Allegheny formation, which conformably overlies the Pottsville formation, contains the most important coal beds in the area. The base of the Allegheny is placed at the bottom of the Buck Mountain (No. 5) coal bed (White, 1900, p. 824). Other important coal beds in this formation in upward succession are as follows: the Seven-foot (No. 6), Skidmore (No. 7), Mammoth zone (Nos. 8, 8½, and 9), and the Four-foot (No. 9½) beds. Conglomerates, sandstones, siltstones, claystones, and coal beds of lesser importance separate these major coal beds. In some places a light-brown siltstone containing large ovoid ironstone concretions occurs at the base of the Mammoth Bottom Split (No. 8) coal bed and can be used for correlation. A massive-bedded conglomeratic sandstone above the Mammoth Top Split (No. 9) coal bed is also locally useful for correlation. The Allegheny formation ranges in thickness from 347 ft in the northwestern corner of the area to nearly 600 ft in the east-central part.

Conemaugh formation

The Conemaugh formation lies conformably on the Allegheny formation. At the base of the Conemaugh is the Holmes (No. 10) coal bed (Lohman, 1937, p. 46). Seven persistent coal beds and several local coal beds occur in the lower part of the formation. These beds are separated by beds of sandstone, siltstone, and claystone; lenticular beds of conglomerate occur above the Holmes, Little Orchard, and Little Tracy coal beds. (See columnar section, sheet 3.) The upper part of the formation has been eroded, leaving only the lower 1,100 ft in the area covered by this report.

QUATERNARY DEPOSITS

Unmapped deposits of boulders, gravel, sand, and silt occur in the valleys but are covered in many places by refuse from the mines and breakers.

STRUCTURE

Each of the Pennsylvania anthracite fields is a composite syncline consisting of a group of roughly parallel overlapping folds, some of which have been faulted. The general trend of these folds is northeastward. The synclines are called basins by the miners, a practice that is followed in this report. The term generally designates a complete syncline consisting of a trough and two limbs, but in some places it is applied to the truncated part of a faulted syncline, as in the North, New, and Locust Summit basins. (See cross section A''—A''' and B''—B''', sheet 3.)

The mapped area includes the south half of the composite syncline that is the Western Middle field and extends south of the coal-bearing rocks to include part of the non-coal-bearing anticline between the Western Middle and the Southern anthracite fields. Measurements on the Lykens Valley No. 2 coal bed show a maximum structural relief of approximately 3,550 ft, as measured in the North basin from a point 2,000 ft below sea level on the projection of the coal bed to 1,550 ft above sea level on the Locust Mountain anticline. (See cross section D-D', sheet 3.)

FOLDS

The folds in the area are asymmetrical, with both northward- and southward-dipping axial planes. Some of the folds are obtuse, as exemplified by the Alaska basin in the north (cross section A''-A''', sheet 3); others are acute, as exemplified by the Mahanoy basin in the south (cross section D-D').

The principal basins, listed from north to south, are the Mount Carmel, Alaska, North, and Mahanoy basins. The north-dipping limb of the Mount Carmel basin crosses the northwest corner of the area. The Alaska basin, immediately south of the Mount Carmel basin, is a southwestward-plunging syncline that dies out in the northwestern part of the mapped area. The North basin, a prominent structure in this part of the Mount Carmel quadrangle, extends across the mapped area. It is essentially the north limb of a basin that has been truncated by the Locust Gap fault. The limb has been folded into minor anticlines and synclines, to which such local names as Germantown basin and North basin have been applied. The syncline south of the Locust Gap fault, the Mahanoy basin, is the largest in the area. It is an asymmetrical syncline that plunges eastward, being 900 ft deeper in the eastern part of the area than in the western part. The Mahanoy basin is complicated by close folding and thrust faulting that has formed the New, Locust Summit, and Laurel Hill basins. These subsidiary basins die out eastward as displacements on the Locust Spring and Locust Summit faults, which in turn decrease until they eventually merge into the limbs of the Mahanoy basin.

FAULTS

Most faults in the area are thrusts and are the result of compression. The largest faults are longitudinal and are parallel with the strike of the folds. The most prominent of these is the Locust Gap fault, which traverses the entire area; others of importance are the Germantown, Locust Spring, Locust Summit, and Locustdale faults. The Locust Gap fault cuts the beds at angles ranging from less than 1° to more than 15° and displaces them as much as 2,000 ft. Folding subsequent to the development of this fault has tilted the fault plane so that at depth it now dips from about 35° S. in the western part of the area to almost 60° S. in the eastern part of the area. The Germantown fault, and other faults that are branches of the Locust Gap fault, apparently formed in the eastern part of the area as the Locust Spring and Locust Summit faults died out.

The Locust Spring fault, a prominent feature in the southwestern part of the Mount Carmel quadrangle, and the Locust Summit fault, prominent in the western part of this area, are both eastward-plunging thrust faults that have been folded in such a manner that the north-dipping side is geometrically a normal fault. The authors interpret the Locust Spring and Locust Summit faults as hinge faults that rotated about an area of no displacement at their eastern ends.

The Locustdale fault in the east-central part of the area represents another type of longitudinal fault. It is a high-angle shear resulting from compression of the strata in the center of the folds. This fault, which transects the beds at angles ranging from less than 1° to about 15°, is a north-dipping reverse fault along which younger beds in the hanging wall are uplifted with respect to the older beds in the footwall.

Oblique faults which are so nearly parallel with the bedding that they cut only a few coal beds occur at angles of about 45° to the trend of the major folds. Compared with the longitudinal faults they have small displacements, but they are important in mining. Some have caused shear zones, in which the coal is sheared and crushed to such an extent that mining is not profitable, or pinch faults, in which the coal is squeezed out from between the top rock and the floor rock.

NOMENCLATURE AND CORRELATION OF THE COAL BEDS

Coal beds in the anthracite fields are generally known as veins, following very early custom. As the term "vein," in geologic usage, refers to tabular mineral deposits that are foreign to, and younger than, the rocks in which they occur, the term is not applicable to deposits of coal. In this report, therefore, the coal deposits are called coal beds.

The coal beds are designated by names or numbers, or by both, but the nomenclature has not been standardized. In the early days of mining, different names were given to beds in isolated mines and no correlation was attempted. Some of the early erroneous correlation has been corrected but many problems of correlation still exist because of gaps between mine workings, complexity of structure and lithology, the scarcity of outcrops, and the difficulty of changing established records.

The names of the coal beds used in this report conform to the consensus of usage among operators and to the nomenclature of the previous reports of this series. These names do not necessarily agree with those used in the reports of the Second Geological Survey of Pennsylvania which conformed to local usage only (Ashburner, 1883, p. 84).

DESCRIPTION OF THE COAL BEDS

The coal beds in the mapped area occur in the upper half of the Pottsville formation, throughout the Allegheny formation, and in the lower part of the Conemaugh formation. (See columnar sections, sheet 3.) The younger coal beds that occur elsewhere in the anthracite fields have been removed by erosion from this area.

Natural outcrops of coal are seldom found because of the cover of soil. The outcrops shown on sheet 1 indicate the positions on the surface of the ground that the coal would occupy if it were projected through this cover. This position may not agree with blooms of weathered coal that are occasionally seen because such blooms, affected by creep of the weathered soil, occur at various distances down the slope from their original position. Exploration for the unweathered coal, therefore, should be started at the position of the outcrop shown on the map and extended in the direction of dip of the strata.

Coal beds less than 1½ ft (18 in.) thick are generally not recorded in this report. Unnamed coal beds 18 in. or more thick, that occur within a relatively small area and are not branches or splits from named beds, are herein termed "local" beds, and are shown on sheet 1 only where mined or located by prospecting. Outcrops of some of the more persistent beds are shown for long distances beyond any known point of outcrop. They indicate the authors' estimate of the position of the horizon of the bed but do not signify that the bed is necessarily minable throughout this extent.

INTERVALS BETWEEN COAL BEDS

The intervals between the coal beds vary considerably. The interval between the No. 8 and No. 5 coal beds thickens eastward from 190 ft in the western part of the area to 360 ft in the eastern part, and the interval between the No. 8 and the No. 2 coal beds thickens from 700 ft in the north to 800 ft in the south. The splitting and merging of the Mammoth coal zone and the occurrence of local beds above the Mammoth zone account for the greatest variations, but no regular trend has been observed.

THICKNESS OF THE COAL BEDS

The coal thicknesses shown in this report were obtained chiefly from underground measurements made by the operators. These measurements, selected from a great many such observations, were chosen so as to reflect the normal thickness of the bed and its included coal in unit areas 1,000 ft square. Wherever possible, at least four measurements were averaged for each unit area. Measurements that were considered to be abnormally affected by structural deformation, such as faulting, pinching, or swelling, were not used; hence, extreme dimensions of the bed are not included. The following table shows the average and range of thickness of these unit areas in the mines of the mapped area. These figures generally are in agreement with the thickness of the coal beds shown in the columnar sections, but not necessarily so, because the columnar sections represent only parts of the area and contain outcrop data, extreme measurements in mines, and other data that may have been excluded from the thickness in the unit areas within the mines.

AVERAGE AND RANGE OF THICKNESS OF COAL BEDS MINED IN THE SOUTHEASTERN PART OF THE MOUNT CARMEL QUADRANGLE

Bed number	Thicknesses: Bed, Average	Bed, Range		Coal, Average	Coal, Range		Percentage of refuse
	Ft. In.	Ft. In.	Ft. In.	Ft. In.	Ft. In.	Ft. In.	
17	4 8			4 0			14.8
16	4 0	2 6	8 4	3 0	1 8	4 6	25.0
15	3 5	2 1	5 10	2 10	1 1	4 10	17.6
14	7 7	3 5	12 10	5 4	2 4	9 5	29.6
13	4 6	2 10	6 2	3 10	2 4	5 2	15.5
12	6 5	3 0	16 1	4 5	1 8	7 8	31.2
11	8 7	2 6	15 3	7 6	1 2	12 7	12.8
11L	8 6	4 5	11 10	3 9	2 10	5 5	55.8
10¾	3 6	3 0	4 1	2 1	1 2	2 5	40.0
10½	4 5	3 9	5 4	3 11	2 4	5 4	11.3
10T							
10	5 1	1 0	11 8	4 4	0 8	11 1	14.7
9½	4 6	2 5	12 3	3 8	0 3	9 11	17.7
9	9 5	5 1	17 6	8 6	4 1	15 5	9.5
8½	10 11	4 1	18 7	9 4	3 7	16 8	14.6
8	8 11	1 6	25 6	7 7	0 8	19 5	14.6
8 and 9	24 4	4 10	57 0	19 6	4 8	57 0	19.7
7	7 7	1 0	14 3	5 6	1 0	9 5	27.6
6	5 5	1 11	9 9	4 4	0 7	7 6	20.3
5	5 11	1 8	13 3	3 3	1 6	5 8	45.7
3							
2	5 1	2 0	10 6	4 8	1 0	10 6	7.8

COAL BEDS OF THE POTTSVILLE FORMATION

Lykens Valley No. 2 coal bed

The Lykens Valley No. 2 coal bed, the oldest coal bed in the mapped area, crops out on the south side of Mahanoy Mountain, in the southern part of the area. The No. 2 bed contains less than 8 percent refuse, which is less than any other coal bed in the area covered by this report. It is mined in the northwestern part of the area in the Reliance and Alaska mines and has been mined both underground and by stripping methods in the Laurel Hill mine on the south flank of Mahanoy Mountain. Thickness of the bed was obtained only for the Alaska-Reliance mine area, where the bed averaged about 5 ft. In the southwestern part of the mapped area a bed designated as 2L occurs from 2 to 12 ft above the Lykens Valley No. 2 coal, and is probably the same bed as one that occurs in a similar position in the adjoining area to the west.

Whites (No. 3) coal bed

The Whites (No. 3) coal bed, which lies about 200 ft above the Lykens coal, crops out on both sides of Locust Mountain in the north, and along the crest of Mahanoy Mountain in the south. The bed has not been mined in the mapped area but it has been cut in bore holes in the Stuartsville and Locust Spring mines. No reliable data on thickness of the coal are available to the authors.

COAL BEDS OF THE ALLEGHENY FORMATION

Buck Mountain (No. 5) coal bed

The Buck Mountain (No. 5) coal, at the base of the Allegheny formation, crops out on both flanks of the Locust Mountain anticline, in the Mahanoy basin, and in the Laurel Hill basin, where it has been extensively strip-mined. This bed was mined underground in the Reliance mine and in Brenzel's tunnel. The Buck Mountain bed is the only major coal bed with more than 40 percent refuse. The thickness of the No. 5 bed is especially variable, ranging from 1 ft 8 in to 13 ft 3 in. within the mapped area.

Seven-foot (No. 6) coal bed

The interval between the Seven-foot (No. 6) coal bed and the Buck Mountain coal bed increases northwestward from 75 to 95 ft in the southern part of the area to a maximum of 120 ft in the northwestern part. The Seven-foot coal bed crops out on both sides of Locust Mountain and on the north side of Mahanoy Mountain. It has been rather extensively strip-mined on the north side of Locust Mountain and has been strip-mined in conjunction with the Buck Mountain bed on the north side of Mahanoy Mountain. The bed also crops out in the west-central part of the area, south of the Locust Gap fault in the Mahanoy basin.

The Seven-foot coal has been mined underground in the northwestern part of the area in the Alaska basin, in the east-central part of the Mahanoy basin, and in the Laurel Hill mine. This bed is thickest in the northwestern and southeastern parts of the mapped area and thinnest in the northeastern part. The Seven-foot coal bed ranges from 1 ft 11 in. to 9 ft 9 in. in thickness in the mapped area and contains an average of 20 percent refuse.

Skidmore (No. 7) coal bed

The Skidmore coal bed, which is separated from the Seven-foot coal bed by 60 to 100 ft of sandstone and claystone, crops out in all the basins in the mapped area. In the eastern part of the Locust Spring mine three splits of the Skidmore bed have been mined, and trenching and independent mining has exposed two splits in the western part of the Germantown mine. The Skidmore has been mined underground in the Locust Spring, Locust Gap, and Potts mines, where the bed ranges in thickness from 1 ft 0 in. to 14 ft 3 in. and has an average refuse content of 27.6 percent.

Mammoth coal zone

The base of the Mammoth coal zone is 235 ft stratigraphically above the Buck Mountain coal bed. This interval, however, tends to increase in the eastern part of the mapped area. The Mammoth coal zone in this area consists, in ascending order, of the Bottom Split (No. 8) coal, the Middle Split (No. 8½) coal, a local coal here called the Local Split (No. 9B) coal, and the Top Split (No. 9) coal. The splits are separated by claystones; the intervals between the Middle Split and the Top and Bottom Splits of the zone vary considerably throughout the area. In some localities the Middle Split and Top Split were recorded and mined as one bed, and in other places the Middle Split and Bottom Split appear to merge. In many places the partings between the splits are so thin that the entire Mammoth zone is mined as one bed, as in parts of the Locust Spring, Locust Gap, Potts, and Germantown mines. In such places thicknesses as great as 57 ft are recorded. The average thickness of the coal in the zone, exclusive of waste and partings, is 19 ft 6 in.

Mammoth Bottom Split (No. 8) coal bed. The Bottom Split (No. 8) coal crops out in all the basins in the mapped area and has been extensively strip-mined. It is mined underground in the Locust Spring, Locust Gap, Alaska, and Reliance mines, where its thickness ranges from 1 ft 6 in. to 25 ft 8 in. The average thickness of the bed is about 9 ft, of which about 15 percent is refuse.

Mammoth Middle Split (No. 8½) coal bed. The Mammoth Middle Split coal bed, where it is mined separately, is from 10 to 50 ft above the Mammoth Bottom Split coal bed. The Middle Split crops out in the New and Mahanoy basins in the southwestern part of the mapped area. It is 3 ft 7 in. to 16 ft 8 in. thick in the Locust Spring mine, where it is mined as a separate bed.

Local Split (No. 9B) coal bed. In the southwestern part of the mapped area, a few feet below the Top Split, a local coal bed called the No. 9B by the authors has been recognized but has not been mined. Immediately west of the mapped area, this local bed was mined by underground methods and by surface stripping. As no corresponding coal is found elsewhere in the mapped area, it is assumed that the No. 9B coal merges into the No. 9 coal to the east.

Mammoth Top Split (No. 9) coal bed. The Mammoth Top Split (No. 9), where present as a separate bed, lies approximately 50 ft stratigraphically above the Mammoth Bottom Split. Where the Middle Split is present, the Top Split may be as much as 100 ft above the Bottom Split. The Top Split crops out on the north flank of Locust Mountain and in the central part of the mapped area in the Locust Summit and Mahanoy basins. In the Locust Spring, Locust Gap, Alaska, and Reliance mines the bed, as shown by mining records, is 5 ft 1 in. to 17 ft 6 in. thick, and the included coal has an average thickness of 8 ft 6 in.

Four-foot (No. 9½) coal bed

The Four-foot coal bed lies 50 to 180 ft stratigraphically above the bottom of the Mammoth coal zone. The larger interval is in the southern part of the mapped area, in the Mahanoy basin, where a conglomeratic sandstone intervenes. The Four-foot coal crops out in all the basins in the mapped area and has been mined locally in the Locust Spring, Potts, Alaska, and Reliance mines. The coal ranges in thickness from 2-inch streaks to nearly 10 ft. The average thickness of the bed in the mines is 4 ft 6 in., of which 18.2 percent is refuse.

Holmes Leader (No. 10L) coal bed

The Holmes Leader is a local coal bed that lies on the south dip of the Mahanoy basin in the southeastern part of the mapped area. The bed has not been mined but has been cut in tunnels in the Potts mine, and occurs 10 to 20 ft under the Holmes (No. 10) coal bed in that area. No information regarding thickness of bed or coal is available.

COAL BEDS OF THE CONEMAUGH FORMATION

Holmes (No. 10) coal bed

The Holmes (No. 10) coal bed, at the base of the Conemaugh formation, ranges from 100 to 250 ft above the bottom of the No. 8 coal bed. The Holmes coal, which, next to the Mammoth coal zone, is the most extensively mined bed in the area, crops out in all of the major basins. It is mined in the Alaska, Reliance, Locust Spring, Locust Gap, Potts, and Germantown mines, where the average thickness of the bed and its included coal is 5 ft 1 in. and 4 ft 4 in., respectively.

Holmes Top Split (No. 10T) coal bed

A local bed, the Holmes Top Split (No. 10T) coal, splits from the Holmes coal bed in the central part of the area. It has been found in an exploration trench south of the Merriam shaft of the Germantown mine and in diamond drilling in the same area. The Holmes Top Split has been mined locally, but no information on thickness is available. Drill-hole records show coal 6 ft 2 in. thick.

Rough (No. 10½) coal bed

The Rough (No. 10½) coal bed, which is about 60 ft stratigraphically above the Holmes coal, is not a persistent bed. It crops out in the Alaska basin northwest of Locust Mountain, where it has been strip-mined, and also crops out in the Mahanoy, Locust Summit, and New basins. The Rough coal has been mined underground in the northwestern part of the area and in the Mahanoy and Locust Summit basins. The average thickness of the coal in this bed in the mined area is about 4 ft.

Local (No. 10¾) coal bed

The Local (No. 10¾) coal bed is mined in the northwestern part of the mapped area and in the east-central part of the Mount Carmel quadrangle (Rothrock et al., 1951). A bed that is correlated with the No. 10¾ coal crops out on the south side of Locust Mountain and on the north side of Mahanoy Mountain. The average thickness of the bed in the mined area is 3 ft 6 in., and 40 percent of this is refuse.

Primrose (No. 11) coal bed

The Primrose (No. 11) coal bed is about 230 ft stratigraphically above the Holmes coal bed in the western part of the area and 130 to 170 ft above it in the eastern part. This thinning of interval, which continues eastward into the adjoining area, is accounted for by lensing of the conglomeratic beds above the Holmes. The Primrose crops out in all the major basins in the area except the Alaska basin; it has been mined in the Potts, Locust Spring, Locust Gap, and Germantown mines. The Primrose is one of the better coal beds in the area and averages about 8 ft in thickness, with little waste.

Orchard (No. 12) coal bed

The Orchard (No. 12) coal bed is 80 to 100 ft stratigraphically above the Primrose coal. The intervening rock is mostly claystone. The Orchard coal crops out in the North, Mahanoy, and Mount Carmel basins and has been mined underground in the Potts, Locust Spring, and Reliance mines. This coal bed is locally 16 ft 1 in. thick, but its average thickness is only 4 ft 5 in.

Little Orchard (No. 13) coal bed

The Little Orchard (No. 13) coal bed is about 130 ft stratigraphically above the Orchard coal in the western part of the area, but this interval thins to 60 ft in the east. The intervening strata consist of claystones and sandstones. The Little Orchard occurs locally in the New, Mahanoy, and Locust Summit basins, where it has been cut in tunnels and diamond-drill holes in the Locust Spring mine and has been mined in the Potts mine. The average thickness of the bed in the mined area is 4 ft 6 in., 15.5 percent of which is waste.

Diamond (No. 14) coal bed

The Diamond (No. 14) coal bed lies 230 ft stratigraphically above the Orchard coal. In the mapped area the Diamond occurs in the New, Locust Summit, Mahanoy, and Germantown basins and is mined in the Germantown, Locust Spring, and Potts mines. The bed is 3 ft 5 in. to 12 ft 10 in. thick and contains 30 percent of waste.

Little Diamond (No. 15) coal bed

The Little Diamond (No. 15) coal bed occurs about 20 ft above the Diamond coal in a tunnel and in local workings in the Locust Spring and Potts mines, where the coal averaged 2 ft 10 in. in thickness.

Tracy (No. 16) coal bed

The Tracy (No. 16) coal bed lies approximately 180 ft stratigraphically above the Diamond coal bed in the eastern part of the Mahanoy basin. The Tracy coal has been mined underground in small areas in the Potts and Locust Spring mines. The average thickness of the Tracy bed in this area is 4 ft, 25 percent of which is refuse.

Little Tracy (No. 17) coal bed

The Little Tracy (No. 17) coal bed is the youngest coal in the mapped area. It occurs in the southeastern part of the area in the Mahanoy basin where it is approximately 200 ft stratigraphically above the Tracy coal. The Little Tracy has not been mined but has been cut in diamond-drill holes in the Potts mine and in the Keystone water-level tunnel. Core-drill records show the bed to be 4 ft 8 in. thick and the included coal to be 4 ft thick.

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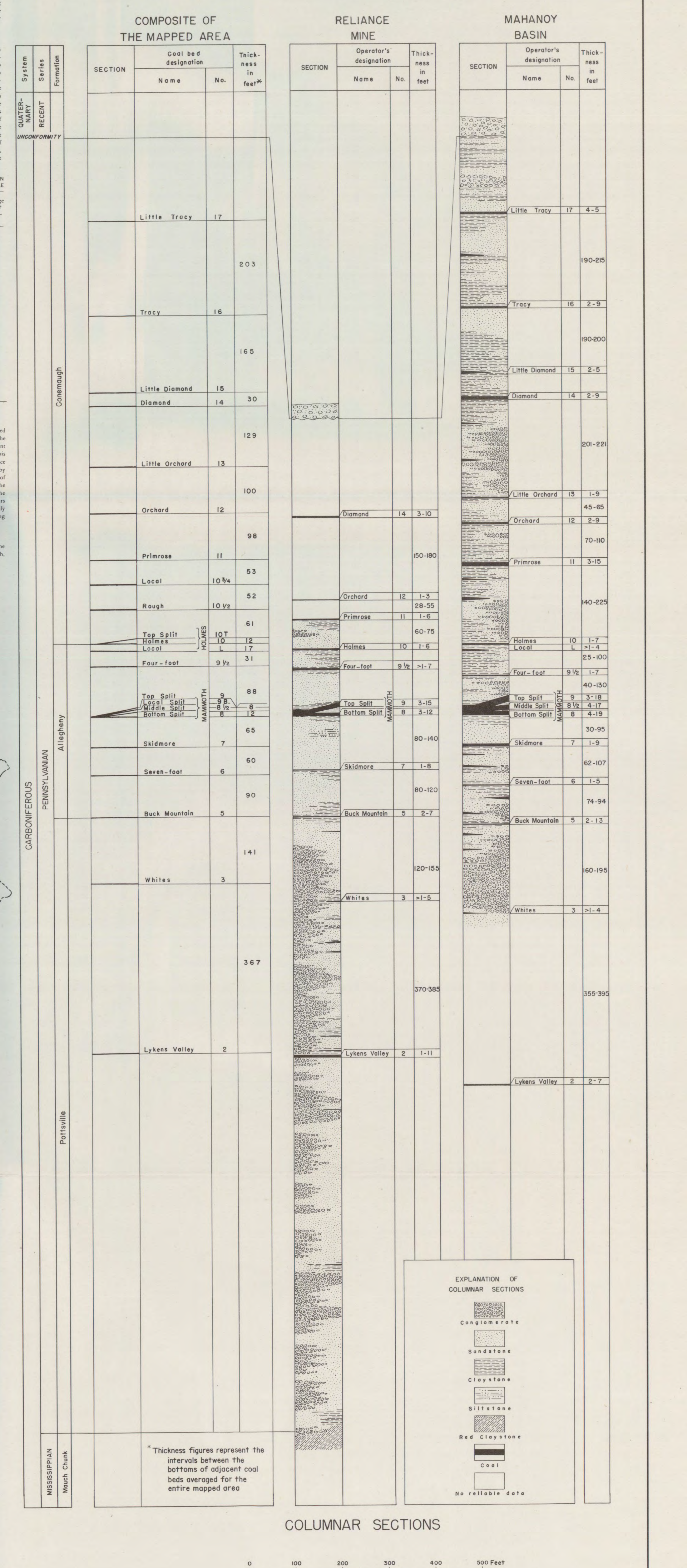


COLUMNAR SECTIONS

GEOLOGY OF ANTHRACITE IN THE SOUTHEASTERN PART OF THE MOUNT CARMEL QUADRANGLE, PENNSYLVANIA

By
Howard E. Rothrock, Holly C. Wagner, Boyd R. Haley and Harold H. Arndt

1953

COAL INVESTIGATIONS
MAP C12 (IN 3 SHEETS) SHEET 3

For sale by U. S. Geological Survey, price $1.50 per set

GEOLOGY OF ANTHRACITE IN THE WESTERN PART OF THE ASHLAND QUADRANGLE, PENNSYLVANIA

COAL INVESTIGATIONS
MAP C13 (SHEET 1 OF 2)

COAL OUTCROP MAP

STRUCTURE MAP OF THE BUCK MOUNTAIN AND MAMMOTH COAL BEDS

EXPLANATION
OUTCROP MAP

- Coal outcrop — *Solid where location is known, long dashes where uncertain. Number designates coal bed; L, lionel bed; T, top split; M, middle split; B, Mammoth Bottom Split leader.*
- Fault showing dip and relative position of sides — *Real direction of movement not necessarily known; U, upthrown side; D, downthrown side; T, overthrust plate. Fault trace is solid line where accurately known, long dashes where approximately located.*
- Anticline — *Showing crest line*
- Syncline — *Showing trough line*
- Strike and dip of bed
- Structural cross section
- Strip-mined area
- Back-filled stripping
- Surface opening on coal bed
- Shaft
- Tunnel
- Exploratory trench — *Tick shows where coal was found.*
- Crop fall — *Collapsed area where surface has fallen into underground workings.*
- Mine waste — *Includes such refuse from mining and breaker operations as culm, rock banks, coal piles, back fill, and silt in settling basins.*
- Stream transported waste
- Boundary of mine
- ANDREW PORTER — Warranty tract — *Boundaries are indicated for general orientation and identification but are not authenticated for legal purposes.*
- Borough line

EXPLANATION
STRUCTURE MAP

Note: Green structure and outcrop symbols apply to the Buck Mountain coal bed. Red structure and outcrop symbols apply to the bottom split of the Mammoth coal bed.

- Outcrop of coal beds
- Fault cutting contoured bed showing dip of fault plane, relative position of faulted segments, and overthrust segment. — *Fault trace is solid where accurately located, long dashes where approximately located. Fault traces on underlying plate is indicated by short dashes where accurately located and dots where approximately located. U, upthrown plate; D, downthrown plate; T, overthrust segment.*
- Shear zone
- Anticline — *Showing crest line; solid where location is known, dashed where location is uncertain.*
- Syncline — *Showing trough line; solid where location is known, dashed where location is uncertain.*
- Contours on the bottom of the contoured coal bed — *Solid in mined areas; long dashes in unmined areas; in those places where a part of the bed lies beneath another part of the same bed short dashes are used in mined areas, and very short dashes in unmined areas.*
- Structural cross section
- Drainage tunnel
- Barrier pillar in contoured bed
- Boundary of mine
- ANDREW PORTER — Warranty tract — *Boundaries are indicated for general orientation and identification but are not authenticated for legal purposes.*

Base: U. S. Geological Survey topographic map. Polyconic projection. 1927 North American datum. Topography was contoured from aerial photographs made in 1942. Correction has generally not been made for topographic changes resulting from strip mining or alteration of mine refuse banks since 1942.

Prepared in 1951 from data supplied by the Hazle Brook Coal Co., Raven Run Coal Co., Lehigh Valley Coal Co., and Philadelphia and Reading Coal and Iron Co., with modifications by the U. S. Geological Survey.

Scale 1:12,000

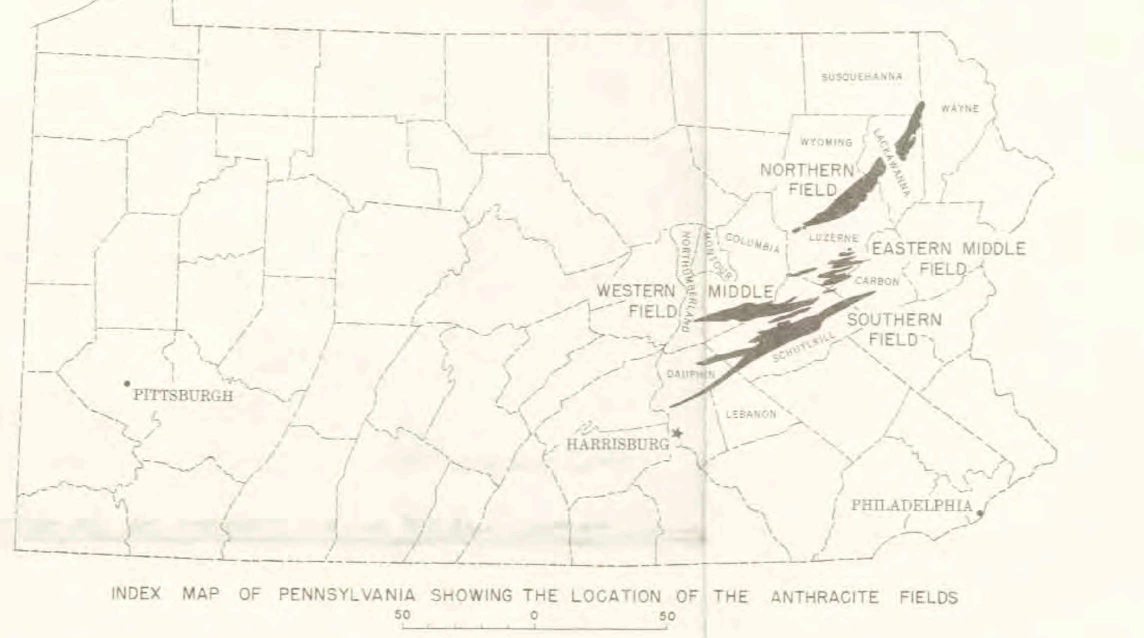
1000 0 1000 2000 3000 4000 5000 6000 Feet

Topographic contour interval is 20 feet
Structure contour interval is 100 feet
Datum is mean sea level

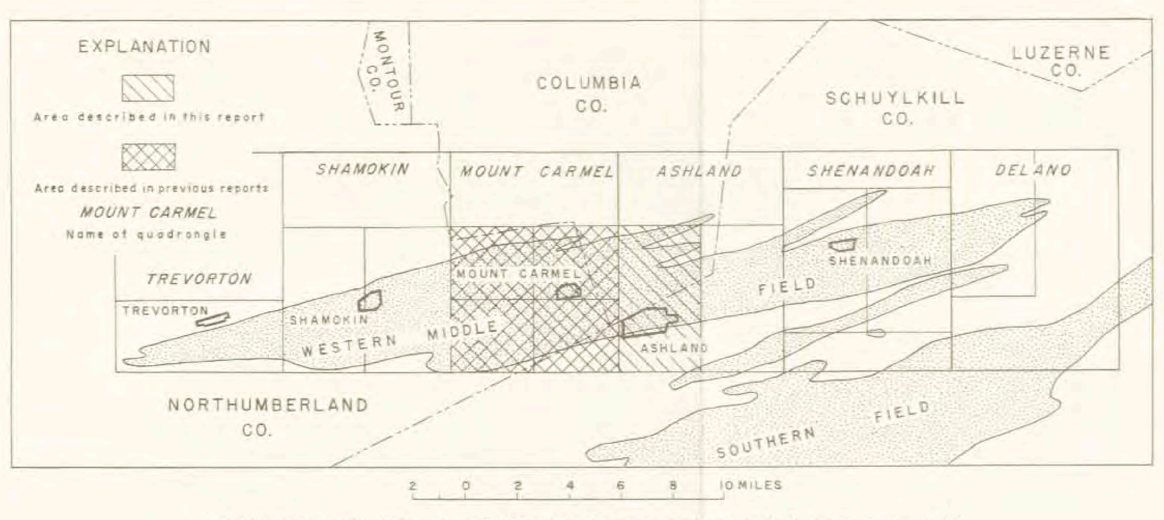
APPROXIMATE MEAN DECLINATION, 1953

DIAGRAM OF A TOPOGRAPHIC QUADRANGLE SHOWING THE AREA INCLUDED IN THIS MAP

INTERIOR—GEOLOGICAL SURVEY, WASHINGTON, D. C.
For sale by the U. S. Geological Survey, price $1.50 per set

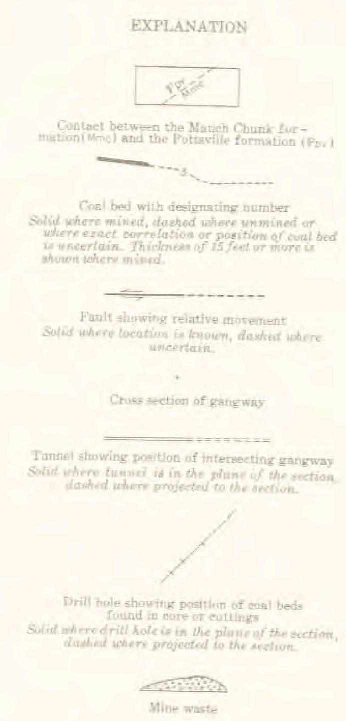


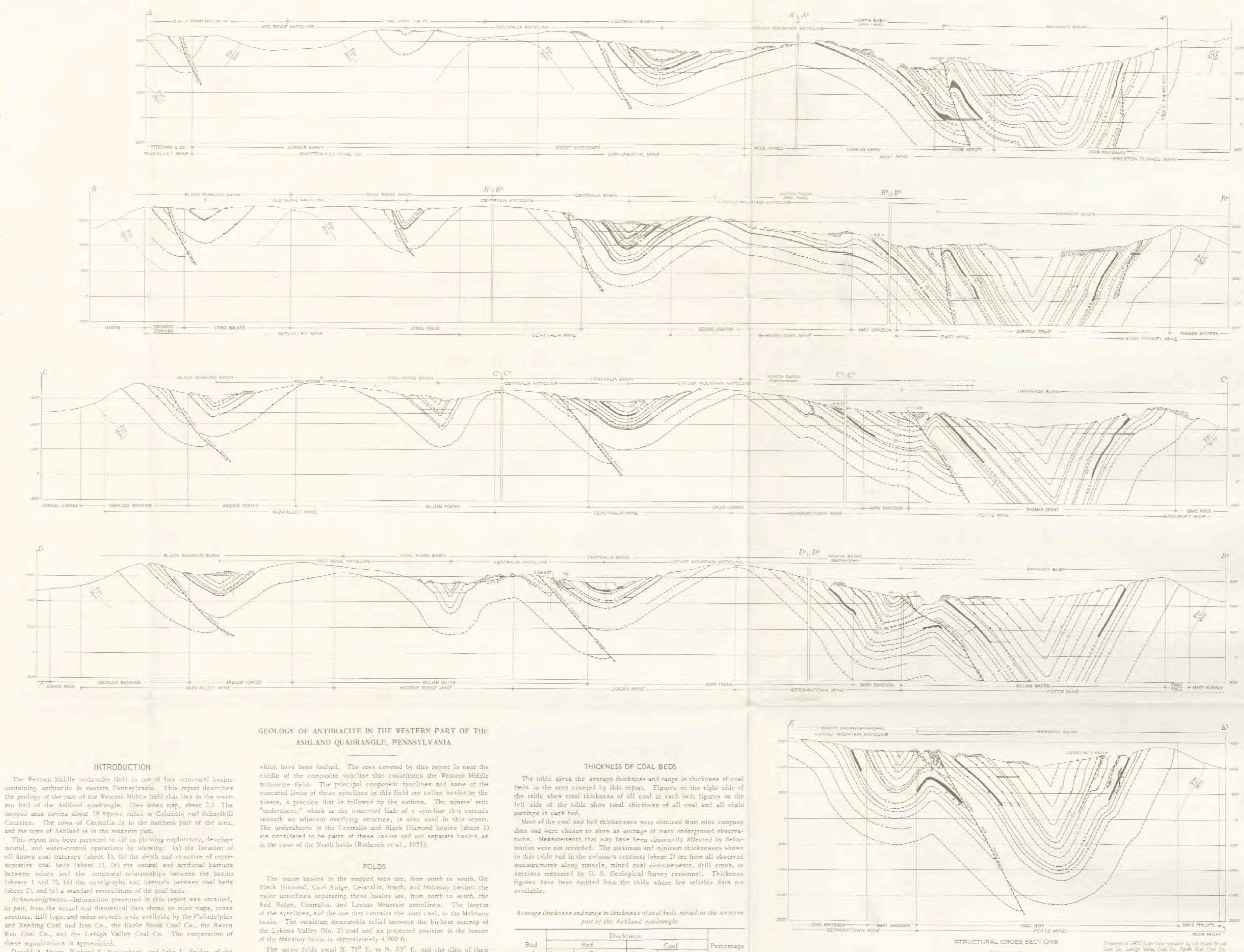
INDEX MAP OF PENNSYLVANIA SHOWING THE LOCATION OF THE ANTHRACITE FIELDS



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

COLUMNAR SECTIONS





STRUCTURAL CROSS SECTIONS

INTRODUCTION

The Western Middle anthracite field is one of four structural basins containing anthracite in eastern Pennsylvania. This report describes the geology of the part of the Western Middle field that lies in the western half of the Ashland quadrangle. (See index map, sheet 2.) The mapped area covers about 19 square miles in Columbia and Schuylkill Counties. The town of Centralia is in the northern part of the area, and the town of Ashland is in the southern part.

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) a standard nomeclature of the coal beds.

Acknowledgments.—Information presented in this report was obtained, in part, from the actual and theoretical data shown on mine maps, cross sections, drill logs, and other records made available by the Philadelphia and Reading Coal and Iron Co., the Hazle Brook Coal Co., the Raven Run Coal Co., and the Lehigh Valley Coal Co. The cooperation of these organizations is appreciated.

Donald A. Myers, Richard E. Bergenback, and John L. Snider, of the U. S. Geological Survey, aided in the field mapping of this area.

STRATIGRAPHY

Rocks of the Carboniferous and Quaternary systems crop out in the mapped area. The Carboniferous rocks belong to the upper part of the Mauch Chunk formation of Mississippian age and to the Pottsville, Allegheny, and lower part of the Conemaugh formations of Pennsylvanian age. Unconsolidated alluvial clay, silt, sand, and gravel of Quaternary age have been deposited on the Carboniferous rocks in the stream valleys. Stream-transported mine waste, some of which contains valuable deposits of detrital coal, has also been deposited along many streams. The Quaternary alluvium has not been mapped, but the economically important deposits of mine waste are shown on the outcrop map (sheet 1).

MISSISSIPPIAN ROCKS

The Mauch Chunk formation crops out in the northern part of the mapped area north of Big Mountain and north and south of Coal Ridge, and in the southern part of the area south of Mahanoy Mountain and north of Broad Mountain. Only the upper 1,800 ft of the formation is exposed in the mapped area.

The strata in 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. All the beds are abruptly lenticular. The contact between the Mauch Chunk 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 12 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 are the most persistent of the lithologic units. The other rock units exhibit such abrupt changes in lithology that they are of little value for use as reference or key beds.

Pottsville formation.—The Pottsville formation, which includes the oldest Pennsylvanian rocks in the area, lies between the Mauch Chunk formation and the overlying Allegheny formation. It consists of resistant conglomerate and sandstone and is expressed topographically by forming all of the mountains and most of the major ridges in the mapped area. The formation is approximately 1,050 ft thick in the western and southern parts of the area but thins to approximately 860 ft in the north-central part. This thinning is due in part to a local disconformity that is apparent in the exposure of Mauch Chunk and Pottsville rocks along the Aristes-Catawissa highway. In this exposure a persistent coal bed known as the Lykens Valley (No. 2) coal bed and approximately 180 ft of strata in the upper part of the formation are missing.

The lower 100 ft of the Pottsville formation is composed of beds of gray conglomerate, gray, green, brown, and red sandstone or 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) coal is near the middle of the formation. Two nonpersistent coal beds—Whites (No. 3) and Little Buck Mountain (No. 4)—and a local coal bed are present at some places in the upper part of the formation.

Allegheny formation.—The Allegheny formation, 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 thickness of the Allegheny formation ranges from 390 ft to 600 ft and averages about 460 ft. It is composed of conglomerate, sandstone, siltstone, claystone, and coal. The coal beds are the only laterally persistent lithologic units. In general, conglomerate and sandstone are more abundant in the lower part of the formation than in the upper part. In the Black Diamond basin the formation consists almost entirely of sandstone.

The Allegheny formation is the source of most of the coal mined in the mapped area. Five persistent coal beds—the Buck Mountain (No. 5), Seven-foot (No. 6), Skidmore (No. 7), and two beds in the Mammoth zone (No. 8 and No. 9)—are present in the Allegheny formation. The Buck Mountain and the Mammoth zone coal beds are the most important of these.

Conemaugh formation.—The Conemaugh formation, the base of which is the Holmes (No. 10) coal (Lohman, 1937, p. 40), overlies the Allegheny formation. Erosion has removed all of the formation in the northern part of the area, but 1,200 ft of the Conemaugh remains in the Mahanoy basin. The formation is composed of gray or brown sandstone, siltstone, claystone, scattered lenses of conglomerate, and coal. This formation contains six persistent coal beds—the Holmes (No. 10), Primrose (No. 11), Orchard (No. 12), Diamond (No. 14), Tracy (No. 16), and Little Tracy (No. 17)—which are of economic value throughout most of their extent.

STRUCTURE

Each of the Pennsylvania anthracite fields is a northeast-trending composite syncline composed of several overlapping folds, some of

GEOLOGY OF ANTHRACITE IN THE WESTERN PART OF THE ASHLAND QUADRANGLE, PENNSYLVANIA

which have been faulted. The area covered by this report is near the middle of the composite syncline that constitutes the Western Middle anthracite field. The principal component synclines and some of the truncated limbs of these synclines in this field are called basins by the miners, a practice that is followed by the authors. The miners' term "undersheet," which is the truncated limb of a syncline that extends beneath an adjacent overlying structure, is also used in this report. The undersheets in the Centralia and Black Diamond basins (sheet 1) are considered to be parts of these basins and not separate basins, as in the case of the North basin (Rothrock et al., 1951).

FOLDS

The major basins in the mapped area are, from north to south, the Black Diamond, Coal Ridge, Centralia, North, and Mahanoy basins; the major anticlines separating these basins are, from north to south, the Red Ridge, Centralia, and Locust Mountain anticlines. The largest of the synclines, and the one that contains the most coal, is the Mahanoy basin. The maximum measurable relief between the highest outcrop of the Lykens Valley (No. 2) coal and its projected position in the bottom of the Mahanoy basin is approximately 4,000 ft.

The major folds trend N. 75° E. to N. 83° E. and the dips of their axial planes range from 78° N. to 80° S. The folds are concentric, and the limbs subtend angles ranging from 65° to 115° and so include both acute (Black Diamond basin) and obtuse (Centralia basin) folding. Most of the synclines are more acutely folded than the adjacent anticlines.

FAULTS

Most faults in the mapped area are thrust faults that dip southward and are the result of compression. They generally trend northeast, paralleling the axes of the folds and cutting the bedding at angles generally less than 60° except where drag has affected the beds. The principal faults, from north to south, are the Midvalley, Centralia, and Locust Gap faults. These faults cut the northern limbs of the Black Diamond, Centralia, and Mahanoy basins, respectively, and they dip southeastward. The dips and the displacements of the principal faults increase from north to south. The Locustdale and Ashland faults in the southern part of the area are high-angle geometrically reverse faults resulting from compression of strata in the center of the folds. These faults cut the beds at angles ranging from 0° to 15° and dip northwestward.

Several faults in the mapped area cut obliquely across the folds, making angles ranging from 25° to 60° with the fold axes. These faults have relatively small displacements that range from a few feet to a few tens of feet. In many places they are associated with shear zones. Other shear zones, which have no apparent displacement, are thought to represent an arrested early stage in the development of an oblique fault. Some of these zones are linear and trend obliquely to the fold axes, but others are irregular and have no apparent orientation (see sheet 1).

An oblique fault of special interest is the Aristes fault (see sheets 1 and 2), which has cut and rotated clockwise as arcuate segment of the Coal Ridge basin. The position of the basin axis on opposite sides of the fault suggests that little vertical movement has taken place. This fault is probably the result of differential pressure applied during the formation of the major structures.

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

A fault may increase or decrease the thickness of the coal bed by thrusting or dragging one part of the bed over another, or by telescoping the coal bed. The thickening of the Mammoth, as shown on cross section E^2–E^3 (sheet 2), is attributed to such action. 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 the coal beds of the different mines are designated by a number, a name, or both. This nomenclature has not been standardized 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) the structure and 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 all cases with those used in the Second Geological Survey of Pennsylvania (Ashburner, 1883, pp. 83-107), and they do not agree in all 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 a continuous coal bed. 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 ft.

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 they 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 horizon and does not mean that the coal is of minable thickness throughout its indicated extent. Local or leader coal beds less than 18 in. thick were not mapped.

THICKNESS OF COAL BEDS

The table gives the average thickness and range in thickness of coal beds in the area covered by this report. Figures on the right side of the table show total 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 mined in the western part of the Ashland quadrangle

Bed number	Thickness: Bed: Average Ft	In.	Range Ft	In.	Ft	In.	Coal: Average Ft	In.	Range Ft	In.	Ft	In.	Percentage of refuse
17			1	0	5	0							25.0
16	5	0	2	6	8	4	3	0	1	8	4	6	40.0
15			1	10	6	0							
14	9	1	3	10	15	1	6	4	2	4	12	2	30.3
13	7	4	2	8	11	6	4	6	0	8	8	8	38.6
12	9	1	1	0	15	0	5	10	1	0	10	11	35.8
11T	7	5	4	0	10	11	6	7	4	2	9	6	11.2
11	8	11	3	4	18	7	7	11	1	1	16	0	11.2
11L	4	8	2	6	6	2	3	8	2	6	6	2	21.4
10½	3	11	0	8	4	0							48.7
10T	5	2	3	0	7	3	4	6	2	10	7	0	12.9
10	4	8	1	8	10	4	4	5	1	8	10	0	5.4
9½	3	4	0	10	16	4	2	7	0	10	6	0	22.5
9L	5	2	1	4	14	0	4	6	1	2	14	0	12.9
9	6	1	3	0	12	6	5	2	3	6	11	10	11.0
8	8	8	3	0	14	0	8	5	3	0	14	0	2.9
8 & 9	23	4	7	8	65	5	18	5	6	8	65	2	21.1
8L	4	1	1	0	8	6	2	8	1	0	8	5	34.7
7T			0	10	4	0							
7	4	10	0	8	9	2	3	5	0	6	9	2	29.3
6	5	2	1	5	8	5	2	7	0	11	4	10	50.0
L	3												
L			0	10	5	0							
5T	3	6	1	6	13	0	2	11	1	6	13	0	17.1
5M	2	0	1	6	2	5	1	8	1	0	2	3	16.6
5	9	11	1	8	24	11	8	6	0	11	16	0	14.3
4	5	5	3	7	8	2	3	7	2	1	5	11	33.3
3	2	0	1	7	2	7	1	10	1	7	2	5	10.0
2	4	4	0	6	9	6	3	6	1	0	9	0	19.2

COAL BEDS MINED IN THE AREA

The Lykens Valley (No. 2) coal bed is the only persistent coal in the Pottsville formation. It ranges in thickness from a few inches to as much as 9 ft.

The Buck Mountain coal bed and the Mammoth zone coal beds are the most important coals in the Allegheny formation. The Buck Mountain coal bed overlies the resistant rocks of the Pottsville formation and underlies the less resistant rocks of the Allegheny formation. The resultant topographic bench in some areas readily identifies the Buck Mountain coal bed and allows the outcrop line to be mapped rather accurately. The persistence, quality, and thickness of this coal bed make it economically important. The Buck Mountain has been mined extensively in the mapped area, in some places as a single bed and in other places as two or three splits. The three splits are best developed in the western end of the Centralia basin (see coal outcrop map, sheet 1), where they have been exposed by strip mining and surface openings along the coal outcrop. Where these splits are too close together to be mapped separately they are shown as a single coal bed on the coal outcrop map.

The Mammoth coal zone is economically the most important group of coal beds in the Allegheny formation. It is persistent and is easily identified by its thickness, which attains a maximum of 65 ft in some parts of the mapped area. In the adjacent Mount Carmel quadrangle the Mammoth zone consists of a Bottom Split (No. 8) and a Top Split (No. 9), but in the area covered by this report these two splits are generally so close together that they are mined as one bed (No. 8 and No. 9). Only the Bottom Split (No. 8) is recognized in the Black Diamond basin. In the western part of the Coal Ridge and Centralia basins the Mammoth Top Split (No. 9) is mined as a separate bed. In the western part of the Centralia basin the Mammoth zone also contains two leaders—the Mammoth Top Split Leader (No. 9L) and the Mammoth Bottom Split Leader (No. 8L).

The Holmes coal bed is the most important coal of the Conemaugh formation. Extensive mining and a rather uniform interval from the Mammoth coal zone are two factors that make the Holmes coal useful as a key bed. The Holmes coal is mined as two splits in most of the Centralia and North basins and in parts of the Mahanoy basin. The two splits merge in the eastern part of the mapped area and are mined as one coal bed.

The Primrose and Diamond coal beds contain two splits in some parts of the mapped area.

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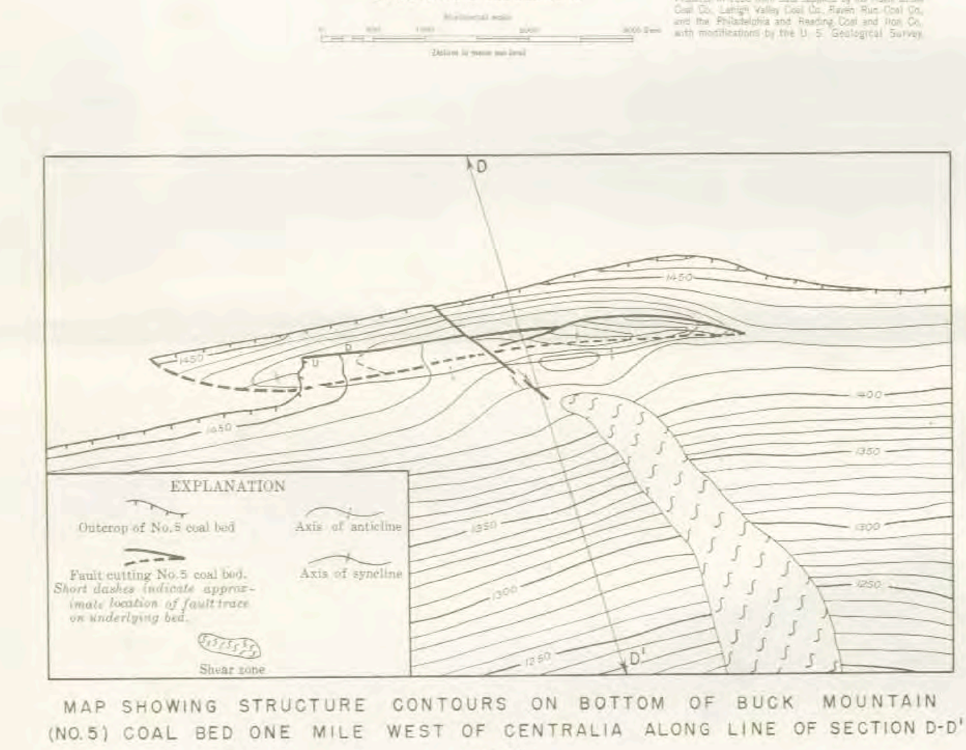
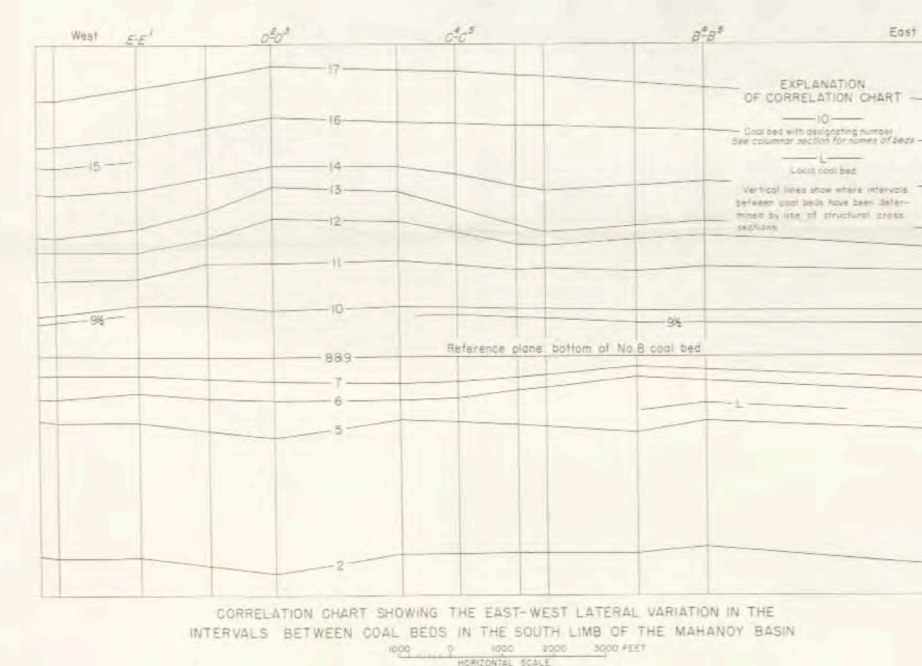


MAP SHOWING STRUCTURE CONTOURS ON BOTTOM OF BUCK MOUNTAIN (NO.5) COAL BED ONE MILE WEST OF CENTRALIA ALONG LINE OF SECTION D-D'



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

GEOLOGY OF ANTHRACITE IN THE WESTERN PART OF THE ASHLAND QUADRANGLE, PENNSYLVANIA

By
Boyd R. Haley, Harold H. Arndt, Howard E. Rothrock, and Holly C. Wagner

1953

DEPARTMENT OF THE INTERIOR
UNITED STATES GEOLOGICAL SURVEY
W. E. WRATHER, DIRECTOR

COAL INVESTIGATIONS
MAP C14 (SHEET 1 OF 2)

COAL OUTCROP MAP

Base: U. S. Geological Survey topographic map.
Polyconic projection. 1927 North American datum.
Topography was contoured from aerial photographs made in 1942. Correction has generally not been made for topographic changes resulting from strip mining or alteration of mine refuse banks since 1942.

EXPLANATION
OUTCROP MAP

- Coal outcrop — *Solid where location is known, long dashes where uncertain. Number designates coal bed; L, local bed; T, top split.*
- High angle fault showing dip — *U, upthrown side; D, downthrown side.*
- Fault showing relative movement
- Thrust or low angle reverse fault showing dip — *T, upper plate.*
- Anticline — *Showing crest line.*
- Syncline — *Showing trough line.*
- Overturned anticline — *Showing crest line and direction of dip of the limbs.*
- Overturned syncline — *Showing trough line and direction of dip of the limbs.*
- Structural cross section
- Strip-mined area — *Shaded area back-filled.*
- Surface opening on coal bed
- Exploratory trench — *Tick shows where coal was found.*
- Crop fall — *Collapsed area where surface has fallen into underground workings.*
- Mine waste — *Includes such refuse from mining and breaker operations as culm, rock banks, coal piles, back fill, and silt in settling basins.*
- Stream-transported waste
- Boundary of mine
- NECHO ALLEN — Warranty tract — *Boundaries are indicated for general orientation and identification but are not authenticated for legal purposes.*
- Borough line

EXPLANATION
STRUCTURE MAP

Note: Green structure and outcrop symbols apply to the Buck Mountain coal bed. Red structure and outcrop symbols apply to the bottom split of the Mammoth coal bed.

- Outcrop of coal beds
- Fault cutting contoured bed showing dip of fault plane, relative position of faulted segments, and overthrust segment. — *Fault trace is solid where accurately located, long dashes where approximately located. Fault trace on underlying plate is indicated by short dashes where accurately located and dots where approximately located. U, upthrown segment; D, downthrown segment; T, overthrust segment.*
- Shear zone
- Anticline — *Showing crest line; solid where location is known, dashed where location is uncertain.*
- Syncline — *Showing trough line; solid where location is known, dashed where location is uncertain.*
- Overturned syncline — *Showing trough line and direction of dip of the limbs.*
- Contours on the bottom of the contoured coal bed — *Solid in mined areas; long dashes in unmined areas; in those places where a part of the bed lies beneath another part of the same bed short dashes are used in mixed areas, and very short dashes in unmined areas.*
- Structural cross section
- Barrier pillar in contoured bed
- Boundary of mine
- NECHO ALLEN — Warranty tract — *Boundaries are indicated for general orientation and identification but are not authenticated for legal purposes.*

Scale 1:12 000
1000 0 1000 2000 3000 4000 5000 6000 Feet
Topographic contour interval is 20 feet
Structure contour interval is 100 feet
Datum is mean sea level

APPROXIMATE MEAN DECLINATION, 1954

STRUCTURE MAP OF THE BUCK MOUNTAIN AND MAMMOTH COAL BEDS

Prepared in 1951 from data supplied by the Hazle Brook Coal Co., Lehigh Valley Coal Co., and Philadelphia and Reading Coal and Iron Co., with modifications by the U. S. Geological Survey.

DIAGRAM OF A TOPOGRAPHIC QUADRANGLE SHOWING THE AREA INCLUDED IN THIS MAP

INTERIOR—GEOLOGICAL SURVEY, WASHINGTON, D. C. M-8481S
For sale by the U. S. Geological Survey, price $1.00 per set

COAL INVESTIGATIONS
MAP C14 (SHEET 1 OF 2)

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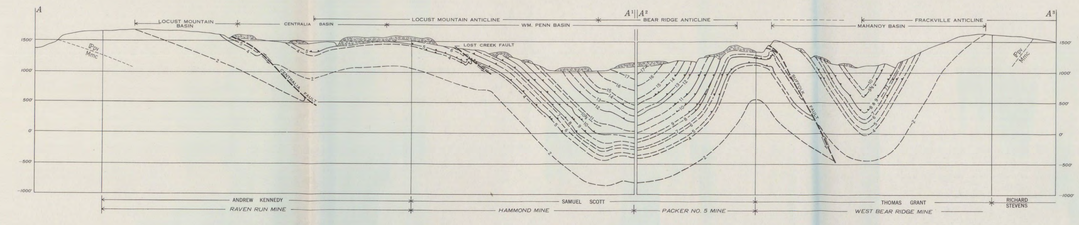
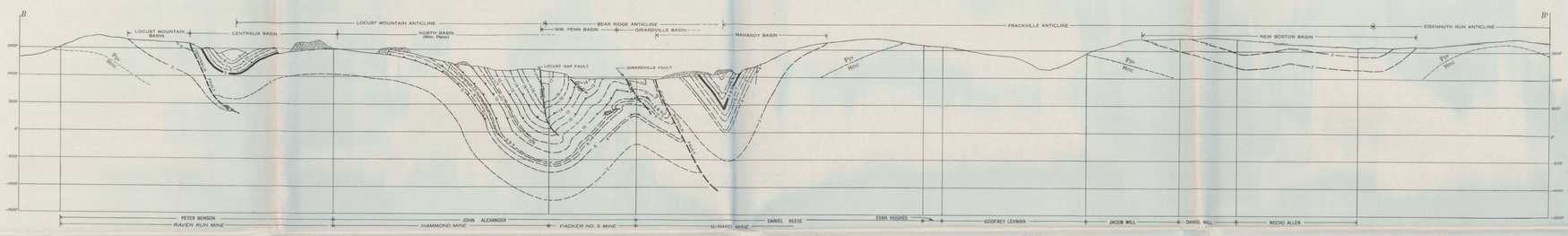
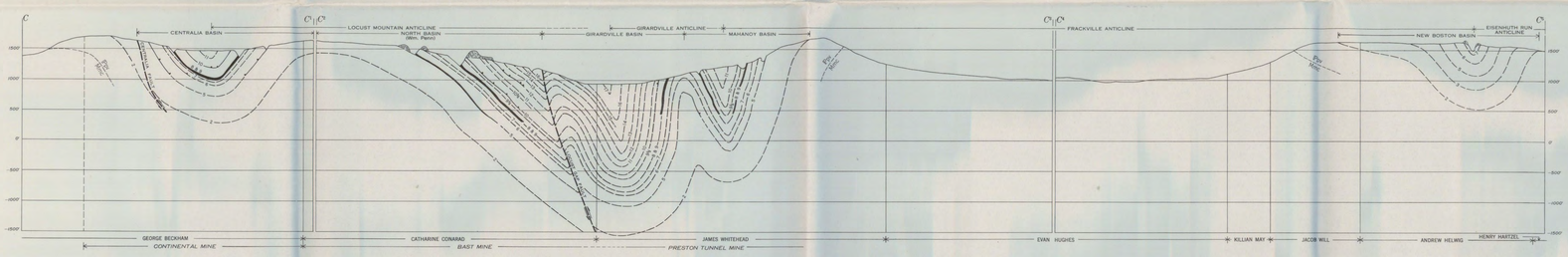
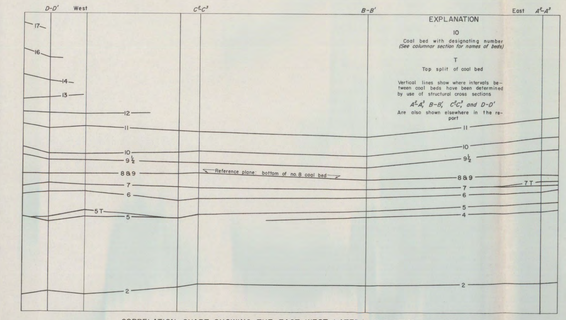
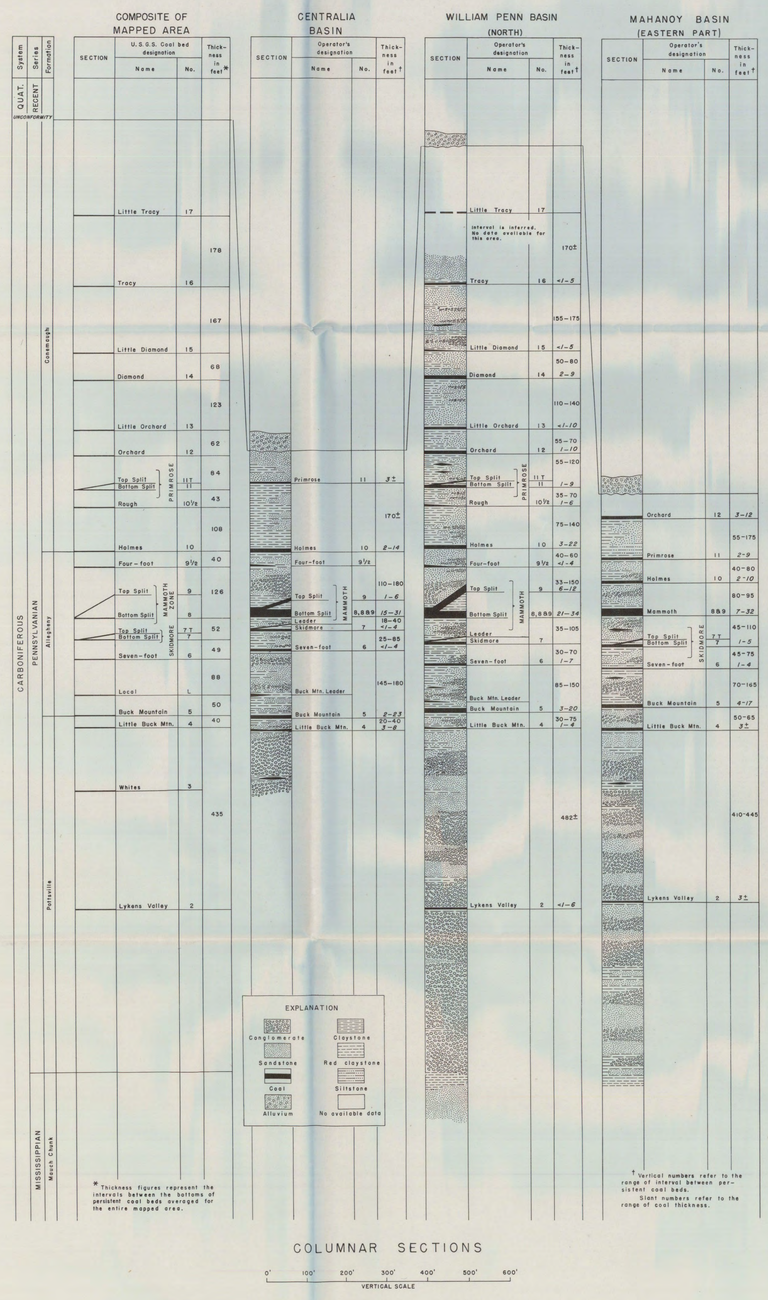


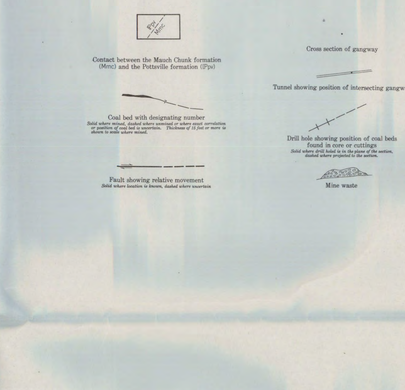


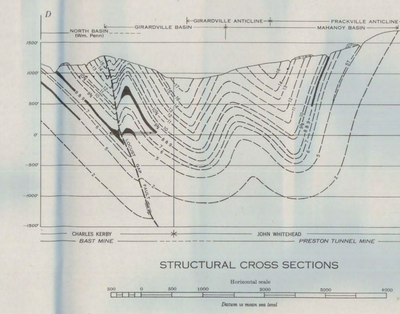




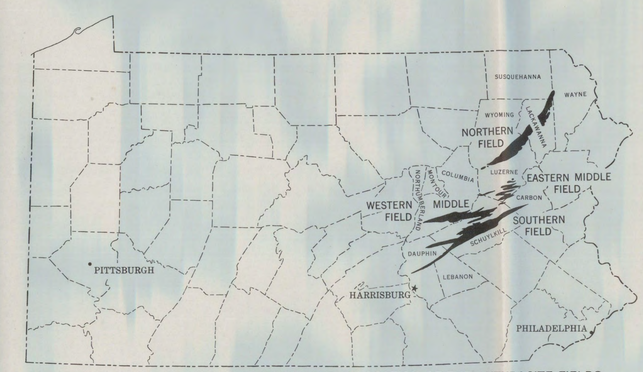
CORRELATION CHART SHOWING THE EAST-WEST LATERAL VARIATION IN THE INTERVALS BETWEEN COAL BEDS IN THE SOUTH LIMB OF THE MAHANOY BASIN



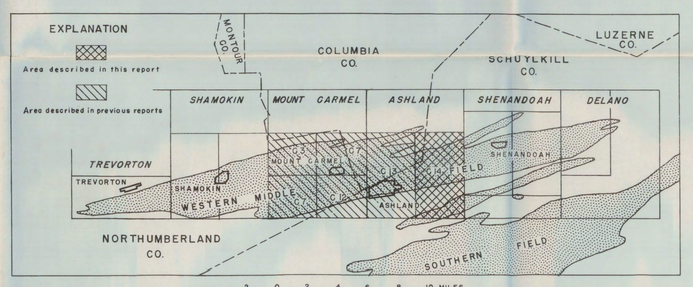




STRUCTURAL CROSS SECTIONS



INDEX MAP OF PENNSYLVANIA SHOWING THE LOCATION OF THE ANTHRACITE FIELDS



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

most of the major ridges in the mapped area. The formation is approximately 1,000 feet thick in the southern part of the area but thins to approximately 880 feet in the northern part. The lower part of the Pottsville formation extends southward across the Eisenhuth Run anticline and into the Southern anthracite field.

The rocks of the Pottsville formation are mainly conglomerate and sandstone, but they also include small amounts of siltstone, claystone, and coal. Most of the strata are gray, but brown, red, and green beds are present near the bottom of the formation. The conglomerate is poorly bedded and contains well-rounded and well-sorted pebbles of quartz and scattered pebbles of chert embedded in a siliceous matrix. In diameter the quartz pebbles are as much as 4 inches and the chert pebbles are generally less than 2 inches. The sandstone in the formation is medium- to coarse-grained and commonly grades laterally into conglomeratic sandstone and conglomerate.

A persistent coal bed known as the Lykens Valley (No. 2) coal bed is near the middle of the Pottsville formation in all the basins in the area. Two nonpersistent coal beds—Whites (No. 3) and Little Buck Mountain (No. 4)—are present in the upper part of the formation.

Allegheny formation.—The Allegheny formation, the base of which was designated by White (1900, p. 824) as the Buck Mountain (No. 5) coal bed, overlies the Pottsville formation and underlies the Conemaugh formation. The Allegheny formation ranges from 300 feet to 450 feet in thickness and averages about 400 feet. This formation is composed of conglomerate, sandstone, siltstone, claystone, and coal. The coal beds are the only laterally persistent lithologic units. In the lower part of the formation, sandstone and conglomerate are abundant; in the upper part, claystone and siltstone are more common, and the conglomerate is a minor constituent.

Five persistent coal beds—the Buck Mountain (No. 5), Seven-foot (No. 6), Skidmore (No. 7), and two beds in the Mammoth coal zone (No. 8 and No. 9)—are present in the Allegheny formation. A nonpersistent coal bed, the Four-foot (No. 9½) bed, also is present near the top of the formation.

Conemaugh formation.—The Conemaugh formation overlies the Allegheny formation. The base of the Conemaugh is the Holmes (No. 10) coal bed according to Lohman (1937, p. 40), and, although the lower 1,000 feet of strata is present in the central part of the area, the top of the Conemaugh has been removed by erosion. These rocks consist of sandstone, siltstone, claystone, and scattered lenses of conglomerate, interbedded with six persistent coal beds and several local beds (columnar sections, sheet 2). The Holmes (No. 10), Primrose (No. 11), Orchard (No. 12), Little Orchard (No. 13), Diamond (No. 14), and Tracy (No. 16) are the persistent coal beds in the Conemaugh.

STRUCTURE

The anthracite fields of Pennsylvania occur in four structural basins. Each basin is a synclinorium or composite syncline consisting of several overlapping characteristically asymmetric folds; some of the folds have been faulted. The area covered by this report is in the eastern part of the synclinorium that constitutes the Western Middle anthracite field. The principal component synclines and some of the truncated limbs of synclines in this field are called basins by miners, a practice that is followed by the authors of this report. The miners' term "undersheet"—a truncated limb of a syncline that dips below an adjacent overlying structure—is also used in this report. The undersheet in the Centralia basin is considered to be a part of that basin and not a separate basin as in the case of the North basin (sheets 1 and 2).

FOLDS

In the northern part of the mapped area the Western Middle field consists of a large synclinorium and in the southern part a small syncline. The synclinorium consists of several complete basins, faulted segments of basins, and the intervening anticlines. The principal basins are the Locust Mountain, Centralia, North, William Penn, Girardville, Mahanoy, and New Boston basins. The maximum structural relief of these features is about 3,100 feet as measured on the Lykens Valley (No. 2) coal bed (cross sections, sheet 2).

The Locust Mountain basin is the truncated north limb of a syncline that is probably related to the synclinal Centralia basin, which adjoins it on the south. Truncation was caused by the southward-dipping Centralia fault, which separates the two basins (cross sections BB[1], CC[1], and DD[1], sheet 2). The Centralia basin, a complete obtuse syncline, terminates or "spoons out" in the northeastern part of the area. The next basin to the south is called the William Penn basin in the eastern part of the area where it is a complete, slightly asymmetric syncline. In the central and western part of the area the syncline is bisected by the Locust Gap fault, and the undersheet of this fault becomes the North basin. This structural situation is reversed in the Girardville basin, the next basin to the south, which is an acute, asymmetric syncline in the western part of the area but is cut by the Suffolk fault, which begins near the middle of the area and increases in displacement eastward. The Mahanoy basin is the most southerly basin in the composite syncline. It is also the most acutely compressed of the major structures, its limbs subtending angles as small as 45°. Its depth and width in the mapped area are much less than in the areas to the west. The New Boston basin extends into the area from the east and is the southernmost basin in the Western Middle field.

The folds in the area are of the parallel type and are slightly asymmetrical, the northward-dipping limbs having the greater dips. The axial planes range in dip from 80° N. to 75° S. The limbs of the folds subtend angles ranging from 45° to 140° and so include both acute and obtuse types of folding. The Dear Ridge anticline and the Girardville basin are overturned in the area east of Girardville (sheet 1). The overturning may be attributed to the transfer of movement from the Locust Gap fault to the Suffolk fault.

FAULTS

Most faults in the mapped area are thrust faults that dip southward and are the result of compression. They may be classified as longitudinal faults or as oblique faults. The longitudinal faults have the largest amount of displacement and are generally parallel to the strike of the major folds. The most important longitudinal faults are the Centralia, Locust Gap, and Suffolk faults. The Centralia fault is along the north limb of the Centralia basin and extends across the mapped area and into the adjoining areas. The Locust Gap fault extends into the area from the west and dies out along the north limb of the William Penn basin near Connerton. The displacement on the Locust Gap fault decreases eastward and is taken up by small movements on several small longitudinal faults, such as the Girardville and Lost Creek faults, by bedding slips, and by closer folding of the beds. Movement on the Locust Gap fault may have been partly transferred to the Suffolk fault in the eastern part of the mapped area.

Several faults in the mapped area cut obliquely across the folds, making angles ranging from 25° to 60° with the fold axes. These faults have relatively small displacements that range from a few feet to a few tens of feet. In many places they are associated with shear zones, which have no apparent displacement, and are thought to represent an arrested early stage in the development of an oblique fault. Some of these zones are linear and trend obliquely to the axes of the folds, but others are irregular and have no apparent orientation (sheet 1).

Mining is adversely affected by (1) faults with displacements greater than the thickness of the respective coal bed—called rock faults by the 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 profitably mined.

COAL BEDS

NOMENCLATURE

In the Western Middle anthracite field the coal beds of the different mines are designated by a number, a name, or both. This nomenclature has not been standardized 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) the structure and 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 all cases with those used in the Second Geological Survey of Pennsylvania (Ashburner, 1883, p. 84), and they do not agree in all cases with the nomenclature used by the mining companies in the mapped area.

In this report a coal bed is described as persistent, nonpersistent, or local, or as a leader. A persistent coal bed can be traced 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 a continuous coal bed. 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 when 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.

OUTCROPS OF COAL

Coal beds are rarely exposed in natural outcrops owing to the cover of soil. The outcrops 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.

It was necessary to project some coal beds beyond their last known point of occurrence. This has been done to show the authors' estimate of the extent of that particular coal horizon 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 thickness and range in thickness of coal beds in the area covered by this report. Figures on the right half of the table show total thickness of all coal in each bed; figures on the left half 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 of beds 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 the 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 eastern part of the Ashland quadrangle

Bed number	Thickness of Bed: Average	Bed: Range	Coal: Average	Coal: Range	Percentage of refuse
	Ft in.	Ft in. – Ft in.	Ft in.	Ft in. – Ft in.	
17					
16		0 9 – 5 0			
15		0 11 – 5 4			
14	8 0	3 6 – 11 10	6 4	2 0 – 9 4	20.8
13	6 6	4 4 – 12 2	4 7	1 10 – 10 10	29.5
12	8 4	3 6 – 13 1	6 6	1 2 – 9 8	22.0
L		1 8 – 3 6			
11T					
11	7 8	2 7 – 14 8	5 11	1 1 – 12 4	22.8
10½		1 2 – 6 1			
10	9 6	2 2 – 28 0	8 0	1 7 – 28 0	15.8
9½	7 4	2 8 – 11 11	6 5	1 8 – 10 10	12.5
9	9 2	2 0 – 14 7	7 1	1 5 – 12 8	22.7
8	18 10	12 2 – 24 4	16 10	9 10 – 22 2	10.6
8 & 9	26 10	13 0 – 44 0	20 7	9 0 – 34 8	23.3
7T	2 0	0 7 – 2 4	1 6	0 7 – 2 1	16.6
7	3 6	1 0 – 13 11	2 6	0 10 – 12 10	28.6
L		1 2 – 2 7			
6	3 10	1 7 – 11 0	2 7	0 10 – 6 7	32.6
L		0 9 – 3 1			
5	11 11	1 7 – 23 0	9 8	1 6 – 23 0	18.9
4	3 8	2 7 – 8 0	3 5	1 0 – 8 0	6.8
3					
2		0 7 – 6 2			

COAL BEDS MINED IN THE AREA

Eleven coal beds have been mined in the mapped area. Of these, the Buck Mountain (No. 5), Seven-foot (No. 6), Skidmore (No. 7), two splits of the Mammoth coal zone (No. 8 and No. 9), Holmes (No. 10), Orchard (No. 12), and the Diamond (No. 14) coal beds are economically the most important.

The Buck Mountain (No. 5) coal bed, basal unit of the Allegheny formation, overlies the more resistant rocks of the Pottsville formation and underlies the remaining beds of the Allegheny, which are less resistant. As the result of differential resistance to erosion a topographic bench forms in some areas, making it possible to map the outcrop of the Buck Mountain coal bed rather accurately. In the western part of the Ashland quadrangle, to the west (see index map, sheet 2), the Buck Mountain consists of two or three splits, Nos. 5, 5M, and 5T, which are mined as separate coal beds. From the outcrop the splits merge eastward into the area of this report, and the combined No. 5 coal bed contains only discontinuous partings that are generally less than a foot thick. The Buck Mountain, which is extensively mined, has an average thickness of nearly 12 feet in the mapped area.

The Seven-foot (No. 6) and Skidmore (No. 7) coal beds are approximately 140 and 190 feet, respectively, above the Buck Mountain (No. 5) coal bed in this area. The intervening rocks are chiefly sandstone, siltstone, claystone, and occasional lenses of conglomerate. Nos. 6 and 7 coal beds crop out in all of the basins in the mapped area. A split of the Skidmore coal bed, the Skidmore Top Split (No. 7T), crops out in the central part of the area in the North (William Penn) basin and in the southeastern part of the area in the Mahanoy basin. The Seven-foot coal bed has been mined at scattered localities throughout the area, and the Skidmore coal bed has been most extensively mined in the western part of the area in the Bast mine.

The Mammoth coal zone, consisting of the Mammoth Bottom Split (No. 8) and the Mammoth Top Split (No. 9) coal beds has been mined as a single unit over most of the eastern half of the Ashland quadrangle. The Nos. 8 and 9 coal beds are separated by carbonaceous claystone and siltstone that may attain a thickness of 60 feet in some places. In parts of the Raven Run and Hammond mines, Nos. 8 and 9 were mined separately. Where the Mammoth coal zone has been mined as a single unit, the average bed thickness is 26 feet, 10 inches. The persistence, quality, and thickness of the coal beds in the Mammoth coal zone make them the most economically important in the area.

The Holmes (No. 10) coal bed is important because of its greater than average thickness, 9 feet, 6 inches, and its smaller than average percentage of refuse, 16 percent. Extensive mining and a rather uniform interval from the Mammoth coal zone are factors that make the Holmes coal bed useful as a stratigraphic marker.

The Orchard (No. 12) and Diamond (No. 14) coal beds, which are the youngest beds mined in this area, crop out in the more deeply folded North and Mahanoy basins. Both No. 12 and No. 14 coal beds have an average thickness of 8 feet. Partings of carbonaceous claystone or bony coal generally constitute more than 20 percent of the bed thickness. These beds attain their maximum thickness in the west-central part of the area, where they have been mined extensively in the Hammond and Bast mines.

A number of coal beds listed in the preceding coal-thickness table are not described in this report. These coals are generally of poor quality or of such local occurrence that they were of little economic importance at the time this report was written. This, however, does not presuppose that they may not be of great economic importance as mining practices improve or as the market for coal increases.

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GEOLOGY OF ANTHRACITE IN THE EASTERN PART OF THE ASHLAND QUADRANGLE, PENNSYLVANIA

INTRODUCTION

The Western Middle anthracite field is one of four structural basins containing anthracite in eastern Pennsylvania. This report describes the geology of the part of the Western Middle field that lies in the eastern half of the Ashland quadrangle (index map, sheet 2). The mapped area covers about 19 square miles in Schuylkill and Columbia Counties, and the borough of Girardville is in the central part of the area. The New Boston basin, a coal-bearing syncline near the south edge of the Ashland quadrangle, is generally considered to be a part of the Western Middle field, although it is separated from the rest of this field by an area along the Frackville anticline that contains no coal. The Eisenhuth Run anticline, which crosses the southeast corner of the mapped area, is the dividing line between the Western Middle and the Southern anthracite fields (sheet 1).

This is the sixth of a series of reports describing different parts of the Western Middle field. Previous reports are listed below under "References;" 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 the planning of 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 kinds of rocks and the intervals between coal beds (sheet 2), and (e) a standard nomenclature of the coal beds.

The information presented in this report was obtained, in part, from the actual and theoretical data shown on mine maps, cross sections, drill logs, and other records made available by the Philadelphia and Reading Coal & Iron Co., the Hazle Brook Coal Co., and the Girard Estate. The cooperation of the officials of these companies is deeply appreciated.

Donald A. Myers, Richard E. Bergenback, John L. Snider, and John A. Maxwell, of the U. S. Geological Survey, aided in the field mapping of this area.

STRATIGRAPHY

Rocks of the Carboniferous and Quaternary systems crop out in the mapped area. The Carboniferous rocks belong to the upper part of the Mauch Chunk Formation of Mississippian age, and to the Pottsville, Allegheny, and lower part of the Conemaugh formations of Pennsylvanian age. Unconsolidated alluvial clay, silt, sand, and gravel of Quaternary age have been deposited along the stream valleys. Stream-transported mine waste, some of which contains valuable deposits of detrital coal, also has been deposited along many streams. Although the Quaternary alluvium has not been mapped, the economically important deposits of mine waste are shown on the outcrop map (sheet 1).

ROCKS OF MISSISSIPPIAN AGE

The Mauch Chunk formation crops out in the northern part of the area on the Red Ridge and Centralia anticlines and in the southern part of the area on the Frackville anticline between Ashland Mountain and Broad Mountain. Only the upper 1,500 feet of the formation is exposed in the mapped area.

The rocks that comprise the Mauch Chunk formation are mainly 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. Most of the strata are quite lenticular. The Mauch Chunk appears to grade upward into the overlying Pottsville formation.

ROCKS OF PENNSYLVANIAN AGE

Rocks of Pennsylvanian age consist of lenticular beds of conglomerate, sandstone, siltstone, claystone, and shale, interbedded with 12 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, some of which extend throughout the Western Middle field, are the most persistent of the lithologic units, whereas the other strata exhibit so many variations that they are of minor value for use as reference or key beds.

Pottsville formation.—The Pottsville formation, which includes the oldest rocks of Pennsylvanian age in the area, overlies the Mauch Chunk formation and underlies the Allegheny formation. The Pottsville consists chiefly of resistant clastic strata that form all the mountains and

COAL INVESTIGATIONS
MAP C14 (SHEET 2 OF 2)

GEOLOGY OF ANTHRACITE IN THE EASTERN PART OF THE ASHLAND QUADRANGLE, PENNSYLVANIA

By
Boyd R. Haley, Harold H. Arndt, Howard E. Rothrock, and Holly C. Wagner

1954

INTERIOR—GEOLOGICAL SURVEY, WASHINGTON, D. C. M-9415
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DEPARTMENT OF THE INTERIOR
UNITED STATES GEOLOGICAL SURVEY
W. E. WRATHER, DIRECTOR

COAL OUTCROP MAP

Base: U.S. Geological Survey topographic map. Polyconic projection. 1927 North American datum. Topography was contoured from aerial photographs made in 1942. Correction has generally not been made for topographic changes resulting from strip mining or alteration of mine refuse banks since 1942.

EXPLANATION
OUTCROP MAP

- **Coal outcrop** — *Solid where location is known, long dashes where uncertain. Number designates coal bed; L, local bed; T, top split.*
- **High-angle fault, showing dip** — *U, upthrown side; D, downthrown side. Solid where location is known, long dashes where uncertain.*
- **Fault, showing relative movement** — *Solid where location is known, long dashes where uncertain.*
- **Thrust or low-angle reverse fault, showing dip** — *T, upper plate. Solid where location is known, long dashes where uncertain.*
- **Anticline** — *Showing crest line.*
- **Syncline** — *Showing trough line.*
- **Overturned anticline** — *Showing crest line and direction of dip of limbs.*
- **Overturned syncline** — *Showing trough line and direction of dip of limbs.*
- **Structural cross section** — A — A'
- **Strip-mined area** — *Shaded area covered by mine waste.*
- **Surface opening on coal bed**
- **Exploratory trench**
- **Crop fall** — *Collapsed area where surface has fallen into underground workings.*
- **Mine waste** — *Includes such refuse from mining and breaker operations as culm, rock banks, coal piles, back fill, and silt in settling basins.*
- **Stream transported waste**
- **Boundary of mine**
- **Warranty tract** — JOHN SCHWARTZ — *Boundaries are indicated for general orientation and identification but are not authenticated for legal purposes.*
- **Borough line**

STRUCTURE MAP

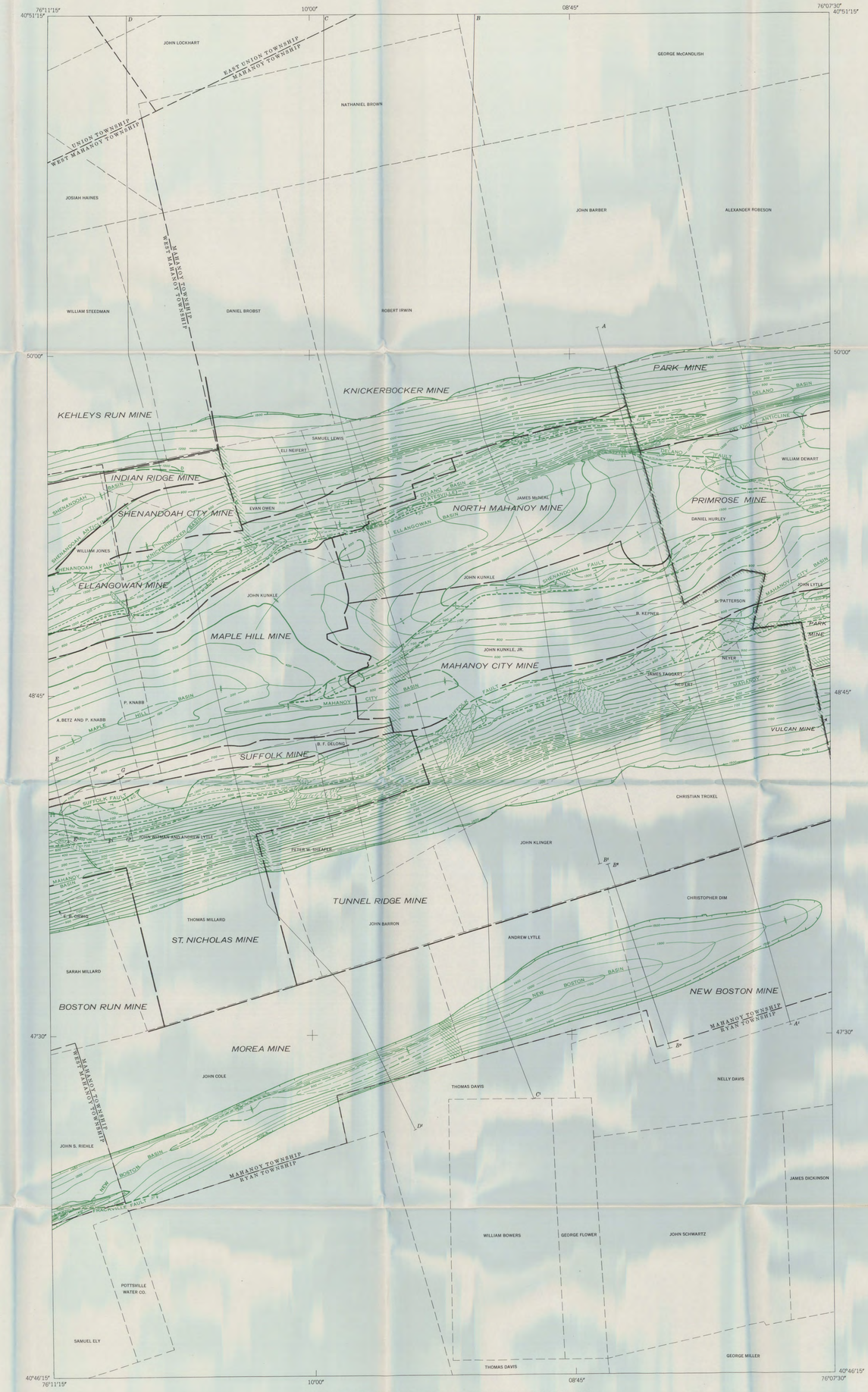
- **Outcrop of coal bed**
- **Fault, showing relative movement**
- **Fault cutting Buck Mountain coal bed, showing dip of fault plane, relative position of faulted segments, and overthrust segment** — *Fault trace is solid where accurately located, long dashes where approximately located. Fault trace on underlying plane is indicated by short dashes where accurately located and very short dashes where approximately located. U, upthrown segment; D, downthrust segment; T, overthrust segment.*
- **Shear zone**
- **Anticline** — *Showing crest line; solid where location is known, dashed where location is uncertain.*
- **Syncline** — *Showing trough line; solid where location is known, dashed where location is uncertain.*
- **Overturned anticline** — *Showing crest line and direction of dip of limbs.*
- **Contours on the bottom of the Buck Mountain coal bed** — *Solid in mined areas; long dashes in unmined areas; in those places where a part of the bed lies beneath another part of the same bed short dashes are used in mined areas, and very short dashes in unmined areas.*
- **Structural cross section** — A — A'
- **Barrier pillar in contoured bed**
- **Boundary of mine**
- **Warranty tract** — JOHN BARBER — *Boundaries are indicated for general orientation and identification but are not authenticated for legal purposes.*

Scale 1:12,000

1000 0 1000 2000 3000 4000 5000 6000 Feet

Topographic contour interval is 20 feet
Structure contour interval is 100 feet
Datum is mean sea level

APPROXIMATE MEAN DECLINATION, 1955



STRUCTURE MAP OF THE BUCK MOUNTAIN COAL BED

Prepared in 1952 from data supplied by the Philadelphia & Reading Coal & Iron Co., the Lehigh Valley Coal Co., and the New Boston Land Co., with modifications by the U.S. Geological Survey.

DIAGRAM OF A TOPOGRAPHIC QUADRANGLE SHOWING THE AREA INCLUDED IN THIS MAP

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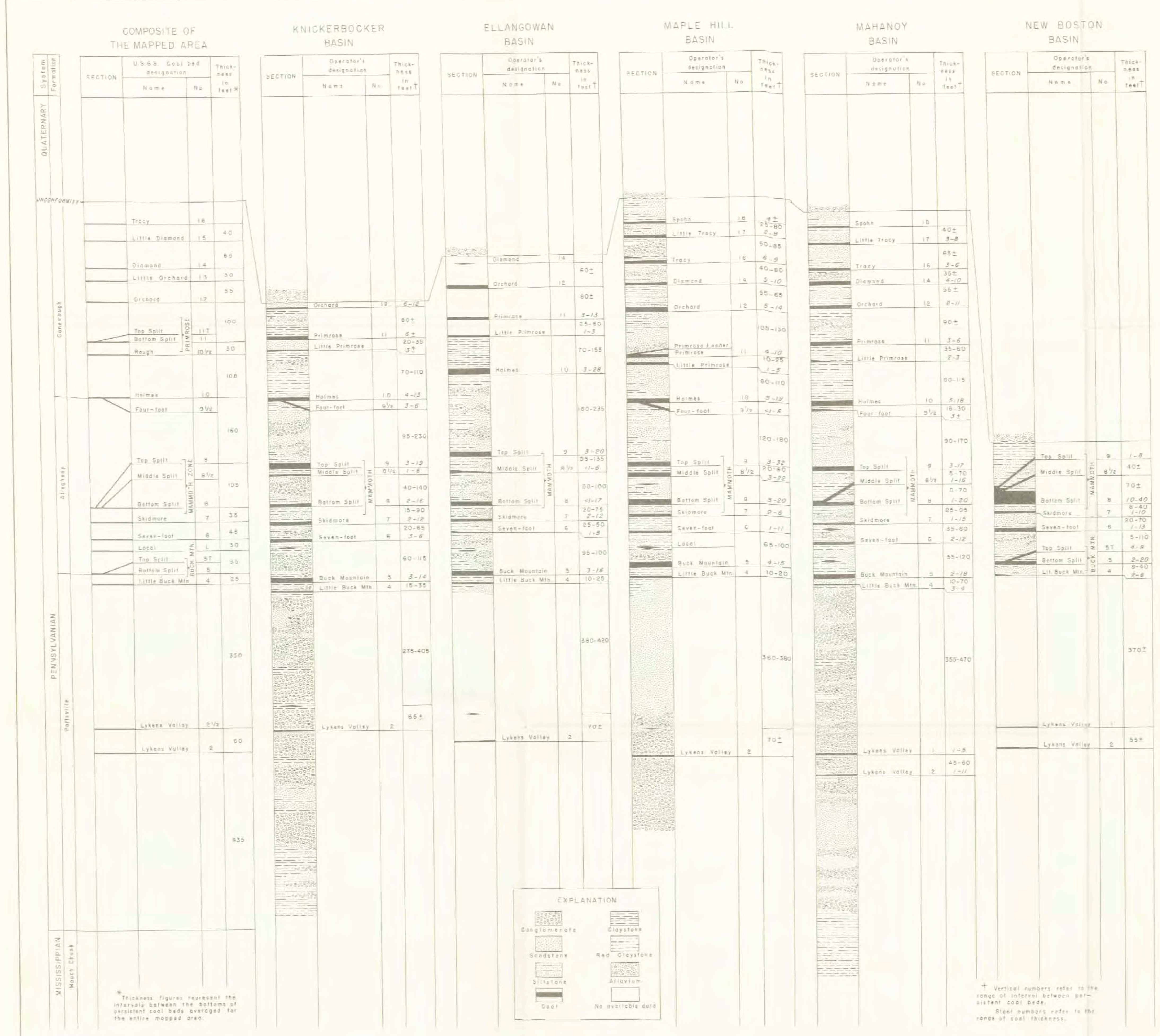
COAL INVESTIGATIONS
MAP C 19, SHEET 1 OF 2

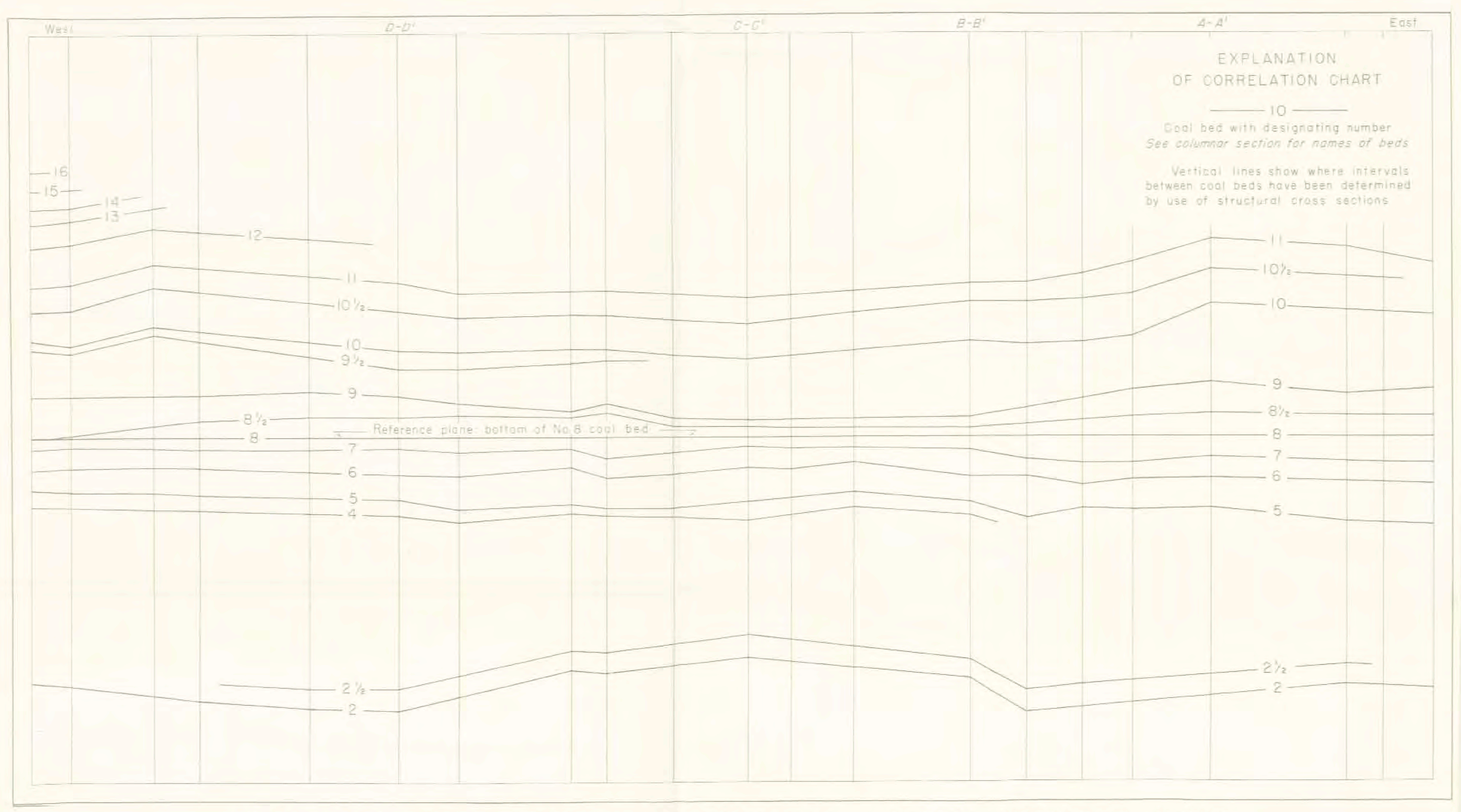
GEOLOGY OF ANTHRACITE IN THE EASTERN PART OF THE SHENANDOAH QUADRANGLE, PENNSYLVANIA

By
Thomas M. Kehn and Holly C. Wagner

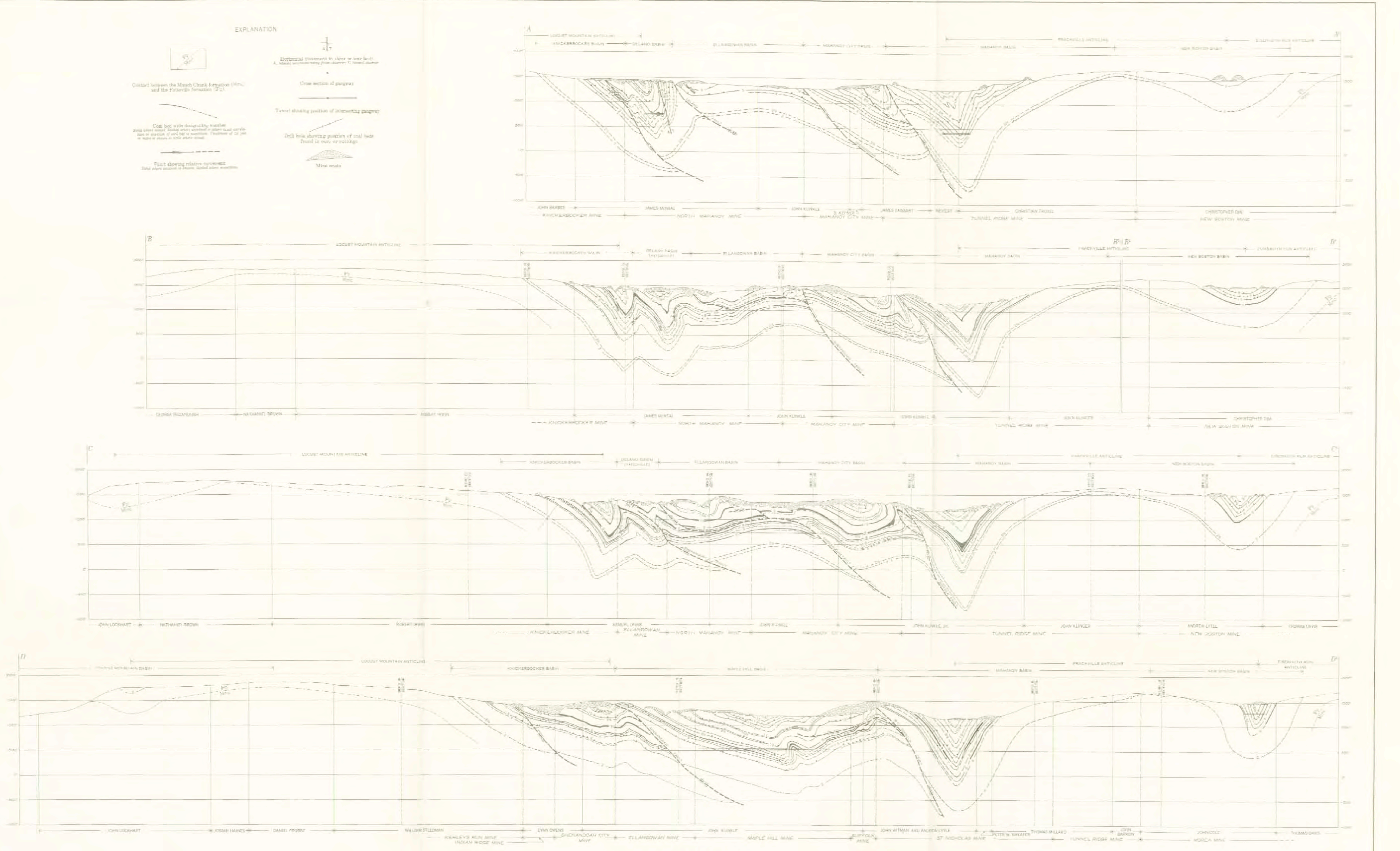
1955



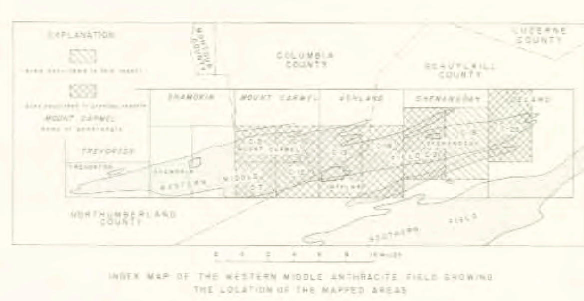
COLUMNAR SECTIONS



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



STRUCTURAL CROSS SECTIONS



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

GEOLOGY OF ANTHRACITE IN THE EASTERN PART OF THE SHENANDOAH QUADRANGLE, PENNSYLANIA

INTRODUCTION

The Western Middle anthracite field is one of four structural basins containing anthracite in eastern Pennsylvania. This report describes the geology of the part of the Western Middle field that lies in the eastern half of the Shenandoah quadrangle (index map, sheet 2). The mapped area covers about 19 square miles in Schuylkill County. Mahanoy City is in the east-central part of the area, and the town of Morea is in the southwestern part.

The boundary of the Western Middle field is considered to be the outcrop of the oldest of the Lykens Valley coal beds (Rothrock et al., 1951). The Lykens Valley (No. 2) coal bed, the oldest known coal in the mapped area, has been mined over the crest of the Frackville anticline into the New Boston basin in the southeastern part of the mapped area. The New Boston basin is, therefore, included in the Western Middle field. The crest of the Eisenhuth Run anticline is the approximate dividing line between the Western Middle and the Southern anthracite fields (sheet 1).

This is the eighth of 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 "References;" 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 basins (sheets 1 and 2), (d) the kinds of rocks and the intervals between coal beds (sheet 2), and (e) a standard nomenclature of coal beds.

Acknowledgments.—The information presented in this report is taken in part from the data shown on the mine maps, cross sections, drill logs, and other records made available by the Philadelphia & Reading Coal & Iron Co., the Lehigh Valley Coal Co., and the New Boston Land Co. The cooperation of these organizations is appreciated.

Walter Danilchik, John A. Maxwell, Frederick N. Rossetter, Boyd R. Haley, Howard E. Rothrock, and Harold H. Arndt aided in the field mapping and in the preparation of the report.

STRATIGRAPHY

Rocks of the Mississippian, Pennsylvanian, and Quaternary systems crop out in the mapped area. The oldest exposed rocks belong to the upper part of the Mauch Chunk formation of Mississippian age, which is overlain by the Pottsville, Allegheny, and lower part of the Conemaugh formations of Pennsylvanian age. Unconsolidated alluvial clay, silt, sand, and gravel of Quaternary age have been deposited on the Carboniferous rocks in the stream valleys but were not mapped. Stream transported mine waste, some of which contains valuable deposits of detrital coal, has also been deposited along many streams and is shown on the outcrop map (sheet 1).

ROCKS OF MISSISSIPPIAN AGE

Mauch Chunk formation.—The Mauch Chunk formation crops out in the northern part of the area north of Locust Mountain basin, and in a small area immediately north of Reservoir No. 3. In the southern part of the area the formation crops out on the crest of the Eisenhuth Run anticline, in the valley occupied by Mill Creek, and in the Locust Creek valley. Only the upper 1,000 feet of the formation is exposed in the mapped area.

The rocks in the Mauch Chunk formation are mainly 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. All the beds are lenticular. The contact between the Mauch Chunk 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.

ROCKS OF PENNSYLVANIAN AGE

Rocks of Pennsylvanian age consist of lenticular beds of conglomerate, sandstone, siltstone, claystone, and shale, interbedded with 12 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 are the most persistent of the lithologic units. The other rock units exhibit so many changes in lithology that they have little value as reference or key beds.

Pottsville formation.—The Pottsville formation, which includes the oldest rocks of Pennsylvanian age in the area, overlies the Mauch Chunk formation and underlies the Allegheny formation. The Pottsville consists mainly of resistant conglomerate and sandstone that form most of the mountains and major ridges in the mapped area. The formation is approximately 860 feet thick throughout the area of this report. The lower 100 feet of the Pottsville formation is composed of beds of gray conglomerate, gray, green, brown, and red sandstone or 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. 2½) coal beds are near the middle of the formation, and the Little Buck Mountain (No. 4) coal bed is in the upper part of the formation.

Allegheny formation.—The Allegheny formation, 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 thickness of the Allegheny formation ranges from 350 feet in the north to a maximum of 530 feet in the south. The formation is composed of conglomerate, sandstone, siltstone, claystone, and coal. The coal beds are the only laterally persistent lithologic units. In general, conglomerate and sandstone are more abundant in the lower part of the formation, and yellow to light-brown sandstone and siltstone are more abundant in the upper part.

The Allegheny formation is the source of most of the coal mined in the area. Six persistent coal beds—the Buck Mountain (No. 5), Seven-foot (No. 6), Skidmore (No. 7), and three beds in the Mammoth coal zone (No. 8, No. 8½, and No. 9)—are present in the Allegheny formation. The Buck Mountain and Mammoth zone coal beds are economically the most important of these.

Conemaugh formation.—The Conemaugh formation, the base of which is the Holmes (No. 10) coal bed (Lohman, 1937, p. 46), overlies the Allegheny formation. Erosion has removed the formation in the northern part of the area, but 550 feet of the Conemaugh remains in the west-central part. The formation consists of silty sandstone, siltstone, claystone, carbonaceous claystone, scattered lenses of conglomerate, and coal. Six persistent coal beds are present in the formation—Holmes (No. 10), Primrose (No. 11), Orchard (No. 12), Little Orchard (No. 13), Diamond (No. 14), and Tracy (No. 16) coal beds—and are of economic value through most of their extent.

STRUCTURE

Each of the Pennsylvania anthracite fields is a northeast-trending synclinorium composed of several overlapping folds, some of which have been faulted. The area covered by this report is in the eastern part of the synclinorium that constitutes the Western Middle anthracite field. The coal-bearing area of the principal component synclines and some of the truncated limbs of these synclines in this field are called basins by the miners and the term is so used in this report. The miners' term "undersheet," which refers to the truncated limb of a syncline that extends beneath an adjacent overlying structure, is also used in this report.

FOLDS

The major basins in the mapped area are, from north to south, the Knickerbocker, Delano, Maple Hill, Mahanoy City, and Mahanoy basins. Anticlines separating these basins have been broken by thrust faults, resulting in partial overlaps of the basins as shown on the cross sections (sheet 2). Two small basins—the Locust Mountain basin in the northern part of the area and the New Boston basin in the southern part of the area—are separated from the main trunk of the Western Middle field by the large, unfaulted Locust Mountain and Frackville anticlines.

The Knickerbocker basin begins in the northwestern part of the mapped area as a faulted segment of the north limb of the Maple Hill basin. It ends in the north-central part of the area on the north limb of the Delano basin.

The Delano basin is a relatively narrow structure that begins in the northern part of the mapped area and extends northeast beyond the limit of the area. This basin lies beneath the Shenandoah thrust fault. A complex shallow syncline, known as the Ellangowan basin in the thrust plate above the Shenandoah fault, is present near the center of the mapped area along the south side of the Delano basin.

At the western edge of the area the westward-plunging Maple Hill basin is about a mile wide, and is one of the broadest basins in the Shenandoah quadrangle. Near the center of the mapped area this basin terminates or "spoons" abruptly.

The western end of the Mahanoy City basin is about a fourth of a mile south of the eastern end of the Maple Hill basin. The Mahanoy City basin plunges northeastward and extends beyond the limit of the mapped area. Its southeastern limb is truncated by the Suffolk thrust fault. North of Mahanoy City this basin is offset by a transverse fault.

The Mahanoy basin is one of the largest and most continuous structures in the Western Middle field. This basin originates near the center of the field, extends across the mapped area and eastward to the end of the field. It is the most acutely folded of the major basins, and the lowest coal beds in this basin are more than 700 feet below sea level.

The Locust Mountain basin extends into the area from the west. Only the Lykens Valley (No. 2) and the Little Buck Mountain (No. 4) coal beds are present in this basin in the mapped area. The New Boston basin extends diagonally across the southern part of the area. The basin becomes broader and shallower toward the east, and the lower coals of the Allegheny formation "spoon out" at the eastern margin of the area.

The major folds in the mapped area trend about N. 70° E. In the southern part of the area the axial planes are inclined approximately 80° to the north. In the northern part of the area, which is more deformed, the axial planes dip 50° to 75° to the south. In the Knickerbocker basin, however, the axial plane has a north dip at depth and a south dip nearer the surface (cross section C-C', sheet 2). The degree of folding, as measured by the least angle between tangents to the limbs of the fold, ranges from 35° to 130°.

FAULTS

Most faults in the mapped area are thrust faults that dip southward and are the result of compression. They generally trend northeast paralleling the axes of the folds and cutting the bedding at angles generally less than 60° except where drag has affected the beds. The principal faults, from north to south, are the Delano, Shenandoah, and Suffolk faults.

The Delano fault begins in the northeastern part of the area and extends into the adjacent area to the east. This fault is present east of a sharp salient in the Shenandoah fault north of Mahanoy City, and its development may have been related to a change in amount or direction of displacement on the Shenandoah fault.

The Shenandoah fault extends into the mapped area from the west, and it terminates in the northeastern part of the area. This is a very irregular fault, as shown on the cross sections. It truncates the southeast limb of the Knickerbocker and Delano basins.

The Suffolk fault begins west of the mapped area and extends into the adjoining area on the east. The fault surface, which dips 60° south, truncates the north limb of the Mahanoy basin. The displacement along the fault ranges from 1,000 feet in the west to 750 feet in the eastern part of the area, with a dip-slip displacement of approximately 450 feet, as measured on cross section A-A' (sheet 2). This displacement brings the Buck Mountain (No. 5) coal bed above the Mammoth Top Split (No. 9) coal bed. Coal beds along this fault have been intensely deformed with the result that in some places the coal has been squeezed into relatively thick, irregular pockets, and in other places coal has been dragged out along the fault into thin sheets of shelly coal.

Several faults in the mapped area cut obliquely across the folds, making angles that range from 40° to 90° with the fold axes. These faults have relatively small displacements that range from a few feet to a few tens of feet. Some of the oblique faults are associated with shear zones in the coal beds; some of the shear zones may represent transverse faulting in an early stage of development.

Mining is adversely affected by (1) faults with displacements greater than the thickness of the respective coal bed—called rock faults by the 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 fractured by differential movement and extreme pressure that it cannot be profitably mined.

COAL BEDS

In the Western Middle anthracite field the coal beds of the different mines are designated by a number, a name, or both. This nomenclature has not been standardized 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) the structure and 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 all cases with those used by the Second Geological Survey of Pennsylvania (Ashburner, 1883, p. 84), and they do not agree in all 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 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 one that can be recognized and correlated in several of the basins, but it is not continuous throughout the basin. A local coal bed is one that cannot be correlated across a basin or between adjoining basins, and generally cannot be traced within a basin for more than 3 or 4 miles. A leader coal bed is one that is present in only a small area, and where first named is so near a well-known or economically important coal bed that it serves 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.

OUTCROPS OF COAL

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 beds from which the material is derived. Explorations for coal outcrops should start where the outcrops 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 probable location 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 thickness and range in thickness of coal beds in the area covered by this report. Figures on the right half of the table show the thickness of all coal in each bed; figures on the left half of the table show the 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 of beds 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 mined in the eastern part of the Shenandoah quadrangle

Bed no.	Thickness												Percentage of refuse
	Bed						Coal						
	Average		Range				Average		Range				
	Ft	In	Ft	In	Ft	In	Ft	In	Ft	In	Ft	In	
16	4	11	4	6	5	2	3	10	3	10	3	10	22.0
15	6	0	2	2	10	0	5	4	2	2	8	0	11.1
14	7	4	1	0	9	6	7	1	1	0	9	0	3.4
13	8	8	4	10	13	0	7	2	4	4	10	0	17.3
12	10	4	5	6	14	10	9	1	5	6	14	4	12.1
11	8	10	2	8	13	11	7	11	2	8	13	11	10.4
10½	3	1	1	0	5	6	2	10	0	11	4	7	8.1
10	11	4	2	0	28	0	10	2	2	0	28	0	10.3
9½	3	10	1	8	7	11	3	2	0	7	6	5	17.4
9	14	1	3	0	41	0	11	1	1	4	32	1	21.3
8½	6	5	1	0	27	0	5	2	0	2	21	6	19.5
8	10	6	1	0	40	0	9	0	0	6	40	0	14.3
7	7	1	1	0	17	11	5	5	1	0	15	2	23.5
6	6	4	1	0	15	8	5	5	0	7	13	0	14.5
5T			2	6	5	0			0	2	5	0	
5	12	0	2	10	23	11	9	11	2	7	20	0	17.4
4	4	6	1	11	9	7	3	4	1	7	5	7	25.9
2½	3	5	1	2	9	7	3	1	1	2	4	8	9.7
2	4	11	1	2	11	4	3	4	1	2	11	4	32.2

COAL BEDS OF ECONOMIC IMPORTANCE

Eighteen coal beds have been mined in the mapped area. Of these, Buck Mountain (No. 5), Seven-foot (No. 6), Skidmore (No. 7), the three splits of the Mammoth coal zone (No. 8, No. 8½, and No. 9), and Holmes (No. 10) coal beds are economically the most important.

The Buck Mountain (No. 5) coal bed, basal unit of the Allegheny formation, overlies the more resistant rocks of the Pottsville formation and underlies the remaining beds of the Allegheny, which are less resistant. As the result of differential resistance to erosion, a topographic bench forms in some areas, making it possible to map the outcrop of the Buck Mountain coal bed rather accurately. The persistence, quality, and thickness of this coal bed make it one of the most economically important coals in the area. The Buck Mountain, which is extensively mined, has an average thickness of 12 feet in the mapped area.

The Seven-foot (No. 6) and Skidmore (No. 7) coal beds are about 85 feet and 130 feet, respectively, above the Buck Mountain (No. 5) coal bed in this area. Both the No. 6 and the No. 7 coal bed have been mined extensively. The No. 7 coal bed contains several bony coal partings and therefore has a higher average percentage of refuse, 23.5, than the No. 6 coal bed, 14.5. The average thickness of the coal in each of these beds is 5 feet 5 inches.

The Mammoth coal zone is economically the most important group of coal beds in the Allegheny formation. Throughout most of the mapped area this zone consists of three coal beds or "splits." These are the Bottom Split (No. 8), Middle Split (No. 8½), and Top Split (No. 9). In the southwestern part of the New Boston basin the three splits merge and are mined as one bed. The Mammoth coal zone is persistent and is easily identified by its thickness; the Bottom Split (No. 8) coal bed attains a maximum thickness of 40 feet in some parts of the area.

The Holmes (No. 10) coal bed, the basal unit of the Conemaugh formation, is economically important because of its greater than average thickness, 11 feet 4 inches, and its smaller than average percentage of refuse, 10.3. Extensive mine-workings and a uniform interval from the Mammoth coal zone are factors that make the Holmes coal bed useful as a stratigraphic marker. The No. 10 coal bed ranges from 2 feet to 28 feet in thickness in the mapped area.

Several coal beds listed in the table on coal thickness are not described in this report. These coals are generally of poor quality or of such local occurrence that they were of little economic importance at the time of writing this report. This, however, does not presuppose that they may not be of greater economic importance as mining practices improve or as the market for coal improves.

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GEOLOGY OF ANTHRACITE IN THE EASTERN PART OF THE SHENANDOAH QUADRANGLE, PENNSYLVANIA

By
Thomas M. Kehn and Holly C. Wagner
1955

INTERIOR, GEOLOGICAL SURVEY, WASHINGTON, D. C. MR-0260
For sale by U. S. Geological Survey, price $1.00 per set

DEPARTMENT OF THE INTERIOR
UNITED STATES GEOLOGICAL SURVEY
W. E. WRATHER, DIRECTOR

Base: U.S. Geological Survey topographic map. Polyconic projection. 1927 North American datum. Topography was contoured from aerial photographs made in 1942. Correction has generally not been made for topographic changes resulting from strip mining or alteration of mine refuse banks since 1942.

COAL OUTCROP MAP

EXPLANATION
OUTCROP MAP

Coal outcrop
Solid where location is known, long dashes where uncertain. Number designates coal bed; L, local bed; T, top split.

High angle fault, showing dip
U, upthrown side; D, downthrown side; dashed where approximately located.

Fault, showing relative movement
Dashed where approximately located.

Thrust or low angle reverse fault, showing dip
T, upper plate; dashed where approximately located.

Anticline
Showing crest line.

Syncline
Showing trough line.

Overturned syncline
Showing trough line and direction of dip of limbs

Structural cross section

Strip-mined area
Shaded area covered by mine waste.

Surface opening on coal bed

Exploratory trench
Tick shows where coal was found.

Crop fall
Collapsed area where surface has fallen into underground workings.

Mine waste
Includes such refuse from mining and breaker operations as culm, rock banks, coal piles, slack fill, and silt in settling basins.

Stream transported waste

Boundary of mine

JOHN RIEHLE
Warranty tract
Boundaries are indicated for general orientation and identification but are not authenticated for legal purposes.

Borough line

EXPLANATION
STRUCTURE MAP

Outcrop of coal bed

Fault, showing relative movement

Fault cutting Buck Mountain coal bed, showing dip of fault plane, relative position of faulted segments, and overthrust segment.
Fault trace is solid where accurately located, long dashes where approximately located. Fault trace on underlying plate is indicated by short dashes where accurately located and dots where approximately located. U, upthrown segment; D, downthrown segment; T, overthrust segment.

Shear zone
Boundary dashed where approximately located.

Anticline
Showing crest line; solid where location is known, dashed where location is uncertain.

Syncline
Showing trough line; solid where location is known, dashed where location is uncertain.

Overturned anticline
Showing crest line and direction of dip of limbs.

Contours on the bottom of the Buck Mountain coal bed
Solid in mined areas; long dashes in unmined areas; in those places where a part of the bed lies beneath another part of the same bed, short dashes are used in mined areas and very short dashes in unmined areas.

Structural cross section

Barrier pillar in contoured bed

Boundary of mine

JOHN RIEHLE
Warranty tract
Boundaries are indicated for general orientation and identification but are not authenticated for legal purposes.

APPROXIMATE MEAN DECLINATION, 1955

Scale 1:12000
1000 0 1000 2000 3000 4000 5000 6000 Feet
Topographic contour interval is 20 feet
Structure contour interval is 100 feet
Datum is mean sea level

STRUCTURE MAP OF THE BUCK MOUNTAIN COAL BED

Prepared in 1952 from data supplied by the Philadelphia & Reading Coal & Iron Co., the Girard Estate, the New Boston Land Co., and Gilberton-Lawrence Fuels, Inc., with modifications by the U.S. Geological Survey.

DIAGRAM OF A TOPOGRAPHIC QUADRANGLE SHOWING THE AREA INCLUDED IN THIS MAP

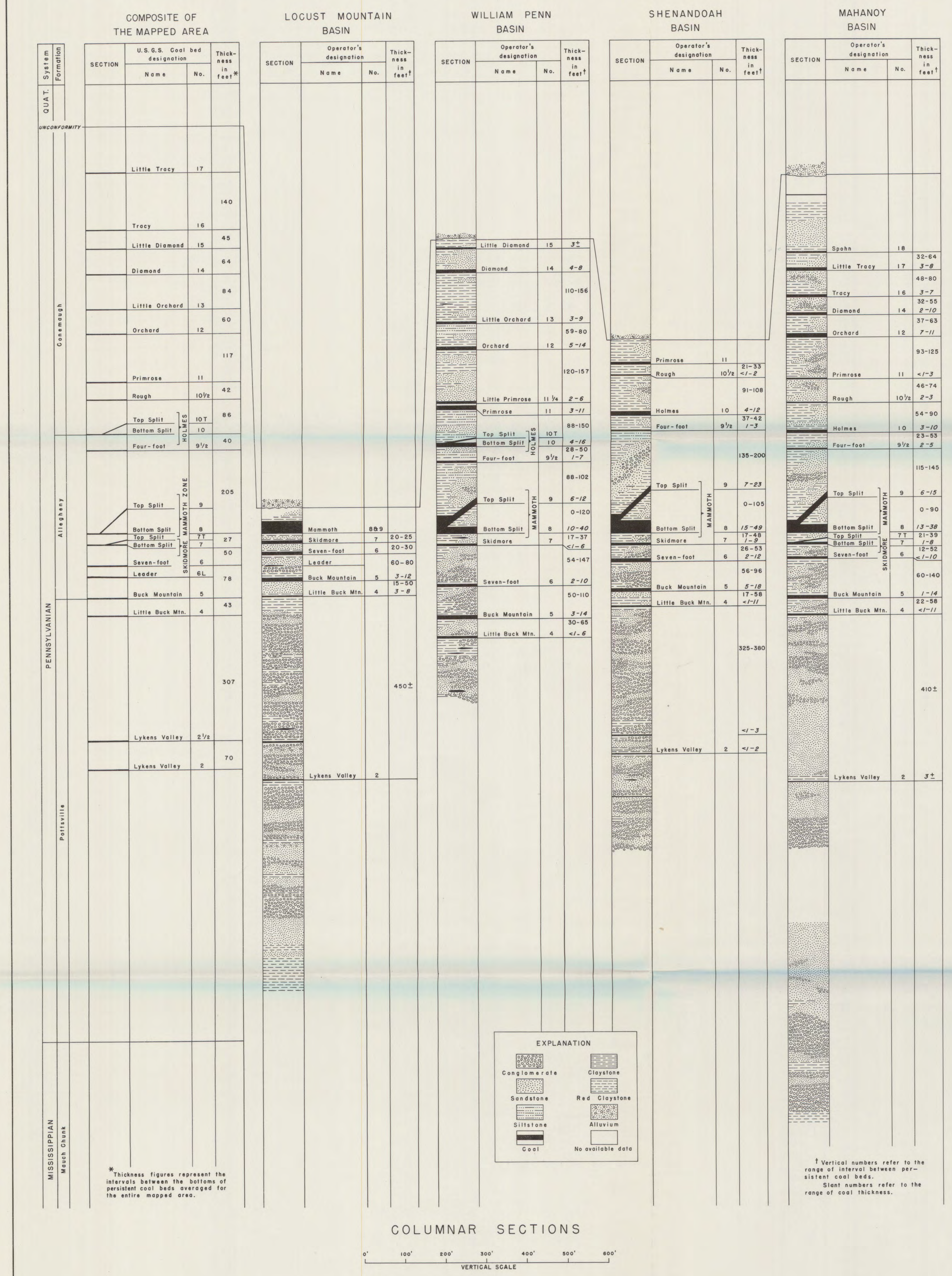
COAL INVESTIGATIONS
MAP C 21, SHEET 1 OF 2

GEOLOGY OF ANTHRACITE IN THE WESTERN PART OF THE SHENANDOAH QUADRANGLE, PENNSYLVANIA

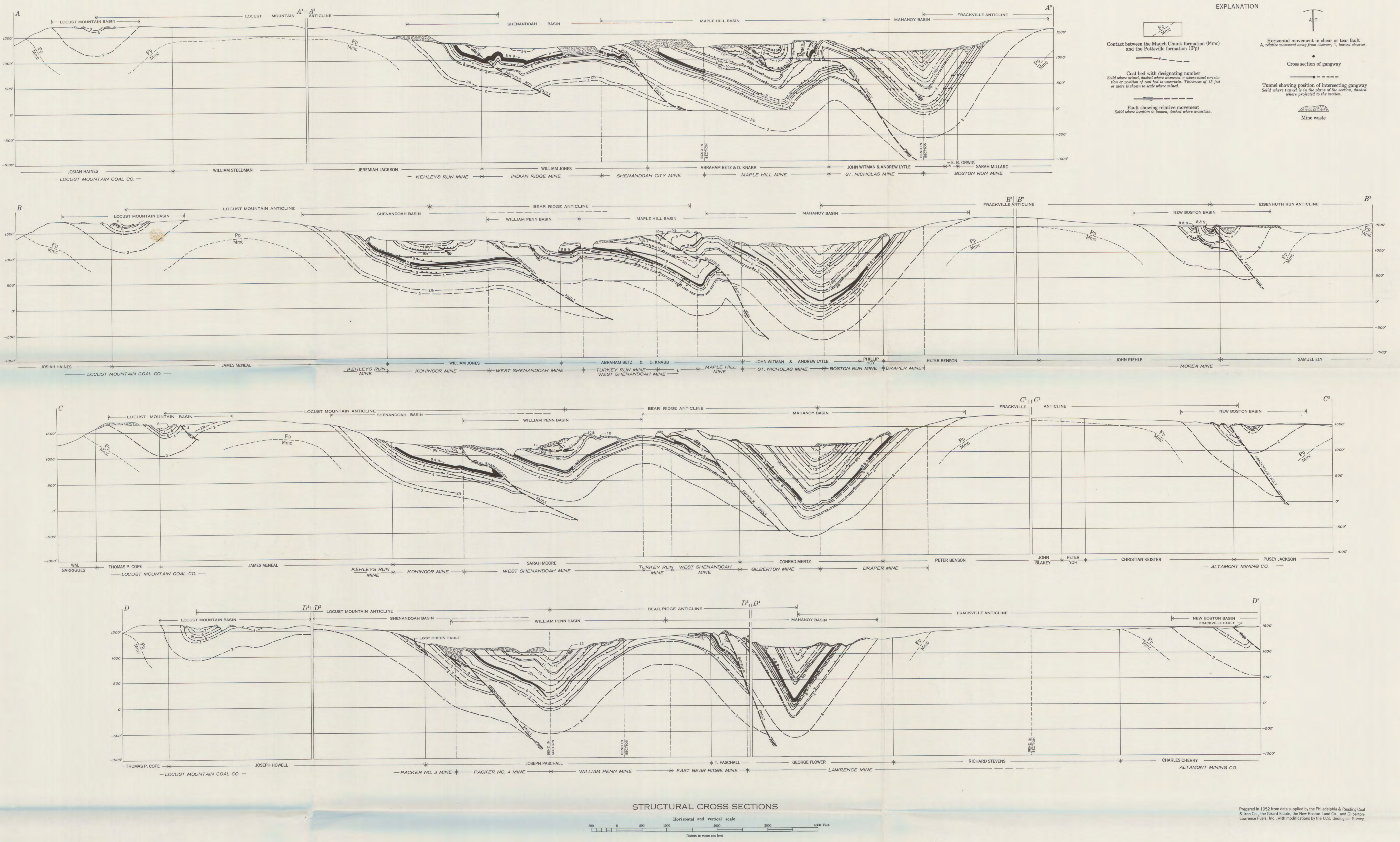
By
Walter Danilchik, Howard E. Rothrock, and Holly C. Wagner

1955

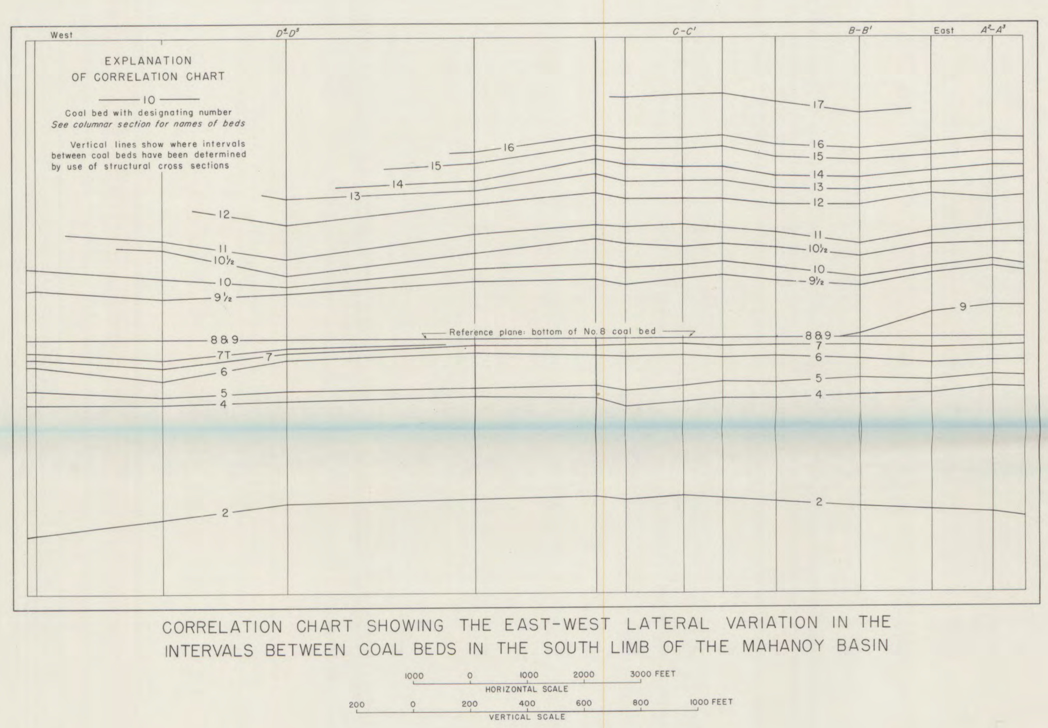
INTERIOR—GEOLOGICAL SURVEY, WASHINGTON, D. C., M-R-6484
For sale by U. S. Geological Survey, price $1.00 per set



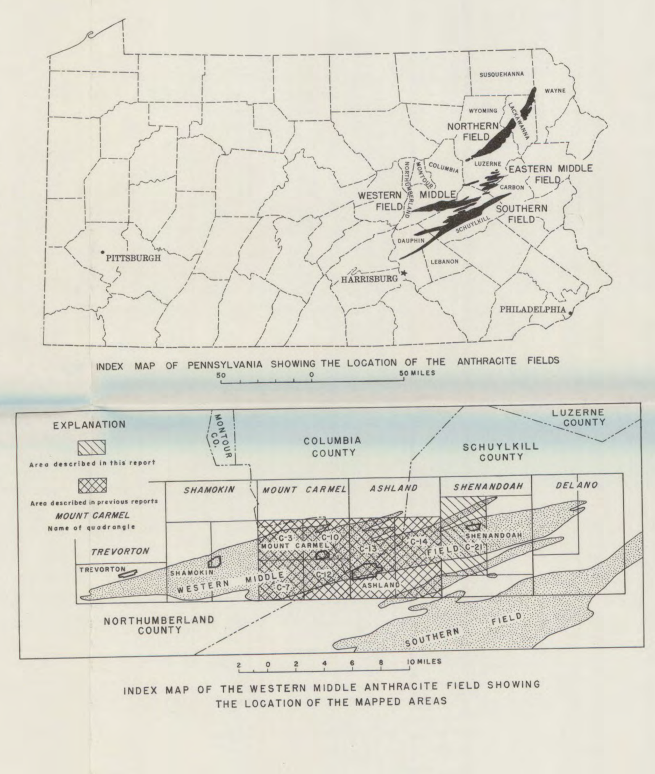
COLUMNAR SECTIONS



STRUCTURAL CROSS SECTIONS

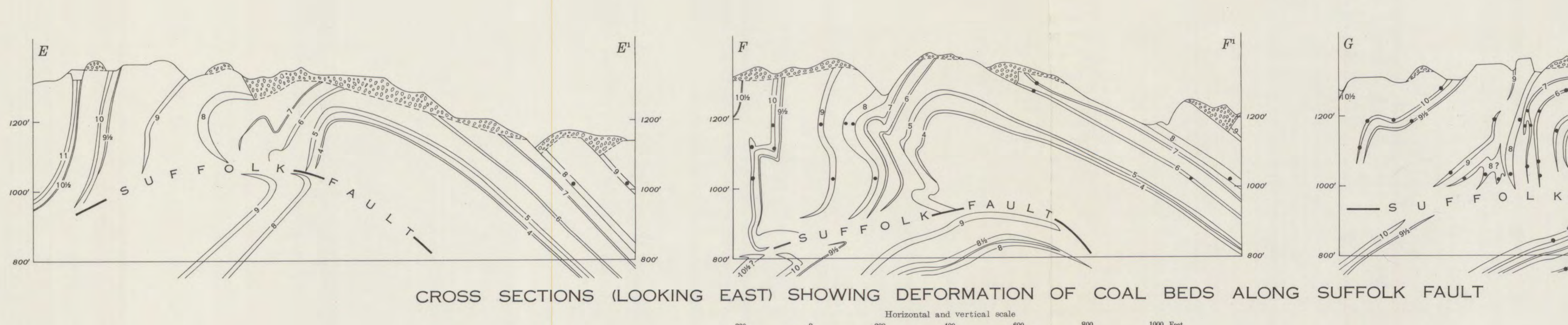


CORRELATION CHART SHOWING THE EAST-WEST LATERAL VARIATION IN THE INTERVALS BETWEEN COAL BEDS IN THE SOUTH LIMB OF THE MAHANOY BASIN



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



CROSS SECTIONS (LOOKING EAST) SHOWING DEFORMATION OF COAL BEDS ALONG SUFFOLK FAULT

Modified from cross sections prepared by the Philadelphia & Reading Coal & Iron Company. Coal bed thicknesses exaggerated.

GEOLOGY OF ANTHRACITE IN THE WESTERN PART OF THE SHENANDOAH QUADRANGLE, PENNSYLVANIA

INTRODUCTION

The Western Middle anthracite field is one of four structural basins containing anthracite in eastern Pennsylvania. This report describes the geology of the part of the Western Middle field that lies in the western half of the Shenandoah quadrangle. (See index map, sheet 2.) The mapped area covers about 19 square miles in Schuylkill County. The town of Frackville is in the southern part of the area, and the town of Shenandoah is in the east-central part.

This is the seventh of 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 "References"; 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 nomenclature of the coal beds.

Acknowledgments.–Information presented in this report was obtained, in part, from the data shown on mine maps, cross sections, drill logs, and other records made available by the Philadelphia & Reading Coal & Iron Co., the Girard Estate, the New Boston Land Co., and Gilberton-Lawrence Fuels, Inc. The cooperation of these organizations is appreciated.

Boyd R. Haley, Harold H. Arndt, Thomas M. Kehn, John A. Maxwell, John L. Snider, and Frederick N. Rossetter, of the U. S. Geological Survey, aided in the field mapping of this area and in the preparation of this report.

STRATIGRAPHY

Rocks of the Mississippian, Pennsylvanian, and Quaternary systems crop out in the mapped area. The oldest exposed rocks belong to the upper part of the Mauch Chunk formation of Mississippian age, which is overlain by the Pottsville, Allegheny, and lower part of the Conemaugh formations of Pennsylvanian age. Unconsolidated alluvial clay, silt, sand, and gravel of Quaternary age occur locally in the stream valleys. Stream-transported mine waste, some of which contains valuable deposits of detrital coal, has also been deposited along many streams. The Quaternary alluvium has not been mapped, but the economically important deposits of mine waste are shown on the outcrop map (sheet 1).

ROCKS OF MISSISSIPPIAN AGE

The Mauch Chunk formation crops out in the northern part of the mapped area north of Locust Mountain, and in the southern part of the area on the crest of Broad Mountain in the vicinity of Frackville and in the valley occupied by Mill Run. Only the upper 1,200 feet of the formation is exposed in the mapped area.

The strata in the Mauch Chunk formation consist of lenticular beds 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. The contact between the Mauch Chunk 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.

ROCKS OF PENNSYLVANIAN AGE

Rocks of Pennsylvanian age consist of lenticular beds of conglomerate, sandstone, siltstone, claystone, and shale interbedded with 12 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 are the most persistent of the lithologic units; the sandstone, shale, and clay beds exhibit so many abrupt changes in lithology that they are of little value as reference or key beds.

Pottsville formation.–The Pottsville formation, which includes the oldest Pennsylvanian rocks in the area, lies between the Mauch Chunk formation and the overlying Allegheny formation. It consists of resistant conglomerate and sandstone and forms the cores of all the mountains and most of the major ridges in the mapped area. The formation is approximately 1,250 feet thick in the southern part of the area but thins to approximately 920 feet in the northern part.

The lower part of the Pottsville formation is composed of beds of gray conglomerate, gray, green, brown, and red sandstone or 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) coal is near the middle of the formation, and two nonpersistent coal beds–Whites (No. 3) and Little Buck Mountain (No. 4)–and an unnamed local coal bed are present in the upper part of the formation.

Allegheny formation.–The Allegheny formation, 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 Allegheny formation is composed of conglomerate, sandstone, siltstone, claystone, and coal and ranges from 350 feet to 420 feet in thickness. The coal beds are the only laterally persistent lithologic units.

The Allegheny formation is the source of most of the coal that has been mined in the mapped area. Five persistent coal beds–the Buck Mountain (No. 5), Seven-foot (No. 6), Skidmore (No. 7), and two beds in the Mammoth zone (No. 8 and No. 9)–are present. Of these the Buck Mountain and the coal beds in the Mammoth zone are the most important.

Conemaugh formation.–The Conemaugh formation, the base of which is the Holmes (No. 10) coal bed (Lohman, 1937, p. 46), overlies the Allegheny formation. It is composed of gray or brown silty sandstone, siltstone, claystone, scattered lenses of conglomerate, and coal. In general, the rocks in the Conemaugh formation are softer, finer grained, and contain fewer and smaller lenses of conglomerate than the rocks in the underlying Allegheny formation. Erosion has removed the formation in the northern and southern parts of the area, but about 600 feet of rocks belonging to the Conemaugh formation remains in the east-central part of the mapped area.

Eight persistent coal beds are present in the Conemaugh formation in the mapped area. These are the Holmes (No. 10), Primrose (No. 11), Orchard (No. 12), Little Orchard (No. 13), Diamond (No. 14), Little Diamond (No. 15), Tracy (No. 16), and Little Tracy (No. 17). (See columnar section, sheet 2.)

STRUCTURE

The anthracite fields of Pennsylvania are northeast-trending synclinoria or 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, a synclinorium with several fingerlike projections to the north and south, is about 36 miles long and 5 miles wide at the widest part. This composite syncline consists of several overturned and therefore overlapping folds, some of which have been broken by thrust faults that trend northeast, paralleling the axes of the folds. The component folds are best developed along the southern margin of the field, where they are tens of miles in length; the folds in the northern part of the field are generally only a few miles long. The area of this report is in the eastern part of the Western Middle anthracite field. (See index map, sheet 2.)

FOLDS

The major basins in the mapped area are, from north to south, the Shenandoah, William Penn, Maple Hill, and Mahanoy basins. Anticlines separating these basins have been broken by thrust faults, resulting in partial overlaps of the basins as shown on the cross sections (sheet 2). Two small basins–the Locust Mountain basin in the northern part of the area and the New Boston basin in the southern part of the area–are separated from the main trunk of the Western Middle field by the large, unfaulted Locust Mountain and Frackville anticlines. These small basins join the main part of the field outside of the area covered by this map. (See index maps of the Western Middle field, sheet 2.)

The Shenandoah basin, northernmost of the major basins, is relatively broad and shallow. In the western part of the mapped area it is the undersheet of the William Penn basin and extends into the adjoining area to the east, where it divides into several smaller, more acute basins.

The William Penn basin is a complex canoe-shaped fold that terminates or "spoons" in the eastern part of the area on the north limb of the Bear Ridge anticline, north of the village of Turkey Run.

The Maple Hill basin develops near Turkey Run on the south flank of the Bear Ridge anticline and pitches eastward. This basin is complicated by an offset in beds along the Suffolk thrust fault that affects mainly the south limb of the basin. Part of the Maple Hill basin lies above this fault and part below it. Several small anticlines and synclines are present in the thrust plate above the Suffolk fault south of Turkey Run.

The southernmost major basin that crossed the mapped area is the Mahanoy basin. This basin is the most continuous and least complicated of the basins, and it is nearly symmetrical in cross section. That part of the south flank of Bear Ridge anticline which lies west of the Maple Hill basin is the undersheet of the Mahanoy basin and is locally referred to as the Mahanoy underlap.

The major folds in the mapped area trend about N. 80° E. In the western part of the area the axial planes of most of the folds dip northward, but in the eastern part of the area, which has been subjected to more intense deformation, the axial planes of most of the folds dip southward. The folds are concentric, and the limbs subtend angles ranging from 65° to 160°. Most of the synclines are more acutely folded than the adjacent anticlines.

FAULTS

The principal faults in the mapped area are thrust faults that parallel the axes of the folds and therefore are called longitudinal faults. These longitudinal faults are the Centralia fault, which terminates in the Locust Mountain basin; the Lost Creek fault, which terminates in the Shenandoah basin; the Shenandoah fault, which truncates the north limb of the William Penn basin to form the west end of the Shenandoah basin; and the Suffolk fault, which truncates the north limb of the Mahanoy basin. These faults are of such magnitude as to constitute absolute limits for mining and are used as natural underground mine boundaries by mine companies.

The most persistent longitudinal fault in the mapped area, the Suffolk fault, has a stratigraphic throw of more than 500 feet and locally brings the Pottsville formation over the entire Allegheny formation. Coal beds along this fault have been intensely deformed, as shown in the detailed cross sections on sheet 2, with the result that in some places the coal has been squeezed into relatively thick, irregular pockets, and in other places coal has been dragged out along the fault into thin sheets of shelly coal.

A number of faults in the mapped area cut obliquely across the folds, making angles ranging from 15° to 70° with the fold axes. These transverse or oblique faults have relatively small displacements that range from a few feet to a few tens of feet. In many places they are associated with shear zones in the coal. 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.

The relationship of the transverse faults to the longitudinal faults is obscure. The transverse fault that crosses the Shenandoah basin east of the town of Shenandoah (sheet 1), however, apparently formed later than the Shenandoah fault.

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 fractured 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, or by telescoping the coal bed. 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 the coal beds of the different mines are designated by a number, a name, or both. This nomenclature has not been standardized 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) the structure and lithology of the strata 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 all cases with those used by the Second Geological Survey of Pennsylvania (Ashburner, 1883, p. 84), and they do not agree in all 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 one that can be recognized and correlated in several of the basins, but it is not continuous throughout the basin. A local coal bed is one that cannot be correlated across a basin or between adjoining basins, and generally cannot be traced within a basin for more than 3 or 4 miles. A leader coal bed is one that 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 the outcrops 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 probable location 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 thickness and range in thickness of coal beds in the area covered by this report. Figures on the right side of the table show the thickness of all coal in each bed; figures on the left side of the table show the 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 of beds 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, and 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 mined in the western part of the Shenandoah quadrangle

Bed no.	Thickness: Bed, Average Ft	In	Range Ft	In	Ft	In	Coal, Average Ft	In	Range Ft	In	Ft	In	Percentage of refuse
17	---	---	---	---	---	---	---	---	---	---	---	---	---
16	4	10	4	6	5	2	3	10	3	6	4	0	20.7
15	7	7	5	2	10	6	6	4	3	4	9	7	16.5
14	7	1	3	0	9	1	6	1	3	0	7	10	14.1
13	7	6	2	10	11	10	5	6	1	6	12	0	26.6
12	10	5	5	0	16	0	8	6	4	7	13	6	18.4
11	10	5	3	0	14	0	8	2	3	0	11	7	21.6
10½	3	4	1	6	7	5	3	1	1	6	7	5	7.5
10T	---	---	---	---	---	---	---	---	---	---	---	---	---
10	9	2	5	4	17	4	8	4	3	1	16	0	9.1
9½	4	1	1	0	7	5	3	7	1	0	7	0	12.2
9	13	2	6	0	28	0	10	7	4	6	23	2	19.6
8½	9	2	3	6	15	5	7	10	2	10	13	5	14.5
8&9	38	7	21	1	66	2	32	9	18	1	54	0	15.1
8	23	7	5	2	57	10	20	6	5	2	48	7	13.1
7T	2	1	1	0	4	4	2	0	1	0	2	7	4.0
7	11	4	1	1	12	8	7	5	0	10	10	1	34.6
6	7	2	1	5	16	0	5	7	0	10	16	0	22.1
5	9	10	2	5	21	1	8	1	1	0	18	0	17.8
4	4	10	1	2	10	6	3	7	0	5	10	6	25.9
2½	---	---	0	6	3	0	---	---	---	---	---	---	---
2	---	---	3	0	10	0	---	---	---	---	---	---	---

COAL BEDS MINED IN THE AREA

Seventeen coal beds have been mined in the mapped area. Of these the Little Buck Mountain (No. 4), Buck Mountain (No. 5), Seven-foot (No. 6), Skidmore (No. 7), two splits of the Mammoth coal zone (Nos. 8 and 9), Four-foot (No. 9½), Holmes (No. 10), and Primrose (No. 11) coal beds are economically the most important.

The Little Buck Mountain (No. 4) coal bed, which is near the top of the Pottsville formation, crops out in all the basins in the mapped area. The average thickness of the No. 4 coal bed in this area is 4 feet 10 inches. It is most intensively mined in the western part of the area in the Lawrence mine, where the bed attains a maximum thickness of 10 feet 6 inches.

The Buck Mountain (No. 5) coal bed, which is the basal unit of the Allegheny formation, is economically and stratigraphically one of the most important coal beds in this area. It rests on resistant beds of the Pottsville formation and underlies rocks of varying resistance in the remainder of the Allegheny formation. In some places it crops out as a small topographic bench. This erosional characteristic and the stratigraphic position of the Buck Mountain make it an excellent bed for correlation purposes. The No. 5 coal bed, which is extensively mined, ranges in thickness from 2 feet 5 inches to 21 feet. The average bed and coal thicknesses are 9 feet 10 inches and 8 feet 1 inch, respectively.

The Seven-foot (No. 6) coal bed is about 140 feet above the Buck Mountain coal bed in the southern part of the area. The same stratigraphic interval is only about 50 feet in the northern part of the area. Apparently this northward convergence is due to northward thinning of an intervening sequence of conglomerate beds. The Seven-foot coal bed has been mined extensively. The bed, which in many places contains partings of bony coal, ranges from 1 foot 5 inches to 16 feet in thickness.

The Skidmore (No. 7) coal bed is approximately 50 feet above the Seven-foot (No. 6) coal bed. A split of the Skidmore coal bed, the Skidmore Top Split (No. 7T), has been mined in the southern part of the area in the Mahanoy basin. Elsewhere the Skidmore is a single coal bed. It has been extensively mined in the western part of the Shenandoah quadrangle. The average bed thickness is 11 feet 4 inches, of which an average of more than 34 percent usually constitutes waste.

The Mammoth coal zone is economically the most important group of coal beds in the Allegheny formation. Over most of the mapped area the Mammoth coal zone consists of two splits, the Bottom Split (No. 8) and Top Split (No. 9). The splits are mined as one bed where the intervening strata are thin, but where the separating strata increase in thickness as much as 120 feet, the splits are mined separately. In the Shenandoah basin the Bottom Split consists of three units–an upper coal; a middle shale, siltstone, and impure coal; and a lower coal. The middle unit is equivalent to the strata that separate the Middle Split (No. 8½) from the Bottom Split in the Maple Hill basin, east of the mapped area. In other places in the Maple Hill basin the Middle Split is just beneath the Top Split and the two coals are mined as one bed. The average bed thicknesses of the Nos. 8 and 9 coal beds are 23 feet 7 inches and 13 feet 2 inches, respectively. Where the Nos. 8 and 9 beds have been mined together the average thickness is 38 feet 7 inches.

The Four-foot (No. 9½) coal bed, near the top of the Allegheny formation, has been mined at scattered localities. West of the mapped area the coal is generally of poor quality and the bed is commonly too thin to mine. In this area the bed is characterized by a rather low percentage (12.2) of waste and an average thickness of 4 feet.

The Holmes (No. 10) coal bed, the basal unit of the Conemaugh formation, is one of the most persistent coal beds in this area. It consists of two splits in the south limb of the William Penn basin. The Holmes Top Split (No. 10T) coal bed merges into the No. 10 coal bed east and west of the south limb of the basin. The average thickness of the No. 10 coal bed is 9 feet 2 inches, of which 8 feet 4 inches is coal.

The Primrose (No. 11) coal bed is approximately 130 feet above the Holmes (No. 10) coal bed. The bed ranges in thickness from 3 feet to 14 feet. It has been most extensively mined in the Packer No. 4, Turkey Run, and Maple Hill mines, in the central part of the area. Coal beds younger than the Primrose are mined in many places but on a smaller scale and under more hazardous conditions because the roofs of these coal beds are difficult to support during mining operations.

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GEOLOGY OF ANTHRACITE IN THE WESTERN PART OF THE SHENANDOAH QUADRANGLE, PENNSYLVANIA

By
Walter Danilchik, Howard E. Rothrock, and Holly C. Wagner
1955

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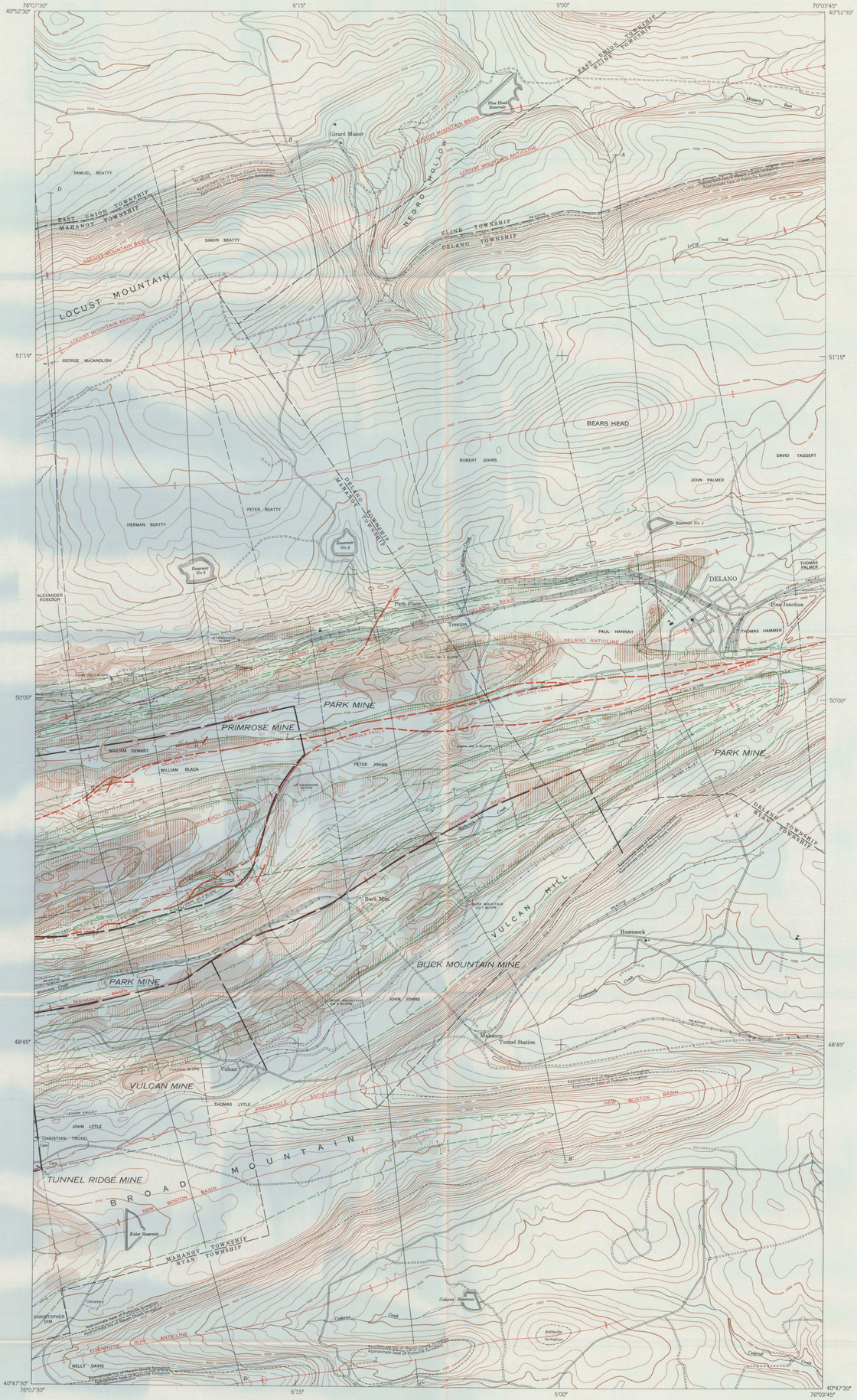

COAL OUTCROP MAP

Base: U.S. Geological Survey topographic map. Polyconic projection. 1927 North American datum. Topography was contoured from aerial photographs made in 1942. Correction has generally not been made for topographic changes resulting from strip mining or alteration of mine refuse banks since 1942.

EXPLANATION
OUTCROP MAP

Coal outcrop
Solid where location is known, long dashes where uncertain. Number designates coal bed; L, local or leader bed; T, top split.

High-angle fault, showing dip
U, upthrown side; D, downthrown side. Fault trace is solid where accurately located, long dashes where approximately located.

Fault showing relative movement
Fault trace is solid where accurately located, long dashes where approximately located.

Thrust or reverse fault showing dip
T, upper plate. Fault trace is solid where accurately located, long dashes where approximately located.

Anticline
Showing crest line.

Syncline
Showing trough line.

Structural cross section

Strip-mined area
Shaded areas covered by mine waste.

Surface opening on coal bed

Exploratory trench

Mine waste
Includes such refuse from mining and breaker operations as culm, rock banks, coal piles, back fill, and silt in settling basins.

Stream-transported mine waste

Boundary of mine

PETER JOHNS

Warranty tract
Boundaries are indicated for general orientation and identification but are not authenticated for legal purposes.

EXPLANATION
STRUCTURE MAP

Outcrop of Buck Mountain coal bed

Fault showing relative movement
Fault trace is solid where accurately located, long dashes where approximately located.

Fault cutting contoured bed showing dip of fault plane, relative position of faulted segments, and overthrust segment
Fault trace is solid where accurately located, long dashes where approximately located. Fault trace on underlying plane is indicated by short dashes where accurately located, very short dashes where approximately located; U, upthrown segment; D, downthrown segment; T, overthrust segment.

Anticline
Showing crest line, solid where location is known; dashed where location is uncertain.

Syncline
Showing trough line; solid where location is known, dashed where location is uncertain.

Contours on the bottom of the Buck Mountain coal bed
Solid in mined areas; long dashes in unmined areas; in those places where a part of the bed lies beneath another part of the same bed short dashes are used in mined areas, and very short dashes in unmined areas. Contour interval 100 feet. Datum is mean sea level.

Structural cross section

Barrier pillar in Buck Mountain coal bed

Boundary of mine

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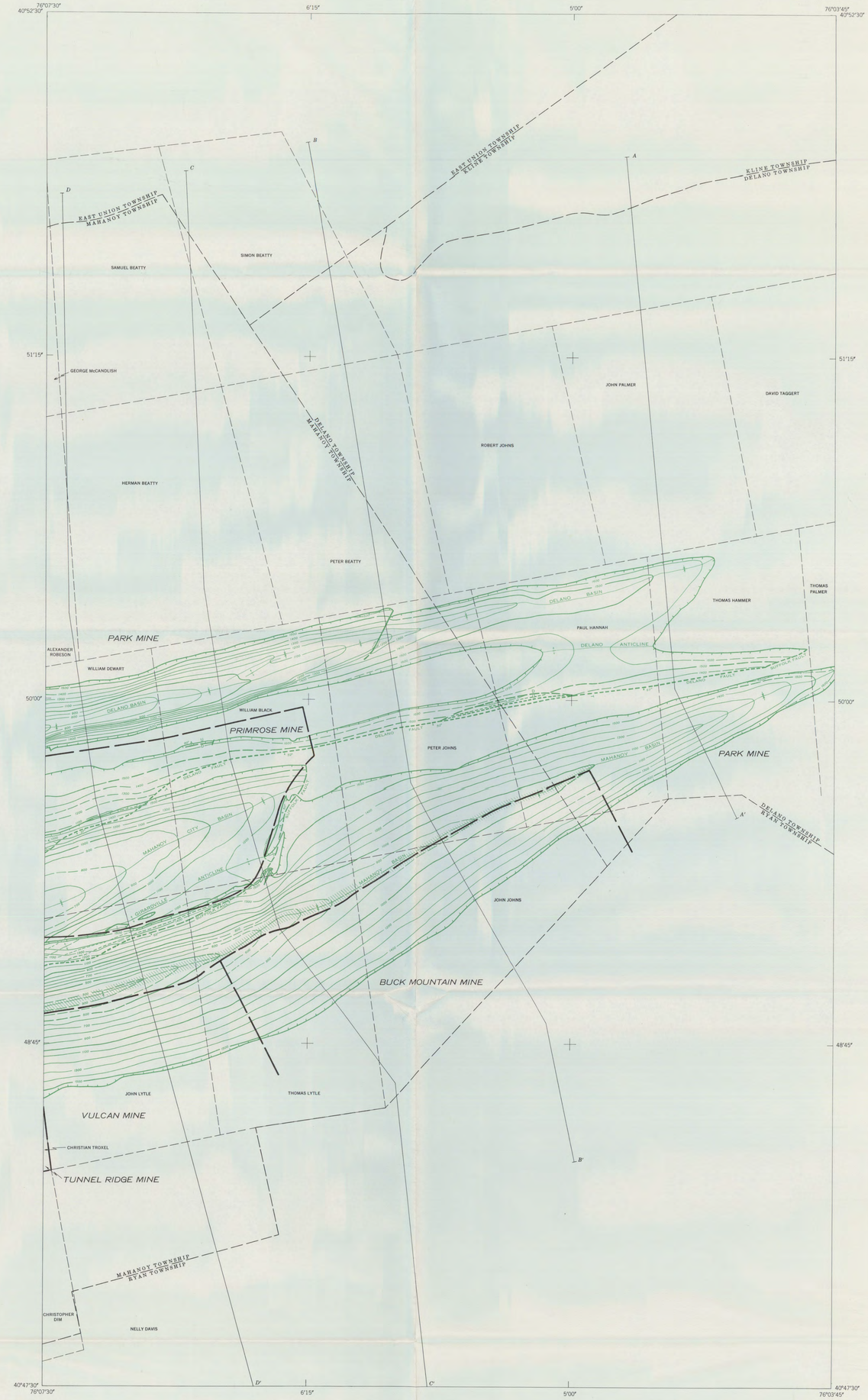

STRUCTURE MAP OF THE BUCK MOUNTAIN COAL BED

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

Scale 1:12 000

1000 0 1000 2000 3000 4000 5000 6000 Feet

Topographic contour interval is 20 feet
Structure contour interval is 100 feet.
Datum is mean sea level.

APPROXIMATE MEAN DECLINATION, 1955

DIAGRAM OF A TOPOGRAPHIC QUADRANGLE SHOWING THE AREA INCLUDED IN THIS MAP

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

By
John A. Maxwell and Howard E. Rothrock

1955

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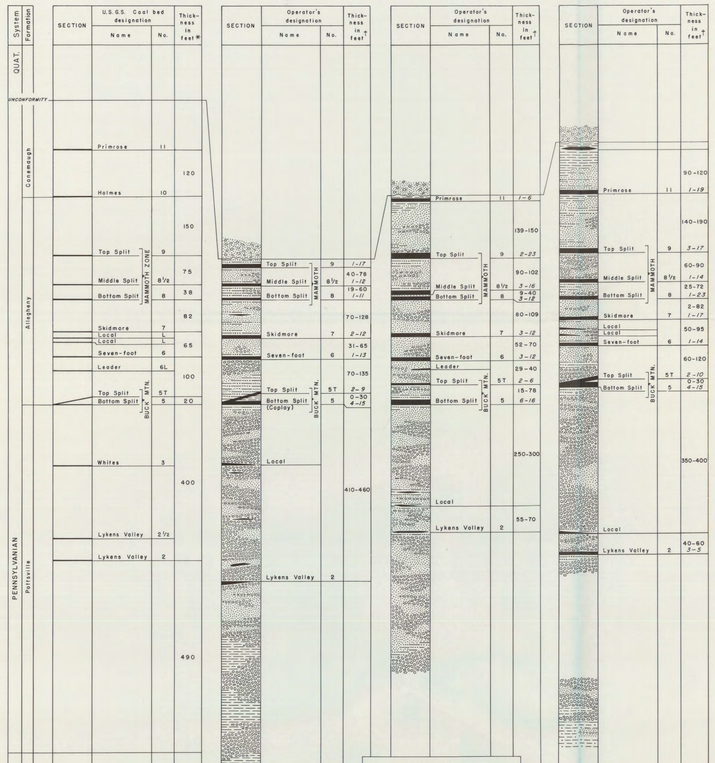

GEOLOGY OF ANTHRACITE IN THE WESTERN PART OF THE DELANO QUADRANGLE, PENNSYLVANIA

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, 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 (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 nomenclature 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 B. 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 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 stream-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 Hosensock 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 mountains 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. 2½) 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. 8½, 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 feature 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 plaze 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 from 25° to 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 southsoutheast 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 locally 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 localities 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: Bed: Average Ft	Bed: Average In	Bed: Range Ft	Bed: Range In	Coal: Average Ft	Coal: Average In	Coal: Range Ft	Coal: Range In	Percentage of refuse
11	No data available								
10	7	5	1 7	19 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. 8½), 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. 8½), 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.

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

By
John A. Maxwell and Howard E. Rothrock

1955

UNITED STATES DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

COAL INVESTIGATIONS
MAP C 3 (IN 3 SHEETS) SHEET I

GEOLOGY OF ANTHRACITE IN THE WEST-CENTRAL PART OF THE MOUNT CARMEL QUADRANGLE, PENNSYLVANIA

BY
Howard E. Rothrock, Holly C. Wagner and Boyd R. Haley

1950

COAL OUTCROP MAP

SCALE 1:6,000

500 0 500 1000 2000 3000 Feet

Contour interval is 100 feet
Datum is mean sea level

Base: U. S. Geological Survey topographic map.
Polyconic projection. 1927 North American datum.

APPROXIMATE MEAN DECLINATION, 1944

DIAGRAM OF A TOPOGRAPHIC QUADRANGLE SHOWING THE AREA INCLUDED IN THIS MAP

Prepared in 1948 from data supplied by the Natalie Coal Corporation, Lehigh Valley Coal Company, and Susquehanna Collieries Company with modifications by the Geological Survey, United States Department of the Interior.

Separate copies of the base for this map, showing ownership, topography, and culture may be purchased from the U. S. Geological Survey.

Drafted by John T. Howells

COAL INVESTIGATIONS
MAP C3 (IN 3 SHEETS) SHEET I

EXPLANATION

J. PAUL — Warranty tract
Boundaries indicated for general orientation and identification, but not authenticated for legal purposes.

Boundary of mine

Area reserved for barrier pillars
Including the Buck Mountain coal bed.

Area reserved for barrier pillars
Only in the Buck Mountain coal bed.

10T — Outcrop and number of coal bed
Long dashes where approximately located; short dashes where covered by mine refuse. T, top split.

U D 65 — Fault showing dip and relative position of sides
Real direction of movement not necessarily known; long dashes where approximately located; short dashes where covered by mine refuse; U, upthrown side; D, downthrown side.

Anticline
Showing position of crest.

Basin or syncline
Showing position of trough.

Overturned anticline
Showing direction of dip of limbs.

A ——— A' — Position of cross section

Shaft
Principal operating shaft.

Surface opening in a coal bed

Exploratory trench

Crop fall
Breach or collapsed area where coal bed has fallen into underground workings.

Stripped area
Width of excavation is indicated by length of lines and slope of floor rock by direction of lines.

Back-filled stripping

Mine refuse
Waste from mining and breaker operations such as culm, rock banks, cast piles, back fill, and silt in settling basins.

Stream transported mine refuse

EXPLANATION

J. PAUL
Warranty tract
Boundaries indicated for general orientation and identification, but not authenticated for legal purposes.

Boundary of mine

Area reserved for barrier pillars in Buck Mountain coal bed

Outcrop of the Buck Mountain coal bed

700 600 400 300 500
Contours on the bottom of the Buck Mountain coal bed
Solid in mined areas; long dashes in unmined areas; in those places where a part of the bed lies beneath another part of the same bed, short dashes are used in mined areas and very short dashes in unmined areas.

D U 125
Fault cutting the Buck Mountain coal bed showing dip and relative position of faulted segments
Long dashes where approximately located; short dashes indicate approximate location of fault trace on underlying bed where beds are duplicated by faulting. U, upthrown side; D, downthrown side; 4 is on upper segment.

Shear zone

Anticline
Showing position of crest. dashed where approximately located.

Syncline
Showing position of trough; dashed where approximately located.

Drainage tunnel

Polyconic projection. 1927 North American datum

STRUCTURE MAP OF THE BUCK MOUNTAIN COAL BED

SCALE 1:6,000
500 0 500 1000 2000 3000 Feet
Contour interval is 100 feet
Datum is mean sea level

9° TRUE NORTH MAGNETIC NORTH
APPROXIMATE MEAN DECLINATION, 1944

DIAGRAM OF A TOPOGRAPHIC QUADRANGLE SHOWING THE AREA INCLUDED IN THIS MAP

Prepared in 1948 from data supplied by the Natalie Coal Corporation, Lehigh Valley Coal Company, and Susquehanna Collieries Company with modifications by the Geological Survey, United States Department of the Interior.

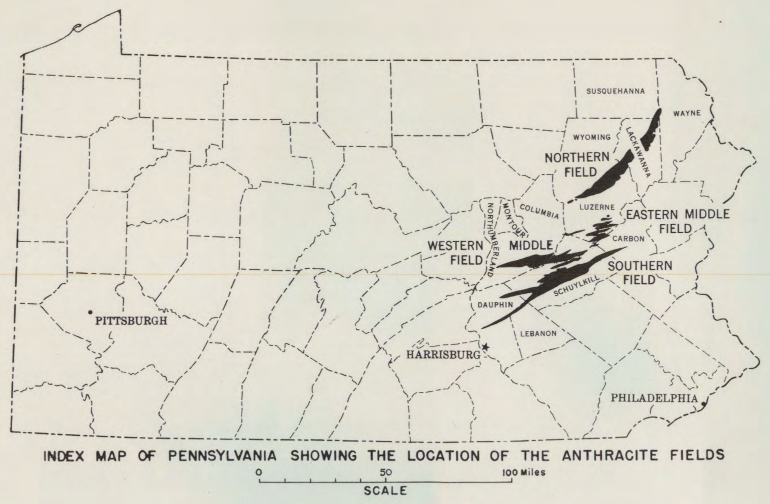
GEOLOGY OF ANTHRACITE IN THE WEST-CENTRAL PART OF THE MOUNT CARMEL QUADRANGLE, PENNSYLVANIA

BY
Howard E. Rothrock, Holly C. Wagner and Boyd R. Haley

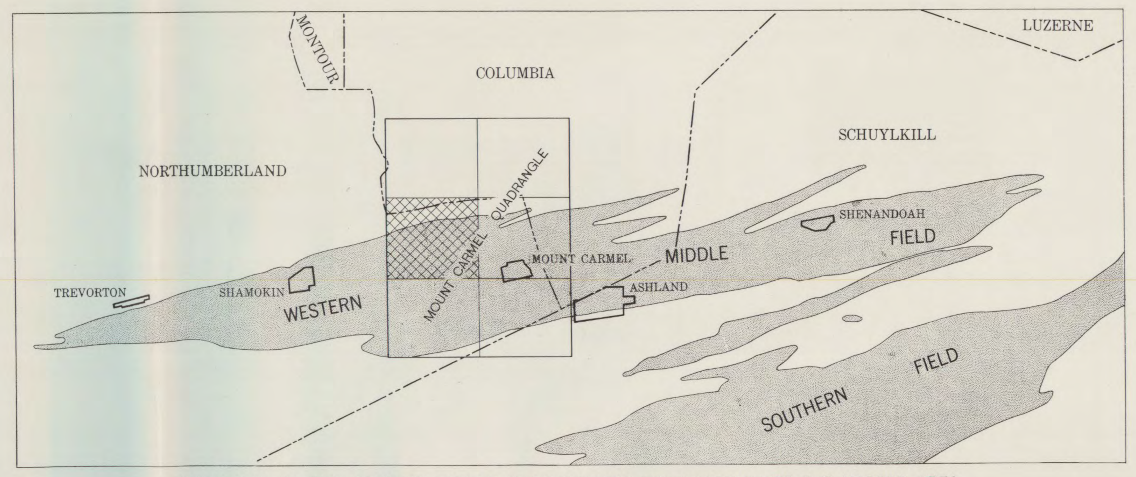
1950

Drafted by John T. Howells

COAL INVESTIGATIONS
MAP C3 (IN 3 SHEETS) SHEET 2

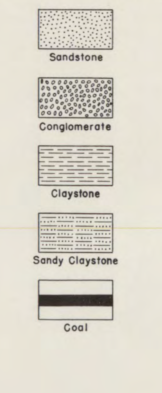


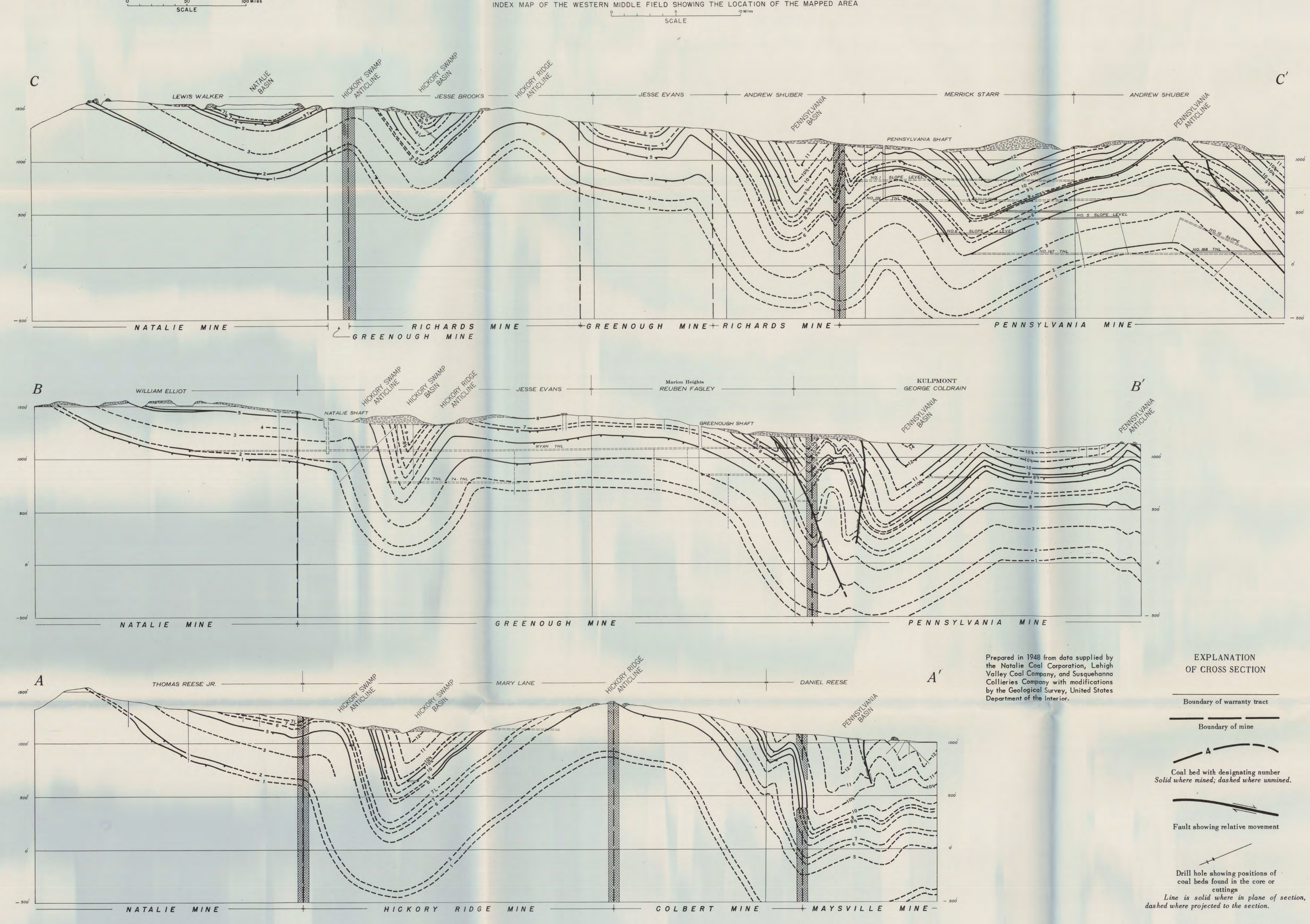
INDEX MAP OF PENNSYLVANIA SHOWING THE LOCATION OF THE ANTHRACITE FIELDS



INDEX MAP OF THE WESTERN MIDDLE FIELD SHOWING THE LOCATION OF THE MAPPED AREA

EXPLANATION OF COLUMNAR SECTION

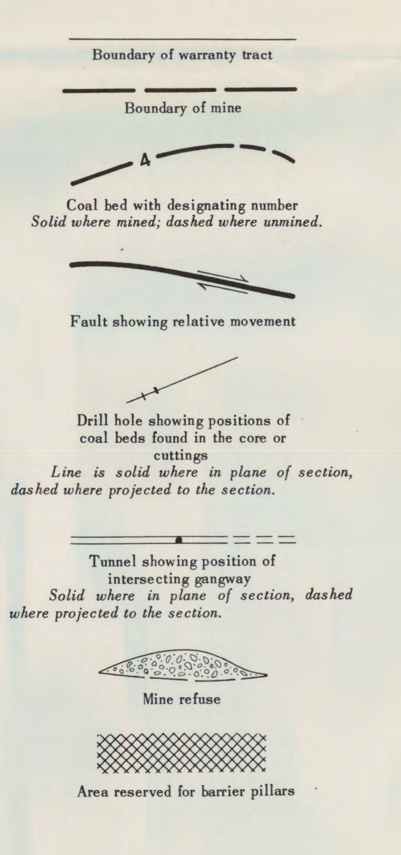


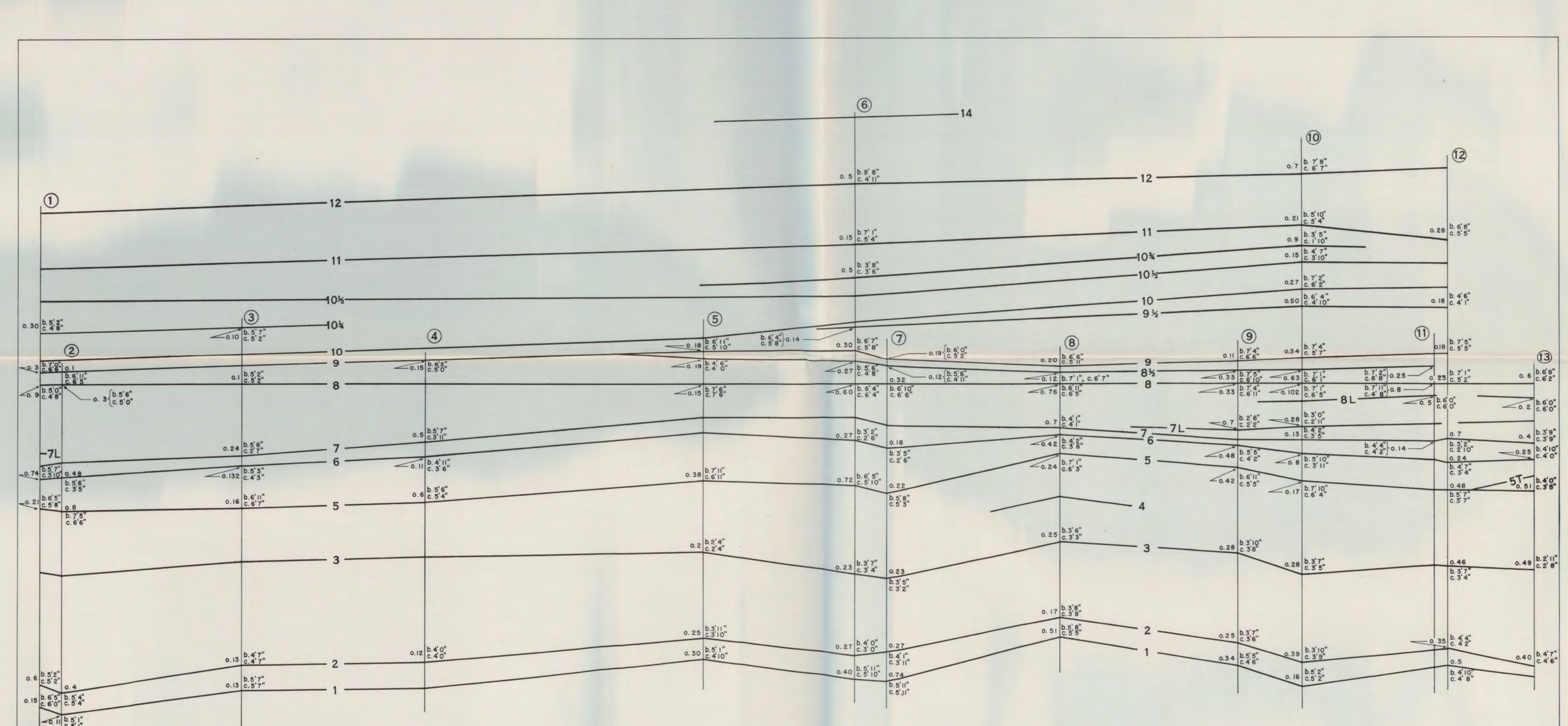


Prepared in 1948 from data supplied by the Natalie Coal Corporation, Lehigh Valley Coal Company, and Susquehanna Collieries Company with modifications by the Geological Survey, United States Department of the Interior.

CROSS SECTIONS SHOWING THE STRUCTURE OF THE COAL BEDS

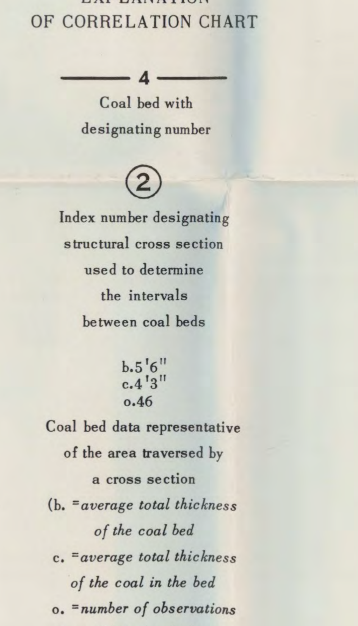
EXPLANATION OF CROSS SECTION





CORRELATION CHART SHOWING THE EAST-WEST LATERAL VARIATION IN THE INTERVALS BETWEEN THE COAL BEDS
(Numbered columns show the intervals that are representative of the corresponding structural cross sections shown on the index map)

EXPLANATION OF CORRELATION CHART



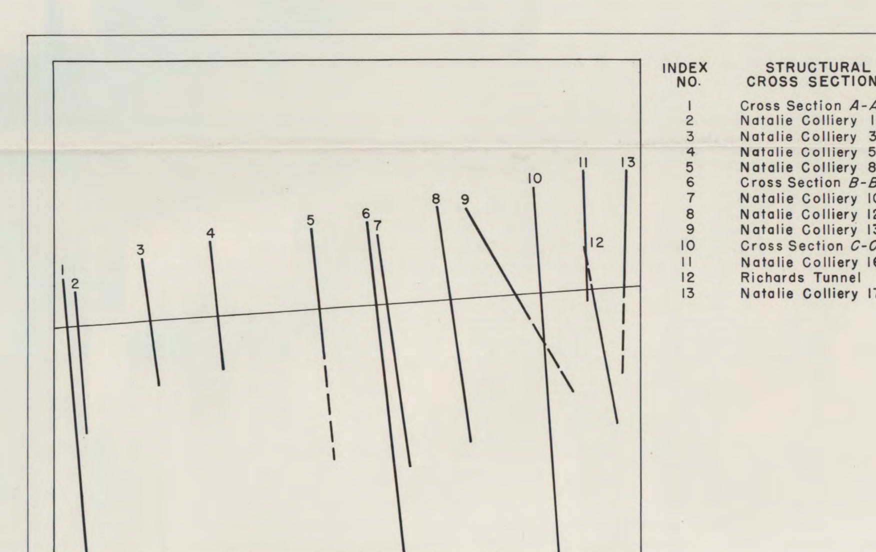
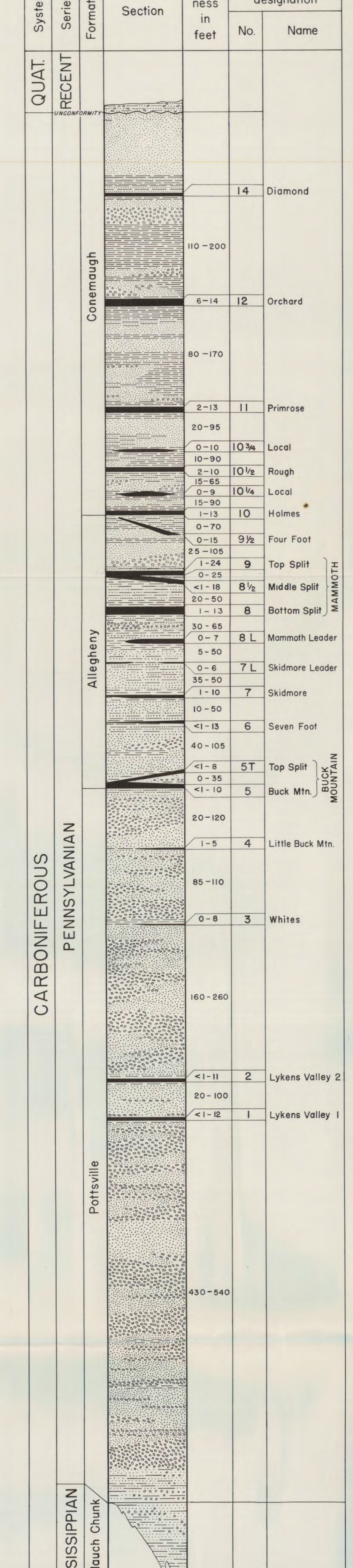


DIAGRAM OF THE MAPPED AREA SHOWING THE LOCATION OF THE CROSS SECTIONS REPRESENTED ON THE CORRELATION CHART



COLUMNAR SECTION

GEOLOGY OF ANTHRACITE IN THE WEST-CENTRAL PART OF THE
MOUNT CARMEL QUADRANGLE, PENNSYLVANIA

INTRODUCTION

LOCATION

The Pennsylvania anthracite fields, consisting of the Northern, Western-middle, Eastern-middle, and Southern fields, are in the eastern part of the Commonwealth of Pennsylvania (index map of Pennsylvania, sheet 3). The margins of the fields are generally delineated by the outcrops of the oldest coal bed in them, which is in a sequence of coal beds called the Lykens Valley zone. Because the form or structure of the coal-bearing rocks is basin-like, the outcrops of this oldest coal bed generally circumscribe each of the fields, except the Eastern-middle field. The Eastern-middle field consists of several closely spaced but disconnected areas of coal-bearing rocks and so is not bounded by a single circumscribing coal bed.

The mapped area here described is near the middle of the Western-middle field and consists of the west-central part of the area included in the Geological Survey's Mount Carmel topographic quadrangle. This part of the quadrangle is between latitudes 40°47'30" and 40°50'00" north, a distance of 2.87 miles, and longitudes 76°26'15" and 76°30'00" west, a distance of 3.26 miles, and is chiefly in Northumberland County but also extends into Columbia County. The town of Marion Heights is near the center of the mapped area.

PURPOSE

The chief purpose of the project is to aid in prolonging mining operations in the anthracite fields by publishing general information about the extent and structural relationships of the fields, and specific information about (1) the location of coal outcrops and the surface workings in them (sheet 1); (2) the depth, pitch, and other structural features of representative coal beds (sheets 2 and 3); and (3) the correlation of the beds, the stratigraphic intervals between them, and the thicknesses, continuity, and other physical characteristics of the coal (sheet 3).

The set of maps that constitutes this report is the first unit of a series of publications about the Pennsylvania anthracite fields. Each unit will be equivalent in area to 1/6 of a 7-1/2 minute topographic quadrangle. Other units will be issued as they are completed.

METHODS OF WORK

The base map upon which the geology is shown was made from the U. S. Geological Survey's Mount Carmel topographic quadrangle, mapped in 1944 from aerial photographs flown in 1942. This map, first compiled on a scale of 1:10,000, was published at a scale of 1:24,000, and prepared to be of standard accuracy at that scale. It was enlarged to a scale of 1:6,000 for use as a base.

The outcrop and structural data were assembled from mine maps and structural cross sections prepared by the operating companies from carefully controlled engineering data. Most of these maps and cross sections are drawn at a scale of 1 inch = 100 feet (1:1,200) and the compilations made for the Geological Survey's project were prepared at the same scale. These compilations were reduced photographically to the scale of 1:6,000 and were registered on the topographic base by means of the culture, political boundaries, and prominent topographic features. The complete assembly was checked in the field by observation or where necessary by plane table survey.

The property lines, taken from company surveys, represent the boundaries of the tracts for which warranty titles or patents were given by the Commonwealth of Pennsylvania. They are shown on the maps as a means of orientation and identification, and are not located with reference to mine workings or coal outcrops with a sufficient degree of accuracy to be a basis for claims of ownership.

The outcrop map shows the positions that the coal beds would occupy if they were projected to the surface of the ground. Only rarely do the beds crop out in this manner because they are generally covered by a mantle of soil, and where they appear in the soil as weathered coal or bloom, they occur down the slope at various distances from their original positions because of creep of the weathered soil. Exploration for the unweathered outcrop, therefore, should be started at the position shown on the map and extended in the direction of the dip.

ACKNOWLEDGMENTS

The foregoing description of the methods used in compiling the data for this report reveals the importance to the project of contributions of technical data by various organizations and individuals. Acknowledgment of this assistance is gratefully made to the engineering personnel in offices of the Glen Burn Colliery of the Susquehanna Collieries Company, the Natalie Colliery of the Natalie Coal Corporation, and the Wilkes-Barre and Hazleton Divisions of the Lehigh Valley Coal Company. Thanks are also due to the officials of these companies for granting permission to release the information required for the report. The project was endorsed by the Bureau of Topographic and Geologic Survey of the Commonwealth of Pennsylvania and was greatly aided by the cooperation of the Mine Inspectors of the Department of Mines of the Commonwealth. Many others have given freely of their experience and data.

GEOLOGY

STRATIGRAPHY

The rocks that crop out in the mapped area belong to the Carboniferous and Quaternary Systems and include in ascending order the upper part of the Pottsville, all of the Allegheny, and the lower part of the Conemaugh formations of Pennsylvanian (Carboniferous) age, and alluvial deposits of Recent (Quaternary) age (columnar section, sheet 3). The boundaries between these formations are considered to be the Buck Mountain coal bed at the base of the Allegheny and the Holmes coal bed at the base of the Conemaugh. (Lohman, 1937, p. 46.) The areal distribution of the upper part of the Pottsville, Allegheny, and Conemaugh formations is indicated on sheet 1 by the outcrops of these coal beds.

PENNSYLVANIAN ROCKS

The Pennsylvanian rocks are of continental origin and consist of lenticular deposits of conglomerate, sandstone, siltstone, claystone (generally called "slate" by the miners), and coal. The beds of coal are the most persistent of these rock types. The others show great lateral variation.

Pottsville formation.--The Pottsville formation, the average thickness of which is approximately 910 feet in this area, is above the Mauch Chunk shale of Mississippian (Carboniferous) age and below the Allegheny formation of Pennsylvanian age. The base of the Pottsville is well exposed in the mapped area only along the highway cut in Big Mountain northwest of Natalie. At this locality the basal strata are gradational with the Mauch Chunk and the boundary between the two formations is considered to be the place above which the weathered beds are predominantly brown and the fresh surfaces predominantly gray, and below which the weathered beds are predominantly brownish-red and fresh surfaces are predominantly reddish-gray. Although conglomerates occur both above and below this horizon they are much more numerous and thicker above it and are preponderant in the upper part of the Pottsville formation. The conglomerates vary greatly in thickness and are composed chiefly of well-rounded ovoid quartz pebbles in a matrix of silica-cemented sand. The pebbles generally range from a few millimeters to two or three centimeters in length. They consist chiefly of quartzite and milky quartz but there are some pebbles of silica-cemented siltstone and dark chert. Coarse- to medium-grained sandstones, locally cross bedded, and a few claystones are interbedded with the conglomerates.

The coal beds in the Pottsville formation are in its upper half. The oldest of the coals belongs to the Lykens Valley zone of coal beds which is 430 feet above the Mauch Chunk shale in a diamond drill hole west of the area and 540 feet above the Mauch Chunk in a bore hole in the Reliance Colliery south of the mapped area. The Lykens Valley zone in the mapped area consists of two beds called in ascending order No. 1 and No. 2 coal beds, but in other areas the zone includes from 1 to 6 beds (Lohman, 1937, p. 48 and Griffith, 1913). No. 1 and No. 2 coal beds are separated by a sandstone, 20 to 100 feet thick, that is conglomeratic in places. Above the Lykens zones the Pottsville formation consists of massive conglomerate interbedded with lenticular sandstone, a lesser amount of carbonaceous shale, and local coal beds. The average thickness of this sequence is 485 feet, but it ranges from 430 to 540 feet. The most persistent of the local coal beds, called the Whites or No. 3 bed, is near the middle of this part of the Pottsville formation. A coal bed of local distribution, called the Little Buck Mountain (No. 4) bed in this report, occurs at distances ranging from 20 to 120 feet below the top of the Pottsville. The lithology of the Pottsville formation, shown in the columnar section (sheet 3), was determined from field observations and from 14 core drill holes drilled in the Natalie mine, one of which reached the Mauch Chunk shale. The intervals between the coal beds in the Pottsville, and also in the overlying formations, were obtained chiefly from operators' cross sections drawn transverse to the longitudinal axes of the folds in the beds at intervals of 1,000 feet or less.

Allegheny formation.--The Allegheny formation, which overlies the Pottsville and underlies the Conemaugh formations, includes the Buck Mountain (No. 5) coal as its basal bed and extends to the Holmes (No. 10) coal, the basal bed of the Conemaugh. The Allegheny formation consists chiefly of sandstone and sandy claystone with intercalated coal beds. Claystone, which is a minor constituent in the lower part of the formation becomes more common in its upper part. Conglomerate or conglomeratic sandstone commonly occurs above the Buck Mountain coal, above and below the coal beds of the Mammoth zone, and in the strata near the top of the formation. All of the strata show lateral gradation into related rock types. The majority of the coal beds found in the mapped area, including the most important ones, occur in the Allegheny formation. Best known of these are the Buck Mountain beds at the base of the formation and the group of beds called the Mammoth coal zone near its middle. The general sequence of rock types in the Allegheny formation in the mapped area is shown by the columnar section (sheet 3) which was made from field measurements, cross sections through the mine workings, and the records of 24 drill holes.

Conemaugh formation.--Only the lower 400 feet of the Conemaugh formation is exposed in the mapped area. The basal bed of the formation is the Holmes coal, which rests on the Allegheny formation. The eroded upper part of the formation is covered by Quaternary soil and alluvium. The formation consists of carbonaceous claystone, sandstone, some of which is conglomeratic, five persistent coal beds, and three local ones. The claystones and sandstones are generally lenticular but a coarse-grained micaceous sandstone a few feet above the Holmes coal is sufficiently persistent to be useful in determining the location of this coal bed.

RECENT DEPOSITS

Deposits of Recent (Quaternary) age consist of silt, sand, gravel, boulders, and water-borne, or alluvial, mine refuse. These materials occur chiefly in the lower valleys where alluvial mine refuse generally forms the top layer of the deposit. As the mapped area was probably covered by ice during the Pleistocene period of the Quaternary era (Ashley, 1931), it is possible that some of the alluvium is of Pleistocene age. No attempt was made, however, to differentiate such deposits.

STRUCTURE

The Western-middle anthracite field is a composite syncline consisting of a group of roughly parallel folds that strike approximately N. 75° E (sheet 2). The mapped area is on the north limb, called the south pitch by miners, of the composite syncline; hence the folds that comprise it extend to progressively lower levels from north to south. The larger folds, the average width of which is about 4,000 feet, persist across the mapped area; the smaller ones tend to overlap. The axes of the folds are slightly undulating both in plan and cross section.

The anticlinal folds in the composite syncline tend to be broad or open arches such as the Hickory Ridge and Pennsylvania anticlines (sheet 3). Subsidiary anticlines such as the Hickory Swamp anticline, are developed in the limbs of some of the folds.

The synclines, which are more closely folded and more complex than the anticlines, plunge westward and are slightly asymmetric. Their axial planes dip northward, a characteristic that is clearly shown by the Hickory Swamp syncline whose limbs generally dip about 60° south and 35° north. The Pennsylvania syncline is the largest and most complex in the area. Synclinal areas, particularly those that are mined as units, are called "basins" in the anthracite fields, a practice that is generally followed in this report.

The rocks are cut by many faults most of which are longitudinal, or parallel with the long axes of the folds. The dips of the faults at the surface, computed in a few places (sheet 1), appear to be generally at angles of from 65° to 90°. A longitudinal fault near the middle of the east margin of the area, however, flattens noticeably underground, ranging from 65° at the surface (sheet 2) to 25° 300 feet underground where it cuts the Buck Mountain coal bed (sheet 2). Another exception is the longitudinal fault, shown near the southeast corner of sheet 2, on which one segment of the Buck Mountain bed has been thrust over another along a plane that dips 45° southward. All of these faults are probably the result of compression or thrusting and are generally reverse faults. Most of the faults in this area occur on the north limb (south pitch) of the synclines.

Two types of deformation that result from longitudinal or strike faulting are represented in this area. In one type, the fault cuts the beds at a relatively low angle with the bedding and produces overlap in the rock segments, as illustrated by the fault shown in the southeast corner of sheet 2 and in the south end of cross section C-C', sheet 3. Such faults are common. They may lie extensively within one coal bed, which acted as a lubricant for the moving masses, and may die out in the adjoining competent rocks without cutting adjacent coal beds. The second type of deformation, which is much less common than the first, produces closely spaced faults that bound uplifted wedge-shaped blocks, called horsts, as shown 1,000 feet south of Greenough shaft (sheet 2 and cross section B-B', sheet 3).

A kind of fault also due to thrusting cuts the beds obliquely to or parallel with their dip, and on the basis of its position may be called an oblique or dip fault. One of the largest of these faults branches northward from a long strike fault in the southwestern part of the area and is associated for most of its length with a shear zone in the Buck Mountain coal bed but dies out in an expanded part of the shear zone at its northern end (sheet 2).

Shear zones in which coal, claystone, or other incompetent rock is deformed with no apparent fracturing of the adjoining competent rock, occur frequently. The coal in these shear zones is reduced to thin lenticular fragments bounded by slickensided faces and is described by the miners as "shelly". The shear zones may be associated with rolls (small local flexures) in which the coal is either "shelly", thinned, or pinched out entirely. Areas of this kind, that are large enough to be mapped, are shown on sheet 2. Most of them are oblique to the longitudinal axes of the structures.

Open fractures, encrusted or filled with quartz crystals, represent a late stage of deformation in which tension appears to have been the predominant force. The largest of these that has come to the attention of the writer extends from the unbroken roof of the No. 3 coal bed in the Greenough mine downward in an undulating plane for at least 300 feet.

COAL BEDS

NOMENCLATURE AND CORRELATION OF THE COAL BEDS

In the Western-middle anthracite field the coal beds are generally known as veins, following very early usage. As the term "vein" generally refers to tabular mineral deposits that are foreign to, and younger than the rocks in which they occur, it is not applicable to deposits of coal. In this report the coal deposits are called coal "beds".

The nomenclature of the coal beds has not been completely standardized, but great progress has been made from the early periods of mining when names were given to beds in isolated mines before correlation could be made. Other factors contributing to this lack of uniformity are the complexity of structure and lithology, and the scarcity of outcrops. Moreover, misnomers persist in some mines because of common usage and the difficulty of changing the records. The bed names used in this report were chosen to conform, so far as possible, to the consensus of usage in the eastern half of the Western-middle field. They are offered tentatively as a standard of nomenclature that, it is hoped, will also apply to other areas of the anthracite fields. These names, however, do not necessarily agree with those used in the anthracite reports of the Second Geological Survey of Pennsylvania, because those reports followed local usage only (Ashburner, 1883, p. 84).

DESCRIPTION OF THE COAL BEDS

THICKNESSES OF COAL

The coal thicknesses shown in this report were obtained chiefly from underground measurements made by the operators. These measurements, selected from a great many such observations, were chosen so as to reflect the normal thickness of the bed and its included coal in unit areas 1,000 feet square. Measurements that were considered to be abnormally affected by structural deformation, such as faulting, pinching or swelling, were not used; hence, the measurements do not include the most extreme dimensions of the bed. Wherever possible at least four measurements per unit area were averaged. In the following descriptions and in the correlation chart, sheet 3, two thickness figures are generally given, the first indicating the total thickness of the bed that contains the coal, and the second the aggregate thickness of the layers of coal in the bed (sheet 3).

The ranges in thickness that are given in the text may be less than the ranges shown on the columnar section, because those in the text represent thicknesses in mined areas, whereas those in the columnar section represent thicknesses throughout the mapped area.

LYKENS VALLEY COAL ZONE

The Lykens Valley zone contains two coal beds in the mapped area. They are differentiated in this report by designating them in ascending order as No. 1 and No. 2 beds. Both beds have been mined extensively for various distances southward from their outcrops on the north slope of Big Mountain.

No. 1 bed of the Lykens Valley coal zone.--The No. 1 bed, the oldest coal in the area, was mined under most of the area known as the Natalie mine and in the northern part of the Greenough mine (sheet 2). In these areas the bed averaged 5'8" thick, of which 5'4" was coal. The range in thickness of the bed was from 12 to 2 feet. The bed thins southward from its outcrop, where it averaged about 7 feet, to the north line of the Greenough mine, where it was about 4 feet thick.

No. 2 bed of the Lykens Valley coal zone.--The No. 2 bed, which is from 20 to 100 feet stratigraphically above No. 1 bed, has been mined extensively in the Natalie mine and in the northwestern part of the Richards mine. It has also been mined in the northern and eastern parts of the Greenough mine, in the southeastern part of the Pennsylvania mine, and possibly elsewhere in the area. In the mined areas the average thicknesses of the bed and its included coal were 4'1" and 3'10", respectively, but the bed ranged from 11'0" to 0'10" thick and the coal from 9'3" to 0'6" thick. The No. 2 bed is very irregular in thickness but shows an over-all thinning southward from its outcrop.

WHITES (NO. 3) COAL BED

A coal bed, which is designated as the No. 3 on the maps of the Natalie Coal Corp., and is sometimes called the Whites coal, occurs from 150 to 200 feet above the Lykens (No. 2) bed. The horizon of the bed is at the surface on the north side of Big Mountain, but no outcrops of coal were found. The approximate location of its outcrop, however, is shown on sheet 1, where underground workings indicate its presence.

The Whites (No. 3) coal was mined in parts of the Natalie, Greenough, and Richards mines, and possibly elsewhere. The workings are generally limited on the north by a pinch near the crest of the Hickory Swamp anticline and on the south by the steeply-dipping north limb of the Pennsylvania basin.

The bed is a lenticular body with an east-west elongation and an average thickness of 3'9", but it varied greatly in thickness throughout the mined area, ranging from 8'4" to 0'5". The bed generally contains partings or lenses of bone which reduced the included coal to an average thickness of 3'1" with a range of 7'4" to 0'5".

LITTLE BUCK MOUNTAIN (NO. 4) COAL BED

In the Natalie mine a local bed was found in core drill holes and in some of the tunnels at a stratigraphic position 80 feet above the Whites bed and from 20 to 120 feet below the Buck Mountain coal. It is correlated in this report with coal bed No. 4 in the Sioux mine found in a similar position, and with a bed elsewhere in the Mount Carmel quadrangle known as the Little Buck Mountain bed, and is called in this report the Little Buck Mountain (No. 4) coal bed.

The thickness of this bed in the Natalie mine ranges from 4'10" to 1'1" but it contains waste which may constitute as much as 40 percent of the bed. The bed is worked a short distance east of the mapped area in the Sioux mine where it contains less waste and is more uniform in thickness, ranging from 3'0" to 4'9".

BUCK MOUNTAIN (No. 5 AND 5T) COAL BED

The Buck Mountain coal bed, from 350 to 400 feet above the Lykens (No. 2) bed, crops out near the top of Big Mountain and in places along the axes of the Hickory Swamp and Hickory Ridge anticlines.

The coal bed has been mined extensively throughout the mapped area, except in the deeper parts of the Hickory Swamp and Pennsylvania basins. The mined areas are approximately equivalent to those on sheet 2 in which the contour lines are solid.

The bed generally contains a parting which in some areas becomes as much as much as 35 feet thick and divides the bed into a bottom split, called No. 5 bed in this report, and top split, called No. 5T. The parting is chiefly carbonaceous claystone and fine-grained sandstone which locally contains lenses of pebble conglomerate. The Buck Mountain bed overlies the thick conglomerate sequence of the Pottsville formation. The rocks between the Buck Mountain coal and the overlying Seven-foot bed are chiefly sandstone but in some places include a bed of conglomerate that is useful in designating the position of the Buck Mountain coal.

The total thickness of the two splits of the Buck Mountain coal bed in the eastern two-thirds of the mapped area ranged from 18'4" to 0'6" with the included coal ranging from 12'0" to 0'4". The average thicknesses of the bed and coal, however, were 6'11" and 5'9", respectively.

SEVEN-FOOT (NO. 6) COAL BED

The Seven-foot (No. 6) coal bed, which is from 40 to 105 feet above the Buck Mountain bed, is known as the No. 5 coal in most of the mines in the mapped area. It is called the Seven-foot bed in this report because that is the name by which it is commonly known elsewhere in the Mount Carmel quadrangle.

The rocks between the Seven-foot bed and underlying Buck Mountain bed consist chiefly of sandstone, which in some places is conglomeratic. The coal bed crops out along the anticlines north of the Pennsylvania basin, and has been mined in parts of the Sioux, Richards, Greenough, Natalie, Hickory Ridge, Scott, and Pennsylvania mines. In these areas the average thickness of the bed and its included coal were 4'7" and 3'4", respectively, but the bed ranged in thickness from 10'3" to 1'5" and the coal from 6'5" to 1'5".

SKIDMORE (NO. 7) COAL BED

The Skidmore (No. 7) coal bed in this area is defined as the first persistent coal below the Mammoth that can be correlated with the bed commonly known as the Skidmore elsewhere in the quadrangle.

In the northwestern part of the mapped area it is 170 feet below the Mammoth and no other coal occurs between the two beds. In the northeastern part of the area, however, this interval decreases to 80 feet and in some places contains two local beds, the Skidmore leader and the Mammoth leader.

The Skidmore bed crops out north of the Pennsylvania basin and has been worked most extensively in that area. Average thicknesses of the bed in the unit areas were generally from 4 to 6 feet but southeastward the thickness decreased to 2 or 3 feet. The maximum range recorded was from 9'11" to 1'6". Coal constituted about 82 percent of bed.

SKIDMORE LEADER (NO. 7L) COAL BED

The Skidmore leader (No. 7L) is a local coal bed that occurs only in the northeastern part of the mapped area, where it is known as the No. 6-½ coal of the Natalie mine. It crops out on the Hickory Swamp anticline and has been mined in the Natalie mine on the limbs of the anticline. The thickness of the bed ranged from a few inches to 3'3". Its average thickness was 2'10", of which 2'5" was coal.

SKIDMORE (NO. 7) COAL BED

The Skidmore (No. 7) coal bed, an important source of coal in adjoining areas, is poorly represented in the mapped area. It is exposed only in the northeastern part of the area, where it has been mined. In the southern part of the area it is not recognized. Elsewhere its presence is inferred from scattered showings in core drill holes and mine workings.

The stratigraphic interval from the Skidmore to the underlying coal beds is quite variable but the interval from the Skidmore to the overlying Mammoth coal is more regular, ranging from 35 to 60 feet. In some places a conglomerate that occurs above the Skidmore coal is an aid in locating its outcrop.

In the mined area the Skidmore bed was from 4 to 6-½ feet thick.

MAMMOTH COAL ZONE

The Mammoth coal zone, the most famous of the anthracite deposits, consists of three principal members throughout most of the mapped area, but in some places, as in the northwestern part, only a top and a bottom member is recognized. The principal members of the zone are called the bottom, middle, and top splits and are designated in this report as No. 8, No. 8-½, and No. 9, respectively. In addition to these principal members a leader bed, called the No. 8L in this report, occurs locally in the northeastern part of the area. The bottom split (No. 8) is generally a distinct bed separated from the upper splits by claystone and siltstone from 20 to 50 feet thick, but in some localities south of the mapped area the bottom and middle splits form a single bed. The middle (No. 8-½) and top (No. 9) splits may comprise a single bed in some localities but elsewhere may be separated by as much as 25 feet of claystone, siltstone, or sandstone. In some areas the partings between the members may be so thin that they are almost unrecognizable. In such areas the coal may be of considerable thickness.

Mammoth leader (No. 8L) bed of the Mammoth coal zone.--The Mammoth leader coal bed occurs locally in the northeastern part of the mapped area where it is known as the No. 7 bed of the Natalie mine. It is included with the Mammoth coal zone in this report because it is so close to the principal bottom member of that zone that the two were mined as a single bed in some places, and because the stratigraphy suggests that it is not the Skidmore bed.

The Mammoth leader bed crops out in the Hickory Swamp and Natalie basins. (See sheet 1.) Its thickness in the workings ranged from 6'7" to 3'0" and averaged nearly 6'0", all of which was coal.

Bottom split (No. 8) of the Mammoth coal zone.--The No. 8 bed, or bottom split of the Mammoth coal, crops out in many places in the area and has been mined in all of the mines. It is a persistent bed and is generally easily recognized. For these reasons it is often used as a reference datum or key bed in determining the stratigraphic positions of other beds or the structure of the rocks. The bed thickened irregularly eastward, having average thicknesses of from 3 to 6 feet in the western part of the area and from 4 to 9 feet in the eastern part. The maximum and minimum thicknesses of the bed, however, exclusive of areas that were faulted or closely folded, were 13'0" and 1'0", respectively. The average thickness of the bed in the mined areas was 6'0" of which 5'3" was coal.

Middle split (No. 8-½) of the Mammoth coal zone.--The middle split (No. 8-½) of the Mammoth coal is present throughout the mapped area except in the northwestern part where it merges with the overlying top split of the Mammoth. The middle split crops out in the eastern half of the Hickory Swamp basin, on the north limb (south pitch) of the Pennsylvania basin, and along the crest of the Pennsylvania anticline.

Extensive workings have been made in this coal, the average thickness of which varied from 4 to 6 feet in the western part of the area and from 5 to 8 feet in the eastern part. The maximum variation in thickness, however, was much more than this, ranging from 18'0" to 2'4". Measurements of the coal in place indicate that it contained an average of about 8 percent of refuse.

Top split (No. 9) of the Mammoth coal zone.--The top split (No. 9) of the Mammoth coal crops out in many places south of the Hickory Swamp anticline. It was mined in all of the mines except the Natalie.

The bed had a wider range of thickness in the workings than older beds, its maximum and minimum being 23'6" and 1'2", respectively. Average thicknesses of the bed in the unit areas, however, displayed a tendency to thicken eastward from a range of 3 to 8 feet in the western part of the mined area to a range of from 4 to 11 in the eastern part. The bed in place contained an average of 20 percent of waste.

FOUR-FOOT (NO. 9½) COAL BED

The Four-foot (No. 9½) coal bed has been mined in the southeastern part of the mapped area. In the eastern part of the mined area it is about 60 feet below the Holmes (No. 10) coal, but westward near the boundary between the Pennsylvania and Scott mines, this interval decreases so much that the Four-foot and Holmes beds are not differentiated in the mine workings. A short distance northeast of the common corner of the Scott, Greenough, and Pennsylvania mines, however, the Holmes and the Four-foot are separate beds with about 65 feet of sandy claystone between them.

The average thicknesses of the Four-foot bed in the northern part of the area of occurrence were from 4 to 11 feet. The bed thinned southward until in the southeastern part of the mapped area it was about 3 feet thick. The maximum and minimum thicknesses, however, were 14'6" and 2'0", respectively. The bed generally contained about 20 percent of waste.

HOLMES (NO. 10) COAL BED

The Holmes coal bed, which is at the base of the Conemaugh formation, is notable for its widespread occurrence and relatively uniform thickness. It occurs in all of the mines within the mapped area except the Natalie mine. It crops out in the western or deeper end of the Hickory Swamp anticline, on both flanks of the Pennsylvania basin, and at various positions along the broad top of the Pennsylvania anticline.

The strata between the Holmes bed and the underlying Mammoth coal zone form an eastward thickening wedge which in the western part of the mapped area is only 30 feet thick. This increase in thickness is gradual through the Hickory Ridge and Scott mines but east of these mines the thickness of the wedge increases rapidly until a maximum of about 150 feet is reached at the east side of the area. This increase is partly due to the presence of the Four-foot coal and the strata which intervene between it and the Holmes bed (see correlation chart, sheet 3).

The Holmes bed is remarkably uniform in thickness, generally averaging from 4 to 6 feet, but extremes, exclusive of closely folded and faulted areas, of 12'7" and 1'0" were recorded. It contains less waste than most of the coal beds in the area, the average proportion being about 16 percent.

LOCAL (NO. 10-¼) COAL BED

In the Hickory Ridge mine a coal bed, called the Hickory Ridge No. 9-¾, occurs about 25 feet above the Hickory Ridge No. 9-½, which is called the Holmes (No. 10) coal bed in this report. The Hickory Ridge No. 9-¾ does not appear to correlate with any of the coal beds in the Greenough mine to the east and is considered in this report to be a local bed which is designated the No. 10-¼.

In the mined area the average thickness of the bed was from about 4-½ to 6-½ feet and its maximum and minimum thicknesses were 8'8" and 3'2", respectively.

Measurements of the bed in place indicate that it contained about 7 percent of waste, which is an unusually small percentage.

ROUGH (NO. 10-½) COAL BED

The Rough (No. 10-½) coal bed, which is about 55 feet above the Holmes coal, crops out on the north limb (south pitch) of the Pennsylvania basin and in the area south of the synclinal axis. It has been mined only in the southern part of the area of occurrence where its average thickness in the unit areas ranged from 3 to 6 feet. Its maximum and minimum thicknesses were 10'2" and 1'10", respectively. About 27 percent of the bed in place was waste.

LOCAL (NO. 10-¾) COAL BED

A coal, called the No. 10-¾, is locally present in the southeastern part of the mapped area. It occurs in the Pennsylvania mine about 25 feet above the Rough coal. The average thickness of the bed ranged from about 3 to 6 feet, of which approximately 24 percent was waste. Maximum and minimum thicknesses of 10'2" and 1'4" have been recorded.

PRIMROSE (NO. 11) COAL BED

The position of the Primrose (No. 11) bed is more accurately determined by the stratigraphic interval above the Holmes coal than by measuring from either the Rough (No. 10-½) or the local (No. 10-¾) coal beds. This interval between the Holmes and the Primrose coals thins eastward from about 200 feet in the western part of the area to about 110 feet in the eastern part.

The Primrose coal generally crops out in the synclines in the southern part of the area. It was mined in the Pennsylvania and Richards mines where it had a relatively uniform thickness of about 7 feet, but had a maximum variation of from 12'7" to 1'7". The proportion of waste in the bed was about 22 percent.

ORCHARD (NO. 12) COAL BED

The Orchard (No. 12) coal bed is from 80 to 170 feet stratigraphically above the Primrose coal. It crops out along the more deeply folded synclines in the southern part of the area where it has been mined at scattered localities, and along the Hickory Swamp basin in the western part. The thickness of the bed in the workings in the southeastern part of the area was generally about 9 feet, but it ranged from 13'8" to 6'0". The proportion of waste in the bed was approximately 10 percent.

DIAMOND (NO. 14) COAL BED

The Diamond (No. 14) coal bed crops out only in the southern part of the area. No record of workings in it was seen but a core drill that cut the bed showed it to be 3'8" thick of which 1'8" was coal.

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GEOLOGY OF ANTHRACITE IN THE WEST-CENTRAL PART OF THE MOUNT CARMEL QUADRANGLE, PENNSYLVANIA

BY
Howard E. Rothrock, Holly C. Wagner and Boyd R. Haley

1950

Drafted by John T. Howells

UNITED STATES DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

OWNERSHIP AND TOPOGRAPHIC MAP OF THE WEST-CENTRAL PART OF THE MOUNT CARMEL QUADRANGLE, PENNSYLVANIA

BY
Howard E. Rothrock, Holly C. Wagner, and Boyd R. Haley

1950

Base: U. S. Geological Survey topographic map.
Polyconic projection. 1927 North American datum.

APPROXIMATE MEAN DECLINATION, 1944

SCALE 1:6,000

500 0 500 1000 2000 3000 Feet

Contour interval is 20 feet
Datum is mean sea level

DIAGRAM OF A TOPOGRAPHIC QUADRANGLE SHOWING THE AREA INCLUDED IN THIS MAP

Prepared in 1948 from data supplied by the Natalie Coal Corporation, Lehigh Valley Coal Company, and Susquehanna Collieries Company, with modifications by the Geological Survey, United States Department of the Interior.

Base for Map C 3 of the Coal Investigation series

Drafted by John T. Howells

DEPARTMENT OF THE INTERIOR
UNITED STATES GEOLOGICAL SURVEY

COAL INVESTIGATIONS
MAP C 43, SHEET 1 OF 2

INDEX MAP OF PENNSYLVANIA SHOWING THE LOCATIONS OF THE ANTHRACITE FIELDS

50 0 50 MILES

Base: modified from U.S. Geological Survey topographic maps.
Polyconic projection. 1927 North American datum.
Topography was transferred from aerial photographs made in 1942.
Correction has not been made for topographic changes resulting from strip mining or alteration of mine refuse banks since 1942.

APPROXIMATE MEAN DECLINATION 1957

GEOLOGIC MAP

Scale 1:12,000

1000 0 1000 2000 3000 4000 5000 6000 Feet

Contour interval 20 feet
Datum is mean sea level

EXPLANATION

SEDIMENTARY ROCKS

Pzp	Post-Pottsville rocks	
Pps	Pottsville formation *Consists in descending order of the Sharp Mountain member (Psp), Schuylkill member (Psp) and Tumbling Run member (Psp).*	PENNSYLVANIA
Psc		
Psr		
Mm	Mauch Chunk formation	MISSISSIPPIAN

CARBONIFEROUS

Geologic contact
Solid where location is known; dashed where location is approximate.

Coal bed outcrop
Solid where location is known or probable as shown by underground mining. Solid with hachures where location is known or probable as shown by underground mining only or by strip-mining and underground mining. Dashed where location is uncertain. Number designates coal bed; L, lead-lander coal bed; Z, Top Split; B, Bottom Split; LV, Lykens Valley.

Thrust fault
Solid where location is known; dashed where location is uncertain; dotted where hypothetical. s, s indicates direction and amount of dip of fault plane; V, upper plate.

Tear fault
Solid where location is known; dashed where location is uncertain. Arrows show relative horizontal movement.

Anticline
Showing trace of axial plane and direction of plunge of axis. Solid where location is known; dashed where location is approximate.

Overturned anticline
Showing trace of axial plane, direction of dip of limbs; direction and amount of plunge of axis. Solid where location is known; dashed where location is approximate.

Syncline
Showing trace of axial plane and direction of plunge of axis. Solid where location is known; dashed where location is approximate.

Plunge of minor anticline
Plunge measured in vertical plane.

4 4' Structural cross section

Surface opening on coal bed

Shaft

Prospect pit

Exploratory trench
Pink shows where coal bed found.

Gravel pit

Depression
Open pit or collapsed area where surface has fallen into underground mine workings.

Prepared in 1954 from field investigations by members of the U. S. Geological Survey and from data supplied by various coal companies and individuals.

HOW TO USE THIS GEOLOGIC REPORT

The principal objectives of this report are to describe and illustrate the geology of the coal beds, stratigraphic relations of the adjacent rocks, and structural features affecting the coal beds and adjacent rocks within the mapped area, if these objectives are to be fully realized, it is necessary to study the geologic map, the columnar sections, the cross sections, the structure features, and the map symbols illustrating them. The geologic map accompanying this report consists of a topographic base map representing the culture and drainage, and a geologic overprint showing the geology of the Tremont quadrangle, upon which the geologic, including the layout of outcrops and inferred outcrops of minable coal beds, has been added.

The various geologic features and map symbols are explained and illustrated under the explanation for the geologic map. By using this explanation it is possible to identify the various rocks and geologic features on the map and to relate them to nearby outlined, hydrographic, and topographic features.

The more common and important cultural and hydrographic symbols that are used on the map are illustrated below.

Paved road — Permanent stream
Dirt road — Lake
Railroad — Dam

The altitudes and map location of hills and valleys within the mapped area can be determined by studying the distribution and spacing of the brown lines, which are known as contour lines. All points along a contour line are at the same altitude above sea level. Contours show graphically the configuration of the land surface. Contours that are close together or that appear crowded together represent a steep slope, and widely spaced a gentle slope; that is, the closely spaced contour lines south of Gordon indicate the steep slopes of Sharp Mountain, and the widely spaced contour lines underlain by rock on top of Broad Mountain indicate a gently rolling landscape. Each contour line is drawn to represent an altitude 20 feet above or below an adjacent contour line. The vertical difference in elevation is the contour interval. Every fifth contour line is heavier than the adjacent ones. These heavier lines represent 100-foot differences in altitude and are commonly referred to as index contours. To determine the elevation above sea level in round feet, for instance, in the vicinity of Gordon the heavy lines are marked 500, 900, 1,000, 1,100, 1,300, 1,500, and 1,700 feet above sea level, respectively, and cover the steeper slopes in the area. The four lines between the heavy numbered contour lines divide the 100-foot altitude differences into fifths; thus, the unit line up from the 1,000 foot contour line is 1,020 feet above sea level, and the unit line down from the 1,100 foot contour line is 1,080 feet above sea level. Even though the difference in altitude between various places in Gordon and various places on the top of Broad Mountain is only 100 feet, the landscape or topography of the area is the result of the varying resistance of the different rock types such as shale, siltstone, sandstone, and conglomerate to erosion. Thus, in the Gordon area, the rocks that underlie the low areas, Broad Mountain and Mine Hill, are underlain by the hard, more resistant conglomerate beds of the Pottsville formation; the lower regions are underlain by the softer, more easily eroded beds of the Mauch Chunk formation, and sandstone beds of the Mauch Chunk formation or by rocks of post-Pottsville age. The relative difference in hardness of the underlying rocks has locally emphasized the various structural features. An understanding of this fact is of primary importance if the accompanying geologic map is to be fully utilized.

The numerous coal beds shown on the map are in many localities interbedded with sandstone, shale, and conglomerate beds. As explained in the "Geologic Map" (sheet 1) shows the various types of the symbols used to indicate the degree of certainty in the location and correlation of a coal bed. Many of the coal beds have been explored by drilling, and test pits or shafts have either through continuous underground or strip mining, or where they are probable as known from closely spaced information. Where coal beds are mined by underground methods, the outcrop of a coal bed is shown by a solid line, a solid hachured line, or a solid interminately hachured line. In other areas where the coal bed is not mined, the outcrop is shown by a dashed line. Because of the lack of underground mining, strip mining, and exposures, the outcrop of a coal bed is shown by a dashed line. It is impossible to state the number of coal beds that may be encountered in drilling, mining, or stripping operations or strip mining in these relatively unmined localities. The thickness, the number of partings, and the percentages of other impurities in these coal beds in these unmined localities are not known; however, where a coal bed is flanked on the geologic map, it is believed that the bed has a minimum thickness of 28 inches.

An examination of the geologic map with reference to the various coal beds, geologic structures such as faults and folds, and the relationship of the coal beds to the topography will indicate the possibilities of finding workable coal beds in the relatively unexplored localities that are believed to be underlain by minable coal beds; localities that should be underlain by specified coal beds that are now mined in adjacent areas; localities where the coal beds are probably missing if coal will be found, as a result of faulting; and the local relationships of individual coal beds to structural features such as synclines, anticlines, and domes. For example, a study of the geologic map (sheet 1) and the cross sections (sheet 2) will indicate whether coal beds cropping out close to the crest of the Broad Mountain anticline are likely to be found at workable depths on the adjacent limbs of the anticline. To give a specific example, along cross section C-C' (sheet 2) the Mammoth coal bed is exposed on the crest of the anticline; it is a north-dipping composite outcrop of the Mammoth Bottom split and Skidmore coal beds where the two are separated by only a few inches of shale, siltstone, and sandstone. These coal beds dip northward on the map are shown separately, but because of the thin stratigraphic interval separating the two beds they are shown as a composite bed on the cross section. Sheet 2 shows the Mammoth Bottom split-Skidmore coal bed, which on the outcrop is dipping south from the crest of the Pisgah Mountain anticline, underground to the north and northeast. Sheet 2 also shows the Mammoth coal bed, which is the north limb of the synclinal axis into two distinct coal beds, the Bottom Split (L) and Skidmore (7), then crossing dip south of the synclinal axis. This information is of great value to individuals who may own the same mineral rights. The dashed line underlying the Mammoth coal bed in the cross sections shows that the northern beforeshown coal bed is not continuous for any considerable distance before being cut off by the fault.

Several coal beds are mapped locally in the Tumbling Run, Schuylkill, and Tumbling Run members of the Pottsville formation. The outcrops of these coal beds have been mined are indicated on the geologic map and in the cross sections. Examination of the map and sections will show the areas in which these coal beds have been mined and the areas in which they are likely to be found, if present, by prospecting in the localities that are shown on the geologic map as being underlain by the appropriate member of the Pottsville formation. Prospecting should be done in the areas in the Tumbling Run member of the Pottsville formation in the southern and western part of the mapped area, therefore, any prospecting for these coal beds should be confined to the areas underlain by the Schuylkill and Tumbling Run member. If this procedure is followed, much of the cost of deep drilling or excessive trenching for coal beds may be eliminated.

Coal beds are seldom exposed in natural outcrops because of heavy soil cover. A few of the geologic maps indicating the trace of a coal bed outcrop is based on the projection of the coal bed from the nearest exposure, and the bed usually is not exactly at the surface. Such locations do not necessarily agree with the thickness of the coal beds, which are normally found lower on the slopes than the outcrop. Prospecting for coal beds shown on the geologic map should therefore start where their outcrops are shown on the geologic map and extend largely in the direction of their dips and to a lesser extent in the direction opposite to their dips.

GEOLOGY OF THE NORTHERN HALF OF THE MINERSVILLE QUADRANGLE AND A PART OF THE NORTHERN HALF OF THE TREMONT QUADRANGLE SCHUYLKILL COUNTY, PA.

INTRODUCTION

The Southern anthracite field is one of four coal fields that contain beds of anthracite in Schuylkill County. This report, the first of a series on the Southern anthracite field, describes the various coal beds, stratigraphy of adjacent rocks, and structure of the northern half of the Minersville quadrangle and a part of the northern half of the Tremont quadrangle (see index map, sheet 1). The area included in the map is about 33 square miles. A part of Minersville, the only large town, lies in the southeastern part of the mapped area.

The primary objectives of this report are to describe and illustrate the geology of the coal beds, the stratigraphy of the adjacent rocks, and the structure of the rocks of the mapped area, and the structural setting of the mapped area in the Appalachian Mountains of eastern Pennsylvania. This report can be used as an aid in exploratory drilling, mining, and mine-operation. Sheet 1 of the report shows: (a) all known natural outcrops or man-made outcrops of coal beds; (b) the location of mine portals in existence at the time the geologic mapping was done; (c) the areas underlain by workable coal beds between faults and between the known outcrops; (d) the outcrop areas of the various formations and members of the Pennsylvanian and Mississippian rock formations; (e) the general structure as shown by the geologic map; and (f) the natural barriers to the circulation of ground and mine water such as large folds, small cross folds, and the Broad Mountain fault. Sheet 2 of the report shows: (a) and (b) the authors; (b) the stratigraphy and thickness of strata between coal beds; and (c) specific examples of the structure as illustrated by cross sections.

The field and office work for this report was done during the late summer of 1953 and continued through 1954. During this period a large area than that described in this report was mapped geologically by the writers, and the interpretations and conclusions in the report were based on data from adjacent areas.

The Philadelphia and Reading Coal and Iron Co., as well as other coal companies and several individuals, have been active in exploring in this area, furnishing information such as mine maps, cross sections, drill-hole records, and records of stratigraphy in drilling. This information has been extremely helpful in preparing this report.

The authors are responsible for all interpretations and conclusions such as the approximate locations of outcrops, projections and correlations of stimlined and intermittently mined coal beds; the correlations of rock strata across fault; the structural geology; the proved amount of displacement and direction of movement along faults; and the structural relationships of the coal beds in areas where the coal beds are not mining. They are responsible also for data such as the surface location of faults and their projections to depth, the surface location of the seal trace of anticlines and synclines, and the structural relationships of the various formations into three members.

The lack of agreement of geologic data on this map with that of the previously published maps indicates that this map is the result of a detailed mapping of the three members of the Pottsville formation, which locally has resulted in more reliable correlation of coal beds and more accurate location of geologic features.

STRATIGRAPHY

CARBONIFEROUS SYSTEM

Rocks of the Mississippian and Pennsylvanian systems and unconsolidated sediments of the Quaternary system are exposed in the area on the surface in the mapped area. The Mauch Chunk formation of Mississippian age crops out in the northern and southeastern parts of the mapped area, and the overlying rocks of Pennsylvanian age crop out through most of the remainder of the area. Unconsolidated clay, silt, sand, and gravel of Quaternary age locally overlie the rocks of the Pennsylvanian and Mississippian systems. The Mississippian and Pennsylvanian formations discussed in this report are not correlated by the authors with the Pennsylvanian and Mississippian rocks described in the Schuylkill County folio, the Geological Survey of Pennsylvania, written communication; and some regional correlations between formations in the Southern anthracite field and elsewhere in the Appalachian region, based largely on fossil identifications by

MISSISSIPPIAN ROCKS

Mauch Chunk formation

The Mauch Chunk formation crops out in the valleys of Hans Yost Creek, Dorr Creek, Shenandoah Creek, and Mahanoy Creek in the northern part of the area. In the mapped area, the upper 2,500(?) to 3,000(?) feet of the formation is poorly exposed in the valley of Hans Yost Creek and in the valley of Shenandoah Creek in the west and north parts of the area. The total thickness of the exposed thickness of the Mauch Chunk formation is uncertain because the component shales and siltstones are commonly red, and the color of numerous small to large building shale and thrust faults and considerable rock fewage that may have either thinned or thickened the formation. Because of the lack of key beds in the upper part of the formation, it is extremely difficult to trace because of excessive soil mantle rules, and the similarity of rock types.

The formation 100 to 200 feet of the Mauch Chunk formation contains one, and in places two laterally persistent units, 20 to 40 feet thick, of gray-yellow to gray-green, fine- to medium-grained, thick-bedded sandstone. These sandstones are interbedded with red shale, siltstone, and sandstone. The lithology of these sandstone units closely resembles that of the underlying Pocono formation, and it is likely that they are tongues of the Pocono. The medial 3,000(?) to 4,000(?) feet of the Mauch Chunk consists of many laterally persistent and lenticular zones of red sandstone, shale, and siltstone. Because of the monotonous color of the rocks, it is difficult to determine the nature of the bedding. In the upper 200 to 400 feet of the formation, several laterally persistent, locally mappable, and regionally recognizable sequences of gray and gray-green pebble and cobble conglomerates and conglomeratic sandstone beds alternate with sequences of red shale, siltstone, and feldspathic sandstone beds. The sequences of coarser clastics consist of several lenticular and irregular bedded, persistent and cross-laminated beds that range in size from 1 foot to slightly more than 6 feet in thickness. The outcrop belts of both types of sequences are enmeshed in the Mauch Chunk and Pottsville formations, and the beds of red shale, siltstone, and sandstone are similar to those found in the Mauch Chunk formation. The alternating lithology of these beds comprise a transitional zone of sediments that contain the lithologic characteristics of both the underlying Mauch Chunk and overlying Pottsville formations. If this interpretation is correct, the time boundary between the Mauch Chunk and Pottsville is a stratigraphic position in the upper part of the Mauch Chunk formation in the mapped area.

The contact between the Mauch Chunk formation and the overlying Pottsville formation is at the top of the uppermost red, White, 1900, p. 351) or brown-red shale, siltstone, or feldspathic sandstone bed in the transition zone between strata typical of the Mauch Chunk and Pottsville formations.

In the mapped area, rocks of the Pennsylvanian system are assigned to the Pottsville formation of Early Pennsylvanian age. At the type section of the Pottsville formation, about 4 miles southeast of the mapped area in Pottsville, Pa., the contact between the Mauch Chunk and the Pottsville is generally considered to be the local arbitrary boundary between the two formations. The contact between the Mauch Chunk and the Pottsville formations is usually determined by reconnaissance mapping that the top of the Mauch Chunk formation is at a stratigraphic position in the mapped area that is at the approximate position of the Pottsville formation. Because of the lack of good exposures, the reasons for the change in stratigraphic position are not definitely known, but the difference in the rocks of the two formations is probably related to the Mauch Chunk and Pottsville formations. If this interpretation is correct, the time boundary between the Mauch Chunk and Pottsville is a stratigraphic position in the upper part of the Mauch Chunk formation in the mapped area.

PENNSYLVANIAN ROCKS

In the mapped area, rocks of the Pennsylvanian system are assigned to the Pottsville formation of Early Pennsylvanian age. At the type section of the Pottsville formation, about 4 miles southeast of the mapped area in Pottsville, Pa., the contact between the Mauch Chunk and the Pottsville is generally considered to be the local arbitrary boundary between the two formations. The contact between the Mauch Chunk and the Pottsville formations is usually determined by reconnaissance mapping that the top of the Mauch Chunk formation is at a stratigraphic position in the mapped area that is at the approximate position of the Pottsville formation. Because of the lack of good exposures, the reasons for the change in stratigraphic position are not definitely known, but the difference in the rocks of the two formations is probably related to the Mauch Chunk and Pottsville formations. If this interpretation is correct, the time boundary between the Mauch Chunk and Pottsville is a stratigraphic position in the upper part of the Mauch Chunk formation in the mapped area.

The Pottsville formation crops out on Broad Mountain, on Mine Hill, and on the mountains between Crystal Run and Pottsville. The rocks are more resistant to erosion than the rocks of the Mauch Chunk formation, and they underlie the high areas in the mapped area. Because of the lack of key beds in the Pottsville outcrops in the mapped area, therefore, the exact thickness of the formation is not known; however, it is known to be in the succession of coal beds and the Pottsville formation is about 2,000 feet thick.

The Pottsville formation is divided into three members, the base upwards into the Tumbling Run, Schuylkill, and Sharp Mountain members. The Pottsville formation is folded and faulted as described at the type locality of the formation in the water gap to the south of Pottsville, Pa., by Wood, Trexler, Jr., Arndt, and Richards (1953). Local variations in stratigraphy and the general range in thickness of the formation and its members are shown in the diagrammatic sections and discussed in the text of the "Geologic Map" (sheet 1), indicate that the Pottsville is about 900 feet.

Tumbling Run member.—The lower beds of the Tumbling Run member of the Pottsville formation are exposed only on and at approximately the same stratigraphic beds of the Mauch Chunk formation. The contact is placed at the top of the uppermost red shale bed in the transition zone between the two formations.

The Tumbling Run member is about 400 feet thick and consists of thick sequences of gray, gray-brown, silvo-gray, and yellow-brown feldspathic and limonite pebble and cobble conglomerates, conglomeratic sandstones, and sandstones and siltstones with thin to thick sequences of gray, gray-green, and dark-gray shale and siltstone beds. From 75 to 100 feet of the lower part of the member is red shale and siltstone sequences. From 75 to 100 feet above the base of the member is a persistent pink vein quartz and quartzite and the remaining 1 to 25 percent are chert, slightly metamorphosed sandstone, and quartzite. The conglomerate and conglomeratic sandstone beds are poorly to well sorted, and the pebbles and cobbles are predominantly well rounded to subangular. The average size of the pebbles and cobbles is about 1 inch, and many pebbles are as much as 3 or 4 inches. A large proportion of the pebbles and cobbles are fractured. At most places the conglomerate and sandstone beds are separated or are well cemented, mostly by silica and to a lesser extent by shale. The amount of conglomerate and conglomeratic sandstone is about equal to the amount of shale in the member. The conglomerate and conglomeratic sandstone beds are parallel to cross laminated and their cross sections are tabular, lenticular, and wedge shaped. The shale beds are parallel to wavy laminated and the siltstone beds are parallel to cross laminated; this is massive bedded; and their cross sections are tabular and lenticular. The conglomerate and conglomeratic sandstone and shale-siltstone sequences are commonly repeated in the member. The shale-siltstone sequences usually exhibit distinct laminations and a moderate fissility in many localities.

The thickness of the Tumbling Run member in the mapped area is difficult to determine because of poor exposures; however, the information available indicates an average thickness of about 410 feet, with a slight thinning to the south and west.

The coal beds in the member are here tentatively correlated with the Lykens Valley No. 4, No. 5, and No. 6 coal beds of the western part of the Southern anthracite field. These coal beds underlie much of the western part of the mapped area, in the localities where their outcrops are shown on the geologic map, the coal beds are inferred to be more than 14 inches in thickness.

Schuylkill member.—The Schuylkill member rests with apparent conformity on the Tumbling Run member of the Pottsville formation. The contact is placed at the base of the Schuylkill and at the top of the uppermost coarse quartzose sandstone, conglomeratic sandstone, siltstone, or shale bed of the Tumbling Run.

The basal part of the Schuylkill member is a sequence of lenticular white quartz conglomerate beds 20 to 50 feet thick. The upper 200 to 250 feet of the member consists of many lenticular and irregular bedded, persistent and cross-laminated quartz conglomerate, quartzose sandstone, and quartzose sandstone; gray, gray-green, and dark-gray siltstone and shale; and coal beds. In the Schuylkill member the diameters of the pebbles range from slightly less than one-quarter inch to about 2 inches, and the average size is about three-eighths of an inch. The pebbles in the basal quartz conglomerate are predominantly vein quartz and quartzite, and the rest are chert. The pebbles in the upper sequences are predominantly vein quartz and quartzite. Throughout the member the pebbles are subrounded to well rounded; most of them are well rounded. The conglomerate and sandstone beds are moderately cemented and the joints are usually around pebbles instead of through them. The average well rounded shape of the pebbles and the cementation of the beds are the reasons for the formation of the large rounded ledges and fragments of pebbles of the underlying Tumbling Run member. The beds of the Schuylkill member range from about 2 inches to slightly more than 5 feet in thickness and are tabular, lenticular, and wedge shaped, and parallel to cross laminated.

The coal beds of the Schuylkill member is difficult to determine because of structural complications; however, the average thickness is about 275 feet and the member appears to thin to the south and west.

The coal beds included in the member are here tentatively correlated with the Lykens Valley No. 1, No. 2, and No. 3 coal beds, and their outcrops are shown on the geologic map. These coal beds underlie much of the central part of the mapped area, in the localities where their outcrops are shown on the geologic map, the coal beds are inferred to be more than 14 inches in thickness.

Sharp Mountain member.—The Sharp Mountain member rests on apparent conformity on the Schuylkill member of the Pottsville formation. The contact is placed at the base of the lowest conglomerate bed in the sequence of coarse clastics that overlies the shale and siltstone sequence that underlies the Buck Mountain coal bed (White, 1900, p. 351). Wood, Trexler, Jr., Arndt, and Richards (1953, p. 734), however, found that the Buck Mountain coal bed is in the area to the east. Although the authors believe that the Buck Mountain coal bed is the lowest coal bed in the Sharp Mountain member in the area of the Sharp Mountain, the member is not the lowest coal bed in the two areas is dissimilar. Locally, in the region surrounding the report area, the Scotty Steel (No. 2, No. 3, and Little Buck Mountain coal beds (No. 4) are mined in the Buck Mountain and the Sharp Mountain members, but because of the poor exposures of the Sharp Mountain member as used in this report and elsewhere, they are not shown on the geologic map.

The basal sequence of quartz cobble and pebble conglomeratic ranges in thickness from slightly less than 40 to slightly more than 100 feet. Individual beds, which range from about 1 foot to about 5 feet in thickness, are parallel to cross laminated; their cross sections are tabular, lenticular, and wedge shaped. The pebbles and cobbles are vein quartz and quartzite are predominant; however, there are a few of chert and metamorphosed sandstones, siltstone, and shale. They are chiefly concentrated in the lower part of the member and are rare in the upper part of the conglomerate. Although the cobbles and pebbles range from subrounded to well rounded, they average well rounded. The diameters of the pebbles range from one-quarter inch to more than 6 inches and average between 1½ and 2½ inches. The matrix of the conglomerate consists of weakly to moderately cemented fine to coarse quartzose sand grains. In many weathered exposures, the matrix is friable and the pebbles and cobbles protrude strikingly. The gravel from the belt of outcrop is mainly concentrated nearby and has been locally excavated for road metal and other construction purposes.

The upper sequence of beds is 100 to 200 feet thick and the beds are thin to massive-bedded, tabular, lenticular, or wedge shaped, and parallel to cross laminated. The sandstone beds usually consist of the troughs or many so-called "buried hollows." Locally this part of the conglomerate is thin or absent. The average shape of the pebbles is well rounded; the average diameter is about a quarter inch, which is much less than that of the pebbles in the basal sequence. The cementation and weathering characteristics are similar to those of the basal conglomeratic sequence.

The thickness of the Sharp Mountain member in the report area averages about 225 feet. The principal coal beds are the Scotty Steel coal beds (No. 2 and No. 3) and the Little Buck Mountain coal bed (No. 4, No. 4B, and No. 4T). The outcrops of these coal beds are shown on the geologic map in the localities where their thicknesses are known or inferred to exceed 14 inches; however, it is possible that these coal beds may be of minable thickness in other areas than those where is a lack of information.

Post-Pottsville rocks

The strata of younger Pennsylvanian age that lie on the Pottsville formation are here termed post-Pottsville rocks. Although the stratigraphic relations between these rocks and the Pottsville are not known in the mapped area, they are known to be present in the upper synclinal basin to the south. The youngest post-Pottsville rocks were noted from the mapped area but crop out to the south.

Numerous thin to thick coal beds of the post-Pottsville rocks are interrelated with quartz-pebble conglomerate, conglomeratic sandstone, sandstone, siltstone, and shale beds. The coal beds are thin to thick and lenticular to persistent. The Top Split (No. 8) and the Bottom Split (No. 9) coal beds are probably a single gray brown coal bed in the area between the Buck Mountain fault and the Orchard fault. The Primrose coal bed, the Holmes (No. 10) coal bed and the Orchard (No. 12) coal bed, the Little Orchard (No. 13) coal bed, the Big Mine Run (No. 14) coal bed, the Little Diamond (No. 15) coal bed and the Diamond (No. 16) coal bed underlie much of the quartz-pebble conglomerate, conglomeratic quartzose sandstone, and quartzose sandstone with subordinate quantities of siltstone and shale. In contrast, the strata between the Bottom Split (No. 8) coal bed and the Holmes (No. 10) coal bed, the Holmes (No. 10) coal bed and the Orchard (No. 12) coal bed, the Big Mine Run (No. 14) coal bed and Peach Mountain (No. 18) coal bed, and above the Tunnel (No. 19) coal bed are chiefly fine quartzose sandstone, siltstone, and shale with a subordinate quantity of quartz-pebble conglomerate and sandstone. Locally the strata are coarse- to medium-grained quartzose sandstone. Post-Pottsville rocks are predominantly gray, gray-green, and dark-gray siltstone and shale; they are commonly massive bedded, they are chiefly cross-laminated quartz-pebble conglomerate, conglomeratic sandstone, or coarse sandstone.

Several of Reed's (1947, p. 274) floral zones have been identified in post-Pottsville rocks in the Southern anthracite field and elsewhere in the Appalachian region, and the Pennsylvanian-Mississippian boundary is also known. Several floral zones and floral species were made by the authors during late 1954 and early 1955. According to the floral zones identified, the Pennsylvanian-Mississippian boundary is also known, and including strata as high as the Faust coal bed contain a flora that is characteristic of the Mississippian system.

Not all the post-Pottsville outcrops in the mapped area; therefore, the regional pattern of thickening and thinning is unknown. Local variations in the thickness and lithology of the mapped rocks, however, are known to exist (sheet 2).

QUATERNARY ROCKS

Surficial deposits of unconsolidated clay, silt, sand, and fine to coarse gravel of Quaternary age cover the Pennsylvanian and Mississippian rocks along the stream valleys and on the crests of the mountains. Although these deposits are mapped only on a small area, they are not shown on the geologic map.

Alluvium of Recent age is present in the flood plain of the stream channels. Terrace deposits have been mapped in the valleys of Hans Yost Creek and Dorr Creek. The terrace deposits are commonly as much as 15 feet above the present stream level. Alluvium, colluvium, and landslide debris of Recent age are present in the mapped area.

STRUCTURE

The mapped area, which is in the Valley and Ridge physiographic province of the Appalachian Highlands, is underlain by folded and faulted rocks of the northern and deformed southern limb of the Minersville synclinorium and the Broad Mountain anticlinorium. The synclinorium and anticlinorium are the two major structural features of the Southern anthracite field (Wood, Trexler, Jr., Arndt, and Richards, 1953). The synclinorium (White, 1900, p. 710), herein named from the town of Minersville, is a large, complex, elongated, northeast-trending structural feature that is exposed in the western part of the mapped area, therefore, any prospecting for these coal beds should be confined to the areas underlain by the Schuylkill and Tumbling Run member. If this procedure is followed, much of the cost of deep drilling or excessive trenching for coal beds may be eliminated.

Coal beds are seldom exposed in natural outcrops because of heavy soil cover. A few of the geologic maps indicating the trace of a coal bed outcrop is based on the projection of the coal bed from the nearest exposure, and the bed usually is not exactly at the surface. Such locations do not necessarily agree with the thickness of the coal beds, which are normally found lower on the slopes than the outcrop. Prospecting for coal beds shown on the geologic map should therefore start where their outcrops are shown on the geologic map and extend largely in the direction of their dips and to a lesser extent in the direction opposite to their dips.

The synclinorium is a broad, open, complex structure that is exposed in the mapped area; however, the synclinorium is known to be present in the upper synclinal basin to the south. The youngest post-Pottsville rocks were noted from the mapped area but crop out to the south.

Numerous thin to thick coal beds of the post-Pottsville rocks are interrelated with quartz-pebble conglomeratic, conglomeratic sandstone, sandstone, siltstone, and shale beds. The coal beds are thin to thick and lenticular to persistent. The Top Split (No. 8) and the Bottom Split (No. 9) coal beds are probably a single gray brown coal bed in the area between the Buck Mountain fault and the Orchard (No. 12) coal bed, the Little Orchard (No. 13) coal bed, the Holmes (No. 10) coal bed and the Orchard (No. 12) coal bed, the Little Orchard (No. 13) coal bed, the Big Mine Run (No. 14) coal bed, the Little Diamond (No. 15) coal bed and the Diamond (No. 16) coal bed underlie much of the quartz-pebble conglomerate, conglomeratic quartzose sandstone, and quartzose sandstone with subordinate quantities of siltstone and shale. In contrast, the strata between the Bottom Split (No. 8) coal bed and the Holmes (No. 10) coal bed, the Holmes (No. 10) coal bed and the Orchard (No. 12) coal bed, the Big Mine Run (No. 14) coal bed and Peach Mountain (No. 18) coal bed, and above the Tunnel (No. 19) coal bed are chiefly fine quartzose sandstone, siltstone, and shale with a subordinate quantity of quartz-pebble conglomerate and sandstone. Locally the strata are coarse- to medium-grained quartzose sandstone. Post-Pottsville rocks are predominantly gray, gray-green, and dark-gray siltstone and shale; they are commonly massive bedded, they are chiefly cross-laminated quartz-pebble conglomeratic, conglomeratic sandstone, or coarse sandstone.

Several of Reed's (1947, p. 274) floral zones have been identified in post-Pottsville rocks in the Southern anthracite field and elsewhere in the Appalachian region, and the Pennsylvanian-Mississippian boundary is also known. Several floral zones and floral species were made by the authors during late 1954 and early 1955. According to the floral zones identified, the Pennsylvanian-Mississippian boundary is also known, and including strata as high as the Faust coal bed contain a flora that is characteristic of the Mississippian system.

Not all the post-Pottsville outcrops in the mapped area; therefore, the regional pattern of thickening and thinning is unknown. Local variations in the thickness and lithology of the mapped rocks, however, are known to exist (sheet 2).

QUATERNARY ROCKS

Surficial deposits of unconsolidated clay, silt, sand, and fine to coarse gravel of Quaternary age cover the Pennsylvanian and Mississippian rocks along the stream valleys and on the crests of the mountains. Although these deposits are mapped only on a small area, they are not shown on the geologic map.

Alluvium of Recent age is present in the flood plain of the stream channels. Terrace deposits have been mapped in the valleys of Hans Yost Creek and Dorr Creek. The terrace deposits are commonly as much as 15 feet above the present stream level. Alluvium, colluvium, and landslide debris of Recent age are present in the mapped area.

STRUCTURE

The mapped area, which is in the Valley and Ridge physiographic province of the Appalachian Highlands, is underlain by folded and faulted rocks of the northern and deformed southern limb of the Minersville synclinorium and the Broad Mountain anticlinorium. The synclinorium and anticlinorium are the two major structural features of the Southern anthracite field (Wood, Trexler, Jr., Arndt, and Richards, 1953). The synclinorium (White, 1900, p. 710), herein named from the town of Minersville, is a large, complex, elongated, northeast-trending structural feature that is exposed in the western part of the mapped area, therefore, any prospecting for these coal beds should be confined to the areas underlain by the Schuylkill and Tumbling Run member. If this procedure is followed, much of the cost of deep drilling or excessive trenching for coal beds may be eliminated.

Coal beds are seldom exposed in natural outcrops because of heavy soil cover. A few of the geologic maps indicating the trace of a coal bed outcrop is based on the projection of the coal bed from the nearest exposure, and the bed usually is not exactly at the surface. Such locations do not necessarily agree with the thickness of the coal beds, which are normally found lower on the slopes than the outcrop. Prospecting for coal beds shown on the geologic map should therefore start where their outcrops are shown on the geologic map and extend largely in the direction of their dips and to a lesser extent in the direction opposite to their dips.

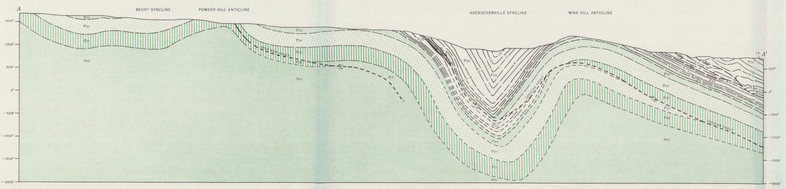
Table 1.—Floral zones in rocks of Pennsylvanian and Mississippian age in the Appalachian region, with reference to the Southern anthracite field[1]

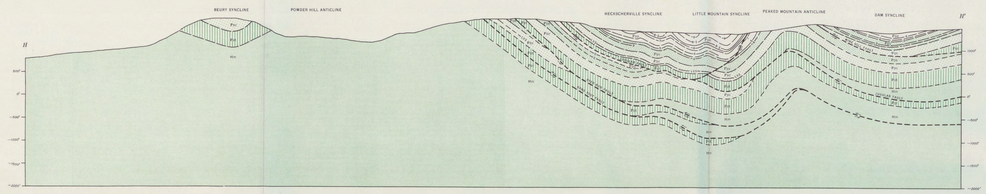
System	Floral zone	Name	Appalachian region except Southern anthracite field	Southern anthracite field
Pennian		Callipteris conferta	Lowest part Permian sequence of rocks	Not known
Pennsylvanian	9	Danaeites spp.	Upper part Monongahela formation	Not known
	8	Lescuropteris spp.	Lower part Monongahela formation	Not known
	7	Neuropteris flexuosa sensu stricto and Pecopteris spp.	Lower part Conemaugh formation to Allegheny formation	Post-Pottsville rocks present in area
	6	Neuropteris rarinervis	Lower part Allegheny formation	Upper part Sharp Mountain member
	5	Neuropteris tenuifolia	Major part Kanawha formation	Not known
	4	Neuropteris scheuchzeri and Cannophyllites	Lower part Kanawha formation	Not known
	3	Mariopteris pygmaea and Mariopteris nervosa	Upper part New River formation to lower part Kanawha formation	Schuylkill member
	2	Mariopteris pygmaea and Mariopteris nervosa	Lower part New River formation	Lykens Valley No. 1 coal bed and adjacent strata of Tumbling Run member
Mississippian	1	Neuropteris pocahontas and Mariopteris sphenopteroides	Pocahontas formation	Lykens Valley No. 5 and No. 6 coal beds and adjacent strata of Tumbling Run member
	3	Cardiopteris spp. and Mariopteris nervosa	Mauch Chunk formation	Mauch Chunk formation
	2	Triphyllopteris spp.	Upper part Pocono formation	Upper part Pocono formation
	1	Adiantites spp.	Lower part Pocono formation	Lower part Pocono formation
Devonian		Archaeopteris spp.	Upper part Devonian sequence of rocks	Upper part of Devonian sequence of rocks

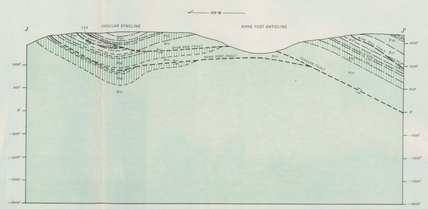
[1]Read, Charles B., 1955, written communication.

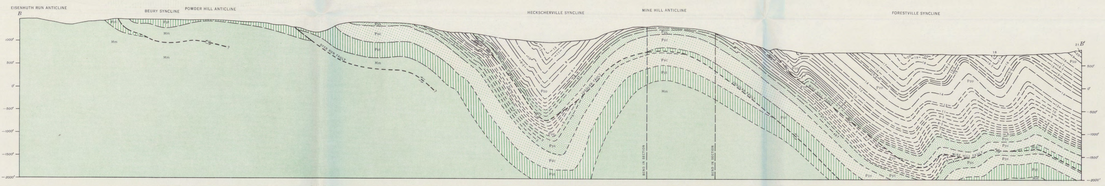
Table 2.—Average thickness and range in thickness of post-Pottsville coal beds and the Little Buck Mountain coal bed in the Minersville quadrangle and the Minersville-Tremont quadrangle and the northeastern part of the Tremont quadrangle

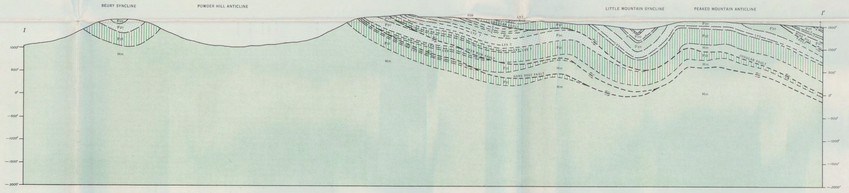
Coal bed number	Average	Maximum	Minimum	Average	Maximum	Minimum	Average	Average percentage of impurities
21	2.00	2.00	2.00					
20	2.25	2.50	2.00					
19	3.00	3.00	3.00					
18	6.00	6.00	6.00	6.33	8.00	5.00	1.00	20
17	6.34	14.00	1.50	4.74	14.00	1.00	1.00	21
16	5.83	7.00	4.00	4.58	6.00	3.00	1.25	21
15	7.84	11.00	4.00	5.50	15.00	1.17	1.16	21
14								
13	4.76	6.50	3.00	3.13	4.50	1.00	1.84	
12	5.00	5.00	5.00	4.00	4.00	4.00	1.00	
11	6.00	6.00	6.00	5.00	5.00	5.00	1.00	
10	5.00	5.00	5.00	5.51	6.00	1.42	1.00	
9	4.00	4.00	4.00	3.00	3.00	3.00	1.00	30
8	10.00	14.67	1.66	8.50	10.00	7.00	1.00	30
9½	4.83	10.00	1.50	3.47	5.25	1.50	29	
8	4.00	4.00	4.00	3.00	3.00	3.00	1.00	30
7	5.00	5.00	5.00	4.00	4.00	4.00	1.00	30
6	5.00	5.00

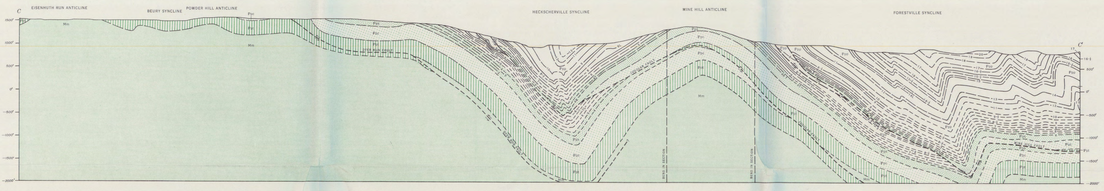


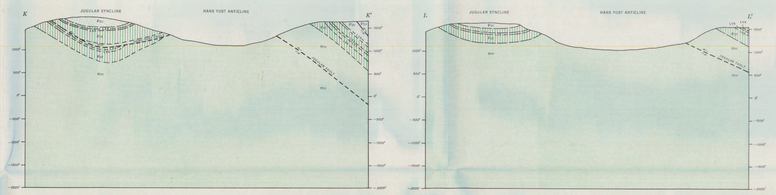


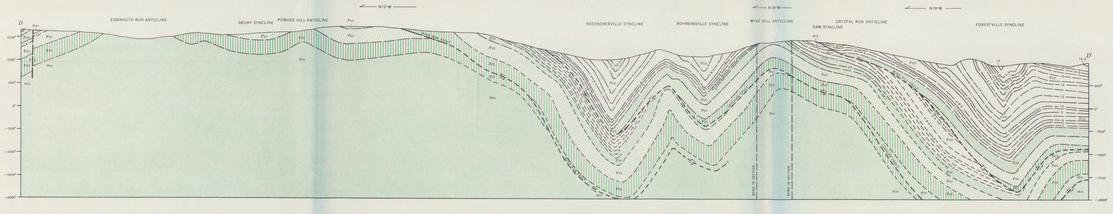


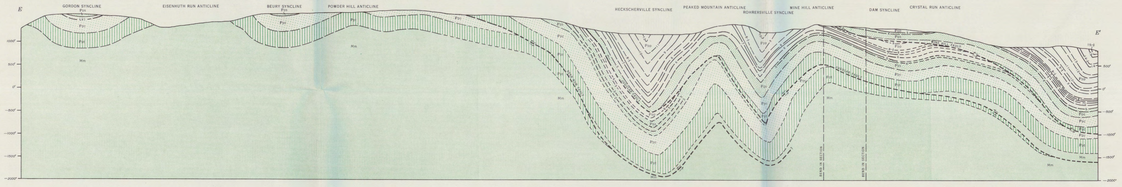


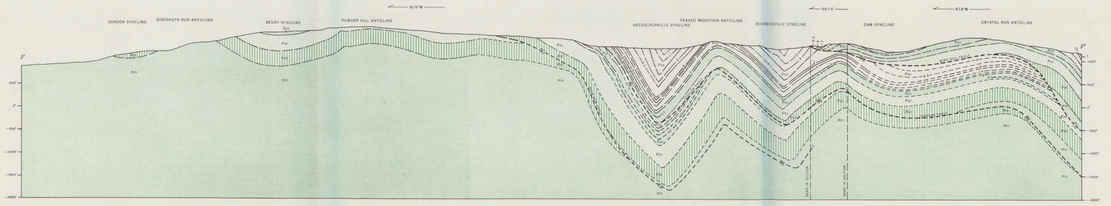


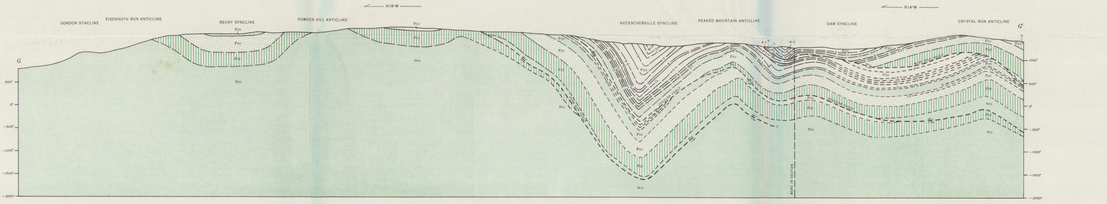












Prepared in 1954 and 1955 from field investigations by members of the U. S. Geological Survey and from data supplied by various mining companies and individuals.

STRUCTURAL CROSS SECTIONS

Scale

500 0 500 1000 2000 3000 4000 Feet

Datum is mean sea level.

EXPLANATION FOR CROSS SECTIONS

- Ppp — Post-Pottsville rocks
- Pps — Sharp Mountain member
- Psc — Schuylkill member
- Ptr — Tumbling Run member
- Mm — Mauch Chunk formation

(Pottsville formation)

Coal bed
Solid where mined; long dashes where underground extension and correlation are relatively certain; short dashes where underground existence, extension, and correlation are hypothetical. Number indicates coal bed; T, top split; B, bottom split; L, local leader coal bed.

Contact
Dashed where approximately located.

Inferred contact

Fault showing relative movement
Solid where certain; long dashes where relatively certain; short dashes where hypothetical.

COMPOSITE STRATIGRAPHIC SECTION

System	Formation	Member	Section	Coal bed: Name	No.	Interval in feet
QUATERNARY						
UNCONFORMITY						
PENNSYLVANIAN	POTTSVILLE	SHARP MOUNTAIN		Fuel	21	
						85-150
				Rabbit Hole	20	
						95-110
				Tunnel	19	
						130-175
				Peach Mountain	18	
						80-160
				Little Tracy	17	
				Upper Four-foot	16-172	50-80
						40-70
				Tracy	16	
				Little Clinton	15-172	
						80-190
				Clinton	15-174	
				Little Diamond	15	
						90-170
				Diamond	14	
				Diamond Leader	ML	
						140-220
				Little Orchard	13	
				Orchard	12	20-35
						50-160
				Primrose	11	
						50-250
				Holmes	10	
				Lower Four-foot	9-172	10-70
						20-90
				Top Split	9	
						15-155
				Middle Split	8-172	40-50
				Bottom Split	8-174	10-40
					8	
				Skidmore	7	0-100
				Skidmore Leader	7L	25-40
				Seven-foot	6	20-45
						30-110
				Buck Mountain	5	
				Little Buck Mountain	4T 4B	20-70
		SCHUYLKILL		Scotty Steel	3	
				Scotty Steel	2	
				Lykens Valley	LV1	
				Lykens Valley	LV2	
				Lykens Valley	LV3	
				Lykens Valley	LV4	
				Lykens Valley	LV5	
				Lykens Valley	LV6	
				Uppermost red shale		
MISSISSIPPIAN	MAUCH CHUNK					

* Indicates range in intervals between coals based only on available drill data.

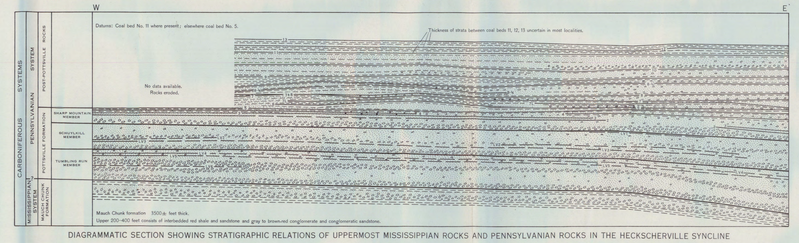
EXPLANATION FOR COMPOSITE STRATIGRAPHIC SECTION

- Conglomerate
- Conglomeratic sandstone
- Sandstone
- Shale and siltstone
- Coal

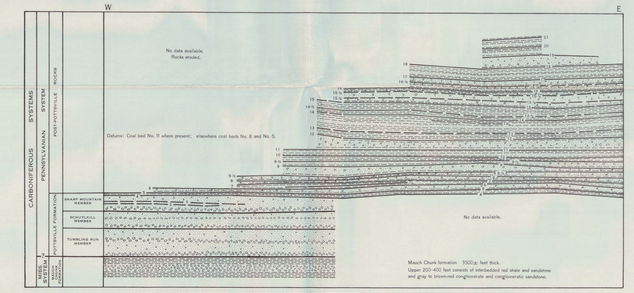
Vertical Scale

600 feet
500
400
300
200
100
0

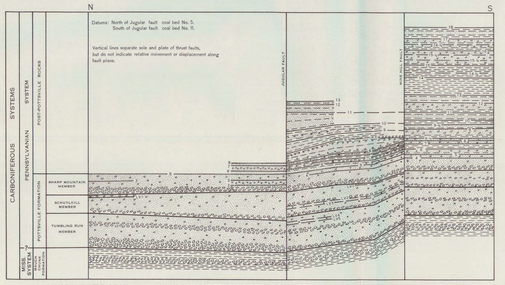
DIAGRAMMATIC SECTION SHOWING STRATIGRAPHIC RELATIONS OF UPPERMOST MISSISSIPPIAN ROCKS AND PENNSYLVANIAN ROCKS IN THE HECKSCHERVILLE SYNCLINE



DIAGRAMMATIC SECTION SHOWING STRATIGRAPHIC RELATIONS OF UPPERMOST MISSISSIPPIAN ROCKS AND PENNSYLVANIAN ROCKS IN THE HECKSCHERVILLE SYNCLINE



DIAGRAMMATIC SECTION SHOWING STRATIGRAPHIC RELATIONS OF UPPERMOST MISSISSIPPIAN ROCKS AND PENNSYLVANIAN ROCKS SOUTH OF MINE HILL FAULT



DIAGRAMMATIC SECTION SHOWING STRATIGRAPHIC RELATIONS OF UPPERMOST MISSISSIPPIAN ROCKS AND PENNSYLVANIAN ROCKS FROM GORDON SYNCLINE TO THE WESTERN PART OF THE FORESTVILLE SYNCLINE

EXPLANATION FOR DIAGRAMMATIC SECTIONS

- Conglomerate
- Conglomeratic sandstone
- Sandstone
- Shale and siltstone
- Coal bed — *Solid where existence and extension relatively certain, dashed where inferred.*

APPROXIMATE VERTICAL SCALE

500 0 500 1000 1500 2000 FEET

APPROXIMATE HORIZONTAL SCALE

N 0 1 2 MILES

GEOLOGY OF THE NORTHERN HALF OF THE MINERSVILLE QUADRANGLE AND A PART OF THE NORTHERN HALF OF THE TREMONT QUADRANGLE, SCHUYLKILL COUNTY, PENNSYLVANIA

By
Gordon H. Wood, Jr., J. Peter Trexler, Andy Yelenosky, and Julian Soren

1958

INTERIOR—GEOLOGICAL SURVEY, WASHINGTON, D. C. M-R 1962

For sale by the U. S. Geological Survey, price $1.50 per set

COAL OUTCROP MAP

Base map by U. S. Geological Survey and Corps of Engineers, U. S. Army

Topography from aerial photographs by stereophotogrammetric methods

Revised and field checked by U. S. Geological Survey, 1952

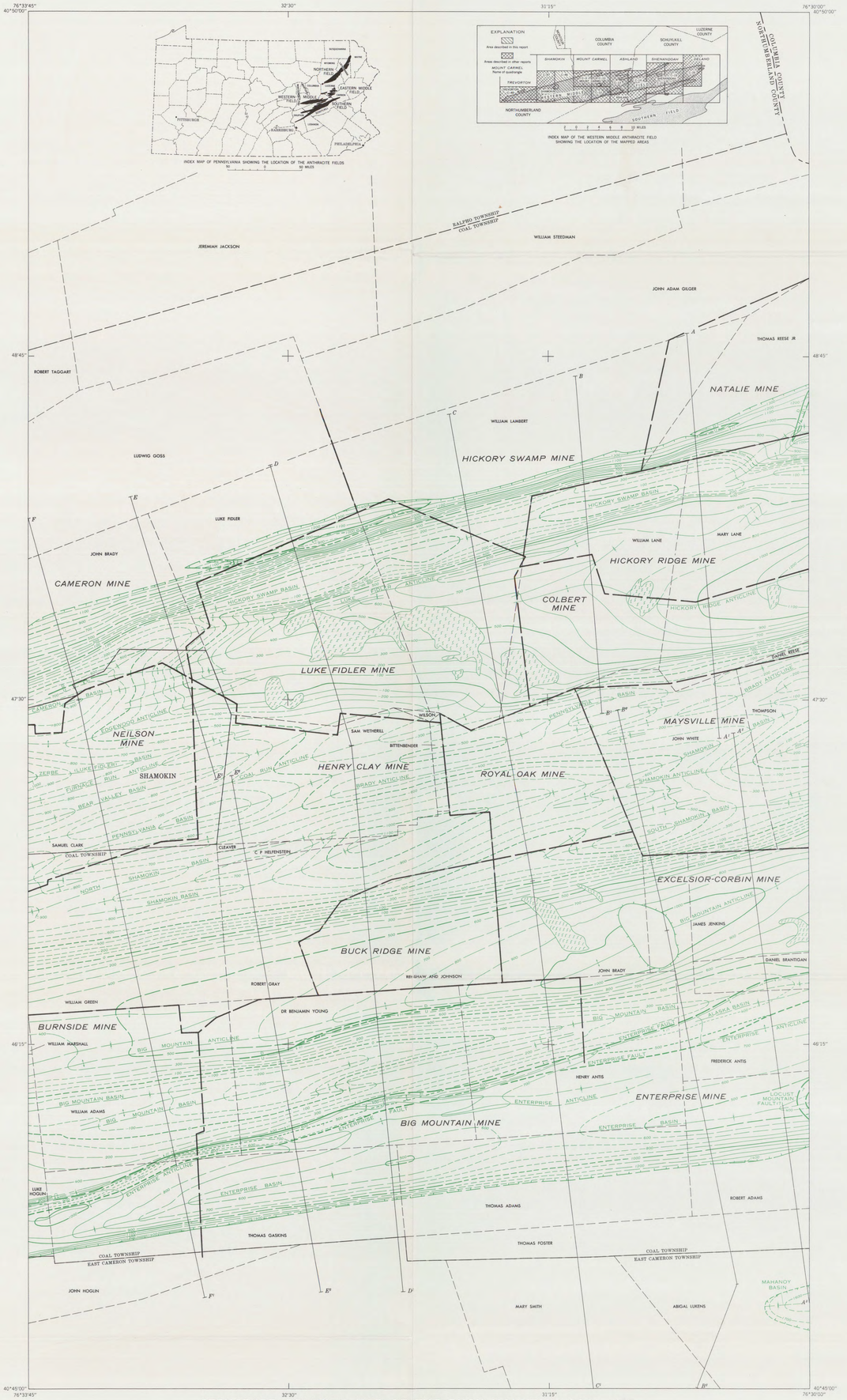
EXPLANATION
OUTCROP MAP

PENNSYLVANIAN — CARBONIFEROUS

- Pzp — Post-Pottsville rocks
- Pp — Pottsville formation
- Mmu / Mmm — MISSISSIPPIAN — Mauch Chunk formation (Mmu, upper member; Mmm, middle member)
- Contact — *Dashed where approximately located*
- Coal bed outcrop — *Solid where mined; long dashed where approximately located; short dashed where inferred. ?, correlation or extension of coal bed is uncertain. Number or letter designates coal beds; L, basal coal bed; ?L, ? Lander coal bed; LVA, Lykens Valley No. 4 coal bed*
- High-angle reverse fault, showing dip as plotted on cross section — *Long dashed where approximately located, short dashed where inferred. U, upthrown side; D, downthrown side*
- Tear fault, showing relative movement — *Dashed where approximately located*
- Thrust or low-angle reverse fault, showing dip as plotted on cross section — *Long dashed where approximately located; short dashed where inferred. T, upper plate*
- Anticline, showing crest line — *Long dashed where approximately located; short dashed where inferred*
- Syncline, showing trough line — *Long dashed where approximately located; short dashed where inferred*
- A — A' — Line of section — *Shown on sheet 2*
- Strip-mined area — *Stippled area covered by mine waste*
- Surface opening on coal bed
- Portal of tunnel or adit
- Exploratory trench — *Tick shows where coal was found*
- Crop fall — *Collapsed area where surface has fallen into underground mine workings*
- Mine waste — *Includes such waste from mining and breaker operations as culm, rock banks, coal piles, back fill, and silt in settling basins*
- Boundary of mine
- SAMUEL CLARK — Warranty tract — *Boundaries are shown for general orientation and identification but are not authenticated for legal purposes*

EXPLANATION
STRUCTURE MAP

- Outcrop of Buck Mountain (No. 5) coal bed — *Solid where mined; long dashed where approximately located*
- Contours on the bottom of the Buck Mountain (No. 5) coal bed — *Solid in mined areas; long dashed where approximately located; short dashed where inferred; very short dashed where a part of the bed lies beneath another part of the same bed*
- Thrust or reverse fault cutting Buck Mountain (No. 5) coal bed, showing dip of fault plane, relative position of faulted segments, and overthrust segment — *Long dashed where approximately located; short dashes indicate trace on underlying plate. U, upthrown segment of high-angle fault; D, downthrown segment of high-angle fault; T, overthrust segment of low-angle fault. Light-weight lines are contours on the bottom of the Buck Mountain (No. 5) coal bed, explained above*
- Shear zone
- Antiline, showing crest line — *Long dashed where approximately located; short dashed where inferred*
- Overturned anticline, showing crest line and direction of dip of limbs
- Syncline, showing trough line — *Long dashed where approximately located; short dashes inferred; very short dashed where in underlying plate of faulted area*
- A' — A — Line of section — *Shown on sheet 2*
- Boundary of mine
- DANIEL REESE — Warranty tract — *Boundaries are shown for general orientation and identification but are not authenticated for legal purposes*



STRUCTURE CONTOUR MAP OF THE BUCK MOUNTAIN COAL BED

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

APPROXIMATE MEAN DECLINATION, 1962

SCALE 1:12 000

1000 0 1000 2000 3000 4000 5000 6000 FEET

Topographic contour interval is 20 feet
Structure contour interval is 100 feet
Datum is mean sea level

DIAGRAM OF A TOPOGRAPHIC QUADRANGLE SHOWING THE AREA INCLUDED IN THIS MAP

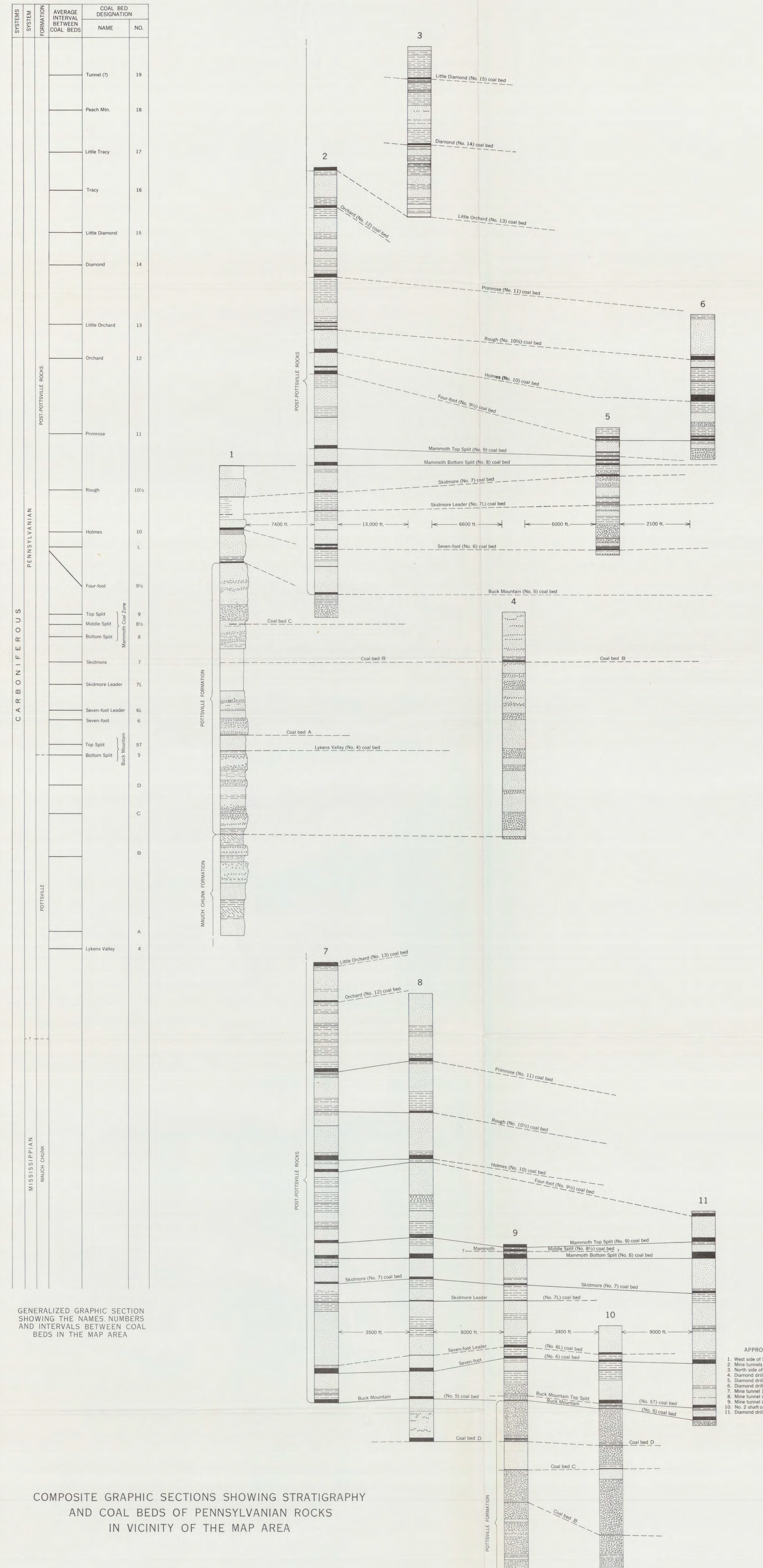
GEOLOGY OF ANTHRACITE IN THE EASTERN PART OF THE SHAMOKIN QUADRANGLE, NORTHUMBERLAND COUNTY, PENNSYLVANIA

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

1962

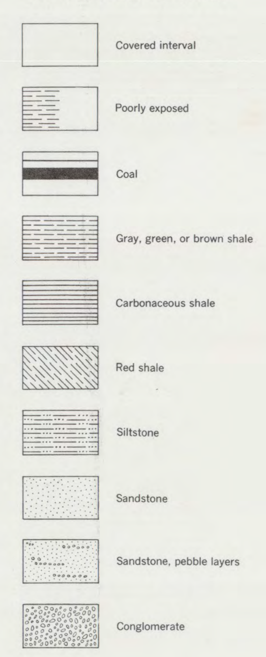
INTERIOR—GEOLOGICAL SURVEY, WASHINGTON, D. C.—81313

For sale by U. S. Geological Survey, price 1.25 per set



GENERALIZED GRAPHIC SECTION SHOWING THE NAMES, NUMBERS AND INTERVALS BETWEEN COAL BEDS IN THE MAP AREA

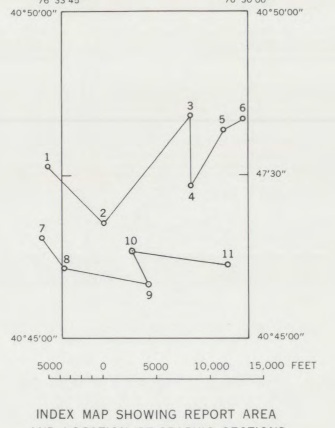
COMPOSITE GRAPHIC SECTIONS SHOWING STRATIGRAPHY AND COAL BEDS OF PENNSYLVANIAN ROCKS IN VICINITY OF THE MAP AREA



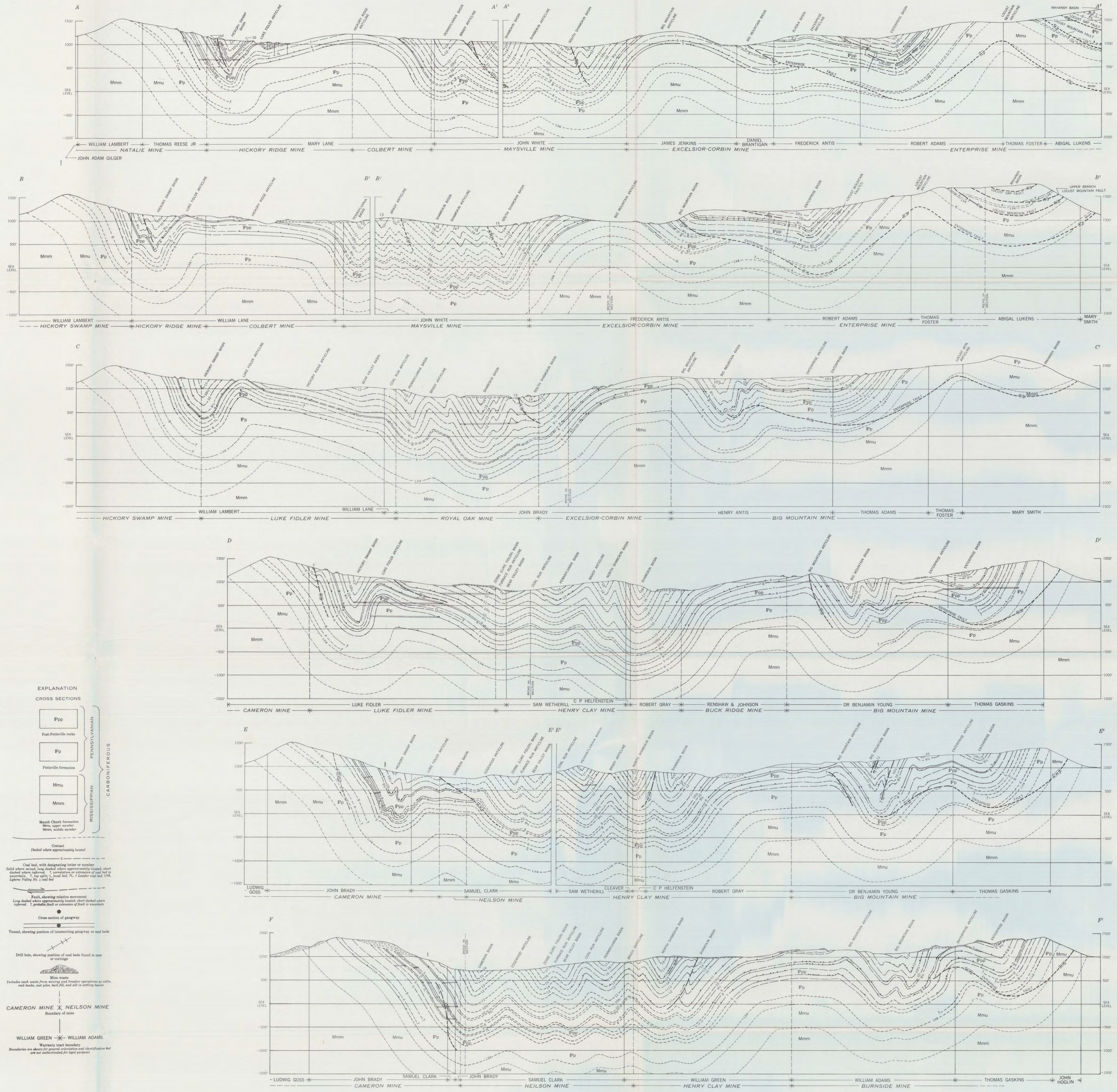
EXPLANATION OF GRAPHIC SECTIONS

APPROXIMATE LOCATIONS OF GRAPHIC SECTIONS

1. West side of Shamokin Creek 1700 ft. north of Shamokin.
2. Mine tunnels on William Green tract.
3. North side of Highway 122 north of Brady.
4. Diamond drill hole in north central part of William Lambert tract.
5. Diamond drill hole in western part of Mary Lane tract.
6. Diamond drill hole in north central part of Mary Lane tract.
7. Mine tunnel 1800 ft. west of mapped area in the William Rockerfeller tract.
8. Mine tunnel in western part of William Adams tract.
9. Mine tunnel in northern part of Thomas Gaskins tract.
10. No. 2 shaft of Big Mountain mine in northern part of Dr. Benjamin Young tract.
11. Diamond drill hole in northwestern part of Robert Adams tract.



INDEX MAP SHOWING REPORT AREA AND LOCATION OF GRAPHIC SECTIONS



CROSS SECTIONS

SCALE
500 0 500 1000 2000 3000 4000 FEET
DATUM IS MEAN SEA LEVEL

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

INTRODUCTION

This report on anthracite in the eastern part of the Shamokin quadrangle, Pa., is one in a series of reports 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 12-square-mile area in the western part of the field. The area described is in the eastern part of Northumberland County and includes the east half of the city of Shamokin.

Other reports in this series, which describe the geology of 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 locations of all known 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 observations and 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.

Much of the data on which these interpretations were based were obtained from mine maps, cross sections, drill logs, and other information made available by the Reading Anthracite Co. and the Susquehanna Collieries Co. The cooperation of these organizations is appreciated.

The field work for this report commenced in the summer of 1952 and was completed in the spring of 1956. Richard Nicholas and Harvey Heilman, Jr., assisted with the fieldwork in the summer of 1952 and Mariano M. Melendres, Jr., of the Philippine Geological Survey, aided in the field mapping in the spring of 1953.

STRATIGRAPHY

The rocks that crop out in the Shamokin quadrangle are of sedimentary origin and include formations of Devonian, Mississippian, and Pennsylvanian ages. However, only the upper part of the Mauch Chunk formation of Mississippian age and the Pottsville formation and the 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 northern part of the area in Brush Valley and on the northern slope of Big Mountain. The upper part of the formation is also exposed in the southern part of the area on the south side of Mahanoy Mountain. The formation 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 bottom of the lowermost conglomerate bed in the upper part of the formation. Beds of red shale, siltstone, and sandstone below the conglomerate compose the middle member of the Mauch Chunk formation.

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

The lithologic change from red shale and sandstone of the upper member of the Mauch Chunk formation to the typical gray conglomerate of the Pottsville formation is gradational. Wood and others (1956, p. 2673) placed the contact between 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 18 persistent coal beds, several local coal beds, and splits of coal beds. The lower part of this thick sequence is conglomeratic, in contrast with the upper part, which is chiefly fine grained. Several conglomeratic zones in the lower part of the 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 rocks of the Pennsylvanian system are divided into two major units, an underlying unit assigned to the Pottsville formation of Early and Middle Pennsylvanian age, and an overlying younger unit of Pennsylvanian age informally designated post-Pottsville rocks (Wood and others, 1958).

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 upper part of the formation is poorly exposed in the water gap south of Brady.

The formation is mainly medium- to thick-bedded conglomerate, conglomeratic sandstone, and sandstone, but includes several thin beds of shale and five coal beds. The Pottsville formation is about 650 feet thick in the southern part of the area, and it probably is at least this thick in the northeastern part. In Shamokin Gap, just west of the mapped area, the Pottsville formation is 580 feet thick.

The lower third of the Pottsville formation is composed of thick beds of coarse olive-gray to light-gray conglomerate and thin to massive beds of olive-gray to light-gray and grayish-brown fine- to coarse-grained sandstone, siltstone, and shale. These rocks rest conformably on the Mauch Chunk formation. Coarse conglomerate, the predominant rock in the lower part of the formation, forms prominent ledges in many places on the north side of Big Mountain and on the 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 of the lower part of the Pottsville seem to be transitional into the rocks of 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 a few thin beds of siltstone and shale. The conglomerate is composed chiefly of quartz and quartzite pebbles and a few scattered pebbles of chert and sandstone. Pebbles in the conglomerate average about ⅜ inch in diameter. In some localities, however, the conglomerate near the top of the formation is almost as coarse as the conglomerate in the lower third of the Pottsville formation. In general, pebbles in the upper two-thirds of the Pottsville 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 between the south slope of Big Mountain and the north slope of Mahanoy Mountain. The sequence has a maximum thickness of about 1,700 feet and includes beds of conglomerate, conglomeratic sandstone, sandstone, siltstone, claystone, and shale, interbedded with 17 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 strata grades upward into thin- to medium-bedded, light-gray to light olive gray and moderate yellowish brown fine- to medium-grained sandstone, and shale.

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 of 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 bottom of the Buck Mountain (No. 5) coal bed by contour lines drawn at 100-foot intervals. The structure map was compiled chiefly from 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 principal coal-bearing synclines, particularly the synclinal areas that are mined as units, are called "basins" by the miners. The term basin is used in this nontechnical sense in this report. The major basins are, from north to south, Hickory Swamp basin, Pennsylvania basin, Shamokin basin, Big Mountain basin, and Enterprise basin. The Luke Fidler and Hickory Ridge anticlines in the northern part of the field, the Coal Run and Brady anticlines in the central part, and the Big Mountain and Enterprise anticlines in the southern part are the other principal folds in this area.

The trend of the major folds is N. 75° E. The axial planes of the folds in the northern part of the coal field are vertical or are inclined steeply either to the north or south. Those in the central part of the field are generally vertical, and those in the southern part are inclined steeply to the south.

FAULTS

The principal faults are essentially strike faults that trend generally subparallel to the axes of the folds; most of the faults dip to the south but a few dip to the north. Most are thrust or reverse faults that resulted from compressional forces. The relative direction of movement on the south-dipping fault surfaces is apparent northward dislocation of overriding blocks. The movement of the overthrust blocks on northward-dipping faults is apparently to the south.

Two thrust-fault segments, called the Enterprise fault, in the southwestern part of the Mount Carmel quadrangle can be traced into the mapped area, where the fault segments reportedly are joined in the Enterprise mine workings on the Mammoth coal bed (Rothrock and others, 1951a). Subsequent investigations, however, indicate that these are not segments of the same fault and that the northernmost, which is herein called the Enterprise fault, probably extends about 3.5 miles west of the reported junction in the Enterprise mine workings. The other fault segment, which has been traced into the mapped area on the south side of the Enterprise basin, apparently dies out in the area where the two segments were thought to join. This fault probably could be traced over the Locust Mountain anticline to the Locust Mountain thrust fault on Boyers Knob. Therefore, it is tentatively referred to as the Locust Mountain fault in this report.

The Enterprise, Locust Mountain, and Locust Gap faults, which seem to be folded similarly to the beds they offset, probably developed before the last stage of folding. As sheets of slightly folded strata were thrust northward to overlap one another the fault surfaces probably buckled, restricting any further movement of the strata along the faults, and under continued compression the slightly folded and faulted mass was more intensely folded.

COAL

Seventeen coal beds in the mapped area are of minable thickness throughout most of their extent, and all have been mined at least locally. They have an aggregate thickness of more than 80 feet of coal, which is nearly 5 percent of the total thickness of the coal-bearing strata. The Buck Mountain (No. 5) and the Mammoth coal zone (Nos. 8, 8½, and 9) have yielded most of the coal mined in this area.

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. Prior to this series of reports, no attempt 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 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 No. 8 coal bed in the eastern part of the mapped area is correlated with the No. 8½ coal bed of previous reports, as a result of more recent field investigations and mining data. 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 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.

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

Coal bed		Thickness in feet						Avg % of waste
		Bed (coal plus shale partings)			Coal			
Name	No.	Avg	Max	Min	Avg	Max	Min	
Post-Pottsville rocks								
Tunnel	19	---	---	---	---	---	---	---
Peach Mountain	18	---	---	---	---	---	---	---
Little Tracy	17	---	---	---	---	---	---	---
Tracy	16	7.0	10.0	5.3	5.6	7.9	4.9	20.0
Little Diamond	15	4.6	5.7	3.5	3.5	5.2	2.6	23.9
Diamond	14	4.6	6.3	2.6	3.1	3.8	2.4	32.6
Little Orchard	13	5.9	8.6	2.7	4.7	7.4	2.0	20.4
Orchard	12	3.1	3.9	2.7	2.9	3.8	2.4	6.5
Primrose	11	6.4	10.9	4.5	5.6	8.9	4.1	12.5
Rough	10½	4.4	8.1	2.4	3.3	7.1	1.0	25.0
Holmes	10	6.2	10.9	3.2	4.6	9.3	1.8	25.8
Four-Foot	9½	7.9	10.9	6.1	4.4	5.9	2.9	44.4
Mammoth Top Split	9	6.9	13.0	1.6	6.1	13.0	1.6	11.6
Mammoth Middle Split	8½	8.2	14.0	4.5	7.8	14.0	3.5	4.9
Mammoth Bottom Split	8	7.9	13.7	5.1	6.6	12.6	2.3	16.5
Skidmore	7	3.8	8.5	.9	2.9	5.3	.6	23.7
Skidmore Leader	7L	4.4	6.6	2.4	3.6	6.1	1.2	18.2
Seven-Foot	6	6.3	10.6	1.8	4.3	7.3	1.3	31.7
Buck Mountain Bottom Split	5	5.3	9.4	1.7	4.0	6.3	1.1	24.5
Pottsville formation								
D	---	a 2.7	3.7	1.7	a 2.1	2.8	1.4	---
C	---	a 3.1	3.2	3.0	a 2.3	2.5	2.1	---
B	---	---	---	---	---	---	---	---
A	---	a 2.4	3.8	1.0	a 1.2	1.3	1.0	---
Lykens Valley No. 4	---	5.5	10.1	1.5	5.1	10.1	1.5	7.3

a Average of two measurements. [-- indicates no data available]

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, is so named 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 a much as 100 feet.

Coal beds in the Pottsville formation.—Of the five coal beds present in the Pottsville formation, only the lowermost bed, which is about 200 feet above the base of the formation, seems to be persistent throughout the mapped 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 Lykens Valley No. 4 ranges in thickness from 1.5 feet to as much as 10 feet; its maximum thickness was measured along the south edge of the field in the Boyers Knob area. The quality of the coal is very high, but in most workings mining is hampered by numerous pinches and small faults. Some of the deepest workings in the Western Middle field are in the No. 4 bed, which has yielded coal at depths exceeding 500 feet below sea level (cross section D).

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. Coal bed *A* overlies the Lykens Valley No. 4 coal within a stratigraphic interval of 5 to 75 feet. Although coal bed *A* has been mined in several places, it is generally too thin to be worked. Coal bed *B* lies about 200 feet stratigraphically above the Lykens Valley No. 4, coal bed *C* about 280 feet, and coal bed *D* about 350 feet. These coal beds have been worked locally in prospect pits on the north slope of Mahanoy Mountain, but they are probably too thin and impure to be mined extensively.

Coal beds in post-Pottsville rocks.—The Buck Mountain (No. 5) coal bed, at the base of the post-Pottsville rocks, has been extensively mined underground and has been strip-mined along most of its outcrop. In the southern part of the mapped area it occurs in two splits known as the Buck Mountain Top Split (No. 5T) and Bottom Split (No. 5). The Buck Mountain is 350 to 460 feet stratigraphically above the Lykens Valley No. 4 coal bed.

The Seven-Foot (No. 6) coal bed is 40 to 120 feet above the Buck Mountain (No. 5) coal bed. In the south-central part of the area it is locally overlain by a thin coal bed designated as the No. 6L coal bed. The Seven-Foot bed has been mined extensively along the north and south margins of the field.

The Skidmore (No. 7) coal bed is about 70 to 190 feet above the Seven-Foot (No. 6) coal bed. The Skidmore Leader (No. 7L) is about 40 feet below the Skidmore bed. The Skidmore coal bed has been mined extensively underground along the north side of the field in the old Cameron and Sterling Colliery workings, but has been mined very little on the south side of the field.

The Mammoth coal zone, composed of the Bottom Split (No. 8), Middle Split (No. 8½), and Top Split (No. 9), includes the most important coal beds in the Western Middle anthracite field. The Middle Split, about 230 to 340 feet above the Buck Mountain (No. 5) coal bed, occurs only in the northwestern part of the mapped area. Elsewhere, the Bottom Split, about 200 feet above the Buck Mountain, and the Top Split are separated by a bed of medium dark gray silty sandstone that ranges in thickness from 1 to 85 feet. Most coal in the Mammoth zone that could be profitably mined has been removed both on the surface and underground.

The Four-Foot (No. 9½) coal bed occurs at a variable stratigraphic distance above the Mammoth Top Split. In the eastern part of the mapped area it crops out along the top cuts of the Mammoth Top Split (No. 9) strippings. The Four-Foot bed generally contains a thin tough claystone parting 1 to 3 feet thick, which restricts mining of this bed.

Of the coal beds above the Mammoth coal zone, the Holmes (No. 10), Primrose (No. 11), and Orchard (No. 12) beds have been mined most extensively. The Holmes and Primrose coal beds have been strip-mined and mined underground in the northern and western parts of the mapped area. The Orchard bed has been extensively strip-mined north of the village of Brady, where a series of faults and shallow folds has brought the bed closer to the surface.

Coal beds younger than the Orchard (No. 12) bed underlie the city of Shamokin, where little or no mining has been done. The youngest coal bed in the mapped area, the Tunnel (No. 19), occupied the core of a tight syncline on the southeast edge of Shamokin and is now completely mined out.

ADVICE TO MINERS

Coal beds are rarely exposed in natural outcrops because of the soil cover. 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. This position may not agree 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 those particular coal beds; however, the coal is not necessarily of minable thickness throughout its 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 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 studing 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, anaylsis 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 at early stage of development; however, some of the shear zones apparently have no regular orientation.

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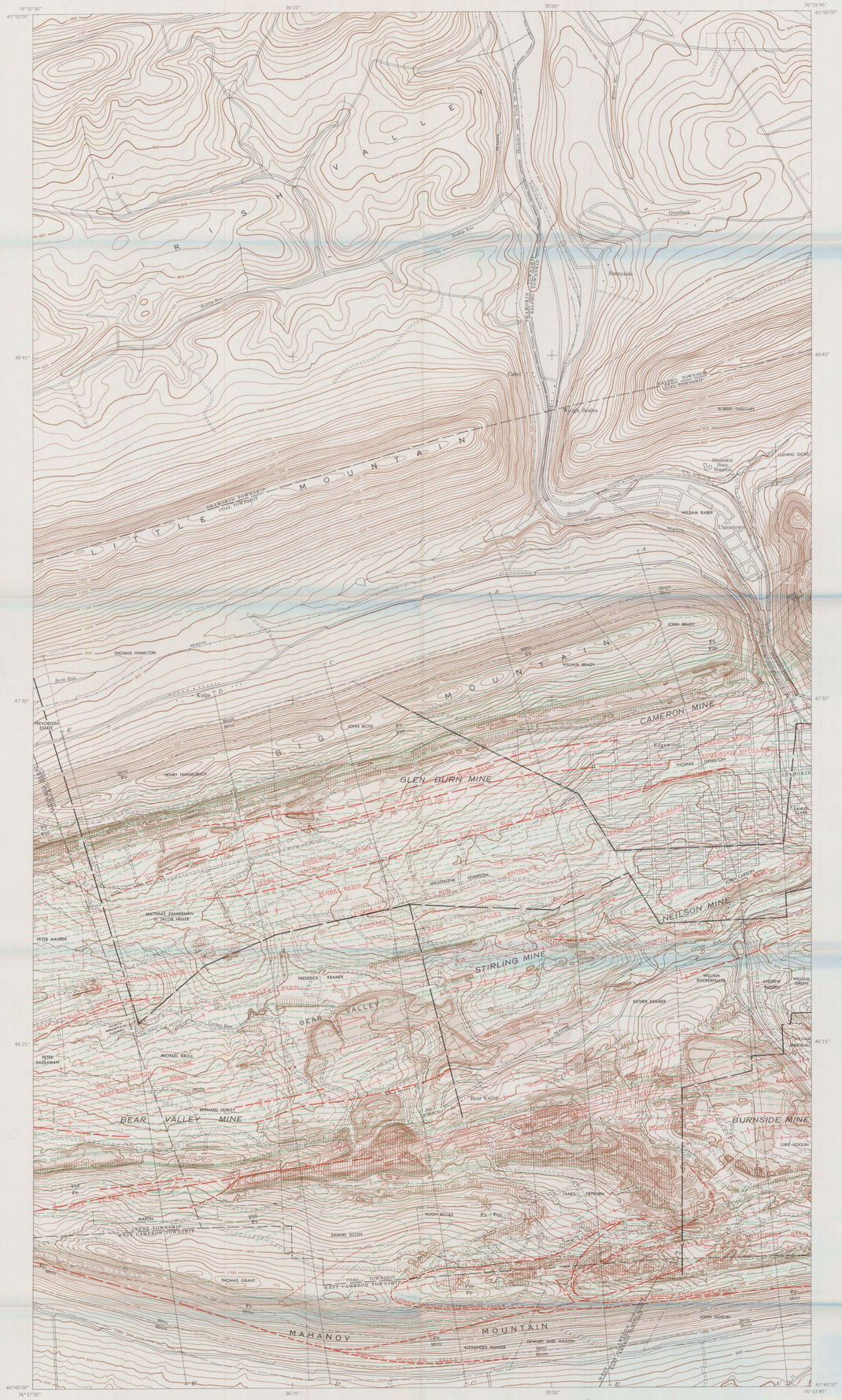
GEOLOGY OF ANTHRACITE IN THE EASTERN PART OF THE SHAMOKIN QUADRANGLE, NORTHUMBERLAND COUNTY, PENNSYLVANIA

By
Walter Danilchik, Harold H. Arndt, and Gordon H. Wood, Jr.
1962

COAL INVESTIGATIONS
MAP C-46, SHEET 2 OF 2

For sale by U. S. Geological Survey, price $1.25 per set



COAL OUTCROP MAP

Base map by U. S. Geological Survey and Corps of Engineers, U. S. Army
Topography from aerial photographs by stereophotogrammetric methods
Revised and field checked by U. S. Geological Survey, 1952

8½° MAGNETIC NORTH TRUE NORTH
APPROXIMATE MEAN DECLINATION, 1962

EXPLANATION
OUTCROP MAP

MISSISSIPPIAN — PENNSYLVANIAN — CARBONIFEROUS

- Ppp — Post-Pottsville rocks
- Pp — Pottsville Formation
- Mmu, Mmm — Mauch Chunk Formation (Mmu, upper member; Mmm, middle member)
- Contact — *Dashed where approximately located*
- Coal bed outcrop — *Solid where mined; long-dashed where approximately located; short dashed where inferred. ?, correlation or extension of coal bed is uncertain. Number or letter designates coal beds: L, basal coal bed; 7, 7 Leader coal bed; LV4, Lykens Valley No. 4 coal bed*
- High-angle reverse fault, showing dip as plotted on cross section — *Long dashed where approximately located; short dashed where inferred. ?, probable fault or extension of fault is uncertain. U, upthrown side; D, downthrown side*
- Tear fault, showing relative movement — *Dashed where approximately located*
- Thrust or low-angle reverse fault, showing dip — *Long dashed where approximately located; short dashed where inferred. ?, probable fault or extension of fault is uncertain. T, upper plate*
- Anticline, showing crest line — *Long dashed where approximately located; short dashed where inferred*
- Overturned anticline, showing crest line and direction of dip of limbs
- Syncline, showing trough line — *Long dashed where approximately located; short dashed where inferred*
- Overturned syncline, showing trough line and direction of dip of limbs
- Line of section — *Shown on sheet 2*
- Strip-mined area — *Stippled area covered by mine waste*
- Surface opening on coal bed
- Portal of tunnel or adit
- Exploratory trench — *Tick shows where coal was found*
- Collapsed area where surface has fallen into underground mine workings
- Mine waste — *Includes such waste from mining and breaker operations as culm, rock banks, coal piles, back fill, and silt in settling basins*
- Boundary of mine
- JOHN BOYD — Warranty tract — *Boundaries are shown for general orientation and identification but are not authenticated for legal purposes*

EXPLANATION
STRUCTURE MAP

- Outcrop of Buck Mountain (No. 5) coal bed — *Solid where mined; dashed where exposed or position of coal bed is uncertain*
- Contours on the bottom of the Buck Mountain (No. 5) coal bed — *Solid in mined areas; long dashed where approximately located; short dashed where inferred; very short dashed where a part of the bed lies beneath another part of the same bed*
- Reverse fault cutting Buck Mountain (No. 5) coal bed, showing dip of fault plane, relative position of faulted segments, and overthrust segment — *Long dashed where approximately located; short dashes indicate fault trace on underlying plate. U, upthrown segment of high-angle fault; D, downthrown segment of high-angle fault; T, overthrust segment of low-angle fault; ?, probable fault. Light-weight lines are contours on the bottom of the Buck Mountain (No. 5) coal bed, explained above*
- Tear fault, showing relative movement
- Shear zone
- Anticline, showing crest line — *Long dashed where approximately located; short dashed where inferred*
- Overturned anticline, showing crest line and direction of dip of limbs
- Syncline, showing trough line — *Long dashed where approximately located; short dashed where inferred; very short dashed where in underlying plate of faulted area*
- Line of section — *Shown on sheet 2*
- Boundary of mine
- THOMAS GRANT — Warranty tract — *Boundaries are shown for general orientation and identification but are not authenticated for legal purposes*

SCALE 1:12 000
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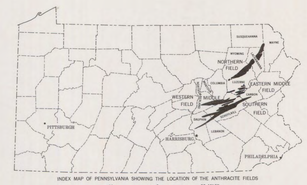
TOPOGRAPHIC CONTOUR INTERVAL IS 20 FEET
STRUCTURE CONTOUR INTERVAL IS 100 FEET
DATUM IS MEAN SEA LEVEL



INDEX MAP OF PENNSYLVANIA SHOWING THE LOCATION OF THE ANTHRACITE FIELDS
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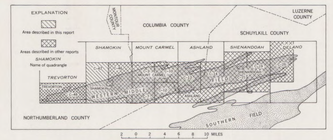


0 2 4 6 8 10 MILES
INDEX MAP OF THE WESTERN MIDDLE ANTHRACITE FIELD SHOWING THE LOCATION OF THE MAPPED AREAS

STRUCTURE CONTOUR MAP OF THE BUCK MOUNTAIN COAL BED

DIAGRAM OF A TOPOGRAPHIC QUADRANGLE SHOWING THE AREA INCLUDED IN THIS MAP

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

INTERIOR—GEOLOGICAL SURVEY, WASHINGTON, D. C.—61314

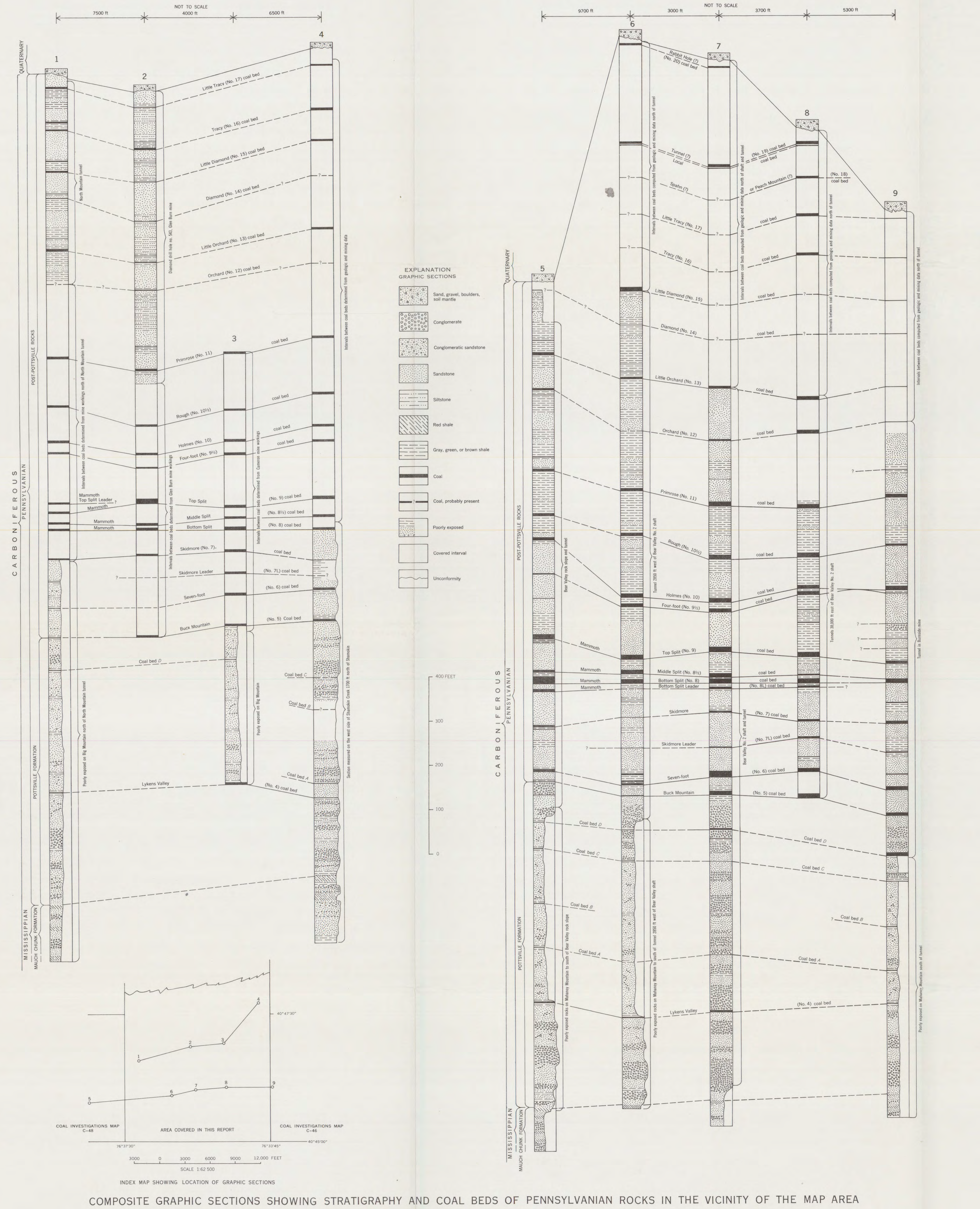
GEOLOGY OF ANTHRACITE IN THE WESTERN PART OF THE SHAMOKIN QUADRANGLE, NORTHUMBERLAND COUNTY, PENNSYLVANIA

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

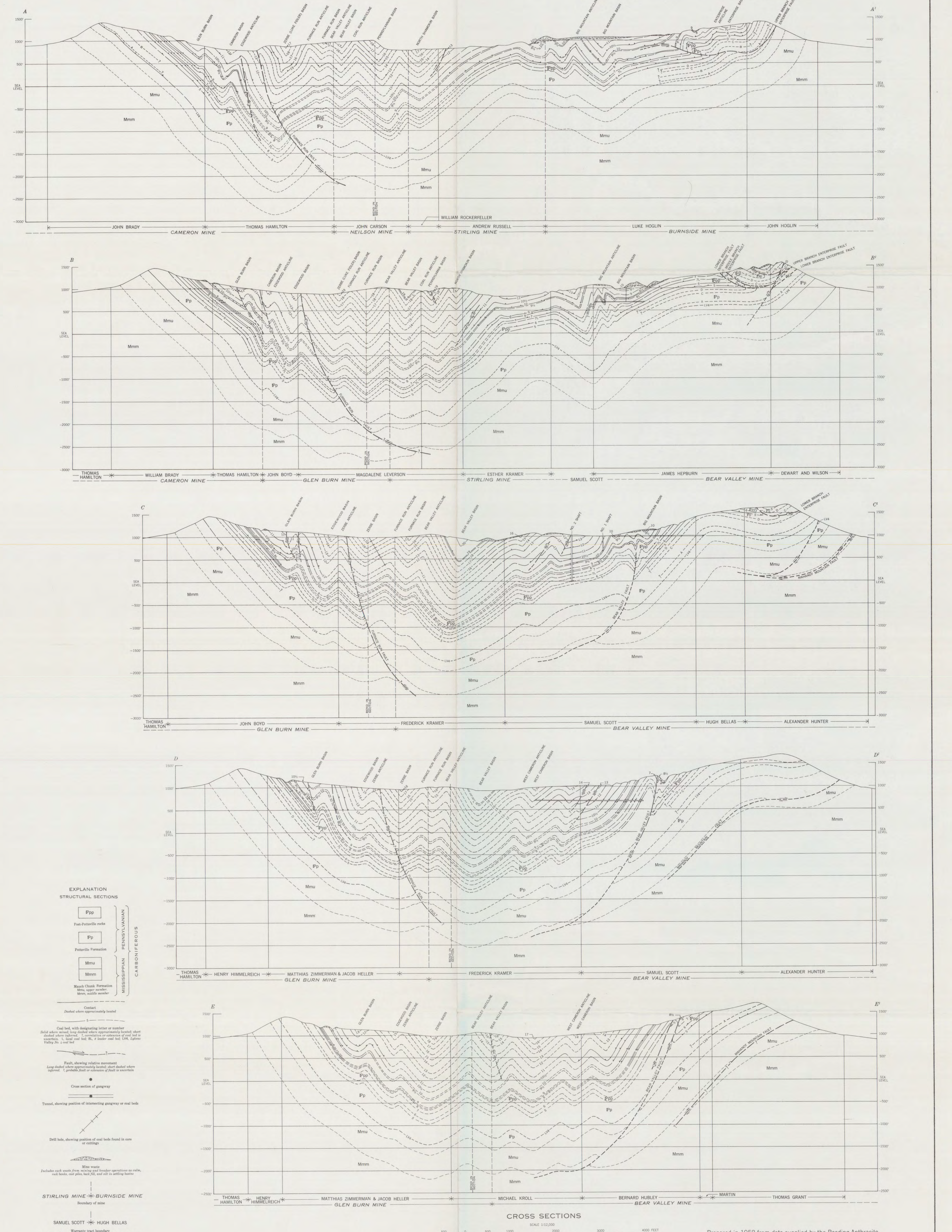
1963

COAL INVESTIGATIONS
MAP C-47, SHEET 1 OF 2

For sale by U. S. Geological Survey, price $1.25 per set



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



CROSS SECTIONS

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 reports 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 eastern part of Northumberland County and includes the west half of the city of Shamokin.

Other reports in this series, which describe the geology of 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 locations 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, 1953, 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 Chuck 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 browinsh-red shale. The shale beds are thicker and brighter red in the middle and lower parts of the member.

The 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. 2673) have placed the contact between 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 splits 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 major 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, 1958).

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 (Lykens Valley No. 4) and four discontinuous coal beds. The Pottsville formation is 580 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 to massive beds of olive-gray to light-gray and grayish-brown fine- to coarse-grained sandstone, siltstone, and shale. These rocks rest conformably on the Mauch Chunk formation. Coarse 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 ⅜ 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 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-Potsville 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 depresssions 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 molds. 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 bottom 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, Furnance 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 asymmetrical 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 compressional features thought to be contemporaneous with the folding. The relative direction of movement on the faults generally is an apparent northward dislocation of the overriding blocks on the southward-dipping fault surface. 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 strike 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 south-central 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 died 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 encounterered 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 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, is so named 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 northeastern 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 not mined in this part of the Western Middle field, but they have been cut in mine tunnels and boreholes, 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 350 to 500 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 bony coal. It has been mined in the Cameron mine on the south flank of Big Mountain and in the Burnside 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 productive 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 scarcely 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 varies, and in some areas it is greater than 75 feet. The rock between the coals 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 150 feet above the Mammoth Top Split (No. 9) coal. The intervening rocks are finer 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 report 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 numered 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. This position may not agree 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 those particular coal beds; however, the coal is not necessarily of minable thickness throughout its 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

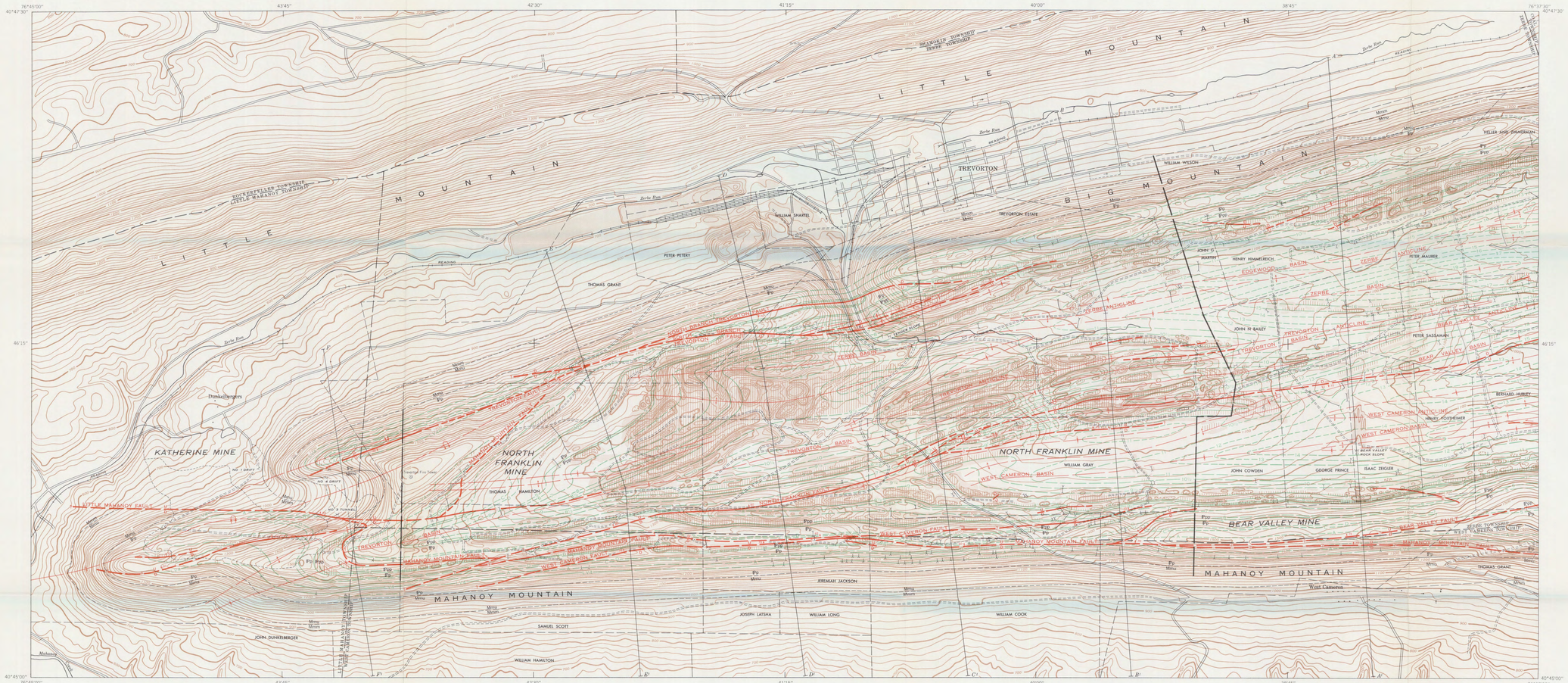
[---indicates no data available. Where no maximum or minimum is shown, only one measurement was available]

Coal bed		Thickness in feet						Average percentage of waste
		Bed (coal plus shale partings)			Coal			
Name	No.	Avg	Max	Min	Avg	Max	Min	
Post-Pottsville rocks								
Rabbit Hole	20	4.6	5.0	3.5	---	---	---	---
Tunnel	19	5.5	11.5	2.0	---	---	---	---
Local	---	---	---	---	---	---	---	---
Spahn or Peach Mountain	18	6.2	---	---	6.2	---	---	---
Little Tracy	17	4.8	---	---	4.8	---	---	---
Tracy	16	5.2	8.0	3.0	4.1	7.5	2.3	21.2
Little Diamond	15	5.3	5.9	3.2	3.6	5.9	1.7	32.1
Diamond	14	3.2	---	---	2.5	---	---	---
Little Orchard	13	5.7	7.9	3.9	4.5	6.1	3.0	21.1
Orchard	12	3.1	5.7	2.0	2.3	3.0	1.4	25.8
Primrose	11	6.6	10.2	2.5	6.1	10.0	2.5	7.6
Rough	10½	6.5	11.5	1.5	5.3	8.9	1.1	18.5
Holmes	10	8.2	13.0	3.8	7.4	13.0	2.8	9.8
Four-Foot	9½	5.5	9.8	2.1	4.3	8.5	2.0	21.8
Mammoth Top Split Leader	9L	7.5	11.6	4.2	5.7	11.4	2.4	24.0
Mammoth Top Split	9	8.3	15.5	1.2	7.8	15.0	1.2	6.0
Mammoth Middle Split	8½	8.3	11.5	4.9	7.3	10.7	4.7	12.0
Mammoth Bottom Split	8	7.7	12.9	2.7	6.7	12.4	2.2	13.0
Mammoth Bottom Split Leader.	8L	4.0	---	---	4.0	---	---	---
Skidmore	7	4.3	8.6	2.4	3.4	5.1	1.9	20.9
Skidmore Leader	7L	3.7	5.9	1.5	2.4	4.8	1.5	35.1
Seven-Foot	6	8.0	14.7	2.8	6.0	10.4	2.0	25.0
Buck Mountain Bottom Split	5	5.2	8.8	2.7	3.8	5.8	1.7	26.9
Pottsville formation								
D	---	2.5	---	---	2.5	---	---	---
C	---	.6	---	---	.6	---	---	---
B	---	---	---	---	---	---	---	---
A	---	---	---	---	---	---	---	---
Lykens Valley No. 4	---	6.6	9.0	3.1	5.4	9.0	1.8	18.2

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

For sale by U. S. Geological Survey, price $1.25 per set



COAL OUTCROP MAP

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

STRUCTURE CONTOUR MAP OF THE BUCK MOUNTAIN COAL BED

Base map by U. S. Geological Survey
and Corps of Engineers, U. S. Army

Topography from aerial photographs by stereophotogrammetric methods. Aerial photographs taken 1943 and 1951
Revised and field checked by U. S. Geological Survey, 1952

SCALE 1:12 000

1000 0 1000 2000 3000 4000 5000 6000 FEET

TOPOGRAPHIC CONTOUR INTERVAL IS 20 FEET
STRUCTURE CONTOUR INTERVAL IS 100 FEET
DATUM IS MEAN SEA LEVEL

APPROXIMATE MEAN DECLINATION, 1963

DIAGRAM OF A TOPOGRAPHIC QUADRANGLE SHOWING THE AREA INCLUDED IN THIS MAP

Prepared in 1958 from data suppied by the Reading Anthracite Co. and the Sunshine Coal Co. with modifications by the U. S. Geological Survey

EXPLANATION
OUTCROP MAP

Ppp — Post-Pottsville rocks

Pp — Pottsville formation

Mmu, Mmm — Mauch Chunk formation (Mmu, upper member; Mmm, middle member)

PENNSYLVANIAN / MISSISSIPPIAN / CARBONIFEROUS

Contact — *Dashed where approximately located*

Coal bed outcrop — *Solid where mined; long dashed where approximately located; short dashed where inferred. ?, correlation or extension of coal bed is uncertain. Number or letter designates coal beds: L, local coal bed; 7L, 7 Lender coal bed; LVA, Lykens Valley No. 4 coal bed*

High-angle reverse fault, showing dip as plotted on cross section — *Long dashed where approximately located; short dashed where inferred. ?, probable fault or extension of fault is uncertain. U, upthrown side; D, downthrown side*

Tear fault, showing relative movement — *Dashed where approximately located*

Thrust or low-angle reverse fault — *Long dashed where approximately located; short dashed where inferred. ?, probable fault or extension of fault is uncertain. ?, upper plate*

Anticline, showing crest line — *Long dashed where approximately located; short dashed where inferred*

Overturned anticline, showing crest line and direction of dip of limbs — *Long dashed where approximately located; short dashed where inferred*

Syncline, showing trough line — *Long dashed where approximately located; short dashed where inferred*

Overturned syncline, showing trough line and direction of dip of limbs — *Long dashed where approximately located; short dashed where inferred*

A — A' Line of section — *Shown on sheet 2*

Strip-mined area — *Stippled area covered by mine waste*

Surface opening on coal bed

Portal of tunnel or adit

Exploratory trench — *Tick shows where coal was found*

Collapsed area where surface has fallen into underground mine workings

Mine waste — *Includes rock waste from mining and breaker operations as culm, rock banks, coal piles, back fill, and silt in settling basins*

Boundary of mine

WILLIAM GRAY — Warranty tract — *Boundaries are shown for general orientation and identification but are not authenticated for legal purposes*

EXPLANATION
STRUCTURE MAP

Outcrop of Buck Mountain (No. 5) coal bed — *Solid where mined; lor dashed where approximately located; short dashed where inferred*

Contours on the bottom of the Buck Mountain (No. 5) coal bed — *Solid in mined areas; long dashed where approximately located; short dashed where inferred; very short dashed where a part of the bed lies beneath another part of the same bed*

High-angle reverse fault cutting Buck Mountain (No. 5) coal bed, showing dip of fault plane, relative position of faulted segments, and over-thrust segment — *Long dashed where approximately located; short dashed where inferred; very short dashes indicate trace on underlying plate. ?, probable fault or extension of fault is uncertain; U, upthrown side; D, downthrown side. Light-weight lines are contours on the bottom of the Buck Mountain (No. 5) coal bed, explained above*

Tear fault, showing relative movement — *Dashed where approximately located*

Anticline, showing crest line — *Long dashed where approximately located; short dashed where inferred*

Overturned anticline, showing crest line and direction of dip of limbs — *Long dashed where approximately located; short dashed where inferred*

Syncline, showing trough line — *Long dashed where approximately located; short dashed where inferred; very short dashed where in underlying plate of faulted area*

B — B' Line of section — *Shown on sheet 2*

Boundary of mine

JOHN COWDEN — Warranty tract — *Boundaries are shown for general orientation and identification but are not authenticated for legal purposes*

GEOLOGY OF ANTHRACITE IN THE SOUTHERN PART OF THE TREVORTON QUADRANGLE, NORTHUMBERLAND COUNTY, PENNSYLVANIA

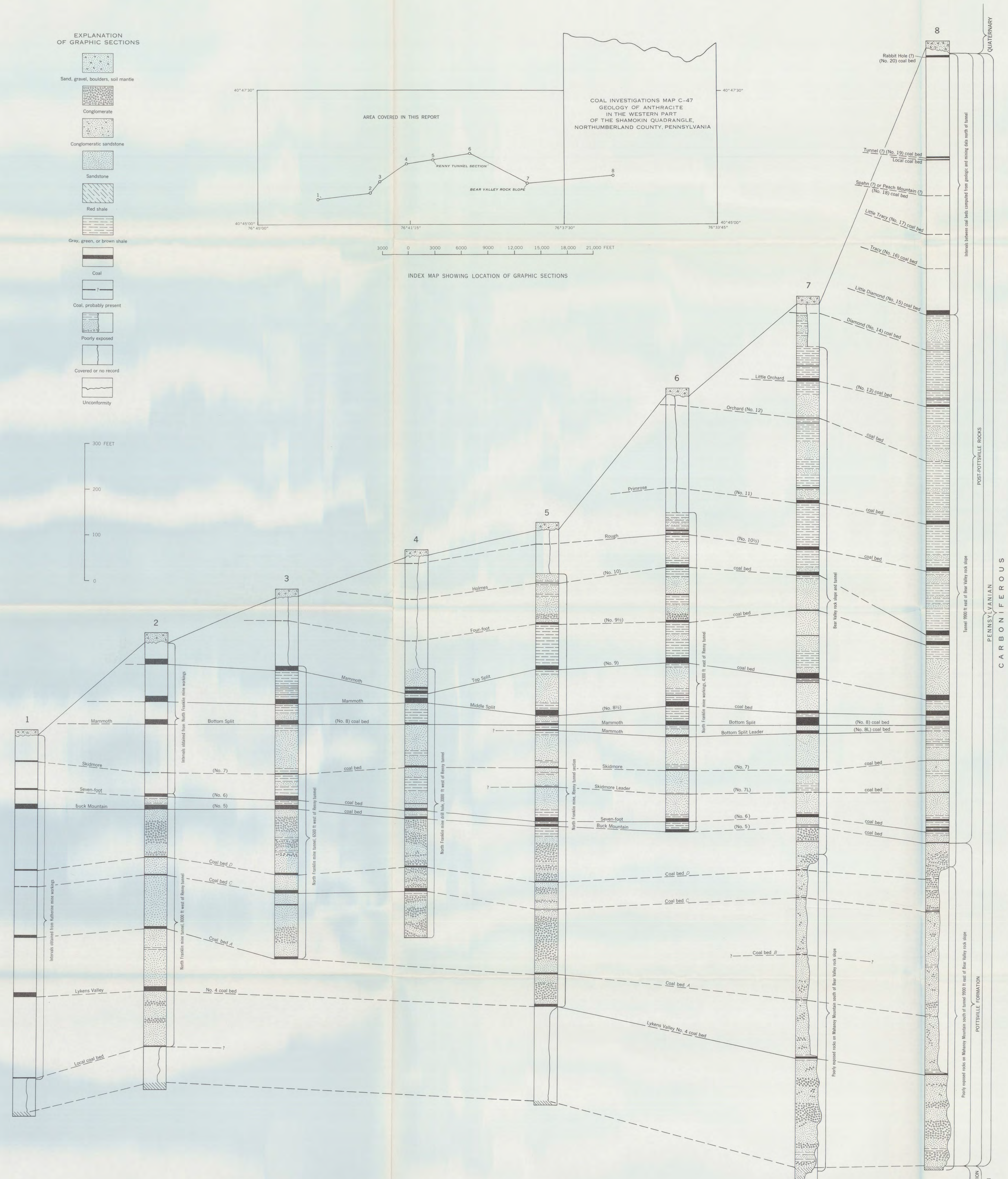
By
Harold H. Arndt, Gordon H. Wood, Jr., and Walter Danilchik

1963

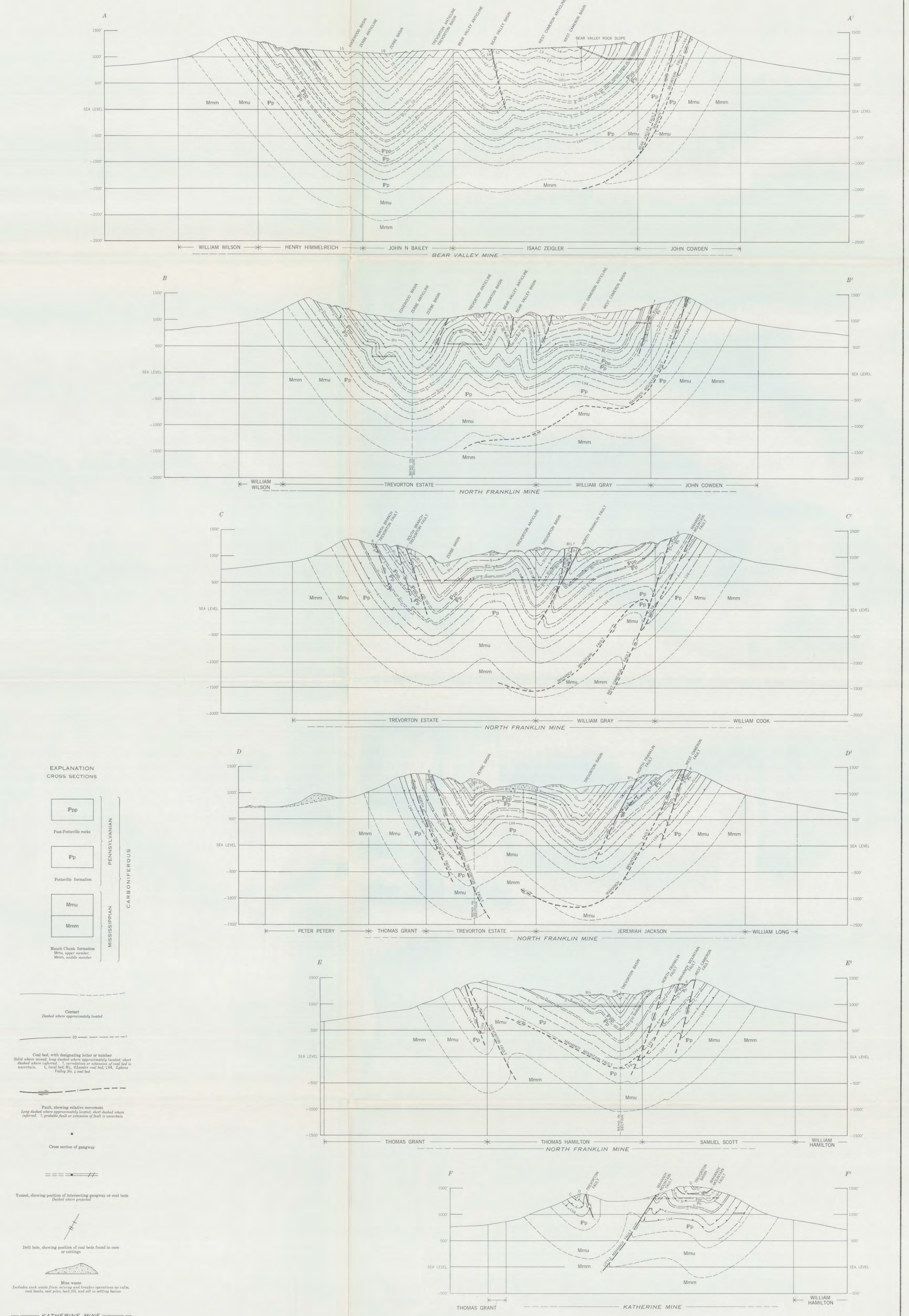
INTERIOR—GEOLOGICAL SURVEY, WASHINGTON, D. C.— 61315

For sale by U. S. Geological Survey, price 1.25 per set

COAL INVESTIGATIONS
MAP C-48, SHEET 1 OF 2



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



CROSS SECTIONS

GEOLOGY OF ANTHRACITE IN THE SOUTHERN PART OF THE TREVORTON QUADRANGLE, NORTHUMBERLAND COUNTY, PENNSYLVANIA

INTRODUCTION

This report on anthracite in the southern part of the Trevorton quadrangle, Pa., is one in a series of reports 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 7-square-mile area at the west end of the field. The area described is in the southwestern part of Northumberland County and includes the town of Trevorton in the center of the area.

Other reports in this series, which describe the geology of 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 for prospecting and drilling, mine development, and water-control operations by showing: (a) the locations 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.

Much of the mining data presented in this report were obtained from mine maps, cross sections, drill logs, and other information made available by the Reading Anthracite Co., the Sunshine Coal Co., and State Mine Inspector Harold E. Shomper. Many independent mine operators also have given valuable information. The cooperation and assistance of these organizations and individuals is gratefully acknowledged.

The fieldwork for this report was done in 1953, 1954, and 1956. John J. Musser and Andy Yelenosky assisted with the fieldwork in the summer of 1953, and J. Peter Trexler in the spring of 1956.

STRATIGRAPHY

The sedimentary rocks exposed in the southern part of the Trevorton quadrangle are of Devonian, Mississippian, and Pennsylvanian ages. The Catskill formation of Late Devonian age crops out in a northeastward-trending belt along the north flank and in the valley north of Little Mountain. The Pocono formation of Mississippian age forms the crest and south flank of Little Mountain. The Mauch Chunk formation of Mississippian age occupies the valley enclosing the west end of the coal field. The Pennsylvanian rocks comprise the Pottsville formation, which forms the crests of Big Mountain and Mahanoy Mountain, and a tightly folded belt of post-Pottsville rocks, which crops out in the valley between these mountains. The upper member of the Mauch Chunk formation, the Pottsville formation, and the post-Pottsville rocks were studied and their areal distribution 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

Mauch Chunk formation.—The Mauch Chunk formation crops out along the north margin of the coal field in the valley occupied by Zerbe Run, and along the south margin and west end of the coal field on the south slope of Mahanoy Mountain. The formation is about 3,000 feet thick in the Trevorton quadrangle and consists mainly of red shale and sandstone, with thin beds of gray-green sandstone and conglomerate, and buff sandstone. Generally the Mauch Chunk is divisible into three members, which are informally called the lower, middle, and upper members.

The lower member of the formation is composed of 100 to 200 feet of red shale and sandstone with several interbedded layers of buff sandstone that seems to be transitional to the buff and olive-gray sandstone in the underlying Pocono formation. The middle member of the Mauch Chunk formation consists of about 2,300 feet of interbedded red shale and sandstone. The upper member includes 400 to 500 feet of laterally persistent sequences of gray to gray-green sandstone, conglomeratic sandstone, and pebble and cobble conglomerate, interbedded with red shale and sandstone.

The contact between the middle and upper members of the Mauch Chunk formation is mapped at the base of the lowermost conglomerate bed in the upper part of the formation. Below that conglomerate, red shale, siltstone, and sandstone predominate. Only the upper member was mapped.

The red shale and gray to gray-green sandstone of the upper member of the Mauch Chunk are transitional to the gray conglomerate of the Pottsville formation. Wood and others (1956, p. 2673) have placed the contact between the Mauch Chunk and Pottsville formations at the top of the uppermost red sandstone, siltstone, or shale. This convenient boundary in mapping is used in this report.

PENNSYLVANIAN SYSTEM

The Pennsylvanian system is composed of the Pottsville formation of Early and Middle Pennsylvanian age and of undifferentiated younger rocks of Pennsylvanian age informally designated post-Pottsville rocks (Wood and others, 1958). The Pennsylvanian rocks consist of conglomerate, sandstone, siltstone, claystone, shale, and 26 beds of coal. The lower part of this sequence is conglomeratic, whereas the upper part is chiefly fine grained. Several successions of conglomerate beds in the Pottsville formation have been traced over wide areas; however, the coal beds seem to be the most persistent lithologic units in the upper part of the sequence.

Pottsville formation.—The Pottsville formation of Early and Middle Pennsylvanian age is about 650 feet thick in the mapped area. It crops out on Big Mountain, along the north margin of the coal field, and on Mahanoy Mountain, at the south margin of the field. It is composed mainly of thin- to massive-bedded conglomerate, conglomeratic sandstone, and sandstone interbedded with several thin beds of shale and six beds of coal.

The lower third of the formation is composed of massive beds of olive-gray to light-gray conglomerate and thin to massive beds of olive-gray to light-gray and grayish-brown sandstone, siltstone, and shale. These rocks rest conformably on the Mauch Chunk formation. Beds of pebble and cobble conglomerate in the lower part of the Pottsville formation form 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 subangular to subrounded quartz and quartzite pebbles and cobbles but also contains many chert, shale, and sandstone pebbles and cobbles. Most of the pebbles are 3/4 to 1½ inches in diameter; however, cobbles as much as 8 inches in diameter are scattered through the lower part of the 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-bedded siltstone and shale. The conglomerate is composed chiefly of quartz and quartzite pebbles, and contains only a few scattered pebbles of chert and sandstone. Pebbles in the conglomerate average about 3/8 inch in diameter; however, in some localities the conglomerate near the top of the formation contains pebbles comparable in size to the large pebbles in the conglomerate beds in the lower part. In general, pebbles in the upper two-thirds of the Pottsville are more rounded and better polished than the pebbles and cobbles in the lower third. The upper part of the formation also contains proportionately more sandstone and shale. 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 coarse conglomerate beds at the top of 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 in a continuous belt between the south slope of Big Mountain and the north slope of Mahanoy Mountain. The sequence in this area has a maximum thickness of about 1,700 feet and includes beds of conglomerate, conglomeratic sandstone, sandstone, siltstone, claystone, and shale, interbedded with 20 beds of coal. The original thickness is unknown because erosion has removed the uppermost part of the sequence.

In general, conglomerate, conglomeratic sandstone, and sandstone are the prevalent rock types in the lower part of the post-Pottsville strata. They 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 strata. Claystone, a minor constituent of the lower part of the post-Pottsville sequence, is more common in its upper part. Medium- to thick-bedded, dark-gray to grayish-black coarse-grained sandstone in the lower part grades upward into thin- to medium- bedded, light-gray to light olive-gray and 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 post-Pottsville rocks. The strata above this horizon are generally lighter than the strata below the No. 9 coal bed.

QUATERNARY DEPOSITS

Unconsolidated deposits of clay, silt, sand, fine to coarse gravel, and boulders 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 in the area. No attempt was made to map these deposits.

STRUCTURE

The anthracite fields of Pennsylvania are in four arcuate structural depressions that trend northeastward across the east-central and northeastern parts of the State. The structural depressions are composite folds or synclinoriums on 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 of the folds. The mapped area includes part of both limbs of the synclinorium at the west end of the Western Middle anthracite field.

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 structure map (sheet 1) shows the configuration of the bottom 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

In the mapped area, the Western Middle synclinorium contains many subparallel subsidary folds. The synclinorium has an easterly plunge, although many of the subsidiary folds are doubly plunging. The trend of the subsidiary folds varies from N. 75° E. to N. 85° E. Many of the folds are less than a thousand feet wide, and only a few persist more than a mile or two along the strike before they merge with or overlap an adjacent fold. The axial planes of the folds in the northern and southern parts of the coal field in the mapped area are vertical or inclined steeply north or south, whereas those in the central part of the field are generally vertical.

The folds in the post-Pottsville rocks generally tend to be tight and asymmetrical, whereas some of the anticlinal folds in the structurally more competent Pottsville rocks are broad or open arches. In some areas the folds change in shape with depth (cross sections, sheet 2).

FAULTS

The principal faults are high-angle reverse faults that strike subparallel to the trend of the folds. The close association between faults and tight folds suggests that the faults as well as the folds are the result of compressional forces. Generally the faults in the northern part of the coal field dip 60 to 75 degrees to the south, those in the southern part have a similar dip to the north, and those in the central part of the coal field may be inclined in either direction. Dislocation of the overriding blocks on the fault surfaces is northward along the south-dipping faults and to the south on faults that are inclined to the north.

The folding and faulting in this area are considered to be contemporaneous. The duplication of the *C*, *D*, Buck Mountain (No. 5), and Skidmore (No. 7) coal beds in the west end of the Trevorton basin suggests that there was displacement along the Mahanoy Mountain fault prior to or contemporaneous with the development of the Trevorton basin and that the fault surface may be intimately folded with the strata at depth. Duplication of Pottsville and post-Pottsville strata elsewhere on Mahanoy Mountain may indicate displacement along the fault to a point about 2 miles east of the mapped area, where movement on the fault apparently dies out in the upper shale beds of the middle member of the Mauch Chunk formation.

The Little Mountain, North Franklin, and West Cameron faults seem to have formed later than the Mahanoy Mountain fault and probably offset the Mahanoy Mountain fault. These and the other high-angle reverse faults in the area probably are upthrusts that developed when the folding became severe. They are inclined toward the center of the synclinorium and undoubtedly provided a release for the compressional forces that tight folding in the Western Middle synclinorium could not fully accommodate.

The Bear Valley fault, which extends into the southeastern part of the mapped area, is believed to merge with the Mahanoy Mountain fault on Mahanoy Mountain just east of the Trevorton-West Cameron highway. About 1½ miles east of this area the Bear Valley fault dies out in a sequence of tightly folded post-Pottsville strata. Similarly, the movement along the Trevorton, Little Mahanoy, North Franklin, and other faults in the area is taken up by tight folding in the post-Pottsville strata.

There are several alternate interpretations of the available data. The faults on the north and south sides of the field might conceivably join at depth and in reality be continuous faults that formed in place, in which event the trough of the synclinorium has risen under compression and overrides the limbs. If the faults on the north and south sides of the field do join at depth it is also conceivable that they are the results of very early overthrusting from the south and now are so intimately folded with the strata they cannot be recognized.

COAL

The coal in the anthracite fields of Pennsylvania is characterized by its hardness, lustrous black color, and conchoidal fracture. There are local and regional variations in the rank and grade of the coal throughout the anthracite region but probably the most marked variation is the progressive increase in the percentage of volatile matter from the eastern to the western part. According to Turner (1938, p. 340), the percentage of volatile matter in the coal in the Western Middle field increases from less than 4 percent in the eastern part of the field to more than 11 percent in the western part, and the coals within the mapped area contain 9 to 11 percent volatile matter.

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. Prior to this series of reports, no attempt had been made to standardize the nomenclature between the different mines 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 of previous reports in 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 bed of the Southern anthracite field, according to White (1900, p. 811-812). No correlations are suggested for the other coal beds in the Pottsville formation, which are designated in ascending order coal beds *A*, *B*, *C*, and *D*. 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 in thickness of the coal beds in the mapped area. Figures on the right side of the table show the total thickness of coal only in each bed; figures on the left side of the table show the combined thickness of coal and shale partings in each bed. Most of the coal and bed thicknesses were obtained from mine company data and are an average of many underground observations. Thicknesses shown in the table also include many 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.

Average thickness and range in thickness of coal beds in the Trevorton quadrangle

Coal bed		Thickness in feet						Avg % of waste
		Bed (coal plus shale partings)			Coal			
Name	No.	Avg	Max	Min	Avg	Max	Min	
Post-Pottsville rocks								
Tunnel	19	---	---	---	---	---	---	---
Spahn or Peach Mountain	18	---	---	---	---	---	---	---
Little Tracy	17	---	---	---	---	---	---	---
Tracy	16	4.1	---	---	3.1	---	---	---
Little Diamond	15	---	---	---	---	---	---	---
Diamond	14	6.1	---	---	3.8	---	---	---
Little Orchard	13	4.7	6.5	3.0	4.0	5.0	3.0	14.9
Orchard	12	4.0	---	---	1.4	---	---	---
Primrose	11	6.6	7.9	5.2	5.5	6.2	5.1	16.7
Rough	10½	6.7	7.8	5.7	6.2	7.2	5.2	7.5
Holmes	10	6.5	8.5	4.3	5.9	7.9	4.0	9.2
Four-Foot	9½	3.3	4.0	2.4	3.2	4.0	2.4	3.0
Mammoth Top Split	9	10.7	13.0	5.8	10.1	13.0	5.0	5.6
Mammoth Middle Split	8½	11.2	14.8	5.6	10.1	13.7	5.6	9.8
Mammoth Bottom Split	8	5.7	11.4	1.2	4.5	10.5	1.2	21.1
Mammoth Bottom Split Leader.	8L	7.1	11.7	5.8	5.6	10.1	3.9	21.1
Skidmore	7	6.1	8.7	3.7	4.2	8.1	2.6	31.1
Skidmore Leader	7L	2.3	---	---	1.1	---	---	---
Seven-Foot	6	7.7	15.2	1.5	6.3	9.1	1.5	18.2
Buck Mountain	5	7.8	15.3	2.5	6.4	15.0	1.8	17.9
Pottsville formation								
D	---	3.2	6.5	1.8	2.3	3.7	1.0	28.1
C	---	3.0	---	---	3.0	---	---	---
B	---	---	---	---	---	---	---	---
A	---	3.9	5.6	2.5	3.7	5.5	2.5	5.1
Lykens Valley No. 4	---	7.8	10.1	4.3	6.8	10.1	3.5	12.8
L	---	---	---	---	---	---	---	---

[--- indicates no data available. Where no maximum or minimum is shown, only one measurement was available]

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 3 or 4 miles. A leader coal bed, which may be widespread, is so named 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 may in some places be separated from the principal bed by a stratigraphic interval of as much as 100 feet.

COAL BEDS MINED IN THE AREA

Mining operations within the mapped area are concentrated for the most part on the margins of the coal field. Mining in the deeper basins in the east-central part of the area has been confined to local operations at shallow depths. The Lykens Valley No. 4, *A*, No. 5, No. 6, No. 8, No. 8½, No. 9, No. 10, No. 10½, and No. 11 coal beds have been mined most extensively.

Coal beds in Pottsville formation.—The Lykens Valley No. 4 coal bed crops out about 200 feet above the base of the formation on the south side of Mahanoy Mountain and on the north side of Big Mountain. Locally the Lykens Valley No. 4 coal bed is mined to comparatively shallow depths in many independent mines along its outcrop on Mahanoy Mountain. It was also extensively mined in the old Katherine mine at the west end of the field.

Mining in the Lykens Valley No. 4 coal bed at most localities is hampered by numerous pinches and small faults. The average thickness of the bed in this area is 7.8 feet. The coal, however, is considerably softer than that mined from this bed in the eastern part of the coal field, and in mining it may be reduced to a very fine size.

Of the 6 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 Western Middle field. This coal, generally referred to as the "*O* vein" by the miners and called the Lykens Valley No. 2 coal bed in the eastern part of the field, is probably a correlative of the Lykens Valley No. 4 coal bed (White, 1900, p. 811-812) of the Southern anthracite field. The name Lykens Valley No. 4 coal bed is used in this report. In the southwestern part of the mapped area a local coal bed, designated the L coal bed, occurs about 175 feet below the Lykens Valley No. 4. Four other coal beds stratigraphically above the Lykens Valley No. 4 are designated in ascending order coal beds *A*, *B*, *C*, and *D*.

Coal bed *A* is in the middle of the Pottsville formation about 100 feet stratigraphically above the Lykens Valley No. 4 coal bed. It is mined almost as extensively as the Lykens Valley No. 4 coal in independent mines on Mahanoy Mountain and in the Katherine mine at the west end of the field. Coal bed *A* was also mined in the North Franklin mine in Big Mountain south of Trevorton. This bed, which averages about 3.9 feet thick, includes a 6-inch shale parting near the top throughout much of the southwestern part of the area. The quality of coal from bed *A* is generally better than from the Lykens Valley No. 4 bed.

The stratigraphic interval between coal beds *A* and *C* ranges from about 200 feet in the eastern part of the area to about 100 feet in the western part. At Bear Valley Rock Slope and east of the mapped area, a thin coal, designated coal bed *B*, is present about 100 feet above coal bed *A*. Coal bed *B* is apparently present west of Bear Valley Rock Slope.

Coal bed *D* is 15 to 50 feet above coal bed *C*. The thickness of both coal beds varies considerably throughout the area, as does the quality of the coal; however, both coal beds seem to be thicker and cleaner, and therefore are mined more extensively, along the outcrop on Big Mountain south of Trevorton than elsewhere within the mapped area. Both coal beds have been mined locally in the North Franklin mine on the south side of Big Mountain. Coal bed *C* has also been worked in several small independent mines on Mahanoy Mountain.

Coal beds in post-Pottsville rocks.—Of the 20 coal beds in the post-Pottsville rocks, the following 18 beds, listed in ascending order, are thought to be persistent: Buck Mountain (No. 5), Seven-Foot (No. 6), Skidmore (No. 7), Mammoth Bottom Split (No. 8), Mammoth Middle Split (No. 8½), Mammoth Top Split (No. 9), Four-Foot (No. 9½), Holmes (No. 10), Rough (No. 10½), Primrose (No. 11), Orchard (No. 12), Little Orchard (No. 13), Diamond (No. 14), Little Diamond (No. 15), Tracy (No. 16), Little Tracy (No. 17), Spahn or Peach Mountain (No. 18), and Tunnel (No. 19). Local variations of the lithology and stratigraphic interval between coal beds are shown in the graphic sections (sheet 2).

The Buck Mountain (No. 5) coal bed, at the base of the post-Pottsville sequence, is 400 to 500 feet above the Lykens Valley No. 4 coal bed. The Buck Mountain has been strip-mined over much of the outcrop length, and mined extensively underground for several hundred feet from the outcrop in the west half of the report area (structure contour map, sheet 1). The coal is of good quality and harder than the coal in most of the other beds in this area, but the bed includes several claystone or siltstone partings that must be mined with the coal. The roof rock is interbedded shale and sandstone that locally contain thin stringers of coal. The BuckMountain coal bed is underlain by conglomeratic sandstone, which in some areas grades laterally into pebble and cobble conglomerate, in the Pottsville formation.

The Seven-Foot (No. 6) coal bed is 15 to 50 feet above the Buck Mountain (No. 5) coal bed. This interval thins westward, and both coal beds are strip-mined as one operation at several localities in the western part of the coal field. The Seven-Foot is also extensively mined underground in the west half of the area. It is similar in appearance and quality to the Buck Mountain coal bed and the combined production from these coals probably ranks second only to production from the Mammoth coal zone.

The Skidmore (No. 7) coal bed, which is 50 to 100 feet above the Seven-Foot coal bed, has been mined very little in the Trevorton quadrangle. A few workings in the Skidmore coal indicate that the bed contains a high percentage (31.1) of waste throughout most of the area. In the southeastern part of the area the Skidmore Leader (No. 7L) coal bed is present about 40 feet below the Skidmore coal bed. The Skidmore Leader is too thin to mine and contains numerous small partings of bony coal and shale.

The Mammoth coal zone consists of three principal coal beds in this area. These beds are called the Bottom Split (No. 8), Middle Split (No. 8½), and Top Split (No. 9) coal beds. In addition to these principal coal beds, the Mammoth Bottom Split Leader (No. 8L) coal bed occurs 10 to 30 feet below the Mammoth Bottom Split in the southeastern part of the area.

The Mammoth Bottom Split coal bed is 60 to 120 feet above the Skidmore coal bed. The stratigraphic intervals between the Bottom and Middle Splits and between the Middle and Top Splits also vary considerably. The interval between the Bottom and Middle Splits ranges from 10 to 60 feet, and that between the Middle and Top Splits ranges from 10 to 160 feet. The rock between these coal beds is claystone, siltstone, and fine-grained sandstone. The average thickness of the coal in both the Middle and Top Splits, exclusive of partings in the beds, is more than twice the average thickness of 4.5 feet of coal in the Bottom Split. For this reason the Middle and Top Splits of the Mammoth zone are more extensively mined than the Bottom Split. However, most of the Mammoth coal that was accessible at shallow depth has been mined out, both on the surface and underground.

The Four-Foot (No. 9½) coal bed is 50 to 150 feet above the Mammoth Top Split coal bed. Although the Four-Foot coal bed averages more than three feet in thickness in the eastern part of this area, it is mined in only a few localities along the north and south margins of the coal field.

Most of the coal produced from coal beds stratigraphically above the Mammoth coal zone is mined from the Holmes (No. 10) coal bed, 100 to 200 feet above the Mammoth Top Split coal bed, and from the Rough (No. 10½) and Primrose (No. 11) coal beds, which are 100 and 200 feet, respectively, above the Holmes coal bed. These three coal beds are mined for several hundred feet from the outcrop near the Bear Valley Rock Slope in the southeastern part of the area. The Holmes and Rough coal beds have also been strip-mined along the north limb of the Edgewood basin in the northeastern part of the area, and the Holmes and Primrose coal beds have been mined both at the surface and underground over the Trevorton and Bear Valley anticlines in the east-central part of the mapped area. The Holmes coal bed, because of its generally uniform thickness, is mined more extensively than the Rough and Primrose coal beds.

The coal beds numbered 12 through 19 overlying the Primrose (No. 11) coal bed in the deeper basins of the eastern part of the report area are mined locally. Most of these coal beds contain a high percentage of waste, and the 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 may not agree with the blooms of weathered coal beds which, because of soil creep, are generally found lower on the slope than the original outcrops. 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 beds.

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 those particular coal beds; however, the coal is not necessarily of minable thickness throughout its 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 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 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 associated, in many places, 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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INTERIOR—GEOLOGICAL SURVEY, WASHINGTON, D. C.—61315

GEOLOGY OF ANTHRACITE IN THE SOUTHERN PART OF THE TREVORTON QUADRANGLE, NORTHUMBERLAND COUNTY, PENNSYLVANIA

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

1963

For sale by U. S. Geological Survey, price 1.25 per set

EXPLANATION

Boundary of mine

J. PAUL

Warranty tract

Boundaries are indicated for general orientation and identification but are not authenticated for legal purposes.

Borough line

Township line

County line

Principal shaft

Strip-mined area

Back-filled stripping

Exploratory trench

Tick shows where coal was found

Crop fall

Collapsed area where coal has fallen into underground workings.

5

Barrier pillar

Area reserved for barrier pillar in one bed only. Number designates the coal bed.

Barrier pillar

Area reserved for barrier pillar in more than one coal bed.

Mine waste

Includes such refuse from mining and breaker operations as culm, rock banks, coal piles, back fill, and silt in settling basins.

Steam-transported waste

A——A'

Structural cross section

Surface opening on a coal bed

5

Coal outcrop

Solid where location is known, long dashes where uncertain, short dashes where covered by mine waste. Number designates coal bed; L, local bed.

D 70

U

Fault showing dip and relative position of sides

Real direction of movement not necessarily known; u, upthrown side; d, downthrown side; →, overthrust plate. Fault trace is solid line where accurately known, long dashes where approximately located, dots where covered by mine waste.

Anticline

Showing crest line

Syncline

Showing trough line

Base: U. S. Geological Survey topographic map, 1944 Polyconic projection. 1927 North American datum.

Topography was contoured from aerial photographs made in 1942. Correction has not been made for topographic changes resulting from strip mining or alteration of mine refuse banks since 1942.

TRUE NORTH
MAGNETIC NORTH

APPROXIMATE MEAN DECLINATION, 1944

COAL OUTCROP MAP

SCALE 1:6,000

500 100 0 500 1000 2000 3000 Feet

Contour interval is 20 feet
Datum is mean sea level

DIAGRAM OF A TOPOGRAPHIC QUADRANGLE SHOWING THE AREA INCLUDED IN THIS MAP

Prepared in 1949 from data supplied by the Philadelphia and Reading Coal and Iron Company and the Susquehanna Collieries Company with modifications by the U. S. Geological Survey.

Separate copies of the base for this map, showing ownership, topography, and culture may be purchased from the U. S. Geological Survey.

INTERIOR—GEOLOGICAL SURVEY, WASHINGTON, D. C.

Drafted by John T. Howells

GEOLOGY OF ANTHRACITE IN THE SOUTHWESTERN PART OF THE MOUNT CARMEL QUADRANGLE, PENNSYLVANIA

By
Howard E. Rothrock, Holly C. Wagner, Boyd R. Haley and Harold H. Arndt

1951

COAL INVESTIGATIONS
MAP C 7 (IN 3 SHEETS) SHEET 1

GEOLOGY OF ANTHRACITE IN THE SOUTHWESTERN PART OF THE MOUNT CARMEL QUADRANGLE, PENNSYLVANIA

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1951

STRUCTURE MAP OF THE BUCK MOUNTAIN AND MAMMOTH COAL BEDS

SCALE 1:6,000

500 100 0 500 1000 2000 3000 Feet

Contour interval is 100 feet
Datum is mean sea level

Polyconic projection. 1927 North American datum.

APPROXIMATE MEAN DECLINATION, 1944

DIAGRAM OF A TOPOGRAPHIC QUADRANGLE SHOWING THE AREA INCLUDED IN THIS MAP

Prepared in 1949 from data supplied by the Philadelphia and Reading Coal and Iron Company and the Susquehanna Collieries Company with modifications by the U. S. Geological Survey.

Drafted by John T. Howells

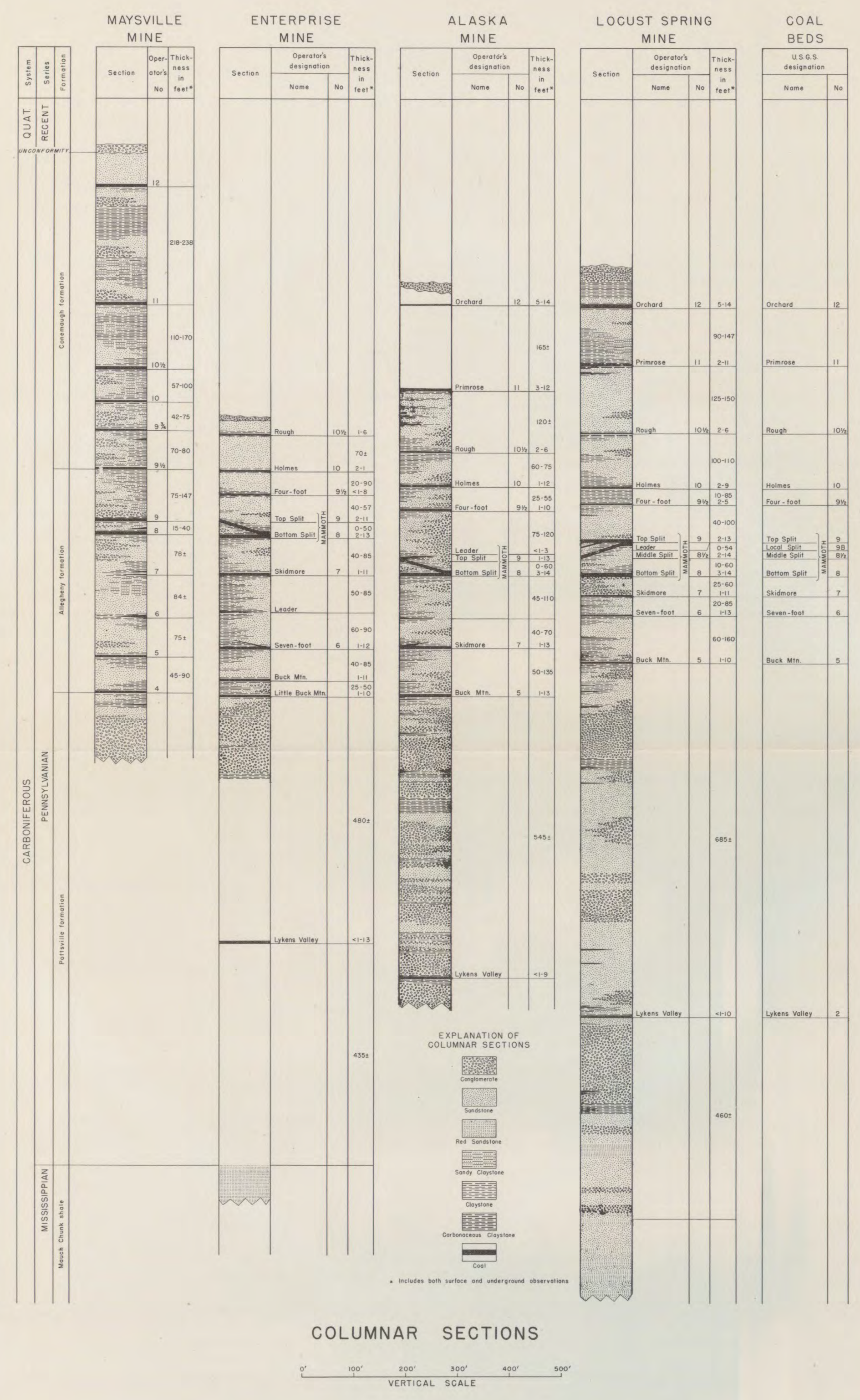
INTERIOR—GEOLOGICAL SURVEY, WASHINGTON, D.C.

EXPLANATION

- Boundary of mine
- J. PAUL — Warranty tract
  Boundaries are indicated for general orientation and identification but are not authenticated for legal purposes.
- Township line
- County line
- A — A′ Structural cross section
- 34 — Cross section from which stratigraphic column 34 of the coal interval diagram was made

Note: Green structure and outcrop symbols apply to the Buck Mountain coal bed. Red structure and outcrop symbols apply to the bottom split of the Mammoth coal bed.

- Outcrop of coal bed
- Fault cutting contoured bed showing dip of fault plane, relative position of faulted segments, and overthrust segment.
  Fault trace is solid where accurately located, long dashes where approximately located. Fault trace on underlying plate is indicated by short dashes where accurately located and dots where approximately located. U, upthrown segment; D, downthrown segment; -t, overthrust segment.
- Shear zone
- Anticline
  Showing crest line; solid where location is known, dashed where location is uncertain.
- Syncline
  Showing trough line; solid where location is known, dashed where location is uncertain.
- Drainage tunnel
- Barrier pillar in contoured bed



COLUMNAR SECTIONS

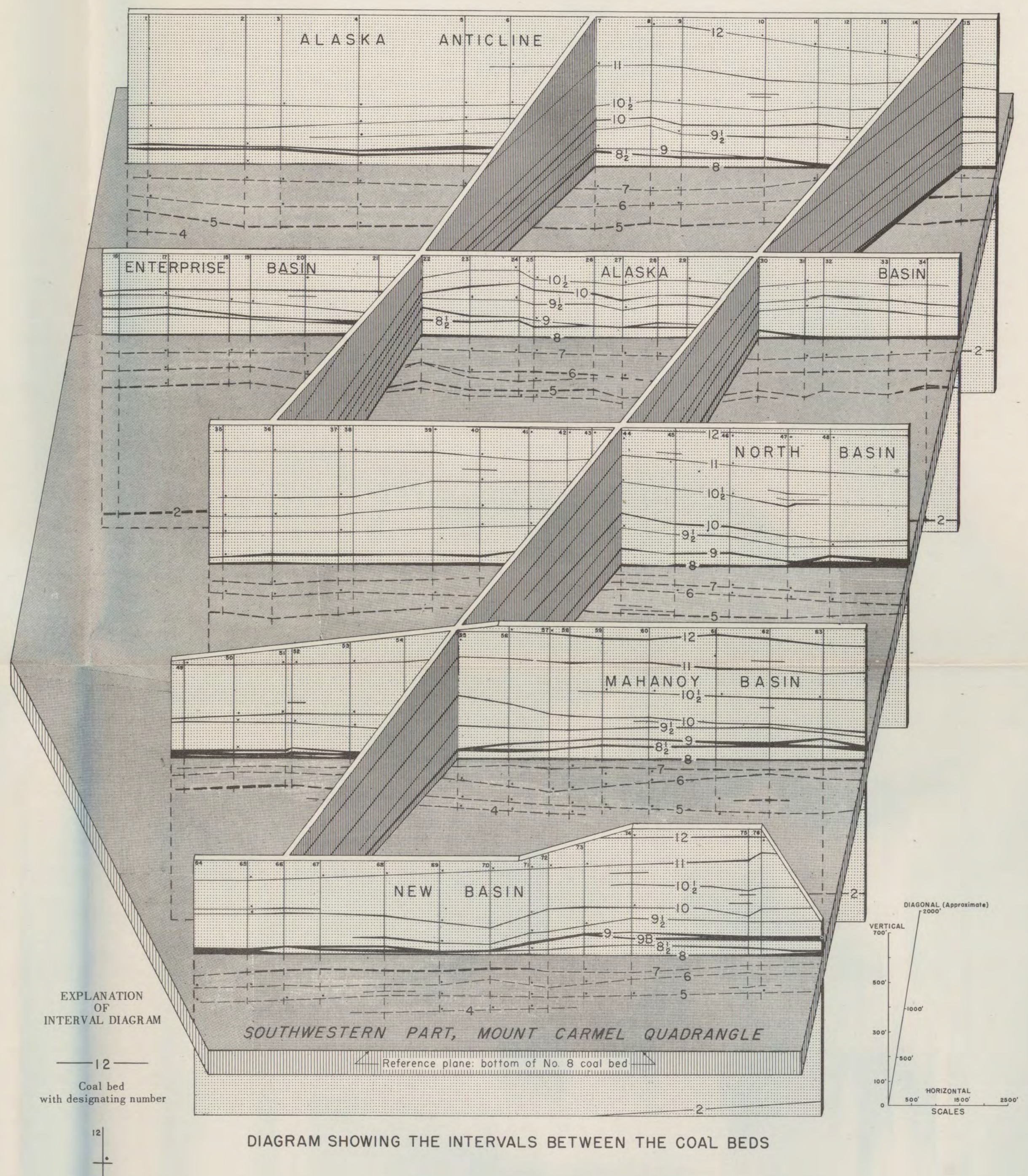
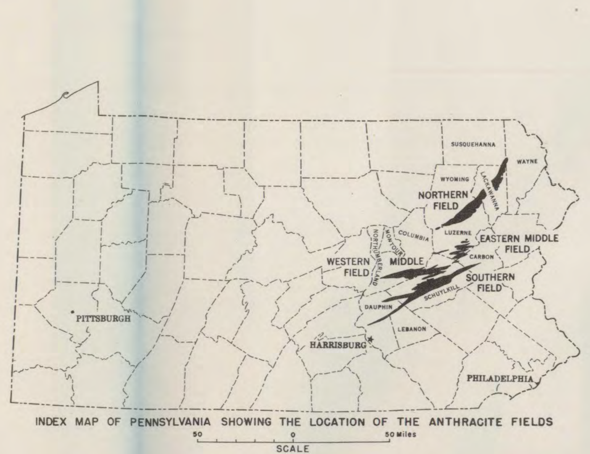
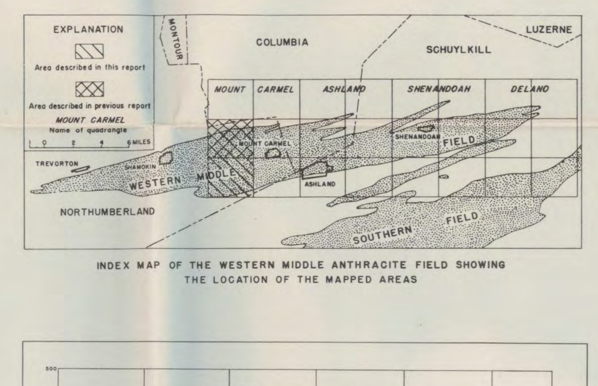


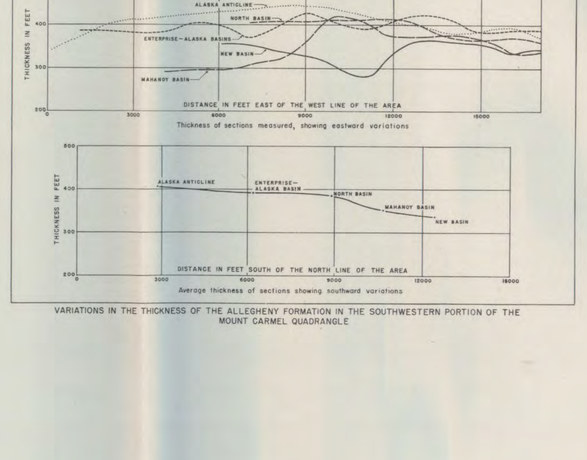
DIAGRAM SHOWING THE INTERVALS BETWEEN THE COAL BEDS



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



VARIATIONS IN THE THICKNESS OF THE ALLEGHENY FORMATION IN THE SOUTHWESTERN PORTION OF THE MOUNT CARMEL QUADRANGLE

GEOLOGY OF ANTHRACITE IN THE SOUTHWESTERN PART OF THE MOUNT CARMEL QUADRANGLE, PENNSYLVANIA

INTRODUCTION

LOCATION

The Pennsylvania anthracite fields, the principal source of anthracite in North America, are in the eastern part of the Commonwealth of Pennsylvania. (See index map of Pennsylvania, sheet 3.) The coal occurs in four roughly crescentic areas, called the Northern, Western Middle, Eastern Middle, and Southern fields, that trend northeastward and lie in echelon arrangement. The fields range in length from 24 to 66 miles and in width from a fraction of a mile to 10 miles, and include about 484 square miles of coal-bearing land. The area covered by this report is in the Western Middle field.

The boundaries of the coal-bearing areas that constitute the anthracite fields are considered to be the outcrops of the oldest of the Lykens Valley coal beds. In each of the fields this boundary is a single continuous line, except in the Eastern Middle field, which consists of several closely spaced but disconnected coal-bearing areas. The approximate boundaries of the fields are generally indicated by outcrops of the conglomeratic Pottsville formation or of the red rocks of the Mauch Chunk shale below the Pottsville.

The mapped area here described is near the middle of the Western Middle field and consists of the southwestern part of the area included in the United States Geological Survey's Mount Carmel topographic quadrangle sheet. (See index map of the Western Middle field, sheet 3.) This part of the quadrangle is between latitudes 40°45'00 and 40°47'30" N., a distance of 2.87 miles, and longitudes 76°26'15 and 76°30'00" W., a distance of 3.26 miles, and is almost entirely in Northumberland County. The town of Locust Gap is near the center of its eastern boundary.

PURPOSE

This report is the second to be prepared as a result of a geologic investigation of the anthracite fields of Pennsylvania begun after consultation with the Bureau of Topographic and Geologic Surveys of the Commonwealth of Pennsylvania. This report and others in preparation will show (1) the location of coal outcrops, (2) the depth, pitch, and other structural features of representative coal beds, (3) the natural and artificial barriers between mines and the structural relationships between the various coal basins, and (4) the correlation of the beds, the stratigraphic intervals between them, and the thickness, continuity, and other physical characteristics of the coal. The reports will bring up to date and amplify the Grand Atlas of the Anthracite Fields published by the Second Geological Survey of Pennsylvania in 1884-1885, and the reports that supplemented that atlas. It is expected that the reports will aid operators who are mining either on the surface or underground, or who are formulating plans for control of mine water. It is hoped that these reports will also direct attention to overlooked or unutilized reserves of coal.

A preceding report described the west-central part of the Mount Carmel quadrangle (Rothrock et al., 1950) and it is planned to publish similar reports on other unit areas as they are completed.

METHODS OF WORK AND ACKNOWLEDGMENTS

The methods used in preparing this report are similar to those described in the first report. Extensive use was made of the coal companies' surface and mine maps and structural cross sections, generally drawn to a scale of 1 inch = 100 feet. The generosity of the Philadelphia and Reading Coal and Iron Company and the Susquehanna Collieries Company in permitting the use of their records is gratefully acknowledged.

GEOLOGY

STRATIGRAPHY

The rocks that crop out in the mapped area belong to the Carboniferous and Quaternary systems and include in ascending order the upper part of the Pottsville formation, all of the Allegheny formation, and the lower part of the Conemaugh formation of Pennsylvanian (Carboniferous) age, and alluvial deposits of Pleistocene (?) and Recent (Quaternary) age. (See columnar sections, sheet 3.) On the south side of Mahanoy Mountain the Mauch Chunk shale of Mississippian (Carboniferous) age is exposed below the Pottsville formation, but the contact was not mapped. The boundaries between the Pennsylvanian formations are considered to be the Buck Mountain (No. 5) coal bed at the base of the Allegheny and the Holmes (No. 10) coal bed at the base of the Conemaugh (Lohman, 1937, p. 36). The outcrops of these two coal beds, as shown on sheet 1, indicate the areal distribution of the Allegheny and Conemaugh formations and of the top of the Pottsville formation. Data for the following stratigraphic descriptions were obtained from field observations and from the study of many mine cross sections, core drill records, and sections measured along mine tunnels, slopes, and shafts. The blank areas in the columnar sections (sheet 3) indicate that reliable information concerning this lithology was not available.

PENNSYLVANIAN ROCKS

The Pennsylvanian rocks are of continental origin and consist of lenticular deposits of conglomerate, sandstone, siltstone, claystone (generally called slate by the miners), and coal. The beds of coal are the most persistent of these rock types. The others, particularly the arenaceous rocks, show great lateral variation.

Pottsville formation. The Pottsville formation of Pennsylvanian (Carboniferous) age consists chiefly of resistant conglomerate that forms the core of Mahanoy and Locust Mountains. It lies above the Mauch Chunk shale of Mississippian (Carboniferous) age and below the Allegheny formation of Pennsylvanian age. The Pottsville formation ranges in thickness from an average of approximately 925 feet in the Enterprise mine area to approximately 1140 feet in the Locust Spring mine area. (See columnar sections, sheet 3.) The base of the Pottsville is exposed in the highway cut on Mahanoy Mountain, northeast of Gowen City, about 2 miles west of the mapped area. In this locality the contact between the Pottsville and the Mauch Chunk is gradational and is considered to be at a place below which the predominant rocks are red, green, and grayish-brown claystone and siltstone. Argillaceous rocks are also present above this horizon, but conglomerate, interbedded with coarse-grained sandstone, predominates. The lower part of the Pottsville formation is well exposed only in the vicinity of the Locust Spring mine, where it is composed chiefly of arenaceous rocks that grade irregularly from siltstone at the base to thick conglomerate at the top. The Lykens Valley (No. 2) coal, which is a convenient datum for separating the lower and upper parts of the formation, lies a few feet above the conglomerate. The upper part of the Pottsville formation consists of conglomerate and coarse-grained sandstone with a few claystones and local coal beds scattered through it. The most persistent of the claystones occurs about 200 feet below the top of the formation in the Enterprise, Alaska, and Locust Spring mine areas and may represent the southern margin of deposition of the Whites coal, which is mined in the west-central part of the Mount Carmel quadrangle.

The pebbles in the conglomerates are mainly quartz and quartzite, although other types such as grayish-black chert, black chert, sandstone, siltstone, and claystone may be locally abundant. The pebbles range in length from a few millimeters to 10 centimeters. A high percentage of the pebbles are ovoid, but in the lower part of the formation semirounded fragments of siltstone are common. At some horizons the chert pebbles are relatively abundant, whereas at others they are very rare. The coal beds in the Pottsville formation are in its upper half and consist of the extensively mined Lykens Valley (No. 2) bed near the middle of the formation, a sparingly mined bed 25 to 50 feet below the top of the formation, called the Little Buck Mountain (No. 4) bed, and four coal beds of only locally minable extent.

Allegheny formation. The Allegheny formation, which overlies the Pottsville formation and underlies the Conemaugh formation, includes the Buck Mountain (No. 5) coal bed as its basal bed and extends to the base of the Holmes (No. 10) coal bed, the basal bed of the Conemaugh formation. The formation consists of interbedded conglomerate, sandstone, siltstone, claystone, and coal. The coal beds are the most persistent of these strata. They comprise the majority of the beds that are mined in the area, including in ascending order the following: Buck Mountain (No. 5), Seven-foot (No. 6), Skidmore (No. 7), Mammoth (Nos. 8, 8½, 9), and the Four-foot (No. 9½) coal beds. Most of the other strata in the formation are too variable to be correlated accurately, but the conglomerates that occur above and below the middle split and above the top split of the Mammoth coal zone are sufficiently persistent to be notable and have been used to correlate the Mammoth zone in small areas. Another lithologic characteristic that is helpful in correlating the bottom split of the Mammoth coal zone is the character of the floor or "bottom" rock of that bed. This rock is thin carbonaceous claystone beneath which is yellowish-brown siltstone that in many places contains ovoid ironstone concretions ranging from 3 inches to 4 feet or more in length.

The thickness of the Allegheny formation, exclusive of local extremes due to deformation, ranges from 428 feet in the Enterprise and Alaska basins to 278 feet in the New basin. The variations in thickness are shown in the accompanying table and in the graphs on sheet 3. The table and the lower of the pair of graphs show that the formation thins southward. The upper graph shows that the thickness of the formation varies from east to west but that this variation is irregular. It also indicates that the greatest variation in thickness occurs in the New and Mahanoy basins, which have been more intensively deformed than the other structures.

THICKNESS OF THE ALLEGHENY FORMATION
IN THE SOUTHWESTERN PART OF THE MOUNT CARMEL QUADRANGLE

Structure	Thickness in feet: Maximum	Minimum	Average	Percentage range of thickness: Above average	Below average
Alaska anticline	420	340	406	3.4	16.2
Enterprise and Alaska basin	428	370	393	8.9	5.9
North basin	408	335	386	5.5	13.2
Mahanoy basin	420	290	351	19.7	17.4
New basin	363	278	337	7.7	17.5

Conemaugh formation. Only 600 feet of the Conemaugh formation is exposed in the mapped area, the upper part having been removed by erosion. The formation includes the Holmes (No. 10) coal bed at its base and extends to about 65 feet above the Diamond (No. 14) coal bed. It is composed chiefly of fine-grained clastics but includes lenticular beds of conglomerate between most of the coals. The coal beds in the formation are, in ascending order, the Holmes (No. 10), Rough (No. 10½), Primrose (No. 11), Orchard (No. 12), Diamond (No. 14), and a few local beds. Above the Holmes (No. 10) coal is a thick-bedded micaceous coarse-grained sandstone that is persistent enough to be useful in correlation.

QUATERNARY DEPOSITS

Pleistocene (?) deposits. No attempt was made to map Pleistocene deposits in the area covered by the accompanying maps. A deposit thought to be of that age is in the southwestern corner of the mapped area about 900 feet south of the common corner between Coal, Mount Carmel, and East Cameron Townships. The exposed part of the deposit is about 75 feet wide and 500 feet long and trends in a northeasterly direction, following the course of the headwaters of the West Branch of Locust Creek. The deposit is a mass of light-gray conglomerate boulders, mostly sub-angular, ranging in maximum diameter from 6 inches to 3 feet but averaging about 1 foot. The subangular shape and common composition of the boulders suggest that they are not far removed from their source, and were not subjected to much stream action or contamination. They are thought to be Pleistocene in age because the agents of transportation of the current cycle of erosion appear to be inadequate to form such a deposit.

Recent deposits. The deposits of Recent age are similar to those in the west-central part of the Mount Carmel quadrangle, where they are described as consisting of "silt, sand, gravel, boulders, and water-borne or alluvial mine refuse" (Rothrock, et al., 1950, sheet 3). These materials occur chiefly in the lower valleys, where alluvial mine refuse generally forms the top layer of the deposit. As the mapped area may have been covered by ice during the Pleistocene epoch of the Quaternary period (Ashley, 1931), it is possible that some of the alluvium is of Pleistocene age.

STRUCTURE

GENERAL DESCRIPTION

Each of the Pennsylvania anthracite fields is a composite syncline consisting of a group of roughly parallel folds, some of which have been faulted. The general trend of these structures is northeastward. The synclinal areas are called basins by miners, a practice that is followed in this report. The term "basin" generally designates a complete syncline, consisting of a trough and two limbs, but in some places it is applied to partial synclines that have been truncated by faulting. (See cross sections, sheet 3.)

The composite syncline that contains the Western Middle field is 4¾ miles wide in the western part of the Mount Carmel quadrangle and has a maximum relief of about 2.200 feet, as measured from the highest outcrops of the Lykens Valley coal bed to its greatest depth (as projected) in the Shamokin basin. The deeper parts of the syncline are near its middle and along its southern margin. The trough near the middle is composed of three closely folded and moderately faulted overlapping basins, the Shamokin and Mount Carmel basins in the northern part of the mapped area and the Pennsylvania basin north of it. The axial plane of the Pennsylvania basin is approximately vertical, but that of the Shamokin basin and part of that of the Mount Carmel basin dip 70° to 80° southward. The trough near the southern margin of the composite syncline of the Western Middle field is also composite, consisting of the New, Mahanoy, and North basins, but it is more extensively faulted and its folds are generally more asymmetrical than its northern counterpart. Parts of these basins actually overlie one another. (See sheet 2.) The southern trough widens northeastward and becomes the predominant structural feature of the eastern part of the Western Middle field.

The area between the two major troughs is dominated by the Locust Mountain anticline which, near the western edge of the mapped area, is almost as high as the margins of the Western Middle field. The anticline plunges gradually northeastward from this locality, being about 500 feet lower at the eastern edge of the mapped area. The structure between the anticline and the middle trough is a broad, gently undulating sequence of folds of low relief, containing the Alaska and Big Mountain basins. The Locust Mountain anticline appears to have constituted a buttress to the deformational forces, which folded the rocks closely on the south but affected those north of it to a much lesser degree.

FOLDS

All the rocks in the area have been folded in patterns suggestive of the type called parallel folding. The principal folds range in degree of compression from obtuse folds such as the Enterprise basin and the Alaska and Big Mountain anticlines, whose limbs enclose angles ranging from 110° to 160°, to moderately acute folds such as the Shamokin and Mount Carmel basins and the basins in the southern trough, whose limbs enclose angles ranging from 75° to 90°. Extremely acute folds are rare except as drag folds or other minor structural features.

The axial planes of the folds are either vertical or inclined a few degrees southward. (See cross sections, sheet 3.) Asymmetry in the New and North basins and in the Shamokin anticline is mostly assumed, but it can be demonstrated in parts of the Mahanoy and Shamokin basins and the Locust Mountain anticline. None of the large folds exhibits the degree of asymmetry that resulted in overturning, sometimes called "inversion," such as that shown in the Locust Gap area on maps of the reports of the Second Geological Survey of Pennsylvania (Ashburner, 1886). Subsequent mining has shown that this structure, as well as several similar structures in adjoining areas, is the result of thrust faulting instead of overturned folding. Overturned folds occur locally, however, as drag folds along faults, and inverted dips are present in some places along the steeply dipping south limb of the New basin.

FAULTS

All the observed faults in the area are genetically thrust shears that dip at angles ranging from vertical to horizontal. The planes of the faults are relatively flat, as in the Mount Carmel basin, or are curved, like the Enterprise, Locust Gap, and Locust Spring faults. (See cross sections, sheet 3.)

Principal faults. The principal faults generally cut the beds at angles of about 45°, but in many places they follow the bedding. (See Enterprise fault, cross section *A-A'*, sheet 3.) Outcrops of the principal faults are few. One of the best can be observed in the field where the Locust Spring fault cuts the west end of the New Basin. The curvature of the faults and the folds of the strata are responsible for the many examples of faults that genetically are thrusts but geometrically are normal faults. (See southern outcrop of Locust Spring fault, sheet 1.)

Evidence relating to the time and method of formation of the curved faults is not complete. It is possible that they were formed well in advance of appreciable folding and produced overlapping sheets or plates of but slightly folded strata. When the mass could no longer be compressed by faulting, the stabilized fault planes, as well as the overlapping plates, were folded.

The hypothesis that deformation occurred in three instead of two principal stages, however, is supported by evidence. According to this hypothesis the first stage resulted in moderate folding such as that in the western part of the Appalachian Valley and Ridge province, west of Willis Mountain, Pennsylvania, and in the adjoining Allegheny Plateau province (Pittsburgh Geological Society, 1948).

The second stage began when compression was relieved partly by shearing and overthrusting and partly by folding. Shearing probably took place on the lee (northwest) flank of the folds, but there is no evidence in the mapped area that faulting was deferred until the folds were extensively compressed or overturned. After faulting began, deformation proceeded both by additional telescoping, or overthrusting, and by greater compression of the folds. These processes probably alternated with each other until the fault planes became so flexed that further movement along them was impossible. Subsequent deformation of the stabilized mass, which took place chiefly by folding, represents the third stage.

Deformation in the Enterprise basin is considered to be representative of the second stage of deformation in the three-stage hypothesis. The folds are of low relief and relatively large amplitude; the Enterprise fault generally cuts the beds at low angles or follows bedding planes; the younger beds moved relatively northward. (See cross section *A-A'*, sheet 3.) The movement pivoted on the east end of the faulted plate where segments of the Enterprise fault terminate near Locust Gap and half a mile southeast of Maysville No. 1 slope. (See sheet 1.) These two segments can be traced westward into the adjoining area through workings in the Mammoth bed, where they are shown to be the same fault. The third stage of deformation is represented by the New, Mahanoy, and North basins.

This three-stage hypothesis is not thoroughly substantiated. More evidence bearing upon it will be obtained during the extension of the current studies to other parts of the anthracite fields.

Subsidiary faults and shear zones. There is no clear line of demarcation between subsidiary (local) faults and principal faults because of intergradation of the two types.

In many places mining operations are more directly affected by subsidiary faults than by principal faults. Bedding-plane faults cause much local disturbance of the coal. The features that miners call "dirt faults," and probably some that they call "pinches," are bedding-plane faults, in contrast to the term "rock fault," which denotes a fault whose offset is transverse to the bed and greater than its thickness.

Oblique faults, also subsidiary, are common in the mines. They generally trend at angles of about 45° with the longitudinal axes of the structures, and may cut one or more beds. They may be associated with shear zones (see sheet 2) or with small folds, called rolls, both of which probably represent an early stage in the development of these faults. Some of these faults offset axes of folds, and so were formed later than the folding that established these axes.

Shear zones also are subsidiary structures that affect mining adversely. Bands of sheared coal occur in places in most of the beds, and large areas of some beds are sheared, but neither condition may be extensive enough to make the bed unminable. In some areas, however, the coal is so extensively sheared that it cannot be mined economically. Such areas are represented as shear zones on sheet 2. This category generally includes the "faulty" areas on company mine maps and areas in which "shelly" coal is predominant. Each shear zone is usually confined to a single bed, but if the zone is associated with a transverse fault it may occur in each bed cut by the fault. Shear zones are generally elongate, but they may be oval, or branching, or have other shapes. They are formed in an incompetent bed by relatively slight differential movement of the adjacent competent rocks, and are composed of the rock fragmented by this movement. If the fragments are coal they occur in thin lenticular masses or flakes bounded by curved slickensided gliding planes, and are called "shelly" coal. Low cohesion between the flakes is indicated by the fact that the sheared coal readily falls apart or "runs" where mined.

EFFECT OF DEFORMATION ON THE THICKNESS OF STRATA

Deformation has affected the thickness of the strata in the mapped area. The effect on coal beds is evident in the troughs of closely folded synclines, which in some places contain masses of coal several times thicker than the normal thickness of the involved coal beds. Some of this thickening is the result of overlapping beds, and some is due to the movement of shelly coal by gliding along its slickensided surfaces. The movement of individual flakes may be small, but the aggregate movement of countless numbers of flakes may be very large. This movement is away from areas of maximum pressure, as on the limbs of folds, toward areas of minimum pressure, as along the axes of folds. The presence of stringers of apparently solid coal in fractures in the rock is believed to be the result of similar gliding between coal flakes or particles.

The effect of deformation on other strata differs with the competency of the rock. Measurements on single beds, however, do not yield reliable quantitative data on this problem because of lateral variation in facies and thickness. Therefore a sequence of such strata, the Alleghany formation, was studied. Stratigraphic sections, measured at places of approximately equal dip, were prepared and their thicknesses averaged for each principal structure. The dip of the rocks at the places where the sections were measured was also determined, and averaged for each structure. Comparison of these data shows that the Alleghany formation thins as the degree of folding increases. This trend is expressed quantitatively in the following table:

RELATIONSHIP BETWEEN THE THICKNESS AND THE DIP OF STRATA
IN THE ALLEGHENY FORMATION IN THE SOUTHWESTERN PART
OF THE MOUNT CARMEL QUADRANGLE

Structure	Average dip where measurements were made	Average thickness of the formation	Percentage decrease from thickness on Alaska anticline
Alaska anticline	19°	406	0.0
Enterprise and Alaska basins	27°	393	3.2
North basin	33°	386 } 368	9.3
Mahanoy basin	34°	351 } 368	
New basin	63°	337	17.0

The relationship between stratigraphic thickness and degree of deformation is also indicated on the accompanying charts showing variations in the thickness of the Allegheny formation. The thickness of this formation varies irregularly along the strike of the folds but exhibits no definite trend in this direction. The degree of irregularity, however, is greater in the southern, more closely folded basins, than in the northern structures.

COAL BEDS

NOMENCLATURE AND CORRELATION OF THE COAL BEDS

Coal beds in the anthracite fields are generally known as veins, following very early custom. The term "vein," in scientific usage, refers to tabular mineral deposits that are foreign to, and younger than, the rocks in which they occur, and so in geology is not properly applicable to deposits of coal. In this report the coal deposits are called coal "beds."

The coal beds of a mine are designated by names or numbers, or by both, but this nomenclature has not been completely standardized. Great progress, however, has been made since the early days of mining, when names were given to beds in isolated mines before correlation could be made. Other factors contributing to this lack of uniformity are the complexity of structure and lithology, the scarcity of outcrops, and the difficulty of changing established records.

The names of the coal beds used in this report were chosen to conform to the consensus of usage among operators and to the nomenclature of the previous report of this series. These names do not necessarily agree with those used in the reports of the Second Geological Survey of Pennsylvania, which conformed to local usage only (Ashburner, 1883, p. 84).

DESCRIPTION OF THE COAL BEDS

THICKNESSES AND OUTCROPS OF COAL

The coal thicknesses shown in this report were selected chiefly from very numerous underground measurements made by the operators. They were chosen to indicate the normal thickness of the bed and its included coal in unit areas 1000 feet square. Wherever possible, at least four measurements were averaged for each unit area. Measurements that were considered to be abnormally affected by structural deformation, such as faulting, pinching, or swelling, were not used; hence, extreme dimensions of the beds are not included. The following table shows the averages and ranges of these unit-area figures in the mapped area. The ranges in thickness shown in this table, however, may be less than the ranges shown on the columnar sections on sheet 3 because those in the table represent thicknesses in mined areas, whereas those in the columnar sections represent thicknesses throughout the mapped area.

AVERAGE THICKNESSES AND RANGES IN THICKNESS OF COAL BEDS
MINED IN THE SOUTHWESTERN PART OF THE MOUNT CARMEL QUADRANGLE

Bed number	Thicknesses: Bed, Average	Bed, Range	Coal, Average	Coal, Range	Percent of refuse
14		1'6" - 8'7"			
12	9'4"	5'0" - 16'2"	6'7"	3'8" - 12'6"	29.4
11	5'10"	1'6" - 11'10"	4'11"	1'6" - 10'10"	15.7
10½	4'7"	3'8" - 6'4"	3'4"	1'11" - 5'7"	27.2
10	4'7"	0'6" - 12'0"	3'11"	0'6" - 7'6"	14.5
9½	3'6"	1'10" - 10'1"	2'10"	0'6" - 9'11"	19.0
9	6'8"	0'10" - 23'4"	5'7"	0'7" - 16'4"	16.2
8½	6'8"	1'4" - 16'7"	5'8"	1'4" - 15'7"	15.0
8	7'0"	0'8" - 16'4"	6'3"	0'2" - 13'7"	10.7
7	3'4"	1'0" - 11'5"	2'7"	0'4" - 8'3"	22.5
6	3'10"	0'10" - 13'6"	2'10"	0'5" - 9'4"	26.0
5T	4'7"	1'4" - 10'4"	2'11"	1'0" - 5'8"	36.4
5	5'5"	1'0" - 13'10"	4'2"	0'1" - 11'7"	23.0
4	4'7"	1'0" - 10'0"	2'11"	1'0" - 5'5"	36.4
2	6'2"	1'7" - 12'6"	5'8"	0'5" - 12'6"	8.1

Coal beds less than 1-½ feet (18 inches) thick are generally not recorded in this report. Coal beds that have thicknesses of 18 inches or more for only short distances up and down, dip or across it are herein termed "local" beds and are shown on sheet 1 for short distances only. Outcrops of the more persistent beds are indicated, in some places, for long distances beyond any known point of occurrence. They give the authors' estimate of the position of the horizon of the bed in order to serve as a guide for prospecting, but do not signify that the bed is necessarily minable throughout this extent.

The outcrops shown on sheet 1 indicate the positions that the coal beds would occupy if they were projected to the surface of the ground. The beds rarely crop out in this manner because they are generally covered by a mantle of soil, and where they appear in the soil as weathered coal or bloom they occur down the slope at various distances from their original positions because of creep of the weathered soil. Exploration for the unweathered outcrop, therefore, should be started at the position of the outcrop shown on the map and extended in the direction of dip of the coal bed.

LYKENS VALLEY (NO. 2) COAL BED

The Lykens Valley (No. 2) coal bed, which lies about 150 feet stratigraphically above the contact of the Mauch Chunk shale and Pottsville formation, is the most widely mined bed in the Pottsville. It has been mined extensively underground in the Reliance mine, and subsurface mining and surface stripping operations have been carried on sporadically in the Helfenstein, Ben Franklin, and Margie Franklin mining areas in the southern part of the mapped area. The bed has been found in tunnels and by exploratory drilling in other mines of the area, but it has not been worked in them. The bed is usually found at the base of an abrupt slope if the outcrop occurs in the side of a mountain.

The Lykens Valley (No. 2) coal bed normally is a single bed of hard, dense, medium-bright coal containing little refuse. Its thickness averages 6'2" but varies widely. The bed contains a parting of gray sandstone 7 feet thick in one of the strippings on the south side of Mahanoy Mountain. A notable example of the detrimental effect of faulting occurs near the boundary of the Reliance and Alaska mines, where a bedding-plane fault has made mining unprofitable.

Several local coal beds, 18 inches or more thick, occur in the Pottsville formation. One of these is indicated by the waste beside a single prospect pit in the southwestern part of the mapped area, where it is approximately 140 feet below the No. 2 bed. Three other local beds, found by diamond drilling and surface prospecting, occur above the Lykens Valley (No. 2) bed. The oldest of these beds lies about 20 feet stratigraphically above the No. 2 bed and consist of 1'6" of sheared coal. About 110 feet higher in the stratigraphic column another local bed, containing 3'2" of coal and refuse, was found. The youngest of these beds lies about 480 feet above the No. 2 coal bed and was found to have a bed thickness that ranged from 7'6" to 1 8", of which 2'7" to 1'8" was coal.

The authors believe that these local beds represent the margins of beds that attain minable thicknesses to the west in the Shamokin and Trevorton quadrangles, and to the southwest in the Southern anthracite field where as many as eight beds within the Pottsville formation have been mined.

LITTLE BUCK MOUNTAIN (NO. 4) COAL BED

The Little Buck Mountain coal bed, approximately 30 feet below the top of the Pottsville formation, is the uppermost coal in the Pottsville. It was mined only in the Enterprise mine, where it was reached by short rock holes from the Buck Mountain bed. The Little Buck Mountain bed does not crop out in the mapped area because it is cut off by faulting. Immediately west of the mapped area, however, it crops out along the north flank of the Locust Mountain anticline. Drill-hole records show the presence of coal at the horizon of the No. 4 bed in the Locust Gap, Locust Spring, Alaska, and Reliance mines.

BUCK MOUNTAIN (NO. 5 AND 5T) COAL BED

The Buck Mountain coal bed marks the base of the Allegheny formation. It lies 330 feet stratigraphically above the Lykens Valley (No. 2) coal in the northern part of the mapped area and 685 feet above it in the southern part. Generally the Buck Mountain is a single bed, but in the western part of the area it consists of two units, or splits, called No. 5 and No. 5T coals in this report. In the Excelsior-Corbin mine, where both splits were worked, they are separated by 10 to 30 feet of shale and sandstone. The No. 5 bed crops out along both the north and the south sides of Locust Mountain and along the north side of Mahanoy Mountain. The Enterprise fault, a strike fault along the north limb of the Locust Mountain anticline, has cut the Buck Mountain coal for a distance of about 2-½ miles, repeating the bed in places and eliminating much of the outcrop in the western part of the area. (See sheets 1 and 2.)

The Buck Mountain bed has been mined extensively in the Scott, Alaska, Excelsior-Corbin, Enterprise, and Locust Gap mines and locally in the Reliance, Pennsylvania, Maysville, and Locust Spring mines as shown on Sheet 2 by the relative abundance of solid as compared with dashed contour lines. The thickness of the coal decreases southeastward from about 7 feet in the northern part of the mapped area to 3 feet in the southern and eastern parts of the mapped area. Mining of the Buck Mountain bed in the Locust Spring mine has been very local, possibly owing to the irregularity in thickness of the coal. The average thicknesses of the bed and its included coal in the mined areas were 5'5" and 4'2", respectively.

The coal in the Buck Mountain bed is typically bright in luster and often breaks to small cubical or rectangular fragments whose faces usually exhibit conchoidal fracture or contain whitish deposits that the miners call "bird-eye." At several places it has been noted that the bed has a high fusain ("mother-of-coal") content.

A local coal bed, which lies approximately 50 feet stratigraphically above the Buck Mountain bed in the Locust Gap mine area, was exposed in two prospect trenches where it is from 3"0" to 2'4" thick but contains a large percentage of waste.

SEVEN-FOOT (NO. 6) COAL BED

The Seven-foot coal bed, which lies about 90 feet stratigraphically above the No. 5 bed, has been found in tunnels and by exploratory drilling throughout the mapped area. Extensive mining in the bed, however, was done only in the Alaska basin portion of the Enterprise and Alaska mines and in the north basin of the Locust Gap mine. Correlation of the bed with its equivalent in the west-central part of the Mount Carmel quadrangle is not positive because the workings in the two areas are not connected.

In most of the mapped area the Seven-foot bed contains such a high percentage of interbedded carbonaceous claystone that mining is unprofitable.

The coal content of the No. 6 bed averages only 2 feet where mined in the central and southern parts of the mapped area, but increases to 5 feet at the eastern border. In the mined areas the average thickness of the bed was 3'10", and the average coal content 2'10", the waste being 26 percent. On the north dip of the Alaska basin, in the area between the Alaska and Enterprise mines, mining suggests that the Seven-foot bed consists of two splits with as much as 40 feet of rock between.

SKIDMORE (NO. 7) COAL BED

The Skidmore bed was mined in the Locust Spring and Locust Gap mines only. Elsewhere its presence in the mapped area was verified by crosscut tunnels and diamond drilling. The Skidmore bed crops out along the north side of Mahanoy Mountain and on both the north and south sides of Locust Mountain. It has been strip-mined in the extreme southwestern part of the mapped area, where the Mahanoy basin "spoons out." In mined areas the average thicknesses of the bed and its included coal were 3'4" and 2'7", respectively, but wide ranges above and below these averages were reported.

MAMMOTH COAL ZONE

The Mammoth coal zone generally consists of three principal coal beds, called splits, except in the North basin where there are two. The splits join or divide abruptly as shown on the correlation diagram on sheet 3.

These principal beds of the Mammoth coal zone are called the bottom, middle, and top splits and are designated in this report as No. 8, No. 8½, and No. 9, respectively. In addition to these beds, a split off the top split, designated as the 9B, occurs locally below the top split in the southeastern portion of the mapped area. The bottom split (No. 8) generally is a distinct bed separated from the other splits by 30 to 50 feet of rock, but this parting or divider thins to only a few inches in places. The parting between the middle and top splits consists of hard, gray, medium to coarse-grained sandstone that is interbedded with 1 to 10 feet of siltstone. The sandstone is conglomeratic in places. It ranges from 10 to 40 feet in thickness but over considerable areas is so thin that the middle and top splits can be mined together.

Bottom split (No. 8) of the Mammoth coal zone. The No. 8 bed, or bottom split of the Mammoth coal, is a very persistent bed and is generally easily recognized. It crops out in many places in the mapped area and has been mined extensively both underground and on the surface. Because of its persistence, the ease with which it is recognized, and the widespread mine workings in it, this bed is often used as a reference datum or key bed in determining the stratigraphic positions of other beds or in depicting the structure of the area. A thin, black, carbonaceous claystone, underlain by brown siltstone that characteristically contains large ironstone concretions, underlies the No. 8 bed in most of the mapped area.

The coal content of the No. 8 bed averaged 6'3" in mined areas and was found to have its greatest average thickness of nearly 9 feet in the eastern part of the Alaska mine area. The bed thickness in all mined areas averaged 7'0".

In the mapped area the coal of the bottom split consists of approximately equal amounts of bright and dull coal in variable layers from 1 to 2 feet thick. It is a very hard bed and cannot, except with much difficulty, be mined with a pick but must usually be blasted.

Middle split (No. 8½) of the Mammoth coal zone. The middle split of the Mammoth coal zone is present throughout the mapped area except in the Locust Gap mine. The absence of the No. 8½ bed in that mine may be due to lensing out of the coal or to merging into either the top or the bottom splits. Coal thicknesses do not appear to verify the latter hypothesis, hence it is assumed that the bed has lensed out. The average thickness of the bed in the mined areas was 6'8", of which 5'8" was coal.

Local (No. 9B) coal bed. A fourth coal bed in the Mammoth zone occurs locally in the Locust Spring mine, where it splits from the bottom of the No. 9 bed and is as much as 25 feet below it. This relationship is the basis for the authors' designation of the bed as No. 9B, although operators have called it a Mammoth leader. It was mined both underground and by surface stripping on the northern side of Mahanoy Mountain, where it consists of 3'6" of coal.

Top split (No. 9) of the Mammoth coal zone. The top split (No. 9) of the Mammoth coal zone is worked in all the mines of the area except in the Alaska and Reliance mines. It was cut in workings of the Alaska mine but was not recognized in the Reliance mine. The thickness of the No. 9 bed ranges from 23'4" to 0'10", the greatest variation in thickness of any of the beds in the area.

Its average bed and coal thicknesses were 6'8" and 5'7", respectively. The average thickness of the included coal was greater however, along a northeast-trending zone through the Enterprise, Excelsior-Corbin, and Scott mines, where the coal averaged 7 feet, and in the Locust Spring mine, where it averaged nearly 9 feet.

FOUR-FOOT (NO. 9½) COAL BED

The Four-foot coal bed, one of the poorer coal beds in this area, is mined locally in the Alaska, Locust Gap, and Locust Spring mines. It occupies a stratigraphic position between the top split of the Mammoth coal zone and the Holmes coal bed and ranges almost completely across the 100- to 150-foot interval between those two beds, approaching within 20 feet of either bed. The average thicknesses of the bed and the coal in mined areas were 3'6" and 2'10", respectively.

HOLMES (NO. 10) COAL BED

The Holmes coal bed, at the base of the Conemaugh formation, occurs in many places in the mapped area, and has been mined in all the mines. It is overlain, at vertical distances ranging from 2 to 20 feet, by a persistent stratum of thin- to thick-bedded brown-weathering micaceous sandstone that ranges from 8 to 20 feet in thickness.

The Holmes bed is not only one of the most persistent coal beds in the area but it is also characterized by low percentage of waste (14½%). The average thickness of the bed in mined areas was 4'7", of which 3'11" was coal.

LOCAL (NO. 10¼) COAL BED

The designation No. 10¼ was assigned to a coal bed in the Hickory Ridge mine in the west-central part of the Mount Carmel quadrangle. This bed also occurs in the Maysville mine area (see sheet 1), where it lies about midway between the Holmes bed and the Rough bed. Workings in this area showed that the thickness of the bed ranged from 1'5" to 9'5", and its coal content ranged from 1'5" to 6'10"

Two coals of less than minable thickness were found between the No. 10 and No. 10½ beds in the eastern part of the area. One of them may correlate with the No. 10¼ bed, but the relationship between these three beds is not completely known.

ROUGH (NO. 10½) COAL BED

The Rough (No. 10½) coal bed was found by development work in all mines in the area but was mined underground in small areas in the Pennsylvania and Reliance mines only, and was locally strip-mined in the Locust Gap mine. The high percentage of waste in the bed (27%) made only the thicker portions of the bed minable. In mined areas the bed averaged 4'7" in thickness, of which only 3'4" was coal.

Two coals of less than minable thickness were noted between the No. 10½ and No. 11 beds in the North basin. One of them may correlate with the No. 10¾ coal bed.

LOCAL (NO. 10¾) COAL BED

The No. 10¾ bed, which is locally present in the northeastern part of the area, does not crop out but is found in workings of the Pennsylvania mine about 30 feet above the Rough coal. The average thickness of the bed in mine workings in the adjoining area to the north was 3 feet, of which approximately 24 percent was waste. Minimum and maximum thicknesses of 1'4" and 10'2" have been recorded.

PRIMROSE (NO. 11) COAL BED

The Primrose coal bed is found approximately 220 feet stratigraphically above the base of the Conemaugh formation. It has been designated by various names and has been mined either by surface stripping or by underground operations in all the mines of the area. Both the roof and the floor rocks of the No. 11 bed in the Locust Gap area are black carbonaceous claystone from 5 to 8 feet thick. The thickness of the Primrose bed in the workings averaged 5'10", of which 4'11" was coal.

ORCHARD (NO. 12) COAL BED

The Orchard (No. 12) coal bed normally lies about 100 feet stratigraphically above the Primrose (No. 11) coal, but the interval increases to as much as 150 feet. This bed crops out in the deeper parts of the Shamokin, Mount Carmel, Mahanoy, and New basins. It has been mined in the Scott, Maysville, Pennsylvania, and Locust Spring mines. The bed averaged 9'4" in thickness, but it contained a high percentage (29%) of waste.

DIAMOND (NO. 14) COAL BED

The Diamond coal bed, the youngest minable coal in the mapped area, was mined locally in the Shamokin basin area of the Maysville mine and in the Locust Spring mine. Available measurements indicate that the Diamond coal ranges from 1'6" to 8'7" in thickness.

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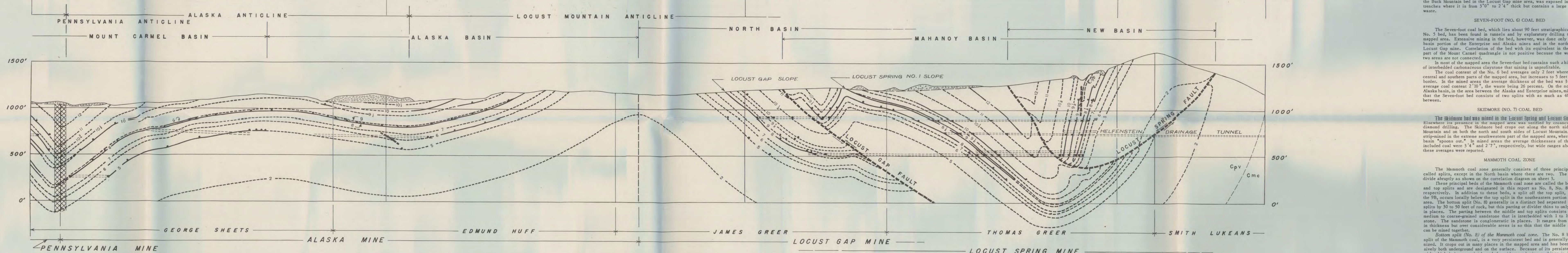
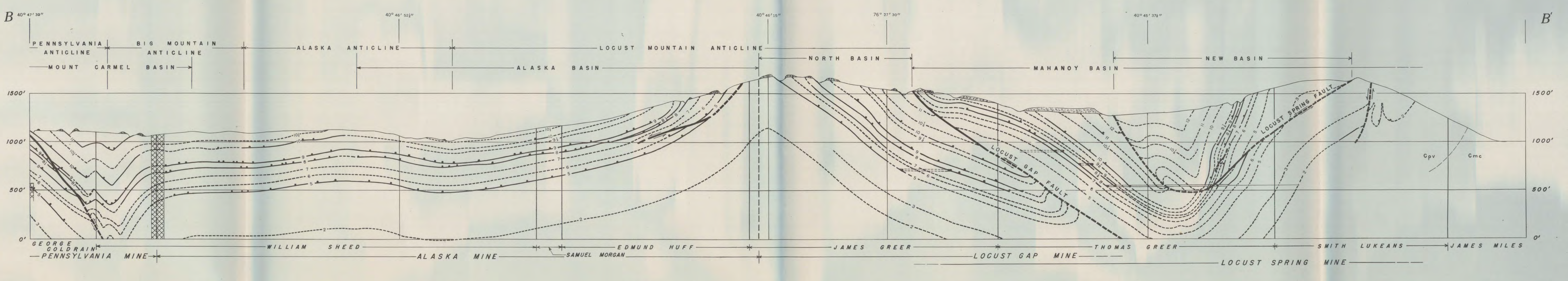
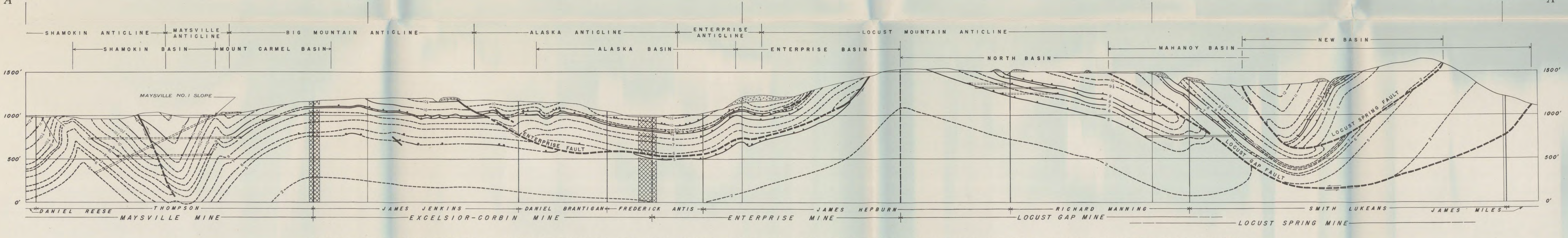
EXPLANATION OF CROSS SECTIONS

- Boundary of mine
- Boundary of warranty tract
- Contact between the Mauch Chunk shale (Cmc) and the Pottsville formation (Cpv)
- Coal bed with designating number. *Solid where mined, dashed where unmined.*
- Fault showing relative movement. *Solid where location is known, dashed where uncertain.*
- Drill hole showing position of coal beds found in cores or cuttings. *Solid where hole is in the plane of the section, dashed where projected to the section.*
- Cross section of gangway
- Tunnel showing position of intersecting gangway. *Solid where tunnel is in the plane of the section, dashed where projected to the section.*
- Mine waste
- Area reserved for barrier pillar







CROSS SECTIONS SHOWING THE STRUCTURE OF THE COAL BEDS IN THE SOUTHWESTERN PART OF THE MOUNT CARMEL QUADRANGLE

SCALE 1:6,000

Datum is mean sea level

Prepared in 1949 from data supplied by the Philadelphia and Reading Coal and Iron Company and the Susquehanna Collieries Company with modifications by the U. S. Geological Survey.

INTERIOR—GEOLOGICAL SURVEY, WASHINGTON, D. C.

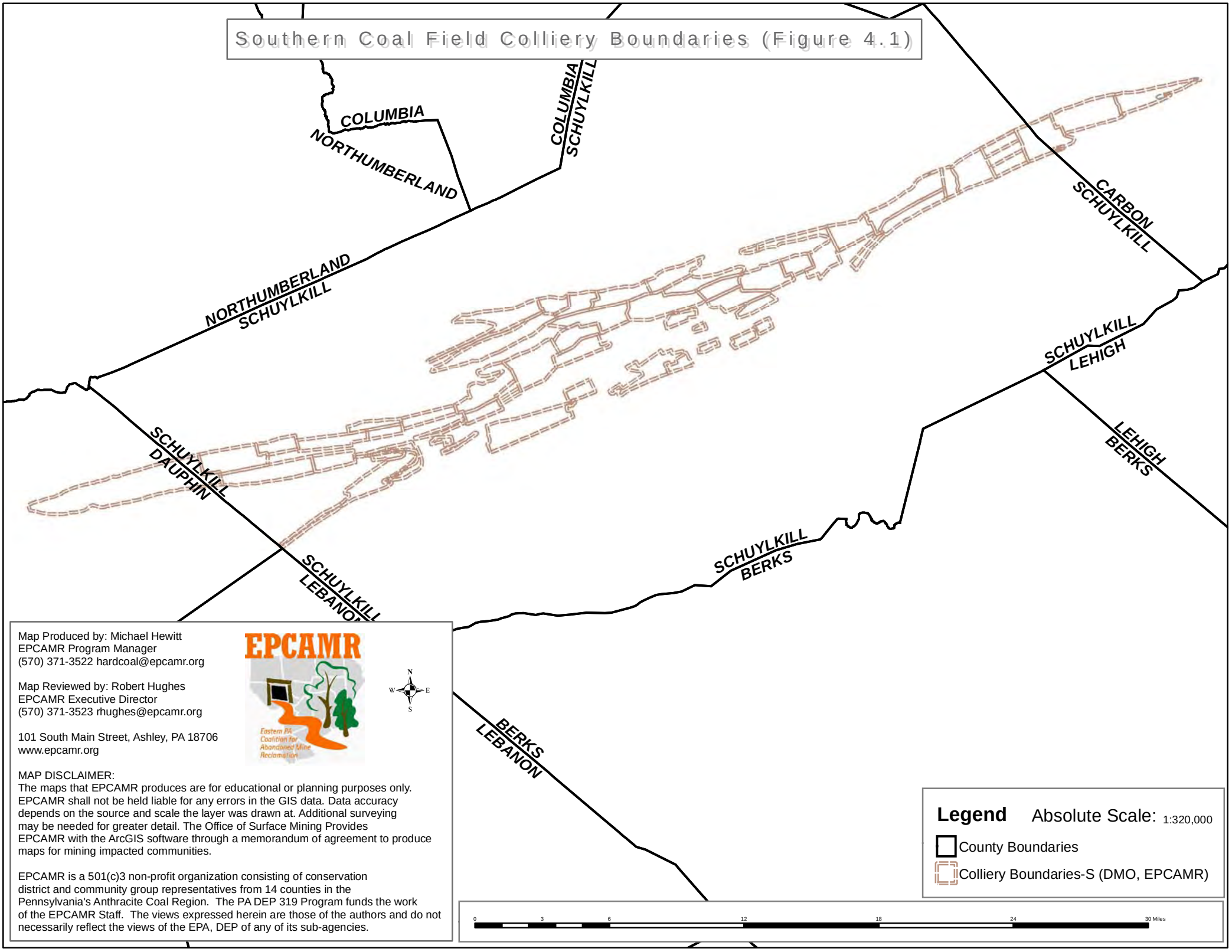
Drafted by John T. Howells

GEOLOGY OF ANTHRACITE IN THE SOUTHWESTERN PART OF THE MOUNT CARMEL QUADRANGLE, PENNSYLVANIA

By
Howard E. Rothrock, Holly C. Wagner, Boyd R. Haley and Harold H. Arndt

1951

Southern Coal Field Colliery Boundaries (Figure 4.1)



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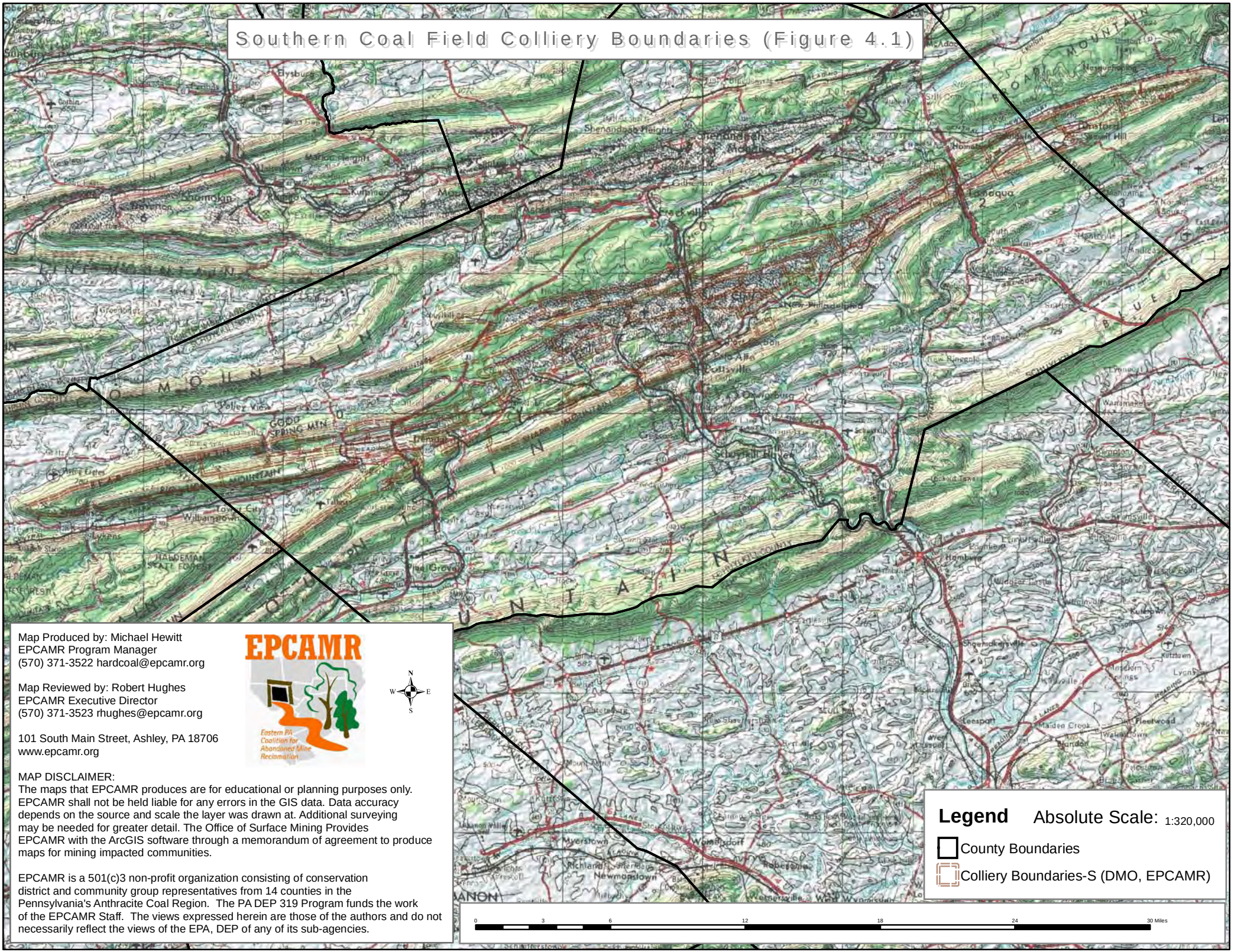
Southern Coal Field Colliery Boundaries (Figure 4.1)



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