GEOLOGY

The Mahanoy Creek Watershed drains most of the Western Middle Anthracite Field. The coal field is one of four structural basins in northeastern Pennsylvania which contain anthracite. The coal field is also one of the larger structural basins approximately 36 miles long and up to 5 miles wide.

STRATIGRAPHY

The sedimentary rocks exposed in the watershed are of Devonian, Mississippian, and Pennsylvanian age. Quaternary deposits of unconsolidated material are also found in the watershed.

The Devonian age rocks are found only in the extreme western end of the watershed, just south of the Western Middle Anthracite Field (see Figure 8, p. 31).

Devonian System

The Devonian rocks in the watershed consist of the Hamilton Group and Onondoga Formation (DHo), Marine Beds (Dm), and the Catskill Formation (DcK). The Hamilton Group and Onondoga Formations, the oldest of the Devonian rocks, range from brown shales and sandstones at the top to black, fissile shales and dark blue to black limestones at the bottom. The Marine Beds (Dm) are light gray to olive sandstones, silt stones, and gray wackes with interbeds of gray to brown shales. Although a complex unit of shales, siltstones, sandstones, and conglomerates, the Catskill Formation consists primarily of red to brown shales and sandstones. It outcrops primarily in the lower subwatershed and along the north flank and the valley north of Little Mountain.

Mississippian System

Forming the crest and southern flanks of Little Mountain, the Pocono Group consists chiefly of sandstones and conglomerates. The rock units also contain thin beds of gray to red shales and siltstones. The Pocono Group contains the first occurrences of coal beds although these beds are of geological interest rather than of mining interest. Sandstone units are usually crossbedded. The rocks are highly resistant to weathering, forming high rough ridges and crests of mountains with steep, natural slopes. It is located in the extreme western end of the watershed.

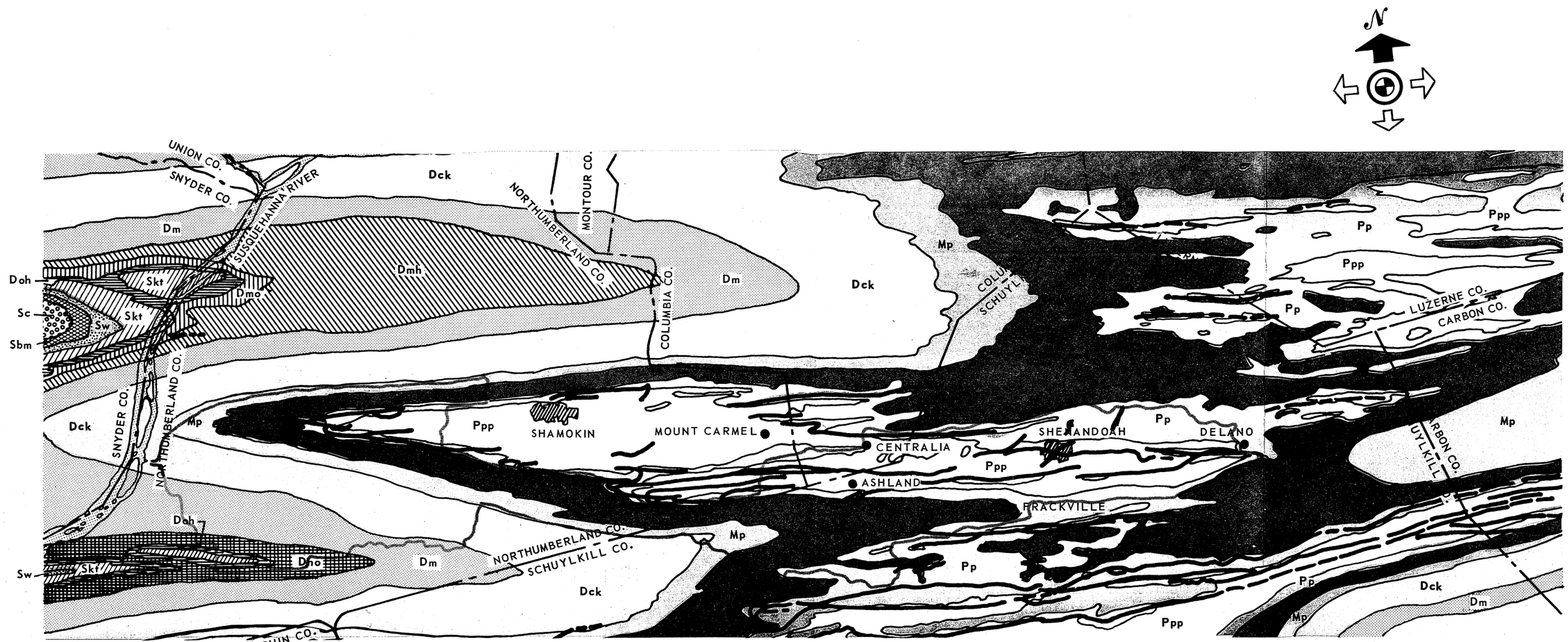
The Mauch Chunk formation outcrops along the north margin of the anthracite field in the valley occupied by Zerbe Run, along the south slope of Mahanoy Mountain, along the north flank of Locust Mountain, and the valley occupied by Messers Run (see Figure 8, p. 31). The dominant rock types are red shales, brown to gray claystones, sandstones and siltstones; other rock types include green siltstones and fine grained sandstones and scattered layers of gray or green conglomerate.

Rocks generally are moderately resistant to weathering, however, shale and claystone outcrops may be severely weathered. The Mauch Chunk Formation is considered the base of the coal field with all mineable coal beds found above this unit. The formation rings the entire coal basin from Hunter to Delano.

The Pennsylvanian System

The oldest of the Pennsylvania rocks is the Pottsville Group which overlies the Mauch Chunk formation. It consists primarily of fine to coarse grained sandstones and conglomerates, with some shales, siltstones and mineable coals. Rock types of the group are predominately light to dark gray in color. Thickness of the Pottsville group ranges from 650 feet near Trevorton to 1,250 feet west of Shenandoah and approximately 900 feet near Delano. Weathering characteristics are variable, reflecting the various rock types. Forming the crests and flanks of ridges as well as the cores of the mountains, the rocks are especially important ridge formers in the coal field. The Pottsville group outcrops on most of the mountains and ridges in the watershed including Big Mountain, Mahanoy Mountain and Locust Mountain. The coal beds of importance in this formation are Lykens Valley No. 2, 2-1/2, Little Buck Mountain (No. 4) and the White (No. 3).

Post-Pottsville (Llewellyn) formations are by far the most extensive rock units found in the Western Middle Anthracite Field. This unit contains numerous mineable coal beds (including all the large beds) and is the predominant rock type in all the coal basins of the region. These rocks conformably overlie the Pottsville group. The contact between the Pottsville group and Post-Pottsville formations is placed at the Buck Mountain (No. 5) coal bed. The three Mammouth coal beds, Skidmore, Seven-foot, Holmes, Primrose, Diamond, and Orchard as well as the Buck Mountain are among the more extensively mined and persistent beds. The formations contain brown gray sandstones and conglomerates, as well as black shales and some claystone. The rocks below the Mammouth Top Split coal bed in the lower section are both coarser and darker in color than the finer grained upper part of the formations. Rocks are generally slightly to moderately weathered, depending on lithology. High contents of iron sulfide are found in the coals and surrounding rock types. For distribution of rock types see Figure 8. The composite stratigraphic section shown in Figure 9, p. 32 indicates the ages of the coals and their relationship with various formations.



PENNSYLVANIAN

- Ppp — POST-POTTSVILLE FORMATIONS
- Pp — POTTSVILLE GROUP

MISSISSIPPIAN

- Mmc — MAUCH CHUNK FORMATION
- Mp — POCONO GROUP

DEVONIAN

- Dck — CATSKILL FORMATION
- Dm — MARINE BEDS
- Dho
  - Dmh — MAHANTANGO
  - Dmo — MARCELLUS FORMATION, ONONDAGA FORMATION
  - Doh — ORISKANY FORMATION, HELDERBERG FORMATION

SILURIAN

- Skt — KEYSER FORMATION, TONOLOWAY FORMATION
- Sw — WILLS CREEK FORMATION
- Sbm — BLOOMSBURG FORMATION, McKENZIE FORMATION
- Sc — CLINTON GROUP

Figure 8. Geological map of the Western Middle Anthracite Field
(After Pennsylvania Topographic and Geological Surveys, 1960)

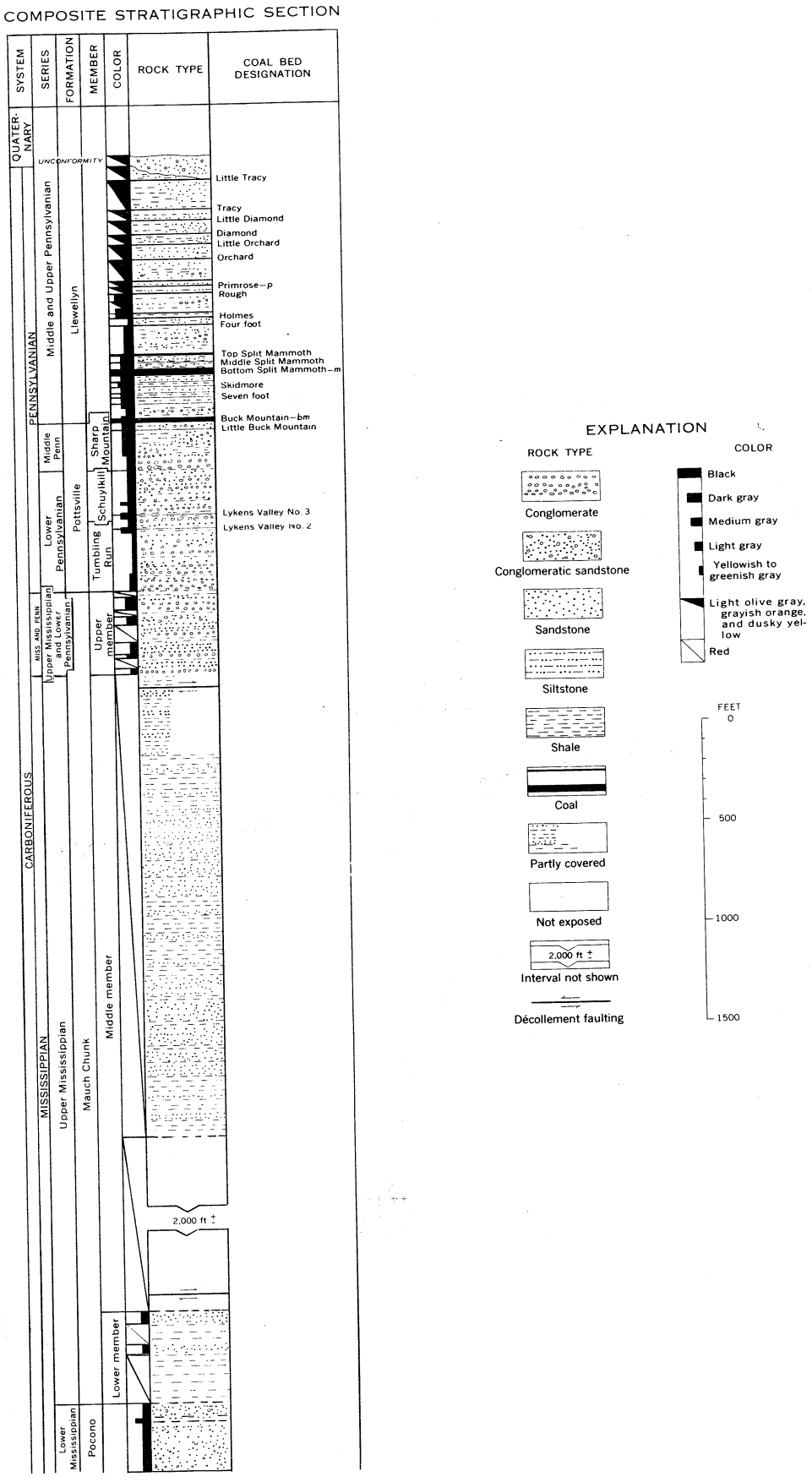


Figure 9. Composite stratigraphic section in the Western Middle Anthracite Field
(After Wood and Arndt, 1969)

Quaternary System

The Quaternary System is represented by deposits of unconsolidated deposits of clay, silt, sand, and fine to coarse gravel which cover bed rock in the valleys of the watershed. This unconsolidated material is either stream deposits, stream transported mine waste (carbonareous silt and fine coal) or talus deposits that occur at the base of steep mountain slopes. The deposits of stream transported coal accumulate locally, becoming economically valuable and are able to support two active dredging operations west of Gowen City.

STRUCTURE

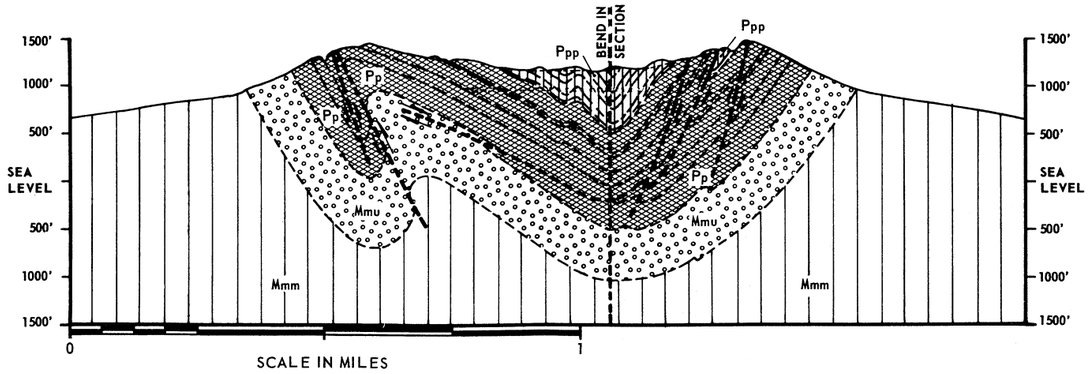
The Western Middle Anthracite Field consists of a plunging synclinorium trending northeastward, with a series of inclinal and synclinal undulations which subdivide the region into smaller coal basins (see Figure 10, p. 34). These minor anticlines and synclines are parallel to subparallel to the trend of the synclinorium. Many of these fields are doubly plunging with some fields broken by thrust faults whose trend is subparallel to the axes of the folds. The trend of the subsidiary folds vary from N75° E to N85° E. Figure 9 indicates the complexity of the folds and the relationship of other structural features such as thrust faults (for location of cross sections see Figure 1, p. 3). Many of the folds are less than 1000 feet wide and only a few are longer than a mile or two along the strike before merging with or overlapping adjacent folds. The axial planes of the folds located in the central part of the coal field are close to vertical while folds near the northern and southern boundaries of the coal field are steeply inclined to the north or south with some cases of vertical axial planes.

While folds in the Post-Pottsville rocks tend to be tight and asymmetrical, anticlines in the structurally more competent Pottsville group generally consist of broad or open arches. Cross sections in Figure 10 indicate that some folds change in shape with depth.

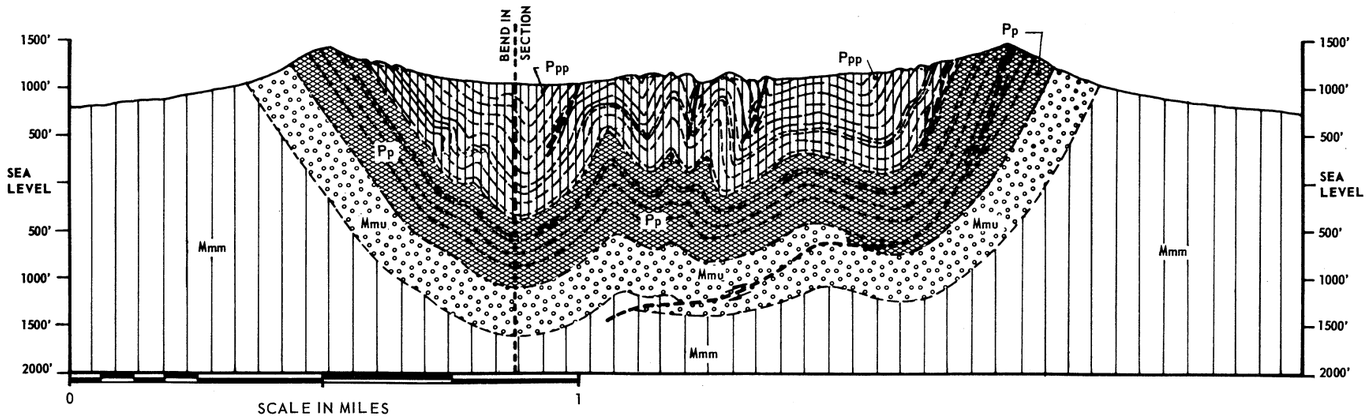
The principal faults in the watershed are thrust faults which generally are parallel to the axes of the folds. They are known as longitudinal faults. This close association between the faults and folds as well as the type of fault suggests that these features are the result of compressional forces. Examples of these faults include the Centralia Fault, Lost Creek Fault, Shenandoah Fault, and the Suffolk Fault. In most cases, the faults are of sufficient magnitude to establish limits for mining and are usually used as underground mine boundaries by the mine companies.

Fault features which adversely affect mining include 1) faults with displacements greater than the thickness of the coal bed, sometimes called rock faults; 2) pinches,

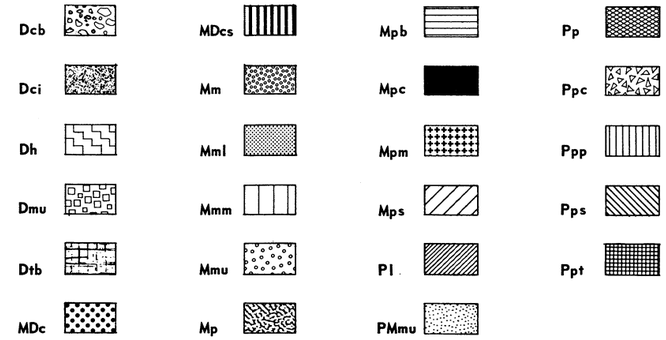
SECTION A-A' (TREVORTON)



SECTION B-B' (TREVORTON)



LEGEND



SECTION C-C' (MT CARMEL)

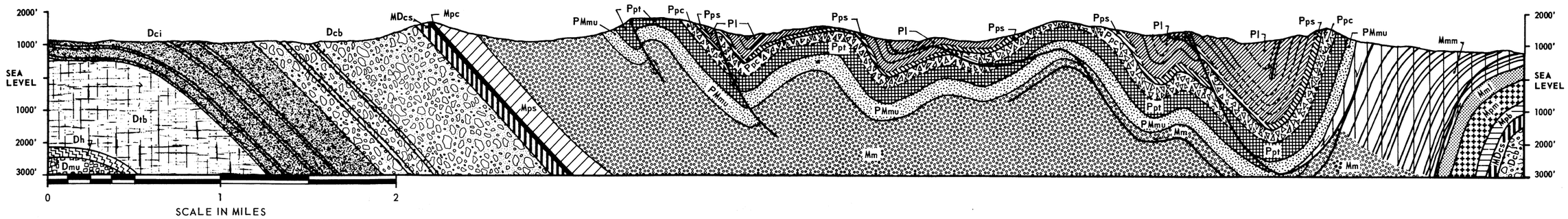
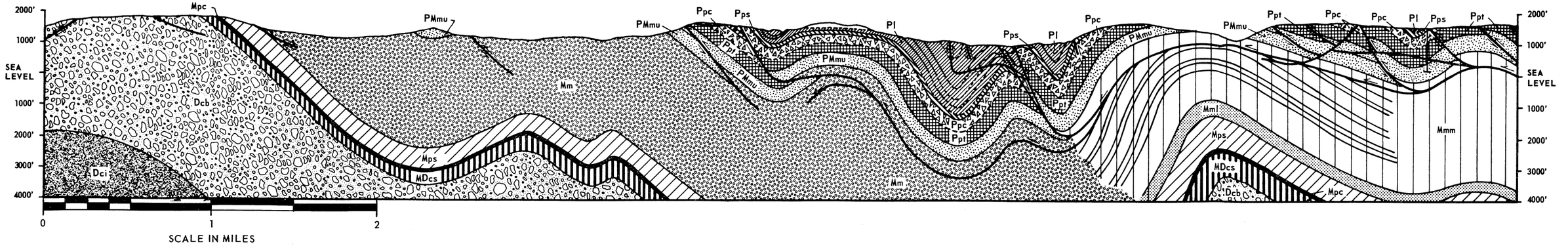
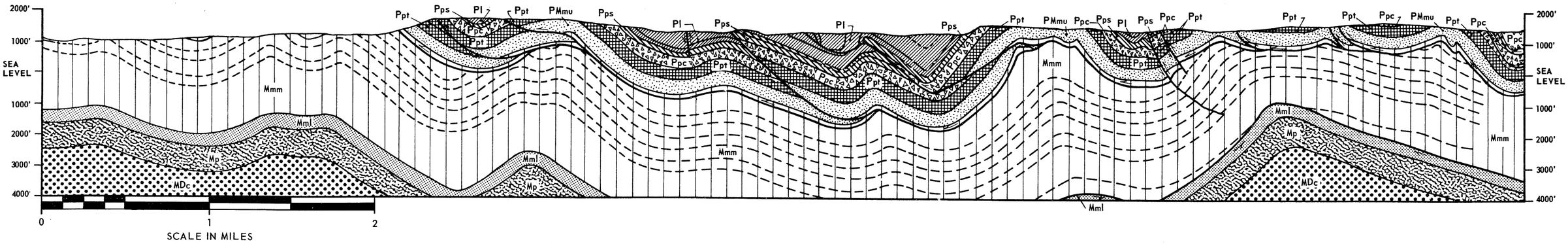


Figure 10. Geologic cross sections in the Western Middle Anthracite Field (sheet 1)
(After Arndt, 1971a, 1971b; Arndt et al, 1963; Maxwell and Rothrock, 1955; Wood and Arndt, 1969)

SECTION D-D' (ASHLAND)



SECTION E-E' (SHENANDOAH)



SECTION F-F' (DELANO)

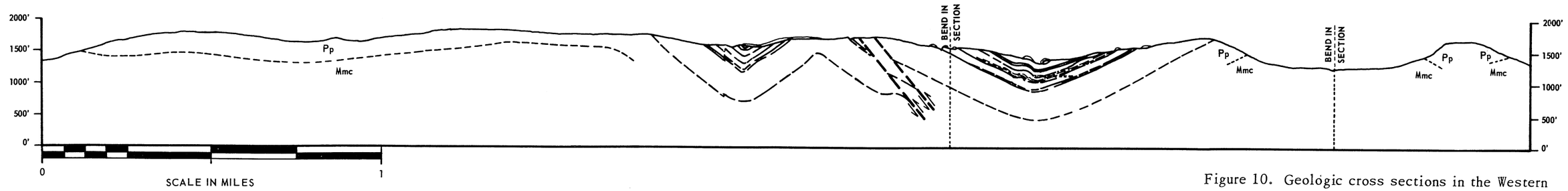


Figure 10. Geologic cross sections in the Western Middle Anthracite Field (sheet 2)
(After Arndt, 1971a, 1971b, Arndt et al, 1963; Maxwell and Rothrock, 1955; Wood and Arndt, 1969)

where the coal has been squeezed from between roof and floor rocks; 3) small folds that have 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.

COAL

Anthracite, characterized by its hardness, lustrous black color, and conchoidal fracture, is a relatively high quality, low-sulfur coal. Variations, locally and regionally, occur in the rank and grade of the coal throughout the Western Middle Anthracite Field and other anthracite fields.

Variation in sulfur content is shown in Figure 11, p.37. The eastern half of the Western Middle coal field is below average to average in sulfur content (.55-.75%) with sulfur progressively increasing from the eastern to the western part of the field. Sulfur is primarily contained in pyrite, with lesser amounts in ferrous sulfate, elemental sulfur and other sulfur compounds.

The greatest variation is found in the progressive increase in the percentage of volatile matter from the eastern (less than 4%) to the western part (more than 11%) of the Western Middle Field. A result of the complex geological features found in the field is a confusing nomenclature used to designate particular coal beds.

Figure 12, p.38 shows the important coal beds which have been or are being mined in the coal field. Relative ages of the coals and the stratigraphic location as well as the average internal or rocks between each coal bed are also given. Shown in Figure 13, p. 39 is the correlation of two important coal beds mined in the Mahanoy Creek Watershed, the lower bed being the Buck Mountain and the upper bed the Mammouth Bed (Bottom Split). From these columnar sections an idea of which coal beds were important in a locality and regional variations in rock types, as well as thickness of sequences, between the two coal beds can be seen. In the eastern region more coal beds appear concentrated together so that fewer mines could produce larger amounts of coal. This may account for the larger number of mines and mine openings in the western section of the coal field (see Figure 4, p. 20) and indicate amounts of waste material generated.

As of January 1, 1970, Recoverable Reserves of anthracite (beds over 24 inches thick) consisted of eight (8) billion short tons with in-place reserves listed as 16 billion short tons (see Table 3, p. 40).

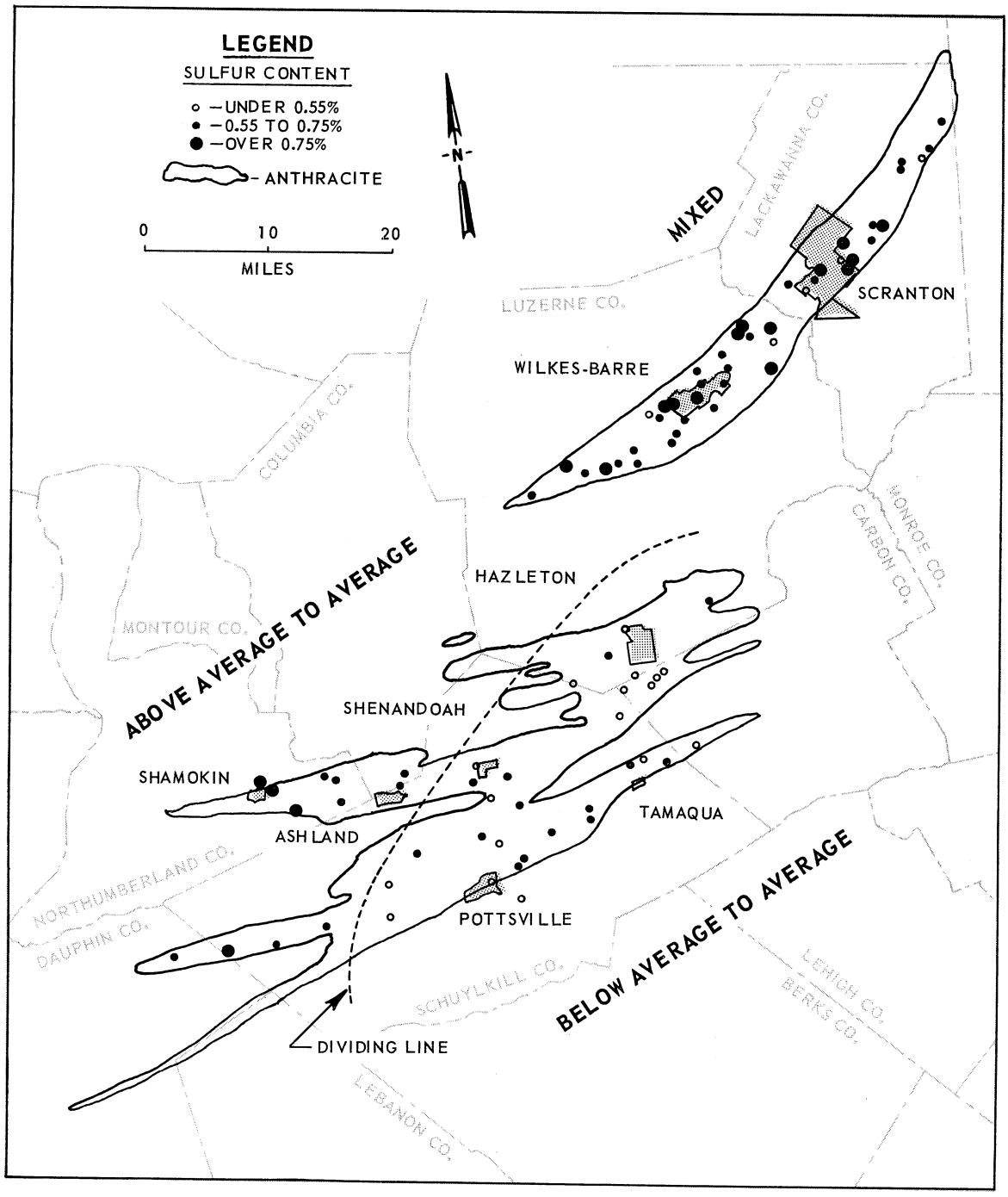


Figure 11. Variation of sulfur in anthracite

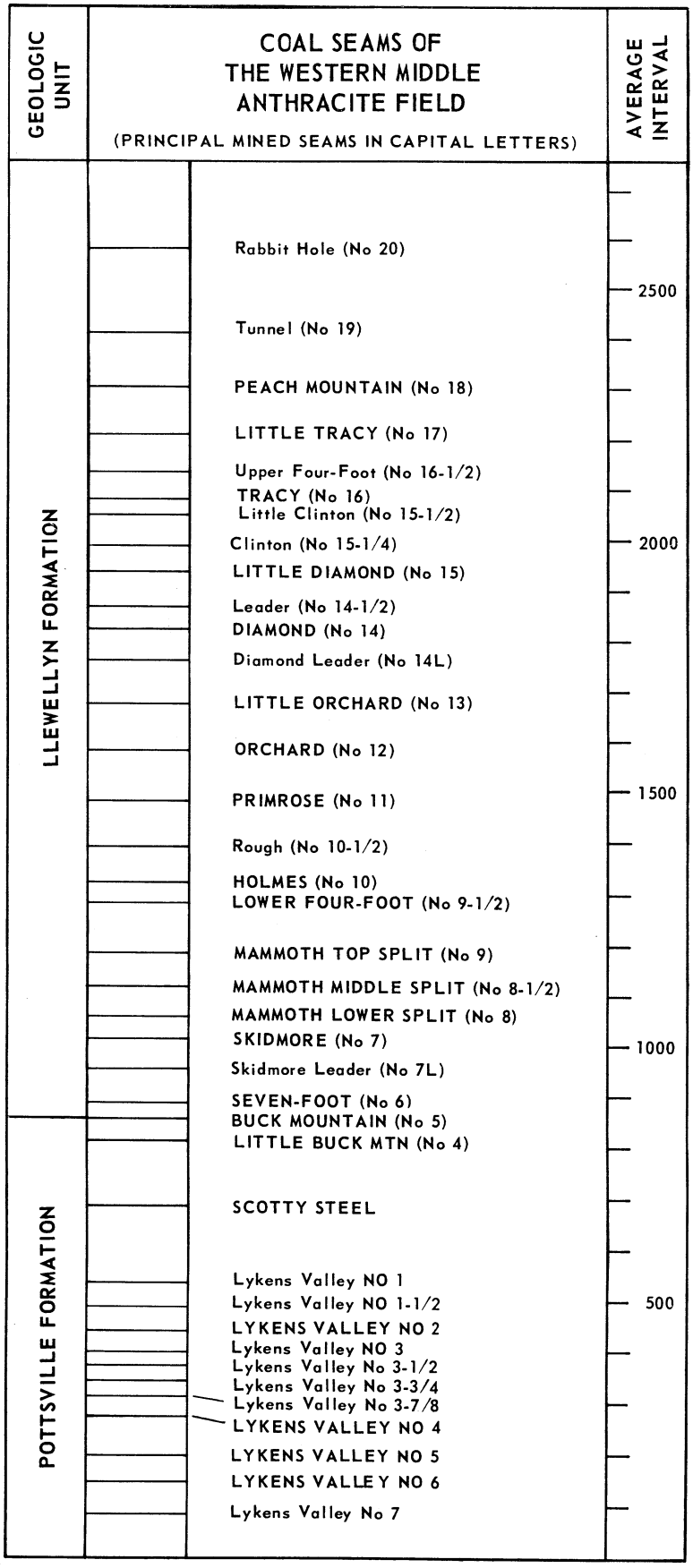


Figure 12. Major coal beds mined in the Mahanoy Creek Watershed (After Edmunds, 1972)

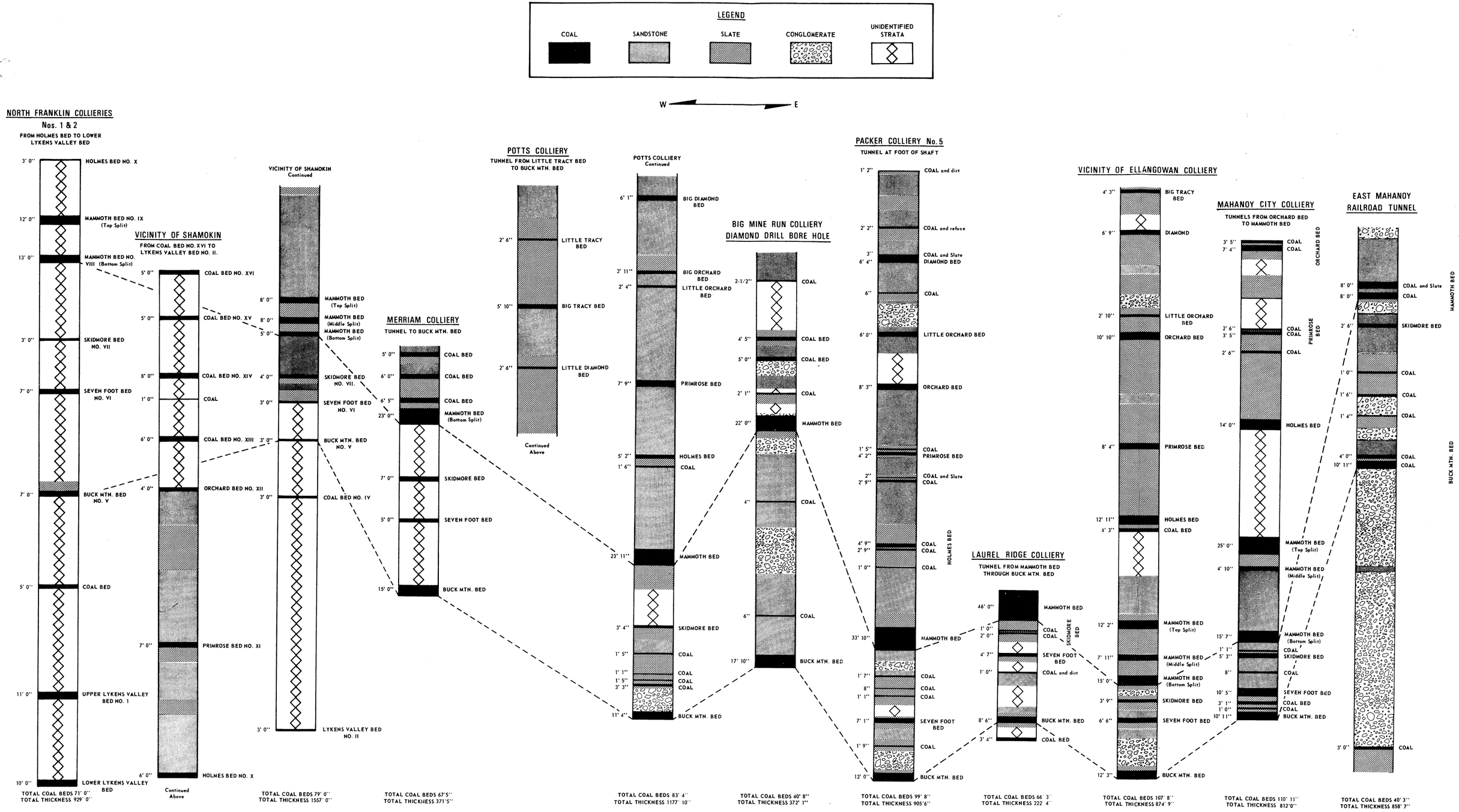


Figure 13. Correlation of the Mammoth and Buck Mountain Coal Beds
(After Pennsylvania Geological Survey, 1887)

TABLE 3

RECOVERABLE ANTHRACITE RESERVES BY COUNTY
(As of January 1, 1970)

COUNTY	SHORT TONS
Carbon	149,626,563
Columbia*	236,114,235
Dauphin	347,013,456
Lackawanna	170,127,429
Lebanon	468,678,971
Luzerne	816,456,269
Northumberland*	940,234,986
Schuylkill*	4,890,300,922
Susquehanna	2,292,609
Wayne	2,959,349
Total	8,023,805,789

* Counties included in Mahanoy Creek Watershed. (after Edmunds, 1972)