DEPARTMENT OF THE INTERIOR
UNITED STATES GEOLOGICAL SURVEY

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Appalachian Regional Commission

MISCELLANEOUS FIELD STUDIES
MAP MF 641—B
Sheet 1 of 2

Hydrogeologic framework and generalized shallow ground-water circulation system, Allegheny County,

Pennsylvania

The sedimentary rocks that crop out in Allegheny County consist of consolidated bedrock units and unconsolidated deposits having a composite thickness of about 1,200 feet (360 m). Bedrock is composed of sandstone, limestone, silt, shale, claystone, coal, and coal underclay that commonly range in thickness from less than 0.4 inch (1 cm) to more than 10 feet (3 m) and in a few localities to more than 30 feet (10 m). Bedrock units include the Allegheny, Conemaugh, Monongahela, and Dunkard Groups, which range in age from Pennsylvanian to Permian. Locally, bedrock is overlain by glacial outwash(?) deposits and alluvium of Quaternary age. The lithologic, structural and hydrologic characteristics of these units are given in Subitzky, 1975a. The areal distribution of the major bedrock units and valley-fill sediments is shown in Gallaher (1973). As used in this study, the shallow ground-water regime at a given point is generally limited to those units at depths approximately equal to the topographic relief at that point; however, greater depths are treated where necessary to include the widely mined Upper Freeport coal bed in the Freeport Formation of the Allegheny Group and the Pittsburgh coal bed in the lower member of the Pittsburgh Formation of the Monongahela Group.

The bedrock strata in the county are deformed by several secondary subparallel folds superposed on a shallow south-dipping homocline. The subparallel folds are very gentle and strike about N. 30° E. The axial traces of the more significant folds are shown on figure 1. The strata of the Allegheny, Conemaugh, and Monongahela Groups are relatively flat-lying and are deformed gently over fold axes. The hydrologic character of the bedrock units and their position to the structural trend of the Pittsburgh and Upper Freeport coal beds are shown on figure 2. Jointing is associated with folding. The joint systems are generally locally developed and are rarely continuous to form individual regional structures.

The shallow ground water is generally under water-table conditions, although there is strong eveidence of water under hydrostatic pressure where sufficient confinement of permeable materials occur in the deeper lying bedrock units (Piper, 1933 and Gallaher, 1973). Water in bedrock units circulates through intergranular openings (pore spaces), fracture and joint systems, bedding planes, and to a small degree through solution openings in limestone. Intergranular openings make up primary porosity; whereas, joints, fractures, and bedding planes compose secondary porosity--openings formed subsequent to deposition and consolidation of the bedrock strata. Porosity of a rock or soil is its property of containing interstices or voids and may be expressed as the ratio of volume of interstices to total volume. The degree of interconnection of bedrock openings that form primary and secondary porosity, determines the ease of fluid transmission. The capacity of materials to transmit fluid is termed permeability, which is expressed as gallons per day per square foot (gpd/ft^2). Porosity and permeability of various rock materials commonly composing the hydrogeologic framework of the study areas are listed in table 1. The relative rates of water movement in the bedrock units have not been determined, but they are generally considered to have low permeability; however, it has been recognized that where fractures increase permeability also increases. The weathered material overlying bedrock forms a hydrogeologic framework containing a greater volume of interstices with different hydrologic characteristics of permeability and porosity than the unweathered material. Such physical changes of rock materials due to weathering may also result in conditions favorable to increased pore-water pressures at interfaces of unweathered bedrock and weathered material, which may reduce slope stability.

The orientation of the regional geologic structure formed by the axial traces of subparallel folds and their respective subsequent joint systems strongly influence the direction of ground-water flow. Moreover, joint systems exhibit some degree of interconnection with other structural elements, such as bedding planes. Interconnection of joint systems tends to be enhanced in those lithologic units overlying mined-out parts of the Upper Freeport coal and Pittsburgh coal beds, where a fissure propogated from mine subsidence transects these systems. This enhancement results in increased hydrologic connection locally within parts of the hydrogeologic framework. Although inwashing of soil particles from precipitation tend to fill near-surface segments of mine-subsidence fissures, these fissures probably remain open at depth and influence subsequent ground-water circulation. Figure 3 shows suggested ground-water circulation, as controlled by the interconnection of jointing and bedding planes and the extent of increased interconnection due to mine-subsidence fissures.

Adequate hydrologic data are not available to fully understand the circulation of water in bedrock units of the shallow ground-water regime overlying coal beds. However, a theoretical pattern of circulation over mined-out parts of the Pittsburgh coal bed in McLaughlin Run and Painters Run basins in south central Allegheny County is shown in figure 4. The extent and distribution of interconnected joints and mine-subsidence fissures suggest that the joints and fissures control ground-water circulation. The lines showing the pattern of flow for this circulation system generally follow somewhat angular paths; some show flow-line paths reflecting ground-water movement directly to a mined-out part of the coal bed, and others follow broad paths to the stream.

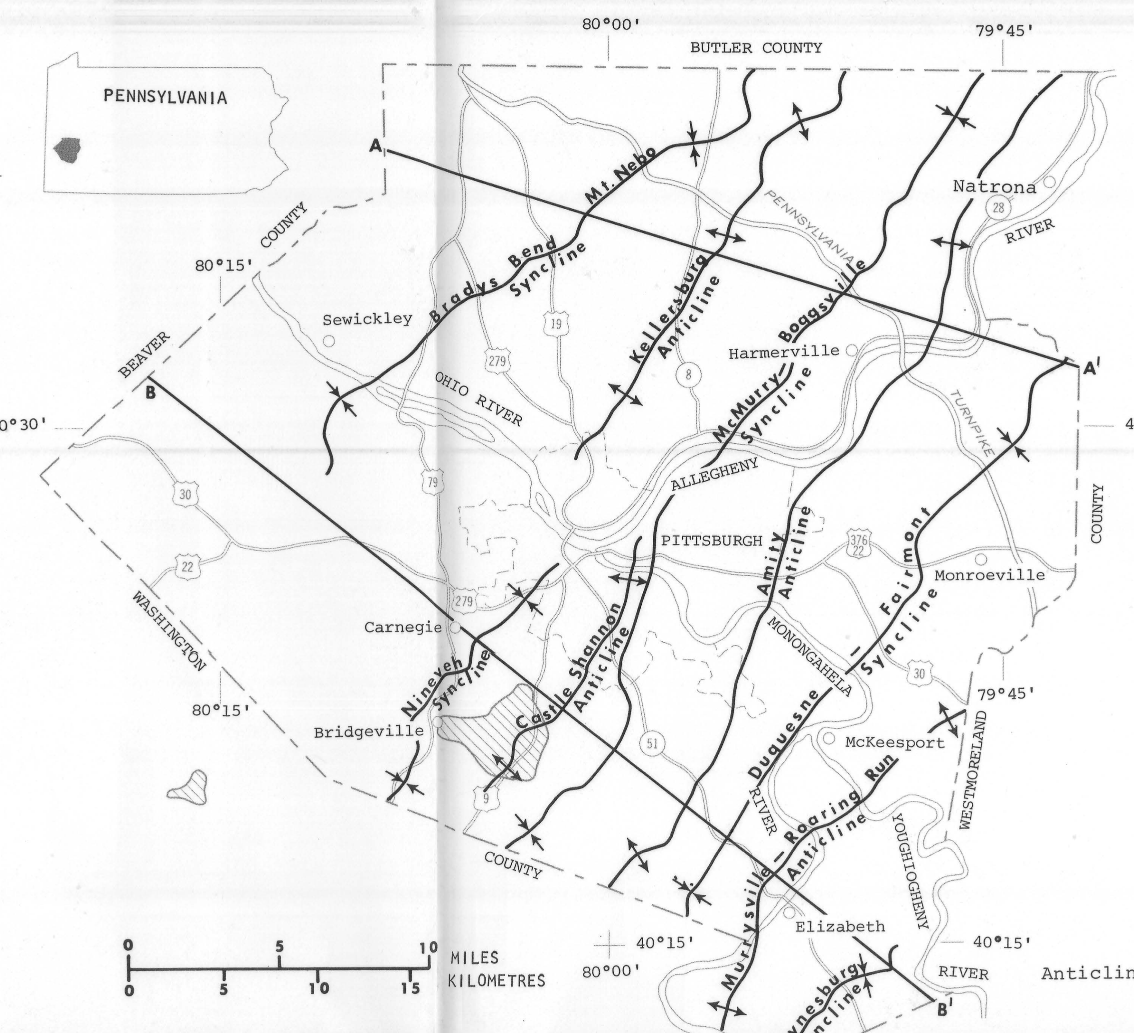
References Cited

Edmunds, Wm. E., 1974, Preliminary structure contour map of Allegheny County Pennsylvania: Pennsylvania Dept. Environ. Resources, Pennsylvania Geol. Survey, open-file map.

Gallaher, J. T., 1974, Summary of ground-water resources of Allegheny County, Pennsylvania: Pennsylvania Geol. Survey, 4th Ser. Water Resources Rept. 71 p.

Piper, A. M., 1933, Ground-water in southwestern Pennsylvania: Pennsylvania Geol. Survey, 4th Ser., Bull. W-1, 406 p.

Subitzky, Seymour, 1975a, Summary of behavior of the hydrogeologic regime as related to environmental characteristics, Allegheny County, Pennsylvania: U.S. Geol. Survey Misc. Field Studies MF 641-A.



Base map adapted from Wagner, W. R. and others, 1970, Geology of the Pittsburgh area: Pennsylvania Geol. Survey, 4th Ser. General Geology Rept. G59, 145 p.

Figure 1. Distribution of axial traces of folds, Allegheny County, Pennsylvania

EXPLANATION

Anticline, showing trace of axial plane

Syncline, showing trace of axial plane

A______A'
Line of section

Axial traces of synclines and anticlines adapted from Preliminary Structure Contour Map of Allegheny County, Pa. by Edmunds, 1974.

Table 1. - Hydrologic properties of rock type as related to the shallow ground-water circulation system. The single values reported reflect estimates of "average" values for that rock type, however, the value at a specific site can differ from these by orders of magnitude.

Rock Type	Permeability (gpd/ft^2)	Porosity (Percent)
Clay and silt	10^{-3}-2 b/	45-55 b/
Clay	10^{-4}-10^{-2} a/	
Sand	100-3,000 b/	35-40 b/
Gravel	1,000-15,000 b/	30-40 b/
Sand and Gravel	200-5,000 b/	20-35 b/
Sandstone	0.1-50 b/	10-20 b/
Silty Sandstone	5x10^{-2} a/	12 a/
Coarse Sandstone	20 a/	
Shale	10^{-5}-10^{-1} b/	1-10 b/
Limestone	2.5 a/	16 a/
Argillaceous Limestone	1.80x10^{-3} a/	2 a/

a/ Davis, S. N., and DeWiest, R. J. M., 1966, Hydrogeology: John Wiley and Sons, Inc., New York, 463 p.

b/ Walton, Wm. C., 1971, Ground-water resources evaluation: McGraw-Hill Book Co., New York, 664 p.

Conversion Table

Permeability (gpd/ft^2) x .041 = hydraulic conductivity (m/day)

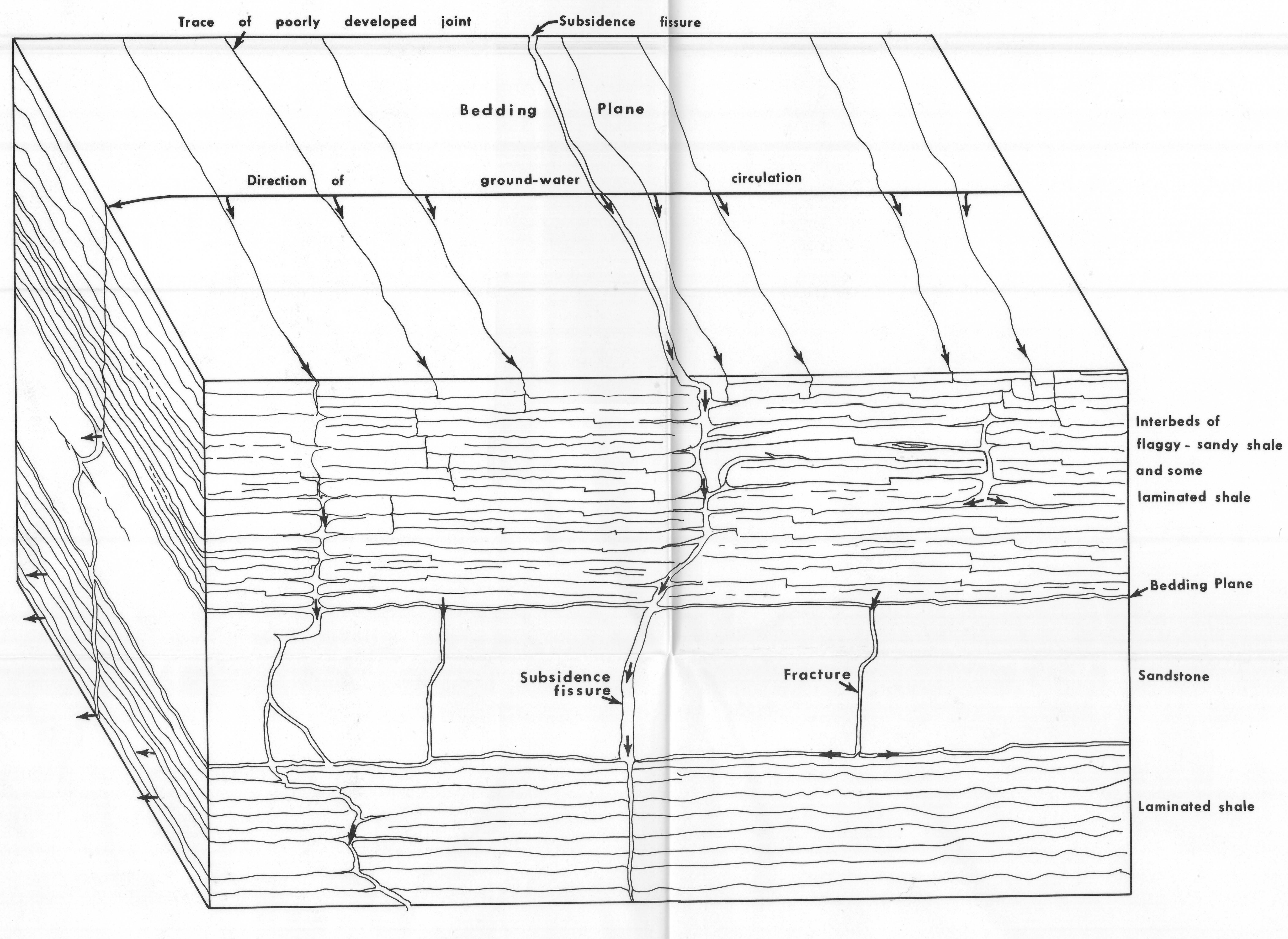
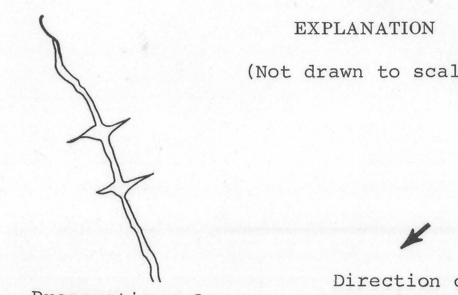


Figure 3. Generalized diagrammatic ground-water circulation system

Ground-water circulation is along bedding planes and joint and fracture systems. A greater degree of hydraulic connection occurs where subsidence fissures interconnect with these systems.

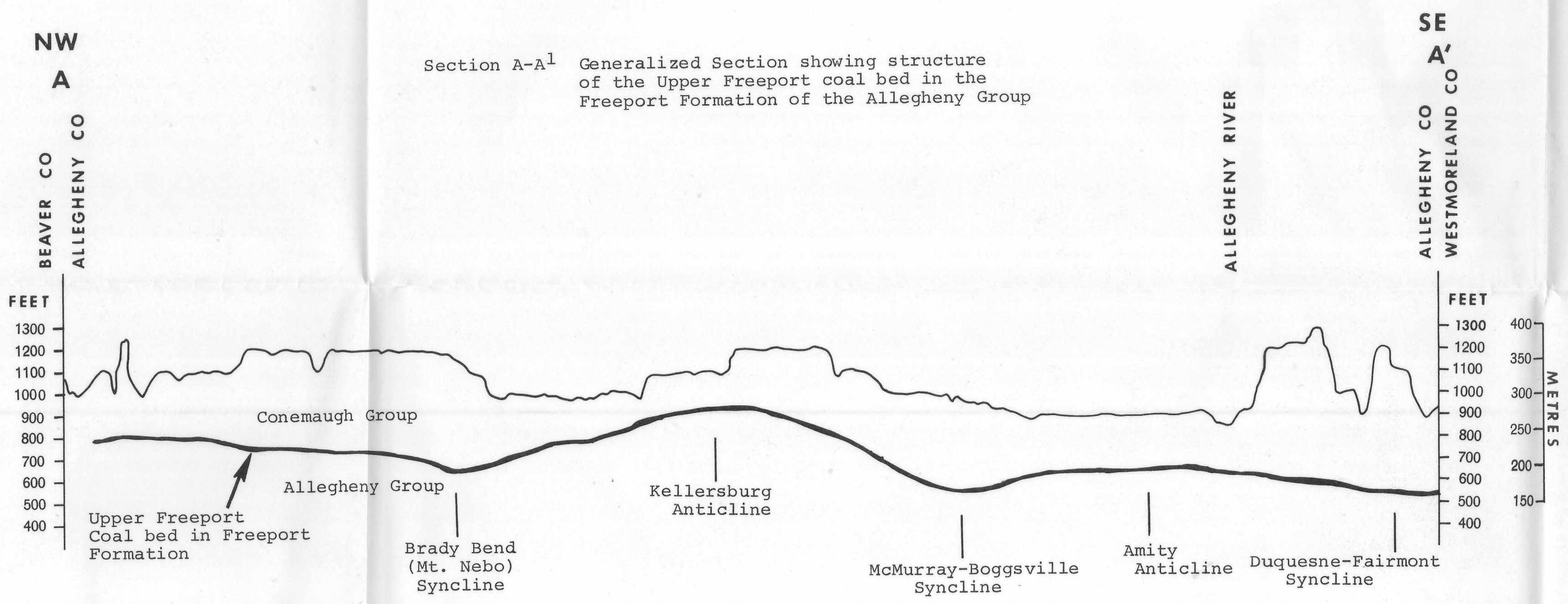
EXPLANATION

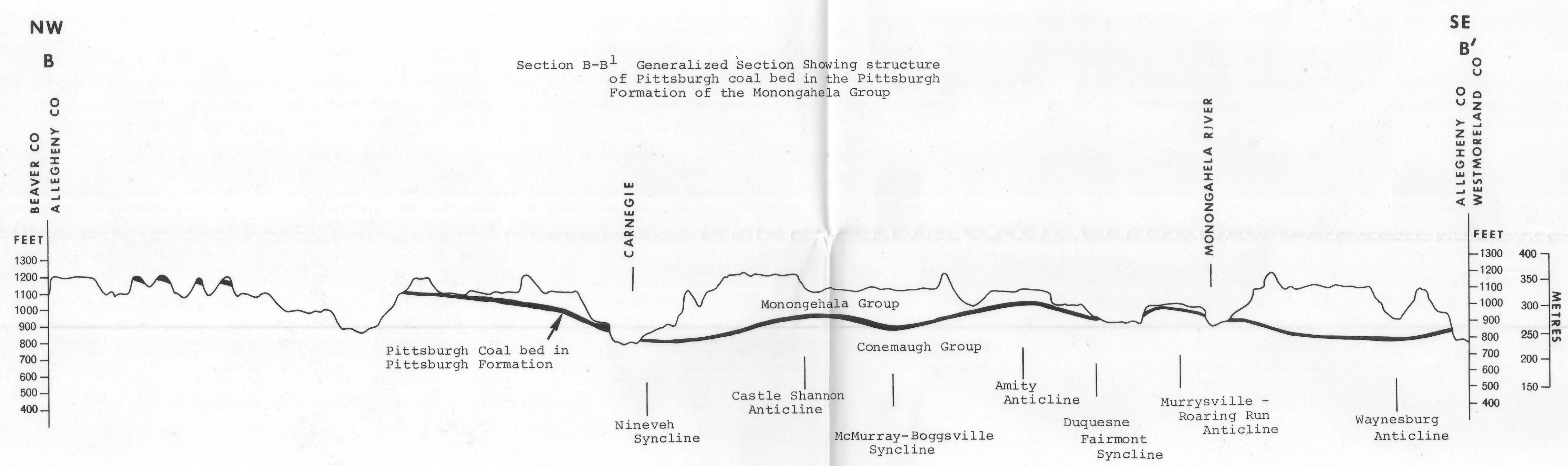
(Not drawn to scale)



Propagation of subsidence fissure

Direction of ground-water circulation





HORIZONTAL SCALE

0 1 2 3 4 5 MILES
0 1 2 3 4 5 6 7 8 KILOMETRES

1.0 MILE = 1.6 KILOMETRES
100 FEET = 30 METRES

Datum is mean sea level

Vertical exaggeration 60X

Conemaugh Group - Chiefly variegated shale and thick coarse sandstone with thin coal beds.

Sandstone yields as much as 100 gal/min (6.3 l/sec) though permeability varies. Shale and some local limestone units yield small supplies to shallow wells, but these units are less permeable at depth. (Adapted from Piper, 1933)

Monongahela Group - Shale, sandstone, and thick limestone with Pittsburgh coal bed at base and other workable coals. A thin zone of similar materials from the Dunkard Group that cap some hilltops are included with the Monongahela Group in this section. Limestone yield as much as 25 gal/min (1.6 l/sec) from bedding planes and joints just below drainage level; sandstones are locally less erratic but have lower permeability than limestones. (Adapted from Piper, 1933)

Figure 2.-Geologic Sections showing generalized regional hydrogeologic framework, Allegheny County, Pennsylvania. Alluvium deposits along river valleys are not shown.

Interior—Geological Survey, Reston, Va.—1976—L26068

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By Seymour Subitzky 1975