DEPARTMENT OF THE INTERIOR
UNITED STATES GEOLOGICAL SURVEY

Prepared in cooperation with the
Appalachian Regional Commission

MISCELLANEOUS FIELD STUDIES
MAP MF 641 – C

Mining and related problems of the shallow hydrogeologic regime, Allegheny County, Pennsylvania

Coal was first mined in western Pennsylvania over 200 years ago (Gray, 1970), and mining of both Upper Freeport and Pittsburgh coal beds in the Pittsburgh vicinity (Allegheny County) dates back more than 100 years (Vandale, 1967).

Much of the past mining was under open-space areas and farmlands, where problems resulting from mine subsidence, flooded abandoned mines, and acid mine drainage either were undetected or were soon remedied by natural processes. However, with urban growth, these problems became significant to land use.

In humid areas and upland regions of moderate relief and moderate rainfall, such as Allegheny County, water accumulations in coal mines are frequently large. Pumpage of water from mines in the area was not available; however, it has been reported by Young (1946) that the mining of bituminous coal beds in western Pennsylvania yield about 2 tons of water for each ton of coal removed. The interbeds of shale, siltstone, sandstone, and limestone occurring with the Pittsburgh coal and Upper Freeport coal beds are highly fractured but generally have a low permeability owing to their fine grain and induration. It appears that the occurrence and distribution of fracture patterns tend to vary with rock type and, therefore, the degree and extent of hydraulic connection of these fractures control the circulation of water in the interbed units above these mineable coals.

Areas overlying mined-out parts of the Upper Freeport and Pittsburgh coal beds are locally subject to subsidence, which may result from mine-roof collapse. The extent of such subsidence is generally dependent on the thickness and lithology of materials overlying the coal bed and to some degree the mining method. In all mine subsidence, the overlying rock units undergo some deformation, varying from bending (flexing) to some vertical displacement within the rock units. Flexing due to subsidence increases fracturing in sandstone and siltstone beds; shale tends to fracture to a lesser extent. Also, fractures due to displacement may transect overlying units, regardless of lithology, forming a subsidence fissure. A subsidence fissure extends across lithologic boundaries, whereas a joint commonly does not. However, the thickness of the overlying rock appears to control the number of subsidence fissures that extend to the surface. The height of fissures differs from place to place in Allegheny County and is difficult to determine. Where a subsidence fissure extends to the surface and no surface displacement is involved, the fissure is quickly healed by inwashed soil. Where strata are displaced, a hummocklike ground surface is formed; also nearby structures may be damaged to some extent. The influence of mine-subsidence fissures on joint and fracture patterns of varying rock types overlying mined-out areas is shown on figure 1.

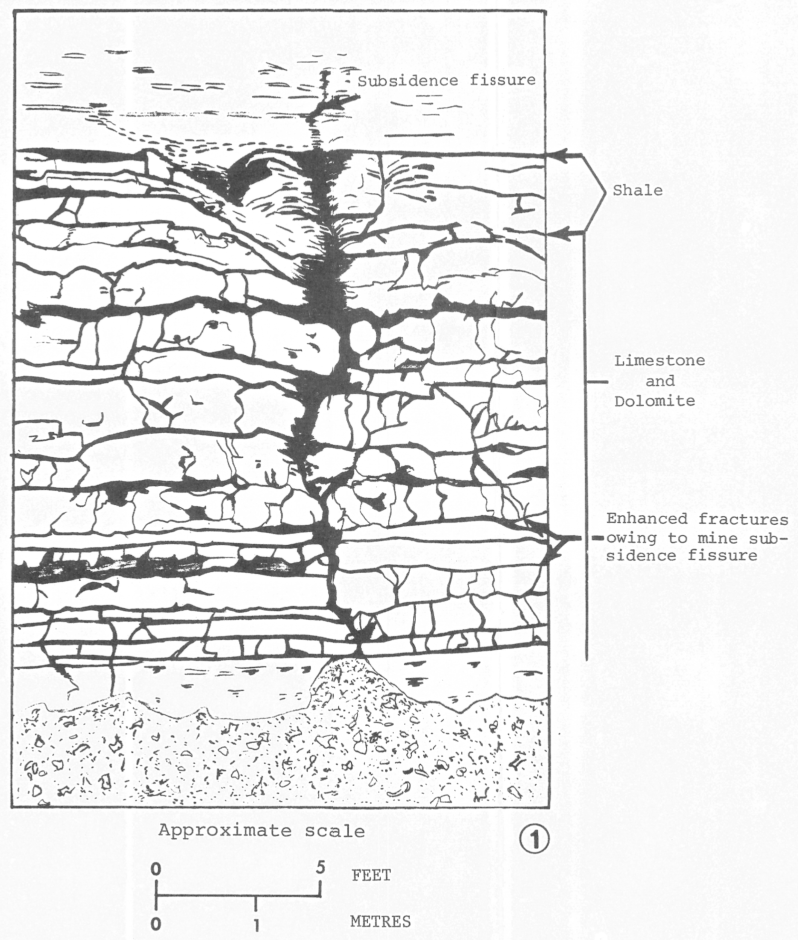
Permeability and porosity of the interbedded rock units of the Monongahela Group overlying the Pittsburgh coal bed and of the Conemaugh Group overlying the Upper Freeport coal bed are generally small. These properties, however, are somewhat enhanced when a system of subsidence fissures is superimposed on the fracture and joint systems. A case history showing the decline of the shallow water table probably due to mining is illustrated in figure 2. Before mining, a former spring in the area suggests a higher position of the premining water table. The position of this water table is shown in figure 2. The decline of the premining level, as determined from the spring location, to the lower position probably resulted from mining.

Piper (1933, p. 154) reported that the Pittsburgh Sandstone and its equivalents have been drained rather completely wherever the underlying Pittsburgh coal bed has been mined out and the roofs above abandoned mine entries have collapsed. Also, locally, mine-roof collapse and subsequent propagation of subsidence fissures above the Upper Freeport coal bed may have resulted in induced drainage from overlying basal members of the Conemaugh Group (Piper, 1933, p. 157). For example, in West Deer Township, Allegheny County drainage of water from wells was reported as early as 1933 in the vicinity of Russelton and again in 1970–71, when approximately 20 wells in the northwest part of the township drained. Figure 3 shows the location of affected wells in the township. Although scant subsurface data are available from well logs, approximately 300 feet (90 m) of fractured roof beds was reported in a log of well Ag 159 in the vicinity of Russelton (Piper, 1933). Some wells in this area were reported to have been drained by failure of mine roofs and were abandoned. Mine-roof collapse and subsequent subsidence fissures tend to increase the hydraulic connection of joints. The increased hydraulic connection and the interconnection of overlying shallow hydrologic units with the fractured roof beds may generally induce subsurface drainage from wells. Figures 4 and 5 show the hydrogeologic framework in West Deer Township and the relation of a zone of mine-roof collapse to overlying units. Similar conditions may have resulted in drainage from wells reported in 1970–71.

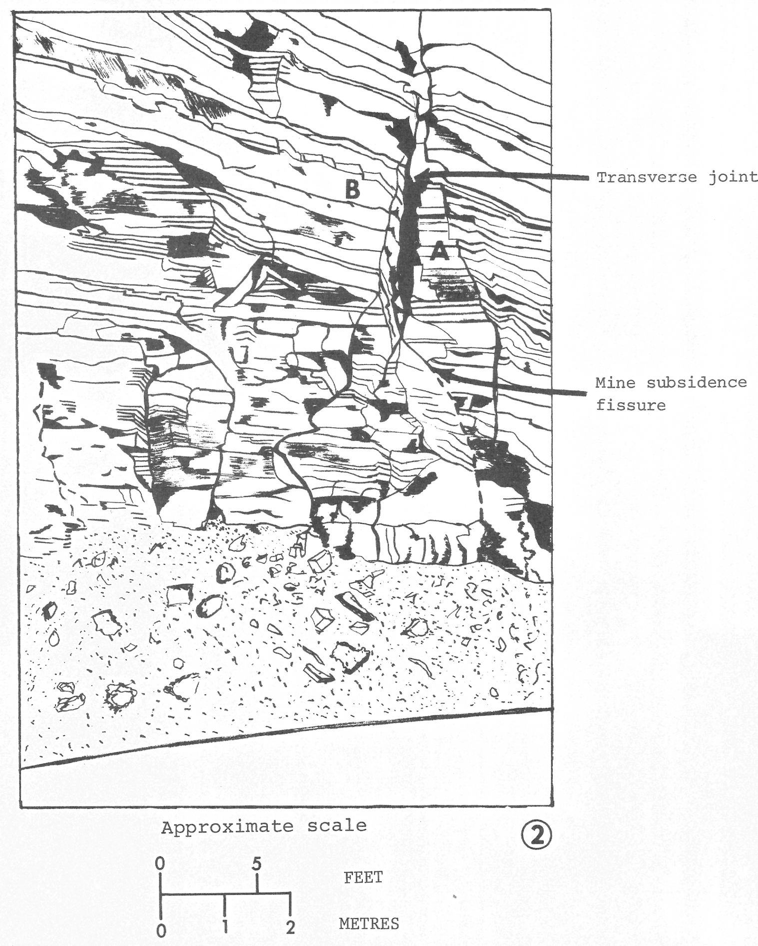
The shallow ground-water regime is stressed by dewatering during active mining. However, when mined-out areas are abandoned or sealed and pumping is stopped, water levels generally recover, at least in part. The extent of mine inundation by the recovery of ground-water levels in above-drainage mines is dependent on the inclination of the coal bed to the portal, rate and amounts of seepage from overlying rock units, and the elevation of the lowest subsidence holes (Moebs and Krickovic, 1970). As ground-water levels rise locally in mined-out areas, acid waters may enter streams where there is sufficient hydraulic connection between the mine and stream channel. In addition, where this rise in water level in abandoned mines permits a significant recovery locally to the water table, seepage from hillside slopes occurs. Deposits at toes of slopes may become saturated to the extent of increased pore-water pressures within these materials. As many newly urbanized areas extend onto land overlying shallow mined-out areas, the increased stress of development on such slopes, including the loading of surcharge fill material, may influence slope stability, causing slumping and cracks in foundations. Seepage from hillside slopes have been reported in the vicinity of some abandoned and flooded mines in Allegheny County. Also, in adjacent Washington County, studies by the Bureau of Mines along Pennsylvania Route 88 in the vicinity of Vestaburg have noted similar seepage conditions (Moebs and Chamberlain, 1972).

REFERENCE CITED

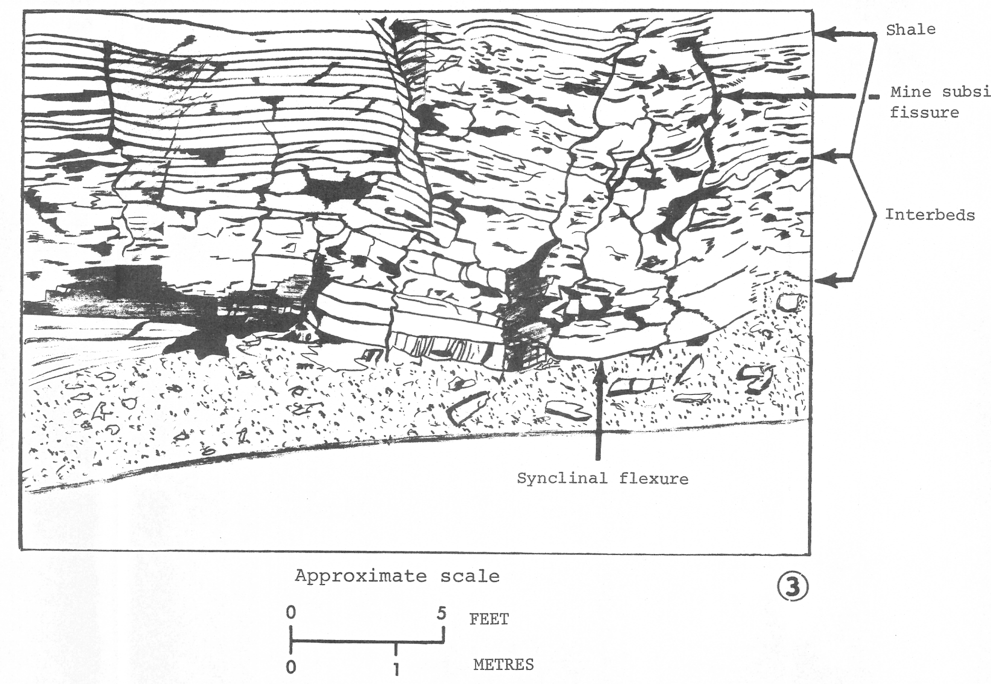
Edmunds, W. E., 1974, Preliminary structure contour map of Allegheny County, Pennsylvania: Pennsylvania Geol. Survey, open-file map.
Gallaher, J. T., 1973, Summary ground-water resources of Allegheny County, Pennsylvania: Pennsylvania Geol. Survey, 4th Ser. Water Resources Rept. 35, 71 p.
Gray, R. E., 1970, Mine subsidence in Wagner, W. R., Heyman, Louis, Gray, R. E., Belz, D. J., Lund, Richard, Cate, A. S., and Edgerton, C. D., 1970, Geology of the Pittsburgh area: Pennsylvania Geol. Survey 4th Ser. Gen. Geol. Rept. G-59, p. 11 (145 p.).
Moebs, N. M., and Chamberlain, C. E., 1972, The effect of atmospheric pressure on the oxygen level in a sealed mine: U. S. Bur. Mines Rept. Inv. 7606, 19 p.
Moebs, N. M., and Krickovic, Stephen, 1970, Air-sealing coal mines to reduce water pollution: U. S. Bur. Mines Rept. Inv. 7354, 33 p.
Piper, A. M., 1933, Ground water in Southeastern Pennsylvania: Pennsylvania Geol. Survey 4th Ser. Bull. W-1, 406 p.
Vandale, A. E., 1967, Subsidence–A real or imaginary problem?: Soc. Mining Engineers, Mining Eng., p. 86–88 (September).
Young, G. J., 1946, Elements of mining, 4th ed.: New York, McGraw-Hill, 755 p.



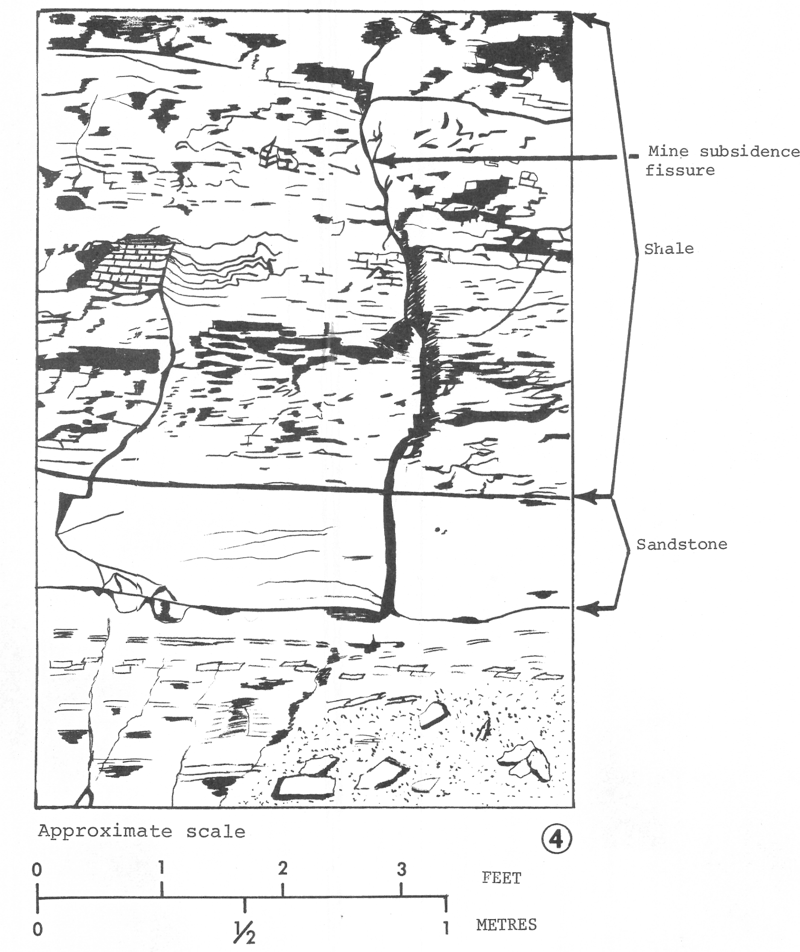

Pittsburgh Formation of Monongahela Group showing upper member (Benwood Limestone as used by Gallaher, 1973) containing interbeds of limestone, dolomite, and shale. Shale layer overlain by siltstone and sandstone. Fracture pattern of limestone and dolomite enhanced by subsidence fissure transecting the total exposed thickness. Area underlain by mined-out Pittsburgh coal bed of lower member.



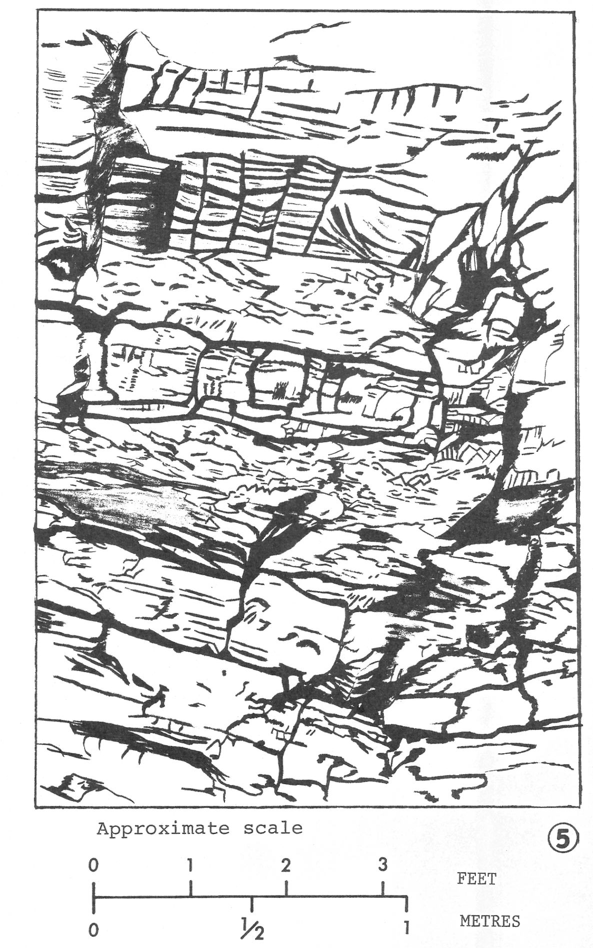

Section of upper member of Pittsburgh Formation (Benwood Limestone as used by Gallaher, 1973) subsidence fissure producing intensive fracture zones and deep transverse jointing between Blocks A and B. This in turn tends to result in slope failure along joint face.




Monongahela Group, undivided showing shale and interbeds of shale, sandstone, and limestone (?). Beds show effect of intensive mine subsidence resulting in deformation of beds forming a syncline. The shale unit shows flexing with lesser fracturing than shown in the interbeds of shale, sandstone, and limestone (?). Also mine subsidence fissures in relation to intensive jointing in the flexed beds increases the hydraulic connection within these units.



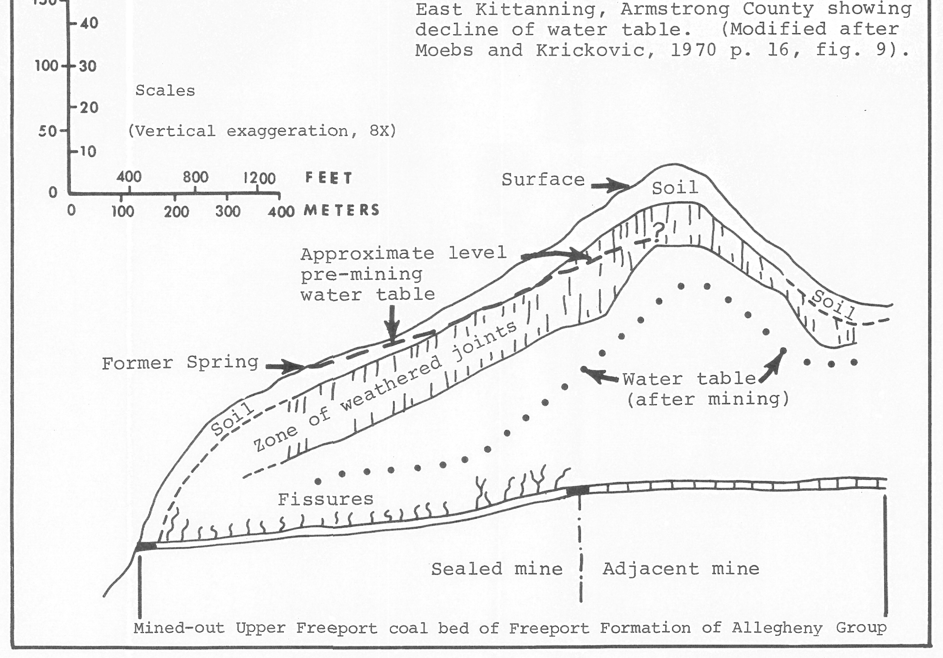

Extent of fracture pattern developed in shale and interbedded sandstone (close view of 3)

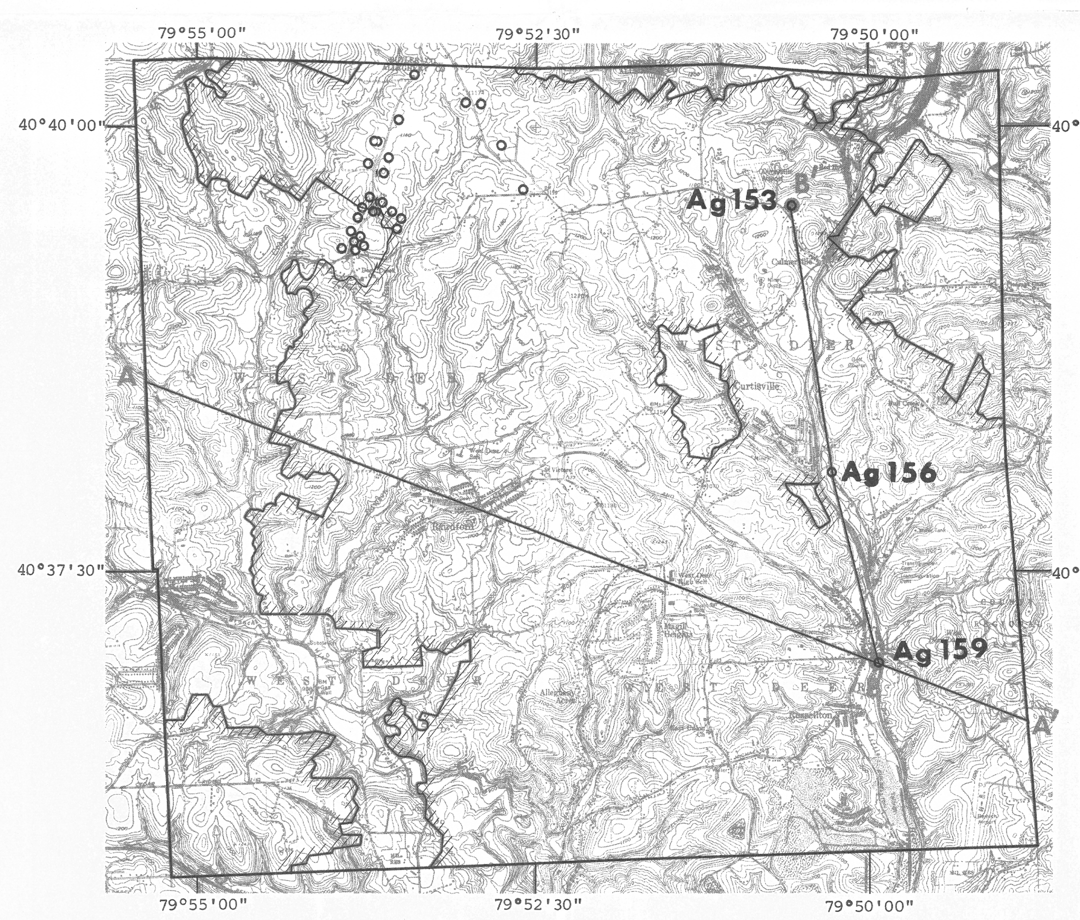



Close view of 3, showing fracture pattern of interbeds of shale, sandstone, and limestone (?).

Figure 1 Mine subsidence, rock fracture patterns, and lithology in relation to the shallow hydrogeologic regime. (Fracture and joint patterns sketched from photographs)

Figure 2. - Shallow ground-water regime affected by mining of Upper Freeport coal bed of Freeport Formation of Allegheny Group, East Kittanning, Armstrong County showing decline of water table. (Modified after Moebs and Krickovic, 1970 p. 16, fig. 9).




EXPLANATION

o Wells affected in 1970-1971 (Location of wells from Allegheny County Department of Planning)

Mined-out area Upper Freeport coal bed in Freeport Formation of Allegheny County

Base map from composite reduction of U.S. Geological Survey Topographic Maps, 1950-60, photo revised 1969

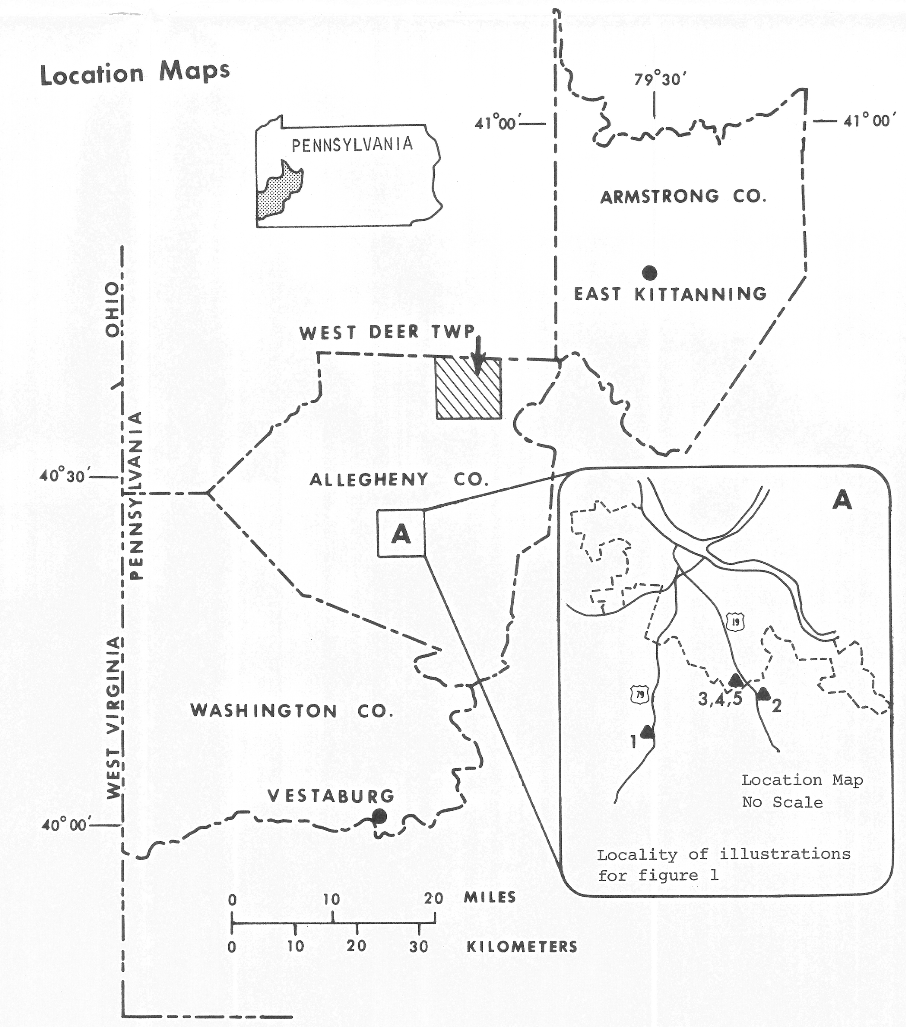
Information from Division of Mine Subsidence Regulation, Pennsylvania Department of Environmental Resources, 1974

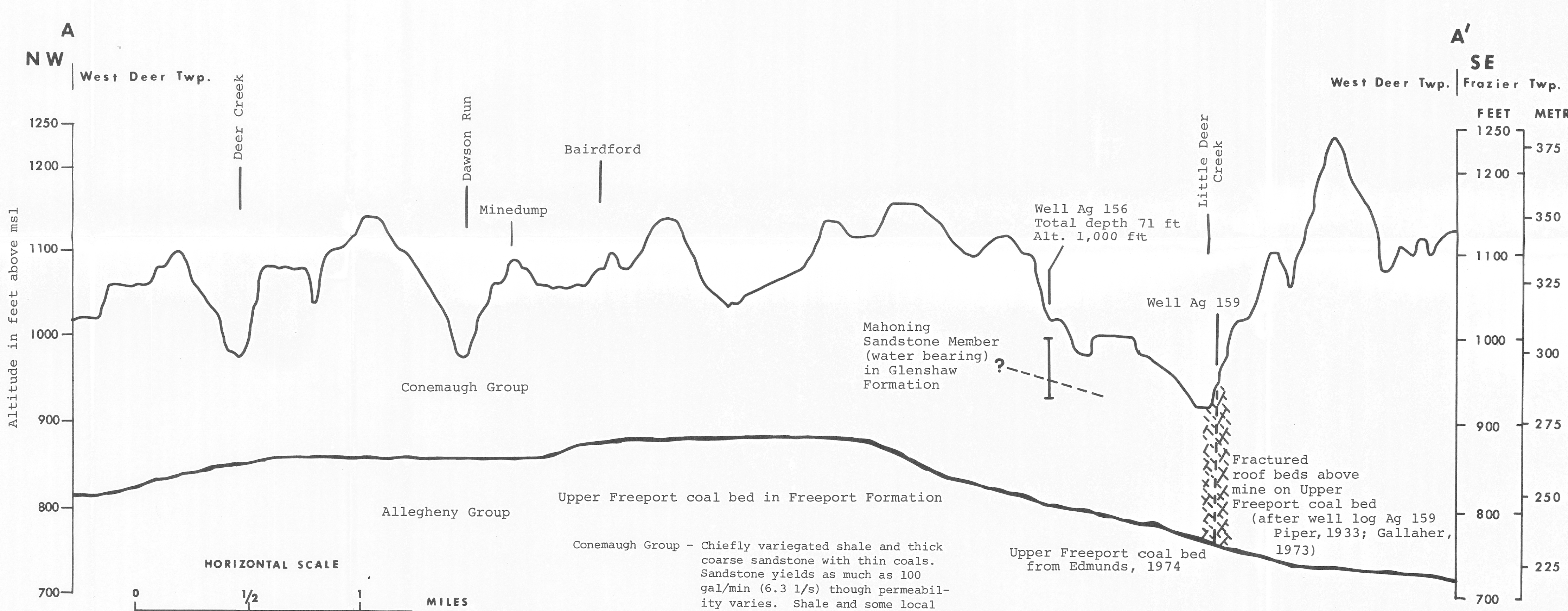
Figure 3.- Map of West Deer Township, Allegheny County showing mined-out areas of Upper Freeport coal bed of Freeport Formation of Allegheny Group and location of wells and cross sections.

0 1 2 3 MILES
0 1 2 3 4 5 KILOMETRES

CONTOUR INTERVAL 20 FEET
DATUM IS MEAN SEA LEVEL

Location Maps



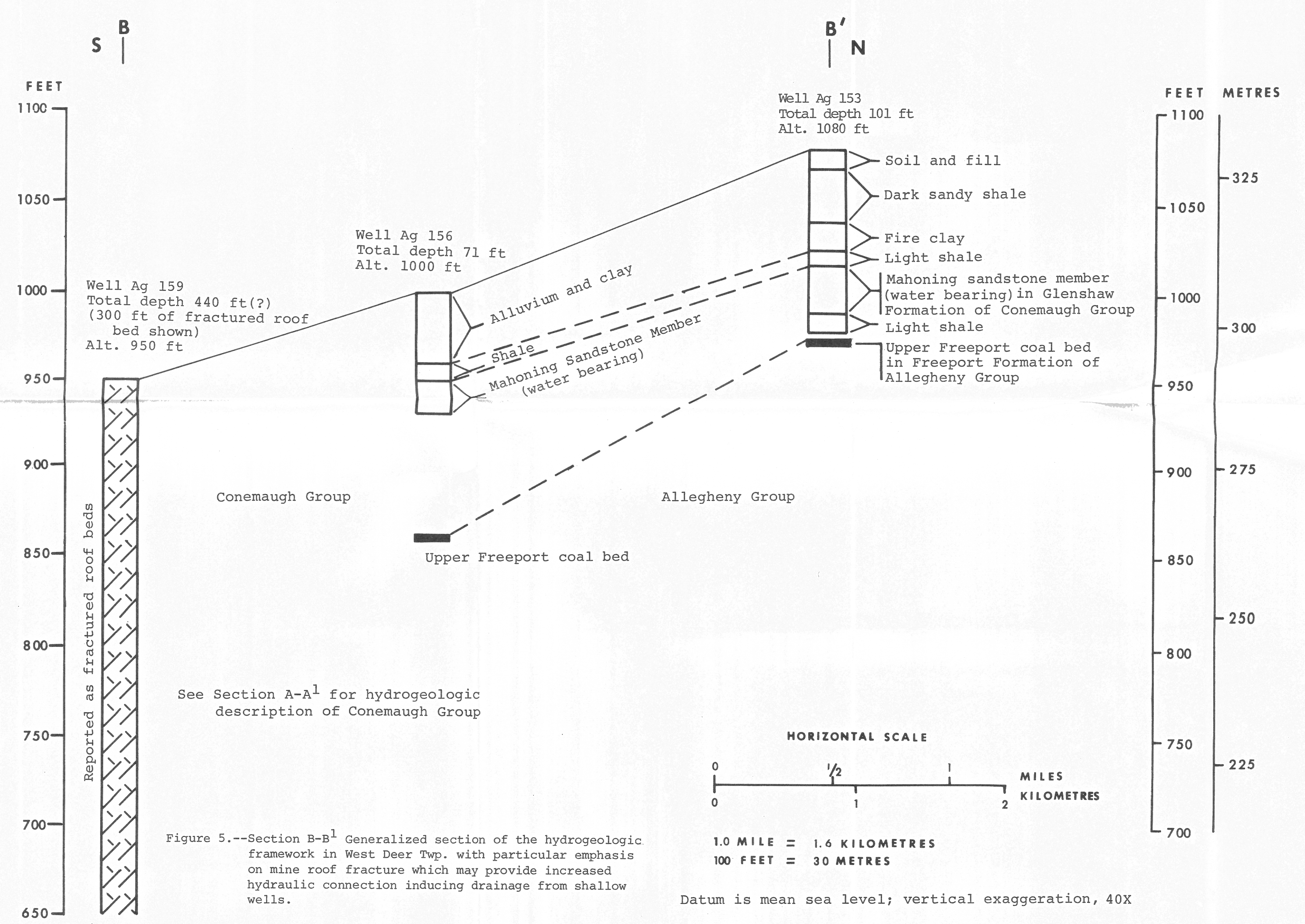




Conemaugh Group - Chiefly variegated shale and thick coarse sandstone with thin coals. Sandstone yields as much as 100 gal/min (6.3 l/s) though permeability varies. Shale and some local limestone units yield small supplies to shallow wells, but these units are less permeable at depth. (Adapted from Piper, 1933)

Datum is mean sea level; vertical exaggeration, 20x

Figure 4.--Section A-A[1] Generalized section of the hydrogeologic framework in West Deer Twp.

Note: Reference source differs by 100 feet
Edmunds, W. E., 1974
Gallaher, J. T., 1973




See Section A-A[1] for hydrogeologic description of Conemaugh Group

Figure 5.--Section B-B[1] Generalized section of the hydrogeologic framework in West Deer Twp. with particular emphasis on mine roof fracture which may provide increased hydraulic connection inducing drainage from shallow wells.

Datum is mean sea level; vertical exaggeration, 40X

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