INTRODUCTION

This map is one result of a series of studies sponsored by the Appalachian Regional Commission as part of a larger U.S. Geological Survey program of environmental analysis of a part of southwestern Pennsylvania. The map summarizes surface features resulting from coal mining. The distribution of surface features is largely from 1973, 1:12,000 scale aerial photographs verified by field reconnaissance in 1973 and 1974. Supplementary interpretations relative to surface subsidence were done using 1939 aerial photographs.

COAL GEOLOGY AND MINING

The exposed bedrock in Allegheny County is coal-bearing rock of Pennsylvanian and Permian age (Wagner and others, 1970) (Kohl and Briggs, 1975). Outcropping formations from bottom to top in the Pennsylvanian are the Freeport in the Allegheny Group, the Glenshaw and Casselman in the Conemaugh Group, and the Pittsburgh and Uniontown in the Monongahela Group; the Waynesburg and Washington in the Dunkard Group are Pennsylvanian and Permian (figs. 1 and 2). The formations are composed of different proportions of sandstone, siltstone, claystone, shale, and limestone, with coal comprising less than 2 percent of the total rock volume. The Upper Freeport and the Pittsburgh are the most important coal beds in Allegheny County. The Upper Freeport is the uppermost unit of the Allegheny Group and the Pittsburgh is the basal unit of the Monongahela Group. The only other coal bed of historic importance in the area is the Redstone in the Monongahela Group (fig. 1). The rocks in Allegheny County generally are inclined southward at less than 100 feet per mile. However, locally the southward inclination is interrupted by broad, north-northeast trending folds that are more pronounced in the eastern part of the county (fig. 2).

Upper Freeport coal bed.--The Upper Freeport crops out only in the northeastern part of the county in the valley of the Allegheny River and in small areas along tributary valleys. Elsewhere, the Upper Freeport most commonly is under at least 200 feet (61 metres) of overburden and in many places is at depths greater than 500 feet (152 metres) below ground surface (Bushnell and Peak, 1975). In most of this area the coal bed is more than 5 feet (1.5 metres) thick, and in the extreme northeastern part it ranges up to 10 feet (3 metres) in thickness, meriting the local name, "Thick Freeport" (Sisler, 1971, p. 12-17). West of the extreme northeastern part of the county, the coal bed commonly is less than 3 feet (1 metre) thick. The Freeport has been mined underground more or less continuously in Allegheny County since the latter part of the 19th century. Strip mining has been relatively minor because of the limited outcrop of the coal and the thick overburden. Recoverable reserves of high-volatile bituminous coal in beds 36 inches (0.9 metre) thick or more in Allegheny County in 1970 totalled 260 million short tons; probably more than 200 million tons of this are in the Upper Freeport coal bed (Edmunds in Nielsen, 1974, p. 550, table 7). More than 3,200,000 short tons of coal were produced from the Upper Freeport in 1973 (Nielsen, 1974, p. 722, 728, 736, 737).

Pittsburgh coal bed.--The Pittsburgh coal bed crops out widely in the southern half of the county. It lies 600 to 650 feet (182 to 198 metres) stratigraphically above the Upper Freeport (fig. 1), and its outcrop north of the Ohio and Allegheny Rivers is limited to small hilltop occurrences. In most of the county the Pittsburgh horizon lies less than 200 feet (61 metres) below ground surface, and rarely does overburden exceed 500 feet (152 metres) (Craft, 1974). The coal bed is remarkably uniform in thickness; of 120 coal sections reported by Sisler (1961, p. 20, 22, 24), the average thickness is 5 feet 6 inches (1.65 metres) and 87 coal sections are between 5 and 6 feet (1.5 and 1.8 metres) thick. Locally the coal bed is more than 10 feet (3 metres) thick. As shown by the map, the Pittsburgh coal bed in Allegheny County has been extensively mined. The great bulk of coal produced from the Pittsburgh was from underground mines; present production is divided about equally between underground and strip mining operations. Although strip mining has been widespread along the Pittsburgh outcrop, current surface operations are largely in the western part of the county.

Redstone coal bed.--The Redstone coal bed is in the Pittsburgh Formation about 70 feet (21 metres) above the Pittsburgh coal bed (fig. 1). Because of this close proximity to the more important Pittsburgh, its outcrop is not shown on the map. In the southeastern part of the county it ranges irregularly from 1 foot 6 inches (0.45 metres) to more than 4 feet (1.2 metres) thick, but elsewhere it is very thin or absent. The Redstone has not been mined extensively underground, probably because the thicker and more consistent Pittsburgh coal bed was more attractive to mining. Appreciable tonnages of Redstone coal probably remain, but large-scale underground mining for the Redstone is not foreseen, because its continuity has been broken by subsidence into voids where the Pittsburgh coal bed has been mined. The Redstone, however, has been widely strip mined. No large-scale strip mines were active in 1974, but future strip mining of the Redstone is likely in areas that have not been urbanized.

Other coal beds.--All other coal beds cropping out in Allegheny County are too thin, too discontinuous, or too impure to mine under current conditions. In the past, however, coal beds in the Conemaugh Group (fig. 1) were mined locally (Munn, 1911), but no maps or other records of such mines are known. On the present map an area of possible underground mining of a coal bed in the Conemaugh Group is indicated in the northeastern part of the county.

Coal beds lower than the Upper Freeport are not known to crop out in Allegheny County, but the Kittanning coal beds (fig. 1) and other coal beds certainly underlie the county. At least one such bed may be thick enough under part of the area so that future economic and technological developments may make mining of that coal bed feasible.

ENVIRONMENTAL EFFECTS OF COAL MINING

Although deposits of iron and limestone and large timber stands for making charcoal were the underlying reasons for the birth of the iron and steel industry in the Pittsburgh area, it was the development of coking techniques for steel in the mid-19th century combined with abundant coking coal that led to the firm establishment of Pittsburgh as the steel center of the nation. In this sense, the development of the area and its present environment is an indirect result of coal mining.

Effects of underground mining.--One deleterious effect of underground mining is mine drainage which is beyond the direct scope of this map. Old mine openings were abundant wherever the Pittsburgh coal bed cropped out but most have caved or been sealed. However, mine water still escapes at many places, and many small stream beds are conspicuously stained by deposits of red and yellow iron compounds (yellow boy).

Refuse banks from underground mines also contribute mineralized water to the stream network, as well as sediment. In addition, refuse banks locally present potential slope-stability problems. Although refuse banks largely are considered eyesores, many small banks have been leached, modified by erosion, and so overgrown that they blend inconspicuously into the landscape, particularly during lush summer growth. Many refuse banks have burned and now are largely ash and clinker (red dog). Many burned refuse banks are being mined for red dog, especially for use as road metal.

Surface subsidence from underground mining is a pervasive problem in Allegheny County. The map outlines areas underground mines through June 30, 1974 on the basis of evidence available to the Pennsylvania Division of Mine Subsidence Regulation, which administers the "Bituminous Mine Subsidence and Land Conservation Act of 1966" (Cortis, 1969, and Gray in Wagner and others, 1970, p. 111-116). Their records are complete only from 1966, but data from all available sources extend the record back to the late 1930's. Details of areas mined prior to the 1930's, when much of the Pittsburgh coal bed was mined, are not well known.

Mine-subsidence has been correlated to geological, coal mining, and developmental factors (Bushnell, 1975a, 1975b, and Bushnell and Peak, 1975). Their conclusion is that future damaging subsidence is more likely in areas where the Pittsburgh coal bed was less than 200 feet (61 metres) deep and was undermined before 1966. The records of subsidence events due to undermining of the Upper Freeport coal bed are incomplete; the pattern of subsidence though somewhat vague, appears similar to that associated with the Pittsburgh coal bed. Mine-subsidence events commonly have been recorded only where damage has resulted in claims or where the extent of damage was noteworthy. Subsidence also occurs in rural undeveloped areas and has been verified at many places where it has produced pits, hummocky, and broken ground surface.

Many areas of subsidence, especially in rural settings were interpreted from patterns recognized on aerial photos. In some cases this leads to discrepancies when compared with the mining record and other data. As shown near the eastern edge of the map, in Plum and Monroeville Boroughs and elsewhere, there are areas interpreted as representing local subsidence events. These areas stratigraphically underlie the Pittsburgh coal bed and overlie the Upper Freeport bed for which there is no record of mining. The cause of subsidence in these areas is unknown. In addition, areas interpreted as subsided appear to be overlapping mined and unmined Upper Freeport coal near the north edge of the map as well as over unmined Pittsburgh and Upper Freeport coal at a few other places. A possible explanation for these discrepancies include extension of subsidence-related ground disruption beyond mined-out areas, or they may be misinterpretation of the aerial photographs, incomplete mining records, or inaccurate plotting of mining limits. The last two reasons are most probable.

A locality in the northeastern part of the mapped area within which one man-made structure was reported as damaged by subsidence but which does not overlie an area of recorded mining has been shown on the map by a dashed circle. Alternative explanations for this apparently anomalous event are discussed by Bushnell and Peak (1975).

Mine subsidence commonly is accompanied by extensive fracturing of overlying rocks which in many places extends to the surface. One effect of this fracturing is to enhance movement of shallow ground water resulting in the drainage of "perched" water tables (Subitzky, 1975).

In Allegheny County mine fires, recognized hazards in coal mining, usually occur in the vicinity of coal bed outcrops. They result from a number of causes, including spontaneous combustion, lightning, trash burning, and, in at least one instance, children lighting a campfire against the outcrop. Free passage of air into old mines perpetuates fires and makes them difficult to extinguish. "Crop fires" result in noxious fumes and possible fire hazards to adjacent man-made structures. Another harmful effect is the destruction of coal pillars in old mines, with resulting subsidence of the surface. The United States Bureau of Mines has extinguished or controlled most of the fires in the Pittsburgh area by use of water injection and excavation.

Effects of strip mining.--Harmful effects of surface mining include: disruption of ground water and surface drainage regimes, ponding of water to form breeding ground for insects, creation of steep potentially hazardous slopes and cliffs (high walls) and unstable spoil piles, withdrawal of land from other uses, and unsightliness. Pennsylvania legislation enacted in 1963 requires restoration of strip-mined land to a close approximation of its original contour; since strip mining was widespread before that date, however, much land remains unreclaimed, as indicated on the map.

Continued improvement of strip-mining equipment and rising coal prices have combined to allow reclamation of some of the older "orphan" strip mines. Economic coal-stripping ratios in the 1940's were about 10 feet of rock to 1 foot of coal. Larger stripping ratios, locally exceeding 20:1, are now achievable. Accordingly, hillsides previously strip-mined are being remined, chiefly west of Imperial, and reclamation following the new mining is eradicating many of the older scars.

Present economic and technical capabilities allow stripping of many areas mined underground in the past, to obtain the 50 percent of coal commonly left as roof support. These operations remove much of the remaining coal which accounts for most of the mine-polluted water. Removal of the coal and reclamation also sets the stage for broader future land use by reducing the potential for surface subsidence over old underground mines. Strip-mined tracts have also been reclaimed through use as disposal sites for solid waste generated in Pittsburgh, for housing and industrial developments, and for parklands.

Slag dumps.--Although slag dumps are not direct products of coal mining, they are included on the map because of their size and because they are a striking mineral-industry feature of the county. Slag is waste from blast and open-hearth furnaces that is dumped in molten or semi-molten form; unlike the loose spoil of strip mines and refuse from underground mines, it is moderately well cemented and stable. Commonly it is stable on slopes greater than 45 degrees. Failure of slag dump slopes is rare. Chemically slag is relatively inert and is not an important contributor to water pollution. For the same reason slag dumps weather and vegetate slowly. Slag dumps are attractive sites for industrial and commercial development because they are generally flat topped and are commonly emplaced in steep-sided valleys. Slag is widely used as a construction aggregate in the Pittsburgh region because other durable aggregate materials, such as sand and gravel deposits, are in relatively short supply (O'Neill, 1974).

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______1974c, Map of land modified by man in part of the Canonsburg 7 1/2 minute quadrangle, Allegheny County and vicinity, Pennsylvania: U.S. Geol. Survey open-file map 74-287.

______1974d, Map of land modified by man in part of the Curtisville 7 1/2 minute quadrangle, Allegheny County and vicinity, Pennsylvania: U.S. Geol. Survey open-file map 74-288.

______1974e, Map of land modified by man in part of the Donora 7 1/2 minute quadrangle, Allegheny County and vicinity, Pennsylvania: U.S. Geol. Survey open-file map 74-289.

______1974f, Map of land modified by man in part of the Freeport 7 1/2 minute quadrangle, Allegheny County and vicinity, Pennsylvania: U.S. Geol. Survey open-file map 74-290.

______1974g, Map of land modified by man in the Glassport 7 1/2 minute quadrangle, Allegheny County and vicinity, Pennsylvania: U.S. Geol. Survey open-file map 74-291.

______1974h, Map of land modified by man in the McKeesport 7 1/2 minute quadrangle, Allegheny County and vicinity, Pennsylvania: U.S. Geol. Survey open-file map 74-292.

______1974i, Map of land modified by man in part of the Monongahela 7 1/2 minute quadrangle, Allegheny County and vicinity, Pennsylvania: U.S. Geol. Survey open-file map 74-293.

______1974j, Map of land modified by man in part of the Murrysville 7 1/2 minute quadrangle, Allegheny County and vicinity, Pennsylvania: U.S. Geol. Survey open-file map 74-294.

______1974k, Map of land modified by man in part of the New Kensington East 7 1/2 minute quadrangle, Allegheny County and vicinity, Pennsylvania: U.S. Geol. Survey open-file map 74-295.

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______1974c, Landslide susceptibility and land modified by man map of part of the Clinton 7 1/2 minute quadrangle, Allegheny County and vicinity, Pennsylvania: U.S. Geol. Survey open-file map 74-234.

______1974d, Map of land modified by man in the Ambridge 7 1/2 minute quadrangle, Allegheny County and vicinity, Pennsylvania: U.S. Geol. Survey open-file map 74-74.

______1974e, Map of land modified by man in the Emsworth 7 1/2 minute quadrangle, Allegheny County, Pennsylvania: U.S. Geol. Survey open-file map 74-73.

______1974f, Map of land modified by man in the Glenshaw 7 1/2 minute quadrangle, Allegheny County, Pennsylvania: U.S. Geol. Survey open-file map 74-119.

______1974g, Map of land modified by man in part of the Mars 7 1/2 minute quadrangle, Allegheny County and vicinity, Pennsylvania: U.S. Geol. Survey open-file map 74-115.

______1974h, Map of land modified by man in the Oakdale 7 1/2 minute quadrangle, Allegheny County and vicinity, Pennsylvania: U.S. Geol. Survey open-file map 74-233.

______1974i, Map of land modified by man in the Pittsburgh East 7 1/2 minute quadrangle, Allegheny County, Pennsylvania: U.S. Geol. Survey open-file map 74-231.

______1974j, Map of land modified by man in the Pittsburgh West 7 1/2 minute quadrangle, Allegheny County, Pennsylvania: U.S. Geol. Survey open-file map 74-230.

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Units of measurement

Customary (English) units of measurement are used for present purposes in preference to International System (SI or metric) units. Some conversion factors are given below:

Multiply	By	To obtain
millimetres	0.03937	inches
inches	25.4	millimetres
inches	2.54	centimetres
feet	30.48	centimetres
feet	0.3048	metres
miles	1.609	kilometres
feet per mile	0.189	metres per kilometres

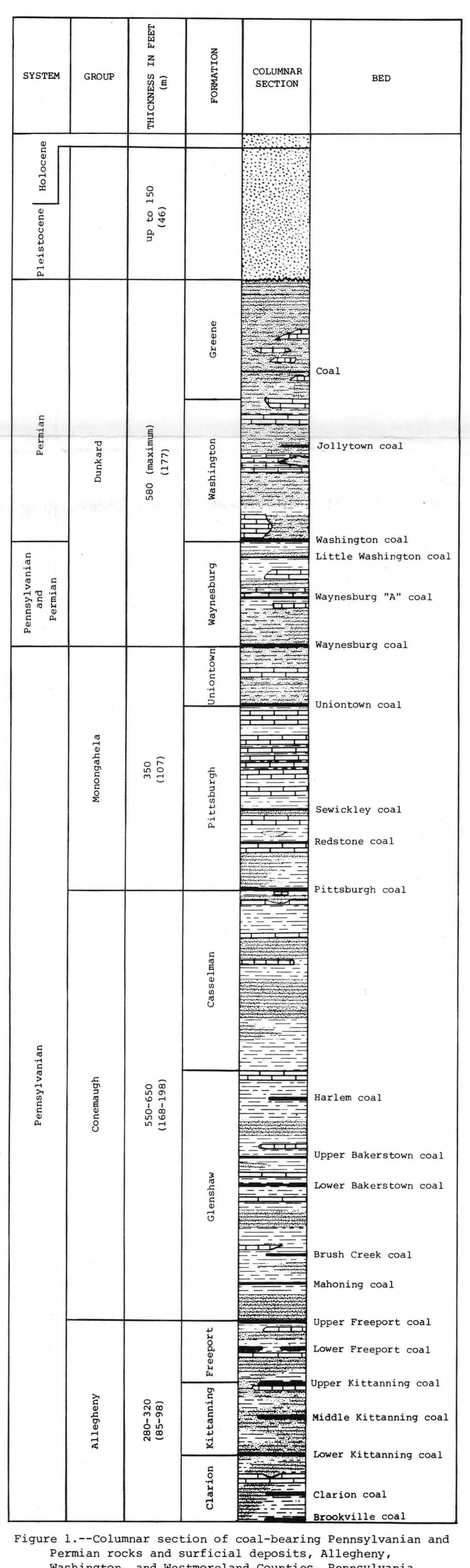
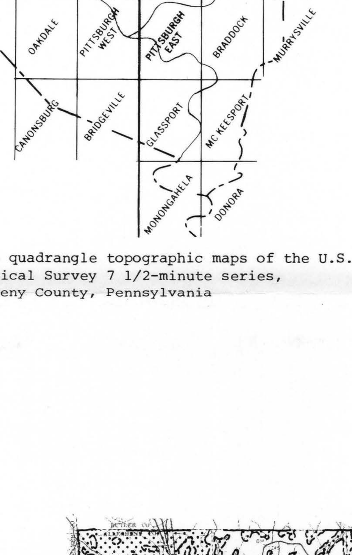
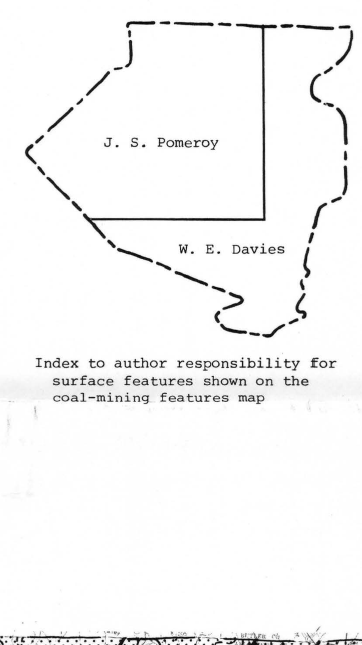


Figure 1.--Columnar section of coal-bearing Pennsylvanian and Permian rocks and surficial deposits, Allegheny, Washington, and Westmoreland Counties, Pennsylvania (from O'Neill, 1974, pl. 3).



Index to quadrangle topographic maps of the U.S. Geological Survey 7 1/2-minute series, Allegheny County, Pennsylvania



Index to author responsibility for surface features shown on the coal-mining features map

Base from U.S. Geological Survey, Greater Pittsburgh region, 1:125 000 1971

Figure 2.--Simplified geologic map of Allegheny County, Pennsylvania

EXPLANATION

PPd — Dunkard Group (in part), undivided. Waynesburg Formation and overlying Washington Formation. Waynesburg coal bed at base — PENNSYLVANIAN AND PERMIAN

Pm — Monongahela Group, undivided. Pittsburgh Formation and overlying Uniontown Formation. Pittsburgh coal bed at base — PENNSYLVANIAN

Pcc — Casselman Formation — Conemaugh Group — PENNSYLVANIAN

Pcg — Glenshaw Formation. Ames Limestone Member at top — Conemaugh Group — PENNSYLVANIAN

Paf — Freeport Formation. Upper Freeport coal bed at top — Allegheny Group (in part) — PENNSYLVANIAN

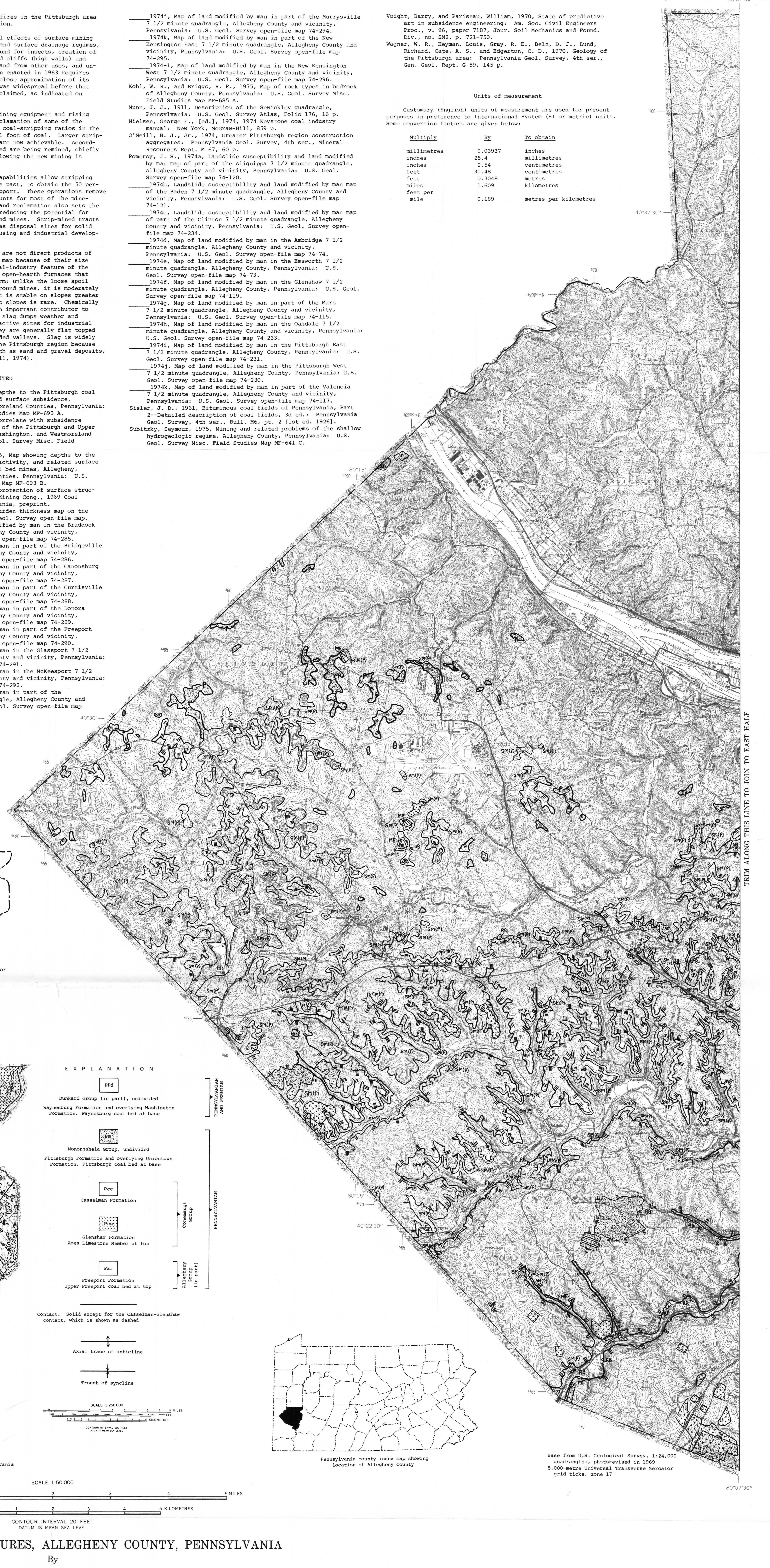
Contact. Solid except for the Casselman-Glenshaw contact, which is shown as dashed

Axial trace of anticline

Trough of syncline

SCALE 1:250 000

CONTOUR INTERVAL 100 FEET
DATUM IS MEAN SEA LEVEL



Pennsylvania county index map showing location of Allegheny County

Base from U.S. Geological Survey, 1:24,000 quadrangles, photorevised in 1969
5,000-metre Universal Transverse Mercator grid ticks, zone 17

TRIM ALONG THIS LINE TO JOIN TO EAST HALF

SCALE 1:50 000

CONTOUR INTERVAL 20 FEET
DATUM IS MEAN SEA LEVEL

MAP OF COAL-MINING FEATURES, ALLEGHENY COUNTY, PENNSYLVANIA

By
William E. Davies, John S. Pomeroy, and William R. Kohl

1976

Interior—Geological Survey, Reston, Virginia—1976

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