DEPARTMENT OF THE INTERIOR
UNITED STATES GEOLOGICAL SURVEY

PREPARED IN COOPERATION WITH
THE APPALACHIAN REGIONAL COMMISSION

MISCELLANEOUS FIELD STUDIES
MAP MF-685B
(SHEET 1 OF 2)

INTRODUCTION

In Allegheny County, more than 90 percent of landsliding and downslope movement of masses of soil and rock is the result of man's modification of sensitive slopes by excavation, by loading, or by altering ground and surface water systems. Most landsliding can be prevented or controlled by proper engineering or by judicious control of land use. The purpose of this map is to define areas where susceptibility to landsliding is greatest and where proper engineering or land-use control are most urgently needed.

This map is a guide to areas of past landslides, presently active landslides, and potential future landsliding. It is principally based upon interpretation of 1973 aerial photographs (series GS-VDGY) and subsequent field studies during 1973 and 1974 (Davies, 1974 a-l; Pomeroy, 1974 a-k). The soil survey of Allegheny County (U. S. Soil Conservation Service, 1973 a, b) was also used as a source of data. The user should bear in mind that features shown on this map are a generalization of material denoted on Davies (1974a-l) and Pomeroy (1974a-k).

Because ground conditions vary, information about a specific area is intended as a general statement and should not be construed as being rigidly applicable to all localities within that area. The map calls attention to potential problems, but it must not be used as a substitute for detailed on-site investigations.

Much of the information presented for the Curtisville, Freeport, and New Kensington West quadrangles (see topographic map index) in the northeastern part of the county is based on a training study of slope stability by Lt. R. Marx, Sp-6 K. Beveridge, and Sp-5 M. Tomayko, 319th Engineer Detachment (Hydrology), U. S. Army Reserve, New Kensington, Pennsylvania.

Preparation of the map was sponsored by the Appalachian Regional Commission as one element of a series contributing to a U. S. Geological Survey program of environmental analysis in the Greater Pittsburgh region.

Many workers have reported on landslides in Allegheny County (Ackenheil, 1954; Briggs, 1974; Craft, 1974; Gray, in Wagner and others, 1970, p. 103-105; Hamel, 1970, 1972; Hamel and Flint, 1969, 1972; Kelley, 1971; Myers, 1935; Philbrick 1959, 1960; Winters, 1972). In addition, there have been two previous treatments of the subject on a county-wide basis (Ackenheil and Associates, 1968, U. S. Soil Conservation Service, 1973a, b). The authors gratefully acknowledge the assistance of R. P. Briggs who contributed substantially to portions of the text and several illustrations and of W. R. Kohl who compiled the map.

Landslide nomenclature and types of slope movement are shown in figures 3-8. Potential consequences of various unstable slope conditions are depicted in figures 10-13.

Bedrock in Allegheny County is composed entirely of coal-bearing rocks of Pennsylvanian and Permian age (figs. 1, 2). Formations from oldest to youngest are the Freeport in the Allegheny Group, the Glenshaw and Casselman in the Conemaugh Group, the Pittsburgh and Uniontown in the Monongahela Group, and the Waynesburg and Washington in the Dunkard Group. Rock layers generally are inclined gently southward, but the structure is complicated by north-northeast trending folds that are more pronounced in the eastern part of Allegheny County.

FEATURES SHOWN ON THE MAP

General descriptions of map features are included in the map explanation; some details are added below.

Recent landslides.--Landslides for which there are historical records are included in this group. Information on recent landslides has been obtained from Ackenheil's study (1974), from newspaper articles, and from William Morrison, Department of Planning and Development, County of Allegheny; H. F. Ferguson, U. S. Army Corps of Engineers; and J. L. Craft, Pennsylvania Bureau of Topographic and Geologic Survey. Most recent landslides were identified by the writers in the field. However, some that have been stabilized by removal of material or were otherwise not identifiable in 1973 and 1974 have been identified from the sources cited.

Much of the landsliding in Allegheny County occurred after World War II and is related to extensive cuts and fills made for highways, industrial and commerical development, and housing; many landslides result from alteration of prehistoric slides by overloading from fills or by excessive and rapid bulldozer cutting of the toe. The increase in recorded numbers of landslides after World War II coincided with the introduction of larger, more effective, and more readily available earth-moving equipment.

Overloading of sensitive slopes with fill is a common practice in Allegheny County. Overloading by fills caused the massive and recurring failure at the intersection of U. S. 30 and Penn. 48 (selected landslide locality no. 13). Placement of smaller fills for landscape grading of homes, schools, and industrial sites has resulted in more landslides than can be counted. Some chiefly involved only the fill material, but others are more complex and involve appreciable subjacent material as well.

Most landslides involve only soil and weathered rock, but one notable exception was the Brilliant Cut event (selected landslide locality no. 9), in which excavation of a railroad cut ultimately resulted in massive rock failure. The Fallen Timber Run landslide area (selected landslide locality no. 10) also involves bedrock, but it is currently under investigation and full details are not available.

Most landslides in Allegheny County result from man's modification of sensitive slopes. Notable exceptions, however, are the landslides in the vicinity of Glassmere (selected landslide locality no. 14), which are probably of natural origin, and the Kilbuck Drive landslide (selected landslide locality no. 6) which appears to have no important man-induced cause.

Ackenheil (1954, pl. 1) recorded the volumes of materials involved in 79 recent landslides. Although they ranged from 1 to 380,000 cubic yards (0.8 to 290, 700 cubic metres) and averaged about 18,000 cubic yards (13,770 cubic metres), about 70 percent of the landslides were less than 1,000 cubic yards (765 cubic metres) and most Allegheny County landslides probably are less than 250 cubic yards (191 cubic metres) in volume. Landslides commonly range from a few feet to 200 feet wide (60 metres) and the horizontal distance from the main scarp of the landslide to the landslide toe is commonly less than 600 feet (182 metres).

Prehistoric landslides.--Most of the prehistoric landslide areas shown on the map do not represent single events. They are accumulations of landslide deposits that probably formed from about 50,000 to a few thousand years ago, during and immediately after Wisconsin Glaciation.

The foot and toe area of one of these deposits commonly is a hummocky benchlike feature, which is termed a slump bench. The landslide deposit is generally less than 2,000 feet (600 metres) from toe to valley head and is wider than it is long. In most cases it is semicircular rather than V-shaped in plan and cross section and rarely contains a well-defined water course. A veneer of heavy clay a few feet thick at the top of a slide probably represents the surface of rupture on which landsliding occurred and today remains highly sensitive to overloading. Toe and foot areas of prehistoric landslides are relatively stable, and many houses built on them decades ago have not been damaged. Excavation at the toe, however, can reactivate sliding.

Large areas of prehistoric landslide are present at many places in the county. Most are developed on parts of the Conemaugh Group where redbeds are present, but they also are common in overlying grayish brown claystone and shale of the Monongahela Group (fig. 2), most notably in the south-central and southwestern parts of the map in a 2-mile-wide band trending from the vicinity of Baldwin, just south of Pittsburgh, westward past Bridgeville, and in the southeast corner of the map on the bluffs facing the Monongahela River. Relations of some prehistoric landslide areas are shown in figure 9 (Davies, 1974a), which is an enlargment of an area shown on the Braddock 7 1/2-minute quadrangle in west-central Allegheny County.

Effects of overloading or excavating prehistoric landslides are readily apparent in the massive landslides at the Sewickley Water Works and on Interstate Highway 79 (selected landslide localities no. 1b and no. 2).

Slopes with moderate to severe susceptibility to landsliding.--Slopes in "redbeds" and "redbed" soils are particularly susceptible to landsliding (Fisher and others, 1968; Winters, 1972), as evidenced by the great numbers of associated recent and prehistoric landslides. "Redbed" soils are up to 5 feet (1.5 metres) thick and their surfaces in many places are somewhat hummocky as a result of creep. "Redbeds" weather very rapidly on exposure to air and water, but where fresh they are sufficiently strong for many structural purposes. Houses with foundations set in "redbed" bedrock appear to stand as well as houses set in other rock types. However, appurtenances to such houses that are set only on soil, such as driveways, buried utilities, and swimming pools, frequently are disturbed within relatively short times after construction.

Slopes with slight to moderate, locally severe, susceptibility to landsliding.--Slopes in this category commonly are in semicircular side valleys such as those upslope from prehistoric landslides, but they lack the hummocky slump benches at the mouths of the side valleys. In many places these may represent settings of prehistoric landslides from which most of the landslide deposits have been removed by subsequent erosion. Elsewhere the slopes are somewhat gentler, and prehistoric landslides probably were not present. The soil on these slopes commonly is 2 to 5 feet (0.6 to 1.5 metres) of heavy clay which chiefly overlies weathered claystone and shale. The weathered rock usually is very wet and there commonly is subsurface water flow at the base of the clay. The clay apparently acts as a single slab moving downslope at a rate that maintains equilibrium between the material removed at the toe where water resurges and the amount of clay formed upslope from weathering. This equilibrium is extremely delicate, and the rate of movement can be greatly accelerated by overloading.

Man-made fills.--Two types of landslides occur in fills: those within the fill material itself which are largely independent of the materials on which the fill was placed, and those landslides which result from emplacement of fill materials on steep unstable slopes, where both fill and slope material move.

Probably the most spectacular landslide involving fill on a slope was on Bigelow Boulevard in 1920 (selected landslide locality no. 7). Little evidence remains except massive retaining walls built to prevent recurrence. However, the Lawnwood Avenue landslide (selected landslide locality no. 8) was active in 1974 and involves at least two generations of fill as well as material of the natural slope.

The Baldwin Road, Robinson Township, landsliding (selected landslide locality no. 3) probably is compounded by other factors. However, it appears that fill slopes were too steep for the material used, some footings probably were set in fill rather than bedrock, and initial provisions for disposal of downspout water were inadequate. Elsewhere in the same vicinity, natural slopes probably were oversteepened beyond their capacity to stand.

SUMMARY

Over 2,000 landslides, prehistoric and active, have been identified in Allegheny County. Most of these landslides are related to specific rock sequences, primarily red shale and claystone in the Conemaugh Group and nonredbeds in the Monongahela Group. Many areas susceptible to sliding also have been identified. These are primarily in small coves where slabs of clay, 5 ft (1.5 m) or less in thickness are in a state of delicate equilibrium. Such areas are very prone to slide when overloaded by fills. Practically all of the slides and slide-prone sites are readily identified in the field and can be stabilized when properly engineered.

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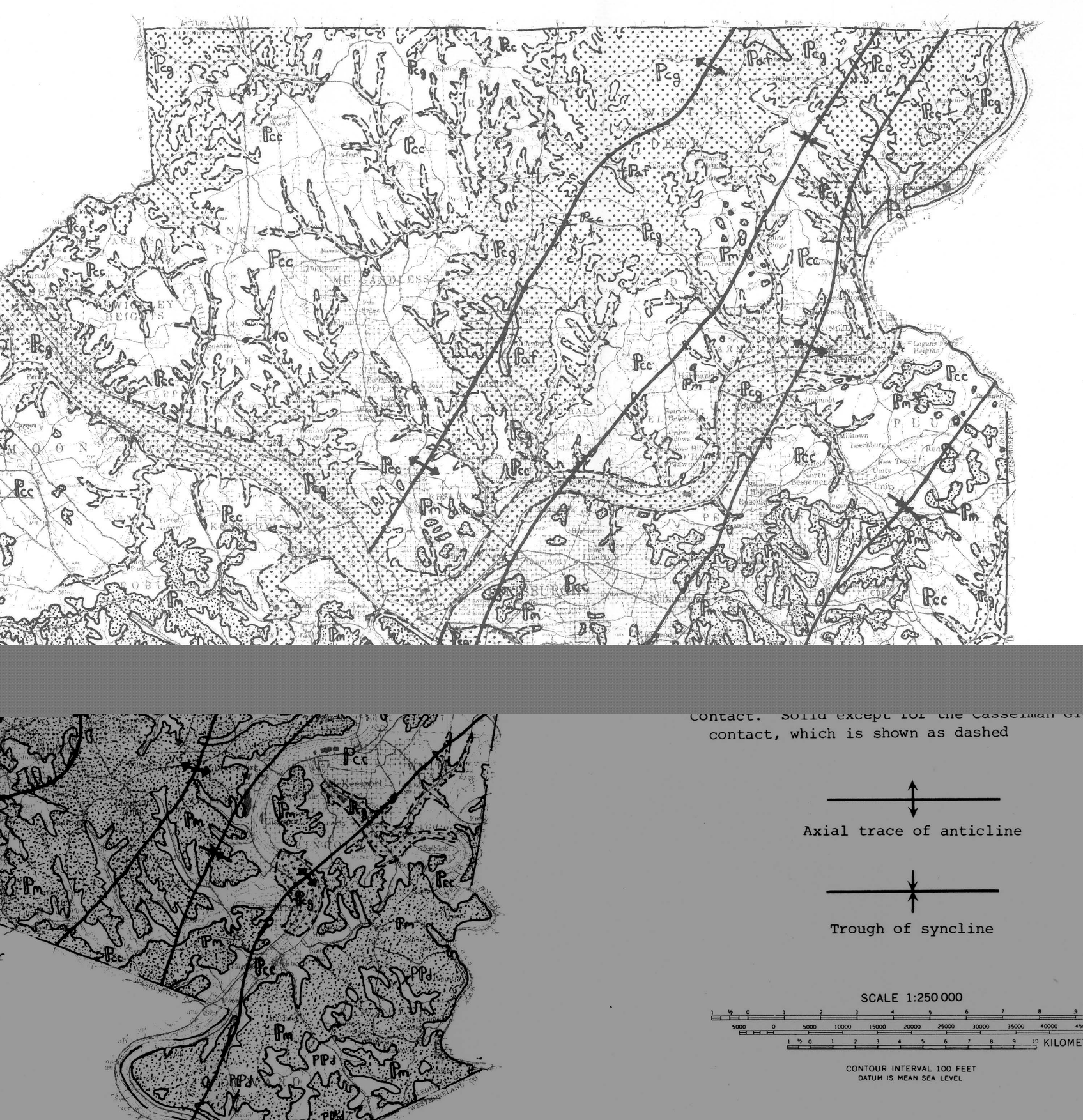
Units of measurement

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



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

Pcc — Casselman Formation

Pcg — Glenshaw Formation. Ames Limestone Member at top

Conemaugh Group — PENNSYLVANIAN

Contact ... contact, which is shown as dashed

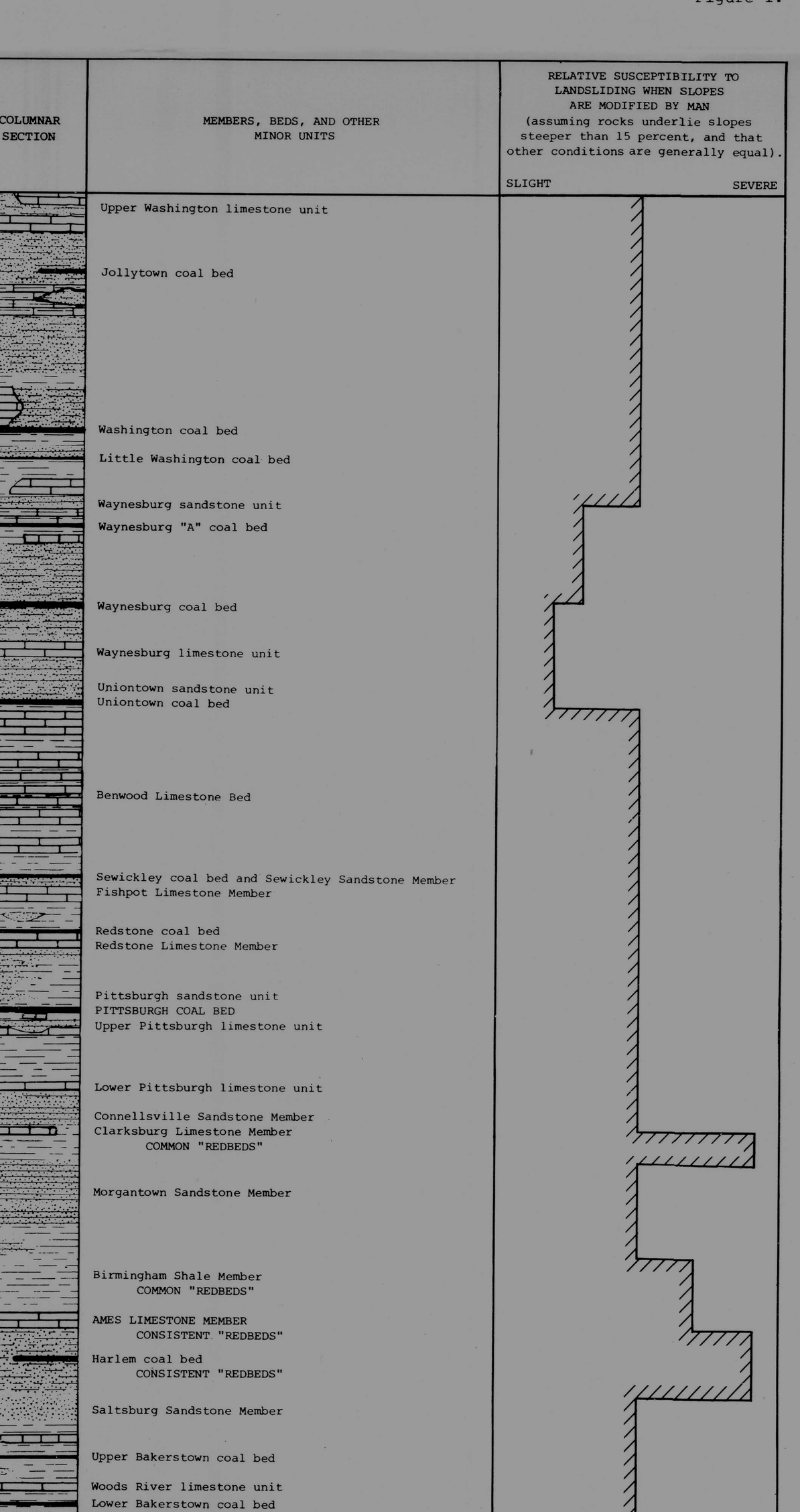
Axial trace of anticline

Trough of syncline

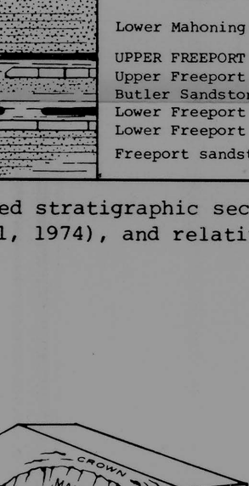
SCALE 1:250 000

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

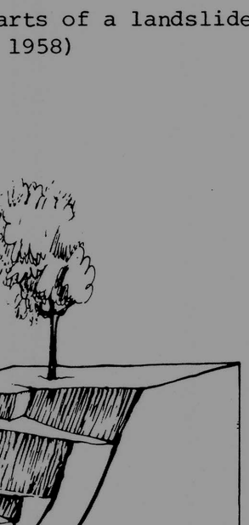
Figure 1.--Simplified geologic map of Allegheny County, Pennsylvania



...ed stratigraphic section, bedrock in Allegheny County, Pennsylvania (modified ...l, 1974), and relative susceptibility to landsliding.



...arts of a landslide ... 1958)



...act masses that move ...on surfaces that ...e the landslide deposit

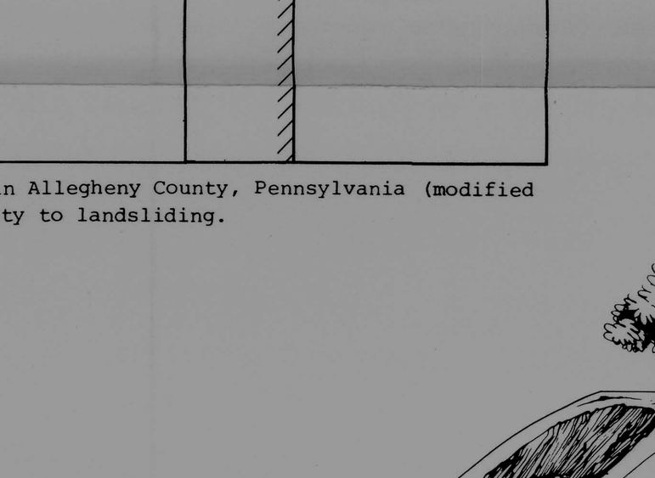


Figure 5.--Earthflow: Colluvial or fill materials that move downslope in a manner similar to a viscous fluid, for example, thick syrup (from Nilsen, 1972)

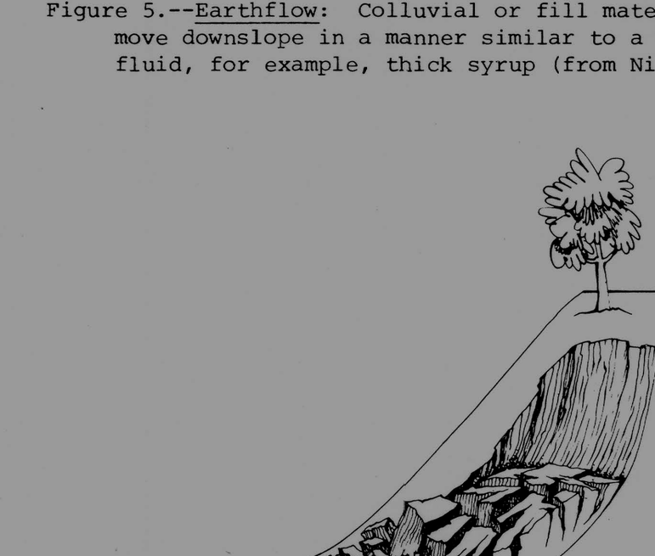


Figure 6.--Debris slide: Incoherent or broken masses of rock and other debris that move downslope by sliding on a surface that underlies the deposit (from Nilsen, 1972)

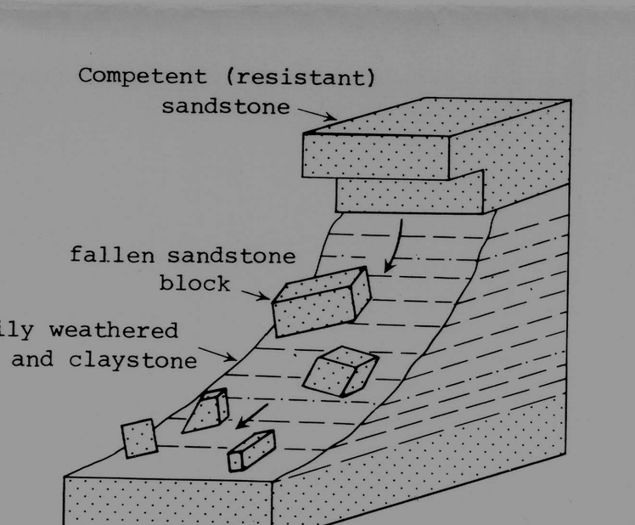


Figure 7.--Rockfall: Rock masses that move primarily by falling through the air (from Pomeroy, 1974a)

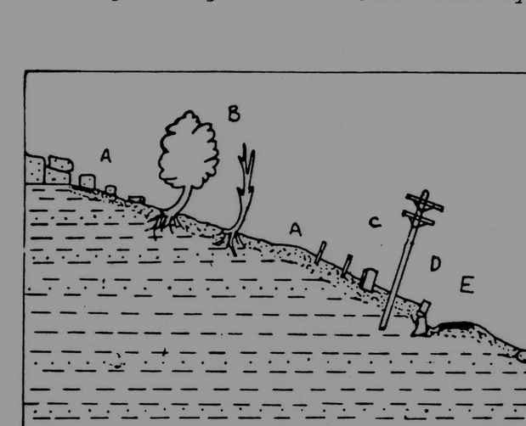


Figure 8.--Creep: Common evidences--(A) moved blocks of rock; (B) trees tilted at appreciable angles downslope with curved trunks concave upslope; (C) displaced posts, poles, and monuments; (D) broken or displaced retaining walls and foundations; (E) roads and railroads moved out of alinement; (F) turf rolls downslope from creeping boulders; (G) stone line at approximate base of creeping soil (modified from Sharpe, 1938)

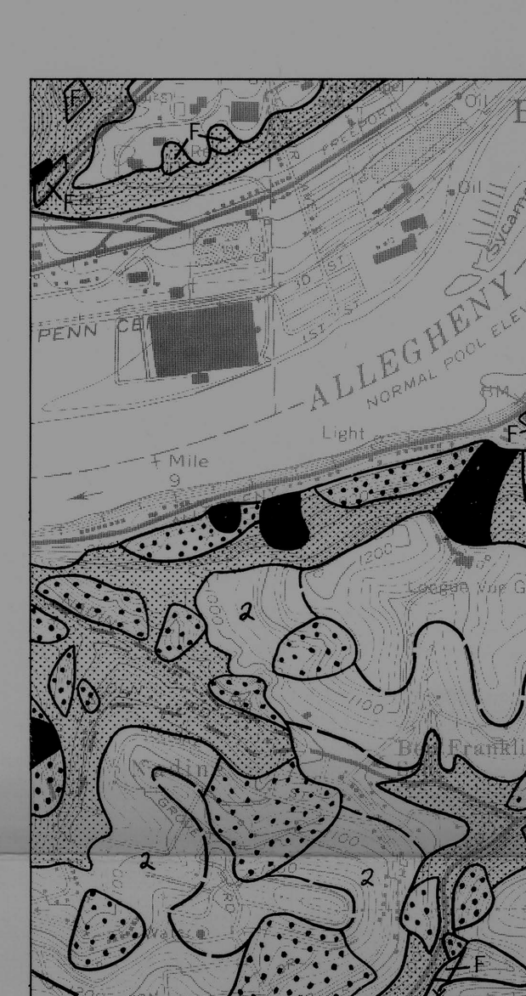


Figure 9.--Part of northwestern corner of the Braddock 7 1/2-minute quadrangle showing enlarged view of prehistoric and recent landslides and associated semicircular side valleys. Landslides symbolized as on main map. From Davies, 1974a

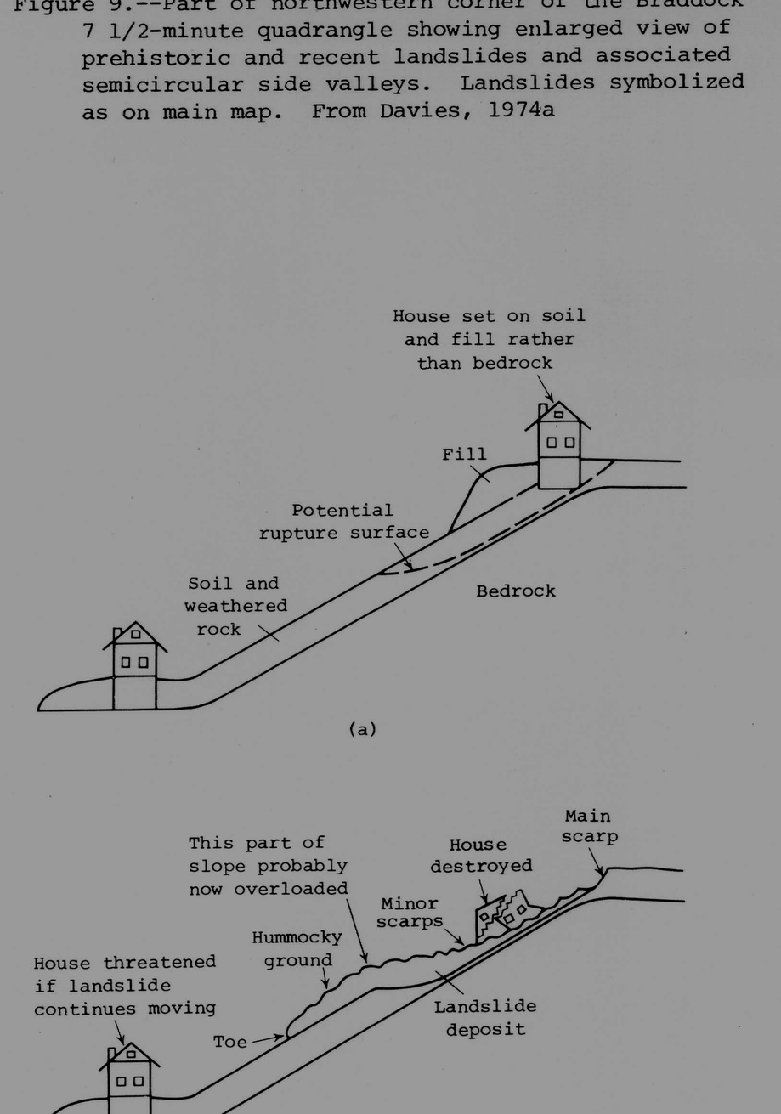


Figure 10.--(a) Sensitive slope overloaded by backyard fill and house set on soil and fill; (b) potential consequences. Slope and soil thickness exaggerated

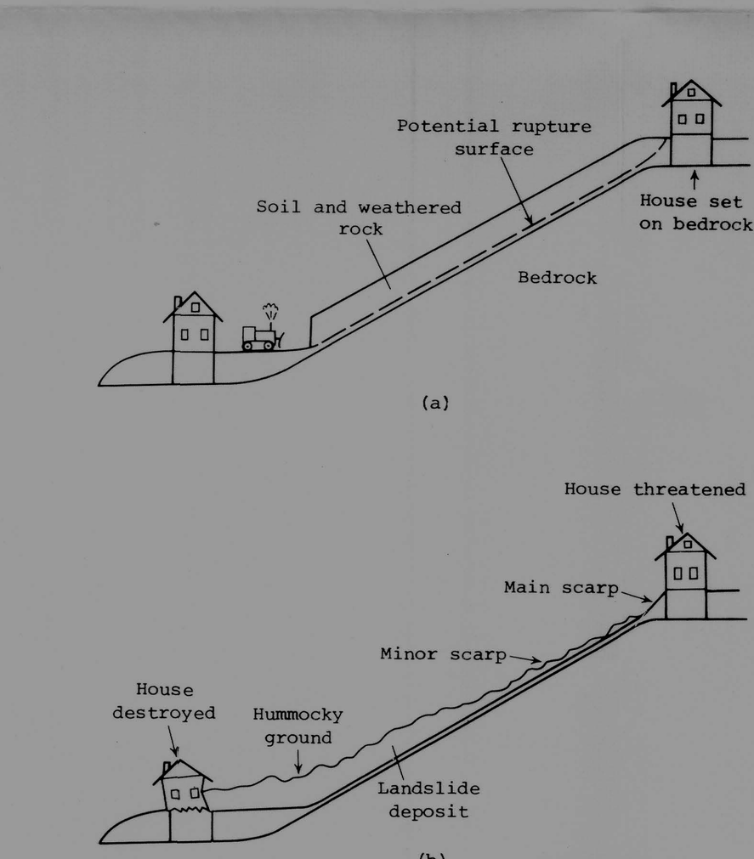


Figure 11.--(a) Sensitive slope excavated at bottom; (b) potential consequences

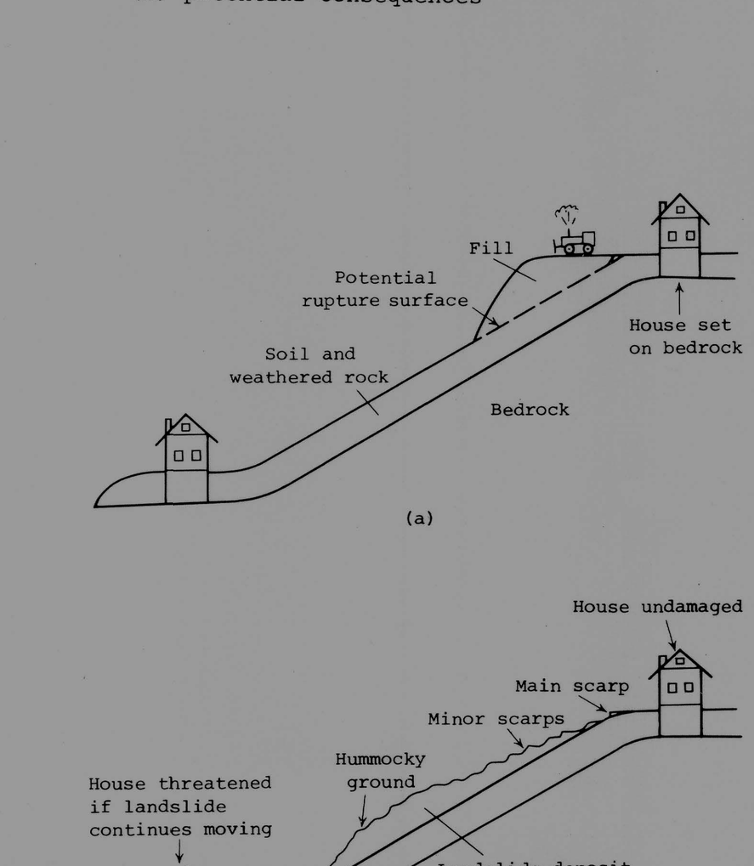


Figure 12.--(a) Backyard fill placed on slope improperly; (b) potential consequences

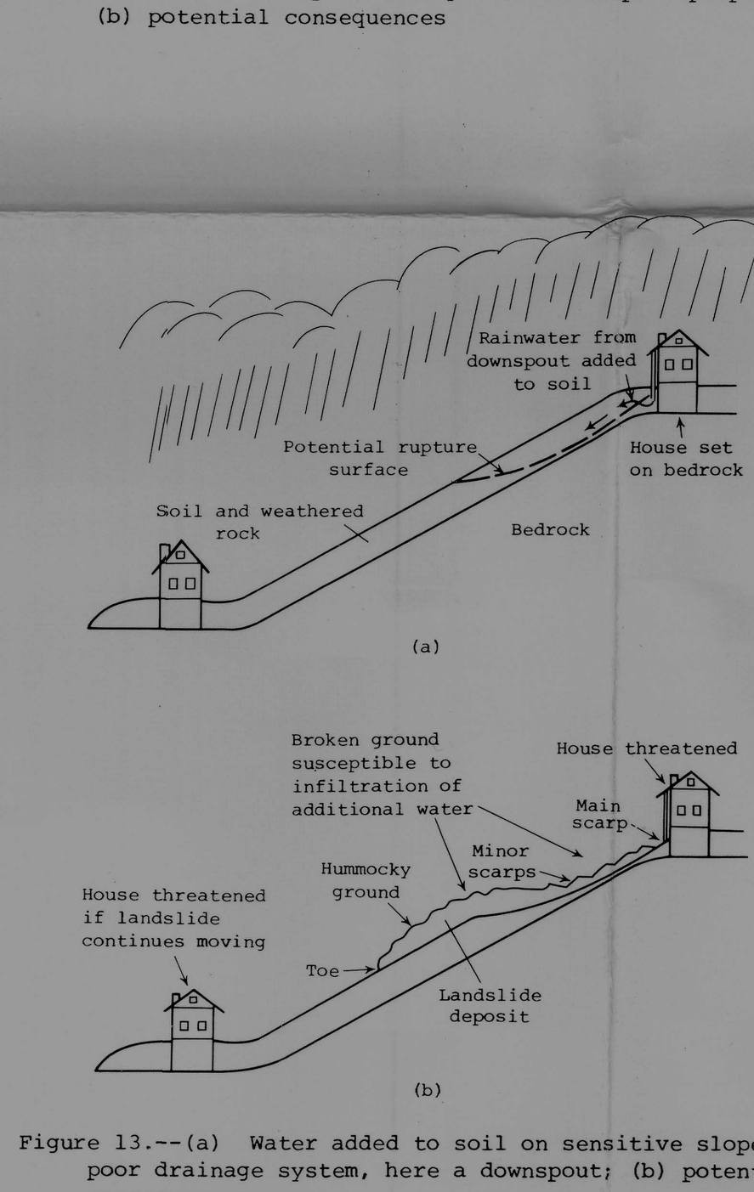
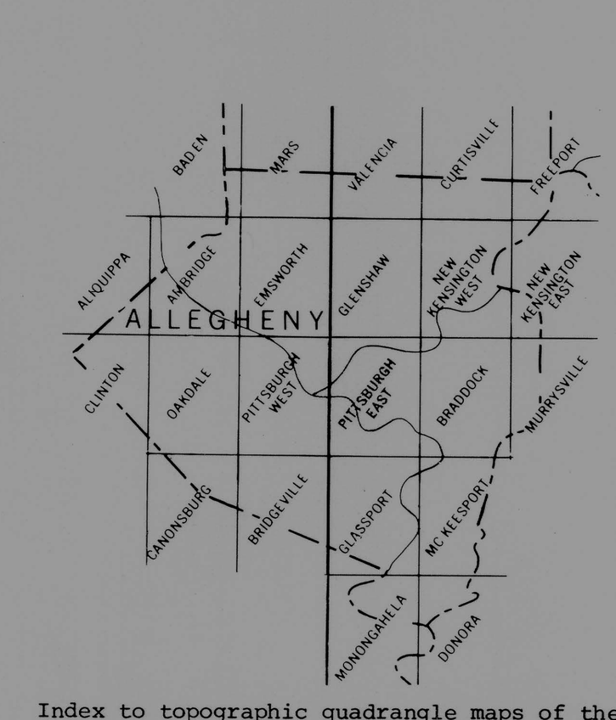
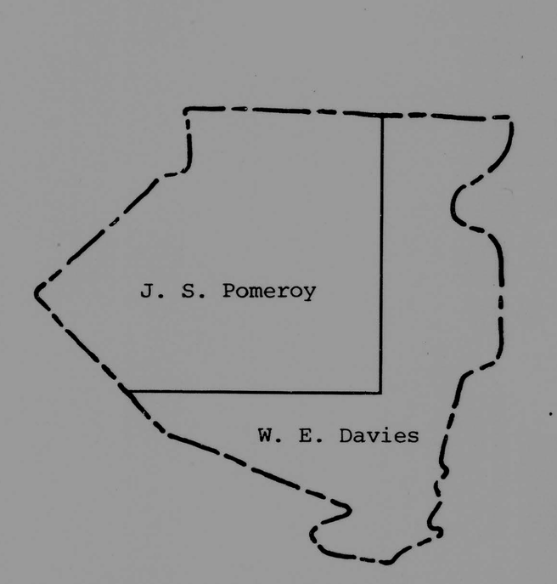


Figure 13.--(a) Water added to soil on sensitive slope by poor drainage system, here a downspout; (b) potential consequences

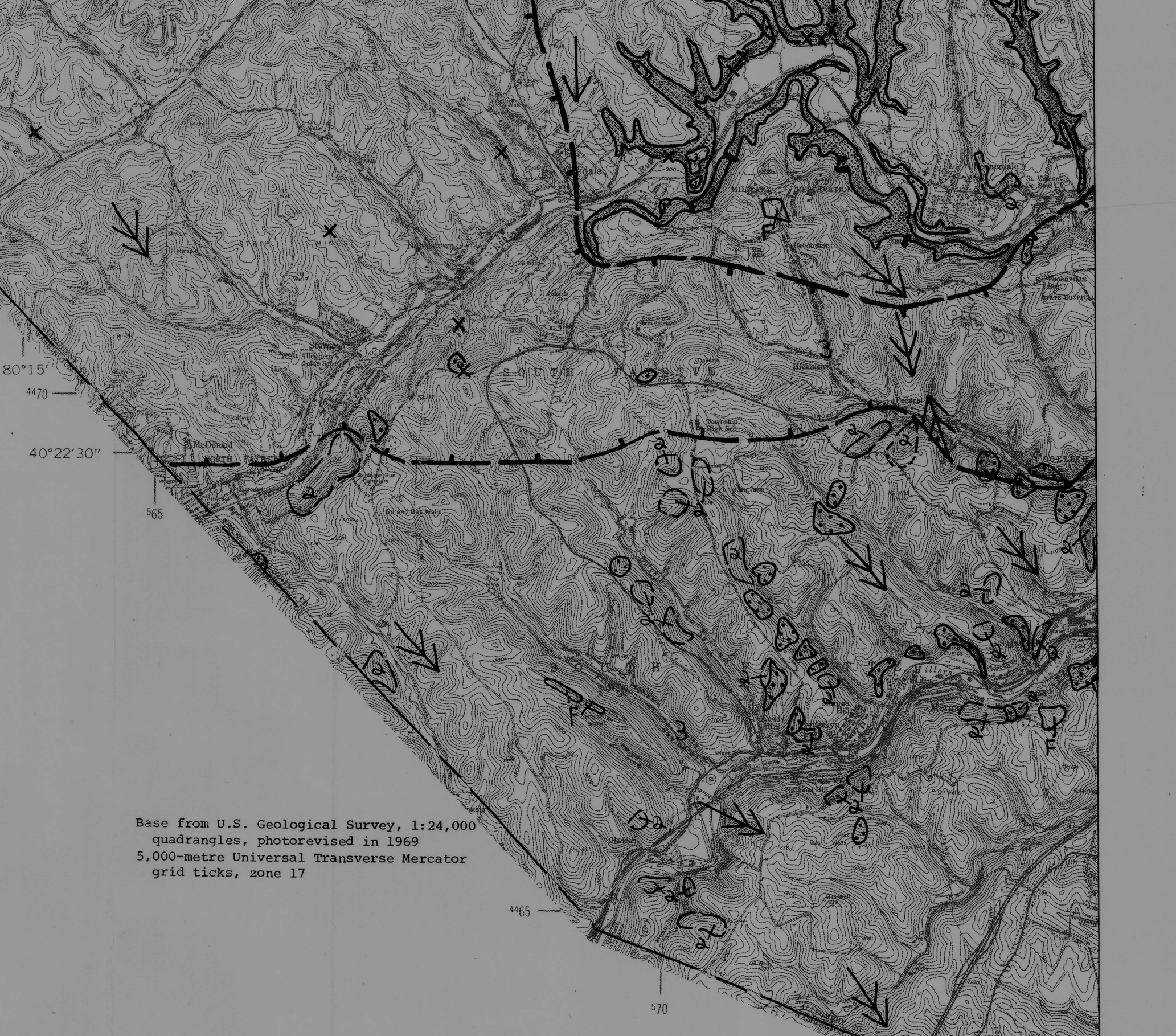
Pennsylvania county index map showing location of Allegheny County



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



Index to author responsibility for features shown on the map



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 ... TO JOIN TO EAST HALF

Table 1. Selected landslide localities

Locality number	Location	Geologic horizon	Comments
1a, 1b	Sewickley Water Works	Redbeds below Ames Limestone Member	1a, 1973 slide; apparently inadequate drainage provisions on upper road 1b, 1940 slide; unusually heavy rainfall plus overloading of redbed slope with quarry waste
2	Interstate 79 (279), Glenfield	Redbeds below Ames Limestone	1968; construction of highway re-reactivation of unrecognized ancient slide masses
3	Baldwin Road, Robinson Twp.	Non-redbeds below and above Pittsburgh coal bed	Possible mine subsidence, oversteeping of fill slopes, soil creep, and incipient landsliding
4	Narrow ridge between Chartiers Creek and Norfolk and Western R.R., Scott Twp.	Non-redbeds above Pittsburgh coal bed	Surface cracks on ridge may be due to undermining. Possible slow-moving landslide involving bedrock.
5	Painters Run, Upper St. Clair Twp.	Non-redbeds about 100 feet (30 m) above Pittsburgh coal bed	1971; failure of backyard fill; additional fill slumped after Hurricane Agnes (1972)
6	Kilbuck Drive, Riverview Park, Pittsburgh	Redbeds below and above Ames Limestone Member	Probably of natural origin, possibly compounded by man-modified upper slope surface drainage changes, 1939 aerial photos reveal smaller slide area.
7	Bigelow Blvd.; Pittsburgh	Redbeds below Ames Limestone Member	1920; massive fill failure on unstable slope
8	Lawnwood Ave., Brentwood Bo.	Non-redbeds above Pittsburgh coal bed	Failure resulting from placing footings on fill has destroyed 3 houses and threatens a fourth one, possible mine subsidence may be a contributing factor.
9	Brilliant Cut, Pittsburgh	Redbeds below Ames Limestone Member	1941; massive rock failure attributed to introduction of water through open joints.
10	Fallen Timber Run, Elizabeth Twp.	Redbeds above Ames Limestone Member	Complex slope failure with slumped backyard fills, extensive soil scarps and cracks, also bedrock cracks.
11	West Smithfield Rd., Lincoln Bo.	Redbeds below Ames Limestone Member	Hummocky ground characteristic of prehistoric landslides.
12	Russian Hill, Wilmerding Bo.	Redbeds below Ames Limestone Member	Haul road fill above houses in old neighborhood altered natural drainage and overloaded old slide area; soil movement forced abandonment of some houses.
13	US. 30 and Pa. 48 intersection	Redbeds above Ames Limestone Member	Fill slump behind shopping center
14	Glassmere vicinity, East Deer Twp.	Redbeds below Ames Limestone Member	Widespread prehistoric landslide deposits, some reactivated by Hurricane Agnes.
15	Elliot Rd., Monroeville Bo.	Redbeds below Ames Limestone Member	Affords visitor close inspection of redbeds and redbed soils with small recent landslide evident.

Table 2. Major landslide-prone soils in Allegheny County (in decreasing order of abundance)

NOTE: Soils shown below are highly plastic and have a moderate or high shrink-swell potential. Shrink-swell potential is defined as the difference between the volume of a wet soil as compared to a dry soil (U.S. Dept. Agriculture, 1973b).

Name	Type	Stratigraphic interval	Lithology of parent material
Guernsey	Residual	Monongahela and Dunkard	Nonred shale and limestone
Gilpin-Upshur	Residual	Conemaugh	Largely red mudstone and shale
Wharton	Residual	Conemaugh	Nonred shale
Guernsey-Vandergrift	Residual	Monongahela and Conemaugh	Nonred and red mudstone and shale; limestone
Ernest	Colluvial	Mostly Conemaugh	Nonred shale and siltstone
Library	Residual	Monongahela and Dunkard	Nonred shale and limestone
Ernest-Vandergrift	Colluvial	Mostly Conemaugh	Nonred and red mudstone and shale
Gilpin-Vandergrift	Residual-colluvial	Conemaugh	Largely red mudstone and shale

Table 3. Percentage of recent landslides (800) in rock groups of the stratigraphic section, Allegheny County, Pennsylvania

Group	Thickness	UNIT	Percentage of recent landslides in group interval
DUNKARD	100'+	WAYNESBURG COAL BED	< 0.5
MONONGAHELA	300'+		16
CONEMAUGH	280'	PITTSBURGH COAL BED (CLARKSBURG RED BEDS)	47
	300'+	AMES LIMESTONE MEMBER (PITTSBURGH RED BEDS)	36
ALLEGHENY	100'	UPPER FREEPORT COAL BED	< 1

Figure 3.--Nome... (simplifi...

Figure 4.--Slump: ... downslope by ro... underlie as a... (from Nilsen, 1...

SCALE 1:50 000

1 ½ 0 1 2 3 4 5 MILES

1 .5 0 1 2 3 4 5 KILOMETRES

CONTOUR INTERVAL 20 FEET
DATUM IS MEAN SEA LEVEL

MAP OF SUSCEPTIBILITY TO LANDSLIDING, ALLEGHENY COUNTY, PENNSYLVANIA

By

John S. Pomeroy and William E. Davies

1975

INTERIOR—GEOLOGICAL SURVEY, RESTON, VA.— 1975 —REPRINTED 1980

For sale by Branch of Distribution, U.S. Geological Survey, 1200 South Eads Street, Arlington, VA 22202