

P **GEOLOGY** **N** **N** **S** **Y** **L** **V** **A** **N** **I** **A**

THE PENNSYLVANIA GEOLOGICAL SURVEY

VOL. 7/1

COMMONWEALTH OF PENNSYLVANIA

Milton J. Shapp, Governor

DEPARTMENT OF ENVIRONMENTAL RESOURCES

Maurice K. Goddard, Secretary

TOPOGRAPHIC AND GEOLOGICAL SURVEY

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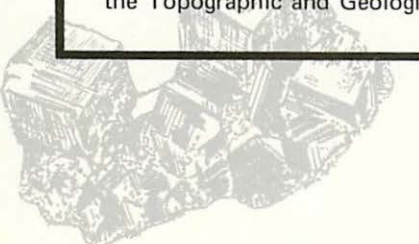
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Cover Photo: Extensive development of pinnacle weathering on Ordovician limestones at Exit 12, Interstate 81, near Carlisle. Such pinnacles are typically developed on carbonate rocks in Pennsylvania and may require special foundation procedures when building large structures. Photo courtesy of Dr. Samuel Root.

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FEBRUARY 1976



FROM THE DESK
OF THE
STATE GEOLOGIST...



OUR GEOLOGIC HERITAGE

As more and more of us are smitten by the Bicentennial "fever", it is appropriate to review the impact of geology on mankind in Pennsylvania, as well as the progress made in understanding the Commonwealth's geology.

As a founding colony with an adventuresome and industrious citizenry, the impact of geology came early in our history, long before independence was proclaimed. The fertile soil, formed from the underlying limestones of the Great Valley, called Cumberland Valley to the south, attracted an early concentration of farmers. But that same southwest-trending valley, with its low terrain, also became a passageway for the more adventurous who strove to move westward and took this easier route, rather than "fighting" the high sandstone ridges of the Appalachian Mountains. Even today, 250 years later, the Great Valley is a center of rich agriculture, community development, and transportation corridors, whereas our Appalachian ridges still are an impediment to westward transportation routes, both road and rail.

As these underlying rock formations have been responsible for our topography and for the various qualities of our soils, so too has Pennsylvania's variety of mineral resources been a controlling factor in our historical development. Limestone was used even in colonial days to make lime for the farms, and as flux-stone in the scores of small iron-making furnaces which dotted the Pennsylvania countryside amongst the hundreds of small iron mines. First using wood as a fuel, the iron-making industry soon turned to our vast resources of coal, and from the "marriage" of our limestone, iron ore, and coal evolved our great steel-making industry which today remains a cornerstone of our economy.

In the 1800's our mineral riches continued to spur our economic development, as our anthracite deposits helped fuel the industrial revolution while the 1859 discovery of the Drake Well at Titusville opened the rich Pennsylvania oil fields to our nation's needs for fuel and lubrication. The development of our natural cement-rock resources and our abundant variety of construction stone materials are further examples of the great stimulus which geology and mineral resources have had on building our Pennsylvania society. The evolution of these geologic impacts, their problems as well as their benefits will be further chronicled in this column as we progress through our Bicentennial year.

Arthur G. Socolow

REEF HUNTING IN MCKEAN COUNTY CONTINUES

by

Robert G. Piotrowski

The first discovery of natural gas in Devonian "pinnacle reefs" occurred in southwestern New York (Steuben County) in 1967. The "reefs" are in the Onondaga Formation of Middle Devonian age in an area where the Onondaga regionally is less than 50 feet thick. This area of Onondaga thinning extends into north-central Pennsylvania. East and west of the "reef" area, the Onondaga thickens to over 150 feet. The "reefs" may have grown because they were located on a stable platform lying between subsiding areas.

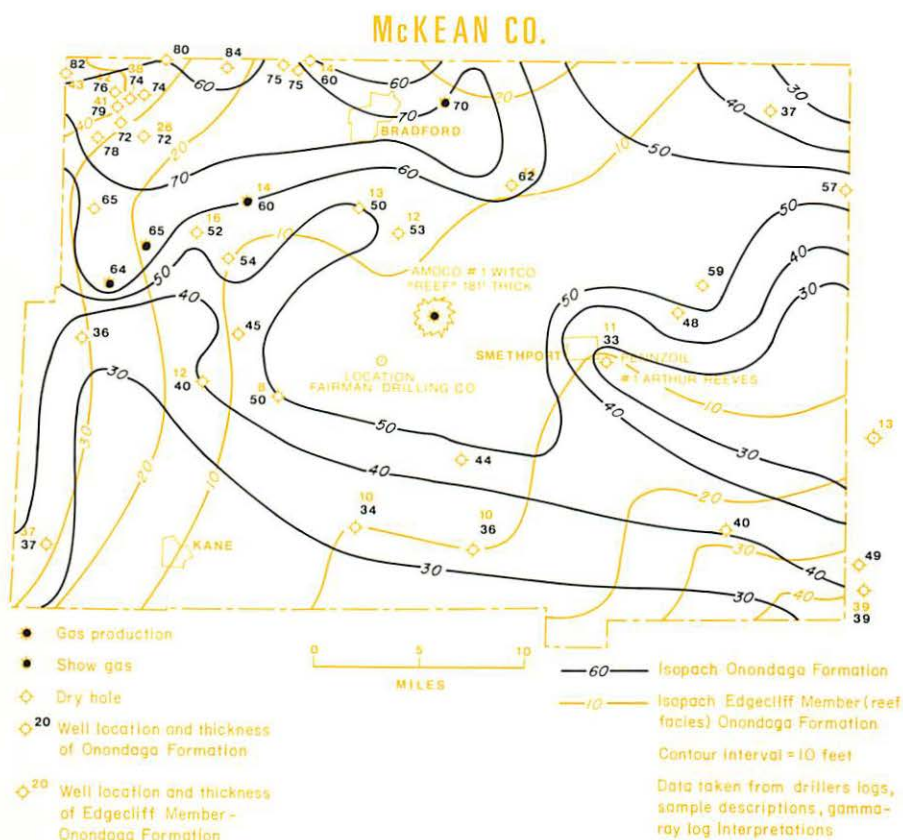
The first Onondaga "reef" discovery in Pennsylvania was made in February 1974, by Amoco Production Company with the drilling and completion of the #1 Amoco-Witco well located just southeast of the town of Cyclone in McKean County. (Fig. 1)

A Middle Devonian Onondaga "reef" was encountered at a depth of 5172 feet. The "reef" is 181 feet thick and has a total gas column of 106 feet. The initial natural production from the well was 200,000 cu. ft. gas per day. An 86-foot interval from 5184 feet to 5270 feet was treated with 13,000 gallons of 28% HCl and 10,000 gallons of 15% HCl resulting in an initial after-treatment production of 3,000,000 cu. ft. gas per day.

Pennzoil drilled a second "reef" test in November 1975. The #1 Arthur Reeves is located southeast of the town of Smethport in McKean County, and approximately 9 miles southeast of the Amoco discovery well.

This well encountered Onondaga at a depth of 4694 feet, but no reef facies was observed. The total Onondaga thickness here was 33 feet, and the portion of the Onondaga which is equivalent to the reef facies (Edgecliff Member) was only 11 feet thick and consisted of interreef grainstones with a porosity of approximately 9%.

Fairman Drilling Company has staked a location for a third reef test just north of the town of Mount Alton and just east of the Bradford Airport in McKean County. This location is approximately 3.1 miles southwest of the Amoco discovery.



Isopach map of total Onondaga Formation and Edgecliff Member of the Onondaga Formation in McKean County.

This location is in an area where the total regional Onondaga thickness is around 50 feet and where the Edgecliff Member of the Onondaga is less than 10 feet thick (Fig. 1). The Edgecliff Member is also observed to thicken away from the thinner area, indicating a possible platform as in New York. This would be an ideal location for reef growth. The situation in McKean County is similar geologically to Steuben County, New York, where the first Onondaga reefs were discovered. The area of thin Onondaga and thin Edgecliff extends from northeast to southwest through McKean County. Additional discoveries are expected in this trend; and as the well head price of gas increases, these "reef" objectives will become increasingly attractive.

Flooding and Flood Protection at Harrisburg

by
Joan J. Sevon

Floods are naturally occurring events which cause problems for man when he builds his cities on a river's emergency overflow course, the flood plain. Harrisburg suffers severe flood damage because the Susquehanna River and Paxton Creek flood plains are highly urbanized areas containing many residences, businesses, and industries. Flood waters come from the Susquehanna into the southern (Figure 1) and northern parts of Harrisburg and from Paxton Creek, the local major tributary, through the center of the City (Figure 2). Data from the U.S. Geological Survey Water Resource Records show that bankfull stage, 17 feet or elevation 307.0 feet msl (mean sealevel) at the Nagle Street gage, has been exceeded at Harrisburg 29 times since 1784. Figure 3 shows the maximum yearly river stages for years of record between 1787 and 1975. Prior to June 1972, the flood of record was the March 1936 flood.



Figure 1. Flooding in south Harrisburg at the intersection of Second and Paxton Streets during the Agnes flood. Photograph from Pennsylvania Power and Light Company.



Figure 2. Paxton Creek flooding through the center of Harrisburg during the Agnes flood. Photograph from Pennsylvania Power and Light Company.

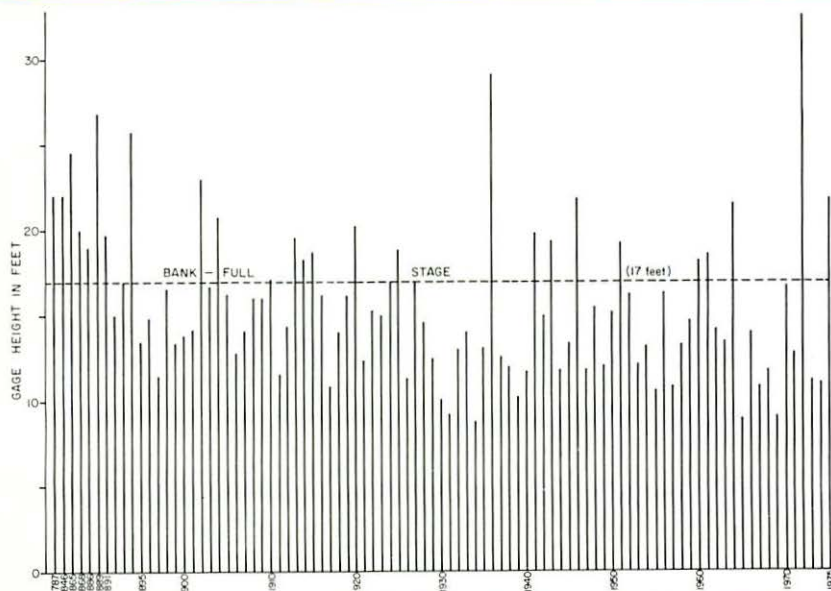


Figure 3. Maximum yearly river stages, 1787 to 1975.

Prior to the March 1936 flood, two to four inches of rain fell in the Susquehanna River Basin on March 11 and 12 . Frozen ground created rapid runoff conditions, and melting snow from above average snow-fall augmented the rain. The River rose to high levels and did not have time to recede before an additional one to seven inches of rain fell on March 17 and 18.

Water flowed into Harrisburg early on March 18. The peak discharge of 740,000 cfs (cubic feet per second), 29.2 feet at the Nagle Street gage, came during the evening of March 19 and caused \$3 million worth of damage. Flood protection became a vital issue, but no construction resulted.

Somewhat different meteorological events caused the 1972 flood. The 1972 flood was the direct result of Tropical Storm Agnes. Agnes did not loop away to the northeast and the Atlantic Ocean as hurricanes generally do, but hooked back into southern New York State and central Pennsylvania where it dumped 4 to 18 inches of rain between the 20th and 25th of June. Already saturated soil caused by frontal showers (June 12 to 16) contributed to rapid runoff and very high discharge (1,020,000 cfs, Nagle Street gage).

The flood crested at Harrisburg in the early hours of June 24 at 32.5 feet (elevation 322.6 feet msl, Nagle Street gage). Fifteen thousand five-hundred and eighty-four acres (22.4 percent of the City's land area), 9,702 residences, and many businesses were flooded. Harrisburg suffered an estimated \$85 million in damages, and four persons lost their lives in the City. Because of the tremendous loss, interest in flood protection stirred again. The U.S. Army Corps of Engineers (hereafter referred to as Corps) completed a flood-control study and proposal, but again no construction materialized before the River once more left its banks.

Tropical Storm Eloise was the direct cause of the most recent flooding at Harrisburg. The Susquehanna reached an elongated peak in the afternoon of September 27, 1975. Gage height at the new City Island gage was 23.81 feet (elevation 313.82 feet msl), and the discharge was 553,000 cfs. This time flood waters did approximately \$600,000 worth of damage. And flood protection is once again a vital issue.

Interest in flood control at Harrisburg has intermittently waxed and waned since its first consideration in 1917. The latest flood-control plan submitted by the Corps (U.S. Army Corps of Engineers, 1974) includes the following provisions for protection against an Agnes level flood (see Figure 4):

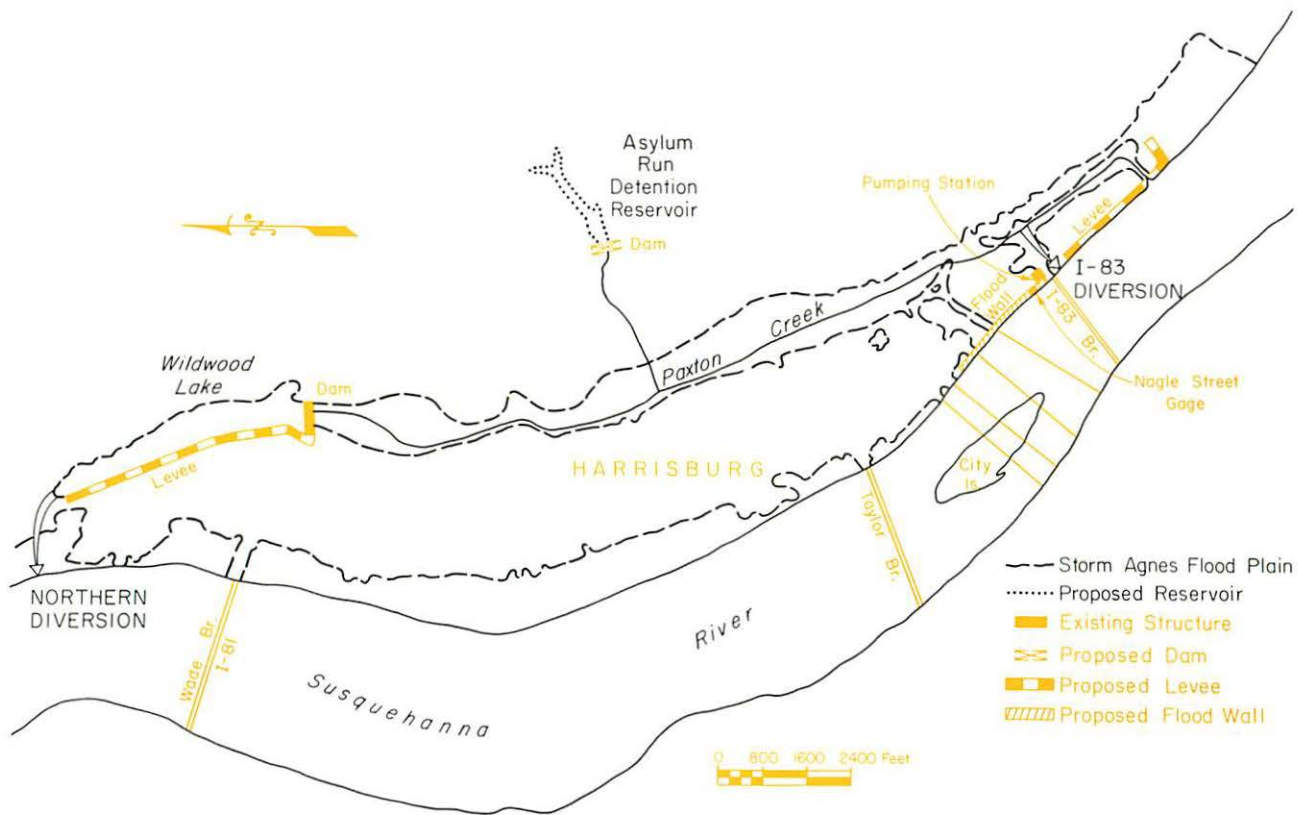


Figure 4. Flood protection proposal.

1) Along Paxton Creek: Wildwood Lake: Wildwood Dam and an upstream diversion from Wildwood Lake to the Susquehanna River provide a small amount of flood control for the City of Harrisburg. They were built in 1912 and have become increasingly ineffective over the years due to the rise in normal lake level caused by siltation and increased runoff from the rapidly urbanizing upper Paxton Creek drainage basin. The Corps plans, therefore, to raise Wildwood Dam 10 feet and dike up the west shore of the Lake to increase the present capacity of the Lake by approximately 1,900 acre feet. Improvements would be made to the northern diversion and the southern outlet through the Dam to carry 4,300 cfs flow from the northern structure and 400 cfs from the southern outlet.

Asylum Run Detention Reservoir: Asylum Run drains approximately 2.7 square miles and enters Paxton Creek about 9,600 feet below Wildwood Dam. Plans for this area include an earth-fill dam making possible a detention reservoir which would hold 410 acre feet at capacity.

Interstate-83 Diversion: The Corps recommends diverting the entire flow of Paxton Creek through a storm drain into the Susquehanna River just below the Interstate-83 bridge across the Susquehanna. The drain is designed to carry 2,520 cfs flow and has gate closures on the Susquehanna side to prevent back-up from the River.

2) In the southern part of Harrisburg: Plans for this area are a subject of controversy. One plan includes a pumping station to pump out interior runoff from behind a reinforced concrete wall 18 feet high by 3,000 feet long and an earth levee 6,000 feet long located 100 to 150 feet back from the River. Another plan puts the wall approximately 800 feet inland from the River to pass behind the area known as Shipoke, thus preserving the residents' unobstructed view of the Susquehanna. This plan, however, would leave 800 residents and 183 buildings worth \$4.5 million, including the City's sanitary pumping station, without structural flood protection; the consequences are illustrated in Figure 1.

3) In the northern part of Harrisburg: Plans for adequate protection by flood walls, levees, and pumping stations along the Susquehanna are currently economically unfeasible and are, therefore, not considered in the overall plan. The Corps recommends flood proofing, building codes (minimum elevation, proper anchorage), and evacuation at flood warnings for north Harrisburg.

Unfortunately, these plans appear to be in limbo at the present time. Some time ago Harrisburg City Council indicated its willingness to enter into a contract for the flood protection outlined above, in-

cluding the flood wall 100 to 150 feet back from the River at Shipoke. Escalating costs due to engineering problems at the Wildwood Lake site and inflation have now put the cost for the entire project beyond the acceptable cost/benefit ratio.

Harrisburg, however, is currently trying to put the cost/benefit ratio back within acceptable limits. The City is reevaluating its urban renewal projects in flood-prone areas and lumping together the City's damage estimates from the 1972 and 1975 floods, thus increasing the "benefits" of flood control. Also, the Corps is investigating the possibility of increasing the capacity of Paxton Creek rather than raising the Dam and constructing levees at Wildwood Lake. In the meantime, Harrisburg's flood-prone areas remain as they have been through 29 floods: without sufficient flood protection.

Reference Cited

U.S. Army Corps of Engineers, 1974, Harrisburg local flood protection study, survey report, Paxton Creek and Susquehanna River, Harrisburg, Pennsylvania: Dept. of Army, 60 p. and Appendices.

pennDOT issues map catalog

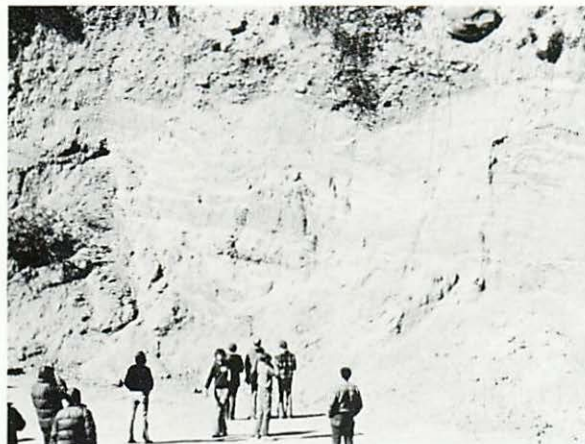
The Pennsylvania Department of Transportation has issued a brochure (Publication #120) entitled "Your guide to maps as published by Pennsylvania Department of Transportation." This publication lists the various maps available through the Department of Transportation. The Pennsylvania Department of Transportation issues several series of maps, largely related to highway and traffic systems, as well as a political subdivision map, a construction bulletin, and an official transportation map. Copies of this catalog may be obtained free of charge by requesting Item No. 0350-5300-1200 from PennDOT Publication Warehouse, Harrisburg International Airport, Middletown, Pa. 17057.

York Mineral and Gem Show

The York Rock and Mineral Club will hold its 7th Annual Mineral and Gem Show on April 3rd and 4th at the Manchester Township Fire Company #1 on Pennsylvania Route 181 at Emigsville.

GEOLOGISTS EXAMINE GLACIATION IN NORTHEASTERN PENNSYLVANIA

Monroe and Carbon counties were the focus in early October of a two-day field conference attended by 127 geologists from Pennsylvania, Virginia, West Virginia, Massachusetts, New Jersey and New York. The annual Field Conference of Pennsylvania Geologists was hosted by the Pennsylvania Geological Survey and was conducted by Messieurs William Sevon and Tom Berg of the Survey, and George Crawl of Ohio Wesleyan. The conference featured two days of trips,



Participants in 40th Annual Field Conference of Pennsylvania Geologists examine a new vertical exposure of Altonian (Mid or Early Wisconsinan) ice-contact stratified sand and gravel overlain by Altonian glacial till.

Unconsolidated and formerly horizontally stratified layers of sand, silt and clay have been deformed by pressure from Altonian ice which moved from right to left about five feet above these layers. The direction of movement is indicated by the fold.





Roger Faill, Pennsylvania Geological Survey, considers the structural implications of small folds in unconsolidated sand and gravel layers. These folds were created by pressure from Altonian ice which moved from right to left over the sands and gravels.

visiting many localities where unconsolidated sediments deposited by the Illinoian, Altonian and Wisconsinan glacial epochs (100,000? to 10,000 years ago) are well exposed. The geologists were treated to many exposures of glacial till and colluvium and had an unusual opportunity to examine the differences between these kinds of deposits. Also observed were examples of disruption of original sedimentary layering which had resulted from the friction of overriding ice (Figure 2) during the glacial advance.

The 1976 meeting of the Field Conference of Pennsylvania Geologists will be conducted by staff of the Geology Departments of Edinboro and Slippery Rock Colleges and will be centered in the Oil City-Franklin area from September 30 through October 2, 1976.

NEW SOIL SURVEY ISSUED

Soil Survey of Franklin County, Pennsylvania, by R. S. Long. U.S. Dept. of Agriculture, Soil Conservation Service, 1975.

This publication includes written descriptions as well as a soil association map. It is useful to people who want a general idea of the soils in the county, or want to compare soils in different parts of the county or who want to know the location of large tracts that are suitable for a specific kind of land use.

Single copies of Franklin County report are free from Soil Conservation Service, 550 Cleveland Avenue, Chambersburg, Pa. 17201.

SURVEY ANNOUNCEMENTS

PENNSYLVANIA OIL AND GAS DEVELOPMENTS IN 1974 PUBLISHED

The annual report in Pennsylvania's oil and gas developments clearly points up the increased exploration, drilling, and production which has resulted from the energy crisis and the accompanying price increases.

Indiana County was the most active area in Pennsylvania in development of gas resources. Here 319 new wells were drilled in 1974. Venango County has the highest number (224) of wells drilled for oil during this same period. Shallow gas production increased 5%, deep gas production was up 10% and Pennsylvania grade crude oil production was up 4% during 1974 over 1973. During the year Pennsylvania had 32,095 oil wells and 17,123 gas wells in production. These and many other facts on oil and gas production in Pennsylvania are included in the recently published report "Oil and Gas Developments in Pennsylvania in 1974" by William S. Lytle. This publication, PR 188, is available for \$1.50 (plus 6% sales tax for Pennsylvania residents) by writing to the State Book Store, P.O. Box 1365, Harrisburg, Pa. 17125.

NEW BASE MAP OF PENNSYLVANIA ISSUED

The Bureau of Topographic and Geologic Survey announces the publication of a new base map of Pennsylvania. This map measures 6½ x 5 feet and comes in two sheets, eastern and western halves, each with a two-inch overlap so that the halves can be joined into one map. Both halves are included in an envelope. The map contains roads, railroads, towns, town names, county boundaries and county names printed in black, as well as streams, lakes, reservoirs with their names printed in blue. Townships, boroughs and city boundaries and their names are printed in pink. Latitude and longitude tick marks appear in black and the Pennsylvania State Plane Coordinate tick marks appear in blue. The new map is at a scale of 1:250,000 (1 inch equals 4 miles). This map can be used for a wide variety of purposes; it will be used as the base for the new geologic map of Pennsylvania currently being prepared. The base map of Pennsylvania, Map #41, is available for \$8.80, plus 6% sales tax for Pennsylvania residents, by writing to the State Book Store, P.O. Box 1365, Harrisburg, Pa. 17125. Both halves are sold as one unit.

SURVEY ISSUES PUBLICATIONS ON HARRISBURG AND McCONNELLS MILL STATE PARK

Two new free publications of general interest have just been released by the Bureau of Topographic and Geologic Survey. One of these is *Park Guide 9*, a 6-page fold-out pamphlet of the geology of the Slippery Rock Creek Gorge in McConnells Mill State Park. This brochure illustrates the geology seen in the gorge through map, sketch and photograph. Copies of *Park Guide 9* may be obtained at McConnells Mill State Park or by writing to the Bureau of Topographic and Geologic Survey, Department of Environmental Resources, P.O. Box 2357, Harrisburg, Pa. 17120.

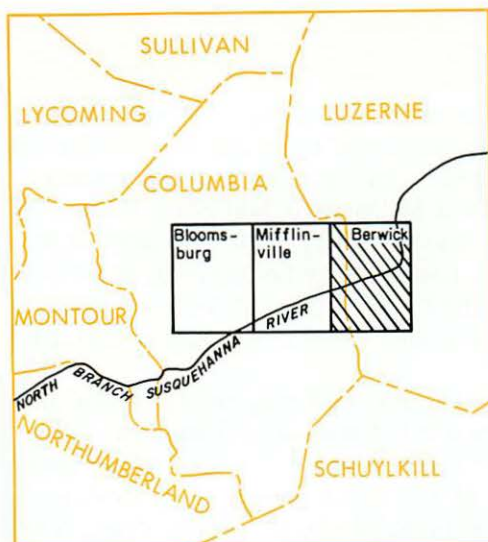
Residents of the Greater Harrisburg Area may be interested in a new map (*Map #48*) issued by the Pennsylvania Geological Survey covering the area from Hershey to Mechanicsburg and south to Goldsboro, showing the distribution of the major kinds of rock units present as bedrock in the area. Areas underlain by limestone, shale, sandstone and diabase are shown on this generalized map which measures approximately 13 x 14 inches. This map may also be obtained free of charge by writing to the bureau address.

PENNSYLVANIA SURVEY'S BEST SELLERS

During the past two years the popularity of G 40, *Fossil Collecting in Pennsylvania*, and G 33, *Mineral Collecting in Pennsylvania*, has continued unabated. G 40 has been our #1 seller for 1974 and 1975 and G 33 was #2 even though it has been out of print since August 1975. The new edition of G 33, due to be printed in Spring, 1976, should be a top seller again. Our Map #1, the *Geologic Map of Pennsylvania*, is tops of the map series with the *Topographic Map of Lehigh County* selling in #2 place.

Energy was the major concern of our book buyers in 1975 with our bulletins M 68, *Bituminous Coal Resources in Southwestern Pennsylvania*, M 69, *Analyses and Measured Sections of Pennsylvania Bituminous Coals*, M 6, *Bituminous Coal Fields of Pennsylvania, Part 2*, and IC 72, *Coal Reserves of Pennsylvania*, selling in the 3rd, 5th, 8th and 9th places among all our publications. Tenth place was shared by parts 3 and 4 of Bulletin M 6. The two guidebooks to the geology of the Philadelphia and Pittsburgh areas sold in the 4th and 6th places. The annual Oil and Gas Developments report (PR 187) was in 7th place, up from 10th place (PR 186) in 1974.

Environmental Geology reports slipped from the top 10 in 1975 but were in 4th (EG 1) and 8th (EG 2) places in 1974.



Geologic Survey Starts Berwick- Bloomsburg Mapping Project

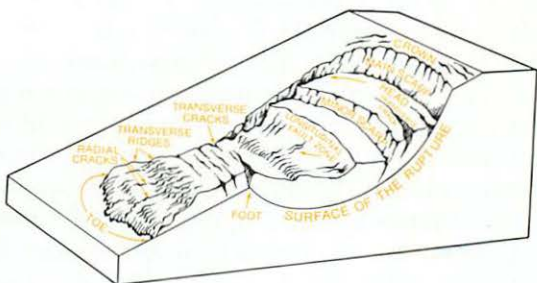
The Pennsylvania Geological Survey has initiated a project to map the bedrock and surficial geology of the Berwick 7½' quadrangle in Columbia and Luzerne Counties, Pennsylvania. This is the first stage of an areal mapping program which will provide the basic information necessary to evaluate the mineral resources, ground water potential, and environmental hazards along the North Branch of the Susquehanna River. This is a developing area as a result of new Routes 80 and 81, the new power plant under construction, and the increased recreation in the region.

Mapping in the Berwick 7½' quadrangle will be carried out by staff geologist Dr. Jon D. Inners. It is anticipated that the project will be completed in 1977. Subsequent geologic mapping is planned for the Mifflinville and Bloomsburg quadrangles immediately to the west.

USGS ISSUES CIRCULAR AND MAP

ON landsliding

The U. S. Geological Survey has just published Circular 728, "Landsliding in Allegheny County, Pa."



This circular includes general descriptions of landslides, slump, earthflow, rock fall, debris slide and creep. It includes recommendations for homeowners, buyers and builders on what to look for and avoid in selecting a homesite. Descriptions are given of 15 specific landslides encountered in this area.

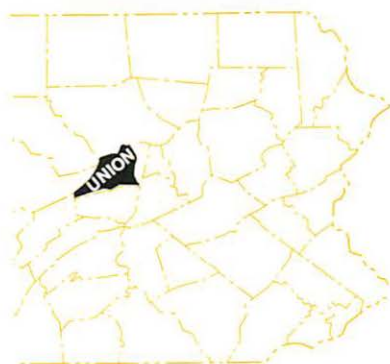
Although Circular 728 concerns Allegheny County, the same conditions prevail in many western Pennsylvania counties and the recommendations are applicable outside Allegheny County as well as other regions and other states in the Appalachians where landsliding is a problem.

Circular 728 has a companion map, #MF 685B, "Map of Susceptibility to Landsliding, Allegheny County, Pa." This map shows where landslides have occurred and are likely to occur in Allegheny County.

Circular 728 is free; Map #MF 685B is available for \$1.00 by writing to: Branch of Distribution, U.S. Geological Survey, 1200 S. Eads Street, Arlington, Va. 22202.

U.S. GEOLOGICAL SURVEY ISSUES UNION COUNTY TOPOGRAPHIC MAP

As a product of the cooperative county mapping program with the Pennsylvania Geological Survey, the U.S. Geological Survey has recently issued a new topographic map of Union County. This new map is at a scale of 1:50,000 (approximately 4000 ft. to the inch) and follows the previously issued maps of Sullivan, Montour, Jefferson, and Forest counties. As is standard with this new series of county maps, contours are shown



in brown at 20-foot intervals, cultural features are shown in black with major roads and urbanized areas in red, forested areas are green, water features are blue, political boundaries for county, townships, and boroughs are outlined in orange. The county map is of widespread use to all who are concerned with county and regional planning, engineering, agricultural, and recreational projects. This map can be obtained for \$2.00 by writing to Distribution Section, U.S. Geological Survey, 1200 South Eads Street, Arlington, Virginia 22202.

New From the U.S. Geological Survey

U.S.G.S. Bulletin 1409. *A summary of oil and gas production and reserve histories of the Appalachian basin, 1859-1972*, by B. M. Miller. 1975. Price: \$0.70

A summary of the oil and gas production and reserve histories of the Appalachian basin, including Pennsylvania, from 1859-1972, compiled on the basis of published information from State and Federal agencies, private agencies, and petroleum companies. Summary compilations categorized by State and geologic age are reported for the distribution of the estimated total proved recoverable hydrocarbons in the Appalachian basin. A detailed bibliography is included.

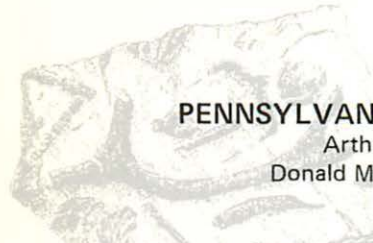
U.S.G.S. Miscellaneous Geologic Investigations Series Map I-844. *Geologic Map of the Surficial Deposits in the Trenton Area, New Jersey and Pennsylvania*, by J. O. Owens. 1975. Scale 1:48,000. Price: \$1.00

U.S.G.S. Miscellaneous Geologic Investigations Series Map I-917, Part C, Part D, *Oil and Gas data from the Appalachian basin*, by R. L. Miller. 1975. Price: \$1.75 each. Scale: 1:2,500,000.

These maps are part of a folio of Appalachian basin oil and gas data. Chapter C shows by isopach maps the extent and thickness of the carbonate and clastic facies of the Upper and Middle Ordovician rocks in the Appalachian basin, including Pennsylvania, as well as the total thickness of these strata. Configuration of the basin is shown by structure contours. Generalized areas of oil and gas production are delineated.

Chapter D shows by isopach maps the thickness and extent of the Lower Ordovician and Cambrian rocks in the Appalachian basin, including Pennsylvania. Structure contours on the top and base of these strata emphasize the importance of growth faulting during the Cambrian. The complex relation of lithofacies in the Lower Ordovician and Cambrian rocks is shown by a series of conceptual geologic cross sections.

U.S.G.S. publications are available from: Branch of Distribution, U.S. Geological Survey, 1200 S. Eads Street, Arlington, Va. 22202.



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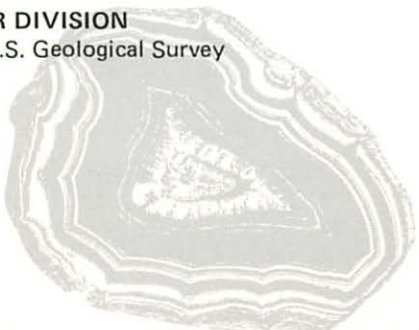
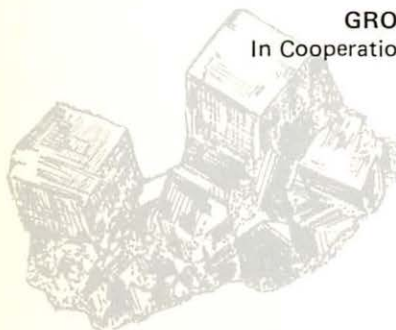
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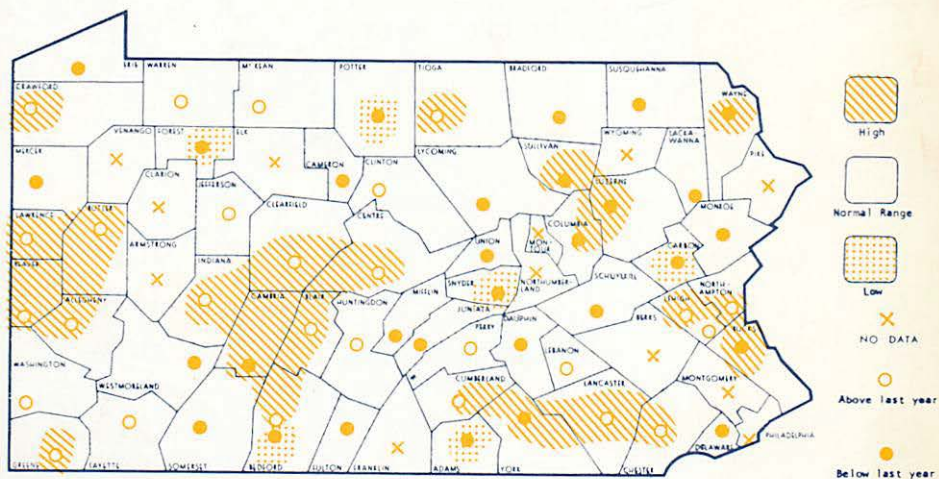
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In Cooperation with The U.S. Geological Survey



JANUARY 1976

GROUND-WATER LEVELS



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