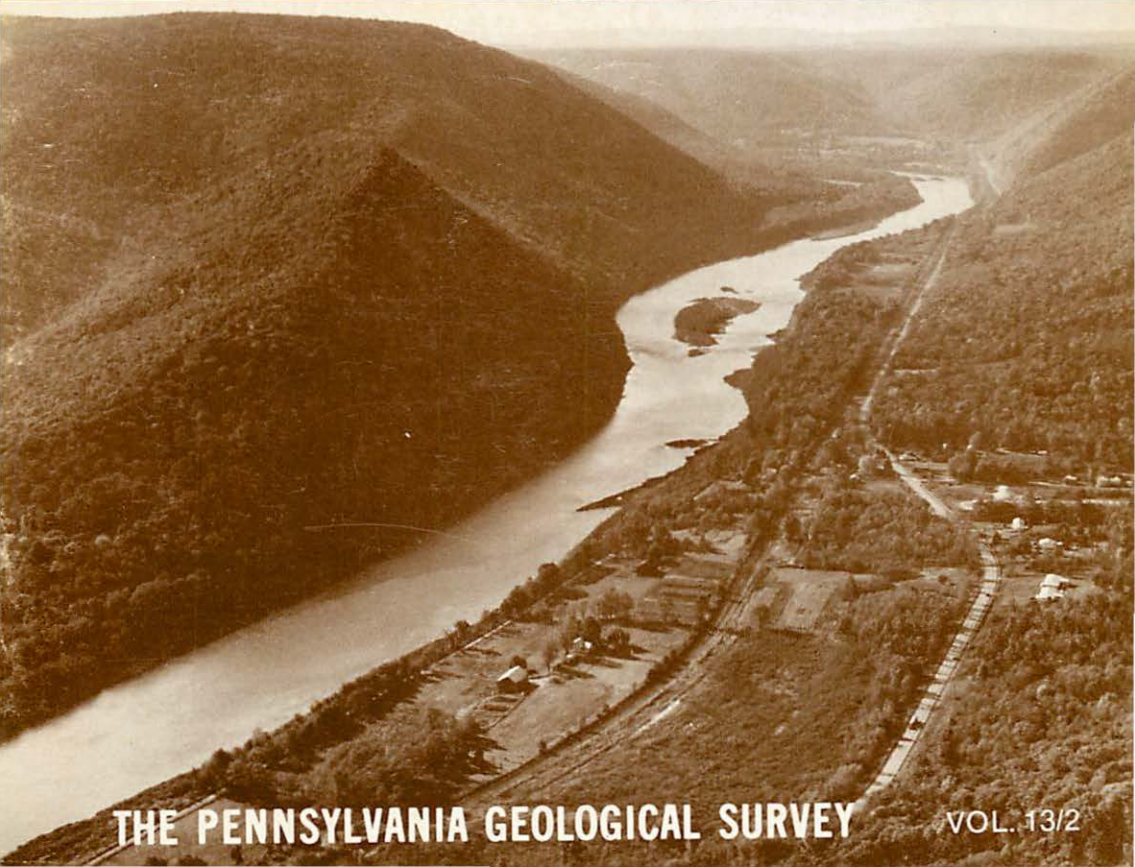
PENNSYLVANIA GEOLOGY



THE PENNSYLVANIA GEOLOGICAL SURVEY VOL. 13/2

COMMONWEALTH OF PENNSYLVANIA
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DEPARTMENT OF ENVIRONMENTAL RESOURCES
Peter S. Duncan, Secretary

OFFICE OF RESOURCES MANAGEMENT
R. Timothy Weston, Associate Deputy Secretary

TOPOGRAPHIC AND GEOLOGICAL SURVEY
Arthur A. Socolow, State Geologist

CONTENTS

ON THE COVER: Hyner View in Hyner State Park, along Route 120, 6.5 miles east of Renova, Clinton County. West Branch of Susquehanna River is downcutting into Catskill Formation, ridges are capped by Burgoon Formation.

PENNSYLVANIA GEOLOGY is published bimonthly by the Topographic and Geologic Survey, Pennsylvania Dept. of Environmental Resources, Harrisburg, Pennsylvania, 17120.

Editor, Arthur A. Socolow; Associate Editor, Donald M. Hoskins.

April 1982

FROM THE DESK
OF THE
STATE GEOLOGIST . . .

HOW I GOT INTO THE MOVIES (ALMOST)

On one normally hectic day last fall our secretary buzzed me to say that I had a call from Hollywood. Knowing of their continuing need for new talent, yet not wishing to appear overly eager, I nonchalantly answered the phone. It was not me they were after, it was Pennsylvania anthracite coal.

It seems that in one of the scenes they were filming for the movie entitled "One From the Heart" there is a miniature movie set for which they wanted the ground to appear as truly black sand. Since nothing else had photographed as desired, the set designer came up with the idea of using pulverized coal, and only the shiny, clean anthracite variety would do. And they needed it within 96 hours — whatever the cost.

While I knew where I could get the 200 pounds of anthracite they needed, there were still some hurdles to overcome. There was no place around here that could pulverize the coal to specifications that quickly; no problem, the studio people said they would take care of the pulverizing — just get the coal out there — fast, and not to worry about the expense. Called the air express people; sorry, coal is combustible and therefore not allowed on planes, even when I suggested bagging it like a passenger. I began to fret; but two heads are better than one, and from my secretary came "Why not ship it by express bus?" A couple of calls verified this approach and we were in business.

That evening I made my first coal purchase in 35 years and wrestled the 200 pounds of gleaming anthracite into four double bags — cloth and paper, so as not to leak away in its cross-country travels.

Next morning, 24 hours after Hollywood called, I pulled up to the bus station and dragged those sacks of Pennsylvania black gold onto the baggage scales. "What have you got there?" the clerk asked. "Just some Pennsylvania coal heading for Hollywood," I replied. Raised eyebrows and laughter followed.

And so it was. 96 hours later came a phone call from California; the coal had arrived in the nick of time, had been pulverized, and was the perfect material for the movie set. Movie producer Francis Ford Coppola was delighted and salutes our gleaming anthracite.

So if any of you should happen to see "One From The Heart," you won't see me in it. But there's a bit of Pennsylvania there — you'll have to look close, because it blends well into the setting.

No, I didn't make it in pictures; Hollywood beckoned, opportunity knocked, and I answered with Pennsylvania's anthracite. Oh well, we also serve.

Arthur A. Socolow

"Oriskany" Sandstone Oil Potential, Northwestern Pennsylvania

by John A. Harper
Pennsylvania Geological Survey

The Lower Devonian "Oriskany" Sandstone* has long been known as one of the more prolific producing horizons for natural gas in Pennsylvania. A handful of large "Oriskany" fields, such as Leidy field in Clinton and Potter Counties and the Punxsutawney-Driftwood field in Clearfield, Elk, and Cameron Counties, accounted for 50 percent or more of the total natural gas produced in the Commonwealth during the 1950's. Today the "Oriskany" has taken a back seat to the Lower Silurian Medina Group in terms of total completed wells drilled each year, but recent "Oriskany" wells in Somerset County are reportedly some of the best producing wells in Pennsylvania.

Despite the good track record of the "Oriskany" as a gas producer, it has never produced oil in Pennsylvania, nor is it considered an outstanding producer in adjacent states. The sand first produced oil at the rate of about 1½ barrels per day from a well in the Austinburg field of Ashtabula County, Ohio, in 1899. However, commercial production of oil from the "Oriskany" did not actually take place until the mid-1920's when oil was discovered in the updip areas of Cambridge field in Guernsey County, Ohio (Hall, 1952). Some oil has also been produced in "Oriskany" wells in western West Virginia, but in Pennsylvania only shows have been reported in this unit. Fettke (1935) first indicated the potential for "Oriskany" oil production in the Bradford area of McKean County. Later, he illustrated an area in western Crawford County having good shows of oil in the sand (Fettke, 1938, 1940). I would like to concentrate on this particular area, the Conneaut field, as a potential oil producing region in the "Oriskany" Sandstone.

*The term "Oriskany" is used here in quotation marks to indicate the questionable usage of the name for a unit which has not specifically been correlated with the type section of the Oriskany Sandstone in New York (see Heyman, 1977; also Abel and Heyman, 1981, for discussion).

The Conneaut field occupies about 250,000 acres in western Erie and Crawford Counties in northwestern Pennsylvania. It comprises a large number of isolated or partially merged pools in the Lower Silurian Medina Group, with subsidiary production from small pools in the Upper Devonian Venango Group, Lower Devonian "Oriskany" Sandstone, Middle Silurian Lockport Dolomite, and Upper Cambrian Gatesburg Formation. A small number of wells in the area just north of Beaver Center, Beaver Township, Crawford County (Figure 1), had reported shows of oil from the "Oriskany" ranging from "show of oil" to 12 barrels per day. These wells, drilled around 1910 for the most part, encountered the "Oriskany" at about 2,300 feet below the surface. No commercial production of oil is known to have occurred.

The "Oriskany" Sandstone in this area, and throughout northwestern Pennsylvania, has a rather patchy distribution. Where it occurs it is typically less than 20 feet thick. This patchiness may serve to create traps where the low, almost featureless structures in the subsurface coincide with development (non-erosion?) of the sand. Wells drilled in these sand traps typically have moderate to large flows of natural gas. The Meade pool in Erie field, Erie County, was discovered in 1946; the discovery well flowed 420 thousand cubic feet of gas per day (Mcfpd). About 60 subsequent wells were drilled in the area in a short time, but the flows could not be sustained. Meade pool, now called Summit Storage pool, was converted to gas storage in 1959, just 13 years after discovery of gas. Typically, storage areas are located in rocks exhibiting excellent reservoir characteristics such as high porosity and permeability, and low water saturation. The McKean pool, also in Erie field, was discovered in 1973 when a well was completed with a natural open flow of 15,000 Mcfpd. The single well pool was shut-in in 1979 after producing a cumulative 135,561 Mcfpd. In Conneaut field two "Oriskany" pools were discovered in the mid-1960's. The Springfield pool discovery well was completed with a natural open flow of 5,600 Mcfpd, and Kidders Corner pool (actually a single commingled "Oriskany" and Medina well) had a reported natural open flow of 7,500 Mcfpd from the "Oriskany." All of these examples are typical of "Oriskany" production, where it occurs, in Erie and Crawford Counties.

The sandstone, as observed in cuttings from the Appalachian Development #1 Cozad well (well #5 in Figures 1 & 2), contains abundant subangular to well-rounded, medium- to coarse-grained, yellowish to clear quartz grains with some minor shaliness (the

shale could be cavings from up-hole). The grains appear to be cemented with calcite in the upper portions of the formation. The samples appear to indicate that there is very little intergranular porosity, but the neutron porosity logs in the area around the oil shows indicate a formation porosity of about 10 percent. A few of the samples observed had clusters of tightly cemented quartz grains with a dark organic-looking substance (bitumen?) in the interstices. It should be noted that the samples described above came from a zone of good quartz sand immediately beneath the horizon referred to by Heyman (1977) as the Bois Blanc Formation. The Bois Blanc carbonates, because of their characteristic clastic content (normally siltstones, shales and fine-grained, glauconitic sandstones), are often identified by drillers as the "Oriskany" in drilling records, especially where the lower sand unit is absent.

Figure 1 shows structure contours on top of the overlying Onondaga Group. The Onondaga was chosen for structural control in this study because of the patchy distribution of the "Oriskany" Sandstone and the unreliability of drillers' records in picking the sand with any degree of accuracy (see the discussion above). Where electric logs are unavailable the top of the Onondaga is generally more

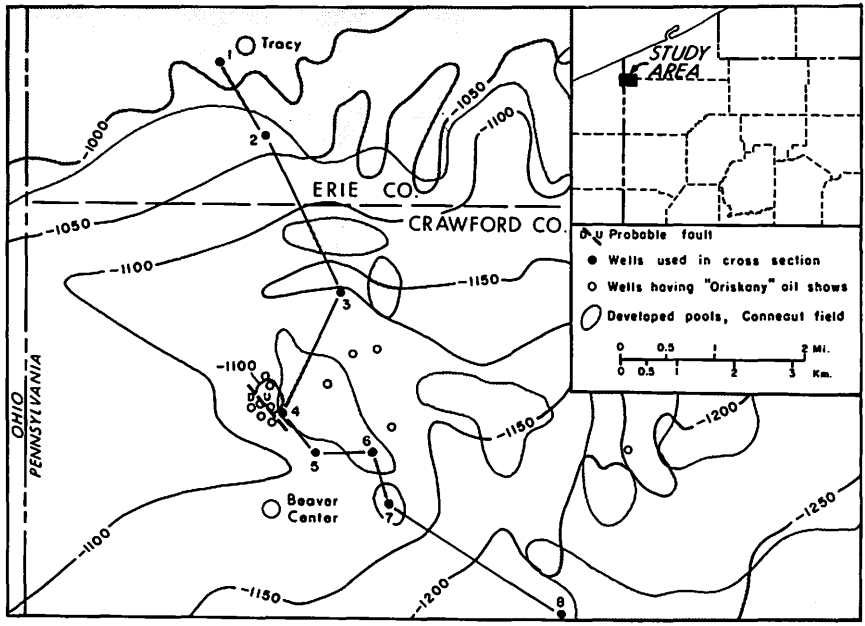

Fig. 1 Location of study area showing "Oriskany" oil shows, locations of wells used to construct cross section (Figure 2), and structure contours on top of the Onondaga Group. Contour interval is 50 feet.

reliable because it is readily identifiable during drilling. Regional structure on the Onondaga indicates a gentle dip to the southeast (about 50 feet per mile), keeping in line with regional structure in the Allegheny Plateau of Pennsylvania. However, in the area around the oil shows in the "Oriskany" the contours bend back on themselves, indicating a gentle anticline over the area of interest. A cross section of the area (Figure 2) corroborates the anticline interpretation and indicates the structure is related to changes in the thickness of the Upper Silurian Salina Group, about 600 feet below. Other cross sections prepared during this study indicate a probable direct relationship between changes in Salina thickness, particularly in the Unit C shale and Unit D salt (see Fergusson and Prather, 1968), and distribution of "Oriskany" sand in the area. On a smaller scale, subsea elevations on top of the Onondaga Group indicate questionable faulting of the section in conjunction with isolated structural highs and lows, also associated with thickening and thinning of the Salina Group. The structural picture at this scale is much too confused by problems of incorrectly reported elevations and formation tops, however, so that no attempt has been made to present a more comprehensive structure contour map than that shown in Figure 1. Faulting, if it occurs in the "Oriskany" and Onondaga sections, is probably not related to faulting described by Wagner (1966) in the Cambrian and Lower Ordovician section in the same area. The plasticity of the Salina salt beds and the Upper Ordovician shales would have absorbed the small 15 or 20 foot displacement observed by Wagner.

The "Oriskany" Sandstone, therefore, exists in the area north of Beaver Center as a relatively isolated patch of sand, thinning to the north and south, situated on a structural high. The sand is good quality reservoir material with formation porosity of about 10 percent. Considering the nearly ideal reservoir and trap conditions of the "Oriskany" in this area, it might seem odd that oil and/or natural gas development from this sand has not been undertaken in more recent times. Several factors could account for lack of development. One of these, and perhaps the most important, is the fact that the Lower Silurian Medina Group sandstones have historically been commercially productive in Erie and Crawford Counties, especially in Conneaut field. The recent designation of the Medina Group as a tight formation by the Federal Energy Regulatory Commission now enables operators to obtain significantly higher prices for gas produced from this reservoir. This in turn makes the Medina an even more attractive target than ever before. Another factor which could account for the lack of "Oriskany" development is connate water in

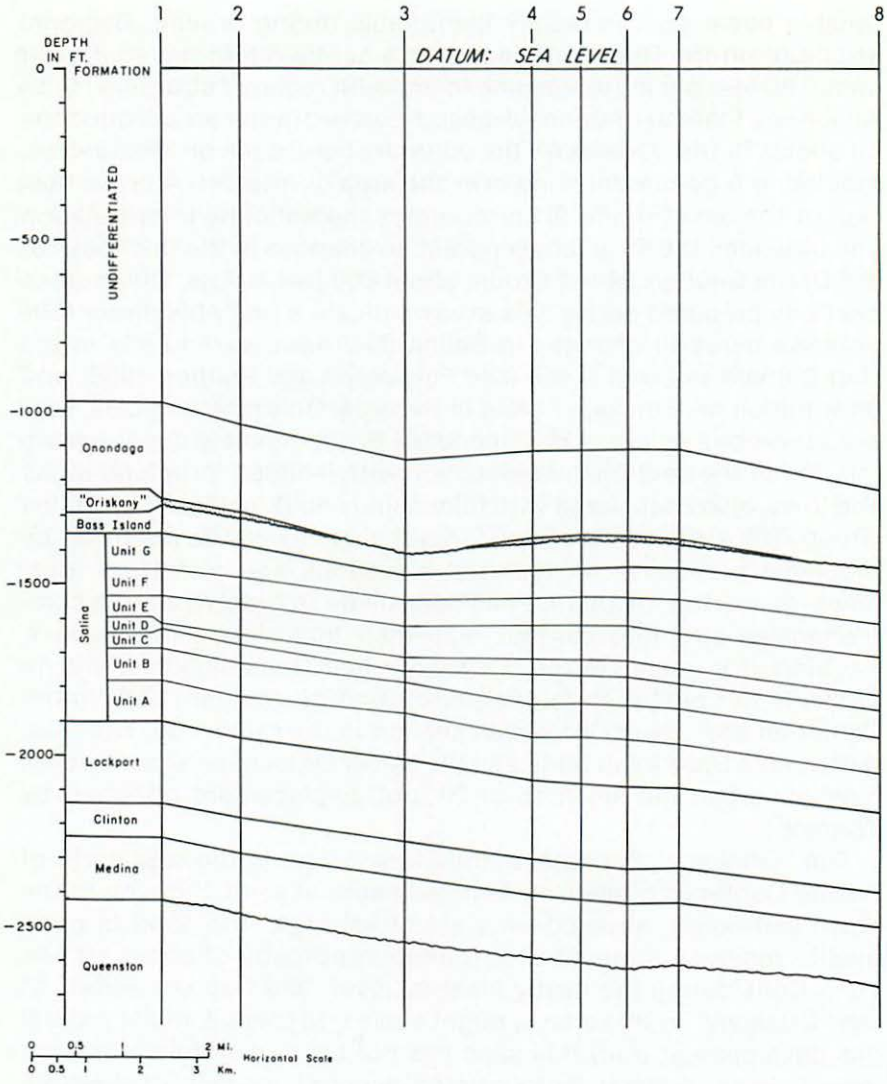

Fig. 2 Structure cross section through study area showing positions of subsurface geologic formations from Onondaga Group to Queenston Formation. Notice patchy development of "Oriskany" Sandstone. Formation tops and "Oriskany" lithology were derived from nuclear logs and samples of wells on file at Oil and Gas Geology Division, Pennsylvania Geological Survey.

the formation. "Oriskany" water content is a known factor to drillers in the northwestern counties, something taken into account while the well is still in the planning stages. Many potentially good "Oriskany" wells have been abandoned or drilled deeper because of flooding problems. One of the "Oriskany" oil wells north of Beaver Center had a show of 12 barrels per day of oil, but 100 barrels per day of water. This particular well, the Patterson #1 George well, was drilled in 1934, a relatively late date for the wells shown in Figure 1, yet no production occurred. Oil recovery technology has improved considerably since that time, however, and it is conceivable that, with present oil prices, economically feasible wells can be drilled that produce large volumes of water along with the oil. The biggest obstacle to such recovery is proper disposal of the water.

The "Oriskany" Sandstone in northwestern Pennsylvania should not be ignored as either an oil or a gas producing formation. Actual distribution of "Oriskany" sand and flooding by connate waters are the only real problems. As such, even though the "Oriskany" could be considered a likely target for drilling in this area, it probably would fare better as a secondary target for wells drilled to deeper horizons. Operators who quickly drill to the Medina Group and evaluate only that portion of the section would do well to take a closer look at the formations up-hole, especially at the "Oriskany" Sandstone.

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Our Publications Have A Market

To those who may wonder if there are users of our geological bulletins and maps, we are pleased to report that in calendar year 1981, the State Book Store filled orders for 14,282 of our technical cost publications. This, of course, does not include the elementary geology pamphlets of our educational series which we supply on request each year to over 100,000 Pennsylvania citizens of all ages and all walks of life.

This response to our publications indicates that we are pretty much "on the mark" in identifying the geologic interests and needs of Pennsylvania's citizenry.

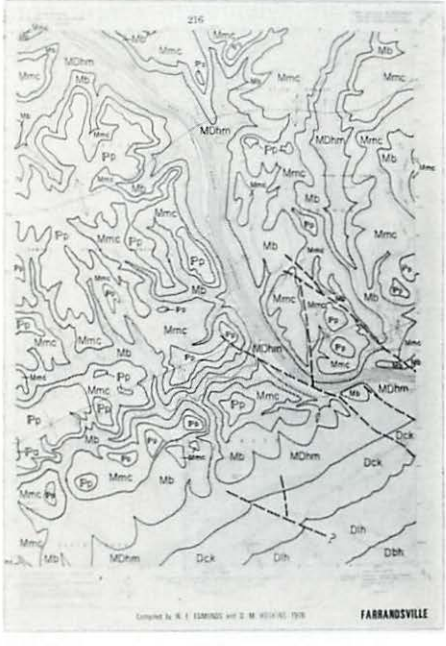
The top ten of our geologic publications sales last year were:

Map 1	Geologic Map of Pennsylvania	593 Sold
EG 7	Outstanding Scenic Geological Features of Pennsylvania	485
Map 3	Oil and Gas Fields of Pennsylvania	405
G 40	Fossil Collecting in Pennsylvania	378
G 33	Mineral Collecting in Pennsylvania	303
PR 193	Oil and Gas Developments in Pennsylvania in 1979	277
Map 19	Oil and Gas Well Base Map of the Brookville, DuBois, Hallton, and Marienville 15′ Quadrangles	235
M 62	Oil and Gas Geology of the Kinzua Quadrangle, Warren and McKean Counties	146
IC 88	Coal Resources of Pennsylvania	136
PR 192	Oil and Gas Developments in Pennsylvania in 1978	133

WHITING REPORT ON OPEN FILE

A reconnaissance study of potential carbonate "whiting" resources has been completed and placed on open-file for examination at the Mineral Resources Division of the Pennsylvania Geological Survey. The location is Room 914, Executive House, 101 S. Second Street, Harrisburg, Pa. In addition to the report, reference rock samples of various sites investigated may be examined. Nineteen samples from fourteen sources ranging in age from Precambrian to Triassic, were analyzed for brightness, whiteness, and chemical characteristics. Potential economic resources have been identified in three formations of southeastern Pennsylvania.

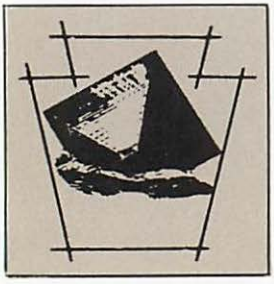
ATLAS OF PRELIMINARY GEOLOGIC QUADRANGLE MAPS OF PENNSYLVANIA



The compilation sheets used in preparation of the new State Geologic Map of Pennsylvania are now available for purchase as Map 61, Atlas of Preliminary Geologic Quadrangle Maps of Pennsylvania. As they were completed, these compilation maps have been available on open file at the Harrisburg offices of the Bureau of Topographic and Geologic Survey. Increasing demand for these maps has prompted publication of the maps in black and white at a scale of 1:62,500. This atlas of 624 preliminary geologic maps is published as a package of 8½ by 11 inch, pre-punched sheets which will fit standard 3-ring binders. The atlas was assembled and edited by T. M. Berg and C. M. Dodge. The geology is drawn on a topographic base, generally the latest 7½-minute quadrangle map (see example of Farrandsville quadrangle). As a time-saving measure, some of the geology was drawn on the older 15-minute base maps in parts of northwestern Pennsylvania.

An index map is included with Map 61 which shows all of the quadrangles in the Commonwealth. The maps included in this atlas are identified by an overprint on the index. For those quadrangle maps not included, the user can refer to an included list of all pub-

lished Pennsylvania Geological Survey or U.S. Geological Survey maps and reports which are available for purchase; they are also available for inspection in many libraries. The geologic maps in Map 61 show mapping that is for the most part, not published anywhere else. Users should keep in mind that these maps are preliminary and do not compare with the detailed and highly accurate, full-color geologic maps that accompany the published Pennsylvania Survey quadrangle Atlas Series, County Reports, and Water Resource Reports, or the U.S. Geological Survey Geologic Quadrangle or Miscellaneous Geologic Investigations Series. This atlas of preliminary maps should be of considerable use to consultants, planners, students of geology, and those concerned with developing rock and mineral resources and fossil fuels. Map 61 may be ordered from the State Book Store, P.O. Box 1365, Harrisburg, PA 17125. The price is $9.60 (Pennsylvania residents should add 6% sales tax).



EARTH SCIENCE TEACHERS' CORNER

new films

The following films were shown recently at the annual meeting of the Geological Society of America:

WHEN THE EARTH MOVES: 22 min., Discusses methods available to people and their governments to lessen or avoid the damages associated with the geologic hazards of volcanic eruptions, earthquakes, landslides, swelling soils and flooding. Dist: Modern Talking Picture Service, Inc., 500 Park Street, N., St. Petersburg, FL 33709 (813) 541-6661.

EARTHQUAKES AND TECHNOLOGY: Film looks at California's second most expensive earthquake — the 1971 San Fernando earthquake — and some of the difficulties involved in conducting research to reduce such hazards. Dist: University Media, P.O. Box 881, Solana Beach, CA 92705 (714) 755-1260.

GLACIAL GEOLOGY — INTERIOR PLAINS REGION: 29 min., The evolution, effects, and processes of Pleistocene glaciation, character and influence of bedrock formations. . .Precambrian rocks at the western edge of the Shield. Dist: Cherry Film Productions Ltd., 25 Bell Street, Regina, Saskatchewan, Canada S4S 4 B7 (306)586-5177.

GEMS OF THE AMERICAS: 30 min, An educational film with the intent of introducing the audience to the origin, natural history and human significance of gemstones. Dist: Gemological Institute of America, 1660 Stewart St., Santa Monica, CA 90404 (213) 829-2991.

THE ROLE OF COAL: 17 min, Explains and illustrates the past and present role of coal as an energy source, as a raw material in chemical and industrial products, and its physical characteristics as a natural resource. Dist: Indiana University Audio Visual Center, Bloomington, IN 47405 (812) 337-8087.

VOLCANO: THE BIRTH OF A MOUNTAIN: 24 min, The formation of Mauna Ulu, the first new volcanic mountain in the United States in historic times, is documented in "Volcano: The Birth of a Mountain." Encyclopedia Britannica Educational Corporation, 425 North Michigan Avenue, Chicago, IL 60611 (132) 321-7105.

CONTINENTAL DRIFT: 30 min, An entertaining and provocative film with computer animation of the drifting continents through 500 million years. Basic concepts of plate tectonics are illustrated and explained by three humorous explorers. Dist: Green Mountain Post Films, Inc., P.O. Box 229, Turner Falls, MA 01376 (413)863-4754/8248.

GROUNDWATER — A PART OF THE HYDROLOGIC CYCLE: 29 min, The film illustrates the occurrence of springs, and the role of groundwater in: soil leaching and saline soil genesis, river bank erosion and landslides, genesis of caves, and the origins of stream flow. Dist: Cherry Film Productions Ltd., 25 Bell Street, Regina, Saskatchewan, Canada S4S 4 B7 (306) 586-5177.

STORM-INDUCED LANDSLIDING, JUNE 1981, IN NORTHWESTERN PENNSYLVANIA

by John S. Pomeroy, U.S. Geological Survey, Reston, Va. 22092 and
Jeffrey W. Popp, Tulane University, New Orleans, La. 70115

On June 9, 1981, torrential rains drenched a large area of northwestern Pennsylvania. A minimum of 4 inches of rain fell on an area 70 miles long by 10 miles wide, trending east-southeast from Crawford County to Jefferson County (fig. 1). Within this same area, higher amounts ranged from about 4.5 inches recorded at Franklin and Cooksburg to 6.4 inches at Cooperstown (National Weather Service, written commun., 1981). Flood damage was particularly extensive along Sage Run southeast of the main part of Oil City.

A brief reconnaissance was made of slopes in the Oil City-Franklin area two weeks after the storm and saw many fresh scars caused by soil slippage. Most of the scars are enlargements of recent slides that were observed during 1978 in a regional slope stability inventory. Most of the landslides occur along man-modified slopes underlain by the Cuyahoga Group of Mississippian age as mapped by Ward and others (1979).

Although the June 1981 storm was considerably wider in extent and was slightly more intense than the Brady's Bend storm of August 15, 1980 (Pomeroy, 1980a), its effect on slopes was less pronounced. A lower landslide density resulted from the storm because of factors related to pre-storm soil-moisture conditions, topography, and geologic and soil materials.

A rainfall of 4 inches for the four-week period prior to the storm contrasts sharply with amounts of 7.5 to 9.5 inches in the Brady's Bend area for the same length of time prior to the August 1980 storm. Thus, soils in the 1981 storm area were considerably less saturated than they were in the previous year's storm at Brady's Bend.

Overall, the slopes in the area of the June 9th storm are more moderate than those in the much smaller area affected by the August 1980 storm. Most of the mass movement of the June 1981 storm was restricted to the steep hillsides along the Allegheny River between Franklin and Oil City. The most intense rainfall occurred north of Franklin at Cooperstown in an area of gentle to moderate slopes, but no mass movement was reported from this area.

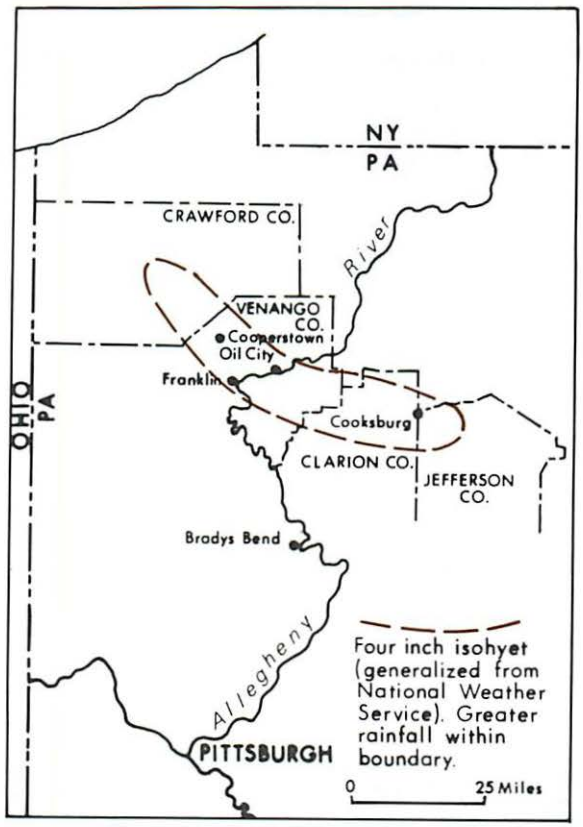


Fig. 1 Map showing area of major rainfall June 9, 1981, northwestern Pennsylvania.

The overall sparsity of landslides can be attributed to the generally well-drained sandy mantle derived from the Pottsville and Allegheny Groups of Pennsylvanian age and glacial deposits derived from these bedrock units. Only along the lower slopes cut by the Allegheny River is there an increase in silty to clayey material derived from the underlying (older) rocks of the Shenango Formation and Cuyahoga Group of Mississippian age. Also, a significantly greater thickness of loose rock and soil exists on these slopes than on those in the adjacent less deeply incised tributary drainages.

One noteworthy storm-induced landslide is located above a parking lot about 0.5 mile east of the Allegheny River-French Creek confluence at Franklin and north of U.S. 62. The slide, consisting of loose rock and soil, is 240 feet wide at its base and extends 90 feet vertically to a head scarp which is about 12 feet high (Figures 2, 3). The slope averages slightly more than 30° (58 percent). Initial move-

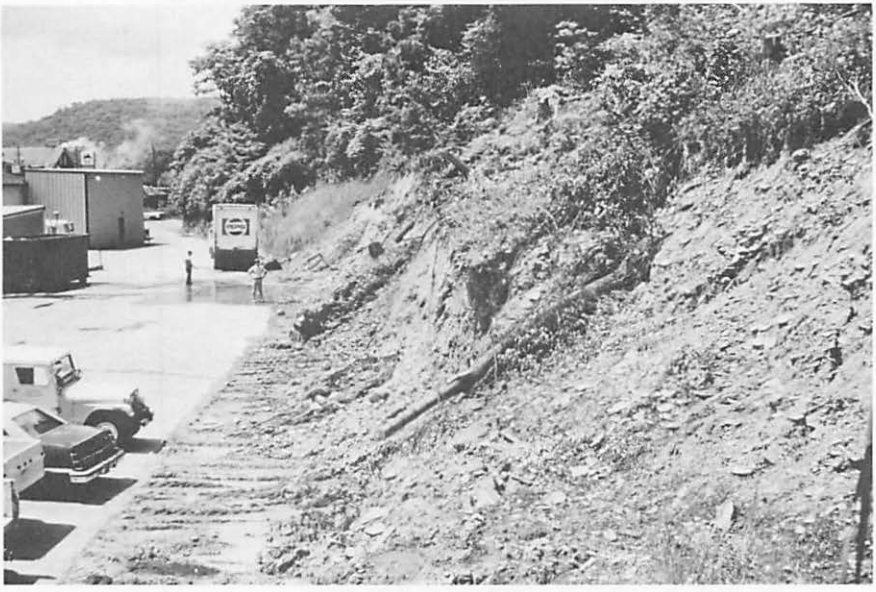


Fig. 2 Base of colluvial slide. Parking lot previously had been covered by soil and rock debris.

Fig. 3 View of slide looking upslope from parking lot. Note scale in front of head (A). B is foot of slide.

ment took place a few days after the storm, according to the plant manager and Lyle Cathcart (U.S. Soil Conservation Service, Franklin). The slide mass spread out over the parking lot to within a short distance of the building, necessitating the removal of the slide at the toe. Trees standing on the slide mass were cut to lighten the load on the unstable slope.

The importance of a single intense storm in initiating mass movement cannot be overstated. For example, climatic records between June 1 and August 4, 1980 (U.S. National Weather Service, written commun., 1980) at Franklin reveal a rainfall of more than 20 inches which is well above normal; however, no single day's total exceeded 2.8 inches. No significant landsliding is known to have taken place.

Flash flooding and accompanying local slope movements have plagued many parts of western Pennsylvania in recent years. Landsliding took place in the Johnstown area in mid-1977 during and after an intense 8- to 12-inch rain (Pomeroy, 1980b). In addition to the 1980 Brady's Bend storm and 1981's flash flooding in northwestern Pennsylvania, many parts of Greene County and southern Washington County in extreme southwestern Pennsylvania have been subject to record rains during the past two years.

On September 2, 1981 the Johnstown area was hit by another storm which caused flooding south and west of the town. Slightly more than 5 inches fell within 3 hours in a region which had not received the brunt of the 1977 storm. However, neither the Pennsylvania Geological Survey office in Pittsburgh (Helen Delano, written commun., 1981) nor the writer received any reports of landsliding.

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NEW STAFF MEMBERS

HELEN L. DELANO joined the staff of the Bureau of Topographic and Geologic Survey as the Environmental Geologist assigned to western Pennsylvania in the fall of 1980. Her office is in Pittsburgh at the Survey quarters in the Kossman Building. Her duties include assisting individuals and planning agencies on questions dealing with landslides and other geologic hazards, groundwater, engineering characteristics of the rocks of western Pennsylvania, and general information on the geologic environment.

Helen received a B.S. in Geology from Tufts University in 1974 and an M.A. in Geological Sciences in 1979 from the State University of New York at Binghamton. At SUNY she concentrated in environmental geology, geomorphology and sedimentology. From graduation until she joined the Survey, Helen was project geologist and crew chief for the National Park Service's archaeological survey of the Cape Cod National Seashore.

Helen is a member of the Geological Society of America, Society of Economic Paleontologists and Mineralogists and the Pittsburgh Geological Society.

CHARLES G. EISIMINGER, who comes from Monongahela in Washington County, is now a part of the Survey's Oil and Gas Inspection Team.

He went to work for Peoples Gas Company in 1959 where he learned the drilling and operating procedures of oil and gas wells. In 1961 he joined the U.S.A.F. Upon being discharged in 1969, he returned to Pennsylvania and went back to work for Peoples Gas in the production and drilling field.

He joined the Survey's Division of Oil and Gas Regulation, as an Oil and Gas Inspector on November 23, 1981.

DAVID W. FORD began employment as an Oil and Gas Inspector on September 24, 1981, with the Division of Oil & Gas Regulation.

David, who is a native of Smethport, Pennsylvania has had extensive field experience in areas such as drilling, plugging, cleaning out and Hydro-fracking. Working throughout northwestern Pennsylvania, eastern Ohio, Tennessee and New York State. From October 1978 thru August 1981 he did contracting work for National Fuel Gas Supply Corporation.

PENNSYLVANIA GEOLOGICAL SURVEY STAFF

Arthur A. Socolow, *State Geologist*

Donald M. Hoskins, *Assistant State Geologist*

TECHNICAL SERVICES

Shirley J. Barner, *Stenographer*
Sandra Blust, *Librarian*
James H. Dolimipio, *Draftsman*
John G. Kuchinski, *Draftsman*
Christine M. Dodge, *Geologist Supervisor*
Mary A. Miller, *Stenographer*
Geary L. Sarno, *Draftsman*
Marjorie Steel, *Stenographer*
Linda Tucker, *Clerk*
Albert Van Olden, *Draftsman*
Janet L. Wotring, *Typist*

ENVIRONMENTAL GEOLOGY DIVISION

Alan R. Geyer, *Division Chief*

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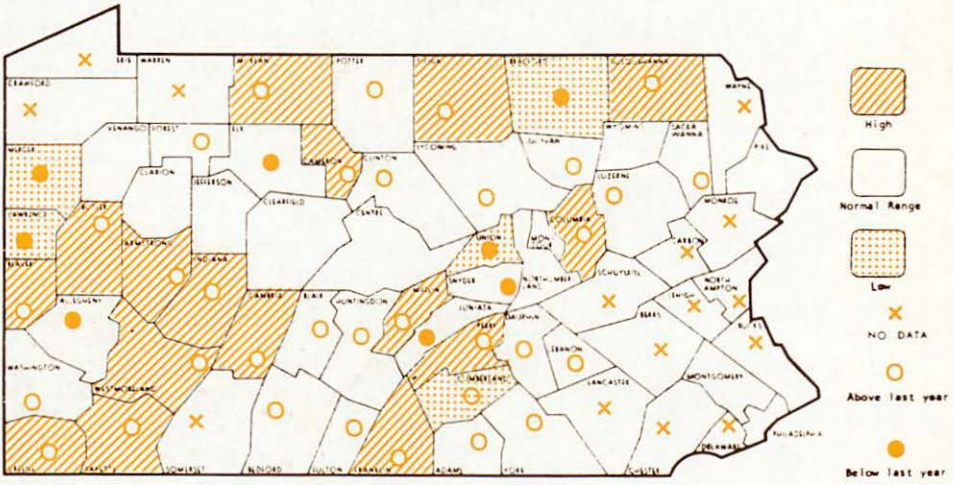
GROUND WATER LEVELS
FOR
February 1982



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Address Corrections Requested

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