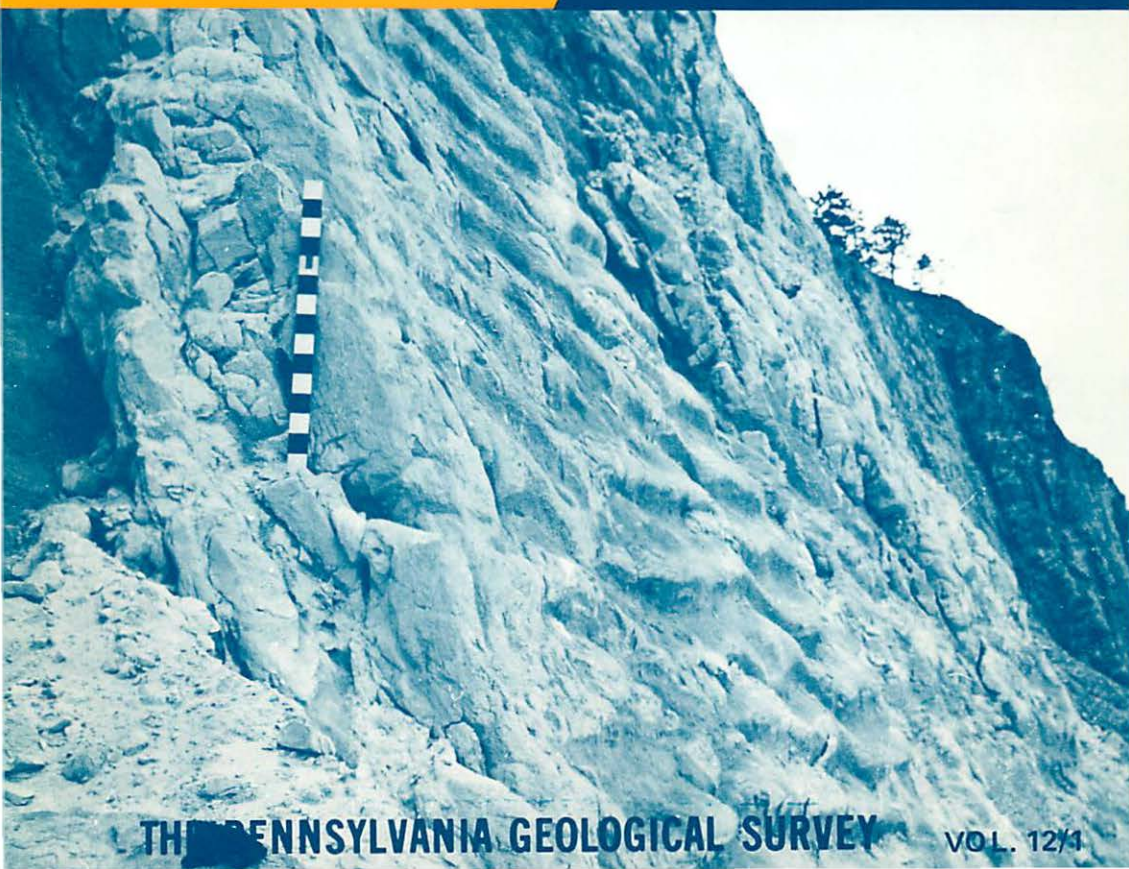
PENNSYLVANIA GEOLOGY



THE PENNSYLVANIA GEOLOGICAL SURVEY VOL. 12/1

COMMONWEALTH OF PENNSYLVANIA
Richard L. Thornburgh, Governor

DEPARTMENT OF ENVIRONMENTAL RESOURCES
Clifford L. Jones, Secretary

TOPOGRAPHIC AND GEOLOGICAL SURVEY
Arthur A. Socolow, State Geologist

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ON THE COVER: Giant, water-formed ripple marks on ancient sandstone near Fayetteville, southeastern Franklin County. Ripples are up to a foot high and three feet from crest to crest. (See article in this issue.) Photo courtesy of J. P. Wilshusen.

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

Articles may be reprinted from this magazine if credit is given to the Topographic and Geologic Survey.

FEBRUARY 1981

FROM THE DESK
OF THE
STATE GEOLOGIST

TWO RIGHTS DON'T MAKE A WRONG

In recent months there has been a marked increase in the number of new oil and gas wells being drilled in Pennsylvania. While 2,199 new wells were drilled in 1980, many more are expected in 1981, based on the drilling permits which have been issued in the last few months. This results from the economic stimulus of rising prices for oil and natural gas.

To many citizens the increased exploration and drilling is seen as offering Pennsylvania a hope for greater energy self sufficiency, with resulting benefits to our industry and our economy. And these optimistic citizens are right.

Other citizens view the increased oil and gas drilling with alarm, because they see that some of the new drilling results in new access roads which in places can get very muddy, and this construction may also cause a loss of some trees. Such practices have recently been publicized in the press. These concerned citizens are also right.

But oil and gas development need not be an "either-or" situation in relation to environmental quality. Responsible industry can and does abide by environmental laws and regulations. Those few, irresponsible operations which are violators will be addressed under the provisions of the Clean Streams Act, the Environmental and Sediment Control Law and the Oil and Gas Act. To ensure that these provisions of environmental safeguard are effectively operative, DER Secretary Clifford Jones has appointed an Oil and Gas Environmental Advisory Committee made up of representatives of public environmental organizations and of oil and gas industry operators. The concerned public, for their part, must recognize that the owner of oil and gas rights on a property does have a legal right of "reasonable access" to drilling sites, and "reasonable" may include a certain amount of road access and related construction impacts.

We can't deny that wherever man has tread he has had an impact on the pre-existing natural environment. This is even true in housing developments and recreation areas. Man himself is a part of our environment, as are man's food and energy resources. With proper industry respect for our environment and for the laws which have been passed to protect it, we can have reasonable access to the oil and gas energy resources we have been blessed with. And with an equal recognition that legally acquired oil and gas rights carry a legal right of reasonable access, we should be able to operate under fair and equitable rules of procedure; we can protect the environment and have our energy too. Both sides of this issue are right; with recognition and tolerance we should be able to proceed with our energy resources while still respecting the environment.

Arthur A. Socolow

CORRECTION: In the October, 1980 issue of PENNSYLVANIA GEOLOGY the State Geologist's article on page 1 incorrectly read "96.3 million cubic feet of natural gas was taken out of the ground in Pennsylvania in 1979." The correct figure is 96.3 *billion* cubic feet. That's quite a difference; we regret the error.

GIANT RIPPLES AT MOUNT CYDONIA

by J. P. Wilshusen and W. D. Sevon

A magnificent exposure of huge, ancient sand ripples (megaripples) (Figure 1) is presently exposed in an active quarry of the Mount Cydonia Sand Company near Fayetteville in southeastern Franklin County, Pennsylvania. These megaripples occur near the middle of the Early Cambrian Antietam Quartzite which is exposed along the north side of South Mountain (Figure 2).

The Antietam Quartzite at Mount Cydonia is a clean, coarse-grained, quartzose sandstone. The sand grains are almost entirely subangular to well-rounded quartz grains, accompanied by rare grains of chert. Quartz overgrowth on the grains are common and these, as well as intergranular quartz, serve as the binder for the rock. The formation has two lithologic subdivisions. The lower part is a resistant, bluish to pink quartzite which varies from structureless, to planar bedded, to thin beds with small-scale, multi-directional cross-bedding. The upper part consists of white to pinkish sandstone containing abundant *Skolithos* tubes (fossil animal burrows). The prominent megarippled surface (Figure 1) is the approximate boundary between the two rock varieties. The Antietam is about 800 feet thick in the quarry and varies regionally from 700 to 900 feet thick (Stose, 1932).

The Antietam Quartzite was folded during the post-Ordovician period mountain building which formed the South Mountain anticlinorium and gave the present 70° northwest dip to the megarippled beds. This deformation also imparted to the Antietam a spaced cleavage which dips perpendicular to the bedding and strikes approximately parallel to bedding.

The trace fossil *Skolithos linearis* (Figure 3) occurs in profusion in the upper part of the Antietam and superb examples can be seen in unquarried rock faces and in numerous quarried blocks. A trace fossil is a fossilized track, burrow, or boring which resulted from the activities of an animal. The morphology of the animal which made the trace is unknown because the animal probably had no hard parts which could be fossilized.

In weathered rock *Skolithos linearis* appears as a remarkably straight, sand-filled tube which has a circular cross section. These tubes are prominent on weathered surfaces because of differential weathering of the apparently less well-cemented tube. In fresh rock

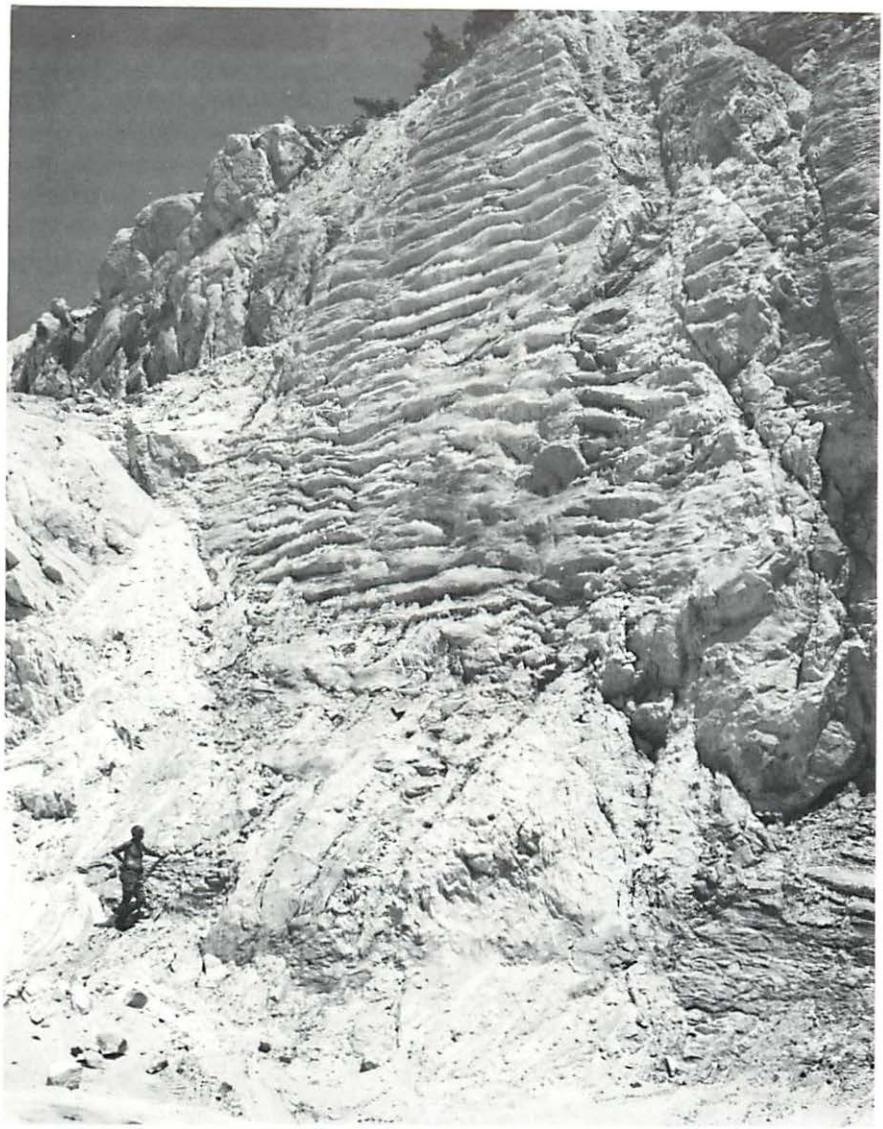


Figure 1. Corrugated surface of megaripples in Lower Cambrian Antietam Quartzite.

Skolithos is not readily discernable. These tubes are thought to have been formed by a worm that lived in the tube and may have fed at or near the sediment-water interface. *Skolithos linearis* is found almost exclusively in sandstones and is one of a suite of trace fossils interpreted to be associated with dominantly high energy shallow marine depositional environments such as offshore bars and beaches and, to a lesser degree, deeper offshore sediments (Banks, 1970). Its presence, as well as rare marine fossils reported from other localities (Fauth, 1968), establishes a marine origin for the Antietam Quartzite.

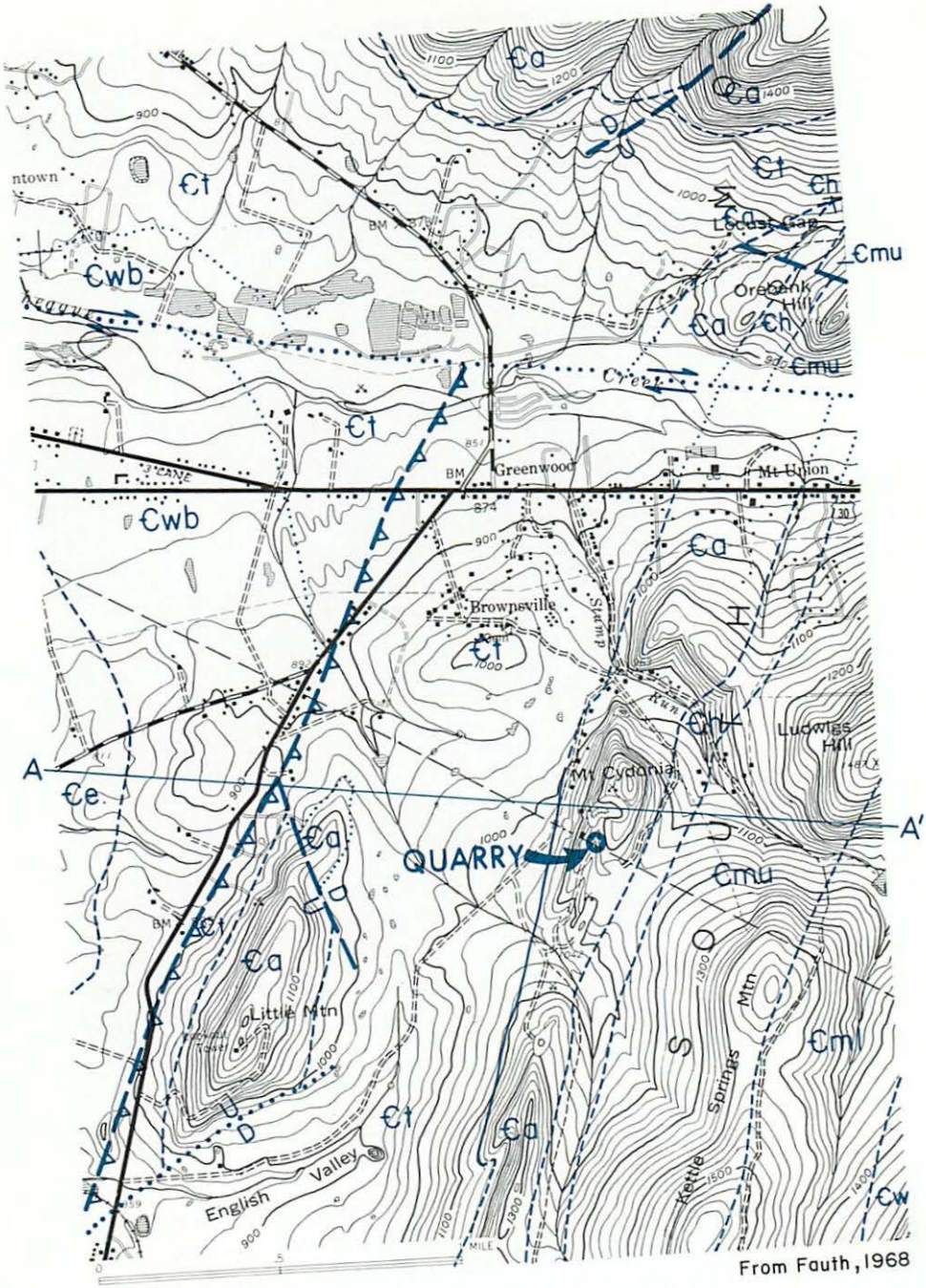


Figure 2. Geologic map and cross section.

LEGEND

Ꞓe

ELBROOK FORMATION

Gray limestone and calcareous sandstone with finely laminated, shaly limestone in lower half.

Ꞓwb

WAYNESBORO FORMATION

Bluish limestone and dolomite with interbedded sandstone and shale.

Ꞓt

TOMSTOWN FORMATION

Gray dolomite with interbeds of white limestone.

Ꞓa

ANTIETAM QUARTZITE

White to gray, medium- to coarse-grained sandstone and quartzite.

Ꞓh, Ꞓmu, Ꞓml

HARPERS FORMATION

Greenish-gray graywacke, Harpers Formation (Ꞓh); light-gray sandstone and quartzite, Upper Montalto Member (Ꞓmu); gray, thin-bedded sandstone and quartzite, Lower Montalto Member, (Ꞓml).

Ꞓw

WEVERTON FORMATION

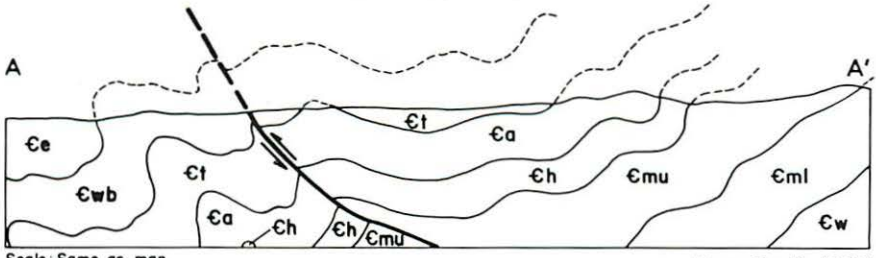
Interbedded sandstone and graywacke with conglomerate and phyllite intervals.

SYMBOLS

Thrust fault

A ——— A′ Line of cross section

CROSS SECTION



Scale: Same as map
No vertical exaggeration

From Fauth, 1968

Figure 3. The trace fossil *Skolithos linearis* appears as narrow gray stripes approximately parallel to the hammer handle in this quartzite boulder. *Skolithos linearis* is always perpendicular to bedding.

The megaripples which occur below the zone of *Skolithos* tubes have heights (amplitudes) of 5 to 10 inches and wave lengths of 18 to 30 inches (cover and Figure 1). The megaripples are asymmetrical in cross section and have unidirectional forset layers which dipped northwest prior to folding. Individual megaripples are laterally persistent and vary from linear to slightly sinuous (Figure 4). The crests of the megaripples are rounded. Other beds near the megaripple horizon have rippled surfaces (Figure 5) but the ripples are smaller in scale. These ripples also have northwest dipping forset laminae.

Megaripples are formed in sand under water by any of three mechanisms: (1) by unidirectional flow of water, such as in a stream, (2) by oscillatory motion of waves in shallow waters of oceans or lakes, and (3) by combination of (1) and (2), such as in a tidal channel. A wave-generated origin in which oscillatory flow is stronger in one direction, generally landward, than the other seems probable for the Mount Cydonia megaripples. Such an interpretation seems

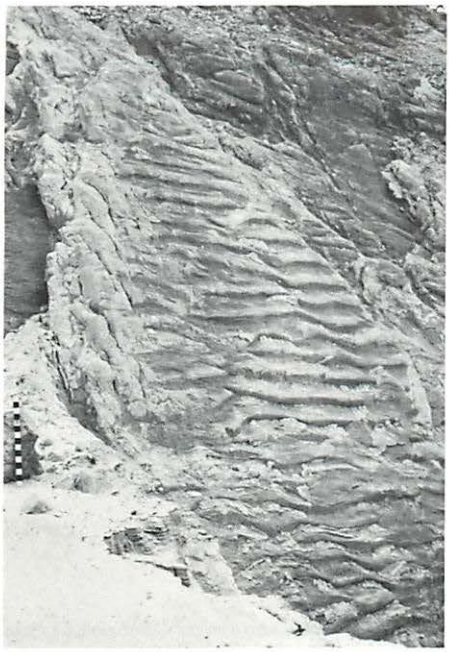
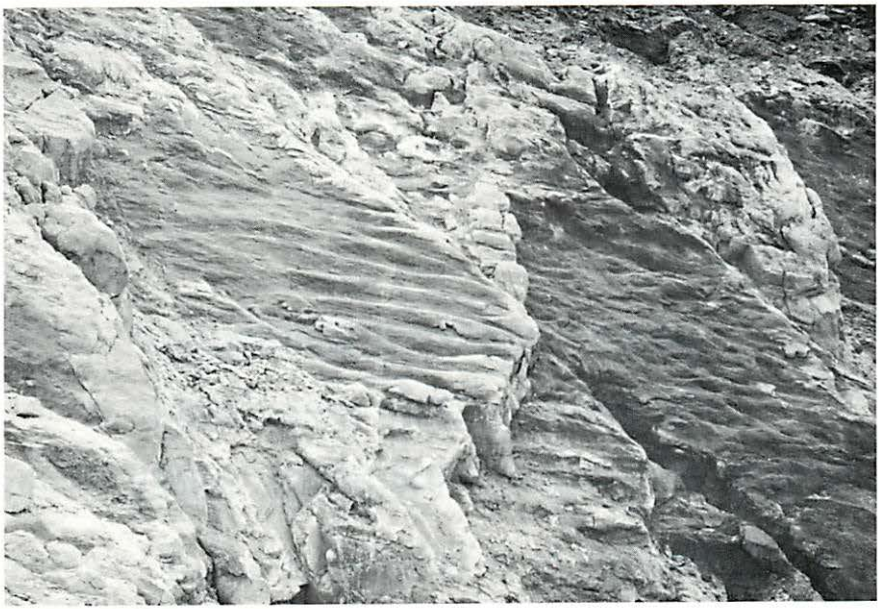


Figure 4. Steeply dipping bedding plane surface of megaripples exposed in the Mount Cydonia Sand Co. quarry, Franklin County. Scale is 1½ meters long.

Figure 5. Two rippled bedding surfaces several feet below the major surface shown in figures 1 and 4.



particularly reasonable because the megaripples occur between the lower part of the Antietam, which has sedimentary structures probably formed in ancient offshore environments below non-storm wave base, and the upper part, which certainly represents ancient near-shore deposition. Thus the megaripples represent wave-generated ripples formed during shallowing of water at a time of deposition of Antietam sands.

Whether or not these megaripples formed along the real coast of the continent in Early Cambrian times or along barrier islands fronting the continent (Kauffman and Frey, 1979) is not known. However, acceptance of a wave-generated origin for the megaripples and a landward dip for their forset layers supports the concept that the source area for the Antietam Quartzite lay to the northwest and that the development of the southeastern source area which dominated most of Paleozoic deposition in Pennsylvania occurred after deposition of the Antietam Quartzite.

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adams county groundwater resources study completed- lebanon and fayette counties study started

Larry E. Taylor and Denise W. Royer, hydrogeologists with the Bureau of Topographic & Geologic Survey, have recently finished a

study of the groundwater resources of Adams County; the results of which will be presented in a report (W-52) scheduled for publication in mid-1981.

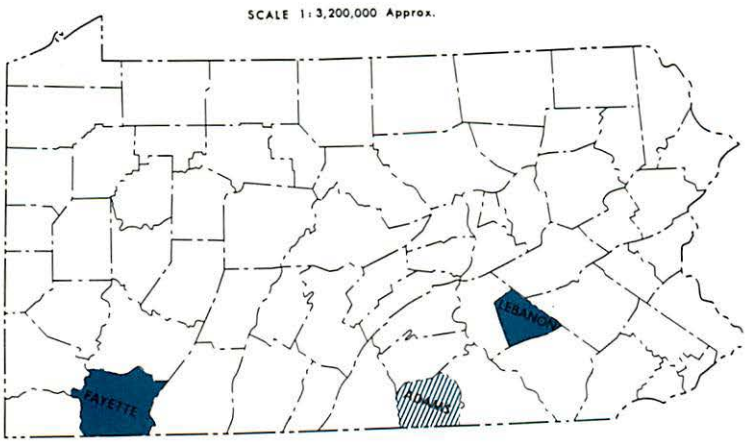
The project utilized groundwater information and interpretations from two previously completed detailed studies on the New Oxford Formation (W-21) and the Gettysburg Formation (W-49), in addition to new groundwater data collected throughout the county. The water well records presented in the report are now open-file and may be viewed at the Survey offices in Harrisburg.

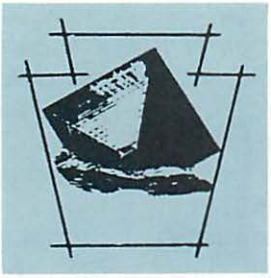
The report will describe the occurrence and availability of groundwater as related to geology, topography, and climate. The natural or existing groundwater quality is also described.

A similar groundwater study has been started recently in Lebanon County by Denise W. Royer. This study will utilize previously completed hydrologic reports for the Lebanon Valley carbonates (W-18) and the Hammer Creek Formation (W-49). New groundwater information will be collected primarily in the northern part of the County.

A study of the groundwater resources of Fayette County was recently started by Survey hydrogeologist Thomas McElroy. The project has two primary objectives. The first is to provide a comprehensive description and inventory of the groundwater resources of Fayette County, enabling the planning of groundwater supplies and groundwater management. The second objective is to monitor groundwater quality in relation to coal mining. Because of the renewed emphasis on coal mining in southwestern Pennsylvania and the popular concern for the protection of groundwater supplies, the second objective is of particular interest.

The estimated completion date of the report is mid-1982.





EARTH SCIENCE TEACHERS' CORNER

new films

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

VENUS PIONEERS (27 min.)
This film uses animation and computer simulations to present information gathered by the Pioneer Spacecraft in 1978.
Dist: National Aeronautics and Space Administration, Code FVM, Washington, DC 20546

A NEW LOOK AT THE OLD MOON (28 min.)
This film reviews the geophysical and sample investigations during the period 1969 through 1979 to present the geological history of the moon.
Dist: A.V. Service Corporation, P.O. Box 58425, Houston, TX 77058, (713) 483-4231

CONTINENTAL DRIFT (22 min.)
Film outlines the processes of plate tectonics. Location footage, diagrams and animation are used to illustrate drifting, faulting, volcanism, earthquakes, and ridge formations.
Dist: Encyclopaedia Britannica Ed. Corp., 425 North Michigan Ave., Chicago, IL 60611, (312) 321-6800

DIVE TO THE EDGE OF CREATION (59 min.)
A mile and a half below the surface of the ocean, life exists in abundance around thermal vents. Discover worlds of life supported by bacteria that convert chemicals into organic matter.
Dist: Karol Media, E. 36A Midland Ave., Paramus, NJ (201) 262-4170

WATER: A PRECIOUS RESOURCE (23 min.)
An examination of the hydrologic cycle, water uses and environmental problems.
Dist: Karol Media

SECRETS OF LIMESTONE GROUNDWATER (25 min.)

Illustrates unusual nature of groundwater systems of carbonate rocks. Concentrates on development of Karst features and groundwater contamination.

Dist: Albert E. Ogden, University of Arkansas, Arkansas Water Resources Center, Fayetteville, AR 72701, (501) 575-4404

MOUNTAIN HERITAGE - THE APPALACHIANS (29 min.)

Evidence that the Appalachians were created by pre-Atlantic convergence is examined with Prof. John McGlynn in Newfoundland. Good geology.

Dist: Films, Inc., 1144 Wilmette Ave., Wilmette, IL 60091, (312) 256-4730

TELEDETECTION: REMOTE SENSING (25 min.)

Superb new film explaining (with excellent graphics and real-world examples) the essentials of Photography, side-looking radar, satellite imagery, and associated data processing. A good introduction to remote sensing—how it is done and what it is good for.

Dist: Available in English through Scientific Attache for Space Affairs, French Embassy, 2011 I Street, NW, Washington, DC 20006, (202) 658-3550

teacher's packets

Packets of earth science teaching aids prepared by the U.S. Geological Survey are available to teachers as a public service without charge. Each packet contains an assortment of general-interest leaflets and booklets related to earth science.

Packet #1—*Selected Packet of Geologic Teaching Materials*

This contains general-interest material selected for elementary and secondary school teachers of courses in environmental education, geography, oceanography, and social studies.

Packet #2—*Teacher's Packet of Geologic Materials*

This includes more specialized reference lists and materials for secondary school and college teachers of earth science courses.

Requests for packets should be in writing on school letterhead, specifying the subject or subjects you teach, grade level, and a self-addressed stick-on mailing label should be enclosed to expedite handling of your order. Mail requests to Branch of Distribution, U.S. Geological Survey, 1200 South Eads Street, Arlington, VA 22202.

SURVEY ANNOUNCEMENTS

REPORT ON PENNSYLVANIA'S OIL AND GAS

Pennsylvania oil production in 1979 totalled 2,816,682 barrels and natural gas production was 96,313 million cubic feet. While this represents a 1 percent decline over the prior year, the most encouraging development was a 6 percent increase in oil reserves (to 50,845,000 barrels) and a 7.5 percent increase in natural gas reserves (to 2,251,312 million cubic feet). This reflects the considerable increase in exploration and drilling for oil and gas during the past year.

These trends and statistics are included in the Bureau of Topographic and Geologic Survey's new publication on "Oil and Gas Developments in 1979." The 65-page report was compiled by Robert Piotrowski, former chief of the Oil and Gas Geology Division, with assistance from the division's staff; numerous tables, maps, and figures are included.

During 1979 the total number of new wells completed in Pennsylvania was 1941, an increase of 11 percent over the previous year. Drilling for natural gas leads this increase, with Indiana, Jefferson, Erie, Westmoreland, and Armstrong Counties showing the greatest amount of gas development. Oil drilling was greatest in Venango, Warren, and Forest Counties, accounting for 99 percent of all oil drilling in the Commonwealth, whereas McKean, Venango and Warren Counties lead in actual oil production.

Progress Report 193, "Oil and Gas Developments in Pennsylvania in 1979," is available from the State Book Store, P.O. Box 1365, Harrisburg, PA 17125. The price is $1.50 (plus 6% sales tax for Pennsylvania residents).

PAUL J. KUCSMA JOINS SURVEY

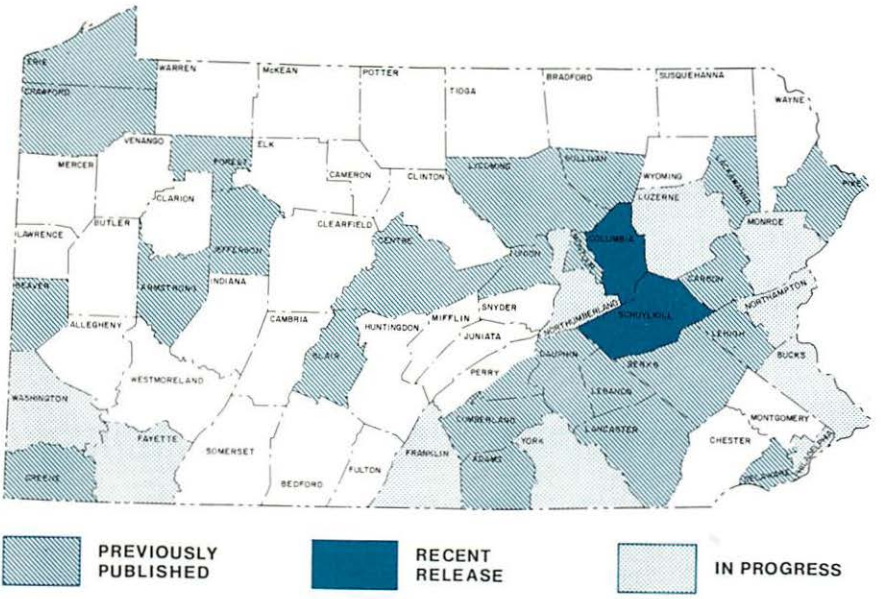
Paul J. Kucsma joined the Bureau of Topographic and Geologic Survey in August, 1980 as a geologist with the Division of Oil and Gas Regulation in Pittsburgh, Pennsylvania.

Mr. Kucsma received a B.S. in Geology from the University of Dayton in 1975 and an M.S. in Geology from Northeast Louisiana University in 1978. He spent one year working for GO Wireline Services as a Field Engineer in Lake Charles, Louisiana and a brief period as a consultant before joining the Survey.

Paul's duties include insuring compliance with the Oil and Gas Conservation and Gas Storage Acts, and other oil and gas projects as they develop to fulfill the responsibilities of that Division.

COUNTY TOPOGRAPHIC MAPS

During the past year, two new county maps have been completed and published as part of the ongoing cooperative topographic mapping program between the Pennsylvania Geological Survey and the U.S. Geological Survey. These are Columbia and Schuylkill (E and W sheet) Counties. Previously published maps include Adams, Armstrong, Beaver, Berks, Blair, Carbon, Centre (E and W sheet), Crawford, Cumberland, Dauphin, Delaware, Erie, Forest, Greene, Jefferson, Lackawanna, Lancaster, Lebanon, Lehigh, Lycoming (E and W sheet), Montour, Pike, Sullivan, and Union Counties. The maps are at a scale of 1:50,000 (approximately 400 feet to the inch). Counties currently in progress include Bucks, Fayette, Franklin, Luzerne, Monroe, Northampton, Northumberland, Philadelphia, Washington, and York.



These maps are multicolored, following the standard colors of the 7-1/2-minute topographic map series, with the addition of political boundaries for county, township and boroughs outlined in orange.

The county maps (with one exception) can be obtained for $2.00 per sheet by writing to Distribution Section, U.S. Geological Survey, 1200 South Eads Street, Arlington, Virginia 22202. The exception is the Lehigh County map which is available for $1.00 (plus 6¢ sales tax) from the Department of General Services, State Book Store, P.O. Box 1365, Harrisburg, Pa. 17125; when ordering, specify Map 39.

GEOLOGY OF THE OIL CITY AREA

"Geology and Mineral Resources of the Oil City [7 1/2-minute] Quadrangle, Venango County, Pennsylvania," by cooperating geologists Drs. Albert N. Ward (Slippery Rock State College), Michael T. Lukert (Edinboro State College), and William F. Chapman (Slippery Rock State College) has been published by the Pennsylvania Geological Survey.

This atlas combines detailed, full-colored maps of the bedrock (1:24,000) and glacial deposits (1:63,360) with text on one plate for convenient use. The three-column explanation provides information on the geology and environmental characteristics (ground-water and engineering characteristics and mineral resources) of the mapped units.

This new atlas provides a basic geologic inventory useful for land-use planning, ground-water and waste-disposal management, and mineral-resource development. It will benefit local officials, planners, industry, conservationists, and residents of the Oil City area.

Atlas 33a, "Geology and Mineral Resources of the Oil City Quadrangle, Venango County, Pennsylvania," is available for $5.10 (plus 6% sales tax for Pennsylvania residents) from the State Book Store, P.O. Box 1365, Harrisburg, PA 17125.

Groundwater Hydrology and Water-Resources Planning

The U.S. Water Resources Council has released a revision of "Essentials of Ground-Water Hydrology Pertinent to Water-Resources Planning." This is Bulletin 16 of the Council's Hydrology Committee. The publication is intended to help bridge the gap between groundwater hydrology and water resources planning.

Groundwater is an integral part of the nation's water resources. In fact, groundwater is often more readily available, less costly and of higher quality than surface water. Groundwater sources have been developed to supply about 20 percent of water withdrawn for use in the United States. In nearly all parts of the country as well as Pennsylvania, moderate to large amounts of groundwater are available for water supply at reasonable costs.

This bulletin presents the essential aspects of groundwater hydrology pertinent to water resources planning and discusses advances in analysis of groundwater systems and the factors influencing the management and administration of the groundwater resource. This report will be useful to those unfamiliar with groundwater analysis, utilization, or management because it introduces the principles and interrelationships that must be considered in the management and protection of the resource. It also will be useful to experienced hydrologists and areawide planners as an aid to integrating groundwater into comprehensive planning.

Copies are available from the Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402. The stock number is 052-045-00083-5, and the price is $2.50.

Drought Conditions Continue In Pennsylvania

Below normal water conditions persist in the eastern half of Pennsylvania. January's streamflow was below the median range at all five eastern index stations as reported by the U.S. Geological Survey in its January issue of "Monthly Water Resources Summary for Pennsylvania." This is the seventh consecutive month in which streamflow has been below normal, causing moderate to severe shortages in some communities.

The map on our back cover shows the generalized pattern of groundwater for January based on index wells. Groundwater levels continued to decline seasonally but were below normal for the eastern half of the State. Groundwater levels refer to conditions near the end of the month. Water level in each observation well is compared with the average level for the end of the month determined from the past record for that well.

The report "Monthly Water Resources Summary for Pennsylvania" is usually published bi-monthly; however, it will be published monthly until drought conditions are improved. Issues of the summary are free upon application to the U.S. Geological Survey, Water Resources Division, P.O. Box 1107, Harrisburg, PA 17108.

The Lehigh Valley Gem and Mineral Show will be held Saturday and Sunday, March 14 and 15, 10 A.M. - 6 P.M. at the U.S. Marine Training Center, Pembroke Rd., Bethlehem, Pa.

MEET THE STAFF...

Robert C. Smith II, Chief
Division of Mineral Resources

Dr. Robert C. Smith, II, for the past 9 years an economic geologist and geochemist in the Bureau's Mineral Resource Division, has been promoted to Chief of that Division, following the recent retirement of Bernard J. O'Neill. Together with mineralogist John H. Barnes and other staff, Bob Smith plans to continue the Division's long standing policy of serving the needs of the mineral industry, fellow state agencies, and the general public. This will continue to be accomplished by obtaining and making available data on the location and distribution of metallic and non-metallic mineral deposits in the Commonwealth. Such data will continue to be made available through published reports, open files, and individual responses for assistance.

In addition to helping sustain Pennsylvania's mineral industry, Bob plans to continue using his geochemical and mineralogic background to serve the general public, mineral collectors, academic institutions, and other governmental agencies. Bob's experience in laboratory analyses will enable him to respond to requests for technical assistance from the Survey's other divisions as well.

Bob's past studies for the Bureau have dealt with zinc and lead, red-bed copper-uranium, asbestos, and mineral collecting in the Commonwealth. Presently, he is studying the distribution of natural radiation anomalies in granitic gneisses with J. H. Barnes. Data on newly found minerals in Pennsylvania are an additional interest. Of special interest to him are metallic minerals and those of rare elements.

Bob Smith is a graduate of Lafayette College and Penn State University where he had conducted comprehensive research on allanite and diabase, respectively. His non-professional activities are predominantly related to his family and church. At home, 25 different fruit trees provide much fun for him and his young daughters, Mandy and Jenny, and more than enough canning work for his wife, Gloria.

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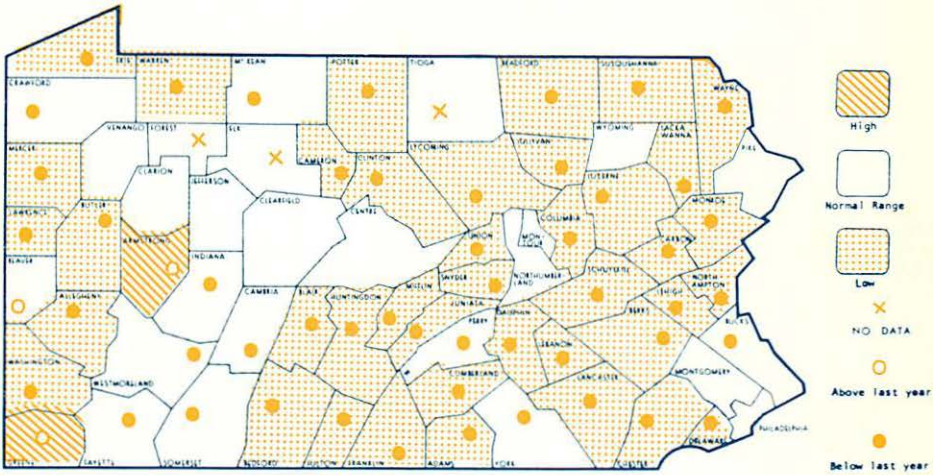

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