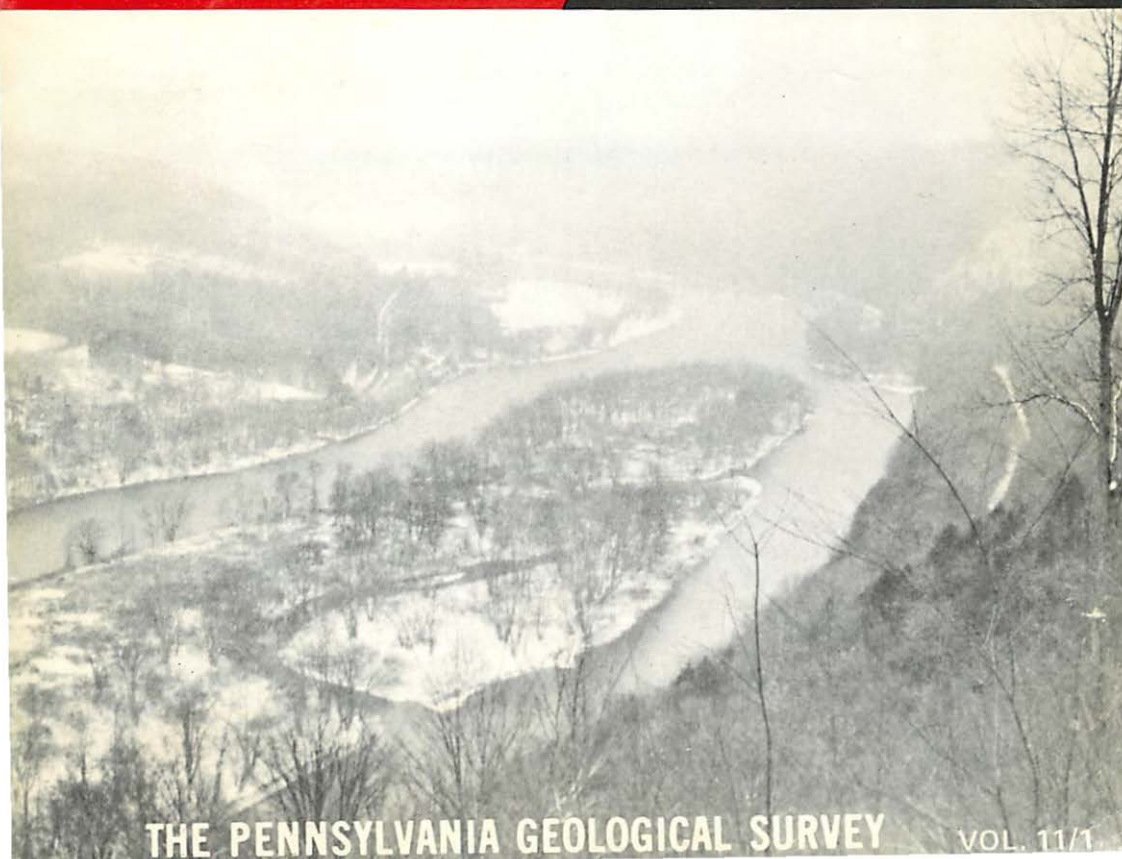
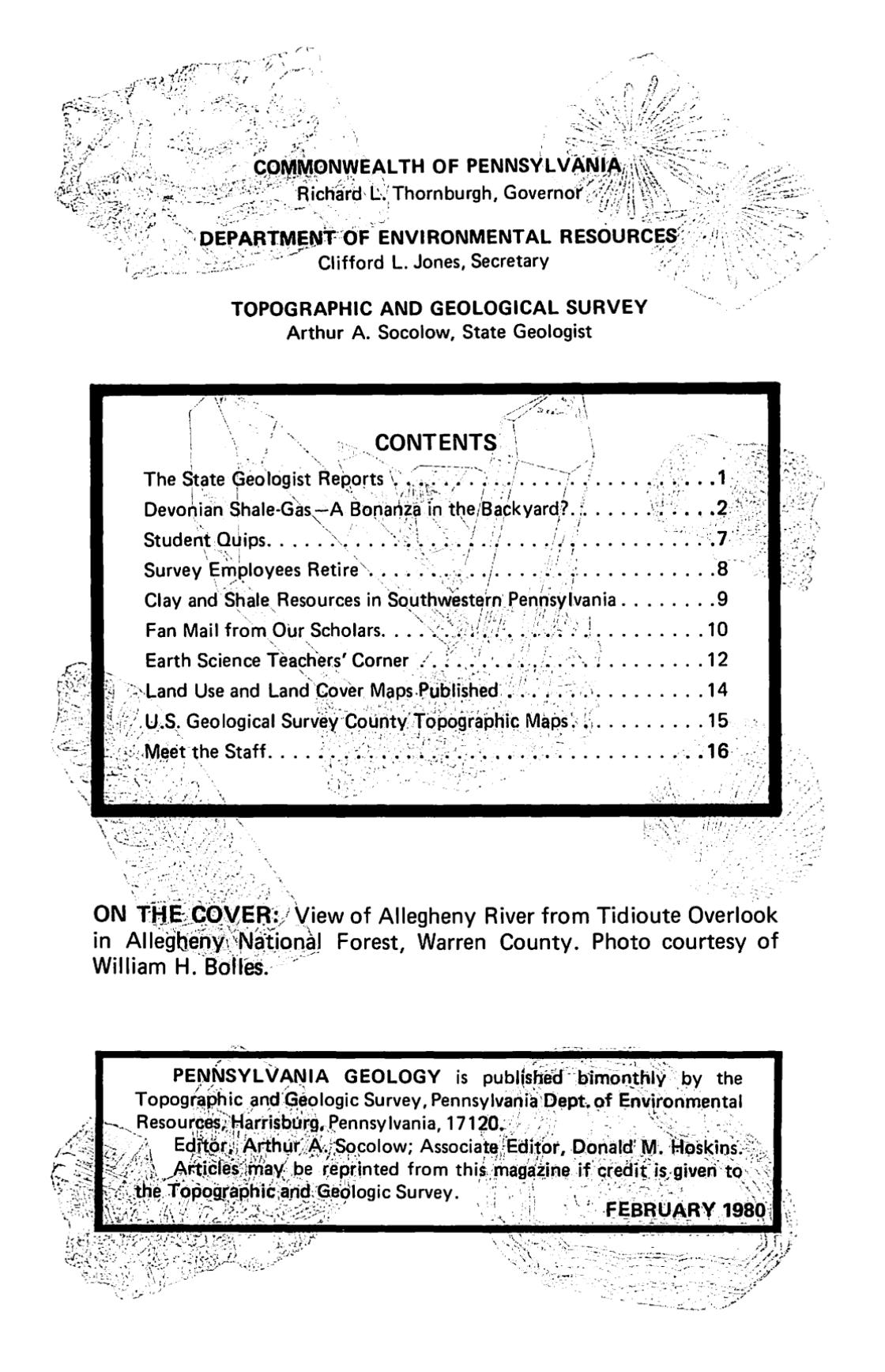


G PENNSYLVANIA O L O G Y



THE PENNSYLVANIA GEOLOGICAL SURVEY

VOL. 11/1



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: View of Allegheny River from Tidioute Overlook in Allegheny National Forest, Warren County. Photo courtesy of William H. Bolles.

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FEBRUARY 1980

FROM THE DESK
OF THE
STATE GEOLOGIST . . .



HOSTAGES — OUR PEOPLE, OUR ECONOMY

Hopefully, by the time this appears in print, the American hostages in the Mid-East will have been released, unharmed and in good health. While many complex events led up to this unfortunate episode, it is worth noting that a critical element of the background causes is the United States' dependence on Mid-East oil. And while our growing dependence on foreign oil imports has been highly publicized in recent years (we now import nearly 50% of the oil we use), the public is less aware that there is a growing list of other essential raw materials for which we are dependent on foreign sources. Included in this list for which we are more than 50% dependent on foreign sources are such industry essentials as bauxite (aluminum), chromium, cobalt, columbium, diamonds, manganese, mercury, mica, nickel, platinum, tin, tungsten, zinc, and potash. Many of these are coming to us from countries which are showing signs of internal instability, as well as from developing countries which are establishing their own industries and curtailing exports.

The taking of our fellow hostages has evoked feelings of anger, fear, and frustration among the citizens of this country. Being an economic hostage, based on our dependence for essential minerals from foreign countries, can only result eventually in similar reactions and drastic economic consequences. Any form of hostage is unpalatable and unacceptable. While the availability of critical mineral resources in the world is very unequal, it is vital to our self interest that this nation identify, make available, and develop its own mineral resources. This means locating deeply buried deposits, yet undiscovered; and it also means developing the expertise needed to extract and utilize our known low-grade mineral resources which are now considered uneconomic. The definition of uneconomic may also have to be reconsidered, for we cannot afford to be held economic hostage. With a long history of past mining and many indications of the presence of essential minerals, Pennsylvania mineral exploration and development should be stimulated as our contribution to avoid the untenable position of economic hostage.

Arthur G. Socolow

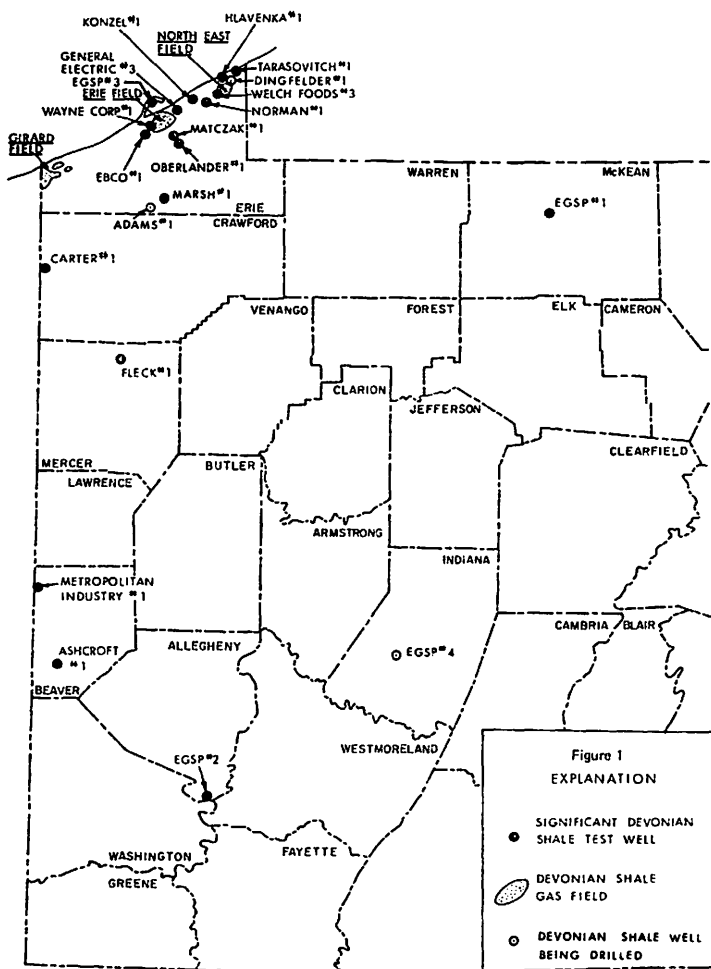
DEVONIAN SHALE GAS - A BONANZA IN THE BACK YARD?

John A. Harper

Every year the price of natural gas rises and many people have difficulties paying their monthly gas bills. For people in the Erie County area at least, there may be a solution—drill your own gas well in the Devonian shales. Erie County, and in particular the region along the lake shore, has been, and still is a leading producer of domestic gas in the state. A well drilled 500 to 1000 feet deep is likely to provide enough gas to meet most home owners' and some small business needs. In the past, however, most drilling attempted to find gas in the sandstone formations; now we are also focusing attention on the shale formations.

My optimism on this subject is the result of the U.S. Department of Energy's (DOE) multiyear program designed to stimulate interest and research in the hydrocarbon potential of the Devonian *shales*. The program, referred to as the Eastern Gas Shales Project, or EGSP for short, has brought numerous individuals, research groups, corporations, and government agencies (including the Pennsylvania Geological Survey) together to determine the factors which influence shale-gas distribution and development. Many agencies are busily attempting to develop stimulation techniques that will prove effective with the tight, massive shales. And as the research continues, some people are already taking advantage of the relatively shallow shale-gas.

Although the natural gas industry officially began about 100 years ago, the first reported well drilled specifically for natural gas was in Fredonia, Chautauqua County, New York, in 1821. The well was bored to a depth of 27 feet after gas was noticed seeping from a nearby creek bed. The gas was used for lighting and was said to have had the power of "two good candles." General Lafayette visited the town in 1825 and proclaimed the well one of the wonders of the world when it was lighted in his honor. In 1850 the well was deepened to 70 feet and produced enough gas to light 200 burners. In 1858 a second well was drilled over 200 feet deep and lasted another 30 to 35 years. What made these wells so interesting is the fact that they produced gas from the Devonian shales.



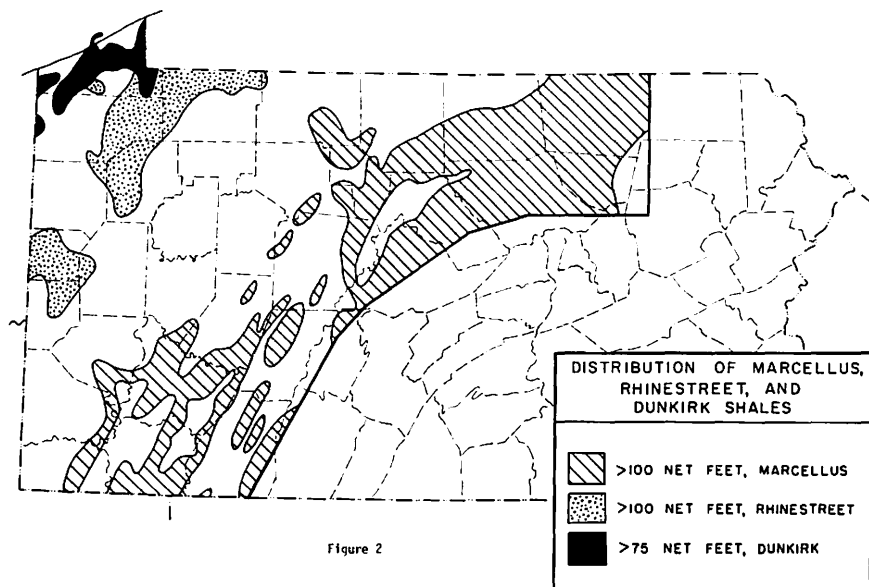
During the time of excitement following the Drake well discovery in 1859, Erie County became a target for oil drilling. Not much oil was encountered, but a great deal of natural gas was found and it soon became apparent that gas could be obtained in almost any well drilled to the proper depth. By 1890 more than 200 wells were known to have been drilled in the vicinity of Erie. Various reports by the existing Geological Survey of Pennsylvania include reference to wells drilled by industry, utilities, and small businesses. The Jarecki Manufacturing Company, the Erie Car Works, Stearne Manufacturing Company, the Erie Gas Company, the Erie Water Works, and Conrad's Brewery are among the many firms that had their own gas wells. Many of the companies partially or totally changed from

coal to gas for their needs. The Jarecki Manufacturing Company, for example, was the first Erie firm to use gas from a well. The well, on an adjoining piece of property, was about 600 feet deep, and as the gas supply gradually dwindled the firm had a second well drilled on the plant site around 1868. This well initially supplied enough gas to light the plant and replace four tons of coal daily in the manufacturing process. Platt (1876) speculated that subsequent drilling in the area reduced both the rock pressure and the quantity of gas, because after seven years the well could only supply enough gas to partially light the plant. However, this may have been due to the normal production decline for shales, rather than overall gas depletion.

The Devonian shales continued to supply gas to industries and utilities, and even private homes and farms, throughout the 1800's and into the 1900's. Many wells drilled in backyards in the 1800's are, incredibly, still functioning, meeting the yearly gas requirements of the owners. The volumes and pressures may be low, but they are apparently enough to keep the home owners satisfied as well as warm during the winter. One home owner recently proudly claimed that during the severely cold winters of 1976 and 1977 he only had to have city gas supplied to his home for a total of five days. Otherwise he hasn't spent a penny for gas in the seventeen years he has lived in the house.

Since 1974, 16 shale-gas wells have been drilled in Pennsylvania and 3 others are being drilled at present (see Figure 1 for names and locations of these wells). This number is very small when compared to the thousands of gas wells drilled in the past six years into sandstone and limestone reservoirs. Most of the shale-gas wells are clustered in the Erie County area; this is because of the production history of the shales there, as well as the relatively shallow drilling depths of that area.

The Devonian shales can be divided into organic-rich, relatively radioactive, black shales and non-radioactive, gray shales and siltstones. Piotrowski and Harper (1979) have shown that the black shales can be divided into three major and three minor units in the subsurface of Pennsylvania. The major units, the Upper Devonian Dunkirk and Rhinestreet Shales and the Middle Devonian Marcellus Formation, have all been explored as natural gas reservoirs. The Dunkirk Shale and the associated gray shales and siltstones which overlie it are the reservoirs for most of the shale-gas production along the margin of Lake Erie (Figure 2). A probable natural fracture system in the shale along the margin of Lake Erie may constitute the



most important part of this reservoir system. Further to the west, the Dunkirk thickens appreciably and becomes known as the Huron Member of the Ohio Shale of Ohio and Kentucky, areas where shale-gas have been produced in quantity for years. The Dunkirk gradually fades out to the southeast and disappears in Pennsylvania along a line from Beaver County to McKean County.

The Rhinestreet Shale and its associated gray shales and siltstones have been explored for gas only three times in Pennsylvania. One attempt, the Fleck well in Mercer County (Figure 1), ended in mechanical failure before completion of stimulation. The other two wells had production which rapidly blew down, probably because the impermeability of the shale prevented anything but a slow leak of gas into the fracture reservoir. The Rhinestreet Shale achieves its maximum development in Pennsylvania from Beaver to Warren Counties (Figure 2) and dies out along a line from Greene to Potter Counties.

The Marcellus Formation has been known for years to have gas in the black shales, but the shale-gas was ignored as a potential target until EGSP. Through DOE funding, three wells have been drilled to the Marcellus in Pennsylvania to test the gas in the Devonian shales and a fourth is currently being drilled (see Figure 1). EGSP #1 in McKean County was considered a lost hole by DOE because of hole

problems. However, EGSP #2 in Allegheny County has been successful in obtaining gas from the Marcellus Shale, although the well is still being tested. EGSP #3 on Presque Isle in Erie County was also successful, but is producing gas from the Dunkirk and associated shales. EGSP #4 in Indiana County is presently being drilled. The Marcellus underlies all of western Pennsylvania, but it reaches its maximum development east of the Chestnut Ridge anticline in the central portion of the plateau (Figure 2).

Most of the shale-gas wells shown in Figure 1 are domestic wells; that is, they are used for private consumption. Most are wells drilled for the purpose of offsetting the rising cost of energy (for example, the Norman #1 well, reported on by Time Magazine in its March 27, 1978 issue). Piotrowski (1978) briefly reviewed the information available on the Welch Foods #3 well and the Erie Burial Case Company (EBCO) #1 well. The Welch Foods #3 well had a large initial flow of gas after stimulation, but the production rapidly dropped off. The well is currently shut-in because it is not considered economically feasible to lay a pipe line from the well to the plant. Piotrowski speculated that the rapid decline in production in the well may be due to depletion of the shale during the 1800's. The EBCO #1 well also had large initial volumes of gas, and as with the Welch Foods #3 well the volume declined. However, according to the plant manager the well is presently supplying enough gas to heat about 1/4 of the building, thus helping to reduce the company's fuel bills.

What makes the EBCO well important, besides proving that gas production from the Devonian shales is feasible, is that samples taken from the gas producing intervals were analyzed and shown to have significant amounts of expandable mixed-layered clay minerals in the shale composition. This phenomenon was first reported by Harper and Piotrowski (1978), and has since been corroborated from many of the Devonian black shales in the subsurface of Pennsylvania by the U.S. Geological Survey. If fresh water got into the well hole either by accident or during stimulation procedures, these expandable clays could cause swelling of the shales which in turn could decrease the flow of gas or even cause uncased portions of the hole to cave in. I suspect that these clays are the primary cause of shale-gas well failures in Pennsylvania where a foam-water fracture was used as the stimulation technique (e.g. Welch Foods #3, Metropolitan Industries #1, EGSP #1). The fact that the EBCO well was not stimulated may lend credence to this suspicion. Future shale-gas operations should be advised against the use of fresh water-based stimulation.

Although some of the problems involved with shale-gas exploration and production seem great, the benefits derived from a shallow shale-gas well would seem to more than offset them. Drilling a well several hundred feet deep could result in energy savings far outstripping the initial cost. The people living in Erie County are extremely lucky in this respect, because they live in an area where the shale-gas is known to occur at shallow depth. This means that a private gas well may be within the means of many home owners in the area. And that could mean a substantial long-term savings in energy costs. It's even better than insulation.

A word of caution: Drilling for natural gas should be done only by experienced gas well drillers and installers so as to insure the safety of the installation, as well as to protect and conserve the gas supply.

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STUDENT QUIPS

from the bulletin

NATIONAL ASSOCIATION OF GEOLOGY TEACHERS

EASTERN SECTION, Fall, 1979 edition.

"I told Mr. Weinle (curator) that I had a semi-precious gemstone that was actually a shell." And he replied, "Abalone."

"Alexandrite the Great tried to conquer the world."

"Amethysts don't believe in God."

Survey Employees Retire

On January 25, Virginia Milewski retired after working 21-1/2 years as a cartographic draftsman for the Survey. During that time, she built a record of outstanding workmanship in the preparation of camera-ready maps and illustrations for the Survey's various publications.

Virginia was born and raised in Mt. Carmel, Pennsylvania, and makes her home there. She joined the Survey in 1958 after working as a draftsman for the U.S. Geological Survey. Over the years, she became the Survey's resident expert on nutrition and health foods. Her other interests include music and gardening.



VIRGINIA MILEWSKI

Virginia's many years of competent and dedicated work, always done with a ready smile and cheerful attitude, has materially helped us to maintain the tradition of publishing high quality maps and reports. We extend our appreciation and gratitude to her on behalf of the Survey and the Commonwealth, and wish her a most successful, happy, and healthy retirement.



FLORENCE VEVERS

Mrs. Florence E. Vevers, retired on January 16, 1980 from the Bureau of Topographic and Geologic Survey, Division of Oil and Gas Regulation, where she served as the Division Secretary. Florence was in the Dept. of Mines and Minerals, now part of the Department of Environmental Resources, for sixteen and one-half years. Her first position was with the Deputy Secretary of Mines & Minerals,

W. Roy Cunningham, during the Scranton administration.

Mrs. Vevers has provided outstanding service to the Department and to the citizens of Pennsylvania, for which we are greatly indebted. We wish her long years of good health and happiness.

CLAY AND SHALE RESOURCES IN SOUTHWESTERN PENNSYLVANIA

A comprehensive report on the potential uses of clays and shales of southwestern Pennsylvania has been issued by the Pennsylvania Geological Survey. Designed to stimulate the ceramic industry and clay-shale production of the region, Mineral Resource Report 77, "Properties and Uses of Shales and Clays, Southwestern Pennsylvania" by Bernard J. O'Neill, Jr. and John H. Barnes, is a 689-page report, complete with detailed maps and tables. Southwestern Pennsylvania, as defined in this report, includes the following 12 counties: Allegheny, Armstrong, Beaver, Butler, Cambria, Fayette, Greene, Indiana, Lawrence, Somerset, Washington, and Westmoreland.

Data concerning physical, firing, chemical, and X-ray mineralogical determinative tests are reported for 413 clay-shale samples collected from 42 different stratigraphic intervals within 15 different geologic formations or groups. Preliminary evaluations indicate that 370 samples have a potential as a raw material for one or more of the following products: building brick, facing brick, floor brick, sewer pipe, drain tile, structural facing tile, nonload-bearing structural tile, lightweight aggregate, vitrified liner plates, and refractories.

The results of correlation studies are presented in order to determine what physical or chemical factors are responsible for favorable use results. Correlations were made employing the following variables: (1) stratigraphic interval and use; (2) mineralogy and use; and (3) chemistry and use. The stratigraphic intervals that correlate well with each use are identified, and the best exploration targets listed.

A geologic map showing the locations of the clay-shale sample sites and differentiating the different geologic formations or groups by color is included along with a generalized stratigraphic column for southwestern Pennsylvania.

Mineral Resource Report 77, "Properties and Uses of Shales and Clays, Southwestern Pennsylvania," may be purchased for \$11.00 (plus 6% sales tax if mailed to a Pennsylvania address) from: The State Book Store, P. O. Box 1365, Harrisburg, PA 17125. Check should be made payable to Commonwealth of Pennsylvania.

FAN MAIL FROM OUR SCHOLARS

Dear Person,
I would like to ^{please} have your
(Geological Survey educational Series)
+ your magazines called (Pennsylvania
Geology) that you put out. Thank
you very much From your intrested
Friend,
Luke

stop
looking
in this corner

Please send The
Stuff to →

Mr. Luke

Thanks!



Dear Sirs,

I am in High School and I must have this. Or I will have to sit in the rat Line so I warn you about this.

Would you please, please please send me a sample rock

This means so much to me if I get I will get an A on my report card I had so far 4 A's and 3 B's

So please send this to me

Or I could even sent in the corner if I dont get it Or you could send me A lot of Books on Rocks, Horses, Fossels

But please this means my life.

Thank you very much.

In the spirit of the Holiday season came this letter to us:

Plays Send Me Pennsylvania

Thank you. Ho Ho Ho

In the interest of economy, we only sent a small piece.

York Mineral Show

The York Rock and Mineral Club will hold its Eleventh Annual Mineral and Gem Show on Saturday, April 5 and Sunday, April 6, 1980 at the Manchester Township Fire Company #1 in the Manchester Township Building, Emigsville, PA on Route 181 going north from York, PA.

Show hours are Saturday, April 5—10 AM to 6 PM. Admission will be \$1.00—children under 12 free.

Survey Library Needs

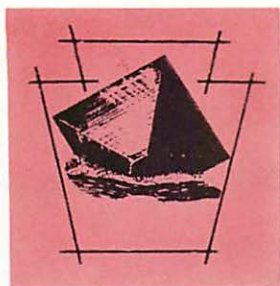
The Pennsylvania Geological Survey Library is in need of the following book:

Stone, R. W. and Mohr, C. E., Caves of Pennsylvania. (National Speleological Society Bulletin vol. 15, 1953)

Please contact us if you have a copy to spare.

Correction

In the article "Ladder-back ripples in the Catskill Formation," Pennsylvania Geology, v. 10, no. 5, line 1 on page 10 should be line 1 on page 11, and vice versa.



hydrologic lab exercises

by John Tomikel, Professor
California State College of Pennsylvania

Hydrologic studies are becoming more important in the school science programs and elaborate discussions of the topic are beginning to become a part of modern textbooks. To tide instructors over until materials are more readily available this list of exercises has been created. This is an outline sketch of suggested activities. The instructor should write up each exercise with explicit directions. A general outline for the exercise format is 1) title, 2) suggested readings, 3) materials needed, 4) procedure, 5) questions to be answered, and 6) evaluation and conclusions.

Activities

1. Dig a cubic foot hole at 3 locations on a hillside, fill each with water and time the rate of percolation. Hand augers may be used for the same purpose as prescribed for on-lot sewage disposal systems. *Purpose: to determine percolation rates of different soils.*
2. Measure the discharge of a small stream by using simple weir and staff gauges for a three month period. A rain gauge can be set up near the weir to be read at the same time as the staff gauge. Perhaps the water level in a nearby well could also be measured. *Purpose: to correlate precipitation with discharge in a small area.*
3. Measure a pond for volume of water, surface area, evaporation rate on a particular day, and weight of water. Also if stream fed, measure the discharge. *Purpose: to convert volumes to weights and this can also be converted to hydro-electric potential.*

4. Get three large tubes, fill one with silt, one with sand, and one with gravel. Measure the rate of percolation through each of the materials. Tape a screen at the bottom open end to hold the sediments in. *Purpose: to illustrate the infiltration rates of different materials.*
5. Dig a hole and identify the soil water zones. Dig where the water table is near the surface. *Purpose: to become familiar with the nature of underground water.*
6. Draw a cross section which illustrates how ground water can occur under both water table and artesian conditions. *Purpose: to illustrate the movement of water in underground conditions.*
7. Based upon air and water temperature, flow rate, and geology attempt to identify the source of the water flowing from a spring. *Purpose: to give students on-site experience in observing phenomena.*
8. Based upon indirect measurements attempt to estimate the flood-flow of a small stream after a flood. Describe the location and types of materials deposited by the flood. *Purpose: to determine the nature of flooding after a particular storm.*
9. On a topographic map outline a drainage basin and draw a topographic profile parallel to and across the main stem of the system. Describe the drainage pattern. *Purpose: to work with maps and identify stream factors from them.*
10. Visit a) sewage disposal plant, b) mine acid drainage settling basin, c) stream gauging station, d) stream locks and dam, e) multipurpose dam, f) city water treatment plant, g) agriculture conservation district office, h) rural water supply company.

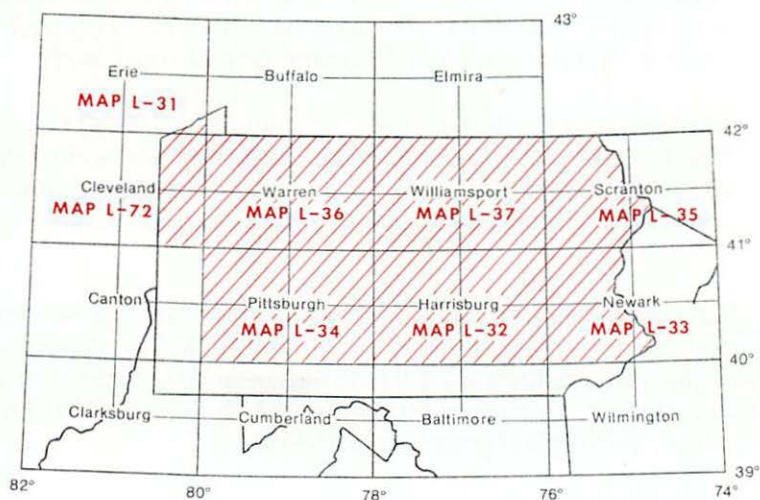
Dr. Tomikel will send a free copy of his article *Stream Sculpture Study*, which appeared in the *Journal of Geography* to anyone who writes to him and encloses a regular self-addressed stamped envelope with letter postage. Write: Department of Earth Sciences, California State College, California, Pennsylvania 15419.

LAND USE AND LAND COVER MAPS PUBLISHED

Prepared in cooperation with the Pennsylvania Department of Environmental Resources, a new Land Use Series of maps has recently been published by the U.S. Geological Survey. Pennsylvania was one of the first states in the Nation to have a complete land use survey using sophisticated new techniques devised by the U.S. Geological Survey. Utilizing the latest photo imagery available from high altitude planes, the land use and land cover maps recognize and delineate as many as 37 separate land use categories, some for areas as small as 10 acres. The scale of the published maps is 1:250,000 or approximately one inch on the map equalling four miles on the ground. Highway-type base material is printed in green with the land use and land cover information printed in black over the base.

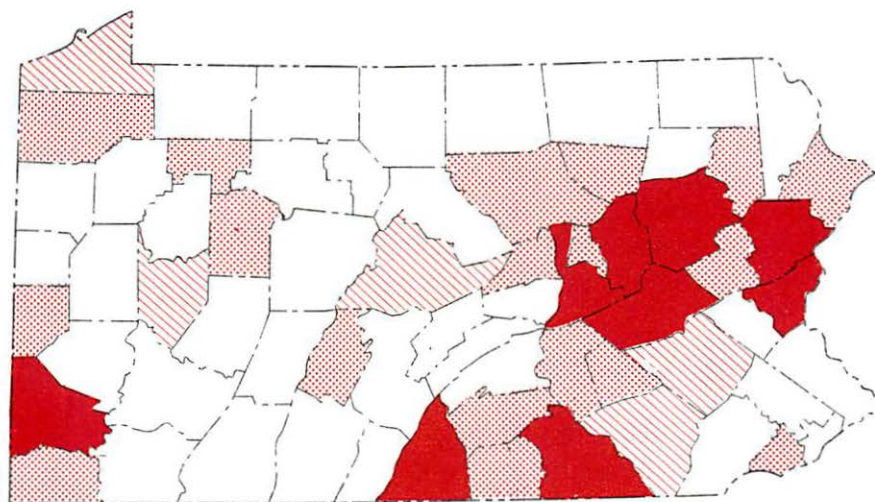
These land use and land cover maps are a valuable tool for anyone involved in comprehensive land-use planning. The maps and data should be of particular benefit to state and local government agencies, planners, industry, conservation groups and recreation agencies.

These new land use maps may be seen on file at the Pennsylvania Geological Survey, or may be purchased at \$1.25 each from the Branch of Distribution, U.S. Geological Survey, 1200 South Eads Street, Arlington, VA 22202. The accompanying diagram shows the name and number of each map available.



U.S. GEOLOGICAL SURVEY COUNTY TOPOGRAPHIC MAPS

During the past year five new county topographic maps have been published by the U.S. Geologic Survey. These include Armstrong, Berks, Centre, Erie and Lancaster counties. The maps are at a scale of 1:50,000 (approximately 400 feet to the inch) and follow the previously issued maps of Adams, Beaver, Blair, Carbon, Crawford, Cumberland, Dauphin, Delaware, Forest, Greene, Jefferson, Lackawanna, Lebanon, Lycoming, Montour, Pike, Sullivan and Union counties. These maps are multicolored, following the standard colors of topographic maps, with the addition of political boundaries for county, township and boroughs outlined in orange. These county maps are of widespread use to all who are concerned with county and regional planning, engineering, agriculture, and recreational projects. These maps may be obtained for \$2.00 each by writing to Distribution Section, U.S. Geological Survey, 1200 S. Eads Street, Arlington, Virginia 22202.



 PREVIOUSLY
PUBLISHED

 IN PROGRESS

 RECENT
RELEASE

 TO BE RELEASED
IN NEAR FUTURE

MEET THE STAFF...

John A. Ifft, Chief
Division of Oil and Gas Regulation



John A. Ifft joined the Department of Environmental Resources as an Oil and Gas Inspector in 1972. At that time his duties were to maintain compliance with Pennsylvania Oil and Gas Laws within a 17 county district in southern Pennsylvania. He joined the Pennsylvania Geologic Survey in April 1979 when the Oil and Gas Division of the Bureau of Land Protection was transferred to the Survey as the "Division of Oil & Gas Regulation." On May 24, 1979 he was promoted to Chief of the Division.

The Division of Oil and Gas Regulation administers several different laws affecting the oil and gas industry. Act 225 provides for permitting of oil and gas wells, the underground storage of gas, mining around wells, and the methods of casing and/or plugging oil and gas wells. Act 359, the Oil and Gas Conservation Law, pertains only to the deeper producing horizons, and provides for the spacing of oil and gas wells, unitization of interests, and the protection of the correlative rights of oil and gas owners. Act 38 relates to the underground storage of gas and the protection of the people residing in the area.

John Ifft was born in Canton, Ohio and spent his early years in the western Pennsylvania oil fields. A veteran of the Korean conflict, he served in the U.S. Army in Korea in 1953-54. John obtained his B.S. degree in Geology and Mineralogy from the Pennsylvania State University in 1960. Prior to joining D.E.R. he owned and operated an oil and gas well contract drilling business in north-western Pennsylvania. He is a member of the American Association of Petroleum Geologists and of the Pittsburgh Chapter of the Society of Petroleum Engineers (SPE-AIME).

John, his wife Judy and their three children live in Washington, Pa. In the summer they can usually be found on weekends in their camp at Henry's Bend on the Allegheny River just north of Oil City.

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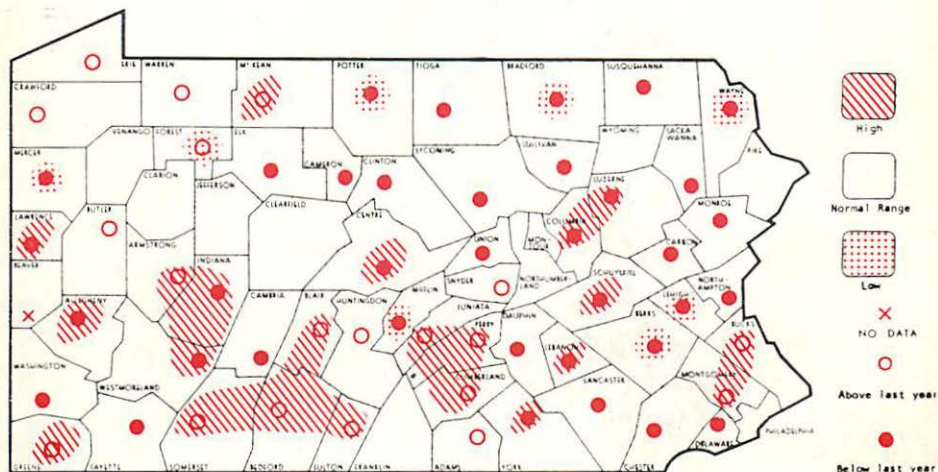
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