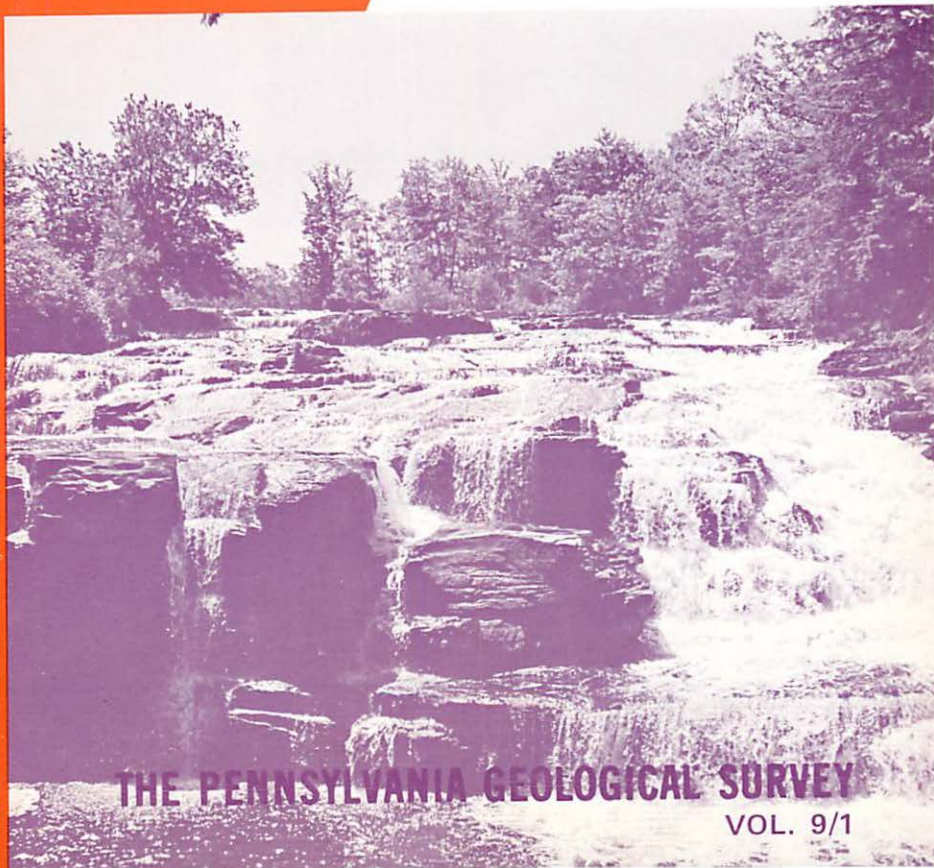


G E O L O G Y **PENNSYLVANIA**



THE PENNSYLVANIA GEOLOGICAL SURVEY
VOL. 9/1

COMMONWEALTH OF PENNSYLVANIA

Milton J. Shapp, Governor

DEPARTMENT OF ENVIRONMENTAL RESOURCES

Maurice K. Goddard, Secretary

TOPOGRAPHIC AND GEOLOGICAL SURVEY

Arthur A. Socolow, State Geologist

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ON THE COVER: Shohola Falls, on State Game Lands 180, along Route 6 approximately 9 miles northwest of Milford, Pike County. Shohola Creek descends 200 feet in half a mile over shales and sandstones of the Catskill Formation. Photo courtesy of William H. Bolles.

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FEBRUARY 1978

FROM THE DESK
OF THE
STATE GEOLOGIST . . .



MINERALS — KEYSTONES OF OUR ECONOMY

The figures just released by the U. S. Bureau of Mines on the annual mineral production in Pennsylvania show that the Commonwealth has reached a new high. In 1977 Pennsylvania mineral production had a raw mineral value of \$3.2 billion. This is just the value of the raw mineral matter, before it is processed into the finished products worth many times the raw value.

In this day and age of \$500 billion dollar national budgets, Pennsylvania's mineral production value may tend to be overlooked, yet it is highly significant. Significant not just because it places us as the 5th largest mineral producer in the country, but significant because it constitutes the foundation for many major industries that are the mainstay of our economy. It is for that reason that in the trade, Pennsylvania's minerals are referred to as industrial minerals.

Our coal production (3rd largest in the country) keeps the generating plants operating and provides an essential raw material and fuel for our steel industry. Our limestone production furnishes the basic ingredient for our cement industry (#3 in the country), for our agricultural lime industry (#2 in the country) and for construction stone (#1 in the country) used in road building, housing, and commercial construction. Our clay production ends up in such "dull" products as bricks and sewer tile which are truly essential. Pennsylvania's oil and natural gas output, the nation's first such production in 1859, still yielded over \$101 million dollars worth in 1977 and greatly contributed to our energy supplies.

Sand and gravel, not generally recognized as "glamorous," had a production value of \$51 million last year in Pennsylvania, and was used for such diverse purposes as road construction, concrete, abrasives, and the basic raw material for making glass.

Even our one and only operating zinc mine produced ore values which place Pennsylvania seventh in national zinc ore production.

All in all, that \$3.2 billion dollars worth of raw minerals produced in Pennsylvania last year, directly employing nearly 50,000 persons, and representing approximately twice the value of all of Pennsylvania's agricultural production, constitutes a basic foundation for our complex economy which goes on to utilize and expand the role of these essential mineral raw materials.

Arthur G. Socolow

DEVONIAN SHALE GAS

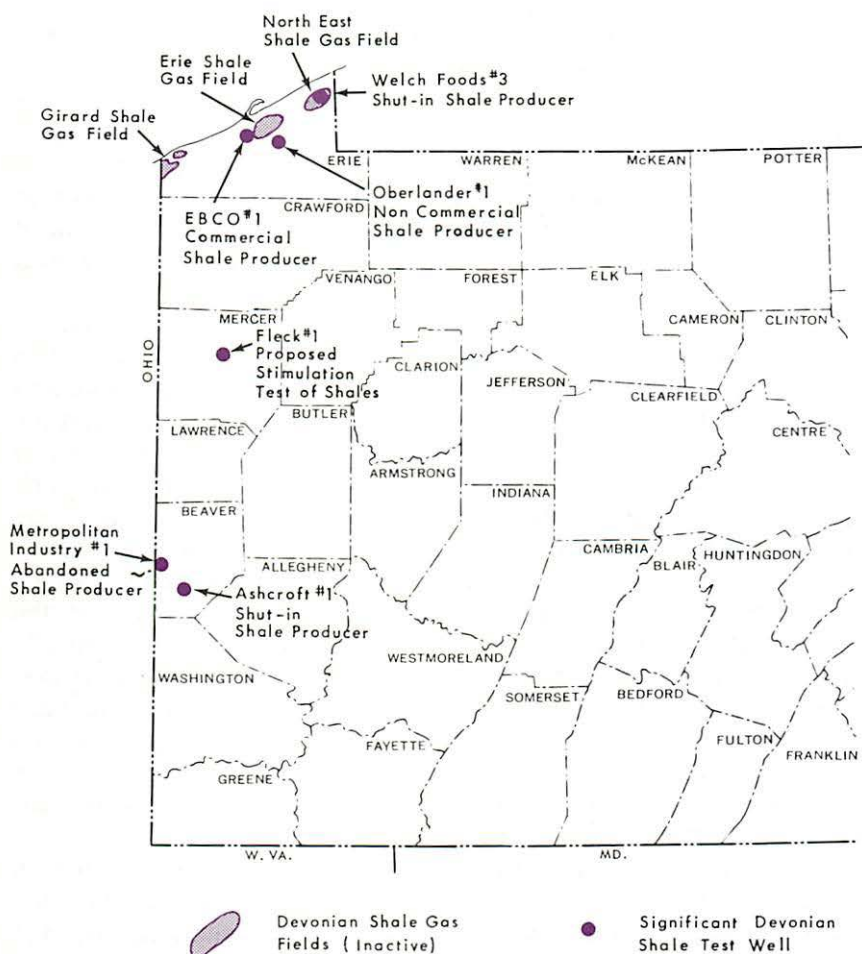
new interest in old resource

by Robert G. Piotrowski

Black organic rich shales of Devonian age underlie a large portion of the eastern United States. In 1821, 38 years prior to the Drake oil discovery, the first well drilled in the United States specifically for natural gas was produced from these black shales. Gas from this well, located in Fredonia, Chautauqua County, in western New York State was used for street lighting. Between the discovery of this well in 1821 and at least until 1880, natural gas was produced from many shallow, low pressure wells in a belt along Lake Erie approximately six miles wide, extending from Dunkirk, New York, through Erie, Pennsylvania, to Sandusky, Ohio. However, other than some descriptive information, little data is available on these early wells.

In Pennsylvania, three shallow gas fields are indicated on old maps of Erie County. The Girard, Erie, and North East fields are part of the gas trend which extends along the Lake and which appears to be associated with the black shale. Locations and drillers' logs are not available for wells in the Erie and North East fields, and the actual limits of the fields are unknown. Some information is available for twenty wells which were drilled in the Girard field. This includes locations, depths, and initial open flow rates. These twenty wells were drilled in 1941 by the Ohio Oil Company in Springfield Township, Erie County, Pennsylvania, and Conneaut Township, Ashtabula County, Ohio. The wells range from 500 to 800 feet deep and had gauged open flow rates of gas from a low of 116,000 cubic feet per day to a high of 4,168,000 cubic feet per day. Unfortunately, the production history of these wells is unknown.

Spurred by the energy situation and rising natural gas prices a renewed interest has been shown in the possible development of the gas resources in the Devonian organic rich black shales. In February 1975, Quaker State completed the #1 Metropolitan Industry well in Beaver County, Pennsylvania, as a Devonian shale discovery. The well was drilled to the Queenston Formation and plugged back to a depth of 4500 feet to test Devonian shale. The well had no natural gas production from the shale, but had an initial potential of 150,000 cubic feet per day at 1150 pounds rock pressure after hydraulic fracturing. When put on line for production, however, the well did not last long. The well delivered 150,000 cubic feet of gas the first day and declined each day thereafter until at the end of 30 days, it



MAP SHOWING LOCATIONS OF SIGNIFICANT DEVONIAN SHALE WELLS AND FIELDS IN PENNSYLVANIA

FIGURE 1.

was non-productive. When shut in, the pressure would build up, but on opening the well it would blow down to nothing in a short time. Evidently, there was very little original porosity. Gas accumulated in fractures induced when the well was completed by hydraulic fracturing, but the extent of this induced fracture system does not appear to be extensive enough to constitute an adequate reservoir for commercial production. The well has been plugged and abandoned.

In December 1975, St. Joe Petroleum Corp. completed the #1 Ashcroft well in Beaver County. The well was drilled to the Queenston Formation and plugged back to a depth of 5145 feet to test Devonian shale. The well had small gas shows in the shale and was hydraulically fractured. The well history is similar to the Metropolitan Industry well mentioned above in that the gas blows down very quickly, but when shut in the pressure builds back up. It appears that the gas accumulates in the relatively small fracture reservoir induced when the well was completed by hydraulic fracturing. This well is currently shut in.

In September 1976, the Welch Foods #3 well was drilled by Moody & Associates as a 900 feet Devonian shale test. The well is located near Lake Erie within the old North East shale gas field, and may be a model for the type of production which occurred along the Lake. The well had a natural gas flow of 12,000 cubic feet per day and a flow rate of 150,000 cubic feet per day with an 80 pound rock pressure after a foam fracture. A sibilation log run in this well indicates the presence of an apparent natural fracture system from which gas enters the bore hole. It appears that the organic rich shales are the source of gas, and the natural fracture system serves as the reservoir. It is also observed that the fracture system is partially within the black shales and partially within the overlying gray shales. After a one month period of testing, the well is reported to have flowed only 3500 cubic feet per day and is currently shut in. The reason for the drop off in production is unknown. It may be that the shales are depleted locally since the well is in the old North East field. Only further drilling and testing will determine this.

In April 1977, Henry Oberlander completed a Devonian shale well on his farm. The well encountered a good gas show at 300 feet and was completed at a total depth of 800 feet. This well was gauged at 4000 cubic feet per day natural production. Although this is a relatively small volume, the well has been hooked up and should be adequate for domestic use.

In November 1977, the EBCO #1 well was drilled by Moody & Associates just west of the old Erie shale gas field. This well was drilled to a total depth of 900 feet into the Devonian black shales. The well encountered three significant gas shows while drilling. The first show of gas occurred at 381 feet. Drilling was temporarily halted to let the gas blow down, and after 2 hours of open flow 1,300,000 cubic feet per day of gas was recorded. The second show occurred at 533 feet and a flow of 1,700,000 cubic feet per day of gas was noted after 2 hours of open flow. The third show was encountered at a depth of 731 feet and a gas flow of 1,300,000 cubic feet per day was gauged after 1 hour open flow. After completion of

drilling to 901 feet on November 9, 1977, a 2 hour natural open flow test was conducted on the well after it had been shut in for five days and had a pressure of 100 pounds. At the end of 2 hours of open flow, a flow rate of 975,000 cubic feet per day of gas was measured. The well was then shut in and a pressure of 60 pounds noted. By November 11 (2 days) the pressure had increased to 120 pounds. Both sibilation and temperature logs run through the shale section in nearby wells and the behavior of this well indicate the presence of an apparent natural fracture system which serves as the gas reservoir. The organic black shales are the probable gas source. It is impossible at this time to predict the potential of the #1 EBCO well. It does appear, however, to be capable of producing enough gas to initially meet the natural gas needs of the Erie Burial Case Company for whom it was drilled. Moody & Associates have recommended that the well be hooked up and used for 1 year while maintaining records of gas volumes used and shut in pressures. The data from this production period could then be used to predict more accurately the total recoverable gas reserves of this well, and to provide some production history for any additional shale wells which may be drilled in the area.

The U. S. Department of Energy is currently conducting an extensive study into the natural gas potential of the Devonian shales in the entire Appalachian Basin. A listing of all participants in the Department of Energy study and a summary of all contracts is available in the report, "Summary of Contracts for the Eastern Gas Shale Project" published by the U. S. Department of Energy, Morgantown Energy Research Center, Morgantown, WV. The Pennsylvania Geological Survey is also cooperating with the Department of Energy and is contracted to provide stratigraphic data on the shales. A summary of this work, which is in preparation, is available in Pennsylvania Geological Survey Progress Report 190, "Oil and Gas Developments in Pennsylvania in 1976." The Department of Energy is also cooperating with Peoples Natural Gas Co. in a planned stimulation of the Devonian shales in Peoples' #1 Fleck well in Mercer County.

The Devonian organic-rich shales appear to be an important resource in northwest Pennsylvania. The energy shortages of the past few years and the rising price of natural gas should make the shales a more attractive drilling target in the near future. The shales are shallow in depth, have a widespread occurrence, and a long production life. They have excellent potential to fill the needs of small commercial, light industrial, and individual users. The development of better technology for inducing and enhancing fracture systems will also have a substantial effect upon the exploitation of this resource.

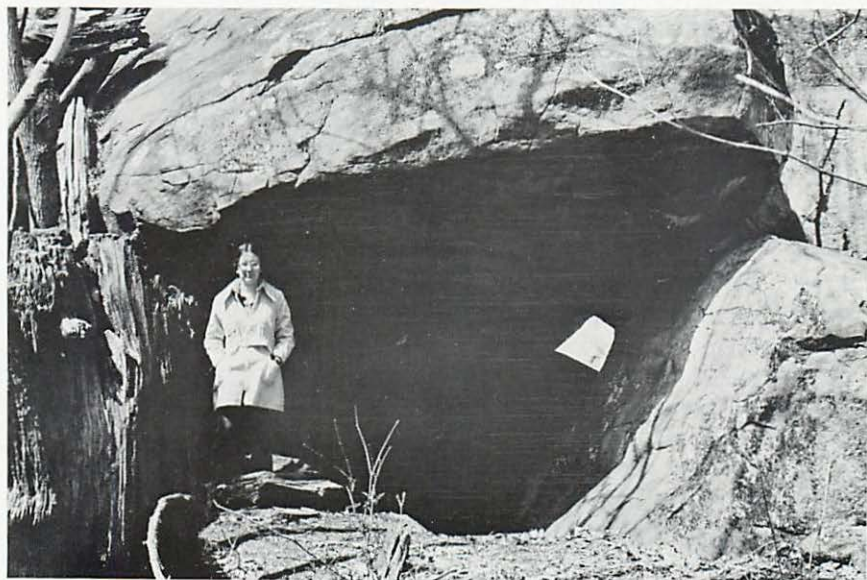
GOVERNOR'S STABLES

by William H. Bolles
Department of Education

At Governor's Stables in eastern Lancaster County large diabase boulders have been weathered in such a manner as to produce a "boulder cave." The rounding of the boulders is due to the exfoliation of thin surficial layers; the same process which formed the famous "Devil's Den" diabase boulder cave on the Gettysburg Battlefield.

Two legends are attributed to the naming of this cave. One claims that prior to 1800 a horse thief, known as "The Governor" used the cave as his headquarters. The other legend claims that Andrew Curtin, Governor of Pennsylvania from 1861 to 1867, took shelter here along with some of his aides when a violent storm caught them while traveling the Falmouth-Elizabethtown Pike on their way from Lancaster to Harrisburg.

The boulder cave is a rectangular room 29 feet by 7 feet and up to 15 feet high, formed by two vertical-standing boulders capped by



The boulder cave which is known as Governor's Stables in Conoy Township, Lancaster County.

a third. Additional boulders partially close the ends of the room. A split in the capping boulder, perpendicular to the long-axis of the room, forms a convenient natural chimney.

Governor's Stables may be reached from Falmouth by traveling one mile northeast on the Falmouth-Elizabethtown road. Turn south on a dirt road and proceed 0.3 miles, then turn off to the southwest and park outside the gate. Follow the road and trail southwest for about 1000 feet until it terminates at a large boulder-strewn slope. The cave is at the base of this slope, 250 feet north of Stony Run.

These boulders are part of a Triassic diabase intrusive sheet (commonly called ironstone) which appears along the northwestern boundary of Lancaster County and Dauphin County.

Among The Many Requests Received...

The Pennsylvania Geological Survey receives requests for many kinds of geologic information and services. Some are more difficult than others. For example, the following letter came from Georgia:

"Gentlemen:

My 11-year old son came home from school yesterday with your address and not much more information. (Knowing you can't get too much information anyway out of a boy that age).

Be that as it may, he informed me I was to write to you and ask you to send him something his teacher told to send for (what I don't know).

If you would send whatever it is, and if there are any charges, please advise.

Thank you in advance.

Most Sincerely,"

This was a tough one. We did our best and hope that both parent and son received what they wanted.

NEW CEMENT PLANT

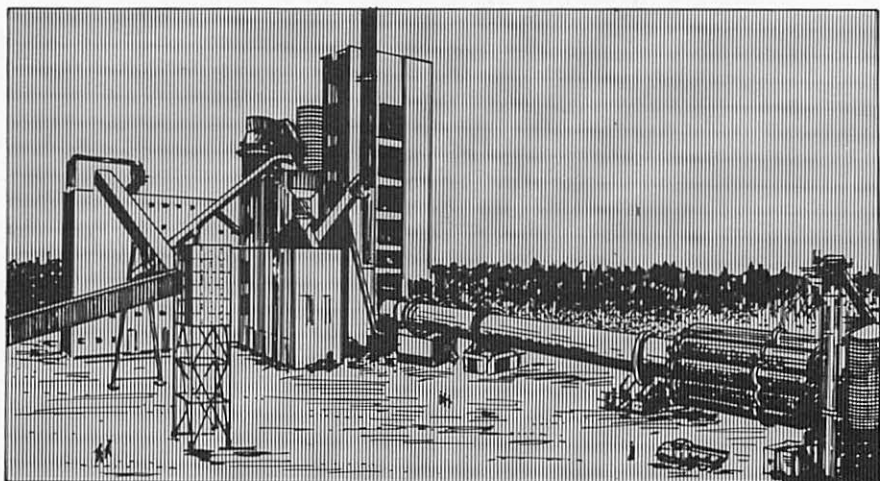
The business section of the December 25th issue of the *New York Times* carries an article by Victor K. McElheny on new cement plants across the country. The following has been taken directly from the article:

"Pursuing both higher output and lower costs, large and small cement companies are scrapping costly, energy-gobbling older plants and are building new ones, often adopting advanced energy-saving technology borrowed from Europe."

"There is plenty of incentive for the \$2.8 billion cement industry to install new production capacity. Many of its plants are antiquated, a condition that exerted a heavy drag on earnings in 1973-75, when housing starts and construction generally went into a tailspin."

"Thanks to a resurgence of demand during the last two years, however, cement shipments are up about 6 percent and are expected to gain 5 percent more in 1978. By 1980, when several of the new plants will be starting to produce, the industry may be operating at as much as 90 percent of capacity -- a level rarely reached since the big construction boom of the 1950's."

"Major new projects include a \$55 million plant being built at Nazareth, Pa., by the Coplay Cement Manufacturing Company. This installation, with capacity of 1.1 million tons of cement a year, will replace 11 smaller plants -- seven of them built more than half a century ago."



"By old technological standards, the new kilns are huge. The one Coplay is installing at Nazareth, for example, is almost 17 feet in diameter and 276 feet long."

"The new plants -- and the new technology -- promise not only significant fuel savings but also major economies of scale. The new installations, typically five times the size of those they displace, are expected to halve the energy use per ton of output by improved handling methods and other techniques that recycle heat from the kilns back to a series of pre-heaters."

"Much of the capital that is going into new cement plants is coming from banks. The cement industry has always relied heavily on borrowed money for expansion, but a series of takeovers has also given some of the producers easier access to capital."

"Coplay Cement Manufacturing was acquired in 1976 by Eurocem Inc., an American subsidiary of one of the largest French cement manufacturers, the Societe des Ciments Francais."

"Lehigh Portland Cement, with headquarters in Allentown, Pa., was taken over two months ago by Heidelberg Cement Inc., an American subsidiary of Portland-Zementwerke Heidelberg A.G. of West Germany."

ERIE GAS FIELD REDEFINED

A large increase in the number of gas wells completed with very small final open flows in an area formerly considered as essentially non-commercial necessitates redefinition of the extent of the Erie gas field, Erie County, Pa. This field as currently defined is number 389 on the 1977 edition of the Oil and Gas Fields Map of Pennsylvania.

The Erie gas field is redefined as comprising all gas production west of 79°55', east of 80°15', and north of 41°55', excepting McKean field, no. 386; Blass pool, no. 387; Summit storage (Meade field), no. 388; and the unnumbered recently discovered Glenwood, Fairview and Charter Oaks fields. Glenwood is between Erie and the Summit storage area; Fairview is about 9 miles southwest of Erie; Charter Oaks is about 3 miles southwest of Erie. All production from rocks above the Tully Limestone or equivalent will be designated Erie field shallow; all production from and below the Tully will be designated Erie field deep.

This redefinition is intended to avoid a proliferation of field and pool names resulting from a multiplicity of so-called new field or new pool discoveries in this area.

A MCKENZIE EURYPTERID

by Emily B. Giffin

A specimen of the eurypterid genus *Eurypterus*, cf. *E. remipes* has been found in the McKenzie Member of the Mifflintown Formation. The specimen (Figure 1) is small, with a total length of only 5.9 cm. Although all of the appendages are missing, the cephalothorax and abdomen are reasonably well-preserved, and lack only the telson, or last abdominal segment.

Eurypterids are among the rarest of Pennsylvania's fossils, the only sizeable collection being the *Lepidoderma* specimens from the Carboniferous Darlington beds of Beaver County. This new find is unusual in that only one other eurypterid, identified as *Eurypterus maria*, has ever been reported from the McKenzie beds of Pennsylvania (Swartz and Swartz, 1930). This specimen, which is of uncertain stratigraphic position, was collected by Dr. Gilbert Van Ingen at the old Swatara Gap section north and east of the old Swatara Creek Bridge.

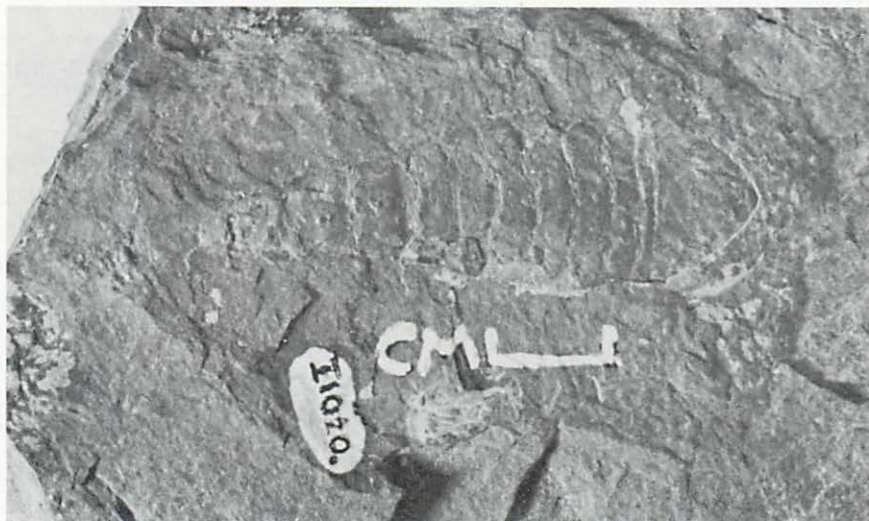


Fig. 1 *Eurypterus* cf. *E. remipes* from the McKenzie Member of the Mifflintown Formation. Scale = 1 cm.

Eurypterids have been a source of curiosity and interest ever since the first specimen was described in 1818. Although this first fossil was identified as a catfish, more recent studies have recognized that the group belongs among the Arthropoda, or jointed-leg animals.

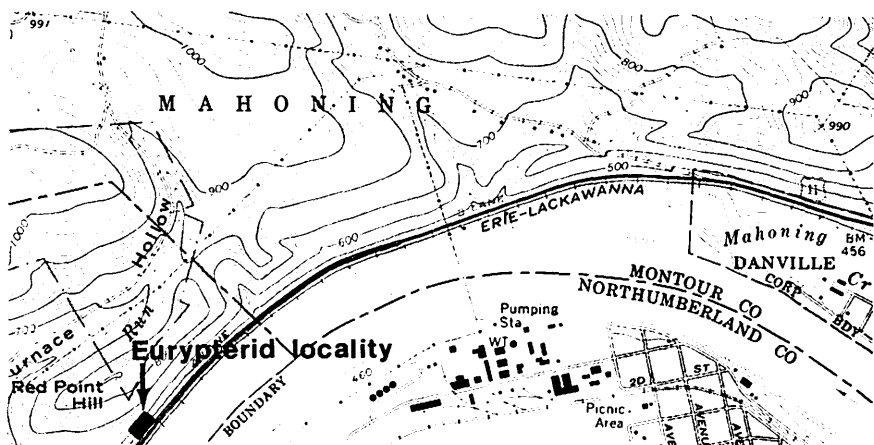


Fig. 2 Location of eurypterid find.

The presence of pincers (chelicerae) identifies eurypterids as members of the Subphylum Chelicerata, and suggests that they are most closely related to the horse-shoe crab and spiders among living arthropods.

The eurypterid reported here was found just west of Danville, where a large road cut on the north side of Route 11 exposes almost the entire Silurian section. The specimen was collected from float in the McKenzie Member of the Mifflintown Formation, about 1.0 miles west of the Northumberland/Montour County line (Figure 2). The lime, medium-gray shale matrix is otherwise unfossiliferous, and is typical of the shale beds that alternate with limestones in the lower part of the McKenzie Member. The shale indicates the presence of mud in the environment of deposition, and suggests that these sediments were deposited in marine seas that lay offshore a coastal plain (Folk, 1962).

The McKenzie has been correlated with difficulty with the classic Silurian section of New York. The sparse fauna, the differences in facies, and the resulting differences in what little fauna that is present have all posed major problems for correlation. Frank M. Swartz (1935) suggested that the McKenzie of Pennsylvania is the time equivalent of New York's Lockport Group largely on the basis of similarities in meagre ostracod faunas. The Lockport correlation is supported by Zenger (1965). In contrast to the McKenzie, the Lockport sequence is more truly marine, and its sediments were probably deposited in more open parts of the sea. Consequently, its fossils are those of animals adapted to this open sea environment.

Eurypterids are known from at least three environmental regimes: a completely marine habitat, a habitat intermediate between normal

marine and brackish, and a fresh to brackish habitat (Kjellesvig-Waering, 1961). The Family Eurypteridae, and thus the genus *Eurypterus*, is typical of the second group, and it is in this intermediate habitat group that the McKenzie beds may be placed.

In contrast, the more truly marine beds of the Lockport Group can be placed in the first, completely marine habitat. Rare eurypterids have been reported from the Lockport Group. Zenger (1965) reported *Eusarcus* (now referred to the genus *Carcinosoma*) from the Sconodoa Member of the Lockport, and Williams (1915) reported the same genus from the Eramosa Member of neighboring Ontario. *Carcinosoma* is found only in marine beds, and is grouped by Kjellesvig-Waering (1961) among eurypterids typical of the most marine environments.

Although one might expect that a new fossil find would aid in correlation problems, it is of limited help here. Certainly *Eurypterus* in the McKenzie and *Carcinosoma* in the Lockport are compatible with time equivalency. However, each has a considerable time range and distinct environmental preference. Thus, even among eurypterids, the facies problem that has prevented easy McKenzie/Lockport correlations is very evident.

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YORK MINERAL AND GEM SHOW

The York Rock and Mineral Club will hold its Ninth Annual Mineral and Gem Show on Saturday, April 1 and Sunday, April 2, 1978 at the Manchester Township Fire Company #1, in the Manchester Township Building, Emigsville, Pa. The firehouse is located in Emigsville, Pa. on Route 181, going north from York, Pa. Show hours are Saturday, April 1 — 10 AM to 9 PM and Sunday, April 2 — 10 AM to 6 PM. Admission will be 75¢ — children under 12 free.

SURVEY ANNOUNCEMENTS

REPORT ON ZINC AND LEAD OCCURRENCES IN PENNSYLVANIA

A thorough field and literature review has been made of all previously reported zinc and lead occurrences in Pennsylvania, as well as a considerable number of occurrences never previously reported. The results of this investigation by Dr. Robert Smith, II, covering over 100 occurrences in 19 counties, have been released by the Bureau of Topographic and Geologic Survey in its new Mineral Resources Report 72, *Zinc and Lead Occurrences in Pennsylvania*. This report updates and revises B. L. Miller's classic report published by the Survey in 1924. The nineteen counties in which the occurrences are located are: Bedford, Berks, Blair, Bucks, Centre, Chester, Columbia, Cumberland, Huntingdon, Jefferson, Lancaster, Lehigh, Lycoming, Montgomery, Northampton, Northumberland, Sullivan, Union, and York.

The new report suggests the most favorable counties and geologic formations for mineralization and provides detailed geologic and mineralogic data for each of the occurrences. The report will be of use to zinc and lead exploration companies, land-use planners, environmentalists, mineral collectors, historians, and the property owners themselves.

Mineral Resources Report 72 is available from the State Book Store, 10th and Market Streets, P. O. Box 1365, Harrisburg, PA 17125. The price is \$11.50 (plus 69 cents tax for Pennsylvania residents); for mail orders, a check or money order payable to "Commonwealth of Pennsylvania" should be enclosed.

HARRISBURG WEST SHORE GEOLOGY

A comprehensive 106-page text and full-color geologic map of the Harrisburg west shore geology has been published by the Pennsylvania Geological Survey. Authored by Dr. Samuel I. Root, *Geology and Mineral Resources of the Harrisburg West Area, Cumberland and York Counties*, provides environmental, engineering, and geological details which will benefit property owners, land use planners, engineers, and the mineral industry of the area.

Atlas 148ab is available from the State Book Store, P. O. Box 1365, Harrisburg, Pa. 17125, for the price of \$9.65 (plus 6% tax for Pennsylvania residents).

DIRECTORY OF MINERAL INDUSTRY IN PENNSYLVANIA

Responding to the demand for updated information on the mineral industry in Pennsylvania, the Pennsylvania Geological Survey has issued a completely revised edition of the *Directory of the Mineral Industry in Pennsylvania*. The directory is divided into three parts. Part 1 lists producers according to the mineral raw materials being produced. Part 2 consists of a listing of the mineral producers on a county by county basis, with the active quarries and plants keyed to an accompanying location map at a scale of 1:500,000 (1 inch equals approximately 8 miles). The kind of rock (limestone, sandstone, diabase, etc.) being extracted or the mineral commodity (cement, etc.) being produced at each locality is indicated by symbol on the map. Part 3 of the directory is a company index arranged alphabetically.

The *Directory of the Mineral Industry in Pennsylvania*, third edition, by Bernard J. O'Neill, Jr., is available from the State Book Store, P. O. Box 1365, Harrisburg, Pennsylvania 17125. The price is \$4.10, plus 6% state sales tax if mailed to a Pennsylvania address. Checks are to be made payable to the Commonwealth of Pennsylvania.

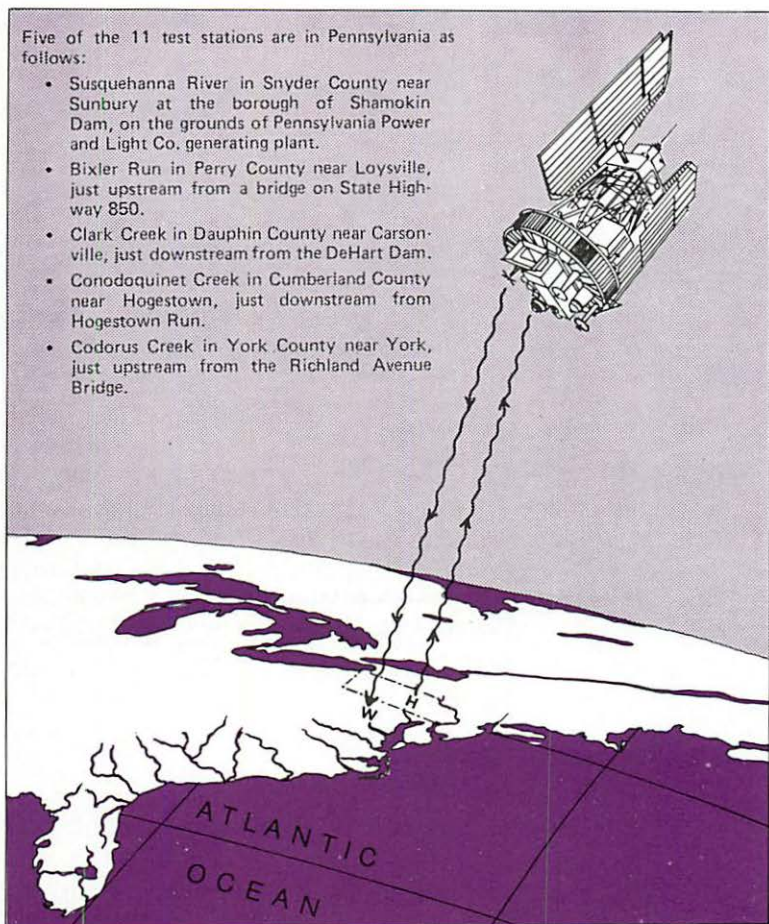
water data relay by commercial satellite to be tested

A six-month demonstration using a commercial communication satellite to relay water data from 11 U. S. Geological Survey's stream monitoring stations will be conducted by the U.S.G.S. with the help of COMSAT General Corporation starting in October, 1977. The COMSAT General demonstration will test the feasibility and cost of using commercail rather than government satellites to relay the hydrologic data to receiving stations. The Survey may eventually integrate all 9,000 of its monitoring stations into a satellite data retrieval system to replace the present method of manually retrieving data tapes from the battery-powered monitoring stations at intervals of four to six weeks.

A satellite retrieval system would have two principal advantages: it would permit processing and retrieval of hydrologic data from U.S.G.S. computers almost immediately after collection rather than after a four to six week delay, and it would free U.S.G.S. personnel from manual collection duties for research and other projects.

Five of the 11 test stations are in Pennsylvania as follows:

- Susquehanna River in Snyder County near Sunbury at the borough of Shamokin Dam, on the grounds of Pennsylvania Power and Light Co. generating plant.
- Bixler Run in Perry County near Loysville, just upstream from a bridge on State Highway 850.
- Clark Creek in Dauphin County near Carsonville, just downstream from the DeHart Dam.
- Conodoquinet Creek in Cumberland County near Hogestown, just downstream from Hogestown Run.
- Codorus Creek in York County near York, just upstream from the Richland Avenue Bridge.



COMSAT General, a subsidiary of the COMSAT Corporation, will use, for this demonstration only, a Telesat of Canada ANIK geostationary communication satellite. The ANIK satellite is stationary above the equator at 104 degrees west longitude, which is almost directly south of Guadalajara, Mexico and Carlsbad, New Mexico.

The water information from Pennsylvania is gathered and used in cooperation with the Pennsylvania Department of Environmental Resources to tackle a growing number of water problems such as: Are stream flows adequate to meet water supply needs or to dilute downstream waste discharges? Do high flows upstream threaten downstream communities? If a chemical is spilled into a stream, how fast will it move downstream to a public water supply? Is the quality of the water changing and will it affect users?

NEW FROM THE U.S. GEOLOGICAL SURVEY AND BUREAU OF MINES

U. S. G. S.
Circular 728

Landsliding in Allegheny County, Pennsylvania, by R. P. Briggs, and others.

The report includes a discussion of landsliding causes and evidence of landsliding, including brief descriptions of specific landslides. Free.

Miscellaneous Investigations Series

Map 1-1035 Landslide Susceptibility Map of Pittsburgh West Quadrangle, Allegheny County, Pennsylvania, by J. S. Pomeroy.

The map identifies with potential slope-stability problems significant to development. It is a guide to areas of past landsliding and present susceptibility. Cost \$1.25.

Order from: Branch of Distribution, U. S. Geological Survey, 1200 South Eads St., Arlington, Va. 22202. For cost publications send check or money order.

U. S. B. M.
Report of Investigations 8226r

Geology and methane content of the Upper Freeport coalbed in Fayette County, Pennsylvania, by P. F. Steidl.

Coal and overburden isopachs, structure and joint pattern maps, and a fence diagram were prepared using data from gas and oil exploration logs and coal outcrops. Free.

Report of Investigations 8247

Geology and gas content of coalbeds in vicinity of Bureau of Mines, Bruceton, Pennsylvania, by C. H. Elder.

Two degasification test boreholes were drilled to depths of 1,238 and 1,212 feet at Bruceton, Pennsylvania. The holes provided detailed geologic information and geologic sections. Free.

Order free U. S. Bureau of Mines publications from: Publications Distribution Branch, Bureau of Mines, Dept. of Interior, 4800 Forbes Ave., Pittsburgh, Pa. 15213.

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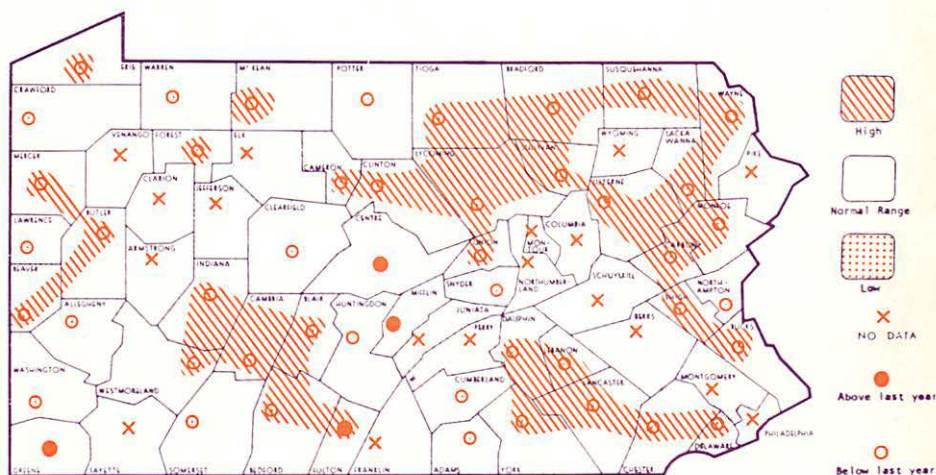
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