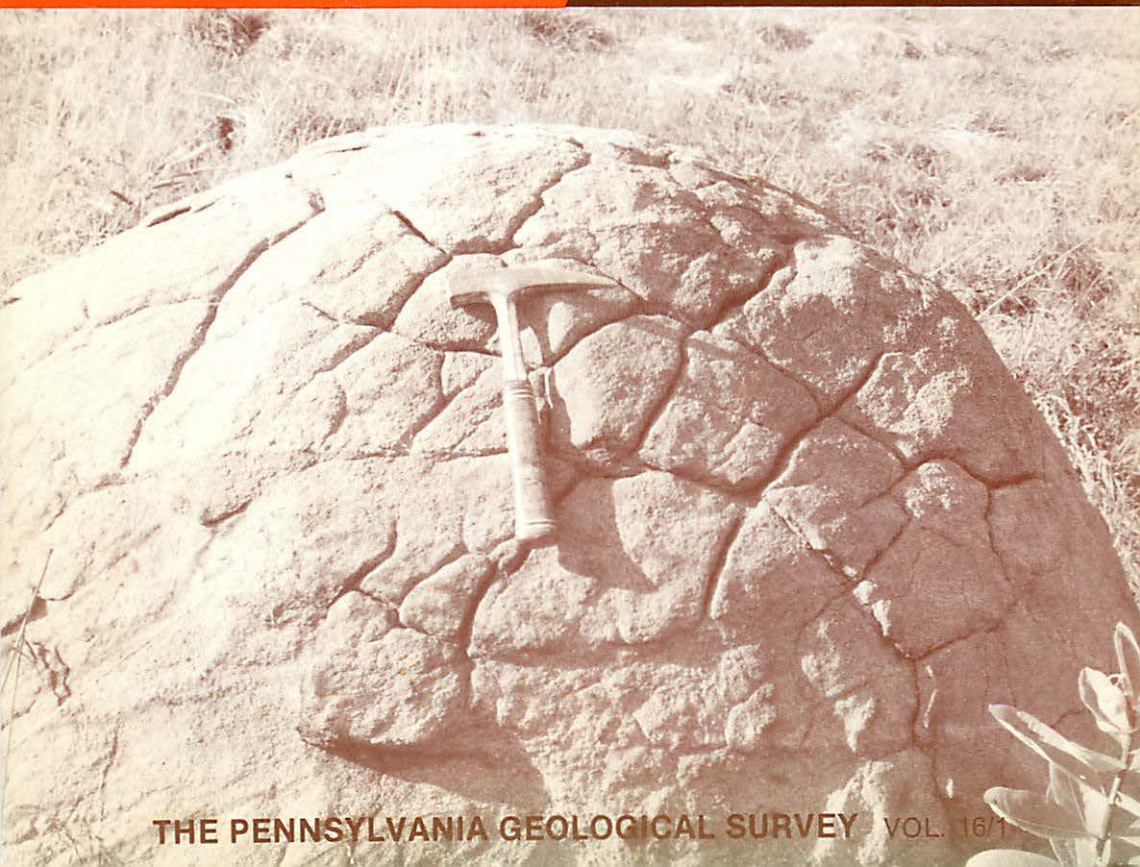
PENNSYLVANIA GEOLOGY



THE PENNSYLVANIA GEOLOGICAL SURVEY VOL. 16/1

COMMONWEALTH OF PENNSYLVANIA
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TOPOGRAPHIC AND GEOLOGIC SURVEY
Arthur A. Socolow, State Geologist

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ON THE COVER: Boulder of Triassic age diabase, near Wellsville, York County, shaped by spheroidal weathering. Polygonal joint pattern, formed when the molten rock cooled, is accentuated by the weathering. Photo courtesy of Robert C. Smith II.

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

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VOL. 16, NO. 1 **FEBRUARY, 1985**

FROM THE DESK
OF THE
STATE GEOLOGIST

AS THE FEDS BOW OUT

As has been mentioned here on numerous occasions, our progressing economic society and our increasing environmental awareness has steadily resulted in an expanding need for geologic maps and geologic evaluations. Detailed geologic maps and data base are essential as we are being called upon to provide technical input into such matters as waste disposal locations, mine land restoration, land use planning, power plant siting, mineral land evaluations, landslide assessment, and sinkhole repairs.

While our State Geologic Survey is faced with an increasing demand for geologic data and services, as is the case with most other State Geologic Surveys across the country, the geologic mapping and detailed investigations by the U.S. Geological Survey and the U.S. Bureau of Mines has been decreasing, particularly in the eastern United States. The declining federal involvement is in part a reflection of the federal manpower and budget reductions and partly the result of Congressional mandates directing the federal capability toward studies on major federal landholdings, which happen to be in the western states and Alaska.

We look back with nostalgia to the first 60 years of the century when the U.S. Geological Survey had literally scores of geologists, actually living and working in Pennsylvania, doing geologic mapping, mineral resource investigations and detailed coal investigations; today there are none. Where once the U.S. Bureau of Mines provided mining and geologic services throughout the state, today that staff and service capability is a shadow of its former self.

With the evaporation of federal geologic activities in our state, we at the Pennsylvania Geological Survey face the responsibility of providing the geologic data and services for which, as indicated above, we are increasingly being called upon by fellow government agencies and the public. Accordingly, we have to plan our geologic programs and utilize our staff judiciously to meet those needs. In an era of our own very real budget and manpower limitations, it makes for an interesting challenge.

Arthur A. Socolow

SILICA 99 AND 44/100% PURE, WAITING TO BE MINED!

by Robert C. Smith, II,
and S. W. Berkheiser, Jr.

Better than Ivory Soap? Not for washing, but one of the largest exposed and easiest to mine pure milky quartz veins (Figure 1) found to date in Pennsylvania contains about 0.2% of metals other than silicon. This quartz vein forms the top of an unnamed ridge near Pine Grove Furnace, Cumberland County, Pennsylvania, which is located in Michaux State Forest, 0.50 mile NW of the intersection at Pine Grove Furnace, Cooke Township. It has a maximum elevation of 1085 feet. The latitude and longitude of the occurrence are 40°02′23″N, 77°18′27″W.

The quartz vein has a true thickness of at least 12 to 17 feet near the center of the outcrop and is 360 feet long in a northwest-southeast direction (Figure 2). Based on the outcrop pattern and measurements of a few schistose inclusions, the vein dips to the southeast and forms a topographic slope. Near the middle, the surface width (dip slope) of outcrop is estimated to be approximately 225 feet, bringing its southeastern edge down to an elevation of about 1015 feet. Abundant, moderately large float boulders of quartz continue to the southeast to Toms Run.

A 12-1/2-foot-long channel sample was collected on the northwest side of the vein. The composite sample was found to contain only 0.24% Al_2O_3 and 0.1% Fe_2O_3, as well as less than 200 parts per million (ppm) Ca, less than 10 ppm Cr, 300 ppm Mg, 30 ppm Mn, 50 ppm Ti, and less than 20 ppm Zr. Other than quartz, the only observed materials in the vein are sparse greenish muscovite and iron stains on broken surfaces. Estimates of the quantity of quartz range from 65,000 to 320,000 tons, depending on the assumed dip of the vein. Probably at least 100,000 tons are potentially mineable. Little or no overburden removal would be required. The host rock to the vein is a metavolcanic schist, the composition of which appears to be intermediate between rhyolite and basalt.

Potential uses for milky quartz such as this range from decorative to high-technology. Decorative uses include exposed aggregate in pre-cast

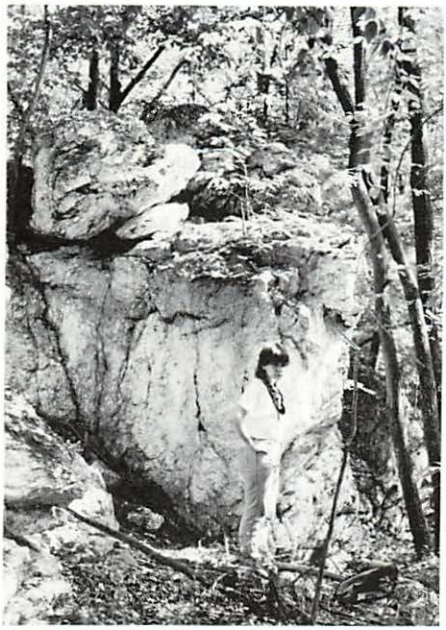

Figure 1. Quartz vein (sample location) on northwest side of Toms Run quartz vein. Geologic Aide (for scale) is about 5 ft tall. Foliation dips to the left of the photo at about 28° SE.

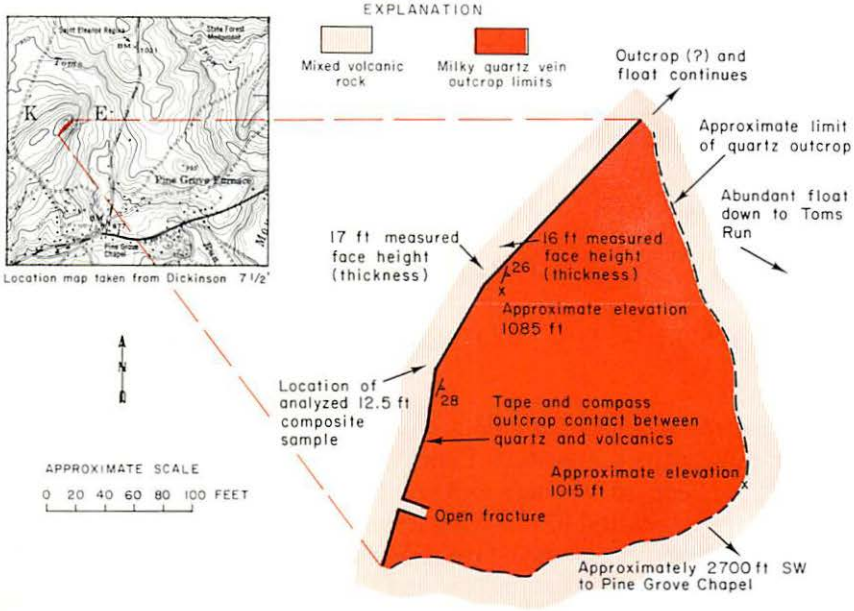

Figure 2. Sketch map of Toms Run quartz vein showing outcrop pattern and sample location.

concrete panels. If beneficiation is feasible (current lab-scale tests of similar quartz veins occurring elsewhere in Pennsylvania have been successful), the quartz might be used for refractories and metallurgical quartz. High-technology uses of beneficiated material might include the manufacture of a fumed product used in the production of fiber-optics, as well as use as a raw material for manufacturing polycrystalline silicon used by the solar photovoltaic and electronics industry.

Although the occurrence was briefly noted by Stone (1939), no evidence of exploration or development was observed. Stone notes that the locality was known as "White Rocks" (a name more commonly associated with sandstone or quartzite ledges elsewhere in Pennsylvania) and that freight-car loads strew the surface. He also notes a possible 50-foot-wide vein along strike to the northeast, where it crossed Pa. Route 233, one mile south of the crest of South Mountain. Data on several other, generally purer, quartz veins and rather pure sedimentary deposits (Smith and Berkheiser, 1983) are being described in an upcoming reconnaissance report on high-purity silica occurrences in Pennsylvania (Berkheiser, in press).

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Surplus Topographic Maps

The Survey has accumulated a quantity of outdated 7½′ quadrangle topographic maps for eastern Pennsylvania. We are offering them, in limited numbers, to teachers and troop leaders.

If you are interested in receiving a limited number of these maps contact Arthur A. Socolow, State Geologist, Dept. of Environmental Resources, Bureau of Topographic and Geologic Survey, P.O. Box 2357, Harrisburg, PA 17120. Maps will be supplied as long as they last on a first-come first-serve basis. Orders for specific quadrangles cannot be accepted.

NEW ROCK MAP OF PENNSYLVANIA

Geologic maps are often somewhat of a mystery to the layperson. The large number of different formation names that may be shown on a geologic map can be very confusing to some. In order to help the non-geologist understand more about the distribution of different kinds of rock in the Commonwealth, the Pennsylvania Geological Survey has published a new map titled *Rock Types of Pennsylvania* (Map 63). This full color map of the state shows 19 basic rock types (or groupings of rock types) such as shale, quartzite, slate, redbeds, sandstone, conglomerate, limestone, igneous rocks, etc. Map 63 is published at a scale of 1:500,000 or 1 inch equals approximately 8 miles. *Rock Types of Pennsylvania* is a simplification and reduction of the new Geologic Map of Pennsylvania (Map 1) issued in 1980, which shows over 180 different groups, formations, and members ranging in age from Precambrian to Recent. Map 63 makes no attempt to show geologic age relationships.

Map 63 is intended for use by all laypersons of all ages. It will be useful for science and earth science classes in junior and senior high schools, and will also be useful for many introductory earth science college courses. The map will be a tremendous aid to the traveler who is interested in knowing the relation between Pennsylvania's scenic ridges and valleys and the underlying rocks. Those interested in the human history of the Commonwealth may find answers to why trade routes were located where they are, and why the location of certain mineral resources had such a profound impact on our development.

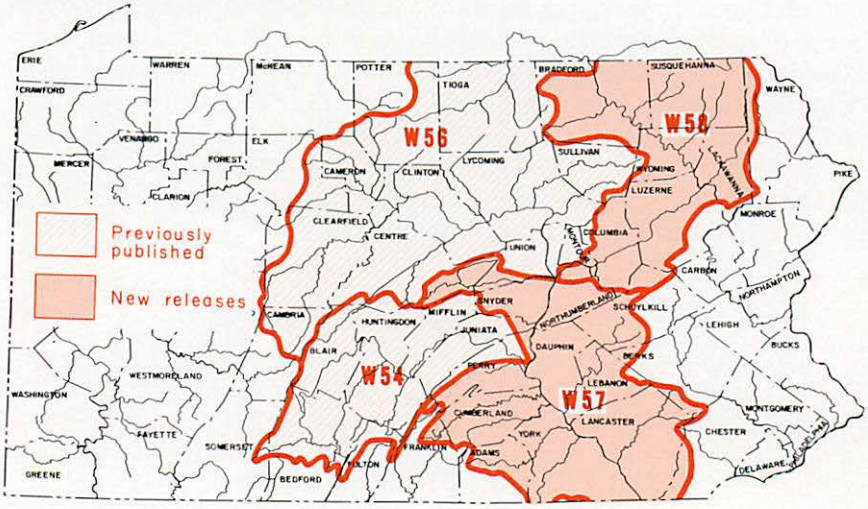
Rock Types of Pennsylvania was compiled by T. M. Berg and W. D. Sevon of the Pennsylvania Geological Survey, and R. Abel of the Defense Mapping Agency. The map is printed on a base which shows major roads, county and city boundaries, a latitude/longitude grid, and all water bodies and rivers. The map is folded in a handy envelope and is available from the State Book Store, P.O. Box 1365, Harrisburg, PA 17105. The price is $4.35 (plus 26¢ sales tax for Pennsylvania residents); please make check payable to "Commonwealth of Pennsylvania."

GROUNDWATER RESOURCES OF THE SUSQUEHANNA RIVER BASIN— LATEST PUBLICATIONS COMPLETE SERIES

With the Pennsylvania Geological Survey's recent publication of two groundwater reports, *Groundwater Resources of the Lower Susquehanna River Basin* (Water Resource Report W 57) and *Groundwater Resources of the Upper Susquehanna River Basin* (Water Resource Report W 58), a series of four reports detailing the hydrogeology of the Susquehanna River basin in Pennsylvania is now available.

These reports contain a substantial amount of new data relative to the quantity and quality of groundwater in the basin. They were prepared as part of the three-year Special Groundwater Study of the Susquehanna River basin by the Susquehanna River Basin Commission (SRBC) in cooperation with various state and federal agencies. Anyone involved with any aspect of water resource utilization and management will find these reports to be an extremely valuable addition to their libraries.

The publications are available from the State Book Store in Harrisburg or by mail. Water Resource Reports W 57 and W 58 are priced at $15.70 (plus 94¢ tax for Pennsylvania residents) and $13.95 (plus 84¢ tax for Pennsylvania residents), respectively. Send mail orders to the State Book Store, P. O. Box 1365, Harrisburg, PA 17105. Make check payable to the "Commonwealth of Pennsylvania."



BASS ISLANDS PRODUCTION IN NORTHWESTERN PENNSYLVANIA

by
Robert M. Harper

Appalachian operators are producing high gravity crude oil and natural gas in New York's Chautauqua and Cattaraugus Counties, adjoining Pennsylvania. The oil and gas are produced from a zone extending from the basal portion of the Middle Devonian Onondaga Formation down into the Upper Silurian Bass Islands Dolomite (Figure 1). Production occurs from fractured reservoir intervals along a fault trend which strikes approximately N55°E across Chautauqua and western Cattaraugus counties (Figure 2) (Van Tyne, 1983). Copley and others (1982) identified the trapping mechanism as a low-angle reverse or thrust fault. Drilling depths through the production zones are reported to average 3,000 feet and initial potentials are stated as greater than 10 MMcfpd for natural gas and up to 500 bbls of oil per day per well (Copley and others, 1982).

Harper and Abel (1981) suggested that the structural trend in New York, along with other similar trends mapped in western New York by Van Tyne (1982), may extend southwestward into northwestern Pennsylvania (Figure 2). The purpose of this article is to describe the stratigraphy of this subsurface interval in northwest Pennsylvania, recount the history of petroleum exploration and development in the Upper Silurian-Lower Devonian carbonates of northwestern Pennsylvania and discuss the relationship of recent production from this zone in northwestern Pennsylvania to the "Bass Islands" play of western New York.

The area of interest in this article is Erie County, in the north-central portion of the Appalachian geosyncline. During most of the middle Paleozoic (Silurian-Devonian) the Erie County area was near the central portion of the Appalachian basin (Kelley and McGlade, 1969).

The Middle Devonian to Upper Silurian stratigraphy includes the Onondaga Formation, Bois Blanc Formation, Helderberg Group, and the Bass Islands Dolomite (Figure 1). These formations will be discussed separately. The Lower Devonian Oriskany may be present in northwest Pennsylvania, though its occurrence is patchy. To date, the Oriskany has not been encountered by drilling in the study area and will not be discussed here.

Middle Devonian	Onondaga Formation
Lower Devonian	Bois Blanc Formation
	Helderberg Group
Upper Silurian	Bass Islands Dolomite
	Salina Formation

Figure 1. General stratigraphic column of the productive interval in the Greenley Pool of Erie County.

The subsurface Middle Devonian Onondaga Limestone is dominated by a moderately deep water carbonate facies which grades northward into shales and cherts (Kissling and Polasch, 1982). The Onondaga consists of finely crystalline limestone somewhat silty and argillaceous, with some chert (Jones and Cate, 1957). The terrigeneous clastics appear to have an easterly source (Cate, 1957). In south-central New York and northwestern Pennsylvania, basin and platform are joined by a south-sloping ramp (Kissling and Polasch, 1982) built by limestone deposition. Bioherms are also present in this area. The bioherms are not wave-resistant reefs; instead they formed at considerable water depths.

The Lower Devonian Bois Blanc Formation is a thin and discontinuous unit beneath the Onondaga. This formation apparently thins and becomes more clastic eastward (Lytle and others, 1977). In western New York, the Bois Blanc is a medium dark-gray, fine-grained limestone. Although the Bois Blanc fauna contains many corals, it is numerically dominated by brachiopods (Oliver, 1967). It is widespread and covers most of eastern North America. The Bois Blanc is representative of a shallow sea that supported abundant life.

In northwest Pennsylvania the Lower Devonian Helderberg is interpreted from lithologic evidence as having originated in a shallow water environment (Jones and Cate, 1957). Fettke (1961) describes the Helderberg of northwestern Pennsylvania as a very fine limestone, crystalline to dense,brownish-gray to gray, somewhat sandy and magnesian; containing considerable light brownish-gray chert with some silt, and in part minutely porous. There is gradual thinning of the Helderberg toward the northwest (Jones and Cate, 1957).

The Upper Silurian Bass Islands is a carbonate unit including limestone, dolomitic limestone, and dolomite. This unit was deposited in an elongate trough basin trending northeast-southwest (Cate, 1965). In northwestern Pennsylvania there appeared during Bass Islands "time" the reactivation of a positive element, a sort of shoal perhaps, plunging slightly westward and trending almost east-west along the Erie-Crawford County boundary (Cate, 1965). Little facies change is evident in the Bass

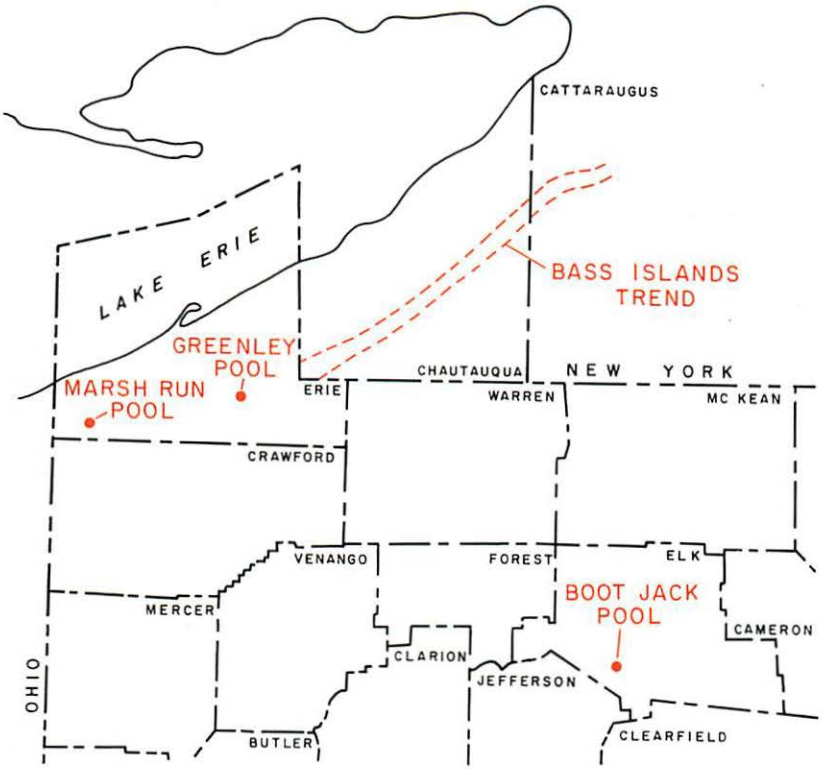


Figure 2. Bass Islands trend in western New York and productive areas in Pennsylvania. New York Fairway mapped by Van Tyne (1983) and discussed by Copley, et. al, 1982.

Islands, and most likely structure will play a major role in the entrapment of gas in this horizon (Kelley and McGlade, 1969).

The first reported discovery of natural gas in Pennsylvania's Bass Islands occurred in 1973. This discovery occurred in the Boot Jack Pool of Elk County (Figure 2), a deeper pool discovery in the Horton Field on the Hebron anticline. It should be noted that the use of the name "Bass Islands" this far southeast is questionable; Abel and Heyman (1981) suggest the Shriver Chert or Mandata Shale may be present instead in this area. Production was from the interval between 6,470 feet and 6,492 feet. Initial production was 531 Mcf. Boot Jack's cumulative production at the end of 1983 was 11,275 Mcf from one well (Harper, 1984). The trapping mechanism at this pool is probably controlled by anticlinal development. This pool was shut-in in 1978.

In 1982, the Marsh Run Pool was discovered in western Erie County (Figure 2). Production was from the interval between 2,125 feet and 2,203 feet. Cumulative production from this pool at the end of 1983 was 858 Mcf from two wells (Harper, 1984). Given the history of Bass Islands production in New York, the Marsh Run Pool may be controlled by the same type of faulting that occurs in that state. This faulting is thought to be caused by movement in the underlying Salina salt. This pool is still producing natural gas. Cumulative production of Bass Islands natural gas, excluding the discovery at Greenley Pool which will be discussed next, was 12,133 Mcf at the end of 1983 (Harper, 1984).

Recent drilling activity has produced good results from these carbonates in eastern Erie County. The production interval is from Lower Devonian Bois Blanc to Upper Silurian Bass Islands in the Greenley Pool of Drumlin Field (Figure 2). Initial potentials range from 4,000 Mcf in the Bois Blanc Formation, in NRM Petroleum Corporations's No. 1 Mitchell-Kestle well, to 27,000 Mcf in the Bass Islands Formation, in N.E.A. Cross Company's No. 1 Serwinski well. The reservoirs are encountered at an average depth of 2,654 feet in Greenley Pool.

Can Greenley Pool be an extension of the Bass Islands trend in New York? Geographically, the Greenley Pool appears to be on the same northeast-southwest trend described by the New York investigators. From all data available it is reasonable to interpret the production in the Greenley Pool as controlled by the same type of thrust faulting that controls the Bass Islands play in New York. The faulting may have occurred through activation of growth faults in the Salina (Figure 3). A growth fault is formed during deposition. This faulting probably occurred during Salina deposition. In Figure 3, the structure section shows the strata was thrust up above well number ERI-23628, which has been pushed down. Production is from well number ERI-23508 and well number ERI-23595, which are stratigraphically the highest wells. The gas migrated up until it was trapped by an impermeable layer of stratum. This is the mechanism responsible for Bass Islands production in this area.

So why doesn't Greenley Pool produce both oil and gas from the same zone as in New York? Harris (1979) mapped conondont thermal alteration indicies in the central Appalachian basin; the alteration index is about 2 in the Silurian through Middle Devonian carbonates near Greenley Pool. This value suggests burial temperatures of 60 to 140°C. The reported conodont alteration indicies are approximately equivalent to vitrinite reflectance values of 0.85 - 1.3 (Harris, 1979). These values indicate that any kerogen in the Silurian through Middle Devonian interval at Greenley Pool is thermally mature. It is probable that oil and gas could have been

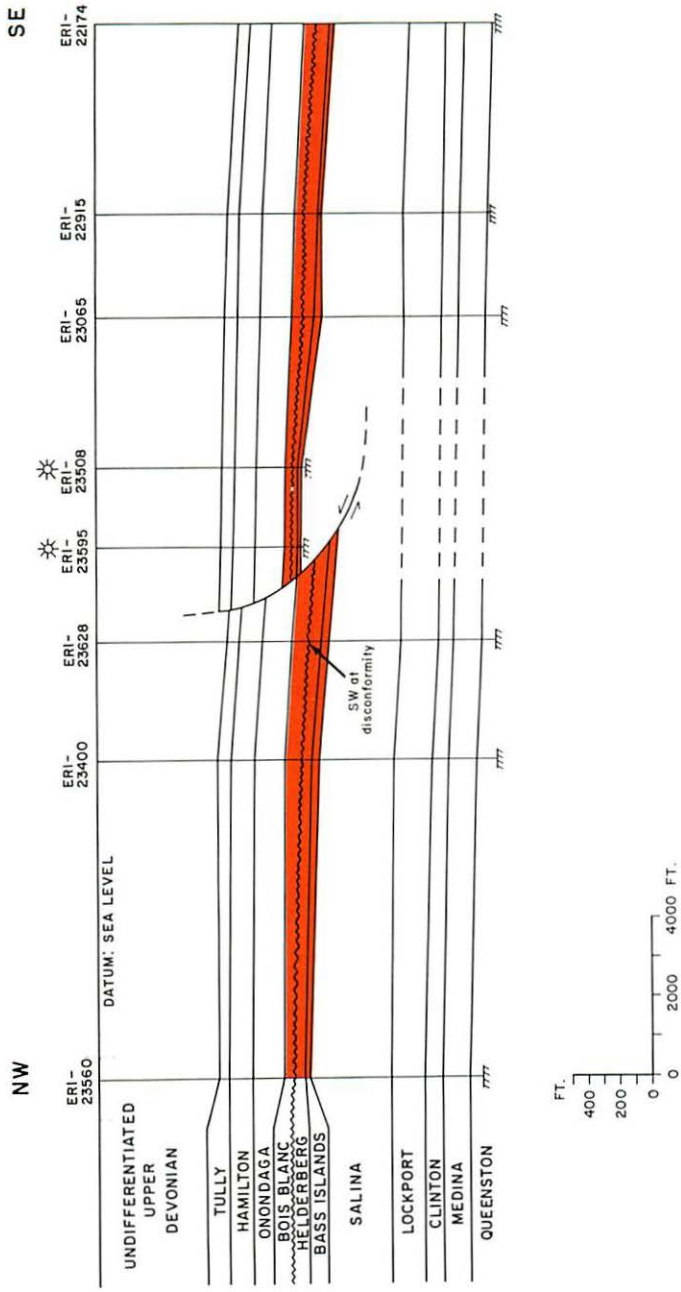


Figure 3. Cross section showing interpreted trapping mechanism for Bass Islands production in Greenley Pool.

generated in this interval. The organic carbon content of these carbonates, however is generally low throughout Pennsylvania (Christopher Laughrey, per. comm.), on the average of 0.3%. An organic carbon content of at least 0.6% is required for oil generation (Tissot and Welte, 1978). There are suitable source beds, however, above the productive section in Greenley Pool. In a nearby well in Erie County, the Marcellus Shale has an organic carbon content of nearly 4% (Streib, 1981). Magara (1973) suggests that overpressuring of shales can lead to the development of a subsurface pressure barrier and force the migration of hydrocarbons downward. The difference in produced fluids at Greenley Pool and southwestern New York reflects a complex petroleum migration history which we do not quite understand.

From the information that has been gathered, it seems the the Bass Islands trend does extend into Pennsylvania from New York. Further exploration along this northeast-southwest trend is expected and will lead to a better understanding of this play in Pennsylvania.

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U.S. Geological Survey Increases Map Prices Effective January 1, 1985.

The U.S. Geological Survey has increased the prices for all map series. The prices of the maps most often requested are listed.

Standard Topographic Maps	1:24,000	$2.50
County Maps	1:50,000	4.00
30 x 60-minute maps	1:100,000	4.00
Intermediate Scale Maps	1:250,000	4.00
State Topographic Maps	1:500,000	4.00

Note: Include $1.00 to cover postage and handling charges on all orders of less than $10.00

For mail orders send to:
Eastern Distribution Branch
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1200 S. Eads Street
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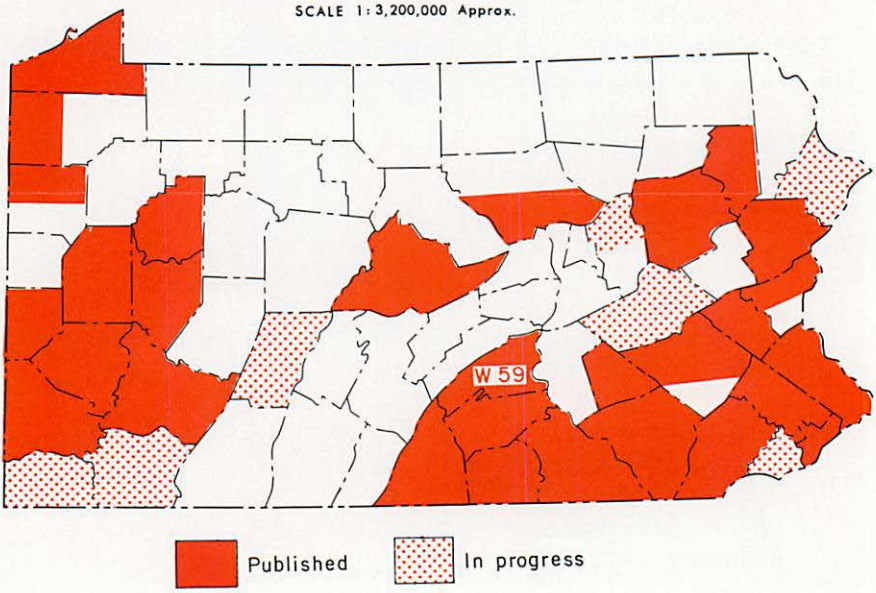
NEW SURVEY PUBLICATIONS

Perry County Groundwater

Water Resource Report W 59, *Summary Groundwater Resources of Perry County* by Denise W. Royer, describes the virtually untapped groundwater resources of this county. Based on the annual water-budget analysis of the county roughly 397 (gal/min)/mi^2 of groundwater is available and only 4.7 (gal/min)/mi^2 was reportedly used in 1981.

The report includes a record of wells, a 20-year annual water budget and baseflow frequency curve for Sherman Creek basin, and descriptions of the aquifers, well and yield characteristics, and drinking water quality. Accompanying the text is a full-color geologic map (scale 1:50,000) with locations of 473 inventoried wells and a detailed legend. The report should be on interest to anyone who is planning for future water needs in Perry County.

Water Resource Report W 59 is available through the State Book Store, P. O. Box 1365, Harrisburg, PA 17105 for $15.30 (plus $.92 tax for Pennsylvania residents). A check made payable to the Commonwealth of Pennsylvania must accompany the order.



Copper-Uranium Occurrences Report Issued

A report on the *Geology and Mineralogy of Copper-Uranium Occurrences in the Picture Rocks and Sonestown Quadrangles, Lycoming and Sullivan Counties, Pennsylvania,* by Robert C. Smith, II, of the Pennsylvania Geological Survey and Donald T. Hoff of the Pennsylvania Historical and Museum Commission, is now available from the State Book Store. Of the 271 pages in this report, 189 pages are devoted to detailed geologic and mineralogic descriptions of approximately 55 copper-uranium occurrences. Thirty-five of these occurrences are previously undescribed; several others had been "lost" and locations are provided. For each occurrence, the exact location is indicated on a 1:24,000-scale map, and by latitude and longitude, bearing and distance from several points, and elevation. A description of each observed major, minor, and trace mineral is provided for each occurrence. The highlight of the report is an 8-page section with 32 full-color photographs of minerals and fossils from the district. The color section includes photos of such rare minerals as chalcophyllite, cuprosklodowskite, metazeunerite, tyrolite, and widenmannite. The report also contains 89 black-and-white figures, most of which are locality and specimen photographs. Appendix 1 contains a list of minerals identified in the area.

For the economic geologist, quantitative analyses for U_3O_8, Cu, As, and Pb have been obtained for 77 channel and dump composite samples. An apparent variation in composition of these red-bed occurrences with stratigraphic position within the Devonian Catskill Formation is noted. Mineral Resource Report 80 can be obtained from the State Book Store, Room G-56, South Office Building, Harrisburg, for $17.65 plus $1.06 tax. If ordering by mail, enclose a check payable to the Commonwealth of Pennsylvania for $18.30 (plus $1.10 tax for PA residents) and send to the State Book Store, P. O. Box 1365, Harrisbug, PA 17105.

PROFESSOR LAWRENCE WHITCOMB, 1900-1984

Dr. Lawrence Whitcomb, Associate Professor Emeritus of Geology at Lehigh University, died on September 6, 1984 at the age of 84. He was an outstanding teacher and a distinguished expert of Paleozoic stratigraphy and paleontology. A graduate of Brown and Princeton Universities, he served on the Lehigh faculty from 1930 until his retirement in 1965.

Widely recognized for his sophisticated research and interpretations, Professor Whitcomb insisted on teaching one or more beginning courses each semister to inspire and establish contact with the students. For his skill and dedication as a teacher, he was awarded the Lindback Distinguished Teaching Award in 1964.

Professor Whitcomb authored 24 papers, including several on the stratigraphy and paleontology of Pennsylvania. The Pennsylvania Survey had high regard for Professor Whitcomb and his research work; in 1932 we published his "Correlation of Ordovician Limestone at Salona, Clinton County" as our General Geology Bulletin G 5.

We recognize the passing of Dr. Lawrence Whitcomb with great sadness.

Announcing—

York Rock & Mineral Show/Delaware Valley Fossil Fair

The York Rock & Mineral Club will hold its Sixteenth Annual Mineral and Gem Show on Saturday, April 13, and Sunday April 14, 1985, at the Alert Fire Company Hall, Emigsville (Rt. 181 north of York). Show hours are 10 a.m. to 7 p.m. on April 13 and 10 a.m. to 5 p.m. on April 14. Admission is $1.00 per person. For further information contact Show Chairman, Ken Kauffman, 747 Florida Avenue, York, PA 17404.

The Delaware Valley Paleontological Society will host its sixth annual Fossil Fair at the Academy of Natural Sciences in Philadelphia on Saturday, March 9 and Sunday, March 10, from 10 a.m. to 4 p.m. This year's Fossil Fair will include numerous exhibits, a fossil sales booth, refreshments, and educational and children's activities. The Pennsylvania Geological Survey will host a booth with books and information on collecting fossils in Pennsylvania. Admission to the Fair is free with admission to the Academy of Natural Sciences.

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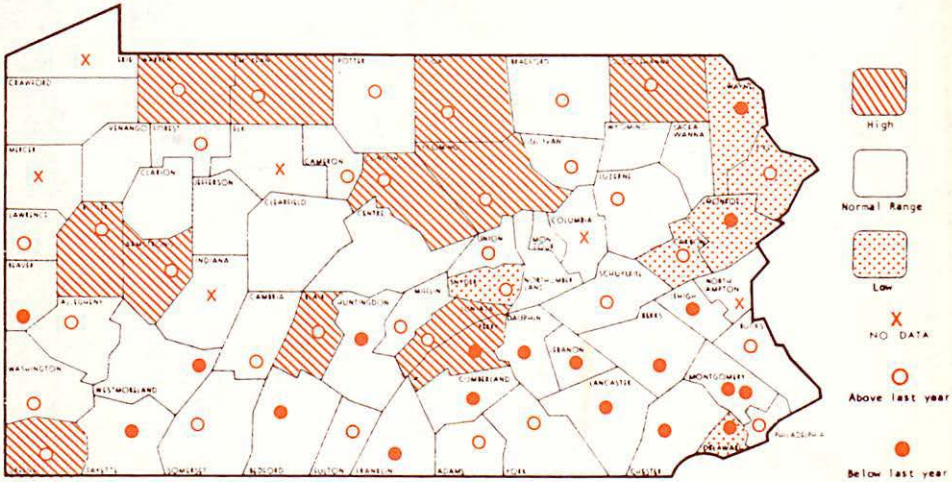

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