PENNSYLVANIA GEOLOGY

PENNSYLVANIA GEOLOGICAL SURVEY
150TH ANNIVERSARY
1836 - 1986

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

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ON THE COVER: Reproduction of a portion of a copper plate lithograph entitled "Pass of the Lehigh at Mauch Chunk", sketched by George Lehman, an artist employed by Henry D. Rogers in the 1840's to illustrate *The Geology of Pennsylvania, a Government Survey*, published in Philadelphia, Pa. in 1858.

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VOL. 17, No. 3 **JUNE 1986**

FROM THE DESK OF THE STATE GEOLOGIST

SIGNING OFF · WITH THANKS TO ALL

This is my last column as the State Geologist of Pennsylvania. Having completed 29 years with the Pennsylvania Geological Survey and having been privileged to serve as Director and State Geologist for 25 years, I am retiring from those duties this August 6th. This being my valedictory statement, I hope you will bear with me as I reminisce. Since this publication, Pennsylvania Geology, was first issued in 1969 to keep you aware of geological developments in Pennsylvania, I have appreciated the opportunity to freely share my thoughts with you in these columns and I have welcomed the responses I have received from so many of you. I like to think of the nearly 5,000 readers of this magazine as family members who want to share in our activities and our progress. At this end the challenge has been to keep the articles lively, current, and respectful of the diverse interests of our readers.

As one who believes that science, and particularly geology, should relate to society and its needs, coming to the Survey from the academic community was for me not a drastic change. I have strived for our Survey to advance the knowledge of Pennsylvania geology in a manner that serves the broad spectrum of Pennsylvania citizens. Not unlike the academic community, this has called for scientific investigation, followed by effective communication of the results, utilizing format, content, and language that will enable the widest possible audience to benefit from the knowledge of the complex geologic environment which surrounds and impacts everyone. Our Survey has also maintained a long-standing policy that the results of each geologic project are promptly published so as to be available to the user public; maps and investigative results are of little benefit if they are only kept in relatively inacessible file cabinets.

At the risk of being immodest (what better occasion!) permit me to enumerate a few of the achievements here of the past 25 years. First, and most important for any manager, was the development and support of a highly competent staff, dedicated to quality work and to the geologic needs of Pennsylvania. As the staff doubled in size, we acquired highly qualified professionals who are a credit to the 150 year heritage of our Survey.

Towards the goal of effective communication, a number of innovations were received with acclaim. Breaking away from a long-standing practice of using dull, standard colors on geologic maps, we instituted contrasting, standout colors (the influence of my artist wife!) to highlight the geologic features and structural relationships on our maps; our striking, bright 1960 state geologic map set the geologic community buzzing and went up on walls throughout the country. This technique has since been emulated by many geologic agencies far and wide.

The innovation of a three-column legend on our detailed geologic maps has provided users ready access to the desired basic information on rock description, mineral and water yields, and engineering characteristics of each rock formation on the map. This has also enabled accompanying reports to be of reasonable and economical length.

The range of our publications was broadened to reflect my belief that geology can serve all walks of life. To supplement our basic technical reports used by industry and professionals, we developed a series of publications for mineral and fossil collectors, hikers, and spelunkers; a series of geological state park guides; an environmental geology series emanating from our newly designated Environmental Geology Division; a series of page-size geologic maps and an educational series of geology booklets which annually has been going out to over 100,000 requesting students, scouts, and clubs. The rock and mineral sets we provided to teachers and students in the 1960's and early 1970's were a tremendous hit, but outstripped our capacity when the demand exceeded 20,000 per year.

Complementing our geologic project work, I have placed emphasis on geologic services to fellow state agencies, local governments, industry, consultants, schools, and the general public. Our annual list of callers has grown to thousands and reads like a who's who of Pennsylvania. Such service represents the application and utilization of the geologic knowledge acquired in our project work and is a reflection of the pertinence of our geologic activities.

Over the past 25 years our Survey has taken on many new responsibilities as the role of geology has received wider recognition. Our involvement has grown to include such environmental issues as waste disposal siting, municipal water resources development, geologic hazard mitigation (landslides, sinkholes, radon), and energy resources extraction while minimizing their environmental impacts. The ever-changing applications and needs for geologic data has kept the work environment here dynamic and challenging; truly, never a dull moment.

Our staff is now rapidly adapting to the benefits of computer technology. Keyboards, terminals, and printers in our midst represent new tools which will provide a major step forward in retrieval, correlation, and interpretation of the mass of geologic data which has been acquired over the years. And while some of us old-timers may fret and mutter choice words when these computers develop "bugs" and "crashes", I have to concede they are tremendous assets as supporting tools.

I wish to extend sincere thanks to the U.S. Geological Survey for continuing to carry on the cooperative programs in geology, water resources, and topographic mapping which were initiated long before my time and whose products have been of great assistance in fulfilling the needs of our Survey and the citizens of Pennsylvania. Ours was one of the first large states to have completed topographic map coverage of the state as a result of the co-op program with the U.S.G.S. Similarly, the co-op groundwater investigations have covered large areas of Pennsylvania. By now my U.S.G.S. colleagues know that when I prod them its because we like their efforts so much we want more! The U.S. Bureau of Mines has also been of important assistance over the years in our work with mineral resources. May these federal support programs continue long into the future!

I am particularly appreciative of the support and confidence provided to me by the seven agency heads I have served under over the past 25 years. Secretary of Internal Affairs Genevieve Blatt was (and is) a staunch supporter of the Survey and our policy to expand its efforts and services. Following her were Secretaries John Tabor, Irving Hand, and Environmental Resources Secretaries Dr. Maurice Goddard, Cliff Jones, Pete Duncan, and currently, Nick DeBenedictis. Each provided welcome support and encouragement to the programs and activities of our Survey.

As 1986 is the 150th anniversary of the founding of the Pennsylvania Geological Survey, I feel proud and privileged to have served as the eighth State Geologist of this distinguished organization. I am confident that it will have a long and healthy future. There will be changes, as there should be for the sake of progress. There is much work yet to be done here in Pennsylvania and the role of geology is ever evolving. Therein lies the excitement and the challenge of the Pennsylvania Geological Survey.

To my successor, to the Pennsylvania Survey, and to all of you kind readers, I extend my sincere best wishes.

Arthur A. Socolow

A Sesquicentennial Story
SUSQUEHANNA RIVER WATER GAPS: MANY YEARS OF SPECULATION

by W. D. Sevon
Pennsylvania Geological Survey

The Problem

The Susquehanna River water gaps north of Harrisburg (Figure 1) have probably inspired more speculation about their origin than any other feature of Pennsylvania landscape. The five impressively scenic water gaps sever imposing, elongate, uniform ridges of resistant rock in apparent defiance of proper stream behavior; that is, the Susquehanna River has cut through the ridges in places which logic suggests could have been avoided by lateral stream migration. Theories about the position of the gaps have been numerous and imaginative.

Some Historical Solutions

The first theory about the water gaps, derived from near folklore of the early 1700's, suggested that the gaps were formed when oceanic waters, which existed as large lakes dammed by the mountain ridges subsequent to uplift of the land above the general level of the sea (possibly the Mosaic flood), burst forth in a catastrophic fashion and cut the water gaps to their present form (Miller, 1939, p. 13–24).

Henry D. Rogers, geologist of the First Geological Survey of Pennsylvania, attributed the erosion of the gaps to paroxysmal movements of oceanic waters during mountain building and the location of each gap to erosion at a position of weakness created by a transverse fault (1858, v. 2, p. 895–897).

Literature of the Second Pennsylvania Geological Survey is largely descriptive and few words are devoted to origins. Claypole (1885, p. 21–23) visualized the downcutting of the Susquehanna River as a slow, lengthy, and continuing process, but said nothing about the location of the water gaps.

William Morris Davis, in his classic paper "The rivers and valleys of Pennsylvania" (1889), attributed the location of the gaps to the circumstance of superimposition. He hypothesized that long-

*Celebrating 150 years of The Pennsylvania Geological Survey—1836 to 1986.

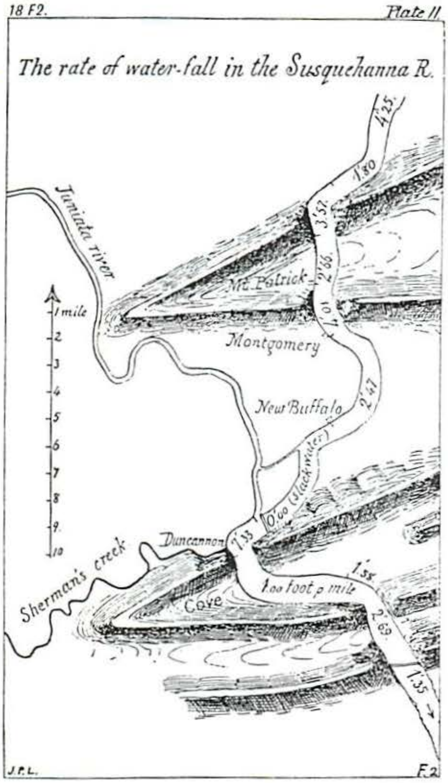

Figure 1. Map of the Susquehanna River water gaps north of Harrisburg and the linear ridges through which they cut (from Claypole, 1885, p. 18).

continued erosion in the Appalachian Mountains produced the Schooley peneplain: a relatively flat, continuous surface, now evidenced only by the crests of the linear ridges (Figure 1). The ancestral Susquehanna River meandered across this surface. Uplift and rejuvenated stream erosion caused river incision at locations unrelated to structural position.

Johnson (1931) also relied on circumstance to account for the gap locations, but by a slightly different mechanism. Johnson hypothesized that a marine transgression occurred across a peneplain surface into the central part of Pennsylvania during the Cretaceous. Deposition of a blanket of sediments supposedly occurred, the sea regressed, and the consequent drainage developed on the sediment surface established some of the stream positions we see today. Thus, as the unconsolidated coastal-plain sediments were eroded, Johnson thought that the major rivers, such as the Susquehanna, maintained a course across the trend of the underlying folded rocks.

Subsequent workers Meyerhoff (1936; 1972) and Thompson (1949) suggested that the gap locations are related to a variety of rock weaknesses or structural positions, but that the course of the river results from gradual headward erosion over a long period of time. Epstein (1966) has argued for structural control of other water gaps in Pennsylvania, and Theisen (1983) recently documented structural weakness in Blue Mountain at the Susquehanna River water gap. Neither worker offers any suggestions as to how rivers establish themselves in these special positions.

A New Proposal

I have argued elsewhere (1985a, b) that neither peneplanation nor a Cretaceous transgression has occurred in the Appalachian Mountains. Because new structural interpretations in southeastern Pennsylvania are considered by some to indicate that the Anthracite basins were once covered by a thrust sheet (Levine, 1985; MacLachlan, 1985), I suggest that following Alleghanian deformation the ancestral Susquehanna River flowed north along the margin of the Anthracite thrust sheet (Figure 2) and established the basic course of the river we see today. The flow direction was reversed from north to south by a process of headward erosion and stream piracy. The specific location of each water gap was determined by local structural features (Hoskins, 1986). Once the Susquehanna River was incised into the very resistant rocks which form the linear ridges, the river was locked into position and could not migrate laterally.

There you have it. Over 150 years of speculation has not resolved the question. Are we getting closer to or farther from the truth?

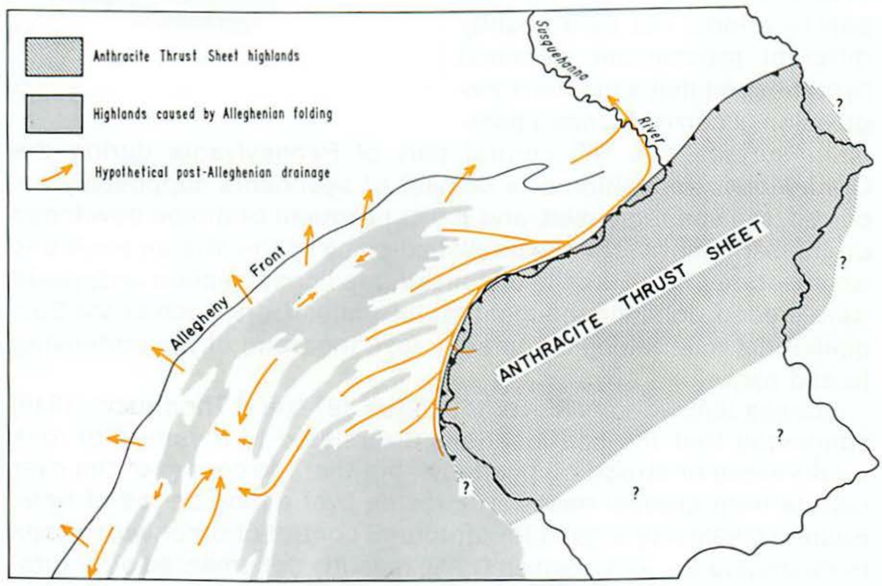

Figure 2. Hypothesized highland areas and drainage network in central and eastern Pennsylvania following Alleghanian deformation.

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NEW U.S.G.S. ADDRESS FOR ORDERING TOPOGRAPHIC MAPS

Effective July 1, 1986, the U.S. Geological Survey is consolidating its Eastern and Western Distribution Sections. All maps must be ordered from: U.S. Geological Survey
Map Distribution
Federal Center, Building 41
Box 25286
Denver, CO 80225

CONTINENTAL CLAY COMPANY
A PART OF PENNSYLVANIA'S MINERAL HERITAGE SINCE 1896

Continental Clay Company of Kittanning, Pennsylvania is the sole surviving United States producer of radial chimney bricks. This type of industrial brick chimney is a common landmark throughout North America. The orange and white aircraft warning bands often seen atop these chimneys are achieved with special glazes developed by Continental Clay. Recently, Continental Clay has been working with various glazes to match the chimney on Ellis Island that is being restored by the National Park Service. The original chimney was built of bricks that came from Germany, and was undoubtedly one of the first sites seen by newly arriving immigrants to this country.

Continental Clay Company has been mining and manufacturing tile and brick products continuously for the past 90 years. Around the turn of the century, according to Henry J. Evans, III, General Manager, most large towns in western Pennsylvania tried to establish two essential industries: a brick plant and a brewery. Kittanning was blessed. At one time, it harbored four brick plants and the now defunct Elk Brewing Company, which is now located on Continental's property. In addition, Armstrong County and Kittanning were well served by railroads and by water transportation via the Allegheny River.

International Chimney Corporation, of Buffalo, New York, the parent company of Continental Clay, purchased Continental Clay Products Company in 1979. Prior to this, three generations of the McNees family worked local clays and shales from underground as well as surface mines for brick and tile manufacture.

GEOLOGY AND MINING. The traditional source of light-colored clay products is from underground workings developed in the Pennsylvanian-age Clarion underclay interval (J. Claycomb, personal communication, 1986). The current service incline and tipple are located about 1400 feet north of the office (Figure 1). An older, sealed adit is said to be near the still-standing mule barn next to the office. Present active underground mining is located about 4000 feet northeast of the incline. Here, about 4.5 feet of basal medium- to light-gray claystone and about 2 feet of upper brownish-black claystone constitute the mining interval. The two distinct claystones are separated by a black claystone band, up to 2 inches thick, used as

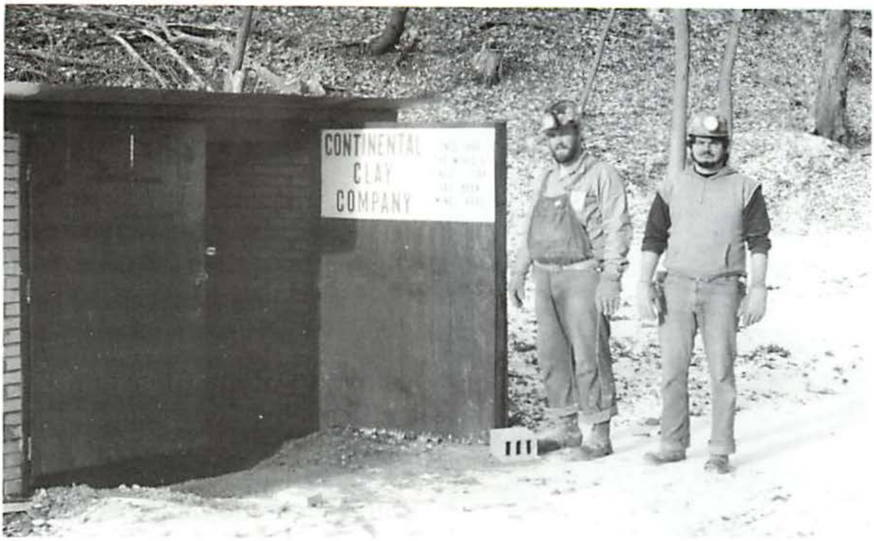

Figure 1. Mr. Joel D. King, Mine Superintendent, and Mr. Keith Bruner, Mine Foreman, standing in front of main service incline. Sign on door reads "Continental Clay Company, since 1896 the world's finest clay has been mined here."

a marker bed throughout the mine. A thin (6- to 8-inch-thick) coal, possibly Clarion (Leighton and Shaw, 1932), can occasionally be seen in the mine roof, especially along north-trending main haulage ways or cross cuts, where roof falls have exposed an additional 5.5 to 7.5 feet of stratigraphic section (Figure 2).

The underground workings are extensive (>100 acres); however, adequate reserves remain. Conventional room-and-pillar mining is used with 12-foot-wide rooms developed on 60-foot centers. Typically, rooms are oriented in an east-west trend. Development faces are drilled with a diesel-powered electric hand drill. Haulage to the surface tipple is with about seven 1-ton rail cars powered by an electric locomotive. The loaded cars are winched up the final tipple incline. Mine production, when needed, is about 70 tons per day in one 7:00 a.m. to 3:30 p.m. shift.

In addition, two surface strip pits currently supply supplemental Pennsylvanian-age shale for red-colored brick and tile products. About 18 feet of a yellowish-gray to light-olive-gray, micaceous, shaly mudstone and a subjacent 15 feet of brownish-black, micaceous, thinly laminated mudstone and claystone are mined about 0.75 mile west-southwest of the office. This sequence is believed to be in the

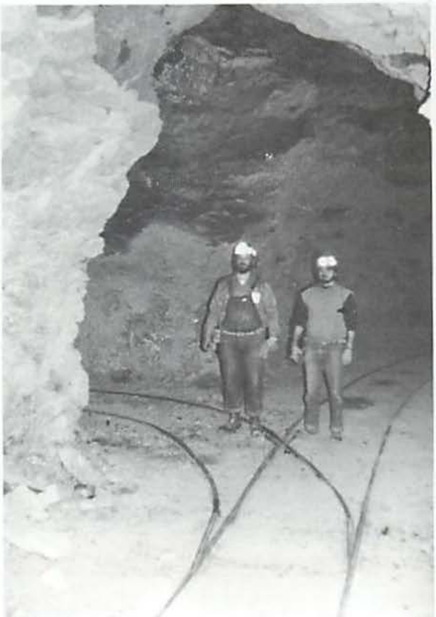

Figure 2. The Clarion underclay interval in the main haulage, where a total of 12 to 15 feet of section is exposed. Note the lighter claystone beneath the darker claystone in the far rib to the left.

lower part of the Glenshaw Formation of the Conemaugh Group (Berg and Dodge, 1981). A second source is mined in Westmoreland County near the village of Sardis, located about 25 miles south-southwest of Kittanning. Here, about 35 feet of moderate-olive-brown to pale-brown claystone, with minor grayish-red interbeds, is exposed on the south side of Pa. Route 286. This has been mapped as the basal Casselman Formation of the Conemaugh Group (Wagner and others, 1979).

MANUFACTURING. The plant in Kittanning is similar to one described by Berkheiser and Inners (1984) and follows the same basic process, only with less automation. Raw material is fed to a primary roller crusher and further reduced in size by two dry pans. This is followed by sizing over a series of screens after which the product is fed into two pugmills. Extrusion through the appropriate dies is followed by a reel-type wire cutting operation. Some structural tile and brick products pass through the glazing line (colored coatings are applied here). Individual unfired clay products are hand loaded onto kiln cars for a trip through one of 17 tunnel driers. These driers are kept at about 135°F by waste heat, and the bricks may spend from 2 to 5 days here depending on the end-product. Moisture content is brought down to less than 2% by preheating the product before it enters the gas-fired 420-foot-long tunnel-kiln. Temperatures in the 32-car tunnel-kiln range from about 400°F at the entrance to about 2275°F in the burn zone. Twenty-four-hour production varies between 8 and 12 kiln cars, depending on the product being fired. After cooling, products are unloaded and packaged for shipment by hand. About 45 to 50 employees are required during production, which is carried on during warm weather to substantially save on fuel bills.

CONCLUSION. Continental Clay Company is rich in mining heritage and has survived the test of time by filling small custom made product niches in the brick and tile industry. As one of Pennsylvania's oldest continuously worked mining companies, the company and its employees are recognized for providing quality handcrafted products in the industrial minerals field.

We are indebted to Mr. Henry J. Evans, III, General Manager, Mr. Joel D. King, Mine Superintendent, and Keith Bruner, Mine Foreman, of Continental Clay Company for their time and cooperation in preparing this article. We also thank Mr. Bill Bragonier and Ms. Joan Claycomb of R&P Coal Company for helping to identify the underground mining interval.

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New County Coal Resource Reports

The Bureau of Topographic and Geologic Survey has released for sale three new county coal-resource reports. The reports, compiled by staff geologists Clifford H. Dodge (M 89 and M 90) and James R. Shaulis (M 91), are three of many that will be published over the next few years for the major bituminous-coal-producing counties in western Pennsylvania. The new coal-resource reports each contain maps showing coal crop lines, surface and deep mined-out areas, and structure contours.

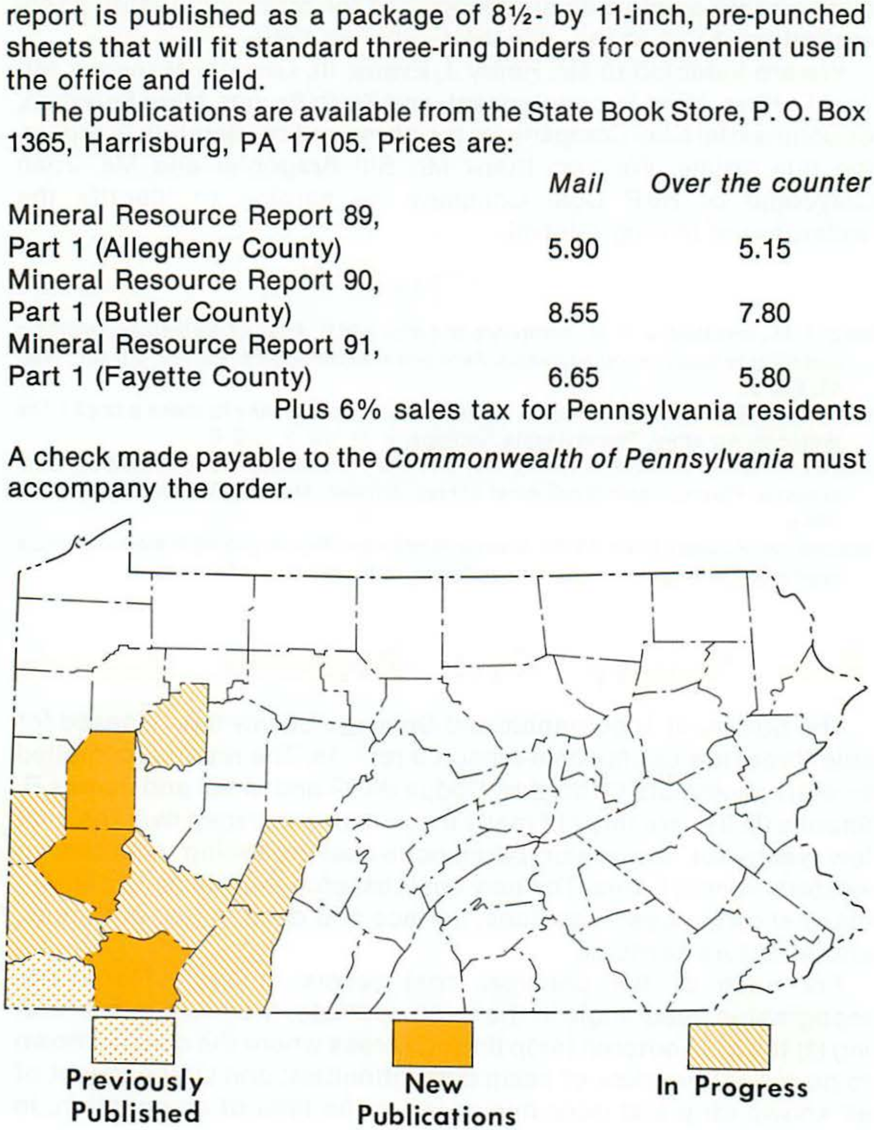
For each of the principal coal seams in each 7½-minute topographic quadrangle in the three counties, there is a map showing (1) the coal outcrop (crop line); (2) areas where the coal is known to be absent because of seam discontinuities; and (3) the extent of all known strip and deep mining up to the time of compilation. In addition, for each quadrangle, there is a composite coal crop map that includes structure contours and fold axes. If none of the principal coals have been mined or crop out in a particular quadrangle, only the second kind of map is included. The two-color maps contain information on sources of published and unpublished data, map reliability, map symbols, map scale (approximately 1:62,500), structure-contour intervals and datums, and names of fold axes. Each report is published as a package of 8½- by 11-inch, pre-punched sheets that will fit standard three-ring binders for convenient use in the office and field.

The publications are available from the State Book Store, P. O. Box 1365, Harrisburg, PA 17105. Prices are:

	Mail	*Over the counter*
Mineral Resource Report 89, Part 1 (Allegheny County)	5.90	5.15
Mineral Resource Report 90, Part 1 (Butler County)	8.55	7.80
Mineral Resource Report 91, Part 1 (Fayette County)	6.65	5.80

Plus 6% sales tax for Pennsylvania residents

A check made payable to the *Commonwealth of Pennsylvania* must accompany the order.



Pennsylvania's 1984 Oil and Gas Developments

In 1984, Pennsylvania's oil and gas industry reported 2,598 wells drilled, a small increase over 1983. The year's total included 1,073 oil wells, 1,379 gas wells, 40 combination oil and gas wells, 60 dry holes, and 46 service wells. The average depth in all wells reported was 2,410 feet. The industry produced 4,824,966 barrels of oil and 166,342 million cubic feet of gas in 1984, for a total value of almost $674 million dollars to industry. Recoverable reserves for oil decreased to 57,859 million barrels, but for gas reserves increased to 1,854,477 million cubic feet. Some of the interesting exploratory and development activity reported included expansion of the Upper Devonian Council Run field in Centre County, and the discovery of the Greenley pool in Erie County. Greenley pool is especially notable because it appears to be a southwestern extension of the fault-controlled Bass Islands play that has kept drillers interested in New York over the last several years.

If this information is interesting or important to you, you will want to obtain a copy of Progress Report 198, *Oil and Gas Developments in Pennsylvania in 1984,* recently issued by the Bureau of Topographic and Geologic Survey. The report includes information on many aspects related to oil and gas in Pennsylvania, including oil and gas prices and drilling costs, secondary and tertiary oil recovery projects, projects in progress at the Survey's Oil and Gas Geology Division, and a summary of the new oil and gas bill that was signed into law in December 1984.

Copies of this report are available from the State Book Store, P. O. Box 1365, Harrisburg, PA 17105 for $2.85 plus 6 percent sales tax for Pennsylvania residents. Checks made payable to the *Commonwealth of Pennsylvania* must accompany the order.

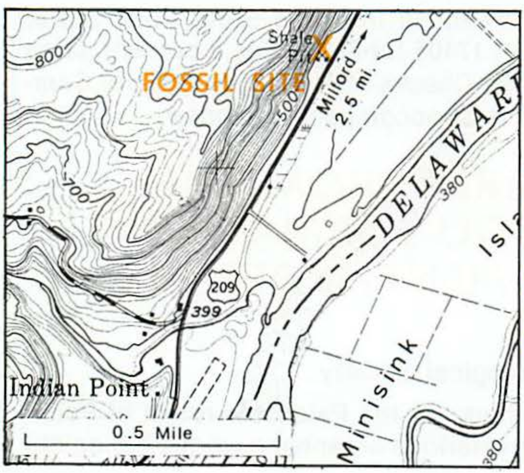
A CONULARID FROM THE MAHANTANGO FORMATION: FIRST DOCUMENTED REPORT

by John M. Kasznica
Delaware Valley Paleontological Society

Many invertebrate fossils found in the Paleozoic rocks of Pennsylvania are the remains of mysterious organisms whose biological affinities are a matter of controversy. Among these are the conularids—small, elongate-pyramidal marine fossils that have distinctly striated, chitinophosphatic shells. Although the conularids appear to have no living relatives, most paleontologists believe that they are an offshoot-branch of the class Scyphozoa ("jellyfish") of the phylum Coelenterata. Some widely used textbooks (Moore and others, 1952; Clarkson, 1979) reject or question this classification and instead consider the conularids part of an extinct phylum.

Whatever their "genealogy," the conularids occur in marine strata that range in age from Early or Middle Cambrian to Early Triassic (or in rocks approximately 570 to 220 million years old). In the Devonian of the Appalachian basin, one species (*Conularia undulata* Conrad) is quite common in the Hamilton Group (Middle Devonian, Erian Stage) of New York State. Conularids are little known, however, from the stratigraphically equivalent Mahantango Formation of Pennsylvania. Previous reports of conularids from this formation have either been proven wrong (see Ellison, 1965; Babcock, 1985) or were cursory (see Hoskins, 1964). This paper is believed to be the first documented report of a Mahantango conularid in Pennsylvania.

A fragment of a conularid (presumably *C. undulata*) was collected by the author from Mahantango siltstone rubble at an abandoned borrow pit about 2 miles southwest of Milford in Pike County (lat. 41°17′42″N/long. 74°49′45″W, Milford quadrangle; Figure 1). (See Hoskins and others, 1983.) The piece of "sharpstone" containing the fossil probably came from the middle member of the Mahantango, the rock unit that forms "The Cliff" along the northwest side of the Delaware River valley in this area (Fletcher and Woodrow, 1970).



NOTE THAT THIS PIT AND ALL OTHERS ON U.S. ROUTE 209 BETWEEN BUSHKILL AND MILFORD ARE NOW PART OF THE DELAWARE WATER GAP NATIONAL RECREATIONAL AREA; FOSSIL COLLECTING ON THIS FEDERAL PROPERTY IS STRICTLY PROHIBITED.

Figure 1. Location map.

The conularid specimen is an incomplete, compressed natural cast in medium-gray siltstone (Figure 2). One side is slightly damaged, and the apical portion is missing. Its exposed dimensions are 1.5 cm long by 1.5 cm wide by 0.5 cm "thick." The visible portion of the shell is shaped like an elongate pyramid with two partially exposed lateral faces. A well-defined furrow marks a corner between two quadrilateral faces, and a median longitudinal groove (parietal line) is just discernible on the right lateral face (see Figure 2). The lateral

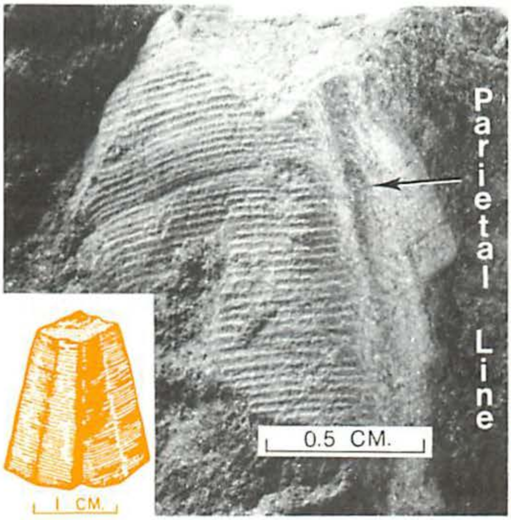


Figure 2. ***Conularia* sp. cf. *C. undulata* Conrad from the Mahantango Formation in Pike County. Inset shows a partial reconstruction of an uncompressed specimen; note the quadrangular outline.**

surfaces are covered with fine transverse striae that have a definite corrugated pattern. Reconstruction of the entire shell suggests that it measured 3.5 cm long and 2 cm in diameter. Since this is relatively small for *C. undulata* (see Hall, 1879), perhaps the specimen is a juvenile form.

Like their phylogeny, the mode of life and environmental tolerances of conularids are conjectural. They are generally interpreted to have been sessile-benthonic as juveniles and nektoplanktonic as adults (Moore and others, 1952; Shrock and Twenhofel, 1953). All juvenile conularids apparently lived attached by the pointed apical end, but in many species the adults seem to have broken loose and become free-moving (Figure 3). In normal marine rocks, conularids usually occur sparingly in company with more numerous corals, brachiopods, bryozoans, mollusks, and arthropods; however, they may be the dominant organic remains in deposits representative of some unusual environments, e.g. certain phosphate-rich, Pennsylvanian black shales in the central United States (Moore and others, 1952). Since the

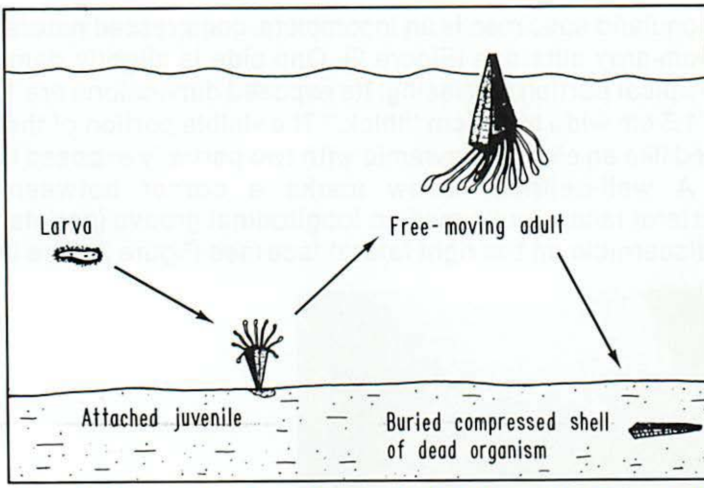


Figure 3. An interpretation of a conularid life cycle. The adult orientation is hypothetical.

Mahantango specimen described here was found in rubble, little is known of its ecologic association. An increased understanding of these creatures in the Devonian rocks of Pennsylvania awaits the discovery of more complete, in-situ specimens.

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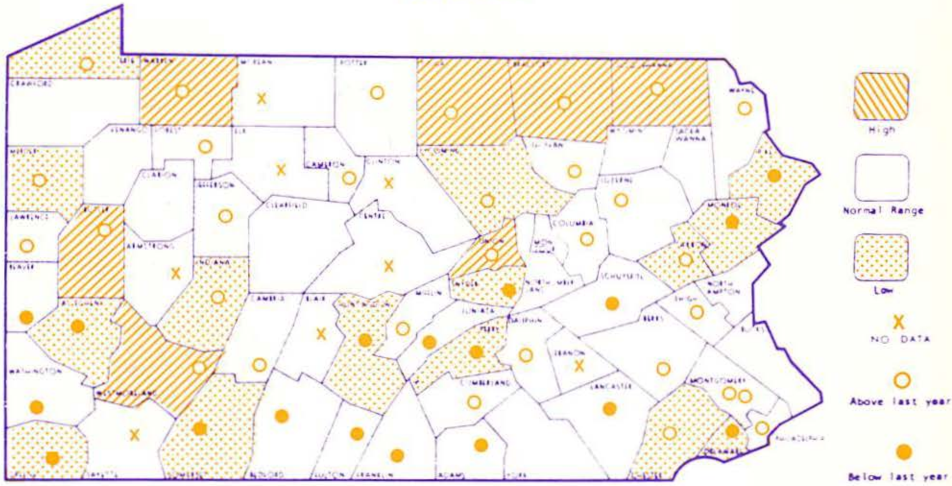

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