PENNSYLVANIA GEOLOGY

PENNSYLVANIA GEOLOGICAL SURVEY VOL. 22/1

COMMONWEALTH OF PENNSYLVANIA
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BUREAU OF TOPOGRAPHIC AND GEOLOGIC SURVEY
Donald M. Hoskins, Director

CONTENTS

ON THE COVER: Doubling Gap, Cumberland and Perry Counties, looking southwest. Blue Mountain, capped by the resistant Tuscarora Formation, "doubles back" on itself and forms a plunging anticline. The phenomenon may be related to a change in regional strike of about N50°E southwest of the gap to N80°E east of the gap. In the upper right background, Blue Mountain extends past the horizon, and the Great Valley is to its east (left). The town in the right foreground is Landisburg. Photograph by T. A. McElroy.

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Editors, Christine M. Dodge and Donald M. Hoskins.

VOL. 22, NO. 1 **SPRING 1991**

Past, Present, and Future

On January 19, 1971, the Pennsylvania Legislature established the Department of Environmental Resources. The department was born of the inevitable conflict resulting from an increasing population's growing demands on natural resources that are limited. Its charge was to define and reconcile the need of the public to use resources with the need to protect the environment of Pennsylvania. The Topographic and Geologic Survey of Pennsylvania was made part of the new department in recognition of the importance of geologic and topographic information in environmental protection and the responsible development and use of Pennsylvania's natural and mineral resources.

Following these two decades of public service, the department has been reorganized to better accomplish its charge. The Survey has been placed with the Bureaus of State Parks and Forestry in an organizational unit concerned with recreational and land resource issues. The role of the Survey has been, and will continue to be, collecting and analyzing geologic and hydrogeologic data to address public interests involving natural resources and environmental geology. Under the new organizational structure, the programs of the Survey will continue without major redirection.

The planned February, April, and June 1991 issues of *Pennsylvania Geology* are being combined into this spring issue. Future 1991 issues await a new budget for the upcoming fiscal year and a decision on whether to begin a subscription service.

More than 2,600 readers from Pennsylvania and 35 other states responded to our notice that the February issue of *Pennsylvania Geology* would not be published. Of those who responded, 98 percent asked to continue to receive *Pennsylvania Geology*. Of those, 72 percent said they would subscribe if a fee was necessary. We thank you all for your responses and your support.

We are very grateful to the nearly 1,100 respondents who wrote personal notes and suggestions for improving *Pennsylvania Geology*. Although 29 percent said no changes are needed or desired, for some time we have been considering format, size, sequence, and content changes. The comments we received will be a guide for us in deciding which changes, if any, will improve *Pennsylvania Geology*.

The Survey's assigned tasks of objectively defining, mapping, and reporting on Pennsylvania's geology and topography to support related public interests are not finished. Future decades will require at least as much as has been accomplished. Through our new organizational structure and through a reborn *Pennsylvania Geology*, we will proceed.

Donald M. Hoskins

Donald M. Hoskins
State Geologist

THE SECOND LEHIGH TUNNEL:
Geology and the New Austrian Tunneling Method

by Jack B. Epstein, U.S. Geological Survey, and
Patricia F. Buis, Pennsylvania Geological Survey*

The Northeast Extension of the Pennsylvania Turnpike (Pennsylvania Route 9) is a major traffic artery in eastern Pennsylvania, extending for 110 miles from the Pennsylvania Turnpike (Interstate Highway 276) near Philadelphia northward to Scranton. The four-lane highway narrows to two lanes at the approaches to the present Lehigh Tunnel through Blue Mountain, a nearly 1,000 foot high ridge at the boundary of Lehigh and Carbon Counties, about 13 miles north of Allentown and 1 mile southwest of Palmerton (Figure 1). Occasionally, this constriction has been the cause of miles-long traffic jams, especially during the summer months, when vacationers visit the Pocono Mountains. In February 1989, construction began on a second two-lane tunnel immediately west of the original. The tunnel

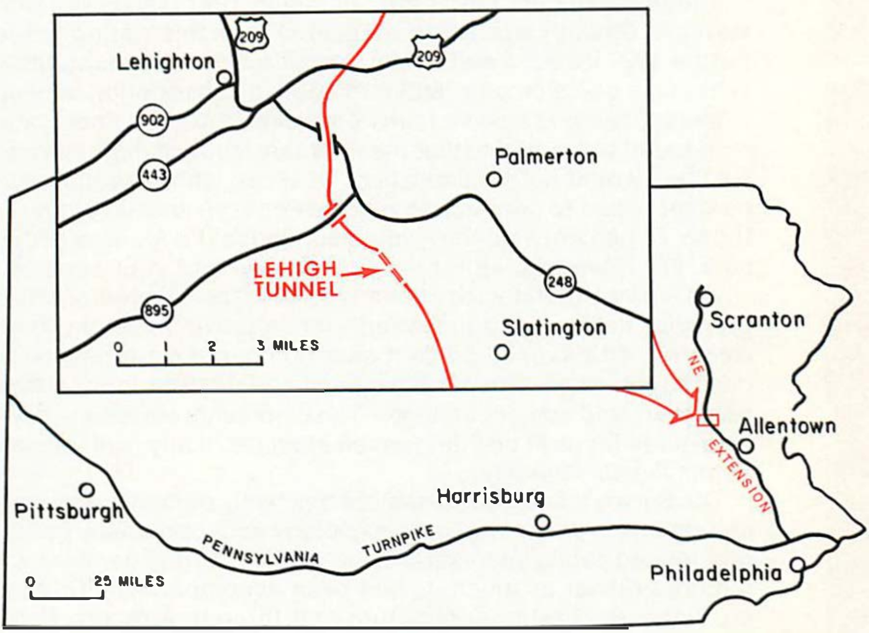


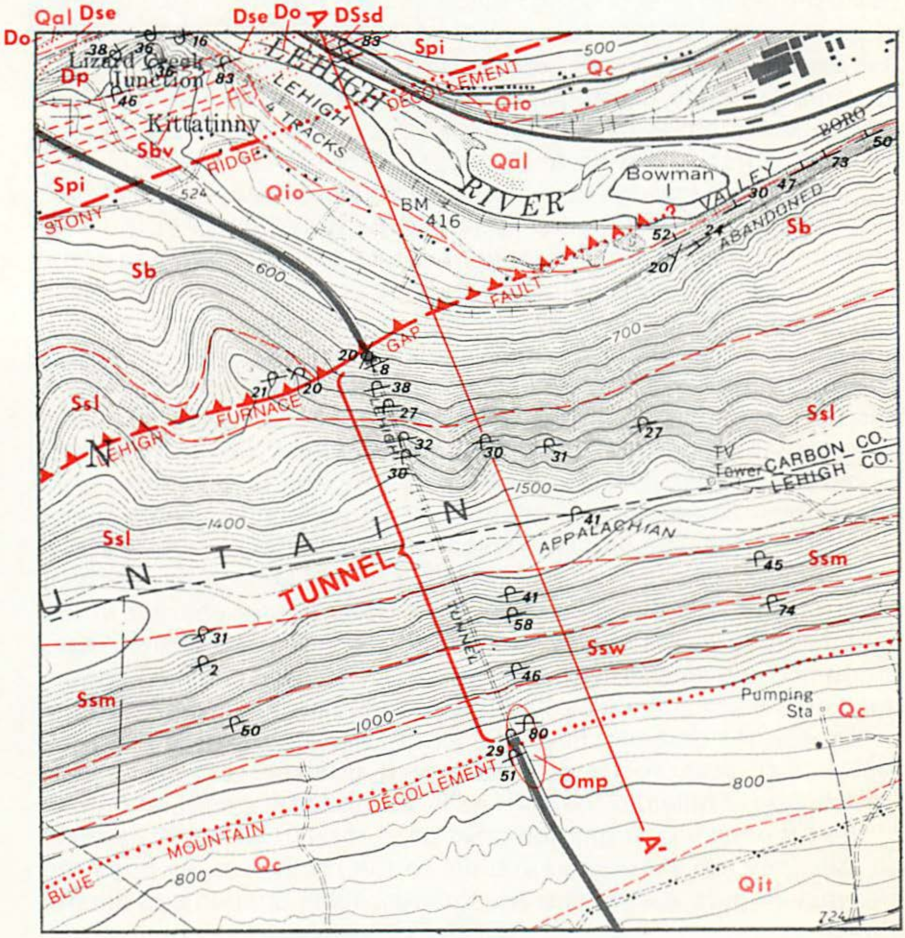
Figure 1. The location of the Lehigh Tunnel on the Northeast Extension of the Pennsylvania Turnpike.

*Present address: 285 East Main Street, Apartment 5, Middletown, PA 17057.

has a projected cost of $37.8 million and will require the excavation of an estimated 200,000 cubic yards of material from Blue Mountain. It is expected to be completed and open for traffic in fall 1991 (Pennsylvania Turnpike Commission, oral communication, 1991).

Blue Mountain is part of a nearly continuous ridge that forms a natural barrier to the north and west of the Great Valley physiographic section through Pennsylvania from New Jersey into Maryland and beyond. At the tunnel site, slates and graywackes of the Martinsburg Formation are present at the south portal, succeeded northward by Silurian quartzites, conglomerates, and shales of the Shawangunk Formation and then by red and green sandstones, siltstones, and shales of the Bloomsburg Formation. These are further succeeded northward by a variety of Silurian and Devonian strata (Figure 2A). These rocks were complexly deformed during the late Paleozoic Alleghanian orogeny. The Martinsburg Formation was also affected by earlier Taconic (Ordovician) deformation and is separated from the younger Shawangunk Formation by an angular unconformity of regional extent. The orogenic episodes created folds, faults, cleavage, joints, surfaces of movement with slickenlines, and a variety of fractures filled with secondary quartz, calcite, and chlorite in the various units. At the unconformity in the tunnel, the Martinsburg is overturned and dips 35 degrees to the southeast, whereas the Shawangunk dips more steeply by 10 degrees and is also overturned to the southeast. No orogenic displacement has taken place at this contact or in adjacent rocks, as is evidenced at the contact exposed at Lehigh Gap, 2 miles to the northeast. At the north portal, the rocks of the Bloomsburg Formation have been rotated past 180 degrees so that they are overturned and dip to the northwest, as does the cleavage (Figure 2B; Epstein and Epstein, 1969; Epstein and others, 1974).

A topographic bench at an altitude of 1,100 feet on the north slope of the mountain, 0.4 mile west of cross section A–A′, marks the position of an imbricate thrust fault at which the overriding beds have been moved up to the northwest and subsequently folded so that the hanging wall is presently down to the northwest. The structure, the Lehigh Furnace Gap fault (Figure 2B), was shown in cross section by Epstein and others (1974) to cut bedding at very high angles. However, because the fault lies at a very low angle to the structural grain (Figure 2A), the fault is reinterpreted to be an imbricate fault that ramps up from a thrust subparallel to bedding in the Martinsburg Formation (Figure 2B). Several similar ramps have been mapped in the New Tripoli and New Ringgold quadrangles to the west, and the entire fault system in the Shawangunk and Bloomsburg Formations is now interpreted as a duplex. The ramps join the floor thrust in



SCALE

0 0.5 MI

EXPLANATION

Bedrock

Surficial

Geologic contacts

Dashed where approximately located; short dashed where inferred; dotted where concealed.

24

Inclined

Vertical

30

Overturned

Strike and dip of bedding

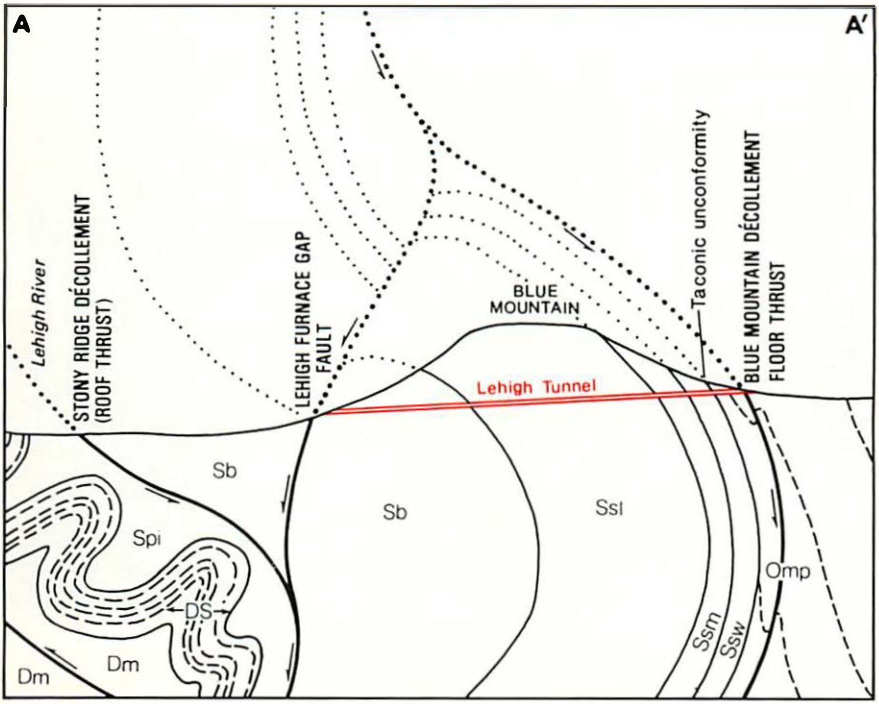
Thrust fault

Sawteeth on upper plate. Dashed where approximately located; short dashed where inferred; dotted where concealed.

Décollement

Dashed where approximately located; dotted where concealed.

2A



2B

Figure 2. Geologic map and cross section at the site of the Lehigh Tunnel (modified from Epstein and others, 1974). A. Bedrock geologic map. B. Geologic cross section. Dashed lines in cross section show bedding within stratigraphic units; dotted lines show contacts projected above ground. Omp, Pen Argyl Member of the Martinsburg Formation; Ssw, Weiders Member of the Shawangunk Formation; Ssm, Minsi Member of the Shawangunk Formation; Ssl, Lizard Creek Member of the Shawangunk Formation; Sb, Bloomsburg Formation; Spi, Poxono Island Formation; DS, various units of Upper Silurian and Lower Devonian age; Dm, Marcellus Formation; Qit, pre-Illinoian till; Qio, pre-Illinoian outwash; Qc, colluvium; Qal, alluvium.

the Martinsburg with a roof thrust in the Bloomsburg, as depicted in Figure 2B. The roof thrust is not exposed, but it is interpreted to be present in the upper part of the Bloomsburg concealed beneath the valley of the Lehigh River. The new Lehigh Tunnel passed through a fault zone, which is believed to be the floor thrust in the Martinsburg, about 350 feet south of the contact with the Shawangunk Formation. This zone is about 27 feet wide and contains intensely sheared and rotated rocks with abundant quartz veins (Figure 3). If this zone is, in fact, the floor thrust of a duplex, it must extend for many miles to the northeast and southwest, parallel to the south slope of Blue Mountain. However, it has only been seen in the tunnel—elsewhere

Figure 3. Shear zone in the Martinsburg Formation exposed in the new Lehigh Tunnel on January 24, 1990, believed to be the floor thrust of a duplex in the Shawangunk and Bloomsburg Formations. Welded wire fabric and spilling pipes at the top are part of the "shotcrete" canopy used to reinforce the tunnel crown and protect the tunnel opening.

the strata that would contain it are buried by thick colluvium and glacial deposits. The floor and roof thrusts may coincide with detachments that have been interpreted to separate lithotectonic units of differing structural characteristics—the Blue Mountain décollement and Stony Ridge décollement, respectively (Figure 2B).

On the north slope of the mountain, at least 15 feet of colluvium was exposed during construction, although in places nearby it is as much as 50 feet thick. The colluvium consists of a mixture of shale and sandstone fragments up to 1 foot long in a pale-reddish-brown silty matrix. No glacial deposits were seen there. On the south side of the mountain, however, the surficial materials consist of a thicker apron of deeply weathered yellowish-brown colluvium and grayish-orange to reddish-brown till, probably of pre-Illinoian age (see Epstein and others, 1974, p. 223). The Martinsburg Formation immediately under the till is also weathered to depths of as much as 50 feet. During preliminary construction in the fall of 1989, a series of small, tight, overturned kink folds was exposed in the Martinsburg just under the till, a few hundred feet south of the tunnel portal (Figure 4). These

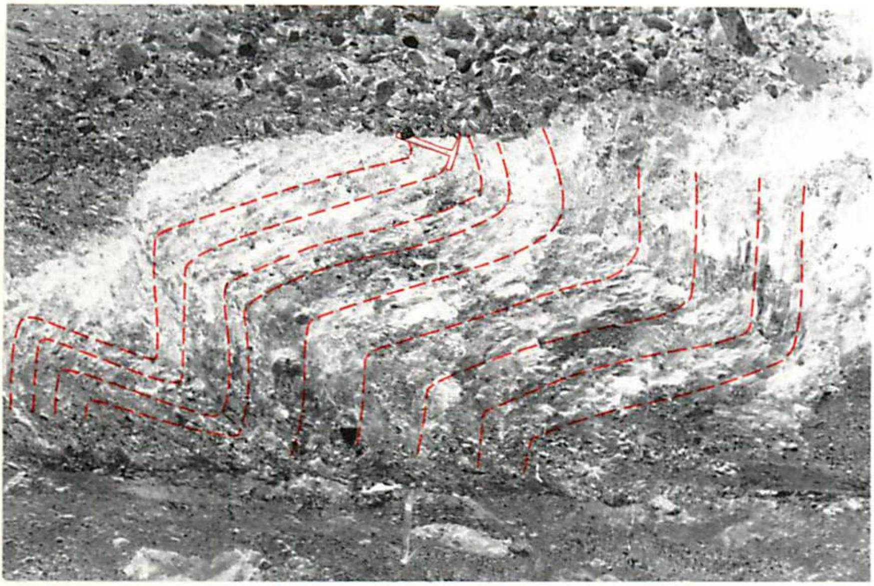


Figure 4. Folds, possibly produced by ice push, in weathered Martinsburg Formation slates underlying pre-Illinoian till near the Lehigh Tunnel on the south slope of Blue Mountain. View looking westward. Hammer gives scale.

folds have wavelengths of about 13 feet and amplitudes of 1 to 2 feet. They verge to the south, opposite to the regional tectonic folds that verge to the northwest. The folds may have formed either by downslope creep or in response to ice push by an overriding pre-Illinoian glacier. The orientation of the fold axes is approximately N60°W, about 45 degrees from the trend of the ridge, which is N75°E. This orientation suggests, but does not prove, a glacial origin for the folds.

The geologic structures found in Blue Mountain created a variety of problems for tunnel construction. An innovative European engineering technique, the New Austrian Tunneling Method (NATM), was used to cut through these rocks. NATM differs from other tunneling techniques in several ways. The tunnels are lined with strengthening material, including rock bolts, welded wire mesh, and lattice girders, immediately after a few feet are excavated, and covered with pneumatically emplaced concrete, or "shotcrete" (Associated Pennsylvania Constructors, 1989). The advantage of this technique is that the rock mass surrounding the tunnel becomes self supporting, so the need for conventional steel support beams is eliminated, thus reducing the costs of construction significantly. Because of this process, the final cross-sectional shape of the tunnel is elliptical, rather than the conventional parallel-sided horseshoe shape (Figure 5).

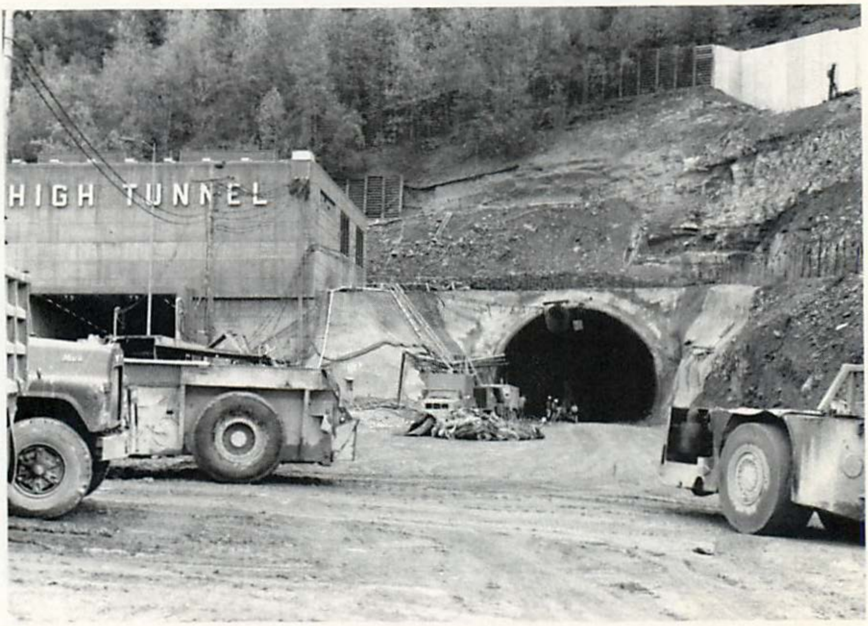


Figure 5. North portal of the second Lehigh Tunnel excavated in the Bloomsburg Formation. Bedding is overturned and nearly recumbent. Note the elliptical shape of the tunnel bore, a diagnostic feature of the New Austrian Tunneling Method.

As part of NATM procedures, continuous pressure and convergency readings must be taken during the tunneling to monitor rock behavior. These readings gauge the amount of support needed at any particular location in the tunnel. Overall, the Martinsburg Formation has required the most support and the Shawangunk Formation the least. However, variations in local rock characteristics have prevented setting definite support limits for each rock unit.

Excavation of the tunnel proceeded from both sides of the mountain and was guided by laser beams positioned by satellite telemetry. The tunnel "holed through" on June 13, 1990, and Ken Pukita, the project manager, noted that the two laser beams coming in from opposite ends of the tunnel were off by only a couple of inches.

The Pennsylvania Turnpike was built 50 years ago as the nation's first four-lane superhighway. For many years, however, two-lane tunnels provided an obstacle to the efficient flow of traffic. In recent years, such impediments have been removed from the Turnpike's main line by the burrowing of parallel tunnels to allow four lanes of traffic, and by rerouting segments of the highway, allowing the elimination of some tunnels. The completion of the second Lehigh Tunnel this fall will remove the last of these impediments on the Pennsylvania Turnpike and provide for more efficient travel along the corridor between Philadelphia and Scranton.

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Epstein, J. B., and Epstein, A. G. (1969), *Geology of the Valley and Ridge province between Delaware Water Gap and Lehigh Gap, Pennsylvania,* in Subitzky, Seymour, ed., *Geology of selected areas in New Jersey and eastern Pennsylvania and guidebook of excursions,* New Brunswick, N.J., Rutgers University Press, p. 132-205.

Epstein, J. B., Sevon, W. D., and Glaeser, J. D. (1974), *Geology and mineral resources of the Lehighton and Palmerton quadrangles, Carbon and Northampton Counties, Pennsylvania,* Pennsylvania Geological Survey, 4th ser., Atlas 195cd, 460 p.

NEW PUBLICATIONS

OIL AND GAS DEVELOPMENTS IN PENNSYLVANIA IN 1989

The Pennsylvania Geological Survey's annual summary of developments in the oil and gas industry for 1989 has recently been released as Progress Report 203. This publication includes news of the industry, such as information on production and reserves, drilling and well completions, and exploration and development. A lengthy table contains summarized records of wells that penetrated rocks of Middle Devonian or older age. The report also includes information on Survey developments that might assist the industry, such as current research on oil and gas resources and the availability of Survey publications and open-file reports that are concerned with these commodities.

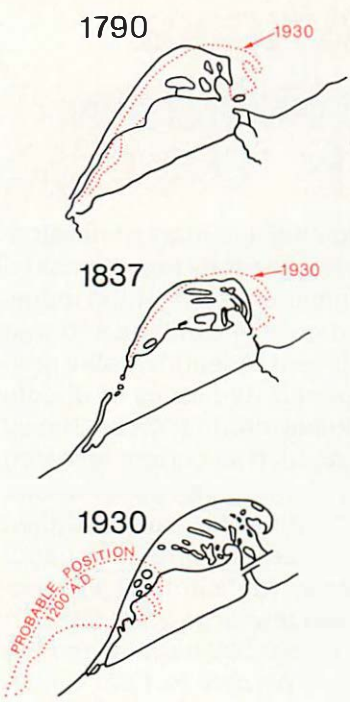
According to this report, there was a general decline in productivity and activity in the oil industry in Pennsylvania in 1989. Production decreased by 7.3 percent from the previous year to 2,601,982 barrels, reserves decreased by 3.6 percent to 41,563,000 barrels, and the total number of wells drilled decreased by 14 percent to 1,527. Sixty-seven percent of those wells were in Warren County, which also led the state in production with 827,916 barrels, or 31.8 percent of the state's total. In contrast to the overall trend for Pennsylvania, that production is 28.3 percent higher than Warren County's production in 1988. Other counties showing increases in production in 1989 were Allegheny, Butler, Clarion, Clearfield, and Jefferson.

The number of gas wells decreased by 19 percent from the previous year, and gas reserves decreased slightly, but gas production rose by 14.8 percent. Seventy-five percent of all gas wells drilled in Pennsylvania were in Warren, Indiana, Venango, Armstrong, Crawford, Erie, Clearfield, and Clinton Counties.

Progress Report 203, **Oil and Gas Developments in Pennsylvania in 1989,** by John A. Harper and Cheryl L. Cozart, is available by mail for $3.25, plus 20¢ sales tax if mailed to a Pennsylvania address, from the State Book Store, 1825 Stanley Drive, Harrisburg, PA 17103. Orders must be prepaid; please make checks payable to *Commonwealth of Pennsylvania*.

—*J. H. Barnes*

GUIDE TO PRESQUE ISLE STATE PARK



An illustration from Park Guide 21 showing the growth of Presque Isle (modified from Jennings, O. E., 1930, Carnegie Magazine, v. 4, p. 171-175).

Named by the French during the eighteenth century, Presque Isle— literally meaning "almost an island"—is rich in history, wildlife, and recreational opportunities. Yet, as revealed in newly issued Park Guide 21, entitled **Presque Isle State Park, Erie County—A Dynamic Interface of Water and Land,** this picturesque area is much more and affords a rare opportunity to view some of the Commonwealth's recent geologic past and various geologic processes actively at work today. As noted by the author, staff geologist Helen L. Delano of the Pennsylvania Geological Survey, Presque Isle, a peninsula and recurved spit, consists of many environments—including beaches, dune ridges, interdune ponds and marshes, and sheltered harbor—all of which are affected and modified through time by the ceaseless actions of waves, currents, and wind.

The 13-page park guide contains a comprehensive overview of the geologic history and depositional environments of Presque Isle and the roles that different geologic processes and human interactions have on modifying its landforms. Topics covered include the origin, growth and migration, and present profile of Presque Isle. Processes responsible for the erosion, transport, and deposition of sediment in different localities are also discussed. Weather and climate are shown to have a profound effect on rates of erosion. It is not surprising that man has endeavored to control erosion and stabilize beaches here for more than a century; the methods employed and their relative success are succinctly summarized. The author concludes that "wise recreational use of this unique coastal land requires careful planning to balance the demands of maintaining public access and service facilities against the possibilities of damaging the complex system of interacting forces which is the shoreline environment."

Published by the Pennsylvania Geological Survey, Park Guide 21 was prepared in cooperation with the Bureau of State Parks, Department of Environmental Resources. It is available free at Presque Isle State Park, or upon request from the Pennsylvania Geological Survey, Department of Environmental Resources, P. O. Box 2357, Harrisburg, PA 17105-2357.

—C. H. Dodge

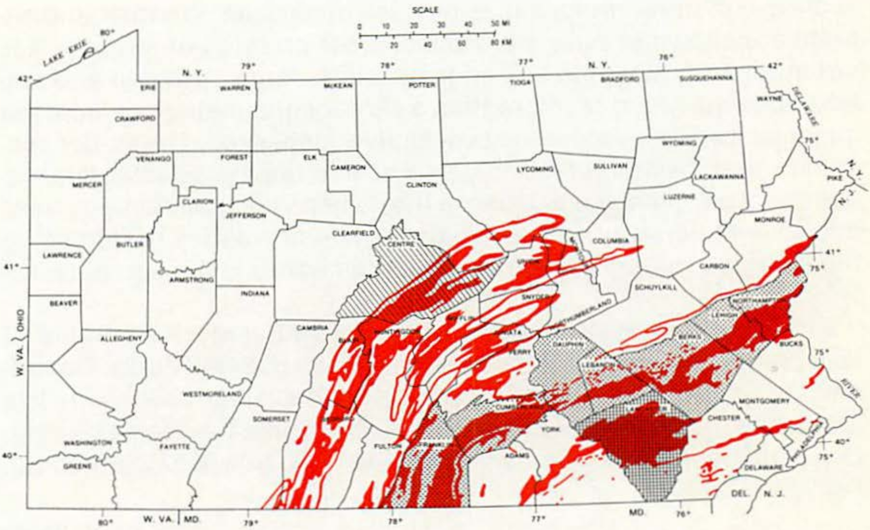
SINKHOLES AND KARST-RELATED FEATURES OF LANCASTER COUNTY

All too often, Pennsylvanians find that what seems to be solid ground under their roads and buildings is anything but solid. Unexpected openings of sinkholes annually cost Commonwealth citizens and businesses thousands of dollars, lost time, and, in some cases, personal injury.

Thanks to a program launched in 1985 by the Pennsylvania Geological Survey, it may be possible to avoid problems caused by sinkholes. The purpose of the program is to identify areas of carbonate bedrock in Pennsylvania that are susceptible to sinkhole development and areas that have a reported history of sinkhole occurrence. The data can be used to develop information leading to preliminary site investigations for land use and development.

To disseminate the information as rapidly as possible, project results are published as open-file reports on a county-by-county basis. The eighth report of the series, Open-File Report 90-01, **Sinkholes and Karst-Related Features of Lancaster County, Pennsylvania,** compiled by staff geologist William E. Kochanov, has recently been released.

The report consists of a brief explanatory text and eighteen 7.5-minute (1:24,000 scale) topographic quadrangle maps. The text contains an introduction, a description of methods used in compiling the report, references, and a glossary. The maps show depressions



EXPLANATION

Area of central and eastern Pennsylvania underlain by carbonate rocks

Area of this report

Area of previously issued reports

Area of report in progress

(closed, semiclosed, and linear), sinkholes, surface mines, cave entrances, and bedrock geology.

The report may be examined at the offices of the Pennsylvania Geological Survey, 9th floor, Executive House, 101 South Second Street, Harrisburg. Copies of the report may be purchased by mail at the prepaid copying and shipping cost of $45.00, plus $2.70 sales tax if mailed to a Pennsylvania address. Send mail orders to the Pennsylvania Geological Survey, P.O. Box 2357, Harrisburg, PA 17105-2357. Checks should be made payable to *Commonwealth of Pennsylvania*.

—*T. A. McElroy*

AAPG PUBLISHES LEIDY GAS FIELD REPORT

As a paper in the first volume of its new series of publications, the *Atlas of Oil and Gas Fields* (part of the *Treatise of Petroleum Geology*), the American Association of Petroleum Geologists (AAPG) has recently released a comprehensive report on the Leidy gas field in Clinton and Potter Counties, north-central Pennsylvania. Authored by John A. Harper, Chief of the Oil and Gas Geology Division of the Pennsylvania Geological Survey, the study contains a detailed account of the history, structure, stratigraphy, trap mechanisms, reservoir characteristics, source beds, and exploration concepts of this historically important gas field. A number of atlases based on trap type are planned and will include several hundred studies of various oil and gas fields worldwide. Three atlases have been published to date.

The Leidy gas field is particularly noteworthy because of the large quantities of natural gas that it produced and because it ushered in a new period of intense oil and gas exploration and development in the Appalachian basin commencing in 1950. The Leidy field consists of six pools, five of which are in the Lower Devonian Ridgeley Sandstone and one in the Upper Devonian Lock Haven Formation. The pools are situated along both flanks of the thrust-faulted Wellsboro anticline and cover an area of more than 24,000 acres. Leidy is considered to be a "deep" gas field with well depths typically exceeding 5,500 to 6,000 feet. Ridgeley Sandstone reservoirs have a combination of structural and diagenetic (i.e., porosity changes) traps, whereas those of Lock Haven reservoirs are chiefly stratigraphic and diagenetic.

The success of the Leidy field was the result of the discovery of gas in the Ridgeley Sandstone, the principal reservoir, in 1950. Although most of the Ridgeley reservoirs were exhausted by 1959 and thereafter converted to storage, the ultimate recoverable reserves in the Ridgeley Sandstone are estimated at 175 billion cubic feet. Ridgeley pools in the Leidy field generally produced large amounts of gas, but were relatively short lived. Some of the Ridgeley wells were spectacularly successful, and one holds the record of the largest official open flow in the Appalachian basin—a reported natural open flow of 145 million cubic feet of gas per day! High-pressure blowouts were a potential hazard in the Leidy field, and the services of none other than "Red" Adair, the famous well-fire expert, were required on at least three separate occasions.

Harper concludes that the lack of suitable structures combined with sufficient porosities makes it unlikely that Ridgeley pools similar to those in the Leidy field will be found elsewhere in north-central Pennsylvania. On the other hand, he notes that the Lock Haven Formation has only recently been recognized as a potentially good reservoir; little development in this formation has occurred prior to 1980. Lock Haven sandstones have been shown to be good reservoirs for both natural gas and oil in the vicinity of the Leidy field. Because it appears to be the best hope for future recoverable reserves in the area, the author recommends thorough test drilling of the Lock Haven Formation throughout north-central and northeastern Pennsylvania.

This report will be of value to geologists interested in detailed field studies illustrating various ways oil and gas are trapped within Pennsylvania and the Appalachian basin. It will also be of use to anyone concerned with the history of oil and gas geology.

All studies in the *Atlas of Oil and Gas Fields* follow a standard format. Texts are concise yet comprehensive. Illustrations are abundant. Detailed "census" information on field description and production data is summarized in two appendices.

Harper's report, entitled *Leidy Gas Field, Clinton and Potter Counties, Pennsylvania*, was published in 1990 in the volume **Structural Traps I—Tectonic Fold Traps**, compiled by E. A. Beaumont and N. H. Foster. The book can be purchased for $39.00, plus $5.75 for shipping, by writing to the AAPG Bookstore, P. O. Box 979, Tulsa, OK 74101-0979, or by telephoning 918-584-2555. Prepayment is required; please make your check or money order payable to *AAPG Bookstore.* All major credit cards are accepted.

—C. H. Dodge

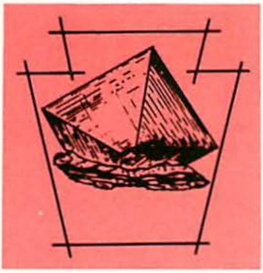
LIST OF U.S. GEOLOGICAL SURVEY REPORTS FOR PENNSYLVANIA AND NEW JERSEY

The U.S. Geological Survey is currently publishing a new series of bibliographies that provide comprehensive geologic information on either a state or regional geographic division. These new bibliographies are produced for the U.S. Geological Survey by the American Geological Institute. Indexed bibliographies have been prepared for Alaska, California, Colorado, Utah, and the Pennsylvania-New Jersey area. Nonindexed lists have been prepared for Arkansas, Florida, New York, Oregon, and the Massachusetts-Rhode Island-Connecticut area.

The list contains reports and maps published by the U.S. Geological Survey relating to the geology and mineral and water resources of Pennsylvania and New Jersey from 1879 to July 1988. Publications released after July 1988 can be found through the monthly catalog **New Publications of the U. S. Geological Survey**. These bibliographies include annual reports, professional papers, circulars, bulletins, water-supply papers, yearbooks, monographs, water-resource investigations, reports available only through NTIS (National Technical Information Service), and maps, charts, and atlases. The individual reports are listed sequentially by report series, and complete bibliographic citations are included. The bibliography is indexed in two parts, a general subject index and an author index.

This new, comprehensive bibliography is available for $2.50 from U.S. Geological Survey, Books and Open-File Reports, Box 25425, Denver, CO 80225. Prepayment is required; please make checks or money orders payable to *U.S. Geological Survey.*

—D. M. Hoskins



EARTH SCIENCE TEACHERS' CORNER

Rock Collecting in Pennsylvania Made Easy

If you would like to have a rock set containing the common rock types that crop out in Pennsylvania but do not have the several weeks of free time needed to collect them, or do not want to drive your car 1,000 miles with one eye on the road and the other on a geologic map, or do not want part of your house or garage to be taken over by a pile of rocks while you try to decide which specimens to keep or throw away, do not despair. During a recent sabbatical leave, Alfred C. Palmer, Penncrest High School teacher and Widener University adjunct professor, has taken care of all of this for you. He has compiled 500 sets of rock samples (each sample measures approximately 2 by 2+ inches), complementing Pennsylvania Geological Survey Map 63, *Rock Types of Pennsylvania*. He also authored an accompanying booklet containing a discussion of the important geologic characteristics and significance of each sample, along with a photograph of the outcrop from which the sample was taken.

The rock set includes 24 samples, Pennsylvania Geological Survey Map 63, and the descriptive booklet. The cost per set is $30.00. Institutions desiring four or more sets may purchase them for $25.00 each.

The project received support from the Pennsylvania Geological Survey, Widener University, the Pennsylvania Science Teachers Association, and the Pennsylvania Department of Education. All proceeds from sales of the sets are being deposited in an account at the Delaware County Institute of Science. They will fund a Pennsylvania Geoscience scholarship.

Orders for the rock sets should be addressed to A. C. Palmer, Penncrest High School, 134 Barren Road, Media, PA 19063. Orders must be prepaid; please make checks payable to *The Delaware County Institute of Science*.

—*J. R. Shaulis*

Environmental Education: A Private Sector Initiative

A professional two-week course will be offered July 15–26, 1991, for science teachers (K–12) and administrators, focusing on **Issues in Environmental Education** that will be critically important in the 1990's. The course will familiarize participants with hazardous waste, landfills, radon, nuclear and alternative forms of energy usage, groundwater contamination and cleanup, and educational resources available to science teachers. The comprehensive lecture- and field-based workshop will be conducted by staff scientists of R. E. Wright Associates, Inc. (REWAI), supplemented by scientists and engineers from local industries and governmental agencies. The workshop will be held at REWAI's Learning Center of Applied Environmental Technology, 3240 Schoolhouse Road, Middletown, Pennsylvania. Financial support for the associated course fees may be available from Title II (Eisenhower) funds through local school districts or through Intermediate Units. For further information and registration materials, call Dr. Marvin E. Kauffman, 717–944–5501 or 800–331–6491.

REMINDER!

We are in the process of revising the circulation list for *Pennsylvania Geology* based on returns to the letter and questionnaire that were sent to all readers in March 1991. If you have not returned your form and wish to continue receiving *Pennsylvania Geology*, please return the form as soon as possible. All readers who have not responded by August 1, 1991, will be dropped from our circulation list.

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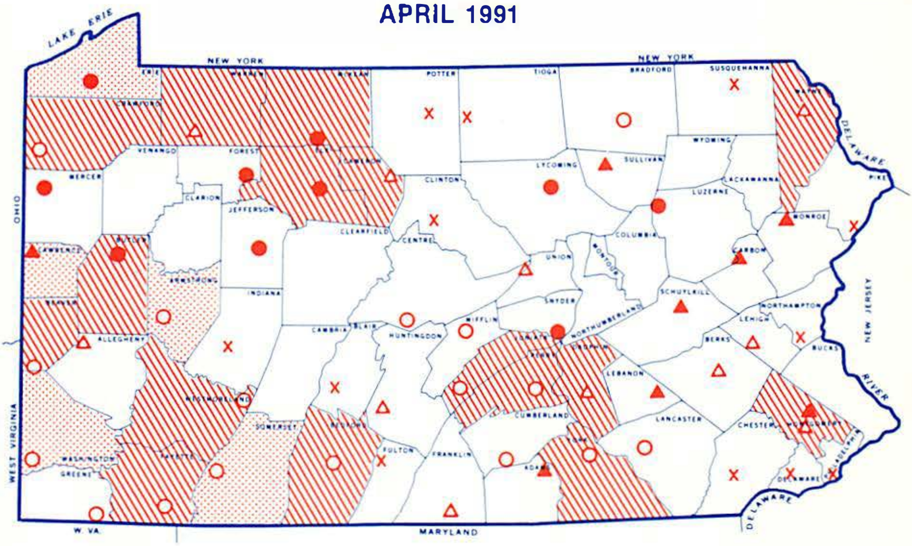
IN COOPERATION WITH THE U.S. GEOLOGICAL SURVEY

TOPOGRAPHIC MAPPING
GROUNDWATER-RESOURCE MAPPING

GROUNDWATER LEVELS
FOR
APRIL 1991



EXPLANATION

Above last year — Below last year
Observation well

Above last year — Below last year
Observation well equipped with data-collection platform

No data

High

Normal range

Low

Bureau of Topographic and Geologic Survey
Department of Environmental Resources
P. O. Box 2357
Harrisburg, PA 17105-2357

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