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Pennsylvania GEOLOGY

COMMONWEALTH OF PENNSYLVANIA
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ON THE COVER

Two museum-quality rock specimens on display at the Middletown office of the Pennsylvania Geological Survey. The one in the front shows two sets of ripple marks (called interference ripples), and the one in the back is part of an ancient coral reef formed by the colonial coral *Halysites* (see article on page 2). Photograph by Gary M. Fleeger.

PENNSYLVANIA GEOLOGY

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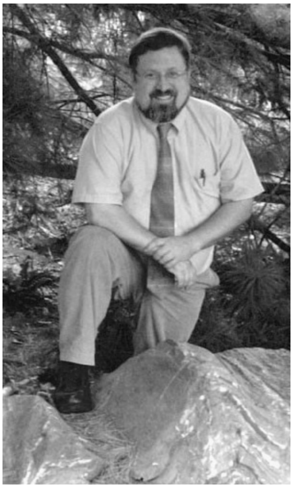
Looking Under the Grass

Our Assistant State Geologist, Sam Berkheiser, frequently says that our job is to get people to "look under the grass." By that, he means that the surface of a nice subdivision may look normal, but underneath the surface, the geology may determine if there will be environmental problems down the road. It is better to plan around the geology than assume that the earth is an infinite homogeneous half-space. An infinite homogeneous half-space is a convenient construction by geophysicists, who assume that the earth is the same in all directions below the surface—kind of like dividing the universe into two halves, air and rock. It makes the mathematics of modeling the earth much easier, but doesn't really capture just how diverse the world really is.

The earth is much more complicated than an infinite homogeneous half-space. But when all we see is suburban grass, we may make the mistake that it is all the same underneath. As good stewards of natural resources, we need to plan which water, mineral, energy, and rock resources should be considered before developing the land surface. For instance, we don't want to pave over our best water supply or put subdivisions on top of our only source of paving stone. Additionally, all those radon-bearing fractures and areas of potential sinkholes can exist under the most uniform of man-made lawns.



If we "look under the grass," we'll see a much more complicated world. But we'll be glad we looked.

Jay B. Parrish
State Geologist

Reefs, Ripples, and Rocks—Home at Last

by Gary M. Fleeger and Donald M. Hoskins[1]
Bureau of Topographic and Geologic Survey

MOVING THE ROCKS. Anyone who ever visited the Harrisburg office of the Pennsylvania Geological Survey in the Executive House, where we were quartered from 1975 to 1993, may remember two large boulders on display in the garden near the rear parking lot. After 10 years of separation, these display boulders have finally found their way home to our new office near Middletown (see back cover), which we have occupied since January 2002.

When the Survey moved in 1993 from the Executive House to the Evangelical Press Building in uptown Harrisburg, we were forced to leave these large boulders behind because there was no place outside the Evangelical Press Building where they could be displayed. When we moved to our current home, we began the process of having our boulders moved from the Executive House so they could once again be displayed near our office. In late May 2003, workers from the Bureau of Forestry generously donated their time and equipment to move the rocks for us. Robert "Pete" Peters and Frank Mertz expertly loaded the rocks, transported them to our new office location, and placed them in the grass adjacent to our parking lot (Figure 1).

After they arrived and were placed, one of the authors, Gary Fleeger, began to wonder about the display history of the two rocks. Both preceded his employment with the Survey, and, in fact, one preceded the employment of almost everyone currently at the Survey. That one is an estimated 3-ton specimen. A plaque on it indicates that it is a 400 million-year-old fossil coral reef from Bloomsburg (Figure 2). The other rock, a beautiful specimen of interference ripples, had no plaque and no explanation.

THE RIPPLED ROCK. Thomas Berg, currently the State Geologist of Ohio and formerly the Chief of the Geologic Mapping Division at the Pennsylvania Geological Survey, was recently in town for a conference that Gary also was attending. During a break, Gary cornered Tom to interrogate him on his knowledge of the two rocks. Tom recalled that he had found the rippled rock (Figure 3) in 1978 in the Catskill

[1]State Geologist Emeritus.

Figure 1. "Pete" Peters and Frank Mertz of the Bureau of Forestry stand next to the fossil coral reef specimen that they had just moved from the Executive House to our new office near Middletown.

Formation along U.S. Route 6 in Tioga County while doing reconnaissance work for the 1980 *Geologic Map of Pennsylvania* (Berg and others, 1980). He mentioned it to Donald Hoskins (one of the authors and, at that time, Assistant Director of the Survey), who went to see it. Don inquired about the rock at the Pennsylvania Department of Transportation (PennDOT) and discovered that the decision had been made to destroy it. Because of the museum quality of the specimen, Don asked PennDOT staff if they could preserve it and transport it to Harrisburg to be put on display. He left his name and office location with the PennDOT staff and returned to Harrisburg. Some time later, a flatbed truck pulled into the Executive House parking lot. The driver asked Don where he wanted the rock to be placed, it was unloaded, and we had our rippled display rock.

"TADPOLE NESTS." The ripple-marked rock is a single layer of sandstone. Its component quartz sand and associated dark minerals (such as mica) were deposited quickly from marine currents in the Late Devonian seas that covered what is now northern Pennsylvania. Most of these seas were relatively shallow, and their currents and waves were similar to those in present-day shallow coastal seas.

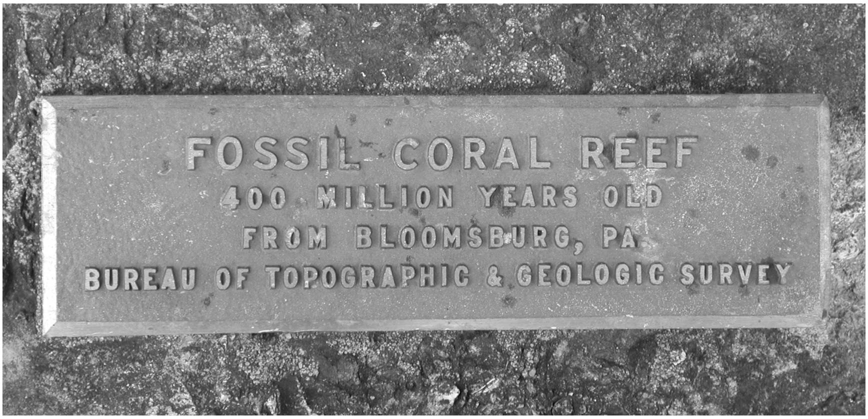


Figure 2. Plaque on the coral reef specimen.

Following deposition of the sand, current action in the shallow waters above the sand produced “waves” in the deposit. These waves are now the preserved ripple marks. The crests (uppermost part) of the ripple marks are oriented perpendicular to the current flow. When ripple-marked rocks are found in outcrop it is thus possible to determine the direction in which the current was flowing when the ripples were formed.

Figure 3. This specimen preserves two sets of ripple marks (interference ripples). The older set trends from lower left to upper right.

Because two sets of ripple marks are preserved, we can conclude that the sand layer experienced flow from two very different directions. The set of ripples that is most prominent was the first one formed. It has a longer wavelength and greater ripple height than the second set. Later, another current flowed over the sand layer from a different direction and produced the second set of ripples, which "interfere" with the original set. Thus, such dual sets of ripple marks are called interference ripple marks. Interference ripples are known colloquially as "tadpole nests" because they were originally thought to have been excavated by tadpoles (Hitchcock, 1858). In our specimen, the ripples in the younger set are largely confined to the troughs of the older set. The second current probably had a lower velocity and/or occurred in shallower water than the first. However, its velocity was sufficient to move the as yet unhardened sand grains so that the new ripple marks could be formed without destroying the first set. There are a number of possible explanations for why the current changed direction, including interfering waves and tidal- or stream-current flow, or the influence of storms.

Soon thereafter, additional sediment was deposited over the two sets of ripple marks, preserving them to the present day.

THE CORAL REEF ROCK. The coral reef specimen (genus *Halysites*) is half of a larger specimen that came from limestone of the Silurian-Devonian Keyser Formation. Richard Conlin and Don Hoskins found it in a quarry (the Grovania quarry of the Lycoming Silica Sand Company, located between Bloomsburg and Danville in Columbia County) when they were doing the reconnaissance work for the 1960 *Geologic Map of Pennsylvania* (Gray and others, 1960). When they saw the specimen, it had been discarded by the quarry operators because it was too large and the silicified corals degraded the quality of the limestone. At that time, Donald Hoff (the geologist curator for the State Museum when it was completed in 1965) was looking for good specimens to install in the new geology section of the museum. He came to the Survey for suggestions. Staff members thought that this rock would be an excellent showpiece for the new museum, and he was taken to the quarry to see it. He agreed that it was a fine specimen but said that it was too large and too heavy for the museum. The Survey went back to the quarry owners and asked if they would break it into two specimens. When they learned that a portion of this rock would be in the museum, they agreed to drill it into two parts. They also consented to bring both halves to Harrisburg.

Exactly where the Survey's half of the rock was first displayed is not certain. The Survey office was in the South Office Building until after the new State Museum opened in 1965. It then was moved to the Old Museum (which is now the Ryan Office Building) adjacent to the Capitol. However, no one has any recollection of the rock ever being at the South Office. Apparently, the first display location of the rock was outside the Old Museum.

The Survey made its infamous move to Cameron Street in 1972, just in time for the flood caused by tropical storm Agnes, but, luckily, the rock had not been moved to Cameron Street. The rock also did not follow the Survey during its several moves to temporary post-flood homes. It was moved when the Survey relocated to the Executive House in 1975, where it remained until May 2003.

The specimen was most likely from the Jersey Shore Member of the Keyser Formation. More commonly, the Jersey Shore Member contains stromatoporoids (extinct Paleozoic marine sponges), rather than coral reef beds (Jon Inners, personal communication, 2003). The Keyser was deposited in a shallow marine, subtidal shelf environment. The corals and stromatoporoids occurred in shallower and more oxygenated, nutrient-rich areas (Inners, 1981).

THE CORAL *HALYSITES*. The predominant coral in the specimen is the genus *Halysites,* or chain coral. *Halysites* is a widespread fossil that occurs in rocks of the Ordovician and Silurian Periods on nearly all continents. It was known to Linnaeus, the famous scientist who developed the style of naming groups of living and fossil plants and animals by genus and species. Linnaeus called it *Tubipora* in 1767 (Linnaeus, 1767). Later, the paleontologist Fischer renamed it *Allysites* (Fischer, 1813), and still later (Fischer, 1828), he changed its name to *Halysites,* by which it has been known ever since. When seen from above (Figure 4), the fossil appears as anastomosing chains (networks of branching and rejoining chains) of small rings. When seen from the side, each ring is actually a small three-dimensional tube that is connected to at least two more similar tubes. When the organism was alive, a small, fleshy coral animal lived attached at the top of the tube, its tentacles waving about in the sea water, collecting bits of food that were then ingested. As it lived, it grew by depositing calcium carbonate vertically on the tube walls. Thousands of tubes grew together and formed a network (called a colony) that eventually trapped calcium carbonate between the chains, which became the hard rock in which we now find the fossil. Later, silica selectively replaced the calcium carbonate deposited by the animal, but not the sedimentary calcium carbonate trapped in the spaces between the chains of tubes.

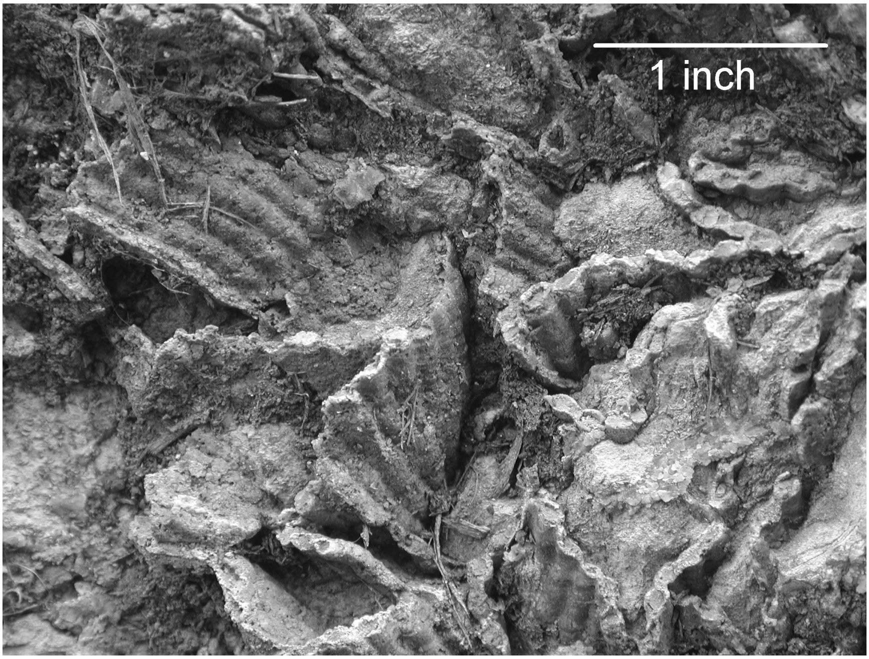


Figure 4. Detail of *Halysites*, showing the chains of individual tubes.

When you stop by our Middletown office, be sure to examine these two outdoor display rocks (see photograph on front cover), as well as many smaller specimens on display in our lobby and throughout the building.

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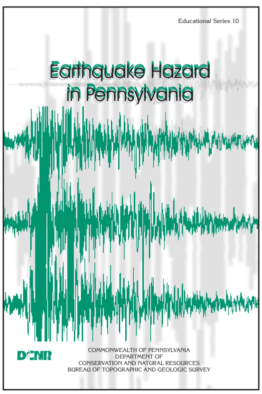
EARTH SCIENCE TEACHERS' CORNER

Earthquake Hazard in Pennsylvania

The Pennsylvania Geological Survey has recently published the second edition of **Educational Series (ES) 10, Earthquake Hazard in Pennsylvania.** The 14-page booklet was revised by Charles K. Scharnberger, a retired professor at Millersville University who also wrote the original version.



Earthquakes occur when there is a sudden release of stored energy as rocks fracture along fault planes within the earth. The energy travels through the earth or along its surface as seismic waves. These waves can be detected and recorded by seismographs. The magnitude of an earthquake (on the Richter scale) is a number that expresses its size relative to other earthquakes. Magnitude is based on the amplitude of the waves recorded by the seismograph. The largest known Pennsylvania earthquake occurred in 1998 in Mercer County and had a magnitude of 5.2.

In Pennsylvania, the earthquake hazard is low. A map in ES 10 shows the relatively small number of earthquakes that had epicenters in our state. Most of the epicenters are concentrated in the southeastern part of the state. More specific information about Pennsylvania earthquakes is included in a table in the booklet.

The author analyzed three regions in the eastern part of the country that have had earthquakes in the past that have affected our state. He concluded that future earthquakes there would probably cause little or no damage here.

The author also included an earthquake-hazard map for the state, which shows areas where certain levels of ground shaking could be caused in the future by earthquakes both in and outside the state.

Copies of ES 10, as well as other booklets in the Educational Series, are free upon request from the Pennsylvania Geological Survey, 3240 Schoolhouse Road, Middletown, PA 17057–3534, telephone 717–702–2017. The booklets are also available as PDF files on the Survey web site at www.dcnr.state.pa.us/topogeo/pub/pub.htm.

NEW RELEASES

Moraine and McConnells Mill State Parks

The Bureau of Topographic and Geologic Survey, in cooperation with the Bureau of State Parks, recently published **Park Guide 4, Moraine and McConnells Mill State Parks, Butler and Lawrence Counties—Glacial Lakes and Drainage Changes.** This new addition to the "Trail of Geology" series combines former Park Guides 4 and 9, which had addressed the two parks separately. In this two-color, well-illustrated 13-page booklet, Survey geologist Gary M. Fleeger and Slippery Rock University Professors Emeriti Kent O. Bushnell and Donald W. Watson explore the geologic history of the parks and highlight places of geologic interest. A centerfold map shows the extent of geologic formations and the southeast limit of glaciation with respect to the parks, as well as the locations of features and sites described in the guide.

How two parks that look so different can be geologically related is the story of this park guide. The dissimilar topography of the two parks resulted from the same glacial events. Lake Arthur, in Moraine State Park, exists at the site of a former glacier-dammed lake, called Lake Watts. Slippery Rock Gorge, in McConnells Mill State Park, contains erosional features—narrow gorges and rapid streams,

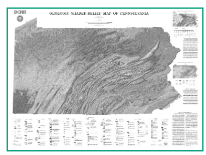
A rock city along the exit road in McConnells Mill State Park. It was formed by separation along vertical cracks in the bedrock.

Winter view of Alpha Falls in McConnells Mill State Park. This stream formed as the glacier that dammed Lake Watts began its retreat, allowing the lake to partially drain past this site. The stream flows into Slippery Rock Gorge, which was eroded by later phases of glacial lake drainage.

numerous waterfalls, and rock cities—that resulted from the drainage of Lake Watts and other glacial lakes.

Park Guide 4 and an expanded interactive version of the guide are posted on the Survey web site at www.dcnr.state.pa.us/topogeo/parkguides/trail.htm. The published guide is available to visitors at the park office, which is located at Moraine State Park, 225 Pleasant Valley Road, Portersville, PA 16051–9650, or it can be obtained from the Pennsylvania Geological Survey, 3240 Schoolhouse Road, Middletown, PA 17057–3534, telephone 717–702–2017.

Geologic Shaded-Relief Map of Pennsylvania



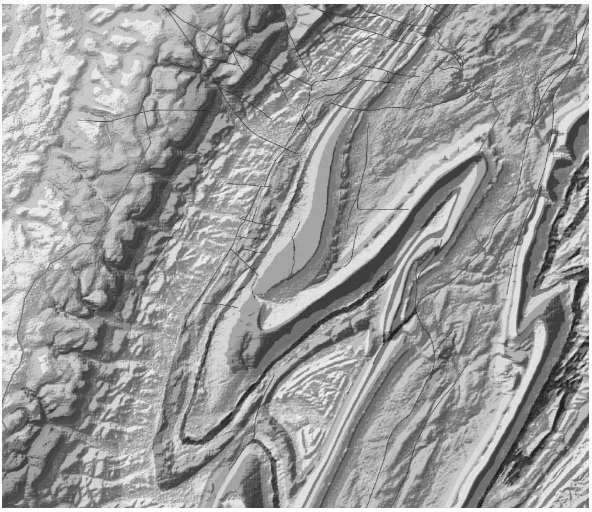
The Bureau of Topographic and Geologic Survey announces the release of **Map 67, Geologic Shaded-Relief Map of Pennsylvania,** a beautifully colored, 46- by 35-inch map of the state showing the bedrock geologic units superimposed on a shaded-relief image. The map is the third in a series of digitally generated full-color 1:500,000-scale maps (the other two are Map 65, *Digital Shaded-Relief Map of Pennsylvania,* and Map 66, *Land-Cover Map of Pennsylvania),* which were printed in cooperation with the U.S. Geological Survey and are distributed free of charge by the Bureau of Topographic and Geologic Survey. All three maps have proved to be popular educational and outreach products.

The geologic shaded-relief map was compiled primarily from two data sets. The first is the National Elevation Dataset (NED) for Pennsylvania, a product of the U.S. Geological Survey that provides regional elevation data for points spaced about every 30 meters. The elevation data were used to generate the shaded-relief image, which gives the map its three-dimensional appearance. The second data set contains geologic contacts and faults that were slightly modified by Pennsylvania Geological Survey staff from the 1980 state geologic map (Pennsylvania Geological Survey Map 1, compiled by T. M. Berg and others, scale 1:250,000). The latter data set was further modified and generalized by Christine E. Miles, the compiler of Map 67. The colors of the geologic units were made transparent by digital procedures so that the shaded-relief image would be visible. The effect of this process is the appearance of the geologic units "draped" over the relief.

The new map shows, in a very striking way, the regional distribution of the geologic units and structural patterns, and the relationship between the geologic units and the topography. No symbols were placed on the map other than fault lines, county boundary lines, and major streams so that the view of the terrain would be as unobstructed as possible.

Two full-color inset maps are included showing (1) physiographic provinces and sections of the state and (2) general ages of the geologic units. Small thumbnail maps in the explanation show the areal distribution of the rock units listed for each geologic period and geographic area.

Map 67 (as well as Maps 65 and 66) may be ordered from the Pennsylvania Geological Survey, 3240 Schoolhouse Road, Middletown, PA 17057–3534, telephone 717–702–2017.



A detail of the geologic shaded-relief map in the west-central part of the state, showing the Allegheny Front, which separates the Appalachian Plateaus physiographic province (west) from the Ridge and Valley province (center and east). The geologic units, which appear in full color on the map, cannot be adequately shown in this grayscale image.

IN MEMORIAM

Jesse L. Craft

1930–2002

1972–1979 Pennsylvania Geological Survey

Dr. Jesse L. Craft was the environmental geologist in the Pittsburgh office of the Pennsylvania Geological Survey from 1972 until 1979. He passed away on December 17, 2002, and is survived by his wife, Joan, and his brother, Floyd.

Jesse was born in Kansas, served in the Air Force during the Korean War, and received geology degrees from Sul Ross State University in Texas, Syracuse University in New York, and the University of Western Ontario. He joined the Survey in 1972 to investigate geologic hazards and conduct studies of the glacial deposits of northwestern Pennsylvania. During his tenure with the Survey, Jesse worked on a variety of projects, but his most important contribution was investigating local geologic hazards. He had a reputation for assisting homeowners with solutions for restoring their property and rebuilding their lives. Twenty years after he left the Survey, the Pittsburgh office still received calls from people who wanted to express their gratitude for his help.

After Jesse left the Survey in 1979, he taught for a year at Kent State University in Ohio before joining the U.S. Bureau of Mines. In 1982, the group he worked with was transferred to the Department of the Interior's Office of Surface Mining, where he remained for the rest of his career. While there, he developed a reputation as one of the nation's leading experts in mine subsidence and reclamation. Perhaps his crowning achievement came in 1985 following the devastating Mexico City earthquake that destroyed hundreds of buildings and killed or injured thousands of people. Many of the victims were buried beneath collapsed buildings. At that time, Jesse's team had been working with a down-hole video camera for investigating mine voids. After the earthquake, Jesse and the team went to Mexico City and used the camera to locate victims trapped in voids within the rubble. This resulted in many people being rescued who otherwise would have been left for dead. As a result, the Mexican government gave Jesse an award of National Gratitude in 1986.

Jesse was generous with his time and knowledge, and was always willing to discuss the intricacies of geology and potential geologic hazards with students, professionals, the public, government officials, and the press. With his passing, the citizens of western Pennsylvania have lost one of their best and most influential advocates.

—John A. Harper

DEPARTMENT OF CONSERVATION AND NATURAL RESOURCES

BUREAU OF TOPOGRAPHIC AND GEOLOGIC SURVEY

Main Headquarters
3240 Schoolhouse Road
Middletown, PA 17057–3534
717–702–2017
FAX: 717–702–2065

Pittsburgh Office
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Pittsburgh, PA 15222–4745
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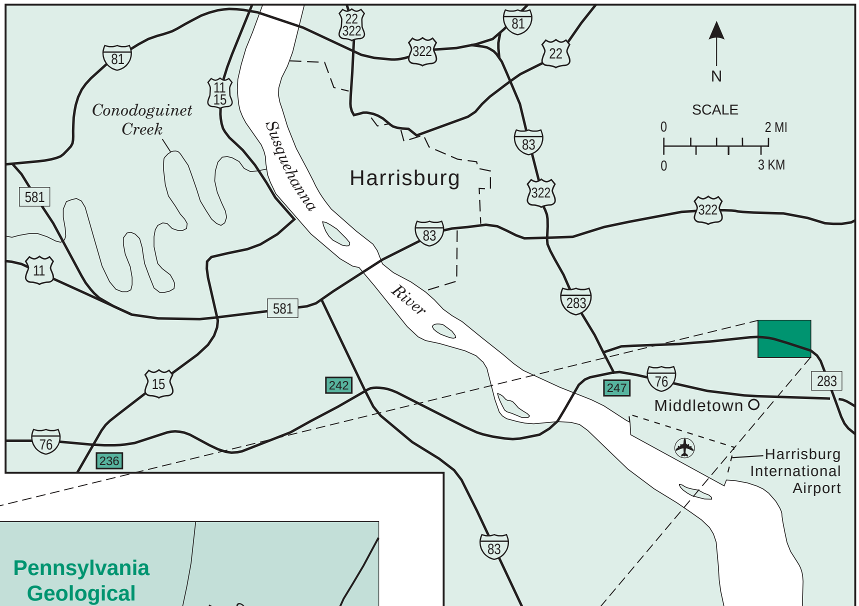

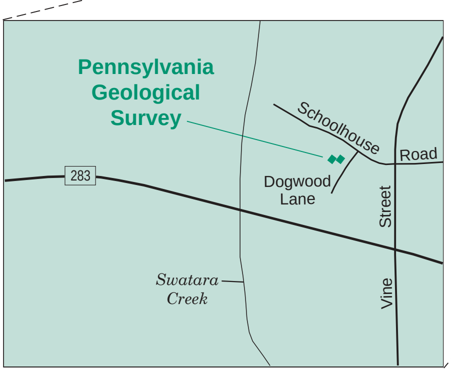

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From Route 283 East—Take the Hummelstown-Middletown exit. At the end of the ramp, turn left onto Vine Street. Stay in the left-hand lane and turn left at the first intersection onto Schoolhouse Road. Make the next left onto Dogwood Lane. At the top of the hill, take the first right into the parking lot.

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