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ON THE COVER


PENNSYLVANIA GEOLOGY

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In this issue of *Pennsylvania Geology*, I am honored to pay tribute to fellow State Geologist Donald M. Hoskins, who has served the Commonwealth of Pennsylvania as Director of the Bureau of Topographic and Geologic Survey since January 8, 1987, and who is retiring January 27, 2001. During his 14 years as State Geologist, the Pennsylvania Survey has achieved great things. I was not at the Survey to observe all of them firsthand, but I did witness great accomplishments under Don’s leadership during the years I spent there, from 1965 to 1989. During most of those 24 years, I was influenced by Don’s management and geological career together with the direction of former State Geologist Arthur A. Socolow. I learned much from both Art and Don that has been invaluable to me as Chief of the Ohio Geological Survey.

Don came to the Pennsylvania Survey in November 1956 and shortly thereafter obtained his doctorate in geology from Bryn Mawr College. He conducted detailed geologic mapping in the Ridge and Valley province and authored the outstanding *Fossil Collecting in Pennsylvania* (General Geology Report 40). I got my first impression of Don Hoskins when I came to interview for a field mapping position with the Bureau in late 1964. Don was asked to ferry me around Harrisburg to show me some housing possibilities for my family. I handed over the keys to my Dad’s car and got the high-speed tour. He didn’t waste a moment. Don was obviously someone who got things done quickly, but I was glad to get the keys back. We hit it off right away because we were both very interested in paleontology. He still maintains that interest, as I do.

Those first impressions of Don were amplified shortly after I began work at the Pennsylvania Survey when he led a staff field trip to his mapping area north of Harrisburg. A convoy of state cars full of excited geologists zoomed through the valleys and along the ridge crests. After examining outcrops at the nose of one ridge, we discovered that someone had closed and locked the road gate; most of the Survey was trapped in the middle of nowhere. I naively thought someone would have to walk out and find a key. However, with two swift blows of his rock hammer, Don dispensed with the lock and we were on our way. Small things never got in Don’s way.
Few years passed before Don Hoskins moved into the position of Editor, and then Assistant State Geologist. No one could ever accuse him of lacking ambition. I knew him as Assistant Director for most of the years I was with the Pennsylvania Survey. Don confronted state-government bureaucracy head-on. He even went to the trouble of attending night school to obtain a master’s degree in government administration. With the very best of them, Don could handle annual budgets, Theory-X management, government audits, decision trees, Gantt charts, position descriptions, personnel-evaluation systems, goal-and-objective setting, PERT networks, management by objectives, strategic planning, and all the trendy management schemes that government bureaucrats continually unearth. To his great credit, Don recognized the urgent need to market the Survey and all of its services. I greatly enjoyed joining Don in giving presentations about the Survey to county officials, trade organizations, other state agencies, and university geology departments. In his own way, he always maintained the strong applied-science and public-service focus that Art Socolow had cultivated for the Pennsylvania Survey.

Now don’t get me wrong. Don Hoskins never succumbed to management superciliousness. Although he embraced the management world with a vengeance, he always remained a first-rate geologist. He kept up with the science. For decades, Don worked hard to maintain and promote the Field Conference of Pennsylvania Geologists. A lot of good science was (and still is) accomplished through the Conference. You could always count on hearing a geological presentation by Hoskins at regional and national Geological Society of America meetings. (Don is a GSA Fellow.) All aspects of geology fascinated him. At a meeting in Providence, R. I., as Don, Bill Sevon, and I were walking to our hotel after dinner, we became captivated with the greenstone base course of a building. Picture the scene: three well-dressed gentlemen on their hands and knees on the sidewalk with noses and hand lenses pressed up against the stone. That’s dedication!
As I knew him, Don Hoskins was also more than the consummate scientist and geological-survey manager. I remember many of his other outside interests. Don grew roses, cultivating unusual varieties. He made fine wines. He became an outstanding sailor, plying the waters of Chesapeake Bay—always wearing his Greek fisherman's hat. Don was constantly interested in physical fitness. He was dedicated to maintaining good health by following the Royal Canadian Air Force daily fitness routine. I will never forget sharing a motel room in Troy, N.Y., with Don and four other geologists (saving money on a tight travel budget). At about 5:00 a.m., a fearful and persistent stomping noise accompanied by heavy breathing awakened me in the darkened room. It was Don running in place as he did his fitness routine. With all of his outside interests, Don knew how to celebrate life. He and his wife Barb were always deeply devoted to their children and their careers. His sense of history and his fascination with the history of geology were contagious. To know Don is to become immersed in the growth and development of our science.

As State Geologist of Pennsylvania, Don Hoskins has worked hard to maintain the Bureau of Topographic and Geologic Survey. Like so many other state geologists, he has had to struggle with the “cut government spending” wave that continues to prevail. Politicians and government bureaucrats persistently overlook the long-term value of geological surveys and the work that they do. Yet Don has never given up the ghost. He has endeavored to market the Pennsylvania Survey and make the geological sciences serve the public good. He has been faithful to neighboring state geologists and the Association of American State Geologists (AASG), serving as president of that association. Don has maintained influential and constructive relationships with the U.S. Geological Survey (USGS) over the years, participating in many cooperative projects with the national survey. Through several AASG committees, he has worked hard to help the USGS keep its focus on citizen needs.

Pennsylvanians have been well served by Dr. Donald M. Hoskins, State Geologist and Director of the Bureau of Topographic and Geologic Survey. Like his predecessors, he has left a legacy that will sustain his successors. The times are changing. The state geological surveys face new challenges in the information-technology revolution. But I believe the Hoskins legacy leaves the Pennsylvania Survey on solid ground. Many thanks to you, Don. I wish many happy years to you as you embrace new challenges ahead.

—Thomas M. Berg, Ohio State Geologist
In 1957, shortly after starting work at the Pennsylvania Geological Survey, Don had the opportunity to show Genevieve Blatt (Secretary, Department of Internal Affairs) and Carlyle Gray (State Geologist) some of Pennsylvania’s fossils.

As Editor in 1966, Don kept track of Survey publications in preparation.
In 1972, the Survey headquarters on North Cameron Street was inundated by floodwaters from tropical storm Agnes. Here, William Sevon, staff geologist, and Don take a break from the cleanup that followed.

*On the move...*
Don (far right) and other Survey staff, including State Geologist Arthur Socolow (far left), try to salvage supplies from the Survey’s oil-soaked building after the 1972 flood.

Field Conference of Pennsylvania Geologists...

Always resourceful, Don holds the sound system so that everyone can hear the speaker at the 1986 Field Conference.
Don was happy to go on field trips in all types of weather, even in rain, such as that which occurred during the Field Conference in 1983. Michael Bikerman of the University of Pittsburgh (now retired) is on the left.

At the 1980 Field Conference, Don and George Crowl, Ohio Wesleyan University (now deceased), enjoyed a river trip.

Don was secretary/treasurer of the Field Conference for 30 years and chairman from 1997 through 2000.

Don and Maria Crawford of Bryn Mawr College at the 1984 Field Conference. As usual, he was paying close attention.
Top left: Don was in a pensive mood at the 1977 Field Conference.
Top right: Dapper Don celebrates the 150th anniversary of the Pennsylvania Geological Survey at the 1986 Field Conference.
Left: Don relaxes during a long stop on the 1976 Field Conference.

Sharing knowledge...

Don talks with grade-school students at a rock and fossil “dig” that took place at the Whitaker Center in Harrisburg during Earth Science Week 1999. Looking on is Caron O’Neil, staff geologist.
Don brings geology to the public by doing an interview for a local television station on the 1987 Field Conference at Presque Isle.

Don leads the staff in discussion at a Survey meeting at King’s Gap in 1986.
Don did not mind going into the field even in snowy weather. When the snow obscured the outcrops, other activities came to the fore. Samuel Root (then Chief of the Field Mapping Division at the Survey) is helping him with this activity in 1978.

Happy days...

Don examines an outcrop with a group of interns in the summer of 1993. Behind Don (wearing a hard hat) is Robert Smith, II, Chief of the Mineral Resources Section of the Survey.

On a trip to England in 1988, Don and Noel Potter, Jr. (Dickinson College), showed the colors of the Harrisburg Area Geological Society.
Members and friends of the Harrisburg Area Geological Society take a break from geology on their trip to England. Prominent in the photograph are Don (far left), his wife Barb (second from left), and Noel Potter (far right).

*Bon voyage...*

Don at the helm of his boat on her maiden voyage on Chesapeake Bay in 1986. We wish him many more years of happy sailing.
From Rails to Trails to Rocks—
Connecting the Classroom to the
Geology of Southwestern Pennsylvania
Part 1. Garrett to Rockwood

by James R. Shaulis
Bureau of Topographic and Geologic Survey
Thomas J. Jones
Rockwood Area Elementary School, Rockwood, PA 17055

ALL ABOARD—INTRODUCTION. Railroads were once smoky, rumbling pathways that connected us to our mineral and energy resources, our industries, and to each other. Today, along many of these same pathways, the resources are depleted, the industries have disappeared, and the rail beds have been replaced with trails where travelers walk and bicycle instead of ride in passenger-train cars. Even though much has changed, these pathways still serve as connections. They now link us to healthy enjoyment of leisure time.

Through the identification of geologic features found along these pathways, there exists the potential for these former roads of rails to connect us to an educational resource, one that remains to help us better understand our earth and our history. Thus, in addition to the pursuit of fitness and fun, the trails link us to knowledge and understanding of our physical world and environment.

NOW LEAVING THE STATION—FIELD TEST. In the spring of 1998, a “Rails to Rocks” pilot project was launched to develop educational activities in earth and environmental science for grades kindergarten through 12 (K–12). The project was based on geological features found along a 7-mile segment of the Allegheny Highlands Trail (between Garrett and Rockwood in Somerset County) and a 26-mile segment of the Youghiogheny River Trail North (between Connellsville and West Newton in Fayette and Westmoreland Counties). Both trail sections are part of a 400-mile trail corridor that begins just west of Pittsburgh and continues southeastward to Washington, D.C. (see back cover).

The trail sections are located along abandoned railways that have been converted to public hiking and biking trails and are referred to as “rail trails.” During the spring and summer of 1998 and 1999, geologically related features visible from the rail trails in these two sections were examined. Rock exposures and other natural features related
to the geology of the region and determined to have significant educational potential were described and interpreted. These features were designated as Geological Educational (Geo Ed) sites. Geo Ed sites for the Garrett-to-Rockwood segment are shown in Figure 1.

Educators from the Pennsylvania State Department of Education and local school districts, Bureau of Topographic and Geologic Survey staff members, Bureau of State Parks Environmental Interpretive Naturalists, Somerset County Parks and Recreation Board members, Youghiogheny River Trail Corporation board members, Rockwood Borough Council and Water Authority members, Youghiogheny River Trail Council representatives, private consultants, and local experts all contributed to this project. Educational materials for use in teacher workshops and outdoor classroom activities for grades K–12 were created (Jones and others, 1999; Jones and Shaulis, 1999).

**LET ME HAVE THE WINDOW SEAT.** Field trips for earth science students are more important to their mastery of the curriculum than for any other subject because many basic earth science concepts are difficult to demonstrate in the classroom. Even though fossils and minerals can be examined in hand specimens at a student's desk, their connection to the earth can remain abstract until they are seen in a natural exposure. Furthermore, because the geographical areas that rock formations and structures cover can be large, relating to them can be difficult for beginning students. Layers of rock that extend many miles horizontally, or a geologic feature such as an anticlinal fold that extends for hundreds of feet vertically, can only be fully appreciated in the field.

**YOU WILL SEE ROCKS AROUND EVERY BEND WHEN YOU RIDE ON THIS “TERRAIN.”** Earth science educators are handicapped in Pennsylvania because extensive vegetation and thick soil cover obscure the bedrock. Because of this, opportunities to see bedrock geology are primarily limited to exposures along highways, railroads, and rivers, or in quarries, which are commonly noisy, dirty, dangerous, difficult to access, and fraught with liability concerns. Although these places may be suitable for college students and adults, they are not well suited for use by elementary and secondary school students. However, with the conversion of abandoned railroad beds into rail trails, exposures that were previously some of the most difficult and dangerous to visit and study are now the safest and easiest. Rock exposures and other geologically related features located along these rail-trail corridors are quiet, safe, available year-round, liability-free, easy to access by biking or hiking, and can be incorporated into K–12 earth science curricula.
A RAIL-TRAIL GEOLOGICAL EDUCATIONAL FANTASY TRIP—THE TRAVEL AGENT’S NAME WAS ANN T. CLINE. Come travel back to a time when the climate was greatly warmer, when oceans were mountains and mountains were oceans. See the results of the greatest collision ever experienced by North America. See the effects that more than 200 million years of differential weathering has had on the landscape. Hear an expert guide point out important geologic features and relationships contained in the rock exposures that span 60 million years of geologic history along one of the most scenic routes of the Appalachian Plateaus province. See resources exposed in their natural setting and how society’s mining of these natural resources has affected the landscape and the environment.

What follows is a fictional transcript of the recollections of passenger Crystal Lynn from the first leg of a train ride between Garrett and West Newton, Pa. Her notes were limited to comments made by tour guide Gemmy Euhedral Orthorhombic Edingtonite (BaAl$_2$Si$_3$O$_{10}$·4H$_2$O), geologist/educator, and student Clay Stone.

Mr. GEO Ed: My name is Gemmy Euhedral Orthorhombic Edingtonite, but you can call me Mr. GEO Ed. I will be your guide today for the “Negro Mountain Anticlinal Fold and Related Geologic Features” tour. Could I have your attention please, everyone? We have just left the Garrett Trailhead, which is located geographically on the eastern edge of Negro Mountain, about half a mile west of Garrett, Pa., and geologically on the eastern side of the Negro Mountain anticline (Figure 1). In a moment, we will be at our first stop (site GR–1).

If you look to your left, you will notice room- to car-sized sandstone boulders. The rock making up these boulders was formed about 300 million years ago during the geologic time interval named for Pennsylvania, the Pennsylvanian Period. At that time, sand was eroded from granitic mountains that were located off to the southeast. The sand was carried by high-energy braided streams to this area and then deposited as thick layers of silica sand onto a subsiding submarine platform. About 200 feet of this material eventually accumulated here. After deposition, silica-rich waters filled the pore spaces between sand grains and formed silica cement, which bound the grains together into rocks that are very resistant to weathering and erosion. The boulders you’re looking at have broken loose from a rock outcrop just up the slope that makes up part of what geologists refer to as the Pottsville Formation (Figure 2; also see Figure 5). This rock unit has played a major role in the formation of Negro Mountain.
To explain, let me begin by saying something about the geologic structure we are riding through today, the Negro Mountain anticline. It is a large-scale, elongated, convex fold in the rock layers, and its axis trends in a northeast-southwest direction (Fai1, 1998). It was formed when previously horizontal layers of rock were pushed up and folded 200 million years ago during the mountain-building event known as the Alleghanian orogeny.

Since that time, these rock layers have been undergoing weathering and erosion. This process has removed softer rocks that once covered Negro Mountain and has exposed the anticlinal mountain, whose crest and slopes are made up of resistant sandstone layers of the Pottsville Formation and the lower part of the Allegheny Formation. Allegheny Formation rocks lie on top of the Pottsville rocks.

Our route today parallels the Casselman River, which, fortunately for us, has cut through the anticline and exposed it, so we can also see the rocks that are within (Figure 3).

**Clay:** Mr. GEO Ed, are you sure it’s safe for us to be riding through here?

**Mr. GEO Ed:** Why do you ask, Clay?

**Clay:** Well, couldn’t more boulders break loose up there and come down and hit us?”

**Mr. GEO Ed:** Oh, you don’t need to worry about that. I should have mentioned that those boulders probably haven’t moved in about 10,000 years (W. D. Sevon, oral commun., 1998). After they broke off from the outcrop, they moved slowly downslope by means of a gravity-driven process that involved freezing of the soil in the winter followed by sliding of the boulders during thawing in the summer. This process
was most active during the last glacial period, about 18,000 to 24,000 years ago (W. D. Sevon, oral commun., 1998). Even though there were no glaciers here, the climate was similar to present tundra climates, and freeze-thaw activities on slopes were much more vigorous.

If you look out the window here (site GR–2), you will notice that the layers of rock are tilted to the southeast and differ markedly in appearance from the Pottsville (Figure 4). They are thinly layered, olive-gray siltstones, sandstones, and limestones, or reddish-brown silty clays. These rocks are in the middle to upper part of the Mississippian Mauch Chunk Formation and are stratigraphically several hun-

Figure 3. Cross section A–B through the Negro Mountain anticline shows the geology and topographic profile (vertical exaggeration of approximately 12.5) a visitor to the trail would see when looking at the southwestern side of the Casselman River gorge between Garrett and Rockwood, Pa. See Figure 1 for the location of the section and an explanation of the symbols and colors.

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Figure 4. Mauch Chunk strata are dipping 3 to 4 degrees to the southeast at site GR–2, which is located on the eastern flank of the Negro Mountain anticline.
dried feet lower than the Pennsylvanian Pottsville sandstone that we just saw (Figure 5).

They are thus geologically older than the boulder-forming rocks. One proof of this is that *Archeopteris* (Gillespie and others, 1978), a fossil fern having an age that is limited to the Mississippian (Wagner, 1984), has been found here (Figure 6).

Further evidence of our different stratigraphic position is the sudden disappearance of living rhododendron plants as we near the middle of the Mauch Chunk Formation (Figure 7). At this point, a change from noncalcareous to calcareous strata occurs. Rhododendrons flourish in the acidic soil derived from rocks in the upper part of the Mauch Chunk Formation, the Pottsville Formation, and the lower part of the Alle-

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**EXPLANATION**

- **Limestone**
- **Shale**
- **Conglomerate**
- **Coal**
- **Sandstone**
- **Siltstone**
- **Red beds**
- **Geological Educational site**

**Figure 5.** A generalized stratigraphic column for the geologic section exposed along the Garrett-to-Rockwood section of the Allegheny Highland Trail.
gheny Formation, but they do not thrive in the alkaline soil formed on the lower half of the Mauch Chunk Formation, which includes the Loyalhanna Member (R. C. Smith, II, oral commun., 1998). Therefore, a direct relationship between the rock strata and the flora can be observed while riding through the Negro Mountain anticline. In approaching the axis of the anticline from either side, the rhododendrons disappear as calcareous, less acidic rocks of the Mauch Chunk Formation are exposed.

As we move deeper into the anticline (*site GR–3*), you’ll notice that the beds are still inclined to the southeast but to a lesser degree, indicating that we are nearing the anticlinal axis, where the beds will be flat lying.

**Clay:** Mr. GEO Ed, what is the thick, gray rock layer having criss-cross lines all over it?
Mr. GEO Ed: I’m glad you asked, Clay. The thick gray rock is a festoon-crossbedded, sandy limestone known as the Loyalhanna Member of the Mauch Chunk Formation. The festoon crossbedding that you noticed was formed by sand waves or submarine dunes that deposited trough-shaped, thinly layered units that crosscut each other. Variations in the composition of trough layers cause them to weather differentially, creating an uneven surface that delineates the intricate crisscross bedding pattern in the rock (Figure 8).

Exposures of Loyalhanna limestone are visible on both sides of the Casselman River at this site. On the north side, entries to a large underground mine are present. The Loyalhanna limestone was quarried by the railroad for ballast and more recently is being used for road aggregate.

We are now on the anticlinal axis (site GR–4). It is unfortunate that there are no good outcrops that we can see directly from the train, but if we had time, we could stop and walk up the streambeds in this area, and you would see that the rocks are flat lying.

If you look out the window, you’ll see an excavated area adjacent to the trail (site GR–5) that contains the Wymps Gap Limestone, a special rock unit in the middle part of the Mauch Chunk Formation. The Rockwood Borough Water Authority dug out this site in the spring of 1999 to expose the fossiliferous layers (Figures 9, 10, and 11). The Wymps Gap Limestone has been interpreted to have been deposited in a nearshore marine environment (Brezinski, 1984). However, we are 1,900 feet above sea level now.

Who can explain to me how it’s possible for evidence of marine life to be present in the rocks here? OK, Clay, I will see how good your notes are.

Figure 8. Tom Jones, Rockwood Area Elementary School science teacher, examines the differentially weathered crossbedding in the Loyalhanna limestone near the axis of the Negro Mountain anticline. Paleocurrent direction, indicated by the crossbedding in the strata, is from right to left.
Clay: The paradox of the presence of marine life well above current sea level can be explained by the rising of the strata during the Alleghanian orogeny that you mentioned earlier, and the subsequent erosion of the overlying units to expose these strata at the surface.

Mr. GEO Ed: Very good, Clay. Sounds as though we’ve already molded you into an “A” student.

Do you recognize the massively bedded, hard, gray sandstone beds exposed in this area (site GR–6)? You’ve seen them before. The large boulders in the river below that came from these layers should give you a clue. This rock formation is the Pottsville, the same one we saw on the other side of the anticline, except that the beds are dipping to the northwest (Figure 12). Large branches of Sigillaria, a fossil tree whose preserved trunks and branches resemble tire tracks, are preserved as casts on the underside of several beds. Notice also that the rhododendrons are growing here and will be with us for the remainder of our journey today.

Clay: Mr. GEO Ed, is that coal?”

Mr. GEO Ed: You’re close, Clay. The large pile of black material on the south side of the trail (site GR–7) is waste-rock material produced during the underground mining of the Lower Kittanning coal seam in this area. This material was an impure part of the coal seam...
not suited for use in the electrical power generation plant, so it was separated and left as a waste pile outside the mine.

Now direct your attention over there to the nonvegetated area in the woods at the base of the slope, which is covered with orange-brown water (site GR–8). This site is an underground-mine entry on the Lower Kittanning coal seam. The orange-brown water that is flowing out of the hill here is acid mine drainage, or “AMD.”

Before AMD can occur, humid air must come in contact with freshly broken rock surfaces containing pyrite. When this occurs, the following reaction takes place: FeS₂ (pyrite) + O₂ + H₂O → Fe(OH)₃ (solid iron hydroxide that colors the water orange brown) + SO₄²⁻ (sulfate) + H⁺ (acid) (Brady and others, 1998). Pyritic surfaces are commonly exposed during the mining of bituminous coal. Groundwater traveling through fractures in the overlying rock percolates down into the mine, encounters these oxidized pyritic surfaces, and becomes acidic, creating AMD. The AMD does not continue on down vertically because immediately under the coal seam lies several feet of claystone that acts as an impermeable barrier. Also, because all the mine workings

Figure 11. The brachiopod genus *Composita*, found in the thin, interbedded limestone and claystone layers that make up the lower portion of the Wymps Gap Limestone marine interval.

Figure 12. At site GR–6, located on the western flank of the Negro Mountain anticline, Pottsville sandstone beds can be seen dipping 3 degrees to the northwest.
are up the rock dip from us at this site, groundwater that has found its way into the mine is being discharged here at the lowest opening. **Clay:** Mr. GEO Ed, why aren’t the layers tilted here (site GR–9)? Are we on the fold axis again?

**Mr. GEO Ed:** Good question, Clay. The rock layers in this area appear to be nearly horizontal even though we are still within the western flank of the Negro Mountain anticlinal structure. The reason for this appearance is that, for the first time today, our direction of travel has changed, and we are now traveling parallel to the fold axis. The rock layers thus appear flat even though they are actually dipping down toward you and to the northwest.

Also at this exposure, you can see the Lower Kittanning coal seam, a gray underclay just below it, and a thickly layered, light-gray sandstone immediately above it (Figure 13) (Flint, 1965). These are Pennsylvanian-age rocks that are from the lower portion of the Allegheny Formation. During the time these sediments were being deposited, this area was near the equator in a coastal-plain deltaic environment covered with peat swamps. The peat has been altered through burial and is now present as coal.

During the early 1900’s, this coal was deep mined and burned in a power plant located near the large waste pile we just saw. If you look on the opposite side of the river, you can see several more waste piles from other Lower Kittanning coal mines. Historically, coal mining has been important to the economy in this area, but not as important as it was to the area we will be visiting next. We are going to stop for a brief layover in Rockwood before continuing on.

*The fantasy train ride will continue in a future issue of Pennsylvania Geology, when Mr. GEO Ed and Clay will examine the geology in the heart of the Pittsburgh coal region, between Connellsville and West Newton.*

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**Figure 13.** At site GR–9, seventh grade science students examine the Lower Kittanning coal seam that was deep mined along the trail near Rockwood in the Penelec No. 3 mine from 1917 to 1932. The average thickness of the coal seam in the mine was 29 inches.
MAKING A 1-PERCENT GRADE IS PASSING FOR A LOCOMOTIVE—FIELD TEST RESULTS. The geoscience activities applicable to each site along the rail trail are being designed to support the Pennsylvania Department of Education Academic Standards for Science and Technology and Academic Standards for Environment and Ecology. For example, along the Garrett-to-Rockwood trail section, students can identify various geologic structures and features, such as an anticline at sites GR–2 through GR–6 and sedimentary crossbedding at site GR–3. In addition, they can analyze the availability, location, and extraction of earth resources by studying Lower Kittanning coal seam deposits at sites GR–7 through GR–9 and limestone deposits at site GR–3.

Teachers participating in the “Rails to Rocks” workshops offered during the 1998 and 1999 “Mathematics On Saturday/Science on Saturday” meetings, sponsored by the University of Pittsburgh at Johnstown Center for Mathematics and Science Education, rated the program as extremely useful and effective and suggested that it be made available for other teachers. In future workshops, teachers will apply what they have learned to outdoor classroom instruction by developing on-site lessons and activities applicable to the various rail-trail sites.

RAILS TO ROCKS, RESPECT, AND RESPONSIBILITY. Interconnection is the goal of the “Rails to Rocks” project. It is hoped that after participating in educational activities designed for the geologic sites found along these rail-trail routes, students will have learned something about how the geology is connected to the topography, history, ecology, and economy of these regions, and as a result, will be better prepared to make decisions that will affect the earth and its inhabitants.

A white paper drafted in March 1999 for use in the “GEO Beyond 2000” strategic planning process by the Geosciences Directorate of the National Science Foundation contained a recommendation that in the area of education, the number-one priority was to promote K–12 geoscience education to ensure that the next generation of scientists and the general public have a more thorough understanding of the nature and limits of geoscience research (Frodeman and Mitcham, 1999). Charles Jordan, Director of the Portland (Oregon) Parks and

“We went from the traditional four-walled classroom to the open outdoors where students should be experiencing science. In this setting, teachers have the resources present to realistically back up textbook theory with real evidence.”
—parochial high-school teacher, written commun., 1998
Recreation Department, summed it up best: “What they don’t understand, they won’t appreciate; what they don’t appreciate, they won’t respect; what they don’t respect, they won’t value; and what they don’t value, they won’t protect.” Connecting our students to the educational resources found along Pennsylvania’s rail trails is a step in a lifelong journey to understanding, respecting, and preserving our earth, which is truly our common wealth.

**LIBRARY CAR—REFERENCES**


**SUPPLEMENTARY READING**


1From keynote address on the important role that outdoor educational programs play in the development of good citizens. Given at the Second International Trails and Greenways Conference in Pittsburgh, June 1999.
by John H. Barnes  
Bureau of Topographic and Geologic Survey

**INTRODUCTION.** The revolution in computer technology that is sweeping the world has brought a number of changes to the Pennsylvania Bureau of Topographic and Geologic Survey. Among these changes is the growth of our World Wide Web site as a source of information. Another example is the sharing with our clients of large electronic databases that pertain to oil and gas wells and hydrogeology. A major undertaking will soon result in the availability of the entire 1:250,000-scale geologic map of Pennsylvania in a digital format. Portions of that map are already available through the Bureau’s web site.

**CHANGE COMES TO THE DIRECTORY.** Change on a more modest level has now come to one of the Survey’s most long-established and heavily used publications, the *Directory of the Nonfuel-Mineral Producers in Pennsylvania.* The directory was first published as a booklet, Information Circular 54, in 1965 and was republished in that format in 1971, 1977, and 1985. In 1997, three versions of a new edition of the directory were published simultaneously: (1) a booklet printed under a public-private partnership agreement; (2) a digital image of the book published by the Bureau on the web as Open-File Report 97–04; and (3) a set of electronic data files that can be downloaded over the Internet and manipulated using common database and spreadsheet programs. Information on all of these can be obtained on the web at www.dcnr.state.pa.us/topogeo/mineral/intro.htm.

A fourth version of the 1997 edition of the directory carries its evolution a step further. The *Directory of the Nonfuel-Mineral Producers in Pennsylvania* is now available as an interactive digital publication that can permanently reside on a modest desktop or laptop computer and can be used to generate customized tables of commodity data and detailed maps of areas of interest to the user.

As in the other three versions, the interactive version contains the names, addresses, and telephone and fax numbers of all 522 known producers of nonfuel-mineral resources in Pennsylvania, as well as the names, telephone numbers, and locations of each of their
operations, the stratigraphic units and lithologies mined, and a list of the products of each operation. (Telephone numbers were updated to reflect the creation of new area codes since 1997; no other changes were made to the data. Comments about some operations that are included in the other three versions are not included in the interactive version because of software limitations.) The locations of operations can be plotted on a simple, uncluttered outline map showing county boundaries and major highways (Figure 1), or they can be plotted on digital versions of highly detailed U.S. Geological Survey (USGS) topographic maps that can be downloaded over the Internet at no charge and stored on a computer.

**OBTAINING THE SOFTWARE.** Viewing the new interactive directory requires the use of a free map- and data-viewing program called ArcExplorer, which was published by Environmental Systems Research Institute, Inc. (ESRI). Information on obtaining both the interactive directory and ArcExplorer can be found on the Bureau’s web site at www.dcnr.state.pa.us/topoge/mineral/iamenu.htm.

![Figure 1. The opening screen of the interactive version of the directory contains a map of the state on which county boundaries and major highways are shown, and a scrollable list of 18 themes, or commodities, that can be plotted.](image)
USING THE NEW INTERACTIVE DIRECTORY. Below is a brief introduction to the interactive version of the directory and several examples of how one might use it.

(1) Displaying and quickly checking the names and properties of operations. When the program is first started, the computer screen shows an outline map of Pennsylvania and a list of map themes (geographic features of the same type, in this case, commodities) to the left of the map (Figure 1). County boundaries and U.S. and Interstate highways are additional map themes that appear at the end of the list. Any number of themes can be displayed on the map by clicking on the checkbox next to the name of each theme.

Data pertaining to each operation within a theme can be displayed if the theme is made “active.” This is done by clicking on the name of the commodity. Only one theme can be active at a time. When a commodity theme is active, the name of the owner of any operation producing that commodity can be displayed by simply pointing at the operation with the mouse pointer. All of the properties of an operation can be displayed by turning on ArcExplorer’s “Identify” function and clicking the mouse on the operation’s map symbol (Figure 2).

Figure 2. The owner of a quarry in Clearfield County that produces construction aggregate (the active theme) is identified by pointing to the operation with the mouse. Information about the operation, which appears in the inset box on the left, was obtained using the “Identify” function of ArcExplorer (see text).
(2) Displaying the locations of all producers of a commodity who meet selected criteria. Using ArcExplorer's “Query” function, any combination of criteria can be applied to locate and identify mineral operations. For example, to check for operations in which the Valentine Member of the Linden Hall Formation is mined for high-calcium limestone, select the theme “high-Ca limestone,” then create a query to search that theme for operations in which the “formation” equals “Valentine Member” (Figure 3).

![Figure 3. A map of Pennsylvania generated using ArcExplorer’s “Query” function shows the locations of four operations mining high-calcium limestone from the Valentine Member (square symbols, circled). Two of the symbols are very close together and overlap at this scale. Other operations mining high-calcium limestone in Pennsylvania (not from the Valentine) are indicated by triangles.](image)

(3) Displaying the detailed location of a specific operation. Using ArcExplorer’s “Query” function, an operation can be located and highlighted on the state map (Figure 4). Included in the data for each operation is the name of the USGS 7.5-minute quadrangle on which it is located. Topographic quadrangle maps can be downloaded from the Pennsylvania Spatial Data Access web site (www.pasda.psu.edu/), which is maintained by the Pennsylvania State University and is funded in part by the Pennsylvania Department of Environmental
Protection. Once downloaded and stored on a computer, an image of a quadrangle map can be displayed with the selected themes. One can then use the zoom control to view the detailed map showing the location of the operation (Figure 5).

**WHY SO MANY VERSIONS?** With four versions of the directory now available, one might wonder whether so many versions are needed. To some extent, the proliferation of versions reflects the evolution of available technology. But it is also true that each version has its own strengths for fulfilling various needs.

The traditional printed book has the advantage of portability and easy access without any technical limitations beyond the ability to read. It can be used equally well in the office or field. It can be browsed at one’s leisure, which may be the best way to discover products and applications that one did not know existed.

The digital version of the book fills the requirements of a person who needs access to at least a part of the book immediately and cannot wait for the post office to deliver it. It can be stored on a com-
puter, and relevant pages can be printed and annotated or carried into the field as needed.

The electronic database files probably constitute the least user-friendly version of the directory. However, we have had a number of requests for that format from people who are comfortable using computers and who wish to have access to the data in its raw form to create customized printouts and maps that meet their specific needs.

The new interactive version accomplishes those same goals, but in a more user-friendly format. The database and ArcExplorer can reside on a personal computer and, being relatively easy to set up and use, extend customized searching and mapping capabilities to more users. Because ArcExplorer does not require an Internet connection when it is operating, the interactive directory can be used on a laptop computer away from the office. A person preparing to visit a number of quarries might first download the relevant USGS topographic maps for those quarries onto a laptop computer in the office and then set out with the program, data, and maps on the computer. As the pace of technological change continues to race along at ever greater speed, one might pause to wonder, “What will the next version of the directory look like?”

Figure 5. The dimension-stone quarry that was the subject of the search in Figure 4 is plotted here on a digital image of part of the USGS Harford 7.5-minute topographic quadrangle.
NEW RELEASES

Landslide Susceptibility in North-Central Pennsylvania

The Bureau of Topographic and Geologic Survey has released Environmental Geology Report 9, Landslide Susceptibility in the Williamsport 1- by 2-Degree Quadrangle, Pennsylvania.

The report, written by Helen L. Delano (staff geologist) and J. Peter Wilshusen (deceased; former chief of the Bureau’s Environmental Geology Division), is a comprehensive study of slope movements in an area of highly varied rock types, geologic structure, and topography. The well-illustrated 192-page text includes descriptions and examples of the seven general types of landslides observed in the approximately 7,150-square-mile area. The appendix contains an inventory of more than 1,300 landslides as well as 99 page-sized topographic maps showing the locations of the slides. A 1:250,000-scale, two-color plate shows zones of interpreted landslide susceptibility.

Environmental Geology Report 9 may be purchased from the State Book Store, 1825 Stanley Drive, Harrisburg, PA 17103–1257, at a cost of $17.45 plus $1.05 state sales tax. Sales tax applies to Pennsylvania residents only. All orders must be prepaid; please make checks payable to Commonwealth of Pennsylvania.

Physiographic Provinces of Pennsylvania

A new edition of Map 13, Physiographic Provinces of Pennsylvania, has been issued by the Bureau of Topographic and Geologic Survey.

The full-color page-sized map, compiled by staff geologist W. D. Sevon, differs significantly from the 1996 edition. Some major changes include (1) addition of a new section and revision of several other sections in the Appalachian Plateaus province; (2) addition of five new sections in the Ridge and Valley province; and (3) elimination of the Blue Ridge province in Pennsylvania. A thorough description of all of the sections is printed on the reverse side of the map.

Copies of Map 13 are available free upon request from the Bureau of Topographic and Geologic Survey, P. O. Box 8453, Harrisburg, PA 17105–8453, telephone 717–787–2169. The map may also be viewed on the Bureau’s web site at www.dcnr.state.pa.us/topogeo/map13/map13.pdf.
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Pennsylvania Geology

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FOUR-HUNDRED-MILE-LONG TRAIL NETWORK
FROM WASHINGTON, D. C., TO PITTSBURGH, PA.
(See article on page 12.)

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