PENNSYLVANIA GEOLOGY

THE PENNSYLVANIA GEOLOGICAL SURVEY VOL. 19/3

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

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ON THE COVER: Five-cent and one-dollar notes issued by the Indiana Iron Works in the mid-nineteenth century for redemption at the company store (see article on page 2). Color is similar to that on the original notes. Notes are shown at 92 percent of their actual size. Photograph by Paul Farmer.

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Editor, Christine M. Dodge

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The Risks of Driving Through Geology

Drivers on Pennsylvania highways need to be aware of the ever present danger of rockfalls, landslides, and other geologic hazards to their safe passage. In this issue we feature a detailed discussion of a recent slide that occurred so suddenly that four vehicles were damaged; luckily no lives were lost. But such is not always the case. In midwinter one life was lost and another person injured on New York State's Governor Thomas E. Dewey Thruway from a rockfall.

Highway design needs to take into account the geology of the area over which traffic is to pass. The roadcuts created by highway construction are important to geologists because they show us the rocks normally hidden by soil or surficial materials. But by "cutting" into the rocks the natural systems are interrupted, and inexorably nature seeks to return to natural slopes. The strength of the rock masses progressively deteriorates. As the roads age we can see and feel the effects through the uneven surface, visible cracks, and potholes that seem to occur overnight.

As the roads age visibly so do the roadcuts, but this weathering is invisible to the passerby. By serendipity the area of the Chulasky rockslide had been examined in detail nearly three decades ago by a Survey geologist. Thus our modern examination of the now-deteriorated rock was aided by the prior description in determining the exact rock layer along which the slide occurred.

We can predict from these examinations that rockfalls and landslides will continue to occur, and with probably greater frequency now that our interstate highway system and system of freeways are several decades old. Thus driving through the geology of Pennsylvania takes on an added consideration, and that is of greater caution while traversing steep roadcuts. The new highways and new roadcuts being produced and being described by geologists will be the site of future rockfalls and should be passed with great caution.

Donald M. Hoskins

Donald M. Hoskins
State Geologist

IRON-MINING STORE SCRIP IN PENNSYLVANIA

by G. Robert Ganis
Tethys Consultants, Inc., Harrisburg, PA

The early manufacture of pig iron in America was a localized industry. Wherever iron ore, fuel, limestone, and power were found in reasonable proximity to each other, small iron furnaces flourished. Because of their remoteness from civilization, these furnaces became the centers of feudal plantations in which the workers were dependent on the paternalistic benevolence of the resident ironmaster or the more remote iron company. Examples of the few restored or fortuitously preserved Pennsylvania iron plantations include Hopewell in Berks County (Inners and Fergusson, 1987) and Mount Etna in Blair County (Inners, 1986).

Many of the companies that controlled iron plantations paid the workers' wages in scrip that could only be redeemed in the company stores, or "pluck me's" (Figure 1). Although such stores were vital to supplying the necessities of life to the inhabitants of the local community, the issuance of scrip, the "liberal" use of charge accounts,

Photograph by Jon D. Inners

Figure 1. Manager's house (left) and office-company store (right) at Mount Etna iron furnace in Blair County.

and high prices meant that the individual worker almost invariably "owed his soul to the company store." (Charging inflated prices in the stores also helped to boost the thin profit margins of the iron manufacturers.) A less sinister effect of the use of scrip was to allow companies to "weather" the periodic depressions and currency shortages that so frequently disrupted nineteenth-century American industry. These money shortages were brought on in part by the hoarding of gold and silver following major economic and political upheavals.

Some of this old iron-furnace scrip has survived to come within the purview of the modern numismatist. Hoober (1985) lists extant scrip of 23 different companies or furnaces. Although most notes are rare, it is still possible to obtain exquisite material from mail-order dealers and at coin-and-currency shows.

An example of Pennsylvania scrip is the "five-cent" note issued by the Cambria Iron Company (Figure 2) of Leathercracker Cove at Henrietta P.O. in Blair County. At the Henrietta ore bank, limonitic lump ore was mined from weathered limestone of Formation No. II (Platt, 1881), the Cambro-Ordovician limestones, undifferentiated, of modern usage. The Hollidaysburg Furnace, which used the Henrietta ores, also issued scrip (Figure 3).

Company scrip was commonly printed by stationers, usually on thin rice paper sheets. Vignettes were often taken from catalogs, and the complexity and originality of the notes varied according to the budget for printing and the need for anticounterfeiting measures. Sheets of the Allegheny Furnace iron works (Figure 4) and the In-

Photograph by Paul Farmer

Figure 2. Cambria Iron Company scrip from Henrietta ore banks. The note is shown at 75 percent of its actual size and was originally printed in red and blue.

Photograph by Paul Farmer

Figure 3. Scrip from Hollidaysburg Furnace. The note is shown at 73 percent of its actual size and was originally printed in black.

diana Iron Works (cover photo) appear to have been made by the same printer. The vignettes on the scrip of these two furnaces may provide rough sketches of their appearance.

Several factors contributed to the demise of small pig-iron operations in the late nineteenth century. The preferred use of steel over iron, particularly in rails, was the greatest blow. Discovery of the great iron ranges of the Lake Superior region in 1844 and opening of the Sault Sainte Marie Canal in 1855, followed by development of the Bessemer converter in 1856 (Bateman, 1950; Hogan, 1971), gave rise to a national dimension for steelmaking and the marketing of steel in America. When the maturation of the railroad system in America made transportation of iron and steel products feasible throughout the country, the small, local blast furnaces dependent on low-grade iron deposits were overwhelmed.

Photograph by Paul Farmer

Figure 4. Scrip from Allegheny Furnace. Color is similar to that on the original note. Note is shown at 70 percent of its actual size.

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NEW USGS PUBLICATIONS

by Thomas M. Berg
Pennsylvania Geological Survey

Two detailed 1:24,000-scale bedrock geologic maps in the Great Valley area of Berks and Lehigh Counties have recently been released by the U.S. Geological Survey. The **Geologic Map of the Topton Quadrangle, Lehigh and Berks Counties, Pennsylvania** (Geologic Quadrangle Map GQ–1609), by Avery Ala Drake, Jr., shows the distribution of complexly folded and faulted Cambrian and Ordovician rocks. The bedrock units shown on the map are parts of three distinctive assemblages of marine sedimentary rocks which are called the Schuylkill sequence, the Lehigh Valley sequence, and the Hamburg klippe sequence. The formations and members within these sequences were deformed during two major mountain-building events called the *Taconic orogeny* and the *Alleghanian orogeny*. Major thrust, tear, and high-angle faults are shown, along with the locations of folds and planar and linear features. Two structure sections are printed with the map, as is a brief description of the stratigraphy and structure of the quadrangle.

The **Geologic Map of the Hamburg Quadrangle, Schuylkill and Berks Counties, Pennsylvania** (GQ–1637), by Gary G. Lash, portrays a similar complex of Cambrian, Ordovician, and Silurian rocks. The northwest portion of this quadrangle includes part of the Ridge and Valley province of Pennsylvania. Faults, shear zones, folds, and planar and linear features are shown on the map; these structural features are elaborated in four structure sections and a number of stereographic projections. A brief text contains an explanation of the geologic structure as well as the depositional environments of all of the sedimentary rock units, which range from deep marine basins to braided rivers.

Both of these new maps are significantly different from earlier renditions of the bedrock geology, as shown on the 1980 *Geologic Map of Pennsylvania* (Pennsylvania Geological Survey Map 1). Drake and Lash have refined and sharpened our understanding of Lower Paleozoic stratigraphy of the Great Valley area, and have greatly clarified the Taconic and Alleghanian structural framework. Geologists, consultants, and engineers will find the maps valuable for understanding the bedrock of these areas. Recent bedrock mapping in adjacent areas includes the **Geologic Map of the Kutztown Quadrangle, Berks and Lehigh Counties, Pennsylvania** (GQ-1577), by G. G. Lash, and **Geologic Map of the Slatedale Quadrangle, Lehigh and Carbon Counties, Pennsylvania** (GQ-1598), by Peter T. Lyttle, G. G. Lash, and Jack B. Epstein.

A new 1:250,000-scale geologic map published by the U.S. Geological Survey includes a large part of southeastern Pennsylvania. The **Geologic Map of the Newark 1° x 2° Quadrangle, New Jersey, Pennsylvania, and New York** (Miscellaneous Geologic Investigations Map I-1715), by P. T. Lyttle and J. B. Epstein, shows a version of the bedrock geology of the Commonwealth between 40° and 41° latitude north, and 74° and 76° longitude west. In the majority of this area, the new map is identical to the 1980 *Geologic Map of Pennsylvania*, but there are significant differences, particularly in the Great Valley, in parts of the Mesozoic Lowlands, and in the Piedmont Uplands. Many of the differences are real improvements, some of the differences are simply based on opinion, and some differences are omissions. Comparing the 1980 *Geologic Map of Pennsylvania* with the Newark 1° x 2° quadrangle is an interesting lesson which teaches that most geologic maps covering large areas are "a moment in time" and are likely to be revised later. A very important aspect of the new map is that it contains proposed new rock nomenclature for the metamorphic rocks of the Piedmont. Additionally, structure sections that accompany the map provide new interpretations which will spark further thought and more accurate future investigations.

The new 1:24,000-scale GQ maps each cost $3.60, and the 1:250,000-scale Newark map costs $6.70. The maps may be purchased from Map Distribution Section, U.S. Geological Survey, Box 25286, Federal Center, Denver, CO 80225. Prepayment is required; make checks payable to *U.S.G.S.* For orders under $10.00, there is a $1.00 charge for postage and handling.

"Danger—Falling Rocks": The Chulasky Rockslide

by Jon D. Inners, Pennsylvania Geological Survey,
and Duane D. Braun and Norman M. Gillmeister,
Bloomsburg University

"Fallen Rock Zone" and "Danger—Falling Rocks" are familiar signs to motorists on highways in the folded Appalachians of central and eastern Pennsylvania. Familiarity in this case does breed contempt, or at least disregard; many a driver has been rudely jarred from reverie by running over a fist-sized chunk of rock on the roadway or, even worse, catching a "gooney" on the hood or windshield. Even a single rock hurtling off a 75-foot-high cut slope can have serious, even fatal, effects on passersby. Yet how much more devastating if a "chunk of mountain" weighing many thousands of tons comes crashing onto the highway! Twice in the last two years such massive rockslides have obstructed traffic on major highways in the North Branch Susquehanna River basin. Both occurred in March—probably the most "propitious" month for seasonal landslides; both took place in areas where rock strata dip out of mountainsides or hillsides toward roadways; and both resulted in property damage, but no fatalities. (Will we be so lucky the next time?) Braun and others (1987) described the first of these rockslides—that on Penobscot Mountain in Luzerne County. The second is the subject of the present article.

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At 11:15 p.m. on Sunday, March 1, 1987, several thousand cubic yards of rock slid onto rain-slicked U.S. Route 11 approximately 2 miles west of Danville in central Pennsylvania. Because of poor visibility and the suddenness of the event, four vehicles—two tractor-trailers and two automobiles—hit the slide mass. Debris from the slide covered all four lanes of Route 11, but did not reach the railroad tracks that lie between the highway and the North Branch Susquehanna River. It took Pennsylvania Department of Transportation (PennDOT) crews 5 days, working 8 to 10 hours a day, to completely remove the slide mass. All four lanes were finally opened to traffic in mid-afternoon on Friday, March 6. As with most highway slope failures, however, removal of the rock debris was only the first step in the difficult task of stabilizing the slope. Remedial sculpting of the slide area in December 1987 removed a precarious overhang and reduced the threat of future slides at this particular location.

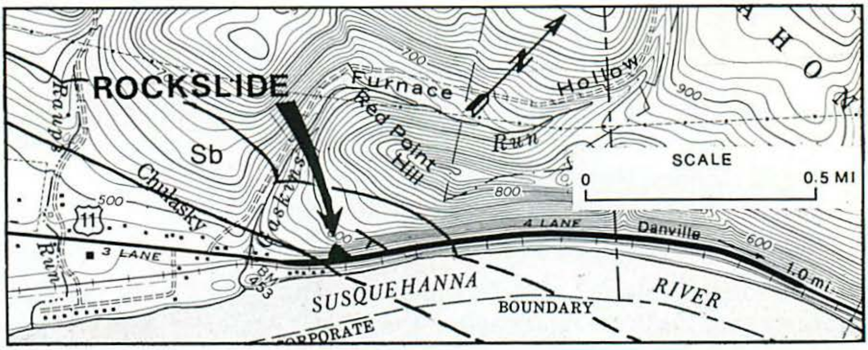

Figure 1. Location map showing the outcrop of the Bloomsburg Formation (Sb) in the vicinity of Chulasky. Note that the rock strata dip to the southeast.

The rockslide took place at the southwest end of a long cut slope on the south side of Red Point Hill at Chulasky, Northumberland County (40°57′22″N/76°39′44″W, Riverside quadrangle; Figure 1). For a distance of more than a mile northeast of "Red Point," a four-lane highway and a single-track railroad grade are squeezed into a narrow space between a loop of the North Branch and Montour Ridge. The transportation corridor trends obliquely across the "strike" of the southeast-dipping bedrock units forming Montour Ridge and its southern foothills. While the highway has followed its present course for more than a century, the last major widening (to four lanes) took place in the mid-1950's. As a result of this construction, the roadway was left with a narrow shoulder adjacent to the slope and a serious rockfall hazard. On February 24, 1970, PennDOT personnel using a crane "surgically" removed a 30- to 35-cubic-yard mudstone block bounded by open joint cracks in the same areas as the 1987 slide. Later that winter, a new ½:1 pre-split cut slope up to 100 feet high was constructed for a distance of 0.4 mile along the northwest side of the highway. This redesigned slope created a 23-foot safety zone between the hillside and the edge of the highway (Roads and Streets, 1971), but at the same time exacerbated the undercutting of the natural hillslope.

The slope failure of March 1987 occurred in thick-bedded, grayish-red (5R4/2) silty mudstone of the upper part of the Bloomsburg Formation. According to the measured section of Hoskins (1961), the beds involved in the landslide lie about 90 feet stratigraphically below the base of the sandy Moyer Ridge Member (Figure 2).

At the site of the failure, the main structural discontinuities in the Bloomsburg mudstones are bedding and three sets of systematic,

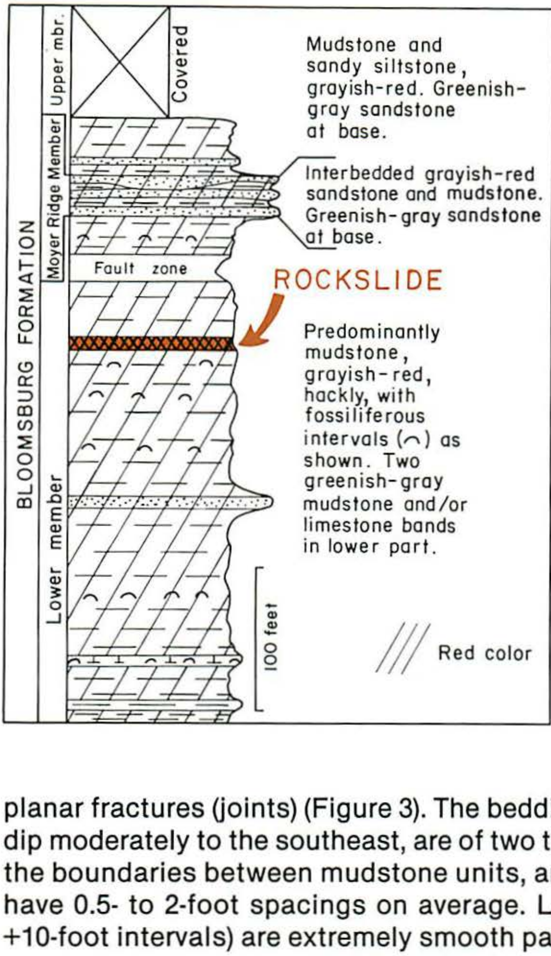

Figure 2. Stratigraphic section of the Bloomsburg Formation, showing the position of beds involved in the Chulasky rockslide (after Hoskins, 1961).

planar fractures (joints) (Figure 3). The bedding-plane partings, which dip moderately to the southeast, are of two types. Most partings mark the boundaries between mudstone units, are relatively smooth, and have 0.5- to 2-foot spacings on average. Less common (spaced at +10-foot intervals) are extremely smooth partings at the top and bottom of thin siltstone beds. Of the dominant fracture sets, strike and oblique joints tend to be moderately discontinuous and relatively smooth, whereas dip joints are generally very discontinuous and rough. Northwest-dipping strike joints that are orthogonal to bedding are the most common fractures; these are typically spaced 0.5 to 2 feet apart, but may repeat at 1- to 2-inch intervals locally.

The slide mass was 57 to 135 feet wide, up to 19 feet thick, and 150 feet long and had a total volume of about 5,000 cubic yards. Since the failure involved intact bedrock, it is classified as a rock block slide (Varnes, 1978). The bounding surfaces of the slide were a pair of smooth, southeast-dipping mudstone-siltstone bedding partings (above and below a 1-inch-thick siltstone bed) that served as the slide surface; a smooth northwest-dipping oblique joint in the west corner; a ragged subvertical dip joint on the extreme southwest side; and

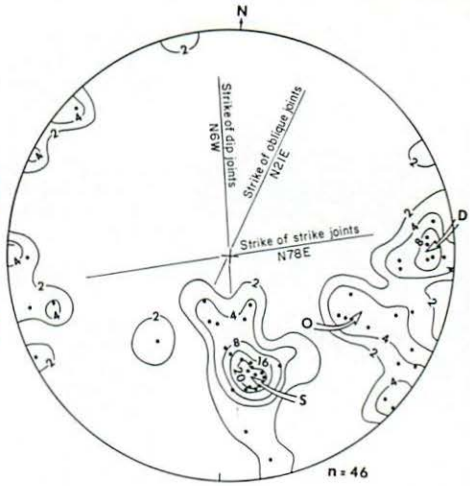

Figure 3. Stereogram (equal-area lower hemisphere projection) of poles to joints in the Bloomsburg Formation at the site of the rockslide. Arrows indicate strike (S), dip (D), and oblique (O) joint sets. Contours are at 2, 4, 8, 16, and 20 percent per 1-percent area.

strike joints along a kink fold at the apex of the head scarp (Figures 4 and 5). The southeast side was the open face of the roadcut. The slide surface stepped down slightly from the top to the bottom of the thin siltstone bed in the northeast part of the slide area (Figure 5). Because the pre-split slope cuts obliquely across the strike of bedding, the slide mass actually rotated about 40 degrees to the southeast toward its unbound side as it moved off the slope.

Like other recent roadcut rockslides in the region (e.g., Allenwood and Nanticoke), the Chulasky slide was probably triggered by high cleftwater pressures developed in the slide mass after heavy rain-

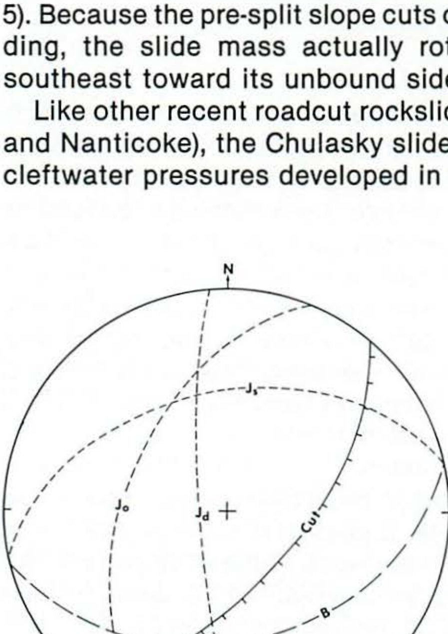

Figure 4. Stereogram (equal-area lower hemisphere projection) of major discontinuity surfaces of the rockslide. Bedding: B, N80E/40SE (failure surface). Joints: J_s (strike), N78E/45NW; J_d (dip), N6W/80W; J_o (oblique), N21E/52NW. The cut face shown (N40E at ½ to 1, or 63 degrees) is the design cut slope prior to failure.

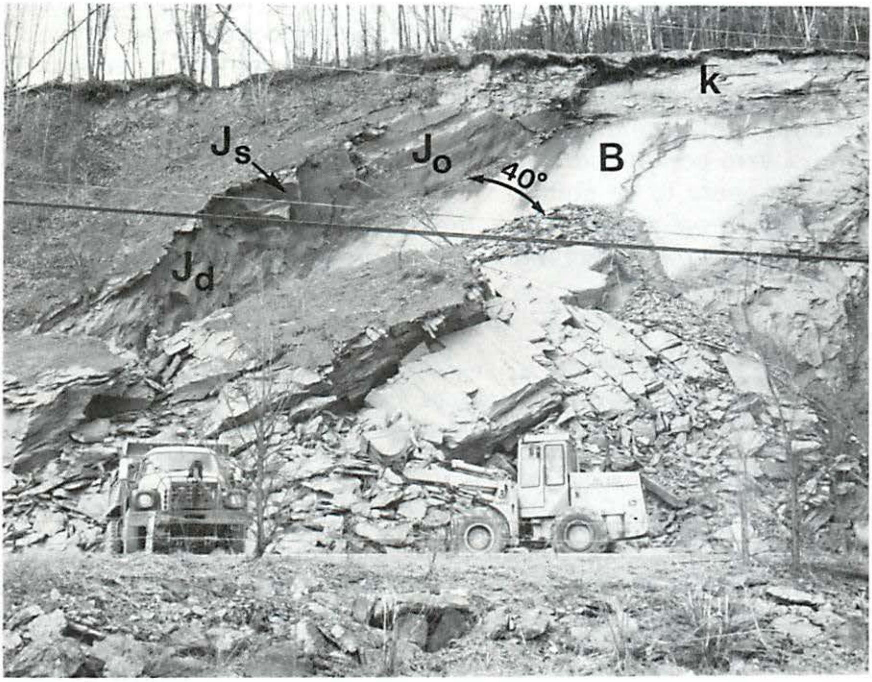

Figure 5. The Chulasky rockslide during cleanup operations, showing the major discontinuities (B, bedding; J_s, strike joints; J_d, dip joints; J_o, oblique joints; k, kink fold). Note the 40-degree clockwise rotation of the slide mass.

fall, ground thaw, and/or significant snowmelt (Inners and Wilshusen, 1986; Inners and others, 1987; Braun and others, 1987; Wilshusen and others, 1987). The immediate cause of failure was probably high cleft-water pressure on the smooth mudstone-siltstone bedding parting, combined with low tensile strength along the bounding joints. Since the only precipitation events recorded at the Williamsport weather station (24 miles to the north-northwest) in the 2 weeks before the failure at Chulasky were 0.6 inch of rain on March 1 and 4 inches of snow (water equivalent 0.28 inch) on February 23 (National Oceanic and Atmospheric Administration, 1987), it appears that precipitation in itself was insufficient to cause the slide. Of greater importance in increasing the water pressure along the failure surface may have been the thawing of ground frost and the melting of a heavy snow-pack that reached a maximum of at least 22 inches on January 23 and had melted to a trace by February 26.

Because the failure of March 1 left large overhangs at the apex and in the west corner (see Figure 5), PennDOT carried out a controlled blast on December 8, 1987, which removed approximately

2,000 cubic yards of rock from these areas. Sufficient blasting compound was used to reduce the mudstone to cobble-size fragments, the largest of which were about 5 inches in maximum dimension. The blast formed an apron of material that completely covered the shoulder and the innermost lane of U.S. Route 11. Cleanup operations were completed on the following day, and the repaired slope now appears to be stable.

The authors thank Jake Schreck and Paul Solomon of PennDOT District 3-0 for information used in preparing this article.

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The Pennsylvania Academy of Science Includes Geoscience

A newsletter, journal, annual meetings at which there are presentations of scientific knowledge, a series of nearly a dozen hardcover publications—these are the tangible benefits to members of the Pennsylvania Academy of Science. Founded in 1924 to unite Pennsylvania scientists into one organization that could effectively advance science in Pennsylvania and the scientific spirit, the Academy now numbers over 800 members. Scientists from all regions of the Commonwealth and from all disciplines have banded together to expand the Academy from the 40 scientists who gathered in 1925 for the first annual meeting and exchange of information to the present organization, which attracts several hundred members to annual meetings and which sponsors a junior academy for young scientists numbering in the thousands.

Over the years, membership has been open to all scientists and those holding an interest in science. Membership of geoscientists continues to be encouraged, and evidence of membership of those having an interest in geology and earth science is apparent each year in the issues of the *Proceedings* and the annual meeting program listings. However, more support from this quarter is needed to provide a true balance in the Academy of those who have an interest in the geosciences.

The Academy welcomes geologists, hydrogeologists, and earth scientists to join in membership with other scientists of Pennsylvania, all of whom have the same objectives: to encourage scientific research and publication; to disseminate scientific knowledge; to form new fellowships with scientists and grow professionally; to extend the information about the Commonwealth to those outside its borders, both domestic and international; and to support the activities of young scientists as their interests in various fields mature.

The Proceedings of the Pennsylvania Academy of Science offers a unique format for publishing the results of scientific research. Published twice per year, the refereed journal is acknowledged by institutions and libraries throughout the world as one of high quality. The Academy urges all of its members to consider publication in the *Proceedings,* and those in the geoscience community are also most welcome to submit manuscripts for publication, one benefit that accompanies membership.

In recent years, the Academy has published a series of books on coal, energy, hazardous wastes, and threatened species, among others. The Academy provides these books at discount to members and in 1988 has offered a free book with new memberships. To receive the details of the book offer and a membership application, contact any officer of the Academy or write to Dr. Howard Pitkow, Pennsylvania College of Podiatric Medicine, 8th and Race Streets, Philadelphia, PA 19107.

The Academy encourages your participation as well as support. Make 1988 your membership year and help the Academy continue its service to Pennsylvania.

REMINDER!
1988 FIELD CONFERENCE
October 6–8

The 53rd Annual Field Conference of Pennsylvania Geologists will meet in Hazleton, Pennsylvania, the "Mountain City." The bedrock and surficial geology of the North Branch Susquehanna River lowland and the Eastern Middle Anthracite field will be emphasized. Of particular geologic interest are planned stops at the great Woodfordian frontal kame near Berwick, the spectacular Council Cup Scenic Overlook at Wapwallopen, exposures of the enigmatic Light Street fault near Bloomsburg and Briar Creek, and two anthracite strip mines near Hazleton (hopefully, including one that exposes the famous Mammoth coal bed). A special treat will be a visit to the Eckley Miners' Village.

If you are not on the current Field Conference mailing list and wish to attend the 1988 Conference, please write to Field Conference of Pennsylvania Geologists, c/o Pennsylvania Geological Survey, P. O. Box 2357, Harrisburg, PA 17120.

Urbanization Degrades Water Quality in Eastern Pennsylvania

The U.S. Geological Survey recently published a study assessing the impact of urbanization on groundwater and surface water. Although the study focuses on eastern Chester County, similar effects can be expected in other areas in Pennsylvania that are urbanized or undergoing development.

The results of the study are presented in the report **Effects of Urbanization on the Water Resources of Eastern Chester County, Pennsylvania,** by Ronald A. Sloto. The report, prepared in cooperation with the Chester County Water Resources Authority, was published as U.S. Geological Survey Water-Resources Investigations 87–4098.

It is demonstrated in the study that the most serious consequence of urbanization is degradation of groundwater quality. Volatile organic compounds were found in 39 percent of 70 wells sampled. The most serious effect on the surface-water system is the absorption and accumulation of PCB and pesticides on stream-bottom sediments. The author also pointed out substantial infiltration of groundwater to sewer systems, which reduces the base flow of streams.

Groundwater infiltration to one sewer system was as much as 4.9 million gallons per day and made up a greater percentage of the flow than did wastewater.

A limited number of copies of the report were printed. They are available from the U.S. Geological Survey, 4th Floor, Federal Building, P. O. Box 1107, Harrisburg, PA 17108-1107.

NEW STAFF MEMBER

David W. Valentino

David Valentino joined the Geologic Mapping Division of the Survey in late April 1988. He has been assigned to the Piedmont province mapping program, a new Survey effort to develop a modern understanding of the geology in southeastern Pennsylvania. David's initial task is to collect samples, measure geologic structures, and describe the rocks, all part of the preliminary approach to unraveling the geology of this metamorphic terrane that extends from York County to southern Bucks County.

David has a strong educational background ideally suited for working with the rocks of southeastern Pennsylvania, which are primarily metamorphic. He studied geology at Temple University, in Philadelphia, earning his Bachelor's degree in 1986 and a Master's degree this year, 1988. For the past year, David was a teaching and research assistant in the Geology Department at Temple; his duties included conducting laboratories in physical and structural geology, evolution, and catastrophic geology.

Photograph by M. L. Crawford

David's Master's thesis consisted of the mapping and interpretation of ductile shear zones along the Rosemont fault in Delaware County. During part of this research he was a volunteer for, and received support from, the Pennsylvania Geological Survey. David's wife Karen, who is graduating from Temple University in geology, also has a strong interest in metamorphic geology.

Geochips

During the summer and fall of 1933, Stan Lohman, a geologist of the U.S. Geological Survey, was studying the groundwater of south-central Pennsylvania in cooperation with the Pennsylvania Geological Survey. On October 13 he collected a sample of water from "Magnesia Spring," one of four springs of the Bedford Springs Hotel and Baths, situated a few miles south of the Borough of Bedford, the county seat of Bedford County. Water from "Magnesia Spring," which had a bitter taste, was used only for so-called medicinal baths. While Stan was filling out a tag to attach to the sample bottle, a long black limousine drove up and parked. The liveried chauffeur stepped out and opened the rear door, from which emerged a well-dressed woman. As she walked toward the spring for a drink, she took from her purse a folding aluminum drinking cup. When she saw the painted sign and saw Stan filling out the tag, she hesitated, and asked about the spring and what he was doing. After he explained the nature of his work, he mentioned that the water from this spring (which flowed about 30 gallons per minute from the Helderberg Limestone) had a bitter taste, and probably contained considerable magnesium sulfate, commonly called epsom salts. She exclaimed in alarm, "Epsom salts! Then—it will physic one, won't it?" He replied, "It shore will!" Whereupon, she thanked him for the warning, returned the cup to her purse, went back to the limousine, and was driven away.

Subsequent analysis of the water sample indicated that it contained considerable calcium and magnesium sulfate, and was the hardest and most highly concentrated sample of groundwater collected in the 14 counties covered by this investigation (see spring 992, p. 126, 132, and 139, in Pennsylvania Geological Survey Water Resource Report 5, 1938).

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GROUNDWATER LEVELS
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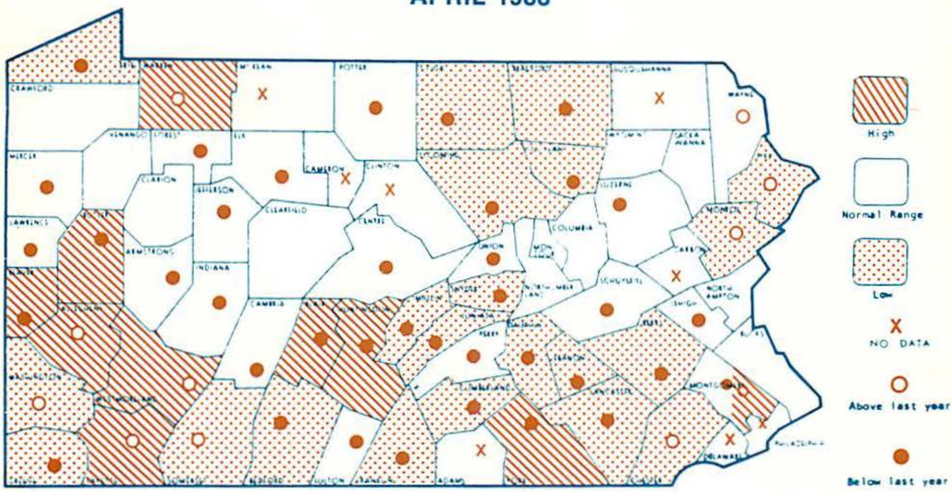

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