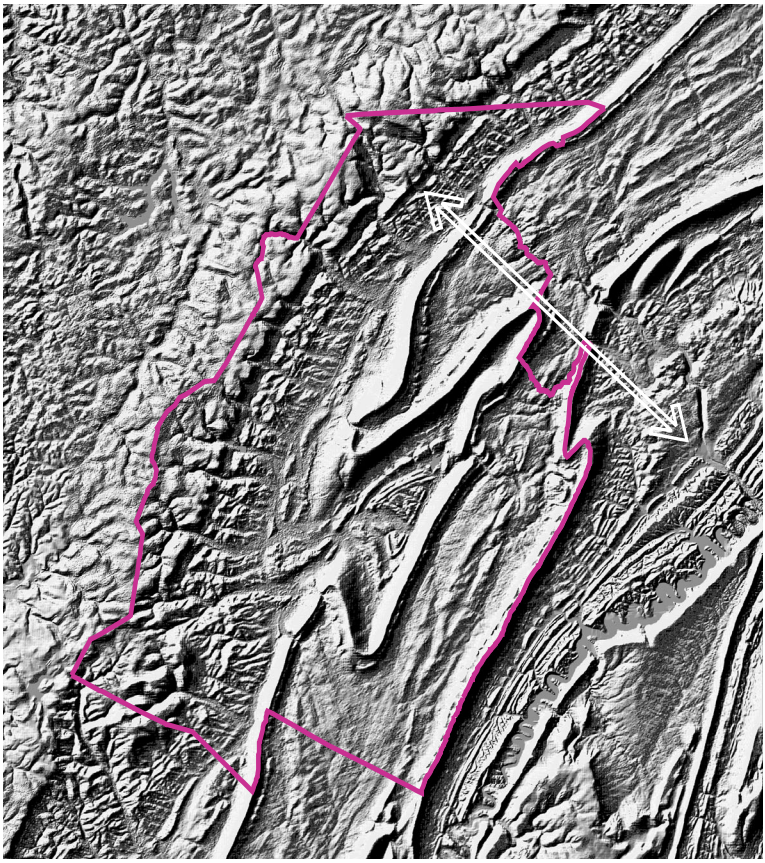
VOL. 33, NO. 4

Pennsylvania GEOLOGY



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ON THE COVER

Shaded-relief image of Blair County and surrounding area. The V-shaped Brush Mountain in the northeastern part of the county and the Little Juniata River along the county boundary form the borders of Sinking Valley. During the Revolutionary War era, lead from this valley was mined to make bullets (see article on page 2). The arrow indicates a northwest-trending zone of increased mineralization. This zone includes the triangular Tipton block in the northwest corner of the county (Faill, R. T., 1981, The Tipton block—an unusual structure in the Appalachians: Pennsylvania Geology, v. 12, no. 2, p. 5–9). C. E. Miles generated the image from the 1999 U.S. Geological Survey National Elevation Dataset for Pennsylvania.

PENNSYLVANIA GEOLOGY

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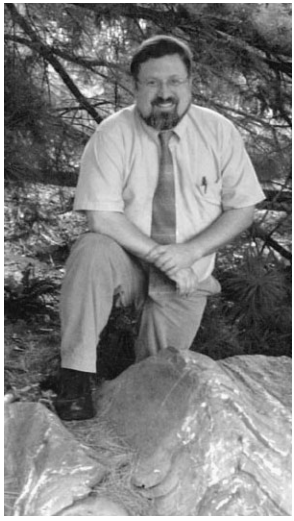
VOL. 33, NO. 4 **WINTER 2003**

STATE GEOLOGIST'S EDITORIAL

The Survey Mandate

Lead was a valuable resource for colonists, but early attempts to locate lead deposits were based on little more than random exploration, aboriginal knowledge, or luck. In 1836, the commonwealth created the First Pennsylvania Geological Survey to map the rock formations of the state. One of the functions of any state geological survey is to provide scientific information that will allow the citizens of its state to find natural resources. A part of the current legislation that gives the Fourth Pennsylvania Geological Survey its mandate is as follows:

> *To undertake, conduct and maintain the organization of a thorough and extended survey of this Commonwealth for the purpose of elucidating the geology and topography of this Commonwealth. The survey shall disclose the chemical analysis and location of ores, coals, oils, clays, soils, fertilizing and of other useful minerals, and of waters, as shall be necessary to afford the agricultural, forestry, mining, metallurgical and other interests of this Commonwealth and the public a clear insight into the character of its resources. It shall also disclose the location and character of such rock formations as may be useful in the construction of highways or for any other purpose.*



As you can see, the mandate is fairly broad, covering most possible clients and uses, and ending with "or for any other purpose." Our job is to describe, locate, and map all natural resources so that they can be evaluated when societal needs dictate. Today much of this information is used to mitigate environmental problems. The use may change, but the mapping remains the base upon which decisions can be made.

Jay B. Parrish
State Geologist

Lead and Zinc in Central Pennsylvania[1]

by Robert C. Smith, II
Pennsylvania Geological Survey

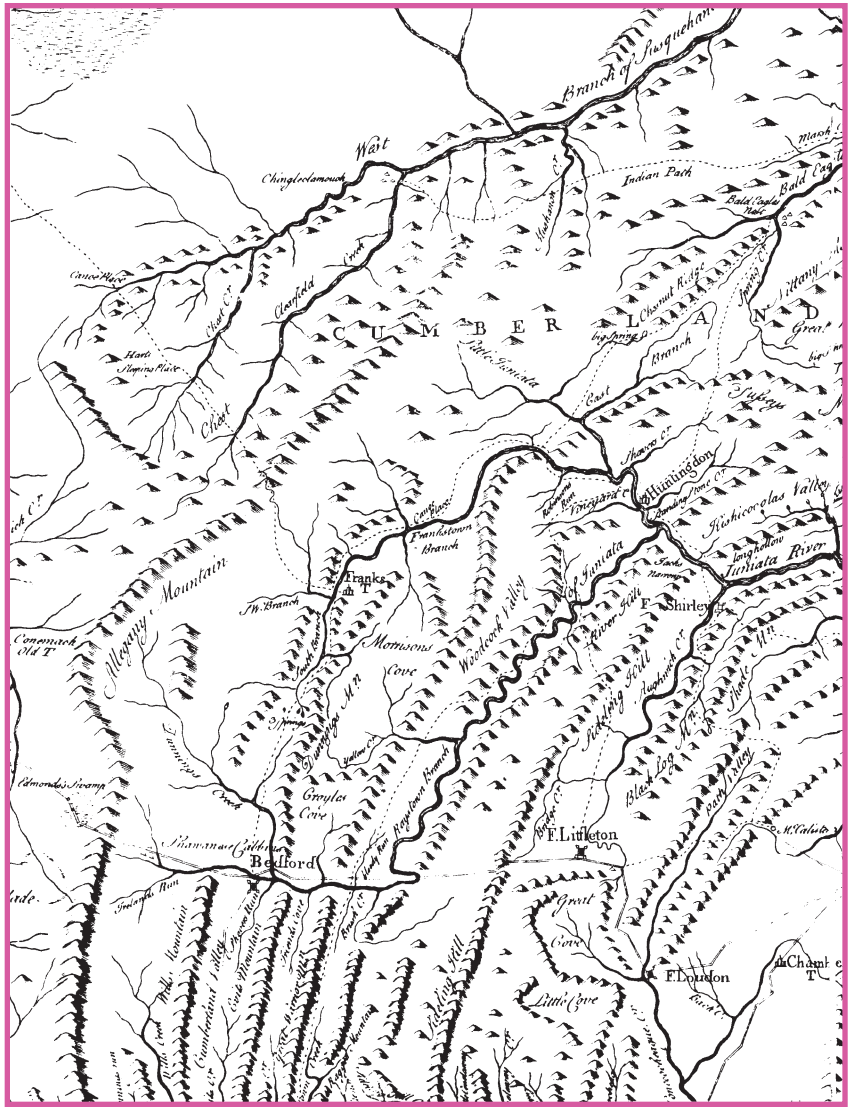
INTRODUCTION. Lead was mined in southern Sinking Valley, Blair County, as early as 1778. Although present, zinc was not recovered during this period of mining. According to Miller (1924, p. 13–14):

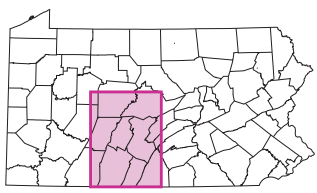
> The first lead and zinc mines of Pennsylvania were operated in the Sinking Valley, Blair County, during the Revolutionary War. The Continental Army being in great need of lead for bullets, a party was sent to investigate some lead deposits said to be in the wilderness near Frankstown [Figure 1]. As a result of the examination General Daniel Roberdeau opened and worked some shallow mines in the southern end of Sinking Valley during 1778 and 1779 [Figure 2]. Several letters from General Roberdeau and others concerning these operations are in the Pennsylvania Archives, (First Series) especially in Vols. 6, 7, and 8. At one time 1,000 pounds of lead was sold to the State at $6.00 a pound in the depreciated currency of the period. It is not known when the mines closed but probably the operations were short-lived because of the expense of transporting materials for mining and smelting the ore, the maintenance of laborers in the Wilderness, as it was called, and the guards that were necessary on account of hostile Indians.

Mining of lead in Pennsylvania probably predated the Revolutionary War efforts. Reports exist about interactions between Native Americans and early colonists looking for lead and silver deposits. Eckman (1927), Price (1947), and Loose (1972) document the probable enslavement of Native Americans from the Conestoga tribe to work lead-silver mines in the Pequea and Burnt Mills areas of Lancaster County (Smith, 1977, p. 62–79; back cover).

A widespread genre of reports about early explorations for lead in central Pennsylvania survived into the late 1960s. The basic theme of these fanciful stories is that an early colonist provides a service for or rescues a Native American. As a means of showing gratitude, the Native American leads the blindfolded colonist to an outcrop where pure natural lead can be cut or carved from the rock. The colonist collects for a day, is blindfolded again, and is conducted safely back

[1]Modified from p. 63–66 of Smith (2003).





Approximate location of area shown on map

Figure 1. Part of the Scull (1770) map of Pennsylvania showing rivers, mountains, towns, and forts. Forts Littleton, Loudon, and Shirley, as well as a fort at Bedford, are shown, but Fort Roberdeau had not yet been built. The area of Sinking Valley, which is not labeled, would be in the upper center part of the map. It is northwest of the Frankstown Branch of the Juniata River and is bordered on the north by the Little Juniata River.

Figure 2. Front entrance of the reconstructed Fort Roberdeau. The original fort was located somewhere on Sinking Spring Valley Manor, a large tract of land owned by the William Penn family that covered most of Sinking Valley. Built in 1778 for the protection of lead-production activities, Fort Roberdeau was used for less than two years and has long since deteriorated (Way, 2003). Photograph by John H. Way, Lock Haven University (Way, 2003, Figure 1, p. 141).

home. The crafty colonist, of course, is not satisfied with a day's production and leaves red threads or breaks twigs on his way home. Later, when he tries to relocate the lead deposit, he finds that the even craftier Native American has left scores of red threads or broken twigs in all directions (Richard Hammon, oral commun., 1973). Rather interestingly, some of those who passed on the genre were skilled amateur prospectors. Richard Hammon's father, Peter, for example, did some skilled lead prospecting at Silver Mine Knob, Huntingdon County, which was not rediscovered by geochemists until the late 1960s (Smith and others, 1971).

At $6.00 per pound, lead produced from the Fort Roberdeau area is likely the highest unit value mineral resource ever produced in central Pennsylvania. Interest in zinc was slower to develop but continued at least into the 1980s when a major corporation unsuccessfully attempted to lease the area of the old Soister iron mine (back cover; see Smith, 1977, p. 120–124, for a discussion of the mine).

MINERALIZATION IN SINKING VALLEY. Minerals found in the Sinking Valley area include the lead-bearing species galena, anglesite, cerussite, and jordanite; the zinc-bearing species sphalerite, hydrozincite, and smithsonite; and the gangue minerals barite and dolomite (Figure 3). It is generally thought that only galena was recovered in the area of Fort Roberdeau and only sphalerite in the Keystone mine (Smith, 1977, p. 89–102) of northern Sinking Valley. Core drilling by the New Jersey Zinc Company yielded some zinc ore intercepts beneath the Keystone mine (Noel Moebs, oral commun., circa 1960). Rose (1999, Table 40D–1, p. 584) estimated a production from Sinking Valley of 3,500 tons of ore having a combined grade of 12-percent zinc and lead. This would have been enough to keep a modern mill operating for nearly two days.

Figure 4 shows the locations of some of the lead-zinc mines, prospects, and occurrences in southern Sinking Valley. Comparing the locations on Figure 4 with the geology shown on Plate 1 of Faill and others (1989) shows that the lead-zinc occurrences in southern Sinking Valley appear to be hosted in dolomites and dolomitic limestones from the upper Bellefonte Formation up to the Snyder Forma-

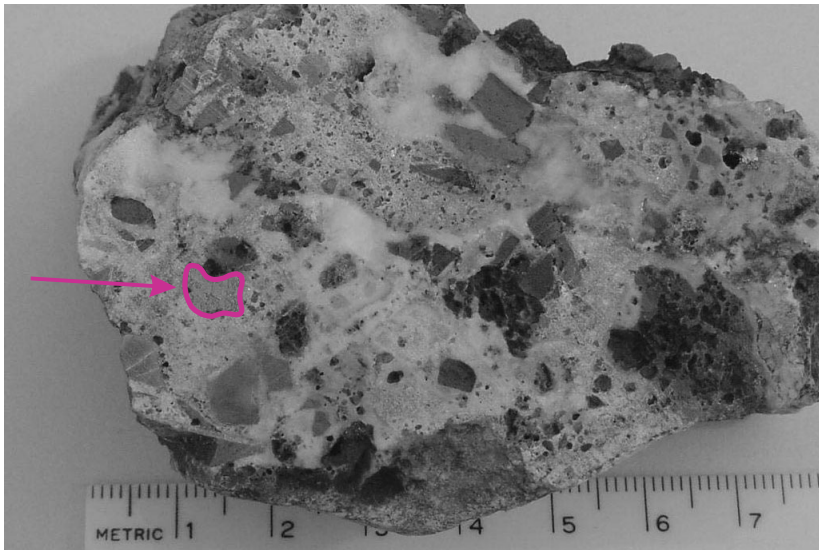


Figure 3. Sample of lead ore from southern Sinking Valley. The outlined crystal is galena, a lead sulfide that was mined in the Fort Roberdeau area. The sample is a mineralized tectonic breccia. It is made up predominantly of barite and exhibits angular carbonate clasts. Photograph by John H. Way, Lock Haven University (Way, 2003, Figure 2, p. 143).

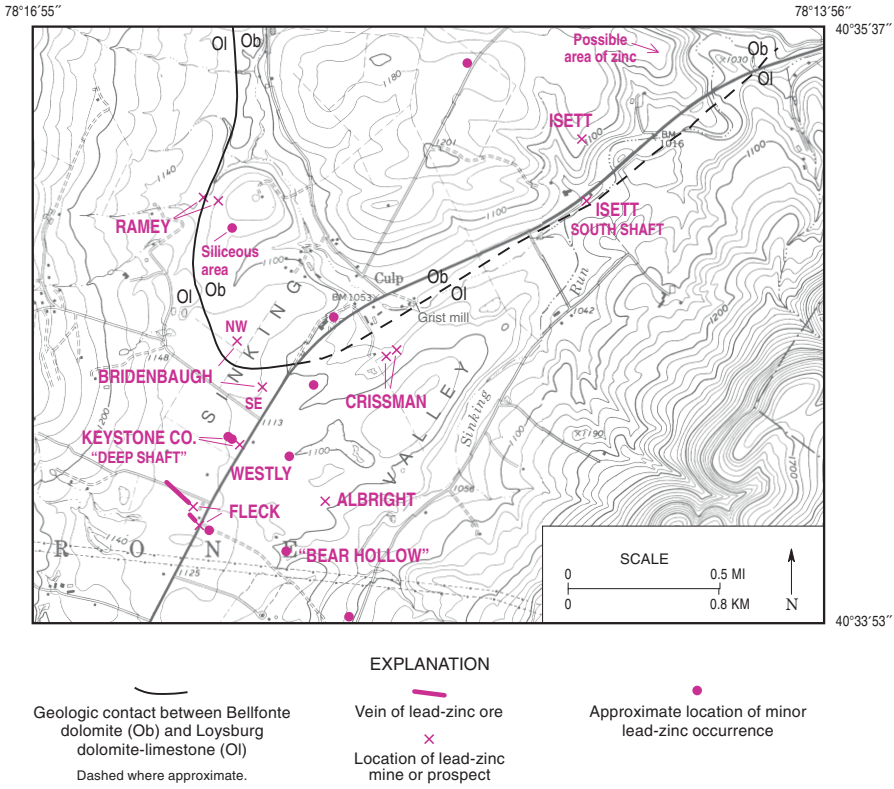


Figure 4. Lead-zinc mines, prospects, and occurrences in southern Sinking Valley from Smith (1977, Figure 49, p. 126). Geologic contact from Faill and others (1989, Plate 1) and Smith (1977, Figure 49, p. 126). Base map from U.S. Geological Survey Bellwood and Spruce Creek 7.5-minute topographic quadrangle maps, 1963, photorevised 1972.

tion (Figure 5). The better lead-zinc occurrences are in a zone along the contact between dolomite of the Bellefonte Formation and overlying interbedded limestones and dolomites of the Milroy Member of the Loysburg Formation (Smith, 1977, p. 134; Figure 4). In northern Sinking Valley in the Keystone mine area, significant mineralization occurs in dolomite of the Mines Member of the Gatesburg Formation, in dolomite and limestone of the Larke-Stonehenge Formations, in dolomite of the Nittany and Bellefonte Formations, and, at the Keystone mine itself, in limestone, possibly from as high as the Snyder or Linden Hall Formations.

Except for a few less brittle limestone beds observed in the Keystone mine that were richly replaced by sphalerite and galena, nearly all of the ore in Sinking Valley is in open spaces in brittle fault breccias

(A. W. Rose, oral commun., 1975; Figure 3). The vein faults at the Fleck occurrences trend N48°W, and those at Bridenbaugh trend N30°W (Figure 4). The Albright mine may be on the extension of this latter fault; however, Reed (1949, p. 5) found that at least one vein at the Albright mine had a strike of nearly east and dipped 80 to 85 degrees to the north.

Based in part on the deformation of main stage galena from many prospects in central Pennsylvania, it can be reasonably hypothesized that such lead-zinc mineralization in this area is a product of the Alleghanian orogeny. It is proposed herein that saline fluids transporting the metals were expelled from shaly units, such as the Antes Shale, as a result of the Alleghanian orogeny. These fluids migrated along a northwest-trending zone of disturbed structures (front cover; Smith and others, 1971, p. 31–33) that included fractures and faults in Upper Ordovician and Lower Silurian clastics (Smith, 1977, p. 99–100). Lead- and zinc-bearing minerals were deposited where the transporting saline fluids encountered sedimentary pyrite in black shaly interbeds in the Tuscarora Formation or in algal mats in the sabkha facies of the Tonoloway Formation or possibly the Milroy Member of the Loysburg Formation. Sphalerite fluid inclusion data from Howe (1981) suggest that the fluids cooled from 160°C to the southwest of Sinking Valley to 140°C to the northeast of Sinking Valley. Where the fluids became oxidized or encountered sulfate-bearing groundwater, barite also precipitated. This was very fortunate for early lead prospectors as the barite associated with the galena in southern Sinking Valley provided a nearly indestructible, readily recognized residue. Early settlers were used to the concept of “tracking,” and it was only a small leap for them to become Pennsylvania’s earliest exploration geochemists.

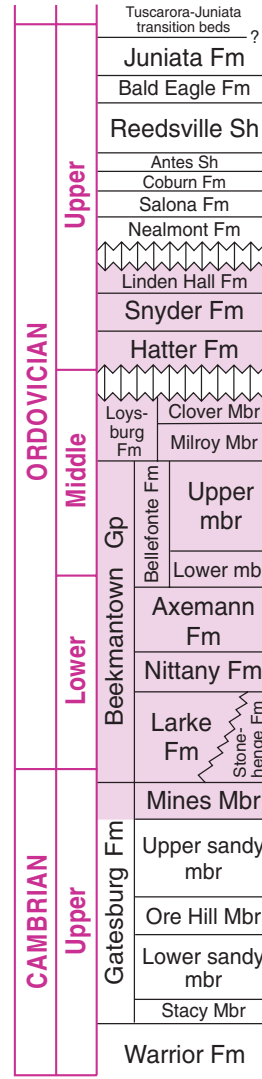


Figure 5. Generalized stratigraphic column for Upper Cambrian through Ordovician rocks in central Pennsylvania (from Berg and others, 1993). The stratigraphic interval from which lead and zinc have been mined in Sinking Valley is shaded pink.

Additional information on Alleghanian unloading and the Mesozoic thermal pulse can be found in Smith (2003), and information on lead-zinc and other metal mines and occurrences can be found in Rose (1970).

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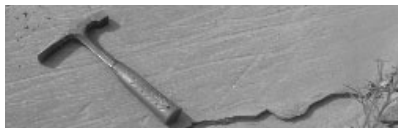
New Look for the Bureau Web Site

The Bureau debuted its web site more than seven years ago. Many trends have come and gone in the internet arena since then, but our commitment to this electronic method of communication remains. To better organize and present web materials, we have incorporated a new format into our site that matches that of the web site of the Department of Conservation and Natural Resources.

Department links are shown across the top of all of our web pages and general topic headings are listed on the left. The home page also includes links to digital geology and hot topics on the right. The Department web site links to the Bureau home page through the word "Geology." The "Geology" link also appears on each of our individual web pages and can be used to return to the Bureau home page.

Along with our new internet face, we have added fresh material to our web site. Look for more information about our staff, the economic resources of the state, collecting rocks and fossils, and groundwater. Check the periodic updates to the "Cooperative Geologist Program" listed under the "Field Geology" link. See the new presentations for coal-bed methane and coal under "Economic Resources." As we grow, watch for more geologic resources for the student and teacher in our "Classroom" web topic. Visitors can view a summary of the latest additions to the Bureau web site through the "What's New" link at the bottom of our home page. As announced in a previous issue of *Pennsylvania Geology* (v. 33, no. 1, p. 1), more



New Additions to the Pennsylvania Geological Survey Web Site

Updates to Local Government Outreach: GIS survey coverage maps and the updated GIS survey database (December 2003)

GIS symbology styles for digital Map 1 bedrock geology units (December 2003)

On-line list of publications by Series type — at our Publications page (December 2003)

Updated "Field Geology" web page including a new feature on field geology abstracts — recent research by PaGS geologists (December 2003)

How carbon dioxide can be a geologic hazard, (PDF document) at our Geohazards page (December 2003)

Map 68, Density of Mapped Karst Features in South-Central and Southeastern Pennsylvania (November 2003)

Map 67, Geologic Shaded-Relief Map of Pennsylvania (November 2003)

For more information, contact the Survey at **717–702–2017**

and more of our products will be available on our web site at www.dcnr.state.pa.us/topogeo.

Another new feature is the opportunity for you, the user, to comment on subjects or particular web pages that you encounter during your visit. Use the "Contact the Survey" link to ask questions about geologic topics or to suggest changes to the web site. As our site grows and improves, your comments can assist us in charting its direction. Thanks for tuning in!

GSA Holds Joint Meeting

The Northeastern and Southeastern Sections of the Geological Society of America will hold a joint annual meeting at the Hilton McLean in Tysons Corner, Va., in 2004. It will begin with a reception on Wednesday, March 24, from 6 p.m. to 9 p.m. Exhibits will open at that time, and a cash bar will be available. Oral sessions will start the following morning and continue through Saturday, March 27. The American Geological Institute, Frederick Community College, George Mason University, George Washington University, Nomad Geosciences, the U.S. Geological Survey, and the University of Maryland are hosting the meeting. It includes the keynote forum "Science and Public Policy," 3 symposia, 25 theme sessions, general technical sessions, 11 field trips, and 9 short courses and workshops.

Staff from the Pennsylvania Geological Survey are among the leaders for two of the premeeting field trips. Field trip participants must be registered for the GSA meeting. One of the field trips, *Terrain and military geology of the Battle of Gettysburg, July 1–3, 1863,* will take place Wednesday, March 24, from 7 a.m. to 6 p.m. in Gettysburg, Pa. It is being led by *Jon Inners, Roger Cuffey, *Lewis Butts, *Helen Delano, *Gary Fleeger, *Richard Keen, *John Neubaum, *Robert Smith, II, and Victor Neubaum (asterisks indicate Bureau staff members).

Monument of General John Buford on McPherson Ridge in Gettysburg National Military Park. Commanding the first Union division to arrive in Gettysburg, General Buford studied the topography and positioned his brigades on higher grounds where they held off the Confederates until Union reinforcements could arrive. A premeeting field trip will study the use of terrain and geology in the Battle of Gettysburg. Photograph by Richard C. Keen, Pennsylvania Geological Survey.

The other trip, *The Paleozoic record of changes in global climate and sea level—Central Appalachian basin,* is being offered from 8 a.m., Monday, March 22, to 6 p.m., Wednesday, March 24. It will begin in Morgantown, W. Va., and end in Tysons Corner, Va. Blaine Cecil, Mitch Blake, Nick Fedorko, David Brezinski, *Viktoras Skema, Frank Dulong, and Rob Stamm are the leaders for this trip.

Survey staff members have also submitted abstracts for the meeting sessions. These include the following: *Efforts of the Pennsylvania Geological Survey to preserve Pennsylvania's geologic heritage,* by *J. R. Shaulis and *C. H. Dodge; *Lee vs. Meade at Gettysburg (July 1–3, 1863)—The influence of topography and geology on command decisions and battlefield tactics,* by R. J. Cuffey, *R. C. Smith, II, *J. C. Neubaum, *R. C. Keen, *J. D. Inners, and V. A. Neubaum; *Postglacial bedrock gorges in northeastern Pennsylvania—Products of localized stream derangement resulting from blockage by glacial deposits,* by D. D. Braun and *J. D. Inners; *The Lower Silurian Clear Springs Volcanic Suite—Sword Mountain olivine melilitite (433±3 Ma) and hanging rock diatreme, Washington County, Maryland,* by *R. C. Smith, II, K. A. Foland, and R. P. Nickelsen; *The nature of the Setters Formation in the Pennsylvania Piedmont,* by *G. C. Blackmer and LeeAnn Srogi; and *Geochemistry—A tool for mapping metasedimentary rocks?,* by C. G. Wiswall, LeeAnn Srogi, and *G. C. Blackmer.

Further information on the meeting can be found on-line at http://www.geosociety.org/sectdiv/northe/04nesemtg.htm.

GEOFACTS

The Peculiar Habits of Geologists

by James R. Shaulis and Gary M. Fleeger
Pennsylvania Geological Survey

Geofact 1

In the field, geologists tend to face in the same direction.

Geofact 2

Like Irish Setters, geologists are trained to point at a quarry.

Geofact 3

All geologists must make a pilgrimage to the Geological Wailing Wall at least once during their lives.

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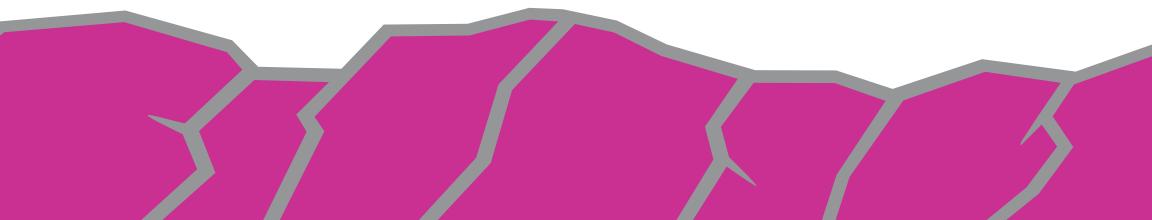
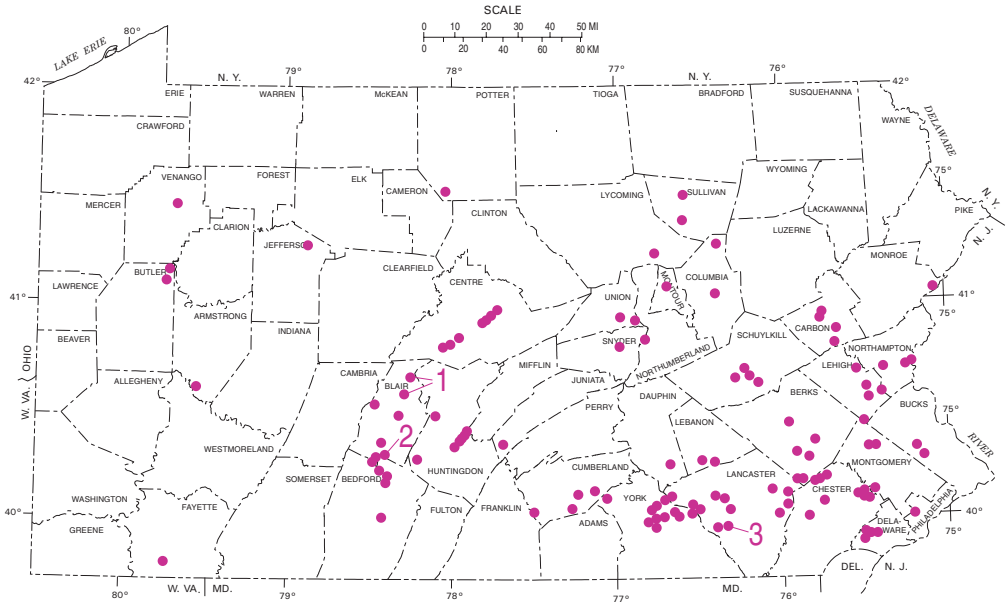


LEAD AND ZINC IN PENNSYLVANIA

(See article on page 2.)



Bullets show locations of lead and zinc mines, prospects, or occurrences (from Rose, 1999, p. 582). The numbered bullets represent places mentioned in the article on page 2: (1) Sinking Valley lead and zinc mines, (2) Soister iron mine, and (3) Pequea lead and silver mine.

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