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Pennsylvania Geology

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A Pennsylvania "mystery rock" (see article on page 9).

—*Photograph by Stuart O. Reese*

EDITORIAL

Sharing What We Know

George E. W. Love, State Geologist
Pennsylvania Geological Survey

This issue of *Pennsylvania Geology* is an interesting contrast to our normal offering, articles that are heavy on the science but presented in a fashion that we hope is both educational and understandable to the public at large.

Now that I have your attention, I ask that you consider the unspoken but important theme of sharing contained within the two principal articles, "Shippensburg Geology Field Trip at the 2013 National Speleological Society Convention" by Katie Schmid of the bureau, and "The Twilight Zone, the Teacher, and the Professor" by Charles Miller, a high school earth science teacher and fellow geology enthusiast.

Those of us who enjoy earth science, and especially those of us who are or have been practitioners of geology, have been fortunate. We have been exposed to people who were/are enthusiastic about the science, interested in lifelong learning, and adamant that it is a field with a future. Don't you think we should share that enthusiasm? Some of our geologic compatriots have taken steps in this direction, as shown in the following two examples:

> The Boy Scouts of America has a new merit badge, "Mining in Society." (A friend and fellow geologist Stan Krukowski was instrumental in its development.) Some of the criteria for earning the badge involve selecting different minerals, identifying what products are produced from them, and determining the role that mining has in providing materials for our everyday needs or wants. What a wonderful way to educate young people.
>
> There is a YouTube video, http://www.youtube.com/watch?v=VxQAbiIOBvw, by students of the College of William and Mary. These aspiring geologists have produced an educational AND entertaining clip that helps personalize what a field mapper does. (I wish electricity and color film had been invented before I went to school. And continental drift, as well!)

Based upon a recent study in the spring of 2013, the American Geosciences Institute found that about 20 percent of people involved in the earth sciences made their decision to go into that field BEFORE beginning college. By my reckoning, that means that we "old geologists" need to share our enthusiasm for the science in the formative years of our children, our friends' children, and our elementary/middle school/high school classes. We need to replace ourselves with the geologists of tomorrow and ensure that the institutional knowledge that we have accumulated is not lost.

So, my point is that we should volunteer to lead field trips, visit classes on career day, stand up at public meetings, and generally help people understand the following basic truths we have come to recognize: (1) if you cannot grow it, you must mine it[1]; (2) the present is the key to the past[2]; (3) geology is the study of pressure and time. That's all it takes, really, pressure, and time[3]; (4) gold is where you find it[4]; and of course, (5) geology is a lifelong passion from which you never recover[5].

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Shippensburg Geology Field Trip at the 2013 National Speleological Society Convention

Katherine W. Schmid
Pennsylvania Geological Survey

During the summer of 2013, I co-led a geology field trip at the NSS (National Speleological Society) Convention in Shippensburg, Pa., with Dr. Thomas Feeney, a hydrogeology professor at Shippensburg University. The NSS is dedicated to the exploration, conservation, and study of caves and karst resources. (The website www.caves.org has more information on this organization.) About 80 people came on this field trip, including several geologists from various states, at least one biologist, a photographer, and several engineers. With this mixed group, we did our best to make the trip interesting for everyone. Because of the connection between water and caves, Tom wanted to show the trip participants a few of the springs around Shippensburg that he has been studying. I wanted to show attendees the carbonate bedrock and the source of the thick covering over much of the bedrock to help them understand the various controls on spring flow in this area. Fortunately, Tom knows Randy Van Scyoc, the vice president of operations at Valley Quarries, Inc. Randy was kind enough to come and give us talks at two of their quarries near Shippensburg, including a limestone quarry and a quartzite quarry (both were on our itinerary). All of the rock formations we visited during this field trip are represented in Figure 1.

Shippensburg lies within the Great Valley section of the Ridge and Valley physiographic province between South Mountain and Blue Mountain. This part of the Great Valley is called the Cumberland Valley and is underlain by Cambrian-Ordovician limestones that were deposited in a marine environment when the center of Pennsylvania formed the eastern edge of a continent around 500 million years ago. In this area, the beds are steeply dipping to slightly overturned and were deformed in the Alleghanian orogeny. The thick colluvium (weathered material from the neighboring mountains) that covers the carbonates in the western half of the valley creates a mantled karst. Many vernal ponds are found at the surface of this mantled karst. They are interpreted to be caused by sinkholes in the Tomstown dolomite that are expressed through a colluvial covering of up to 300 feet.

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EDITORIAL

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[1] Who knows the origin? But this is repeated as part of a workshop for teachers by Barb Ehinger, Summit Middle School, Fort Wayne, Indiana, created for “The Richest Hills: Mining in the Far West, 1865–1920,” sponsored by the Montana Historical Society and funded by the National Endowment for the Humanities Landmarks of American History and Culture: Workshops for Schoolteachers.

[2] A summation of the thoughts of James Hutton.

[3] As mentioned by Morgan Freeman in the movie *The Shawshank Redemption* (1994).

[4] The title of a 1938 American romantic drama about the rivalry between farmers and miners in the Sacramento valley during the years following the California Gold Rush.

[5] Every geologist who ever worked in the career field.

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We drove along Ridge Road from Shippensburg, which runs along the northwest rim of the valley and offers a good overview of the landscape. On our respective buses, Tom and I pointed out the sharp divide in the landscape developed on the Martinsburg shale (Ordovician in age and above the Beekmantown Group) to our left and the Cambrian-Ordovician limestones to our right. On our left we could see deep gullies extending down from Blue Mountain, which contrasted with the gently rolling hills in the valley to our right. We also pointed out the lack of surface drainage to the right. With the lovely clear weather we had that day, it was easy to point out the quartzite quarry on the far side of the valley that we would also be visiting.

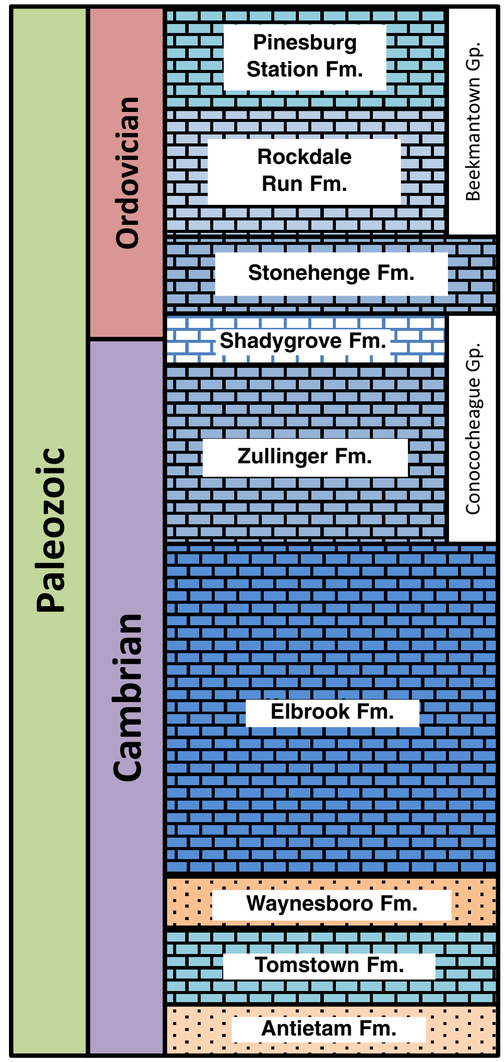

Figure 1. Stratigraphic column of the Cumberland section of the Great Valley.

Figure 2. Steeply dipping limestone in the limestone quarry. Photograph copyright by Kenneth Ingram and used with permission.

At our first stop in the limestone quarry, we examined the steeply dipping beds of the Rockdale Run Formation (Figure 2), and some of us collected rocks containing nice calcite crystals.

Next, we visited the quartzite quarry where Valley Quarries is mining the Antietam quartzite (Figure 3). The Antietam is valued for its pure silica content. This quartzite crops out near the base of South Mountain and is the

Figure 3. View from the quartzite quarry looking across the valley. Photograph copyright by Kenneth Ingram and used with permission.

rock that weathers to form the colluvium that creates the mantled karst. Many of us found *Skolithos* (fossilized worm tubes) in this soft, weathered quartzite.

After our stops at the quarries, we drove past a 600-foot-deep freshwater well to a park for lunch. The steeply dipping beds likely facilitate the occurrence of freshwater at depth. After lunch, Tom gave us an introduction to the springs that we would be looking at and talked about one of the mystery wells that he had drilled nearby (Figure 4). This well had been drilled down to a depth of 830 feet without hitting bedrock at the base of South Mountain. This puts the colluvial depth to within 120 feet of sea level!

After lunch, we visited the Cleversburg Cave sink (Figure 5) in Cleversburg, Pa. This cave formed in the Zullinger limestone and is managed by the Mid-Atlantic Karst Conservancy. The Zullinger limestone is locally known as the ribbon limestone because of the prominent bands in the limestone. Here, we split the attendees into two groups. Tom showed the first group the Cleversburg Cave entrance, while I showed the other group some folds in the outcrop that contains the Den caves. From there we walked a little downstream to where Tom had placed a stilling well (a well that allows measurements to be taken in quiescent water) in the streambed. Data from this well and from monitors inside Cleversburg Cave show the close relationship between water levels in Burd Run and the cave (Figure 6).

Figure 4. At our lunch stop, Tom explained how the water well could have been drilled so deep without hitting bedrock. Photograph copyright by Kenneth Ingram and used with permission.

Figure 5. Cleversburg Cave sink. Photograph copyright by Kenneth Ingram and used with permission.

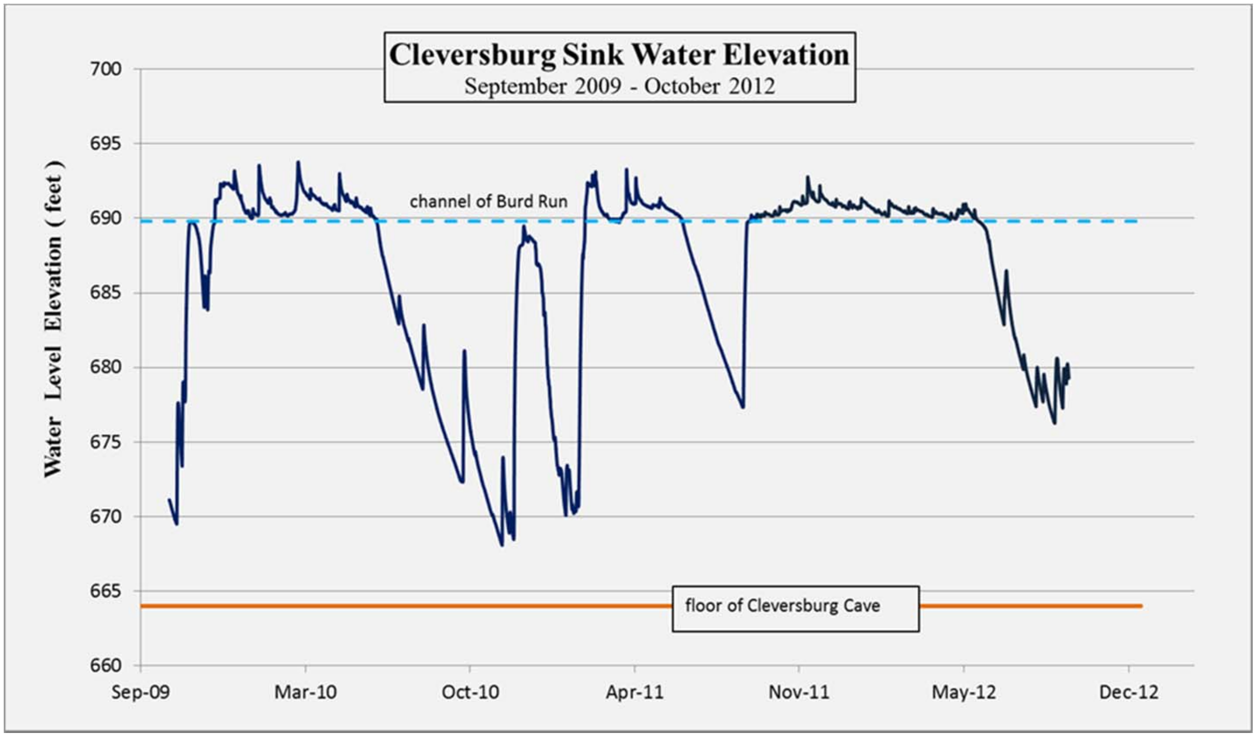

Figure 6. Three years of water-level data collected within Cleversburg Cave sink and the nearby Burd Run stream channel. Chart provided by Thomas Feeney.

The first spring we visited was Dykeman spring, a large spring whose flow is controlled by its proximity to South Mountain and the thick colluvium that water must travel through before reaching carbonate bedrock. The flow of this spring does not change much between drought and heavy rainfall stages. This spring occurs in the Elbrook Formation near the Shippensburg fault where the Elbrook contacts the Shadygrove Formation.

After that, we drove past a storm-water detention basin above the Zullinger limestone where Tom and a colleague had performed a dye-tracer test. With the lack of surface drainage in the Great Valley, there are few places suitable for performing dye-tracer studies, so this storm-water detention basin was a good candidate once it was constructed. The dye was detected to the northeast at Big Spring, our next stop. This demonstrated that waters do not flow north toward the regional drainage in this area, but instead flow northeast along the strike of bedrock. This result was a surprise to the local hydrologists, and it showed just how important the geologic controls are in this basin. Big Spring is one of the largest springs in the state. It is much farther from South Mountain and its flow is much more variable than the flow observed from Dykeman Spring. Big Spring is located in a prominent fold in the Shadygrove and Stonehenge Formations.

From here, we drove back along Ridge Road and let everyone look back over the sites that we had seen throughout the day. The most distal spring we visited was only about seven miles from our starting point. The drive allowed everyone to see how complex geology can affect hydrologic flow patterns even in a small area.

EARTH SCIENCE TEACHER'S CORNER

The Twilight Zone, the Teacher, and the Professor

Charles E. Miller, Jr.
Geologist[1]

Educators have a unique role as purveyors of knowledge. Their impact on students cannot be completely quantified. Students can be graded on exams and projects that, in part, reflect their mastery of what they learned. Certainly an educator feels rewarded when students do well. However, one of the most personal rewards is when an erstwhile student tells how that educator impacted him or her. For example, there is the geology professor who had a graduate student take a course in remedial English. That professor retains a letter from the student, written after graduation. In the letter, the student expressed gratitude for the mentoring, in general, and for the remedial course, in particular.

This is the story of *The Twilight Zone,* a high school earth science teacher, and a college geology professor. The television show *The Twilight Zone* aired from 1959 to 1964, providing stories of science fiction and fantasy. In 2013, the Writers Guild of America ranked it as the third-best-written TV series ever. In 1971, an earth science teacher was completing his first year of teaching at Boiling Springs High School. At the same time, at nearby Dickinson College in Carlisle, Professor Henry Hanson was teaching geology at Dickinson College.

On June 1, 1962, an episode of *The Twilight Zone* called "The Changing of the Guard" aired on television. In that episode, while preparing to leave for Christmas vacation, Professor Fowler is informed by the headmaster of the school where he teaches that, after 51 years of teaching, he is to be forcibly retired. Fowler is devastated by the news and begins to brood. He says to his housekeeper,

> I gave them nothing, I gave them nothing at all. Poetry that left their minds the minute they themselves left. Aged slogans that were out of date when I taught them. Quotations that were dear to me that were meaningless to them. I was a failure, Mrs. Landers, an abject, miserable failure. I walked from class to class an old relic, teaching by rote to unhearing ears, unwilling heads. I was an abject, dismal failure—I moved nobody. I motivated nobody. I left no imprint on anybody.

That evening, having decided that his teaching has accomplished nothing, he takes a pistol and walks back to the school, determined to commit suicide. Suddenly, he hears a school bell. He enters a classroom—and sees the apparitions of a number of his now-deceased students materialize. They are there for a purpose: to convince him that his lessons helped them to go on and commit acts of bravery, to sustain high levels of ethics, and so on. Fowler returns home, satisfied that he has made some mark in the world—and content now to retire.

In October 1991, the former earth science teacher attended the Field Conference of Pennsylvania Geologists. On one day of the conference, attendees were just beginning lunch at a park. The former teacher randomly sat down at a picnic table. A person on the other side of the table was wearing a name tag that read "Henry Hanson, Dickinson College." The two exchanged introductions. The former teacher offered to share a story with Henry. "Please do," was the reply. The story went something like this. Twenty years earlier, the former teacher was finishing his first year of high school earth science teaching at Boiling Springs High School. In the spring, Henry was a guest speaker, presenting the

[1]Retired; State College, Pa.

geology of the Cumberland Valley. Henry dressed in khaki field clothes and carried a backpack. In the backpack was a piece of local limestone riddled with solution channels. He explained that solution channels lead to unfiltered groundwater, sometimes resulting in contamination. Such flow also creates sinkholes, common in the valley. Henry's slide show included pinnacle weathering in limestone along Interstate Route 81, aerial views of the Cumberland Valley, and sinkholes. The teacher was most impressed. Particularly interesting was the piece of limestone riddled with solution channels. The teacher had to have one like it. In the ensuing months, the teacher walked across farmers' rock piles in the valley, looking for a piece of local limestone equal to the one Professor Hanson had used in class. The teacher failed in that goal. Nothing equaled the one Henry had shown. However, numerous lesser quality examples were found. As it turns out, these served the teacher well in later geological pursuits. The former teacher then finished the story, hoping that appreciation and impact had been conveyed. There was a pause . . . and then, Henry said, "You can't believe how good that makes me feel."

Solution channels in limestone.

Henry died about a year later.

The writer was that impressionable first-year high school earth science teacher. Henry Hanson was Professor Fowler—not the abject failure, but the educator who made a significant impact.

A DISCUSSION ABOUT THE GEOLOGIC MYSTERY ROCK

In the Summer issue of *Pennsylvania Geology* (v. 43, no. 2), we asked for comments on the Mystery Rock shown on page 17 of that issue and on the cover of this issue. Here is the promised follow-up article.

To begin with, it is easier to rule out some answers than to provide an unequivocal explanation. The rounded forms on the rock's surface are not fossils. They also are not a separate layer of pebbles such as those in a conglomerate. The holes are not weathered-out mud or shale clasts. There are basically two components: fine to medium sand grains, and cement that was deposited between the grains. So how did the pattern form?

Leonard Eakin, a geologist and western Pennsylvania native now living in the Black Hills of South Dakota, wrote to the Bureau that it reminded him of "boxwork structures that are visible in Jewel Cave and Wind Cave here in the Hills. Perhaps the sandstone in the picture was fractured, the joints were filled with a more resistant cement, and now the less resistant original sandstone within each 'box' is in the process of eroding out?"

This is a good summary of the likely scenario, based on close examination of the rock. Sediments of the Lock Haven Formation are thought to have been deposited in a nearshore marine environment in the Late Devonian. Compaction and probably some pressure solution and enough cementation allowed the sediments to solidify into rock—a process called lithification. Some time later, under stress, the rocks were fractured, and mineralized fluids carrying iron flowed through the rock.

At least five different fracture sets developed in the rock, although it is clear that the chemical precipitation of iron oxide (or perhaps originally siderite, an iron carbonate) favored a specific horizon (bedding plane) of the sandstone. Bill Kochanov, staff geologist, speculated that this bedding layer was host to siderite that later oxidized to iron hydroxides such as goethite, and that this chemical process may have influenced the patterns. Together, the fractures and bedding plane became the highways for the fluid, which filled the fractures and seeped perpendicularly into the pore space of the sandstone. The fractures become hairline into the sandstone, and for whatever reason, iron precipitate was concentrated on the bedding plane.

The angled fracture patterns were numerous enough to create a grid network, forming angular boxed-off segments. From the fractures, the fluids seeped into the pore spaces, creating rinds of slightly different chemical composition, which ultimately controlled the variable response to weathering that occurred long after its precipitation. Symmetry to the weathering pattern is visible in some of the three-dimensional box patterns along the longest fractures that were filled with the cement (Figure 1). The symmetry possibly represents the spreading of cement from a central source, which here would be the fracture planes.

Figure 1. A portion of the mystery rock, showing a vertical plane of approximate symmetry (long dashes) along a fracture filling. The length of the rock portion shown is 4.75 in. (12 cm).

As the rock was exposed to the atmosphere, physical weathering worked at the surface of the rock. The roofs of the individual pods, essentially cased with an armor of cement, were removed, and spheroidal weathering formed rounded pods of the internal sandstone, like eggs in a nest. (No, they are not eggs!) Some pods have eroded out entirely, leaving a neatly formed hole. In one area of the rock, the cementation has overwhelmed the zone between the fracture filling and has become massive, covering up the filled fractures that appear to go through that area and continue on the other side.

—Stuart O. Reese

RECENT PUBLICATION

Mineral Resource open-file report: **(January 2014)**

Bedrock geologic map and coal-resource maps of the Frenchville quadrangle, Clearfield County, Pennsylvania

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