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Pennsylvania Geology

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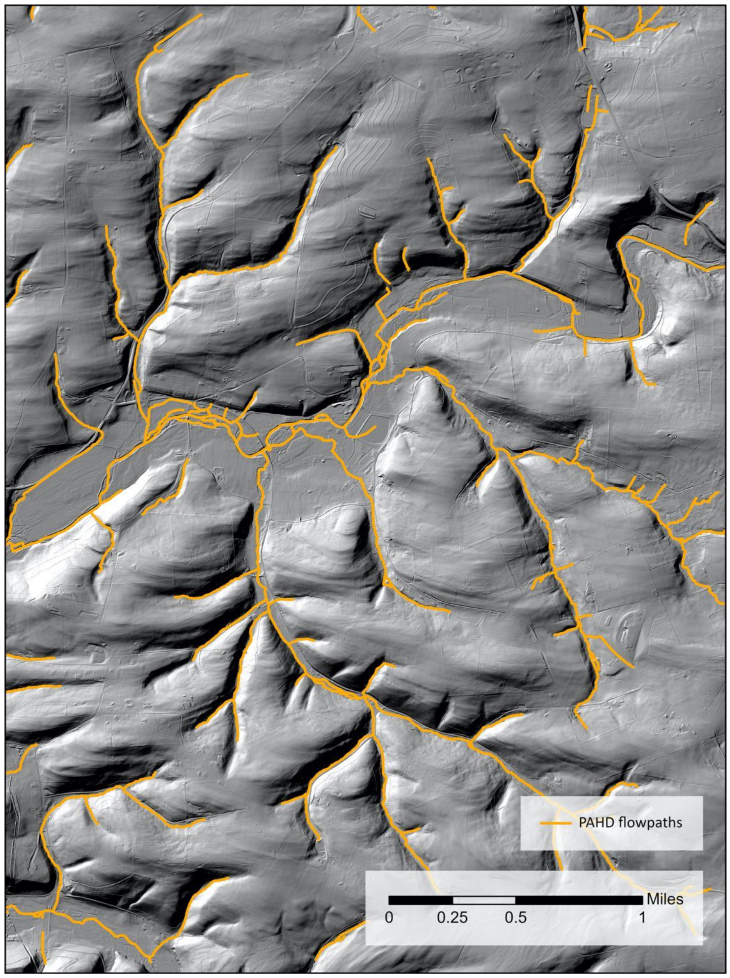

Pennsylvania Hydrography Dataset (PAHD) flowlines shown in orange against a 2017 hillshade. The area shown is a portion of the Catawissa quadrangle in Columbia County, Pa. (see article on page 3).

EDITORIAL

Transitions

Gale C. Blackmer, State Geologist

The transition of seasons and calendars reminds me that transition is a normal part of life. Organizations are not immune.

The bureau is in the thick of the energy transition. This year, we were elated to receive a grant from the Department of Energy for nearly $1 million for the Central Appalachian Partnership for Carbon Storage Deployment. This collaboration among our Survey, West Virginia Geologic and Economic Survey, and Battelle Memorial Institute is focused on reducing barriers for entry to carbon storage project opportunities by providing easy access to comprehensive datasets and information needed to inform injection permitting efforts. Interest in critical minerals remains high. We continue to participate in the U.S. Geological Survey's (USGS) Earth Mapping Resources Initiative (Earth MRI program) and to explore other opportunities for research collaboration. As always, geologic mapping provides foundational data for exploration and for design of infrastructure on the surface. With our fellow state surveys and the USGS, we are working through the challenges of producing 3D geologic models that can be stitched together across regions and ultimately across the nation. These models will facilitate basinwide studies of overlapping subsurface activities.

Regular readers of this magazine will know that staffing is an important area of transition for the bureau. As of this fall, more than half of the staff had been hired since 2021. Only five staff members were here when I started in 1999 (does that make the bureau a Millennial?). Each one of the nineteen new staff members brings with them a new set of talents, skills, and ideas about how to approach our work. It's been a whirlwind. I'm looking forward to finally being able to pause and breathe and get everyone integrated into a Pennsylvania Geological Survey for the twenty-first century.

As we tried to pick up the work of our departing colleagues over the last few years, the stream of rotating vacancies highlighted areas of inefficiency in our internal processes. With a lot of communication, collaboration, and creativity, we are transitioning to more streamlined processes. I am proud to report that, with a great team effort, we released eleven maps, two atlas reports, and two data releases this year, in addition to hundreds of records added to the Pennsylvania Groundwater Information System (PaGWIS) and to the Exploration and Development Well Information Network (EDWIN).

Transitions can be challenging, but they are never dull. I'm excited to see what next year brings. In the meantime, we wish you all a joyous holiday season.

Gale C. Blackmer

Mapping Pennsylvania's Waters

Ellen Fehrs
Pennsylvania Geological Survey

BLUE LINES: WHO CARES?

As of the publication of this article, the oldest known map in the world is thought to be the Saint-Bélec slab, an artifact that has been dated to the Bronze Age (roughly 1900–1640 BCE [Before Common Era]) and discovered in what is now northwestern France (Nicolas and others, 2021). Geologists may at first fixate on the lithologic aspects of this sample. The slab is roughly 2 by 1.5 meters and is composed of a quartz-dominant schist common to the area in which it was discovered (Nicolas and others, 2021). Additional geologic and geographic context can be gleaned from examining the carvings on the slab.

The surface of the Saint-Bélec slab, shown in Figure 1, features symbols that are thought to represent several components, including field irrigation boundaries, property lines, and tributaries. If this interpretation is correct, it means that as long as humans have been mapping the earth, they have been mapping water.

Figure 1. The Saint-Bélec slab, currently the oldest known map in existence. This Bronze Age depiction of the River Odet valley in modern-day France shows, among other geographic markers, a network of tributary features. Public domain photograph by Paul du Châtellier, 1901, Vue générale de la dalle gravée après restauration en 1901 par Paul du Chatellier, archives départementales du Finistère, Quimper, *accessed from Wiki Commons at https://commons.wikimedia.org/wiki/File:Vue_g%C3%A9n%C3%A9rale_de_la_dalle_grav%C3%A9e_de_Saint-B%C3%A9lec.jpg on May 1, 2023.*

The Saint-Bélec slab is an example of hydrography. The term "hydrography" frames water in a geospatial context: it is the mapping of water features. The scope of this field includes topics such as generating computer and statistical models to predict the occurrence of water, field mapping of water features, and the validation of predicted feature locations through methods like dye-trace tests. "Hydrology" is the study of the physical and chemical properties of these features. "Hydrogeology" looks at the interaction between water and rock.

The Saint-Bélec slab demonstrates the relevance of hydrography more than 4,000 years ago—but what does that mean for us today? Geology and water are so intrinsically linked that it is nearly impossible to study one without considering the other. There are many reasons why anyone might need access to accurate hydrography, such as the following:

- Streambeds provide geologists a convenient access point to an outcrop.
- Hydrography is the main data source for tracking pollution in source-water supplies.
- Conservation groups need these data to communicate and evaluate areas of interest.
- The Department of Environmental Protection uses hydrography to identify streams that need remediation efforts.
- The legal obligation to buy (or not buy) flood insurance is partially based on hydrography.

Even recreational pursuits like kayaking and fishing require basic geographic knowledge of water features.

HYDROGRAPHY IN PENNSYLVANIA—HIGBEE'S MAP

Pennsylvania has an impressive hydrographic history. Water features were so significant as geographic markers that early settlers would differentiate native peoples by the river basin they occupied; examples include the Susquehannocks, the Erie, and the Delaware. This reliance on water as an orientation aid continued throughout Pennsylvania's history and is probably best illustrated by the story of Higbee's stream map.

Howard Higbee was a soil scientist at The Pennsylvania State University, who spent 30 years compiling and perfecting a statewide stream map (Figure 2). His *Stream Map of Pennsylvania,* known colloquially as the "Higbee Map," is a 1:380,160-scale map that includes about 86,000 miles of Pennsylvania streams (Higbee, 1965). Upon its publication, the Higbee Map was the most accurate statewide stream map of Pennsylvania ever.

The Higbee Map included a number of previously unmapped tributaries, which Higbee himself took the time to field validate. One of Higbee's preferred methods of surveying was to use his car's odometer—modified by Higbee to measure in 500ths of a mile—and drive along water features to verify their spatial extent (Mellin Guignard, 2021). This attention to detail and passion for his craft resulted in the Higbee Map being a beloved map of the Pennsylvania fishing community.

When the Higbee Map was first published in 1965, Higbee put in an order for 70,000 printed copies of his map (Mellin Guignard, 2021). For the time, this was probably considered a liberal order—copying and scanning technology was considerably more primitive than today's digital counterparts. Full-color copiers were not commercially available until 1968, so thousands of color copies of Higbee's Map would have been considered a costly specialty order (Smith, 1968).

Figure 2. Howard Higbee's Stream Map of Pennsylvania *(1965), Pennsylvania State University Digital Collections, accessed from digital.libraries.psu.edu/digital/collection/maps1/id/2772/ on November 24, 2023.*

However, disaster struck. The printing company contracted by Higbee went out of business and, in doing so, destroyed the original copy of his map and the associated printing plates. The greatest tragedy was that this company used an ink hue called "non-photographic blue" for the majority of the water features shown on the Higbee Map (McLaughlin, 2022).

Non-photographic blue was a color that, at the time, was impossible for lithographic and photographic reproduction processes to recognize and copy. It is a color that has historically been used by architects and artists to draft designs and illustrations before committing to more permanent linework. Modern artists, by convention, still widely use non-photographic blue prior to converting hand-drawn work to a digital format (Figure 3).

This meant that none of the 70,000 printed copies commissioned by Higbee could be copied. In turn, *this* meant that those existing 70,000 copies became extremely valuable to those who cared about Pennsylvania hydrography.

The legend of the "missing Higbee Map" encompasses stories such as the contentious custody battle over a divorcing couple's Higbee Map (Mellin Guignard, 2021). It should be noted that Mellin Guignard did not cite the origin of this story, and that the only other mention of this story online (Seaman, 2006) appears to have been written by a person selling copies of the Higbee Map. I am therefore skeptical that this is anything more concrete than an urban legend.

Having said that, this is an urban legend that persists; nearly every person I have spoken with who is "in the know" regarding Higbee's Map references the hydrography-fueled divorce in a "Oh gee, can you

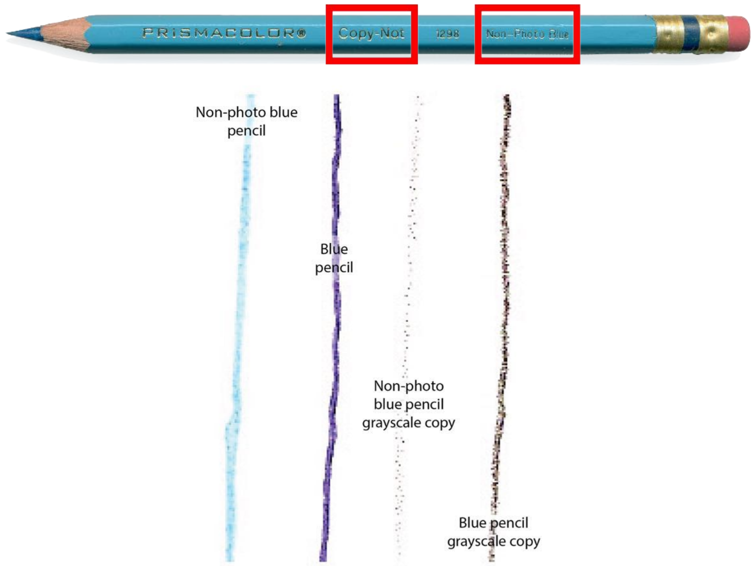

Figure 3. Top. A non-photographic blue pencil sold by Prismacolor supplies. Modified from Prismacolor, n.d., Non-photo blue pencil, accessed from https://johnmuirlaws.com/love-non-photo-blue-pencil/ on July 13, 2023. Bottom. Lines from a non-photographic blue pencil and a normal blue pencil. The two lines on the left have been photographed using modern technology, but the two lines on the right show how these pencil markings would appear with older scanning technology. The non-photographic blue pencil in grayscale is much fainter and would be nearly impossible to pick out from a scanned map. Modified from Scientific29, 2009, Non photo blue vs. blue pen, Wiki Commons, accessed from https://commons.wikimedia.org/wiki/File:NonPhotoBluevs.BluePen.jpg on July 13, 2023.

imagine?" sort of tone. So while this is (probably) an urban legend, it is an urban legend that illustrates the drama and mystery that people already attribute to the "missing Higbee Map."

Luckily for us—and for Higbee—his map did not remain missing. Printing and reproduction technology evolved to the point where "non-photographic blue" became photographic! Howard Higbee was 91 years old in 1991 when he saw his original map fully restored (Mellin Guignard, 2021). Higbee's restored map is still being updated and used today.

FEDERAL FLOWLINES

While Higbee's Map still has practical uses, it was not created with the accuracy that many modern applications require. The water features you see in Google Maps, for instance, are not taken from the Higbee Map. Google map's water geometries are pulled from the U.S. Geological Survey's (USGS) National Hydrography Dataset (NHD).

The NHD traces its origin back to the Environmental Protection Agency (EPA), who created a proof-of-concept database in the 1970s (Environmental Protection Agency, 2012). This dataset did not include the water features we think of when we imagine Google maps. These were not detailed geometries; rather, it was a framework intended to host attribute data, including things like feature identifiers and networking information.

In the 1980s, the USGS finished a 1:100,000-scale digitized hydrography dataset based on topographic maps from the 1970s. This linework was combined with the networking information from the EPA's original database to create the first version of the NHD. Despite the fact that the NHD has undergone a number of updates since the 1990s, the most recent version of the NHD (the NHDPlus High Resolution) still hosts many of those lines originally derived from 1970s topographic maps

Issues with accuracy become obvious when we compare the lines of the NHD to the Pennsylvania Hydrography Dataset (PAHD) (Figure 4 and Glossary on page 8). Even though the NHD is described as being accurate to 1:24,000-scale, it is apparent that the majority of these geometries have not been

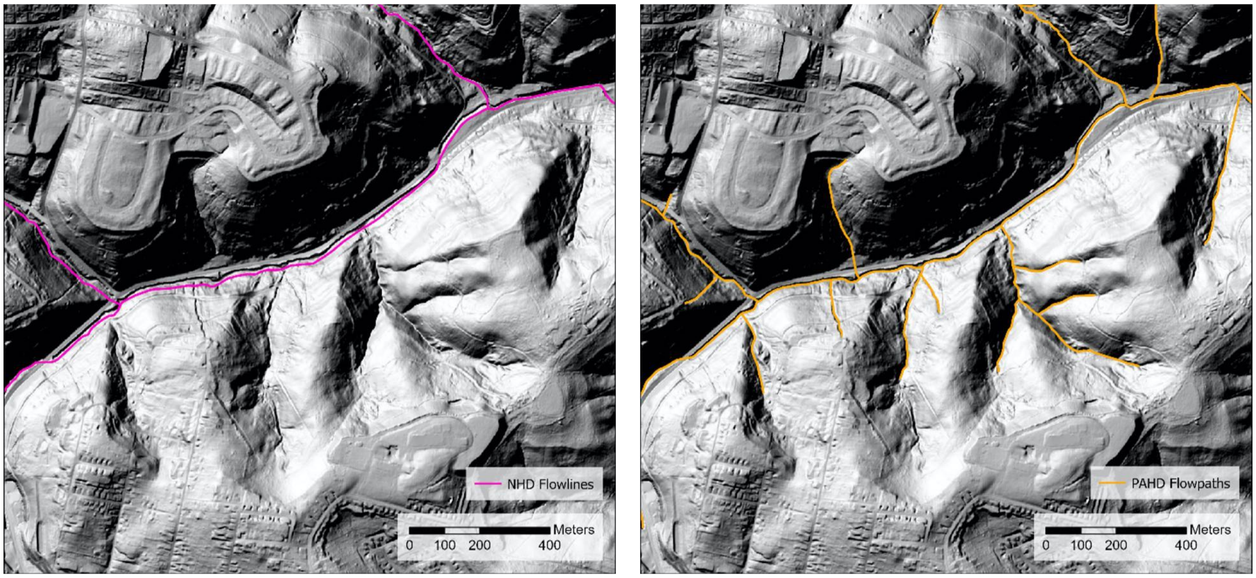

Figure 4. Flowlines from the National Hydrography Dataset (NHD) shown in pink (left) opposite geometries from the Pennsylvania Hydrography Dataset (PAHD) shown in gold (right). PAHD appears to more accurately reflect the channelized features visible in the underlying hillshade.

updated in decades. This raises the question: what might facilitate a regular update cycle for hydrography data?

LIDAR

Lidar is an acronym for **Li**ght **D**etection **A**nd **R**anging. It is an active form of remote sensing frequently described as "radar with lasers" wherein a sensing instrument beams a laser at the surface of the earth and creates an elevation point cloud based on the amount of time it takes the laser to leave the instrument, strike the nearest surface, and return to the sensor.

Lidar can be served up in the form of a point cloud (LAS [a particular file type] point cloud), a surface (digital elevation model), derivative geometries (breaklines), and even a visual aid (hillshade). The word "lidar" can be written as lidar, LIDAR, LiDAR, or (if you're in Europe) LADAR. While there is no clear consensus on capitalization—the USGS uses both "lidar" and "LIDAR" within the scope of the same paper—the Pennsylvania Geological Survey has adopted the convention of spelling the word "lidar" as a pronounceable acronym, similar to laser or radar.

FUN FACT: "LADAR" stands for **La**ser **D**etection **A**nd **R**anging. Considering that "laser" is itself an acronym, LADAR is an acronym containing another acronym. If we were to fully unravel LADAR's originating phrase, we would have "Light Amplification by Stimulated Emission of Radiation Detection and Ranging," which this author finds unwieldly.

On the other hand, "laser" is probably more specific than "light" in describing the energy emitted by most lidar instruments.

Lidar is vital to the automation of hydrography production because it can be used to generate a topographic representation of the earth's surface known as a digital elevation model (DEM). This surface can be used to model where water will flow in a given area.

Benefits of using lidar for hydrography production include the following:

- Pennsylvania has lidar coverage for the entire state (Figure 5).
- The most recent Pennsylvania lidar (referred to as QL2, or Quality Level 2) has a horizontal accuracy of 1 meter.
- These data are publicly available.

PENNSYLVANIA HYDROGRAPHY DATASET GENERATION

I was hired in 2019 to work on the Pennsylvania Hydrography Dataset. The goal of PAHD is to provide a state equivalent to the NHD. PAHD is intended to be a statewide hydrography dataset that can be updated and modified with more agility than an equivalent dataset maintained by federal partners. These updates and modifications will be based on new cycles of lidar as they become available.

The PAHD generation workflow is based around geomorphons (Figure 6). These rasters have 10 different cell classifications, shown in Figure 6 in 10 different colors, representing 10 different landform types. Geomorphons are create by feeding a DEM through a program that will go through the DEM raster one cell at a time, scan the area around that cell, and assign that cell one of the ten landform types based on the shape of the surrounding surface (Figure 7).

GLOSSARY

Attribute data—Tabular or textual data describing the geographic characteristics of features.

Geomorphon—A representation of landscape based on elevation differences within the surrounding area of a target cell. It is based on a powerful algorithm (a step-by-step procedure for solving a problem) that combines elevation differences and visibility concepts to classify terrain into landform types.

Hillshade—Shadows drawn on a map to simulate the effect of the sun's rays over the varied terrain of the land.

Lidar—An active, optical remote sensing technique that uses laser light to measure distances and to densely sample the surface of the earth, objects on the earth, and physical infrastructure. It produces highly accurate x, y, z measurements of the surface dimensions of objects.

Orthoimagery—An image that has been aligned to a coordinate reference system and has been corrected for relief distortion, sensor artifacts, earth curvature, and other perspective distortions.

Pennsylvania Hydrography Dataset—A feature-based database that interconnects and uniquely identifies the stream segments or reaches that make up the state's surface-water drainage system.

Point cloud—A typically large collection of x, y, z coordinates in three-dimensional space representing the real-world surface dimensions of objects.

Rasters—In imagery and elevation, a spatial data model organized into a matrix of equally sized cells, or pixels, and arranged in rows and columns. Each cell contains a numeric value representing information such as temperature at a particular height or depth, elevation, or image brightness value.

Looking at Figure 6, the most hydrographically relevant classes are the blue pixels representing valley features and the navy cells representing pits. These classifications appear to correlate well with actual channelized features in the elevation surface. Unfortunately, when comparing the geomorphon product to the associated orthoimagery, we see that these classes are not only associated with

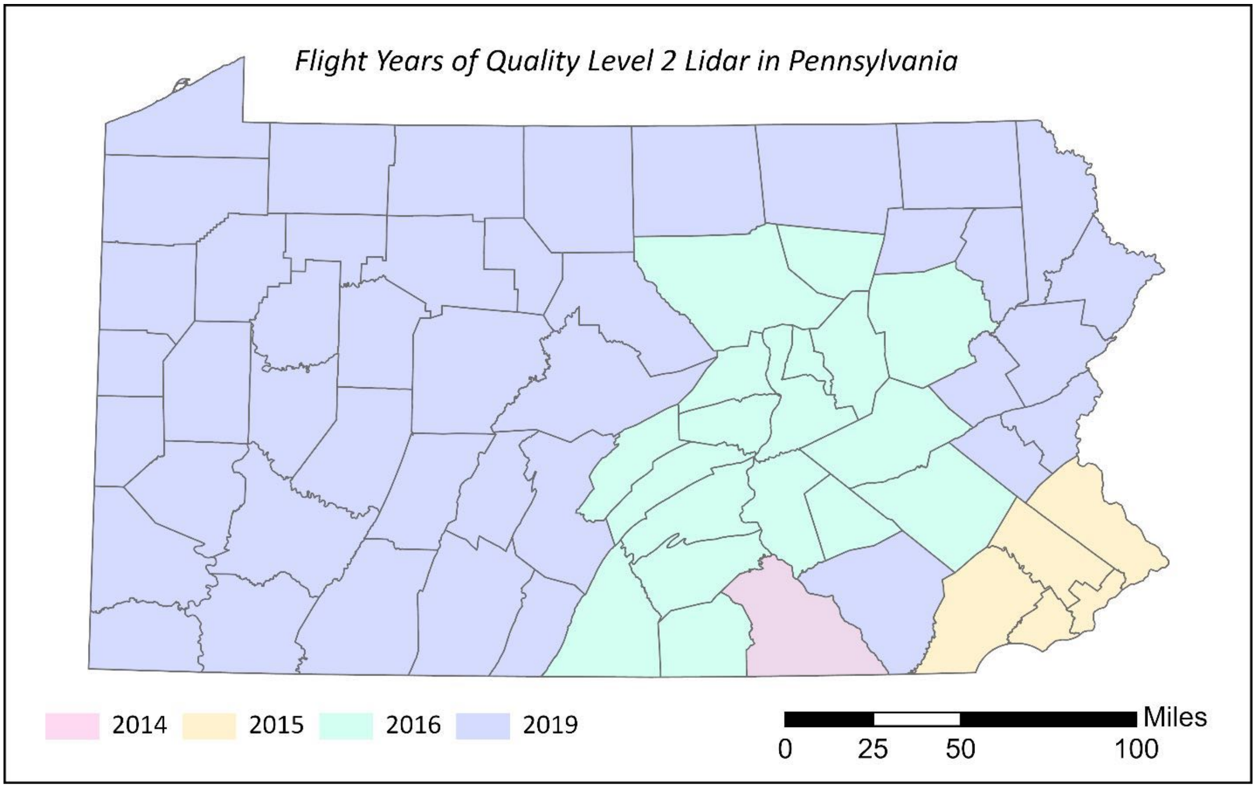

Figure 5. Quality Level 2 lidar (associated with 1-meter resolution DEMs) shown here to be available statewide for Pennsylvania. Portions of the state were collected over multiple years, as shown by the county symbology in this image.

hydrographic channels, they are also associated with the channel features occasionally created by roads, agricultural rills, buildings, and similar structures that are otherwise not linked to hydrography.

The aim of the PAHD workflow (Figure 8) is to winnow out as much of this "incorrectly" classified data as possible following these four main steps: 1) create multiple geomorphon products to target different features (Figure 8A); 2) use these products together to identify and remove non-hydrographic data (Figure 8B); 3) use a modified DEM to predict how all these lines would connect (Figure 8C); and 4) apply manual edits to clean up the resulting geometries (Figure 8D).

CONCLUDING THOUGHTS

Let us close this article by returning to its opening question: blue lines—who cares? There are obviously many reasons why the average person should pay attention to the water around them and give some thought to how its behavior, location, and evolution are recorded. Hydrography, however, has long been an afterthought for geoscientists, frequently considered just a geographic marker, like roads or political boundaries, to be tacked on to a project in the final round of edits.

Howard Higbee began his career as a soil surveyor for the U.S. Department of Agriculture, and later he worked at The Pennsylvania State University on similar mapping projects (Ciolkosz and others., 1998). First and foremost, Howard Higbee was a soil scientist. Despite the popularity of his stream map, Higbee's *Land Resource Map of Pennsylvania* has the highest distribution of any for-purchase Pennsylvania State University publication (Ciolkosz and others, 1998).

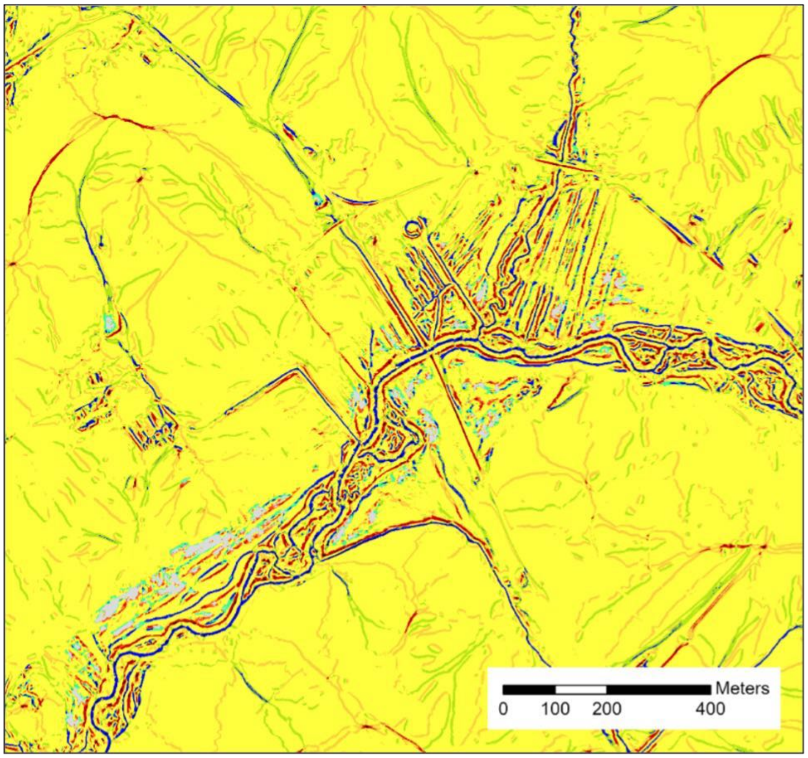

Figure 6. A geomorphon output (top) generated from lidar collected in 2019 for the U.S. Geological Survey, and orthoimagery for the same extent (bottom) collected in 2018 by the Pennsylvania Emergency Management Agency (PEMA). When comparing these images, the blue and navy geomorphon classes (i.e., the valley and pit classifications) seem to correlate with hydrography features visible in the accompanying orthoimagery.

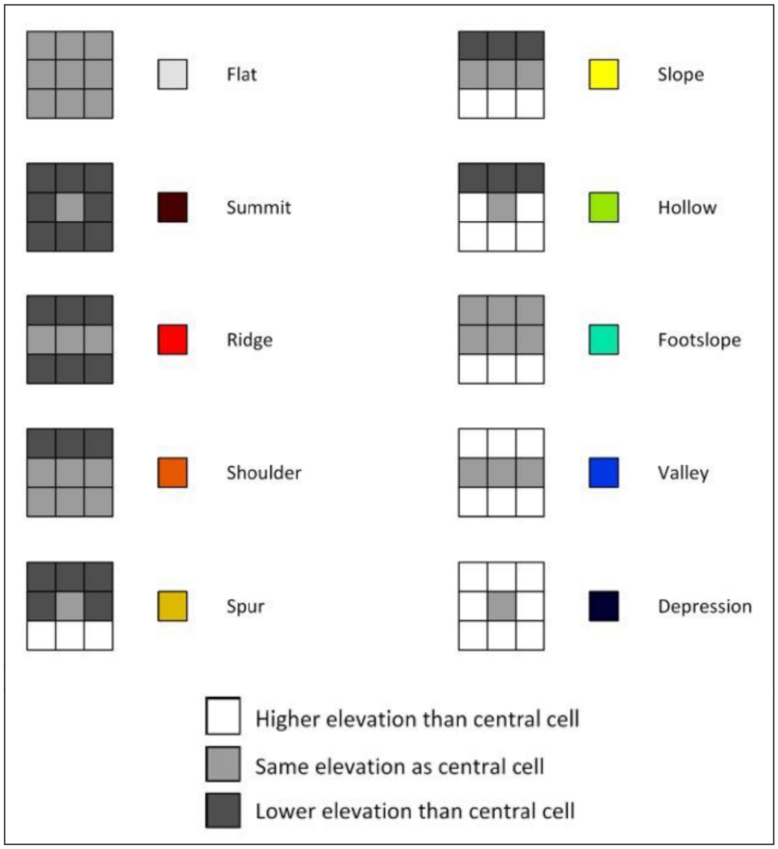

Figure 7. This schematic shows how various geospatial programs assign geomorphon classifications based on the surface morphology of cell neighborhoods in a raster (usually a Digital Elevation Model). Here, a central cell is being analyzed. Neighboring cells are shown in white if they have higher elevation values than the central cell, medium gray if they have the same elevation value, and dark gray if they have lower elevation values. The colors and classifications in this figure match those shown in Figure 6 (top image).

When asked why he spent so much of his personal and private life working on a hydrographic map, Higbee replied, “Because water affects soil” (Mellin Guignard, 2021). Water also affects rock—and, presumably, we can all recognize the importance of that.

The Pennsylvania Bureau of Geological Survey embodies this perspective: hydrography cannot be an afterthought for geoscientists—it should inform their work at every step. To ignore the occurrence and morphology of water features is to ignore one of the fundamental and most visible forces shaping rocks. Through the creation of PAHD, the bureau seeks to empower geoscientists and hydrographers alike with hydrography that is accurate to recent remotely sensed data, reliably updated, and considers the knowledge of local experts.

NOTE

If you have any interest in generating your own hydrographic data, please reach out to Ellen Fehrs (efehrs@pa.gov). The workflow described in this document is not proprietary, and many of the techniques can be accomplished using publicly available data and free software. Just be aware that this workflow is continuously being refined and is subject to considerable alterations.

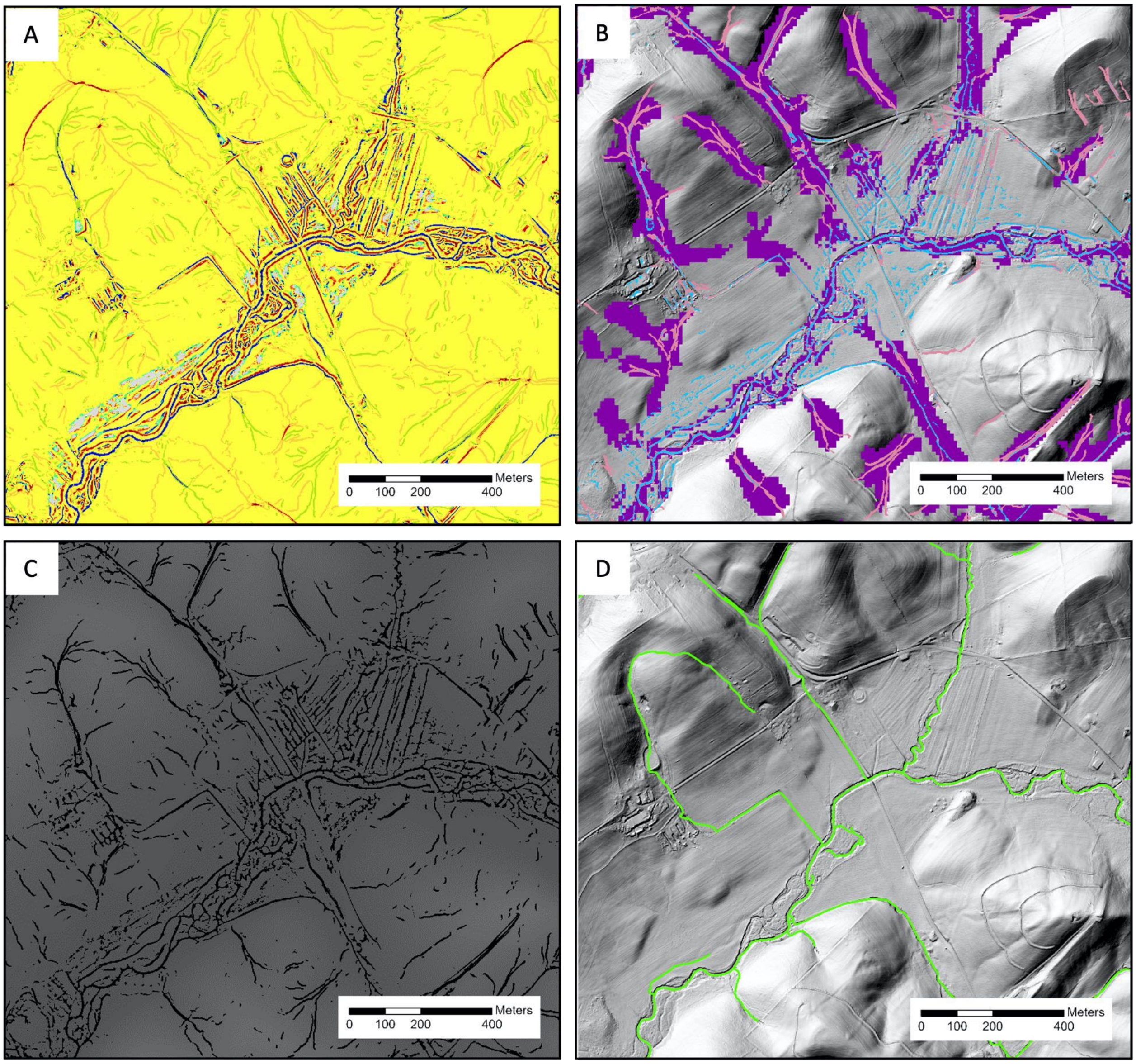

Figure 8. The primary steps of the PAHD workflow are illustrated here. The goal of this workflow is to retain as many correctly identified hydrography features as possible while removing "noisy" data associated with anthropogenic features. A. The first step in this workflow is to create multiple geomorphon products to target different features at different scales, namely channels and valleys. B. These products are then used to identify and remove non-hydrographic data. C. A modified DEM can then be used to predict how all these disarticulated lines would connect. D. Finally, manual edits can be applied to clean up the resulting geometries.

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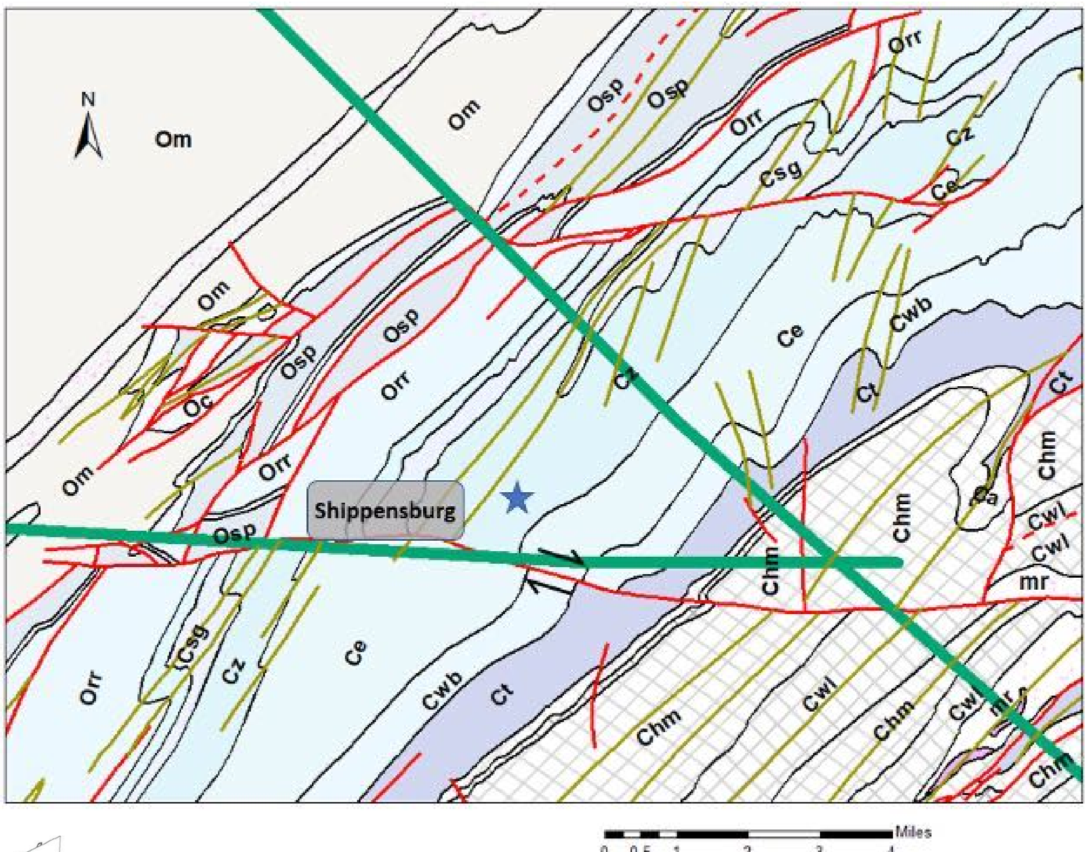
The Geology of Cleversburg Sink Cave

Katherine Schmid
Pennsylvania Geological Survey

Pennsylvania has numerous caves, many of which were developed in carbonate rocks. The Cleversburg Sink Cave near Shippensburg in Cumberland County, Pa., formed in an Upper Cambrian limestone (Figures 1 and 2). Rocks of Cambrian age range from 485 to 541 million years old (Carter, 2019). In contrast, the Vanport and Loyalhanna limestones in western Pennsylvania, which also contain caves, are about 315 and 325 million years old, respectively. These limestones in western Pennsylvania have only been deformed by one mountain-building event, the Alleghany orogeny, whereas the Cambrian limestones in central Pennsylvania have been deformed by multiple mountain-building events (the Taconic, Acadian, and Alleghany orogenies) and by the extensional periods between these mountain-building events.



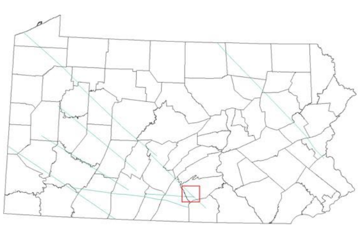


Figure 1. Geologic map of the area (red box on index map) (Berg and others, 1980). The blue star marks the location of the cave. The gray box marks the approximate location of the city of Shippensburg, Pa. The heavy green lines (light green on index map) are basement lineaments (Gold and others, 2005); the red lines are mapped faults (Berg and others, 1980); and the brown lines are anticline and syncline axes (Faill, 2011). The east-west fault just south of the cave is the Shippensburg fault (Becher and Root, 1981), and the black arrows beside the fault denote the direction of offset along this fault. Geologic unit abbreviations are explained in Figure 2.

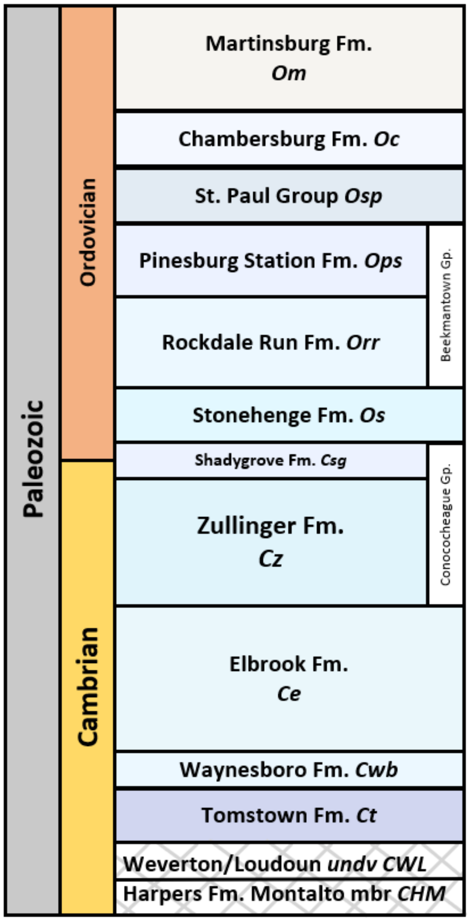


Figure 2. Regional stratigraphic column. Shades of blue denote bedrock that is predominately carbonate. The cross-hatch pattern denotes bedrock that is predominately quartzite.

In 1952, Bernie Smeltzer stated that the Cleversburg cave was formed in the Elbrook limestone (card on file in the National Speleological Society [NSS] library). Most of the Elbrook limestone is composed of thick beds of platy, highly calcareous shale and argillaceous limestone that are light gray with a bluish cast (Becher and Root, 1981). During the 2013 NSS convention geology field trip, Dr. Tom Feeney of Shippensburg University said that the cave was formed in the Zullinger limestone, which is confirmed by Pennsylvania Geological Survey bedrock maps (Figure 1). The Zullinger limestone consists of massive beds of dark-blue-gray limestone that typically contain crenulated siliceous seams (Becher and Root, 1981). According to Dr. Feeney, the Zullinger limestone is locally known as the ribbon limestone because of the prominent bands in the limestone from the siliceous seams (Figure 3). One possible reason for the difference in bedrock identification is that when early geologic maps in Pennsylvania were constructed, deep-water deposits, especially carbonates, were poorly understood (MacLachlan, 1994, p. 4). As shown in Figure 2, the Zullinger limestone is immediately above the Elbrook limestone.

In Figure 1, you can see that the Elbrook (Ce) and Zullinger (Cz) limestones contact each other at the Shippensburg Fault just south of the cave. Note that the Zullinger limestone is offset by about 3 miles to the east on the north side of the fault or to the right as you look across the fault. This means that the fault has a right-lateral offset near the cave in these limestone formations.

When Aron Schmid and I went on the trip to Cleversburg with cavers from the Franklin County Grotto (a name for a local chapter of the NSS) in December 2022, members of the group asked me questions about the geology of the cave. I have not studied the geology of this area, but before going into the cave, I read Bernie Smeltzer's description that had been published in the 2013 NSS convention guidebook. I didn't review my notes from the geology field trip, so I misidentified the limestone as the Elbrook limestone, not the Zullinger. I remembered from the geology field trip that the water levels in Cleversburg are closely tied to the water level of the nearby surface stream, Burd Run. (For more information on this study, see Feeney and Schmid, 2013.) At the time of the field trip in 2013, the cave had been flooded and I didn't get to see more than the entrance gate. On this trip, Gordon Ley pointed out some of the instruments that Dr. Feeney is still using to monitor the water levels in the cave. Other than that, I didn't know much about the geology of the cave, and I was surprised at the geology that I did observe.

One of my early observations was how soft many of the formations looked. This is a result of a repeated process of the formations forming, dissolving, and reforming as water levels in the cave fluctuate (Figures 4 and 5). The phenomenon was mentioned in the description in the NSS guidebook, so I was keeping an eye out for it in the cave. Specifically, Smeltzer mentioned seeing some parts of formations being "as thin as tissue paper" (Figure 6).

Figure 3. The Zullinger limestone (photograph by Kerry Speelman, from Mid-Atlantic Karst Conservancy website at https://www.karst.org/index.php/2020/11/01/cleversburg-sink-photos-2/). Used with permission.

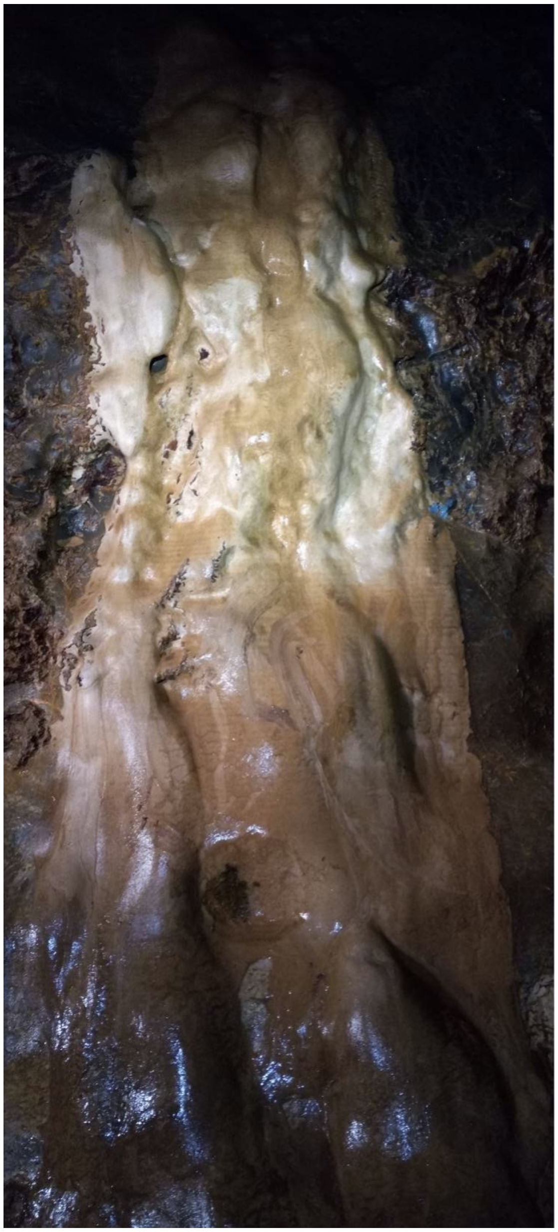


Figure 4. Flowstone on a wall; photograph by Aron Schmid.

Figure 5. Flowstone on a cave wall; photograph by Aron Schmid.

Figure 6. Note the lacy nature of the formations in the lower left of this photograph. Photograph by Aron Schmid.

In the cave, I saw more evidence of the complicated structure of this region than I had been expecting. In the Grand Room, I saw many white calcite-filled veins in the dark limestone. Unfortunately, we didn't obtain any photographs of these. Farther in the cave, I saw a number of joints and minor faults (Figure 7). The fault in Figure 7 shows a small amount of right-lateral offset that may be related to the right-lateral offset observed in the Shippensburg fault (Figure 1).

I still had a blacklight in my cave pack from having led a geology field trip in a different cave, so I used it on this trip. In the Ribbon Room, I had everyone turn off their headlamps and demonstrated how the calcite in the formations fluoresces when a blacklight is used (Figure 8).

On the way out of the cave, one of the Franklin County Grotto cavers noticed an odd purple color on the ceiling (Figure 9) and asked me about it. Purple is an odd color to see in caves. This odd purple coloring does seem to be spreading from a natural crack in the ceiling. Could it be mineralization from minerals seeping in along the seam? I hypothesized that it might be iron in the same state that gives amethyst its purple color. It might also be from something biologic, as this location is not very far into the cave. During the geology session at the 2023 NSS convention, I gave a brief talk about this cave to fill in some time when a scheduled speaker didn't show up. After the talk, one of the audience members commented that this purple feature looked similar to something that has been observed in Mammoth Cave, Ky. He said that in Mammoth, the purple coloration was a result of biologic activity and was probably related to hydrogen sulfide or another gas. (I think he said that the other gas was methane, but I'm not sure.)

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Figure 7. A near-horizontal minor fault. The red arrows denote the direction of the offset. Photograph by Aron Schmid.

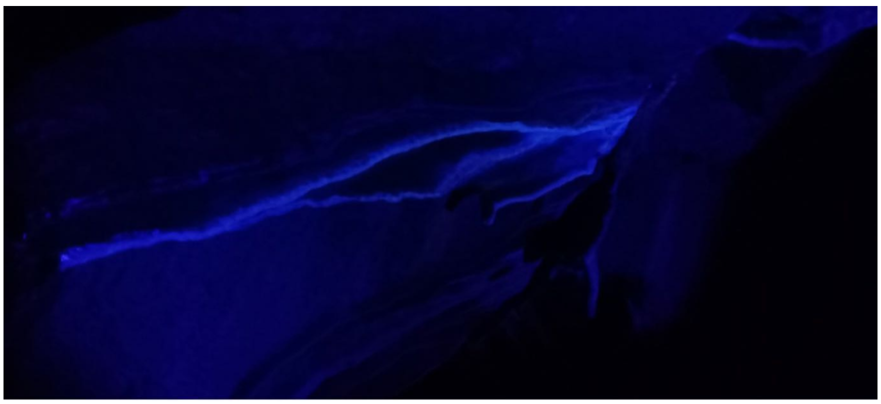


Figure 8. Blacklight (ultraviolet) shone on draperies in the Ribbon Room. Fluorescent minerals glow in this light.

Figure 9. Odd purple coloring on the ceiling.

STAFF NEWS

Another New Staff Member Arrives

Harry C. Wise. Harry has worked for the Pennsylvania Department of Environmental Protection (DEP) in the Bureau of Oil and Gas Planning and Program Management for the past 11 years. He served as the section chief for the Legacy Well and Geologic Support Section for approximately 6 years. Prior to that, Harry worked in the Subsurface Section of the Bureau of Oil and Gas Planning and Program Management for 4-plus years as a Licensed Professional Geologist. Previous to his time at DEP, he worked as a geologist for geotechnical consulting firms in Pennsylvania and California.

Harry earned a bachelor's degree from Franklin and Marshall College in Lancaster, Pa., and took master's degree courses at California State University in Fresno.

RECENT PUBLICATIONS

Maps (December 2023)

- Surficial Geologic Map of Pike County, Pennsylvania (ZIP)
- Surficial Geologic Map of the Corry Area, Erie County, Pennsylvania (ZIP)

Maps (November 2023)

- Surficial Geologic Map of Wayne County, Pennsylvania (ZIP)
- Bedrock-Topography and Drift-Thickness Maps of the Beaver Falls, New Galilee 7.5-Minute Quadrangles, and Pennsylvania Part of the East Palestine 7.5-Minute Quadrangle, Beaver and Lawrence Counties, Pennsylvania (ZIP)

Atlas (November 2023)

- Bedrock Geology of the Albion, Fairview, and Swanville 7.5-Minute Quadrangles, Erie County, Pennsylvania (ZIP)

Atlas (October 2023)

- Geology of Northern Portions of the Ambler, Hatboro, and Langhorne 7.5-Minute Quadrangles, Bucks County, Pennsylvania (ZIP)

Data Releases (October 2023)

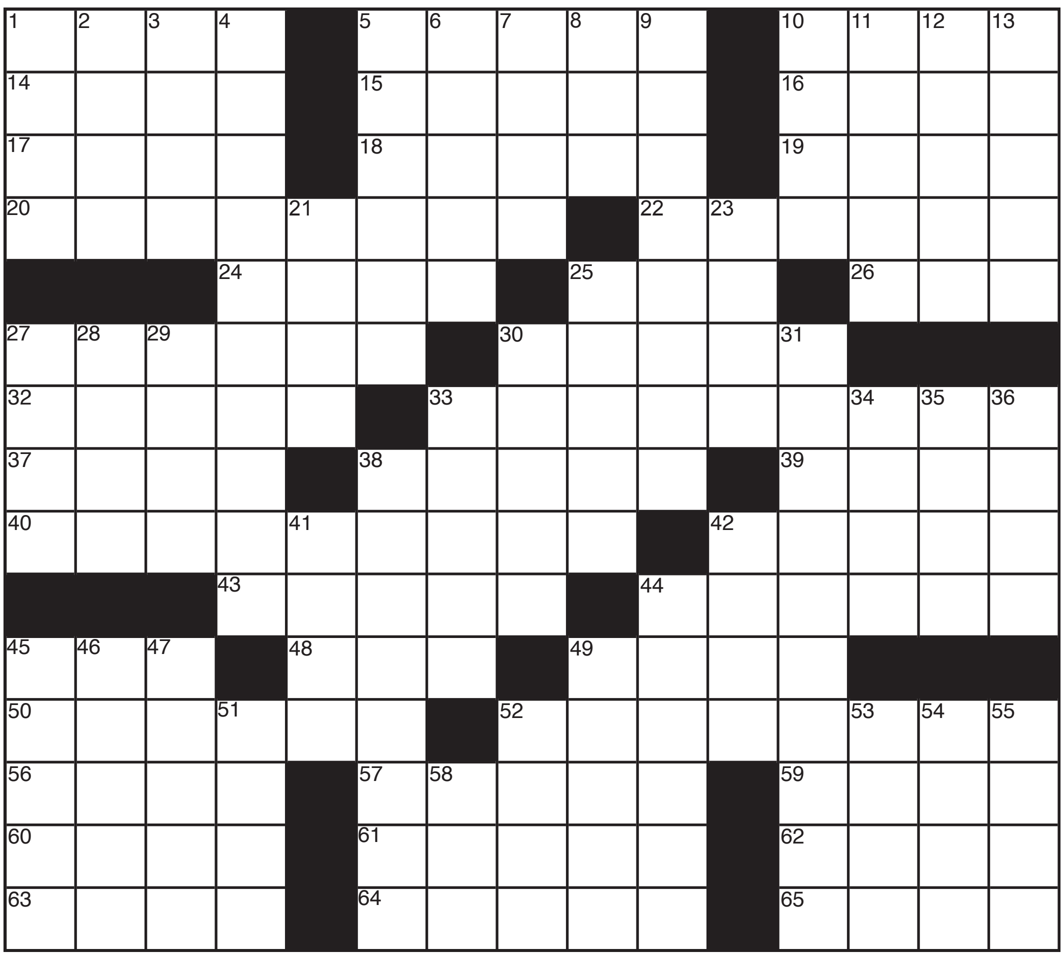
- Bedrock Surface Topography Digital Elevation Raster of Pennsylvania (opens in a new window)
- Modeled Pennsylvania Hydrography Dataset for Allegheny County (opens in a new window)

GEOPUZZLE

Geopuzzle Number 4

(Solution on page 23)

Stuart O. Reese
Pennsylvania Geological Survey, retired



ACROSS

1. Colorless; bland; dull
5. Pains
10. Specified contract element
14. "E. ____" contaminant
15. Praises
16. Fuzzy red puppet
17. Air hazard
18. Jewish holiday
19. Close by
20. Extensive Devonian formation of Pennsylvania
22. ". . . we here highly resolve that these dead shall not have died __ ____."
24. Rose quartz's most common color
25. Crime-solving forensic data
26. Like a fox
27. Chess knight, of course (two words)

ACROSS *(Continued)*

30. M & M's little candy
32. Hit 61 in '61, and played for Reading, Pa., Indians in '55
33. Central Pa. limestone formation
37. Omen
38. Direction pointer
39. Children's detective, "____ the Great"
40. Taconic and Alleghanian
42. Hershey foundation
43. Horse's night home
44. Bounces (off)
45. Corn's body part
48. Gas plant prod.
49. Wine (Ital.)
50. 20-across includes this bedding
52. Edible provisions
56. Not early
57. Stadium
59. Soot particle
60. Islamic chief
61. Combined
62. Alphabet sequence: dial 5666
63. Fiddler location, perhaps?
64. King of oom-pah-pah
65. Body exercise system

DOWN

1. Shermans Cr. Mbr. of 20-across
2. Tomato type
3. Much in quantity (two words)
4. Commonly found feature with units like 33-across and 45-down? (two words)
5. Glaciation type
6. Protect against leaks
7. Throw
8. Elec. Data Interch.
9. Fictional ship taken on a 3-hour tour
10. Loc. of Las Vegas
11. Emotional requests
12. Virtual correspondence
13. Cheesy, as in humor
21. A peck on the cheek
23. Finger or finishing
25. Many kids' reptile favs.
27. Retort to "are not!"?
28. 1967 Broadway rock musical of the hippie lifestyle
29. Should I stay __ __?
30. Pennsylvania edible mushroom variety
31. Loudly
33. Musical quaver
34. Central Texas city
35. Chemical building block
36. The ____ have it. The vote is passed.
38. Smug - gums - mugs, examples
41. Pennsylvania borough or European stratovolcano
42. Tilt
44. Pa. summer bug
45. Southeastern Pa. Ordovician limestone formation
46. Texas remembrance
47. One:another
48. Racecar tap or brand foam toy
49. Long tangling plants
51. Soft-toy maker
52. Collegiate robotics competition
53. Soldiers often run low on this
54. Respiratory organ
55. Greek portico
58. Braz. city

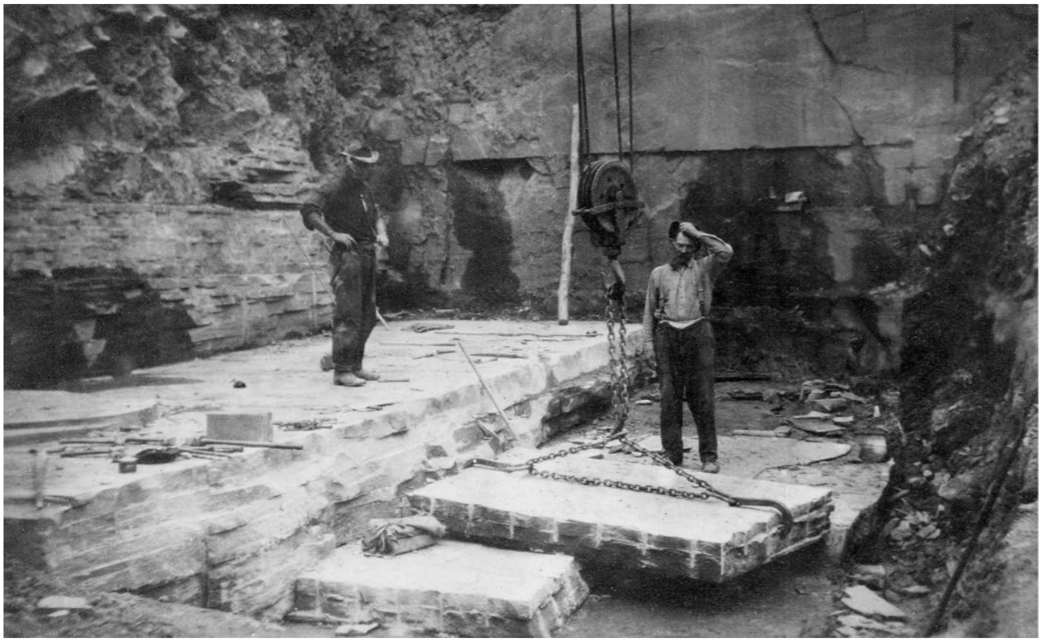
The theme of this crossword puzzle is *Pennsylvania Features*. This puzzle may be categorized as difficult. Please allow yourself five "lookups." No one will consider it cheating.

Thanks to Raymond Rizzo and Daniel Reese for their early helpful reviews, John Barnes for a later review, and to editor Anne Lutz.

Solution to Geopuzzle Number 4

D	R	A	B		A	C	H	E	S		S	P	E	C
C	O	L	I		L	A	U	D	S		E	L	M	O
S	M	O	G		P	U	R	I	M		N	E	A	R
C	A	T	S	K	I	L	L		I	N	V	A	I	N
			P	I	N	K		D	N	A		S	L	Y
A	H	O	R	S	E		M	I	N	I	S			
M	A	R	I	S		T	O	N	O	L	O	W	A	Y
S	I	G	N		A	R	R	O	W		N	A	T	E
O	R	O	G	E	N	I	E	S		C	O	C	O	A
			S	T	A	L	L		C	A	R	O	M	S
E	A	R		N	G	L		V	I	N	O			
P	L	A	N	A	R		V	I	C	T	U	A	L	S
L	A	T	E		A	R	E	N	A		S	M	U	T
E	M	I	R		M	I	X	E	D		L	M	N	O
R	O	O	F		S	O	U	S	A		Y	O	G	A

A Look Back in Time



Former bureau geologist Ralph Stone took this photograph of two unidentified workers at the Walters and Call flagstone quarry in Lanesboro, Susquehanna County. Here, a large crane is being used to lift blocks onto what is most likely a wagon. Flagstone is abundant in northeastern Pennsylvania, and especially in Susquehanna County. This photograph was taken on August 12, 1922.

To see more photographs from the bureau's archives, please visit the library's Historical Photographs collection page.

For additional reading, see the following publications:

- Glaeser, J. D., 1969, Geology of flagstones in the Endless Mountains Region, northern Pennsylvania: Pennsylvania Geological Survey, 4th ser., Information Circular 66, 14 p.
- Stone, R. W., 1932, Building stones of Pennsylvania: Pennsylvania Geological Survey, 4th ser., Mineral Resource Report 15, 316 p.

—Jody Smale, Librarian

Calling All Authors

Articles pertaining to the geology of Pennsylvania are enthusiastically invited.

Pennsylvania Geology is a journal intended for a wide audience, primarily within Pennsylvania, but including many out-of-state readers interested in Pennsylvania's geology, topography, and associated earth science topics. Authors should keep this type of audience in mind when preparing articles.

Feature Articles: All feature articles should be timely, lively, interesting, and well illustrated. The length of a feature article is ideally 5 to 7 pages, including illustrations. Line drawings should be submitted as jpg files. Ensure that black and white drawings are not saved as color images.

Articles should be submitted as Microsoft Word files. Feature articles will be reviewed by at least one bureau staff member. It is the author's responsibility to obtain approval for use of any illustrations that are copyrighted, including those taken from the Internet.

Earth Science Teachers' Corner: Articles pertaining to available educational materials, classroom exercises, book reviews, and other geologic topics of interest to earth science educators should be 5 pages or less in length and should include illustrations where possible.

Announcements: Announcements of major meetings and conferences pertaining to the geology of Pennsylvania, significant awards received by Pennsylvania geologists, and other pertinent news items may be published in each issue. These announcements should be as brief as possible.

Photographs: Photographs should be submitted as separate files and not embedded in the text of the article. Please ensure that photographs as submitted are less than 10 inches wide in Photoshop or equivalent. Also ensure that black and white photographs are not saved as color images.

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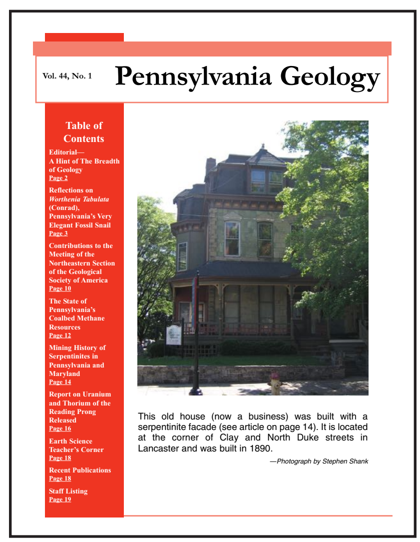
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This old house (now a business) was built with a serpentinite facade (see article on page 14). It is located at the corner of Clay and North Duke streets in Lancaster and was built in 1890.

—*Photograph by Stephen Shank*

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