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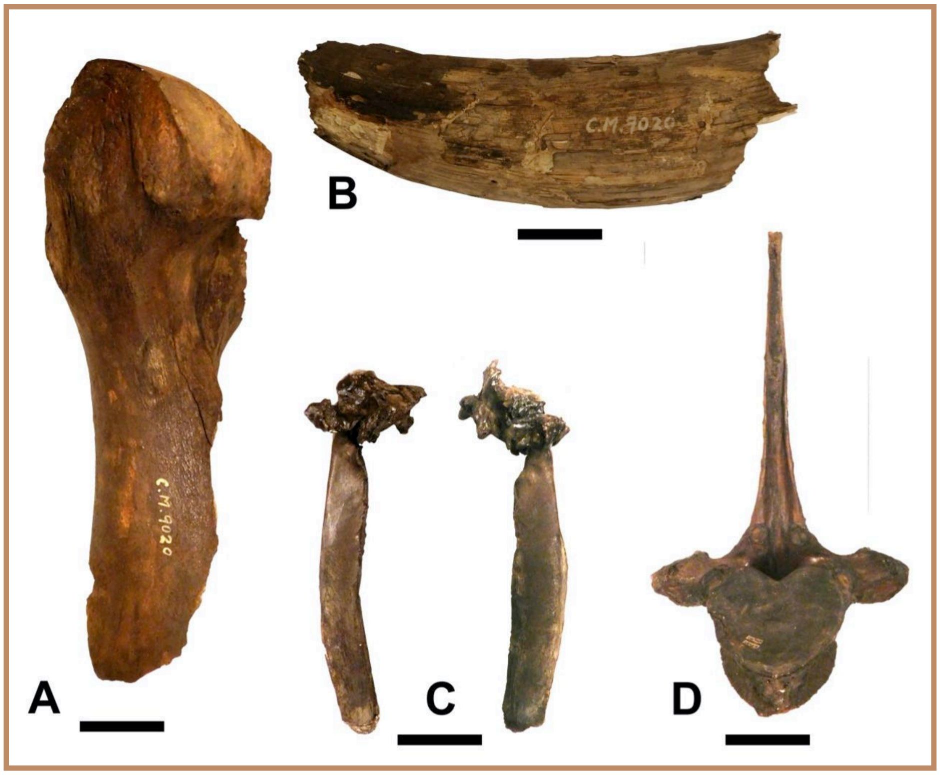

Some of the mastodon bones found in the Bridgeville peat bog (Allegheny County, Pa.) and now in the collections of the Carnegie Museum of Natural History (CM). A. Lower left foreleg, CM 9020. B. Part of one tusk, CM 9020. C. Two ribs, CM 9156. D. A vertebra, CM 9161. Scale bars = 10 cm. (See article on page 3.)

EDITORIAL

Earth Science Week

Gale C. Blackmer, State Geologist
Pennsylvania Geological Survey

Every year, the American Geosciences Institute (AGI) holds Earth Science Week. The week has a theme, and AGI distributes kits of resources and activities designed to engage students and others in exploring aspects of earth science. (AGI sends a supply of kits to state geological surveys, so if you would like one, please let us know.) Earth Science Week 2022 is October 9–15. The theme is "Earth Science for a Sustainable World." According to the Earth Science Week website, the theme emphasizes the essential role of earth science in helping people make decisions that maintain and strengthen the planet's ability to support thriving life.

Sustainability is an interesting thing because it means different things to different people. To some, sustainability means not taking anything from the earth. That's a fallacy, though, because from the food we eat to the electricity that powers our "sustainable" homes and cars, there is no form of energy that comes without extracting something, whether that is nutrients from the soil or critical minerals for electronics. To me, sustainability means developing a lifestyle that allows us to have the things we have come to need (or is it want?) while maintaining healthy and livable conditions on the planet. You may have a different definition, but I think that one is pretty good from an earth science perspective.

Then what can we do as earth scientists to help people make good decisions that lead to a sustainable world? The work we do with water, energy, and mineral resources comes immediately to mind. Helping people understand how to live with geologic hazards is another way we contribute. Earth science can help with mitigating and adapting to climate change in a variety of ways from carbon storage to flood mitigation. We can help communities stay economically viable by identifying local sources of construction materials, which will help to ensure cost-effective physical growth. The articles in this issue remind us that sustainability can apply to human resources, too. Training the next generation of earth scientists is critical to sustaining our science and our profession.

Gale C. Blackmer

Geology of a Former Pleistocene Bog in Bridgeville, Allegheny County, Pennsylvania

John A. Harper and Albert D. Kollar
Carnegie Museum of Natural History[1]

INTRODUCTION

In 1837, the great Swiss paleontologist and geologist Louis Agassiz hypothesized that ancient glaciers even larger than those that flowed out of the Alps covered the entire northern hemisphere in a prolonged ice age (Agassiz, 1840). When he arrived in the United States in 1846, he found that large portions of North America had been covered by glacial ice that extended from the northern pole across Canada and down across much of the midwestern and eastern United States. We now recognize the brilliance of Agassiz's work and the existence of the Pleistocene Epoch, or Ice Age, the lowest and, so far, longest epoch of the Quaternary Period of geologic history. The international geological community recognizes that the Pleistocene started 2.588 million years ago and ended 11,700 years ago. Many of us were taught (in the distant past!) that the Pleistocene in North America consisted of four glaciations named the Nebraskan, Kansan, Illinoian, and Wisconsinan stages, each separated by interglacial stages of varying ages named Aftonian, Yarmouthian, and Sangamonian stages. Over the years, however, the names Nebraskan, Aftonian, Kansan, and Yarmouthian became meaningless in terms of the actual glacial-interglacial record, and they were abandoned. Instead of two glacial stages prior to the Illinoian, science now recognizes eleven. Therefore, the old names have been abandoned and replaced by a single, very long pre-Illinoian Stage. Today, the four North American Pleistocene stages consist of the pre-Illinoian, Illinoian, Sangamonian, and Wisconsinan, with the pre-Illinoian representing most of the epoch (Figure 1). The Illinoian and Wisconsinan glacial stages retain their formal names; all of the earlier ones, labeled A to K, are part of the pre-Illinoian Stage. The Sangamonian is the only formally named interglacial stage.

BABY, IT'S COLD OUTSIDE

In western Pennsylvania, Pleistocene glacial tills and moraines are restricted to the northwestern counties; the maximum glacial advance reached only as far south as Butler and Beaver Counties. The Ice Age climate, however, greatly affected all of western Pennsylvania, with tundra conditions dominating the environment during glacial episodes. Tundra refers to a biome where low temperatures and short growing seasons hamper plant growth, and rainfall is scant. A good place to see a tundra biome is at the Polar World exhibit in the Carnegie Museum of Natural History in Pittsburgh. Snow typically covers the surface soils of tundras throughout most of the year. The subsoil is permafrost, ground whose temperature remains at or below 32ºF (0ºC) for two or more successive years. Continuous permafrost occurs in regions with mean annual air temperatures lower than about 17ºF to 21ºF (−6ºC to −8ºC); discontinuous permafrost occurs in regions with mean annual air temperatures lower than about 28ºF to 31ºF (−0.5ºC to −2ºC) (Merritts and others, 2014). Relatively few plant and animal species can live in the tundra because of environmental stress. Even areas many tens of miles from the edge of a glacier can experience deep-freezing conditions. As a result, evidence of Pleistocene tundra conditions can be found in many places in southwestern Pennsylvania, especially in the highlands where alpine tundra conditions prevailed. Brezinski and Kollar (2004, 2021) for example, documented patterned ground, rock cities,

[1]Carnegie Museum of Natural History, 4400 Forbes Avenue, Pittsburgh, PA 15213

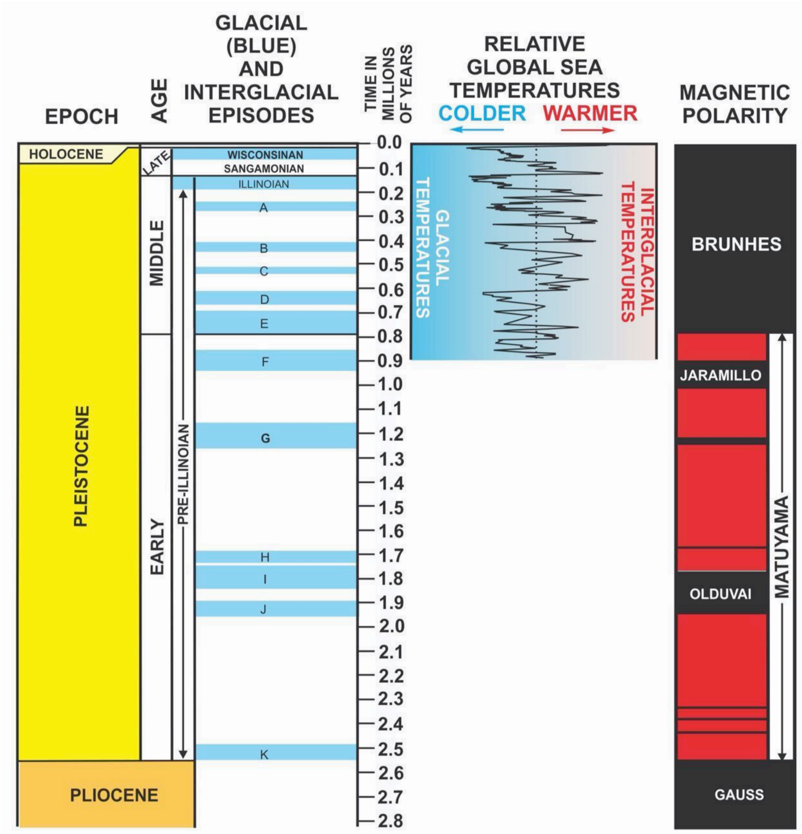

Figure 1. Glacial (blue) and interglacial stages of the Pleistocene Epoch correlated with reversals of the earth's magnetic field (normal polarity is shown in black, reverse polarity in red), and the temperature record for the last 800,000+ years.

and periglacial[2] bogs, all resulting from former tundra conditions, in the Laurel Highlands of Fayette, Somerset, and Westmoreland Counties. Most of the peat bogs that occur in Pennsylvania are relics of Pleistocene periglacial environments (see below). Today, geologists recognize that all of these periglacial environments and features exist in various places in southwestern Pennsylvania, more than 10,000 years since the last glacier retreated into the Arctic.

In addition, there were several times, possibly beginning with the earliest western Pennsylvania glaciation (whenever that occurred), that the south-flowing ice blocked the northwest-flowing streams in western Pennsylvania, causing the rivers to pond against the leading edges of the glaciers to form enormous pro-glacial ponds, each of which has been called *Lake Monongahela* (see Harper, 2002, and references therein). There is some disagreement as to how many such ponding episodes occurred in western Pennsylvania, but we know that each time Lake Monongahela formed, it never reached the level of the previous one (Table 1). Each iteration also formed separate levels of lacustrine deposits above current stream elevations, which occur in many places in western Pennsylvania as remnant terraces. This is

Table 1. Levels of Terraces Above the Three Rivers in the Vicinity of Pittsburgh, Pa.
(From Marine, 1997)

Terrace	Feet above river (normal pool level)	Feet above mean sea level
First	30	740
Second	160	900
Third	220	960
Fourth	260	1,000
Fifth	330	1,040

[2]"Periglacial" refers to cold climate environments both with and without permafrost (Washburn, 1980).

fortuitous as it allows geologists to distinguish different ages for each recognized terrace. The oldest Pleistocene deposits in southwestern Pennsylvania are called the Carmichaels Formation.[3] Campbell (1902) named this formation for lacustrine deposits preserved in an abandoned meander channel about 300 feet above the Monongahela River at Carmichaels, Greene County. The formation typically consists of clay, silt, and sand with subangular to well-rounded clasts ranging in size from pebbles to boulders (Donahue and Kirchner, 1998). The Carnegie Museum of Natural History and adjacent Museum of Art, which are located in the Oakland neighborhood of Pittsburgh, were constructed upon the Carmichaels (Kollar and others, 2020).

OH, FOR PEAT'S SAKE!

Peat bogs found scattered throughout western Pennsylvania, Maryland, and northern West Virginia developed when increased precipitation during glacial episodes inundated poorly drained low areas. Those bogs still in existence, such as Spruce Flats bog (Figure 2) (situated at the crest of Laurel Hill in Somerset and Westmoreland Counties), preserve localized pockets of unusual plant communities as refuges (Brezinski and others, 2005). It is only one of many bogs that still sustain relict plant communities in Pennsylvania (Figure 2). Botany Hall in the Carnegie Museum of Natural History has a diorama of a Pennsylvania Ice Age bog on display (Brezinski and Kollar, 2008). During the Pleistocene glacial episodes, increased rain in summer months and snowfall in winter months filled low-lying areas with cold water. These ponds and lakes froze in the winter but were open water in the summer. The cold

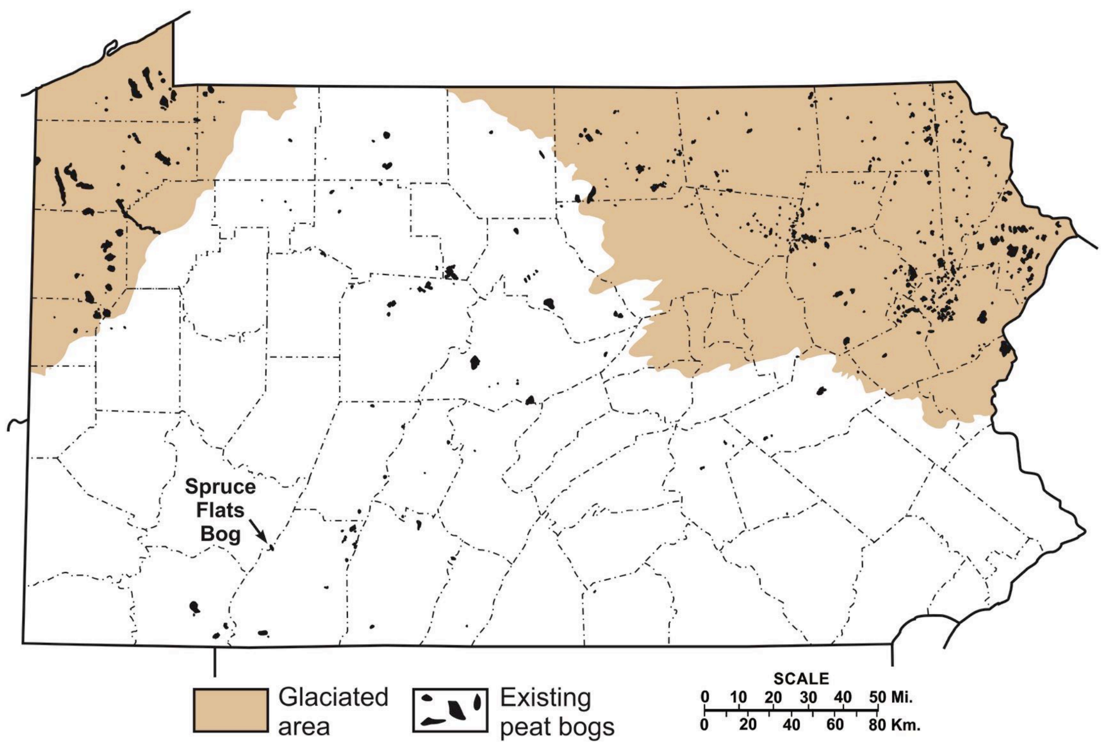

Figure 2. Map of Pennsylvania showing the locations of known peat bogs (redrawn from Western Pennsylvania Conservancy, 2022). Notice that the majority of peat bogs occur on formerly glaciated land in northern Pennsylvania.

[3]The name "Carmichaels Formation" is commonly used incorrectly for all Pleistocene terrace deposits in western Pennsylvania. Most of the terrace sediments along the Allegheny and Ohio Rivers are glacial outwash deposits that are distinctly different from the sediments of the Carmichaels.

water, which could support only specialized plants able to withstand the intensely cold conditions, prompted these plants, such as sphagnum (peat moss), to grow in dense floating mats on the surface of the water, where they produced acidic and low-oxygen conditions in the open water below. The moss accumulated over time to produce thick deposits. Such bogs are interesting ecological features supporting unusual low-diversity, acid-loving plant communities that are rare elsewhere (Brezinski and Kollar, 2004). Through time, the bogs would fill from the sides and top down rather than from the bottom up. When they fill, they typically take on a grassy, or even an arboreal, biota and become meadows. Fort Necessity National Battlefield in Farmington, Fayette County, sits on the Great Meadow, a former peat bog (Brezinski and Kollar, 2005). We are not entirely sure what plants and animals were native to southwestern Pennsylvania during the Pleistocene as only a few records exist and the ages of much of the data are uncertain. Guilday and others (1964) reported the first detailed record of the late-glacial range of boreal species of birds and mammals, which included 2,769 vertebrate skeletal remains associated with plant pollen and carbon from a late Pleistocene cave deposit in New Paris, Bedford County. Archeological excavations at Meadowcroft Rockshelter in Washington County contained " . . . sections of tree trunks and limbs, with and without bark, minute seeds and seed coats, fruits, charcoal, and small amounts of pollen" (Adovasio and others, 1984, p. 358). Also found were the remains of at least 5,634 individual vertebrates, representing 151 taxa, but these were mostly from Holocene strata. The only extinct animal remains found were those of passenger pigeons. Schopf and Cross (1947) documented a few species of plants from the Wisconsinan-age Bridgeville peat bog (see below), including an assemblage of mosses, ferns, club mosses, and seed plants. They also mentioned that insect remains were found in the peat, as well as some bones of a mastodon. Other fossils from southwestern Pennsylvania include the following: (1) a mastodon tusk found at Sharpsburg, Allegheny County, in 1909 (Figure 3) that currently resides in the Carnegie Museum; (2) the lower jaw of a

Figure 3. Historic photograph of a mastodon tusk (CM 11002) that John Clouse found at Sharpsburg on May 3, 1909. The tusk was once on display at the Carnegie Museum of Natural History, but it now resides in the Little Bone Room of Pleistocene Fossils, out of sight of museum visitors. CM, Carnegie Museum.

mastodon found in the bed of the Grays Fork of Tenmile Creek, Greene County (reported by Hay, 1923); and (3) a mastodon tooth found at Lone Pine, Washington County (reported by Hay, 1923). Most of what we know of the flora and fauna of the Pleistocene in the region, however, comes from outside of southwestern Pennsylvania (e.g., Guilday, 1971; Guilday and others, 1978).

HEY, MAN, THAT BOG IS MINE(D)

The Bridgeville area in southern Allegheny County is of interest because of its multiple Pleistocene deposits. Numerous distinct Pleistocene terraces occur within the area (Figure 4). The highest terrace is capped by the Carmichaels Formation, whereas later Pleistocene lacustrine sediments cap the lower one. Holocene and possibly Pleistocene alluvium fills the creek valleys. Two terraces can be seen on the hill east of the peat bog area (Figure 4), and several more can be seen to the north and northeast. Given the amount of residential and commercial development of the Bridgeville area over the last 100+ years, it is uncertain if any of the Carmichaels sediments still exist. If they do, one should be able to see them in fresh excavations.

A fossil peat bog at one time was situated in South Fayette Township southwest of the intersection of State Route 50 and Interstate 79, across Chartiers Creek from Bridgeville (Figure 4). Today, the location of the bog is occupied by a business park and a hotel, but it was once the site of the former Mulach Steel plant. Prior to that, the site was part of a strip mine in the Pittsburgh coal, which occurred at shallow depth. The bog became exposed during strip mining during World War I (Schopf and Cross, 1947).

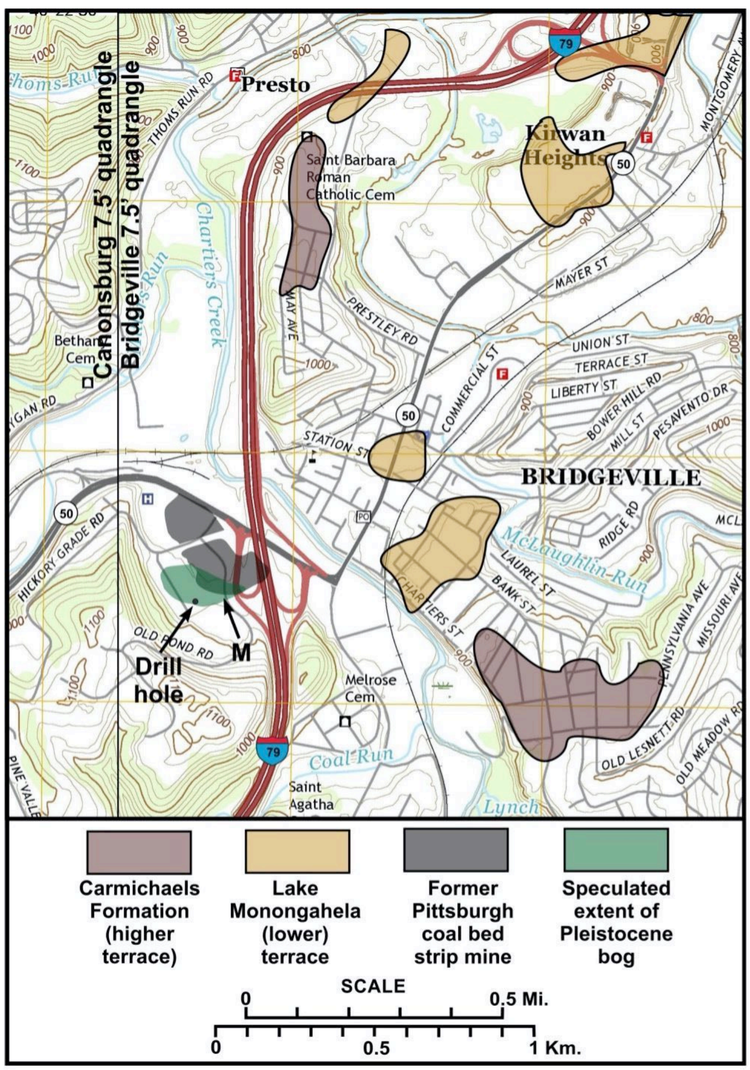

Figure 4. Map of portions of the Bridgeville and adjacent Canonsburg 7.5-minute topographic quadrangles showing the location and speculated extent of the Pleistocene bog (based on A Glacial-Age Peat Deposit Near Pittsburgh, *Schopf, J. M., and Cross, A. T., American Journal of Science, 1947, fig. 1, reprinted by permission of the American Journal of Science), and the locations of Pleistocene lake terraces along the Chartiers Creek valley (based on Shaw and Munn, 1911). See the text for details.*

The peat was found in the face of the strip pit about 10 or 12 feet above the level of the coal, situated under shallow cover at the base of the hillside where Chartiers Creek formed a tight meander on the west side of Bridgeville (Figure 4). The peat did not attract attention at the time it was first exposed. Chunks of it could still be found in old spoil banks from the early mining operation when the Pittsburgh Coal Company (now part of Consol Energy) renewed mining early in the summer of 1945. Schopf and Cross (1947) visited the site in June 1945 and began documenting the peat and associated sediments.

The elevation of the top of the bog was approximately 820 feet above sea level. The lowest terrace level above the current Chartiers Creek flood plain is about 60 feet above the level where the peat was found. The peat formed on a substrate of clay and coarse gray gravel and cobbles, which overlaid the coal bed locally, while finely textured plastic clay, oxidized alluvium, and soil occurred above the peat (Figure 5). Figure 5 illustrates the irregular contact of peat with the overlying clay. Thicknesses of the strata above the bedrock unconformity between units 12 and 13 in Figure 5 varied quite a bit. Schopf and Cross (1947) described the peat as thinning and becoming very clayey, with increasing thickness of clay partings toward the eastern part of the mine. The strata consisted almost entirely of bedrock at the eastern end of the mine. Although most of the glacial-age strata ended abruptly against the bedrock slope, the peat deposit itself was not truncated abruptly. Rather, close to the hill east of the mine the strata beneath the peat were thicker and less distinctive. Eventually, the peat graded laterally into clay. A coal core taken near the speculated southern extent of the bog ("Drill hole" in Figure 4) showed that the peat probably was present in several more acres of potential coal reserves. The core reached the coal at a depth of 64 feet 8 inches. The strata above bedrock were not preserved, but the core record indicated "sand, clay and vegetable matter" at a depth of 48 feet

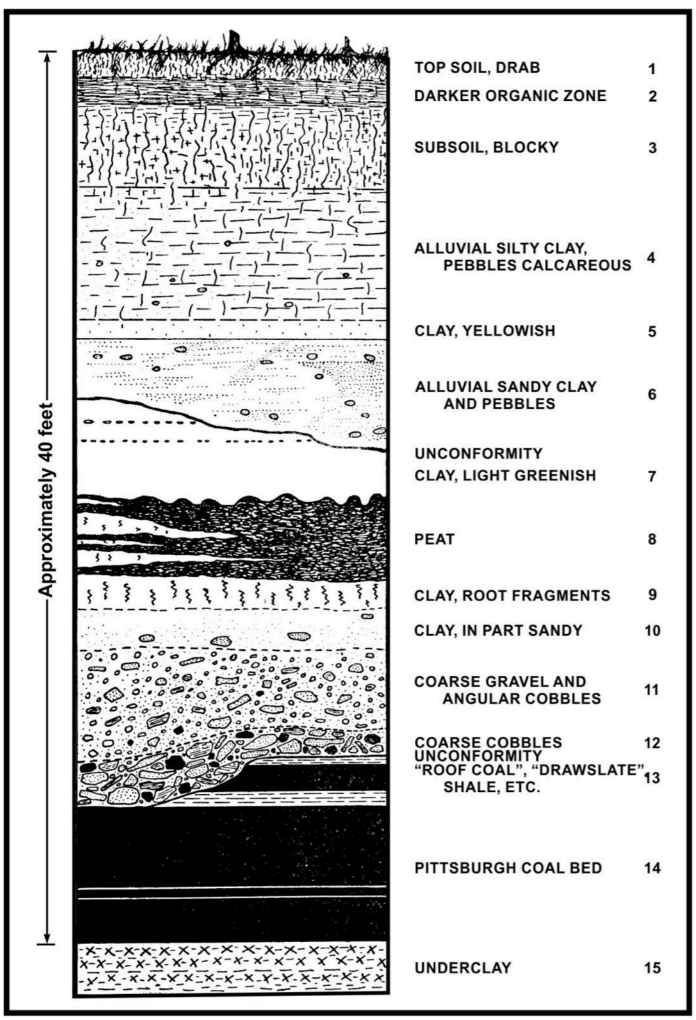

Figure 5. Diagram of the geologic section exposed at the Hussey strip operation near Bridgeville (from A Glacial-Age Peat Deposit Near Pittsburgh, *Schopf, J. M., and Cross, A. T., American Journal of Science, 1947, fig. 2, reprinted by permission of the American Journal of Science).*

to 54 feet 8 inches. Apparently the contours of the bedrock surface controlled the actual area of peat accumulation.

Schopf and Cross (1947) speculated that the Bridgeville peat probably formed during a short-term warming period ("intersubstadium") within the Wisconsinan glacial stage following ponding of Chartiers Creek to the level of the peat. Later additional ponding to a higher level (Wisconsinan age Lake Monongahela) drowned the peat and preserved it under later sediments. They considered the bog unusual because it was located at a significant distance south of the known limit of glaciation in Butler County. Most deposits of Pleistocene peat recorded outside the glacial border in the eastern United States were considered to have been of interglacial origin, so they weren't classified as being related to active glaciation as in the case of the Bridgeville deposit.

Schopf and Cross (1947) also documented a few species of plants from the peat. They used test tubes to collect samples for pollen analysis at regular intervals within the peat, but the analyses were not complete at the time of publication of their report. The assemblage of mosses, ferns, club mosses, and seed plants that had been identified at that point was sufficient to indicate boreal conditions, with the neighboring hillslopes occupied predominantly by a coniferous forest at the time the peat was being deposited. In addition, numerous insect remains found in the peat, many showing their original coloration, were sent to the Carnegie Museum in Pittsburgh for study. Bones of a mastodon were recovered from the peat that, according to Rudy Eller, former Curator of Invertebrate Paleontology at the museum, were well preserved but disarticulated (cover illustration). The approximate location of the bones is indicated by the M in Figure 4.

"AGE DOESN'T MATTER, UNLESS YOU ARE A CHEESE"[4]

As mentioned previously, the top of the bog was situated at an elevation of approximately 820 feet above sea level, lower than the older terrace deposits mapped by Shaw and Munn (1911) (lower terrace deposits in Figure 4). It is actually closer in elevation to the late Wisconsinan gravels near the mouth of Chartiers Creek where it flows into the Ohio River at McKees Rocks. This suggests a Late Wisconsinan age for the deposit (Schopf and Cross, 1947; Richardson, 1985). Radiocarbon dates derived from various samples of the peat over the years confirmed the Late Wisconsinan age of the peat bed (Arnold and Libby, 1951; Suess, 1954; Flint and Rubin, 1955; Volman, 1981). Table 2 shows the various previously published dates for samples of the peat. Richardson (1985) remarked on the tight cluster of three of the dates (samples W–66, SI–4237B, and SI–4237C), but W–66 was obtained more than 20 years before the first use of accelerator mass spectrometry (AMS) in radiocarbon dating, which is far more accurate than previous methods. Muller (1977) first demonstrated the value of AMS for determining radioisotope dates, and it took until the early 1980s for the technique to become the standard in radiocarbon dating. The dates of samples SI–4237B and SI–4237C average out to 23,255 ± 33 BP (before present). More recently, we had a sample of the peat in the collections of the Invertebrate Paleontology Section at the Carnegie Museum analyzed (thanks to efforts by Professor Mark Abbott of the University of Pittsburgh), which resulted in a date of 24,720 ± 130 BP, older than Volman's (1981) average but significantly younger than her sample SI–4237A. The reason for the different dates is not known. Subtracting Volman's (1981) youngest date from her oldest, however, gives a value of 8,220 years, which indicates that the bog might actually have existed for at least that long. Inasmuch as the

[4]Quote from Mary William Ethelbert Appleton Burke—actress Billie Burke, better known as Glinda, the Good Witch of the North, from the movie "The Wizard of Oz" (1939).

Table 2. Chronological Dates Established for the Bridgeville Peat Bog Based on Radiocarbon Analyses
(Ages based on data from Dawson, 2013)

Sample number	Date B.P.	Age	Reference
C–438	>16,000	Late Late Wisconsinan	Arnold and Libby, 1951
W–66	23,000 ± 800	Middle Late Wisconsinan	Suess, 1954; Flint and Rubin, 1955
SI–4237A	31,390 ± 860	Early Late Wisconsinan	Volman, 1981[1]
SI–4237B	23,340 ± 600	Middle Late Wisconsinan	Volman, 1981[1]
SI–4237C	23,170 ± 270	Middle Late Wisconsinan	Volman, 1981[1]

[1]Radiocarbon dates obtained by the Smithsonian Institution

yearly accumulation of peat in boreal peatlands is only about 0.01 to 0.02 inches per year, it takes thousands of years to develop peat deposits of 5 to 7.5 feet in thickness (Hugron and others, 2013). Schopf and Cross (1947) measured the maximum thickness of the Bridgeville bog peat at 3.6 feet, considerably less than the 5 feet Hugron and others (2013) suggested as a lower limit for thousands of years of peat production, but then "thousands of years" is not a very precise number.

HOW TO MAKE A PEAT BOG IN ONE EASY LESSON

Sevon and others (1999, especially the figure on p. 10) illustrated a generalized sequence of events showing how we believe the Bridgeville peat bog might have been created and covered during the Late Wisconsinan. Their illustration agrees well with numbers 2 through 6 of the suggested sequence of deposition for the Quaternary sediments at the Bridgeville mining site by Schopf and Cross (1947, p. 429–430) and the explanation of the development of the ponding that allowed the bog to form, which was as follows:

"1. Active local erosion, possibly accompanied by torrential flooding, resulted in accumulation of unsorted cobble and gravel deposits;
2. Pond-water flooding of the area, to a depth corresponding approximately to the present peat elevation, greatly retarded erosion and permitted deposition of fine-textured sediments;
3. Aquatic plants grew rooted in the fine-textured clay and somewhat later a lush growth of aquatic or semi-aquatic mosses formed a bog and accumulated to become peat;
4. Pond flooding of the area to a higher level terminated bog conditions and was followed by deposition of dense plastic clay on top of the peat;
5. The ponded area was drained and subjected to moderate erosion as the present drainage was established; silty and sandy deposits of the existing flood plain were laid down;
6. A soil profile has developed on the flood-plain alluvial deposits with at least local leaching of carbonates to a depth of over five feet."

They went on to further speculate (Schopf and Cross, 1947, p. 430):

> "Although a very local damming of Chartiers Creek might account for deposition of gravel and accumulation of peat, the presence of clay *above* the peat can hardly be explained in this way, and it seems reasonable to believe that the whole succession is related to Pleistocene events affecting the Pittsburgh region. Two successively higher levels of ponding in the Chartiers Valley are indicated. Valley train deposits in the Ohio River Valley could have blocked the mouth of Chartiers Creek where it empties into the Ohio eight miles below Bridgeville, and there is abundant proof of the great depth attained by the Ohio Valley filling. No other agency has been recognized that could account for successive levels of ponding at Bridgeville."

GONE BUT NO LONGER FORGOTTEN

The Bridgeville bog is long gone, and only museum specimens and a few publications remain to indicate that it ever existed. From our standpoint, it is depressing to stand on a slab of concrete parking lot and stare at a bunch of buildings that now occupy the area where mastodons looked for succulent plants to devour 23,000 to 24,000 or more years ago. We hope that more people will become aware of the bog's former existence. Perhaps at some point in the future someone will discover similar features while excavating for construction purposes along Chartiers Creek.

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A Summer of Geology—Activities at the Pennsylvania Geological Survey

Rose-Anna Behr, Ellen Fehrs, and Adam Ianno
Pennsylvania Geological Survey

With the lift of COVID restrictions, staff members have returned to public outreach efforts. They conducted a program for the Bureau of State Parks called *Women in the Wild,* hosted tables at STEAM (Science, Technology, Engineering, Arts, and Mathematics) nights at elementary schools, presented geology topics to senior citizens, guided college groups through caves, and educated water-well drillers. This outreach is an exciting way to get people interested in geology!

Staff member Ellen Fehrs shared the joy of fossils with a student at Rossmoyne Elementary School STEAM (Science, Technology, Engineering, Arts, and Mathematics) night in May. Photograph by Rose-Anna Behr.

(Continued on next page)

A huge component of connecting with the community is the chance to guide young geologists through their studies and early stages of their careers. For the first time in two years, the Bureau of Geological Survey was able to accommodate intern positions. Pictured below are eight of this year's interns and some staff members after touring the Cornwall Iron Furnace and grounds.

Clockwise from left: Gideon Olufemi-Ajayi, Ryan O'Hagan, Kristen Hand (staff), Tyler Smith, Evan Bechtel, Max Kasian, Jes Hetrick, Miller Ballew, Sim Suter (staff), Mat Dearing-Grover, Chris Oest (staff), and Hailey Filippelli (staff). Photograph by Rose-Anna Behr.

(Continued on next page)

In this photograph, staff member Morgen Weiant models the interesting texture of exposed potholes downstream from Conewago Falls. Photograph by Adam Ianno.

Interns and staff alike make the trek across the field of exposed potholes downstream from Conewago Falls. Photograph by Miller Ballew.

Staff member Adam Ianno demonstrates the depth and diameter of some of the potholes downstream from Conewago Falls via "groundhogging." Photograph by Ty Johnson.

Staff member Steve Shank (top) and intern Evan Bechtel peer down into a pothole. Photograph by Ty Johnson.

Interns had the chance to experience the ins and outs of seismic data collection, which supported the work of intern Evan Bechtel, who is conducting his senior thesis project at Dickinson College on geophysical methods in an active karst terrane. On the left is a seismic profile line laid out from a stormwater retention basin to a yard where sinkholes have been an ongoing problem since Hurricane Ida last fall. On the right, Tyler Smith prepares to deliver the hammer blow for the seismic signal while Chris Howard keeps the signal cable safe from damage. Photographs by Rose-Anna Behr.

Interns Chris Howard and Mat Dearing-Grover set up for seismic data collection. Photograph by Rose-Anna Behr.

Interns Sean Bergsten, Miller Ballew, and Ryan O'Hagan take a well-deserved break. Photograph by Rose-Anna Behr.

Interns and others must watch their steps at the "river of rocks," Hickory Run Boulder Field! One intern is shown in this photograph (Sean Bergsten, at right); the rest are high school students exploring careers in geology with the help of staff geologist Sim Suter and interns Sean Bergsten, Miller Ballew, and Ryan O'Hagan, as well as Diane Madl, a staff member at Hickory Run State Park. Photograph by Rose-Anna Behr.

A Summer That Rocked

Cheyenne Woodward and Chris Howard
Summer Interns, Pennsylvania Geological Survey

Interns are stereotypically known for being the coffee runners, paper pushers, and overall pack mules; however, as Rock Sample Library interns, we have contributed value with both brains and brawn. The role we played as interns has been more than just handling samples of core and cuttings, even though that is an important component of our job. Doing things such as cataloging cuttings, photographing and transporting core, and assisting with external and internal service requests allowed us to be a part of a much larger picture. We were able to assist in climate-change mitigation, participate in research projects, and contribute toward a new geologic map of the state.

Our tasks of entering data and photographing core could be perceived as busy work, but they were a foundation for public outreach, scientific research, mapping, and various projects for the Pennsylvania Geological Survey. Something as simple as assisting researchers with examining core or sending data sheets to those requesting information allowed us to serve individuals with different geologic interests and to reinforce the public view of the bureau as a reliable and trustworthy source for data acquisition. One of our tasks included a service request for a company looking to gather information concerning their efforts in renewable natural gas. By presenting the company with the data they were seeking, we became an asset in the broader objective of climate-change mitigation. Additionally, part of our duties included participating in critical field work. Although being out in the field was certainly fun, it also gave us the ability to contribute to large projects such as the next state geologic map. Another opportunity arose from a service request that led to an invitation to see a natural-gas drilling operation. Seeing a drilling-rig operation allowed us to have a better understanding within the broader objective of how core and cuttings are procured and how the information is applied.

The skills and knowledge gained from serving in the bureau's Rock Sample Library allowed us to assist others within the bureau and in the community at large. As interns we have become advocates for the Pennsylvania Geological Survey by informing our friends, family, and visitors what we have learned and experienced this summer. We have had our share of fun, and that fun advanced current and future projects of the bureau.

Cheyenne and Chris at a natural-gas drilling site near Montrose, Pa.

A Small, Deep Natural Earthquake in Northwestern Pennsylvania

Katherine Schmid,[1] Robin Anthony,[1] and Kyle Homman[2]

INTRODUCTION

On Monday June 28, 2022, the Pennsylvania State Seismic Network (PASEIS) (http://paseis.geosc.psu.edu) recorded a small seismic event (magnitude 1.8) in northwestern Pennsylvania (Figure 1). When PASEIS detects events such as this, specialists at the Pennsylvania State University notify geologists at the Pennsylvania Geological Survey, where we work with Department of Environmental Protection (DEP) colleagues to determine if the seismic event was induced by human activities such as mining or oil and gas drilling, or if it was a natural tectonic earthquake. Most often, we find that the seismic events are related to active mines.

BACKGROUND

What comes to mind when we think of seismic events are those large-magnitude earthquakes (naturally occurring tectonic seismic events) along plate margins that cause destruction to human life and infrastructure. Although geologists have long been aware that the earth is tectonically active and animals can often sense vibrations that humans cannot, only recently has modern technology allowed us to record small-magnitude events such as this one. One example of this technology is PASEIS, which has been in operation since late 2016. With these new data, geophysicists now have an expanded opportunity to develop new hypotheses and refine existing models of the earth's tectonic mechanisms. Yet, new data often raise as many questions as they answer. This is especially true when rarer earthquakes happen in a place that is not found along a plate margin, occurring instead as *intraplate* tectonics.

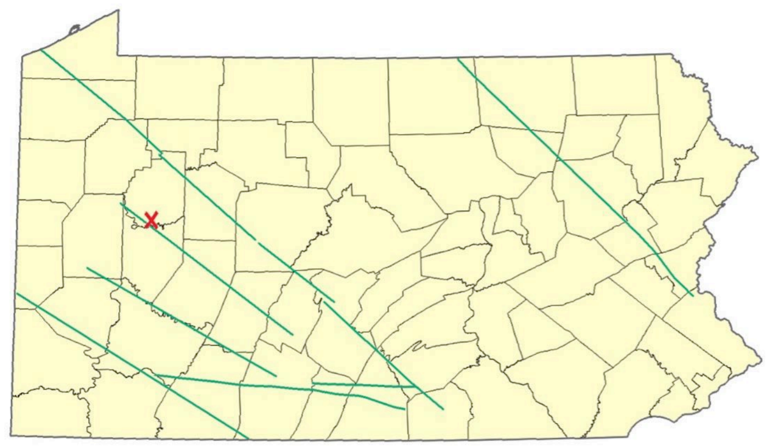

Figure 1. Event location map showing county outlines and locations of major lineaments (from Gold and others, 2005). The red X marks the location of the June 28, 2022, earthquake.

The magnitude distribution of earthquakes in Pennsylvania detected by PASEIS ranges from 0.7 to 3.3 (Homman and Nyblade, 2020) (Figure 2). Humans generally would not detect a magnitude of 1, while the 2011 earthquake in Mineral, Va., a 5.7 magnitude at its epicenter, was attenuated (reduced in amplitude) by the time it reached southwestern Pennsylvania to around a level 2; thus, it was felt in southwestern Pennsylvania more as an internal sensation of slight imbalance or nausea. On the other hand, a magnitude 3 earthquake (such as those attributed to glacial isostatic adjustment that occur occasionally around Lake Erie) is a vibration that can definitely be felt, perhaps best described as a heavy truck lumbering down a brick road (without the noise).

[1]Pennsylvania Geological Survey
[2]The Pennsylvania State University

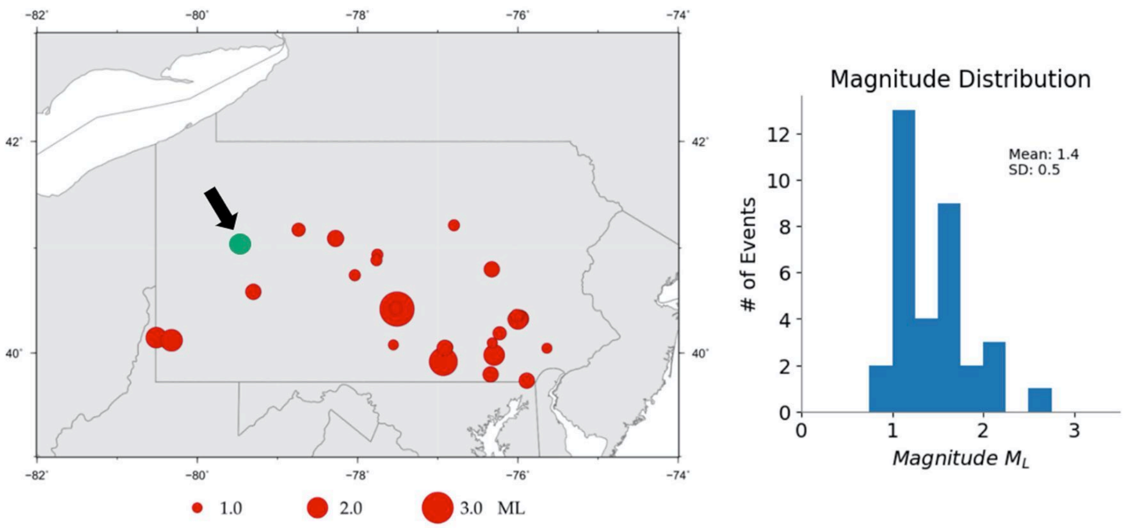

Figure 2. Location of the magnitude 1.8 seismic event of June 28, 2022, (green dot) in relation to other naturally occurring earthquakes recorded by PASEIS from September 2016 to February 2020. The bar graph on the right shows magnitude distribution. ML, local magnitude. Modified from Homman and Nyblade, 2020.

Pennsylvania lies within the interior of the North American plate. Unlike earthquakes at plate boundaries, determining the causes of intraplate earthquakes can be very challenging. Remember, we live on a brittle crust that is moving on a spherical body. Shifts in the crust must happen periodically to accommodate this movement; these are felt as earthquakes and do not always happen at plate boundaries. Most earthquakes in North America east of the Rockies occur as faulting within bedrock, usually miles deep. Although less frequent than those in the west, they are typically felt over a much broader region than the western ones of similar magnitude. Unlike those in the west, however, few of these have been definitely linked to mapped geologic faults. Scientists who study eastern and central North American earthquakes (e.g., Harper, 1989; Dewey and Gordon, 1999) often work from the hypothesis that modern earthquakes occur as the result of slip on preexisting faults that were formed in earlier geologic eras and that have been reactivated under the current stress conditions (West Virginia Geological and Economic Survey, 2022).

Prior to the PASEIS network, a map was made of seismic events from the 1700s through 2003 that shows that a higher magnitude or frequency of events does occur in certain intraplate areas more than in others (Figure 3). Possible causes of intraplate earthquakes include glacial isostatic adjustment, ridge-push effects, lithospheric foundering, and sublithospheric mantle convection (Pazzaglia, 2016) that leads to mantle drag. Mantle drag is an important driving force in plate tectonics (Becker and Faccenna, 2011). In addition to mantle drag, Anderson (2022) described mantle waves that not only move plates horizontally on the surface of the earth, but can also result in vertical uplift or subsidence of plates. The Appalachian basin is currently in the uplift phase of a mantle-wave passage (Anderson, personal communication, 2021).

Scientists study the mantle in an attempt to explain some of these intraplate earthquakes, but modeling mantle flow is difficult. This is partially due to the phase transitions that occur at the high temperatures and pressures in the mantle and partially because the plate tectonic style of convection has a toroidal (doughnut-shaped) component that is not observed during convection in a normal fluid (Karato, 2010). This toroidal component leads to the development of transform faults that on continental plates may be expressed as lineaments, such as the Homewood-Gallitzin lineament.

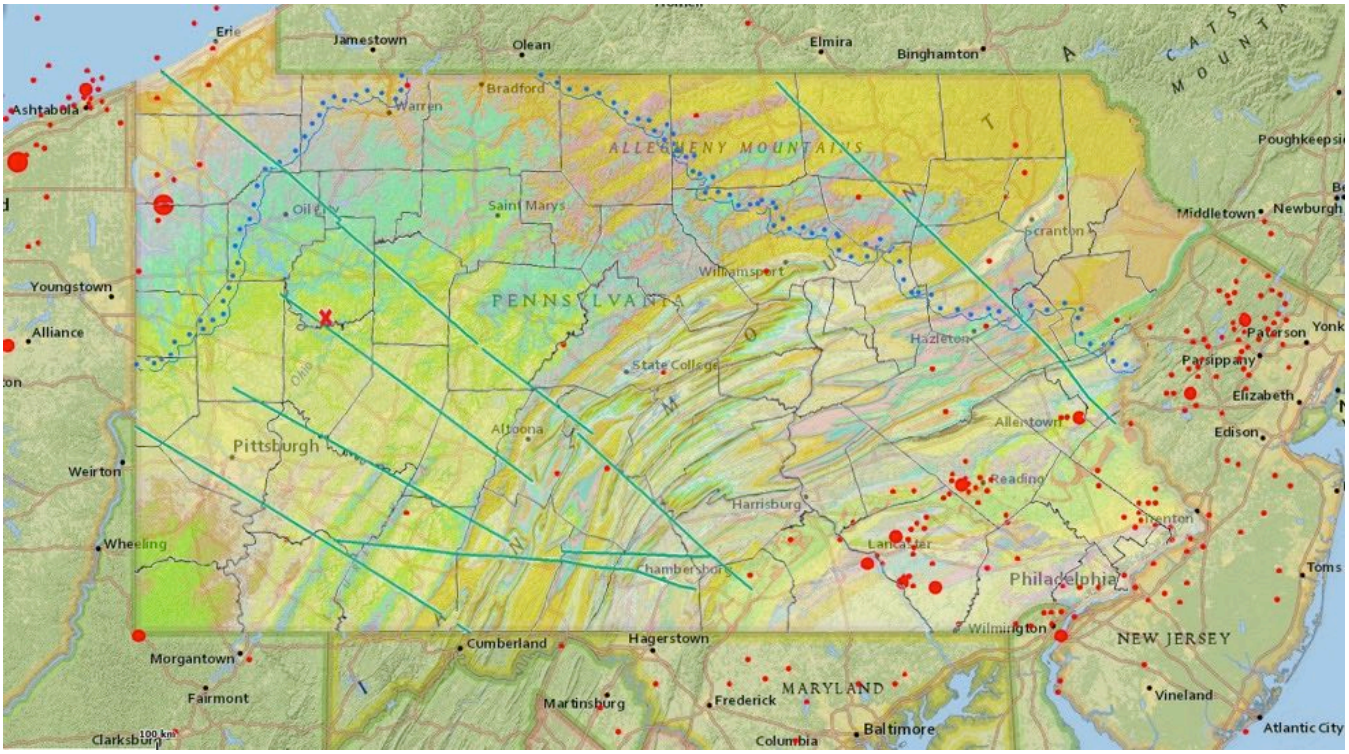

Figure 3. Map of seismic activity from 1724 through 2003, which predates the PASEIS network, overlain by lineaments from Figure 1, showing higher magnitudes (larger dots) and frequencies of events in the Piedmont province in the southeastern part of the state. A recent model in this area (Pazzaglia, 2016) indicates a steep gradient beneath the Appalachian Piedmont, largely coincident with seismicity, where the crust thickens from ~30 to 40 km. The model suggests that seismicity and crustal deformation in this area arise from a combination of lithosphere topography and structure, coupled with the effects of density-driven mantle flow. The glacial rebound areas in the northwestern and northeastern portions of Pennsylvania also show greater frequency and, in the northwest, magnitude of earthquakes. X marks the spot of the recent lower magnitude seismic event in June of 2022, which is in an area not known for its seismic activity, although it is proximal to the Homewood-Gallitzin lineament. Could a mechanism for enhancing shear localization explain the presence of this strike-slip fault and the recent seismicity?

DISCUSSION

The small seismic event recorded by PASEIS in northwestern Pennsylvania on June 28, 2022, (Figure 1) is unique both because it happened in an area where we don't usually see earthquakes, and because the hypocenter is more than 8 miles (14.1 km) deep, deeper than most events measured in PASEIS. In order to give an indication of how special this event is, the PASEIS catalog from September of 2016 (when PASEIS became operational) through the end of February of 2020 recorded 1,102 seismic events, of which 1,068 events were mine-related blasts, leaving only 34 events that were probably earthquakes (Homman and Nyblade, 2020). Figure 2 shows the magnitude and surface location of those natural occurrences relative to the most recent magnitude 1.8 event in Clarion County.

Figure 4 shows an example of seismic waves detected from this June 28, 2022, event. Seismic waves produced by an earthquake consist of surface waves and body waves. Surface waves travel along the surface and create the shaking associated with an earthquake. Body waves travel through the interior of the earth. Seismologists use the arrival times of these body waves at several different stations to

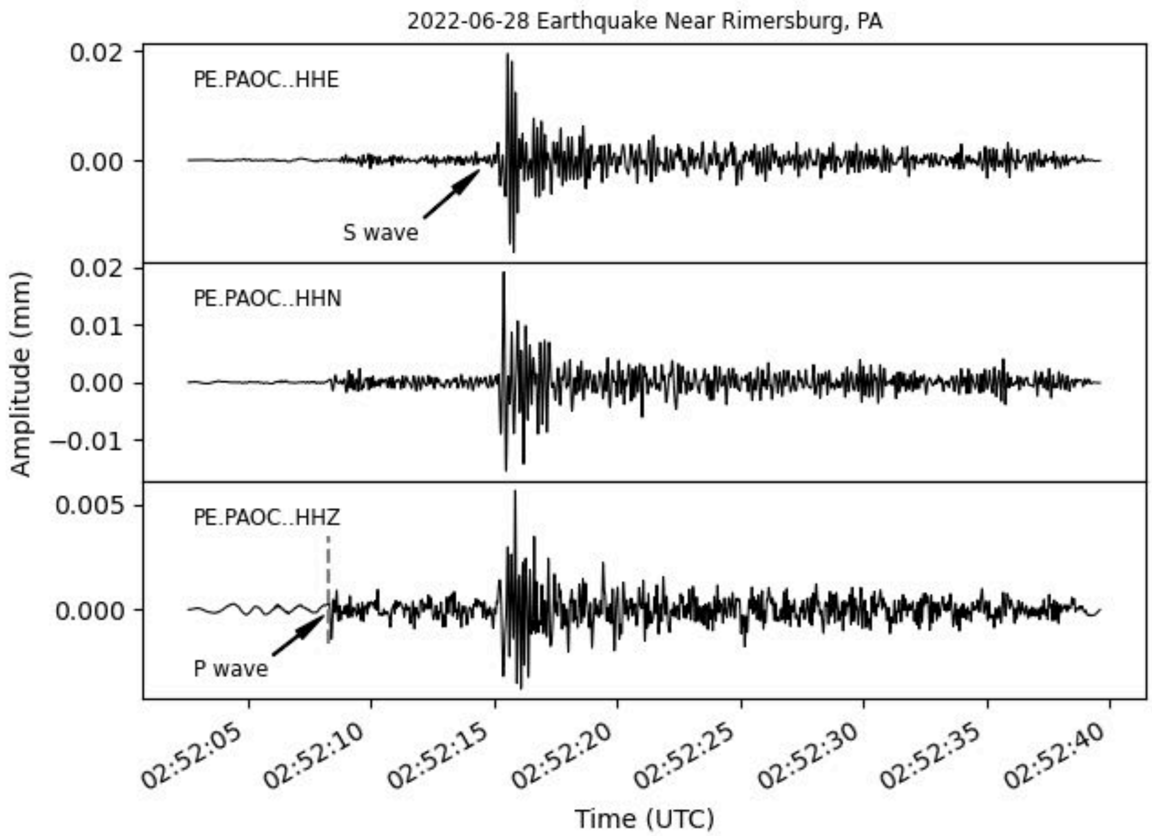

Figure 4. Shown are the seismic waves from the June 28 earthquake as recorded on the seismic station at Oil Creek State Park in Oil City, Pa. The seismometer records ground motion in three directions; each direction is shown as a subplot. The bottom subplot (PE.PAOC..HHZ) shows vertical ground motion, the middle subplot (PE.PAOC..HHN) depicts ground motion in the north-south direction, and the top subplot (PE.PAOC..HHE) shows ground motion in the east-west direction. The waveforms in this plot have been filtered from 1–10 Hz (hertz) to differentiate the earthquake signal from the background noise. The P and S wave arrival times are annotated in these subplots.

pinpoint the underground location (the hypocenter) of the recorded earthquake. Two main types of body waves that help determine the location of the seismic event are highlighted in the figure. P waves, or primary waves, are the first arriving signal recorded on a seismic station from an earthquake. S waves, or secondary waves, are the second type of wave to be recorded at a seismic station following an earthquake. Homman and Nyblade (2020) detail how the PASEIS system collects, interprets, and uses these measurements and determines associated uncertainties.

When PASEIS detects earthquakes like this, we check to see if the seismic event was caused by human activities such as mining or oil and gas drilling, as these are more common than natural causes of seismic activity in Pennsylvania. Our DEP colleagues confirmed that there was no active oil and gas activity in this area. The Upper Kittanning coal seam was mined here in the 1960s, but maps from Pennsylvania Spatial Data Access (PASDA) (https://www.pasda.psu.edu/uci/SearchResults.aspx?Shortcut=energy) did not show any active mining.

However, our mapping did show that there are deep structures in this area that may be related to the seismic event (Figure 5). This seismic event is located close to several geologic structures, including the axis of the Brady's Bend syncline, the Homewood-Gallitzin lineament, and a mapped fault. According to

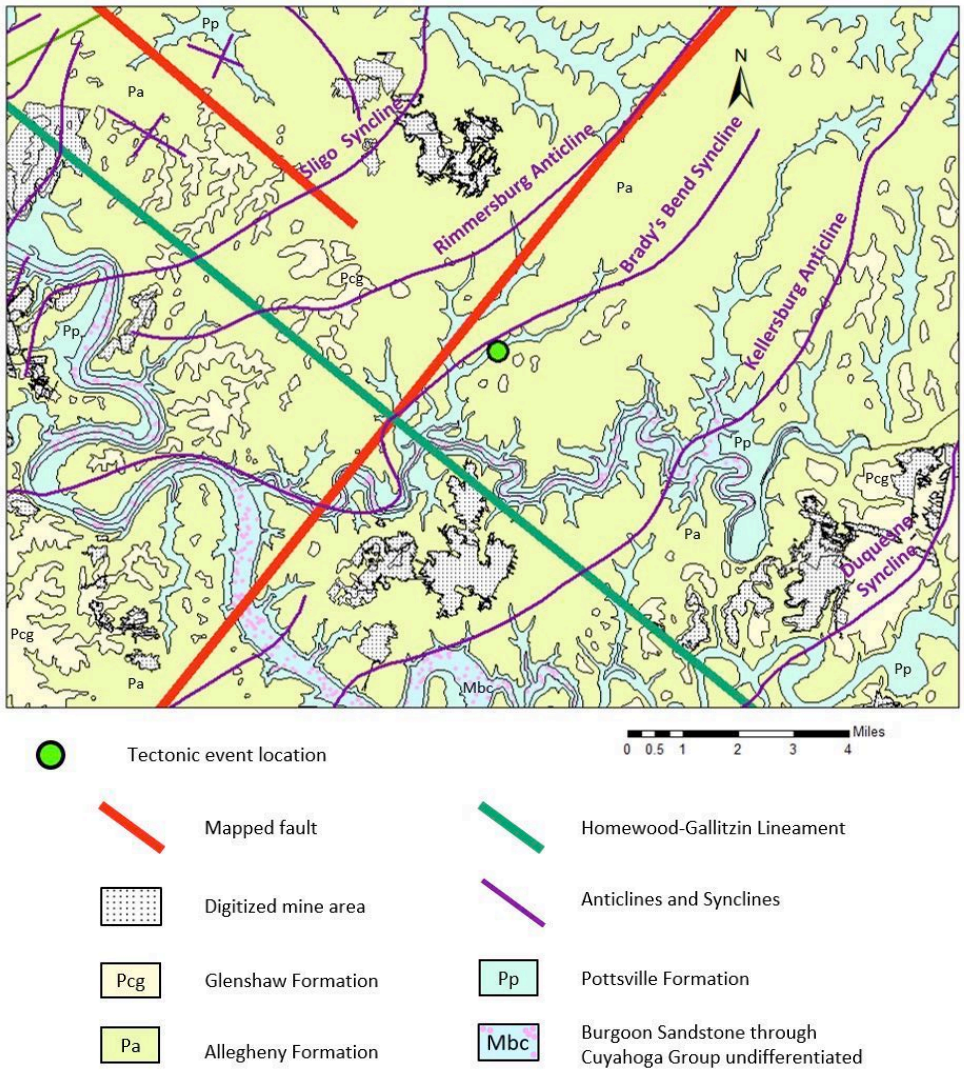

Figure 5. A zoomed-in view of the June 28, 2022, earthquake epicenter on a geologic map showing the regional bedrock, mapped anticlines and synclines (from Faill, 2011), mapped faults from the Midwest Regional Carbon Sequestration Partnership (MRCSP) project (Dooley and others, 2005), and mapped basement lineaments (from Gold and others, 2005). Note the lack of active mining at this location. Also note the epicenter's proximity to the Brady's Bend syncline, the mapped fault, and the Homewood-Gallitzin lineament.

Southworth (1986), lineaments in the central Appalachians have an average width of 6.2 miles, so this location is well within the range of the Homewood-Gallitzin lineament. This location is also close to the hinge line of the Rome trough, a deep basement feature, where the trough steepens as indicated in Figure 6. Incidentally, pinch-out of overlying Oriskany sand also occurs in this area.

CONCLUSION

Lack of evidence of man-made activity, along with proximity to known structural geologic features, points to this being a deep, tectonic earthquake in an area without any known earthquake activity. Again, this was a very mild earthquake. We do not know if any residents in the area noticed it. Indeed, the earthquake did not have any noticeable effects in the mined-out section of a cave (in which there are loose piles of mined rocks and rotten wood pillars) seven miles from the epicenter of this earthquake.

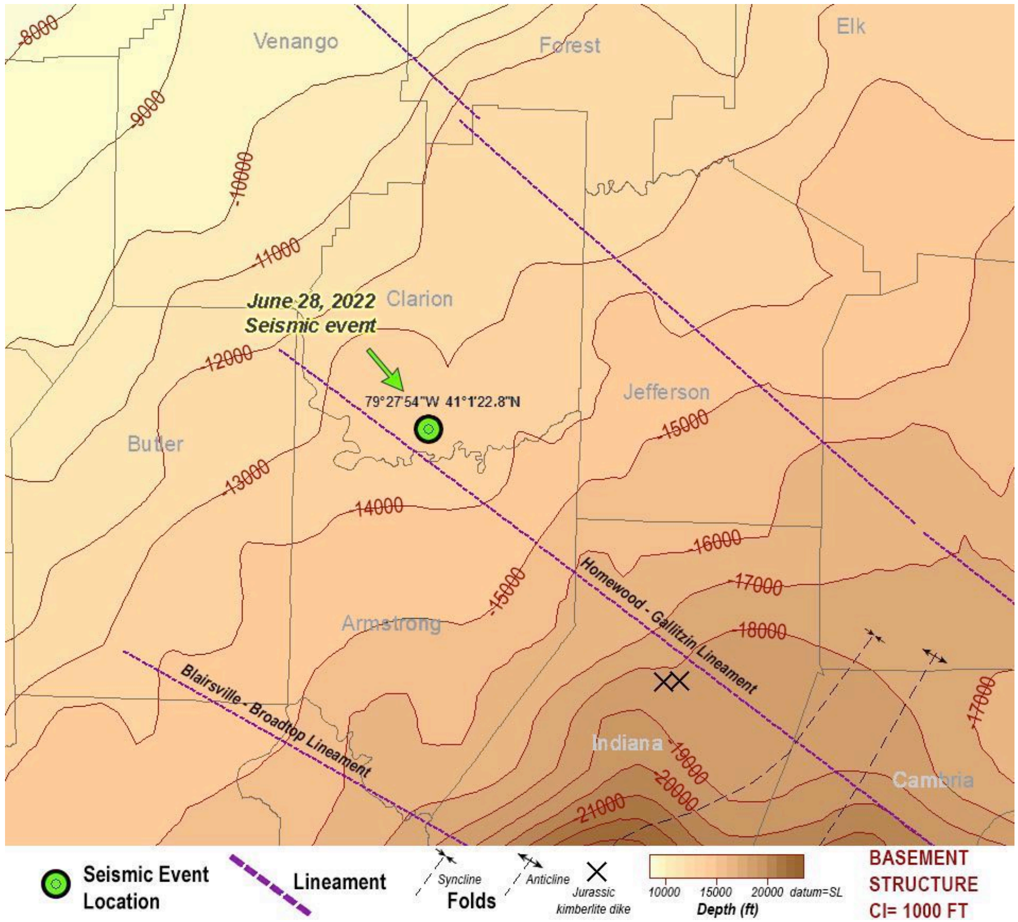

Figure 6. Basement contour map (from Homman and others, 2022) showing the location of the June 28, 2022, tectonic event, lineaments, folds, and kimberlites. In this area, the Rome trough is expressed as a gentle ramp to the northwest, as shown by the wide contours. The trough becomes a steep grabenlike feature to the southeast where the contours are more closely spaced. Any movement, no matter how subtle, tends to concentrate stress along the hinge line where the structure changes from a gentle ramp to a steep graben, so this is where subsurface displacements are most likely to occur. Two of the lineaments terminate just west of the event, while a major lineament to the north of the Homewood-Gallitzin lineament shows an offset along this hinge line. Jurassic kimberlites (black Xs) also make their appearance along the Homewood-Gallitzin lineament. The east-west orientation of the river marking the southern boundary of Clarion County could indicate a zone of weakness in the bedrock. Both the deep basement structure and the current river alignment support the idea of recurrent movement and fracturing along these lineaments. Lineaments, folds, and kimberlites are from Gold and others, 2005.

Although this was an intraplate event, not all intraplate earthquakes are the same. Certain factors make more sense in certain areas than in others. For example, earthquakes occurring in the northernmost part of northwestern Pennsylvania likely have a strong glacial isostatic adjustment component, while the 2011 Mineral, Va., earthquake, along with earthquakes in southeastern Pennsylvania's Piedmont province, occur closer to the plate boundary, which some geologists hypothesize is not as passive a margin as previously thought. The recent event in Clarion County, which falls between these regions of previous glaciation and plate margin, does occur close to a lineament, however, which Karato (2010) suggests is the crustal expression of a toroidal component in the mantle.

This may be a useful event for stress modeling. It could provide a new data point in an area with few data points. This data point may also be useful for refining hypotheses about mantle waves or sublithospheric mantle convection. However, the low magnitude and deep depth of this event will make getting this information problematic. Could proximity to the Homewood-Gallitzin lineament be the significant contributing factor to this seismic event?

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Reflections on Regional and International Science Fairs

Antonette Markowski
Pennsylvania Geological Survey

INTRODUCTION

Encouraged by the Covid-19 vaccines that brought us closer to normalcy this year, the following science fairs offered virtual and in-person options, although student attendance remained down from pre-pandemic levels. Motivated and guided by inspiring teachers, parents, and mentors, these developing scientists are truly an investment in our future. The arsenal of skills that students applied at these events from experiential learning are more relevant today than ever as they adopt habits of critical thinking and understanding accuracy, limitations, and uncertainty in solving society's evolving challenges. The investment will become apparent when these skills are transferred to and leveraged in a more collaborative, interdisciplinary workforce shaped by demand, technological innovations, and economic growth.

VIRTUAL PENNSYLVANIA JUNIOR ACADEMY OF SCIENCE REGION 4 COMPETITION

Over the past 88 years, the Pennsylvania Junior Academy of Science (PJAS) has stimulated and promoted interest in science among junior and senior high school students through the development of research projects and investigations. It is one of six regional fairs in the state and is supported by the Pennsylvania Academy of Science (https://pennsci.org). Dauphin County Technical School originally planned for a live PJAS Region 4 Competition at Lancaster Country Day School on February 26, but instead decided to go virtual from February 26 through March 6. Students prepared PowerPoint® presentations on experiments of their choice within ten-minute (maximum allowed time) sessions.

Staff geologist Antonette Markowski nominated two out of three environmental science projects for 1st Awards, which both won. The first (9th grade) student demonstrated that airborne microplastic particles increased proportionate to the rise in economic activity post Covid-19 lockdown. The second (11th grade) student proved that there is a clear correlation between using natural material as barriers and a reduction in the amount of erosion with different soil types. Another 11th grade student earned a 2nd Award for a presentation on the continuing invasion of the spotted lanternfly in the northeast. Fifty-four other volunteers served as judges for the PJAS Region 4 Competition.

According to PJAS Director Emilie Tekely (email communication, 2022), a total of 81 students participated from 15 schools in Region 4 (Figure 1). Attendance recovered slightly compared to early February 2020. The award total of $875 was distributed to the students in amounts of $100, $50, and $25, depending on project eligibility. Thirty-one 1st Award winners were able to participate in the PJAS State Meeting, which, after a two-year hiatus, was held at the The Pennsylvania State University from May 15 through May 17.

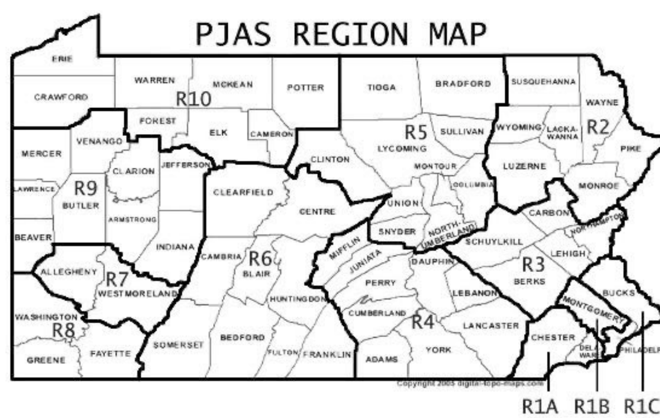


Figure 1. Map showing the location of Region 4 (R4), from https://www.pjas.net/find-your-region. Used with permission from the Pennsylvania Junior Academy of Science.

Anyone interested in volunteering at the 2023 PJAS Regional Competition should contact PJAS Director Emilie Tekely at pjasr4director@gmail.com. For further information, please see the Pennsylvania Junior Academy of Science web page (https://www.pjas.net).

HYBRID CAPITAL AREA SCIENCE AND ENGINEERING FAIR

Staff geologists Victoria Neboga and Antonette Markowski, respectively, performed live category judging at the Colonial Park Mall and virtual category judging with 120 other volunteers at the 65th Capital Area Science and Engineering Fair (CASEF) (Figure 2), held March 15 through March 17. The fair hosted 103 participating students from 23 schools in 37 counties to exhibit their critical thinking and communication skills, according to CASEF Director Valerie Knowles (email communication, 2022). The number of participating students continued to decline compared to before the pandemic.

Figure 2. Capital Area Science and Engineering Fair 2022 logo.

Neboga judged six junior chemistry projects, where students showcased their creativity and knowledge in areas such as the usage of Coca-Cola as a cleaning product, what makes bread rise the most, which drink will refresh your body with electrolytes, what brand of battery lasts the longest, and the conductivity of water as an indicator of pollutants.

Markowski recommended 1st Award to five of eight junior chemistry projects based on descriptive files and videos. They included the following cause-and-effect topics: heat on lip balm "smearability," baking sheet types and burn rate of cookies, optimal pH for juice-ball formation, burn times for various wood types, and the most smudge-proof mascara. Four 1st Award projects and one 2nd Award project were nominated for the Dr. George Hayward Love Sr. Judges' Award. Special award nominations for the Ricoh Americas Corporation Award and Wegmans Award, respectively, went to "Graffiti: What is the Best Way to Remove It?" and "The Effect of Different Baking Sheets on the Rate of Burning Cookies." Excellent video presentation, clever camera angles, and strong use of metrics led to grand champion endorsement for "The Juice Ball Spherification Experiment" (for an example of this type of experiment, see https://www.chefsteps.com/activities/direct-spherification) (accessed September 5, 2022).

Ten CASEF junior division students won the Broadcom MASTERS (Math, Applied Science, Technology, and Engineering for Rising Stars) Middle School Competition Award. National semifinalists for the virtual 2022 Broadcom MASTERS Competition, affiliated with Society for Science and the Public (SSP), will be announced on September 21. These select middle school delegates can attend Broadcom MASTERS International to observe and interact with next year's Regeneron International Science and Engineering Fair (Regeneron ISEF) students (see next page). SSP features the top 10 percent of United States middle school students and has been dedicated to the achievement of young scientists in independent research and to public engagement in science since 1921. SSP informs, educates, and inspires through world-class competitions such as Broadcom MASTERS, Regeneron Science Talent Search, Regeneron ISEF, and its award-winning magazines, *Science News* and *ScienceNewsExplores*.

Overall, 32 students won 1st Awards (highlighted in the 2022 CASEF Awards Program Booklet) and 88 were special awardees (including multiple special award recipients), according to Valerie Knowles (email communication, 2022). The names of grand champion finalists and grand champions (11 total), division special awardees, and category awardees can be seen here. Local and regional scientific, professional, industrial, educational, and governmental organizations sponsored $64,000 in special awards and scholarships. Thirty-four 11th and 12th grade CASEF students received merit-based prizes and scholarships from Harrisburg University amounting to between $11,000 and $16,000 per academic year for four years (Valerie Knowles, email communication, 2022).

New judges, special awards, and sponsorships are always welcome, especially a sponsor for the judging portion of the fair. Please consider joining Bureau of Geological Survey staff at next year's category and/or grand champion judging in March 2023 by contacting CASEF Director Valerie Knowles at director@casef.org or 717–580–3812. For further information and confirmation of the CASEF event, see https://www.casef.org/.

HYBRID REGENERON INTERNATIONAL SCIENCE AND ENGINEERING FAIR

The Regeneron ISEF has grown to be the world's largest precollegiate science, technology, engineering, and mathematics (STEM) competition since 1950, welcoming 1,750 finalists from 63 countries this year in a hybrid format (although student attendance declined about 10 percent from average pre-pandemic levels). A majority of Regeneron ISEF high school scientists finally competed in person in Atlanta, Ga., (Figure 3) from May 8 through May 13 after a two-year interruption. More than half of the finalists presented projects at the Georgia World Congress Center, and the remaining finalists participated by virtual format. Regeneron ISEF top winners received awards and scholarships worth up to $8 million.

Two grand champion CASEF students advanced to the Regeneron ISEF. CASEF representatives were Ian Lentz (Camp Hill High School) for "Native Predators of the Spotted Lanternfly," and Sadie Zehner (Berwick Area High School) for "Vertical Aeroponics vs. Horizontal Raft Aquaponics." Earth and Environmental Science Projects ranged from the carbon and climate change mitigation topics of "Enhanced CO_2 Capture via Carbon Mineralization" and "Big Data Analysis of Climate Change" to "Qube Network for Early Earthquake Warning" and "Predicting Future Tropical Cyclone Intensity."

Figure 3. Regeneron International Science and Engineering Fair 2022 logo.

Regeneron ISEF outreach and equity efforts through STEM action grants include Leveling the Playing Field for Girls in STEM. STEM action grants provide up to $5,000 to innovative nonprofit organizations led by social entrepreneurs to help build the workforce of the future by empowering underserved communities.

The following panel discussions were offered live and are being made available online on YouTube by clicking on these links:

Regeneron ISEF 2022—Excellence in Science and Technology Panel
Regeneron ISEF 2022—Innovation, Entrepreneurship, and Impact Panel, presented by Rise
Regeneron ISEF 2022—Women in STEM Panel, presented by Johnson & Johnson.

For those who are interested in judging or volunteering in other capacities at Regeneron ISEF 2023 in Dallas, Tex., please sign up at https://www.societyforscience.org/isef/. For additional information, see Mission and History—Society for Science and associated tabs.

BUREAU NEWS

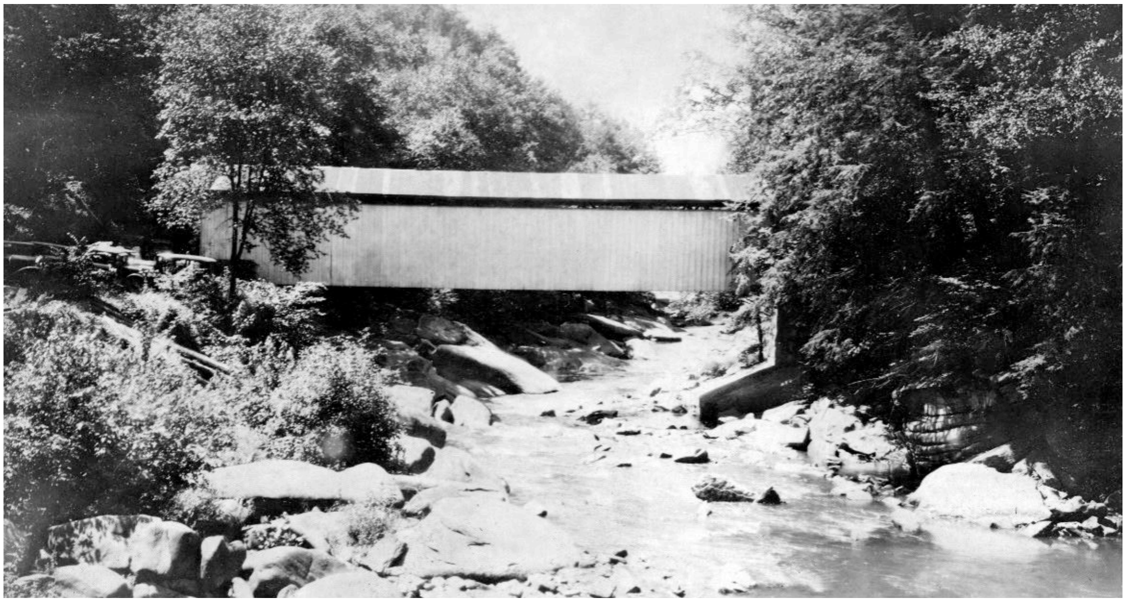
From the Stacks . . .

Jody Smale, Librarian
Pennsylvania Geological Survey

After a brief hiatus, the bureau library is once again adding new resources to the collection. Recently added titles can be found below; they include publications from the Geological Society of America, the American Geosciences Institute, and the Society for Sedimentary Geology. Several new hydrogeology texts have also been added, as well as a new book about the mines and mineral resources of Bucks County. Is there a publication pertaining to geology that you are looking for that the library does not own? Suggestions for new purchases can be sent to ra-pagslibrary@pa.gov.

- ***The Appalachian geology of John M. Dennison—Rocks, people, and a few good restaurants along the way*** / edited by Katharine Lee Avary, Kenneth O. Hasson, and Richard J. Diecchio, Geological Society of America Special Paper 545, 2020.
- ***Applied hydrogeology*** (5th ed.) / C. W. Fetter and David Kreamer, Waveland Press, 2022.
- ***Carboniferous giants and mass extinction—The late Paleozoic ice age world*** / George R. McGhee, Jr., Columbia University Press, 2018.
- ***Directory of geoscience departments*** (57th ed.) / edited by Christopher M. Keane, American Geosciences Institute, 2022.
- ***Geology field trips in and around the U.S. capital*** / edited by Christopher S. Swezey and Mark W. Carter, Geological Society of America Field Guide 57, 2020.
- ***Geoscience for the public good and global development—Toward a sustainable future*** / edited by Gregory R. Wessel and Jeffrey K. Greenberg, Geological Society of America Special Paper 520, 2016.
- ***The mines and minerals of Bucks County, Pennsylvania*** / by Ronald A. Sloto, [Ronald A. Sloto], 2022.
- ***New advances in Devonian carbonates—Outcrop analogs, reservoirs, and chronostratigraphy*** / edited by Ted E. Playton, Charles Kerans, and John A. W. Weissenberger, Society for Sedimentary Geology Special Publication 107, 2016.
- ***Practical hydrogeology—Principles and field applications*** (3rd ed.) / Willis D. Weight, McGraw-Hill, 2019.
- ***Quaternary glaciation of the Great Lakes region—Process, landforms, sediments, and chronology*** / edited by Alan E. Kehew and B. Brandon Curry, Geological Society of America Special Paper 530, 2018.
- ***Remote Sensing—Principles, interpretation, and applications*** (4th ed.) / Floyd F. Sabins, Jr. and James M. Ellis, Waveland Press, Inc., 2020.

A Look Back in Time



The McConnells Mill Covered Bridge (shown here) spans the Slippery Rock Creek in McConnells Mill State Park. It was built in 1874 and is one of the largest Howe Truss bridges (named for William Howe) in Pennsylvania. Such bridges have load-bearing structures composed of a series of wooden or metal triangles, known as trusses (https://www.britannica.com/technology/truss-bridge). In recognition of the bridge's historical significance, it was placed on the National Register of Historic Places in 1980.

This site will be visited during the 2022 Field Conference of Pennsylvania Geologists in October. Recently, two sandstone samples were taken from here for cosmogenic age dating in an attempt to date the age of the Slippery Rock Gorge. These findings will be discussed at the Field Conference.

The photograph was taken by bureau geologist Ralph W. Stone on July 23, 1932. To see more photographs from the bureau's archives, please visit the library's Historical Photographs collection page.

—Jody Smale, Librarian

RECENT PUBLICATIONS

Open-File Reports (May 2022)

- Water Depth of Pymatuning Reservoir—Pymatuning State Park, Crawford County, Pennsylvania and Ashtabula County, Ohio (ZIP)
- Water Depth of East Branch Lake—Elk State Park, Elk County, Pennsylvania (ZIP), now showing updated depth contours for normal pool levels and including the contour data

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 1 to 2 pages 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.

Submittal: Authors may send their article and illustrations as email attachments to RA-pageology@state.pa.us if the file sizes are less than 6 MB. For larger sizes, please submit the files on CD–ROM to the address given below. All submittals should include the author's name, mailing address, telephone number, email address, and the date of submittal.

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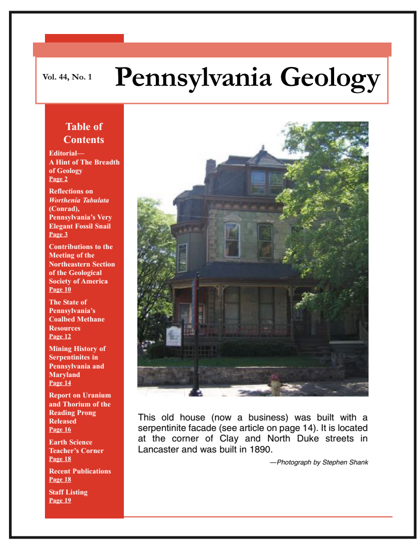
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This old house (now a business) was built with a serpentinite facade (see article on page 14). It is located at the corner of Clay and North Duke streets in Lancaster and was built in 1890.

—*Photograph by Stephen Shank*

Department of Conservation and Natural Resources
Bureau of Geological Survey

Main Headquarters
3240 Schoolhouse Road
Middletown, PA 17057–3534
Phone: 717–702–2017

Pittsburgh Office
400 Waterfront Drive
Pittsburgh, PA 15222–4745
Phone: 412–442–4235

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Contributed articles are welcome.

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