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Pennsylvania Geology

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Section of a fulgurite core from Rebersburg, Pa., measuring 15.5 cm long and 8 cm wide. An iron-silicide nodule (silver-gray sphere) is visible on the left side. (See article on page 3.)

EDITORIAL

A Contradiction

Gale C. Blackmer, State Geologist
Pennsylvania Geological Survey

I've been thinking a lot lately about the mixed messages coming to the geologic community. On one hand, it's a great time for the geological sciences. There is an increased awareness of geologic hazards, which is not good for the affected communities but means that geology and geologists get more media time. Geologists have significant contributions to make to advancing climate change mitigation and adaptation efforts. Through the Bipartisan Infrastructure Law, the federal government is making historic investments in geologic research related to carbon storage and critical minerals. Then there are the constant needs for clean water, geotechnical information, and energy and mineral resources. The Bureau of Geological Survey has more federal grants than ever and is fairly drowning in work.

At the same time, there is a looming crisis in geoscience education and workforce development. Our bureau, like many geological surveys around the nation, is in the midst of a retirement wave. We are fortunate that we can fill the vacancies and that we have had top-notch candidates, although the candidate pools have been quite small. Other states are having real difficulty in finding qualified candidates for some of their positions. At a moment when academic institutions should be turning out more geoscience graduates, they are instead watering down or eliminating geology programs. Many graduates have not been offered the two courses specifically named as requirements for professional licensure—structural geology and field methods. That's bad for their career prospects and bad for all of us who rely on the expertise of professional geologists for safe infrastructure and a constant supply of natural resources.

It's hard to determine the root of the crisis. Geology departments in most liberal arts colleges are small, making them easy targets for cost cutting. I have heard anecdotally that students don't want to study geology because they regard it as the province of climate-change-inducing energy companies. Whatever the cause, I think it is safe to say that we as a geologic community could do better at educating and informing the public about the importance of geology to society and the part geologists and geological sciences play in mitigating the effects of climate change. That's something each one of us can do to help the cause.

Gale C. Blackmer

A Unique Fulgurite from Rebersburg, Pennsylvania

Ronald A. Sloto[1]
Loretta D. Dickson[2]
R. Stephen Carter[3]

INTRODUCTION

Many different natural processes that melt rocks can also produce naturally formed glasses. Volcanism produces a glassy rock called obsidian from the rapid cooling of molten rock, and high-strain-rate faulting causes intense friction that produces another type of very fine grained to glassy rock called pseudotachylite (Spray, 1995). Meteorite impacts generate glasses generally known as tektites, with variants such as moldavites and Libyan desert glass (Barrat and others, 1997; Delano and Lindsley, 1982; Engelhardt and others, 1987).

Fulgurites are natural glasses formed when lightning strikes the ground and causes an enormous and instantaneous increase in temperature (Daly and others, 1993; Pye, 1982). Temperatures of fulgurite formation are estimated to exceed 3,000 kelvins (approximately 2,700ºC or 4,900ºF), which is high enough to reach the boiling point for most silicate earth materials, within tens of milliseconds (Chen and others, 2017; Essene and Fisher, 1986; Pasek and others, 2012).

When lightning strikes the surface of the Earth, its target undergoes rapid physical, chemical, mineralogical, and morphological changes. Electrical current flows through the path of least resistance—materials that are highly conductive and highly saturated with water. With rapid heating, the resultant boiling produces voids and vesicles following the path of the lightning into the target, allowing the escape of volatiles (Pasek and others, 2012; Pye, 1982). This rapid heating and release of volatiles produces a cylindrically shaped glassy core, usually hollow, that is surrounded by a rough outer surface composed of both melted and unmelted grains. Such unmelted grains coat the outside of the structure in many collected fulgurites that were formed in a sandy environment. Branching fulgurites are formed when the electrical current divides along its path. Most side branches lose their energy rapidly, forming offshoots smaller in diameter than the main body (Block, 2011).

Block (2011) and Pasek and others (2012) classified fulgurites into four categories. Type I fulgurites are quartz-sand fulgurites with thin glass walls; Type II fulgurites are clay fulgurites consisting of thick melt-rich walls; Type III fulgurites are caliche (a natural cement of calcium carbonate binding sedimentary materials) fulgurites consisting of thick glass-poor walls; and Type IV fulgurites are rocks partially melted to glass from lighting strikes on mountaintops. The Rebersburg fulgurite, which has a solid glass core formed in a soil and rock-fragment target, does not readily fit into any of these categories. It is the largest known fulgurite discovered in Pennsylvania.

DISCOVERY OF THE REBERSBURG FULGURITE

The Rebersburg fulgurite was discovered in November of 2015 near Rebersburg, Centre County, Pa., (Figure 1) by a member of the Amish community, who we will refer to as Mr. Weaver to protect his privacy. According to Mr. Weaver, he was hunting on private property where there was about an inch of

[1]Department of Earth and Space Sciences, West Chester University, West Chester, Pa.
[2]Department of Environmental, Geographical, and Geological Sciences, Lock Haven University, Lock Haven, Pa.
[3]Penn Minerals, Scranton, Pa.

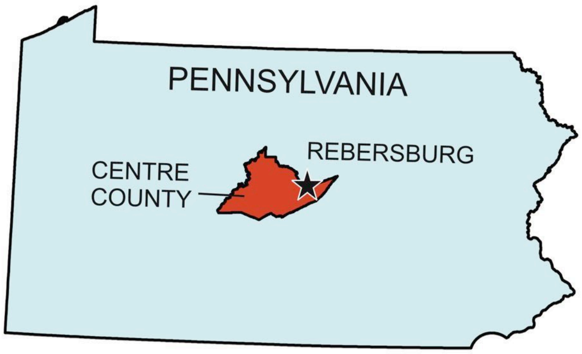

Figure 1. Location of Rebersburg, Centre County, Pa.

fresh sleet and snow covering the ground. As he walked along an unpaved road through the woods, he came upon what he described as the site of a "large hot fire that had exploded." He stated, "There were dozens of pieces of something black scattered on the snow. I remembered thinking 'this is pretty, whatever it is.' I stood there for 10 minutes or more. I recall it so vividly. I was confused because I knew something unusual happened, but I had no idea what it was." He then left the area to continue hunting.

A year later, in the fall of 2016, Mr. Weaver took his daughter and son on a hike to the same area. He came upon the site and found shards of black glass scattered among the fallen leaves. He gathered a few pieces and noticed a large chunk of what appeared to be black glass protruding from the ground.

With the help of a friend, Mr. Weaver met with Dr. Loretta Dickson at Lock Haven University and provided a specimen of the black glass for her to identify. After hearing the story behind the unusual piece, she performed an analysis and concluded that the material was an unusual fulgurite having a composition consistent with soil and rock.

DESCRIPTION AND INTERPRETATION OF THE REBERSBURG FULGURITE

In late November of 2017, Mr. Weaver and his friend took Dr. Dickson and her Lock Haven University colleague Dr. Joseph Calabrese to the location of the black glass. There, they exposed, documented, and excavated most of the fulgurite. During the past several years, the entire fulgurite has been excavated.

The fulgurite consisted of a 5-meter- (16.4-foot-) long central axis that extended in an east-west direction along the center of the unpaved road (Figure 2). The top of the fulgurite was several centimeters below the road surface. At least four bifurcating branches extended 2 m perpendicular to the central axis. Three branches extended to the south, and one branch extended to the north. The central axis and four bifurcating branches that extended perpendicular to the central axis probably correspond to the path of the lightning as it dispersed into the ground.

The interior of the central axis consisted of a solid black- and brown-colored glass core that measured up to 20 cm across with large (3 to 4 cm) vesicles distributed along the length of the fulgurite core. In many places, the central glass core was absent of vesicles and occurred as a solid flattened cylinder of black glass exhibiting a

Figure 2. Field location of the Rebersburg fulgurite on an unpaved road near Rebersburg, Pa. The fulgurite extended along the center of the road just beneath the ground surface.

Figure 3. Solid glass sample from the central axis of the Rebersburg fulgurite measuring 17 by 6 cm in cross section.

subconchoidal to conchoidal fracture (Figure 3). The largest recovered section was solid black glass 10 by 20 cm in cross section and 56 cm in length; it weighed more than 20 kg (Figure 4).

Figure 4. The largest section of the Rebersburg fulgurite that was recovered. It is 56 cm long, 10 by 20 cm in cross section, and weighs more than 20 kg.

The interior core of the central axis was rimmed by a 2-cm zone of pumiceous material with a high concentration of small vesicles that ranged in size from 0.2 to 2 mm (Figure 5). The pumiceous zone thinned to 2 mm at the top of the fulgurite. The pumiceous zone was coated with a thin (1 to 3 mm) rim of partly fused rock fragments, giving the fulgurite a rough outer surface (Figure 6). The rock fragments consisted mostly of siltstone and shale.

Figure 5. Section of the Rebersburg fulgurite measuring 15 by 10 cm in cross section and having 3- to 4-cm vesicles. This specimen also has an outer 2-cm zone having smaller vesicles.

The bifurcating branches decreased in diameter with distance from the central axis. A nearly round 14.5-cm-long section measuring 4 by 5 cm formed a solid rod of black glass with a partly fused rock fragment included in the glass

Figure 6. Fulgurite section with rough outer surface of partly fused rock particles. Sample measures 30 cm long and 10 cm wide.

visible on the broken end. Vesicles on top of it were distorted and appeared to wrap around the branch. The lower part of the branch retained a 1-cm pumiceous zone and a thin outer coating of rock fragments. Another sample showed a bifurcation into two branches that separated to project approximately 35° from one another (Figure 7). This sample contained large internal vesicles that gave the branch a hollow appearance.

The broken ends of two fulgurite branches contained multiple distorted vesicles that occurred in a stacked configuration (Figure 8). The vesicles ranged from 1 to 3 cm along the longest axis. The vesicles were flattened in the horizontal direction, curved, and concave downward (Figure 8). Some of the pumiceous material had a specific gravity less than one and floated in water. The distorted shape of the stacked vesicles may be explained by the motion of gas bubbles rising while the material was in a molten but highly viscous state. The uppermost bubble became distorted as a bubble from below moved upward and impinged on its space. The repeated upward movement of multiple bubbles distorted each overlying bubble, producing the stacked, concave-downward bubble configuration.

The central axis varied along its length from flattened cylinders with multiple vesicles that gave a hollow appearance to solid, flattened cylinders of glass that lacked vesicles. The solid glass cores may be explained by gas bubbles coalescing and escaping before the molten cylinder solidified. This process likely occurred only in some places along the central axis and not along the entire length of the fulgurite, due to slight variations in the viscosity of the molten material based on the composition of soil and rock fragments. Because the gravel-sized shale fragments contain less silica than the soil, a higher shale-to-soil ratio would result in a less viscous melt. Gas bubbles in a lower viscosity melt would have a greater propensity to coalesce and rise through the melt, leaving behind bubble-free material.

Figure 7. Sample of a branch that extended away from the central axis of the Rebersburg fulgurite showing bifurcation into two branching segments.

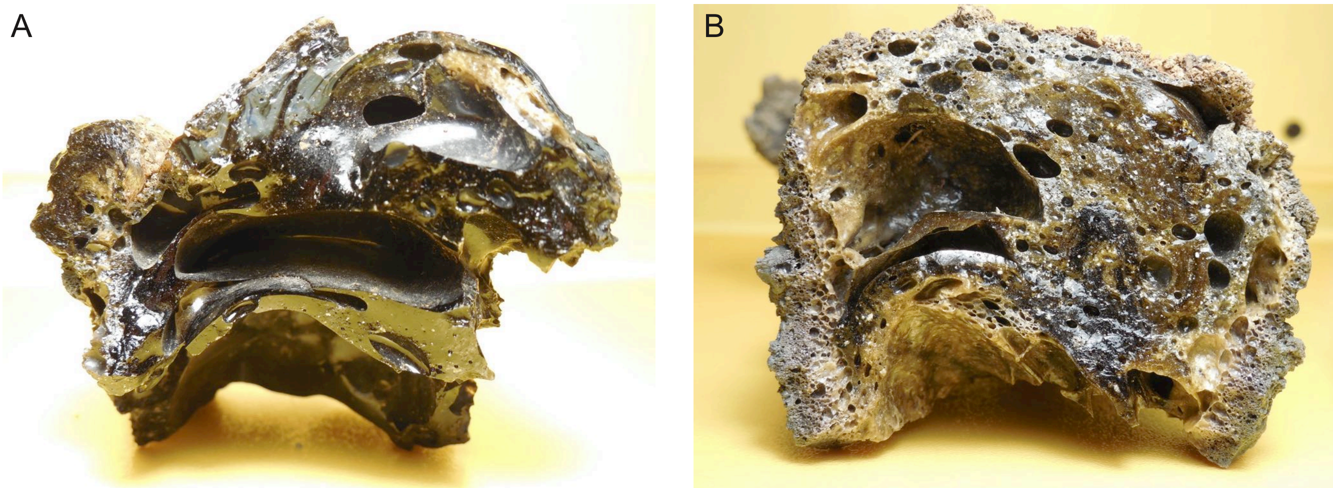

Figure 8. Samples of branches that extended away from the central axis of the Rebersburg fulgurite. Samples are oriented as they were excavated; the up direction is toward the top of the image. A. Partial fulgurite section with internal stacked, distorted, and concave vesicles. Sample measures 4 cm across. B. Partial fulgurite section having a 6-mm-thick zone of pumiceous material and a thin outer coating of partly fused rock particles; the bottom rim is missing. Sample measures 5.5 cm across and also shows internal stacked, distorted, and concave vesicles.

GEOCHEMICAL ANALYSIS

Geochemical analysis results for major and minor element concentrations in the fulgurite glass are presented in Table 1. Geochemical analysis results for major and minor element concentrations in the soil and rock fragments are presented in Table 2. Data are reported in weight percent for each element.

Table 1. Major and Minor Element Concentrations in Fulgurite Glass Samples
(Values are in weight percent)

	Fulgurite glass sample									
Element	FG–1	FG–2	FG–3	FG–4	FG–5	FG–6	FG–7	FG–8	FG–9	FG–10
O	64.27	76.54	64.33	62.45	61.81	62.78	62.72	65.57	65.00	68.74
Si	22.8	13.37	21.7	22.61	22.1	21.42	21.38	20.79	22.76	19.27
Ti	.25	.04	.3	.35	.3	.26	.24	.21	.23	.17
Al	7.49	5.38	7.2	8.04	9.36	9.68	10.32	8.19	7.08	6.99
Fe	1.38	.17	2.47	2.54	2.33	1.91	1.63	1.50	1.55	1.11
Mn					.05					
Mg	1.48	1.26	1.49	1.53	1.59	1.61	1.54	1.46	1.34	1.47
Ca			.13					.09		
Na	.9	2.54	.76	.78	.68	.72	.72	.88	.87	1.02
K	1.43	.5	1.62	1.72	1.66	1.49	1.32	1.13	1.18	.96
P					.12	.14	.13	.17		.27

Table 2. Major and Minor Element Concentrations in Soil and Rock Samples
(Values are in weight percent)

	Soil samples			Rock samples						
Element	SOIL 1	SOIL 2	SOIL 3	RK–1	RK–2	RK–3	RK–4	RK–5	RK–6	RK–7
O	62.22	59.39	61.18	54.68	49.48	48.35	54.61	55.11	60.57	59.83
Si	25.30	26.65	24.91	25.14	21.22	20.45	25.45	25.31	25.27	23.62
Ti	.38	.44	.43	.47	.51	.52	.49	.51	.45	.41
Al	5.73	6.00	6.25	7.95	8.13	7.69	9.02	8.81	6.52	7.97
Fe	2.89	3.74	3.47	6.74	15.34	17.54	4.76	4.77	3.51	3.92
Mn	.09	.10	.10	.18	.49	.64	.09			
Mg	1.01	.99	1.06	1.34	1.24	1.23	1.53	1.50	1.09	1.39
Ca	.42	.40	.42	.39	.29	.35	.33	.30	.31	.23
Na	.41	.43	.46	.42	.38	.40	.61	.58	.44	.49
K	1.56	1.87	1.71	2.21	2.32	2.16	2.84	2.84	1.84	2.14
P				.48	.60	.67	.27	.28		

Major and minor element concentrations are as expected for typical soil and for siltstone and shale of sedimentary origin. Si content is high in fulgurite glass and most closely matches the high Si content in soil sampled from the unpaved road. The Al concentration is slightly elevated in some fulgurite glass samples compared to the highest Al concentrations in the soil and rock samples. Fe concentrations are much less in the fulgurite glass samples than in the soil and rock samples. Ti is characteristically less than 1 weight percent, as would be expected in soil and sedimentary materials; however, the Ti concentration is somewhat less in the fulgurite glass samples. The major and minor element concentrations in the fulgurite glass are comparable to the major and minor element concentrations in the soil and rock, suggesting that the soil and rock in the road is the material that formed the lightning-induced molten material that cooled and hardened to form the fulgurite glass.

A sample was analyzed that included melted rock (glass) and unaltered rock (Figure 9 and Table 3). A small zone of darkened rock lies between the glass and unaltered rock. Major and minor element concentrations in glass and unaltered rock are similar except for Mn, which is absent in the glass.

OCCURRENCE OF IRON SILICIDES IN THE REBERSBURG FULGURITE

A small number of metallic nodules were embedded in the Rebersburg fulgurite glass (photograph on cover; Figure 10). The nodules were spherical to irregular in shape, bright metallic silver in color, less than 1 mm to 2 cm in size, and most were strongly magnetic. Analysis by an energy-dispersive X-ray spectrometer (EDS) indicated that most of the magnetic nodules were iron silicide minerals (silicide is a binary compound of silicon with another element or group), which are known to occur in both terrestrial and extraterrestrial samples. Iron silicides tend to be more common in extraterrestrial rocks such as meteorites. Their existence in terrestrial rocks is limited by the extremely reducing (oxygen poor) conditions necessary for their formation. The high energy associated with lightning strikes makes it one of a few natural processes that reduce oxides in target materials. During fulgurite-forming

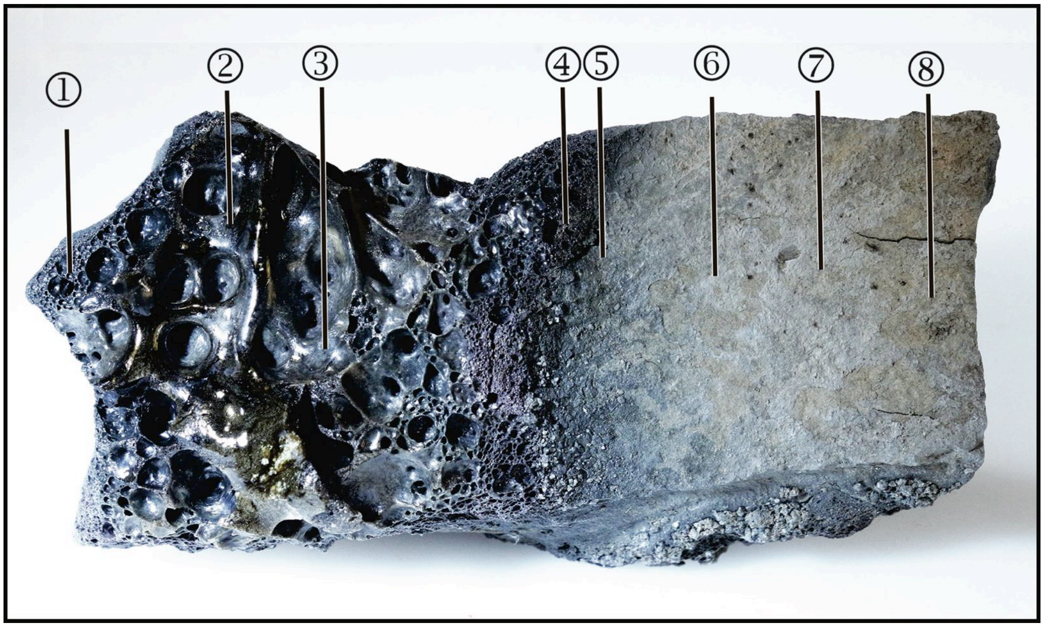

Figure 9. Sample of original bedrock (right) grading into melted rock (left) from the Rebersburg fulgurite location. Analytical results for each of the numbered locations are given in Table 3.

lightning strikes, the extremely high-energy and high-temperature environment generated enables the reduction of oxide minerals to oxygen-poor compounds, such as iron silicides (Essene and Fisher, 1986; Hiltl and others, 2011).

The metallic nodules likely were formed by their immiscibility (the inability of two distinctly different liquids to mix) and segregation from the chemically distinct silicate liquid, similar to a drop of oil coalescing from an oil-water mixture. The nodules formed by immiscibility were preserved when the two liquids were rapidly quenched to glasses (Essene and Fisher, 1986). Pasek and others (2012)

Table 3. Major and Minor Element Concentrations in Fulgurite Glass and Rock
(Values are in weight percent)

	Measurement sites shown on Figure 9							
Element	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6	Site 7	Site 8
O	51.16	54.61	42.45	47.00	43.35	45.11	47.28	48.63
Si	23.03	25.59	20.78	22.45	25.54	22.67	24.54	24.60
Ti	.55	.51	.79	.79	.87	.62	.74	.70
Al	11.34	9.50	15.66	10.92	11.04	10.22	10.65	10.05
Fe	7.98	4.47	12.94	12.55	11.83	10.22	8.48	7.93
Mn					.77	5.84	2.67	2.98
Mg	2.39	1.79	3.38	1.89	1.39	1.25	1.41	1.25
Ca	.16	.19	.28	.29	.44	.49	.59	.52
Na	.89	1.06	.60	.42	.78	.54	.55	.55
K	2.50	2.28	2.97	3.57	3.81	2.75	2.88	2.55
P				.11	.16	.31	.21	.24

Figure 10. Metallic nodule, 7 mm in diameter, embedded in black glass of the Rebersburg fulgurite.

described two fulgurite samples from York County, Pa., that showed the reduction of iron to a metal that contained an assortment of Fe–Ti and Si–P compounds.

In addition to iron silicides present in the Rebersburg fulgurite, preliminary analyses indicate an array of reduced metals, including metallic Si, Si–Al alloys, Fe–Si–Ti alloys, and Al–Si–Mn alloys. The iron silicide mineral gupeiite (Fe_3Si) (Yu, 1984) has been positively identified in the Rebersburg fulgurite (Figure 11). The EDS analyses (Table 4) gave the idealized formula Fe_3Si. Work is continuing to identify the other iron silicides and metallic alloys in the Rebersburg fulgurite.

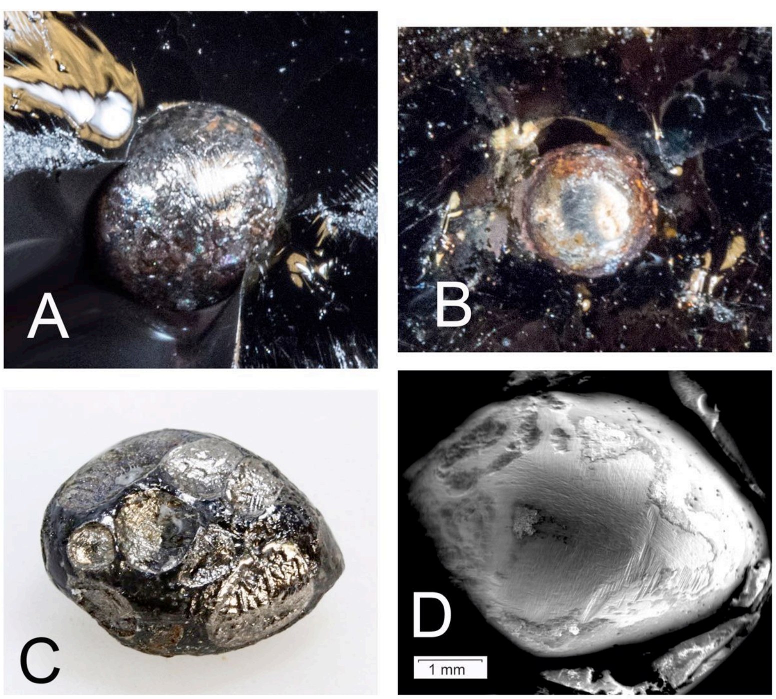

Figure 11. Metallic nodules of gupeiite analyzed from the Rebersburg fulgurite. Analytical results are given in Table 4. A, RFX–05, 2 mm; B, RFX–20, 1.5 mm; C, RFX–32, 1 cm; D, scanning electron microscope image of RFX–46, 5.6 mm.

Table 4. Element Concentrations in Metallic Nodules in the Rebersburg Fulgurite
(Values are in weight percent)

Element	Gupeiite (Yu, 1984)	Nodules in the Rebersburg fulgurite RFX–05	RFX–20	RFX–32	RFX–46
Fe	84.80	81.58	83.00	83.48	83.86
Si	14.10	14.05	12.67	11.32	13.05
O	—	3.58	3.61	2.98	—
Ti	—	.32	—	1.60	.26
Al	—	.47	.63	—	—
Mn	.70	—	—	.14	—
Ni	.80	—	—	—	—
P	—	—	.30	—	—

METHODS AND ACKNOWLEDGMENTS

A special thank you is extended to Mr. Weaver for bringing the Rebersburg fulgurite to the attention of the academic community, to Dr. Joseph Calabrese for his help in field sampling, to Lana Dickinson for editorial assistance, and to John S. White for encouraging collaboration of the authors and for his review of the manuscript.

Geochemical analysis of fulgurite glass, soil, and rock fragments was performed at Lock Haven University using a Tescan scanning electron microscope (SEM) with an Oxford Instruments INCA energy-dispersive X-ray spectrometer (EDS). Geochemical analysis of metallic nodules and rock samples was performed at the West Chester University Center for Microanalysis and Imaging Research and Training (CMIRT) using an FEI Quanta 400 environmental SEM equipped with an Oxford Instruments AZtec EDS. A section of the fulgurite core kindly donated by Mr. Weaver is on display in the Geology Museum located in the Schmucker Science Center at West Chester University (Figure 12).

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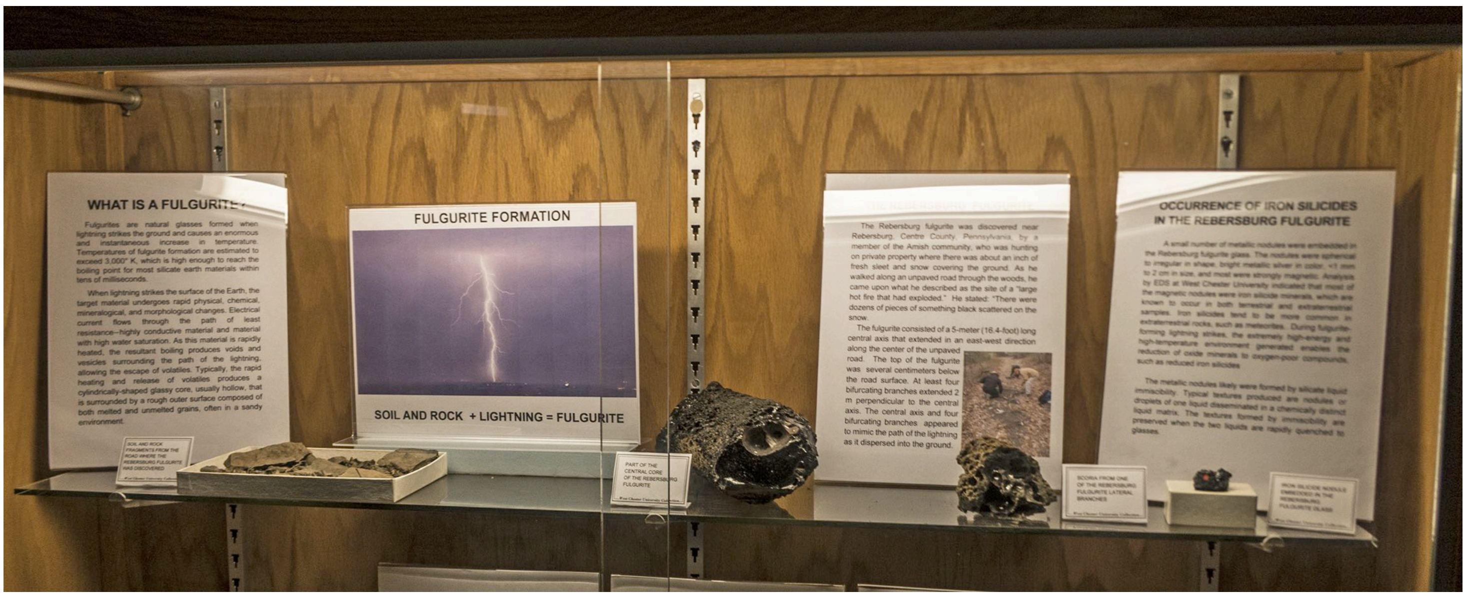


Figure 12. Section of the Rebersburg fulgurite core on display in the Geology Museum in the Schmucker Science Center at West Chester University.

BUREAU NEWS

New Staff Members

The bureau is pleased to welcome and introduce four new employees who have recently joined our staff, two in the Middletown office and two in the Pittsburgh office.

MIDDLETOWN OFFICE

Kyle Rybacki. With more than a decade of experience spanning the academic and federal sectors, Kyle Rybacki joined the Middletown office of the bureau as Geoscience Manager of the Geologic Mapping Division in December 2022. Prior to joining the bureau, Kyle served as the National Cave and Karst Resource Management Program Lead and Idaho Mining Law Administration State Lead for the Bureau of Land Management (BLM). While with the BLM, Kyle tackled a wide range of issues including advising foreign countries on cave protection and mining-law reform, reviewing plans of operations for large-scale mines in Arizona and Idaho, and processing applications for permit to drill in the Permian Basin. Kyle began his professional career in academia as research faculty at the Georgia Institute of Technology in Atlanta, Ga., where he studied the chemical evolution of Earth's oceans and atmosphere across the Archean-Proterozoic transition. Drawing from a broad range of geologic experiences, Kyle plans to deliver timely and relevant mapping products to the stakeholders throughout Pennsylvania.

Kyle Rybacki

Kyle holds B.S. and M.S. degrees in geology and geophysics from the Missouri University of Science and Technology (formerly the University of Missouri–Rolla), and a dual-title Ph.D. in geoscience and astrobiology from The Pennsylvania State University. Outside of work, Kyle prefers to remain on the go pursuing his passions in project caving, diving, mountaineering, skiing, long-distance hiking and paddling, and technical rescue.

Theodore (Ted) Tesler. Ted recently joined the bureau's Groundwater and Environmental Geology Section in Middletown, bringing with him more than 30 years of experience in environmental geology. He graduated with a B.S. degree in geology from Lafayette College in Easton, Pa., and completed his field camp program through Ball State University. Working in private consulting for 18 years, Ted conducted environmental investigation and remediation projects throughout the mid-Atlantic region. These projects included delineating impacted groundwater, fate and transport modeling (fate and transport models estimate the movement and chemical alteration of contaminants as they move through air, soil, or water), and implementing innovative in-place remediation techniques. Ted joined the Department of Environmental Protection's Interstate Waters Office in 2011, working on Pennsylvania's Phase 2 Chesapeake Bay Watershed Implementation Plan and reporting Pennsylvania's Best

Theodore Tesler

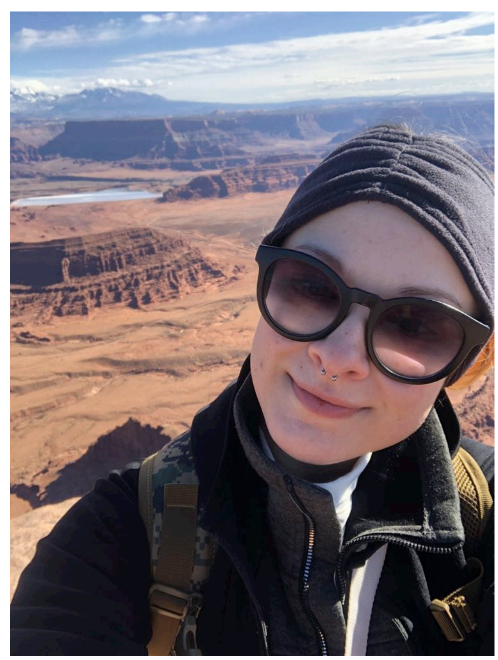
Management Practice data for use in the Chesapeake Bay model. This experience impressed upon him the significant need for improved technology in governmental data management and how complex solutions could be achieved through innovative data surveys and improved collection technologies. Ted also has more than 17 years of service as a geologist board member and former chair of the State Registration Board for Professional Engineers, Professional Geologists, and Professional Land Surveyors and a subject matter expert for the National Association of State Boards of Geology licensing examinations. He looks forward to using his skills in managing large datasets to support PAGWIS (Pennsylvania Groundwater Information System) and in conducting research and outreach in furthering the mission of the Department of Conservation and Natural Resources to conserve and sustain Pennsylvania's vital groundwater resources. Ted lives in Harrisburg and enjoys cycling, jogging, playing piano, mushroom hunting, and exploring new culinary creations through a vegan lifestyle.

PITTSBURGH OFFICE

Callie Merz. Callie began working for the bureau in January 2023 as a Clerical Assistant in the Petroleum and Subsurface Geology Section in the Pittsburgh office. She is a Berks County native and has a colorful history. She earned a Bachelor of Music degree from West Virginia University in 2014 with a focus in Voice Performance. She then moved to New York City to pursue a career in opera and lived throughout Manhattan, Brooklyn, and Queens from 2014 to 2021. She attended Mannes School of Music at The New School for her Master of Music degree in 2016 and was trained in intensive programs at the Curtis Institute in Philadelphia and the University of Houston.

Callie switched career paths in 2016 and began working as a freelance and studio makeup artist with a passion for prosthetics and all things creepy and horror related. In 2021, Callie moved to Pittsburgh and has been working in the makeup industry and performing as the lead singer of the Pittsburgh-based 80's band, Ridgemont High.

Since childhood, Callie has enjoyed hiking and the great outdoors. She attends yearly hiking trips with her father to various national and state parks and trails throughout the United States and Canada.



Callie Merz

Lisa Woodward

Lisa Woodward. Lisa joined the Pennsylvania Geological Survey this past February and currently serves as a Geoscientist in the Petroleum and Subsurface Geology Section in Pittsburgh. Upon graduating from The Pennsylvania State University with a B.S. degree in Geosciences in 2019, she worked for a small geotechnical engineering company in Pittsburgh as a Field Technician. There, she performed compaction testing at the Shell ethylene cracker plant in Monaca, Pa., while it was under construction. Lisa then went on to work for the West Virginia Geological and Economic Survey in Morgantown, W. Va., as a Geologist for 2.5 years in their Oil and Gas Division. There she worked with and processed geophysical well logs, well cores, core cuttings, oil and gas completion reports, location plats, and plugging affidavits. Lisa then decided to return to her home state and take a job with the Pennsylvania Department of Environmental Protection (DEP). At the DEP, Lisa worked in the Safe Drinking Water Program as a Geoscientist specializing in source-water protection. Since joining our bureau, Lisa is most excited to continue building upon her oil and gas knowledge and to become more involved in carbon capture and sequestration initiatives.

From the Stacks . . .

Jody Smale, Librarian
Pennsylvania Geological Survey

Need to improve your writing skills? Want to start studying for the ASBOG® licensing exam? Maybe you need some help moving from Esri's ArcMap to ArcGIS Pro. If so, you might want to check out these and other newly added resources in the bureau's library.

- ***Environmental impacts from the development of unconventional oil and gas reserves*** / edited by John F. Stolz, Daniel J. Bain, and W. Michael Griffin, Cambridge University Press, 2022.
- ***Communicating rocks—Writing, speaking, and thinking about geology*** / Peter Copeland, Pearson, 2012.
- ***Geology study manual—2021 review for the National (ASBOG®) geology licensing exam*** / Patti Sutch and Lisa Dirth, REG Review, Inc., 2021.
- ***Introducing hydrogeology*** / Nicholas Robins, Dunedin Academic Press Ltd., 2020.
- ***Practice quizzes—2020 review for the National (ASBOG®) geology licensing exam*** / Patti Sutch and Lisa Dirth, REG Review, Inc., 2020.
- ***Switching to ArcGIS Pro from ArcMap (2nd ed.)*** / Maribeth H. Price, Esri Press, 2022.
- ***Writing science—How to write papers that get cited and proposals that get funded*** / Joshua Schimel, Oxford University Press, 2012.

A Look Back in Time

Bureau geologist John T. Miller is seen here using a Sketchmaster (an instrument that allows the geologist to see one image superimposed on the other) to create geologic maps of Perry County. Miller has taped four topographic maps together and is transferring detail from the aerial photograph onto the maps. This photograph was taken by the bureau's coal petrologist, Edwin F. Koppe, in 1957 or 1958.

Miller went on to author Atlas 127, *Geology and Mineral Resources of the Loysville Quadrangle* (1961), and later with Richard B. Wells coauthored General Geology Report 30, *The Geology of the Hidden Valley Boy Scout Camp Area, Perry County, Pennsylvania* (1971).

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

—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.

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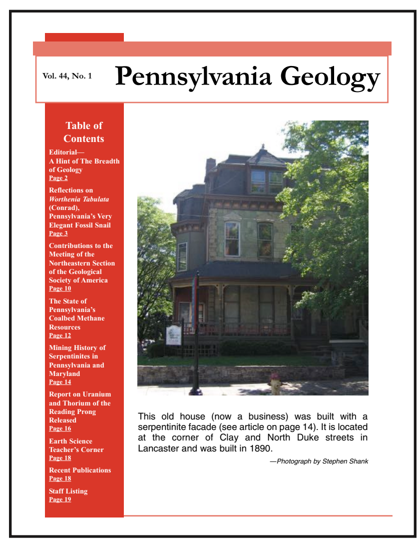
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This old house (now a business) was built with a serpentinite facade (see article on page 14). It is located at the corner of Clay and North Duke streets in Lancaster and was built in 1890.

—*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
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Contributed articles are welcome.

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