THE NORTHERN VIRGINIA MINERAL CLUB INC

The Mineral Newsletter

Next meeting: February 5   Time: 7:30 p.m.

Dunn Loring Fire Station, 2148 Gallows Road, Dunn Loring, VA

Boleite

Amelia Mine, Santa Rosalía, Baja California Sur, Mexico

Source: Wikipedia   *Photo: Rob Lavinsky.*

Volume 64, No. 2
February 2024
Explore our website!

Meeting Program:

Rocks, Minerals, and Artists' Pigments

Details on page XX

In this issue …

Mineral of the Month
Boleite

by Sue Marcus

For our February Mineral of the Month, we will learn about boleite (pronounced BOW-lee-ite). It is an unusual mineral because there are not as many halide mineral species as there are in larger groups like silicates, carbonates, or sulfides. With a chemical formula of $KPb_{26}Ag_9Cu_{24}(OH)_{48}Cl_{62}$, boleite contains three metallic elements—also unusual.

Name and Geologic Environment

Boleite was named for its type locality, El Boleo, a large economic mineral deposit near Santa Rosalía in Baja California Sur, Mexico. The type specimens were reportedly found by Edouard Cumenge, a mining engineer. Cumenge shared them with Ernest Mallard, who described the new mineral in a paper authored by both men. Mallard was a geoscientist with many talents. He was a field geologist and mapper. He studied halide minerals, which probably prompted Cumenge to contact him with the unknown minerals from El Boleo. Mallard was deeply interested in the causes of crystal structure and symmetry (more about the original discovery and description of the new mineral is in the section below on Mexico).

Boleite is a secondary mineral. It forms from the reworking of primary deposits by dissolution in fluids followed by redeposition. Rich copper and/or lead deposits containing some silver have the metallurgical components for boleite formation. Boleite, pseudoboleite, and cumengeite are chemically related minerals that are often found together. Boleite crystals are reportedly inert in water.

Occurrences

Montana. Boleite occurs in the Phillipsburg Mining District in Granite County, between Missoula and Butte. Based on the images posted on Mindat for this locality, the boleite crystals are small, up to 1 millimeter (0.04 in) in size. They are usually an opaque light blue, more green than typical boleite crystals.

Colors range from lighter than robin's egg blue, to shades that appear more green-blue, to baby blue (with a hint of gray). Although individual crystals are tiny, they can coat surfaces up to about 9 centimeters (3.5 in) in size with cubes and penetration twins.

Happy New Year!

Northern Virginia Mineral Club members,

Please join our February speaker, Dr. Barbara Berrie, for dinner at the Olive Garden on February 5 at 6 p.m.

Olive Garden, Baileys Cross Roads (across from Skyline Towers), 8133 Leesburg Pike, Vienna, VA
Phone: 703-893-3175

Reservations are under Craig Moore, Vice President, NVMC. Please RSVP to me at vicepresident@novamineral.club.

Boleite, Amelia Mine, Baja California Sur, Mexico. Source: Mindat; photo: Rob Lavinsky.

Penetration twins are exactly what the sound like, when one crystal penetrates another of the same mineral through rather than along a crystal axis.

California. A few crystalized boleite specimens have been recovered from many localities throughout the world. Mindat localities usually show one to three photos of micromounts. These localities include the Bird's Nest Drift and the C-site at the Blue Bell Mine near Zzyzx in the Silver Lake Mining District of San Bernardino County. The two microspecimens from the Blue Bell Mine shown on Mindat are robin's egg blue.

Arizona. The Mammoth-St. Anthony Mine in Pinal County was a significant gold producer, with underground workings up to 343 meters (1,125 ft) deep. This is the type locality for more than 10 minerals. Stunning specimens from this deposit exhibit small boleite crystals in shades of blue that are encrusted with sugary anglesite. Other boleite crystals vary from the usual cubic forms, showing translucent to opaque cuboctohedral shapes in specimens up to small miniatures; one boleite crystal is 3 millimeters (0.12 in) across.

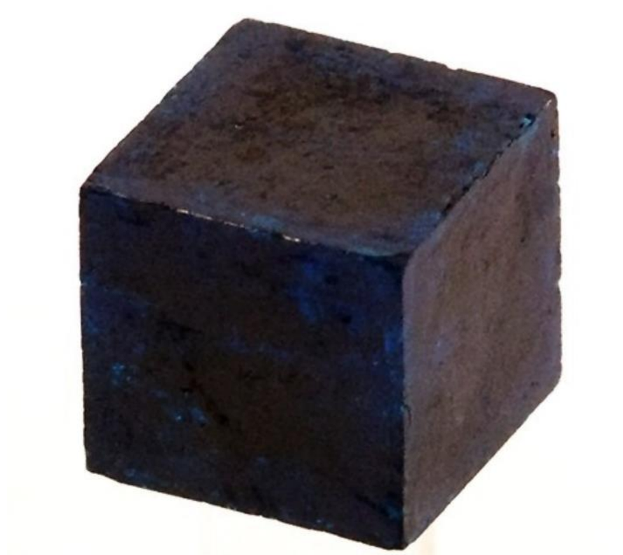
The Rowley Mine in Maricopa County is known for an array of beautifully crystalized minerals like wulfenite. It is not known for boleite. Micromounters collected a few specimens, possibly in the 1990s. The boleite crystals are more aqua and more transparent than specimens from other localities. The Rowley boleite crystals are no more than 1 millimeter (0.04 in) in size, so there is not as much mass to look through; and the tiny crystals probably formed faster than other, larger boleite crystals found elsewhere.

Mexico. El Boleo is the name of a large copper deposit and mine in southern Baja California.

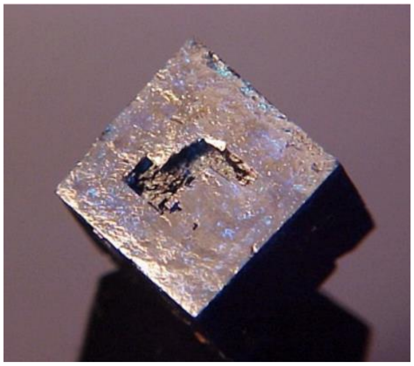
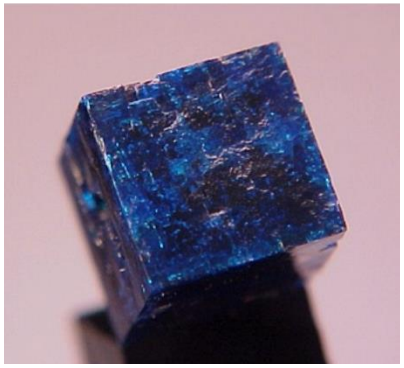
Now for a brief lesson in Mexican Spanish. It's a bit awkward to use this location name because *el* in Spanish means "the" so "The El Boleo Mine" is redundant, yet "El" is part of the official name. So we will use the Spanish phrasing and it will be El Boleo.

Next, I checked the meaning of *boleo* and fell down a rabbit hole of multiple possibilities. (A Spanish speaker can inform me, please!) *Boleo* can mean a tango step; or, according to one source, it can be used in Mexican geology to mean a waste dump, an ore nodule, or an ore nodule in a vein. *A boleo* (an adverb) can mean "blindly" (perhaps, in this context, a buried deposit that geologists call a blind deposit?).

Boleite with mammothite, Tiger, Pinal County, AZ. Source: Mindat; photo: Dan Polhemus.



Boleite, Amelia Mine, Baja California Sur, Mexico. Source: Mindat; photo: Rob Lavinsky.

Boleite, Boleo District, Santa Rosalía, Baja California Sur, Mexico. Source: Mindat; photos: Jason McAvoy.

The deposit was discovered in 1868 and worked on a small scale by Mexicans and Germans. In 1885, a French company took over mining and developed the property into Mexico's largest copper producer. Using the latest technology, production continued until 1954. Extraction was intermittent for many years.

The property is now controlled by a South Korean company. I could not determine whether mining is currently occurring. The minerals are there, but problems lie with finding ways to economically mine the complex assemblage of metals. Currently, cobalt in the ore has the highest value, although copper, zinc, manganese, and possibly silver could be recoverable.

The ores of El Boleo were deposited horizontally in what geologists call a manto. The ore-forming fluids entered the sedimentary host rocks along a bedding plane (the relatively flat surfaces laid down by the sediments). The entire El Boleo ore zone is huge—11 kilometers (6.3 mi) long. Cumenge likely worked at the mine when it had French owners. In his original description with Mallard, they write of the new mineral boleite forming sharp cubic crystals up to 2 centimeters (0.8 in) on a side. The crystals "isolate" themselves from the gangue (host rock). "Isolate" may mean that they easily fall out of the matrix or occur in isolated single crystals; the former possibility seems more likely because the host rock can be clayey and relatively soft.

The first boleite specimens must have been lovely. Mallard and Cumenge described them as indigo colored and found with anglesite, phosgenite, atacamite, and gypsum. The blue, green, and white or clear crystals would have shown attractively contrasting colors.

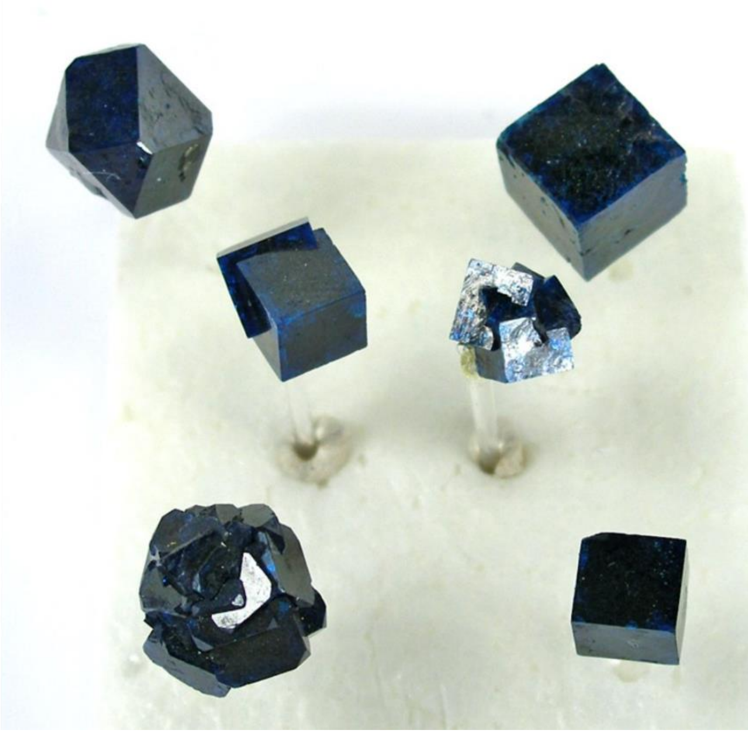
The authors also mention octahedral boleite crystals that tended to be smaller than their cubic versions. Boleite crystals may have overgrowths of pseudoboleite. The pseudoboleite grows epitaxially, meaning on preferential surfaces of boleite crystals formed earlier.

Interestingly, boleite contains silver, whereas pseudoboleite does not. Wilson and Rocha (1955) reported that the Amelia Mine was the primary source of boleite in the El Boleo District. The shaft caved in after extraction exhausted that part of El Boleo, so by 1955 the best specimens were expected to be in museums, with a few smaller specimens left on the dumps. I could not determine whether open pit mining would have obliterated the Amelia shaft, possibly by mining through any boleite-rich zones.

According to Wilson and Rocha (1955), the type specimens of boleite, along with the type specimens of pseudoboleite and cumengeite, were found in the Cumenge Shaft in the Amelia Mine.

Chile. Chile is the world's leading copper producer, mining more than twice the amount of ore than the world's second largest producer. Luckily for mineral collectors, at least one of the copper deposits has also produced boleite specimens.

Boleite, Boleo District, Santa Rosalía, Baja California Sur, Mexico. Source: Mindat; photo: Rob Lavinsky.



Boleite specimens, Amelia Mine, Santa Rosalía, Baja California Sur, Mexico. Source: Mindat; photo: Rob Lavinsky.

Tiny, translucent to transparent blue boleite crystals perch attractively on white to slightly iron-stained yellow massive or sucrose quartz matrix from the San Francisco Mine in the Caracoles mining district in Antofagasta Province. These would be nice additions to micromineral collections. Collectors occasionally found micromount-size boleite crystals at other mines, such as the La Compañia and Santa Ana Mines in the same province.

Mines and prospects near Cerro Challacollo in Chile's Tamarugal Province were another Chilean source of microcrystals and boleite mixed with pseudoboleite.

England. The mines of Cornwall have long been known for lead, tin, and other metals as minable ores and for a plethora of collectible mineral species. Boleite specimens from the Cornish mines are rare, though Mindat offers one image each of microcrystals from the Wheal Penrose, Wheal Galway (Cuddrabridge Mine), and Wheal Rose; "wheal" is the Cornish word for workings—in this context, for mine. At Wheal Rose, the boleite crystals sit attractively atop an unidentified green mineral, possibly pyromorphite.

Boleite has been reported from other mines and diggings in Cornwall as well. At Newporth Beach, tiny boleite crystals may have been formed postmining by seawater acting on exposed lead minerals.

Spain. The beautiful Prussian blue boleite microcrystals remind me why I wanted to write about this mineral: it is attractive. The main boleite locality I found in Spain is the Sol Mine near Almería in Andalusia. Boleite is one of many secondary copper minerals found here. Most form microcrystals.

I did not find any Spanish boleite for sale when I looked online on January 15, 2024. All specimens shown on Mindat are lovely, so I expect that a Spanish specimen of boleite would interest most micromounters.

One specimen of light aqua boleite microcrystals was shown on Mindat from Mina Casualidad, also in Andalusia.

Australia. The Broken Hill Mine in New South Wales exploits one of the largest and richest zinc-lead deposits in the world. The deposit has been mined since the 1880s. A few boleite specimens were found here, including one owned by the British Museum of Natural History. That specimen, on matrix, has very dark, almost black boleite crystals up to at least 0.5 centimeters (0.2 in) in size. The matrix is coated by a fine-grained orange-yellow mineral or minerals, possibly iron oxides. The specimen is very different from the usual bright blue boleite crystals on white matrix that are found elsewhere; it was found in rare microcrystals at Broken Hill.

Slag

Boleite forms after mining in the slag (melted waste rock) left over from smelting and refining processes. There could be more boleite crystals from slag deposits than from natural sources; however, the specimens in slag are minute.

Some slag heaps are adjacent to the mines where the ore was extracted. At other locations, ore is shipped for processing elsewhere, so the slag dump is far from the mined source. In either case, the boleite is of anthropomorphic origin. I will briefly discuss slag sources of boleite to help you recognize specimens from slag if you see them for sale.

The ASARCO smelter in Tacoma, WA, is now closed, and the site has probably been reclaimed.

A German slag deposit processed mostly lead ore containing other metals, along with elements that formed barite, cuprite, and other minerals, including boleite. The Herzog Julius smelter in Lower Saxony operated from 1270 to 1988, presumably intermittently. Microcrystals of boleite were found there with paralaumonite and gypsum.

Slag from iron mines in Italy's Tuscany region has been dumped into the Mediterranean Sea in the Gulf of Baratti. The mines date from the Etruscan era, extending back more than 2,000 years. Mindat shows one specimen of microboleite crystals from this locality.

The slag deposits in Laurion, Greece, were created more than 2,000 years ago. That is plenty of time for secondary minerals like boleite to form. The minute (microscopic) crystals are sometimes associated with phosgenite or paralaurionite. Mindat has pages on two Laurion (or Lavrion) sites that include photos of similar boleite specimens. One other Greek locality with minor boleite in the Laurion area is a mine, not a slag dump. Only one specimen of boleite microcrystals is shown.

Uses

Boleite is not found in sufficient quantities to be an economically viable ore mineral. It contains lead, silver, and copper. In deposits of metals in supergene orebodies (ores in near-surface enrichment zones), limited quantities of boleite may occur and be mined. Geologists and miners won't look for boleite when searching for valuable deposits for mining.

Boleite is not an impressive faceted stone, at least to me. It is dark blue and cloudy. Since it is relatively soft and easily cleaved, it cannot readily be worn. It is rare and crystals are small. Faceted boleite is best left for collectors of odd minerals that can be cut. I found an online site offering a 1.44-carat faceted boleite for $360 ($250 per carat). The stone measured 6.6 millimeters (0.26 in).

If you want to add boleite to your collection, specimens are available from many sources. Online prices in January 2024 started at about $20 for tiny blue dots on white anglesite and $24 for a 4.5-millimeter (0.18-in) single crystal. At the high end, a 2.2-centimeter (0.87-in) specimen with a 1.1-centimeter (0.4-in) boleite crystal can set you back $3,500. Somewhere in between, a nice boleite specimen—a single cube from the Amelia Mine in Mexico, 0.4 centimeters (0.16 in) on a side—was listed for $60. ⛏

Boleite, Amelia Mine, Santa Rosalía, Baja California Sur, Mexico. Source: Mindat; photo: Michael C. Roarke.

Technical details

Chemical formula .... $KPb_{26}Ag_9Cu_{24}(OH)_{48}Cl_{62}$

Crystal form .... Isometric

Hardness............................... 3-3.5

Specific gravity...................... 5.05

Color .... Azure to royal blue

Streak .... Greenish blue

Cleavage............................... 1 perfect, 1 good, 1 poor

Fracture .... Uneven

Luster .... Glassy, rarely pearlescent

Sources

Arem, J.E. N.d. (no date). Boleite value, price, and jewelry information. International Gem Society.

Cornish Secrets. 2021. Wheal secrets from Cornwall.

Duran, P. 2021. Minera El Boleo receives green light from SEMARNAT. 1 July. Mexico Business.

Flanagan, D.M. 2023. Copper. Mineral commodity summaries 2023: U.S. Geological Survey.

Gemdat. N.d. Boleite.

Mallard, F.E.; Cumenge, E. 1891. Sur une nouvelle espèce minérale, la boléite. Bulletin de la Société Française de Minéralogie 14: 283-293.

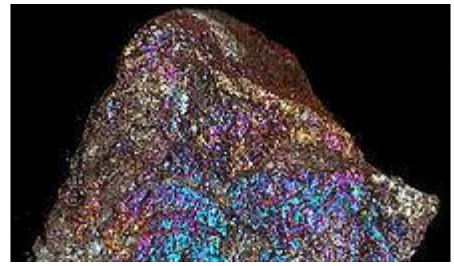
Mindat. N.d. Boleite.

Boleite on matrix, Mammoth-St. Anthony Mine, Tiger, Pinal County, AZ. Source: Mindat; photo: Jamison K. Brizendine.

Mindat. N.d. The Gannel Smelter slag locality, Cornwall.
Mindat. N.d. Vrissaki Point slag locality, Larion, Greece.
Mindat. N.d. Thorikos Bay slag locality, Lavrion, Greece.
Mindat. N.d. Passa Limani Cove slag locality, Lavrion, Greece.
Mindat. N.d. Legrena Cove slag locality, Lavrion, Greece.
Minerals.net. N.d. The mineral boleite.
The Mineralogical Record. N.d. Cumenge, Edouard.
Tureng. N.d. Spanish-English: boleo.
Wikipedia. N.d. Boleite.
Wilson, I.F.; Rocha, V.S. 1955. Geology and mineral deposits of the Boleo copper district, Baja California, Mexico. Prof. Pap. 273. Washington, DC: U.S. Geological Survey.

Erratum: Erubescite, Not Erubeacite

by Sue Marcus



A reader of our newsletter, Hendrik van Oss, kindly pointed out an error in our January Mineral of the Month article on carrollite.

I mentioned that carrollite was associated at the type locality for this mineral (the Patapsco Mine in Maryland) with “erubeacite,” but I was unable to find out what that was. Hendrik pointed that a *Glossary of Obsolete Minerals* he has contains no erubeacite but does show “erubescite” as another name for bornite, citing “Am. Min., 1964, v. 49, p. 224.”

Erubescite is probably what was meant, with the error attributable to a mistake on a hand-written specimen label or perhaps to a keyboard typo. Thanks so much, Hendrik!

Dr. Barbara H. Berrie

Rocks, Minerals, and Artists’ Pigments

February 5 Program

Dr. Barbara H. Berrie will join us in person to deliver her presentation on how rocks and minerals have affected the use of pigments by artists over the centuries.

Dr. Berrie is head of scientific research and a senior conservation scientist at the National Gallery of Art in Washington, DC. Her expertise is in the identification and characterization of inorganic artists’ pigments and what that can tell us about the history of artists’ use of colorants. She obtained a BSc(Hons) from the University of St. Andrews in Scotland, where she studied chemistry and geology; and a Ph.D. in chemistry from Georgetown University.

President's Collected Thoughts

by Jason Zeibel, President

February is often a time to sit in front of the fireplace sipping hot cocoa and enjoying the snow coming down. As I write this, I am doing just that while my girls are basking in the boundless enjoyment of school being canceled due to snowfall. As we get older, we unfortunately lose the ability to experience the carefree exuberance of a meteorologically liberated 6^{th} grader. Therefore, I will continue to temporarily procrastinate from shoveling our driveway while I put together some thoughts for this month.

I am very much looking forward to this month's program. I hope that you are able to join us in person for Dr. Barbara Berrie's talk "Rocks, Minerals, and Artists' Pigments." Barbara is the head of scientific research and a senior conservation scientist at the National Gallery of Art in Washington, DC. She has studied inorganic pigments in artwork and what they can tell us about the history of artists' use of colorants.

I met Barbara while working at the National Gallery, and she is a wonderful speaker. To whet your appetite, figure 1 shows a photomacrograph of "Madonna and Child" by the 16^{th}-century Italian artist Antonio da Correggio. In the image, you can see traces of the mineral orpiment, an orange-yellow arsenic sulfide (As_2S_3). Orpiment is found in volcanic fumaroles, low-temperature hydrothermal veins, and hot springs; it forms by sublimation (a gas becoming solid without first becoming liquid). Orpiment takes its name from the Latin *auripigmentum* (*aurum* for gold and *pigmentum* for pigment) due to its deep yellow color. It was one of the dominant yellow pigments for European painters for centuries.

I know that some of you are curious to know how I came to work at the National Gallery of Art when I work for the U.S. Army as a senior research scientist. During World War II, an Army squadron was briefly in charge of locating masterworks stolen by the Nazis, popularized by the film "The Monuments Men;" otherwise, the Army and the Gallery aren't typically involved with one another.

About 20 years ago, the former director of our Army laboratory was appointed to an advisory position at the Andrew W. Mellon Foundation due to some of his philanthropic work. The Mellon Foundation is a big supporter of the arts and funds the salaries and grants for a number of the research scientists at the Gallery. One of them (Dr. John Delaney) volunteered to give a talk about some of the image research at the Gallery.

Figure 1—*Superposition of a chunk of orpiment on a photomacrograph of the surface of* Madonna and Child, *a painting by Correggio containing particles of orpiment.*

After his talk, our lab director asked me to see whether we could help out in some way by lending our sensors and/or sensor expertise to the Gallery to help with imaging masterworks. So, on a spring day in 2007, I loaded up a few prototype spectral imaging cameras into my Toyota Landcruiser and headed to Washington, DC.

Since then, we have engaged in dozens of collaborative imaging efforts (fig. 2), including trips to the Metropolitan Museum of Art in New York, the Rijksmuseum in Amsterdam, and the Mauritshuis in The Hague. We have published several papers and even been issued a couple patents for our techniques. Unfortunately for me, the work has been so successful that the Gallery has been able to fund purchases of their own copies of our fancy spectral imaging sensors—thereby no longer needing our services nearly as often!

Dr. Berrie is the head of scientific research at the Gallery and has supported our collaborative imaging efforts for years. Without her support, the imaging spectroscopy techniques that we collectively pioneered for the conservation of masterworks would not have become mainstream among art conservators.

Also note that we will go out to dinner with Dr. Berrie at the Olive Garden near Tysons Corner at 6 p.m. before the meeting to share in some fellowship and conversation before the presentation. We try to do this any

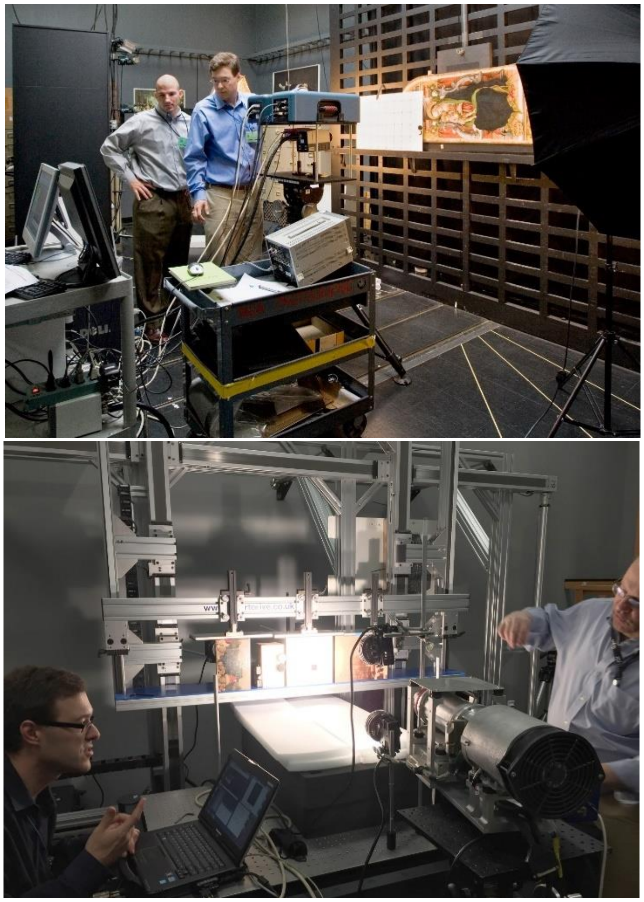


Figure 2—*Collaborative spectral imaging with the National Gallery of Art. Top: Dr. Jason Zeibel of the U.S. Army (right) and his colleague Dr. Roy Littleton working with spectral imaging camera systems at the Gallery. Bottom: Dr. Zeibel (left) and Dr John Delaney imaging masterworks at the Gallery.*

time that we are fortunate enough to bring in an outside speaker for an in-person presentation. All are welcome.

We will also do our best to support a Zoom hybrid meeting for this (and most) meetings. If any of you would prefer to come in person but have transportation or mobility issues, then please consider reaching out and we'll see about arranging a car pool or ride share.

I want to take a moment to thank our recent volunteers for secretary and field trip chairpersons. Without volunteers like these, our club struggles. I am very hopeful that it means we will have great notes and go on some awesome field trips in 2024!

I hope that those of us who were online for the January virtual meeting enjoyed our Rock-N-Talk segment. We will attempt to continue this each month. So if you have something exciting to share with the group for a couple of minutes, please come prepared to do so. Extra credit is offered to any of our young geologists. It doesn't have to be a long speech or cover the entire geologic history of the region—just a cool rock, mineral, or fossil and where/when you found it!

Please do make an effort to bring a check for dues to the February meeting if you haven't already paid your dues. I know that I am still delinquent myself and will be remedying it in February. Also, consider bringing a friend or two!

Until then, stay warm and dry in these cold winter months—hopefully by a fireplace somewhere with loved ones!

To Form Pink Diamonds, Build and Destroy a Supercontinent

by Nikk Ogasa

Editor's note: *The story is adapted from ScienceNews, 19 September 2023. Thanks to Sue Marcus for the reference!*

The world's largest source of natural diamonds—and of more than 90 percent of all natural pink diamonds found so far—may have formed due to the breakup of Earth's first supercontinent, researchers reported on September 19 in *Nature Communications*.

The diamond-bearing rocks of the Argyle Mine in Western Australia probably formed about 1.3 billion years ago, the analysis shows, along a rift zone that sundered the supercontinent Nuna. The finding suggests that exploring ancient rift zones for diamond troves may be more worthwhile than previously thought. … *Read more here.*

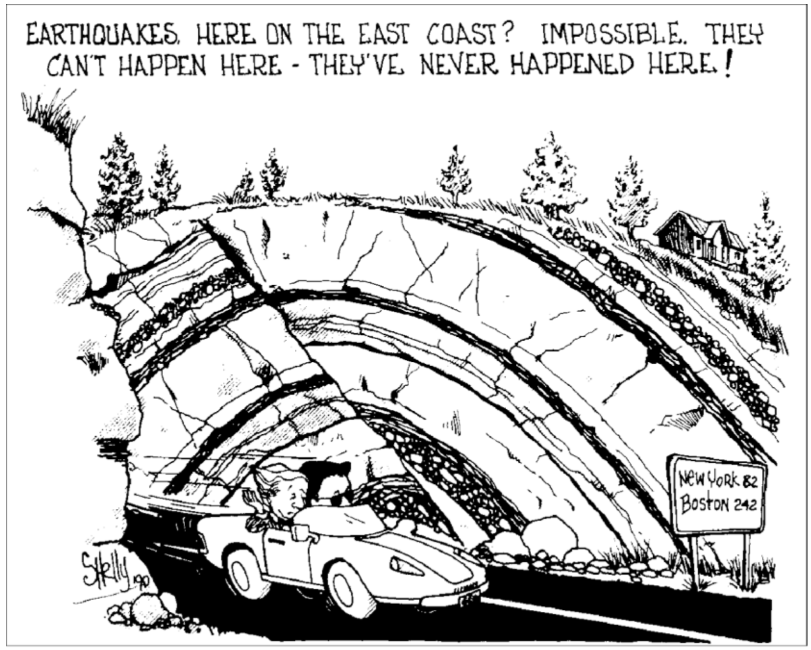
Historical Geology: Free Online Textbook

by Hutch Brown

Professors of geology have long posted helpful online summaries of regional geological history (see, for example, The Geological History of Virginia and the Mid-Atlantic Region). Now comes Historical Geology at OpenGeology.org, dated 2020 and self-described as a "work in progress" intended for undergraduate courses on the history of the Earth. The lead author is Professor Callan Bentley, who has presented to our club in the past and currently teaches at Piedmont Virginia Community College in Charlottesville, VA.

The site's many sections include individual "chapters" (such as on plate tectonics and on the Earth's geological history); "case studies" (such as the rifting of Rodinia and the Taconian Orogeny); "tools of the trade" (such as mineral identification and geologic maps); "virtual experiences" (essentially, field trips to the Massanutten synclinorium, along Corridor H in West Virginia, and elsewhere); and "virtual sample sets" (photos of rock types, tectonic structures, and more). The main topics are briefly summarized and explained with the help of annotated photos, diagrams, and short videos, some based on Gigapan or Callan Bentley's Mountain Beltway blogs. Many topics are punctuated by short multiple-choice quizzes to test your knowledge.

It's great set of tools and information for anyone interested in our area's geology. I will certainly use it!



Bench Tip: Silver Solder From Scrap

Brad Smith

After sawing patterns, there's always a little cleanup to do, and the smaller cutouts can be a challenge. Needle files (7-8 inches) can get into the larger areas, and escapement files (4 inches) can get into some of the corners.

But I often find myself wanting even smaller files. I couldn't find them, even at a watchmaker tools supply company, so I had to try something else. I ended up grinding down the tip of a small 4-inch barrette file using a separating disk (or cutoff wheel) in your Dremel or Foredom.

Be sure to wear your safety glasses when using this tool. A flake of steel in your eye makes for a bad day.

Smart Solutions for Your Jewelry Making Problems
amazon.com/author/bradfordsmith

Wildacres in Spring

Wildacres is a fantastic retreat located on Pompeys Knob just off the Blue Ridge Parkway about an hour north of Asheville, NC. Signing up for the May 13–19, 2024, session will give you the opportunity to take one or two classes and hear excellent talks from the guest speaker, Mike Colella, an artist with many talents and hobbies. You will also be able to participate in a variety of other activities.

You can register on the EFMLS Wildacres website. The guest speaker and the courses listed below are firmly lined up for May.

Coming to Wildacres in May 2024 …

Beading I (*Cheryl Brown*): Learn a variation of peyote stitch; make a bracelet with different-size beads, with earrings to match. Tools and materials provided; bring magnification. No experience needed. 2-day class, semester 1.

Beading II (*Cheryl Brown*): Learn bead embroidery; make a necklace with a stone cabochon. Learn how to add fringe and other enhancements. No experience needed. Tools and materials provided; bring magnification. No experience needed. 2-day class, semester 2.

Chainmaille, beginner (*Marilou Hillenbrand*): Create jewelry using unsoldered links. Learn the basics of making jump rings and how to open and close them. Make earrings and bracelets. Tools provided; bringing an optivisor suggested. No experience needed. 4-day class.

Chainmaille, intermediate (*Marilou Hillenbrand*): Build on your abilities with more basic or new advanced projects. Tools provided; bringing an optivisor suggested. Basic skills required. 4-day class.

Faceting (*Bernie Emery*): Learn to cut and polish a 57-facet round brilliant quartz gemstone, how to identify well-cut stones, and select rough material. No experience needed. 4-day class.

Geology I (*Rob Robinson*): Learn how geologists interpret rocks to tell geologic history, including rock formation, deformation, and sequence and timing of geologic events; includes field trip (weather permitting) with limited walking. Loupe suggested, plus sturdy shoes and outdoor clothes. No experience needed. 2-day class, semester 1.

Geology II (*Rob Robinson*): Learn about plate tectonics, geologic history, and the geology/minerals of the Blue Ridge region. Includes field trips (weather permitting). Knowledge of basic mineralogy and geology preferred. Loupe suggested, plus sturdy shoes and outdoor clothes. 2-day class, semester 2.

Intarsia (*Chuck Bruce*): Learn to make intricate scenic and/or geometric patterns from small stone pieces of colorful/interesting matrix cut to precision and fitted together, leaving no gaps. Cut and shape square or linear stones to create a composite piece for making into a cabochon. Cabbing experience required. 2-day class, both semesters.

Silversmithing I (*Richard Meszler*): Learn to work silver sheet & wire to fabricate jewelry. You get a kit with metals/supplies & a step-by-step description of each project. No experience needed. 2-day class, semester 1.

Silversmithing II (*Richard Meszler*): Learn to make a bezel setting & bail for setting a cabochon to make a pendant. You get a kit with all you need. Basic silversmithing experience, including soldering. 2-day class, semester 2.

Soapstone Carving 101 (*Ken Valko*): Learn the material/tools/methods used to complete a carving. Produce a simple piece; progress toward a more advanced sculpture. No experience needed. 2-day class, semester 1.

Soapstone Carving 102 (*Ken Valko*): Advance to a more advanced sculpture or hone your artistic skills. Skills learned in first semester required. 2-day class, semester 2.

Viking Knit I (*Danny Griffin*): Learn the weaving technique and how to add/blend in wire of different colors. Tools provided, eye protection required, optivisor suggested. No experience needed. 2-day class, semester 1.

Viking Knit II (*Danny Griffin*): Learn to develop the strands you made into necklaces and bracelets. Tools provided, eye protection required, optivisor suggested. 2-day class, semester 2.

Wirewrapping (*Jacolyn Campbell*): Use pliers/gold-filled or sterling silver wire/assorted beads or gemstones/ basic wire-craft techniques to create rings, bracelets, pendants, and earrings. All tools/materials provided.

Session I (beginner): Make an adjustable ring, 2 bracelets, pendant, 2 pairs of earrings. 2-day class, semester 1.

Session II (intermediate): Make a fitted ring, 2 pairs earrings, cabochon pendant, and bracelet. 2-day class, semester 2.

The Rocks Beneath Our Feet
Geology Walk Near Great Falls, MD

by Hutch Brown

On Sunday, January 7, 2024, NVMC member Sue Marcus and I joined geologist Joe Marx and four others on a walk along the C&O (Chesapeake and Ohio) canal in Maryland to explore the geology of the Potomac River's Mather Gorge. The six participants registered for the 3-hour event with Nature Forward (formerly the Audubon Naturalist Society) at a cost of $46 each for nonmembers.

Joe, who lives in Falls Church, VA, taught physical and historical geology for more than 15 years at Northern Virginia Community College. Now retired, he still leads field trips for Nature Forward to areas of local geological interest. In November 2019, Joe gave a presentation at our NVMC meeting, explaining the geology of Maryland's Sugarloaf Mountain. (For a summary of his presentation, see the December 2019 newsletter.)

We met Joe across from Old Anglers Inn on MacArthur Boulevard near Great Falls National Park and followed the towpath along the C&O Canal to Widewater (fig. 1), where the canal fills an ancient meadow. At stops along the way, Joe explained two different parts of the local geology: the formation of the bedrock more than half a billion years ago; and the formation of the Potomac River and Mather Gorge within the last several million years. I'll summarize what we learned.

Figure 1—*Widewater on the C&O Canal along the Potomac River, destination of a Mather Gorge geology walk led by Joe Marx in January 2024. Photo: Hutch Brown.*

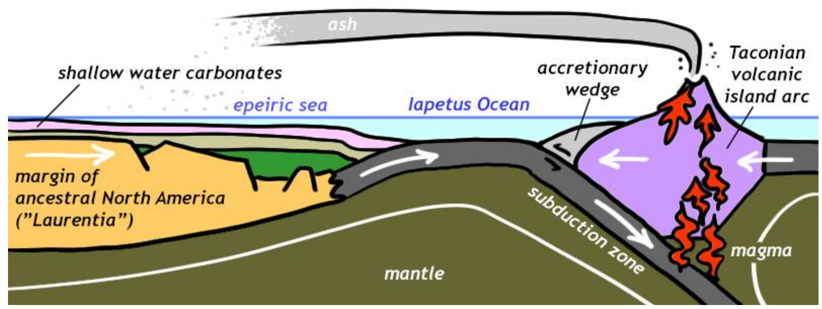


Figure 2—*Volcanic island arc (the Taconic Terrane) approaching Laurentia about 570 million years ago. Note the subduction zone for the continental crust, the rising magma, and the wedge of materials building up in the trench at the leading edge of the island arc. Source: Opengeology.org.*

Bedrock Story

Mather Gorge is part of the Piedmont geologic province, which originated more than half a billion years ago in a volcanic island arc in the Iapetan Ocean (predecessor of the Atlantic). Known as the Taconian (or Taconic) Terrane, the island arc was akin to the Japanese islands in the Pacific today. One name that geologists give for ancestral North America is Laurentia (fig. 2); Laurentia's continental crust, driven by convection currents in the Earth's mantle, subducted under an approaching oceanic plate. The resulting friction melted the crust and sent plumes of magma upwards to form the volcanic islands.

As it approached Laurentia, the island arc created a deep-sea trench at its leading edge. Volcanic activity caused earthquakes and undersea landslides, sending rocks, sands, silts, and other sediments cascading into the trench. The materials settled onto the seafloor in murky clouds called turbidites, with the sediments sorting out by size. Over time, the turbidites built up to form layers of sedimentary rock ranging from mudstones to graywackes and sandstones. (Compared to sandstone, graywacke has fewer quartz grains and more clay, silt, feldspar, and volcanic particles.)

The Taconic Terrane finally collided with Laurentia and rode up over the continental margin, depositing sedimentary rock from the trench and forming a mountain range overhead. The tremendous heat and pressure of the colliding tectonic plates turned the layers of sedimentary rock into the metamorphic rock types exposed today in Mather Gorge, what geologists call the Mather Gorge Formation (fig. 3).

In the process of uplift and folding, the Taconic Orogeny (mountain-building event) upended the originally flat layers of rock on the seafloor. Our geology walk, instead of traversing a single rock layer, cut through parallel bands of metamorphic rock (fig. 3).

We started in a band of phyllonite (fig. 3, **CZmp**—"C" for Cambrian, "Z" for Proterozoic, "m" for Mather Gorge, and "p" for phyllonite). Joe explained the metamorphic progression from sedimentary siltstone to slate, then to phyllite (pronounced PHIL-ite), and finally to schist. In the process, the fine mica flakes in siltstone are reoriented to lie in the same direction while increasing in size to form the distinctive foliation of schist, along with its relatively large mica flakes, giving the rock a mica sheen (fig. 4).

From the phyllonite, we moved into an area of migmatite, which Joe said was not so much a type of metamorphic rock as an advanced stage of metamorphism. Most rock types comprise multiple minerals (quartz, orthoclase, muscovite, and so on). "Felsic" minerals like quartz and feldspar melt at lower temperatures than "mafic" minerals rich in iron and magnesium. As the metamorphism proceeds, the melting felsic minerals, which are lighter in color, separate out from the darker mafic minerals (like olivine and biotite) and fill cracks in the bedrock. If the rock completely melts, it becomes igneous (in effect, magma); but if the melt stops short of completion, then it becomes migmatite, with a swirl of light and dark bands ("like marble cake," as Joe put it).

Figures 5 and 6 show outcrops along the C&O Canal at Widewater, our final destination. On our walk, the changing rock types phased into each other, so the differences weren't pronounced. For example, we saw what appeared to be migmatite (fig. 5, top) in close proximity to what looked (at least to me) like metagraywacke containing quartz nodules (fig. 5, bottom). The nodules might have been part of the original sediments on the ocean floor; or they might have formed from quartz melting out of the rock during metamorphism and recrystalizing within crevices—what geologists call segregation quartz.

At Widewater, Joe also showed us a band of amphibolite (fig. 3, white arrow). During the Taconic Orogeny more than half a billion years ago, rising magma intruded the bedrock, forming igneous sills that were later metamorphosed into amphibolite by the same extreme pressures and temperatures that turned the surrounding bedrock into migmatite. The upended amphibolite sills have eroded faster than the migma-

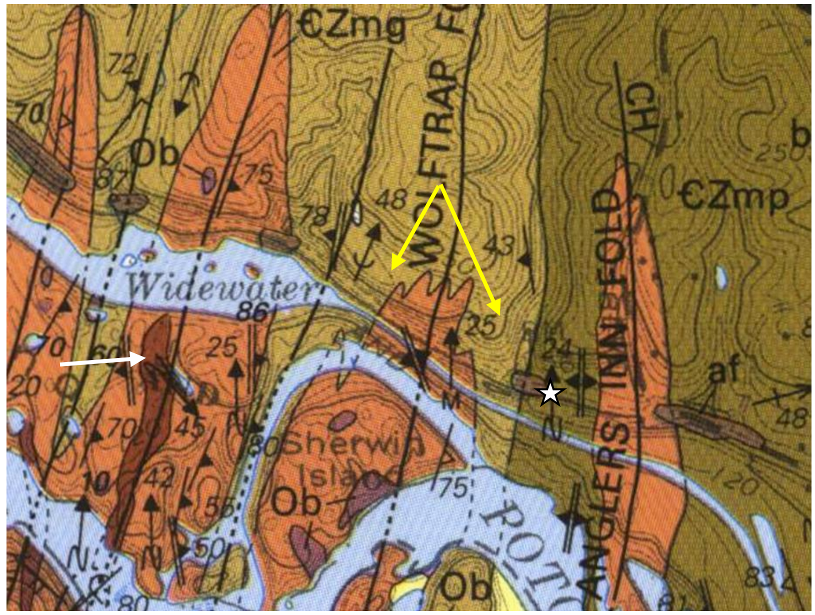


Figure 3—*Geologic map detail for the area of our walk on the towpath along the C&O Canal from Old Anglers Inn (white star) to Widewater. We passed through multiple bands of metamorphic bedrock, starting with phyllonite (dark brown,* **CZmp***) and continuing with migmatite (light brown, yellow arrows), metagraywacke (orange,* **CZmg***), and amphibolite (maroon, white arrow). The area also has small intrusions of Bear Island granodiorite (burgundy,* **Ob***). Source: Drake and Froelich (1997).*

Figure 4—*Mather Gorge schist in an outcrop on the Virginia side of the gorge. Photo: Hutch Brown.*

Figure 5—*Rock outcrops at Widewater.* ***Top:*** *Light/dark bands swirling in the rock suggest migmatite.* ***Bottom:*** *Quartz nodules (possibly segregation quartz) in the metamorphic rock. Photos: Hutch Brown.*

tite, forming gaps along Mather Gorge and depressions in the hinterland, ideal seasonal wetland habitats.

Figure 3 shows small intrusions of Bear Island granodiorite in the metamorphic bedrock (burgundy, **Ob**—"O" for Ordovician and "b" for Bear Island). Some of the magma rising during the Taconic Orogeny cooled

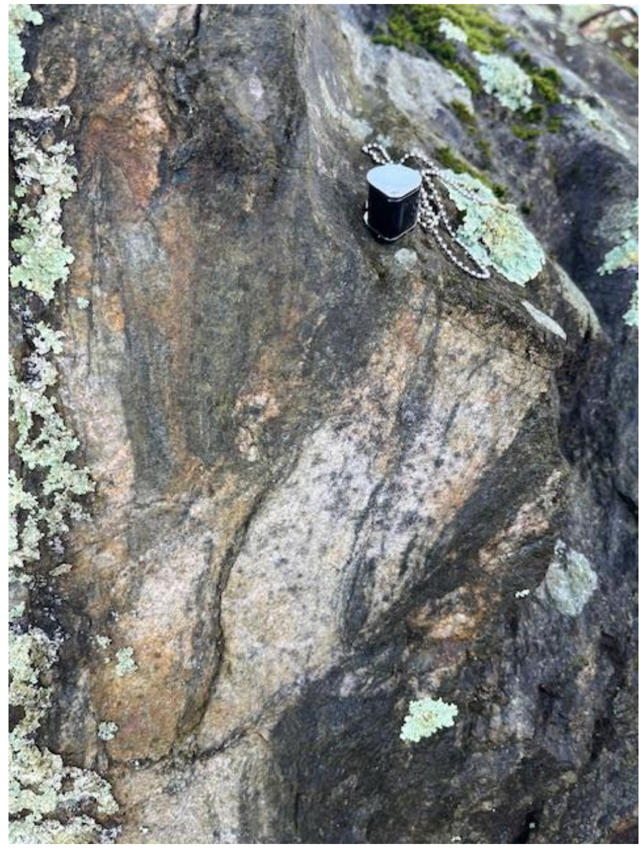


Figure 6—*Intrusion of light-colored Bear Island granodiorite into dark metamorphic rock at Widewater. Photo: Hutch Brown.*

underground, forming plutons that are now exposed in our area. One pluton is the Bear Island granodiorite, named for a large island in Mather Gorge. Joe pointed out a small outcrop of it at Widewater (fig. 6).

We did not go far enough to find another igneous rock, lamprophyre, a grayish-brown rock that intrudes metamorphic rocks near Great Falls. Lamprophyre is low in felsic minerals like quartz and rich in mafic minerals like magnesium oxides. In a mountain-building event beginning about 320 million years ago, proto-Africa slammed into Laurentia, becoming part of a supercontinent called Pangaea. Volcanic islands and rising magma again accompanied the event, which geologists call the Alleghanian Orogeny. Some of the magma filled cracks in the bedrock, creating dikes and sills of lamprophyre (more on those below).

Potomac River Story

Widewater is part of a former channel of the Potomac River. Joe explained next how the river was formed, the second part of the Mather Gorge story—and how the 19th-century builders of the C&O Canal then took advantage of ancient river channels.

The story of the Potomac began only recently (in geologic time). A long period of tectonic calm followed the breakup of Pangaea beginning about 230 million years ago, ending with our area as a flat and featureless plain. Shallow braided rivers drained the area, leaving sediments in the form of terraces across much of what is now Arlington and parts of Fairfax County.

About 5 million years ago, according to Joe, gentle uplift resumed across our area and continues today. The uplift is driven by shifts within the Earth's mantle, perhaps due to isostatic adjustments following the disappearance of the great Alleghanian Mountains, once as high as the Himalayas today.

As the gradient steepened, the inland rivers and streams consolidated into the Potomac River system, forging the watersheds and landscapes we know today. The Potomac River originally flowed across a bed of sediments almost level with the bed upstream from Great Falls (fig. 7). When sea levels precipitously dropped with the onset of Pleistocene glacial advances about 2.6 million years ago, the Potomac began cutting a gorge into the rising bedrock. Downcutting slowed when sea levels rose in the interglacial periods during the Pleistocene, only to quicken when the glaciers advanced again and sea levels fell.

Riverine downcutting tends to start downstream and work its way upstream in a process known as headward erosion. Subjected to tremendous heat and pressure during mountain building, the ancient metamorphic bedrock is full of joints, folds, faults, and fissures; Joe pointed out some of them. A river flowing over the faults and fissures will find the weak points, wearing away at them with the help of scouring sands and gravels.

According to Joe, Great Falls originated about where Theodore Roosevelt Island is today and slowly worked its way upstream through headward erosion. The lower Potomac Gorge upstream from where Key Bridge is now located would have worn away first; the river still forms a deep and narrow channel there. In places such as Little Falls, the river found more points of weakness in the rock, forming the rapids you can see there today.

The weaknesses are especially prominent at Great Falls and in Mather Gorge, where they are still evident. In both places, the Potomac twists and turns at sharp angles and flows in lines that are almost straight. The lines and angles suggest that the river found faults in the bedrock. For example, if you stand on the lip of the gorge in some places, you can see dikes of lamprophyre across the river (fig. 8). The counterpart dikes on the Virginia side are 100 feet upstream from those on the Maryland side—evidence of what geologists call a strike-slip fault: during mountain building, tectonic forces sheared away the bedrock on the Virginia side and moved it to the north of the bedrock on the Maryland side.

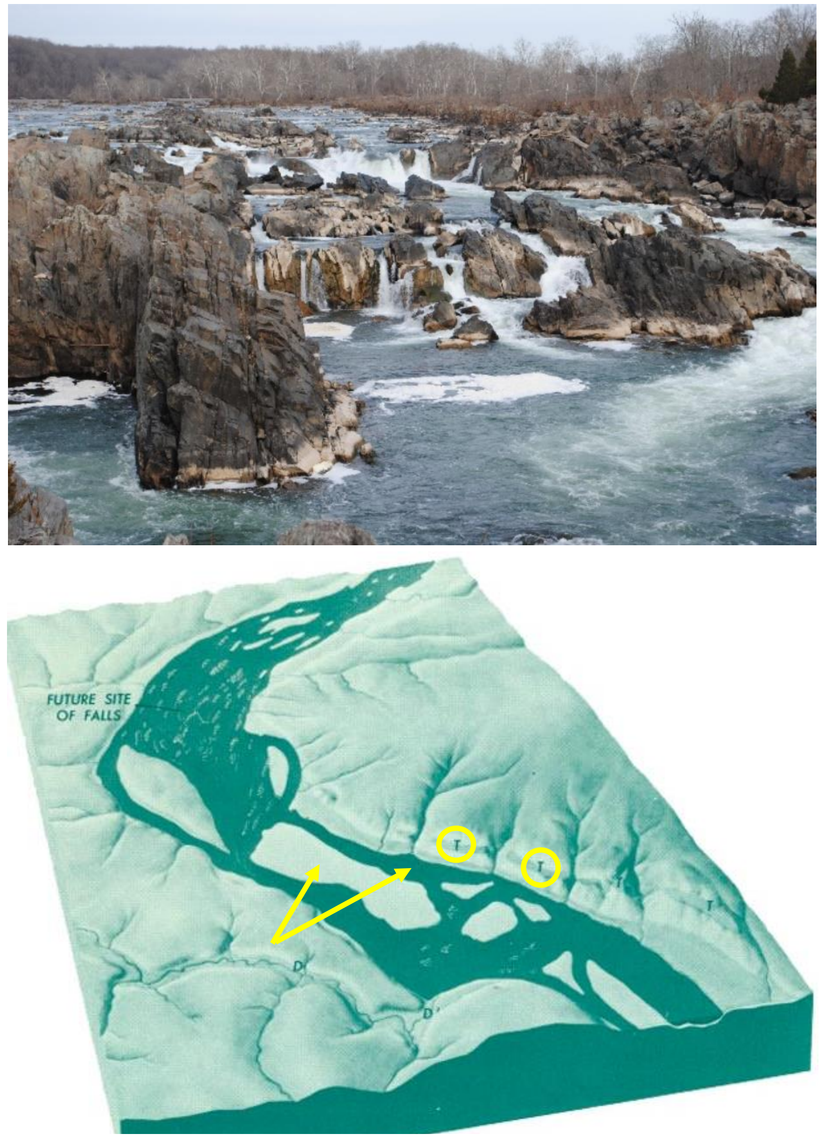


Figure 7—*Great Falls today (top, with exposed metagraywacke) and about 2 million years ago (bottom). The river was wide and shallow, with islands and channels—as it still is above the falls. Arrows point to Widewater and Bear Island, parts of the riverbed at the time; "T" (circled) marks terraces from older riverbeds. Photo: Hutch Brown; source (bottom): Reed and others (1980).*

Figure 8—*Lamprophyre dikes in Mather Gorge. The dikes are recessed in the surrounding metamorphic rock because lamprophyre is more erodible. Photos: Gigapan (left); Hutch Brown (right).*

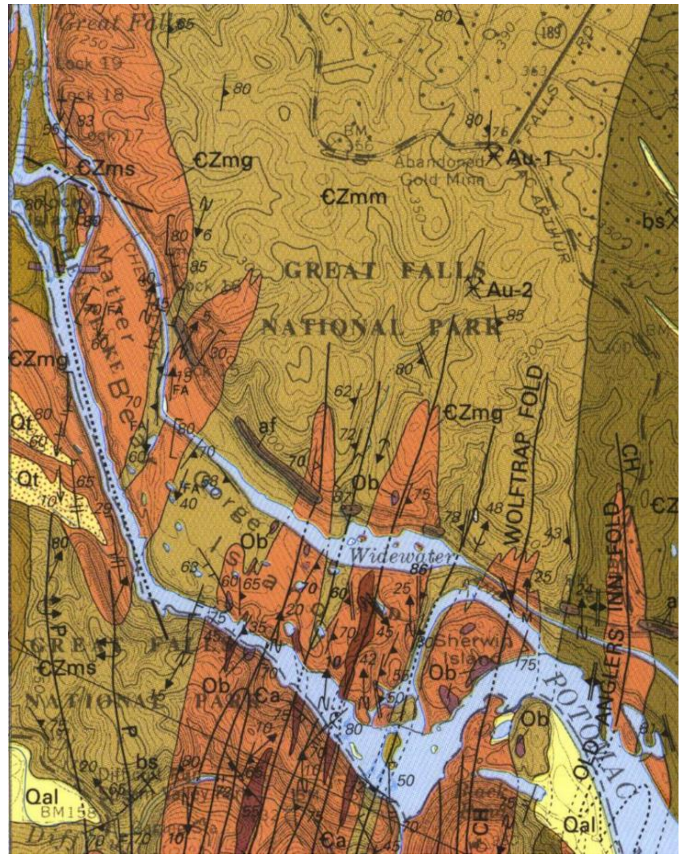


Figure 9—*Detail of a geologic map of Mather Gorge, showing the river cutting through every band of rock in its way. Brown (upper left,* **CZms***) = schist; orange (***CZmg***) = metagraywacke; light brown (***CZmm***) = migmatite; maroon = amphibolite; dark brown = phyllonite; yellow = alluvium (***Qal***). Source: Drake and Froelich (1997).*

In such faults, the river found its points of least resistance and followed them while further deepening its channel and forming the steep cliffs of Mather Gorge. In the process, the Potomac cut almost straight through every band of metamorphic bedrock in its way, from the metagraywacke at Great Falls (fig. 7, top) through the schist, migmatite, amphibole, and phyllonite downstream (fig. 9). As the river poured into its deepening central channel, its side channels dried up and its islands all but disappeared, leaving Mather Gorge as it appears today.

As Joe pointed out, the river also left a series of handy terraces for people to use in building not only the C&O Canal but also the aqueduct on Berma Road that supplies water to Washington, DC, along with arterial roads higher up, such as MacArthur Boulevard.

Acknowledgment

Thanks to Sue Marcus for taking the time to review and improve the article!

Sources

Drake, A.A., Jr.; Froelich, A.J. 1997. Geologic map of the Falls Church Quadrangle. GQ 1734. Reston, VA: U.S. Geological Survey.

Opengeology.org. No date. Historical geology: The Taconian Orogeny.

Reed, J.C., Jr.; Sigafoos, R.S.; Fisher, G.W. 1980. The river and the rocks. USGS Bull. 1471. Washington, DC: U.S. Government Printing Office.

Joe Marx completing our geology walk at Widewater, C&O Canal. Photo: Sue Marcus.

February 2024—Upcoming Events in Our Area/Region (see details below)

Sun	Mon	Tue	Wed	Thu	Fri	Sat
				1 Show: Tucson, AZ	2 Show: Tucson, AZ	3 Show: Tucson, AZ
4 Show: Tucson, AZ	5 **NVMC meeting**	6	7 MSDC mtg	8	9	10
11	12 GLMSMC mtg	13	14 **Valentine's Day**	15	16	17
18	19 **Presidents' Day**	20	21	22	23	24
25	26	27	28 MNCA mtg	29		

Event Details

1-4: Tucson, AZ: Annual show; JOGS Tucson Gem & Jewelry Show; Tucson Expo Center, 750 E Irvington Rd; daily 10-5, Sun. 10-4; adults $20, military/children free (no children under 14); the show features a wide variety of products from a diverse group of vendors, including jewelry designers, manufacturers, miners, wholesalers, and jewelry liquidators from around the world; info: Yelena Masenko, 213-629-3030, advertising@jogsshow.com, www.jogsshow.com.

5: Dunn Loring, VA—Northern Virginia Mineral Club; https://www.novamineralclub.org/.

7: Washington, DC—Mineralogical Society of the District of Columbia; info: http://www.mineralogicalsocietyofdc.org/.

12: Rockville, MD—Gem, Lapidary, and Mineral Society of Montgomery County; info: https://www.glmsmc.com/.

28: Arlington, VA—Micromineralogists of the National Capital Area; info: http://www.dcmicrominerals.org/.

The Northern Virginia Mineral Club

Visitors are always welcome at our club meetings!

PLEASE VISIT OUR WEBSITE AT:
http://www.novamineralclub

Please send your newsletter articles to:
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Arlington, VA 22203
hutchbrown41@gmail.com

RENEW YOUR MEMBERSHIP!

SEND YOUR DUES TO:

Roger Haskins, Treasurer, NVMC
4411 Marsala Glen Way, Fairfax, VA 22033-3136

OR

Bring your dues to the next meeting.

Dues: Due by January 1 of each year; $20 individual, $25 family, $6 junior (under 16, sponsored by an adult member).

2024 Club Officers

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secretary@novamineral.club
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Club purpose: To encourage interest in and learning about geology, mineralogy, lapidary arts, and related sciences. The club is a member of the Eastern Federation of Mineralogical and Lapidary Societies (EFMLS—at http://www.amfed.org/efmls) and the American Federation of Mineralogical Societies (AFMS—at http://www.amfed.org).

Meetings: At 7:30 p.m. on the first Monday of each month (except January and September) at the Dunn Loring Fire Station, 2148 Gallows Road, Dunn Loring, VA.* (No meeting in July or August.)

**Changes are announced in the newsletter; we follow the snow schedule of Fairfax County schools.*