THE NORTHERN VIRGINIA MINERAL CLUB INC

The Mineral Newsletter

Meeting: February 26 Time: 7:45 p.m.

Long Branch Nature Center, 625 S. Carlin Springs Rd., Arlington, VA 22204

Pyromorphite

Daoping Mine, Guangxi Zhuang Autonomous Region, China

Source: Wikipedia. Photo: Rob Lavinsky.

Volume 59, No. 2
February 2018
Explore our website!

February Meeting Program:

Kola Peninsula Minerals

In this issue …

Deadline for Submissions

February 20

Please make your submission by the 20th of the month! Submissions received later might go into a later newsletter.

Mineral of the Month
Pyromorphite

by Sue Marcus

This month, we are learning together about the mineral pyromorphite.

Name Origin

One of the first things I learned is to be grateful for the name. This lead mineral has been known since at least the mid-1700s, when it was called *Grön Blyspat* (Swedish), *Minera plumbi viridis* (Latin), and *Mine de plumb verte* (French). I assume the latter two are roughly translated as "green lead mineral."

Grön Blyspat was the name used by the Swedish chemist Johan Gottschalk Wallerius (1709–1785). The cognate in German would be *Grünbleispat* or *grüner Bleispat*, meaning green lead spar. Pyromorphite was also known as *Grünbleierz* (green lead ore), *Braunbleierz* (brown lead ore), *Traubenblei* (grape-shaped lead, no doubt for a botryoidal form), polysphaerite, nuissierite, miesite, cherokine, collieite, plumbeine, and finally (true!) sexagulit.

Why so many different names? Probably because this mineral is unusual (though not rare) and often colorful (though in different colors or shades), so people thought they had specimens of different chemical compositions and therefore different minerals.

The name "pyromorphite," bestowed in 1813 by the German mineralogist Johann Friedrich Ludwig Hausmann (1782–1859), makes sense when we tease out its meaning. *Pyro* means fire in Greek, and *morpho* is shape. When melted, by heat (fire), the goo will begin to recrystallize as it cools, taking shape, as it were, from the fires of melting.

Characteristics

Pyromorphite is known for occurring in shades of green (like on the cover), from deep forest greens, through richer, brighter hues, then into the yellow-greens, like the color of the different mineral olivine (peridot). Pyromorphite also forms lovely yellow crystals; unusual orange crystals take their coloration from arsenic.

The crystals of pyromorphite are often barrel-shaped and sometimes hollow. Single crystals are rare, although micromounters can probably mount one. Like

Happy Valentine's Day!

Northern Virginia Mineral Club members,

Please join our February speaker, Casper Voogt, for dinner at the Olive Garden on February 26 at 6 p.m.

Olive Garden, Baileys Cross Roads (across from Skyline Towers), 3548 South Jefferson St. (intersecting Leesburg Pike), Falls Church, VA
Phone: 703-671-7507

Reservations are under Ti Meredith, Vice-President, NVMC. Please RSVP to me at ti.meredith@aol.com.

Pyromorphite from New South Wales, Australia (top) and the Bunker Hill Mine in Idaho (bottom). Source: Smithsonian National Mineral Gallery; photos—Chip Clark.

the samples on the cover and shown above, pyromorphite commonly forms clusters, with the best specimens being lustrous.

When calcium replaces some of the lead in the crystal lattice (structure), the specimens are lighter in weight (with less lead) and usually lighter in color, too.

With a chemical formula of $Pb_5(PO_4)_3Cl$, pyromorphite can be used as a lead ore if present in sufficient quantities—though as a mineral collector, I don't want to think of crystalized specimens going through the mill!

Pyromorphite forms a solid solution series with mimetite ($Pb_5(AsO_4)_3Cl$), so some specimens may be somewhere along the spectrum from pure pyromorphite to pure mimetite. In fact, these two minerals are good examples of a solid solution series—that is, minerals that share very similar chemical formulas but have chemical substitutions that form a range in the composition from one mineral to the other. Vanadinite ($Pb_5(VO_4)_3Cl$) also forms a chemical series with pyromorphite, although intermediate specimens (chemically between pyromorphite and vanadinite) are rare and unknown to me.

Pyromorphite is a secondary mineral, forming through the oxidation of primary lead minerals and ores. So where there is lead, there may be pyromorphite. Pyromorphite isn't rare, although excellent specimens are always sought by collectors.

Pyromorphite can even form from biological processes! *Paecilomyces javanicus*, a mold in lead-polluted soil, can form biominerals of pyromorphite.

Localities

We are fortunate to have a former major pyromorphite locality in the United States. The Bunker Hill Mine, in the Coeur d'Alene District of Idaho, was a significant source of specimens at all prices, for many years. Although mining began in the 1880s, most mineral specimens came out in the 1980s and 1990s.

The mine is now closed and is a superfund site. Unfortunately, mining polluted the Coeur d'Alene River with lead and other toxic materials.

The mines near Phoenixville, PA, were another famous U.S. locality for pyromorphite. The mines closed more than a century ago, so fine specimens are rare. Collecting may still be allowed for pay at the dumps on the grounds of a local country club. Wonder whether rockhounds are welcome at the country club in collecting attire?

Easthampton, MA, has produced small though lovely crystals. Closer to home, pyromorphite has been found in several places in Virginia, although not in stunning specimens. Mindat reports it from the Morefield and Rutherford Mines near Richmond.

France is the source of some of the first and finest pyromorphite specimens. The Les Farges Mine specimens are noted for their intense green color. The Beauvoir Quarry in the French Alps produced delicate, tiny crystals.

Broken Hill, Australia, is another noted specimen locality, and China is currently producing nice specimens. Germany and Mexico are also sources of pyromorphite specimens.

Although pyromorphite can be faceted or used as a gem, specimens are seldom large enough, and fracture-free, and wearing lead-based minerals or gems is not advisable. Pyromorphite is an unusual gemstone for these reasons.

Technical details:

Chemical formula	$Pb_5(PO_4)_3Cl$
Crystal form	Hexagonal
Hardness	3.5–4
Specific gravity	6.5–7.1
Color	Usually green, though also orange, yellow, brown, white, rarely colorless
Streak	White
Cleavage	None
Fracture	Subconchoidal
Luster	Vitreous, resinous

Sources

Amethyst Galleries. 2014. The mineral pyromorphite.
Gemdat. 2018. Pyromorphite.
Mindat. 2018. Pyromorphite.
Mineralogy Database. N.d. Pyromorphite mineral data.
Minerals.net. 2018. The mineral pyromorphite.
Penn Minerals. 2017. Museum: Pyromorphite from Wheatley Mines Phoenixville, Chester County, PA.
Wikipedia. 2017. Pyromorphite.

Casper Voogt

Kola Peninsula Minerals

February 26 Program

Last year, from August 24 to September 1, Mindat hosted an adventure trip to the Kola Peninsula in the far northwestern part of Russia. The Kola Peninsula is home to a huge number of rare mineral species, many of them found nowhere else on Earth. Guided by local and international experts, a group of 12 people visited some of the most exciting and remote mineral localities in the world.

One participant in this Mindat adventure was NVMC member Casper Voogt. Casper will present an overview of the trip, which included visits to museums and private collections in addition to various Kola Peninsula localities—mines, dumps, and quarries in Apatity, Afrikanda, Kovdor, and Lovozero. Participants had opportunities for both purchasing and collecting. Casper will present mineralogical and other highlights of the trip, showing us some of the specimens he brought back.

Casper is a part-time mineral dealer, lifelong mineral collector, and avid traveler. His academic background is in architecture (Princeton and Georgia Tech). He has lived in the United States, the Netherlands, Aruba, and Switzerland. In "real life," he runs a web development company and is the webmaster for the NVMC and cowebmaster for the MSDC.

Casper Voogt collecting minerals on the Kola Peninsula. Photo: Casper Voogt.

The Prez Sez

by Bob Cooke, President

There's no rest for the weary. Just got back from my son's wedding and Hutch is telling me how anxious he is to go to print with this newsletter and I'm the holdout. So I guess I'd better suck it up and get on with business.

At this point, I should tell everyone what a great package of activities we have lined up for the coming year. Oops! I have no idea what's planned. That is Ti's purview. She is the one who has planned and organized all the meeting programs. I have no idea how she has found such great speakers for us, but she has come through again and again. I, for one, am extremely grateful for her efforts. If you are aware of potential speaker or if there's a subject that you would like to learn about, please let Ti know.

For the past several years, Professor Lance Kearns of James Madison University has invited NVMC, along with other mineral clubs in the metro area, to visit James Madison University to see the school's mineralogy facilities and mineral museum. This has always been an enjoyable trip and has allowed us to acquire specimens from Lance's stock of minerals that were excess to his teaching and research needs.

Unfortunately for us, Lance has retired. The JMU road trip will not be possible this year. We will always be appreciative of Lance's companionship and his support for our club.

Despite rumors to the contrary, I have not forgotten about the new NVMC nametags. We did agree at the November meeting that the club should subsidize costs so that members will pay only $5 for the nametag. However, for the club to subsidize costs, we must first approve a 2018 budget and allocate funds to the subsidy.

Our outgoing and incoming Treasurers are currently working hard to figure out the club's actual income and expenses for 2017 so we have a reasonable basis for a proposed 2018 budget. We hope to have that proposal available for discussion at the February meeting. It appears that nothing is ever as easy as it ought to be.

Thank all of you!

Bob

Meeting Minutes
January 23, 2017

by David MacLean, Secretary

Vice-president Ti Meredith called the meeting to order at 7:55 p.m. at the Long Branch Nature Center, Arlington, VA.

The minutes of the December 2017 meeting were approved as published in *The Mineral Newsletter*.

The Vice President recognized past President Barry Remer. She also recognized guests Matthew Keeler and his son Aydin.

The members conducted no business because the number present did not constitute a quorum.

Announcements

The GLMSMC show will be on March 17–18, 2018, at the Montgomery County Fairgrounds in Rockville, MD.

The MNCA Midatlantic Micromounters Conference will begin on Friday evening, April 6, and continue all day Saturday, April 7, at the Holiday Inn and Suites, Richmond Highway (Highway 1), Alexandria, VA.

Monday, May 28, is Memorial Day. The Long Branch Nature Center will be closed. The NVMC May meeting is therefore rescheduled to May 21.

In the News

A large meteorite fell in the Detroit, MI, area during the week of January 15, 2018. Reportedly, Christies is offering $20,000 for 2 pounds of it.

A reference was made to a meteorite which fell through the roof of medical clinic. There was a dispute between the tenants and the landlord about ownership. The meteorite was sold and the proceeds used for relief in Haiti

Discussion

One person said that club field trips are almost always to working quarries where the quarry requires all attendees to be 12 and older or 18 and older. She asked where eager young children under age 12 or 18 can go to collect rocks or fossils. A whole list of suggestions followed.

The program for the meeting was show-and-tell. Jason and Celia Zeibel showed off items from their mineral collections.

- A sluice for panning gold and gemstones at Lucky Lake, about 10 miles west of Interstate 95 and about 40 miles north of the North Carolina border.
- A sluice for children at Smoke Hole Caverns near Seneca Rocks, WV, about 3 hours from Arlington, VA.
- Earthen Paradise, VA, offers blue kyanite.
- Some have collected marine fossils along roadcuts and in a borrow pit near Cacapon, WV.
- Sharks' teeth can be found at a Maryland state park reached by state highway 220, 1.9 miles south of Liverpool Road.
- Sharks' teeth and other fossils are found on the beach at Matawaka Cabins near Westmoreland State Park, VA. There may be a fee for beach access. Reference was made to a Matawaka meteorite.
- Cape May diamonds (quartz) are found at Cape May, NJ, about 3.5 hours from Arlington, VA.
- Barry Remer said that fossilized sandworm tunnels are found in the stream gravels below the nature center where our club meets.

Display Table

Jason Zeibel showed petrified wood he found at the U.S. Army Proving Grounds in Yuma, AZ. The sample resembled somewhat splintery weathered wood.

Jason also showed a black-fluorescing green willemite crystal in red-fluorescing calcite from the Franklin area of New Jersey.

Celia Zeibel showed several red and black quartz geodes from Mt. Vesuvius near Naples, Italy.

Talaya Ridgely showed lapis lazuli eggs, lapis lazuli jewelry, and raw lapis lazuli from Afghanistan. Her father bought them in Kabul.

John Kress described deaccessing his large mineral specimens and teaching himself to micromount minerals. He displayed a large cigar box of 200 mounted microminerals.

Talaya Ridgeley displaying lapis lazuli jewelry and John Kress showing off his micromineral collection.

Foundling

by Megan Levad

... for a 67-pound nugget of Lake Superior copper found in an Iowa cornfield.

Before the earliest flute
was carved from a vulture's wing,

before we—what few we were—
bowed to the moon,

the balmy, secular night,
you were coming.

Snug in the great throat of a glacier.
Still as a wish, until its sighing end.

I like to think you waited years
for us, one shoulder greening in the damp,

the other burnished by long leaves
of wheat, before we called it wheat.

Or was it loess, the wind's fine veil,
polished you so bright we would know you at first sight?

What have you seen in the ice and the earth?
Is hell cold, or hot?

Do you pray, too? And to what god?
Or whale, or bigger rock?

About this poem: Iowa, my home state, was shaped by glaciers. When they finally melted, around the time people first settled in the Midwest, they left behind erratics, some they had carried for thousands of years. Those stones offer an everyday experience of the sublime in a place that is not known for its landscape.

–Megan Levad

Safety Matters

Time Travel

by Ellery Borow, EFMLS Safety Chair

Editor's note: *The article is adapted from the* EFMLS Newsletter *(February 2018), p. 8.*

Time travel is a hot topic in my household. Time: lack thereof, slow passage thereof, quick passage thereof—always fodder for a great conversation.

The topic this time is about the beginning of another trip around the sun. As new officers begin their administration of their clubs for the year ahead, there is the usually a swearing in, pledging, passing of the ceremonial gavel, and otherwise commencing the new term.

As part of the process, the outgoing editor passes to the new editor all of the salient documents related to the position. The new treasurer gains check signing responsibilities and copies of all financial documents. The new show chair receives all the show history files and so on.

Now, what about your new safety chair? Safety chairpersons should also receive all pertinent files from the outgoing chair. Your club does have a safety chairperson, does it not? In this litigious and safety-conscious society, I sure would suggest having one in your club!

Anyway, safety files maintained by a safety person might include a club's safety history; general and specific safety guide books; and an area's specific mine, quarry, pit, or dig safety information and requirements.

There are numerous general safety guides in print. Specific rockhound safety guides are often available through your regional federation.

The club's own safety history is often a vital part of the overall safety picture. Local safety information might include information about specific local weather conditions (anomalies), local mine and quarry rules and regulations, and specific safety guides for your show and meeting hall or venue. Other local items to consider are regional poisonous plants, critters, and insects. Safety concerns might also include local area flooding concerns.

Lastly, a club's safety or first aid kit should be passed on to the new chair or the designated medical safety person, who may or may not be the safety chair. The "Kit" should then be checked for outdated meds and supplies ... but that will be the topic of another "Safety Matters" article.

Seriously, keeping track of a club' s own safety files is a very important task. One might even say that safety files are the more important of the time-travel items ... as in time to travel on to the next chair.

I wish you all a good and safe collecting season during this trip around the sun. Please remember that your safety matters at all times!

Federation News

EFMLS/AFMS Annual Convention

Editor's note: *The article is adapted from* EFMLS News *(February 2018), p. 1.*

The Tar Heel Gem & Mineral Club is proud to present the 68th Annual EFMLS Convention held in conjunction with the 71st Annual AFMS Convention and the annual Tar Heel Gem & Mineral Club show. The get-together will be held in Raleigh, NC, on April 5–9, 2018.

Registration forms are posted on the EFMLS and AFMS websites. If they are not there already, they should be shortly.

The host hotel for the convention is the Embassy Suites by Hilton, Raleigh Crabtree, 4700 Creedmoor Rd., Raleigh, NC 27612, phone 919-881-0000. A block of rooms has been set aside, but you must call the hotel directly to make your room reservations.

Let the reservations clerk know that you are with the EFMLS Convention (or Tar Heel Gem & Mineral Club) to obtain the group rate. The rate includes a full hot breakfast each day and is good for Wednesday, April 4, through Monday, April 9.

EFMLS and AFMS conventions are fun and an important way for you and your club to discover what your federations do for you. Meetings are usually reasonably short, open, and friendly.

Best of all, you have an opportunity to meet the folks who have stepped up to volunteer for an officer or committee position and to put a face to a name. Over the years, many strong friendships have developed through meetings at these federation confabs.

Every EFMLS club should send at least one representative to the annual EFMLS meeting so that your club can have a say in what's happening. A delegate registration form giving your club an official vote at the meeting is included in the February issue of the EFMLS newsletter. The deadline for submitting the form is March 22; the mailing address is on the form.

Federation News
2018 Regional Federation Conventions

by Emerson Tucker

Editor's note: *Adapted from* A.F.M.S. Newsletter *(December 2017), p. 8. (Not all federations had yet set dates.)*

April 4–8	AFMS/EFMLS Raleigh, NC
April 27–29	Northwest Federation Yakima, WA
May 5–6	South Central Fed'n Lubbock, TX
June 8–10	Rocky Mountain Fed'n Fairplay, CO
October 6–7	Midwest Federation Springfield, IL

Save the dates!
Field Trip Opportunities

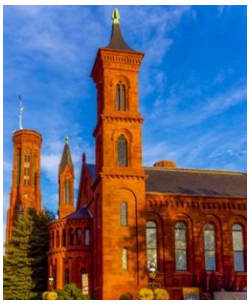
Northern Virginia Community College *Geology Field Trips*

NOVA's Annandale campus offers 1-day weekend courses—essentially, field trips—related to our hobby. You can get more information at the Field Studies in Geology—GOL 135 Website.

Paleozoic Geology of Virginia/West Virginia

April 7, 7 a.m.–9 p.m. This field trip will let you explore the late Silurian and Devonian geology of western Virginia and West Virginia, considering ancient depositional settings (tropical marine reefs, lagoons, shelves, deep basins, and terrestrial flood plains) and fossils, as well as later deformation (faulting and folding) associated with the Valley and Ridge Province.

Building Stones of the National Mall, Washington, DC



April 14, 2018, 9 a.m.–6:30 p.m. We will visit over 20 sites on the Washington Mall, examining the geologic history and architecture, including the rocks used to construct the federal buildings and monuments.

Cretaceous Geology of Maryland and Fossil Hunt

April 15, 2018, 10 a.m.–6 p.m. Well-known dinosaur expert and paleontologist Dr. Peter M. Kranz will lead this fun outdoor expedition to nearby fossil sites, where you can discover many exciting fossils to take home.

Audubon Naturalist Society

The ANS offers classes and nature programs, including short field trips. You can get more information and register at the ANS website.

Geology at the National Zoo

March 10, 1–4 p.m. The cost of this field trip, led by Joe Marx, is $36 for nonmembers. We will examine metamorphosed seafloor sediments and a large fault zone on a hike of about 2 miles, using a loop of paved trails from the Zoo entrance at Connecticut Avenue to Rock Creek to Klingle Road. The walk will be neither rocky nor muddy, but some parts will be rather steep. The pace set on geology field trips is faster than our usual "naturalist's shuffle."

Geology of Holmes Run Gorge

March 17, noon–4 p.m. The cost of this field trip, led by Joe Marx, is $34 for nonmembers. Holmes Run, a relatively large upland watercourse in Alexandria, has sliced through multiple geological layers down to the bedrock on which they rest. We will walk about 3 miles on good trails and mostly level ground through the Holmes Run Gorge, examining outcrops of granite, schist, and partially formed sedimentary rock. The discussion will focus on the ancient origins of the various rock types we see and on changes that have happened within the gorge in historic time. An added bonus will be a miniature magnolia bog!

Debate Over Grand Canyon's Age Over?

by Alexandra Witze

Editor's note: *The piece is adapted from* Crack 'n Cab *(newsletter of the Gem & Mineral Society of Syracuse, NY), September 2014, p. 5–7. It originally appeared in* Nature News *(1/27/14). Images are added, with sources at the end.*

A longstanding geological fight over the age of one of the most iconic landscapes in the United States—Arizona's Grand Canyon—might finally be over.

The massive chasm does not date back 70 million years, as earlier work had suggested, but was born in its entirety 5–6 million years ago when older, shorter canyons linked together to form the complete structure.

This explanation aims to reconcile a flurry of seemingly contradictory findings that enlivened discussion about when the canyon was carved.

"I think we've resolved the 140-year-long debate about the age of the Grand Canyon," said Karl Karlstrom, a geologist at the University of New Mexico in Albuquerque. He and his colleagues describe the findings in *Nature Geoscience*.

Geologists agree that the colorful layers of rock that make up the canyon walls are ancient, dating back as much as 1.8 billion years. The debate focuses on a different number—when exactly the Colorado River began cutting through those layered rocks, forming the three-dimensional chasm that tourists swarm to today.

Canyon experts had generally thought that the chasm formed around 5–6 million years ago. But over the past few years, several studies have marshaled a range of geologic evidence to suggest that the canyon could be tens of millions of years old. Karlstrom and his team find that parts of the canyon could be tens of millions of years old, but that the canyon as a whole is much younger.

Tracing Geologic History

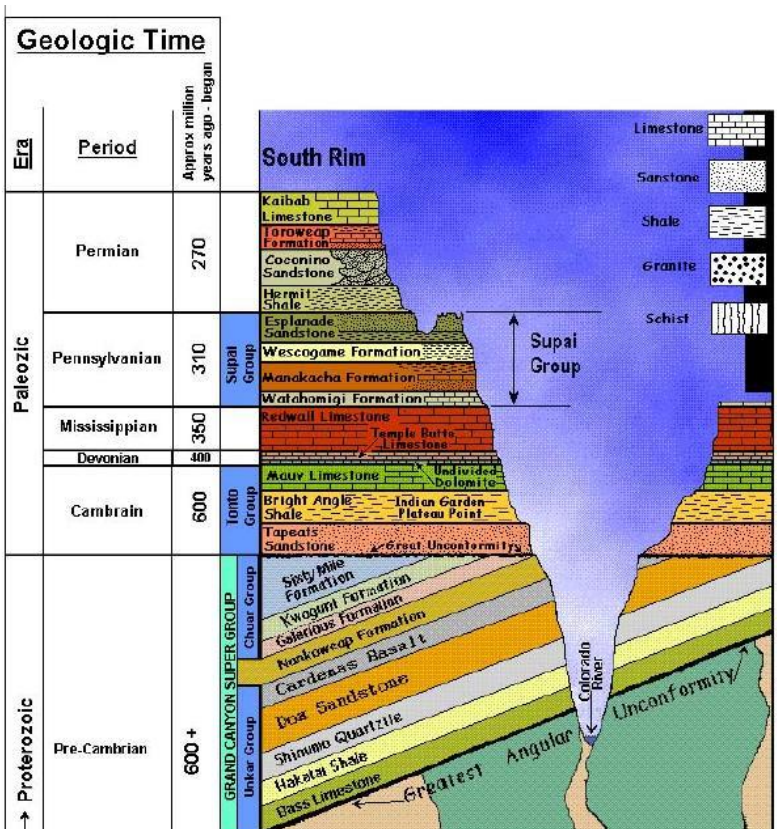
Scientists can date a canyon's formation with geochemical techniques that measure the temperature of rocks over time. The deeper a rock is buried, the warmer it is. When erosion removes the overlying rocks, as when a canyon forms, the rock is moved closer to the surface and cools down.

View down the Colorado River from Nankoweap in Marble Canyon, Grand Canyon National Park. Source: National Park Service (2016).

Grains of the mineral apatite contain several lines of evidence that can be used to trace a rock's temperature history. For instance, the decay of radioactive uranium within the apatite produces helium atoms, which diffuse out of the mineral depending on how warm the rock is.

In 2012, geologists Rebecca Flowers of the University of Colorado in Boulder and Kenneth Farley of the California Institute of Technology in Pasadena used this technique, among others, to conclude that some now-exposed rocks in parts of the canyon must have been cool for as long as 70 million years. In other words, they must have been at or near the surface for that long, indicating that the canyon must have existed for 70 million years.

In their study, Karlstrom and his colleagues used the helium technique, as well as other dating methods, to study rocks from the length of the Grand Canyon. The team found that two stretches near the canyon's middle are indeed quite ancient: The eastern Grand Canyon is



Geologic timescale for the Grand Canyon, which exposes pre-Cambrian rocks that are up to 1.8 billion years old. (By contrast, the oldest rocks in our area, the Blue Ridge granitoids, are about 1 billion years old.) However, the canyon itself is at most tens of millions of years old. Note the flat layers during the entire Paleozoic Era, suggesting tectonic calm for hundreds of millions of years, even as great continents collided beginning about 320 million years ago. Source: USGS (2015).

15–25 million years old, and another stretch downriver is 50–70 million years old.

But the researchers also found that two other segments—Marble Canyon, the farthest stretch upriver studied, plus the westernmost Grand Canyon—were carved far more recently.

"Different segments of the canyon have different histories and different ages, but they didn't get linked together to form the Grand Canyon with the Colorado River running through it until 5 to 6 million years ago," said Karlstrom.

Still, these findings may not be the last word on the matter. Flowers had pointed out that she and Karlstrom's group have similar helium dates for the westernmost part of the canyon, and yet the teams come to wildly different conclusions about what those data mean.

"It will take a bit more time to understand fully why their interpretations are so different from ours," she said.

Small changes in assumptions can mean big changes in interpretation. For instance, some studies assume that the ground temperature at the surface is 25 ºC, whereas Karlstrom's team used a range of 10–25 ºC. Such changes mean big differences for interpreting how long a particular piece of apatite has been buried.

"That just hit me like a ton of bricks," said Brian Wernicke, a Caltech geologist who has argued for an ancient canyon, of Karlstrom's choices. "They're not thinking this through."

Karlstrom said that it makes more sense to use a range of surface temperatures, because they probably varied over millions of years. It remains to be seen where the debate might move next.

Sources

National Park Service. 2016. Photo gallery: Grand Canyon scenic splendor. Washington, DC.

USGS (U.S. Geological Survey). 2015. School yard geology: Ages of rocks. Reston, VA.

GeoWord of the Day

(from the American Geoscience Institute)

glacial striations

A series of long, delicate, finely cut, commonly straight and parallel furrows or lines inscribed on a bedrock surface by the rasping and rubbing of rock fragments embedded at the base of a moving glacier, usually oriented in the direction of ice movement; also formed on the rock fragments transported by the ice. Syn: glacial scratch; glacial stria; drift scratch.

(from the *Glossary of Geology*, 5th edition, revised)

The Rocks Beneath Our Feet

Mountain Lake: A Geologic Puzzle

Part 2

by Hutch Brown

Editor's note: *The article continues a three-part series on the geology of Virginia's Mountain Lake. The first part is in the January 2018 issue.*

Located near Blacksburg in southwestern Virginia, Mountain Lake is one of only two natural lakes in all of Virginia. In fact, it is the only natural lake in the entire Southern Appalachians.

The lake's water levels fluctuate. The 1987 movie *Dirty Dancing* (starring Jennifer Gray and Patrick Swayze) was filmed at the Mountain Lake resort when the lake was full (fig. 1, top). As of October 2017, the lake was nearly empty (fig. 1, bottom).

What is going on?

Mountain Lake Bedrock

Geologic puzzles like this usually find their solutions in the bedrock. Something is happening in the lake bottom, and Mountain Lake is underlain by three separate rock formations (fig. 2).

The three formations are all sedimentary rock. They range from shale in the south (the Martinsburg Formation); to sandstone or graywacke, an intermediate phase between shale and sandstone (the Juniata Formation); to a very hard sandstone in the north, one that resembles quartzite (the Tuscarora Formation).

Figure 1—*Mountain Lake in southwestern Virginia. The lake was full (top) when the resort was featured in the 1987 movie* Dirty Dancing. *In October 2017 (bottom), the author's son sat on an outcrop of the Juniata Formation (a silvery sandstone or graywacke) overlooking the empty lakebed behind him. Sources: Top—N.a. (2011); bottom: Hutch Brown.*

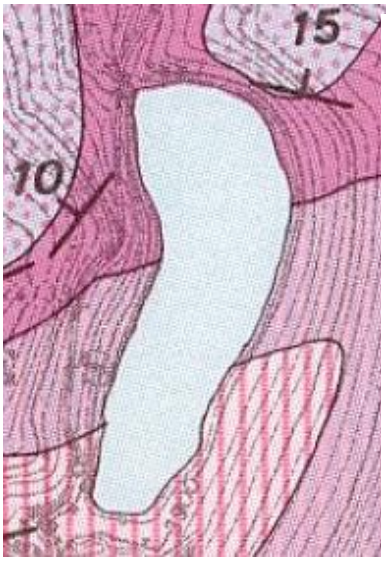


Figure 2—*Geologic map of the Mountain Lake vicinity, showing the elongated shape of the lake, its south-to-north orientation, and its three kinds of bedrock. Pink stripes = Martinsburg Formation; lavender = Juniata Formation; dark pink = Tuscarora sandstone. Source: Radford University (2014).*

The source of all these sediments was an ancient mountain chain that weathered away. From about 445 million to 430 million years ago, the sediments gradually filled a marine basin at the foot of the mountains. The sediments came in sequence: first the Martinsburg silts (the oldest); then the coarser Juniata sediments; finally the pure Tuscarora sands (the youngest).

A core principle of geology is the Law of Superposition: as sediments settle onto the floor of a basin, the youngest will be on top and the oldest on the bottom.

But that's not what we see today (fig. 2). Today, we see all three superposed rock formations lying side by side under Mountain Lake.

How did that happen?

The Alleghanian Orogeny

The three formations that underlie Mountain Lake are part of a much greater column of sedimentary rocks. Table 1 shows all of the formations exposed in Giles County, VA, where Mountain Lake is located. Laid down over a period of about 85 million years, they formed relatively flat rock layers in a solid column thousands of feet thick. The column remained largely undisturbed for another 85 million years.

Then came the tectonic event that shaped the bedrock of the entire mid-Atlantic region as we know it today (fig. 3). About 320 million years ago, proto-Africa (known to geologists as Gondwana) collided with proto-North America (Laurentia), closing the proto-Atlantic Ocean. As the ocean closed, Gondwana rode up over the Laurentian continental margin, pushing up the great Alleghanian Mountain chain that once covered what is now Virginia (fig. 3, red diamond).

Table 1—*Rock layer sequence in Giles County, VA, middle Ordovician to late Silurian Periods.*

Formation name	~Age (million years)	~Thickness (feet)	Component(s) (most to least)
Tonolaway	405–410	<100	Limestone
Keefer	410–420	100–230	Sandstone,[a] graywacke[b]
Rose Hill	420–430	100–270	Shale, siltstone, sandstone
Tuscarora	430–435	50–210	Sandstone,[a] graywacke[b]
Juniata	435–440	150–375	Shale, siltstone, graywacke,[b] sandstone
Martins-burg	440–455	1,000–1,800	Shale, siltstone, mudstone, limestone
Middle Ordovician carbonates	455–490	600–1,200	Limestone, dolomite

a. Pure and hard, sometimes compared to quartzite.
b. Sandy shale (intermediate between shale and sandstone).
Sources: Folk (1960); McDowell and Schultz (1990).

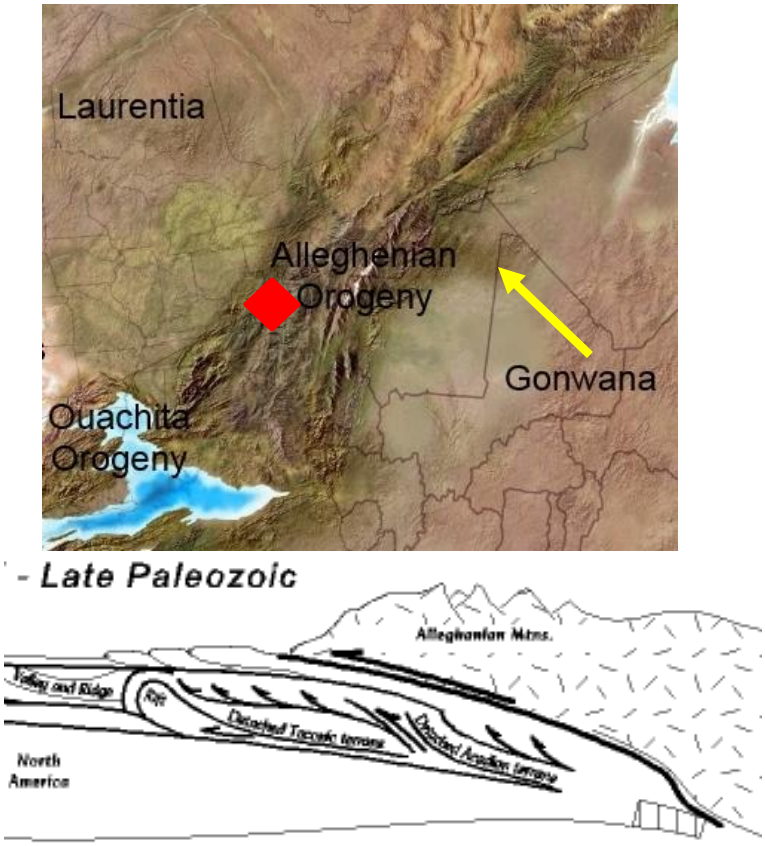
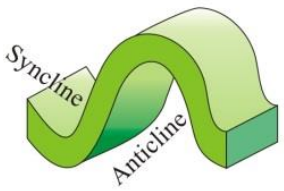


Figure 3—*The Alleghanian Orogeny, about 300 million years ago (during the late Paleozoic Era). The red diamond (top) shows the approximate location of Virginia; the yellow arrow shows the direction of plate movement. As proto-Africa rode up over proto-North America, thrust faulting pushed the Piedmont and Blue Ridge bedrocks westward while folding the flat sedimentary rocks beyond. Sources: Fichter and Baedke (1999); Harwood (2014).*

As it advanced, proto-Africa scraped up parts of the North American continental crust and transported them to the west on great thrust faults (fig. 3, bottom). In the process, the Alleghanian Orogeny configured today's Piedmont and Blue Ridge Provinces.

In addition, the collision with proto-Africa transported and buckled the flat sedimentary rock layers in today's Valley and Ridge Province. Under tremendous pressure, the sedimentary layers exposed in Giles County (table 1) crumpled and folded. The folding formed a series of rounded humps and dips, much like a rug being pushed together. Geologists call the humps anticlines (with downturned ends) and the dips synclines (with upturned ends).



The humps (anticlines) formed ridges and the dips (synclines) became valleys. All were oriented in the same direction, from southwest to northeast, the same orientation as the Alleghanian Mountains (fig. 3, top). The parallel orientations were because proto-Africa collided with proto-North America from what today would be the southeast (fig. 3, yellow arrow).

Salt Pond Mountain Anticline

The Alleghanian Orogeny had the same effect on the rocks underlying Mountain Lake: they all have the same parallel orientation from southwest to northeast (fig. 4). The lake was originally known as Salt Pond, partly for its diminutive size and partly for a nearby salt lick used by livestock. The ridge to the southeast of Mountain Lake also runs from southwest to northeast (fig. 4); known as Salt Pond Mountain, it has the highest elevations in the area, up to 4,365 feet.

Four of the seven formations shown in table 1 are exposed near Mountain Lake (fig. 4): the Martinsburg, Juniata, Tuscarora, and Rose Hill. Farthest to the northwest and southeast are outcrops of the Rose Hill rocks (fig. 4). They are the youngest rocks (table 1), Silurian in age (hence the "S" in **Srh**).

The Rose Hill outcrops are bordered by bands of Tuscarora sandstone (**Stu**), which in turn border on Juniata rocks. The Juniata Formation is Ordovician in age (hence the "O" in **Oj**).

In the middle are Martinsburg rocks (**Orem**), the oldest rocks in the area (table 1). The Martinsburg shale is bordered on both sides by bands of Juniata, Tuscarora, and Rose Hill rocks (fig. 4), in that order.

The relative ages and the parallel placement of the exposed rock formations suggest that tectonic forces associated with the Alleghanian Orogeny folded the rock layers into an anticline. The youngest rock (Rose Hill) is on the outer edges and the oldest rock (Martinsburg) is in the middle. Salt Pond Mountain forms a southeastern limb of the anticline (fig. 4).

The great Alleghanian Mountains buried the anticline for tens of millions of years, until they finally eroded away. Nothing remains today of the mountains or of proto-Africa. Rivers carried the sediments to the west, filling great inland seas.

Alleghanian folding and faulting fractured the sedimentary rock layers, making them more susceptible to erosion, particularly at the anticline arch. When finally

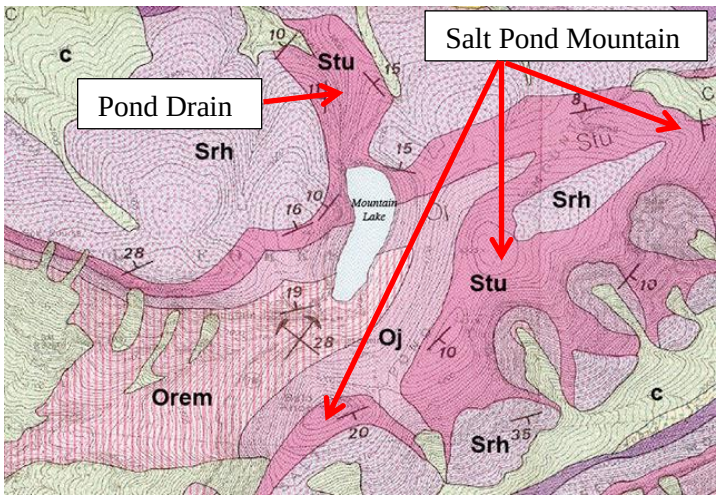
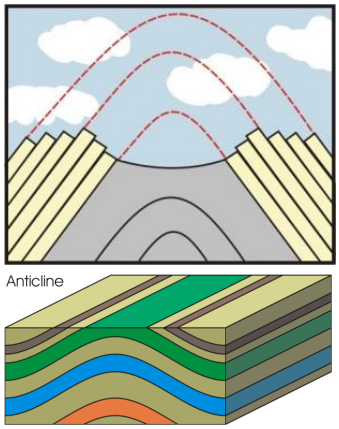


Figure 4—*Geologic map of the area in Giles County, VA, near Mountain Lake (blue). From youngest to oldest, the exposed formations are Rose Hill (***Srh***), Tuscarora (***Stu***), Juniata (***Oj***), and Martinsburg (***Orem***); lower slopes in the area (green) contain colluvium (***c***) from landslides and erosion. Parallel placement of the exposures suggests a "breached" anticline. Source: Radford University (2014).*



exposed, the upper part of the Salt Pond Mountain anticline eroded away, "breaching" the anticline and leaving a flat surface with multiple rock types. By about 230 million years ago, what is now Virginia had eroded down to an alluvial plain drained to the northwest by slow meandering rivers. The only remaining river today, its meandering course a telltale relic of the ancient Virginia alluvial plain, is the curiously named New River, which drains much of Giles County today.

About 45 million years ago, gentle uplift began in the western part of Virginia, forming today's valleys and ridges, including the New River gorge. The softer rock layers, such as limestones and shales, eroded faster than the harder sandstones, which gradually formed ridges running from southwest to northeast, the orientation of the underlying geology.

Salt Pond Mountain, capped by the tough Tuscarora sandstone (fig. 4), is a perfect example. The Rose Hill Formation is mainly shale, softer than the Tuscarora

sandstone, as are the Martinsburg and Juniata rocks. The erosion-resistant Tuscarora sandstone therefore caps the highest elevations of Salt Pond Mountain.

The New River steadily cut through the rising ridges, forming a series of water gaps on its northerly course across southwestern Virginia, and its tributaries did the same. Long before Mountain Lake formed, gentle uplift was raising the Salt Pond Mountain anticline. The stream now called Pond Drain originated in the rising Martinsburg and Juniata rocks and cut through the softer Rose Hill rock, exposing the underlying Tuscarora sandstone, which now forms the northern part of the lakebed and the bed of the outflow stream (fig. 4).

In fact, Salt Pond Mountain marks a continental divide (fig. 5). Pond Drain is part of the New River drainage to the northwest, flowing into the Ohio River and ultimately into the Gulf of Mexico. Johns Creek, on the southeastern side of Salt Pond Mountain (fig. 5), is part of the James River watershed, flowing southeast into Chesapeake Bay.

Why Mountain Lake?

And so it would have remained, with Salt Pond Mountain forming a continental divide between two small streams. Glaciers never reached into the Southern Appalachians, so they carved no basins to fill with lakes.

Yet a natural pond, now known as Mountain Lake, somehow formed at the base of Salt Pond Mountain. What created Mountain Lake? Why did it persist? Now that it is largely empty, will it ever refill?

Next: The origins of Mountain Lake.

Acknowledgment

The author thanks NVMC member Sue Marcus for reviewing and improving the article. Any errors are the author's alone.

Sources

Allen, C. 2013. Introduction to physical geography. Spring. University of Colorado at Denver. http://clasfaculty.ucdenver.edu/callen/1202/

Bentley, C. 2010. Deducing my first anticline. Mountain Beltway. 27 September.

Dott, R.H., Jr.; Batten, R.L. 1988. Evolution of the Earth. New York, NY: McGraw Hill, Inc.

Fichter, L.S.; Baedke, J.K. 1999. The geological evolution of Virginia and the mid-Atlantic region. Harrisonburg, VA: College of Science and Mathematics, James Madison University

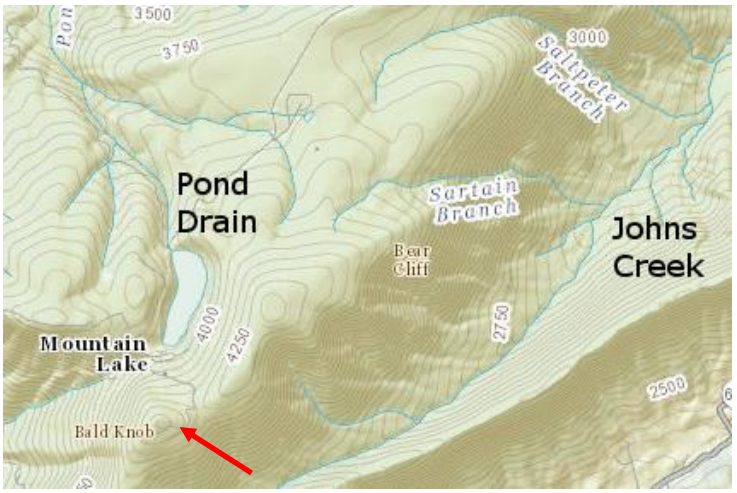


Figure 5—*Eastern Continental Divide. Salt Pond Mountain runs from lower left (Bald Knob, red arrow) to upper right, marking the divide between Johns Creek in the James River watershed and Pond Drain in the New River watershed. The James flows into Chesapeake Bay and the New River feeds the Ohio. Source: USGS via Grymes (2017).*

Folk, R.L. 1960. Petrography and origin of the Tuscarora, Rose Hill, and Keefer Formations, lower and middle Silurian of eastern West Virginia. Journal of Sedimentary Research 30(1) 1–58.

Grymes, C.A. 2017. Virginia places: Watersheds—Mountain Lake. Geography of Virginia (GGS380). Fairfax, VA: George Mason University

Harwood, R. 2014. Historical Geology 102: Paleozoic Era I. Black Hawk College, Moline, IL.

McDowell, R.C.; Schultz, A.P. 1990. Structural and stratigraphic framework of the Giles County area, a part of the Appalachian Basin of Virginia and West Virginia. USGS Bull. 1839–E,F. Washington, DC: Government Printing Office.

Radford University. 2014. Valley and Ridge physiography: Scenic tour of the Valley and Ridge (part 4)—Mountain Lake. Radford, VA.

Final GeoWord of the Day

(from the American Geoscience Institute)

breathing cave

A cave that has an alternating movement of air through its passages. Cf: *blowing cave*.

(from the *Glossary of Geology*, 5th edition, revised)

February 2018—Upcoming Events in Our Area/Region (see details below)

Sun	Mon	Tue	Wed	Thu	Fri	Sat
				1	2 Groundhog Day	3
4	5	6	7 MSDC mtg, Wshgtn, DC	8	9	10
11	12 GLMSMC mtg, Rockville, MD	13	14 Valentine's Day	15	16	17
18	19 Presidents Day	20	21	22	23	24
25	26 NVMC mtg, Arlington, VA	27	28 MNCA mtg, Arlington, VA			

Event Details

7: Washington, DC—Monthly meeting; Mineralogical Society of the District of Columbia; 7:45–10; Smithsonian Natural History Museum, Constitution Avenue lobby.

12: Rockville, MD—Monthly meeting; Gem, Lapidary, and Mineral Society of Montgomery County; 7:30–10; Rockville Senior Center, 1150 Carnation Drive.

26: Arlington, VA—Monthly meeting; Northern Virginia Mineral Club; 7:45–10; Long Branch Nature Center, 625 S Carlin Springs Rd.

28: Arlington, VA—Monthly meeting; Micromineralogists of the National Capital Area; 7:45–10; Long Branch Nature Center, 625 S Carlin Springs Rd.

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THE NORTHERN VIRGINIA MINERAL CLUB INC
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Mineral of the Month: Pyromorphite

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OR

Bring your dues to the next meeting.

Dues: Due by January 1 of each year; $15 individual, $20 family, $6 junior (under 16, sponsored by an adult member).

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 7:45 p.m. on the fourth Monday of each month (except May and December)* at **Long Branch Nature Center**, 625 Carlin Springs Road, Arlington, VA. (No meeting in July or August.)

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