THE NORTHERN VIRGINIA MINERAL CLUB INC

The Mineral Newsletter

Meeting: March 24 Time: 7:30–9:00 p.m.

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

Volume 55, No. 3
March 2014
You can explore our club website:
http://www.novamineralclub.org/

Club Member Auction Coming Up

March 24 Meeting

Our March 24 club meeting will feature our spring Club Member Auction! Proceeds from the auction go into the Fred Schaefermeyer Scholarship Fund, which supports students in the field of geology.

The meeting will start promptly at **7:30 p.m.** (*note:* this is 15 minutes earlier than usual). We will quickly move through the business part of the meeting so we can get to the fun!

Sellers, come early to help set up the room and your items. Bid slips, which you may copy if more are needed, are contained in this newsletter below.

Don't hesitate to bring a guest or invite non-members! Although only current 2013 club members are allowed to sell, the meeting and auction are open to all.

Auctioneers, accountants, and runners are volunteers—help us out here, folks!

Northern Virginia Mineral Club board members,

The club board will hold a meeting before the March club member auction. Board members will meet on March 24 at 6 p.m. at the Olive Garden.

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 Kathy Hrechka, Vice President, NVMC. Please RSVP to my cell at (703) 407-5393 or kshrechka@msn.com.

Bring small bills, bid early and often, and help us move on to the next item. We need to be out of our meeting room by about 10 p.m.

**** Note Current Club Auction Rules****

- Any member may offer up to 20 specimens or up to 4 flats for auction.
- Each flat is one auctionable item.
- The club gets **15%** of the purchase price; the remainder goes to the seller.

- Anyone may donate items to the auction to fully benefit the club (no money goes back to the donor).
- The minimum bid is **$1** on any item. Bids up to $**20** increase by $**1**; bids above $**20** increase by $**5**.
- We start with a silent auction, so look carefully and start bidding. Items with multiple bids during the silent auction will be brought sooner to the vocal auction.

Winning bidders must pay for the item promptly, with cash or check.

Previous Meeting Minutes

February 24, 2014

by Ti Meredith, Secretary

Vice-President Kathy Hrechka called the meeting to order at 7:45 p.m.

Presentation

Mr. Paul M. Young, the U.S. Geological Survey's (USGS's) Acting Associate Director for the Energy and Minerals and Environmental Health mission areas, gave a presentation about USGS.

In the 1800s, the federal government was interested in surveying unknown and unexplored parts of the United States. For example, Clarence King led the 40th Parallel Survey from 1867 to 1873, exploring areas from Wyoming to the California border. John Wesley Powell led a survey of the Rocky Mountain region from 1869 to 1879.

King became the first USGS Director when the agency was created on March 3, 1879. He served until 1881.

USGS provides information to the President, Congress, other federal agencies, states and tribal organizations, and others. The agency's mission is to help decisionmakers make better decisions affecting ecosystems, the environment, and the Earth.

USGS provides resource assessments; research products and subsurface information; impartial science; and geological, geophysical, and geo-

USGS Trio

Presenter Paul Young from USGS (center) poses with Mike Kaas and Sue Marcus, both USGS retirees. Photos: Kathy Hrechka, Pat Flavin.

chemical data, including information about rare earth minerals.

Paul provided information about hydraulic fracturing. Hydraulic fracturing is the process of injecting wells with water, sand, and chemicals at very high pressure to extract oil, natural gas, and geothermal energy from deeply buried rocks.

Paul mentioned a USGS Website on the subject at http://www.usgs.gov/hydraulic_fracturing. He also encouraged club members to view a video on the topic called "Science or Soundbite? Shale Gas, Hydraulic Fracturing, and Induced Earthquakes." In the video, USGS scientists discuss the opportunities and challenges associated with hydraulic fracturing. You can view the video at http://gallery.usgs.gov/videos/533

Business Meeting

Door prizes came from Rick Reiber, Mike Kaas, and Barry Remer. They included minerals, Tucson bags, and a poster of crystals. Door prize winners included Jeff Guerber, Pat Flavin, Mike Kaas, Craig Moore, Barry Remer, and Jennette Baughan.

Past presidents were recognized, including Sue Marcus, Rick Reiber, Wayne Sukow, and Barry Remer. Jennette Baughan was recognized as a new member.

Certificates of appreciation for volunteers at the 2013 George Mason University (GMU) club

mineral show were available for club members to pick up. Former President Rick Reiber presented the President's Award for Outstanding Service in 2013 to newsletter editor Hutch Brown for his behind-the-scenes work.

Despite the efforts of a search committee, Wayne Sukow was the only candidate to stand for club president in 2014. Kathy described Wayne's many contributions to the club, and Wayne was elected by acclamation.

Treasurer Kenny Loveless reported that the NVMC has $24,989 in its account. That does not include funds for the Fred C. Schaefermeyer Scholarship Awards, which amounted to $1,100.

Club members voted to grant a Fred C. Schaefermeyer Scholarship Award in the amount of $250 to Brandon C. Euker, a geology student at James Madison University. Dr. Lance Kearns nominated Brandon (see *The Mineral Newsletter* for February 2014).

Dr. Julie Nord of George Mason University has nominated another potential award recipient (see page 5 below). The club will vote on the nomination at the March meeting.

As part of his project for Eagle Scout, club member Conrad Smith is preparing an educational module for use in mineral shows, especially for Cub Scouts. Jim Kostka is helping him, and he said that Conrad's posterboard presentation materials are available for editing. Conrad has also made 300 Boy Scout giveaway bags in preparation for this year's GMU club mineral show. He is putting the NVMC storage shed to good use!

The Thin Section Lab at the Annandale campus of Northern Virginia Community College was a resounding success, as was the field trip to James Madison University. Thanks to Tom Tucker!

The meeting was adjourned at 10:00 p.m.

Asteroid Slams into Mars

Thanks to Kathy Hrechka for the link!

Take a look at a recent impact crater on Mars caused by a small asteroid. The image was taken in November 2013 by a camera on NASA's Mars Reconnaissance Orbiter.
http://wattsupwiththat.com/2014/02/05/small-asteroid-slams-into-mars-impact-captured-by-orbiter/

Thanks from George Mason University

Editor's note: Julia Nord, professor of geology at George Mason University (GMU) in northern Virginia, sent a note of thanks to the NVMC for working with the university to put on the club's annual GMU mineral show in November 2013 and for donating minerals and other items to the GMU collection.

Dear all at the Northern Virginia Mineral Club,

Thank you for the donation of minerals, a fossil fish, and the sea spider to the department. We will use a lot of the pieces in the displays and for teaching upper level courses.

I would love to set up a time that you all could visit the new building and see the classrooms and displays. And see you all, same time, same place, in 2014!

We enjoy working with you,

Julia

What *Is* This Rock?

Editor's note: Mr. Matthew Shelato contacted our club in February 2014 to ask for help in identifying a rock he found along the Potomac River. NVMC President Wayne Sukow offered his opinion; their exchange, slightly edited, is shown below. If you can be of further help to Mr. Shelato in identifying his rock, please contact him at matthew.shelato@gmail.com.

Rock found along the Potomac—fulgurite?

I think I found a fulgurite this summer, about the size of a deflated basketball. The rock rings like a bell when you tap it, and it seems to be made of fused sand and pebbles. It was on the bank of the Potomac River, on the Maryland side. Can you help identify this thing?

Matt

Editor's comment: Fulgurite, according to Wikipedia, is rock formed when lightning with a temperature of at least 3,270 °F strikes sand on a conductive (perhaps wet) surface and fuses the grains together, usually creating a tube. One of the longest known fulgurites, found in northern Florida, is 16 feet in length. Fulgurites occasionally form as glazed tracks on solid rocks.

Matt,

It's tough to identify a mineral from a photo, but here's my 2 cents worth.

The black portions look glassy and rounded, not branched like many fulgurites. Your rock does not have the appearance of a fulgurite. Are any of the black chunks hollow, like many fulgurites are? If the rounded black chunks are glass, you might try scratching them with quartz.

Frankly, it looks like a "clinker" from an old iron ore furnace. Temperatures in those furnaces were high enough to melt silica. Less dense than the iron, the silica would form near the top and be skimmed off and discarded in an ash bed, where it would melt some of the ash, connecting the ovoid silica pieces to form the clinker.

That brings to mind a story. Early in my mineral collecting career, I heard about amethyst cobbles with small rounded bits of silver in them. My father-in-law, like me a collector of Lake Superior agates, was a carpenter working on a job on Lake Michigan in Marinette, MI. He gave me one of those beautiful cobbles, and I cut and polished it. It took a great polish, as did the silvery metal in it. Wow!

So off I went the next weekend, and luck was with me. I picked up about 20 pounds of those fist-size cobbles. Every one glowed like amethyst when I pulled it from the lake and held it up to the sun. I cut several, and each slice had some silvery globs in it. Double wow!!

So back I went, more than once, with equal success. But only once did I see someone else collecting.

So I talked with some local folks and asked if they knew about the amethyst cobbles with silver in them. They chuckled and said sure! Then they told me that it wasn't really amethyst and that the silver wasn't really silver.

What??

They explained that there used to be iron ore processing in Marquette, MI. The slag and wastes were dumped along the lake front. I visited the area and found a clinker with "amethyst" cobbles embedded in it.

The lesson I learned was this: Talk with the locals, then collect.

Cheers,

Wayne

Fulgurite from Nagshead, NC, 3-1/2 inches by 3/16 inches. Source: Mindat.

Thanks, Mr. Sukow!

I know that there are 200-plus years of industrial waste along the banks of the Potomac and its tributaries. I also know that this is hard to do online, and thanks for your patience!

But my rock looks a lot like the samples at the following URL, showing pieces of a partially collapsed fulgurite tube from Florence, AZ: http://www.turnstone.ca/rom124fu.htm.

Matt

Fred C. Schaefermeyer Scholarship Award Nominee

Editor's Note: Kathy Hrechka, NVMC Vice-President, recently asked Dr. Julia Nord, professor of geology at George Mason University, whether she had a student deserving of a $250 scholarship award for 2014. Here is her reply.

I would like to suggest Jon Culpepper for the Fred C. Schaefermeyer Scholarship Award.

Jon is a senior undergraduate getting a bachelor's degree in geology. He is presenting a paper at the Geological Society of America, Northeastern Region, in Lancaster, PA, on March 23–24, 2014. Jon's paper is titled "Formation and Closure of a Wave-Dominated Tidal Inlet: Implications for a Multiple-Channel Inlet System along Assateague Island, Maryland."

Thank you,

Julia Nord
Department of Atmospheric, Oceanic, and Earth Sciences
George Mason University

Virginia ROCKS!
Geologic Selections on Display

Thanks to Sue Marcus for the link!

The University of Richmond Museums has more than 40 specimens on display through June 12, 2015. The exhibition presents an introduction to the geology of Virginia, highlighting the processes that shaped the land.
http://museums.richmond.edu/exhibitions/lora-robins-gallery/Virginia-rocks.html

Carrot, carat, or karat?

Editor's note: The piece is adapted from Goldrush Ledger *(newsletter of the Charlotte Gem and Mineral Club, Charlotte, NC), October 2013, p. 7.*

The term *carat* comes from the Middle French word carat, which came from the Italian carato, which came from the Arabic qirat, which came from the Greek keration, which meant carob seed.

A carat (abbreviated as ct.) is a unit of weight equal to 200 milligrams, or one-fifth of a gram. It contains 100 points, each equal to 2 milligrams. Accordingly, a stone that is 10 carats and 15 points weighs 2,030 milligrams ((10 × 200 mg) + (15 × 2 mg)).

Points are often used in the diamond industry to demark the weight of very small stones. For example, a dealer might say, "The diamond was a 10-point melee piece." (That is, equivalent to one-tenth of a carat.)

The term *karat* (sometimes also written as carat and abbreviated as kt) describes the purity of a metal. Pure gold is 24 karats.

The weird numbering comes from the Roman Emperor Constantine, who minted a gold coin called the solidus. It weighed 1/72 of a libra (or pound) of Roman gold and was worth 24 siliquae, a coin of lesser value. So each siliqua was equivalent to 1/1728 of a libra, the precise weight of a karat. (Wasn't that easy?)

So gold content by karat measure goes roughly like this:

- 24 kt = 100%
- 18 kt = 75%
- 14 kt = 58.3%
- 10 kt = 41.7%

Finally, we come to the word *carrot*. It comes from the Latin carote, with came from the Greek karotov, derived from the Indo-European ker- (meaning horn).

A carrot, as you know, is a vegetable; people generally prefer to eat the root. The first carrots were red or yellow, and it was not until reaching the Netherlands around 1600 that the carrot developed its distinctive orange color.

29.5-Carat Blue Diamond Discovered in South Africa

by Kathy Hrechka, Vice-President

Editor's note: The piece is adapted from The Mineral Mite (*newsletter of the Micromineralogists of the National Capital Area, Inc.), February 2014, pp. 6–7.*

On January 21, 2014, a miner discovered a 29.5-carat blue diamond, one of the rarest and most coveted gems, at the Cullinan Mine near Pretoria, South Africa.

Famous Mine

The Cullinan Mine, owned by Petra Diamonds since 2008, was formerly known as the Premier Diamond Mine. The mine owner, Sir Thomas Cullinan, accidentally discovered a 3,106-carat diamond on January 26, 1905. It was the largest gem-quality rough diamond ever recovered, and it was named after its discoverer.

The original uncut Cullinan Diamond has been cut into 9 major stones and 98 minor ones.

The ***Cullinan I***, known as the Star of Africa, is the largest of the Cullinan diamonds, with a pear-shaped cut and weighing 530.2 carats. King Edward VII had the diamond mounted on the head of the Royal Scepter, and it is now on display in the Tower of London.

The ***Cullinan II***, known as the lesser Star of Africa, is the second largest Cullinan diamond, with a cushion shape and weighing 317.4 carats. It is mounted on the band of the Imperial State Crown of Great Britain.

The ***Cullinan III*** weighs 94.4 carats and has a pear-shaped cut. It is mounted in the crown worn by Queen Mary, consort of King George V. It can also be combined with Cullinan IV to form a pendant-brooch; most of Queen Mary's portraits show her wearing the brooch.

The ***Cullinan IV*** weighs 63.6 carats and has a cushion-shape cut. Like the Cullinan III, it was originally mounted on Queen Mary's crown, but it was subsequently combined with Cullinan III to form a brooch.

The ***Cullinan V*** weighs 18.8 carats and has a triangular heart-shaped cut. It also has a dual use as both the centerpiece of a brooch in the royal Delhi Durbar necklace and as part of the queen's crown.

The ***Cullinan VI*** is a marquise-cut stone with a weight of 11.5 carats. King Edward VII purchased the diamond and presented it to his consort, Queen Alexandra, as a personal gift. Queen Alexandra had the diamond mounted in her regal circlet.

The ***Cullinan VII*** is also a marquise-cut stone, but it weighs 8.8 carats. It is set as an asymmetrical pendant in the Delhi Durbar necklace.

The ***Cullinan VIII*** is a cushion-cut 6.8-carat diamond set as the centerpiece of a brooch in the Delhi Durbar necklace, along with the Cullinan VI. The combination came to be known as the Cullinan VI and VIII Brooch.

Finally, the ***Cullinan IX*** weighs just 4.4 carats. Its cut is a pear-shaped modification of the round brilliant cut known as the pendeloque. The stone was set in a platinum ring for Queen Mary in 1911.

The Cullinan diamonds all belong to the personal collection of Queen Elizabeth. They are on display in the Tower of London's vault.

Centenary Diamond

In 1986, the Centenary Diamond was the third-largest diamond ever recovered from Premier Mine. It weighed 599 carats.

The diamond was officially unveiled in May 1991 with a faceted heart shape. It weighed 273.85 carats and had an unprecedented 247 facets. There were also two separate pear-shaped diamonds, both flawless.

The Centenary Diamond was sold in June 2008 by De Beers.

Seneca Creek Sandstone

by Hutch Brown, Editor

I work for the U.S. Forest Service in the historic Yates Building, located next to the Holocaust Memorial in Washington, DC. The Yates Building is down the street from the Smithsonian Institution building called the Castle. The Yates Building looks a lot like the Castle, but it is made of red brick rather than red sandstone.

I have often wondered about the origins of that red sandstone in the Castle. Where did it come from? And what is the geological story behind it?

Good Building Stone

The Castle was designed by architect James Renwick, Jr., to house the Smithsonian Institution. Completed in 1855, it was initially an isolated building, but it became the anchor for the Washington Mall as other federal buildings, including the Yates Building (completed in 1890), were constructed nearby.

Seneca Creek sandstone was chosen for the building for two reasons: it was soft enough for easy quarrying, but after exposure it became extremely hard and weather-resistant; and, after quarrying, it changed color from grayish purple to a deep pleasing red. No one living has seen the Castle in its original color.

The first quarry, known as the Seneca Quarry, is located on the Chesapeake and Ohio (C&O) Canal on the north bank of the Potomac River, just

The Seneca stone-cutting mill, built in 1837, cut the stone for the Smithsonian Castle.

The Smithsonian Institution Castle (above), made from Seneca Creek sandstone (right) quarried in Maryland.

west of where Seneca Creek drains into the river. Quarrying began in the 1780s, providing stone for canals built to skirt the falls of the Potomac; Seneca Creek sandstone is still visible in the locks at Great Falls, VA. It was also used to build the C&O Canal on the Maryland side of the Potomac River, a more successful venture that operated until 1924, finally failing due to competition from railroads.

Quarrying Seneca Creek sandstone was highly successful due to the workability, durability, and coloration of the stone and its proximity to the C&O Canal. The most profitable year for quarrying was 1871, when 850,000 tons of stone were transported by canal. According to the 1897 Geological Survey of Maryland, Seneca Creek sandstone was still "one of the best Triassic sandstones." The biggest quarries of sandstone from the Triassic belt at the time were all in Seneca Creek sandstone.

Rifting Event

So how did the Seneca Creek sandstone get there in the first place? After all, Seneca Creek is squarely in the mid-Atlantic Piedmont geologic province, where highly folded, fractured, and faulted metamorphic rocks prevail. How did sedimentary rock get mixed in with the schists, metagraywackes, and other metamorphic rocks commonly exposed by the Potomac and its tributaries in the Piedmont?

About 320 million years ago, the proto-African continent slammed into proto-North America in a great mountain-building event known as the Alleghanian orogeny. The orogeny formed three of the five geologic provinces in the mid-Atlantic region: the Piedmont, Blue Ridge, and Valley and Ridge.

During the Permian Period (from about 286 to about 245 million years ago), the last of the great Alleghanian mountain chain was eroding down to a plain. All of Earth's continents were united at the time in the so-called Pangaea supercontinent.

The great weight of a supercontinent increases heat and pressure from the mantle, resulting in its eventual rifting and breakup. Upwelling magma stretches and softens the overlying rock at preexisting points of weakness. Where it reaches the surface, the magma creates volcanoes and lava flows; where it does not, it forms great intrusions called plutons, helping to lift and break the brittle surface rocks (fig. 1).

Entire blocks of rock slip down along fault lines in the brittle overlying rock, forming steep cliffs (horsts, from the German word for eyrie). The horsts tower over deep trenches (graben, from the German word for pit). In a classic rifting event, rifts break along an axis with three limbs, much as Africa is breaking away from Arabia today (fig. 2).

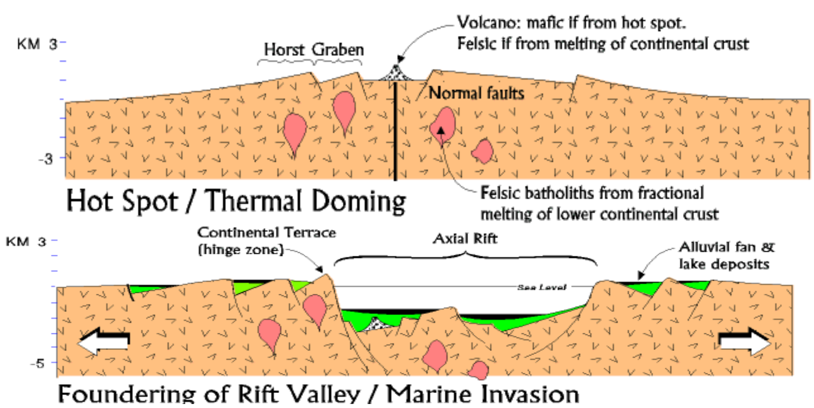
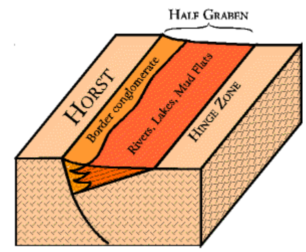


Figure 1—*Rifting event as a continent breaks up. Magma wells up at a "hot spot" in the rock, thinning and uplifting the continent and breaking the overlying brittle rock. Masses of rock slide down along fault lines, forming horsts and graben. As the axial rift widens, seawater intrudes, creating an incipient ocean. As the ocean widens, sediments accumulate, burying the axial rift, its dormant volcano, and the parallel rifts. Source: Fichter and Baedke (1999).*

Each axial rift forms a full graben, with fault lines on each side. Paralleling the axial rift are half grabens, with a fault on only one side; rift valleys form as rock slides down the fault as if on a hinge.



And that's what we have at Seneca Creek: a half graben filled with sediments that became sandstone.

Culpeper Basin

About 230 million years ago, Pangaea began to break up. Upwelling magma found old fault lines between proto-Africa and proto-North America and reactivated them. That included the old suture line between the Piedmont and Blue Ridge Provinces, where island arcs had collided with proto-North America, attaching terranes—pieces of ocean plates—onto the edge of the continent more than 350 million years ago.

As magma rose under the continent, the brittle overlying rock broke along the old fault line, now known as the Bull Run fault. A half graben formed along the western edge of the Piedmont Province. The rift valley to the east, now known as the Culpeper Basin, extends from what is now Frederick, MD, to about 40 miles south of Manassas, VA (fig. 3).

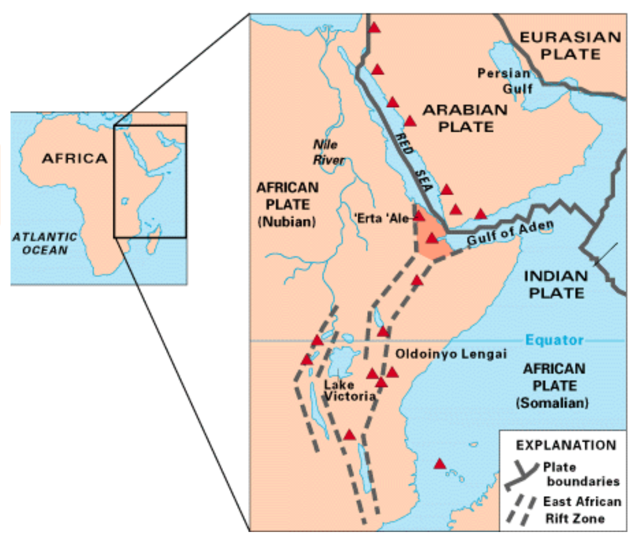


Figure 2—*The Afar Triple Junction, a rifting event that is forming the Red Sea, Gulf of Aden, and Great Rift Valley. Source: Wikipedia.*

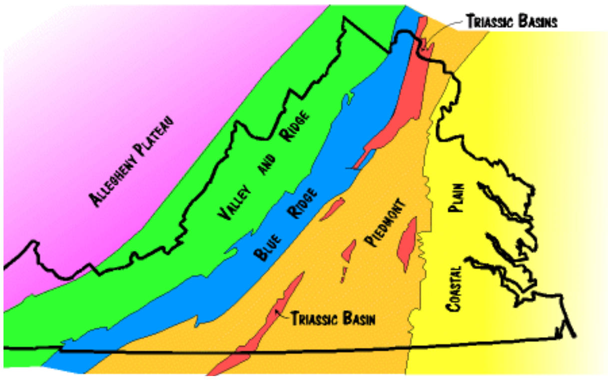


Figure 3—*Triassic basins in Virginia (red). The northernmost is the Culpeper Basin, extending into Maryland. Source: Fichter and Baedke (1999).*

Even while the basin was still forming (which took tens of thousands of years), it was already starting to fill (fig. 4). Rifting was associated with volcanic activity and lava flows that became layers of basalt, as well as with nonsurfacing magma that became dikes and sills of diabase. Gravels and sands washed from the horst in great alluvial fans, and a river formed in the basin, along with associated lakes, much as the upper Nile River drains portions of the Great Rift Valley today (figs. 2, 4).

Over about 30 million years, the basin gradually filled with river and lake deposits and other sediments. The sediments consolidated into various kinds of sedimentary rock: siltstones, shales, sandstones, and conglomerates, including Balls Bluff siltstone, Bull Run shale, and Manassas sandstone. Some contain fossils and animal imprints.

According to one source, Seneca Creek sandstone is composed of quartz and feldspar with a dark-red to reddish-purple clayey silt matrix. It contains mica, and it is part of a broader geological formation, the Manassas formation, which contains quartzite pebbles and conglomerate lenses.

The inclusions indicate that the original sediments came from adjacent metamorphic highlands, such as those associated with the eastern edge of the Blue Ridge Province (the horst, formed in part by Weverton and Antietam quartzites). Sediments might also have come from granite intrusions to the east, along the rift valley hinge (fig. 4). The sediments were depos-

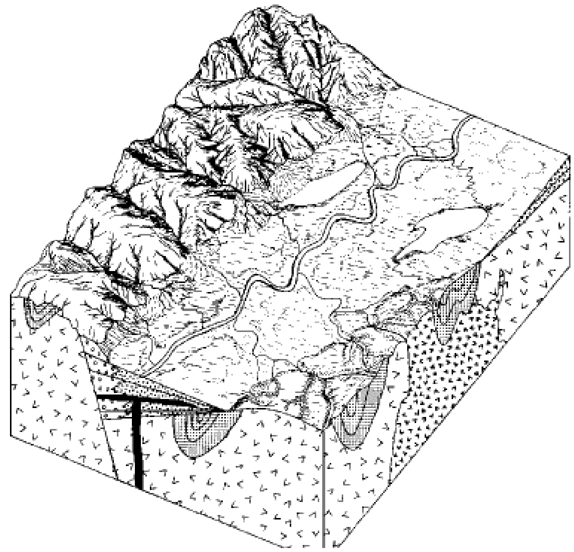


Figure 4—*Schematic drawing showing part of Culpeper Basin about 200 million years ago. The basin is gradually filling with sediments eroded from the horst and carried in by the river that drains the basin. The fault and hinge are visible in the cross-section, as are a dike and lava flow (black bars). The Vs indicate bedrock; the dots on the right indicate igneous plutonic rock on the hinge. Source: Fichter and Baedke (1999).*

ited by braided streams with headwaters likely to the northeast and southwest, at both heads of the basin (fig. 3). The outflow was likely to the east, draining into the Atlantic.

According to another source, the red color of the Seneca Creek sandstone came from sediments rich in iron, also found in other kinds of Culpeper Basin rock, such as in the nearby Balls Bluff siltstone. In a wetter climate, the feldspar and matrix components would have weathered into clay; but the Seneca Creek sandstone solidified in an arid climate, with enormous desert flats, much like the Mojave Desert today. The intermittent groundwater helped the sandstone absorb iron-rich minerals over tens of thousands of years. In effect, the sandstone "rusted."

End of an Era

The ancient horst has long since eroded away, though since rejuvenated as Bull Run Mountain, Catoctin Mountain, and other familiar landforms in our area. After all, the underlying geology remains the same. The Potomac River has eroded away some of the sedimentary rock in the

Culpeper Basin, exposing a bluff of Seneca Creek sandstone along its Maryland bank.

However, the sandstone's extent was limited to alluvial fans from the ancient horst and to the relatively narrow river beds and floodplains of the ancient rift valley. The best sandstone was apparently in a wide and deep river lens near Seneca Creek. By 1900, it was gone, and use of the C&O Canal was declining. Moreover, demand for highly colored stone was falling.

In 1901, the Seneca Quarry closed. Production of Seneca Creek sandstone continued, but only at very small quarries that supplied a limited amount of material to local communities. Demand for building materials shifted to the lighter colored marbles, granites, and limestones you can see in the monuments and government buildings on the Washington Mall. ⛏

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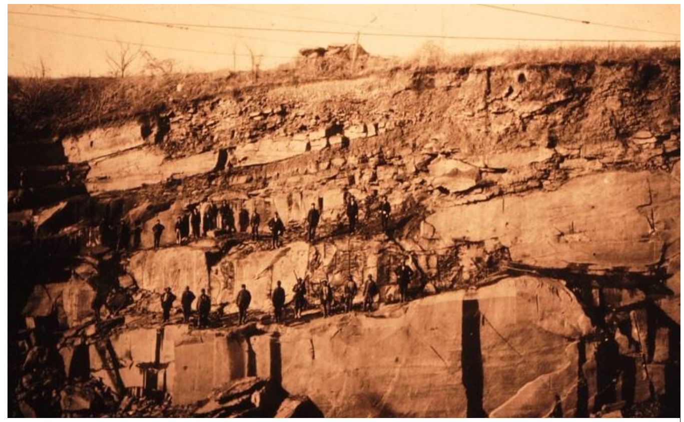

Seneca Quarry in about 1890. Source: Peck (2013).

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Mineral Evolution

by Dr. Vivien Gornitz

Editor's note: The piece is adapted from Goldrush Ledger (*newsletter of the Charlotte Gem and Mineral Club, Charlotte, NC), January 2013, pp. 5–7. It originally appeared in the* Bulletin of the New York Mineralogical Club*, June 2010; it won third place in the 2011 AFMS contest for Original Adult Articles, Advanced.*

Minerals evolve! Robert Hazen and his colleagues came to this startling conclusion to explain the wide variety of minerals on Earth.

Although the evolution of minerals and the evolution of biology involve totally different principles, both share a number of fundamental characteristics: basic selection rules, increasing complexity over time, and extinction.

Unlike biological systems, however, minerals cannot mutate or pass on information to succeeding generations through genetic codes. Furthermore, minerals have hardly ever gone extinct on Earth. (Diamond may be a rare exception. Diamonds crystallized billions of years ago in the Earth's upper mantle and came to the surface much later in violent volcanic eruptions.)

Mineral extinction has occurred elsewhere. On the Moon, volcanism ceased several billion years ago. On Mars, deposition of clay and sulfate minerals stopped after the Red Planet grew drier and colder.

At its most basic level, evolution is simply change over time; in this simple sense, mineral evolution has undoubtedly occurred.

Furthermore, mineral assemblages on Earth have grown more diverse and complex over time, going from the handful of minerals predating the origin of the solar system to over 4,400 kinds known today.

Thus, mineral evolution illustrates the growing complexity of the universe. Other examples include cosmic evolution from the Big Bang; the creation of chemical elements in stars; the formation of galaxies and the solar system; the differentiation of the Earth into core, mantle, and crust; the history of life; the development of languages; and the growth of technology.

Hazen and his colleagues proposed three major eras, subdivided into ten stages of mineral evolution. Summarized in table 1, the eras are closely linked to major biological and geochemical transformations.

Over 4.6 billion years ago, before the solar system formed, the clouds of dust and gas swirling around stars created a mere dozen minerals. Tiny nanograins of diamond, graphite, moissanite, spinel and other rare stardust "ur-minerals" survive in the universe's oldest meteorites.

Meteorites provide our only window into the first era of mineral evolution, about 4.56 to 4.55 billion years ago, during the formation of the solar system and planetary accretion. At that time, the first iron-nickel, sulfides (such as troilite), phosphides (such as schreibersite), and high-melting silicates (such as anorthite) appeared, bringing the total number of minerals in existence to 60. Toward the end of the first era,

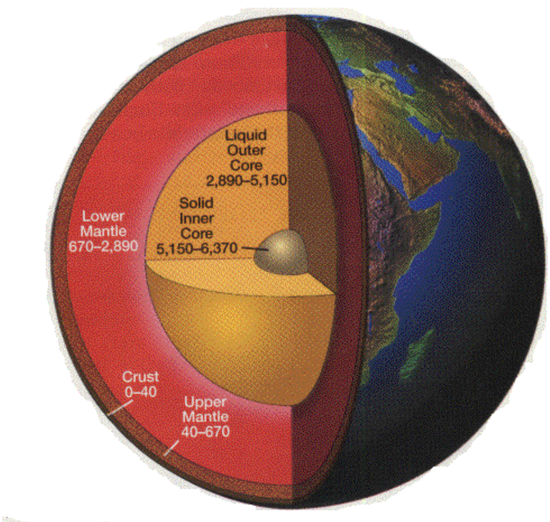
Table 1—Eras of mineral evolution, by age and number of minerals in existence.

Era	Age (billion years ago)	Number of minerals existing	Examples
Before solar system	>4.6	12	Nanodiamond, graphite, moissanite
Solar system forms	>4.55	250	Iron-nickel, troilite, olivine, pyroxene
Plate tectonics begin	4.55	1,500	Quartz, mica, orthoclase, tourmaline, zircon, pyrite, kyanite
Biological influences begin	2.5	4,400+	Hematite, calcite, aragonite, hydroxyapatite, abundant clays

additional heating, remelting, and alteration by water expanded the list to 250.

During the second era, from about 4.55 to 2.5 billion years ago, the Earth differentiated into core, mantle, and crust, generating a cumulative total of 1,500 minerals. New minerals formed as a result of igneous and volcanic processes, metamorphism, and the chemical interaction of fluids with rocks.

Part of the NWA 869 chondrite, a piece of an asteroid that predates the solar system. It contains bits of diamond, graphite, and other early minerals. Source: Wikipedia.



The differentiation of the Earth into core, mantle, and crust gave rise to geological processes that formed new minerals. Source: Dolphin (2002).

Plate tectonics began. Starting with basalt, partial melting and crystallization led to formation of granitic rocks and pegmatites, along with their characteristic minerals, such as quartz, microcline, muscovite, albite, tourmaline, beryl, topaz, uranium, thorium, and rare earth minerals. Hydrothermal ore deposits also accumulated in veins, producing many sulfides, sulfarsenides, and sulfantimonides. Life originated toward the end of this era, but its impact on mineralogy was initially small.

Before 2.5 billion years ago, when atmospheric oxygen levels were still quite low, detrital pyrite and uraninite grains were able to concentrate in gold and uranium deposits at Witwatersrand, South Africa—deposits that are 2.9 to 2.7 billion years old. Today, these minerals would rapidly oxidize at the Earth's surface, so they never occur as detrital grains.

During the third era, from about 2.5 billion years ago to the present, biology began to influence mineralogy, producing over half of all known minerals. The Great Oxidation Event, from about 2.5 to 2.4 billion years ago, marked a major bio-geochemical milestone, when atmospheric oxygen levels reached over 1 percent of modern values, irreversibly transforming the Earth's surface mineralogy.

The oxygen we breathe was initially produced by photosynthesizing cyanobacteria and later by

High-grade gold ore from Witwatersrand, South Africa, deposited more than 2.7 billion years ago. Source: Wikipedia.

plants that converted the sun's energy, water, and carbon dioxide into carbohydrates and other organic molecules. The Great Oxidation Event resulted in an abundance of banded iron formations. These deposits, our main source of iron, consist of layers of red jasper, hematite, and magnetite, with lesser amounts of iron sulfides, carbonates, and other minerals.

From the perspective of mineral evolution, the rise of atmospheric oxygen probably represents the most important cause of mineral diversification. Of over 4,400 known minerals, more than half are oxidized and hydrated minerals that are weathered or altered from other minerals.

Sedimentary phosphates and sulfates (such as gypsum and anhydrite) grew more abundant in shallow seas. Colorful secondary copper minerals such as turquoise, azurite, malachite, and brochantite could not have appeared until enough biologically produced oxygen had accumulated in the atmosphere. The same holds true for many other elements, such as uranium, vanadium, arsenic, antimony, and boron.

Banded iron formation, about 2.1 billion years old. Source: Wikipedia.

The last chapter of the third era, from 542 million years ago to the present, saw the great diversification of life, from trilobite to Homo sapiens. The proliferation of life resulted in extensive biomineralization. The remains of marine organisms, for example, formed most limestones and phosphatic rocks. Microbial reduction of evaporitic gypsum produced the native sulfur deposits of the Gulf Coast. Other biominerals include whewellite and whitlockite.

Directly or indirectly, living organisms have contributed to the formation of more than 60 minerals, but the influence of life extends way beyond these. Soil microbial activity has hastened chemical weathering. Biology affects the geochemical cycling of many elements, such as carbon, nitrogen, sulfur, and phosphorus through the atmosphere and in rocks.

Altogether, through various geological and biological processes, the Earth now boasts a grand total of over 4,400 minerals, and new ones are still being discovered. This novel perspective enables us to appreciate the coevolution of minerals and life. Life did not evolve passively, merely adapting to changing environmental conditions. Life has actively participated in shaping the geology and climate of this planet.

Whewellite (hydrated calcium oxalate), found in coal and limestone nodules, has biological origins. Small crystals are sometimes found in plants. Source: Mindat.

Sources

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I Need to Inspect It ...

Editor's note: The piece is adapted from The Cowtown Cutter *(newsletter of the Fort Worth Gem and Mineral Club), April 2013, p. 6. It reinforces the need to respect private property while collecting.*

A cocky official from USDA stopped at a farm to talk to an old farmer.

"I need to inspect your farm," he said.

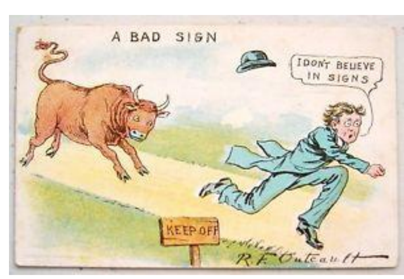
"Okay," the farmer replied, "but don't go in that field right over yonder."

"Look, mister," the official declared, "I have all the authority of the United States government. See this card? This card means I go wherever I want on any agricultural land, no questions asked."

The farmer shrugged and went about his business. A few minutes later, he heard screams and saw the official running for the fence. Behind him, closing fast, was the farmer's prize bull.

The farmer threw down his tools and ran over to the fence, shouting with all his might.

"Your card! Your card! Show him your card!"



Upcoming Events
(of interest in the mid-Atlantic region)

March

7–9: 26th Annual Aiken Gem, Mineral, and Fossil Show; Fri.–Sat. 10–7, Sun. 11–5; Julian Smith Casino, 2200 Broad St., Augusta, GA

8: 24th Annual Mineral, Jewelry & Fossil Show; Sat. 10–5; The Show Place Arena, 14900 Pennsylvania Ave., Upper Marlboro, MD http://www.smrmc.org

14: Auction, estate of Dale Fisher; Chesapeake Gem and Mineral Society; preview 7 p.m., action 7:30 p.m.; slab saws, tumblers, microscope, cut stones, thumbnail minerals, and more; 2414 Westchester Ave., Oella, MD http://www.chesapeakegemandmineral.org/

15–16: Annual Gem Mineral and Fossil Show Gem Lapidary and Mineral Society of Montgomery County
Sat. 10–6, Sun. 11–5; adult admission: $6 Montgomery County Fairgrounds, 16 Chestnut St., Gaithersburg, MD
http://www.glmsmc.com

22–23: 45nd Annual Gem & Mineral Show Che-Hanna Rock and Mineral Club, Athens Twp. Vol. Fire Hall, 211 Herrick Ave., Sayre, PA; Contact: Bob Mcguire (570/928-9238) http://www.chehannarocks.com

29–30: 64th Annual EFMLS Convention and Show; Philadelphia Mineralogical Society and Delaware Valley Paleontological Society; LuLu Temple, Plymouth Meeting, PA

April

4–5: Atlantic Micromounters' Conference; Spring Hill Suites Alexandria, VA, by Marriott, Rt. 1; preregistration required: http://www.dcmicrominerals.org/

7–13: EFMLS workshops at Wildacres Geology Retreat; Spring classes; tuition $390 www.amfed.org/efmls

11–13: NY/NJ Mineral, Fossil, Gem, and Jewelry Show; 350–400 exhibitor booths with minerals, fossils, dinosaurs, meteorites, gems, jewelry, gold, silver, turquoise; New Jersey Convention & Exposition Center, 97 Sunfield Avenue, Edison, NJ

18–19: Gem, Mineral, and Fossil Show North Museum of Natural History and Science; Fri. 10–6, Sat. 10–5; Farm and Home Center, 1383 Arcadia Rd (off Manheim Pike) Lancaster, PA; Educational programs, door prizes, food; contact: Alison Mallin, 717-358-7188; amallin@northmuseum.org

26: Sterling Hill Super Dig; ultraviolent event; registration fee: $21 http://www.SterlingHillSuperDig.org

May

3–4: Treasures of the Earth: 11th Annual Show and Sale; The Mineralogical Society of Northeastern Pennsylvania, Oblates of St. Joseph, 1880 Highway 315, Pittston, PA

17–18: 46th Annual World of Gems and Minerals: Gemstone, Jewelry, Bead, Mineral and Fossil Show; Berks Mineralogical Society, Leesport Farmer's Market, Route 61, Leesport, PA

24: Ruhl Armory Show; Sat. 10–4; Chesapeake Mineral Club, Baltimore, MD http://www.chesapeakegemandmineral.org/

June

7: 62nd Semi-Annual Mineralfest; Pennsylvania Earth Sciences Association; Macungie Memorial Park, Poplar Street, Macungie, PA

August

15–17: Gem Miners Jubilee; Fri. 10–6, Sat. 10–6, Sun 10–4; admission: $6; Lebanon Expo Center, Lebanon, PA http://www.gem-show.com

September

1–7: EFMLS workshops at Wildacres Geology Retreat; Fall classes, tuition $390 www.amfed.org/efmls

November

23-24: Northern Virginia Mineral Club Annual Show; George Mason University; Braddock Rd. and Rte. 123, Fairfax, VA

AUCTION BID SLIP

ITEM # ____ _______________
DESCRIPTION ____________
FROM _________________________
Starting Bid amount:__________
Bidders: You need to bid on this item if you want it to be auctioned! Place bid below.
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President: Wayne Sukow
d8olite@fastmail.fm
Vice-President: Kathy Hrechka
kshrechka@msn.com
Co-Secretary: Ti Meredith
ti.meredith@aol.com
Co-Secretary: Laurie Steiger
steigerlm@mail.nih.gov
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kenny53@verizon.net
Co-Treasurer: Rick Reiber
mathfun34@yahoo.com
Chair: Ted Carver
jtcarve@msn.com
Webmaster: Casper Voogt
webmaster@novamineralclub.org
Communications: Jim Kostka
jkostka@juno.com
Editor: Hutch Brown
hutchbrown41@gmail.com
Show Co-Chair: Tom Taaffe
rockcllctr@aol.com
Show Co-Chair: Jim Kostka
jkostka@juno.com
Greeter/Door Prizes: Ti Meredith
ti.meredith@aol.com

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

The Northern Virginia Mineral Club

You can send your newsletter articles to:

hutchbrown41@gmail.com

Visitors are always welcome at our club meetings!

RENEW YOUR MEMBERSHIP!

SEND YOUR DUES TO:
Kenny Loveless, Treasurer, NVMC
PO Box 10085, Manassas, VA 20108

OR

Bring your dues to the next meeting.

Purpose: To promote and 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, http://www.amfed.org/efmls) and the American Federation of Mineralogical Societies (AFMS—at http://www. amfed. org).

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

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 22204. (No meeting in July or August.)

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