

# The Mineral Minutes

“The Geology of Santorini”  
by Dr. Robert Hutchins “Hutch” Brown



Volume 77-10  
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Santorini is one of the most famous Greek islands in the Aegean Sea. If you’ve ever seen a Greek island in a tourism commercial, chances are it was Santorini. Hutch Brown happened to go there in summer 2018 on vacation with his family. He knew nothing about the geology of Greece, but from the moment he arrived, he knew there was a terrific story there – actually, multiple stories.



Hutch will explain why the island exists, from its origins in metamorphic bedrock to its status today as a sunken caldera partially ringed by the remains of ancient volcano walls.

Santorini is part of an island arc formed by the collision of Africa with Eurasia, and Hutch will discuss the corresponding tectonic processes. The same processes are building a new volcanic shield in the middle of the caldera today. As time permits, Hutch will talk about the last violent eruption of the volcano more than 2,000 years ago and its connection with the ancient myth of Atlantis. He will also show photos of the cave dug into the volcanic tuff to create the vacation home where he and his family stayed.

Robert Hutchins “Hutch” Brown has a Ph.D. in German Literature from the University of California–Berkeley. After getting his degree in 1992, Hutch moved to northern Virginia, where he worked as a contract editor for various organizations, including the U.S. Geological Survey, the National Science Foundation, and the U.S. Forest Service. He took adult education courses in natural history, including a course in geology. In 2000, the Forest Service hired Hutch as a full-time writer/editor, mainly to write speeches for the Forest Service Chief. In addition to writing speeches, Hutch edits and writes articles for Fire Management Today, the quarterly journal for the Forest Service fire organization.

Please join us in taking Hutch to dinner on October 2nd at 6:00 pm at the Elephant and Castle at 1201 Pennsylvania Avenue, NW. If you cannot make it to dinner, please go directly to the lobby of the Natural History museum (Constitution Avenue entrance) at 7:30 pm. We will head upstairs to the Cathy Kerby Room at 7:45 pm for Hutch’s presentation.

## Sharing Time

by Dave Hennessey, MSDC President

For our sharing this month, it seems appropriate that we should look to minerals with a volcanic origin, but volcanoes are not a good source for minerals. They are a good source for rocks – like basalt, pumice, and obsidian. So, let’s expand our sharing to minerals with an igneous origin. Bring in your favorite igneous minerals or any other minerals you think the club will find interesting and tell us what makes them special and appreciated.

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## Prez Says...

by Dave Hennessey  
MSDC President

In May of 2002 my wife and I vacationed in Greece, flying in and out of Athens. A few days were spent in Athens doing the typical tourist things – the Acropolis, Parthenon, various temples and museums – but the remaining time was spent in the Cyclades islands. We traveled between the port of Athens (Piraeus) to Mykonos, Naxos, and Santorini. We enjoyed all the islands but the crown jewel was the island of Santorini.

(cont. on p. 2)

## MSDC's September 4, 2019 Business Meeting Report

by Andy Thompson, MSDC Secretary

President Dave Hennessey called the meeting to order, welcomed the guests and thanked the attending MSDC past presidents for their service.

Treasurer's Report: Dave called on John Weidner to provide an update on MSDC's finances. John noted that the club's cash flow in part derives from membership dues and currently there are thirty-four paid members. He also provided an overview of additional funds earmarked for future donations.

Approval of the Business Minutes: Dave then thanked Yury for editing and sending out the September Mineral Minutes newsletter and asked for a motion to accept the June Business Minutes published therein. Having received a motion which was seconded, the vote was to unanimously accept the minutes as published.

Old and New Business: No issues were cited as needing discussion.

Geology in the News: Dave asked if anyone saw recent interesting "Geology in the News" items.

- Robert reported on a recent press report describing evidence that a large asteroid impact contributed substantial oxygen to early Earth.
- Alex reported that one of the most famous sources of minerals in Brazil, the Batalha mine in the state of Paraiba, will be reopening. A particularly treasured specimen is an elbaite variety of tourmaline having a strikingly bright blue color. Dave Hennessey commented that the rare mineral, also identified as cuprian elbaite, when it comes onto the mineral market, will require serious dollars for purchase. He said almost any gem minerals that come from that reopened mine, will be treasured by collectors.
- Jeff reported that scientists have verified the discovery of iron carbide which had never before been found in nature. The specimen, named edscottite, was extracted from the Wedderburn meteorite found in Australia in 1951.
- Kathy brought samples of four newly issued Tyrannosaurus rex forever stamps and noted that the artwork was provided by Julius Csotonyi whose murals are found in the Fossil Hall of the National Museum of Natural History.

"Coming Events", a sub-category of Geology in the News, were cited by attendees, including the Atlantic Coast "Gem, Mineral, Jewelry and Fossil Show" to be held 28-29 Sept. For more information see: [www. Gemcutterguild.com](http://www.Gemcutterguild.com). That show is not to be confused with the Chesapeake Gem and Mineral Society Auction to be held October 11th in Oella, Maryland, 21043. See [chesapeakegemandmineral.org](http://chesapeakegemandmineral.org) for further details. And lastly, members may want to consider visiting the Yale Symposium coming on October 18-20. Details provided at: <http://peabody.yale.edu/events/peabody-mineral-symposium>.

With no further business to be addressed, Dave called for and received a motion and vote to close the meeting. He then asked Program V.P. Yury Kalish to introduce the evening's presenters, Dr. Shaunna Morrison and Cadence Boucher.

## September 4, 2019, Program Presented by Dr. Shaunna Morrison and Cadence Boucher "Network Analysis of Mineralogical Systems"

Synopsis by Andy Thompson, MSDC Secretary

MSDC's Vice President for programs, Yury Kalish, introduced the evening's program being presented by both Dr. Shaunna Morrison and teenage scientist Cadence Boucher. Shaunna began by explaining that she loved her early training in geology which was traditional in its emphasis on "description" of minerals and geological processes. Tonight's presentation, she noted, describes some of the benefits of her more recent research which is based less on description and more on data analysis. Also, her overview of "Network Analysis of Mineralogical Systems," the title of Shaunna's and Cadence's presentation, emphasizes prediction rather than description.

(cont. on p. 3)

Santorini is basically the rim of an exploded volcano and our hotel in Fira was perched on the side of the rim overlooking the water-filled caldera. The setting is breathtaking today, but I would not want to have been there when the volcano blew its top. I am looking forward to our presentation this month on the geologic history of Santorini and encourage everyone to follow the links to look at our presenter's articles on this subject published in the Northern Virginia Mineral Club newsletter. The links are:

Santorini, Greece: Sunken Caldera

<https://www.novamineralclub.org/sites/default/files/newsletters/2019-02/NVMC%20Feb%202019%20newsletter.pdf>

Santorini Greece: Volcanic History

<https://www.novamineralclub.org/sites/default/files/newsletters/2019-03/NVMC%20Mar%202019%20newsletter.pdf>

Santorini, Greece: Ancient Atlantis?

<https://www.novamineralclub.org/sites/default/files/newsletters/2019-03/NVMC%20Apr%202019%20newsletter.pdf>

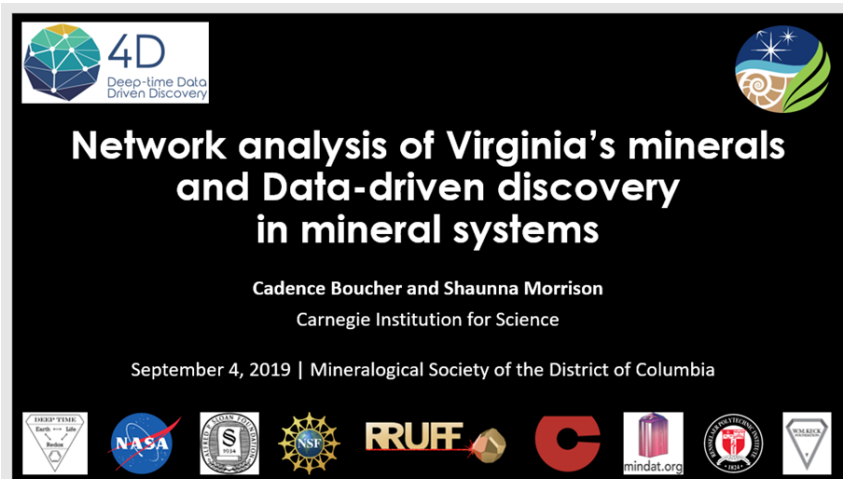
Santorini, Greece: Cave Vacation

<https://www.novamineralclub.org/sites/default/files/newsletters/2019-05/NVMC%20May%202019%20newsletter.pdf>

(September 4th Program... cont.)

This new data-centered method of exploring mineralogy opens new doors for:

- Predicting the location of minerals
- Predicting the existence of missing minerals
- Identifying affinity relationships among minerals
- Identifying the environment in which certain minerals have formed
- Discovering previously unknown minerals
- Characterizing the co-evolution of geology and the biosphere
- Helping explore the mineralogy of planets beyond Earth.



What enables this work-in-progress to happen is various scientists and institutions cooperating in creating, integrating and analyzing very large databanks on minerals, their locations, environment and history. Some of the sources include Mindat.org and the RRUFF Project (rruff.info), which is assembling a complete set of spectral data on minerals that allows scientists and the general public access to a standardized method for identifying minerals. The RRUFF Project also houses the Mineral Evolution Database (rruff.info/Evolution), an interactive, searchable databank of mineral-locality-age information based on the Robert Hazen's

concept of Mineral Evolution. Additional resources are the up-and-coming, NASA-funded MoonDB.org, intended to provide myriad details on meteorites.

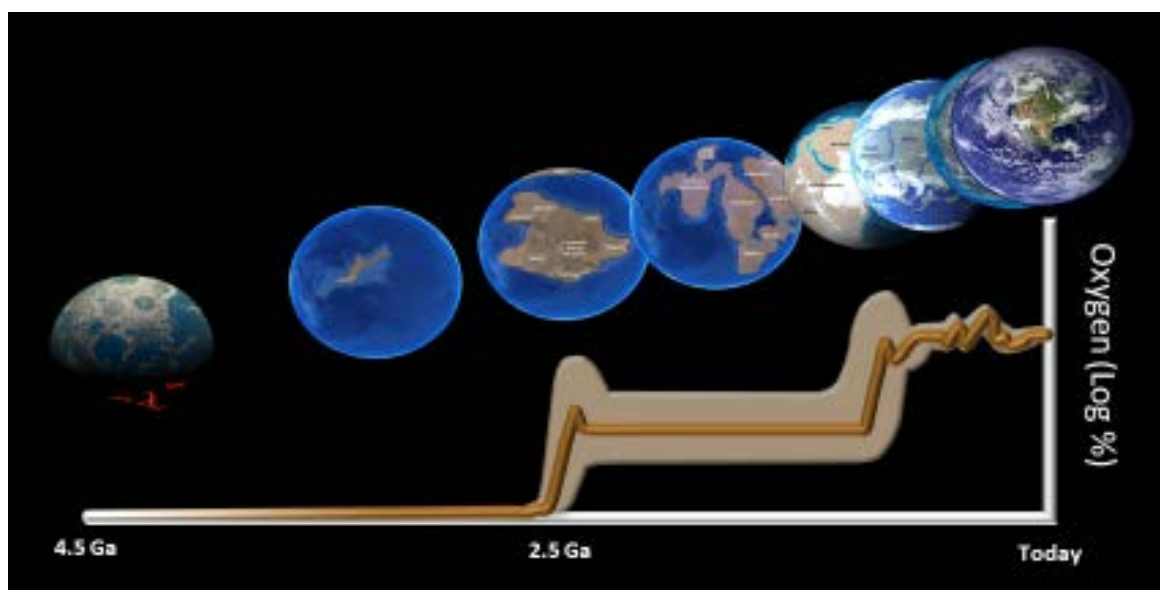
The networking of these databases is being assisted by the staff of several universities, including the University of Arizona, RPI (especially for visualization techniques) and Columbia University (which provides data infrastructure and curation expertise). Throughout her presentation, Shauna identified the many scientists and organizations collaborating with the Carnegie Institution for Science to further this mineral network analysis methodology.

An additional important aspect of this predictive methodology is that it uses "time" as the fourth dimension, deep time, to provide an extensive context for how, where and when minerals have aggregated. For further information she recommended visiting several websites including: 1) the Deep-Time Data Infrastructure site at [dtdi.carnegiescience.edu](http://dtdi.carnegiescience.edu), and 2) [4d-workshop.net](http://4d-workshop.net).

Shauna gave an example of how this method helps researchers bring together mineralogy and geologic processes illustrated below. The X-axis plots the earliest stages of the Earth's continents' formation associated with the Y-axis which plots rising oxygen levels. The method's synoptic view shows how at 2.5 Ga years, the great oxidation event occurred simultaneously with the initial coming together of the continents (Kenorland) and their biospheric production of cyanobacteria off-gassing of oxygen. That facilitated the formation of new mineral compounds containing oxygen.

This correlating mineral formation with biosphere formation in deep time, is but the first of three aims of the network analysis methodology, illustrated below.

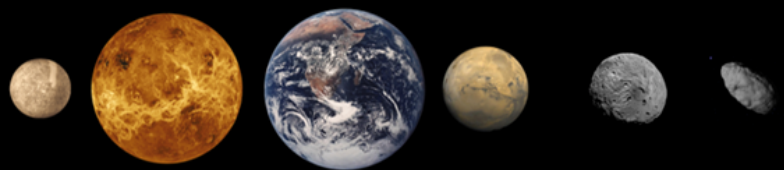
The practical result of aggregating enormous quantities of data on minerals is that researchers can then:



- use the RRUFF.info and Mindat.org information to identify patterns in the locations where minerals exist across the Earth's surface,
- identify which other minerals they are typically associated with (affinity),
- predict which minerals should exist which have not yet been discovered and
- illustrate the minerals' interactions and relationships over time with the biosphere.

### Research Aims

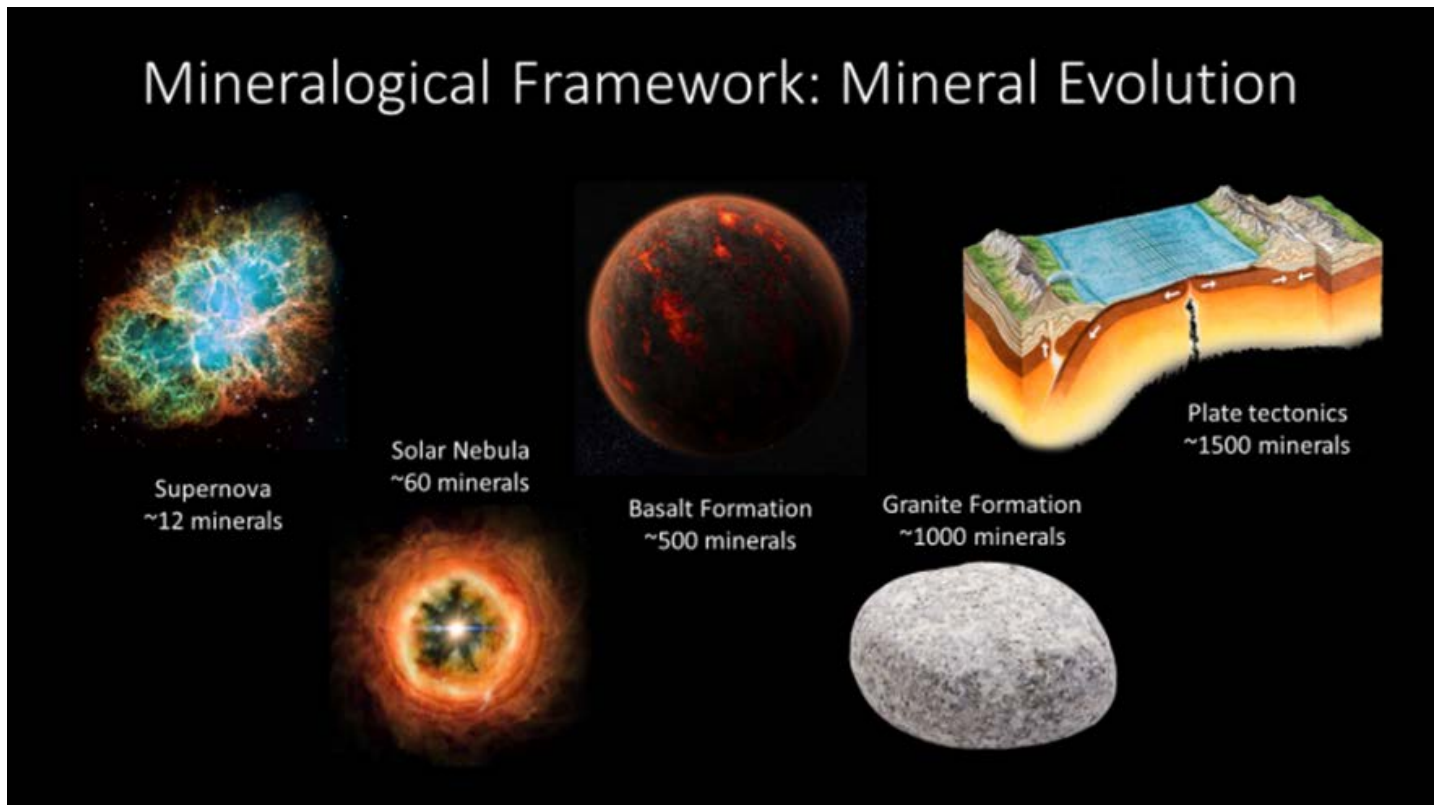
- Relating Earth's mineralogy and geochemistry to large-scale geologic processes and events through deep time.
- Deconvolve and characterizing the complex feedback systems between Earth's geosphere and biosphere.
- Assessing systematic trends in mineralogy, petrology, and geochemistry across rocky bodies in our solar system.



Mineralogical evolution happens, Shaunna explained, at both the cosmic as well as planetary levels. Led by Dr. Robert Hazen and his team of researchers, they discovered a pattern of increasing numbers of minerals associated with specific stages in the evolution of matter from a supernova to more complex formations. The explosion of a supernova typically has but a dozen minerals. The next stage, the formation of a solar nebula, has 60 minerals. When a planet forms, during its basalt stage it

has about 500 minerals and then as granite develops increases to 1,000 minerals. Lastly, with the arrival of plate tectonics, the team determined about 1,500 minerals had evolved. The Mineralogical Framework slide below illustrates those stages of mineral evolution.

## Mineralogical Framework: Mineral Evolution

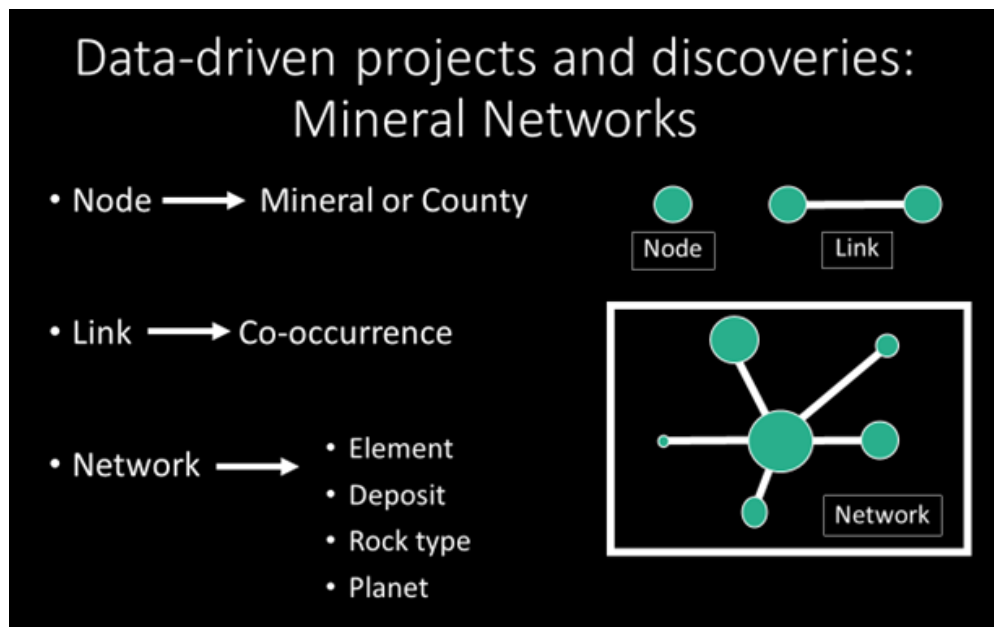


Supernova ~12 minerals      Solar Nebula ~60 minerals      Basalt Formation ~500 minerals      Granite Formation ~1000 minerals      Plate tectonics ~1500 minerals

With the above foundational overview, including the discussion of many additional discoveries of mineral evolutionary processes, Shaunna then introduced Cadence Boucher who presented her original research into how she applied the Mineral Network Analysis Method to the mineral systems of Virginia.

Cadence Boucher: Application of Network Analysis to the Mineralogy of Virginia

In effect, Cadence took the relevant data on the types and extent of minerals found throughout various locations in Virginia, and coded that information so she could perform a network analysis. A key component of this method is to use a sophisticated system of graphics allowing comparisons among the extensive data she programmed (coded). Cadence identified a particular variable, such as a type of mineral, as a node in the form of a circle. Then she identified other variables, such as particular counties or different minerals that are typically affiliated with the first mineral, and portrayed those relationship as links, as illustrated on the right.



The beauty of this multivariable analytic method is Cadence could code any number of diverse variables drawn from Mindat.org or other sources, and then use the graphic systems to show their intercorrelations. Illustrated below, for example, she portrayed the 8 color-coded types of tectonic deposits, from continental crust to clastic sediment, and linked them with the minerals typically found within each type of deposit. By doing that with a wide number of variables, that creates a network of information not previously available for graphic display.

## Virginia's Geology

- North America and an unknown plate collided
- They drifted apart and the Iapetus Ocean filled the space between
- Volcanic action
- African plate collided with North American plate
- They drifted apart and the Atlantic Ocean filled the space between

### A Brief Tectonic History of Virginia

1999, C. M. Bailey, College of William & Mary

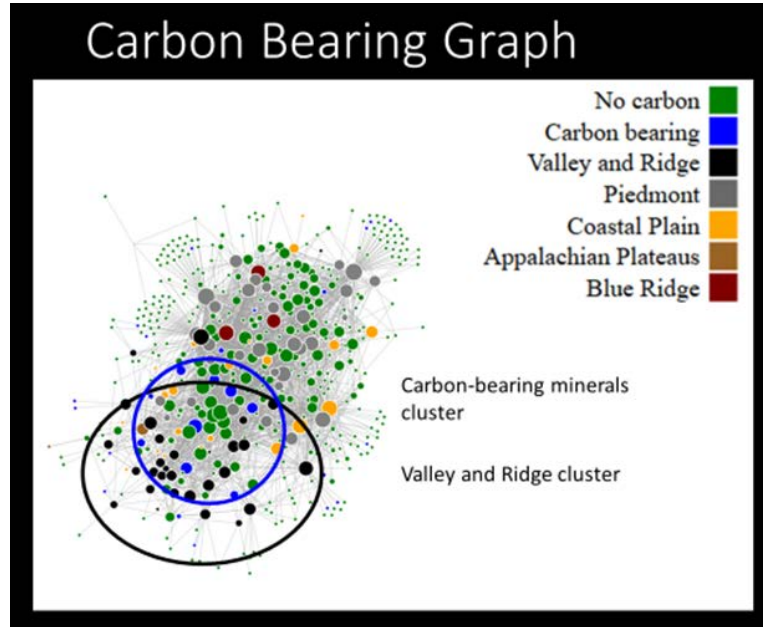
**Explanation**

<ul style="list-style-type: none"> <li><span style="display: inline-block; width: 15px; height: 10px; background-color: #f4a460; border: 1px solid black; margin-right: 5px;"></span> Continental Crust</li> <li><span style="display: inline-block; width: 15px; height: 10px; background-color: #000000; border: 1px solid black; margin-right: 5px;"></span> Ocean Crust</li> <li><span style="display: inline-block; width: 15px; height: 10px; background-color: #ff8c00; border: 1px solid black; margin-right: 5px;"></span> Mantle</li> <li><span style="display: inline-block; width: 15px; height: 10px; background-color: #ffff00; border: 1px solid black; margin-right: 5px;"></span> R/R Sediment</li> </ul>	<ul style="list-style-type: none"> <li><span style="display: inline-block; width: 15px; height: 10px; background-color: #add8e6; border: 1px solid black; margin-right: 5px;"></span> Carbonate Sediment</li> <li><span style="display: inline-block; width: 15px; height: 10px; background-color: #800080; border: 1px solid black; margin-right: 5px;"></span> Accretionary Wedge Sediment</li> <li><span style="display: inline-block; width: 15px; height: 10px; background-color: #ff0000; border: 1px solid black; margin-right: 5px;"></span> Volcanic-Plutonic Arc</li> <li><span style="display: inline-block; width: 15px; height: 10px; background-color: #90ee90; border: 1px solid black; margin-right: 5px;"></span> Clastic Sediment</li> </ul>
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<http://geology.blogs.wm.edu/virginias-geologic-history/>

Cadence did this analysis for several variables including linking the five geomorphic provinces of Virginia with the geological age of its deposition and with the type of soil or rock found in each, as noted below. Having coded all these variables, she and additional researchers around the nation and world can incorporate her data and analyses of Virginia mineralogy into future related research studies.

Cadence showed how the network analysis method was capable of constructing a sophisticated illustration of any particular genre of mineral, such as carbon bearing minerals, and showing their presence in each of the seven Virginia crustal regions. As shown in the Distribution chart on the right and in the next Carbon Bearing Graph graphically, the carbon minerals were most strongly present in one particular region, the Valley and Ridge, circled in black. That region had the highest concentration of carbon bearing minerals, practically 4.6%.



	Non-Carbon-Bearing Minerals	Carbon-Bearing Minerals
Valley:	21.96%	4.59%
Piedmont:	46.63%	4.81%
Coastal:	12.34%	0.87%
App:	1.09%	0.17%
Blue Ridge:	7.04%	0.48%

Cadence demonstrated that the same types of relationships can be graphed for any mineral for which data has been aggregated. She showed separate graphs identifying the concentrations of copper, silver, gold and pyrite throughout Virginia’s seven crustal regions. Such correlations are but one aspect of network analysis, the discovery and illustration of various affinities between mineralogical, biological and temporal variables. Importantly, Shaunna pointed to the additional areas as exciting, future exploration for mineralogists, namely predicting where, based on affinity analysis, scientists and field collectors can find particular minerals.

Although conclusions for this presentation are many, she ended by suggesting network analysis and data-driven discovery have the potential to integrate

and expand our scientific knowledge beyond Earth mineralogy, and across disciplines into a synthesis with the biological and planetary worlds, as stated below.

MSDC President Dave Hennessy thanked Cadence and Shaunna for their extraordinary presentations. They fielded attendees’ questions and everyone applauded their mind-expanding research findings. One attendee offered the opinion that this information can change people’s lives. “It certainly has changed mine,” said Shaunna.

### Data-driven projects and discoveries: Affinity Analysis

Based on all known mineral occurrences on Earth, we can generate association rules.

The association rules allow us to ask questions like:

1. Where can I find a new location of mineral X?
2. What other minerals, as-yet unreported, are likely to exist at a location of interest?
3. Where can I find a deposit or environment characterized by a certain mineral assemblage?

Morrison et al. In Prep; Prabhu et al. In Prep

### Conclusion

We have the opportunity, with the aid of data science, to look outward and integrate our multidimensional knowledge and understanding of Earth materials with that of other fields, including biology and astronomy, and to be key in answering long-standing, cross-disciplinary questions in Earth and planetary science.

## MSDC Club Information

Meetings are the First Wednesday of the Month (Jan-Jun and Sep-Dec). We meet in the Constitution Avenue lobby of the Smithsonian National Museum of Natural History at 7:30 pm.

Website <http://mineralogicalsocietyofdc.org/>

Facebook [www.facebook.com/Mineralogical-SocietyOfTheDistrictOfColumbia](http://www.facebook.com/Mineralogical-SocietyOfTheDistrictOfColumbia)

## 2019 Officers and Directors

**President** - Dave Hennessey | davidhennessey@comcast.net

**Vice President** - Yury Kalish | yury.kalish@gmail.com

**Secretary** - Andy Thompson | thompson01@starpower.net

**Treasurer** - John Weidner

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### THE MINERAL MINUTES

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NEWSLETTER OF THE MINERALOGICAL SOCIETY OF THE DISTRICT OF COLUMBIA

Mineralogical Society of DC  
Time Sensitive Dated Material  
First-Class Mail

Useful Mineral Links

	<p>American Federation of Mineralogical Societies (AFMS)</p>	<p><a href="http://www.amfed.org">www.amfed.org</a></p>
	<p>Eastern Federation of Mineralogical and Lapidary Societies (EFMLS)</p>	<p><a href="http://www.amfed.org/efmls">www.amfed.org/efmls</a></p>
 <p><a href="http://mindat.org">mindat.org</a></p>	<p>MINDAT</p>	<p><a href="http://www.mindat.org">www.mindat.org</a></p>
	<p>Mineralogical Society of America (MSA)</p>	<p><a href="http://www.minoscam.org">www.minoscam.org</a></p>
	<p>Friends of Mineralogy</p>	<p><a href="http://www.friendsofmineralogy.org/">www.friendsofmineralogy.org/</a></p>
	<p>WebMineral</p>	<p><a href="http://webmineral.com">webmineral.com</a></p>
	<p>The Geological Society of America (GSA)</p>	<p><a href="http://www.geosociety.org/">www.geosociety.org/</a></p>
	<p>Jeff Scovil Mineral Photography (not advertising - just great photos)</p>	<p><a href="http://scovilphotography.com/">scovilphotography.com/</a></p>
	<p>United States Geological Survey (USGS)</p>	<p><a href="http://www.usgs.gov">www.usgs.gov</a></p>
	<p>The Geological Society of Washington (GSW)</p>	<p><a href="http://www.gswweb.org/">http://www.gswweb.org/</a></p>

Mineralogy Events in DC Area

*Paul Desautels Memorial Micromount Symposium*

Date: October 11-13, 2019  
 Place: The Friends School of Baltimore, 5114 North Charles Street, Baltimore, MD 21210.

For more information, contact the symposium chair, MikeSeeds (mseeds@fandm.edu) or Steve Weinberger (cscrystals2@gmail.com).

Also, see: [www.BaltimoreMineralSociety.org](http://www.BaltimoreMineralSociety.org).

*The Chesapeake Gem & Mineral Society Auction*

Date: Friday, October 11th, 2019  
 Time: 7:30 pm (viewing at 7:00 pm)  
 Place: Westchester Community Center 2414 Westchester Ave., Oella MD 21043  
 Items that can be found are Gemstones, Cutting rough, Jewelry, Minerals, Fossils, Books, Magazines, and Lapidary equipment.

Refreshments are available.

Directions:

From the north:  
 Take I-695 to US 40 west (exit 15B). Turn left on N. Rolling Rd. Turn right at Old Fredrick Rd. (You will pass through 1 roundabout). Turn right on Oella Ave. Turn left on Westchester Ave. Westchester Community Center is on the right.

From the south:

Take I-695 to Fredrick Rd. (exit 13). Turn left on Fredrick Rd. Follow Fredrick Rd. approx. 2.7 miles. Turn right on Oella Ave. Turn left on Westchester Ave. Westchester Community Center is on the right.

Need a map? You can find one at: [chesapeakegemandmineral.org](http://chesapeakegemandmineral.org)





## AFMS Code of Ethics



- I will respect both private and public property and will do no collecting on privately owned land without the owner's permission.
- I will keep informed on all laws, regulations of rules governing collecting on public lands and will observe them.
- I will to the best of my ability, ascertain the boundary lines of property on which I plan to collect.
- I will use no firearms or blasting material in collecting areas.
- I will cause no willful damage to property of any kind – fences, signs, and buildings.
- I will leave all gates as found.
- I will build fires in designated or safe places only and will be certain they are completely extinguished before leaving the area.
- I will discard no burning material – matches, cigarettes, etc.
- I will fill all excavation holes which may be dangerous to livestock. [Editor's Note/Observation: I would also include wildlife as well as livestock.]
- I will not contaminate wells, creeks or other water supply.
- I will cause no willful damage to collecting material and will take home only what I can reasonably use.
- I will practice conservation and undertake to utilize fully and well the materials I have collected and will recycle my surplus for the pleasure and benefit of others.
- I will support the rockhound project H.E.L.P. (Help Eliminate Litter Please) and will leave all collecting areas devoid of litter, regardless of how found.
- I will cooperate with field trip leaders and the se in designated authority in all collecting areas.
- I will report to my club or Federation officers, Bureau of Land management or other authorities, any deposit of petrified wood or other materials on public lands which should be protected for the enjoyment of future generations for public educational and scientific purposes.
- I will appreciate and protect our heritage of natural resources.
- I will observe the "Golden Rule", will use "Good Outdoor Manners" and will at all times conduct myself in a manner which will add to the stature and Public "image" of rockhounds everywhere.

MEMBERSHIP APPLICATION OR RENEWAL  
THE MINERALOGICAL SOCIETY OF THE DISTRICT OF COLUMBIA (MSDC)

(\_\_\_) Family – \$25.00 per year. One address.

(\_\_\_) Individual – \$20.00 per year.

(\_\_\_) New \*      (\_\_\_) Renewal Dues are for Year \_\_\_\_\_\*

For new members who join in the last months of the year, membership will extend through the following year with no additional dues.

**ANNUAL DUES – PLEASE PAY YOUR DUES PROMPTLY.**

Pay at next meeting or mail to:

Mineralogical Society of DC  
c/o John Weidner  
7099 Game Lord Drive  
Springfield, VA 22153-1312

Name(s) (First and Last) \_\_\_\_\_

Address \_\_\_\_\_

City \_\_\_\_\_ State \_\_\_\_\_ Zip: \_\_\_\_\_

Phone(s): Home/Work/Mobile \_\_\_\_\_

Email(s): \_\_\_\_\_

OK TO INCLUDE YOU ON CLUB MEMBERSHIP LIST?

(    ) Yes – Include name, address, phone, email.

If you want any information omitted from the membership list, please note:

Omit my: (    ) Email; (    ) Home phone; (    ) Work phone; (    ) Mobile phone; (    ) Address; (    ) Name

SPECIAL CLUB-RELATED INTERESTS? \_\_\_\_\_

Meeting Dates, Time, and Location: The first Wednesday of each month. (No meeting in July and August.) The National Museum of Natural History, Smithsonian Institution, 10th Street and Constitution Ave, Washington D.C. We will gather at the Constitution Avenue entrance at 7:30 PM to meet our guard who will escort us to the Cathy Kerby Room.