



# Arizona Geological Society Newsletter

FEBRUARY 2017

## February 7, 2017 DINNER MEETING

**Who:** Daniel Hummer, Southern Illinois University, will present “Mineral ecology and evolution: Using large datasets to tell the story of the co-evolution of Earth and life.”

**Where:** Sheraton Tucson Hotel and Suites, 5151 East Grant Road, (at the intersection of Grant and Rosemont on the North side of Grant in the *SABINO BALLROOM* (enter at northwest corner of the building) and go upstairs to the meeting room.

**When:** Cash Bar at 6 p.m.—Dinner at 7 p.m.—Talk at 8 p.m.

**Cost:** Members \$30, Guests \$33, Students Members free with on-line reservation (\$10 without).

**RESERVATIONS ARE REQUIRED:** Reserve on the AGS website ([www.arizonageologicalsoc.org](http://www.arizonageologicalsoc.org)) by **11 a.m. Friday, February 3**. Please indicate Regular (Prosciutto wrap chicken breast with 3-cheese sauce), Vegetarian (vegetarian lasagna) or Machaca Chicken Salad meal preference. Please cancel by **Friday, February 3 at 11 a.m.** if you are unable to attend - no shows and late cancellations will be invoiced. (Please call or text Alison Jones (520-270-2825) if you must cancel after the deadline. We may be able to sell your meal and you won't be billed).

### ABSTRACT

#### **Mineral ecology and evolution: Using large datasets to tell the story of the co-evolution of Earth and life by Daniel Hummer, Southern Illinois University**

Large datasets of mineral species and their associated chemistries, properties, localities, and geologic ages have enabled an unprecedented way to explore Earth's history. Analyses of these datasets led to the discovery that minerals conform to a Large Number of Rare Event (LNRE) statistical distribution, the same distribution adopted by words in a book. Most mineral species (>50%) occur at only 5 or fewer localities, while only a few mineral species are widespread. The same analysis can be done with subsets of minerals – in particular, we have analyzed the distribution of carbon-bearing minerals and used the results to predict the existence of 145 undiscovered carbon mineral species. We have launched a worldwide search for these minerals called the “Carbon Mineral Challenge” (details discussed during the lunchtime talk). In addition, plotting the coexistence of minerals leads to social network diagrams that reveal new patterns in the distribution of minerals on Earth, and can even be used to develop a statistical foundation for all of petrology. Geologic ages in the database allows the introduction of a time dimension, and shows us how Earth's mineralogy (and overall chemistry) has changed over time. We find that the formation of new mineral species is highly correlated to periods of supercontinent formation, with conspicuous gaps in the production of minerals during intervening time periods, indicating that plate tectonics played a crucial role in Earth's mineralogical development. We also see an increase in the oxidation state of redox sensitive transition metals over Earth's history, especially for minerals of manganese, indicating that mineralogical data can be used to trace the oxygenation of Earth's surface. Correlating these data sets

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with corresponding data sets for rocks, fossils, and proteins reveals exciting new details about how the delicate interplay between geological, chemical, and biological processes eventually produced the Earth we see today.

**BONUS TALK!!** *AGS Members are invited to Dr. Hummer's lunchtime talk in room 353 of the Environment and Natural Resources (USGS) Building (corner of Park Avenue and Sixth Street) at 12:10 pm on February 7. Park in the 6th Street Garage, about 500 feet east of the Park Avenue-6th Street intersection, on the north side of 6th street.*

**ABSTRACT****The Carbon Mineral Challenge: A first of its kind worldwide search for new mineral species**

The discovery of new minerals typically happens by accident, when a minor phase cannot be readily identified. Is it possible to turn mineralogy from a purely descriptive science into a predictive science, by postulating and then searching for undiscovered mineral species? We sought to answer this question through a unique, worldwide effort called “The Carbon Mineral Challenge”. Statistical analyses that are normally used for biological populations have recently been applied to worldwide mineral distributions, giving rise to the new field of “mineral ecology”. Due to carbon’s importance to life and many other aspects of Earth’s near-surface environment, we analyzed the distribution of carbon minerals and found that it conforms to a Large Number of Rare Event (LNRE) statistical distribution. This analysis revealed that although we know of 403 carbon-bearing mineral species (as of April 2015), there are approximately an additional 145 remaining to be discovered. Analyzing subsets of carbon-bearing minerals that also contain O, Na, Ca, etc. can be used to learn about the chemistry of these “missing” carbon minerals, and isomorphic relationships together with synthetic analogues can even be used to make specific predictions about their identities. The Carbon Mineral Challenge was launched in December 2015, with the goal of testing these predictions by mobilizing both professional mineralogists and knowledgeable collectors to scour laboratory shelves, museum drawers, and prolific mineral localities for undiscovered carbon minerals. An advisory board of over 20 professionals in mineralogy from universities, museums, labs, and mineral societies in every part of the globe promotes the challenge and assists with analysis of samples. To date, we have discovered eight new carbon minerals, with two of them conforming to minerals that were specifically predicted. We hope that the challenge will make a substantial impact on our knowledge of Earth’s mineral inventory, and lead to transformative discoveries about the many roles of carbon on our planet.

**About the February Dinner Speaker**

Daniel Hummer is an Assistant Professor of Geology at Southern Illinois University in Carbondale, IL. He is a mineralogist and geochemist whose research attempts to answer fundamental questions about how minerals crystallize, particularly from aqueous fluids, how different crystal structures result in different phase stabilities, and how Earth’s mineralogy has changed over time. Hummer received B.S. degrees in both Geology and Chemistry from Iowa State University in 2004. He then earned a Ph.D. in Geoscience from Penn State University in 2010, working with Peter Heaney on the aqueous crystallization of titanium oxide minerals. Subsequently, he was a postdoctoral researcher at the Carnegie Institution for Science and UCLA before starting as an Assistant Professor at Southern Illinois University in 2016. Hummer has earned multiple awards for his work in experimental mineralogy, including a fellowship at the Carnegie Institution for Science, and the Kraus Award for Crystallographic Research from the Mineralogical Society of America.

## MEMBERSHIP SPOTLIGHT: JAN RASMUSSEN

Jan Rasmussen was born in small town in northwest Iowa. She grew up on a farm where her family raised corn, soybeans, alfalfa, and cattle. Jan learned to drive tractors, fix broken mowers, and care for animals, all the while developing a strong work ethic. Her varied geologic career is a testament to that work ethic. You can see much of her work at [www.JanRasmussen.com/research.html](http://www.JanRasmussen.com/research.html). Jan has been very active in AGS, co-chairing two conferences and serving in many different capacities, including as President in 1985. She lives in Tucson, and is available for consulting work.

***What was your first job?*** Working on the farm. Baling hay was the absolute worst farm job – those heavy bales just kept coming and hay fever made me miserable. Feeding cattle at 30 below zero was a close second worst. But riding and raising quarter horses and Appaloosas was a joy.

***How did you become interested in geology?*** I decided to be a geologist when I did a report for my fourth grade teacher about the Ice Ages. My interest was sparked by my father, who was a water well driller and knew the depth to the Dakota Sandstone throughout northwest Iowa. All of my dad's brothers, my grandfather, and all my grandfather's brothers and father were also water well drillers. Our family frequently traveled to National Parks in the West. We were fascinated by the explanations about the geology of the areas we visited. My brother, Gary, and my niece, Tiana, also became geologists. Later, I discovered that my mother's grandfather (who had been in the Civil War) and his brothers had been involved in coal mining in Iowa and silver mining in Idaho.



***You're a UA Wildcat, right?*** Yes! Part of the reason I chose the University of Arizona was the climate, as well as the interesting geology courses they offered. My senior thesis at the U of A College of Mines was on the mud chip dunes on the east side of Willcox Playa. My master's thesis in Geology was on the Permian-age Colina Limestone in the Tombstone Hills. After years of raising a family and working, I returned to UA in the Ph.D. program in Economic Geology under John Guilbert and Mary Poulton, graduating in 1993.

***Tell me about your career path.*** When I finished my master's degree, I took education classes to get my teaching certificate. The only job available for women in geology in Tucson in the mid-1960s was as a secretary for a mining company. I had no interest in that, so I taught Physical Science at Pueblo High School for two years. Then Wes Peirce hired me to research and write about coal, oil and gas in Arizona at the Arizona Bureau of Mines (now the Arizona Geological Survey). Two years later, I had to quit that tenured job in the College of Mines when my son was born. There was no such thing as maternity leave at the time.

After our children, Andrew and Janelle, were in nursery school, I became the Associate Curator of the University of Arizona Mineral Museum and taught Geology for Teachers in the Geology department. After about four years at the museum, Wes Peirce hired me (again) at the Arizona Bureau of Geology and Mineral Technology (now AZGS) to research Arizona molybdenum and Arizona uranium in Tertiary rocks with Stan Keith. While at the Bureau, I co-edited the New Mexico Geological Society's 29th Guidebook, Land of Cochise, writing most of the road logs with Stan.

While I was working toward my Ph.D., I served on the Arizona Oil and Gas Commission, appointed by Governors Bruce Babbitt and Rose Mofford. After earning my Ph.D., I worked for Woodward-Clyde Federal Services on the Yucca Mountain Project out of Las Vegas, Nevada, supervising drilling and writing geochemistry and natural resources reports. I returned to Arizona in 2001, working for MagmaChem Exploration in Sonoita and later for SRK Consulting in Tucson, where I worked on Aquifer Protection Permit applications, other permitting documents, and Canadian National Instrument 43-101 reports.

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**What is your most memorable field experience?** The month-long class field trip to more than 30 South African mines, led by Dr. John Guilbert. Going a mile underground in a gold mine and holding a million dollar ingot of gold were unforgettable. It was especially unnerving to see a sign entering a deep gold mine in mid-January that said there were only 32 fatalities so far this year. When I asked, they said about 2 people out of the 5000 employees died per day, mostly geologists and deep mine workers from rock bursts. I was especially wary of overlying “widow-makers” while crawling through the tunnels. I should have known we were in for a challenge when we were issued knee pads.

**What aspects of your career make you most proud?** Throughout my career, I have been committed to educating the public about the value of mining and geology. I’ve taught part-time in most places I have lived: Austin Community College in Texas, Cochise College at Fort Huachuca, and Pima Community College in Tucson. I am proud of the Outstanding Adjunct Faculty award I received in 2007 from Pima Community College for teaching excellence and commitment to education.

From 2007 to 2010, I was curator of the Arizona Mining and Mineral Museum in Phoenix. I envisioned a large diorama of a modern open pit copper mine. Brian Beauleau created the exhibit in 2010 with funding from members of the Mining Foundation of the Southwest. Larry and Iris Dykers and I refurbished the diorama (<http://www.miningmineralmuseum.com/open-pit-mine-model>) in 2015. It is now in the Arizona Historical Society museum in Tempe. Unfortunately, Governor Jan Brewer gave the Mining and Mineral Museum to the Arizona Historical Society in 2010 and AHS closed the AZMMM building in 2011, moving the minerals into storage and other museums. (Photographs of the museum as it was in 2010 can be seen at [www.MiningMineralMuseum.com](http://www.MiningMineralMuseum.com)). I am also proud of the Individual GEM (Government, Education, & Mining) award I received from the Society of Mining, Metallurgy & Exploration in 2010 for transforming a small mineral museum into a mining museum dedicated to modern mining practices and uses of minerals.



Copper mine diorama at the Arizona Mining and Mineral Museum (now closed)

Unfortunat-ly, Governor Jan Brewer gave the Mining and Mineral Museum to the Arizona Historical Society in 2010 and AHS closed the AZMMM building in 2011, moving the minerals into storage and other museums. (Photographs of the museum as it was in 2010 can be seen at [www.MiningMineralMuseum.com](http://www.MiningMineralMuseum.com)). I am also proud of the Individual GEM (Government, Education, & Mining) award I received from the Society of Mining, Metallurgy & Exploration in 2010 for transforming a small mineral museum into a mining museum dedicated to modern mining practices and uses of minerals.

**What are you up to now?** I have been writing permitting documents and NI 43-101 reports as a senior associate of SRK and as Jan Rasmussen Consulting. My recent research has also involved a project on UltraDeep Hydrocarbon with MagmaChem Exploration for a Norwegian oil company. While waiting for the price of oil and metals to rise, I have been working on a chapter on the Geologic History of Arizona for a new Mineralogy of Arizona book by Ray Grant and Ron Gibbs. I also keep busy on my hobby of making and furnishing doll houses ([www.MinatureGems.com](http://www.MinatureGems.com)).

**Any parting words?** My hope for the future of our profession is that the general public will realize the importance of mining and geology to their lifestyle and safety, understand how minerals are used in the products they depend on every day, be less antagonistic towards mining, and be aware of geologic hazards.

**THANKS, JAN!**



## Arizona Geological Survey UPDATE

by Mike Conway



UA SCIENCE



What's new at the AZGS in Jan. 2017?

**Budget News!** Governor Ducey's proposed FY 2018 budget does not provide funds for AZGS. This was not unexpected. Fortunately, AZGS legislative allies are strategizing on how to reinstate an allocation of state funds. (Wish them luck!). Sen Griffin just introduced a bill refunding the AZGS at 2016 levels. We'll keep you informed as the budget story develops.

Following a 9-month long hiatus, AZGS staffers are once again drafting and submitting proposals to support our mapping, research, and geologic hazards work. Our US Geological Survey STATEMAP program proposal is out the door and we are drafting a proposal to the National Geological and Geophysical Data Preservation Program to update and enhance our digital geologic map data and establish a permanent archive for AZGS geoproducts at the University of Arizona Library. If successful, this is the first step in re-establishing a sustainable digital archive to preserve our legacy data. By way of reminder, nearly all geoproducts produced from 1915 to 2017 are available to download at the AZGS Document Repository.

**Earth fissure news:** AZGS geoscientists Joe Cook and Brian Gootee documented a fresh, two-mile long earth fissure in southern Pinal County (Figure 1). Using a drone operated by Brian Gootee, they captured images and two marvelous drone videos of the feature. See our Arizona Geology Blog for a short report with links to the videos. <http://arizonageology.blogspot.com/>



Figure 1. Open segment of 2-mile long, N-S oriented earth fissure whose north half formed between Mar. 2013 and Dec. 2014; the southern half post-dates Dec. 2014. Fissure width ranges from inches to 10 feet and up to 30 feet deep. Note the extensive tension fractures outboard of the fissure.

State Reps. Finchem and Leach, District 11, posted a news release warning their constituents: <http://www.azleg.gov/press/house/53LEG/1R/170124FISSURE.pdf> The timing of interest in the geohazard responsibilities is in AZGS's favor.

**Lee Allison honored.** Former State Geologist M. Lee Allison will be honored during the February Mining Appreciation Celebration, "Women in Mining – Celebrating a Journey of Success". The annual event is hosted by the Southern Arizona Business Coalition. For details contact Rick Grinnell (<mailto:rick@soazbc.com>)

**Arizona Mining, Mineral & Natural Resources Museum News!** MMNRE staffer, Catie Carter, is working on a mining and mineral exhibit, "Mining powers the Arizona Experience", on the 3rd floor lobby of the

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Arizona Senate Building on the Capitol Mall in Phoenix. The exhibit will explore the past, present and future of mining in Arizona.

Later this month, the Arizona Board and Commissions will advise Gov. Ducey on appointing members to the MMNRE Advisory Board. Dr. Phil Pearthree, AZGS Director and State Geologist, heads up the board.

The proposed state allocation for the museum in FY 2018 is \$428,000, identical to last year's funding. The lion's share of the funds are for leasing the Polly Rosenbaum Building, remaining funds are for the museum curator's salary and benefits.

Would you like to support the museum? Please pledge your tax deductible support through the University of Arizona Foundation: <http://tinyurl.com/SupportMM-NREMuseum> . Thanks!

**New Publications and publications newly released online:**

Ferguson, C.A. and Cook, J.P., 2016, Geologic map of the Mount Nutt 7½' Quadrangle, Mohave County, Arizona. Arizona Geological Survey Digital Geologic Map 118, one map plate, 1:24,000 map scale.

Gootee, B.F., Spencer, J.E., Tosdal, R.M., Pearthree, P.A. and House, P.K., 2016, Geologic map of the Mule Wash 7 ½' Quadrangle, La Paz County, Arizona, and Riverside County, California. Arizona Geological Survey Digital Geologic Map DGM-117, scale 1:24,000, 9-p. report.

Johnson, B.J., Pearthree, P.A., and Ferguson, C.A., 2016, Geologic map of the Corona de Tucson 7 ½' Quadrangle, Pima County, Arizona: Arizona Geological Survey Digital Geologic Map DGM-115, scale 1:24,000.

Marshall, L., 2017, A Review of "Water in the Desert: The Grand Valley and Its Rivers". Arizona Geology e-Magazine, Winter 2016-2017.

Richard, S.M., 2000, Geologic Map of Arizona. Arizona Geological Survey Map-35, 1,000,000 map scale. (Released online 1/2017)

Spencer, J.E., Pearthree, P.A., Gootee, B.F., and Tosdal, R.M., 2016, Geologic map of the Dome Rock Mountains SW 7 ½' Quadrangle, La Paz County, Arizona: Arizona Geological Survey Digital Geologic Map DGM-116, scale 1:24,000, 1 sheet.



**Concerns, questions or comments?** Contact Mike Conway at [fmconway@email.arizona.edu](mailto:fmconway@email.arizona.edu) or 520.621.2352

This map shows the approximate locations of the digital geologic maps listed above.

# Lower Colorado River Tour

April 5-7, 2017 **Field Trip**

Presented by



**WATER EDUCATION  
FOUNDATION**

This 3-day, 2-night tour travels along the lower Colorado River from Hoover Dam to the Salton Sea and Imperial and Coachella valleys to show how California, Arizona and Nevada use and manage this water to meet agricultural, urban, environmental and industrial needs. Along the way, experts discuss challenges related to what is among the most contested, beloved for recreation and meticulously managed rivers in the US.

On this action packed tour, you will learn about:

- Drought conditions & contingency plan in the Lower Basin
- Lower Basin state perspectives: Arizona, California and Nevada
- Binational water management ➤ Agricultural water use, drainage and salinity ➤ The Colorado River Basin Study
- Endangered species and the Multi-Species Conservation Program
- Salton Sea restoration efforts ➤ Climate change

This fast-paced tour begins at 7:30 a.m., Wednesday, April 5 in Las Vegas and will end at approximately 6 p.m., Friday, April 7 in Ontario, California. There is an option to depart by bus from Ontario International Airport on Tuesday, April 4, contact us for details.

This tour is cosponsored by the Bureau of Reclamation, Lower Colorado Region.

Registration: \$790 per person, Early Bird Discount for purchase before March 6 is \$765. Fee includes all meals, transportation, materials, snacks and hotel accommodations while on the tour.

Deadline to cancel and receive a full refund is 5 p.m. March 22 due to hotel, meal and transportation bookings. Substitutions may be made through Friday, March 31.

**REGISTER ONLINE TODAY** at [watereducation.org/tour/lower-colorado-river-tour-2017](http://watereducation.org/tour/lower-colorado-river-tour-2017)  
or call Tour Director Dan Scott at (916) 444-6240. Seating is limited.

**Stops Include:**

- Hoover Dam, featuring a private facility tour
- Central Arizona Project facilities
- Havasu National Wildlife Refuge
- Metropolitan Water District of Southern California facilities
- Farms in the Imperial and Coachella valleys
- The Salton Sea
- Warren H. Brock Reservoir and the All-American Canal

## SPONSOR A DINNER MEETING!!!

Company sponsorship of AGS dinner meetings is a great way to get the message out about your company. You will receive an advertisement in the newsletter, a slideshow during the social hour, and a brief presentation to the attendees of the dinner meeting. To find out more about how your company can sponsor a dinner meeting, please contact Ann Pattison at

[info@arizonageologicalsoc.org](mailto:info@arizonageologicalsoc.org)

AGS Newsletter editor, Alison Jones, is accepting articles for this newsletter. The subject should be of geological interest, preferably regarding (but not limited to) Arizona. It should not be political in nature. If you have an idea that you think will be of interest to the Society, please contact Alison at [ajones@clearcreekassociates.com](mailto:ajones@clearcreekassociates.com)

## Mining Leadership Program - February 7-10, 2017



LOWELL INSTITUTE FOR  
MINERAL RESOURCES



We are pleased to announce that the University of Arizona Lowell Institute for Mineral Resources and Vanto Group are jointly sponsoring a Mining Leadership Program. The inaugural offering of the four-day program "Leadership: Inventing the Future, A Breakthrough Leadership Program for the Mining Industry and Its Stakeholders," will be February 7-10, 2017, in Tucson, Arizona, and will be led by executives of the Vanto Group. Please go to the IMR home page at <http://imr.arizona.edu>, click on the Featured Project (Mining Leadership Program), then download the Information Packet for further information and instructions regarding registration. Please contact Rocío Brambila by e-mail at [brambila@email.arizona.edu](mailto:brambila@email.arizona.edu) to register.

## Welcome New AGS Members

John Schieffer

Thomas Blake

Ken Wallace

Reese Woodling

Eros Bilyeu

Melanie Lindsey

Glen Adams

**Arizona Geological Society is grateful to Freeport-McMoRan, Inc. for their generous support of our student members! Freeport-McMoRan sponsored student dinners for the 2017 AGS monthly meetings.**



**FREEPORT-McMoRAN**

### 2017 AGS MEMBERSHIP APPLICATION OR RENEWAL FORM

YOU CAN RENEW OR SIGN UP as a new member and pay online. Please go to our website, [arizonageologicalsociety.org](http://arizonageologicalsociety.org). Or use the form below if you are more comfortable with the old school approach.

Please mail check with membership form to: Arizona Geological Society, PO Box 40952, Tucson, AZ 85717

Dues (check box)  1 year: \$20;  2 years, \$35;  3 years: \$50;  full-time student (membership is free)

NEW MEMBER or RENEWAL? (circle one) Date of submittal \_\_\_\_\_

Name: \_\_\_\_\_ Position: \_\_\_\_\_

Company: \_\_\_\_\_

Mailing Address: \_\_\_\_\_

Street: \_\_\_\_\_ City: \_\_\_\_\_ State: \_\_\_\_\_ Zip Code: \_\_\_\_\_

Work Phone: \_\_\_\_\_ Home Phone: \_\_\_\_\_

Fax Number: \_\_\_\_\_ Cellular Phone: \_\_\_\_\_

E-mail: \_\_\_\_\_ Check this box if you do not have an email address

***All newsletters will be sent by email. If you do not have an email address, we will mail a hard copy to you, but we cannot guarantee timeliness.***

If registered geologist/engineer, indicate registration number and State: \_\_\_\_\_

Enclosed is a \_\_\_\_\_ tax-deductible contribution to the  J. Harold Courtright or the  M. Lee Allison Scholarship Funds.