EARTHQUAKE
e-Newsletter about what's movin' and shakin' at the Earth Science Museum

Earth Science Museum, 3215 W. Bethany Home Rd., Phoenix, AZ 85017
www.earthsciencemuseum.org, scote@earthsciencemuseum.org, 602-973-4291

November 2024
Volume 13, Issue 11

ESM OUTREACH UPDATE

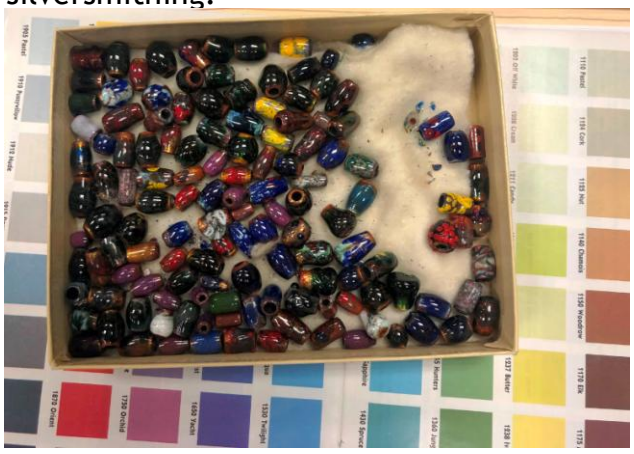
Mardy Zimmermann, Outreach Coordinator

November Outreach

By S. Coté with photos by Sue Bartz and Brieanna Blakesley

Doug Duffy, ESM board member and Maricopa Lapidary Society (MLS) member, demonstrated how to make enamel on copper beads to MLS members at their meeting Tuesday, November 19th. MLS meetings are held at North Mountain Visitor Center (NMVC), 12950 N. 7th St. in Phoenix, on the third Tuesday at 7:00 pm. He explained that his enameling supplies were purchased from Thompson Enameling Supplies in Bellevue, KY. He learned many years ago how to make the beads through a VHS tape and pamphlet by Pam East. Pam now has a DVD available.

Doug demonstrated the technique at his teaching studio at NMVC where he holds day classes in the lapidary arts and silversmithing.



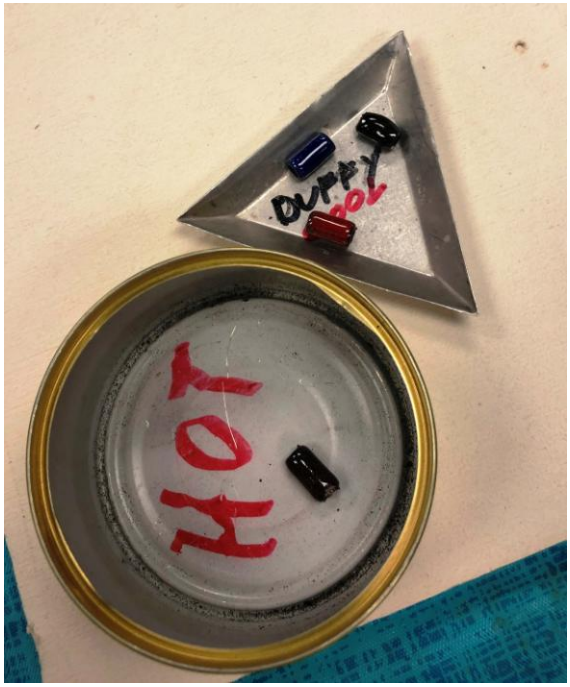
Enamel color chart under a collection of Doug's enamel on copper beads.

While demonstrating Doug explained the processs. He uses a 1/4 in. piece of copper tubing that is a ½ in. long. He heats the copper tubing on a mandrel using a small propane tank and torch. He said that it is imperative to keep the mandrel twirling for even heating and coating. When the copper becomes red hot, he applies two or three coats of flux by rolling the heated copper through the flux and heating each coating to red hot again in between. The flux is used to help the enamel adhere to the copper.

Doug then continues heating the flux coated copper and applies three or more coats of crushed, colored enemal to make the bead the size desired.

Doug is rolling the copper in crushed red enamel.

When the bead is the desired thickness, Doug uses a pair of plyers to loosen the copper bead so that it slides off the mandrel into a small metal cup to cool and quenches the mandrel in water to prepare for the next bead.



Soldering boards, fire brick, propane tank with torch and containers for water and finished beads.

MLS club members observing Doug's demontration of creating enamel on copper beads.

SAFETY FIRST

As you can see in the pictures, Doug is very safety conscious. He uses fire resistant sodering boards as a base for his set up, a piece of wood paneling with a hole to keep the propane bottle and torch at a confortable height and a fire brick set up across from the from the flame of the torch to protect his fellow club members during the demonstrations. To hold the crushed enamel and flux Doug uses a glazed porcelain tile on a small turntable for easy access.

Evolution of Earth's Rotation

By Harvey Jong

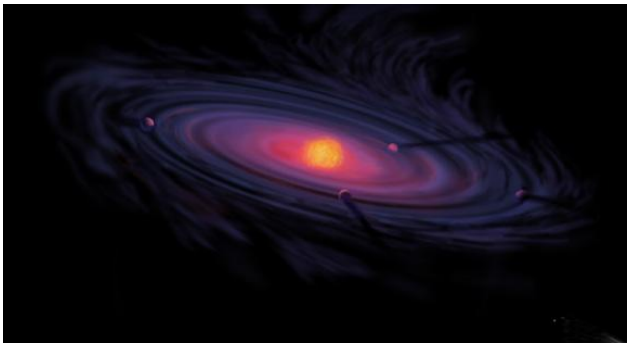
Fall is here which marks the end of daylight saving time – a time change ritual that most of Arizona doesn't observe. But the "fall back" clock adjustment event provided the inspiration for this article which explores the Earth's rotation and changes in the length of day.

Star Trails Due to the Earth's Rotation
Anton Yankovyi photo, - CC_BY_SA-4.0 International, via Wikimedia Commons
Image aimed at Polaris, the North Star
This long-exposure photo of the northern night sky was captured on March 11, 2011 in the Himalayas in Nepal. It shows apparent circular paths of the stars as the Earth rotates.

Earth's Rotation Over Geologic Time

Throughout its history, the Earth's rotation has changed significantly, and the length of day has progressively grown longer. The deceleration of our planet's rotation, however, has been non-uniform due to a variety of different factors which we will examine in the following sections.

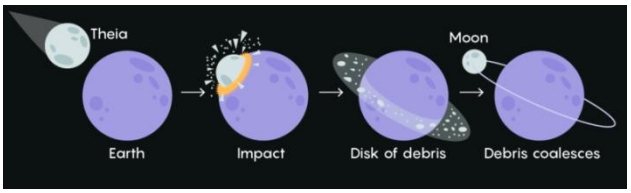
In the Beginning... (~4.5 Billion Years Ago)



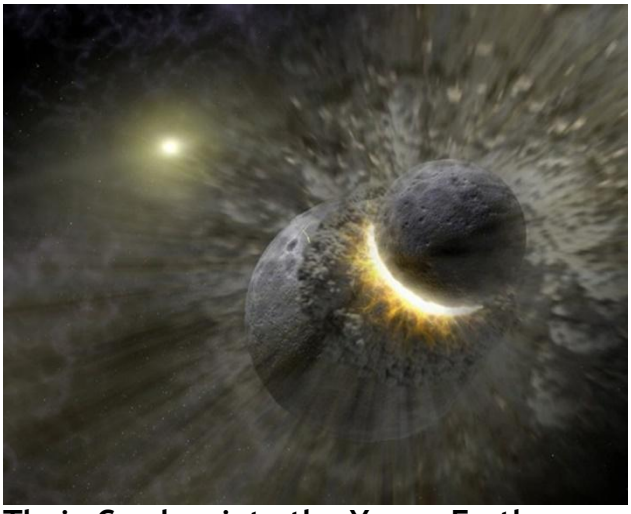
Artist's Concept of a Protoplanetary Disk
Pat Rawlings (1955-)/NASA drawing, - PD, via Wikimedia Commons

The Earth formed from a rotating protoplanetary disk of dust and gas. As it developed, repeated collisions with formative rock debris imparted the forces that caused the early planet to spin. The rate of rotation was likely much faster than today, and the length of day has been estimated to be as short as four hours (Sasaki, 2016).

A key event in Earth's early history may have involved the hypothetical giant impact with a Mars-size proto-planet, known as Theia. This collision may have occurred in the early Hadean eon about 20 to 100 million years after the Solar System coalesced. It may not only have led to the formation of the Moon, but may have also altered the Earth's rotation. The Earth-Moon system has an unusually high angular momentum compared to other terrestrial planets, and this excess momentum may have been supplied by the massive impact (Barr, 2016).



Simple Representation of the Giant Impact Hypothesis
Citronade graphic, - CC_BY_SA-4.0 International, via Wikimedia Commons



Theia Crashes into the Young Earth
NASA illustration, - PD, via science.nasa.gov
The tremendous collision flung molten and vaporized debris into space which would later coalesce into the Moon. This may have occurred just beyond Earth's Roche radius (2.9 Earth radii) at an orbital distance of about 3.8 Earth radii (24,236 km, 15,059 mi) (Canup, 2012).

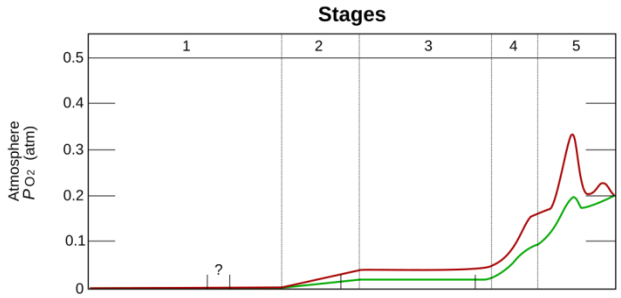
Hadean and Archean Eons (4.5 – 2.5 Billion Years Ago)

Artist's Concept of the Early Earth Being Bombarded by Asteroids
NASA Goddard Space Flight Center Conceptual Image Lab graphic, - PD, via Wikimedia Commons
The early Earth during the Hadean-Archaean period was covered by a global ocean of magma which eventually cooled and solidified releasing carbon dioxide and liquid water. Intense bombardment by asteroids and comets may also have contributed additional water.

The gravitational interaction between the newly-formed Moon and the Earth resulted in tidal friction which gradually slowed the Earth's rotation. This process of tidal braking transferred the Earth's rotational angular momentum to the Moon, moving the Moon away from the Earth. The slower rotation resulted in a longer length of day, but making an accurate estimate is difficult given the limited information about tidal dissipation rates. Some simulation models indicate that the length of day may have varied between 6 and 9 hours and that it was likely above 12 hours by the end of Archean time (Spaulding et al., 2019).

Proterozoic Eon (2.5 Billion to 541 Million Years Ago)

The Earth's rotation continued to slow over the Proterozoic as oceanic tidal friction driven by the pull of the Moon exerted a decelerative torque. The eon also involved a build-up of oxygen in the Earth's atmosphere called the Great Oxidation Event.

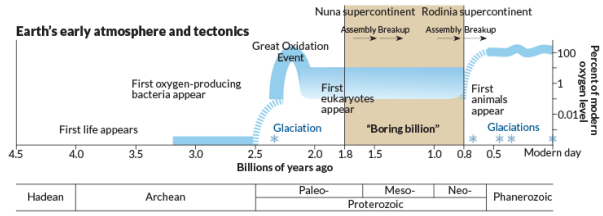


Estimated Evolution of Oxygen in Earth's Atmosphere
Heinrich D. Holland diagram, - GNU Free Documentation License-1.2, via Wikimedia Commons
This diagram depicts the upper (red line) and lower (green line) range of estimates of atmospheric oxygen. The time span and development for each stage is listed below:
Stage 1 (3.85-2.45 Ga), practically no O_2 in the atmosphere
Stage 2 (2.45-1.85 Ga), O_2 levels rise to 0.02-0.04 atmospheres, but is absorbed by oceans and seabed rock
Stage 3 (1.85-0.85 Ga), O_2 released by saturated oceans, but is absorbed by land surfaces

Stage 4 (0.85-0.54 Ga) and Stage 5 (0.54 Ga-present), O_2 accumulates in the atmosphere as oxygen reservoirs are filled

Proterozoic Stromatolite
Daderot photo, Houston Museum of Natural Science specimen, - CC0-1.0 UPD, via Wikimedia Commons
Bitter Springs formation, Alice Springs, Northern Territory, Australia
Stromatolites are layered sedimentary formations created by photosynthetic microorganisms, such as cyanobacteria. The presence of cyanobacteria triggered the gradual oxygenation of Earth's atmosphere-hydrosphere system.

The absorption of sunlight by water vapor and ozone in the atmosphere created atmospheric tides which resulted in an accelerative torque on the Earth's rotation. A tidal resonance condition may have developed where the lunar oceanic torque was cancelled by the solar atmospheric torque. Subsequently, the length of day stalled at about 19 hours roughly between 1.8 billion and 800 million years ago (Mitchell and Kirscher, 2023). This stalling coincided with a period of relatively limited biological evolution known as the "Boring Billion".



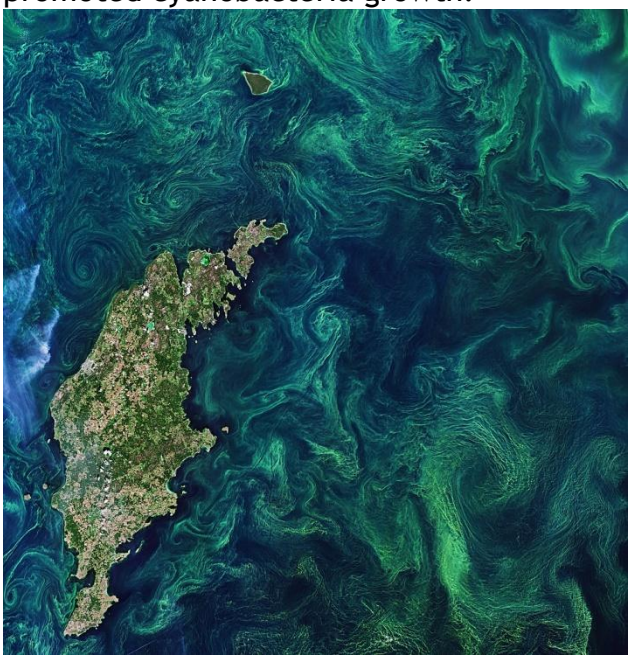
"Boring Billion" in the Timeline of Earth's Evolution
J. Hirshfeld diagram, - CC_BY_SA-4.0 International, via Wikimedia Commons

The deceleration of Earth's rotation resumed when the tidal resonance condition was broken. A large, fast increase in global temperature, such as the thawing of a "Snowball Earth" glacial period, has been proposed as a possible mechanism (Bartlett and Stevenson, 2016). Based on the analysis of tidal rhythmites (sedimentary rocks laid down with obvious periodicity), this resonance breakage might have occurred about 600 million years ago (Williams, 2000).

Tidal Rhythmite (Tidalite)
John St. John photo, - CC_BY_SA-2.0
Siltstone
Elatina Formation, Neoproterozoic, Pichi Richi Pass stream cut, South Flinders Range, South Australia

It is interesting to note that the Earth's rotation rate may be linked to the planet's oxygenation (Klatt et al, 2021). A longer day has been proposed as a possible cause of the Neoproterozoic Oxidation Event (NOE) which significantly increased the oxygen levels in

the atmosphere. The NOE occurred around 850 to 540 million years ago where longer periods of uninterrupted daylight may have promoted cyanobacteria growth.



Satellite Photo of Cyanobacterial Blooms in the Baltic Sea
European Space Agency image, - Contains modified Copernicus Sentinel data 2019, via Wikimedia Commons

Phanerozoic Eon (541 Million Years Ago to Present)

At the start of the Phanerozoic Eon, the length of day may have been about 22 hours. Tidal friction continued to slow the Earth's rotation, but anomalies in geomagnetic intensity and tectonic plate motion during the Mesozoic may have played a role in lengthening the day to the present 24 hours (Denis et al., 2002).

Due to the irregular, continuing slowdown in the Earth's rotation, one second adjustments, called leap seconds, are occasionally applied to Coordinated Universal Time (UTC) which is precisely measured by atomic clocks. The leap second system was introduced in 1972, and as of 2024 27 leap seconds have been added. The most recent leap second occurred on December 31, 2016. Since leap seconds have been disruptive for precise time-critical applications, a decision by an international standards body was made in November 2022 to abandon the leap second by or before 2035.

References

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Arizona Rocks 138

Text & photos by Ray Grant

An interesting place to visit if you go to the Petrified Forest or you are in that area is Jim Gray's Petrified Wood Company in Holbrook. It is a gigantic rock shop with lots of things for sale, mainly fossils. There are also educational exhibits and other things to see, and of course endless petrified wood. As I have said before, you do not have to buy anything when attending mineral shows or visiting rock shops, just looking is very educational. You can easily spend an hour or more there.

Jim Gray's shop in Holbrook

Some of the petrified wood in the parking lot

Part of the educational exhibits

Fish pond in the shop

Very small part of the petrified wood for sale

AZ Mining, Mineral & Natural Resources Education Museum Update November 2024

https://ammnre.arizona.edu/

Catie Carter Sandoval
cscarter@email.arizona.edu
703.577.6449

Help support the museum at:
http://tinyurl.com/SupportMM-NREMuseum

We (Curator Catie and Executive Director Marta) recently made a trip to the University of Arizona campus in Tucson to participate in an outreach event called "Mines for Limitless Minds" hosted by the UofA School of Mines & Mineral Resources. The purpose of the event was to foster student interest in minerals and mining and showcase careers in the mining industry. We hosted a table along with other exhibitors from various mining companies and campus groups, and offered a fun rock and mineral dig where attendees could sift for, and take home, six different specimens: invertebrate fossils, amethyst, calcite, pyrite, apache tears and beryl. We were happy to interact with not only college students at the event, but also high school students and younger kids as well. We also used the event as an opportunity to gather feedback about students' interest in Arizona's natural resources – mining, farming, forestry, and water – along with topics like clean energy and human innovation. We plan to share that data with our planning team as they define the major content areas of our new museum. It's always fun to speak directly with students and it's very helpful to hear their input about what they are looking for in a new natural resources museum.

We hope you have a wonderful Thanksgiving and beginning of the holidays! Thanks for your support!

Museum Director Marta Bones at the Mines for Limitless Minds event on UofA campus

UofA students digging for rock and mineral specimens at the event

Students filling out one of our surveys, which gauged interest in Arizona's different natural resources

Educators from the school of Mining & Mineral Resources filling out our survey at the event

Pinal Museum and Society News

351 N. Arizona Blvd., Coolidge, AZ

Pinal Geology and Mineral Society next meeting

NO REGULAR MEETING IN December

Meetings are the third Wednesday at 7pm, doors open at 6:00

www.pinalgeologymuseum.org

Ray Grant ray@pinalgeologymuseum.org

Pinal Geology and Mineral Museum

September – May hours are Wednesday – Saturday from 10-4, admission is free.

Groups can arrange special visits please call 520-723-3009.

We are going to have an open house and pre-Christmas sale at the Museum from 10 - 4 on Saturday December 7th. Everyone is invited to set up a table to sell minerals, fossils, or jewelry. You do not have to be a Pinal Club member. There will be no charge for setting up the table, any time after 9. Depending on the weather and how many people set up we may need to put some outside. We hope this will bring out hobbyists and give you a chance to find some special gifts. Location and other information at pinalgeologymuseum.org.

Remember no meeting on December 18.

SUN CITY ROCKHOUND MINERAL MUSEUM
SUNDIAL RECREATION CENTER
14801 N. 103RD AVE.
SUN CITY, AZ 85351
scrockmuseum@gmail.com
623-428-6442

C. Sandoval photo

WINTER HOURS
OCTOBER – APRIL
10 AM TO 1 PM
CLOSED THURS., & SUNDAY
SUMMER HOURS
MAY-SEPTEMBER 10AM-1PM
SATURDAYS ONLY

Sun City Rockhound Club and Mineral Museum

By Carol Bankert-George Vice President

November was a busy month for the Rockhound club and museum. We started the month off with Peter Huegel, local historian, frequent guest speaker and board member of the S.A.L.T. organization at our monthly club meeting. Peter has been a favored speaker for the last ten years with his presentations on the Native American history, and local plants and animals. He is a board member of S.A.L.T. (Studying Ancient Lifeways and Technologies) organization who meet monthly at the S'edav Va'aki (formerly Pueblo Grande) museum in Phoenix. For more information on this organization click this link. S.A.L.T. Skills Meetings and Classes

This month he did two presentations:

- Preserving History and Customs Without a Written Language - Just How Did the Ancient People Do That?"
- A presentation on the Sun City Rockhound Club donation of artifacts to the S.A.L.T. organization last year-what the organization has uncovered.

NOTE: If you are interested in having Peter as a guest speaker, please contact either the S.A.L.T. organization at the link above or the Sun City Rockhound club and museum at the email above.

On Thursday November 21st Peter and members of the S.A.L.T. organization joined with the Rockhound club members for a museum reception on the new S.A.L.T. display case. The case highlights skills that are taught at S.A.L.T. monthly meetings with examples of many items.

Lastly, our biggest event of the year comes Friday and Saturday after Thanksgiving. The club/museum participates in the Sun City Fall Festival. The 2-day event is located at the Sundial recreation center, the location of the club's Mineral Museum. The club has ten tables selling rocks and minerals at the event. We also have a 'rock wheel', 3 spins for $1.00 and every spin is a winner. The club has also started the egg carton activity where you get twelve rocks to fill an egg carton for $1.00. These two activities are favorites for many rockhounds and shoppers, young and old alike, who return year after year.

S.A.L.T. Guest display reception at the Sun City Rockhound Mineral Museum. Pictured are members of the S.A.L.T. organization.

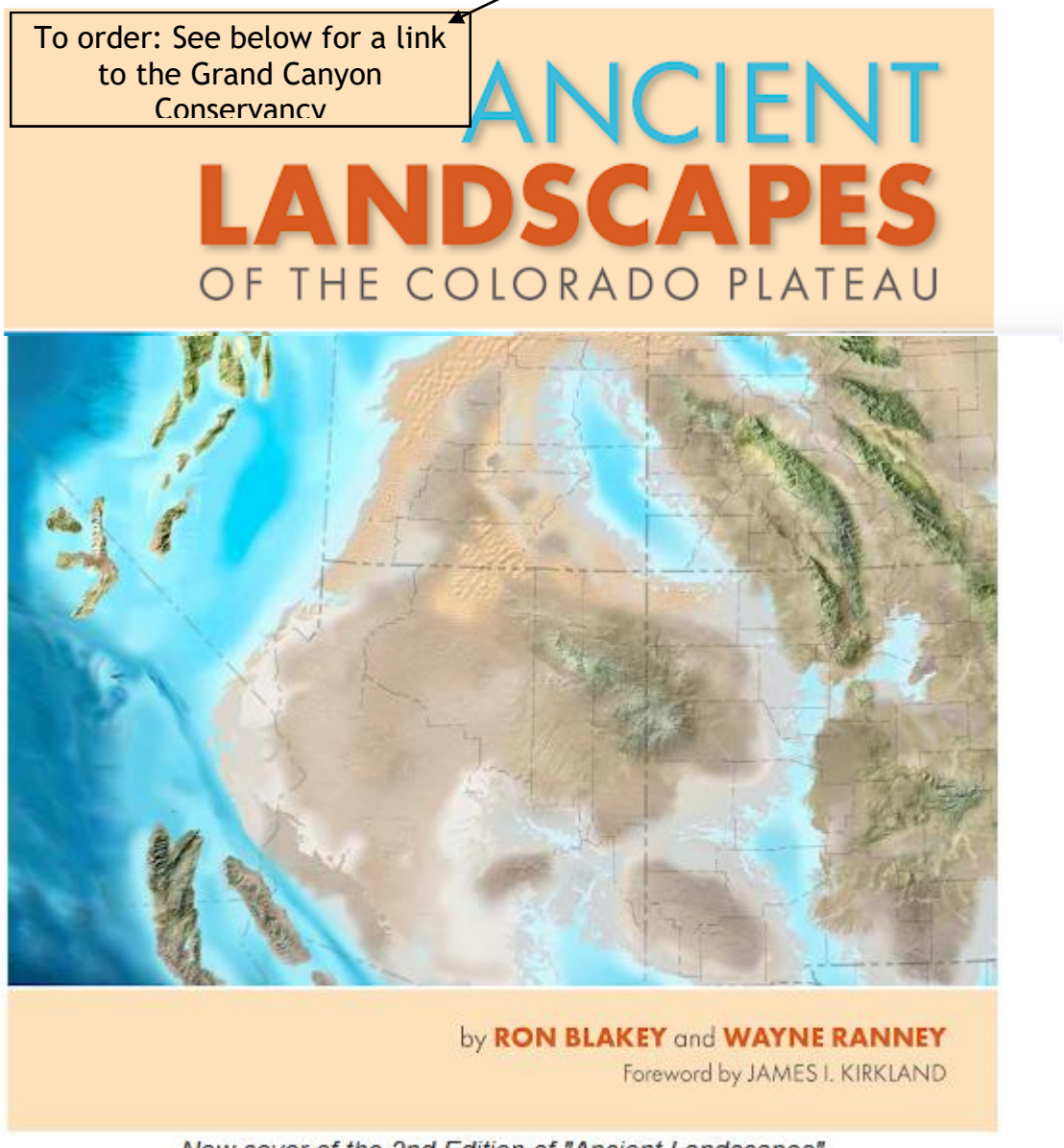
The museum does offer private party tours. Clubs and private individuals interested can contact the museum at scrockmuseum@gmail.com.

A Fully Revised 2nd Edition of "Ancient Landscapes of the Colorado Plateau"

Nov 15, 2024 09:05 pm

"***Ancient Landscapes of the Colorado Plateau***", first published in 2008, is now available in a fully revised and completely updated 2nd Edition! Published by the Grand Canyon Conservancy, it is being featured as a special Holiday offering here. The book will make a fantastic gift for your Earth-minded friends and family! (I recommend buying directly from here as proceeds go to support Grand Canyon National Park.

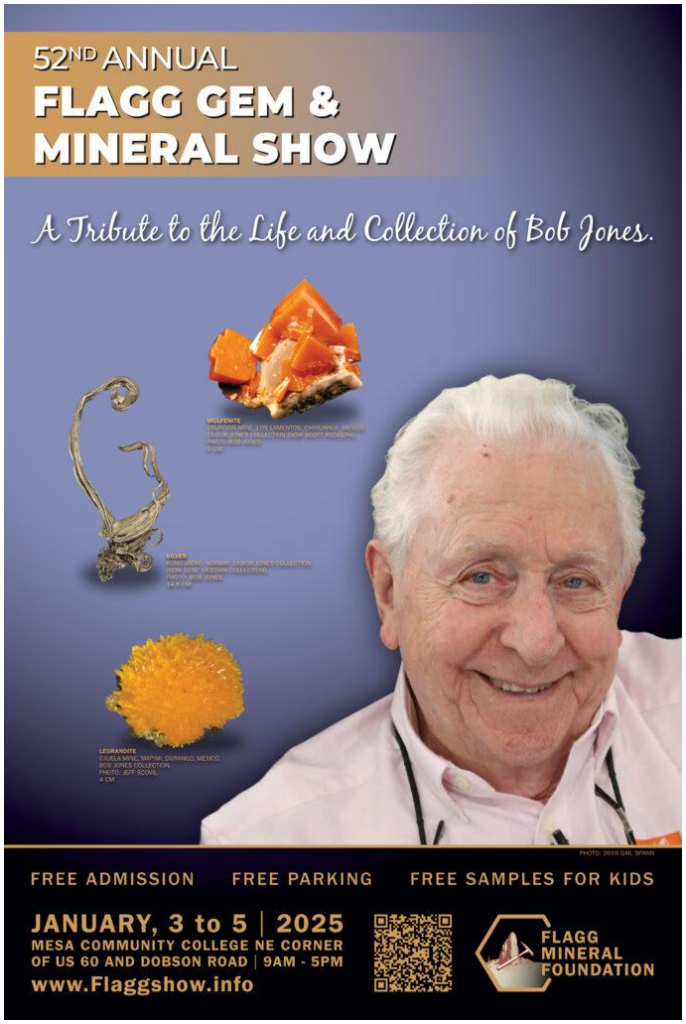
To order: See below for a link to the Grand Canyon Conservancy



New cover of the 2nd Edition of "Ancient Landscapes"

https://www.grandcanyon.org/products/ancient-landscapes-of-the-colorado-plateau

Arizona Rock and Gem Shows



Apache Junction Rock & Gem Club
Meetings are on the 2nd Thursday
Next Meeting: December 12, 2024, 6:30 pm
www.ajrockclub.com
@ Club Lapidary Shop
2151 W. Superstition Blvd., Apache Jct.

Daisy Mountain Rock & Mineral Club
Meetings are on the 1st Tuesday
(unless a Holiday then 2nd Tuesday)
Next Meeting: December 3, 2024, 6:30 p.m.
Please go to their website for more info
www.dmrmc.com
@ Anthem Civic Building
3701 W. Anthem Way, Anthem, AZ

Maricopa Lapidary Society, Inc
Note: New meeting day
Meetings are on the 3rd Tuesday
Next Meeting: December 17, 2024, 7:00 pm
www.maricopalapidarysociety.com
@ North Mountain Visitor Center
12950 N. 7th St., Phoenix, AZ

Mineralogical Society of Arizona
Meetings are on the 3rd Thursday
(Except December & June)
December 14, 2024
Holiday Jamboree/Christmas Party
Scottsdale Location and Time to be revealed
at sign up on website.
www.msaaz.org

Pinal Geology & Mineral Society

SPECIAL EVENT – DECEMBER 7, 2024, 10-4
NO REGULAR MEETING IN December
www.pinalgeologymuseum.org
351 N. Arizona Blvd., Coolidge

West Valley Rock & Mineral Club
Meetings are on the 2nd Tuesday
Next Meeting: December 10, 2024, 6:30 pm
www.westvalleyrockandmineralclub.com
Buckeye Community Veterans Service Center
402 E. Narramore Avenue, Buckeye, AZ

Gila County Gem & Mineral Society
Meetings are on the 1st Thursday
(unless a Holiday then the next Thursday)
Next Meeting December 5, 2024, 6:30 pm
www.gilagem.org
Club Building
413 Live Oak St, Miami, AZ

Wickenburg Gem & Mineral Society
Meetings are on the 2nd Friday
(February & December on the 1st Friday)
Next Meeting: December 6, 2024, 7:00 pm
www.wickenburggms.org
@ Coffinger Park Banquet Room
175 E. Swilling St., Wickenburg, AZ

ESM's Meeting Notice

ESM's next meeting will be at North Mountain Visitor Center, 12950 N. 7th St., Phoenix, on Tuesday, TBA 2024, at 6:30 p.m.

BECOME A MEMBER!

Join the Earth Science Museum's

esi: Earth Science Investigation team

IS IT TIME TO RENEW YOUR MEMBERSHIP?
Please renew today! ☺☺☺

_ _ _ _ _ _ _ _ cut here _ _ _ _ _ _ _ _ _

ESM Earth Science Investigation Team Membership Form

_____ New Member _____ Renewal

Membership levels:

_____ ESI Family $20

_____ ESI Individual $10

Membership benefits:

- Monthly e-newsletter *Earthquake*
- Official team membership card
- Knowledge that your contribution is making a difference in earth science education.

MANY THANKS TO OUR MAJOR DONORS!

AZ Leaverite Rock & Gem Society

Flagg Mineral Foundation
www.flaggmineralfoundation.org

Friends of the AZ Mining & Mineral Museum

Maricopa Lapidary Society
http://maricopalapidarysociety.com/

Mineralogical Society of AZ
www.msaaz.org

Payson Rimstones Rock Club
https://www.rimstonesrockclub.org/

Sossaman Middle School

White Mountain Gem & Mineral Club
www.whitemountain-azrockclub.org

Sun City Rockhound Club & Mineral Museum
https://suncityaz.org/recreation/clubs/rockhound-club-mineral-museums/

Wickenburg Gem & Mineral Society
http://www.wickenburggms.org
www.facebook.com/pages/Wickenburg-Gem-and-Mineral-Society/111216602326438

West Valley Rock and Mineral Club
http://www.westvalleyrockandmineralclub.com/

Staples Foundation
www.staplesfoundation.org

Anita Aiston	Will & Carol McDonald
Peter & Judy Ambelang	Debbie Michalowski
Stan & Susan Celestian	Janet Stoeppelmann
Russ Hart	Dennis & Georgia Zeutenhorst

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Visit us at:

www.earthsciencemuseum.org

Mission
Our Mission is to excite and inspire all generations about earth sciences through educational outreach.

Vision
We envision a community where students and the general public have curiosity about, passion for, and understanding of the underlying principles of earth sciences.

For more information about the ESM, how to become a member or how to arrange for a school visit or Community function, go to: www.earthsciencemuseum.org.

NOTICE:
ESM's next meeting will be at North Mountain Visitor Center, 12950 N 7th St, Phoenix, on Tuesday, TBA 2024, at 6:30 p.m.

THANK YOU FOR YOUR CONTINUING INTEREST & SUPPORT!!!

Earth Science Museum
3215 W. Bethany Home Rd.
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