EARTHQUAKE
EARTH SCIENCE MUSEUM
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

January 2025
Volume 14, Issue 1

ESM OUTREACH UPDATE

Mardy Zimmermann, Outreach Coordinator

January Outreach

By Shirley Coté

On January 21st ESM board member, Shirley Coté, provided the Maricopa Lapidary Society (MLS) members and guests with Part I of her presentation on mineral identification at their monthly meeting. Part II will be given at a later monthly meeting.

The Maricopa Lapidary Society meets on the third Tuesday of the month at North Mountain Visitor Center, 12950 N. 7th St. in Phoenix, at 7:00 p.m.

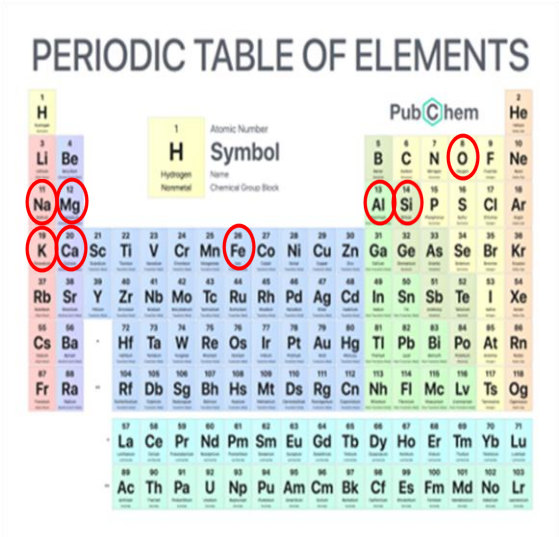
22 MLS members including six guests attended January's MLS meeting.

The program began with a quick review of how and where igneous rocks form.

The igneous rock basalt forms from rapidly cooling lava and is considered the most common rock type on Earth, making up a large portion of the Earth's crust with nearly all oceanic crust composed of basalt primarily generated at mid-ocean ridges.

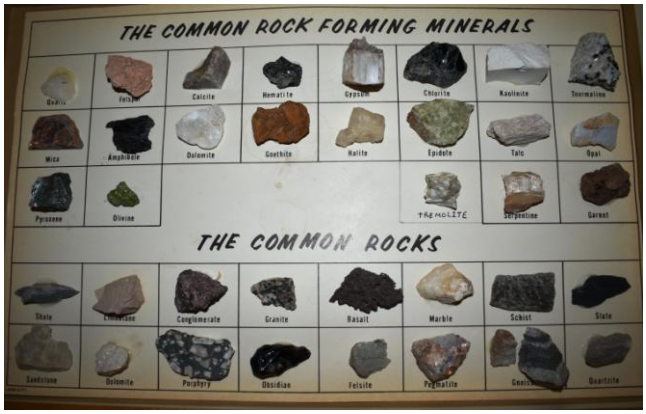
Shirley explained that it is most helpful to know the chemical symbols for the eight most abundant elements in the Earth's crust as the chemical composition of most minerals you find will include combinations of two or more of these elements.

(O) Oxygen - 46.1%
(Si) Silicon - 28.2%
(Al) Aluminum - 8.23%
(Fe) Iron - 5.63%
(Ca) Calcium - 4.15%
(Na) Sodium - 2.36%
(Mg) Magnesium - 2.33%
(K) Potassium - 2.09%

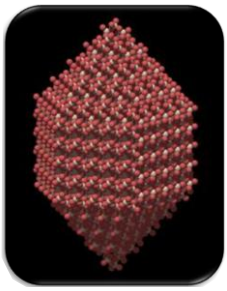


Periodic table of elements showing where on the table the eight most abundant elements are located

The following are some highlights of the mineral identification program.



Examples of the common rock forming minerals and the common rocks



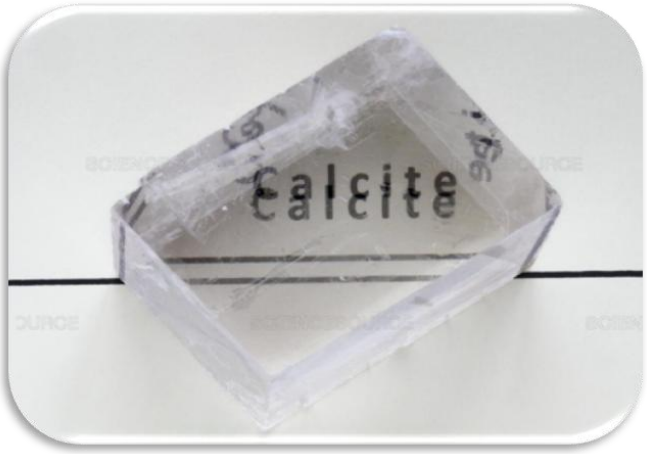
In well-formed crystals, the symmetrically arranged faces reflect the internal arrangement of atoms. In this example of quartz, there is a six-sided prism terminating with six-sided pyramids at each end.

A mineral is a naturally occurring, inorganic, solid with a regular internal crystalline structure and a definite chemical composition.

Different crystalline structures result in different minerals and different chemical compositions result in different minerals. These two aspects determine a mineral's physical properties. We use these physical properties to identify minerals.

Some physical properties of minerals are color, shape, habit, diaphaneity also known as transparency, luster, streak, fracture, cleavage, specific gravity, tenacity and hardness among others.

Here are a few examples of other physical properties . . . my favorites!



Double refractive calcite

Fiber optic ulexite

Twinning –Japan Law twin of quartz

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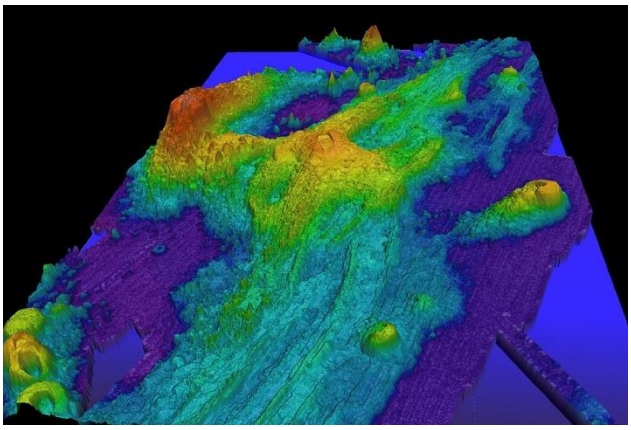
Undersea Volcano Predicted to Likely Erupt in 2025

By Harvey Jong

At the December 2024 meeting of the American Geophysical Union, a team of scientists reported that an undersea volcano 470 km (292 mi) off the Oregon coast will likely erupt sometime in 2025 (Chadwick et al., 2024). Such a long term prediction is somewhat unusual since most eruption forecasts involve only a few hours in advance of an event.

Axial Seamount

The underwater volcano in question is the Axial Seamount which is the most active submarine volcano in the Northeast Pacific. Eruptions have occurred in 1998, 2011, and 2015. The basaltic shield volcano was detected in the 1970s via satellite altimetry data and is named for its position at the intersection of the Cobb-Eickelberg Seamount chain and the Juan de Fuca Ridge. The first bathymetric survey (study of underwater depths of ocean floors) of the area was compiled in 1981.

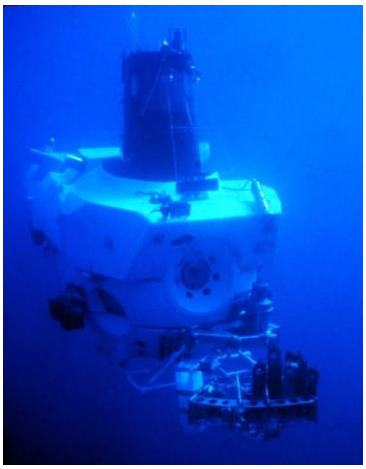


Axial Seamount

NOAA Photo Library, - CC_BY_SA-2.0, via Wikimedia Commons

This image presents an exaggerated swatch bathymetry of the Axial Seamount. The summit rises 700 m (2,297 ft) above the central Juan de Fuca Ridge and reaches about 1.4 km (0.87 mi) below the ocean surface. An oval horseshoe-shaped ~3 x 8 km (1.86 x 4.97 mi) caldera is located at the summit and opens to the southeast between two rift zones. The caldera walls rise about 100 m (328 ft) above the caldera floor.

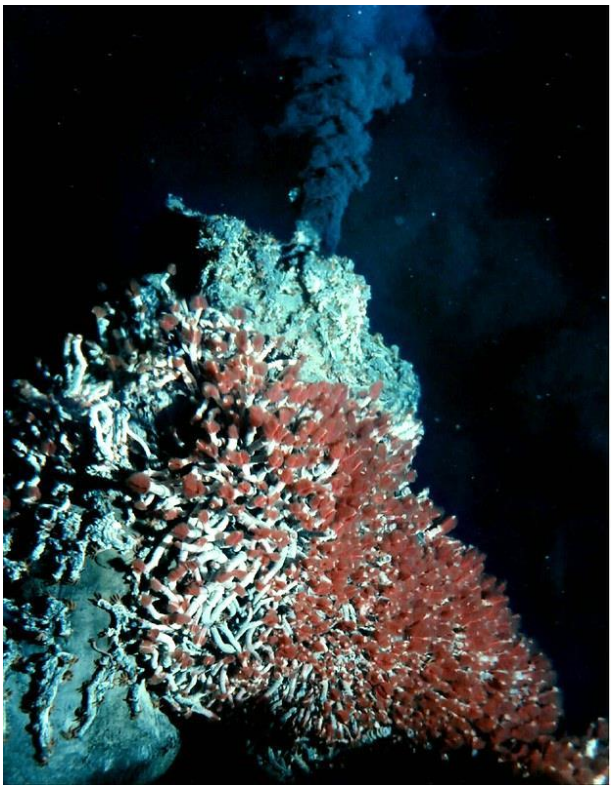
In 1983 and 1984, submersibles, such as the DSV Alvin, explored the volcano and discovered the first active hydrothermal (black smoker) vents in the Northeast Pacific.



DSV Alvin Submersible

NOAA Photo Gallery, -PD, via Wikimedia Commons

August 1978 photo



Black Smoker Vent Community

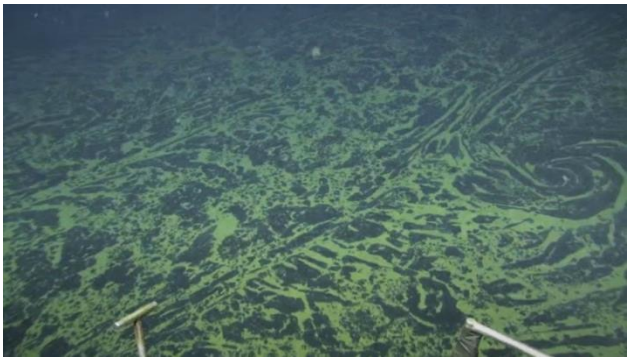
University of Washington/NOAA/OAR/OER photo, NOAA Photo Library, - CC_BY_SA-2.0, via flickr.com
Colony of giant red tube worms and squat lobsters gather around this hydrothermal vent located on the Juan de Fuca Ridge.

More recently, exploration of the Axial Seamount has been carried out by Remotely Operated Vehicles (ROVs), such as the Woods Hole Oceanographic Institution's Jason-Medea ROV system.

The Jason ROV Being Lowered into the Water
Screen capture of 2013 Axial Seamount Expedition/Oregon State University video, via https://www.youtube.com/@oregonstateuniversity-cime9808

The Oregon State University-Cooperative Institute for Marine Ecosystem and Resources Studies (OSU-CIMERS) center maintains a video archive of the Axial Seamount expeditions. Below are a few highlights:

El Guapo Hydrothermal Chimney - Axial Seamount 2013 Expedition



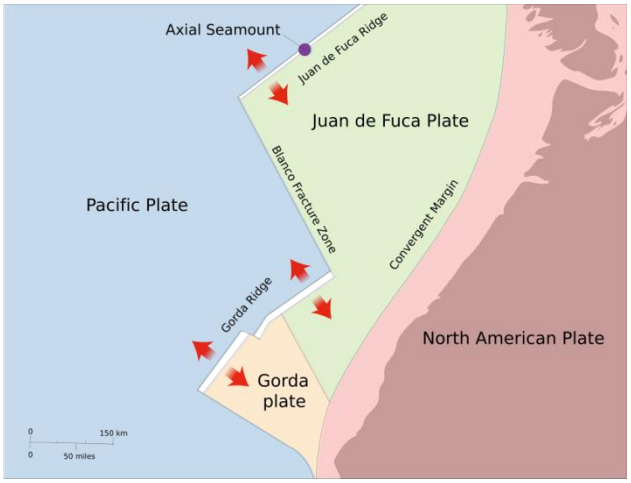
New Lava Flows - Axial Seamount 2013 Expedition

Axial Seamount 2015 Expedition

Axial Seamount 2017 Expedition

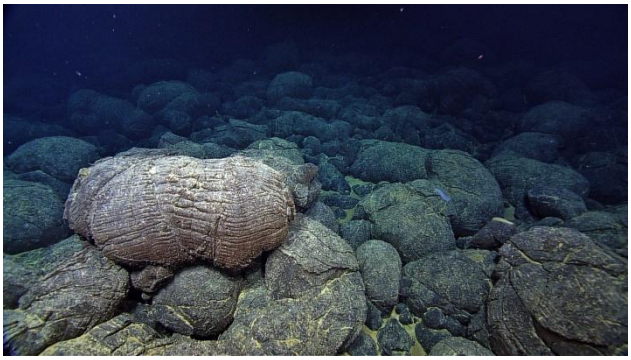
Geologic Setting

The Axial Seamount is the most prominent feature of the Juan de Fuca Ridge. This ridge is an oceanic spreading center between two tectonic plates: the Pacific and Juan de Fuca plates. It has a spreading rate of ~6 cm/year (2.36 in/year) (Johnson and Embley, 1990). The area is seismically, hydrothermally, and volcanically active.



Map of the Axial Seamount Location
Lyn Topinka/USGS map, - PD, via Wikimedia Commons
This map shows the location of the Axial Seamount on the Juan de Fuca Ridge. The red arrows indicate the ridge-spreading directions of the diverging Pacific and Juan de Fuca plates.

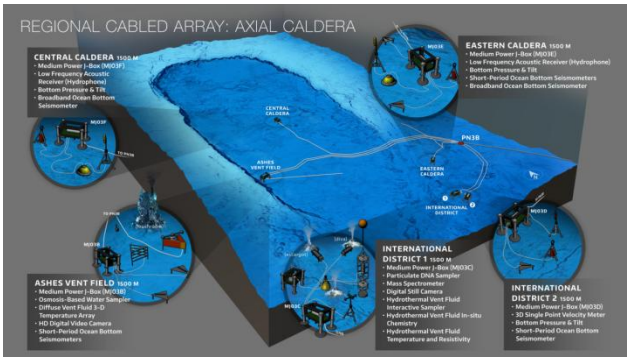
The undersea volcano is the most recent eruptive center of a volcanic seamount chain created by a mantle plume known as the Cobb hotspot. This hotspot, however, differs from other hotspots, such as the one associated with the Hawaiian Islands, in that the resulting basalts have an unusual chemistry similar to mid-ocean ridge basalts (Desonie and Duncan, 1990).



Axial Seamount Pillow Basalts
University of Washington/NSF-OOI/CSSF; V14 photo, via https://interactiveoceans.washington.edu/axial-caldera-image-gallery

This group of pillow basalts includes an example of the "bread crust" form.

Because of its unique geologic setting and proximity to west coast ports, the Axial Seamount has been the focus of extensive investigation and was selected as the site of the world's first underwater volcano observatory which is known as the **N**ew **M**illennium **O**bservatory (NeMO). The observatory operates a network of ocean-bottom seismometers; GPS, temperature, and pressure sensors; cameras; mass spectrometers; and water samplers.



Array of Instruments on the Axial Seamount Caldera
Center for Environmental Visualization, University of Washington graphic, - CC_BY_SA-2.0, via Wikimedia Commons

Eruption History

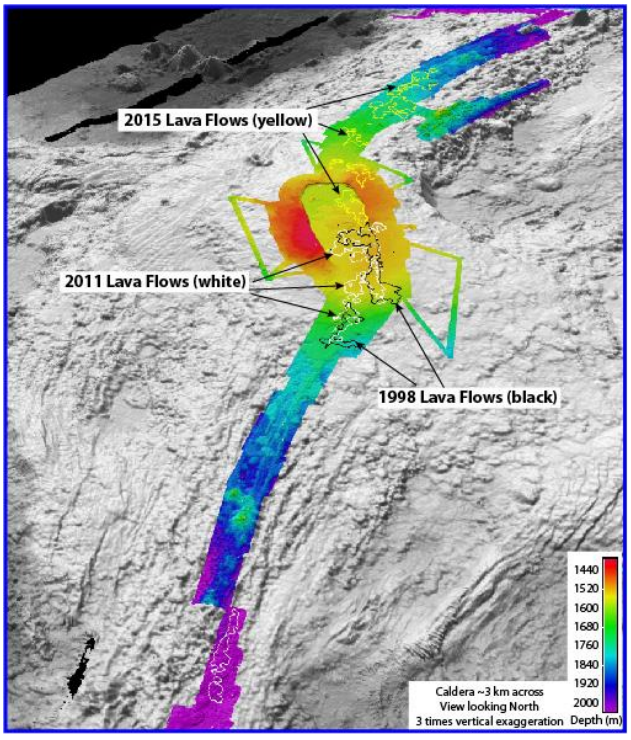
According to the Smithsonian Institution's Global Volcanism Program, the Axial Seamount has 12 confirmed Holocene eruptive periods:

Date	VEI[1]
2015 Apr 23 – 2015 May 24 ± 1 days	0
2011 Apr 6 – 2011 Apr 12	0
1998 Jan 25 – 1998 Feb 5 (?)	0

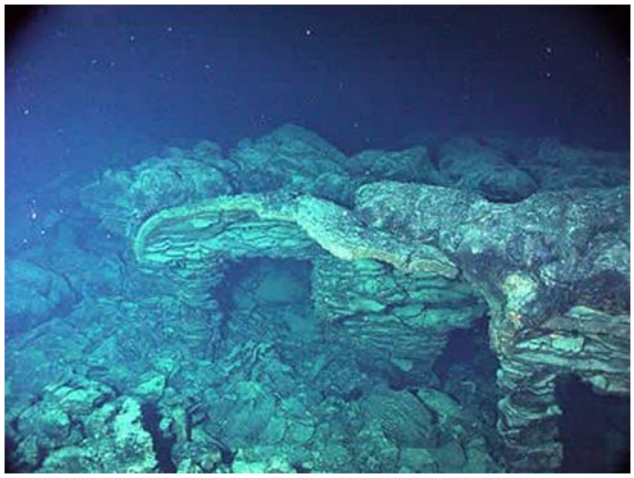
Continued on next page

[1] Volcanic Explosivity Index (VEI) is a logarithmic scale (from 0 to 8) used in measuring the size of volcanic eruptions. It combines measurements and observations, such as eruption volume and column height, which limits its usefulness for underwater effusive eruptions.

Date	VEI
1976 Jan 1 ± 6 years - 1982 (in or before)	0
1650 ± 117 years	0
1400 ± 71 years	0
1300 ± 91 years	0
1260 ± 72 years	0
1230 ± 76 years	0
1000 ± 98 years	0
0800 ± 107 years	0
0410 ± 123 years	0



Recent Axial Seamount Lava Flows
NOAA map, - PD, via axial2017-education.blogspot.com



Submarine Lava Flow
NOAA NeMo Observatory photo, - PD, via volcano.si.edu
The 1998 eruption, which occurred at the southern end of the Axial caldera, produced this submarine lava flow that later collapsed.

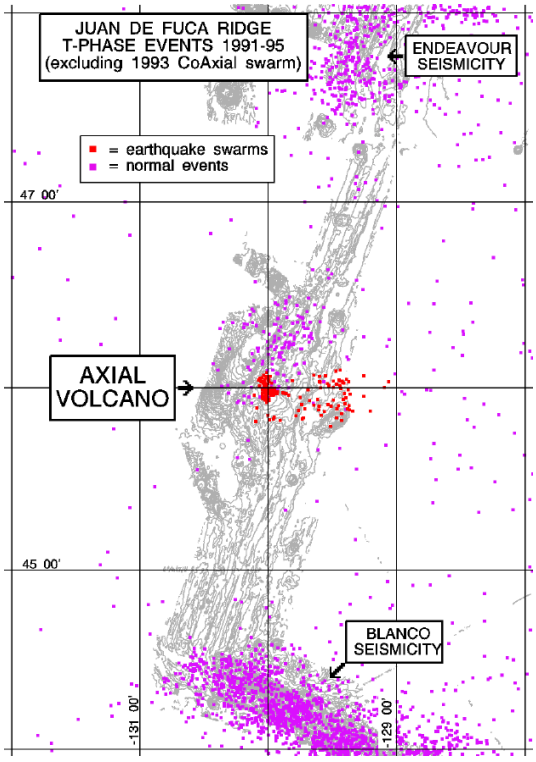
Lava Pillars
NOAA NeMo Observatory photo, - PD, via volcano.si.edu
These lava pillars formed after the collapse of the 1998 lava flow. The layers of the pillars developed when ponded lava drained away.

Eruption Patterns and Prediction

Predicting eruptions typically involves pattern recognition where pre-eruptive conditions are evaluated to determine if a

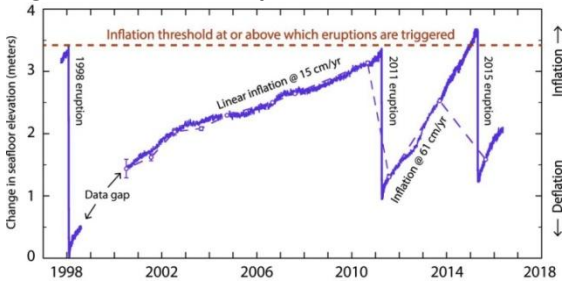
volcano is trending towards an eruption. Some key indicators include:

1. Seismic activity: Earthquake swarms in which the frequency and intensity of tremors increase often precede an eruption.



Seismic Activity at the Axial Volcano
NOAA map, -PD, via Wikimedia Commons

2. Magma accumulation: As magma accumulates beneath a volcano, the pressure builds causing deformation and uplift of the surrounding terrain. A sustained period of inflation may signal that an eruption is imminent.



Inflation-Deformation Time Series at the Axial Seamount Caldera
Figure 17 from (Nooner and Chadwick, 2016), via volcano.si.edu

This graph shows the changes in seafloor elevation from 1998 to about May 2016. The dotted red line indicates the inflation threshold which triggered the eruptions in 1998, 2011, and 2015.

3. Gas emissions: Increased levels of volcanic gases, such as carbon dioxide, may provide an early warning sign of an eruption.

The Axial volcano has exhibited a predictable eruption cycle based on magma inflation. This led to a successful forecast of the 2015 eruption. Starting in the fall of 2023, the rates of inflation and seismicity have been increasing, and as of July 2024 the rate of inflation reached 25 cm/year (10 in/year). Overall, the Axial Seamount has re-inflated to >95% of its last pre-eruption threshold making an eruption likely before the end of 2025 (Chadwick et al., 2024).

References:

Chadwick, W.W., W.S.D. Wilcock, S.L. Nooner, J.W. Beeson, and M. Zhang (2024) 'V22B-03 Axial Seamount has suddenly woken up! An update on the latest inflation and seismic data and a new eruption forecast'. American Geophysical Union Presentation, Washington, D.C., 2024.

Desonie, D.L. and R.A. Duncan (1990) The Cobb-Eickelberg Seamount Chain: hotspot volcanism with mid-ocean ridge basalt affinity. *Journal of Geophysical Research* 95: B8, 12,697-12,711.

Johnson, H.P. and R.W. Embley (1990) Axial Seamount: an active ridge axis volcano on the central Juan de Fuca Ridge. *Journal of Geophysical Research* 95: B8, 12,689-12,696.

Nooner, S.L. and W.W. Chadwick, Jr. (2016) Inflation-predictable behavior and co-eruption deformation at Axial Seamount. *Science* 354:6318, 1399-1403.

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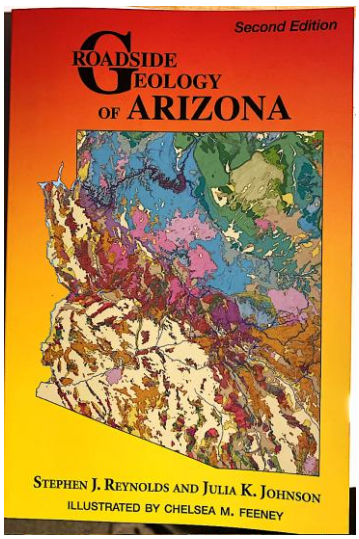
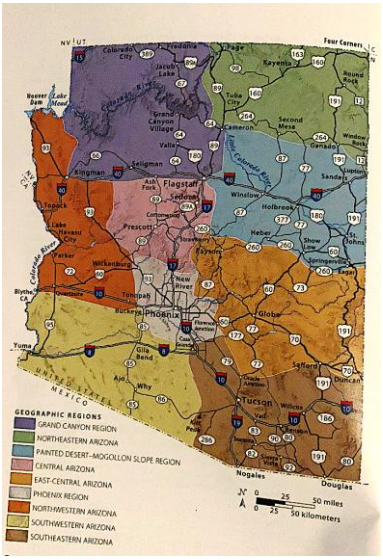
Arizona Rocks 140

Text and photos by Ray Grant

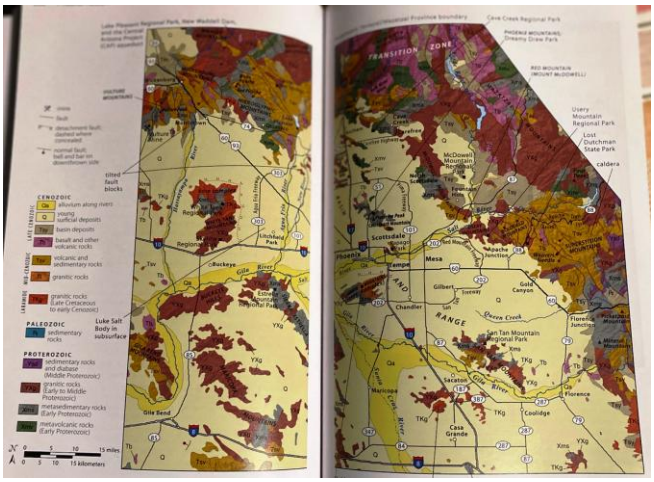
There is a new book about Arizona geology. It is the second edition of Roadside Geology of Arizona by Stephen Reynolds and Julia Johnson (2025). If you only have one book about the geology of Arizona this is the one to have. The introductory Geologic History section is a good summary of the geology of the state



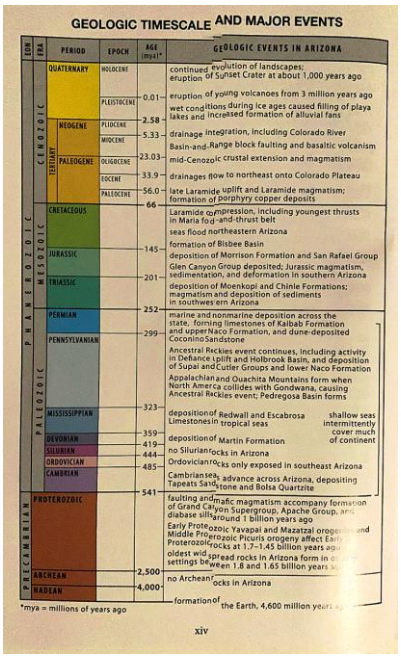
They divided Arizona into nine regions. For each part there is a geologic map, a timescale, and information about key units, structures and landscape features. This is followed by the description of the geology along the main routes and any special locations in the region. The book has hundreds of photographs of rock outcrops that are carefully placed by the description along the highway with the milepost number or information about the outcrop location.



The book is available from Mountain Press on the internet at mountain press publishing.



Geologic map for the Phoenix region



Example of one of the geologic timescales, this one for the state

Pinal Museum and Society News

351 N. Arizona Blvd., Coolidge, AZ

Pinal Geology and Mineral Society next meeting

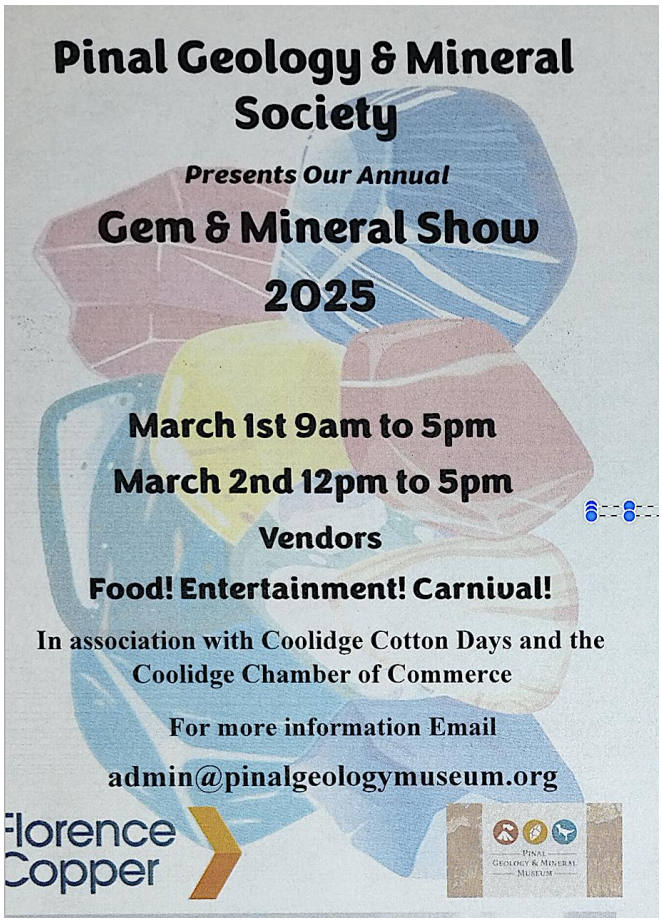
February 19, 2025

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.



AZ Mining, Mineral & Natural Resources Education Museum Update December 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

Happy New Year! We are looking forward to exhibiting at the 2025 Tucson Gem and Mineral Show, coming up in mid-February. This year, we will present a twist on the "Shades of Green" theme with an educational display that features different minerals and ores needed to transition from fossil-fuel based energy to "green" energy that harnesses renewable natural resources. As you may know, the infrastructure that supports clean energy systems is made from mined material. Solar panels, wind turbines, electric vehicles and batteries all require important, and sometimes rare, elements and minerals and the demand for mining them will increase in the coming years. Our exhibit will showcase some neat ores of copper, silver, lithium, cobalt, and nickel, among others. While the specimens won't be green in color, we hope they'll be equally appreciated for their importance in building a more sustainable "green" energy future. It will also be fun to introduce some of the content that will be explored in our new museum.

In museum planning news, we are wrapping up with our planning team and have reactivated the design-build team to prepare for construction. Director Marta is working hard behind the scenes with our Governor-appointed Advisory Council and University of Arizona administration. We have some fun educational outreach on the horizon and are always looking for new exhibit and collaboration opportunities. Thank you for your support and see you at the Tucson show!

Minerals in Solar Panels

From across the web

Solar panels are made from a variety of minerals, including:

Silicon
The primary mineral used in solar panels

Silicon's semiconducting properties allow it to capture sunlight and convert it into electricity

Cadmium
Used in cadmium telluride solar cells to improve efficiency

Cadmium telluride is a thin film product that can rival monocrystalline silicon cells However, cadmium is highly toxic, which can be a concern for disposal

Tellurium
Used in small amounts to improve the stability of solar panels

Selenium
Used in the production of solar panels to help prevent damage from sunlight

Aluminum
Used for the frames of solar panels to support and protect the photovoltaic cells

Aluminum is also used for racks because it's versatile and inexpensive compared to other metals

Copper
Used for wiring and making connections because it's a great electrical conductor

Silver
Used in photovoltaic cells to improve efficiency

Gallium
Used in gallium-arsenide semiconductors for solar cells

Zinc
Used to provide a corrosion-resistant coating

SUN CITY ROCKHOUND MINERAL MUSEUM
SUNDIAL RECREATION CENTER
14801 N. 103RD AVE.
SUN CITY, AZ 85351
THE MUSEUM DOES OFFER PRIVATE PARTY TOURS. CLUBS AND PRIVATE INDIVIDUALS INTERESTED CAN CONTACT THE MUSEUM AT SCROCKMUSEUM@GMAIL.COM.

Sun City Rockhound Club and Mineral Museum
By Carol Bankert-George Vice President

January brought a couple of sizable donations to our club and museum. Club members will be busy in February reviewing and cataloging these new items. Many will be up for sale at our March Rock Sale Event. This year the sale will be moving to the breezeway outside of the museum making it very convenient to visit the sale and the museum.

Our sale will be in conjunction with an Open House event for other clubs that share our location. There will be raffles and other activities involved with the event.

The Open House event will be 2 days:

Friday March 7th
Saturday March 8th
9-2pm

The Rock Sale is Saturday ONLY 8-1pm

The address is 14801 N. 103rd Avenue
Sun City, AZ 85351

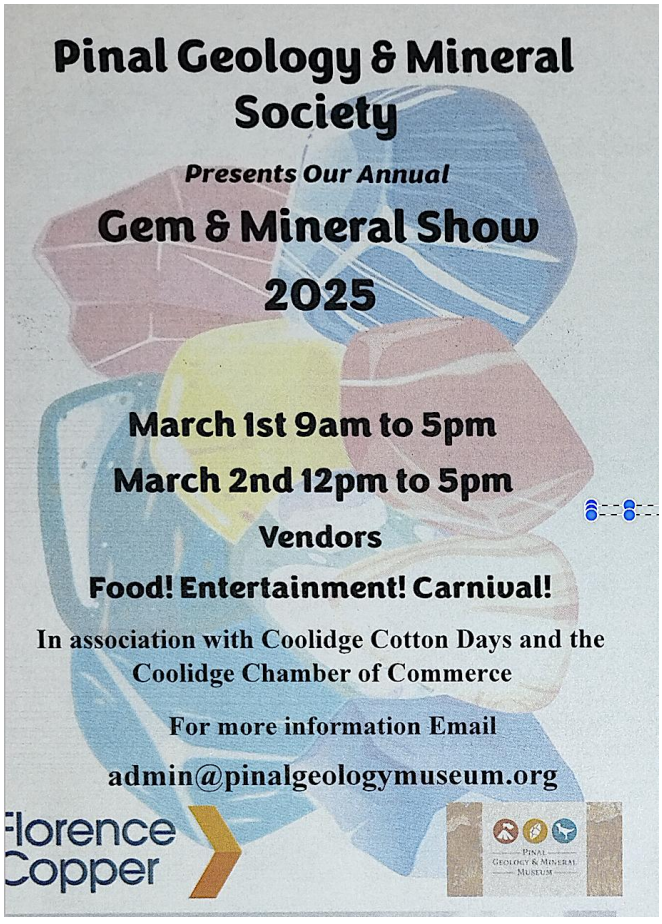
C. Sandoval photo

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

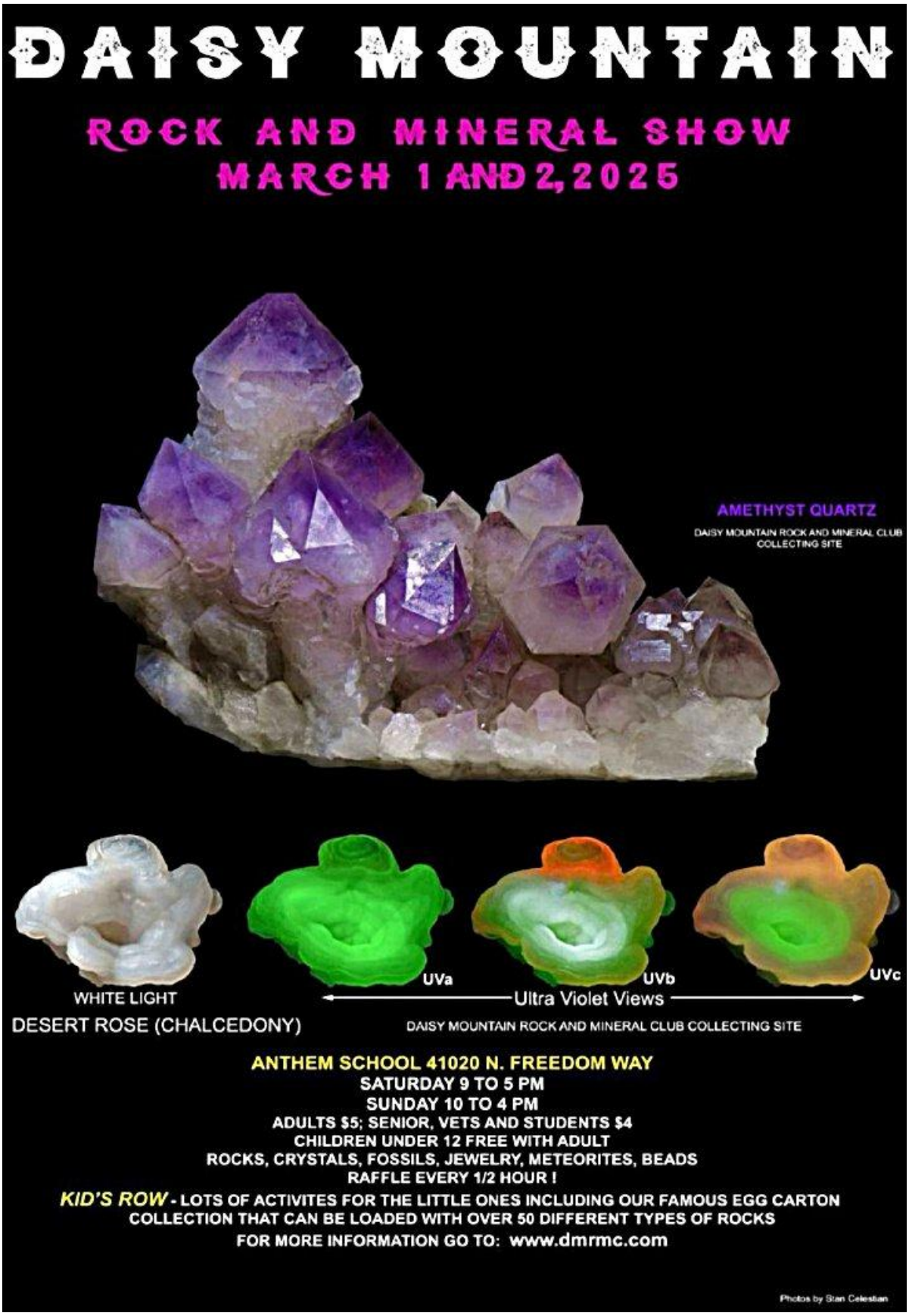
Donation from the Sun City Silver Stones

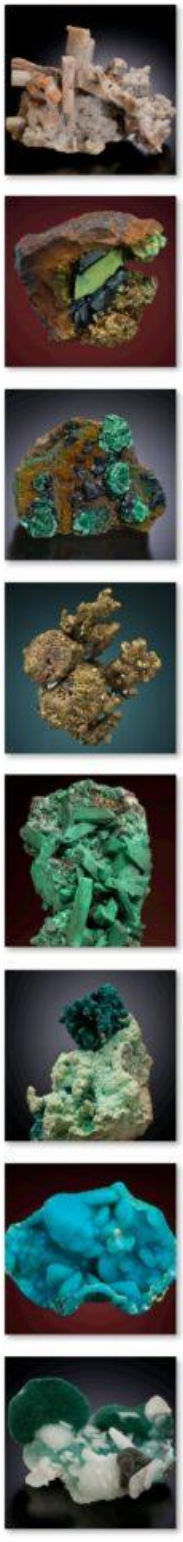
Arizona Rock and Gem Shows

Arizona Rock and Gem Shows



Arizona Rock and Gem Shows





32ND ANNUAL

APRIL 5TH, 2025

SOUTHEAST REGIONAL LIBRARY

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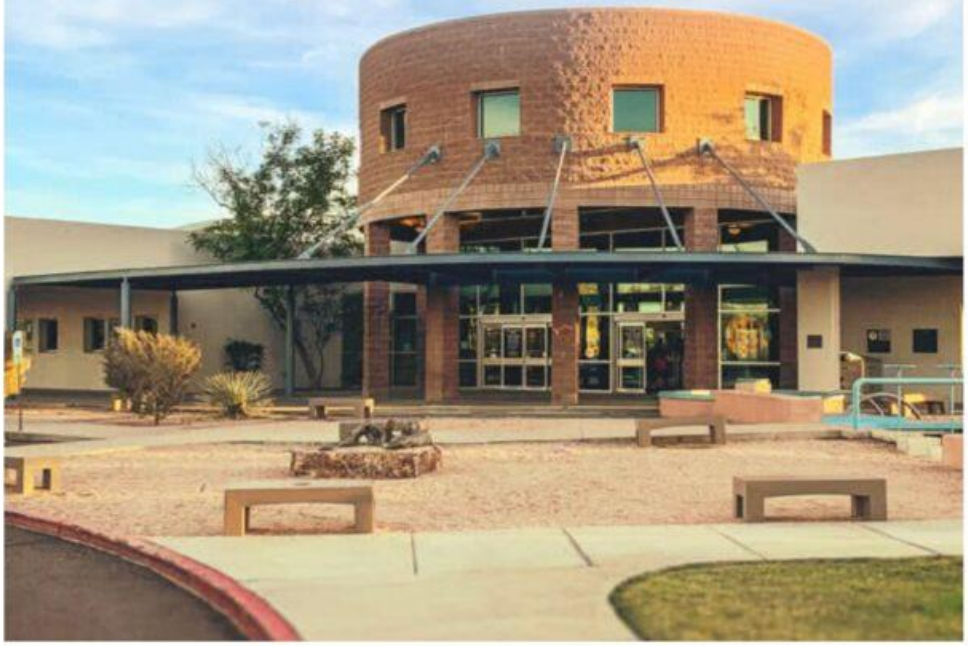
MINERALS OF ARIZONA SYMPOSIUM



Chairperson
Les Presmyk

Co-Chairperson
Catie Sandoval

FLAGG MINERAL FOUNDATION

Apache Junction Rock & Gem Club
Meetings are on the 2nd Thursday
Next Meeting: February 13, 2025, 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: February 4, 2025, 6:30 p.m.
www.dmrmc.com
@ Anthem Civic Building
3701 W. Anthem Way, Anthem, AZ

Maricopa Lapidary Society, Inc
Meetings are on the 3rd Tuesday
Next Meeting: February 18, 2025, 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)
February 20, 2025
@ Franciscan Renewal Center, Piper Hall
5802 E. Lincoln Drive, Scottsdale, AZ
www.msaaz.org

Pinal Geology & Mineral Society
Meetings are on the 3rd Wednesday
Next Meeting: February 19, 2025, 7:00 pm
www.pinalgeologymuseum.org
351 N. Arizona Blvd., Coolidge

West Valley Rock & Mineral Club
Meetings are on the 2nd Tuesday
Next Meeting: February 11, 2025, 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 February 6, 2025, 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: February 14, 2025, 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 2025, 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! ☺☺☺

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ESM Earth Science Investigation Team Membership Form

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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!

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Flagg Mineral Foundation
www.flaggmineralfoundation.org

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Maricopa Lapidary Society
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www.msaaz.org

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

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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
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Phone:
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Editor E-Mail:
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We're on the Web!

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 2025, at 6:30 p.m.

THANK YOU FOR YOUR CONTINUING INTEREST & SUPPORT!!!

Earth Science Museum
3215 W. Bethany Home Rd.
Phoenix, AZ 85017