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
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May 2025
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ESM OUTREACH UPDATE
Mardy Zimmermann Outreach Coordinator

There were no outreach programs this month.

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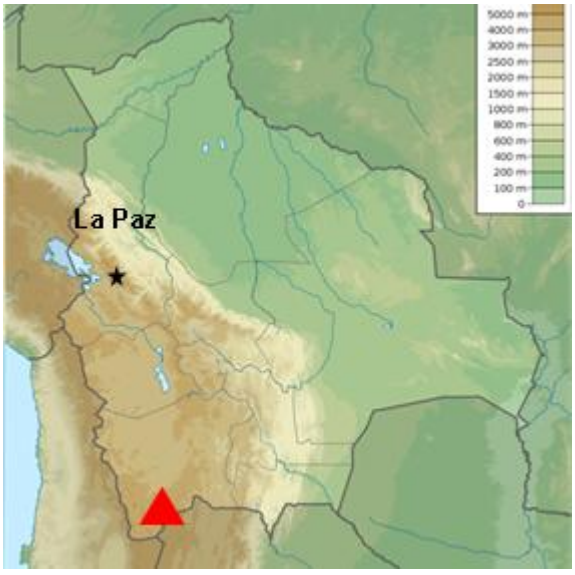
Mysterious Bolivian "Zombie" Volcano
By Harvey Jong

Uturuncu is a dormant volcano located in southwestern Bolivia which last erupted around 250,000 years ago. For several decades, it has, however, been showing sporadic signs of activity in the form of gas emissions, earthquakes, and deformation of the surrounding ground. Because of this unrest, Uturuncu has been called a "zombie" volcano. A recent paper published in the *Proceedings of National Academy Sciences* analyzed the hydrothermal magmatic system behind these activities (Liu et al., 2025).



Location of the Uturuncu Volcano
Urutseg map, - CCO-1.0 UPD, via Wikimedia Commons
The location of the Uturuncu volcano is indicated by the red triangle. The term uturuncu means "jaguar" in the Quechua language.

Summits of the Uturuncu Volcano
Ceky photo, - CC_BY_SA-3.0 Germany, via Wikimedia Commons
The Uturuncu volcano is the highest peak in southwestern Bolivia rising to a height of 6,008 m (19,711 ft). A second summit, which is 5,930 m (19,460 ft) high, is located about 1 km (0.62 mi) away, and a fumarole field is found between the two peaks.

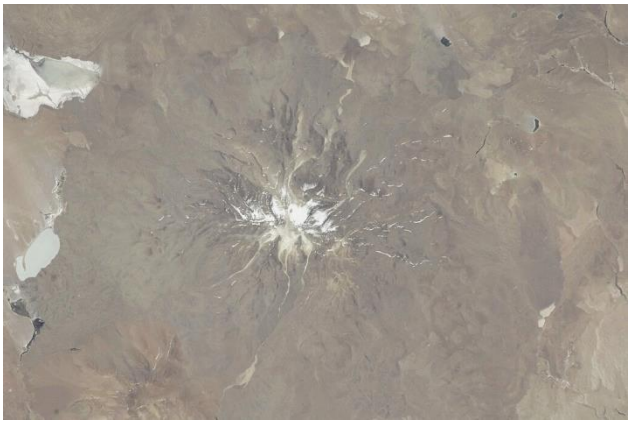
View from the Summit of the Uturuncu Volcano

Marquex bol photo, - CC_BY_SA-4.0 International, via Wikimedia Commons

Fumaroles of the Uturuncu Volcano
Albert Backer photo, - CC_BY_SA-3.0, via Wikimedia Commons
Steam is rising from some of the volcano's fumaroles.

Discovery and Tectonic Setting

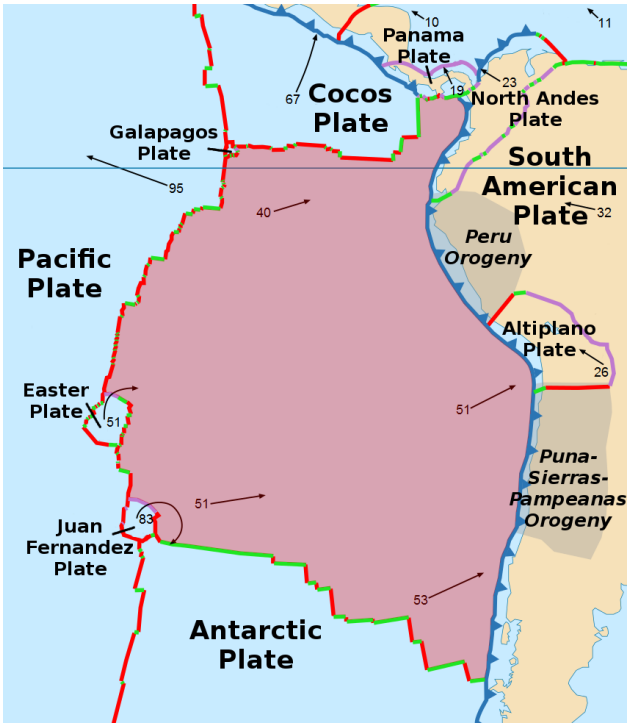
Although some sulfur mining occurred around the region, Uturuncu wasn't actively studied until 1992 when satellite observations indicated large-scale uplift centered on the stratovolcano. The deformation pattern resembled a sombrero with a rising central region surrounded by a ring of subsidence. Radar interferometric measurements revealed a deformation rate of 1-1.5 cm yr^{-1} (0.39-0.59 in yr^{-1}) (Pritchard and Simons, 2002).



The Uturuncu Volcano as Viewed from Space
ISS029, Earth Science and Remote Sensing Unit, Johnson Space Center, NASA photo, - PD, via Wikimedia Commons

The volcano has a volume of 85 km^3 (20 mi^3) and covers an area of 400 km^2 (150 mi^2). It is made of porphyritic dacite lava flows and lava domes with ages ranging from 890 to 271 ka. The lava flows extend 15 km (9.3 mi) from the volcano and are several tens of meters thick.

The Uturuncu volcano is part of the Altiplano-Puna Volcanic Complex (APVC) which is one of the largest and youngest volcanic fields on Earth. The complex was formed by the subduction of the Nazca Plate beneath the South American Plate.



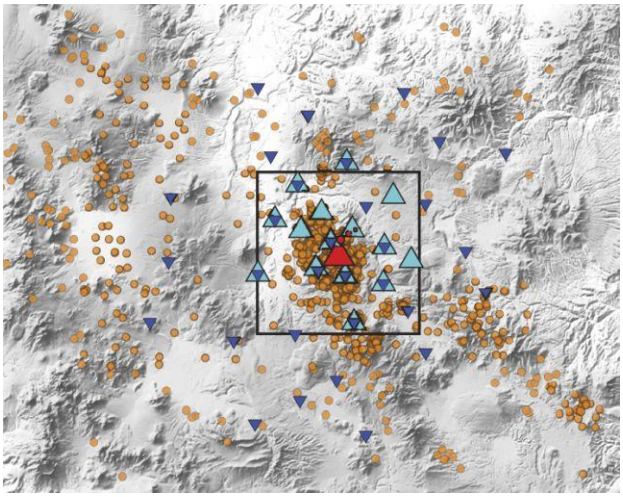
Map of the Nazca Plate
Eric Gaba (Sting) map, - CC_BY_SA-2.5, via Wikimedia Commons
This map depicts the extent of the Nazca Plate and boundaries with adjacent tectonic plates. The subduction of this plate along the Peru-Chile Trench is largely responsible for the formation of the Andes Mountains. The Nazca Plate emerged from the breakup of the Farallon Plate about 23 million years ago.

Delamination of the crust under the volcanic field produced the Earth's largest known

active magma body, the Altipano-Puna Magma Body (APMB). The magma body has a diameter of about 200 km, a depth of 14-20 km, and a total volume of approximately 500,000 km^3 (Ward et al., 2014).

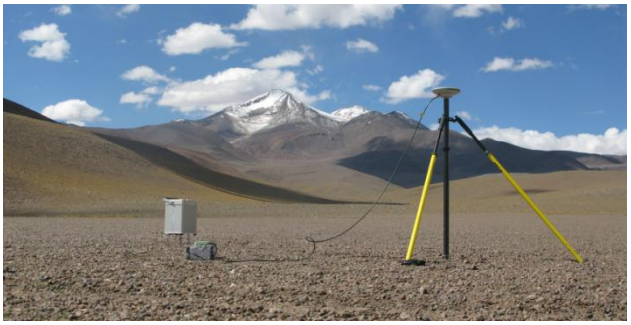
Monitoring and Analysis of the Uturuncu Volcano

An international team of geoscientists from Cornell University, University of Oxford, and University of Science and Technology of China (USTC) has been investigating the Uturuncu volcano. A field expedition began in 2019 which detected over 1,700 earthquakes using 48 seismometer stations.



Map of Seismic Events Detected Around the Uturuncu Volcano
Map from (Liu et al., 2025), accessed via https://www.sciencealert.com/zombie-volcano-in-bolivia-appears-to-be-stirring-deep-underground
Seismic activity is indicated by the ochre dots; the blue triangles are seismic monitoring stations, and the red triangle corresponds to the main volcano peak. Data collected from the seismic events provide a way of imaging the interior of the volcano, similar to medical imaging techniques. Seismic waves propagate at different speeds through different rock materials as energy is absorbed in the subsurface. This attenuation can be used to map where and why hydrothermal fluids accumulate in magma (Hudson et al., 2023).

In addition to seismicity, the researchers monitored changes in the gravity field and underground electrical currents.

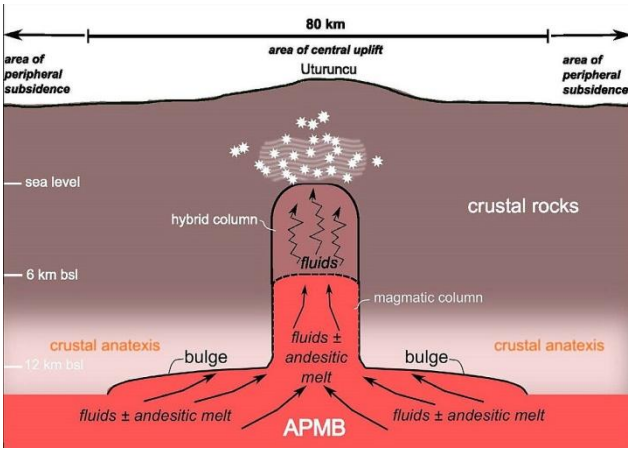


A Gravimeter and GPS Station Used in Studying the Uturuncu Volcano
Duncan Muir/Cardiff University photo, accessed via https://www.eurekalert.org/news-releases/1081500
Gravimeters are sensitive geophysical tools that detect changes in subsurface mass by measuring microgravity changes. Combined with ground deformation data, this instrument can provide details on the processes involved with subsurface magma flows.

Monitoring underground electrical currents can supply insights into the quantity, geometry, and composition of molten and partially molten rocks. It can detect differences in the electrical resistance of a layered magma body, and measurements are compared with seismic data to confirm the interpretation of magma movement.

This information was linked with earlier petrological analysis and rock physics models to produce a comprehensive high-resolution view in three dimensions of the plumbing system beneath the Uturuncu volcano. The plumbing system is a complex mixture of fluids and gases in magmatic reservoirs and hydrothermal systems. Previous studies have shown that the volcano is situated above the world's largest known magma

body, the Altiplano-Puna Magma Body (APMB).



Model of the Deformation Surrounding the Uturuncu Volcano
Gottsmann et al., 2017 diagram, - CC_BY_SA-4.0 International, via Wikimedia Commons
This diagram shows the extent of the deformation and subsidence of the surface surrounding the Uturuncu volcano. It indicates how the APMB may be causing this deformation.

How fluids and gases move through this underground system was unknown and represented the focus of the research study. The detailed analysis described possible upward migration pathways and revealed how liquids and gases may accumulate in reservoirs directly below the volcano's crater. The geoscientists concluded that this movement may be causing the deformation at the volcano's center and that the risk of an eruption is low (Liu et al., 2025).

Significance of the Study

The investigation has demonstrated that combining seismology, petrology, and rock physics can reveal insights into the activity observed at the Uturuncu volcano and its eruption hazard. Co-author Professor Matthew Pritchard of Cornell University commented that "the methods in the paper could be applied to the more than 1400 potentially active volcanoes and to the dozens of volcanoes like Uturuncu that aren't considered active but that show signs of life – other potential zombie volcanoes."[1]

References

Gottsmann, J., J. Blundy, S. Henderson, M.E. Pritchard, and R.S.J. Sparks (2017) Thermomechanical modeling of the Altiplano-Puna deformation anomaly: Multiparameter insights into magma mush reorganization. *Geosphere* 13: 1042-1065.

Hudson T.S., J.M. Kendall, J.D. Blundy, M.E. Pritchard, P. MacQueen, S.S. Wei, J.H. Gottsmann, and S. Lapins (2023) Hydrothermal fluids and where to find them: using seismic attenuation and anisotropy to map fluids beneath Uturuncu volcano, Bolivia. *Geophysical Research Letters* 50(5) 2022GL100974.

Liu, Y., J.M Kendall, H. Zhang, and P. MacQueen (2025) Anatomy of the magmatic-hydrothermal system beneath Uturuncu volcano, Bolivia, by joint seismological and petrophysical analysis. *Proceedings of the National Academy of Sciences* 122(18) e2420996122.

Pritchard, M.E. and M. Simons (2002) A satellite geodetic survey of large scale deformation of volcanic centers in the Central Andes. *Nature* 418(6894): 167-71.

Ward, K.M., G. Zandt, S.L. Beck, D.H. Christensen, and H. McFarlin (2014) Seismic imaging of the magmatic underpinnings beneath the Altiplano-Puna volcanic complex from the joint inversion of surface wave dispersion and receiver functions. *Earth and Planetary Science Letters* 404(15): 43-53.

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[1] From: Anatomy of a "zombie" volcano: investigating the cause of unrest inside Uturuncu, EurekAlert! AAAS News Release, 28-Apr-2025, https://www.eurekalert.org/news-releases/1081500

Arizona Rocks 144

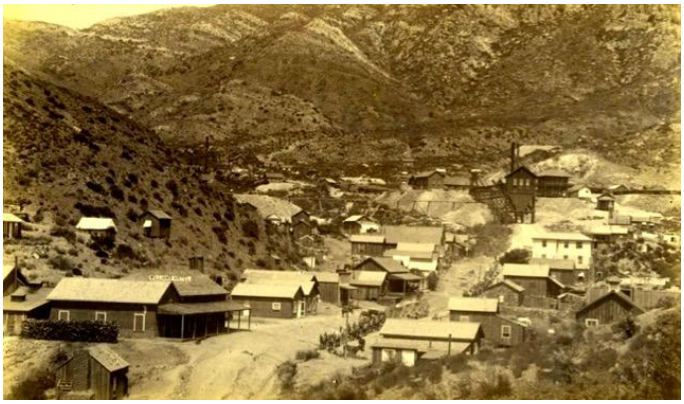
Text by Ray Grant

Arizona silver continued: the Silver King Mine north of Superior was very important to the development of the region. The story starts road construction over the Mountain where the Silver King Mine is located. John Sullivan working on the road picked up some heavy black rocks that he found out were silver. After he left the army, he worked on a ranch near Florence and told his boss Charles Mason about where he found the silver. Mason and friends opened the mine and from 1875 to 1889 – 5,943,157 ounces of silver were mined worth over 6.5 million dollars. The town of Silver King was where the miners lived and the ore was taken to town of Pinal for smelting. Both those towns are completely gone. The town of Florence was "civilization" as an alternate to the mining and milling towns. In the early 1880s, there were 28 saloons, two hotels, a brewery, a Chinese bakery, flourmills, restaurants, and much more. Today, the Silver King hotel and a couple of houses built by mining people are still there.

Several attempts at mining have been tried since 1889 without much success. Some silver specimens from the early mining have been preserved and they are exceptional specimens and very valuable.

Silver Kng miners in early 1880s, Arizona Geological Survey photograph

Silver King Hotel today in Florence, Ray Grant photograph



Town of Silver King in early 1880s, Arizona Geological Survey photograph

Wagons hauling ore from Silver King to Pinal, Arizona Geological Survey photograph

Silver specimens, Silver King Mine. Some of the best silver specimens in the world are from the Silver King, Jeff Scovil photographs

Pinal Museum and Society News

351 N. Arizona Blvd., Coolidge, AZ

Pinal Geology and Mineral Society next meeting

September 17, 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
May – September hours are Fridays from 10-3, admission is free.
Groups can arrange special visits please call 520-723-3009.

No club meetings in summer and museum open only Fridays 10 - 3 until September

On May 10, a small group of third graders from the Imagine School in Coolidge visited the museum. They did the exhibit questionnaire and received a treasure bag of specimens to take home.

AZ Mining, Mineral & Natural Resources Education Museum Update May 2025

https://ammnre.arizona.edu/

Catie Carter Sandoval
cscarter@email.arizona.edu
703.577.6449

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

Arizona has been the leading producer of copper in the United States since at least 1910, and our state currently produces around 70% of the nation's copper. Arizona has certainly earned the nickname "the Copper State" - in fact, copper was even designated the official State Metal of Arizona by law in 2015. The AMMNRE Museum collection contains several beautiful and historic Arizona copper specimens. Here are photos of some of our favorites. We have put all of these specimens on display in different exhibits over the past few years.

Copper from the Ray Mine, Pinal Co., AZ. This specimen has been showcased at the Tucson Gem and Mineral Show and is currently on display at the South Mountain Visitor Center in Phoenix.

Copper from Bisbee, Cochise Co., AZ. This specimen is currently on display at the Sun City Rockhounds Mineral Museum in Sun City.

Copper from the New Cornelia Mine, Ajo, Pima Co., AZ. You can see this 7-foot-long specimen on display at the Arizona Heritage Center in Tempe.

Copper after cuprite pseudomorph from Bisbee, Cochise Co., AZ. We put this specimen in our "Mineral Oddities" display at the 2024 Denver Gem & Mineral Show.

Case of Arizona copper specimens currently on display at the Arizona Senate building in Phoenix.

Specimen localities include (clockwise beginning from top left) Jerome, Bisbee, Morenci, Ray, and Bisbee. The public is welcome to visit the Senate and see this display anytime.

Sun City Rockhound Mineral Museum
Sundial Recreation Center
14801 N. 103rd Ave.
Sun City, AZ 85351

The museum offers private party tours for schools, clubs and individuals. We'd love to show off our museum to your club or private group. If you are interested, please contact the museum at scrockmuseum@gmail.com.

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 members turn their attention to inside museum activities to stay cool

By Carol Bankert-George Museum Director

The museum has been preparing for renovations by emptying out key display cabinets that have to be moved for the upcoming museum painting. During this process we decided to reduce inventory to make way for new displays in the fall. The museum recently donated uranium minerals, gemstones and agate cabochons to the Pinal Geology & Mineral Museum. Thanks to Catie Sandoval of the AZ Mining, Mineral & Natural Resources Education Museum who got us in touch with Dana Slaughter of the Pinal Geology & Mineral Museum to help make this donation happen. Dana has since visited our museum and has graciously offered his time and knowledge to help us with verification of specimens in our collection and in our museum.

Bob Holmes, local meteorite collector, has added a new specimen to his guest meteorite display at the museum. The new specimen is from the Hammadah al Hamra 346 'Ghadamis' L6 site in Libya. It's a large, very impressive specimen. Bob now has a display of 29+ specimens at the museum. It's worth a visit if you are interested in meteorites.

Please take a minute to check out our new website at scrockmuseum.com.

Bob Holmes holding newly added meteorite to his museum display

Dana Slaughter and Cheryl Alvord holding a uranium mineral donated to Pinal Geology & Mineral Museum

Arizona Rock and Gem Shows

POSTPONED – The 5th Phoenix Heritage Mineral Show

We sincerely regret to inform you that **The 5th Phoenix Heritage Mineral Show** which had been scheduled to take place June 6-8, 2025 at the Phoenix Shrine Auditorium has been postponed due to logistical challenges that could not be handled in time with an unexpected change of staff at the venue as well as the change to a June Show that had originally been planned for April.

We are in the process of rescheduling **The 5th Phoenix Heritage Mineral Show** for Spring 2026 and will keep you updated as soon as we have more information.
Please don't hesitate to contact us at show@msaaz.org or MSAClub1935@msaaz.org with any questions or concerns.
We apologize for the inconvenience, and we appreciate your understanding.

Warm Regards,
PHMS Show Committee
The 5th Phoenix Heritage Mineral Show
Mineralogical Society of Arizona
Arizona's Oldest Mineral Society
Celebrating 90 Years! (1935-2025)
email: show@msaaz.org
msaaz.org

Arizona Rock and Gem Shows

Pinal Geology & Mineral Museum presents

Arizona Fossil Festival

Saturday June 28th

10am to 2pm

351 N. Arizona Blvd Suite 2

Coolidge, AZ

Free Admission

- **ARIZONA FOSSILS ON DISPLAY**
- **Bring your fossils to be identified**
- **Fossils for Sale**

For more information visit our website

www.pinalgeologymuseum.org

admin@pinalgeologymuseum.org

(520) 723-3009

Light Refreshments

Apache Junction Rock & Gem Club
Meetings are on the 2nd Thursday
Next Meeting: June 12, 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: June 3, 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: June 17, 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 June & December)
Saturday, June 21, 2025 @ 11:00 am
@ LGF Natural History Gallery
North Scottsdale, AZ
MUST REGISTER
www.msaaz.org

Pinal Geology & Mineral Society
Meetings are on the 3rd Wednesday
Next Meeting: September 17, 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: June 10, 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 June 5, 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: September 12, 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

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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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
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Phoenix, AZ 85017