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

May 2022
Volume 11, Issue 5

ESM OUTREACH UPDATE

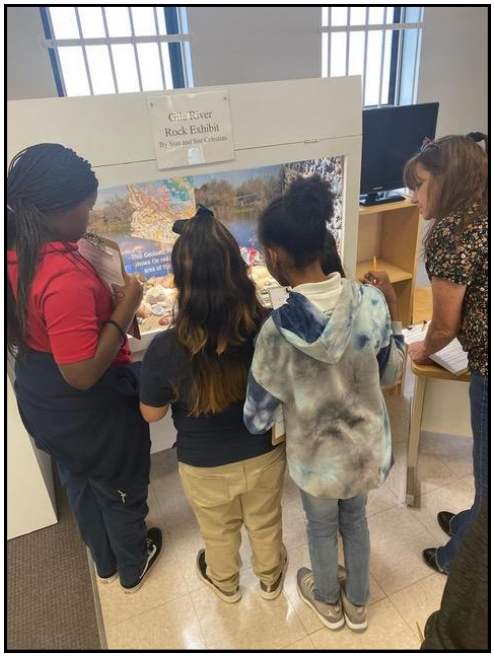
Mardy Zimmermann, Outreach Coordinator

In early May, three third grade classes (about 90 students) from the Imagine School in Coolidge visited the Pinal Geology Museum run by ESM board member, Dr. Ray Grant. Each class spent an hour at the Museum. They were divided into two groups; one group would work on answering questions about the fossil and geology exhibits while the other group did an introduction to mineral identification. After 30 minutes they would switch and do the other activity. When they left they received a treasure bag with several mineral and fossil samples.

Dr. Ray Grant conducts mineral identification class

Because they were only in third grade we made the geology questions multiple choice; they searched the exhibits and had to circle the correct answer. There were 12 questions including –

1. Apache tears are granite, obsidian, or sandstone?
2. A megalodon is a shark, snake, or mouse?
3. Mammoths and saber-tooth cats used to live in Pinal County, yes, or no?



Students finding answers to questions

The mineral identification activity had nine specimens for them to identify. Because of the limited time they were guided through naming each specimen using luster (metallic or nonmetallic), color (copper and azurite), magnetism (magnetite), specific gravity (galena), streak (pyrite and hematite), cleavage (muscovite and gypsum) and hardness (gypsum and quartz).

In other outreach this month, ESM board members, Doug Duffy and Shirley Coté gave their program on "Rockhounding in Arizona" to 29 members of the West Valley Rock and Mineral Club. ESM thanks the WVRMC for their $200 donation.

Tombstone's Emerald Mine and Rare Emerald-Green Tellurium Minerals

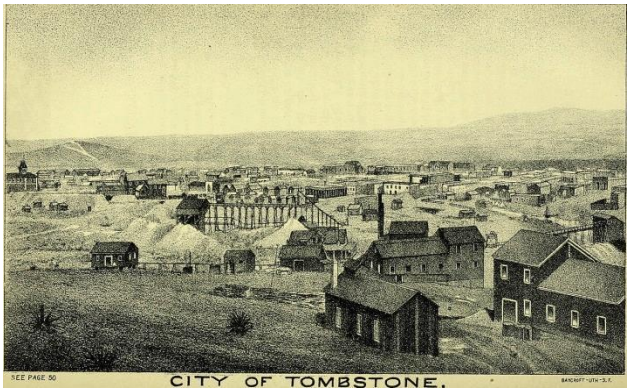
By Harvey Jong

Emerald is May's birthstone, so it seemed appropriate to write an article about the green gemstone variety of beryl found in Arizona. Unfortunately, unlike with other birthstones, such as amethyst and peridot, Arizona is not known as a source of emeralds. This was confirmed in reviewing the 85 beryl occurences in Arizona listed at mindat.org. Only six localities have reported occurrences of light-green, pale green, or green beryl:

- Aquarius Cliffs pegmatites, Mohave County
  Green beryl with monazite and euxenite (Meeves et al., 1966)
- Bagdad area, Yavapai County
  Pale-green beryl with black wolframite in narrow quartz veins (Anderson et al., 1955)
- Estrella Mountains, Maricopa County
  Light green beryl crystals up to 10 cm in diameter and 26 cm long in the Sierra Estrella pegmatites (Melchiorre, 1993)
- Juniper Beryl Group, Yavapai County
  Light greeen beryl crystals up to 2 inches in diameter (Meeves et al., 1966)
- Midnight Owl Mine, Yavapai County
  Pale green to white anhedral crystals 1/8 inch to 3 ½ inches (Jahns, 1952)
- Weaver Mountains, Monte Cristo pegmatite, Yavapai County
  Green crystals up to 2 feet long and 14 inches in diameter with albite, muscovite, and quartz (Mohon, 1975)

The references do not indicate that gem quality material was found at these locations, while a few Yavapai County occurrences seem doubtful since samples have also been described as being light blue or aquamarine (blue variety of beryl).

Given the limited information on Arizona emeralds, the emerald theme has been extended (perhaps overextended?) to include Tombstone's Emerald Mine which has produced some rare emerald-green tellurium minerals.

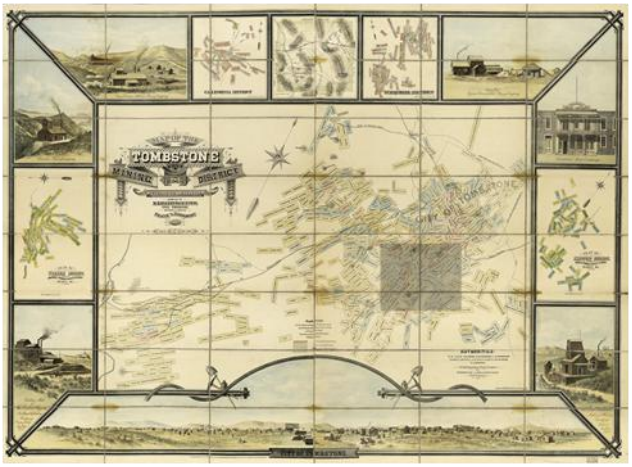


1883 illustration from *The Resources of Arizona, 2nd edition* compiled by Patrick Hamilton – PD, via Wikimedia Commons

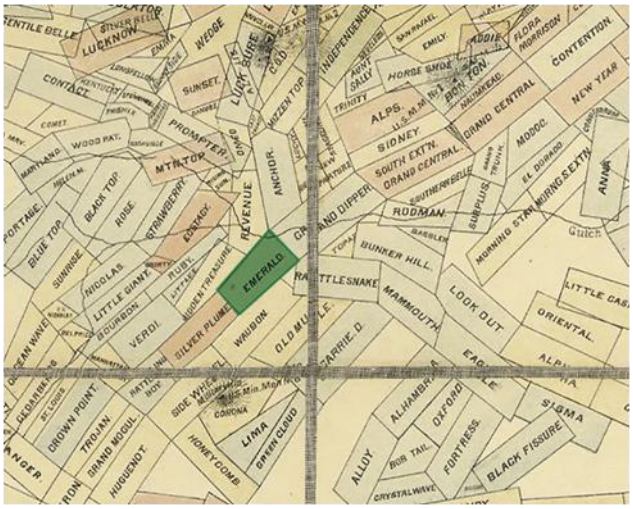
Tombstone's Emerald Mine

The Emerald Mine is a former underground silver-lead-zinc-copper mine that worked one of the largest ore bodies in the Tombstone Mining District. The ore body extends 335 meters (1,100 feet) long and 3 meters (10 feet) wide. The mine had nine levels, reached a depth of 788 feet, and operated until 1892. Mining activity focused on enriched sulfides, such as chalcocite. One carload of chalcocite from the ninth level was reported to contain 40 percent copper (Butler et al., 1938). Other ore minerals included galena, malachite, and wulfenite. The amount of production is not known since the mine's output was combined with the Grand Central Mine.

Please note: Pages 5, 7, 8, & 9 have photo links that involve copyrighted images that can be viewed by clicking on the link.



Map of the Tombstone Mining District
1881 color lithograph by H.S. Crocker – PD, via Library of Congress
This map shows the numerous claims in the Tombstone Mining District. The surrounding border features maps of nearby mining districts, the City of Tombstone, and several prominent buildings. The gray rectangle indicates the area of the following map close-up.



Close-up of Tombstone Mine Claims
From 1881 color lithograph by H.S. Crocker – PD, via Library of Congress
The Emerald Mine, highlighted in green, is located near several well-known claims, such as the Silver Plume, Grand Central, and Contention.

According to mindat.org, the number of minerals found at the Emerald Mine includes 30 valid species plus 'khinite-3T' which is designated as a first recorded locality (FRL) of an unapproved mineral. Note that 'khinite-3T' was previously named "parakhinite" and has been discredited as a separate species since it is a khinite polytype (mineral with same chemical formula but different crystal structure).

List of Minerals Found at the Emerald Mine		
Acanthite	**Emmonsite**	Osarizawaite
Anglesite	Galena	Pyromorphite
Beudantite	Gartrellite	Rutile
Bromargyrite	Gold	Silver
Cerussite	Hetaerolite (var. hydrohetaerolite)	Sonoraite
Chalcocite	Housleyite	Turquoise
Chlorargyrite	Jarosite	Wavellite
Choloalite	**'Khinite-3T' (FRL)**	Wulfenite
Chrysocolla	Kuksite	Xocomecatlite
Duftite	Linarite	
Dugganite	Malachite	

Bold type face indicates type mineral.

Tombstone's Tellurium Minerals

Tellurium is a rather rare element with an estimated abundance of 1 x 10^{-7}% (or 0.001 parts per million) of the Earth's crust[1]. Despite this scarcity, the element is found in a wide variety of minerals. The current International Mineralogical Association (IMA) master list of approved minerals includes 194 species containing tellurium.

An additional tellurium species, murphyite, was recently discovered in Tombstone and approved in March 2022 which brings the total to 195 minerals (Miyawaki et al., 2022). Murphyite is one of the thirty nine tellurium-bearing minerals that occur in the Tombstone Mining District. It is also one of the ten tellurium species first discovered at the district's mines. (See the following table.)

[1] Source: Abundance in Earth's Crust of the elements web page, https://periodictable.com/Properties/A/CrustAbundance.html

In keeping with the "extended" emerald theme, we will focus on Tombstone tellurium minerals which are noted for exhibiting a green color. The latest chemical formula from the IMA list and key characteristics will be presented along with a representative photo or link to such a photo. (Note some images may feature specimens from other localities if a noteworthy photo of a Tombstone sample is not available.)

Tellurium-bearing Mineral Occurrences in the Tombstone Mining District		
Adanite	Goldfieldite	Quetzalcoatlite
Altaite	Hessite	Rickardite
Backite	Housleyite	Rodalquilarite
Bairdite	**Khinite/ Khinite-3T**	**Schieffelinite**
Cervelleie	Krennerite	Sonoraite
Cesbronite	Kuksite	Spiroffite
Choloalite	Mackayite	Tellurium
Dugganite	Montanite	Tlapallite
Emmonsite	**Murphyite**	**Tombstoneite**
Empressite	Ottoite	Utahite
Fairbankite	Paratellurite	**Winstanleyite**
Flaggite	Plumbotellurite	Xocomecatlite
Frohbergite	Poughite	Yafsoanite

Bold type face indicates type mineral; the featured green minerals appear with an emerald green background.

Note that girdite and oboyerite were previously identified as Arizona type minerals containing tellurium, but they have been discredited as mixtures of ottoite and plumbotellurite.

Bairdite $Pb_2Cu^{2+}{}_4Te^{6+}{}_2O_{10}(OH)_2(SO_4) \cdot H_2O$

Bairdite is a lime green lead copper tellurate-sulfate that was discovered in 2013 at the Bird Nest drift, Otto Mountain near Baker, California. The mineral is named for Jerry A. Baird (b. 1940) of Lake Havasu City who is a mineral collector that collected extensively at Otto Mountain and provided samples for analysis. In the Tombstone district, bairdite has been found at the Grand Central Mine.

Bairdite occurs in quartz vugs associated with khinite, cerussite, goethite, and hematite. Its formation involves partial oxidation of primary sulfides (galena and chalcopyrite) and tellurides (hessite) during or following brecciation of quartz veins. The diamond-shaped, tabular crystals consist of stair-step-like layers with hexagonal close packing of $Te^{6+}O$ and $Cu^{2+}O$ octahedral groups (Kampf et al., 2013).

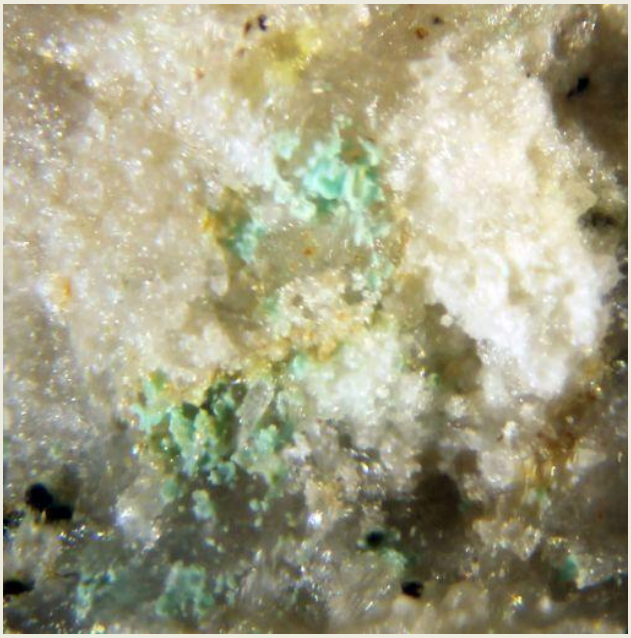
Bairdite
RRUFF project specimen and photo
Tombstone, Tombstone Mining District, Cochise County, Arizona

Cesbronite $Cu_3Te^{6+}O_4(OH)_4$

Cesbronite is a rare secondary mineral that occurs in oxidized copper-tellurium-lead sulfide deposits. The copper tellurate was first found in 1974 at the Bambollita Mine (Oriental Mine), Moctezuma, Sonora, Mexico and named in honor of Dr. Fabien P. Cesbon (b. 1938), a French mineralogist with the

Bureau de Recherches Géologiques et Minières, BRGM, Orléans. France (Williams, 1974). Samples of the mineral have been collected at an unspecified locality in the Tombstone district.

Cesbronite may occur as spherules of radiating crystals or fanlike aggregates on quartz. Its color varies from light emerald green to beetle green.



Cesbronite
David Hospital photo – CC-BY-SA-4.0, via Wikimedia Commons
Tombstone, Tombstone Mining District, Cochise County, Arizona

Choloalite $(Pb,Ca)_3(Cu,Sb)_3Te_6O_{18}Cl$

Choloalite is a tellurite found in the oxidized portions of base and precious metal deposits. It may be associated with cerussite; "opal"; and other tellurium minerals, such as emmonsite, hessite, and rodalqulite.

The mineral was first found at an unidentified locality in Saudi Arabia, but was later described in 1981 based on samples from the Bambollita Mine (Oriental Mine), Moctezuma, Sonora, Mexico (Williams, 1981). Occurrences in the Tombstone Mining District include the Emerald Mine and dumps between the Joe and Grand Central shafts. The name is derived from the Nahua (group of indigenous people of Mexico, El Salvador, Guatemala, Honduras, and Nicaragua) word "choloa" which means evasive and refers to the fact that the mineral escaped detection for many years.

Octahedral crystals up to 2 mm have been reported, while the color has been described as forest green or dark green.

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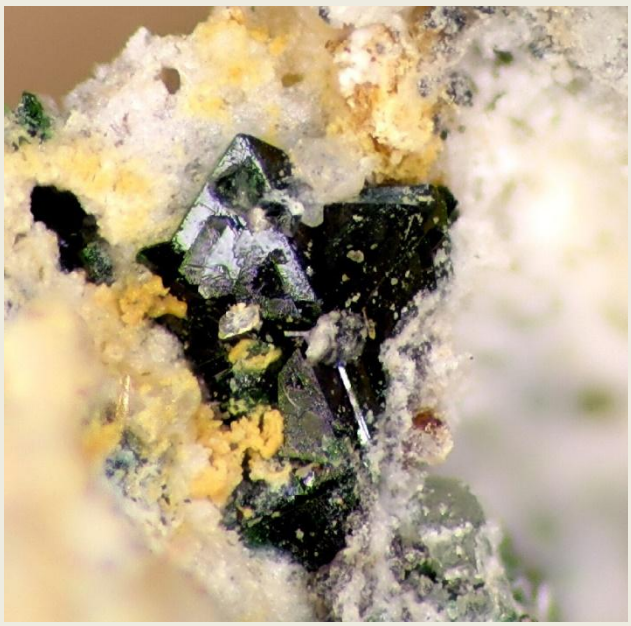
Choloalite with Emmonsite, Cerussite, and Jarosite
Brent Thorne specimen and photo
Joe & Grand Central shafts area, Tombstone Mining District, Cochise County, Arizona



Choloalite
Christian Rewitzer specimen and photo – CC-BY-SA-3.0, via Wikimedia Commons

Moctezuma Mine (Bambollita Mine), Moctezuma, Sonora, Mexico
Field of view: 1.5 x 1.5mm

Dugganite $Pb_3Zn_3(TeO_6)(AsO_4)_2$

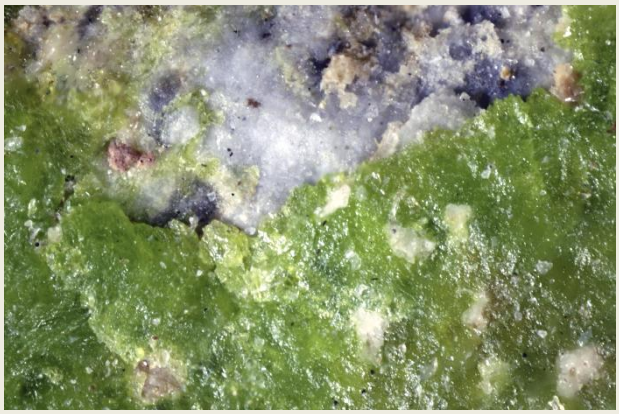
Dugganite is a lead zinc tellurate arsenate that was discovered at the dumps of the Emerald Mine. Approved in 1978, the mineral was named in honor of Marjorie Duggan (1927-2002), an analytical chemist for the Phelps Dodge mining company (Williams, 1978).

Dugganite forms from severe oxidation in acidic water, but quickly dissolves in mildly alkaline water. Drusy clusters of curved, stubby prismatic crystals occur with either quartz or manganese oxide. The color may be colorless to various greens depending on inclusions of copper tellurate minerals or substitution of copper ions for zinc.

Dugganite
RRUFF project specimen and photo
400 ft. level, Empire Mine, Tombstone, Cochise County, Arizona

Emmonsite $Fe^{3+}_2(Te^{4+}O_3)_3 \cdot 2H_2O$

Emmonsite is a ferric tellurite that was discovered in 1885 at an unspecified locality near Tombstone. It represents one of the earliest minerals that were first found in Arizona. W. F. Hillebrand named the new mineral in honor of American economic geologist, Samuel Franklin Emmons (1841-1911) of the U.S. Geological Survey and reported it as "yellowish-green color, translucent, and occurred in crystalline scales and patches throughout a rather hard and brownish gangue, composed of an intimate mixture of lead carbonate, some quartz, and much of a brown substance containing iron and tellurium" (Hillebrand, 1885).



Emmonsite
Harvey Jong specimen and photo
Tombstone, Cochise County, Arizona
Field of view: 4 mm

Flaggite $Pb_4Cu^{2+}_4Te^{6+}_2(SO_4)_2O_{11}(OH)_2(H_2O)$

Flaggite, which is also known as IMA 2021-044, is a new tellurate sulfate that was approved in August 2021 as a valid mineral species (Miyawaki et al., 2021). The mineral was discovered at the Grand Central Mine and is named in honor of Arthur L. Flagg (1883-1961), the first curator of the Arizona Mining & Mineral Museum and founder of the Mineralogical Society of Arizona and other mining and mineralogical organizations.

Flaggite occurs in quartz cavities and is associated with alunite, backite, cerussite, jarosite, and rodalquilarite. Crystals are lime-green to yellow-green and found as thin

plates grouped as rosettes up to 0.1 mm in diameter. The crystal structure is related to bairdite and has similar stair-step-like layers of octahedral TeO_6 and CuO_6 groups (Kampf et al., in press).

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Flaggite with Schieffelinite and Adularia on Quartz
Brent Thorne specimen and photo
Grand Central Mine, Tombstone Mining District, Cochise County, Arizona

Khinite/Khinite-3T $Cu^{2+}_3PbTe^{6+}O_6(OH)_2$

Khinite is a rare secondary mineral which forms under acid oxidizing conditions of gold-telluride ores. This mineral along with a related species, "parakhinite", was initially described in 1978 (Williams, 1978). Samples from the Old Guard Mine were used in identifying khinite, while the analysis of "parakhinite" involved material from the Emerald Mine. Khinite is named in honor BaSaw Khin (b. 1931), a mineralogist with the Phelps Dodge Corporation who collected the first specimens of "parakhinite".

In 2008, the chemical formula for khinite was revised, while the polytypism of khinite and "parakhinite" (mineral with the same formula but different crystal structures) was described (Copper et al., 2008). As a result of this analysis, khinite, which has an orthorhombic structure, was renamed khinite-4O, while "parakhinite", which is trigonal, was discredited as a separate species and designated as khinite-3T. The numbers before the letters reflect the number of $TeCu_3O_6$ layers comprising a particular crystal structure.

Crystals of khinite-4O/khinite-3T may have a deep green to bottle green color, exhibit dipyramidal to prismatic forms, and be up to 0.5 mm.

Khinite-3T (Formerly Known as "Parakhinite")
RRUFF project specimen and photo
400 ft. level, Empire Mine, Tombstone, Cochise County, Arizona

Mackayite $Fe^{3+}Te^{4+}_2O_5(OH)$

Mackayite is an extremely rare iron tellurite that was discovered in 1944 in Goldfield, Nevada at the McGinnity shaft and Mohawk Mine (Frondel and Pough, 1944). Bideaux et al., 1960 reported that the mineral also occurs at the Toughnut Mine in the Tombstone Mining District. It is named for John W. Mackay (1831-1902), an Irish-American Comstock Lode financier and mine operator, in recognition of his endowment of the School of Mines of the University of Nevada.

Mackayite occurs in the oxidized zone of gold and tellurium deposits. Short prismatic crystals, up to 1 mm in size, may be found in vugs and seams in silicified rhyolite and dacite. The mineral may be associated with alunite, baryte, blakeite, emmonsite, limonite, and quartz. The color varies from light peridot-green to olive- and brownish-green.

Mackayite with Quartz
RRUFF project specimen and photo
Lone Pine Mine, Lone Pine Hill area, Wilcox District, Catron County, New Mexico

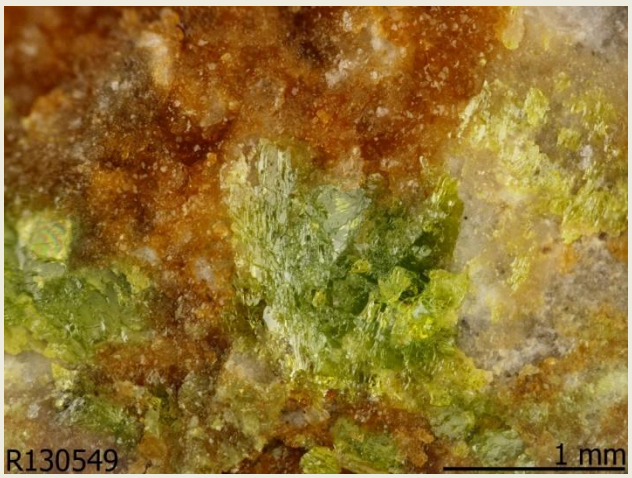
https://www.mindat.org/photo-1190352.html

Mackayite
Gianfranco Ciccolini specimen and photo
Toughnut Mine, Tombstone Mining District, Cochise County, Arizona

Rodalquilarite $H_3Fe^{3+}{}_2(Te^{4+}O_3)_4Cl$

Rodalquilarite is one of the nine known tellurite minerals that contain hydrogen. The mineral was discovered in 1967 at the Rodalquilar gold deposit, Almería Province, Andalusia, Spain, and is named after this locality. In the Tombstone Mining District, rodalquilarite occurs at the Grand Central and Joe Mines.

Rodalquilarite is found in the oxidation zone of tellurium-bearing precious metal deposits. Samples may include crusts or stout crystals up to 2.5 cm and be associated with emmonsite, gold, alunite, jarosite, and quartz. The reported range of colors include grass green, emerald green, oil green, pistachio green, and yellow green.



Rodalquilarite
RRUFF project specimen and photo
Tombstone, Cochise County, Arizona

Tlapallite
$(Ca,Pb)_3CaCu_6O_2[Te^{4+}{}_3Te^{6+}O_{12}]_2(Te^{4+}O_3)_2(SO_4)_2 \cdot 3H_2O$

Tlapallite is one of the only three known tellurium minerals which have mixed tellurium valence states of 4^+ and 6^+. The two states lead to a layered crystal structure involving complex arrangements of $Cu^{2+}O_6$ and $Te^{6+}O_6$ octahedral groups; mixed-valence anions, $[Te^{4+}{}_3Te^{6+}O_{12}]^{12-}$; and $Te^{4+}O_3$ pyramid groups. The mineral was initially found in 1972 at the Bambollita Mine (Oriental Mine), Moctezuma, Sonora, Mexico, but difficulties in analyzing samples delayed its approval until 1977. The characterization problems were resolved with a re-examination of a specimen labeled as emmonsite from Tombstone's Lucky Cuss Mine (Williams and Duggan, 1978). The name is derived from the Nahua word "tlapalli" for paint which refers to paint-like films on fracture surfaces.

Tlapallite occurrences may involve partial oxidization of tellurium-bearing sulfide deposits or alternation of tellurides in

tactites. The paint-like botryoidal crusts are made up of tabular or bladed monoclinic crystals up to 0.1 mm. The mineral may be associated with carlfriesite (another mixed-valence state tellurium mineral), calcite, baryte, muscovite, and quartz. The color may vary from veridian green to Cyprus green.

Tlapallite
RRUFF project specimen and photo
La Oriental Mine, Moctezuma, Sonora, Mexico

Tombstoneite
$(Ca_{0.5}Pb_{0.5})Pb_3Cu^{2+}{}_6Te^{6+}{}_2O_6(Te^{4+}O_3)_6(Se^{4+}O_3)_2(SO_4)_2 \cdot 3H_2O$

Tombstoneite involves a new mineral structure type and represents the first species comprised of tellurate ($Te^{6+}{}_2O_6$), tellurite ($Te^{4+}O_3$), selenite ($Se^{4+}O_3$), and sulfate (SO_4) anion groups. The new mineral was approved in September 2021 and is pending publication (Miyawaki et al., 2021). It was identified using samples collected at the Tombstone Mining District's Grand Central Mine and is named for the district.

Tombstoneite has a trigonal structure with crystals up to 0.1 mm. The platy, emerald green crystals occur on quartz with rodalquilarite and jarosite.

https://www.mindat.org/photo-1174975.html

Tombstoneite
Anthony Kampf photo of Natural History Museum of Los Angeles County specimen
Grand Central Mine, Tombstone Mining District, Cochise County, Arizona

Xocomecatlite $Cu_3(Te^{6+}O_4)(OH)_4$

Xocomecatlite is a rare secondary mineral found in the oxidized zone of hydrothermal gold-tellurium deposits. The copper tellurate was discovered at the Bambollita Mine (Oriental Mine), Moctezuma, Sonora, Mexico and approved in 1974 (Williams, 1975). In the Tombstone Mining District, xocomecatlite occurs at the Emerald Mine with dugganite and 'khinite-3T' (Williams, 1978). The name is derived from Nahua word, "xocomecatl", for grapes which refers to the mineral's appearance as clusters of spherules.

Xocomecatlite crystals are orthorhombic and form radial and spherical aggregates up to 0.15 mm. The color is bright emerald green.

Xocomecatlite
RRUFF project specimen and photo
Bambollita Mine (Oriental Mine), Moctezuma, Sonora, Mexico

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Catie Carter Sandoval
cscarter@email.arizona.edu
703.577.6449

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

The museum has put together a limited number of "Arizona Rocks and Minerals" mini teacher's kits that are now available for educators. The kits consist of 10 rock and 15 mineral specimens, plus a magnet and a streak plate. The rocks include basalt, apache tear (obsidian), pumice, sandstone, coal, limestone, phyllite, marble, petrified wood, and fossil coral. The minerals include calcite, quartz, azurite and/or malachite, barite, chalcedony, chalcopyrite, chrysocolla, garnet, glauberite pseudomorph (calcite after glauberite or gypsum after glauberite), muscovite mica, peridot (olivine), pyrite, amethyst (quartz), magnetite, and blister copper. Each specimen is labeled with a letter or number that corresponds to a key.

Before it closed, the Arizona Mining and Mineral Museum had a robust and popular teacher kit program, run by volunteers, with kits containing several dozen specimens and other educational material. After the museum closed, the Earth Science Museum took over that responsibility and developed new kits that were distributed to thousands of students. The new mini kits are prototypes that we are trying out over the summer in preparation for the next school year. Teachers, parents and all educators are welcome to request a free kit by emailing Catie at cscarter@arizona.edu.

The 10 rock specimens included in the teacher's kit.

The 15 mineral specimens included in the teacher's kit.

Teacher's kit boxes packed and ready to go.

IN MEMORY OF

JERRY OHLUND

March 24, 1937 – April 30, 2022

Jerry was a long time member of the Arizona Mining and Mineral Museum's Monday Crew. As an electrician by trade, he was indispensible to the museum's operation. He did the electrical work for the stamp mill, added additional electrical outlets in the main and copper galleries, and brought the lapidary shop wiring up to code. When new cases for the museum store arrived, Jerry wired and put in the lighting system. A very big job Jerry accomplished was redoing the lighting for the refurbished cases in the museum's main gallery. He also helped with all the jobs that the other crewmen worked including restoring the stamp mill, crushing rocks, working in the pit, cleaning up the machine shop, etc. When the museum was closed (April 30, 2011), Charlie Connell saved the sign that Jerry had made for the Copper Gallery and gave it back to him.

Jerry and Charlie are such big losses for the museum, the clubs, and the greater community.

Jerry adding electrical wiring for the cases in the main gallery

Jerry working on the lighting for the refurbished cases

Results of Jerry's work lighting the gift shop display cases (left) and the refurbished cases in the main gallery (above).

Arizona Rocks 108

Text and photos by Ray Grant

Last month I described the Tonto Natural Bridge as the world's largest travertine bridge. What is travertine? It is the mineral calcite deposited from flowing water especially springs. The water evaporates and the calcite is deposited as layers. Calcite is usually white but if other minerals are present the travertine can have multicolored layers.

Travertine is often called onyx. Onyx was originally the name for a black and white banded agate (quartz). Over time onyx was also used for other colors of banded quartz and more recently for the banded calcite (travertine). Travertine carvings, bookends and other tourist items made from Mexican travertine are sold as Mexican onyx. Calcite is much softer than quartz and so easier to cut and polish.

Calcite in the form of travertine has been mined and collected at many localities in Arizona. The most colorful travertine in Arizona comes from a deposit just north of Mayer, Yavapai County. Mining started there in the late 1800s and over the years it has been a popular spot for collectors and now is mined commercially. This travertine has red, yellow, brown, and white bands. It is mined by Arizona Onyx, and they have two products from their quarry, Black Canyon Onyx which is black, gray, amber, and white and Grand Canyon Onyx, which is brown, red, white, and green. I checked with one rock company, and you can buy boulders of either type for twenty cents a pound. That is a bargain price for a good lapidary rock to make things like book ends. Another location is the white travertine deposit about ten miles north of Kingman in the Stockton Hills. This location was claimed in the past by the Kingman lapidary club.

Arizona has some great travertine for your yard or your lapidary projects.

Charlie Brown's Great Pumpkin, travertine deposited by a spring in the Grand Canyon

Travertine (Arizona Onyx) boulders in yards in my neighborhood

Travertine blocks at Arizona Onyx Quarry in Mayer (Photograph from Arizona Onyx website - Arizonaonyx.com)

Pinal Museum and Society News

351 N. Arizona Blvd., Coolidge, AZ

Pinal Geology and Mineral Society meeting

September 21, 2022

www.pinalgeologymuseum.org

Ray Grant raycyn@cox.net.

The Pinal Geology & Mineral Museum will be open from 10 to 3 on Friday for June, July, and August.

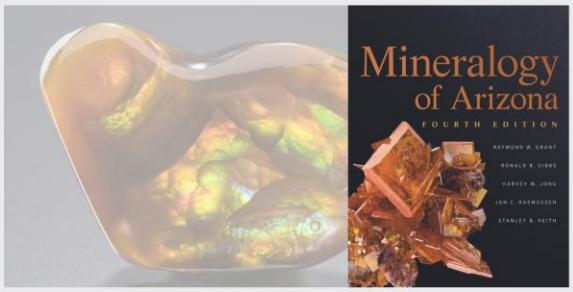
Masks are now optional at the Museum. Please bring your own mask if you wish to wear one. We will have some masks on hand at the Museum, but cannot guarantee to provide them.

This a good deal on June 25 - the admission for the Museum is $15 for adults 13 to 64, $10 for seniors and $5 for children 4 to 12. If you buy a book two free admissions come with it.

Book price and details in flyer!

For the Love of Minerals:
Book Launch Celebration
for 'Mineralogy of Arizona,
Fourth Edition'

June 25, 2022



The University of Arizona Alfie Norville Gem & Mineral Museum, and the University of Arizona Press invite you to celebrate the publication of *Mineralogy of Arizona, Fourth Edition*.

When: Saturday, June 25, 11 a.m.-3 p.m. at the Alfie Norville Gem & Mineral Museum, 115 N Church Ave., Ste 121, Tucson.

Authors will be in the museum auditorium to answer all your mineralogy questions, and sign books, which will be available for purchase from 10 a.m. to 3:10 p.m. Museum Admission for two adults is included with purchase. Cost of the book is $75 for hardcover, and $49.95 for paperback.

This fourth edition covers the 992 minerals found in Arizona, showcased with breathtaking new color photographs throughout the book. The new edition includes more than 200 new species not reported in the third edition and previously unknown in Arizona. Chapters cover gemstones and lapidary materials, fluorescent minerals, and an impressive catalog of mineral species. The authors also discuss mineral districts, including information about the geology, mineralogy, and age of mineral occurrences throughout the state. The book includes detailed maps of each county, showing the boundaries and characteristics of the mineral districts present in the state.

Parent/Teacher Resource Pages

HTTPS://WWW.EARTHSCIWEEK.ORG/NEWSLETTER

EARTH SCIENCE WEEK UPDATE
May 2022

FIND NEW WAYS TO ENSURE 'NO CHILD LEFT INSIDE'

Find your geoscience inspiration in the great outdoors! Any day can be "No Child Left Inside" Day — a time for outdoor activities allowing young people to experience Earth science firsthand. And the NCLI Day Guide now offers lots of learning activities to help you do just that.

This free online guide provides everything you need to start planning your own NCLI Day event, including activities designed specifically for elementary, middle, and high school students.

Begin now to plan your NCLI Day event for Tuesday, October 11, during Earth Science Week 2022, when educators and young people nationwide will be wading into creeks, climbing hills, and searching the skies to learn Earth science. Or plan your own NCLI Day whenever it's most convenient for you.

Find AGI's NCLI Day Guide on the Earth Science Week website. Have a great NCLI Day!

PARTNERS TEACH KIDS ABOUT SCIENCE OF CONSERVATION

Partners in Resource Education (PRE), an Earth Science Week partner, provides programs and activities to get young people excited about the geoscience of conservation. Focusing on national resource priorities such as pollinators, wetlands, oceans, invasive species, endangered species, fire, and climate change, PRE teaches people about sustaining and safeguarding living resources in their own backyards.

PRE is a consortium of several federal agencies — Bureau of Land Management, Fish and Wildlife Service, Forest Service, National Park Service, Natural Resources Conservation Service, National Oceanic and Atmospheric Administration, and Environmental Protection Agency — and the National Environmental Education Foundation (NEEF). By combining staffs and resources, the agencies educate young people, introduce them to natural resource careers, and cultivate the next generation of land and water stewards.

PRE's signature project, Hands on the Land, connects students, teachers, and parents to public lands and waterways. Education specialists work closely with teachers to develop programs that meet state standards and engage students in hands-on activities. Students to take part in environmental monitoring and other activities through distance learning and the project website.

NSTA PROVIDES LINKS TO FREE SCIENCE RESOURCES

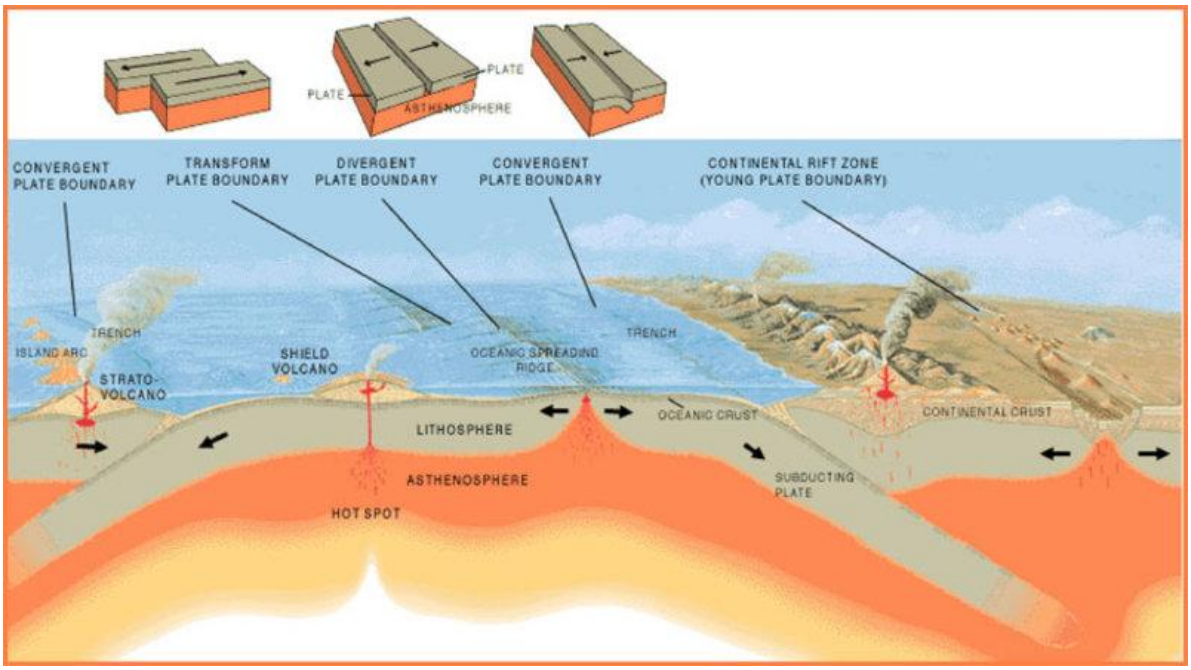
Looking for teaching resources? Check out Freebies for Science Teachers on the National Science Teaching Association website.

Updated periodically, this searchable "array of free resources for you and your classroom" frequently features online links to publications, CD-ROMs, DVDs, videos, kits, and other materials for Earth science education. Learn more about NSTA Resources.

https://oceanexplorer.noaa.gov/facts/plate-boundaries.html

What are the different types of plate tectonic boundaries?

There are three kinds of plate tectonic boundaries: divergent, convergent, and transform plate boundaries.



The Earth's lithosphere, which includes the crust and upper mantle, is made up of a series of pieces, or tectonic plates, that move slowly over time.

A **divergent boundary** occurs when two tectonic plates move away from each other. Along these boundaries, earthquakes are common and magma (molten rock) rises from the Earth's mantle to the surface, solidifying to create new oceanic crust. The Mid-Atlantic Ridge is an example of divergent plate boundaries.

When two plates come together, it is known as a **convergent boundary**. The impact of the colliding plates can cause the edges of one or both plates to buckle up into a mountain ranges or one of the plates may bend down into a deep seafloor trench. A chain of volcanoes often forms parallel to convergent plate boundaries and powerful earthquakes are common along these boundaries. The Pacific Ring of Fire is an example of a convergent plate boundary.

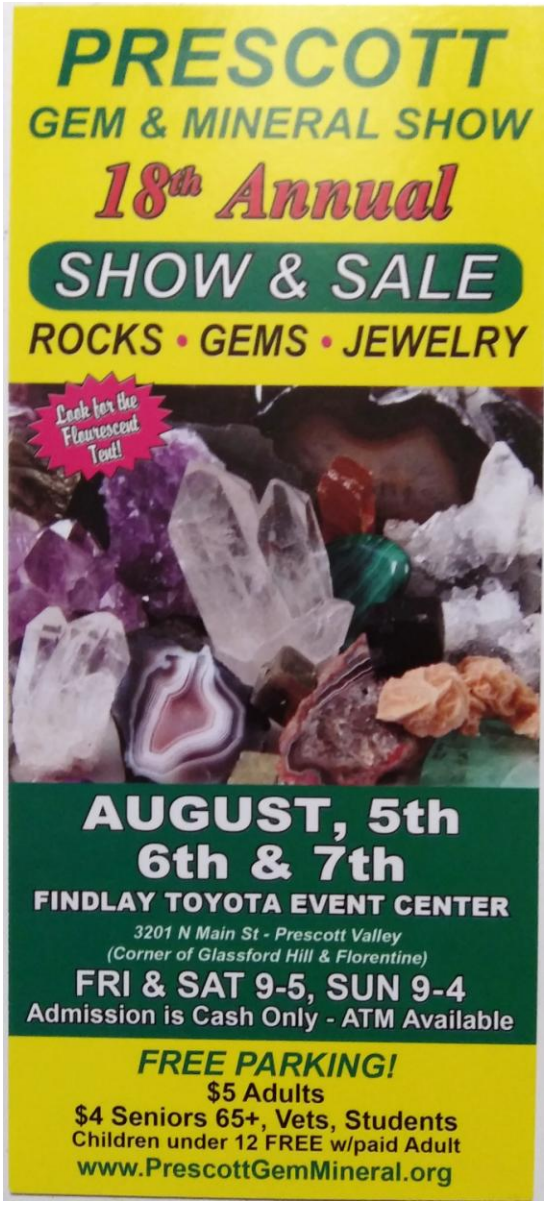
At convergent plate boundaries, oceanic crust is often forced down into the mantle where it begins to melt. Magma rises into and through the other plate, solidifying into granite, the rock that makes up the continents. Thus, at convergent boundaries, continental crust is created and oceanic crust is destroyed.

Two plates sliding past each other forms a **transform plate boundary**. One of the most famous transform plate boundaries occurs at the San Andreas fault zone, which extends underwater. Natural or human-made structures that cross a transform boundary are offset—split into pieces and carried in opposite directions. Rocks that line the boundary are pulverized as the plates grind along, creating a linear fault valley or undersea canyon. Earthquakes are common along these faults. In contrast to convergent and divergent boundaries, crust is cracked and broken at transform margins, but is not created or destroyed.

White Mountain Gem
and Mineral Annual Show
July 9-10, 2022
Sat. 9-5, Sun. 10-
Adults $2.00
Juniors 18 and under with Student ID
Free when accompanied by an adult
Elks Lodge
805 E. Whipple Street
Show Low, Arizona
www.whitemountain-azrockclub.com

48th ANNUAL HUACHUCA MINERAL, GEM, AND JEWELRY SHOW

8th AND 9th OCTOBER 2022
2200 EL MERCADO LOOP,
SIERRA VISTA, AZ
For Information;
Contact Maudie Bailey, gmbailey@msn.com,
520 249-1541



ALL ARIZONA CLUB MEETINGS MAY BE CANCELED DUE TO HEALTH CONCERNS!

Apache Junction Rock & Gem Club
Meetings are on the 2nd Thursday
Next Meeting: September 8, 2022, 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 7, 2022, 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
Meetings are on the 1st Monday
(unless a Holiday then 2nd Monday)
Next Meeting: June 6, 2022, 7:00 pm
www.maricopalapidarysociety.com
@ North Mountain Visitor Center
12950 N. 7th St., Phoenix

Mineralogical Society of Arizona
Meetings are on the 3rd Thursday
Next Meeting: June 16, 2022, 7:30 pm
Please go to their website for the June meeting location under Events
www.msaaz.org
@ Franciscan Renewal Center
Room: Padre Serra
5802 E. Lincoln Dr., Scottsdale

Pinal Geology & Mineral Society
Meetings are on the 3rd Wednesday
Next Meeting: September 21, 2022, 7:00 pm
On YouTube until further notice
www.pinalgeologymuseum.org
@ Artisan Village
351 N. Arizona Blvd., Coolidge

West Valley Rock & Mineral Club
Meetings are on the 2nd Tuesday
Next Meeting: June 14, 2022, 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 2, 2022, 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: October 14, 2022, 7:00 pm
www.wickenburggms.org
@ Coffinger Park Banquet Room
175 E. Swilling St., Wickenburg

ESM's Meeting Notice

ESM's next meeting will be at North Mountain Visitor Center, 12950 N. 7th St., Phoenix, on Tuesday, TBA 2022, 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! ☺☺☺

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

Sossaman Middle School

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

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

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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.

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

Name: _____

Address: _____

City, State, Zip: _____

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3215 W. Bethany Home Rd., Phoenix, AZ 85017

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Phone:
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Editor E-Mail:
scote@earthsciencemuseum.org

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 2022, at 6:30 p.m.

THANK YOU FOR YOUR CONTINUING INTEREST & SUPPORT!!!

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