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

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ESM OUTREACH UPDATE

Mardy Zimmermann, Outreach Coordinator

October-November Outreach

By Shirley Coté and Carol Bankert-George

In October, Shirley Coté and Doug Duffy visited the Sun City Rockhound Mineral Museum to deliver six nut jars of rocks and minerals including fluorite, quartz, travertine, and jasper. The Sun City museum plans are to set up and offer the egg carton program at the upcoming Flagg Show at Mesa Community College the first weekend in January.

Shirley Cote and Doug Duffy presenting rocks and mineral specimens to Sun City Rockhound president, Cheryl Alvord and vice president, Carol Bankert-George in the Sun City Mineral Museum

The Sun City Rockhound Club met and has been working with a host of individuals: Catie Sandoval from AMMNREM, Shirley Cote, Doug Duffy, Mardy and Dick Zimmerman from ESM. Club members Cheryl Alvord and Carol Bankert-George, took a trip to Mardy and Dick Zimmermann's place. This trip was in preparation for taking part in the upcoming Flagg Gem and Mineral show. Mardy and Dick supplied the Sun City club with 80 egg cartons and about 14 different types of rocks and minerals.

The Sun City club did a 'trial run' at our annual Fall Festival event on November 24, and 25. Coming in late in this activity, we only had the 80 egg cartons. All cartons and almost all rock specimens were donated to the Sun City club by Shirley, Doug, Mardy and Dick. The 80 cartons were sold by mid-day the 25th. The event was a success! Now it's time to plan and prepare for the Flagg show.

Sun City Rockhound President, Cheryl Alvord, working with Mardy and Dick Zimmerman preparing the club for upcoming egg carton activities

Sun City Rockhound Club members Gale, Deb and Maryann 'working' the egg carton activity at the Fall Festival

A Trinitite Christmas

By Harvey Jong

Christmas is just around the corner which means it's time for another Christmas-themed article. In an earlier newsletter, we celebrated the holiday's traditional red and green colors by exploring different combinations of fluorescent minerals. Inspired by the movie *Oppenheimer*, the focus this year will be on the post-atomic material, "trinitite", which you may have guessed occurs in red and green varieties.

Trinitite Origins

Trinitite, which is also known as atomsite or Alamogordo glass, is a glassy material produced by the first atomic bomb test near Alamogordo, New Mexico. Scientists developing the atomic bomb had concerns about whether it would work and lobbied for a test to evaluate the novel, but mostly unproven, plutonium implosion design. Dr. J. Robert Oppenheimer (1904-1967), who was the director of the Los Alamos Laboratory, named the test "Trinity" based on a somewhat vague reference to the poems by John Donne (1572-1631).

The bomb prototype was called the "Gadget" and contained about 6.1 kg (13.6 lb) of plutonium.

Plutonium Bomb Prototype Shortly Before the Trinity Test

From The Manhattan Project – an Interactive History, U.S. Department of Energy photo, - PD, via osti.gov

Only about 15% of the prototype's 6 kg of plutonium actually underwent fission. Most of the nuclear fuel was vaporized, and after cooling the plutonium along with bomb detonation products were deposited downwind from the Trinity site.

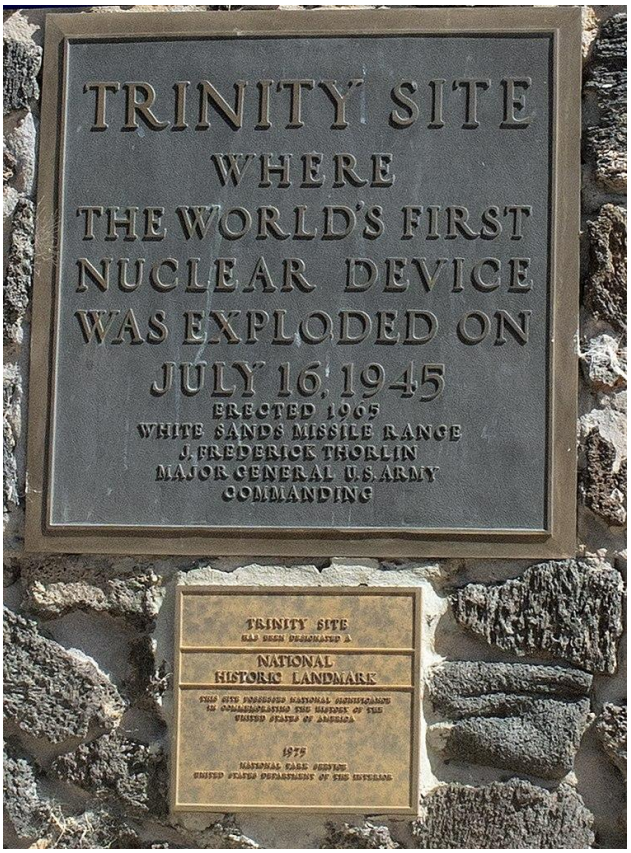
Trinity Test

From The Manhattan Project – an Interactive History, U.S. Department of Energy photo, - PD, via osti.gov

This is the only existing color photo of the test which happened on July 16, 1945. The mushroom cloud of the 24.8 ± 2 kiloton explosion reached a height of 38,000 ft. Note that the previous U.S. Department of Energy yield of 21 kilotons has been revised based on a recent new analysis of trinitite samples (Selby et al., 2021).

Trinity Site Obelisk
U.S. Department of Energy photo, - PD, via energy.gov

The Trinity test site, which is located on the White Sands Missile Range, is closed to the public, except on the first Saturday in April and the third Saturday in October. Ground zero of the test is marked by an obelisk.



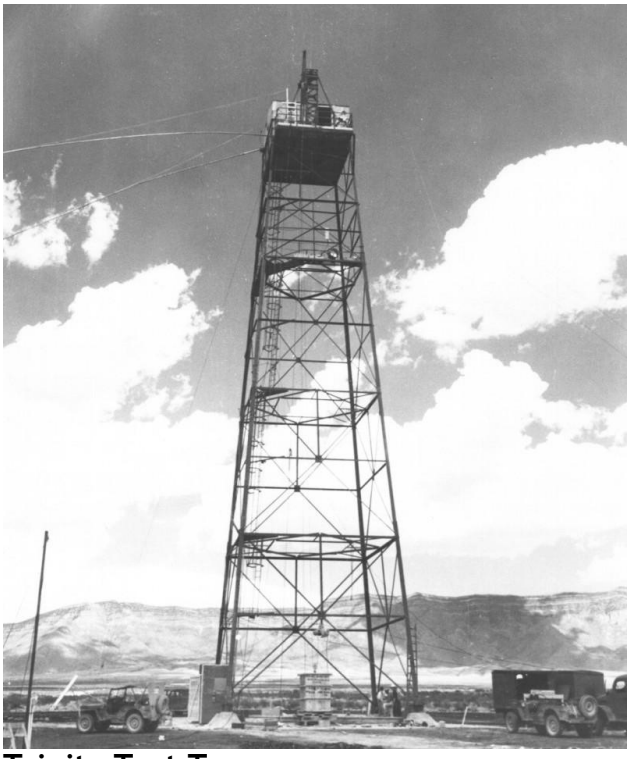
Close-up of the Obelisk Plaques
Thomas Farley photo, - CC0-1.0 UPD, via Wikimedia Commons
The obelisk features two plaques – the original 1965 monument plate and a smaller 1975 marker that commemorates the National Park Service's designation of the Trinity site as a National Historic Landmark.

Collecting Trinitite is Now Strictly Prohibited
Wendy Brown/Fort Bliss Bugle photo, - PD, via Wikimedia Commons
Concerned about residual radioactivity and scavenging by collectors, the U.S. Army in 1952 removed most of the trinitite and buried it in an undisclosed location in the New Mexico desert. It also bulldozed the crater and made collecting illegal. This sign warns visitors not to take samples during the Trinity site open houses.

Trinitite collected prior to the ban, however, remains fair game. It has and continues to be sold as souvenirs and occasionally used in jewelry.

Trinitite Composition and Properties

Trinitite is an atomic blast thermal alteration product of an arkosic sand comprised of at least 25% feldspar grains along with quartz fragments. Its starting composition also includes plutonium bomb components and test infrastructure, such as the 30-m (100-ft) steel tower and associated instrumentation.



Trinity Test Tower
U.S. Department of Energy photo, - PD, via Wikimedia Commons

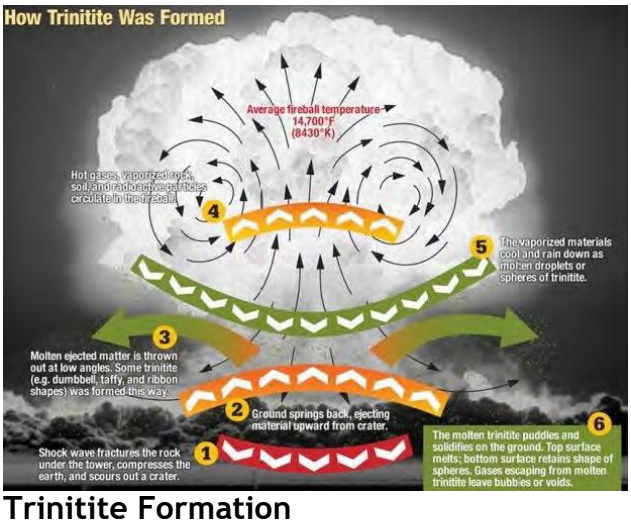
The tremendous heat of the explosion [estimated to be around 8,430 ˚K (14,700 ˚F)] either melted or vaporized the various constituent materials. Upon cooling, a glassy mixture of desert sand and radioactive debris was produced. The material resembles other substances created by high temperature, short duration events, such as fulgurites (glass fused by lightning strikes) or tektites (glass fused by meteorite impact).

Trinitite has a heterogeneous composition down to a scale of tens of microns that reflects different blast fallout conditions. It may contain two distinct types of glass, an alkali glass formed from feldspar minerals and a silica glass from quartz. Minimal mixing of the two glasses has been observed, and they have different indices of refraction. The alkali glass has a higher index of refraction (1.51-1.54), while the silica glass has a lower index of refraction of 1.46 (Ross, 1948).

Different forms of trinitite occur at the test site and include:

1. Bottle green glassy fragments and splatter.
2. A pale green to gray glassy crust around 1-5 cm thick deposited on desert sand. This material has been called pancake trinitite.
3. Small, widely distributed green bead or dumbbell shapes that have been referred to as ant hill trinitite. Like the pyrope garnets found in northeastern Arizona, these particles are collected by ants as they excavate underground passages and deposited around the margins of ant hills.
4. Copper-bearing red aggregates that are found north of ground zero. Samples may contain "bits of bomb" as spherical inclusions of copper, lead, or iron.

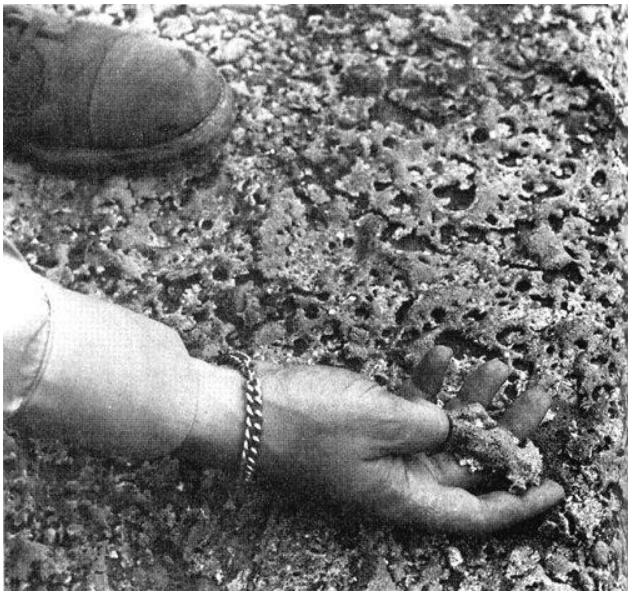
Initially, the formation of trinitite was thought to simply involve the intense heat of the blast melting the desert sand, much like a blow torch used in preparing the French dessert crème brûlée. The different varieties, however, suggested a more complex mechanism which is shown below:



Trinitite Formation
From Trinity Site Digital Brochure, U.S. Army graphic, - PD, via army.mil

This graphic depicts the steps involved with the formation of trinitite:

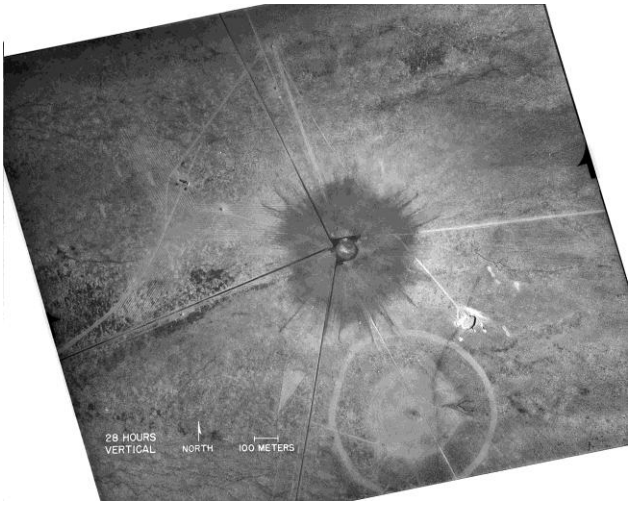
1. The shock wave of the explosion fractures and compresses rock under the test tower creating a crater about 3 m (10 ft) deep.
2. The ground springs back ejecting material upward from the crater.
3. Some of the molten ejecta are thrown out at low angles forming dumbbell and ribbon shapes.
4. Hot gases; vaporized rock, soil, and test structures; and radioactive particles circulate in the fireball.
5. Vaporized materials cool and rain down as molten droplets or spheres.
6. Molten trinitite puddles and solidifies on the ground. Escaping gases, such as water vapor, leave bubbles in the trinitite.
7. Top surface of the trinitite is heated by the fireball and develops a smooth texture.



Ground Covered with Trinitite After the Blast
Unknown photographer, - PD?, courtesy of Carey Sublette/nuclearweaponarchive.org

Eight weeks after the Trinity test, the U.S. Army invited reporters to the site. A *Time* magazine correspondent wrote the following description:

"Lake of Jade. Seen from the air, the crater itself seems a lake of green jade shaped like a splashy star and set in a sere disc of burnt vegetation half a mile wide. From close up the "lake" is a glistening incrustation of blue-green glass 2,400 ft. in diameter, formed when the molten soil solidified in air. The glass takes strange shapes—lopsided marbles, knobbly sheets a quarter-inch thick, broken, thin-walled bubbles, green, wormlike forms."[1]



Aerial View of the Trinity Test Site after the Detonation
U.S. Department of Energy photo, - PD, via Wikimedia Commons
This aerial photo was taken 28 hours after the explosion. The trinitite forms the dark layer with radiating spikes around ground zero. The crater to the southeast is from an earlier 100-ton test shot, while the dark lines are roads.

Before the 1952 cleanup, a field study of the Trinity site was conducted in 1949. The glassy material was found to cover an area of about 610 m (2,001 ft) in diameter with an estimated total mass of 1.8×10^6 kg (1,984 tons) (Staritzky, 1950).

[1] From Science: Atomic Footprint, *Time*, Sept. 17, 1945.

Even 78 years after the test, trinitite remains slightly radioactive due to the incorporation of post-detonation debris and by-products. The type and quantity of radionuclides (radioactive elements) may vary significantly resulting in a large range of activity. For example, the measured activity for ^{241}Am when normalized to the time of detonation ranges from 1 to 42 Bq/g (Bellucci et al., 2013). (Note that ^{241}Am is an isotope of americium produced by neutron capture during detonation. Bq is the abbreviation for the Becquerel, an SI unit of radioactivity defined as one nucleus decays per second.)

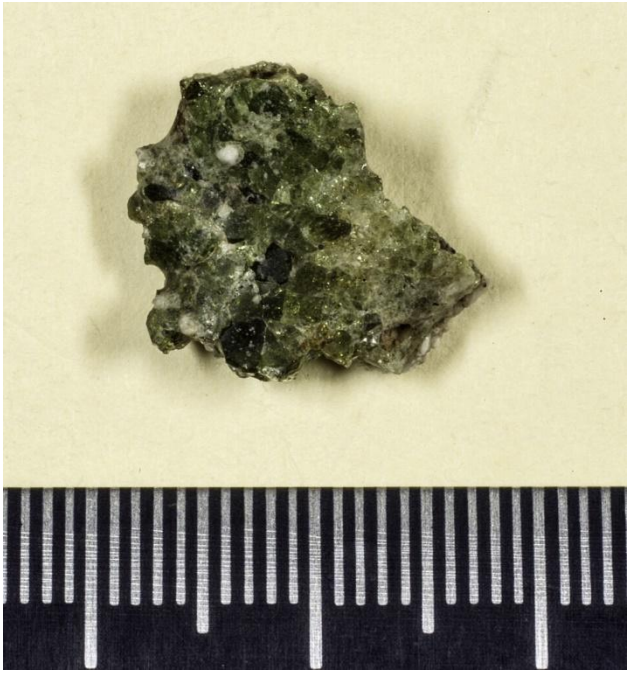
A comprehensive study of trinitite radioactivity was performed 60 years after the Trinity test. Alpha-, beta-, and gamma-spectroscopy detected the presence of several radionuclides (Parkeh et al., 2006):

Nuclear fuel remnants: ^{239}Pu, ^{240}Pu
Fission products: ^{90}Sr. ^{117}Cs
Activation products (neutron reactions with plutonium): ^{60}Co, ^{133}Ba, ^{157}Eu, ^{154}Eu, ^{238}Pu, ^{241}Am
Natural radionuclides: ^{40}K, ^{232}Th, ^{238}U

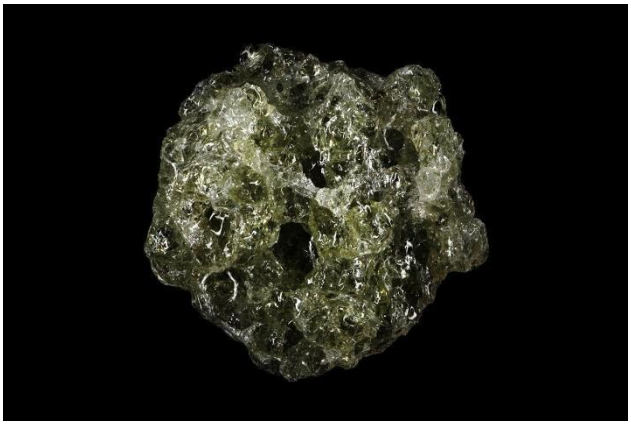
Green Trinitite Glass

This trinitite variety was found widely around the immediate vicinity of ground zero and formed the top part of the trinitite layer. Partly resorbed quartz grains are often present indicating that the fragments started to but didn't fully melt. These grains are composed of α-quartz, the low pressure-temperature polymorph, which shows that the bomb detonation didn't produce the conditions needed for a higher pressure-temperature polymorph. Various oxides, such as Al_2O_3, FeO, MgO, CaO, Na_2O, and K_2O, may be present in the glass suggesting the melting of minerals in the original sand.

Green Trinitite Glass
Shaddack photo, - CC_BY_SA-3.0, via Wikimedia Commons
The glassy residues may occur in various shades of green. This specimen is a light green example that shows the fused structure.



Green Trinitite Glass
Hannes Grobe photo, - CC_BY_SA-4.0 International, via Wikimedia Commons
This sample shows the more common darker, olive green color.



Green Trinitite Glass
H. Hiller photo, - CC_BY_SA-3.0 Germany, via Wikimedia Common
Dimensions: approximately 6 mm (0.2 in) in diameter
This dark green sample has a melted appearance with small vesicles.

Pancake Trinitite

Pancake trinitite is typically around 2 cm (0.79 in) thick with a glassy surface on top ("glassy side") and fused globules or mineral grains on the bottom ("sandy side"). It represents a common occurrence, and the pale green color has been attributed to iron. Samples may have numerous vesicles from escaping gases, and brown staining due to desert sand and dirt may occur on some specimens. Small feldspar inclusions have also been noted.

A Group of Pancake Trinitites
Thomas Bresson photo, - CC_BY_SA-3.0, via Wikimedia Commons

These samples illustrate some of trinitite features – smooth top surface, brown staining, and vesicles.

View of a Pancake Trinitite with Vesicles
Scherff photo, - CC_BY_SA-3.0, via Wikimedia Commons
This specimen shows vesicles are distributed throughout the material. Vesicle size and distribution are used as a nuclear forensics tool.

Close-up of Pancake Trinitite
John Taylor photo, - CC_BY_SA-2.0, via Wikimedia Commons
This close-up shows the "glassy side" texture of a trinitite with a few small surface vesicles.

Trinitite Beads and Dumbbell Shapes

This small particle-size variety of trinitite is widely distributed throughout the Trinity site. It resembles tektites in both physical appearance and chemical properties. The

aerodynamic shapes reflect the formation and dispersal conditions of the atomic explosion's fireball. Glass composition may vary significantly, and two different formation processes have been proposed. Silica and alkali glasses involved condensation from a molten phase of quartz or feldspar grains. Some glasses rich in calcium, magnesium, or iron, however, condensed from vaporized materials, such as fragments of fossiliferous limestone or actinolite. Detectable radioactivity seems to be prevalent in these CaMgFe-rich glasses (Bonamici, 2018), and plutonium isotopes (^{238}Pu, ^{239}Pu, ^{240}Pu) along with ^{241}Am have been identified in some beads (Mercer et al., 2021).

Ant Hill Trinitite
From *Trinitite - the Atomic Rock* – faculty.uml.edu, 2010 Geological Society of America presentation by N. Eby, N. Charnley, and J. Smoliga, https://faculty.uml.edu/Nelson_Eby/Research/Trinitite/NE_SE%20GSA%20trinitite%20presentation.pdf , Abstracts with Programs 42, 1, 77, accessed October 30, 2023.
Beads remain in the Trinity site subsoil and may be brought to the surface by ants.

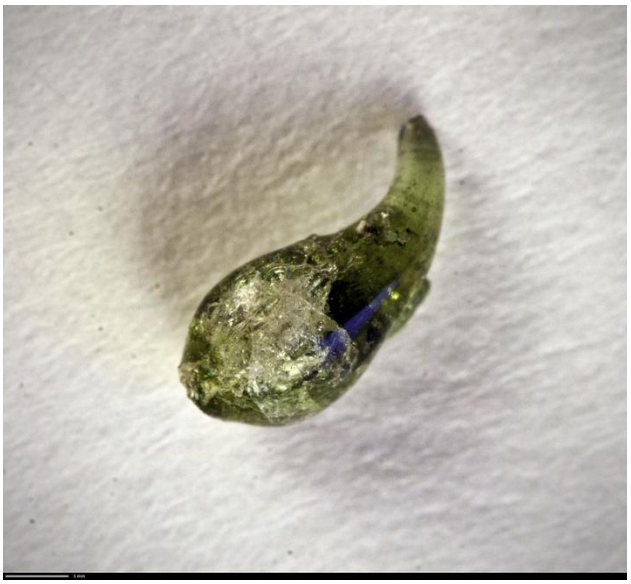
Trinitite Beads and Dumbbells
Mouser Williams photo, CC_BY_NC_ND-2.0 DEED, via flickr.com
Different shapes, sizes, and shades are represented in this assortment of trinitite particles.

Trinitite Bead
Mouser Williams photo, CC_BY_NC_ND-2.0 DEED, via flickr.com
Dimensions: 3.7 x 3.8 mm
A nearly spherical trinitite bead!

A Group of Trinitite Beads
Mouser Williams photo, CC_BY_NC_ND-2.0 DEED, via flickr.com
Dimensions: lower right bead -4.5 x 5.6 mm
Some examples of intergrown dark green trinitite beads.

A Pair of Trinitite Dumbbells
Mouser Williams photo, CC_BY_NC_ND-2.0 DEED, via flickr.com
Dimensions: left - 1.6 x 5.8 mm
right – 2.2 x 6.3 mm

Examples of "clean" and "dirty" trinitite dumbbells. Partially melted quartz grains cover the dirty dumbbell.



Trinitite Tear
Mouser Williams photo, CC_BY_NC_ND-2.0 DEED, via flickr.com
Dimensions: 2.6 x 5.8 mm
An interesting tear-shaped trinitite.

Red Trinitite

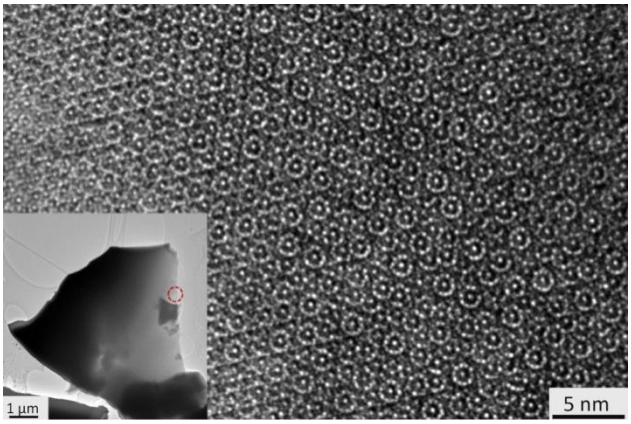
Red trinitite has been found interspersed with green trinitite. The reddish color is due to the presence of a copper oxide. Since samples seem occur to the north of ground zero, power transmission lines in this area have been assumed to be the source of the copper.

Metallic inclusions may be present in some red trinitite specimens. In addition to copper-bearing spherules, these inclusions may involve lead-rich blebs, which have been attributed to lead bricks scattered around the test site, and iron droplets that may have been derived from bomb components or the test tower.

Quasicrystal Discovery

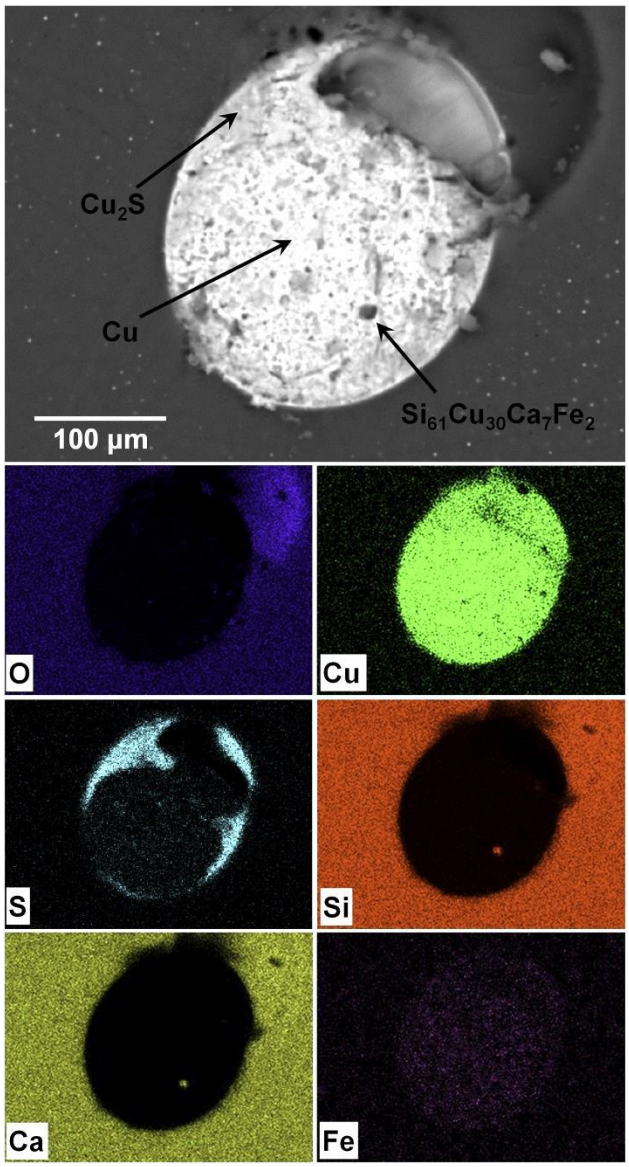
In 2021, a previously unknown isosahedral quasicrystal was discovered in a red trinitite sample. Quasicrystals, which were first identified in the 1980s in metal alloys, are

exotic materials that do not follow classical crystallographic rules. Although they have an ordered structure, it is not periodic. Based on meteorite studies, a mechanism for forming quasicrystals has been proposed which involves extremely strong shock waves followed by rapid cooling (Bindi et al., 2015). The Trinity test certainly represents such an intense shock event.



High-resolution Transmission Electron Microscopy (HRTEM) Image of a Khatyrka Meteorite Fragment
Bindi et al., 2015 photo, - CC_BY_SA-4.0 International, via nature.com
This HRTEM image shows the ten-fold symmetric pattern of the quasicrystal $Al_{71}Ni_{24}Fe_5$ that was discovered in a Khatyrka meteorite.

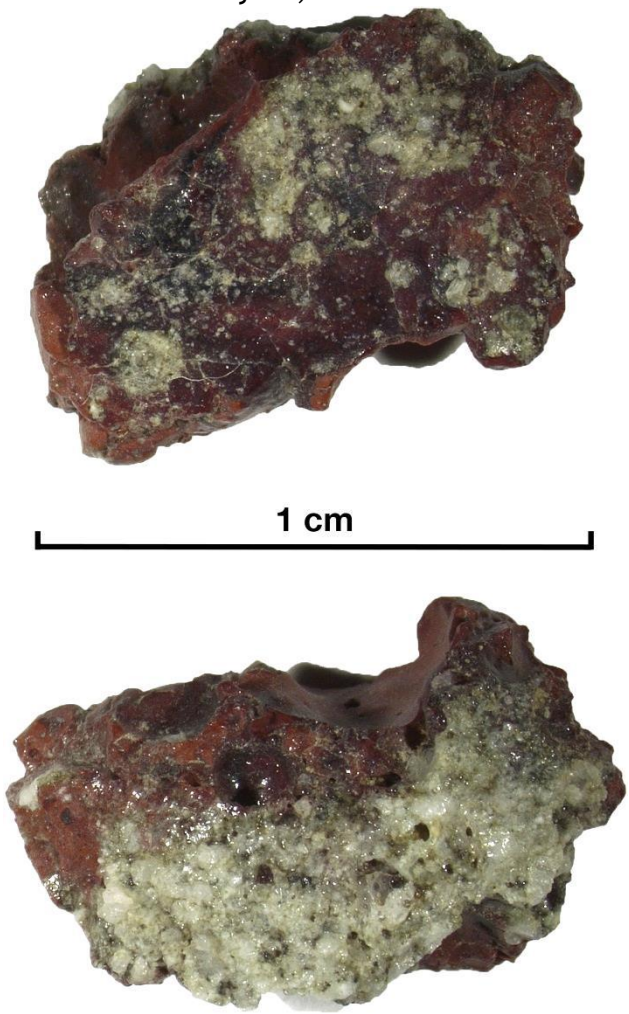
The search for the new quasicrystal focused on red trinitite since this variety is typically rich in metallic spherules. The quasicrystal was found in a tiny metal inclusion about 10 µm across. It has a chemical formula of $Si_{61}Cu_{30}Ca_7Fe_2$ and five-fold rotational symmetry. (Note regular crystals can have only two-, three-, four-, and six-fold rotational symmetries.)



Images of a Metal Inclusion with the Icosahedral Quasicrystal, $Si_{61}Cu_{30}Ca_7Fe_2$
Bindi et al., 2021, Fig. 3 photo, - ©2021/CC BY-NC-ND, via pnas.org
The top photo is a back-scattered scanning electron microscope image of the metal droplet. X-ray maps for various elements appear below.

The new quasicrystal $Si_{61}Cu_{30}Ca_7Fe_2$ has several unique attributes. It was discovered in the fused remnants of an atomic blast, but has not yet been synthesized in the laboratory. No other quasicrystalline material involves the combination of silicon, copper, and calcium or has silicon as a dominant element. In addition, the time

when the quasicrystal was created is precisely known - 05:29:45 A.M. Mountain War Time on July 16, 1945.



Red Trinitite
Bindi et al., 2021, Fig. 1 photo, - ©2021/CC BY-NC-ND, via pnas.org
Front and back views of a sample used in the quasicrystal investigation.

[An Assortment of Red Trinitite Samples]
Trez collection and photo, via treasurenet.com Vesicles may form from escaping gases as illustrated in this group of red trinitite.

[Red Trinitite and Metallic Spherules]
Trez specimen and photo, via treasurenet.com This close-up shows some metallic spherules that formed with the red trinitite.

Red Trinitite with Green Trinitite
Mouser Williams photo, CC_BY_NC_ND-2.0 DEED, via flickr.com
Dimensions: 2.5 x 4.2 cm
This relatively large sample includes good coverage of red trinitite with some pale green trinitite and white quartz grains. The red color, which has been described as oxblood red, suggests that the copper may have been reduced to produce cuprous oxide (Cu_2O).

[Red Trinitite Under Short Wave Ultraviolet Light]
Trez specimen and photo, via treasurenet.com Red trinitite may fluoresce a light blue and yellow under short wave UV. Possible

minerals and their activators, however, have not been identified.

Red and Green Trinitite

Trez specimen and photo, via treasurenet.com

Finally, this last image displays a rare combination of bright red and green glassy trinitite together.

Summary

Hope you have enjoyed this somewhat unusual pairing of traditional holiday colors and trinitite. Best wishes for a wonderful Christmas or whatever holiday you may be celebrating this season!

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AZ Mining, Mineral & Natural Resources Education Museum Update November 2023

https://ammnre.arizona.edu/

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703.577.6449

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

A few months ago we began the search for a founding Museum Director to lead museum planning, development, and fundraising, and then to ultimately oversee the new facility once it is open. Our latest update is that interviews are in progress. It has been exciting to see the collaborative effort of many administrators and leaders at the University of Arizona to make this happen. Exciting times are ahead for museum.

In other news, we are still looking for new exhibit and loan opportunities. If you know a museum or cultural institution in Arizona that is open to the public, has secure exhibit space, and would be interested in a potential mineral display, let us know. Thank you!

Happy holiday season from the museum!

A BLAST FROM THE PAST!

Please enjoy some pictures from the old AZ Mining and Mineral Museum's exhibits and gift shop.

During the holidays at the old AZ Mining and Mineral Museum, staff set up the "Banquet of Rocks" display in addition to the part that was on permanent display.

"Banquet of Rocks" that was on permanent display

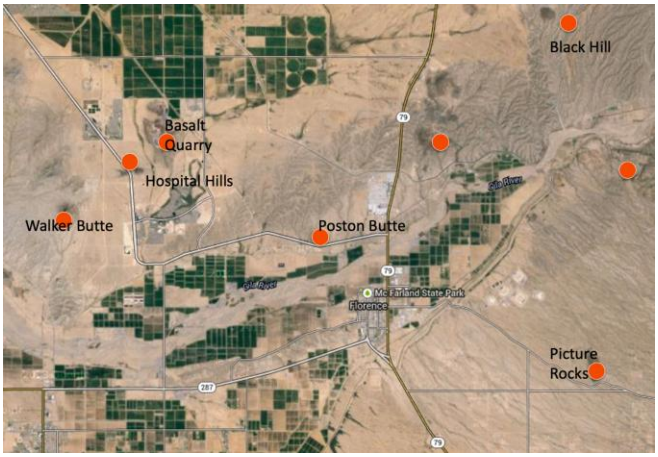
The gift shop had carvings, jewelry, books, mineral and fossil specimens; perfect gifts for the holidays!

Arizona Rocks 126

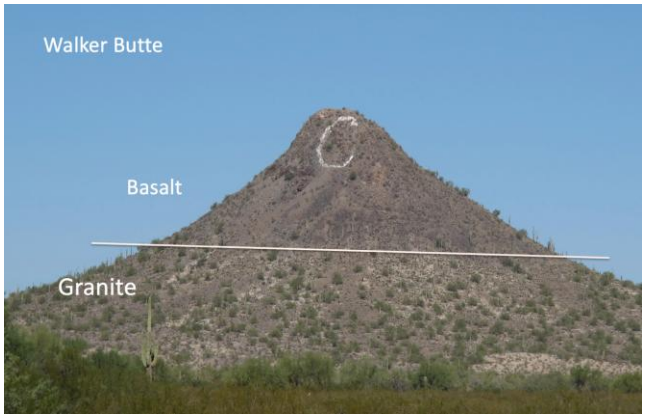
Text & photos by Ray Grant

Florence has F Mountain, Poston Butte (Arizona Rocks 125) and Coolidge has C Mountain or Walker Butte, named for John Walker an early settler in the area. Walker Butte is more spectacular and is an important local landmark. Roads in the area line up on the Butte. Pilots call it the volcano because of its shape like a volcano. It was earlier named Cheene, Pima for "bird beak" because of its sharp peak. There is no trail and it is steep.

But, it is not a volcano; the geology is the same as Poston Butte basalt over granite. The granite is 1.4 billion years old and the basalt is six million years old. There are eight hills around Florence with basalt on top. Where is the volcano? The most likely location is at the Vulcan Materials Quarry. Here there are thick layers of basalt and cinders. The basalt flowed out from here and covered a fairly large area and subsequent erosion has removed most of it except for the few hill tops.



Location of basalt capped hills in Florence/Coolidge area
Google photo



Walker Butte, 1.4 billion year old granite at bottom, 6 million year old basalt on top

Thick basalt at Vulcan Quarry, Walker Butte in background

Cinders at Vulcan Quarry

Pinal Museum and Society News

351 N. Arizona Blvd., Coolidge, AZ

Pinal Geology and Mineral Society next meeting

December 20, 2023

Meetings are the third Wednesday at 7pm, doors open at 6:30.

www.pinalgeologymuseum.org

Ray Grant ray@pinalgeologymuseum.org

Through next May, we will have our hours of 10 to 4 Wednesday through Saturday, admission is free.

Pinal Geology and Mineral Society and Museum schedule of events

December 20 – Meeting Pot-Luck Geology Cookie PARTY! Fun, activities, cookies, and more

January 13 – GIANT BOOK GIVEAWAY, 10-4 at the museum. Check it out! Geology related books on all sorts of topics. Bring Your Own Bag.

January 17 – Meeting - Paul Marsh, Arizona State Mine Inspector

March 2, 2024 – PGMS Annual Mineral Show in Coolidge

Geology and Mineral Book Bonanza!

A geological treasure trove! We're giving away an extensive collection of Geology and Mineral books that will leave you awestruck. Dive into a world of coffee table masterpieces, stunning fossil and minerals, how-to guides, government geological publications, textbooks, historical accounts, and a plethora of earth science wonders. **Bring your own bag.**

Mark your calendar:

Date: Saturday, January 13, 2024

Time: 10:00 AM - 4:00 PM

Location: Pinal Geology and Mineral Museum,

351 North Arizona Blvd., Coolidge, Arizona

Visit our website at pinalgeologymuseum.org for more details.

It's all free, though donations while you grab your favorite books would be welcome. No pressure!

Don't miss this golden opportunity to add to your library and explore the museum. Admission to the museum, the kids' fossil dig, Cullen's Rock and Mineral Dig for Kids, and field trips/tours are always free of charge. Join us for a great day of discovery!

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 Celebrates Diamond Anniversary 1963-2023

By Carol Ann Hewett

60 years ago, three Sun City residents Claude Cherry, Carl Bell and Clark Hall got together around the pool in Sun City and discussed if there might be any interest in forming a rockhounding club. Their experiences with rockhounding varied greatly. Claude Cherry chaired a large rockhounding organization in California. Carl Bell was an Arizona rancher and knew the Arizona terrain and outdoor life. Clark Hall did lapidary and was instrumental in forming the Sun City Lapidary Club. The three men decided to take a few investigative trips out into the desert and mountain areas to see what specimens might be collected. What these men lacked in experience they made up for with their enthusiasm and vision.

On October 28, 1963, the Sun City Rockhound Club was formed at the Sun City Oakmont Recreation Center. Membership has ranged from 62 members in the early days to 635 members in 1978. Currently we have approximately 125 members.

In November 1963, the newly formed club took its first field trip to the Constellation Road area near Wickenburg. Since then, the club has been on over 300 field trips throughout Arizona and New Mexico, Nevada and California.

In January 1972, the Rockdust newsletter was started to keep members informed of club activities. In 1978 the clubs newsletter won 3rd place at the Rocky Mountain Federation of Mineralogical Societies. The newsletter continues today and contains important club information as well as informative educational articles.

The first rockhound show also took place in 1972 and attracted 1063 visitors. The show was designed to illustrate the activities of the rockhound club. In 1973 the second show had over 3,700 in attendance. This has evolved over the years into biannual rock and mineral sales that take place in November and March. You can purchase specimens at the sales or in the club's museum gift shop.

In October 1990, the Sun City Mineral Museum opened its doors. Many hours of manual labor by the dedicated members made this dream become a reality. By November of that year, over 700 guests had visited the museum, and 585 specimens were on display, all donated by 52 donors. The museum is a "true gem" with three rooms that contain an impressive collection of 1500 specimens, artifacts and fossils which come from 41 countries. A highlight in the museum is the fluorescent room which has over 100 specimens that take on vibrant colors in the dark under UV lights. Visitors by the hundreds have come to experience the brilliance of this one-of-a-kind exhibit. It is well worth a visit if you have not gone!

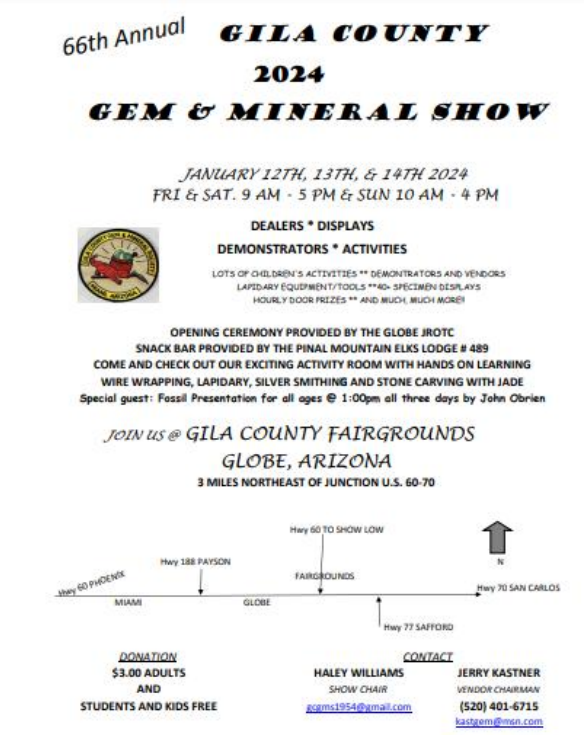
The museum is open to both Sun City residents and nonresidents. We welcome visits by schools and other community groups to share this rich learning environment. Contact us to find out more, or to book a tour.

We hope to see you soon!
Find us on: Facebook: Sun City Rockhounds

Arizona Rock and Gem Shows

Flagg Mineral Foundation
51st Annual
Flagg Gem and Mineral Show
January 5-7, 2024
Fri., Sat., Sun. 9-5
Free Admission and parking
Mesa Community College
1833 W. Southern Ave.
Corner of Dobson Rd. and US60
Mesa, AZ

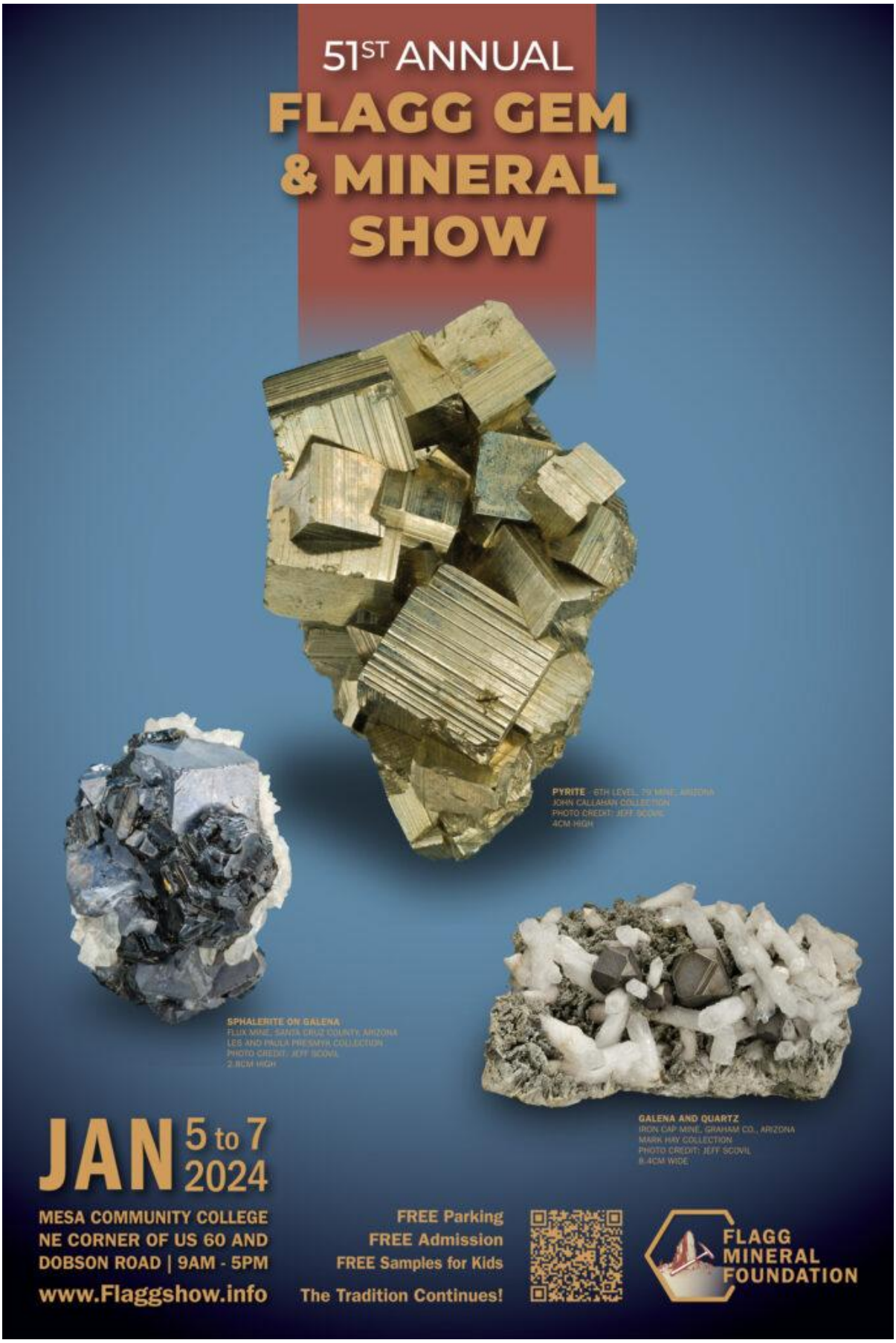
Gila County Gem and Mineral Society
Gila County Gem & Mineral Show
January 12-14, 2024
Fri. & Sat. 9-5, Sun. 10-4
$3 Adults, Students and Kids Free
Gila County Fairgrounds
3 miles northeast of Jct. US 60-70
Globe, AZ

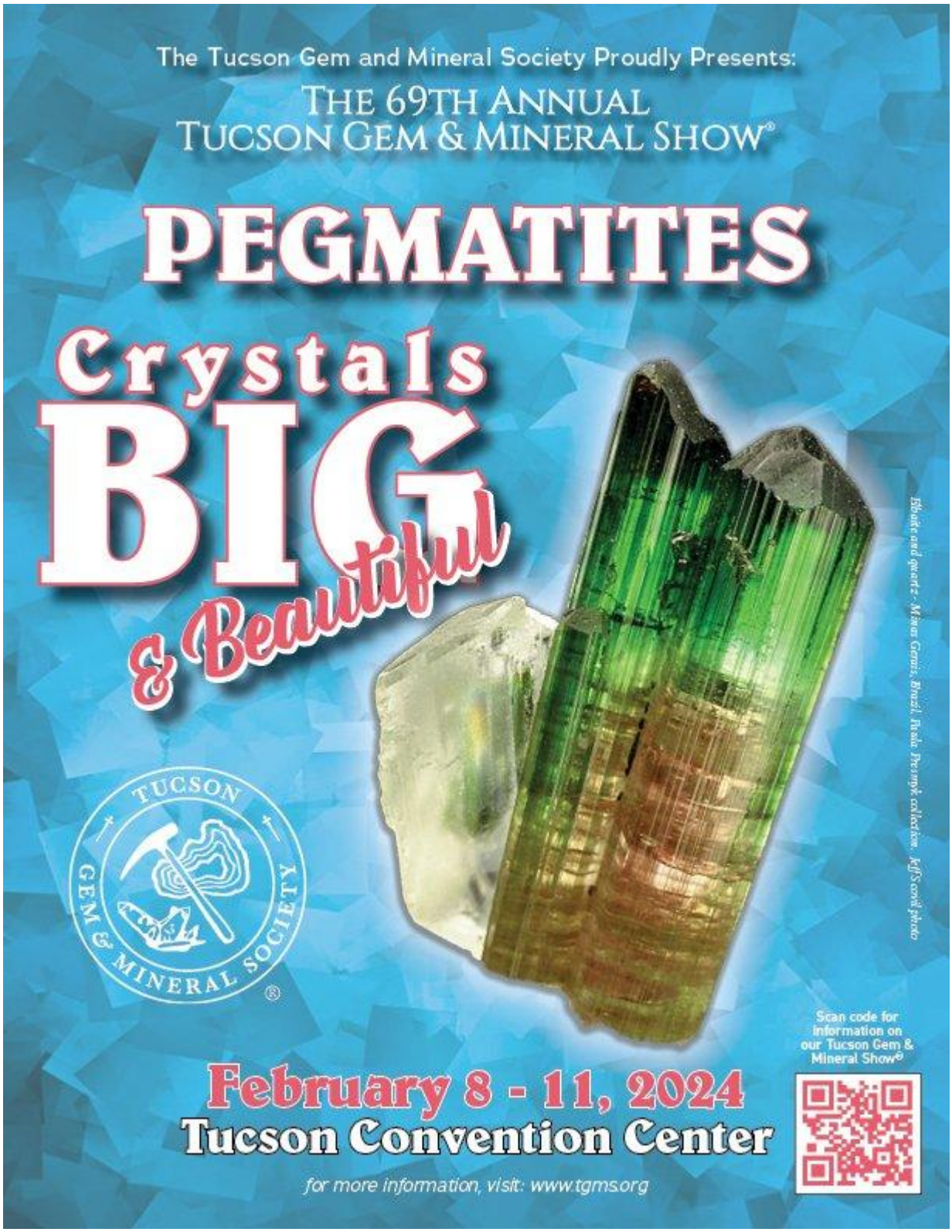


Tucson Gem and Mineral Society
proudly presents the 69th
Tucson Gem and Mineral Show®
February 8-11, 2024
Thurs., Fri., Sat. 10 - 6
Sun. - 10 - 4
Tickets $12.00 with a $1.00 TCC ticket tax
Children 14 and under are free
with a paying adult
Tucson Convention Center
260 S. Church Avenue

Mingus Gem & Mineral Club
Annual show
February 23-25, 2024
Fri. 9-5, Sat. 9-5, Sun. 9-4
Free Admission
Clark Memorial Clubhouse Auditorium
19 N. Ninth Street
Clarkdale, AZ

Daisy Mountain Rock and Mineral Club
Daisy Mountain Rock and Mineral Show
March 2-3, 2024
Sat. 9-5, Sun. 10-4
Adults, $5,
Seniors, Vets, students $4
Children under 12 free with adult
Anthem School
41020 N. Freedom Way
Anthem, AZ


51ST ANNUAL
FLAGG GEM & MINERAL SHOW
PYRITE · 8TH LEVEL, 79 MINE, ARIZONA
JOHN CALLAHAN COLLECTION
PHOTO CREDIT: JEFF SCOVIL
4CM HIGH
SPHALERITE ON GALENA
FLUX MINE, SANTA CRUZ COUNTY, ARIZONA
LES AND PAULA PRESMYK COLLECTION
PHOTO CREDIT: JEFF SCOVIL
2.8CM HIGH
GALENA AND QUARTZ
IRON CAP MINE, GRAHAM CO., ARIZONA
MARK HAY COLLECTION
PHOTO CREDIT: JEFF SCOVIL
8.4CM WIDE
JAN 5 to 7 2024
MESA COMMUNITY COLLEGE
NE CORNER OF US 60 AND
DOBSON ROAD | 9AM - 5PM
www.Flaggshow.info
FREE Parking
FREE Admission
FREE Samples for Kids
The Tradition Continues!
FLAGG MINERAL FOUNDATION


The Tucson Gem and Mineral Society Proudly Presents:
THE 69TH ANNUAL
TUCSON GEM & MINERAL SHOW®
PEGMATITES
Crystals
BIG
& Beautiful
Elbaite and quartz - Mawi Gems, Brazil. Brad Prentiss collection. Jeff Scovil photo
TUCSON GEM & MINERAL SOCIETY
Scan code for information on our Tucson Gem & Mineral Show®
February 8 - 11, 2024
Tucson Convention Center
for more information, visit: www.tgms.org

Apache Junction Rock & Gem Club
Meetings are on the 2nd Thursday
Next Meeting: December 14, 2023, 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 5, 2023, 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: Change of meeting day
Meetings are on the 3rd Tuesday
Next Meeting: December 19, 2023, 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)
Holiday Jamboree/Christmas Party
December 9, 2023,
Time & Place TBA
Please go to their website for more information
www.msaaz.org

Pinal Geology & Mineral Society
Meetings are on the 3rd Wednesday
Next Meeting: December 20, 2023, 7:00 pm
In person meeting
www.pinalgeologymuseum.org
351 N. Arizona Blvd., Coolidge

West Valley Rock & Mineral Club
Meetings are on the 2nd Tuesday
Next Meeting: December 12, 2023, 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 7, 2023, 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 1, 2023, 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 2023, 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: _____

Email: _____

Phone Number: _____

Mail form & payment to: Earth Science Museum
3215 W. Bethany Home Rd., Phoenix, AZ 85017

For Office Use Only

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Earth Science Museum
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Phoenix, AZ 85017

Phone:
602-973-4291

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 2023, at 6:30 p.m.

THANK YOU FOR YOUR CONTINUING INTEREST & SUPPORT!!!

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