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

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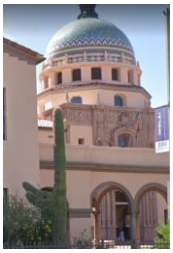
Volume 11, Issue 6

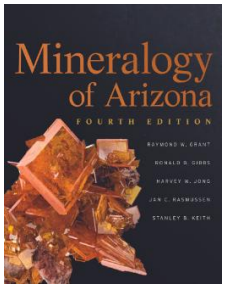
ESM OUTREACH UPDATE

Mardy Zimmermann, Outreach Coordinator

On June 25, 2022, ESM board members, Dr. Raymond Grant (far right) and Harvey Jong (center), joined fellow authors Ronald Gibbs, Jan Rasmussen and Stanley Keith (far left), for a book signing event launching the 4th Edition of the Mineralogy of Arizona. The kick-off celebration was held at the recently opened UA Alfie Norville Gem and Mineral Museum located in Tucson's renovated Historic Pima County Courthouse building.

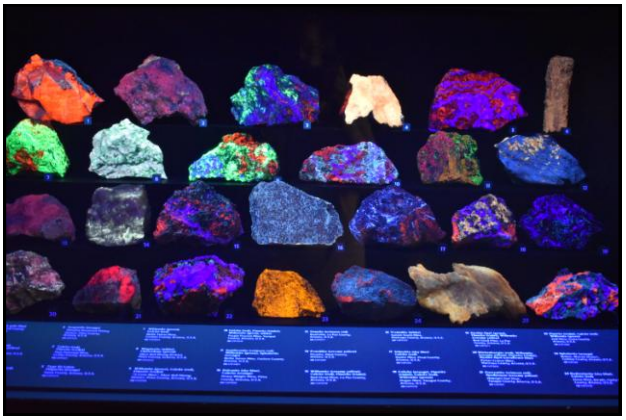


Mineral and lapidary enthusiasts from across Arizona attended the event and were treated to free admission to the new museum with the purchase of the *Mineralogy of Arizona*. This fourth edition covers the 992 minerals found in Arizona, showcased with breathtaking new color photographs throughout the 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.



The ESM made a donation that helped support the inclusion of color photography in the book.

Be sure to pay a visit to the museum and enjoy these and many other beautiful and educational mineral displays!



A Special Day for Meteors and Asteroids

By Harvey Jong

June 30th represents a special day for celebrating all things involving meteors and asteroids. It is National Meteor Watch Day, while a 2016 United Nations resolution designated the date as International Asteroid Day, an occasion to educate the public about asteroids and the importance of defending the Earth against a potential impact.

It is not known why June 30th was selected for National Meteor Watch Day since no well-known meteor showers peak around this date. International Asteroid Day, on the other hand, marks the anniversary of the 1908 Tunguska event, when an asteroid is believed to have leveled a forest in Siberia.

Trees Flattened by the Tunguska Event Blast

Soviet Academy of Science photo, circa 1927 – PD, via Wikimedia Commons

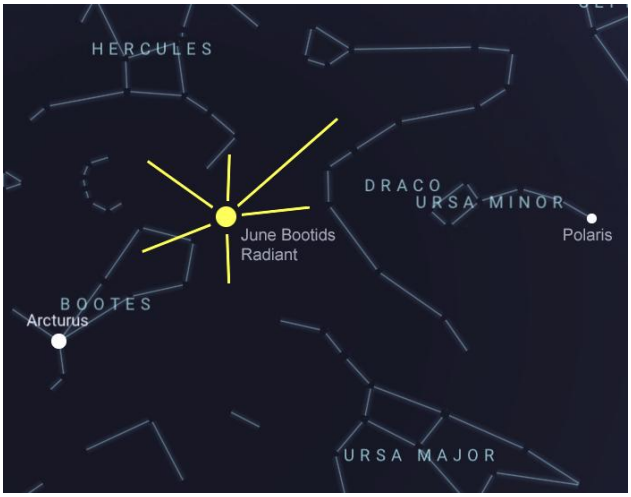
The Tunguska event is the largest recorded impact event on Earth which flattened an estimated 80 million trees over an area of 2,150 km^2 (830 sq. mi.). Different hypotheses on what caused this explosion have been proposed, but it is generally attributed to an air burst of a small asteroid that grazed the Earth.

We will begin exploring these out-of-this-world objects and their connections to Arizona by reviewing some terminology. An **asteroid** is a metallic or rocky body that orbits within the inner Solar System. The size and shape varies widely, and the largest asteroid, Ceres, is almost 1000 km (600 mi) across. A **meteoroid** is a small metallic or rocky object that may be a fragment of an asteroid or comet. When an asteroid or meteoroid enters the Earth's atmosphere, a streak of light or fireball may result due to atmospheric heating and is called a **meteor**. A **meteorite** is a remnant of a meteoroid that has survived entering the atmosphere and impacted on the Earth's surface.

A **meteor shower** is a celestial event that involves a number of meteors which radiate from one point in the night sky. This point is known as the **radiant** and is associated with a debris field left behind by an asteroid or comet. Meteor showers are named after the constellation (e.g. Perseids) or bright star in the constellation (e.g. Alpha Scorpiids) closest to the radiant at the peak of the shower. Note that a Greek or Roman letter prefix may be used to indicate a specific star within a constellation. The International Astronomical Union's Meteor Data Center maintains a database of meteor showers which currently lists 996 reported events with 112 established or approved showers.

June Boötid Meteor Shower

As mentioned earlier, National Meteor Watch Day doesn't seem to be associated with a particular meteor shower. A possible candidate, though, might be the June Boötid meteor shower which is active from June 22 to July 2 with a peak around June 27. The radiant point is located near the constellation Boötes (the Herdsman), and the shower has been identified as the debris stream of the comet 7P/Pons-Winnecke.



Location of the June Boötid Radiant
Annotated Stellarium Screen Capture

Typically, only 5 or 6 meteors an hour have been observed with the June Boötid shower, but it can be unpredictable with sudden outbursts. In 1998, about 100 or more meteors an hour were reported during the shower's peak.

Arizona's Meteor Connection

Arizona's connection to meteors is well-known with 179 meteorite occurrences reported by the Meteoritical Society database (https://www.lpi.usra.edu/meteor/metbull.php). The state's desert environment is ideal for preserving meteorite falls, and Meteor Crater represents one of the most dramatic and accessible impact craters on Earth.

Meteor Crater or Barringer Crater is located 29 km (18 mi.) west of Winslow. It is about 1,200 m (3,900 ft) in diameter, 170 m (560 ft) deep, and has a rim that rises 45 m (148 ft) above the original surface. The crater formed about 50,000 years ago when a nickel-iron meteoroid about 50 m (160 ft) across impacted the site. Half of the meteoroid is estimated to have been vaporized during its passage through the atmosphere, while the impact energy may have been the equivalent to 10 megatons of TNT.

Aerial View of Meteor Crater
NASA Earth Observatory photo – PD, via Wikimedia Commons

Panoramic View from the Upper Deck of the Crater
Tsaiproject photo – CC_BY_SA-3.0, via Wikimedia Commons

Meteorites found in the area are called Canyon Diablo meteorites, after the closest community to the crater in the late 19th century. With an estimated total mass of 30 tons, thousands of meteorite fragments ranging from 50 g (1.8 oz) to 639 kg (1,409 lb) have been found since 1891. The largest fragment is approximately 0.8 m (2.5 ft) across and is named for Samuel Holsinger who was the foreman and drill supervisor of the Standard Iron Company, a mining firm founded by Daniel Barringer. The company staked a claim around the crater and attempted to mine the potential deposit of meteoric iron. However, after 27 years of exploration and drilling to a depth of 419 m (1,375 ft), no significant deposit was found.

Holsinger Meteorite Fragment
Mario Roberto Duran Ortiz photo – CC-BY-SA-3.0, via Wikimedia Commons
The Holsinger fragment is on display at the Meteor Crater visitor center.

Arizona's Meteorite Minerals

Meteorites represent a key part of the mineralogy of Arizona. Currently, Arizona has 90 type minerals, and the discovery of seven of these minerals involved meteorites or meteorite localities. The tremendous heat and pressure associated with atmospheric entry and surface impact are needed to form the meteorite minerals.

Mineral	**Meteorite/ Meteorite Locality**
Brezinaite	Tucson Ring Meteorite
Coesite	Meteor Crater
Haxonite	Canyon Diablo Meteorite
Krinovite	Canyon Diablo Meteorite
Lonsdaleite	Canyon Diablo Meteorite
Moissanite	Canyon Diablo Meteorite
Stishovite	Meteor Crater

(Note: photos of samples from other meteorites or synthetic sources are included below since images of Arizona specimens were not available for most of the meteorite minerals.)

Brezinaite Cr_3S_4

Polished Fragment with Brezinaite
RRUFF project specimen and photo
Tucson Ring Meteorite

The second tiny spot below the larger dark brown bleb on the left side of the sample contains brezinaite with kamacite and forsterite. Bunch and Fuchs, 1969 reported that brezinaite occurs as anhedral grains 5-80 μm across with iron-free silicate inclusions or in the nickel-iron matrix. The mineral is named for Aristides Brezina (1848-1909), a past director of the mineralogy-petrography section of the Natural History Museum, Vienna, Austria.

Tucson Ring Meteorite
Wesley Fryer photo – CC_BY_SA-2.0, via Wikimedia Commons

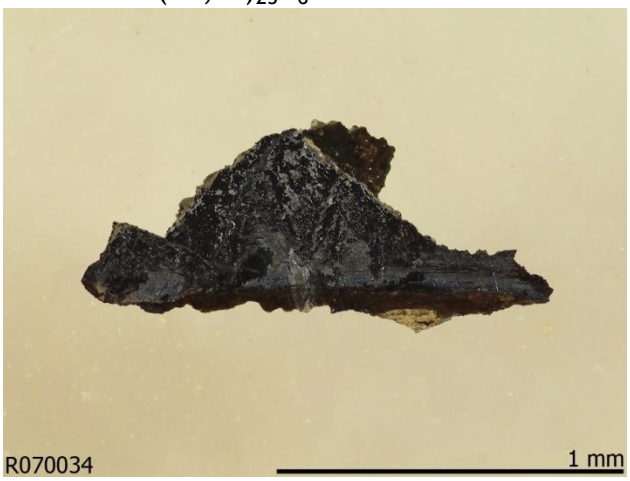
The Tucson Ring meteorite is a 688 kg (1,400 lb) ring-shaped meteorite that was found before 1845 in the Sierra de la Madera range (now the Santa Rita Mountains) and moved to Tucson where it was used as an anvil for many years. The meteorite is now on display at the Smithsonian's National Museum of Natural History.

Coesite SiO_2

Synthetic Crystalline Fragments of Coesite
RRUFF project specimen and photo

This coesite sample was created with a pressure of 45 kbar and a temperature of 650 °C. The first natural occurrence of the high-pressure silica polymorph was identified in sheared Coconino sandstone samples collected from Meteor Crater (Chao et al., 1960). The coesite appeared as irregular to vaguely rectangular grains ranging from 5 µm to more than 50 µm. The synthetic material and the mineral are named in honor of Loring Coes, Jr. (1915-1978), the chemist who first synthesized it.

Haxonite $(Fe,Ni)_{23}C_6$



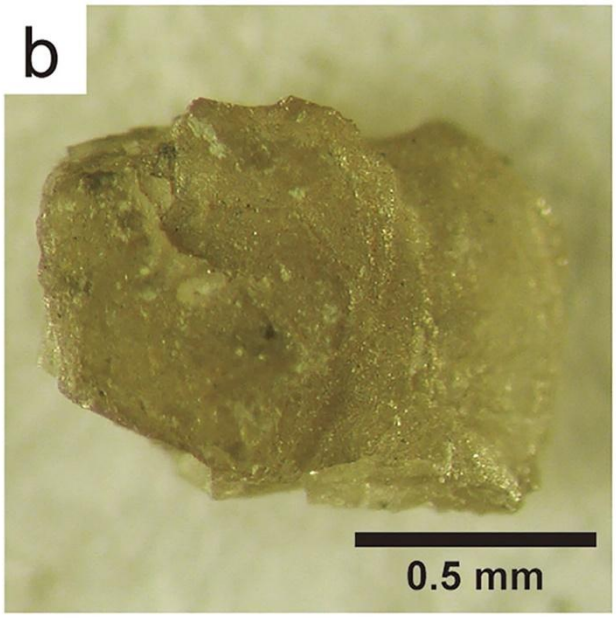
Haxonite Fragment
RRUFF project specimen and photo
Egvekinot meteorite, Chukot Province, Russia
This specimen was found in July 1970.

The description of haxonite was published in 1971 and reported that the cubic carbide was found in polished sections of the Canyon Diablo and Toluca meteorites (Scott, 1971). The mineral honors Howard J. Haxon (1924-1992), a metallurgist and expert on meteorite mineralogy at the University of Manchester, Manchester, England.

Krinovite $Na_2Mg_4Cr^{3+}_2(Si_6O_{18})O_2$

Krinovite was discovered in 1968 within graphite nodules of three octahedrite iron meteorites which included the Canyon Diablo meteorite (Olsen and Fuchs, 1968). The deep emerald green silicate occurs as minute subhedral grains up to 200 µm and may be associated with graphite, roedderite, albite, richterite, forsterite, kosmoclar, and chromite. The mineral is named in honor of Evgeny L. Krinov (1906-1984) who was a Russian investigator of meteorites.

Lonsdaleite C



Mixture of Diamond and Lonsdaleite
Photo from (Ohfuji et al., 2015) – CC-BY_4.0 International, via Wikimedia Commons
Popigai crater, North central Siberia, Russia

Lonsdaleite was first identified in 1967 in samples of the Canyon Diablo meteorite. Bundy and Kasper, 1967 described the mineral as a new crystalline form of carbon with a hexagonal lattice, "hexagonal diamond", and named it in honor of Kathleen (Yardley) Lonsdale (1903-1971), a distinguished British crystallographer, University of London, London, England.

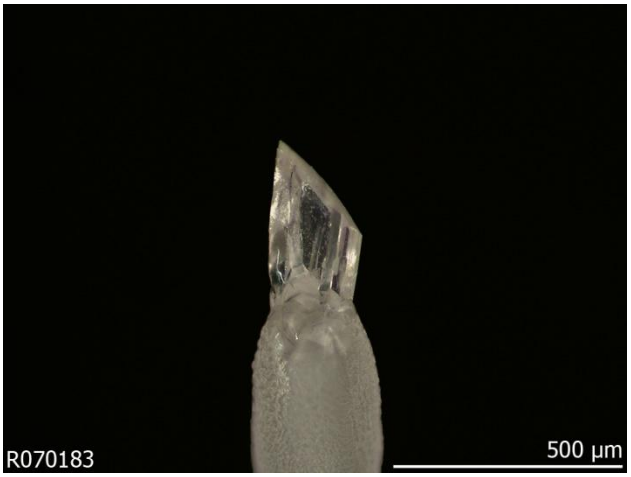
Moissanite SiC

Hexagonal Plates of Moissanite
RRUFF project specimen and photo
China

This specimen from China resembles a man-made silicon carbide polymorph, alpha silicon carbide. The synthetic material is called carborundum and is used in abrasive and cutting applications.

Natural moissanite was first identified in 1905 in the Canyon Diablo meteorite by Henri Moissan (1852-1907) and is named after the French chemist. Some controversy surrounded this discovery as it was suggested that samples may have been contaminated by tools used in sawing the meteorites. Leung and Winston, 2004, however, reported finding three varieties of moissanite crystals up to 200 µm in Canyon Diablo meteorites.

Stishovite SiO_2



Synthetic Stishovite Fragment
RRUFF project specimen and photo

Stishovite is an extremely hard, dense tetragonal form of silica that resembles the crystal structure of rutile. It is formed by the shock metamorphism of quartz at temperatures greater than 1200 °C and pressures around 100 kbar. The silica polymorph was discovered in 1962 in the shocked Coconino sandstone from Meteor Crater (Chao et al., 1962). The mineral is named in honor of Sergei M. Stishov (b.

1937), a Russian high-pressure physicist and crystallographer who first synthesized the substance in 1961.

Arizona's Asteroid Connection

The Arizona connection to asteroids involves NASA research projects with the University of Arizona (UA). A few activities in the news include the following terrestrial and spacecraft-based programs:

1. Catalina Sky Survey
2. Near Earth Object Wide-field Infrared Survey Explorer (NEOWISE) mission
3. Origins, Spectral Interpretation, Resource Identification, Security, Regolith Explorer (OSIRIS-REx) mission

Catalina Sky Survey

The Catalina Sky Survey (CSS) is a NASA funded project which is dedicated to discovering and tracking Near-Earth Objects (NEOs). This research represents an effort meet a congressional mandate to catalog at least 90 percent of the NEOs larger than 140 m (459 ft) and identify Potentially Hazardous Asteroids (PHAs) that pose an impact threat to the Earth.

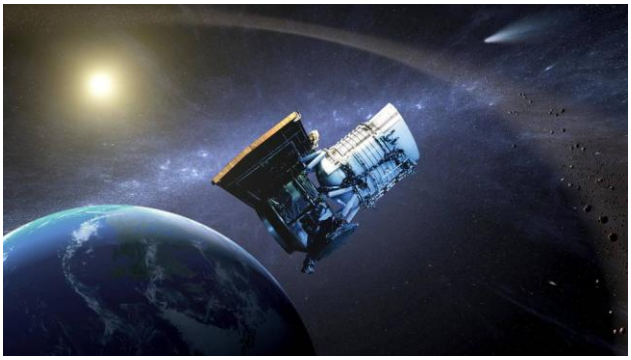
To carry out this mission, the CSS uses three telescopes of the UA Stewart Observatory. Two telescopes, a 1.5 m (59 in), f/1.6 Cassegrain reflector and 1 m (39 in), f/2.6 Cassegrain reflector, are located on Mount Lemmon. A third telescope, a 0.7 m (28 in), f/1.8 Schmidt telescope, is based on Mt. Bigelow, just east of Mt. Lemmon.

Mount Lemmon Observatory in the Santa Catalina Mountains near Tucson
Daniel Oberhaus photo – CC_BY_SA-4.0, via Wikimedia Commons

As of 2020, the CSS has cataloged about 47% of the total known NEO population. Some notable discoveries include 2008 TC_3, the first asteroid discovered before Earth impact, and Comet C/2021 (Comet Leonard) (See the Dec. 2021 newsletter for more information on Comet Leonard).

NEOWISE Mission

The NEOWISE spacecraft was originally the Wide-field Infrared Survey Explorer, a NASA infrared-wavelength space telescope. Its initial mission was conducted from Dec. 2009 to Feb. 2011 until the telescope's hydrogen coolant was exhausted. In Sept. 2013, the spacecraft was reactivated and assigned a new mission to identify and characterize near-Earth objects. Recently, NASA extended operations until June 2023. The principal investigator for NEOWISE and its successor spacecraft, the NEO Surveyor, is based at the University of Arizona.



Artist's Concept of NASA's WISE/NEOWISE Spacecraft
Illustration courtesy of NASA/JPL-Caltech – PD, via nasa.gov

As of 2021, NEOWISE has provided size estimates for over 1,850 NEOs. In 2020, it discovered a new comet which was named after the mission. (See July 2020 newsletter for more information on Comet NEOWISE.)

OSIRIS-REx Mission

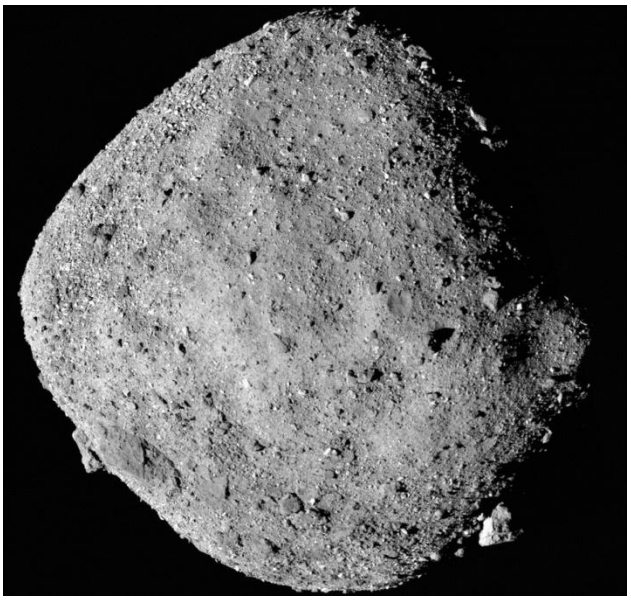
OSIRIS-REx is an ambitious NASA space mission to travel to the asteroid Bennu and collect a sample. Bennu is a carbon-rich asteroid that was discovered in Sept. 1999 during a near-Earth asteroid survey. The name was selected from over 8,000 student entries to a "Name That Asteroid!" contest run by the University of Arizona. Bennu is a mythological bird that was the living symbol of the Egyptian god Osiris.

Bennu has a roughly spherical shape and a mean diameter of 490 m (1,619 ft). It is believed to have formed from the breakup of a planetoid or proto-planet and may provide information on the early history of the Solar System.

Key science objectives of the OSIRIS-REx mission include:

- Return a sample of Bennu's surface
- Document the sample site
- Map the asteroid
- Measure its orbit and deviations caused by non-gravitational forces

The spacecraft was launched on Sept. 8, 2016 and arrived at Bennu on Dec. 3, 2018. It orbited the asteroid at distances ranging from 1 km (0.6 mi) to 1.3 km (0.8 mi). Over several months, OSIRIS-REx performed a detailed survey to identify candidate sample collection sites.

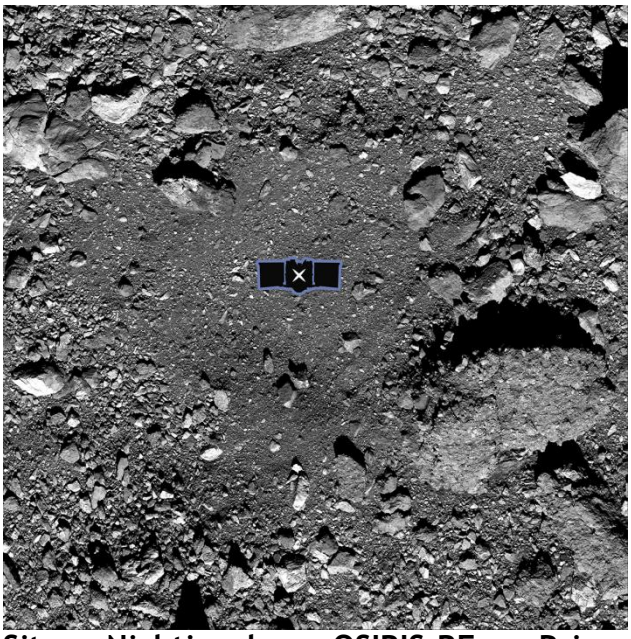


Mosaic Image of Asteroid Bennu
Image courtesy of NASA/Goddard Spaceflight Center/University of Arizona – PD, via nasa.gov
This image is composed of 12 PolyCam images collected on Dec. 2, 2018.

An award-winning narrated tour of Bennu's main features can be viewed at the following URL:
https://www.youtube.com/watch?v=QunVAWABQSc

Collecting a sample of Bennu represents a rather amazing technological achievement. The spacecraft had to descend down to the surface; make contact with its articulated arm for about 6 seconds to allow material to

enter the sample head; and then back away using its thrusters. The selected sample site was just 16 m (52 ft) in diameter and was surrounded by several boulders larger than the spacecraft.



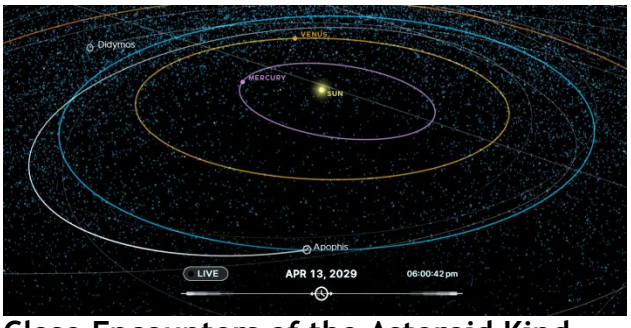
Site Nightingale, OSIRIS-REx Primary Sample Collection Site
Image courtesy of NASA/Goddard Spaceflight Center/University of Arizona – PD, via asteroidmission.org
This image shows the sample site overlaid with a graphic of the OSIRIS-REx spacecraft.

OSIRIS-REx had to perform the sampling task without direct guidance from Earth since signals take nearly 20 minutes to reach the spacecraft. This touch-and-go collection event occurred flawlessly on Oct. 20, 2020 and captured about 400 g (14 oz) of material.

Artist's Concept of NASA's OSIRIS-REx Approaching the Surface of Bennu
Image courtesy of NASA/Goddard Spaceflight Center/University of Arizona – PD, via nasa.gov

On May 10 2021, OSIRIS-REx fired its main engines to begin a 2.5 year journey back to Earth. It should arrive on Sept. 24, 2023 when a capsule containing the Bennu sample will separate from the spacecraft and land at a test range in Utah.

Breaking News: On April 25, 2022, NASA announced an extended mission for the OSIRIS-REx spacecraft which will study the near-Earth asteroid Apophis, an S-type or stony asteroid that was discovered in 2004 by astronomers at the Kitt Peak National Observatory in Tucson. The detection of Apophis raised some concerns as initial calculations indicated a small probability (2.7%) that the asteroid would impact the Earth in 2029. Further review, however, ruled out a collision with the 340 m-wide (1,120 ft-wide) asteroid. It is now expected to pass 31,600 km (19,635 mi) from the Earth which is still a rather close encounter.



Close Encounters of the Asteroid Kind
Screen capture of NASA/JPL-Caltech *Eyes on Asteroids* interactive animation
This graphic shows the trajectory of Apophis leading to its close approach to Earth on Apr. 13, 2029.

Animated Close Approach of Apophis to the Earth
Screen capture of NASA/JPL-Caltech *Eyes on Asteroids* interactive animation

Real time animations of Apophis and other NEOs can be viewed at the following link: https://eyes.nasa.gov/apps/asteroids/#/asteroids

The new proposed 18-month mission has been named OSIRIS-APEX (APophis EXplorer) and involves some technical risk as the modified trajectory will bring the probe within 0.5 astronomical units (46.5 million miles) of the Sun. This is much closer than the original mission designed for Bennu. OSIRIS-APEX will arrive at Apophis just days after the asteroid's closest approach to Earth.

OSIRIS-APEX will not collect a sample, but mission plans call for a maneuver in which the spacecraft will approach the surface, fire its thrusters, and then back away. This event is based on the observation that the thrusters had a significant effect on Bennu's surface due to the asteroid's weak surface gravity. The objective is to probe Apophis' subsurface by moving some surface material.

References:

Bunch, T.E. and L.H. Fuchs (1969) A new mineral: brezinaite, Cr_3S_4, and the Tucson meteorite. *American Mineralogist* 54: 1509-1518.

Bundy, F.P. and J.S. Kasper (1967) Hexagonal diamond – a new form of carbon. *Journal of Chemical Physics* 46(9): 3437-3446.

Chao, E.C.T., E.M. Shoemaker, and B.M. Madsen (1960) First natural occurrence of coesite. *Science* 132: 220-222.

Chao, E.C.T., J.J. Fahey, and J. Littler (1962) Stishovite, SiO_2, a very high pressure new mineral from Meteor Crater, Arizona. *Journal of Geophysical Research* 67: 419.

Leung, I.S. and R. Winston (2004) Historical and new perspective of moissanite in the Canyon Diablo meteorite. *American Geophysical Union*, Fall Meeting 2004, abstract P33A-1008.

Olsen, E. and Fuchs, L. (1968) Krinovite, $NaMg_2CrSi_3O_{10}$: a new meteorite mineral. *Science* 161: 786-787.

Scott, E.R.D. (1971) New carbide, $(Fe,Ni)_{23}C_6$, found in iron meteorites. *Nature* 269: 61-62.

This pallasite can be found at the UA Alfie Norville Gem & Mineral Museum in Tucson. Pallasites are a rare type of stony-iron meteorites that contain olivine crystals.

AZ Mining, Mineral & Natural Resources Education Museum Update June 2022

https://ammnre.arizona.edu/

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

On June 23, the Arizona State Legislature passed the Fiscal Year 2023 budget after several months of deliberation. The budget allocates $126 million to the University of Arizona, with $12 million specifically appropriated to the AMMNRE Museum to be used for capital improvements. The money must be used by the end of Fiscal Year 2024. This is fantastic news for the museum and UA administration will be developing a plan of action in the coming weeks. We are very thankful to Rep. Gail Griffin (District 14) for being a champion for the museum within the Arizona legislature.

In other news, Catie and Bill recently returned three large mineral specimens to museum storage after three years on display at AZ Heritage Center in Tempe. These included a native copper specimen from Bisbee, a beautiful malachite and brochantite specimen from Bisbee, and malachite breccia boulder from Bagdad, Yavapai Co., AZ.

Catie after loading the heavy specimens on to the moving truck

Native Copper from Bisbee; this specimen was displayed for many years at the AZ Mining and Mineral Museum.

Finally, we have 10 remaining "Arizona Rocks and Minerals" teacher's kits still available for educators. Kit details are listed in the May 2022 newsletter; please email Catie if you would like a free kit.

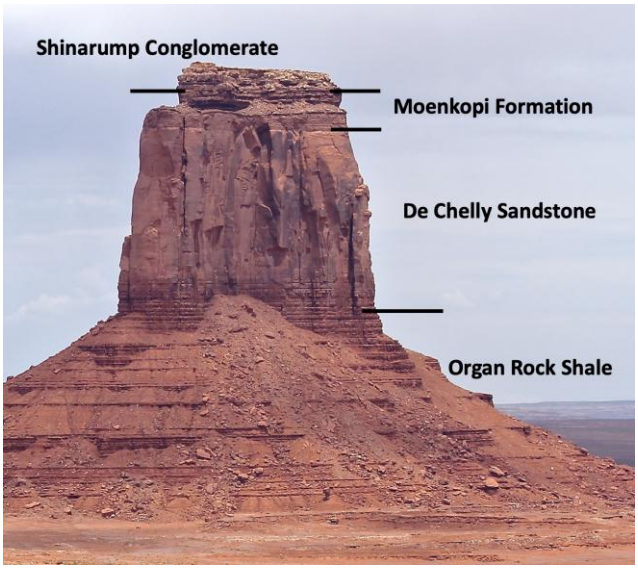
Arizona Rocks 109

Text and photos by Ray Grant

I missed a very important Arizona location! In searching for the next Arizona Rocks, I found that I have not written about Monument Valley. It is a famous geological/tourist destination; recognized by people around the world because of the films made there showing the spectacular scenery. Located on the Arizona-Utah border, the entrance road is in Utah, but the area open to the public is in Arizona. It is a Navajo Tribal Park, and you should check the website before visiting to be sure it is open, the hours, the fees, and any restrictions (https://navajonationparks.org/tribal-parks/monument-valley/). There is a 17-mile loop road with scenic stops that visitors can drive.

The geology is typical Colorado Plateau, uplifted horizontal sedimentary rocks. They have been eroded into mesas, buttes, and pinnacles making the fantastic views. Remember that sandstone forms cliffs and shale forms slopes. The lowest rock is the Organ Rock Shale, it is Permian in age, about 270 million years old, and was deposited by streams in tidal mud flats. The De Chelly Sandstone is also Permian and was deposited as sand dunes. The Moenkopi formation is Triassic, about 245 million years old, and is interbedded shale and sandstone deposited in a tidal zone. The Shinarump Conglomerate is Triassic and was deposited by rivers.

It is a long drive to northern Arizona, but a great place to visit. Besides the self-drive loop there are a number tours to special parts of the valley not open to the public. Hotel and camping on the rim overlooking the valley are great for sunset and sunrise views.



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.

Chris Whitney-Smith, president of MSA presenting new case and collection to MSA members at the Museum

Parent/Teacher Resource Page

HTTPS://WWW.EARTHSCIWEEK.ORG/NEWSLETTER

EARTH SCIENCE WEEK UPDATE
June 2022

VIEW AGI'S 'FACES OF EARTH' TELEVISION SERIES IN HD

AGI's award-winning "Faces of Earth" series is now available on YouTube in full High Definition, allowing wider use in K-12 classrooms. From the cacophony that originated Earth 4.6 billion years ago to the changes that shape it today, AGI's "Faces of Earth" explores the natural processes of planet Earth — and humans' relation to those processes.

"Building the Planet," episode one in the four-part series, travels back in time and strips away layers of Earth to witness the explosion that formed the planet. Earthquakes rumble, volcanoes explode, and lands transform as viewers explore the science behind plate tectonics in "Shaping the Planet," the second episode. In "Assembling America," the third installment, viewers explore how time and natural forces have shaped the United States.

Finally, in "A Human World," viewers learn how Earth has shaped human evolution and how humans, in turn, are shaping the world — including concepts central to this year's Earth Science Week theme of "Earth Materials in Our Lives." Experience eye-popping imagery, exclusive interviews, and captivating commentary from distinguished geoscientists. See the series online.

NASA LEARNING RESOURCES ARE OUT OF THIS WORLD

Educators and students are invited to explore Earth science through a galaxy of NASA education resources:

- NASA Earth Observatory: How to Interpret a Satellite Image — Satellite images are full of useful and interesting information. These tips come from the NASA Earth Observatory's writers and visualizers, who use them to interpret images daily. They will help you get oriented enough to begin to unlock the rich information in a satellite image.
- NASA Mapping Our World Interactive — The interactive visualization and poster allow you to explore data sets from over a dozen NASA Earth science missions for 25 unique views of our world.
- NASA's EO Kids — Check out this issue, "From School to NASA Earth Scientist." What do you want to be when you grow up? Find out what three NASA scientists wanted to be when they were young and discover what they do now. Then, be a scientist yourself. Learn how to use the Globe Observer app to collect your own scientific observations.
- NASA on National Parks from Space — This collection of stories and images was compiled from NASA's Earth Observatory. The IGES team worked with Earth to Sky (a NASA-National Park Service partnership) and NASA's Landsat mission outreach to create this curated collection and identified strategies and supplemental resources for educators to use the stories with middle and high school students.
- NASA Educator Toolkit: Framing Phenomena-Based Student Investigations — NASA Earth science research, observations, visualization tools, and education resources are available for learners of all ages to connect learning to real world science, across topics - including: Earth systems, climate and weather, global climate change, and natural hazards.


Mineralogical Society of Arizona presents
1st PHOENIX HERITAGE GEM & MINERAL SHOW
Get Ready to Rock Phoenix!
MINERALOGICAL SOCIETY OF ARIZONA
FEATURED VENDORS
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Shannon's Family Minerals
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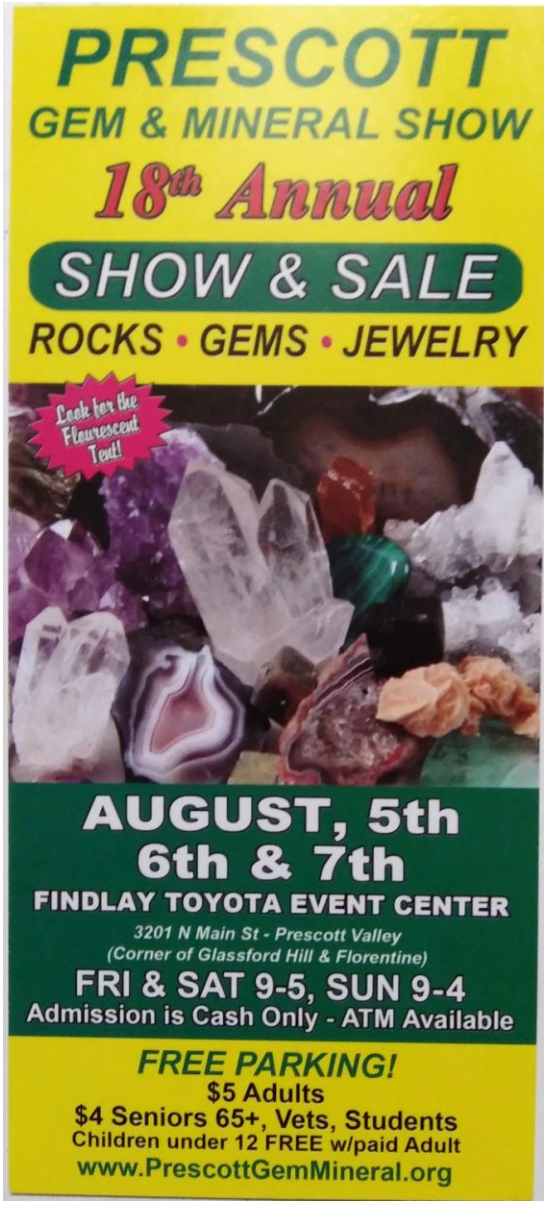
Rocky Houndenstein Mineral Showcase
The Dusty Gem
Red Cloud Mine
Kerry Cooper
IC Minerals
Mexican Minerals
De Natura
Lucky Muckers
Headframe Minerals
Blue Sky Minerals
Pyrites De Navajun
Canyon Colors
Treasures of Darkness
El Cucuy Minerals
Color Gems
Uncover the Earth
Featured Exhibits: Moon, Mars & Meteorites, Red Cloud Wulfenite, Rowley Heartbeat Wulfenite
Saturday Night Program: Speaker, Dinner & Auction for additional fee. Special Hotel Room Rate
FREE EVENT PARKING
Saturday 9 am – 5 pm
Sunday 9 am – 4 pm
JULY 30-31, 2022
RADISSON HOTEL PHOENIX AIRPORT
427 N 44TH ST, PHOENIX, AZ 85008
www.MSAAZ.org
The show is open to the general public. Admission Donation $1.00.
Children 14 years old and younger are free with paying adults.

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: September 6, 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: August 1, 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: September 15, 2022, 7:30 pm
Please go to their website for more information
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: July 12, 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: July 7, 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

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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
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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.

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Visit us at:

www.earthsciencemuseum.org

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

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

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

NOTICE:
ESM's next meeting will be at North Mountain Visitor Center, 12950 N 7th St, Phoenix, on Tuesday, TBA 2022, at 6:30 p.m.

THANK YOU FOR YOUR CONTINUING INTEREST & SUPPORT!!!

Earth Science Museum
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Phoenix, AZ 85017