

The Tektites and Meteorites of

Griffith Observatory

Los Angeles, CA



Aubrey Whymark

20 September 2012





America's First Satellite Explorer

Explorer 1 was the first satellite launched by the United States. It was launched on January 31, 1958, and was the first satellite to orbit Earth. It was launched from the Cape Canaveral Air Force Station in Florida. The satellite was designed to study the Earth's atmosphere and to test the ability of a satellite to communicate with Earth. It was the first satellite to be launched by the United States and the first satellite to be launched by any country.

Everyone Can Participate

California observatories and their amazing discoverers raise visibility for astronomy. Each year, people across the state participate in the program.

Historic sites like Goldilocks Observatory join to observe astronomical events. In 2014, 10,000 people gathered for its watch of Comet NEOWISE on 9/13/2020 and again in 2021.

Advocacy from the Labwork

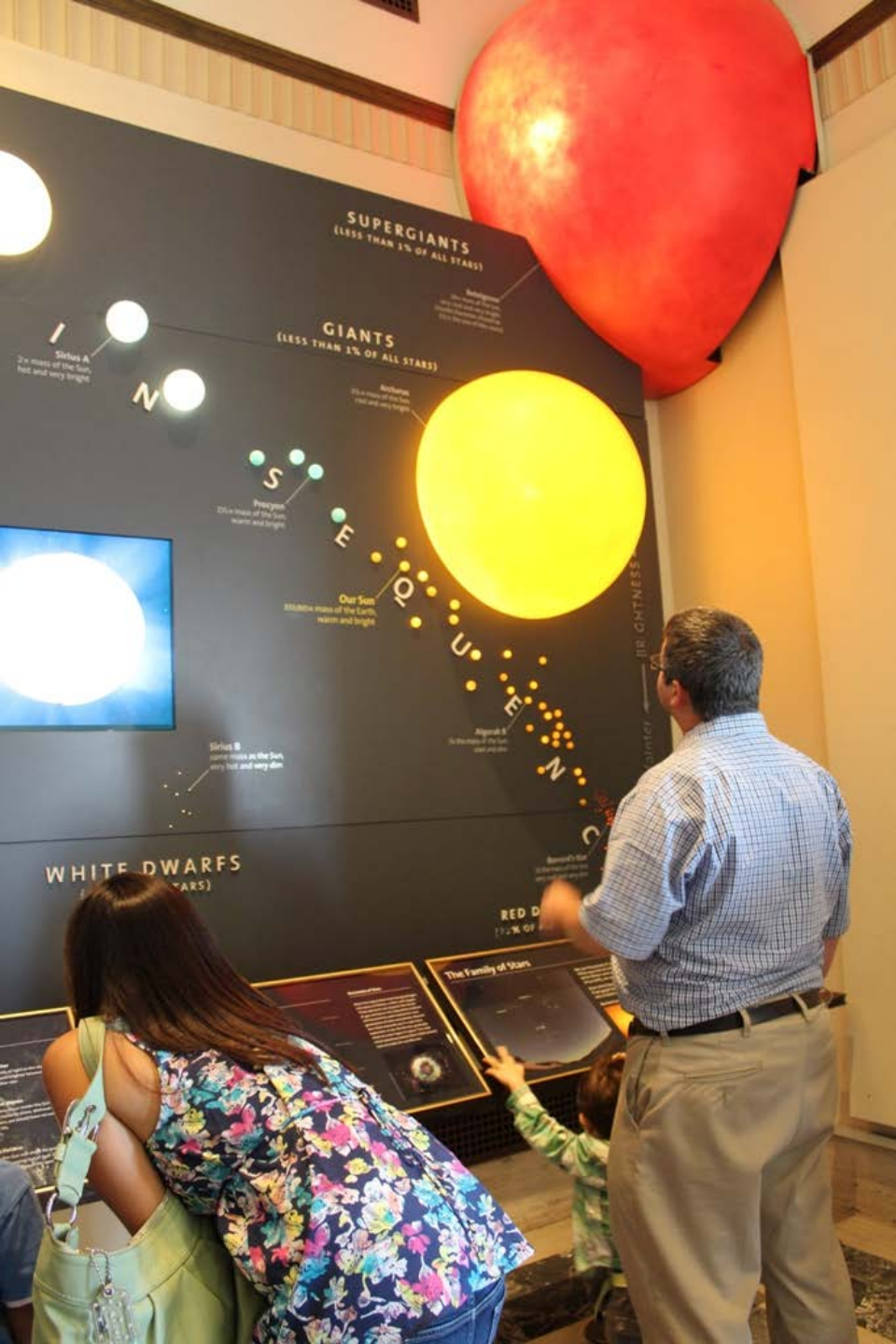
Work the best of the state and national U.S. groups to build the observatory network. The observatory network is the only one in the world. The observatory network is the only one in the world. The observatory network is the only one in the world.



This display was fantastic in explaining seasons. The model moved, which provided a great visual for kids.



Again, the moon moved here which makes it simple for kids to understand.



Stars!



This is the meteorite and impact section. Spent a long time here!

California Meteorites



California Meteorites



How Meteorite Hunters Know Where to Look for Their Quarry



Most meteorite hunters know where to look for their quarry. They know the best places to look for meteorites are in the desert, where the ground is dry and cracked, and the rocks are small and dark. They also know that meteorites are most likely to be found in the mountains, where the rocks are larger and more varied in color.



California has many rich meteorite grounds. The most successful hunters use very thorough search techniques.



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How Meteorite Hunters Know Where to Look for Their Quarry



Although countless meteorites fall to Earth each year, finding them is tricky. They land everywhere, but if they plunge into the ocean or drop into forests and fields, they are probably lost forever. The best meteorite hunting grounds are places where these rocks stand out against the landscape: the deserts of Australia, Africa, and the Middle East; the frozen fields of Antarctica; and the dry lakebeds of California and the American southwest.

Meteorites can be hidden by Antarctic snow for years. Every year, expeditions hunt for them in the ice fields during summer in the southern hemisphere. The meteorites that fall in the world's deserts and on dry lakebeds can lie undisturbed until hunters like Jason Utas (above) find them. Here, he signals his fourth find of the day at a lakebed site in eastern California.



Two meteorite specimens, one dark and one lighter, mounted on pins.

How to Recognize a Meteorite

Most years, average-looking rocks in a desert are the weight of a brick, the size of a baseball, and have a reddish-brown color. They are usually found in the same places as meteorites. If you find a rock that is dark, shiny, and has a reddish-brown color, it is a meteorite.



A lakebed site in eastern California, showing the cracked earth where meteorites are often found.





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Meteorites are not round or smooth like these normal rocks.



How to Recognize a Meteorite

Not every strange-looking rock is a meteorite. The weight of a rock, the minerals it contains, the way its surface looks, and the place where it was discovered all help meteorite hunters determine whether a lucky find came from space.

until hunters li
Here, he signal
lakebed site in

Meteorites are not
round or porous like
these normal rocks.



Stony and iron meteorites
can have melted, glassy surfaces.
Some have pits and markings.



An iron meteorite will attract
a magnet. Some stony meteorites
are also slightly magnetic.





7 COYOTE DRY LAKE
Stony (Chondrite)
Found in California, 2005
Loaned by Peter and Jason Utas



7 COYOTE DRY LAKE

Stony (Chondrite), 51.2 g

Found in California, 1999

Loaned by Robert Verish



7 COYOTE DRY LAKE

Stony (Chondrite), 148 g

Found in California, 1999

Loaned by Robert Verish



7 COYOTE DRY LAKE

Stony (Chondrite), 344 g

Found in California, 1999

Loaned by Robert Verish



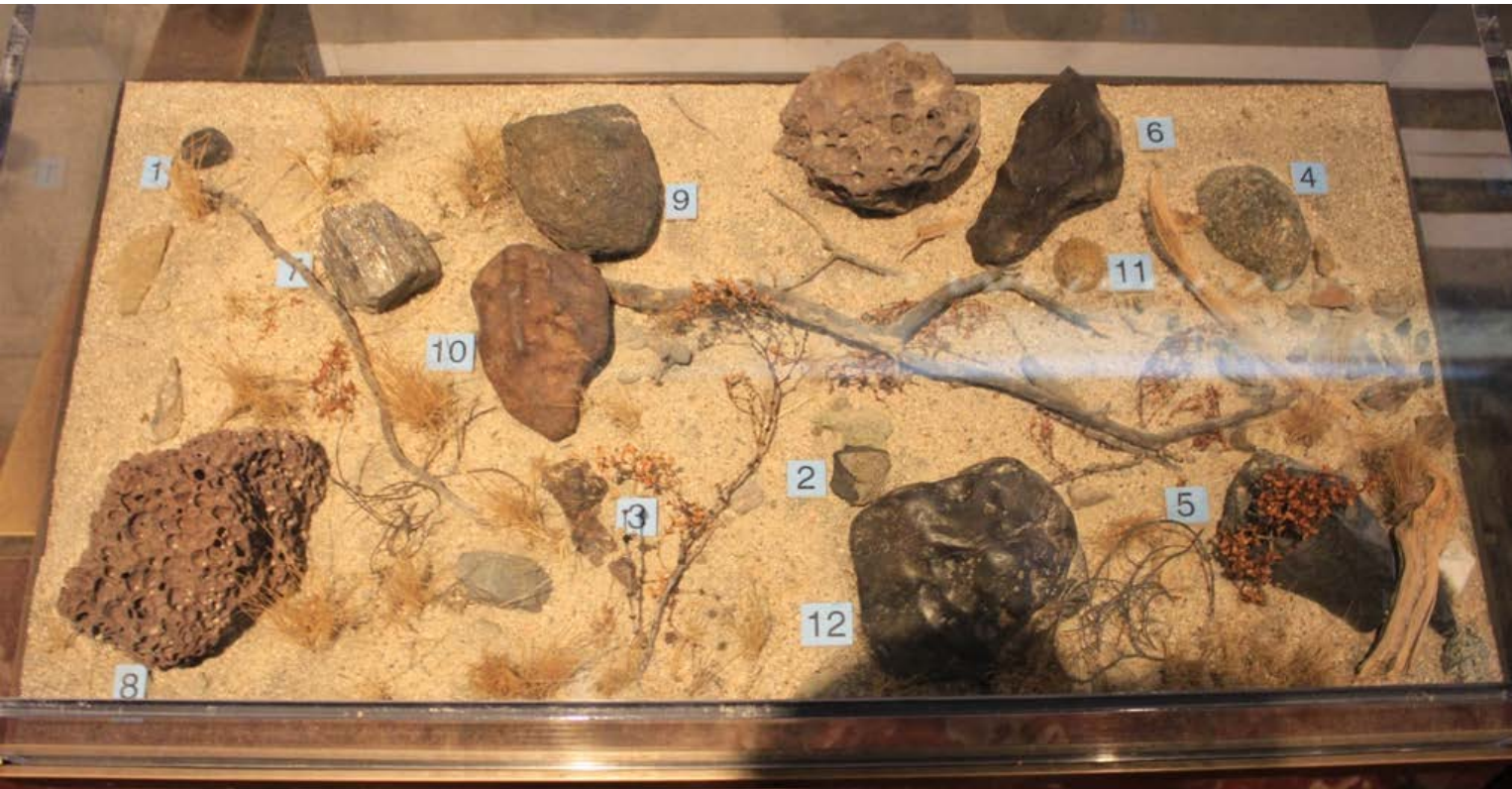
7 COYOTE DRY LAKE

Stony (Chondrite), 162 g

Found in California, 1999

Loaned by Robert Verish

Meteorwrongs



Answers

1. Meteorwrong: Iron oxide (hematite)
2. Meteorite: Stony with fused crust
3. Meteorwrong: Iron slag
4. Meteorwrong: Geode
5. Meteorwrong: Basalt
6. Meteorite: Iron meteorite
7. Meteorwrong: Metallic slag from a furnace
8. Meteorwrong: Volcanic rock
9. Meteorwrong: Iron oxide (hematite)
10. Meteorite: Stony meteorite with weathered crust
11. Meteorwrong: Common rock
12. Meteorwrong: Iron oxide (hematite)

California has many rich meteorite grounds.
The most successful hunters use very thorough
search techniques.

Meteorites have been found all over the Golden State, but many collectors go hunting in California's flat, dry lakebeds. Rocks that land in these desert areas often remain visible and undisturbed indefinitely.

Successful meteorite hunters are methodical in their searches. They lay out grids at each site and then systematically examine every square foot for unusual stones. This is not easy because conditions can be very hot and dry. The hunters photograph meteorites exactly where they find them and record each location with a detailed description. The best teams can find several meteorites a day. The large numbered dots on the map (right) represent the California meteorites in Griffith Observatory's collection. The small dots document other finds in the state.



The Bouseville Meteorite

In 1964, a meteorite was discovered in a desert area near Bouseville, California. It was a large, dark, iron meteorite that was found in a desert area. It was the largest meteorite ever found in California. It was found in a desert area. It was the largest meteorite ever found in California.

Meteorite From Mars
This meteorite is a piece of Mars that was found in California. It is a dark, iron meteorite that was found in a desert area. It was the largest meteorite ever found in California.

Meteorite Finds (1804-2003)





10
RIDGEVILLE
Stone (Chert)
Found in California
1900s

11
Ridgecrest, California
9.7 grams
Found by
Lee E. Humiston

12
LUCER
Stone (Chert)
Found in California
1900s

13
MUROC
Stone (Chert)
Found in California
1900s



BRUCEVILLE
Many Characteristics of S 46
Found in California, 1998
Specimen No. 100-100000



The Bru
in 1998, far
on his prop
struck a hug
visitor from
meteorite fo
knocked off
it wandered
to Earth thou



On his property near Sacramento when he struck a huge rock. It turned out to be a visitor from space. This 283-pound (85 kg) meteorite is the largest known stony meteorite found in California. After it was knocked off the surface of an asteroid, it wandered through space, and then fell to Earth thousands of years ago.



RECEVILLE
 Weight: 275 pounds (125 kg)
 Found in California, 1898
 Photo: © Smithsonian

Meteorite From Mars

When meteorite hunter Robert Welsh discovered two small stones in the Mojave Desert, he knew they were unusual. These rocks were once part of a lava flow on Mars some 180 million years ago. A thin slice shows the structure of the stones.



LOS ANGELES 2
 Weight: 0.0000022 kg
 Found in California
 Photo: © Smithsonian



Polignone, California
 Weight: 1.7 grams
 Found by
 Leon E. Hounshell



ere once part of a lava river on
ome 180 million years ago. A thin
shows the structure of the stone

PARK
San Diego

1 LOS ANGELES 2
Stony (Shergottite), 245 g
Found in California
 loaned by Robert Swick

2 VENTURA
Iron, 4.57 kg
Found in California

3 CHUCKWALLA
Iron, 1.81 kg
Found in California, 1992

4 STEWART VALLEY
Stony (Chondrite), 207 g
Found in California, 1996
 loaned by Robert Swick

5 ROSAMOND DRY LAKE
Stony (Chondrite), 79 g
Found in California, 1988
 loaned by Robert Swick

6 TWENTYNINE PALMS
Stony (Chondrite), 84 g
Found in California
 loaned by Robert Swick

7 FINTE MOUNTAIN
Stony (Chondrite), 88 g
Found in California, 1964
 loaned by Robert Swick

8 LUCERNE VALLEY
Stony (Chondrite), 2 g
Found in California
 gift of Robert Swick

9 LUCERNE VALLEY
Stony (Chondrite), 0.92 g
Found in California
 gift of Robert Swick

10 LUCERNE VALLEY
Stony (Chondrite), 3.30 g
Found in California
 gift of Robert Swick

11 LUCERNE VALLEY
Stony, 1.73 g
Found in California
 gift of David Eason

12 MURC DRY LAKE
Stony (Chondrite), 149 g
Found in California
 gift of Ted & Marianne

13 HARPER DRY LAKE
Stony (Chondrite), 35 g
Found in California, 1999
 loaned by Robert Swick

14 OCOTILLO
Iron, 85 g
Found in California, 1990



3 CHUCKWALLA

Iron, 1.81 kg

Found in California, 1992



8 VENTURA

Iron, 4.57 kg

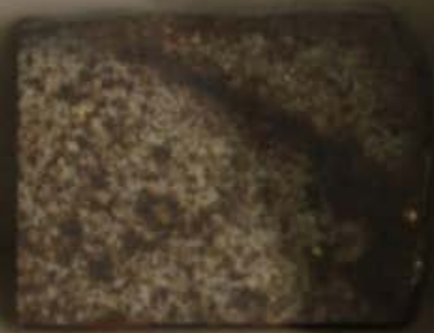
Found in California



3 CHUCKWALLA

Iron, 1.81 kg

Found in California, 1992



10 PINTO MOUNTAINS

Stony (Chondrite), 84.3 g

Found in California, 1954
Loaned by Robert Verish

NE PALMS

14 g



RY LAKE

149 g



6 HARPER DRY LAKE

Stony (Chondrite), 35 g

Found in California, 1999
Loaned by Robert Verish



14 OCOTILLO

Iron, 86 g

Found in California, 1990



9 ROSAMOND DRY LAKE
Stony (Chondrite), 70 g
Found in California, 1999
Loaned by Robert Verish



7 TWENTYNINE PALMS
Stony (Chondrite), 84 g
Found in California
Loaned by Morris Opema



10 PINTO MOUNTAIN
Stony (Chondrite), 84.3 g
Found in California, 1954
Loaned by Robert Verish

11 LUCERNE VALLEY
Stony (Chondrite), 0.91 g
Found in California
Gift of Darwin Ochs



5 MUROC DRY LAKE
Stony (Chondrite), 149 g
Found in California
Gift of Lee E. Humiston



6 HARPER DRY LAKE
Stony (Chondrite)
Found in California
Loaned by Robert Verish

11 LUCERNE VALLEY
Stony, 1.73 g
Found in California
Gift of Darryl Futrell





13 LOS ANGELES 2
Stony (Shergottite), 245 g

Found in California

Loaned by Robert Verish

Meteorite From Mars

When meteorite hunter Robert Verish discovered two small stones in the Mojave Desert, he knew they were unusual. These rocks were once part of a lava river on Mars some 180 million years ago. A thin slice shows the structure of the stones.



LOS ANGELES 001

Stony (Shergottite), 452 g

Found in California

LOS ANGELES 002

Stony (Shergottite), 245 g

Found in California



13 LOS ANGELES 2

Stony (Shergottite), 245 g

Found in California

Loaned by Robert Verish

Meteorite From Mars

When meteorite hunter Robert Verish discovered two small stones in the Mojave Desert, he knew they were unusual. These rocks were once part of a lava river on Mars some 180 million years ago. A thin slice shows the structure of the stones.



LOS ANGELES 001
Stony (Shergottite), 452 g
Found in California



LOS ANGELES 002
Stony (Shergottite), 24 g
Found in California



13 LOS ANGELES
Stony (Shergottite), 24 g

Found in California
Loaned by Robert Verish

Meteorite From Mars

When meteorite hunter Robert Verish discovered two small stones in the Mojave Desert, he knew they were unusual. These rocks were once part of a lava river on Mars some 180 million years ago. A thin slice shows the structure of the stones.



LOS ANGELES 001
Stony (Shergottite), 452 g

LOS ANGELES 002
Stony (Shergottite), 2



13 LOS ANGELES 2
Stony (Shergottite), 245 g

Found in California
Loaned by Robert Verish



2 STEWART VALLEY
Stony (Chondrite), 635 g
Found in California, 2003
Loaned by Robert Verish



2 STEWART VALLEY
Stony (Chondrite), 872 g
Found in California, 2003
Loaned by Robert Verish



3 ROSAMOND DRY LAKE
Stony (Chondrite), 70 g
Found in California, 1999
Loaned by Robert Verish



12 TWENTYNINE PALMS
Stony (Chondrite), 84 g
Found in California
Loaned by Morris Ojeda

11 LUCERNE VALLEY
Stony (Chondrite), 3.04 g
Found in California
Gift of Steve Luberman



11 LUCERNE VALLEY
Stony (Chondrite), 5.94 g
Found in California
Gift of Alan Clapp



11 LUCERNE VALLEY
Stony (Chondrite), 2 g
Found in California
Gift of Robert and Beth Verish



11 LUCERNE VALLEY
Stony (Chondrite), 0.91 g
Found in California
Gift of Darwin Otto



4 MUROC
Stony (Chondrite), 14 g
Found in California
Gift of Lee E. Hamilton



11 LUCERNE VALLEY
Stony (Chondrite), 4 g
Found in California
Gift of Robert and Beth Verish



11 LUCERNE VALLEY
Stony (Chondrite), 3.30 g
Found in California
Gift of Richard Russell



11 LUCERNE VALLEY
Stony, 1.73 g
Found in California
Gift of Garry Fussell



11 LUCERNE VALLEY

Stony (Chondrite), 2 g

Found in California

Gift of Robert and Beth Verish



11 LUCERNE VALLEY

Stony (Chondrite), 0.91 g

Found in California

Gift of Darwin Ochs



11 LUCERNE VALLEY

Stony (Chondrite), 3.30 g

Found in California

Gift of Richard Russell



11 LUCERNE VALLEY

Stony, 1.73 g

Found in California

Gift of Darryl Futrell



11 LUCERNE VALLEY

Stony (Chondrite), 3.04 g

Found in California

Gift of Steve Lieberman



11 LUCERNE VALLEY

Stony (Chondrite), 5.94 g

Found in California

Gift of Alan Crisp



4 MUROC

Stony (Chondrite), 14 g

Found in California

Gift of Lee E. Humiston



11 LUCERNE VALLEY

Stony (Chondrite), 4 g

Found in California

Gift of Robert and Beth Verish





④ STEWART VALLEY
Stony (Chondrite), 875 g
Found in California, 1911
Gift of Richard Brown

⑤ STEWART VALLEY
Stony (Chondrite), 775 g
Found in California, 1911
Gift of Richard Brown

⑥ KEESAUQUALLY GNEISS
Stony (Chondrite), 19 g
Found in California, 1911
Gift of Richard Brown

① LUCERNE VALLEY
Stony (Chondrite), 5.04 g
Found in California
Gift of Steve Cassaman

② LUCERNE VALLEY
Stony (Chondrite), 5.94 g
Found in California
Gift of Alan Cook

③ LUCERNE VALLEY
Stony (Chondrite), 2 g
Found in California
Gift of Robert and Beth Vetch

④ LUCERNE VALLEY
Stony (Chondrite)
Found in California
Gift of Robert and Beth Vetch

17
Ridgecrest, California
Stone 9.7 grams
Found by
Lee E. Humiston

④ MUROC
Stony (Chondrite), 14 g
Found in California
Gift of Lee E. Humiston

⑤ LUCERNE VALLEY
Stony (Chondrite), 4 g
Found in California
Gift of Robert and Beth Vetch

⑤ LUCERNE VALLEY
Stony (Chondrite), 3.30 g
Found in California
Gift of Richard Brown

⑤ LUCERNE VALLEY
Stony (Chondrite)
Found in California
Gift of Richard Brown

Meteorite Impacts

Meteorite Impacts

Comets and asteroid fragments have hit all of the solar system's planets and moons. We find impact craters everywhere.

Impacts shape the surface of worlds. Craters on the Moon tell us about the solar system's history and evolution. The heat of an incoming object affects the size of the "blast" it makes and the amount of material blasted around the site. Craters larger than a few miles are made by very small projectiles that have been in the general area for very long periods.

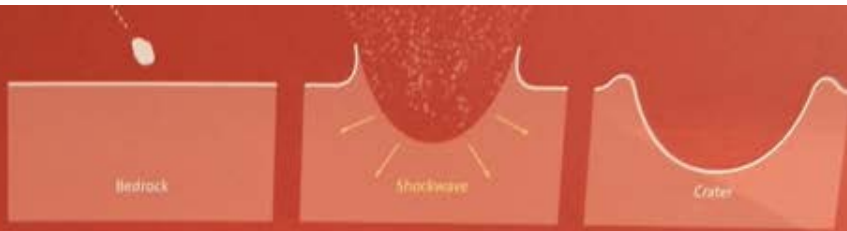
On Earth, the largest objects to survive a trip through our atmosphere that did large impact events. In the history of Earth, most of the impact events that have occurred have been small. Most of the largest impact events have occurred in the last few billion years. The largest impact event on Earth was the impact that created the 10-km-wide crater in the Gulf of Mexico. The impact was caused by a large object that was about 10 km wide and hit the Earth about 65 million years ago. The impact caused the extinction of the dinosaurs and other large animals.



A huge Canadian nickel mine lies at the site of an ancient asteroid impact.

Since 1988, a large nickel mine has been operating at the site of an ancient asteroid impact. The impact was caused by a large object that was about 10 km wide and hit the Earth about 65 million years ago. The impact caused the extinction of the dinosaurs and other large animals.





When the meteorite hits the ground, the energy is so great that it melts the rock around it, creating a crater. The molten rock is scattered in all directions.

Meteorite Impacts Can Create Tektites

An impact digs up surface material and blasts it away. During large collisions, a lot of heat gets generated, which melts rock. Some of this "impact melt" flows away while some is blasted into the air with the rest of the ejected rocks and meteorite fragments.

As the airborne splashes of hot liquid rock fall back to Earth's surface, they cool into interesting shapes. These bits of melted earth are tektites, and each sample contains different materials formed under unique conditions.

Tektites are found in a few scattered locations on Earth. These Bediasites were found in Texas. The Libyan Desert Glass is strewn across the northern African deserts. Moldavites come from the Czech Republic and neighboring countries.

BEDIASITE

Tektite

Found in Texas



SOUTHEAST ASIA

Tektites (aerodynamic, regular and lumpy)

Found in Southeast Asia (all of Southeast Asia)



IMPACTITE

Impact Glass

Found in Australia, Kazakhstan, South Africa, Tanzania, Utah, Russia, Bolivia, and Siberia



MOLDAVITE

Tektite

Found in Czech Republic



LIBYAN DESERT GLASS

Tektite

Found in Libya

Meteorite Impacts Can Create Tektites

An impact digs up surface material and blasts it away. During large collisions a lot of heat gets generated, which melts rock. Some of this "impact melt" flows away, while some is blasted into the air with the rest of the ejected rocks and meteorite fragments. As the airborne splashes of hot liquid rock fall back to Earth's surface, they cool into interesting shapes. These bits of melted earth are tektites, and each sample contains different materials formed under unique conditions.

Tektites are found in a few scattered locations on Earth. These Bediasites were found in Texas. The Libyan Desert Glass is strewn across the northern African deserts. Moldavites come from the Czech Republic and neighboring countries.

BEDIASITE

Tektites

Found in Texas



SOUTHEAST ASIA

Tektites (aerodynamic, regular and layered)

Found in Southeast Asia
Gift of David Talbot



IMPACTITE

Impact Glass

Found in Australia, Kazakhstan,
Saudi Arabia, Tanzania
Gift of Russian Academy of Sciences



MOLDAVITE

Tektites

Found in Czech Republic



LIBYAN DESERT GLASS

Tektites

Found in Libya



Meteorite Impacts Can Create Tektites

An impact digs up surface material and blasts it away. During large collisions, a lot of heat gets generated, which melts rock. Some of this "impact melt" flows away, while some is blasted into the air with the rest of the ejected rocks and meteorite fragments.

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BEDIASITE

Tektites

Found in Texas



SOUTHEAST ASIA

Tektites (aerodynamic, regular and layered)

Found in Southeast Asia
Gift of Darryl Futrell



MOLDAVITE

Tektites

Found in Czech Republic





IMPACTITE
Impact Glass
 Found in Australia, Kazakhstan,
 Saudi Arabia, Tasmania
 *Gift of Russian Academy of Sciences

SOUTHEAST ASIA
*Tektites (aerodynamic, regular
 and layered)*
 Found in Southeast Asia
 Gift of Darryl Futrell



MOLDAVITE
Tektites
 Found in Czech Republic



LIBYAN DESERT GLASS
Tektites
 Found in Libya

Meteorite Impacts Can Create Tektites

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BEDIASITE

Tektites

Found in Texas



SOUTHEAST ASI

Tektites (aerodynamic and layered)

Found in Southeast
Gift of Darryl Futrell



MOLDAVITE

Tektites

Found in Czech Republic



BEDIASITE

Tektites

Found in Texas



SOUTHEAST ASIA

Tektites (aerodynamic, regular and layered)

Found in Southeast Asia

Gift of Darryl Futrell



MOLDAVITE

Tektites

Found in Czech Republic



BEDIASITE

Tektites

Found in Texas





SOUTHEAST ASIA

*Tektites (aerodynamic, regular
and layered)*

Found in Southeast Asia

Gift of Darryl Futrell



IMPACTITE
Impact Glass

Found in Australia, Kazakhstan*,
Saudi Arabia, Tasmania

*Gift of Russian Academy of Sciences



MOLDAVITE

Tektites

Found in Czech Republic

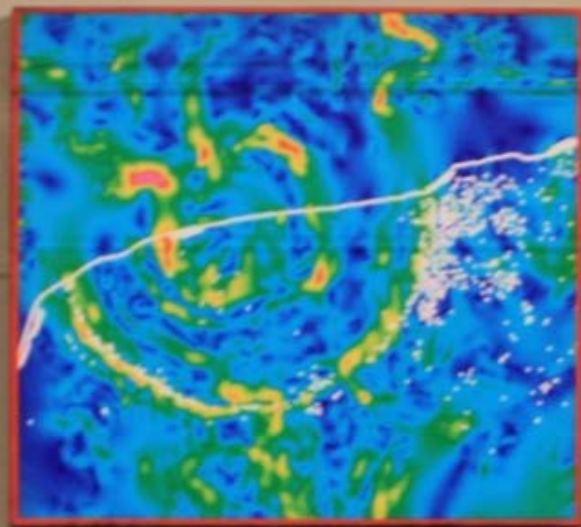


LIBYAN DESERT GLASS

Tektites

Found in Libya

An Impact Killed the Dinosaurs



Horizontal global map of Chaco impact crater. © Alan Hildebrand, Mark Pilkington, and Martin Cottrell



We find evidence for the impact in the K/T Boundary, a layer of clay deposited around the time of the extinction. It is rich with rare elements like iridium that most likely originated in a rock from space.

Sixty-five million years ago, the dinosaurs and other animals died off. This extinction probably happened because a huge asteroid or comet struck the ancient shoreline of the Yucatán Peninsula in Mexico. It hit with the force of a 100-million-megaton bomb and made a crater 60 miles (97 km) across.

The impact raised dust that blocked incoming sunlight. Temperatures fell, and plant photosynthesis was interrupted. The hostile conditions and food shortages helped kill off most of Earth's animals.



Tertiary

Clay Layer

Cretaceous

Gift of Adriana Ocampo to the Planetary Society, A.T. Egerton



A huge Canadian nickel mine lies at the site of an ancient asteroid impact.

Almost 2 billion years ago, an asteroid crashed into central Canada, near the current town of Sudbury, Ontario. It vaporized a chunk of Earth's crust and created a crater 12 miles (19 km) deep. The impact tore away rock layers and exposed Earth's upper mantle. This allowed metal-bearing magma to flow to the surface. Today we find rich deposits of nickel, copper, and platinum on the site. Near the point of impact, rock melted instantly, flowed as liquid, and cooled into black melt glass. The impact also tossed out fragments of bedrock and pieces of the meteorite which fell back to the area surrounding the crater.



Melt glass
Sudbury Crater, Ontario



Meteorite
Sudbury Crater, Ontario



Meteorite
Sudbury Crater, Ontario



Shattercones: Proof of an Ancient Impact

Shattercones are often associated with impact events. They are angular, often conical, rock fragments that are formed by the fragmentation of bedrock during the shockwaves generated by an impact. They are often found in the same pattern as other impact-related features. They are the only rocks that have been found to be associated with impact events.

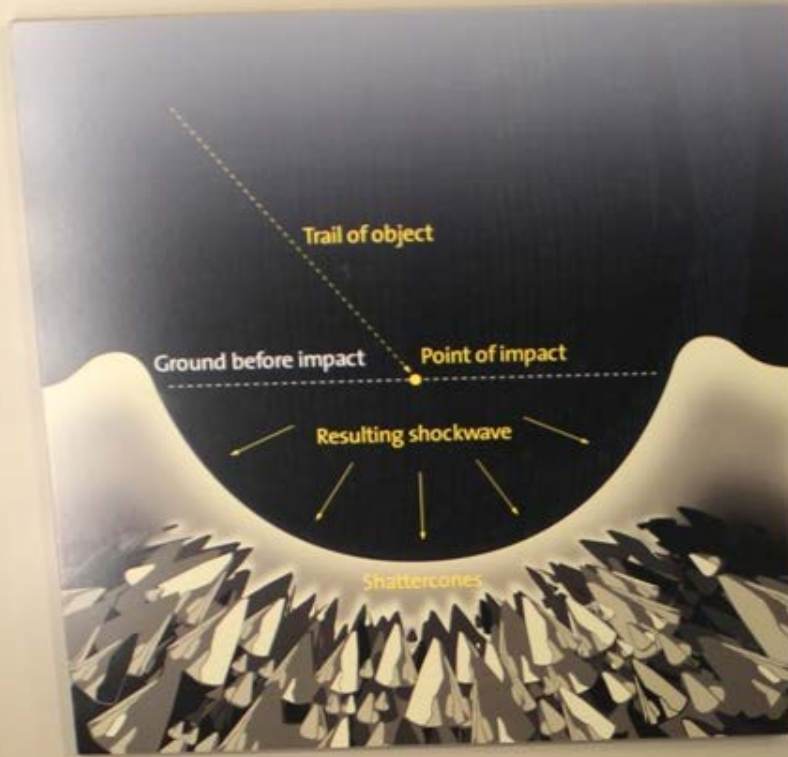


Shattercones
Sudbury Crater, Ontario



Shattercones
Sudbury Crater, Ontario





Shattercones: Proof of an Ancient Impact

Shattercones are shock waves preserved in stone. They occur when an impact blasts into layers of bedrock and puts the rock under tremendous pressure. It shatters, creating three-dimensional cone-shaped patterns. The tips of the cones point back to the impact source.

SUDBURY
Shattercone, 716 g
Found in Canada

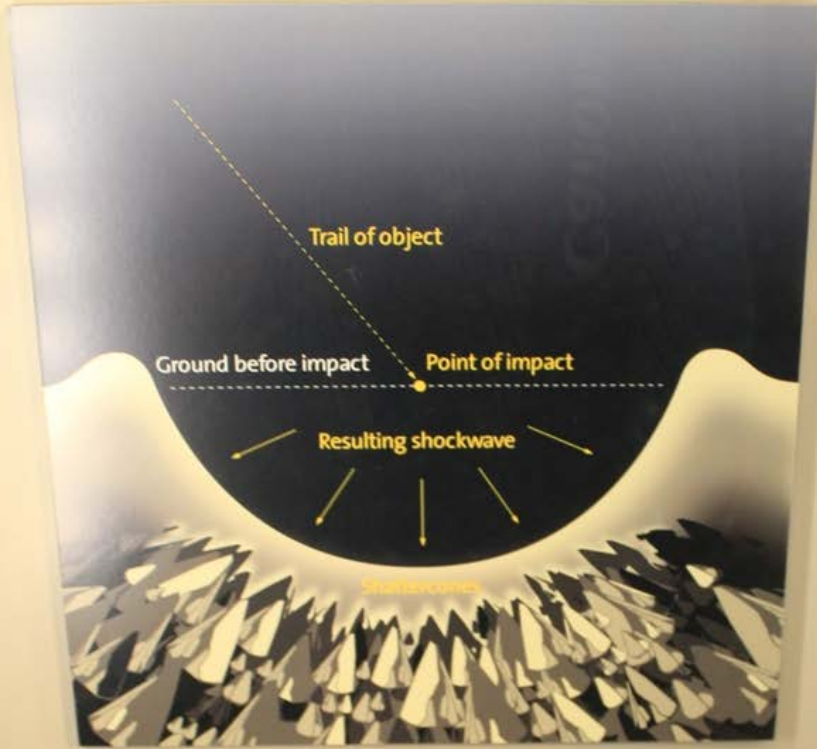


SUDBURY
Shattercone, 292 g
Found in Canada



Top: Earth from Outer Space
Above: Sudbury Crater from NASA's Apollo 16 mission
Canada Centre for Remote Sensing/Canadian Space Agency





Shattercones Ancient Im

Shattercones are
They occur when
bedrock and puts
pressure. It shatte
cone-shaped patte
point back to the i

SUDBURY
Shattercone, 292 g
Found in Canada





Meteorite Histories



Meteorite Histories

Asteroids are made of some of the oldest materials in the solar system.

Asteroids formed more than 4.5 billion years ago out of the same rocky materials as the planets. Some of them have not changed since they were born. Others melted, formed layers, or were broken apart by collisions.



1. Formation
Countless large asteroids were assembled from chunks of material in the early solar system.



2. Layering
When some of the largest asteroids melted, they sank to their centers and formed cores. Lighter rock floated up to create mantles and crust layers.



3. Activity
As a result of their internal melting, gases blew up to the surface from molten areas in the crust. Lava flows have been found on several asteroids.



4. Unaltered Asteroid
An asteroid that has not been broken apart by collisions may have a core, mantle, and crust. On the surface, they do resemble an asteroid.



5. Fragmenting an Asteroid
Collisions break apart large asteroids, scattering fragments through space. The mineral content of each piece tells us where it formed in the original asteroid.

Stony Meteorites
Stony meteorites are the most common type of meteorite. They are made of silicate minerals and are composed of two main types: chondrites and achondrites. Chondrites are primitive meteorites that have not been melted and are composed of small, rounded grains called chondrules. Achondrites are differentiated meteorites that have been melted and are composed of various types of igneous rocks.

Stony-iron Meteorites
Stony-iron meteorites are a rare type of meteorite. They are composed of equal parts of silicate minerals and iron-nickel metal. They are thought to be the remains of the cores of small asteroids that were destroyed by collisions.

Iron Meteorites
Iron meteorites are the second most common type of meteorite. They are composed of iron-nickel metal and are thought to be the remains of the cores of large asteroids that were destroyed by collisions.

Stony Meteorite

Look a Piece of a Primitive World
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Stony Meteorites

More than 85 percent of meteorites that fall to Earth are stony. They originate in asteroids with mantles and crusts, and contain minerals similar to those in Earth rocks. Some meteorites formed when rock inside their parent asteroids melted completely. Others came from partially melted rock, while the rest originated in asteroids that never melted. Many meteorites contain chondrules, spheres of minerals that are among the oldest unchanged materials in the solar system.

FOREST CITY
Stony (Chondritic) 122 g
Morrison, USA



GOLD RAIN
Stony (Chondritic) 220 g
Forest in Ontario
and nearby Quebec



BRUDERHEIM
Stony (Chondritic) 200 g
Lancaster, Ontario
and Cornwall, Canada



BEUDANT
Stony (Chondritic) 100 g
Lancaster, Ontario
and Cornwall, Canada



BRUDERHEIM
Stony (Chondritic) 200 g
Lancaster, Ontario
and Cornwall, Canada



PLANIFER
Stony (Chondritic) 1.87 kg
Pescadore, Canada



LANANOR
Stony (Chondritic)



Stony-iron Meteorites

Many stony-iron meteorites come from the thin zone of melted rock that lies between an asteroid's mantle and core. These meteorites contain droplets of the silicate mineral olivine trapped in the iron. This translucent, olive-green mineral forms in heated rocks and is common on Earth. Meteorites with olivine in them are rare and beautiful.

ESQUEL
Stony-iron (Pallasite), 149 g
Found in Argentina, 1951



BENHAM
Stony-iron (Pallasite), 58 g
Found in Kansas, 1908



BENHAM
Stony-iron (Pallasite), 49 g
Found in Kansas



SPRINGWATER
Stony-iron (Pallasite), 1.7 kg
Found in Canada



ESQUEL

Stony-iron (Pallasite), 149 g

Found in Argentina, 1951



Iron Meteorites

These meteorites come from the heavy iron cores of layered asteroids. They are scattered throughout space when collisions smash their parent bodies into pieces.

In asteroids that melted, iron sank to the cores. Over long periods of time, the cores cooled slowly, allowing iron crystals to grow. These crystals show up as cross-hatched patterns when an iron meteorite is sliced, polished, and etched with acid.



Meteorite Origins



Meteorite Origins

Meteorites have their origins in the larger bodies of the solar system. They come from asteroids and from the surfaces of the Moon and Mars.



Most meteorites are **chondrites**, the commonest type of rock. They are made of small grains of silicate minerals that formed in the protoplanetary disk of gas and dust around the Sun. Chondrites are the most primitive material available on Earth. They have not been melted since they formed, so they contain the original composition of the solar system.



Thousands of pieces of the sky rain down on a small city in Mexico.



These are some of the meteorites that have been found on Earth. They are all made of silicate minerals and are the result of collisions between asteroids and the Earth.



What Do You See?



Touch a Piece of Mars and the Moon





Thousands of pieces of the sky rain down on a small city in Mexico.



On February 8, 1969, a blue-white fireball streaked across the early-morning sky above rural northern Mexico. A tremendous explosion followed, as a piece of space rock weighing several tons broke into bits. As the fragments fell, the commotion woke up the villagers of Pueblo de Allende. Soon people began gathering samples of what came to be known as the Allende meteorites.

The village was not far from Houston, so the meteorites were taken to NASA's Johnson Space Center. The fall occurred just before astronauts brought back the first Moon rocks, and NASA scientists were still testing ways to analyze lunar samples. The Allende samples were a perfect test of their methods, using real space rocks. To everyone's surprise, the meteorites turned out to be the same kind of rock that formed the inner planets and asteroids. This discovery revealed what the material in the early solar system was like.



Small meteorite fragment from the Allende meteorite.



Large meteorite fragment from the Allende meteorite.



Small meteorite fragment from the Allende meteorite.



Allende and the Early Solar System

Allende meteorites are pieces of very ancient solar system rocks. They contain some of the rocks in the solar system that formed before the planets and asteroids formed. The presence of these materials tells scientists that the rocks in the solar system were formed from the disk of the solar system more than 4 billion years ago.



Small meteorite fragment from the Allende meteorite.

The 525 km diameter asteroid Vesta and associated Millbillillie meteorites. The crater at the 'top' of this asteroid is 505 km in diameter.



MILLBILLILLIE
Stony (Achondrite), 307g total
Found in Australia, 1960



Smaller Asteroids

Each of the asteroids modeled here was photographed by passing spacecraft or imaged by radar. The differences between them tell us about their compositions and histories. Most asteroids are fragments of the original mini-planets. Their battered surfaces, strange shapes, and erratic movements are clues to the collisions they have experienced since forming. Mathilde is darker than charcoal and irregularly shaped. Ida is a lumpy, cratered asteroid with its own tiny moon, Dactyl. Oddly shaped Eros was the first asteroid visited by a spacecraft. Asteroid Gaspra was once part of a larger object and is covered with craters. Toutatis has a smooth surface, is as big as a city, and tumbles wildly through space.



MATHILDE



DACTYL AND IDA



EROS



GASPRA



TOUTATIS



DHOFAR 026

Stony (Anorthositic), 2.9 g

Found in Oman, 2002

Lunar Meteorite



ZAGAMI

Stony (Shergottite), 120 g

Found in Nigeria, 1962

Martian Meteorite

Meteors and Comets



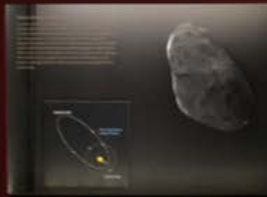
Meteors and Comets

Pieces of comets and asteroids fall from space and cause the flashes of light in the sky that we see as meteors.

The space between the planets is not empty. It is filled with dust and small pieces of rock called meteoroids. As Earth's path takes us through this debris, pieces fall to earth and burn up. The resulting streaks of light are called meteors. The resulting meteorites are the pieces that fall to earth and are collected as meteorites.

Meteoroids are small pieces of rock and metal that have broken off from a comet or asteroid. They are usually smaller than a grain of sand. As they enter the Earth's atmosphere, they burn up and create a streak of light in the sky. The meteorite is the piece that survives and falls to earth.

Meteorites are the pieces that survive and fall to earth. They are usually smaller than a grain of sand. As they enter the Earth's atmosphere, they burn up and create a streak of light in the sky. The meteorite is the piece that survives and falls to earth.



What Happens to a Meteor on Its Way Down to Earth?

As a meteoroid enters the Earth's atmosphere, it is heated and begins to glow. The resulting streak of light is called a meteor. The meteorite is the piece that survives and falls to earth.



What Do You See?





STEWART VALLEY 345
Stony (Chondrite), 375 g
Found in California, 2001
Loaned by Robert Verish



TABORY
Stony (Chondrite), 21 g total
Fell in Russia, 1877



CANYON DIABLO
Iron, 2.5 kg
Found in Arizona
Gift of John Russell

Pieces of the Sky

Pieces of the Sky



Earth is bombarded by a constant rain of debris from space. Most of it is fine dust that drifts down to the surface. Other pieces can be as small as a grain of sand or larger than a house. We see flashes of light when pieces of comets, asteroids, and other planets fall through our atmosphere.

After these bits of the sky land on Earth, they are collected as meteorites. We study space rocks to learn more about the formation of our solar system and the evolution of our planet.



269-pound (122-kg) Iron Meteorite

This fragment came from more than 30 tons (27,000 kg) of meteorites found at the Barringer Meteor Crater in Arizona. It is 92-percent iron and 7-percent nickel.

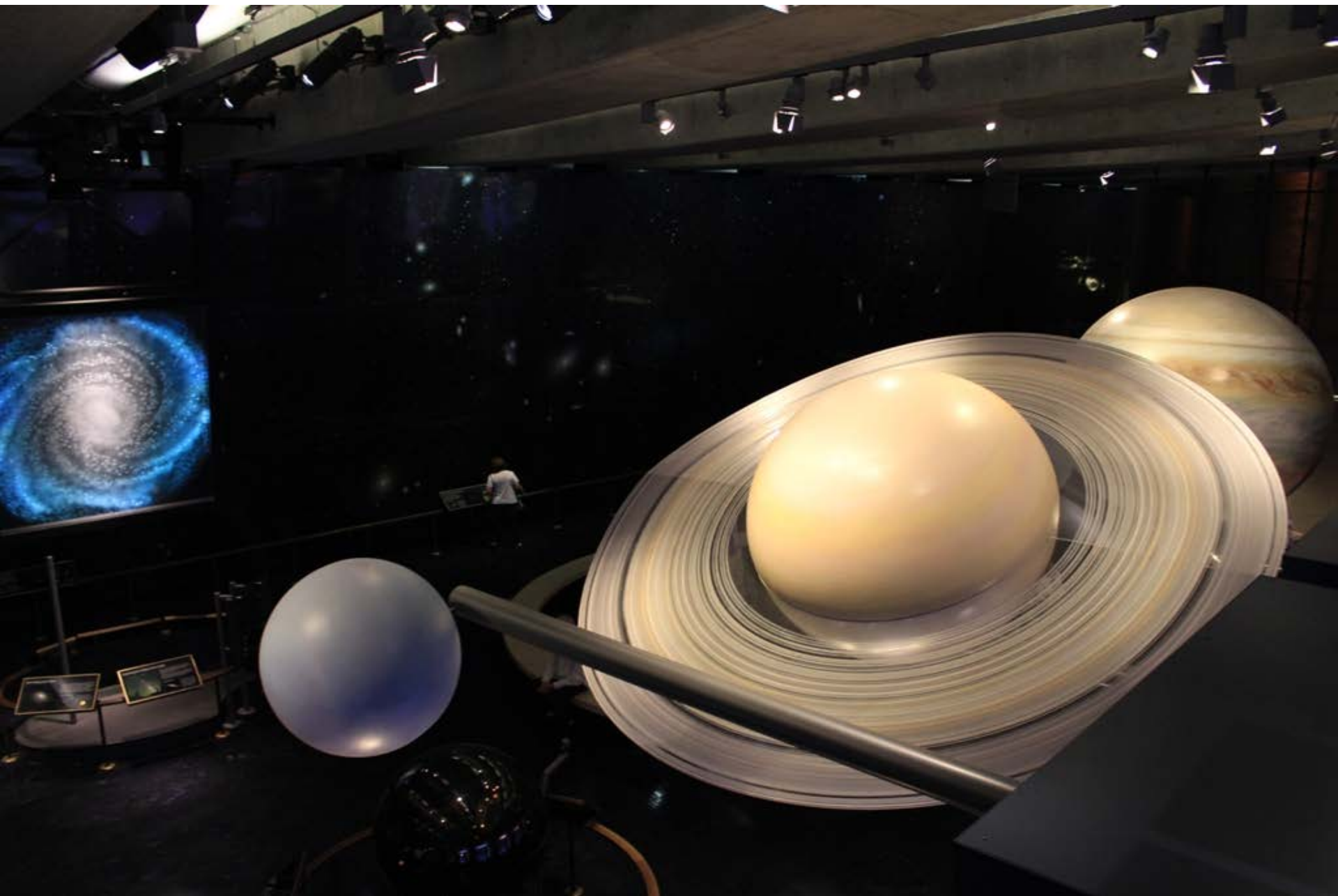
Lent to the Geology Department of Pomona College



395-pound (179-kg) Iron Meteorite

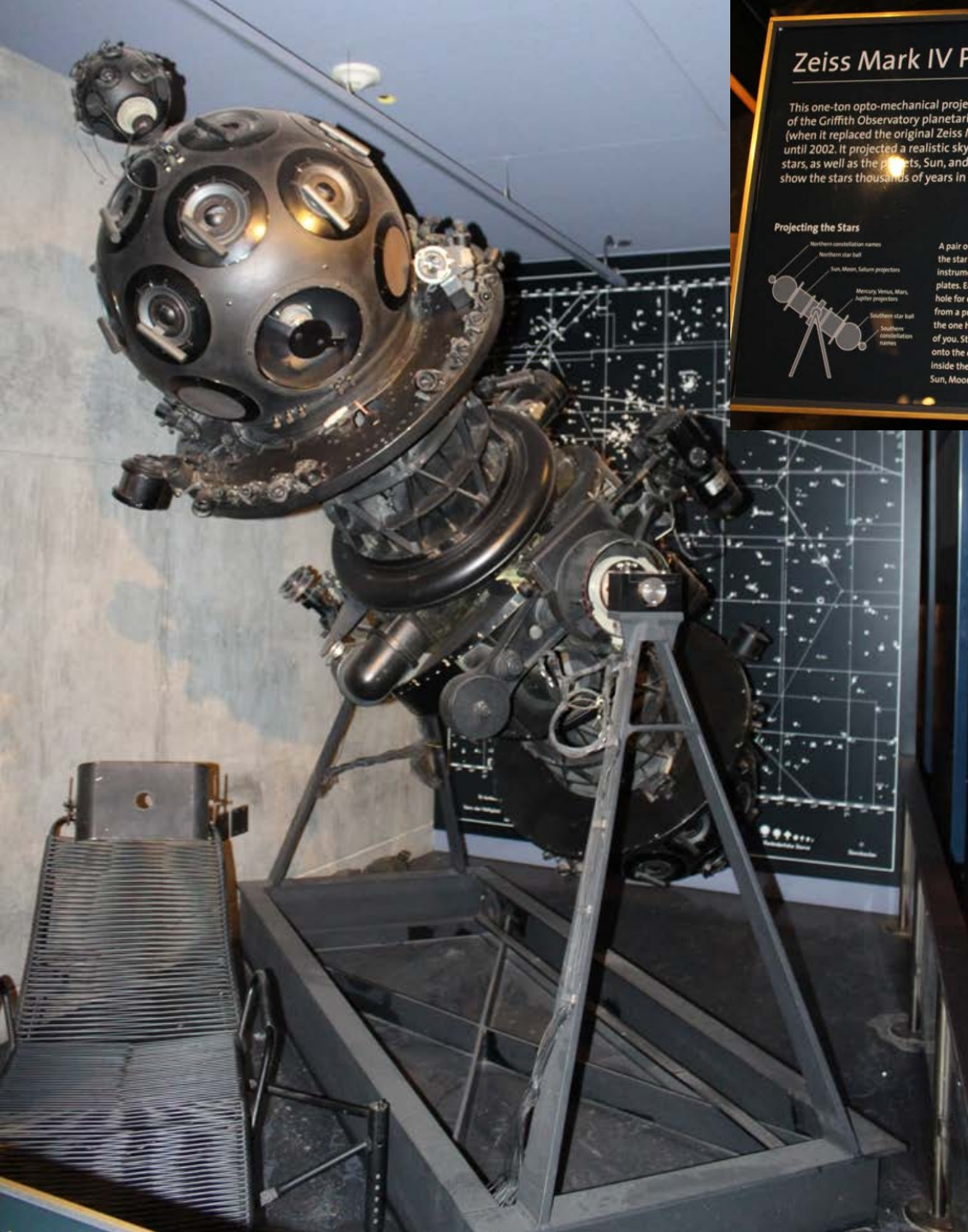
This is a fragment of a huge object that crashed into the Arizona desert and created the Barringer Meteor Crater about 50,000 years ago. The crater is 4,200 feet (1,280 m) in diameter.

Back to other displays!





These planet models are great. Look at how small our rocky planet is (far left)



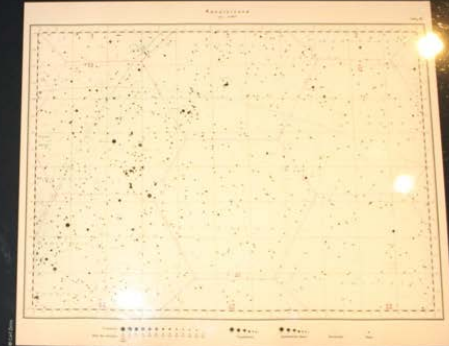
Zeiss Mark IV Planetarium Projector 1964–2002

This one-ton opto-mechanical projector was the heart of the Griffith Observatory planetarium theater from 1964 (when it replaced the original Zeiss Mark II instrument) until 2002. It projected a realistic sky complete with 8,900 stars, as well as the planets, Sun, and Moon. It could also show the stars thousands of years in the past or future.

Projecting the Stars



A pair of thousand-watt lamps in the star balls of this Zeiss planetarium instrument projected light onto 32 plates. Each was perforated with one hole for every star's position, plotted from a precise celestial map like the one here and on the wall in front of you. Stars were then projected onto the dome by lenses. Instruments inside the central cage produced the Sun, Moon, and five of the planets.



Modeling the Sky

Throughout history, people devised machines to explain sky motions. (Below) mimicked the planets' motion as seen from "outside" the solar system.



The planetarium projector put viewers "inside" the sky and shows the system as seen from Earth. Digital systems let viewers explore the system through animations. The San Francisco Planetarium theater has a similar system and a video system to simulate

Zeiss Mark IV Planetarium Projector.

I want one!



Our Closest Neighbor in Space

is 238,855 miles (384,400 km) away and is only
4.5 billion years old.

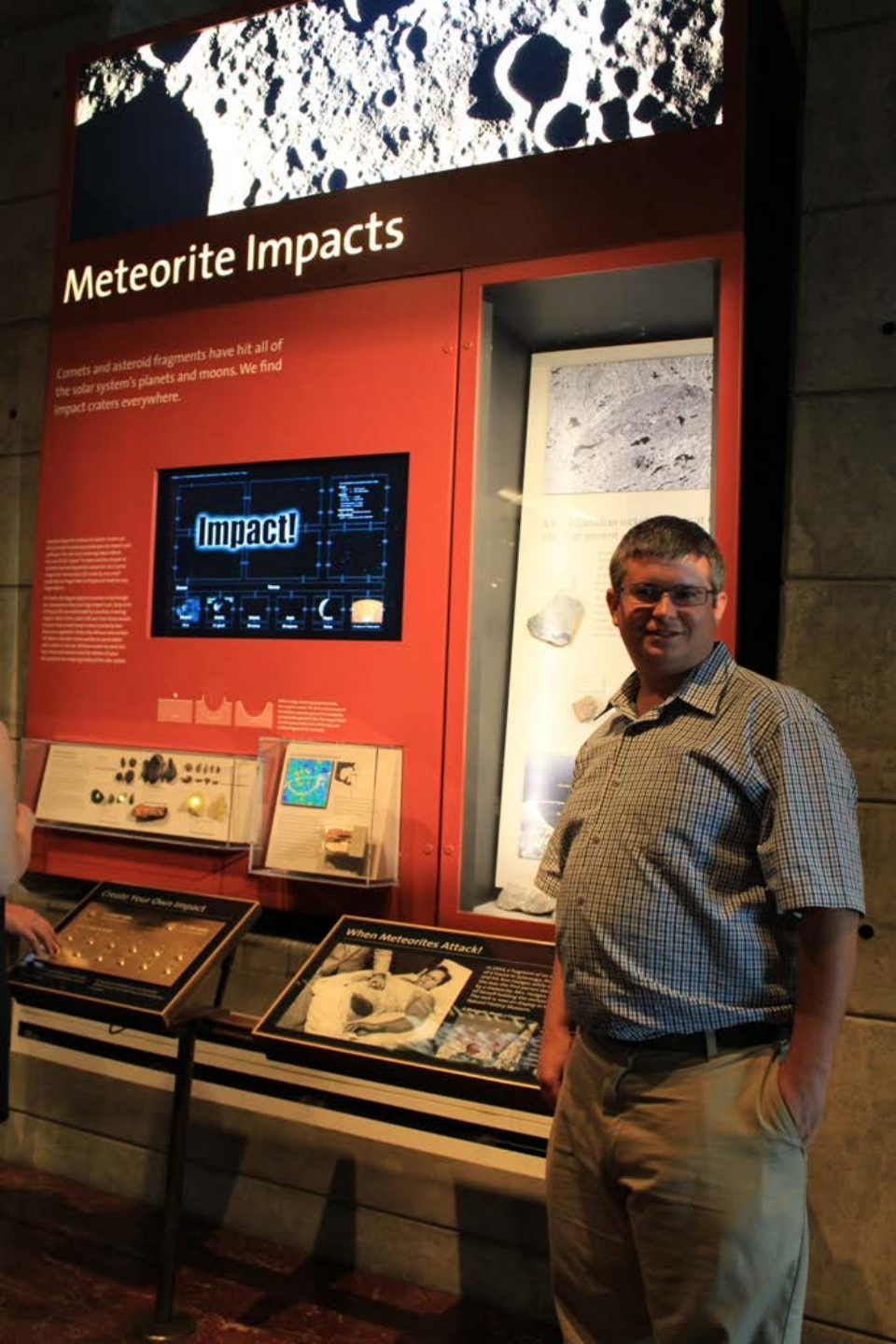


A great view of the Hollywood sign outside the observatory. Unfortunately we were one day too early to see the Endeavour Space Shuttle flyover. The shuttle will be displayed in the California Science Center, Los Angeles.



Also a good view of downtown Los Angeles from the Griffith Observatory.





Thank You!

I hope you enjoyed this presentation

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