Meteor Crater®

BRIEF HISTORY

You are at one of the most extraordinary places on earth!

Welcome to Meteor Crater

50,000 years ago, an unbroken plain stretched in front of where you now stand. Suddenly, out of the northeastern sky, a pinpoint of light grew rapidly into a brilliant meteor. This body was probably broken from the core of an asteroid during an ancient collision in the main asteroid belt some half-billion years ago. Hurtling at about 26,000 miles per hour, it was on an intercept course with Earth. In seconds, it passed through our atmosphere with almost no loss of velocity or mass.

In a blinding flash...

A huge iron-nickel meteorite or dense cluster of meteorites, estimated to have been about 150 feet across and weighing several hundred thousand tons, struck the rocky plain with an explosive force greater than 20 million tons of TNT.

Moving at hyper-velocity speed, this impact generated immensely powerful shock waves in the meteorite, the rock and the surrounding atmosphere. In the air, shock waves swept across the level plain devastating all in their path for a radius of several miles. In the ground, as the meteorite penetrated the rocky plain, pressures rose to over 20 million pounds per square inch, and both iron and rock experienced limited vaporization and extensive melting. Beyond the melted region, an enormous volume of rock underwent complete fragmentation and ejection.

The result of these violent conditions was the excavation of a giant bowl-shaped cavity. In less than a few seconds, a crater 700 feet deep and over 4000 feet across was carved into this once-flat rocky plain. During its formation, over 175 million tons of limestone and sandstone were abruptly thrown out to form a continuous blanket of debris surrounding the crater for a distance of over a mile. Large blocks of limestone, the size of small houses were heaved onto the rim. Flat-lying beds of rock in the crater walls were overturned in fractions of a second and uplifted permanently as much as 150 feet. Fragments of rock and iron-nickel, some as large as a few feet across, were thrown as far as several miles away. In some of the shocked meteorites, the intense pressures transformed small concentrations of graphite into microscopic-sized diamonds.

A dense hot cloud quickly rose high above the crater carrying with it droplets of molten iron-nickel, pieces of molten rock, and abundant shocked rock debris. This material rained down as fallout until the cloud drifted away and dissipated.

Meteorite fragments that separated early from the main mass during its passage through the atmosphere continued to fall at lower velocities on the crater and surrounding area during and immediately after the impact. Some of these fragments are on display in our museum.

Prior to impact, less than a percent or so of the meteorite was lost due to atmospheric heating and ablation as it plummeted to Earth. During impact, however, it is believed that a small percentage was vaporized, whereas the majority was melted. Any meteorite material that did not vaporize or melt was intensely fragmented and either thrown out during excavation or mixed with the fragmented rock that remained in the crater. About half is thought to have been ejected out of the crater, and about half is thought to be present in very small to microscopic iron-nickel spherules and fragments scattered throughout the Breccia lens beneath the crater floor.

From where you now stand, the floor of the crater is 550 feet deep, equivalent to a 60 story building. If the Washington Monument were placed on the floor of the crater, its top would be at eye level. The crater is over 4,000 feet across and and 2.4 miles in circumference. For a meteorite only 150 feet across to blast a hole three quarters of a mile wide and sixty stories deep, its high velocity is clearly one of the major factors required to create a crater this large.

To give you a better idea as to the crater's size, imagine twenty football games being played simultaneously on its floor, while more than two million spectators observe from its sloping sides.

There is evidence of the crater being referenced by Native Americans in the area, however the first written report was not made until 1871 by a man named Franklin who served as a scout with General Custer. For years the crater was referred to as Franklin's Hole.

Later, local settlers named it Coon Butte and it was thought to be just another extinct volcano, possibly part of the Hopi Buttes volcanic field located northeast of here.

In 1886, iron-nickel meteorites were found by a sheepherder, but believing them to be silver, he did not report his findings until 1891. Eventually, such discoveries led to the suggestion, by some, that the crater had been formed by a giant meteorite.

During that year, the chief geologist of the United States Geological Survey, G.K. Gilbert, briefly visited the crater. He had earlier correctly concluded that the bulk of the craters on the moon were formed by impacts. However, he interpreted the field evidence at Meteor Crater incorrectly and concluded it had a volcanic origin. Although this idea held fast for the next two decades, a major change in scientific thinking was about to occur.

In 1902, Daniel Moreau Barringer, a Philadelphia mining engineer, had become interested in the site as a potential source for mining iron. He later visited the crater and was convinced that it had been formed by the impact of a large iron meteorite. He further assumed that this body was buried beneath the crater floor.

Barringer formed the Standard Iron Company and had four placer mining claims filed with the Federal Government, thus obtaining the patents and ownership of the two square miles containing the crater. This was ten years before Arizona became the 48th state.

Barringer was correct. The crater was formed by a meteorite impact. What he did not know was that the meteorite underwent total disintegration during the impact through vaporization, melting and fragmentation. There was never a single large mass buried beneath the crater.

In 1903, Barringer came to Meteor Crater and spent the next 26 years attempting to find what he believed would be the giant iron meteorite. For the next two and one-half decades, his work and scientific research were carried on with great perseverance and bitter disappointment.

Since the crater is roughly circular, it was natural at that time to assume that the body that formed it lay beneath its center. Consequently, the first shaft was started where the low, white mounds of pulverized Coconino sandstone can still be seen on the crater floor. A few small meteoritic fragments were reported in the shaft, but unfortunately, the pulverized rock beneath the water table turned to quicksand and prevented mining to a depth where the main body was suspected to lie.

After the initial exploration, Barringer conducted some simple experiments and discovered that a rifle bullet fired into thick mud, even at a low angle, generally produces a round hole. This was an important clue...could the meteorite have penetrated at an angle and buried off center?

Looking at the south crater wall you will see, as did Barringer, that the rock is noticeably uplifted. Sandstone and limestone beds, which were once deeply buried are now more that 250 feet above their pre-impact levels. In fact, they are higher than anywhere else in the crater.

This observation, coupled with the fact that many meteorite fragments had been found on the northeast side of the crater, led Barringer to conclude that the mass had come in at an angle from that direction and buried itself beneath the south rim of the crater.

Looking again at the south crater wall, you will see a notch with a streak of red debris running down the slope. Drilling was started at that notch and at a depth of 1,250 feet Barringer reported increasing numbers of oxidized meteorite fragments. At times, hours passed with no progress in deepening the hole and the drill bit would gouge into something at least as hard as the drill bit itself. Then at 1,376 feet, the rotary drill bit jammed completely. Barringer interpreted this to be caused by meteorite debris. The bit was permanently stuck, the drill cable broke, funds were exhausted, and the exploration was abandoned in 1929.

Although Barringer died later that year, he lived to see his theory of the impact origin of the crater begin to be increasingly accepted by the scientific community.

In 1941, the Barringer family entered into a lease with Bar T Bar Ranch Company, a cattle operation which started in the 1880's and owns or leases the surrounding lands. In 1955, Bar T Bar Ranch Company formed a separate corporation, Meteor Crater Enterprises, Inc., and entered into a long term lease with the Barringers.

All the facilities at Meteor Crater were built, maintained, and are staffed by the Enterprises. Today the Barringers still own the land and both the Barringer family and the owners of the Enterprises regard the property as a public trust. Each year both make substantial contributions to science and education through grants, scholarships, and special awards.

Today, modern geological and geophysical exploration techniques have largely replaced the earlier method of just digging shafts and simple rotary drilling. New approaches include the use of seismic, gravity, magnetic, and electrical field techniques. Recently, cosmic ray spallation procedures were used to arrive at a more accurate age of Meteor Crater and C14 dating techniques have been used to address erosion and climactic issues. Advanced microscope, x-ray, and other laboratory procedures are in use to study the shocked rocks, meteoritic material, and their histories.

Dr. Eugene Shoemaker, former Chief of the Branch of Astrogeology of the U.S. Geological Survey in Flagstaff, proved in 1960, beyond any doubt that Meteor Crater was indeed the product of a giant impact event. Shoemaker and his wife Carolyn have recently completed a number of studies that provide estimates of the rates and energies associated with comets and asteroids that might impact Earth. For example, a Meteor Crater size event should occur about once every 50,000 years...

Dr. Shoemaker, Ed Chow, and Don Milton, all of the U.S. Geological Survey, discovered two important new minerals at Meteor Crater: coesite and stishovite. Both are high-pressure polymorphous forms of silica, or silicon dioxide (SiO_2), altered to very dense crystalline states by extremely high pressures equivalent to more than 20,000 times atmospheric pressure, or 300,000 pounds per square inch. Although coesite and stishovite can be produced in the laboratory, they had not before been identified in nature. Since the Meteor Crater research, both minerals have been identified at a number of other geological features called astroblems. These two high pressure minerals are now diagnostic criteria proving these sites are the scars of ancient impact craters.

In recent years, work has been completed at Meteor Crater in the fields of terrestrial impact craters, cratering mechanics, planetary studies, and astronaut training. From 1964 through 1972, the U.S. Geological Survey and NASA provided extensive science training at Meteor Crater for the Apollo astronauts, under the guidance of Dr's Eugene Shoemaker and David Roddy, both with the Branch of Astrogeology of the U.S. Geological Survey. This training was particularly significant because scientists were extremely interested in what materials lay on the lunar surface as well as what was beneath the surface.

At an impact site, the cratering process ejects material that actually originates below the surface of the crater, therefore, when our astronauts went to the moon, they knew they should be able to collect material on ejecta blankets that originated beneath the cratered region--a valuable sampling technique learned at Meteor Crater.

Photographs of our moon, the other planets and their satellites clearly show that the millions of craters on their surfaces were caused by meteorite, asteroid and comet impacts. Three decades of research on the earth's surface now show that it too has been the target of numerous collisions, both large and small.

Today, Mother Nature continues her process of slow but inevitable erosion by wind, water and heat. Fortunately for science and all of us, Meteor Crater has sustained relatively little removal of material since it's formation 50,000 years ago. The crater walls have only been slightly modified by erosion and, in places, still exhibit some of the original fallout from the debris cloud. The rim crest is estimated to have been lowered by erosion less than a few tens of feet and still stands some 150 feet above the surrounding plain. The majority of the ejecta blanket is still present.

Most of the craters on Earth have been leveled by erosion. Although there are many larger terrestrial impact sites, Meteor Crater is the first proven and best preserved impact site on Earth.

This feature, named Meteor Crater or Barringer Meteorite Crater, represents the most basic type of impact crater in the solar system. In 1968, Meteor Crater was designated a Natural Landmark by the Department of the Interior.

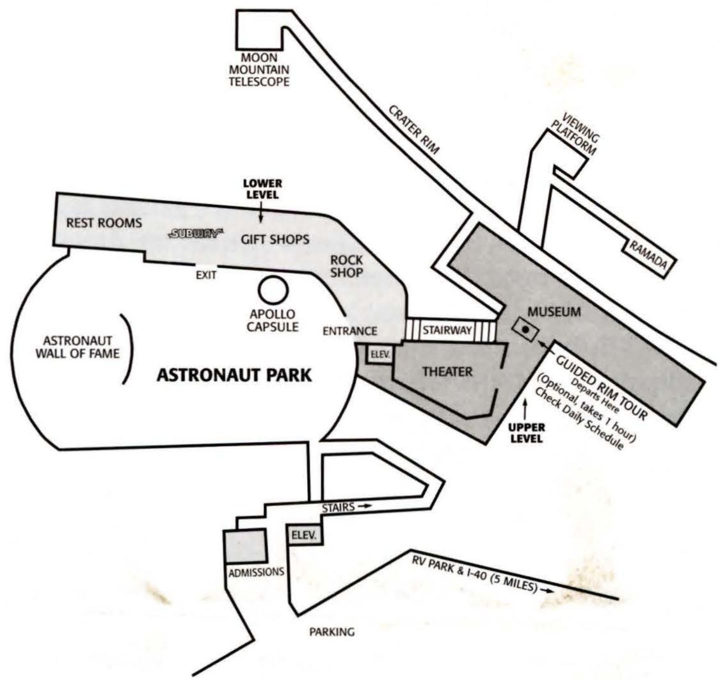
Here at Meteor Crater, we are attempting to illustrate collision and impact processes which played a dominant role in the development of our planets, satellites, asteroids and comets. The geologic and planetary records are clear: collisions, ranging in size from microscopic to gigantic events, have occurred since the beginning of the solar system, and will continue to occur.

Indeed, the very course of life on Earth has been affected by this endless bombardment.

No less can be expected in the future!!!

MOVIE SCHEDULE

On the hour and half hour
"Collisions and Impacts" (length 10 min.)



METEOR CRATER • MUSEUM • GIFT SHOP

Located 35 miles east of Flagstaff off I-40
(928) 289-2362

RV PARK • COUNTRY STORE • MOBIL GAS • SUBWAY

At the intersection of I-40 and Meteor Crater Road
(928) 289-4002

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