Sunset Crater

National Monument
National Park Service
U.S. Department of the Interior

Geology of Sunset Crater National Monument

Sunset Crater is the youngest dated volcano in Arizona. The volcano is about 1,000 feet (305 m) high and over a mile (1.6 km) wide at the base. The crater at the top of the volcano is about 400 feet (120 m) deep and 2,250 feet (868 m) from rim to rim.

Sunset Crater began erupting in A.D. 1064 or 1065 through a fault line or fissure in the earth's crust. Volcanic rocks called pyroclastics were ejected into the air and formed cinders, which fell to the ground around the vent to build a cone-shaped cinder cone volcano.

At about this time, the Kana-a lava flow extruded from a fissure near the eastern base of Sunset Crater. In A.D. 1180, the Bonito lava flow, a composite pahoehoe (pa-hoy-hoy) and aa (ah-ah) lava flow, extruded from the western base of Sunset Crater. In all, the eruption extruded a billion tons of material.

Dating the Eruptions of Sunset Crater

Dendrochronology

Three dating methods were used to date Sunset Crater's eruption. Dendrochronology, the study of tree ring growth, established that the eruption began in A.D. 1064 or 1065. Paleomagnetic studies and field observations provided more information on the sequence of events and duration of volcanic activity.

Dr. Harold Colton, founder of the Museum of Northern Arizona, became interested in dating Sunset Crater when a museum staff member found prehistoric pottery shards in Bonito Park, west of Sunset Crater. The shards indicated an archeological site may have been buried by the eruption of Sunset Crater. John McGregor, the museum's curator of archeology, excavated the site. In 1945, Dr. Colton determined that the eruption occurred between A.D. 1046 and 1071.

In 1958 Terah Smiley, a researcher at the Geochronology Laboratories of the University of Arizona, decided to refine Dr. Colton's dates even further. "The hypothesis was devised that, if the eruption took place in that short of time (A.D. 1046–1071), an examination of tree ring specimens which were growing near the crater and which continued to live through the activities should show differences in growth (non-climatic) when compared to the 'normal' pattern (climatic) for that particular time."

A climatic pattern of tree rings was established for the past 2,000 years by the study of specimens taken from various locations in this area. The specimens used to date Sunset Crater were ponderosa pine timbers taken from Wupatki pueblo, twelve miles northeast of Sunset Crater.

The Wupatki timbers matched the climatic pattern of tree rings through the year 1065. The climatic pattern should have continued for the life of the trees, but the interruption by the non-climatic pattern suggests that the trees grew abnormally due to severe local conditions, probably created by the development of the Sunset Crater cinder cone. The cone ejected volcanic cinder and ash into the sky which fell on nearby trees and stripped them of branches and foliage. Trees that survived the eruption displayed an abnormal tree ring growth patter, marking the beginning of Sunset Crater's eruptive activity. Smiley concluded that the eruption started sometime between the fall of 1064 and the spring of 1065.

Paleomagnetism

In 1985 Eugene Shoemaker, a geologist with the U.S. Geological Survey, used paleomagnetic studies to determine that Sunset Crater's eruption may have continued intermittently for about 150 years.

Microscopic iron particles in lava have a weak but measurable magnetic field. When lava is still very hot, the earth's magnetic field causes the lava's magnetism to point to the magnetic north pole. When lava has completely cooled, this magnetism is permanently "frozen." The position of the magnetic north pole recorded in the lava can be measured by geologists hundreds or even millions of years later.

Paleomagnetic studies have determined that the magnetic north pole has moved throughout time. A lava flow is dated by comparing its magnetism to that of other rocks and magnetic directions of known ages. The Bonito lava flow's magnetism points to a magnetic north pole that existed about A.D. 1180.

Field Observations

Dr. Richard Holm, associate professor of geology at Northern Arizona University, has studied Sunset Crater and, on the basis of field relationships and volcanological interpretations, has identified six eruptive episodes:

1. A.D. 1064–1065: Cinder and ash eruption began building Sunset Crater.
2. A.D. 1064: Extrusion of the Kana-a lava flow from a fissure near the eastern base of Sunset Crater.
3. Continued cinder and ash eruption building Sunset Crater and covering much of the Kana-a lava flow.
4. A.D. 1180: Extrusion of the Bonito lava flow from the western base of Sunset Crater. As the lava extruded it disrupted the west flank of the cinder cone, and sections of the rim were rafted away on top of the lava flow.
5. Continued cinder and ash eruption, covering the Kana-a and Bonito lava flows, and formation of Sunset Crater as you see it today.

Fumarolic vapors oxidized the black cinders on the rim to a rusty red color. John Wesley Powell noted, "The contrast in the colors is so great that on viewing the mountain from a distance the red cinders seem to be on fire. From this circumstance, the cone has been named Sunset Peak." The name was later changed by Harold Colton to Sunset Crater.

6. Extrusion of the late Bonito flow around the edges of the earlier flow, and the formation of a small crater on the east side of the summit.

Sunset Crater has been closed to hiking and climbing since 1973 to preserve the fragile cinder cone. You are welcome to hike nearby Lenox Crater and the self-guiding Lava Flow Trail at the base of Sunset Crater.

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