Volcanic Hazards

The San Francisco Volcanic Field consists of a large volcano (background) surrounded by numerous smaller cinder cones and lava flows. One of these cinder cones, known as S P Crater, (center), produced a large lava flow. This view is from the northeast looking southwest. (Photo © Peter L. Kresan)

Volcanic Activity In Arizona

Volcanic activity has occurred repeatedly in Arizona. Most of Arizona's copper deposits formed during intense volcanism 70 to 55 million years ago. Another episode of widespread volcanic activity occurred from about 30 to15 million years ago. Although widespread volcanism decreased markedly about 15 million years ago, some volcanic activity has continued to the present. The San Francisco Volcanic Field (SFVF), in the Flagstaff-Grand Canyon region of northern Arizona, represents some of this 'leftover' volcanism. Lava flows and cinder cones erupted as recently as 800 years ago.

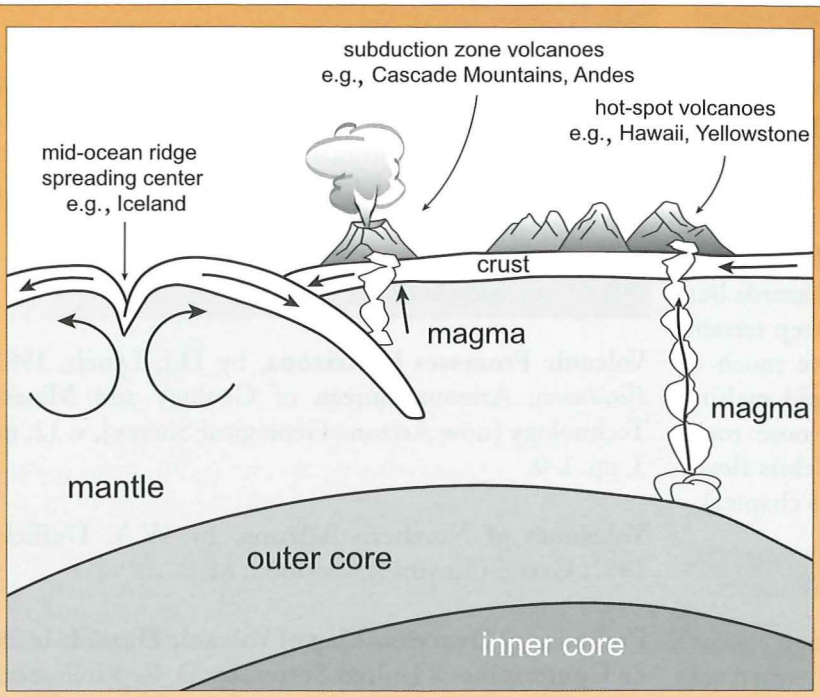
Active Volcanism In Arizona

Although volcanoes have erupted in Arizona numerous times in the geologic past, they pose little risk today. Volcanic eruptions are preceded by swarms of small earthquakes and occasionally by venting of volcanic gases. An eruption without warning is unlikely.

The most active volcanic region in Arizona is the southwestern Colorado Plateau. A zone of volcanic activity migrated slowly northeastward during the past 15 million years from south of the Mogollon Rim in central Arizona to its present position immediately northeast of Flagstaff. Although eruptions in the Grand Canyon-Flagstaff region have occurred as recently as about 800 years ago, there has been no sign of recent magma movement beneath the SFVF that would signal the beginning of a new phase of activity.

Hazards associated with volcanic activity include ash and cinders that can overload the weight-bearing capacity of some roofs. Houses built in the Flagstaff area, where snow is routine, are already designed with loading in mind. Volcanic gases include carbon dioxide and sulfur gases that are sometimes at concentrations that may be harmful to breath. The kind of volcanic eruptions characteristic of the SFVF, however, tend to produce only small quantities of ash and gas.

As with earthquakes, Arizona could be affected by volcanic eruptions in nearby states. Ash clouds from violent volcanic eruptions can travel across the continent, dropping several inches of ash hundreds to thousands of miles away. The closest known active volcanic area that could impact Arizona is the Long Valley caldera region along the east side of the Sierra Nevada in east-central California. The Mammoth Lakes area, part of this volcanic center, has experienced signs of activity recently, including earthquake swarms and venting of gases. Although the likelihood of a volcanic eruption in anoth-



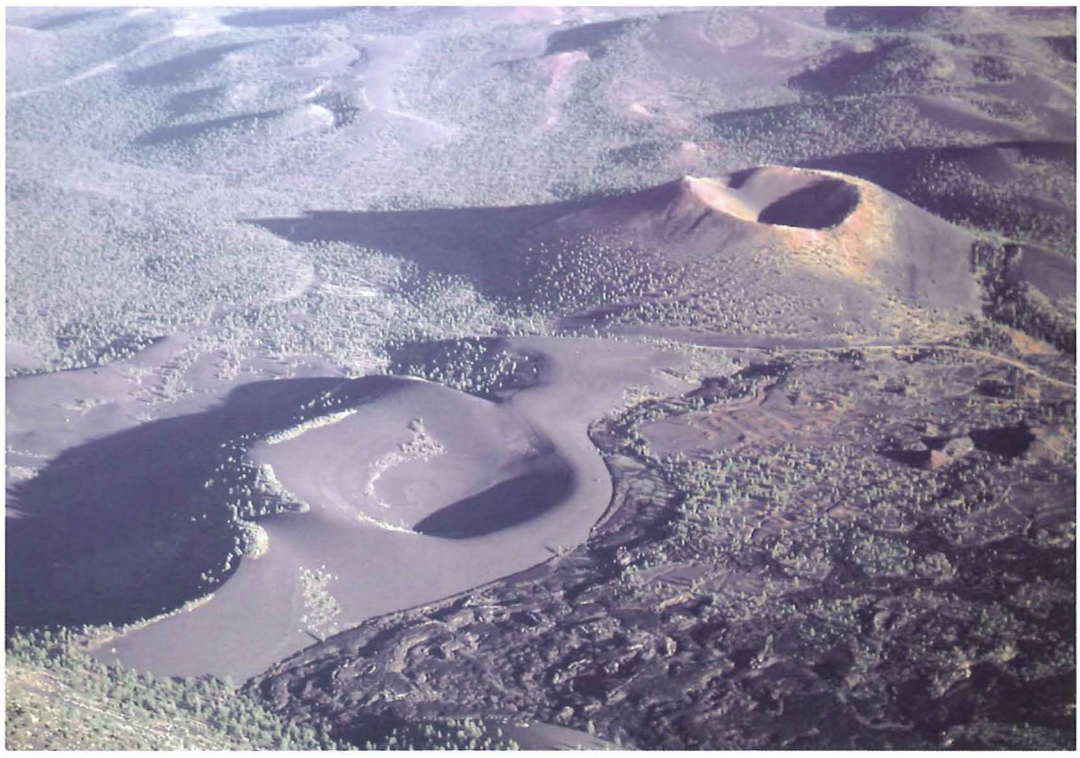
How Magma Forms

Volcanic rocks form in several distinct settings. Along margins where tectonic plates are diverging from each other, igneous rocks erupt in a process called sea floor spreading. The rocks formed there are solidified basalt lava flows. Sea floor spreading centers, or mid-ocean ridges, extend around the globe like seams on a baseball. Some of the oldest rocks at Jerome, in central Arizona, including the large copper deposit there, formed at a sea floor spreading center 1.8 billion years ago.

Another type of volcanic activity is the result of pools of magma, called "hot spots," that form near the Earth's core-mantle boundary. Magma generated there punches its way through the mantle and crust, erupting enormous volumes of lava at the surface. A long chain of large volcanoes that increase in age away from the current volcanic vent are formed as a tectonic plate moves over the hot spot, which is stationary. Chains of volcanoes that formed in this manner include the Hawaiian Islands, Galapagos Islands and volcanic centers of the Snake River-Yellowstone region.

A third setting for igneous activity is above subduction zones, where tectonic plates are colliding. As one plate descends beneath another, the subducted plate heats up and magma forms. This magma rises through the over-riding plate and forms long, narrow volcanic mountain ranges, such as the Cascade Mountains of the Pacific Northwest and the Andes of South America. Volcanic activity related to subduction has occurred repeatedly in Arizona. Most of Arizona's copper deposits formed during volcanism 70 to 55 million years ago. Another episode of widespread volcanic activity occurred from about 30 to 15 million years ago.

Visit the AZGS website for links to online information about volcanoes.



Sunset Crater (upper right) is a 1000-year-old cinder cone in the northeastern part of the San Francisco Volcanic Field. (Photo © Peter L. Kresan)

er state significantly affecting Arizona is exceedingly small, ash clouds could cause damage if enough ash fell on roofs not strong enough to support the extra weight. Ash could also pose a danger to aviation by damaging aircraft engines. The impact of ash fall would depend on which direction the wind happened to be blowing when the volcano erupted.

Some of the hazards associated with volcanic peaks in the Flagstaff area are not direct volcanic hazards but, rather, those connected with any high and steep terrain. Because the peaks north of Flagstaff receive much of their precipitation in the form of snow, rapid melting may produce flooding. Steep slopes with loose rocks present the same hazards from landslides, debris flows, and rockfalls (discussed in **Mass Movements** chapter).

Planning for Volcanic Hazards

When will the next volcanic eruption occur? Geologists are unable to predict with certainty when volcanoes will erupt. When "dormant" (temporarily inactive) volcanoes awaken, they typically send signals in the form of earthquake swarms, bulging of the surface, or gas venting. Geologists consider the San Francisco Volcanic Field to be potentially active because eruptions have taken place less than a thousand years ago, which in geologic terms, is practically yesterday. At the present time, however, there are no indications of movement of magma that would herald the beginning of a new eruptive phase. Because there is so little risk in Arizona, special design or construction techniques are not warranted.

Where To Go For More Information

Geologic maps showing young volcanic rocks in Arizona are available from AZGS. General information on volcanic hazards is available from the U.S. Geological Survey Flagstaff Field Center and on the Internet at www.usgs.gov.

Selected References

Volcanic Processes in Arizona, by D.J. Lynch, 1982: *Fieldnotes*, Arizona Bureau of Geology and Mineral Technology [now Arizona Geological Survey], v. 12, no. 3, pp. 1-9.

Volcanoes of Northern Arizona, by W.A. Duffield, 1997: Grand Canyon Association, 68 p.

Preliminary Overview Map of Volcanic Hazards in the 48 Conterminous United States, by D. R. Mullineaux, 1976: U.S. Geological Survey Miscellaneous Field Studies Map MF-768, scale 1:7,500,000.

HISTORY OF ARIZONA GEOLOGICAL SURVEY

The 11th Legislative Assembly of Arizona Territory established the Office of the Territorial Geologist in Prescott in 1881. After the University of Arizona (UA) opened in Tucson in 1891, Territorial Geologists held joint appointments as faculty members in the College of Mines. In 1915, three years after Statehood, the legislature continued the functions of the Office of the Territorial Geologist within the Arizona Bureau of Mines, which was administered by the UA.

Sixty-two years later, in 1977, the legislature modernized the enabling statutes of the Arizona Bureau of Mines and renamed it the Arizona Bureau of Geology and Mineral Technology. In 1988, the legislature transformed the Geological Survey Branch of the Bureau of Geology and Mineral Technology into the Arizona Geological Survey (AZGS), a stand-alone State agency that reports to the Governor. The Arizona Oil and Gas Conservation Commission was attached to the AZGS for administrative and staff support in 1991.