Earth Science

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Understanding the potential for volcanoes at Yucca Mountain

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By studying the rocks and geologic features of an area, experts can assess whether it is vulnerable to future volcanic eruptions. Scientists have performed extensive studies at and near Yucca Mountain to determine whether future volcanoes could possibly affect the proposed repository for nuclear waste.

What causes volcanoes?

The earth's crust is broken into plates that resemble a giant jigsaw puzzle. Our planet has 16 major plates. These rigid plates sit on a layer of molten rock. As the plates move about, they slide past each other, push together, or pull apart.

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Most volcanoes occur near the edges of continental plates. In areas where plates are moving apart, magma can come to the surface and erupt. When plates push together, one plate will sometimes slide beneath the other. If the plunging plate goes deep enough, some of its rock melts and forms magma that can move upward and erupt at the earth's surface.

The "Pacific Ring of Fire" is an example of where volcanoes are occurring along the edges of continental plates. Currently, more than half of the world's active volcanoes encircle the Pacific Ocean. In the United States, most of these volcanoes are in the Aleutian Islands, the Alaska Peninsula, the Hawaiian Islands, and the Cascade Range of the Pacific Northwest.

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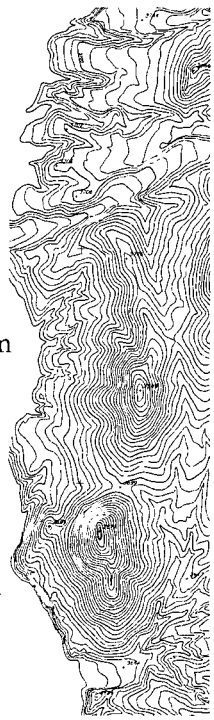
In addition, there are a few areas on the earth called "hot spots," where magma has melted through the plate. Because it is lighter than the solid rock around it, the magma rises and collects in magma chambers. If water is nearby, the magma heats the water, which sometimes erupts at the surface in the form of geysers. "Old Faithful" in Yellowstone National Park is a geyser resulting from a current hot spot. Under certain conditions in a hot spot, magma can move through vents and fissures and erupt at the earth's surface. (Once on the surface, it is usually called lava.)



Some volcanic eruptions are explosive, and others are not. The explosiveness of an eruption depends on the consistency of the magma. If the magma is thin and runny, gases can easily escape. When this type of magma erupts, it flows gently from cracks in the earth's surface. If the magma is thick and sticky, gases cannot escape, and pressure builds until the gases explode in a violent eruption.

Volcanoes: Past, present, and future

Volcanoes that are now extinct contributed significantly to the formation of the earth's crust. Over time, the cooling and hardening of the earth's crust has forever changed the conditions under which these early volcanoes existed. Smaller-scale volcanic activity will continue in vulnerable areas such as hot spots

or where continental plates meet. Experts agree that future volcanism is more likely to occur within or near areas where volcanoes have occurred in the past several hundred thousand years.

Using modern dating methods, experts can determine when volcanoes occurred in a specific area.

Yucca Mountain's volcanic history

Millions of years ago, a series of large explosive volcanic eruptions occurred to the north of Yucca Mountain. These eruptions produced dense clouds of volcanic ash and rock fragments, which melted or compressed together to create layers of rock called *tuff*, forming the mountains and hills of the region. The large-scale volcanic eruptions that produced Yucca Mountain ended about 12 million years ago. This explosive volcanism produced almost all (more than 99 percent) of the volcanic material in the Yucca Mountain region.

Several million years ago, a different type of eruption began in the area. These eruptions were smaller and much less explosive. These small eruptions were marked by lava and cinders seeping and sputtering from cones or fissures. The last such small eruption occurred about 80,000 years ago. The remaining volcanic material (less than 1 percent) in the Yucca Mountain region is a result of these smaller eruptions.

Yucca Mountain is not in an area where continental plates meet, nor is it located near any volcanic hot spots. In fact, experts consider the Yucca Mountain region one of the least active volcanic fields in the western United States.

Involving the world's top volcano experts in studies of Yucca Mountain

To assess the possibility of future volcanic activity in the Yucca Mountain area, the U.S Department of Energy relied upon careful evaluation by some of the world's foremost experts in such fields as volcanology, geophysics, and geochemistry.

Their studies started with extensive analysis of the location, age, and volume of past volcanic activity in the Yucca Mountain area. Using the data from these studies, along with information from studies of both modern and ancient volcanoes throughout the world, the scientists performed a volcanic hazard analysis.[1] This analysis evaluated the likelihood of magma entering the potential repository area. The analysis also evaluated the possibility of magma intersecting the repository and erupting up through the mountain's surface. A panel of independent external experts continues to provide the DOE with ongoing advice about volcanic hazards. This will help ensure that a sound technical basis is presented in future licensing interactions with the U.S. Nuclear Regulatory Commission.

Could a future volcano disrupt a repository at Yucca Mountain?

Using their extensive studies of the Yucca Mountain region, experts estimate the chance of a volcanic event disrupting the proposed repository to be about one in 63 million per year. This equals about 0.0000016 percent chance per year that a volcano will disrupt the repository. Put another way, it means there is about a 99.9999984 percent chance per year that a volcanic event will ***not*** disrupt the repository.

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1. *Probabilistic Volcanic Hazard Analysis for Yucca Mountain, Nevada* (U.S. Department of Energy, CRWMS M&O 1996)

U.S. Department of Energy
Office of Civilian Radioactive Waste Management

YUCCA MOUNTAIN
SITE CHARACTERIZATION
PROJECT

P.O. Box 364629
North Las Vegas, NV 89036-8629
1-800-225-6972
http://www.ymp.gov

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