Basin & Range Province

Background pages to accompany: **IRIS' Animations: Basin & Range** and **Interactive Animations**

Introduction

The Basin and Range Province, centered on the state of Nevada and extends from southern Oregon to western Texas, is an immense region of alternating, north-south-trending, faulted mountains and flat valley floors. It has no counterpart elsewhere in the U.S. The province was created about 20 million years ago as the Earth's crust stretched, thinned, and then broke into some 400 mountain blocks that partly rotated from their originally horizontal positions. These mountains of late Precambrian and Paleozoic rock continue to erode and fill the intervening valleys with fresh sediment.

Generalized margins of the Basin and Range Province. Image from the Interactive Basin and Range

The animations in this set address many geologic aspects seen in the Basin and Range, such as:

Why is the crust so thin in the Basin and Range?

Tension* created by movements of Earth's **tectonic plates*** have stretched the Earth's surface to the breaking point. The entire region has been pulled apart, fracturing the tectonic plate and creating large **faults***. When viewed from a satellite, they look like an "army of caterpillars" (see image above right). It is actually a series of adjacent north-south oriented mountain ranges that were created when this region was stretched, causing the surface of the Earth to fracture into blocks that tilt and alternately drop or rise.

Why is the area elevated?

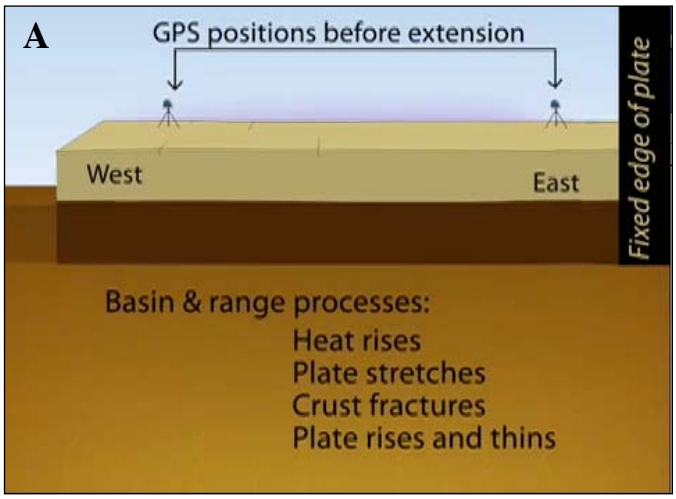
When the plates pull apart, they thin allowing the hot mantle to rise closer to the surface of the earth. The hot rock is buoyant, allowing the region to rise upward. The average elevation is 1400 m (4600 ft) above sea level.

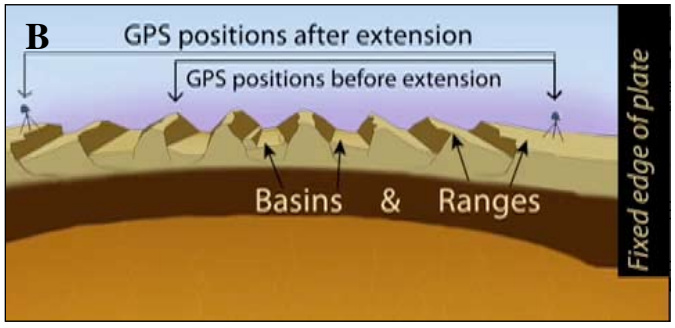
*Vocabulary on Page 3

Below: *frame grabs from animations.*

A. *Before Extension*

B. *After extension.*





Why did so many volcanoes erupt in the middle of a tectonic plate?

Although volcanoes usually form along the edges of interacting tectonic plates, geologic forces can produce volcanoes in the middle of a tectonic plate. Continental rifting leads to creation of faults and a thinning of the tectonic plate that allows magma to reach the surface. As the plate thins, hot mantle rises closer to the surface. When it reaches lower pressure, the rock begins to melt creating magma. This magma is under high pressure and is being squeezed up through faults.

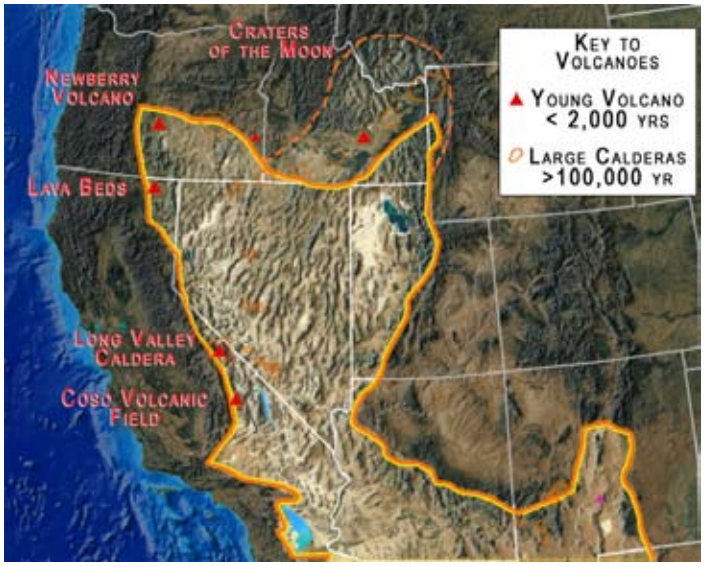
What types of volcanoes are in this region?

Cinder cones (Lava Beds National Park, Sconchin Butte Lava Beds National Monument, and Craters of the Moon National Monument), lava domes (Mammoth Mountain and the Coso volcanic field), and giant calderas (Long Valley).

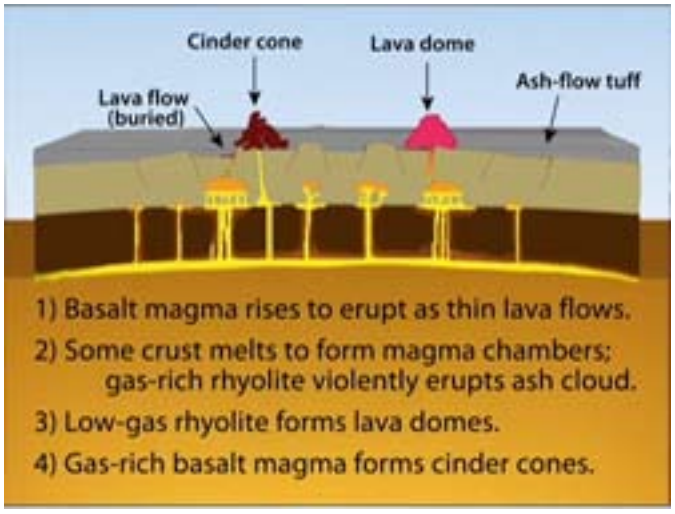
Are any of these volcanoes active today?

None of the volcanic areas in the Basin and Range Province are actively erupting. The last eruption was hundreds of years ago. However, several areas do show signs of activity, including the release of large amounts of carbon dioxide gas from beneath the surface of the Earth. Long Valley Caldera, Mammoth Lakes, and Craters of the Moon are technically considered "active" because they have the potential to erupt in the future. They are not extinct.

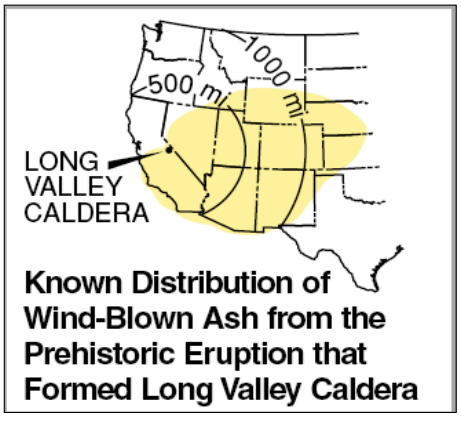
Long Valley Caldera is one of the largest calderas on Earth (32 km x 17 km; 20 mi x 11 mi) It produced one of the largest eruptions on the North American continent. We can't predict the next Long Valley Caldera eruption with any certainty. The last eruption in this region was around 1800, and in the past eruptions have happened every 500 years on average. The Long Valley caldera experiences earthquake swarms, ground deformation, and carbon dioxide gas emissions, which are carefully monitored by the USGS' Long Valley Volcano Observatory. However, unrest of this type can last for decades or even centuries without leading to an eruption.



Graphic from **Interactive Animations Basin & Range volcanoes** *shows significant volcanic centers in the Basin and Range Province.*



Frame grabs from animation on B&R volcanics.



See **Interactive Animations—Long Valley Caldera** *to learn facts about Long Valley.*

Will any new volcanoes form in this region?

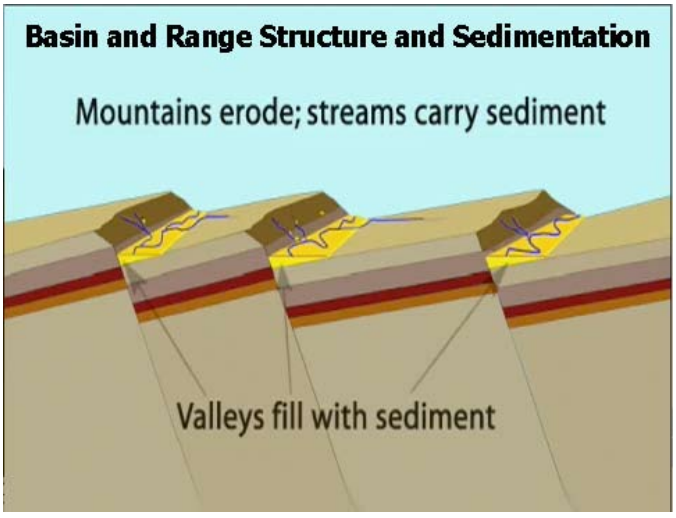
The Basin and Range has a thinner tectonic plate and a higher heat flow than the rest of the contiguous US, which implies that the hotter mantle is near the surface, and could lead to the formation of new volcanoes. The most active extension taking place in the Basin-Range Province is in the northwest sector, thus that would be a region of interest. In fact, that is where the youngest volcanic rocks are today.

How do we know the area is actively extending?

GPS units placed all over the region show that parts of the region are on the move relative to the stable North American continent. Many are moving relative to Colorado. See images on lower right of Page 1.

If the mountains are eroding, why don't they fill up the valleys?

The mountains rose and valleys dropped faster than erosion could keep up with (image below). This is a region that is not in equilibrium. Over time, millions of years, if extension stops, the mountains will level off.



Frame grabs from animation on structure and sedimentation.

Vocabulary

Caldera—A large and usually bowl-shaped depression formed by volcanic collapse during a catastrophic eruption.

Continental rifting—The process by which a continent stretches and splits apart; if successful, this process separates a larger continent into two smaller continents separated by an expanding ocean.

Fault— A break in the earth's crust resulting from the movement of one side with respect to the other.

Magma—Molten rock below the surface of the Earth. Lava is molten rock on the surface of the Earth.

Tectonic plate—A large, solid section of the Earth's crust and outermost mantle that moves relative to other plates over the deeper mantle.

Tension— in this context, it is stress that stretches or extends rocks so that they become thinner vertically and longer laterally.

Volcanic activity—The escape of hot, molten rock, ash, and gases from below the surface.