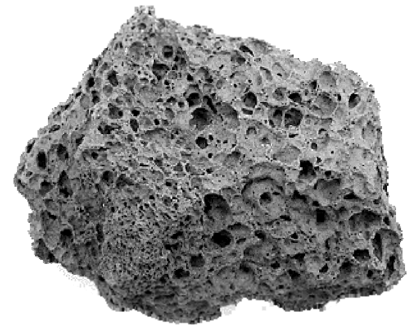
Lava Beds

National Park Service
U.S. Department of the Interior

Lava Beds National Monument

The Geology of Lava Beds



Why Is There Lava Here?

Lava Beds National Monument protects a wide variety of well-preserved lava features resulting from many eruptions of the *Medicine Lake shield volcano* over the past 500,000 years—including cinder and spatter cones, 'lava beds', and almost 700 lava tube caves. These features result from a tectonic plate beneath the Pacific Ocean slowly sliding under the continental plate. As it dives deep into the earth, this oceanic plate melts into magma, which then rises to the surface as lava several hundred miles inland from the coast. The Medicine Lake volcano is one of many places where these eruptions occurred throughout the Cascade Range of volcanoes, which stretches from northern California into British Columbia.

Medicine Lake is unique among Cascades volcanoes for its great surface area, as well as the wide variety of features left behind by eruptions of different characteristics and composition. These special places are yours to explore both here and throughout the surrounding area. Please remember that the unique geology of Lava Beds belongs to everyone, and rock collection is prohibited.

Why Doesn't It Look Like a Volcano?

Lava Beds lies on the northern flank of the Medicine Lake volcano and covers only about 10 percent of its surface area. At approximately 150 mi (241 km) around the base, 7900 ft (2408 m) in height, and covering over 700 square mi (1125 km^2), Medicine Lake is by far the largest volcano by volume in the Cascade Range. It is believed to have many small underground magma chambers rather then one large chamber. Eruptions from nearly 200 surface vents have created a volcano with a low, broad, gently sloping profile—like a shield. This profile built up over time by relatively mild eruptions of fluid lava flowing over large areas. The amount of gas and certain chemicals present in magma also contribute to the way a volcano erupts. Current eruptions on the Hawaiian islands are a good example of what the Medicine Lake volcano looked like as it formed.

By contrast, composite, or strato-, volcanoes are what many people think of when they hear the term 'volcano'. Familiar composite volcanoes of the Cascade Range include Mounts Shasta, Lassen, Mazama (Crater Lake), St. Helens, and Rainier. These volcanoes result from layers of lava and ash that pile up primarily around one central vent, creating the characteristic pointed cone. These eruptions are often violent, and may include the ejection of large amounts of ash, pyroclastic materials such as hot rocks, and even massive mudflows (lahars) if glaciers on a volcano's peak melt quickly.

Activity and Age

The Medicine Lake volcano has erupted intermittently for approximately half a million years. The most recent flows of pumice and obsidian at Glass Mountain (south of Lava Beds in the Modoc National Forest) occurred less than 900 years ago. Since there have been no eruptions within historical times, and there are no signs that the volcano is getting ready to erupt soon, geologists consider Medicine Lake 'dormant'. However, since the tectonic forces beneath all the Cascades volcanoes are still in motion, it is likely that there will be an eruption here again sometime in the future. Perhaps Native Americans watched as the volcano came alive here hundreds or thousands of years ago, and fountains of glowing rock fed rivers of fire that poured over the landscape. Perhaps future generations will witness this awesome spectacle again someday.

Today you can see the hardened results of over thirty separate lava flows exposed at Lava Beds. Rocks visible within the Monument range from two million year old volcanic tuff at Gillem Bluff in the northwest corner, to basalt about 1100 years old at the Callahan Flow in the southwest corner. Multiple eruptions of liquid basalt that flowed from Mammoth and Modoc Craters (on the Monument's southern boundary) between 30,000 and 40,000 years ago formed most of the lava tube caves here. This flow covers about 70 percent of the Monument. A different flow in the southeast corner of the park that emerged around 11,000 years ago was lower in viscosity and created smoother-textured caves, including Valentine Cave. Cinder cones, spatter cones, and other surface lava flows also appeared periodically between every few hundred and every few tens of thousands of years.

Volcanic Features

Lava Tube Caves
A gentle slope and very fluid lava are required for the formation of lava tubes. Lava up to 2000° F (1093° C) flows downhill and immediately begins to cool and solidify upon contact with the ground and air. Lava touching the ground solidifies first, followed by the sides and then the top of the flow. This hard shell of cooled lava insulates the liquid rock inside, allowing it to flow long distances before it cools and comes to a stop. The lava continues to flow until it either drains out or seals the end of the tube. Imagine when lava tubes extended largely unbroken for up to 10 miles from Mammoth Crater, stopped only by the waters of Tule Lake! In the millenia since, weather and gravity have punched holes in the ceilings of these extensive tube systems every few hundred feet, leaving behind almost 700 individual caves. These caves now provide not only outstanding opportunities for exploration, but habitat for a host of species ranging from threatened bats and bacteria, to tree frogs and sword ferns that cannot survive in the dry surface environment. The perennial ice formations found in some caves also give scientists an opportunity to study the effects of climate change.

Cinder Cones
The rounded mounds of many cinder cones dot the Lava Beds landscape. A cinder cone forms when high pressure and dissolved gases in magma cause an eruption that blows a fountain of lava into the air. The cooling lava then falls as cinders around the vent. Many cinder cones also ooze liquid lava from their bases if the eruption's underground magma source changes character, such as the Schonchin Lava Flow emanating from Schonchin Butte. This is the only cinder cone with a trail to the top; please help preserve others by not climbing on them.

Spatter Cones
Sometimes thick blobs of lava resembling lumpy oatmeal are thrown out of a vent. Thicker than cinders and thrown less high into the air, they form a cone where they land. Black Crater is an example of an impressive spatter cone. A hollow chimney may also form where the lava emerged — those found at Fleener Chimneys are 150 ft (46 m) deep.

Craters
Mammoth Crater once contained a massive lake of lava that overflowed rather than erupted, and left behind an enormous empty crater. The highly fluid, basaltic lava was transported many miles to the northern part of the Monument, creating networks of lava tube caves all along the way.

Fault Scarps
Gillem Bluff is an example of a fault scarp, a place where large blocks of crust move relative to each other, sometimes during violent earthquakes. Many long cliffs or ridges in this area are found along faults. Gillem Bluff has moved up relative to the basin below, exposing layers of ancient basalt believed to be two million years old.

Rock Composition And Types

The name given to each type of volcanic rock is determined by the amount of silica (a glassy mineral that crystalizes and changes the viscosity of a lava flow) present, as well as by the character of the resulting rock.

Basalt contains the least amount of silica of rocks found here, at around 47 percent. Approximately 90 percent of the rocks at Lava Beds are basaltic. Its extremely hot, fluid character allowed it to flow rapidly over large areas to create expansive lava beds and tube cave systems. **Aa** and **pahoehoe** are two Hawaiian terms used to describe the texture of basaltic lava. Aa is very rough and jagged—the Devils Homestead lava flow is one example. Pahoehoe has the consistency of pudding—smooth and ropy—and is perfect for making lava tube caves. Pieces of basalt full of bubbles from trapped gasses are called **scoria** and make up the 'cinders' of most cinder cones.

The remainder of Lava Beds' surface rocks are primarily **andesite.** Containing more silica than basalt, andesite is slightly thicker and more resistant to flow**. Rhyolite** has the highest content of silica, up to 77 percent. Eruptions of rhyolite tend to be either explosive or very slow moving, forming thick flows. One form of rhyolite is **obsidian**, a volcanic glass prized by Native Americans for making arrowheads and other tools. The nearest location of an obsidian flow is Glass Mountain, located about 30 mi (48 km) from the Visitor Center in the Modoc National Forest.

Pumice is another rhyolitic rock that is filled with gas bubbles and blown high into the air. Tiny bits of pumice from Glass Mountain's last eruption 900 years ago cover almost the entire surface of Lava Beds. This keeps the soil loose and well drained. Rainwater soaks in quickly, nourishing only plants with deep roots and leaving no surface water behind.

Tuff forms from compacted layers of volcanic ash. The tuff of Petroglyph Point formed when lava erupted into Tule Lake and exploded into ash, violently reacting when it mixed with the cool lake water. Tuff is very soft in comparison to other volcanic rocks. Native Americans took advantage of this to inscribe the cliffs of Petroglyph Point.

Learn More

Learn more about the geology of Lava Beds by viewing the video in the Visitor Center, looking through the interpretive binders there, and speaking to a ranger. Daily ranger-guided cave tours are offered in summer, and geology slide programs are among those offered on summer evenings. View labeled rock samples and cave formations in the Visitor Center museum, on the trail between the Visitor Center and Mushpot Cave, and inside Mushpot. You can also take a virtual tour of Valentine Cave in the museum, and more than a dozen wayside displays explain geologic features at roadside and trailside throughout the Monument. Teachers can also borrow curriculum-based geology activity trunks to use in the classroom. Enjoy your geologic adventure!