Mount Rainier National Park

National Park Service
U.S. Department of the Interior

Geology of Mount Rainier

Evidence of the complex geological processes which continue to shape this land are all around us, from the mountain itself–an active volcano–to the river valleys carved by glaciers and washed out by mudflows. To understand the geology of Mount Rainier is to understand the power of nature in shaping the landscape–and our lives.

Ring of Fire

In 1883, Geologist Bailey Willis called Mount Rainier "an awful power clad in beauty." Today, the mountain continues to command our respect and awe. At 14,410 feet, Mount Rainier is the highest peak in the Cascade Range, a chain of volcanoes extending from northern California to southern British Columbia. The range includes nearby Mount St. Helens and Lassen Peak in California, both of which have exhibited violent eruptions in the 20th century. The complex geologic processes responsible for forming this impressive range of volcanoes continue today. The Pacific Northwest is part of the "Ring of Fire," a global zone of frequent earthquake and volcanic activity along the Pacific Ocean's rim. The concentration of geologic activity in these areas marks the location of shifting tectonic plates. About sixty miles off the coast of Washington and Oregon, the Juan de Fuca Plate begins its slide beneath the North American Plate, in a process called subduction. It moves at a rate comparable to the growth of your fingernails, about one to two inches per year. Subduction provides the forces that generate earthquakes and the magma that feeds volcanoes in the Pacific Northwest.

Like bubbles in boiling tomato sauce, the modern volcanoes of the Cascade Range represent only the most recent activity in an area where volcanoes have been bubbling along for at least 40 million years. About 500,000 years ago, vigorous eruptions of lava began building the present cone of Mount Rainier on the wreckage of ancient volcanoes. A prominent cone developed and lava flowed repeatedly on the edges of ice-age glaciers, forming the steep ridges that we see radiating out from the summit today. Through this process, the mountain reached an elevation that may have been 2,000 feet higher than today's summit.

Glaciers

The mountain's great height and its proximity to the ocean influences local climate. Moisture-laden bodies of air flow eastward from the Pacific and encounter Mount Rainier's lofty bulk where they cool, condense and create abundant precipitation and high volumes of accumulated snowfall. Fields of snow compact into ice under the weight of overlying layers. As the ice on the mountain's steep slopes thickens, gravity causes glaciers to change shape and flow downhill. These moving rivers of ice continually carve away at the flanks of Mount Rainier. Twenty-five major glaciers radiate outward from the summit, forming a cubic mile of ice and snow. As much snow and ice exists on this single peak as exists on all of the other Cascade volcanoes combined!

Eruptions and Debris Flows (Lahars)

In addition to the erosive might of glaciers, Mount Rainier's height has been further eroded by a series of large-scale eruptions, collapses, and debris flows. Contributing to many such events is a process known as hydrothermal alteration, a process by which acidic solutions originating from the magma chamber weaken the stability of the rock by gradually transforming hard rock into clay.

Perhaps the single most catastrophic event in Mount Rainier's recent history occurred about 5,600 years ago as a result of such instability. A small eruption caused the upper portion of the mountain to collapse into a fast-moving flow of mud and debris known today as the Osceola Mudflow. The mountain lost about 1,000 feet of elevation as muddy debris raged down both forks of the White River as far as the Puget Sound. Yellowish, concrete-like outcrops of Osceola Mudflow material can be seen along the trail to Glacier Basin. The enormous amphitheater left behind by this event is clearly visible on the east side of the park. Other debris flows have occurred frequently throughout the history of the volcano, including a small event that damaged trails and temporarily closed the road to Paradise in 2001.

Mount Rainier is still an active volcano. Its last significant eruption was a small amount of pumice hurled out between 1820 and 1854. Steam and acidic gases currently vent near the summit. This volcanic heat has melted a network of ice caves and a small lake underneath the icy summit crater. Scientists at the US Geological Survey and University of Washington closely monitor Mount Rainier for signs of renewed volcanic activity.

Twelve seismometers inside and outside the park record both tectonic earthquakes, which occur in response to stresses within the earth, and volcanic tremors, small earthquakes caused by rising magma shouldering aside existing rock. A significant increase in the frequency and intensity of volcanic earthquakes typically precedes volcanic eruptions, and will one day signal a period of renewed eruptive activity at Mount Rainier.

Detailed information is available at park visitor centers or from scientists at the USGS Cascades Volcano Observatory, 1300 SE Cardinal Court, Building 10, Suite 100, Vancouver, WA 98683, or visit the USGS Cascade Volcanoes website: vulcan.wr.usgs.gov.