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Volcano Hazards in the Cascade Range

Expanding populations near volcanoes put more people at risk.

In Cascade Range vicinity, the number of people at immediate risk during eruptions is greater than at any other volcanic area within the United States. The 2010 census notes that more than 10 million people live in Washington and Oregon alone, and populations are increasing in areas at risk for volcanic hazards. Additionally, aviation air space between the Canadian border and Mount Shasta accommodates almost 2,000 flights daily. The next eruption near a Cascade volcano could upset the lives of hundreds of thousands of people and disrupt many others.

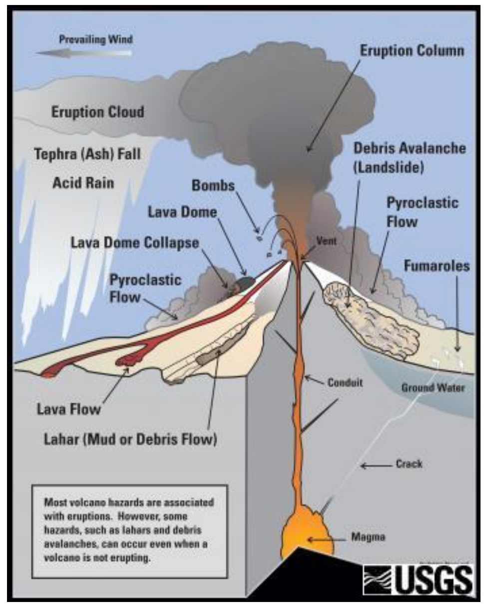
Mount Hood with Portland International Airport (Oregon) in the Foreground. An ash-producing eruption of Mount Hood could ground air traffic and significantly impact commerce in surrounding states.

Cascade Range volcanoes produce multiple hazards.

When Cascade volcanoes erupt, a common sequence of events unfolds. Explosive eruptions of tephra are followed by effusion of lava flows. High-speed avalanches of hot rock and gas (pyroclastic flows) can accompany both of those events—columns of tephra collapse, or the fronts of lava flows crumble, both of which can send pyroclastic flows down the volcano's flanks. Finally, when the erupted material mixes with river water or melts snow and ice, volcanic mudflows (lahars) sweep down valleys and can devastate areas more than 50 miles downstream. Rivers can continue to carry volcanic sediment downstream and force flooding for decades to hundreds of years. The most significant threats are from volcanic ash and from the slurry of mud and debris within lahars.

Even in the absence of eruption, the flanks of Cascade volcanoes can collapse, which result in landslides and debris avalanches that can destroy areas downslope from the collapse location.

Volcanoes pose multiple types of hazards and the initiation and duration of eruptions is relatively uncertain. Therefore, authorities and populations at risk, both close to and far from the volcano, must be knowledgeable about volcanic hazards so that they can be flexible and prepared in their response.

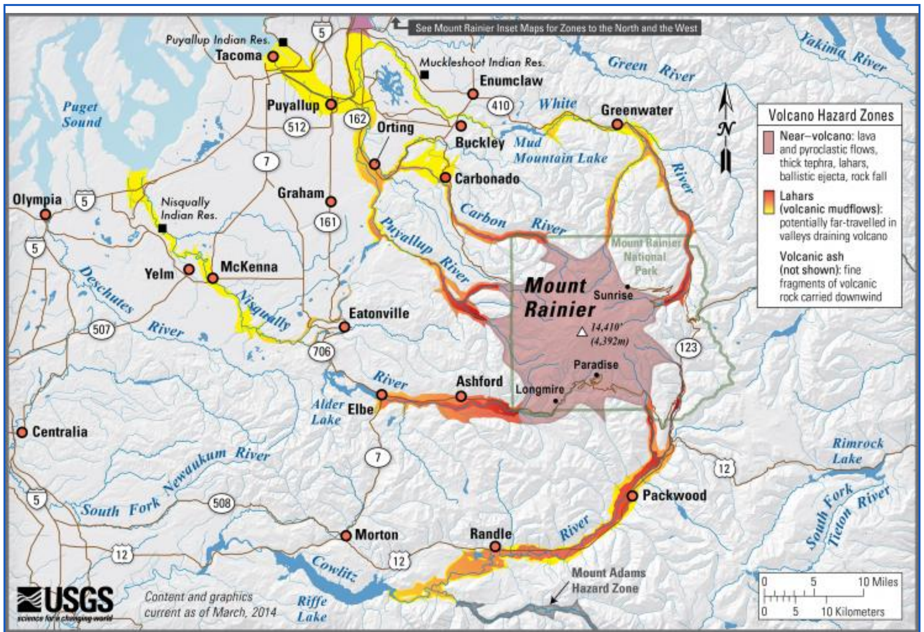


Geologic Hazards at Volcanoes. To download the full poster click here.

To learn more about general volcano hazards, visit the Volcano Hazards Program website.

Simplified Volcanic Hazard Maps for Washington and Oregon

Hazard maps illustrate potential for ground-based volcanic impacts—lava flows, hot rocks, volcanic gases, and more far-reaching hazards (primarily lahars) in valleys that drain the volcano. When eruptions are imminent, the USGS and its partners will analyze wind conditions and post maps that indicate areas most likely to receive ash fall. Use the "Find a Volcano" drop-down menu at the top of this website to learn about the volcanoes that could affect your community.



Mount Rainier, Washington simplified hazards map showing potential impact area for ground-based hazards during a volcanic event.

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Lahars – The Most Threatening Volcanic Hazard in the Cascades

Lahars, along with debris flows and debris avalanches, are masses of rock, mud and water that travel rapidly downslope and downstream under the action of gravity. Volcanoes are a perfect setting for these events because of an abundance of steep, rocky rubble and a ready source of water in the form of rain, snow or ice. Lahars can flow many miles downstream from the volcano, making this the most threatening hazard in the Cascades.

Lahars from Mount St. Helens carried this large boulder downstream as it ripped down trees and left a thick mud flow deposit after the May 18, 1980 eruption. Muddy River, Washington.

Lahars transform the landscapes around Cascade Volcanoes.

Lahar is an Indonesian word describing a mudflow or debris flow that originates on the slopes of a volcano. Small debris flows are common in the Cascades, where they form during periods of heavy rainfall, rapid snow melt, and by shallow landsliding. These relatively small debris flows seldom move more than a few miles down valleys. In the Cascades, the word lahar is typically reserved for larger events that occur in conjunction with volcanic eruptions, and travel many miles down valleys and affect local communities. Lahars can occur by rapid melting of snow and ice during eruptions, by liquefaction of large landslides (also known as debris avalanches), by breakout floods from crater lakes, and by erosion of fresh volcanic ash deposits during heavy rains. During and immediately following volcanic eruptions, lahars can pose the most severe hazard to populated valleys downstream from Cascades volcanoes. Visit individual volcano websites to learn more about specific Cascade lahar histories and hazards (volcano drop down from CVO home page).

Lahar (dark deposit on the snow) originating in the Mount St. Helens crater after an explosive eruption on March 19, 1982.

About 500 years ago, the collapse of weakened rocks caused a large lahar at Mount Rainier. Called the Electron Mudflow, the lahar traveled through the Puyallup River valley. A 2009 USGS study by Wood and Soulard noted that 78,000 residents lived in the area covered by Electron Mudflow deposits. Today, those numbers are greater, and the next lahar in the Puyallup Valley could create significant impacts on the community and economy.

To learn more about general lahar hazards and their effects, visit the Volcano Hazards Program lahars webpage.

Research addresses trigger mechanisms, flow dynamics, forecasting, and improved warning systems.

To understand lahars, scientists observe and quantify what happens when these events occur naturally, derive equations to describe lahar behavior, and perform controlled experiments in a 300-feet (100-m) long debris flow flume. The results help us to understand flow dynamics and develop improved technologies for mitigating the destructive effects of debris flows.

Because of the danger presented by lahars, scientists are ready to deploy lahar-detection systems when eruptions are imminent. Officials near Mount Rainier maintain a permanent lahar-detection system and accompanying public notification system. *If you are on the floor of a valley that heads on a volcano when* *officials announce the presence of an oncoming lahar, seek high ground.* Find out more about lahar safety in the preparedness section of this website.

In this video Scientist Richard Iverson describes how lahars form and shows experiments that help scientists to model lahar behavior.

Excess Sediment Accumulation Causes Flooding in the Cascades

Sediment carried downstream remains as a lasting legacy of volcanic activity.

Eruptions, and subsequent erosional processes, can deliver vast quantities of sand and gravel to rivers on or near volcanoes. Mobilized material can move rapidly as voluminous slurries of rocks and debris (lahars) that can destroy structures along their path and deposit vast quantities of sediment along a valley floor. Flood-transported sediment can do similar damage but over a longer period of time, and post-eruption sediment transport can have socioeconomic consequences more severe than those caused directly by an eruption.

Dredging of the Toutle River after the Mount St. Helens 1980 eruption. Project removed huge volumes of material to prevent river from being choked with sediment.

Release of excessive sediment from volcanically disturbed watersheds can persist for decades and greatly extend the duration of an eruption's damaging effects. In the three decades following the Mount St. Helens eruption, the U.S. Army Corps of Engineers has spent more than $0.5 billion to dredge sediment from the Toutle, Cowlitz, and Columbia rivers, build a sediment retention structure, and construct a tunnel to stabilize the level of Spirit Lake; it continues efforts to mitigate ongoing volcanic sediment release. Sediment accumulated (aggradated) to about 20 m (65 ft) thick 60 to 90 km (40 to 55 mi) downstream of Mount Hood (Oregon) during a modest dome-building eruption (A.D. 1781 to 1793), owing simply to the steady erosion and transport of sediment shed from the growing lava dome. The size or type of eruption may not determine the impact from prolonged sedimentation, which can occur for decades after an eruption.

Sediment retention dam on the North Fork Toutle River is designed to help stop downstream movement of sediment near where it begins on Mount St. Helens' debris avalanche deposit.

North Fork Toutle River Above the Sediment Retention Structure, Mount St. Helens.

Debris Avalanches Occur at Many Cascade Volcanoes

Massive slope collapse is natural part of the life cycle of Cascade volcanoes.

Small hills NNE of Mt. Shasta are hummocks created during a massive landslide between 380,000 and 300,000 years ago.

Volcanoes are naturally weak structures and at times are subject to slope collapses that range in size from small rock falls to very large landslides or debris avalanches. These catastrophic collapses of a volcano's slopes happen most often during volcanic activity but sometimes occur in non-eruption times, and they often transform into lahars that threaten populated regions downstream. They can be triggered by eruption, earthquake, or by long-term exposure to weathering of the rocks that make up the volcano. The 500-year old Electron Mudflow and the 5,600-year old Osceola Mudflow on Mount Rainier originated in areas of the volcano that had been structurally weakened by long-term exposure to acidic groundwater. Such weakened zones are common at ice-mantled Cascade volcanoes, where abundant melt water infiltrates porous volcanic rocks.

Debris avalanche deposit with hummocky terrain resulting from the May 18, 1980 eruption of Mount St. Helens. View to the east toward Coldwater Lake.

One well-known debris avalanche happened at Mount St. Helens on May 18, 1980 when the entire north face (volume equivalent to 1 million Olympic swimming pools) of the volcano slid away and deposited a layer of hummocky terrain 600 feet thick in the upper North Fork Toutle River Valley. As the eruption roared in the background, the landslide deposit mobilized into a destructive lahar, which moved 100 km (60 mi) down valley destroying everything in its path. Scientists observed and studied this massive debris avalanche and its deposits in detail and thereafter have been able to spot evidence of older debris avalanches at many other Cascade volcanoes. Mount Baker, Mount Rainier, Mount Adams, Mount St. Helens, Mount Hood, and Mount Shasta have all been reshaped by debris avalanches. At Mount St. Helens and its earlier proto-cone, geologists have found evidence of three pre-1980 debris avalanches. Debris avalanches are a natural part of the life cycle of Cascade volcanoes.

To learn more about these large landslides and how they affect areas around volcanoes, visit the Volcano Hazards Program debris avalanche webpage.

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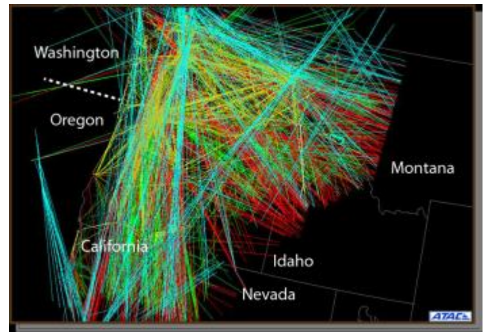
Tephra Fall Is a Widespread Volcanic Hazard

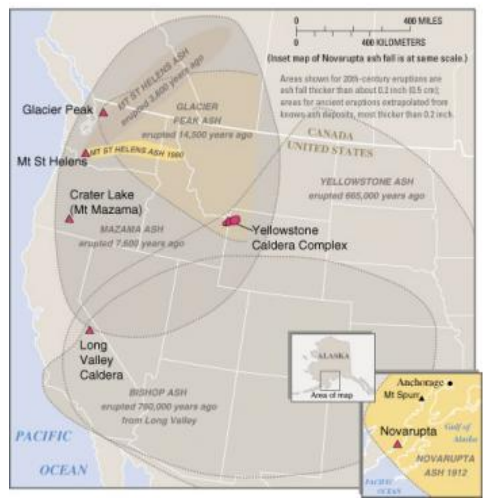
Falling volcanic ash can disrupt lives distant from an erupting volcano.

The term tephra defines all pieces of all fragments of rock ejected into the air by an erupting volcano. Most tephra falls back onto the slopes of the volcano, enlarging it. But, billions of smaller and lighter pieces less than 2 mm diameter (half an inch), termed ash, are carried by winds for thousands of miles.



Air traffic routes over the Cascade Range in a typical day include more than 2000 flights. State outlines in pale gray.

Falling ash, even in low concentrations, can disrupt human activities hundreds of miles downwind, and drifting clouds of fine ash can endanger jet aircraft thousands of miles away. Aircraft that fly in the dense network of aviation routes across the Cascade Range carry nearly 200,000 people daily over Cascade airspace—an amount equivalent to the population of the City of Spokane, Washington. When it has settled on and near the ground, volcanic ash threatens the health of people and livestock, damages electronics and machinery, and interrupts power generation, water and transportation systems, and telecommunications.



Shaded areas indicate where tephra layers remain from associated very large eruptions. At the time of eruption, lighter ash fall extended to greater distances than shown here.

Some ash falls are extensive with far-reaching effects.

Evidence from past eruptions shows that three Cascade Range volcanoes are capable of erupting massive volumes of volcanic ash—Glacier Peak, Mount St. Helens, and Mount Mazama (Crater Lake). While the extent of these ash layers is widespread, minor eruptions of ash from any Cascade Range volcano can cause serious societal disruptions. Keep in mind that the next volcanic ash fall that drifts over your community might be from a distant volcano.

1980 volcanic ash disrupted many lives.


Ash from the May 18, 1980 eruption of Mount St. Helens covering the ground and road at a farm in Connell, Washington, approximately 300 km (180 mi) from the volcano.

On May 18, 1980, Mount St. Helens sent an enormous column of volcanic ash and gas more than 80,000 feet into the air in less than 15 minutes. As ash clouds drifted over eastern Washington, a rain of ash covered homes, farms, and roads to a depth up to four-inches. Small ash particles penetrated even the mostly tightly sealed structures and disrupted businesses and services on farmlands and in communities. By end of the day, more than 500 million tons of ash had fallen onto parts of Washington, Idaho, and Montana. Many small communities became temporarily isolated, and more than 10,000 people became stranded on roadways because of poor visibility, slippery roads, and ash–damaged vehicles. Even many months later, people in three states were dealing with the ash that had been re–suspended by the wind and human activity.

What would an explosive eruption from Mount St. Helens look like today? View three different computer-generated ash-cloud simulations.

Ash may impact areas very far from volcanoes, be prepared.

Ash, erupted from the early phases of the 2004 Mount St. Helens activity, is remobilized from the surface of an ash-covered from a moving vehicle.

Westerly winds dominate in the Pacific Northwest sending volcanic ash east and north–eastward about 80–percent of the time, though ash can blow in any direction. Volcanic ash that reaches your community might be from a distant volcano, and not necessarily from the Cascades volcano closest to you. Organizations at many levels – families, businesses, and public services – will benefit from a plan that aims to help them live with reasonable comfort and safety during, and for many months following, significant volcanic ashfall. The Volcanic Ash webpages are intended to help people prepare and recover from volcanic ashfall.

To learn more about ash and tephra, visit the Volcano Hazards Program tephra webpage.

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Lava Flows, Domes, and Pyroclastic Flows Build Cascade Volcanoes

Cascade Range stratovolcanoes are built as repeated eruptions accumulate hundreds of overlapping lava flows, lava domes, and layers of rock rubble from pyroclastic flows.

Collapsing lava flows, domes, and large ash columns create pyroclastic flows and lahars.

Pyroclastic flows can be formed in a couple of different ways. If lava flows and domes break apart, gravity may cause the material to flow rapidly downhill to form these avalanches of hot rock and gas. Also, during highly explosive eruptions that produce large vertical columns of ash and pumice, a portion of the columns can collapse to form pyroclastic flows that sweep down the flanks of volcanoes. Regardless of their source, pyroclastic flows on snow and ice are hot and turbulent, and as they flow they erode and melt snow and ice in their path, which can create enough melt water to mobilize loose volcanic rock into muddy slurries called lahars. This has occurred at all of the principal Cascade volcanoes including Mount St. Helens and Mount Rainier.

To learn more about general pyroclastic flow hazards, visit the Volcano Hazards Program webpage about their effects.

Pyroclastic flow during August 7, 1980 Mount St. Helens eruption. The view is from Johnston Ridge, located 8 km (5 mi) north of Mount St. Helens.

Hot lava meets snow and ice at ice-clad Cascade volcanoes.

An estimated two cubic miles of glacier ice and perennial snow cover the Cascade Range volcanoes today, and more than half of that amount is on Mount Rainier. During past Ice Ages, glaciers were more extensive and enveloped many Cascade Range volcanoes. Ice–age glaciers played an important role in shaping some volcanoes by influencing the placement of lava flows. At many locations, glacier ice slowed or halted the movement of lava flows. Elsewhere, glacier ice channeled lava flows and allowed them to travel several miles from the base of the volcano. At Mount Rainier, the 40,000 year-old Ricksecker Point lava flow pooled at the juncture of the ancestral Nisqually and Paradise Glaciers.

To learn more about general lava flow hazards, visit the Volcano Hazards Program webpage about their effects.

Ricksecker Point lava flow (the ridge in the center of the photo) erupted 40,000 years ago on the flanks of Mount Rainier along a high ridge adjacent to valley filling glaciers.

Ice-chilled lava columns at the end of a Glacier Peak lava flow, Washington.