

Volcano Studies in National Parks

--USGS helps NPS to keep a watchful eye on restless volcanoes while improving our understanding of how volcanoes work--

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Of 65 U.S. volcanoes that have been active over the past 2,000 years (Wright and Pierson, 1991), about 20 are within or near a national park or monument (Fig. 1). One park, Yellowstone, was the site of extensive volcanism as recently as 70,000 years ago and continues to be restless as evidenced by slow ground deformation there. An active volcano in a park can challenge park managers: eruptions are both a grand natural spectacle and a scientific laboratory, but they can threaten park visitors and facilities as well.

Eruptions involve a variety of processes. A lava flow can bury everything in its path. A vent and associated ground deformation can develop where none had been before, damaging roads and facilities. Explosive eruptions such as Mount St. Helens (1980) typically have widespread impact: airborne ash can fall thick enough to collapse roofs miles from the volcano, pose a hazard to aviation, and can be a nuisance up to hundreds of miles away. Fast-moving pyroclastic flows incinerate or suffocate anything in their path and are mobile enough to jump ridges. Floods and landslides can occur even without an

eruption; mudflows in the Philippines, for example, have resulted from rain-induced erosion of 1991 ash deposits of Mount Pinatubo. The mudflows have forced thousands of villagers to evacuate their homes and will recur for years.

Geologic information is of value to park managers for siting and design of facilities and trails, for preparing emergency plans prior to natural disasters, and for interpreting the geologic history of a park. Information about volcanoes is the focus of the USGS Volcano Hazards Program (VHP), which has grown since 1980 in response to eruptions or volcanic unrest. VHP scientists are working with NPS managers and resource specialists in several parks, providing hazard maps, advising about eruptive activity, and helping with interpretation. Equally important, studies of volcanoes in these parks serve to better our understanding of how volcanoes work and to improve monitoring techniques. Three parks serve to illustrate the benefits of these cooperative efforts.

A) Hawaii Volcanoes NP (HVNP)

The USGS Hawaii Volcano Observatory (HVO), the oldest volcano observatory in the U.S., is located at the summit of Kilauea Volcano. Kilauea and nearby Mauna Loa are partly within HVNP. Because these volcanoes are

frequently active, HVO has been fertile ground for the development and testing of volcano monitoring techniques that can be used throughout the world. HVO studies have also expanded our understanding of how basalt magma forms, rises, and erupts. HVO staff offer lectures and field trips to HVNP staff and have provided a volcanic hazard map that is used by park planners (Wright and others, 1992).

The present ongoing eruption of Kilauea began in 1983 (Heliker and Wright, 1991). During eruptions, HVO staff constantly share new information with park staff. Based on HVO predictions, HVNP rangers close roads to the public and evacuate areas where and when lava is likely to break out. HVO also warns of likely sites of ground subsidence caused by underground movement of magma. Park managers and staff rely on HVO interpretations to determine safe viewing areas for visitors and to take preventive measures to control forest fires set by lava flows.

B) Crater Lake NP (CLNP)

Crater Lake is sited in a caldera, a basin formed when a volcano subsided due to rapid

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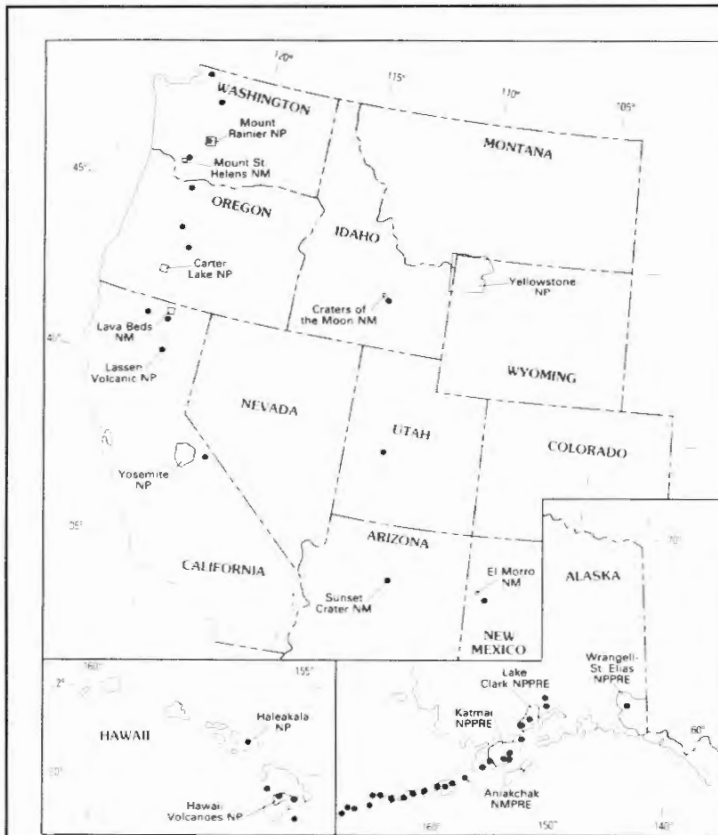


Figure 1. Index showing U.S. volcanoes active in the past 2,000 years (dots; after Wright and Pierson, 1991) and nearby national parks or monuments. NP = national park; PRE = preserve; NM = national monument.



Figure 2. View of Mount Rainier from the Tolmie Peak fire lookout in the northeast corner of Mount Rainier National Park. Note the steep slopes and extensive cover of snow and ice. Photo courtesy of Mount Rainier National Park.

emptying of a subsurface magma chamber during a large explosive eruption. USGS investigations at CLNP are focused on the processes by which magma accumulated beneath the volcano and then catastrophically erupted 7700 years ago. Geologic mapping of the volcano and radiometric dating of pre-caldera lavas have improved our understanding of the volcanic history prior to the catastrophic eruption. Results will aid in evaluation of the hazards posed by the volcano and will lead to a better understanding of explosive volcanism elsewhere in the world.

Related studies at CLNP include deformation monitoring. Distances between bench marks on opposite sides of the caldera, and elevations along three road segments, are measured periodically in order to detect changes in horizontal distances and ground tilt that might be related to impending volcanic activity. Other studies, funded partly by the Geothermal Research Program of the USGS, are aimed at understanding the hydrothermal system of hot subsurface fluids that developed after the caldera formed. All post-caldera lavas were vented on the caldera floor, many of them beneath Crater Lake. Post-caldera lavas have been sampled and hydrothermal features on the lake floor have been observed by use of a manned submersible in cooperation with NPS and NPS-sponsored investigators.

C) Mount Rainier NP (MRNP)

Mount Rainier is arguably the most hazardous volcano in the conterminous U.S.: its steep slopes are weakened by fumarolic alteration, it is extensively covered by glaciers, and it is close to a major population area. The most recent eruptions occurred in the late 1800's and an eruption is likely within a few centuries (Crandell, 1973). The volcano poses a major hazard to Puget Sound and Columbia River drainages because of the potential for large mudflows of meltwater generated during an eruption. Even without eruptive activity, landslides and avalanches have occurred several times in the past few thousand years (Crandell and Mullineaux, 1967). Mount Rainier is the second most seismically active volcano in the Cascade Range (Norris, 1991) and is seismically monitored by the University of Washington and the USGS.

The volcano is sited within MRNP and is a potential threat to park visitors and facilities. Additionally, parts of Puget Sound communities outside MRNP are built on mudflows as young as 500 years (Scott and others, 1990). The NPS, USGS, and other state and federal agencies hope to better determine the nature of the hazards posed by Mount Rainier. NPS personnel and state, federal, and university geologists met recently to discuss ways to enhance monitoring, to improve our understanding of how the volcano works, and to translate these

studies into a comprehensive disaster-response plan (Swanson and others, 1992).

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