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Monitoring Volcanism

The eruption at Mount St. Helens brought shock and deep anxiety to the Pacific Northwest and evoked sympathy from others around the world. The eruption was not as powerful as some, but it caused destruction estimated at over $2 billion and the loss of nearly a hundred lives. The death toll would have been much larger had warnings not been issued and had the Forest Service not acted to minimize the number of people close to the mountain.

Geophysicists and petrologists are necessarily somewhat uncertain about the detailed processes that give rise to volcanism. The phenomenon involves magma and temperatures of 1100°C and more. At the pressures and temperature existing at 100 kilometers, it is supposed that partial melting of the rocks there would occur. In areas such as the "ring of fire" that surrounds the Pacific Ocean, the movement of tectonic plates would influence events. Relative movement of the plates would be likely to produce weak areas through which magma might migrate. The magma is less dense than the solid from which it is derived. Rock pressure exerts a powerful force tending to move magma toward the surface.

Evidence from a variety of volcanoes shows that interconnected pools of lava with total volumes of cubic kilometers may accumulate in the quiescent periods between episodes. When such a volume moves toward the surface, seismic activity can be noted. In the 2 months preceding the eruption at Mount St. Helens, a large number of local earthquakes were recorded. Their number and intensity justified the warnings and the Forest Service restrictions on travel near the mountain.

The seismic activity that began in March 1980 did not come as a complete surprise. On 7 February 1975 *Science* published a report* which began, "Mount St. Helens, a prominent but relatively little known volcano in southern Washington . . . has been more active and more violent during the last few thousand years than any other volcano in the conterminous United States. Although dormant since 1857, St. Helens will erupt again, perhaps before the end of this century." Many of the earlier eruptions of Mount St. Helens were dated by carbon-14 techniques. The hot ash converted some of the nearby trees to charcoal. In addition, examination of the geologic column has revealed widespread ashfalls derived from eruptions at St. Helens.

An interesting fact also mentioned in the report is that the composition of the material vented by the mountain on different occasions has varied widely. Correspondingly, the nature of the volcanism has varied. A magma that is high in silica (65 percent or more) is very viscous and tends to be associated with violent eruptions. A magma with about 50 percent silica is much less viscous and flows rather quietly from the volcanic vent. In the past, both types of volcanism have occurred at St. Helens; what form the volcanism will take next is unpredictable. The same is true of other volcanoes, both here and abroad. History tells us that destructive episodes involving great loss of life have occurred and will occur again. We need not go back to Vesuvius and Pompeii. In 1902 Mont Pelée on Martinique commenced to eject ash, which drifted down over the city of Saint-Pierre 10 km away. Two weeks later a violent explosion killed all but one of the 30,000 inhabitants.

Most of the Cascade Range volcanoes and those around Cook Inlet in Alaska have manifested volcanic activity of some sort during the last 200 years. The U.S. Geological Survey proposes to expand its monitoring of them. The program would include emplacing seismometers, tiltmeters, and distance measuring facilities on the more active peaks. In addition, careful studies of earlier ashfalls would be made, including carbon-14 dating to determine the frequency and characteristics of earlier events. Even with detailed knowledge, one cannot hope to forecast precisely when eruptions will occur. However, better knowledge would surely lead to saving many lives. The proposed program, which would cost about $6 million annually, should be speedily authorized, supported, and implemented.—PHILIP H. ABELSON

*D. R. Crandell, D. R. Mullineaux, M. Rubin, *Science* **187**, 438 (1975).