# Long Valley Is on Low Simmer for Now

## *The rumbling and bulging of the ground near Mammoth Lakes, California, has subsided but not halted as two other calderas threaten volcanic eruptions*

It was a quiet year in Long Valley. Researchers keeping an eye on this ancient scar of a great volcanic eruption have watched the intense earthquake activity and ground deformation of early January 1983 taper off to relatively low levels and stay there during the past year. Compared to the ominous behavior of calderas in Papua New Guinea and Italy, Long Valley has been quite sedate. Still, even by the standard of California's San Andreas fault, Long Valley continues to be restless.

The signs of quiet at Long Valley are everywhere. The injection of magma beneath the valley floor—which had domed it upward 45 centimeters in about 5 years and as much as 7 centimeters around the time of the January 1983 earthquake swarm—has slowed so much that uplift has been undetectable during the past 6 months. The January swarm was the ninth and most intense to strike the southern edge of the caldera in 3 years, but there has been none since then; the seismic quiet of the past year has been deeper than the lull that preceded that swarm. And the steady increase in the earth's magnetic field over the valley, presumably a measure of increasing crustal strain, ceased a year ago.

The quiet is not absolute. On 28 April a magnitude-4.2 earthquake and its aftershocks struck the southern edge of the caldera, near where the swarms and ground deformation had suggested the upward movement of magma. The April earthquakes, though, did not form the crescendo and diminuendo of a swarm that is usually associated with the movement of fluids in rock.

More indicative of continuing activity beneath Long Valley are the precise measurements of distance across the caldera made by John Langbein and Mark Linker of the U.S. Geological Survey (USGS) in Menlo Park. Using the travel time of laser light to measure distances from their site at Casa Diablo, Langbein and Linker have found continuing expansion since last summer across some survey lines at rates as high as 6 parts per million per year. In other terms, in some places a kilometer of valley floor is growing at a rate of 6 millimeters per year. Where there is expansion, the typical rate of a few parts per million per year is ten times the rate that the crust is being strained along the San Andreas.

The expansion seems to be consistent with either of two kinds of magma injection beneath Long Valley. Both include injection into the main magma chamber, which has now been firmly located 7 to 8 kilometers below the central part of the caldera. James Savage of the USGS in Menlo Park has suggested that a lateral feeder from the main chamber has supplied magma to a vertical column or dike of magma pushing up beneath the area of the earthquake swarms on the southern edge of the caldera. This dike would extend to within 3 kilometers of the surface (*Science*, 10 June 1983, p. 1138). A bit less ominously, John Rundle of Sandia Laboratories has since proposed that injection of magma into a second, smaller chamber 5 kilometers beneath Casa Diablo, a few kilometers northeast of the swarm area, could have triggered the swarms on a preexisting fault. In either arrangement, the expansion requires continuing magma injection at relatively shallow depths.

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Although Long Valley has quieted down, two other calderas that have had quiet times of their own seem to be approaching crises again (*Science*, 28 January 1983, p. 373). The Phlegraean Fields caldera, within which live 200,000 people, returned to life in 1970 after more than four centuries of slow subsidence following an eruption in 1538. Within 2 years, the ground across a 12-kilometer circle had risen as much as 170 centimeters. During the next 10 years, though, there was no net uplift. Then in 1982 the uplift resumed, and by March 1983 it was accompanied by increasingly intense seismic activity. At rates as high as 4 millimeters per day, the ground rose another 142 centimeters by the end of March. The suburban Naples town of Pozzuoli, which sits atop the uplift, is now deserted by night.

The seaport of Rabaul on New Britain Island, Papua New Guinea, has been living under a stage 2 volcano alert—an eruption is possible within a few months—since last October. The relative quiet after the last eruption in 1941 had given way to renewed uplift that had averaged 10 centimeters per year since 1973 and is now running at 5 centimeters per month. The number of earthquakes per month in the caldera continues to increase, hitting 8729 in March.

Long Valley's quiescence has given geologists a chance to inspect the area for clues to the style of any future eruptions. Kerry Sieh of the California Institute of Technology and C. Dan Miller of the USGS in Denver have independently studied different sections of the Mono and Inyo craters, a string of eruption sites that runs 30 kilometers from Mono Lake southward into the western sector of Long Valley. At its northern end, Sieh found a 6-kilometer line of six vents that erupted in a single episode rather than independently, as previously assumed. To the south, Miller found a similar cluster of eruptions among three vents and a dozen explosion pits on a single 11-kilometer section.

When Miller and Sieh compared their best radiocarbon dates for the two clusters, both sets of eruptions were about 500 to 600 years old within the precision of the measurements. Thus, not only might whole 10-kilometer sections fire off at once or nearly at once but the entire Mono-Inyo chain could be active at once. The likely underlying cause of such synchroneity is the injection of fresh magma all along the dike that presumably supplies the craters from an underlying magma chamber. An analogy with the adjacent Long Valley magma chamber and its proposed 8-kilometer-long dike seems reasonable.

The subsidence of activity at Long Valley coincides with the announcement by the USGS that it is eliminating the hierarchy of hazard alerts under which a notice of potential volcanic hazard had been issued for the area. In order to eliminate "excessive concern from the public, news media and public officials," only a single warning involving an immediate hazard can be issued, a warning that Long Valley might not qualify for at the moment. USGS officials are now considering whether to drop the Long Valley hazard notice in favor of informal communications with public officials.

—RICHARD A. KERR