

# Deep magma matters in volcanic eruption cycle

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Lava pours out of Montserrat during an eruption. Researchers have used observations to create a new model that better explains what happens beneath the volcano's surface. Image: University of Arkansas

Although the Soufriere Hills volcano on Montserrat exhibits cycles of eruption and quiet, an international team of researchers found that magma is continuously supplied from deep in the crust but that a valve acts below a shallower magma chamber, releasing lava to the surface periodically.

"Continuous records of surface deformation are available for only a few volcanoes," says Derek Elsworth, professor of energy and geo-environmental engineering, Penn State. "The Soufriere Hills volcano has been erupting since 1995 and provides a peek into the processes

occurring deep beneath this stratovolcano."

Stratovolcanoes are one of the most common forms of volcano on Earth. They are cone-shaped with steep sides created by episodic eruptions of magma that flow down from the cone a short way and create layer upon layer of volcanic material.

The researchers, who include Elsworth; Barry Voight, professor emeritus of geology and geological engineering, and Joshua Taron, a doctoral student in energy and geo-environmental engineering, Penn State; Glen Mattioli, professor of geosciences, University of Arkansas, and Richard Herd, senior lecturer in geophysical Earth observation, University of East Anglia, UK, report on using measurements of ground inflation and deflation as a window to the transfer of magma deep within the crust. From these observations, "it is apparent that the major changes in magma storage that have supplied the eruption are from depth, with the lower reservoir contributing only a third of the erupted volume," they say in today's issues (Oct. 9) of the journal *Science*.

In 1995, Soufriere Hills volcano began the current series of eruptions and pauses. The November 1995 event lasted until March 1998, during which time a dome of andesite – a volcanic rock – grew continuously. From March 1998 until November 1999, there was a pause in above ground volcanic activity and the lava dome collapsed from its own weight and inactivity. Beginning in December 1999, the second episode continued until mid-July 2003, followed by a pause until October 2005. The third episode began then and ended in March 2007.

"The pause that began in 2007 apparently ended in August 2008 with the slow extrusion of lava on the western flank of the dome," says Elsworth.

The pattern of eruptions and pauses might suggest that the magma beneath the Earth behaves in a stop-and-start pattern but the data

indicate that magma production beneath the volcano is continuous and relatively constant. During eruptive pauses, the magma supply inflates the deep chamber until this stored magma is released into the upper chamber where it forces a renewed eruption. These observations implicate the deep reservoir in setting the timing of eruptions, rather than the shallow chamber, as had previously been considered.

The researchers believe that the upper reservoir is open and that there is a "valve" between it and the lower reservoir because the lower reservoir can refill while the upper reservoir is open and unaffected. It is unknown whether a build-up of heat or the pressure of gas breaches the valve from the lower to upper reservoir.

Analysis of the data collected on the Soufriere Hills volcano also indicates that the periodic eruptions deplete only the lower magma reservoir, not the upper reservoir. During lulls in eruption, the deep reservoir refills but at only half the rate that the magma was lost. Because the pauses between eruptions are shorter than the eruptions, the deep magma chamber does not make up the pre-eruption volume and the deep magma chamber, over time, contains less and less magma.

Source: Penn State

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