# Volcanoes inner workings disclosed when the Earth moved

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While volcanologists can see the dome of the Soufriere Hills Volcano on the island of Montserrat grow and collapse, it takes instrumentation to delve beneath the surface. Now, Penn State geologists, using tiltmeter measurements, have investigated a shallow area under the dome and what they found was not quite what they expected.

"The Soufriere Hills Volcano has been building a lava dome, collapsing and rebuilding a dome since 1995, when it first erupted," says Dr. Christina Widiwijayanti, postdoctoral researcher in geosciences, working with Dr. Barry Voight, professor of geosciences. "We are working with data collected from tiltmeters in 1997 to try to understand the volcano's behavior and what is happening inside."

Voight had placed several tiltmeters around the crater rim of the volcano in 1996-97, but no more than two were ever working at once and during the important June 25, 1997 dome collapse, only one was operational. However, from a record the previous month, two tiltmeters recorded the cycle of pressurization and depressurization that took place under the dome on a 3 to 30-hour cycle.

A tiltmeter, like a carpenter's level, measures the local angular movement of the Earth. With synchronized data from two tiltmeters, the researchers, who included Dr. Amanda Clarke a former Penn State graduate student who is now an assistant professor at Arizona State University, and Dr. Derek Elsworth, professor of energy and geo-environmental engineering, could determine the depth of the source

region causing the tilting near the dome. They reported their work in a recent issue of Geophysical Research Letters.

"But, what we really would like to know is the configuration of the pressurized area, its shape and size, as well as position," says Widiwijayanti. "We know the size and shape of the conduit system that delivers the lava, but our results suggest that a more extensive region is involved in the pressurization."

The researchers found the pressure to be centered about a half mile below the dome or nearly 2.5 miles above the magma chamber feeding the surface flow of lava. The magma tube or conduit in this area is about 100 feet in diameter, but, using tiltmeter data collected during the collapse, the researchers found that the region undergoing pressurization and depressurization is between about 700 and 1100 feet in diameter. The researchers used a sphere and a cylinder to model the pressurized area. The known size of the dome collapse could be used to calibrate the source pressure.

"When the dome collapses, the area should be rebounding, going up, but the tiltmeter shows that it goes down" said Widiwijayanti. "There must be something related to depressurizing the system in the volcano that does this."

The researchers believe that the region around the conduit is fractured, with the pore spaces filled by hot water and gas. "When the volcano conduit at depth is under pressure, super-heated steam and other gases can leak out of the conduit and raise the pressure in the fractured rock over a broad region. That is what we think we are seeing as the pressurized zone," says Voight.

The 1997 dome collapse, with 8.5 million cubic yards of lava and talus, was not the largest at the Soufriere Hills Volcano, although 19 people

were killed by it and the event rewrote the political history of Montserrat. In July 2003 the dome collapse produced 275 million cubic yards, the largest on Earth in historic time.

The 2003 collapse was recorded using new and more varied equipment installed by the CALIPSO project (Caribbean Andesite Lava Island Precision Seismo-geodetic Observatory), funded by the National Science Foundation and the U.K. Environment Research Council. Voight is project director of the consortium, which involves a number of institutions in the U.S. and U.K. While researchers recorded the 1997 data before the initiation of CALIPSO, the analysis of both data sets is part of the project.

Source: Penn State