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**More than 500 million people, or about 10 percent of the world's population, live within 100 kilometers of an active volcano.**

# Seismic signals

## Magma-mapping to forecast volcanic hazards

Volcanoes produce a rich variety of seismic signals in addition to those generated during normal earthquakes. The signals that result from movement of magma or other volcanic fluids, or the resonance of fluid-filled cracks, have distinct characteristics. These characteristics make volcanoes difficult to analyze using the same methods employed to study the earthquakes that occur in such places as California's San Andreas Fault. Yet understanding these volcanic earthquakes is paramount to determining the dynamics of magmatic plumbing systems—and ultimately to forecasting volcanic hazards.

Gregory P. Waite is using syneruption volcanic earthquakes to map magma conduits by modeling high-fidelity recordings of the events. This is only possible from recordings made at close range. To collect these data, Waite and his research team hike high onto the flanks of erupting volcanoes to place seismometers, which detect ground vibrations, and infrasonic microphones, which detect low-frequency pressure waves in the air.

Their work at Mount St. Helens led to a new model to explain the cause of shallow, repetitive earthquakes associated with the recent minor eruption—an eruption that continued for several years, from 2004 to 2008.

They showed that the source of these earthquakes might consist of a shallow hydrothermal crack, filled with a mixture of meteoric and juvenile steam that is pressurized by the magmatic activity. Over a period of three to five minutes, gas pressure rises until a threshold is reached and steam is forced from the crack, causing the crack to partially collapse and resonate. The collapse of this crack, which is adjacent to the magma conduit, triggers a second type of earthquake in the magmatic system, the source mechanism of which indicates a corner in the magma conduit where the pathway deviated from that which fed earlier eruptions.

Waite's research team is applying these techniques to study volcanic earthquakes in other areas—such as at Pacaya and Fuego volcanoes in Guatemala—and integrating data from volcanic gas emissions to better understand the role of magmatically-derived gas in the generation of volcanic earthquakes. Ultimately, this work should lead to an improved eruption prediction at hazardous volcanoes worldwide.