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Active Source Seismic Experiment Peers Under Soufrière Hills Volcano

Characterizing internal structures of active volcanoes remains an enigmatic issue in geology. Non-invasive structural imaging techniques such as seismic tomography can greatly improve hazard assessments, helping geologists locate key volcanic signatures, geodetic deformation, and gas emissions, data that can be used to improve models of volcanic behavior and future eruptions.

Several passive seismic tomography experiments—such as the use of time lapse of seismic waves around volcanic structures to image underground structures—have been conducted at Soufrière Hills volcano (Montserrat, Lesser Antilles) and Mount Etna (Sicily, Italy). These methods can help locate magma bodies, and can be used to predict and forecast volcanic eruptions.

Soufrière Hills is an active volcano located on the Caribbean island of Montserrat. It is known for its large, explosive eruptions and has been monitored closely since its eruption in 1995.

Montserrat's Volcanic Complexes

Three centers of volcanism have been previously identified on Montserrat, with two occurring during a single eruption: Soufrière Hills and Montserrat's volcanic center. Soufrière Hills is a complex system that has been active for over 1000 years, while Montserrat's volcanic center has been active for at least 5000 years. Both centers are characterized by a variety of volcanic features, including lava flows, pyroclastic deposits, and volcaniclastic rocks.

The SEA-CALIPSO Active Source Experiment

The SEA-CALIPSO experiment involved installing a 3-D seismic array consisting of 28 three-component seismometers (Reftek model RT125A) and 200 one-component “Texas” seismometers (Reftek model RT125A), and an array of ocean bottom seismometers (OBS), which were deployed and deployed continuously at 200 or 100 samples per second. This allowed for the observation of seismic events with high temporal resolution, enabling the detection of short-lived seismic signals.

A preliminary 2-D inversion of a subset of the data suggests that there are a number of distinct volcanic centers beneath Soufrière Hills. This is further supported by the observation of a number of seismic events that are not currently understood.

The inversions based on active source data were compared to 25 km of depth with lesser precision using teleseismic data. Receiver function studies define the Mohorovicic discontinuity (the boundary between the crust and the mantle) of about 30 km in depth.

The SEA-CALIPSO study is a novel active source tomographic experiment of a hazard of anesitic island stratovolcano, and the first to present a detailed 3-D model of the volcano in the Lesser Antilles. Initial and future results will help scientists understand volcanism and provide insights into how regions of intermediate composition, such as the Lesser Antilles, are formed and evolve. The findings could also inform the development of volcanic observatories, which are critical for monitoring volcanic activity and predicting eruptions.
Volcano Imaging on Montserrat,” focuses on this project, its setting in the West Indies, and the ongoing eruption of Soufrière Hills volcano (see http://www.agu.org/journals/gl/special_sections.shtml?collectionCode=CALIPSO2&journalCode=GL).

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References


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