

Small inflations prior to volcanic earthquakes at Azuma volcano, Japan

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Existence of volcanic fluid in the shallow crust beneath active volcanoes is considered to be closely related to the generation process of volcanic earthquakes such as the nucleation of shear faulting due to the reduction in effective normal stress on the faults and the creation of tensile faults. In addition, the movement of volcanic fluids sometimes causes earthquake swarms and migration of hypocenters. Therefore, the observation and understandings of fluid-related phenomena associated with volcanic earthquakes would be important for understanding of volcanic phenomena. In this presentation, as an example of such interaction between volcanic earthquakes and volcanic fluids, I will report the detection of small inflation phase prior to the occurrence of volcanic earthquakes observed at Azuma volcano, Japan.

Azuma volcano is one of the quaternary volcanoes located at the volcanic front of the Northeast Japan arc, and it consists of overlapping stratovolcanoes of shield volcanoes, lava domes, and pyroclastic cones. Historical eruptions of Azuma volcano were mostly small phreatic eruptions at Issaikyo and O-ana crater at the northern end of the Higashi-Azuma volcanic complex. Just beneath the O-ana crater, occurrence of various types of volcanic earthquakes including volcanic, tremor, low-frequency earthquakes, monotonic/harmonic earthquakes, and Tornillos as well as the volcano-tectonic earthquakes have been reported, and these facts suggest the existence of hydrothermal system and fracture system beneath the volcano. Since 2014, the activity of Azuma volcano become rather high, and subtle ground deformation and increase in seismicity are observed. In addition, there is an earthquake swarm in the middle of January 2015.

To understand the nature of this earthquake swarm, we carefully analyze the seismic and geodetic (tilt) records observed at nearby stations, and detect the existence of small inflation phase just prior to the occurrence of volcanic earthquakes. The inflation phase starts about five seconds before the occurrence of earthquakes, and observed displacement and tilt vectors roughly point to the epicentral area. The depth of the inflation source determined by fitting of displacement and tilt waveforms is around 2 km, and thus the location of inflation source is just below the source of thermal demagnetization/magnetization detected by the repeating magnetic field survey in this area. These results provide a direct evidence of the interaction between volcanic earthquakes and volcanic fluids, and further study may reveal the generation and triggering processes of shallow volcanic earthquakes.

Keywords: Volcanic earthquake, Volcanic fluids, Earthquake nucleation