

Trapdoor faulting near Kita-Ioto Island: Quantification of magma overpressure beneath a submarine caldera

*Osamu Sandanbata¹, Tatsuhiko Saito¹

1. National Research Institute for Earth Science and Disaster Resilience

Monitoring of submarine volcanoes are important to investigate volcanism on the Earth and to assess potentials of volcanic hazards, but often challenging due to their inaccessibility. Utilization of remotely observed data of seismic and tsunami events at submarine calderas is a useful way to study submarine volcanoes.

In this study, we first report that moderate-sized and non-double-couple earthquakes with seismic magnitudes $M_w \sim 5$ repeated at a submarine caldera near Kita-Ioto Island every several years, without any eruption report. Following the earthquake in 2008, a millimeter-scale tsunami signal was recorded by an ocean-bottom-pressure sensor about 1,000 km away from the caldera. These observations indicate that so-called *trapdoor faulting*, involving dip slip of an intra-caldera fault and deformation of an underlying sill-like magma reservoir, was driven by overpressure of magma that had accumulated in the reservoir (Sandanbata et al., 2020, JpGU).

We propose a physics-based model of trapdoor faulting that quantitatively relates the stress drop on the intra-caldera fault and the pressure drop in the magma reservoir with the magma overpressure as the driving force. By quantifying the trapdoor faulting size of the 2008 event with the milli-meter tsunami data and long-period seismic data in/around Japan, we estimated that the magma overpressure of >10 MPa caused the trapdoor faulting with an intra-caldera fault slip of >5 m. Our model shows that the magma depressurization due to the trapdoor faulting was only 10–20 % of the overpressure before the event. These results suggest that the submarine caldera can constantly contains highly pressurized magma in the underlying reservoir, which results in recurrence of trapdoor faulting. We speculate that the magma pressure relief by trapdoor faulting postpones the eruption timing and makes the reservoir accommodate larger volume of magma.

Keywords: caldera, magma, volcanic tsunami, volcanic earthquake, submarine volcano