

## Source location of volcanic earthquakes and tremors at Sakurajima volcano based on seismic correlation

\*Theodorus Permana<sup>1</sup>, Takeshi Nishimura<sup>1</sup>, Hisashi Nakahara<sup>1</sup>

1. Solid Earth Physics Laboratory, Department of Geophysics, Graduate School of Science, Tohoku University

Precise source locations of volcanic tremors and earthquakes are one of the most basic information that is important to understand the volcanic process. The spatio-temporal changes of these source locations may provide insights into the eruption mechanism and the movement of volcanic fluids. However, the determination of those source locations is quite challenging due to the difficulties to distinguish their seismic phases and precisely measure the arrival times. Recently, we developed a hypocenter determination method for volcanic earthquakes and tremor, which adopts seismic interferometry processing technique for calculating cross-correlation functions (CCFs) and the source-scanning algorithm (SSA) (Permana et al., in preparation). Here, we apply our method to observed data recorded at Sakurajima volcano. We first locate volcano-tectonic earthquakes (VTs) and evaluate the location errors by comparing the results with the hypocenters determined by a phase-picking method. Then, we locate volcanic tremors and discuss their source locations, which cannot be obtained from phase-picking methods due to indistinguishable phase arrivals.

We analyze VTs that occurred during a rapid dike intrusion on August 15, 2015. Our result shows the hypocenters are distributed beneath the Mt. Minamidake mainly at 0-4 km depths. Our source locations are consistent with the hypocenters obtained by using the method of Hirata and Matsuura (1987), and the errors are estimated to be 2 km or less.

We determine the source locations of two kinds of tremors occurred on August 22-25, 2017. The first is a 13.5 hours long continuous tremor accompanying Strombolian eruptions on August 22-23. The second is a series of intermittent tremors that are recorded following the explosion earthquakes associated with Vulcanian eruptions which followed the continuous tremor. We calculate the CCFs at 1-3 Hz by using 20 s time windows with 19 s overlap for these tremors and stacked them to obtain average CCFs. Our results show that the source locations of the first 6 hours of continuous tremor, which are determined every 10 minutes, are located beneath Mt. Minamidake at depths from about 3 km to below the active crater. The sources of the following continuous tremor are located at shallower depths, from about 2 km depth to the ground surface on the southern flank of Mt. Minamidake. The sources of 61 segments of the intermittent tremors are densely distributed at 0-2 km depth beneath Mt. Minamidake.

The observed tremors are related to the eruptive activities at Sakurajima volcano and their sources are expected to be located at the eruptive conduit. Our estimated sources are distributed at the shallow depths beneath the active craters within the estimated errors. Therefore, our results show the prospect of our method as an alternative for tremor source location determination and volcano monitoring. The depth range of our results for continuous tremor also coincides with the previous studies on the generation depth of volcanic earthquakes.

Keywords: volcanic earthquakes, volcanic tremor, source location, cross-correlation, hypocenter