Comparison of Source Location Methods: CCF-based SSA and ASL

*Theodorus Permana[1], Takeshi Nishimura[1], Hisashi Nakahara[1]

1. Tohoku Univ.

Source location determination of volcanic tremors is a challenge in seismology due to unclear phase arrivals of P- and S-waves, which makes conventional hypocenter methods using phase arrival times inapplicable. Previous studies have proposed alternative methods using spatial distributions of seismic amplitudes, called the amplitude source location (ASL) method (e.g. Battaglia & Aki, 2003; Kumagai *et al.*, 2010), which have been applied at various volcanoes. Another is the method using the seismic cross-correlation functions (CCFs), which is called the CCF-based Source Scanning Algorithm (CCF-based SSA) method proposed by Droznin *et al.* (2015). Both methods work by performing a grid search to find an optimal point that represents the source location. However, the CCF-based SSA method by the previous study does not determine the source depth, and there are only a small number of studies that apply the method to real data. We recently modified the CCF-based SSA method to determine the horizontal location and source depth (Permana et al., submitted). In this study, the performances of CCF-based SSA and ASL methods to locate seismic sources are compared. We use seismic records of volcano-tectonic earthquakes (VTs) at Izu-Oshima and Sakurajima volcanoes. The VT hypocenters located by using an arrival time method (Hirata and Matsuura, 1987) are used as the reference. By assuming that S-wave is dominant in the waveforms, we locate the VTs using CCF-based SSA and ASL methods and calculate the misfits by comparing the obtained source locations with the reference hypocenters.

The results show that the misfits for the ASL method are more horizontally shifted from the reference than those for CCF-based SSA method, although the standard deviations of the ASL method are smaller. The results also show that the ASL method is much affected by the selection of the constant S-wave velocity, quality factor Q, and site amplification factors: S-wave velocity and Q have a more significant effect on the source depth, while the site amplification factor affects the horizontal location. On the other hand, the CCF-based SSA method does not show such systematic biases in the locations, but slightly larger standard deviations of up to about 2 km are obtained. In both methods, the configuration of seismic stations has an important role in constraining the source location.

We finally point out the advantage of using CCF-based SSA method as it requires smaller number of the initial information and is able to consider a complex velocity model.