Time-lapse monitoring of seismic velocity associated with the 2011 Shinmoedake eruption using seismic interferometry

*Kiwamu Nishida[1], Yuta Mizutani[1]

1. Earthquake Research Institute, University of Tokyo

In recent years, the number of applications of seismic interferometry is increasing. In the analysis, the cross-correlation function between ambient noise records of a pair of stations can be regarded as a virtual seismic waveform recorded at one station when the source is placed at the other station. Since, in any time period, the seismic velocity around the station pair can be estimated from the cross-correlation function calculated without an earthquake, the seismic interferometry has been applied in many studies to monitor the temporal change of the seismic velocity. A number of studies have monitored the seismic velocity change in the volcanic region with seismic interferometry and detected the temporal change in seismic velocity associated with the eruption (Brenguier et al., 2008; Rivet et al., 2015). Inferred seismic velocity changes in the volcanic region frequently show the seasonal variations, which were caused by precipitation. The amplitude of seasonal fluctuation has the same order of magnitude of velocity change associated with the eruption. Therefore, in order to detect the transient velocity change accompanying the eruption, it is important to evaluate the seasonal fluctuation due to precipitation quantitatively and remove it appropriately from the estimated seismic velocity change. In this study, seismic interferometry was applied to a seismic array around Shinmoedake to monitor the seismic velocity change, aiming at detecting the velocity change associated with the Shinmoedake eruption in 2011. First, a cross-correlation function was calculated for each pair of stations using continuous ambient noise data for 8 years from May 2010 to April 2018. The stretching method (Sens-Schönfelder and Wegler, 2006) was applied to the calculated cross-correlation function to estimate the temporal change of the seismic velocity. From the estimated seismic velocity change by the stretching method, the seasonal variation affected by precipitation was detected as in the previous study (Wang et al., 2017). Therefore, the effect of precipitation was quantitatively evaluated using pore pressure model (Roeloffs, 1988; Talwani et al., 2007). After the effect of precipitation was subtracted, the seismic velocity change associated with the eruption was detected in several pairs. In order to constrain locations of the seismic velocity change in space, the horizontal and depth sensitivity kernel was calculated. The kernels suggested that structural changes would not occur in the depth of 1-3 km in the southeastern side and in the depth of 1-2 km in the northwestern side of Shinmoedake.

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