Japan Geoscience Union Meeting 2014
(28 April - 02 May 2014 at Pacifico YOKOHAMA, Kanagawa, Japan)

SSS27-04 Room:411 Time:April 29 09:45-10:00

Temporal changes of auto-correlation functions associated with the volcanic activity in Hakone volcano, central Japan

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Auto-correlation functions (ACFs) of ambient noise are thought to be a powerful tool for searching temporal change of crustal structure associated with strong ground motion, or volcanic activity. In this study, we investigated the velocity changes at Hakone volcano associated with an intense swarm activity.

Hakone volcano is located at the northern boundary zone of the Izu?Mariana volcanic arc in central Japan, Many intense periods of swarm activity have occurred in the caldera. It was noted, in last two decades, that seismic swarms were remarkably prevalent in 2001, 2006, 2008-2009, 2011 and 2013. During the swarm activities, except for that in 2011, crustal deformations related to volcanic activities were detected by the GNSS stations network in and around the caldera of Hakone volcano. In particular, remarkable tilt changes were also detected by the tiltmeters within the caldera in 2001 and 2013 activities. It is interpreted that the crustal deformation was caused by pressure from a Mogi point source or dike at a depth of 7 km and two shallow open cracks in the caldera (e.g. Daita et al., 2009; Harada et al., 2009).

To estimate the velocity changes associated with the 2013 activity, we used the continuous velocity waveforms recorded at the stations of Hot Springs Research Institute, National Research Institute for Earth Science and Disaster Prevention Hi-net, Japan Meteorological Agency in and around the caldera, in the period between January 2012 and December 2013. Filtered trace at the frequency band of 1-3 Hz was used to calculate autocorrelation by one-bit correlation technique. To obtain stable record of the one-day ACF, we stacked the ACFs for time intervals of one week. We obtained fluctuations of the velocity structure by using the stretching method (e.g. Wegler et al., 2009).

The velocity fluctuations at the stations in the caldera show a gradual decrease prior to the swarm activity. The velocity decreases at these stations are consistent with increases in base length detected by the GNSS stations around Hakone volcano. We also found that there was sudden velocity decrease at Owakudani station near fumarolic area just after the beginning of swarm activity and tilt changes. We interpreted the velocity decrease at these stations as a material change or a crustal deformation associated with the volcanic activity.

Keywords: auto-correlation functions, volcanic activity, Hakone volcano