Scattering and intrinsic absorption parameters at active volcanoes in Japan estimated by using envelopes of seismic ambient noise cross-correlation functions

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In recent years, space-time imagings of seismic velocity changes and/or seismic scattering property changes associated with large earthquakes or volcanic activities have been conducted using seismic interferometry (e.g., Obermann *et al.*, 2013a; Obermann *et al.*, 2014; Machacca *et al.*, 2019). Estimating scattering and intrinsic absorption parameters is important to conduct such analyses because these parameters are necessary to locate the change region of seismic velocity change and/or seismic scattering property change precisely. In the last few decades, those parameters have been estimated using records of natural earthquakes or active seismic experiments (e.g., Carcole and Sato, 2010; Yamamoto and Sato, 2010). Conducting such estimations estimation is difficult in regions with low seismicity and no active seismic experiment. Recently, Hirose et al. (2019) developed a passive estimation method of scattering and intrinsic absorption parameters based on seismic interferometry and estimated these parameters at Sakurajima volcano. This method enables us to estimate those parameters in various regions. In this study, we apply the passive method at 9 active volcanoes in Japan (Izu-Oshima, Miyakejima, Asosan, Kirishimayama, Tokachidake, Asamayama, Unzendake, Fujisan, Kusatsu-Shiranesan), and estimate scattering and intrinsic absorption parameters of Rayleigh waves.

We used seismic ambient noise data recorded at V-net and JMA stations. The number of seismic stations is 5-11 for each volcano. Adopting temporal flattening technique (Weaver, 2011a) to the seismic ambient noise data, we computed daily cross-correlation functions (CCFs) (ZZ, ZR, RZ, ZT, TZ) at 0.5-1 Hz, 1-2 Hz, and 2-4 Hz bands, and stacked them as following procedures: We simply averaged causal and acausal part of ZZ, and averaged causal part of ZR (ZT) and acausal part of RZ (TZ). Then, we stacked these averaged daily CCFs and computed mean squared envelopes by smoothing squared amplitude with 4 s (0.5-1 Hz), 2 s (1-2 Hz) or 1 s (2-4 Hz) long time windows. Parameters of scattering and intrinsic absorption were estimated by modeling the space-time distribution of energy density calculated from CCFs with 2D radiative transfer theory.

Estimated scattering mean free paths of Rayleigh waves were 1.4-3.5 km at 0.5-1 Hz, 0.7-2.6 km at 1-2 Hz, and 0.7-1.5 km at 2-4 Hz. Intrinsic absorption parameter b ($b=Q_I^{-1}\omega$) were estimated to be 0.03-0.18 s^{-1} at 0.5-1 Hz, 0.04-0.10 s^{-1} at 1-2 Hz, and 0.05-0.19 s^{-1} at 2-4 Hz. The estimated scattering mean free paths at the 9 active volcanoes are 2-3 orders shorter than those in non-volcanic regions (e.g., Sato *et al.*, 2012) suggesting that medium heterogeneities are strong at shallow parts of these active volcanoes. The estimated values of scattering and intrinsic absorption parameters in this study will be useful for the space-time imaging of seismic velocity and/or scattering property changes associated with volcanic activities.

Acknowledgements: We used seismograms recorded by Japan Meteorological Agency (JMA) and National Research Institute for Earth Science and Disaster Resilience (NIED).

Keywords: seismic interferometry, scattering mean free path, intrinsic absorption parameter, active volcano

