Passive estimation of scattering and intrinsic absorption parameters at 18 active volcanoes in Japan using envelopes of seismic ambient noise cross-correlation functions

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Estimating seismic scattering and intrinsic absorption parameters, which are measures of medium heterogeneity, is important for understanding the complex structure in shallow regions of volcanoes. In recent years, seismic ambient noise cross-correlation functions (CCFs) have been used instead of records of natural earthquakes or active seismic experiments to estimate those parameters (e.g., Hirose et al., 2019; Hirose et al., 2020; van Dinther et al., 2020). This passive approach possibly allows us to estimate scattering and intrinsic absorption parameters in previously unmeasured regions and frequency bands. In this study, we apply the passive estimation method proposed by Hirose et al. (2019) to 18 active volcanoes in Japan and measure those parameters of Rayleigh waves. We used three-component seismic ambient noise data in the frequency bands of 0.5-1 Hz, 1-2 Hz, and 2-4 Hz at seismic stations of NIED, JMA, HSRI, and MFRI. Before computing CCFs, the temporal flattening technique (Weaver, 2011) was applied to ambient noise data for reducing the effect of temporal fluctuations in noise levels with retaining relative amplitudes among the stations. Daily CCFs of three components (ZZ, ZR, ZT) were computed by stacking 10-minutes-CCFs. We stacked daily CCFs over 1 year 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. Scattering and intrinsic absorption parameters were estimated by modeling the space-time distributions of energy densities calculated from CCFs with 2D radiative transfer theory. Best-fit values of scattering mean free path at the 18 active volcanoes range between 1.0-4.6 km at 0.5-1Hz band, 0.7-2.9 km at 1-2 Hz band, and 0.9-2.9 km at 2-4 Hz band, respectively. These values are 2 orders of magnitude shorter than those in non-volcanic regions (e.g., Sato et al., 2012). Those of intrinsic absorption parameter range between 0.05-0.26 s\(^{-1}\) at the 0.5-1 Hz band, 0.06-0.24 s\(^{-1}\) at the 1-2 Hz band, and 0.06-0.32 s\(^{-1}\) at the 2-4 Hz band, respectively. They are at most one order of magnitude larger than those in the non-volcanic regions. Especially strong intrinsic attenuations are estimated at volcanic islands. Water-bearing layers at a depth of several hundred meters below these islands may cause such strong intrinsic attenuations. The frequency dependence of scattering attenuations is also strong at these volcanic islands, suggesting non-uniform structures that largely fluctuate along depths. The results of this study suggest that the passive estimation method of scattering and intrinsic absorption parameters proposed by Hirose et al. (2019) is applicable to various volcanoes. Comparing estimated values of these parameters at various volcanoes will improve our understanding of complex structure at the shallow regions of...
volcanoes. Moreover, the parameters estimated in this study will boost locating spatial distributions of seismic velocity and/or scattering property changes associated with volcanic activities at the 18 volcanoes.

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