Scattering and attenuation characteristics at active volcanoes inferred from envelope widths of volcano-seismic events

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We propose a method to estimate scattering and attenuation characteristics beneath active volcanoes using envelope widths of volcano-seismic events. In this method, we estimate the peak amplitude (A) and cumulative amplitude (I) using an observed envelope waveform of a volcano-seismic event at each station. We define the ratio of the cumulative amplitude to the peak amplitude (I/A) as the envelope width (T). We used the approximate analytical equation of Paasschens (Phys. Rev. E, 1997) for the radiative transfer theory in 3D isotropic scattering medium to derive the relationship of p with the total scattering coefficient g0 and intrinsic attenuation Q. The estimated relationship indicated that p increases with increasing g0 and Q at a constant source-station distance, and p also increases with the source-station distance. We estimated p values for volcano-tectonic (VT) events at Taal volcano, Philippines, and long-period (LP) events at Nevado del Ruiz volcano, Colombia. Our estimated p values increased with increasing source-station distances in the ranges between 1 and 5 s. We found no correlations between p and event size, indicating that p is determined by the medium characteristics. The observed p values were explained by the mean free path l0 (1/g0) of 500-1500 m assuming Q = 50 based on the relationship. These values are consistent with those estimated at other volcanoes. We compared p values for VT events at Taal, of which source locations were very similar, and found the p values at individual stations showed similar values among the different events. However, these p values were not explained by assuming constant g0 and Q in space. Furthermore, we found that p values at a particular station where rays passed through the attenuation region estimated by Kumagai et al. (GRL, 2014) showed different values in time. These results indicate that the envelope width may be used to as a parameter to estimate the scattering and attenuation characteristics beneath volcanoes.

