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S wave attenuation and high-frequency seismic wavefield at Taal volcano, Philippines, inferred from waveform simulations

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Taal volcano is one of the world's most active volcanoes. The existence of a region of strong attenuation (a low-Q region) near the ground surface, which may represent degassing magma, was estimated at Taal volcano, Philippines, from source location analysis using the amplitude source location (ASL) method. The ASL method uses high-frequency amplitudes under the assumption of isotropic S wave radiation caused by the scattering of seismic waves. To investigate the validity of the estimated Q structure based on a stochastic approach of the ASL method and to understand the nature of seismic wavefield, we used a deterministic approach based on numerical simulations of high-frequency seismic waveforms. We synthesized waveforms of volcano-tectonic events at Taal using a 3-D finite-difference method. We used focal mechanisms derived from first-motion polarities, and examined various sizes of Q anomalies, in which P and S wave velocities and density were assumed to be constant. To evaluate the fits between the observed and synthesized waveforms, we calculated the normalized residual using mean amplitudes in four frequency bands (1-6, 3-8, 5-10, and 7-12 Hz). Our simulations provided the minimum residual when using the low-Q region estimated by the ASL method. Although our simulation is a deterministic approach and different from the stochastic approach of the ASL method, the low-Q region estimated from these approaches was coincident. There were possible focal mechanisms for each VT event because they were derived from fisrt-mostion polarities at a small number of stations. We found that the residuals depended on assumed focal mechanisms. If the radiation pattern of the observed waveforms is isotropic, it is expected that the residuals do not depend on mechanisms. The coincidence of the estimated low-Q region and the residual dependence on focal mechanisms indicate that the radiation pattern of the observed waveforms in a high-frequency band is not completely isotropic and is also affected by focal mechanisms.

Keywords: Q factor, Magma, Amplitude source location method, Finite-difference method, Radiation pattern