Deconvolving explosion waveforms to estimate the Q structure beneath a volcano

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Active seismic experiments using explosion sources have been conducted in various volcanoes in Japan. Deriving detailed images of velocity and Q structures beneath volcanoes are important to our understanding of magma supply systems. Tomatsu et al. (GJI,146,781-794,2001) estimated the P-wave Q structure beneath the Kirishima volcanic complex using the pulse broadening method, in which the first arrival pulses in explosion waveforms were estimated assuming that source time functions of explosions are simple, impulsive waveforms. This assumption is, however, not always valid, and therefore, a better approach to reconstruct the first arrival pulses may be required. In this study, we show that an approach based on the deconvolution of explosion waveforms is useful for this purpose.

We use the method developed by Ohminato et al. (JGR,103,23839-23862,1998) to estimate a source time function of an explosion source. In this method, a source time function is expressed by a superposition of elementary source time functions assuming a fixed point source. We use observed vertical velocity waveforms from 14 stations near the S2 source in the active experiment conducted at the Kirishima volcanic complex in 1994. After instrumental corrections, the observed waveforms are integrated and bandpassed between 1 and 12.5 Hz. Assuming the isotropic source, we obtain the source time function of the S2 source, which is not simple pulse but is characterized by an oscillating feature.

We divide the observed waveforms by the source time function in the frequency domain, which are transformed into the time domain to estimate the impulse responses. In the divisions, the technique based on the water level is applied to avoid numerical instabilities. We find that the first arrival pulses in the impulse responses are more clearly and impulsively reconstructed compared to those estimated by Tomatsu et al. (2001), indicating the successful applicability of our approach.

We will reconstruct the first arrival pulses from all the sources in the active experiment at the Kirishima volcanic complex, which will be used to determine the pulse widths based on the method developed by Hasada et al. (EPS,53,3-11,2001). Such pulse width data will provide better solutions in the Q tomography compared to the previous study. It should be noted that dense observations surrounding explosion sources may also be required in future experiments for the waveform inversions.