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Mode conversion and energy partitioning revealed by an active seismic experiment at Sakurajima volcano

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Volcanoes are one of the most heterogeneous fields in the Earth's crust, and the understanding of such inhomogeneities in volcanoes may provide us important information on the various volcanic processes. In such small-scale heterogeneities, seismic waves and their energy are affected by the scattering and, in strong heterogeneities such as volcanoes, the multiple scattering and mode conversion mainly control the propagation of seismic energy. So far, using the spatio-temporal distribution of propagating seismic energy observed by the dense seismic network deployed by the active seismic experiment at Asama volcano, we have revealed the characteristics of multiple scattering and mode conversion between P and S modes. Although these studies succeeded in estimating the scattering parameters beneath the volcano, we miss the direct evidence of energy partitioning between P and S energies since the network at Asama volcano is composed mostly of vertical sensors.

In this study, we present results of our analysis on the separation of P and S energies and quantification of the energy partitioning revealed by our observation with a dense three-component seismic array. The array observation was conducted in November 2008 as a part of an active seismic experiment at Sakurajima volcano (Tameguri et al, this meeting) in which total of 15 artificial shots were exerted as sources for refraction and reflection surveys. To separate the modes of propagating energy, we deployed a square-shaped array composed of four three-component seismometers (Mark Products/Sercel L-22D) with a separation of 10 m, and recorded the outputs with 1 kHz sampling rate. To minimize the effect of the difference in responses of the seismometers, we measured the sensor response using the Signal-coil calibration method (Rogers et al, 1995) at the observation site and in the laboratory.

The seismograms observed by the array are characterized by spindle-like envelopes having small P-onsets and long codas lasting for more than 10 sec, and the decomposed P and S energies show the following characteristics: S energy rapidly increase just after the arrival of direct P wave and S energy exceed P energy about 2 sec after the first arrival; the ratio of P and S energies make the gradual transition to the equilibrium over about 5-10 sec. This behavior can be explained by the radiative transfer theory, taking into account the multiple scattering and mode conversion, in a medium characterized by the scattering parameters similar to those we obtained for Asama volcano, and the fact indicates the existence of strong heterogeneity beneath Sakurajima and the contribution of the mode conversion due to the heterogeneity. In addition, the ratio of P and S energies is estimated as around 5-7, and the ration shows weak frequency dependence. The result suggests the possibility to estimate the subsurface structure based on the energy partitioning.

These results suggest that the mode conversion from P to S and significant multiple scattering of each mode have an indispensable effect on the seismic wave propagation in heterogeneous volcanic environments. We expect our results on the energy partitioning and its transition to be of help to justify the applicability of seismic interferometry and pseudo-reflection method.