Crustal structure beneath Aso caldera, Japan, as derived from receiver function analyses of waveform data from densely distributed stations

Yuki Abe[1], Takahiro Ohkura[1], Takuo Shibutani[2], Kazuro Hirahara[1], Shin Yoshikawa[1], Hiroyuki Inoue[1]

[1]Graduate School of Science, Kyoto University, Japan, [2]Disaster Prevention Research Institute, Kyoto University, Japan

E-mail: abeyuki@aso.vgs.kyoto-u.ac.jp

Aso volcano, which is an active volcano, rises in the Kyushu district, Japan. It erupted over 600 km^3 of pyroclastic deposit 90 thousand years ago and formed a caldera with dimensions of 18 km by 25 km. After the huge eruption, small eruptions formed the central cones. Abe et al. (2010, JVGR) estimated the crustal structure beneath the caldera with receiver function (RF) analyses. They obtained a low velocity layer whose S-wave velocity is 2.4 km/s at depths between 15 km and 21 km beneath the western part of the caldera. They did not estimate the crustal structure beneath the eastern part because of the lack of seismic stations.

We set 5 stations in the eastern part of the caldera in July 2009, and started observation. We used waveform data obtained at these temporal stations and permanent stations established in and around the caldera by Aso Volcanological Laboratory, Kyoto Univ. and National Research Institute for Earth Science and Disaster Prevention, and examined the crustal structure beneath the whole of Aso caldera with RF analyses.

We used waveform data of teleseismic events (epicentral distances: 30-90 degrees, Magnitude: greater than 5.5) for calculating RFs with the extended-time multitaper method (Shibutani et al., 2008, BSSA), and estimated the S-wave velocity structure with genetic algorithm inversion of the RFs (Shibutani et al., 1996, GRL).

We revealed that low velocity layers whose S-wave velocities are 2.2-2.6 km/s exist between 8 km and 28 km in depth beneath Aso caldera except the northern and southern rim. Considering a study by Takei (2002, JGR), we estimated from the S-wave velocity structure that these low velocity layers contain 15% of melt or 30% of water at maximum. If the low velocity layers contain melt, its amount is 300 km^3 at maximum, which is about the same amount as magma erupted at the last huge eruption: 200 km^3 (Kaneko et al., 2007, JVGR). Beneath the eastern flank of the central cones, a low velocity layer whose S-wave velocity is 2.6 km/s exists only at depths of 8-15 km. Beneath the same area, a swarm of low frequency events exists at 15-25 km in depth according to a hypocentral catalog by Japan Meteorological Agency, and Geographical Survey Institute (2004, Report of Coordinating Committee for Prediction of Volcanic Eruption) detected a sill-like deformation source at 15 km in depth. Fluid movement just beneath the low velocity layer would cause low frequency earthquakes and crustal deformation. We can expect that melt is intruding through the swarm of the low frequency earthquakes, accumulating at the deformation source, and melting the crustal material above it.