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Crustal structure beneath Aso caldera, Japan, as derived from receiver function analyses

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Aso volcano which rises in the Kyushu district, Japan, is one of the most active volcanoes in Japan. Aso volcano experienced a huge pyroclastic eruption 90 thousand years ago, and formed a caldera with dimensions of 18 km by 25 km, one of the largest in the world. After the huge eruption, small eruptions formed the central cones. For understanding the activity of a volcano, it is important to examine the crustal structure and reveal the region where fluid is contained and the amount of the fluid beneath the volcano. Beneath Aso caldera, Sudo and Kong (2001, Bull. Volcanol.) estimated the crustal structure down to 10 km in depth with seismic tomography. They detected a low velocity region which is interpreted to be a magma chamber at a depth of 6 km beneath the western part of the central cones. The crustal structure deeper than 10 km was estimated by Abe et al. (2010, J. Volcanol. Geotherm. Res.) 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, and interpreted that the low velocity layer contains 15% of molten rocks or 30% of aqueous fluid at maximum. They did not estimate the crustal structure beneath the eastern part of the caldera because of the lack of seismic stations. Therefore, Ohkura et al. (2010, JpGU meeting) set 5 seismic stations in the eastern part of Aso caldera in June 2009, and started the seismic observation for revealing the crustal structure. We use waveform data obtained at these temporal stations and permanent stations which are distributed in and around the caldera, and examine the crustal structure beneath the whole of Aso caldera with RF analyses.

We calculate RFs from waveforms of teleseismic events (epicentral distances: 30-90^o, Magnitude: greater than 5.5) which were observed at the 5 temporal stations and permanent stations of Hi-net and Aso Volcanological Laboratory, Kyoto University. RF is calculated by deconvolving vertical component of a teleseismic P-wave from the corresponding horizontal component. In this study, we calculate RFs with the extended-time multitaper method (Shibutani et al., 2008, Bull. Seismol. Soc. Am.) and estimate the S-wave velocity structure with genetic algorithm inversion (Shibutani et al., 1996, Geophys. Res. Lett.) of the RFs.

We reveal that the low velocity layer beneath the western part of the caldera detected by Abe et al. (2010) extends beneath the northeastern part of the caldera. It is also revealed that the low velocity layer does not exist beneath the southeastern part. This low velocity layer would have some relationship with the past huge pyroclastic eruptions and/or the future one. Petford et al. (2000, Nature) and Kaneko et al. (2007, Chikyu Monthly) indicated that magmas of huge pyroclastic eruptions are derived from the molten crust melted by high-temperature molten rocks intruded from the mantle. The low velocity layer beneath Aso caldera is possible to be such a molten region.

We use waveform data of National Research Institute for Earth Science and Disaster Prevention.

Keywords: Aso caldera, receiver function, genetic algorithm inversion, crustal structure