Tomographic image of the crust beneath the Aira caldera in southern Kyushu

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Associated with the Philippine Sea plate subduction, a nearly straight chain of active Quaternary volcanism runs almost parallel to Nankai Trough in the central part of southern Kyushu. In this region, there are four large calderas: the Kakuto, the Aira, the Ata and the Kikai calderas.

We applied the tomography method with a fine grid configuration to the P- and S-wave arrival times of 829 local earthquakes well observed at 101 stations in central and southern Kyushu, and revealed the detailed three-dimensional seismic velocity structure of the crust, especially the region beneath the Aira caldera.

In a shallow range from 0 to 10 km depth, low velocity zones (LVZs) are found in the eastern part of Kyushu, where basement rocks are made up of uplifted sedimentary marine terraces (Nakada et al., 2002). The LVZs are also distributed along the volcanic front between Kirishima volcano to Kaimon volcano. Meanwhile, the hypocenters occurred in the inland area are obviously concentrated in regions with a relatively higher velocity and a low Poisson's ratio at a depth of 10 km.

At 20 km depth, the most interesting feature is that a distinctly high Poisson's ratio zone is located exactly beneath the Aira caldera. This compacted zone also extends southward and connects the Aira caldera with the Ata caldera. At 30 km depth, a small zone with high Poisson's ratio appears to remain beneath the Aira caldera. This small zone is assumed to be a portion of the distinctly high zone at 20 km depth. We also found that the velocity distribution in the western region (Satsuma Peninsula) is quite different from that in the eastern region (Ohsumi Peninsula): the western region is characterized by high P- and S-wave velocities, while the eastern region is characterized by the low velocities.

The anomaly with a very high Poisson's ratio at 20 km depth beneath the Aira caldera possibly suggests the presence of partial melts and the source of volcanism in the area. It is also found that LF earthquakes occur in the lower crust in and around the Aira caldera. A deeper part of the focal zone of these LF earthquakes appears to overlap the high Poisson's ratio zone observed at 30 km depth. These facts lead us to postulate that magma penetrating into the crust from the upper-most mantle may construct the high Poisson's ratio zone at about 30 km depth, and move upwards through the LF focal zone, and finally be stored at about 20 km depth.

Ishihara (1990) described the magma supply system of Sakurajima volcano wherein one magma reservoir is located at about 4 km depth just beneath Sakurajima volcano and another at 8 to 10 km depth beneath the Aira caldera. Although space resolution in our tomography is insufficient to distinguish these magma reservoirs in the upper-most crust, our result puts forward a possibility of the deeper magma reservoir supplying two shallow magma reservoirs previously found.