Fluid distribution beneath central and southern Kyushu imaged by 3-D electrical resistivity model

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The island of Kyushu is characterized by a high concentration of active Quaternary volcanoes along a volcanic front of N30˚E–S30˚W associated with the subduction of the Philippine Sea Plate. Some of the active volcanoes exist in southern Kyushu (the southern volcanic region), whereas no volcano exists in central Kyushu (the non-volcanic region). Most of volcanoes in the southern volcanic region exist in the Kagoshima Graben, whose formation was created with ejecting huge pyroclastic flows by the Quaternary volcanism. The Kirishima volcano group appears in Kakuto-Kobayashi caldera on the northern edge of the graben. Shinmoe-dake of the Kirishima volcano group experienced a magmatic eruption of the VEI 3 in 2011 and ash emissions in March 2018. Moreover, Iwo-yama of the Kirishima volcano group experienced hot material ejections in April 2018. Besides, Sakurajima volcano in the southern part of the graben has experienced 153–1,355 small eruptions per year for the last 10 years (the Japanese Meteorological Agency).
The Philippine Sea Plate, whose subduction involves the formation of the volcanic island of Kyushu, in and around Kyushu is classified into three portions: a younger portion, an older portion, and the other part of the Kyushu–Palau Ridge between the two portions. A non-volcanic region distributes in central Kyushu above a junction where the three portions of the subducting Philippine Sea Plate contact with each other. Owing to the subduction of the Philippine Sea Plate, moment magnitude 7-class thrust earthquakes have repeatedly occurred in the Hyuga-nada, lying offshore of the southeast Kyushu. In addition, recent studies using continuous global-navigation-satellite-system data have revealed that long-term slow slip events and short-term slow slip events occur in the Hyuga-nada. Besides, most of the earthquakes in the land area occur along three tectonic lines: Oita-Kumamoto tectonic line, Usuki-Yatsushiro tectonic line and Butsuzo tectonic line.
Fluid distribution in the mantle wedge is an essential factor for the seismic activity and magmatism leading to volcanic activity. Electromagnetic sounding data have high sensitivity to a few percent of interconnected fluids (aqueous fluid and melt). In this study, we generated a three-dimensional (3-D) electrical resistivity model by inverting magnetotelluric data, which covers the active southern volcanic region and the non-volcanic region, to examine the fluid distribution in the mantle wedge beneath Kyushu. We find three important conductive features in the 3-D model. A magma system and a fluid system imaged as two vertical conductors relating to slab-derived fluid, which exist along the volcanic front beneath the southern volcanic region and the non-volcanic region, respectively. The other conductor, relating to the presence of slab-derived fluid and serpentinite in the mantle wedge, appears at a blank area of the slow slip events.

Keywords: 3-D electrical resistivity model, Fluid distribution, magmatism, seismic activity, mantle wedge

