

活発な火山・地震活動で特徴づけられる九州の3次元電気比抵抗構造から推定される地下の流体分布

Fluid distribution beneath volcanically and seismically active island, Kyushu, based on 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. The active volcanoes exist in northern Kyushu (the northern volcanic region) and southern Kyushu (the southern volcanic region), whereas no volcano exists in central Kyushu (the non-volcanic region). Most of volcanoes in the northern volcanic region lie at the Beppu-Shimabara graben, travels across the island of Kyushu almost in an E-W direction, along three tectonic lines (Oita-Kumamoto tectonic line, Usuki-Yatsushiro tectonic line and Butsuzo tectonic line). Aso caldera was formed at the south-central part of the graben by a series of huge eruptions, with a volcanic explosivity index of 7, during 270–90 ka. A post-caldera cone of Naka-dake in Aso caldera is a quite active volcano, at which magmatic and phreatomagmatic eruptions occurred during 2014–2016 and ash eruptions (emissions) have continued since July 2019. On the other hand, 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. The 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 (M_w) 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, in the land area, historic earthquakes of at least M_w 6.0 repeatedly occur along the three tectonic lines, which travels across the central part of Kyushu almost in an E-W direction.

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 presentation, three-dimensional (3-D) electrical resistivity models by inverting magnetotelluric (MT) data and/or network-MT data, which have been acquired on the whole of Kyushu island by various surveys, are shown to discuss the fluid distribution beneath Kyushu. The 3-D resistivity models indicate magma systems and fluid systems relating to slab-derived fluid as significant conductive features/anomalies. In addition, the conductive anomalies exist along the volcanic front beneath the northern and southern volcanic regions, respectively.

Importantly, a clear conductive anomaly in the 3-D models fail to reach the crust through the Moho discontinuity beneath the non-volcanic region in Kyushu. Moreover, another conductor, relating to the presence of slab-derived fluid in the mantle wedge, appears at a blank area of the slow slip events.

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