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Imaging of Upwelling Fluids and Partial Melt in the Subduction Zone with 3D Regional Electrical Resistivity Structure by the Network-MT Data

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Subduction zones are where oceanic plate and seawater (aqueous fluids) return to Earth's mantle and the fluids released into the mantle from the downgoing slab as a consequence of metamorphic reactions [e.g., Tatsumi, 1989]. Such the fluids trigger partial melt of upper mantle and crust. As a result, igneous activity forms volcanoes as typical surface expressions in subduction zones because the partial melt rises owing to its lower density. The island of Kyushu in the Southwestern Japan is a typical high angle subduction zone, at which the hot Shikoku basin (15–27 Ma) and the cold Philippine Sea plate (45–55 Ma) subduct beneath the Eurasian plate. Kyushu can be separated into three parts; northern Kyushu, central Kyushu and southern Kyushu, and there exist many quaternary active volcanoes, as the Aso and Kuju volcanoes in the northern part and Kirishima and Sakurajima volcanoes in the southern part, with defining a volcanic front. Moreover, the central Kyushu is devoid of active volcanoes, where it is considered that the buoyant Kyushu–Palau Ridge subducts. It is important to investigate structure beneath Kyushu for understanding the volcanic formation.

In the Kyushu district, the Network-Magnetotelluric (MT) observations were carried out from 1993 to 1998 to cover the whole island of Kyushu. The Network-MT method employs metallic wires in a commercial telephone network to measure the electric potential difference with a dipole length of ten to several tens of kilometers. The Network-MT data provide valuable information on fluid and partial melt (magma) generation because the electromagnetic soundings are highly sensitive to the presence of a few percent of interconnected fluids (aqueous and/or melt). We analyzed the Network-MT data sets, which have geoelectromagnetic information from the crust to upper mantle, in order to determine regional scale electrical resistivity structure.

We applied three-dimensional (3D) inversion analyses using the WSINV3DMT inversion code of the version for the Network-MT impedance responses [Uyeshima et al., 2008]. Two remarkable features are found that a conductive block exists beneath the volcano of which the bottom extends to the backarc side and the forearc side including the Philippine Sea plate is resistive. Moreover, the resistive region distributes along the hinge line of the subducting plate as imaged by seismicity. The former conductor is thought to represent fluids released from the slab or partial melt related to the fluid, constituting a magma source for subduction zone volcanoes. In this presentation, we would like to explain details on the 3D resistivity structure related to the subducting Philippine Sea plate and the active volcanoes.