3次元比抵抗構造から推定される倶多楽火山の熱水系
Hydrothermal system of Kuttara volcano inferred from 3D resistivity modeling

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Estimation of volcanic hydrothermal system that is composed of an alteration zone, a fluid upflow zone and a heat source, is a key feature in predicting phreatic eruptions and evaluating geothermal resources. Magnetotelluric method is one of the effective ways of estimating such hydrothermal system since it has sensitivity to hydrothermal fluid and hydrothermal alteration zones (seal zones).

Kuttara is a caldera volcano located in the southwestern Hokkaido, which was formed by several silicic explosive eruptions and construction of an andesitic stratovolcano built up from ca. 80 to 40 ka. Lake Kuttara is a caldera lake formed by a violent explosive eruption at ca. 40 ka (Katsui et al., 1988; Moriizumi, 1998). Noboribetsu volcano, a postcaldera volcanism on the western foot of the stratovolcano at ca. 15 ka , formed Hiyoriyama cryptodome and Jigokudani geothermal field. We also see hot spring areas around Kuttara volcano at Noboribetsu, Carls and Kojo-hama.

Although some previous studies (Goto and Johmori, 2011, 2013, 2015) revealed 2-D resistivity cross sections by CSAMT and TDEM methods at Kuttara volcano, they did not reach deeper than about 1km. In this study, we carried out a wideband MT survey in 2017 at 49 stations in the area of 20x20 km wide, and estimated 3-D resistivity structure covering Kuttara volcano. We used ModEM (Egbert and Kelbert, 2012) as the 3-D inversion code, using a model space containing topography and sea bottom relieves. We used both tipper and MT impedance as input data. We found that our 3-D resistivity model had sensitivity up to ca. 3 km deep.

Our 3-D inverted model has revealed a relatively high resistivity zone beneath Lake Kuttara, and a low resistivity zone beneath Noboribetsu hot spring and a columnar low resistivity zone reached to the bottom of Lake Kuttara from the depth. These low resistivity zones indicate hydrothermal system in the Kuttara-Noboribetsu area. Low resistivity layer is also imaged just below Carls hot spring with a high resistivity zone underneath, suggesting a hot rock that provides heat separately from Noboribetsu hot spring area. This image is also consistent with the drilling data around Carls hot spring area and the chemical analyses of the hot spring water (NEDO, 1991) suggesting that the hydrothermal system of Carls hot spring has a separate origin from Noboribetsu area. This study is the first trial of 3-D MT modeling for Kuttara volcano and further detailed comparison to geology, hydrology, drilling data, and hydrothermal simulation is necessary to better understand the current and future activity of the volcano.

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