Three-dimensional resistivity structure beneath the crater of Tokachidake

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Tokachidake is an active volcano located in the central part of Hokkaido, Japan. Magma eruptions have occurred in 1926, 1962, and 1988-89 since the beginning of 20th century, and hydrothermal explosions also have occurred frequently. Active fumarolic activities have been continuing at 62-2 crater and Taisho crater since the eruption of 1988-89. Ground deformation suggesting the inflation beneath the crater and total magnetic change indicating demagnetization at the shallower depth beneath the crater has been observed since 2006.

In this study, AMT survey was performed to clarify a shallow resistivity structure around the crater region at 22 sites in 2009, 2014, 2015, 2016 (Figure 1). We acquired time-series data of the two components of the electric field and the three components of magnetic field. The remote reference processing was applied to minimize local noise using the reference data obtained at about 3 km away from the northwest of survey area. Apparent resistivity and phase were calculated at the frequency range of 10, 400 - 0.35 Hz.

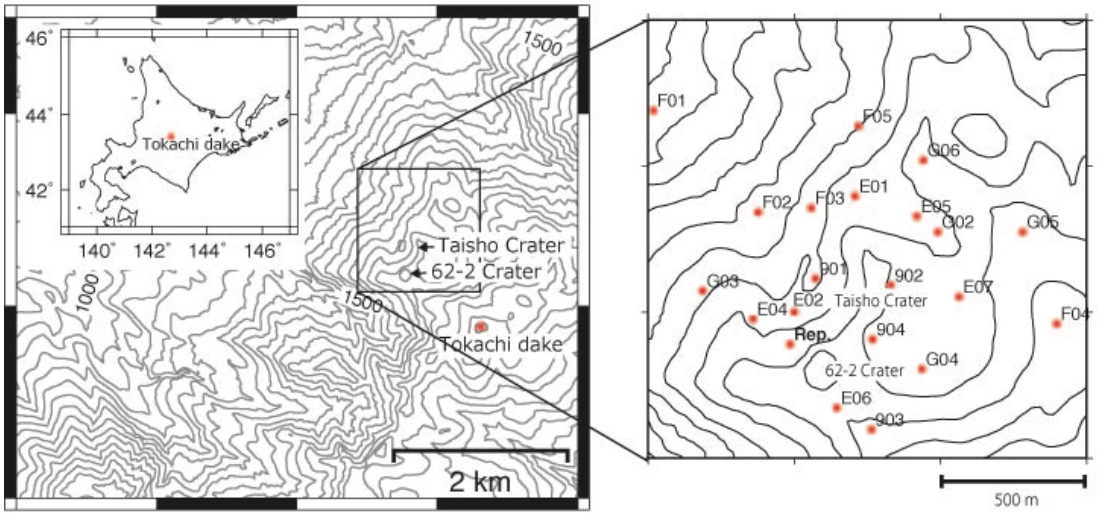

Fig. 1. Map of Tokachi-dake (inset) and a topographic map around the volcano (left panel) and distribution of observation points around crater (right panel).

Three-dimensional inversion was carried out using ModEM (Egbert and Kelbert, 2012) to construct a resistivity model including topography. We inverted four components of impedance at 13 periods between 900- 0.7 Hz. The initial model was set as 10 Ohm-m for land and 10^6 Ohm-m for air (fixed). Normalized RMS decreased from 10 to 2.3 during 91 iterations in the inversion. The obtained resistivity structure has the following characteristics. (1) The extremely shallow part is covered with a high resistivity layer of about 100 Ωm, (2) A region with a low resistivity (several Ωm) spreads horizontally around 800 m at the shallow part of the crater zone, (3) This low resistivity region seems to be composed of two low resistivity zones.

The depth of the estimated low resistivity region is almost the same as the inflation source of the ground deformation (a few hundred meters; Takahashi et al., 2017). The depth of demagnetization source of total magnetic field (150 m; Hashimoto et al., 2010) is almost corresponding to the top of the low resistivity region. It is suggested that hydrothermal fluid possibly exists in this area. Moreover, the two low resistivity zones may give some suggestion for the difference in volcanic gas composition for each crater (Okamoto et al., 2015). However, the spread of the low resistivity zone and the absolute value of the resistivity may change depending on the parameter setting of the inversion. The future investigation is necessary to obtain a more robust model.

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