Three-dimensional resistivity structure beneath the crater of Tokachidake and its temporal change

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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. Since the eruption of 1988-89, active fumarolic activities have been continuing at 62-2 crater and Taisho crater. 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, we performed AMT survey to clarify a shallow resistivity structure around the crater region at 22 sites in 2009, 2014, 2015, 2016. Time-series data of the two components of the electric field and the three components of magnetic field were acquired. 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. One of the site was repeatedly observed in all years to confirm whether the resistivity structure temporally change.
The apparent resistivity increasing and phase decreasing were seen in the low-frequency band higher than 10 Hz between 2014 and 2015. This change suggests that the resistivity region at a depth of about several hundred meters increased between 2014 and 2015. Meanwhile, no change of apparent resistivity and phase at other sites were observed between MT surveys (Takahashi et al., 2017) in 2016 and this AMT surveys in 2009. Thus, the range of the change in resistivity structure captured at repeated observation is limited around the site.
Three-dimensional inversion was carried out using ModEM (Egbert and Kelbert, 2012) to construct a resistivity model including topography. We used the data recorded in 2014 as the data of the repeated observation point. Normalized RMS decreased from 11.8 to 3.89 during 105 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) and the demagnetization source of total magnetic field (150 m; Hashimoto et al., 2010). 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.
The three-dimensional inversion was performed again using the data recorded at the repetition observation point in 2015 to explain the resistivity change from 2014 to 2015. As a result, we obtained a structure in which the low resistivity zone just under the repeat observation point slightly increased. However, higher resistivity zone is required to explain the data of repeated observation point. Further investigation including examination of input data is necessary to obtain a model explaining the change from 2014 to 2015.

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