Three-dimensional resistivity structure in Tarumai volcanic area including the effects of regional structure and topography

Yusuke Yamaya[1]; Toru Mogi[2]; Takeshi Hashimoto[2]

[1] Earth and Planetary Sci., Hokkaido Univ.; [2] Inst. Seismol. Volcanol., Hokkaido Univ.

The magnetotelluric (MT) method is one of the geophysical explorations to investigate a electrical resistivity structure of subsurface. Recently, 2-D inversions have been the favored method on analyzing the MT data. However, the topography and specific structure of volcanoes can be considered as the 3-D geometry. We should adopt the 3-D analysis to clarify the actual structure of volcanoes. In this study, we carried out the magnetotelluric survey at Tarumai Volcano, which is an active volcano located at the southwestern Hokkaido, and then estimate the structure using the 3-D analysis.

The measured MT data included small impedance phases in the low frequency band, and thus could be affected by the regional structure. The measured induction vectors also suggested the effect by the ocean and sedimentary rocks which is called as Ishikari Plain.

We carried out a 3-D resistivity modeling in order to evaluate the regional effect, with the aid of the forward modeling calculation code developed by Fomenko and Mogi (2002). We fixed the resistivities of the ocean and Ishikari plain as 0.25 and 3 Ohm-m, respectively, to calculate the response of the resistivity model. The calculated induction vectors and phase tensors were well explained by the regional effects. Since, at the same time, the calculated impedance phase show the same tendency as the observed one, it should be considered that the MT impedance also strongly affected by the regional conductive structure. Therefore, we have to take into account the effects in order to detect the actual resistivity structure beneath the study area.

We also estimated the effect due to the 3-D topography of the volcano, assuming the practical topography in the study area. The results showed that the apparent resistivity decreases to maximum 20 Ohm-m (-80 %) at the top of the topography, while the impedance phase increases to maximum 55 degree (+20 %) there. Since these changes exceed the range of error, we cannot neglect the topographic effect in the modeling.

We carried on a 3-D modeling based on the wide band MT data fixing the regional structure and topography. The induction vector was an efficient parameter to constrain the horizontal extent of the resistivity bodies in the modeling. The final model showed the great resistivity boundary dividing the Shikotsu caldera and Ishikari Plain. We considered that Tarumai Volcano is generated along the regional structure boundary which may be also related with the formation of the Shikotsu caldera. Low frequency earthquakes, which suggest the degassing from a magma chamber, occurred at the sea level beneath Tarumai Volcano (Aoyama et al., 2004). The magma chamber including the partial melt can be found as a conductor. However, no conductor at such a depth was found in our model. Since the high temperature gas tends to show high resistivity, there can be not the magma chamber but the gas reservoir at the depth.