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Application of induction vectors to 3-D modeling of the shallow resistivity structure of Aso volcano

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Electrical resistivity structure beneath a presently active volcano brings important information on the state of receptacles for magma, fluids, or heat as a preparation zone for volcanic explosions. No remarkable volcanic activity had been observed at Aso volcano since 1995. The whole area of Nakadake 1st crater, an active crater of Aso during recent 70 years, had been covered with hot acid water, which is a characteristic phenomenon in a quiet period of the volcanic activity. Some eruptive activities, such as decrease of the crater lake water, mud eruptions, or crater glows, has been observed since 2000.

Geomagnetic total intensities have been recorded by Kyoto University around Nakadake craters since late 1980's (Tanaka, 1993). Recent changes in total intensities strongly suggest that thermal energy storage is in progress at the shallow part beneath Nakadake 1st crater or its around. The thermally demagnetized zone was inferred during 1989-1990 eruptive activities at depths of 200-300 m southwest of the 1st crater. The source region of the long period tremors was also estimated at depths of 1-1.5 km southwest of the crater, suggesting the flow of volcanic fluids through an aquifer (Kawakatsu et al., 2000).

We carried out audio-frequency magneto-telluric (AMT) surveys around Nakadake craters in August 2004 and June 2005. The main objective of the surveys is to find a relation of those geophysical sources to the resistivity distribution. Results of 2-D inversions for some sections crossing Nakadake craters revealed that extremely low resistivity was found at about a few hundreds meter depth just beneath the 1st crater. This conductor probably corresponds to the zone of thermal energy storage inferred from geomagnetic field variations. On the other hand, no shallow conductor was found beneath the 4th crater, which is inactive during past 70 years. Those results suggest that the shallow conductor beneath the crater is closely related to the mechanism of controlling the volcanic activity of Nakadake (Kanda et al., 2005).

In this study, the vertical geomagnetic field is used to investigate a 3-D resistivity structure of Aso volcano. Induction vectors (Parkinson, 1962) of all the sites tend to point the 1st crater or its southwest at a frequency bands from about 1000 Hz to 3Hz. The existence of a conductor around the crater is suggested. At around 1Hz, vectors tend to point west of the Nakadake area, which is consistent with the regional tendency of the induction vectors shown by Hashimoto et al. (2002). Then, we tried to construct a 3-D model around Aso volcano that can explain qualitative nature of induction vectors. The WinGLink software developed by Geosystem Srl. was used for a forward calculation of the 3-D resistivity modeling, which is based on a finite differencing scheme on staggered grids of Mackey et al. (1993). Behaviors of induction vectors and phase tensors were examined by adding 3-D bodies into a background 1-D structure (especially the second layer from 50 to 800m depth) that is five-layered model representing the results of 2-D inversion. Although final model has not been obtained, models with gradually decreasing resistivity towards the 1st crater reasonably reproduce nature of induction vectors at present.