

Electrical resistivity structure around the active crater of Nakadake, 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. Increase in eruptive activities, such as decrease of the crater lake water, mud eruptions, or crater glows, has been observed since 2000. It is a good timing to reveal the preparation zone for volcanic explosions.

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).

In this study, we carried out an audio-frequency magneto-telluric (AMT) survey around Nakadake craters in order to estimate the detailed electric structure down to 1 km or so. The main objective is to find a relation of those geophysical sources to the electrical structure. Many electromagnetic and electrical soundings were conducted around Nakadake craters. However, the previous studies did not succeed in revealing the detailed structure deeper than a few hundred meters because of very low resistivity anomaly at the surface.

The AMT survey was conducted during a period of Aug.18-29 in 2004. AMT data were collected at 38 locations around Nakadake craters at intervals of about 300m. At each station, electromagnetic fields data over the frequency range of 1-10000 Hz were recorded for 10 hours at night using six Phoenix Geophysics MTU-5A systems. A remote-reference site was not installed, so that the impedance responses were estimated by a local-site reference.

Impedance skews at most sites showed about 0.1, while only a few site exceeded 0.3 that is known as an index of three-dimensional structure. We assumed that a rough structure around this region is two-dimensional and applied a tensor decomposition technique (Groom and Bailey, 1989). The distribution of GB-strike estimates showed N-S to NWN-SES direction. As a preliminary modeling, N15W was assumed as a strike direction of this region, which approximately follows the chain of older craters. After the impedance tensor at each site was rotated to the strike direction, it was decomposed to TM- and TE-mode components. A 2D inversion (Ogawa and Uchida, 1996) was applied to each data set along 5 lines that are nearly perpendicular to the estimated strike direction.

As results of inversions, resistivity sections showed following features. At the section crossing the 1st crater, a conductive zone was found at depths of 100-400 m beneath the crater and its western side. Another conductor was located beneath the crater at depths of 500-1500 m. Those conductors were also seen at the section crossing 3rd crater located south of 1st crater but broadly expanded in the EW direction at deeper part. At other sections, shallow conductor was not seen, and deep one was restricted at depths of 0.8-1.2 km. Shallow conductor may correspond to the zone of thermal energy storage inferred from geomagnetic field variations and deep one to the hydrothermal system supplying the thermal energy with volcanic fluids to the shallow part. In the presentation, we will also discuss about significance of those conductors by sensitivity analysis.