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Resistivity structure around Chishinshan, Matsao, and Tayukeng areas, Taiwan, revealed by audio-magnetotellurics

Shogo Komori[1*], Mitsuru Utsugi[2], Tsuneomi Kagiyama[2], Hiroyuki Inoue[2], Chang Hwa Chen[1], Hsieh Tang Chiang[3]

[1]Institute of Earth Sciences, Academia Sinica, [2]Aso Volcanological Laboratory, Kyoto Univ., [3]Institute of Oceanography, National Taiwan University

Electromagnetic surveys have found the low resistivity region beneath the active volcanoes. This is because high- salinity and temperature hydrothermal fluids decrease the resistivity of the pore water and rock matrix, when the volcanic fluids are released from magma and injected into the aquifer. The spatial extent of the low resistivity region could be used for evaluating the eruptive potentiality of volcanoes from the viewpoint of magma degassing.

Tatun Volcano Group is composed of over twenty volcanoes, which were formed within the graben at the northern part of Taiwan. So far, these volcanoes were regarded as extinct because of no historical record of eruption. However, recent studies have found the relatively young ejecta (Chen and Lin, 2002; Belousov et al., 2010), high $^{3}He/^{4}He$ ratio (Yang et al., 1999; Ohba et al., 2010), and hypocenter distribution suggesting the fluid flow and the high temperature condition (Konstantinou et al., 2007); that suggest the presence of potentially eruptive magma beneath TVG. Further, active heat discharge from fumaroles and springs also suggests a large amount of the volcanic fluids released from magma beneath Chishinshan volcano. Focusing on this phenomenon, Utsugi et al. (2012, workshop at TVO, Taiwan) conducted AMT surveys at the volcano for a better understanding of this magma degassing, and showed the preliminary resistivity structure suggesting the low resistivity region at the depths of 1-2km.

On the basis of their work, the authors conducted further AMT surveys around Matsao hot spring and Tayukeng fumarole areas, about 2 km northeast of the volcano from Dec. 9th to Dec. 16th in 2012. Two Phoenix MTU5A systems were used at the same time for the remote reference processing (Gamble et al., 1979). Time series of the electric and magnetic fields were acquired for about 4 hours at each site. Totally 10 observation sites were configured to cover the areas. After data acquisition, the frequency domains were obtained from the time series, using FFT processing. The impedances were estimated for each frequency. The obtained frequency range was between 1 and 10400 Hz.

First of all, the spatial extent of the rotational-invariant apparent resistivity was estimated, using the both data obtained by the authors in 2012 and Utsugi et al. (2012) in 2011. At a several thousands Hz, the low resistivity areas of 10-30 Ohm-m are found separately at Lengshueiken, Matsao, and Tayukeng. With decrease in the frequency, the area is extending more spatially. At a several tens Hz, the above three low resistivity areas are connected to each other, and the extremely low resistivity area less than 3 Ohm-m emerges near the central part of Chishinshan volcano. These features suggest the hydrothermal fluids are flowing from the central area of the volcano toward Matsao and Tayukeng areas.

Impedance phase tensor analysis (Caldwell et al., 2004) found that Chishinshan volcano, Matsao, and Tayuheng areas have each features with respect to its main axes. The axes almost perpendicular to the Jinshan fault are dominant at Chishinshan volcano. Matsao area has two modes of the axes; one is almost perpendicular to the fault, and the rest is toward the valley between Chishinshan and Chigushan, where hot spring is discharged. Tayuken area has the axes toward its fumarole area. Following the above features, the following regional strikes were estimated: N52.5E for Chishinshan volcano, N70E for Matsao, and N90E for Tayuken. In the presentation, the estimated two-dimensional resistivity structures beneath three areas will be shown.

Keywords: low resistivity region, hydrothermal fluids, hydrothermal alteration, magma degassing, Tatun Volcano Group, Taiwan