Hydrothermal structure beneath the lava dome of Nasu-Chausudake volcano (Japan) inferred from the AMT survey and the diffuse soil gas flux measurement

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Nasu-Chausudake volcano is an andesitic stratovolcano located on the northern part of Tochigi prefecture. The volcanic activity in Chausudake volcano started 16,000 years ago, and six large-scale eruptive activities including the magmatic eruptions and many phreatic explosions were reported. In recent years, phreatic explosions were occurred (in 1953, 1960, and 1963), and fumarolic activity is observed there these days. In a volcano that repeated phreatic explosion, the hydrothermal system is usually developed, and a risk of phreatic explosion arises. A deep understanding of hydrothermal structure is crucial for monitoring volcanic activity and mitigating volcanic disaster.

In this study, an AMT (audio-frequency magnetotelluric) survey was conducted in the whole area of the lava dome of Chausudake volcano in 2016 to clarify the structural feature of the hydrothermal system and the paths of volcanic fluids. A three-dimensional resistivity structure model was inferred from the observed AMT data and the previously obtained data. For inversion, we used the data-space 3-D inversion code based on a finite element method with unstructured tetrahedral elements to represent the steep topography of the lava dome. In order to interpret the resistivity structure model, the measurements of diffuse soil gas flux (CO_2 and H_2S) and ground temperature were conducted in 2017.
As a result, it was suggested that the hydrothermal fluids ascended from the deep part in the northern area of the summit, and that the hydrothermal reservoir has been developed at altitudes of 1200~1400m. It was also found that a high resistive body suggesting a remnant magma erupted during the same eruptive period when the lava dome was formed in the summit is present beneath the crater of recent phreatic eruptions. As for the paths of hydrothermal fluids, the lava dome is thought to prevent the hydrothermal fluid from ascending through the central vent because we observed low soil gas flux and low ground temperature in the summit crater. Low-resistivity zones, high-flux zone of soil gas, and high-temperature zones are consistent with the hydrothermally altered zones (southwestern, eastern, and northern sides). From these results, the fluid paths are thought to be restricted to the structural boundaries such as the boundary of a sector collapse or the boundary between the lava dome and the pyroclastic cone.

Keywords: Nasu volcano group, Chausu-dake volcano, resistivity structure, lava dome, hydrothermal system, diffuse soil gas flux

