Shallow hydrothermal system at Mt. Motoshirane inferred from an audio-frequency magnetotelluric survey

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Mt. Motoshirane is one of the pyroclastic cone groups of Kusatsu-Shirane Volcano in Gunma Prefecture. Kusatsu-Shirane Volcano is known for its crater lake Yugama, active fumaroles, and seismic activity, all of which occur around Mt. Shirane, at northern part of the Kusatsu-Shirane Volcano. Routine observations have been made around Mt. Shirane, but not at Mt. Motoshirane, which is at the southern part of Kusatsu-Shirane Volcano. The 2018 phreatic eruption occurred suddenly at Mt. Motoshirane, which was not expected to erupt, and caused great damage. It is assumed that phreatic eruptions require the hydrothermal fluids in the shallow underground and the resistivity structure estimated from the magnetotelluric (MT) method is suitable for clarifying the distribution of hydrothermal fluids. Although the resistivity distribution of Mt. Motoshirane was investigated for a deep subsurface by the MT method (Matsunaga et al. 2020), shallow structures were not in good resolution and not clarified yet. Therefore, an AMT (audio-frequency magnetotelluric) survey targeted for shallow underground was conducted in 2020 to clarify the structure of the shallow hydrothermal system of Mt. Motoshirane using a three-dimensional (3-D) inversion. As a result of the inversion, it was found that the resistivity near the surface is high, while the resistivity at the depth is low. In comparison with geological studies (Uto et al. 1983), the high resistivity near the surface is assumed to be Quaternary lava. The low resistivity layer just below the surface is considered to be a hydrothermally altered layer of Neogene lava, which is considered to be the basement rocks of Kusatsu-Shirane Volcano. In the upper part of the basement rock, some high resistivity areas were found. We interpreted that those areas were destroyed by the eruption. In comparison with the study of volcanic tremor sources before the eruption (Yamada et al. 2021) and the analysis of tilt changes before and after the eruption (Terada et al. 2021), we speculate that the fluid migrated just before the eruption was supplied to the lower part of the low resistivity zone. In the upper part of the zone, a relatively high resistivity region was found, which we interpreted as a low-temperature fluid reservoir because only low-temperature fumaroles are found around Mt. Motoshirane. The 2018 eruption is considered to have occurred when a high-temperature hydrothermal fluid supplied from the depths intruded to the shallow fluid reservoir which caused the rapid vaporization. This presentation will summarize our results and interpretation.

Keywords: Mt. Motoshirane, magnetotelluric method, audio-frequency magnetotelluric method, Hydrothermal system

