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Resistivity structure of geothermal area at south area of Yakedake Volcano

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Resistivity structure of geothermal system at south area of Yakedake Volcano

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Some hot-springs and fumaroles are seen around the Yakedake Volcano. High temperature hot springs such as Nakanoyu and Shirahone hot springs are located at the south area of the Yakedake volcano, but the relations between the volcano and geothermal system have not been clarified yet. Geophysical studies concerning the structure of geothermal fluid reservoir and heat source of the hot springs have never been performed in this area.

Hokkaido University carried out a MT survey to clarify the subsurface structure at six sites between Sirahone hot spring and Sawando area in 2013 and indicated distribution of geothermal fluid reservoir beneath Shirahone hot springs and Sawando area (Yamaya et al., 2014). But they did not clarify the extent of geothermal fluid reservoir under these area. We installed two additional MT sites each at outside of the previous survey area in 2014 to investigate extension of these reservoirs.

We recorded MT signals for about 48 hours at each site, and obtained the apparent resistivity and phase at a frequency range of 0.03-100Hz. We applied the remote magnetic reference (Gamble et al., 1979) and manual data editing by MTEDITOR to remove local electromagnetic noises.

The magnetotelluric phase tensors (Caldwell et al., 2004) and induction vectors were calculated to verify structural dimensionality and to determine the 2D strike direction for the 2D inversion. According to the phase tensor ellipse and induction vector at the lower frequency range, the deeper layer have 2D structure and we decided that 2D strike direction is N60W in this area.

We performed two types of 2D inversion, which used the TM mode and TE+TM modes, respectively. We used the inversion code proposed by Ogawa and Uchida (1996), which minimized ABIC as convergent criterion in the iteration process. The ABIC criterion includes smoothness, least square mean error and static shift correction.

As a result, we indicate that geothermal fluid reservoir correspond with low resistivity is extending at directly under the Shirahone hot spring area, and it ranges in the limestone body. Dissolved limestone is origin of milky hot spring that characterizing the Shirahone hot spring. The low resistivity zone was also found at the depths of 500m down in the Sawando area. Although no geothermal manifestation is recognized at the surface of the Sawando area, but this low resistivity zone probably indicates a geothermal reservoir.

Furthermore, these two low resistivity structures corresponding each geothermal fluid reservoir join together at the depths of 2 km below. The columnar low resistivity zone extends to deep. Comparing the geology, the Sakaitouge fault runs through at the columnar low resistivity zone. The resistivity structure suggests that geothermal fluid ascends from deeper zone along the Sakaitouge fault. Based on this result, we can propose two possibilities of the heat source of geothermal fluid. One possibility is that hot volcanic fluid flows out from the Yakedake volcano along the fault. The other is that heating water is ascending along the fault from the hot rock area extending in the Japanese Northern Alps area.

Keywords: Geothermal area, Resistivity structure, Yakedake