Letter

Bull. Volcanol. Soc. Japan
Vol. 56 (2011) No. 4·5, pp. 153–160

Controlled Source Audio-frequency Magnetotelluric (CSAMT) and Time Domain Electromagnetic (TDEM) Resistivity Measurements at Noboribetsu Geothermal Field, Kuttara Volcano, Hokkaido, Japan

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(Received February 10, 2011; Accepted August 9, 2011)

Controlled source audio-frequency magnetotelluric (CSAMT) and time domain electromagnetic (TDEM) resistivity measurements were performed in April 2008 at the Noboribetsu Geothermal Field, Kuttara Volcano, Hokkaido, Japan. Both sets of measurements were carried out using a high-precision electromagnetic system, Geo-SEM, controlled by GPS (Global Positioning System). The 2×2 km survey area covered the entire geothermal field and included 66 measurement sites. Interpretation of the CSAMT and TDEM data revealed the subsurface resistivity structure shallower than 1,400 m below sea level (b.s.l.). The most prominent feature of the resistivity structure is a region of low resistivity (<10 Ω·m) beneath the geothermal field. The low resistivity varies in lateral extent and outline at different depths. At 200 m above sea level, it comprises two domains with long axes oriented NNW–SSE. From 0 to 200 m b.s.l., the two resistivity lows combine, forming a large semicircular low of 1,500×1,500 m in lateral extent. From 400 to 600 m b.s.l., the low resistivity has an irregular outline and includes linear low-resistivity zones trending NNW–SSE and ENE–WSW. From 800 to 1,400 m b.s.l., a linear NNW–SSE-trending region of low resistivity is apparent in an irregular overall pattern of resistivity. In a N–S vertical cross-section, the region of low resistivity extends vertically for more than 1,400 m. We attribute the low resistivity beneath the geothermal field to the presence of conductive clay minerals produced by hydrothermal alteration, which was in turn induced by high-temperature geothermal fluid ascending along fractures.

Key words: resistivity structure, controlled source audio-frequency magnetotelluric (CSAMT) survey, time domain electromagnetic (TDEM) survey, Noboribetsu Geothermal Field, Kuttara Volcano

1. Introduction

Resistivity surveying provides valuable information on underground geological structures at active volcanoes and within geothermal fields (*e.g.*, Risk *et al*., 2003; Aizawa *et al*., 2008; Srigutomo *et al*., 2008). Such data are particularly useful for understanding hydrothermal systems, as the resistivity of volcanic rocks shows a marked change with the presence of alteration minerals and thermal waters. Resistivity data are therefore essential for scientific studies of volcanic activity and for geothermal exploration.

We performed controlled source audio-frequency magnetotelluric (CSAMT) and time domain electromagnetic (TDEM) resistivity measurements at Noboribetsu Geothermal Field, Kuttara Volcano, Hokkaido, Japan. The CSAMT method employed here used electric currents at frequencies from 1 to 8192 Hz. The TDEM method employed here was the long offset transient electromagnetic method (LOTEM; Strack, 1992). The Noboribetsu Geothermal Field is one of the major geothermal fields in Japan, and resistivity measurements are a promising tool for studying subsurface geologic structures within the geothermal field and for examining its hydrothermal systems. Sixty-six receiver stations were distributed in a 2×2 km area covering the whole geothermal field, and processing of the CSAMT and TDEM data revealed the subsurface resistivity structure shallower than 1,400 m below sea level (b.s.l.). This paper describes the results of the resistivity measurements and discusses the nature of subsurface geologic structures beneath the geothermal field.

2. Noboribetsu Geothermal Field

The Noboribetsu Geothermal Field lies in the western

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