Article

Bull. Volcanol. Soc. Japan
Vol. 58 (2013) No. 2, pp. 365–376

Resistivity Structure of the Hiyoriyama Cryptodome at Kuttara Volcano, Hokkaido, Japan

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(Received March 1, 2012; Accepted March 15, 2013)

Direct current (DC) electrical and controlled source audio-frequency magnetotelluric (CSAMT) surveys were performed over the Hiyoriyama Cryptodome in Kuttara Volcano, Hokkaido, Japan. Both surveys were performed on the same survey line across the cryptodome in a NE–SW orientation. Two-dimensional joint inversion of the DC electrical and CSAMT data revealed the underground resistivity structure at depths less than 400 m beneath the cryptodome. The resistivity structure suggests that the cryptodome comprises a dacite intrusion of 150 m wide and 80 m thick (20–50 Ω·m), and overlying pyroclastic deposits that are 10–30 m thick (> 100 Ω·m). The dacite intrusion is underlain by a convex-shaped, low-resistivity layer (< 5 Ω·m) that is interpreted to be smectite-rich, altered pyroclastic deposits that have been subjected to low-temperature (< 200℃) hydrothermal alteration. The low-resistivity layer is underlain by a slightly higher-resistivity layer (10–30 Ω·m) that is interpreted to be altered pyroclastic deposits that were subjected to higher-temperature (> 200℃) hydrothermal alteration in a relatively deep, hot region near the conduit of the cryptodome.

Key words: resistivity structure, DC electrical method, CSAMT method, Hiyoriyama Cryptodome, Kuttara Volcano

1. Introduction

Resistivity surveying provides valuable information on the underground geological structures of active volcanoes (*e.g.*, Risk *et al*., 2003; Aizawa *et al*., 2008; Srigutomo *et al*., 2008). We performed direct current (DC) electrical (for details of the method, see Milsom, 2003) and controlled source audio-frequency magnetotelluric (CSAMT) surveys (see Sandberg and Hohman, 1982) at the Hiyoriyama Cryptodome in Kuttara Volcano, southwestern Hokkaido, Japan, in order to investigate its internal structure. The cryptodome is inferred to have formed by the uplift of pre-existing pyroclastic deposits due to the intrusion of dacitic magma (Katsui *et al.,* 1988), but its internal structures are poorly constrained. This paper presents the results of the resistivity surveys and discusses the nature of subsurface geological structures beneath the cryptodome.

2. Hiyoriyama Cryptodome

The Hiyoriyama Cryptodome is located in the northern area of the Noboribetsu Geothermal Field, in the western part of Kuttara Volcano (Fig. 1). The volcano consists mainly of an andesitic stratovolcano (summit at 549 m above sea level) with a small caldera at the summit (Lake Kuttara). The volcano evolved over the period 80–45 ka, involving early silicic explosive activity and subsequent stratovolcano building associated with caldera collapse at 40 ka (Katsui *et al.,* 1988; Yamagata, 1994; Moriizumi, 1998; Moriya, 2003).

The Noboribetsu Geothermal Field, which is inferred to have formed after the collapse of the caldera (Katsui *et al.,* 1988), is approximately 1 km wide (NE–SW) and 1.5 km long (NW–SE) (Fig. 1). The geology of the Noboribetsu Geothermal Field consists mainly of pyroclastic deposits erupted from Kuttara Volcano (mainly the Kt-1 pyroclastic flow deposit; Moriizumi, 1998). The deposits are > 200 m thick (NEDO, 1991) and consist of dacitic pumice clasts up to tens of centimeters in diameter.

The Hiyoriyama Cryptodome (Fig. 2) is elliptical in plan view, ranging in diameter from 350 m (NE–SW) to 550 m (NW–SE). In cross-section, it has a pyramidal form with steeply sloping sides (Fig. 2A). It rises 130 m above the surrounding area, with the highest point being 377 m above sea level. The surface of the cryptodome is covered with pyroclastic deposits (< 15 m thick) that were uplifted by growth of the dome (Katsui *et al*., 1988). The cryptodome has an explosion crater (Hiyoriyama Summit Crater; Fig. 2B) at its summit. The crater is 40 × 95 m in area (elongate along a NW–SE axis) and 20 m deep, and contains active fumaroles (Goto *et al*., 2011a, b) with a maximum temperature of 134℃ (measured on 6 July 2009). The slopes of the

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