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Three-dimensional Digital Mapping of the Noboribetsu Geothermal Field, Kuttara Volcano, Hokkaido, Japan, using a Helicopter-borne High-resolution Laser Scanner

Yoshihiko GOTO*, Satoru MATSUZUKA** and Seiji KAMEYAMA**

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An aerial high-resolution laser-scanner survey was performed in November 2006 over the Noboribetsu Geothermal Field on Kuttara Volcano, Hokkaido, Japan. The 2×2.4 km survey area covers the entire geothermal field. A three-dimensional digital map, produced from the laser-scanning data, shows detailed topographic features of the geothermal field. Notable features include a cryptodome formed by the intrusion of high-viscosity magma, a plain that is inferred to have formed by river damming due to growth of the cryptodome, and explosion craters that are aligned NW–SE. These features suggest that the geothermal field has evolved by complex volcanic activity and ground deformation involving cryptodome growth, river damming, and phreatic explosions. The NW–SE elongation of the cryptodome and the NW–SE alignment of explosion craters indicate the injection of magma and hydrothermal fluids along NW–SE-trending fractures. High-resolution laser-scanner surveys provide valuable information for understanding the geology of geothermal fields.

Key words: laser scanner, digital mapping, three dimensions, explosion crater, Noboribetsu Geothermal Field, Kuttara Volcano

1. Introduction

LIDER (light detection and ranging) is a powerful tool for studying the morphological features of volcanoes (*e.g.*, Hunter *et al*., 2003; Chiba *et al*., 2007a, 2007b; Pesci *et al*., 2007). Three-dimensional digital mapping based on high-resolution laser-scanning data provides invaluable information on the distribution and morphology of craters, lavas, domes, and pyroclastic deposits, as well as reworked deposits. Laser-scanner mapping is particularly useful for surveying topographic features in thickly vegetated areas, for which "tree-removing" data filtering can be used to reveal the topography of the ground surface.

We performed an aerial laser-scanner survey over the Noboribetsu Geothermal Field at Kuttara Volcano, Hokkaido, Japan, using a high-resolution laser scanner mounted on a manned helicopter. The Noboribetsu Geothermal Field is covered with thick vegetation, and three-dimensional digital mapping based on the laser-scanning data provided an excellent tool with which to study detailed topographic features of the geothermal field, as a basis for understanding its geology. This paper describes the topographic features of the geothermal field and discusses the characteristics of volcanic activity in the field.

2. Noboribetsu Geothermal Field

The Noboribetsu Geothermal Field lies in the western part of Kuttara Volcano (Fig. 1), an andesitic to rhyolitic composite volcano (elevation, 549 m above sea level) with a small caldera at its 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 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), and is situated at an altitude of 200–370 m. It is one of the major geothermal fields in Japan.

The geothermal field is characterized by a dacitic cryptodome (Hiyoriyama Cryptodome), a volcanic lake (Oyunuma Lake), and a fumarolic valley (Jigokudani Valley) (Fig. 1). The Hiyoriyama Cryptodome, in the northern part of the geothermal field, rises 377 m above

*College of Environmental Technology, Graduate School of Engineering, Muroran Institute of Technology, Mizumoto-cho 27–1, Muroran, Hokkaido 050–8585, Japan.
**Tanaka Consultant Co., Ltd, Shinkai-cho 2–1–3, Tomakomai, Hokkaido 050–8585, Japan.

Corresponding author: Yoshihiko Goto
e-mail: ygoto@mmm.muroran-it.ac.jp