

Resistivity Structure of the Showa-Shinzan Dome at Usu Volcano, Hokkaido, Japan

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A controlled source audio frequency magnetotelluric (CSAMT) survey was conducted over Showa-Shinzan Dome at Usu Volcano, Hokkaido, Japan, in order to investigate its internal structure. The Showa-Shinzan Dome (800–1000 m across, 350 m high) is a partly extruded cryptodome that formed in AD 1943–45 due to the uplift of pre-existing rocks and sediments by the intrusion of dacitic magma. The dome comprises a flat-topped cryptodome called ‘Yaneyama’ and a dacitic lava dome projecting above the Yaneyama cryptodome. The CSAMT survey was carried out on a 1600-m-long line that crosses the Showa-Shinzan Dome in an east-west orientation. Two-dimensional inversion of the CSAMT data revealed the resistivity structure at depths less than 1000 m beneath the dome. The resistivity structure suggests the existence of a sub-spherical dacite intrusion (resistivity 50–130 $\Omega \cdot \text{m}$; ~400 m across) below the summit of the Showa-Shinzan Dome. The dacite intrusion may represent the solidified dacitic magma emplaced in AD 1943–45. The Yaneyama cryptodome only comprises pre-existing rocks and sediments uplifted by the intrusion of dacite magma. The upper zone of the Yaneyama cryptodome consists of the Usu Somma Lava (> 100 $\Omega \cdot \text{m}$), whereas the lower zone consists of Quaternary pyroclastic flow deposits and sedimentary rocks (< 30 $\Omega \cdot \text{m}$), such as the Toya pyroclastic flow deposits, the Fukaba Formation, the Takinoue welded tuff, the Sobetsu pumice flow deposits, and the Yanagihara Formation. There is no dacite intrusion beneath the Yaneyama cryptodome. This structural model is consistent with the distribution of active fumaroles on the Showa-Shinzan Dome, and also with historical records of dome growth. The geophysical data provide new insights into the formation mechanism of the Showa-Shinzan Dome.

Key words: resistivity survey, CSAMT method, Showa-Shinzan Dome, internal structure, Usu Volcano

1. Introduction

Resistivity surveying provides valuable information on the underground geological structures of active volcanoes (e.g., Aizawa *et al.*, 2008, 2009; Aizawa, 2010; Fikos *et al.*, 2012; Matsushima *et al.*, 2001; Nishida *et al.*, 1996; Ogawa *et al.*, 1998; Risk *et al.*, 2003; Srigutomo *et al.*, 2008; Yamaya *et al.* 2009). We have conducted a controlled source audio frequency magnetotelluric (CSAMT) survey (Milsom, 2003; Sandberg and Hohmann, 1982) of the Showa-Shinzan Dome of Usu Volcano, Hokkaido, Japan, in order to investigate its internal structure. The Showa-Shinzan Dome is a partly extruded cryptodome formed in AD 1943–45 due to the uplift of pre-existing rocks and sediments by the intrusion of dacitic magma (Katsui, 1988; Mimatsu, 1962; Minakami *et al.* 1951; Soya *et al.*, 2007; Yokoyama *et al.*, 1973). The internal structure of this dome has previously been studied using various geophysical techniques, including seismology (Kato and Shoji, 1949; Hayakawa *et al.*, 1957; Nemoto *et al.*, 1957), magnetic surveying (Nishida and Miyajima, 1984), and

muon radiography (Tanaka *et al.*, 2007; Tanaka and Yokoyama, 2008), but still remains poorly constrained. Herein, we present the results of a CSAMT survey of the Showa-Shinzan Dome and discuss the nature of the subsurface geology beneath the dome.

2. Showa-Shinzan Dome

The Showa-Shinzan Dome is located at the eastern foot of Usu Volcano (Fig. 1). The dome is elliptical in plan view with a diameter ranging from 800 m (N-S) to 1000 m (E-W), and it rises 350 m above the surrounding area (Fig. 2). The highest point of the dome is 398 m above sea level. The dome consists of a flat-topped cryptodome called ‘Yaneyama’ and a pyramidal dacitic lava dome projecting above the Yaneyama cryptodome (Fig. 2A).

The Yaneyama cryptodome is pancake-shaped, 800–1000 m across, and 200 m thick. The surface of the cryptodome mainly comprises andesitic lava blocks (2–5 m in size) of the Usu Somma Lava (Yokoyama *et al.*, 1973) and unconsolidated sediments (soil, clay, and volcanic ash) that

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