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Geomagnetic changes over Usu Volcano detected from aeromagnetic repeat surveys

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1. Introduction

We conducted an aeromagnetic survey over Usu Volcano in September 2010. The survey was planned to compare the previous one in June 2000 by GSJ, AIST (Okuma et al., 2001), with detection of temporal changes during this decade as its main objective. In this paper we summarize the 2010 survey and discuss the magnetic changes for the ten years by comparing with the recent measurements on the ground.

2. Summary of the 2010 aeromagnetic survey

The survey flight was designed to optimize the conditions required for the generalized mis-tie control method (Nakatsuka and Okuma, 2006). Magnetic field and sensor position were measured at 10 Hz and stored in the instruments in a bird which was suspended from a helicopter. Flight was done with a constant (about 150 m) spacing to topography. The 2010 survey successfully retrieved the magnetic total field over the recent eruptive areas in 2000 (NW foot), 1977-82 (summit crater), and 1943-45 (Showa-Shinzan).

3. Detection of temporal changes validated with the aid of ground surveys

After the data processing with the mis-tie control method, we successfully retrieved some distinct magnetic changes over the three areas mentioned above, in which amplitude of the anomalous changes overwhelms the detection error level. Another related paper (Nakatsuka et al., 2011; this JpGU meeting) discusses in detail on the data processing and a factorial analysis of possible contributing elements on the estimation errors.

Preceding the flight, Hokkaido University has repeated magnetic surveys on the ground since 2003 for NW foot and since 2008 for the summit crater and Showa-Shinzan. As was already reported by Hashimoto et al. (2010; JpGU meeting), these three areas show clear magnetizing trends which is plausibly due to cooling. We here extrapolated the linearly-fitted rates of change for ten years and projected the estimated magnetic changes onto a smoothed plane 200 m over the topography, which ensured a general agreement with the aeromagnetic result. Our result may be the second case succeeding the one at Kuju Volcano (Utsugi, 2010), in which magnetic time changes with grounded validation are detected from repeat aeromagnetic surveys. Availability and usefulness of this method now became more pronounced.

4. Discussion on the magma cooling beneath the summit crater

We here describe some features of the magnetic changes in the summit crater where the 1977-82 eruption tool place.

(1) A distinct magnetic increase was recognized around Gin'numa crater. It agreed well with the estimation from the ground measurements from 2008 through 2010. This subsequently suggests that the recent magnetizing trend is not a temporary one but a steadier process at least for these ten years.

(2) Cooling of the intruded magma in the 1977-82 eruption might be a candidate for the source. However, no remarkable magnetic change was detected over Usu-Shinzan itself, under which the intruded magna is thought to remain (e.g. Matsushima et al., 2001).

(3) A remarkable decrease was found over the NW somma (Kita-Byobu-Iwa). It might be the counterpart of the increase which is mentioned in (1). This implies the possibility that a substantial part of the intruded magma under Usu-Shinzan still keeps a high temperature and thus is not yet able to be magnetized.

(4) Some magnetic changes with relatively small amplitude are recognized around Oo-Usu lava dome, which also suggest cooling magnetization. The significance, however, should be carefully investigated as we have no ground data on that area.

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Keywords: Geomagnetic field, Usu Volcano, Aeromagnetic survey, temporal variations, helicopter, magma cooling