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# Usefulness and limitations of the high-resolution aeromagnetic survey - in a case of Usu Volcano, Hokkaido Japan

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Usu Volcano, Hokkaido, Japan erupted in 2000 for the first time since the 1977-1978 eruption. The volcano consists mainly of dacitic volcanic rocks and has erupted every 20-30 years. A stinger-mounted helicopter-borne high-resolution aeromagnetic survey was conducted to better understand the subsurface structure of the volcano in late June 2000 almost three months after the start of the eruption. The survey was flown at an altitude of 150 m above terrain along north-south survey lines and east-west tie lines, spaced 200 m and 1000 m apart, respectively. DGPS with an accuracy of 50cm was employed for flight-path recovery. Total magnetic intensity was observed in every 0.1 second and anomaly was calculated by a subtraction of the IGRF-10 from the observed values. Aeromagnetic anomalies were reduced onto a smoothed observed surface with a method in space domain and some filtered maps such as reduction to the pole were created. Preliminary 3-D imaging of magnetic anomalies over Usu Volcano was also conducted to constrain the subsurface structure. The survey was capable of revealing the subsurface structure of the volcano as the characteristics of the distribution of reduction to the pole anomalies shown as follows:
1) Magnetic highs occupy the main edifice of Usu Volcano, suggesting the subsurface distribution of the Usu Somma Lava, which is overlain by pyroclastic rocks.
2) Magnetic highs are distributed over lava domes such as O-Usu, Ko-Usu and Showa-Shinzan and crypto domes such as Usu-Shinzan and Ogari-Yama, showing the volcanic rocks comprising those domes are cool enough to acquire magnetism.
3) Regional magnetic lows lie northwest of the active craters areas. Neogene volcanic rocks are distributed in the area and their reversal magnetization can be responsible for the magnetic lows.
4) A magnetic low lies over the Higashi-Maruyama, which was believed to be a crypto dome. A magnetic modeling suggests the mountain is composed of reversely magnetized volcanic rocks, probably the Takinoue Pyroclastic Flow Deposits during Early Pleistocene, which outcrops both in the surrounding areas and in the hot spring exploration wells.
5) The chains of magnetic highs are distributed over the south and southwestern flanks of the main edifice of the volcano. They correspond well on ground to the distribution of the Zenkoji Debris Avalanche Deposits, which were formed by a summit corruption about 7000-8000 years ago.
Although the survey was successful to better understand the surface and subsurface distribution of volcanic rocks which constitute the basement and edifice of Usu Volcano, some limitations exist. No information about the magmas intruded during recent eruptions such as in 1977-1978 and 200 0 has not been obtained by the high-resolution aeromagnetic survey, though some intrusions were suggested by other geophysical data. No large magnetic contrast between the intruded magmas and their host rocks might be one of the most probable reason. This implies that the intruded magmas were not cool enough to be strongly magnetized. Consequently, it is not easy to get useful information associated with the volcanic activity of a volcano only form a single survey. The repeated high-resolution aeromagnetic survey is a promising way to extract temporal magnetic anomaly changes over the active volcanoes with rugged terrain. The crossover analysis

method has been already developed for that purpose (Nakatsuka and Okuma, 2006). Fortunately, large temporal magnetic changes (>50nT/year) have been observed by repeated magnetic measurements at fixed observation points on ground in the Nishi-Yama Craters Area. Therefore, meaningful magnetic anomaly changes can be detected by the repeated high-resolution aeromagnetic survey with a combination of the appropriate survey specification (low flight altitudes and dense line spacing) and the crossover analysis.

Keywords: Usu Volcano, 2000 Eruption, Aeromagnetic Survey, Magnetic Anomaly,
Magnetic Structure, Volcanic Hazard