[EJ] Evening Poster | S (Solid Earth Sciences) | S-TT Technology & Techniques

[S-TT49]Airborne surveys and monitoring of the Earth

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Airborne surveys are useful to better understand the whole and/or the detailed structures of the Earth and their variations. They can be implemented from a traditional manned and newly-developed unmanned aircraft to efficiently map very large or remote areas with difficult access. We invite studies on theory, instrumentation, processing, modeling or inversion and applications of airborne surveys.

[STT49-P07]Airborne surveillance using an unmanned autonomous helicopter at Noboribetsu Volcano

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1. Introduction

Volcanic eruptions generally prohibit humans from approaching active craters. Meanwhile, it is important during an eruption to perform visual surveillance, geophysical measurements, material sampling in the vicinity of the craters. These are useful in deciding emergency actions such as evacuation or recovery plans considering the ongoing volcanic activity and possible subsequences. We started airborne volcano surveillance using an unmanned helicopter on a trial basis in cooperation with the Hokkaido Regional Development Bureau since 2011. We performed the experiments at Noboribetsu volcano in 2016 and 2017. Noboribetsu volcano is a post-caldera volcano of Kuttara volcano in the southwestern part of Hokkaido, and it consists of Mt. Hiyoriyama cryptdome, Lake Ohyunuma and Jigokudani geothermal field. The latest eruption of Noboribetsu volcano is a phreatic eruption that occurred after 1663 AD (Goto et al., 2013). As of 2017, active geothermal activity including hot springs continues at Noboribetsu area. In this study, we report the results of aeromagnetic survey in the area around Lake Ohyunuma and the remote measurement of chemical component of the fumarolic gas at Mt. Hiyoriyama.

2. Aeromagnetic surveys

We performed the first airborne magnetic survey in Oct. 2016. The vehicle flew on the programmed route in the autonomous flight mode with the aid of GPS navigation. The second survey in September 2017 added routes to the northern part of Mt. Hiyoriyama in addition to the route of the first survey. The patterns of geomagnetic field anomaly were consistent in the two measurements. As for the distribution of magnetic anomalies, it is about 300-500 nT lower than the average total magnetic field in the area from Jigokudani to Lake Ohyunuma. In the northeastern part of Jigokudani, the value was higher by about 300 nT. Since the primary purpose of the present survey was to collect reference data during the volcanic activity was quiet, we first checked the reproducibility of the magnetic anomaly obtained by the two surveys. Magnetic field record in the air showed that the field gradient along the flight paths was within a range of approximately ±1 nT/m. Since the majority of the deviation in

positioning between the two surveys was kept within 10 m, we checked the reproducibility of the measurement was by taking the difference between the field data of the closest points. Considering the above magnetic field gradient, the error due to the positioning shift is less than ± 10 nT. However, no significant difference in magnetic anomaly exceeding this error range was detected between the two surveys. This is consistent with the fact that the surface activity of Noboribetsu volcano has been almost unchanged in this period. Thus, we confirmed that we successfully acquired a reference field data to be compared in future surveys when volcanic activity is elevated.

3. Gas measurements

In order to remotely measure the chemical components of the volcanic plume from Mt. Hiyoriyama, gas sensors in a meshed bag were pulled down from the unmanned helicopter and were suspended in the plume for several minutes. The sensors logged three kinds of gas concentrations of CO_2, H_2S and SO_2 with temperature and humidity. Based on the temperature and humidity data, we calculated the concentration of water vapor that exceeded the background level. Since high correlation was found between the measured gas species, component ratios were determined from the slope of the regression line of the scatter diagram between the components. The measurement in Oct. 2016 has revealed the following. Mt. Hiyoriyama's fumarolic gas is dominated by H_2O, accounting for about 99 vol%. The second most major component is CO_2, but it is only about one percent of H_2O. The next largest is H_2S, which is about a fifth of CO_2. SO_2 is contained only about 2 vol% of H_2S. Noboribetsu area is a rich source of hot springs and magmatic SO_2 may have dissolved in hot spring water in the shallow part. In the second measurement in Sep. 2017, CO_2/ H_2S and H_2O/H_2S were close to the first measurement, but the H_2S/SO_2 was increased about 4 times, suggesting that the SO_2 concentration decreased. Our field experiments confirmed that remote measurements of volcanic gas component ratios can safely be practically carried out by using an unmanned helicopter even with a simple apparatus.

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