Special Techniques for Airborne Survey Technologies Using Unmanned Helicopters in Noboribetsu Volcano

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1. Introduction
Because the use of unmanned robot technology is an effective way for performing studies in entry-restricted areas during volcanic activity, we have been working to develop survey technologies using a small unmanned helicopter owned by the Hokkaido Regional Development Bureau on Tarumae Volcano, Usu Volcano, and Noboribetsu Volcano through industry-university-government collaboration. In this paper, we discuss the special techniques that we employed with regards to airborne survey technologies, namely, installing antennas using a lift type vehicle, sampling volcanic ejecta, and measuring thickness of volcanic ash as well as discuss the equipment used and specific methods for performing these tasks.

2. Small unmanned helicopter specifications and survey location:
In this study, we used YAMAHA RMAX-G1 type. The helicopter's maximum flight time is roughly 90minutes with a range of up to a 5km radius from the base station. Its payload capacity is 10kg at an elevation of 0meters at 20ºC.
In this study, the survey location was the Noboribetsu volcano, and set up a takeoff/landing pad at an elevation of 578.7m near Kaminoboribetsu. We flied the helicopter to the northern slope of the Mt. Hiyoriyama 2.0km away, all studies were conducted from the air.

3. Installing antennas using a lift type vehicle:
Wireless transmission between the base station and the small unmanned helicopter consists of a 2.4GHz data communication band for operations, and an analog 1.2GHz band for camera images. Both bands require good visibility. Trees may often not have a blocking effect, but we used a lift type vehicle to install both antennas higher than the tree. The lift type vehicle is the so-called "super deck" with a platform of approximately 2.5×1.5m. It allows two people. With the use of this, we were able to assign both the antenna operator and visual helicopter watchperson at the high platform, and the antennas could be attached to the handrails.

4. Volcanic ejecta sampling method:
For volcanic ejecta sampling, the helicopter was again hovered roughly 50-60m above the ground, and a hanging sampler was lowered by winch to collect volcanic ejecta. Before the operation, we fixed a 2x2m square blue sheet in place at the target point, and laid volcanic ash onto this sheet to a few cm. The pumice type (there are around Hiyoriyama, Kt-1 tephra) and the fine grain volcanic ash type (from Sakurajima) were installed. We tested samplers as the ball types and the bucket types. The ball type samper were sticked volcanic ash evenly in both cases. The bucket type was superior in sampling 190g of the fine grain volcanic ash compared to 124g of the pumice.

5. Measuring volcanic ash thickness
The method of measuring volcanic ash thickness is photographing the marker that can identify the volcanic ash thickness from the sky. The markers used different heights, shapes, and colors, referring to

Tsutsumi et al. 2019, and set the height to 10mm, 20mm, and 30mm, we identified whether it was more than 10mm thick.

6. In closing:
In order to implement emergency studies during an eruption, we will need to have command of these special techniques as part of our know-how.

References
Tsutsumi H, Okazaki S, Yamamoto Y, Kamijo T, Tagta S, Sekimoto A(2019); The Study of Simple Measurement of Volcanic Ash Deposit(Part 2); 2019 Conference Japan Society of Erosion Control Engneering

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