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, collecting water from the air, and sampling volcanic ejecta 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. For water collection, the helicopter was flown to Oyunuma 1.9km away, and for volcanic ejecta sampling, 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. Collecting water from the air:

The helicopter was flown to Oyunuma and made to hover roughly 50-60meters above the ground. Its hanging water collector (Multi-purpose underground water collecto) was then lowered by winch to collect water. While this was a relatively simple method of collection, we needed to employ special techniques to ensure that [1]mixing of bottom mud in sampled water and, and [2]tipping over the sampler on the ground. We were able to overcome issue [1] by checking the distance between the swamp's surface and the water collector's shadow. As for [2], hovered the helicopter about 5m above, and successfully leaned it against the rod.

5. 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. We tested a variety of shapes, including ball types and bucket types, and while we used a very simple method consisting of double-sided tape attached to a ball type sampler to make the volcanic ejecta attach to the sampler. Because sampling will be more consistent the flatter the touchdown surface is, we used weights used in pickling pots, and have determined the optimum weight to be 1.5kg taking into consideration winch load. As for double-sided tape, we tested tapes [1] 1.2mm thick, [2] 0.75mm thick (for plastics), [3] 2mm thick, and [4] 0.75mm thick (multi-purpose). The amount of attached material was the greatest on tapes [1] and [4], and smallest on tape [3].

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.

Keywords: unmanned helicopters , industry-university-government collaboration, volcano


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