Primary data collection and prospects for penetrator system in the Antarctic environment at JARE64

Kodai YAMAMOTO[1], Masa-yuki YAMAMOTO[2], Yasuhiro NISHIKAWA[2] , Satoshi TANAKA[3]
[1] *Aerospace Engineering course, Graduated School of Engineering, Kochi University of Technology.*
[2] *School of Systems Engineering, Kochi University of Technology.*
[3] *Department of Solar System Sciences, Institute of Space and Astronautical Science (ISAS), JAXA*

This abstract introduces the research plan of AH1002 (Development of Antarctic Observation Penetrators and Intensive Observation in the Shirase Glacier and Surrounding Area) at the 64th Japanese Antarctic Research Expedition (JARE-64). JARE64 is the first year of the three-year project of AH1002[1)], and the primary mission of the first year is to collect primary data to implement future observation plans. First, we explain the mechanism of the penetrator. The penetrator shape is like a pencil, and sensors for physics and environmental study, like seismometers, are installed. It is possible to create an observation point by dropping the observation device onto the ground from the sky using a drone, allowing it to penetrate the ground surface[2)]. We understood that a penetrator can be installed at the human inaccessible places (unmanned places) from the characteristics of this system. The penetrator consists of three factors: penetration, observation, and communication. If these elements do not work, the operation of the penetrator cannot be considered successful. Therefore, we investigated whether penetrators could be operated in Antarctica or not. We considered three types of implementation plans: 1. Glacier observation, 2. The confirmation of UAV flight operations, and 3. Independent functional verification of penetrators (Fig. 1). (Operation confirmation of observation/communication functions of the penetrator, study of penetrating conditions using dummy penetrator). Then, we examined the results. Each experiment will be explained below.

1. Glacier observation

Project AH1002 investigates the amount of glacier runoff yearly by observing ice quakes at Shirase Glacier using penetrators. For this purpose, it was necessary to determine the target glacier. We observed the glaciers concentrated on the coast of Lützo-Holm Bay near Syowa station. The inspection route was Langhovde, Honnor, Teeren, Skaeren, and Shirase Glacier. After considering glacier conditions and accessibility, the candidate sites for next year and beyond were decided to be Shirase Glacier and Langhovde Glacier.

2. The confirmation of UAV flight operations

We can choose how to drop the penetrators using manned or uncrewed aircraft. Crewed aircraft requires much time, money, and human resources, so they are not preferred in Antarctica, where such resources are limited. However, drones can reduce those resources. Therefore, we verified the operation of drone-type UAV flights for penetrator drops.

3. Independent functional verification of penetrators

As mentioned at the beginning, verifying the penetrator's system was necessary by dividing it into three types of functions. A dummy penetrator was used to examine the penetrating conditions. An observation penetrator with a seismometer and an infrasound sensor was used to check for successful observations. To confirm satellite communication, a communication penetrator was used to confirm that Iridium satellite communication was possible and that the system operated normally.
At the symposium, we will explain these results and processes in detail. We also propose a method to improve the power problem of the penetrator system, which is one of the problems that will be raised when operating it in unmanned places in the future.

Figure 1. Three types of penetrators

References

1) Tanaka *et al*., *Development of a Penetrator for Antarctica region*. Chikyu monthly. 2023, vol.45, No.4, p222-227
2) Shirai et al., *Development of penetrator probe for volcano monitoring deployed from unmanned aerial vehicle*, International Association of Volcanology and Chemistry of the Earth's Interior, 2023, Abstract.