

Outline of the Japanese Arctic Glaciological Expedition (JAGE) in 1991–1992

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Abstract

In order to clarify the mutual interactions among air, ice and snow in the Arctic region, studies of ice and snow, and observations of atmospheric constituents, have been carried out in Greenland and in the Svalbard archipelago. The purpose of these observations is to determine what substances are transported from the atmosphere to Icesheet and glacier in precipitation, and through what processes those substances are sedimented into ice and snow layers.

To attain these objectives, ice coring was carried out on the summit area of the Greenland Icesheet and on Svalbard glaciers in the summers of 1991 and 1992. The ice and snow cores obtained were analyzed to determine the structure, physical properties and chemical composition of deposited snow and ice formed from it. In addition, detailed year-round observations were carried out on the Brøgger Glacier on Spitsbergen to learn more about the transport of atmospheric constituents into glacier with precipitation under present atmospheric conditions.

In addition, a scientific station has been established at Ny-Ålesund on Spitsbergen. There observations of trace atmospheric constituents have been carried out, together with vertical atmospheric radar and infrared radiation observations to study precipitation processes.

This report outlines field observational activities in the summers of 1991 and 1992.

1. Introduction

The Japanese Arctic Glaciological Expedition (JAGE) is a 6-year project started in 1987. The activities in 1987 and 1989 have already been outlined in reports by O. Watanabe and Y. Fujii (1988 and 1990). The years without observations were used for analysis and tests on samples performed in Japan. The program was planned by an Arctic Research Committee under auspices of the Japanese Society of Snow and Ice, headed by Prof. S. Kobayashi of Niigata University until 1990 and subsequently by Prof. S. Takahashi of Kitami Institute of Technology, and implemented by research teams under the leadership of Prof. O. Watanabe of the National Institute of Polar Research. There were 3 research teams : one conducted snow-ice drilling in Greenland ; one conducted snow-ice drilling on the Svalbard archipelago ;

and the third was an atmosphere and ocean research team based at Ny-Ålesund. The three teams pursued their observations independently.

The observational activities of the three JAGE teams in 1991 and 1992 are described in this report. Sites of the observational activities during 1987 and 1992 are shown in Fig. 1.

2. Objectives of JAGE in 1991 and 1992

JAGE is a 6-year project (1987–1992). The main objectives of the first phase (1987–1990) were to perform shallow drilling, to depths from 10m to 200m, at several locations in the Arctic region having different cryospheric environmental conditions : at Site J in the southwestern part of the Greenland Icesheet ; on mountain glacier (Högste Breakulen) on mainland Norway ; and on an ice dome in the Svalbard archipel-

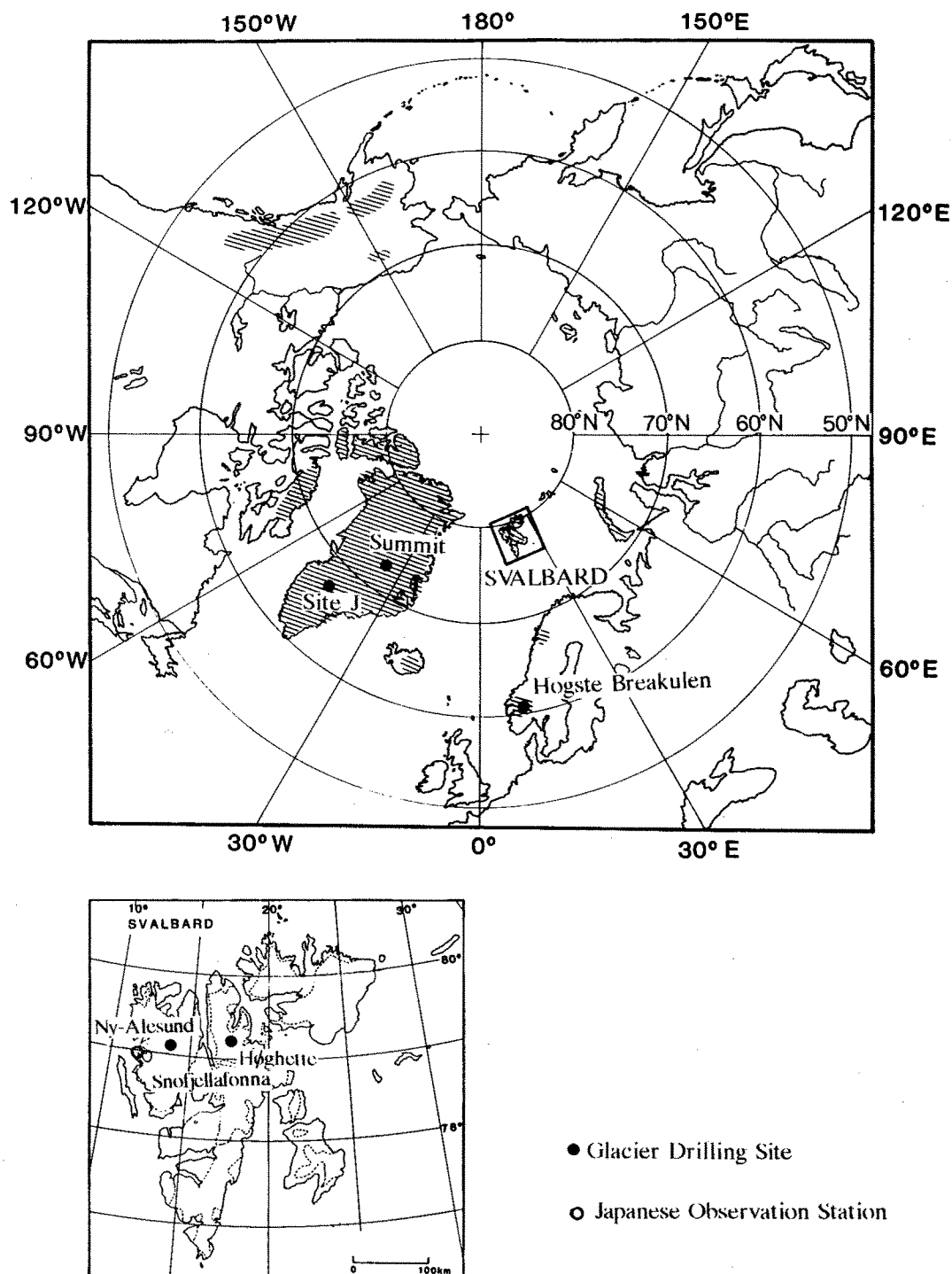


Fig. 1. Sites of the observational activities of JAGE in 1987-1992.

ago (Høghetta ice cap on Asgårdfornna, Spitsbergen), and, through analysis of the cores that were obtained, to clarify the changes in regional climate and environment over the last several hundred years indicated by the various signals in those cores, and then to compare them with one another.

The objectives of the second phase of JAGE, 1991–1992, are to clarify (i) the sources of the materials producing the various signals (types of substances and their variations) in the ice and snow layers of Icesheet and glaciers and how they are transported through the atmosphere to the ice and snow region; (ii) how those signal substances are sedimented into the ice and snow layers of Icesheet and glaciers; (iii) how those signal substances and their properties vary from one region to another, and, if there are significant variations, what causes them.

3. Research program on the summit of the Greenland Icesheet in 1991–1992

3.1. Objectives

The shallow coring program on the summit area of the Greenland Icesheet had two objectives. The first was to conduct an operational test of a prototype of the deep ice coring drill to be used for planned drilling in the interior of Antarctica through ice and snow layers deposited over the last 200,000 years. This drill is of the liquid-filled bore hole type. First it was necessary to drill a 100 m deep bore hole with a shallow type drill and use the snow-ice core obtained for analysis of the climatic and environmental changes in the vicinity of the Greenland Icesheet summit over the last several hundred years. Then the hole was filled with kerosene, and a deep drilling test conducted, yielding a core from depths below 100 m which was then analyzed. This series of tests served mainly to develop drilling technology for future observations.

Analysis of the properties of the cores obtained is to be carried out as a joint project with the Geophysical Institute, Copenhagen University starting in 1993.

3.2. Research sites and field operations

The drilling site was on the summit dome of the Greenland Icesheet at 72°35'N, 37°38'W, 3,230 m elevation, adjacent to the deep drilling site of GRIP (Greenland Icecore Project) planned as joint research of researchers of several European countries under auspices of the European Science Foundation. Japan's

deep drilling test received electrical power and logistical support from GRIP.

Drilling was done on the summit dome of the Greenland Icesheet for 26 days, from June 20 to July 15, 1991. First shallow drilling was done to 76 m; then the bore hole was filled with kerosene, and a deep drilling test in the liquid filled bore hole was conducted to 96 m.

Drilling was done again for 29 days from June 1 to 29, 1992. At that time a newly developed reamer was tested, and a test was also conducted of deep drilling below 90 m. The reamer enlarges the bore hole diameter for insertion of the casing that is used to prevent leakage of the filling liquid from the firn layer during liquid-filled drilling.

3.3. Participants

Chief investigator in the 1991 and 1992 project

Okitsugu WATANABE : National Institute of Polar Research (N. I. P. R.)

Field members in the 1991 operation

Hitoshi SHOJI : Faculty of Science, Toyama University

Kunio KAWADA : Faculty of Science, Toyama University

Takao KAMEDA : Kitami Institute of Technology

Hideaki MOTOYAMA : N. I. P. R.

Kunio SHINBORI : Institute of Low Temperature Science, Hokkaido University

Yoichi TANAKA : Geosystems Co. Ltd

Morihiro MIYAHARA : Geotech Co. Ltd

Field members in the 1992 operation

Yoshiyuki FUJII : N. I. P. R.

Nobuhiko AZUMA : Nagaoka Institute of Science and Technology

Hitoshi SHOJI : Faculty of Science, Toyama University

Yoichi TANAKA : Geosystems Co. Ltd

Morihiro MIYAHARA : Geotech Co. Ltd

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4. Research programs in western Spitsbergen, Svalbard, in 1991–1992

4.1. Objectives

The Arctic region, in addition to being a heat sink

of the earth, is also a sink of substances that are released into the atmosphere from various sources. It is believed that the types and amounts of substances vary with changes in climate and environment, so the state of these substances in the atmosphere can be regarded as a kind of signal indicating what the climate and environment are like.

Such substances in the atmosphere are either washed out by precipitation, or settle out ("dry fall"). One of the objectives of this research is to clarify the processes and mechanisms by which these substances which are washed out of the atmosphere or settle ("dry fall") out fall onto the snow, become mixed in and then are fixed into the snow and ice structure.

As a fixed base for this research, Ny-Ålesund in western Spitsbergen (78° 54' N, 11° 50' E) was selected. The process by which substances are mixed into accumulating snow was observed directly on the Brøgger Glacier near Ny-Ålesund. In addition, shallow drilling was carried out on the Snøfjellaafonna, the name given to the summit area of the West Spitsbergen Icefield, and cores were obtained which will be analyzed for signals which indicate climatic and environmental changes.

4.2. Research program in western Spitsbergen, 1991-1992

4.2.1. Observations at Japanese Ny-Ålesund Base in 1991-1992

The following fixed point observations were conducted year-round to clarify the meteorological conditions that bring about precipitation on the western coast of Spitsbergen and to investigate the year-to-year variations in precipitation and how these are related to changes in the area covered by the permanent Arctic Ocean ice pack.

- a) General meteorological observations
- b) Observations of carbon dioxide and ozone at ground level
- c) Vertical microwave radar observation of cloud water content and infrared radiometer measurements of cloud bottom temperatures

We note here that the Svalbard archipelago is located at the boundary between the permanent ice pack and the seasonally ice-covered zone, the location of which changes from year to year

4.2.2. Observations on the Brøgger Glacier

Year-round observations were conducted with

the objective of determining the chemical and particulate constituents in accumulated snow on the glacier, their seasonal variations, and their redistribution through penetration of melt water into the snow cover during the melting season. In particular, the following observations were carried out :

- a) Observations of snow stratification and taking of snow samples from the surface layer of snow in a pit
- b) Observations of changes in the amounts of organic substances and of biological activity in the surface layer of the glacier
- c) Observations of glacier surface temperature and of the behavior of surface melt water using an infrared camera
- d) Meteorological observations to determine the thermal budget of the glacier

4.2.3. Taking of snow-ice cores by shallow drilling at the upper end of Snøfjellaafonna

In order to verify the process of mixing of various substances into the accumulated snow layer as observed on the Brøgger Glacier, and to study the changes in these substances over the last few decades, shallow drilling to 24m and to 84m was carried out at the upper end of the Snøfjellaafonna. In addition, the temperature distribution in these bore holes was measured, and an infrared camera was used to observe the temperature distribution on the glacier surface. These data are presently being analyzed in the laboratory.

4.3. Participants

Chief Investigator in the 1991 and 1992 project

Okitsugu WATANABE : N.I.P.R.

Field Member in the 1991 project

Shun'ichi KOBAYASHI : Leader, Niigata University

Shuhei TAKAHASHI : Kitami Institute of Technology

HiroYuki ENOMOTO : Kitami Institute of Technology

Kumiko GOTO-AZUMA : Nagaoka Institute of Snow and Ice Studies, National Institute for Earth Science and Disaster Prevention (NIEP)

Field Member in the 1992 project

Shuhei TAKAHASHI : Leader, Kitami Institute of Technology

Shiro KOSHIMA : Tokyo Institute of Technol-

ogy

Takao KAMEDA : Kitami Institute of Technology

ogy

Kumiko GOTO-AZUMA : Nagaoka Institute of Snow and Ice Studies,
NIEP

Jon O. HAGEN : Norwegian Institute of Polar Research

Okitsugu WATANABE : Temporary participants, N.I.P.R.

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A report on the research activities in western Spitsbergen in 1991-1992 has been given in S. Takahashi, S. Kobayashi and O. Watanabe (1993), "Field activities of the Japanese Arctic Glaciological Expedition to the western Spitsbergen in 1991 and 1992 (JAGE 1991-1992)".

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