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Report

Japanese glaciological study efforts in the North Greenland Ice Core Project (NGRIP)

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Abstract: Deep ice cores from polar ice sheets form a proxy data bank for global climate variations. Japanese researchers have been involved in international core drilling and analysis projects in Greenland since 1989. One of the major outcomes of the GRIP project is the possible existence of rapid climatic oscillation during the Eemian interglacial period. However, physical property observations suggest that this apparent oscillation could have resulted from complicated ice flow near the bed as revealed by disturbed cloudy band features. A new ice core project, NGRIP, is expected to resolve the above question.

1. Introduction

Japanese glaciological research operations have been performed in Greenland (Fig. 1) since 1989 in a systematic way as described by Watanabe and Fujii (1990). International collaboration efforts in field and laboratory works have been conducted with the University of Copenhagen (UCPH), Denmark during the GRIP (GReenland Ice-core Project) operation as summarized by Clausen *et al.* (1996). Study results on the GRIP ice core are reported with those of a sister project, GISP2, in GISP2 and GRIP (1998). One of the major outcomes from the GRIP operation is a finding of fast climatic oscillations during the Eemian interglacial period, which may suggest future instability in the Holocene climate. But another possibility is that this could be spurious if there is ice folding and/or boudinage near the bed as shown by disturbed layers of the cloudy band (GRIP Members, 1993; Dansgaard *et al.*, 1993). A new international project called NGRIP (North GRIP) was planned and organized for deep ice coring and analysis, especially for study of climatic instability before and during the Eemian period by UCPH in 1995. Japanese participated as members of NGRIP under the auspices of the National Institute of Polar Research (NIPR, PI: O. Watanabe).

2. Ice core analysis

Ice core analysis has been planned and conducted in Japan within the framework of NGRIP as shown in Fig. 2. Physical property measurements and mechanical tests are being conducted at the Institute of Low temperature Science (ILTS), Hokkaido University, Kitami Institute of Technology (KIT), Toyama University and NIPR in close collaboration

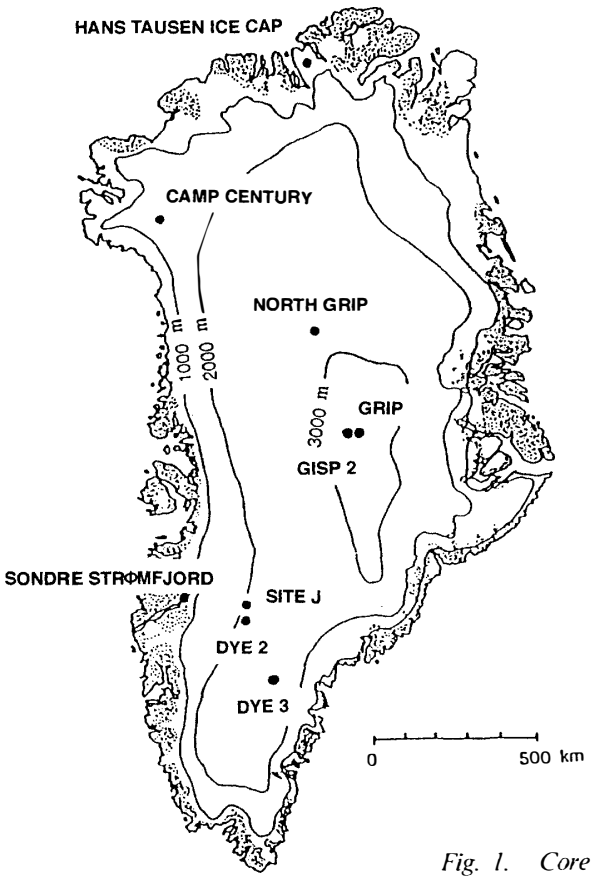

Fig. 1. Core drilling sites in Greenland.

with UCPH, Alfred Wegener Institute (AWI) in Germany, and others (Miyamoto *et al.*, 1997, 1999; Castelnau *et al.*, 1998; Pauer *et al.*, 1999). Chemical analysis and stable isotope study are conducted at NIPR as collaborative research with UCPH and others, although on a smaller scale. Gas analysis is planned and started at Tohoku University as a member of the NGRIP gas consortium.

Domestic NGRIP meetings have been held several times a year and their research plan is proposed in the NGRIP meeting in Copenhagen. Logistics expenses for Japanese participation are mainly covered by NIPR and the rest by other institutes to a lesser degree.

3. Field activities

NGRIP field activities are conducted from May to August each year. Approximately thirty persons join the NGRIP camp (75°06′N, 42°20′W). Transportation of both personnel and cargo is mainly by C-130 Herculus between Sondre Strømfjord (Kangerlussuaq) and the NGRIP camp.

Participants are assigned to certain tasks depending on their skills/background and interests. Some may work as drillers in a drilling trench (Fig. 3) and some as core processors in a science trench (Fig. 4). Nationality is not necessarily a factor for a task assignment. Two Japanese researchers participated as drillers in 1996. Six researchers joined the field work in 1997, three as core processors/loggers and three as drillers. One researcher participated as a

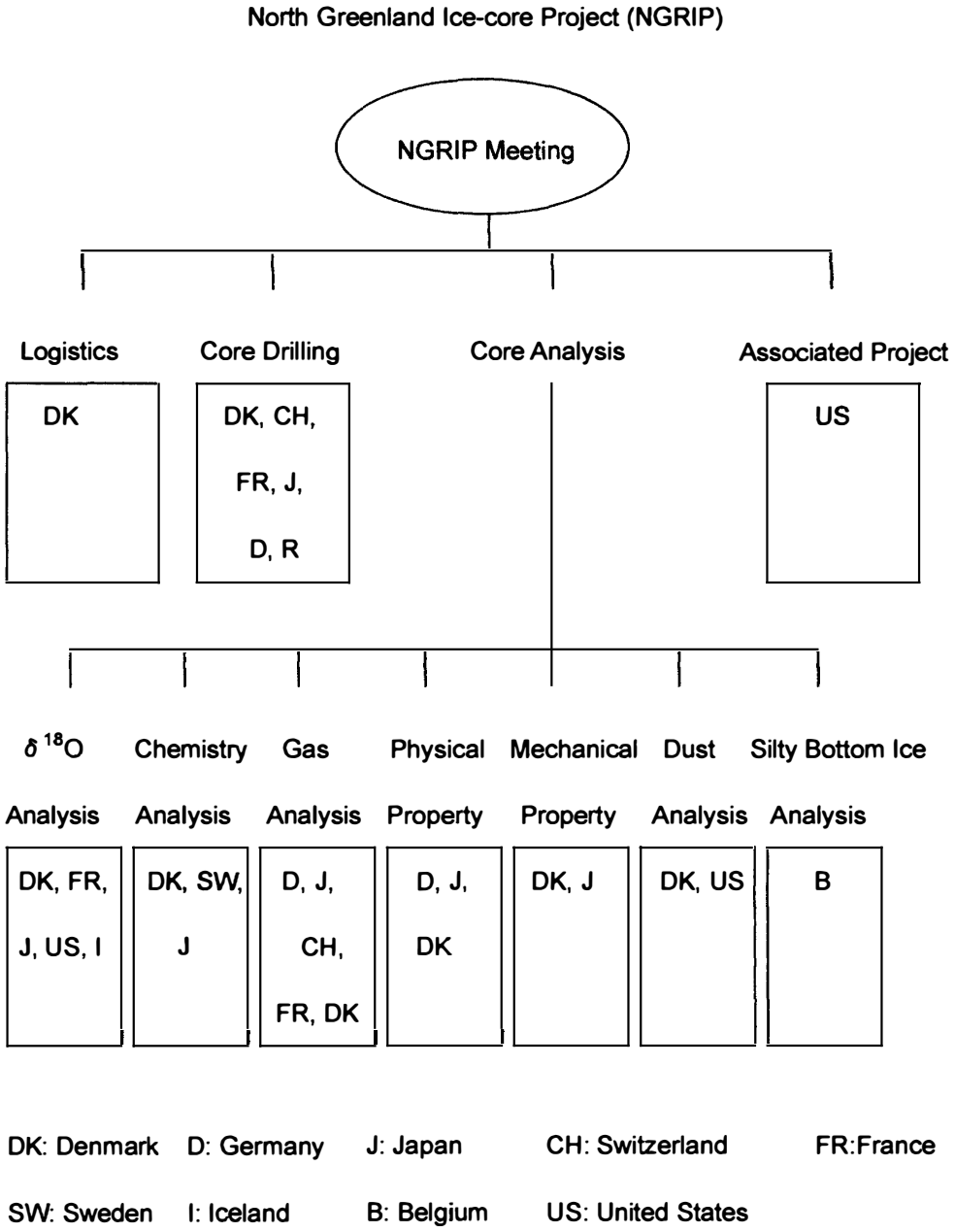

Fig. 2. Infrastructure of NGRIP and Japanese study efforts.

core processor/logger in 1998 and three researchers participated in 1999, two as core processors/loggers and one as a driller.

A pilot hole drilling was conducted in 1996 and a casing was made down to a depth of 93.1 m. A deep core drilling was started in a liquid filled hole from a depth of 111 m. The Core drilling was continued from a depth of 351 m in 1997 and completed down to a depth of 1373 m, where the drill was stuck and has never been recovered. Another new pilot hole drilling was started in 1998 at a position approximately 25 m from the first NGRIP hole. A new deep core (NGRIP2) was drilled down to a depth of 1751.47 m in

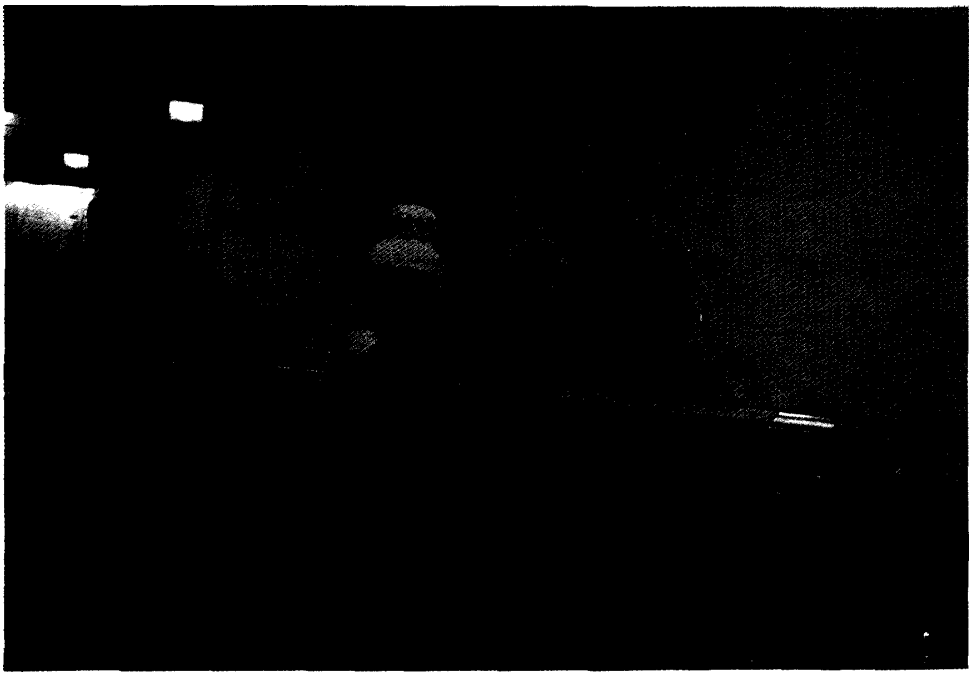

Fig. 3. Deep ice coring operation in NGRIP.

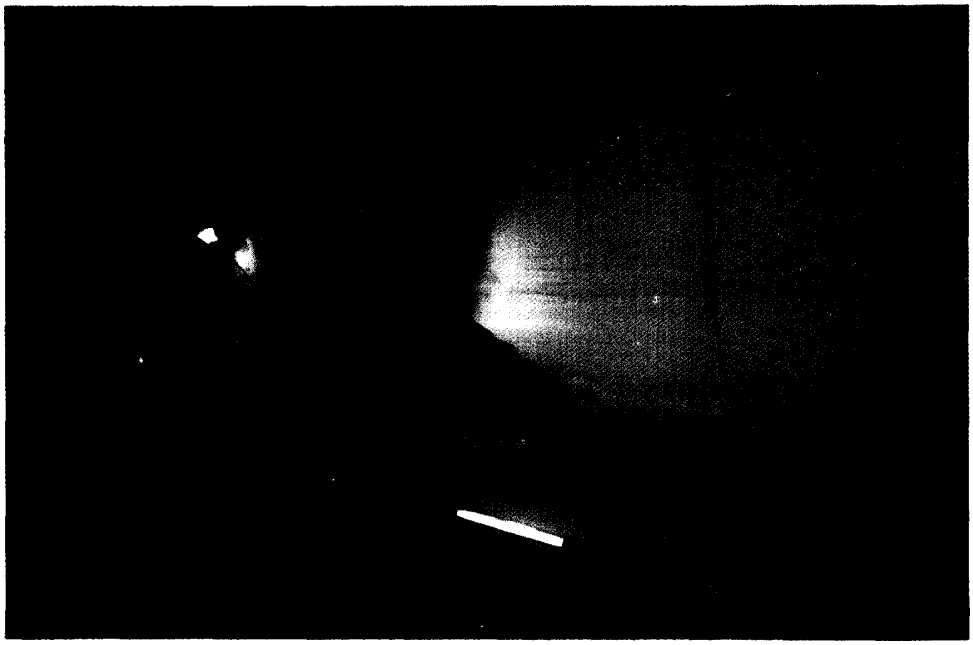

Fig. 4. Field core measurement on DC electric conductivity.

1999. A brittle zone has been encountered between about 800 and 1300 m in both deep holes.

Frozen ice core samples have been shipped to Japan by air with pit study samples collected near the surface, and laboratory analyses are under way.

4. Future collaboration

Eight Japanese researchers were scheduled to join the NGRIP field operation from KIT, ILTS, Hokkaido Univ., Tohoku Univ., Nagaoka Univ. Tech., NIPR and Geo. Tech. Co. Ltd. in 2000. They were to do field measurements, core drilling, processing and/or logging/packing as members of the NGRIP international project.

The Eemian age ice and also older ice were expected be extracted during the 2000 season, and to supply detailed information on fast climatic oscillation by core analysis. This should be a breakthrough in Greenland ice study and enables a bi-polar comparison with the Dome Fuji (Watanabe *et al.*, 1999; Hondoh *et al.*, 1999) and Vostok (Petit *et al.*, 1999), Antarctica core data for long term climate variations.

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