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SPECIAL SESSION

Report 1. Status of Drilling Plan

The session was chaired by H. RUFLI and current and future drill plans were presented as follows. (Documented by Y. FUJII)

Australia

1. Deep drilling

The current project is 'Deep Ice Drilling on Law Dome'. The main part of the field work (*i.e.* the ice drilling part) was completed in February 1993. Drilling stopped at 1200 m when silty ice with small rock fragments were obtained. About half of the core (553 to 1193 m) was very brittle and was left in the drilling shelter. Some sampling and analyses will be done in 1993/94 and the core will be brought to Australia in March 1994. Analysis of the core is expected to continue for a number of years. Presently involved in the analysis are: Australian Antarctic Division, CSIRO Division of Atmospheric Research, and CNRS-Laboratoire de Glaciologie et Géophysique de l'Environnement.

2. Shallow drilling

As part of a detailed study of the surface snow characteristics along the Lambert Glacier Basin traverse route shallow cores are drilled with hand augers (PICO corers), or with an experimental dry-hole electromechanical drill. To date, drilling has been to depths of about 50 m but this may be extended to ~100 m for next season. The principal analysis is fine detail $\delta^{18}O$ measurements and conductivity which are used to determine accumulation (in regions where annual layers are preserved). Mean $\delta^{18}O$ values are also obtained which add to our general knowledge of $\delta^{18}O$ of the Antarctic ice sheet.

3. Intermediate depth drilling

In 1994/95, in conjunction with work in the Prince Charles Mountains we would like to drill another hole on the Amery Ice Shelf. This would confirm the three layer structure of the ice shelf (local accumulation, inland ice from the Lambert Glacier and basal frozen-on sea water), and other measurements such as temperature would allow further studies of the dynamics of this major outflow of the Antarctic Ice Sheet. A depth of 300–400 m is required. The Antarctic Division dry-hole electromechanical drill is not suitable for this project as the drill rig will have to be flown to the site in a small helicopter. We are considering buying or building a lightweight drill.

4. Future work

There is a broad plan for another deep drilling project on the inland ice sheet about 600 km south of Casey. The ice thickness here is about 4000 m and the accumulation is only about 5 cm of ice equivalent. A deep ice core would give a record of perhaps 400000 years covering a number of glacial cycles. We would probably use the same electro-mechanical drill as was used on Law Dome (with a few modifications) and a similar form of drilling shelter.

(V. MORGAN)

China

Ice drilling technology has developed in China since 1988. A few of glaciers have been drilled to the bedrock at the high mountains, such as No. 1 Glacier in Tianshan Mts., Chongce Ice Cap in west Kunlun Mts., Nakedora Glacier in Xixiabangma Range by a Chinese drill. Dunde ice cap in Qilian Mts. and Guliya Glacier in west Kunlun Mts. were drilled to the bedrock by the Sino-American team by the use of an American drill. Since the special importance of Tibetan Plateau in cryosphere, we are planning to drill to obtain more ice cores on Tangula Mts. and others in Tibet. Ice core drilling is planned in the East Antarctica, near our Zhongshan Station. In the Antarctic, we have succeeded in the drilling activities in past few years in Collins Ice Cap, King George Island, West Antarctica.

(J. HAN)

France

An agreement was signed March 1993 between Italy and France to develop cooperation on scientific programs in Antarctica. Two institutes are involved in this cooperation:

*Ente per le Nuove technologie, l'Energia e l'Ambiante (ENEA) for Italy.

*L'Institut Français pour la Recherche et la Technologie Polaire (IFRTP) for France.

A cooperation is planned to built a permanent station for 20 persons at Dome C, East Antarctica (For summer activities a camp close to the station will receive 50 persons) and to develop scientific programs on glaciology, astronomy and astro-physics, earth science and medicine and human biology.

Glaciology program (as other scientific programs) is open to other countries, in particular to countries from European community. Following glaciological themes are concerned; climatic data, glacio-chemical studies, physical and rheological properties, remote sensing and ice flow modeling.

Drill equipment should be developed in cooperation between Italy and France. Definite parameters are as follows.

*Electromechanical technology.

*Core retrieve in horizontal position to provide a good core recovering.

*Pulling up and down speed: 60 m/min to 100 m/min to reduce operating time.

*Appropriate core length: 2.5 m to 4 m to reduce number of run and to give easy handling.

Proposed schedule:

*Building station at Dome C

Starting season: 1993–94

Going on: 1994–95 to 1995–96

*Deep drilling

Preparing season: 1994–95

Drilling: 1995–1996 and following years

(L. AUGUSTIN)

Iceland

1. Ongoing program of 10–20 m hand-auger coring in Icelandic glaciers.

2. A steam drill is being developed for drilling in the ice-shelf in the Gvinsvödrs caldera.
3. Within five years a 800 m deep drilling will be planned in one of the calderas formed in either Vetnajökull or Hofsjökull glaciers.

(S. JOHNSEN)

Japan

The Dome Fuji Deep Ice Coring Project is the third phase of a comprehensive Antarctic glaciological projects done by JARE, following the Mizuho Plateau–Enderby Land Project which started in 1967 and the East Queen Maud Land Glaciological Project which started in 1982.

The project inherits the main purposes of the previous two projects: (i) the dynamic state of the ice sheet and its changes, (ii) ice sheet environment, and regional characteristics and processes of snow and chemical elements deposition, and (iii) reconstruction of long-term paleo-climate and environment on the basis of ice core studies. The project consists of two main scientific activities, that are the glaciological research from the coast to the dome summit and the deep ice core drilling at Dome Fuji.

The site planned for the deep ice core drilling and the glaciological and atmospheric research is the summit of Dome Fuji at 77°22′S, 39°37′E and 3810 m a.s.l, the highest point of the Queen Maud Land ice sheet. The station will have five above-ground prefabricated structures: living huts, a mess hut, an observation hut and a generator hut. The construction will start in 1993/1994 summer and will be completed in 1994/1995 summer. The drilling site will be a roofed trench 28 m long, 4 m wide and 4 m deep. There will also be a tent-type Quonset work hut for oversnow vehicle storage and maintenance, and emergency work. It can accommodate up to ten personnel.

The drilling operation will be carried out in 1995 and 1996 by the 36th and 37th JARE wintering teams. The drilling system was developed by the National Institute of Polar Research. The system can be operated by 2 persons. The actual drilling speed is about 30 cm/min, but most of the time is taken up by pulling the drill up and down. The winch is designed to have an average up and down speed of 2500 m/hour, so if work continues for 10 hours each day, it is estimated that when breakdowns and auxiliary operations are included it will take 2 years to reach the target drilling depth. Butyl-acetate is to be used for the borehole liquid.

Two series of core analyses are to be carried out. One is called basic analyses and the other detailed analyses.

Basic analyses

Continuous analyses throughout the whole core are planned in order to provide general trends of various elements such as isotope concentration, insoluble particles, major anions, major cations, pH, ECM, DEP and stratigraphy. Discontinuous analyses to be made also aim at obtaining profiles along the whole core. The analyses include those on air inclusions, ice crystals and hydrate crystals. The basic analyses are to be completed within a few years after the coring. The analyses are hence to be carried out with conventional methods/tools with reasonable experiences.

Detailed analyses

This will be done after the completion of the basic analyses whose results are to be referred to. The detailed analyses should aim at revealing certain events in detail or

obtaining new information with innovative methods.

(O. WATANABE)

Russia

Antarctica: Financial problems limit drilling operations in Antarctic Ice Sheet. Some drilling activities take place at Vostok Station. Unfortunately drilling at Dome B location (–58°C, depth about 2800 m; subglacial lake) can not be continued. Temporal Station Dome B has generators (16×2 kW), some supply of fuel, drilling equipment and living facilities for 6 persons.

Arctic: Since 1989 few shallow ice cores were obtained in Svalbard and Franz Josef Land glaciers by hand augers. With foreign financial support joint ship expedition can be organized for multy-disciplinary study of several Eurasian Arctic glaciation (Franz Josef Land, Severnaya Zemly and Novosibirskiye Ostrova).

(V. ZAGORODNOV)

Switzerland

Swiss drilling activities in 1973–93:

a) Various shallow + intermediate electro-mechanical drilling project in Alps, Greenland and Antarctica
(University of Bern)
b) Contribution to GISPI and GRIP : drill head, cutter, GRIP tower
(University of Bern)
c) Hotwater drilling in Swiss Alps and Greenland (A. Iken,
Versuchsanstaff für Wasseban, Hydrologie and Glaciologie, EHT Zürich)

Status of drilling equipment in 1993 (University of Bern):

3" SIPRE hand auger (max. depth: 13 m)
2" solar powered electro-mechanical drill., extra light
(30 kg including batteries) (25 m)
3" electro-mechanical drill (130 m)
3" electro-mechanical drill with tiltable tower (150 m)
4" electro-mechanical drill (400 m)

Future project:

1993 Colle Graffiti (Swiss Alps 4500 m a.s.l) in frame wash of NFP 31
(Special Research Program of Swiss NSF on extreme wealthier conditions)
1993/4 ITASE (International Transantactic Scientific Expedition). Participation of one Swiss scientist in Swedish Traverse: Several shallow drilling (2" and 3").
1996 EPICA (European program for ice core drilling in Antarctica). If this effort is taken, Swiss experience will be available.

(J. SCHWANDER)

U. K.

Palaeoclimatic reconstruction on Antarctic Peninsula both an east and a western sides. Three sites at same latitude, Dollman Is., Dyer Plateau, and Beethoven Peninsula have been completed. Depths of (65–135 m), Dyer with PICO drill (235 m). Future ice core

work, collaboration with AWI (Germany) to drill on Berkner Island. Initially 100–300 m cores to be taken, with a future view of a bed rock core (1000 m).

Hot water drilling was carried out on Ronne Ice shelf for oceanographic work (CTD) and instrument deployments, so far to depths of about 550 m.

Future work to the southern sections of Ronne Ice Shelf initially to depths of 850 m, with a future view to collaborative work in areas with ice thickness of 1200m.

(K. MAKINSON)

U. S. A.

The major US ice coring effort supported through the Polar Ice Coring office (PICO) by the Office of Polar Programs (NSF/OPP), National Science Foundation is the completion of the deep drilling on the Greenland Ice Sheet in support of GISP-2. Approximately 1000 m of ice coring remains. The electromechanical "wet" drill (drilling in n-butyl acetate) has been modified to accept a rock drilling bit and motor section to core basal material and possibly bedrock. This part of the program will be jointly conducted in corporation with GRIP. PICO also supports an atmospheric monitoring station on the Ice Cap.

Deep drilling will proceed in 1993 and 1994 in support of a Univ. of Washington project on McMurdo Dome, Antarctica. Core will be processed on-site as was done in Greenland. N-butyl acetate will be used as the drilling fluid.

Hot water drilling will proceed in Antarctica in support of the AMANDA project (Univ. of Wisconsin). The AMANDA project is a high energy astrophysics project requiring 50 or more holes to as deep as 2000m. The object is to detect neutrinos.

Other projects will be conducted to support NOAA projects in Peru (Guelccaya) in 1993. A successful program was recently carried out on the Guliya Ice Cap in China by electromechanical and thermal drilling.

Additional projects are scheduled for drilling sea ice (hand augers) on the Arctic ocean sea ice.

(J. KELLY)

Report 2. Status of Shallow Drill

The four problems related with status of shallow drill were brought up by S. JOHNSEN as follows:

(1) Recent development
(2) Core quality
(3) How to stuck and escape
(4) Any other

At first, the recent development of drill systems were introduced with Denmark Drills (for example, tinny drill for one person and GRIP drill etc.) by S. HANSEN.

Following the introductions, we discussed about the cable used for the shallow drill. Kevlar cable have an advantage in specific strength which is seven times as strong as steel. For high altitude work which uses electro-mechanical or thermal drills this is the only choice. There are often ways of minimize cable weight and size by keeping power