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 requirement low as the Danish dry drill. Problems with Kevlar cable are more related to cable construction type than Kevlar fiber itself. The weight, strength and wear properties change with each different construction type. The perceived problem with Kevlar cable use in shallow drills has been confused. PICO has successfully used Kevlar cables to drill many hundreds of meters without problems. Also, in connection with cable type Australian drilling group has considered a battery powered drill using radio for communication. This allows the cable to be a simple standard steel wire (yacht rigging wire) or a Kevlar string. This greatly simplifies the winch and cable formations.

ATED equipment was explained here. The total weight of the equipment (200 m depth) including power generator (2.5 kW) and fuel is about 180 kg. Without using of ethanol the ATED method (drill) can be utilized on glaciers with ice temperature of 0 to –5 °C. With limited quantity of ethanol (10% of the borehole volume) the shallow drilling with ATED can be done at ice temperature of –15°C.

Secondly, we discussed about the core quality. Many improvements have been made over the past 30 or 40 years in shallow drilling in ice. However, there is still great room for improvement with respect to core quality. The core quality depends on what measurement they are used. Here, how drilling should be performed without cracks was mainly discussed. Use of round cutter was proposed. The round cutter have producted fine chips because the bit geometry as currently used causes the cutter to have a near vertical face as it approaches the edge. Then, B. KOCI suggested that the rake angle is 15° and relief angle is 45° on edge of cutter. Other is addition of small amount of liquid to bottom of hole in shallow drilling to prevent crack formation or crack propagation. This is a danger for core contamination. We need to sort out eventually what types of tests need to be conducted to truly understand "how the system" works through international cooperation.

Above problems of (3) and (4) were not discussed because of not enough time.

(Chaired by S. JOHNSEN; Documented by H. NARITA)

Report 3. Status of Deep Drill

According to the summary given by N. GUNDESTRUP, there are several types of deep drills:

1. The thermal type, introduced by V. ZAGORODNOV

The core displaces a solution that dissolves the water produced by melting. This type has the best ratio between core length and drill length: the drill is hardly longer than the core. This means that this type of thermal drill can use a higher viscosity hole liquid than other drills. The problem with this type of drill is the hole liquid. It has only been tried with alcohol, and which has quite a high density. Thus, it is natural that this drill has only been tried to the depth of 900 m. It can possibly drill deeper, but the drilling has to be fast in order to avoid hole closure.

The hole will be lost after a few years due to the pressure difference between the ice and the hole, and creation of slush by constant interaction of alcohol with the ice hole wall. V. ZAGORODNOV reported on one such incident. If the hole is lost, it will not be possible to obtain information on ice flow with depth.

2. Thermal type with pump, modified CRREL version