PERFORMANCE OF THE UCPH SHALLOW - AND HAND AUGERS

by

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ABSTRACT

The UCPH shallow drill is intended as a fast drill, operating to depths between 25 and 100 m. A 25 m core can be retrieved in 4 hours, and a 100 m core in one day. The maximum obtained depth is 325 m, with a decreased drilling time for depths higher than 100 m. At depths deeper than some 130 m the core fractures. The core quality was improved at depths below 200 m, by applying a smaller pitch. This created fine chips which enhanced the risk for the drill to get stuck.

INTRODUCTION

UCPH made their first version of the Rand-Rufli shallow drill (Rand, 1976) for the 1976 field season. The drill employed cutters with a 30° rake angle (Mellor, 1976), and a knife antitorque section (Rufli and others, 1976). The drill worked well in a test in South Greenland at Dye 3. Later in the season the drill was lost on the Hans Tausen Ice Cap in Pearyland, North Greenland. The drill was lost mainly due to :

A) The stainless steel outer barrel became slightly banana shaped for unknown reasons.

B) The knife type antitorque section did not provide sufficient antitorque in the heavily layered ice.

C) The cable was attached to the antitorque section without a rotating slip ring section.

After that season, a new version of the drill was developed (Johnsen and others, 1980), and in 1977, five 100 meter cores were obtained. After the ISTUK deep drilling, the drill head was modified (Gundestrup and others, this volume), and the drill has until 1989 augered 26 cores with an accumulated length of 2110 meters. The deepest core is 325 m. The drill has only been used on cold glaciers, i.e. in ice temperatures between -15°C and -32°C.

DRILL HANDLING EQUIPMENT

For holes up to 100 meter, the drill is normally mounted on a 12' Nansen sledge (Fossum skifabrikk, Norway). Thus the set up time is reduced to around one hour. A key point is to reduce the ground time to a minimum, not just to save time, but also to avoid heating of the drill by sunlight. The drill is normally used directly at the surface without drill pits and shelter. Also, the drill components must not be exposed to direct sunlight on the snow surface otherwise snow sticks to the drill. A small rack is placed a few meters from the drill, and the inner core barrel is placed there when the core is extracted.

The inner core barrel, the drill head and coupling to the drill motor are cleaned with a brush and pressurized air. Solvents are not used, as remnants of solvents may cause refreezing in contact with snow down bore hole. If the hammer section in the antitorque section needs to be cleaned, it is heated to around 100°C for some hours, and the drilling is resumed when the drill again is cooled to below the freezing point.

Our main generators are two 3 kW Bosch generators purchased in 1976, one serving as abackup. We have now purchased a 4 kW MASC generator as backup.

If the drilling takes place inside a tent, a modified (oversized) tourist type tent of aluminized nylon is used. Although this tent is a bit weak, it has survived several snowstorms.

CORE PROCESSING EQUIPMENT

The cores are cut into 55 cm lengths, bagged and put into the storage boxes : moulded commercial freezer styrofoam boxes. These boxes are insulated with 5 cm of styrofoam, and the inside dimension are 60*50*60 cm. Empty space is filled with cold snow to prevent the cores from moving during transport. The maximum weight of a full box is 90 kg.

If a 25 m core is drilled, and the air temperature is well below 0°C, all ice cores are placed on the surface shaded against the sun : No core processing takes place during drilling. When the 25 m of core is recovered (2 h) an accurate depth measurement is made, and the cores are then cut based on this numbering scheme : bag 1 spans 0 to 55 cm, bag 2 55 to 110 cm etc. The key point is, that the bag number is a depth reference. If there is a core break within 3 cm from the bag limits, the core break will be used instead of cutting the core exactly at the 55 cm limit, thus we are sure to avoid cumulative errors. The cores are cut after carefully fitting each core break. The drilling ends with a 2 m hand augured core overlapping the upper part of the 25 m shallow core.

When the cores are bagged in a shaded area, they are placed in the freezer box within minutes, because the clear plastic bag acts as a very efficient solar energy collector. If a bagged core is left in the sun for just a few minutes, the surface conductivity signal on the outer layers of the ice core is destroyed.

When cores are drilled to greater than 25 m, 3 drillers are normally used, two are drilling, and one takes care of the processing of the core. Normally, no measurements are performed in the field except for density measurements, however at times, the Laki eruption is identified by measuring surface conductivity. This eruption is a major marker at the 100 m depth range, and it is essential, that cores are sufficiently deep to span this eruption to insure a fixed point on time scale of the ice core.

EXAMPLE OF A SHALLOW DRILLING EXPEDITION

As part of a joint american-swiss-danish effort to locate a suitable deep drilling site in Central Greenland, a team of 3 was put on the ice by a US C130, June 30, 1985. The total weight including 3 heavy "skidoo's", 6 Nansen sledges and 600 liters of mogas was 4000 kg. During a period of 16 days, the team travelled 120 km, made 5 camps recovering a core at each site. Three 100 m cores and two 25 m cores were recovered. By July 15 everything was packed and the team was ready for pick up.

CORE QUALITY

Up to a depth of 130 m, the core quality is very good with literally no fracture. At 140 m, we experience breaks originating from the core catchers and running along the length of the core. Also, a few breaks perpendicular to the core axis start to form. On the Renland Ice Cap in East Greenland, we went deeper, and around the depth of 250 m, the core tended to create wafer type breaks similar to those experienced with thermo drilled cores. In order to preserve core quality, the pitch was reduced to 3 mm. This reduced the chip thickness to 1 mm. This stabilized the core quality somewhat, and it was decided to continue with the low pitch in spite of the problems introduced by the fine cuttings. The fine cuttings are dificult to transport up the auger flights, and they tend to stick to the surfaces. This is a real threat to drilling safety because we had to use the hammer frequently in order to move the drill downwards, and also to use the hammer while breaking the core. Both problems are caused by chips which are not collected inside the drill, and which stuck to the hole wall. Finally, close to bedrock (fine clay particles in the core), we were not able to break the core, and the drill was stuck. The problem here was simply a very tough ice as the drill was not wedged in - it could be moved around 10 cm. In order to free the drill, 20 liters of a 30 % glycol/water mixture was dropped down the hole through a 50 m long plastic tubing. The mixture was not heated, because it would have cooled down before reaching the drill 325 meters below. The next day, the drill was free and used to recover another 90 cm long core.

SPECIFIC ENERGY

The specific energy (the energy required to produce 1 m^3 of cuttings) and motor current, using the modified drill head described by Gundestrup and others (this volume), are estimated to be :

	100 m	250 m	325 m
MJ/m3	3.4	7	9
I [A]	1.8	2.8	3.4

For the ISTUK deep drill used at Dye 3 in South Greenland, the specific energy was around 5 MJ/m^3 at 500 m and around 16 MJ/m^3 at 2000 m (Gundestrup and others, 1984, 1985). Thus, in spite of the fact that ISTUK was operating in a liquid filled hole, the cutting energies are comparable.

PENETRATION RATE

A 25 m drilling, including setup, repacking and moving the drill 5 km to the next site, takes 4 hours. For deeper drillings, figure 2 shows depth versus drilling time. The time used is the actual time spent on drilling, including set up, erection of drill tent, repairs etc. It is interesting to note, that the penetration rate is around 300 m/week, independent of depth ! The reason is, that the time added by moving the drill up and down the hole is compensated by the experience gained by the drillers. For the deepest drilling, the penetration rate even increased below 180 m ! The reason is, that the drill team was increased to 4 people which made it possible to extend the drilling time to 16 hours a day using two shifts.

The **hand auger** was used at Camp Century (Gundestrup and others, 1987). Here, 44 cores with an accumulated length of 358 m were recovered by two of the authors in 5 days when they awaited a pickup. Only a few of these cores were processed - most were discarded.

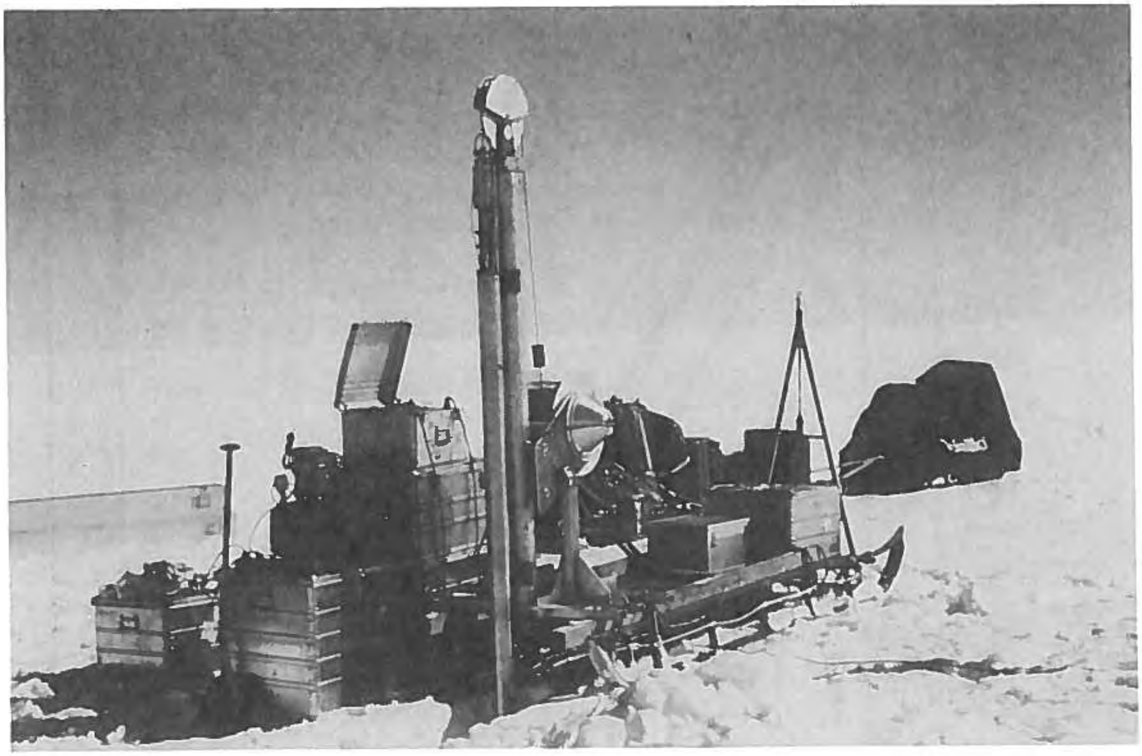

Figure 1 - Drill set up as used in Central Greenland. The tiltable "tower" in mounted on a 12' Nansen sledge. The console is placed on top of a transport box.

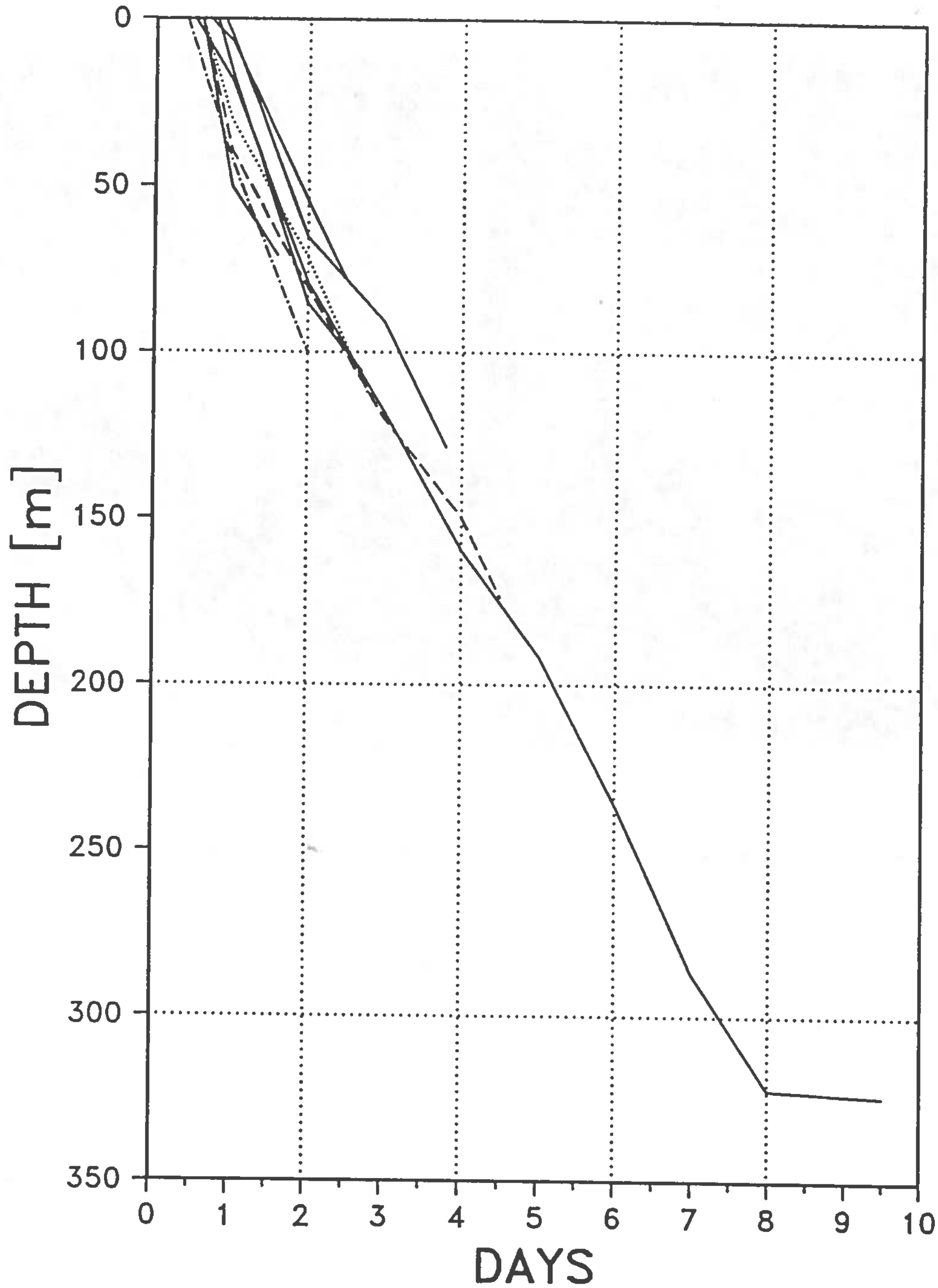

Figure 2 - Time of day versus depth for 8 shallow drillings. The time used includes set up, repair, erection of tent etc.

SUMMARY OF UCPH SHALLOW DRILLINGS

The shallow drill has been used to recover the following ice cores :

1976	Dye 3	100 m
	Hans Tausen	60 m, drill lost
1977	Dye 2	100 m
	Camp Century	100 m
	Camp Century upstream	70 m
	North Central, 1	100 m
	North Central, 2	102 m
	North Central, 3	107 m
	North Central, misc	2*25 m
1978	Dye 3	100 m
1983	Dye 3, 4B	174 m
1984	Dye 3, 18C	113 m
	Dye 3, misc	5*25 m
	Central Greenland, D	100 m
	Central Greenland, B	100 m
	Central Greenland, C	25 m
1985	Central Greenland, E	78 m
	Central Greenland, F	25 m
	Central Greenland, G	71 m
	Central Greenland, H	26 m
	Central Greenland, A	129 m
1988	Renland, long	325 m
	Renland, short	90 m

Total 26 cores, 2110 m of ice with same drill, same cable.

Since 1976, the drill has remained almost unchanged with the exception of changes to the drill head. The cable is that purchased in 1976.

FUTURE CHANGES

No change to the set up is planned except for a possible modification to the drill head incorporating the small cutters in front of the main cutters to facilitate freeing the core. This change is inspired by the swiss group (this volume). Also, the controller should be replaced by a hermetic version. The shallow drill will be duplicated in order to have a backup version.

ACKNOWLEDGEMENTS

This work has been sponsored by the University of Copenhagen, the Danish Commission for Scientific Research in Greenland, the Danish Natural Science Research Council, the European Economic Community (contract CLI-067 DK(G)) and the Nordic Council of Ministers.

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