GERMAN INTERMEDIATE ICE CORE DRILLING SINCE 1981

- Technique and Experience -

by

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1 - ABSTRACT

The development of a Rufli type drill system for electromechanical ice coring, it's use at several locations in the Antarctic and future modifications based on experience during field work are outlined. A short video record, taken during the German Antarctic Expedition in 1987 in the Ritscher Hochland and the Ekström ice shelf gives an impression of the drill procedure and occuring problems.

2 - INTRODUCTION

Since the International Geophysical Year scientific investigations on ice cores and in drill holes are important tools for glaciological research.

Down to depths of 30 m ice cores can be obtained with hand operated drills.

Because of the technological requirements only a few drill systems for greater depths are available. Most of these systems are designed for drillings in dry holes down to 400 m.

Four nations have developed techniques for deeper drilling (to 4000 m) using expensive drill technologies with liquid filled holes. At present most international interests in ice

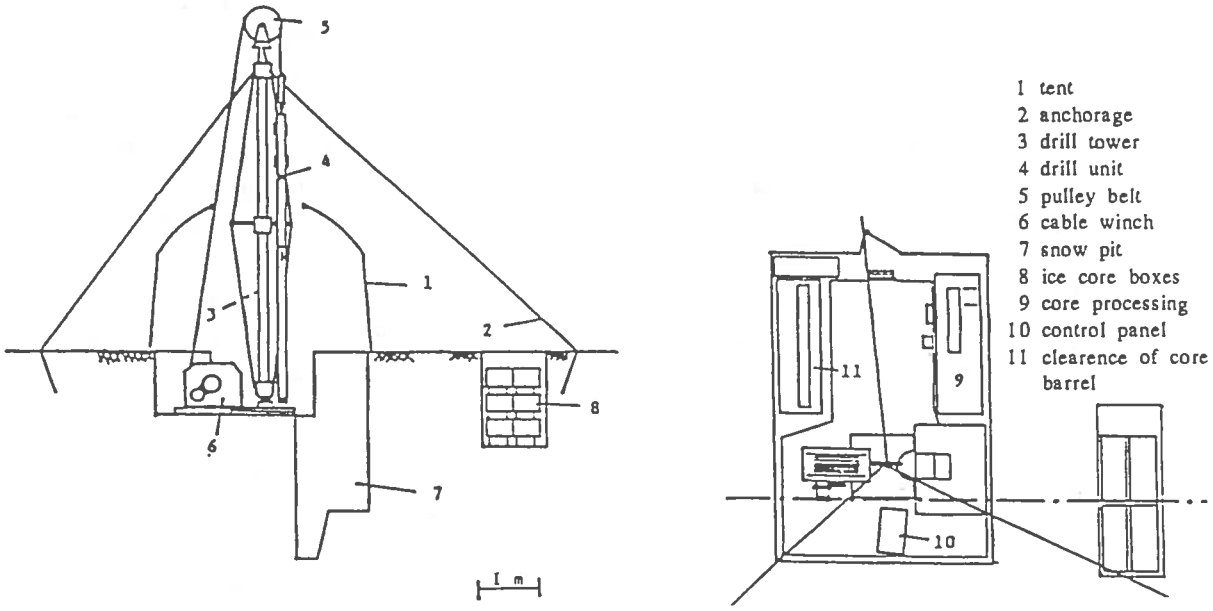

Fig. 1 - Arrangement of the drill equipment

core research can be satisfied with intermediate cores.

3 - REVIEW OF THE DRILL DEVELOPMENT

In 1981 the Institute for Soil Mechanics and Foundation Engineering at the Ruhr University Bochum (RUB) built the first German intermediate ice core system following the design of the Swiss drill with support of H. Rufli and sponsored by the Alfred-Wegener-Institute for Polar and Marine Research (AWI). In period of 6 months the system was available for the first drilling in the cold ice of the Antarctic near the German station "Georg von Neumayer".

A test on an Alpine glacier (Kaprun) gave the possibility to check the main functions. The present arrangement of the drill equipment is shown in fig. 1. Housed in a tent (Hansen Weather Port) the drill system, mainly the same as described in Jessberger et al, 1984, except with a few modifications is operated.

Based on the experience from two drill holes (50 m ; 73 m) some modifications on the cutter heads were performed between the Antarctic seasons 1982 and 1983. A leaf spring antitourque system and a lighter winch with Kevlar cable was introduced to reduce the weight of the system and to improve the penetration rate and the core quality.

In January 1983 the Ekström ice shelf was penetrated (203 m / 15 days) and the drill got stuck at the bottom. In 1983 a new drill unit was built and using rounded cutters (Holdsworth, 1984) the equipment was tested on the Jungfraujoch. Good experience was obtained with the rounded cutters during a drilling on the Filchner/Ronne ice shelf in 1984. A 100 m core of good quality was drilled. The core quality improved from 70 m onwards after replacing the angular SIPRE cutters by the rounded cutters. The greater area of cutting seems to reduce the stress in the core. The comparison of the recorded speed of rotation between the angular and rounded cutters in fig. 2 (Jessberger et al, 1985) exhibits a strongly fluctuating decrease for the angular and a constant decrease for the round cutters.

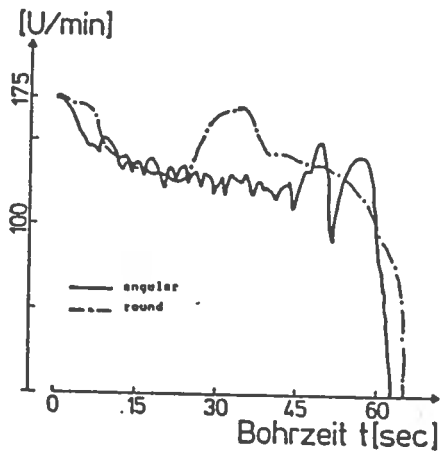

Fig. 2 - Recording of the cutter head rotation.

In 1987 two cores of 42 m and 47 m length were obtained in the Ritscher Hochland 220 km south of "Georg von Neumayer".

Hard thick ice layers of refrozen firn between the accumulated firn hindered further penetration with the rounded cutters. The pitch on the cutter head might have been too great and therefore the fine powder produced in this ice layer instead of coarse chips could not be carried away and the cutters slid. By using the SIPRE cutters a broken core was gained and thereafter further penetration was possible with the rounded cutters. But because of bad core dog design and incorrect epoxy potting of the Kevlar cable the cable failed and one drill unit was lost. With the second unit a hole (204 m) on the Ekstroem ice shelf 70 km south of "Georg von Neumayer" was drilled.

4 - PRESENT AND FUTURE MODIFICATION

The pitch of the cutter head spitals is altered from 60 to 30 deg. New core dogs following the design of Koci, 1987 were manufactured. The conical form of the cutter head (see fig. 3), used earlier for core catching, will be used only near the surface in low density firn in order to prevent damage of the core.

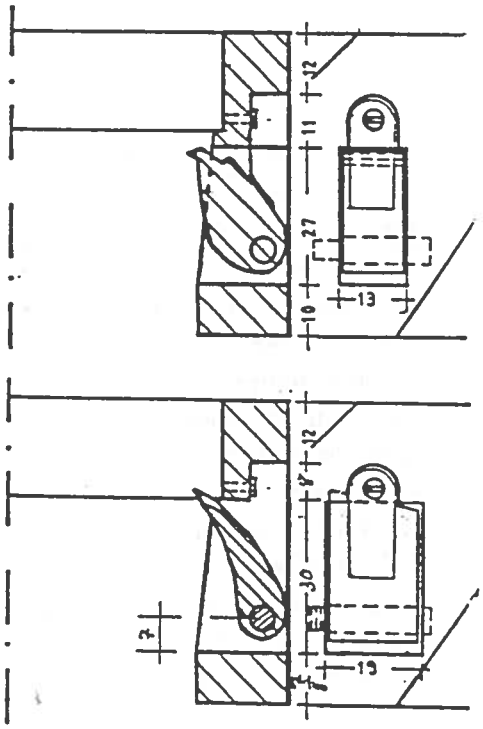

Fig. 3 - Comparison between new and old core dog design.

The cable terminal will be changed. The use of a new commercially available slip ring assembley and a nylon braided Kevlar cable enables splicing in spite of epoxy potting.

An improvment for the winding of the cable will be tried with a new stiffer base plate, a grooved LeBus drum and a LeBus level wind system.

REFERENCES

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