SETTING UP A DEEP ICE CORE DRILLING FACILITY AND PRELIMINARY TESTS TERRE ADELIE - ANTARCTICA

by

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INTRODUCTION

The goal of the summer 1987-88 field operations was to test the thermal drill equipment designed to work in a fluid filled hole and developed at the LGGE.

At the laboratory we had at our disposal a 8 m deep ice pit but was not deep enough to run the assembled drilling system. Each of the six components was checked separately. The 22.4 m long assembled unit was operating for the first time in the field.

This drilling equipment should allow recovery of very deep ice cores during only one summer period, assuming that people work 24 h a day.

DRILLING SITE :

D47 (67°23'38"S, 138°43'31"E)

D47 is located in Adelie Land, 107 km from Dumont d'Urville and 1560 m above sea level.

This station has a mean annual temperature of -26°C and a snow accumulation rate of 26 cm H_2O yr^{-1}. The maximum observed wind speed is 34 m s^{-1}.

Difficulties encountered in the field were mainly linked to the bad climatic conditions prevailing in this area. During austral summer 1987-88 snow drift and wind were very strong and temperature varied between -25°C and -10°C.

WINCH (photo)

The winch is the heaviest piece of equipment. It weighs 6T and cannot be taken to pieces. The 4000 meter long cable is spooled on the winch drum using the Lebus system which allows spooling speed to vary from 50 to 90 m min^{-1}. The 75 kW hydraulic driving motor of 1979 cm3 generates at 400 bar a torque of 1258 m. daN. The maximum rotation speed is 120 rpm.

The winch is equipped with a static brake ensuring 944 m. daN. This brake operates in case of pressure loss or hydraulic circuit failure. The winding diameter is 700 mm and the drum width is 1100 mm. The rotation speed can be changed by using a pump with varying output and driven by a MOOG valve.

HYDRAULIC POWER-STATION

This power-station was designed to supply 95 kW at 3200 m a.s.l. At 2000 rpm, the thermal diesel motor (Deutz F8L413) supplies 135 kW. Electric power is considered to be decreased by 30 % at an altitude of 3200 m.

Four pumps are connected to the motor :

- the main one, with varying cubic capacity, drives the winch motor and is governed by a "Moog" servovalve (series n° 62),
- the second one is a 22 cm^3 per revolution auxiliary pump,
- the third pump is a 30 cm^3 p.r. auxiliary pump driving the hydraulic jack at high spooling speed,
- the last pump (4 cm^3 p.r.) supplies the winch motor braking unit.

TOWER (photo)

The tower, designed and built up to recover 8 m long ice cores below the drill, must support stress reaching 15 t during drilling operations and withstand wind as strong as 30 m s^{-1}. It is made up of seven floors 3.70 m high and 3 m wide. The five upper floors are similar, the two lower ones can be open on one side, allowing to free the core and to place it onto its support. Each floor section weighs about 350 kg.

A 4 m stroke hydraulic jack on which the counting wheel is fixed is fastened to the middle of the upper level by four arms. Slow hydraulic jack down motion is controlled by an electrovalve of varying output.

Assembling the tower requires 3 days work for six people. Fitting it out (power supply, hydraulic pipes, ladders, safety equipment) requires three more days.

MEASUREMENT EQUIPMENT OF THE DRILL UNIT

Thermal drilling produces water in amounts proportional to both section of the ice melted and core length. This melt water is stored in a tank.

Regular drill down motion and good core quality require continuous checking of the tank for : water inflow rate, level and temperature. Measurements are performed inside the tank by using platinium probes. They are recorded allowing to show more clearly when the fluid (DFA) - water interface arrives as fluid temperature is negative and water temperature is positive (see fig. 1). Water level reaching 50 mm below the 6 th. probe means that the tank normally fills. If the water didn't reach this probe within a well defined time, efficiency of the fluid circulation inside the drill must be suspected and all required tests must be performed.

The first probe is located close to the tank inlet just at the top of the pipes and is used to check the drilling fluid circulation and temperature inside the tank ; this probe also allows to adjust the power to the resistance heaters for the suction pipes which are fastened around the drill barrel. Temperature between 10 and 15°C at the pipe outlet provides good results.

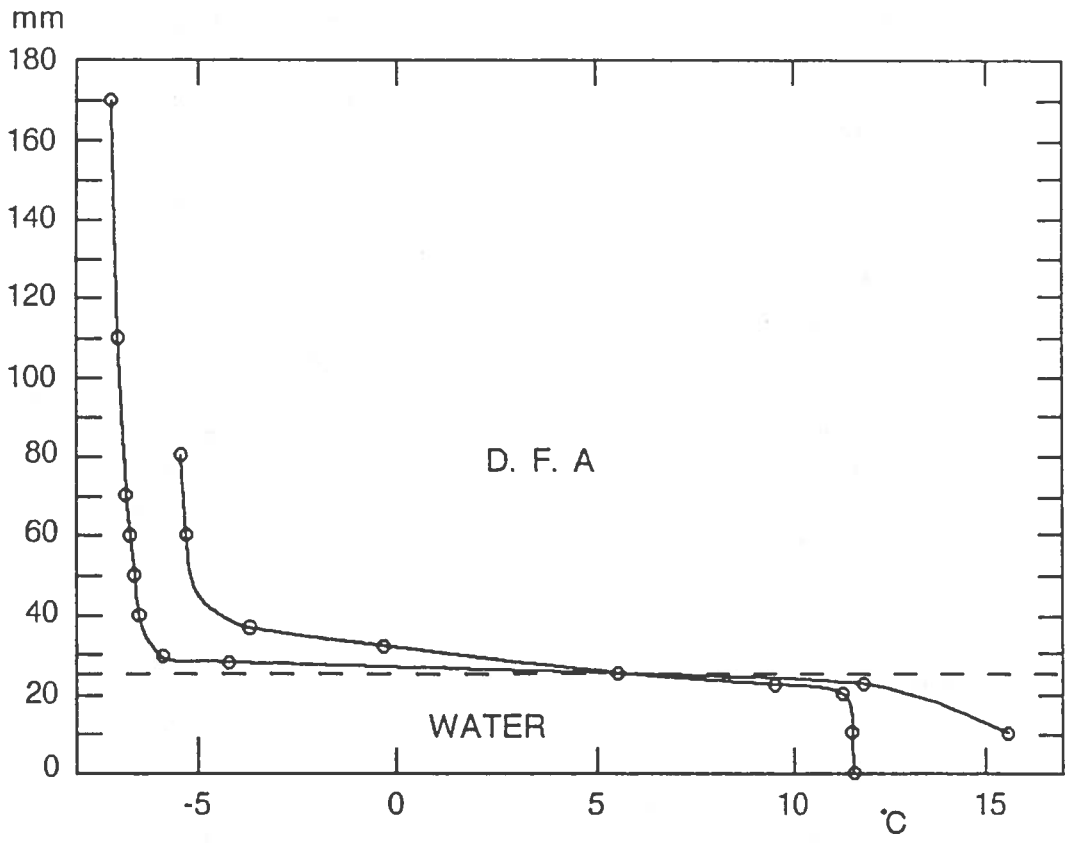
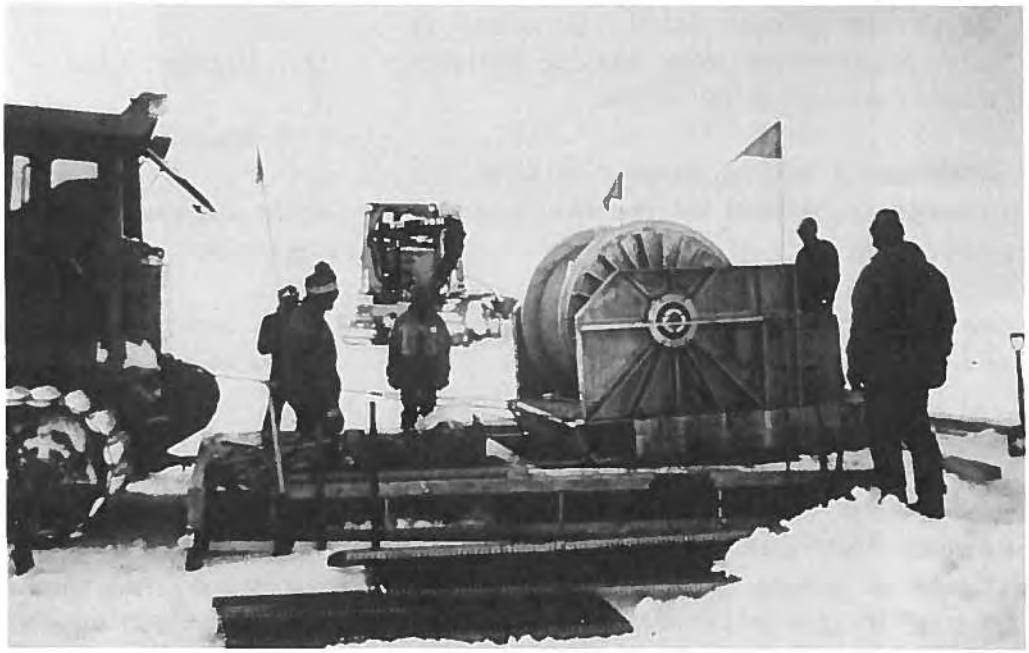


Fig.1 - Temperature profile at the water-DFA interface

Tower assembly



Winch