

## Modification of the PICO 5.2-inch Ice Coring Drill to Sample Rock at the Base of Glaciers

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### Introduction

PICO has developed a deep ice coring drill designed to take a 5.2-in diameter core in a fluid-filled (n-butyl acetate) hole. It is desirable that this drill, or an alternative method, be capable of sampling to rock contact and beyond to ascertain that the ice-bedrock interface has been reached.

Two approaches were studied to solve the problem of obtaining rock core: (1) use of an off-the-shelf wireline system and (2) modification of the existing 5.2-in drill.

### Wireline

Although the use of an existing wireline system is feasible, it is costly and weighs in excess of 200,000 lbs (100,000 kg). Estimates are based on the use of an AQ or BQ<sup>1</sup> wireline system with 10,000 ft (3,000 m) of drill rod. Currently, we feel the costs and logistic burden are unjustified for obtaining a small rock sample.

### PICO 5.2-in Drill

The PICO ice coring drill was designed with enough weight and power to drill in rock with minimum modifications. A one-inch (2.5 cm) core diameter is suggested, given the 4 kW available power, 1,500 lbs (700 kg) weight on the bit and a pullback of 3,000 lbs (1,500 kg). A conceptual drawing of the modified drill is shown in Figure 1.

### Description of Modifications

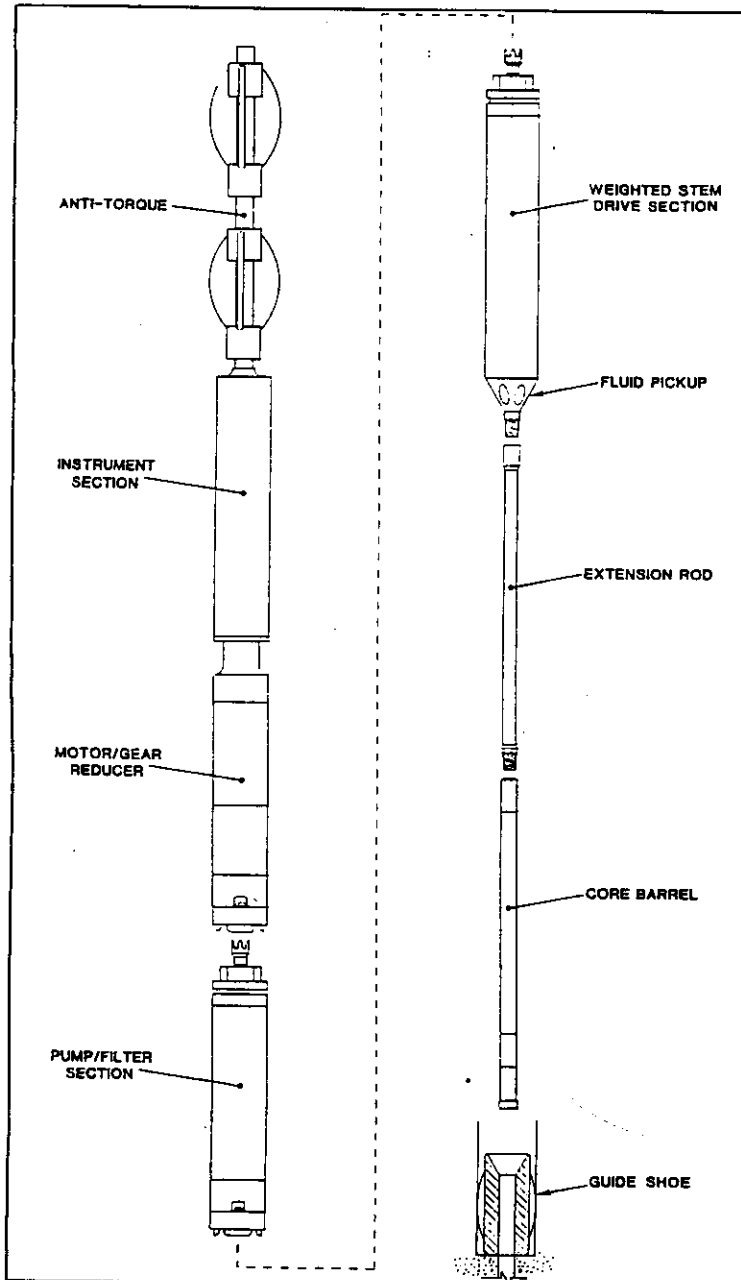
A standard AQ or BQ core barrel and diamond bit will be used for rock penetration. Any moraine encountered before intersection with the rock will be drilled using the standard 5.2-in ice coring drill and modified drill bit. Unfrozen till can be drilled and cased using a BQ casing advancer followed by AQ coring operations in rock. Since diamond bits require a high rotation rate (500 rpm for small sizes), a 5:1 gear reducer will be substituted for the current 17:1 ratio. A model 2L4 Moyno pump will be used to supply the 3-8 gpm (15-30 l/m) required for chip wash.

<sup>1</sup> AQ bit size - OD = 1.89 in (48 mm), ID = 1.20 in (30 mm)

BQ bit size - OD = 2.36 in (60 mm), ID = 1.60 in (41 mm)

## Test Results of Rock Drill Modification

In the spring of 1991 tests were conducted at Longyear in Salt Lake City, Utah, to determine minimum torque and weight requirements for coring granite with AQ and BQ bits. Synthetic and premium grade diamonds were tested on both core barrels. The Carbinado (synthetic) bits polished immediately with a 1,000-lb cutting load. Premium grade diamonds cut at 4-7 in/min (10-17 cm/min) for 5 ft (1.5 m) before polishing. In both cases, a pull back of <1,500 lbs (700 kg) was required to break the core. Tests were conducted in Georgia grey granite.



## Conclusion

Preliminary tests have demonstrated that coring operations are possible with the existing 5.2-in GISP drill. Bit life will be short because of limited weight on bit available but cores in excess of 1 m should be feasible.

Temperature modeling<sup>2</sup> and recent temperature profiles<sup>3</sup> from the summit area of the Greenland ice sheet suggest that the basal ice temperature should be -10 to -12°C, removing concerns about basal water freezing the drill. As a result, the complex problem of casing the hole near the bottom can be avoided. However, close monitoring of borehole temperature and pressure cannot be overemphasized.

Figure 1. Modifications required to adapt a rock coring bit to the PICO drill. (Artist rendition: Larry Kozycski)

<sup>2</sup> Waddington, E. D. 1989. Estimated temperature-depth profile at Summit, Greenland. Geophysics Program AK-50, Univ. Washington. Pers. comm.

<sup>3</sup> Gonderstrup, N. S. 1992. Dept. Glaciology, Geophysical Institute. Univ. Copenhagen. Pers. comm.