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2. Drilling Operations[1]

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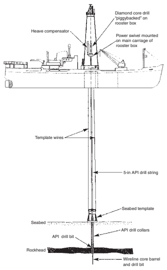
INTRODUCTION

Ocean Drilling Program Leg 163X was a 2-yr operation (1998 and 1999) using two different drilling systems deployed from two different vessels. In 1998, we chartered the *Norskald*, owned and operated jointly by Det Søndenfjelds-Norske Dampskibsselskab and SEATEAM Technology. The *Norskald* is a 99-m-long, 2781-ton (dead-weight tonnage), ice-class vessel with a center moonpool and derrick. In 1999, we chartered the *Aranda*, which is a 59.2-m-long, 1724-ton, ice-class vessel owned and operated by the Finnish Institute of Marine Research. The A-frame of the *Aranda* was used to deploy the British Geological Survey's (BGS's) seabed diamond coring Rockdrill. Fundamental differences in the drilling systems used on the *Norskald* and *Aranda* resulted in differences in core recovery and core handling procedures. These differences are discussed below and in the **"Explanatory Notes"** chapter. More extensive descriptions of the drilling systems are found in the drilling consultant's operations reports (Skinner, 1998, 1999).

DRILLING FROM THE *NORSKALD*

The drill system of the *Norskald* consists of a standard American Petroleum Institute (API) drill string for normal boring driven by a hollow spindle power swivel. For hard rock coring, a "piggyback" system is used, consisting of a wireline diamond coring rig on the top of the platform of the power swivel for the API system (Fig. **F1**). The piggybacked wireline is run through the main API pipe and is advanced ahead of the API pipe during drilling into hard rock. In this mode of operation, the API drill string is first lowered through the moonpool to the seabed along with the guide frame template. The API system is used to bore to rockhead, after which the drill pipe is locked in place by the seabed

F1. *Norskald* drill system, p. 5.



[1]Examples of how to reference the whole or part of this volume.
[2]Scientific Party addresses.

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template. This pipe serves as casing for the wireline drill string that is run to the bottom of the hole, where diamond coring commences. Core passing into the inner barrel is retained by the core catcher and retrieved by wireline. This double-barrel arrangement reduces disturbances of the core during drilling and avoids having to pull up the drill string to retrieve the core. Despite some technical difficulties, the system was very successful in drilling basalt, even in cases of highly fractured bedrock as shown in Figure F2.

F2. Recovered basalt, p. 6.

Dynamic positioning of the *Norskald* was accomplished by two pairs of thrusters located forward and aft with input signals from one of three motion detection systems: (1) an acoustic beacon mounted to the seabed template, (2) tension sensors on guide wires of the seabed template, and/or (3) deflection sensors on a tautwire positioned outboard of the seabed template (Fig. F1). Any two of these systems provided redundancy, and commonly the tautwire was not used.

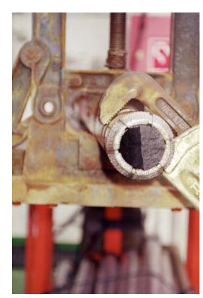
Under normal operating conditions the vessel can be moved short distances (<400 m) in areas of smooth ground without retrieving the drill string. This is accomplished by first withdrawing the wireline system well above the seabed and then lifting the API drill string and seabed template slightly off the seabed by elevating the heave compensator to the top of the derrick. For more remote repositioning, the wireline core barrel and seabed template can be raised completely and the total length of the API drill string reduced sufficiently to avoid potential obstacles. More often, when moving the vessel >400 m, the entire API pipe has to be retrieved. These differences in operation are important because they form the basis for the site and hole designations. We designate a new site if it is necessary to completely raise the wireline system and seabed template to reposition the vessel. If relocation can be accomplished using the heave compensator to lift the API drill string and seabed template off the seabed, as explained above, we designate a new hole but retain the site number.

F3. Secured Rockdrill, p. 7.

DRILLING FROM THE *ARANDA*

Drilling operations onboard the *Aranda* were carried out using the BGS Rockdrill. The BGS system is a compact seabed-drilling platform that is deployed from a standard A-frame by a cable and winch carrying power and data transmission lines. The drill kelly and retraction winch are powered hydraulically by a three-phase electric pump mounted on the platform. Additional electric pumps are used for flushing the drill bit. The standard BGS system is equipped with a 5-m-long core barrel; however, because of the small A-frame and aft deck layout of the *Aranda* this core barrel was reduced to 3 m (Fig. F3). Unlike the wireline diamond coring system on the *Norskald*, holes drilled by the BGS system are limited to a 3-m depth. Core is recovered only by raising the drilling platform to the surface. The drill collects a 49-mm-diameter core using a double-walled core barrel. The core in the inner barrel is retained by a spring forming a wedge between the core and the barrel wall. The most commonly used core bit was a surface-set diamond bit with a stepped profile on the outer diameter (Fig. F4). A steel rod (called the "Tasiilaq insert") was hung within the core barrel during drilling at some sites to keep stones from entering and jamming the bit throat (Fig. F5). Although the short penetration depth and inconvenience of raising the entire system to retrieve core are disadvantages of the BGS robotic seabed system, the ease and speed of deployment and recovery are distinct

F4. Drill bit and core, p. 8.

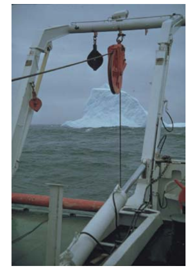


F5. Rounded clasts, p. 9.

advantages for operating under Arctic conditions where weather and heavy ice can be serious impediments to conventional ocean drilling (Fig. **F6**).

Dynamic positioning of the *Aranda* was achieved by differential Global Positioning System and a multiple thruster system. This system was connected to the BGS Trac-C system that operated as a slave for monitoring vessel station and warning about position loss while the Rockdrill was on the seabed. On a number of occasions, the Rockdrill was deployed multiple times using the same set of navigation coordinates. This was done, for example, if we discovered that the bit had jammed or if we were unsure whether basement lithology was sampled. In these instances, we commonly redeployed the drilling platform using the same navigation coordinates. In other cases, inclement weather or threatening ice flow forced us to abandon a station. Once the danger had passed, we would reoccupy the position using the same set of navigation coordinates. Therefore, with the *Aranda* we define a site by a unique set of navigation coordinates. Using a new set of navigation coordinates constituted the establishment of a new site. If the navigation coordinates were identical, successive drilling at the same site was identified by a new hole, regardless of core recovery. This site and hole designation differs slightly from that adopted on the *Norskald* cruise.

F6. *Aranda* fantail, p. 10.



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Skinner, A.C., 1998. DLC coring offshore Greenland: shallow coring programme using the drilling vessel *"Norskald"* (WP/98/50C). *Br. Geol. Surv. Tech. Rep., Mar. Rep. Ser.*

Skinner, A.C., 1999. DLC south east Greenland project: rock drilling and geophysics from RV *"Aranda"* (WB/99/20C). *Br. Geol. Surv. Tech. Rep, Mar. Rep. Ser.*

Figure F1. Schematic illustration of the *Norskald* drill system used in 1998. API = American Petroleum Institute.

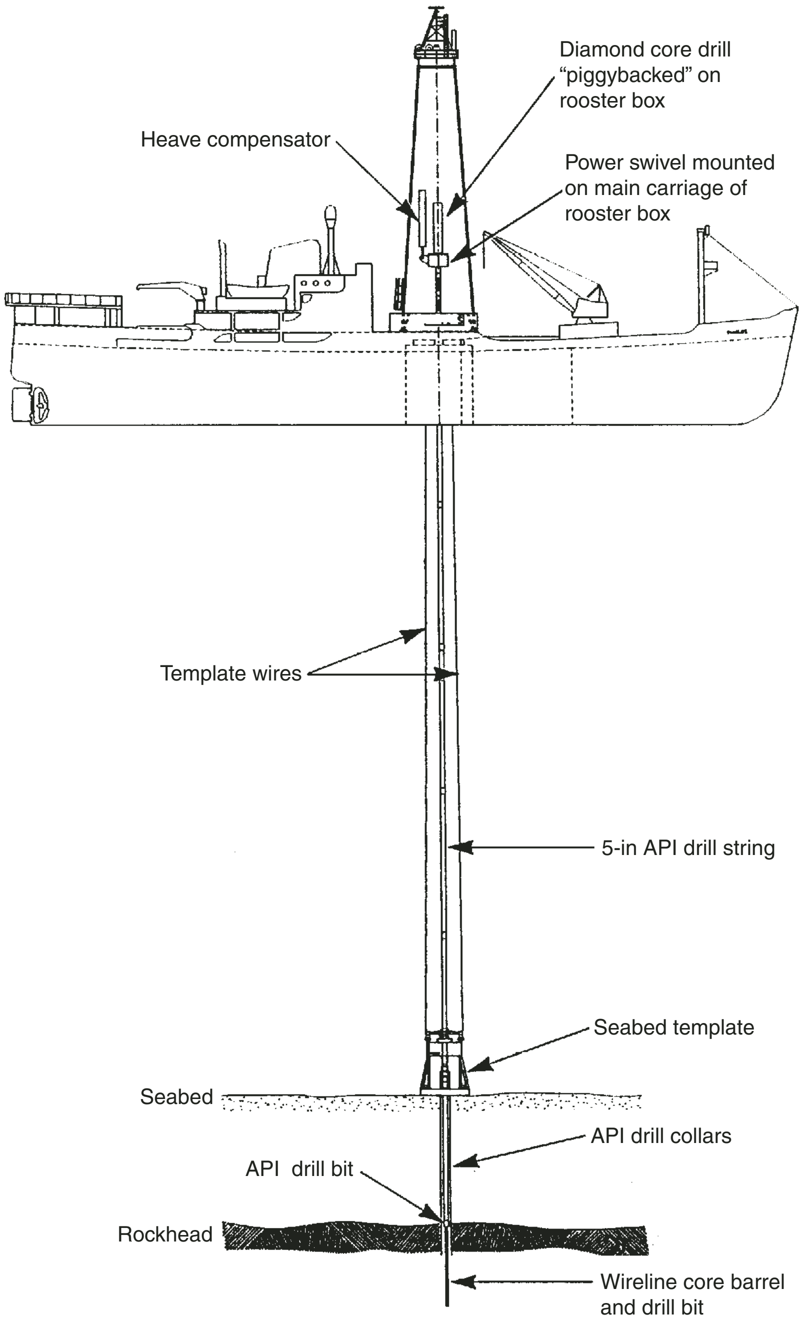

Figure F2. Highly fractured basalt recovered by wireline diamond coring system on the *Norskald* (Piece SEG02A-5-1, 20–55 cm). Core diameter is 56 mm. Arrow on the left indicates stratigraphic up direction.

Figure F3. British Geological Survey–modified 3-m Rockdrill secured during transit on the aft deck of *Aranda* in 1999. The East Greenland coast of uplifted Precambrian basement is visible in the background.

Figure F4. Core in throat of stepped diamond drill bit used on the British Geological Survey–modified 3-m Rockdrill.

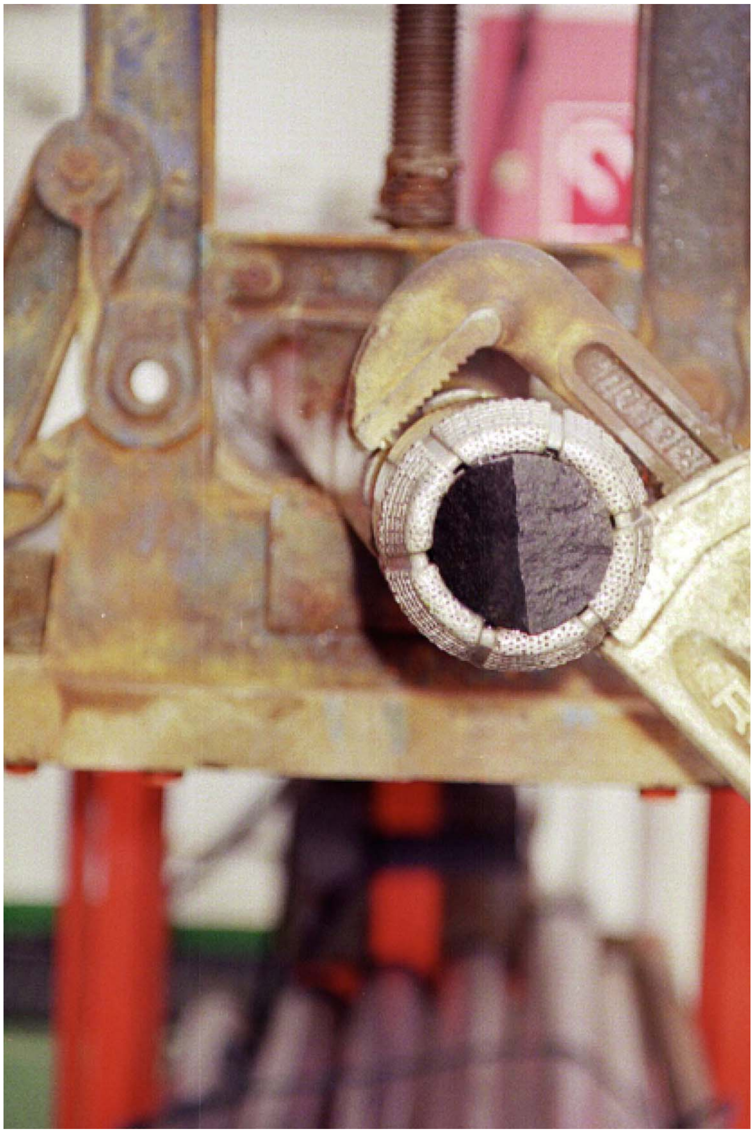

Figure F5. Rounded clasts from glaciomarine sediment jammed in core catcher. This recurring problem led to the development of the "Tasiilaq insert," which is a steel rod hung within the core barrel to keep stones from entering and jamming the bit throat while advancing through unconsolidated sediment.

Figure F6. View of fantail of *Aranda* with the umbilical power cable leading to the British Geological Survey's (BGS) Rockdrill positioned on the seafloor. An iceberg looms in the background, but its presence did not terminate drilling. The rapid deployment and recovery of the BGS system, coupled with greater maneuverability when using a seabed drilling platform with umbilical cable, is ideal for the drilling conditions encountered on the East Greenland shelf.