A concept for marine shallow drilling

Drill test from R/V Håkom Mosby in Nov. 1995


Commercial rig built by GeoDrilling

BACKGROUND

There is a quantum leap between the costs of marine operations using conventional sediment coring devices with or without piston for 10-15 m of core recovery and drilling from a dedicated drill ship to increase penetration and recover more core material. A drill ship is far beyond funds available for the average research project and require large coordinated international efforts. However, in special cases such as in ice covered waters or sheltered fjords where the need for heave compensation is greatly reduced, it should be possible to carry out shallow drilling from a research vessel with a simple drill rig. Institute of Solid Earth Physics (Y. Kristoffersen), University of Bergen contracted Terra Bor A/S, Namsos in the spring of 1994 to carry out drilling tests with research vessel “Håkon Mosby” in water depths of 130 m and 197 m in Trondheimsfjorden. This experience was the background for proposals to drill on the continental shelf in the Weddell Sea, Antarctica during the 1995/96 season and later the Lomonosov Ridge, Arctic Ocean.

The key issue was reduced equipment weight. This was achieved by using a small mining exploration drill rig and thin-walled BX drill rods. The riser was a plastic tube clamped to a tight wire anchored by a bottom template. Based on the experience accumulated by the end of 1996, a scale model (1:10) of a conceptual drill rig to be housed in a single 20 foot container was handed over to Geo Drilling A/S (former Terra Bor) of Namsos. The idea was to build a rig that could be accomodated by even small research vessels (150 foot) and serve as a useful tool for science.

The concept formed the basis for Geo Drilling A/S to attract Nok. 28 mill. in venture capital to build a shallow drilling unit for commercial operations. A rig was built in Holland and the drill rig now encompassed seven 20 foot containers with a total weight of about 90 tons. The new rig was successfully tested from the vessel "Geograf". Unfortunately, the new rig was far beyond the carrying capacity of R/V Håkon Mosby and left out the possibility of obtaining a crucial initial track record of shallow drilling from scientific projects in a cooperation between industry and the university. With no track record, commercial jobs did not materialize as expected and the company eventually went bankerupt.

SCIENTIFIC FIELD PROJECTS

Antarctica:

A glacially eroded shelf often exposes truncated sediment sequences at the sea floor, and provides access to a geological record that ranges from younger sediments at the shelf edge to successively older strata towards land or an ice shelf. Increased penetration beyond the conventional gravity- and piston-core sampling is a pre-requisite to new advances in our knowledge of ice sheet history from continental shelf sediments. This requires shallow drilling (<100 m sub-bottom).

Shallow drilling in Antarctica began with the Dry Valley Drilling Project (1970-75), and progressed offshore to drilling from a sea-ice platform during the MSSTS and CIROS projects. More recently, drilling off Cape Roberts reached a record 939 mbsf. in a water depth of 295 m. Marine shallow drilling from over the stern of a research vessel using a light mining rig with riser was first attempted by University of Bergen from the Finnish research vessel "Aranda" on the Weddell shelf during the 1995/96 season. The string had reached 15 mbsf with 18% recovery when the site had to be abandoned due to a change in the ice situation. The greatest operational flexibility is provided by a remotely operated rock drill deployed from a research vessel. In early 1998, a unit, capable of taking up to 5-m-long cores, was used in shelf areas of the northern Antarctic Peninsula. There, 77 rock drills were attempted, and 26 of these were successful in recovering rock cores (mostly less than 1 m., but one at 1.4-m-long and one at 2.5-m-long). Most of the rest recovered ”mixed pebbles”, i.e. loose ice-rafted debris. Two were empty. Although, the results obtained to date by mobile systems deployed from research vessels are modest when compared to the achievments of drilling from fast ice, it should be pointed out that the resource requirements for these two different approaches are widely different.

Finnish reasearch vessel Aranda off Kvitkuven Ice Rise, Weddel Sea in Febr, 1995.
Note drill rig mounted on the stern.

Use of mobile light mining rigs used over the side or the stern of Antarctic research vessels have been shown to be feasible, but we still need to refine equipment and operating procedures. Also, experience suggests that for drilling within drifting sea ice fields on the Antarctic shelf, a moon pool is not necessarily required to provide protection. A drill string over the side may be adequately protected by a simple guard below the water line, thereby reducing the technical challenge to one of determining how best to secure the guard.

Publications:

Kristoffersen, Y., Strand, K., Vorren, T., Harwood, D., and Webb, P., 2000: Pilot shallow drilling on the continental shelf, Queen Maud Land, Antarctica. Antarctic Science, 12: 463-470 http://www.geo.uib.no/hjemmesider/yngve/docs/pilot_shallow_drilling.pdf.

Kristoffersen, Y., Cooper, A., and Goodwin, I.,(Eds.), 2000: Report of a Workshop on Geological Studies to Model Antarctic Paleoenvironments er the past 100 Million Years, Wellington, New Zealand, 10-11 July, 1999 Scientific Committee on Antarctic Research (SCAR) Report # 19, 31 pp. Available at: http://www.scar.org/publications/reports/19/

Arctic Ocean:

An important driving force for development of an inexpensive shallow drilling capability was the potential scientific reward of obtaining pre-Quaternary sediment samples from the Arctic Ocean. Bear in mind that this was years before a proposal was submitted to ODP for Lomonosov Ridge drilling and almost a decade before ACEX became a reality.

Oden at location on the Lomonosov Ridge August 1996. Drill rig was mounted next to the bridge.

Building on the results from a station keeping test of icebreaker "Oden" in 1991 and successful shallow drilling on the Antarctic continental margin in early 1996, a proposal was submitted jointly with Dr. Jan Backman, Stockholm University to attempt shallow drilling on the Lomonosov Ridge from "Oden". The Swedish Polar Secretariat was positive to the idea and the Swedish National Maritime Administration contributed to installation of a 0.6 m diam. moon pool on the starboard side behind the reamer of the icebreaker. On the Lomonosov Ridge, we were able to set the riser in 962 m water depth, and were underway with about 250 m drill string out when the attempt had to be aborted due to ice.

Publications:

Kristoffersen, Y., 1997: A pilot project for shallow drilling during Arctic Ocean-96. Yearbook 1995/96, Swedish Polar Secretariat, p. 72-74. http://www.geo.uib.no/hjemmesider/yngve/docs/LRdrilling96.pdf