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New capability to recover intermediate depth cores from the sea floor beneath floating ice platforms

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Abstract
Much of the direct geological evidence for the instability of Antarctica's ice sheets and shelves in past warmer climate regimes is now hidden beneath thick floating and grounded ice. The ANDRILL project showed the scientific rewards of deep geological drilling through the Ross Ice shelf, but was on a logistical (>250 tonnes of equipment) and financial (USD30M) scale that is not sustainable on a year-by-year basis by most national Antarctic programmes. In contrast, deployment of short gravity and piston corers requires less resources but they are unlikely to penetrate sediments more than few metres thick and likely no older than the Last Glacial Maximum.
The new capability described below is intended to provide a drilling capability that can recover core from depths of 100 –200 m below the sea floor, or beneath a grounded ice sheet, with a footprint that is logistically supportable by many Antarctic national programmes. The system is designed to be integrated with an existing hot water drilling (HWD) system that can penetrate 1000 m thick ice.
Minerals industry-based coring technology has recovered high quality core from sea floor sediments during several inshore Antarctic drilling operations since 1975. Wireline tools have been developed and improved since then to allow good recovery of core from a range of settings. These include hydraulic piston coring for soft sediments and rotary diamond coring for indurated rock.
However, the challenge is to make a system sufficiently light and compact that it can be operated by a small rig integrated with our current HWD infrastructure but still recover a scientifically useful length of core. A small rig has limited pull back and this is a limiting factor for the length of drill pipe and casing that can be deployed. Therefore, we propose to use an ice and sea riser that combines light weight Glass Reinforced Epoxy (GRE) casing with thin walled steel casing. This will reduce system weight, enabling us to use a smaller rig and greatly reducing operational costs. Stress analysis of the GRE casing has been carried out for several drilling scenarios with differing ocean current flows, water depth and ice shelf (the drilling platform) thickness and movement. The results show the concept is feasible, within the limits of the rig and environmental site parameters.
The projected limits to coring depth below sea floor and core diameter are constrained by:
• Maintaining an open hole through shelf ice will require proportionally more time and resources to be committed to hot water drilling as the ice shelf thickens. Ultimately this will limit the amount of time the rock drill is able to utilise the hole and thus time for sea floor coring.
• Even with lightweight casing and drill pipe, the "pull back" capability of the drill rig will ultimately limit the length of drill string that can be used for coring.

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