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Rationale for future Antarctic and Southern Ocean drilling

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Valuable insights into future sensitivity of the Antarctic cryosphere to atmospheric and oceanic warming can be gained from the geologic record of past climatic warm intervals. Continental to deep ocean sediments provide records of contemporaneous changes in ice sheet extent and oceanographic conditions that extend back in time, including periods with atmospheric CO_2 levels and temperatures similar to those likely to be reached in the next 100 years.

The Circum-Antarctic region is under-sampled respect to scientific ocean drilling. However, recovery from glacially-influenced, continental shelf and rise sediments (expeditions ODP178, 188 and IODP 318), provided excellent records of Cenozoic climate and ice sheet evolution. The ANtarctic DRILLing program achieved >98% recovery on the Ross Sea shelf with a stable platform on fast ice with riser drilling technology. Newer technologies, such as the MeBo shallow drilling rig will further improve Antarctic margin drilling.

Drilling around Antarctica in the past decades revealed cooling and regional ice growth during the Cenozoic, coupled with paleogeographic, CO_2 atmosphere concentration and global temperature changes. Substantial progress has been made in dating sediments and in the interpretation of paleoclimate/paleoenvironmental proxies in Antarctic margin sediments (e.g. orbital scale variations in Antarctica's cryosphere during the Miocene and Pliocene). Holocene ultra-high resolution shelf sections recently recovered can be correlated to the ice core record, to detect local mechanisms versus inter-hemispheric connections.

While the potential for reconstructing past ice sheet history has been demonstrated through a careful integration of geological and geophysical data with numerical ice sheet modelling, uncertainties remain high due to the sparse geographic distribution of the records and the regional variability in the ice sheet's response. Projects developed using a multi-leg, multi-platform approach (e.g. latitudinal and/or depth transects involving a combination of land/ice shelf, seabed, riser, and riserless drilling platforms) will likely make the most significant scientific advances. Fundamental hypothesis can be tested and accomplished by drilling depth transects from ice-proximal to ice-distal locations, that will enable researchers to link past perturbations in the ice sheet with Southern Ocean and global climate dynamics.

The variable response of the ice sheet to ongoing climatic change mandates broad geographic drilling coverage, particularly in climatically sensitive regions, like those with large upstream drainage basins, whose marine terminus is presently melting, due to ocean, warming water impinging the continental shelf. Key transects were identified at community workshops (http://www.scar-ace.org) in the frame of the SCAR/ACE (Antarctic Climate Evolution) and PAIS (Past Antarctic Ice Sheet dynamics) programs. New proposals, also for MSP expeditions were then submitted to IODP, in addition to the existing ones, in the frame of a scientific concerted strategy and with a significant European participation.

Main questions underpinning future scientific drilling tied IODP Science themes:
1) How did and will the Antarctic Ice Sheets respond to elevated temperatures and atmospheric pCO_2? What is the contribution of Antarctic ice to past and future sea level changes?
2) What was the timing of rifting and subsidence controlling the opening of ocean gateways and the initiation of the circumpolar current system and the onset of glaciations?