Antarctic Scientific Drilling: What, Where and Why

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Antarctic scientific drilling, meaning drilling down to recover the sediment and rock record of geologic and environmental change, has been going on for almost 40 years. This scientific drilling has included marine, ice, and land-based platforms. In the ocean, these have included the Deep Sea Drilling Project (DSDP), Ocean Drilling Program (ODP), Integrated Ocean Drilling Program (IODP), and SHALDRIL; for land- and ice-based programs these have included the Dry Valley Drilling Program (DVDP), McMurdo Sound Sediment and Tectonic Studies (MSSTS), Cenozoic Investigations in the Western Ross Sea (CIROS), the Cape Robert Project, and now ANDRILL. Future efforts will depend on new drilling proposals being submitted to international funding agencies and a community-based effort to develop an integrated science plan to galvanize international support for additional scientific drilling projects to improve our understanding of the temporal and spatial evolution of landscapes and environments on and around Antarctica.

Limited exposures of Cenozoic strata in Antarctica (due to the ice cover), the low number of stratigraphic drillholes on the continental margin, and the short time that Antarctica has been explored, led geologists to rely on information derived from lower latitude proxy records. The oxygen isotope record from deep-sea cores, and eustatic changes inferred from sequence stratigraphic records on passive continental margins have been leading paradigms for the interpretations regarding Antarctic ice sheet history. However, interpretations based on these proxy records of glacio-eustasy have little direct confirmation from geologic records in Antarctica, and in numerous cases have led to conflicting interpretations. ANDRILL, SHALDRIL and other drilling projects in and around Antarctica seek to remedy this situation with the recovery of new sections of Cenozoic strata from locations proximal to the ice sheet that are ideally suited for recording and dating ice sheet oscillations, and associated oceanic and climatic variations. These will contribute to a better understanding of the global climate system and clearer linkage between the high and low latitude records.

ANDRILL (ANtarctic geological DRILLing) is a multinational initiative with the objectives to recover stratigraphic core records for use in interpreting Antarctica's climatic, glacial and tectonic history over the past 50 million years and at varying scales of age resolution (0.1 to 100 k.y.). A key motivation of ANDRILL is to understand the role of the Antarctic cryosphere (ice sheets, ice shelves & sea-ice) in the global climate system. Understanding the past history of ice volume variation in Antarctica and associated physical changes in this region is critical to proper assessment of the global climate system and interaction of ice sheets with the ocean, atmosphere and biosphere.

During the 2006-2007 field season, the ANDRILL Program was initiated by the McMurdo Ice Shelf (MIS) Project, which is the first of a portfolio of sites grouped under the McMurdo Sound Portfolio (MSP). The Southern McMurdo Sound (SMS) Project, which will conduct drilling during the 2007-2008 Antarctic field season, will continue the execution of this portfolio. Additional field activities will be undertaken to advance the level of maturity of the remaining projects in the MSP through the execution of geophysical and environmental

surveys. In addition, new proposals are being prepared for national and international review in the coming year.

The portfolio approach is designed to help guide the recovery of sediment and rock sequences representing critical intervals of Earth's past climate history, where the dynamic behavior of ice sheets, ice shelves and sea-ice on Antarctica is thought to have influenced global ocean & atmospheric circulation and global sea-level elevation. In adopting this approach, we acknowledge that efforts to understand the role of Antarctic drivers on global climate variability requires a fundamental knowledge of Antarctic cryospheric evolution not only in recent times, which is plainly vital, but also for past times when global temperature and atmospheric carbon dioxide were last similar to that which might well be reached by the end of this century.

Determination of the scale and rapidity of changes affecting large ice masses is of vital importance because (i) ice volume variations lead to changing sea levels, (ii) ice sheets influence sea-ice distribution and latitudinal climatic gradients, and (iii) ice sheets, and particularly the bordering ice shelves, generate cold bottom-water that flows through the world's oceans. In order to validate climatic models, we need to look to archives of climatic change preserved in the ice core record (100,000 year time scale) and in the sedimentary record (10 million year time scale), to determine the relationship between ice sheet fluctuations and climatic change.

The ANDRILL consortium currently consists of four member countries - Germany, Italy, New Zealand and United States - with additional guidance provided by the United Kingdom. Other interested nations are welcome to join this initiative. Additional opportunities exist to broaden the participation in SHALDRIL and other projects, and to partner with IODP and the ICDP (International Continental Drilling Program) to achieve better integration of overall community efforts to advance the scientific goals of the community. In the future, the development of a better understanding of Antarctic climate and glacial history and this region's influence on global climate will benefit from the combined efforts of the Integrated Ocean Drilling Program (IODP), the ANDRILL Program, and various SHALDRIL projects, among others. These are all complimentary efforts with similar goals, but they are each able to reach different stratigraphic targets around the Antarctic margin using a range of drilling technologies and platforms.