

Antarctic Cryosphere Evolution Project (AnCEP): New IODP proposal for transect drilling in the Southern Ocean

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The Southern Ocean has played a very important role in the global climate system through geologic history to the present day. To understand the processes that change atmospheric CO₂ concentrations, it is important to understand the sub-systems and processes of the Antarctic cryosphere, such as changes to the Antarctic Circumpolar Current (ACC), the Weddell Gyre, the biological pump, sea surface temperature, the polar front location, the distribution of sea-ice, and the Antarctic ice sheet on modern and geologic time scales. The evolution of the Antarctic cryosphere for major climate shifts during the Cenozoic is still poorly understood. The key motivation for the IODP scientific drilling in the Southern Ocean stems from a lack of knowledge of the complex role the Antarctic cryosphere plays in the global climate system and water circulation. Understanding the history of variations of ice volume and associated cryospheric changes during the Cenozoic is of great importance because changes of ice volume and distribution change global sea levels, affect Earth's albedo, control the latitudinal temperature gradient of the Southern Hemisphere and thus heat transport via atmospheric and oceanic circulation, and influence the distribution of ice shelves and seasonal sea ice, which are commonly considered to cause the cold bottom waters that drive global ocean circulation.

We will propose the drill sites along a north to south transect in the Indian sector of the Southern Ocean. The proposed sites are on sediment drift deposits on the Conrad Rise, and on the Del Caño Rise. The arrangement of those sites is crossing the oceanic fronts, the subtropical front, subantarctic front, Antarctic polar front, and winter sea ice limit. These sites contain continuous sedimentary sequences exhibiting moderate to high sedimentation rates. Age control will be provided by oxygen isotope stratigraphy, relative geomagnetic paleointensity with conventional geomagnetic polarity stratigraphy, and high-resolution biostratigraphy. The data from this drilling will greatly advance our understanding of the relationship between Antarctic climate change and Southern Ocean paleoceanographic variability.

The proposed sites are strategically located to reveal the evolution of the Antarctic cryosphere and to investigate the role of the ACC and Weddell Gyre system in that evolution. The Indian sector of the Southern Ocean is a most suitable high-latitude ocean to elucidate the evolution of the Antarctic cryosphere. Our main objectives are:

- 1. Evolution of the ACC and Weddell Gyre system:** To test the hypothesis that considerable expansion of the ACC and Weddell Gyre system caused global cooling and a large decrease in the thickness of the EAIS during the mid-Pleistocene transition (MPT).
- 2. Variability of the Antarctic climate and sea-ice distribution during the Quaternary:** To reconstruct high-resolution records of ACC migration, sea ice coverage, surface-water stratification, the biological pump, acidification of ocean waters, and eolian dust inputs in the Southern Ocean.