Plio-Pleistocene Southern Ocean Paleoceanography: Latitudinal drilling in the Southwestern Indian sector of the Southern Ocean

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Proposal 918-pre in the Southern Ocean exists in the current science evaluation system of IODP. Site surveys were completed in 2019. We would like to develop an international research project based on this proposal by conducting new drilling/coring in the IODP3. First, we would like to drill by riserless drilling vessel, but if drilling is not feasible, we plan to consider giant piston coring as an option.

The Southern Ocean (SO) is a key region that profoundly influences climate variability throughout the Cenozoic. Because the SO redistributes heat, fresh water, carbon, and nutrients around the global ocean it plays a key role in the climate system. The growth of ice sheets in the Antarctic continent and changes in sea ice in the surrounding ocean are important variables in Earth’s climate system. Upwelling of deep waters in the Antarctic Circumpolar Current (ACC), in particular, is a key process of the meridional overturning circulation (MOC) as it constitutes the return path for deeply-sequestered carbon and nutrients towards the surface and hence important in the partitioning of carbon between the ocean and the atmosphere. Furthermore, physical and biogeochemical processes modulate nutrient export through SO-sourced intermediate waters that ventilate 75% of the world’s thermocline, thus playing a vital role in influencing low-latitude productivity and ecosystems.

The western Indian sector of the SO, located at the confluence of the SO overturning cells and the MOC return surface flow, is a key region to document the links/teleconnections between the SO, global ocean/atmospheric circulations and hence climate (Fig. 1). It provides a unique opportunity to obtain exceptionally high-resolution sediment records to document and unravel the interaction and feedbacks between atmosphere, ocean and cryosphere from millennial to orbital-timescales during the late Neogene and Quaternary, focus on past 6 Ma (Fig. 2).

Specifically, the proposal aims to constrain further – (A) past changes in the upwelling and latitudinal position of the ACC; (B) the dynamic controls of circum-Antarctic deep ocean ventilation/overturning circulation; (C) their link to the global ocean circulation; (D) past changes in the sea ice coverage and dust inputs; and (E) their implications for the marine biogeochemical
cycles of carbon and nutrients. The anticipated results will elucidate the evolution of the SO carbon cycle, identify potentially dominant physical and biogeochemical mechanisms of change, document past oceanic bipolar teleconnections with global MOC dynamics, and provide constraints on its future evolution in response to anthropogenic warming.

Our scientific objectives relate to Strategic Objective 3 (Earth's climate system), Strategic Objective 4 (Feedbacks in the Earth system), and Flagship Initiative 1 (Ground truthing future climate change) in the 2050 Science Framework.