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Variations in Ventilation and Deep-Water Export in the Scotia Sea during Glacial-Interglacial Cycles

MORITZ HALLMAIER[1], MARCUS GUTJAHR[1], JÖRG LIPPOLD[2], OLIVER ESPER[3], SIDNEY R HEMMING[4], LUKAS GERBER[5], MICHAEL E WEBER[6] AND ANTON EISENHAUER[1]

[1]GEOMAR Helmholtz Centre for Ocean Research Kiel
[2]Heidelberg University
[3]Alfred Wegener Institute Helmholtz Centre for Polar and Marine Research
[4]Lamont-Doherty Earth Observatory of Columbia University
[5]Institute of Earth Sciences, Heidelberg University, Heidelberg, Germany
[6]Institute for Geosciences, University of Bonn

The Scotia Sea is a key area in the Southern Ocean, where newly formed well ventilated Weddell Sea Deep Water (WSDW) mixes with the Antarctic Circumpolar Current (ACC). We investigate the bottom water oxygenation and export productivity along with sedimentation dynamics and provenance at IODP Site U1537 (59°6.65′ S, 40°54.37′ W, 3713 m) during past glacial-interglacial cycles by using several geochemical proxies.

At this site in the Antarctic zone, authigenic uranium (aU) in bulk sediment serves as an indicator of export productivity. Strikingly high interglacial productivity leads to substantial remineralization and oxygen consumption at the seafloor and thus to formation of authigenic uranium. However, during periods of low export productivity, as shown by independent productivity proxies such as biogenic barium, aU also provides information about the predominant bottom water oxygenation and potentially changes in the export of freshly formed WSDW. Conversely, older sediment sections downcore show signs of partial uranium remobilization and vertical diffusion at some stage following burial. In order to distinguish bottom water oxygen starvation from porewater oxygen depletion, the reconstruction of past bottom water oxygenation at Site U1537 is also complemented by micropaleontological investigations of dinocysts. These yield information independent of changes in export productivity that cannot be obscured through diagenetic alteration.

Additional use of provenance proxies can serve as a measure of WSDW export independent of the bottom water redox conditions. Neodymium (Nd) and lead (Pb) isotopes in Southern Ocean sediments allow continental source tracing due to the distinct crustal ages of Antarctica and its surrounding areas upstream of the core site. Our results show significant variations in detrital and authigenic isotopic compositions during glacial-interglacial transitions. We will demonstrate how far Nd and Pb isotopic excursions are controlled by changes in IRD flux, Southern Ocean overturning circulation, dust input, or a combination of these. Ultimately, our goal is to unravel the relative contributions of these sources to the isotopic signals over time.

Taken together, our study presents multiple proxies that provide valuable insights into the ventilation of the Scotia Sea, along with substantial changes in WSDW export under different climatic conditions.