Southern Ocean response to Antarctic glaciation in the mid Oligocene

Claire E. Huck[1], Myfanwy Wood[1], Diederik Liebrand[1], Ursula Röhl[2], Paul Wilson[1], Tina van de Flierdt[3] and Steven M. Bohaty[1]

[1]Ocean and Earth Science, National Oceanography Centre, University of Southampton, European Way, Southampton, SO14 3ZH UK, c.e.huck@soton.ac.uk;
[2]MARUM – Centre for Marine Environmental Sciences, University of Bremen, Leobener Strasse, D-3829, Germany;
[3]Department of Earth Science and Engineering, Imperial College London, Exhibition Road, London SW7 2AZ, UK.

Abstract

The early stages of the modern 'Icehouse' climate state first developed in the Oligocene following rapid global cooling and the onset of Antarctic glaciation at the Eocene-Oligocene Transition (34 Ma). The size of the early Antarctic ice sheets, however, varied considerably, and a series of intense glacial-interglacial episodes occurred during the Mid Oligocene Glacial Interval (MOGI; ~28 to 26.3 Ma). In order to assess Southern Ocean paleoceanographic changes in response to this predominantly cool glacial phase, we investigated mid-Oligocene hemipelagic cores recovered at Ocean Drilling Program (ODP) Leg 113 Sites 689 and 690 on Maud Rise (eastern Weddell Sea). We generated new high-resolution x-ray fluorescence (XRF) scanning, benthic foraminiferal stable isotope, and fish-tooth neodymium (Nd) isotope records. The composited XRF records from these sites exhibit prominent orbital-scale cyclicity in iron/calcium (Fe/Ca) ratios (indicative of lithological changes clay vs. carbonate content), providing a record of carbonate dissolution intensity and/or changes in clay flux from the East Antarctic margin. Peak glacial conditions are inferred at ~27 Ma during long-term Eccentricity Cycle 67 based on the astronomically tuned benthic foraminiferal data from Site 689. During the peak glacial interval, a negative excursion in fish tooth Nd isotope record reveals a change in ocean circulation patterns, likely resulting from a shift in the relative contributions of deep-water sources to the Southern Ocean. This change in circulation is accompanied by a simultaneous increase in Fe/Ca ratios suggesting that enhanced weathering of nearby Antarctic bedrock by enhanced glacial activity may have also contributed to the short-term change in seawater chemistry during this time.

Keywords: Oligocene, Southern Ocean, Antarctica