

East Antarctic Ice Sheet dynamics and Southern Ocean paleoceanography at the Middle Miocene Climate Transition; evidence from diatoms

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Abstract

The Middle Miocene Climate Transition (MMCT), c.13.9 Ma, is recognised as one of the most important steps in Cenozoic Antarctic climate evolution. The event is characterised by a ~1‰ shift in global benthic $\delta^{18}\text{O}$, reflecting global cooling and polar cryospheric expansion. In Antarctica, the MMCT is thought to have driven the final extinction of tundra on the continent, a transition from wet- to cold-based East Antarctic glacial regimes and a strengthening of the Antarctic Circumpolar Current. The cause of the MMCT remains largely unknown, although a role for the carbon cycle has been traditionally invoked due to the simultaneous carbon isotope excursions evident in global carbonate records.

A relative paucity of high-resolution Southern Ocean records across the MMCT, particularly from the highest latitudes, has made it difficult to fully determine the role of the Southern Ocean in and dynamic ice/ocean interactions during this key interval of Antarctic Ice Sheet evolution. For example, to explore the hypotheses that a warm Southern Ocean acted as a source of moisture for ice growth, or that increased ocean productivity contributed to CO₂ drawdown and global cooling. The impact of massive continental ice growth on the surrounding ocean also remains relatively unclear.

Here we present three quantitative sub-orbital resolution diatom abundance and assemblage records documenting surface water conditions at Antarctic Zone ODP Sites 1165B, 744B and 747A across the MMCT interval (15-12 Ma). Our data facilitate a basic reconstruction of Amery Ice Shelf dynamics as well as Southern Ocean paleoceanography, e.g. relative paleotemperatures, frontal boundary positions and sea ice cover in the Prydz Bay/Kerguelen Plateau region before, during and after the MMCT. Finally, we comment on the impact of this episode of dramatic environmental change on diatom diversity and paleoproductivity in the Antarctic Zone, and its implications for the global carbon cycle.

Keywords: Miocene, diatoms, paleoceanography