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Geochemical Insights into Antarctic Glaciation at the Eocene-Oligocene Transition

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The Eocene-Oligocene Transition (EOT) is an important time period, recorded by a pronounced quasi-permanent increase in the global deep ocean oxygen isotope record. Interpretation of $\delta^{18}O$ records in terms of ice volume / sea level change require an independent paleothermometer (e.g. foraminiferal Mg/Ca or clumped isotopes), and an understanding of additional complicating factors on both proxies, including diagenesis, carbonate saturation state, and regional salinity variations. These have precluded quantitative analysis of the oxygen isotope record at some sites.

Electron Probe Micro Analysis (EPMA) maps can show the presence of high-Mg banding within the foraminifera test wall, which suggests whether the Mg/Ca record can be robustly interpreted in terms of temperature change [1]. Here we revisit the classic EOT section at ODP Site 1218 (Equatorial Pacific), using new analytical techniques (EPMA and Laser Ablation ICP-MS) to interrogate the existing benthic foraminiferal Mg/Ca record, which at face value fails to record a cooling through the glaciation event [2]. We also present paired planktic foraminiferal trace element and stable isotope records from the EOT at ODP Site 1138 (Central Kerguelen Plateau), alongside intra-test EPMA maps of Mg/Ca from selected samples.

We reconstruct cooling and freshening in the Southern Indian Ocean across the latter part of the EOT at ODP Site 1138, despite evidence that the $\delta^{18}O$ increase at this point is dominated globally by the ice volume signal with little cooling (e.g. [3]). We suggest that ODP Site 1138 recorded a local shift in surface water mass properties, likely reflecting a northward shift of the polar front as the ice sheet blanketed the Antarctic continent, impacting regional climate, as well as enhanced upwelling and export productivity.

Our records point towards a complex set of climate-ice-ocean feedbacks associated with Antarctic glaciation, with implications for the subsequent stability of the nascent ice sheet.

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