

Short-term Antarctic Ice-Sheet dynamics during the late Oligocene: multi-proxy records from ODP Site 689

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Palaeoceanographic records from the Oligocene (33.9–23.03 Ma) offer valuable insights into Antarctic Ice Sheet (AIS) dynamics in a world warmer-than-today. While the long-term evolution of Oligocene glaciations is relatively well-known, our knowledge of short-term (i.e., orbital to suborbital scale) AIS dynamics is still limited. Here, we present a high-resolution multi-proxy record from Ocean Drilling Program Site 689 (Maud Rise, Southern Ocean) to investigate the short-term AIS variability during the late Oligocene (26.2–25.2 Ma). Variations in ice volume were quantified using the stable oxygen isotope composition of seawater ($\delta^{18}\text{O}_{\text{sw}}$) inferred from benthic foraminiferal $\delta^{18}\text{O}$ and Mg/Ca-based bottom-water temperatures. Our $\delta^{18}\text{O}_{\text{sw}}$ record reflects large, eccentricity-paced ice volume fluctuations during the studied interval. These climate state dependent fluctuations exerted a significant control on the different types of rocks eroded as the AIS advanced/retreated, which can be monitored by the radiogenic isotope compositions of detrital neodymium (Nd) and authigenic lead (Pb) in deep marine sediments adjacent to the AIS. These isotopic signatures co-vary with $\delta^{18}\text{O}_{\text{sw}}$ for most of the record documenting changes in sediment provenance and weathering regime driven by ice-sheet variability. In addition, the rather invariant but pronounced incongruent Pb isotope signal observed confirms the presence of a major East AIS during our entire studied interval. Our results emphasize the sensitivity of radiogenic isotopes to past ice-sheet dynamics and provide new geochemical evidence of AIS fluctuations during the late Oligocene on orbital to suborbital time scales.