Geological evidence for Late Pleistocene variability of the East Antarctic Ice Sheet?

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Abstract

Understanding ice sheet behaviour in the geological past is essential for evaluating the role of the cryosphere in the climate system and for predicting sea level rise in future warming scenarios. Recent estimates of past and future sea level rise from ice sheet modelling point towards an Antarctic ice sheet that is more sensitive to oceanic and atmospheric warming than previously envisioned, but it is crucial that such estimates are independently constrained by geological reconstructions. While data and models both indicate instability of marine-based sectors of the East Antarctic Ice Sheet during Pliocene warm periods, its behaviour during interglacial periods of the Late Pleistocene remains uncertain.

In this study, we use detrital sediment provenance measurements from IODP core U1361A to explore the ice sheet behaviour in the Wilkes Subglacial Basin of East Antarctica during the Late Pleistocene (MIS 1 to MIS 12; ~0-500 ka BP). Neodymium (Nd) isotopes fingerprint changes in the locus of glacial erosion, revealing distinct sediment provenance between interglacial and glacial periods, as well as differences between individual interglacials. The Late Pleistocene provenance variations are similar in magnitude to those previously observed during the Pliocene and co-vary with XRF-derived records of Ba/Al (i.e. retreated ice margin during warmer times characterised by higher productivity). The temporal relationship between iceberg-rafted debris and sediment provenance does not display a unique pattern for all interglacials. Provenance shift and IRD supply coincide at the start of MIS5 and 9, but the provenance change is longer lasting. For MIS7 and MIS11, a more complex relationship is observed, including early (deglacial?) IRD peaks preceding the major change in provenance. Overall, a remarkable correlation is observed between interglacial epsiolon Nd values and Southern Ocean temperatures and sea level.

In a global palaeoclimate context, our new records from a site proximal to the Wilkes Subglacial Basin provide evidence supporting the notion that low-lying parts of the East Antarctic Ice Sheet may have contributed to elevated sea level during warm Late Pleistocene interglacials (e.g. MIS 5, MIS 11). Furthermore, we suggest that relative ice sheet stability during the Holocene may be atypical of past interglacial climate states.