Sequence of Pliocene Deglacial Events in East Antarctica and Their Wider Implications

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Abstract

The extent of the Antarctic ice sheet was reduced during warmer-than-present times throughout the Pliocene (5.3 to 2.6 Ma). Such variations in ice volume resulted in changes to sea level, ocean circulation and ultimately global heat transfer. For example, increased Antarctic glaciation in the Late Pliocene has been invoked to explain global cooling, culminating in Northern Hemisphere Glaciation. However, detailed studies on the Pliocene dynamics of the large East Antarctic ice sheet are scarce. In particular, high resolution records from the East Antarctic margin are needed to unravel the sequence of waxing and waning ice dynamics, their magnitude, and the timescales involved.

In order to provide detailed insight into the sequence of Pliocene deglacial events, here we present provenance analyses on Pliocene-aged detrital marine sediment recovered from offshore of the Wilkes Subglacial Basin (IODP Expedition 318, U1361A). Detrital marine sediment was analysed for strontium and neodymium isotopes, which have been shown in previous studies to be effective tracers for sediment provenance changes and, by inference, ice dynamics in this region.

Our new high resolution study spanning orbital scale cycles in the Pliocene confirm substantial retreat of the ice margin during warm phases of the Pliocene. For the first time, we can tentatively suggest that deglacial provenance shifts occurred gradually over timescales on the order of a few millennia. This geological evidence corroborates the timescales of East Antarctic ice sheet retreat suggested by recent modelling studies for both the Pliocene and future warming scenarios. Our high resolution sampling also provides novel insights into the concatenation of events during ice retreat in the Wilkes Subglacial Basin. A distinct increase in the amount of iceberg rafted debris (IBRD counts) predates shifts in sediment provenance (detrital radiogenic isotope records) and ocean productivity (XRF scan records) during Pliocene retreat events, providing geological support for large scale ice margin retreat. Furthermore, this sequence of events suggests that upon ice retreat, the changed provenance of sediments may have played a critical role in releasing bioavailable iron into the Southern Ocean, thereby adding to increased ocean productivity during warm conditions.

In order to link these events to a broader view of East Antarctic ice sheet dynamics and its role in the onset of Northern Hemisphere Glaciation, we will compare our results from offshore of the Wilkes Subglacial Basin with a new Plio-Pleistocene record of ice dynamics from the Ross Sea (CIROS 2, Ferrar Glacier) and a record from Prydz Bay (ODP Site 1165).

Keywords: Sediment provenance, Wilkes Subglacial Basin, Ross Sea, Pliocene