

Oligocene sea water temperatures offshore Wilkes Land (Antarctica) indicate warm and stable glacial-interglacial variation and suggest latest Oligocene ice-sheet decline

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Abstract

At present, warming of the waters below the Antarctic ice shelves is a major contributor to the instability of the Antarctic cryosphere. In order to get insight into future melt behavior of the Antarctic ice sheet, it is important to look at past warm periods that can serve to inform future changes. The Oligocene (~34-23 Ma) is a period within the range of CO₂ concentrations predicted by the latest IPCC report for the coming century and is characterized by a very dynamic Antarctic ice sheet, as suggested by benthic $\delta^{18}\text{O}$ records from ice-distal sites. We suspect that, like today, environmental changes in the Southern Ocean are in part responsible for this dynamicity. To gain more insight into this, we have reconstructed sea water temperatures (SWT) based on Thaumarchaeotal lipids (TEX₈₆) for the Oligocene record obtained from the ice-proximal Site U1356 (Integrated Ocean Drilling Program), offshore Wilkes Land. Part of our record is dominated by mass waste deposits. However, the rest shows a strong coupling between the lithology and SWT, which we attribute to glacial-interglacial variation. Our data shows that both glacial and interglacial temperatures are relatively warm throughout the Oligocene: 14°C and 18°C respectively, which is slightly warmer than previously published estimates based on U^K₃₇ and clumped isotopes for the early Oligocene. Glacial and interglacial reconstructed SWTs show a consistent 2-4°C offset and follow the same long-term trend with temperature optima around 30.5 and 25 Ma. Remarkably, the long-term trends of our TEX₈₆-based SWT record are very much comparable to the long-term trends in the benthic $\delta^{18}\text{O}$ records. This suggest that long-term episodes of ice-sheet growth and decline are absent during the Oligocene. However, a discrepancy in the timing of SWT decline and benthic $\delta^{18}\text{O}$ increase during the latest Oligocene suggests that this period likely experienced a decrease in ice volume preceding the Mi-1 glaciation. Towards the end of the Oligocene our reconstructed SWT record also shows some large temperature drops of which one can be related to the Mi-1 event.

Keywords: Oligocene, TEX₈₆, Wilkes Land, sea water temperature