New evidence for widespread extreme warmth at southern high latitudes during the Late Cretaceous

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The Late Cretaceous was a greenhouse world, characterised by elevated temperatures and high atmospheric pCO_2. Even in the context of an extreme greenhouse climate, existing planktic foraminiferal $\delta^{18}O$ data from the southern high latitudes (palaeolatitude of ~55–60˚S) suggest anomalous warmth, with sea-surface temperatures (SSTs) >30°C for much of the Late Cretaceous. Recently published SST records, based upon TEX_{86} (an organic geochemical palaeothermometer) from the South Atlantic and southern Tethys support these findings, demonstrating extremely high temperatures in the mid-Cretaceous, followed by steady cooling.

Here we present the first Late Cretaceous TEX_{86}-SST records from the Great Australian Bight and Mentelle Basin (IODP Expedition 369 Sites U1512, U1513, U1514, U1516). These sites provide a new perspective on temperature variations in the southern high latitudes, during the extremes of the mid-Cretaceous and the cooling that followed, and offer an opportunity to investigate the tectonic and palaeoceanographic influence on climate during the separation of Australian and Antarctica.

Comparison of new and existing TEX_{86} data indicates extreme and widespread warmth in the southern high latitudes during the Late Cretaceous, with SSTs reaching over 33°C in the peak warmth of the early Turonian. The long-term trends in the TEX_{86} data from IODP Expedition 369 are also comparable to those recorded at similar palaeolatitudes in other ocean basins, indicating a consistent evolution of southern high-latitude temperatures. Intriguingly, the Great Australian Bight record shows greater short-term SST variability than previously published records, suggesting a strong local influence on SSTs, particularly during the Turonian–Coniacian interval. We discuss the possible mechanisms causing the observed variability, and highlight the implications of these high-latitude records for polar climates and latitudinal temperature gradients in a greenhouse world.