

Exceptionally warm surface temperatures during the early Oligocene in equatorial Africa (Tanzania)

TOBIAS AGTERHUIS¹, GAVIN L FOSTER¹, PAUL N PEARSON^{2,3}, BRIDGET S WADE³ AND GORDON N INGLIS¹

¹University of Southampton

²Cardiff University

³University College London

The Oligocene (34–23 Ma) was an enigmatic period in Earth's history. Alkenone carbon isotope records indicate declining atmospheric CO₂ levels, while benthic oxygen isotope records suggest a relatively stable climate on long time scales. This conundrum suggests that either CO₂ and temperature were decoupled, or that existing CO₂ and/or temperature estimates are incorrect. Biomarkers (e.g., TEX₈₆ proxy) can be used to directly infer sea surface temperature (SST). The generation of long-term regional SST records is important for assessing spatial and temporal patterns of temperature change, which can help identify the driving forces of climate change. To date, we lack robust surface temperature estimates from the low latitudes. Here we present a low-resolution TEX₈₆ record spanning the late Eocene to early Oligocene (42–30 Ma) and the mid-late Miocene (16–10 Ma) from equatorial Africa (Tanzania). This record is based on isoprenoidal GDGT assemblages from outcrop samples, which represent open marine sediments from the narrow continental slope that have subsequently been uplifted onto land. The majority of the Miocene-aged GDGT assemblages exhibit a typical marine GDGT distribution and yield SST estimates that range between 27 and 41 °C. In contrast, most of the late Eocene to early Oligocene-aged sediments contain very high TEX₈₆ values (up to 0.99) that would yield extreme SST estimates (38 to 45 °C). However, these samples are also characterised by unusually high relative abundance of crenarchaeol regioisomer and yield high *f*_{cren} values (>0.4). Comparison with Nitrososphaerota culture data indicates that the Oligocene GDGT distributions are similar to those produced by Nitrososphaerota type I.1b, which inhabit terrestrial environments. As type I.1b cultures show a relationship between growth temperature and cyclisation, this suggests that our high TEX₈₆ data may reflect continental surface temperatures instead of SSTs. Regardless, we propose that Oligocene surface temperatures in tropical Africa were exceptionally warm. Focussing on relative temperatures, we do not observe a cooling from the Eocene into the Oligocene on long time scales (Δ SST = 0.06 °C). This may support the suggestion that temperature and atmospheric CO₂ were decoupled in the Oligocene, but more SST and CO₂ reconstructions are required to solve its climate conundrum.