Early Oligocene to middle Miocene surface ocean conditions offshore Cape Adare (Ross Sea, Antarctica); palynological and temperature records of DSDP Site 274

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Ocean-induced ice loss from the Antarctic ice sheet (AIS) is accelerating. Projecting climate-ocean-ice interactions into the future remains challenging, which hampers predictions of future sea level rise. The Oligocene-Miocene experienced climate conditions similar to those projected for the near future, making geological records from this interval valuable.

We present past ocean conditions in ice-proximal Oligocene-Miocene sediments at DSDP Site 274, offshore the Ross Sea continental margin. By deploying the modern ecological affinities of dinoflagellates[1] (Fig. 1b), we interpret fossil (dinocyst) assemblages to reconstruct past oceanography (Fig. 1c)[2], while organic geochemical biomarker, TEX_{86}, analysis yields a quantitative proxy for past (likely summer-biased) sea surface temperature (SST)[3].

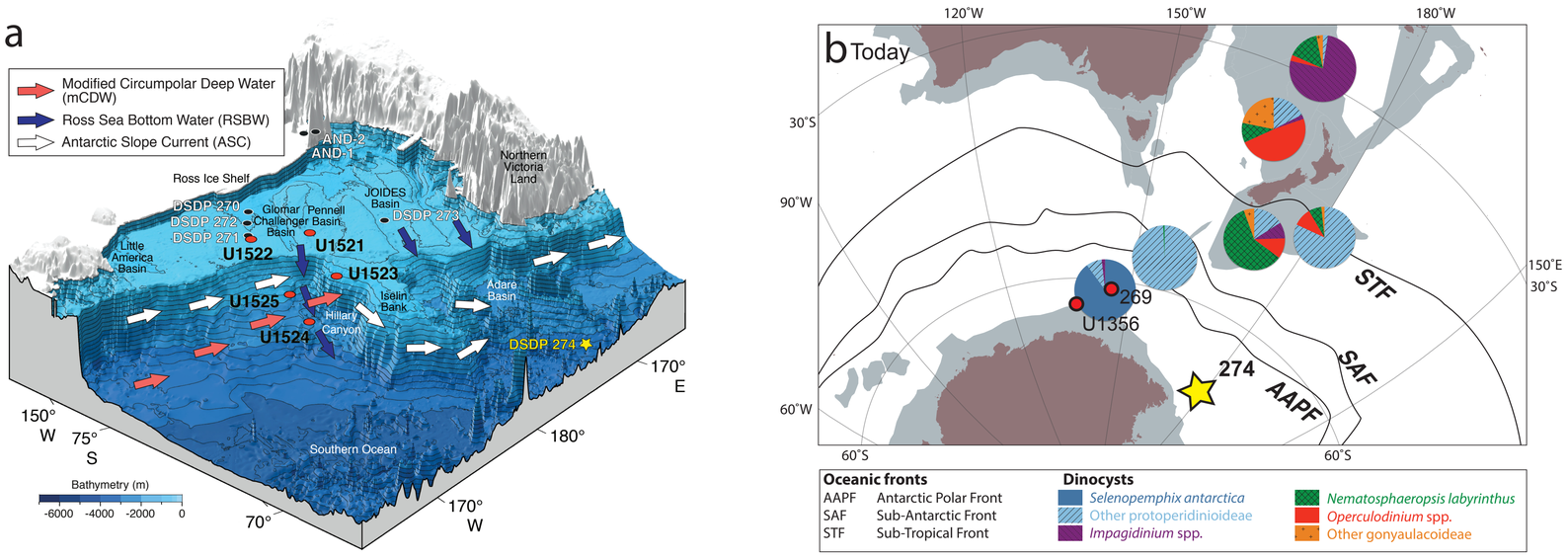


Figure 1

a: Location of the DSDP/IODP drill-sites in the Ross Sea and indication of the major water masses circulating around the sites. Modified after McKay et al., (2019)[4].

b: Modern Southern Ocean surface oceanography and dinocyst assemblages[2]. STF: Subtropical front, SAF: SubAntarctic front, AAPF: Antarctic polarfront. Red dots:previously studied sites. Yellow star: Study site. Modified after Sangiorgi et al., (2018)[5].

c: Paleoposition of continents and sites and estimated oceanic frontal system at 24 ma [6]. pSAF: proto-SAF, AAD: Antarctic Divergence.

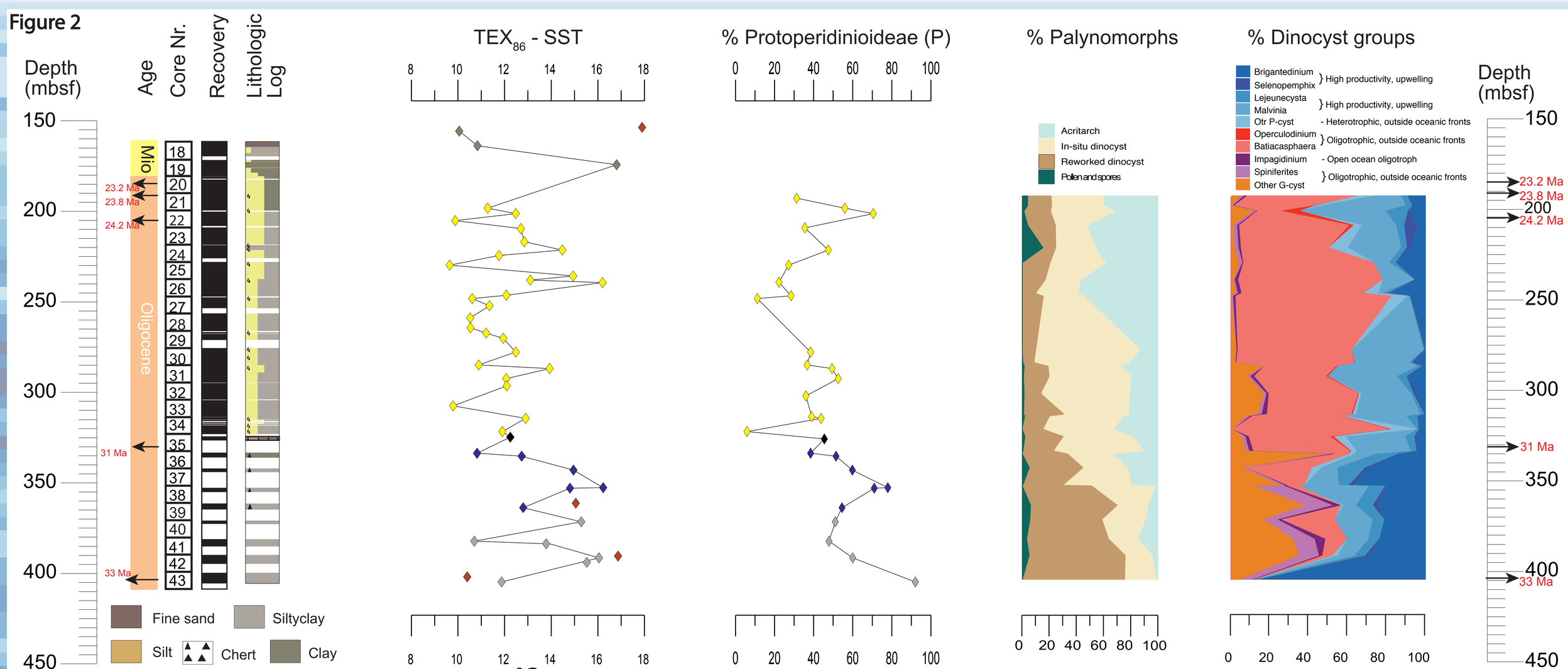
Tools

1. Dinoflagellate (unicellular planktonic protists) distribution is linked to environmental conditions of the surface waters. Thus, dinocyst (the fossil remain) assemblages can be used as a paleoceanographic proxy.
2. The TEX_{86} paleothermometer employs the temperature-dependent relative abundance of a suite of thaumarchaeotal membrane lipids; glycerol dibiphytanyl glycerol tetraethers (GDGTs). We calculate the TEX_{86}–SST relations using the linear calibration (error ±5.2°C), Kim et al., 2010[7].

Results

- Sediments at Site 274: diatom-rich silty clay with IceRaftedDebris. Cherts compromise core recovery below 320mbsf.
- Dinocyst biostrat: bottom of the hole early Oligocene age and the OM-boundary between Core 19 and 20.
- TEX_{86} results unbiased: Low BIT (marine OM dominates), no overprints. Warm-temperate conditions.
- Dinocyst assemblages: variations between cold-upwelling, high- nutrient open ocean heterotrophic (P) species to lower-nutrient temperate autotrophic (G) dinocysts, in line with TEX_{86} results.
- More reworking in early Oligocene.
- Compared to IODP site U1356 and DSDP site 269 (Fig. 1b): similar temperatures and oceanographic conditions.

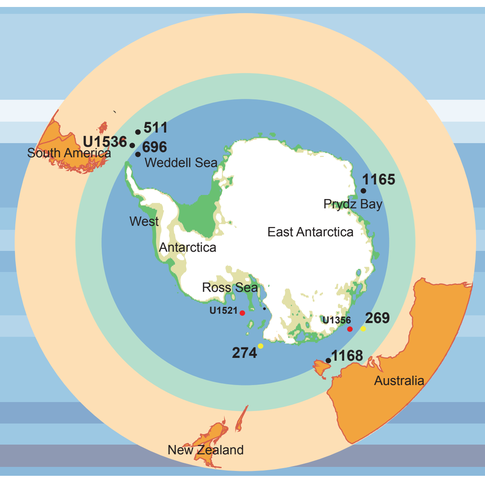
Figure 2



Conclusions

- Oligocene oceanographic conditions warm-temperate (i.e., 10-16 °C, ±5.2°C) offshore Ross Sea
- Warm early Oligocene, colder mid-Oligocene, late Oligocene warming, cool early Miocene
- Temperate dinocysts close to the Antarctic continent confirm TEX_{86} - SST results
- Southward shift of ocean fronts during Oligocene
- Extends warm Oligocene conditions from Site U1356 and 269 into south Pacific

Up next:



Referances

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