Paleogene Polar Plankton and export productivity changes between the Eocene and Oligocene

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Motivation

The Eocene-Oligocene transition (EOT), ~33.7 million years ago (Zachos et al. 2001), marks the first permanent glaciation on Antarctica and brought significant global climate changes.

This project investigates the role that the phytoplankton played during the EOT in order to understand how this climatic event affected the phytoplankton and consequently the carbon pump, which in return affected global climate through a drawdown of pCO_2. Investigating the nature of this interaction will provide significant insight into the functions of the oceans as climate regulators.

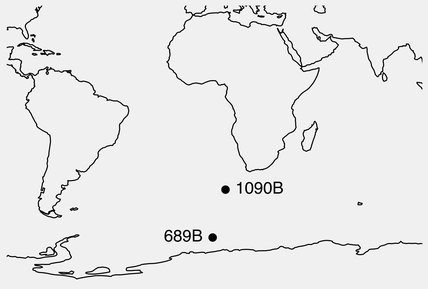
Target sites

The Southern Ocean plays an important role in the global climate system, being the focal point of climatic and oceanographic changes at the EOT, therefore it is a key area for reconstructions during this period.

We are generating data in various deep-sea drilling sites in and around the Southern Ocean. Here, we present our preliminary findings in 2 localities (Figure1).

- ODP Site 689B (Antarctic - Weddell Sea)
- ODP Site1090B (Subantarctic - Agulhas ridge).

1



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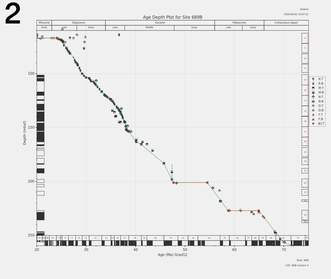

Figure 2. Revised Paleogene age model for Southern Ocean Hole 689B (GPTS: Gradstein et al. 2012). All known published stratigraphic data synthesized, original paleomagnetic polarity data and interpretation of Spiess (1990) reinterpreted (left axis), though rejected polarity picks still shown on plot.
Note: radiolarian events mostly calibrated from this hole, explaining 'perfect' fit.

Preliminary results

Neptune database

The diversity measurements of each planktonic group during the Cenozoic (Figure 3) will allow us to position our Eocene-Oligocene results in a broader evolutionary context.

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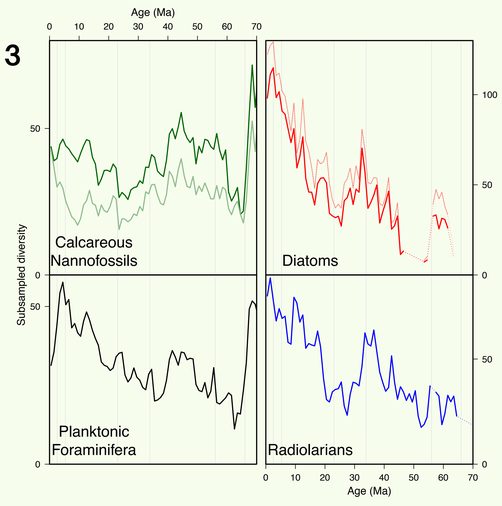

Diatoms are one of the major primary producers in the ocean and considered to be the principal agents of the biological pump in the Southern Ocean.

Our primary results in Diatom's diversity history across the Eocene-Oligocene boundary has shown a diversification event close to the EOT in the South Atlantic (ODP Site 1090B) – Figure 5. This event is an evidence of an increase in productivity in the Southern Ocean.

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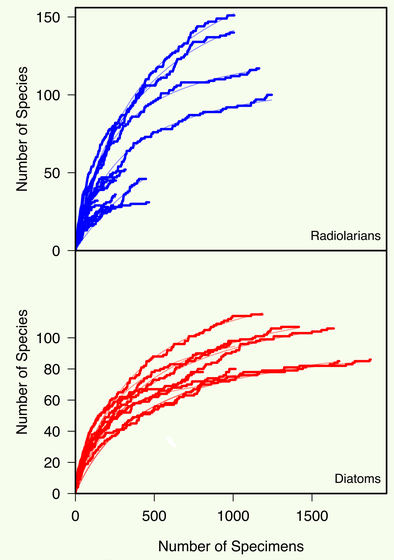

Figure 4. Species accumulation curves for radiolarians and diatoms

Diatom's diversity

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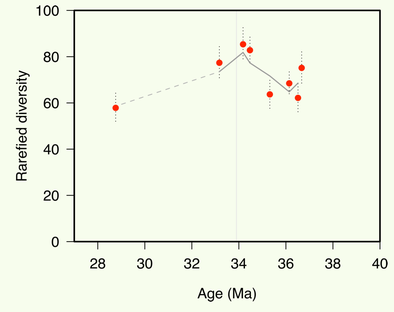

Carbonate isotope analysis

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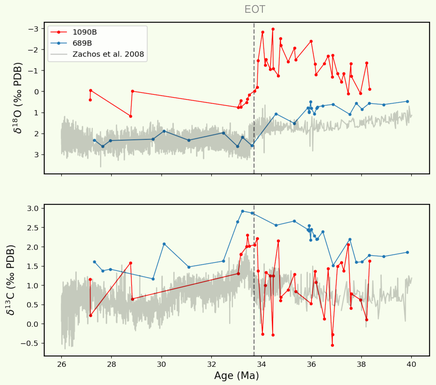

We have measured stable carbonate isotope composition of fine fraction (<45 μm), primarily composed of coccoliths.

Our new isotope records show a $\delta^{18}O$ increase across the EOT consistent with previous observations. This increase is more pronounced on the Subantarctic site (1090B), whereas the Antarctic ODP 689B shows a pattern similar to benthic $\delta^{18}O$ changes recorded by Zachos et al. 2008.

The trend of fine fraction $\delta^{13}C$ towards more enriched values near the EOT and a subsequently decrease after the global cooling converges with the diversification of diatoms, possibly as a result of an increase in productivity at the Eocene Oligocene boundary.

Additional productivity analysis, exploring different proxies may confirm this trend.

References: 1. Zachos, J., M. Pagani, L. Sloan, E. Thomas, and K. Billups (2001), Trends, rhythms, and aberra- tions in global climate 65 Ma to present, Science, 292, 686–693. 2. Renaudie, J., Lazarus, D.B., Diver P. (2020), NSB: an expanded and improved database of marine planktonic microfossil data and deep-sea stratigraphy. 3. Zachos, J., Dickens, G. & Zeebe, R. (2008), An early Cenozoic perspective on greenhouse warming and carbon-cycle dynamics. *Nature* 451, 279–283.

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