Are calcareous phytoplankton affected by the onset of the Antarctica ice-sheet at the Eocene – Oligocene transition?

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This project will use calcareous nannofossil assemblages to undisclose the climatic and biotic evolution during the Eocene-Oligocene transition (EOT). This event is a period of profound global change lasting 500 Kyr at ca. 33.8 Ma and marks a major step toward the modern glaciated world thus representing the ideal case study to reconstruct the extinction and speciation rates of this group of microfossils which will be eventually used to understand the oceanic reorganization that took place during that time. The ambitious aim of this project is to obtain a throughout understanding of this critical climatic transition and this, in turn, is important for highlighting the mechanisms and sensitivities of Cenozoic climate, and addressing topical questions relating the dynamic of global change during greenhouse-icehouse climate switching (Coxall & Pearson, 2007).

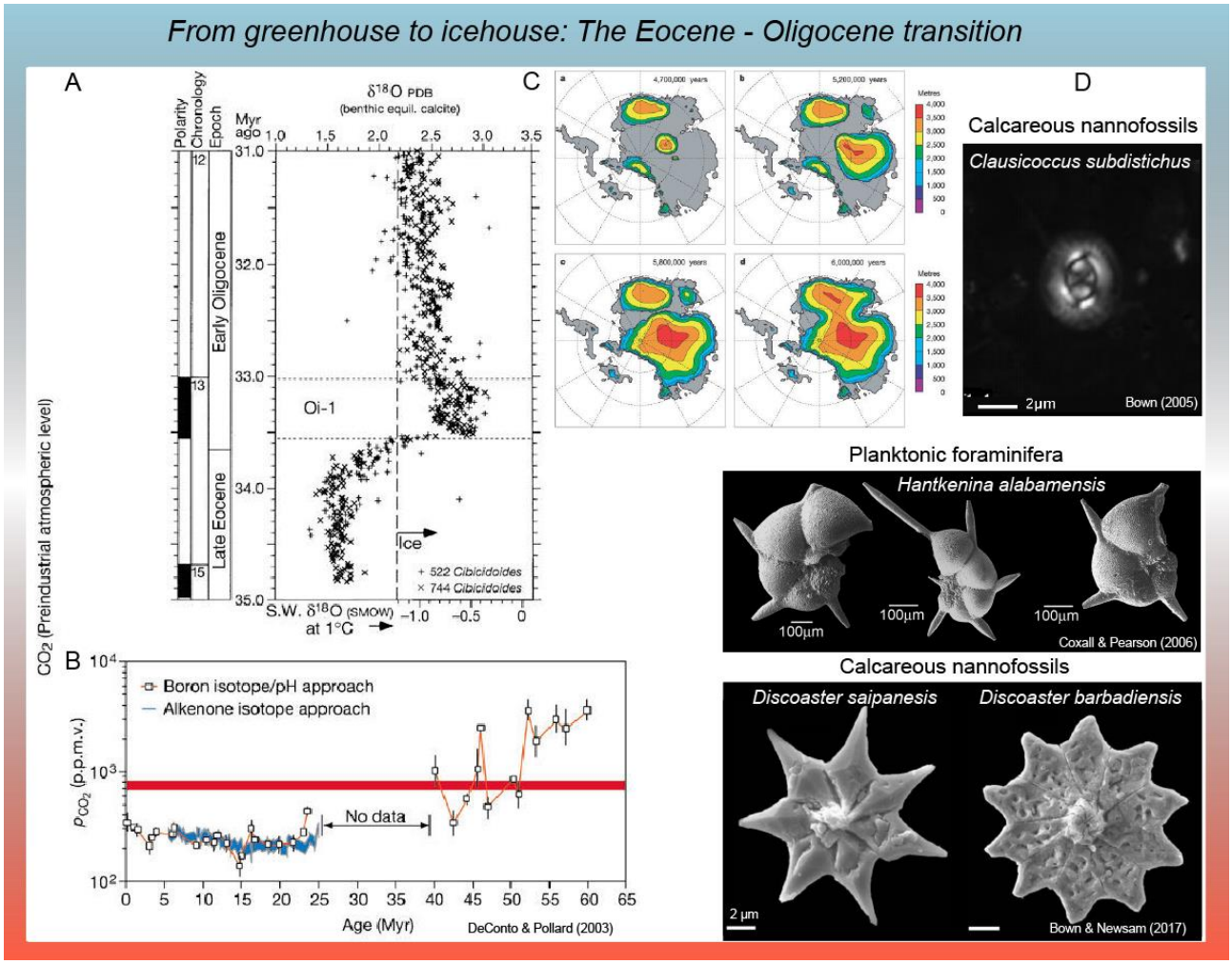

Figure 1. Some of the changes recorded during the EOT: A) the $\delta^{18}O$ positive shift, B) the decrease in the pCO_2 values, C) the onset of the Antarctica ice-sheet, D) the extinction and the recovery of calcareous plankton (calcareous nannofossils and foraminifera).

Two low-resolution syntheses of the mode and rates of evolutionary changes in the Paleogene (66-23 Ma) calcareous nannoplankton are available from literature (Bown et al., 2004; Aubry 1992; 1998). This dataset well designs the very long-term evolution of this group but lacks the necessary resolution to capture the real pace and style of extinction and speciation rates trough time. The Paleogene is paved with remarkable climate changes which could have stimulated/forced this group to change/adapt. From the early Eocene on the Earth experienced a progressive cooling that is associated

with the decrease in diversity and biomass of calcareous nannoplankton, this trend confirms that there is a broad link between nannoplankton diversity and climatic trends, and in particular as climate cooled there is a significant loss of diversity documented (Bown et al. 2004; Newsam et al., 2017).
The EOT represents an interval of profound perturbation of the abiotic and biotic systems but in contrast with what is observed for planktonic foraminifera (calcareous zooplankton), a group that is deeply affected by the Eocene – Oligocene Transition (EOT), no dramatic extinctions are observed in coincidence with the event in calcareous nannofossils, rather the extinction recorded in this group well anticipated the climatic event. Even more interestingly, an acme interval of a single taxon seems to coincide with the EOT in some areas (Figure 1).
In this project, we propose to investigate Paleogene Zealandia sediments recovered at Sites U1507 and U1509 during IODP Exp. 371 (South Pacific Ocean), which represent a unique record of the middle Eocene - early Oligocene interval (ca. 45-ca. 30 Ma, Sutherland et al., 2018) and ODP Site 756 (Indian Ocean; Peirce et al., 1989), which is crucial because of its location at the transition between low-middle and high latitudes. The study of this material would allow to have a more global perspective on the response of calcareous nannoplankton to the EOT and depict a more comprehensive scenario of what occurred in the sea surface at the base of the food chain during this crucial interval.
In this context, the intent of this project is thus to:
-to provide a rigorous chronologic age model for the study sections and possibly improve the biostratigraphic and biochronological framework;
-to compare calcareous nannofossil assemblage data will with paleoceanographic and paleoclimatic proxies (e.g., C and O isotopes, Mg/Ca ratio, TEX86, $CaCO_3$ content and micropaleontological data).
Hopefully the results obtained will serve to pin point the moments of evolution and how these relate with changes in climate and environment in background and extreme conditions across the EOT.

References

Aubry, M.-P., 1992. Eocene–Oligocene Climatic and Biotic Evolution. Princeton Univ. Press, Princeton, NJ, pp. 272–309.
Aubry, M.-P., 1998. Late Paleocene–early Eocene Biotic and Climatic Events in the Marine and Terrestrial Records. Columbia University Press, New York, pp. 158–201.
Bown, P.R., Lees, J.A. & Young, J.R., 2004. Coccolithophores – From Molecular Processes to Global Impact, 481–508. Springer, Berlin.
Coxall, H.K., Pearson, P.N. (2007) Geological Society Special Publication, pp. 351-387.
Newsam, C., Bown, P.R., Bridget, S., Jones, H.L., 2017. Newsletters on Stratigraphy, 50 (3), pp. 297-309.
Peirce, J. et al., 1989. Proc. ODP, Init. Repts., 121: College Station, TX (Ocean Drilling Program). doi:10.2973/odp.proc.ir.121.1989.
Sutherland, R., et al., 2018. IODP: Preliminary Reports, (371), pp. 1-44.

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