Southern Ocean nitrogen and silicon dynamics during the last deglaciation

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The reinvigoration of overturning in the Southern Ocean is hypothesized to have returned CO_2 from the deep ocean to the atmosphere at the end of the last ice age. Large peaks in opal accumulation have been put forward as evidence for an increase in wind driven upwelling between 10 and 15 kyr BP [1]. Here, we use coupled nitrogen and silicon isotope records alongside opal accumulation rates to provide quasi-quantitative estimates of Southern Ocean nutrient supply, by upwelling, and nutrient utilization across this interval. Significant changes in the consumption of N and Si across the two opal accumulation peaks indicate major changes in both upwelling and nutrient demand. We find N and Si consumption to be relatively incomplete during peak opal accumulation. Nutrient supply must have been significantly enhanced. Differences between the Si and N responses during opal peaks may stem from decreasing iron availability across the glacial termination. The reinvigoration of overturning circulation during the deglaciation is hypothesized to cause a transient peak in nutrient supply to the low latitudes [2]. This is supported by our data, which indicate that relatively high macronutrient concentrations were maintained in the Southern Ocean surface waters despite high demand.

[1] Anderson *et al*. (2009) *Science* **323**, 1443–1448. [2] Spero & Lea (2002) *Science* **296**, 522–525.

A re-compiling of Cretaceous SST proxy data

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The Cretaceous was generally a period of extreme global warmth, most likely caused by elevated atmospheric pCO_2 levels, during which geologically brief (<1 Myr duration) carbon-cycle perturbations were common. Thus, the geological recod of this time period may hold clues as to the mechanics of the Earth system under different conditions to those experienced at the present-day and, also, to the long-term response of the planet to severe environmental perturbation. However, extraction of meaningful inferences about the Earth system from the Cretaceous geological record requires confidence in the proxies used to reconstruct environmental variables, such as temperature and pCO_2.

The last decade has seen significant shifts in the understanding and number of geochemical proxies used to reconstruct sea-surface temperatures (SSTs) in the Cretaceous. The recognition of early bottom-water recrystallization of planktic foraminifera has resulted in the re-appraisal of what is considered 'excellent' calcite preservation suitable for oxygen-isotope and Mg/Ca analysis. Organic geochemistry has provided a new proxy, TEX_{86}, that has permitted the generation of SST records in time periods and environments that were previously unobtainable by calcite $\delta^{18}O$. Additional insights have been provided by $\delta^{18}O$ of phoshate from biogenic apatites and new water-phosphate fractionation equations have been defined. These new insights and developments provide the justification for a re-appraisal of the temporal and spatial variability in Cretaceous SSTs. We attempt here to provide an up-to-date synthesis of Cretaceous proxy SST data that is mindful of the lessons and developments of the last decade. Using this new compilation allows us to build a more comprehensive view of Cretaceous palaeoclimates and to explore a number of questions that are pertinent both to Cretaceous palaeoclimatology and wider inferences about the mechanics of the Earth system.