Calibrating the coccolithophore Sr/Ca nutrient proxy in the modern oceans

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Introduction

Quantifying the variability in key components of the oceanic biological pump – the biologically mediated export of carbon from the surface to the deep ocean – is critical for paleoceanographic studies. The availability of major nutrients (nitrate, phosphate) to the oceanic phytoplankton is a primary control on gross carbon fixation in the surface ocean. The availability of nitrate to one group of these photosynthetic plankton, the calcifying coccolithophore algae, appears to influence the rate of incorporation of strontium into the biomineralized calcium carbonate plate-like scales, or coccoliths, produced by these single celled eukaryotes. The concentration of strontium in both modern and fossil coccoliths, which are common in marine sediments stretching back some 200 million years, may thus trace the changing patterns of nutrient availability, primary productivity and the strength of the biological pump over time. To provide support for the use of coccolith Sr/Ca as a paleoproductivity indicator in paleoceanography, additional data are required from the modern ocean that investigate the controls on coccolith Sr/Ca. This project will make use of modern coccolith material collected directly from the surface ocean during a series of research cruises associated with the NERC/DEFRA/DECC-funded UK Ocean Acidification programme. One of these cruises has already sampled coccolith material extensively across the north-west European shelf (2011), with two further cruises planned to the Arctic and Southern Ocean. These cruises provide a unique opportunity to tie microplankton sampling with nutrient data from CTD sampling, bioassays and underway sampling of nitrate and phosphate concentrations. This project will determine the Sr/Ca ratio of coccoliths sampled during these cruises and investigate variability in coccolith Sr/Ca with nutrient availability and across the major modern coccolithophore species. The results of this project will substantially improve our understanding of coccolith Sr/Ca and its application as a paleoproductivity proxy.

Methods

Initially, this studentship will use coccolithophore material collected by co-supervisors Drs Jeremy Young (UCL) and Toby Tyrrell (National Oceanography Centre) on board the UK research vessel RRS Discovery during the UK Ocean Acidification Programme cruise that circumnavigated the British Isles in June-July 2011. This cruise collected detailed ocean chemistry, nutrient and biological data that will provide an excellent baseline for understanding the controls on coccolith Sr/Ca ratios in the natural living environment in the modern oceans. It is anticipated that further cruise material from UK Ocean Acidification cruises to the Arctic (summer 2012) and Southern Ocean (winter 2012/2013) will come available during the first year of the studentship.

The strontium concentrations of coccolith material collected on these cruises will be analysed using Secondary Ionisation Mass Spectrometry (SIMS), principally at the NERC ion microprobe facility at the University of Edinburgh. This technique allows for the analysis of individual coccoliths and has already been successfully used for fossil material. As the research project progresses the analyses may be extended to include determining the patterns of trace element incorporation during controlled coccolithophore culture experiments via SIMS or ICP-OES.

Benefits and training

This studentship will provide a detailed training in modern coccolithophore taxonomy, phytoplankton ecology and fundamental geochemical analysis techniques (SIMS and ICP-OES). Co-supervision will be provided by world-leading experts in coccolithophore research (Drs Young and

Tyrrell) and will be integrated with ongoing research into the application of the Sr/Ca nutrient proxy to paleoceanographic research (Dr Dunkley Jones). It is envisaged that the student will become involved with the activities of the wider UK Ocean Acidification programme and be given the opportunity to interact with world-leading scientists involved in this research.

Preferred Background

This project would be suitable for those with a first degree in Earth Science, Oceanography or Biological Science. Candidates with training in cell biology and/or biological oceanography are particularly encouraged to apply.

Contact

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