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RECONSTRUCTING THE BIOLOGICAL PUMP IN THE SOUTHERN OCEAN

Maria T. HERNANDEZ[1], Jon LLOYD[2], Rachel MILLS[3] and Peter STATHAM[3]

[1] Organic Geochemistry Unit, Bristol Biogeochemistry Research centre, School of Chemistry, University of Bristol, Cantock's Close, Bristol, BS8 1TS; [2] School of Earth Sciences, University of Manchester, Manchester M13 9PL; [3] School of Ocean and Earth Science, National Oceanography Centre, Southampton. European Way, Southampton SO14 3ZH.

The Southern Ocean is the largest High Nutrients Low Chlorophyll (HNLC) area and is thought to play an important role in regulating glacial-interglacial atmospheric carbon dioxide concentrations (Indermuhle et al 2000). Two regulating mechanisms have been proposed for the Southern Ocean. The first suggests an increase in the efficiency of the biological pump due to a large apport of dust and associated trace nutrients during glacials (Martin, 1990). The second proposes a stratification of Southern Ocean waters due to an expansion of the Antarctic ice sheet during glacial periods (Petit et al 1999). However, none of these hypotheses have been proved so far. Through the analyses of inorganic proxies and the isotopic composition of biomarkers in marine sediments, a reconstruction of the biological pump during the past is possible and the multiple factors controlling Southern Ocean productivity and circulation can be resolved. With this purpose three sediment cores were retrieved from the Crozet Plateau, a region characterised by an annual algal bloom, believed to be fertilized by iron from the Crozet islands; these sediment cores were analysed and processed for biomarker, mineralogy and trace metal concentrations.

Three different stations were cored during the CROZEX programme: two to the north of the plateau, characterized by high and intermediate productivity regimes (M10 and M5, respectively) and one to the south (M6), which constitutes a HNLC area at present. Lipids were extracted from the sediment, quantified and identified by GC and GC/MS. Among the algal biomarkers identified were a range of sterols, including dinosterol, alkyl diols and alkenones. Also present are higher plant biomarkers such as *n*-alkanes and *n*-alkanols. Dinosterol is typically more abundant than alkenones, implying that dinoflagellates were an important part of the community; dinosterol and alkenone abundances are higher to the north of the plateau (M5), which is consistent with present productivity estimates (Lucas et al, unpublished data) and paleo export inferred from Ba_{ex} measurements (Marsh et al, unpublished data).

In the South, last glacial *n*-alkane abundances are higher than those in Holocene sediments. Ongoing work will determine the degree of sediment focussing in this region to

confirm the trends implied by biomarker abundances. If these are robust, the elevated glacial *n*-alkane abundance is consistent with a higher dust input during the last glacial as hypothesized by Martin. In contrast, *n*-alkane concentrations in M5 are higher in Holocene sediments relative to our glacial sample. In addition, there is a pronounced maximum in *n*-alkane abundances at 22 cmbsf (Fig. 1a), which could be due to a higher terrigenous input from the Crozet Islands during deglaciation.

Bulk sediment composition and biomarker abundances in the northern M5 core also indicate changes in the oceanographic conditions between glacial and Holocene periods. Glacial sediments are characterized by a higher percentage of carbonate and, surprisingly, higher sea surface temperatures (Fig. 1c) than Holocene sediments.

These suggest a more southward position of the Polar Front during the last glacial, such that sediments derived from warmer waters of the subantartic zone. Further evidence for significant changes in oceanographic regime come from changes in algal biomarker distributions (reflected by the alkenone profile shown in Fig. 1b). Further work will focus on resolving how interplay between oceanographic and changing nutrient input governs export productivity from this critical area of the ocean.

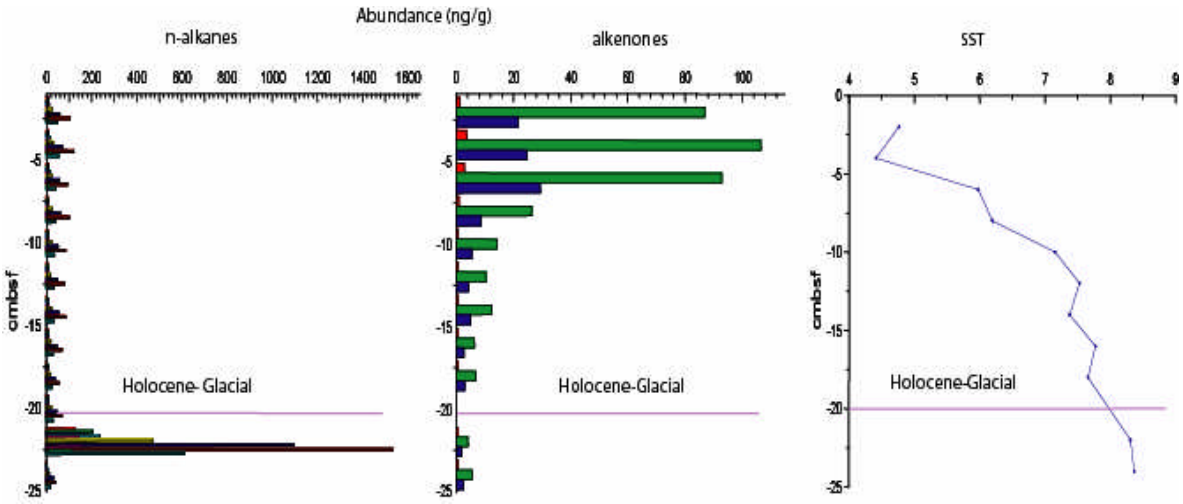

Figure 1. Depth profiles of biomarker abundances and SST estimated from alkenones for one of the sites north of Crozet Plateau (M5). The straight line at 20cmbsf represents the LGM-Holocene boundary, centred about 10Ka BP for this region (Francois et al, 1993).

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