Project AFI 4/02

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Co-Investigators: Dr. R. Ganeshram[3] & Dr. R. E. M. Rickaby[1]
Field Personnel: Dr. R. Ganeshram[3], K. R. Hendry[1] & Amber Annett[3].
Additional laboratory work in the UK by D. S. Carson[3].

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Introduction:

Central to the global impact of the Southern Ocean and Antarctica on both past and future climate change is the sea-ice surrounding the continent. Sea-ice plays a significant role in atmospheric gas exchange, regional weather patterns and biological productivity. Variations in biological productivity may be an important factor modifying atmospheric carbon dioxide levels, for example, over glacial-interglacial timescales. However, we do not yet fully understand how biological productivity has varied in the past, how past and future changes in sea-ice extent may influence this productivity and how these changes may impact carbon dioxide levels. In addition, we do not understand how biogeochemical cycling in a sea-ice environment may impact geochemical proxies such as the stable isotopic and trace element composition of organic matter and diatom opal. The purpose of this project is to understand how primary productivity in the surface oceans varies in a nearshore, seasonal sea-ice environment off the Western Antarctic Peninsula.

The objectives for the 2006-2007 field season were similar to previous years: (1) to investigate seasonal variation in dissolved and particulate stable isotopes and trace metals by diatoms in a near-shore environment and (2) investigate past changes in Marguerite Bay using the geochemistry of fossil diatoms. The specific goals this season were:

1) To collect early spring sea-ice and seawater and diatom opal samples, *in lieu* of spring 2004 when sampling was not achieved (KRH);
2) To collect further dissolved and particulate samples for the study of organic carbon and nitrogen isotope cycling suspended particulate matter; nutrients; alkalinity, pH and dissolved O_2 (AA);
3) To collect and preserve plankton assemblages for species enumeration. Analysis and interpretation will focus on (a) changes in diatom:phaeocystis ratios as well as species composition of the diatom community and what is driving it; (b) changes in $\delta^{13}C$ of POC and whether this is correlated with changes in phytoplankton assemblages (AA);
4) To collect further box cores from Marguerite Bay for sediment and opal analysis (KH, AA & RG);
5) To assist with recovery and redeployment of the Marguerite Bay sediment traps (KH, AA & RG).

Field personnel:

At Rothera – K. R. Hendry, A. Annett
On the RRS *James Clark Ross* (cruise JR 155) – K. R. Hendry, A. Annett, R. Ganeshram

Fieldwork

Despite delays to the season, AA and KRH arrived in Rothera in late November. In late November to December, there were a total of three sea-ice sampling events and two open water sampling events, one at 15m and one depth profile of samples at 0, 5, 10, 15 and 25m. The samples were filtered and preserved in the Bonner Laboratories at Rothera Research Station. A sediment sample was collected from Hangar Cove. In addition, twelve brine samples collected during winter 2006 by Helen Rossetti were thawed, filtered and preserved (KRH).

Although it was not originally in the plan, delays in leaving Rothera allowed KRH to participate in box coring with RG and AA during the RRS *James Clark Ross* cruise JR155. Three box cores were collected and subcored from near the Marguerite Bay mooring sites. The subcores were sectioned on board. The shallow mooring sediment traps were successfully recovered; the deeper mooring was not recovered.

KRH and RG flew out of Rothera in late December 2006 to Stanley, and finally arrived in the UK via South America. AA remained in Rothera until February and carried out 9 further sampling events including 5 depth profiles.

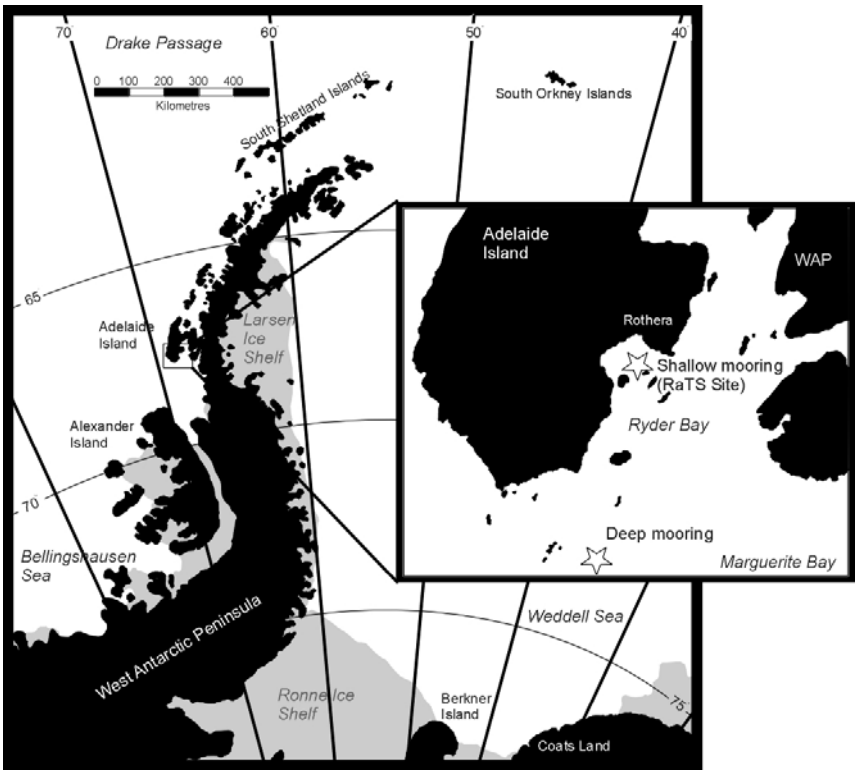

Figure 1: Map of the field area. Water samples were pumped from depth through acid-cleaned silicon tubing deployed off a small boat in Ryder Bay at the Rothera Oceanographic and Biological Time-Series (RaTS) site. Moorings were recovered and redeployed from the "shallow" site (near the RaTS site) and the "deep" site. Box cores were collected near the two mooring sites.

Laboratory analysis:

Stable isotope analysis is being carried out on brine, seawater, and particulate samples at East Kilbride (DSC, AA). Barium analysis (ICP-OES) and XRD are being carried out at the University of Edinburgh (DSC). Cell enumeration is being carried out at the University of Edinburgh (AA).

Trace metal analysis (Cd and Zn) was carried out on the brine (Figure) and seawater samples (Figure), using the same method as for previous seasons (KRH).

Preliminary results from AFI4-02:

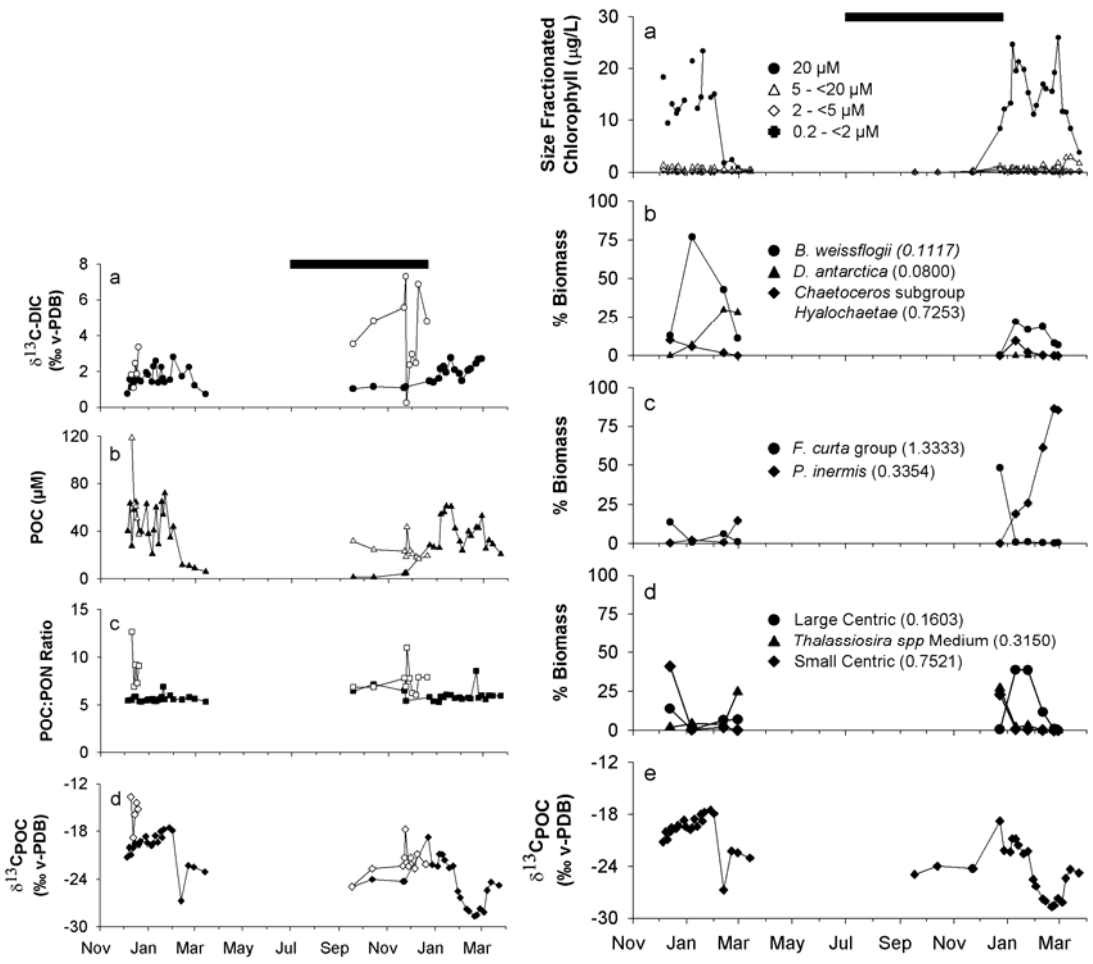

Figure 2: Particulate organic carbon (POC) isotopic composition, dissolved organic carbon (DIC) isotopic composition and population structure for Ryder Bay 2004-2006. The black bar shows persistent sea-ice coverage (Carson et al., in review).

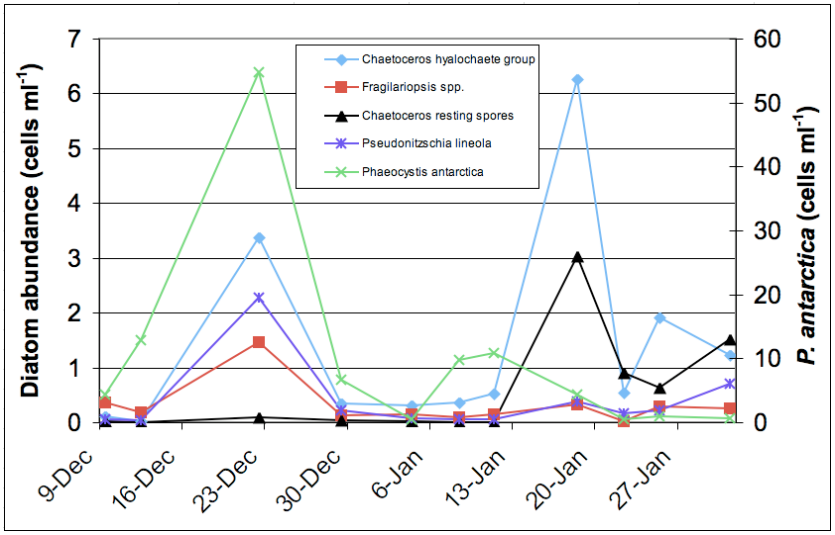

Figure 3: Cell enumeration for 2006-2007 (Annett, unpublished)

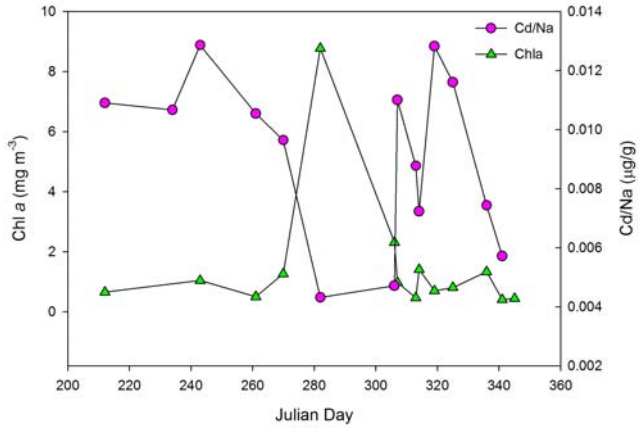

Figure 4: An example of micronutrient data from sea-ice brine collected in 2006. Cadmium, a biologically important trace metal, is taken up by phytoplankton living in the brine channels (quantified by the algal pigment, chlorophyll a).

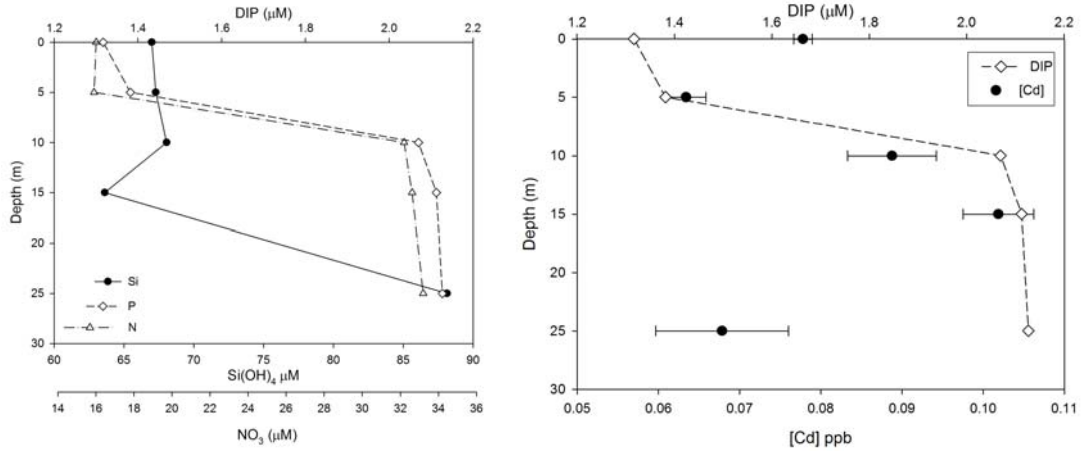

Figure 5: Results from the 25m depth profile carried out in December 2006 showing a) macronutrients N, P and Si and b) Cadmium. Error bars show ±1σ. (Hendry et al., *in prep.*)

Publications and presentations arising:

Carson, D. S., Annett, A. L., Ganeshram, R. S., Fallick, A. E. & Clarke, A. Factors influencing $\delta^{13}C$ of suspended organic matter in the Antarctic coastal sea ice environment. Geophysical Research Letters (in review)

Carson, D. S. & Ganeshram, R. S. (2006) Reconstructing biogeochemical processes in the nearshore Antarctic sea ice environment. Geochimica et Cosmochimica Acta, 18, doi:10.1016/j.gca.2006.06.084.

Hendry, K.R. & Rickaby, R.E.M. A novel proxy approach to assess recent glacier meltwater flux from the West Antarctic Peninsula, Geology (in review)

Hendry, K.R., Weston, K. & Rickaby, R.E.M. (in prep. for Environmental Chemistry) Seasonal variation in uptake of dissolved metals from seawater in a coastal Antarctic environment

Hendry, K.R., Carson, D.S., Meredith, M., Rickaby, R.E.M. & Elderfield, H. (in prep.) Seasonal variation in geochemical properties of planktonic foraminifera from a time series sediment trap study

Carson, D. S. & Ganeshram, R. S. (2007) Biogeochemical controls on paleoproductivity proxies: The Antarctic sea ice environment. *(Poster presented at the AGU Joint Assembly, 2007, Acapulco, Mexico)*

Hendry, K.R. & Rickaby, R.E.M. (2007) A novel proxy approach to assess recent glacier meltwater flux from the West Antarctic Peninsula *(Oral presentation at 9th International Conference in Paleoceanography, Shanghai, 2007)*

Hendry, K.R. & Rickaby, R.E.M. (2007) Cadmium and phosphate in coastal Antarctic waters: is there a global relationship? Geophysical Research Abstracts (9) 00749 *(Oral presentation at European Geophysical Union Assembly, Vienna, 2007)*

Acknowledgments:

We would like to acknowledge the help of the Rothera Marine Assistants, Helen Rossetti and Alison Massey; AFI4-13 members Mark Brandon, Tim Jickells and Keith Weston; divers Matt Brown and Dan Smale; boatmen Bernard and Jim; the Base Commander and all the staff at Rothera Research Station for logistics help and support. Many thanks also to the Master and crew of the RRS *James Clark Ross* for their help and hospitality.