

## SCAR Fellowship Report 2013/2014



UNIVERSITY OF  
BIRMINGHAM

### **Late Oligocene to Pliocene Antarctic climate and oceanographic reconstructions using molecular and isotopic biomarker proxies**

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#### **Host**

Dr. James Bendle, University of Birmingham, United Kingdom

#### **Introduction**

Atmospheric CO<sub>2</sub> reconstructions ranged between 500 and 300ppm across intervals of significant climate and environmental change from the late Oligocene to the Pliocene, indicating that major climate thresholds were passed during periods of relatively modest CO<sub>2</sub> variation<sup>1,2,3,4</sup>. This implies the Earth's climate system is highly sensitive to feedbacks associated with changes in global ice sheet and sea-ice extent, as well as terrestrial and marine ecosystems. This study focuses on several key intervals and events during the evolution of the Antarctic Ice Sheet, in particular the Oligocene/Miocene boundary, at which the East Antarctic Ice Sheet expanded to close to or greater than present day volume<sup>5,6,7</sup>, and the Mid-Miocene Climate Optimum (MMCO ~17-15 Ma), a period of global warmth and moderately elevated CO<sub>2</sub> (350->500 ppm) which was subsequently followed by rapid cooling at 14-13.5 Ma<sup>4,8</sup>. Modelling of global climate, vegetation, and ice sheet extent has tried to reconcile the various feedbacks that led to these events. However, modelling studies are limited by a lack of geological data of hydrological processes and high latitude temperatures.

This study will produce new proxy climate reconstructions using terrestrial and marine organic biomarkers from Antarctic drill cores and outcrop samples that span from the Oligocene/Miocene boundary up to the Pliocene Warm Period, including within that the MMCO, and the subsequent cooling event that followed. Variations in *n*-alkane abundances and concentrations will be used to identify changes in the distribution of terrestrial vegetation. These and other biomarkers will be analysed to determine biomarker syngeneity and abundances across a range of lithologies. Bacterial ether-lipids will be analysed to determine terrestrial mean annual temperatures and soil pH (via the

methylation and cyclisation indexes of branched tetraethers – MBT and CBT, respectively). Tetraether-lipids of crenarchaeota found in marine sediments sampled from continental shelves around Antarctica will be used to derive sea surface temperatures using the TEX<sub>86</sub> index.

### **Outcomes of Fellowship**

This fellowship supported a visit to the University of Birmingham (UoB), UK in October/November 2013, funded a second visit to UoB in June/July 2014 and enabled me to present at the SCAR Open Sciences Conference in Auckland, New Zealand in August 2014. The laboratory techniques used in the methods described in the introduction are currently not performed in New Zealand, and so a key outcome of this fellowship has been for me to not only process and analyse samples at UoB, but also to learn the techniques and bring that knowledge home to New Zealand. This knowledge enabled us to put forward a funding proposal to purchase laboratory equipment which will allow the development of a biomarker capability in New Zealand, and this funding has now been approved.

In October/November 2013 I extracted, separated and performed initial gas chromatography analysis on 115 marine and terrestrial samples from across Antarctica. In June 2014, I returned to UoB to discuss and interpret initial results with Dr Bendle, and prepare a second focused sample run. Samples have also been prepared for compound specific carbon and hydrogen isotopes, which will be analysed when the GC-irMS at UoB is available in late 2014/early 2015. Samples were also filtered and prepared for GDGT analysis, which is being performed at Yale University, US in late 2014. I presented a poster with preliminary data from work achieved at UoB at the SCAR Open Sciences Conference in Auckland in August 2014, and am now in the process of preparing the first of several manuscripts which will be based on this data.

### **Financial Statement**

Amount awarded: \$US 11,000, which converted to \$NZ 13, 515.

\$NZ 900 was spent on flights, accommodation and expenses for SCAR Open Sciences Conference. \$NZ 5,950 was spent on accommodation and expenses in Birmingham for visits in Oct/Nov 2013 and June/July 2013. Return flights to the UK for June/July 2014 were \$3,700. The remainder of the funds went towards laboratory costs and consumables at the UoB.

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