Deep-Sea Antarctic Ecosystems 1 Million Years Ago: Trace Fossils in the Sediment Record as Analogs for Modern Day Ecosystem Dynamics

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Introduction

Climate change is affecting all aspects of biodiversity on Earth. Warming temperatures are drastically affecting oceanic ecosystems, knowing how they will be affected as temperatures increase is extremely valuable information. By looking at sediment records it is possible to conclude what the global average temperatures were millions of years ago; from that you can observe how organisms reacted to oscillating temperature intervals. The aim of this project was to analyze if there was a difference in the amount of bioturbation 1 million years ago (MIS 31) in the Dove Basin (Drake Passage, Scotia Sea) as the temperature fluctuated

Background

The history of the ocean can be understood through analyzing sediment cores from ocean drilling programs. The data from this project came from IODP Expedition 382. This expedition drilled in the Dove Basin which is within the Drake Passage in the Scotia Sea. The Drake passage in the area between the southern tip of South America and Antarctica.

Marine Isotope 31 (MIS 31) is a time interval approximately 1 million years ago. This interval is seen as an analog to modern day Antarctica because it is the most recent geological warm period and the temperatures during MIS 31 are similar to modern Antarctic temperatures.

A fundamental aspect of this project was being able to analyze images from warm and cool intervals in MIS 31. This was possible due to a thorough data set of diatom abundance during MIS 31(Warnock et, al.) Warm and cool periods were discerned by the abundance of open ocean diatoms. If there were more open ocean diatoms, it was assumed that this means there was less ice cove and subsequently warmer temperatures. If there were fewer open ocean diatoms, it was assumed that there was more ice cover and therefore cooler temperatures. Diatom abundance is also linked to productivity. If there is more primary productivity we hypothesized that there would be more bioturbation.

Once images from warm and cool periods were obtained, the bioturbation was analyzed. Bioturbation is the reworking of soil and sediment by plants and animals. Examples of this would be footprints or borrows.

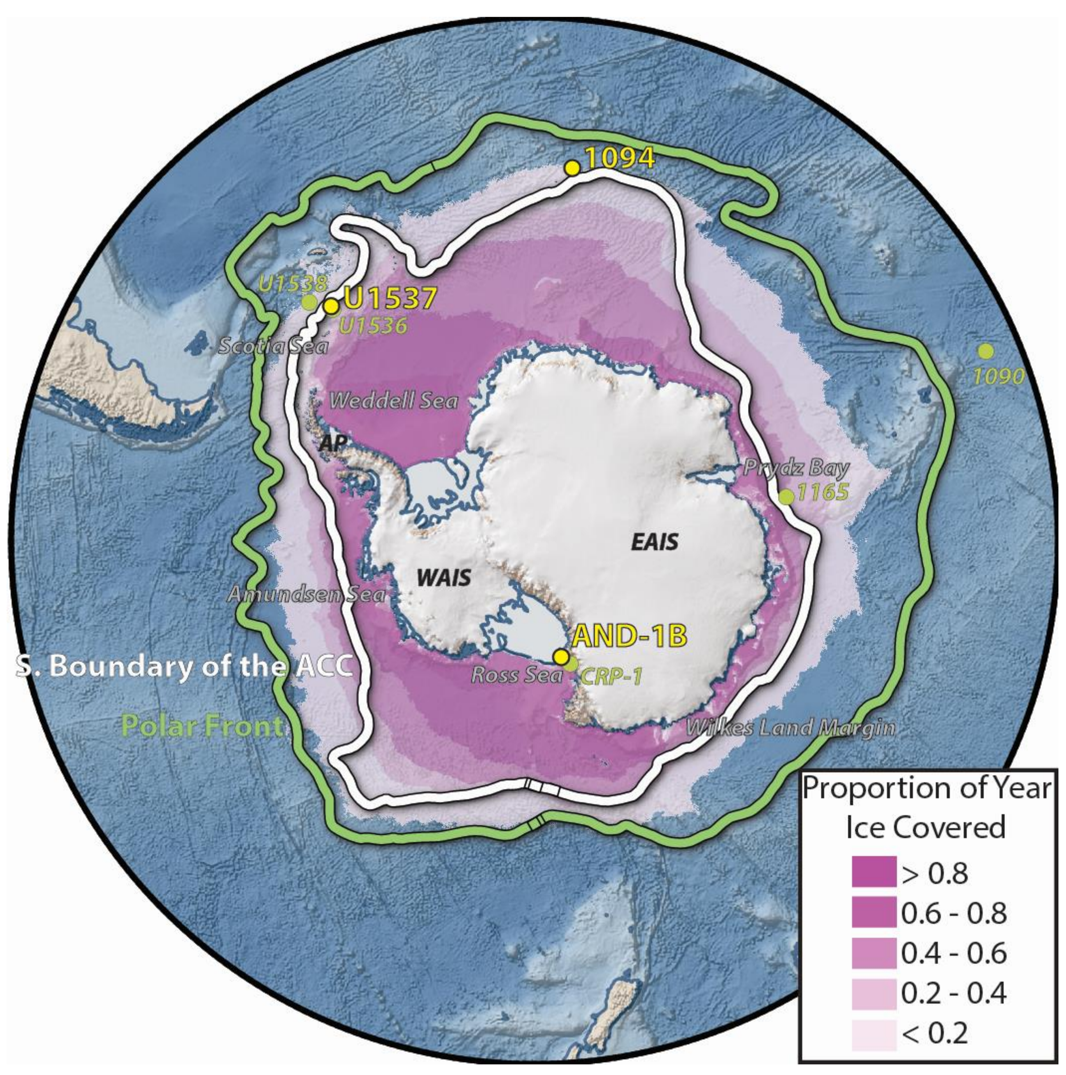

Figure 1. A map of Antarctica specifying IODP Expedition 382 drilling sites. Split core images from site 1537 were surveyed for this project. *Warnock et, al. in review*

Methods

- Six images of split cores were obtained, three correlating to a warm period in MIS 31, 3 correlating to a cool period in MIS 31.
  - This was done by cross referencing points on a graph displaying diatom fluctuations and time with a data set linking core depth and time. (Warnock et, al.)
- Once the images were obtained, they were modified in photoshop to enhance the visibility of bioturbation.
- The initial adjustments made were adjusting the brightness and contrast, levels, and vibrance. On average the brightness adjustment was 150, and contrast was -50. On average the level adjustment was 255 for white, 140 for black and .67 for gray. The average brightness adjustment was -52. (Dorador et, al. 2014)
- Once the initial adjustments were made, the bioturbation was selected using the magic wand tool.
- The tolerance was adjusted between a range of 5 to 30.
- The bioturbation percentages were determined by calculating the percentage of selected pixels compared to the total number of pixels in the image

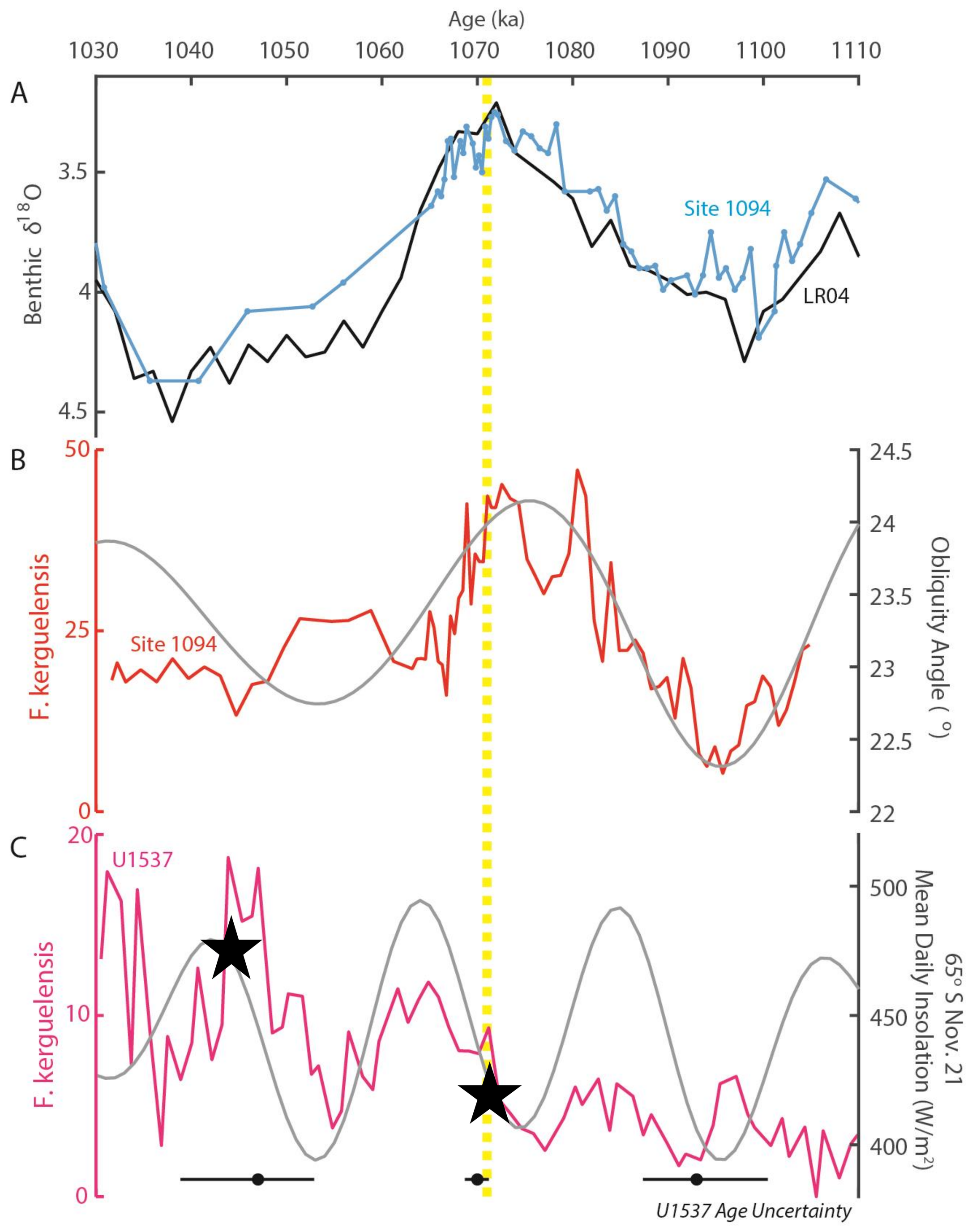

Figure 2. Data indicating F. kerguelensis (open ocean diatom) fluctuations matching 20,000-year (precession) temperature oscillations (Warnock et, al.). C is the focus because the data is from dill site 1537. The Black stars indicate the two intervals' images were selected from, the star on the left is the warm period and the star on the right is the cool period. The pink line is the abundance of F. kerguelensis, the gray line is the mean daily insolation.

Preliminary Results

The results of the selection of bioturbation in the enhanced split core images was that on average, the percent bioturbation in the images in cooler periods ranged from 2% to 2.1%. In warmer periods, the percent bioturbation ranged from 2% to 4%. Due to this area being considered a low bioturbated area before this analysis, this difference is substantial enough that it would garner continued research on the subject

Split Core Images

Figure 3. Original image of a split core

Figure 4. Split core image after the contrast, brightness, levels and vibrance had been adjusted in Adobe Photoshop

Figure 5. Split core images after the bioturbation had been selected for with the Magic Wand Tool

Discussion/Results

Due to this area being a low bioturbated area, any difference in the results are note worthy. **These results show that when there were more open ocean diatoms and more primary productivity in the ocean there were more, active organisms on the sea floor**.

Future Research with X-Rays

An interesting next step would be to analyze the abundance of all bioturbation at Site 1537. A third variable could be added to the graph seen in Figure 2. A comparison of diatoms, bioturbation and mean daily insolation would be distinct conformation of the link between insolation and oceanic productivity. Another avenue that should be pursued is the use of X-Rays for analyzing bioturbation. Split cores only show you what is on the split surface but X-Rays make it possible to see below the surface. Seeing more than the surface allow a 3-D view, and hence a more complete identification of bioturbation (borrows, casings etc.)

Figure 6. An X-Ray image of the split core image shown above

References and Acknowledgements

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