

# **An Investigation of Antarctic Circumpolar Current Strength in Response to Changes in Climate**

**Presented by  
Matt Laffin**

# Presentation Outline

Introduction to Marine Sediment as a Proxy

Introduction to McCave paper and inference of current strength

Discuss Sediment Core site

Discuss sediment deposition and oceanography of the region

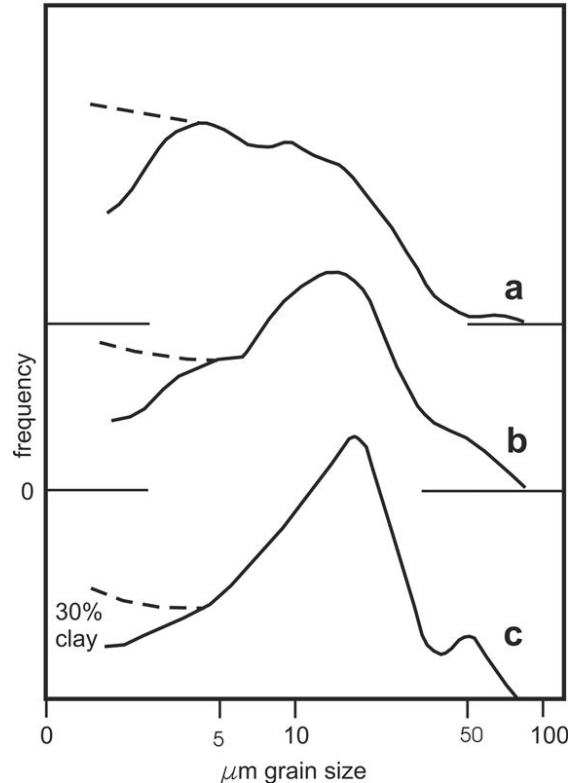
Discuss sorting sediment process and Particle Size Analyzer

Discussion of results



- Marine sediment cores are an excellent resource to determine information about the past.
- As climatic changes occur so do changes in sediment transportation and deposition.
  - Sedimentation rates
  - Temperature
  - Biology

# How can we determine past ocean current strength using marine sediment?



## McCave et al, 1995

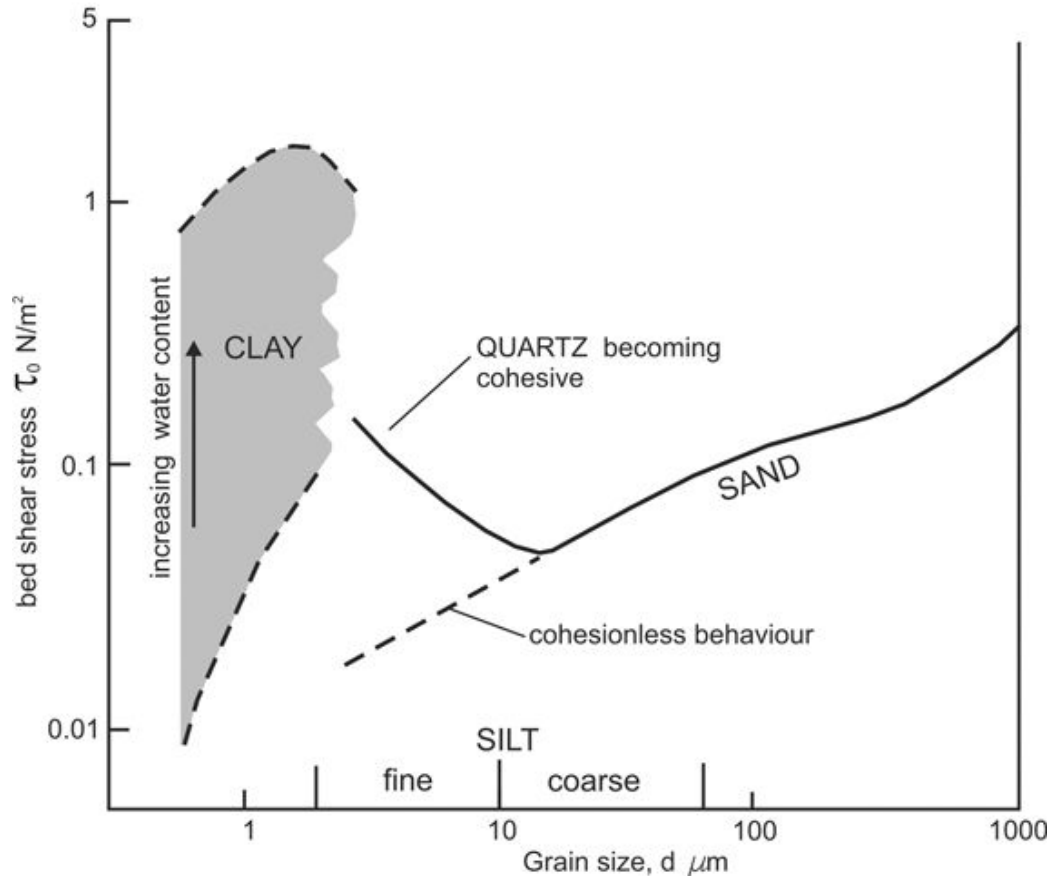
- “Sortable silt” flow speed proxy
- Size distributions of sediment from the Nova Scotian Rise measured by Coulter Counter

(a) Dominant 4  $\mu\text{m}$  and weak 10  $\mu\text{m}$  mode under slow currents

(b) Silt signature after moderate currents of 5–10  $\text{cm s}^{-1}$

(c) Pronounced mode in the part of the silt spectrum  $>10 \mu\text{m}$  after strong currents (10–15  $\text{cm s}^{-1}$ )

# Complications to determine current strength

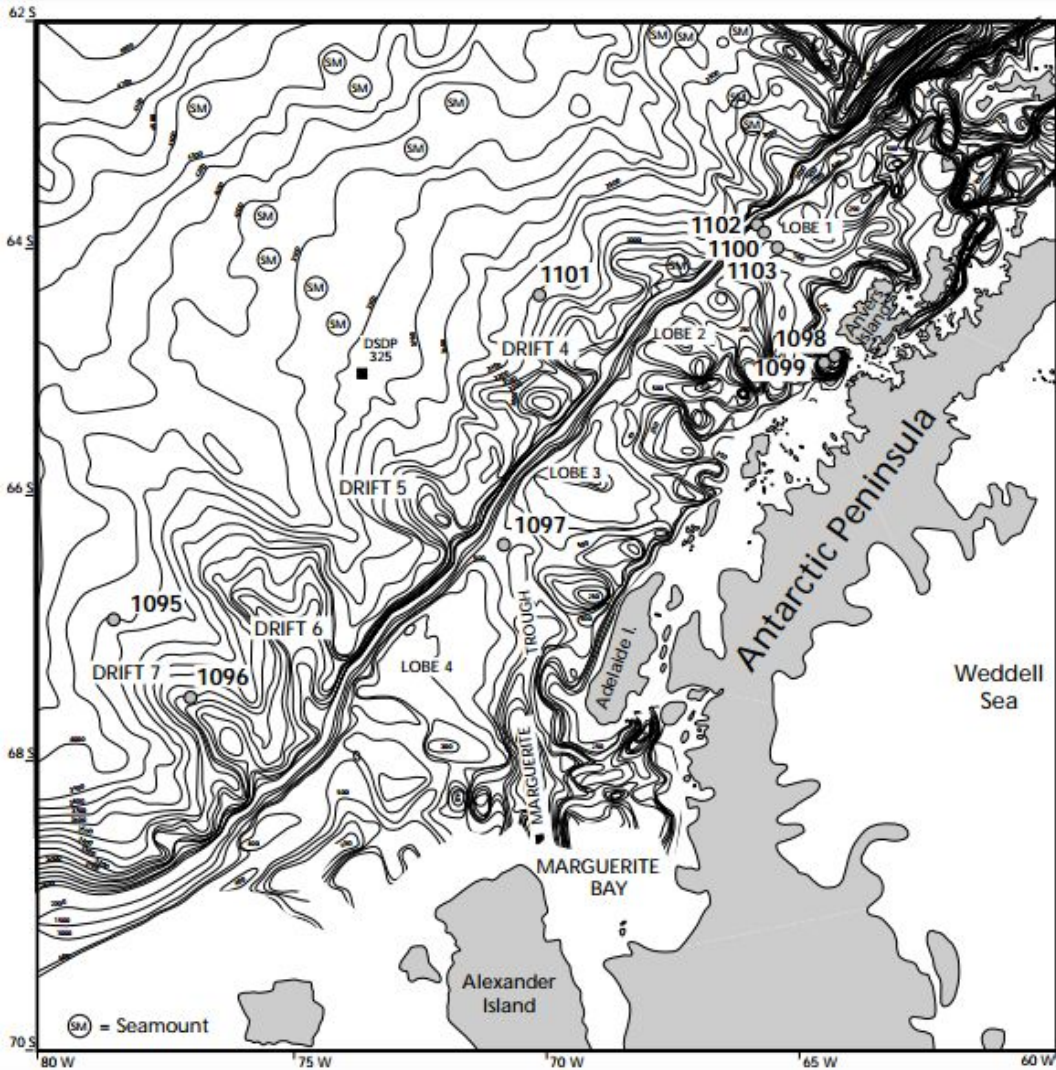


- Particles  $< 10 \mu\text{m}$  are subject to electrostatic forces which bind them
- The mean of 10–63  $\mu\text{m}$  sortable silt denoted as  $\overline{ss}$  is a more sensitive indicator of flow speed.





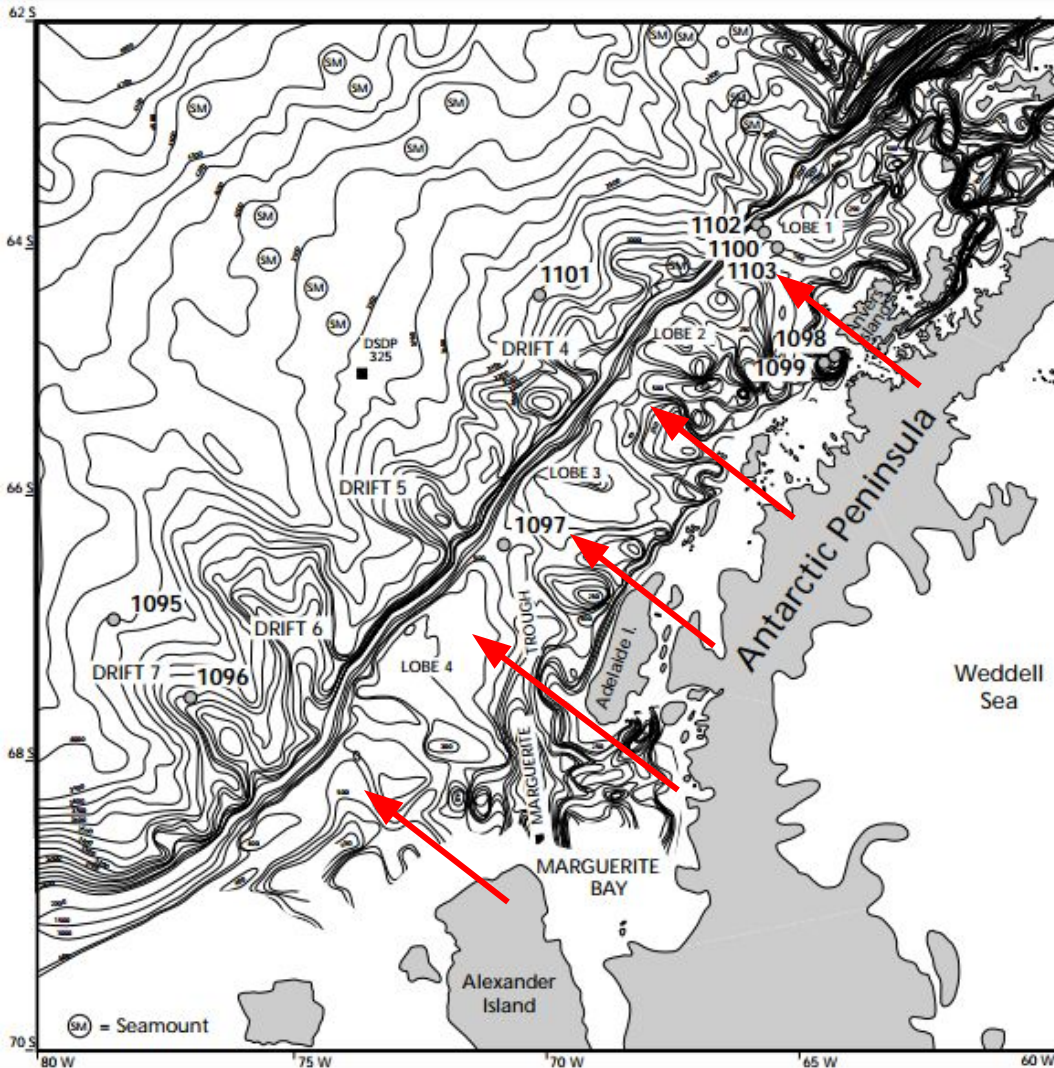
# Depositional Environment



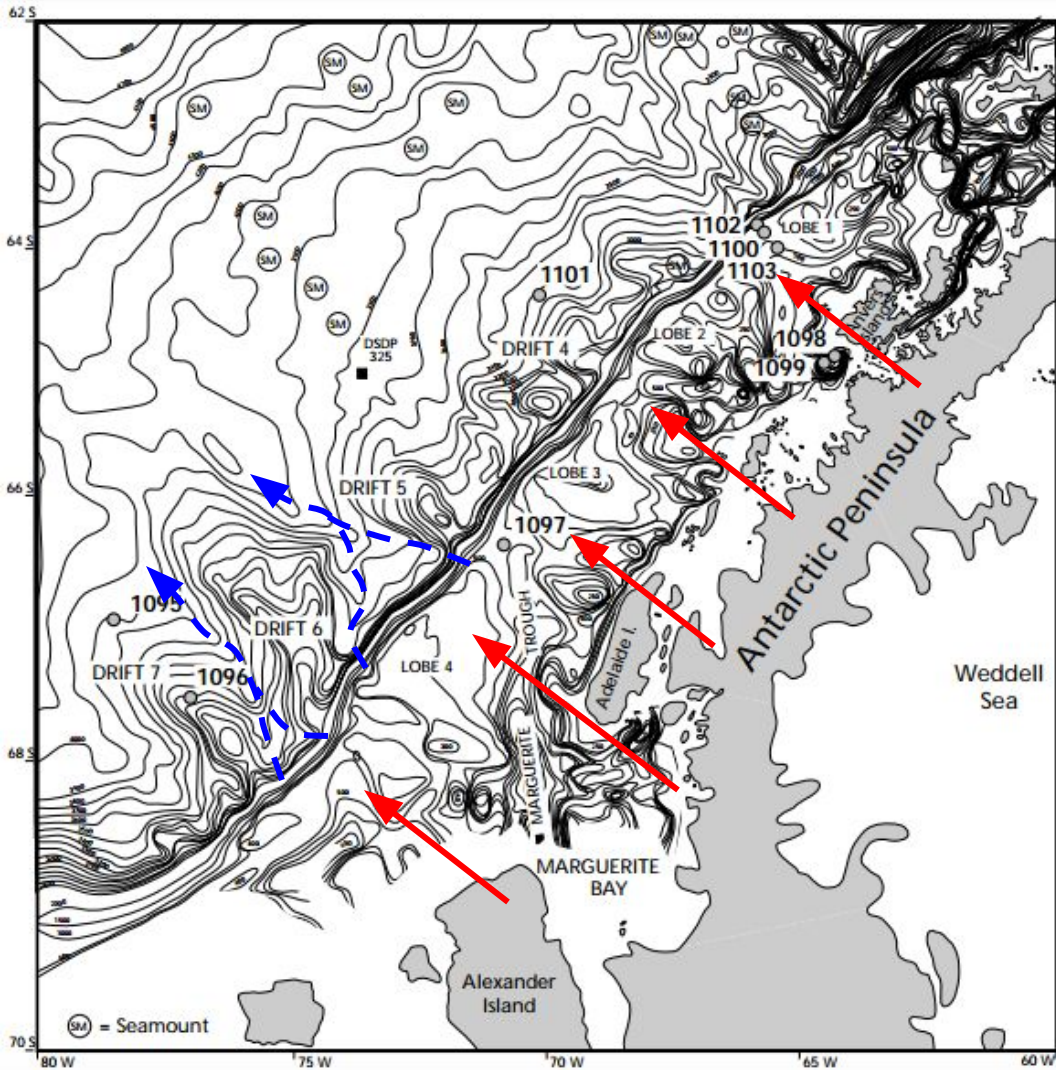


# Depositional Environment

- Sediment is eroded and transported by ice and runoff to the continental shelf

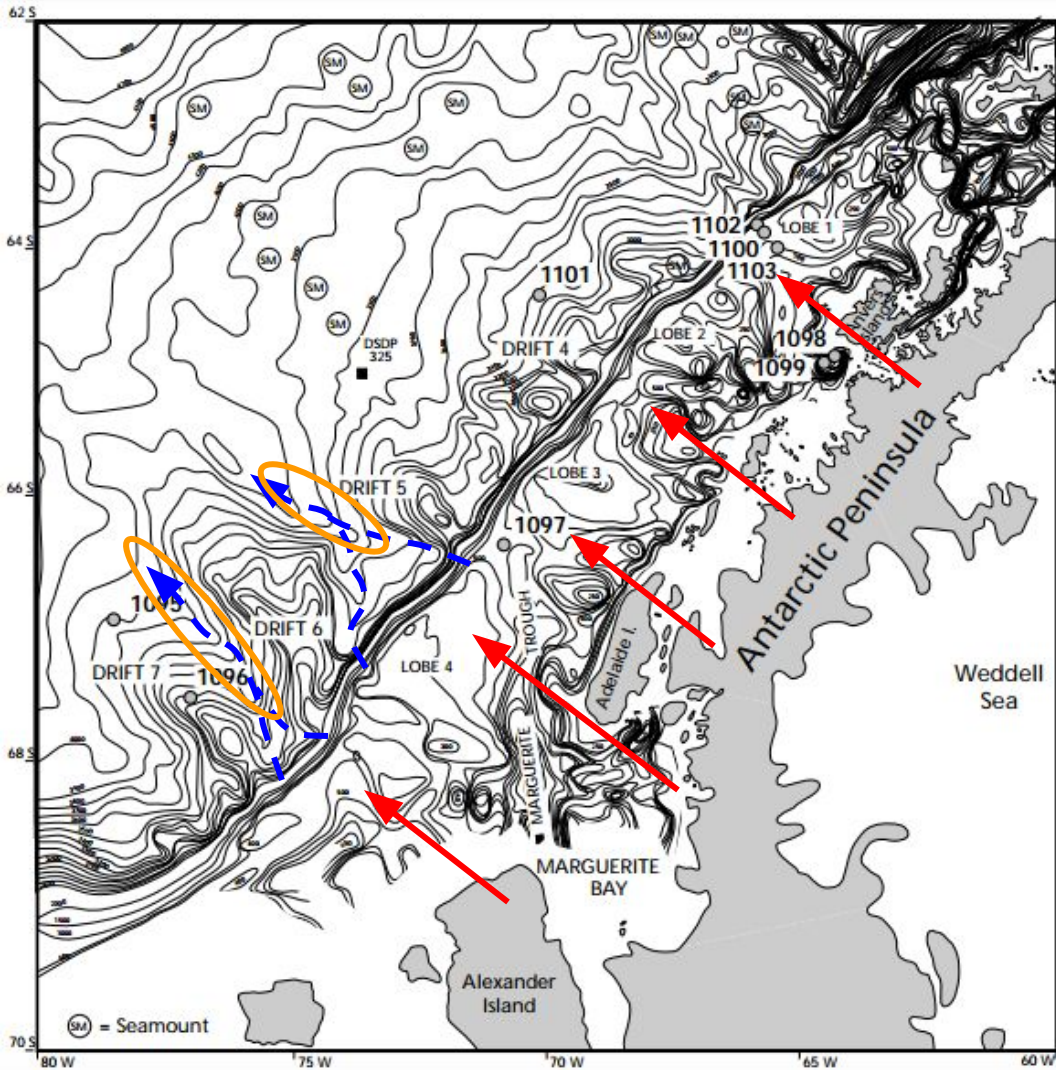






## Depositional Environment

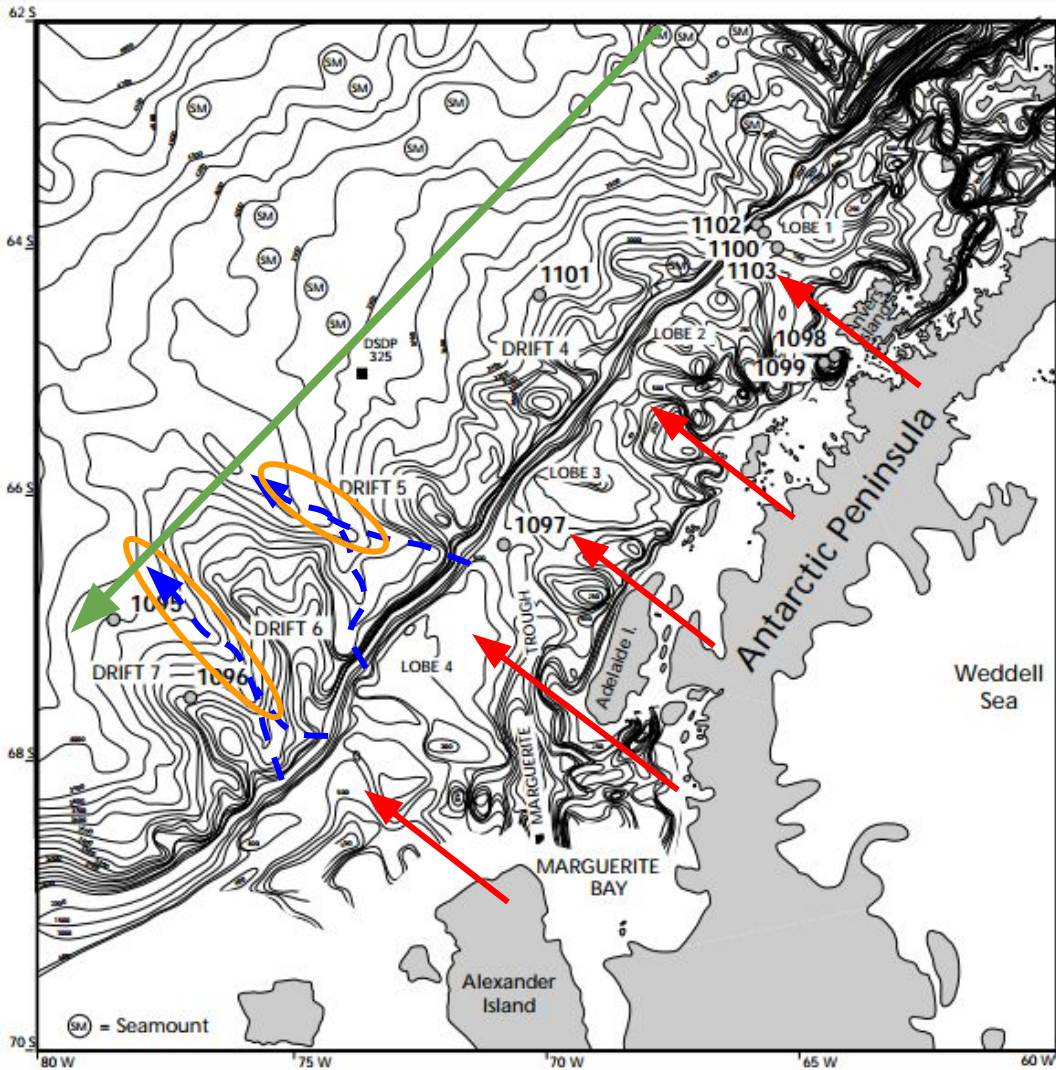
- Sediment is eroded and transported by ice and runoff to the continental shelf
- Continental Margin defined by Dendritic Channels
- Channels are maintained by turbidity currents



## Depositional Environment

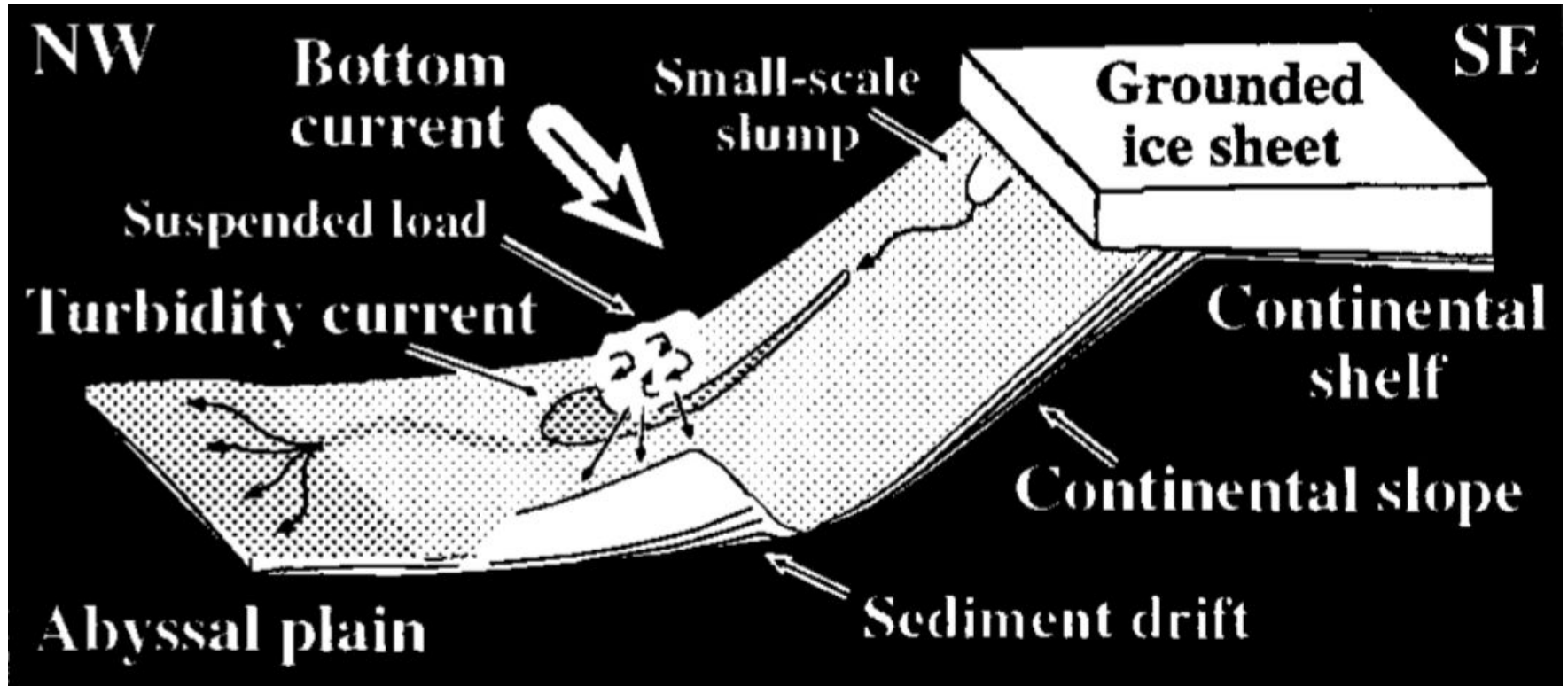
- Sediment is eroded and transported by ice and runoff to the continental shelf
- Continental Margin defined by Dendritic Channels
- Channels are maintained by turbidity currents
- As turbidity currents occur sand, silt, and clay size sediment becomes suspended in the water column





## Depositional Environment

- Sediment is eroded and transported by ice and runoff to the continental shelf
- Continental Margin defined by Dendritic Channels
- Channels are maintained by turbidity currents
- As turbidity currents occur sand, silt, and clay size sediment becomes suspended in the water column
- Sediment is entrained in overlaying ocean current and deposited mostly in the abyssal plain beyond the drifts.





# Site 1096

## Oceanography

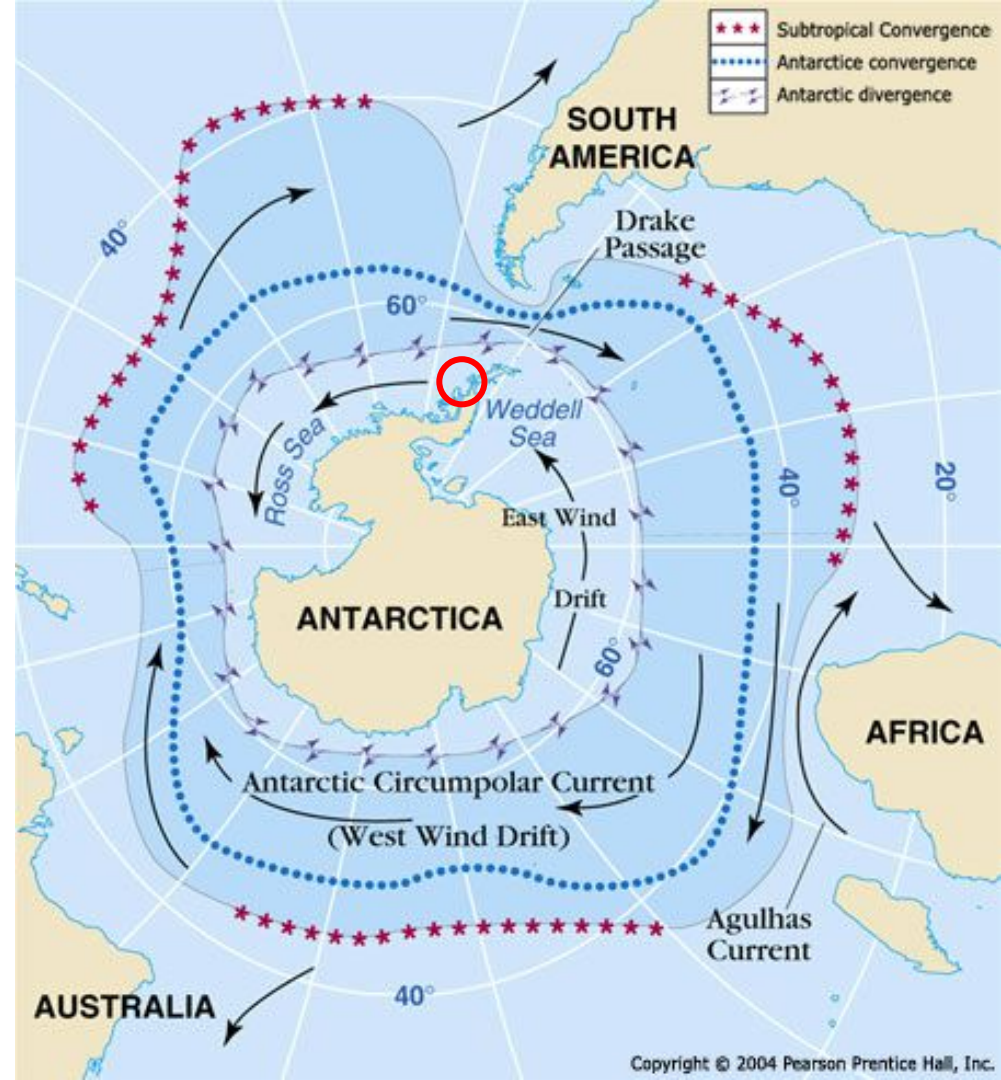
Antarctica is surrounded by the Antarctic Circumpolar Current (ACC)

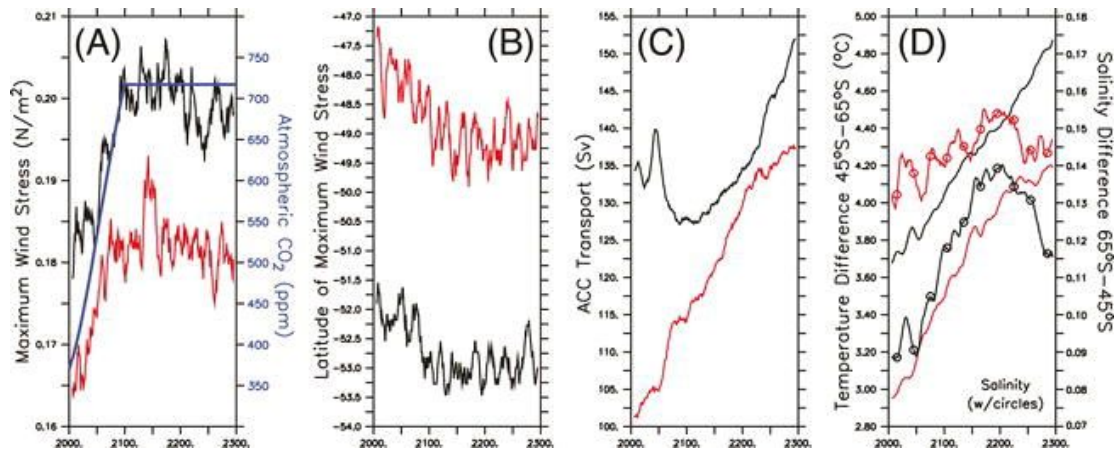
Two gyres are part of the physical oceanography system

- Weddell Gyre
- Ross Gyre

ACC is important to climate

- Isolates Antarctica
- Deep water gas exchange
- Current strength

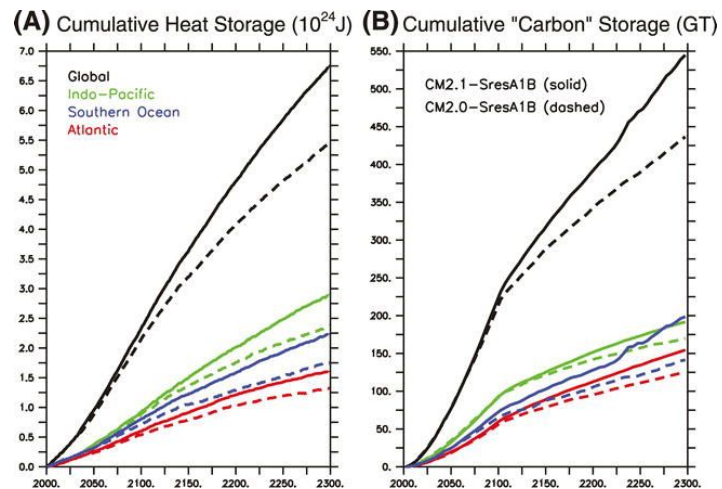




**Fig. 1.** Time series of (a) the maximum zonally averaged wind stress between  $70^\circ$  and  $30^\circ$  S, (b) the latitude of the maximum zonally averaged wind stress, (c) the strength of the ACC transport at Drake Passage, and (d) the mean temperature (solid) and salinity (solid with circles) differences (averaged globally from the surface to 2500-m depth) between  $65^\circ$  and  $45^\circ$  S. In (a)–(d), the black line is the result from the CM2.1 experiment and the red line is the result from the CM2.0 experiment. The blue line in (a) is the time history of atmospheric  $CO_2$  used to force both model runs..

## The Southern Hemisphere Westerlies in a Warming World

Russell et al, 2006



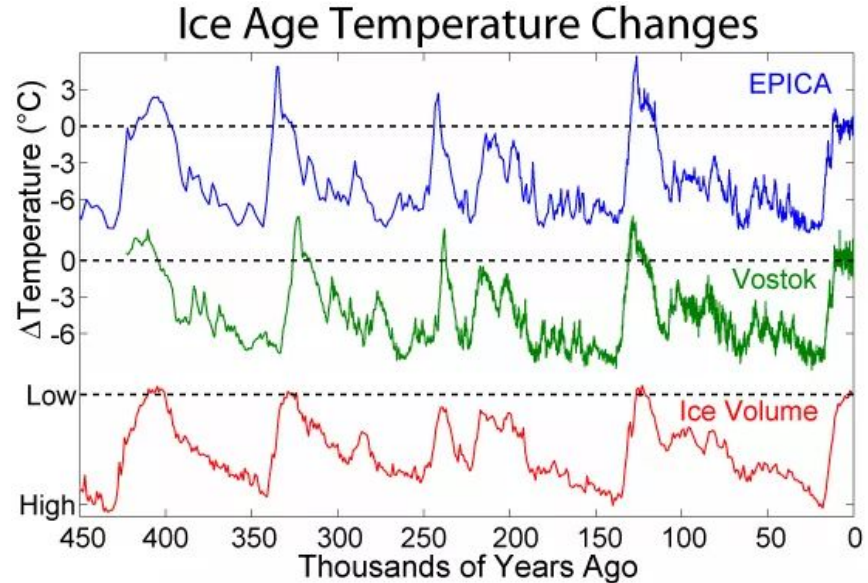
# Why Sample from present through MIS 5

MIS 5 was the last full interglacial period before the Holocene

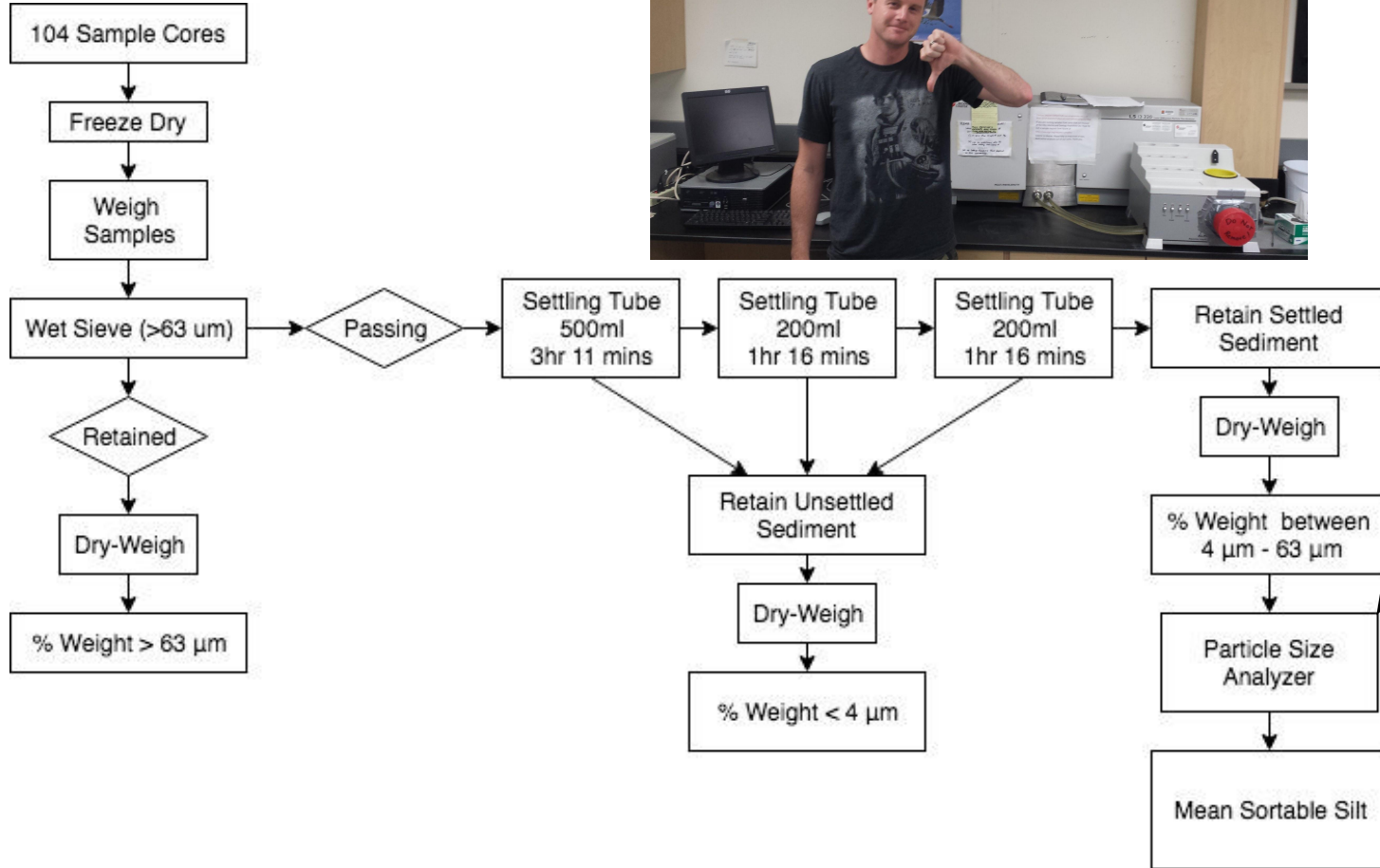
Mean global surface temperatures were 2 °C warmer

Mean sea level was 4-6 m higher

MIS 5e may be a good analogue for future climate

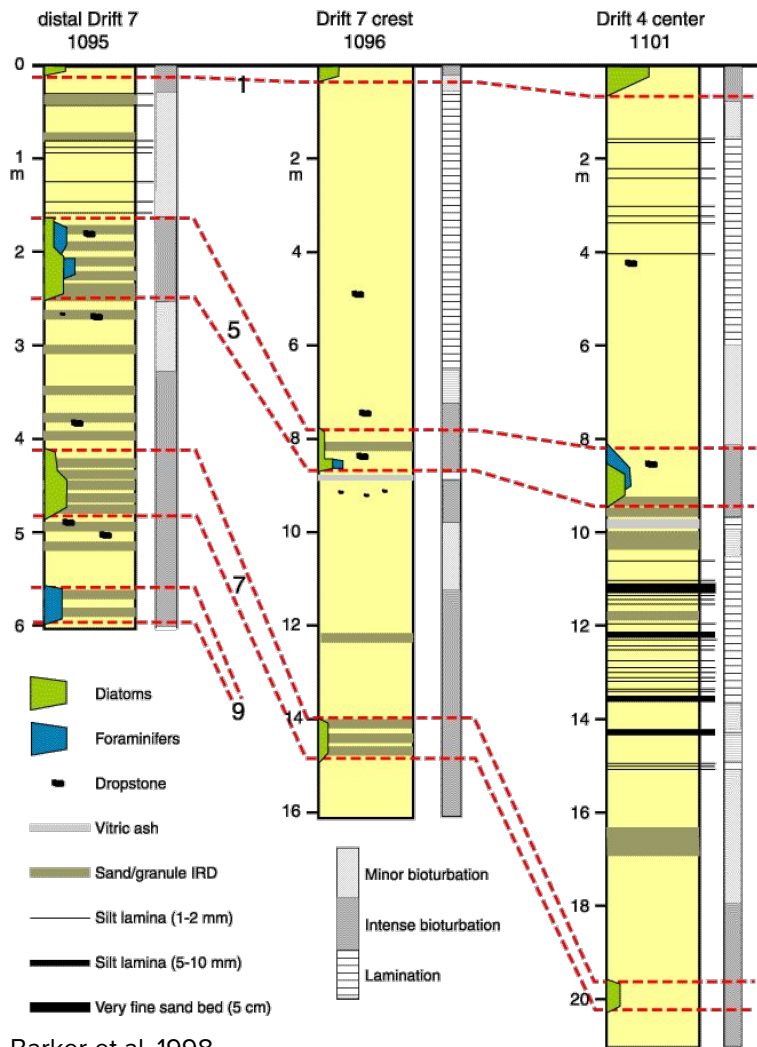


# Methods



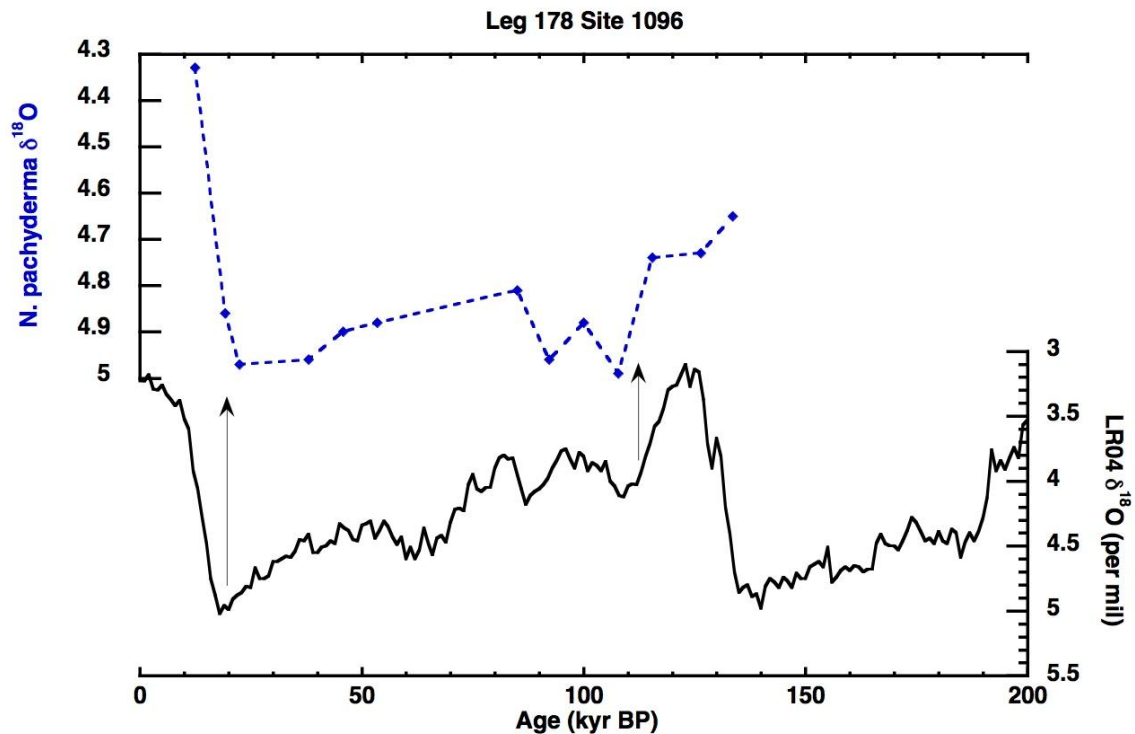
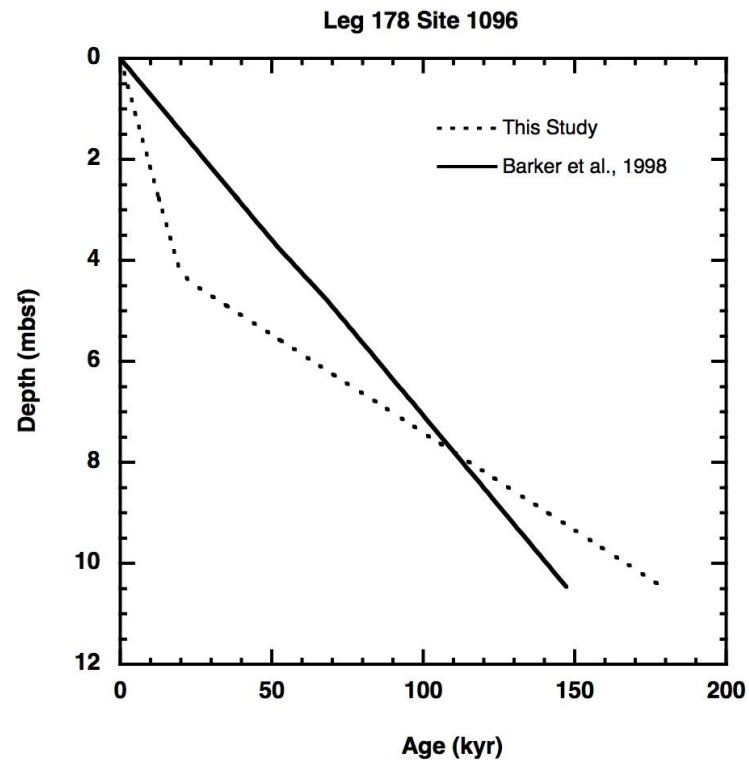


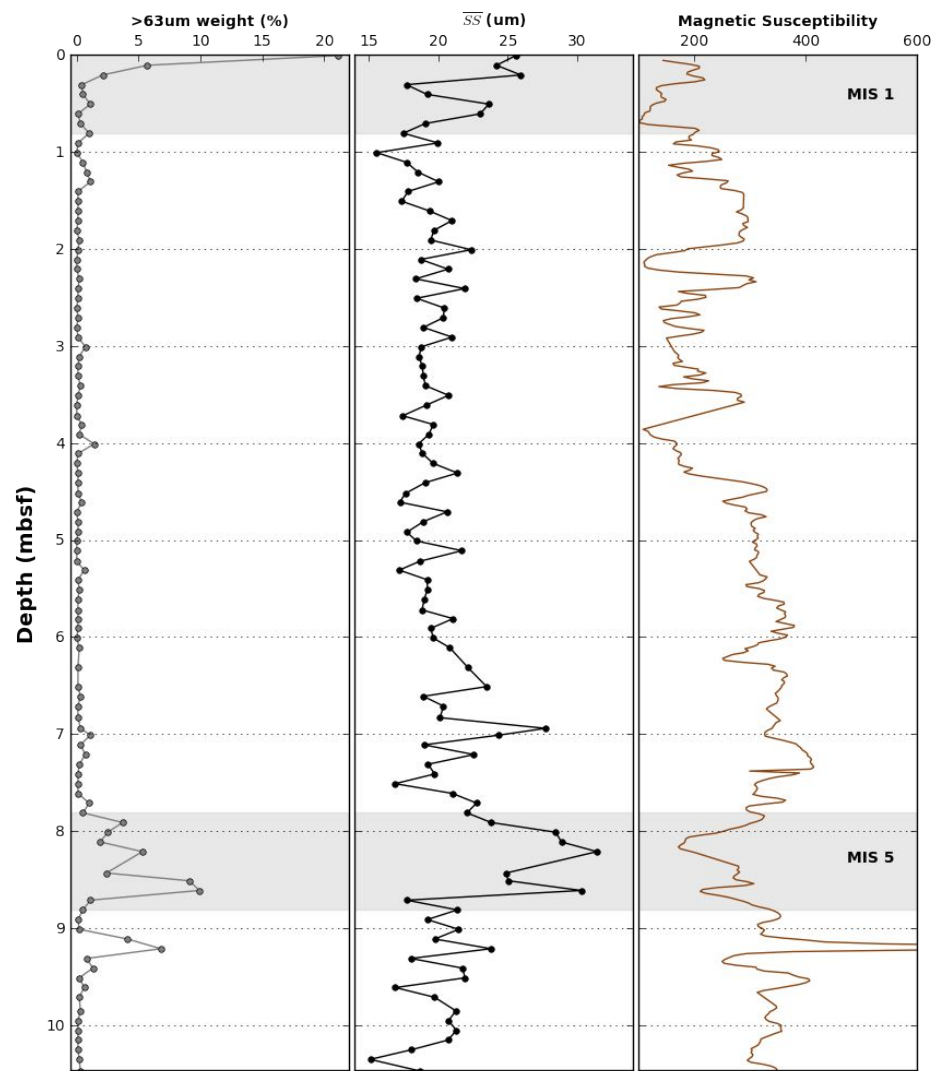
# Site 1096 Lithology



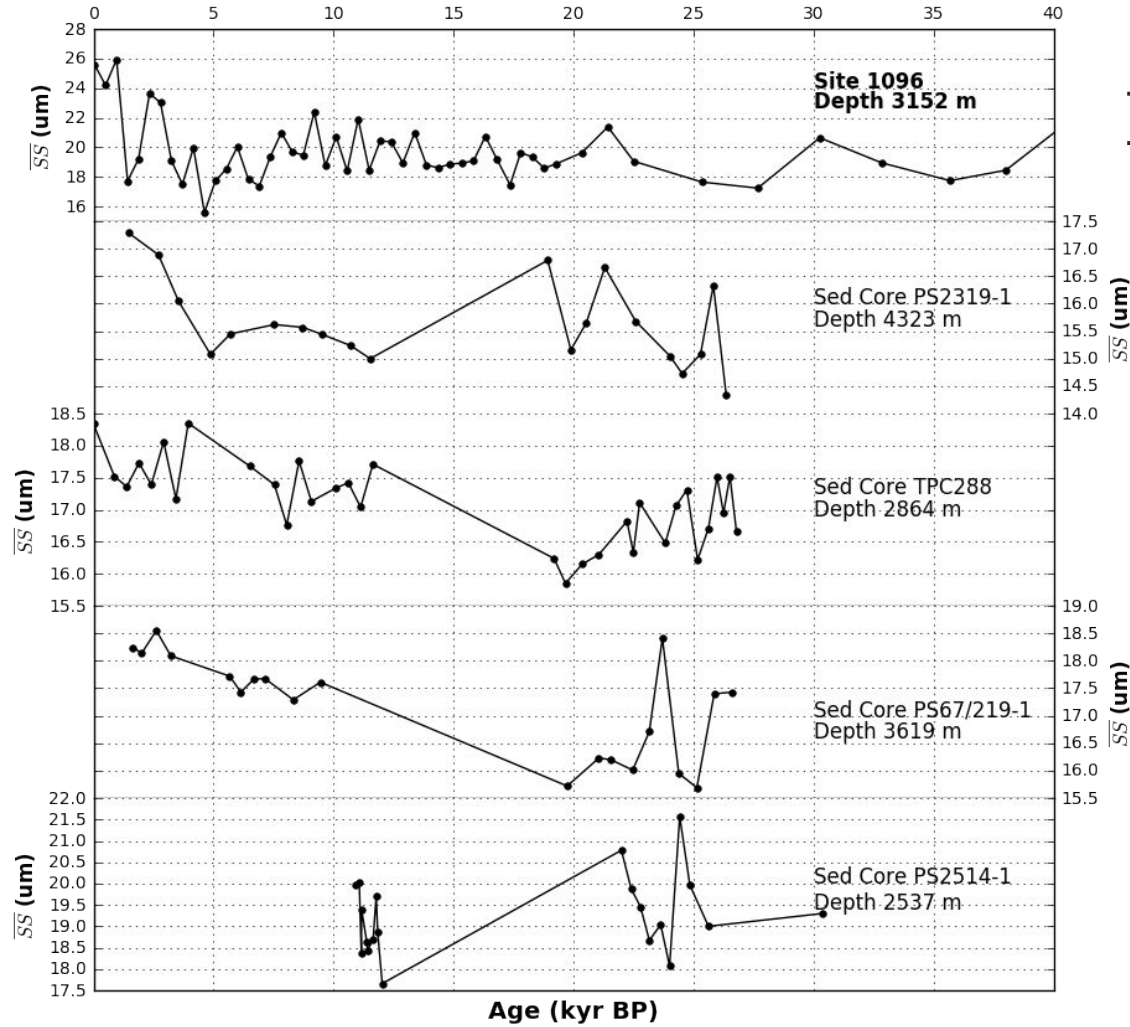
- Lamination is seen mostly during MIS 2, 3, and 4
- Intense and minor bioturbation seen currently and during MIS 5
- Interesting feature about drift formation
  - Accumulation seems to be more rapid during glacial periods as indicated in the thickness of MIS 1 and 5 compared to MIS 2, 3, and 4.

# Age Model

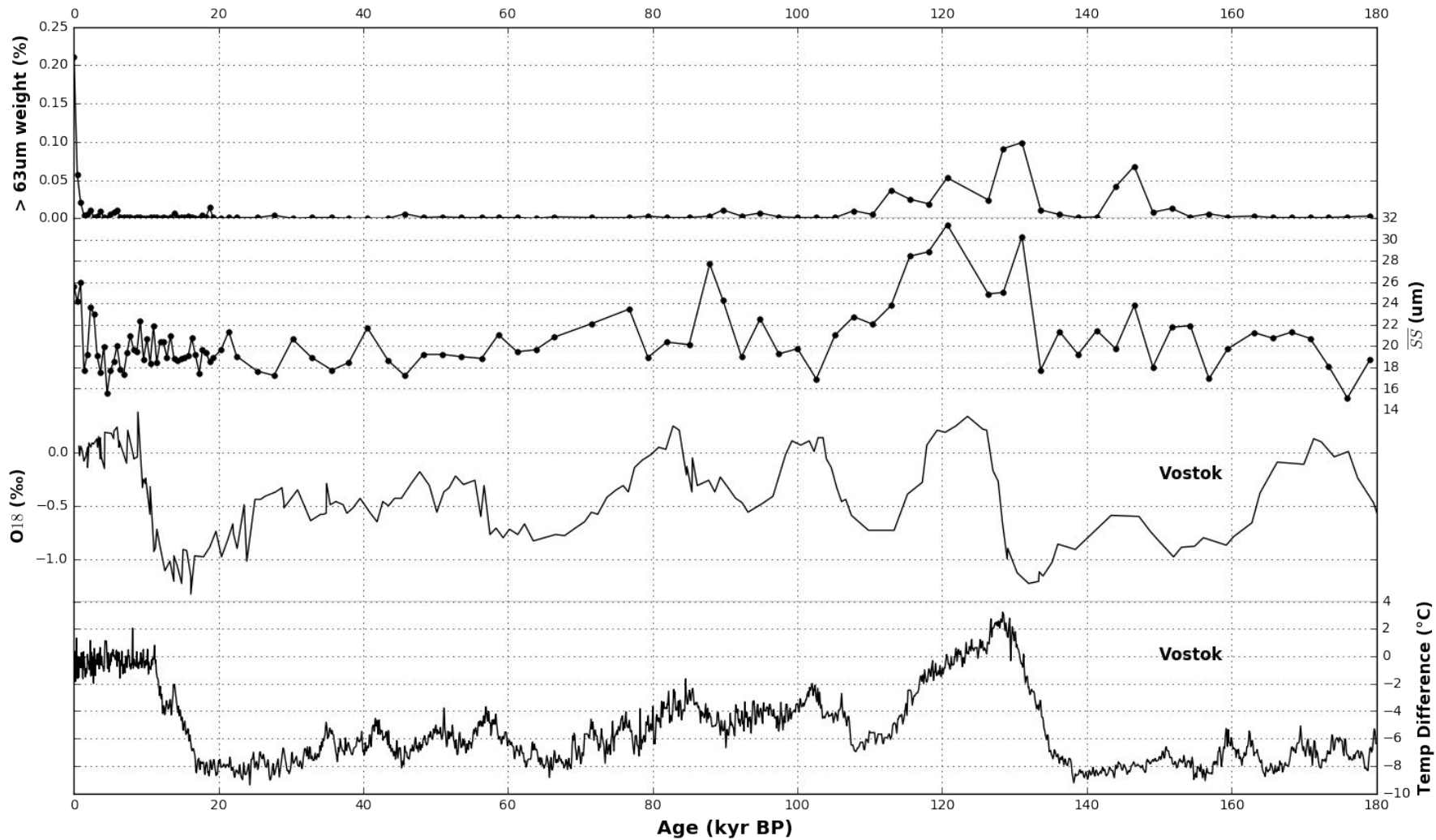




# Data Corroboration







# Take Home Points

Sediment core record from Drift 7, West of the Antarctic Peninsula

Records the current strength from present through MIS 5

MIS 5 had stronger current flow which may be analogue for today.

# Acknowledgments

Thank you to...

Maziet Cheseby  
Bran Black

Helpers who worked on the Isotopes for the age model.

Anders Carlson

Maureen Walczak