IODP – 751 Full

Ocean Ice Sheet Interactions and WAIS vulnerability

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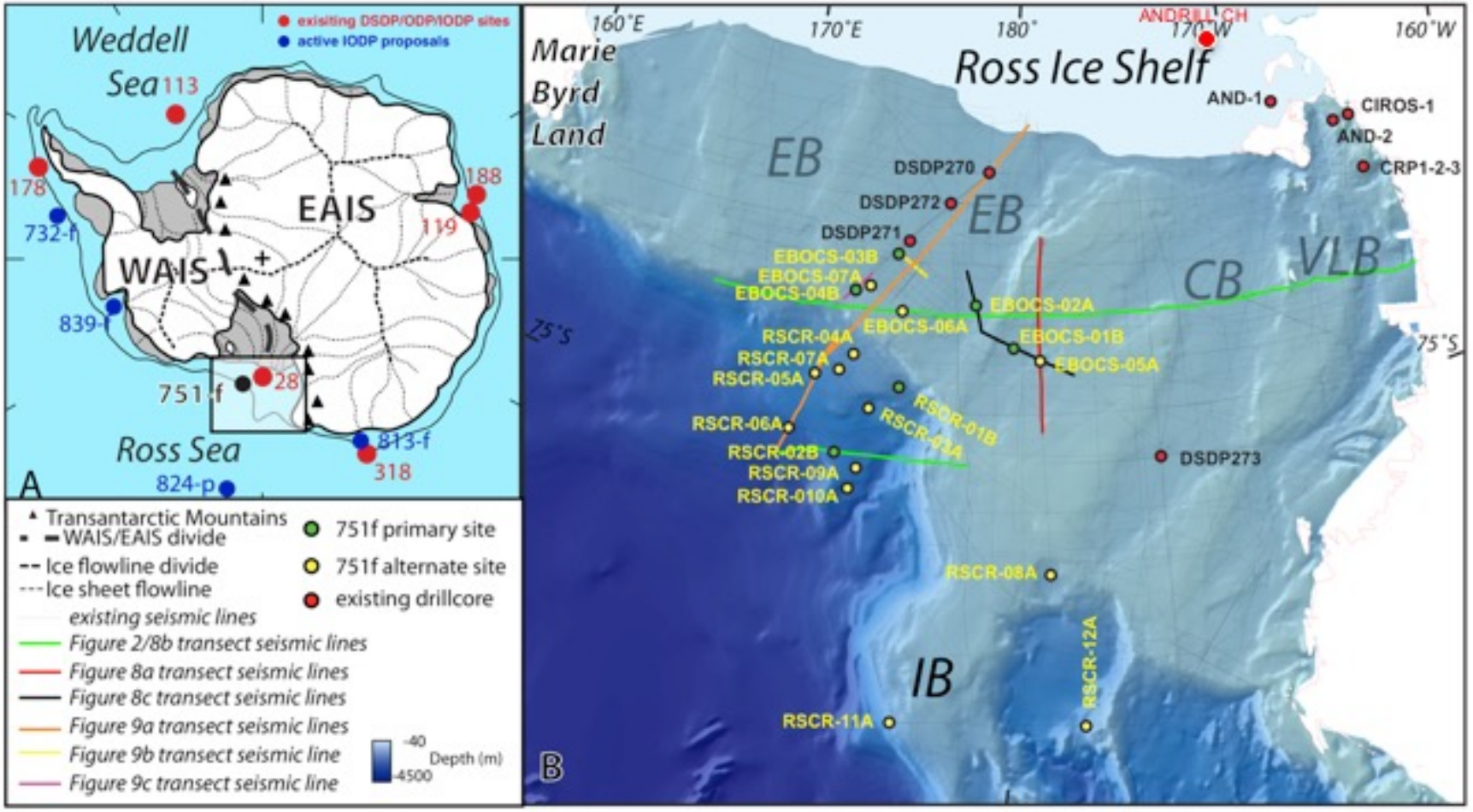
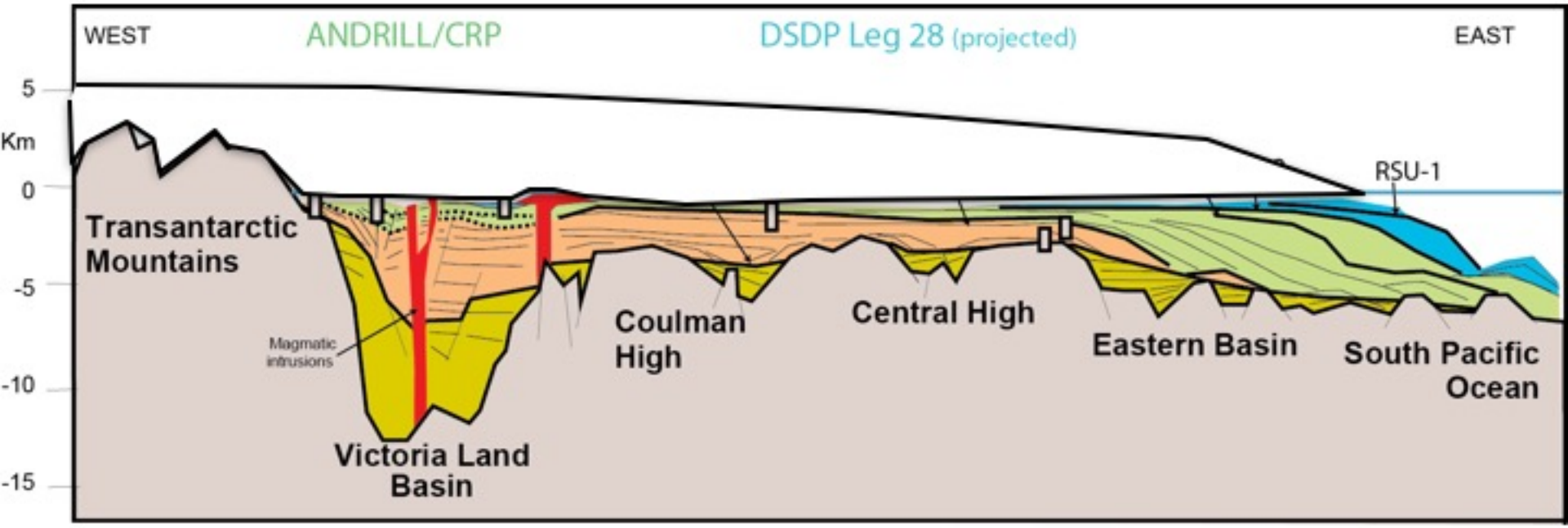




Objectives

1.Reconstruct ice proximal atmospheric and oceanic temperatures to identify past polar amplification and assess its forcings/feedbacks.

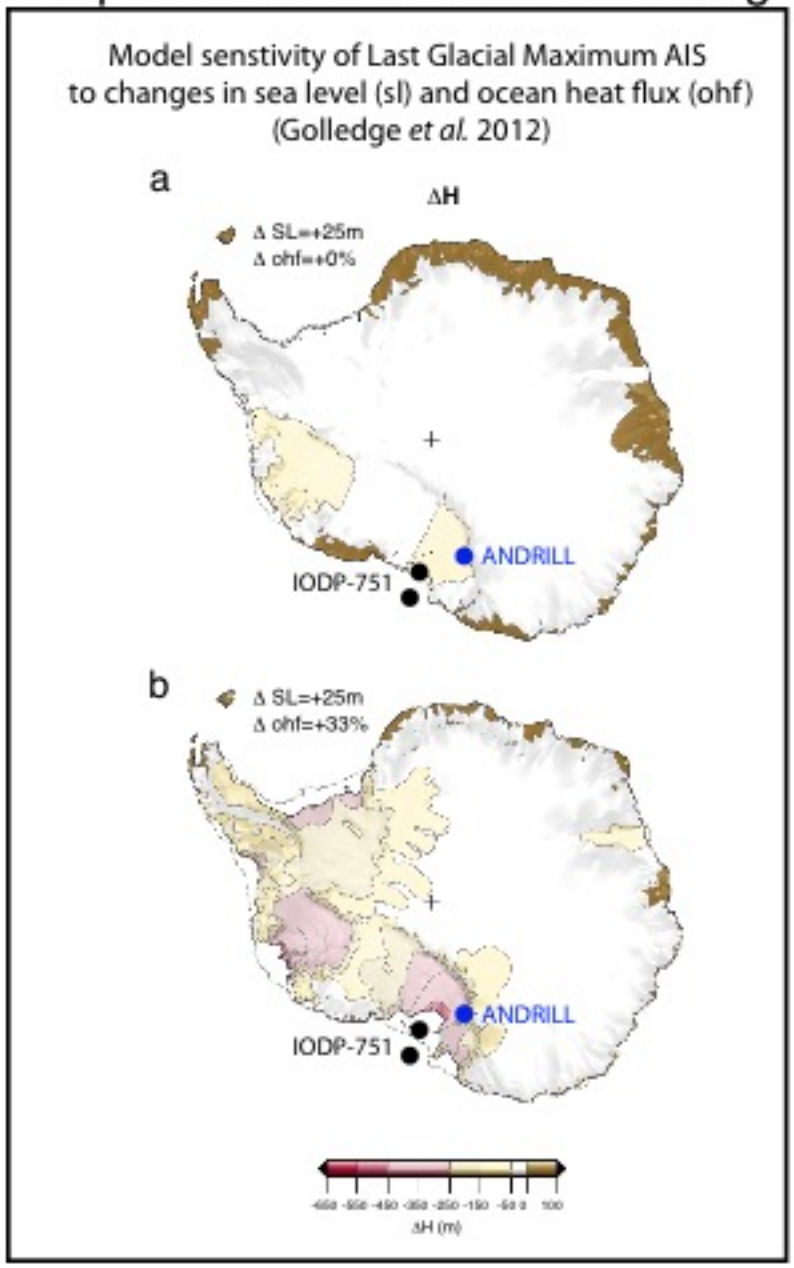
2.Assess the role of oceanic forcing (e.g. sea level and temperature) on marine ice sheet stability/instability

3.Evaluate the contribution of West Antarctica to far-field sea level estimates.

4.Identify the sensitivity of WAIS to Earth's orbital configuration under a variety of climate boundary conditions

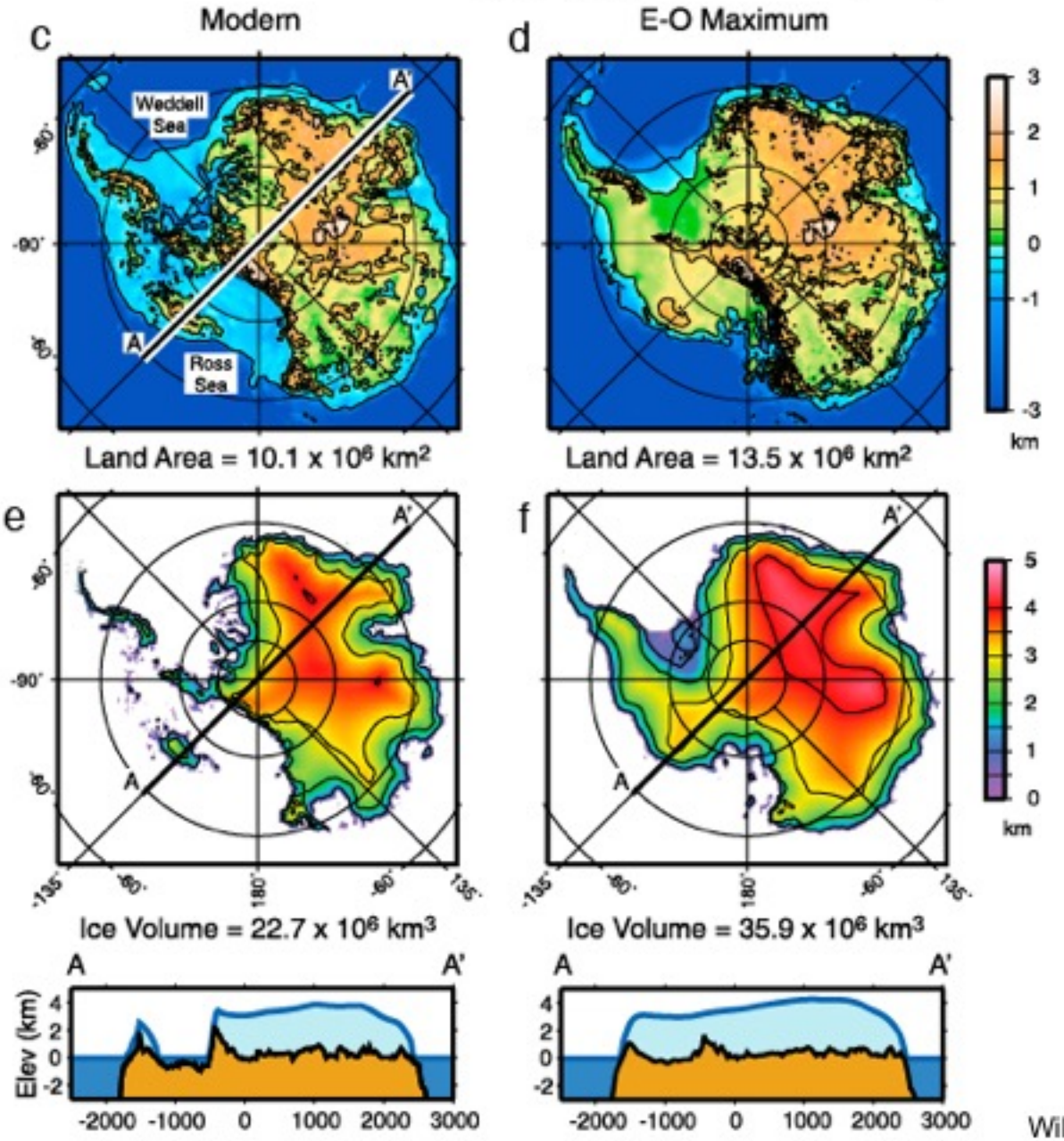
5.Reconstruct Eastern Ross Sea bathymetry to examine relationships between sea-floor geometry, ice sheet stability/instability, and global climate.

Objective 1: Reconstruct ice proximal atmospheric and oceanic temperatures to identify past polar amplification and assess its forcings/feedbacks.



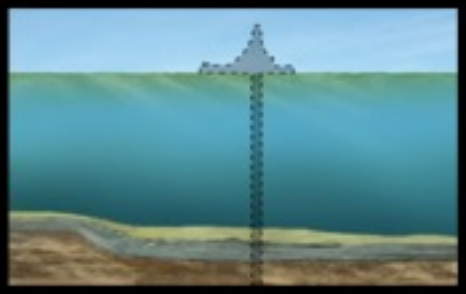
Golledge et al., 2012, PNAS

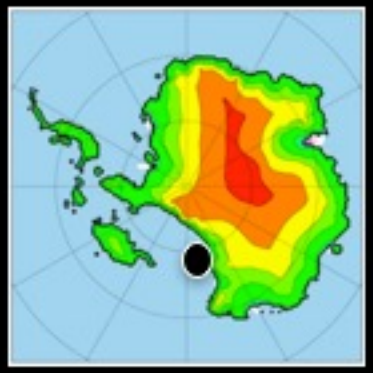
Terrestrial-based AIS extent (modelled) due to changes in topography (after Wilson et al., 2013)

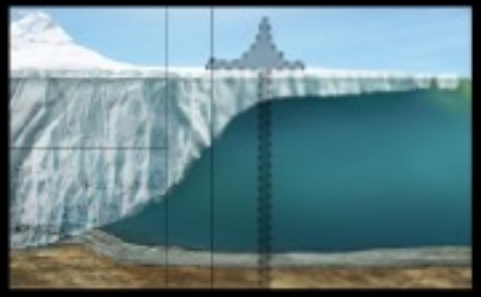


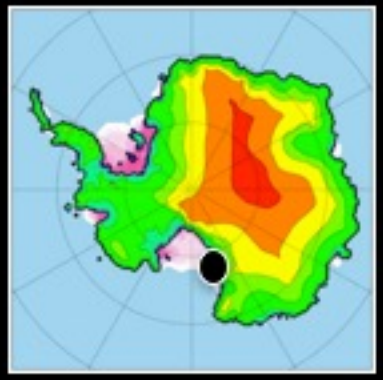
Wilson et al., 2013 GRL

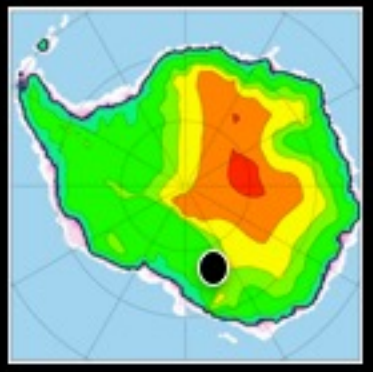
Drill core evidence of past West Antarctic Ice Sheet collapse





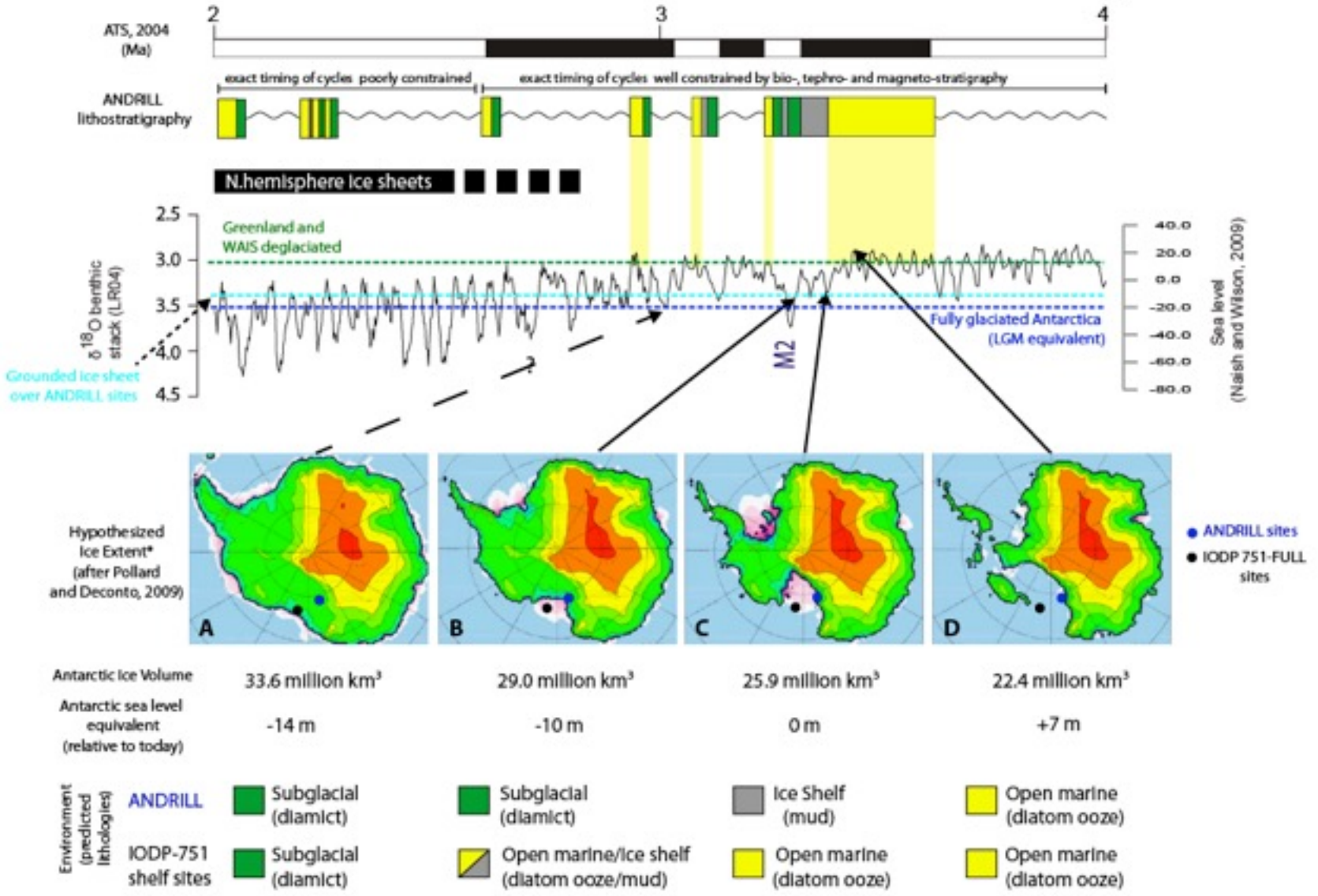


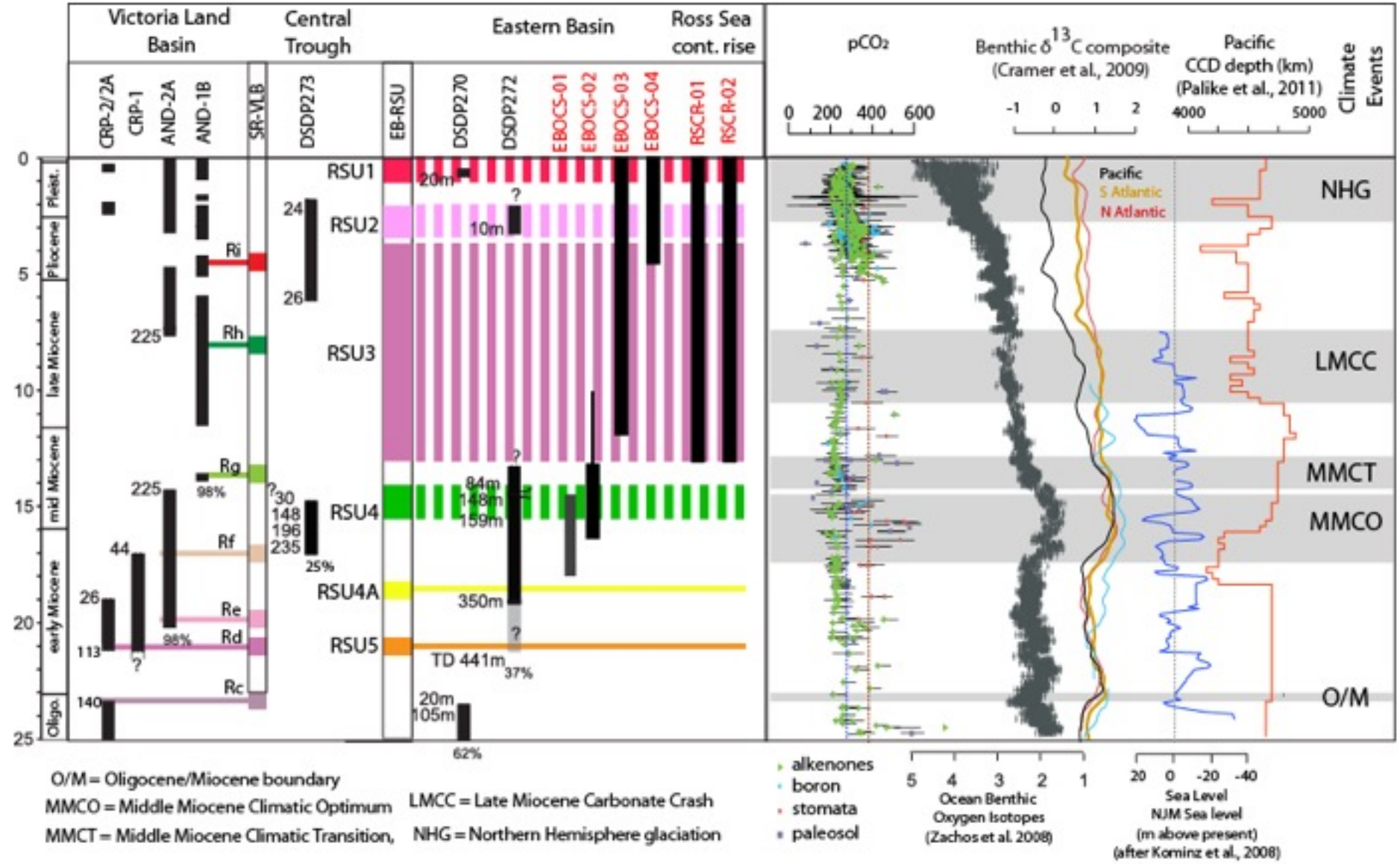




Objective 1. Evaluate the contribution of West Antarctica to far-field ice volume and sea level estimates.

Use data and models to reconcile intervals of maximum Neogene and Quatenary Antarctic ice advance with far-field records of eustatic sea-level change.





O/M = Oligocene/Miocene boundary

MMCO = Middle Miocene Climatic Optimum

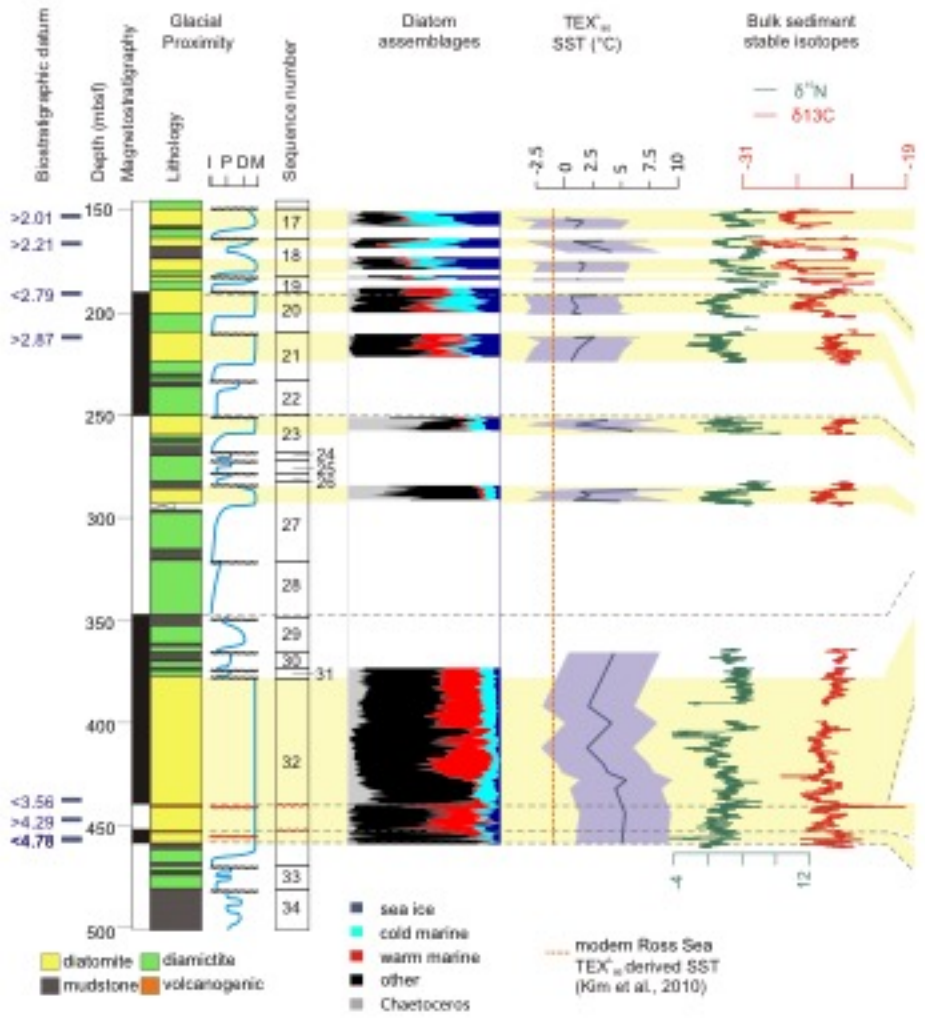
MMCT = Middle Miocene Climatic Transition,

LMCC = Late Miocene Carbonate Crash

NHG = Northern Hemisphere glaciation

Objective 2. Reconstruct ice proximal atmospheric and oceanic temperatures to identify past polar amplification and assess its forcings/feedbacks.

Reconstruct past changes in oceanic and atmospheric temperatures using a multi-proxy approach.



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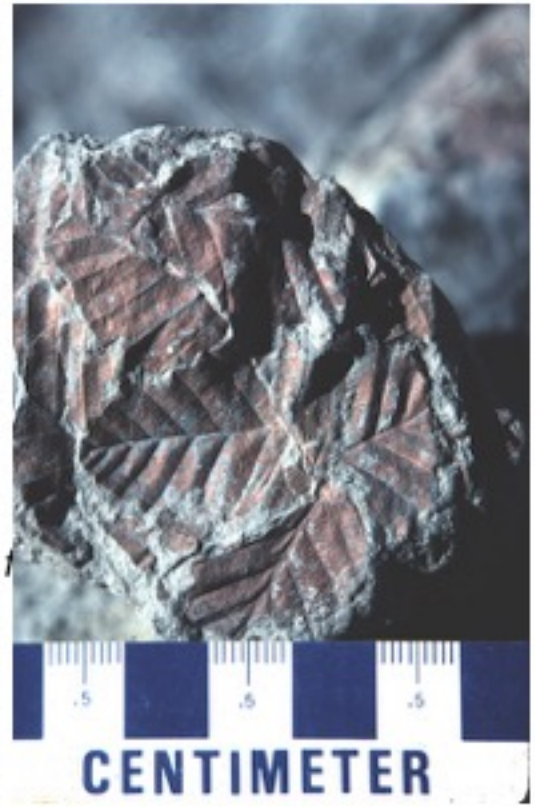
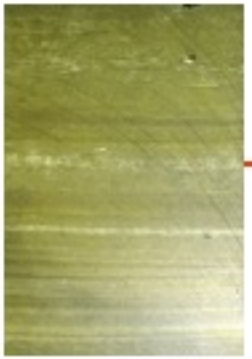
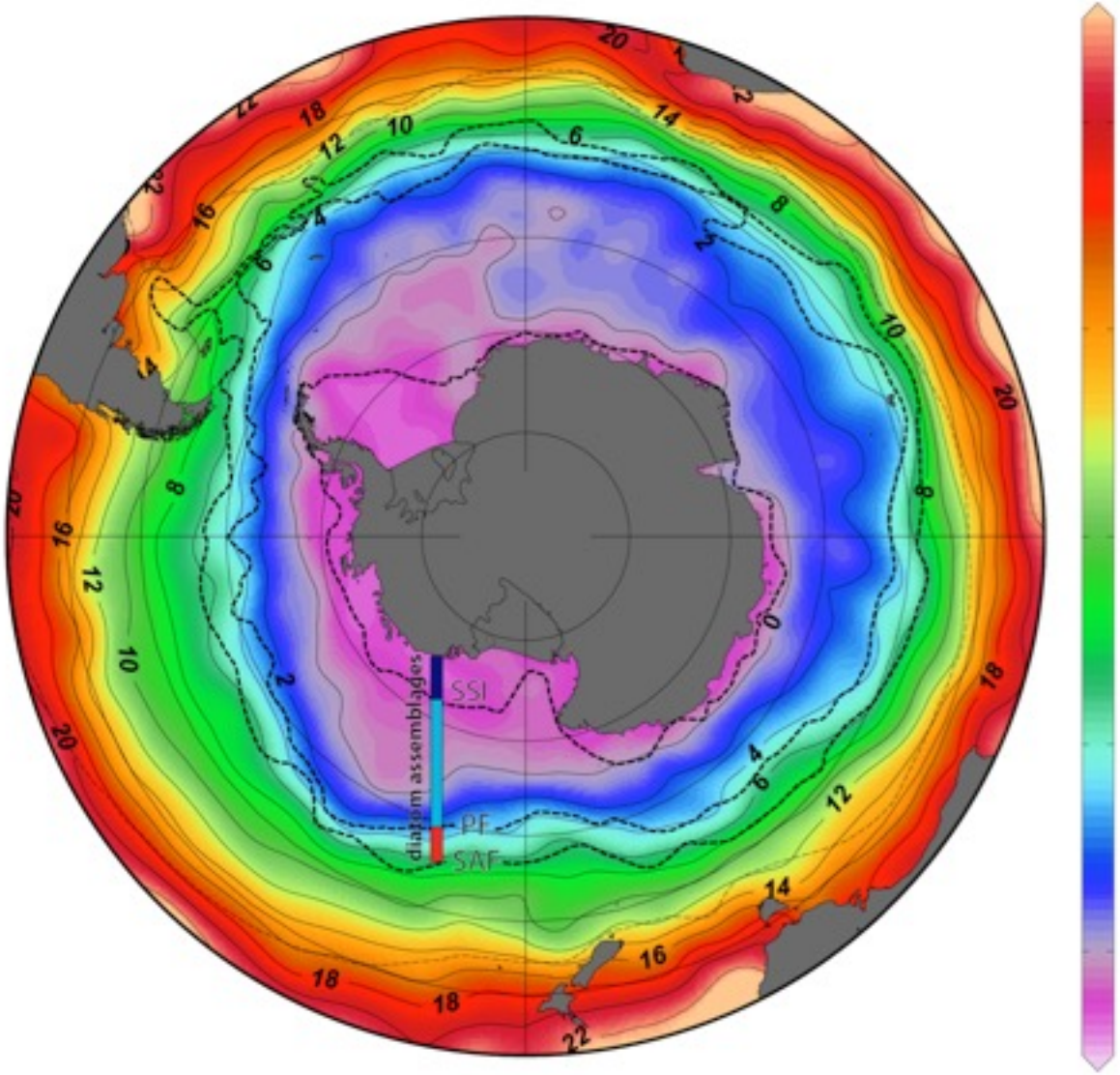






We can also reconstruct:

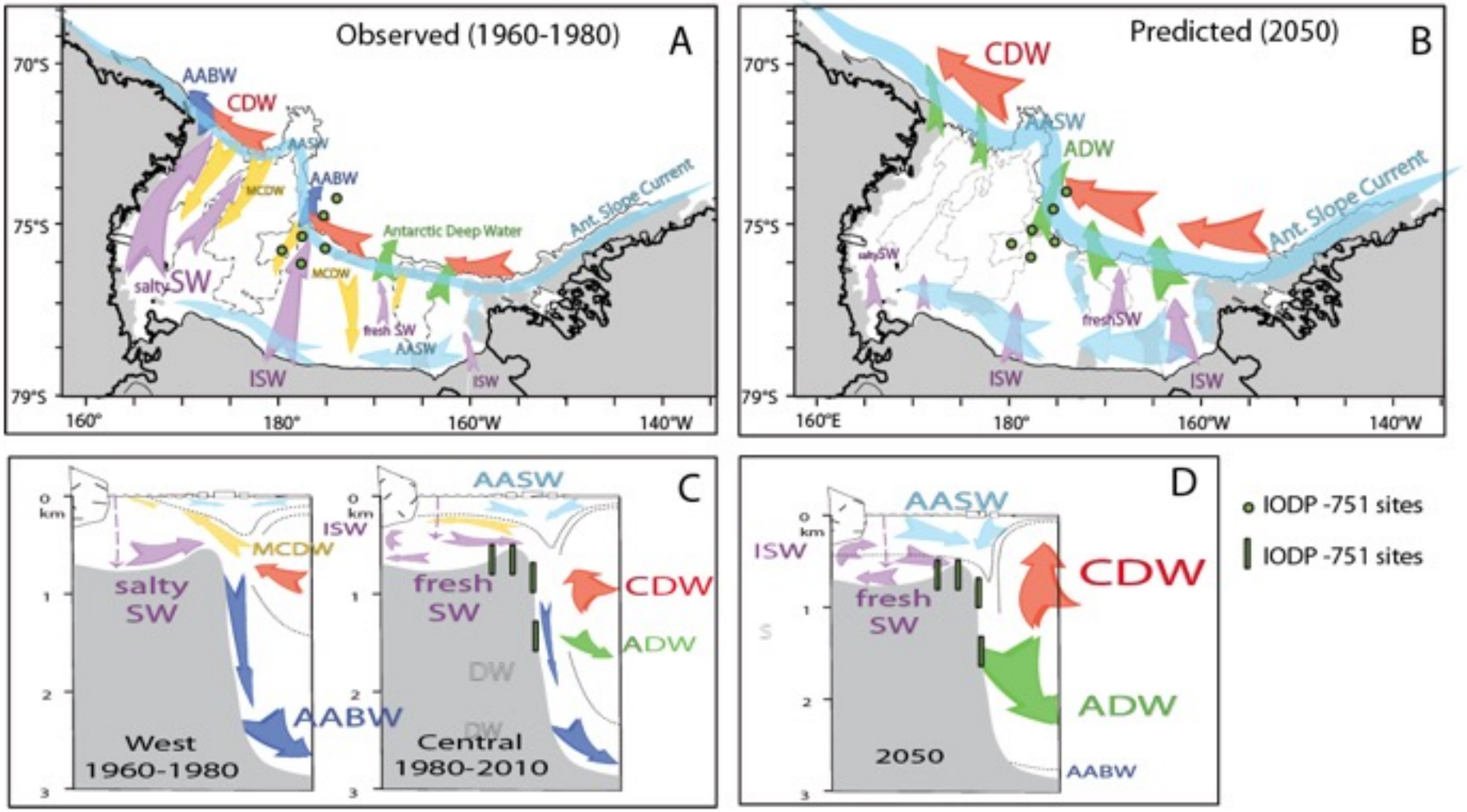
- Sea surface temp
- primary productivity,
- nutrient uptake, surface
- water stratification,
- bottom water formation

Using a range of proxies

- Microfossils
- Lipid biomarkers
- Clumped isotopes
- Stable isotopes (18O, 13C, D, 15N)
- Trace element geochemistry (Mn, Nd, Sr)

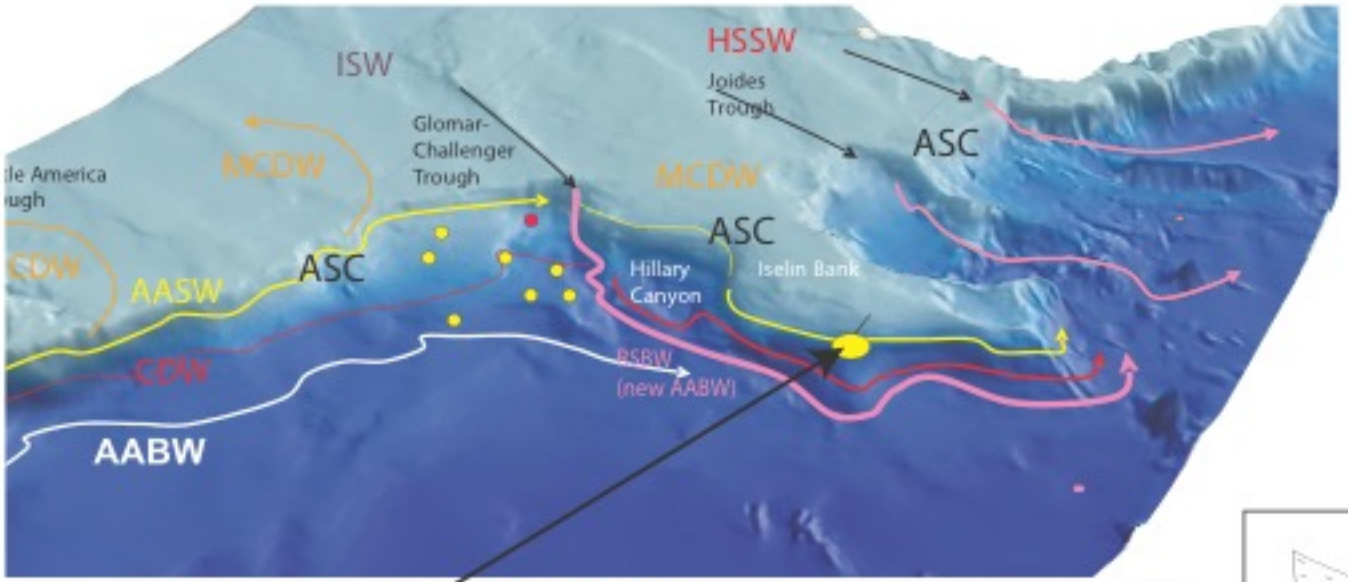
Orsi and Whitworth (2005)

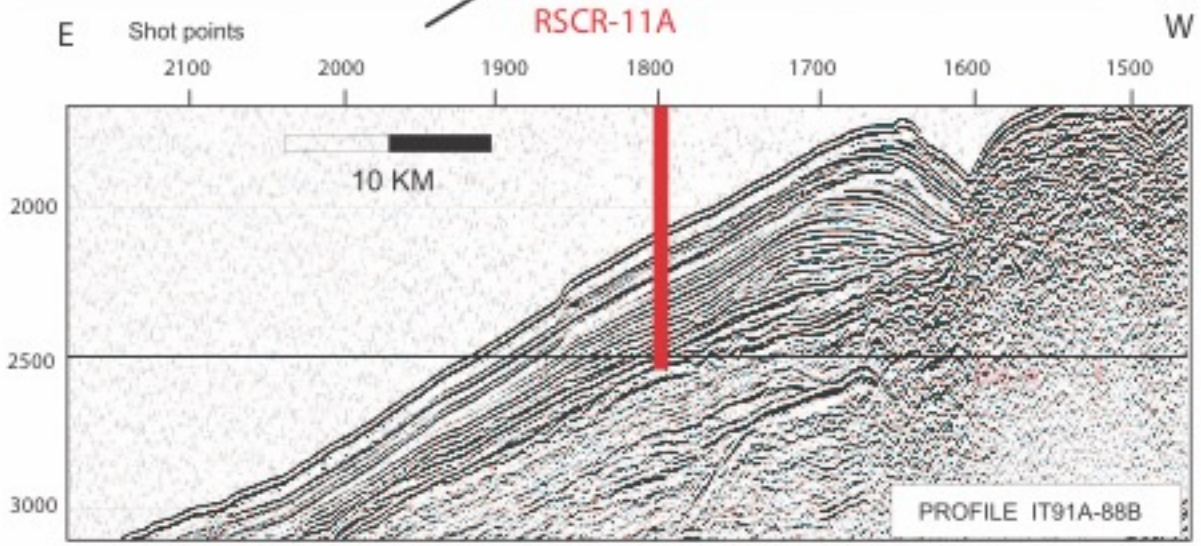
3. Assess the role of oceanic forcing (e.g. sea level and temperature) on WAIS stability/instability.

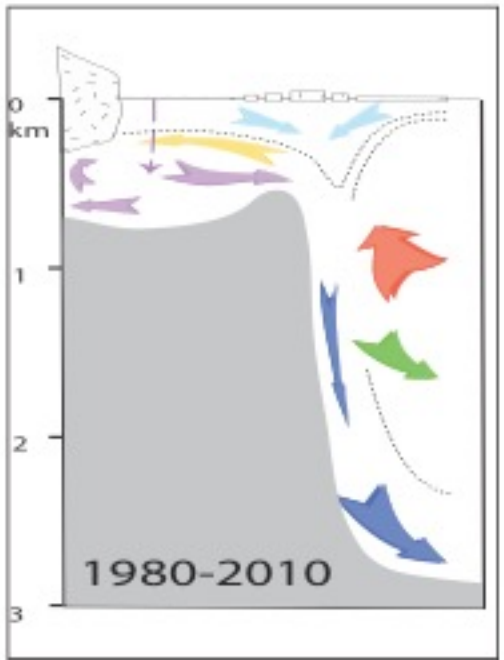


Smith et al., 2012 (oceanography)

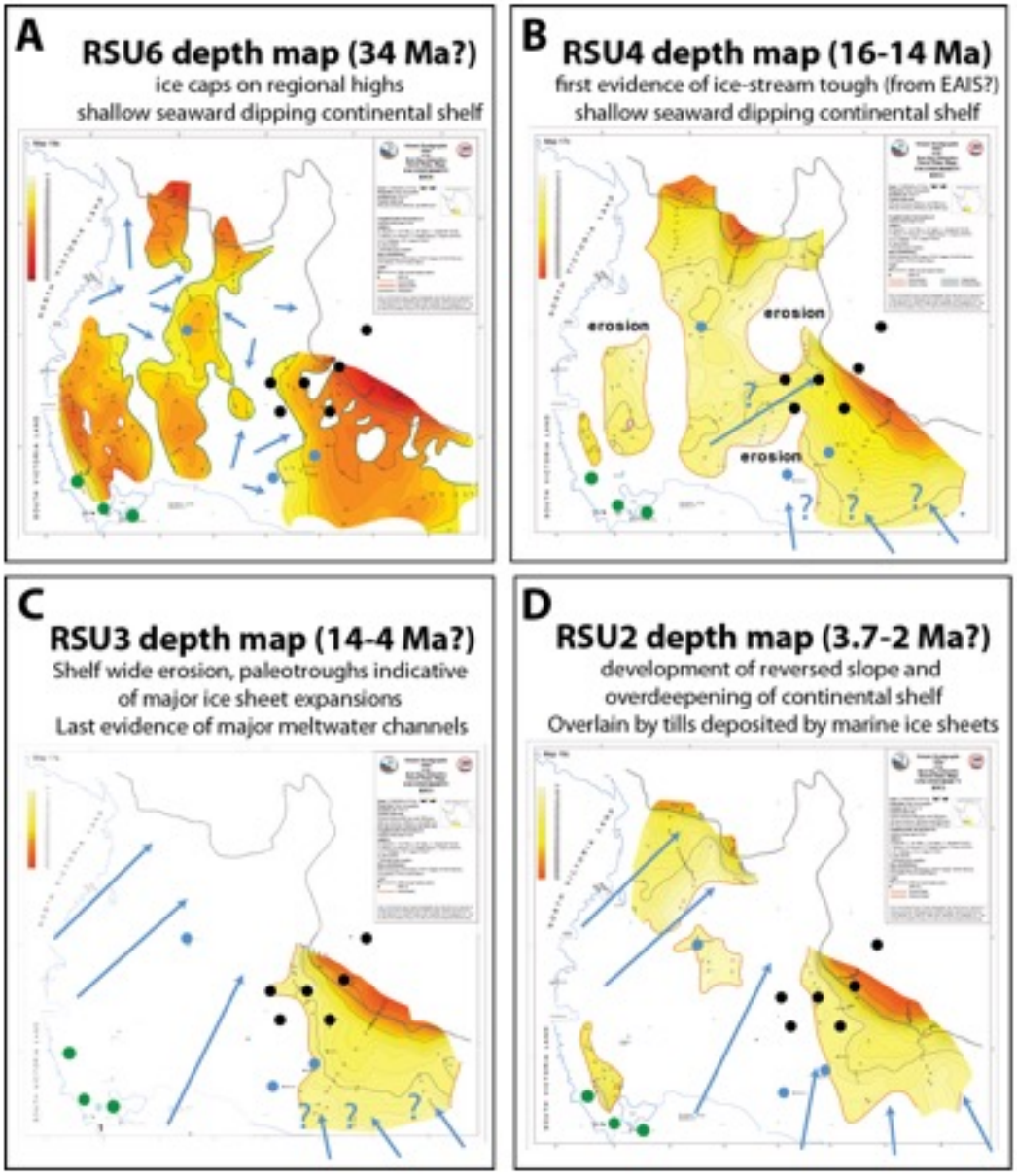
Hypothesis to test: The vigor of the Antarctic Slope Current, and surface water variance is the main control on oceanic heat flux onto the Ross Sea Continental Shelf

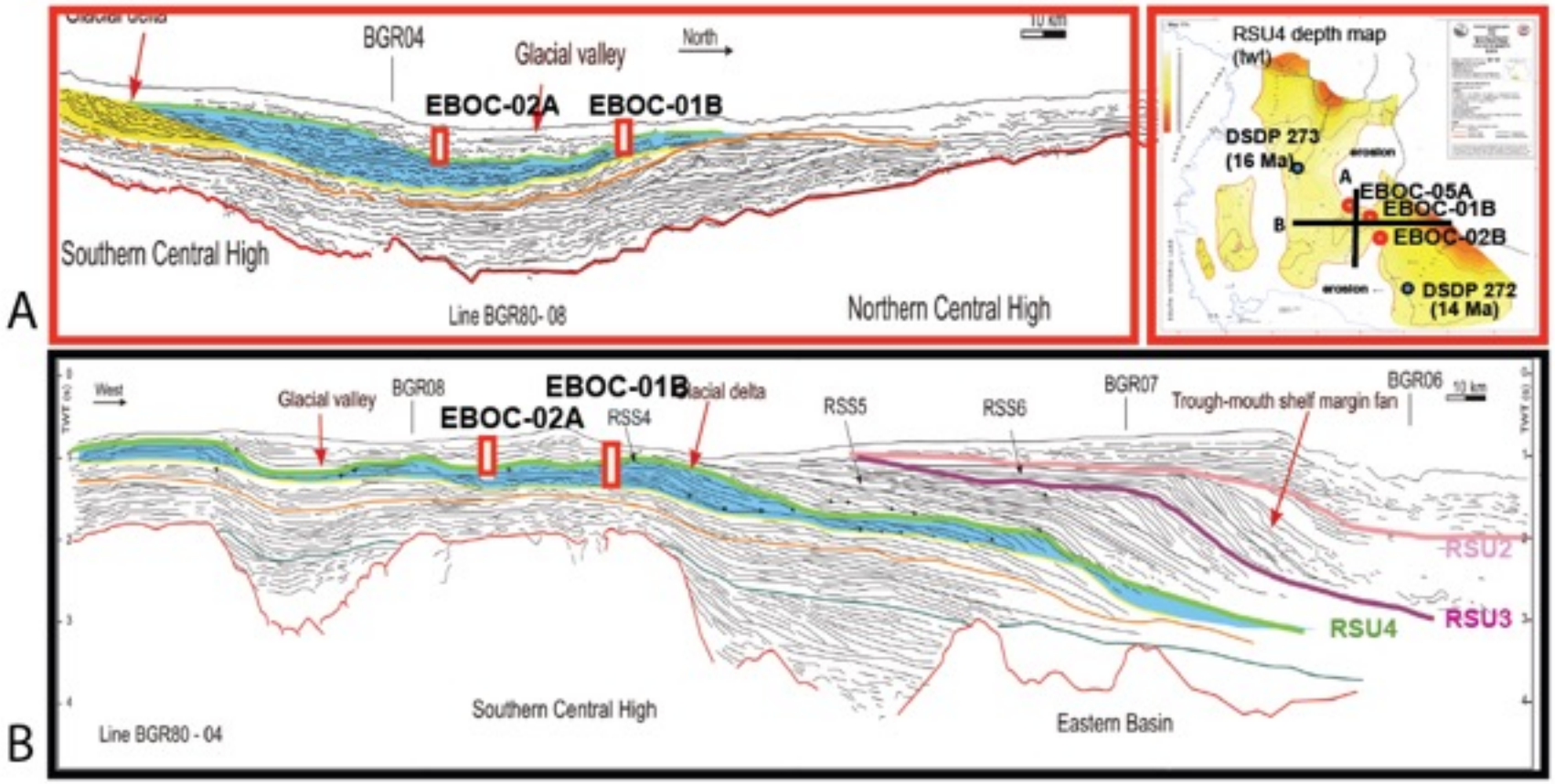


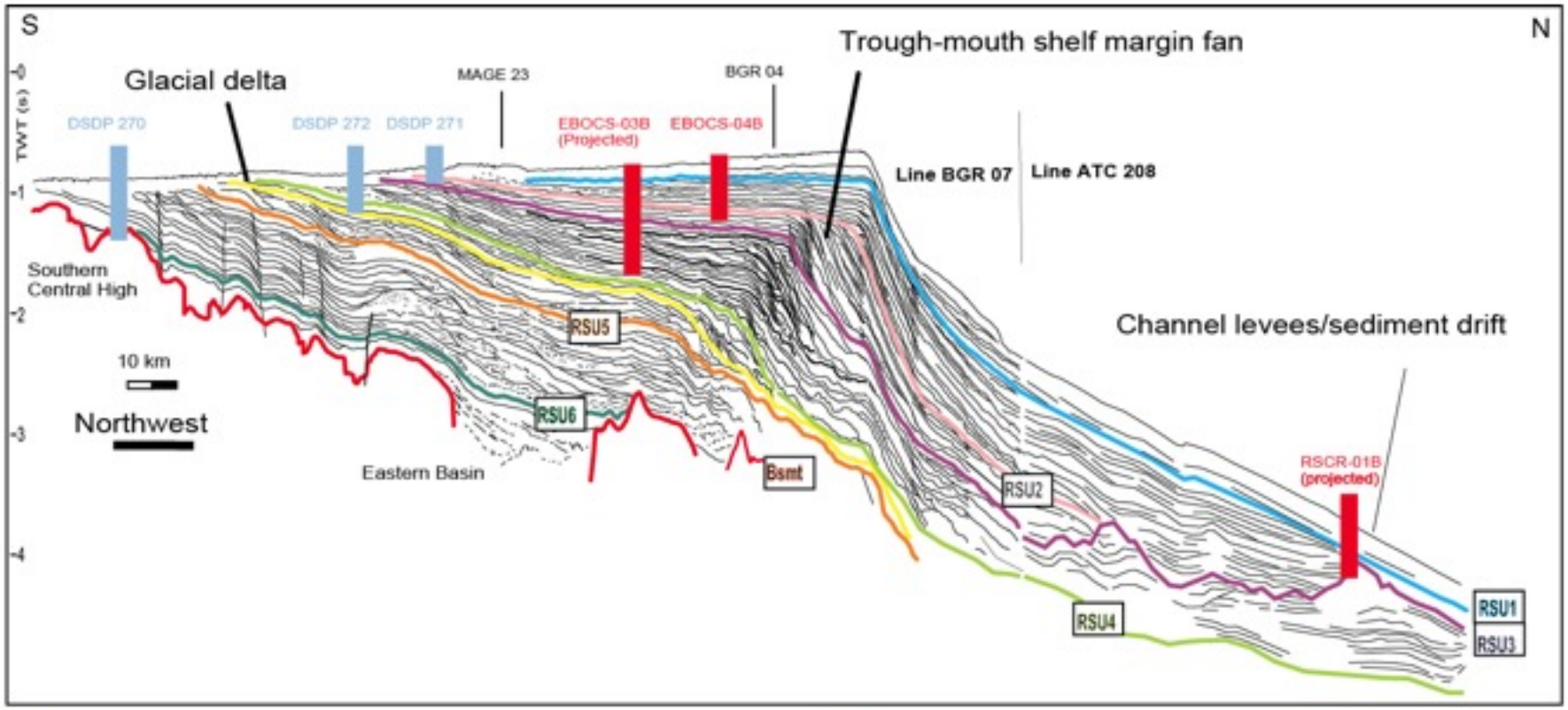


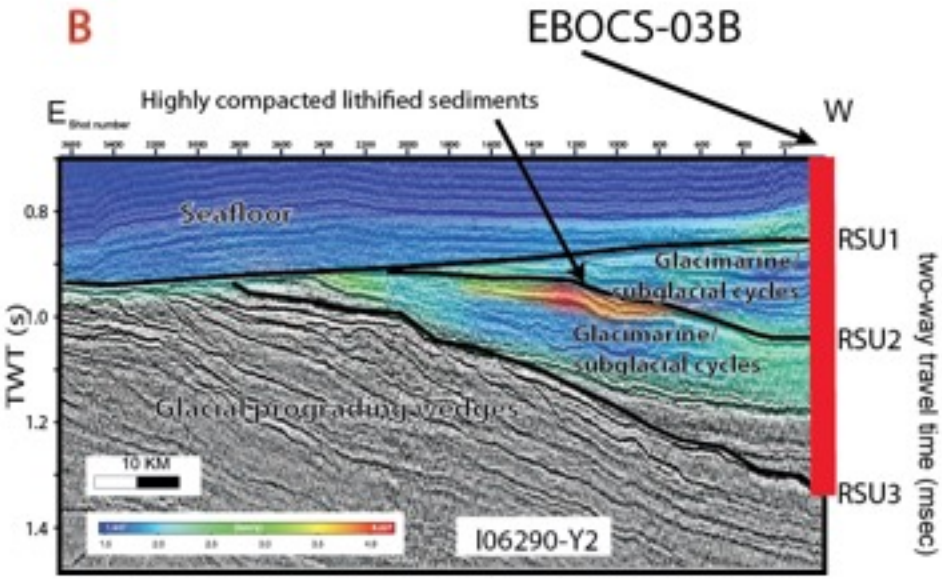


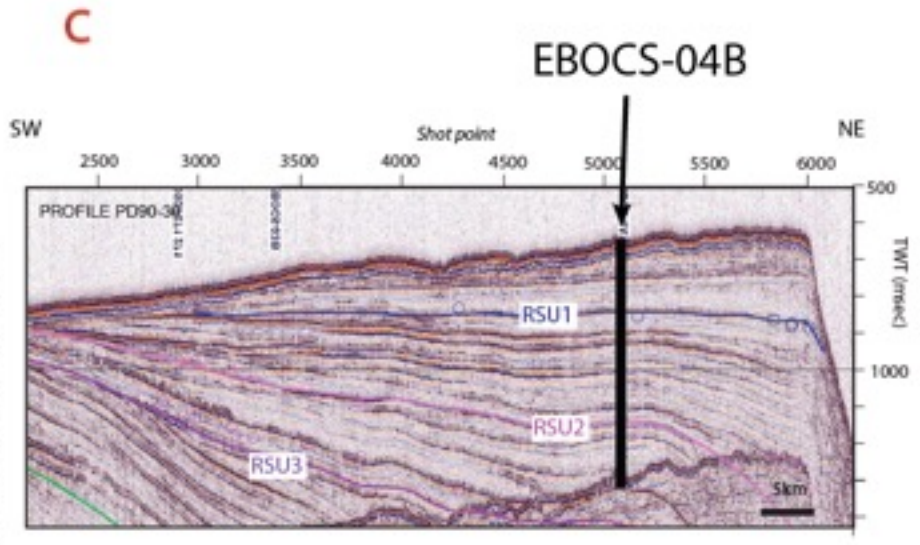
5. Reconstruct Eastern Ross Sea bathymetry to examine relationships between sea-floor geometry, ice sheet stability/instability, and global climate.




A
BGR04
Glacial valley
North
EBOC-02A
EBOC-01B
Southern Central High
Line BGR80- 08
Northern Central High
RSU4 depth map
(twt)
DSDP 273
(16 Ma)
erosion
A
EBOC-05A
EBOC-01B
B
EBOC-02B
erosion
DSDP 272
(14 Ma)
B
West
Glacial valley
BGR08
EBOC-01B
EBOC-02A
RSS4
Glacial delta
RSS5
RSS6
BGR07
Trough-mouth shelf margin fan
BGR06
RSU2
RSU3
RSU4
Southern Central High
Line BGR80 - 04
Eastern Basin
C
S
PD90-35
N
EBOC-02A
SP
1500
2000
2500
3000
3500
500
1000
1500
S(TWT)
RSU4
glaciomarine
(post MMCO?)
till tounge
10km
SE
PD90-36
NW
EBOC-01B
EBOC-05A
500
1000
1500
2000
2500
meltwater
channels
till tounge
interstratified
glacimarine till
glaciomarine
MMCO?
till tounge
glaciomarine
MMCO?


S
N
Trough-mouth shelf margin fan
Glacial delta
MAGE 23
BGR 04
DSDP 270
DSDP 272
DSDP 271
EBOCS-03B (Projected)
EBOCS-04B
Line BGR 07
Line ATC 208
TWT (s)
Southern Central High
RSU5
Channel levees/sediment drift
10 km
Northwest
RSU6
Eastern Basin
Bsmt
RSCR-01B (projected)
RSU2
RSU4
RSU1
RSU3

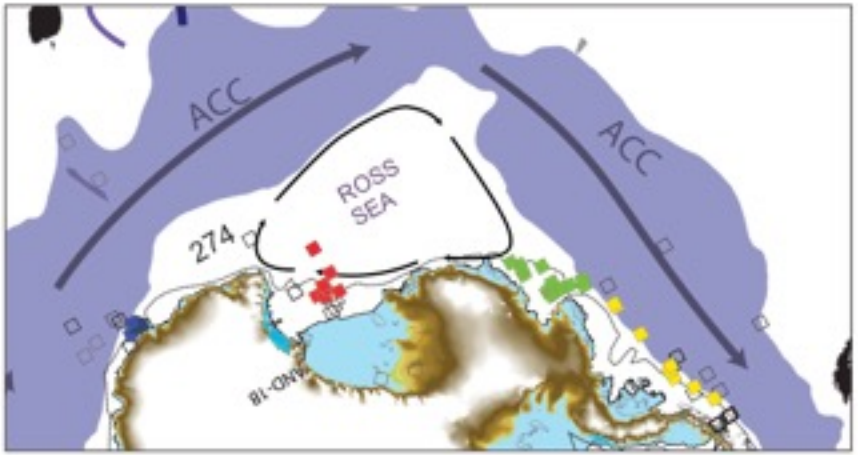

B
EBOCS-03B
E
Highly compacted lithified sediments
W
Seafloor
Glacimarine/ subglacial cycles
Glacimarine/ subglacial cycles
Glacial prograding wedges
10 KM
I06290-Y2
RSU1
RSU2
RSU3
TWT (s)
two-way travel time (msec)


C
EBOCS-04B
SW
Shot point
NE
PROFILE PD90-30
RSU1
RSU2
RSU3
5km
TWT (msec)

Summary

Drill a total of 6 six sites

- 4 continental shelf, 2 continental rise/slope,
- 8 alternates (room for more)



Objectives

- Polar amplification in higher CO_2 world – back to Middle Miocene
- Oceanic interactions with marine ice sheets
- Reconcile Neogene sea level estimates
- Orbital forcing of ice sheet through major climatic transitions
- Reconstruct Eastern Ross Sea bathymetry and influence