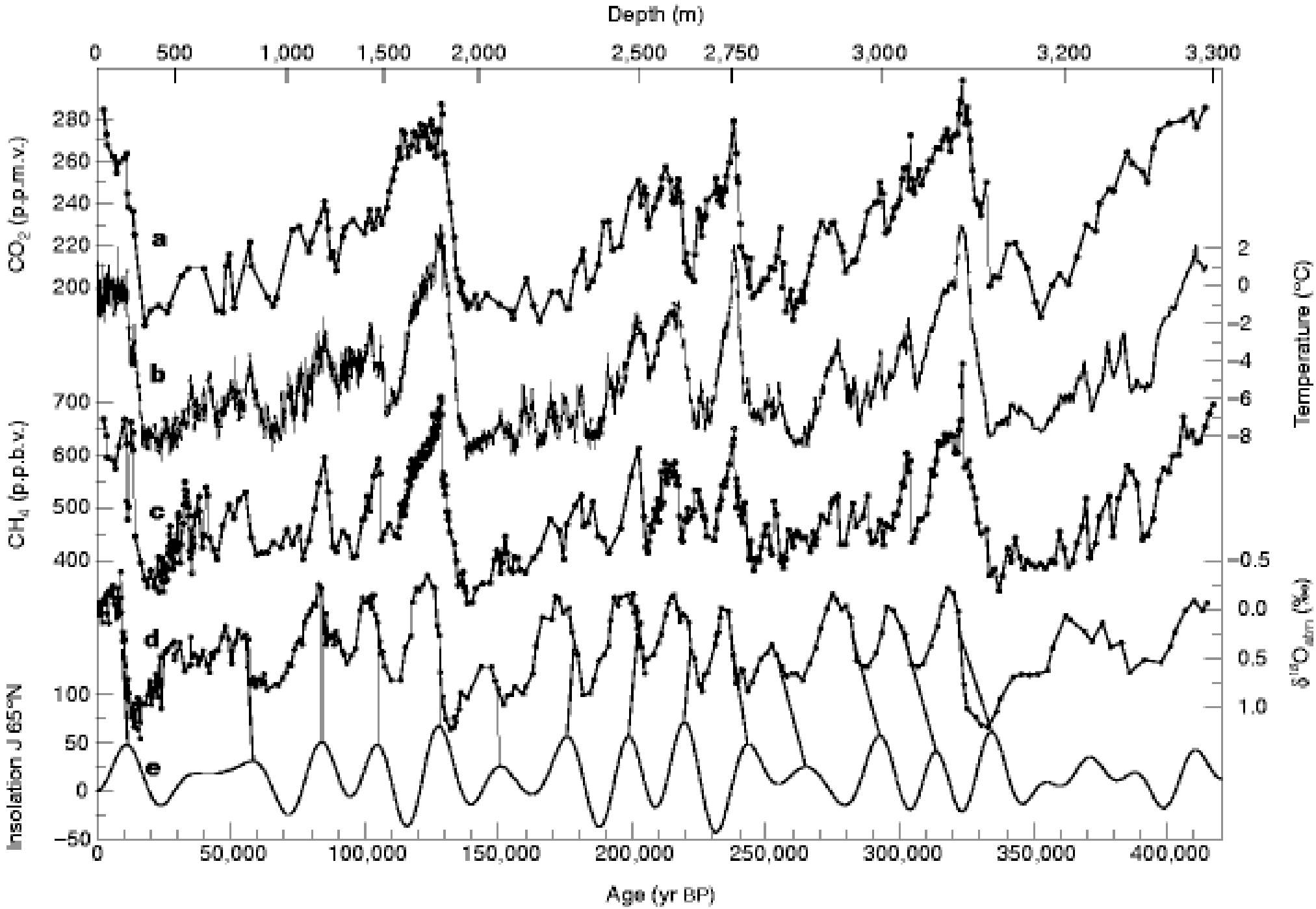
Paleoceanography and deep-sea corals: Circulation and Temperature Proxies

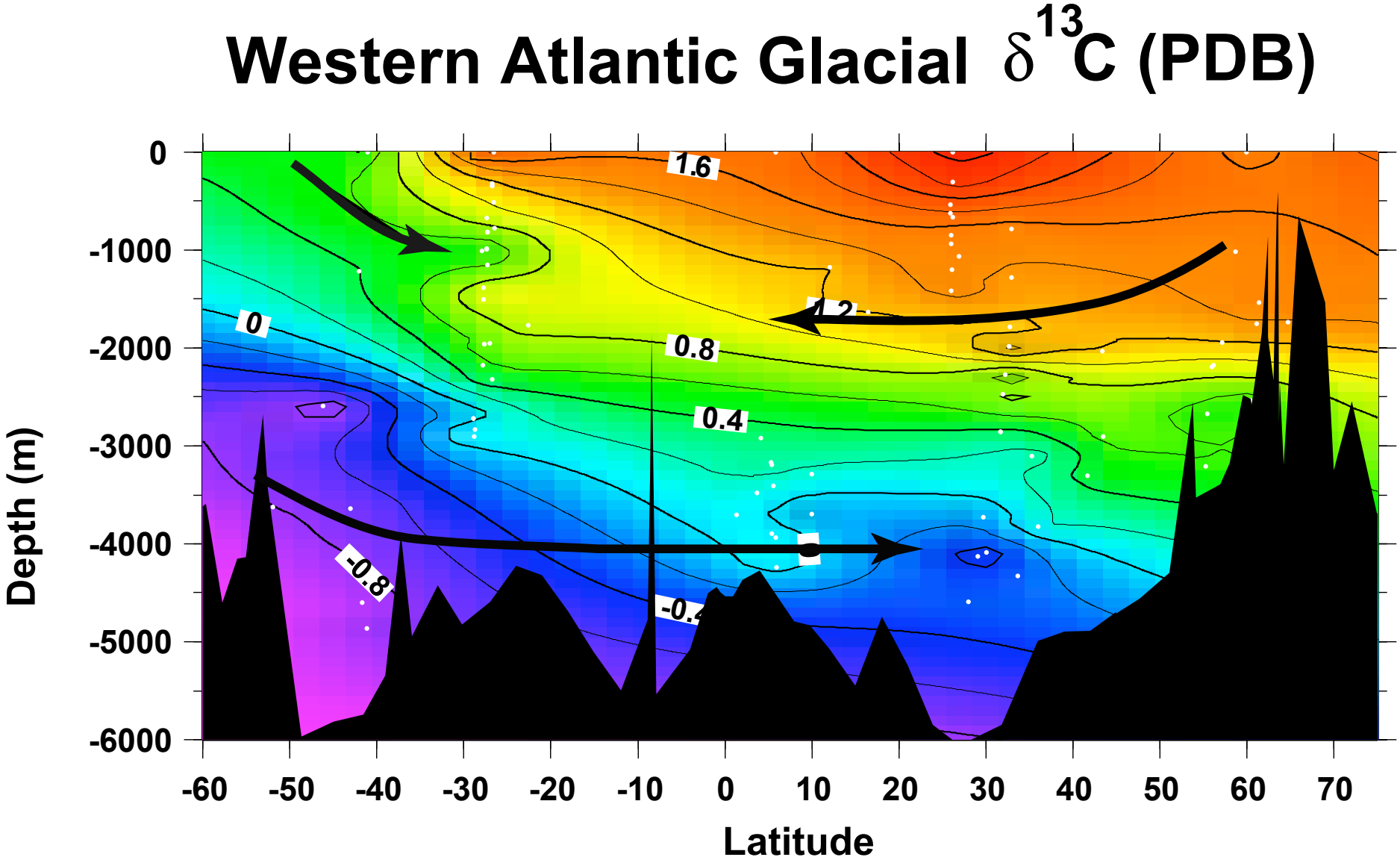
Possible barriers to entry in paleo:

- Perceived paucity on the sea floor
- Not able to get continuous records
- Age distribution
- Clear "vital effects" in early studies

Vostok Gases and Temperature



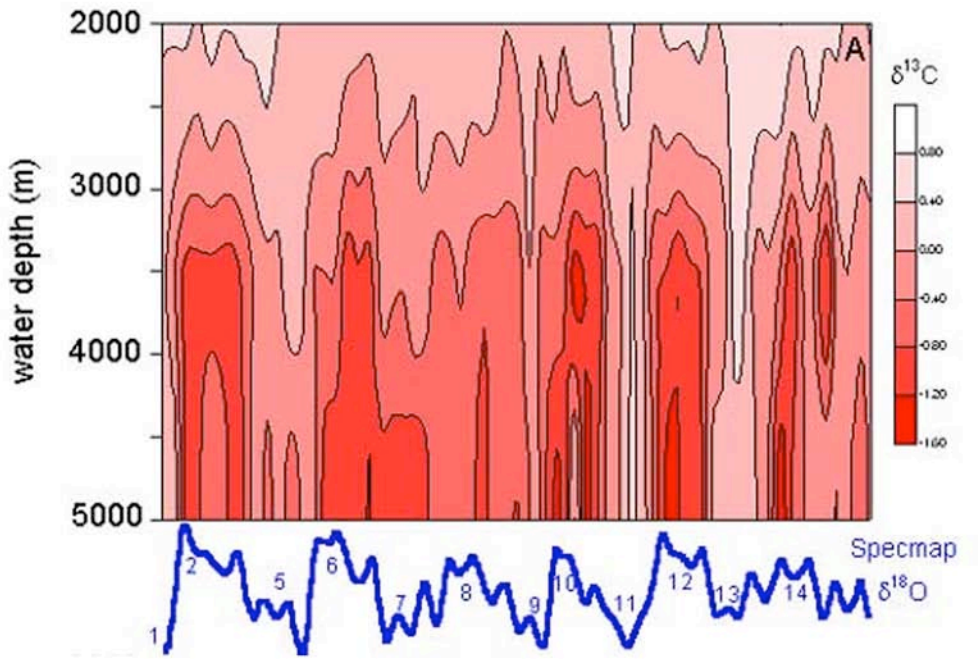
The deep ocean circulation pattern has changed in concert with climate

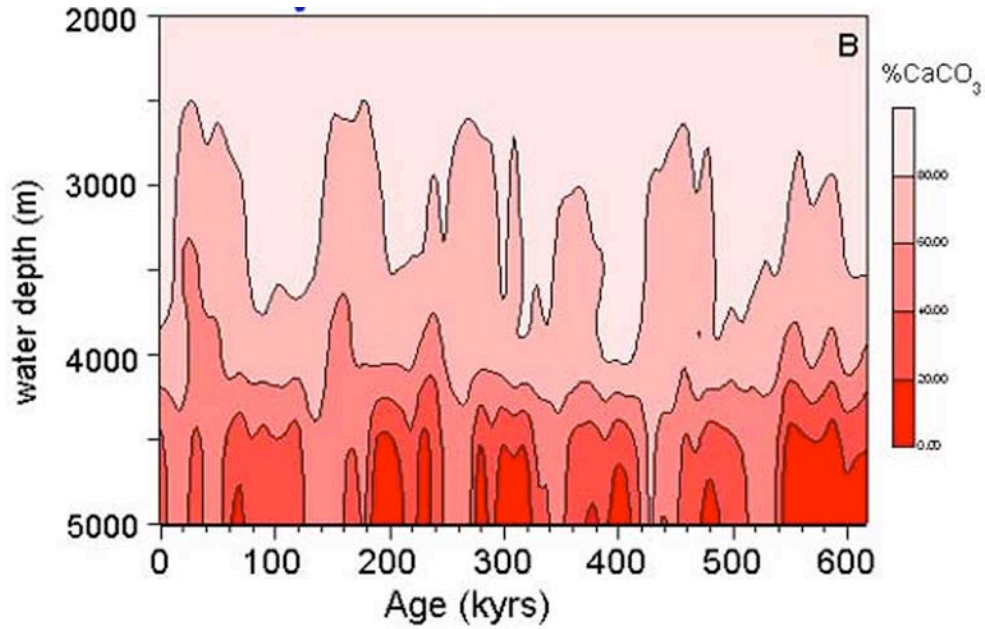


Curry and Oppo, 2005

Deep Water Oscillations Over Time

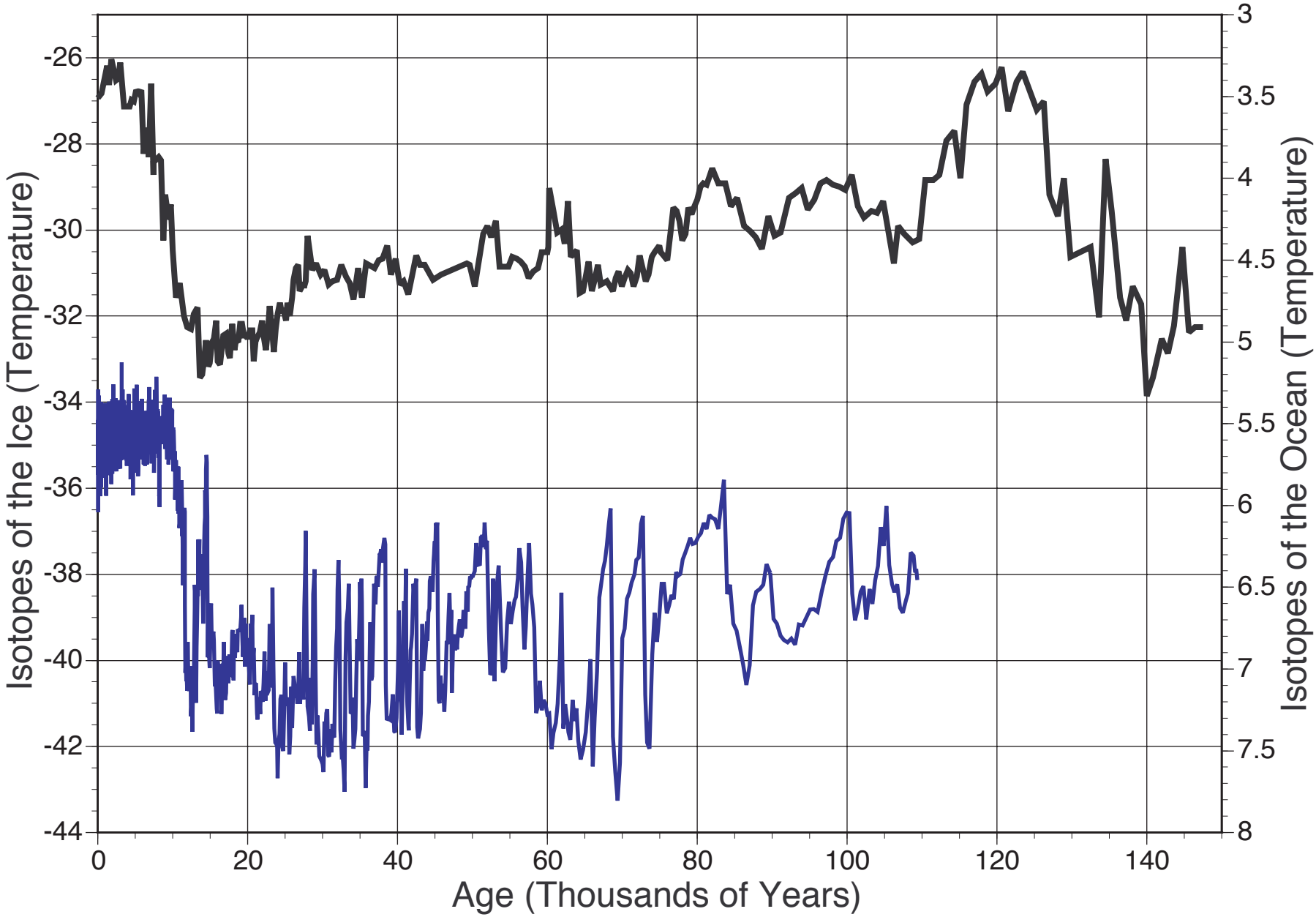
-Cores are between 40 and 45°S



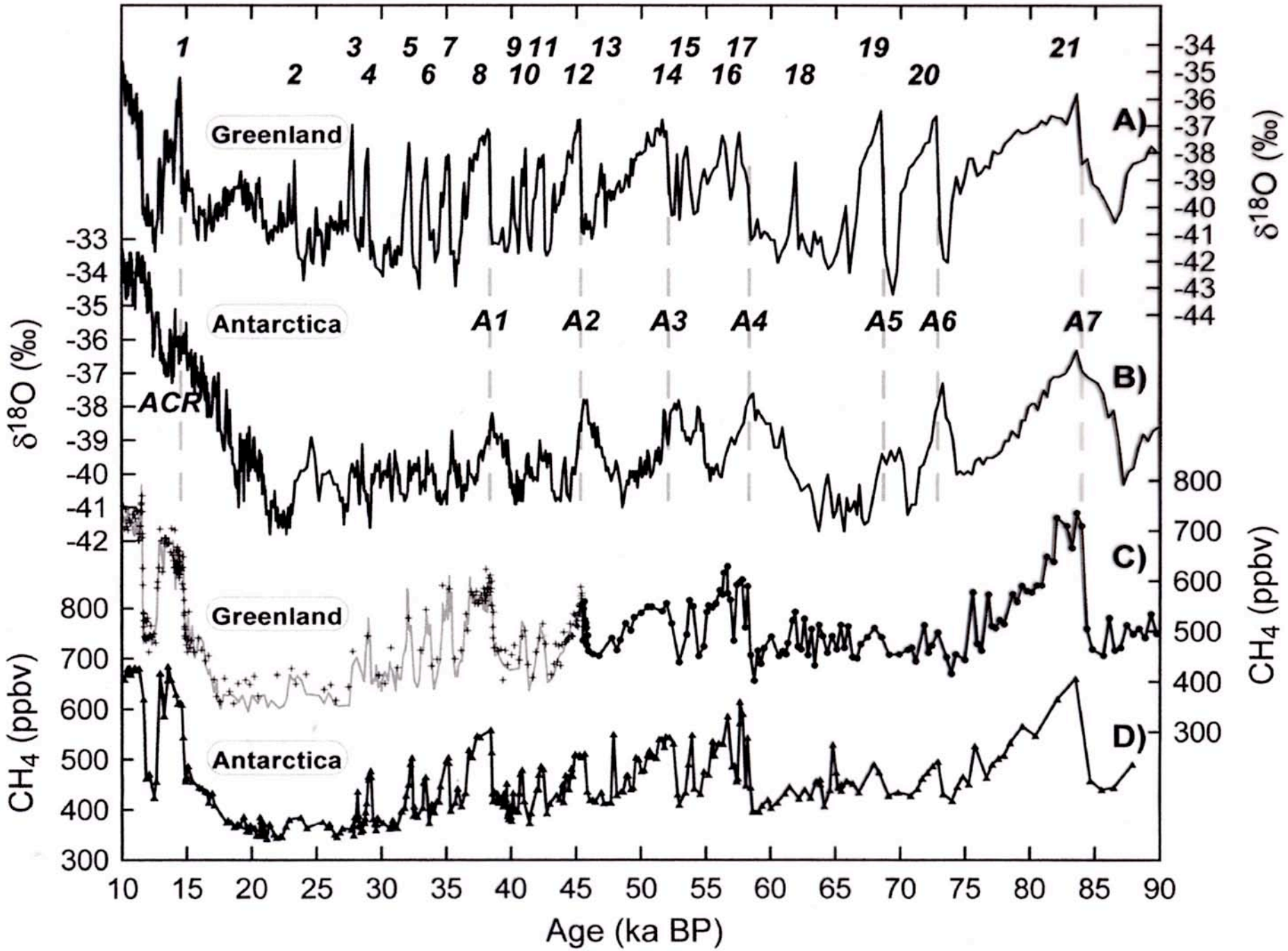


Hodell et al., 2003

But in the early 1990's our whole view changed: the time scale for change shrank dramatically

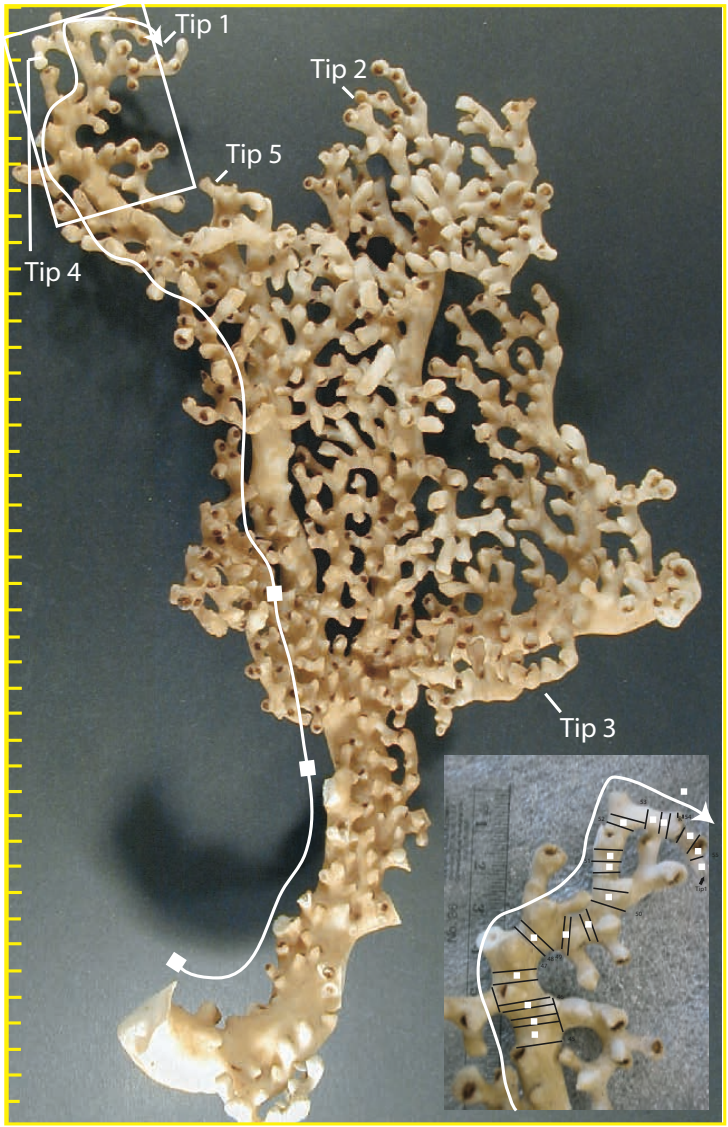


The poles do NOT change synchronously...

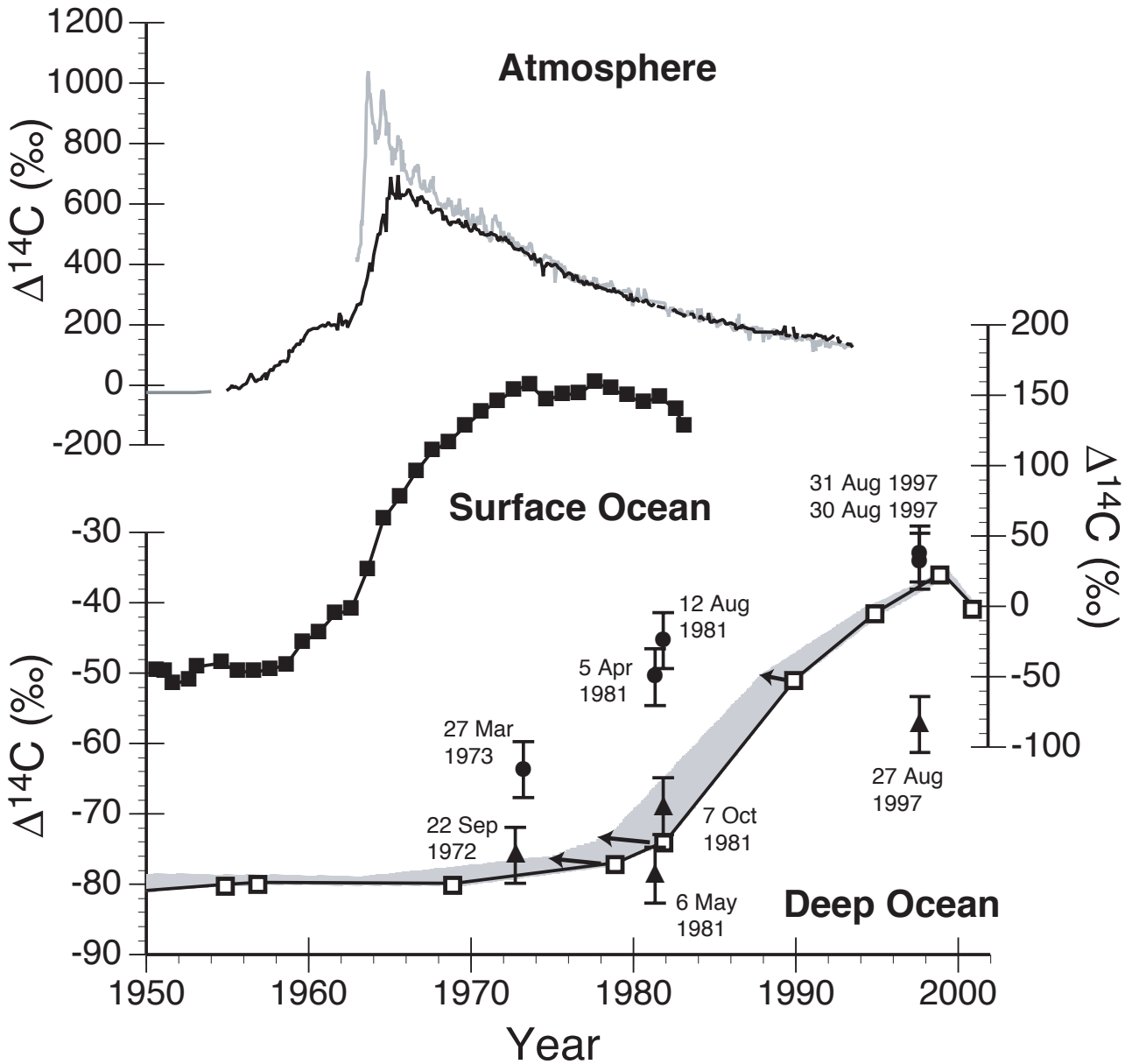


Blunier + Brook

Bomb ^{14}C at 1400 meters off Bermuda



50 cm long *E. rostrata*
-picked alive in Sept. 2001



Eltgroth et al., in prep

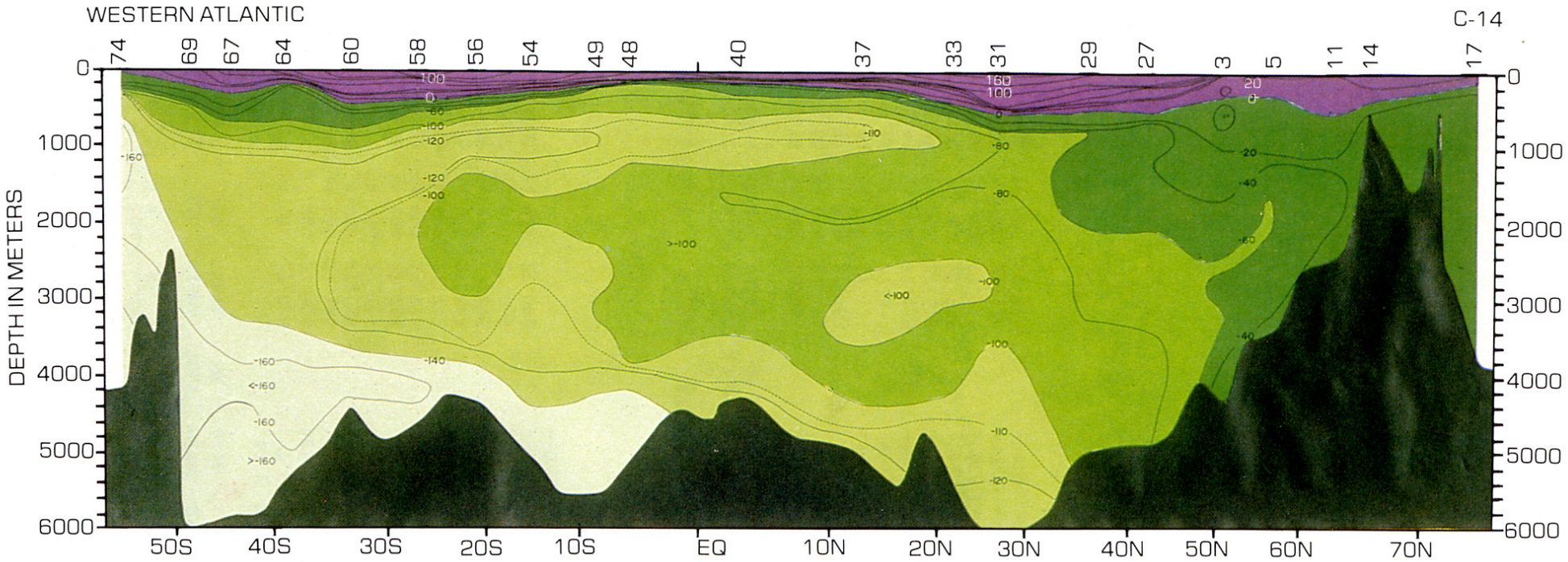


PLATE 1

Western Atlantic Ocean; N-S section. Isolines are in $\Delta^{14}C$ units.

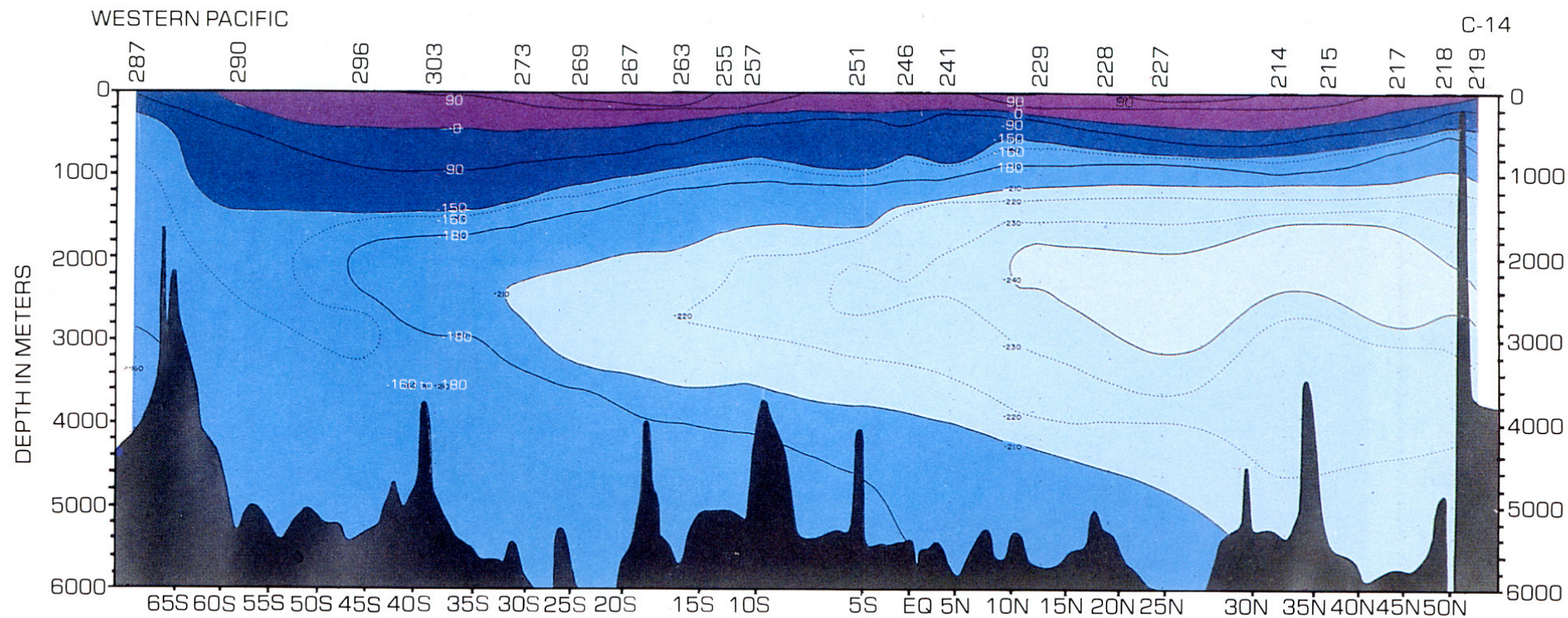


PLATE 1

Western Pacific Ocean; N-S section. Isolines are in $\Delta^{14}C$ units.

RADIOCARBON ALONG GREAT CONVEYOR BELT

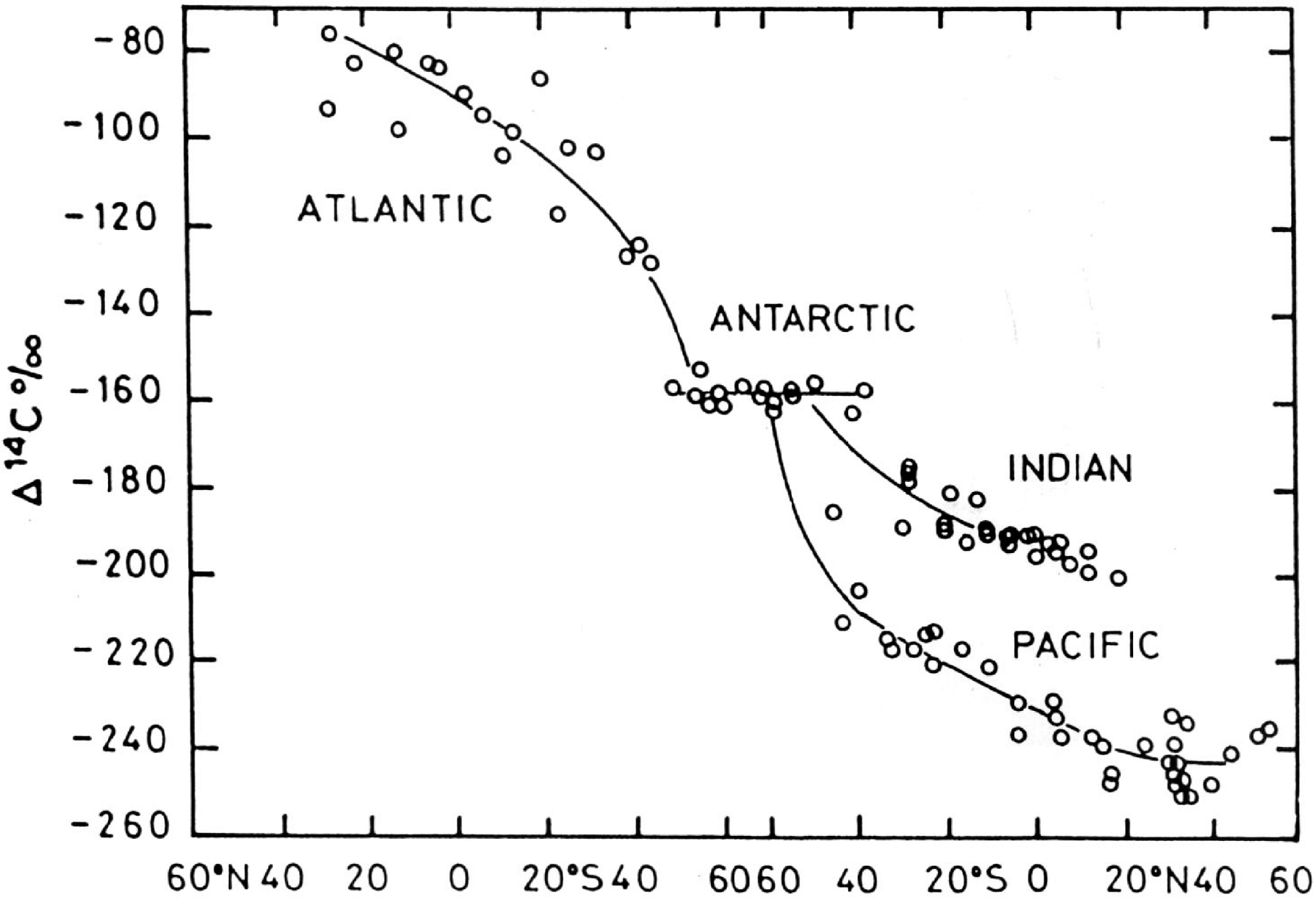
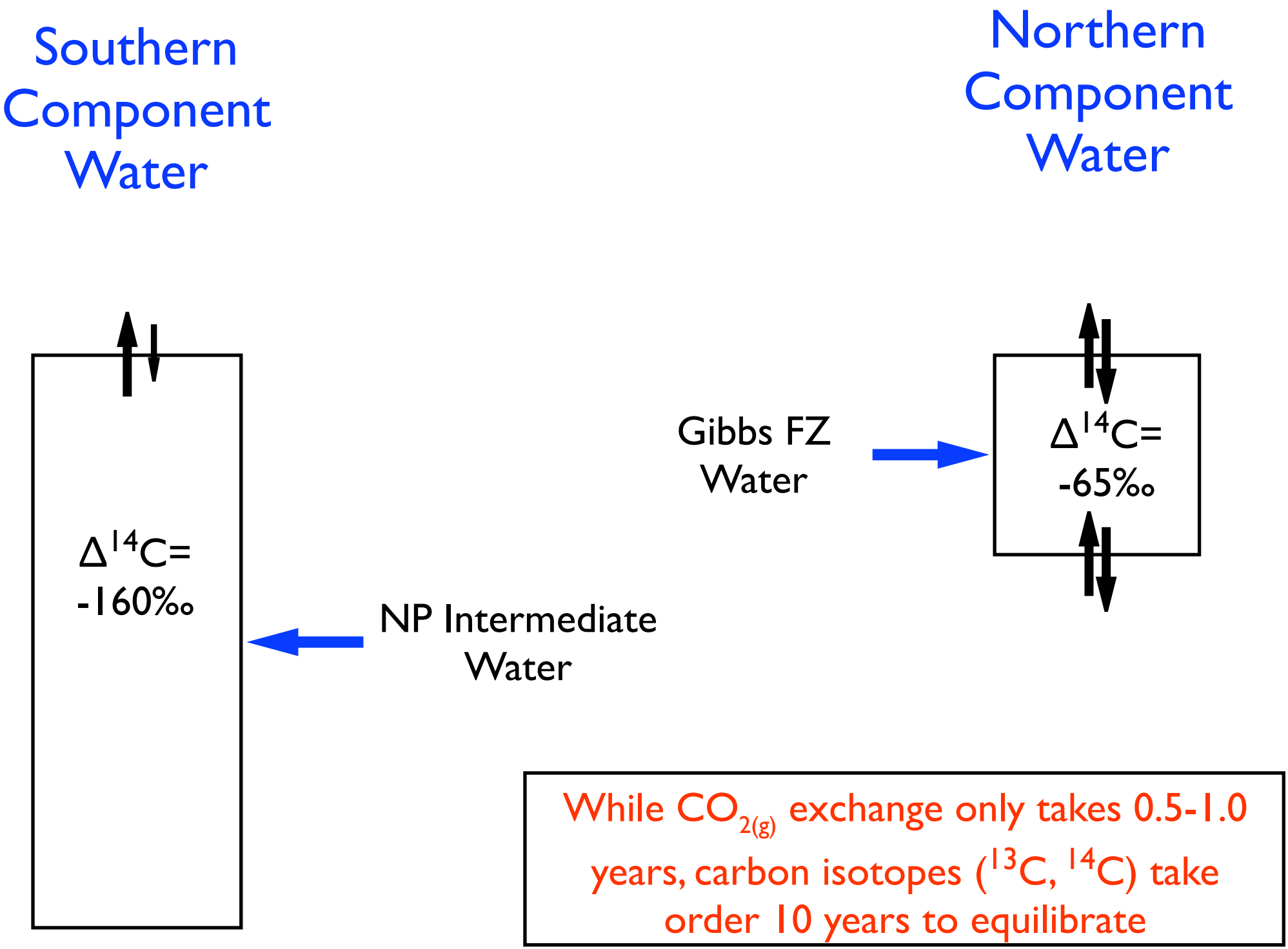


Figure 2.5.6


Southern Component Water
Northern Component Water
Gibbs FZ Water
Δ14C= -65‰
Δ14C= -160‰
NP Intermediate Water
While CO2(g) exchange only takes 0.5-1.0 years, carbon isotopes (13C, 14C) take order 10 years to equilibrate

We have two radioactive clocks in the same sample; ^{238}U - ^{234}U - ^{230}Th and Radiocarbon.

(1)
$$\left(\frac{^{14}C}{^{12}C}\right)_{MEAS.} = \left(\frac{^{14}C}{^{12}C}\right)_{PIPN} e^{-^{14}C\ Age/8033}$$

(2)
$$\left(\frac{^{14}C}{^{12}C}\right)_{MEAS.} = \left(\frac{^{14}C}{^{12}C}\right)_{Deep\ Water} e^{-Cal.\ Age/8266}$$

This lets us solve the first order decay equation:

$$N=N_0e^{-\lambda t}$$

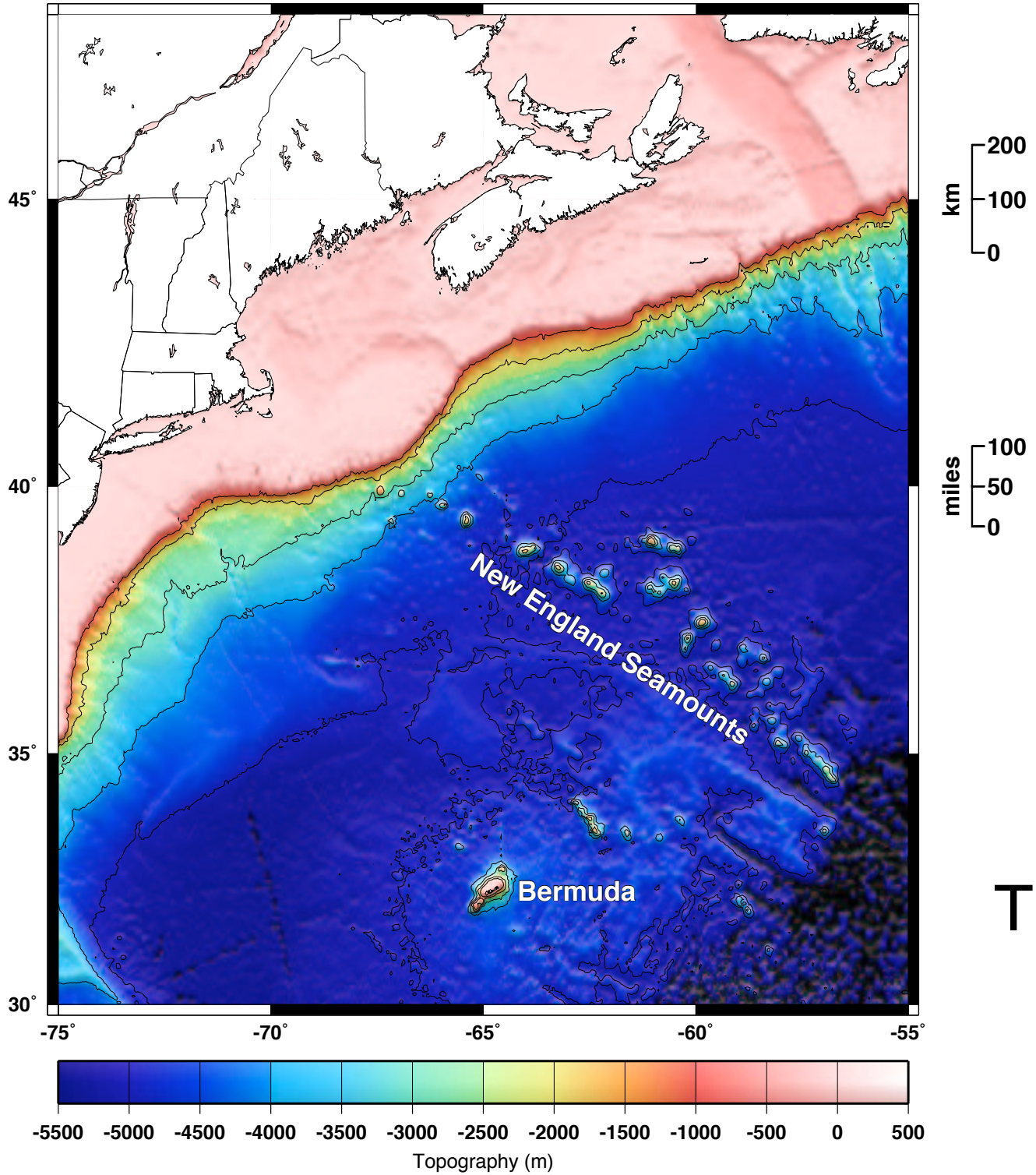
for the initial amount of ^{14}C in the ocean where the coral grew.

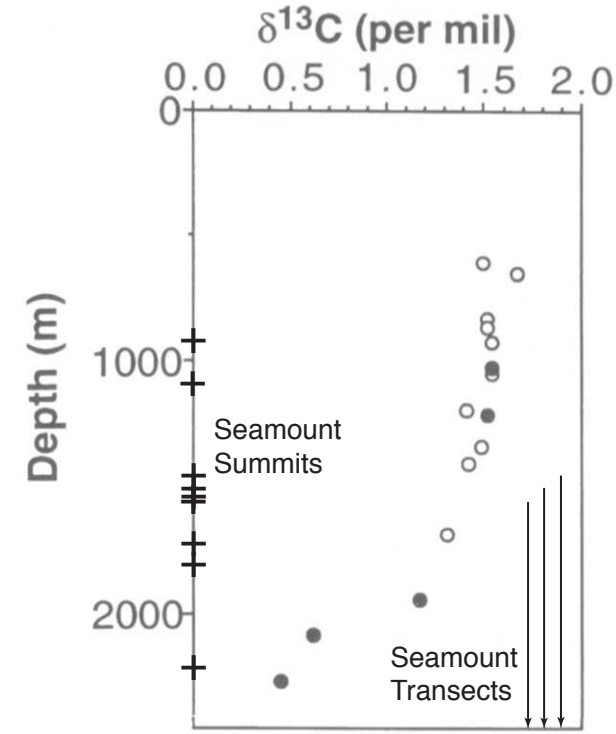
$$\left(\frac{^{14}C}{^{12}C}\right)_{Deep\ Water} = \frac{\left(\frac{^{14}C}{^{12}C}\right)_{PIPN} e^{-^{14}C\ Age/8033}}{e^{-Cal.\ Age/8266}}$$

$$\Delta^{14}C_{Deep\ Water} = \left(\frac{\left(\frac{^{14}C}{^{12}C}\right)_{Deep\ Water} - \left(\frac{^{14}C}{^{12}C}\right)_{PIPN}}{\left(\frac{^{14}C}{^{12}C}\right)_{PIPN}}\right) \times 1000$$

$$\boxed{\Delta^{14}C_{Deep\ Water} = \left(\frac{e^{-^{14}C\ Age/8033}}{e^{-Cal.\ Age/8266}} - 1\right) \times 1000}$$

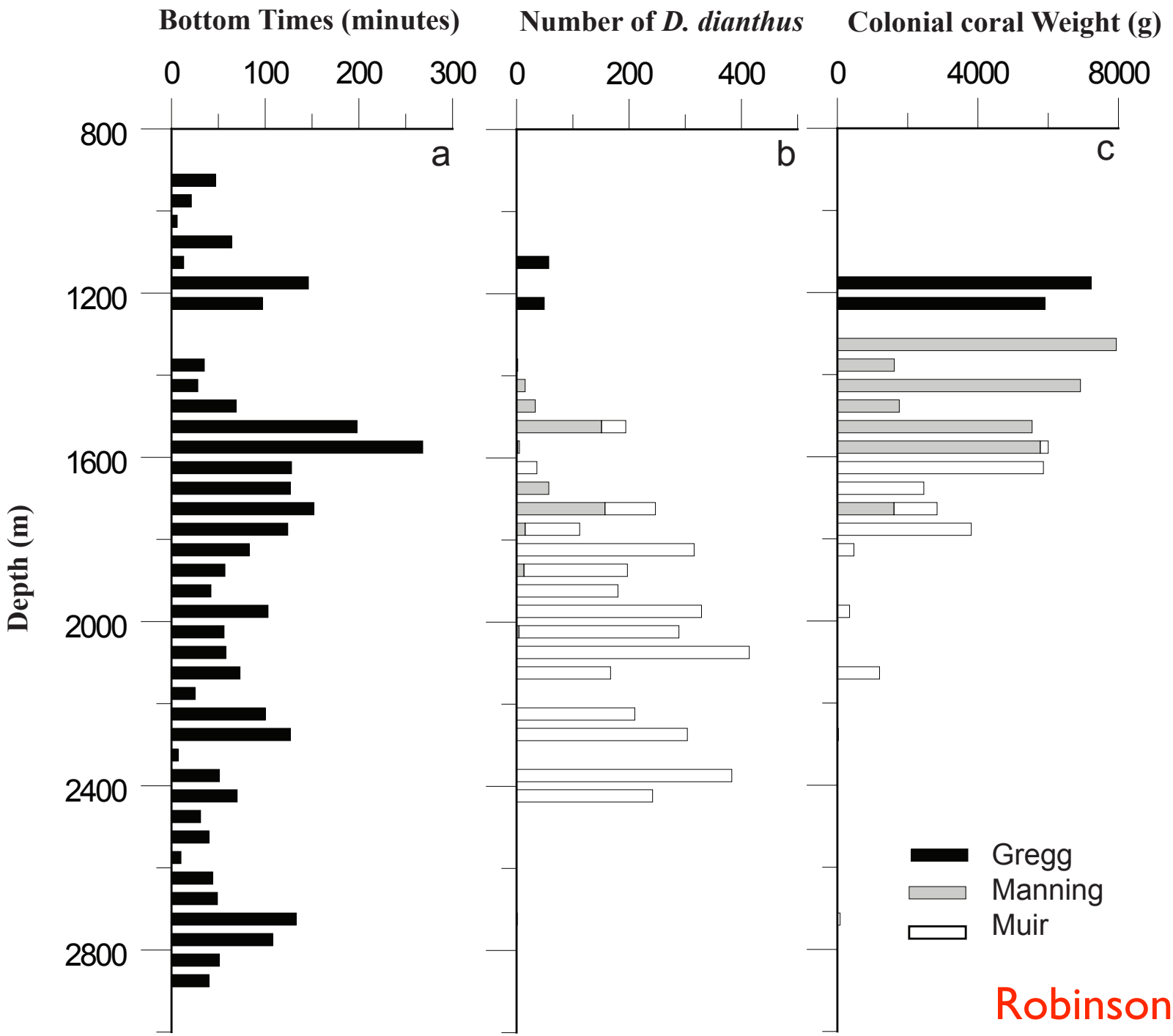
Similar calculation for Benthic-Planktonic Forams





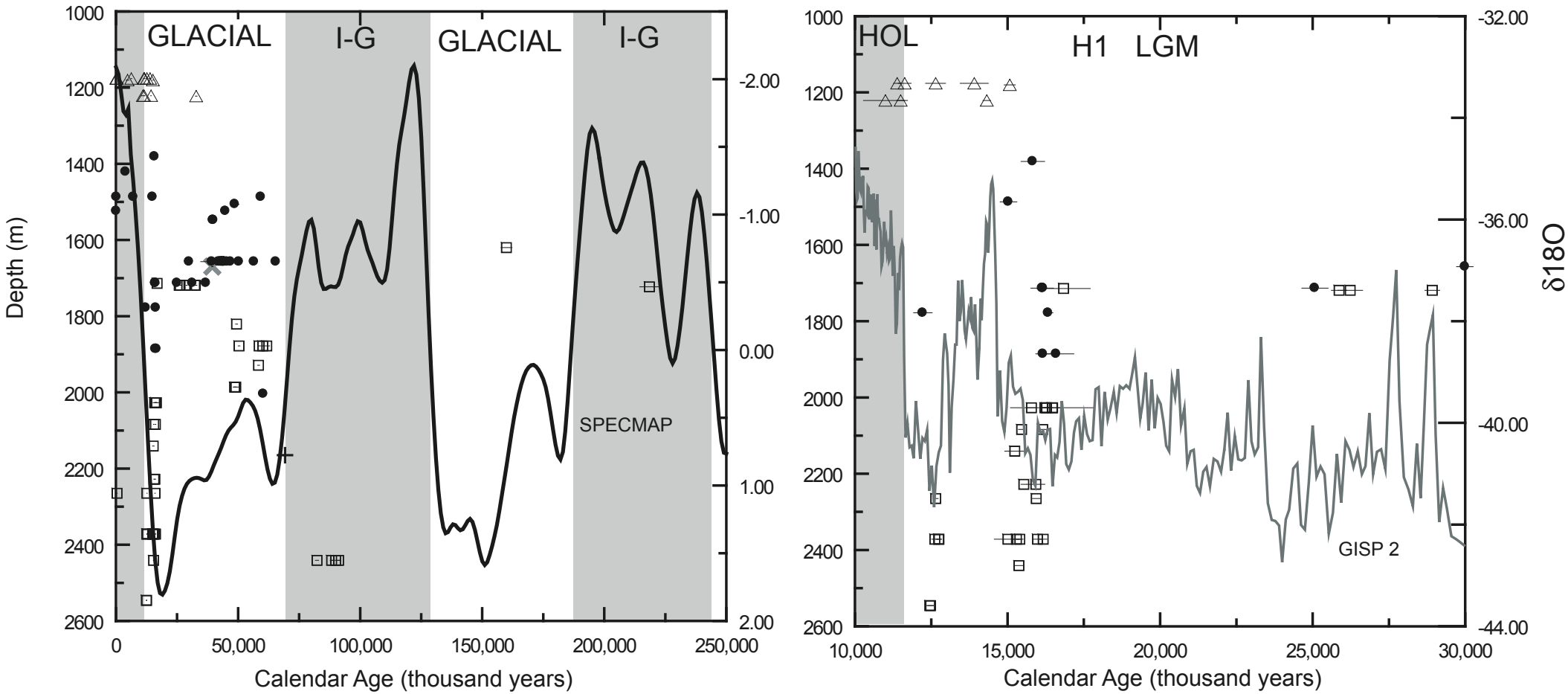
The Last Glacial Water Column at the NE Semounts

NE Seamount Fossil Coral Distribution in Depth



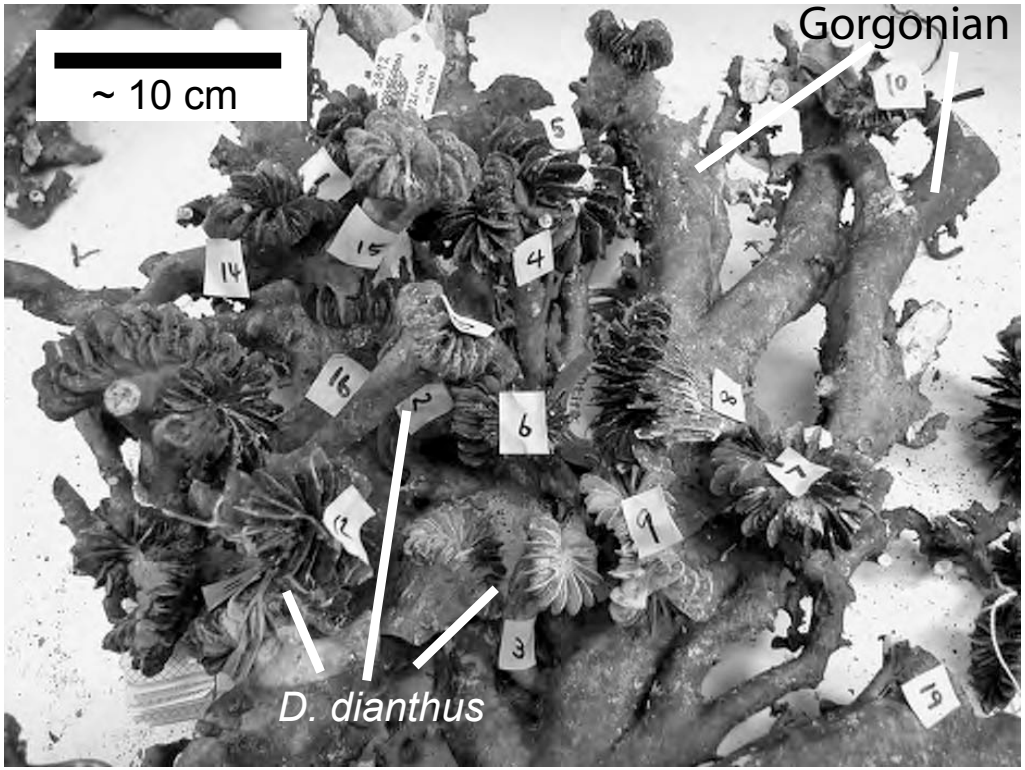
Robinson et al., 2007

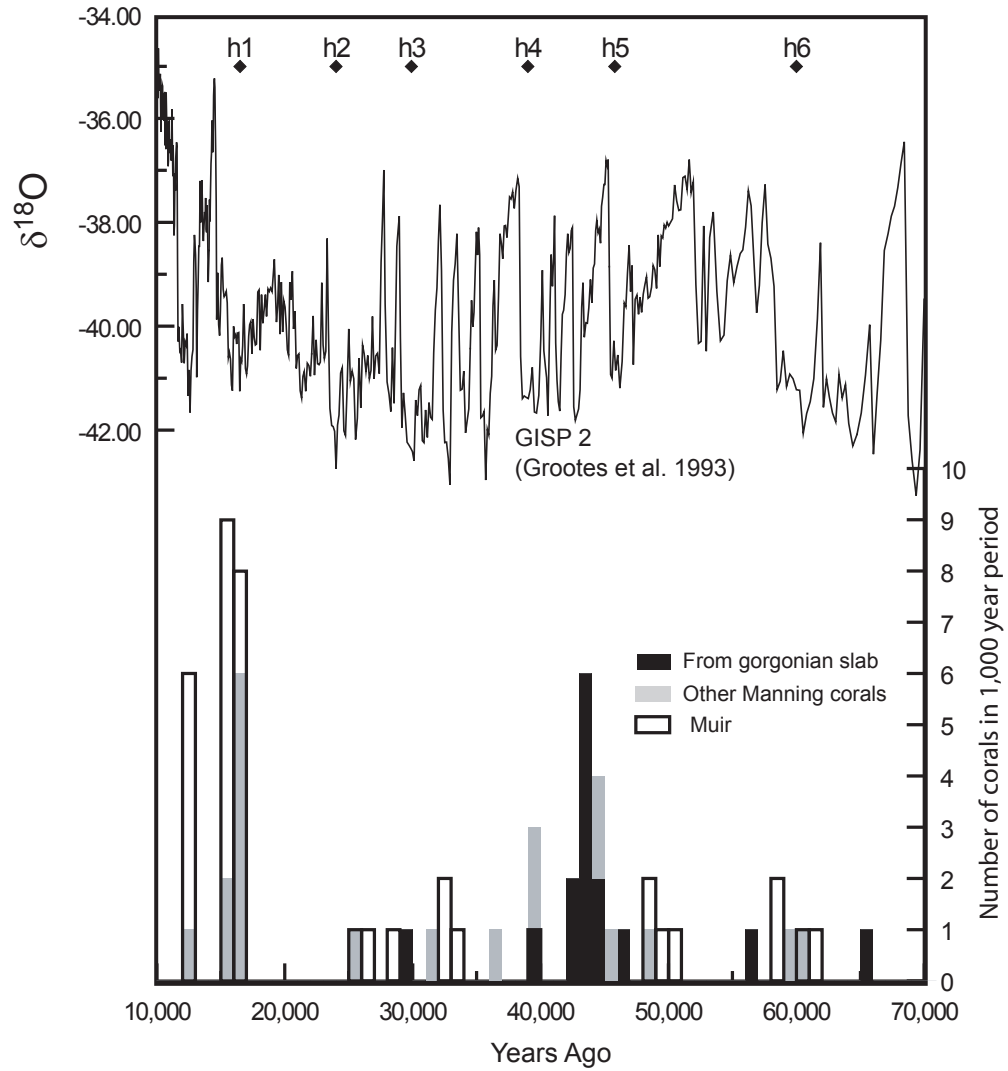
NE Seamount Fossil Coral Distribution in Time



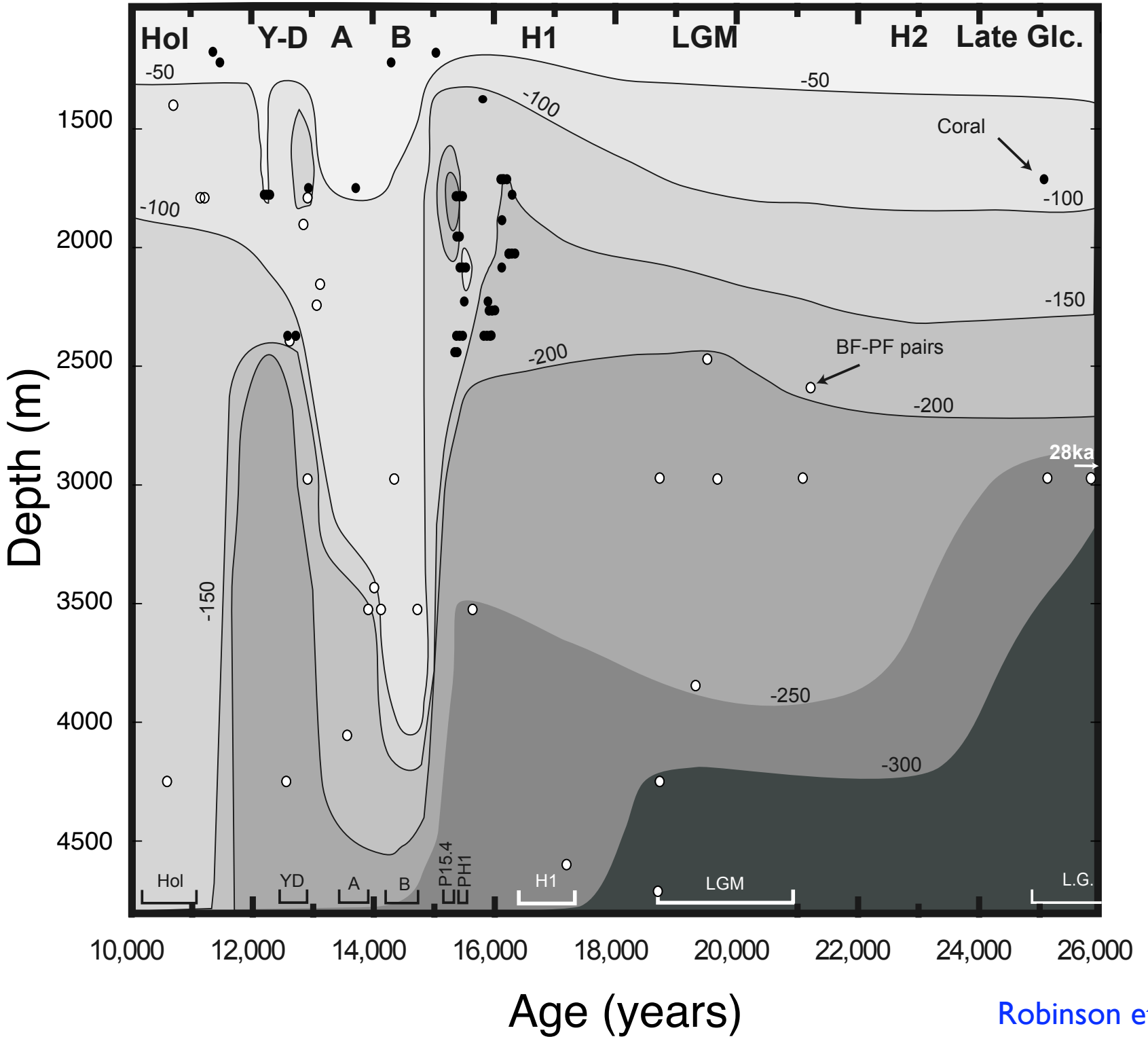
Robinson et al., 2007

Even solitary corals can be found in Bunches...



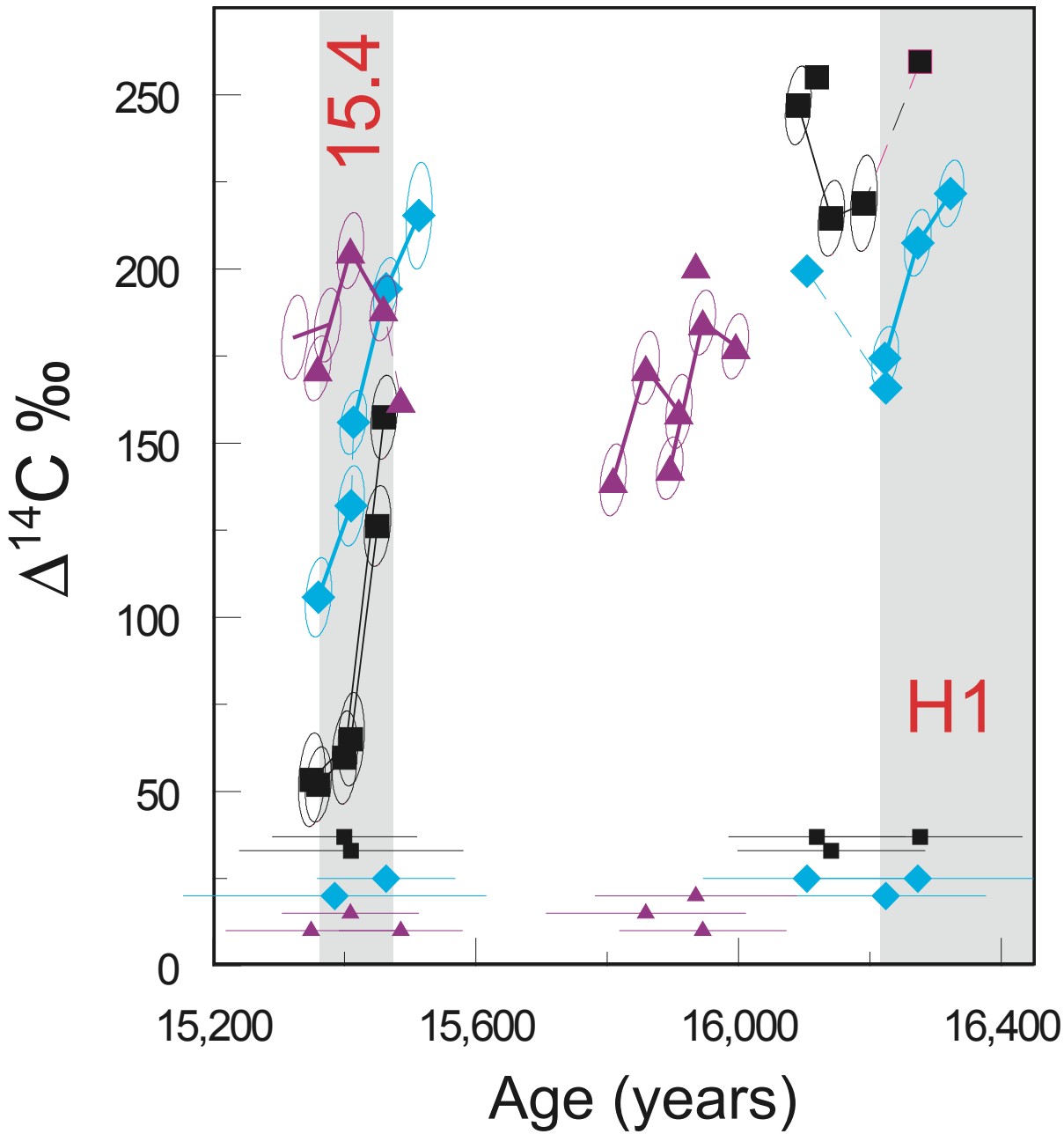


Robinson et al., 2007



Robinson et al., 2005

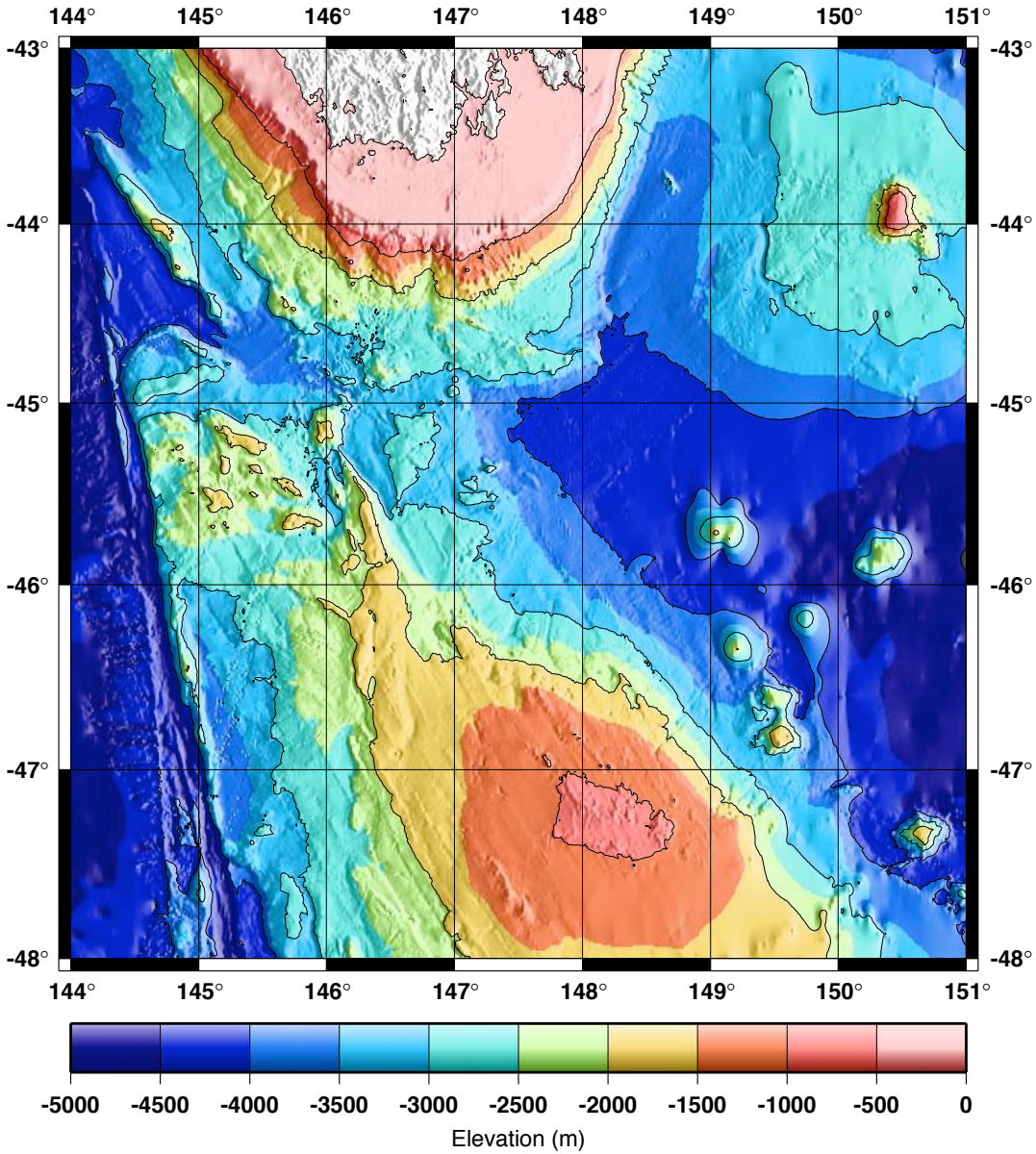
Very rapid, very large shifts in $\Delta^{14}C$ from Upper Deep Waters



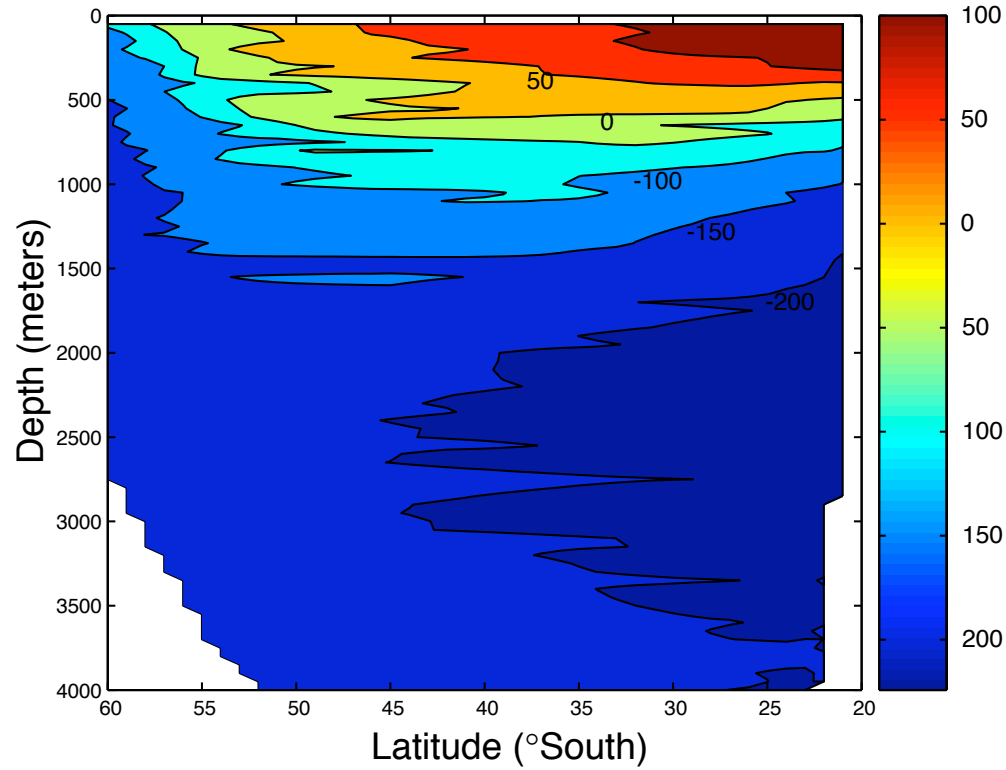
Individual corals can record deep water events. Multiple corals at the same depth "catch" same event.

Squares are 1700m
Diamonds are 2000
Triangles are 2500m

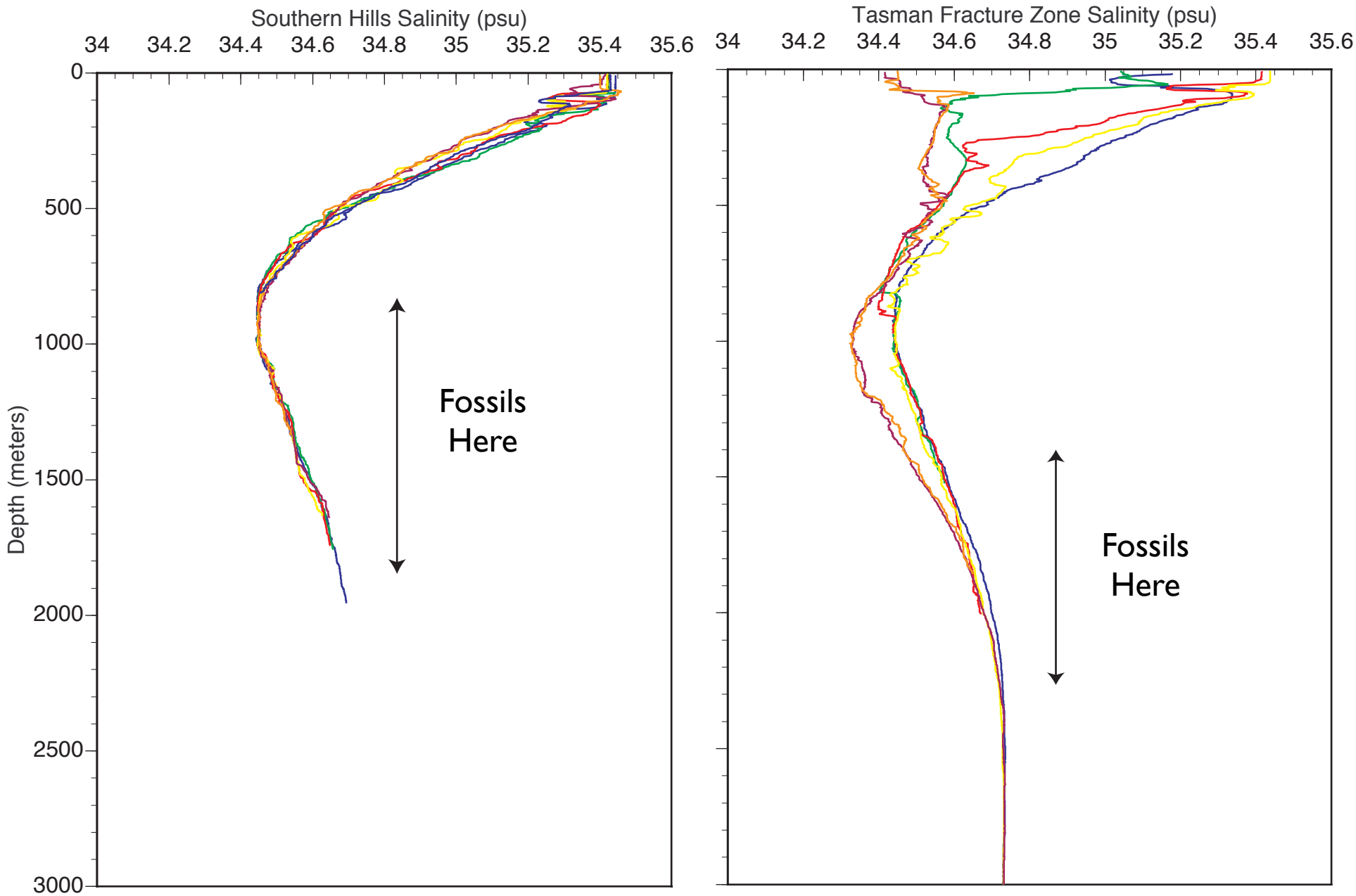
We still need constraints on the Southern Ocean end member in time



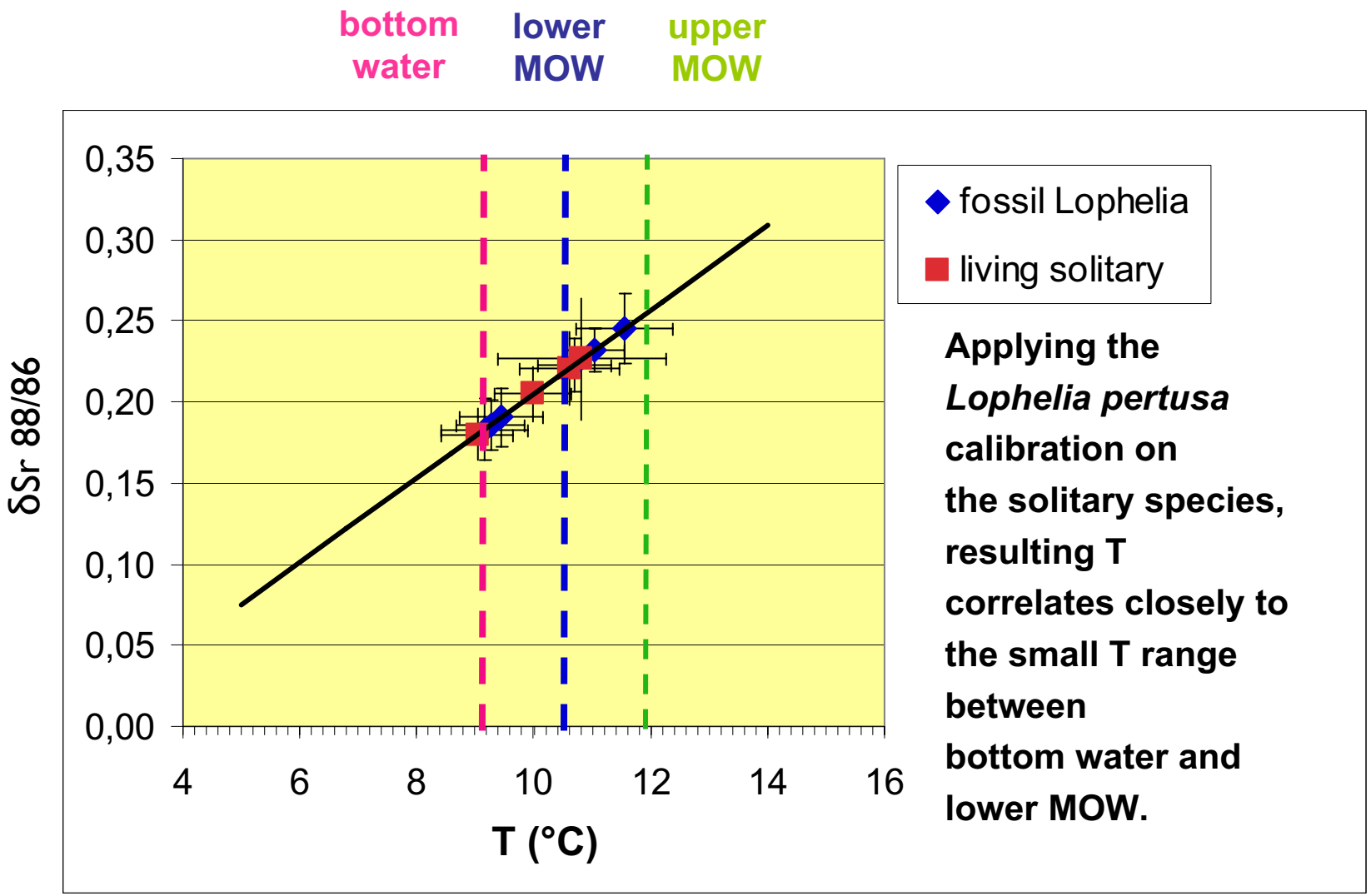
WOCE Line P16
Radiocarbon



Summary fossil scleractinian corals found with ABE/dredge south of Tasmania...



Sr-isotopes as new tracer of temperature

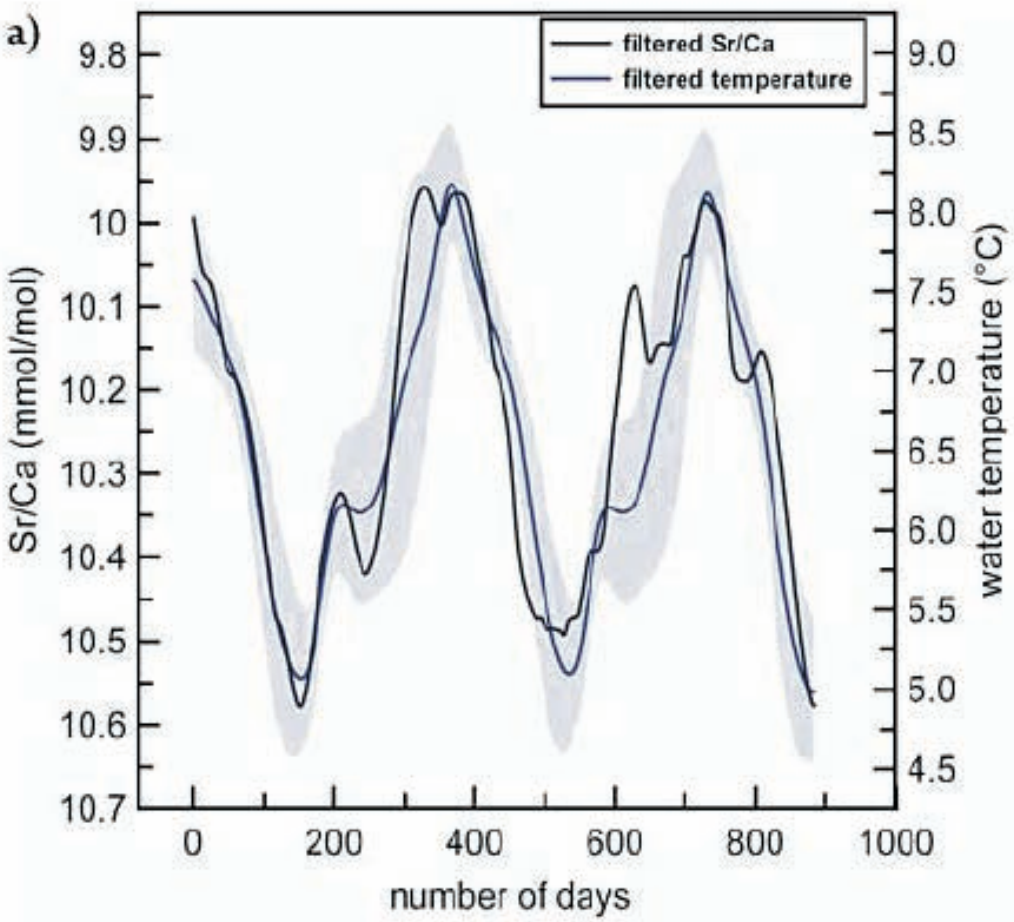


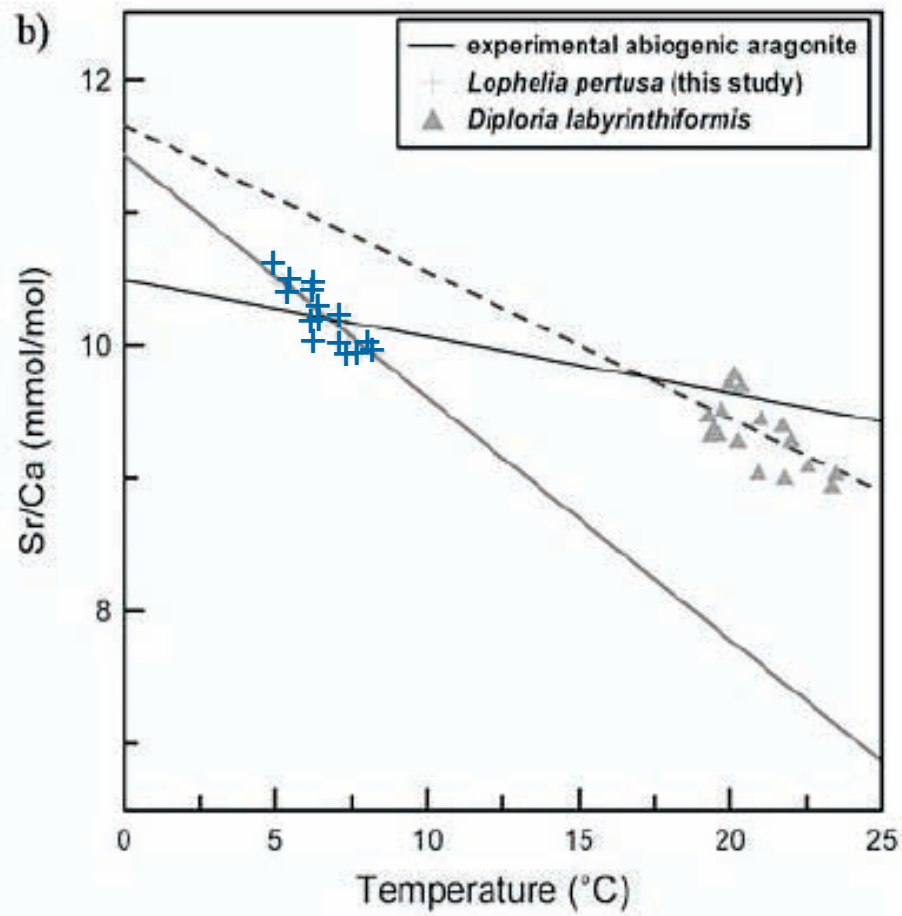
Applying the *Lophelia pertusa* calibration on the solitary species, resulting T correlates closely to the small T range between bottom water and lower MOW.

Liebetrau et al., Goldschmidt-2007, A-579

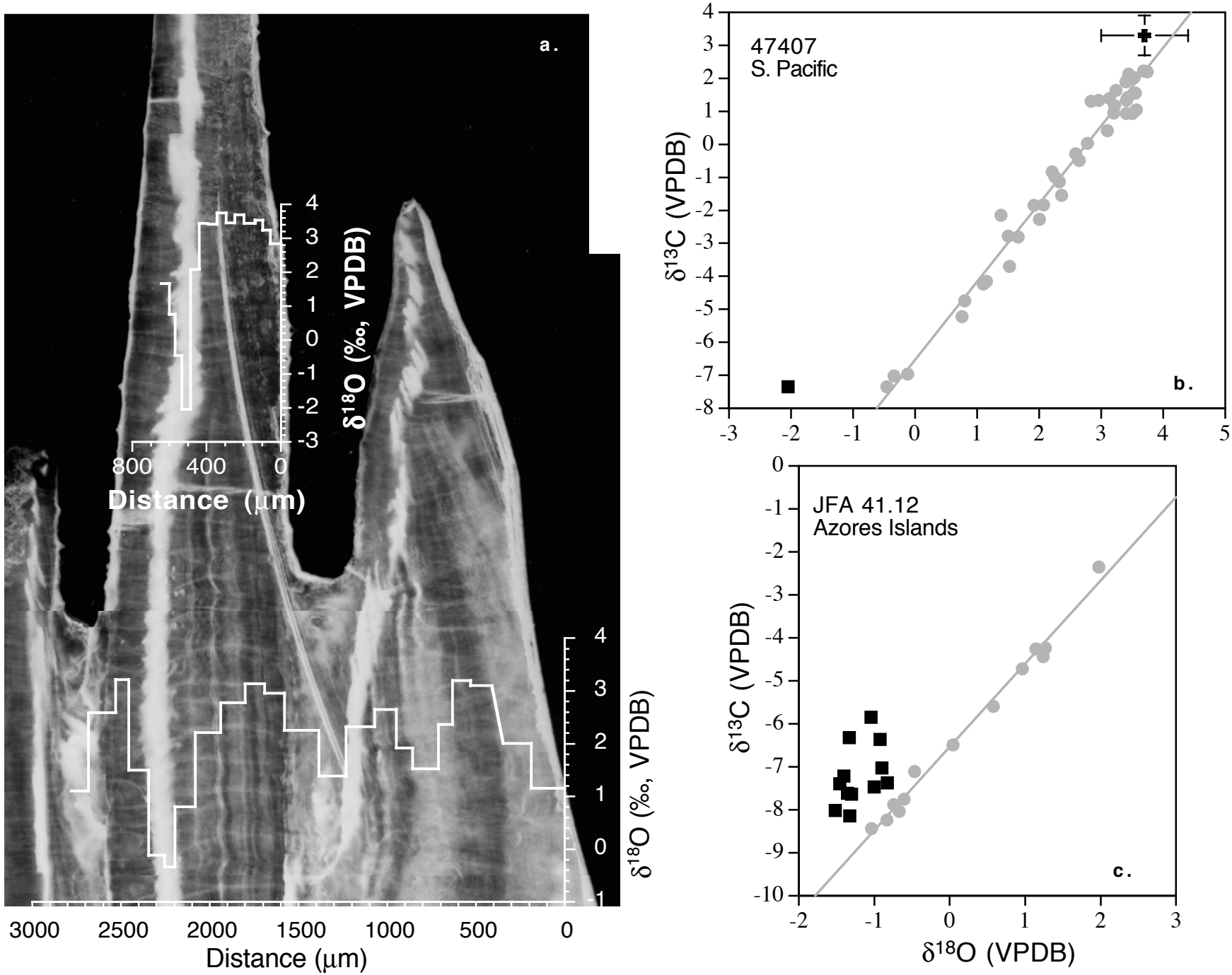
IFM-GEOMAR

Sr/Ca in Lophelia shows promise





Cohen et al., 2006


a.
Distance (µm)
δ18O (‰, VPDB)
47407
S. Pacific
b.
δ13C (VPDB)
JFA 41.12
Azores Islands
c.
δ18O (VPDB)

The Caltech fossil coral database is now on line...

coral

http://131.215.65.18:8088/fmi/iwp/cgi?-db=coral&-loadframes

Caltech Library System | Gunung Buda... Collection | Phins.com | Research Sh...d Schedules | The New Yor...Multimedia | Apple | .Mac | An

Browse

Layout: Web

View as: Form

Record: 1

Found Set: 2310

Total Records: 2310

Unsorted

Log Out

Coral Database

Sample Name	ALV-4162-1457-001-001-2086		
Station Number	1	Dive Number	4162
Platform	Alvin	Sample Code	1
Sample Number	1		
Time (GMT)	14:57		
Date	10/28/2005		
Depth (m)	2086	Size cm	
Alvin X	4962	Morphology	aggregate
Alvin Y	7702		
Latitude		Longitude	
Lat Deg		Long Deg	
Lat Min		Long Min	
Lat Dir		Long Dir	
Sea Mount	Picket		
Weight (grams)	307.5		
Genus Type	Desmophyllum		
species	dianthus		

Research Goals/Big Questions

-Dates, dates, dates
-Spatial Patterns
-Move South (climate goal)
-Proxy Development (fit in TRACES?)