

Evidence for meltwater pulse 1a in the Gulf of Mexico based on bulk sediment $\delta^{18}\text{O}$ and radiogenic isotopes

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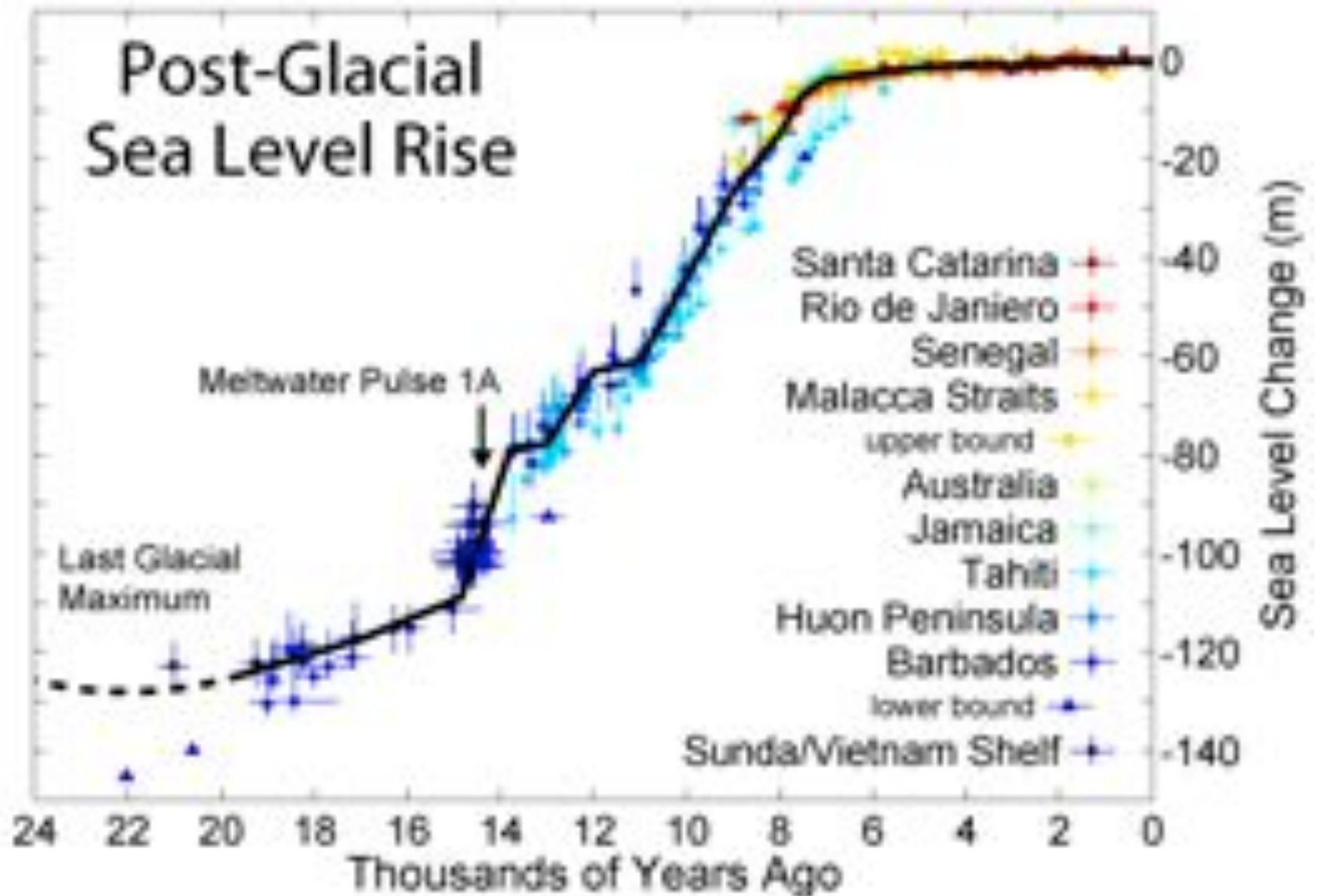
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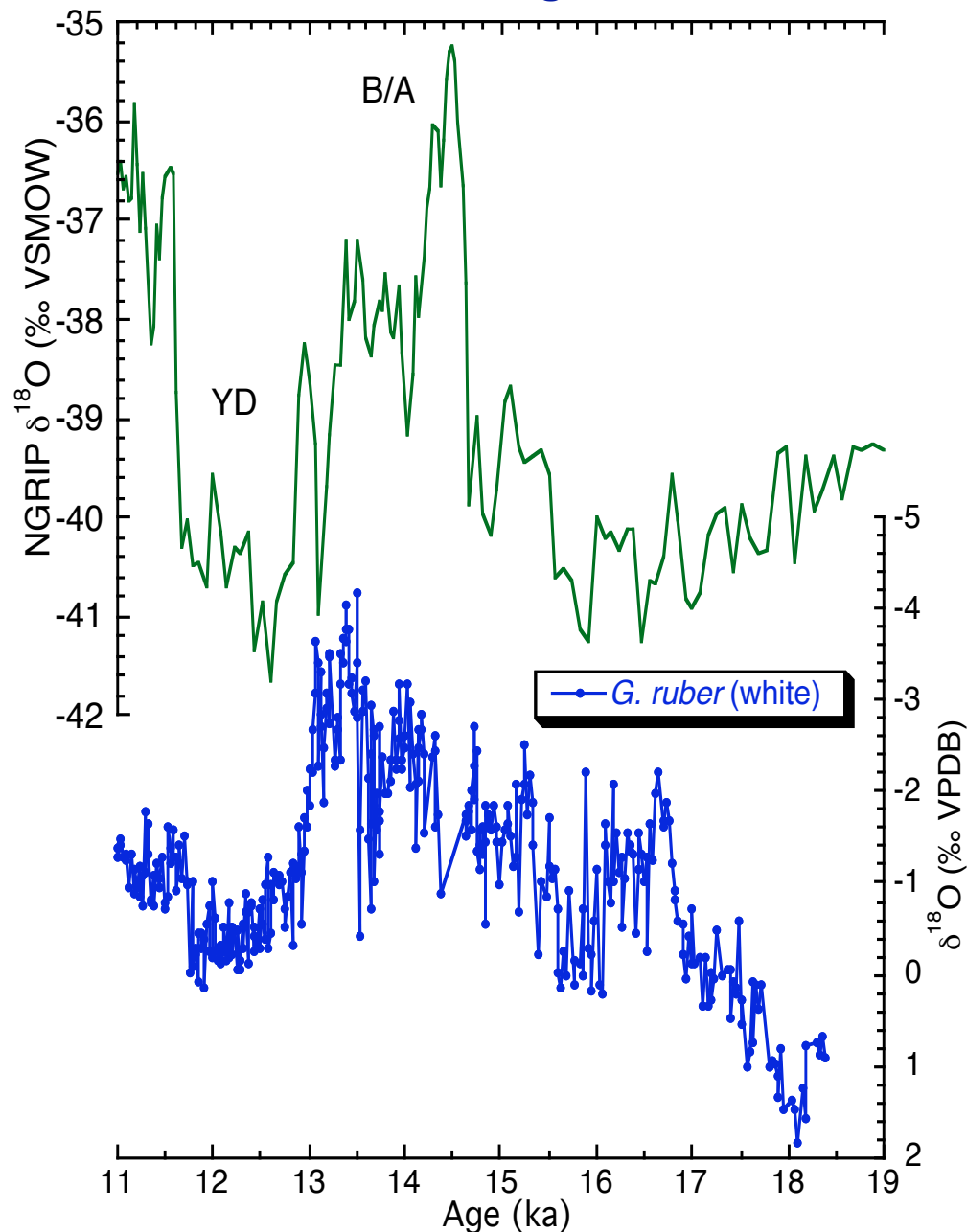


1. Research Motivation: What was the source of MWP-1A?



- 24 m rise in <500 years ca. 14-14.6 ka
- Ice-sheet modeling indicates LIS source but “sea-level fingerprinting” says Antarctica

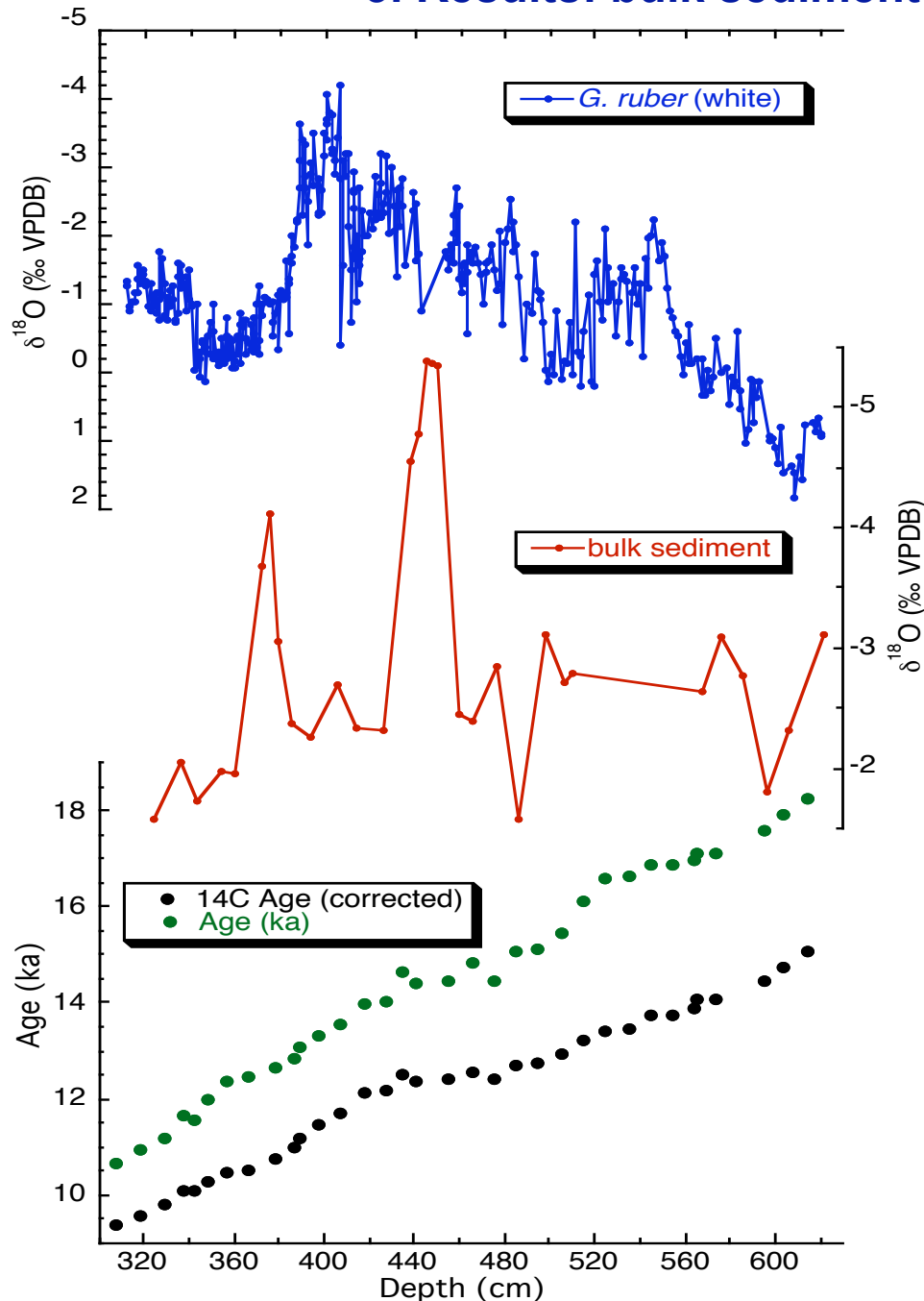
2. Background: LIS meltwater to Gulf of Mexico



- Foraminiferal $\delta^{18}\text{O}$ from Orca Basin core MD02-2550 indicates LIS meltwater from ca. 17-13 ka (Flower et al., 2004, 2011; Williams et al., submitted)
- Could data gap due to lack of foraminifera ca. 14.4 ka reflect MWP-1A?



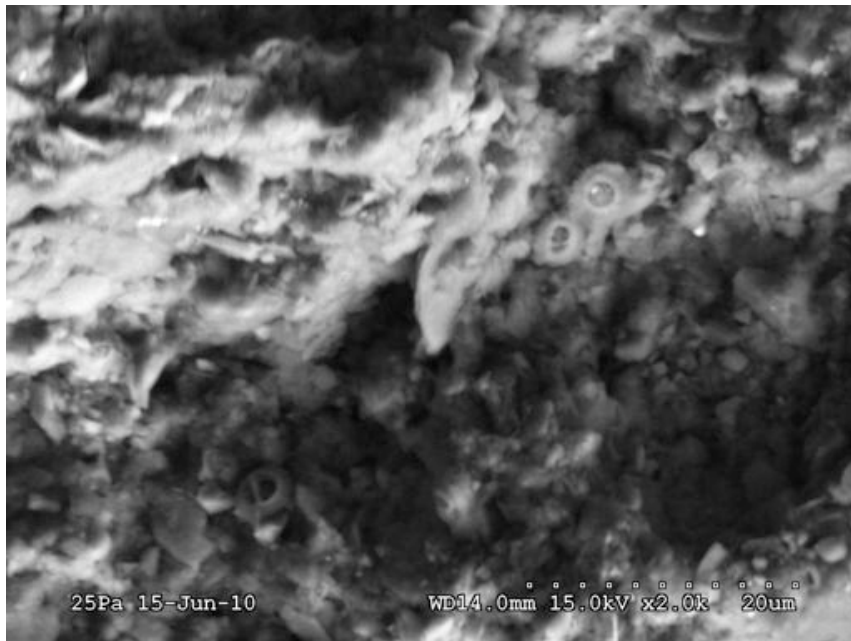
3. Results: bulk sediment $\delta^{18}\text{O}$ from Orca Basin



- Bulk sediment $\delta^{18}\text{O}$ reveals two negative excursions to about -4 to -5‰ at 442-453 cm (ca. 14.35-14.54 ka) and 372-380 (ca. 12.57-12.74 ka)
- Fine carbonate sediment from Canadian Paleozoic marine carbonates, analogous to detrital carbonate in the North Atlantic ($\delta^{18}\text{O} = -5\text{‰}$; Hodell and Curtis, 2008)

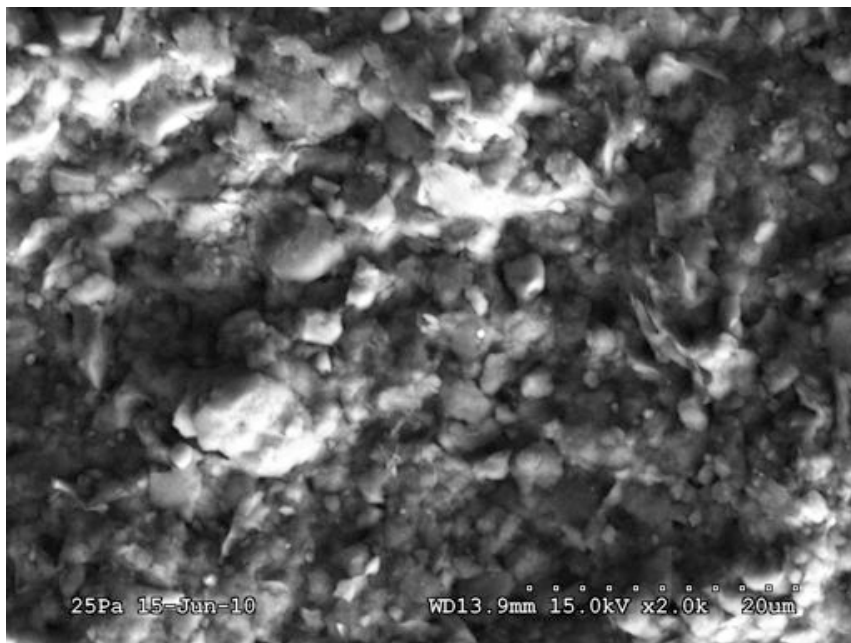


Paleozoic limestones near Montana/Alberta border



Normal sediment SEM

Coccoliths are readily visible in normal sediment (336 cm at 2000X)



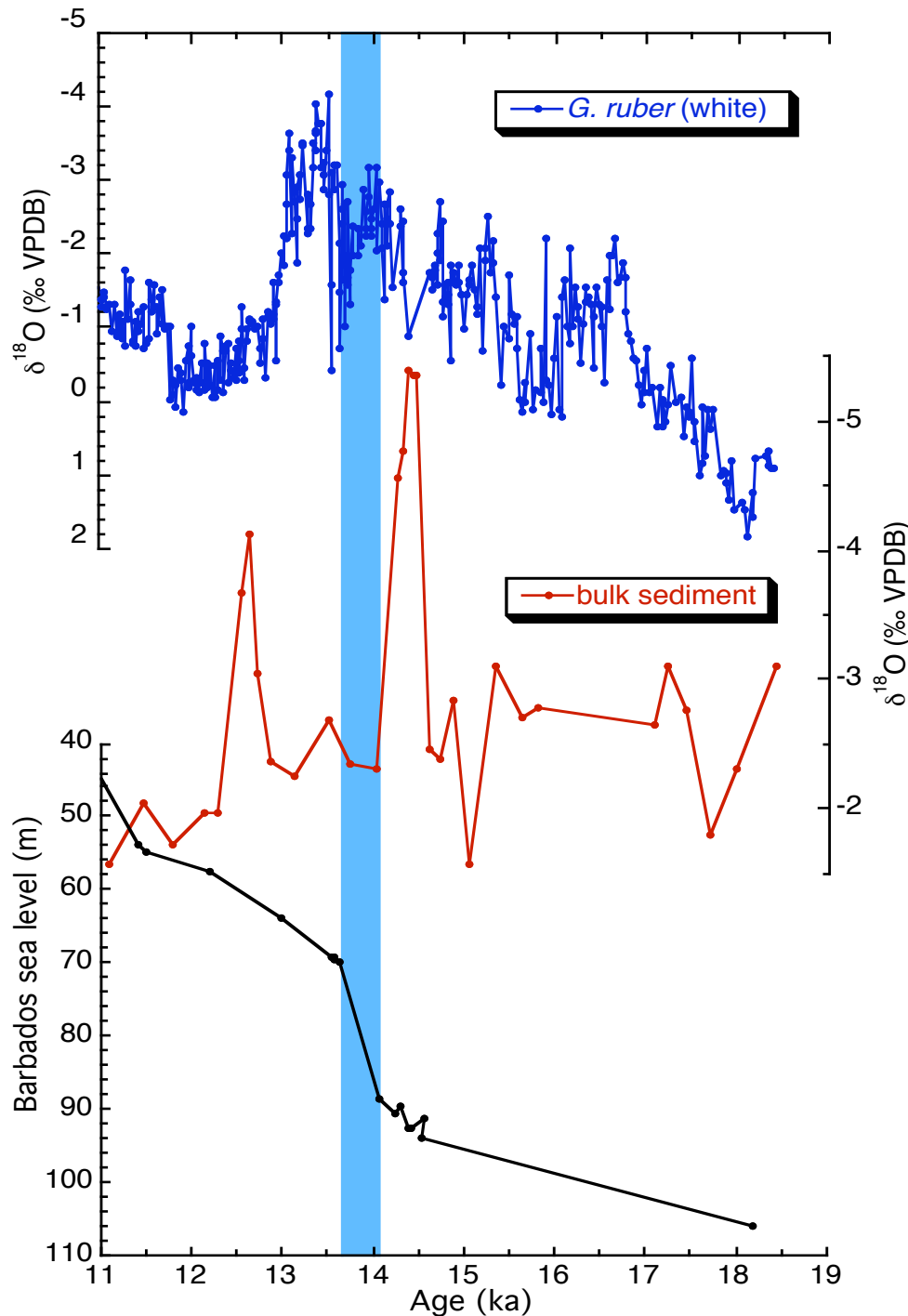
Foram-poor interval SEM

Coccoliths are absent in foram-poor interval (448 cm at 2000X)

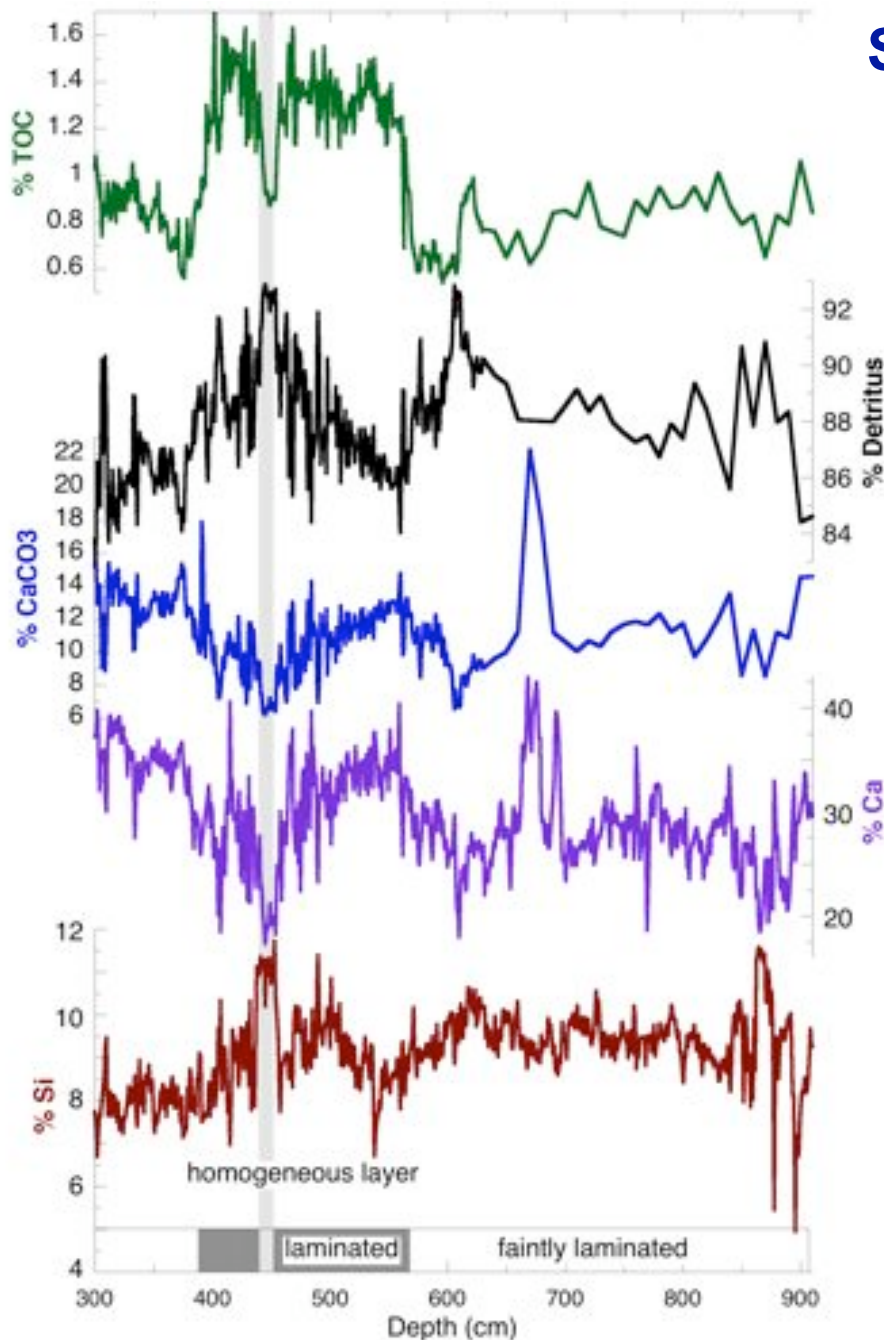
Photo credit: Paul Suprenand

Evidence for MWP-1A?

- First $\delta^{18}\text{O}$ excursion from ca. 14.54-14.35 ka seems to precede MWP-1A ca. 13.61-14.17 ka (Stanford et al., 2006)
- However, data from new Barbados drillcores indicate a ~20 m MWP-1A ca. 14.6-13.9 ka (Mortlock et al., 2010)



Significant pulse of terrestrial input

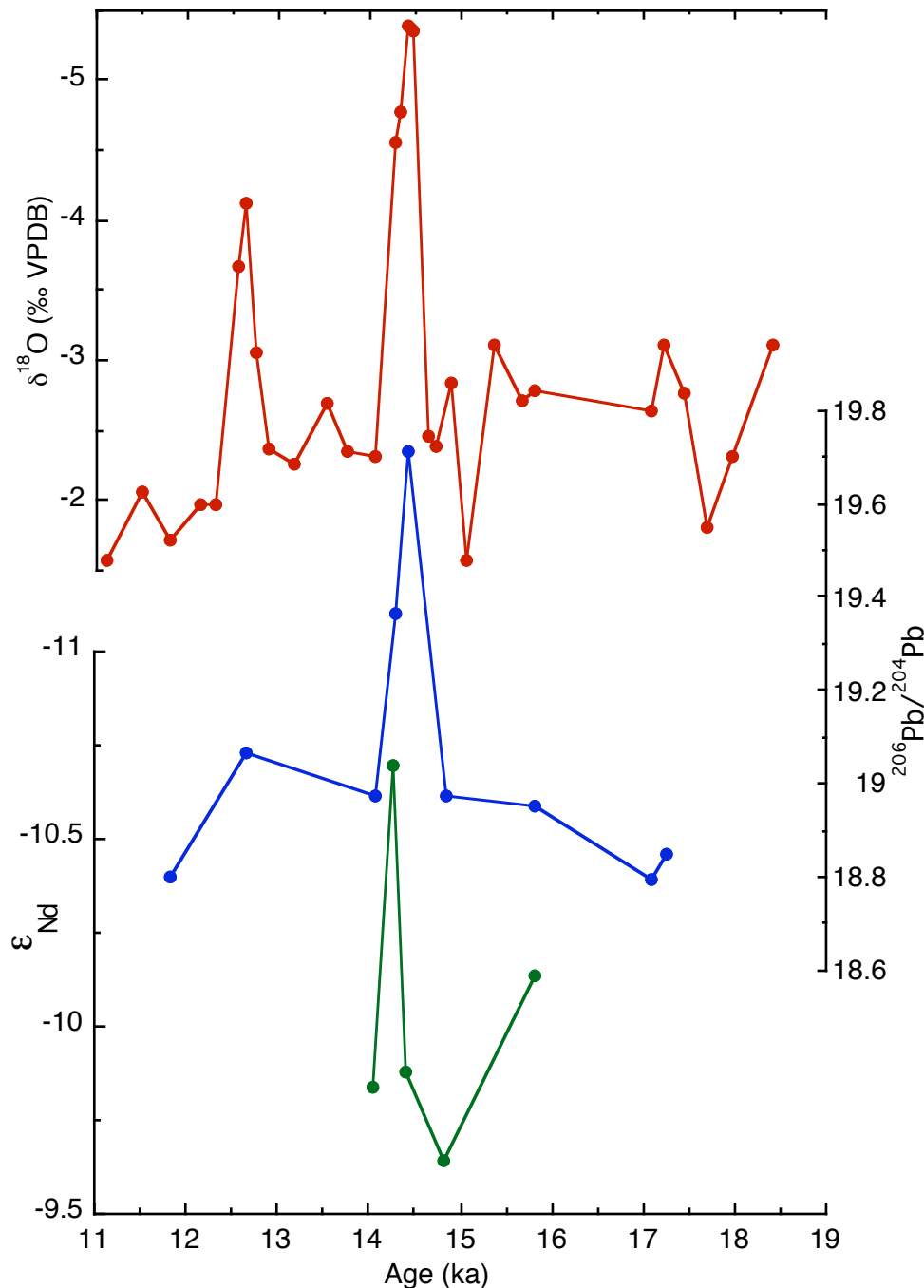


- First $\delta^{18}\text{O}$ excursion coincides with unique homogeneous layer at 442-453 cm
- Homogeneous layer is marked by distinct minima in %TOC, %CaCO₃, and %Ca, (plus $\delta^{13}\text{C}_{\text{org}}$; not shown)
- Distinct maxima are seen in %Detritus and %Si (plus %Ti; not shown)
- These spikes are consistent with a significant, brief pulse of terrestrial input, and/or a pause in marine input

**(after Meckler et al., 2008, EPSL;
unpublished XRF scanning data)**

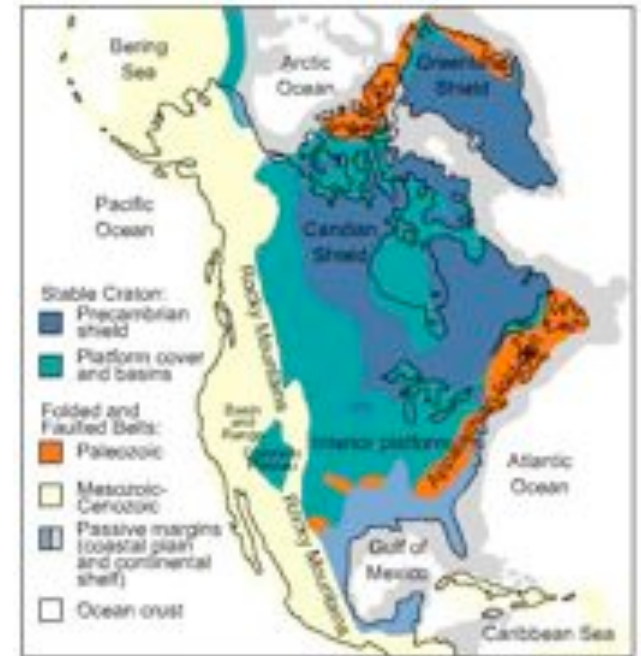
Radiogenic isotope data (E. Martin and N. Biller, UF)

- Peak $^{206}\text{Pb}/^{204}\text{Pb}$ values (more radiogenic) coincident with lowest $\delta^{18}\text{O}$
- Minimum ϵ_{Nd} values (less radiogenic) close to peak $^{206}\text{Pb}/^{204}\text{Pb}$ values
- These data are consistent with a spike in older continental material from Canadian sources



High $^{206}\text{Pb}/^{204}\text{Pb}$
Low ϵ_{Nd}

Low $^{206}\text{Pb}/^{204}\text{Pb}$
High ϵ_{Nd}



Tectonic features of North America. From Press and Siever (1995).

Conclusions

- First $\delta^{18}\text{O}$ excursion may reflect fine carbonate delivered 14.54-14.35 ka from Canadian bedrock, associated with MWP-1A
- Correlative geochemical data indicate a significant increase in terrestrial input
- Radiogenic isotope data confirm an increase in older continental material derived from Canada relative to younger material from the Mississippi River drainage basin
- Coincidence would imply that MWP-1A included an LIS source
- Association with the onset of the Bølling suggests a high sensitivity of the Laurentide Ice Sheet to rapid warming