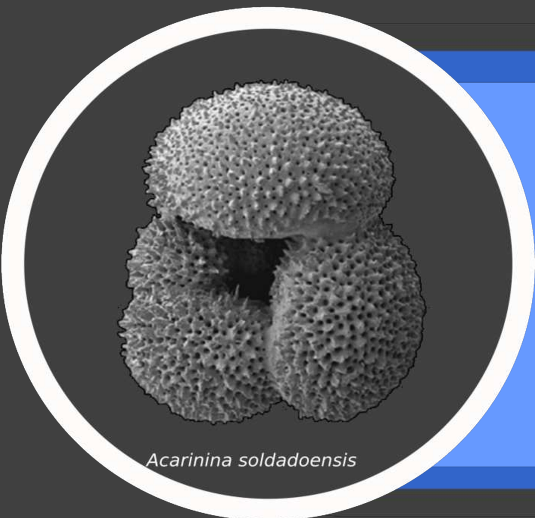

Early Antarctic ice-sheet variability: deep-sea temperature and global sea-level evolution in the early Oligocene derived from clumped isotopes

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1 Climate of the past

Aim: reconstructing Cenozoic climate history

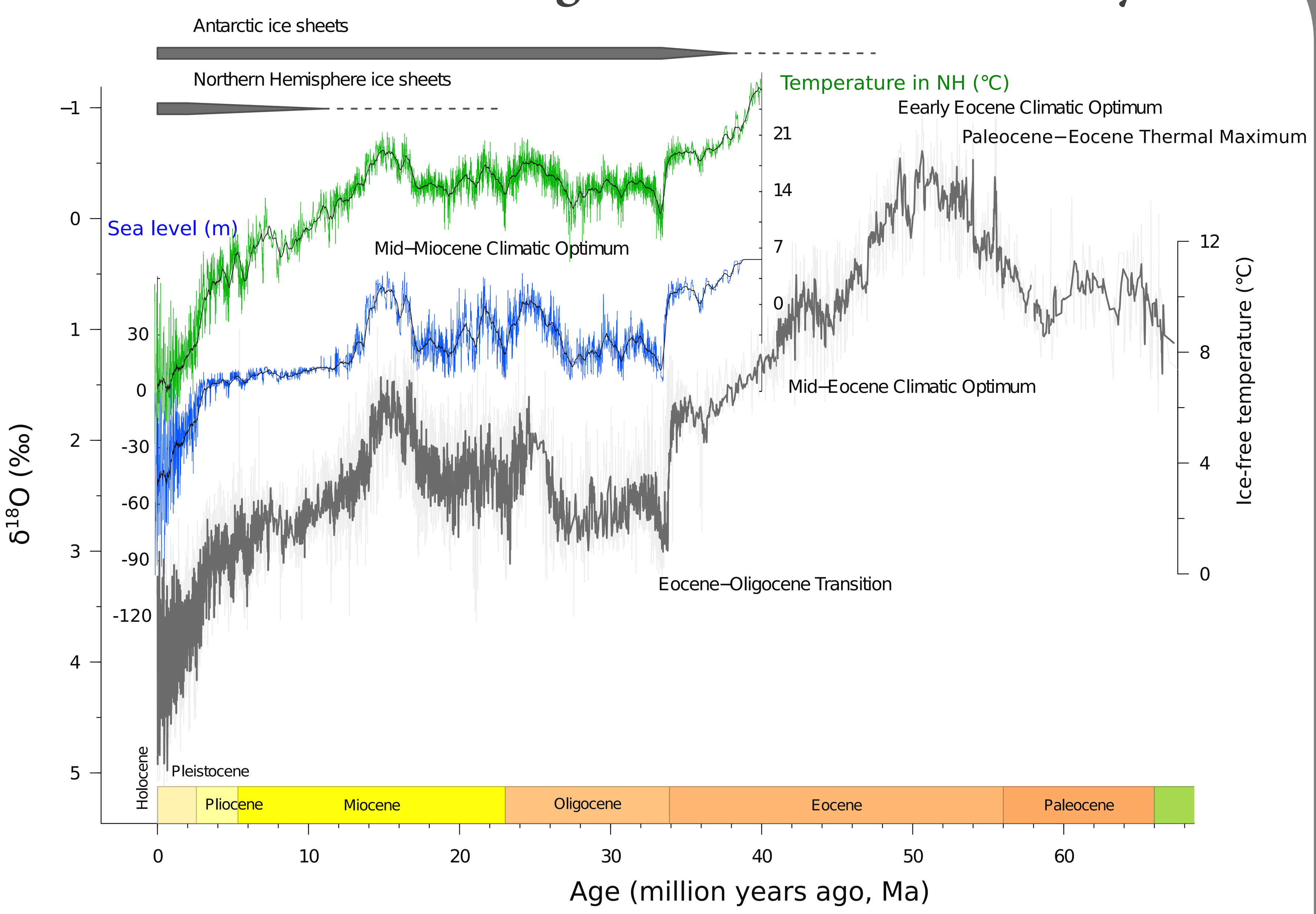
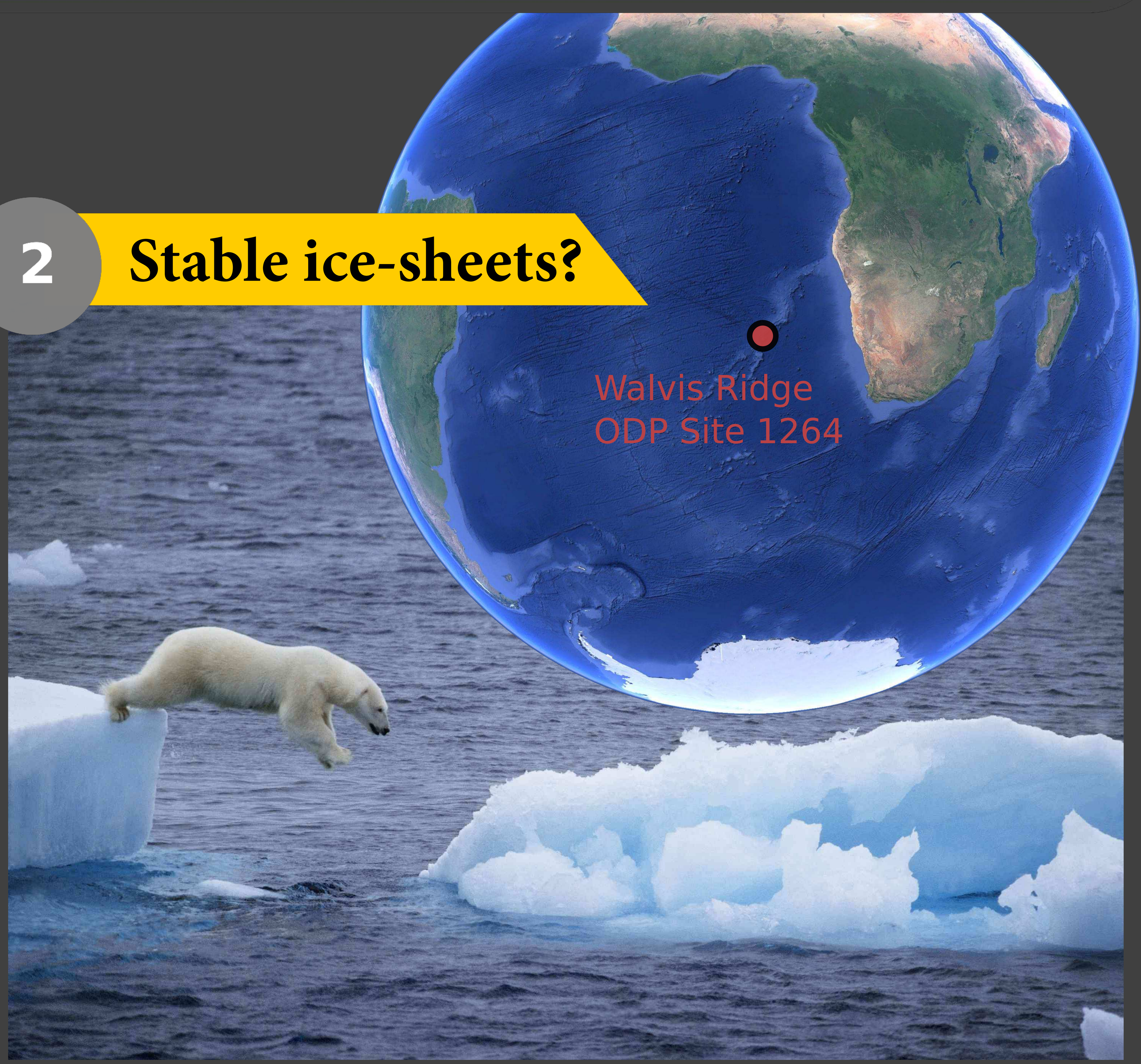


Figure 1: Cenozoic oxygen isotope ($\delta^{18}O$) compilation from deep-sea benthic foraminifera (gray)[1,2]. Split into sea-level (ice-volume) (blue) and temperature (green) components—relative to present-day—from a transient 3D ice-sheet model[3].

2 Stable ice-sheets?



Strong 100-kyr cycles in $\delta^{18}O$: sea-level or temperature?

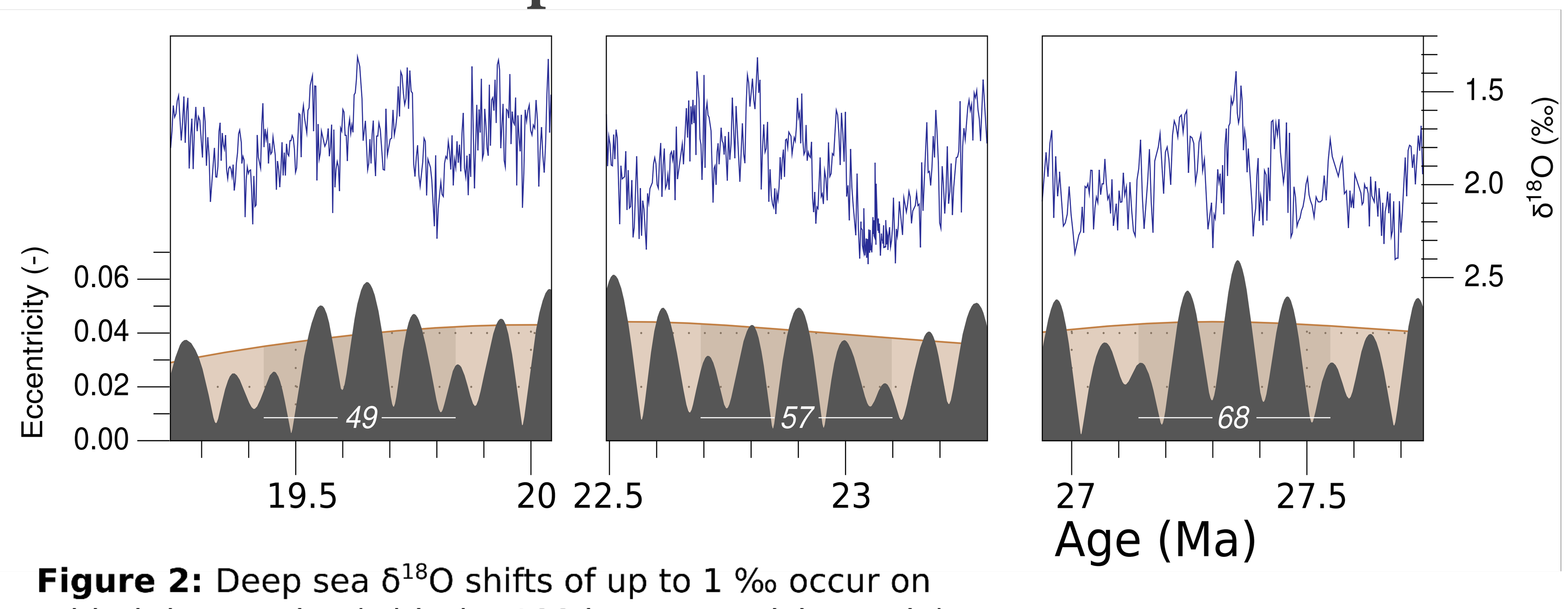


Figure 2: Deep sea $\delta^{18}O$ shifts of up to 1 ‰ occur on orbital time-scales (with the 100 kyr eccentricity cycle) shortly after the EOT. Under ice-free conditions this would correspond to ~4 °C. Figure adapted from[4].

3 Clumped Isotopes

Clumped isotopes are only affected by temperature

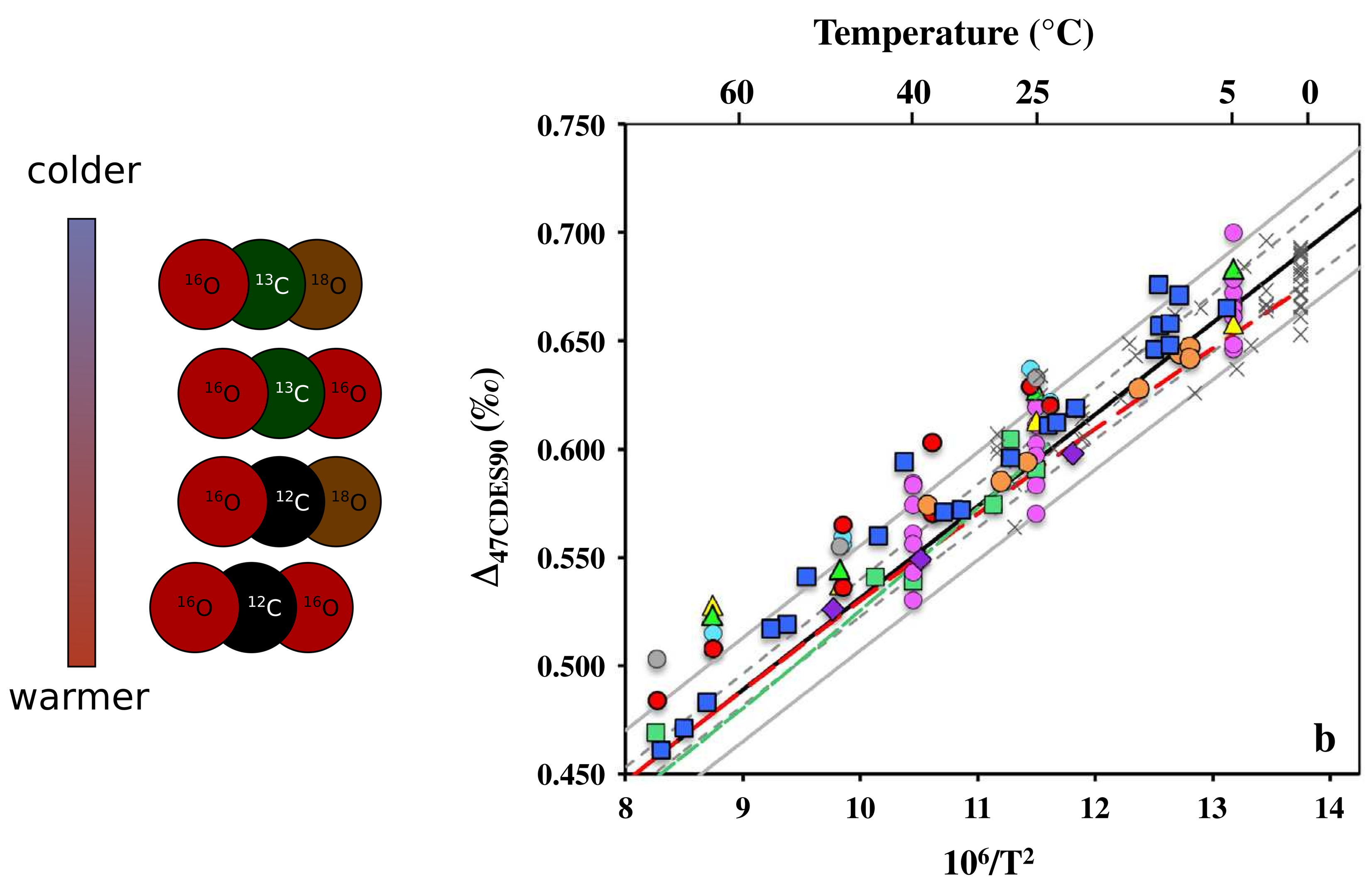
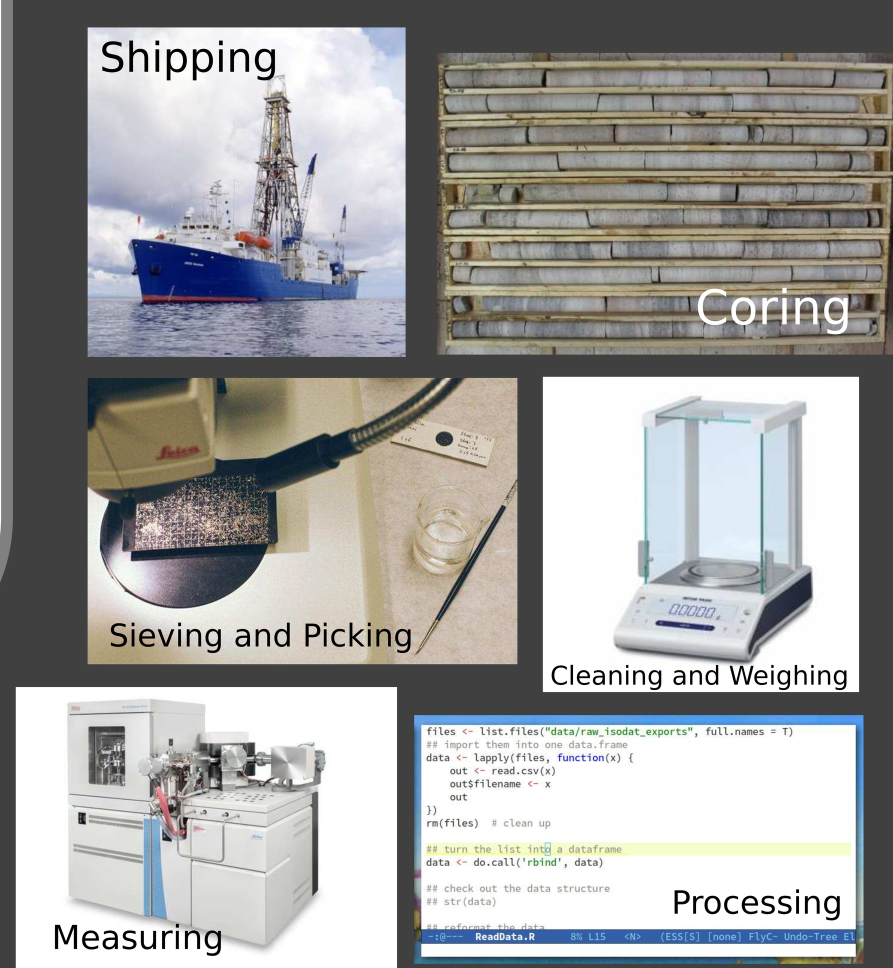


Figure 2: Heavier stable isotopes of oxygen (^{18}O and ^{17}O) and carbon (^{13}C) are preferentially embedded in CO_3^{2-} when surrounding temperatures are cooler. Right figure adapted from[5].

Methods 4



Our Δ_{47} measurement methods

0. 25–35 aliquots of 10–15 (~120 µg) foram shells.
1. Dissolve washed foraminiferal shells in phosphoric acid at 70 °C in a Kiel 3[4] device.
2. Purify released CO_2 with cold traps and a porapak (to get rid of organic compounds).
3. Measure on a Thermo Scientific MAT 253[+] spectrometer.
4. Perform Pressure Base Line correction.
5. Apply ETF using 4 carbonate standards.
6. Apply acid fractionation correction.
7. Get high-res $\delta^{13}C$, $\delta^{18}O$, and a low-res Δ_{47} record.
8. Profit.

5 Limitations

The uncertainty in measurements requires many replicate measurements, and thus ample sample material.
We try to improve measurement precision and accuracy by including many standards in an optimal measurement regime.

6 Preliminary conclusions

The ideal carbonate standard distribution significantly reduces the uncertainty of the final temperature estimate.

For a sample of 0 °C, changing the distribution of standards results in a 24% decrease in the uncertainty. Adding a new cold standard would result in a 35% decrease.

Acknowledgements

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