Estimating **PALEOSEASONALITY** using Clumped Isotopes on Gastropods

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How can we use new techniques to improve paleoclimate reconstruction?
(PALEO) SEASONALITY

Changes in seasonality impact…

- Agricultural effects
- Ice sheet mass balance

More *felt* by average person than +0.5°C MAT
(PALEO) SEASONALITY

- Get it from models, but not from many proxies
- No idea whether models are accurately predicting seasonal cycle!
Isotopic SCLEROCHRONOLOGY
Isotopic SCLEROCHRONOLOGY

Distance (mm) along growth axis

d18O (pdb)
Isotopic SCLEROCHRONOLOGY

Temp = 21.8 - 4.69*(δ^{18}O_{carb} - δ^{18}O_{water})

[Assumed = 1.1‰]

Isotopic Sclerochronology

Max-Min Range = 8°
Isotopic Sclerochronology

Max-Min Range = 8°

Actual < 2°
Changes in $\delta^{18}O_{\text{water}}$ can effect inferred temperature seasonality in either a constructive or destructive way.
Clumped Isotopic SCLEROCHRONOLOGY

\[ \Delta_{47} = f (\text{Temperature}) \]
Clumped Isotopic SCLEROCHRONOLOGY

\[ \Delta_{47} = f \left( \text{Temperature} \right) \]

\[ \text{Temp} = 21.8 - 4.69 \left( \delta^{18}O_{\text{carb}} - \delta^{18}O_{\text{water}} \right) \]

→ Can calculate Temperature AND \( \delta^{18}O_{\text{water}} \) and determine whether each varies subannually
why hasn’t this been done before?

• Time Intensive
  • 6 hours of machine time per data point

• Requires large amounts of sample material
  • 15-25mg per data point
Marine GASTROPODS

• Fast growing
• Easy to get enough material for SUBANNUAL clumped isotopes
• More $\Delta_{47}$ calibration work needed!

Indian Top Shell
Cittarium pica

Knobbed Whelk
Busycon carica

Florida Fighting Conch
Strombus alatus

Lightning Whelk
Busycon contrarium

Atlantic Auger
Terebra dislocata

Turritella variegata
Example: Modern *C. pica*

Temperature Range from $d_{18}O$ assuming $d_{18}O_w=1.2$

D47-based Temps

Jan-June Monthly SST range

DJF-JJA 3-month mean SST range
$\Delta_{47}$ CALIBRATION using modern gastropod species

- Nothing grossly out of equilibrium
- Certain species (Turritella, Campanile) biased too cold
- Whelks, Top Shell look good!
PALEOSEASONALITY
via Clumped Isotopic Sclerochronology

- Better constrain past seasonality
- Validate models
- Learn something about hydrological cycle