Reliability and applicability of planktonic foraminiferal Na/Ca as a paleo-salinity proxy

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Single foraminiferal analysis with the electron microprobe

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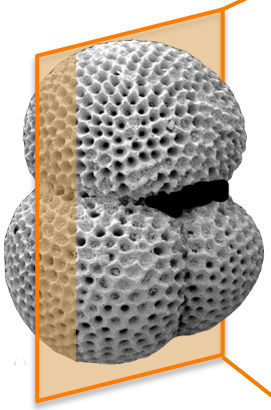
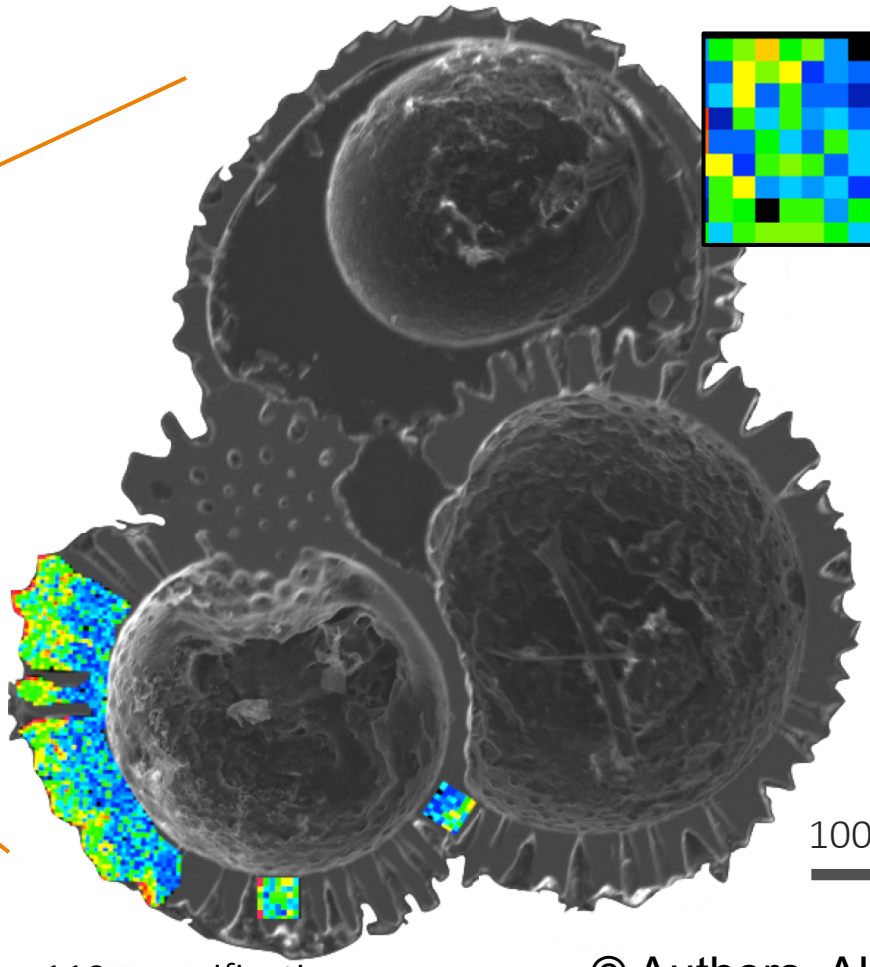
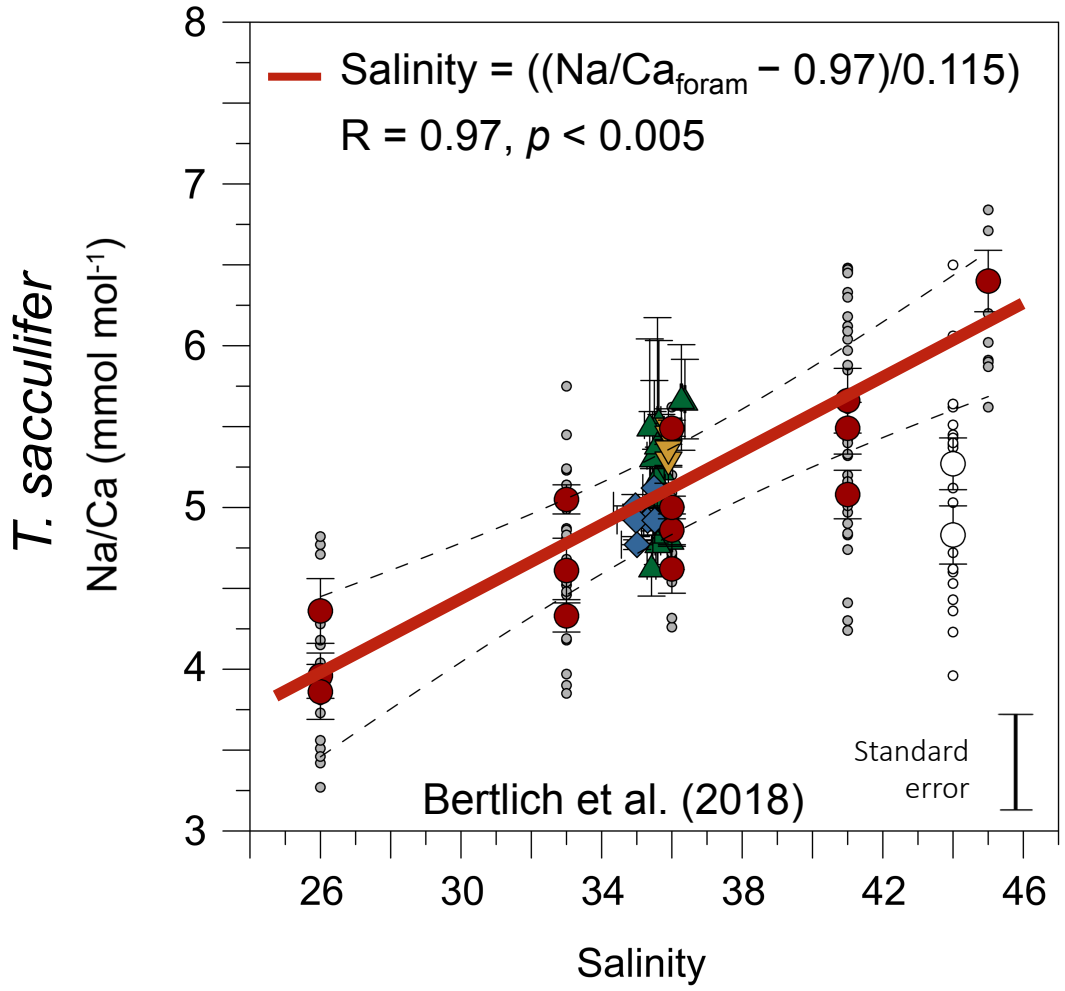
Chamber wall cross section



(modified after Hemleben et al., 1987)



Secondary electron image, x110 magnification

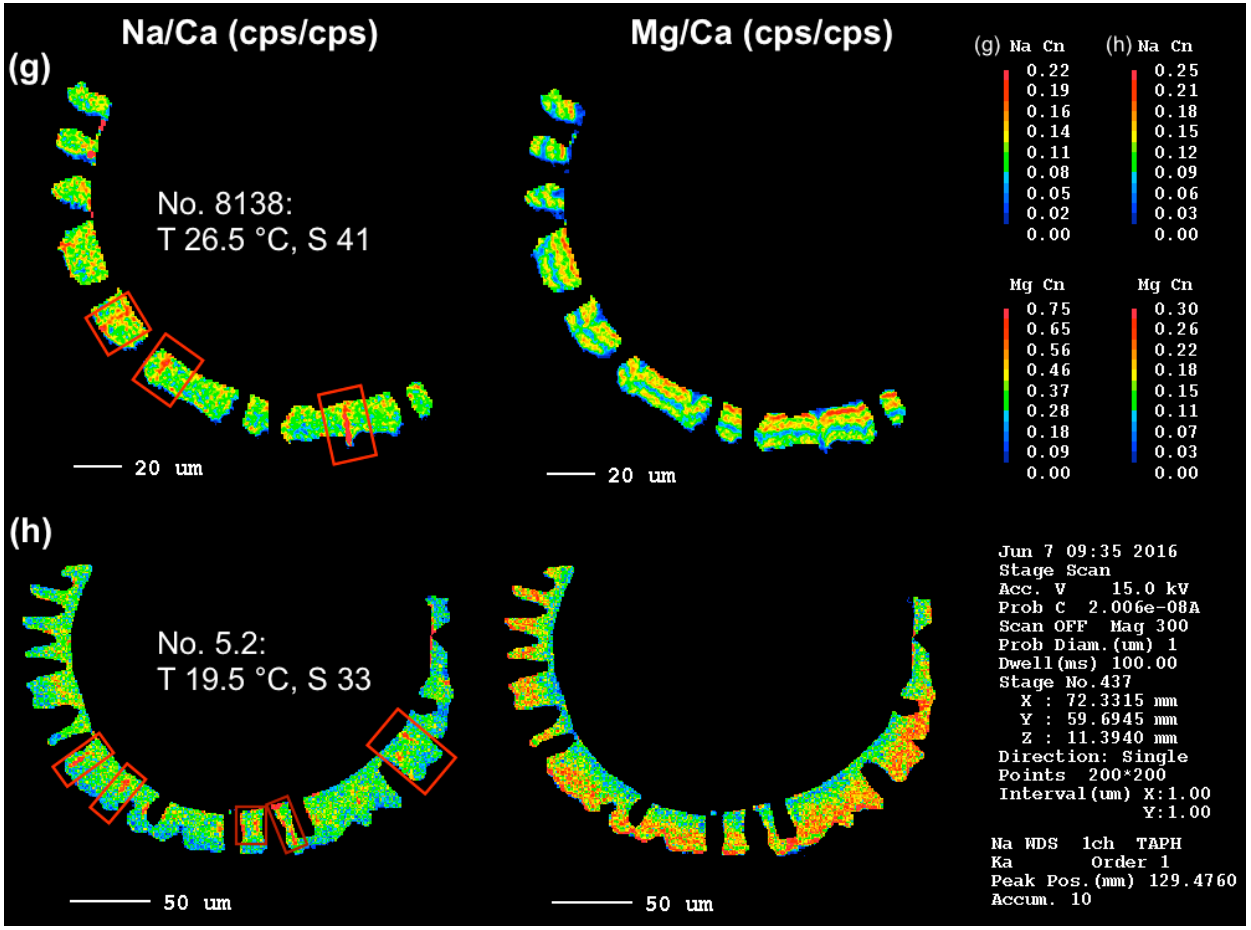


✓ **Significant positive linear correlation**

- Cultured *T. sacculifer*, average Na/Ca values
- Single map analysis
- In situ grown chambers - S 36, T 27 °C

Change of 1 salinity unit = 2.25 % increase in shell Na/Ca.

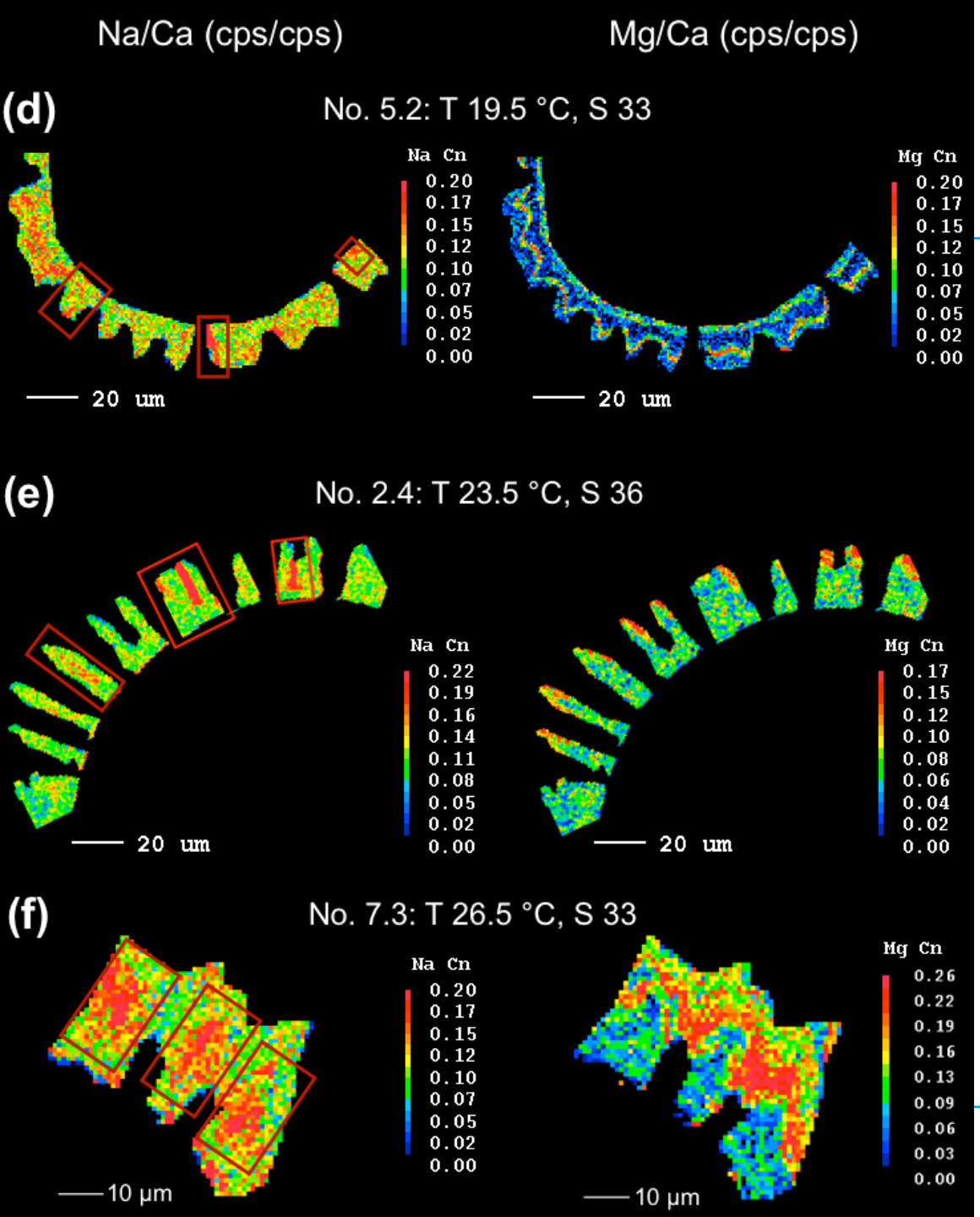
Potential secondary controls on shell Na/Ca incorporation



Changes in shell geochemistry due to unequal contributions of spines/spine bases?

See Mezger et al. (2019)

EPMA images from Bertlich et al. (2018)



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High-elevated Na/Ca values
at spine bases

EPMA images from
Bertlich et al. (2018)

HELMHOLTZ RESEARCH FOR GRAND CHALLENGES

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Living versus fossil foraminifers

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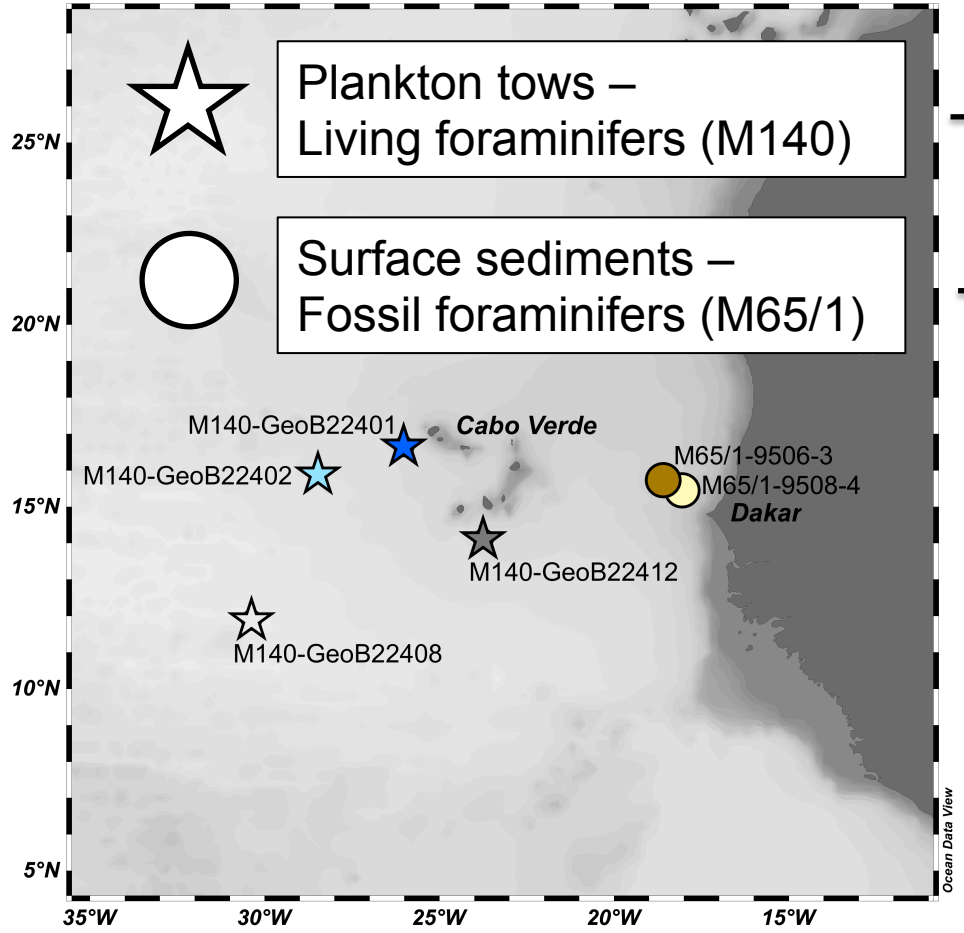

→ RV Meteor cruise M140: Kucera et al. (2019)

→ RV Meteor cruise M65/1: Mulitza et al. (2008)

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Living versus fossil foraminifers

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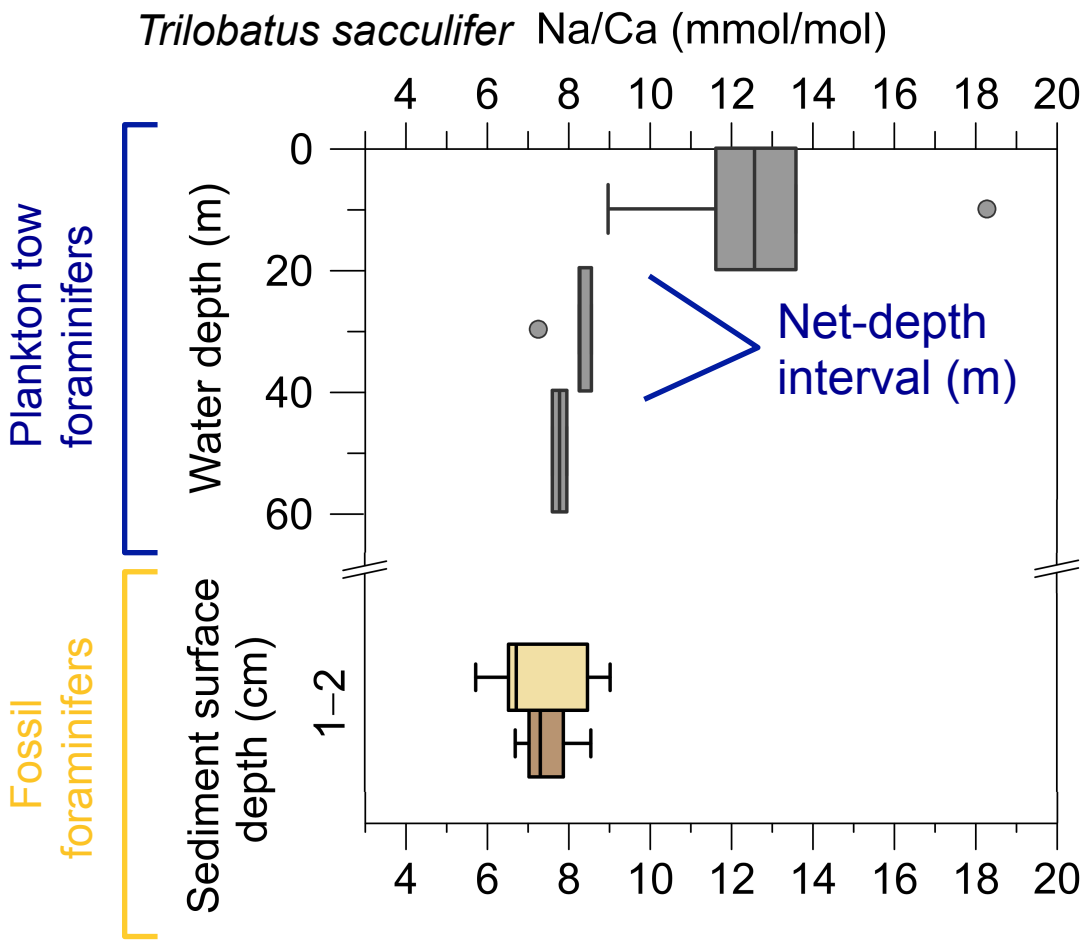

High Na/Ca values at surface waters! – Why?

1. Calcite dissolution?

2. Accelerated growth rates at juvenile life stage
= enhanced Na incorporation, onset of spines?

3. Adult specimens: lower growth rates, spine shedding
= size effect?

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No calcite dissolution effect on shell Na/Ca > Δ [CO_3^{2-}] 20 µmol/kg!

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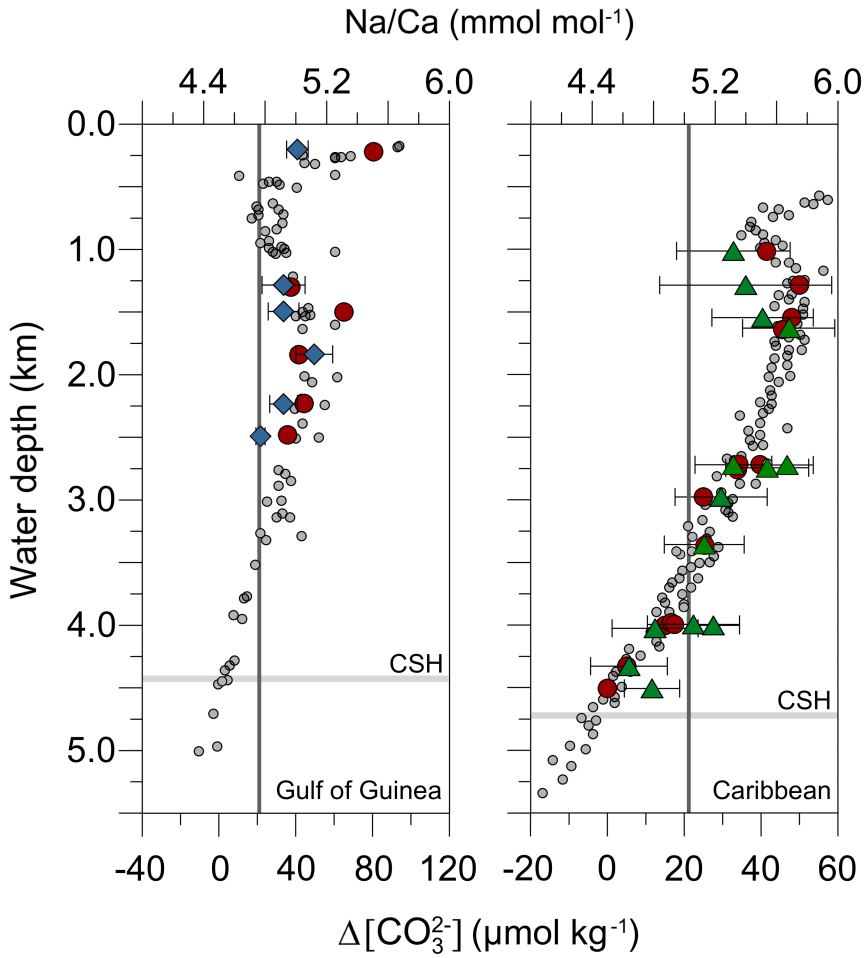

Bertlich et al. (2018)

Na/Ca (mmol/mol):

Surface sediment samples

- Gulf of Guinea (RV M6-5)
- Caribbean Sea (RV SO164)

Δ [CO_3^{2-}] (µmol/kg):

- At sampling sites
- Along Gulf of Guinea and Caribbean water depths (km)
- CSH = Calcite Saturation Horizon
- Critical threshold value (~21-26 µmol/kg) – onset of Mg/Ca dissolution (Regenberg et al. 2006; 2014)

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Conclusions

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Na/Ca-salinity relationship in the cultured planktonic species *Trilobatus sacculifer*:

- significant positive linear relationship of shell Na/Ca and salinity in culture
- no temperature effect on shell Na/Ca incorporation in culture

➤ reconstruction of large freshwater events (exceeding 0.5 salinity units)

Internal controls on Na/Ca incorporation (spine versus whole shell geochemistry)

- Variability of Na/Ca partly assigned to ontogenetic variations during foraminiferal development
- spines are not well preserved in marine sediments

➤ this strengthens reliability of Na/Ca as paleosalinity proxy

External controls on Na/Ca incorporation: living vs. fossil foraminifers

- environmental parameters co-vary, but pH, alkalinity, $[CO_3^{2-}]$ can be ruled out:

➤ salinity remains as primary control on shell Na/Ca

- Na/Ca based salinity reconstructions allow reconstruction of a high-vertically resolved salinity depth profile:

➤ high potential to complement and improve existing approaches (e.g., paired shell Mg/Ca, $\delta^{18}O$)

Questions?

Visit our session ITS1.11/OS1.14:
https://egu2020.eu/chat/chat35676.html

and I am looking forward to answer your questions
in the live chat.

or

contact me via mail: jbertlich@geomar.de

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