

# Biocalcification stress and a foraminiferal extinction at the Aptian-Albian boundary

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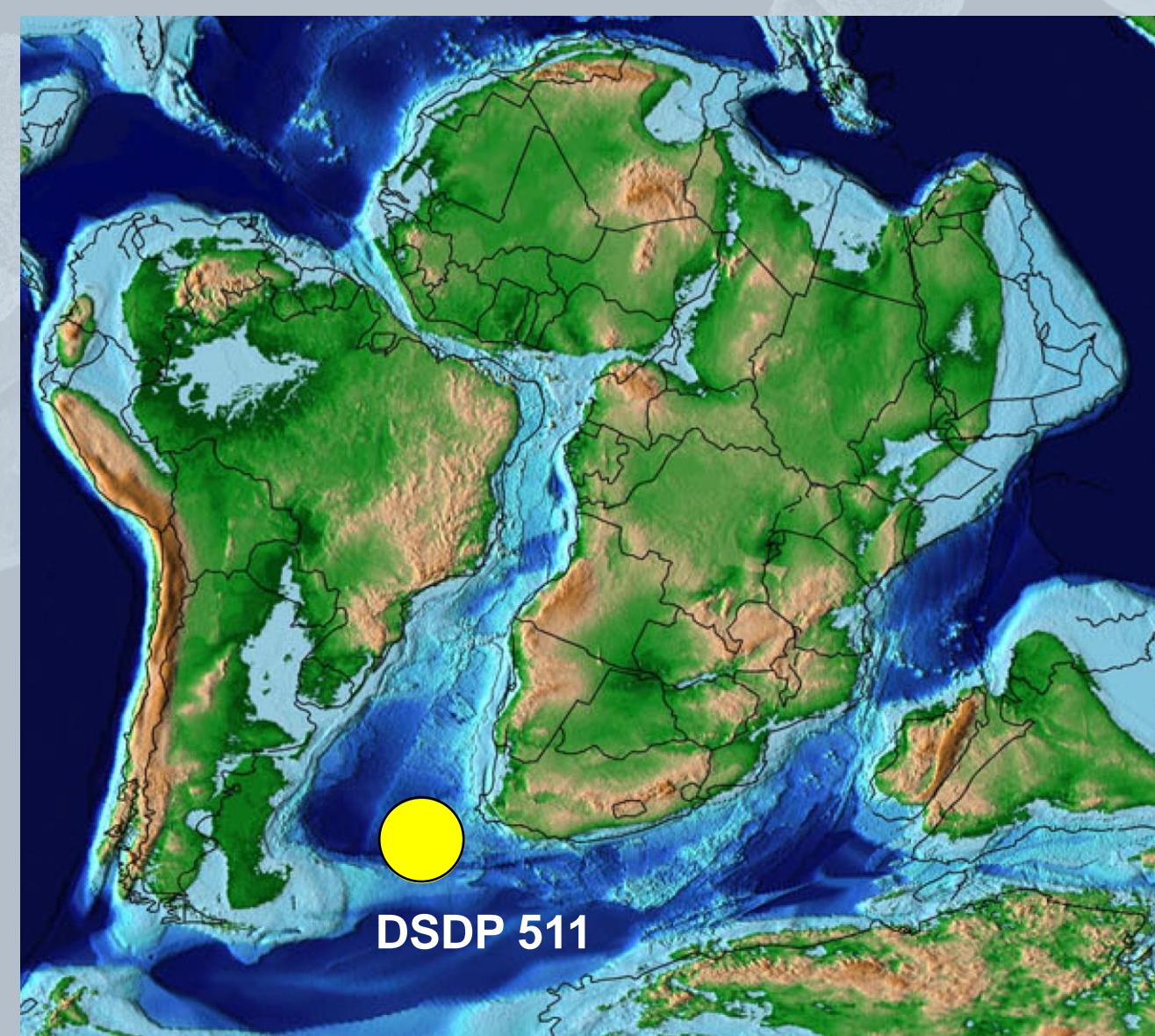
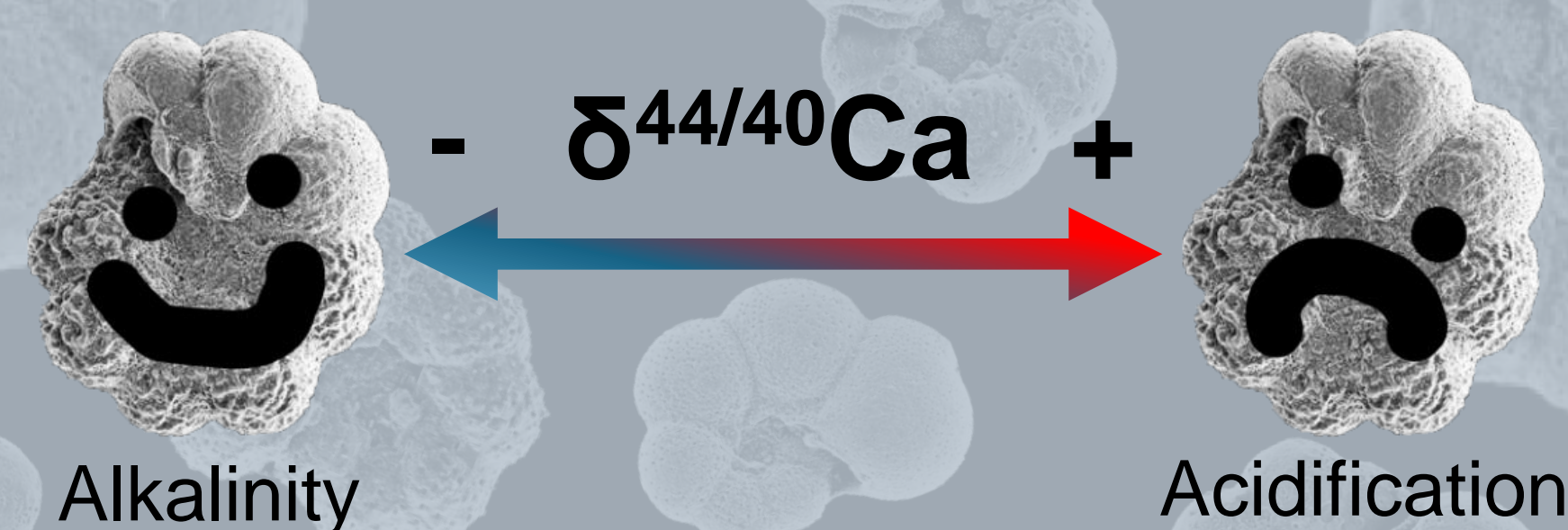
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## Introduction

Excluding the end-Cretaceous asteroid impact, planktic foraminifera have never experienced extinction to the extent recorded 113 million years ago, during the Aptian-Albian boundary interval (AABI). The AABI was a time of dramatic environmental change, coinciding with volcanism and oxygen depletion encompassed by Oceanic Anoxic Event 1b. However, traditional geochemical studies have had limited success in resolving the drivers of this foraminiferal extinction (Fig. 1).

The calcium isotope composition of carbonates has emerged as a novel proxy for biocalcification stress. Decreases in shell size and thickness recorded in AABI planktic foraminifera suggest that ocean acidification-related stress may have played a role in their extinction. We present high-precision  $\delta^{44/40}\text{Ca}$  thermal ionization mass spectrometer (TIMS) measurements of Aptian-Albian planktic and benthic foraminifera and bulk carbonates from Deep Sea Drilling Project (DSDP) Site 511 (Falkland Plateau, South Atlantic)—comprising the first calcium isotope records for the AABI.

## The $\delta^{44/40}\text{Ca}$ Proxy, Simplified



**Figure 2.** Paleogeographic map of Gondwana during the AABI, showing location of DSDP Site 511. From Balestra et al. (submitted).

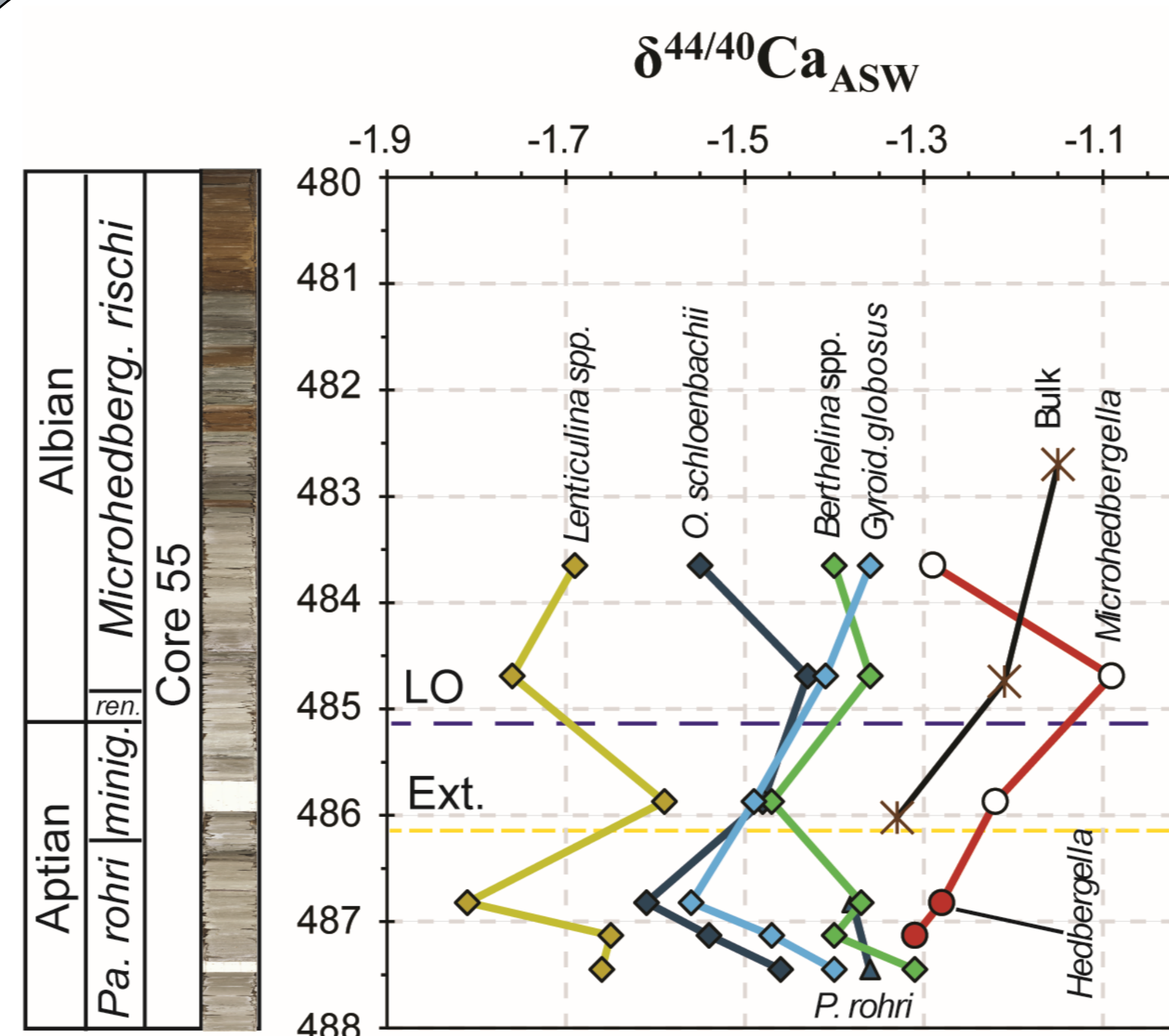
## Methods

- Complete tests of the following AABI foraminifera were picked from DSDP Site 511:
  - Planktic: *Hedbergella* spp., *Microhedbergella* spp., *Paraticinella rohri*
  - Benthic: *Lenticulina* spp., *Berthelina* spp., *Osangularia schloenbachii*, *Gyroidinoides globosus*
- Samples were analyzed for  $\delta^{44/40}\text{Ca}$  using a  $^{43}\text{Ca}$ - $^{42}\text{Ca}$  double-spike technique and a Thermo-Fisher Triton MC-TIMS
- All  $\delta^{44/40}\text{Ca}$  sample processing was conducted under clean room conditions

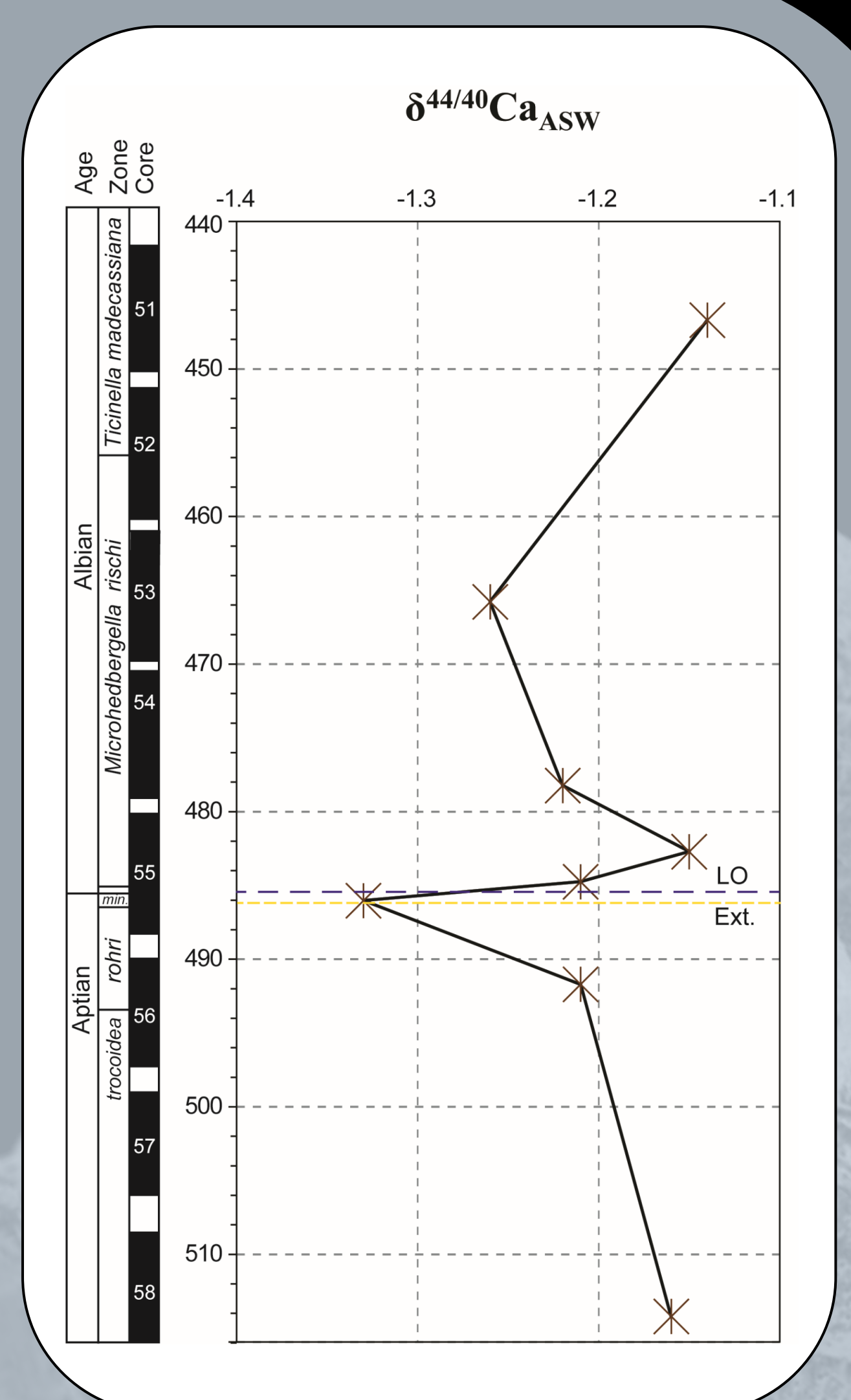
## Results

- Negative excursion recovered at ~486-487 mbsf in both benthic and bulk records
- Positive excursion develops throughout extinction interval in planktic records (Fig. 3)
- Bulk record exhibits negative excursion at ~486 mbsf, followed by positive excursion at ~482 mbsf (Fig. 4)

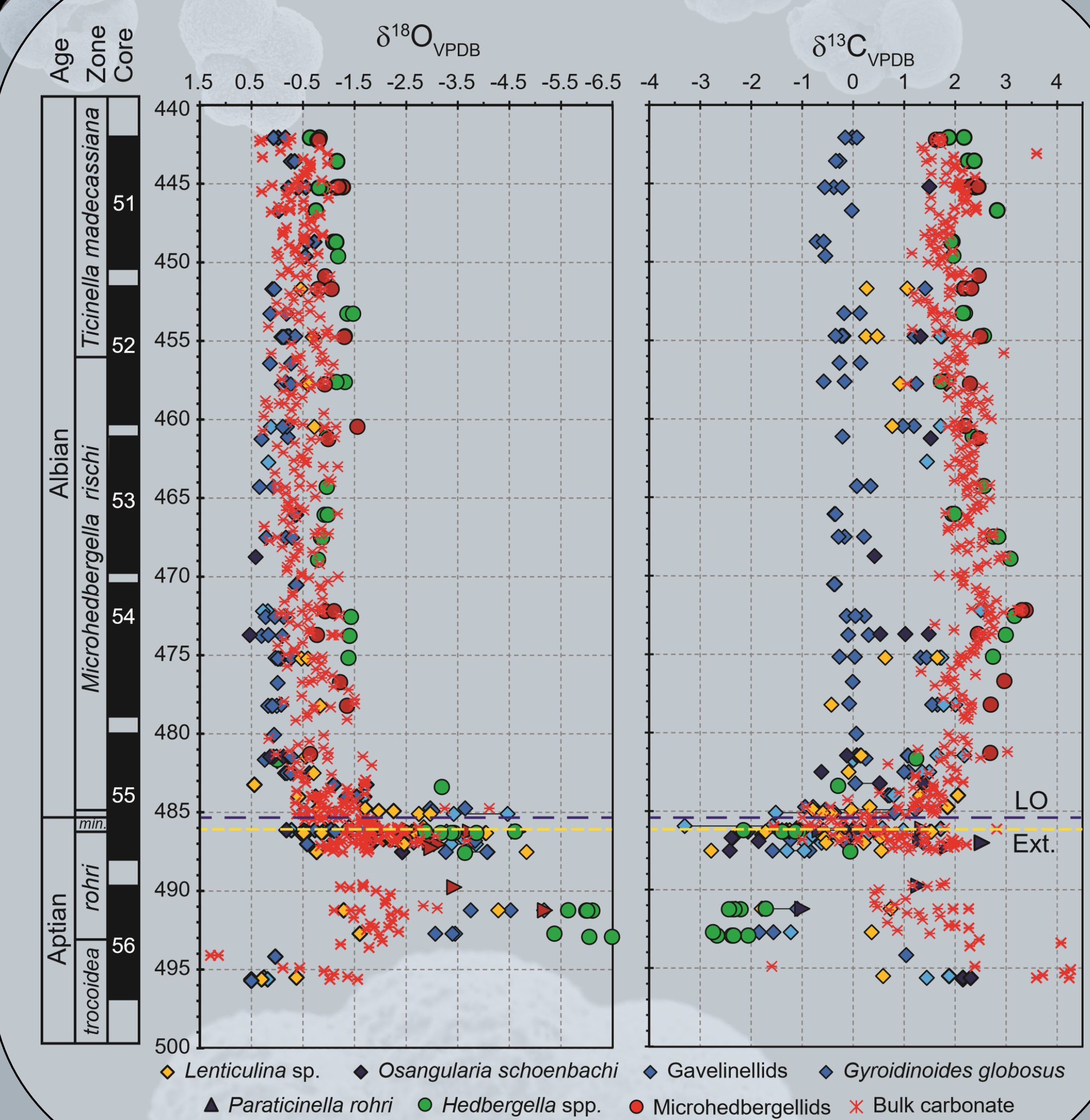
## $\delta^{44/40}\text{Ca}$ Records



**Figure 3.** Calcium isotope ( $\delta^{44/40}\text{Ca}$ ) measurements of AABI planktic and benthic foraminifera and bulk carbonates from DSDP Site 511.



**Figure 4.** Calcium isotope measurements ( $\delta^{44/40}\text{Ca}$ ) of bulk carbonates from DSDP 511, ranging from the Late Aptian to Early Albian.

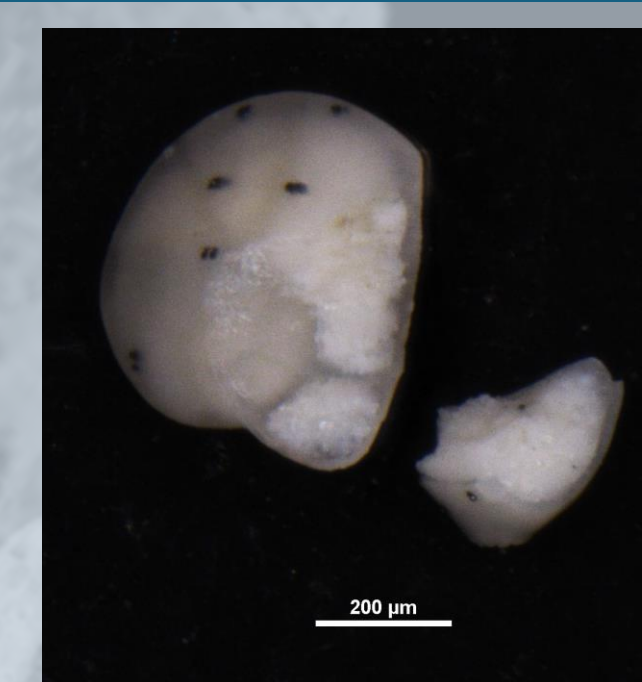


**Figure 1.** Stable oxygen ( $\delta^{18}\text{O}$ ) and carbon isotope ( $\delta^{13}\text{C}$ ) measurements of AABI planktic and benthic foraminifera and bulk carbonates from DSDP Site 511. Data from Huber et al. (2018).

## Thoughts

- $\delta^{44/40}\text{Ca}$  of AABI planktic foraminifera appear indicative of biocalcification stress, coincident with the extinction interval
- $\delta^{44/40}\text{Ca}$  of benthic foraminifera and bulk carbonates trend inversely to planktic trends, possibly due to biological compensation
- Sparry calcite infilling raises concerns about interpretation of isotopic records

## Future Directions: Surgery on a foram?



**Figure 6.** EDF image of dissected *Lenticulina* sp. infilled with clay.



**Figure 7.** Micromanipulator device used for foram dissections.

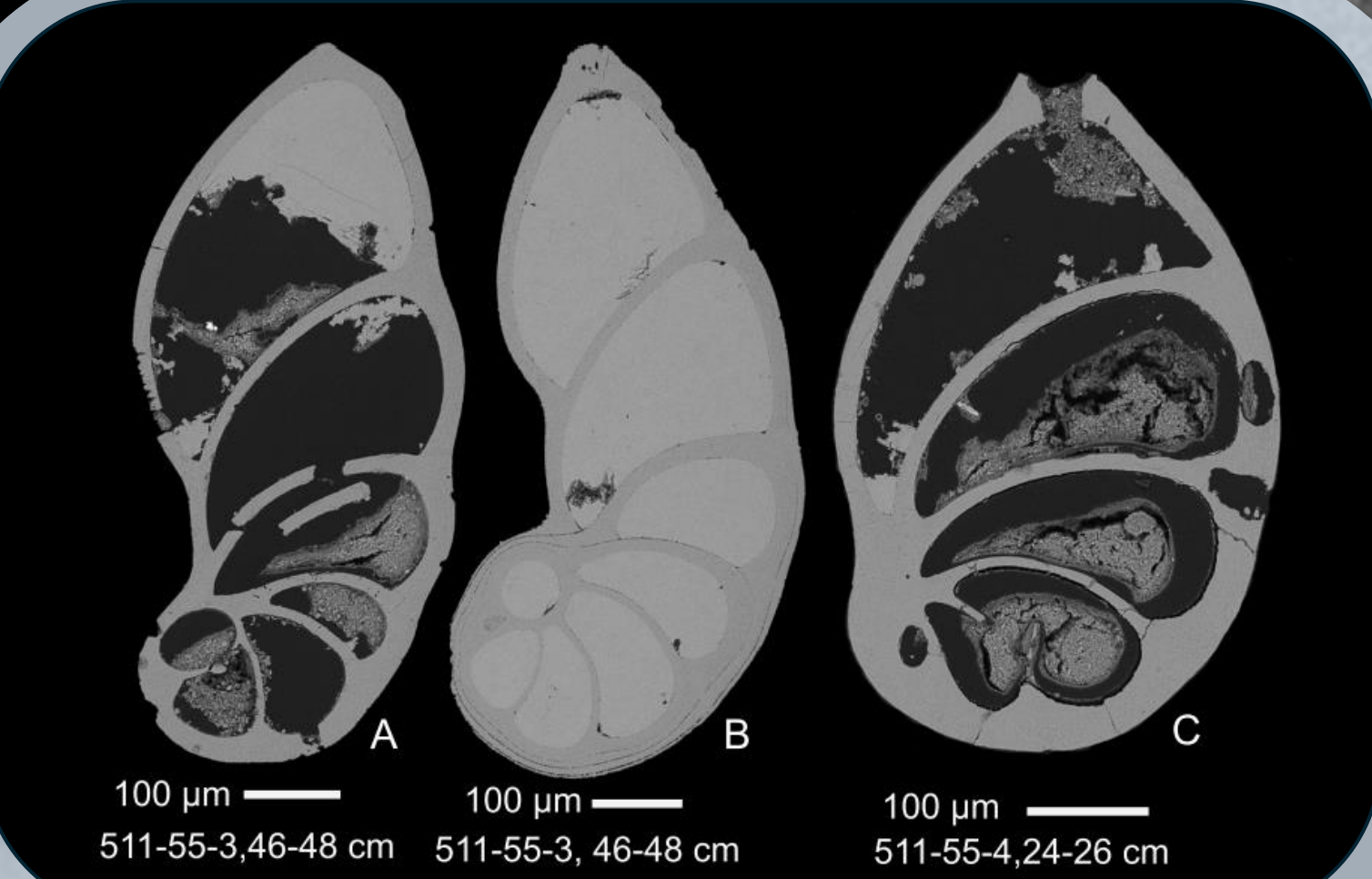
## References:



## Acknowledgements:

This research was made possible by funding provided by NSF, REU Site, OCE-2244445.

Thank you to Vanessa González, Jessica Johnston, Ioan Lascu, and Virginia Power for their support of the NHRE program and this project.



**Figure 5.** Thin-section SEM images of infilled *Lenticulina* spp. across the AABI extinction interval, DSDP Site 511. From Balestra et al. (submitted).

Examination of foraminifera tests through the extinction interval revealed significant sparry calcite infilling. This infill may explain depleted oxygen, carbon, and calcium isotope values.