

# A coral $\delta^{18}\text{O}$ reconstruction from Kiritimati, Kiribati during the Little Ice Age

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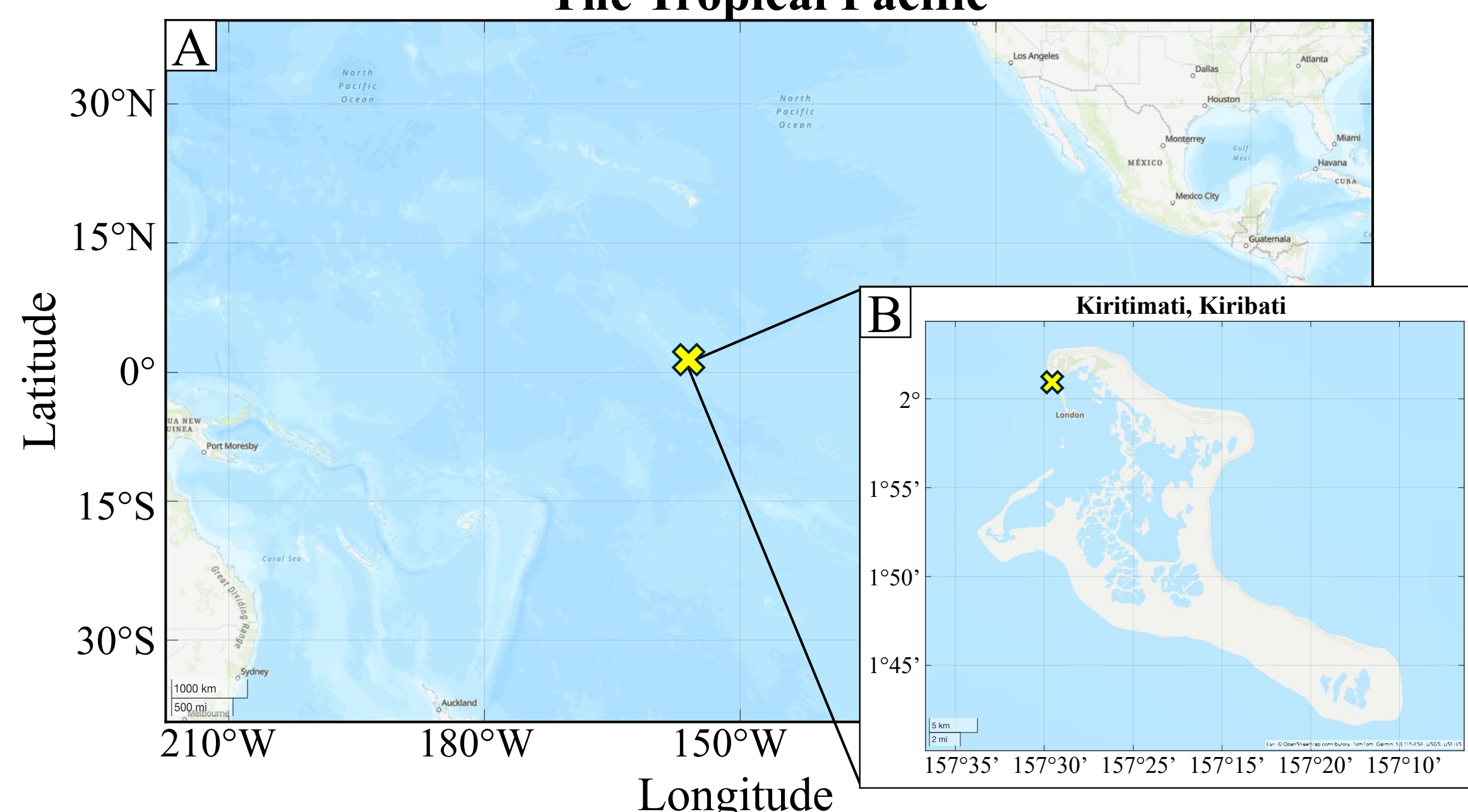
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## Introduction

Corals are a valuable tool in reconstructing past climates due to their skeletal aragonite ( $\text{CaCO}_3$ ) geochemistry (Thompson 2021). The El Niño/Southern Oscillation (ENSO) is one of the primary drivers of global climate (Grothe et al., 2019). Kiritimati Atoll ( $1.9^\circ \text{N}$ ,  $157.4^\circ \text{W}$ ) is a strategic location due to its position in the Central Pacific as one of the key ENSO activity sites. This allows corals there to record past sea surface temperature (SST) conditions throughout the Holocene to interpret changes in ENSO variability (Grothe et al., 2019).

Currently, there are temporal gaps in climate reconstructions throughout the Holocene with the Last Millennium (LM) being one of the largest (Grothe et al., 2019). Specifically, the gap spans The Little Ice Age (LIA), a period with relatively cooler conditions compared to other time periods within the LM (Cobb et al., 2003). This study presents a 20-year long  $\delta^{18}\text{O}$  reconstruction of a 210-year-old coral skeleton (X15c-35-11) from Kiritimati Atoll, in the republic of Kiribati that spans 20 years in the LIA to gain better insight of climate variability in the early- to mid- 18<sup>th</sup> century.

The Tropical Pacific



**Figure 1:** (A) Kiritimati Atoll's location the Pacific Ocean, indicated by the yellow marker and (B) site map of Kiritimati where the yellow marker indicates Field Site 35 where sample X15c-35-11 was collected.

## Methods

- 70-105 $\mu\text{g}$  of coral powder were drilled from a main transect and a series of validation transects.
- Coral  $\delta^{18}\text{O}$  data was generated using a Delta V Isotope Ratio Mass Spectrometer (IRMS) coupled to a Kiel IV Carbonate Device.
- $\delta^{18}\text{O}$  data was analyzed using seasonal tie points to convert millimeters into units of time relative to the coral's U/Th age.
- SEM (Scanning Electron Microscopy) images were scored following the guidelines in Rodriguez et al. (2025).

## Results

X15c-35-11 - Slab b

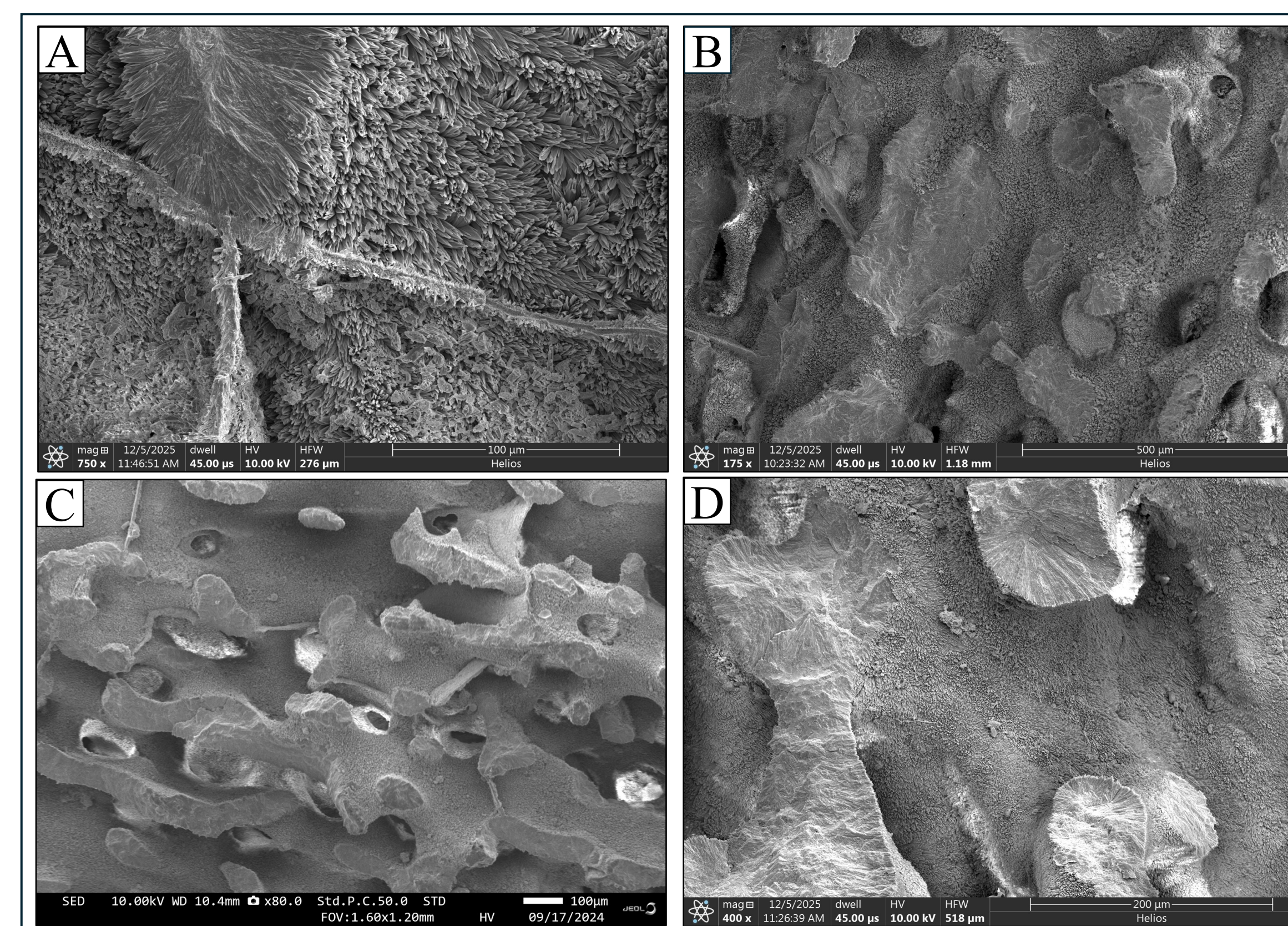


— Transect 1  
 ■ SEM Chip    ●  $\delta^{18}\text{O}$  High  
 ■ U/Th Chip    ●  $\delta^{18}\text{O}$  Low

**Figure 2:** An X-ray of X15c-35-11. Seasonal tie points along transect 1 (black) are labeled for  $\delta^{18}\text{O}$  high (yellow) and  $\delta^{18}\text{O}$  low (blue) along with SEM (pink) and U/Th chips (green).

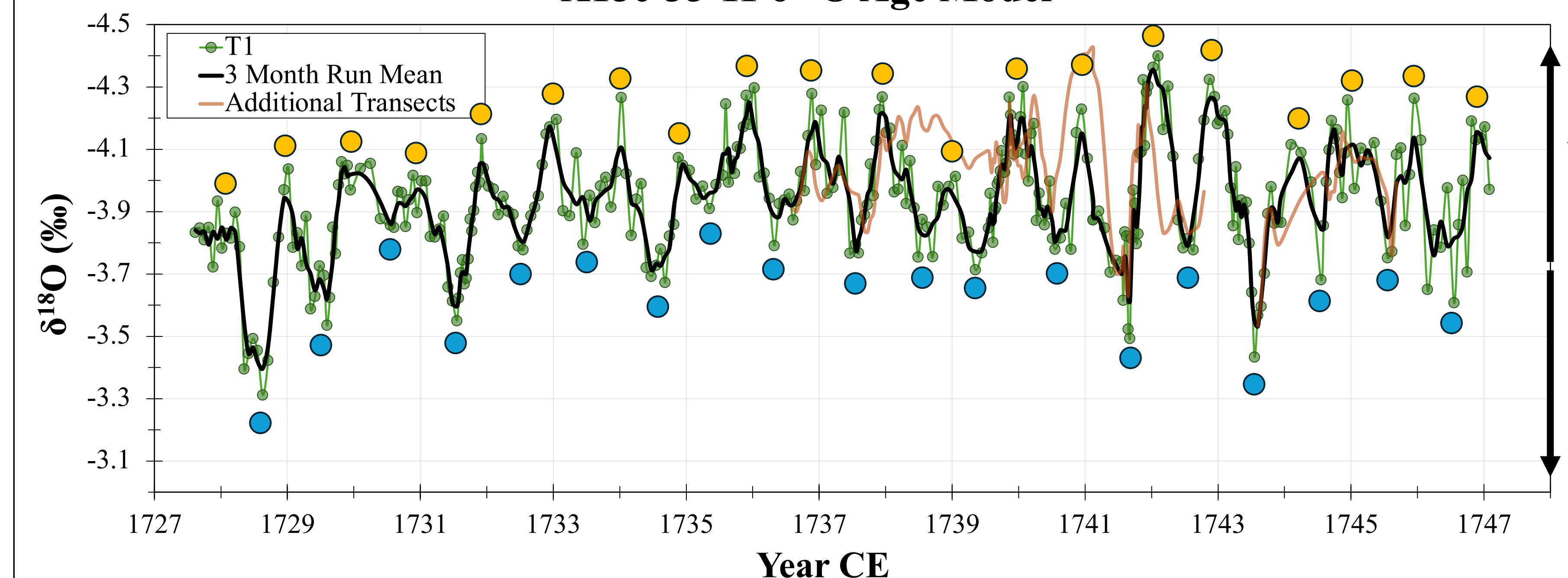
**Table 1:** SEM scores by coral slab depth (Figures 2–3) for Area of Secondary Aragonite (ASA), Length of Secondary Aragonite (LSA), and Dissolution (DIS), following Rodriguez et al. (2025) guidelines (1 = lowest quality; 5 = pristine coral).

Slab depth	ASA	LSA	DIS	COM
30 mm	1	3-4	5	3.2
125 mm	1	3-4	5	3.2
175 mm	1	4	5	3.3
275 mm	1	4	5	3.3



**Figure 3:** SEM Images of X15c-35-11 from (A) 30 mm, (B) 125 mm, (C) 175mm, (D) 275mm. SEM Scoring was done to address diagenesis and alteration of the coral aragonite (Table 1).

X15c-35-11  $\delta^{18}\text{O}$  Age Model



**Figure 4:** An age model of X15c-35-11 including seasonal tie points.  $\delta^{18}\text{O}$  highs and lows are indicated by yellow and blue dots respectively. Transect 1 is displayed by raw  $\delta^{18}\text{O}$  values (green line) and 3 month running mean values (black line). Orange lines indicate  $\delta^{18}\text{O}$  data generated from additional transects on the coral.

### Key Results:

- The average annual extension rate of X15c-35-11 is **16.1 mm/year**.
- This time series spans **19.45 years** from 1727-1747 CE.
- The mean  $\delta^{18}\text{O}$  for this time series is **-3.94 $\pm$ 0.19‰**.
- **ASA score of 1** across all SEM chips indicates significant alteration throughout the slab.

## Conclusions

In coral paleoclimatology, alteration of the coral skeleton, also known as diagenesis, adds uncertainties to coral paleoclimate records. SEM images and scores from X15c-35-11 show evidence of minor, but pervasive alteration (Table 1; Figure 3), flagging this coral for further diagenesis screening. Replicate transects on additional coral slabs were drilled to validate questionable sections of the main transect (Transect 1).

The coherent and well-defined seasonal variability in the transects supports the coral's fidelity as a robust paleoclimate record (Figure 4). Transect 1 was deemed the highest quality transect in this study and thus all age model reconstruction was done based on this transect. The resultant well-validated record from X15c-35-11 can be integrated with other datasets to evaluate ENSO variance during the LIA and assess changes over the last millennium (Conklin et al., 2026).

## Next Steps

- Identify additional temporal gaps during the LM spanning the LIA and Medieval Climate Anomaly (MCA).
- Select suitable samples for future  $\delta^{18}\text{O}$  analyses: Ideally greater than 200 mm in length, low SEM scoring, minimal calcite, and within the LM during the LIA or MCA.
- Train to slab and clean corals, lay transects, run the Kiel IV Carbonate Device/Delta V IRMS, for future  $\delta^{18}\text{O}$  analyses.

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## Selected References

