Multi-trace Element Reconstructions of Modern *Porites* spp. Corals from Isla Floreana, Galápagos Islands, Ecuador

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Introduction

The Galápagos Islands have unique oceanographic conditions relative to the rest of the Pacific (*Climatology Database*, n.d.). The Equatorial Undercurrent (EUC) flows eastward at about 200 meters depth, shoaling at the western boundary of the Galápagos. This causes the upwelling of cold, nutrient-rich water throughout the archipelago. Changes in the strength of the southeast trade wins and the South Equatorial Current (SEC) can also result in short extreme temperature swings that make Galápagos corals prone to significant stress. For this project, *Porites* spp. corals were collected from Isla Floreana (1°15'47" S, 90°21'40" W) during an expedition to the Galápagos Islands in August 2024. Sr/Ca, which is a commonly used trace element ratio for sea surface temperature (SST) paleoclimate reconstructions (Smith et al., 1979; Bradley, 2014; Corrège, 2006), was extracted from coral GL24a-FL1-5 to create an SST timeline for the time of its growth

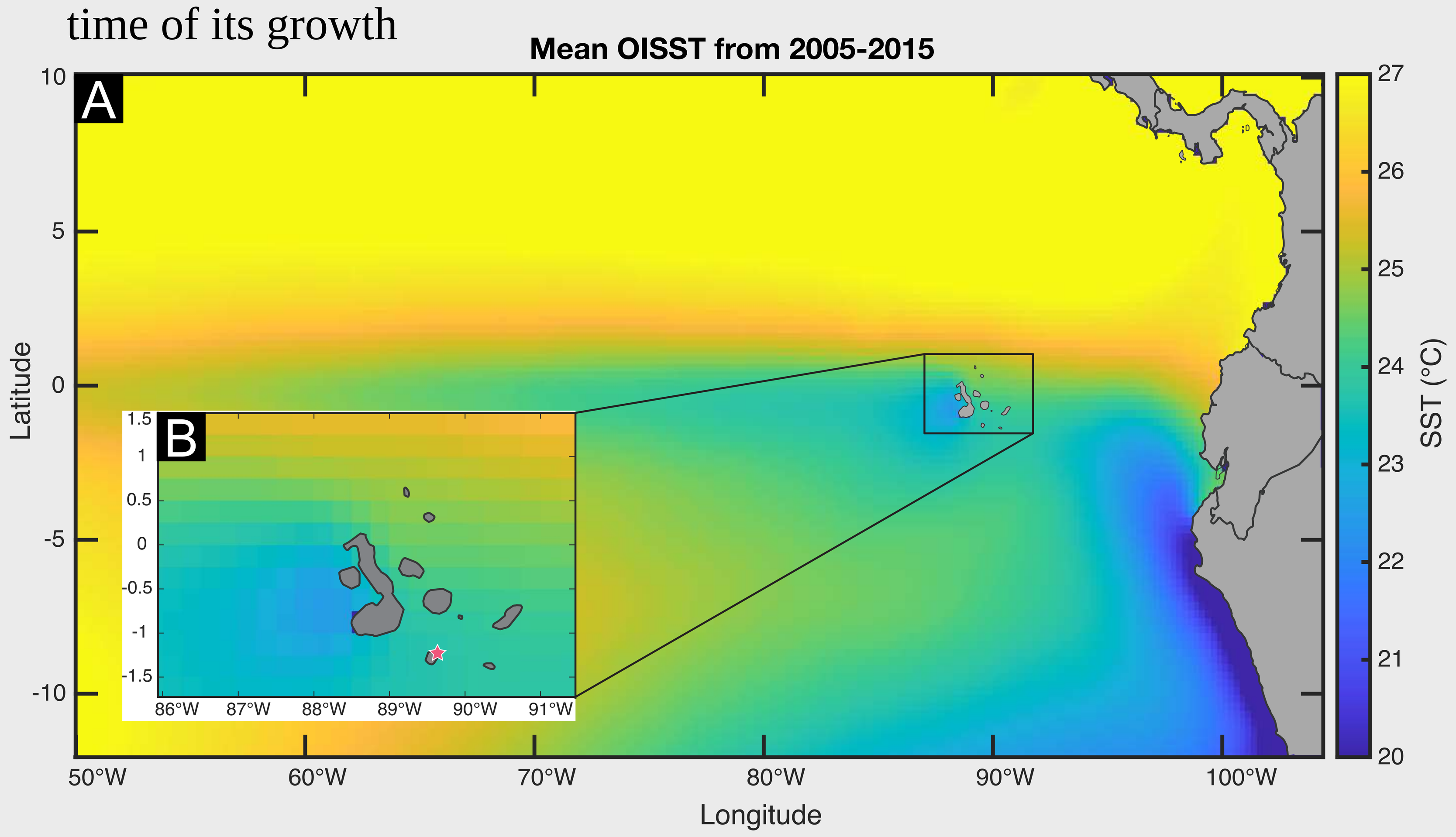

Figure 1: (A) The oceanographic setting of the Galápagos Islands relative to the rest of the tropical Pacific Ocean. Mean OISST values for the duration of the study period are plotted on the map. (B) The location of the study site, Isla Floreana, in the Galapagos Islands.

Methods

Coral GL24a-FL1-5 was imaged on a JEOL SEM in the FSU Department of Chemistry to determine its level of diagenetic alteration, which manifests as secondary aragonite and can cause discrepancies in the coral's SST reconstruction.

150-200µg of coral powder was drilled along its primary growth axis at a millimeter scale. The powder was then dissolved in 2% Optima Grade Nitric Acid and run on an Element2 HR-ICP-MS for Sr/Ca and U/Ca at the National High Magnetic Field Lab. Age modeling for coral GL24a-FL1-5 was executed by assigning tie-points between OISST and Sr/Ca values to build a coral Sr/Ca age model.

Results

The SEM images of GL24a-FL1-5 (Figures 4 and 5) presented a clear and unaltered coral skeleton, which earned the coral an in-house SEM score of 5/5 (Rodriguez et al., in review). This allowed us to proceed with the Sr/Ca analysis. Creating an age model with the interpolation of the coral's Sr/Ca data and SST and relating it to the recorded SST data gave us two closely-fitting graphs, which represents a strong relationship between the Sr/Ca proxy and recorded SSTs. Assigning points between the Sr/Ca data and the coral's growth axis millimeter, according to the peaks and valleys of the age model, relates seasonality to its location on the coral skeleton. A calculation of the coral growth given the points assigned to the age model yielded an average growth rate of 14.6 mm/yr. The average SST was 23.3ºC and the average Sr/Ca was 9.26 mmol/mol during coral growth.

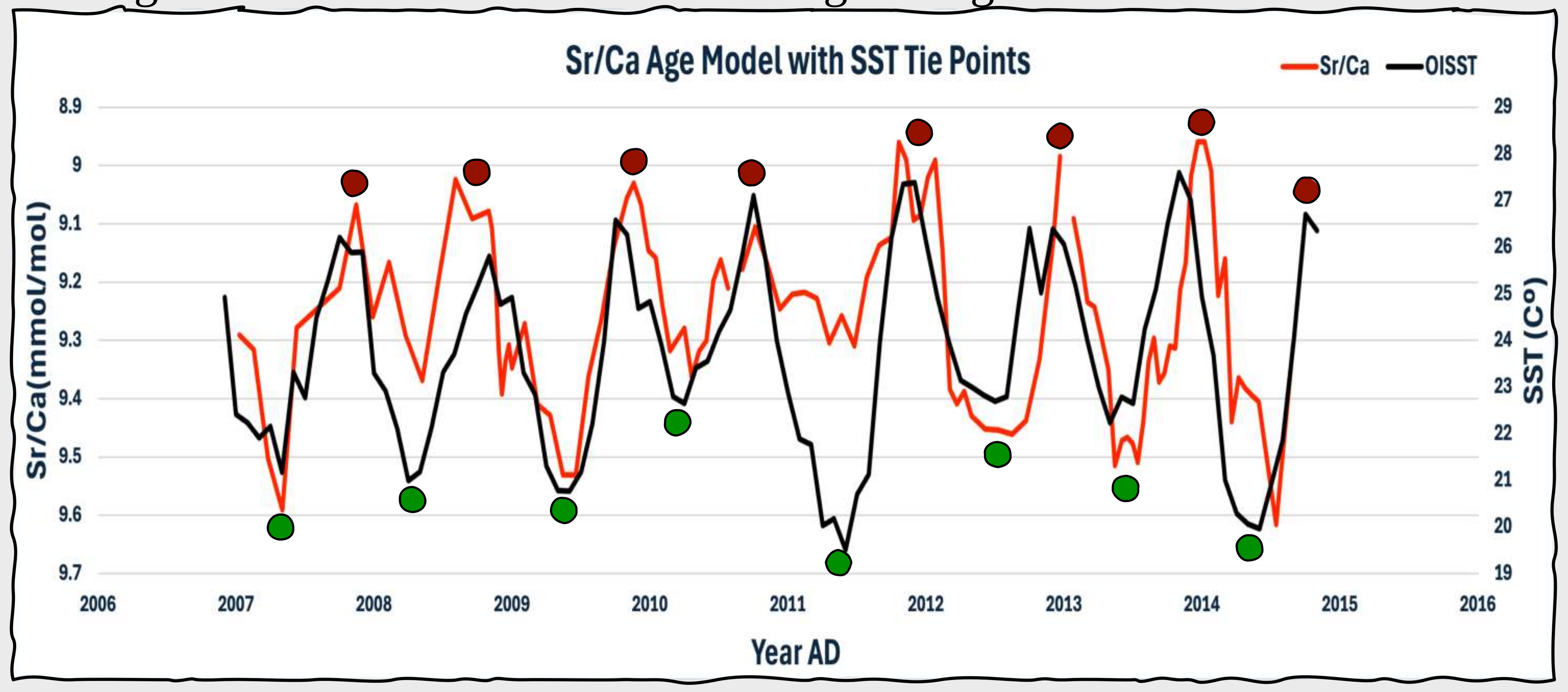

Figure 2: The constructed age model for GL24a-FL1-5. Red and green dots represent tie points from the coral transect, shown in Figure 3.

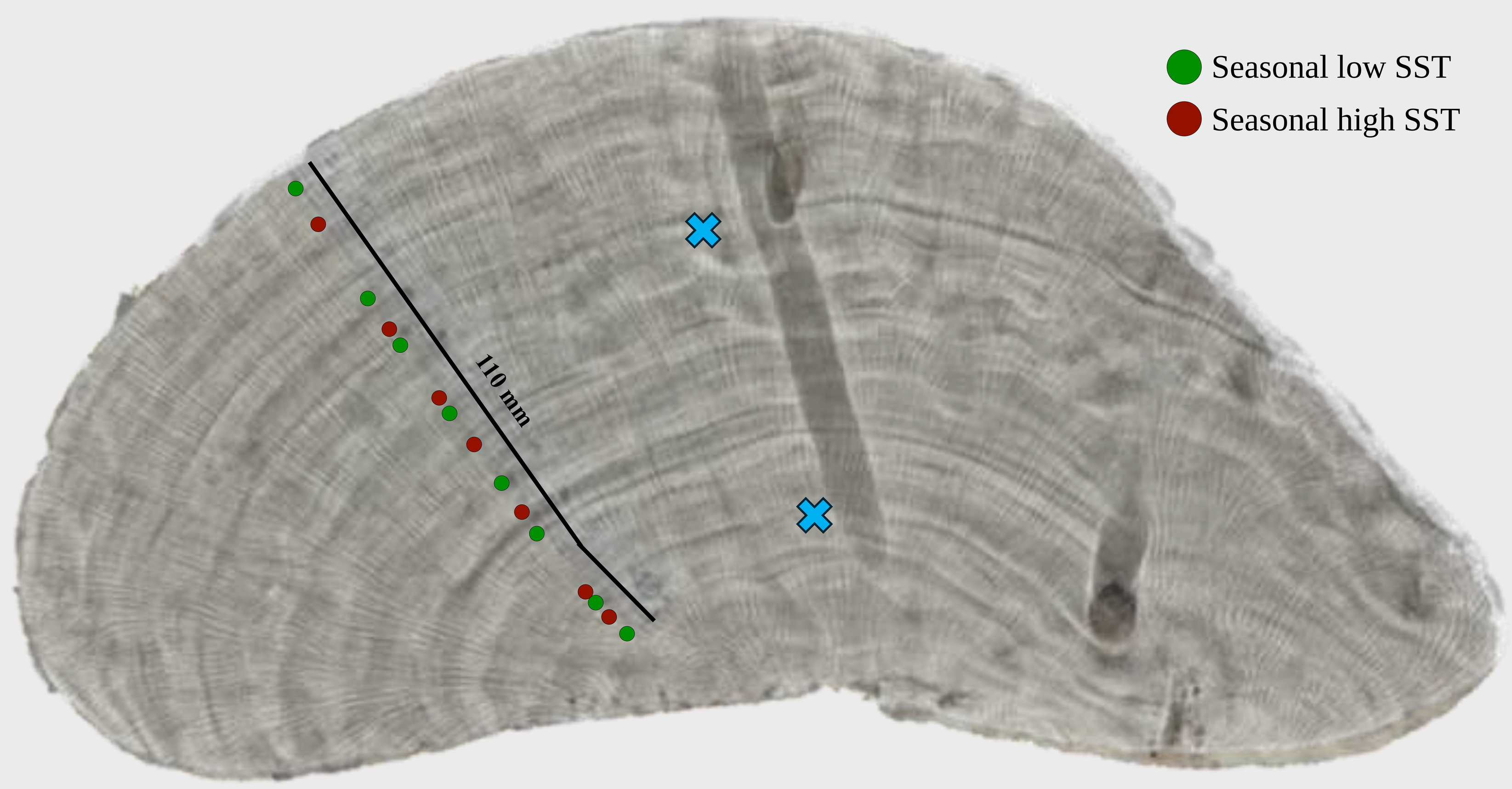

Figure 3: GL24a-FL1-5 X-ray overlain on slab image. The X-ray shows the growth bands of the coral, which demonstrate its growth axis. Tie points from Figure 2 are shown here, aligned along the coral transect. Their positions along the growth axis are related to seasonal high and low SSTs during coral growth, which are supported by the presence of dark and light growth bands. Coral transect is 110 mm long.

Acknowledgments

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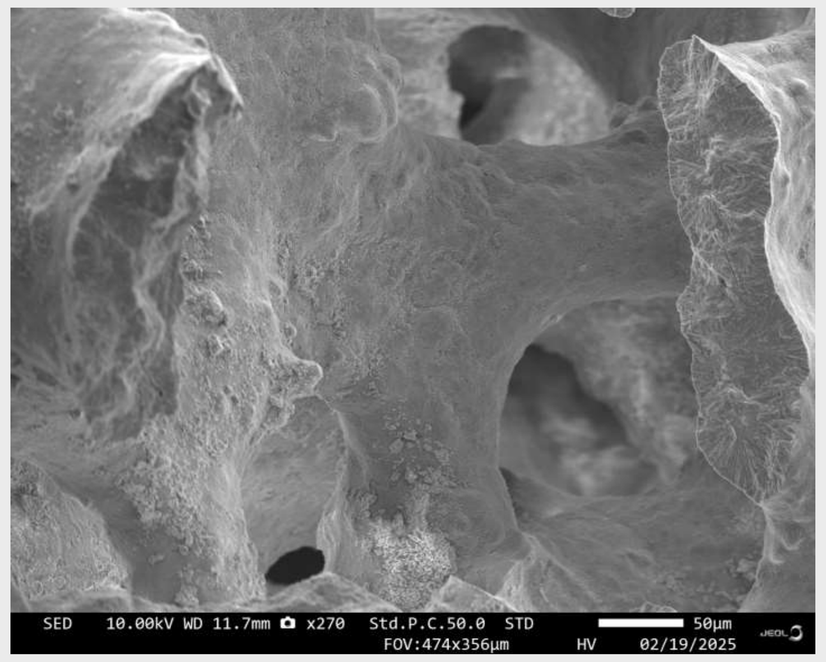

Figure 4: SEM image taken from a sample chip that was cut out from the upper part of the GL24a-FL1-5 slab. Though some debris is likely present on the left pat of the image, no alteration seems to have occurred in the coral's geochemistry. The location of the chip is shown by the top cross on Figure 3.

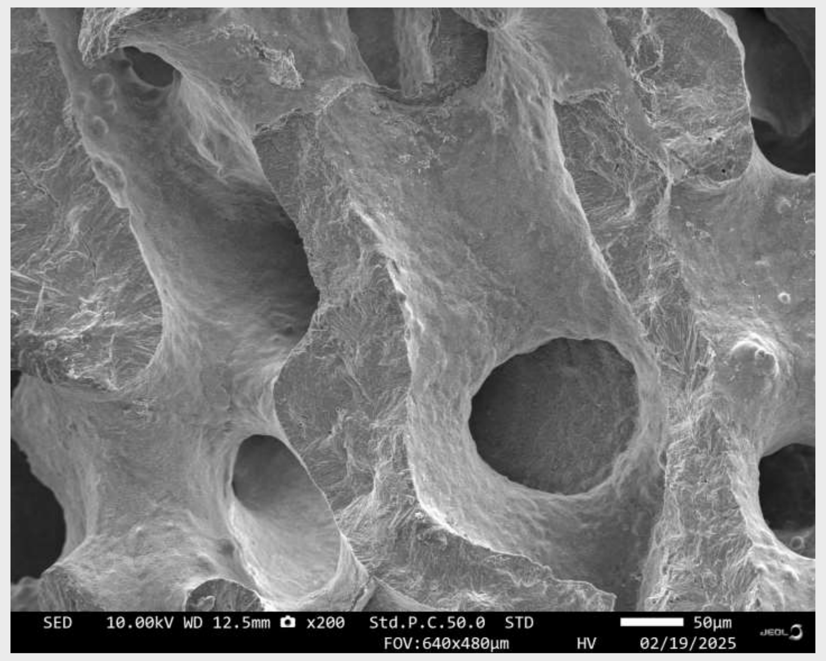

Figure 5: SEM image taken from the lower part of the GL24a-FL1-5 slab. The coral surface is smooth and shows no signs of secondary aragonite, which forms during geochemical alteration. The location of the chip is shown by the bottom cross on Figure 3.

Conclusions

The completed age model tells us that this coral was growing from around 2006 to 2015. Given that OISST data is very accurate, and Sr/Ca is widely used as a proxy for SST reconstructions (Bradley, 2014), the strong relationship between the patterns present in the coral age model and SST data gives us confidence in the accuracy and validity of our Sr/Ca data.

However, the validity of another SST proxy, Sr-U, is uncertain, especially in the unique conditions of the Galápagos Islands. Sr-U is the pairing of Sr/Ca and U/Ca ratios, which can be carried out now that GL24a-FL1-5's Sr/Ca data is established.

Next Steps

This Sr/Ca record will be regressed against the U/Ca record to evaluate the relationship between the two proxies. These two records will be paired to calculate Sr-U, a mean temperature proxy in the Galápagos Islands. By completing this calculation, this coral will contribute to a spatial study that assesses the validity of coral Sr-U in the Galápagos Islands.

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