

Motivations/Background

The El Niño-Southern Oscillations (ENSO) impact ocean climate by altering sea surface temperature (SST) and salinity. Studying these warming periods helps us understand climate change and predict future trends. The Galápagos Islands, Ecuador, are ideal for studying ENSO due to their equatorial location in the central Pacific, where these oscillations occur. The Galápagos Islands have a large amount of upwelling which brings cool, nutrient-filled water to the surface. ENSO variabilities cause warming of the ocean surrounding the Galápagos. This leads to better understanding of acidification and warming. (Manzello et al., 2014).

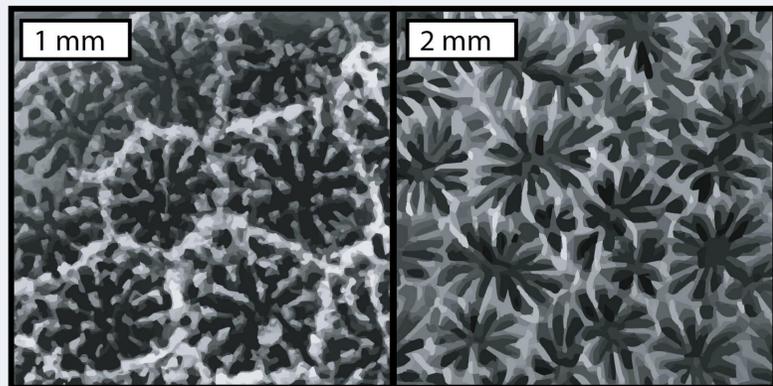


Figure 1: microscopic image of *Porites* (left) and *Pavona* (right) corallite skeletons. Figure adapted from Veron (2000a).

Porites spp. corals are the one of the most used genera in paleoclimate reconstructions because their skeletons are highly sensitive to SST changes, but also extremely resilient. They have a skeleton of tiny, uniform corallite that creates a light skeleton. *Pavona* corals corallite skeletons are less uniform and almost intertwined making the skeleton denser. *Pavona* corals have not been thoroughly researched for climate reconstruction, but they can also be used to identify oxygen isotope $\delta^{18}O$ and Sr/Ca ratios. This studies the difference between whether *Pavona clavus*, found in the Galápagos, can serve as an Sr/Ca proxy for reconstructing past ENSO variability in the Galápagos as Sr/Ca ratios and SST are inversely related.

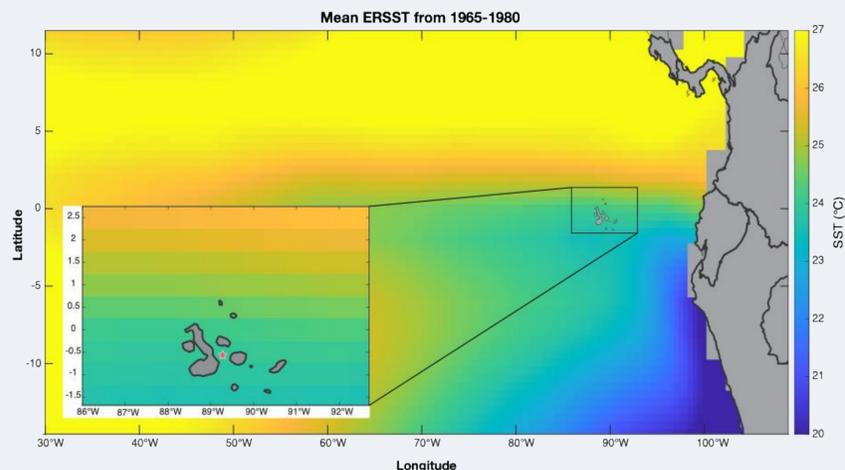


Figure 2: (A) Oceanographic setting of the Galapagos relative to the rest of the Pacific Ocean during the study period. (B) A map of the Galapagos Islands and the study site, Isla Pinzon (red star).

Methods

- Coral DI-12 was collected from the modern reef in 1977 and was provided by Dr. Ellen Druffel at the University of California – Irvine to conduct geochemical analyses.
- 150-200 μ g of coral powder was drilled along the 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 DI-12 was completed by assigning tie-points between ERSST and Sr/Ca values to align results with the timescale and evaluate the relationship between the patterns in Sr/Ca variations and SST variations.

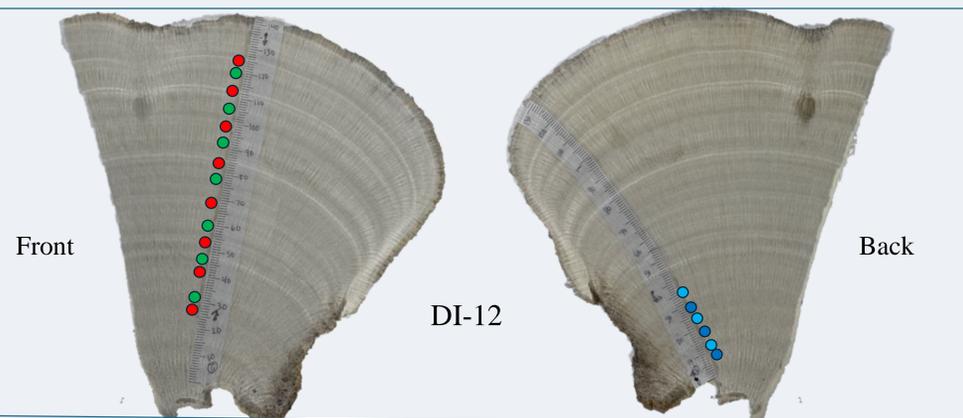


Figure 3: X-Ray of Coral DI-12 overlain with a photo of the coral slab. The dots on the X-Ray indicate correlated peaks and troughs in the Sr/Ca time series in figure 2. Left image shows transect 1 Red represents high SST Low SST. Right image shows transect 2 light blue representing high SST and dark blue as low SST

Results

Two transects were laid, ensured with overlap, to show continuous data.

- We see similar trends between the given ERSST SST and the Sr/Ca ratios. The variations between seasonal high and low SST follow the same patterns which can help replicate climate history.
- When lining up the Sr/Ca ratios and the recorded SST, we can determine how many years of data DI-12 can provide.

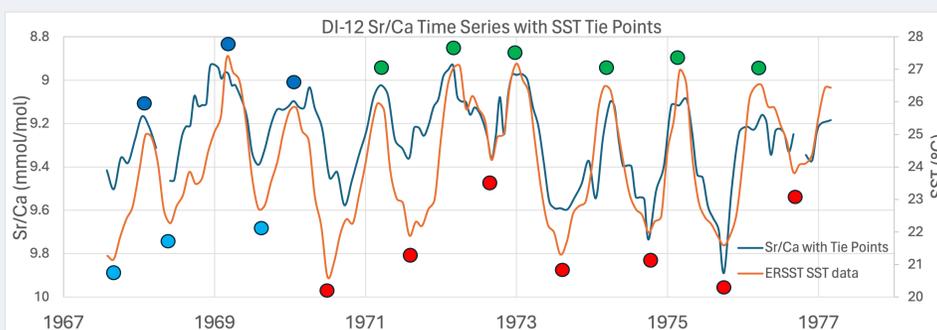


Figure 4: Spliced Sr/Ca data from both transects put together (orange) compared to the ERSST dataset for 1967-1977 (blue)

Conclusions

- The reconstructed age model of this coral shows DI-12 covers 10 years of climate variations.
- The data supports the conclusion that *Pavona clavus* could be used as a Sr/Ca proxy for reconstructing past SST and ENSO variability
- These results help demonstrate the potential of *Pavona clavus* as a reliable proxy for reconstructing past climate conditions, offering new insights into climate history.

Next steps

- 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 multi-site and genus study that assesses the validity of coral Sr-U in the Galápagos Islands.
- A regression comparison could also be created to identify the correlation slope between SST and Sr/Ca .
- DI-12 shows strong correlation in later years and showing high SST, but cold extremes are not as similar. This warrants future investigation as to why the colder temperatures are not producing similar SST values.

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References

Bradley, Raymond S. *Paleoclimatology: Reconstructing Climates of the Quaternary*. Academic Press, 2015.

Druffel, E. M. (1981). Radiocarbon in annual coral rings from the eastern Tropical Pacific Ocean. *Geophysical Research Letters*, 8(1), 59–62. <https://doi.org/10.1029/g1008i001p00059>

Dunbar, R. B., Wellington, G. M., Colgan, M. W., & Glynn, P. W. (1994). Eastern Pacific sea surface temperature since 1600 A.D.: The $\delta^{18}O$ record of climate variability in Galápagos Corals. *Paleoceanography*, 9(2), 291–315. <https://doi.org/10.1029/93pa03501>

Manzello, D. P., Enochs, I. C., Bruckner, A., Renaud, P. G., Kolodziej, G., Budd, D. A., Carlton, R., & Glynn, P. W. (2014). Galápagos coral reef persistence after ENSO warming across an acidification gradient. *Geophysical Research Letters*, 41(24), 9001–9008. <https://doi.org/10.1002/2014gl062501>

Smith, S. V., Buddemeier, R. W., Redalje, R. C., & Houck, J. E. (1979). Strontium-Calcium Thermometry in Coral Skeletons. *Science*, 204(4391), 404–407. <https://doi.org/10.1126/science.204.4391.404>

Veron, J.E.N. (2000a). *Corals of the World*. Townsville: Australian Institute of Marine Science. Volumes 1-3. 1410pp.