

Unlocking how biomineral crystals record their environments

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Biomaterials that form layered skeletons and shells have long been studied as a way to understand past environments via empirically-based chemical and isotope paleoproxies. Aragonitic (CaCO_3) coral skeletons and mollusk shells are of particular interest since they serve as representatives to important coral reef, coastal, and lacustrine ecosystems. Yet, few studies have sought to base environmental proxies on quantitative crystal chemistry and crystal structure. Taking a mineralogical perspective to studying corals and pearls (pristine nacre time capsules) is a first step to understanding why these proxies work and how environmental conditions are reflected in biomineral crystal structures. Beyond studying past climate, being able to understand biomineral crystallography under various environments may also help to predict their fate under future climate conditions.

During this presentation, we will tour the mineralogical laboratories at the Smithsonian NMNH and explore how we are using X-ray, laser, and electron-based techniques to study these complex biomineral materials on an atomic- to micrometer-scale. First, we will focus on coral skeleton crystallography and what it can tell us about how coral aragonite crystals grow and how they are influenced by ocean conditions (Farfan et al. 2022). Second, we will observe how farmed freshwater pearl nacre records seasonal chemical, isotope, and crystallographic signals that correlate with local lake environmental variables, such as temperature, dissolved oxygen, and more (Fig. 1; Farfan et al. 2021).

References

- Farfan, G. A., Apprill, A., Cohen, A., DeCarlo, T. M., Post, J. E., Waller, R. G., & Hansel, C. M. (2022). Crystallographic and chemical signatures in coral skeletal aragonite. *Coral Reefs*, 41(1), 19-34.
- Farfan, G. A., Zhou, C., Valley, J. W., & Orland, I. J. (2021). Coupling mineralogy and oxygen isotopes to seasonal environmental shifts recorded in modern freshwater pearl nacre from Kentucky Lake. *Geochemistry, Geophysics, Geosystems*, 22(12), e2021GC009995.

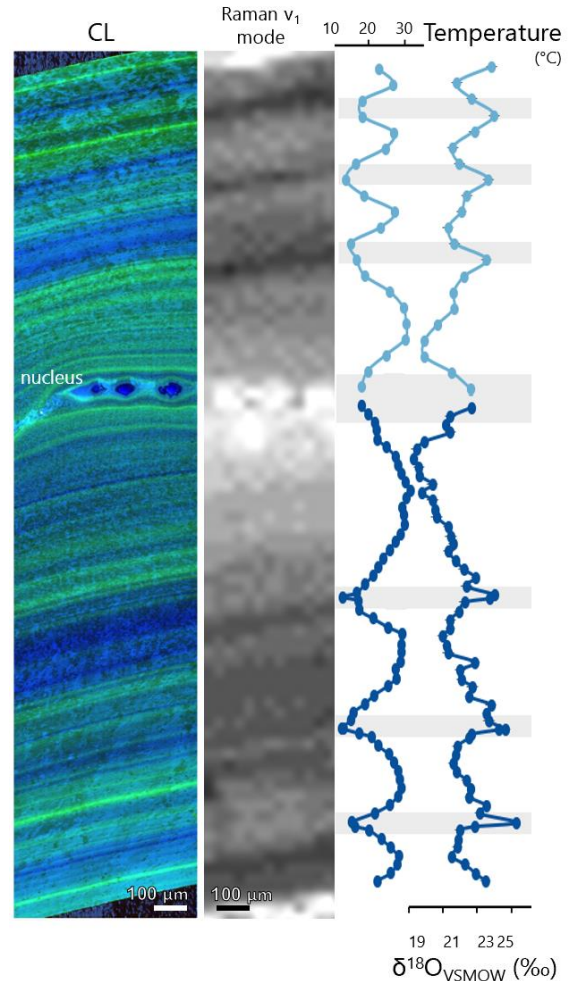


Figure 1. A cross-section of a freshwater pearl revealing seasonal-scale heterogeneities via cathodoluminescence (CL) and Raman spectroscopy mapping. Features broadly correlate with nacre oxygen isotope measurements and lake environmental conditions (i.e. temperature).