Goldschmidt 2022 Abstract
https://doi.org/10.46427/gold2022.10218

Links between oxygen isotopes, geochemistry, mineralogy, and the environment captured in freshwater pearl nacre

GABRIELA A FARFAN[1], EMMA BULLOCK[2], CHUNUHI ZHOU[3], JOHN W. VALLEY[4] AND IAN ORLAND[5]

[1]Smithsonian Institution–National Museum of Natural History
[2]Carnegie Insitution for Science
[3]Gemological Institute of America
[4]University of Wisconsin–Madison
[5]University of Wisconsin–Madison, Wisconsin Geological and Natural History Survey

Presenting Author: farfang@si.edu

Biocarbonates are important aquatic environmental recorders across paleontological to modern times. Thus far, most approaches to studying biocarbonate paleoproxies rely on empirical observations of isotope and trace element measurements. While these are proven to be extremely useful, relatively little attention has been paid to the crystal chemistry and structures of the minerals in which those signatures are bound. Linking paleoproxies to concrete crystallographic measurements and crystal chemistry may prove useful for establishing future proxies—and in some cases, mineralogical features themselves (crystal morphology and structure) have proven useful as independent or complementary paleoproxies. In this study, we use modern freshwater pearls (nacre) from Kentucky Lake, TN, USA as pristine time capsules to study the relationships between measured environmental aquatic conditions (data collected by the Kentucky Lake Long-Term Monitoring Program by Murray State University), novel SIMS-based $\delta^{18}O$ measurements, trace element geochemistry, and aragonite mineralogical signatures (Farfan et al. 2021, G^3). Specifically, we explore Raman vibrational modes of the carbonate bonding environment, nacre tablet size, organic content, and cathodoluminescence signatures. Beyond their usefulness in coupling paleoproxies with mineralogy, farmed cultured pearls in particular also represent a billion-dollar industry that will benefit from better understanding the environmental variables that influence nacre formation.

Our findings confirm a strong correlation between pearl $\delta^{18}O$ values at the µm-scale and lake temperature, as well as additional correlations with lake dissolved oxygen concentrations and light levels at 1m depth. Raman vibrational mode peak intensities of the atomic bonding environments in aragonite also record seasonal zoning correlating with lake temperature and dissolved oxygen levels. We will present new high-resolution Raman and cathodoluminescence maps that correlate with Mn and structural defects and we will explore how trace element concentrations and CL signals correlate to the environmental variables in Kentucky Lake.

We expect that future detailed mineralogical approaches to studying biomineral-based trace element and isotope paleoproxies will positively add to the field and could be applied to many other biomineralizing organisms from corals to foraminifera.

Reference:

Farfan et al. 2021 Coupling mineralogy and oxygen isotopes to seasonal environmental shifts recorded in modern freshwater pearl nacre from Kentucky Lake, *G-cubed*