Coupling cultured pearl nacre mineralogy with environmental conditions

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Biominerals that accrete shell or skeleton are commonly used as windows to past geochemical environments. Using biominerals as paleoproxies depends on the assumption that biominerals faithfully and predictably record environmental parameters, yet, little has been done from a mineralogical perspetive to understand how various environmental shifts impact shell and skeleton mineralogy. Modern pearls cultured in Kentucky Lake, TN present an opportunity to determine how environmental factors impact mollusk nacre mineralogy, since the lake has been closely monitored by the Kentucky Lake Monitoring Program for decades. In this study, we correlate environmental lake data with mineralogical and chemical signatures of cultured pearl nacre. Six pearl transects were measured from core to edge for $\delta^{18}O$ using SIMS (IMS-1280). These same transects were then probed for shifts in nacre tablet thickness, carbonate bonding environments, and major cation incorporations via SEM, Raman spectroscopy, cathodoluminscence, and electron microprobe.

In addition to oxygen isotope ratios that strongly correlate with seasonal oscillations in lake temperature, our measurements suggest that nacre tablet thicknesses and the intensities of the carbonate Raman ν_1 vibrational modes are also zoned along the pearl transects on similar seasonal timescales. Carbonate ν_1 vibrational mode peak heights are inversely correlated with $\delta^{18}O$ (~19 to 26‰) and positively correlated with nacre thickness and OH/O ratios, which suggests that these variables may be interrelated and require further examination. This approach in combining geochemical, isotopic, mineralogical, and environmental data lends a wholistic view to biomineralization in natural systems and to the decoding of environmental signatures.