

Calcite biomineralization insights from high-resolution Raman and element spatial analyses

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Calcite biomineralization is affected by multiple environmental and physiological factors, which in turn, can be observed through variations in element geochemistry, crystallography, and mineralogy. For instance, seawater temperature and food availability are known to influence the rates of calcite precipitation by marine calcareous organisms and correspondingly their skeletal/shell geochemistry (e.g., abundance of minor elements such as Mg, Sr, and S) as well as the degree of crystalline disorder [1,2]. Moreover, Mg incorporation in biogenic calcite is not only a product of physicochemical controls (e.g., temperature, carbonate chemistry) but also taxon-specific effects possibly explained by organic macromolecules or other calcification mechanisms [3-5]. The relative contributions of these environmental and physiological factors are not well known for various calcitic taxa.

High-resolution techniques like Raman spectral mapping and Electron Probe Micro-Analysis (EPMA) have provided a path toward quantifying micron-scale spatial heterogeneity in calcite crystallography, element content, and a potential proxy for calcifying fluid saturation state (Ω) [1,2,6]. Here, we pair Raman and EPMA maps with corresponding oceanographic data to investigate finescale environmental and physiological effects on calcite crystallography and element geochemistry within pelagic barnacle (*Lepas anserifera*), abalone (*Haliotis discus hannai*), and mussel (*Mytilus* sp.) shells. This will be paired with our empirically-derived trendlines between Raman spectral parameters and the concentrations of minor elements in laboratory-grown inorganic calcite to partition crystalline disorder into element-driven and non-element components. We will discuss our results in the context of the differences in biomineralization processes across several taxa, which have important implications for studying potential organismal vulnerabilities to ocean acidification and paleo-proxy development.

[1] Vielzeuf et al. (2013), *Chem. Geol.* 355, 13-27. [2] Conner et al. (2023), *Am. Min.* 108, 999-1013. [3] Morse et al. (2007), *Chem. Rev.* 107, 342-381. [4] Lebrato et al. (2016), *Global Biogeochem. Cycles* 30, 1038-1053. [5] Long et al. (2011), *Cryst. Growth Des.* 11, 2866-2873. [6] DeCarlo et al. (2019), *Glob. Change Biol.* 25, 1877-1888.

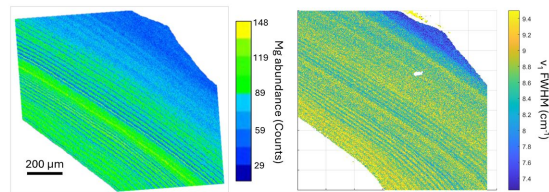


Figure 1