Goldschmidt 2025 Abstract
https://doi.org/10.7185/gold2025.30152

Multiscale Characterization of Recent Benthic Foraminifera and Bryozoa: Essential Prerequisites for Robust Proxy Archives

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Marine calcifiers play an important role in ocean biogeochemical cycles and the geochemical information archived in their shells and skeletons serve as significant records for paleo-environmental and -climatological reconstructions. Their hard parts are natural nano-composite materials with up to 4 wt% organics heterogeneously intermingled with the mineral phase [1]. Thus, their material and geochemical properties can be quite different from geological carbonates and can introduce deviations from predicted properties based on thermodynamic modelling for inorganic carbonates [2]. Understanding the architecture and biomineralization mechanism of potential and existing proxy archives is therefore an essential prerequisite for addressing their suitability and robustness.

To address this, we present a multi-scale characterization study of recent species from two phyla of marine calcifiers, namely bryozoa and benthic foraminifera. While foraminifera are among the most widely used and important geochemical archives in the ocean, bryozoa are still underused, although they present a significant part of the calcifying fauna outside the tropics where corals are scarce. While bryozoan colonies are smaller and more fragile compared to molluscs or corals [3], they can live for decades and develop seasonal growth bands showing good potential to be used as proxy archives where corals are not available [4].

Our study uses Electron Probe Microanalysis (EPMA), Electron Backscatter Diffraction (EBSD), Photo-induced Force Microscopy (PiFM), Atomic Force Microscopy (AFM), and micro-Raman spectroscopy to explore the nanoscale structure and organic-inorganic interface of the biocalcite that form their hard parts. We show the architectural, chemical, and organic variations in bryozoa and foraminifera and how these differences affect their mechanical properties, then use these results to evaluate their calcification processes.

[1] J. Gim et al., (2019) *Nat Commun* 10, 1-8

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[3] D.E. Jacob et al., (2019) *Sci rep* 9, 11439

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