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## A chemical investigation of microstructural changes in oyster (*Magallana gigas*) shells

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The shells of oysters (Family Ostreidae) are predominantly composed of two different calcite microstructures: A dense foliated structure consisting of sheet-like folia (“foliated” microstructure) and a more porous microstructure consisting of less well organized leaf-shaped crystals (“chalky” microstructure). These unique characteristics of oyster shells have been subject to a number of studies, with some authors hypothesizing that the chalky structures are mineralized by bacteria living in the shell (Vermeij, 2014). The formation of these microstructures is of great interest, because the phenomenon is unique in the mollusk phylum and because the shells of oysters are popular archives for paleoclimate and paleoenvironment reconstructions (e.g. Bougeois et al., 2018; de Winter et al., 2018). Previous authors have challenged the bacterially mediated mineralization hypothesis through microstructural observations of different parts of the oyster shell (Checa et al., 2018).

Here, we expand on this structural evidence by adding detailed observations of differences in chemical composition between the foliated and chalky microstructures. We combine information on trace element concentrations with stable carbon, oxygen, nitrogen and sulfur isotope ratios as well as carbonate clumped isotope analyses of samples from foliated and chalky structures in multiple modern specimens of *Magallana gigas*, the Pacific oyster. These analyses shed light on the chemical variability within the oyster shell and how it relates to the occurrence of various calcite microstructures. Given the unique isotopic signature of bacterially mediated calcite, our isotopic analysis results allow us to definitively conclude whether the chalky shell structure in modern oysters was precipitated via symbiotic microbes. Furthermore, the degree of intra-shell chemical variability has implications for paleoclimate and paleoenvironmental reconstructions from fossil oyster shells, for which the applied trace element and isotope systems function as

important proxies. The results of this study therefore yield important recommendations for sampling fossil oyster shells for reconstructions, and provide a baseline for the investigation of chemical variability between shell microstructures throughout the Ostreidae family and the mollusk phylum.

## References

Bougeois, L., Dupont-Nivet, G., De Rafélis, M., Tindall, J. C., Proust, J.-N., Reichart, G.-J., de Nooijer, L. J., Guo, Z. and Ormukov, C.: Asian monsoons and aridification response to Paleogene sea retreat and Neogene westerly shielding indicated by seasonality in *Paratethys* oysters, *Earth and Planetary Science Letters*, 485, 99–110, 2018.

Checa, A. G., Harper, E. M. and González-Segura, A.: Structure and crystallography of foliated and chalk shell microstructures of the oyster *Magallana*: the same materials grown under different conditions, *Scientific reports*, 8(1), 7507, 2018.

Vermeij, G. J.: The oyster enigma variations: a hypothesis of microbial calcification, *Paleobiology*, 40(1), 1–13, 2014.

de Winter, N., Vellekoop, J., Vorrsselmans, R., Golreihan, A., Soete, J., Petersen, S., Meyer, K., Casadio, S., Speijer, R. and Claeys, P.: An assessment of latest Cretaceous *Pycnodonte vesicularis* (Lamarck, 1806) shells as records for palaeoseasonality: a multi-proxy investigation, *Climate of the Past*, 14(6), 725–749, 2018.