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The Mg – SST relationship in mollusc shells: is there a rule? Examples from three tropical species

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The geochemistry of mollusc shells is currently viewed as a powerful tool for paleoenvironmental reconstructions. Indeed, molluscs are ubiquitous animals, with a worldly geographical and environmental distribution, providing various environmental records. Moreover, mollusc shells are abundantly found in fossil and archaeological settings. In the paleoclimatic reconstructions, the sea-surface temperatures (SST) are a key parameter. If shell stable oxygen isotope signatures can provide accurate SST records, this proxy is also influenced by the water isotopic composition. To find another tracer which would depend on the SST solely, the relationship between Mg content changes in mollusc shell and SST has been investigated for a few years. Nevertheless, if the reliability of shell Mg as SST tracer has been proven in some species, this is clearly not a “universal” and definitive rule.
To reconstruct the past tropical SSTs, Mg calibration studies were undertaken on Concholepas concholepas (gastropod, South America), Protothaca thaca (bivalve, South America) and Tridacna squamosa (bivalve, New Caledonia). The very high-resolution (infra-daily) analyses of the C. concholepas gastropod revealed a significant metabolism control, at the nyctemeral scale, on the Mg incorporation into the calcite shell layer. Over a two months period, the Mg fluctuations in C. concholepas shell do not match with the SST instrumental measurements. Mg content changes along the aragonitic shell growth axis of several living P. thaca from a same Peruvian site are significantly different indicating no relationship between Mg and SST. The Mg variations measured in a Chilean P. thaca shell are, surprisingly, similar to variations of the instrumental SST. Unless this quite reliable relationship between P. thaca shell and SST is confirmed, and that the inter-site difference in Mg response to environmental forcing is understood, P. thaca shell Mg cannot be used as SST proxy. Lastly, a preliminary work carried out on the external aragonitic shell layer of T. squamosa showed that, over 14 months of growth, Mg and SST are well conversely correlated but the seasonal cycle is interrupted by a Mg peak that corresponds to a shell growth anomaly. Additional studies, especially dedicated on anomalies-related Mg increases, must be performed to validate the T. squamosa shell as a reliable SST proxy.
Considering previous works and the results presented here, one can definitively conclude that, at least, calibration procedures are indispensable before using Mg as a SST proxy in mollusc shells. In addition, further work specifically directed towards the role of the metabolism on the incorporation of Mg in mollusc shells could be the key to understand, and thus to use, this proxy for which, at the present time, no single rule is applicable to molluscs.

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