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Inferring biomineralisation processes from geochemical responses to environmental variability.

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The geochemistry of biominerals is known to change in response to variations in the physical and chemical environmental that the organism lives in. This has led to a wealth of research using the trace element content and stable isotopic ratios of biominerals as proxy archives for past climate change. However, none of these geochemical proxies provide a perfect climate archive. Every geochemical system that has been studied in detail has been found to be strongly influenced by the biological and mineralogical processes of biomineralisation, which cause the composition of the biomineral to deviate from an inorganic precipitation formed in the same physico-chemical conditions.

The impacts of biomineralisation on geochemistry are termed the 'vital effect', and are commonly treated as a 'nuisance' parameter that must be dealt with when constructing palaeoclimate records. Alternatively, the differences between the geochemistry of inorganic precipitates and biomineral can be interpreted as a rich archive of the underlying mechanisms of biomineralisation. This approach allows us to indirectly interrogate the fine-scale mechanisms and dynamics of biomineralisation, which are exceptionally difficult to study directly *in vivo*. Particularly useful insights can be gained from the response of biomineral geochemistry to variations in the external environment. This approach is essentially the inverse of palaeoproxies – using geochemical patterns in biominerals produced under well-known conditions to infer the mechanisms that give rise to the 'vital effect'.

Here, we will consider the geochemistry of foraminiferal tests and coral skeletons grown in seawater where the concentration of Ca^{2+} and CO_3^{2-} have been independently varied. Both these ions are integral to the formation of $CaCO_3$ minerals, and the geochemical response to their variation reveals key insights into the processes of biomineralisation and the dynamics of ion uptake in these organisms. We compare and contrast geochemical response of corals and foraminifera to these conditions, and consider what these patterns tell us about their biomineralisation mechanisms.