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Calcareous marine skeletons as recorders of global climate changes

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The trace element and stable isotope (TEI's) profiles of calcareous skeletons have long been recognized to represent records of past and present environmental conditions, thus carrying potential for reconstruction of climate change. Since the composition of biogenic carbonates is also clearly influenced by biological factors the correct interpretation of these TEI archives requires a precise understanding of the processes controlling the incorporation of these proxies, and hence of bio-mineralization. We focused on proxy calibration using different types of marine biogenic carbonates and selected three taxa of potential recorders (sclerosponges, bivalves, and echinoderms) having contrasting characteristics, such as lifetime, growth rate, and mineralization features.

Some highlights of this study are: (i) In all three groups (sclerosponges, bivalves and echinoderms) δ^{18}O is an excellent proxy although the (mostly) unknown value for ambient water (which is related to salinity) can cause severe errors when calculating SST.. Therefore, either a salinity proxy or a salinity independent SST proxy would greatly benefit SST reconstructions; (ii) Both, laboratory and field based experiments with bivalves illustrated that the background Ba signal in the shell (i.e. not considering the Ba peaks commonly occurring in spring) reflects the dissolved Ba in the ambient solution and is thus a potential indicator for barium and salinity in estuarine environments. However, this proxy needs to be further refined; (iii) For annually resolved archives the problem of transforming data from a growth axis (i.e. distance axis) into a time axis is now partly solved via a nonlinear transformation. This allows for a more accurate comparison of proxy records in calcareous archives with corresponding records of environmental signals.

Our workplan for the near future aims at bringing together a multidisciplinary network of biologists, chemists, geologists and engineers, in order to: (i) investigate the effects of time averaging on the signal; (ii) address the mechanisms of proxy incorporation in the biogenic carbonate matrix, to better constrain the proxies under study; (iii) reconstruct past environmental conditions.

Based on species/proxy combinations, we will develop multi-proxy transfer functions using different types of marine carbonate skeletons and associated organic matrix. These proxies will include both established proxies (δ^{18}O, δ^{13}C, Ba/Ca, Mg/Ca) and newly developed ones (δD, δ^{26}Mg). Analyzing the same proxy in aragonite and calcite (a single archive can consist of both minerals; e.g., shells of the blue mussel), known to record environmental conditions differentially, will allow to deconvolve effects of multiple controls on the proxy (e.g. separate salinity from temperature effects).