# Seeking a mechanistic understanding of cold-water coral trace metal composition through culture experiments with decoupled carbonate chemistry parameters

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Trace metal/calcium (Me/Ca) ratios measured in well-preserved fossil corals can yield important insight into past variations in seawater temperature, carbonate chemsitry, and elemental composition. Our current ability to develop and apply these proxies, however, is limited by (1) the lack of mechanistic biomineralization models that clearly link the composition of seawater to the geochemistry of coral skeletons, and (2) the co-variation of $CO_2$ system variables in natural seawater, which makes it difficult to identify how changes in distinct $CO_2$ system variables control coral geochemistry and calcification. Culture experiments are uniquely suited to separate the influence of different $CO_2$ system parameters on skeletal geochemistry and to generate samples for testing mechanistic biomineralization models.

We cultured juvenile individuals of the cold-water coral, *B. elegans*, in a set of experiments with decoupled carbonate chemistry parameters. Using a multi-element mixed spike ID-ICP-MS method, we then analyzed cultured skeletons for Me/Ca ratios, including U/Ca, Sr/Ca and Mg/Ca. We find that U/Ca and Sr/Ca ratios in cultured B. *elegans* are both most strongly correlated with solution DIC and not pH or $[CO_3^{2-}]$. We also observe that Me/Ca ratios measured in our coral skeletons co-vary, consistent with previously published work. The consistency of Me/Ca correlations across our culture conditions suggests that biomineralization affects coral geochemistry in systematic ways. Moreover, these consistent patterns can be used as targets for biomineralization models. Using a steady state model of coral calcification, we show that variations in *B. elegans* Me/Ca ratios reflect both changes in external seawater chemsitry and modifications to the coral's calcifying environment in response to changing seawater composition. This work emphasizes the potential for mechanistic models of biomineralization to improve the interpretation of trace element proxies in coral.