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Geochemical constraints on the use of an amorphous precursor phase by corals

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A growing body of evidence suggests that corals, like many other marine calcifying organisms, may form at least parts of their aragonite skeleton via an amorphous calcium carbonate (ACC) or other metastable precursor phase. This is in apparent conflict with our understanding of coral skeletal chemistry, in that most trace element systems can be modelled with minor modifications to the inorganic aragonite distribution coefficients (e.g. via Rayleigh fractionation), whereas ACC, and crystalline $CaCO_3$ derived from ACC, has a vastly different chemistry. Via a simple geochemical model, we show that these observations may be reconciled provided that ACC undergoes near complete dissolution and exchange with the calcifying fluid during crystallisation. Coral skeletons comprise two micro-structural components: Centres of Calcification and thickening fibres. Comparing the chemical composition of these two components additionally demonstrates that differential degrees of ACC utilisation is unlikely the main cause of their well-documented micro-scale chemical heterogeneity. While important processes remain poorly constrained, in particular the mode and chemical dynamics of ACC crystallisation in biological systems in seawater, our results highlight how biomineral geochemistry can place important constraints on the role of ACC in forming biominerals.