

Novel measurements of inorganic and biogenic calcite dissolution kinetics in seawater

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We present here the dissolution kinetics of inorganic, benthic foraminiferal, and coccolith calcite, as well as high-Mg calcite from the soft coral *Rhythismia fulvum* in seawater. Dissolution rate measurements were conducted using a novel ¹³C-based tracer measurement, which traces mass loss via isotopic enrichment in a closed system of calcite and seawater. Inorganic calcite dissolution rates are highly nonlinear with respect to saturation state ($1-\Omega$), and imply multiple dissolution mechanisms. Our work validates early characterizations of highly nonlinear dissolution rates, and also agree with far-from-equilibrium rate determinations. Dissolution rates of biogenic materials are also highly nonlinear, and appear to be well-normalized by reactive surface area as determined by Kr-BET. The high-Mg coral dissolution rates must be evaluated independently, since the solubility of high-Mg calcite is unconstrained. These biogenic dissolution rates provide a new constraint on the sensitivities of these minerals to saturation state, both in the deep ocean water column and in the surface ocean as saturation state is decreasing due to ocean acidification.

Finally, we present a mechanistic experiment on calcite dissolution in seawater, and show the kinetics to be limited by hydration of aqueous carbon dioxide, across a wide range of undersaturations. Experiments in the presence of carbonic anhydrase increase dissolution rates across all undersaturations, by as much as a factor of 700. At high carbonic anhydrase concentrations, the dissolution rate is shown to be essentially linearly dependent on carbonic acid concentration. This work provides a greater fundamental understanding of the nature of calcite dissolution.