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Using the silica isotope composition of biogenic materials in marine sediments to reconstruct ocean chemistry

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The silicon isotopic composition of sedimentary biogenic opal can be used to track shifts in the balance between silicon inputs to the ocean and outputs by burial. In addition to biosilicification and opal burial, the global cycles of climate (hydrology, weathering, glaciation, etc.), tectonics (volcanoes, LIPs, mountain building, etc.) and geochemistry (reverse weathering, inorganic Si precipitation, etc.) have driven variations in the global Si cycle over geologic time. Prior to the start of the Phanerozoic it is thought that burial in the global oceans was controlled inorganically through chert formation. The evolution of the Si depositing organisms, radiolarians and sponges, reduced oceanic dissolved Si, but the largest reductions occurred with the evolution of the diatoms bringing dissolved Si to the low concentrations (relative to saturating concentrations) observed today. However, the timing of the depletion of dissolved Si by diatoms is currently under debate.

Our understanding of the biological components of the Si cycle has grown enormously. In the last decade, silicon isotope ratios (expressed as δ30Si) in marine microfossils are becoming increasingly recognised for their ability to provide insight into silicon cycling. In particular, the δ30Si of deep-sea sponge spicules has been demonstrated to be a useful proxy for past dissolved Si concentrations. However, more recent studies find anomalies in the isotopic fractionation of sponge spicules that relate to skeletal morphology: reliable reconstructions of past dissolved Si can only be obtained using silicon isotope ratios derived from sponges with certain spicule types. We are applying δ30Si proxies from biosiliceous material contained in sediments to generate robust estimates of the timing and magnitude of dissolved Si drawdown. We will provide fundamental new insights into the drawdown of dissolved Si and other key events, which reorganized the distribution of carbon and nutrients in seawater, with implications for productivity of the biological communities within the ancient oceans.