The formation of different calcium carbonate polymorphs driven by microbial sulfate reduction

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Microbial sulfate reduction, coupled either to organic matter oxidation or anaerobic methane oxidation, may be one of the key drivers of sedimentary authigenic carbonate formation in marine sediments, intertidal marshes and hypersaline lakes. While much work has been done exploring the precipitation of different carbonate polymorphs in abiotic conditions, less is known about the different carbonate polymorphs produced during microbial biomineralization driven by microbial sulfate reduction. In this study, we grow sulfate reducing bacteria (*D. bizertensis*) in media with varying Mg/Ca and seeding materials (calcite and kaolinite). Our results suggest that sulfate reducing bacteria induce carbonate precipitation and serve as a nucleation for the growing carbonate; the majority of our carbonate was found grew on cell material rather than the mineral seeds. We also find the Mg/Ca ratio in the media plays a key role in controlling how quickly carbonate is produced and which polymorph grows. In media where the Mg/Ca is greater than 2, a crystalline monohydrocalcite is the primary carbonate mineral produced. We converted monohydrocalcite to either calcite or aragonite abiotically at the end of the incubation. Although phosphate concentrations have a lesser effect on which polymorph initially precipitates, the presence stabilizes monohydrocalcite crystals and prevents their transformation to more stable polymorphs. This study suggests that calcium carbonate cements precipitated through microbial sulfate reduction pass through several carbonate precursors and may be partially decoupled from the polymorph predicted by the initial pore fluid chemistry.