Carbonate minerals as records of chemical conditions before the rise of atmospheric oxygen

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Dolomite is a common sedimentary mineral, but how it forms at low temperature remains an open question. Roles for microbial surfaces, sulphate reduction, hypersaline conditions and methanogenesis have all been postulated. Here, we show that the precipitation of dolomite preserves the fine textures of microbial biofilms driven by sulfide-oxidizing anoxygenic photosynthetic microbes in solutions with normal salinity. Nanocrystalline dolomite nucleates on extracellular polymeric substances or on cell surfaces, depending on the sulphide concentrations. The presence of light and 0.1-1 mM manganese all increase the abundance of dolomite. The presence of dissolved Mn(II) stimulates dolomite precipitation, but the presence of Fe(II) in the solution increases the abundance of ankerite and calcite at the expense of dolomite. Thus, carbonate minerals can record past biological activity in chemical gradients of reduced iron, manganese and sulfide. Carbonate precipitation in gradients of these chemicals may account for the abundant Mn-rich lagoonal or platform dolomite in some Archean and Proterozoic environments.