

Microbial influences on the precipitation of hydrated magnesium carbonate minerals

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Hydrated magnesium carbonates are rare on Earth, but may be important targets of the search for biosignatures in samples returned from Mars. This study aims to characterize the role of biology in the formation of hydrated magnesium carbonates at low temperature and assess the potential for these minerals to retain organic signals. Experiments evaluated the influences of two different cyanobacterial species and a range of commercially available sulfated and carboxylated polysaccharides on the mineralogy, morphology and precipitation rate of these minerals. Oxygenic photosynthesis increased the saturation of hydrated magnesium carbonates in solution, but cyanobacterial polymers determined the mineralogy of precipitates in saturated solutions and the abundance of precipitates in cyanobacterial biofilms. Extracellular polymeric substances (EPS) extracted from cyanobacterial cultures enabled the precipitation of spheroidal dypingite ($\text{Mg}_5(\text{CO}_3)_4(\text{OH})_2 \cdot 5\text{H}_2\text{O}$), whereas acicular nesquehonite ($\text{MgCO}_3 \cdot 3\text{H}_2\text{O}$) precipitated in sterile solutions that lacked organic amendments or were amended by commercial polysaccharides. Dypingite spheroids that precipitated around coccoidal cyanobacteria contained cell-shaped voids and their Raman spectra exhibited organic bands. Comparable features were also identified in samples of hydromagnesite ($\text{Mg}_5(\text{CO}_3)_4(\text{OH})_2 \cdot 4\text{H}_2\text{O}$) microbialites from Lake Salda, SW Türkiye, a terrestrial analog for Jezero Crater, Mars. Palisade textures were present in microbialites of various ages and Raman spectroscopy identified organic signals in hydromagnesite from fossil samples, but not in carbonate veins that occur in altered mafic bedrock around the lake. These experiments and analyses show that hydrated magnesium carbonates can preserve organic matter and textural biosignatures, enabling the distinction between organic and inorganic environments of mineral formation.