American Mineralogist, Volume 97, pages 556–567, 2012

Polysaccharide-catalyzed nucleation and growth of disordered dolomite: A potential precursor of sedimentary dolomite

Fangfu Zhang, Huifang Xu,* Hiromi Konishi, Evgenya S. Shelobolina, and Eric E. Roden

NASA Astrobiology Institute, Department of Geoscience, University of Wisconsin–Madison, Madison, Wisconsin 53706, U.S.A.

Abstract

The origin of dolomite is a long-standing enigma in sedimentary geology. It has been proposed that microorganisms, especially anaerobic microorganisms, can overcome kinetic barriers to facilitate dolomite precipitation, although their specific role in dolomite formation is still unclear. Our experimental results demonstrate that disordered dolomite can be synthesized at room temperature abiotically from solutions containing polysaccharides such as carboxymethyl cellulose or agar. We propose that when dissolved in solution, polysaccharides can be strongly adsorbed on Ca-Mg carbonate surfaces through hydrogen bonding. The adsorbed polysaccharides may help weaken the chemical bonding between surface Mg^{2+} ions and water molecules, which can lower the energy barrier to the desolvation of surface Mg^{2+}-water complexes, enhance Mg^{2+} incorporation into the precipitating carbonate, and thereby promote disordered dolomite formation. In natural environments, it is possible that polysaccharides produced by microorganisms, e.g., extracellular polysaccharides, may play a key role in promoting disordered dolomite nucleation and crystallization. In marine sediments, the accumulated dissolved carbohydrates produced from organic matter degradation during early diagenesis may also serve as catalysts for disordered dolomite formation.

Keywords: Disordered dolomite, dolomite, extracellular polysaccharides, carboxymethyl cellulose, agar