

Microbial Biomineralization Processes of Stromatolitic Dolostone from the Ediacaran Period in Sichuan Basin, Southeast China

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Abstract

The extraordinary abundance of dolomite in the Ediacaran Period challenges our understanding of Precambrian marine environments. Here we show that syngedimentary marine dolomite precipitation was pervasive within Ediacaran Period carbonates from the Sichuan Basin, Southwest China. The Dengying Formation of Ediacaran was divided to 4 members. All the rocks are dolostones except the thin clastic rocks in Member 3 because of short regression. The microbial dolostones of Dengying Fm. include: Stromatolitic dolostone, Laminae dolostone, Thrombolitic dolostone, Cystose dolostone and Oncolitic dolostone. These microbial dolostone are also good reservoir, which develop abundant dissolution pores and framework pores. With the High-resolution SEM and TEM, we studied the microstructure of stromatolitic dolostone and found abundant spherical, oval-like dolomites, the size of which are 5-15 microns. The Mg/Ca ratios of these spherical dolomites are 0.65-1.11. There are many nanoglubules on the surface of these spherical dolomites. Some extracellular polymeric substances (EPS) were also found under the SEM. With the studies of petrology, sedimentology and geochemistry, these microstructures are inferred to be the products of microbial biomineralization processes. The microbes can promote the precipitation of dolomite with 3 aspects: (1) The metabolic processes of microbes can secrete EPS, which has abundant functional groups (including Carboxyl, hydroxyl, amino acid, sulfate, sulfoacid, sulfhydryl). These groups have strong ability of complexing

metallic ions and other ions. They can absorb Mg^{2+} , Ca^{2+} , Si^{4+} and lead to the forming of dolomites. (2)The microbes can form protein layers on their cell surfaces, which could be the nucleation center of dolomite. (3)The abundance of the microbes can change the physical and chemical characteristics of water bodies (like pH, element abundance, etc). Some silicons were also detected under SEM, which indicate that the early-stage silicification preserved the microbes' cell and ultra-microstructures. The discoveries of these kind of ultra microstructures would provide some intuitive evidence for the microbial origin dolostones in ancient strata. Calculated paleo-seawater temperature of Dengying Stage, Ediacaran Period is about 40.8°C. Previous mimetic dolomitization cannot explain the widespread huge thick dolostone. Abundant early marine dolomite precipitation implies a radically different seawater chemistry for the Ediacaran. In late Ediacaran Period, there was high seawater salinity, high CO_2 partial pressure, anoxic and hot, evaporative condition in South China. Perhaps these aragonite-dolomite seas are associated with extreme Neoproterozoic glacial events and/or ocean anoxia.