Microbially Induced Dolomite Precipitation Associated With Evaporites in Hypersaline Lake: A Case Study From the Eocene Es4x Interval, Dongying Depression, Bohai Bay Basin, China

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ABSTRACT

The origin of dolomite remains a subject of ongoing debate. This study examines thick sequences of evaporites, carbonates and dark mudstones in hypersaline lake sediments at burial depths of 4000~5000m in the Eocene Es4x interval in Bohai Bay Basin and provides insights regarding the origin of dolomite in continental lacustrine deposits. Evaporite deposits in Eocene Es4x interval consist of gypsum and anhydrite, whereas associated carbonate deposits contain early diagenetic micritic dolomite. SEM images show that these dolomite crystals range from 3-40μm in diameter with spheroidal and dumbbell-like growth habits. Based on core observations, a close spatial relationship occurs between dolomite and evaporite deposits. Based on point count data, the contents of dolomite cements can reach up to 25% where the samples are in close proximity to evaporites and are less than 5% away from evaporites. δ13CPDB values for micritic dolomite cements are depleted (-7.45 to -2.57‰) due to microbial sulfate reduction (MSR) under shallow burial conditions. Based on oxygen isotopic compositions of micritic dolomite cements (δ18OPDB values from -11.60 to -9.50‰), precipitation temperatures ranged from 57.5 to 72.8oC. These temperatures are likely to have developed at relatively shallow depths in a rift basin with a high geothermal gradient and are consistent with dolomite formation within or below the maximum temperature range (60°C–80°C) over which MSR occurs. SEM images demonstrate that framboidal pyrite is closely associated with micritic dolomite and infills primary pores between uncompacted framework grains. Compared with δ34SCDT values in sulfate cements (+21.2‰ to +37.8‰), more negative 34SCDT values in framboidal pyrite (-3.9‰ to +5.7‰) support a MSR origin for hydrogen sulfide (H2S) in reducing conditions during early diagenesis. Petrographic and geochemical evidence support a microbial origin for dolomites in the Eocene Es4x interval in continental lacustrine basin. Specific evidence supporting this contention include: 1) spheroidal and dumbbell-like dolomite crystals; 2) negative δ13CPDB values of the dolomite; 3) relatively low precipitation temperatures of dolomite; 4) negative 34SCDT values of associated framboidal pyrite. Therefore, this study illustrates the role of MSR in dolomite precipitation in a semi-closed and reducing lacustrine basin during Eocene time.