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The primary mineralogy of dolomites from Sichuan Basin, China: Implications for the evolution of seawater chemistry during late Ediacaran

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Seawater chemistry is crucial for the origin and evolution of life in ocean. The major ion compositions (e.g. Ca, Mg) of ancient seawater can influence the variation of primary marine carbonate mineralogy. Oceans with high Mg/Ca molar ratios (e.g. >2) preferentially precipitate aragonite, while low Mg/Ca molar ratios (e.g. <1, or even <0.3) mainly form calcite. The corresponding "aragonite seas" and "calcite seas" have alternately dominated during the Phanerozoic. For the Precambrian seawater, the "dolomite seas" (with Mg/Ca molar ratios >10) is popular during Cyrogenian. The "aragonite-dolomite seas" seems to transferred to "aragonite seas" in early Ediacaran. For the ubiquitous dolomitization in Precambrian, determining the primary mineralogy is complicated, as the primary aragonite or high-Mg calcite is susceptible to dissolution and replacement during diagenesis. Thus, we carried out a case study of Dengying Formation from Sichuan Basin, China. Primary mineralogy of multi-phase dolomite cements is identified through petrology and crystallography (especially the elongation sign), aiming to decipher the seawater chemistry evolution during the late Ediacaran.

The dolomites of Dengying Formation from Sichuan Basin are mainly composed of micrite dolomite matrix and multi-phase fabric dolomite cements. Four types of marine dolomite cements are identified in order of formation according to the shape and elongation sign: radial slow dolomite (RSD), radial fast dolomite (RFD), fascicular slow dolomite (FSD) and fascicular fast dolomite (FFD). RSD is the first generation of dolomite cement with fibrous single crystal (200-400 μm long and 10-20 μm wide), isopachous lining the matrix. RFD consists of columnar crystals in a radial pattern with the tip showing rhombic shape followed by RSD. FSD is characterized by fan-like bundles of fibrous subcrystals, and the clear growth layer can be observed under cathodoluminescene. FFD is the last dolomite cement and always forming agglomerated palisade botryoids. Aragonite and calcite are originally length-fast, while dolomite is length-slow. Mimetic dolomitization can retain the primary fabric. Thus, the length-slow dolomite cements (both RSD and FSD) here suggest direct dolomite precipitation. Alternated length-slow and length-fast dolomite cements indicate the undulate Mg/Ca ratios and the "aragonite-dolomite seas" during the terminal Ediacaran.