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Inorganic synthesis of disordered dolomite at room temperature

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Dolomite is an abundant carbonate mineral in ancient rocks, but it only occurs in limited modern environments such as hypersaline lakes and cold seeps. Dolomite still cannot be well synthesized at low temperatures. This paradox has been repeatedly referred to as the “dolomite problem” [1].

Here we conducted an inorganic synthesis experiment to explore the possibility that dolomite inorganically forms under certain conditions at room temperature. A solution was prepared by dissolving $MgCl_2$. $6H_2O$ and $CaCl_2$. $2H_2O$ in distilled water and mixed with a sodium bicarbonate solution. The mixed solution was aged for seven days at 30 ℃. The Mg/Ca ratio is fixed at 5, and the concentrations of Ca^{2+} were set at 10, 15, and 20 mM. The concentrations of HCO_3^- were set at 30, 50, and 100 mM.

Disordered dolomite was formed even in ordinary temperatures and pressures where (1) Ca^{2+} and Mg^{2+} concentrations are 1 to 2 times that of seawater, (2) HCO_3^-concentration is from 30 to 100 mM. The required concentrations of HCO_3^- are higher where the concentration of Ca^{2+} and Mg^{2+} is lower, and (3) pH is from 8.5 to 8.8.

It is generally considered that modern dolomites at hypersaline lakes are intermediated by microbes [2]. Since some hypersaline lakes satisfy these conditions, it is possible that inorganic precipitation overlaps in addition to bacterial-mediated precipitation of dolomite in natural environments.

[1] Hans G. Machel (2004), Concepts and models of dolomitization: A critical reappraisal. Geological Society London Special Publications, **235**, 7-63.

[2] Bontognali et al.(2010), Dolomite formation within microbial mats in the coastal sabkha of Abu Dhabi (United Arab Emirates). Sedimentology, **57**, 824-844.

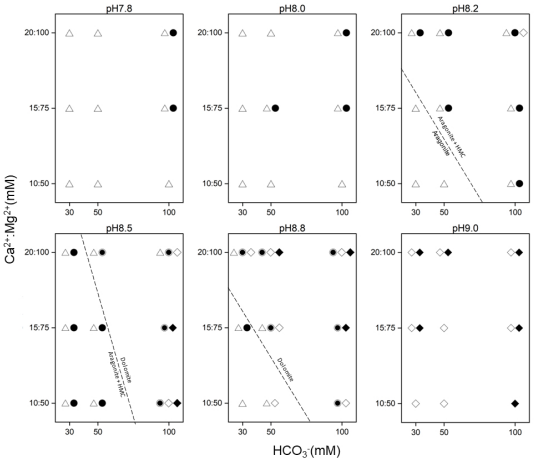

Fig.1 Precipitates synthesized from $CaCl_2$-$MgCl_2$-$NaHCO_3$ solution (△: aragonite, ●: HMC (4 to 39 mol% $MgCO_3$), ●: disordered dolomite($MgCO_3$ mol% ≥40), ◇: monohydrocalcite, ◆: nesquehonite)

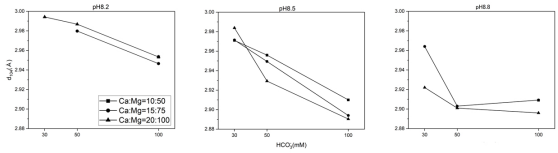

Fig.2 Relationship between d_{104} value and concentration of solution in the Ca-Mg carbonite minerals