

Geochemical controls on the elemental composition of siderite: Implications for palaeo-environmental reconstructions

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Siderite is found throughout the geological record from the Precambrian, to modern and recent sediments, and is widely used in terrestrial climate reconstructions [1][2][4][5]. Even though the elemental composition of siderite has been used to differentiate between marine, brackish and terrestrial deposits [2][4][5], the controls on Mn, Ca, and Mg incorporation are poorly understood. Although previous experimental studies have focused on Ca and Mg incorporation in siderite [3][6], the uptake of Mn, an environmentally informative and, in some cases, dominant component, has not been explored.

Here we describe the results of an experimental approach designed to evaluate controls on siderite composition during homogeneous nucleation and during seeded growth. Siderite was nucleated and grown under strictly anoxic conditions using solution matrices with varying Fe^{2+} , Mg^{2+} , Mn^{2+} and Ca^{2+} concentrations, pH, carbonate concentration, salinity, and at variable temperature. This approach includes growth at low supersaturation in order to investigate the slower growth rates typically observed in nature.

Results show that at ambient temperature (25°C), and under a variety of conditions, Mn^{2+} is coprecipitated in marked preference to Ca^{2+} and Mg^{2+} . Ca^{2+} uptake occurred only during nucleation and not growth, while appreciable Mg uptake did not occur in any ambient temperature experiments. We also observe that saturation state is a strong control on coprecipitation. These results are evaluated in the context of growth rate, precipitation mechanism, surface structural controls, the presence of competing cations, and other chemical parameters to provide a more comprehensive view of the controls on siderite composition across a range of sedimentary systems.

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