

Strontium partitioning in calcite: from inorganic to foraminiferal calcite

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The Sr/Ca ratio in calcite records the environment conditions of crystal formation, and has been widely used to study the diagenetic process and ocean chemistry in geological history. The use of Sr/Ca in calcite as a geochemical tool requires full understanding of the partition coefficient of strontium between calcite and the seawater (D_{Sr}). However, precipitated in a modified microenvironment, D_{Sr} of biogenic calcite (e.g. foraminiferal shells) exhibits large offset from that of inorganic calcite. Here we explore the link between Sr partitioning of foraminiferal and inorganic calcite. We develop an extended ion-by-ion model for inorganic calcite [1] which considers the contribution of both HCO_3^- and CO_3^{2-} to calcite precipitation to fit the relationships between D_{Sr} and calcite precipitation rate (R_p) at various solution pH [2]. This ion-by-ion model [1] can also reproduce R_p and the associating D_{Sr} at various temperatures of 5, 25 and 40 °C [3]. We couple this model [1] with an existing framework for coral calcification [4], which accounts for transmembrane transport, active proton pumping and calcite precipitation. This coupled model successfully explain the D_{Sr} data in benthic foraminiferal calcite [5]. The model results show that foraminifera elevate the pH of the internal fluid by about 1 unit, and thus calcified in a highly saturated solution. The partitioning of Sr in foraminiferal calcite is consistent with that in inorganic calcite, accounting for an elevation of pH in the calcifying fluid by proton pumping.

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