



Coupled Effects of Aspartic Acid and Magnesium on Biocalcification

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Trace element compositions preserved in biogenic calcium carbonates such as foraminifera tests, coral skeletons, bi-valves, and belemnites, provide information on the past temperature and chemistry of the oceans. This paleoceanographic information is essential to validate climate models, used to predict the response of the atmosphere-ocean system to changes in atmospheric CO₂ concentrations.

However, biogenic minerals may have compositions deviating significantly from those of minerals precipitated inorganically from the same environmental fluids (Urey et al., 1951). The so-called vital effects that cause these deviations complicate the paleoenvironmental interpretation of trace element signatures of biogenic minerals in the sedimentary record (Lowenstam and Weiner, 1989). The processes behind these vital effects are diverse, ranging from intracellular transport processes to a complex interplay between organic molecules and crystal surfaces.

This study focuses on the interactions between aspartic acid and Mg during biocalcification. Aspartic acid is known to be incorporated into the calcium carbonate of certain foraminifera tests (King and Hare, 1972). It is also known that L- and D-aspartic acid affect the morphology of precipitating calcite (Orme et al., 2001). The presence of Mg during the precipitation of CaCO₃ on the other hand, causes the mineral aragonite to form instead of the thermodynamically more stable phase calcite (Wada et al., 1995). It also has a strong affinity for acute growth steps on the calcite surface, leading to

differential incorporation (Paquette and Reeder, 1995).

Inorganic experiments were performed using the Gruzensky (1967) method to precipitate calcium carbonate in the presence of varying amounts of L-, D-, and poly-aspartic acid and Mg. The solids formed showed strongly differing morphologies: from rhombohedrons in control runs, to angularly stacked rhombohedrons, needles, spiky and smooth balls. Also the mineralogy of the products varied from pure calcite to mixtures of calcite and aragonite or calcite and vaterite. Additionally, the partition coefficient of Mg for the solid varied up to an order of magnitude depending on aspartic acid type and concentration. These results show that the presence of aspartic acid does not only influence the crystal morphology but also influences the Mg incorporation.

References: Gruzensky P. M. (1967) In: *Crystal Growth* (ed. Peiser H. S.), 3675- 367. Pergamon; King K. and Hare P. E (1972) *Science* 175(4029), 1461-1463; Lowenstam H. A. and Weiner S. (1989) *On Biomineralization*. Oxford University Press; Orme C. A., Noy A., Wierzbicki A., McBride M. T., Grantham M., Teng H. H., Dove P. M. and De Yoreo J. J. (2001) *Nature* 411, 775-779; Paquette J. and Reeder R. J. (1995) *Geochim. Cosmochim. Acta* 59, 735-749; Urey H. C., Lowenstam H. A., Epstein S., and McKinney C. R. (1951) *Bull. Geol. Soc. Am.* 62, 399-416; Wada N., Yamashita K., Umegaki T. (1995) *J. Crystal Growth* 148, 297-304.