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Biogeosciences Discussions

Interactive comment on "Biomineralization of dolomite and magnesite discovered in tropical coralline algae: a biological solution to the geological dolomite problem" *by* M. C. Nash et al.

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Nash et al. present mineralogical and geochemical data suggesting that tropical coralline red algae biomineralize protodolomite and magnesite, in addition to their normal high-Mg calcite. They extrapolate these observations to the geologic record of marine carbonates to argue that dolomite in limestones and dolostones may not be the result of diagenesis (the conventional belief), but rather the result of primary dolomite mineralization by algae, and possibly the result of diagenetic stabilization of accompanying magnesite.

The author's observations that the algae are precipitating dolomite and magnesite are

novel and appear scientifically sound. These observations, in their own right, are worthy of publication. However, the authors' extrapolation of these results to solution of the 'dolomite problem' (i.e., Title: 'a biological solution to the geological dolomite problem') appear a bit overstated.

My main concern with their extrapolation stems from the fact that dolomite is found in a wide range of fossils throughout the geologic record, including echinoids, receptaculitids, stromatoporoids, stromatolites, etc, not simply in the fossils of coralline red algae. Thus, invocation of a biological origin for the 'geological dolomite problem' would require that the authors demonstrate that each of these additional taxa also biomineralize dolomite. Although this may be the case, the authors would need to demonstrate this for additional taxa (and also for additional species of coralline red algae) in order to make this assertion with the force that they have in their present manuscript. Furthermore, kilometer-thick units of dolomite and interlaminated dolomite/calcite are widespread in Precambrian (and some Phanerozoic) bulk limestones around the world, and these formations appear to lack a biogenic origin. To claim that coralline algal biomineralization is responsible for these massive dolomite deposits, to which the 'dolomite problem' also pertains, is obviously problematic.

The manuscript would also benefit from a more rigorous statistical treatment of the data. The authors should state clearly in the text the number of specimens that were analyzed, from where they were obtained, how many analyses were made per specimen, and standard deviations for all repetitive measurements (hopefully there were some). Many of these factors could be calculated from data presented in the supplementary materials, but this should really be summarized in the main manuscript, preferably in the form of a table. Detailed information about the source of all specimens should also be provided, including geographical coordinates, water depth, and water temperature/salinity at time of collection. Specimen IDs should be decoded so that the reader knows if different IDs refer to different species, individuals, branches of an individual, etc. The methods section would benefit from a quantitative estimate

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of the precision of the analytical approaches used (e.g., EDS, XRD, ICPAES, etc), a more detailed description of how %-abundances of calcite, aragonite, dolomite, and magnesite were determined, and how the XRD was calibrated for these analyses.

And finally, one minor correction: the authors state that 'Dolomite formation is thought to control the history of Mg/Ca ratio in the ocean throughout the Phanerozoic (Holland, 2005; Wilkinson and Algeo, 1989)'. However, other work suggests that the hydrothermal alteration of oceanic crust also plays an important role in the evolution of seawater Mg/Ca ratios throughout Phanerozoic time (e.g., Hardie, 1996, Geology). There is a large body of literature, as well as strong empirical support, for this alternative/complementary hypothesis (for Review, see: Ries, J.B., 2010, Geological and experimental evidence for secular variation in seawater Mg/Ca (calcite-aragonite seas) and its effects on marine biological calcification. Biogeosciences 7: 2795–2849)

Overall, the authors' discovery that coralline red algae biomineralize magnesite and protodolomite are key observations with important implications for the fields of carbonate sedimentology, paleoceanography, and biomineralization. The extrapolation of these results to 'solution of the dolomite problem' are not needed to justify publication of the fundamental and novel observation that coralline red algae biomineralize magnesite and dolomite; indeed, this extrapolation may even detract from the authors' discovery.

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