Biogeosciences Discussions

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Comment on bg-2021-222

Theodore Present (Referee)

Referee comment on "Experimental burial diagenesis of aragonitic biocarbonates: from organic matter loss to abiogenic calcite formation" by Pablo Forjanes et al., Biogeosciences Discuss., https://doi.org/10.5194/bg-2021-222-RC2, 2022

The authors present moderately low-temperature (80C) hydrothermal alteration experiments to assess the alteration of biogenic aragonite in shallow burial environments. They also compare their results to previously published similar but higher-temperature (175C) experiment. With a combination of bulk (XRD, TGA) and microscopic material characterization methods (laser confocal, scanning electron, and atomic force microscopy; electron backscatter diffraction), they compare changes in three aragonitic animals during burial diagenesis. A key finding of this paper is the recognition that pervasive biogenic aragonite at higher temperatures than 80C, and these results show enough partial alteration to develop a sequence of alteration events (biopolymer degradation, bioargonite dissolution and porosity increase, abiogenic aragonite precipitation, calcite precipitation).

I particularly appreciated the explanation of how abiogenic aragonite precipitates in pores following biogenic aragonite dissolution, especially under high Mg conditions. This result explains the observed coarsening of aragonite crystal size during alteration, even without (much) calcite replacement. It also indicates that even nearly pure-aragonite fossils may have experienced meaningful alteration. The authors seem to suggest that this may overprint some geochemical proxy information, but I do note that the model presented here is of epitactic aragonite overgrowth in closed pore volumes, so the low water-rock ratio may protect some (but not all) geochemical proxy archives from significant alteration. For example, trace elements kinetically controlled by biomineralization processes or whose distribution coefficients are temperature-dependent, or carbonate clumped isotope thermometry may be 'reset,' but other tracers like bulk oxygen or carbon isotope ratios shouldn't change under these conditions.

This paper is exceptionally well-presented, clear, and complete, and I think it would make a valuable contribution to Biogeosciences. I think it could be accepted and published without modification. Should revisions occur, I have a few nearly negligible questions/comments:

- Were the animals alive when their biogenic aragonite was sampled, or had the samples experienced some minor marine diagenesis?
- Were the samples weighed in advance, and was the water-rock ratio constant across experiment arms? I wonder about the extreme difference in calcitization of the gastropod between 4 and 6 months of alteration.
- Line 174: was brachiopod shell calcite analyzed in this study? Why is it referred to here?
- This paper is a valuable contribution towards understanding early burial diagenesis. Do the authors expect significant differences if some alteration first occurred in shallow (low-T) marine diagenetic environments?
- I appreciate the consistency with other burial diagenesis experiments to facilitate comparison, but why are 100 mM NaCl + 10 mM $MgCl_2$ solutions chosen? This is a lower solute concentration than seawater (465 mM Na^+ + 53 mM Mg^{2+}). Aren't burial formation waters often brinier?

Thank you for the opportunity to review this manuscript!

Sincerely,

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