

## ***Interactive comment on “Experimental diagenesis: Insights into aragonite to calcite transformation of *Arctica islandica* shells by hydrothermal treatment” by Laura A. Casella et al.***

**Anonymous Referee #3**

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Overall assessment The manuscript presents an interesting study of the simulation, of taphonomic processes with two different experimental fluids, called meteoric and burial. In both cases the shells of *Arctica* are subjected to increasing temperature. The authors show how the changes in mineralogy, from aragonite to calcite, progress across the growth planes and analyze the orientation, composition, size and distribution of the neoformed crystals, as well as the timing of the transformation process. The study is competent, and the techniques (mainly XRD, EPMA and EBSD) are adequate. The wealth of data coming from the crystallographic study (EBSD) is particularly remarkable. The results are very interesting and are highly significant with regards to the taphonomy of aragonitic shells (although not in a general sense, but in the case

C1

in which transformation of aragonite to calcite progresses by a process of coupled dissolution-reprecipitation mechanism).

I will now deal with the specific aspects required by Biogeosciences Discussions (BGD): 1. Does the paper address relevant scientific questions within the scope of BG? YES, particularly taphonomy of shells. 2. Does the paper present novel concepts, ideas, tools, or data? YES, particularly, the focus is highly innovative. 3. Are substantial conclusions reached? YES, it adds substantial knowledge to the particular process studied. 4. Are the scientific methods and assumptions valid and clearly outlined? YES, in general, although I find that some conceptual aspects should be explained more in length (see detailed comments. 5. Are the results sufficient to support the interpretations and conclusions? YES, in general (but see detailed comments). 6. Is the description of experiments and calculations sufficiently complete and precise to allow their reproduction by fellow scientists (traceability of results)? YES, in general, although additional data on the composition of the fluids (Table 1) are needed. 7. Do the authors give proper credit to related work and clearly indicate their own new/original contribution? YES, in general (but see detailed comments). 8. Does the title clearly reflect the contents of the paper? YES. 9. Does the abstract provide a concise and complete summary? YES. 10. Is the overall presentation well-structured and clear? YES. 11. Is the language fluent and precise? YES. 12. Are mathematical formulae, symbols, abbreviations, and units correctly defined and used? Some technical abbreviations (EPMA, TAP, PET, LPET, LLIF...) should be defined for non-specialists. 13. Should any parts of the paper (text, formulae, figures, tables) be clarified, reduced, combined, or eliminated? NO. 14. Are the number and quality of references appropriate? YES. 15. Is the amount and quality of supplementary material appropriate? YES.

Detailed comments: 133. ‘for physiological generate’, this is an odd expression. 138. ‘pre-Neogene *A. islandica*’, certainly not this species. 157. ‘mineral in reference’, reference mineral? 159: ‘knifes’, knives, blades. 193. Remove ‘and’ 198-199. This initial

C2

bit needs to be expanded further. More data on the composition of fluids and why their compositions have been chosen are necessary. 207. At least a reference is needed before the period. 237-238. This feature is not visible at the magnification of Fig. 1B. 240. Fig. 2B is heavily etched. Accordingly, any conclusion about the density of pores is doubtful. 260. Again, the nanogranules I Fig. 3C are etching and not original features. 260-261. 'These are co-aligned to form mesocrystals', probably true, but not demonstrated here. I advise deletion. 284-287. 'holes', do the authors refer to the membranes between mineral units? Please, be precise. 302-303. the coincidence in the orientations of the c-axes of aragonite and calcite, before and after alteration, is remarkable. I would like the authors to comment on this. Could there be some kind of epitaxial growth of calcite on the aragonite? 303. insert 'the', before 'fact'. 304-305. 'and to the patterns of growth lines', what is meant with this exactly? please reword. 305-306. There is something wrong here. The maximum for  $a^*$  is more or less coincident with the maximum of  $c^*$ , and does not conform with the orientations of  $b^*$ . The authors should review their data to make sure that the  $a^*$  pole figure is the correct one. 306. 'the', before 'c-axis' 329-330. The explanation based on the small number of crystals mapped is not enough. Again, as above, is there the possibility of epitaxial growth? 351. Subsection 4.1.- I do not think that the title (particularly 'Characteristics of the grains') actually conforms to the contents. 372. 'Figs. 7, 8, 9', I find that only Fig. 9b is relevant in the context. 394-395. May be I do not understand properly, but in the scale of misorientations, blue colors imply very low values, whereas green, yellow and red are increasing values. Isn't it the other way round? 400-401. 'numerous small 400 calcite crystallites, a clear cause for the occurrence of internal strains'. Something is inconsistent here. Crystallite boundaries are defined by misorientations values above  $5^\circ$ , but this is not real, just a convenience. At the positions of 'crystallites' (defined in this way) misorientations values just peak. Therefore, they are not real and cannot be the origin of misorientations. To demonstrate that they are real, other techniques (e.g., TEM) are necessary. 411. '13B', rather 13C? 412. The linear structures in 13C at consistent angles argue for crystalline structures ( $\{104\}$  faces of calcite?). 422-424.

C3

This conclusion does not seem significant in the absence of a statistical analysis, and in view of the low number of data which deviate from the trend in 14B. 426-428. I cannot follow the statements contained in the two sentences. 431. Subsection 4.3.- In my opinion, the paragraph immediately above could be included within this subsection. 451. Fig. 6C-D is not relevant within the context. The images supporting this statement have to be referred unequivocally. 472. 'it a', insert 'is' 475. 'mineral', minerals. 485. 'molluscs, mollusc. Page 13, last paragraph. Somewhere around here, the authors should state that the change from aragonite to calcite does not always proceed in this way. For instance, there is also the possibility that total dissolution followed by precipitation by calcite (or other minerals, gypsum, pyrite) takes place. Page 14. Conclusions, point 7.- Please, state clearly that the recognition of the first tipping point ( $50^\circ$  to  $60^\circ$ ) is not derived from the present study. 598. Dr. E.M. Harper is also a coauthor; please remove. 654, 657, 666, 677. As far as I know, some of these Spanish names should bear accent. Please check. In 666, 'Gonzales' is actually González. 670, 775. Italicize species and genus names. Check other cases I could have missed. 718. Space between 'bivalve' and 'molluscs' 826. 'Zetterstrom' is Zetterström. 1023-1024. How do the authors know that the minute holes were filled with biopolymer fibrils. I do not think the statement can be drawn with the techniques used in this study. I will remove it.

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C4