Review to the manuscript bg-2016-355:

"Experimental diagenesis: Insights into aragonite to calcite transformation of Arctica islandica shells by hydrothermal treatment", by L. A. Casella, E. Griesshaber, X. Yin, A. Ziegler, V. Mavromatis, D. Müller, A.-C. Ritter, D. Hippler, E. M. Harper, M. Dietzel, A. Immenhauser, B. R. Schöne, L. Angiolini and W. W. Schmahl

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This is a very interesting manuscript on the effect of burial and diagenetic processes on the characteristics of the microscopic structure of *Artic Islandica* shells. Using with guarantees the fossil register as a source of information on the paleo-Earth's physicochemical conditions requires understanding how the record of these conditions in fossils may have been altered during diagenesis. This work represents an important step in this direction.

The topic of this manuscript fits the scope of Biogeosciences and may be of interest to a variety of geoscientists.

This work approaches the problem of fossils' diagenetic changes in an innovative experimental way. The experiments are well design and the samples are thoroughly characterized using EBSD to analyze changes in *Artic Islandica* shells' microstructure. This approach produces a sound set of results which is discussed taking into consideration both, the physicochemical characteristics of the $CaCO_3$-H_2O system and most recent advancements in the understanding of mineral replacement phenomena.

This manuscript is well written and clearly organized. The methods section is very thorough. The results are presented in a clear way and illustrated by well selected images. The discussion is well organized and easy to follow. Finally, the conclusions of this work are relevant and well based on the experimental results. Furthermore, the reference list is extended and very complete. I only have a few suggestions (see list below) for the authors to consider. Most regard with typos and statements that, in opinion, could be better qualified.

1. Line 279: "... SEM images on the left hand side of Figs. 5 and 6 are taken from ..." Shouldn't it read Figs. 4 and 5?

2. Line 303: "... The small changes in MUD values must be attributed to **the** fact that it was impossible ..."

3. Lines 343-348: " Thus, as the replacement reaction proceeds, the percolating diagenetic pore fluid is undersaturated with respect to aragonite but is saturated with respect to calcite." If the fluid were saturated with respect to calcite this phase would not nucleate in the first place and would not grow after its nucleation. A certain degree of supersaturation is required for the system to overcome the energy barriers associated to both, heterogeneous nucleation of calcite on aragonite and calcite growth. This could be better explained.

4. Lines 420-428: I basically agree with the authors explanation. However, I would have liked a discussion of the Mg content of the newly formed calcite. If this is magnesian calcite, is higher solubility compared to that of pure calcite would determine a smaller driving force for the transformation. In other words, both nucleation and growth would occur under lower supersaturation, which would further explain the smaller number of crystals and their larger sizes.

5. Line 472: " in palaeontology as it **is** a prerequisite to taxonomic, taphonomic...."

6. Line 489: " In particular, the resistance of biogenic aragonite to replacement by calcite up to temperature of 175 °C during hydrothermal alteration offers an additional explanation for the preservation of aragonitic shells/skeletons, besides the taphonomic windows envisaged by Cherns et al. (2008)." The authors conduct experiments at two temperatures, 100 and 175 ºC. In my opinion, the fact that at 100 ºC the aragonite-calcite transformation does not occur after 28 days does not qualify them to state that there is a resistance of biogenic aragonite to be replaced by calcite at temperatures below 175 ºC. The window temperature between 100 and 175 ºC is too large and 28 days is not such a large time, not for an experiment and more so when compared to geological times.

7. Conclusion 7. This is not a conclusion of this work. I understand that it must correspond to the paper by Balthasar and Cusack (2015), but it is not supported by results in this manuscript.

8. Conclusion 8. See comment 6.

9. Lines 1019-1020. "... shown in Fig. 5. 10 mM ...". I gues that it should read ""... shown in Fig. **4**. 10 mM ..."

10. Fig. 14 label. I miss a discussion of why the mean misorientation within the individual, newly formed grains in contact with burial solutions. I guess that this points to Mg incorporating into the newly formed calcite.