

Interactive comment on “Environmental controls on the boron and strontium isotopic composition of aragonite shell material of cultured *Arctica islandica*” by Y.-W. Liu et al.

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Referee #2: R. Gabitov

The manuscript submitted to Biogeosciences entitled: “Environmental controls on the boron and strontium isotopic composition of aragonite shell material of cultured *Arctica islandica*” by Liu et al. is focused on evaluating of geochemical response of bivalve aragonitic shells on change in marine environmental conditions, and therefore, this work is within the scope of Biogeosciences journal. Abstract and title reflect the content of the paper. I think the paper is generally well written. Please see my comments and concerns below.

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We thank R.I. Gabitov for his helpful and constructive comments to improve the manuscript. All the comments from the referee have been addressed. Our response to specific comments is listed below each comment from the referee.

Page 2980, Line 19: Please define pH(shell)

We added the definition of pHshell in the abstract.

Page 2981, Lines 16-19: I suggest splitting this sentence into two.

We revised as suggested.

Page 2982, Line 4: Additional explanation why Sr isotopes were chosen to evaluate growth rate effect will be helpful. Sr is heavy and relative mass difference between 86 and 88 is small. Why effect of growth rate is expected?

Temperature range in the experiment is over 15 °C and the growth rate at least double during the experiment, in which may result in over 1.5 ‰ change in $\delta^{88}/^{86}\text{Sr}$ (Stevenson et al., 2014). Because we would like to use radiogenic Sr to determine the seawater source, we incorporate the stable Sr isotopic ratios, which can be analyzed at the same run of sample, to assess the potential kinetic effect. We added explanation to the expectation of the potential $\delta^{88}/^{86}\text{Sr}$ changes with respect to the temperature or growth change during the experiments in our discussion.

Page 2983, Line 6: Please explain what “equilibrium pH” means or rewrite the sentence. For example: “Equilibrium ^{11}B fractionation factor between $\text{B}(\text{OH})_3$ and $\text{B}(\text{OH})_4^-$ does not depend on pH (REF)”

We deleted “equilibrium” in the text. Here we simply want to express the off set is constant at a certain pH condition.

Page 2983, Lines 8-9: There are a number of works suggesting strong effect of $\text{B}(\text{OH})_3$ especially for calcite. Please mention it here.

We added in the text.

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Page 2984, Line 7: Are there references about those few measurements? Please specify. We revised the sentence and added references from Heinemann et al. (2012) and Penman et al. (2012).

Page 2989, Line 2: Please specify the relative masses of sample and H₂O₂ solution. Was the sample ultrasonicated, centrifuged, or kept stagnant?

To further improve the reproducibility for carbonate samples, an extra 2 μ L of 30 % H₂O₂ was added to the purified solution (\sim 90 % of the volume before sublimation) for all the runs after 23 April 2014. Sample solution was then set stagnant in the vial, and the cap of the conic vial was then loosened for two hours to reduce the organic levels and liberate the product oxygen gas.

Page 2990, Lines 15-16: Please expand this sentence. In the present form it is confusing for people who do not use TIMS routinely.

We expanded the sentence to better show the settings.

Page 2996, Lines 1-2: Based on Figure 6b significant number of shell $\delta^{11}\text{B}$ data lie below the curve where $\alpha=1.0272$. I think it should be addressed here.

We mention the lower boron in the result section as suggested and address more in the discussion section to explain the data.

Page 2996, Lines 25-26: I think the term equilibrium is vague here because variation between individual samples was observed. The previous sentence already addressed the observations on Sr isotopic consistency between shell and seawater. I suggest to remove the sentence "Therefore, incorporation of radiogenic Sr ratios into the shells are in equilibrium with ambient seawater." or say that fractionation of radiogenic Sr isotopes is close to equilibrium.

We re-worded the sentence as suggested.

Page 2997, Line 18: Do you mean $\delta^{88}/^{86}\text{Sr}$? If yes then please continue to use delta

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notation further in the text.

We replaced "stable Sr" with " $\delta^{88}/^{86}\text{Sr}$ " in the text

Page 2997, Line 20: Please identify the studied temperature and growth rate ranges.

We added the temperature and growth range and the expected change in stable Sr isotopic composition in the text (P2997 line 18).

Page 2997, Line 26: The suggested physiological control is questioning an achievement of thermodynamic equilibrium stated in the sentence at the end of the page 2996 (Lines 25-26).

We revised as "Therefore, incorporation of radiogenic Sr ratios into the shells occurs without measurable fractionation and reflects the composition of ambient seawater" in the text on page 2996 line 25 to differentiate the physiological control to Sr/Ca uptake from isotope incorporation here.

Page 2998, Line 3: You may add Gaetani and Cohen (2006) here.

Reference added as suggested.

Page 2998, Line 22: Fig.6b shows that some data deviate from the range between prediction lines. Based on Figure 6b significant number of shell $\delta^{11}\text{B}$ data lie below the curve where $\alpha=1.0272$. Please address it in the text.

Previous studies suggested a range of fractionation factors might be applied, and an additional constant offset might better describe the empirical $\delta^{11}\text{B}$ -pH relationship (Anagnostou et al., 2012; Hönisch et al., 2004; Rae et al., 2011). Therefore a species-specific offset many accounts for the smaller variations before week 19, where many of the results lie under the prediction lines and the negative ΔpH here. In this study, because the temperature and salinity are not close to constant, we can hardly determine precise transfer function for *A. islandica*. However, the total variation throughout the experiment is about 10 ‰ and has an obvious trend after week 19, there must be

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some other controls to boron incorporation in the shell. We addressed the interpretation above in our text to explain the boron data lie below the curve and try to differentiate the potential cause to positive deviation trend later in the season.

Page 3000, Line 3: It is possible to relate spring bloom to the data on Figure 7b? Otherwise this sentence could confuse the reader.

The rapid growth rate change is related to spring bloom. Our data shows no correlation between boron isotopic compositions in the shell and the shell growth so we do not think growth or spring bloom is the primary control to the boron deviation in the culture experiment. We also reword the sentence to clarify our interpretation.

Page 3014, Table 1: Please define the alpha below in the table. We added as suggested.

Page 3016, Table 3: Please add below: $\Delta\text{pH} = (\text{pH}_{\text{shell}} - \text{pH}_{\text{sw}})$. We added as suggested.

Page 3016, Fig 1: I like illustration of c and d. However, more details are needed for description of Figures a-c. It will help reader to identify differences between those images. Figure captions do not address why figures a and b are shown here. I was not able to find it in the text too.

Fig 1 (a) to (c) show that one can see nature marking on the external shell, or calcein mark in the cross-section under microscope to constrain the shell growth. Page 3022, Fig 6: Please define fractionation factors presented here, i.e. $\alpha = 1.0272$ (Klochko et al., 2006) and $\alpha = 1.0194$ (Kakihana et al., 1977). Specify between what phases or species fractionation occur. We modified as suggested and also added the definition of fractionation factor alpha in the text.

Page 3023, Fig 7b: Please identify the colors of the symbols in (b)

Colors shown in (b) represent the temperature corresponded to each data point, with low temperature in blue to high temperature in red.

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Please also note the supplement to this comment:
<http://www.biogeosciences-discuss.net/12/C1533/2015/bgd-12-C1533-2015-supplement.pdf>

Interactive comment on Biogeosciences Discuss., 12, 2979, 2015.

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