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Interactive comment on "Mn / Ca intra-test variability in the benthic foraminifer *Ammonia tepida*" *by* Jassin Petersen et al.

Anonymous Referee #1

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Review of "Mn/Ca intra-test variability in the benthic foraminfer Ammonia tepida" by Petersen et al., submitted to Biogeosciences, Aug., 2017.

These authors present new laser ablation ICP-MS Mn/Ca (Mg/Ca and Sr/Ca) data from individual chambers of a benthic foraminer species taken from the upper sediment of a non-freshwater lake. These data are analyzed with respect to the potential use of Mn/Ca as a proxy for bottom water oxic conditions. The conclusion is that while there may be systematic variability, deconvoluting the three possible sources of non-ontogenetic variability (change in environment, movement of foram and timing of chamber formation) makes such data prohibitively complex. The ms. is very well written and illustrated well. Details of the methodology and results are very good. The conclusions reached are generally supported; in fact, the main criticism I have is that

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these data were not explored further (see my comments below). Kudos to the authors for a job well-done.

Major Questions:

1. why not further explore the data? The Mg/Ca and Sr/Ca are only very briefly mentioned. I understand the authors have a story about Mn/Ca and redox to discuss, and I appreciate keeping this story clear. However, their data shows a very large variability in Mg/Ca that does indeed co-vary with Mn/Ca (I calculate a r2 of 0.6). Does temperature vary this much in the lake? Can this help explain Mn/Ca variability (e.g., through a Q10 type foram response)?

2. Following from point 1, it would be useful to have better context for the life environment of these forams. At least there should be a location map where the samples were taken, and some idea of salinity and temperature. Other details, such as organic loading and bioactivity (even human activity) would be useful too. The authors suggest all these data exist - can they plot some of them over the time of interest? Best of all, of course, would be some record of bottom water redox condition over the time of interest. Does any such record exist?

3. More on data comparisons: Can the authors plot the variability of chambers that might be considered time-equivalent? That is, the ultimate chamber of each (presumably live) specimen should be time-equivalent. Can all these be compared? Then similarly for all the second chambers (assuming all the individuals grew similarly, which may be a false assumption, I know.) I did not see such a plot, and could not find the necessary data to generate one myself. This would seem to me to be instructive about variability between individuals that are living in the same chemical environment.

In summary, I would say that this paper is fine as is (with minor revisions), but would be a more substantive contribution with further exploration of the data.

Minor Issues: Cite Froelich et al., 1979, and even add a comment regarding "remnant

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Mn peaks" and moving fronts of redox state. These would certainly pertain in this time-sensitive data.

What does "adequately" mean on L.13 pg. 2?

Could there be any problem with Mn or Ca in CellTracker Green?

If these are living (stained) forams, I am confused how high values on the inner and outer shell can be contamination. Of what?

Does their LOD and LOQ not preclude them from measuring low Mn? e.g., what you expect to find in more oxic conditions?

Their statistical analyses seem very robust, but there is not much take away from it.

The range of data in Fig. 4 is perhaps most interesting; is the minimum the same in all cases? i.e., is there a minimum Mn incorporation in shells regardless of environment/ontogeny?

The section on ontogeny on p.16 shoudl come earlier, and provide information on how fast are chambers grown, what kind of time range does each chamber represents, and if the chambers grow at all times of the year. At least to the ability that the authors can provide this information.

Section 4.2.2. - The use of % variability might be a poor option here, as it depends on the Mn/Ca measured.

Conclusion presented (e.g., L. 15, conclusions): the intra-test variability may be caused by environmental change (Mn front shifting), but wouldn't this be recorded more consistently in all the samples?

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