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Climate of the Past Discussions

Interactive comment on "The B/Ca proxy for past seawater carbonate chemistry reconstructions-laser ablation based calibrations for *C. mundulus*, *C. wuellerstorfi* and its morphotype *C. cf. wuellerstorfi*" *by* F. Kersten et al.

Anonymous Referee #1

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Review of "The B/Ca proxy for past seawater carbonate chemistry reconstructions-laser ablation based calibrations for C. mundulus, C. wuellerstorfi and its morphotype C. cf. wuellerstorfi " (doi:10.5194/cpd-9-4425-2013) by Kersten et al.

Overview:

In this study, Kersten et al present new core-top B/Ca data for three benthic foraminiferal species C. mundulus, C. wuellerstorfi and C. cf. wuellerstorfi from the

South Pacific Ocean using the laser ablation ICP-MS technique. They show that (i) C. mundulus and C. wuellerstorfi B/Ca from the S Pacific plot along the trends from Yu & Elderfield (2007) EPSL; (ii) C. cf. wuellerstorfi B/Ca appear to show a greater sensitivity to deep water DCO32- (mainly driven by 4 data points, see below); and (iii) Mg/Ca and B/Ca within shells are somewhat (but one profile is less clear; see below) negatively correlated, which is attributed to ontogenic influences.

Points (i) and (iii) have been previous published by Yu & Elderfield (2007) EPSL and Raitzsch et al (2011) Geology, respectively. Point (iii) is somewhat new, but Rae et al (2010) EPSL also noted some morphological impacts on shell B/Ca. Therefore, this study does not present anything truly new. However, no B/Ca data from the South Pacific have been published previously, due to the challenge to obtain core-top samples from this region (mentioned by the authors). Therefore, this study may present some valuable B/Ca data, if the ages of the core-tops can be justified to be within Holocene (<5 ka).

Major points:

1. For all core-top samples, we have no age control - this is very critical, and ages for these core-top samples have to be robustly established; otherwise, it would be meaningless to compare benthic B/Ca with modern deep water DCO32-. A new table with ages and sed rates, etc will be helpful.

2. In addition to ages, it is highly preferable to provide sedimentation rates for these multi-cores, so that we have some idea about bioturbation effects. Bioturbation influences have been mentioned in a recent study by Yu et al. (2013) QSR. Since only a very limited number of shells were analysed by LA-ICP-MS, a single shells from glacials would bias the ratio very significantly. Thus, an evaluation of bioturbation influence is critical for this work.

3. Although some new B/Ca for C. mundulus and C. wuellerstorfi from the S Pacific are valuable, I find it is not the right place to construct a new calibration for C. cf. wueller-

storfi. Such a job could be best done in the Atlantic Ocean, where age models are much easier to constrain and much more samples could be measured (to improve confidence with the calibration). At present, we only have 12 core-top C. cf. wuellerstorfi samples whose ages are unknown. Critically, the great sensitivity for C. cf. wuellerstorfi is mainly driven by 4 samples (2 high B/Ca data from PS75/105-1 0cm and 1 cm; two low B/Ca from SO213 68-1 0cm and SO21379-1 0cm). The rest samples plot along the C. wuellerstorfi B/Ca-DCO3 trend. If I were authors, I would make effort to pick additional C. cf. wuellerstorfi from other regions such as the North Atlantic Ocean to ensure that these values/relationships are reproducible.

4. Further descriptions about similarities and differences between C. wuellerstorfi and C. cf. wuellerstorfi are needed. Based on Fig. 3, it appears that C. wuellerstorfi seems to have compressed chambers on the umbilical side and raised/thickened sutures on both sides, while C. cf. wuellerstorfi shows widely convex chambers and depressed/indented sutures on the umbilical side. I would definitely prefer more pictures of C. cf. wuellerstorfi in the text (and supplementary if needed), as this will greatly help the reader out.

5. I am also interested to see C.wuellerstorfi from <1000 m water depths (Fig. 2). Personally, I have never seen any C. wuellerstorfi from such shallow water depths. Please present images of the these shells.

6. For many sensitivity comparisons, the authors make strong claims based on a limited number of measurements. As mentioned above, the greater sensitivity of C. cf. wuellerstorfi B/Ca versus deep water DCO32- (compared to C. wuellerstorfi) heavily dependents on 4 data points from 3 samples whose ages are unknown. They did the same thing for C. wuellerstorfi from DCO32- < $\sim$15 umol/kg (Fig. 7b) and for C. mundulus (Equation 4). No errors are given to the slopes and intercepts. Clearly, robust statistical analyses are needed before any claim can be made. The authors should be more cautious about the limit number of measurements presented, which prevent them from making any robust statement regarding different sensitivities between species.

The number of samples is just too limited. Also, what are the uncertainties associated with deep water DCO32- (which should be considered during regression analyses)? Also, the recent paper by Yu et al. (2013) QSR compiles new and published B/Ca for C. wuellerstorfi and C. mundulus, which should be considered. The authors may plot the new data against data from Yu et al. (2013) QSR, to see any differences/similarities.

7. I am not convinced by the negative correlations between B/Ca and Mg/Ca in Fig. 6. Cross plots are needed, with statistical analyses (R2, P value, etc).

8. I suspect the errors in Fig. 5 are underestimated, especially for sample #1. How many shells in each sample were analysed (I note 3-6 shells/sample, but it would help to be more specific with each sample)? The analytical errors and variances in Fig. 6 for B/Ca are much larger. Why are errors in Fig. 5 so small?

9. While acknowledging LA-ICP-MS is a useful technique to obtain data for shell depleted samples, this method measures a much smaller quantity of carbonate materials than the traditional bulk/wet ICP-MS method. Are these small quantity of materials representative of the integrated averages of bulk samples (say, ratios based on 10 shells using wet ICP-MS method)? I am dubious, but we need more data. It is important to make a direct comparison between B/Ca ratios from these two methods at least for some, if not all, samples. This is especially critical for samples that lead to different sensitivities (see above). At present, the authors are comparing B/Ca based on different methods, and it is impossible to exclude analytical offsets as a reason for different sensitivities (in addition to very limited data points used for regressions and poor age controls).

10. Line 16-17 in Abstract, Section 4.2, and Line 14-16 in Conclusion: provide a cross plot between B/Ca and age of deep waters. Otherwise these statements and Section should be deleted. I am not convinced by the argument.

Other points:

1. I do not understand the logic behind "Intra-shell variability equals intra-sample variability, mean sample B/Ca values can thus be reliably calculated from averaged spot results of single specimen" lines 15-17 in Abstract and lines 12-14 in Conclusion.

2. Line 5-6, P4427: further references are needed - such as Raitzsch et al., (2011) Geology, Yu et al., (2013) QSR, Brown et al., 2011, EPSL.

3. Line 10-12, p4434: invalid argument - it has been shown that Mg/Ca in C.wuellerstorfi does not reflect changes in BWT. See Elderfield et al., (2006) EPSL, Yu & Elderfield (2008) EPSL.

4. Line 20-23, p4436: unsupported argument and should be deleted. Nowadays, we can measure $\sim$8 shells and even less (say $\sim$4-5) without any problem!

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