Biogeosciences Discuss., 9, C40–C46, 2012
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Biogeosciences Discussions

Interactive comment on "Relationships between bottom water carbonate saturation and element/Ca ratios in coretop samples of the benthic foraminifera *Oridorsalis umbonatus*" *by* C. F. Dawber and A. Tripati

Anonymous Referee #2

Received and published: 2 February 2012

General comments

This manuscript presents new trace element data from the benthic foraminifera Oridorsalis umbonatus and discusses how these data may be controlled by various biomineralisation processes. The dataset is extensive and thoughtfully discussed, and the manuscript is well written. However there are several issues with the analysis and the manuscript that should be addressed prior to final publication.

This paper is set-up as investigating the relationship between DCO3= and X/Ca. DCO3= is implied to be the major control on X/Ca for the range of sites chosen (which have a relatively small range in temperature) and biomineralisation mechanisms are discussed within this framework. Although I wanted to see more discussion of the potential effect of other factors (such as temperature - see below) I was happy to accept that the main focus of this manuscript was the DCO3= vs. X/Ca relationship with respect to biomineralisation.

However a potential pitfall of this approach is that future studies might take the given X/Ca vs. DCO3= relationships as full proxy calibrations. These relationships might be applied these back in time at sites with a broader range of environmental conditions, where the "other" parameters which have not been examined, such as temperature, might exert a more important control.

So I was thus surprised to find that these authors do just that in another manuscript under interactive discussion, *Dawber and Tripati, 2011. Element/Calcium ratios in middle Eocene samples, CPD, 7, 3795-3821*. In this manuscript Dawber and Tripati show that the X/Ca ratios examined here do not show coherent covariations throughout their record, in contrast to what is implied in this manuscript!

It thus seems important that the lack of suitability of these relationships as downcore bottom water DCO= proxies is spelt out. The authors have significantly advanced understanding of these X/Ca ratios in this species between their two papers. As the implications of both of these papers are available, they should both be taken into account, and as mentioned in a comment on the CPD manuscript, several of the analyses and parts of the discussion in that paper might be more appropriately placed in this one.

Dx PLOTS AND DISCUSSION

Much of the discussion hinges on the relationship between DCO3- and empirical partition coefficients (Dx) or fraction of Ca used (F). However the plots provided make this

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very difficult to assess, as these parameters are not clearly plotted against one another. Instead DCO3= is shown in colour shading, which makes its relationship to Dx or F very hard to assess.

Figure 3 would be improved by making a plot for each element with DCO3= on the x axis and Dx on the y, with the different species shown as different symbols. Some species could be cut for clarity if necessary, as not many of them are discussed. A condensed version of the current figure (but omitting the DCO3= shading) could be used in another panel if comparison of the different Dx for the different elements is important.

Figures 4 and 5 would also be improved by plotting DCO3= on the x axis. As F is just a function of D, there seems little point in plotting these separately each time; instead these parameters could both be shown by showing two y axes, one D, one F.

To repeat my main point, as we are asked in the text to compare D (and/or F) to DCO3=, this relationship really needs to be shown.

Expressions defining D and F should also be given at the start of this point in the discussion, and a reference for the seawater X/Ca values used.

DISCUSSION OF OTHER POSSIBLE PARAMETERS - i.e. TEMPERATURE

Temperature could have a control on the X/Ca data within many of the mechanisms discussed, through changing diffusion and metabolic rates. This merits more discussion, even though the T range is small, especially given the correlations with temperature shown for Mg/Ca by previous authors (e.g. Lear 2002). I'd be interested to see plots of X/Ca vs. temperature, or at least to hear how they compare to the relationships with DCO3=, even if the focus remains DCO3=.

PREVIOUS B/CA DATA AND PORE WATER INFLUENCE

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Previous B/Ca data have been published for Oridorsalis umbonatus by Rae et al. 2011 and Brown et al. 2011. This should be included in Figure 1. A rough version of this compilation is attached (made in Illustrator as the data were not tabulated - please include a data table or supplement in the final version).

Inclusion of all available B/Ca data significantly decreases the correlation of B/Ca with DCO3=. Previous studies attribute this to the pore-water environment of O. umbonatus, which may have different DCO3= and B/Ca to that in bottom water. This influence of pore water environment may also be important for the other trace elements (again, due to altered DCO3= or X/Ca) and should be discussed.

Specific comments

Materials and Methods:

- what morphotype of Oridorsalis umbonatus was used? There are two types. Would be great to include a photo.

- how many tests were run?

- what concentrations were samples run at?

- would be good to re-state the exclusion ratios used.

- is reproducibility really that similar for B/Ca and Mg/Ca? I would be interested to see the actual numbers for each X/Ca ratio, and would also prefer to see 2 s.d. given. Also how many replicates is this based on?

- as mentioned above, doesn't include data of Rae 2011 or Brown 2011.

1490, 19: I don't think sensitivity is the right word to use here - it links the data too much with the supposed mechanistic relationship to DCO3=. For instance, the range of Mg/Ca is low, but this is typical for this element in hyaline benthic foraminifera - Mg/Ca is not very sensitive in general. Maybe instead discuss ranges and correlations.

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1492, 5: after [CO3=] would be good to have “(and DCO3=)” as this is the important parameter in this study, where CO3= will vary significantly with depth.

1493, 27: again may be interesting to discuss with reference to pore water conditions.

1494, 1-3: again, although I can accept the different sense of these relationships, it is very hard to see if they are "well defined" or not without them being properly plotted.

1495, 9: interesting hypothesis - are there any other data or studies which support this?

1495, 26: another sentence here re-stating hypothesised relationship between calcite phases and DCO3= would make this more clear.

1496, 16: wouldn’t use "similar" relationship - really just that they all show an increase with increasing DCO3=.

1497, 25: see first general comment about applicability of these relationships back in time.

Figures:

Provide a map of core locations.

Show $R^2 in Figure 1$

Little discussion of Figure 2 in text.

As previously mentioned, this MS really needs a table of the data and the locations used.

Technical corrections

1487, 4: be more clear about what the Fraction Ca model is alternative to (presumably SEMO, not vacuolisation as described in the previous paragraph).

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Interactive comment on Biogeosciences Discuss., 9, 1483, 2012.

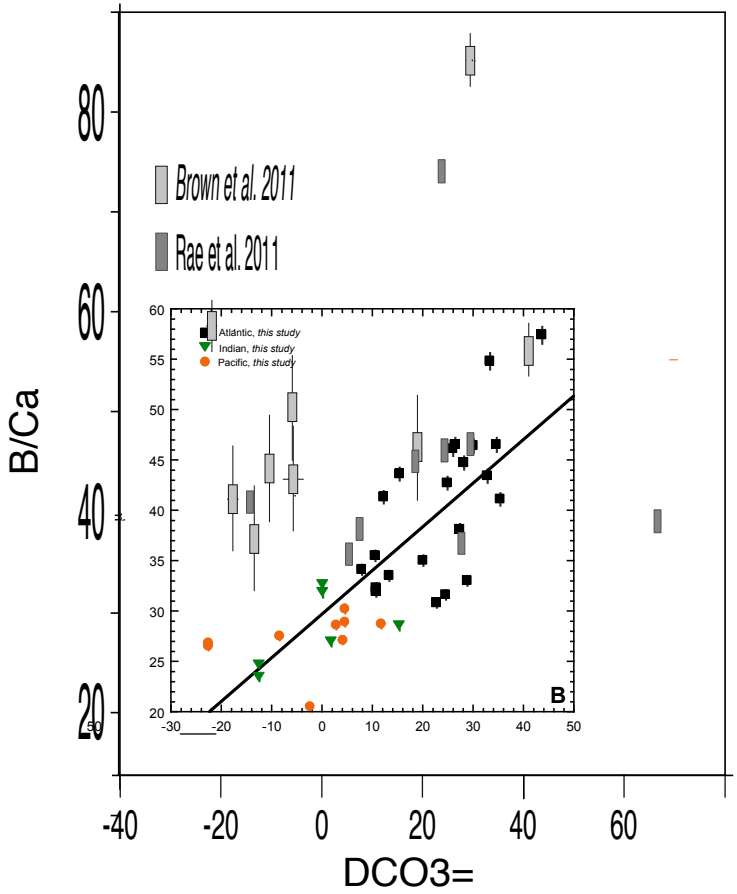

Fig. 1. Comparison to B/Ca data of Rae et al. 2011 and Brown et al. 2011. Inclusion of all available B/Ca data significantly decreases the correlation of B/Ca with DCO3=.

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