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Climate of the Past Discussions

Interactive comment on "Element/Calcium ratios in middle Eocene samples of Oridorsalis umbonatus from Ocean Drilling Program Site 1209" *by* C. F. Dawber and A. K. Tripati

Anonymous Referee #2

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General comments

This manuscript provides one of the first down-core comparisons of several different trace element ratios that have been touted as palaeoceanography proxies. Variations in these X/Ca ratios in Oridorsalis umbonatus during the Eocene are compared to each other and to a number of other proxy records. No coherent relationships emerge between these records. Different controls on the X/Ca ratios are discussed, including different parameters (DCO3= vs. temperature), seawater X/Ca composition, pore water chemistry, and various climatic influences.

LACK OF A SIMPLE DCO3= CONTROL ON X/CA

The major issue with this manuscript is that the trace element ratios studied are set-up as recording DCO3=, despite the fact that a quick look at Figure 1 shows that there is clearly not a single control on these data. The authors clearly realise this, and spend the rest of the manuscript trying to find ways out of the assumed X/Ca to DCO3= relationship. However the manuscript would be far clearer, more useful and more citable if this lack of a single control was clearly stated at the start of the results and the discussion, and if the phrasing of the results and discussion in terms of DCO3= changes was avoided. The potential influence of DCO3= should be discussed, but only in the same way that temperature, seawater chemistry etc. are. This general change will, I think, place the paper more safely back in the calibration category for these novel data, where they can make a useful contribution.

For instance, several of these ratios have been applied in isolation as proxies for DCO3= or temperature, or have been used to make corrections on each other to try and isolate these competing factors. This dataset offers the opportunity to give a frank assessment of these approaches for this particular species.

MULTIVARIATE ANALYSIS

One of the most interesting approaches in this paper was the first application to foraminifera X/Ca of the global minimisation technique used by Gaetani et al. for coral X/Ca (Section 4.2), along with the multiple linear regression of core-top data (Section 4.1.1). However the data used in this regression analysis need to be shown and plotted, and the results of the global minimisation should also be shown - we are just given a description and table of parameters, without seeing the relationships involved.

CORE-TOP PAPER

Furthermore, it seems that the more appropriate place for the multiple linear regression (which is based on core-top data) would be the author's current Biogeosciences

Discussions manuscript, which discusses controls on X/Ca in core-top O. umbonatus *Dawber and Tripati, 2012. Relationships between bottom water carbonate saturation and element/Ca ratios in coretop samples of the benthic foraminifera Oridorsalis umbonatus.* . Tweaking which content is included in each manuscript would make both papers stronger: a decent discussion of the effect of temperature and pore water chemistry is needed in the core-top paper, and would be more appropriate there than here. Furthermore, this would allow both papers to be more a discussion of different potential effects, rather than pitching the core-top solely in terms of DCO3=, which is taken up at the start of this manuscript, and then has to be taken apart.

Specific comments

Most of my specific comments relate to repeated phrasing of the different changes observed in the different X/Ca in terms of DCO3=, and to my difficulty in see the correlations in the data that the authors describe in the text.

3796, 16: suggests that DCO3= IS the dominant control for all of Li/Ca, B/Ca and Sr/Ca.

3697, 6: and shorter than weathering/volcanic degassing timescales ($10^6, 10^7$)

3797, 14: though linking intermediate water DCO3= to pCO2 may always be difficult. Biggest differences in mid-depth DCO3= in the modern ocean are a function of ventilation and productivity (compare North Atlantic to North Pacific at 2000 m). Still, guess it's worth a shot...

3798, 5: how many tests?

3798, 7: don't think the reference to the "standard Cambridge oxidative procedure" adds much to those not at Cambridge - best to stick to the reference to Barker.

3798,9: what concentration were solutions measured at?

3798,16: give these values

3798, 19: are the uncertainties really just based on 1sd of 1 set of 3 replicates? Or do you analyse several samples 3 times? 3 is a pretty small sample size, so please be more clear.

3799, 10: out of interest, do you see any difference between well preserved and poorly preserved samples?

3800, 3: don't think this section should be phrased in terms of DCO3=, as discussed above.

3800, 13: some discussion of the short term variability would be good - is there any correlation here between the X/Ca ratios or any other parameters? Perhaps try subtracting the long term trends and making cross plots of the different ratios - could be a good examination of any common controls. Would be good to show a zoomed in plot.

3800, 18: found some of these changes very hard to see.

3800, 23: is there really more variability, or just more data?

3801, 5: could do with another subheading here (something like Comparison to other carbonate system records) and again, less discussion in terms of DCO3=.

3801, 8: but again, almost all of the implied changes in DCO3= are different!

3801, 14: this study may suffer from the same issue as seen here and in the author's BGD manuscript: the changes seen in the specific locations where DCO3= changes are big over a small range of temperature may not apply to more general locations, where big changes in DCO3= and temperature may occur.

3802, 4: again, discrepancies between ALL the X/Ca data!

3802, 11: the Sr/Ca changes seem small compared to the scatter

3802, 17: the phrasing of this seems to be the wrong way round: d13C and wt percent organic carbon would be most likely to be PRIMARILY controlled by CaCO3:Corg rain

rate, which may have some control on DCO3=.

3802, 22: again, I'm afraid I don't see this relationship: the Sr is pretty flat, and the only variations within the CCD record seem to show anti-correlations with Li and Sr, if anything at all.

3803, 9 - 16: this is a massive stretch and really doesn't add anything - should be cut.

3804, 5: again, should be in core top, and actually shown.

3804, 12: what diagenetic alteration in core tops?

3804, 23: they all seem different to each other - Mg/Ca doesn't seem to stand out.

3805, 4: what does vacuolisation have to do with this? Surely the point is that seawater is the starting solution.

3806: very hard to see these correlations.

3806, 19: different diagenesis and dissolution histories could also affect these X/Ca differences.

3807, 5: again, this section needs a figure, which should also indicate which data are excluded.

3807, 20: *this nicely makes the point that there is not a common control (or even couple of controls) or these data*

3808: this section is needed in the core-top paper, especially once the core-top O. umbonatus B/Ca data of Brown et al. 2011, EPSL and Rae et al. 2011, EPSL are considered.

3808, 4: and measurements, e.g. Archer et al., 1989, GCA.

3808, 21: no, borate speciation and DCO3= will go together - they have the same controls, unless there are very significant changes in porewater B/Ca. Changes in X/Ca in pore water is a potential issue that could be discussed.

3808, 24: and other infaunal species in Rae et al. 2011, EPSL.

3809, 3-5: no, we really can not make this claim from these data.

3809, 20: as above, local changes in productivity and ventilation are likely to have the largest effect on DCO3= at these depths.

3810, 12: don't think anyone has successfully cultured deep sea forams like O. umbonatus.

FIGURES

Figure 1:

- Would be helpful to see the d18O stack for reference.

- Don't think it's appropriate or helpful to show the DCO3= scales - too much interpretation for this first figure.

- Show representative error bars.

Figure 2:

Labels are too small.

weight percent CaCO3 and fragmentation are compared several times - would be better to have them adjacent, then CCD, then Corg.

Technical corrections

3797, 23 and elsewhere: does this need to be Dawber and Tripati, submitted?

3800,1: sort syntax here.

3800, 16: could cut the "measurements ... prior to 41 Ma" bit

3804, 18: A similar approach

REFERENCES:

A paper by Edgar et al. 2008, which is cited in the text, is not included here. Check for other omissions too.

Interactive comment on Clim. Past Discuss., 7, 3795, 2011.