

Interactive comment on “Trace metal/Ca ratios in benthic foraminifera: the potential to reconstruct past variations in temperature and hypoxia in shelf regions” by J. Groeneveld and H. L. Filipsson

Anonymous Referee #2

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Dear Editor,

After careful judgment of manuscript number bg-2013-28, I recommend to publish this work in Biogeosciences. The results are novel and this manuscript fits the scope of Biogeosciences. However, there are a number of issues that need to be resolved before acceptance. In addition, I found many minor things that need to be addressed before acceptance, all of which are listed below.

General

1. Do I understand correctly that for every sample moment, only 1 group of 3-20 specimens were analyzed for Mg/Ca and Mn/Ca? Since we know that Mg/Ca can display

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relatively large inter-specimen variability, the values reported here may not necessarily be representative for all specimens living at that place and time. I think the authors need to discuss what this small sample volume may mean for the reported Mg/Ca and Mn/Ca, and uncertainties therein. 2. The discussion hints to the use of Mn/Ca as a proxy for pore water manganese content/ redox state/ oxygenation. However, the lack of pore water Mn/Ca prevents accurate interpretation of the benthic foraminiferal Mn/Ca. Therefore, the authors need to stress the qualitative nature of their dataset and should include the outlook that linking pore water [Mn²⁺] to foraminiferal Mn/Ca is the only way to develop a proxy for redox conditions. 3. Are the authors sure that Mn/Ca is not affected by diagenesis? With the potential long lifespan of benthic foraminifers, Mn/Ca at the surface may be altered before the end of the foraminifer's life. To test the homogeneity of Mn/Ca throughout the test wall, either depth resolved-laser ablation data or mapping of a sectioned test wall should be included. If not available, please state explicitly the possibility of surface-enriched Mn/Ca. 4. The text of this manuscript can be condensed considerably. Particularly the Discussion is too long for its information content. I think that the discussion can be reduced by at least 50%!

Title

Since the manuscript only reports values for Mg and Mn, I suggest to change the title of this manuscript from 'Trace metal/Ca ratios...' to 'Mg/Ca and Mn/Ca ratios...'.

Abstract

Lines 19-20: please mention that there may be practical problems when translating 'open ocean' isotope and element-calibrations to foraminifera living in coastal environments. Apart from species-specific offsets in calibrations, elements and isotopes in foraminifera from shallow areas should just as well reflect ambient temperature, pH, etc. The real 'problem' is caused by small-scale environmental variability (seasonal, daily), but is not a calibration- or proxy-based problem. Lines 29-30: I think 'carbonate ion saturation state' is incorrect. Seawater is either (under)saturated with respect

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to calcite/ aragonite, or carbonate ion concentrations may be very low (affecting the CaCO₃ saturation state). Line 31: change into 'Mn/Ca ratios from Globobulimina...'
or 'Mn/Ca ratios from the calcite of Globobulimina...'. Lines 37-38: please change to something like '...but inorganic carbon chemistry may additionally impact foraminiferal Mg/Ca and Mn/Ca in these regions.'

Introduction

Line 41: proxies themselves are not 'open ocean', but instead, often applied to or calibrated in, open ocean settings. Lines 45-46: change 'local and regional patterns' to 'local from regional signals' and remove 'which hampers...'. Line 60: please change 'going down' to 'decreasing' Line 63: I don't understand use of 'intensifying'. If the natural variability is amplified (i.e. extremes occur more often/ extremes become extremer), can't that in itself be of anthropogenic cause? Lines 83-93: this paragraph can be condensed considerably. E.g.: 'Since incorporation of many elements is shown to be species-specific, calibrations for species may not be easily translated to those dominant in coastal environments and call for field calibrations for shallow-water species.'

Methods

Line 162: change 'a much higher accuracy is needed' to something like: 'distinguishing living from dead specimens requires a more accurate method'. Lines 169-170: with a potential long lifespan for foraminifera, couldn't diagenesis affect the (surface) geochemistry of living specimens too? Do the authors have any idea about the rate at which Mn/Ca can be altered in foraminifera? How does this compare to the lifespan of benthic foraminifera? Lines 190-194: I don't understand why the analytical precision is different for the two species/ locations. I could see how the variability in Mg/Ca and/or Mn/Ca is different for the two species or locations, but not why this is based on different analytical precision. Lines 206 and 209: what are the standard deviations for these seawater Mg/Ca ratios? To avoid confusion between foraminiferal Mg/Ca and seawater Mg/Ca, I suggest using Mg/Ca_{sw} for the latter.

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Results

Line 216: rephrase so that it doesn't sound as if 5 specimens of *B. marginata* were measured. Line 216-217: does this mean that no specimens of *B. marginata* were found in the 1-2 cm interval? Table 2a seems to suggest so, but better to mention this also in the text. Lines 218-229: is discussion and does not belong to this section. Line 230: rephrase so that it doesn't sound as if 8 specimens of *G. turgida* were measured. Line 232: change 'systematic' to 'significant'. Line 233: remove either 'in general' or 'significant'. Lines 232-241: is discussion and should be cut and paste to next section. Line 244: add uncertainties to average values (also in the rest of this section).

Discussion

Line 292: change 'chapters' into 'sections'. Lines 298-306: delete. Lines 337-351: this can be stated in 1-2 sentences. Lines 357-380: these values probably refer to bottom water conditions. In-sediment saturation states (where benthic forams calcify) may be (much) lower and hence affect Mg/Ca. Line 418: 'foraminifera' should be 'calcite'. Lines 439-443: take into account the longevity of benthic forams, and the potential of 'diagenesis' in living specimens under low oxygen conditions. Lines 452-457: doesn't look significantly different to me. Either test with appropriate statistics or remove these lines. If there would be differences in Mn/Ca between individuals from the same species, would that mean that part of the population is adapted to a deeper habitat? Lines 485-489: since there is no pore water Mn data, and vertical migration may cause a variable habitat depth, calculation of partition coefficients does not make sense. Please remove.

Tables

Table 1: place units to the first column. Most of the notes can then be placed right after the values. Also put note '4' after CO₂-, ΔCO₂-, etc.

Figures

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Figures 3 and 4: change symbols from stars to dots or diamonds. Figure 4a: how many specimens were analyzed per sample? What is the difference between replicate measurements?

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