**Biogeosciences
Discussions**

Interactive comment on "Encrustation and trace element composition of *Neogloboquadrina dutertrei* assessed from single chamber analyses, implications for paleotemperature estimates" *by* L. Jonkers et al.

Anonymous Referee #1

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This study aims at clarifying the geochemical meaning of foraminiferal test chemistry of a crust-forming planktonic foraminifer, Neogloboquadrina dutertrei, by chamber-specific LA-ICP-MS analysis. Mg/Ca, Mn/Ca and Sr/Ca have been reported for the trapped material from Mozambique Channel and sedimentary foraminiferal tests from SE Africa margin (core-tops and LGM). The major findings are 1) Mg/Ca and Mn/Ca of the outer calcite are lower than the corresponding ratios of the inner calcite, 2) the outer calcite thickness is variable with chamber and sediment age, and 3) the outer calcite Mg/Ca does not seem to be directly related to seawater temperature. Based on

these findings, the authors suggest the difficulty to use Mg/Ca of the whole N. dutertrei tests as subsurface temperature indicator.

General comments

The manuscript presents a unique data set with fine spatial resolution of Mg/Ca that could contribute to better understanding of foraminiferal test chemistry. The study has a big potential to improve the interpretation of Mg/Ca ratios of crust-forming species that have been used to reconstruct past water column stratification by combining with surface dweller Mg/Ca values. I believe that this paper has a general interest for the community although several points should be clarified. My major concerns can be summarised as follows:

1. Definition of crust

The authors define lower Mg and Mn layers as crust parts. But what is a criterion of low Mg and Mn layers (statistic criteria)? For example, Mg/Ca of N. dutertrei of LGM from SE African margin (Fig. 6 upper panel) shows gradual increases with ablation time and the boundary of inner calcite and outer calcite is not so obvious. Since all discussion is based on the difference between the inner wall and the outer calcite, this point should be clearly defined in the manuscript. On the other hand, the difference of crystal size is mentioned as a feature of crust using SEM image (Fig. 2) but this is very surface information. Further, crystal size is different between trapped material from the Mozambique Channel and the sedimentary tests from SE African coast. Is the relationship between crystal size and low Mg/Ca layer robust?

2. Difficult comparison between trapped material and sedimentary tests

In the introduction, the authors propose a very attractive approach about the comparison between trapped material and sedimentary tests to infer the diagenetic influence on test chemistry. However, the trapped and sedimentary samples came from very different oceanic regions that we discover in the section of "Regional hydrology" (the

authors should present a map of studied sites with WOA09 data position). Does this combination of the trapped and sedimentary samples allow estimating diagenetic influence on foraminiferal test chemistry? Why the authors analysed only F-2 chamber of the trapped samples? The information on other chambers of trapped samples will be helpful and be shown in Figs. 4 and 5 (together with core-top).

The sedimentary foraminiferal tests were extracted from 5 cores of which the depth in water column varies from 1626 m to 3076 m (Table 1). Examining the test chemistry in relation to water depth could be an alternative way to deduce test preservation state. Is there any difference of foraminiferal test chemistry among the studied cores? Since the results from different cores and distinct periods are combined for "statistically robust estimate", detailed information is not accessible in the present manuscript. It would be interesting to compare not only average values but also the size of dispersion.

3. Representativeness of results

It is not clear for me whether presented results represent the whole data sets or only limited data were acquired. The typical example of this confusion is seen in Fig. 9 (comparison of Mg/Ca between two tests from the same sediment trap). The Mg/Ca values of the inner calcite are similar between the two tests whereas the Mg/Ca ratios of the outer calcite are different (Fig. 9). From this observation, the authors suggest that outer Mg/Ca does not reflect sounding seawater temperature. Is the analysis of two tests enough to support this hypothesis? What we observe in Fig. 9 could simply be inter-test variability.

Are the results shown in Figs. 4 and 5 typical examples of intra-test variability or only limited samples were ablated to examine the variability among different chambers? How many specimens are shown in these figures? Why for the core-top data, the results of thickness and elemental ratios are from different samples?

4. Depth of calcification

I think that the crust thickness variable with chamber is an interesting feature. This discovery is somehow contradictory with the conventional idea that N. dutertrei forms the inner calcite close to the surface and adds crust at deeper depths. The crust observed in this study is rather similar to the part formed by typical lamellar calcification. Then, what is the authors' hypothesis about calcification depth for the inner and outer calcites? Are the assumed calcification depths consistent with WOA09 data once foraminiferal Mg/Ca is converted into seawater temperature?

5. Other points

When crust thickness trend is compared with Mg/Ca (Figs. 4 and 5 LGM sample), I see some anti-correlation between them. Does this trend exist for other samples? If yes, what is the possible explanation for this correlation?

The implication to other crust-forming species is mentioned but not enough discussed. It will be nice to develop this aspect.

Minor and specific comments - A map of studied sites with WOA09 data position will be useful. The position of "Natal Bight" should be also shown. In this figure, schematic presentation of meso-scale eddy activities would be presented since such activities characterise the studied region.

- Table 1. What is the depth of trapped material? When there is no notation "a, b, c", the cores were used for which periods and which dating method was used for them?

- Table 2. The meaning of numbers of samples is unclear. Do they correspond to specimen numbers or ablation hole numbers?

- Comparison with independent whole test analysis (Fallet et al., 2010; Fallet et al., 2012 DSR) will be interesting.

- Figs. 2B and 2C. Scale bar is not visible. The same amplification?

- Fig. 3. Ca profile might be interesting to show since this element can present CaCO3

density change, thus crust and inner wall distinction.

- Fig. 9. It will be interesting to show Mn/Ca of the same tests to examine whether Mn/Ca of the inner tests are close to each other and Mn/Ca of the outer calcite is decoupled, as observed for Mg/Ca.

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