

## **Review of “Element/Ca ratios in Nodosariida (Foraminifera) and their potential application for paleoenvironmental reconstructions”**

Submitted by Pacho et al. to *Biogeosciences*

6/27/23

**Summary:** Pacho et al. submitted a very good manuscript that matches well the scope of *Biogeosciences*; it is suitable for publication after minor revisions.

Foraminifera are arguably one of the most important archives of the Earth’s past climate, however, the incorporation of environmental signals into the shell chemistry is only well-studied for foraminifera of the order Rotaliida. Using other foraminifer orders for paleoclimate reconstructions such as the order of the Nodosariida would open the door to countless new applications. For example, Nodosariata appear much earlier in the fossil record than the Rotaliida, which could extend the range of foraminifera-based reconstructions significantly.

However, published data and proxy calibrations (in particular for trace element based proxies) for Nodosariata are very sparse to non-existent, thus, the study presented by Pacho et al. presenting B/Ca, Na/Ca, Mg/Ca, Sr/Ca and Ba/Ca measurements from Nodosariata shells (by LA-ICP-MS) and relationships between Mg/Ca and temperature as well as Na/Ca and salinity is a highly appreciated first step to expand the Mg/Ca temperature proxy (and Na/Ca salinity proxy) to a new and vastly underutilized order of foraminifera.

I have a couple of minor comments and remarks that I would like to see addressed and/or included in the paper before I consider this manuscript ready for publication:

### **Discussion:**

The fact that Nodosariata appear in the Carboniferous provides researchers with the opportunity to extend the range of foraminifera-based climate reconstructions significantly (the authors are also mentioning this in the abstract as a motivation for this study). However, how realistic would it be to find Carboniferous shells that are well-enough preserved for paleoclimate reconstructions? Any prior studies assessing the preservation of these shells? I think this needs several sentences of discussion.

Also, there are many studies discussing the evolution of seawater Mg/Ca over time - this is relevant for the accuracy of the Mg/Ca temperature proxy in ‘deep-time’. I believe that the discussion-section of this manuscript would benefit by the addition of a few sentences addressing this topic.

### **Method:**

LA-ICPMS analyses of foraminifera shells are not trivial, and many papers have been published, discussing different approaches of analysis and methodologies to process the data. I am not able to find many information within this manuscript. For example, was the entire LA-ICPMS profile integrated, and the average element/Ca ratios calculated? Was the intrashell variability monitored, while the laser milled through the chamber wall? There could be some additional information in this signal. Where there any criteria for cut-off? (e.g., laser penetrates the chamber wall – at what point to end integration of the data). What type of laser was used, what was the wavelength (193 nm?). In addition, I had to google the NFHS-2-NP standard. Please add some info. Did the authors perform a standard-sample-standard bracketing approach? I assume they did, but I wasn’t able to find this in the description.

**Figure 1:** The legends in the temperature and salinity plots are not clear. What are the symbols labeled “Nodosariida?” I am guessing the actual water depths of the sediment samples from which the shells were recovered. What are then the symbols labeled “sample\_location”?

According to the text, samples were collected at 105 m, 272 m, and 619 m water depth. Thus, we should have data from only 3 depths. Why are more depth intervals in the plot?

Also, why are >20 red dots/markers in the map? This is not clear. According to table 1, there are just 3 stations where foraminifera, chemical and physical seawater parameters were collected. Then why so many dots? Please revise the legend and caption of Fig. 1, otherwise, it is very confusing.

### **Some minor items to address:**

**Figures 3, 4:** please write rose-Bengal observed (or living) instead of rB observed

Line 58: it shall read: “...*that* can be optically...”

Line 67: ~ 190 Ma

Line 73: suggest

Line 75: along *a* depth transect

Line 117: It sounds as if the repeatability is based on data from a different analytical session (Boer et al., 2022) using NFHS-2-NP standard. However, this study used the MACS-3 standard for calibration. What is the repeatability on MACS-3?

Line 117: It seems that 2-3 analysis were placed in the final chamber (Fig. 2). Please add this information here.

Line 135: **the** package

Line 136: Dot before “Identified” missing.

Line 157: over **a** the

Line 159: please also mention the water temperatures, as temperatures are more relevant than the water depth (correlation between Mg/Ca and temperature, not water depth)

Line 206: variability **in the chemical composition**

Lines 206 – 218: please add some discussion of past seawater Mg/Ca and the implication on ‘deep-time’ T-reconstructions

Line 225 **for** seawater

Line 242 range instead of change?

In addition, I strongly recommend that the authors upload their data to a open-access database such as Pangaea.de.