



Corrigendum: Intrashell Variability of Trace Elements in Benthic Foraminifera Grown Under High CO₂ Levels

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A Corrigendum on

Intrashell Variability of Trace Elements in Benthic Foraminifera Grown Under High CO₂ Levels

by Levi, A., Müller, W., and Erez, J. (2019). *Front. Earth Sci.* 7:247. doi: 10.3389/feart.2019.00247

In our original article an error occurred during its preparation. While the subject and the content of our paper is very different to that of Not et al. (2018), we used their introduction initially to obtain recent references on the effects of pCO₂. By act of technical mistake, their introduction was copied into our manuscript during the initial writing process and then was not removed. We are deeply sorry for this mistake and would like to convey our sincere apologies to C. Not, B. Thibodeau, and Y. Yokoyama and to the journal for our oversight. We completely rewrote the introduction. We confirm that our experimental data and subsequent interpretation are original and genuine and only the introductory text was affected, which is now remedied.

(Not, C., Thibodeau, B., and Yokoyama, Y. (2018). *Incorporation of Mg, Sr, Ba, U, and B in high-Mg calcite benthic foraminifera cultured under controlled pCO₂*. *Geochem. Geophys. Geosyst.* 19, 83–98. doi: 10.1002/2017GC007225)

A correction has been made to the introduction:

“Foraminifera shells are well-known archives for paleoceanography and paleoclimate reconstructions. In addition to the use of foraminifera for biostratigraphy and paleoecology (e.g., CLIMAP project, 1976; Crowley, 2000), stable isotopes ($\delta^{18}\text{O}$ and $\delta^{13}\text{C}$), trace elements and their isotopes (Cd/Ca, Mg/Ca, U/Ca, $\delta^{11}\text{B}$, and more) are successfully used for studying past ocean chemistry and paleocirculation (e.g., Emiliani and Shackleton, 1974; Sanyal et al., 1996; Lea, 1999; Nürnberg, 2000; Barker and Elderfield, 2002; Lear et al., 2002; Katz et al., 2010; Allen et al., 2016; Foster and Rae, 2016). Recently it has been proposed that Na/Ca could be used to reconstruct past ocean calcium concentrations (Hauzer et al., 2018). However, different species of foraminifera at the same location show different shell chemistries and isotopic compositions, which are attributed to “vital effects” representing deviations from expected thermodynamic equilibrium (e.g., Erez, 1978). These deviations are mostly associated with the calcification process that is biologically controlled and thus may affect the incorporation of trace and minor elements and their isotopes into the calcite shells (e.g., Erez, 1978, 2003; Elderfield et al., 1996; Bentov and Erez, 2006; Zeebe et al., 2008; de Nooijer et al., 2014; Gussone et al., 2016). One of the main factors that control foraminiferal calcification is the carbonate system in seawater (e.g., ter Kuile et al., 1989; Spero et al., 1997; Erez, 2003). It is therefore expected that the increase in atmospheric CO₂ (pCO₂), causing

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ocean acidification, may reduce foraminiferal calcification as well as affect their shell chemistry (e.g., Erez, 2003; Kuroyanagi et al., 2009; Dias et al., 2010; Fujita et al., 2011; Vogel and Uthicke, 2012; McIntyre-Wressnig et al., 2013). For example Mg/Ca in planktic foraminifera shows species-specific sensitivity to the carbonate system (e.g., Russell et al., 2004; Kisakürek et al., 2008; Allen et al., 2016; Evans et al., 2016, 2018; Holland et al., 2017; Gray and Evans, 2019).

An additional complication in the study of foraminiferal proxies is the intra-shell compositional variability (or banding) within individual specimens of both planktic and benthic foraminifera. This has been demonstrated in both trace elements and stable isotopes (e.g., Erez, 2003; Eggins et al., 2004; Rollion-Bard et al., 2008; Hathorne et al., 2009; Branson et al., 2015; Spero et al., 2015; Jonkers et al., 2016; Fehrenbacher et al., 2017; van Dijk et al., 2017, 2019; Geerken et al., 2019; Davis et al., 2020). Intensive experimental work (Eggins et al., 2004; Spero et al., 2015; Jonkers et al., 2016; Fehrenbacher et al., 2017) on planktic foraminifera demonstrated that Mg-rich bands are deposited during the night hours while low-Mg bands are precipitated during the daytime, perhaps connected with mitochondrial activity. Erez (2003) proposed that in large benthic foraminifera banding occurs when a new chamber is created in a

two-step process: the first layer of organic-rich matrix (primary calcite) is associated with high concentrations of trace elements, while the secondary thick layer, often termed lamination, covers the existing exposed chambers and is composed of low trace element calcite (secondary calcite). The alteration between high and low elemental bands may thus be attributed to the process of sequential chamber formation (Erez, 2003; Bentov and Erez, 2005, 2006). While this may explain the daily banding in planktic foraminifera that add a chamber every day, the banding phenomena overall are not well-understood. Furthermore, the effect of ocean acidification on the element banding is not known.

In this study, we measured the intra-shell variability of trace elements (B, Mg, Na, K, Sr, Ba, and U) in the two benthic foraminifera species *Amphistegina lobifera* and *A. lessonii*, cultured at four DIC concentrations (2,340, 2,420, 2,440, and 2,570 μM). These correspond to four pCO₂ levels of 430, 560, 740, and 1,390 μatm . These two species are commonly found in coral-reef environments of the Gulf of Eilat, and as such they are an important component of the carbonate sediments in this marine environment (Reiss and Hottinger, 1984).

The authors apologize for this error and state that this does not change the scientific conclusions of the article in any way. The original article has been updated.

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