Clim. Past Discuss., 11, C230–C234, 2015
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Climate of the Past
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11, C230–C234, 2015

Interactive Comment

Interactive comment on "Onset of the Paleocene–Eocene Thermal Maximum in the southern Pacific Ocean (DSDP Site 277, Campbell Plateau)" *by* C. J. Hollis et al.

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Received and published: 14 April 2015

A sediment core drilled in 1973 on the western margin of the Campbell Plateau by the Deep Sea Drilling Project (DSDP Site 277) was re-examined by Hollis et al. Within the past ∼40 years, a large number of studies was published based on material from this core, however, Hollis et al. are the first to discover that the PETM is preserved in a 34 cm-thick interval within these sediments.

The authors used an innovative multi-proxy, multi-instrument approach (in situ measurements of trace elements in individual planktic and benthic foraminiferal shells by LA-ICP MS, d18O and d13C analyses in bulk carbonate and foraminiferal shells, XRF

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scans of core sections, measurements of carbonate content and magnetic susceptibility) to delineate the PETM recorded in these sediments and to compile a robust paleorecord by combining data created by this multi-proxy approach to assess the degree of alteration of foraminiferal shells and exclude Mg/Ca measurements from samples that underwent significant diagenesis.

While this study certainly warrants publication and is suitable for the journal “Climate of the Past”, I highly encourage the authors to address the potential impact of diagenesis on the Mg/Ca, d18O, and d13C values in more detail. According to the authors (page 250, lines 6 ff.), “samples were selected based on light microscope assessment of preservation, which was subsequently confirmed by SEM”. In my experience, this approach of sample screening is not sufficient.

Within the past years, I analyzed hundreds of foraminiferal shells in high magnification by SEM and screened more than one thousand polished chamber wall cross-sections in epoxy mounts using SE, BSE, and CL detectors in order to locate suitable, well preserved domains for SIMS analyses. Thereby, I realized that it is practically impossible to estimate the actual preservational state of ‘frosty’ foraminiferal shells from their outer appearance. Two shells, that appear to feature the same preservational state, may turn out to be altered to completely different degrees when examining their polished chamber wall cross sections. Thus, my concern is that differential diageneses within the studied core section may have been overseen. For example, it was shown in previous studies that foraminiferal shells at the PETM onset may be altered to a larger degree due to the effect of ‘burn-down’ (e.g. Walker and Kasting, 1992; Kozdon et al., 2013). Hollis et al. emphasize a different trend in PETM-warming at DSDP Site 277 compared to other sites, but I am not convinced that the data shown in this study exclude the possibility that part of this observation could also be caused by differential diagenesis within the core.

However, the laser ablation data provide a great wealth of information that can be used to asses foraminiferal diagenesis in more detail, and I am surprised that the authors didn't explore all the benefits of this in situ approach. Based on the method description and the data presented in Fig. 3, the Element/Calcium ratios of the three laser ablation analyses (=profiles through chamber wall) for each shell were simply averaged. If the (averaged) Al/Ca and Sr/Ca ratios exceeded certain threshold values, the shell was considered to be significantly affected by alumina-silicate contamination and/or diagenesis, consequently, the Mg/Ca ratio was not used for climate reconstruction.

In my opinion, there is much more to explore. While the laser is 'drilling' through the foraminiferal chamber wall (with an ablation rate of 0.2-0.3 μm/s), the Element/Ca ratios are measured in real time (with a few seconds delay, as the ablated material needs to pass through tubes and the spray chamber before being ionized in the plasma). Therefore, it is possible to compute elemental concentration profiles through foraminiferal chamber walls at $\sim$micrometer resolution. These laser ablation profiles provide detailed insights in the degree of diagenesis and/or recrystallization, as demonstrated in previous studies (e.g. Hathorne et al., 2003; Regenberg et al., 2007; Pena et al., 2008; van Raden et al., 2011). In processing these LA depth-profiles, it should be possible to determine if diageneses and/or alumina-silicate contamination affects only on the outer and inner surface of the shells, or if these 'unwanted' phases penetrate deeper into the chamber wall. These information can also be used to locate domains that are less affected by diagenesis than the remaining shell (likely the inner part of the chamber wall). Would it be possible to compile – for comparison – an alternative Mg/Ca record using exclusively data from less altered portions of the shell? These are just suggestion, but I think they are worthwhile to explore. There are certainly more information in the data set than shown/discussed by the authors. Is it also possible to show some representative laser ablation profiles in the supplementary material?

Other comments:

- Hollis et al. analyzed nine element by LA-ICP MS (Mg, Al, Si, Ca, Ti, Mn, Zn, Sr, and Ba), however, only Al/Ca, Sr/Ca and Mg/Ca ratios were used to assess the degree of diagenesis. What about Mn/Ca and Ba/Ca? The authors themselves cite studies

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using Mn/Ca and Ba/Ca ratios to evaluate contamination or diagenesis of foraminiferal shells. As the mechanisms of diagenesis are very complex and site-specific, it may be possible that the data are not conclusive, however, results from other Element/Ca ratios should be at least briefly mentioned. Furthermore, the authors emphasize a positive linear correlation between measured Al/Ca and Mg/Ca ratios. This linear correlation is difficult to identify from the data shown in Fig. 3. Therefore, I suggest to include an Al/Ca:Mg/Ca cross plot in the supplementary material

- Page 259, lines 23-26: The observation that the Mg concentration is not being reset during shell recrystallisation is important and confirms in situ measurements of Mg/Ca ratios in diagenetic overgrowth that approach the values of biogenic foraminiferal calcite (Kozdon et al., 2013). However, these findings contradict the results of inorganic precipitation experiments showing about an order of magnitude more Mg in diagenetic than in biogenic calcite (e.g. Mucci and Morse, 1983; Oomori et al., 1987), and I encourage the authors to take this opportunity and emphasize the difference between diagenesis in the sediment column and the results from inorganic precipitation experiment. Some scientist still believe that non-elevated Mg/Ca ratios are an indicator for good preservation.

- Page 259, line 22: it shall read “Fig. 4d”.

- Fig. 4d: is it possible to add a horizontal axis for d18O and Mg/Ca?

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Interactive comment on Clim. Past Discuss., 11, 243, 2015.