

Interactive comment on “Early Paleogene variations in the calcite compensation depth: new constraints using old boreholes across Ninetyeast Ridge in the Indian Ocean” by B. S. Slotnick et al.

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We thank Anonymous Referee #2 for commentary. We mostly agree with the comments, and it improves our manuscript. Below we address each comment.

In their contribution, ‘Early Paleogene variations in the calcite compensation depth’, Slotnick et al. provide an updated estimate of CCD evolution in the central Indian Ocean from 62–48 Ma. The authors combine refined biostratigraphy and subsidence curves, with detailed measurements of wt % carbonate and bulk carbonate isotopes (d13C and d18O) to revisit issues of Paleogene carbon cycling in their regional update.

This is a nice contribution: the main compilation (Fig. 11) provides a solid regional
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overview and supports the author’s case additional early Paleogene drilling is needed in the Indian Ocean. I agree with the First Referee on their overall summary: this is good contribution but the authors should address a few comments to clean it up. The First Referee has already discussed a number of biostratigraphic terminology details that need to be addressed as well with issues with figure clarity. My comments are largely minor ones of language, although I too list additional issues with the figure captions/methodology explanations.

Text Edits: line 15, pg 3165. This sentence needs moved to the methods: ‘Throughout this work, we follow the astronomically tuned “Option-1” early Paleogene time scale of Westerhold et al. (2008) for ease of reference and comparison to other data sets (Table 1), although this has been argued to be offset by one 400 kyr eccentricity cycle near the late Paleocene (Hilgen et al., 2010; Vandenberghe et al., 2012).’ It currently breaks up the flow between two otherwise cohesive paragraphs of the introduction. -We have moved this sentence to the methods, as recommended, and expanded it to clarify.

line 27, pg 3165. Delete ‘However’ -‘However’ deleted.

line 11, pg 3166: ‘From the perspective of the sedimentary record, the lysocline is where calcite dissolution first becomes apparent (Kennett, 1982), while the calcite compensation depth (CCD) is where calcite dissolution balances “calcite rain” from above.’ Please add a sentence or embedded the idea in the above sentence to give the actual definition of the lysocline. -This sentence was reworded for clarification purposes.

line 16, pg 3166: ‘CaCO₃ drops below < 10 % due to dissolution’. Change ‘to <10%’ as you don’t actually test whether it is due to dissolution. You simply assume it is and stating that is due to this process is misleading. -We have reworded this sentence and added another. The referee is correct in the sense that CaCO₃ can drop below 10% because of dilution. However, this is not the case in most low-latitude, open ocean settings, such as the central Indian Ocean.

line 7, pg 3169: change ‘offer’ to ‘provide’ -Changed.

line 10-13: 'Most of the earlier work is not on a common and current early Paleogene time scale, and needs amendment for comparison to other locations.' This will always be the case as time scales are updated and it is no fault of the previous work, as is almost implied by the wording of this sentence. Better to restate in the positive (i.e., in order to consider all the work to date, you've updated all the previous work to a common time scale) -We have reworded this.

line 18, pg 3169. 'The combination almost necessarily implies discontinuous sedimentary records that contain disturbed intervals.' Understanding this sentence necessitates a previous, detailed understanding of coring. For your junior readers, it would be better if you explain up front, as you do later in line 22, why the combination leads to discontinuities. -We have tried to rewrite as best as we can.

line 23, pg 3169 'As discovered on drilling expeditions circa 1985–1987, typically about 1 m (but up to 3 m) may be missing between successive hydraulic piston cores.' Reference needed. -As above.

line 8-9, pg. 3170. Does it matter that you sampled with a plastic scoop? I cannot imagine why. If not central, just collapse these two sentences as 'A total of 395, 10-cc, early Paleogene sediment samples were taken from Sites 213, 214, and 215.' -This is important in some cases, but not here; thus, we have collapsed the sentences following referee's recommendation.

line 9, pg 3175. 'although a rigorous comparison cannot be made because of slight differences in depth between samples.' Seems overstated -interpolation is a tool of science, you just chose not to do it. -We have kept the sentence as is, because interpolation between samples several at significant distance/time is not a good idea for the early Paleogene.

Line 11, pg 3175 "lead to a" –they don't lead to anything. Replace with 'have a' - Changed.

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line 16, pg 3176 'lead to' . Same issue. Replace. -Changed.

line 17, pg 3176 'curves with some noteworthy observations' .The curves don't have noteworthy observations, but you hopefully are about to make some about them. Please reword accordingly. -Wording changed.

line 24, pg 3178. 'fairly reasonable correlation' since you don't measure the correlation at all, it would be better to replace correlation (a statistical term) with 'match' or 'alignment' to make it clear that you are just eye-balling the similarity between curves. -We think this comment is meant for pg 3177, and have modified the sentence on this page.

line 5, pg 3178. 'a fact substantiated by'. All facts had better be substantiated by something. It would be better to replace this with a more direct, short 'as indicated by' -Modified.

line 19, pg 3178. replace 'confront' with 'exist'. The problems aren't confronting the depth reconstruction (rather, they confront the person doing the reconstruction) -Changed.

line 5, pg 3180. 'a concept inferred'. Better as 'as inferred'. -Changed.

line 9, pg 3180. Delete 'As an aside' because it shouldn't be. This is important stuff you are talking about in that mini-paragraph. -Deleted.

line 16, pg. 3180. Delete 'in an effort' as it is not needed. -Deleted.

line 25 pg 3180. Is 'strongly' really needed? Otherwise delete it. -Deleted.

line 3, pg 3180. Without doing assemblage counts, or direct assessments of preservation (besides the visual classification) how can you call the effect of dissolution 'relatively minor'? Delete it if no additional evidence exists to back this up. -We believe referee meant pg 3181 for this comment. Although we did not do assemblage counts, we did take into account our findings regarding degree of preservation of specific nanofossils (see tables 2, 3, and 4). This information is what we used to substantiate this

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point of 'relatively minor.'

line 22, pg 3183. Perhaps better as 'poorly constrained' rather than 'poorly defined'?
-Changed.

line 13, pg 3183. 'Prior to our work, the early Paleogene CCD was poorly constrained, especially for the Indian Ocean.' As the authors describe in detail in the preceding paragraphs, much remains to be done to described the early Paleogene CCD as 'well constrained' as implied by this sentence. I would suggest rephrasing this sentence to reflect the incremental advance made, leaving room for future work. -We believe referee meant pg 3186 in regards to this particular comment. This paragraph has been modified.

line 18, pg 3186. 'Following our work and after considerable hindsight, we begin our conclusions with an admission: ' This could be entirely deleted but if you must keep some of it. . .nah, it really is not needed. -All of this has been deleted.

line 2, pg 3187. 'luxury is not so clear' how can a luxury be clear or not clear?
Rephrase. -Rephrased.

line 4-5, pg 3178. 'Second, the three sites contain fairly thick sediment sections that overlies Paleocene basalt in the central Indian Ocean' How is this a problem that makes it difficult to constrain Indian Ocean CCDs? Rephrase to be a second problem. -We think this reviewer meant pg 3187 for this particular comment. The paragraph this comment is regarding has been changed.

line 11, pg 3178. 'Third, new sites are required to fully address the problem.' How is this a problem? Rather, this seems to be a need arising from #1 and #2. -Changed wording to reflect this point as a need.

Figure Edits: Figure 1. How is the brown line drawn?? It doesn't seem to be constrained by the actual records so requires some explanation. Also, you need a caption for the red and blue biostrat triangles. Why are they red and blue? Actually, did you re-

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use the age modes for 1370, 259, 1215, 1220, 1219, and 1331 using the nano-dates? If so, might be good to indicate in the caption that the triangles were the datums you used at all sites to revise age models. -We've amended the figure caption so that it better explains the brown line denoting the early Paleogene CCD as well as the bit regarding the red and blue triangles.

Figure. 3 I would have found this easier as a legend within each of Figures 4, 5, 6. -We understand this referee's point about fig 3. However, there are pros and cons regardless of what to do with what is in this figure. If it were placed in figures 4, 5, and 6 then doing so would be repetitive and make each figure more detailed with more the reader could then look at. But, this comes with the following limitation: keeping fig 3 where it is it is then not physically on each of the next three figures so the reader may need to flip back and forth between the figures. We the authors did not identify a necessary reason to embed fig 3 onto figs 4, 5, and 6 so we left it as is.

Captions of Figures 4,5,6: -How are the Age estimates derived from Agnini? Are they perhaps just 'from' Agnini? If they are indeed derived from Agnini this requires some methodological explanation - what is the heavy pink color block from 53-50? -Reworded to make more clear.

Other Figure Consideration: The biostrat data from 4,5,6 could be shown (flipped by 90degrees) along the sides of Figures 8,9,10. However, if space isn't limiting, duplicating the figures is fine. -Yes, this could be done, but if we made this adjustment, the figures would not be straightforward since the data we generated was biochronologic. Since we already show both the nannofossil and foraminiferal biozones along the left side of each figure, adding more would make figures 8, 9, and 10 overly detailed and more confusing to the reader.

Fig. 11. Are the aberrant Site 213 d13C values that you discuss in the text shown? If so, they don't seem so aberrant because I can't see them. . . or are they the values that sit up w/site 214? Fig. 11 Caption: Same questions w/nanno-datums. Do

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they apply to all the records that are aligned? -There are no aberrant Site 213 or 215 d13C values, as discussed in the text. What is mentioned is that Site 214 d13C values from cores 36-39 originated in a shallow setting and therefore are unrelated to global d13C records. These were the samples we elected not to include in Figure 11. Yes, nanno-datums apply to all records that were aligned.

Supplement: I had trouble accessing this. Do the authors give all the data (including ages) for multisite alignments in Figures 1 and 11? If not, please do. It greatly speeds subsequent work to be able to simply use the same tables (w/mbsf, mcd, age, %carbonate, bulk isotope values) for all the sites, rather than recompiling the data from the primary literature. -What supplement? There is no supplement.

Interactive comment on Clim. Past Discuss., 10, 3163, 2014.