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Climate of the Past Discussions

Interactive comment on "Life and death in the Chicxulub impact crater: A record of the Paleocene-Eocene Thermal Maximum" *by* Vann Smith et al.

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Many thanks for your comment, Dr. Littler! We will respond to your points in order.

1. We have added a supplementary Methods document in the Supplementary Information. A short discussion of the sampling strategy and resolution has been added to the Methods section in the main manuscript. In some cases the sampling resolution was limited by practical considerations (e.g., lack of funding). The Bioturbation Index has been briefly described. The location of the ECS and Delta instruments, and the analytical precision, has been included in the Supplementary Information. A mention of the δ15N and δ13CTOC isotope standards has been added to the Methods section. De-

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Discussion paper

scription of the methods used for biomarker analysis is included in the Supplementary Information.

2a. As you note, the Paleocene record has been challenging due to extremely low palynological abundances and low TOC. Although multiple late Paleocene samples were analyzed for biomarkers, TOC was too low to determine TEX86 for all but one sample. The latter point has been clarified in the Methods section. Also, there are at least two manuscripts in preparation by various co-authors which deal with later Eocene hyperthermals and the Early Eocene Climatic Optimum, limiting our ability to discuss these upcoming results. However, more information on the palynological assemblages in the PETM section relative to the later Ypresian has been added.

2b. TOC values in the Site M0077A core generally increase upsection (Gulick et al., 2017). Other laminated dark shale and marlstone sections are present in the later Ypresian, notably a laminated marlstone section at ∼598-597 mbsf. This section is the subject of current research, so we are limited in our ability to discuss these results. The two black layers visible above the partial PETM section in Figure 2 are actually black cherts; this has been clarified near the beginning of the Results section.

3a. Figure 2 has been modified to include a separate column illustrating the unconformities present. Abbreviations have been used to label lithological units in the stratigraphic column. Additionally, the first paragraph of section 4.1 has been revised to include depth ranges for the lithological units described.

3b. In the abstract the PETM record is now referred to as "…a new record of the body of the PETM." The incomplete nature of the PETM record at this site is discussed in the Results section (which has been reorganized to include some text previously in the Discussion section). The Discussion section now begins: "As described earlier, the PETM section in the Site M0077 core is bracketed by unconformities and incomplete, with the onset and recovery missing, and only part of the body of the PETM preserved." After discussion with the co-authors, we considered that referring to the PETM record throughout the manuscript as a "partial PETM record" is unnecessary, as we explain the incompleteness of the record in the manuscript.

4. The BAYSPAR and linear TEX86 calibrations yield unrealistically high PETM SSTs in excess of 44 °C, likely above the heat tolerance for dinoflagellates, foraminifera, and other eukaryotic plankton. The TEX86H calibration of Kim et al. (2010) provides more realistic SST estimates which are in agreement with other published GDGT data for the PETM in the region (Zachos et al., 2006; Jaramillo et al., 2010, Sluijs et al., 2014). A short discussion of this has been added to the manuscript. Complementary data comprising BIT, MI and fCren to evaluate applicability of the TEX86 proxy (exclusion criteria as compiled in O'Brian et al. (2017)) are provided in the supplementary materials. The thermal maturity as determined by side chain isomerization of C29ïĄąïĄąïĄą steranes [20S/(20S+20R)] and C31ïĄąïĄćïĂăhopanes [22S/(22S+22R)] average 0.13 and 0.35, respectively (see supplementary materials), which is indicative of a low maturity equivalent to a vitrinite reflectivity of 0.3 to 0.35%. This is supported by Rock Eval Tmax values averaging 428°C. No maturity impact on the GDGT data is observed. Preservation of immature biomarkers is further supported by the presence of thermally labile aromatic carotenoids. The first paragraph of section 4.2 has been revised to include discussion along these lines.

5. As described, the carotenoid biomarkers are present, albeit in trace concentrations, above and below the black shale interval. In the crater basin, evidence of periods of photic zone euxinia was reported for the limestone interval prior to the PETM, as shown by Schaefer et al. (2020). Here, different sources (microbial mats versus open water column PZE) for the elevated carotenoids have been proposed. Abundant PZE markers are ascribed to plankton concentrated at the chemocline, as found in restricted marine basins where high concentrations of hydrogen sulphide occur within the sunlight zone. Alternatively, PZE markers reflect a change in the microbial community, either within the water column triggered by stratification, or via the transport of microbial mats from the shallow waters surrounding the crater, as indicated by elevated concentrations

of cyanobacterial biomarkers and intact heterocyst glycolipids.

6. The absolute age column has been removed.

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