Our responses are shown in **bold, red text**

Reviewer #2

General Comments

Sharman et al. present a wealth of high-quality datasets, including the important Corg CIE, Apectodinium, and Rhomboaster, which constrain the PETM in the deepwater Gulf of Mexico in the Anchor 3 well and allow details of the biotic and geochemical changes through the event to be evaluated. The deep-water Anchor 3 location is crucial for evaluating sediment supply characteristics and timing in large-scale routing systems, especially for rapidly deposited, mud-silt turbidites in distal marine PETM sections. Furthermore, their interpretations strengthen the hypothesis that the Gulf of Mexico (GoM) was open and hydraulically connected to the Atlantic before, during, and after the PETM despite potential blockage by collision of the Cuban and North American Plates. This manuscript is well written with datasets, assumptions, and interpretations clearly described and explained. Figures and captions are clear and well annotated.

Specific Comments

Line 205 – 235 - The overall biozonation and age model and co-occurrence of Apectodinium, Rhomboaster, and CIE provide convincing evidence for the PETM, main body and recovery intervals at the Anchor well. However, more scrutiny of the main d13Corg CIE is needed given the very organic-lean nature of the PETM interval dominated by coaly and inertinitic kerogen. This may indicate that it contains recycled organic material from older onshore sections. To what degree is this CIE being influenced by terrestrial or even recycled terrigenous kerogen and not recording the global exogenic carbon cycle (as in Sluijs and Dickens, 2012)?

Our Response: This is a good consideration. We now include a statement in section 5.1.2 that makes a link between the degraded nature of the kerogen with the overall noisiness of the d13C isotopic excursion, citing Sluijs and Dickens (2012) and Aze et al. (2014). We have also added a statement in section 5.1.2 that notes the uncertainty in the boundary between our interpretations of the main CIE and CIE recovery.

Also, what is the effectiveness of the extraction/clean-up procedure to remove invaded petroleum prior to d13Corg and TOC analysis? A further explanation of the amount of contamination noted and pre- and post-extraction TOC differences would help improve confidence in the results.

We now provide an additional supplemental table (Table S3 in the revised submission) that includes data on how TOC values vary by treatment (raw, solvent extracted, and solvent extracted + decarbonated). Table S3 shows that TOC values do not substantially decrease in mudstone samples following solvent extraction, unlike in sandstones which are clearly oil stained. We also provide an appendix (Table S2) that describes the result of an experiment where the solvent extraction was shown to be ~99.998% effective at removing petroleum contamination (two-stroke motor oil) applied to standards.

Line 503-507 - Sharman et al. propose a flood of TOC-poor terrigenous clay as an explanation for the remarkable TOC decrease at Anchor in Units B and C of the PETM. This organic lean clay is suggested to have been sourced from terrestrial environments undergoing enhanced oxidation of paleosols perhaps 100s of km from the well location given the ~31 ky time lag from PETM onset to lithologic response (Line 565). It seems important to also recognize the enlarging neritic mud apron associated with sea-level rise as the main or intermediate source regions for the low TOC clay. Drops in palynomorph and phytoclast abundance, oxidation of organics, and longer sediment residence times may have occurred there and further decreased TOC in the clay fraction. The time lag may reflect the reorganizing and mobilizing of muds in the submarine segment of the routing system.

Our Response: We now include a statement that allows for the possible contributions of organic matter degradation within the shallow marine environment in section 5.1.2.

Line 569-574 - The shale and sandstone CIA signals appear to become noisy during the CIE making the placement of clear offsets and estimated lags questionable. Also, CaO continues to increase through the Eocene after the PETM carbonate pulse suggesting carbonate minerals may be affecting the later shale CIA readings. It would be better to recognize the interpreted increasing influence of erosional denudation in the catchment through and following the PETM without being too explicit with the timing.

Our Response: We have deleted the two paragraphs that interpreted the lag time associated with changes in CIA in section 5.1.4. We agree that the resolution on the lag-time is a bit noisy given variability observed around the PETM. We instead focus our interpretation on the general change in CIA values from late Paleocene to early Eocene time in section 5.1.3.

Line 663-676 - The drop in TOC beginning in Unit A and mainly affecting Units B and C of the main CIE is incongruous with evidence for deoxygenation including lack of bioturbation and loss of benthic foraminifera. The ICPMS results in the supplement for Anchor do not show U and V enrichments and other redox-sensitive ratios in the CIE which along with low TOC suggest only weak benthic deoxygenation may have existed at Anchor. Given this, preservation of marine organics would have been diminished and high siliciclastic sedimentation rates (Line 508) should have not led to a dilution penalty on TOC in Units B and C. New data published in Vimpere et al. (2023) for the Logan well which is more distal than Anchor also show a drop in TOC over the clay-rich main CIE. However, the TOC decrease is not as severe as at Anchor despite a much higher sedimentation rate over the CIE. The differing decreases in TOC through the main CIE at Anchor and Logan suggest that although the influx of organic-lean clay was broadly distributed, depositional and organic preservational conditions varied over the GOM fan system.

Our Response: We now include discussion of U, V, and Mo concentrations from ICP-MS and provide a supplementary table with the aluminum-normalized values and the enrichment factors for Mo and U. The concentrations of redox sensitive trace elements such U, V, and Mo are either low or below detection limit, which may be consistent with suboxic conditions, but do not provide evidence of significant anoxia.

We also now include a comparison with organic carbon values in the Logan well (Vimpere et al. (2023): *Geology*) in our discussion section 5.1.2. As noted by Reviewer #2, Vimpere et al. (2023) observed a decrease of ~0.6% from late Paleocene to the PETM CIE, which is less pronounced than we found in our core samples. However, we are uncertain to what extent these differences may reflect differences in sample type (ditch-cuttings vs core plugs), location, or other factors.

Section 5.4 - This important section is too heavy on literature discussion and needs more focus on the Anchor routing system, specifically the transition from terrestrial to marine segments of the routing system. The PETM seal-level rise presumably led to the growth of a mud-rich apron in the transition region. Did clays and organics from terrestrial environments continue to follow the long-lived routing system through this region or did a modified marine routing system develop?

Our Response: We now include a reference to a study that is in revision to Palaeo3 (Sharman et al., http://dx.doi.org/10.2139/ssrn.4200185) which is relevant to the terrestrial-to-marine segment of the Wilcox sediment routing system. However, given the unpublished nature of this work, we prefer to put our results in context with other better-documented PETM localities that span onshore to offshore setting (e.g., Fig. 10). We agree with the general point made here that it would be helpful to identify additional Paleocene-Eocene boundary sections within the greater Wilcox system to better understand sediment transport. However, it is worth noting that much of the Wilcox between the relatively shallow, onshore (fluvio-deltaic) and distal, deep-water sections is buried very deeply beneath younger Cenozoic fill of the northern Gulf of Mexico.

Finally, I think the length and level of detail in this manuscript are warranted given the size and scope of the datasets. However, the impact of this manuscript will be increased if the Logan well results are integrated into the discussion. This may expand the understanding of organic-lean clay injection and spatial variations in deoxygenation and marine versus terrestrial organic matter supply over the PETM in the deep-water GoM.

Our Response: We now include references to Vimpere et al. (2023) throughout the revised manuscript, as suggested.

Vimpere, L., et al., 2023, Carbon isotope and biostratigraphic evidence for an expanded Paleocene–Eocene Thermal Maximum sedimentary record in the deep Gulf of Mexico: Geology, v. XX, https://doi.org/10.1130/G50641.1

Text and Figure Corrections

Our Response: We have made all suggested changes to text and figures below.

Figure 2 – change Suwannee Straight to Strait

Table 1 – LF-1 vs Lf-1

Line 141 – Add core depths in meters. Given the use of feet and meters in the text, the well data profiles would benefit from having the depth scale provided in meters as well as feet instead of having just a dual scale bar in Figures 4-7.

Line 516 - …to record a transition from low TOC…

Line 533 – hydrologic vs hydraulic cycle?

Line 552 – finger-grained to finer-grained

Line 553 – coaster to coarser

Line 773 – coaster to coarser