Reviewer # 1

Comment: The title overstates what the manuscript is able to demonstrate in its current form.. or perhaps in general.

Reply: Thank you for highlighting this issue. We have revised the title to: **"Drastic Changes in Depositional Environments at the Ross Sea Continental Margin Since the Mid-Pleistocene."**

Comment: A lot of weight has ben placed on interpretation of the magnetic susceptibility but the assumptions made are incorrect. MS is a magnetic mineral concentration proxy and will provide insights into the ratios of ferri/ferro magnetic, paramagnetic and diamagnetic components in a sample. Ohneiser et al 2019 showed the relationship very clearly MS and magnetic mineral concentration at LC47.

Reply: We have rectified our assumptions on the interpretation of MS values. Please see line no. 123-133. **"Ohneiser et al. (2019) provide a comprehensive analysis of the magnetic mineralogy of sediment cores from the Ross Sea. Their study shows that sediment cores collected near the continental margin are relatively coarser and contain magnetic minerals with lower coercivity compared to those from deeper waters. Additionally, there seems to be a connection between increased concentrations of magnetic minerals and glacial periods, as indicated by the benthic $\delta^{18}O$ stack LR04 (Lisiecki and Raymo, 2005). The elevated levels of magnetic minerals during these glacial periods suggest changes in sediment transport or winnowing processes, which are associated with variations in ice volume and bottom water flow from the continental shelf.."**

Comment: You need to reference the Ohneiser et al 2019 paper which provides the chronology for LC47. The B/M boundary at 11.65 m (773 ka) provides your chronological anchor from which you can correlate to LC42.

Reply: We have referred to Ohneiser et al. (2019) paper in line no. 101-103.

Comment: Carefully read the Bollen et al. (2022) paper and see how their data and interpretations work with yours. In their work they develop a more complex chronology of ice advance and retreat than what is presented for LC47 which makes me think that some more detail can be extracted form this record.

Reply: Thank you for your suggestions. We have added additional paleoclimatic inferences, referencing Bollen et al. (2022), which can be found in Sections 4.1.3 and 4.3.2. However, due to the lack of a well-established chronology, we could not incorporate high resolution climatic variations.

Comment: There appears to be discussion in this manuscript on lower portions of the core than what is presented.

Reply. We partially agree with the reviewer's observation. The lower section received more detailed discussion due to the interesting values of sedimentary components observed between 773 and 550 ka. However, we have now expanded our interpretations in the other sections as well. Please refer to Sections 4.1.3 and 4.3.2 for these additional insights.

Comment: Line fits and statistics need to be presented so that we can see how strong the correlations are and in turn how valid the discussion and conclusions are.

Reply: Thanks for pointing the issue. Now, we have added line fits and statistics to all our figures.

Comment: Add MIS labels to all figures so we can see what is being referred to.

Reply: The suggestion has been included to the figures. Please see figs. 4 and 8.

Comments: There is no mention of MIS 12. This is a deep cold glacial which some speculate resulted in reorganisation in Antarctic more persistent sea-ice cover.

Reply. We appreciate the esteemed reviewer's concerns regarding MIS 12. However, we did not observe any noticeable signatures of this interval in our sediment core, nor has it been clearly identified in the nearby sediment core RS15-LC42. This period corresponds to a zone of dampened MS values in the Ross Sea sediment core. We speculate that the absence of this signature in our sedimentological and geochemical results may be due to the core's location being farther from the Antarctic continental margin.

Comment: The discussion on CaCO3 preservation needs more development. Bonaccorsi et al., 2007 present a record of only the last few thousand years so this is not comparable with the LC47. No mention is made to carbonate production and its relationship to LC47. What is the carbonate? Is it foraminifera, coccoliths? Is it old recycled washed in from the shelf or new carbonate? Can assumptions on dilution made from CaCo3 data be corroborated with microscope images demonstrating varying dissolution? To discuss carbonate preservation more data are needed and a discussion on assumptions of production rates which will have been strictly during warm interglacials.

Reply: We agree that our data set is insufficient to discuss the calcium carbonate preservation elaborately. However, following the reviewer's concerns we have modified the discussion on the carbonate preservation. Please see section 4.3.2.

Comment: The Be data discussion needs to be reviewed by a specialist other than me. Figure 6 needs some statistics to see how good the line fits are so the reader can deduce how robust the discussion and conclusions are. At the moment I can't tell if the data support the discussion or conclusions. More work is needed in clear data presentation and their statistical significance before discussions on CDW/ACC and ice sheet evolution can be evaluated.

Reply: We agree that our data needed statistical analysis done. We have added line fits and statistics to all our figures.

Line wise comments:

Lines 24-25. From these data you can't propose a collapse of the WAIS or ice shelf collapse.

We agree with the reviewer and removed the WAIS collapse statement from our abstract.

Line 39. You need a reference to support the statement 'Ross Sea is the primary drainage...'

Reference added to the specified section. Please check line no. 41.

Line 42: What is meant by elucidating historical ice sheet dynamics? Ice sheet dynamics which have happened since the arrival of humans and documentation? Current ice sheet dynamics?

We have modified the lines: "Thus, studying the sedimentation pattern in this region is critical in elucidating paleoceanographic changes and past ice sheet dynamics". Please see line no. 50-51.

Line 54: Naish et al do not present organic geochemical data.

Thanks for the comment. We have modified the lines as " Sedimentary facies records from AND-1B showed a consistent increase in the duration and the coverage of sea ice during the past 3 Ma (Naish et al., 2009)". Please see line no. 66-67.

Line 55: Suggest referring to the Ohneiser et al 2023 Nat Geo paper here where we showed persistent ice advance and retreat paced by obliquity until 400 ka. Its the only other Pleistocene record from on the shelf which spans the last c 1 myr.

We have referred to the findings from Ohneiser et al. (2023) in line no. 56-58.

Line 97: You need to reference Ohneiser et al 2019. Ohneiser et al established the magnetostratigraphy and the placed the B-M boundary at 11.65 m (773 Ka) which provides the original age model for LC47 (and LC42). Bollen et al 2022 developed Ohneiser Line 115. This age has been revised and is now 773 ka.

We have revised the B-M boundary age based on the work of Ohneiser et al. (2019). Please see the updated text in lines 101-104: Ohneiser et al. (2019) utilized magneto-biostratigraphic age models, integrating diatom records and geomagnetic reversals, to establish a chronology for sediment cores from the Ross Sea. In the RS15-LC47 core (this study), the Brunhes-Matuyama (B-M) reversal, dated at 773 ka, was identified at a depth of 1165 cm. Our study focuses up to the B-M reversal (773 ka), which is the only established magneto-biostratigraphic age marker for the RS15-LC47 core.

Line 120: You need to show the statistics associated with the line fits to see how strong the correlation is.

Yes, we have added line fits to all relevant figures. Although the R^2 values for some line fits are not particularly strong, there are still distinctive trends between the parameters. While the correlation coefficients may not always be high, the observed trends in the line fits offer valuable insights into the depositional processes and environmental changes along the Antarctic margin. We believe these trends are meaningful and reflect the inherent variability of the depositional environment.

LIne 120: I suggest making cross plots of MS vs biogenic opal and other parameters. I suspect the correlation biogenic % and Ms will be stronger then grainsize and MS.

We have followed the suggestion and plotted MS versus biogenic opal (Fig. 7b). Please refer to lines 387-391: “Opal content does not correlate with MS values (Fig. 7b), likely because Opal content lacks the high-frequency variations observed in MS in the studied core. In general, $Opal_{MAR}$ is influenced by opal deposition and their preservation, while opal content may be additionally affected by dilution with other sedimentary components, primarily lithogenic particles drift sediments.”.

Line 125: Ohneiser et al 2023 showed that the LR04 does not reflect ice advance and retreat pacing in the Ross Sea. δ18O is a globally mixed record and not region specific.

We have referred to Ohneiser et al. (2023) in lines 130-133. **“**

This lack of correlation may be attributed to the asynchronous nature of glaciation worldwide, as highlighted by Raymo et al. (2006). Consequently, this global signal in $\delta^{18}O$ may not accurately capture specific ice volume changes in the Ross Sea region or the expansion/retreat of the WAIS (Ohneiser et al., 2023). The studied core RS15-LC47 is too far from the ice margin and will capture a mixed oceanographic and ice sheet advance record”.

Line 125:You need to acknowledge here that LC47 may be too far from the ice margin and will capture a mixed oceanographic and ice sheet advance record.

We have acknowledged this fact. Please see the above reply.

Line 140: Strictly speaking these are no organic geochemical proxies since organic geochemistry implies analysis of carbo base organic molecules (alkenones, alkenes/anes.. other lipids etc etc).

We agree and have modified the term organic geochemical proxies section as geochemical proxies. Please see section 3.2.

Line 149. It would be good to demonstrate whether the visual correlation is real.. i.e. statistically.

We have done DTW analysis to the MS values of two cores to test their similarity (Supplementary material I). DTW is a robust statistical technique used to measure the similarity between two time series by optimally aligning their temporal sequences, accounting for potential shifts and variations along the time axis. This method is particularly suited to our data, as it allows for the alignment of similar trends even when minor temporal discrepancies exist, which is expected due to natural variability between cores in close proximity.

LIne 164. Need to provide a reference on where these broad climatic zones come from.

We have modified the lines. Please see caption of fig. 4. **“The broad climatic zones based on sedimentological and geochemical analysis are represented with coloured boxes”.**

LIne 170. refer to figure.

We have referred to the figure. Please see line no. 164.

LIne 189 - poor sorting?

We have included the suggestion. Please see line no. 179.

Line 193 - Ohneiser et al 2019 interpreted these thin gravel as lag surfaces which indicate enhanced current strength and winnowing. They likely provide a protective armoured surface once formed that prevents further erosion of underlying sediments.

We have added this interpretation. Thanks! Please see lines 183-185.

LIne 197 - what is meant by 'this temporal span'? this interval?

We have included the suggestion. Please line no. 190.

LInes 205-215. This reads like a collection of bullet points. It should be revised into a coherent block of text with references.

We have modified this section Please see lines 190 to 207. " This period is characterized by large scale expansion of the Antarctic ice sheets (McClymont et al., 2013; Sutter et al., 2019) and northward migration of the polar front (Kemp et al., 2010). During periods of full glaciation, the ice sheet extends to the outer continental shelf, restricting the Antarctic Slope Current (ASC) to a narrower slope (Conte et al., 2021). This confinement limits energy dissipation and water exchanges, potentially intensifying the ASC, which plays a crucial role in regulating Circumpolar Deep Water (CDW) inflow and Ross Sea Bottom Water (RSBW) outflow. During full glacial intervals, the expansion of the ice sheet across the Antarctic continental shelf is evident from the erosional surfaces in the sedimentary strata (McKay et al., 2012b; Bollen et al., 2022). In the Ross Sea sector, there have been multiple instances of the grounding line advancing toward the shelf break during glaciations since the Mid-Pleistocene Transition (MPT) (McKay et al., 2012b). The advance of the grounding line initiates sediment gravity flows and turbid plumes, which are funneled to the outer continental margin through the canyon networks (Fig. 5c; Larter and Barker, 1989; Lucchi et al., 2002). The presence of millimeter-scale faults observed within this interval indicates they are synsedimentary, likely forming due to the increased sedimentation associated with these turbid plumes. As the finer fractions of these flows settle, they are transported westward by along-slope currents, highlighting the combined influence of downslope sediment gravity flows and along-slope currents in shaping channel-levee systems along the Antarctic margin during glacial periods. This sedimentation pattern is further corroborated by the higher clay content, mass accumulation rates (MAR), and poor sorting observed at the study site during this interval (Fig. 4). Additionally, the increased sedimentation rates and harsh glacial conditions likely suppressed biological activity. The elevated and irregular magnetic susceptibility (MS) values observed during this period also suggest poor sorting, consistent with sedimentation dominated by gravity flows."

Line 214. McKay et al 2012 do not discuss winnowing of magnetic susceptibility.

Thanks for the suggestions. We have removed this sentence from the paragraph (Above paragraph).

LIne 260. Im not sure this is a correct statement. The AND-1B site is in a very different setting because it was grounding zone proximal with multiple grounding zone advance and retreat cycles directly over the site. LC47 is oceanic and has never been near the grounding zone.

Thanks for the suggestion. We have modified the section 4.1.3.

LIne 261 - where did temperatures increase by 1-2C°?

We have included the suggestion in the line no. 240-250. Ice sheet models and proxy records from the Antarctic continental margin indicate that, following MIS 11, interglacial temperatures increased by 1-2°C in the high latitudes of the Southern Ocean and Antarctica, leading to greater ice volume variability with smaller interglacial and larger glacial ice sheets (Sutter et al., 2019).

LInes 266-335- this discussion on Be data needs to be reviewed by someone other than me. Figure 6 needs some statistics to see how good the line fits are so the reader can deduce how robust the discussion and conclusions are.

We have added statistics to Fig. 6.

Lines 338 - most agree that the MPT was complete at around 800 kyr.

Please see below in the response of line 395

LInes 340 etc. the presented interval in LC47 does not extend older than MIS19!

Please see below in the response of line 395

Line 395. The record presented here does not cover the mid-pleistocene transition which is generally agreed to be complete at around 800 kyr. Please revise this section.

We have removed the discussion on MPT from the manuscript. Please see section 4.1.