Reviewer comment – EGUsphere Open Review

Manuscript: Sedimentary insights into organic matter alteration in Arctic Alaska's saline permafrost

General assessment

This manuscript presents valuable data on organic matter (OM) alteration processes in saline permafrost sediments from Arctic Alaska. The topic is highly relevant to understanding carbon cycling and permafrost-climate feedbacks in rapidly warming Arctic systems. However, the current version would benefit from clarification of sampling strategy, clearer data grouping logic, and an expanded discussion on the broader implications of saline permafrost thaw. Figures and tables could also be improved for interpretability.

Overall, the study has great potential, but the manuscript would be strengthened by addressing the following minor points.

Comments

(Lines 35–45)

Expand the discussion of how increased salinity can enhance ground warming, potentially accelerating carbon degradation. Clarifying this physical–biogeochemical linkage would strengthen the introduction.

(Section 2.21, Line 145)

It is not clear at this part whether only surface sediments or deeper permafrost cores were analysed. This is important, as surface layers are likely subject to strong mixing due to seasonal freeze–thaw dynamics.Please provide sampling intervals, total number of samples per core, and core depths. Without this, the representativeness of the dataset cannot be evaluated. Consider whether surface scouring or removal by groundfast ice might have influenced surface sediment preservation, as this could bias near-surface data (see Table S1).

Figure 1: Consider enlarging or dividing into two panels (e.g., adding a panel showing core depths) to improve readability and convey stratigraphic context. The current layout is difficult to read. Either enlarge the figure or add a second panel showing core depths to improve interpretability.

Table 3: The rationale for grouping samples after individual core analyses remains unclear. Please clarify the purpose and implications of this grouping, particularly why some groups were excluded from the PERMANOVA due to small sample sizes ($n < 5$). The statistical framework appears rigorous and well executed, but it becomes somewhat detached from the broader scientific narrative. Consider linking these statistical groupings more clearly to the ecological and biogeochemical processes

discussed elsewhere in the paper to ensure that the results contribute directly to understanding the mechanisms of organic matter alteration under different thermal and saline regimes.

(Lines ~535–580)

The discussion could be expanded to better situate the findings within the broader permafrost–climate context. At present, there is no information provided on lake surface areas or volumes, which would help to contextualize how these systems influence thermal forcing and potential greenhouse gas emissions. Including even basic estimates or references for lake morphology would strengthen the discussion. Moreover, while the manuscript effectively documents organic matter alteration across thermal and saline regimes, it stops short of linking these findings to methane production or carbon loss processes in saline permafrost environments. A qualitative discussion of how organic matter degradation under saline, unfrozen conditions may contribute to methane or CO_2 release would significantly enhance the manuscript's broader relevance. In addition, the term "availability" (around line 570) could be replaced with a more precise descriptor such as "degradation potential" or "reactivity" to better reflect the geochemical processes described. Finally, a clearer statement on why saline permafrost thaw is globally significant would be valuable—ideally supported by literature estimates of the spatial extent and carbon pool size of saline permafrost deposits. These additions would help connect the strong sedimentary and statistical analyses to the larger climatic implications of thawing saline permafrost.

Overall recommendation

This study presents a strong and well-structured dataset with great potential to advance understanding of organic matter alteration in saline permafrost systems. The manuscript would benefit from greater methodological transparency and clearer contextual framing to fully highlight its scientific importance. I recommend a minor revision focusing on the following key aspects:

Clarify the sampling design and rationale for data grouping, particularly in Table 3, to ensure the statistical analyses are clearly linked to the environmental processes being studied.

Improve figure readability and presentation (especially Figure 1) to better convey stratigraphic and spatial relationships.

Expand the discussion to more explicitly address the broader climatic implications of saline permafrost thaw, including its potential influence on methane production, carbon degradation, and Arctic greenhouse gas feedbacks.

Addressing these points would substantially improve the manuscript's clarity, coherence, and overall impact within the context of Arctic carbon cycle research.