Public justification (visible to the public if the article is accepted and published): Dear authors,

I have received three independent reviews of your manuscript. A first reviewer agrees with the changes made, while two reviewers still provide both content as presentation suggestions. Please address these minor comments, which will be addressed by the AE (will not need a separate round of reviews).

Best regards,

Cindy De Jonge, the AE

Author Response (AR): Thank you for this round of reviews. We have addressed all comments which have improved the content as well as the figures of the manuscript.

Report #1 Accepts as is

AR: Thank you very much for your support

Report #2

Reviewers Comment (RC): Dear authors, thank you for the article you have provided! This work addresses current issues of soil organic matter alteration in the Arctic, specifically under conditions of saline permafrost. The work was done at a high scientific level, however, I still have a number of comments on the text. There are grammatical and stylistic errors in the work that need to be corrected before accepting the publication.

Author Response (AR): Thank you very much for your feedback and support.

RC: 4.2, 4.3 sections - In this section, the authors actively use the term "degradation" of organic matter. It is necessary to clarify what you mean by degradation. For example, the C/N ratio is not evidence of degradation, it only indicates the degree of organic matter transformation, as well as CPI.

AR: We appreciate the reviewer's comment and agree that parameters such as C:N ratio and CPI do not directly demonstrate degradation, but rather reflect the degree of organic matter transformation and maturity. To avoid ambiguity, we clarified the terminology in the Introduction. We now define "degradation" in the context of microbial transformation toward a more mature state of organic matter. Specifically, we added the following sentence: "On this issue, Giest et al. (2025) recently quantified a stronger degradation signal (in the context of microbial transformation toward a more mature state) in saline deposits compared to non-salt-influenced sites using biogeochemical sediment analyses."

For the method description we added: "The C:N ratio is a common **indirect** indicator of organic matter degradation **if assuming a same source signal**, with lower values reflecting higher decomposition"

RC: Minor comments:

Line 34 Please provide the quantitative organic matter stocks, as these data are more informative.

AR: sure, we added "~1460–1600 gigatons" to this sentence now saying: "With~1460–1600 gigatons, the terrestrial permafrost region stores about three times as much organic carbon as global vegetation, which is vulnerable to mineralization with warming temperatures and permafrost thaw (Schuur et al., 2022; Strauss et al., 2025)"

RC: Line 80 Please indicate how much these variables have increased over this period.

AR: We added "by 1.1 °C decade $^{-1}$ and 23.1 mm decade $^{-1}$, respectively".

RC: Line 170 Was carbonate content analysis performed on the studied samples before TOC analysis?

AR: No, with the setup of temperature ramping the TIC is measured on the same run

Report #3

Reviewers comment (RC): This manuscript by Seemann et al. titled 'Sedimentary insights into organic matter alteration in Arctic Alaska's saline permafrost' investigates organic matter composition and degradation status across a thermal and saline gradient in northernmost Alaska. This study provides new insights into local organic matter dynamics in a transect covering drained lake basins, lagoons, thermokarst lakes and tundra. I suggest this manuscript for publication with the minor corrections addressed, see below.

AR: Thank you very much for your support and time invested in helping to improve our manuscript.

RC: General comments:

1. Could the authors visualize the correlations (C/N and d13C) in the supplement? Also, correlation analysis has not been mentioned in the method section (include relevant details such as which correlation analysis was used).

AR: Thank you, we added a correlation plot as Figure S1 to the supplement. Moreover, we added a sentence on how correlations were tested to the method section 2.2.3.: "Correlations between geochemical variables were assessed using Pearson correlation analysis.".

2. Could the authors add a supplementary table on the results of the Kruskal Wallis tests, and report test statistic, degrees of freedom in addition to only p-values (as now given in the text).

AR: Thank you for indicating the need to report comprehensively on the test statistics. We have added Tables (Table S9 and S10) to the supplement, including detailed information on the statistics. In this step, we removed Table 1 and 2 from the manuscript in order to not repeat this information.

3. Just a note that the discussion section tends to repeat the results making it a bit heavy to read, and could benefit from shortening in these terms. In the section '4.3 implications and outlook' the writing is more in the style of discussion and reads well.

AR: We have removed some results that were repeated in the discussion, in order to improve the flow. Also, we have addressed several minor issues on the writing in the discussion and throughout the manuscript.

RC: Minor comments (line numbers refer to the tracked changed document):

Line 42: Are the authors able to give an estimate of the extent of these saline deposits in e.g. km2? This would give the reader a better idea how significant these saline deposits are.

AR: Actually, this would be amazing, but reliable data on this is not published yet.

RC: Line 62: 'Biogeochemical analyses' sounds vague, why not just write 'using lipid biomarkers' as aren't those the main analyses showing degradation status in Giest et al. 2025?

AR: Thanks, changed accordingly.

RC: Line 67: Also citing some of the earlier biomarker work in the region would be appropriate here e.g., Goñi et al. 2000.

AR: Thanks, we added this citation to the manuscript.

RC: Line 69: As the authors say, these are widely applied so would be good to cite some of this work done outside your research group as well.

AR: Sure, we added Martens et al 2023 (https://www.nature.com/articles/s41467-023-37766-5) and Andersson et al. 2012 (https://www.sciencedirect.com/science/article/pii/S0146638012000952)

RC: Line 74: Should this be Utqiaġvik Peninsula (following the official name Utqiaġvik) instead of Barrow Peninsula? Using this name would also distinct your study area from Barrow Peninsula, Canada.

AR: Changed accordingly.

RC: L83: I suggest removing 'significant'

AR: Changed accordingly.

RC: Line 95: This sentence is a bit confusing, perhaps: ' Both lakes investigated in this study, West Twin …'

AR: Changed accordingly.

RC: Line 110: There is an extra g in 'Utqiaġvik'.

AR: Changed accordingly.

RC: Line 126: Were these cores kept chilled (if not frozen)?

AR: We added "thermoboxes" to this sentence.

RC: Line 135: The word 'treated' does not sound quite right, perhaps 'prepared' or 'processed' if that is what the authors mean.

AR: Thank you, we changed it to processed.

RC: Line 137: Perhaps use the word 'taken' instead of 'divided' or: 'sediment cores were subsampled in adjusted steps..'

AR: Thank you, changed to "sediment cores were subsampled".

RC: Line 162: The word treated does not sound quite right here either. It sounds like something was actively done to the samples, perhaps instead: 'All samples were kept at 4 °C.'

AR: Changed accordingly.

RC: Line 175: Presumably the Solitoc and N analyzer are from Elementar? Include this information.

AR: Yes, they are from Elementar. This information has been added.

RC: Line 190: I suggest writing ‘Alfred Wegener Institute (AWI)’ as mentioned here for the first time (not just abbreviation).

AR: Changed accordingly.

RC: Line 205: Add a reference for the standard acid-base-acid treatment. Not all readers might be familiar with this.

AR: Yes, of course. This is also based on Mollenhauer et al. (2021) which is now part of the sentence.

RC: Line 280: Are the groups based on thermal and salinity condition the same as mentioned above? Please clarify as now it sounds like new groups were created.

AR: We added some meta communication to the beginning of our result section: “The following subchapters are organized according to their geomorphological position. Chapter 3.2, by contrast, is structured based on thermal and salinity differences.”

RC: Line 288: Are these standard deviations that are given with the mean values (also elsewhere in this chapter)? Perhaps mention somewhere here or in methods how the results are reported.

AR: We added in the method section 2.2.3: “Mean values are reported alongside their standard deviations.”

RC: Line 298: Add correlation analysis in the method section.

AR: Added accordingly.

RC: Lines 307-311: Could the authors add standard deviations (if that is used in the paragraph above) also to this paragraph as now only means are given.

AR: Standard deviations are now reported in 3.1.2 and elsewhere.

RC: Line 464: Remove the word ‘much’.

AR: Changed accordingly.

RC: Line 482: Has the abbreviation ETL been introduced previously ?

AR: ETL is now written out to East Twin Lake.

RC: Line 487: Young radiocarbon ages? Add a description of the radiocarbon units .

AR: Well spotted. Referring to radiocarbon dates here is not of importance and is therefore deleted. Instead, salinity is the important fact here which is already mentioned.

RC: Lines 544-545: The CPI seems very similar in these lakes with only 0.7 difference. Can this be considered as stronger degradation??

AR: Yes, the CPI values are similar, but a difference of 0.7 can be considered as “signs for stronger degradation”. We adjusted the sentence accordingly.

RC: Line 545: This sentence is not clear. So, CPI is similar to Yedoma and stronger with other thermokarst lake sediments?

AR: now changed to “Compared to Yedoma and other thermokarst lake sediments, the CPI values indicate a similar degree of organic matter decomposition (Jongejans et al., 2020) or even stronger decomposition (Jongejans et al., 2021).”

RC: Line 553: I suggest replacing ‘near-significant’ with ‘non-significant’.

AR: Changed accordingly.

RC: Line 582: Should ‘and’ be ‘where’ instead? So saline deposits underlay Holocene deposits in permafrost uplands?

AR: Yes, thank you. Changed accordingly.

RC: Line 584: Could the authors give a rate for the active layer deepening here?

AR: This would be great. We changed the sentence to a more quantitative statement by including “with widespread thickening across >80% of northern permafrost regions since 2003”, but we would like to avoid inventing a single “cm per year” value unless you extract a region-specific trend from another paper, because Liu et al. stress strong spatial heterogeneity.

RC: Line 611: Is there a reference for these microbial community differences between the lakes?

AR: Thank you. There are no direct references for microbial analysis in these lakes. But Jenrich et al. (2024) and Yang et al. (2024) studied the consequences of a shift from freshwater to brackish water on microbial communities and found that methanogens and sulfate-reducers can co-occurre which intensifies GHG production. To be clearer here we added these references directly after the sentence you gave feedback on.

RC: Figures:

Fig. 1 Is the thermokarst lagoon here the same as the semi-open lagoon that is referred in the text (e.g., lines 103, 118). I suggest using the same name consistently.

AR: Yes, this is the same lagoon. In the text the “semi-open lagoon” is now always referred to as “semi-open thermokarst lagoon” For formatting reasons in the figure, we would like to keep it in the figure short (just thermokarst lagoon). Also, since Elson Lagoon is clearly mentioned in the figure, the difference between those two sites is clear. Some minor changes were made in the figure (color of Elson Lagoon symbol to match Figure 3. Coordinate style were adjusted).

RC: Fig 3. How about adding the core section units (I-V) to this figure as well?

AR: Due to the relatively low biomarker sample number, we have not included units to Fig. 3. In Figure 2, biomarker sample depths are marked, thus it is possible to follow in which unit which biomarker sample lies. Nevertheless, we revised Figure 3 to a more condensed version. In this new figure it is possible to better compare the biomarker results between the cores.

RC: References:

Goñi, M. A., Yunker, M. B., MacDonald, R. W., and Eglinton, T. I.: Distribution and sources of organic biomarkersin arctic sediments from the Mackenzie River and Beaufort Shelf, Mar. Chem., 71, 23–51, https://doi.org/10.1016/S0304-4203(00)00037-2, 2000.

AR: The reference has been added to the manuscript.