Response to Reviewer 1: TC-2023-70 by Allison Lepp et al. “Insights into glacial processes from micromorphology of silt-sized sediment”.

The comments of the reviewer are listed below with our responses below in *blue italics*.

Comments by tc-2023-70-RC1: Bradley W. Goodfellow <bradley.goodfellow@sgu.se>:

Thank you for the opportunity to review *Insights into glacial processes from micromorphology of silt-sized sediment* by Lepp et al. The paper reports a study of micromorphology of silt-sized quartz in meltwater plume deposits (MPDs) offshore of six presently and formerly glaciated catchments. The micromorphologies of the silt-sized quartz from these deposits are compared with those in glacial tills, which are assumed to represent the parent material prior to glaciofluvial transport to form the MDPs. The authors investigate micromorphologies to elucidate the dominant mechanism(s) of sediment transport by glaciers. The authors interpret their results as indicating that grain characteristics reflect mainly glacial abrasion, and that meltwater transport has made only a minor contribution to grain evolution. This information may provide a basis for inferences on glacial meltwater flow rates, distances, and pathways, which may also inform paleoglaciology and paleoclimatology.

I believe that the authors have completed an innovative study that could be of general interest to the glaciology community. I also thought that the results were well presented in the Figures. However, there is a large opportunity to improve the presentation of the study, including especially its key findings, through addressing important issues with the writing. At present, the key findings are not clearly and simply stated. In particular, the Abstract, Introduction, Methods and Conclusions are afflicted by a lack of clarity. The presentation of the Results and the Discussion is clearer. The main issues contributing to a lack of clarity are frequent grammatical errors, long and complex sentences, being indirect in the presentation of information, and frequent gaps in logic. It is this latter point that is probably the most critical to address in a future revision. The Introduction could **better establish the key relevant micromorphological features**, including a brief overview of the relevant mechanical work that appears (too briefly) in the Discussion. What might seem clear to a glacial sedimentologist is not necessarily clear to a more general reader and, as a non-sedimentologist, I felt that there are many important gaps in logic in the present

manuscript. My general impression is that it is presently difficult for the reader to 'distinguish the forest from the trees', which is a pity because it detracts substantially from what I believe has been a good study.

I have appended a marked-up version of the manuscript with detailed comments and suggestions for improvement to the manuscript. Many of these are minor, but I am of the view that substantial rewriting would greatly assist the presentation of this study.

We thank Dr. Goodfellow for their review of our paper and for highlighting many areas of text that can be improved for readability and for logical flow. We will gladly incorporate their line-by-line editorial suggestions and prompts for additional details or information into the revised manuscript. Please find below a synthesized response to Dr. Goodfellow's comments, arranged by manuscript section:

***Abstract**.*
The revised manuscript will incorporate the reviewer's editorial suggestions. Longer sentences will be broken into two or more shorter sentences for improved readability. We will use direct language to more clearly introduce the experimental objectives (as suggested at L25) and to better connect our results to our interpretations (e.g., as suggested at L28). Text discussing microtexture work will be modified for a more general audience as suggested (e.g., L29), and key implications of the findings will be more explicitly phrased as also suggested by R2. We will remove text about till maturity from the abstract and focus the implications on the relative magnitude of meltwater drainage events and the input of supraglacial meltwater to the subglacial environment.

Introduction.
The reviewer has highlighted several opportunities to improve the readability and make the manuscript more accessible for Cryosphere readers. We will revise the introduction to introduce microtexture analysis with more detail and briefly detail some surface textures associated with the relevant sediment transport processes.

Regarding the reviewer's request for additional information on the subglacial geology of the sites in section 1.1, we acknowledge that readers will likely be curious of site-specific details beyond what is presented. We also acknowledge, however, that the level of detailed understanding available at some sites (e.g., Thwaites and Pine Island glaciers, which have been heavily surveyed) does not exist on a continent-wide scale. We will prioritize including additional references and details for other sites as available, with an emphasis on grain-size details requested by R1.

Additionally, the reviewer identified the term "glacial system" as being ambiguous (R1 comment at L35 and throughout). We use "glacial system" throughout the manuscript as an umbrella term to refer to a glacier and its relevant (and variable, in this study) components. These components may include an ice shelf or ice cliff, portions of streaming ice and non-streaming ice, etc. While "glacial catchment" is not necessarily inclusive of floating extensions of land-based ice, we will substitute "glacial system" with "glacial catchment" throughout the text, and specify floating ice as needed.

Materials and Methods.

An important issue that R1 and R2 raised is the need for us to more clearly justify and distinguish how and why we incorporate ice-proximal diamicton. The samples we include and identify as ice-proximal diamicton may be better characterized as grounding-zone proximal diamicton. The Pine Island Glacier diamicton was collected via hot water drilling through the Pine Island Ice Shelf (PIG-B; see Smith et al., 2017 in Nature) as well as from the same coring location via ship following a 2020 calving event (NBP20-02 KC26; see Comas et al., 2022, AGU Abstract Bibcode: 2022AGUFM.C32E0878C). The Thwaites Glacier diamictons (JGC11, JGC17, KC04, KC23) were collected from previous pinning points of the Thwaites Glacier Tongue and (JGC17 and KC04) and from ice-marginal settings (JGC11 and KC23). In all instances, the aforementioned diamictons are interpreted to have formed predominantly through mass flow deposition. Given the core sites and facies interpretations, it is likely that the matrix material in the diamicton primarily consists of recycled subglacial material rather than melted out englacial debris and therefore is appropriate for both (1) merging with subglacial till and (2) comparing against MPDs when no till is available. We will present these important details into the revised manuscript and will replace "ice-proximal diamicton" with "grounding-zone proximal diamicton" throughout to more accurately reflect the depositional environment.

In addition, the reviewer has identified aspects of the methodology that require further context for a more general audience, notably in section 2.2. We will gladly revise the manuscript to include details of grain shape measurements, and more context for why quartz is preferred for microtextural analysis (quartz grains are targeted for microtexture analysis because of their prevalence across depositional environments and their mineralogical resistance to weathering).

Results.

Reviewer suggestions in the Results section are limited to minor recommendations, which we will gladly incorporate into a revised manuscript.

Discussion.

The reviewer has raised the need to clarify terminology and discussion of the reference materials used (basal ice debris from Siple Dome ice core, supraglacial cryoconite from Qaanaaq Glacier, and fringe ice debris from Pope Glacier). To address this request, we will add additional text to section 4.1 to distinguish till that was deposited subglacially and sampled from marine sediment cores from the other samples which, as the reviewer notes, can also be considered as tills though not deposited subglacially. We will also more clearly describe how the sediment transport processes in these settings differ from one another and how those differences manifest in grain shape and surface textures. The modifications to the Introduction as described above will address other comments from the reviewer, notably around microtexture assemblages and subglacial sediment transport (comments at L365-L368 and L381-L382).

We will gladly take into account the other editorial and suggestive comments from R1 throughout the Discussion.

Conclusions.

The reviewer has identified portions of text in this final section that can be improved for clarity and logical flow. We will adjust the text accordingly in the revised manuscript to more clearly state the implications of our findings and re-phrase or re-write text that is unclear.

Figures and Tables.

We appreciate the reviewer's feedback on our figures and tables, and we will integrate their suggestions into the revised manuscript.