

Response to Reviewer 2: 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-RC2: Anonymous Referee:

Abstract

Is clear and well-written; possibly lacking in impact/significance at the end i.e. why is this research so important and how will it help future analyses of these types of deposits...and what will that mean for reconstruction purposes or for better understanding processes.

We appreciate the reviewer's suggestions to improve the abstract. We will modify the abstract conclusion to better emphasize broader implications (also addressing the reviewer's recommendations at Lines 401-402).

Introduction

Intro is well written and concise; again more significance/impact needed; other minor comments within the manuscript itself.

We will incorporate the reviewer's editorial comments in the Introduction. We appreciate their suggestion to restructure the Introduction by shifting text discussing the broader significance of the study to the end of the section.

Materials and methods

Not sure why till and ice-proximal diamicton deposits are considered to be the same in terms of sediment transport processes and thus grain textures; sec 2.1 needs references; see other comments within the manuscript itself.

Additional references will be added to Section 2.1 for grain-size analysis and to Section 2.2 on microtextural analysis. We note that, for the latter, the scarcity of references is due to the novelty of our analysis; though a plethora of studies have used SEM to examine microtextures on glacial grains, this has exclusively been done on the sand fraction.

We thank the reviewer for identifying the need for us to better explain the depositional context from which the ice-proximal diamicton were recovered. We recognize that existing works have identified ice-proximal diamicton that comprises hemipelagic muds reflecting biogenic rainout and current-transported sediments, with varying concentrations of ice-rafted debris. In these instances, IRD may have been mobilized from the ice-sheet interior predominately as englacial debris and may have experienced little to no subglacial transport.

The samples we include and identify as ice-proximal diamicton may be better characterized as grounding-line 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 less than two weeks after a calving event in 2020 (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. 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 remobilized 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 the text to more accurately reflect the depositional environment.

Results

The main issue with the description of the results is that it is unclear what deposits the grains have come from for each of the different site locations – MPD or till? Just please remind the reader throughout. Also, there is no real mention of the results of grains from ice-proximal diamictons – presumably because (according to an earlier sentence in the methods section) the till and ice-proximal diamicton results have been merged together?? But it remains unclear why this is, why not just keep them separate, since they are entirely different kinds of deposits? There seems to be some inclusion of interpretations (the bit about how the local geology may reflect some of the grain results) when this info is probably better off in the discussion?

The reviewer's suggestions to improve the results are appreciated, and we feel their request for clarity around which grain populations are being described is well justified. The reviewed version of the manuscript will be structured to first describe grain-shape distributions for both grain populations by region, and then consider shape distributions by deposit type. We will be sure it is clear which type of deposit and which region is being discussed throughout.

We hope that our response in the Materials and Methodology section above adequately addresses the reviewer's concerns over our use of subglacial till deposits and grounding-zone proximal deposits. We note that the only region for which till grains and grounding-zone proximal diamicton grains are considered together is Pine Island Glacier. Grounding-zone proximal diamicton grains are considered in place of till for Thwaites Glacier, where subglacial till has not been recovered.

If this added clarification still presents concerns with the study and should the editor request, we will modify the sample list to remove grounding-zone proximal diamicton from the Pine Island Glacier samples. We could also include a supplemental figure to illustrate the comparability of grain-shape distributions of subglacial till and grounding-zone proximal diamicton.

Discussion

In general, there is a lack of reference to the actual sites/results from this study – would like to see the results and sites more systematically dealt with within each sub-section of the discussion. Many sentences in the discussion are not worded very well, the writing style could be tightened up significantly.

4.1– Geological differences at each site are not explained anywhere – what is the local geology for each site? this section is really difficult to follow since there is a lot of information that the reader is assumed to know (but doesn't know); see comments within the Ms itself on where and how to make sentences clearer

Both R1 and R2 request additional information regarding subglacial geology of the study sites. We include in section 1.1 of the introduction an overview of geological differences in these regions, but we note 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 and, as requested, better integrating the influence of regional geology on grain morphology into the discussion.

Additionally, we will follow the reviewer's suggestion to shift text from the Results section (L235-249) to the Discussion. The remaining comments from the reviewer will be considered in the revised manuscript.

4.2 – this reads much better than section 4.1; it tells the reader what has been seen (from these results) and what they mean (whereas 4.1 fails to do that)

We will integrate the comments from the reviewer into the revised manuscript.

4.3 – is fine, see comments within.

We will revise the manuscript to include additional details and more clear explanations as requested by the reviewer in section 4.3. Regarding their comment at L434, we note that the sentence indicates MPDs consist of grains with more rounding and regularity than both subglacial till grains and grounding-zone proximal diamicton grains. Given the aims of the study do not include considering how grain micromorphology may be altered via sediment gravity flows on the downstream side of grounding zones, we do not feel the request to consider these groups separately is within the scope of the paper.

4.4 – needs clarification in place, see comments within.

The reviewer has identified a need to use more specific language when discussing our results in the context of paleo-subglacial hydrological conditions. We thank the reviewer for identifying several instances where we can replace broad language with more specific results. We will incorporate these suggestions into the revised manuscript which will improve readability.

Conclusions

Might be better off as bullet points? See comments within.

We will gladly incorporate all of the reviewer's suggestions in the conclusion into the revised manuscript. We will defer to the editor regarding either a bullet-point or paragraph formatting of the conclusion.