

Clim. Past Discuss., author comment AC2
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Reply on RC2

Raisa Alatarvas et al.

Author comment on "Heavy mineral assemblages of the De Long Trough and southern Lomonosov Ridge glacigenic deposits: implications for the East Siberian Ice Sheet extent" by Raisa Alatarvas et al., Clim. Past Discuss., <https://doi.org/10.5194/cp-2021-111-AC2>, 2022

Response to RC2

We appreciate Leonid Polyak's very detailed comments and suggestions on the manuscript. We are thankful for the chance to adjust the manuscript according to his comments and suggestions. Comments and suggested references are valid and constructive.

Response to major comments:

Comment: In particular, a lack of samples from the LR core above the MIS6 diamicton doesn't allow for a comparison with interglacial/deglacial environments and with the ESS cores, which represent different geographic, depositional, and possibly stratigraphic settings. Also, the ESS shelf record is poorly represented by just two samples from the last deglaciation.

Response: We now specifically concentrate on correlating diamicts between the studied cores and improve our interpretations. This is actually the primary aim of this study. Our sample set in 24-GCI is useful to do compositional comparison between diamicts and overlying sediments and not for detecting several transitions from glacial to interglacial.

Comment: In addition to the new data, the paper provides a compilation of potential source rocks, which is useful both for this and future provenance studies in the region. It would be more logical, however, to present this information in the Study Area section rather than in the Discussion.

Response: A compilation figure and table of the potential source rocks is now presented in the Study Area section.

Comment: The discussion is not well structured and can be difficult to follow, especially without a graphic summary.

Response: The discussion will be structured better, and a summary table or graphic summary added.

Comment: The discussion in section 5.3 is even more confusing as the interpretation of

the new data is mixed with inferences from or attributed to prior studies, lumped together in one paragraph. At the same time, depositional environments and processes are not adequately explained

Response: Depositional environments and processes of diamicts will be explained as a separate paragraph within section 5.3. At the same time relevant references can be added.

Comment: Identifying the ice-sheet provenance from the data under study is problematic as sediment delivered by ice directly from the mainland may not be easily distinguishable from sediment redeposited from the shelf. This task is even more complicated by multiple mechanisms of glacigenic sedimentation, such as subglacial till, proglacial debris flows, icebergs, etc. As these processes are not identified or even discussed in the paper, I don't see how the authors can reconstruct the ice origin.

Response: Depositional environments and processes will be discussed more adequately as a separate paragraph including identification of different glacigenic processes for generating diamicts.

Comment: The inference on different sources for glacigenic sediments in cores from the DLT and LR is more convincing and informative. However, it raises questions too. Most important, the SW provenance of the MIS6 diamict in the LR core is inconsistent with the direction of the eroding ice flow indicated by the seafloor bedforms (Jakobsson et al., 2016). One possibility is that the erosional event is not reflected in the sedimentary record (hiatus), while the diamict was deposited from icebergs. In any case, this issue needs to be discussed.

Response: This is a good notice. The SW provenance of the MIS6 diamict in the LR core and the direction of the eroding ice flow indicated by the seafloor bedform will be discussed. Regarding the 'SW sources', there are a couple of options here aside from different transport/re-deposition processes. In the paper by West et al., 2021 he shows that the base of 29-GC may not be the actual glacial diamict associated with scouring of the Ridge, but a later one, maybe break up and large-scale iceberg inputs. This opens the door for more SW sources of material being transported there. This will be added to the discussion.

Comment: References are limited. Only studies of heavy minerals are used for discussing the ESS sediments, while papers dealing with other mineralogical aspects could provide a more comprehensive context (e.g., Washner et al., 1999; Viscosi-Shirley et al., 2003; Nwaodua et al., 2014; Ye et al., 2020). Relevant studies of the distribution and composition of glacigenic deposits at or adjacent to the ESS margin are also missing (e.g., Schreck et al., 2018; Joe et al., 2020; Ye et al., 2020). A broader Arctic Ocean context can be derived from recent provenance papers (e.g., Dong et al., 2020; Xiao et al., 2021).

Response: References will be added for other mineral aspects supporting interpretations of heavy mineral distribution. The distribution and composition of glacigenic deposits at the ESS margin will be added compiled with the results from the Polarstern cruises.

Response to additional comments:

Comment: In Abstract; "This study concentrates on defining the mineralogical signature and dynamics of the ESIS (p. 1, lines 16-17)". This statement is misleading. The study deals with mineralogical signature of sediments from the ESS margin. Whether it reflects the ESIS provenance is a matter of interpretation, even more so for the ice-sheet dynamics.

Response: The study will mainly deal with mineralogical signature of sediments from the ESS margin.

Comment: In Introduction; "... previous studies have suggested the existence of ice sheets over parts of the East Siberian continental shelf during the larger Pleistocene glaciations following the mid-Pleistocene transition (Colleoni et al., 2016; Niessen et al., 2013), the Saalian (Marine Isotope Stage 6) (Jakobsson et al., 2016)" (p. 2, lines 2-4). This statement is inaccurate and confusing. Are we talking about multiple glaciations or just the MIS6? And where does the MPT come from? While there is evidence for a very large impact of the MIS6 glaciation on the Arctic, we do not know whether it featured the largest ice sheet on the East Siberian margin. Niessen et al. (2013) demonstrated glacial seafloor features in this region but have not constrained their age. Later studies suggested a very extensive glacial footprint in at least some parts of the East Siberian and Chukchi margin for MIS4 (Schreck et al., 2018; Joe et al., 2020; Kim et al., 2021).

Response: This statement will be revised for the suggested glacial extents.

Comment: In Materials and Methods; What is the point for a detailed description of seismostratigraphy? These data are not used in the paper.

Response: The description of seismostratigraphy will be shortened and condensed. Overall, description of seismostratigraphy can help correlation between the studied cores.

Comment: In Discussion; What are "our mineral assemblages" (p. 13, line 19)? Please be specific - What is "the eastern sector of the East Siberian Ice Sheet" (p. 13, line 27)? So far, the extent and configuration of this, largely hypothetical ice sheet is very poorly understood. What can be inferred from the data is that the mineralogical signature indicates delivery from the eastern part of the ESS.

Response: "These results can be detected also within our studied heavy mineral assemblages." It is accurate, that the mineralogical signature indicates only delivery from the eastern part of the ESS.

Comment: In Conclusions, "This suggests that due to dynamics of the ice flow and deposition the glacial ice not only grew out from the East Siberian shelf but also from the New Siberian Islands and westerly sources" (p. 14, lines 10-11). How could the ice sheet grow from the new Siberian Islands, if it was advancing on the islands from the north (Nikolskiy et al., 2013)? And what are the "westerly sources"?

Response: This sentence could be revised, and the following references taken into count. "There could have been a smaller local ice cap developed over the De Long Islands during a stadial of MIS 5 (O'Regan et al. 2017)." "The ice stream occupying the DLT was likely connected to glacial ice over the De Long and New Siberian Islands (O'Regan et al. 2017)." Westerly sources relate mostly to the Laptev Sea.

Comment: In Terminology; I don't think the "Central plateau" is a good term for the study area as the entire East Siberian shelf is pretty flat. This term has been used indeed by Naugler et al., 1974, but it doesn't make much geomorphic or geological sense. More generic terms like "inner shelf" or just "shelf" would be more appropriate.

Response: More generic terms like "inner shelf" or just "shelf" can be seen appropriate.

Recommendations: Overall, I believe the MS requires a considerable revision. Ideally would be to investigate a few more samples to fill the gaps in the sedimentary record under study, notably from post-MIS6 sediments in the LR core and from the Holocene on the ESS shelf. However, I understand the practical constraints. The text, especially the

Discussion, needs to be better articulated, with a clear delineation of inferences from the data reported and a more comprehensive and to the point use of information from prior studies. A summary figure would be very helpful for following and comprehending the interpretation. The conclusions, abstract, and the title need to be coherent with the data-based interpretation. An accurate title would be something like "Heavy mineral provenance of glacial deposits at the East Siberian margin, Arctic Ocean".

Response for recommendations: There is no specific need for few more samples as detecting several transitions from glacial to interglacial is not a target in this study. We specifically concentrate on correlating diamicts within each studied core and improve our interpretations for existing glacial processes and diamict provenances. The text can be articulated better, and more accurate title will be considered.

Cited references:

O'Regan, M., Backman, J., Barrientos, N., Cronin, T.M., Gemery, L., Kirchner, N., Mayer, L.A., Nilsson, J., Noormets, R., Pearce, C., Semiletov, I., Stranne, C., Jakobsson, M.: The De Long Trough: a newly discovered glacial trough on the East Siberian continental margin. *Climate of the Past*, 13, 1269–1284, <https://doi.org/10.5194/cp-13-1269-2017>, 2017.

West, G., Alexanderson, H., Jakobsson, M., and O'Regan, M. Optically stimulated luminescence dating supports pre-Eemian age for glacial ice on the Lomonosov Ridge off the East Siberian continental shelf. *Quaternary Science Reviews*, 267, <https://doi.org/10.1016/j.quascirev.2021.107082>, 2021.

Please also note the supplement to this comment:

<https://cp.copernicus.org/preprints/cp-2021-111/cp-2021-111-AC2-supplement.pdf>