

Responses to reviewer #1

Thank-you for the positive comments and pointing out the grammatical and linguistic changes that could improve the manuscript. Below we outline how we have/will address each of these.

1. Lines 85 to 90. Can you just say how long the fjord is and how long the ice tongue is? These details can be stated more clearly.

This depends on where we place the landward, sub-ice limit of the fjord. This is not 100% straightforward. We had originally referenced the length of the fjord with respect to the ice tongue terminus: *"Sherard Osborn Fjord is ~17 km wide and extends ~55 km from the ice tongue margin of Ryder Glacier out towards the Lincoln Sea. Ryder Glacier is currently grounded below sea level, with the grounding zone located ~26 km landward of the ice tongue terminus"*

However, we agree that this could be clearer, and can use the modern grounding zone position as a reference. Therefore we can write: *"Sherard Osborn Fjord is ~17 km wide and extends ~81 km from the modern grounding zone of Ryder Glacier out towards the Lincoln Sea. Ryder Glacier is currently grounded below sea level, with an ice tongue that extends ~55 km from the grounding line out into the fjord"*

2. Line 88. Instead of sills 'dissecting' perhaps say 'crossing'. I don't think dissecting is quite right.

We have made this change.

3. Line 89. Define what you mean by 'overdeepened'.

'overdeepened' has been removed. The sentence now reads: "These sills bound a basin that has a maximum depth of 890 m"

4. Line 141. Delete 'that extent'.

Yes, this has been deleted. Not sure why it was there in the first place.

5. Line 150. Replace 'exerting' with another word...'exhibiting'?

Changed as suggested.

6. Line 162. Delete 'a'.

Yes, this is deleted.

7. Line 167. Replace 'highly lithified' with 'compacted' or 'consolidated'. It has not been formed into rock so is not lithified.

We have changed to 'consolidated'

8. Line 214. Delete 'the'.

Yes, we deleted this.

9. Line 221. Is the piston core just the 'reference core'? I don't know why it is called 'undistorted'. That seems unlikely actually, and the word is not needed.

The reviewer is correct, the word is not necessary and slightly misleading. We have removed 'undistorted'.

10. Line 229 under radiocarbon dating. I suggest you use *Cassidulina neoteretis* throughout and cite Cage et al., 2021 <https://doi.org/10.5194/jm-40-37-2021> which is a paper that clearly shows how to identify *C. neoteretis* and *C. teretis*.

We have changed the name throughout the paper to Cassidulina neoteretis and refer the readers to Cronin et al. (2019) and Cage et al. (2021) for discussions of this foraminiferal species in the Arctic and Nordic seas respectively.

11. Line 230. What benthic foram species were included in the mixed benthics. These appear to be older than the single species dates on *C. neoteretis*. It is important to present the species dated. If Miliolid species were included in the dated material (e.g. *Triloculina* or *Quinqueloculina*) this can explain the too old results. Hopefully the specific contents of the mixed benthic dates was recorded and can be reported here. It is useful information to guide future chronological studies.

Although Miliolid species were present, they were not used in the mixed benthic dating. We have added what species were included in the mixed benthic samples. These include C. neoteretis, C. reniforme, O. tener, E. excavatum clavata. We have included this in the manuscript. Unfortunately, we do not have details on the exact composition in each sample.

12. Line 260. *Neoteretis*.

This has been corrected throughout Table and C. neoteretis is now used.

13. Line 266. Delete double s in cores.

Spelling mistake is fixed.

14. Line 271. Is it diamict or diamicton. I think diamicton is correct.

We have changed to 'diamicton' throughout.

15. Line 280. Is deformation beneath grounded ice the only way to get deformation? Can this deformation be due to coring or slumping? I am not contesting that the unit is subglacial in origin.

The reviewer is correct in that deformation in sediment cores can occur from numerous causes including coring deformation and mass transport/gravity flow deposits or glacial deformation. In this case, it does not appear to be coring induced, as the interval is found in the middle of a core section and has abrupt upper and lower contacts with laminated sediments and a massive clast-supported diamicton respectively. While a transition from a massive diamicton, to a deformation till to grounding-zone proximal laminated meltwater influenced sediments makes perfect sense, we cannot rule out gravity-driven deposition.

In the revised manuscript we can remove the interpretation from this sentence and include it at the end of the paragraph (as reviewer 2 suggested). In doing so we will acknowledge that it can either have been deposited beneath grounded ice (deformation till), or proximal to the grounding line (gravity flow deposit). This will not influence our glacial reconstructions in any way, but is a more honest interpretation of the data.

16. Line 326. Suggest you delete 'Across Sherard Osborn Fjord' and just begin the sentence with LU4.

This has been changed accordingly.

17. Or you could say 'Throughout Sherard....'.

We have changed 'Across' to 'throughout'.

18. Line 430. Delete one l in Fulford.

Corrected spelling mistake.

19. Line 480. Not clear what 'become cut-off from the main fjord' means. Does it mean the ice retreated onshore?

We had originally followed this sentence with a more detailed explanation of what we meant. However, We can improve the clarity by simply removing 'far enough inland to become cut-off from the main fjord ' since the following 3-4 sentences describe how we believe the inland retreat would result in the slow deposition of the diamicton of LU3.

*Therefore the new opening sentences of this paragraph will be changed from:
"The explanation that best fits evidence from terrestrial field studies, and the overall facies succession, is that the condensed diamict of LU3 was deposited when Ryder Glacier retreated far enough inland to become cut-off from the main fjord. In Sherard Osborn Fjord, a relatively deep, isolated marine embayment exists behind a prominent topographic high lying 40 km inland of the modern grounding zone (Fig. 11)."*

To:

"The explanation that best fits evidence from terrestrial field studies, and the overall facies succession, is that the condensed diamict of LU3 was deposited when Ryder Glacier retreated inland. In Sherard Osborn Fjord, a relatively deep, isolated marine embayment exists behind a prominent topographic high lying 40 km inland of the modern grounding zone (Fig. 11)."

20. Lines 515, 525, 565 suggest you refer to Detlef et al., in review, which provides important sea ice reconstructions and marine conditions for Petermann Fjord over the same time period. See <https://doi.org/10.5194/tc-2021-25>

We have not drawn comparisons with Detlef et al. (2021) that is also undergoing review at this time. There are a number of mutual co-authors on these papers so we are very aware of the work. Similar biomarker-based reconstructions of sea ice are being conducted on Lincoln Sea and Sherard Osborn Fjord sediments. We feel it is better to wait until these results are ready before a more detailed analysis of regional sea ice conditions is undertaken. Furthermore, we feel it is generally better to reserve citations to manuscripts that are accepted, and since these are both going through review at the same time, this is a bit tricky.