

Review of Bierman et al., "Scientific history, sampling approach....Camp Century...."

Responses to reviewer comments are in italic below

I enjoyed reading this manuscript. It's an informative paper and provides some important background and context for the ongoing, and potentially future, analyses of the Camp Century subglacial sediment core. It is a little unusual in that significant parts of it are in a narrative style but I think in this case it is entirely justified. For the samples to be most useful their origin and handling need to be absolutely clear and the authors have done a significant service in doing the 'detective work' to track down much of this information. This information will be useful to anyone wanting to work on the material, and I suspect this paper will be their first port of call before starting, and indeed I would expect Figure 8 to be widely cited and reproduced.

Thank you for considering and appreciating the need to document the core and its provenance and handling

The primary analyses reported (mainly summarised Fig 8) are useful in and of themselves for understand the material and its origins and so there is a clear and original research contribution as well as the documenting of process and history.

The paper is original and within scope of The Cryosphere. Methods are appropriate and results are appropriately discussed with excellent use/citation of previous literature. The abstract is a good summary of the paper. The paper makes a contribution to our understanding of sub-glacial sediment form a near-unique physical archive, and is of broad relevance.

I have provided minor edits on the attached pdf but the text is generally clearly structured, well-written and figures and tables are to a high standard.

Other more discursive queries and comments below:

Line 69 – all of the other four sections in this paragraph explain the purpose of the section, except the first one. So could add clause after 'sub-glacial sediment', along lines: "...in order to provide clear context and documented handling information for ongoing and future analyses"

This is a good suggestion and we have adopted the proposed wording

Table 2:

- Formatting probably needs grid lines to line up entries/rows more clearly. At present some of the relationships between entries in different columns are ambiguous without going to Fig 4. (this also applies to Table 3)
- Line 150 - What subtraction error are you referring to? I can see what look like a number of differences between values in Column 3 and Column 4.
- In the table what is the meaning of the apparent reversal in depth of core (column 4) in core tube 1058? Depths in tube 1057 reach 1373.5 and then a sequence of 1374.69 and 1371.92 (i.e. a reversal) before 1373 in tube 1059

We will adopt the suggest to use grid lines for clarity of allowed by the editors. We will reword the table to more closely reference figure 4 from which the table is derived. The apparent reversal referred to by reviewer is present in figure 4 and likely is the result of transcription/subtraction errors to which we refer in the ms and about which the reviewer comments. We will clarify the text in response to this comment.

Table 3:

- Please define all the institutional acronyms (final column) in the caption.
- Count 25 – thermal state reads ‘Frozen and’. And what ?
- This table could be improved by ordering rows by the sub-sample a,b etc. This would also have benefit of more closely tying it to text and Fig 6.

We will define all acronyms, remove the “and” which was a typo. We disagree about reordering the table believing it is more clear to sort by analysis as is currently done.

Length of core and post-depositional changes

- Line 393 –. The statement on difference of core length between 3.55 and 3.44m is left unexplained or perhaps implicitly might be seen as suggesting an earlier mis-measurement. But I was struck that the difference is only ~3% and visual comparison of the 1972 and 2021 photos suggests that there has been substantial changes to the segments: for example there is much more surface relief, larger surface grooves etc on several of the segments when photographed more recently. I think this raises the possibility that as well as partial thawing noted in the text that there may have been other long-term changes perhaps caused by sublimation-induced drying out and shrinkage. If

so this could explain the 3% difference in length without a measurement error.

This is an interesting and important thought and we will add it as a possibility to the paper.

Figure 8

The missing sections (e.g. 1063-3) are displayed in the stratigraphic log with an assigned brown colour when they should be blank.

We will make this change.

Magnetostratigraphy

I note that 6 samples were judged to have been stored upside down. Given the comment on development of a viscous remnance during storage (line 472), it would be helpful to see a comment if there is any difference/anomalies in the magnetic measurements for those samples.

We address these two comments together:

The 3 samples that may represent genuine reversed polarity intervals are 1061-D1, 1061-D3, and 1062-3*, where * indicates samples that were stored upside down. Other samples display negative inclinations at just one AF level, which is likely noise (for example 1063-8), or the trend appears to be shallowing and would likely shift to positive inclination if higher AF demagnetization levels had been applied (for example 1063-4). The following patterns are the basis for suggesting potentially robust reversed polarity:*

- *Sample 1061-D1 shows a near vertical inclination at the NRM step (0 mT), then swings to negative values following AF demagnetization. This is consistent with a viscous overprint in the vertical direction, which could represent either a drilling overprint or a storage overprint, which is removed at the 10 mT AF demagnetization level.*
- *Sample 1062-3* shows shallow positive inclination at the 0 mT level, which becomes progressively more negative at the 10 mT and 20 mT steps. This similarly suggests removal of an overprint in the same sense as 1061-D1.*
- *Sample 1061-D3* displays consistently negative inclinations at the 0, 10, and 20 mT AF levels, suggesting no overprint.*

There is no systematic behavior in the AF demagnetization behavior of the 5 samples that were stored upside down (a 6th sample stored upside down was a pilot sample in Christ et

al., 2021 and was not sampled for paleomagnetic work). We observe steepening and shallowing of the inclination in these samples as well as noisy behavior. There are no systematic differences between the samples stored upside down and the rest of the sample set.

We will add the following text to end of section 4.4:

"The majority of our samples display positive inclinations, consistent with normal polarity, with the possibility of 3 reversed polarity or excursion intervals in Units 1 and 2 recorded in samples 1061-D1, 1062-3, and 1061-D3. Although the AF demagnetization data are limited, these samples display inclinations that become progressively more negative at higher AF levels, consistent with removal of vertically downward overprint, or inclinations that remain moderately negative at all AF demagnetization levels."

Other analyses

Is there a reason why there is no analytical pathway for microbiology (cf. micro-paleontology). Subglacial biology is of course an area of huge interest and the omission was notable. Was this due to a judgement that the lack of a sterile handling chain over 50 years rules out meaningful or robust analyses on these core samples ? Or another reason? A sentence or two on this might be helpful.

There is a microbiology pathway in table 3 (11,12,15) and in figure 8 (microfossils and pollen) and we are making such analyses including environmental DNA. We will clarify this during revision.

Data from Christ et al., 2021

Line 537 introduces an age constraint that has not been previously discussed. Given the usefulness and likely reproduction of Figure 8 is it worth adding an annotation to figure or comment in caption on likely age ranges of top and bottom (pilot) samples, taken from Christ et al.

Good suggestion, we will implement in revision.

Future availability of samples

Given the statement in Line 70 on approach to sample distribution I was expecting something explicit towards end about availability of material. Had the authors considered including something, perhaps in code/data availability, on how other groups might get hold of some of these materials, especially if they can suggest collaborative/novel analyses? Who would they speak to ? Who decides on what

happens to the material ? And if not are all these analyses already planned to be undertaken by the institutions noted in final column of Table 3?

This is a useful addition to the ms and we thank the reviewer for suggesting it. We will add text explaining that the archive half of the core remains in Copenhagen and will be accessible for those wishing to do further analyses upon application to the ice core facility there and a plan for collaboration with Danish scientists. Similarly, material presently in the US will be sent to the US Ice core facility for preservation and future distribution under similar protocols after current NSF funding ends, that is approval of a sample request proposal and collaboration with US scientists.

All of the analyzed in Table 3 have been or will be completed as part of the NSF-funded project.

We have reviewed the comments made on the PDF by the reviewer. All are minor wording clarification suggestions or inclusion of other hypotheses that we will accept and make while revising the ms.

Mike Bentley

22/2/24