



## ***Interactive comment on “Two-dimensional impurity imaging in deep Antarctic ice cores: Snapshots of three climatic periods and implications for high-resolution signal interpretation” by Pascal Bohleber et al.***

**Anonymous Referee #2**

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This paper shows some of the first images produced with a new laser ablation – ICPMS system that is configured to produce two dimensional maps at high resolution. The paper shows maps from 3 cores, representing the Holocene at Talos Dome, MIS2 and MIS 5.5 at dome C. In fact the method itself and the results from the Talos Dome Holocene core have already been presented (in the authors' JAAS paper). However this paper is definitely an advance in that it shows the wide applicability and potential of the method, displays some beautiful images for the glaciological community, and

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considers some issues related to how such a method should be used, processed and imaged.

The highlight of the paper is certainly the lovely images we see in Figs 2-4. These really are a fine technical achievement and a joy to look at and think about. The paper considers the differences between elements (Na, Mg and Sr), and the differences between climate periods. The second of these is indicative but difficult to pursue: with only one example from each climate period, can we be sure that the findings are typical? I accept that it is unreasonable to expect more at this stage, and I am willing to ignore this problem this time. However in the future it will be necessary to see enough different sections in each climate period to really understand the rules.

The discussion of how to average the records in order to use the method to its best effect is important, but is not very well-explained. I think I got it in the end, and the result is worth discussing, but I will suggest some better explanation of what was done. I like the thinking in this section though – until now it seems to have been assumed that better resolution is always good. Here the authors show clearly that better resolution helps with understanding microstructure, but will have to be sacrificed to understand large-scale layering.

Overall, I do see some ways in which the explanations in the paper could be improved. But as a well-illustrated proof of concept this is an excellent paper and should be published.

Detailed comments:

Page 1, line 11 “it is demonstrated how instrumental settings can be adapted specifically fit-for-purpose”. This doesn't quite make sense, I suggest “it is demonstrated how instrumental settings can be adapted to be fit-for-purpose”.

Line 41. I suspect this became available after the paper was prepared but the authors may wish to reference Ng et al 2021 here as well as Rempel et al.

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Line 68-71. Like the other reviewer, I didn't understand how one could reach 294 Hz if the washout time is 34 ms. Please explain this further.

Line 75. I don't think you mean 150 mm square! Maybe 150  $\mu\text{m}$ ? But anyway please be clear whether this means 150 x 150, rather than a size that amounts to an area of 150  $\mu\text{m}^2$ .

Figs 2-4. I really like the elemental maps but am a little less clear what I am seeing in the composites in part c. Perhaps it's just the colour scale that is confusing me, because superimposing even the lightest colours shown there will certainly not give a white. Should the scales run through to very light blue/red/green to more correctly characterise what you did?

Line 140. I don't really understand this discussion which leads to the discussion about the use of NIST glass reference standards. I can understand that the instrument can be more sensitive to Na, and that Na is at higher concentrations so should give higher counts. But I'm not understanding how the standards would affect the background or why this is relevant. Do you mean that there is a contamination background because of the standard? But then you're clearly seeing a stronger signal response as well as a background response for Na. As you can see I am confused so please explain what you are suggesting here.

Line 170 and Table 3. Are the elemental ratios in Table 3 ratios by weight or molar ratios?

Around lines 170 and 230: You seem to suggest maybe the marine material is at the grain boundaries and the crustal dust in the grains. While this makes sense the ratio of Na/Mg in the grain boundaries is much higher than that of sea salt. Might be worth discussion.

Page 11. I found it really hard to follow what the correlation matrices in Figs 7-9 are. I think I got it in the end but please spell it out. If I have understood correctly you have

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taken all the parallel vertical profiles (ie at 420  $\mu\text{m}$  resolution you'd have 10 parallel profiles) and correlated them against all the others. This should then lead to a symmetrical pattern where perfect correlations would be white across the entire diagram. Please explain it in these kind of simple terms. I think it's harder to grasp because you have put the figures as rectangles rather than squares, leading the reader to think they might be looking at a map, and also to the plot not looking symmetrical.

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Interactive comment on The Cryosphere Discuss., <https://doi.org/10.5194/tc-2020-369>, 2020.

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