

Interactive comment on “Cryoconite as an efficient monitor for the deposition of radioactive fallout in glacial environments” by Giovanni Bacco et al.

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General comments

This paper is an interesting summary of an emerging research area, that of cryoconite as a record of fallout radionuclides and a potential concentrator of impurities. I cannot comment on the nuclide analysis methods, but they seem sound and reference other publications, so I have confidence in the research team to conduct these analyses appropriately. The paper is generally well written and presents some interesting results. I particularly liked the dating hypothesis discussion, and was gratified that the authors acknowledge that this is an area that needs more work, rather than trying to sew up everything in this one paper. I found the carbon discussion a little distracting and would

C1

recommend removing this section since it didn't really contribute to the main story.

The figures were sometimes a little confusing, with too much colour and too much information presented simultaneously. I make some suggestions for improvement below, but would certainly recommend testing for colour-blind readers as a minimum, and improving/simplifying the labelling and shortening the captions.

I would also suggest that the abstract is rewritten to better reflect the key findings of the paper (which I understand as): that cryoconite is an important concentrator of FRNs; that FRNs in different Alpine Glaciers are similar to each other; that Alpine glaciers are similar to other glaciers but show important differences with respect to proximity to some sources; and that FRNs could be a way of dating cryoconite, since they accumulate over time (in contrast to previous suggestions). As written now, I didn't think it represented the key findings of the paper. The distinction between local and global sources is also confusing, since most cryoconite research considers 'local' to be within catchment (when defining, for example, debris sources or microbial seeding grounds). Instead, perhaps be specific that Chernobyl impacted the Alpine Glaciers but not so much the Svalbard one. The processes description in the abstract is particularly weak and I didn't think very relevant. Use the words for your dating hypothesis instead.

Specific amendments P1, L20: 'extremely rich' is too subjective

L23: 'among the most radioactive environmental matrices' is rather vague – can you be specific?

L27: can you elaborate here? What specific aspects of their interaction?

P2 L33: 'the latter of these' instead 'of which'

Suggest combining the first two paragraphs, they are very short.

L45: 'incoherent' is awkward, suggest replacing with 'unconsolidated'

L46: I would dispute that cryoconite requires abundant meltwater to form - it is found

C2

on ice surfaces in Antarctica with extremely limited quantities of meltwater

L50: please include a reference on the role of cyanobacteria

L53: I think this is specific to cryoconite granules – cryoconite may be present without forming granules (eg. Antarctica). I would suggest adding 'granules' to the end of this sentence.

L59: could you include some example references or a review paper here?

Figure 1: please indicate the scale on A and B, or state the approx. hole diameter in the text

P4 L104: could you include some example references or a review paper here?

L106: can you tell us when it detached, rather than 'few years'?

L114: tell us why this is favourable for the formation of cryoconite (simply put: because there is more source material)

L118: define 'clean' – how were they cleaned? Deionised water? Ethanol? Between samples? In what vessels were the samples stored, and how were they treated?

L128: How were the sampling sites chosen, and how widespread were they?

L131: this is the assumption of all papers. Instead of saying that the material are not published, I would suggest rephrasing to say that accompanying gamma spectroscopy data can be found in the 2017 publication.

L172: Is the equation and description of Pearson Correlation necessary? I think the reference is sufficient, but leave this at the author's discretion

Figure 3: Can the lines be labelled on the plot rather than in the very long caption? For example, the yellow (continental crust), black (average (mean?!)) and dashed (st dev) could be labelled instead, reducing the overlong caption. I would also check the colours for use by colour-blind readers – perhaps patterns could be used instead?

C3

L190: I don't understand why the difference between K40 and the UCC is not significant, but the difference between U and Th is significant, considering the scales on the activity plots. This is because this is beyond my subject area, but may be the case for other readers, so I suggest clearer explanation on the differing scales and assignation of significant differences.

Figure 4: Nice clear plot, although check the colours again.

L246: This is really interesting!

L260: Include a reference

L272: Fascinating!

L362: Include a ref on plutonium deposition in snow here

Figure 5 is quite baffling. I like the labelled sections, but it's unclear whether the labels refer to a whole box or a specific point. The percentage lines on the lower plot are also quite confusing – would this be better presented in a table?

L360-366: include more details on this in the methods section

Section 4.4: is this relevant to the overall story of the paper? There are many studies exploring carbon and black carbon content of cryoconite, particularly in Greenland, and I wonder if these data would be more relevant in another comparative study.

L387: typographical error

Figure 7 is slightly confusing, could only the most important be labelled in C?

L406: yes, this would be really cool! You could refer to the work of Tranter, Fountain or Bagshaw on using chloride to date hydrological age of cryoconite in Antarctica as an example if you wanted to include a comparison.

L 431-445: This hypothesis seems sound and defensible, except the supposition that cryoconite only forms when meltwater is available (L445). I would rephrase this.

C4

L466: give examples of the legislations, or remove this sentence (it's not particularly relevant)

L484: I think that rather than 'absorbs', 'binds' would be a better description, since you seem to show that the EPS sticking the granules together binds up the impurities as well

Final sentence is not strictly relevant and a bit literary.

Data availability are not shown. This must be corrected.

Interactive comment on The Cryosphere Discuss., <https://doi.org/10.5194/tc-2019-176>, 2019.