

Dear authors,

Thank you for submitting your revised manuscript. I have now assessed your revisions and will be pleased to recommend it proceeds to publication subject to a few technical corrections on the added text in Section 5.3, corrections to the References, and an edit to the Data Availability statement. Please do a full and thorough final proofread before final submission.

L684: capital A mid-sentence. Make lowercase

We didn't find this (line numbers were incorrect), but we did do a final proofread with final edits. The capital A may have been referring to an intentional *A* corresponding to the temperature-dependent ice softness parameter.

L690: 'Given upper timescale limit of 1.1 Gyr, it is likely that cirque-like alcoves had erosion rates higher than 6.7 m/Myr'. 1.1Gyr based on crater counting refers to the minimum age of the surface layer, such that the ice beneath could be much older than this. This timescale 'limit' also assumes that the surface ages are the true ages of the underlying ice, and that cirques were eroded wholly by the presently observed glaciers, which may not be the case. I therefore suggest either clarifying this statement with a clear explanation of the assumptions, or removing it.

We removed this statement.

L636: 'In order to remove the debris, cirque-like alcove erosion has occurred either concurrently or after lobate debris apron formation'. Two issues with the precision of the wording here:

- What do you mean by 'remove the debris'? Do you mean to erode it from the alcove walls? In that case, it would be 'produce the debris'. Or do you mean to evacuate it from the alcove altogether, and onto an LDA surface beyond the alcove? It will be clearer if you state whether you are referring to superposition relationships observed beyond alcoves (i.e. at their outlets) versus on ice deposits within alcoves.

We meant the latter here, so evacuated from the alcove and onto an LDA surface beyond the alcove. We deleted these sentences for clarity since it was redundant with the same information as prior sentences.

- As currently written this statement reads as if you are suggesting primary cirque erosion processes (i.e. basal abrasion, plucking etc) occurred after lobate debris

aprions, to produce supraglacial debris on the LDAs. Again, the robustness of this interpretation this depends on whether the LDAs in question are within the alcoves or beyond them (this makes some sense if the debris is being evacuated beyond the alcove onto a more distant LDA, but seems unnecessarily complex if simply trying to explain supraglacial debris within an alcove itself). It also depends on what you mean by 'cirque like alcove erosion' – are you referring to the formation of the entire alcove via primary cirque-forming processes, or are you referring to secondary modification of cirques via paraglacial mass wasting processes once the support of ice was removed? Distinguishing between the two is important. If simply aiming to explain how debris gets onto the surface of extant ice within the alcoves, paraglacial/mass wasting processes would be the simplest and most likely explanation. In this case, it would be clearer, with something like 'secondary erosion of cirque-like alcoves continued via paraglacial mass wasting of the alcove walls'.

The LDAs are beyond the alcoves, so this is not referring to debris on the surface of extant ice within the alcoves. Whether the cirque-like alcove erosion is primary or secondary that occurs after the ice formation of the LDA is unknown, and either one would in effect act to erode the cirque-like alcoves. We added the following text to address this issue: "Whether this stage of erosion of the cirque-like alcoves is primary or secondary modification (e.g., via paraglacial mass wasting) is unclear."

References: There are issues remaining with the reference list, including the omission of reference information. For example, Cuffey and Patterson 2010 is missing Edition number (4th, I believe) and number of pages, and Evans and Cox 1974 is missing volume information. DOIs are also missing. Please do a thorough check of the reference list before submission to ensure they are both accurate and complete.

Cuffey and Paterson now includes an edition number and number of pages: "Cuffey, K. M., and Paterson, W. S. B. The physics of glaciers. Fourth edition. Amsterdam, Academic Press., 704 pp. ISBN 9780123694614, 2010."

Evans and Cox 1974 was updated as follows: "Evans, I. S., and Cox, N. Geomorphometry and the operational definition of cirques. Area, 6(2), 150-153, 1974."

DOIs were also added for papers published after 1997.

Data availability statement: If the shapefiles will be made available, even if via a repository, a statement needs to be added to say 'The shapefiles for cirque-like alcoves are available at: [URL]'.

We have updated the statement under Data availability to read as follows: "The shapefiles, spreadsheet, and corresponding table of column descriptions for the 434 cirque-like alcoves are available at: <https://doi.org/10.5281/zenodo.1752729>."

Note that we also deleted what was previously Appendix C and its associated table that contained the column descriptions because they are now available at the same link at the data repository.

I think the authors for their hard work and patience through multiple rounds of revision, and for enhancing our understanding of cirque-like alcoves on Mars. I also extend my thanks to the reviewers for their diligent and insightful reviews.

We thank the editor for dedicating the time to improve this manuscript, and we are looking forward to its publication!

Many thanks
Frances Butcher
Associate Editor