The Cryosphere
Open Access
Discussions

EGU

Interactive comment on "Thermal legacy of a large paleolake in Taylor Valley, East Antarctica as evidenced by an airborne electromagnetic survey" *by* Krista F. Myers et al.

Anonymous Referee #1

Received and published: 19 November 2020

This manuscript presents a novel approach based on airborne transient EM resistivity surveys and permafrost refreeze modeling to reconstruct the recent (<8 ka) paleo-hydrological history of the Lake Fryxell basin in the McMurdo Dry Valleys. The resistivity data collected within the Lake Fryxell basin show a clear signal of subsurface brine and permafrost distribution, which is analyzed to provide a maximum age for the last lacustrine draw down event of 1-1.5 ka. Permafrost depth and refreeze modeling suggest that following the ice sheet retreat at 8 ka, lake levels likely fluctuated to up to 81 m above sea level until 1.5 ka. These results provide new insight and place new constraints on recent groundwater and lake level variability that were not detected by other techniques.

Printer-friendly version

Discussion paper

I have only one major comment regarding the assumptions made in permafrost modeling. As acknowledged in the discussion section, "this model assumes a constant rate of lake level drop and constant Tps for simplification." I strongly recommend including a dedicated paragraph to discuss the ramifications of these assumptions and how results may be affected. For example, how much would the maximum permafrost age change if Tps was allowed to vary by an extra 2, 3, 5 K? What would be the effect on permafrost growth at depth if the ice dam partially collapsed in one or more episodes instead of allowing for a more gradual draw down?

——————- Minor comments below, indexed by line and figure number ——————-

General comment on acronyms: the manuscript contains a lot of acronyms, which affect the readability for readers who are less familiar with the region and/or techniques in this study. Some acronyms are only used a handful of times, such as RIS, GLW, AEM, DOI, and DVDP, and thus I suggest spelling out the entire words instead. "LGM" appears to be used only four times but is a well-known acronym and I feel it can be left as it is. Also, there are two acronyms that are not spelled out: 49: TV - Taylor Valley? 118: DVDP - Dry Valley Drilling Project?

102: What type and parameters of kriging interpolation was used? Also, why was kriging preferred over other interpolation techniques? Kriging is a predictive algorithm and may diverge or create artifact under certain conditions. I believe the authors need to provide some information regarding the configuration of the kriging interpolation and motivate the choice over other algorithms.

113: I suggest adding some information on the DEM employed in this study.

134: Here the authors use the -20 °C average air temperature of Lake Fryxell from Obryk et al. (2020) to calculate the age of permafrost. However, this temperature was calculated over a timespan of 30 years, and thus may not be representative of the air temperature since the permafrost refreeze initiation. I understand that the Monte Carlo analysis takes the uncertainty of each parameter into account, but I think there should

be a discussion on the reliability of a recent temperature measurement in the context of a much longer time scale.

145: Is a geometric mean appropriate to calculate the bulk thermal conductivity of sediment, fluid, and air mixtures in this scenario? I recommend motivating the usage of a geometric mean over other mixing formulas. For example, Fuchs et al. (2013; https://doi.org/10.1016/j.geothermics.2013.02.002) explore a few different mixing formulas and find that some are better than others for specific sediment mixtures.

152: I recommend writing either "variance" or "standard deviation." As it is written in the manuscript, it seems like the two are the same thing.

General comment on the results section and related figures: I suggest moving or at least copy some of the text in the result section over to the caption of relevant figures. Currently, the captions are on the minimalistic side, and I believe that adding further explanations would greatly improve the readability of the paper when readers glance through it quickly.

247: Inherent -> inherit ?

Fig. 6 and 7: The usage of this rainbow color scale is problematic for a couple of reasons. (1) It is visually non-linear, with sudden jumps in hue that may result in apparent variability of the dataset that does not actually exist. For example, there is a large jump in light blue-green-yellow that conveniently coincides with the proposed boundary between brine and permafrost resistivities; although this helps locating such putative boundary, I find it potentially misleading. (2) It is very hard to read by colorblind people. To the most kind of color blindness cases, this color scale looks symmetrically identical below and above 200 ohm*m, thus making it very difficult to distinguish which areas are low and high resistivity. Fig. 8 and 13 also employ a non-linear color bar with a large jump mid-range.

Interactive comment on The Cryosphere Discuss., https://doi.org/10.5194/tc-2020-241, 2020.