

Interactive comment on “Past freeze and thaw cycling in the margin of the El’gygytgyn Crater deduced from a 141 m long permafrost record” by G. Schwamborn et al.

Anonymous Referee #1

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General Comments: This paper presents data from a permafrost core drilled in an alluvial fan near the shoreline of Lake E. The stated objectives are to reconstruct past freeze and thaw cycles and this is attempted based on 3 lines of evidence; 1) ground ice stable isotopes, conductivity and ionic composition, 2) relict shorelines that occur both above and below the modern lake level, and 3) three points of age-depth determined by pollen assemblages that are subsequently related to the permafrost core via sand lens interpretations. The field and analytical methods are sound and the permafrost data are of good quality and will be of interest, particularly to a growing community that are working on permafrost isotopes.

The paper could explore a variety of hypothesis to explain the permafrost record but

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the authors have a preferred idea, namely that flooding and exposure of near shore alluvial sediments have induced freeze-thaw cycles. This leaves the reader with a sense that the authors have over-interpreted their evidence and failed to acknowledge important assumptions and limitations. Critical gaps include; 1) the lack of a chronology and corresponding sedimentological interpretation for most of the pre-LGM portion of the core, making it impossible to interpret the timing of the sedimentary sequences and their relationship to the lake level changes 2) what appears to be an incomplete assessment of the relationship between lake level changes and alluvial processes that affect sedimentation rates, dis- and un-conformities and other alluvial process such as stream migration, 3) inconclusive evidence that the isotope and chemical parameters reflect freeze-thaw cycles as opposed to changes in sources of pore water, and/or hydroclimate. If some of these issues have been addressed previously then this paper does not adequately summarize that knowledge.

That the alluvial fan development and lake level processes may have been intertwined is barely addressed. I suspect this is because there is essentially no chronology for the fan. This major uncertainty should inspire the authors to temper their certain tone in assigning MIS stages to various freeze-thaw cycles. Revisions should include significantly more discussion about alternative hypothesis. The writing is generally adequate but a number of awkwardly phrased sections and repetitions need significant revision. Paragraph organization is frequently confused because concluding statements precede supporting arguments rather than the other way around (a good example is the first two sentences of the abstract).

Specifics: -The abstract should begin with what was done, not the conclusion of the study

Introduction -First paragraph -1st sentence of the introduction should say 'The water levels...' How is the reader supposed to know what 'levels' refer to? This sentence then goes on to say that lake levels have changed – based on what? Don't assume that readers are familiar with all the citations. Throughout the paper be more specific

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when referring to previous work. -5th sentence refers to work by Schwamborn et al., 2012 indicating that permafrost cores suggest a linkage with alluvial fan growth and sediment delivery to the lake – explain specifically what was interpreted from the permafrost core to make that conclusion (see previous comment) -7th sentence needs a supporting reference (i.e, marginal lake sediments are de-stabilised by higher lake level) -last sentence “. . . growth and shrinkage of the catchment area in the course of Quaternary lake level changes. . .” It is unclear what ‘in the course of ‘ means here. . . do you mean the catchment area has changed?

Introduction – Last paragraph -2nd sentence unclear and very awkwardly phrased i.e., ‘the assumption that the output from this research’ and should not focus on the lake level permafrost process without acknowledging that alluvial processes (ie., stream migration etc.) could be equally important. -Something must be said about the chronology (and lack of it) in the introduction. The reader has no idea what to expect because it is still not clear what is going to be done in this study.

Results: 4.2 Hydrochemical zonation -define variability by standard deviations and define low and high contents with values in parenthesis. -The whole section is highly repetitive and would be much more interesting to read if it were a condensed description from the bottom to the top of the core.

Discussion: 5.1 Ground Ice Origin. -There is no discussion of lake water chemistry here and how it compares with permafrost and there should be. -It seems hard to believe that bicarbonate originates from the atmosphere –or is it meant that it is derived via dissolution of CO₂ in lake water? What is the lake water [HCO₃⁻]? Most of the first paragraph would be better placed in the results. -3rd paragraph is where the reasoning in the discussion section starts to ramble yet it is critical that it be crystal clear how readers are to follow all of these lines of reasoning. -The referral to Ugolini and Anderson, 1973 about greater chlorine mobility appears to be incorrectly summarized by the phrase ‘. . . because. . . of the attraction between the negatively charged cation exchange and the positively charged Na⁺ ion’. . . this suggests why they are strongly

bonded not why chlorine migrates. -Define AD -Last paragraph here is the first mention of lake water isotopes as a source for permafrost water but it is very hard to follow the reasoning of this paragraph. It ends with a massive interpretive leap that is simply not substantiated.

5.4 Interpretation based on permafrost and lake dynamics -2nd paragraph, 2nd to last sentence is first mention of the possibility of erosional unconformities. Last sentence is the stunning assumption that despite a lack of knowledge about sedimentation rates or the presence of unconformities that somehow the lake level changes are preserved in the permafrost core. . . this is quite a leap of faith that many readers may not take with you! What is the evidence that the permafrost core is a record of continuous sedimentation and a steady rate? -From this point to the end of the paper if a reader is unconvinced by the interpretation they will find the text to be repetitive and without additional illumination. The discussion should be shortened.

-Captions for Figs 5 and 7 are reversed.

-In Fig 9 MIS 5 appears out of nowhere – it is not indicated on Fig. 2, 3 or 4 and is barely discussed in the text.

-Fig 8 has the sedimentary interpretation of the alluvial fan! This should be on Figure 1.

-Expand the axis on Fig 5 (d18O-v-d2H) so that the error bars end – remove all the extraneous horizontal lines.

-The ternary plots are interesting but their significance is unclear.

-The borehole data is interesting on Fig 9 but it is unclear how it contributes to this study.

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