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Interactive comment on "27 m of lake ice on an Antarctic lake reveals past hydrologic variability" *by* H. A. Dugan et al.

Anonymous Referee #1

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The paper presents a variety of physical and chemical data of a 27m ice core taken in 2010 from Lake Vida together with GPR profiles and samples from the surrounding area with the aim to study its past hydrological conditions. This is a very comprehensive dataset which can give new insights to hydrologic past of the lake and may increase the understanding of paleoenvironmental conditions in the McMurdo Dry Valleys. However, I have some concerns about the presentation and discussion of the data which does also reflect on the conclusion. The nature of the data are covering a wide area of applications but the presentation and discussion of these data is missing its depth and detail to support the questions and conclusions. I especially see some deficiencies in the usage and modeling of the stable isotopes. While there are some attempts in modeling the isotopes during freezing processes such modeling is missing for the chemistry data which could support or contradict some of the conclusions drawn from

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the isotope data.

In summary the paper presents very interesting data with high potential to extract paeloenvironmental and process oriented information but it is lacking in a thorough evaluation and modeling of the data. The conclusions are at this stage not well supported through the discussion and seem to be in part disconnected from the data presented in the paper. There are a number of grammar and spelling errors which I did not listed at this point. Some terms and definitions may also need reconsideration. This paper would need major revisions especially in its discussion and modeling aspects. I more thorough modeling of chemical data would help to support isotopic data.

Detailed comments are listed below:

The abstract is short and informative but the paper does not discuss the application of this work to extraterrestrial environments and the last sentence in the Abstract may be deleted.

Methods: P4132, 20ff: What are the criteria of an Aeolian sediment? Considering the strong winds in this valley windblown material from soil surfaces would be another source.

Results: P4133, 15ff: It is not clear why the major anion/cation ratio would reflect on the contamination by the upwelling brine? It would be good to be more specific here, do you mean SO4/Cl ratios?

P4134, 5ff: Do you mean stream and Aeolian samples when referring to Victoria Valley samples? Be concise with the names? I wonder how representative the analysis of a handful of stream and Aeolian samples are considering the catchment/fetch of the lake. Looking at Figure 6a it is difficult to follow your argumentation in mineral differences. Maybe selecting just the most important minerals and display in triangle plot would be a better choice. What does enrichment in quartz and PLG feldspar mean?

10ff: Wouldn't you expect a mixture between these microtextures in all deposits, e.g.

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Aeolian transported sediments can have a glacial or fluvial primary source and vice versa? Therefore, these textures may not be exclusive for source study.

20ff: The C-14 age determination is somehow very vague. What is the amount of organic and inorganic carbon in the material (ice and sediment) and how much could be separated out. Why are the ice core-dates a mixture? What material gave the C-14 ages organic and or inorganic? Obviously the dates fit with the algae dates from Hall et al (2002) and former investigators of the lake sediments but it would be good to be more specific here and also give more information about the data quality assessment. For example it is not clear to me how the reservoir effect was determined in these samples and also why these ages represent maximum ages.

P4135, 1ff: I cannot follow the argumentation for the stable isotopes. First of all it is very difficult to create the observed deviation from the meteoric water line when sublimating massive ice and this is discussed in the papers the author is referring to. When speaking about depletion and enrichment of O-18 a reference value/sample is needed. With regards to Figure 8, I assume that all analyzed samples are describing a well-defined regression. It would be helpful to display this regression line with its 2 sigma error to evaluate if sample 12.75m is significantly depleted and the sediment layers are enriched. This may also help to evaluate potential processes responsible for this trend based on slope and intersect with GMWL. On another note the salinity of brine and some of the pore water may require to look at the activity rather than concentration of isotopes but it is not clear what is displayed in figure 8 and used in the discussion. Horita (2009) explains the potential effects in the first sections of his paper.

Discussion

P4135, 14ff: It is not clear where the 3.5m lake level rise is derived from and there is nothing mentioned in the results. If this results from another publication it should be referenced here. It is very difficult to evaluate a discussion based on unpublished data. Either they should be presented in this paper or dismissed for discussion. 24ff:

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The entire chain of argument in this paragraph is weak and conclusions are not well supported by the arguments. How was the initial delta value and "f" determined? The initial delta value seems far away from the meteoric water line which, based on Figure 8, would give a value of -34 (intersect of trend line with meteoric water line and also some initial surface waters from Victoria Valley) which would make the ice at 12.75 m very close to its initial value. A better explanation of the calculation/equation and parameter that have been used is needed. Why choose alpha 1.0029 and how is that related at the given temperature? Further, the fractionation process not only depends on the primary and final volume. The isotope fractionation strongly depends on the kinetics of freezing. To support the conclusion would need to perform a detailed Rayleigh fractionation model for freezing the 4m of (fresh)water evaluating how fast/slow freezing must be to achieve the observed value and if this is feasible with respect to climate. To further support the conclusions should address the observed chemistry and if it is in agreement with the freezing process when assuming freshwater as initial composition. Another aspect that should be addressed is the water volume needed to rise the water level to 4 m above its former level. How would that compare to water runoff during the 2001/2002 flood year? What temperatures would be expected to reach this water volume and have such high temperature excursions seen in other reservoirs such as glacier or lake sediments?

P4136-4137: 1ff: The argumentation for formation of sediment layer from inflow is somehow not well established. While the freshwater related diatom communities seem to give some indications freeze on processes may be as well. Comparing lake ice to glacier seem to be a far fetch but contrary to the statement in the text, basal ice can have m thick sediment layers as evident in some Alaska and Greenland outlet glacier. Again, the discussion should also consider the chemistry of the brine to evaluate if freezing would have been possible and how much ice could have been formed from it to create the observed concentrations.

P4130, 20ff: The discussion of the age is very vague and it seems that with the un-

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known reservoir effect the sediments could also just be a few hundred to thousand years' old and C-14 ages and OSL age would be in good agreement. From the data discussed so far sediment could have just accumulated over time on a thin ice surface at the lake bottom without the necessity of ablating a large amount of ice. There is no evidence presented in the paper of undulating climate and that sediment had to accumulate on a thick layer of ice which then ablated to form the sediment layer.

The conclusions are not well established through the data and their discussion (see comments above).

Interactive comment on The Cryosphere Discuss., 8, 4127, 2014.