Clim. Past Discuss., 9, C127–C137, 2013
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Climate of the Past Discussions

Interactive comment on "Inorganic data from El'gygytgyn Lake sediments: stages 6–11" *by* P. S. Minyuk et al.

Anonymous Referee #1

Received and published: 11 March 2013

Running comments on doi:10.5194/cpd-9-393-2013, Minyuk et al., Cimate of the Past

Abstract

Please indicate what size fraction was analyzed, or if these are bulk samples.

Line 4: you probably determined more than presence/absence of elements; insert "concentrations" and accuracy (ppb or ppm?)

Line 5: replace "covering the timeframe between" with "dating from"

I hope it's made clearer in the paper, but in the abstract I can't tell if you are determining the interglacial or glacial status of samples by their geochemistry, or are relying on a different chronometer.

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Interactive Discussion
Discussion Paper

Explain in the abstract why the similarities in structure of certain elemental profiles with other records is important during Stage 11.

Provide in the abstract one or two examples of the elemental ratios that indicate weathering or diagenesis.

Introduction

Line 3; catchments area = catchment

Line 4: The only outlet is via the Enmyvaam River to the south.

Line 7 sites; make sure the sites are labeled on a map; otherwise just leave them out.

Lines 8-9; provide units for the measurement (mg/L?). Alkalinity is a useful measurement to provide.

Line 10: I have never heard the word "circumneutral". Most people who are reading this will know how what the pH values mean with respect to neutrality. At least we can hope. I suggest combining the last two paragraphs. A lot of what is said in the first paragraph is duplicated in the Figure caption. Section 1.2

Line 28. "Core sequences"... consider using "core segments".

Line 1, p 396. Suggest "Interglacial periods are represented by massive silt that is enriched in SiO2... but depleted in TiO2... Glacial periods were represented by xxxx (tell us the lithology so it can contrast with interglacial sediment), and are more chemically altered. Please tell us why sediments are MORE altered during glacials... this is counterintuitive.

In the Introduction, there should be a paragraph about why the research for this paper was done even if it was done just to characterize the chemical signatures during a specific time period.

Its also not clear how the chronology was derived. You may have to cite work in this

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compendium of papers.

Methods

Line 10. Using your numbers, I get about 1,000 samples should have some out of 2,000 cm of core sampled every 2 cm. This means there is about 60% core recovery? A scan of your profiles suggests that there is much less core loss than that. The upshot is that there should be more samples.

Line 11. rock (not rocks)

Line 12. Spectrometer (not spectrometers)

Line 16. Can you write “layered with boric acid” rather than “layered with a boric acid base”?

I am not qualified to review the technical parts of this paper

Page 397, line 2, replace “achieved” with “determined”

General: Detection limits should be provided in a table, and not included in the text.

Results

Should also include exogenic sources of sediment borne from Aeolian deposition. I can only imagine it gets pretty windy out there!

The r2 data and Pearson coefficients are useful data to analyze. I also strongly recommend that you explore the structure of your data further using Principle Components Analysis. No doubt you will find groups of elements that behave similarly. It should show the same kinds of things you have pointed out, but it goes a step further and shows the relatedness of all variables in one diagram (several kinds of plots are typically used). Using an analysis like this helps to identify the “best” pairs of elements for indicating changes in provenance and weathering. Perhaps you have already tried this and the results were too noisy to be of use! But its very easy to do. . . there are many

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"canned" stats programs that will run this with ease, such as SYSTAT or, easier still, the on-line program PAST.

Page 398, line 15, then = than

It might be useful to discuss enrichments of elements like SiO2 in terms of biogenic sequestration. The weathering of the volcanic rocks should bring into the basin dissolved silica, and this can either be bypassed and lost due to overflow, or captured (sequestered if buried in the sediment) by organisms, in this case diatoms.

Last line on pg 398 begins a sentence that is hard to follow.

It would be very useful at some point to discuss the mineralogy of the sediments that you analyzed. This kind of information should be presented up front, rather than later on. The silica to aluminum ratio discussion is left (in my mind) a bit muddy because I'm not sure what phases these elements are in. You've mentioned biogenic silica, and that's about it. What is the proportion of quartz to feldspar, for example? How much clay is there? The claims of "textural maturity" mean relatively little unless we know or can intuit what minerals will weather fastest.

Page 399, Section 3.1.2

The lead paragraph is bit misleading? The papers that I recognize are based on lacustrine systems that are much different that Lake E. If there is a study that has a similar setting, perhaps you could highlight that one, and discuss the similarities. Can you subtract out BSi from your analyses of Al vs silica? The results might lead to more meaningful data regarding relative weathering during glacials and interglacials. What mineral is the source of Ti? Illmenite? It's a common constituent in volcanic rocks. Its also magnetic, and your MS data may be able to correlate high Ti with high MS (but a certain kind that measures moments from coarser grains).

Page 400, line 2, seams = seems

Line 18, intense = relatively intense. Weathering at this latitude is going to be very

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slow, so using an adjective like “intense” can be misleading. Page 401. This page is difficult to follow partly because its hard to go from the text to the figures.

The discussion about Ti in chlorite is interesting, but is hard to follow and hard to justify since there is no discussion about the phases (minerals). If there is chlorite, where is it coming from? In most cases I’m aware of, Ti often substitutes for Fe, and might comprise about 1% of the rock as an oxide, but the rocks are typically low-grade metamorphic rocks.

Page 401, first sentence under 3.1.3, First sentence should read “Phosphate and manganese oxide concentrations have a relatively strong linear relationship (r = 0.55).”

Line 25 – depth = depths, but I strongly recommend not listing the various depths... it’s a long (perhaps tedious) list, that perhaps would be better presented in a figure.

Page 409, lines 2 and 3; replace “be the main drivers” with “control rates of”, and delete “rates in watersheds” on line 3

Line 4, delete “rather”

Line 5, insert “reconstruction of “before “maximum”

Tell us how much warmer and wetter this period was compared to the mean Holocene instead of just say “higher than those” (line 6)

Line 10. Next two paragraphs. Reorganize and rewrite. If you are trying to convince the reader of something, start out with what you believe, and then follow with justifications, then caveats and less favored explanations. This is suggested because you want to be clear to your reader. I suggest starting this section “The greater surface area to volume ratio of clay particles probably accounts for the greater values of weathering indices for glacial versus interglacial lake sediment. (provide textural data, if you have it, rather than just descriptions). (The description of the various facies is OK, but diagrams would be better, especially if they are plotted with the indices). (It might be instructive to add a grain-size ratio to your multivariate analysis... you might find correlation among fine-

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grained sediment and particular elements, which of course are tied to mineralogy).

Line 10. When you do your rewrite, keep in mind that glacial and interglacial are nouns... you treat them as adjectives in some places. You can fix this problem by simply adding "sediment"... then sediment is the noun, and gl and intergl are adjectives.

The argument that you make for no Aeolian input is not very strong if the composition of the loess or other Aeolian particles is the same or nearly the same. It seems strange that there would be very little dust falling into a large lake like Lake E especially with active glaciers all around (albeit not that close). The far distance from loess/dust sources indicate that the grain size of the Aeolian component might be quite small.

Line 29, tell us what kind of chlorite... there are several kinds, each with different compositions. I assume that Lake E chlorites are Fe and Mg-rich. But not all chlorites are.

Page 410. It took me a long while to sort out what was being said on this page. Start out a paragraph with a topical sentence, and then provide supporting discussion/data. The great amount of clay in glacial sediment is a puzzlement given that the watershed was never glaciated. The bottom paragraph on pg. 410 reveals "the answer", and this should be presented at the beginning of the discussion. If I understand the argument, the finer-grained sediment is attributed to (year-round?) anoxia (due to year-round ice-cover?)... the anoxia leads to dissolution of iron-bearing minerals (a well known phenomenon among folks who work with magnetic susceptibility), but apparently can lead to dissolution of silicate minerals as well. I would imagine this process would attack glassy or otherwise poorly crystallized volcanic rock fragments should they make their way into the lake. It would seem to me that SEM analysis of mineral particles might reveal if this process is actually occurring. I wonder if the process is bacterially mediated like many reactions involving magnetic minerals. It would also be interesting to pursue this... I have been working with sediment that were deposited under season-

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ally anoxic conditions... does this reduction of grain size occur at a fast-enough rate so that it can significantly alter grain-size distribution data? Obviously this occurs with magnetic minerals, but they make up only a small party of the mineral assemblage. If all feldspars, for example, are quickly irradicated under anoxic conditions, this would be news (I think...!). The material in bold above should be presented at the beginning of this section. A lot of the rest of the discussion seems not necessary.

Page 411

Delete "Obtained data indicate". Start with "Our". It seems that the "controlling mechanism" is anoxia, and should be mentioned in the concluding statement of this section. Section 4.

First paragraph. This would be much more effectively presented as part of a figure. Just point out the substages in a figure, then you don't need the first paragraph. You may already have.

Line 11. Why are you pointing out the vivianite and the ice-rafted sand grains? This is a discussion, so you should, perhaps, make an interpretation (about the vivianite and sand), and then back it up with evidence.

Line 14. Again, you are giving us evidence for something, but not directly telling us what the interpretation is. Presumably the higher BSi levels are related to higher paleoproductivity (in Lake Baikal and Lake E). Start out a section with this interpretation, and follow it up with the evidence. If the special issue that this chapter belongs to has an article about diatoms, you may want to cross-reference your data. The diatom article will, no doubt, make use of a BSi curve.

Line 18. This paragraph needs rethinking and reorganization. What are your points about this paragraph? Clearly it needs to be broken up into at least two paragraphs. You need to tell us your interpretation first. "High BSi values indicate relatively high paleoproductivity during deposition of SS 11.3, especially in the middle. The high silica

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valuss mute the concentrations of other elements (list), but, curiously?, values of LOI, Cr and NI are abnormally high. (do you have an explanation for this?)"

Page 412. Very interesting material, but again, I suggest that you reorganize the paragraph so your interpretation is given first. The reader will have a much easier time digesting all of this information, and that is what we are striving for. Start a paragraph pointing out alternating anoxic and oxic conditions are indicated by ...., and perhaps go beyond this and tell us why this is important. I would think that this signature could be attributed to ice-cover vs. ice-free conditions, and indicates high climatic variability.

Line 17. Delete this paragraph? It points out that upper 11.3 is transitional, and unless you have something to say about this in terms of an interpretation, the observations that are made are easily seen in the figures and don't really need to be pointed out.

Line 20. Give us an interpretation of the significance of these data, then provide the evidence.

Page 413. Start this paragraph "The lowest BSi values, reflecting the lowest paleoproductivity, occurred during interpreted MIS 6.6. and 7.4. These zones also have relatively high values of Ti... etc., suggesting biogenically mediated diagenesis of transition metals and organic matter under anoxic conditions". Then give details as you see fit.

Page 414. Conclusions.

Line 2 – stages 6-11 are not the "last 500,000 yrs". I don't know if this will be covered in another chapter, but your paper should stand alone in terms of presenting evidence critical to your interpretations. So there are two things you need to do early on... what is the basis for "glacial" and "interglacial"? It doesn't appear to be the data you present on its own merit. Your data can support the glacial vs. interglacial interpretation. But please indicate the basis upon which these basic and essential distinctions are made. Second, what is the chronology based upon? Do you have tephrochronology? Magne-

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tostratigraphy? I wouldn't necessarily just cite a chapter or paper, but provide at least rudimentary information to the reader about what the timeframe is based upon.

Last paragraph... you also attributed the loss of mobile elements to diagenesis of silicate minerals, and creation of somewhat finer-grained material... I thought that was a fascinating suggestion which could be backed up by SEM work on grain surfaces (searching for evidence of chemical erosion).

Bibliography... not reviewed.

Tables.

Table 1. "Pearson correlation coefficients for ... MIS 6-11 sediments, Lake E"

Figures.

Figure 1. It would make it much easier for the reader if you gave a lithologic synopsis for each geological unit. Then there would be no need to reiterate this information in the text.

The latitude line for 67"30" is missing, probably because it conflicts with other labels. I suggest placing tick marks for lat long on the periphery of the figure.

In a heavy line, provide an outline of the watershed.

Figure 3. I sure hope that this is published so that its easier to read!! This is a good reason to do the multivariate analysis!

Figure 4. Same comment as above.

For Figures 3 and 4. I think that a plot of age should be provided, not just depth and MIS. I suggest plotting age next to depth. Or at the very least, provide an age-depth model.

Figure 7. I do not see any arrows.

Figures 8 and 9... nicely presented!

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SUMMARY I think the discussion and analysis of your data could be greatly enhanced by multivariate analysis. Not only will the “glacial” vs. “interglacial” signal be apparent, but you may discover relationships that weren’t considered before. Paleoecologists do this all the time for paleoecological interpretations based on assemblages of species, and then assume the environmental factors that controlled assemblage composition are reflected in axes scores. In your case, the “species” are chemical species. You probably will find that Axis 1 will control most of the data variability, and that likely can be attributed to anoxia-oxic conditions. Then the stratigraphically constrained scores can be plotted up. The shape of the curve will not be a surprise to you, in all likelihood, but it will simplify the discussion and interpretation greatly! Probably the easiest and most efficient way to run these data would be on the on-line program PAST. You should run PCA and DCA. If you think that something like paleo-DO values are the primary control, DCA will likely yield more realistic-looking curves and relationships. But you have so many data, it probably won’t make much of a difference.

Comprehension and reader interest of the discussion section will be greatly enhanced by reorganization. Readers generally don’t like to read about descriptions of quantitative things that they can readily see in the figures. Improve your discussion by expanding it to include your interpretations, and present the interpretations at the beginning of the paragraph. I think that a lot of the discussion can be condensed if the multivariate analysis is done, and the results described early on in the paper.

In your interpretations, keep in mind the focus of the journal: climate change. The big story in this paper is how chemistry helps tie together the two main lake processes; anoxia and primary productivity (BSi production). The authors actually do a pretty good job of this, but the paper needs to be reorganized as suggested above. It may be unfair to be critical of this, but the authors should discuss topics that are directly related to their interpretations. Three things immediately come to mind: climate, chronology, and mineralogy. They all are important and deserve their own development in the introduction.

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I didn't correct all of the English errors because in general the paper needs to be reorganized. The mistakes I ran across were primarily spelling ("seem" vs. "seam") and singular/plural, and related verb agreement.

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