

Interactive comment on “Factors controlling the geochemical composition of Limnopolar lake sediments (Byers Peninsula, South Shetland Island, Livingston Island, Antarctica) during the last ~ 1600 years” by A. Martínez Cortizas et al.

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General issues

- Given that the paper by Toro et al. (2013) describes a composite core (using two of the eight cores sampled, LIM08-D and LIM08-E) taken in the same lake it seems logical that it is of reference for the present study on a shorter core. In fact, most of the co-authors of this paper are also co-authors of the paper published in Antarctic Science. The Toro et al. (2013) paper deals with the main chronostratigraphical information of

C224

the Limnopolar sediments based on mineralogy, SEM, magnetic susceptibility and XRF core scanner data. The methodology followed in the present paper is similar but, as indicated in the text, we used X-ray fluorescence dispersive EMMA-XRF analysis to quantitatively determine the elemental composition of the sediments. The EMMA-XRF equipment provides concentration data (and not counts per second), more elements were determined, and the short core contains the uppermost 10 cm section that was not included in the previous publication. This new data and samples enable a detailed comparison with previous research on elemental composition of soils, sediments and tephra layers from Livingston Island and the Antarctic Peninsula, to investigate on the main sedimentary processes affecting it (supported by multivariate statistics), and establish a precise chronology for the last 15 centuries. Our findings have been contextualized within the framework of those of Toro et al. (2013). Therefore, we do not find the work done in this manuscript is repetitive but a new contribution which tries to deepen in the processes involved in the changes of the chemical nature of the lake sediments.

- As the reviewer notes, the paper deals with the inorganic composition and determines that the main driver for the changes observed in the last 1600 years was the volcanic activity in Deception Island. It has been previously proposed that climate may also have a role in changes in geochemical composition of Antarctic ecosystems but, to our knowledge, this has not yet been demonstrated. We also considered this possibility, although for the period represented by the LIM03/1 core and the range of elements analysed in our study climatic effects (apart for the brief mention we do at the end of the discussion) seem to have been overridden by the volcanic activity. Nevertheless, we can't rule out a climatic control on sedimentary processes responsible for the transport of reworked volcanoclastic material to the lake and a stronger climatic signal at longer time scales. Thus, the climatic control is a topic that will deserve further investigation, which will also benefit by the study of other complementary proxies not as largely affected by volcanic activity as those presented in our paper. Ongoing research is on this direction.

C225

Specific comments

1. Chromium: we agree, we do not demonstrate that Cr is of anthropogenic origin. We will remove the sentence from the abstract.
2. The sectioning of the core was done in the field without previous knowledge of the sediment accumulation rate and was intended to obtain the best possible resolution for the study of biological proxies (e.g. diatoms). Given the accumulation rate obtained with the age model, and to optimize analytical effort and costs, this sectioning resulted to be excessive for the geochemical study and representative sections -covering the whole core- were selected keeping a reasonably good chronological resolution. The results obtained suggest that the selection has been efficient in capturing the main chemical patterns, although small details may not be represented. We will include a phrase in the methods section on this.
3. All correlation coefficients mentioned in the text are highly significant ($p < 0.01$). We'll add this information in the methods section.
4. Chromium: to our knowledge there are no detailed studies of Cr distribution in sediments from lakes of the same area. This is also a topic that should be developed further. Regarding the use of enrichment factors, although helpful under some circumstances, these may not be indicative in this case. Enrichment factors (EF) are usually calculated as normalized ratios between the metal of interest and a conservative element (Ti, Zr, Al, and other); the reference element and the reference material (from which the ratio for the normalization is taken) have been a matter of debate in environmental archives (see for example Reimann and de Caritat, 2005; Kylander et al., 2006). Without going into discussion of the details, it is useful to remind that the EF assume that the conservative element used as reference accounts for the bulk contribution of "natural background" fluxes of the metal of interest (thus, representing the geogenic contribution). If the EF is large, it is taken as an evidence of an excess of the metal and, thus, may point to pollution. As our PCA results demonstrate, Cr does not share

C226

any variance with Ti, Zr or Al (no source or process responsible for the distribution of the potential reference seems to be involved on the variation of Cr in the sediment), and thus the ratio does not provide any further information compared to records of Cp7 scores or the concentrations of the element.

5. Figure 1 is a modified version of that in Toro et al. (2013). We will include the corresponding reference in the figure caption.

References

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C227