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

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We thank the reviewer for his positive comments. Below are detailed answers to the reviewer's concerns.

- Contribution of the paper: This is an issue that was also raised by the first reviewer. We believe it was already conveniently addressed in the response (see the 'Response to the reviewer comments' available in the SE web).

- Overview of publications on elemental composition of rocks, soils, and lake sediments

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of Byers Peninsula: most of the available publications are referred to in the text to contextualize the data obtained by us. Literature on this topic is not quite extensive and, in some way, an overview may result a bit repetitive or the text would need some reorganization. We believe this may not improve the manuscript to a large extent and prefer to leave it as it is now.

We thank the reviewer for providing the reference of a recent publication on the role of plant communities on biogeochemical cycling of micronutrients in the catchment of Limnopolar Lake and adjacent areas. Of the elements analysed in the paper by Otero et al. (2013) a proper comparison can only be made for Fe, since this is the only element for which total concentrations are provided (Table 2 of the mentioned paper). The paper does not give total concentrations for the other two elements (Fe and Mn). For Mn we may have to assume that the sum of the fractions given in Figure 5 is a good estimation of total contents, and this is not a likely situation (for Fe, for example, the sum of extractable fractions is about one third of the total Fe content of the soil); while Cu cannot be compared since in Figure 7 the concentrations in different soil fractions are given as percentages (of total content?) and the only concentration that is mentioned in the text corresponds to one fraction (F2, associated to carbonates, as indicated in the methods section- page 148). The Fe concentrations found in the sediments of Limnopolar lake are between 60 and 80 mg kg<sup>-1</sup> (Figure 2 of our manuscript), which is about twice the values given by Otero et al. (2013) for the soils of the area. The sediments of core LIM03/1 are composed of silts and clays and it is known (as indicated by Otero et al. 2013) that secondary Fe (and other metals) phases concentrate in the fine grain size fractions of the weathering products. The preferential transport to the lake of these fractions may explain the larger Fe contents (Otero et al. provide no clues on the role of tephra materials on the composition of the soils).

Although not strictly related to the main objectives of our paper, some of the inferences proposed by these authors may be of application to our research in the geochemistry of the lake sediments. They propose that an increase in temperature may lead to an

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increase in the fluxes of biolimiting nutrients to the lake, affecting primary productivity to some extent (other factors seem to be much more limiting in Limnopolar lake, such as the length of the period of ice cover, light, tephra deposition, etc). Thus, we may expect this to also affect the chemistry of the sediments deposited under changing climate conditions. As already indicated in our manuscript, no clear trend of increasing concentrations was found in the superficial sediment layers for Fe, Mn and Cu, suggesting that: i) the proposed process might not be intense enough to be detected, ii) the increase is restricted to the more labile/mobile metal forms (as shown by Otero et al., 2013) and it is masked by total concentrations (other metal forms may be dominant in the sediment - a fractionation study as the one performed in the cited paper is worth doing).

- Smaller issues:

1. The non-permanent research camp is located 1700 m away from Limnopolar lake; it was installed in 2001 and used for periods of 1-3 months each year. The other two research infrastructures mentioned are located 35 km to the east. We'll include this information in the methods & material section.

2. The lack of an increase in the concentration of metals for the Industrial period (i.e. last 200-300 years) supports the interpretation that there is no significant recent anthropogenic pollution in this area. The literature on this topic, using environmental archives (such as lake sediments, peat, glacial ice, etc.), is quite extensive and it is far from the scope of this paper to provide an in depth comparison. Nevertheless, some key studies will be cited here, so the interested reader can find good examples of the reconstruction of historical metal atmospheric pollution.

Regarding this issue, it is worth mentioning that a recent paper by Laluraj et al. (2014; Atmospheric Environment 90, 23-32) may help in the interpretation of the metal record of the superficial layers of Limnopolar lake sediments. In our manuscript we indicated that Cr is the only element showing a steady increase in concentrations in the last ~100

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years (see Figure 6), which may be interpreted as evidence of atmospheric pollution, although a clear explanation for this increase could not be provided. The first reviewer showed some concern on this interpretation and we proposed to moderate the comment. Laluriaj et al. (2014) made a high-resolution study of a firm core sampled in East Antarctica to determine to which extent recent climatic variability has affected the fluxes of dust and trace elements. They found enhanced dust and trace metal (Ba, Cr, Cu and Zn) fluxes during the last 50 years, which attribute to reduced moisture content and increased wind intensity. Thus, it is possible that the recent increase in Cr concentrations observed in LIM03/1 core are the result of changing climatic conditions and not necessarily of anthropogenic pollution. An aspect that remains unexplained is why the other metals (Cu and Zn) do not show the same trend as Cr; although it may be related to the actual concentrations of these elements in the local mineral matter sources and the dust component deposited into the lake. Unfortunately, Laluriaj et al. (2014) do not provide dust metal concentrations and a proper comparison cannot be made.

3. Typos: we will correct the typing errors.

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Interactive comment on Solid Earth Discuss., 6, 761, 2014.

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