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## ***Interactive comment on* “Trace metal distribution in pristine permafrost-affected soils of the Lena River Delta and its Hinterland, Northern Siberia, Russia” by I. Antcibor et al.**

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General

The paper describes soil properties (pH and texture) and trace element concentrations (12 elements: C, N, Cd, Pb, Ni, Cu, As, Fe, Mn, Zn, Co, Hg) from 7 soil profiles collected along a south-north transect in the Lena river delta and from 5 additional soil profiles collected on Samoylov Island. The authors try to establish background levels of the discussed trace elements for the Lena river delta based on their results and to unravel processes determining the trace element distribution within the profiles. Based on a comparison with values reported for the upper continental crust and “world soils” they

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come to the conclusion that they look at natural concentrations of trace elements in the Lena delta.

These are certainly interesting data from a little visited part of the world. Unfortunately, I have severe objections against the statistical treatment and presentation of the data.

## Specific comments

### Introduction

Starts with “Heavy metals” – throughout the paper you use quite consistent the much better term “trace metals” – why here right at the start the ill defined term “heavy metals” (see Duffus, 2002, Chapman, 2007)? Kola Peninsula: the classical reference to the distribution of trace metals in the environment surrounding the Nickel and Monchegorsk smelters is the Kola Atlas (Reimann et al., 1998).

### Methods

The description is in parts a bit chaotic and needs some revision. You did certainly not first grind the samples to then determine the grain size composition. For the determination of the trace elements you used obviously an aqua regia extraction, this should be spelled out. DIN ISO 11466 is missing in the references. An aqua regia extraction does NOT result in “total metal concentrations”. I miss some words on quality control.

Statistical data analysis: the very first problem you meet here is that you are dealing with compositional data. Classical statistics are not suitable for the analysis of closed data. It is well established that PCA and correlation analysis are especially prone to fail (see, e.g., Aitchison, 1986, 1997).

### Trace elements in soils

Table 5 shows mean values and standard deviations – these are not suitable measures of central tendency and variation for compositional data. You should use the median, and given that you have so relatively few results (between 2 and 8 samples for the

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calculations) provide minimum and maximum value so that the reader gets an unbiased impression of the variation. The statistical tests and p-values for results based on so few samples may look impressive but make little sense. I also react a bit to the fact that you first collect all the different horizons and then throw the trace element data together here. With the data at hand you should use simple EDA (exploratory data analysis) techniques to present and study your data graphically. It could for example be interesting to study a few transect (south-north) plots of your data – preferably top and bottom horizons plotted separately. Looking at the sample names in the tables I get the impression that more than the reported locations have been sampled (TIK locations)? Are their additional data that are not presented here?

In Figure 2 the scales used for top and bottom soils are quite different – that makes comparison quite difficult for the reader.

#### Discussion

You compare here to rather outdated reference values, there exist much newer and better compilations, some even providing aqua regia data. When comparing to Taylor, Vinogradov or Bowen you compare to true total concentrations (as measured by XRF or INAA). Please use a recent compilation (e.g., Caritat et al., 2012), or the existing modern soil values from north-western Russia as provided in the Kola atlas (Reimann et al., 1998) or the Barents atlas (Salminen et al., 2004).

Note that you suddenly start to use the ill-defined term “heavy metals” quite a bit in the discussion.

PCA: how was that carried out? Were the data opened prior to applying PCA? In addition you have very few samples and more variables than samples: this is a situation where PCA may not be an ideal multivariate technique. The PCA can also not be used to prove anything, it may suggest certain relations, but the proof would have to come from somewhere else.

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## Conclusions

I do usually not expect to find references in the conclusion. Topics that still need references should be treated in the Discussion.

The moment the data are presented in an appropriate and statistically correct way this paper will make an interesting contribution.

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