

Comments to Anonymous Referee #2 of “Trace metal distribution in pristine permafrost-affected soils of the Lena River Delta and its Hinterland, Northern Siberia, Russia”

by I. Antcibor et al.

Referee #2, general comments:

The Manuscript on the trace metal distribution in the Lena Delta Region by I. Antcibor et al. describes the concentrations of different trace metal in different geologic settings in the Delta Region. In a second step the authors related this data set against different environmental parameters of the soils.

The data set is very interesting and important. However, the presentation of the data could be improved. The data set should be sorted into relevant groups and analyzed accordingly. Also many statistical correlations are shown without an obvious question behind it.

Thus I recommend a structural reworking mainly of the Result and Discussion section (see below). Also the literature cited should be updated.

We thank the referee for helpful comments to improve the clarity and conciseness of the text and the presentation of the data.

Referee #2, specific comments:

Introduction

P 2208 L1: Wording: Soil can function as barrier by...

Author’s response: Suggestion was adopted and sentence changed to: *Soil can function as barrier by adsorbing contaminants and preventing their further migration to aquatic ecosystems for example through seepage water and groundwater (Dobrovolskiy et al., 1986).*

P 2208 L3: However, climate change.... I do not understand how climate change could change the function of soil as pollutant filter.

Author’s response: Definitely, the climate change cannot change the function of soil as a pollutant filter. However, its indirect consequences could influence some soil processes and properties (e.g. redox potential) that could lead to more intensive migration of some trace elements decreasing soil barrier function. The sentence was replaced with: *However, indirect consequences of climate change and anthropogenic impacts may affect soil properties (e.g. soil moisture, redox potential) increasing the migration ability of pollutants (Dube et al., 2001, Weller, 1995).*

P 2208 L13: Why will global warming mobilize the trace elements from the soil?

Author’s response: By this we wanted to say that temperature increases may enhance biochemical and geochemical cycles involving metals (e.g. alter metal methylation and demethylation rates, bioaccumulation of metals). The sentence was replaced with: *We assume that the predicted temperature increase due to global warming is likely to intensify biogeochemical cycling within the upper layers of permafrost-affected soils.*

P 2209 L5: How is the Lena 2009 expedition related to the present study?

Author's response: We thank the referee for helpful comment. To avoid repetition and obscurity, the first paragraph of “Study site” section was changed to: *The investigation area is located in the northern part of eastern Siberia between 73.5° N and 69.5° N. It covers the delta of the Lena River in the north (2T-1, 3T-1, 3T-2, Samoylov Island, 1T-1) and its nearby hinterland to the south (H-1, H-2, H-3) (Fig. 1). The investigations of the soils were most intense on Samoylov Island in the southern-central Lena River Delta. This site is representative for the younger delta areas including a Holocene estuarine terrace and various flood-plain levels (Boike et al., 2012).*

P 2209 L16: *Is there no more recent study (> 1968) on the winds in Russia?*

Author's response: New data on the winds in Russia of the period from 1998 to 2012 (source: http://meteo.infospace.ru/wcarch/html/e_sel_stn.sht?adm=612) was included into the revised version of manuscript.

P 2209 L17 - 2210 L20: *(1) I found the description of the stations rather confusing. Either you describe the stations along the north south gradient if this is important. Or the stations are described according to their affiliation to the different terraces. (2) Additionally the terraces should be described from 1.order to third, but not 2 –3 – 1. Also, I find the abbreviations for the different sites not very helpful, I would suggest Something along this line 1T - 1 (first terrace station 1), 3T- 2, or Sam_1....or PoCe 1 (Polygon centre 1)*

Author's response: (1) The station description was changed of from 3-2-1 terrace order in the revised version. (2) The station abbreviations named “TIK” were used since the same ID had been used in other studies reporting on the same sites (*Herzschuh et al., 2009**, *Zubrzycki et al., 2012***). Following the suggestions of the referee the station abbreviations of the present study were changed to more appropriate form (see, please, the previous answer on comment P2209 L5). A correspondence table with ID names of the present study and the previous was added to the supplement of the revised version of manuscript.

* - Herzschuh, U., Bolshiyarov, D., Pestrjakova, L., Boersma, M., Abramova, K., Zubrzycki, S., Biskaborn, B., Klemm J., and Vakhrameeva, P. “Ecological state of permafrost lakes and their catchment along a North-South transect in north-central Yakutia: past and present”, *Polarforschung*, 600, 22-24, 2009.

** - Zubrzycki, S., Kutzbach, L., Vakhrameeva, P., Pfeiffer, E.-M., 2012: Variability of Soil Organic Carbon Stocks of Different Permafrost Soils: Initial Results from a North-South Transect in Siberia., In: Hinkel, K.M. (eds.) *Proceedings of the 10th International Conference on Permafrost*. Salekhard, 485-490

P 2210 L23: *(1) Polygonal tundra..... start a new paragraph. (2) Which are the respective sites for the polygonal tundra??*

Author's response: (1) The paragraph was reworked. (2) Polygonal tundra is typical for the studied sites Samoylov Island and Tit-Ary Island described above (P 2210 L 4 – P 2210 L 29). It is characterized by two different microforms: polygonal centers and polygonal rims which were studied in details on Samoylov Island.

P 2210 L6ff: *refer to table 2 in the text.*

Author's response: The table 2 was referred in the text as suggested.

Material & Methods

P 2212 L7: How were the soil samples transported to Germany, frozen or dried?

Author's response: The soil samples from the Expedition 2009 were collected in water proof plastic bags (Whirl Pack) without drying and preserved at +4 °C in thermo boxes until they reached Germany for the laboratory analyses. The soil samples from the Expedition 2010 were collected in water proof plastic bags (Whirl Pack) and were air-dried prior transport to Germany. The information was added to the revised version of manuscript.

P 2213 L8: Wording: Statistical data analyses were performed with SPS...

Author's response: Suggestion was adopted and sentence changed to: *Statistical data analyses were performed with SPSS package version 20.0 and the OriginLab package 8.6.*

P 2213 L10: Wording: change to „..... general relationships between amounts of trace metals and soil properties.

Author's response: The sentence was changed as suggested.

Results

P 2214 L9: Wording: except study PJ5

Author's response: Suggestion was adopted and sentence changed to: *The studied soil profiles of polygonal rims and polygonal centers had mainly slightly acid environmental reaction except at the study site PJ5 located in the MF.*

Trace elements in soils: P 2214 L19 - P 2215 L6: This paragraph is a mere description of the data in table 5. As such it is very hard to read and find any connection between the statements. The data have to be grouped in sensible way, for example all site from the 3rd terrace had..... or grouping the metals...

Author's response: This important comment was carefully considered. The data was presented as suggested.

Second paragraph: why is it necessary to present both data, in mg/kg AND in mg/m³??

Author's response: In our study we compared the top and bottom layers in the investigated soil profiles of the stations located along the north-southern transect. The TOP/BOTTOM layers ratio is quite often used to identify anthropogenic element addition to the soil system, because it is assumed that the deepest horizon unlikely has an influence caused by anthropogenic activity. However, comparing the surface and bottom layers it is necessary to take into account that the top horizon is usually organic-rich and reflects the biogeochemical cycles on the earth surface. It is distinguished from the subsurface horizons which are usually minerogenic and reflect mineralogical changes during weathering and other processes.

Therefore, it can be a defective impression when the higher element concentrations are found in the surface horizons interpreted as an anthropogenic addition. To make it possible to better compare the top and bottom horizons of our site, we calculated the volumetric trace metal contents expressed in mg m^{-3} using bulk density data.

May be table 5 could be presented as a supplement?

Author's response: The suggestion was considered. The table was moved to the supplement in the revised version.

The paragraph on the vertical distribution of Ni in Samoylov soils (P 2216 L15:) should directly follow the paragraph on the vertical distribution of Cu (P 2215 L27:). And the r^2 should be indicated as in the figures.

Author's response: Changed as suggested. In the revised version of the manuscript to indicate positive relationship between the elements the R coefficient was included instead r^2 .

The paragraph on the Fe content (P 2216 L5:) should start with the sentence „The ratio of different Fe fraction can be used to.....“ And then this ratio is applied to the different soils to look for their different degrees of pedogenesis. In the end it should be stated which different degrees of pedogenesis were observed.

Author's response: The changes were implemented in the text as suggested

And what is the point in knowing that Fe is related to As content??

Author's response: It is stated that As minerals and compounds being soluble and the migration of this element is greatly limited due to the strong sorption by hydroxides besides clays, and organic matter. Thus, arsenates are known to be fixed most active by hydrated Fe and Al oxides (Kabata-Pendias et al., 2001, Adriano, 1986). It was reported by Norrish (1975) that a strong association of As with Fe (mainly goethite) in soils takes place. Additionally, Dudas (1987) found the strong association of As with both crystalline and amorphous forms of Fe oxides.

I do not like the principle component analysis at all. Two tables and one figure are necessary to show us what? There are four important variables, which determine the trace metal distribution, but you do not know which ones. And in table 8 it seems as if the all possible combinations of factors have been tested, but with no apparent outcome or apparent over all pattern.

Author's response: The Principle Component Analysis was implemented as the first step for showing the possible relations between our observations and variables. However, following the referee's comments we have assumed that the PCA technique is not an ideal tool and is not applicable to our data.

The direct regression analysis was much more impressive (figure 3, 5). Are there more metals related to clay content or Corg or other environmental factors??

Author's response: Spearman rank correlation analysis has revealed positive correlation between Cd-Fed, Cd-Feo, Cd-Pb, Cd-As, Cd-Cu, Cd-Ni, Cd-Corg, between Clay-Pb, Clay-

Cu, Clay-Zn, Clay-Cd, Clay-Fe, between Ni-Pb, Ni-Zn, Ni-Cu, and between Feo-Cu. The relationships were presented by XY-plots in the revised version of manuscript.

Discussion

For the discussion in general, there are too many numbers in the text. This is hard to read. If the numbers are really important for comparison they should be put in a small table. Or simply the outcome of the comparison should be stated.

Author's response: This important note was adopted and implemented in the revised version of manuscript.

P 22018 L1 - 18: I do not understand this comparison, but I am not a trace metal person. Why would you compare your data with data from the world soil in the 60ies? Is this a Comparison between today and 50 years ago?? Or what are the world soils?? Would a Comparison between arctic, boreal or tropical soils be more appropriate??

Author's response: The average chemical element concentration in “world soils” is a mean value which is used to compare the obtained results to (Bowen, 1979, Kabata-Pendias et al., 2001, Vinogradov, 1957). These values are based on data from existing soil surveys in different parts of the world. However, we agree that these values quoted for “world soil” should not be compared to the element contents extracted by aqua regia since they represent true total element concentrations (see: de Caritat, et al., 2011). The results obtained were compared now to the existing modern soil values from north-western Russia as provided in the Barents Atlas (Salminen et al., 2004).

P 2218 L19 ff: Aha, the trace metals behave differently in the soil and there are different groups according to their transport or adsorption behavior. This information has to go to the beginning of the Ms, and should be used to group the investigated metals. And test the groups versus the determining factor.

Author's response: This suggestion was adopted and implemented.

P 2219 L14 ff: So is the Lena Delta region now pristine or not??

Author's response: According to our study the Lena Delta region is considered to be pristine one. The text was revised.

P2220 L21ff: The comparison between iron and the other element is an important finding, but should go to the result section.

Author's response: This change was performed as suggested.

Conclusions

The conclusions are much too long and should be shortened to the really important outcomes.

Author's response: This suggestion was adopted and implemented.

Tables:

Table 1, what for is the information on the vegetation needed? In the text there is no reference to it.

Author's response: A type of vegetation can serve as an indicator of hydrological regime and other conditions which influence on biogeochemical processes that take place on the landscape. The reference to the vegetation information was added as suggested.

Table 1 and 2 could be combined as both are describing the different study sites. Also, I think that it would better to sort the study sites according to their landscape affiliation i.e. all site on the 3rd terrace together, followed by all sites on the second terrace.....

Author's response: This suggestion was adopted and implemented.

Dito for table 4, all sites on the polygon rim together and then the ones in the centre.

Author's response: This suggestion was adopted and implemented.

Figures:

Fig. 2 (1) *The scale of the yaxis for top and bottom soil has to be the same! Otherwise difference cannot be seen. Would it be possible to apply the same scale for all y-axis, may be on a log scale. For the x-axis the break is not necessary.* (2) *How did you define top and bottom layer?* (3) *Wording: „Volumetric conc. of trace elements in.....*

Author's response: (1) This suggestion was adopted and implemented. (2) The top and bottom layers are the genetic layers defined according to the soil classification during the field expedition and later clarified according to the laboratory analyses. (3) Changed as suggested.

Fig. 3 (1) *Aga in the abbreviations for the sites are not helpful at all, they should be given names from which in can easily be seen where their origin is.* (2) *For 3b) the regression line should be plotted in the figure,* (3) *is the correlation for all Samoylov Stations?* (4) *And what sort of regression is it? Linear or exponential?*

Author's response: (1,2) This suggestion was adopted and implemented. (3) The correlation for all Samoylov stations was implemented. (4) We used the linear regression to plot Fig.3b).

Fig. 5 *See comments for Fig. 3*

Author's response: Please, see the previous response.