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Content and distribution of trace metals in pristine permafrost environments of Northeastern Siberia, Russia

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Arctic regions are one of the most sensitive areas with respect to climatic changes and human impacts. Research is required to discover how the function of permafrost soils as a buffering system for metal pollutants could change in response to the predicted changes.

The goal of this work is to determine the background levels of trace metals in the pristine arctic ecosystems of the Lena River Delta in Northeastern Siberia and to evaluate the possible effect of human impacts on this arctic region. The Lena River Delta represents areas with different dominating geomorphologic processes that can generally be divided between accumulation and erosion sites. Frequent changes of the river water level create different periods of sedimentation and result in the formation of stratified soils and sediment layers which are dominated either by mineral substrates with allochthonous organic matter or pure autochthonous peat. The deposited sediments that have formed the delta islands are mostly composed of sand fractions; therefore the buffering effects of clay materials can be neglected. Samoylov Island is representative of the south-central and eastern modern delta surfaces of the Lena River Delta and is selected as a pilot study site.

We determined total element contents of Fe, Mn, Zn, Cd, Ni, Cu, As, Pb, Co and Hg in soil horizons from different polygonal elevated rims, polygonal depressed centers and the middle floodplain. High gravimetric concentrations (related to dry mass of soil material) of Mn and Fe are found within all soil profiles and vary from 0.14 to 1.39 g kg^{-1} and from 10.7 to 41.2 g kg^{-1}, respectively. While the trace element concentrations do not exceed typical crustal abundances, the maximum values of most of the metals are observed within the soil profile situated at the middle floodplain. This finding suggests that apart from the parent material the second potential source of trace metals is due to allochthonous substance input during annual flooding of the middle floodplain. Correlation analysis between element concentrations, grain-size distribution and carbon content revealed a direct dependence of the element distribution within all soil profiles on its mineralogical composition. Based on the obtained results we suggest that there are negligible atmospheric depositions caused by human activity on the investigation site. Therefore this data can provide a point of comparison against man-made influences on permafrost-affected landscapes and also on similar pristine areas in the Arctic region.