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Geochemical composition of permafrost-affected soils around the town Tiksi, Northern Yakutia, Russia

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Northeastern Siberia represents an area remote from evident anthropogenic trace metal sources. However, a risk of airborne pollution by trace metals from anthropogenic sources connected to the settlements exists. The largest of these are the settlements Tiksi (71° 42' 55.6" N, 128° 48' 46.3" E) and Kyusyur (70° 45' 41.7" N, 127° 23' 04.7" E). The area of Tiksi is located between the Lena River and the Kharaulach River mouths. It covers parts of Primorsky Ridge and Kharaulach Mountains which are a part of the Verkhoyansk Range. The objective of this study was to investigate features of the spatial element distribution in representative landscape-geochemical units of the Tiksi area and to identify whether local pollution from the settlement takes place. The physical and chemical properties of soils were accessed at three sites located radially in the immediate vicinity to the town Tiksi and one control site remote 10 km south from the settlement. The elements measured were As, Cd, Co, Cu, Fe, Mn, Ni, Pb, and Zn in soils. Differences in the element content were found for various relief forms (depressions, slopes, and elevations). The coefficient of soil buffer capacity (Bf) for the surface soil horizons in depressions was the highest (Bf > 40 %) for the majority of elements indicating their intensive accumulation there. In the surface soil horizons of elevated landscape forms the coefficient, by contrast showed low to very low soil buffer capacity to accumulate metals (0 % < Bf < 20 %). The hill slopes of the study area were characterized by moderate to high Bf (20 - 40 %) for As, Cd, Co, Cu, and Mn, low to moderate Bf (10 - 30 %) for Zn, and very low Bf (< 10 %) for elements Fe, Pb, and Ni. Based on the results, it was concluded that element properties and soil acidity together with features of topography and water drainage are likely to govern more intensive element migration to adjacent landscapes and their accumulation on acid-base barriers. No significant difference in metal distribution among studied sites was revealed, except for the western site which was characterized by the highest median Ni concentration. The data suggest that ecological impacts at the studied sites were low except for one site north to Tiksi where signs of local pollution probably as a result of local emissions of fuel and mining operations were detected.

Keywords: Trace metals; Russian Arctic; Northeastern Siberia; Permafrost-affected soils.