Serpentine-reached mining wastes as a geochemical barrier for the soil remediation under the ongoing Cu-Ni pollution in the Russian Arctic

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The main factors for the degradation of the ecosystems in the metal-polluted territories are soil toxicity, organic matter degradation and violation of macro-element cycles. Heavily contaminated soils lose their ability to maintain sustainable vegetation, which leads to the formation of industrial barrens as the final stage of plant cover digression, where the vegetation cover is less than 10%. The deposition of mobile metal compounds into an insoluble form by alkaline sorbents is one of the most effective remediation techniques in situ. Technosol engineering is a trigger for the beginning of plant and soil cover development and the recovery succession under high pollution with metals compounds.

Field experiment of remediation using three types of serpentine mining wastes, expanded vermiculite and grass seeds mixture was laid down in 2010-2013 in the impact zone of the copper-nickel ore processing enterprise on the Kola peninsula (northern Europe) beyond the Arctic Circle at two sites with podzol and peat soil. The results obtained in 2019 showed that the immobilization effect was strengthened by high pH inherited from the alkaline wastes making Technosols a geochemical barrier. For the first 5-8 years of the experiment, the Technosol upper layers primary consisted of serpentine minerals, accumulated more than 1 g·kg⁻¹ Ni and 0.1 g·kg⁻¹ Cu which are constantly deposited from the atmosphere as a result of the Cu-Ni enterprise activity. They also affected the underlying soil and neutralized the most toxic water-soluble and exchangeable fractions of Cu and Ni. Grass growing and litter deposition (in total 4.5-6 kg·m⁻²) during the experiment term led to the accumulation of organic carbon by serpentine minerals about 1.5%. Organic matter accumulation also played a significant role in metal binding by upper Technosol layers. Summarily, the remediation technology through the use of serpentine-reached mining wastes bound metals emitted by smelter into insoluble forms, reduced the toxicity of water-soluble and exchangeable fractions of heavy metals and promoted the sustainable development of plant cover.

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