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Changes in soils of Central Russian forest-steppe under the impact of sulfur coal mining (the Moscow basin)

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In mining areas of the Moscow brown coal basin, soils are impacted by acid mine drainage (AMD), solid sulfide-bearing mine wastes and carbonaceous particles. Spoil heaps of overburden rocks and subsidence areas over the mined space are formed at abandoned mine fields. Most of the spoil heaps have not been remediated and erode intensively due to physical and chemical properties of waste rocks. AMD of sulfuric acid, Al and Fe sulfates as well as pyritized material, entering from the eroded spoil heaps, results in morphological changes in soil properties. Other environmental concern is the formation of subsidence areas over the mined space due to the dewatering of abandoned coal mines. It results in alteration of the soil water regime. On deluvial and proluvial dump tailings around spoil heaps technogenically transformed soils are common.

The aim of the study was to examine the post-mining evolution of natural soils under the impact of supply of technogenic material from the spoil heaps and changes of the terrain in abandoned sulfur coal mining areas.

We investigated two key sites within abandoned coal mine fields in the central part of the Moscow basin (the Tula region, Russia). Prevailing natural soils are Greyic Phaeozems and Haplic Chernozems (WRB 2014) (Grey forest and Leached Chernozems in Russian classification).

Soil samples and soil solutions were analysed for (acid-base properties, content and composition of readily soluble salts, content of Fe^{2+} and Fe^{3+} , H^+ and Al^{3+} , carbonates, composition of exchangeable cations, particle size content, total content of S, Al, Fe and organic carbon). Soil solutions were displaced by ethanol (Ishcherekov-Komarova method, Russia) (Snakin et al. 2001). The level of saturation of soil solutions by gypsum, iron and aluminum hydroxides was evaluated.

Properties of newly formed soils differ significantly from natural soils. We identified the transformation of the composition of soil solutions. Key geochemical processes at mine sites in soils were: (1) acidification and Fe-Al- SO_4 salinization of soil profile along with the increment in H^+ and Al^{3+} ions content; (2) cation exchange, leading to displacement of Ca^{2+} and Mg^{2+} ions by Al^{3+} , H^+ , Fe^{2+} and, perhaps, by Fe^{3+} in soil ion-exchange complex; (3) alteration of radial differentiation of organic carbon and carbonates in soils; (4) mineral transformations.

Semi-hydromorphic soils with signs of gleying and peat accumulation were formed in subsidence

areas. In Greyic Phaeozems the intensification of podzolization process could be noted. In Haplic Chernozems gypsum neoformations (neogypsans) were observed. Post-technogenic soils have no analogues in natural forest-steppe landscapes of the Russian Plain.