

First characterization of technosols developed on coal mining tailings in the North of France

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Recently new concerns have emerged regarding the preservation and management of the anthropized environments. The tailings from coal mining (mainly black shales) in the North of France are a good example. These mining wastes, piled up in the form of spoil tips, can exhibit natural revegetation by birch, oak and bryophytes, or host unique ecosystems composed of pioneer and endemic species requiring sustainable management.

The implementation of such management requires a study of tailing evolution under supergene conditions. The main result of this evolution is the formation of technosols on the slopes of spoil tips, which have never been described in the North of France, nor the pedogenesis processes leading to their formation. Here, we fill this gap via the first detailed characterization of technosols from three vegetated spoil tips of the Nord Pas-de-Calais mining basin area, involving a series of physical (particle size distribution, bulk density), chemical (pH, major, trace elements, CNS, Rock-Eval organic carbon differentiation), and mineralogical (X-ray diffraction) analyses.

Although young, these soils already exhibit clear pedogenetic indicators, including horizon formation, signs of oxidation, and acidity gradients. They are mainly composed of decomposing organic matter, quartz and clay minerals, as well as secondary minerals such as jarosite and iron oxihydroxides, which result from the oxidative alteration of the shale pyrites. These soils also exhibit significant pH variability, from 3.82 to 7.51, depending on type of plant cover and horizon depth. C/N ratios vary along the soil profiles, reflecting the combined influence of vegetation decomposition and organic carbon incorporation.

Acid mine drainage occurring on spoil tip surfaces, initiated by revegetation, constitutes the first step of pedogenesis. Subsequently, the interaction between shale weathering and OM incorporation leads to the development of soil profiles with up to four distinct horizons, up to 30 cm thick, in just 30 years. Although the temperate climate, conical spoil type morphology, and erosion due to steep slopes (~30°) create a challenging environment for the stability of these soils. Our results clearly highlight an active pedogenetic dynamic, demonstrating a gradual evolution towards more mature soils.