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Dynamics in soil fertility and quality during pristine soil formation on a mining spoil tip

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In the Nord Pas-de-Calais region (Northern France), coal mining has lasted for about 270 years, with the last mine having closed in 1990. The coal extraction industry has piled up some 339 spoil tips made of black shale and shaly sandstone debris of the carboniferous coal bearing Namuro-Westphalien deposits. The spoil tips have been conquered by pioneer vegetation after cessation of the mining activity, thereby initiating soil formation processes (Bafounga et al., this conference). Elemental transfers between this rock waste, exposed to supergene conditions, and the biosphere and hydrosphere remain largely unexplored, thus motivating the present study on dynamics of soil fertility and soil quality during the formation of these soils.

The conical and partially vegetated spoil tip of Ostricourt (Nord department, France), was erected between 1923 and 1961. An indepth understanding of the soil development is important for a cautious integrated management of this ecosystem. The granulometric analyses, the mineralogy and the petrographic study confirmed our field observations showing that soils develop differently from one slope to another on the spoil tip: almost no development on the southern slope (short and endemic vegetation), and advanced, organically rich soil, with mineral neoformations, on the northern slope (forest vegetation). Phosphorus originates from the weathering of primary apatite present as a trace mineral in the shale material constituting the spoil tip and not from anthropogenic input of fertilizer. Sequential extraction tests, validated specifically for the spoil tip soils, reveal how phosphate abundance and availability is linked with soil formation.

The shale also contains some pyrite leading to AMD type trace metal release, confirmed by ICP-OES and ICP-MS analyses. Concomitantly with phosphorus, some metals, in particular As, Se, and Zn are accumulated in the soil, revealing how fertility and metal pollution develop simultaneously. Iron oxyhydroxide formation plays a central role in these accumulation processes that we will try to quantify. Our final goal is to describe the dynamics of soil quality change in the course of soil formation on this particular “rock waste” substrate.

Key Words : phosphorus, nutrients, iron oxyhydroxide, clay minerals, sequential extraction, soil, spoil tip, black shales.