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Hard pan formation in mining dumps

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Introduction

The formation of hardpans has been observed in mining dumps, located in middle Europe. Generally, hard pans form by precipitation of colloids, circulating in soil pore water and eventually agglutinate the soil particles to crusts marked by reduced pore space (Rammlmair & Grissemann, 2000). The hypothesis is that the presence of these crusts in the dumps not only has a stabilizing effect, but could also prevent drainage of toxic elements, mobilized by rainwater from the dump body into the groundwater. Therefore, the goal of this research is to find out which processes lead to crust formation and to find out if they prevent drainage.

In this project we investigate mining dumps with geophysical methods to gain information on the large scaled dump structure (contribution: U. Noell). Moreover, we try to consider all processes (mineralogical, biological, geochemical) which influence the crust formation in small scale.

This presentation is about the hydro/ geochemical and mineralogical investigations performed at one of our case study objects: a soda rich slag heap from an iron smelter, located in northern Germany. Several crust layers of 10-30 cm thickness were identified in the mostly coarse grained, sandy dump.

Results

The solid phase, determined by X-ray diffraction, consists mainly of typical slag minerals as iron (γ-Fe), magnetite (Fe_3O_4), cohenite (Fe_3C) and glass but also of quartz

(SiO_2) and calcite ($CaCO_3$). By analysis of a transparent cut with a microprobe it was possible to describe the state of weathering of the different solid phases. Especially, the glass and iron carbides dissolve and re-precipitate as sodium-rich silica-gel and Fe-hydroxides, which fill the pore space between the grains and thereby form the crust. Elution tests with dump material and water confirmed that observation, because of the high release of silicon and sodium. Colloids, collected by ultra filtration from pore water of the same material and analyzed by Fourier Transform infrared spectroscopy, predominantly consist of calcium carbonate and silicon oxide.

Reference

Rammlmair, D. & Grissemann, Ch., 2000. Natural attenuation in slag heaps versus remediation. In: Applied Mineralogy in Research, Economy, Technology, Ecology and Culture. Volume 2. Ed. Rammlmair, D., Mederer, J., Oberthür, Th., Heinemann, R.B. & Pentinghaus, H. Balkema, Rotterdam, 645-648.