Feasibility Study for Crust Formation as CO_2 Sink in Uranium and Brown Coal Post-Mining Sites.

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The feasibility of catalysed crust formation in mining residues was investigated as part of the project "Crust formation as CO_2 sink" (supported by the Saxon State Agency of Environment and Geology) using lab and field experiments. The sites for field studies included a former brown coal mining site as well as a dump and tailings from former uranium mining. Purpose of the research project was to investigate, if a metal binding crust formation can be induced by CO_2 infiltration, but also the possibility to use post-mining sites for CO_2 sequestration.

The project was divided into two phases. In a first phase, on lab scale, column tests considering representative profiles from dump and tailings material were performed, using CO_2 as gas input. In an accompanying investigation phase, a similar experimental arrangement was practised on field scale. The following types of mining waste were considered: brown coal dump site Nochten (Lusatia), uranium tailings pond Lengenfeld (Vogtland) and uranium waste dump Schneeberg (Ore Mountains). Lab and field studies included gas and water investigations, soil investigations, isotopic studies, and mineralogical investigations. The supporting investigation methodology for analysis and interpretation included:

- hydrochemical characterisation of the processes studied, using lab analyses, but also geochemical models,
- water balance calculations and geohydraulic characterisation of the test fields using models for the gas and water phase,
- mineralogical characterisation of the supposed crust formation using mineralogical analyses and geochemical modelling,
- characterisation of CO_2 flow and transformation processes using isotope data ($^{12/13}C$) and process analysis.

The results of the investigations have shown that a binding of carbon in post mining sites is feasible. During the CO_2 input in columns and test fields, the saturation index for various minerals increased significantly. It can be concluded that the binding of CO_2 in post mining areas is feasible in principle. As the investigation results show, the binding of CO_2 happened in the pores of the soil matrix. There is a significant CO_2 binding potential in the dumps and tailings of former uranium mining sites. Due to the climatic situation (low temperature, high rainfall), the kinetics of the reactions, however, in comparison to crust formation processes in arid landscapes is much slower. No CO_2 binding was observed in the test materials of the brown coal mining site Nochten due to the very low pH in the original mining waste. A positive influence of fly ash as soil cover was observed, especially in test columns with originally acidic to slightly alkaline pH range. Lab experiments and modelling have shown that CO_2 is restrained in the system. These results were confirmed by the field tests. Although the formation of crusts as secondary minerals and/or hard pan formation was not measured due to the short investigation period, the models showed that at a longer time scale this must be the binding mechanism. A verification of these binding mechanisms in further investigations is necessary.