Theme: In-situ Remediation of Uranium in Groundwater

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Severe soil and groundwater contaminations occur at Königstein, Ronneburg and many other areas in East Europe as a result of uranium (U) mining with the technique of In Situ Leaching (ISL) using sulfuric acid solutions. At Königstein, about 1,8 million m3 of leaching solutions remain trapped within the rocks. The level of heavy metals and radionuclides is up to one hundred times higher than the German drinking water standards (1). The mine is situated within an aquifer and must be restored to background quality to prevent contamination of the surrounding groundwater. Radionuclide contaminants are usually removed by ion exchange, reverse osmosis, microfiltration, precipitation, or flocculation (2). These methods require the retrieval of groundwater for treatment (pump-and-treat); they may also be arduous to accomplish and can be prohibitively expensive for large water volumes.

Due to the well known limits of the pump-and-treat technology, in situ treatment technologies have been successfully tested for halogenated organic compounds and great efforts are made in order to extend their application on a large spectrum of contaminants. The widespread application of this technology evolved that an interceptor trench containing an appropriate treatment media be place in the ground such that the quality of the contaminated groundwater flowing through it will be significantly improved (3). Another possibility of forming an in-situ barrier consist in injecting reactive fluids (through wells) which can react with naturally occurring minerals (4). This alternative is particularly indicated for the treatment of deep contaminated aquifers and sites where surface disturbances are unacceptable or impossible. At present, no single example of the in-situ remediation of groundwater at old ISL-sites with sulfuric acid has been reported, these sites are characterized by low pH values (2 – 2,5) and major damage of the aquifer geochemistry.

The objective of this study is to develop a concept at the laboratory scale, for the in-situ treatment of groundwaters with respect to U at ISL mine sites by inserting selected materials that are known to be effective for reducing U (zero-valent iron), concentrating U into ore deposits (humic materials: wood, peat, coal, lignite), or treating wastewater (fly ash). Since substantial quantities of materials would be required, availability and costs were also considered in the selection process. It is though to insert the material in the aquifer via wells (injection and production wells from recovery actions) to form local reaction zones.

The goal is to immobilize U, by reducing it, principally with zero-valent iron, from the oxidation state +6 to the lower state +4 which is essentially insoluble and/or to precipitate U as secondary minerals. Since adsorption is influenced by externally determined solution variables such as pH, the other materials are though to facilitate the reduction reaction in accumulating uranium. On the other hand, these materials will be studied as support for biological activities leading to U immobilization. A particular attention will be given to the post-behaviour of the formed secondary minerals by varying experimental conditions as it can happen in natural waters (variation of the pH, the carbonate concentration...). The behaviour of other elements (heavy metals) will be investigated.

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