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In-situ Treatment of Mining Waste Waters Using Fe(0) and Fe/Mn-Compounds

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After the unification of Germany the flooding and remediation of mining sites in east Germany is one of the recent environmental problems. During flooding of the mines considerable amounts of uranium, radium and arsenic are released into aquifers and nearby rivers by percolating waters. The Ministry of Environment and Agriculture of Saxony started a research project to find alternative water treatment methods for these contaminated mine waters. These treatment methods should be applicable with a minimum of energy, manpower and without use of changeable chemicals, like reactive walls and successive alkalinity producing systems.

To immobilize radionuclides and arsenic different chemical ways can be used: adsorption on reactive surfaces, a reducing geochemical milieu or co-precipitation with iron-hydroxides. Especially for uranium the aim of the study to find a way to reduce mobile six-valent uranium to immobile four-valent uranium. The idea was to use reactive materials, which can be deposited in the shafts while flooding. Following topics were investigated in detail: geochemical modeling of suitable reactive materials, column tests using reactive materials and mine waters, underground field tests using Fe(0)-, Fe/Mn-compounds and peat, observation of the output of radionuclides and arsenic, evaluation of the immobilisation rates of uranium, radium and arsenic. In two old shafts of the ore mountains (Oberwiesenthal and Johanngeorgenstadt) underground reactive test fields were installed in order to observe the geochemical behaviour and the fixation of radionuclides. Fe(0)-, Fe/Mn-compounds and peat were used as reactive materials. While Fe(0) and Fe/Mn-compounds are changing the oxidizing geochemical milieu into reducing milieu, peat has an adsorption capacity for metals and radionuclides. The fixation capacity of the peat material for radionuclides and arsenic was reached within half a year. The Fe/Mn-compounds consist of sludge from water works, which is a residue of the drinking water treatment. The elimination capacity of the Fe/Mn-compounds was less than that of Fe(0)-compounds.

The results of the experiments show, that Fe(0) is a suitable material for alternative water treatment of mine waters. Due to the reducing capacity of Fe(0)-compounds highly insoluble four-valent uranium is produced. In addition iron hydroxides co-precipitate the residual contaminants. An upscaling of the test fields is in preparation.

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	Oberwiesenthal	Johanngeorgenstadt	Fe/Mn-compounds Fe(0)	Fe/Mn-compounds Fe(0)
Uranium	38%	96%	70%(2)	80%(2)
Radium-226	73%	50%	52%	43%
Lead	57%	77%	53%	65%
Arsenic	85%	84%	55%	70%
Sulphate	0%	52%	13%	3%
Nitrate	1%	55%	25%	56%

Table 1:% immobilisation of contaminants in flooding waters