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The relevance of geochemical fronts in leaching behaviour of cement-based materials

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The leaching behaviour of potentially toxic elements from cement based materials such as cement-stabilized waste, with respect to potentially toxic elements is an important factor in determining the suitability of these materials for use as construction materials. The mobility of most heavy metals is strongly detemined by the pH of the matrix because of pH dependent precipitation and adsorption reactions. Therefore, accurate prediction of pH levels, in combination with a proper model for pH dependent precipitiation / adsorption, is a prerequisite for accurately predicting metal leaching rates. A complicating factor is that, when exposed to air, the pH of cement based materials changes from initially highly alkaline (pH>12) to near neutral as a result of reaction with CO_2 (carbonation, conversion of calcium and magnesium hydroxides to carbonates). Depending on porosity and composition of the material and the external condtions this may lead to steep pH and element concentration gradients the soilid matrix.

This work shows that emission of reactive substances from such materials, by leaching or diffusion, is strongly determined by such geochemical fronts i.e. by local chemistry and transport processes. Emissions are therefore not necessarily related related to the bulk composition of the material. This is demonstrated here by comparing model calculations assuming a well mixed average bulk composition of the material (that changes over time), to model calculations that take spatial distribution of concentrations and geochemical front formation into account (semi 2d reactive transport model). Both models use the same set of chemical reactions, and are implemented in the Orchestra framework [1]. The model predictions are compared with experimental data. This work increases the understanding of processes that determine time dependent leaching in cement-based materials. This has clear implications for appropriate design of testing procedures and risk asessment studies.

Reference

[1] Meeussen, J.C.L. (2003) *Environ. Sci. Technol.* **37,** 1175-1182.

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Biogenic redox front formation: Symbiotic activity of metal oxidizing and reducing bacteria in sedimentary sequence

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Redox fronts inevitably form near the earth's surface and influence elemental accumulation, but symbiotic microbial activity as a mechanism for redox reaction in the sedimentary rock matrix has received relatively little attention. Here we describe a cycling process with metal oxidizing and reducing bacteria mediated redox front, and the development into a sedimentary sequence with bands of highly concentrated trace elements, including rear earth elements (REEs), accumulated for the last ca. 105 years. Direct microscopic observations and 16S rDNA analysis of microbe extracted from the rock matrices resulted that both iron oxidizing and reducing microbes have a symbiotic activity to form a redox front with high concentration of trace elements, Fe, Mn and Si by forming of the fossilized pellets encrusting a microbial colony in the pore spaces. These findings suggest microbial activity obviously can generate both redox reactions and substantial elemental accumulation under low temperature conditions. The observations and analysis made here have profound implications for the role of microbe in secondary metal accumulation and deposition by redox reaction invariably identified during weathering and/or pollutants migration due to the redox front formation in the geological environment.