

Metal attenuation in tailings

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Oxidation of sulphide mineral in mine waste can result in extensive release of metals, which may escape the waste via groundwater discharge. However, the metals may also be attenuated by various processes in which metal ions are re-associated with the solid matter within the tailings. The objective of our work is to identify the minerals in mining waste that are of significance for the attenuation in short and long term perspective of heavy metals release in mine waste by quantifying the metal retardation capacity of tailings of different properties or origin.

The metal uptake capacity has been studied for Cu, As, Zn and Cd in batch and column experiments on tailings sampled in four different locations: Kristineberg, Aitik, Zinkgruvan and Boliden. In order to distinguish between adsorbed metal and precipitation of metal oxide/hydroxide, the acid neutralization capacity of the tailing was neutralized before the batch and column experiments. The elemental composition of tailings and pore-water was analysed using ICP-AES/MS. Characterization of the mineralogical composition by using Mineral Liberation Analysis and the speciation and local structure of metal ions associated with tailings was investigated using X-ray Photoelectron Spectroscopy and synchrotron based X-ray Absorption Spectroscopy.

Our result for Cu shows that there is an initial uptake likely explain by precipitation of $\text{Cu}(\text{OH})_2$ (supported by XANES analysis) follow by a slower process involving phase transformation e.g. formation of secondary copper sulphide. The copper uptake capacity was highest, up to $50 \mu\text{mol/g}$ of tailing, for Kristineberg and Zinkgruvan. Uptake of arsenic appears to be more strongly correlated to sulphide content of tailings with an uptake capacity similar to copper for tailings with high sulphide content. For cadmium no significant uptake could be observed.

Donnan equilibrium in Na-montmorillonite from a molecular dynamics perspective – Consequences for diffusional transport

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Bentonite clay is proposed as buffer material in several concepts of High Level Radioactive Waste repositories, and a correct description of ion diffusion in this material is of vital importance for any quantification of the chemical evolution of the repository near field.

This study investigates the importance of ion equilibrium between montmorillonite interlayer space and an external solution for the diffusional behaviour of bentonite.

We present molecular dynamics simulations of the Donnan equilibrium principle in compacted montmorillonite with three hydration layers of water in the interlayer. This draws attention to the misconception, frequently seen in the literature, stating that anions cannot enter interlayer space due to electrostatic repulsion forces, sometimes referred to as anion exclusion. However, the calculations presented here show that excess salt, i.e., both anions and cations enter interlayer space to the extent predicted by Donnan equilibrium. Thus the excess salt concentration is reduced in the interlayer in comparison to the external electrolyte but not totally excluded [1].

Taking into account that anions can and will enter the interlayer space a general theoretical framework for describing through-diffusion in montmorillonite is developed [2]. By using a single pore space, the interlayers, cations and anions are treated symmetrically as opposed to conventional multiporosity models where anions and cations follow different pathways. The validity of the presented approach is further justified in comparisons to experimental chloride tracer diffusion data [3].

[1] Hedström & Karnland (2011) *Geochim. Cosmochim. Acta*, submitted [2] Birgersson & Karnland (2009) *Geochim. Cosmochim. Acta* **73**, 1908-1923. [3] Van Loon, Glaus & Müller (2007) *Appl. Geochem.* **22**, 2536-2552.