Incorporation of dissolved selenium during fast precipitation of pyrite: Efficiency and morphological features

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Radionuclides could be released through the different barriers of a high-level nuclear waste (HLW) disposal site into the host rock, when it gets into contact with groundwater. The fission product of ^{235}U and ^{239}Pu, the radionuclide ^{79}Se plays an important role due to the long lifetime and the high mobility of its oxidized species Se(IV) and Se(VI).

In the host rock, pyrite formation is an important sink for several radionuclides due to sorption and incorporation that could prevent the migration to the biosphere. This has been quantitatively demonstrated in our experiments, in which up to 99 % of Se are removed from solution during pyrite precipitation at initial Se(-II) concentrations of 10^{-3} – 10^{-6} M.

The Se-doted pyrite exhibit a Se content of up to 2 wt. % with a substitution of sulfur by selenium, suggesting a slightly distorted pyrite structure. The grain sizes of the Se-doted pyrites are between 1 to 2 μm. Although these results are similar to Diener *et al.* [1], the crystals show a different morphology. This can be attributed to the optimized synthesis process, in which it is possible to increase the purity of pyrite and Se-doted pyrite significantly [2]. The Se-doted pyrite exhibits a Se rich pyrite core with a radial epitaxial growth of long, slender prisms of pyrite crystals reflecting a fast consumption of Se during the formation of the core. The pyrite synthesis shows a core with a typical pyrite cube shape on which the long, slender prisms of pyrite crystals grew more regularly compared to the Se-doted pyrite. This result agree with the proposal by Sun *et al.* [3] suggesting an aggregate of smaller particles, due to an epitaxial growth rather than a continious crystal growth.

[1] Diener *et al* (2012) *J. Contam. Hydrol.* **133**, 30–39 [2] Kim & Batchelor (2009) *Mater. Res. Bull.* **44**, 1553–1558 [3] Sun *et al* (2012) *J. Colloid Interf. Sci.* **388,** 170–175