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Uranium sources and mobility related to mining areas

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Uranium speciation in ore-water systems is mainly influenced by pH, Eh, uranium oxidation state (U^{4+}, U^{6+}), and the presence of complexing ligands (CO_3^{2-}, SO_4^{2-}, OH^-, PO_3^{4-}, SiO^{4-}, NO_3^- and VO_4^{3-}ions). U^{4+} is less soluble and forms stable compounds whereas U^{6+} tends to form numerous anionic complexes with oxygen-containing ligands that vary in solubility and mobility in aqueous solution.

Excess process water with a high uranium concentration (14,8 µg/L) was discharged from the Luossavara-Kirunavaara AB (LKAB) Svappavaara magnetite enrichment plant into the Liukattijoki river. Consequently, uranium concentrations exceeding the maximum allowable uranium concentration of 8.6 µg/L in Swedish surface waters have been detected in the river. To identify the critical factors that increase uranium mobility in the enrichment plant, process water, and solid samples were collected at different points in the enrichment plant. Elemental screening analyses of the samples were performed using ICP-SFMS. Correlations between uranium and important critical factors for uranium mobility were identified. Geochemical modeling was conducted in PHREEQC to determine uranium speciation.

The iron ore fed that is fed into the enrichment plant had a low uranium content (0.98 ppm), and the release of U from the ore was low. Therefore, the iron ore is not an important source of the high uranium concentrations observed in the dissolved phase (14.8 µg/L). In contrast, groundwater that was pumped from the mine's open pit to the enrichment plant had a higher uranium concentration of 54.5 µg/L. The groundwater had high alkalinity (145 mg/L) compared to the process water in the enrichment plant (42,6 mg/L). The process water had high SO_4^{2-} (1230 mg/L), NO_3^- (16,7 mg/L) levels compared to the groundwater (SO_4^{2-} - 145 mg/L, NO_3^- - 1,91 mg/L). Geochemical modeling revealed that uranyl carbonate complexes dominate speciation in both the groundwater and process water. The process water in the thickener before tailings deposition was found to be saturated with respect to gypsum and correlated to uranium implying that gypsum precipitation might control uranium mobility. Mineralogical characterization of gypsum in the enrichment plant and important rock types in the open pit is ongoing and the results will be presented.