

U and ²²⁶Ra mobility in the uranium mill tailings of Bellezane (France)

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In France, Uranium mines were exploited between 1947 and 2001, with a production of 51 Mt of mill tailings stored on 17 storage sites. Studies are under way to determine the long term mobility of U and ²²⁶Ra. The multiscale methodological approach includes five steps: 1) historical study regarding the ore sources, mill process and repository management; 2) radioactivity and geochemical logs and grain size analysis; 3) mineralogical characterization (SEM, TEM, XRD) on discrete samples; 4) assessment of the reactivity of the main phases towards U and ²²⁶Ra through sequential leaching experiments; 5) geochemical modelling based on the previous results and interstitial water analysis.

A focus is made on Bellezane's repository with previous results regarding the identification of the main mechanisms involved in the U and ²²⁶Ra mobility^[1,2,3]. Interstitial waters are moderately acid, weakly oxidizing with U and ²²⁶Ra concentrations of 3.5 mg/L and 0.5 Bq/L. Mean U and ²²⁶Ra contents measured in solid are respectively 169 ppm and 23 Bq/g, with a U/Ra ratio ranging from 0.04 to 0.07. The different mineralogical groups are: 1) main minerals phases of the granitic rock (Qz, micas, K-fd); 2) ancillary inherited minerals (zircons, monazites, apatites, barite, Fe-Pb sulfides and Ti-oxides); 3) newly formed minerals (clay minerals, HFO, gypsum, occasionally carbonates and barite). U-minerals are inherited coffinite and uraninite, both included in quartz grains while neoformed U-phosphates and carbonates are also observed. Sequential leaching experiments and hydrochemical modeling are consistent with U immobilized mainly onto HFO and clay minerals through sorption process, while ²²⁶Ra is immobilized in barite. These results indicate that sinks exists in Bellezane mill tailings for U and ²²⁶Ra, even in oxidizing conditions.

¹: Nos *et al.* (2013). *Mineralogical Magazine* **77**(5), 1863.

²: Descostes *et al.* (2013). AREVA Mines Technical report AMS-DEXP-DRD-RT-0002 – Public.

³: Nos *et al.* (2014) AREVA Mines Technical report AMS-DEXP-DRD-RT-0039 – Public.