Redox cycling of uranium phosphate minerals in a mining-contaminated wetland

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Reduction of uranium (VI) to low soluble uranium (IV) species in wetlands is expected to limit the transfers of this toxic element to downstream waterways. However, in such environments, long-term uranium (U) scavenging may be perturbed by hydrological and redox fluctuations. Here, based on field [1] and laboratory investigations, we detail the mechanisms of uranium redistribution from U-phosphate minerals in a heavily contaminated wetland from Brittany, France.

Using U L_{III}-edge (micro-) X-ray absorption spectroscopy, electron microscopy and geochemical analyses, we show that uranium released by the oxidative dissolution of U(IV)-phosphate minerals, especially ningyoite $CaU(PO_4)_2 \cdot 2H_2O$, is rapidly converted to organic-bound mononuclear U(VI) species. These latter can be then reduced to organic-bound U(IV) species under water-saturated conditions [1]. Moreover, oxic and anoxic incubations of soil samples reveal that specific U-phosphate minerals, autunite $Ca(UO_2)_2(PO_4)_2 \cdot 11H_2O$ and lermontovite $U(PO_4)(OH) \cdot H_2O$, are the most resistant uranium species to redox cycling occurring in the studied soils.

Altogether, the results of this study bring important informations to assess the long-term stability of uranium in seasonally saturated organic-rich mining-impacted environments.

[1] Stetten *et al*. (2018) *Environ. Sci. Technol*. **52** (22), 13099–13109