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Investigation of a wetland contaminated by uranium mine tailings in Central France

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The release of uranium from mine tailings may present a hazard to the environment, which is the reason for the monitoring of the relevant storage sites in many countries. Studying the behavior of released radionuclides at these sites serves to better estimate the local risk and can help to improve the understanding of the geochemistry of the involved contaminants, e.g. for the application in transport modelling.

The storage site Roffin, located in the Region of Auvergne, France, contains approximately 30 000 t of mill tailings from the adjacent processing plant of the same name, which operated from 1947 to 1956. After the shutdown of the plant, the responsible operator has remodeled the site several times over the decades, in order to meet updated environmental standards [1].

Recent gamma-ray surveys have shown elevated radiation levels alongside a creek downstream of the storage site, especially in a wetland area in some two hundred meters distance of the site. Drill cores taken in this area show uranium concentrations up to 2000 ppm in the upper 30 cm, with peak concentrations in a whitish, clayey layer with a thickness of about 5 cm at a depth of 20 cm. Besides this anomalous layer, the soil is of the histosol type, with very high contents of organic matter and mostly saturated with water. The goal of our study is to identify the involved uranium species in the solid and aqueous phases, in order to understand the influence of discharge history and geochemistry on the risk presented by this contamination.

Sequential extractions performed on the different layers of the soil following the protocol of Tessier et al. [2] indicate a majority of the uranium to be bound to soil organic matter. Yet scanning electron microscopy analysis (SEM) of the white layer shows the presence of particles containing high uranium concentrations with sizes around 10 µm. Energy dispersive X-ray spectra (EDS) of some of these particles give compositions corresponding to a specific mineral processed in the plant, which is Parsonsite [Pb2(UO2)(PO4)2]. Dating the soil with the C-14 of the soil organic matter and the depth profile of Cs-137 from nuclear fallout further suggests that the origin of the white layer is connected to the active period of the site. X-ray absorption spectroscopy performed on the soil shows a variable distribution of U(IV) and U(VI) in the different layers. Porewater obtained by centrifugation contains uranium concentrations up to 1000 ppb.

Further studies aim to quantify the distribution of uranium between the different solid phases of the soil, as well as the identification of the main species in the porewater.

Literature

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Primary author: FICHTNER, Andreas (Subatech IMT Atlantique Nantes)

Co-authors: SACHS, Susanne (Helmholtz-Zentrum Dresden-Rossendorf, Institute of Resource Ecology); Dr ROSSBERG, André (The Rossendorf Beamline at ESRF); Dr SCHEINOST, Andreas C. (The Rossendorf Beamline

at ESRF); Dr ARNOLD, Thuro (Helmholtz-Zentrum Dresden-Rossendorf, Institute of Resource Ecology); MONTAVON, Gilles (Subatech IMT Atlantique Nantes); Prof. STUMPF, Thorsten (Helmholtz-Zentrum Dresden-Rossendorf, Institute of Resource Ecology)

Presenter: FICHTNER, Andreas (Subatech IMT Atlantique Nantes)

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