

Effect of natural organic matter on the speciation and transfers of Uranium(VI) in a wetland soil impacted by a former uranium mine (Roffin, France)

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To understand the fate of uranium (VI) in environments with technologically enhanced natural radioactivity, it is necessary to describe the links between its speciation and transfers in the soil-water-plant continuum. The links between speciation, lability and availability of U(VI) are major issues in forest environments where organic speciation of U(VI) predominates. The aim of this work was to elucidate the effect of natural organic matter - and its molecular-scale fractionation on (nano)mineral surfaces during sorption- on speciation and soil-water transfers of U(VI) in a wetland.

We carried out laboratory experiments related to a wetland soil profile showing humic and sub-surface clay horizons, with the latter being highly enriched in uranium (up to 2000 ppb) due to former U mining activities (Puy-de-Dôme, France). We used a combination of traditional batch techniques, fluorescence spectroscopy and Electrospray Ionisation mass spectrometry (ESI-MS) . Results from desorption experiments provided evidence that U(VI), desorbed from wetland soil sub-samples with a solution at pH 5, is found in a colloidal fraction of 1-60 nm size. This fraction also contains iron oxide nano-minerals and condensed aromatic-type organic molecules as well as molecules with phosphate functions, while protein-like molecules are present in dissolved organic matter (DOM).

This has enabled us to define experimental conditions for studying model mineral-solution systems under controlled laboratory conditions, that contain U(VI), soil OM (extracted from the wetland clayey horizon) and an iron oxide (hematite of ca. 80 nm in size). In the absence of hematite, most of U is in the form of uranyl organic colloids (> 200 nm in size), made up of an OM component of biological origin. In the ternary hematite-MO-U system, the presence of U promoted OM adsorption on hematite, -more precisely of a fraction made up of “humic-type molecules” such as condensed aromatics-. We thus observed the formation of ternary hematite surface-U-MO complexes, which were associated with a change in DOM composition. These results were consistent with those of desorption experiments, pointing to the involvement of OM and Fe-oxides in U desorption from wetland soils.