Influence of dissolved natural organic matter on the mobility of uranium and lanthanides in surface waters of a former U-mining site

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Introduction : Understanding mobility of Uranium (U) or lanthanides (Ln) in surface waters requires knowledge on the U and Ln species forming in solution or at surfaces of suspended colloids in the presence of natural organic matter such as Fulvic Acids (FA), which are complex mixtures of many organic molecules of different chemical reactivities. To address the issue of chemical identity of the FA molecules affecting speciation and mobility of U and Ln, we performed multivariate analysis, including FA molecular-level analysis, of surface waters collected in a watershed of a former U mine.

Materials and methods : Water samples were collected (winter and spring 2017-2018) along streams flowing into a watershed (with a U-Ln downstream accumulation zone, a.z.), and in a tailings storage area (s.a.), of a former U mine operating in the 1950s (Roffin, Fr). FA were extracted using IHSS protocol (DAX resin) and analysed by electrospray ionisation mass spectrometry (ESI(-)-FTMS). Concentrations of U and Ln were determined by ICP-MS analysis.

Results and conclusion : The U-Ln water concentrations range from 0.9 to 5ppm and 0.01 to 0.8ppm, respectively, with the highest values being found in spring for samples collected at the outlet of s.a. and at the lowest point of a.z. The high values of dissolved organic carbon (DOC) recorded for these samples, and their DOC seasonal variations (both in molecular composition and in concentration, i.e., from 2.0 $mg.L^{-1}$ in winter to 9 $mg.L^{-1}$ in spring) are expected to strongly influence mobility of U and Ln. Molecular-level data of the FA extracts indeed show the presence in these waters of aromatic and highly oxygenated aliphatic molecules (H / C <1 and O / C> 0.5) that likely have a high affinity for U-Ln. There was also observed a trend of a concomitant increase in U, Ln, Fe and DOC concentrations in the waters, suggesting the presence of Fe-colloids influencing mobility of metals and organic matter (in spring), too. Therefore, the mobility of U and Ln may result from both metal complexation with the aromatic and oxygenated aliphatic molecules in solution and interactions in ternary systems U-Ln / FA / Fe-colloids.