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U(IV) release from a mining impacted wetland

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U contamination as a result of U mining and processing is ubiquitous. In the environment, uranium is typically present in either its oxidized, soluble hexavalent state [U(VI)] or its reduced, insoluble tetravalent state [U(IV)]. The concentration of U was observed to increase as stream flowed through a wetland contaminated with U. This was unexpected as U is usually found in its sparingly soluble tetravalent state in the reducing environment of wetlands and, as a result, release would be expected to be minimal. This investigation aimed at characterizing the speciation of U to attempt to explain this phenomenon.
U was present in the top 40 cm of the soil and was identified as almost exclusively a non-crystalline U(IV) species using X-ray absorption spectroscopy. Additionally, electron microscopy revealed that U was associated primarily with amorphous Fe-P-Al-Si assemblages. Surprisingly, little U was associated with the clay phases (e.g., muscovite, smectite) that dominate the mineralogy of this soil.
In contrast, a relatively high concentration of porewater U was distributed uniformly throughout the soil depth in the porewater. Further characterization of the speciation of U revealed the presence of U associated with colloids of Fe and organic matter. This finding suggests that U is labile and mobile in the soil and is released into the porewater and eventually into the stream due to the formation of U-bearing colloids. Using laser fluorescence spectroscopy, these colloids were shown to be associated with tetravalent uranium.
This study highlights the mobility of U from a wetland even though U is present in a reduced valence. This is the first time that such mobility is demonstrated in the environment and it brings into question the use of constructed wetlands for the treatment of U-impacted waters.

Primary author: Prof. BERNIER-LATMANI, Rizlan (Ecole Polytechnique Federale de Lausanne (EPFL))

Presenter: Prof. BERNIER-LATMANI, Rizlan (Ecole Polytechnique Federale de Lausanne (EPFL))

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