Mineralogical, geochemical and radiological characterisation of weathered uranium ore

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Uraninite (UO_2) ores are considered as natural analogue systems for the disposal of spent nuclear fuel, which contain ~95 % UO_2. It is well established that UO_2 remains stable if the oxidation state of the matrix does not exceed $UO_{2.25}$. In this presentation, we describe the mineralogical, geochemical and radiological transformations that occur to UO_2 ore when it is exposed to oxidising, and sometimes dynamic, sub-surface environments.

Using a complementary suite of synchrotron x-ray microanalyses, high resolution gamma spectrometry and geochemical analysis, we have characterised a series of uranium ores exposed to weathering processes in the sub-surface. The distribution of uranium-bearing phases was mapped using x-ray fluorescence (μ-XRF) and the oxidation states were identified through a combination of x-ray absorption near edge spectroscopy (μ-XANES) and oxidation state mapping by μ-XRF. Uranium phase identfication was performed using x-ray diffraction (μ-XRD). Quantitative determination of the radionuclide elements present was achieved using gamma spectrometry. Additionally, the likely environmental mobility of uranium was assessed using sequential extraction techniques.

This study indicates that the stability of uranium ore in the subsurface, and upon exposure to environmental conditions, is variable and highly sensitive to the local environment. Additionally, the utility of spatially-resolved, high resolution synchrotron microprobe techniques to resolve heterogeneity in uranium mineralogy and chemistry, at the micron scale, is demonstrated.