Long-term interactions of radionuclides and minerals in radioactive waste geodisposal and contaminated land environments

The UK has a substantial legacy of radioactive wastes and their safe management using deep geological disposal is a national priority (Figure 1). Understanding the long-term fate of radionuclides in the environment is key to developing safe management of radioactive wastes and radioactively contaminated land. In radioactive waste disposal, during evolution of the repository, iron (oxyhydr)oxide (e.g. hematite and magnetite) minerals will be present in wastes and will also form during the corrosion of steel canisters and engineering iron in the site. Recent studies have indicated that iron oxyhydroxides can incorporate a range of radionuclides, including actinides (Marshall et al., 2014a, b; Bots et al., 2015; Roberts et al., 2017, Figure 2) and Tc (Marshall et al., 2015). These incorporation processes have the potential to act as a long-term barrier to radionuclide migration in waste disposal systems with the radionuclides immobilised within the mineral structures. However, changes in both abiotic and biologically driven geochemical processes that occur over the long-term within the environment will alter the biogeochemistry within and around the repository (e.g. Newsome et al., 2014). In turn, this will influence the stability of the iron oxyhydroxide minerals formed and ultimately these changes will impact on the fate of the radionuclides with the potential for re-mobilisation to occur.

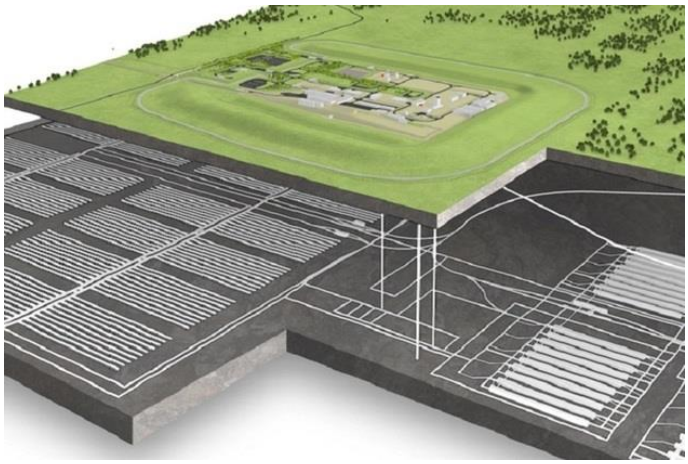

Figure 1. Schematic representing a deep geological disposal facility for higher activity radioactive wastes. (www.gov.uk)

This experimental project will focus on characterising the fate of key radionuclides such as uranium, technetium and neptunium associated with deep geological disposal relevant iron oxyhydroxide minerals during conditions relevant to the long-term biogeochemical evolution of a repository. The project will examine the influence of both abiotic and biological processes on radionuclide behaviour, and utilise advanced geochemical, nanoscale characterisation and microbiological genomic techniques to probe the mechanisms of radionuclide interactions.

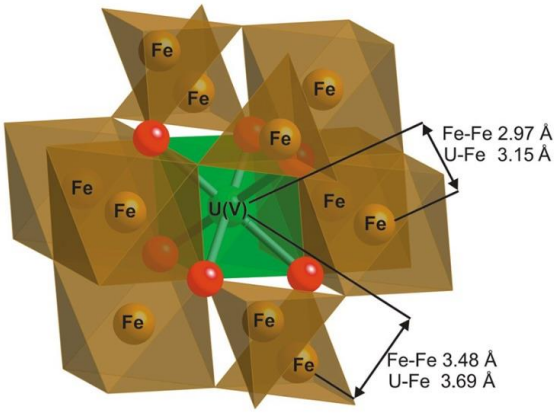

Figure 2. Uranium(V) incorporated into magnetite (Fe_3O_4) via direct substitution for Fe.

Training: This industrially sponsored PhD projects will be based in the School of Earth & Environmental Sciences at The University of Manchester. The project is experimental in scope, and the successful candidates will join a significant ongoing research effort associated with the Next Generation Nuclear Centre for Doctoral Training. The project will be based at The University of Manchester and run in collaboration the National Nuclear Laboratory. Currently, we have over 20 PhD researchers training across the nuclear environmental area, all of our nuclear PhD graduates have gained employment in academia / industry. The project will also benefit from the excellent facilities within the Williamson Research Centre for Molecular Environmental Science to perform chemical, mineralogical and microbial studies. The student will also have access to advanced facilities available

within The University of Manchester (e.g. electron microscopy, X-ray photo electron spectroscopy, mass spectrometry), as well as national and international facilities where we are able to analyse radioactive samples e.g. Diamond Light Source (http://www.diamond.ac.uk). Finally, the students will work closely with industrial supervisors within the National Nuclear Laboratory.

Candidate Skills: These projects are experimental in scope and the successful candidates should have a strong background in Chemistry, Environmental Chemistry, Environmental Sciences, Geology, Geochemistry or similar. If you require further details about the project please contact Prof Sam Shaw (sam.shaw@manchester.ac.uk).
Details of the Next Generation Nuclear Centre for Doctoral Training can be found at http://www.nextgennuclear.manchester.ac.uk/our-research/manchester/
Applications can be made through The University of Manchester site http://www.manchester.ac.uk/study/postgraduate-research/admissions/

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