Understanding Uranium Migration in Hard-Rocks.

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Geological disposal is the preferred management end-point for high-level radioactive waste and, in some countries, also spent fuel. A safety assessment procedure for disposal has to demonstrate for a given case that any releases of radionuclides, that will almost certainly occur at some time in the future, have negligible impact.

Although a large body of quantitative information on trace element migration through various host rock matrices has been accumulated over the past 30 years, many of the processes affecting migration have not yet been adequately characterised. In particular, the geochemical behaviour of uranium, the transuranics and certain fission products is insufficiently known at the microscale. Detailed process knowledge is required as a basis for informed simplification, as required by performance assessment models. This knowledge can be developed through well-defined experimental programmes.

Field observations and tracer tests carried out at natural uranium ore bodies in southern Finland have been augmented by laboratory-scale migration tests on prepared borehole cores. A disc of depleted uranium, forming the source, was placed between two granite cores in a triaxial cell. Pre-equilibrated water was passed through the cell under slight over-pressure and changes to the flow and chemical composition of the effluent monitored for a period of one year.

The source term and the response of the column were simulated using the mixing cell transport model within PHREEQC. Predictions of the likely solid phases controlling uranium retention were used to test our understanding of both the migration behaviour and the adequacy of extant thermodynamic solubility data.

Implications for performance assessment modelling and the safety case are discussed.