Petrology of column experiments on the interaction of young cement leachate with silicate host rock in a geological disposal facility

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The current UK concept for the disposal of low- and intermediate-level radioactive wastes involves a mined geological disposal facility (GDF) located several hundreds of metres below the surface. The waste material will be encapsulated in a cementitious matrix within steel or concrete containers, and will be placed in disposal vaults backfilled with a cement-based material. After closure, the vaults will saturate with groundwater and become part of a modified regional groundwater flow system. Groundwater will equilibrate with the cement and produce an alkaline leachate. This will migrate from the repository into the surrounding rock and produce a 'chemically disturbed zone' (CDZ) with an elevated pH. Reactions will occur between the alkaline waters and the rock, potentially causing mineral dissolution and precipitation, which will modify the local geosphere prior to possible eventual radionuclide release. These changes in the CDZ will be critical controls on radionuclide behaviour and transport, and thus on the safety and environmental impact of a GDF. Consequently, it is desirable to understand these reactions and their impacts in terms of predicting localised changes to the transport properties of the host rock (porosity, permeability) and changes in groundwater flow, together with alteration of minerals and mineral surfaces that may have an effect on radionuclide migration and retardation. This work focuses on experiments designed to simulate the evolution of the alkaline plume from the GDF, to evaluate the spatial and temporal distribution of mineral alteration within the CDZ, and to quantify its impact on porosity and permeability.

The results presented here represent a summary of the mineralogical observations from Stage 1 of the column experiments, which investigate the interaction of a K-Ca-rich Young Cement Leachate (pH 13.1) with a "model" host rock. Significant interaction is observed within the reacted columns, with physical movement of fines, dissolution of silicate minerals, and the precipitation of secondary K-Al-bearing calcium silicate hydrate phases, all of which will impact on the transport properties of the host rock.