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.

Syringe based flow injection MC-ICP-MS: Rotal sample consumption and rapid sample standard bracketing

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Sample-standard bracketing is a widely used standardization technique for the determination of precise isotope ratios by MC-ICPMS. The frequency of standard bracketing needed to compensate for mass bias drift increases with required precision and decreasing mass. Many isotope systems below 100 amu necessitate the analysis of a standard after every sample. This combined with low sample flow rates (typically $\leq$ 100uL/min) requires that a significant amount of time is wasted during uptake and wash cycles. A newly designed, syringe driven, flow injection system precisely and accurately loads exact volumes into a loop and syringe injects them at any user defined flow rate (10-1000uL/min). The valve on the flow injection system selects from two discrete parallel flow paths for standard and samples. This allows rapid switching between sample and standard solutions with minimal dead volume between the valve and the nebulizer. During the standard analysis the sample flow path is prepared by, 1) rapidly vacuum rinsing the uptake probe and sample loop, 2) resetting the sample syringe, and 3) accurately and precisely loading the exact sample volume into the loop. Alternatively, during sample analysis the standard side of the system is preparing for standard injection by resetting the standard syringe. The resulting benefits of flow injection MC-ICPMS are; 1) rapid wash out, 2) rapid uptake, 3) rapid sample-standard bracketing, 4) syringe controlled sample volumes, and 5) syringe controlled sample flow rates. This presentation will illustrate the utility flow injection and its benefits with respect to total sample consumption, absolute detection limits and sample standard bracketing.

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DOI:10.1180/minmag.2013.077.5.6