Geophysical Research Abstracts
Vol. 16, EGU2014-748-1, 2014
EGU General Assembly 2014

Modelling matrix diffusion in high-pH infiltration tests in concrete columns

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Tracer tests in concrete columns have been carried out to improve the characterization of the transport properties of the concrete from the Radioactive Waste Disposal Facility at El Cabril (Spain). High entry pressure has been employed in order to perform the experiments in a reasonable time span. Three tests have been performed using different infiltration solutions, with pH 12.6, 7.0 and 13.4, respectively. Lithium, bromide and deuterium have been used as tracers. Experimental results show that permeability decreases with time probably because of mineral precipitation. So, solute transport in concrete cannot easily be decoupled from reactions. A preliminary model of only advection and dispersion could not be fitted satisfactory to the breakthrough curves of conservative tracers. Therefore, we added matrix diffusion between a mobile pore domain, where water can flow, and an immobile zone without any advective flow. Three conceptual models have been compared, considering the immobile zone as (i) slabs, (ii) spheres and (iii) tubes. Porosity of the mobile and immobile zones, size of the immobile zone and a diffusion coefficient are estimated by calibrating the model results to the measured breakthrough curve. The calculated values show that matrix diffusion plays an important role in solute transport. The best fit is obtained with the tube concept: cylindrical diffusion from concrete (large radius) to mobile zone (small radius).