Cs batch sorption and column transport experiments on sand from the Yamin plain, Israel – Experimental results and modelling

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The Yanim plain hosts the national Israeli radioactive waste disposal site. The site is located on the Miocene aged Hazeva formation, comprised of loose sand, sandstone and dispersed clay layers. The current research examines the sorption capacity of the local sand to solutions doped with Cs ions. The sand contains ~95% quartz and ~5% of various clays, carbonates, and oxides. Batch sorption experiments were conducted at a liquid to solid ratio of 10. Two end-member solutions were used, fresh (MQ) and concentrated (Na-Nitrate solution). Both solutions were doped with 0.1, 1, 10, 100 and 1000 ppm of Cs (as a nitrate). For the MQ experiments Kd values ranged between ~2 and ~1300, where the highest Kds were registered for the 1 ppm doping level, and the smallest Kds were for the 1000 ppm doping level. For the concentrated solution Kd values ranged between ~0 and ~1.5, where the highest Kds were for the 1 ppm doping level, for all other doping levels Kds were <1. Freundlich and Langmuir isotherm calculations revealed a significantly better correlation on a linearized Freundlich isotherm, indicating a multi-layer and multi-site sorption model, with a similar slope for both solutions, indicating a common sorption mechanism. Column transport experiments (L=25cm, r=2cm, ϕ=30%, 1PV=180cc) have shown minimal retardation of the Cs in the concentrated solution flow experiments (R= ~2). A second, probably colloid-related peak, showed an early breakthrough with respect to a conservative color tracer. On the other hand, when MQ was run in the column no breakthrough was observed within 10 column pore volumes. In one fresh experiment a very small colloid related peak was found with breakthrough similar to the conservative tracer. We used the CXTFIT model to calculated the dispersity (λ [L]) and normalized velocity (V) of the measured tracer. For the conservative tracer the values were λ=0.13 cm and V=0.9 cm. For Cs transport in the concentrated solution λ=0.22 cm and V=1.6. Thus, it may be concluded that even in similar doping levels in the same matrix the solution chemistry will play a major role in contaminant retardation. Thus, rain episodes which abruptly change the solution chemistry, can significantly affect solute and colloid mobility.

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