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Reactive transport modeling for Cs retention: from batch to field experiments

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A Permeable Reactive Barrier has been designed to treat ^{137}Cs polluted groundwater. In order to check both reactivity and permeability, laboratory batch and column tests combined with reactive transport modeling have been performed. The trapping mechanism is based on the sorption of cesium mainly on illite-containing clays. Batch experiments were conducted to obtain the partition coefficients (Kd) of different clay samples in solutions with different potassium concentration. A clear correlation of Kd values with potassium content was observed. The results were modeled with a cation-exchange model.

The permeability of the reactive material is provided by the dispersion of the clay on a matrix of wooden shavings. Constant head tests allowed obtaining permeability values. Several column experiments with different flow rates were conducted to confirm the ^{137}Cs retention under different conditions. A blind 1D reactive transport model based on the cation-exchange model was able to predict reasonably well the results of column experiments.

The reactive transport model, validated with the column experiments, was used to investigate the performance and duration of 1m thick barrier under different scenarios (flow, clay proportion, ^{137}Cs and K concentration). As expected, the sensitivity tests proved that the retention capacity of dissolved ^{137}Cs in groundwater depends linearly on the amount of clay used in the filling material. As well, the operation time increases linearly when decreasing the flow rate. Finally, the concentration of potassium in inflow water has a remarkable and non-linear influence in the retention of ^{137}Cs. Very high concentrations of potassium are the greatest threat and can lead to the unfeasibility of a permeable reactive barrier. Due to the Cs-K competition, the barrier is comparatively more efficient to treat high concentrations of ^{137}Cs.

Up to now, preliminary results from a field scale experiment have confirmed the reactivity and permeability obtained from the laboratory tests and predicted by the reactive transport modeling.