The Effect of Desorption Kinetics and Unsaturated Conditions on the Colloid-Facilitated Transport on Cesium and Strontium

The presence of small particles (colloids) in natural soil and groundwater systems has been well established. Under certain environmental conditions, the sorption of contaminants to mobile colloids can increase transport in a process known as colloid-facilitated transport (Turner et al., 2006; Buddemeier and Hunt, 1998). In order for colloid-facilitated transport to be significant, however, three conditions must be met: 1) mobile colloids must be present, 2) the contaminant must associate with the colloids, and 3) the contaminant must stay associated with the mobile colloids long enough to be transported. The goal of our research was to identify and quantify the effects of desorption kinetics from illite clay colloids on the transport of cesium and strontium through a quartz sand column at different degrees of saturation (moisture contents). Cesium and strontium were used as model contaminants because they are common contaminants found on Department of Energy sites in the US and because they have contrasting sorption kinetics with illite. Breakthrough experiments were conducted using a rainfall simulator suspended over a column (12.7 cm diameter and 33.5 cm long) packed with clean, sieved quartz sand with a median grain size of 0.325 mm (See Figure 1). The effluent was collected with a peristaltic pump and a fraction collector and measured for total and dissolved ions, pH, and colloid concentration.

The presence of illite colloids increased the transport of both cesium and strontium; however, the transport of cesium was increased more than strontium, likely due to cesium binding more strongly to the frayed edges of illite. A previously developed model for saturated colloid-facilitated transport of cesium and strontium has been extended to accommodate partially-saturated conditions. Fitting the experimental data (See Figure 2) to the model produces cesium desorption rates almost three orders of magnitude slower than strontium. Partially-saturated conditions can potentially increase the transport of cesium and strontium more than saturated conditions due to the decreased effective surface area of the sand media. As the moisture content decreases, the increased removal of colloids offsets this enhanced transport, suggesting there is an optimal partially-saturated moisture content for CFT to occur.