Sorption properties of selected radionuclides and elements on sedimentary rocks in highly saline solutions

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In Canada, sedimentary rocks are being considered as potential formations to host a deep geologic repository for long-term management of radioactive waste. Within deep-seated low permeability groundwater systems these sediments have been observed to contain Na-Ca-Cl brine solutions with total dissolved solids (TDS) ranging between 200 and 400 g/L. A database of distribution coefficients (K_d) for 28 elements (C, Cl, Ca, Ni, Cu, As, Se, Zr, Nb, Mo, Tc, Pd, Ag, Cd, Sn, I, Cs, Eu, Hg, Pb, Bi, Ra, Th, Pa, U, Np, Pu and Am) has been developed for shale, limestone and bentonite clay in such high ionic strength waters under neutral pH conditions. The database was compiled following extensive reviews of the open literature and international sorption databases, and has been augmented with measured values for elements of interest to a repository safety case.

The K_d values for Ni, Cu, Pd, Zr, Sn, Cs, Eu, Pb and Th were measured in a range of high salinity solutions, which included a synthetic porewater brine with a TDS of 275 g/L (SPW), by both batch and long-term (1 year) through-diffusion experiments. K_d values obtained by batch tests were found consistent with those derived from diffusion tests for most elements provided reduced access to sorption sites within the rock matrix was taken into account. Similarly, batch and diffusion derived K_d provided insight and confidence with respect to the applicability of the K_d approach to simulate sorption during diffusive mass transport in shale and limestone. The K_d values for redox sensitive As, Se, Tc, U, Np and Pu were measured in the SPW under reducing conditions, as expected within a deep geological repository, within a glove box. U and Np sorption was also measured under oxidizing conditions in a range of high salinity solutions that include the SPW. The effects of ionic strength and pH of solutions on the sorption were also investigated.