The stability of colloidal U(VI) nanoparticles under alkaline conditions in the presence of quartz, orthoclase, & cement phases

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Colloidal U(VI) nanoparticles have been observed and characterised in a high pH (pH > 13.1) cement leachate [1]. Thermodynamic modelling and X-ray absorption spectroscopy analysis shows these systems are supersaturated with respect to a number of calcium and sodium uranate phases. This study investigates the stability of these U(VI) colloids in a range of single minerals and cement sorption systems run under high pH conditions relevant to the disposal of intermediate level radioactive wastes in cement containing engineered barrier systems. The U(VI) colloids were found to be stable and remained in solution in the presence of quartz and orthoclase for periods of at least 2.5 years. By contrast, when contacted with Nirex Reference Vault Backfill (NRVB), significant (> 95 %) amounts of the added uranium was retained on solids after 1 month. X-ray absorption spectroscopy of the NRVB system confirmed the formation of a uranate-like phase associated with the solids. Interestingly, after one month of reaction with the cement system, U was present at levels which were supersaturated with respect to a number of U(VI) phases according to solubility calculations. This suggests that intrinsic U(VI) colloids are poorly reactive with pure mineral phases, but that significant reactivity occurs with NRVB.

[1] P. Bots, K. Morris, R. Hibberd, G. T. W. Law, J. F. W. Mosselmans, A. P. Brown, J. Doutch, A. J. Smith, S. Shaw (2014) *Langmuir* **30**, 14396 – 14405.