

The Aqueous Chemistry of Actinides and Metalloids

The aqueous chemistry of actinides and metalloids is very intricate and difficult to study due their reactivity, redox chemistry and acid /base behaviour. However, some of the major global challenges to environmental quality are associated with these element groups and my group is studying in particular the interactions of arsenic and uranium with mineral and organic substrates in the context of water quality and nuclear waste.

The first area of interest focusses on arsenic contamination of drinking water. Approximately 170 million people in over 70 countries are threatened by arsenic polluted drinking water. Our work addresses two distinct challenges, one more technological oriented, one more environmental oriented. The first area is addressing the widely observed failure of iron oxides, the state of the art removal technology, to remove arsenic concentrations to the safe levels when dealing with groundwater removed from anoxic depths. This is because the reduced form of arsenic adsorbs poorly to iron and aluminium oxides. To this end, we are developing treatment devices for municipal scale plants using FeIII oxide and TiIV dioxide combined in a bi-functional composite material as it integrates the adsorption performance of the iron phase and the titanium phase photo-catalytically oxidizes AsIII. To optimise the cartridge design, we are at present studying in detail the photo oxidation and the adsorption mechanism and developing surface compilation models to predict the amount of arsenic adsorbed under different groundwater. Future work aims on to enable photo oxidation in the visible light range. The second area focuses on the effect of climate change on arsenic mobility in aquifers in coastal areas. It is predicted that sea level rise will increase the salinity of groundwater aquifers and on great unknowns is how this change in aqueous chemistry will affect the performance of treatment plants and of the arsenic chemistry in soils

The first area of interest focuses on the actinide geochemistry in alkaline solutions. The release of uranium from disintegrating cement containers is the critical controlling process during leakage of radio nuclides form nuclear waste repositories but the controlling biogeochemical processes are widely debated. Recent work of our group supports the hypothesis that the formation of colloids is a major controlling process but it remains unclear how these colloids are formed and if these lead to an increase in mobility. We are in particular interested in understanding better the role of host rock and of microorganism and organic ligands.

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