The biogeochemical fate of organic decontamination agents in low level radioactive waste disposal

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Organic complexants in radioactive waste may challenge disposal as they can enhance subsurface mobility of contaminants via chelation. The principal sources of organic complexing agents in the UK's low level radioactive waste (LLW) inventory originate from chemical decontamination activities. Polycarboxylic organic decontaminants (e.g. citric and oxalic acid) are of interest as models underpinning Environmental Safety Cases (ESC) rely on assumptions about their biodegradability at high pH. Experimental results will further underpin current model outputs. This work explores the biogeochemical fate of citric acid, a model decontaminant, under high pH conditions relevant to cementitious LLW repositories.

Anaerobic microcosm experiments were set up using a high pH adapted microbial inoculum. A series of microcosms were poised at pH 10, 11 and 12 and citrate was supplied as the sole electron donor and carbon source, under fermentative, NO_3^--, Fe(III)- and SO_4^{2-}- reducing conditions. Results show citrate is oxidised using NO_3^- or Fe(III) as the electron acceptor at pH > 11. Fe(II) ingrowth was observed at pH values recorded up to 11.7. Mineralogical analysis of the resultant Fe-phase indicated that nanocrystalline magnetite was formed as an end product of Fe(III)-reduction at high pH. Sulfate reduction occurred in a single microcosm at pH 10; here citrate was fully removed from solution.

These results will improve long-term environmental safety case development of cementitious LLW repositories.