Long-term immobilisation of technetium via bioremediation with proprietary electron donors

LAURA NEWSOME[1], ADRIAN CLEARY[1],
KATHERINE MORRIS[1], JONATHAN R LLOYD[1]

1 Research Centre for Radwaste Disposal and Williamson Research Centre, School of Earth, Atmospheric and Environmental Sciences, University of Manchester, Manchester, M13 9PL, United Kingdom
laura.newsome@manchester.ac.uk

Technetium groundwater contamination is an issue at a number of nuclear sites such as Sellafield and Hanford, particularly due to its environmental mobility and its biological availability as a sulfate analogue. In oxic waters Tc is present as aqueous and mobile pertechnetate $Tc(VII)O_4^-$, but under reducing conditions it can precipitate or sorb from solution as Tc(IV). Biostimulation of sediment microbial communities via the addition of an electron donor can lead to the removal of Tc(VII) from groundwater as Tc(IV), driven by the microbially-mediated formation of Fe(II).

Here we investigated the potential for different slow-release proprietary electron donors to stimulate Tc bioremediation using sediments collected from a UK nuclear site. These included a poly-lactate substrate (HRC®), a poly-lactate substrate containing a sulfur moiety (MRC®) and a plant material mixed with zero valent iron (EHC®). Slow-release donors are beneficial as they do not require large volumes of substrate to be pumped into the subsurface which may affect the groundwater flow regime, nor do they require frequent reapplication. Sediment microcosms were supplemented with a proprietary electron donor and then monitored for changes in aqueous and solid phase geochemistry over three months.

Results revealed that Tc(VII) was removed from solution following biostimulation with each proprietary electron donor. X-ray absorption spectroscopy showed that it was precipitated as a $Tc(IV)O_2$-like phase with HRC® and EHC®, while the spectra with MRC® appeared similar to $Tc(IV)S_2$. The reduced Tc(IV) phases were then exposed to air to assess their sensitivity to oxidative remobilisation; monitoring showed negligible quantities of technetium were re-released to solution under these highly oxidising conditions, unlike in an acetate-amended system where 50 % of Tc was reoxidised.

In summary, we have demonstrated that targeted treatments can be used to stimulate the *in situ* formation of recalcitrant Tc(IV) biominerals, and therefore could be effective in the long-term remediation of Tc contaminated groundwater.