Imaging ^{99}Tc bioreduction in sediment columns.

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The behaviour of technetium at ultra-trace (< 10^{-10} M) concentrations in sediment columns was investigated using ^{99m}Tc γ-camera imaging. Experiments were representative of the subsurface at the Sellafield nuclear facility in Cumbria, UK, where ^{99}Tc is mobile in groundwaters [1]. The focus was on bioreduction as a potential treatment option for mobile ^{99}Tc. Technetium-99m at ultra-dilute concentrations (5 x 10^{-10} M) was added to flowing sediment columns (4.63 x 10^{-6} ms^{-1}) at intervals during acetate stimulated reduction and subsequent re-oxidation with the radionuclide imaged using a gamma camera at the Manchester Royal Infirmary. During imaging, ^{99m}Tc was retained in Fe(III) reducing areas in the sediment and Tc retention was commensurate with increasing sediment 0.5 N HCl extractable Fe(II)/Fe(III) ratios [2]. Retention of Tc was presumably due to reduction of Tc(VII) to Tc(IV) and subsequent sorption of Tc(IV) to the sediment, even at ultra-dilute concentrations below the theoretical solubility limit of hydrous TcO_2 (~ 10^{-8} mol l^{-1}). In oxic columns ^{99m}Tc behaved as a conservative tracer and gave information on porosity and flow dynamics. These results demonstrate the potential for biostimulation to immobilise ultra-trace concentrations of ^{99}Tc in the presence of biogenic Fe(II) in sediments over fast (minutes) timescales [3]. Ongoing experiments are also investigating the rate of column re-oxidation with oxygenated water and nitrate and preliminary results will be presented.

[1] Stamper et al. (2013) Sellafield Ltd, Technical report: LQTD000032. [2] Lear et al. (2010). *Environ. Sci. Technol.* *44*, 156-162. [3] Burke et al. (2010) *Appl. Geochem.* **25**, 233-241.