Imaging the microbe mineral interface during Fe(III) reduction

HELEN F DOWNIE[1*], VICKY S COKER[1], BURKHARD KAULICH[2], RICHARD F COLLINS[1], DAVID A POLYA[1] AND JONATHAN R LLOYD[1]

[1]University of Manchester, Oxford Rd, Manchester M13 9PL
*Helen.Downie@Manchester.ac.uk
[2]Diamond Light Source, Harwell Science & Innovation Campus, Oxfordshire OX11 0DE

Bacteria influence the mineralogy of the terrestrial subsurface. For example, dissimilatory Fe(III) reduction is a ubiquitous process which influences the geochemical cycling of bulk and trace elements in the environment. Microbial reduction of arsenic-bearing Fe(III) oxyhydroxide phases (e.g. ferrihydrite) is thought to play a significant role in releasing the toxic metalloid into aquifers, threatening the lives of tens of millions of people worldwide [1]. To date, most experimental work has studied the influence of microbes on the overall chemistry and mineralogy of sediments. In contrast, nanoscale imaging approaches can provide information on the morphology of bacteria, biofilms, EPS and their local influence on the chemistry of minerals [2].

Our aim was to combine imaging techniques to provide a holistic understanding of the microbe mineral interface in these systems. Pure cultures of *Geobacter sulfurreducens* were grown on thin films of ferrihydrite that could be imaged directly without disruption, preserving the spatial distribution of microbes and minerals by avoiding homogenisation before imaging.

A combination of epifluorescence microscopy and cryo electron tomography was used to image cell colonisation and microbe-mineral interactions at submicron resolution, alongside changes in metal oxidation state induced locally by microbial metabolism using cryo scanning X-ray microscopy (SXM) with near edge X-ray absorption fine structure (NEXAFS) of the thin film system.

In summary, we have developed a new ferrihydrite thin film system to facilitate imaging the microbe-Fe interface. We have brought together numerous imaging techniques to analyse different aspects of the microbe metal interface, from bacterial colony proliferation to the direct impact on associated trace elements during iron respiration.

[1] Polya D, Charlet L. Environmental science: rising arsenic risk? Nat Geosci. 2009;2(6):383–4. [2] Coker VS, et al. Characterisation of the dissimilatory reduction of Fe(III)-oxyhydroxide at the microbe-mineral interface: the application of STXM-XMCD. Geobiology 2012;10(4):347–54.