Size dependent microbial redox cycling of Fe within magnetite

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The ability for Fe metabolizing bacteria to produce magnetite has been known for several decades, either externally through dissimilatory Fe(III) reduction [1] or internally in the form of magnetosomes [2]. However the potential for bacteria to futher interact with the mineral in the environment once formed is relatively underexplored. We recently demonstrated that the phototrophic Fe(II)-oxidizer *Rhodopseudomonas palustris* TIE-1 can directly oxidize magnetite nanoparticles in the presence of light, with the process reversible in the dark by the dissimilatory Fe(III)-reducer *Geobacter sulfurreducens* [3]. We postulated that depending on the redox conditions present each bacterium could use the magnetite as a natural battery, i.e. as an electron sink or source. Furthermore, we suggested that this microbe-mineral interaction was confined to the surface of the magnetite, with the bulk properties remaining relatively intact. Whilst this may help to support microbial respiration/growth in redox active areas, changes to the stoichiometry (i.e. Fe(II)/Fe(III) ratio) of magnetite will have direct impacts upon its potential use as a magnetically recoverable remediation agent [4].

In this study we probe the size dependence of microbe-magnetite redox interactions and the potential impacts of these interactions on magnetite reactivity. We compare nanoparticles (~10 nm) against larger microparticles (100-300 nm) and react the particles after microbial reduction/oxidation with Cr(VI). Through a combination of synchrotron and lab based experiments including x-ray absorption (XAS) x-ray magnetic circular dichroism (XMCD), magnetic susceptibility, x-ray diffraction (XRD) and Mössbauer spectroscopy, we have probed the changes to the distribution of iron within magnetite nano and microparticles induced by Fe-metabolizing bacteria. This work has several important implications in the understanding of biogenic mineral interactions and its impact upon many different areas of research including remediation and environmental magnetism.

[1] Lovley D. R., and Philips E. J. P., (1986) *AEM* **52**, 751-757. [2] Blakemore R., (1975) *Science* **190** 377-379. [3] Byrne J. M., et al. (2015), *Science* **347** 1473-1476. [4] Latta D. E., et al. (2011), *ES&T* **46**, 778-786.