

Remediating acidic metal(loid) contaminated groundwater using *in situ* biogenic magnetite

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Both neutral and acid mine drainage (AMD) are often associated with elevated metal(loid) concentrations. In principle many iron minerals are capable of retaining these contaminants [1] and various related *in situ* technologies that use these properties have been attempted. However, these can fail as most newly formed iron minerals undergo re-dissolution due to the acidity of AMD and/or variable redox gradients in the subsurface environment [2].

The present study investigates the formation of *in situ* biogenic magnetite (Fe₃O₄), which has previously been shown to remain stable under a remarkably wide range of geochemical conditions [3]. *In situ* magnetite formation may involve co-precipitation of cations (e.g., Al³⁺, Ti⁴⁺, Cr³⁺, Co²⁺, Ni²⁺, Zn²⁺ and Cd²⁺) as well as oxyanions (e.g., As) via incorporation into the crystal structure [3, 4]. After formation, magnetite may act as an effective adsorbent for metal(loid)s.

The study aims to identify the key factors controlling the formation of *in situ* magnetite for a broader pH range and to deepen our understanding of the microbially mediated anaerobic nitrate-dependent Fe(II) oxidation pathway.

The potential for bioremediation of AMD sites using magnetite is explored through a combination of batch and column studies. The experiments investigate both pure cultures of denitrifying bacteria in synthetic systems and sediments from mine impacted sites.

Our laboratory-scale experiments underpin the development of a numerical modeling framework that can be used to support and optimise the design of a field-scale implementation for acid/neutral mine drainage and/or industrial contaminant sources).

[1] Webster, J. G., et al. (1998) *ES&T* **32**(10): 1361-1368. [2] Benner, S. G., et al. (2002) *ES&T* **36**(8): 1705-1711. [3] Sun, J., et al. (2016) *Chemosphere* **144**: 1106-1115. [4] Coker, V. S., et al. (2006) *ES&T* **40**(24): 7745-7750.