Bioengineering nano-magnetite for contaminant clean-up

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The engineering of novel materials is a key development in the challenge of remediating toxic metals and radionuclides in the subsurface. Our work focuses on utilising nano-scale magnetite, synthesised through the bioreduction of ferrihydrite by *Geobacter sulfurreducens* at ambient temperatures. In order to increase the activity and longevity of this substrate in key reactions, including chromium(VI) and toxic organics reduction, the surface of the nano-magnetite is functionalised by a precious metal catalyst, nano-palladium, in a simple, one-step process, aided by the organic residue on the iron mineral surface derived from the bacterial culture [1].

Pd-functionalised nanomagnetite has been tested in the remediation of Cr(IV) in batch and continous-flow column experiments and in hollow-fibre membrane units. Conditions in the column studies were varied to take into account key environmental parameters including oxic, anoxic, and a nitrate co-contamination. An electron donor, sodium formate, was supplied in the influent leading to a substantial increase in the removal capacity of the Pd-magnetite. In addition, the columns containing both Pd-biomagnetite and formate were found to maintain an 80 % removal beyond 300 hours, whereas without formate complete breakthrough occurred at 60 hours. We hypothesise that oxidation of formate in these experiments is coupled to recharge of the nanocatalyst surface by the Pd, maintaining the reductive power of the system.

Cr(III) formed was associated strongly with the biomagnetite, and XMCD studies suggest that the Cr(III) replaces Fe in the magnetite lattice, effectively 'locking-up' the Cr, as seen previously [2]. This novel system could provide effective and sustained immobilisation of contaminants, far outreaching the reductive capacity of non-functionalised magnetite.

[1] Coker *et al*. (2010) *ACS Nano* **4**, 2577-2584. [2] Cutting *et al*. (2010) *Environ. Sci. Technol*. **44,** 2577-2584.

PGE contents and spinel compositions of different podiform chromitites in the Eastern Anatolia complex, Turkey

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This study presents mineralogy, PGE contents and spinel compositions of four different podiform chromitite localities in the east of Turkey. The ophiolitic rocks are observed as relatively large tectonic units in the Eastern Anatolian Accretionary Complex [1]. Chromite texture are observed as massive, nodular and dissemine-banded type. The highest value (390 ppb) of ΣPGE are obtained from milonitic shear zone chromitites with an average ~290 ppb. Os, Ir and Ru show relatively enrichment, compare to Pt, Pd and Rh elements. This enrichment are consistent with other chromitite deposits in Turkey. Chromite grains contain inclusion of mafic silicates (olivine, amphibole and clinopyroxene), sulphides (etc. millerite, heazlewoodite, awaruite, chalcopyrite, godlevskite, orcelite) and euhedral Laurites. The chromite compositions of different localities ore exhibit characteristic of different tectonic setting. The high Cr# and low TiO_2 content of spinel from the eastern Anatolia chromitites possibly has genetic linkage with a boninite melt generated by high degrees of partial melting and the others are formed in island arc setting towards to back arc basin [2, 3].

[1] Sengör *et al*. (2008) *Earth Science Rev*. **90**, 1-48. [2] Kamanetsky *et al*. (2001) *Journal of Petrology* **42,** 655-671. [3] Zhou *et al*. (1998) *Geochimica et Cosmochimica Acta*, **62**, 677–688.