Bio-extraction of cobalt & nickel from laterites at near-neutral pH

LAURA NEWSOME[1], RICHARD A PATTRICK[1], JONATHAN R LLOYD[1]

[1] Williamson Research Centre, School of Earth and Environmental Sciences, University of Manchester, Manchester, M13 9PL, United Kingdom
laura.newsome@manchester.ac.uk

Cobalt is an essential element for modern technology, and is critical for a low carbon economy. The most recently developed cobalt resource is a by-product from the mining of Fe-rich nickel laterites developed on deeply weathered ultramafic rock. Here we describe the fate of cobalt and nickel during the establishment of microbially-induced reducing conditions at near-neutral pH.

Three lateritic sediments were examined; two fossil laterites (Çaldağ, Turkey and Shevchenko, Kazakhstan), and one actively-forming laterite (Acoje, Philippines). Goethite was the predominant iron-containing mineral phase and the laterites contained 20-45 wt% Fe, 1.4-1.7 wt% Ni, 0.12-0.2 wt% Co and 0.4-1.2 wt% Mn. Sequential extraction showed the majority of the Co and Mn were present in the reducible fraction, while the Ni and Fe were largely associated with the recalcitrant residual fraction.

Anoxic sediment microcosms were set up for each laterite with acetate added as an electron donor to stimulate the natural microbial community and the development of reducing conditions. Parallel microcosms were set up in a bicarbonate buffer with acetate and inoculated with *Geobacter sulfurreducens* to enhance iron(III)-reduction. Controls contained no added electron donor.

Distinct morphological changes were apparent in the laterites after Fe(III)-reducing conditions were stimulated, and these occurred more rapidly when *G. sulfurreducens* was added. However, only trace amounts of metals were released to the aqueous phase. Sequential extractions found a significant quantity of metals (up to 30% Co, 9% Ni) had been transformed into the exchangeable 'sorbed' fraction after biostimulation, and these could be readily solubilised by extraction with acetic acid. Fe $L_{2,3}$-edge XAS indicated that the majority of the iron remained present as Fe(III) and Ni *K*-edge XAS showed that Ni speciation did not change after biotransformation.

These results suggest that stimulating bioreduction processes has real potential for extracting cobalt and nickel from laterites.