Surface Leaching of Vanadium from BOF Steel Slag: a μXAS and SEM Study

ANDREW J. HOBSON[1], DOUGLAS I. STEWART[2], ANDREW W. BRAY[1], WILLIAM M. MAYES[3], MICHAEL ROGERSON[4] AND IAN T. BURKE[1]

[1]School of Earth and Environment and [2]School of Civil Engineering, University of Leeds, Leeds, LS2 9JT, UK. Email for correspondance: ear3a2jh@leeds.ac.uk

3Centre for Environmental and Marine Sciences, University of Hull, Scarborough, YO11 3AZ, UK.

4Department of Geography, Environment and Earth Sciences, University of Hull, , Hull, HU6 7RX, UK.

Steel slags are a byproduct of steel manufacture produced in large quantities worldwide. Whilst some slags are recycled (e.g. as construction aggregate) much is still dumped in open air slag heaps. Steel slag is generally composed of Ca, Al, Mg and Fe oxides and silicates and is often significantly enriched in toxic trace metals. Rainwater interacting with CaO and Ca-silicate phases in steel slags produces a high pH leachate (pH 12). In recent years concerns have been raised over the potential for mobilisation of trace metals such as V and Cr into leachate during weathering processes. This study presents data concerning speciation of V in steel slags during aerobic and anaerobic leaching.

Samples were collected from the Yarborough Landfill, Scunthorpe, UK and leached in DIW under aerobic and anaerobic conditions for 6 months. SEM/EDX identified 4 principal mineral phases in unweathered slag comprising a CaO-rich phase, a Ca-silicate phase, a brownmillerite–like phase and a wustite-like phase. V was hosted primarily within the Ca-silicate and brownmillerite phases. XANES analysis showed V to be predominantly present as V(V) within Ca-silicate and as V(III/IV) within brownmillerite. Following weathering a 20-50μm thick 'rind' was visible with similar composition in aerobic and anaerobic systems. This region was depleted in V(V) and contained neoformed C-S-H. Little alteration of the brownmillerite phase was evident hence weathered regions were enriched in V(IV) compared to the unweathered sample. Results show that V is leached preferentialy from Ca-silicates as V(V) due to dissolution of these phases. Increased concentrations of V in leachate under aerobic conditions are possibly due to oxidation of V(IV) to V(V) from brownmillerite-like phases. Release of V is environmentally significant, however, precipitation of C-S-H may have an armouring effect reducing the long term potential for V release by protecting the interior portion of slag blocks.