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Investigating trace element geochemistry in bauxite residue using coupled nanoscale XRF, XANES and XRD

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Bauxite residue (or 'red mud') is a highly alkaline and saline tailings material, produced during the Bayer process for alumina production. *In situ* remediation aims to decrease alkalinity and salinity to enable revegetation of bauxite residue after storage facility closure. A detailed understanding of trace element geochemistry within the residue is key to predicting trace element behaviour, particularly As, Cr, and V, during this remediation process (which decreases pH from 12 to 7-8). This is essential for assessing potential plant uptake during closure and revegetation of residues, or transport offsite through leachates and dust. Therefore, identifying the mineral hosts and speciation of As, Cr and V within the residue are key for creating appropriate remediation targets, and ensuring successful rehabilitation can occur.

Here, we utilised the combined nanoscale XRF, XANES and XRD capabilities of the Hard X-ray Nanoprobe at UK's Diamond synchrotron, to gain unprecedented insight into trace element geochemistry within bauxite residue before and after a year-long *in situ* remediation field trial. The iron oxides, hematite and goethite, were found to be key hosts for As, Cr and V. Calcite was identified as an additional host for As, and the Bayer process mineral katoite was an additional host for V. Calcite precipitation may act to immobilise As during remediation, as calcite is known to precipitate within residues during pH neutralisation. However, further decreases in pH to *ca.* 6-7.5 may result in some As release due to calcite dissolution [1]. Hematite and goethite were identified as stable hosts for Cr, likely through isomorphous substitution. Our results also suggest pH neutralisation during remediation could result in partial mobilisation of V, as host mineral katoite is dissolved. Insights from this work will be incorporated into geochemical modelling and assist with development of appropriate remediation targets for trace elements As, Cr and V.

[1] Khaitan, Dzombak & Lowry (2009), *Environmental Engineering Science* 26, 873–881.