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Analysis of metal entrapment within anthropogenic tufa using synchrotron micro-XRF

Susan Cumberland[1], Kieran Tierney[1,2], Joanna Renshaw[1], Kalotina Geraki[3], and John MacDonald[2]
[1]University of Strathclyde, Glasgow, Scotland, UK (susan.cumberland@strath.ac.uk)
[2]University of Glasgow, Glasgow, Scotland, UK
[3]Diamond Light Source, Oxford, UK

The leaching of heavy metals from post-industrial slag and other anthropogenic waste sites is detrimental for human health and the wider environment. Remediation of these sites can be costly and sustainable low carbon solutions are preferably sought. Examining natural analogues which stabilize metals could provide valuable insights into low-cost solutions to the legacy problems of aquatic environments that are impacted by leaching. Calcareous tufa, sometimes known as travertine limestone, forms naturally when calcium-rich groundwater is exchanged with atmospheric CO_2 at mid to hyperalkaline pH resulting in a calcite ($CaCO_3$) precipitation. Tufa has also been observed to form at a small number of old industrial sites (e.g. mining, steel works, paper mills) across northern England and Scotland. One site of interest is at Consett, N.E England, UK. Here tufa precipitates in the Howden Burn stream, a tributary of the River Derwent, as it emerges from the slag heaps from old steel work's. Bulk analysis shows lead, arsenic, vanadium and zinc are present in the Howden Burn up to several 100 ppm. Analysis of the water downstream of the tufa shows metal concentrations are considerably reduced compared to concentrations upstream. High spatial resolution LA-ICP-MS analysis of the solid tufa sampled reveal metals present within the tufa structure. This leads to the hypothesis that the metals are precipitated together with the tufa during its formation. However, little is known about metal capture processes during tufa formation and the form that these metals are in. Here we present synchrotron micro X-ray fluorescence (μ-XRF) element maps of the tufa in cross-section that show the distributions of the metal within the laminations of the tufa structure. Understanding and exploitation of artificial tufa for metal capture could have potential as a CO_2 positive solution for sustainable in-stream remediation.