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Field portable XRF as a tool for the assessment of contaminated peat soils

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Upland blanket bogs in the UK have suffered severe erosion over the last millennium but there is evidence to show that this has increased in intensity in the last 250 years, coinciding with increased pressures on the land during the British Industrial Revolution. Upland peat soils in close proximity to urban and industrial areas can be contaminated with - and act as sinks for - high concentrations of atmospherically deposited lead. Atmospheric pollution has been shown to have had significant effects on blanket bog vegetation, the damage and removal of which makes the peat mass highly susceptible to erosion. Erosion of these soils has the potential to release lead into the fluvial system. Detailed quantification of lead concentrations across the surface of actively eroding peatlands is vital in order to understand lead storage and release in such environments.

Previous attempts to quantify peatland lead pollution have been undertaken using the inventory approach. However, there can be significant within-site spatial heterogeneity in lead concentrations, highlighting the need for multiple samples to properly quantify lead storage. Lead concentrations in peat are traditionally derived through acid extraction followed by ICP-OES or AAS analyses, but these can be time consuming, expensive and destructive. By contrast, field portable x-ray fluorescence (FPXRF) analysers are relatively inexpensive, allow a large number of samples to be processed in a comparatively short time, giving a high level of detail with little disturbance to the surrounding area. FPXRF continues to gain acceptance in the study of metal contaminated soil but has not been used to conduct field surveys of contaminated peat soils due to their high moisture content.

This study compares lead concentration data obtained in situ using a handheld Niton XL3t 900 XRF analyser with data derived from ex situ lab based analyses. In situ measurements were acquired across degraded and intact peatland sites in the Peak District, UK. Field samples were then dried, homogenised and analysed again using the FPXRF before subsequent acid digestion and analysis using ICP-OES. The moisture content of the samples was also determined and used to normalise the in situ field measurements.

Good relationships were found between in situ and ex situ lead concentration data. When comparing in situ and ex situ derived FPXRF concentrations, linear regression analysis yielded R2 values of 0.86. This was improved significantly when in situ concentrations are normalised for moisture content (R2 = 0.92). A similar relationship was found between moisture corrected in situ results and ICP-OES derived values. These is also and excellent relationship between ex situ FPXRF and ICP-OES data (R2 = 0.99). This study reveals that FPXRF can provide an accurate, rapid and cost-effective means of assessing lead content in contaminated peat. The FPXRF analyser can be used to produce high quality data both in situ and ex situ, and shows promise as a tool for use in sediment source fingerprinting and understanding sediment dynamics in wet, organic systems.