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Influence of sediment geochemistry and catchment morphology on temporal dispersion of lead in stream water

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Millennia of metal mining has caused widespread contamination of soil and sediment in mineralised catchments around the world. It is well known that contaminated sediments generate critical toxic environment reducing biodiversity and degrading the ecosystem health. Furthermore, metal-enriched soil represents a potential secondary source of metals, which release into the water columns can be empathised under particular streamflow conditions. Nevertheless, identifying the sources of contaminated soils and their relative importance, such us their magnitude, remains of difficult achievement due to the complexity of the catchment geomorphology, the vegetation distribution, and the streamflow variations.

This study aims to identify the hydrological and wider catchment controls on lead storage and release. A first characterisation of the sediment lead content and the mineralogical association was performed with a portable XRF and SEM analysis. Furthermore, the variability in total lead loads across a range of flows was estimated through the execution of several slug injections. Finally, identified potential lead sources were provided with a topographical and vegetation presence description. Results show that lead enriched sediments are mainly located at the river headwater represented by loose mine tips. In addition, river water data collected during high streamflow conditions clearly identifies the mine tips as the main source. Further secondary sources are localised in downstream reaches characterised by gentle topography, meanders, and denser vegetation. Along these reaches lead water load decrease unless high streamflow conditions occur and mobilise lead-enriched particles. Moreover, SEM analysis reports high spot concentrations of lead associated with iron and manganese hydroxide and sulfate minerals.

This work highlights the necessity to couple water quality monitoring and sediment characterisation to better estimate metal-enriched sediment at the river catchment scale. Temporal variations in river water metal flux highlight the potential for mine polluted zones to release or attenuate trace metals as a function of morphological features and vegetation presence. Concluding, this multi-method approach can guide strategies to address eco-toxicity remediation and promote their long term efficiency.