

From remediation to recovery: options for legacy metal-rich waters in the UK

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The UK has a considerable legacy of water pollution arising from abandoned mine sites and allied mineral processing sites (e.g. steel mills and refineries). Many of these polluting waters arise from sites where there is no party liable for remedial costs. As such, there is increasing focus on options for value recovery from remediation schemes to offset ongoing treatment costs. Such legacy discharges cover an incredibly diverse range of geochemical conditions with pH alone ranging from <2 to >12. This study provides an overview of databases of major legacy fluxes of metal(loid)s to the water environment, and considers examples of potential opportunities and challenges to value recovery.

Metal mine waters discharge an estimated 9.8 tonnes of As, 0.9 t Cd, 42.4 t Cu, 2.7t Ni, 23.4 t Pb and 263 t Zn to the aquatic environment from ~380 discharges. The majority (83%) are within the circum-neutral pH range (6-8) and dominated by Ca-SO₄-HCO₃ facies from orefields hosted in carbonate-rich country rock. Dominant trace metals at these sites are Zn, Pb and Cd which geochemical modelling suggests are predominantly present as carbonate complexes. While these metals accumulate in treatment substrates (e.g. sorbent media and bioreactors) to high concentrations (e.g. 3-7 g/kg Zn), key constraints for practical recovery are centred on the disparate nature of many mine sites in remote settings, large distances away from processing facilities. There are a small number of highly acidic and metal-rich discharges (notably Parys Mountain which discharges 13 tonnes Cu/yr) which may provide alternative options for biologically-mediated selective metal recovery.

Metal-rich processing wastes, such as steel slags generally give rise to much lower fluxes of metals, but some are potentially higher value critical raw materials. For example oxyanion-forming elements such as V and Cr soluble at high pH (>11) in slag leachates pose both environmental risks but have been recovered using ion exchange resins (>85% recovery at pH 11.5 in < 20 min for V). Here, advantages of being proximate to active steel plants that could utilise V from pregnant liquors recovered from resins may aid economic feasibility of recovery.