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ECOTOXIC METAL(LOID) GEOCHEMISTRY AND MINERALOGY IN COASTAL LEGACY WASTES

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In coastal areas, legacy wastes co-exist with human populations and ecosystems are vulnerable to sea level rise, flooding, and coastal erosion. Coastal areas have been used for centuries to dispose of colliery, industrial, and municipal wastes. In recent years increased efforts from regulators, land owners and researchers have led to the further development of legacy waste datasets and source-pathway-receptor models to shed light on the release of contaminants in coastal environments. It has emerged, however, that some fundamental knowledge remains lacking with regard to coastal legacy waste geochemistry and mineralogy, which is limiting the efficacy of environmental protection frameworks.

Legacy wastes in the UK coastal zone were identified through multicriteria decision analysis based on their likelihood of being exposed to coastal erosion, flooding, proximity to sensitive environmental receptors. A total of 80 composite samples from municipal, colliery, and slag (ferrous and non-ferrous) wastes were collected from 16 sites. Total elemental concentrations were measured through total acid digestion followed by ICP-MS, and their mineralogy by XRD and automated scanning electron microscopy (QEMSCAN). Coal wastes and municipal wastes were predominantly composed of silicate minerals (50-90%). Coal wastes contained an average of 70 mg/kg As associated with pyrite, secondary sulfate minerals, and Zn-, Cu-, Pb-, and Cr-bearing Fe-oxides. In municipal wastes, Fe-oxides were associated with Cu and Zn; their average concentrations were 370 mg/kg, and 970 mg/kg, respectively. Slag wastes had the highest mineralogical and metal(loid) geochemical variability. In non-ferrous slags, metal(loid)-bearing phases included carbonates (cerussite, $PbCO_3$), oxides (As-bearing Fe-oxides and Sn-oxides), sulfides (sphalerite, ZnS; arsenopyrite, FeAsS), and metallic droplets (Cu and Pb). Lead and As averaged 1350 mg/kg and 6950 mg/kg.

Arsenic, Cu, Pb, and Zn concentrations were all above the eco-toxicity probable effect level (Canadian soil guideline), suggesting that the waste can pose a risk to the environment, although their mineralogy will pay a key role in metal(loid) release. Further research is ongoing which will link legacy waste mineralogy with metal(loid) environmental leaching behaviour and therefore help further develop source-pathway-receptor models for the vitally important coastal zone.