

Arsenic Speciation and Evolution in Coastal Legacy Wastes

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Arsenic (As) is an ecotoxic metalloid that can occur in colliery and industrial slag wastes. Its mobility depends on its speciation and mineralogy, and the biogeochemical conditions of the environment in which it occurs. In coastal areas, such wastes are mainly exposed to changes in redox and salinity. Knowledge of how As-bearing minerals in the wastes will behave under such changes will enable regulators to predict the potential mobility and toxicity of arsenic in the coastal zone.

Legacy colliery and non-ferrous slag solid wastes were collected from Lynemouth and Capper Pass, UK, respectively. Their geochemical compositions were determined by acid digestion and ICP analysis, and their mineralogical compositions were determined by XRD, automated SEM and targeted SEM-EDX on specific grains of interest. μ XANES analysis was conducted at the As K-edge @ 11.9 keV on grains in polished blocks and on bulk samples. The Lynemouth wastes had low concentrations of As (68-84 mg/kg). Arsenic occurred as As³⁺ in pyrite, which weathered to form As(V)-bearing Fe oxides and oxyhydroxysulfates. 0.4-25 % and 0.07-7.7 % of the total As were leached in deionised water and simulated seawater, respectively. The Capper Pass wastes had up to 7000 mg/kg As. Arsenic occurred in arsenopyrite and Fe- and Sn-oxide phases. Arsenic speciation varied from As³⁺ to As⁵⁺, although As⁵⁺ was more abundant in the bulk samples. 0.03-0.15 % and 0.23-0.26 % of the total As were leached from the deionised water and simulated seawater, respectively.

Although the concentrations of As were lower in the Lynemouth wastes, they have higher potential to be leached in seawater and particularly, in deionised water, likely through the oxidation of As-bearing pyrite that results in the formation of As-bearing Fe oxide. In the Capper Pass wastes, the occurrence of As in crystalline Sn oxides may explain the low amounts of leaching in both deionised and simulated seawater. The study shows that the evolution of As speciation and mineralogy is dynamic, and that As release from colliery wastes could be more significant than from non-ferrous slag wastes, although the degree of mobility also depends on the total As concentrations in the wastes.