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Chromium in urban sediment particulates: an integrated micro-chemical and XANES study

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Chromium is generally common within the urban sediment cascade as a result of abundant industrial and transport-related sources. The risks that Cr-bearing particles pose to ecosystems and humans depend on the solid phase chemical speciation of Cr in the particles. In this study, we use bulk chemical digests, sequential chemical extraction analysis, electron microscopy, electron microprobe and microfocus XANES analysis to describe the solid-phase speciation of Cr in urban particulate matter from both aquatic sediment and road dust sediment (RDS) in Manchester, UK.

Cr-bearing grains within RDS are predominantly iron oxide grains, commonly of goethite or haematite mineralogy, but Cr-bearing silicate glass grains are also present. Iron oxide glass grains most likely have sorbed Cr, and derive from the rusting of Cr-steel particles from vehicles. Electron microprobe analysis indicates concentrations of Cr up to 3200 μg/g in these grains, and XANES analysis indicates that Cr(III) is the dominant oxidation state, with some trace amounts of Cr(VI). Cr-bearing grains within aquatic sediments are dominated by alumino-silicate glass grains derived from industrial waste. These grains contain Cr-rich areas with up to 19% Cr_2O_3 and XANES analysis indicates that Cr is present as Cr(III).

The dominance of Cr(III) in these urban particulate grains suggests limited bioavailability or toxicity. However, the presence within two markedly different grain types (iron oxides and silicate glasses) indicates that the long-term geochemical behaviour and environmental risk of RDS and the aquatic sediments studied are likely to be quite different. These findings highlight the importance of understanding sources of metal contaminants in urban environments and the geochemical processes that affect their transfer through the urban sediment cascade and the wider river basin.