Urban sediments: geochemistry and mineralogy towards improved risk assessments

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Road deposited sediments (RDS), the accumulation of particles on pavements and road surfaces, have been documented to carry a high loading of contaminant species, including trace metals. These potentially harmful elements (PHE) may cause deleterious health effects to urban residents and commuters due to RDS high susceptibility to remobilisation and transport - RDS is spatially and temporally highly variable. Furthermore, urban agglomerations tend to grow and so does the importance of RDS characterization and monitoring: 50% of the world population currently lives in urban centres, a figure which is set to increase in the next decades.

With the purpose of better understanding RDS compositional variations across Manchester, UK, and its relationship to soil geochemistry, 144 RDS samples were collected in two seasons across 75Km^2 of Manchester urban centre. Samples underwent elemental analysis by X-ray fluorescence spectrometry (XRF), organic matter determination, grain size analysis by laser diffractrometry, and grain-specific microanalysis by scanning electron microscopy (SEM-EDS).

The amount of RDS collected in summer was generally larger than in winter and grain size was also coarser in summer for most samples. Nevertheless, PHE content remained similar between seasons for each location. GIS (geographic information system) spatial interpolation analysis allowed the detection of contamination hotspots present in both winter and summer datasets, where PHE concentrations (namely Cr, Ni, Cu, Zn, Pb and Cd) were above the 90th percentile. Further GIS data analysis pointed proximity to main roads and industrial areas as the main influencial factors on RDS composition, which can vary considerably over short distances.

Grain size analysis evidenced that among the most contaminated samples are those with highest contents in grain size fractions below 63μm. However, correlation and principal component analysis showed that PHE tend to be associated to the 63-125μm, suggesting that these might act as hosts for PHE rather than the finest fractions of the sediment (<63μm). Elements correlated to the 63-125μm fraction include Zn, Pb and Cd for both seasons, as well as Co, Ba, Ni and Cu only for the summer dataset. Further SEM-EDS analysis revealed grains between ~90-130μm composed by combinations of the above elements, either in crystalline forms or aggregates. The source of these grains still needs further investigation.

Future sequential extraction analysis of trace metals will clarify the availability of these PHE, providing essential information for the risk assessment to human populations. With the aid of geostatistical models, PHE associations will be defined, as well as the spatial, geochemical and mineralogical linkages between RDS and other environmental media, namely soils - for which similar research is being undertaken presently. This will lead to a better understanding of PHE dynamics in urban systems and add vital knowledge on the risks posed to human populations by RDS exposure.

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