Urban soil-dust interactions: improving urban risk models

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Introduction

Road deposited sediments (RDS) carry a high loading of potentially harmful elements (PHE). Another environmental media that is a likely source of PHE in urban areas is soil. PHE present in these media may cause deleterious human health effects due to close proximity to the receptors; furthermore, urban agglomerations tend to grow exponentially and so does the importance of RDS and soil characterization and monitoring. The aim of this research is to explore the spatial, geochemical and mineralogical linkages, and produce novel mineralogical data on the PHE/particulate relationships within and between soils and RDS.

Results and Conclusion(s)

Geochemical datasets are composed of 144 RDS and 300 soil samples, collected across 75 Km^2 of Manchester urban centre. PHE maximum and average concentrations, determined by XRF, are generally higher in soils than in RDS. Geographic information systems (GIS) allowed the spatial detection of contamination hotspots for these media, where PHE concentrations (namely for Cr, Ni, Cu, Zn, Pb and Cd) were in excess of the regional 90th percentile. Spatial analysis pointed to localised contamination sources as main influences on RDS composition, which vary considerably over short distances. However, spatial distribution of PHE in soil highlighted four broader areas with systematically high concentrations. Principal component analysis (PCA) has evidenced important PHE associations both for soils and RDS. PCA of grain size data obtained by laser diffractometry revealed that, in RDS, the 63-125μm fraction might act as hosts for PHE. SEM-EDS analysis supported this observation, but the source(s) of these grains still needs further investigation - they have also been observed in soil samples from the same area.

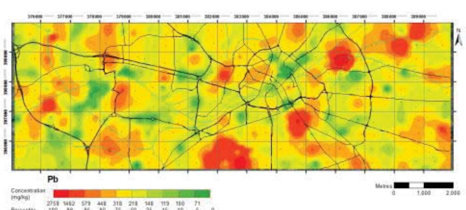

Figure 1: Interpolated surface for lead in Manchester soils.

This detailed geochemical and mineralogical characterization of both soil and RDS, as well as their spatial associations, allow a better understanding of PHE dynamics in urban systems and add vital knowledge on the risks posed to human populations by PHE exposure.

Icelandic zircon: Illuminating juvenile silicic crust construction

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Iceland's crust (thick, juvenile, silicic and mafic, zircon bearing, with an elevated geothermal gradient) resembles what is visualized for the early (Hadean-Archean) crust, whose physical record exists only in detrital zircon. It is tempting to postulate that Icelandic crust construction is an analogue for early-Earth processes. We explore this hypothesis using trace elements (SHRIMP) and O (SIMS) and Hf (LA-MC-ICPMS) isotopes to characterize zircon from 15 samples (active and ancient volcanoes, intrusions, sandstones, river sands) spanning Iceland's range of ages and tectonic settings.

Our Icelandic "protocontinental" zircons exhibit setting-specific variability, but together share elemental and isotopic characteristics that clarify silicic petrogenesis in this type of environment. They define a narrow range of compositions, overlapping with zircon from ocean islands and, notably, Alid Volcanic Center (continental-oceanic transitional rift, Eritrea); their compositions are largely distinct from continental, MORB, arc, and Hadean zircon (e.g., on plots of U/Yb vs Y, Yb/Nb vs U/Yb). Icelandic zircons are typically ~3x richer (~15 vs 5 ppm) and more variable in Ti than Hadean-Archean zircons, suggesting higher crystallization temperatures. Their range of $\delta^{18}O$ (~0 to +3‰ on-rift, ~+3 to +5‰ off-rift, to -6‰ hydrothermal-like) is very low by global standards, and significantly lower than reported Hadean-Archean values (~4.5-7.5‰). Icelandic zircon ε_{Hf} typically ranges from +10 to +17 (lowest off-rift, highest on), spanning reported values for Icelandic basalt. Extremely low ε_{Hf} of +5 for zircon from Askja 1875 AD pumice (host pumice ε_{Hf} +14) suggests that Icelandic rhyolite might not all be truly juvenile; ancient crust may influence petrogenesis, in discrete locations.

Our data set, while not precluding petrogenetic similarities between Icelandic and early-Earth silicic magmas, demonstrates differences in zircon that call into question a closely similar origin.