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Technogenic magnetic particles (TMPs) of urban soils in steel industrial region of Northeast China: SEM and μ-XRF results

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Urban soils contain large amount of technogenic magnetic particles (TMPs) derived from various industrial processes. These TMPs are an important source of heavy metals and magnetic carriers in soils. They contain abundant information on the origin of heavy metal contamination and can be used for proxy indication for degree of heavy metal contamination in urban soils. The TMPs were separated from urban topsoils from a steel industrial city of Northeast China. Their morphology and microstructure were studied using scanning electron microscopy equipped with energy-dispersive X-ray spectroscopy (SEM/EDS). The micro-scale spatial distribution of heavy metals in TMPs was determined by synchrotron-radiation-based microprobe (μ-XRF). Three shape types: spherule, irregular-shaped, and aggregate particles in TMPs, were observed by SEM. SEM observation indicated that the TMPs were dominated by the spherules with grain sizes ranging from several to more than one hundred of micrometers. The μ-XRF mapping provide information on the micro-scale spatial distribution of heavy metals in TMPs. The elemental mapping of TMPs showed that the spatial distribution of Fe is highly heterogeneous at the micrometer scale. Visual inspection showed that Co, Cr, Pb, Cu, As, Ti, and Ni were closely associated with Fe phases. The coexistence of iron phases and these elements suggests that iron phases are the main carriers of these potentially toxic elements. The spatial distribution of Fe phases and heavy metals in TMPs at the micrometer scale confirmed the signature of different industrial pollution sources. Our results suggest that microstructure and elemental mapping of TMPs can be used as tracers for polluting sources in urban soils.