

## **Geochemical sources, forms and phases of soil contamination in an industrial city**

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Globally, industrial cities pose a range of environmental contamination management challenges. This work examines our ongoing investigation of soil contamination in the Australian industrial city of Newcastle. Many years of industry have contributed to substantial environmental contamination of the soils in the city. Surface soils (n = 170) contained metal(loid)s elevated above their respective Australian Health Investigation Levels (HIL) with lead (Pb), the most common contaminant in the city, exceeding the HIL in 88% of private soils (median: 1140 mg/kg). In-vitro Pb bio-accessibility analysis of soils (n = 11) showed high affinity for Pb solubilisation (maximum Pb concentration: 5190 mg/kg, equating to 45% Pb bio-accessibility). Highly soluble Pb-laden Fe- and Mn-oxides likely contribute to the bio-accessibility of the Pb. Public and private space surface soils contain substantially less radiogenic Pb (range:  $^{208}\text{Pb}/^{207}\text{Pb}$ : 2.345–2.411,  $^{206}\text{Pb}/^{207}\text{Pb}$ : 1.068–1.312) than local background soil ( $^{208}\text{Pb}/^{207}\text{Pb}$ : 2.489,  $^{206}\text{Pb}/^{207}\text{Pb}$ : 1.198), indicating anthropogenic contamination from the less radiogenic Broken Hill type Pb ores ( $^{208}\text{Pb}/^{207}\text{Pb}$ : 2.319,  $^{206}\text{Pb}/^{207}\text{Pb}$ : 1.044). High-temperature silicates and oxides combined with rounded particles in the soil are characteristic of smelter dust emissions, indicating the city's historic copper and steel industries contributed the most soil contaminants through atmospheric deposition and use of slag waste as fill material. Additionally, a preliminary investigation of polycyclic aromatic hydrocarbons in soils, sometimes associated with ferrous metal smelting, coal processing or burning of fossil fuels, shows that these too pose a health exposure risk (calculated in comparison to benzo(a)pyrene: n = 12, max: 13.5 mg/kg, HIL: 3 mg/kg). This study adds to our understanding of environmental contamination and exposure risks in industrial cities globally.