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Mapping lead speciation in residential soil depth profiles to determine mechanisms of mobility and bioavailability

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Lead (Pb) is a well-established, ubiquitous contaminant in urban soils in the US, Europe, and globally due to widespread use of lead-containing paint and leaded gasoline. While most developed countries phased out lead-based paint and gasoline several decades ago, legacy lead remains in soils. In low and middle income countries, lead based paint is still widely sold. Exposure to lead-contaminated soil is linked to elevated blood lead levels in children with ensuing neurological effects. Lead is a neurotoxin long recognized to affect childrens' cognitive, emotional, and behavioral development.

Lead distributions within individual residential yards are not well understood, despite yards being where exposure is likely to occur during play and gardening. Despite lead typically being considered poorly mobile in soils, recent results from home lot surveys in the Twin Cities, Minnesota, US have shown that maximum lead concentrations adjacent to house foundations are often not at the surface. Maximum Pb concentrations were found at the surface in only 1/8th of transects, and were within the top 10 cm in approximately half the transects, indicating downward mobility of lead on the decade-century scale. Here, we investigated the chemical form of downwardly-mobile lead in a soil core taken from adjacent to a foundation of a house (built in the early 1900's) historically painted with lead paint in St. Paul, MN, US. Lead concentrations in the soil were over 1200 mg/kg, exceeding the US EPA threshold of 200 mg/kg for residential yard soils and were higher below the surface. We used synchrotron-based micro X-ray fluorescence mapping and X-ray absorption spectroscopy to identify the spatially resolved chemical form of lead. Results will help determine mechanisms of lead movement in soils and inform ways to keep children safe from exposure to bioavailable lead in residential yards.