Goldschmidt 2026 Abstract
https://doi.org/10.46427/gold2026.37532

Connecting lead distribution to bioavailability in urban residential soils in the midwestern US

SARICK L MATZEN[1,2], ASHLEY HANSEN[3], JOCELYN WAGNER[2], BRANDY D. STEWART[4], TYLER D. SOWERS[5] AND NICOLAS A JELINSKI[1]

[1]University of Minnesota
[2]University of Illinois Chicago
[3]City of Minneapolis
[4]SLAC National Accelerator Laboratory
[5]United States Environmental Protection Agency

Lead (Pb) is a well-established, ubiquitous contaminant in urban soils in the US and globally due to widespread historical use of lead-based 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 permanently affect children's cognitive, emotional, and behavioral development.

Lead distributions within residential yards are not well understood, despite yards being where exposure is likely to occur during play and gardening. Here, we investigate the chemical and physical distribution of lead in residential soils in the Twin Cities, Minnesota, and Chicago, IL, two US cities known to have soil lead concentrations in excess of the US EPA residential lead soil screening level (200 mg/kg) and which serve as models for cities with housing stock 50-150 years old. We analyzed a suite of researcher and community-collected samples using portable X-fluorescence screening, total metal analyses following wet chemical digestions, in vitro bioaccessibility assays to measure lead bioaccessibility using a linear regression to estimate relative bioavailability, and synchrotron-based X-ray fluorescence (XRF) mapping and X-ray absorption near-edge spectroscopy (XANES) to determine elemental co-associations and lead speciation. We propose geochemical processes leading to changes in lead distributions.

In the Twin Cities, lead concentrations decreased exponentially from the building foundation to mid-yard, halving every 2.2 meters. Random forest modeling showed that although lead was higher in houses sided in wood than in vinyl or stucco, house age was the dominant predictor of lead levels. Lead concentrations were more dilute in surface soils than at lower depths (down to 30 cm), and XRF mapping paired with bulk XANES revealed speciation differences with depth, suggesting weathering and degradation of lead due to urban pedogenesis. We will present new results including bulk lead XANES and lead distributions and bioavailability in Chicago. We combine novel bioaccessibility and speciation techniques to assess factors driving lead exposure spatially across urban residential environments.