Speciation, distribution, mobility and prediction of Pb in an urban soil

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Lead (Pb), notorious for its impacts on human health, has achieved worldwide environmental dispersal resulting from centuries of use by human society. The toxicity of Pb is governed largely by its speciation, which is in turn controlled by pH, localized reactivity and soil processes that differ according to soil type, location and Pb source. Given the context of these localized dependencies, or site specificity, efforts to predict Pb toxicity and refine sustainable remediation techniques are most useful when Pb behavior is constrained and predicted within environments with homogeneous conditions, such as a single soil.

Using a combination of synchrotron-based tools (uXRF, uXRD), microscopy, bioaccessibility testing, column experiments and geospatial analysis we determined Pb speciation, distribution and mobility in Pb-paint contaminated soils. Predictive geospatial modeling was eventualy used to assess potential impacts and refine sustainable remediation methods.

At the soil scale, Pb was present within paint chips as hydrocerussite, weathering to anglesite over time. Pb also attracted clay minerals electrostatically and became incorporated into heterogeneous soil aggregates. Column experiments, designed to reproduce in-situ remediation protocols, yielded little evidence of Pb mobility change in response to amendments.

At the city scale, bioaccessible and total Pb were well-correlated, to the extent that bioaccessibility could be predicted for the soils. Combining this with predictive blood lead level modeling we establishment a site-specific revised soil Pb limit of 360 mg kg^{-1}, lower than the EPA's general soil Pb threshold of 400 mg kg^{-1}.

This multiscale analysis provides the framework necessary to develop and refine sustainable remediation strategies at the city scale.