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Transformation of soil lead and arsenic to low bioavailability phases *in situ*: Connecting geochemistry and toxicology to limit exposure

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Soils are common sources of metal(loid) contaminant exposure globally. Lead (Pb) and arsenic (As) are of paramount concern due to detrimental neurological and carcinogenic health effects, respectively. Pb and/or As contaminated soils require remediation, typically leading to costly and environmentally damaging excavation practices. Chemical remediation techniques may allow for *in situ* conversion of soil contaminants to phases that are not easily mobilized upon ingestion; however, effective chemical remediation options are limited. Here, we present a soil remediation method that can transform both Pb and As into alunite group minerals, specifically plumbojarosite and beudantite, with exceptionally low bioavailability. Bulk and spatially resolved X-ray absorption spectroscopy paired with bioaccessibility assays revealed that all treatments were effective at converting Pb and As contaminated soil to plumbojarosite and beudantite minerals with bioaccessibility reduced to <10%. Additionally, we successfully show remediation stability following lime application and productive grass growth, ultimately facilitating residential acceptance. The proposed treatment is cost-effective, potentially saving millions of dollars per acre while dually providing treatment to areas where excavation is not feasible. Research presented here facilitates future field experiments actively in development at U.S. EPA.