Goldschmidt 2026 Abstract
https://doi.org/10.46427/gold2026.36544

Geochemical stabilization of Pb in contaminated soils to reduce the human health risk around an ancient smelter plant in Matehuala, S.L.P., Mexico.

DR. DR. ERNESTO HERNÁNDEZ-MENDIOLA, PHD IN GEOCHEMISTRY[1], FRANCISCO MARTÍN ROMERO[1], JUANITA SIERRA-SALAMANCA[2] AND PROF. NADIA MARTINEZ-VILLEGAS, PHD[3]

[1]Universidad Nacional Autónoma de México
[2]SERVICIO GEOLOGICO COLOMBIANO
[3]IPICYT

Lead (Pb) contamination at historical mining sites with inadequate waste management poses a persistent threat to environmental and human health. This study investigates the geochemical controls on Pb contamination around an abandoned smelter plant in the Municipality of Matehuala (MMat), San Luis Potosí, Mexico, where surrounding soils are highly contaminated with heavy metals, mainly lead, due to mining activities. Lead causes effects on the blood, as well as the nervous, immune, renal, and cardiovascular systems, with particular risks to early childhood and prenatal development. Based on detailed mineralogical (DRX, SEM-EDS) and physicochemical characterization (pH, CE, Sequential extraction, FRX) of soils, as well as evaluation of the geo- and bio-accessible lead fractions, this study assesses environmental and human health risks using EPA methodologies. Results reveal that Pb resides in multiple solid phases in soils, such as secondary carbonates, Pb-bearing iron (oxy)hydroxides, and phosphate phases. These different hosts exhibit differential solubilities under simulated environmental and gastrointestinal conditions. Sequential extraction data corroborate these findings, demonstrating that Pb in soil reservoirs varies systematically with waste source type, geomorphological soil characteristics, and weathering history. By integrating the geochemical information, we propose two laboratory-scale chemical stabilization methods specifically designed for Pb at this historically contaminated site. Solidification and chemical stabilization are treatment technologies recommended to clean up contaminated sites. In this study, we promote immobilization via solidification or by the creation of a highly insoluble mineral to reduce Pb's bioaccessibility in soils, thereby reducing the associated human health risk and offering a possibility to restore the urban soils of MMat. After chemical stabilization treatment, the bioaccessibility shows a 40–70% reduction in soil samples. Mechanisms of precipitation and sorption were identified. The authors recommend pilot-scale field testing of reported chemical stabilization to evaluate soil cleanup efficiency.