MINERALOGICAL CONTROLS ON LEAD BIOACCESSIBILITY IN TAILINGS DUST

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One of the main risks that exposed and unvegetated tailings pose to human health is airborne dust that may be inhaled or ingested. In the case of Pb-bearing dust, both particle size and the identity of the Pb-hosting minerals affect the degree of risk. Finer dusts (<5µm diameter) have a higher potential of being ingested deeper into the human lung causing possible tissue damage and toxic effects. We have collected size-fractionated airborne dust and near-surface tailings at New Calumet Mine, Quebec, Canada, a former Pb and Zn producing mine. The project is intended to evaluate and improve methods for risk assessment of abandoned and unvegetated mine waste based on mineralogical speciation and bioaccessibility testing. The most bioaccessible Pb compounds are $PbCO_3$ (cerussite), $Pb_3(CO_3)_2(OH)_2$ (hydro-cerussite) and PbO, followed by $PbSO_4$ (anglesite), PbS (galena) and $Pb_5(PO_4)_3Cl$ (pyromorphite) (Plumlee and others, 2006). Airborne dust samples were collected on the tailings piles using a PIXE (Particle Induced X-ray Emission) Cascade Impactor which separates aerosol fractions onto nine impactor stages ranging from 16µm to 0.06µm. These stages were then analysed by PIXE to obtain elemental concentrations. Bulk samples of the tailings were collected for bioaccessibility tests as well as for total metal content, grain size distribution, and Pb speciation using ESEM (Environmental Scanning Electron Microscope) techniques. Both airborne dust and bulk tailings samples underwent synchrotron microanalysis including microXRD (micro X-ray Diffraction) for identification of microcrystalline compounds and microXRF (micro X-ray Fluorescence) for element mapping and metal ratio evaluation. The bioaccessibility tests involved gastric and pulmonary leaching of metals by simulated body fluids. Despite extensive oxidation of iron sulphide minerals in the near-surface tailings, galena persists as the most abundant Pb-bearing phase. However, rims of hydrocerussite forming alteration rims on some galena grains have been identified by ESEM, microXRD and microXRF. Element mapping also indicates a correlation of Pb with Cl and Fe suggesting that additional Pb may be hosted in Fe oxyhydroxides and pyromorphite.

[1] Plumlee, G.S., Morman, S.A. and Ziegler, T.L. (2006) The toxicological geochemistry of earth materials: An overview of processes and the interdisciplinary methods used to understand them. Reviews in Mineralogy and Geochemistry. V 64, pp.5-57.

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