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Relationships between particle size, arsenic concentration, surface area, and arsenic bioaccessibility in mine tailings from the Empire Mine, CA

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Waste material left over from the processing and extraction of metals in many mining areas contains associated and elevated levels of toxic metal(loid)s including arsenic (As), which can be mobilized into surrounding communities and incidentally ingested or inhaled by residents or recreational visitors to these sites. Additionally, erosive events such as crushing, affect contaminant bioaccessibility in ways that may influence risk approximation for the surrounding residents. Sediments from Empire Mine in Grass Valley, California were collected from twenty sites including mine tailings and waste rock. Samples containing As concentrations approaching 10,000 ppm were collected and separated via mechanical sieving into eleven distinct size fractions ranging from ≥2830 µm to ≤20 µm. Shatterbox crushing was carried out on samples from each size fraction to ≤10 µm. Nitrogen absorption surface area analysis and initial elemental concentrations (including arsenic) were measured for unground and ground samples. Speciation characterization of As was completed through EXAFS analysis at the Standford Linear Accelerator Center (SLAC). *In vitro* simulated gastric fluid extraction tests were then performed to determine the bioaccessibility of As for each discrete unground and ground particle size fractions as well as the ≤250 µm size regime (corresponding to the directly ingestible size fraction). Arsenic bioaccessibility was highly variable and strongly correlated with particle size and the presence of soluble As species. Controlled crushing experiments and As speciation analysis demonstrate that this correlation primarily arises through the removal of soluble As phases from within larger particle sizes. These findings demonstrate extended variability in arsenic bioaccessibility over time and indicate an increase in exposure risk through incidental ingestion following the crushing events.