Effects of speciation and spatial distribution on arsenic bioaccessibility in mine wastes

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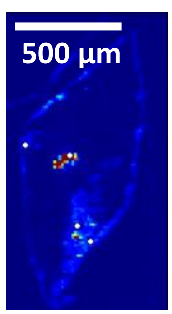
Highly elevated levels of arsenic, a known carcinogen, are common in mine wastes produced by the mining of gold and other metals throughout the state of California. The potential for arsenic to be mobilized in a human body –also known as bioaccessibility– is influenced by both physical and chemical attributes such as the size distribution and surface area of the mine waste as well as the chemical speciation and spatial distribution of arsenic within the waste material.

Size-separated mine tailings samples from the Empire Gold Mine, CA, USA were exposed to simulated gastric fluid and analyzed using X-ray absorption spectroscopy (XAS) and micro-X-ray fluorescence (µXRF) techniques to determine changes in arsenic oxidation state, chemical speciation and spatial distribution in pre- and post-exposure samples.

Reduced arsenic species (e.g. arsenopyrite) were identified in grain interiors, while oxidized species (secondary arsenic minerals such as yukonite, arseniosiderite, and scorodite and As(V) sorbed to iron hydroxides) were generally more abundant and preferentially enriched on particle surfaces. This latter category of oxidized, surface-bound arsenic phases was preferentially removed as a result of simulated gastric fluid exposure and likely influences short-term arsenic bioaccessibility, while the proportion of interior-bound arsenic can serve as a proxy for long-term bioaccessibility.

Determining the relationship between arsenic bioaccessibility, speciation, particle size fraction and surface area will enable more predictive assessments of the short- and long-term effects of exposure to these materials in mining regions and potentially assist environmental regulation agencies in developing effective remediation strategies.



Arsenic-bearing mine waste particle showing interior hot spots and surface enrichment. White circles = µXANES analysis.