Arsenic spatial distribution in mine wastes: Developing a proxy for short and long-term exposure risks

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Mining and processing of mineral resources (e.g. Au, Ag) in California has resulted in a legacy of metal(loid)-bearing mine wastes. Some of these elements, including arsenic, are potentially toxic and pose health threats to humans and the environments surrounding the mine sites. Arsenic bioaccessibility, the percentage of arsenic that can become soluble and mobilized in bodily systems, is dependent on the physical and chemical properties of the waste materials such as particle size, surface area, initial arsenic concentration, speciation, and spatial distribution. However, the relative contribution of spatial distribution to potential toxicity is not sufficiently understood.

X-Ray absorption spectroscopy (XAS) and X-Ray fluorescence (XRF) techniques that target arsenic species were applied to analyse size-sorted mine-tailing samples collected from the Empire Gold Mine, CA, USA. We employed GIS and deep learning-based methods for image analysis of XRF maps to characterize arsenic spatial distribution in mine tailings. Extended X-ray Absorption Fine Structure (EXAFS) analysis before and after exposure to simulated gastric fluid helps us determine arsenic speciation changes. We hypothesize the preferential immediate removal of surface-bound and more oxidized arsenic phases and the gradual removal of more concentrated and reduced arsenic phases. Insights in these relationships should enable us to produce more comprehensive assessments of short and long-term potential health hazards and help inform the remediation efforts of contaminated environments.