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Correlating Arsenic Bioaccessibility with Spatial Distribution in Mine Wastes: An Integrated Analysis

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Arsenic (As) is a toxic trace metalloid that can harm both humans and the environment due to its carcinogenic nature. Anthropogenic activities such as metal mining can mobilize arsenic when enriched in fine-grained mine wastes. Prolonged exposure to low-level arsenic can pose risks to populations near abandoned mine sites, primarily through inhalation or ingestion pathways. Therefore, accurately quantifying arsenic bioaccessibility is critical for long-term risk assessment and remediation efforts. Arsenic bioaccessibility is influenced by various factors including initial concentration, surface area, and particle size. Additional variables such as spatial distribution within particles remain under-studied due in part to the challenges in quantification and resolution, despite their potential influence in arsenic release and bioaccessibility. This study seeks to assess the effectiveness of arsenic spatial distribution as an indicator of changes in bioaccessibility over time, with the objective of better prioritizing mine sites for remediation efforts.

Simulated gastric fluid (SGF) extractions of ground and unground mine waste samples were performed to simulate the pathway of ingestion and analyzed using ICP-OES to calculate the percent arsenic bioaccessibility. Micro X-ray fluorescence (μXRF) maps collected at the Stanford Synchrotron Radiation Lightsource of samples before and after simulated ingestion were analyzed to determine potential changes in the spatial distribution and speciation of arsenic (***Figure 1***). By identifying such correlations, the value of using spatial distribution as a predictor of arsenic bioaccessibility was assessed. These findings have the potential to streamline the process of assessing long-term risks of arsenic exposure from abandoned mine sites and informing remediation strategies based on spatial distribution data and bioaccessibility correlations.

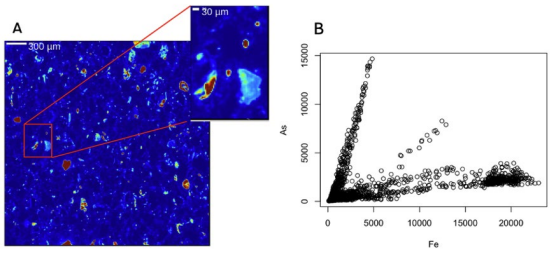

Figure 1: A. µ-xrf As intensity map of Descarga Mine Tailings. B. As vs. Fe scatterplot of µ-xrf map with a semi-quantitive, iterative fitting applied to the data to divide it into groupings based on the slope.