Windborne transport and surface enrichment of arsenic in semi-arid mining regions: examples from the Mojave Desert, California

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Extensive gold and silver mining throughout the state of California has left an environmental legacy of exposed mine wastes containing elevated levels of toxic metals and metalloids including arsenic (As), a known carcinogen. These mine tailings, particularly the fine-grained size fractions, are susceptible to weathering and windborne transport, significantly increasing the spatial extent of contamination in topsoils and potential exposure of humans to toxic metal(loid)s.

Surface enrichment of arsenic in soils was determined by collecting samples at depths of 0-5 cm and 5-10 cm below the surface. Twenty residential lots in Red Mountain, CA were also sampled at depths of 0-5cm, 5-15 cm, 15-30 cm, and >30 cm. Distance from a tailings pile was also determined for these samples to determine that As concentrations correlated with wind direction. These depth-based field sampling of soils surrounding several abandoned mines in the Mojave Desert (southern CA) have identified an exponential decline in As soil enrichment with increasing distance from tailings piles consistent with prevailing easterly wind directions.

In vitro extraction studies using a phagolysosomal simulant fluid (PSF), mimicking the inhalation of the most finely-sieved size fraction of selected samples ($\leq$20 μm), indicate that initial solid As concentration is the strongest indicator in predicting the concentration of As released in the lung. When extraction data are incorporated into exposure risk assessment calculations, the majority of samples investigated exceed both cancer risk thresholds and non-cancer-related minimal risk levels (MRLs) based on long-term chronic exposure to airborne mine tailings dusts. This suggests that long-term residents of communities located close to these abandoned mine sites, especially those who reside downwind (i.e. east) of mine tailings piles, face possible health effects due to the inhalation of fine-grained mine tailings mobilized through aeolian processes.