Mineralogy and bioaccessibility of arsenic-bearing secondary phases in gold mine tailings

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High concentrations of arsenic in windblown and vehicle-raised dust from abandoned gold mine tailings in Nova Scotia, Canada pose a potential health risk for local residents who use these areas for recreational activities. The exposure involves inhalation of dust, as well as oral ingestion of particles. It is critical to understand the nature of the arsenic-hosting mineral phases in dust particles in order to evaluate the human health risk.

The tailings consist dominantly of quartz, muscovite, Fe-rich clinochlore, and albite. Arsenic concentration in the samples collected from three sites varies from 400 to 28,600 ppm in the bulk samples and 3000 to 10,500 ppm in the <38 µm fraction. This significantly exceeds 12 ppm, the soil quality guideline of the Canadian Council of Ministers of the Environment. The arsenic was originally in the form of arsenopyrite, but vigorous oxidation has destroyed most of the sulfide in near-surface samples. Scorodite ($FeAsO_4{\cdot}2H_2O$) was found to be the dominant secondary phase in some samples. At the microscopic scale, scorodite cements silicate grains and in the field it forms hardpans which, at some sites, have been pulverized by vehicle activity. In other samples, arsenic is hosted in iron oxyhydroxides with variable As_2O_5 and CaO concentrations (up to 30 wt.% and 8 wt.%, respectively).

In order to evaluate how much of the arsenic is bioaccessible, the samples were subjected to an *in vitro* two-part extraction method designed to mimic the human digestion system. The results indicate that the percent of bioaccessible arsenic in the scorodite-rich samples is significantly lower than in the samples where arsenic is hosted by iron oxyhydroxides and Ca-Fe arsenates. However, because the total arsenic in the scorodite-rich sample is much higher, the actual concentration of arsenic that is bioaccessible is also higher.

Recent recognition that expanding residential developments are increasing the chances of human exposure to arsenic-bearing tailings at many abandoned sites in Nova Scotia has led to the formation of a government-managed advisory committee as well as an interdisciplinary research group. Residents in several areas have been advised to avoid contact with gold mine tailings.