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Sulfidation of As_2O_3 Roaster Waste from Giant Mine, NWT: Leachability of the Amorphous As_2S_3 Product

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Giant Mine, located outside of Yellowknife NWT, is host to 237,000 tonnes of soluble As_2O_3-rich roaster waste that is stored in the underground workings, posing a risk to the surrounding environment. Remediation efforts at Giant Mine focus on preventing interaction with groundwater by pumping to maintain an artificially low water table and freezing the surrounding ground.

To protect the surrounding population and environment, there is a need to develop a maintenance-free, 'walk-away' remediation option for the roaster waste. This study aims to transform the soluble As_2O_3 to a low-solubility, amorphous As_2S_3 solid and to assess its stability for disposal in the anaerobic deep mine-water environment. As_2S_3 can be formed from the sulfidation reaction between aqueous As^{III} and sulfide, in this case, $H_2S_{(g)}$. Details of the sulfidation experiments are presented in a companion paper (Simard et al) while this paper focuses on leaching experiments that test the solubility of As_2S_3 in waters with a range of compositions representative of the deep mine environment.

The solids from sulfidation experiments were dried in an anaerobic chamber and characterized by powder XRD. In the first experiments, leaching tests were conducted in triplicate at 22 °C, with initial pH values 5, 6 and 8, versus time to determine the time required to reach equilibrium. Data from these experiments indicate that equilibrium is reached after 30 days. Subsequent tests are underway in triplicate for 30 days at a range of ionic strengths (I; 0 to 1.13 mol/L; TDS ≈ 47 g/L), temperatures (4 and 22 °C) and initial pH values (5, 6 and 8).

Consistent with thermodynamic predictions, the solubility of the As_2S_3 increases with pH and ionic strength. At the highest ionic strength (I = 1.13 mol/L), As concentrations range from 5.07×10^{-5} mol/L (3.78 mg/L) at pH 5 to 6.41×10^{-5} mol/L (4.81 mg/L) at pH 8. The XRD data indicate the As_2S_3 is amorphous, but diffraction patterns from As_2S_3 formed at temperature increments between 22 and 80 °C suggest there may be a slight increase in crystallinity with temperature.