Goldschmidt 2024 Abstract
https://doi.org/10.46247/gold2024.22747

Geochemistry of arsenic trioxide roaster waste at the former Giant Mine, NWT, Canada

DR. VALERIE A. SCHOEPFER[1], ARDALAN HAYATIFAR[1], HEATHER E. JAMIESON[2], JOYCE M. MCBETH[3] AND MATTHEW B. J. LINDSAY[1]

[1]University of Saskatchewan
[2]Queen's University
[3]University of Regina
Presenting Author: valerie.schoepfer@usask.ca

Large quantities of toxic arsenic trioxide roaster waste (ATRW) were generated during the processing of Au-bearing arsenopyrite ore in Yellowknife, NWT, Canada. In addition to aerial distribution, the 234,000 tonnes stored in underground chambers remain a long-term environmental and human health risk. Although dominated by arsenolite [As_2O_3], additional phases (e.g., sulfides, oxides, arsenates) and elements (e.g. Sb, Fe, Ca) present in minor to trace amounts may alter ATRW solubility and reactivity. These compositional differences have potentially important implications for ongoing evaluation and development of permanent remediation approaches.

Nine underground ATRW samples were studied to identify composition and variability [1], with four selected for additional analysis of factors influencing solubility and reactivity. Subsamples were equilibrated for two weeks under various aqueous geochemical conditions, ensuring remnant solids remained. Aqueous geochemistry results reveal that substantial As dissolution occurred during equilibration at various pH (4, 6, 8), ionic strength (0.02 M NaCl, 0.2 M NaCl), and temperature (5°C, 25°C) conditions. We found that temperature had the largest influence on As dissolution, followed by ionic strength and pH. However, only between 41% and 87% of theoretical As_2O_3 solubility was achieved, suggesting ATRW chemical composition controls dissolution.

There were no differences in X-ray diffraction patterns before and after dissolution. Arsenic K-edge X-ray absorption spectroscopy (XAS) further indicate resemblance to arsenolite, but Sb K-edge XAS reveal increased Sb bonding with As in residual solids following dissolution. Increased Sb-As bonding is supported by electron microprobe and automated mineralogy analysis, which further indicate a solid-solution between As_2O_3 and Sb_2O_3. Support from XRD-pair distribution function analysis indicates a relation between samples with lower solubility and samples that contain a larger proportion of Sb-rich arsenolite particles, indicating Sb incorporation may influence ATRW geochemical properties.

This research shows ATRW compositional variability influences solubility, which has implications for ongoing work into eventual implementation of a new arsenic control strategy in Yellowknife.

[1] Lum, J. E.; Schoepfer, V. A.; Jamieson, H. E.; McBeth, J. M.; Radková, A. B.; Walls, M. P.; Lindsay, M. B. J. (2023), *J. Hazard. Mater.*, *458*, 132037. https://doi.org/10.1016/j.jhazmat.2023.132037.