

Vitrification: A potential solution for stabilizing arsenic trioxide roaster waste at the Giant Mine (Yellowknife, NT)

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Historical roasting of arsenopyrite (FeAsS) ore at the Giant Mine (Yellowknife, NT) in Canada left 237,000 tonnes of arsenic trioxide roaster waste (ATRW) in underground chambers and mined-out stopes, posing significant risks to the surrounding environment. A permanent stabilization approach is being sought to reduce the risk of As mobilization. Vitrification of the ATRW has been proposed as a potential method. This study evaluates whether vitrification of ATRW reduces the geochemical leachability of As. Three vitrified-arsenical glasses were prepared by Dundee Sustainable Technologies using the ATRW collected from the Giant Mine. Synchrotron-based techniques were used to determine elemental distributions and the local bonding environment of As atoms within the glasses. Subsamples of the glasses were crushed to assess the impact of changing surface area on the leachability of As. Geochemical stabilities were evaluated using selective-chemical-extraction protocols on both the uncrushed and crushed glasses by immersing each subsample into solutions targeting water-soluble, Ca²⁺-exchangeable, PO₄³⁻-exchangeable, weak-acid extractable, crystalline reducible, amorphous-crystalline reducible, oxidizable, and strong-acid leachable fractions. Results of the synchrotron-based experiments indicate that vitrified-arsenical glasses were amorphous, and As was evenly distributed within the glasses. Results of selective-chemical extractions showed limited release of As in solutions with neutral to near neutral pH values with glass containing up to 15 wt.% As. Higher release of As was observed in more acidic solutions (pH < 3). Furthermore, samples of crushed glasses leached commensurately higher masses of As compared to samples of uncrushed glasses. Results of this study indicate that vitrifying ATRW decreases its solubility and associated As release, and that the long-term behaviour under different geochemical conditions should be defined/understood before applying this approach at a large scale.