

ARSENIC IN OXIDATION PRODUCTS OF HIGH SULFIDE, REFRACTORY ARSENOPYRITE MINE WASTE, SNOW LAKE, MANITOBA, CANADA¹

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Abstract: Between 1948 and 1959, 250 000 tonnes of cyanide treated, high sulfide refractory ore concentrate were stored in a waste rock impoundment at Nor-Acme Mine, Snow Lake, Manitoba, Canada. Over 40 years of exposure resulted in the development of a supergene alteration profile in the waste. The pile was capped with layers of waste rock, clay and silt in 2000 to prevent water infiltration and the oxidative release of arsenic.

The primary sulfide mineralogy of the residue was 55% arsenopyrite, 10% pyrrhotite, and 5% pyrite. Prolonged exposure of the sulfide residue to air and water initiated oxidation of sulfide minerals, forming an alteration zone 0.5 m thick. Arsenic accumulated in secondary phases, including X-ray amorphous iron sulfoarsenates (AISA), scorodite ($\text{FeAsO}_4 \cdot 2\text{H}_2\text{O}$), and jarosite ($\text{H}_3\text{O}^+, \text{K}$) $\text{Fe}_3((\text{S}, \text{As})\text{O}_4)_2(\text{OH})_6$). Low solubility phases, including scorodite and jarosite, precipitated during the early stages of alteration. Scorodite occurred as microcrystalline aggregates, discrete grains, and inclusions in later AISA phases. Anhydrous jarosite inclusions in AISA contained 0.94 wt% As in the upper alteration zone, and 2.2 wt% As in the lower zone of alteration. The prevalent secondary phase was reddish-yellow brown AISA, containing 16 to 37 wt% As. The As/S ratio of AISA decreased with progressive mineralization. The arsenic content in water infiltrating through the oxidized layers is controlled by the solubility of residual arsenopyrite and secondary As-phases.

The earliest stages of weathering were observed in the refractory wastes below the alteration zone, where the oxidative dissolution of arsenopyrite led to the release of arsenate, arsenite, sulfate and ferrous ions to pore water solution. Arsenic concentration in aqueous phases is controlled by the solubility of residual arsenopyrite and secondary As-phases in the alteration zone. Pore water in the unoxidized zone contains up to 100 mg/L total arsenic (up to 25 mg/L As (III)).

Additional keywords: arsenic, scorodite, jarosite.

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