

THE SOURCE, ATTENUATION AND POTENTIAL MOBILITY OF ARSENIC AT NEW BRITANNIA MINE, SNOW LAKE, MANITOBA¹

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Abstract: The source, attenuation, and potential mobility of arsenic are being investigated in surface and groundwater at New Britannia Mine, Snow Lake, Manitoba, Canada. Concentrations of arsenic, averaging 20.0 mg/L (1995 – 2005) persist in the groundwater at monitoring well 17 (MW17) below the former Nor Acme emergency tailings disposal area. Arsenic is toxic and mobile under typical surface and groundwater conditions (pH 5-9). Snow Lake is approximately 500 m from the mine and provides drinking water as well as a recreation site for the population of the town of Snow Lake.

During the early 1950's, 227 000 tonnes of cyanide-treated, refractory sulphide concentrate with a grade of 9.60 g/tonne of gold were stored in an Arsenopyrite Residue Stockpile (ARS) in hopes of eventually developing a safe and economic means of extracting the refractory gold. The ARS, which contains pore water concentrations of arsenic up to 98.3 mg/L near the base of the pile, was capped in 1995 to prevent further oxidation of the sulphide concentrate and surface runoff. MW 17 is 100 m downgrade from the ARS.

The stockpile has been determined to be the most probable source of elevated arsenic concentrations to the groundwater at MW17. Hydrogeological modeling indicates a flux of 3.15×10^{-9} m/s through the base of the pile into the underlying aquifer. Arsenic concentrations in the pore water extracted from the Nor Acme tailings are consistently low, ranging from 0.09 – 3.8 mg/L As. Arsenic levels decrease gradually with depth into the reduced zone, with the greatest concentrations occurring at the interface between the oxidized and reduced tailings. The total amount of arsenic bound to solids also decreases gradually with depth through the tailings.

Scanning electron microscopy (SEM) and electron microprobe analysis (EMPA) show arsenic bound to secondary phases comprising of Fe and Ca indicating that As may be adsorbed, with Ca, on Fe oxides and/or hydroxides.

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The concentration of As in surface water along the predicted flow path between the tailings and the inlet to Snow Lake gradually decreases with 0.8 mg/L As in the swamp water adjacent to the tailings and 0.01 mg/L As at the inlet to the lake. In 2005, water samples from different locations and depths in Snow Lake had concentration of As averaging 0.004 mg/L.

The most-probable-number (MPN) microbiological assay method, which estimates the dissimilatory arsenic-reducing bacteria (DARB), is included in the investigation to delineate relative concentrations and locate zones where chemical reactions are being enhanced by bacterial activity.

A low lying swampy area north of the ARS contains elevated As concentrations in the surface water and pore water extracted from the organic matter. This area is being investigated to understand how As behaves in the presence of organic matter. The area received runoff from a lined leach basin employed during unsuccessful attempts in the late 1980's to retrieve the refractory gold from the stockpile residue. Water from this area joins the surface water flowing towards Snow Lake from the Nor Acme Tailings Area. Arsenic here is bound with Fe and Ca to precipitates coating plant material.