
Distinguishing between geogenic and anthropogenic sources of arsenic in soils in the North Brookfield Gold District, Nova Scotia

LORI A. WRYE¹; HEATHER E. JAMIESON¹;
MICHAEL B. PARSONS², AND STEPHEN R. WALKER¹

1. Department of Geological Sciences, Queen's University, Kingston, ON, K7L 3N6 Canada <wrye@geoladm.geol.queensu.ca> ¶ 2. Geological Survey of Canada Atlantic, Dartmouth, NS, B2Y 4A2 Canada

Soils in the North Brookfield Gold District, Nova Scotia are enriched in arsenic (As) both naturally, associated with local gold mineralization in bedrock, and anthropogenically, due to the processing of gold ore. The focus of this research is on soils surrounding the abandoned, publicly-accessible North Brookfield Gold Mine which operated from 1887–1936, and produced approximately 43,000 troy ounces of gold from 105,000 tonnes of crushed rock. At present, the North Brookfield district is a popular recreational site with off-road vehicle enthusiasts, who have constructed ramps and jumps using the historical mine tailings. North Brookfield is a unique site because it is the only Nova Scotia Gold mine that, in the early years of operation (from 1897 to 1903), combined roasting and chlorination in the extraction of gold from the arsenopyrite (FeAsS)-bearing ore. Roasting of the gold ore decomposed the arsenopyrite to iron oxides, releasing sulphur dioxide (SO₂) and arsenic trioxide (As₂O₃) from the stacks to the surrounding area. Arsenic trioxide is a very soluble and potentially mobile form of arsenic and understanding its fate in the environment is important for assessing the potential risks associated with human exposure to these soils. In 2007, 10 shallow soil cores

(40–60 cm long) were taken with the objective of developing and applying methods of distinguishing between geogenic and anthropogenic sources of As in North Brookfield soils. Samples were taken within 1 km upwind and downwind of the approximate location of the historic roasting stacks. Results from bulk aqua-regia soil digestions and ICP-AES analysis show that the average As concentrations for all sub-samples was 300 ppm (median= 38 ppm), exceeding the Canadian Soil Quality Guideline of 12 ppm (residential and parkland soils). Five sub-samples from two locations stand out, with As concentrations in the top 10 cm ranging from 350 to 4300 ppm. These samples were taken within 100 m of the furnaces and chlorination house. The high As sub-samples were magnetically separated, then magnetic materials and residuals were made into thin sections. Roaster-derived Fe-oxides, natural Fe-Ti oxides and primary sulphides were identified in the sections, along with an as yet unidentified brown mass. Synchrotron-based microanalytical techniques were then used to identify nanocrystalline As-bearing phases and results indicated that As was associated with all of the above phases. Preliminary examination of XANES (X-ray absorption near-edge spectroscopy) data shows that the As was predominately As⁵⁺ with typically 10% As³⁺, however one sample of the weakly reflective brown mass had significant As³⁺. Work to-date suggests that anthropogenically derived As is associated with the brown mass, while natural As-bearing materials such as the weathering products of arsenopyrite were also observed. Future work on soils from the area will include sequential selective extractions on high-As samples, as well as scanning electron microscopy and electron microprobe analysis.