

Mineralogical controls on arsenic mobility and bioaccessibility at historical gold mines in Nova Scotia

M.B. PARSONS^{1*}, S.R. WALKER^{2,3}, H.E. JAMIESON²,
L. MEUNIER⁴, I. KOCH⁴ AND K.J. REIMER⁴

¹Geological Survey of Canada (Atlantic), Dartmouth, NS
(*correspondance: Michael.Parsons@NRCan.gc.ca)

²Queen's University, Kingston, ON

³AMEC Environment and Infrastructure, Mississauga, ON

⁴Royal Military College of Canada, Kingston, ON

Recent studies of historical gold districts in Nova Scotia have identified several areas where exposure to mine wastes may represent a potential risk to both ecosystem and human health [1]. Two sites, Montague and Goldenville, are of particular concern as the tailings are located close to residential areas and are occasionally used for racing off-road vehicles. Arsenopyrite (FeAsS) occurs naturally in these gold deposits, and was concentrated in the tailings during milling. We have examined the concentration, speciation and bioaccessibility of As in tailings, airborne particulates and soils to clarify the spatial extent of tailings, the mineral hosts for As, and the fate of windblown tailings dusts. Total As concentrations in 487 tailings samples range from 10 mg/kg to 31 wt.% (mean = 12,000 mg/kg). Micro-mineralogical analyses show that As is hosted in arsenopyrite and a variety of weathering-related phases, including three forms of ferric arsenate: scorodite (FeAsO₄•2H₂O), amorphous Fe arsenate, and kaňkite (FeAsO₄•3.5H₂O); two Ca-Fe arsenates (yukonite [Ca₂Fe₃(AsO₄)₃(OH)₄•4H₂O] and an amorphous form), one arsenite phase (tooeleite [Fe₆(AsO₃)₄(SO₄)(OH)₄•4H₂O]), and As bound to Fe oxyhydroxides [2]. The bioaccessibility of As was measured using a physiologically-based extraction test (PBET) and ranged from 0.1 to 49% of total As. These values are controlled by the relative proportions of the As-bearing phases, although grain size and texture also play a role. The highest As bioaccessibility is associated with the presence of Ca-Fe arsenates. Samples containing As predominantly as arsenopyrite or scorodite have the lowest bioaccessibility (<1%). Only a weak correlation was observed between total and bioaccessible As concentrations [3]. Results from this study have been shared with the Nova Scotia Gold Mines Historic Advisory Committee and are being used to evaluate the human health risks associated with exposure to As-bearing tailings, and to help guide management actions.

[1] Parsons *et al* (2012) GSC Open File 7150, doi:10.4095/291923. [2] Walker *et al* (2009) *Can. Min.* **47**, 533-556. [3] Meunier *et al* (2010) *ES&T* **44**, 2667-2674.