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Challenges of Antimony Leaching in Mining Environments

LISA C. FÜLLENBACH[1], JEFFREY A. CLARKE[2], ROBERT BOWELL[3] AND STEPHEN J. DAY[2]

[1]SRK Consulting (UK) Ltd.
[2]SRK Consulting (Canada) Inc.
[3]SRK Consulting

Presenting Author: lfuellenbach@srk.co.uk

Antimony is an element of concern at a gold producing mine situated in a temperate rainforest climate, where it is hosted in sulphide minerals. The exposure of these minerals to air and surface waters during production and waste rock disposal may potentially produce acid rock drainage and (neutral) leaching of metal(loid)s including antimony and arsenic. Although arsenic and antimony often occur together and are considered of similar species-dependent toxicity, much less is known about the geochemical behaviour of antimony.

To estimate the potential toxicity of antimony in the rock leachates from subaqueous disposal and subaerial storage of waste rock, the speciation of antimony needs to be known. Therefore, ten leachate samples collected from kinetic laboratory humidity cell and subaqueous column testing were analysed for Sb(III), Sb(V), trimethyl antimony (TMSb), and total antimony (Sb) using coupled ion chromatography and inductively coupled plasma mass spectrometry.

The speciation analyses showed that antimony was present as Sb(V) in all leachate samples, with two samples collected from the bottom ports of column tests (considered less oxygenated) containing detectable proportions of Sb(III). As Sb(V) is considered less mobile and less toxic than Sb(III), these results may suggest a lower risk of antimony toxicity. However, the kinetic leach tests are not designed to assess metal(loid) speciation, and sample material is exposed to air during sample handling and to oxygenated water over long testing periods of tens of weeks. Thus, the results of the antimony speciation analyses must be considered with caution.

The following developments are required to address the challenges associated with potentially antimony leaching mine wastes: (1) effective preservation techniques and sampling procedures of field samples would allow for more reliable assessment of antimony speciation under field conditions, (2) water quality guidelines for antimony would facilitate regulation and management strategies, (3) improving the Sb-speciation thermodynamic database would allow for more accurate predictions of the geochemical behaviour of antimony under the respective field conditions. This study aims to highlight this need for the development of methodologies and water quality guidelines to assess, evaluate, and manage the potential hazard caused by antimony leaching from mine wastes.