Antimony in the New Zealand environment

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Abstract

Antimony (Sb) is a metalloid like arsenic, and reputedly has similar toxicity in humans. Like arsenic, antimony has been employed extensively for a wide range of uses historically, but those uses are declining because of increasing world-wide environmental and toxicological concerns. Nevertheless, Sb still has a range of common uses in modern society, particularly in plastics. Sb has similar chemical behaviour to arsenic, in that it has 3+ and 5+ oxidation states, and forms oxyanions in solution.

Sb occurs at low background levels in New Zealand rocks (typically 0.01-0.1 mg/kg), distinctly lower than arsenic (2-20 mg/kg). Sb is readily mobilised from background rocks by hydrothermal waters, and some is transported to hot springs and near-surface geothermal systems in the North Island, accompanying As and Hg. Ancient mesothermal vein systems in the South Island also contain variable amounts of Sb, and some minor Sb mining has occurred historically. Sb occurs at elevated levels (typically 10-100 mg/kg), but is subordinate to arsenic, in most mesothermal gold deposits in the South Island. Stibnite (Sb_2S_3) is the most common Sb sulphide mineral, and this mineral commonly occurs with arsenopyrite (FeAsS). Arsenopyrite can have up to % level Sb in solid solution, and stibnite can have % level As in solid solution.

Stibnite oxidises to a variety of Sb oxide minerals, principally valentinite ($Sb^{III}_2O_3$) and stibiconite ($Sb^{III}Sb^{V}_2O_6OH$) under surficial conditions. These oxides are soluble and dissolved Sb up to 50 mg/kg can arise, as $Sb^{V}O_3^-$ or $Sb^{V}(OH)_6^-$. Dissolved Sb is readily attenuated by, for example, high surface area iron oxyhydroxide, with empirical K_d of ca. 10^5 L/kg, similar to dissolved arsenic as $HAsO_4^{2-}$. Without this type of attenuation, elevated dissolved Sb can be traced for kilometres or even hundreds of kilometres from point sources.

Sb has received little publicity compared to arsenic in the past, and Sb is not commonly analysed in environmental evaluations. However, the close chemical similarity between Sb and As throughout the geological environment means that wherever arsenic is present at elevated levels, Sb can be expected as well, albeit at lower levels (typically 0.1-0.01 of As levels).