Mercury mobilization to the aquatic environment from cyanide-rich gold mine tailings

S.A. SHAW[1], T.A. AL[1] AND K.T. MACQUARRIE[2]

[1]Department of Geology, [2]Department of Civil Engineering
University of New Brunswick, Fredericton, NB, Canada
(sean.shaw@usask.ca, tal@unb.ca, ktm@unb.ca)

Introduction

Gold was extracted by cyanidation from a gossan that overlies a Cu-Zn massive sulfide deposit in northern New Brunswick, Canada. Approximately one Mt of tailings are stored on-site in an unsaturated pile that contains residual CN and Hg, mainly in the form of cinnabar. Elevated Hg concentrations have been detected over the past 15 years in the groundwater adjacent to the tailings pile (up to 8,000 mg/L in 1991) and down gradient in the water of Gossan Creek, a local 1st-order stream.

Experimental Methods

The relationship between observed Hg contamination in the aquatic environment and residual CN in the tailings was investigated through: 1) tailings column leach experiments; 2) geochemical sampling of the groundwater and Gossan Creek; 3) geochemical speciation calculations.

Results and Discussion

Initially CN leaches conservatively from the columns but as time progresses the data suggest that geochemical reactions control the release of CN. A strong correlation is observed between Hg and CN concentrations in the column leachate, groundwater and surface water in Gossan Creek. Geochemical modeling suggests that Hg-CN complexes account for > 99% of the measured Hg, predominantly as $Hg(CN)_2$.

Conclusions

Residual CN in the tailings mobilizes Hg from cinnabar into the pore-water through the formation of Hg-CN complexes. These complexes facilitate the transport of Hg to the surrounding environment.

Dissolved, adsorbed, organic bound and mineral bound mercury transport by rivers, British Columbia, Canada: The role of rock weathering

K.H. TELMER AND J.D. SPENCE

School of Earth and Ocean Sciences, University of Victoria, Victoria, Canada (ktelmer@uvic.ca; jodys@uvic.ca)

Water and suspended particulate from the Fraser, Skeena and Nass river systems of the western Canadian Cordillera have been analysed for mercury (Hg) concentrations in the dissolved, adsorbed, organic bound and mineral bound phases. The total annual export of Hg to coastal waters by these rivers is determined to be 10.9×10^3 $kg{\cdot}yr^{-1}$, of which 6% (630 $kg{\cdot}yr^{-1}$) is in the labile phases (dissolved < adsorbed < organic bound). Dissolved Hg concentrations range from <0.3 to 1.4 $ng{\cdot}L^{-1}$ (ppt). Particulate Hg concentrations (dry weight) range from 3 to 88 ppb (adsorbed), 4 to 270 ppb (organic bound), and 5 to 2000 ppb (mineral bound).

Chemical weathering of bedrock transfers Hg from bedrock to the pedosphere, biosphere, atmosphere, and hydrosphere. Using measured chemical weathering rates and conservative estimates of Hg in bedrock, Hg release by weathering in the study area is calculated by mass balance. Results indicate weathering is the dominant source of Hg in the Cordilleran rivers, with sulphide oxidation having the greatest influence on Hg release bedrock weathering.

Comparison of data collected during the high stage (June) and low stage (October) of the hydrograph shows a seasonal variability in Hg concentrations and relative distribution between the adsorbed, organic bound and mineral bound phases. In June, the labile Hg dominantly exists in the adsorbed phase, with little organic bound Hg. The opposite distribution is observed in October. This is consistent with a change in composition and source of the suspended particulate matter from relatively unweathered rock flour in June (alpine source) to substantially more weathered material in October (valley source) containing a greater percentage of organic material and secondary minerals that form during soil development.

The mineral bound Hg concentrations also show seasonality, with Fraser, Skeena and Nass main stem samples having as much as an order of magnitude more Hg in June than October. Lower Hg concentrations in the low-land derived particulate suggests that soil development may be associated with direct loss of Hg to the atmosphere.