Determining the long-term persistence of Hg releases to the environment from cyanide rich gold-mine tailings

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Mining operations that utilize cyanide (CN) for the recovery of gold may mobilize mercury (Hg) from natural sources in the gold ore. Residual CN in mine tailings may result in the formation of soluble Hg-CN aqueous complexes in the pore waters that leach from the tailings and are transported to the surrounding environment. The Murray Brook gold mine, located in northern New Brunswick, represents an example of this type of Hg contamination. Quantification of the initial total mercury (Hg_T) and total cyanide (CN_T) concentrations in the tailings solids indicates heterogeneous concentration profiles versus depth, with peak values of 39.5 mg Hg/kg and 9.5 mg CN/kg. In this case, Hg mobility is intimately linked to the presence of CN. We are assessing the long-term persistence of Hg releases by studying the controls on CN losses from the tailings with a series of in situ and laboratory-based investigations.

Cyanide may degrade oxidatively through reaction with O_2 in the pore gas, and Hg may escape from the tailings in the volatile Hg^0 state. Therefore, a monitoring program for tailings pore-gas concentrations was implemented to investigate the flux of O_2 into the pile and Hg^0 from the pile. Measurements were made near the centre of the pile at 1 m intervals to a depth of 15 metres. Consistent trends were observed through time over a period of 1 year for both O_2 and Hg^0. Contradicting the initial hypothesis that downward diffusion of O_2 from the atmosphere replenishes O_2 consumed by CN degradation, the profiles display relatively high O_2 concentrations at depth, suggesting that downward diffusion is not the controlling mechanism of O_2 transport. The Hg^0 pore-gas concentration profiles are erratic versus depth, and do not provide strong support for the hypothesis that Hg^0 diffuses outward from the pile to the atmosphere.

Loss of Hg and CN from the pile may also occur through leaching with infiltrating meteoric water. Laboratory-based column experiments were designed to quantify the amount of Hg_T and CN_T that could potentially be leached. Initial aqueous effluent concentrations from the columns reached maximum values of 12 900 µg Hg/L and 16 000 µg CN/L. The concentration versus time profiles display an initial rapid decline, followed by a prolonged period of asymptotic concentration decrease. In order to assess the longevity of Hg and CN leaching from the tailings pile, numerical modelling will be conducted to scale the experimental results to the field scale.