Mercury loss from stream water by evasion and sedimentation

T.A. AL[1], K.T. MACQUARRIE[2], D. FOX[3] AND A. MAPRANI[1]

[1]Dept. of Geology, [2]Dept. of Civil Engineering, University of New Brunswick, Fredericton, NB, Canada (tal@unb.ca)
[3]New Brunswick Dept. of Environment and Local Government, Fredericton, NB, Canada

In northern New Brunswick, Canada, a contaminated groundwater plume, originating from gold-mine tailings, discharges to a small headwater stream. Elevated concentrations of Hg (Hg_T up to 60 µg/L) and CN (up to 27 µg/L) occur in the stream water. Around 95% of the aqueous Hg_T load is attenuated by processes such as evasion and sedimentation within 4 km from the source. A method was developed to quantify Hg evasion from the stream, and mineralogical investigations were conducted to determine the forms of Hg that have accumulated in the sediment.

The evasion rate of Hg from the stream was estimated by combining a measured relationship between Hg and propane evasion coefficients in turbulent systems with propane tracer experiments in the field (Maprani et al. in press).

Mineralogical investigations indicate that Hg is stored in the sediments in the form of Au-Ag-Hg amalgam and HgS. Similar to Hg, the Au and Ag were transported to the creek as aqueous CN complexes in groundwater from the tailings (Leybourne et al. 2000). Nano particles of HgS +/- Au occur commonly at a scale of approximately 5-10 nm (Fig. 1).

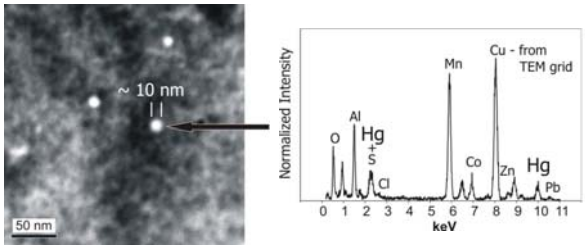

Figure 1. Dark-field STEM image of HgS nanoparticles within Mn-Al-oxyhydroxide precipitate from the stream sediments (left) and corresponding EDS analysis (right).

References

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The potential for methyl mercury production in constructed wetlands and a riparian setting

MAE SEXAUER GUSTIN[1], RAJ CHAVAN[1,2], JELENA STAMENKOVIC[1], JODY ERICKSEN [1], SCOTT BROWN[1], LAUREL SAITO[1], KEITH DENNETT[2], ERIC MARCHAND[2] AND SUSAN DONALDSON[3]

[1]Department of Natural Resources and Environmental Sciences, University of Nevada, Reno, NV 89557
[2]Department of Civil Engineering, University of Nevada, Reno, NV 89557
[3]University of Nevada Cooperative Extension, Reno, NV 89520

Many watersheds of the western United States have mercury (Hg) contamination that originated from mining and processing of gold and silver ores during the late 1800's. Wetland and riparian areas are important aquatic habitats in the water limited west, but may also be potential sites for formation of methyl Hg (MeHg), a subtle neurotoxin that is bioaccumulated in ecosystems.

This project investigated the potential for MeHg production in flow-through wetland mesocosms as a function of 1) soil and water Hg concentrations on a seasonal timestep; and 2) experimental manipulations using chemical additions and regulating water flow. Some mesocosms had sediment (0.1 to 2.0 mg/kg) and water (20 to 350 ng/L) derived from a creek contaminated with mine waste containing Hg that was used to amalgamate gold and silver ore. Wetland mesocosms (10 total) were densely vegetated and consisted of four replicated experimental designs. Water quality parameters and Hg concentrations in all mesocosms were monitored for > two years. In addition, the potential for MeHg production associated with a vegetated reach of the contaminated creek was investigated.

In general, the wetlands were a sink for total Hg and seasonally dependent sources for MeHg with greater production in the summer. Mesocosms with contaminated sediments and uncontaminated waters were the most significant MeHg sources. Drying and wetting resulted in flushing of MeHg from the wetlands and increased water retention time enhanced MeHg release. Chemical manipulations using sulfate and nitrate additions produced no significant change in MeHg concentrations.

No trends in MeHg concentrations along the stream reach were observed. However, sampling of shallow ground water in piezometers showed that the hyporheic zone could be an area of significant MeHg formation in riparian areas with mercury contamination.