Determination of species-specific Selenium exchange fluxes across the sediment-water interface

D. WALLSCHLÄGER[1]*, J. LONDON[1], Y.-W. CHEN[2], N. BELZILE[2] AND A. J. MARTIN[3]

[1]Trent University, Peterborough, ON K9J 7B8, Canada (*correspondence: dwallsch@trentu.ca)
[2]Laurentian University, Sudbury, ON P3E 2C6, Canada
[3]Lorax Environmental Services Ltd., Vancouver, BC V6J 3H9, Canada

Selenium (Se) is frequently accidentally discharged into aquatic ecosystems from large-scale industrial operations, including coal-fired power plants, petroleum refineries and various types of mines. It may cause reproductive effects and deformities in aquatic wildlife, but the mechamism of Se bioaccumulation in the aquatic environment is generally still not well understood. Particularly, it is unclear in most case studies whether current Se loads in the waters (via littoral food chains) or historic Se deposits in the sediments (via benthic food chains) play the dominant role in the bioaccumulation process. Consequently, it is important to study and characterize Se exchange between water and sediments in environments receiving Se emissions.

In this study, we collected water and pore water samples around the sediment-water interface at two lentic locations impacted by industrial Se emissions, using peepers to obtain high spatial resolution on both sides of the interface. Samples were collected and processed anoxically to prevent speciation changes by oxidation. Discrete inorganic Se species were determined by anion-exchange chromatography-inductively-coupled plasma-mass spectrometry, and operationally-defined organic Se was determined by hydride generation-atomic fluorescence spectrometry after UV-irradiation.

At both locations, total Se decreased sharply across the sediment water interface, from 15 or 25 µg/L at the bottom of the water column to 1.5 or 2.5 µg/L in the sediment pore waters, indicating a strong Se removal flux to the sediment. In the overlying water column, selenate was the major Se species, but organic Se was the major species in the sediment pore waters. Diffusion-based flux calculations indicate a strong flux of selenate to the sediments, and a smaller flux of organic Se back into the water column. While the removal of selenate is probably a reductive process, it did not match the sulfate reduction profiles, indicating a separate mechanism. Selenite concentrations spiked just under the sediment-water interface and coincided with manganese reduction profiles, suggesting a removal process that involves both selenite reduction and its binding to manganese oxide minerals.

Using stable isotopes in water to characterize water sources to abandoned mine tunnels

K. WALTON-DAY

U.S. Geological Survey, Denver, CO 80225 (kwaltond@usgs.gov)

Understanding the source of water draining into abandoned mine tunnels may help minimize water-quality degradation from acid-mine drainage and aid management of water-supply resources. The Dinero tunnel drains abandoned mine workings in the Sugarloaf mining district near Leadville, Colorado, USA, and flows into a tributary of the Arkansas River, which is used for municipal water supply. Turquoise Lake, a water-supply reservoir, lies north of and at greater elevation than Dinero tunnel. Stable isotope ratios (δD, $\delta^{18}O$) were determined in more than 250 water samples collected from mine tunnels, transmountain diversion tunnels, springs, and streams from March through November 2002 through 2006. Results were used to trace sources of water to Dinero tunnel including Turquoise Lake. The isotope ratios defined two distinct water types that occur on separate meteoric water lines in δD-$\delta^{18}O$ space. There is some mixing of the two water types at some locations. The first type of water is primarily surface water and includes Turquoise Lake, local streams, and water imported from across the continental divide; isotope ratios exhibited a large range of seasonal variation. The second type of water is primarily ground water and includes springs and draining mine tunnels, including Dinero tunnel; isotope ratios exhibited minimal seasonal variation. Isotope results and mixing calculations indicate that the portal discharge of the Dinero tunnel is primarily composed of inactive, deep ground water, has minimal contribution from seasonal recharge, but contains 10 to 15% Turquoise Lake water when the lake surface is within 5 meters of maximum elevation. From a water-supply perspective it is desireable to enlarge Turquoise Lake which would increase storage capacity and full-pool elevation of the reservoir. However, the study results indicate that, without mitigation, enlarging Turquoise Lake may increase the flow of low-quality water from Dinero tunnel and further degrade the quality of downstream water supplies.