



## SCIENCE BRIEF (June 2004)

# SEPARATING NATURAL FROM HUMAN-RELATED METALS IN THE ENVIRONMENT

### ISSUE

Metals can be hazardous to both human beings and the environment, and can be transported long distances by air currents in the atmosphere. However, metals occur naturally in the environment, and elevated concentrations are not always the result of human activities. To deal appropriately with the hazards posed by metals to humans and the environment, we need to know the sources of those metals.

### SIGNIFICANCE

**This research has provided new tools to determine whether metal loadings to ecosystems are due to atmospheric deposition from human activities or to natural sources. Unnecessarily stringent environmental regulation of the industrial sector, based on incomplete knowledge of natural sources, may result in severe economic consequences with no measurable benefit to Canadians or the environment. Better estimates of natural contributions of metals to the environment are important both for regulators setting regulatory guidelines and for industries that are required to meet those regulatory guidelines.**

### BACKGROUND

Metals in the atmosphere are generally associated with particles (dust), except for mercury, which occurs mostly in gaseous form. Identifying the source of atmospheric metals, whether natural or human-related, is termed “source apportionment”.

Long-range transport of metals from human activities is generally considered responsible for elevated metals concentrations at remote sites, but natural geologic sources can be significant in some areas. For example, metals can originate naturally from certain types of bedrock and geothermal regions. Lake sediments and soils derived from these

sources can also accumulate naturally high metal concentrations. Areas with thermal springs and volcanic activity often have concentrations of mercury and aluminum in vegetation similar to those found near geothermal power plants. Dust storms in Asia and Africa can carry metals from a variety of sources to North America.

Although techniques used prior to this research were generally appropriate for identifying elevated concentrations of metals within about 50 kilometers from a major point source, they were less appropriate as distance from such a source increased, and were not very appropriate for diffuse or non-point sources. Surprisingly, research on natural sources of metals and their impact and contribution to elevated concentrations at remote and background sites has been relatively scarce.

## **FINDINGS**

This research, carried out through the Metals in the Environment Research Network (MITE–RN) program, has resulted in the development of techniques and procedures that substantially improve current source apportionment for mercury, zinc, lead, copper and nickel. Natural emissions of gaseous mercury can be elevated at remote sites, depending on geology and vegetation. Researchers have successfully quantified and differentiated natural background mercury concentrations from mercury transported there from distant sites. They have also shown that background zinc, lead, copper, and nickel concentrations in Canada are typical of those at other global background sites.

The major limitation to atmospheric source apportionment is the availability of reliable particulate matter (dust) samplers – concentrations of particulate matter tend to be extremely low at remote (background) sites. The analytical techniques are adequate but, at remote sites, large errors can occur in dust sampling. However, by using a sufficiently long time series of chemical and physical data, together with appropriate environmental data and multivariate statistics, we have been able to apportion sources successfully using a “weight of evidence” approach. This approach is readily usable by and can be adopted by researchers attempting source apportionment for atmospheric metals.

## **CONTINUING RESEARCH**

Research is needed to further validate the above new field sampling approach described above. Since it is difficult and costly to reach remote sites and monitor them over time long periods, continued research is needed to assess whether laboratory methods, which use soil samples from remote sites, can be used to distinguish natural from human sources of metals. Research is being conducted to determine the persistence and biological availability of metals in the atmosphere, in other words, to determine whether or not and under what conditions atmospheric metals could harm humans or other organisms.

## **ADDITIONAL INFORMATION**

G. M. Dias and G. C. Edwards. 2003. Differentiating natural and anthropogenic sources of metals to the environment. *Human and Ecological Risk Assessment*, volume 9, number 4, pages 699 to 721.

R. G. Garrett. 2000. Natural sources of metals to the environment. *Human and Ecological Risk Assessment*, volume 6, number 6, pages 945 to 963.

P. E. Rasmussen. 1998. Long-range atmospheric transport of trace metals: the need for geoscience perspectives. *Environmental Geology*, volume 33, numbers 2/3, pages 96 to 107.

P. E. Rasmussen. 1994. Current methods of estimating atmospheric mercury fluxes in remote areas. *Environmental Science and Technology*, volume 28, number 13, pages 2233 to 2241.

<http://www.mite-rn.org/research/era/era.shtml>

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