USGS

WATER RESOURCES RESEARCH GRANT PROPOSAL

Project ID: 2002VT6B

Title: Substrate- and size-dependent measurement of particle-phase mercury in the atmosphere by aerosol mass spectrometry

Project Type: Research

Focus Categories: Methods, Toxic Substances, Solute Transport

Keywords: Mercury, particle mass spectrometry, atmospheric deposition, flux measurements

Start Date: 03/01/2002

End Date: 02/28/2003

Federal Funds: $24,004

Non-Federal Matching Funds: $24,700

Congressional District: First

Principal Investigator:
None

Abstract

Atmospheric deposition of mercury is believed to be the most important source of mercury input to natural waters. There is special concern that, in Lake Champlain, atmospheric sources of mercury may be responsible for increasing mercury concentrations. This has already been shown to be the case in many remote lakes of the Great Lakes region, where research has indicated that the transport and deposition of atmospheric mercury is the the processes and rates of deposition by which mercury enters the aquatic environment are poorly understood. Specifically, the role of the various physical and chemical forms of mercury deposited from the atmosphere needs to be determined. It has been hypothesized that particle-phase mercury may play a disproportionately large role in the mercury concentrations in various environmental systems. Atomic and ionic (Hg2+) mercury may dissolve into rain water or adsorb onto atmospheric particles and subsequently be precipitated or deposited. These deposition processes provide the major transport pathways for atmospheric mercury to the Lake Champlain basin and hence, the watershed.

Work is proposed on the development of an aerosol mass spectrometer (AMS) for the measurement of particle-phase mercury in the atmosphere. The proposed method will be capable of making such measurements on-line, in real time and with high sensitivity. It is estimated that the (absolute) mass limits of detection for Hg analysis with the proposed AMS is approximately 10-19 - 10-20 g. This detection limit translates to the ability to detect Hg at the one part-per-million level in particles with diameters as small as 0.2 µm.

The on-line measurement capabilities and fast analysis times possible with the aerosol mass spectrometer will provide freedom from extended sampling periods and complicated sample-handling procedures. In addition, sampling and analysis with the AMS is performed in such a way that particles of interest never come into contact with any surfaces. These benefits make the AMS practically immune to the problems associated with contamination and sampling artifacts observed with conventional techniques for mercury analyses. In addition, the aerosol mass spectrometer will provide simultaneous physical and chemical characterization of single atmospheric particles. Using the AMS, we will be able to assess not only the

particle-phase Hg, but also the class (for example: sulfate, organic or soot) of particle with which the Hg is associated. This multidimensional approach will provide essential insight on the environmental fate and availability of the mercury and on source apportionment.

Aerosol mass spectrometry will be used to determine the impact of particle composition on particle-phase atmospheric mercury concentrations. This information is of vital importance in understanding the total particulate mercury fluxes involved in the basin, and in elucidating the subsequent fate of the deposited mercury in the environment. Finally, results correlating mercury content with particle size will yield needed data concerning possible enrichments of mercury in particles that carry a much greater environmental impact. The results will be of immediate use in areas of numerical modeling, toxic transport, environmental fate and vertical fluxes of mercury within the Lake Champlain basin.