USGS

WATER RESOURCES RESEARCH GRANT PROPOSAL

Title: Cycling and Speciation of Mercury in the Soil of the Acadia National Park

Focus Categories: HYDGEO, TS, NPP

Keywords: Geochemistry, Toxic Substances

Duration: 1/9/99-31/8/01

Federal Funds Requested: $26,942.

Non-Federal Funds Pledged: $46,186.

Principal Investigators: Aria Amirbahman (Department of Civil and Environmental Engineering), Terry A. Haines (U.S. Geological Survey and the Department of Biological Sciences) and Jeffrey S. Kahl (Water Research Institute).

Congressional District: Second

Statement of critical Regional Problem

Even though the waters surrounding the Acadia National Park are largely unaffected by direct discharge of mercury, fish from these waters have some of the highest values of mercury in the nation with concentrations in some fish exceeding 3 ppm. This has led the state health agencies to issue more fish consumption advisories for mercury than for all other contaminants combined. The high mercury concentrations also pose a threat to fish-eating birds and mammals. The impending deregulation of the electric utility industry raises the additional concern that deposition of mercury may increase in the future. The possible future operation of coal-fired power plants in the coastal eastern and midwestern USA will also result in more input of pollutants such as mercury in Maine. Given the importance of the preservation of a pristine environment in the Acadia National Park, the threat to the wildlife, and the recreational implications of the mercury advisories, a better understanding of the role of the watersheds in the park in cycling and transport of mercury is needed.

Statement of Results and Benefits

The soils of the forested watersheds are known as important sources for the methylation of Hg and the export of both Hg and monomethyl mercury (CH3Hg). The mercury burden in higher organisms consists almost entirely of CH3Hg, with a biomagnification factor of about 10 between trophic levels. Successful completion of this study will contribute to the currently limited mechanistic knowledge of the role of forest soils in speciation and transport of Hg and CH3Hg. When combined with other ongoing projects at Acadia, the information collected in this study will also assist us obtain mass balance

on mercury species in the entire watershed. This information can be used to define aquatic resources at risk from high mercury concentrations in biota.

Nature, Scope and Objectives of the Research

Mercury is an important contaminant of major concern in the northeastern United States. The biota in the Acadia National Park (ANP) possesses some of the highest Hg concentrations in the world for the sites with no point source. This is primarily due to the atmospheric input of Hg averaging a wet-only deposition of 7.9 mg/m2-yr into the ANP. Dry deposition is expected to be a major source of Hg as well. The University of Maine and the National Park Service are presently conducting a 'paired watershed' study to gain more insight into the biogeochemistry of Hg in two watersheds at the ANP, one recently burned, with thin soils and deciduous vegetation, and one unburned, with thicker soil and coniferous vegetation. As part of this study, the concentrations of Hg and methylmercury (CH3Hg) will be measured in the litterfall, throughfall and stream water. Wet deposition will be monitored by the Mercury Deposition Network (MDN). As such, a general mass balance may be established that accounts for the main sources and sinks of Hg in the watershed.

In the ANP, however, the role of soil in the accumulation and possible methylation of Hg is unknown and requires further study. Depending upon the presence of organic carbon in soil and in groundwater and physical factors such as soil drainage, the distribution and speciation of Hg will vary. In the forested watersheds, production of CH3Hg is expected to take place primarily in the subsurface under anaerobic conditions.

The objective of this study is to study cycling and transport of Hg and CH3Hg in the soil of the ANP. This study will include sampling and analysis of the physical and chemical parameters that control the fate of mercury species in soil. Similar to the ongoing study, a 'paired watershed' approach will be followed, where a recently burned watershed and an unburned watershed in Acadia will be studied. The contrasting characteristics of these two watersheds will allow us to better understand the factors that control the cycling and speciation of Hg in forested watersheds. The data collected from this study and the ongoing study at the ANP may be incorporated into watershed models to provide a complete regional mass balance for Hg.

The different vegetative covers, organic matter concentrations and solution chemistry will influence the distribution of Hg and CH3Hg in the recently burned and the unburned watersheds in Acadia. The differences in chemical parameters would be the greatest in the upper soil horizons, and therefore, sampling and analysis will be focused on the upper increments. Soil and water samples will be taken from the plots of land pre-established as a template. These plots have been previously designated and are distributed appropriately by soil and forest type.

Soil samples will be collected from the designated plots and the distribution of the adsorbed Hg and CH3Hg will be determined. The soil samples will also be characterized with respect to their organic matter content and mineralogy. Speciation of Hg will be

correlated to the relevant physical and chemical parameters in the aqueous and solid phases.

Soil water samples will be collected periodically from lysimeters and the concentrations of the dissolved organic carbon, Hg, CH3Hg, major cations, anions, pH and temperature will measured at the site or in our laboratory facilities.