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Reduction in Mercury Loading: Timing and Magnitude of an Ecosystem Response

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RESEARCH SUMMARY:

Reduction in Mercury Loading: Timing and Magnitude of an Ecosystem Response

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Atmospheric transport, deposition, and reemission of Mercury (Hg) are key processes of its movement through our environment. Historically, it has been difficult to understand these processes because of our inability to differentiate between mercury that has been recently deposited from human generated (or anthropogenic) sources and mercury occurring naturally in place. Discovering how mercury moves through the environment has become of vital importance in determining sources and levels of mercury pollution from human activity. As new regulations on atmospheric emissions of mercury from the USEPA approach, it is important that regulatory decisions are based on sound, scientifically defensible data on mercury cycling in the environment.

The Mercury Experiment to Assess Atmospheric Loading in Canada and the United States (METAALICUS) is a major project organized to study the movement and behavior of mercury in an entire watershed located in northwestern Ontario in the Canadian Experimental Lakes Area (ELA), located just north of the Minnesota-Ontario border. The project involved a multidisciplinary team of twenty principal investigators from twelve US and Canadian institutions. This included the Environmental Chemistry and Technology Program at the University of Wisconsin-Madison, whose portion was funded by the Wisconsin Focus on Energy Environmental Research Program. Each institution was responsible for evaluating a different aspect of the ecosystem response.

Using an advanced technology only recently available, the project team released identifiable isotopes of mercury into the watershed and followed the location and timing of these isotopes as they proceeded through the watershed. Stable isotopes of mercury were applied to both the lake and watershed as a tool for identifying the key processes. These isotopic techniques have provided the first direct evidence of a whole lake and whole watershed response to “new” atmospheric inputs of mercury.

Two of the major goals of the project were to determine the fate and transport of the new mercury through the watershed (for example, how quickly the added mercury is chemically transformed and bioaccumulated in fish), and to assess the watershed recovery time due to reductions in atmospheric mercury deposits.

The specific goal of the UW-Madison work was to determine the timing and magnitude of the mercury’s effect once deposited in the lake. In particular, this work measures the speciation (or chemical form), the partitioning (or physical location), and the mobility (transport, transformation and bioaccumulation) of mercury within the lake. The team placed special emphasis on observing how the interface between sediment and water serves as a mechanism to transfer mercury.

The team found that the inorganic mercury isotopes bound rapidly to lake particulate matter settling to the bottom. A significant portion of the mercury was methylated (transformed to toxic methyl mercury) where the water meets the lake bottom just below the hypolimnion, the deepest and most dense layer in the stratification of a lake. This team's research indicates that the hypolimnion plays an important role in transforming mercury to its bioaccumulative, methylated form due in part to the bacterial environment created by the lack of oxygen. Furthermore, the zone at the sediment-water interface rapidly recycles material that falls and further releases methyl mercury to the overlying waters.