

# The Influence of Water Level Fluctuations on Mercury Biochemical Cycling

Stephanie Payne<sup>1</sup>, Dr. Tom Holsen<sup>2</sup> and Dr. Stefan Grimberg<sup>3</sup>  
Civil and Environmental Engineering

## INTRODUCTION

The St. Lawrence River is a major body of water that is approximately 1000 kilometers long and acts as a drainage flow for the Great Lakes. It has an average flow rate of 7500 m<sup>3</sup>/s, and a basin area of 660,000 ha. Human development of dams along the St. Lawrence River has created an ideal location to study water level fluctuation's impact on the rate of methyl-mercury formation. The St. Lawrence River has numerous hydroelectric dams that cause daily and monthly water level fluctuations; thus, the river column changes an average of 1-1.5 meters a month and 0.3 meters a day. The water level fluctuations create an alternating aerobic and anaerobic environment for the bacteria within the river sediment. As the water level grows raises, the sediment is not exposed to air and remains in an anaerobic environment. When mercury in the sediment is contained in an anaerobic condition, it is reduced from insoluble HgS to Hg(0), Hg(II), or methyl-mercury (MeHg) (Stumm and Morgan, 1996). From these forms methyl-mercury is a primary health concern because it is water soluble and bioaccumulates in the food chain. When the sediment is exposed to oxygen and an aerobic environment operates in the system. In the aerobic system, HgS is formed. HgS is not considered an extremely dangerous compound either (Stumm and Morgan, 1996).

## HYPOTHESIS

It is the cycling between aerobic and anaerobic conditions that allow for the possibility of a Hg “pump” to occur within the water column. The “pump” is believed to operate in a manner in which inorganic mercury forms in oxic conditions, then undergoes a transformation to the lethal Me-Hg form in non-oxic conditions (U.S. EPA, 1997). The hypothesis of the study is that **the dynamic changes in the sediment redox conditions will result in a net increase in mercury methylation**. If the redox conditions change rapidly, then methyl mercury should be produced at a faster rate. However, if redox conditions remain stagnant, then the methyl-mercury should form at a slower rate.

## OBJECTIVE

The purpose of this study is to clarify some of the ambiguity regarding the methods used to evaluate the kinetics of mercury formation in aquatic environments. The study also aims to indicate whether repeated changes in redox conditions will mobilize methyl-mercury in the waterways. Currently,

there is little information available regarding the oxidation and reduction conditions of mercury in the sediment water column. Thorough studies are necessary for humans to understand the processes that mercury undergoes when forming methyl-mercury.

## MATERIALS AND METHODS

### 1.) Mercury Analysis

To test the hypothesis, a simulation was created where the conditions of the St. Lawrence River were mimicked in a laboratory setting. A glass bubbler was filled with distilled water and sediment from Coles Creek in the St. Lawrence River. The sediment was spiked to 200 Hg ng/ml, which is the average Hg concentration that is currently found in the St. Lawrence River (Lean, 2000). Nitrogen and air were pumped into the system, at alternating intervals, to mimic the aerobic and anaerobic conditions of the river. The alternating interval system was compared to two control systems. The first was purged with air and the second was purged with nitrogen only. The concentrations of gas phase mercury were obtained every four hours during the initial cycling changes in the experiment. However, the liquid phase mercury concentration was obtained in a secondary step, which involved oxidizing the mercury with BrCl, baking it overnight, and reducing it again with  $\text{NH}_2\text{OH}\cdot\text{HCL}$  before it can be added to the bubbler and measured with the “Gold Trap” apparatus. The use of “Gold Trap” analysis allowed us to determine the rate at which the mercury formed Hg(II) under alternating conditions and enables us to make a comparison between the rate of formation in two types of systems.

### 2.) Control Measures

In a process called “Blanking the Bubbler,” a glass bubbler flask was purged with nitrogen and was used to remove any trace mercury contaminants present on any of the glassware and apparatus in the system. A calibration curve for the glassware was made to obtain the correct amount of mercury present in the laboratory atmosphere and also allowed to find possible contamination errors within the system itself. The mercury in the system had to be under 5ng because the spectrophotometer could not output accurate results with larger quantities of mercury.

## PRELIMINARY RESULTS

Initial experiments evaluated the system’s ability to trap a known amount of mercury in the Gold Traps and reproduce that amount in the spectrophotometer. The preliminary results indicated that the system was being contaminated with each additional calibration test. The error margin between known mercury concentration and projected mercury concentration grew rapidly (Figure 1). This problem will be considered when analyzing results, so extra cleansing steps will be included in future tests. Results

regarding the accuracy of the aquatic analysis method and data concerning the formation of methyl mercury will be presented at the conference in August.



Figure 1. Calibration Curve for Glassware<sup>1</sup>

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<sup>1</sup> Class of 2004 Department of Biology, University of Puget Sound

<sup>2</sup> Tom Holsen, Department of Civil and Environmental Engineering, Clarkson University

<sup>3</sup> Stefan Grimberg, Department of Civil and Environmental Engineering, Clarkson University