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M.S. degree in Geological Sciences

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ACCUMULATION AND INVENTORY OF MERCURY IN SEDIMENTS OF THE GREAT LAKES

(with appendix data for arsenic, cadmium, and Lead)

• Volume 1 •

By:

William J. Sitarz

A THESIS

Submitted to
Michigan State University
in partial fulfillment of the requirements
for the degree of

MASTER OF SCIENCE

Department of Geological Sciences

1996

ABSTRACT

Accumulation and Inventory of Mercury in Sediments of the Great Lakes

by: William J. Sitarz

Sediment cores were obtained from lakes Superior, Michigan, and Ontario to determine anthropogenic loading histories, chemical inventories, and accumulation rates of mercury. Pre-industrial concentrations of mercury, which were found to be typical for soils in the area, were determined and subtracted from the total mercury concentration to estimate anthropogenic concentrations. Sediment ages were determined by ^{210}Pb dating, while accumulation rates and inventories were corrected for sediment focusing by ^{210}Pb inventories. Focusing-corrected sediment accumulation rates of mercury were compared to focusing-corrected metal inventories in the sediments and estimated atmospheric deposition rates from Eisenreich and Strachan (1992).

The results show that mercury loading rates are decreasing to the present. Inventories uncorrected for sediment focusing were highly variable among lakes, within lakes, and within depositional basins of the lakes. Corrected inventories for mercury are similar within lakes, but the inventories change as a function of the lakes: Ontario >>> Michigan Superior. The trends in sediment accumulation rates of mercury among, and within the lakes, are similar to those of mercury inventories. Lakes Superior, Michigan, and Ontario appear to be well mixed with respect to mercury, and that accumulation of mercury in Lakes Superior and Michigan is driven by atmospheric deposition, while non-atmospheric inputs appear to be the most important factor for mercury accumulation in Lake Ontario.

" Lulled by the soft sell and the hidden persuader, the average citizen is seldom aware of the deadly materials with which he is surrounding himself; indeed, he may not realize he is using them at all."

Silent Spring, Rachel Carson (1962)

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A project of this size would not have been possible without the help of numerous people. I would first like to thank my thesis advisor Dave Long for his knowledge and guidance throughout the project (I am sure that he never worried about me finishing the study). Thank you to my thesis committee members, Sharon Anderson and Nathaniel Ostrom on their suggestions regarding my work. Nathaniel's time and effort put into the later revisions of my thesis were very helpful. I would also like to thank Steve Eisenreich and his students at The University of Minnesota on providing the lead-210 data used in this study. Thanks as well to Loretta, Cathy, and Jackie in the Geology Department Office for their help in the everyday operations. Now to the "little" people. Thanks to Anton Spirenburg who left to find true love in Paris and made it possible for me to join the group, and thanks to Adam Heft for his assistance in the early stages of the project. Finally, a special thanks to Jon Kolak, who was especially helpful during the laboratory analysis phase of the study (huh, huh, geochemistry is cool !).

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I. INTRODUCTION

1.1 - Introductory Remarks:

After nearly a century of industrial growth, population increases, habitat destruction, and unchecked air, water and soil pollution, an intensive rehabilitative effort began by the United States and Canada in the early 1970s has lead to dramatic improvements in environmental quality of the Great Lakes. The lakes, however, are still confronted by serious problems such as the long term accumulation of sediment bound toxic chemicals. Mercury appears to be one of the most problematic toxins in the Great Lakes basin. Fecal and chemical contamination still close beaches around the Great Lakes on a regular basis, and at present there are still 42 "areas of concern" (Figure 1) which have been identified by the International Joint Commission (IJC) as areas so badly contaminated that site remedation will take decades and billions of dollars (Colborn et al., 1990).

Previous to this study there has only been regional studies on mercury pollution. This research will provide data needed to estimate the historical and present day accumulation rates of mercury in sediments of the Great Lakes. The purpose is to quantify fluxes of atmospheric deposition of mercury to the entire Great Lakes basin. Detailed evaluations of non-atmospheric mercury source inputs to Lake Ontario will also be discussed.

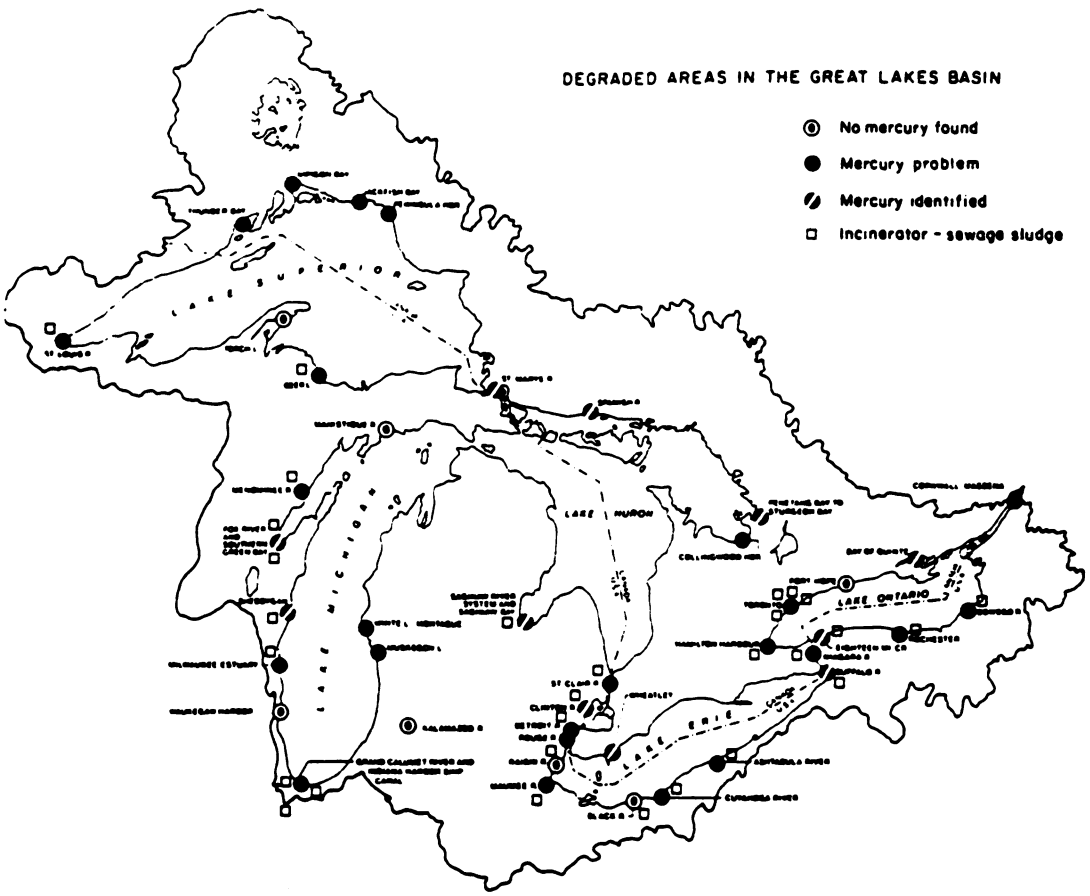


Figure 1. Areas of concern in the Great Lakes Region (Colborn & Davidson, 1990)

The only way to understand the contamination problem in the Great Lakes is to develop an "ecosystem approach" to basin management. In 1978 a revision was put forth to the 1972 Great Lakes Water Quality Agreement. This new document identified the problem of toxic contaminants in the Great Lakes. "Zero discharge" and "elimination of persistent toxic chemicals" became the philosophy of the policy. Trace metals such as arsenic, cadmium, lead and especially mercury were recognized as toxic and enduring substances. The 1978 revisions defined a toxic substance as persistent if it had a half life in the lake water greater than 8 weeks. Because mercury persists in the water for 3-6 months, the importance of its pathways of introduction and cycling within the lakes was deemed essential information needed to lessen its input to the Great Lakes ecosystem (IJC, 1978).

Mercury has been affirmed as being representative of many toxic substances within the Great Lakes. The definition of a toxic substance as written in the 1978 agreement is:

- *"a substance which can cause death, disease, behavioral abnormalities, cancer, genetic mutations, physiological or reproductive malfunctions or physical deformities in any organism or its offspring, or which can become poisonous after concentration in the food web or in combination with other substances."*

The tenacious bioaccumulation, extreme volatility, unusual environmental chemistry, and its tendency to form the cancer causing $HgCH_4$ species in aquatic systems has resulted in tumered fish, developmental abnormalities in shore birds, and declines in fishery stocks. With increasing consumer demands for the natural resources found in the

Great Lakes area, and continuing pressure for development along the shoreline, this fragile ecosystem has become markedly stressed. In Michigan, 71% of pre-settlement coastal wetlands have been lost to development, and in the urban sector of southern Lake Michigan, the wetland loss is 90% (Colburn et al., 1990). Wetland loss is devastating to the water quality of the Great Lakes because of the natural filtering process of overland flow and sediment laden stream waters (Nriagu, 1984).

Mercury is the only toxic trace metal which unquestionably biomagnifies through the food chain (Lingberg, Stokes, & Goldberg, 1987). As a result of such findings, two Canadian provinces and 21 U.S. states have issued consumption advisories for mercury contaminated fish (CISCIN, 1993). In December of 1988, Michigan's Department of Public Health (MDPH) declared broad health warnings to limit the consumption of fish because of increases in mercury contamination (MDPH, 1989). This restriction was applied to all of the states 11,000 inland lakes (Glass et al., 1990). The MDPH also advised anglers not to consume more than one fish per week, of any size of the following species: rock bass, muskie, northern pike, walleye, small mouth bass, large mouth bass, and crappie and pearch greater than 9" in length (CISCIN, 1993). Similar advisories were also issued in Minnesota, Wisconsin, and Ontario.

The Great Lakes basin (Figure 2) is a highly industrialized area, mainly because of its historical significance as a convenient and cost effective way of transporting the massive wealth of raw materials found in this region. Industry within the Great Lakes region has had a profound influence on the worlds economy. Table 1 shows the major physical parameters of Lakes Superior, Michigan, and Ontario. These lakes are a vital inland transportation route for the movement of coal, iron-ore, limestone, sand, and a

variety of grains. For example, in 1987, 63.3 million net tons of iron-ore, 37.7 million tons of coal, and 22.7 million tons of grain were transported on the Great Lakes. In 1986 almost 17% of the United States manufacturing industry was located in the basin, and 72% of Canadian and 45% of U.S. steel production occurs within the Great Lakes watershed (Institute of Water Research-MSU, 1990).

Municipal, industrial, and agricultural activities, are very important to the economy of the Great Lakes region. However, these activities are partly responsible for the degradation of the water and soil quality by adding large quantities of polluting chemicals. Only through scientific understanding of the behavior and mobilization of the polluting chemicals, along with cooperation with various business and political bodies, will control strategies and regulation of toxins be developed.

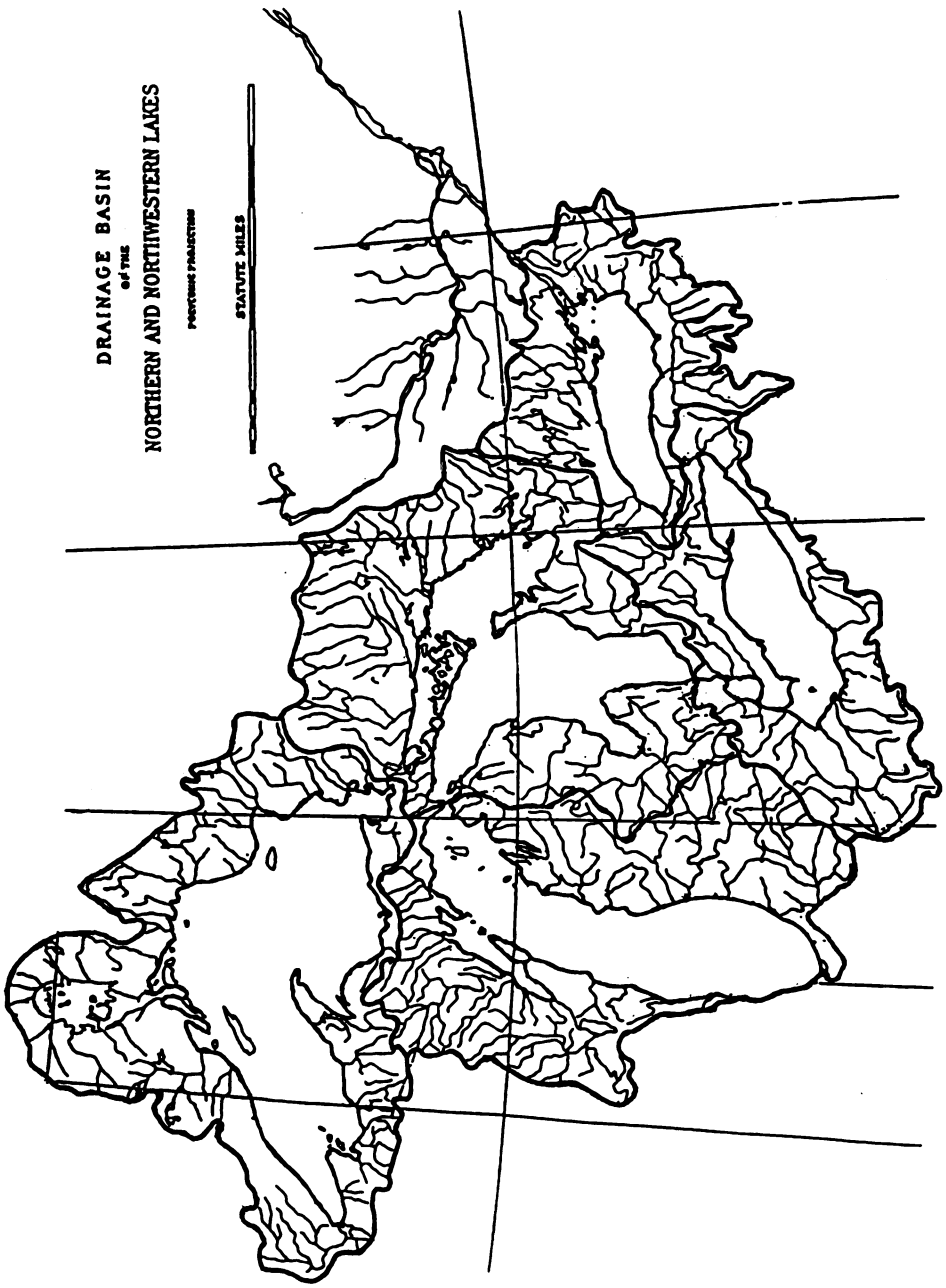


Figure 2. The Great Lakes drainage basin. (Hough, 1958)

Table 1: Major Physical Parameters of Lakes Superior, Michigan, and Ontario (Eisenreich et al., 1992b; Institute of Water Research-MSU; [1]CISCIN, 1993)

Dimensions	Lake Superior	Lake Michigan	Lake Ontario
Length (km)	563	494	311
Breadth (km)	259	190	85
Shoreline Length (km)	4,385	2,670	1,168
Elevation (m)	183	177	75
Population (U.S.)	474,150	8,709,907 *13,700,000**	2,657,432
Population (Canada)	155,675	-	4,616,070
Drainage Area (km^2)	127,700	118,100	70,700
Surface Area (km^2)	82,100	57,800	19,520
Bottom Sediment Area (km^2)	4.1	2.9	0.75
Mean Average Depth (m)	149	85	86
Maximum Depth (m)	407	281	244
Lake Volume (km3)	12,230	4920	1636
Mean Inflow ($10^{10}m^3$/year)	-	-	21
Tributary Inflow ($10^{10}m^3$/year)	5.4	2.9	3.0
Mean Outflow ($10^{10}m^3$/year)	7.1	4.9	25
Annual Precipitation (m/year)	0.76	0.79	0.89
Water Residence Time (year)	191	100	6.5
Sedimentation Rate (g/m^2 year)	200	400	400
[1]Number of Wetlands	348	417	312
[1]Total Area of Wetlands (km^2)	267	490	84
[1]Mean Area of Wetlands (km^2)	0.77	1.18	0.27
[1]Percent of Total Area (%)	22.1	40.5	6.9
River Outlet	St. Marys	Straits of Mackinac	St. Lawrence

* *The Lake Michigan population figures noted here includes approximately 5 million residence of the city of Chicago and surrounding areas who depend on Lake Michigan water, but reside just outside of the drainage basin.*

Table 2: International Joint Commission's Critical Pollutant List for the Great Lakes (IJC Report, 1978)

Trace Metals	*Organic Contaminants*
arsenic	polychlorinated biphenyls (PCBs)
cadmium	benzo (a) pyrene (B{a}P)
lead	polycyclic aromatic hydrocarbons (PAHs)
mercury	hexachlorobenzene (HCB)
	mirex
	dieldrin
	hexachlorocyclohexanes (HCHs)
	DDT
	toxaphene
	polychlorinated dibenzo-p-dioxins (PCDDs)
	polyclorinated dibenzofurans (PCDFs)

1.2 - Problem Statement:

Atmospheric deposition is believed to be the dominant contributor of mercury and other toxic metals to the Great Lakes, especially to the upper lakes (Strachan & Eisenreich, 1988). The Great Lakes are particularly sensitive to atmospheric deposition because of their high surface area to drainage basin area ratios. About 50 % of all the water derived from precipitation falls directly on the lake surfaces (Strachan & Eisenreich, 1988). Lake Michigan and Lake Ontario are believed to be impacted the most by atmospheric fallout because they are downwind of major urban and industrial centers (Nriagu, 1984).

Mercury is toxic to all lifeforms, even in trace amounts (D'Itri, 1978). Therefore, it is necessary to determine the accumulation of mercury beyond the natural levels in the aquatic environment to minimize any additional exposure to humans and wildlife. The large amount of concern toward mercury in the environment by both the public and scientific community is a result of the extreme toxicity of the methylated form (CH_3Hg^+) that is produced by common microbes in aquatic systems (Stumm, 1982). Methyl-mercury will bioaccumulate in all organisms and becomes a problem for humans that rely on these organisms as a food source. Methyl-mercury is the principal species of mercury found in fish, and 90% of this toxin is adsorbed by humans after consumption (Ramamoorthy, Moore, & George, 1985). Several studies have concluded that the presence of excess (anthropogenic) mercury in large concentrations in the surface sediments of the Great Lakes threatens the health and well-being of all plants and animals (Annett et al., 1972; Thomas, 1974; Annett et al., 1975; Evans, 1986; Johnson, 1987; Glass et al., 1990).

Sediments contaminated with trace metals and organic chemicals are a very serious problem in 41 of the 42 "areas of concern" in the Great Lakes basin (Colburn et al., 1990). Several locations of intense contamination, such as the Duluth basin, Detroit river, Niagara river, and Green Bay, have sediments that will remain a continuing source of contaminants to the environment for many decades. Remobilization of previously deposited chemicals could also be a problem in the future for areas that are heavily contaminated.

1.3 - Hypothesis:

The purpose of this research is to quantify the spatial distribution and temporal variations of mercury inputs to the sediments of the Great Lakes. This study hypothesizes that the atmosphere is the major medium through which mercury enters the waters of the Great Lakes. Atmospheric deposition is believed to be highly dispersed over the Great Lakes, and that precipitation amounts over the whole watershed basin are consistent affecting both the near-shore and mid-lake waters alike (Tisue & Fingleton, 1984).

If this hypothesis is true, when a sediment focusing correction is used to account for variable sedimentation rates, corrected mercury inventories and current accumulation rates should have similar values within each lake at the representative sampling sites. If, however, the focusing corrected values are significantly different between each site, this suggests that local point sources may dominate the input of mercury to the lake. Because of the variation in sedimentation rates between each depositional basin, mercury inventory (total mass of anthropogenic mercury in the sediment) and accumulation rate values will differ. To account for this variation and enable a comparison between sites, a focusing factor determined by the lead-210 sediment dating will be used to normalize the data.

1.3.1 - Study Objectives and Goals:

This project was developed to better understand the relative importance of the atmosphere in mercury loading to the Great Lakes. Several goals were used to identify atmospheric importance:

1. Determine the spatial variation in mercury concentration in the Great Lakes.
2. Determine the temporal variation in mercury inputs to the Great Lakes.
3. Calculate the anthropogenic inventory of mercury in sediments from the Great Lakes.
4. Calculate the past and present accumulation rates of mercury in the Great Lakes.
5. Compare resent sediment accumulation rates to atmospheric deposition rates.
6. Compare Great Lakes sediment accumulation rates of mercury to rates of mercury input and consumption to identify predominant sources.
7. Develop a better understanding of the behavior of mercury in sediments (i.e. the mercury concentrations affected by redox processes).

II. BACKGROUND INFORMATION

2.1 - Background Information:

2.1.1 - Lead-210 Dating Introduction:

The most widely used method for evaluating ages and sedimentation rates of aquatic sediments is lead-210 dating. This procedure is also helpful in determining the history of anthropogenic inputs to the Great Lakes and their watersheds. Lead-210 dating of sediments also provides information on early diagenetic events (Benoit & Hemond, 1991).

The radionuclide ^{210}Pb is produced from decay of ^{222}Rn after ^{222}Rn diffuses out of soils that contains ^{226}Ra. Because of the short 3.8 day half life, a continuous source of ^{210}Pb is produced by decay. Excess ^{210}Pb from the amount in equilibrium with ^{226}Ra is used to date the deposited layers. Lead-210 is assumed to be deposited at a contant rate and becomes immobilized in sediments (Schell, 1986). Lead and ^{210}Pb, however, can be mobilized by organic-rich waters present in many wetlands and bogs (Urban et al., 1990).

The atmospheric residence time of ^{210}Pb is 4 to 30 days. Because ^{210}Pb is sorbed by and deposited with tropospheric particulate matter (Schell, 1986), it can be used as a regional tracer of particle deposition from the lower troposphere. The deposition rate of ^{210}Pb is estimated at 15.5 pCi/cm^2 (Eisenreich, personal communication).

The sediment cores used in this study were dated by using the steady-state mixing model developed by Robbins (1982). This model assumes that new material is homogeneously mixed throughout a mixed zone, S (g/cm2), in the sediment column, and moves upward at a sedimentation rate, W (g/cm^2yr), with the sediment below the mixing being undisturbed (Golden et al., 1994). A least squares fit of equations (1) and (2) is used to determined the sedimentation rate when the lead-210 flux is constant.

$$A(z) = A_m \quad for\ z \leq S \qquad (1)$$

$$A(z) = A_m \exp\{\frac{-k(z-S)}{W}\} \quad for\ z > S \qquad (2)$$

A(z) = unsupported ^{210}Pb activity as mass depth z
A_m = unsupported ^{210}Pb activity in the mixed zone
k = decay constant (0.0311 per year)

If a mixed zone is not present in the core, then the rapid steady state mixing model (Robbins, 1982) simplifies to the constant flux - constant sedimentation (cf:cs) model (Robbins, 1978) represented by equation (3).

$$A(z) = A_s \exp\{\frac{-kz}{W}\} \qquad (3)$$

A(z) = unsupported ^{210}Pb activity as mass depth z
A_s = unsupported ^{210}Pb activity throughout core
k = decay constant (0.0311 per year)

2.1.2 - Sediment Focusing:

Because trace metals have a strong affinity with particulate matter, they are effectively scavenged out of the water column and settle on the lake bottom (Swackhamer & Armstrong, 1986). Since the bottom topographies of the Great Lakes are not perfectly horizontal, but consist of deep depressions called basins, sediments settling out of the water column are focused toward these low points and become concentrated in these regions (Figs. 3, 4, 5, 6, 7). The focusing of fine grained sediment occurs as a result of wind energy, current energy, and gravitational energy. To account for sediment redistribution, focusing factors (FF) were estimated and are used to apply specific core information such as inventories and accumulation rates to a whole basin or lake. Focusing factors are calculated for each site from the ratio of unsupported ^{210}Pb inventory measured in the core to the ^{210}Pb inventory expected from atmospheric deposition (eq. 4). The expected ^{210}Pb deposition, as defined by Urban et al. (1990), is 15.5 pCi/g. This value was found to be the average amount of ^{210}Pb accumulated in remote peat cores across the Great Lakes region as is recognized as representing the regional atmospheric input.

FF = ^{210}Pb Measured Inventory (pCi/g) / Expected ^{210}Pb Inventory (pCi/g) (4)

The focusing factors in this study varied from 1.069 in the Mississagua basin of Lake Ontario to 3.21 in the northern Duluth basin of Lake Superior.

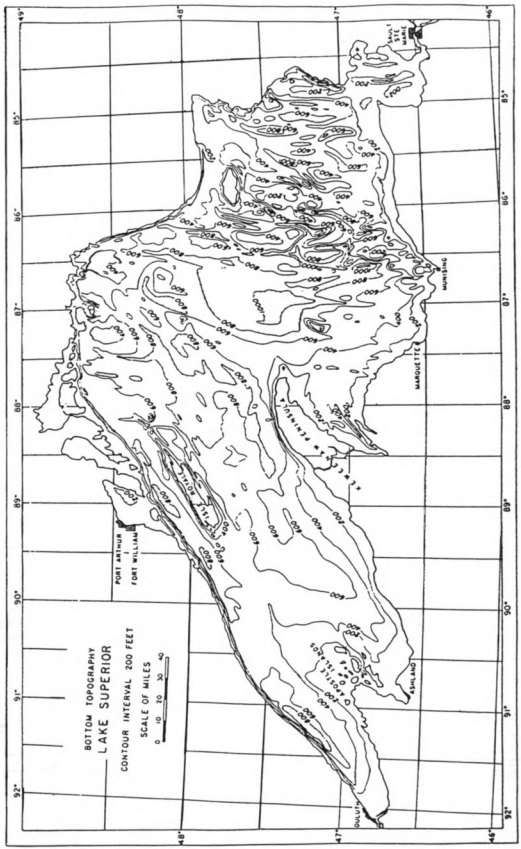


Figure 3. Bottom topography of Lake Superior. (Hough, 1958)

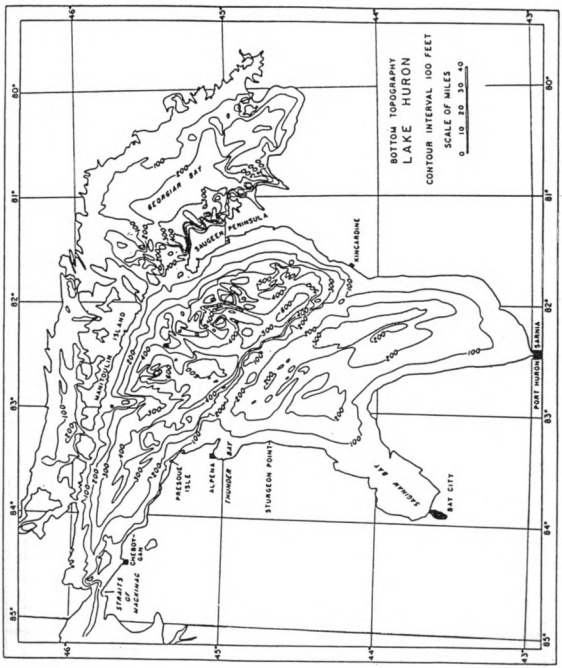


Figure 4. Bottom topography of Lake Huron. (Hough, 1958)

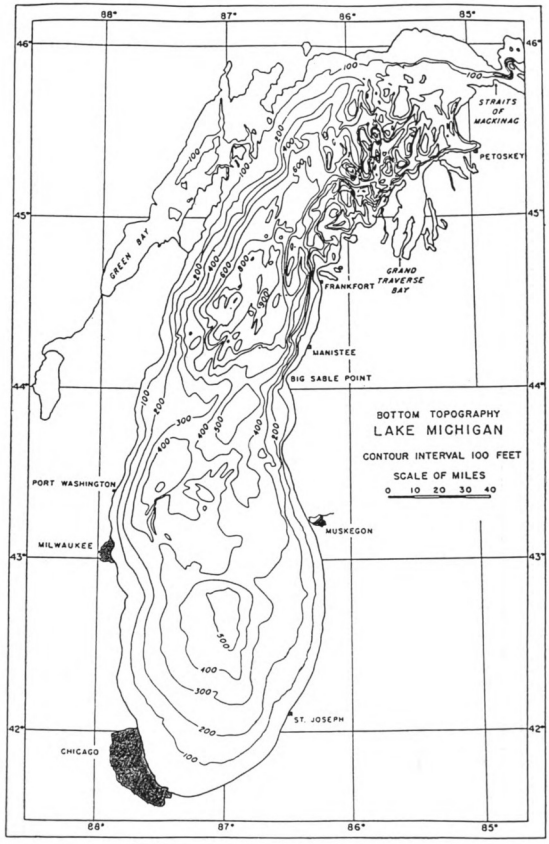


Figure 5. Bottom topography of Lake Michigan. (Hough, 1958)

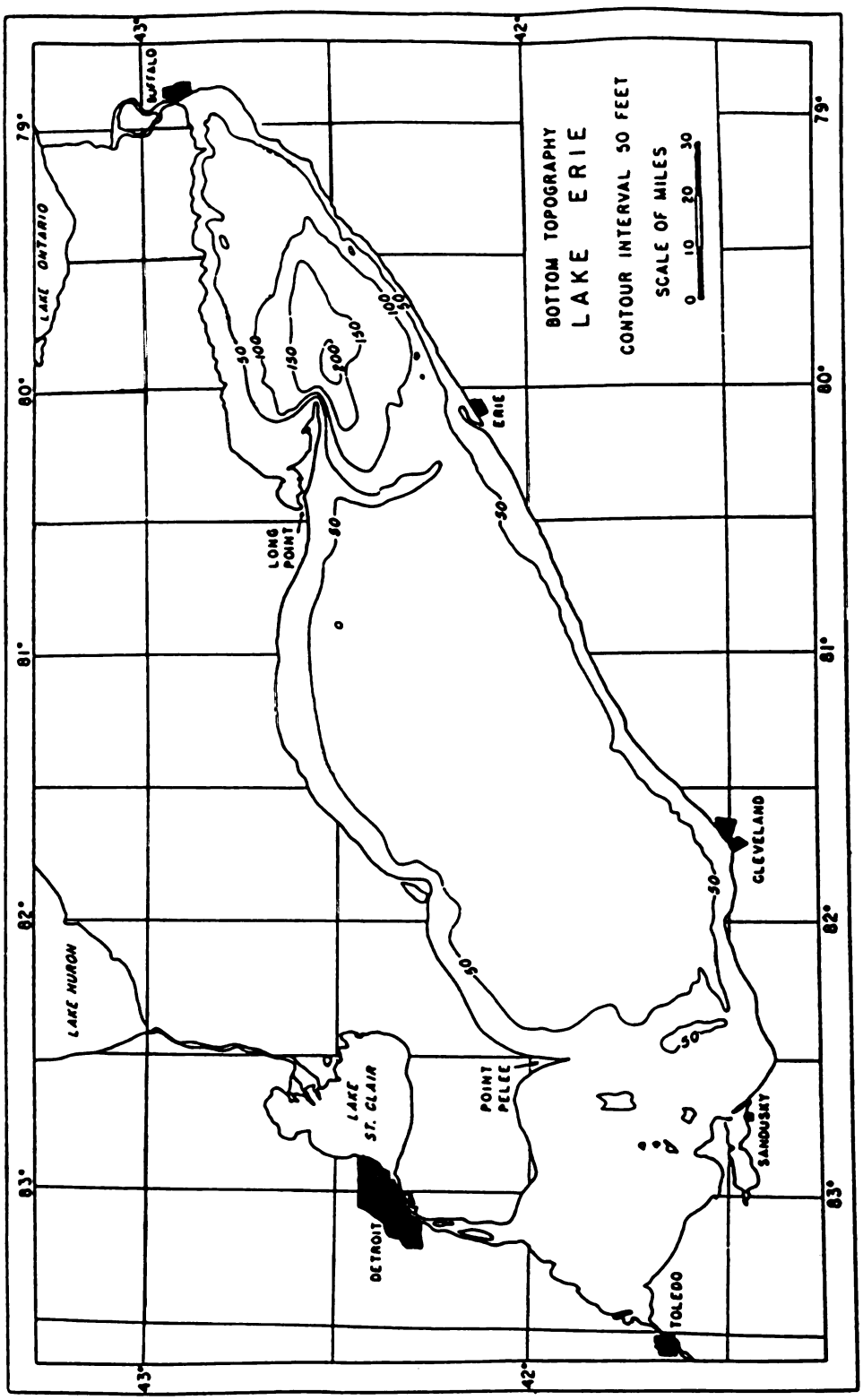


Figure 6. Bottom topography of Lake Erie. (Hough, 1958)

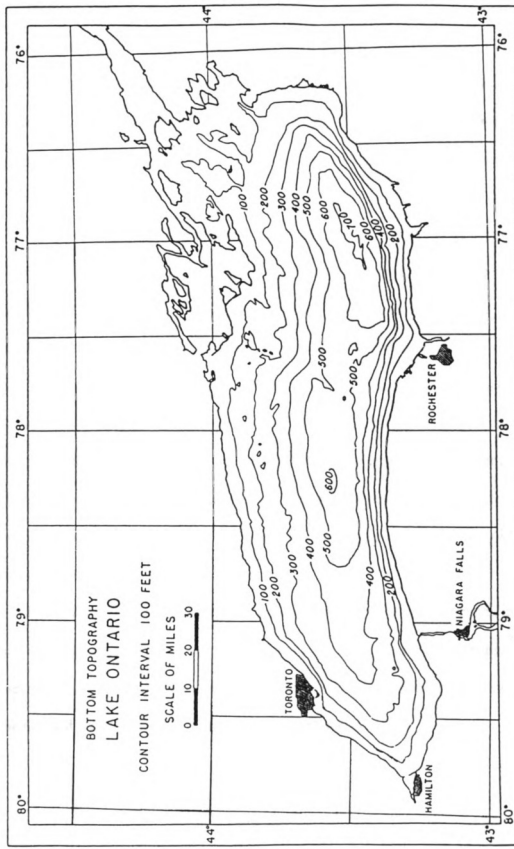


Figure 7. Bottom topography of Lake Ontario. (Hough, 1958)

2.1.3 - Sediment Core Profiles:

Sediment Core profiles graphically illustrate the geochemical data obtained by analysis of the sediment cores. Notable features such as Fe & Mn oxide layers, trends in mercury accumulation, onset of anthropogenic inputs, and background concentration values can be quickly retrieved. Throughout this study, sediment core profiles are used to compare data from several different sampling sites, as well as, comparing point sources to sediment accumulation rates.

To better understand the sediment core profiles, several terms will be necessary to define (Figure 8). The surficial concentration is defined in this study as the concentration of mercury at the surface of a core. This concentration was used to calculate the accumulation rates of mercury. In most every core analyzed, the concentrations of mercury decrease toward the present. The anthropogenic activity is the shaded part of the figure, and it represents the "chemical inventory" of the element, and represents the total anthropogenic loading of mercury to the sediment. The background depth is that point at which the concentration at becomes constant. This constant value is the natural level concentration of mercury in the sediment, prior to anthropogenic activity, and is called the background concentration.

This study will present two types of profiles. The first profile will show all the cores within a specific basin and concentrations as a function of age (spatial profiles). The second profile will show concentration as a function of depth (temporal profiles) and will be detailed with the physical features found in the sediment core.

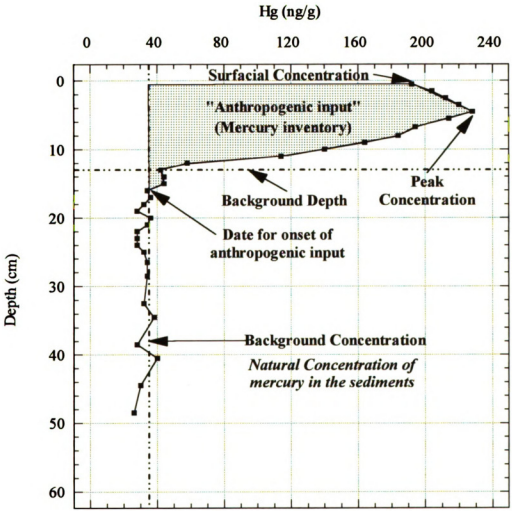


Figure 8. Sediment core profile definitions

2.2 - Mercury Cycling and Pathways in the Environment

2.2.1 - Pathways of mercury:

Mercury can be introduced to the Great Lakes through various pathways such as, direct atmospheric deposition (wet or dry), groundwater discharge, and overland flow from rivers and streams (Strachan & Eisenreich, 1988). An important distinction between atmospheric deposition and overland flow as a major source of contaminants is that shoreline and stream sediment inputs, along with sorbed contaminants, are introduced only to the near-shore waters, while the aerosol load in the atmosphere is highly dispersed in a homogeneous manner over both the near-shore and middle lake waters (Tisue & Fingleton, 1984). Only about 10 % of eroded shoreline soil is likely to be transported past the immediate shoreline region (Chesters & Delfino, 1978). Fitchko and Hutchinson (1975) discovered that only a very small percentage of suspended river sediments are transported away from the shoreline. Contaminants such as mercury dissolved in the tributary input, however, could have significant impacts on the entire lake if bottom currents are strong, or if a major river empties directly into a depositional basin (Schmidt & Andren, 1984).

Mercury is usually present in the atmosphere as the vapor phase species (Hg^0), once oxidized to Hg^{+2} it becomes particle reactive. Mercury (II) will then sorb onto dust grains in the atmosphere and will be deposited upon lake waters as dry fallout, or be "scavenged" by rain or snowfall. Because mercury has a high affinity for small charged particles, once it sorbs onto a particle it is usually bound very strongly. The mercury laden particles will then settle out of the water column to be stored in the lake sediments.

The largest sources of mercury in the environment continue to be natural, not anthropogenic (Mason et al., 1994; Fergussion, 1990; Nriagu, 1989; Lindberg et al., 1987; Fitzgerald, 1984). Natural sources which can be almost 60% of the total input (Wilber, Smith, & Malanchuk, 1992) usually consist of mercury vapor (Lindberg, 1987) that originates from volcanoes, exposed rocks, ore-bodies, volatilization from soils, and the ocean (Nriagu, 1986). There are still significant amounts of mercury coming from non-point sources, however, and these anthropogenic inputs may be dominant in localized areas (Andren & Nriagu, 1979; Eisenreich & Strachan, 1992), for example, the Duluth basin of Lake Superior, or Green Bay.

The predominance of the "vapor form" of mercury enables mercury to undergo global dispersion; thus, once released into the atmosphere mercury can be transported from one environmental medium to another where it can then be bioaccumulated and transferred into more toxic forms. The atmospheric residence times of mercury has been estimated to be between 10 and 90 days (Andren & Nriagu, 1979; Fergusson, 1990). Wet deposition is the primary process by which mercury is removed from the atmosphere and deposited back to the land (Mason et al., 1994; Lindberg, 1987). Atmospheric oxidation of Hg^0 in clouds and in aerosols seem to be the main source of reactive mercury in precipitation (Mason et al., 1994).

2.2.2 - Mercury Phases in the Atmosphere:

Mercury is a highly volatile element, and as a result, is present in the atmosphere in many different phases, such as: a vapor phase (Hg^0, $HgCl_2$, $Hg\{OH\}_2$), in an aqueous

phase ($HgCl_2$, $Hg\{OH\}_2$, sulfites), or in the solid particulate phase (HgO, HgS) (Seigneur, Wrobel, & Constantinou, 1994). The particulate and gaseous forms of mercury are usually removed from the atmosphere through dry deposition and direct gas exchange, and by "scavenging" by water droplets and ice particles (Arimoto, 1989). Vapor phase mercury concentrations determined in the atmosphere are in the ranges of parts-per - trillion (ppt) or nanogram-per-cubic meter (ng/m^3), and represent only a very minute percentage of the conventional gaseous pollutants such as: sulfur dioxide, carbon monoxide, and nitrogen oxides (Schroeder, 1982).

The anthropogenic input of mercury is believed to be 50% elemental and 50% as various divalent forms (Lindqvist et al., 1991). The background concentration of mercury found in the atmosphere is elemental (Hg^0) and is transported to very distant locations, while particulate and gaseous mercury are short lived in the atmosphere and usually are deposited within 100 km of its source (Lindqvist et al., 1991). In remote areas, away from industrial point sources, it is believed that vapor phase mercury in the atmosphere consists of only 1-10 ng/m^3, or 1-10 % of the total atmospheric burden of mercury (National Academy of Sciences, 1978). In a speciation experiment conducted in the Tampa Bay area by Johnson & Braman (1974), they found that of the 54 atmospheric measurements taken that only 4% of the total measurements had mercury in the particulate fraction, while the other 96% were divided as follows: Hg(+2) type, 25%; methylmercury (+2) type, 21%; Hg^0, 49%; and dimethylmercury, 1%. Eventhough atmospheric measurement are highly variable from region to region, there study further confirms the relative abundance of the vapor phase mercury species (Hg^0) within the atmosphere. The

height at which a particular mercury species is released into the atmosphere governs the distance it is likely to travel before it is removed, or scavenged by receptor surfaces (Schroeder & Lane, 1988).

2.2.3 - Atmospheric Deposition of Mercury:

Mercury deposition from the atmosphere is controlled by the oxidation of Hg^0 to Hg(+2) in the air, followed by dissolution in atmospheric water (wet deposition by rain), or adsorption to particles (dry deposition.) (Amyot, 1994). Wet deposition includes all processes by which mercury is transferred to the Earth's surface in an aqueous form (rain, snow, or fog). While dry deposition denotes the direct transfer of gaseous and particulate mercury to the Earth's surface (Schroeder & Lane, 1988), and of heterogeneous oxidation reactions of elemental Hg on humid surfaces (Lindqvist, 1991). It is believed that the oxidation of elemental Hg in polluted areas may increase the deposition rate at the local level. Therefore, mercury must be evaluated as having two different types of atmospheric cycles, a global and a local level (Lindqvist, 1991).

Studies on the wet deposition of pollutants are prevalent in the literature do to the relatively simple measurement process. However, the knowledge of the overall importance of dry deposition is lacking because of the difficulty in obtaining a measurement. Many researchers have turned to elaborate mathematical models to aid in there understanding of the depositional process.

2.2.4 - Dry Deposition:

Dry deposition of mercury are a function of three basic mechanisms, these include: diffusion, impaction, and sedimentation. The dry deposition of aerosols depend on the size and shape of the particle, various chemical and physical properties, wind speed, and atmospheric friction velocity. While the variables for gaseous mercury are: molecular weight, polarity, water solubility, and chemical reactivity (Schroeder & Lane, 1988).

The velocity of particle deposition was thoroughly studied by Sehmel and Sutter (1974) with the results indicating that for particles smaller than 2 μm in diameter the deposition velocity was very small. For particles in the 0.1 to 0.5 μm range, depositional velocities of 0.01 cm/s were obtained, and particles larger than 5.0 μm will continue to fall out of the air regardless of the atmospheric conditions. Over large distances of the air trajectories in the open waters of the Great Lakes, large sedimenting particles do not appear to be of significant pollution interest (Hicks, 1977). However, near urban areas, larger particles can be responsible for a good portion of the total dry deposition flux (Holsen & Noll, 1992). PCB's in dry deposition near urban areas of Lakes Michigan and Huron have been found in association with the larger particles (Murphy, 1984). Current models today using the average -particle concentrations greatly underestimate the contribution of coarse particles to the environment, and the pollution associated with them. Further study of the importance of larger particles is needed to evaluate there importance in dry depositionial flux (Holsen & Noll, 1992).

2.2.5 - Wet Deposition:

Several processes contribute to the pollutant removal via wet deposition: dissolution (by which gases or particles dissolve in cloud water or raindrops), impaction (which results from the collision of raindrops and particles), Brownian capture (which occurs in clouds and relies on kinetic motion to bring contaminants into contact with cloud droplets), and nucleation (naturally occurring or pollution derived aerosol particles which serve as a condensation nucleus for atmospheric water vapor) (Schroeder & Lane, 1988).

There are two main pathways in which gases and aerosols are scavenged from the atmosphere, below cloud scavenging (washout) and in cloud scavenging (rainout). Figure 9 shows a diagram of a typical cloud which is defined by three regions, region 1 is the cloud base which is all liquid with temperatures above 0° C. Removal of aerosols by nucleation is the main pathway here. Region 2 is defined as the supercooled area of the cloud with temperatures from 0°C to -40°C, and region 3 is the glaciated region consisting of all ice with temperatures below 0°C (Nriagu, 1984).

The term, which corresponds to the concentration of a pollutant associated with precipitation water (Cr), must be evaluated more closely before a full understanding of wet depositional processes is accomplished. Most of the pollutant mass associated with a precipation particle is obtained by the process of accretion of very small cloud droplets. It is very important that precipation growth processes and chemistry of the cloud droplets being scavenged by the falling precipation be considered in any model which attempts to define wet deposition (Sorensen et al., 1994). There tends to be a strong relationship between mercury concentrations and precipation depth

For the Great Lakes region, it is believed by many researchers, that wet deposition is more important than dry particle deposition (Mackey et al., 1986; Eisenreich, 1987; Eisenreich, 1992b; Long et al., 1995), however, in locialized areas dry deposition near major industrial sites might contribute a significant amount to the total deposition (Sorensen et al., 1994). In a study conducted by the Minnesota Pollution Agency (1990), they determined that a paper products industry in International Falls, MN has increased the local emission of mercury in both wet and dry deposition.

2.2.6 - Geological Sources of Mercury:

Evaluation of the impact of anthropogenic mercury emissions to the atmosphere requires an understanding of natural background levels and cycling processes. It has been found that crustal emissions of mercury exhibit extreme temporal and spatial variation. Variations in atmospheric mercury have been related to air and soil temperatures, barometric pressure, and relative humidity (Sorensen et al., 1994). Because of significant spatial variability of mercury in the surface environment, single average background values of mercury should be not be considered accurate indicators of geological sources (Rasmussen, 1994). Andren and Nriagu (1979) suggest 330 ng/g dry matter as a global average for mercury concentration in upper layers of freshwater sediments, while several other authors suggest 100 ng/g dry matter as an acceptable "background level" (Forstner and Wittmann, 1981).

Natural emissions of mercury are usually found in continental plate margin areas where crustal mercury vapor migrates to the surface along conduits provided by faults and

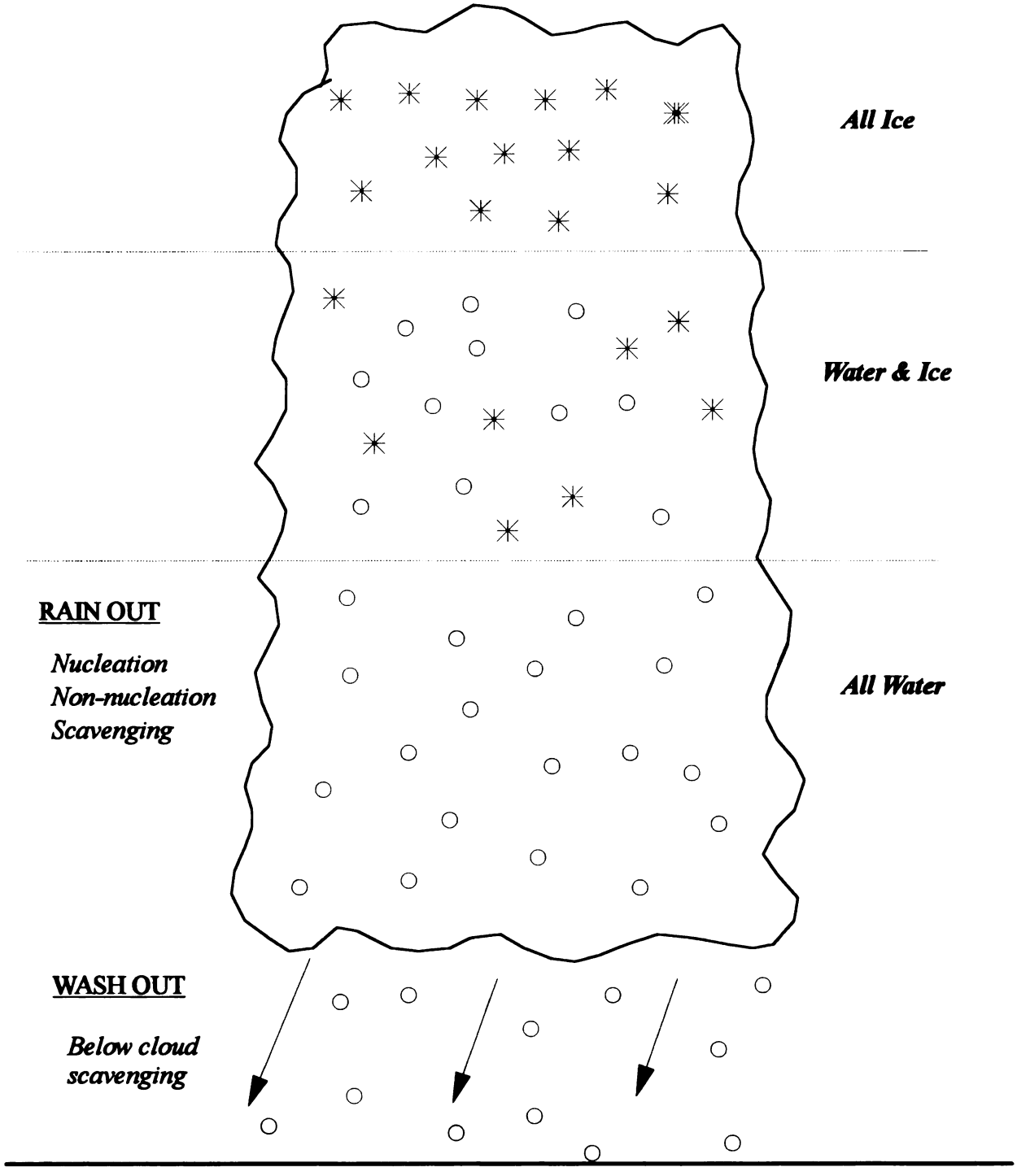


Figure 9. Cloud scavenging of gases and aerosols. (Nriagu, 1984)

fractures in the bedrock (Rasmussen, 1994). In remote areas of North America, soils are the primary source of mercury to the surfical environment (Rasmussen, 1994). The predominant input to the soils is from crustal out-gassing and weathering of mercurial minerals (Sorensen et al., 1990). Geological formations in the Great Lakes basin, however, were not found to contain significant amounts of mercurial minerals (Moore and Ramamoorthy, 1984).

Geochemical processes such as remobilization, upward migration, adsorption onto oxides, and biogeochemical reactions near the sediment - water interface, are known to cause surface enrichment of many elements and trace metals in sediment columns. Mercury concentrations, however, can not be related to these processes (Rasmussen, 1994). According to Kemp (1978), surface enrichment of mercury in isolated lakes indicates a resent increase in atmospheric loading in response to anthropogenic activities. In this study, the relative contributions of mercury from anthropogenic and geological sources was calculated based on variation in mercury concentrations with depth in sediment cores.

2.2.7 - Industrial Use of Mercury:

The EPA has found that air over southern Michigan, between Chicago and Detroit, contains the highest levels of mercury anywhere in the nation (CICEN, 1993). Power plans, incinerators, farms, and local consumers all have contributed to the high levels of mercury. The lower Great Lakes region contains a large number of industrial incinerators and large power grids fed by several coal powered utilities. Coal burning by large power plants is the single largest source of mercury to the Great Lakes (CICEN, 1993).

Michigan's power plants release 1.7 tons of mercury each year to the atmosphere. Atmospheric mercury is mostly washed out by rain or snow events and falls back into the Great Lakes watershed. The states largest utility, Consumers Power Co., releases between 700 and 900 pounds of mercury each year from its coal burning plants in Bay City, Grand Rapids, Muskegon, and Monroe. Utilities and incinerators are the largest point source of anthropogenic mercury in the United States today. Eighty percent of the 253 tons of mercury released annually are derived from the major utilities and incinerators (CICEN, 1993). Municipal incinerators routinely burn batteries which contain large amounts of mercury. Industrial boilers used by industry still contain mercury fuel cells, and the chloro-alkali plants continue to discharge wastewater containing mercury. The electrolytic preparation of chlorine and caustic soda in chloro-alkali plants accounted for up to 40% of the present industrial use mercury (Reese, 1990). Since 1985, three mercury-cell chloro-alkali plants were permanently closed and, the Occidental Chemical Corp.'s Niagara Falls, NY plant was temporary closed. By the beginning of 1986 twenty mercury-cell chloro-alkali plants were still in operation (Carrico, 1985). More closures are expected over the next several years as stricter environmental regulations are anticipated (Reese, 1990).

Mercury markets and consumer products containing mercury continued to decline in the early 1990's due to the public perception of its extreme toxicity. Consumer products which ranged from light bulbs to thermometers, accounted for only 1% of mercury use in 1990, while the United States only primary mercury producing mine in Nevada was closed that same year. As of 1991, paint makers were required by the EPA to remove all mercury from their paints, and Severe restrictions were emposed on the

manufacture of mercury containing products, and has led to the development of many mercury substitutes (Reese, 1990). Consumption of mercury in 1990 (Figure 10) was reported by 275 plants in the United States, of which 50-60% were located east of the Mississippi River. Primary mercury accounted for 68% of the total reported consumption, while redistilled and secondary mercury use was 22% and 10% respectively (Carrico, 1985). The worlds mercury market during the 1990's is characterized as having an abundant supply but a lower demand. This trend is expected to continue, however, total elimination of mercury use is unlikely. The historical use of mercury since 1945 is very important to understand because it is during this time-frame that sediments containing mercury in the Great Lakes reached there highest levels (Figures 11 and 12).

2.2.8 - Natural Emissions of Mercury:

As much as 60% of all mercury species introduced to the waters of the Great Lakes are from natural sources (Wilber, Smith, & Malanchuk, 1992). Natural emissions of trace elements can be a major source of regional and local contamination which significant anthropogenic sources are not important. In the Great Lakes basin, local geological formations surrounding and underlying the lakes are a constant source of trace metals to sediments (Nriagu, 1984). Every sediment core analyzed in this study was found to have substantial "natural background" concentrations of mercury.

Worldwide concentrations of trace metals (Table 3) are difficult to constrain owing to the lack of reliable data (Fergussion, 1990). Two seasalt productions processes have been considered as natural emission sources: 1.) "bubble bursting" (Cd & Pb) and 2.) gas exchange (As) (Nriagu & Davidson, 1986). Another method for estimating the natural

concentrations of trace metals is by analyzing remote and ancient samples (Table 4). Remote locations include the Arctic, Antarctic, Greenland, mountain areas, and northern Canada. The ancient concentrations of trace elements have been determined on materials such as bone, teeth, hair, ice, and peat (Fergussion, 1990).

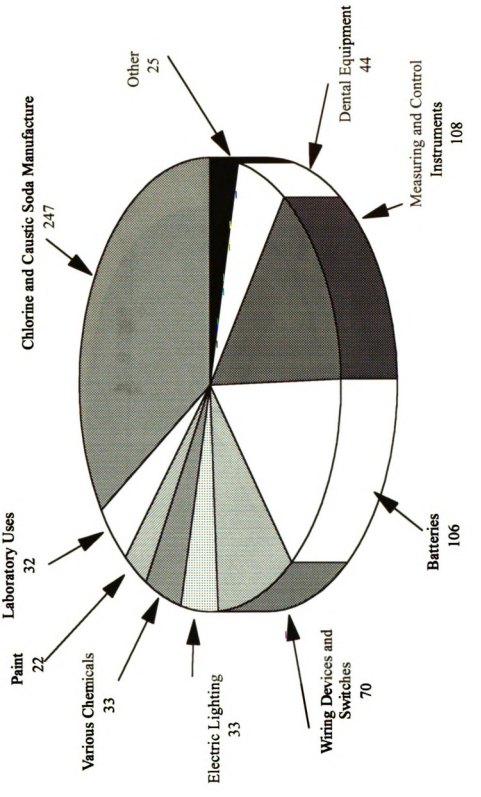


Figure 10. U.S. Industrial Consumption of Mercury (1990)
source: *The Minerals Yearbook*

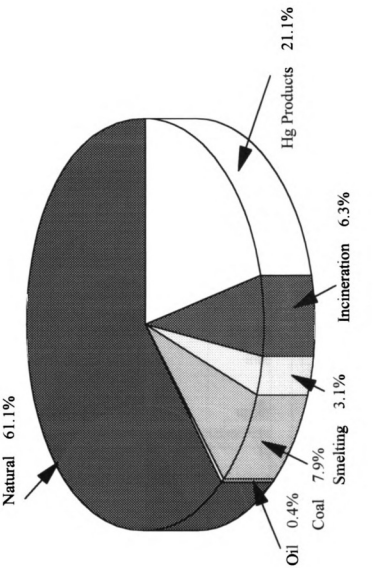
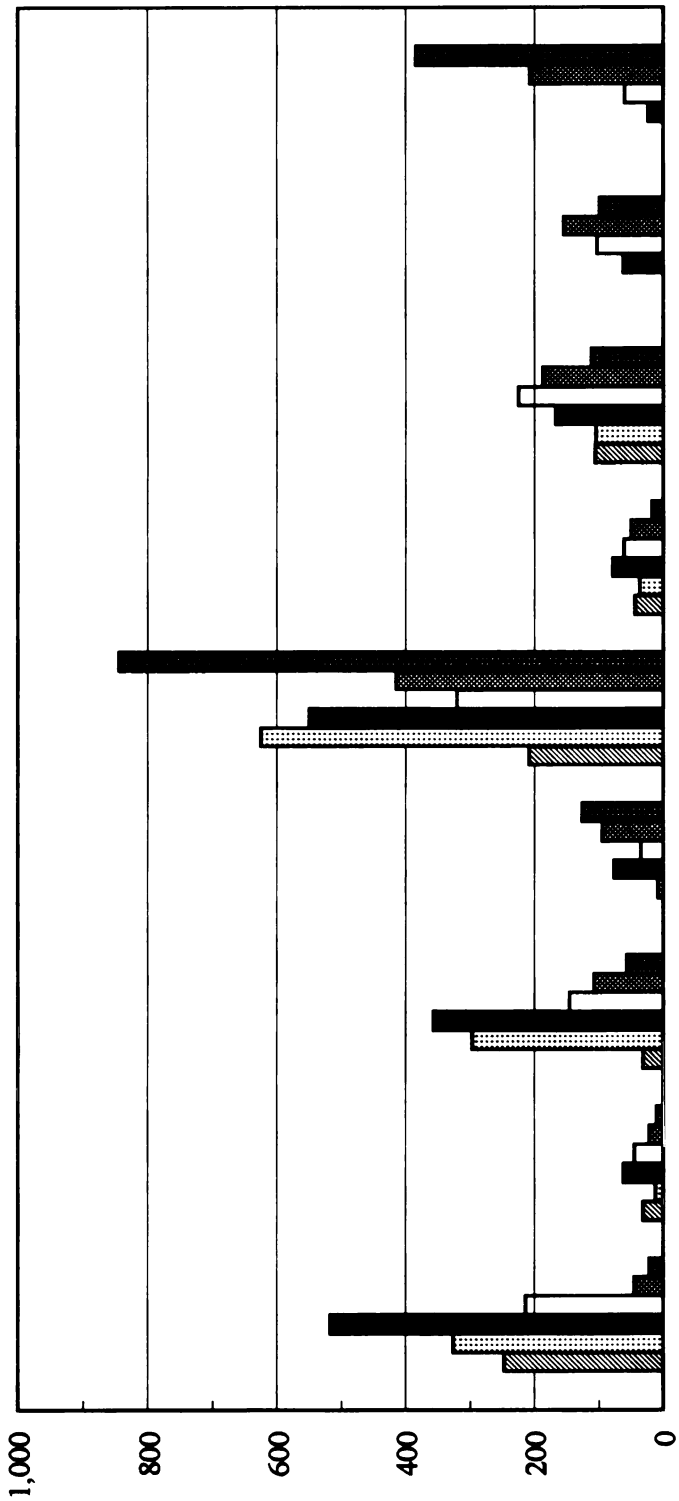


Figure11. Mercury Emission in the United States (1992)
(from Wilber et al. 1992)



	Chlorine prep.	Lab uses	Paint	Catalysts	Electrical	Dental	Industrial	Agriculture	Pharmaceuticals
1990	247	32	32	0	209	44	106	0	0
1980	326	13	297	9	625	37	105	0	0
1970	517	62	357	77	550	79	167	62	24
1960	214	45	146	35	320	61	225	103	60
1950	45	22	108	95	415	50	187	155	207
1945	22	11	57	126	844	18	112	99	384

Figure 12. Industrial Use of Mercury 1945-1990 (metric tons)
source: The Minerals Yearbook

Table 3: Worldwide Emissions of Trace Metals from Natural Sources
Annual Emission (ppm)

	Arsenic	Cadmium	Lead	Mercury
Windblown Dust	0.24	0.25 (0.05 - 0.85)	10 (3 - 35)	0.03 (0.005 - 0.035)
Volcanogenic Particles	7.0 (0.3 - 39)	0.50 (0.4 - 7.8)	6.4 (0.4 - 96)	0.03 (0.01 - 0.24)
Forest Wildfires	0.16	0.01 (0.01 - 0.15)	0.5 (0.04 - 6.8)	0.10 (0.04 - 0.16)
Vegetation	0.26	0.20 (0.05 -2.7)	1.6 (0.2 - 21)	-
Seasalt	0.14	0.002 (0.001 - 0.4)	0.1 ((0.001 - 5)	0.003 (0.001 - 0.006)

Table after Nriagu & Davidson (1986)

Table 4: Concentrations of Arsenic, Cadmium, Lead, and Mercury in Ancient Samples.

Location & Element	Material	Date	Ancient levels	Reference
		Arsenic		
Antarctic	Ice	< 12000 bp	≤ 4 pg/g	Boutron (1982,86)
		Cadmium		
Antarctic	Ice	< 12000 bp	2.6 pg/g	Boutron (1982)
Greenland	Ice	800 bp	5-14 pg/g	Boutron (1982)
Sweden	Mosses	1916-1942	0.23 ug/g	Coleman & Hutton (1985)
		Lead		
Antarctic	Ice	< 12000 bp	1-2 pg/g	Boutron (1982)
Antarctic	Ice	1797-1801	1.6 pg/g	Boutron & Patterson (1982)
Sweden	Mosses	1916-1942	61 ug/g	Coleman & Hutton (1985)
Sweden	Mosses	1860	20 ug/g	Coleman & Hutton (1985)
United Kingdom	Peat	800 AD	4 ug/g	Coleman (1985)
United Kingdom	Peat	pre 700 BC	8 ug/g	Lee & Tallis (1973)
United Kingdom	Peat	Roman Times	40-50 ug/g	Lee & Tallis (1973)
		Mercury		
Arctic	Ice	800 BC	30-75 pg/g	Alderton & Coleman (1985)
Greenland	Ice	1-3 century	2-19 pg/g	Alderton & Coleman (1985)
Norway & Alaska	Ice	Pre-industrial	3-400 pg/g	Alderton & Coleman (1985)

2.2.9 - Anthropogenic Emissions of Mercury:

The term "anthropogenic" in this study refers to human induced contamination of trace metals through every day activities such as mining, waste incineration, combustion of fossil fuels, and direct discharge into the environment. There are many other means by which toxins enter the environment by anthropogenic activities, some of which are listed in table 5. The build-up of mercury in the environment due to anthropogenic inputs is a very persistent problem in the Great Lakes basin. The estimated anthropogenic emission rate of mercury is 649.7 million g/yr (Fergussion, 1990), with chloro-alkali plant emissions and power generating plants being the largest source followed by agriculture and mining industries (Lindberg, 1987). Recently, studies have confirmed that abandoned waste deposits associated with non-operating chloro-alkali plants may be a significant source of contamination (Lindberg & Turner, 1977; Lindberg, 1987).

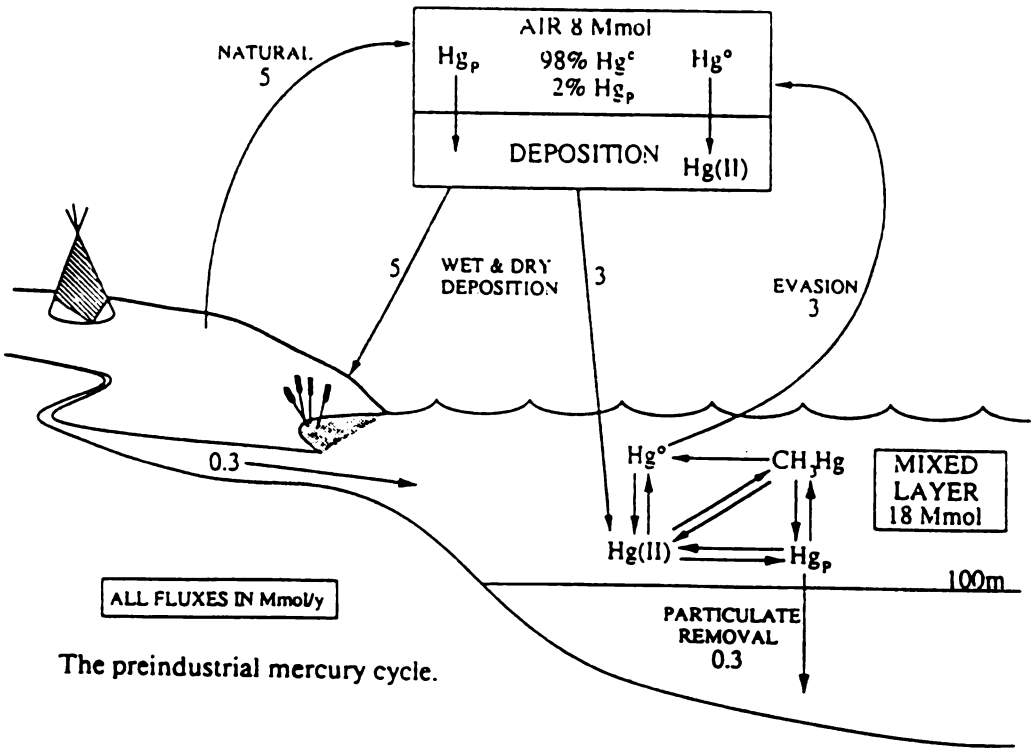
Mercury released from both high and low temperature processes enter the atmosphere primarily as mercury vapor (Hg^0) (Lindberg, 1987). In the Great Lakes region large areas of industrial production, coal combustion, and chloralalkali waste dumps emit large amounts of mercury vapor to the atmosphere every day. The Michigan Department of Natural Resources (MDNR) estimates that about 37,000 pounds of anthropogenic mercury is emitted yearly in the state and that Michigan ranks 10th nationally in mercury emission (Water Impacts, 1994). Emission measurements and mass balance calculations performed at a coal-burning power plant indicate that 80 to 100% of the mercury in coal escapes into the atmosphere and is releases in close proximity to the source (Lindberg, 1987; Schroeder & Lane, 1988) The height at which mercury vapor is emitted governs its atmospheric residence. Natural sources such as volcanoes emit

mercury far into the upper atmosphere, thus dispersing on a global scale. However, sources such as power plants or landfills release mercury mush closer to the earth's surface. Anthropogenic sources therefore become more important on a local or regional scale (Lindberg et al., 1987). Current estimates from lake studies suggest that less than 30% of the atmospheric deposition to the watershed reaches the lake (Swain et al., 1992). Therefore, the influence of anthropogenic mercury on the Great Lakes watershed would persist for a substantial period after a reduction in emissions.

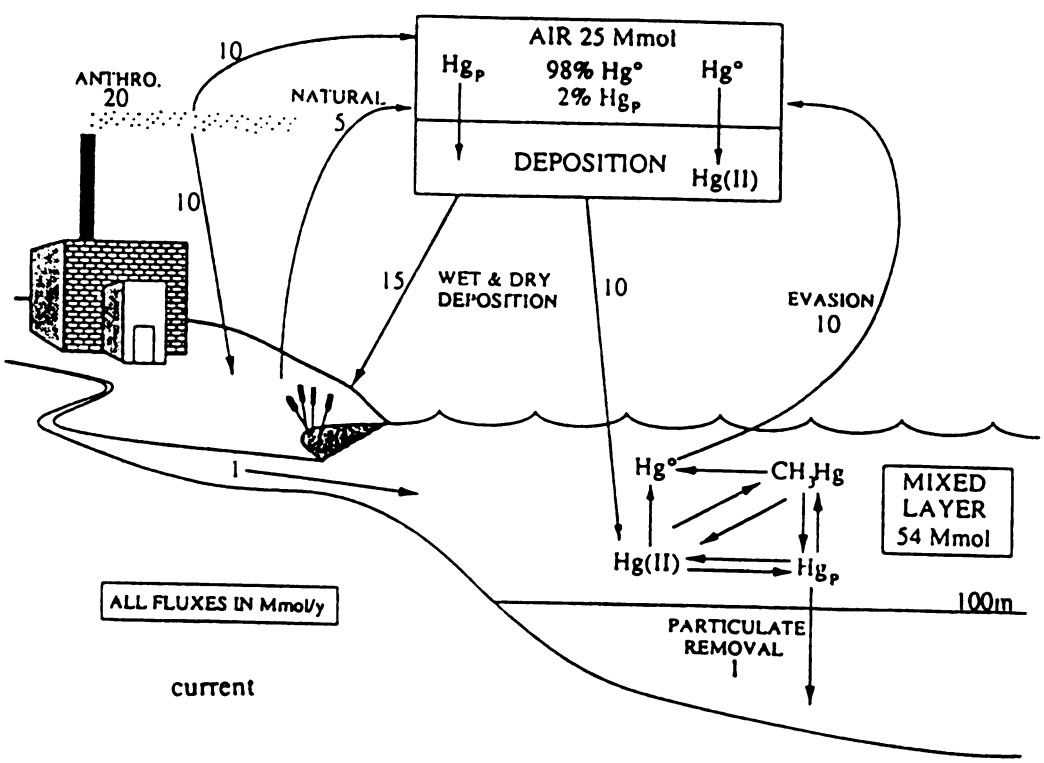
Even though anthropogenic emissions of mercury have increased several times between pre-industrial times and the present, the total global atmospheric load of mercury is relatively insensitive to anthropogenic inputs (Fitzgerald et al., 1984). The current and pre-industrial mercury cycles are shown in Figure 13.

Table 5: Anthropogenic Emissions of As, Pb, & Hg in the United States (1985).

source - EPA, 1984, 1985, 1986, 1987	Metric Tons Per Year
Lead:	***21,305***
Gasoline Combustion	15,400
Municipal Waste Incineration	2,800
Industrial Processes	2,300
Coal Combustion	778
Oil Combustion	27
Arsenic:	***3,332***
Use of Arsenic Pesticides	1,500
Coal Combustion	1,390
Oil Combustion	19.8
Nonferrous Smelters	
primary copper	312.2
primary lead	37.8
zinc & zinc oxide	8.8
secondary lead	7.1
Arsenic Mining	17.5
Cotton Ginning	2.7
Glass Manufacturing	33.5
Municipal Waste Incineration	2.7
Mercury:	***1,668***
Natural Emissions	1,009
Use of Consumer Goods	352
Coal Combustion	132
Municipal Waste Incineration	68
Copper Smelting	41
Sewage Sludge Incineration	36
Other Sources	20
Cadmium:	***210.5***
Fossil Fuel Combustion	121.7
Nonferrous Smelting	
primary cadmium	1.8
zinc & zinc oxide	2.2
primary copper	30.3
primary lead	22.0
Municipal Waste Incineration	20.7
Iron and Steel Production	11.3



The preindustrial mercury cycle.



current

Figure 13. Current and pre-industrial cycles of mercury. (Mason & Fitzgerald, 1994)

2.3 - Environmental Chemistry of Mercury

2.3.1 - Chemical Processes Affecting Mercury Cycling:

The environmental chemistry of mercury is very complex, not only because of its various oxidation states (0, +1, +2), but also because of biotic / abiotic methylation and the extreme volitility of mercury (Stumm, 1982). A unique feature of mercury with respect to other trace metals, is that the monovalent (+1) oxidation state is not expected. This is a result of Hg(+1) not forming any covalent bonds with other elements because of its tendency to disproportionate (Schroeder, 1982). Mononuclear Hg(+1) would be paramagnetic, unusual for a p-block element (Fergusson, 1990). The compounds of Hg(+1) are typical metallic compounds, and involve a binuclear cation (Hg_2^{+2}). All are ionized in aqueous solution, and are sparingly soluble to insoluble in water at normal temperatures (Schroeder, 1982). The state with the inert pair is Hg(0), while Hg(+2) is formed by the loss of two electrons ($6s^2$).

Mercury has an atomic number of 80 and is positioned in the periodic table under the transitional elements of zinc-cadmium-mercury in Group 2B (Figure 14). Group 2B elements resemble the alkaline earth metals (Group 2A) in that they all have the same valence electron configuration, ns^2. However, the chemistry of the two groups are quite different do the contrast in the number of electrons in the outermost shell. Chemical similarities occur mainly within vertical groups. As the number of valence electrons change, there appears to be chemical variations. In contrast, the transition metals, which include Hg, show great similarities within a given period as well as within a given vertical group. Caicium, strontium, and barium only have 8 electrons (s^2p^6) while zinc, cadmium,

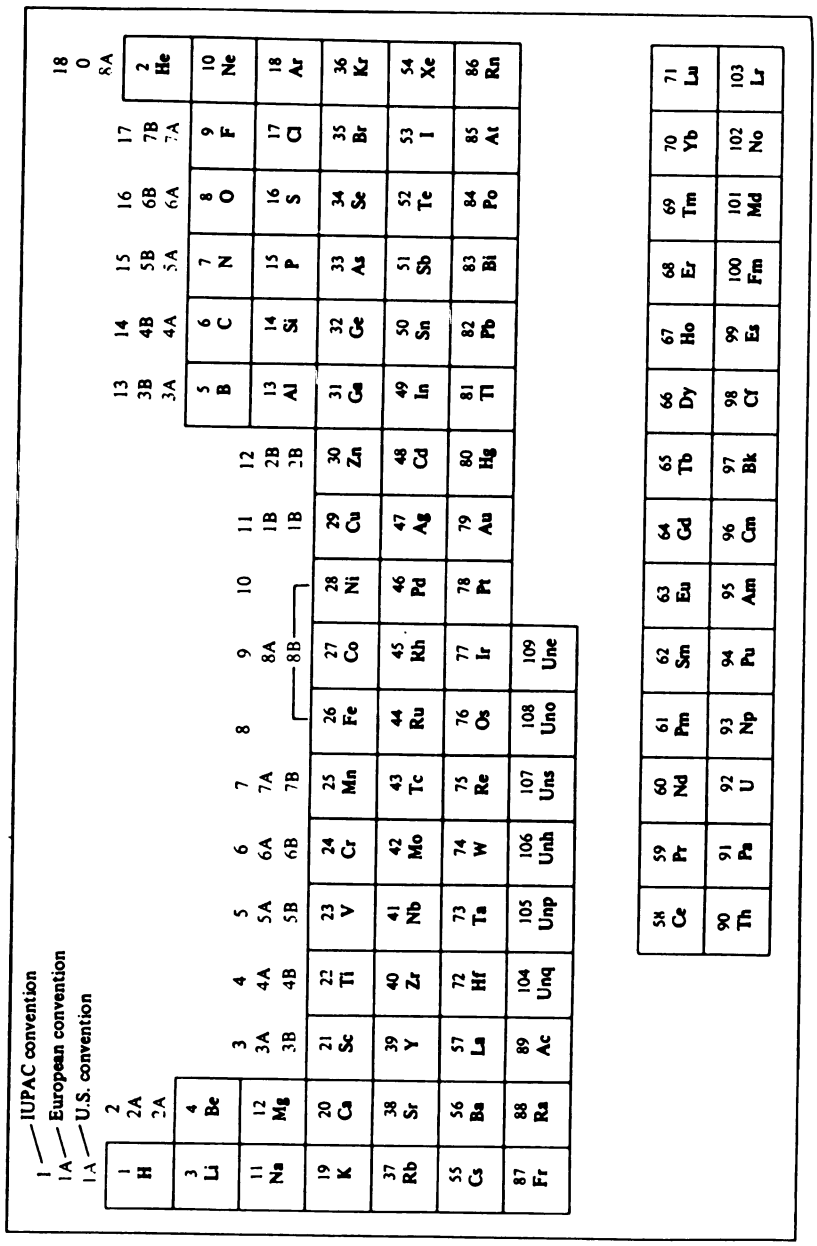


Figure 14. Representation of mercury in the periodic table. (Ebbing, 1987)

and mercury have 18 electrons ($s^2p^6d^{10}$). The *d* orbitals, which are found in zinc, cadmium and mercury, do not shield the outer electrons as effectively from the nucleus as the *p* orbitals in the alkaline earth metals. The inner *d* electrons cannot participate in bonding as can the valance *s* and *p* electrons. For similar reasons, cadmium and mercury lose electrons more readily than the Group 2A elements, strontium and barium. Therefore, Group 2B elements (Zn, Cd, Hg) are less reactive and electropositive and will have a greater tendency to form covalent compounds.

2.3.2 - Methylation of Mercury:

During the 1960's Swedish investigators first discovered that microbial activity in aquatic environments can result in methylation of inorganic mercury (Jensen & Jernelov, 1967). Investigators believed that the mechanism involved the nonenzymic methylation of mercuric mercury ions by methyl carboning compound (Vitamin B_{12}) that are produced as a result of bacterial synthesis. Researchers today understand that environmental mercury forms many stable organometallic compounds in the environment with alkyl groups, such as CH_3Hg^+ and CH_3HgCH_3 (monomethyl- and dimethylmercury). Monomethylmercury (CH^3Hg^+) is recongnized as the most toxic mercury species toward living systems because of its tendency to bioaccumulate. Dimethylmercury (CH_3HgCH_3) is also toxic, however, its highly volatile and tends to escape into the atmosphere (Berman & Bartha, 1986).

Methylmercury may be formed under a variety of conditions, such as in both aerobic and anaerobic waters, in the presence of various types of microbial populations, soil solutions, and in different types of freshwater bodies from eutrophic to oligotrophic lakes (Clarkson et al., 1984; Stumm, 1982). An important factor of the methylation of

mercury in aquatic sediments is that this conversion may result in remobilization of precipitated or sorbed mercury (Stumm, 1982). At present, there is no direct evidence for point sources of methylmercury into the aquatic environment (Hintelmann, Hempel, & Wilken, 1995).

The rate at which mercury is methylated in the environment depends on several factors which include: the total concentration of Hg^{+2}, the microbial population, pH, temperature, and redox potential. The methylated form of mercury is Hg(+2). Mercury species such as phenylmercury, Hg(liq), and Hg(+1) are readily available for methylation by a conversion to Hg(+2). Mercuric sulfide (HgS) is very insoluble as it stands by itself, however, aerobes can solubilize Hg(+2) from HgS by oxidizing the S^{-2} ion to sulfate via sulfite (McComish & Hooi Ong, 1988). In a study conducted by Berman & Bertha (1986), they determined that high sulfide levels in aquatic sediments prevent the methylation of mercury. Craig and Bartlett (1978) also demonstrated that monomethylmercury may be depleted by sulfide by is interconversion to the highly volatile dimethylmercury species by disproportionation.

The demethylation of mercury, just like methylation, is carried out by bacteria. This breakdown is believed to be caused by the hydrolase enzymes cleaving the carbon mercury bond and releasing the methyl group. As a result of this action, ionic mercury is converted to the metallic elemental form which diffuses out of the water as the vapor phase Hg^0 (Clarkson, 1984). At normal temperatures, Hg^0 is rapidly lost from aqueous environments. Stumm and Morgan (1982) report a Henrys law constant of 8.5 atm M^{-1} for $Hg^0(aq)$.

The chemistry of mono- and dimethylmercury are well known and have been thoroughly studied for many years now. Recent studies of the sediments around industrially contaminated sites have discovered many other "exotic" organomercury compounds such as methoxyethylmercury ($CH_3OC_2H_4Hg^+$), D,*p*-mercuribenzoic acid ($COOHC_6H_4Hg^+$), E,ethylmercury ($C_2H_5Hg^+$), F,ethoxyethylmercury ($C_2H_5OC_2H_4Hg^+$), G,phenylmercury ($C_6H_5Hg^+$), H,nitromersol ($OHCH_3NO_2C_6H_2Hg^+$), and I,p-tolylmercury ($CH_3C_6H_4Hg^+$). These organo-mercury compounds were mostly used in the fungicide producing industries, and eventhough most of these compounds are banned in production, they continue to pollute the soils and air in closed company landfills.

2.3.3 - Aqueous Chemistry of Hg:

Several mercury compounds are readily precipitated from an aqueous solution (Figure 15). Mercury(+2) complexes are generally more stable than complexes of the same ligand with zinc, cadmium, or Hg(+1) ions (Hepler & Olofsson, 1975). One of the reasons for this stability comes from the overlapping of the large 6s orbitals bonding the two Hg(+1) ions, a bond which would be unlikely formed by the smaller 5s and 4s orbitals of cadmium and zinc respectively (Fergussion, 1990). In water the moderately stable Hg(+2) ion hydrolyzes to produce small amounts of Hg_2OH^+, which is the dominant Hg species in fresh water at pH's 2-4 (Stumm, 1982), however $Hg(OH)_2$ becomes

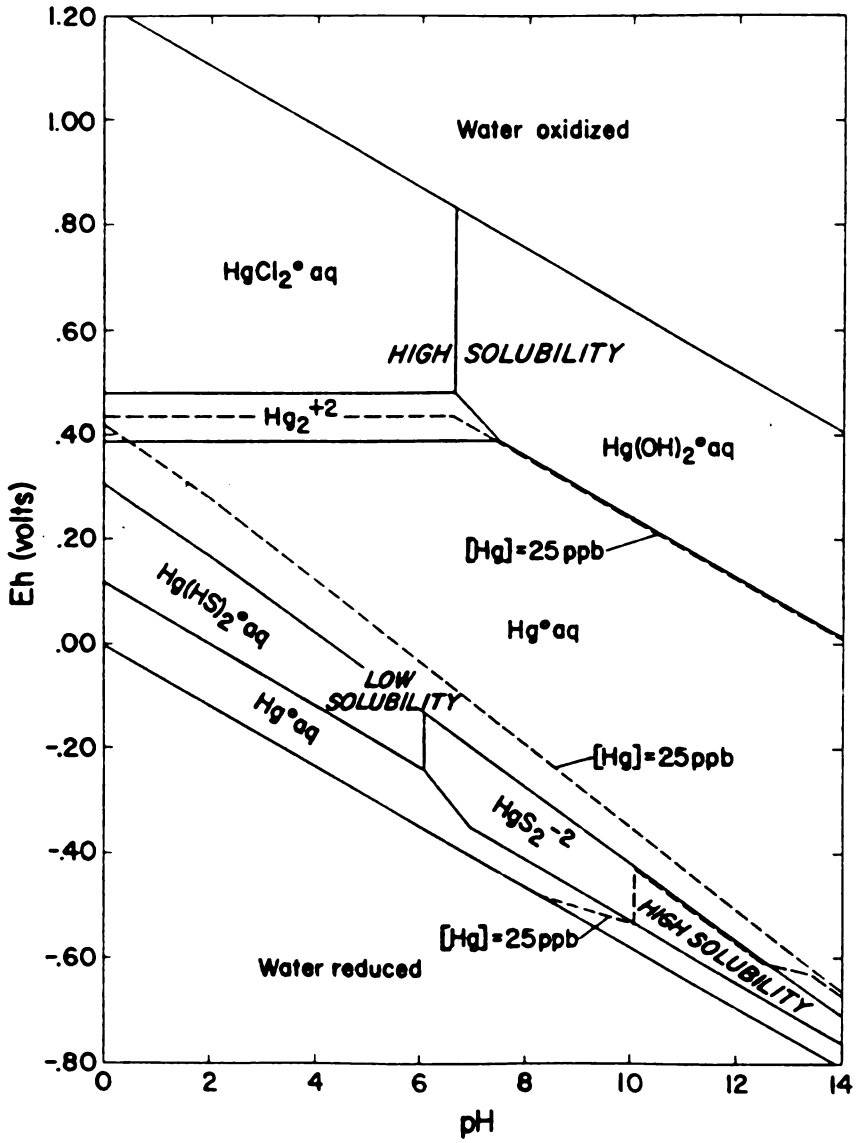


Figure 15. Stability fields of aqueous mercury. (O'Neill, 1985)

dominant at higher values of pH (Bisogni & Lawrence, 1975). The Hg(+2) ion is polarisable and acts as a soft acid. Therefore, it associates strongly with soft bases such as: OH^-, Cl^{-2}, $S2^-$, CN^-, and R_2S. The two dominate mercury species under standard conditions in aqueous environments are $Hg(OH)_2$ and $HgCl_2$ (Fergussion, 1990).

2.3.4 - Charged Surfaces of Particles:

Because mercury is particle reactive, particles become a major player in the cycling and fate of mercury and its species. There are many processes at the particle-water interface which describes trace metal mobility, discussion of all of them is beyond the scope of this study and only a few will be discussed.

The solid phases that exhibit surface reactivity in the environment, and which mercury is strongly attracted to, consist mostly of the clay fraction (< 2μm) (Sposito, 1984; Evans, 1989). Clay minerals are simply defined as being polymers which are compounds or mixtures of compounds formed by the bonding of repeating molecular units (Sposito, 1984). Clays consist of silica tetrahedrons (SiO_4^{4-}) forming a tetrahedral layer and metal cations (M^{m+}) with there anion pairs (X^b) forming octahedral layers. These two layers polymerize to form sheet structures (Figure 16). These polymeric sheets further combine to form the phyllosilicate clays. Because of the "sandwiching" of the two different layers, a structural distortion develops. This distortion is a result of the apical oxygen atoms in the tetrahedral sheets not fitting in the corners of the octrahedra. The two layers can only be bonded together by rotation of the two tetrahedra sheets (one clockwise and the other counterclockwise). A lower symmetry is a result of this rotation,

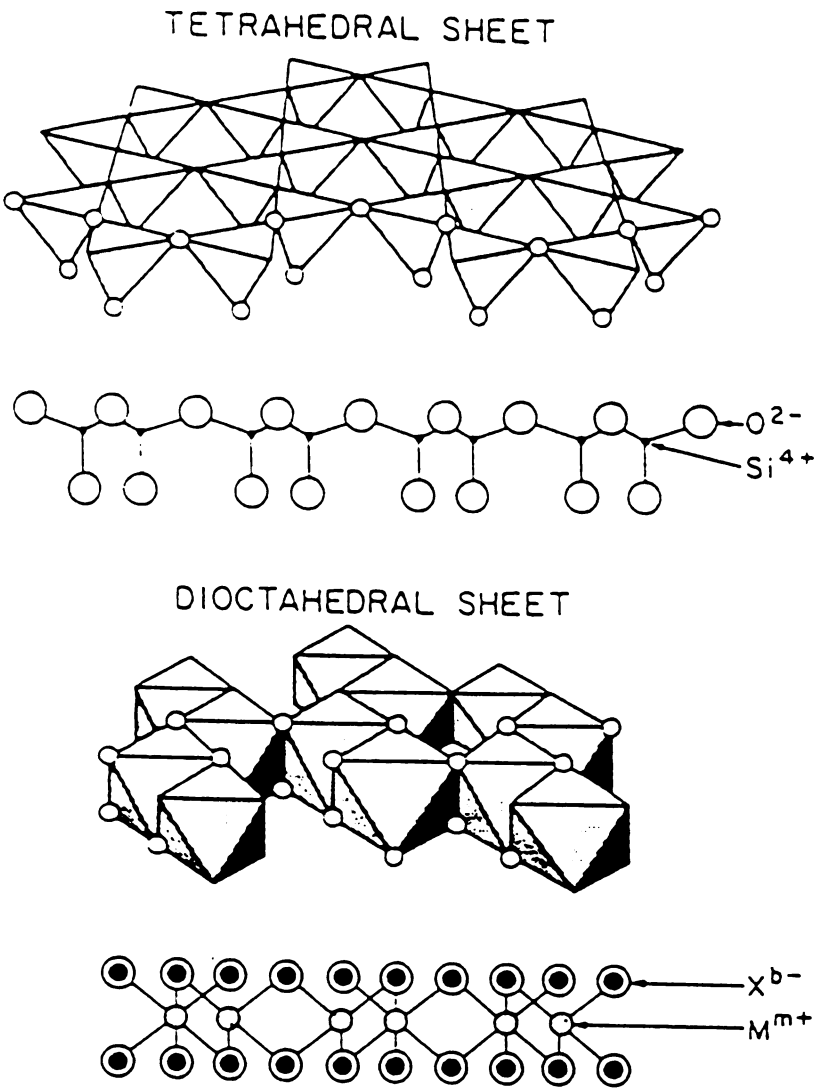


Figure 16. Sheet structures of SiO4 tetrahedra and MX6 octahedra. (O'Neill, 1985)

and isomorphic substitution of cations between layers becomes possible (Sposito, 1989). Isomorphic substitution creates charge imbalances within the phyllosilicate structure leading to permanent structural charges (Evans, 1989). However, the overall charge on the unit structures is always negative. Although positive charges can develop through structural imperfections within the clay minerals, these charges are neutralized by the negative charges within the tetrahedral and octahedral sheets (Evans, 1989). Therefore clays can be regarded in the aquatic environment as anions. Because mercury (Hg^{2+}) has a low hydration engery, it will display a very short association with water molecules, and will become particle reactive toward anions (clay minerals) in solution.

2.3.5 - Surface Functional Groups and Complexation:

The surface functional group is the molecular unit bound into the structure of a solid (clay mineral), but is available at the surface to be immersed in a solution. When a surface functional group reacts with a molecule dissolved in a surrounding fluid to form a stable unit, surface complexes are formed (Stumm, 1992). There are two forms of surface complexes, inner-sphere complexes have no molecule of the "bathing solvent" (water) in-between the surface functional group and the binding molecular unit, if there is at least one solvent molecule in-between the functional group and the bound molecule an outer sphere complex is formed (Figure 17). Inner-sphere complexes tend to be more stable than outer-sphere because of the ionic or covalent bonding involved. The electrostatic bonding of the outer-sphere is usually a weaker bond (Sposito, 1984).

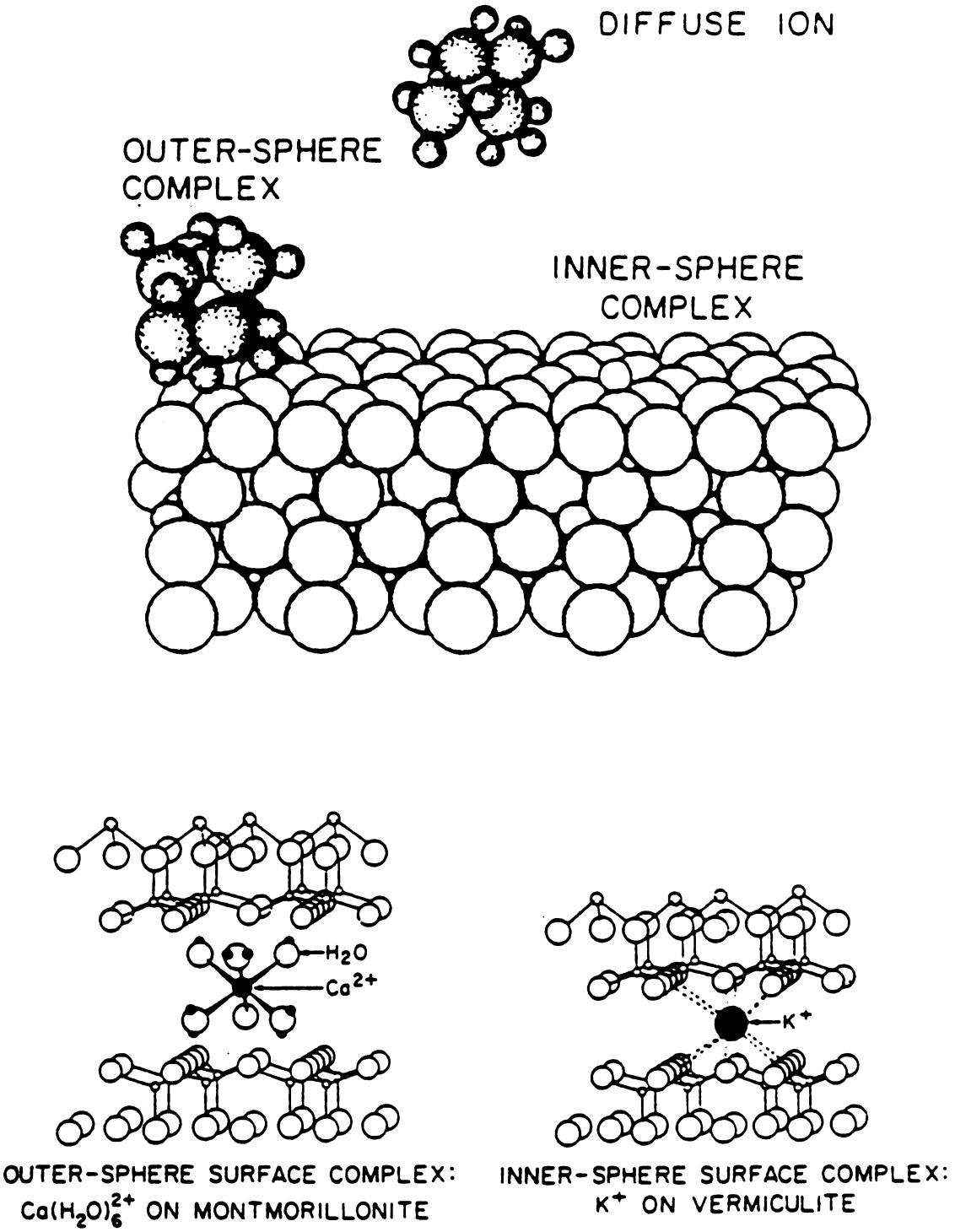


Figure 17. Inner and outer sphere surface complexes. (Sposito, 1989)

The siloxane ditrigonal cavity is the most important functional group in 2:1 clay minerals. It is formed on the siloxane surface(a plane of oxygen atoms) of the tetrahedral silica sheet of the clay mineral. The siloxane ditrigonal cavity is a "hole" surrounded by six oxygen atoms in a distorted hexagonal array. This cavity is the result of the tetrahedral sheet rotation discussed earlier. The negative charge created by substitution of one ion for another is "felt" by ions in solution as they approach the ditrigonal cavity. The siloxane cavity is bordered by six sets of lone-pair electron orbitals emanating from the surrounding ring of oxygen atoms. This feature makes the ditrigonal cavity a "soft"lewis base, which are species which donate electrons. Mercury is classified as "soft" lewis acid capable of accepting electrons because of its unshared pairs of electrons. In general, soft acids prefer soft bases. Therefore, mercury because of its soft acid nature and its ability to lose its hydration shell easily, can be strongly bound to the cavity in an inner-sphere complex, thus, creating a very strong bond between the clay mineral and the mercury species. As a result of these surface reactions, mercury can be strongly scavenged out of the water column by small highly reactive particles. Adsorption is viewed as a major pathway by which trace metals are removed from the water (Stumm, 1981, Evans, 1989).

2.3.6 - Adsorption:

Adsorption is the accumulation of matter at the solid-water interface and is the primary basis of surface-chemical processes (Stumm, 1992). Affecting the transportation of trace metals to the sedimentary basins of the Great Lakes, adsorption influences the distribution of contaminants between the aqueous phase and the particulate matter. Adsorption also effects the reactivity of surfaces, the electrostatic properties of suspended

particles, and has a pronounced effect on the speciation of aquatic contaminants (Stumm, 1992).

The pH of the medium in question (soil or water solution) does have a noticeable affect on adsorption. When pH values are low there tends to be almost no adsorption of trace metals onto oxides, hydroxides, or charged particles, and at higher pH values all cations are strongly adsorbed (Kerndorff & Schnitzer, 1980; Drever, 1988). In the case of mercury however, studies by Kerndorff & Schnitzer (1980) found that mercury was removed very effectively at all pH values from 2.4 to >5.8. It is believed that the hydration shell of the M^{2+} cation prevents adsorption (Drever, 1988), and because mercury loses its hydration shell readily it will adsorb to particles over a wider pH range than compared to other cations.

Once inorganic mercury is adsorbed to lake bottom sediments, desorption of mercury appears to be negligible (Ramamoorthy & Rust, 1976). In a study conducted by Ramamoorthy and Rust (1976) on river sediments, they found that desorption of mercury was less than 1%. However, increasing the amount of dissolved oxygen appears to increase the ammount of Hg^{+2} in solution. Mercury is strongly associated with sulfides in soils, and increasing the dissolved oxygen content will decrease the sulfides (Stumm & Morgan, 1982). This fact has major implications on mercury cycling in aquatic environments. Dredging of river and harbor sediments in areas of high mercury sediment concentrations will remobilize mercury back into solution.

Hydrous oxides of Mn and Fe provide the principal control on the fixation of metals in soils and freshwater sediments (Vuceta & Morgan, 1978). These oxides are present as surface coatings on the major solid phases like $SiO_{2(s)}$. It has been found that

mercury adsorbs more strongly on $Fe(OH)_{3(s)}$ than on $SiO_{2(s)}$ or $MnO_{2(s)}$ (Vuceta & Morgan, 1978) Mercury and iron-oxides have a large affinity for each other probability because, like mercury, iron (Fe^{2+}) is adsorbed over the whole pH spectrum of natural waters (Stumm, 1982).

III: METHODS

3.1 Sampling

3.1.1 - Sample Locations:

In this study, a total of sixteen sediment cores were used to generate the data sets found in the appendix, five were collected from Lake Superior, six from Lake Michigan, and five from Lake Ontario. The research vessels *Lake Guardian* (USEPA) and *Seward Johnson* provided the access for the sediment core sampling. All of these cores were collected in the deep depositional basins of the lakes. Table 6 gives the specific site locations and sampling dates.

The deep depositional basins of the Great Lakes are active areas of sedimentation, and were chosen for sample coring based primarily on this fact. Because of the depths of these basins, sometimes reaching over 250 m, collection of relatively undisturbed sediment was conducted with a large stainless steel box coring device which measured 30cm x 30cm x 70cm, and was lowered by a cable connected to an "A frame" base on the back of the ship to provide stability to the box core when lowering it to the lake bottom and on retrieving it fully loaded. Upon retrieval from the lake bottom, the box core will contain about one meter of sediment; the sediment boundary layer with "fluff" material, and about 10 cm of the water found just above the sediment surface at the lake bottom. The term "fluff" refers to the suspended material at the sediment water

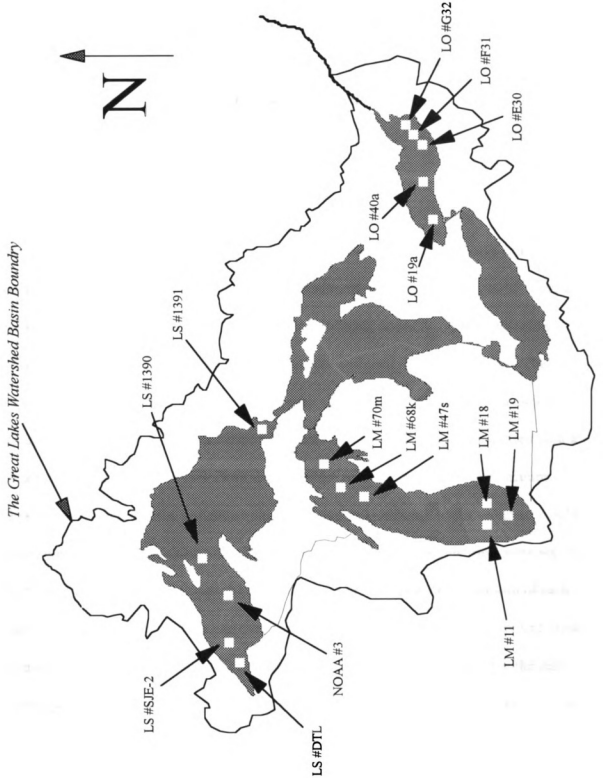


Figure 18. Sampling site locations

interface. Most of the mercury accumulation should be found in the first several centimeters of sediment. To prevent any compacting or loss of critically important "fluff" material, retrieval of boundary layer water within the box core is required. Using a large box core is the most efficient way to collect large amounts of undisturbed lake sediment (Smith & Loring, 1981).

3.1.2 - Sediment Coring and Sub-coring:

A large amount of sediment was collected at each site. Five subcores were extracted from the boxcore to provide enough sediment for complete analysis of, organic contaminants, trace metals, lead-210 dating, and sediment porosity. In the sub-coring process, 8 cm PVC tubes were used to retrieve the sediment from the box core. The sample tubes were place 5 cm from the box core walls to avoid the disturbed sediment found in this region caused by the coring process. The PVC tubes were then fitted with a small vacuum attachment which fit on the top of the tube like a stopper. The vacuum attachment operated under a slight negative pressure so insertion into the sediment would not compact or smear the along the sides of the tube. Once all five sub-cores were set, the bottom of the box core was opened and rubber stoppers were put on the bottom of each core. The top of each sub-core was then fitted with a polyethylene cover to prevent cross-contamination of sediment and air borne contamination. All people involved in the sub coring process wore latex lab gloves to further prevent any contamination of the sediment. The sub-cores were then carefully removed one by one, and immediately transferred from the ship's deck to the on-board lab for sectioning.

3.1.3 - Sediment Sectioning:

All of the sediment cores were sectioned into centimeter increments. Because concentrations in the first few centimeters determine the accumulation rates for that site, sectioning was done with extreme care to insure that the fluff and wet unconsolidated sediments are not mixed or disturbed. Material in the first 5 cm was sectioned in 0.5 cm increments.

The sediment cores that have not been sectioned in 0.5 cm increments include sites LS1383 and LS1391 in Lake Superior. These two cores were sectioned by a previous study at 1 cm increments. This sectioning might have homogenized too much top sediment, resulting in a sediment core profile which does not show any decrease to recent times. Because the sediment core descriptions of this cores describe a "fluff layer" at the top, erosion does not seem likely to have caused this feature.

The majority of the cores were sectioned into 1.0 and 2.0 cm increments, with the larger increments occurring toward the bottom of the core. All of the cores were sectioned under air, and no noticeable contamination occurred during the on-ship sectioning. Tools used for the sectioning were all polyethylene. At no time during the process were any metal objects used on the sediment, or in the immediate region of the sectioning area. This precaution was to prevent introduction of metals to the sediment which would increase the method errors and lead to overestimates of the actual concentration values.

Hydraulic extrusion was the method used to section the sediment cores in this study. The double-stoppered tubes were then placed upon the extruder. This prevented

introduction of water to the bottom of the core. The extruder forces sediment up the core tube from the water pressure and allows accurate measurements of the sections. Once measured to the precise increment a Teflon spatula was used to scrape away any sediment smearing which might have occurred along the tube walls. The increments were then described in a field book noting any physical features such as color banding, color change, grain size, texture, presence of redox horizons, Fe & Mn oxide layers, foreign objects of any kind (carbon, wood, large grains), and biota (worms). Core descriptions were used to evaluate any depositional features found in the sediment profiles. The sampled increments were placed into individual 60 ml polyethylene bottles that were acid washed and rinsed with doubly distilled water (DDW). After all samples were placed into the polyethylene bottles, they placed in dark room storage at 4° C.

3.2 - Digestion and Chemical Extraction

3.2.1 - Sample Preparation:

All of the samples were frozen until ready for analysis. Cores were digested one at a time. After the core had thawed, a Teflon stirrer was used to homogenize the sediment. This mixing step is necessary to make sure that any representative sample taken out of the bottle is a true representative of that interval, because only a small amount of sediment is used for analysis. The rest of the sediment remaining is frozen again until it is needed for QAQC checks.

After homogenization approximately 5 g of wet sediment are weighed out on acid cleaned watch-glasses, and placed into a convection oven for 24 hours at 50°C. The

convection oven completely dry the sediment. Organic particles are burned off during this step. Once all of the watch-glasses are removed from the oven they are ground into a very fine power by the use of a mortar and pestle. Between sample grindings the mortar and pestle are rinsed thoroughly with DDW to prevent any cross contamination of the sediment. The resulting power is weighed to exactly 0.500 g per sample, and is then placed into 100 ml polyethylene reaction vessels for sediment digestion.

A CEM MDS-81D microwave with pressure regulation was used for sediment digestion. The digestion program consisted of using 12 reaction vessels at a time (11 samples and 1 blank), and running the microwave for 15 min. (100% power) at a pressure regulated to a 150 psig maximum. During the digestion, the reaction vessel tray is slowly turned by the microwave to achieve even heating of the vessels. A 20 min. (0% power) cool down is used after the heating to allow the pressure to fall below 10 psig before opening the door. This method of sediment digestion dramatically speeds up the process because of the reaction vessels being completely sealed to the outside air. The possibility for external contamination is greatly lessened or even eliminated altogether (Hewitt & Reynolds, 1990).

Wet digestion of sediment for mercury using concentrated HNO_3 recovers up to 100% of the bound inorganic mercury (Hewitt & Reynolds, 1990). The purpose of the digestion step is to liberate the trace metals (mercury) from the sediment into an aqueous phase which is called the sample leachate. Ten milliliters of ultrapure nitric acid (HNO_3 ,15M) is used as the chemical leaching agent. The concentrated HNO_3 will react with the power in the reaction vessel to effectively strip off the strongly bound mercury from the

sediment. This acidification of the leachate sample to pH values ≤ 1 will prevent the loss of mercury by adsorption onto the container walls (Cragin, 1979). To prevent additional loss of mercury by reduction ($Hg^{2+} \rightarrow Hg^{0}$) and volatilization, 100 ul of a gold chloride solution ($AgCl_2$) will be added for every 10 ml of mercury leachate (Moody et al., 1978). Stabilization of Hg^{2+} is very important because Hg^{0} vapor diffuses easily through polyethylene containers (Haydom & Damsgaard, 1982). Acidification of the mercury leachate is also very important to prevent the oxidation of Hg^{2+} ($Hg^{2+} + Hg \rightarrow Hg_2^{2+}$: +12 kj/mole).

3.2.3 - Analytical Procedures:

After sediment digestion, 10 ml of leachate was diluted with 90 ml of DDW. No significant adsorption or leaching of ultra trace elements, including mercury, takes place in most dilute aqueous solutions (Heydorn & Damsgaard, 1982). Once all the samples were diluted, the leachate was mixed with the sediment remaining in the vessel to produce a homogenized liquid. Homogenization is a very important step because mercury is measured at the ppb level. Complete mixing of the sample is necessary to furnish a representative sample.

Analytical preparation consisted of filtering the sediment / leachate mixture. The leachate was filtered through acid cleaned, and DDW soaked, 0.45 um Nucleopore membrane filters into two 60 ml sample bottles. The filtered samples were then stored in a 4° C dark cold room until analysis. Cold storage of mercury samples is the best way to prevent mercury vapor contamination (Heydorn & Damsgaard, 1982).

Leachate samples were analyzed for total mercury by hydride-reduction / cold vapor flow injection, using a Perkin Elmer 5100pc spectrophotometer with a FIAS 200 gold foil amalgamation system. Standard and solutions used during the analysis (appendix 4C) were prepared in acid-washed and DDW rinsed 100 ml borax glass flasks. The program for Hg analysis used in this study is also given in the appendix. As a further precaution against mercury vapor contamination, solution preparation was done in a class 100 biohazard fume hood. Sterile latex lab gloves were worn by all personal in the lab during sample preparation and analysis. At no time were metal based objects used for any of the analytical steps in the lab.

All items used in this study were cleaned by suggested EPA methods. A Corning water still (model AG-22) was used in the manufacture of DDW. After use, bottles, flacks, syringes, ect., were rinsed four times in DDW and then placed in a 10% HCL acid bath for 24 hours. Acid cleaned materials were again rinsed in DDW to remove any residue left from the bath, and then dried in a polyethylene container inside a laminar flow class 100 hood. Acid baths were changed with fresh acid and cleaned every two weeks. The drying time varied from one to two days, and once completely dried, the items were then sealed inside pre-acid cleaned and DDW rinsed plastic bags. Sample bags were sealed with tape and placed in lined clean drawers until needed.

3.2.4 - Lead-210 Dating Methods:

Lead-210 concentrations used in this study were supplied by Dan Engstrom at The University of Minnesota. Two dating methods were used to calculate the sedimentation

rates for the sample sites. The first method is called "cf:cs" or "constant flux:constant sedimentation" and assumes that the sedimentation rate at a specific site is constant with time. The cf:cs dating method provided information for the creation of graphs of log unsupported (excess) Pb-210 activity vs. cumulative dry mass. In an ideal situation the line , which is fitted to the data points, is linear. The slope of this fitted line then becomes the mean sedimentation rate. The second method is known as the "crs" or "constant rate of supply", and assumes that the supply of lead-210 to the site is constant but the sedimentation rate changes. Because this method incorporates a changing sedimentation rate, it is determined as the slope between any two adjacent points. Thus the sedimentation rate is different for every increment. Ideally, the two methods provide similar results.

Extensive use of both dating methods by Steve Eisenreich and co-workers (1982,1989,1990,1992a,1992b,1995), reveal that for organic compound such as PCBs and DDTs that the "crs" model seemed to be taking variations in the data which were probably due to analytical errors and implying that the variations were real and use only the "cf:cs" dating in their organics research. However, checking the validity of the two methods is necessary to determine which one to use, and is done by comparison of the chemical profiles data to the estimated dates to see if peaks in the profiles align to where they are expected. For organic chemicals this is very easily done because there is no natural background level of PCBs or DDTs in the sediments, only anthropogenic levels. If the date of maximum production and use of these chemicals (PCB $\approx$ 1970 and DDT $\approx$ 1960) are known , then matching the expected dates to the two dating methods should give one method which more closely approximates the known production date. For Lake

Michigan and Ontario, the organics (PCB & DDT) data suggests that the "cf:cs" model corresponded with the expected PCB and DDT profiles. This study also found that the trace metals As, Cd, Pb, and Hg profiles were more closely matched to the "cf:cs" model. For Lake Superior the variable "crs" model was found to be the best model for the trace metals.

3.2.5 - Quality Assurance & Quality Control:

The complete quality control data set for the trace metals: arsenic, cadmium, lead, and mercury are presented in the appendix. The accepted level of uncertainty for all mercury inventory and accumulation data is 20%. All of the samples in this study are within the projects tolerance limits.

The uncertainty will be calculated from lab duplicates and sample re-analysis which should be representative of overall measurement uncertainty. Several procedural blanks are included for every sediment core analyzed to monitor any cross contamination. Method precision will be monitored by the analysis of 5% of the sediment samples split into two equal fractions after homogenization and each analyzed as a separate sample. Accuracy is defined as the absolute uncertainty about the true value. Accuracy for this study will be evaluated by total mercury recovery from NIST standard reference sediments (NIST Buffalo river sediment #2704). Instrument precision will be defined by the method detection limit (MDL), which is the minimum concentration above which you have confidence the analyte was present or not.

The MDL was be determined at 3 standard deviations around the mean

$$MDL = 3\sigma \quad (5)$$

IV: RESULTS

4.1 Sediment Core Profiles

4.1.1 - Sediment Profile Methodology:

Because trace metals such as arsenic, cadmium, lead, and mercury have "natural" or background levels in the sediment, the evaluation of anthropogenic accumulation is readily evaluated by sediment core profiles of mercury. Sediment cores provide information on the past 150 years of deposition within each basin. Sixteen sediment cores were studied from Lakes Superior, Michigan, and Ontario. The sediment core concentration data in addition to numerical dates can be compared with the production of a major pollutant source such as the production of mercury based paints. These two profiles can then be superimposed along with other major source functions to give a picture on which anthropogenic source is contributing to the accumulation of mercury.

The profiles presented in this chapter will show accumulation trends, peak concentration , onset of contamination, background depth, and any diagentic features or redox zones. There will be a point at a specific depth when the concentration profile becomes constant with depth. This point defines the boundary between the natural and anthropogenic concentration values. Anthropogenic activity can be readily evaluated by knowing background concentrations of mercury. The data will show that for most cores

the onset of anthropogenic contamination occurs in the mid to late 1800's. Because this time corresponds with industrial growth in the lower Great Lakes basin, the background concentrations of mercury found in the cores can be considered pre-industrial sediment concentrations

4.1.2 - Lake Superior Profiles:

The concentrations of mercury in Lake Superior exhibited elevated background concentrations relative to Lakes Michigan and Ontario (Figures 19-25). The highest background levels were found in the western basins of Duluth, Chefswet and Isle Royale. In these basins background values were mostly in the range of 40-45 ng/g Hg. However, site LS-DTL in the Duluth basin had a background concentration which averaged at 75 ng/g Hg. Site LS-1391 in the far south-eastern Isle Parisienne Basin had background concentrations as low as 15 ng/g Hg. This low value can be attributed to the younger Paleozoic rocks of the Michigan Basin that underlay the Isle Parisienne basin. Variations in regional geology may be a factor contributing to the higher background concentrations in certain basins of Lake Superior. The western, central, and most of the eastern part of Lake Superior is underlain by the Canadian Shield, that consists of Precambrian and Cambrian rocks which include, slate, greywackes, mercury rich shales, granites, iron formations, pegmatites, basalts and gabbros. The rocks of the Canadian Shield commonly have elevated concentrations of mercury containing minerals (Long, Eisenreich, & Swackhammer, 1995). Some shales and graywackes have mercury concentration as high as 450 ng/g and 110 ng/g respectively (Nriagu, 1984). Regional outcroppings of these

mercury rich rocks can lead to localized "hot spots" of sediment concentrations and abnormally high background values.

The Duluth basin of western Lake Superior exhibited the highest sediment concentrations (Figure 19). Site LS-DTL is the closest of all sites to the city of Duluth, MN, and was characterized by a peak concentration of 680 ng/g Hg in 1956 and surfical sediment concentrations of 168 ng/g Hg (Figure 21). The peak concentration value at this site is very high relative to other cores. This high concentration could possibly be related to anthropogenic emissions of numerous paper mills and factories that were in operation in the Duluth area 40 to 50 years ago. Site LS-SJE-II is also located in the Duluth basin, however, its further offshore than LS-DTL. This greater distance from Duluth could explain the lower surficial concentration of 110 ng/g Hg at site LS-DTL.

The remainder of the Lake Superior cores sampled ranged from 160 ng/g Hg in the west to 88 ng/g Hg in the east. The onset of anthropogenic mercury input for the Duluth basin began around 1880 to 1890, and the most rapid increase in concentrations occurred from 1880 to 1960. Since 1960 mercury concentrations have been decreasing from their maximum concentrations. Sites LS-1390 and LS-1391 do not exhibit decreases to present times. The explanation for the lack of a decreasing trend could be due to resent erosion of these surfaces by strong bottom currents.

4.1.3 - Lake Michigan Profiles:

The geological setting of Lake Michigan differs greatly from that of Lake Superior and is underlain by the Michigan Basin sediments of Paleozoic age. The rocks of the

which are more likely to have a lower natural mercury content than the granitic Canadian shield rocks found under Lake Superior. The background concentrations of mercury in Lake Michigan (Figures 26-33) appear to be similar among the six sites within the northern and southern basins. This study estimated an average background value for the entire lake to be 26.6 ng/g Hg. The estimated background value is in good agreement with the concentrations of soils in the Great Lakes basin. The average background concentration for various sites in the Great Lakes average around 30 ng/g Hg (Conner & Shacklette, 1975).

The highest surfical concentrations in Lake Michigan sediments occurred at site LM-68k (212 ng/g) in the Algoma basin which lies directly across from the Green Bay inlet. The other two northern Lake Michigan sites had surfical concentrations of 130 ng/g Hg, while the southern core site LM-18 had a surfical concentration of 192 ng/g Hg. Sites LM-11 and LM-19 showed slump features which might suggest that events have reworked the top half of the sediment and prevented useable concentration profiles. The onset of anthropogenic input of mercury occurred around 1825 for all of the Lake Michigan cores. The most rapid rate of concentration accumulation in Lake Michigan occurred from 1890 to 1970. Omitting the influence of Green Bay's pollution input into north-central Lake Michigan, cores in the northern basins showed a lower surfical concentration of mercury than the southern cores. All cores in Lake Michigan show a decrease in mercury input towards present times.

4.1.4 - Lake Ontario Profiles:

4.1.4 - Lake Ontario Profiles:

Lake Ontario lies at the southern most boundary of the Canadian Shield. The influence of the shield on background concentrations of mercury in Lake Ontario sediments, however, does not appear to be significant. The average lake-wide background value for mercury is estimated to be at 36.6 ng/g Hg, a value more like that of Lake Michigan which is totally outside of the shield (Figures 35-40).

Lake Ontario has three basins which are partially divided by sills of glacial material of similar character to inshore sediments of gravels, sands, silty sands, and silts. Basin accumulation of sediments over the past 11,600 years consist of fine grained clays and silty clays (Thomas, 1972). The bedrock which lies under Lake Ontario is mostly Paleozoic aged rocks of limestones, sandstones, and carbonates.

Relative to Lakes Superior and Michigan, Lake Ontario has surfical concentrations 2 to 8 times their values. Maximum anthropogenic concentrations of Lake Ontario range from 2220 ng/g Hg in the central basins to 3560 ng/g Hg in the far eastern Rochester basin. The onset of anthropogenic mercury introduction into Lake Ontario was 1840. Dramatic increases in concentration lasted from 1840 to 1940, with a large decrease in surfical concentrations up to the present day.

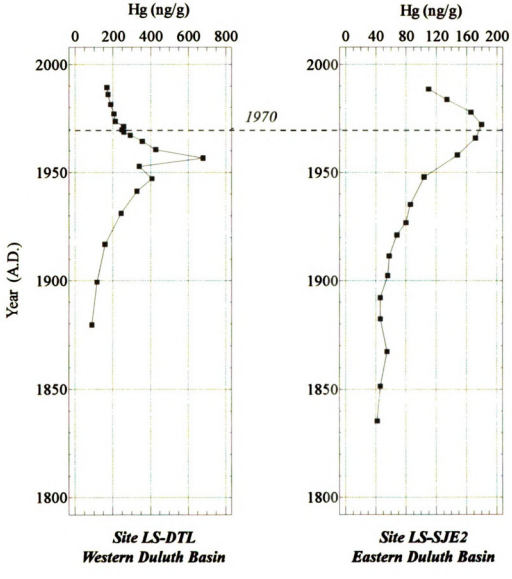


Figure 19. Mercury concentration profiles as a function of time in the Duluth Basin.

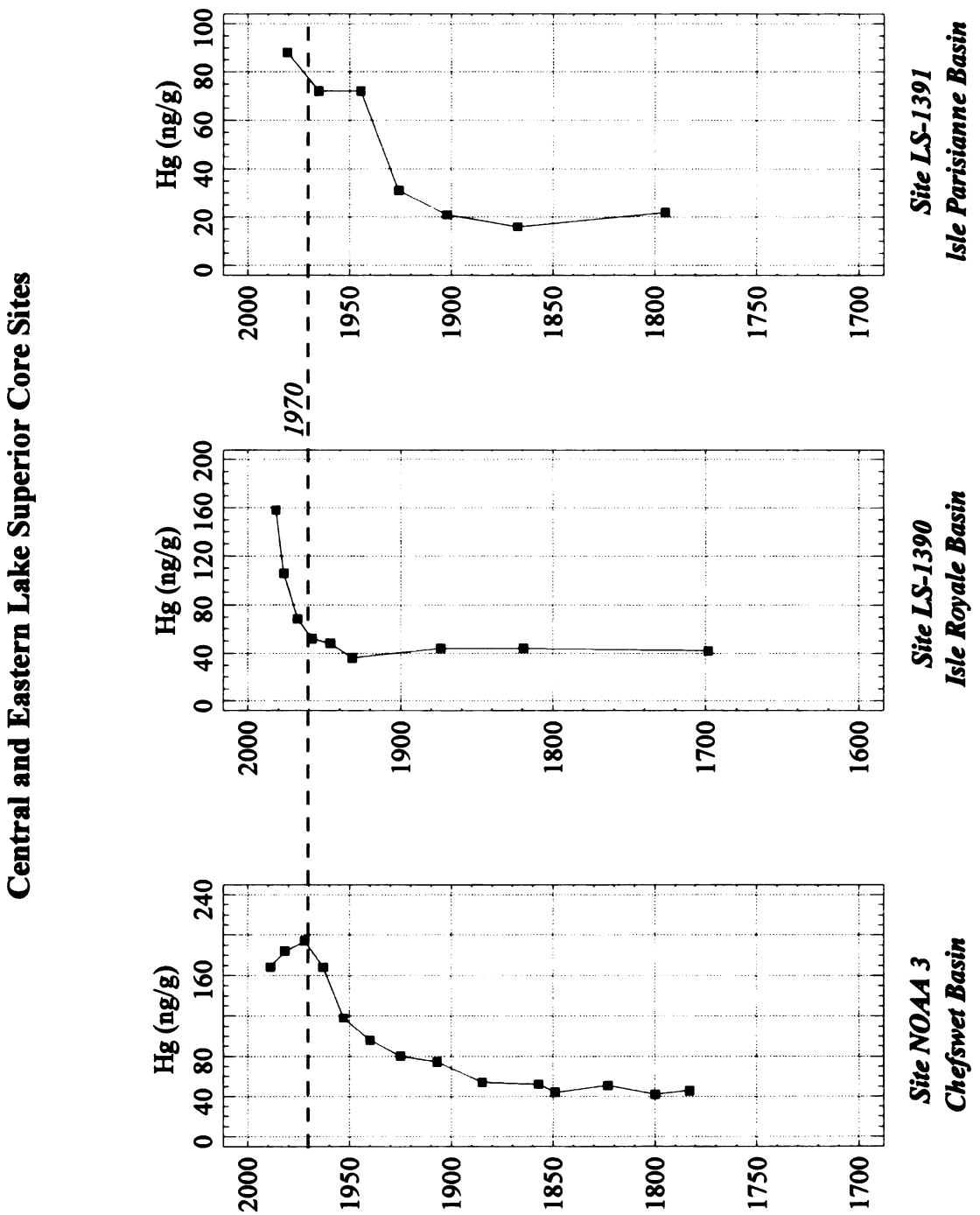


Figure 20. Mercury concentration profiles as a function of time in central and eastern Lake Superior.

Site LS DTL - Duluth Basin, Lake Superior

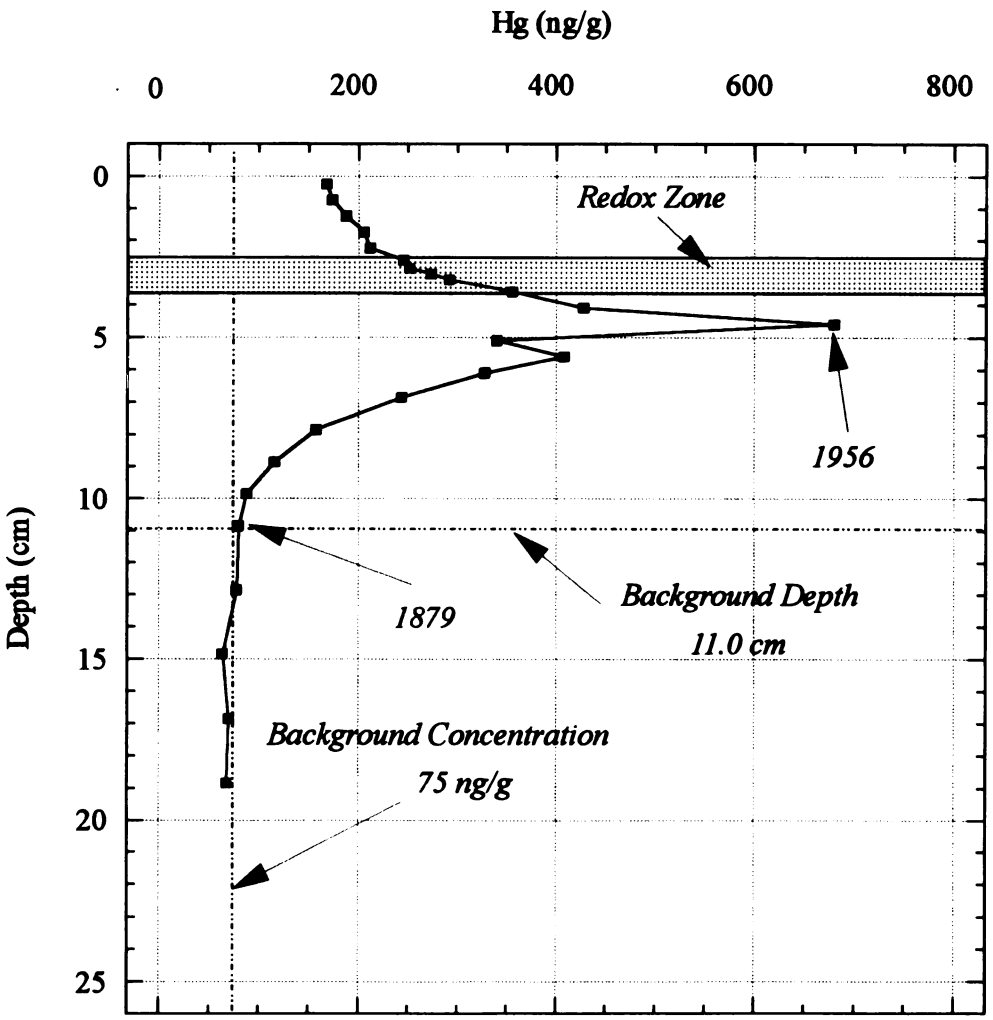


Figure 21. Mercury Concentration Profile as a function of depth at site LS DTL.

Site LS SJE2 - Duluth Basin, Lake Superior

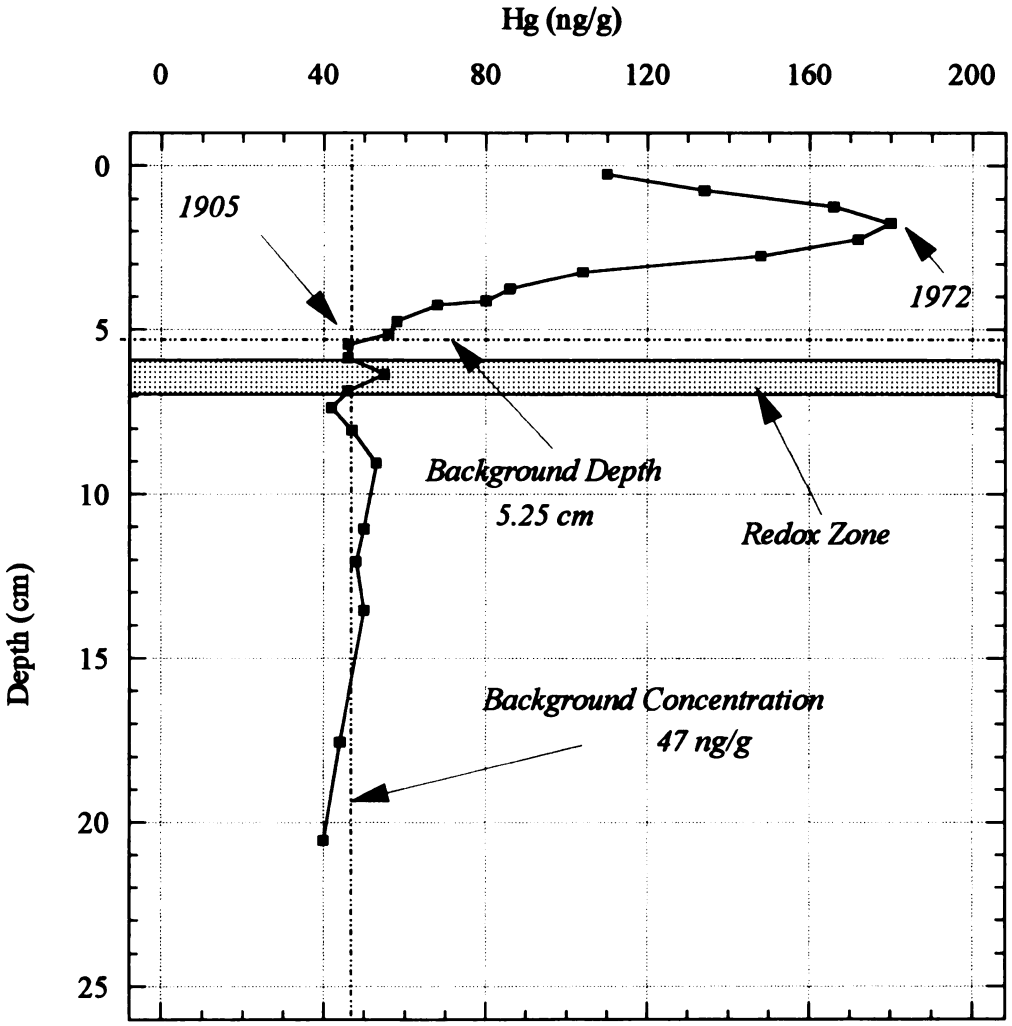


Figure 22. Mercury concentration profile as a function of depth at site LS SJE2.

Site NOAA 3 - Chefswet Basin, Lake Superior

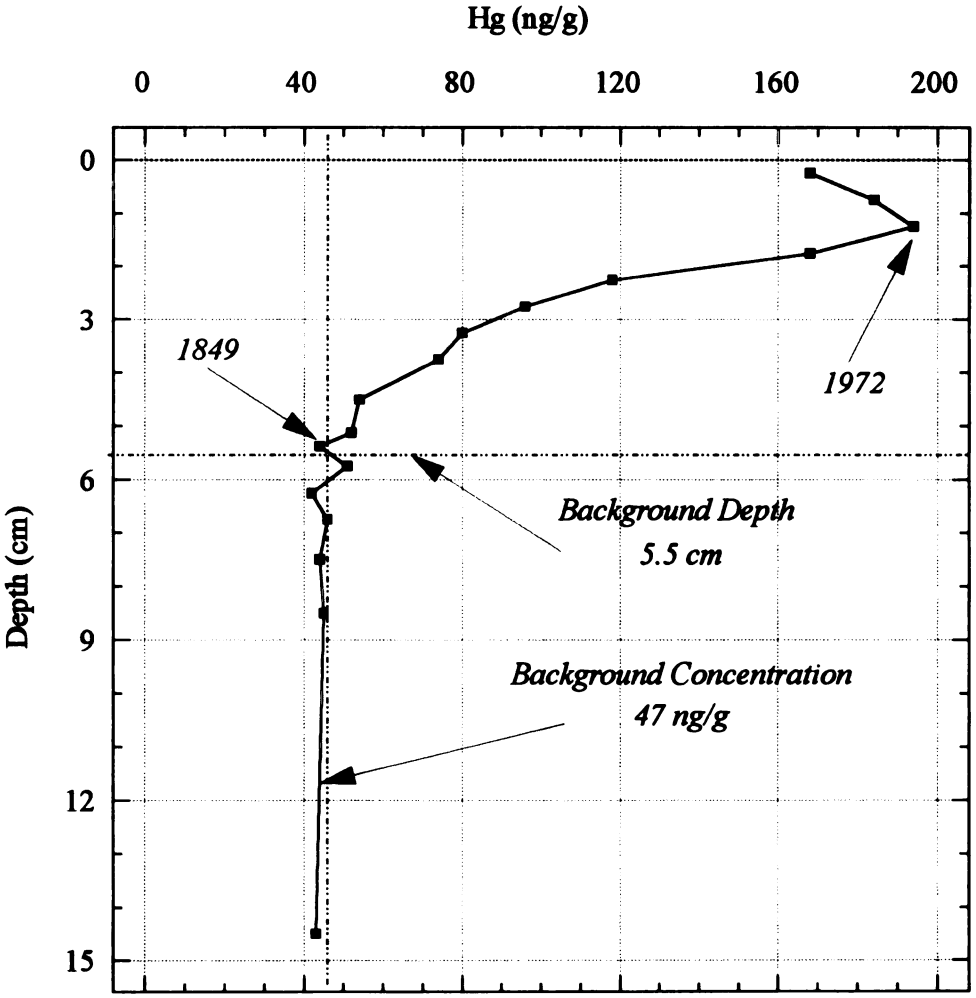


Figure 23. Mercury concentration profile as a function of depth at site NOAA 3.

Site LS 1390 - Isle Royale Basin, Lake Superior

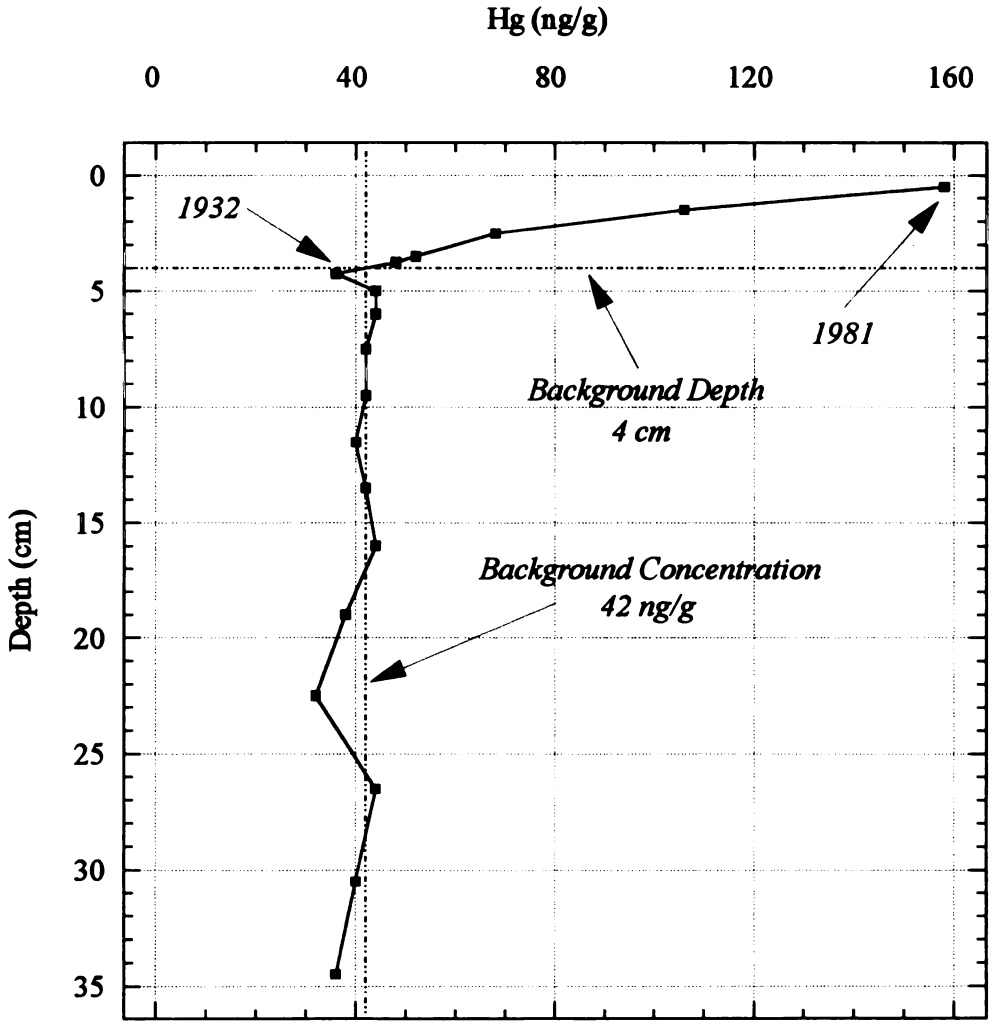


Figure 24. Mercury concentration profile as a function of depth at site LS 1390.

Site LS 1391 - Isle Parisianne Basin, Lake Superior

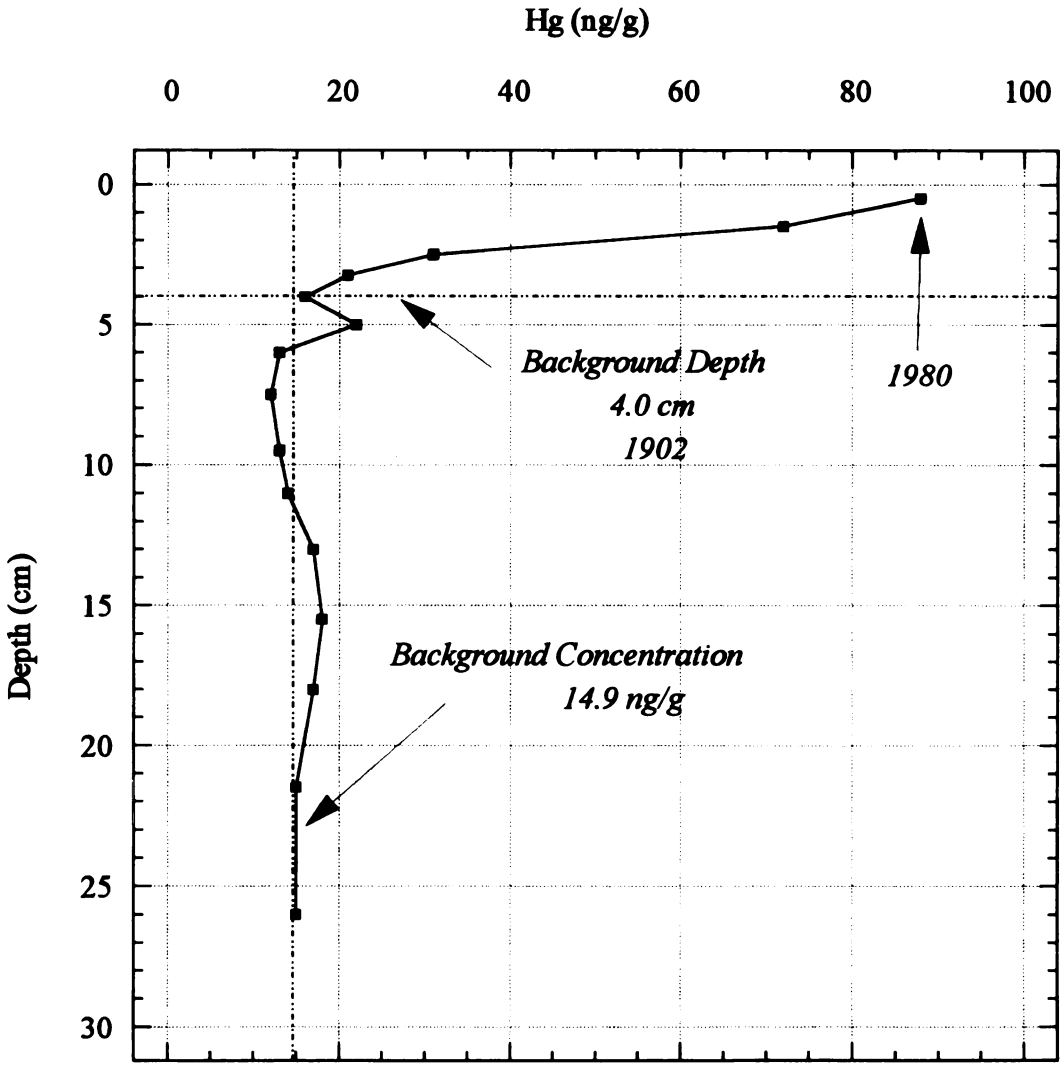


Figure 25. Mercury concentration profile as a function of depth at site LS 1391.

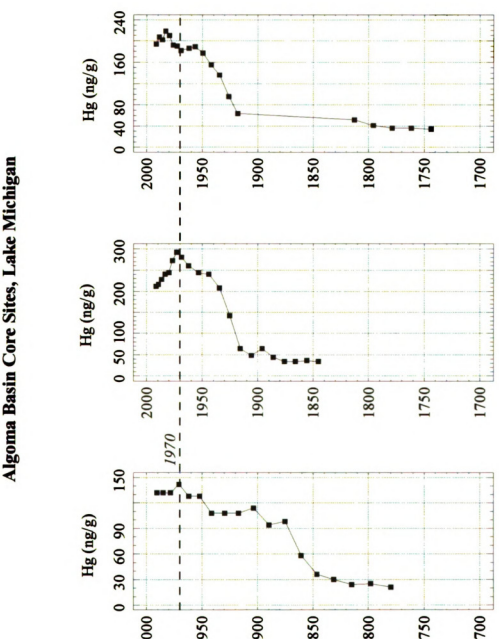


Figure 26. Mercury concentration profiles as a function of time in the Algoma Basin.

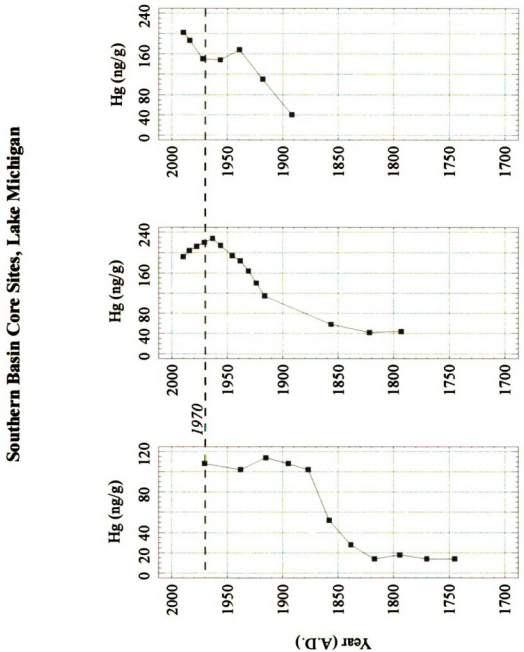


Figure 27. Mercury concentration profiles as a function of time in the Southern Basin.

Site LM 70m - Algoma Basin, Lake Michigan

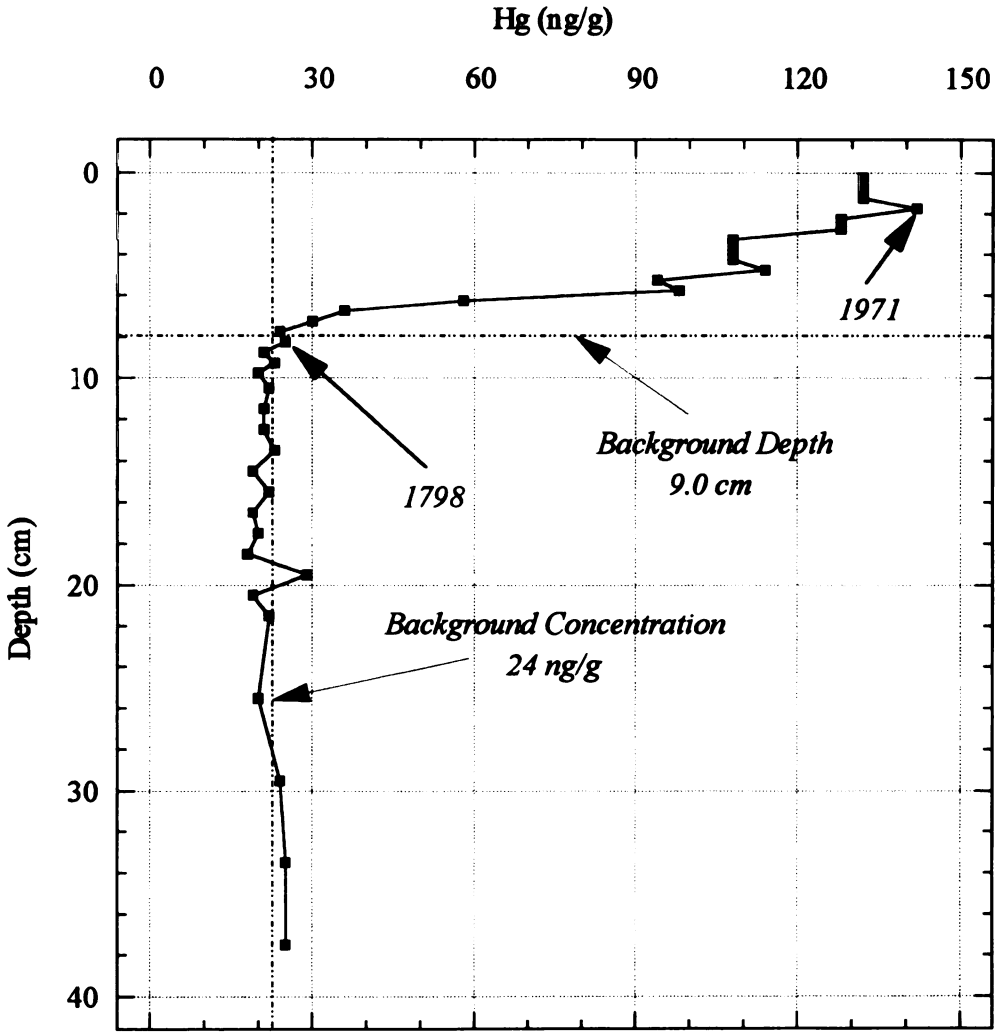


Figure 28. Mercury concentration profiles as a function of depth at site LM 70m.

Site LM 68k - Algoma Basin, Lake Michigan

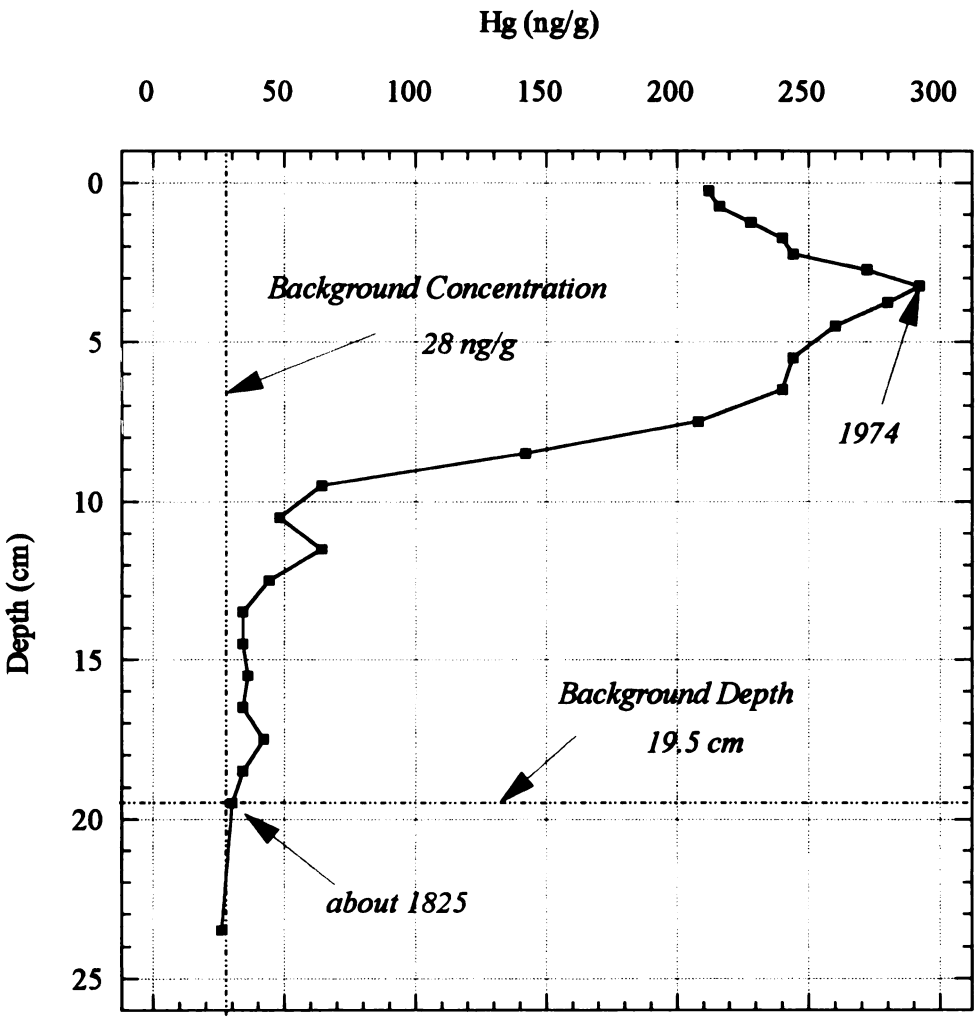


Figure 29. Mercury Concentration profile as a function of depth at site LM 68k.

Site LM 47s - Northern Algoma Basin, Lake Michigan

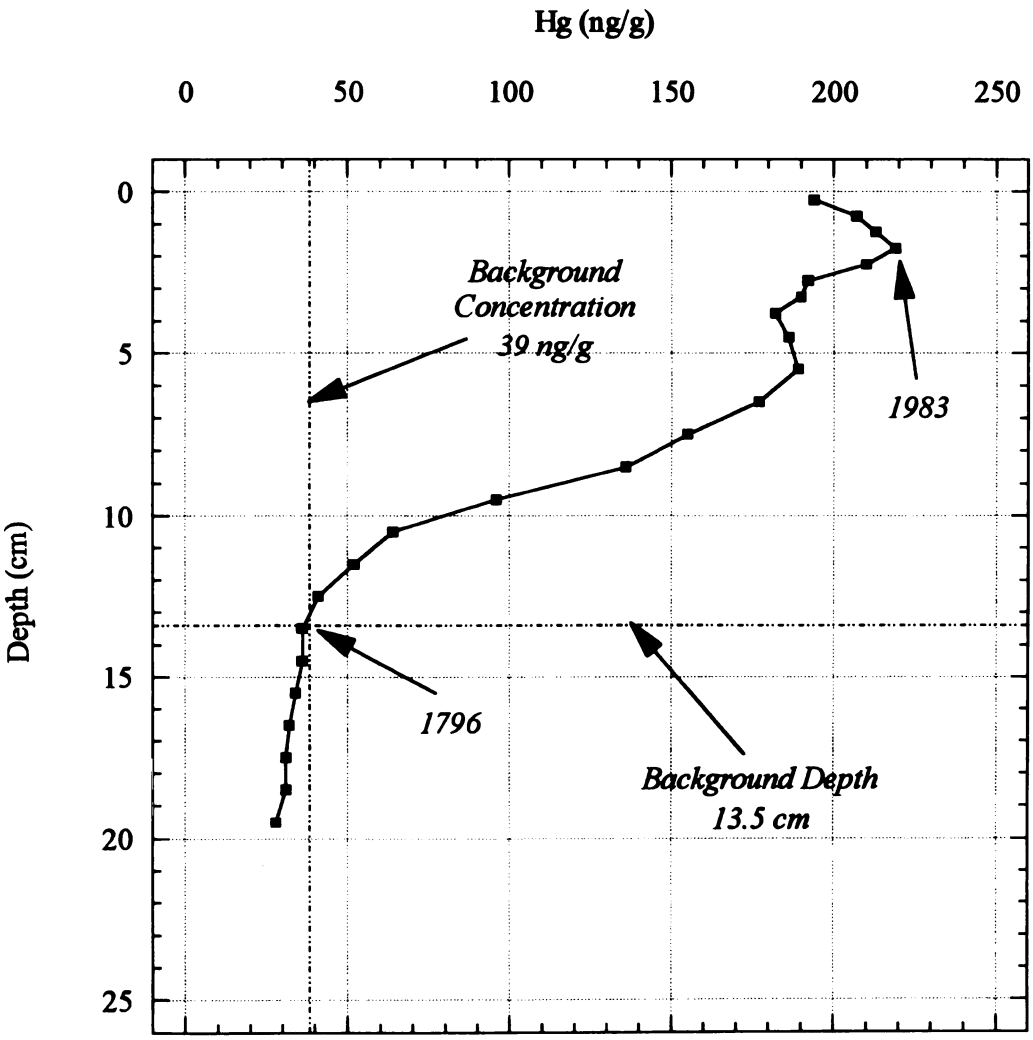


Figure 30. Mercury concentration profile as a function of depth at site LM 47s.

Site LM 11 **- Southern Basin, Lake Michigan**

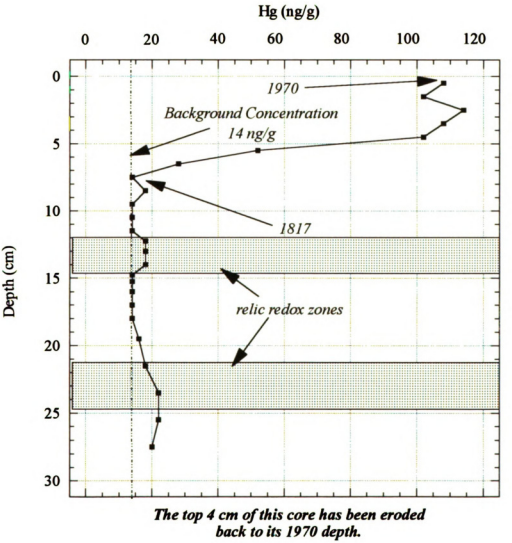


Figure 31. Mercury concentration profile as a function of depth at site LM 11.

Site LM 18 - Southern Basin, Lake Michigan

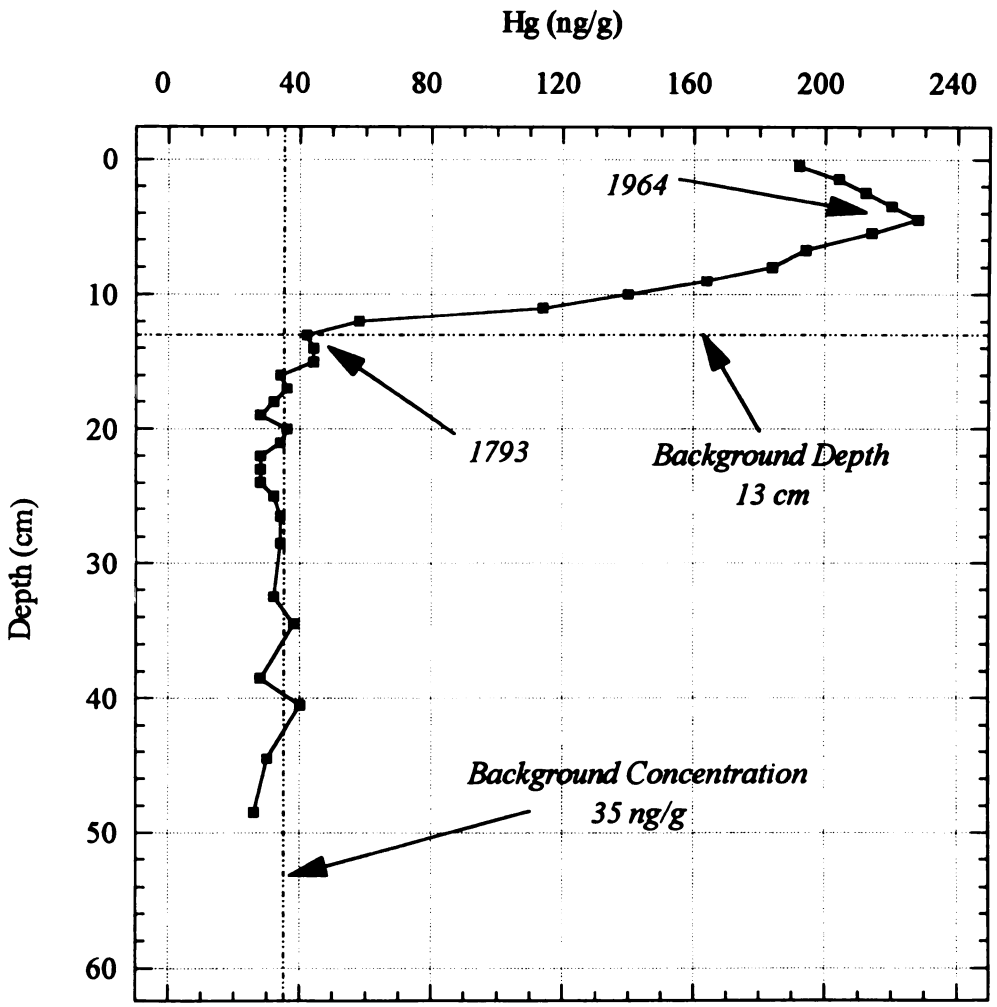


Figure 32. Mercury concentration profile as a function of depth at site LM 18.

Site LM 19 - Southern Basin, Lake Michigan

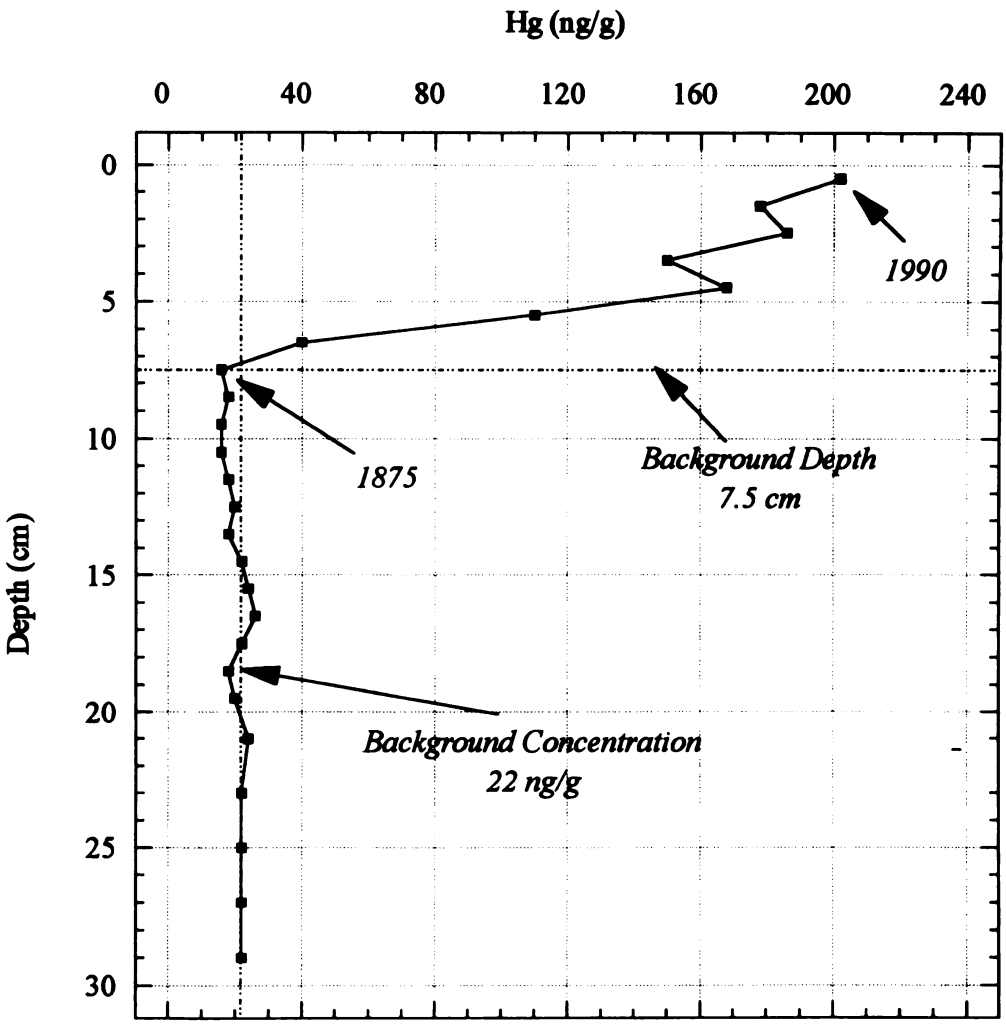


Figure 33. Mercury concentration profile as a function of depth at site LM 19.

Site LM 23 - Grand Haven Basin, Lake Michigan

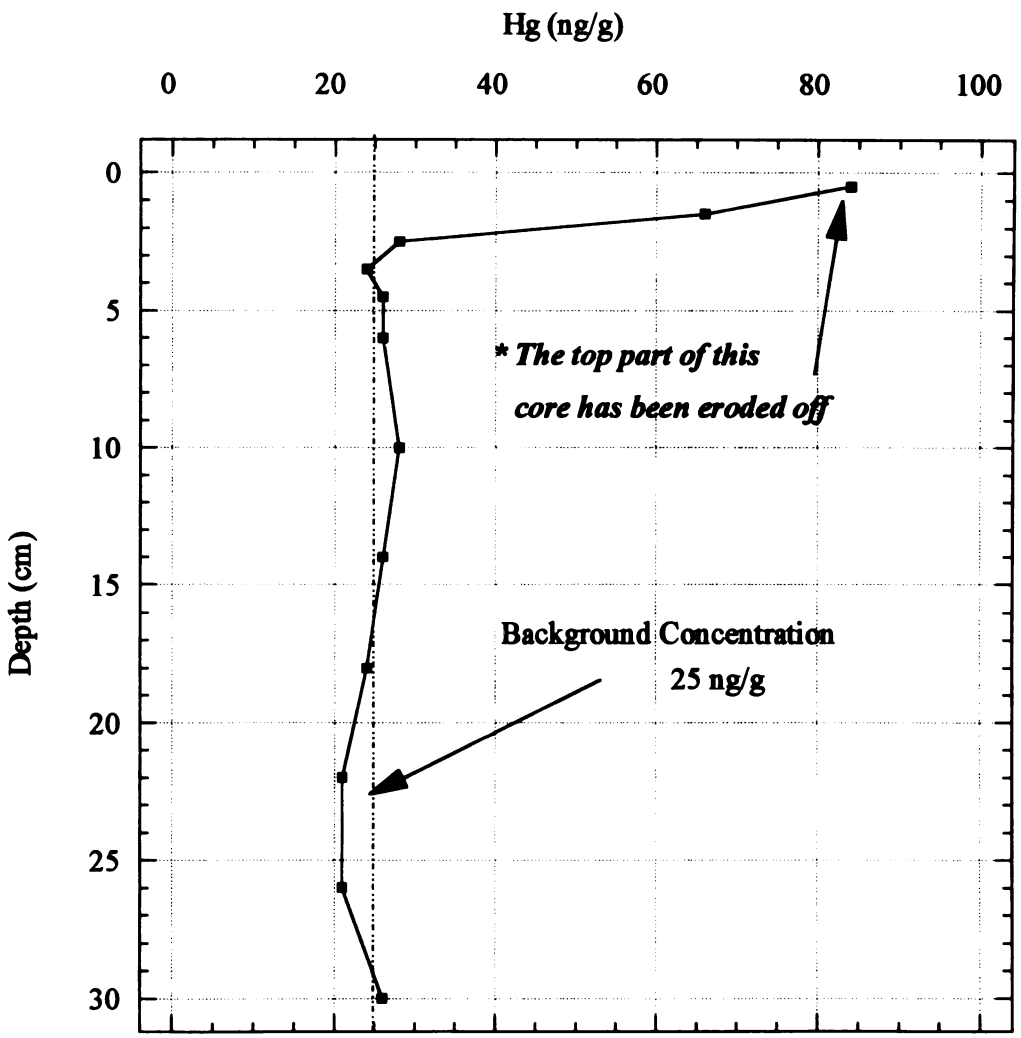


Figure 34. Mercury concentration profile as a function of depth at site LM 23 Grand Haven Basin, Lake Michigan.

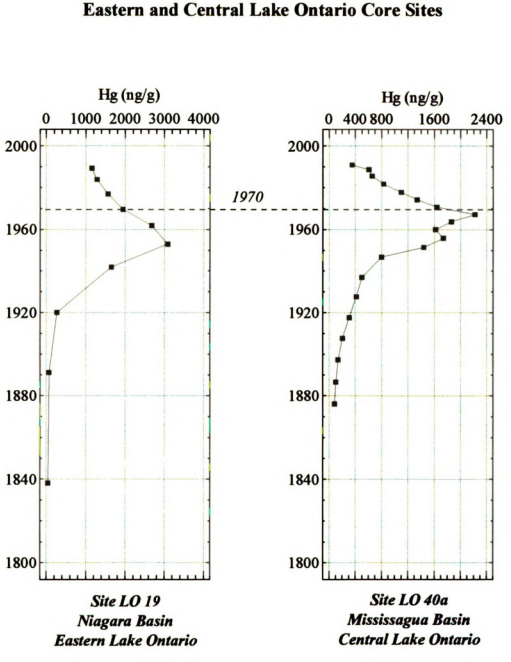


Figure 35. Mercury concentration profiles as a function of time in eastern and central Lake Ontario.

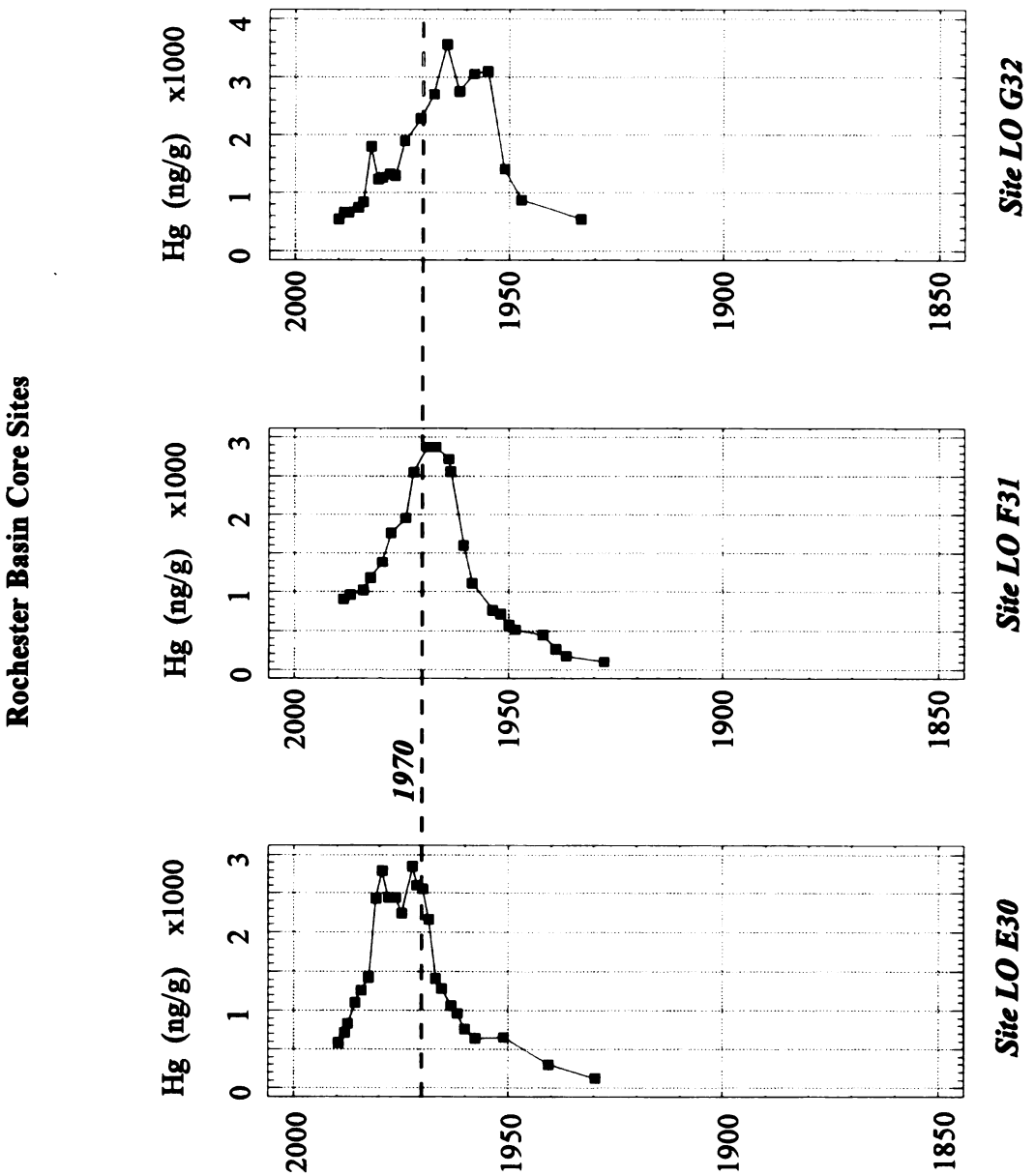


Figure 36. Mercury concentration profiles as a function of time in the Rochester Basin, Lake Ontario.

Site LO 19 - Mercury and Arsenic Comparison in a Redox Zone

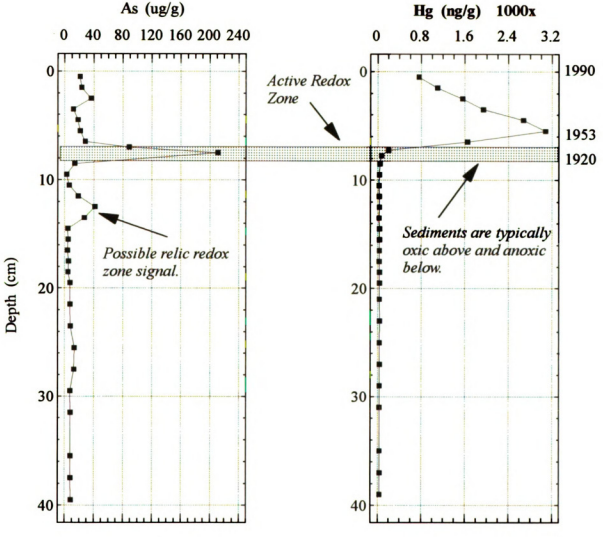


Figure 37. Representation of mercury stability with respect to arsenic in a core with a strong redox zone

Site LO #40a - Niagara Basin, Lake Ontario

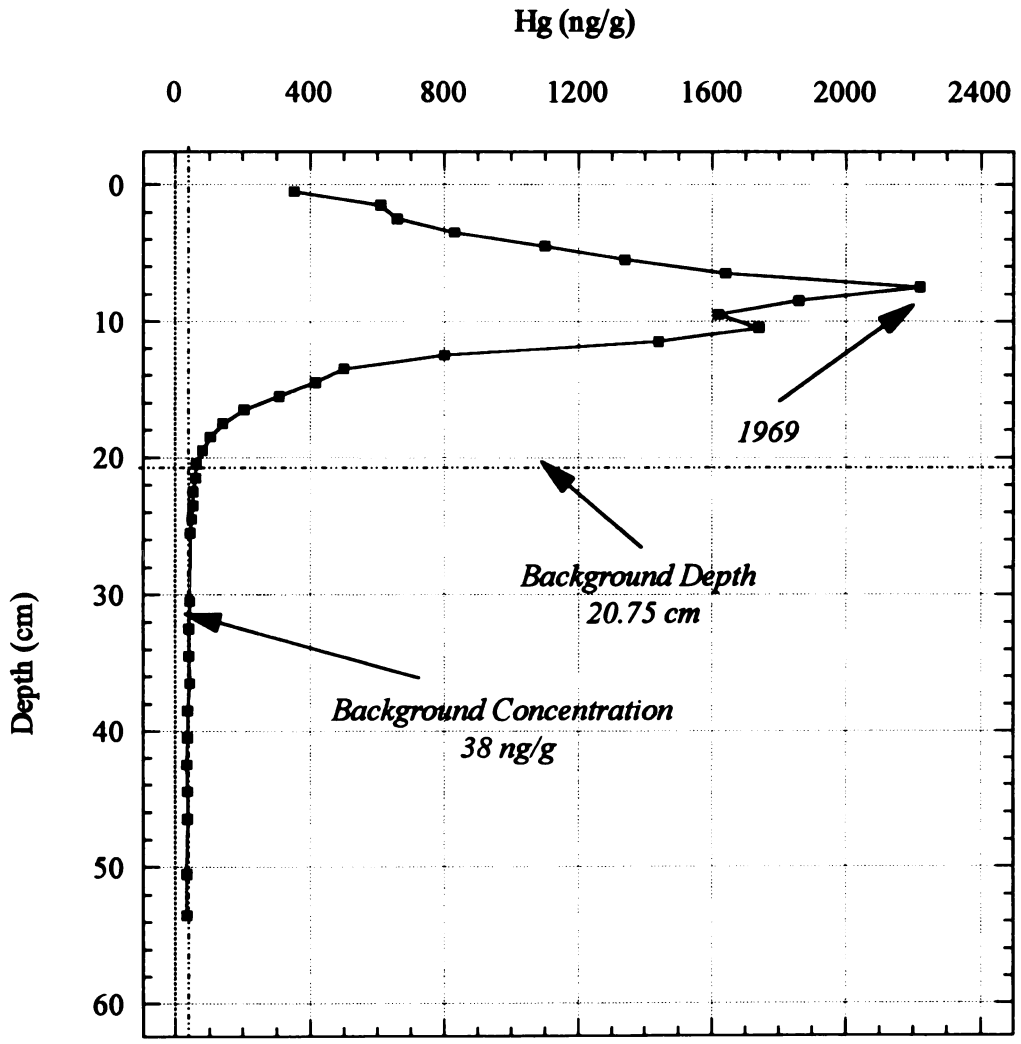


Figure 38. Mercury concentration as a function of depth at site LO 40a.

Site LO #E30 - Rochester Basin, Lake Ontario

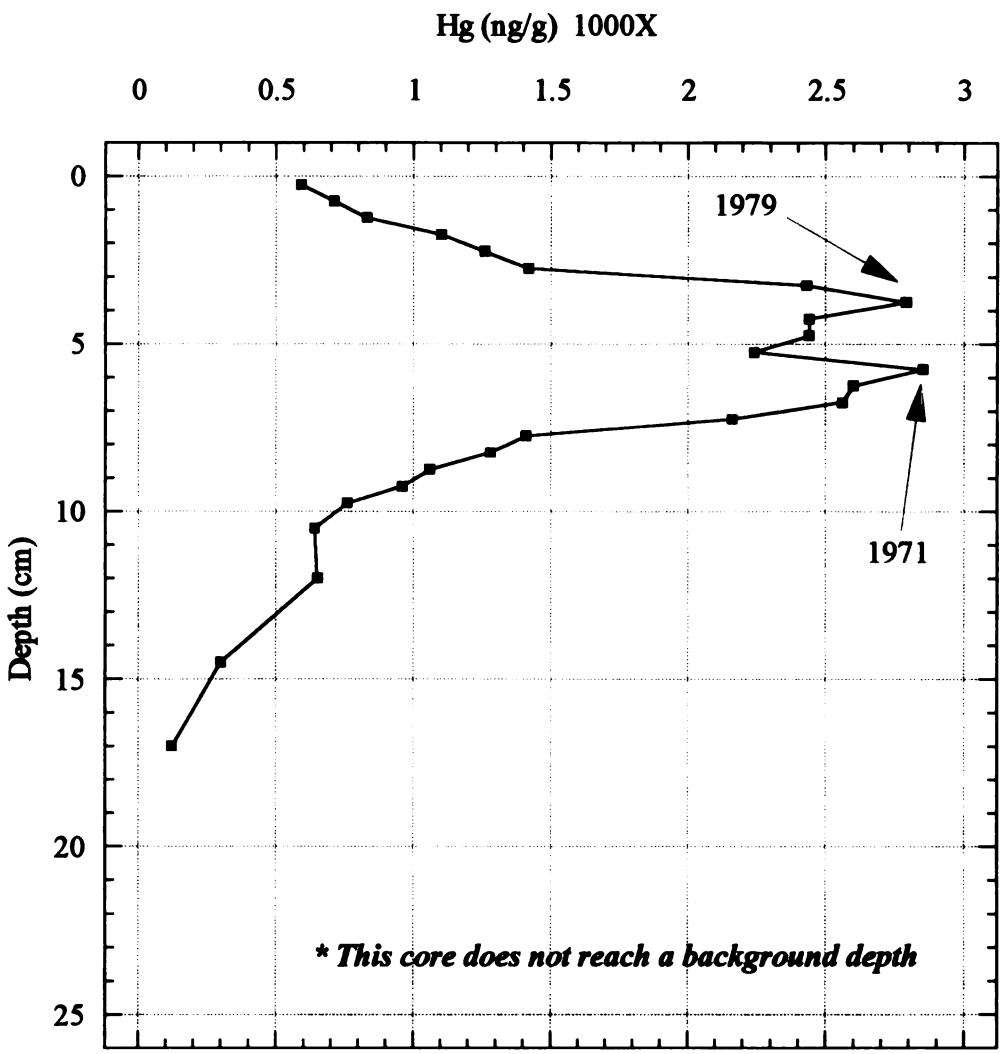


Figure 39. Mercury concentration profile vs. depth of site LO #E30.

Site LO #F31 - Rochester Basin, Lake Ontario

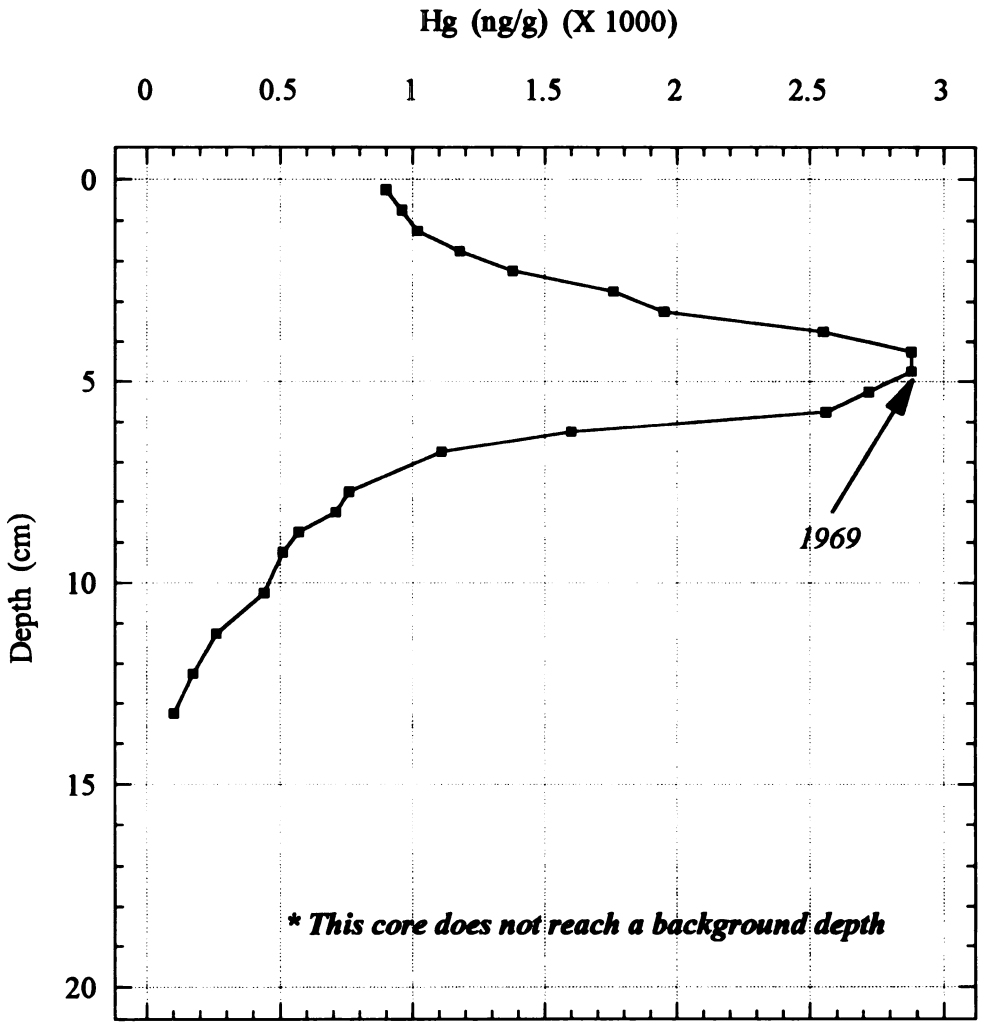


Figure 40. Mercury concentration profile as a function of depth at site LO F31.

Site LO #G32 - Rochester Basin, Lake Ontario

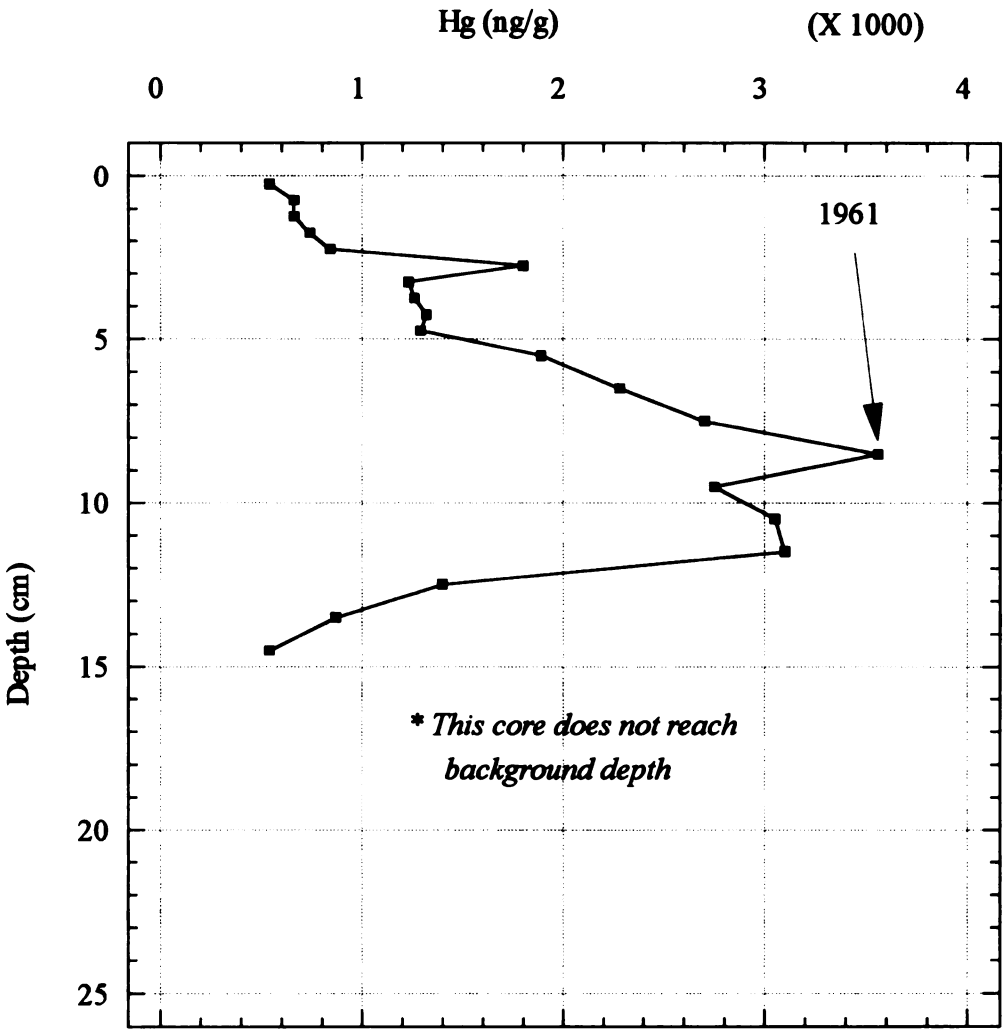


Figure 41. Mercury concentration vs. depth at site LO #G32.

V: DISCUSSION

5.1 - Sources of Mercury to the Great Lakes:

5.1.1 - Lake Ontario Area of Concerns:

Of the 43 areas of concerns (AOC) as identified by the EPA, 42 have major problems with sediment contaminated by toxic sediments. The 1987 amendments to the clean water act specified five areas (Ashtabula River, OH; Buffalo River, NY; Grand Calumet River, IN; Saginaw Bay, MI; and the Sheboygan Harbor, WI.) as requiring priority consideration. (EPA, 1995; CICEN, 1993).

Lake Ontario is home to 8 AOCs (Figure 42), with three rivers being major sources of mercury to the lake, these include: The Niagara River, The Genesse River, and the Oswego River. The Niagara River act as a major conduit for contamination transport originating from the Buffalo River AOC and points further west.

The Niagara River AOC - The Niagara River flows between the United States and Canada connecting Lake Erie to Lake Ontario. The river is 37 miles long and is the largest tributary input to Lake Ontario, providing 83% of the total water input (EPA, 1995). The AOC is located in Erie and Niagara counties in western New York State. Tributaries of the Niagara River include Smokes Creek, Buffalo River, Scajaquada Creek, Two Mile Creek, Tonawanda Creek, Cayuga Creek, and Gill Creek. These tributaries have all been found to have mercury contaminated sediments (NYSDEC 1, 1989). The primary land use within the AOC is industrial and residential (CIESIN, 1993).

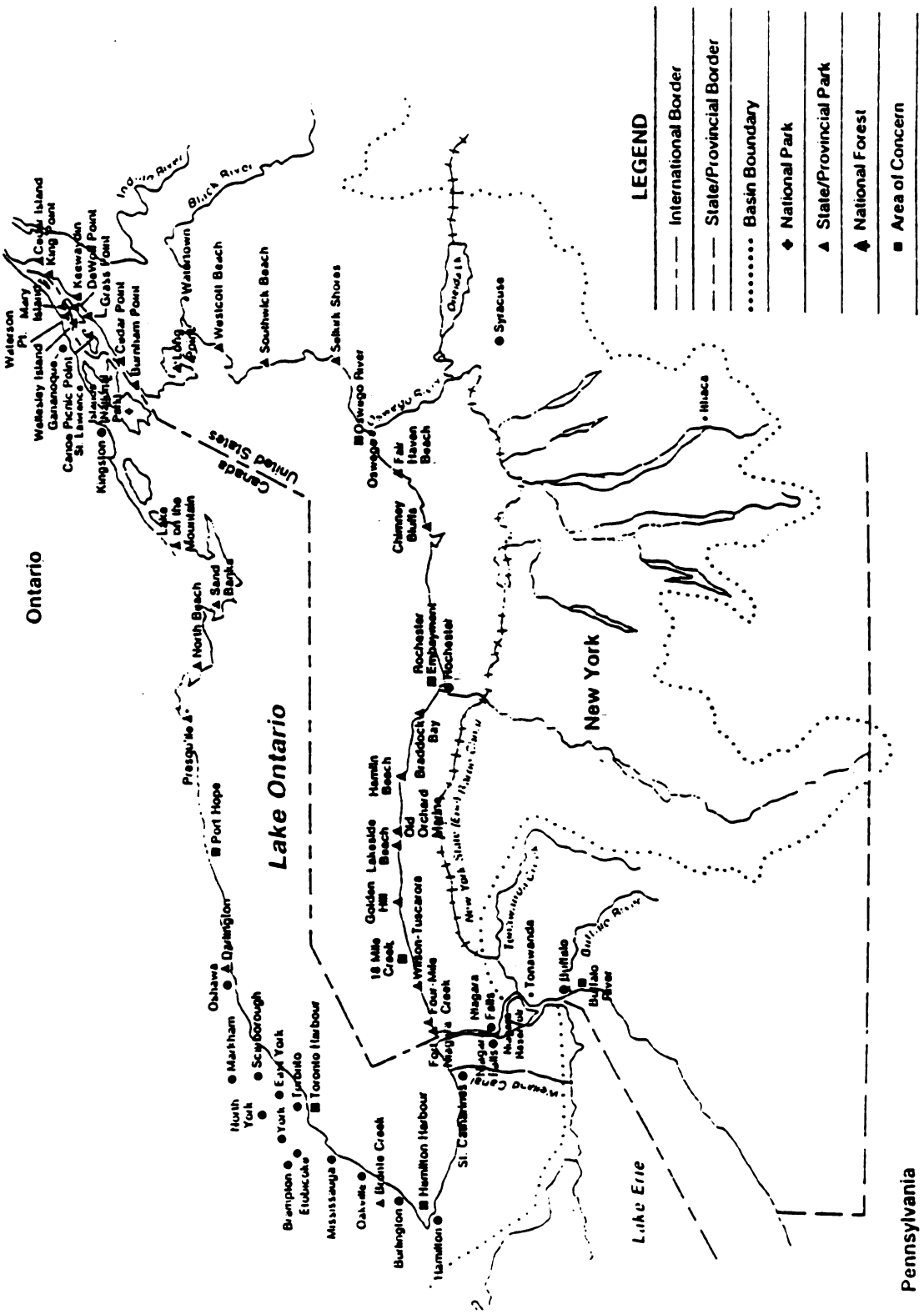


Figure 42. Lake Ontario areas of concern (CICEN, 1993)

The Niagara River AOC is unique in that very rapid flow of the water prevents the settling of any sediment. There is simply no "in-place" sediments because the Niagara River is scoured to bedrock and till. The river acts as a conduit or "pipeline" for any sediment toward Lake Ontario. Mercury has been one of many contaminants identified as polluting the sediments within the Niagara River AOC (NYSDEC 1, 1989). The areas within the AOC reporting contaminated sediment problems included three nearshore embayments, Petit Flume, 102nd Street Embayment, and Lower Gill Creek, which are located next to an inactive hazardous waste site, and a section of the Buffalo River. As of 1993, the Gill Creek sediment remediation project has been completed with 76,000 cubic yards of contaminated sediment being removed, approximately 20% of the loading measured from the Niagara River to Lake Ontario (CIESIN, 1993).

One hundred sixty four (164) landfills exist within 5 km of the Niagara River. In 1985, Canadian officials listed five landfills within Canada that were leaching mercury into the Niagara River. In 1989, U.S. officials reported that of the 200 known hazardous waste sites within the Niagara River AOC, 20 were contributing 99% of the daily 694 lb. of toxic loads into the AOC, with five of these sites marked as Comprehensive Environmental Response, Compensation, and Liability System National Priority List Sites (Superfund). These sites are identified as Love Canal, 102nd Street Landfill, Occidental Chemical's Hyde Park Landfill, S-area Landfill, and the Niagara County Refuse Landfill (NYSDEC1, 1989). The New York State Health Department issued a 1992-1993 fish and wildlife advisory to eat NO American eel, channel catfish, white perch, lake trout, chinook

salmon, and coho salmon over 21", rainbow trout over 25", brown trout over 20", and to completely refrain from eating any carp out of the Niagara River (NYSDEC 3, 1993).

Some of the identified point sources of mercury include Occidental Chemical's 100 acre Buffalo Ave. plant which contributes 340 lb. of toxic chemicals daily to the AOC. The 50 acre Niagara County Refuse Disposal site loads 88 lb. of toxic chemicals daily to the AOC, and the Dupont / CECOS International Landfill (410 acres) is located only 2.4 km from the Niagara River and has contaminated groundwater which leaches 65 lb. of toxics to the AOC per day. Other possible sources of mercury contamination may come from several of the following organizations: Bethlehem Steel, Buffalo Sewer Authority, Columbus-McKinnon, DuPont-Necco Park, Occidental Chemical's Durez plant, Bell Aerospace, and INS Equipment (EPA, 1992). In 1989, EPA and NYSDEC identified the Falls Street Tunnel as responsible for over 50% of the aggregate point source loading to the Niagara River. Since then, construction to divert all of the dry-weather flow from the City of Niagara Falls to their wastewater treatment plant has been implemented.

There are currently 41 industrial dischargers permitted by the National Pollutant Discharge Elimination System (NPDES) in Niagara County, New York, and 11 in Ontario. All of this discharge is in addition to 15 wastewater treatment plants located in New York and Ontario which also discharge effluent directly into the Niagara River AOC (EPA, 1992).

The Niagara River AOC is a very complex system regarding pollutant loading and is considered a major source of mercury to Lake Ontario. Ambitious remeadition projects

are underway to attempt a long term course of action for environmental clean up of a region damaged beyond repair.

The Rochester Embayment AOC - The Rochester Embayment is located on the southern shore of Lake Ontario near the city of Rochester, NY. The embayment and AOC are formed by the indentation of the Monroe County shoreline between Bogus Point in the town of Greece and Nine Mine Point in the Town of Webster. The major tributary of the Rochester Embayment is the Genesee River, which flows from the New York - Pennsylvania border to Lake Ontario. Land use within the AOC is defined as being industrial and residential (CIESIN, 1993).

The sediments in the Rochester Embayment AOC are contaminated with heavy metals, Cyanide, and PAHs. A 1990 sediment analysis showed the sediments of the AOC to be in the "moderately polluted" range (CIESIN, 1993). As of 1992 sediments of the Genesee River were given the "green light" for open lake disposal. The Harbor of the Genesee River is dredged annually by the USACE with all of the dredge spoil being dumped in the open waters of Lake Ontario (CIESIN, 1993).

There are 83 inactive hazardous waste sites within the Rochester Embayment AOC. The Trimmer Road Landfill is the only site that is under consideration for superfund status. The Genesee River, unlike The Niagara River is considered only to be a secondary source of mercury to Lake Ontario

The Oswego River AOC - The Oswego River / Harbor AOC is located on the southeastern shore of Lake Ontario and is centered in the city of Oswego, NY. The AOC is defined as the area at the mouth of the Oswego River bounded by the breakwalls and an

imaginary line connecting the breakwalls, the Oswego River as far south as the Varick dam. The land use within the AOC is mostly urban and residential. 1.2 million people live within the AOC boundaries and along the Oswego River basin (CIESIN, 1993). The Oswego River is second only to the Niagara River in terms of tributary input to Lake Ontario. Although Onondaga Lake is not officially located in the Oswego River AOC, it is a considerable source of mercury to the AOC through the Seneca River, a tributary of the Oswego River (CIESIN, 1993). There is only one superfund site, Volney Landfill, located in the AOC. This site is a likely source for PCBs and mercury to the Oswego River.

There are no restrictions on the disposal of dredged material from the Oswego Harbor and all material is open lake disposed. The sediment contamination of the Oswego River is undetermined. Insufficient data leads to a general unknowing of contaminated conditions of the river. Because there is evidence to support the fact that most of the contamination entering the Oswego River is from upriver sources including Onondaga Lake, removal of river sediments is being suspended for fear of remobilization of sediment bound toxins (CIESIN, 1993). Excessive nutrients and sedimentation from agriculture are believed to be the major problems in the Oswego River AOC. Current point source dischargers are considered to be minor sources when compared to other sources.

The Remedial Action Plan of the AOC has led to a settlement and enforcement action, whereby Bristol Myers Squib in East Syracuse agreed to a $30 million upgrade of its chemical pretreatment facilities and to conduct site investigations and pollution prevention activities. Onondaga Lake which is located along the northern edge of the city

of Syracuse has been identified as having serious mercury pollution problems because of the excessive loading from large municipal discharge facilities.

5.1.2 - Lake Ontario Mercury Sources:

When compared with Lakes Superior and Michigan, Lake Ontario displays a far greater mercury accumulation rate and sediment inventory. It has been shown earlier that atmospheric input of mercury to Lake Ontario is low (on the order of 15-20%) with most if is loading coming from other sources. Because Lake Superior and Lake Michigan receive 90-99% of their mercury loading from the atmosphere, point source determination is more difficult to identify. Mercury's long range transport behavior makes it possible for mercury loading being generating from outside of the Great Lakes basin to gradually drift in. Therefor a small percentage of mercury input to the Great Lakes can be attributed to long range atmospheric transport.

Figures 43- 63 exhibit the mercury source information that was collected from *The Minerals Yearbook.* The graphs show mercury use from 1945 - 1990 along with the mercury sediment concentrations of each sampling site. The data was normalized for quick and easy comparison between the two data sets. It must be noted before discussion of the graphs that in certain situations, one source function may not be the only major player in determining a relationship. Several variables may be working together, especially if the source is located close to the basin in question, therefore evaluations of all trends and peek values from every source must be studied in detail.

Site LO 19 - Niagara Basin - Site LO 19 is located just outside of the Niagara River / Lake Ontario inlet in a deep quiescent section of the Niagara Basin. Because Lake Ontario is not atmospherically driven for mercury, an attempt will be made to single out the major uses of mercury over the past 50 years within the Lake Ontario Basin to find and identify regional point sources. This should provide some explanation of the very large sediment inventories of mercury in the lakes sediment.

Figures 43 - 45 give the source function data vs. the sediment concentration at site LO 19. The chloro-alkali production which has been the major use of mercury lately, has peeked several times over the past 50 years. The first peek occurred in 1968, and remains as the highest peek to date. Several other smaller peeks were dated at 1973, 1979, and 1989. Site LO 19, however, peeks much earlier at around 1954. Although the trend over the past 25 years follows closely to the mercury concentration of the site, it seems to reason that other source functions must be more important in establishing a source match.

The agricultural use of mercury in the Lake Ontario and Lake Erie basin appears to be an important factor, more so than any of the other primary uses of mercury for explaining the mercury inventory at site LO 19. Figure 43 shows the two graphs peeking around the same time, 1955. Although there is a discrepancy of 3 years in the peek dates of the two graphs, the time frame is within the 2-3 year error margin for the lead -210 dating of the sediments (Eisenreich, personal commutation). From an evaluation of the source function graphs for site LO 19, agricultural input is the major source function of mercury to the Niagara Basin, with chloro-alkali production becoming more important over the last 25 years.

Site LO 40a - Mississagua Basin - Site LO 40a is located in the deep portions of the centrally located Mississagua basin. Because of a counter-clockwise current and the large sediment input of the Niagara River to Lake Ontario, the Mississagua basin receives large amounts of mercury through inter-basin flow. Primary mercury sources for this site include, in order of importance, Industrial production of mercury, chloro-alkali production, and use of mercury in paints (Figure 46). Site LO 40a also displays very good correlation with several other variables that include, agricultural use of mercury and catalysis (Figure 47), and the total U.S. consumption of mercury (Figure 48). Mercury found in the Mississagua basin sediments would seem to have originated in the Niagara River valley. Chloro-alkali plants located along the Niagara River, along with other industries, discharged mercury contaminated water directly into the river. Heavily industrialized and very polluted, the Niagara River acted as a "pipeline" for the contaminated sediments which traveled all the way to central Lake Ontario.

Site LO E30, F31, G32 - Rochester Basin - These three sites are located in the western part of the Rochester basin. This region was the most heavily contaminated zone of the entire Great Lakes region. Mercury contamination in the sediments reached levels of 3500 ng/g, almost 20 times that of Lake Michigan, and Lake Superior. Because only 10-15% of the mercury found in the sediments of Lake Ontario is atmospheric in origin, local contamination of the major tributaries must be severe. The Niagara River, Genesse River, and the Oswego River, provide the vehicle for most (85-90%) of the mercury input in Lake Ontario (CISCEN, 1993).

A detailed study of the tributary input of mercury to the Great Lakes is beyond the scope of this study. However, several sources in the Lake Ontario basin can be identified as being the cause of the majority of the contamination. Site LO E30 provides the best evaluation of the non-atmospheric inputs toward the Great Lakes. Examination of figures 51 and 52 show an almost perfect match for a source function. Chloro-alkali production and mercury use in paints can be easily identified as major sources of mercury to Lake Ontario. Because the use of mercury in paints has been almost eliminated since 1991, the chloro-alkali industry is left as the primary point source for mercury to Lake Ontario.

Mercury losses from the production activities at chloro-alkali plants can be estimated from the annual record for caustic soda (NaOH) production. The cores which display the closest correlation between the history of mercury fluxes and the mercury input function are in closest proximity to the source of mercury inputs (Smith & Loring, 1981). The 2-4 year time lag between graphs (Figures 51 & 52) are in agreement with the 5-10 year range for fine sediment deposition in the Great Lakes (Smith & Loring, 1981).

5.1.3 - Lakes Superior and Michigan Mercury Sources:

The St. Louis River / Bay AOC - The pristine waters of Lake Superior contain 8 AOCs. However, only 1 AOC, the St. Louis River, has a major impact on the aqueous mercury loading to the lake. The St. Louis River flows 171 miles from its headwaters in Minnesota into Lake Superior. The lower section of the river is a freshwater estuary from just below the Fond du Lac Dam to the outlet at Lake Superior. The AOC is defined as being that area of the river below Cloquet, including St. Louis Bay, Superior Bay, Allouez

Bay and the lower Nemadji River. It is the lower 39 miles of river between the city of Cloquet and Duluth that has historically been the area of most intense development and industrial uses (CIESIN, 1993).

The sediments in the St. Louis River AOC are heavily contaminated with arsenic, cadmium, chromium, copper, lead, and mercury, cyanide, dioxin, PCBs, and PAHs. Several sites along the river are targeted as point sources, and have very high localized sediment concentrations of contaminants. These sites are identified as, the Embayment that received discharge from the Western Lake Superior Sanitary District in Duluth (WLSSD), Minnesota, the Interlakes Superfund site in Duluth, Minnesota, the US Steel Superfund site in Duluth, Minnesota, Newton Creek and Hog Island Inlet of Superior Bay, Wisconsin, and the Crawford Creek Wetland / Koppers Co. in Superior Bay, Wisconsin (MPCA & WDNR, 1992).

In a study conducted by Glass et. al. (1990), mercury discharge by the WLSSD's sludge incinerator was identified as the primary source for mercury to the St. Louis River estuary. The mercury concentration which originates in the WLSSD's plant water discharge is believed to be around 364 ng Hg/l, that's 66% of the total mercury input to the entire St. Louis estuary (Glass et al., 1990). Removing mercury from incinerator scrubber water and landfilling rather than direct river discharge is one method suggested by WLSSD staff as a way to dramatically reduce mercury loading to the St. Louis River (Glass et al., 1990).

The Duluth Basin in western Lake Superior has an elevated sediment mercury inventory when compared with the other sites in central and eastern Lake Superior. Site

LS DTL, in the Duluth Basin, has mercury inventories that are 8 times the lake wide average. Site LS SJE-II, also located in the Duluth Basin, does not show the large increases in inventories as site LS DTL does. This lower inventory can possibly be linked to a dilution effect caused by taconite tailings which were deposited near LS SJE-II in the 1950s and 1960s at a rate of 67,000 tons a day (U.S. Dept. Int. Rept., 1969).

It is interesting that even though a single source function (Incinerator burning) was identified as a major pollutant for the Duluth Basin, the mercury source function graphs show the strongest correlation with agricultural mercury use (Figure 60).
Figure 60 shows exhibits further evidence that the atmosphere is a dominate source of mercury to Lake Superior. Because mercury can be transported vast distances in the atmosphere, the heavy use of mercury containing pesticides mean that large concentrations of airborne mercury drift in from the agricultural heartland just to the southwest of the Lake Superior watershed. Several previous studies have also hypothesized the atmosphere in their research as being the major source for contaminants to the Lake Superior region (Eisenreich et al., 1990; Arimoto, 1989; Eisenreich, 1987;).

Lake Michigan - Lake Michigan does not have the locally polluted basins like Lakes Ontario and Superior, therefore, source function graphs (Figures 61-63) provide little evidence for identification of local point sources. Mercury contamination in Lake Michigan is primarily from atmospheric fallout from the Chicago area, Milwaukee, and Green Bay. The northern Lake Michigan sites (Figures 61 & 62) show the strongest correlation to the industrial use of mercury, which would support the hypothesis of the

industrial contaminated air from Chicago and surrounding areas flowing over the length of Lake Michigan.

Site LO 19 - Niagara Basin, Lake Ontario

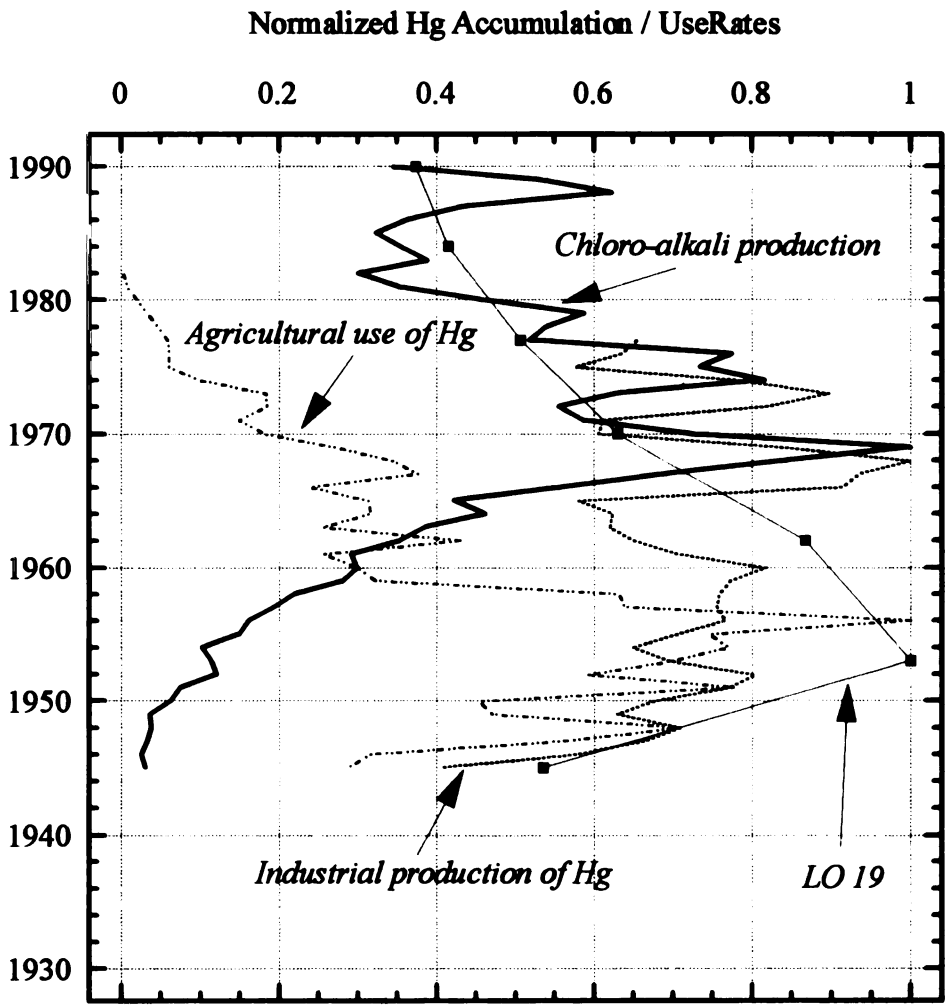


Figure 43. Mercury source usage rates as a function of time at site LO 19.

Site LO 19 - Niagara Basin, Lake Ontario

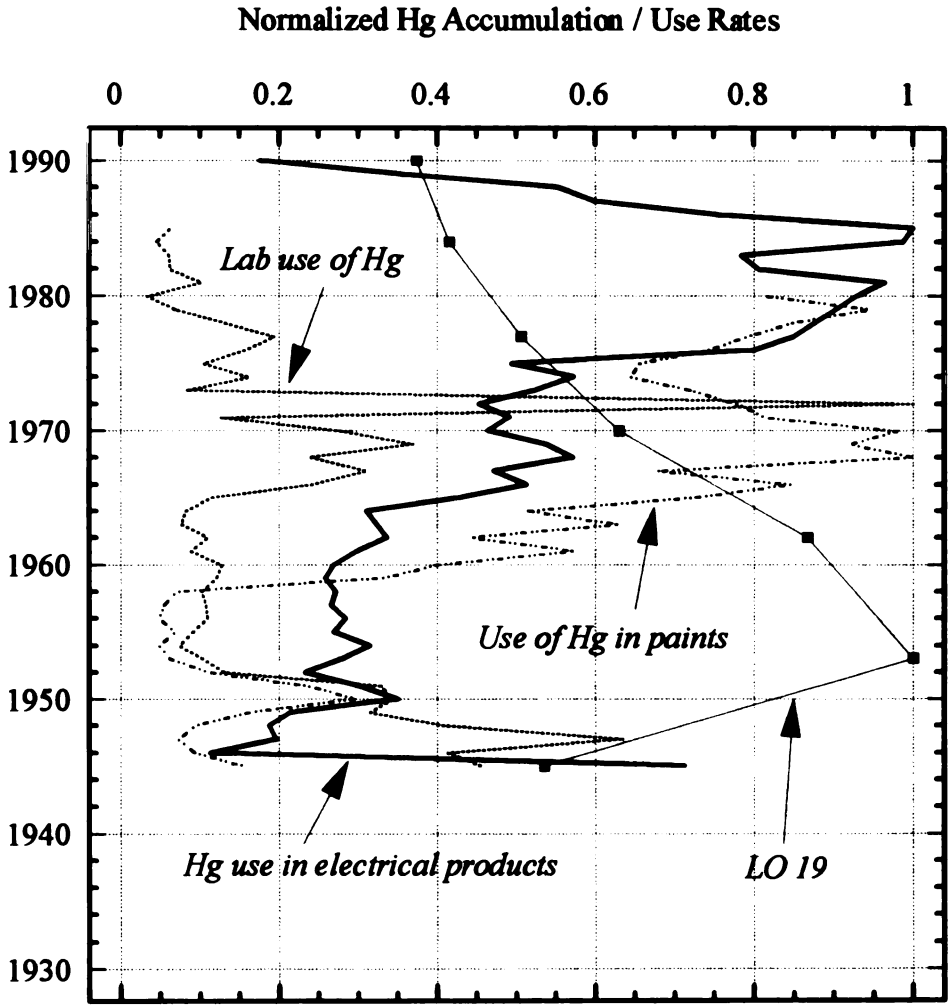


Figure 44. Mercury source usage rates as a function of time at site LO 19.

Site LO 19 - Niagara Basin, Lake Ontario

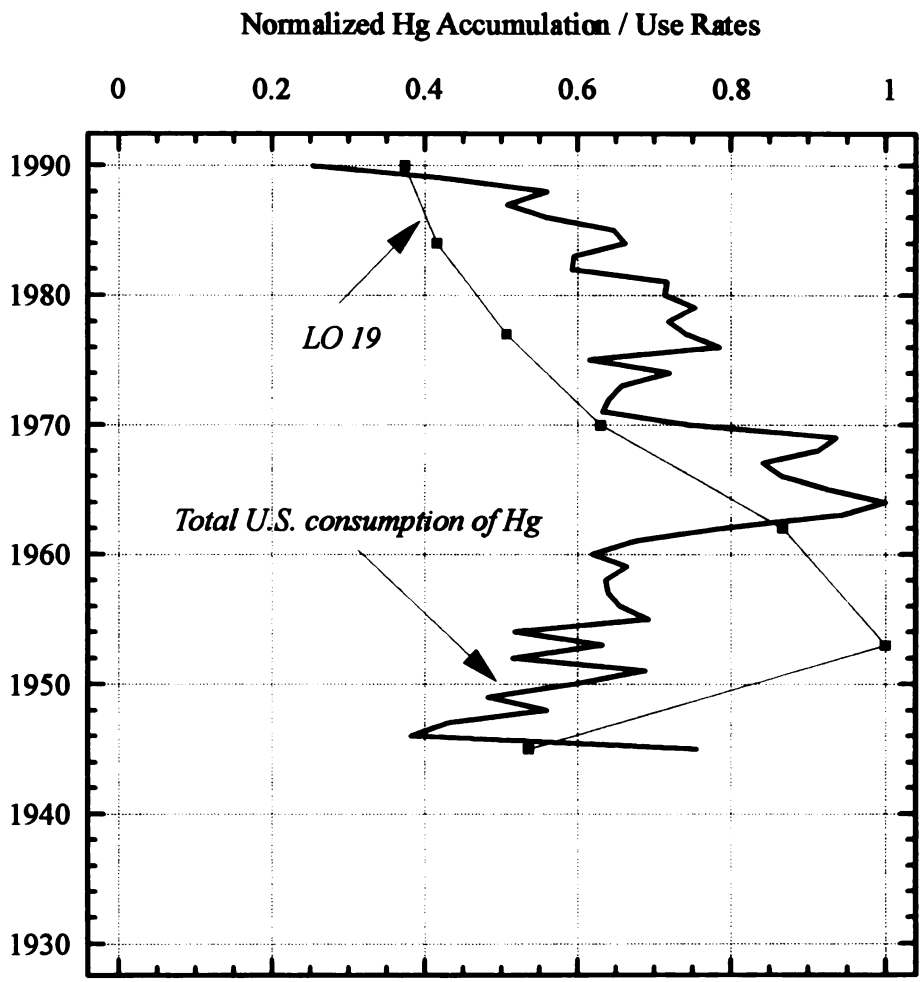


Figure 45. Total U.S. consumption of mercury as a function of mercury concentration at site LO 19.

Site LO 40a - Niagara Basin, Lake Ontario

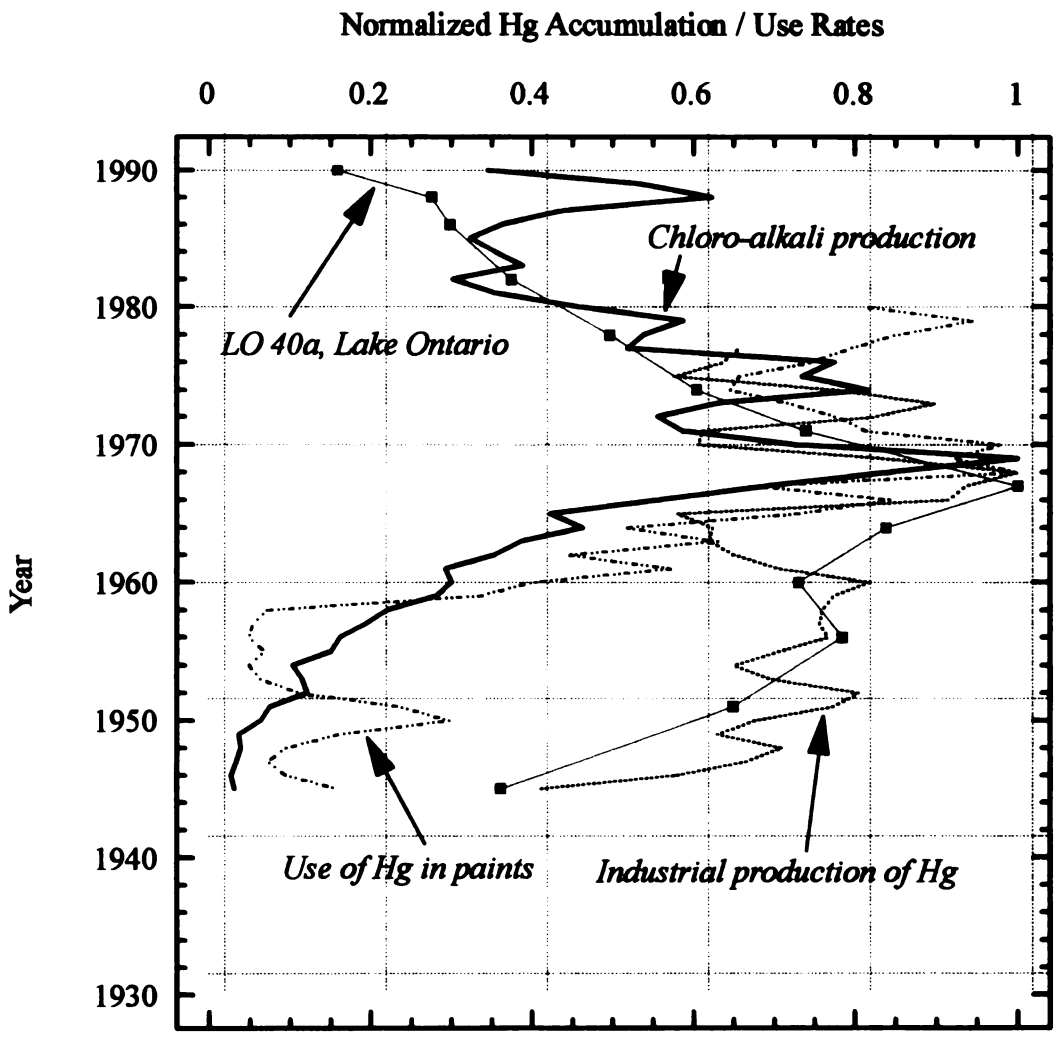


Figure 46. Mercury source usage rates as a function of time at site LO 40a.

Site LO 40a - Mississagua Basin, Lake Ontario

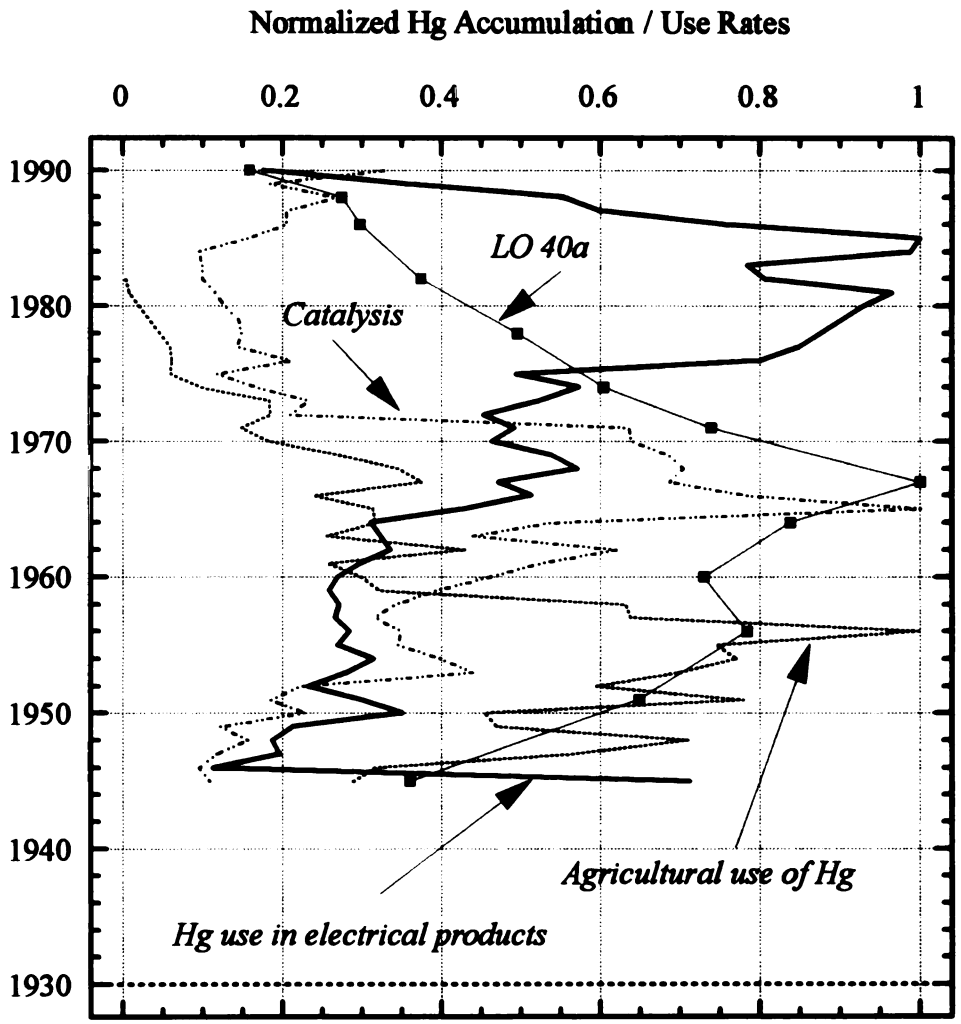


Figure 47. Mercury source usage rates as a function of time at site LO 40a.

Site LO 40a - Mississagua Basin, Lake Ontario

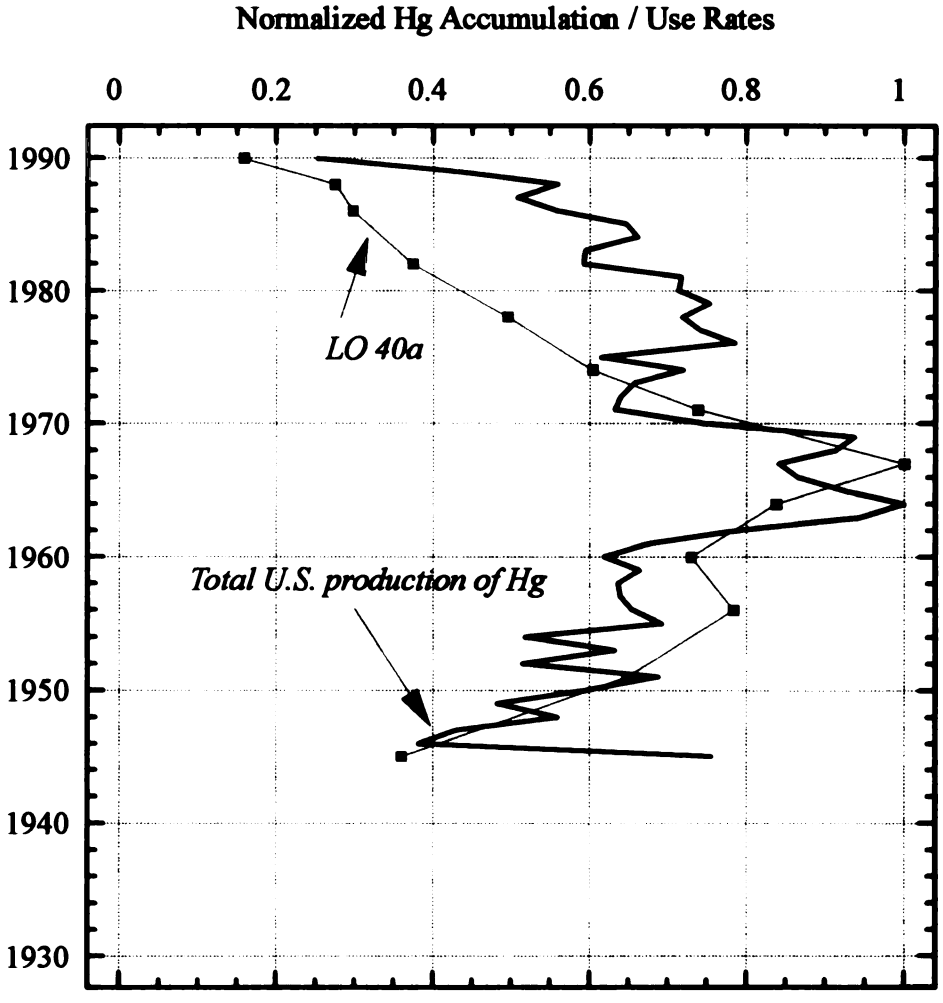


Figure 48. Total U.S. production of mercury and mercury concentration as a function of time at site LO 40a.

Site LO E30 - Eastern Rochester Basin, Lake Ontario

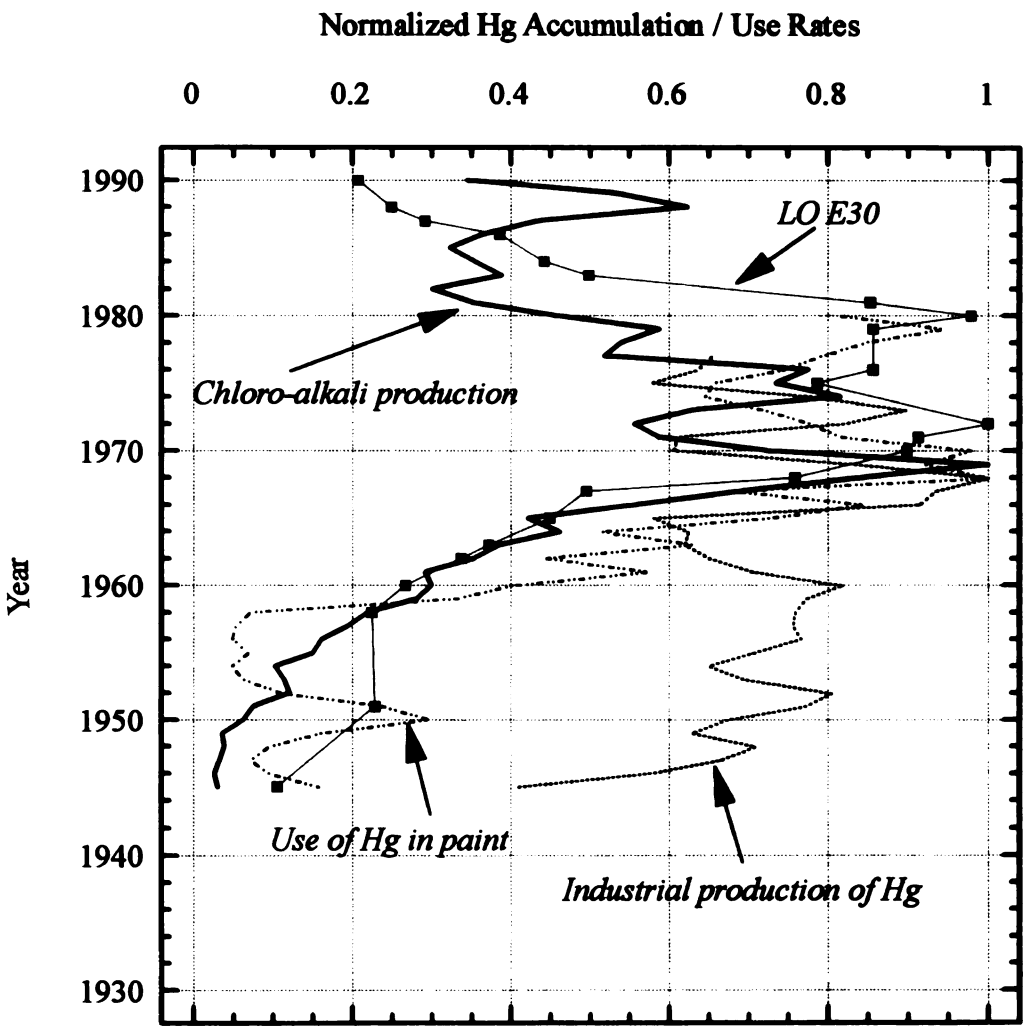


Figure 49. Mercury source usage rates as a function of time at site LO E30.

Site LO E30 - Eastern Rochester Basin, Lake Ontario

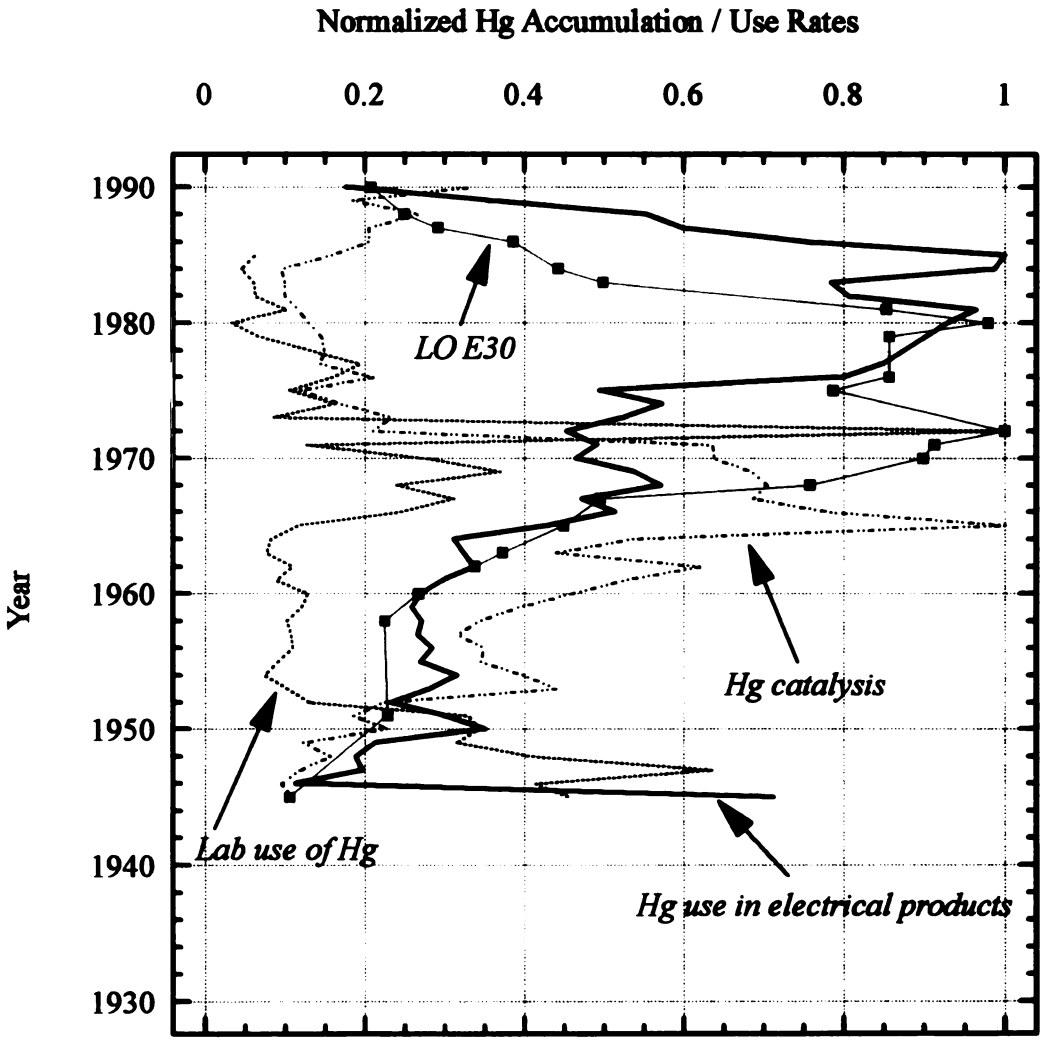


Figure 50. Mercury source usage rates as a function of time at site LO E30.

Site LO E30 - Eastern Rochester Basin, Lake Ontario

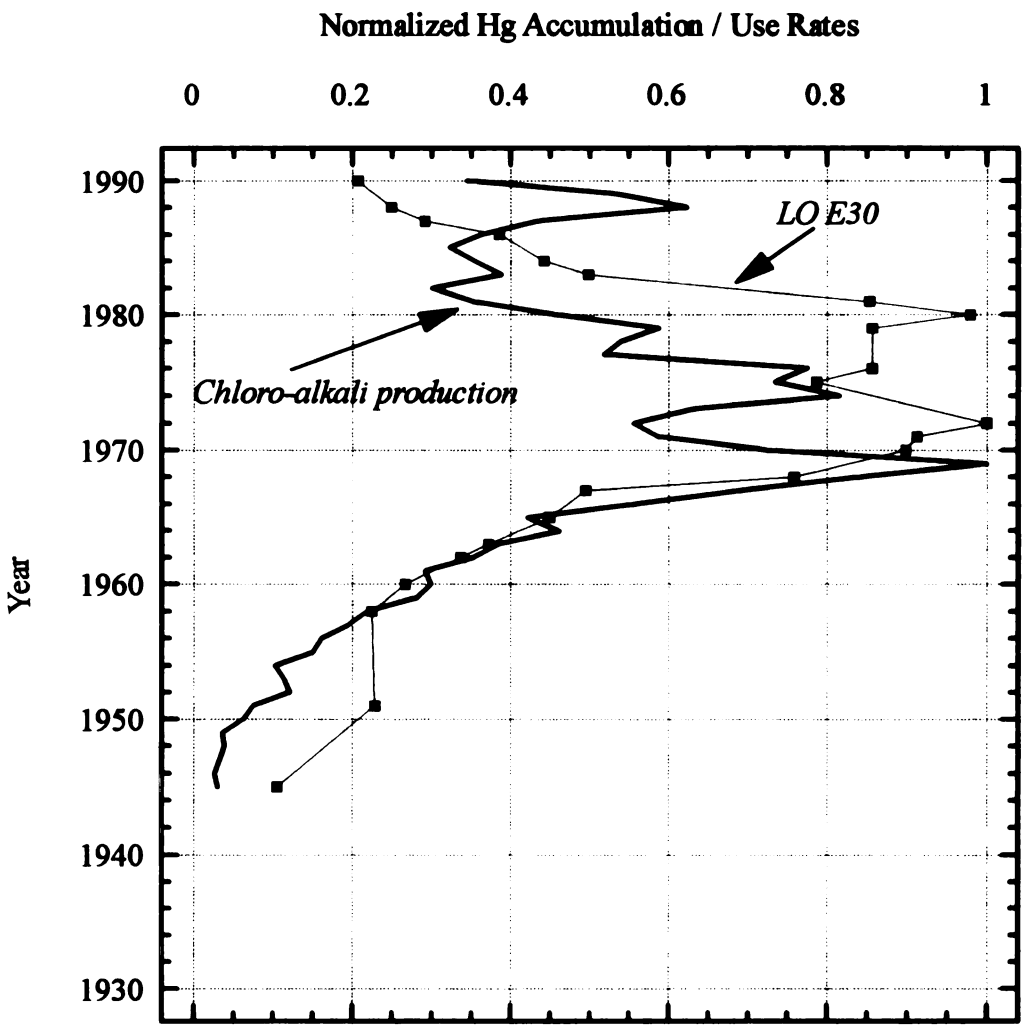


Figure 51. Chloro-alkali production and sediment mercury concentration as a function of time at site LO E30.

Site LO E30 - Eastern Rochester Basin, Lake Ontario

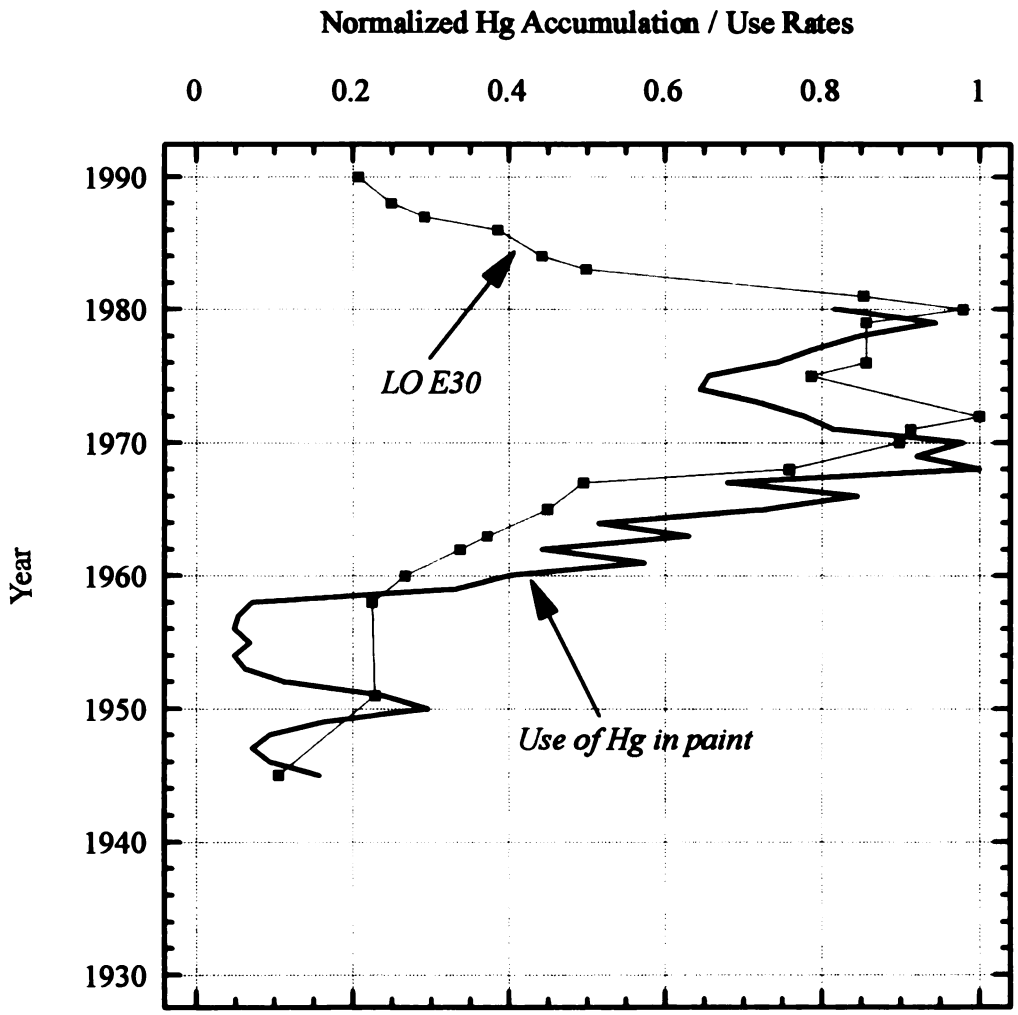


Figure 52. Mercury paint usage and sediment mercury concentration as a function of time at site LO E30.

Site LO E30 - Eastern Rochester Basin, Lake Ontario

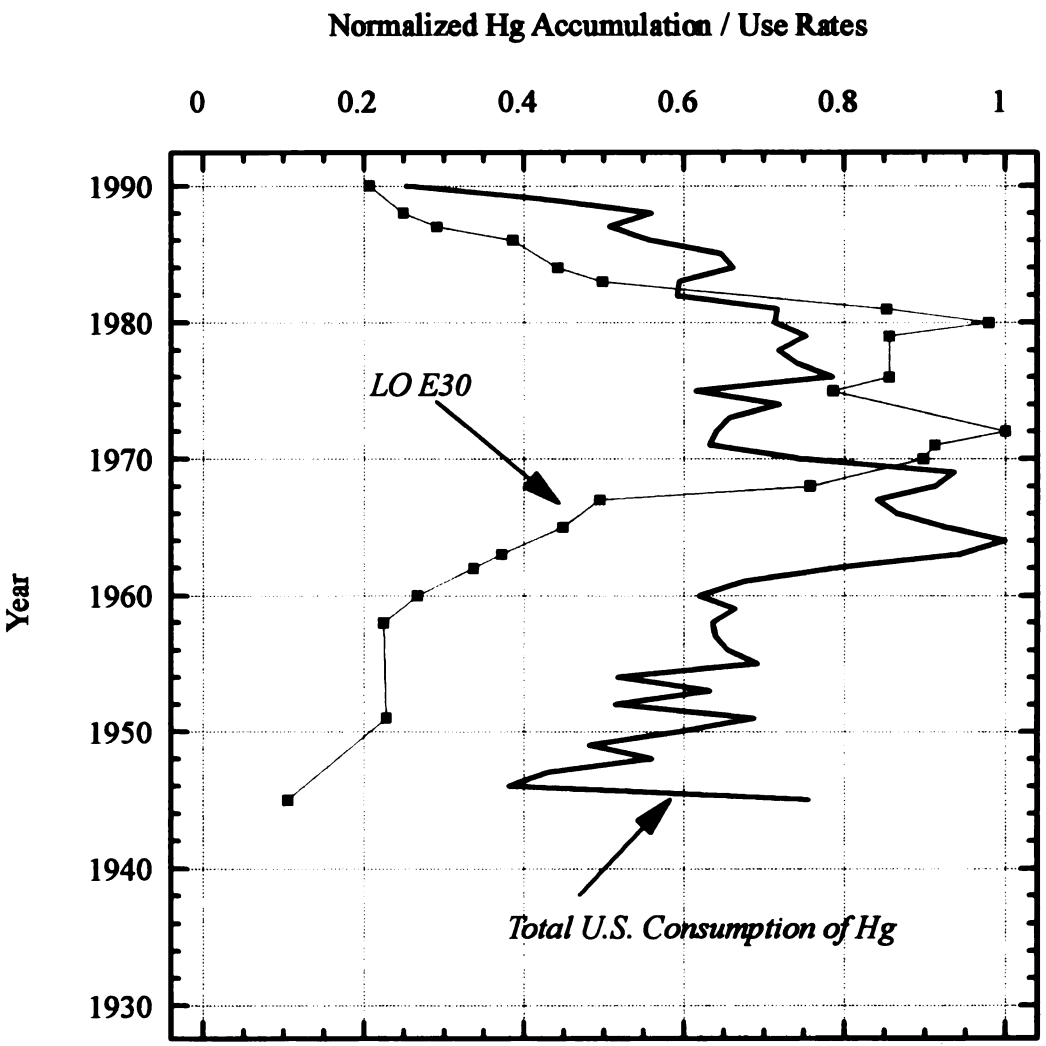


Figure 53. Total U.S. consumption of mercury and sediment mercury concentration as a function of time at site LO E30.

Site LO F31 - Eastern Rochester Basin, Lake Ontario

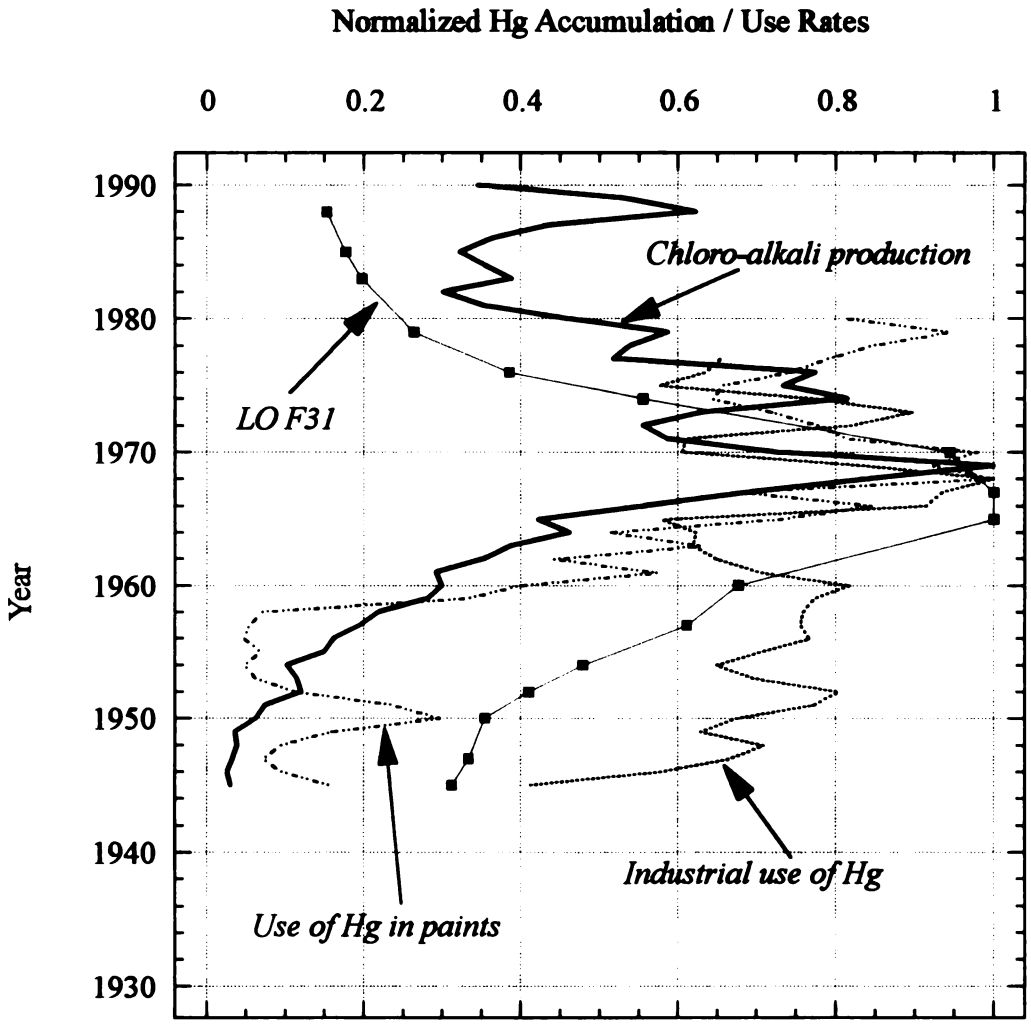


Figure 54. Mercury source usage rates as a function of time at site LO F31

Site LO G32 - Eastern Rochester Basin, Lake Ontario

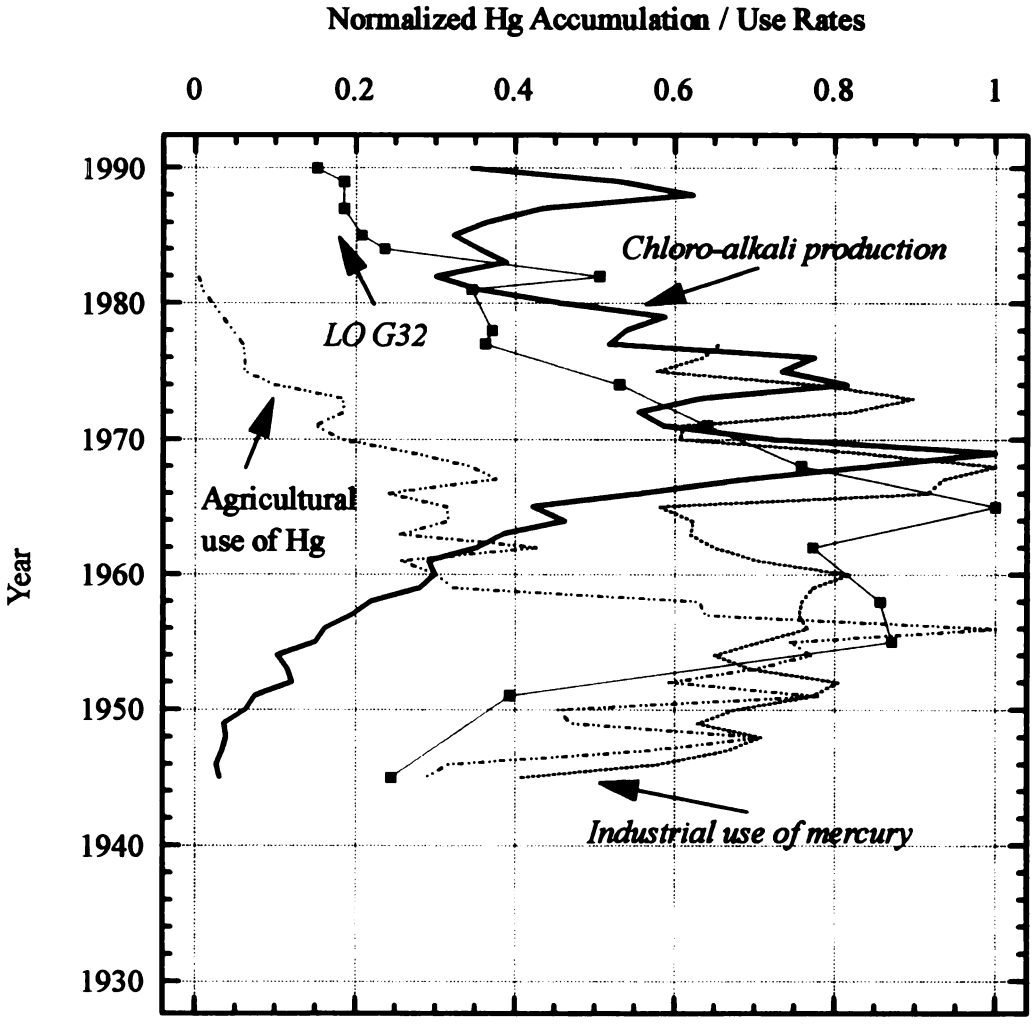


Figure 55. Mercury source usage rates as a function of time at site LO G32.

Site LO G32 - Eastern Rochester Basin, Lake Ontario

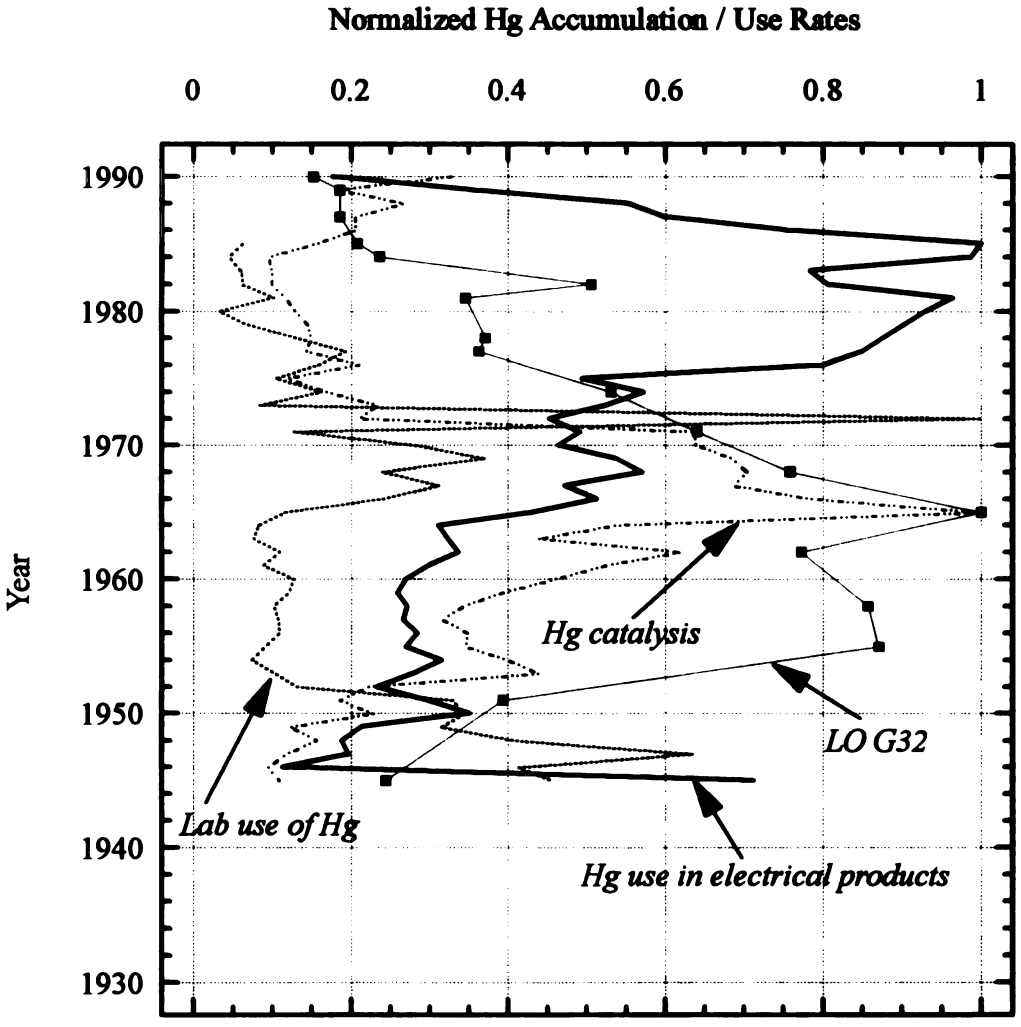


Figure 56. Mercury source usage rates as a function of time at site LO G32.

Site LO G32 - Eastern Rochester Basin, Lake Ontario

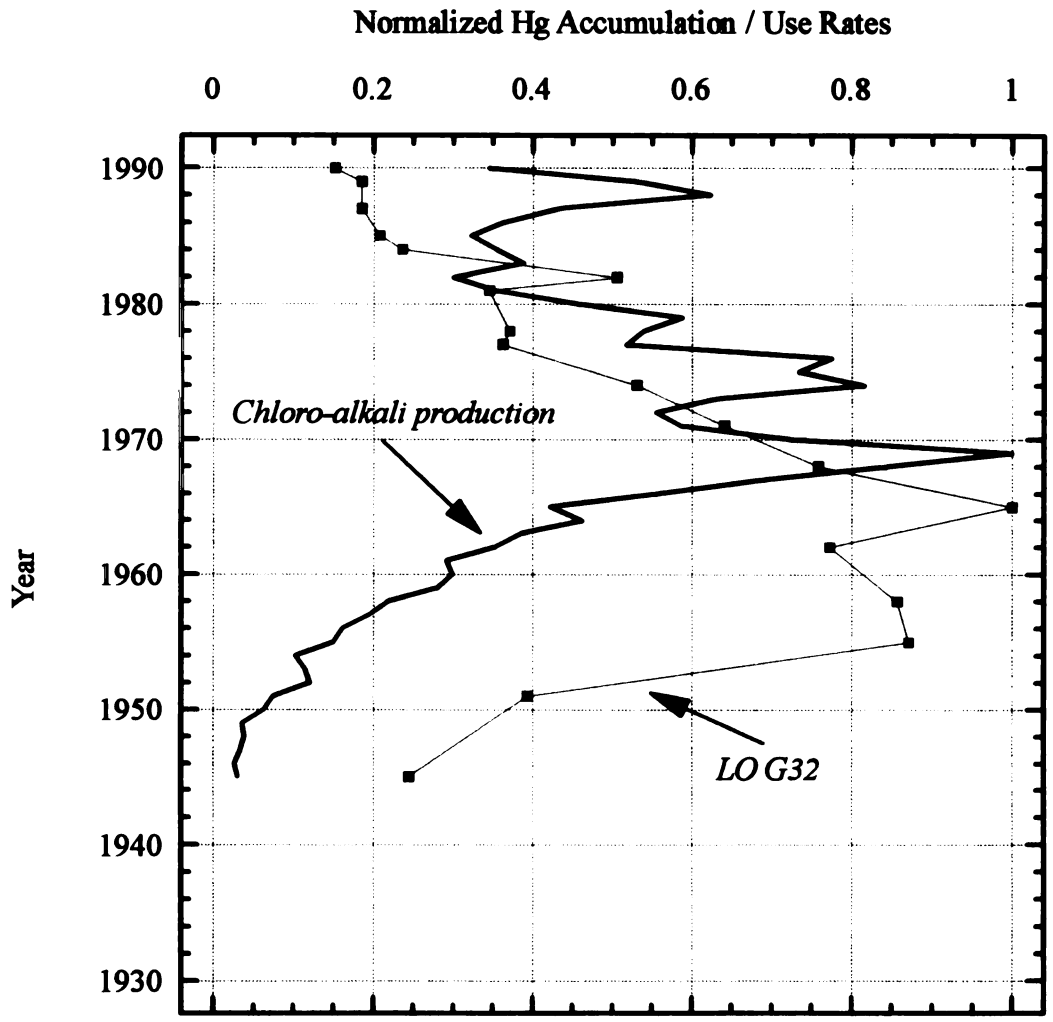


Figure 57. Chloro-alkali production and sediment mercury concentration as a function of time at site LO G32.

Site LO G32 - Eastern Rochester Basin, Lake Ontario

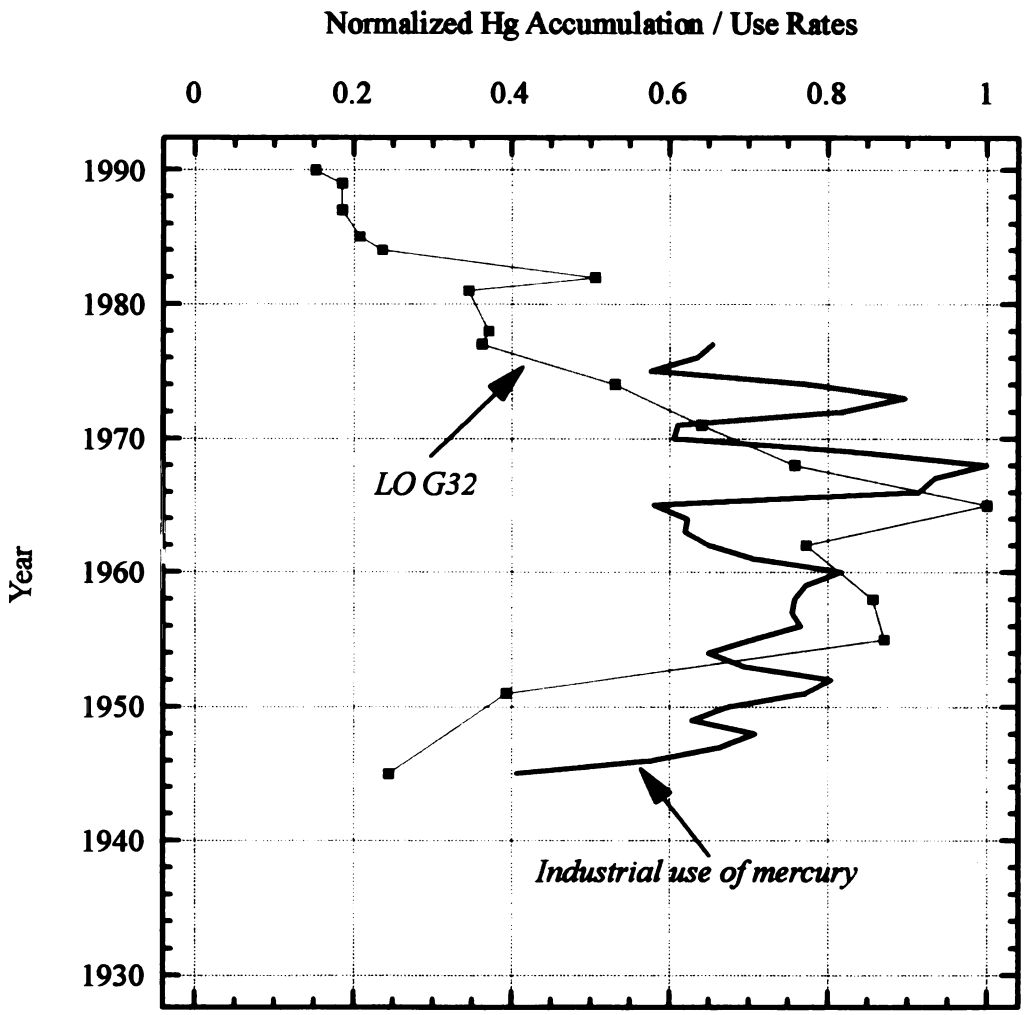


Figure 58. Industrial use of mercury and sediment mercury concentration as a function of time at site LO G32.

Site LS DTL - Duluth Basin, Lake Superior

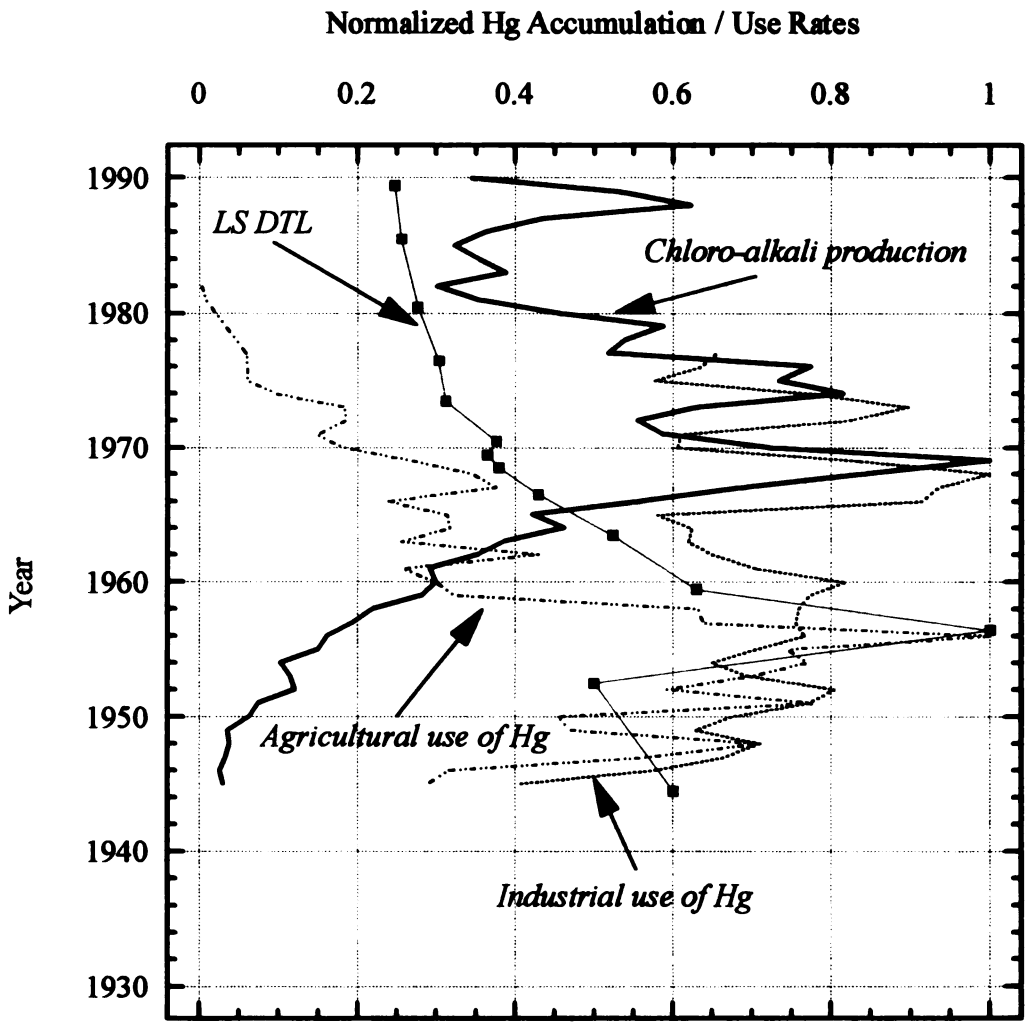


Figure 59. Mercury source usage rates as a function of time at site LS DTL.

Site LS DTL - Duluth Basin, Lake Superior

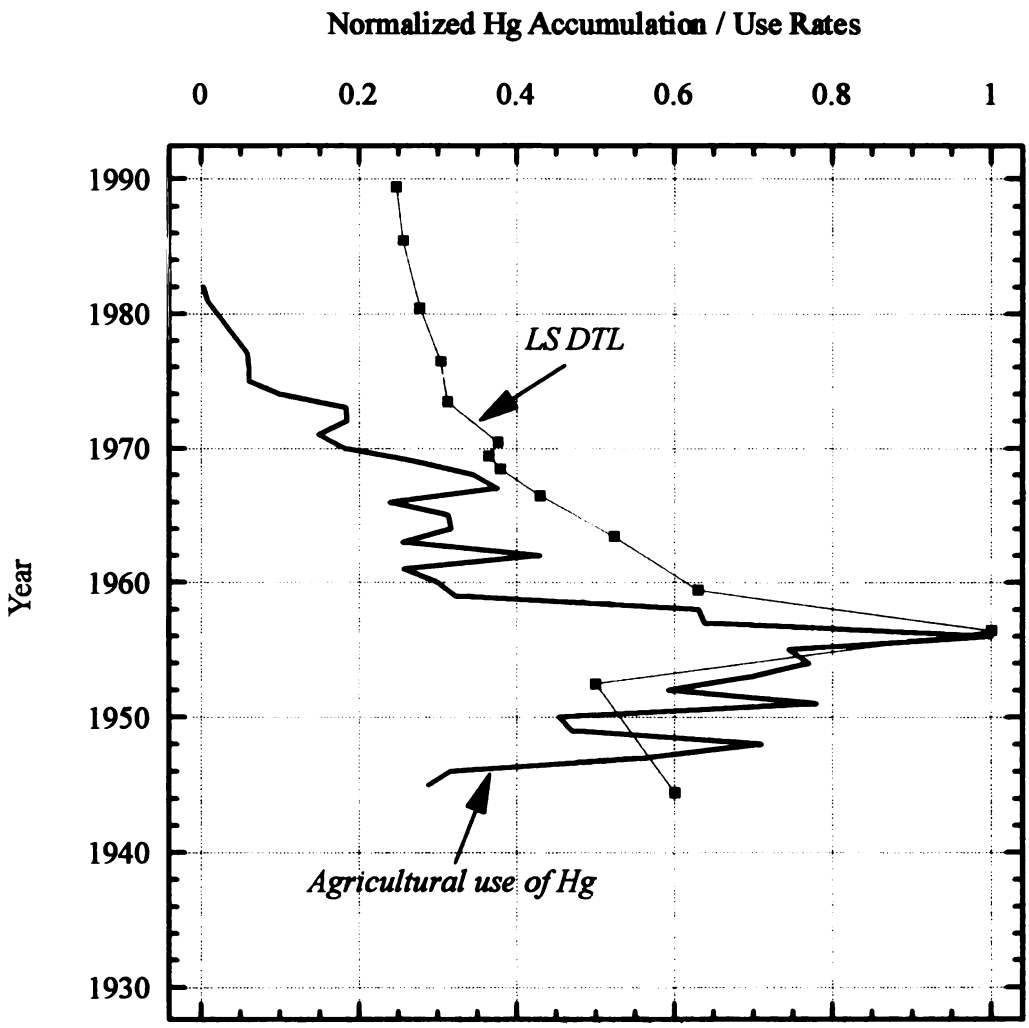


Figure 60. Agricultural use of mercury and sediment mercury concentration as a function of time at site LS DTL.

Site LM 47s - Algoma Basin, Lake Michigan

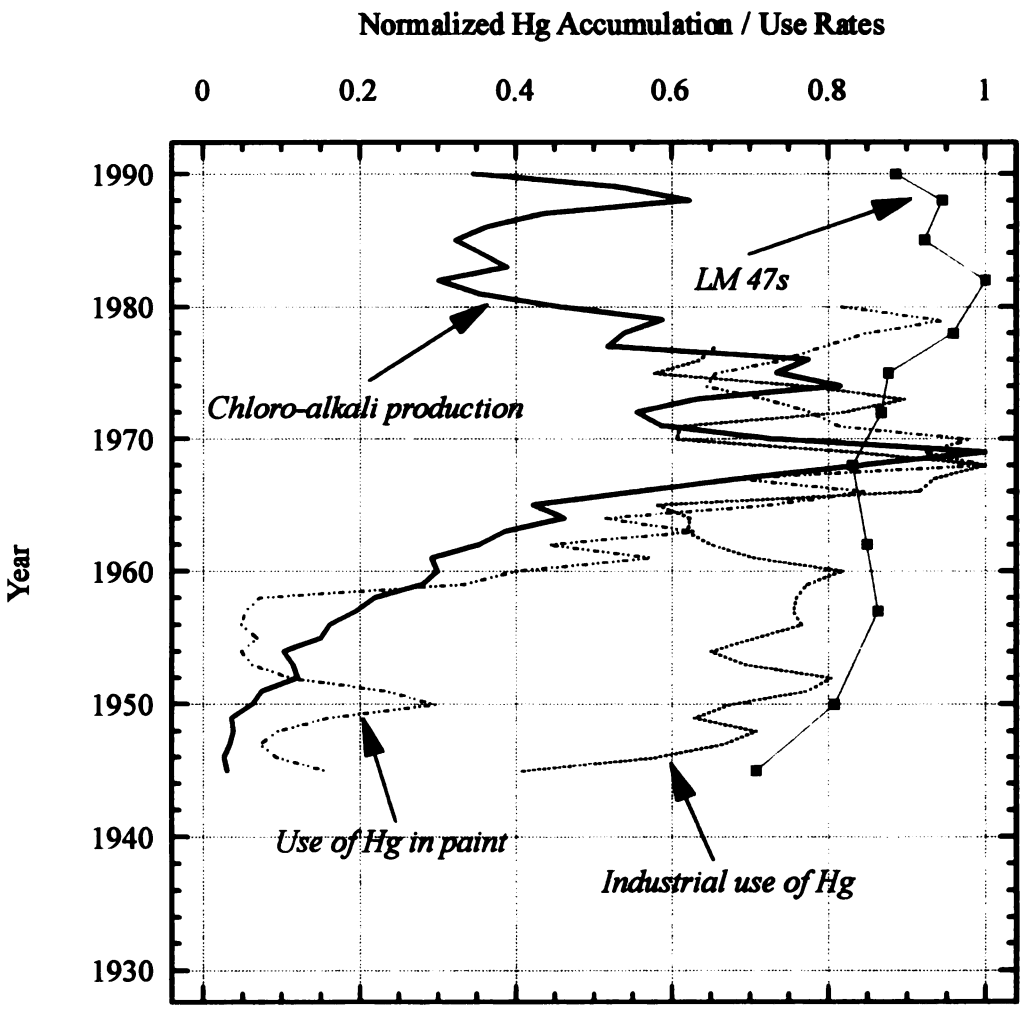


Figure 61. Mercury source usage rates as a function of time at site LM 47s.

Site LM 68k - Algoma Basin, Lake Michigan

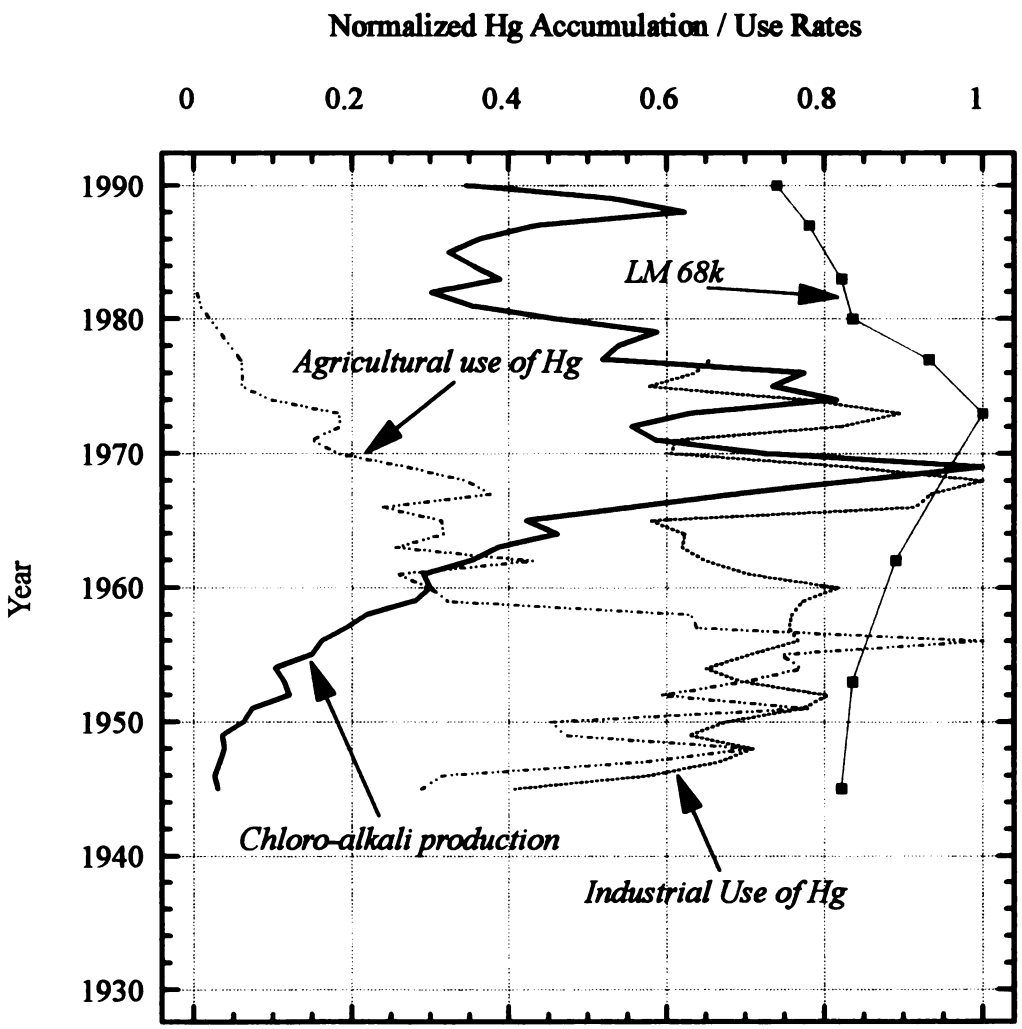


Figure 62. Mercury source usage rates as a function of time at site LM 68k.

Site LM 18 - Southern Basin, Lake Michigan

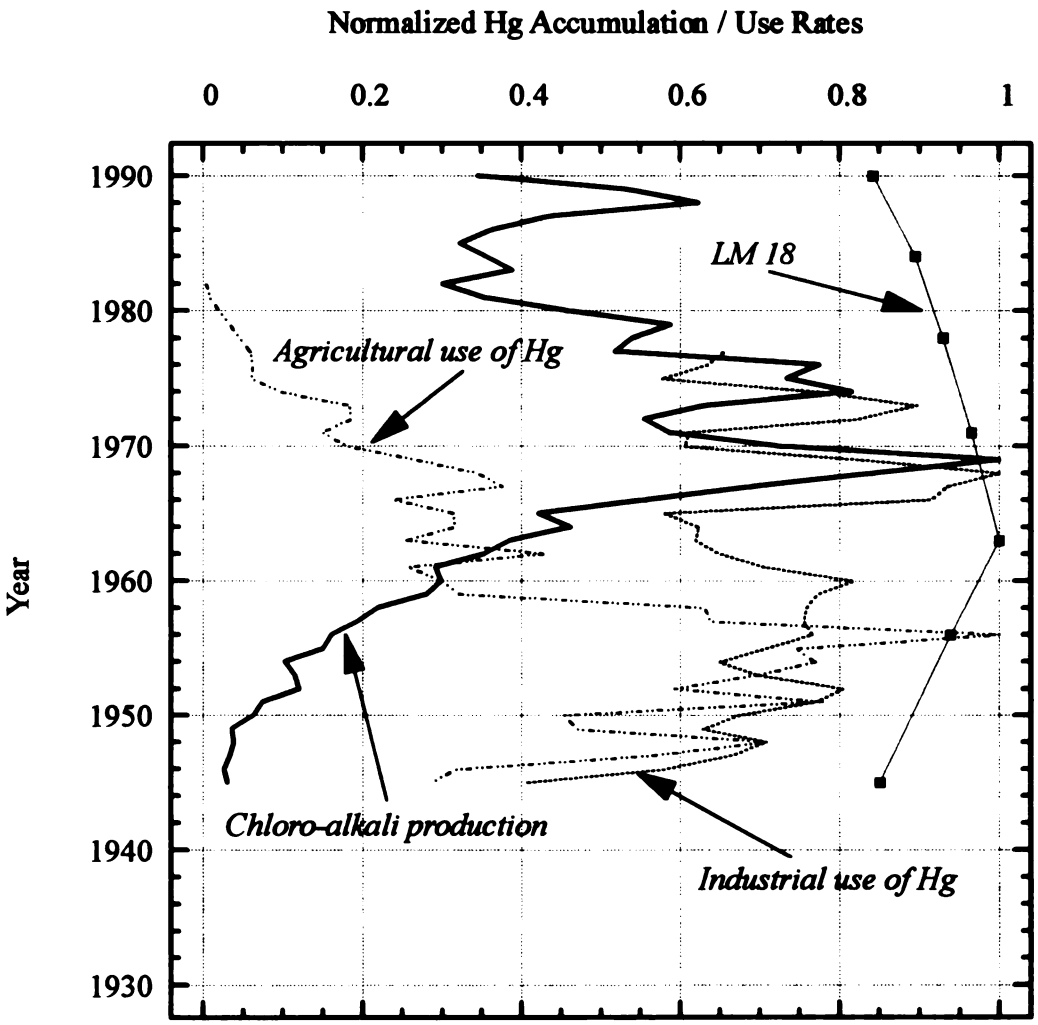


Figure 63. Mercury source usage rates as a function of time at site LM 18.

5.2 Chemical Inventories of Mercury

5.2.1 - Sediment Inventory Concepts:

The sediment inventory of mercury refers to the total mass of mercury in the sediments of a lake due to anthropogenic inputs only. Inventories allow an evaluation of the spatial patterns of contamination within a given lake, and to compare the contamination between several lakes. The sediment inventories used in this study were calculated by an equation used by Eisenreich et. al (1989) and follows their work on hydrophobic organic compounds in Great Lakes sediment. This equation was modified for the use of trace metals by factoring in the natural background levels (Long et al., 1995) and appears as follows:

$$Inv^{i}_{s}\ (ng/cm^2) = \sum_{x} [Csed^* \times ((1-\phi) \times \rho \times d)] \qquad (6)$$

where,

Inv^{j}_{s}= inventory (ng/cm^2) of i^{th} metal in the sediment core at s^{th} site,
Csed* = background corrected concentration of a metal in the sediment (ng/g),
i = metal,
s = sediment core sampling site,
ϕ = porosity of the sediment core,
ρ = dry density of the sediment (g/cm^2),
d = thickness of sediment increment (cm),
x = number of depth increment.

Because of the focusing of fine grained sediments to the deep depositional basins inventories are site specific. The sediment inventories calculated by equation 8 need to be corrected for the focusing of sediments to allow for the variation in sediment loads between sampling sites. The uncorrected inventories can vary considerably between the lakes and inter-lake basins. Once corrected for sediment focusing the inventories calculated within each lake attain similar values. Correction for focusing was performed by the following equation (Long et. al., 1995).

$$Invc^{s}_{i} = Inv^{s}_{i} \;/\; FF_{s} \qquad (7)$$

where,

$Invc^{s}_{i}$ = corrected inventory (ng/cm^2) for the i^{th} metal at s^{th} sampling site,
FF_s = focusing factor at s^{th} sampling site,
i = metal,
s = sediment core sampling site.

After the sediment inventories are calculated and corrected for focusing, the anthropogenic sediment burden (ASB) of mercury can be evaluated by using the following equation (Long et al., 1995),

$$\mathbf{ASB}^{l}_{i}\ (\mathbf{kg}) = \frac{\sum_{1}^{s} Invc_{i}}{n_s} \times SA_l \qquad (8)$$

where,

$\mathbf{ASB}^{l}_{i}$ = anthropogenic sediment burden for i^{th} metal at s^{th} sampling site,
$Invc^{s}_{i}$ = corrected inventory (ng/cm^2) for i^{th} metal at s^{th} sampling site,
i = metal,
s = sampling site of sediment core,
l = lake,
n_s = number of sites,
SA*l* = surface area of l^{th} lake (m^2).

5.2.2 - Inventory Discussion:

The uncorrected inventories for mercury varied from lake to lake, while the focusing corrected inventories collapsed the large variance in values to similar values (Figure 64). The results support one of the study hypothesis' that inputs of mercury to the Great Lakes from different sources can be integrated into a lake-wide signal. The sediments in Lake Ontario have higher sediment concentration values than the sediments of Lakes Superior and Michigan. Lake Michigan had inventories that were slightly higher than the lowest values found in Lake Superior.

The Duluth basin in Lake Superior had the highest corrected inventories of all other basins. Site LS-DTL in the far western part of the Duluth basin had the largest corrected sediment inventory of 592.57 ug/cm^2, a value 4 times higher than Site LS-SJE-II just a few more miles offshore. This value reflects the greater pollution of sediments in closer proximity to the city of Duluth, MN and the inflow of the Fox River. Therefore the

two Duluth basin sites (DTL & SJE-II) may not, therefore, be representative of the mercury inventories of Lake Superior. The rest of the sample sites (NOAA#3, 1383, & 1391) have similar inventories, however, there is a slight west to east gradient in corrected inventories (Figure 65).

In Lake Michigan, the corrected inventories were similar between sites. Site LM-70m in the northern Algoma basin had the lowest inventory value of just 87.96 ug/cm^2. The highest inventory, 202.58 ug/cm^2, was at site LM-68k which is just outside of Green Bay. Green Bay has been shown to be a major source of organic contaminants to northern Lake Michigan. (Eisenreich et al. personal communication). This may also be true for mercury input to the Algoma basin. There does not appear to be a north/ south gradient of mercury inventories in Lake Michigan (Figure 66).

Lake Ontario had very high sediment inventories for mercury. The highest value was in the eastern Rochester basin at site LO-G32 and was 3484.03 ug/cm^2 (Figure 67). The lowest inventory value of 2084.66 ug/cm^2 was found just a few miles away at site LO-E30. Lake Ontario does not seem to have any spatial trends in mercury inventories.

The average sediment inventory for mercury in Lake Superior was 74 ug/cm^2, for Lake Michigan it was 152 ug/cm^2, and for Lake Ontario it was 3007 ug/cm^2, 40 times Lake Superior's value and 20 times Lake Michigan's. The anthropogenic sediment burden (ASB) for mercury was highest in Lake Ontario at 5.46×10^5 kg. Lakes Michigan and Superior have ASB's an order of magnitude less, at 8.78×10^4 kg and 4.8×10^4 kg respectively.

The Great Lakes seem to be well mixed with respect to anthropogenic mercury inputs as shown by the relatively consistent focusing corrected inventories within each lake for mercury. Several areas exhibited localized contamination that were above lake averages. The Duluth basin in Lake Superior is one example of a locally contaminated area and does not appear to be representative of the whole lake. Lakes Superior and Michigan have received anthropogenic mercury pollution at a lower rate than Lake Ontario which has been significantly impacted by industrial input.

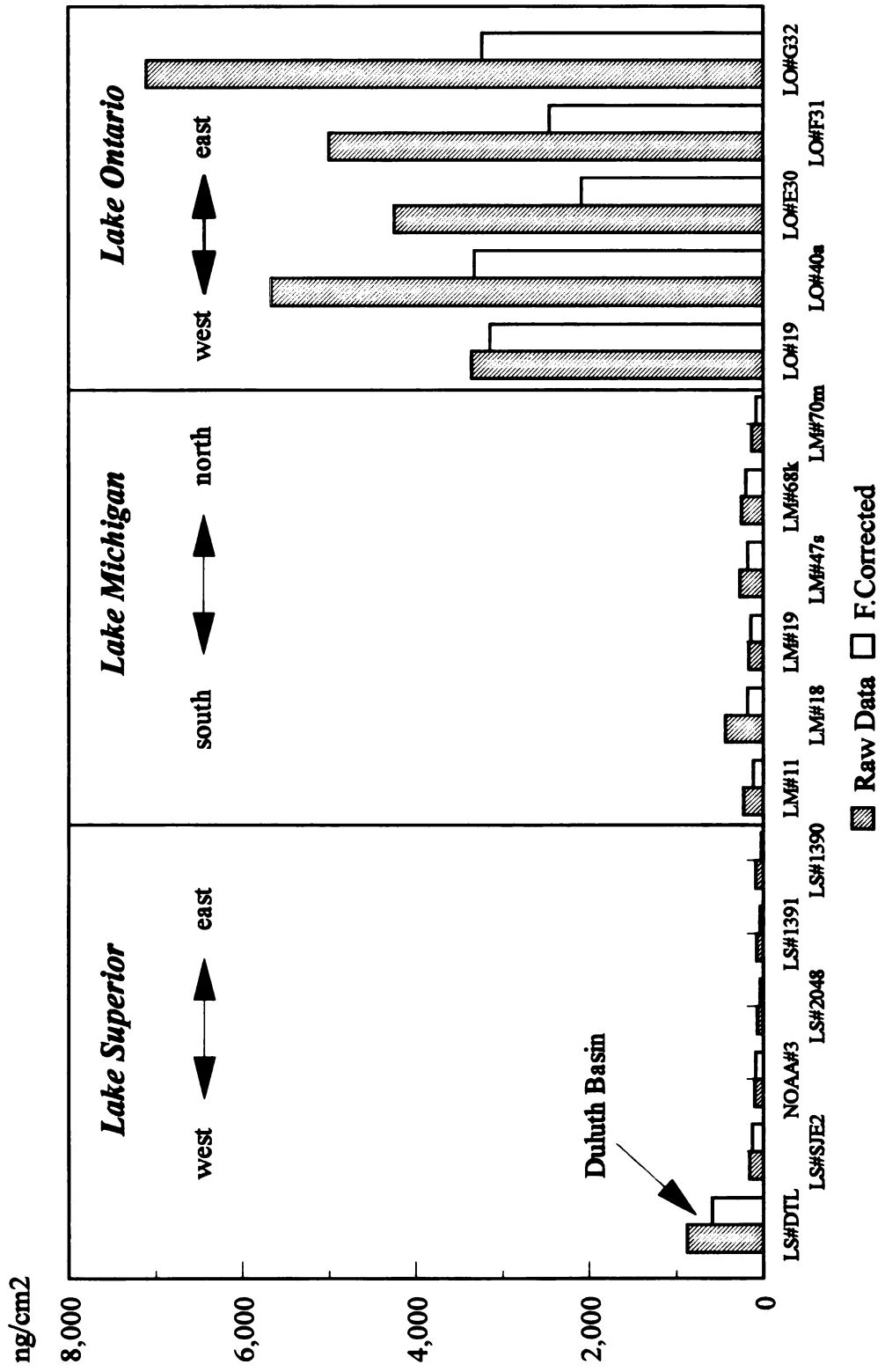
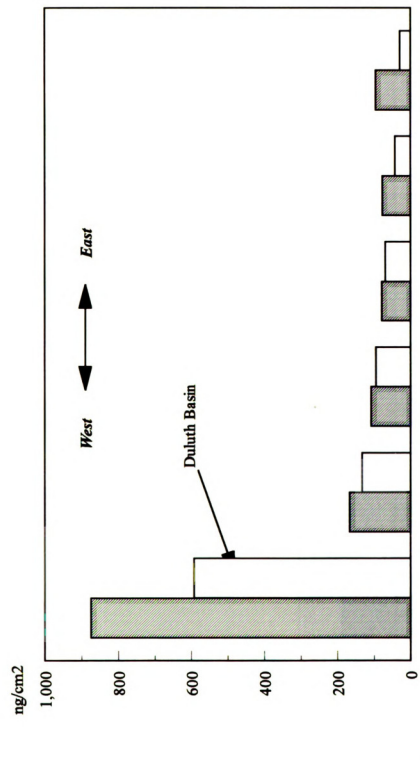


Figure 64. Mercury Sediment Inventories for the Great Lakes



	LS#2055	LS#2059	NOAA#3	LS#2048	LS#1391	LS#1383
Raw Data	874.62	166.68	107.33	78.99	76.39	94.98
F.Corrected	592.57	132.18	94.31	69.41	42.67	29.59

Figure 65. Mercury Sediment Inventories for Lake Superior

Figure 66. Mercury Inventories for Lake Michigan

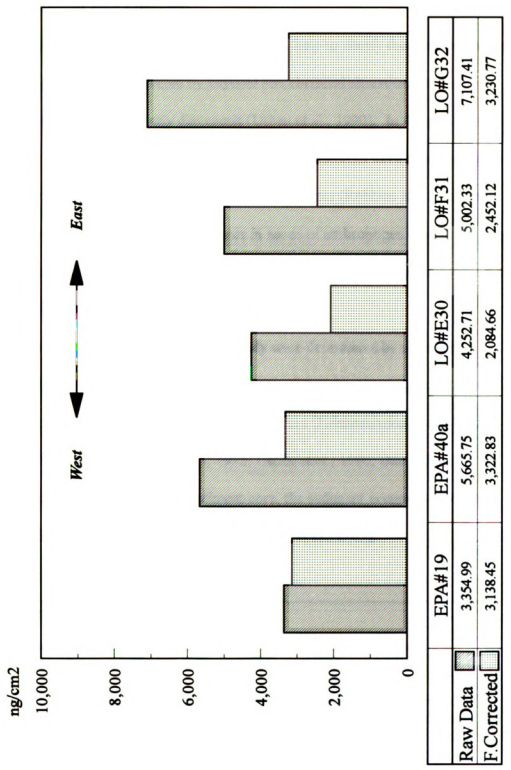


Figure 67. Mercury Sediment Inventories for Lake Ontario

5.3 Accumulation Trends for Mercury

5.3.1 - Accumulation Rate Concepts:

The accumulation rates calculated in this study help to clarify the interpretation of cores which might have been affected by physical and chemical alterations such as compacting of the sediment or early diagenesis (Urban et al., 1990). In the past , the interpretation of chemical profiles in fresh water surfical sediments have been limited by the absence of the knowledge of sediment accumulation rates (Robbins & Edgington, 1975). The use of sediment accumulation rates in zones of anthropogenic pollution may aid in the evaluation of man's influences from natural diagenesis, and allow separation of the two processes (Robbins & Edgington, 1975).

Temporal accumulation trends in this study were determined by calculating sediment accumulation rates for each core increment. Several authors agree that lead-210 is ideal for dating lake sediments as far back as 150 years (Krishnaswami et al., 1971; Koide, 1972,1973; Robbins & Edgington, 1975; Urban et al., 1990; Das & Singh, 1994). For each vertical increment in a given sediment core, the sediment accumulation rates were calculated by using the following equation (Long et al., 1995).

$$SAR^i_s\ (ug/m^2yr) = C^i_s \times W_s \times 10^4 \qquad (9)$$

where,

SAR^i_s = sediment accumulation rate (ug/m^2yr) for i^{th} metal at s^{th} sampling site,
C^i_s = background corrected concentration of i^{th} metal in the sediment (ug/g) at s^{th} site,
W_s = mass sedimentation rate (g/cm^2yr) in s^{th} site based on ^{210}Pb dating,
i = metal,
s = sediment core sampling site.

Once the sediment accumulation rates were calculated they were corrected for the variations in sediment focusing among the different sites by dividing the accumulation value by the focusing factor for that specific site. All sampling sites in this study were corrected for sediment focusing form the following equation (Long et al., 1995).

$$FCSAR^{i}_{s}\ (ug/m^2\text{-}yr) = SAR^{i}_{s} \ / \ FF \qquad (10)$$

where,

$FCSAR^{i}_{s}$ = focusing corrected sediment accumulation rate (ug/m^2yr) for i^{th} metal at s^{th} site,
i = metal,
s = sediment core sampling site.

5.3.2 - Sediment Accumulation Rate Discussion:

Sediment accumulation rates (SAR) are site dependent values. Focusing corrected sediment accumulation rates (FCSAR) provide basin and lake wide values in the absence of large point sources and allow comparisons of sediment cores with varying sedimentation rates and focusing factors (Golden et al., 1994). The average focusing corrected accumulation rates for Lakes Superior, Michigan, and Ontario are 14 ug/m^2yr, 26 ug/m^2yr, 212 ug/m^2yr respectively.

Three sites have been chosen from each of the three lakes in this study, and termed "lake representative sites". In choosing a representative site for a lake, an assumption is made that the Great Lakes are well mixed with respect to mercury, and that precipitation patterns over the Great Lakes basin is mostly uniform. Figure 68 shows the lake

representative sites as being, for Lake Superior, site NOAA 3, for Lake Michigan, site LM 68k, and for Lake Ontario, site LO 40a.

A small number of well placed sediment cores can provide accurate estimates of the whole lake or lake-wide sediment inventory of mercury. Because the lakes are well mixed with respect to mercury and other trace metals, several sediment cores that are placed in just the right spot could yield lake-wide inventory data similar to data obtained from large and expensive coring programs in which tens to hundreds of cores are used. Perhaps if this idea is valid, lake-wide representative sites would be the single representative for the entire lake when comparing anthropogenic trends between the lakes. The cores chosen for these sites must not have any unusual features which would render them unique and incomparable. These features may include zones of Mn and Fe oxide layers, bioturbation of the upper layers of sediment, erosional features, sediment slumping within the core, sediment smearing during sampling, or lead-210 dating artifacts. The sampling core logs and lead-210 dating information suggested that cores NOAA #3, LM #68k, and LO #40a were good cores to use as representative sites.

The three representative sites will provide an insight into the "basin wide" similarity between the Great Lakes in terms of onset of anthropogenic mercury pollution, dates of peak accumulation and current trends in sediment loading. Although separated by large distances the representative sites have similar characteristics. Peak accumulation occurs around 1970 for all three cores (Figure 69). Mercury emissions form chloro-alkali plants have been reduced substantially during the late 1960s and early 1970s, this might support the idea that atmospheric mercury concentrations along with the uniform

precipitation patterns over the lakes have produced an atmospheric basin-wide peak signal of around 1970. The onset of anthropogenic pollution started around 1885 for Lakes Superior and Michigan, and just after 1900 for Lake Ontario. All three sites showed a gradual increase in mercury loading from background levels between 1885 and 1920. After 1920, Lake Michigan's site displayed a much more pronounced increase in loading compared to the earlier years. This feature is identified as being the major onset of mercury loading to Lake Michigan. Lake Superior also showed a major onset around 1950, and Lake Ontario around 1940. The major onset for all three sites continued until 1970 when mercury concentrations peaked. Since 1970 mercury loading has declined to almost pre-onset levels in Lake Ontario, while Lake Michigan and Superior have only seen moderate declines (Figure 70).

Figure 70 provides another piece of evidence for the importance of non-atmospheric loading of mercury to Lake Ontario. If the atmosphere was a more important source of mercury to the lake, it would not have such a pronounced decline in mercury loading to the sediments as shown in the concentration profiles. The large decline cannot be attributed to a decrease in atmospheric mercury concentrations alone, but is accounted for by major decreases in local point sources. The closer the source of mercury, the more pronounced the sediment record will be (Smith & Loring, 1981; Mierle, 1989).

Mercury accumulation rates in Lake Ontario were greatest, followed by Lake Michigan, and Lake Superior which had the slowest rates. Mercury accumulation rates are also decreasing the greatest in Lake Ontario, with Lake Michigan slower, and Lake Superior slower still.

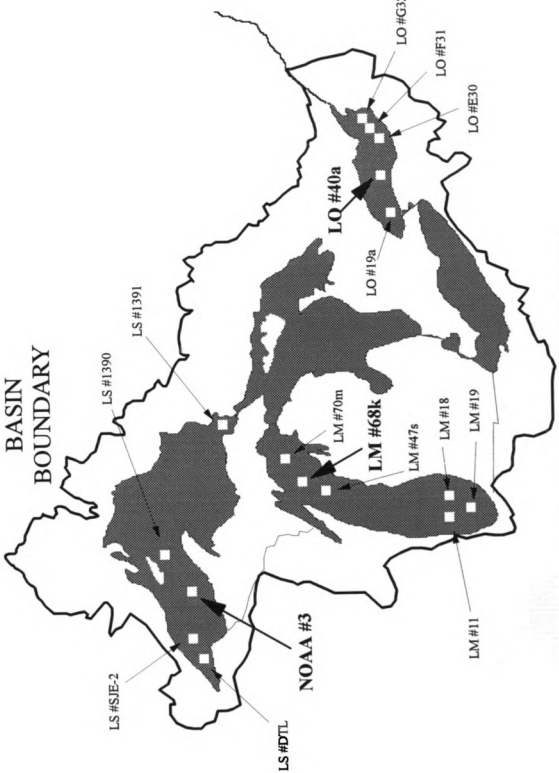


Figure 68. Diagram of sampling sites in the Great Lakes.

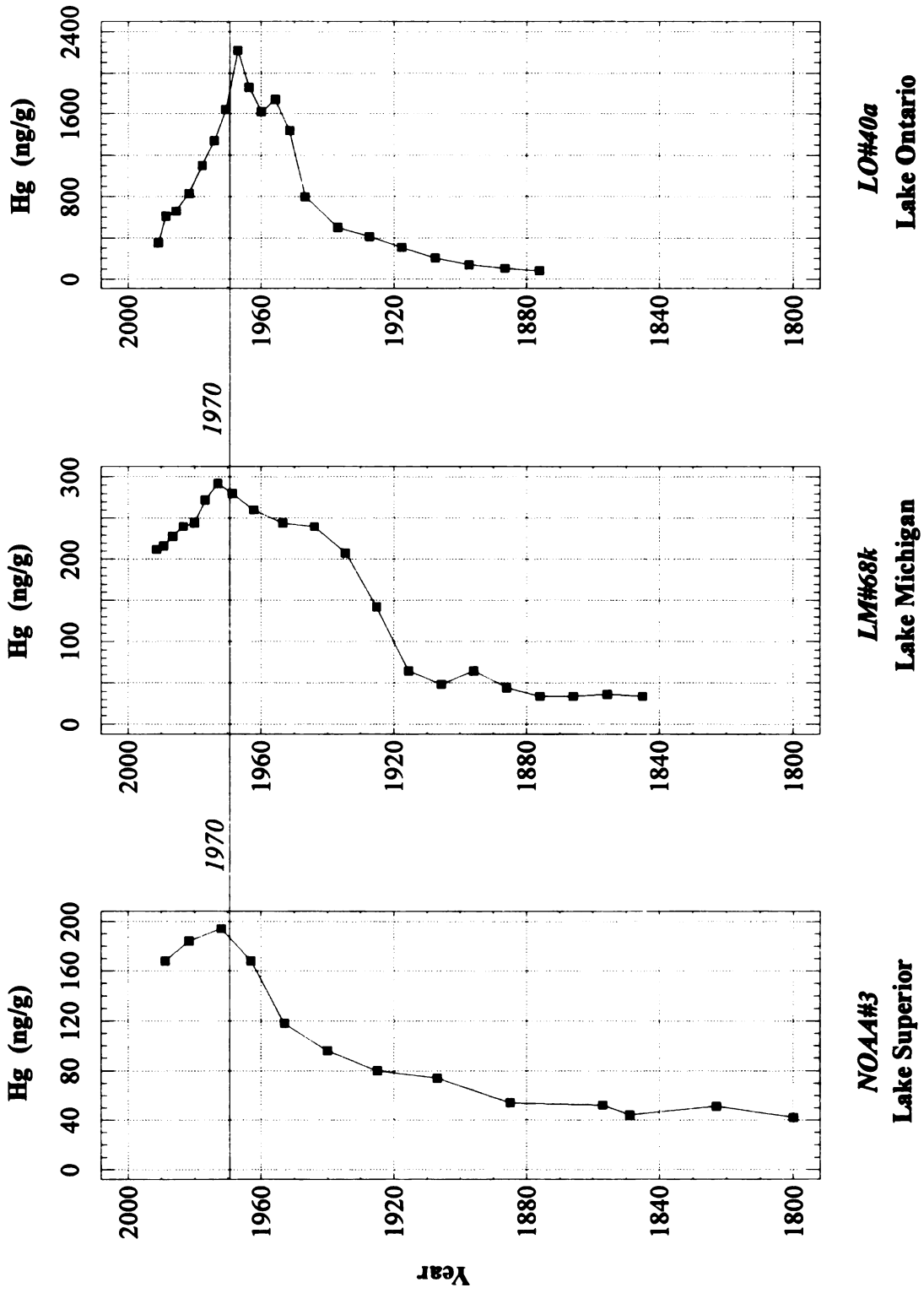


Figure 69. Representative sites for lake wide accumulation of mercury

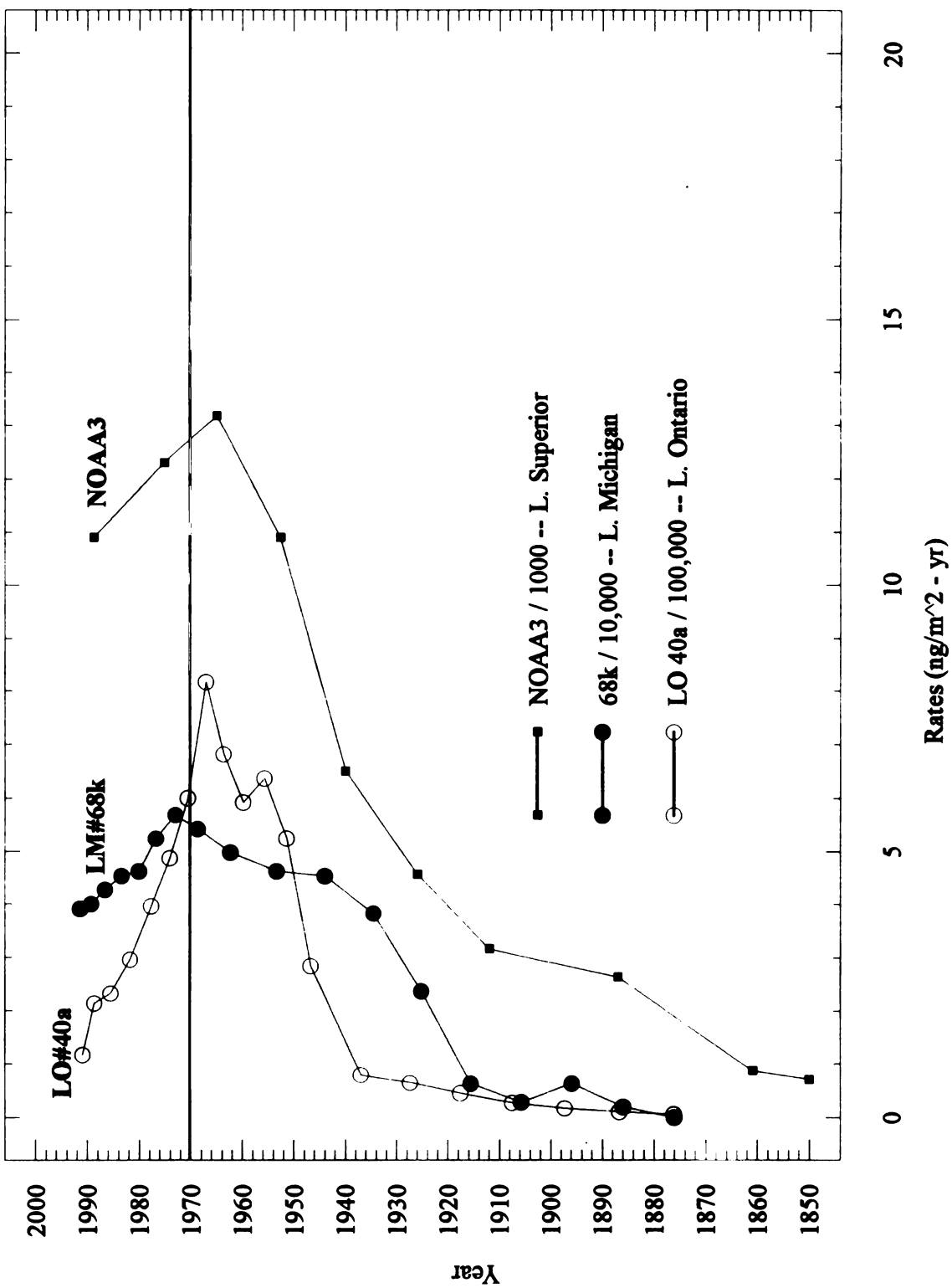


Figure 70. Mercury accumulation rates at representative sites in the Great Lakes.

The high levels of mercury present in the sediments of Lake Ontario could be due to large point sources in the region, and not the result of atmospheric deposition. Thomas et al. (1972) found that in the region of the Niagara River high mercury concentrations occur as a "plume" extending northeastwards from the Niagara source region. A branch of this plume extends along the southern shore of Lake Ontario. The Niagara River discharges 6400 m^3/sec of water into Lake Ontario (Kuntz & Warry, 1983) with an annual sediment load of 4.7 million tons of fine-grained sediment, or 52% of the total sediment input to the lake (Kemp & Harper, 1976). The sediments in this branch contain high concentrations of mercury as far as Oswego, and into the Rochester basin (Figure 71). The Oswago River enters Lake Ontario in the eastern Rochester basin at Oswago, New York. This is a major point source for Lake Ontario. Mercury laden sediment from the Oswago River enters the Rochester basin and moves in a north-northeastward direction.

Because the basins in Lake Ontario are not totally separated by underwater sills (Figure 72), the Niagara River has a significant effect on the sediment quality of the entire lake (Thomas, 1972). Particles from the Niagara River adsorb contaminants from the river water and settle temporarily in the vicinity of the river mouth. Dynamic current behavior at the mouth of the Niagara River, along with an anti-clockwise movement of contaminated sediments that occur as a plume emanating from the river mouth, push the slow settling fine particles westward into the Niagara basin. Strong wind driven surface currents push buoyant particles eastward into the Rochester basin. Movement of sediment from the Niagara River has been found to be mainly north-northeast from the mouth into Lake Ontario (Mudroch, 1982).

Fall and Winter are times of violent storms on Lake Ontario, and because of the isothermal conditions which occur during that time of the year, wind driven currents reach deep into the lake and cause a significant resuspension of the temporarily stored Niagara River sediments and redistribute it to the various basins (Oliver & Charlton, 1984). Sandilands and Mudroch (1983) suggest that the nepheloid layer in Lake Ontario is due to resuspended bottom sediments. Lake Ontario is unique when compared to the other Great Lakes in that none of the other lakes is dominated by large rivers entering near deep depositional basins and having river dominated circulation.

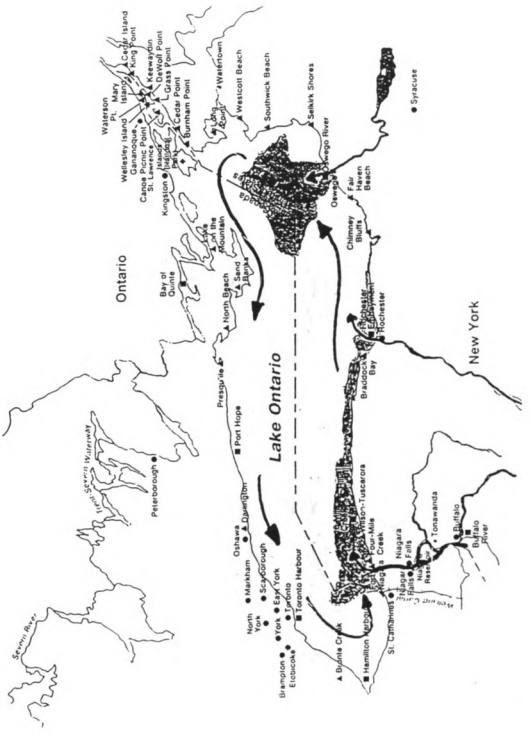


Figure 71. Mercury plumes in Lake Ontario (Thomas, 1972)

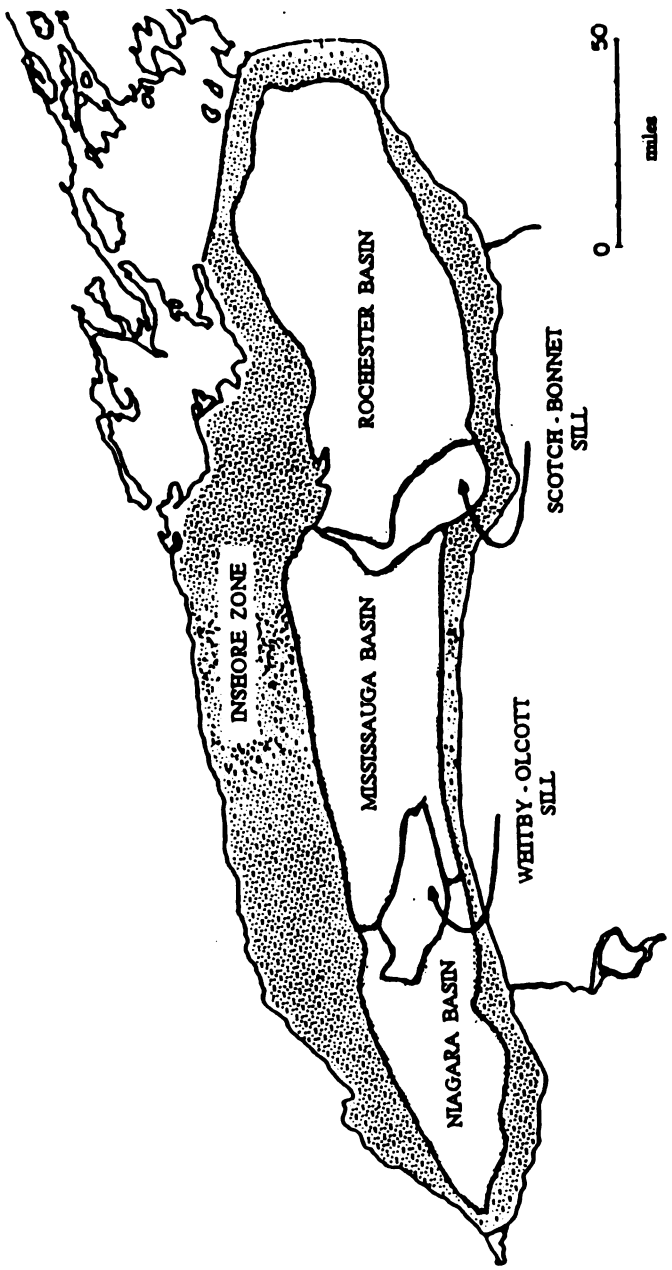


Figure 72. Depositional basins in Lake Ontario (Thomas, 1972)

5.4 Current Sediment Accumulation of Mercury

The total sediment accumulation rates of mercury are calculated by several steps. First, accumulation rates need to be calculated and corrected for variations in sediment accumulation at each sampling site. As an example, site LM 18 will be examined below in detail.

The lead-210 spreadsheet in table 6 gives a large amount of information that are used in many different ways. For this study the unsupported lead-210 and sedimentation rate data was used to calculate the focusing factors (FF), accumulation rates, and focusing corrected accumulation rates (FCAccum). The unsupported lead-210 is defined as being the lead-210 originating from atmospheric input, and for site LM 18 is 37.7311 pCi/g.

Because this study compared several cores from many basins of varying sedimentation rates, focusing factors (FF) were used to correct for these differences allowing direct comparison between all cores. Taking the unsupported lead-210 value of 37.7311 pCi/g and dividing by the average lead-210 atmospheric deposition found by Urban et al. (1990) of 15.5 pCi/g gave a focusing factor of 2.43 for site LM 18.

The accumulation rate at LM 18 was determined by multiplying the surfacial mercury concentration of 158 ng/g by the sedimentation rate of 0.040 g/cm^2yr. This resulted in a value of 63.48 ng/m^2yr. Lastly, the focusing corrected accumulation rate (FCAccum) is found by dividing the accumulation rate (63.48 ng/m2yr) by the focusing factor (2.43) which resulted in a value of 26.1 ng/m^2yr.

Table 6. Lead-210 dating information for LM 18.

(Analysis by Dan R. Engstrom, The University of Minnesota)

Top of Interval (cm)	Base of Interval (cm)	Cum. Dry Mass (g/cm^2)	Unsup. Activity (pCi/g)	Error of unsup.act (+,- S.D.)	Cum.Act. below int. pCi/cm^2	Age:Base of int. (year)	Error of Age (+,- S.D.)	Date A.D. "crs"	Sed. Accum. g/cm2yr
0.0	1.0	**0.1572**	**19.114**	0.3239	34.727	2.66	0.77	1989.0	0.0590
2.0	3.0	**0.6711**	**18.079**	0.4305	25.322	12.81	0.90	1978.9	0.0480
4.0	5.0	**1.2502**	**17.146**	0.4357	15.260	29.07	1.26	1962.6	0.0320
5.0	6.0	**1.5290**	**12.878**	0.3955	11.669	37.69	1.56	1954.0	0.0324
6.0	7.0	**1.8033**	**9.4609**	0.2585	9.0743	45.76	1.94	1945.9	0.0340
8.0	9.0	**2.3423**	**6.2175**	0.1988	5.3238	62.89	1.88	1928.8	0.0306
10.0	11.0	**2.9414**	**4.6568**	0.1164	2.3219	89.53	2.80	1902.2	0.0200
11.0	12.0	**3.2531**	**3.3232**	0.1678	1.2861	108.51	4.83	1883.2	0.0164
12.0	13.0	**3.5648**	**1.8365**	0.0660	0.7137	127.42	8.62	1864.3	0.0165
14.0	15.0	**4.1867**	**0.5726**	0.0440	0.1888	170.12	7.52	1821.6	0.0146

Date Sampled: 1991.7

Supported Pb-210: 1.0684 +/- 0.0244 pCi/g

Unsupported Pb-210: **37.7311 pCi/g**

Sedimentation Rate: **0.040 g/cm^2yr** to 11.5 cm. *cf:cs determined*

0.018 g/cm^2yr below 11.5 cm. *cf:cs determined*

Calculations for Accumulation Rates using ^{210}Pb

- Focusing Factor: 37.7311 pCi/g + 15.5 pCi/g = **2.43**
- Accumulation Rate: 158.7 ng/g × 0.040 g/cm2/yr × 10^4 × 10^{-3} = **63.48**
- ACCUM / FF: 63.48 / 2.43 = **26.1**

Table 7. Site Information and Locations.

Lake	*Site*	*Year*	*Water Depth*	*Location*	*Location*
			m	Lat. (N)	Long (W)
Superior	LS#DTL	1990	-	46° 50' 50 "	91° 45' 11"
	LS#SJE2	1990	244	47° 02' 00"	91° 17" 94"
	NOAA3	1990	180	47° 19' 89"	89° 15' 14"
	LS#1390	1986	-	47° 39' 24"	87° 57' 98"
	LS#1391	1986	-	46° 45' 40"	84° 47' 09"
Michigan	LM#70m	1993	147	45° 40' 00"	86° 10' 00"
	LM#68k	1992	194	45° 05' 59"	86° 22' 59"
	LM#47s	1992	177	44° 41' 47"	86° 41' 04"
	LM#11	1991	110	42° 22' 36'	86° 59' 05"
	LM#18	1991	151	42° 44' 44"	87° 00' 10"
	LM#19	1991	86	42° 44' 00"	86° 35' 00"
Ontario	LO#19	1991	90	43° 22' 15"	79° 22' 11"
	LO#40a	1991	189	43° 37' 00"	78° 05' 00"
	LO#E30	1986	213	43° 32' 16"	76° 54' 03"
	LO#F31	1986	179	43° 35' 11"	76° 48' 00"
	LO#G32	1986	144	43° 39' 17"	76° 41' 99"

Table 8. Accumulation Rates of Mercury in the Great Lakes

Lake	*Site*	*Surface Conc. adjusted*	*Sed. Rate*	*Accum. Rate*	*FF*	*Accum / FF*	*^{210}Pb dating method*
		Hg (ng/g)	g/cm^{2}yr	ng/m^{2}yr		ng/m^{2}yr	
Superior	LS#DTL	96.0	0.0342	32.8	1.48	22.2	cf:cs
	LS#SJE2	63.0	0.0267	16.8	1.26	13.3	cf:cs
	NOAA3	124.0	0.0123	15.3	1.14	13.4	cf:cs
	LS#1390	117.7	0.0390	45.9	3.21	14.3	cf:cs
	LS#1391	72.0	0.0200	14.4	1.79	8.0	cf:cs
Michigan	LM#70m	109.8	0.0314	34.5	1.56	22.1	cf:cs
	LM#68k	177.2	0.0280	49.6	1.27	39.1	cf:cs
	LM#47s	164.0	0.0320	52.5	1.34	39.2	cf:cs
	LM#11	91.6	0.0490	44.9	1.99	22.5	cf:cs
	LM#18	158.7	0.0400	63.5	2.43	26.1	cf:cs
	LM#19	179.9	0.0230	41.4	1.22	34.0	cf:cs
Ontario	LO#19	1117.1	0.0302	337.4	1.07	315.4	cf:cs
	LO#40a	311.8	0.0639	199.2	1.71	116.9	cf:cs
	LO#E30	560.0	0.0683	382.5	2.04	187.5	cf:cs
	LO#F31	866.1	0.0310	268.5	1.72	156.1	cf:cs
	LO#G32	500.0	0.0815	407.5	2.20	185.2	cf:cs

From the FCAccum value, which is calculated for every site, the current lake wide accumulation rate (CAccum) for mercury is found by: (Long et al, 1995).

$$CAccum^{i}_{s} = FCAccum^{i}_{l} \times SA_{l} \qquad (11)$$

where,

$CAccum^{i}_{s}$ = current lake-wide sediment accumulation rate (ng/m^2yr) for i^{th} metal in the sediment at the s^{th} site,
$FCAccum^{i}_{s}$ = focusing corrected lake-wide sediment accumulation rate (ng/m^2yr) for i^{th} metal in the sediment in *l*th lake,
SA_l = surface area of *l*th lake,
i = metal,
l = lake.

The lake-wide focusing corrected sediment accumulation rate (FCAccum) for mercury are taken from the already established results of this study and are calculated from the following equation (Long et al, 1995).

$$FCAccum^{i}_{l} = \sum CASAR^{i}_{s} / n_j \qquad (12)$$

where,

$FCAccum^{i}_{l}$ = focusing corrected lake-wide sediment accumulation rate (ng/m^2yr) for i^{th} metal in l^{th} lake,
$CASCAR^{i}_{s}$ = current anthropogenic sediment accumulation rate (ng/m^2yr) for i^{th} metal at s^{th} site in a lake,
i = metal,
s = sediment core site,
l = lake,
n_j = number of sites.

5.5 Atmospheric Deposition Estimates of Mercury to the Great Lakes

Only then, after generating the previous values can an estimate of the relative importance of atmospheric deposition (%Atmo) for mercury be calculated (Long et al, 1995).

$$\%Atmo = (RAtmo\text{-}depo^{i}_{l} / FCAccum^{i}_{l}) \times 100 \qquad (13)$$

where,

%Atmo = relative importance of atmospheric deposition of a metal in a lake,
$FCAccum^{i}_{l}$ = focusing corrected lake-wide sediment accumulation rate (ng/m^2yr) for i^{th} metal in l^{th} lake,
$RAtmo\text{-}depo^{i}_{l}$ = possible revision to the estimates of atmospheric deposition (ng/m^2yr) of ith metal in *l*th lake (Eisenreich & Strachan,1992),
i = metal,
l = lake.

The atmospheric deposition of mercury (Atmo-depo) was calculated from atmospheric fallout data by Eisenreich and Strachan (1992). This data was collected over the entire Great Lakes basin and will be used with the data generated from this study to determine the importance of atmosphere as a source of mercury to the waters and sediment of the Great Lakes (Table 8). The FCAccum data from this study will be compared directly with the Atmo-depo values generated by Eisenreich and Strachan (1992). If the FCAccum values are close to the Atmo-depo values, then the suggested value for the representative lake will be the FCAccum data. However, if the numbers differ in large amounts, as in Lake Ontario, the Atmo-depo values will be used as the

suggested value, and will be renamed as the atmospheric deposition revision (Ratmo-depo).

Lake Superior - The FCAccum rate is less than the Atmo-depo value. Therefore, the FCAccum value of 14 ug/m^{2}yr is chosen as the Ratmo-depo. The CAccum rate was calculated to be 1150 kg/yr, which results in the input of mercury to lake Superior as 100 % atmospheric.

Lake Michigan - The FCAccum rate is considered the same as the Atmo-depo value. Thus, one again the FCAccum is taken as the Ratmo-depo. The CAccum rate was calculated to be 1610 kg/yr, which results in the input of mercury to Lake Michigan as 100 % atmospheric.

Lake Ontario - Because the FCAccum rate for Lake Ontario is significantly higher than the Atmo-depo value, the 30 ug/m^{2}yr Atmo-depo value is chosen as the Ratmo-depo. This value is more consistent with the data from Lakes Superior and Michigan. The Caccum rate was calculated to be 13,500 kg/yr, which results in the input of mercury to Lake Ontario as 14 % atmospheric.

When viewing the accumulation rate graphs it is important to notice that the uncorrected sediment accumulation varies widely between the sites in each of the lakes. When corrected for the sediment focusing the accumulation rates for mercury reduce to similar values. This factor allows us to suggest that the lakes are behaving as well mixed systems homogenizing the contaminant signal.

The mercury accumulation in Lake Ontario is 8 times higher than that of Lakes Superior and Michigan (Figure 73). In Lake Superior, there appears to be a slight west to east gradient in sediment accumulation with the highest accumulation occurring in the

Duluth basin (Figure 74). For Lake Michigan there does not seem to be any accumulation gradient for mercury (Figure 75). The Lake Ontario accumulation graph shows the affect of the Niagara River as a major pollutant source to the lake. Site LO 19 which is just northeast of the river mouth had the highest corrected accumulation rate of any of the lake cores. The rates for LO 19 were 2.5 times higher than the average of the other cores. Sites LO-E30 and LO-G32 in the Rochester basin just outside of the Oswago River also had very high accumulation rates (Figure 76). These results suggest that the findings of other researchers (noted earlier) that these two rivers are major point sources to Lake Ontario are confirmed by our results on the sediment contamination of mercury. The focusing corrected accumulation rates for mercury show a strong gradient in the order of highest to lowest: Lake Ontario >> Lake Michigan > Lake Superior.

Table 8. Current Accumulation rates and atmospheric deposition of mercury.

Lake Superior

	Hg	*Notes*
CAccum	1150 kg/yr	lake-wide
FCAccum	14 ug/m^2yr	this study
Atmo-depo	26.54 ug/m^2yr	E & S (1992)
RAtmo-depo	14 ug/m2yr	suggested value
%Natural	26 %	Long et al. (1995)
%Atmo	100 %	this study

Lake Michigan

	Hg	*Notes*
CAccum	1618 kg/yr	lake wide
FCAccum	28 ug/m^2yr	this study
Atmo-depo	27.14 ug/m^2yr	E & S (1992)
RAtmo-depo	28 ug/m^2yr	suggested value
%Natural	17 %	Long et al. (1995)
%Atmo	100 %	this study

Lake Ontario

	Hg	*Notes*
CAccum	4210 kg/yr	lake wide
FCAccum	216 ug/m^2yr	this study
Atmo-depo	29.14 kg/yr	E & S (1992)
RAtmo-depo	30 ug/m^2yr	suggested value
%Natural	11 %	Long et al. (1995)
%Atmo	14 %	this study

E & S = Eisenreich and Strachan (1992)

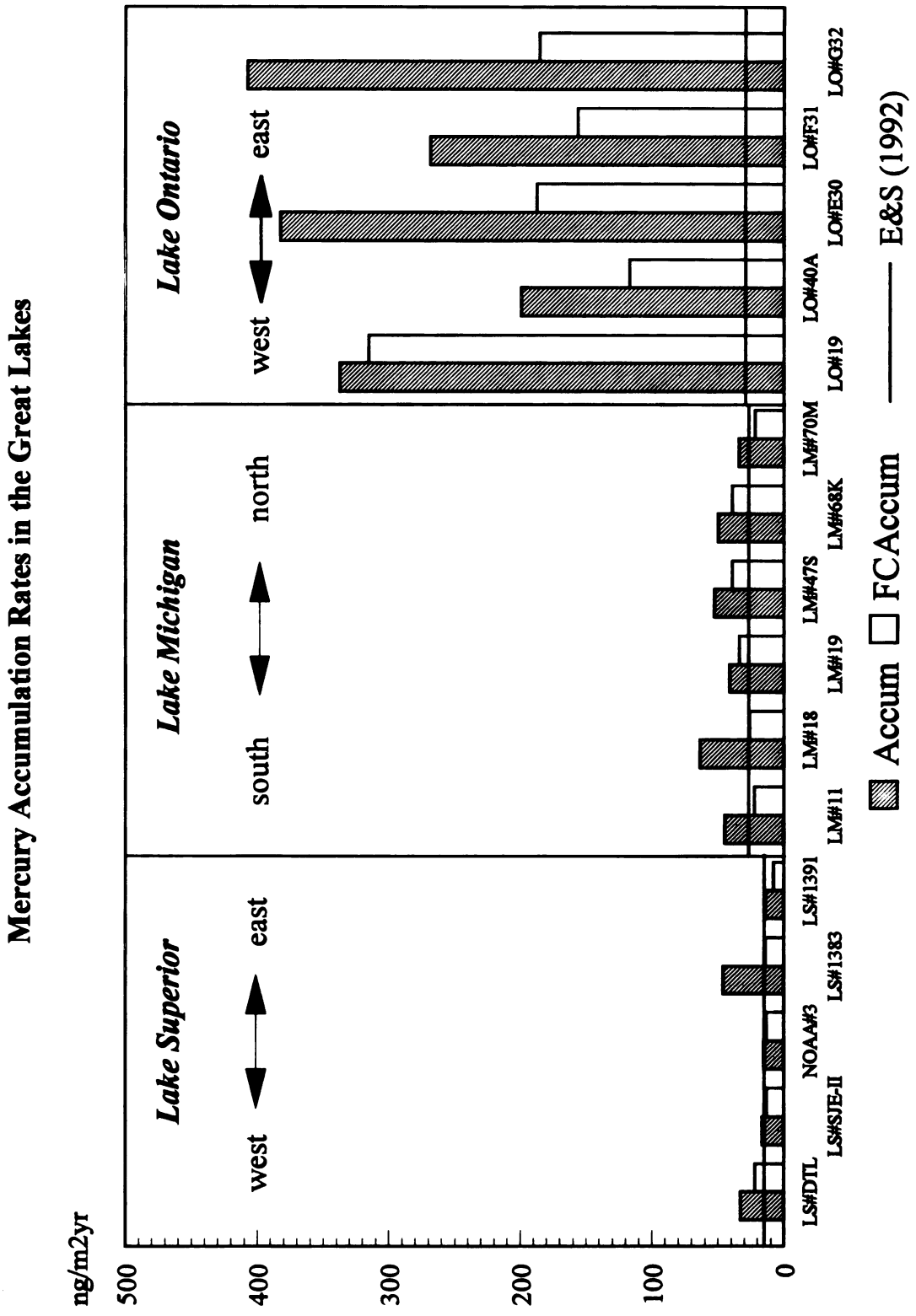


Figure 73. Accumulation rates for mercury in the Great Lakes

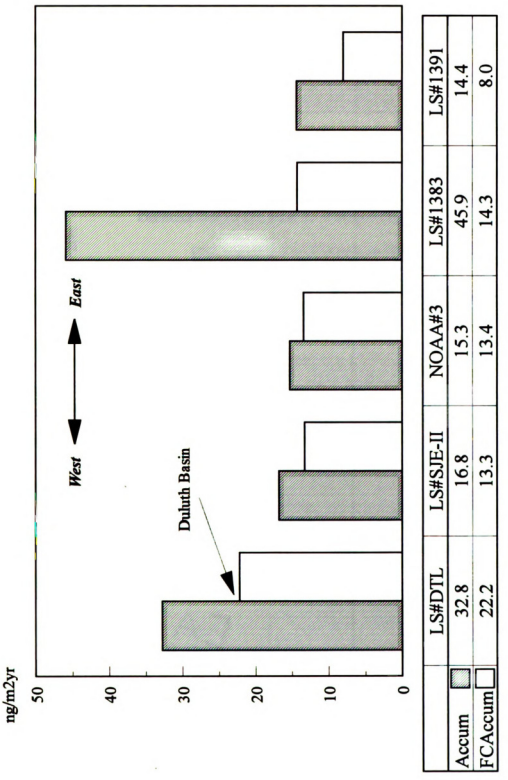


Figure 74. Accumulation rates of mercury in Lake Superior

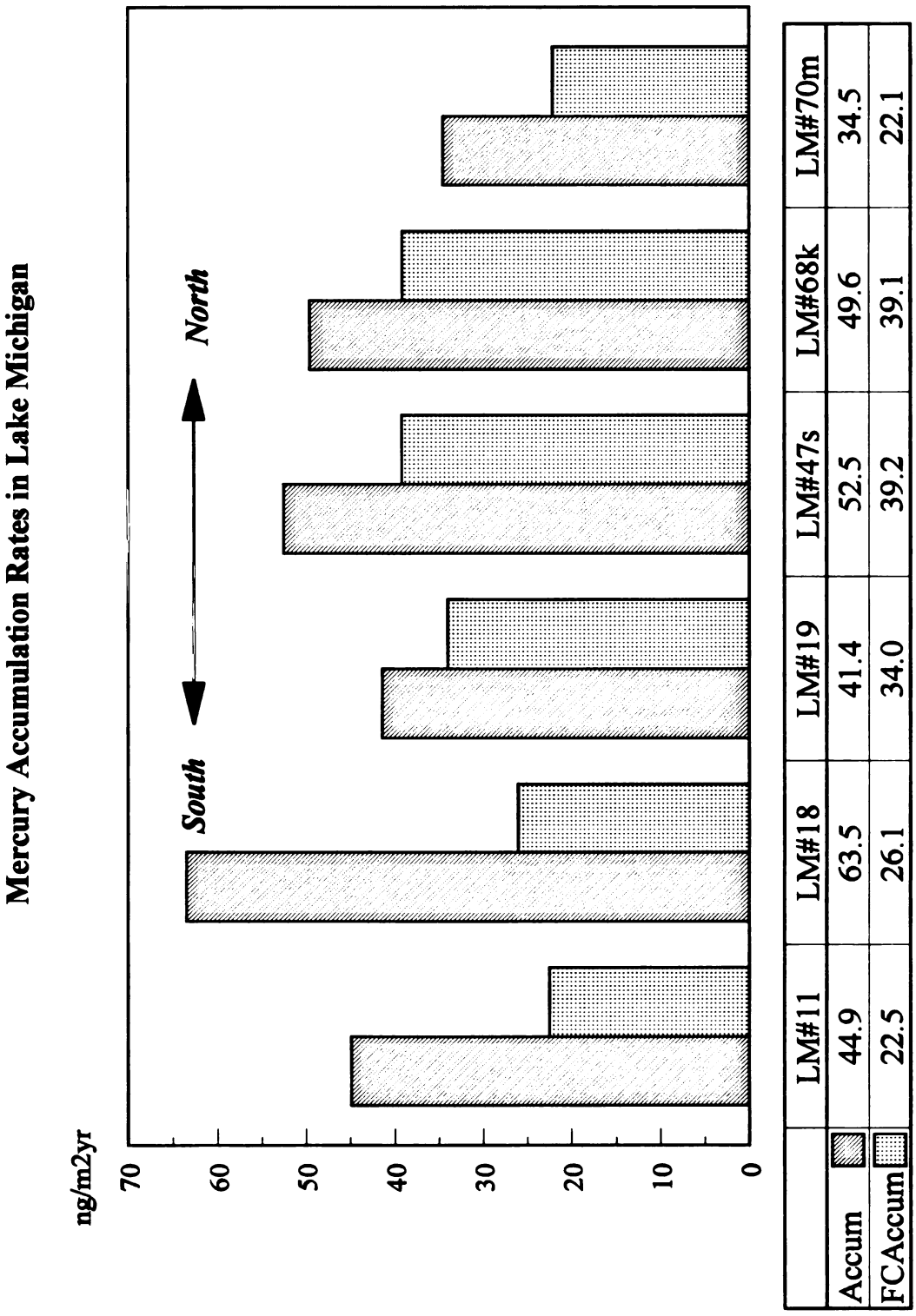


Figure 75. Accumulation rates of mercury in Lake Michigan

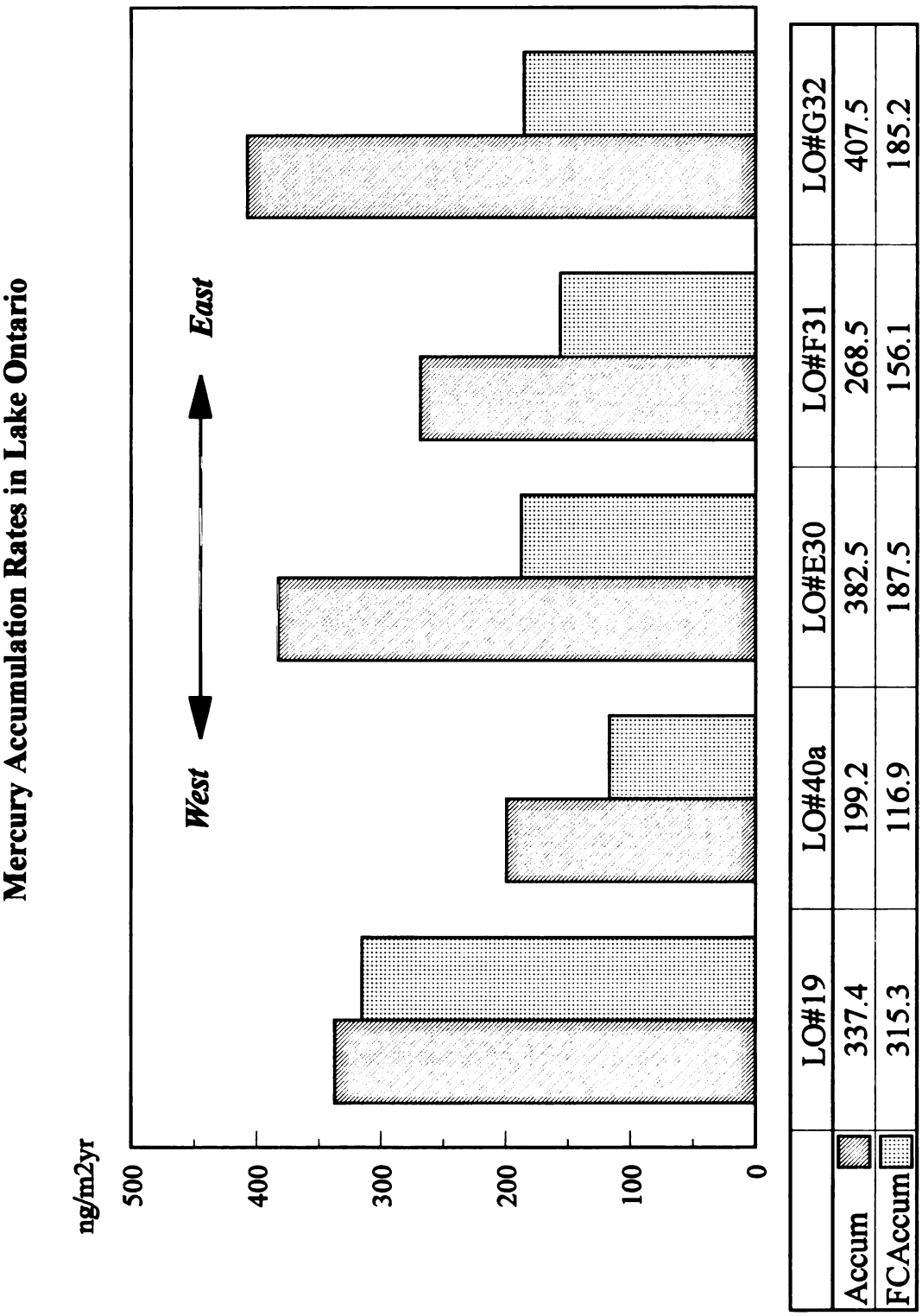


Figure 76. Accumulation rates for mercury in Lake Ontario

VI: CONCLUSIONS

The build-up of anthropogenic mercury in the Great Lakes began in the late 1800s and reached a peak during the 1960s and early 1970s. The early source of mercury to the lakes is believed to have been derived from the burning of coal (Nriagu, 1986). The emergence of cities like Chicago, Detroit, Buffalo, and Cleveland as industrial centers resulted in large amounts of airborne mercury to the Great Lakes basin. Atmospheric mercury was washed out in rain and snow events to fall directly on the lakes surfaces. The continued addition of anthropogenic mercury to "natural levels" of mercury in sediments resulted in degradation of the Great Lakes water quality. Billions of dollars later, the governments of Canada and the United States have finally reversed this trend in mercury loading. Every core site in this study has shown decreasing trends in mercury accumulation.

Sediment cores collected from Lake Superior, Lake Michigan, and Lake Ontario, allowed an examination of regional and local trends in addition to regional gradients of mercury accumulation. Because this study was developed in response to The Great Lakes Water Quality Agreement and Annex 15 of the Water Quality Amendments, assumptions were made in the proposal stage as to the expected results of mercury loading and gradients. Perhaps the most interesting result was the unexpected insignificance of the atmosphere as being the major source of mercury to Lake Ontario. Only 10-14% of the

mercury found in Lake Ontario sediments are of atmospheric origin. In contrast, Lake Superior and Lake Michigan derived nearly all of their mercury input from atmospheric sources.

This study anticipated that there was going to be a significant south to north decreasing gradient for mercury loading in Lake Michigan.. It was believed that the influence of urban activity on the atmospheric signal would be assessed by comparing the mercury flux from northern to southern Lake Michigan cores, with direct point sources in the southern part of the lake adding to the lake burden of mercury. The Milwaukee to Muskegon sill in south-central Lake Michigan (Figure 77) was thought to split the lake into two sections for contaminant accumulation, with significant atmospheric contribution to the southern part from Chicago and Gary, IN. What was found instead was that Lake Michigan had no north-south or south-north gradients. The air being released from Chicago and Gary was drifting over the entire surface area of the lake. Inventories and accumulation rates for mercury as well as arsenic, lead and cadmium were as high or higher in the north basin of Lake Michigan. Site LM 70m in the far northern part of Lake Michigan had mercury accumulation rates which matched the values found in Lake Superior rather than those of the rest of Lake Michigan.

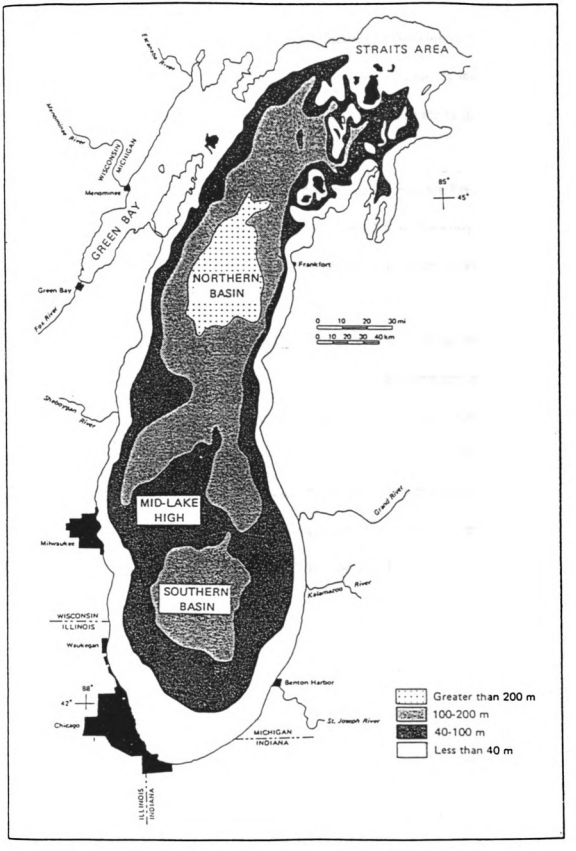


Figure 77. Depositional basins in Lake Michigan (Nriagu, 1984)

Lake Superior data for mercury exhibit concentrations, accumulation rates, and inventories that yield the same results after sediment focusing. The Duluth basin, and more specifically site LS DTL, displayed a significant increase in mercury inventory relative to the rest of Lake Superior. This result was expected because of the proximity of the site to Duluth and the St. Louis River inlet.

In Lake Ontario site LO 19, just to the northwest of the Niagara River inlet, had the highest accumulation rates for mercury of any core sampled in this study. Several major point sources in the Niagara River valley contributed to the high concentration values in western Lake Ontario.

The results show that trends in sediment accumulation rates of mercury among and within lakes are similar and increase from Lake Superior to Lake Michigan to Lake Ontario. When sediment accumulation rates are compared to estimated atmospheric deposition rates (focusing corrected sediment accumulation rate / atmospheric accumulation rate) x 100) it was found that Lake Superior and Michigan had a 100% atmospheric mercury signal, while Lake Ontario was only 9%. Non-atmospheric inputs appear to the most important source of mercury for Lake Ontario.

5.1 Overview of Results

- Build up of anthropogenic mercury started in the late 1870s.
- Dates of peak accumulation for mercury vary among the lakes:
  1971 for Lake Superior, 1973 for Lake Michigan, and 1967 for Lake Ontario.
- Mercury enters the Great Lakes from various sources and through different media, and mercury input has been found to be spatially variable around the lakes. However, mercury inventories and accumulation rates corrected for sediment focusing indicate that each lake is behaving as a well mixed system despite the heterogeneous inputs.
- The Sediments of Lake Superior have been contaminated the least with mercury, while Lake Ontario has become heavily contaminated, and is the most impacted lake.
- Mercury has not been affected by active redox zones or Fe & Mn oxide layers in the sediment. Mercury is very strongly sorbed onto sediment particles.
- The current trends in mercury accumulation have been in decline from their 1970s peak values in all of the lakes.
- Natural inputs of mercury account for less than 50% for Lakes Superior and Michigan, and less than 11% for Lake Ontario.
- Atmospheric mercury is a significant source ($\approx$ 100%) in Lake Superior and Lake Michigan, while in Lake Ontario atmospheric sources contribute only 10% of the mercury found in the sediments. Point sources are the major source for mercury in Lake Ontario.
- Anthropogenic mercury concentrations in the sediments of Lake Ontario can be strongly correlated to the emissions of chloro-alkali plants in the Niagara River basin and Northern New York, the agricultural use of mercury, and the use of mercury in the paint industry. The Industrial use of mercury in the Lake Ontario basin also contributes to the total flux.
- Point sources for mercury in Lakes Superior and Michigan are more difficult to detect. This was a very unexpected result. Possible non-atmospheric sources of mercury to Lake Superior is the St. Louis River near Duluth, MN, and for Lake Michigan, the Fox River/Green Bay area, the Grand River in Michigan, and the Grand Calumet River near Chicago.

Table 9. Environmental Data for Mercury in the Great Lakes.

PARAMETER	SUPERIOR	MICHIGAN	ONTARIO
Relative Inventories	low	low	high
Atmospheric Source	100 %	100 %	14 %
Recent Accumulation Trend	decreasing	decreasing	decreasing
Peak Accumulation Date	1971	1973	1967
Peak Source Match	Chloro-alkali ?	Chloro-alkali ?	Chloro-alkali Industrial agriculture
Peak Source Medium	atmosphere	atmosphere	Niagara River Oswego River
Current Accumulation Rate	1150 kg/yr	1610 kg/yr	4210 kg/yr
Anthropogenic Burden	4.80×10^4 kg	8.78×10^4 kg	54.6×10^4 kg
Present Natural Input	26 %	17 %	11 %

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ACCUMULATION AND INVENTORY OF MERCURY IN SEDIMENTS OF THE GREAT LAKES

(with appendix data for arsenic, cadmium, and Lead)

• Volume 2 •

By:

William J. Sitarz

A THESIS

Submitted to
Michigan State University
in partial fulfillment of the requirements
for the degree of

MASTER OF SCIENCE

Department of Geological Sciences

1996

APPENDICES

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APPENDIX A:

Sediment Core Descriptions

Table A-1:
Site LS #DTL - Duluth Basin, Lake Superior
1990 - Sediment Core Description
46°50'50" N - 91°45'11" W

Sample	Interval (cm)	Thickness (cm)	Description
1	0.0-0.5	0.5	Reddish mud.
2	0.5-1.0	0.5	Reddish mud.
3	1.0-1.5	0.5	Reddish mud.
4	1.5-2.0	0.5	Reddish mud.
5	2.0-2.5	0.5	Reddish mud.
6	2.5-2.75	0.25	mud above redox zone.
7	2.75-3.0	0.25	Black redox zone.
8	3.0-3.10	0.1	Very thin iron redox zone.
9	3.10-3.35	0.25	Red layered mud.
10	3.35-3.85	0.5	Red layered mud.
11	3.85-4.35	0.5	Red layered mud.
12	4.35-4.85	0.5	Red layered mud.
13	4.85-5.35	0.5	Mud somewhat darker.
14	5.35-5.85	0.5	Darker Mud.
15	5.85-6.35	0.5	Alot of slag in a dark mud.
16	6.35-7.35	1.0	Slag material in a dark mud.
17	7.35-8.35	1.0	Slag amount decreasing.
18	8.35-9.35	1.0	Little slag material left.
19	9.35-10.35	1.0	Black layer (1mm thick).
20	10.35-11.35	1.0	No black layers left.
	11.35-12.35	1.0	--- Skip ---
21	12.35-13.35	1.0	Dark mud.
	13.35-14.35	1.0	--- Skip ---
22	14.35-15.35	1.0	Dark mud.
	15.35-16.35	1.0	--- Skip ---
23	16.35-17.35	1.0	Dark mud.
	17.35-18.35	1.0	--- Skip ---
24	18.35-19.35	1.0	Dark mud.

Table A-2:
Site LS #SJE-II - Duluth Basin, Lake Superior
1990 - Sediment Core Description
47°02'00" N - 91°17'94" W
Depth = 244 m

Sample	Interval (cm)	Thickness (cm)	Description
1	0.0-0.5	0.5	Brown muddy sediment.
2	0.5-1.0	0.5	Brown muddy sediment.
3	1.0-1.5	0.5	Brown muddy sediment.
4	1.5-2.0	0.5	Brown grading to gray colored sediment.
5	2.0-2.5	0.5	Sediment darkening.
6	2.5-3.0	0.5	Dark sediment.
7	3.0-3.5	0.5	Dark sediment.
8	3.5-4.0	0.5	Dark sediment, appears mottled.
9	4.00-4.25	0.25	Mottled, Mn oxide layer, dark sediment.
10	4.25-4.40	0.15	Redox zone, 4.40 to 4.50 cm increment was thrown away.
11	4.5-5.0	0.5	Slight color change to reddish.
12	5.00-5.25	0.25	Reddish colored mud.
13	5.25-5.65	0.4	Better developed redox zone.
14	5.65-6.05	0.4	Redox zone with interspaced material.
15	6.05-6.55	0.5	Redox zone with wet mud.
16	6.55-7.05	0.5	Redox zone ending, wet mud.
17	7.05-7.55	0.5	Brown-red uniform mud.
18	7.55-8.55	1.0	Brown-red uniform mud.
19	8.55-9.55	1.0	Small (<1mm) black band.
	9.55-10.55	1.0	---Skip---
20	10.55-11.55	1.0	Dark streaks in sediment.
21	11.55-12.55	1.0	Mostly lighter sediment.
22	12.55-14.55	2.0	Large dark band (2mm thick).
	14.55-16.55	2.0	---Skip---
23	16.55-18.55	2.0	Dark material fades out.
	18.55-20.55	2.0	---Skip---
24	20.55-22.55	2.0	Dark material fades out.

Table A-3:

Site NOAA #3 - Chefswet Basin, Lake Superior

1990 - Sediment Core Description

47°19'89" N - 89°15'14" W

Depth = 180 m

Number	Interval (cm)	Thickness (cm)	Description
1	0.0-0.5	0.5	Tan-soupy mud.
2	0.5-1.0	0.5	Tan mud.
3	1.0-1.5	0.5	Tan mud.
4	1.5-2.0	0.5	Tan mud.
5	2.0-2.5	0.5	Tan mud.
6	2.5-3.0	0.5	Numerous small clinkers.
7	3.0-3.5	0.5	Firmer, gray mottled toward base.
8	3.5-4.0	0.5	Darker material present, clinkers also present.
9	4.0-5.0	1.0	Redox zone at base.
10	5.0-5.25	0.25	Brown to dark green redox zone.
11	5.25-5.5	0.25	Red redox material.
12	5.5-6.0	0.5	Tan clay.
13	6.0-6.5	0.5	Tan clay, redox crust.
14	6.5-7.0	0.5	Gray-tan clay.
15	7.0-8.0	1.0	Gray-tan clay.
16	8.0-9.0	1.0	Gray-tan clay.
	9.0-14.0	5.0	***Skip***
17	14.0-15.0	1.0	Gray-tan clay.

Table A-4:
Site LS #1390 - Isle Royale Basin, Lake Superior
1986 - Sediment Core Description
47°39'24" N - 87°57'98" W

Number	Interval (cm)	Thickness (cm)	Description
1	0.0-1.0	1.0	Greenish-brown wet fluff.
2	1.0-2.0	1.0	Greenish-brown wet fluff.
3	2.0-3.0	1.0	Greenish-brown fluff, tan contact near base.
4	3.0-3.5	0.5	Tan sediment, slightly drier.
5	3.5-4.0	0.5	Greenish-black sticky material, possible start of redox.
6	4.0-4.5	0.5	Flaky dry pale orange sediment, redox boundry.
7	4.5-5.5	1.0	Gray, wet sticky clay.
8	5.5-6.5	1.0	Gray, wet sticky clay.
9	6.5-8.5	2.0	Gray, wet sticky clay.
10	8.5-10.5	2.0	Gray, wet sticky clay.
11	10.5-12.5	2.0	Gray, wet sticky clay.
12	12.5-14.5	2.0	Gray, wet sticky clay.
13	14.5-17.5	3.0	Gray, wet sticky clay.
14	17.5-20.5	3.0	Gray, wet sticky clay.
15	20.5-24.5	4.0	Gray, wet sticky clay.
16	24.5-28.5	4.0	Gray, wet sticky clay.
17	28.5-32.5	4.0	Gray, wet sticky clay.
18	32.5-36.5	4.0	Gray, wet sticky clay.

** Remainder of sediment discarded.**

Table A-5:

Site LS #1391 - Isle Parisienne Basin, Lake Superior

1986 - Sediment Core Description

46°45'40" N - 84°47'09" W

Sample Number	Sediment Interval (cm)	Description
1	0.0-1.0	Brown fluff material.
2	1.0-2.0	Dark Brown sediment.
3	2.0-3.0	Very dark brown \ sandy.
4	3.0-3.5	Redox zone, black-red sediment.
5	3.5-4.5	Light red sediment.
6	4.5-5.5	Black material below redox.
7	5.5-6.5	Light gray \ black sediment.
8	6.5-8.5	Light gray \ black sediment.
9	8.5-10.5	Light gray \ black sediment
10	10.5-11.5	End of black sediment.
11	11.5-14.5	Gray sediment.
12	14.5-16.5	Gray sediment.
13	16.5-19.5	Gray sediment.
14	19.5-23.5	Gray sediment.
15	23.5-28.5	Gray sediment.

Table A-5:
Site LM #70m - North Algoma Basin, Lake Michigan
1993 - Sediment Core Description
45°40'00" N - 86°10'00" W
Depth = 147 m

Sample	Interval (cm)	Thickness (cm)	Description
1	0.0-0.5	0.5	Runny, flocculent. Greenish-brown-gray. Worm holes, lots of pont.
2	0.5-1.0	0.5	Still flocculent, greenish-brown-gray sediment with burrowing.
3	1.0-1.5	0.5	Browner sediment, burrowing
4	1.5-2.0	0.5	Brown-green-gray sediment, smoother.
5	2.0-2.5	0.5	Brown-green-gray sediment.
6	2.5-3.0	0.5	Brown-green-gray sediment.
7	3.0-3.5	0.5	Brown-green-gray sediment.
8	3.5-4.0	0.5	Brown-green-gray sediment. 1 thin red worm, 1inch long.
9	4.0-4.5	0.5	Same as 7, with 1 worm, begin to see some thicker gray material.
10	4.5-5.0	0.5	Same as 9.
11	5.0-5.5	0.5	Brownish-gray with tiny black specks, slightly thicker material, two worms.
12	5.5-6.0	0.5	Top half brown-gray, bottom half dark gray, thicker material, 1 worm.
13	6.0-6.5	0.5	All dark gray, thick and stands up well.
14	6.5-7.0	0.5	Dark gray, one rock (1 cm diam.) discarded.
15	7.0-7.5	0.5	Dark gray, bottom half is almost black and is thicker and chunkier.
16	7.5-8.0	0.5	Very dark gray and thick.
17	8.0-8.5	0.5	Immediately changes to gray, not as thick as 16.

Table A-5: Continued

Sample	Interval (cm)	Thickness (cm)	Description
18	8.5-9.0	0.5	Gray sediment.
19	9.0-9.5	0.5	Gray sediment.
20	9.5-10.0	0.5	Gray sediment, thicker.
21	10.0-11.0	1.0	Gray sediment.
22	11.0-12.0	1.0	Gray sediment.
23	12.0-13.0	1.0	Gray sediment.
24	13.0-14.0	1.0	Gray sediment
25	14.0-15.0	1.0	Gray sediment.
26	15.0-16.0	1.0	Gray sediment.
27	16.0-17.0	1.0	Gray sediment.
28	17.0-18.0	1.0	Gray sediment.
29	18.0-19.0	1.0	Gray sediment.
30	19.0-20.0	1.0	Gray sediment.
31	20.0-21.0	1.0	Gray sediment.
32	21.0-22.0	1.0	Gray sediment, thicker.
SKIP	22.0-25.0	3.0	** Sediment discarded **
33	25.0-26.0	1.0	Gray sediment.
SKIP	26.0-29.0	3.0	** Sediment discarded **
34	29.0-30.0	1.0	Gray sediment.
SKIP	30.0-33.0	3.0	** Sediment discarded **
35	33.0-34.0	1.0	Gray sediment.
SKIP	34.0-37.0	3.0	** Sediment discarded **
36	37.0-38.0	1.0	Gray sediment.

Table A-9:
Site LM #11 - Southern Basin, Lake Michigan
1991 - Sediment Core Description
42°22'36" N - 86°59'05" W
Depth = 110 m

Number	Interval (cm)	Thickness (cm)	Description
1	0.0-1.0	1.0	Dark gray soupy material.
2	1.0-2.0	1.0	Dark gray soupy material.
3	2.0-3.0	1.0	Dark gray, less soupy.
4	3.0-4.0	1.0	Dark gray, almost solid.
5	4.0-5.0	1.0	Dark gray, solid material.
6	5.0-6.0	1.0	Upper part dark gray, lower 0.2 cm light red color, possible worm burrows.
7	6.0-7.0	1.0	Light gray with tan mottling, some dark spots (carbon).
8	7.0-8.0	1.0	More rigid, slightly more tan coloration and mottling, possible Fe oxides.
9	8.0-9.0	1.0	Upper part firm, lower part soupy, same coloration.
10	9.0-10.0	1.0	Sand present in this layer.
11	10.0-11.0	1.0	Higher sand content, possible Fe oxides.
12	11.0-12.0	1.0	Light tan upper portion,redox bands begin (tilted), yellow redox crust at base of section.
13	12.0-12.5	0.5	Yellow redox crust cements the sediment, 1 cm thick, remainder of section is light tan material, firm.
14	12.5-13.5	1.0	More redox material, light tan material.

Table A-9: Continued

Sample	Interval (cm)	Thickness (cm)	Description
15	13.5-14.5	1.0	light tan material with dark specks (carbon?), redox material at base with green material (vivianite?).
16	14.5-15.0	1.0	Redox crust (2) each 0.1 cm thick fe/Mn oxides, remander is light tan material.
17	15.0-15.5	0.5	Tan gray mottling material, very dry.
18	15.5-16.5	1.0	Some more redox, no sand.
19	16.5-17.5	1.0	Redox layer near bottom of section.
20	17.5-18.5	1.0	Thicker redox layer, pockets in mittle of section, dark tan blobs 2 mm across.
21	18.5-20.5	2.0	Mottling disappears.
22	20.5-22.5	2.0	Redox layer 0.75 cm from section top, some mottling, remainder is tan.
23	22.5-24.5	2.0	Redox layer, no mottling, tan with some gray material, current active redox layer (color change).
24	24.5-26.5	2.0	Light gray, several black layers, much more soupy (anoxic layers).
25	26.5-28.5	2.0	Same as 24, slightly more black material.

Table A-10:
Site LM #18 - Southern Basin, Lake Michigan
1991 - Sediment Core Description
42°44'44" N - 87°00'10" W
Depth = 151 m

Number	Interval (cm)	Thickness (cm)	Description
1	0.0-1.0	1.0	Dark gray soupy material.
2	1.0-2.0	1.0	Dark gray soupy material.
3	2.0-3.0	1.0	Dark gray, less soupy.
4	3.0-4.0	1.0	Dark gray, less soupy.
5	4.0-5.0	1.0	Dark gray, almost firm.
6	5.0-6.0	1.0	Gray material, firm.
7	6.0-7.5	1.5	Gray material, firm.
8	7.5-8.5	1.0	Gray material, firm.
9	8.5-9.5	1.0	Gray Material, firm.
10	9.5-10.5	1.0	Gray material, firm.
11	10.5-11.5	1.0	Slightly lighter gray, some sand.
12	11.5-12.5	1.0	Mottled gray and tan, some zones of black material, much more sand.
13	12.5-13.5	1.0	Same as 12.
14	13.5-14.5	1.0	Zones of dry dark material (carbon?), some mottling, gritty.
15	14.5-15.5	1.0	Less black material, sand content decreases.
16	15.5-16.5	1.0	Mostly gray, black almost gone, no sand.
17	16.5-17.5	1.0	A few dark streaks.
18	17.5-18.5	1.0	Same as 17.
19	18.5-19.5	1.0	No dark streaks, same as18.
20	19.5-20.5	1.0	Dark band at base, remainder is gray/tan material.
21	20.5-21.5	1.0	Dark gray, some sand.

Num

Table A-10: Continued

Number	Interval (cm)	Thickness (cm)	Description
22	21.5-22.5	1.0	Same as 21.
23	22.5-23.5	1.0	Same as 21.
24	23.5-24.5	1.0	Same as 23.
25	24.5-25.5	1.0	Same as 23.
26	25.5-27.5	2.0	Same as 23.
27	27.5-29.5	2.0	Some slight mottling, dark bands at base.
SKIP	29.5-31.5	2.0	Material discarded.
28	31.5-33.5	2.0	More soupy, less dark material. mostly light gray with some mottling.
29	33.5-35.5	2.0	Same as 28.
SKIP	35.5-37.5	2.0	Material discarded.
30	37.5-39.5	2.0	No dark streaks, all gray material.
31	39.5-41.5	2.0	Mostly very dark material, remainder is light gray.
SKIP	41.5-43.5	2.0	Material discarded.
32	43.5-45.5	2.0	Very dark material.
SKIP	45.5-47.5	2.0	Material discarded.
33	47.5-49.5	2.0	Very dark material with some tan layers, bottom of core touches stopper.

Table A-11:
Site LM #19 - Southern Basin, Lake Michigan
1991 - Sediment Core Description
42°44'00" N - 86°35'00" W
Depth = 86 m

Number	Interval (cm)	Thickness (cm)	Description
1	0.0-1.0	1.0	Dark gray soupy material.
2	1.0-2.0	1.0	Dark gray soupy material.
3	2.0-3.0	1.0	Dark gray, less soupy.
4	3.0-4.0	1.0	Dark gray, almost solid.
5	4.0-5.0	1.0	Dark gray, almost solid.
6	5.0-6.0	1.0	Dark gray to tan, almost firm.
7	6.0-7.0	1.0	Light gray and tan.
8	7.0-8.0	1.0	Same as 7.
9	8.0-9.0	1.0	Same as 7 with mottling.
10	9.0-10.0	1.0	Light tan with increasing light material, some sand present.
11	10.0-11.0	1.0	Light tan material with sand.
12	11.0-12.0	1.0	Tan material with rust brown spots (Fe minerals?).
13	12.0-13.0	1.0	Darker and more gray, more rust spots.
14	13.0-14.0	1.0	Same as 13, fewer rust spots, light mottling.
15	14.0-15.0	1.0	Dark tan color deepens to base of sample.
16	15.0-16.0	1.0	Redox zone: dark tan band 0.4 cm thick, dark gray band 0.2 cm thick, rust brown band 0.4 cm thick-solid crust.
17	16.0-17.0	1.0	Dry tan crust at top, gray watery material below (0.6 cm).

Table A-11: Continued

Number	Interval (cm)	Thickness (cm)	Description
18	17.0-18.0	1.0	Gray creamy textured material.
19	18.0-19.0	1.0	Same as 18.
20	19.0-20.0	1.0	Same as 18 with dark spots of organic material present.
21	20.0-22.0	2.0	Dark gray sandy material with black streaks at base of section.
22	22.0-24.0	2.0	Same as 21, with a 0.3 cm band of black, rigid organic material.
23	24.0-26.0	2.0	Lighter gray creamy texture with some dark spots.
24	26.0-28.0	2.0	Same as 23 with sand and gravel up to 1 mm in size.
25	28.0-30.0	2.0	Darker gray than 24, sand and gravel up to 1.5 mm in size.

Table A-12:
Site LO #19 - Niagara Basin, Lake Ontario
1991 - Sediment Core Description
43°22'15" N - 79°21'11" W
Depth = 90 m

Number	Interval (cm)	Thickness (cm)	Description
1	0.0-1.0	1.0	Tan soupy material, worm burrows.
2	1.0-2.0	1.0	Tan soupy material.
3	2.0-3.0	1.0	Tan material, less soupy.
4	3.0-4.0	1.0	Tan material grades into gray material, almost firm.
5	4.0-5.0	1.0	Gray material, slightly watery.
6	5.0-6.0	1.0	Gray color darken at base, some sand.
7	6.0-7.0	1.0	Gray material with dark spot, grades into tan material, slightly gritty.
8	7.0-7.5	0.5	Tan material grades into gray.
9	7.5-8.0	0.5	Dry redox boundry (orange).
10	8.0-9.0	1.0	Gray material with some gray chunks.
11	9.0-10.0	1.0	Gray material with some black spots.
12	10.0-11.0	1.0	Darker gray material with dry black spots.
13	11.0-12.0	1.0	Dark gray with dark spots, shades to lighter gray with dark black spots.
14	12.0-13.0	1.0	Same as 13, dry at base.
15	13.0-14.0	1.0	Mostly dark material mixed with light gray material.
16	14.0-15.0	1.0	Same as 15.

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Table A-12: Continued

Number	Interval (cm)	Thickness (cm)	Description
17	15.0-16.0	1.0	Same as 16, pockets of water in light gray material.
18	16.0-17.0	1.0	Same as 17.
19	17.0-18.0	1.0	Same as 18.
20	18.0-19.0	1.0	Light gray shades into dark gray material.
21	19.0-20.0	1.0	Same as 17.
22	20.0-22.0	2.0	Dark gray grades into watery light gray material.
23	22.0-24.0	2.0	Same as 22.
24	24.0-26.0	2.0	Tan to dark tan in color.
25	26.0-28.0	2.0	Tan to dark tan material
26	28.0-30.0	2.0	Same as 25.
27	30.0-32.0	2.0	Same as 25.
SKIP	32.0-34.0	2.0	*Material discarded*
28	34.0-36.0	2.0	Same as 25.
29	36.0-38.0	2.0	Same as 25.
30	38.0-40.0	2.0	Same as 25.

Table A-13:
Site LO #40a - Niagara Basin, Lake Ontario
1991 - Sediment Core Description
43°37'00" N - 78°05'00" W
Depth = 189 m

Number	Interval (cm)	Thickness (cm)	Description
1	0.0-1.0	1.0	Tan fluff, some spots of black material.
2	1.0-2.0	1.0	Same as 1, some gray spots.
3	2.0-3.0	1.0	Tan with gray spots, almost firm.
4	3.0-4.0	1.0	Greenish tan material, very soupy, black and gray spots at base of section.
5	4.0-5.0	1.0	Gray colored material, some chunks of black material, almost firm.
6	5.0-6.0	1.0	Same as 5, darker toward base, and black stuff gets coarser.
7	6.0-7.0	1.0	Gray darkens, black chunks get larger.
8	7.0-8.0	1.0	Dark gray with tan mottling, color darkens toward base with black chunks.
9	8.0-9.0	1.0	Mostly tan with black mottling (chunks).
10	9.0-10.0	1.0	Very dark gray to black material.
11	10.0-11.0	1.0	Same as 10, black chunks and gray mottling at base of section.
12	11.0-12.0	1.0	Fewer black chunks, tan with black mottling at base of section.
13	12.0-13.0	1.0	Same as 12.
14	13.0-14.0	1.0	Dark gray color turns to light gray at base, becomes creamy texture.

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Table A-12: Continued

Number	Interval (cm)	Thickness (cm)	Description
15	14.0-15.0	1.0	Lighter color tan/gray, small black chunks..
16	15.0-16.0	1.0	Gray color with black spots increasing to the base.
17	16.0-17.0	1.0	Gray/tan material darkens toward base, becomes firm.
18	17.0-18.0	1.0	Uniform black material.
19	18.0-19.0	1.0	Same as 18, becomes lighter to base.
20	19.0-20.0	1.0	Dark gray/tan with black chunks within light tan patches.
21	20.0-21.0	1.0	Medium tan to darker gray.
22	21.0-22.0	1.0	Lighter tan with light patches.
23	22.0-23.0	1.0	Light tan at top with black layers 0.1 mm thick, tan becomes dark toward base.
24	23.0-24.0	1.0	Light to dark tan mixture with black mottling at top, becomes light tan at base, two thick black layers in section.
25	24.0-25.0	1.0	Light tan with a black layer, darkens to dark tan color at base.
26	25.0-26.0	1.0	Same as 25, more black material, more wet.
27	26.0-27.0	1.0	Same as 26.
28	27.0-28.0	1.0	Mixture of light and dark tan material.
29	28.0-29.0	1.0	Same as 28.
SKIP	29.0-30.0	1.0	* Material discarded *
30	30.0-31.0	1.0	Creamy light and dark tan material.
SKIP	31.0-32.0	1.0	* Material discarded *
31	32.0-33.0	1.0	Light tan changes to dark tan at base, some kind of grass like material.
SKIP	33.0-34.0	1.0	* Material discarded *
32	34.0-35.0	1.0	Light tan material with black spots.

Number

SKIP

33

SKIP

34

SKIP

35

SKIP

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SKIP

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SKIP

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SKI

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Table A-12: Continued

Number	Interval (cm)	Thickness (cm)	Description
SKIP	35.0-36.0	1.0	* Material discarded *
33	36.0-37.0	1.0	Light tan material, some dark specks and a black patch.
SKIP	37.0-38.0	1.0	* Material discarded *
34	38.0-39.0	1.0	Mostly light gray, some light tan with dark specks and some grit.
SKIP	39.0-40.0	1.0	* Material discarded *
35	40.0-41.0	1.0	Mixture of dark tan and light gray with some dark spots.
SKIP	41.0-42.0	1.0	* Material discarded *
36	42.0-43.0	1.0	Dark and light tan material.
SKIP	43.0-44.0	1.0	* Material discarded *
37	44.0-45.0	1.0	Very dark gray material with a light gray layer in the middle of the section.
SKIP	45.0-46.0	1.0	* Material discarded *
38	46.0-47.0	1.0	Light tan turns dark gray, then back to light tan toward bottom of section.
SKIP	47.0-48.0	1.0	* Material discarded *
39	48.0-49.0	1.0	Dark gray with mottling.
SKIP	49.0-50.0	1.0	* Material discarded *
40	50.0-51.0	1.0	Same as 39, dark patches and light mottling.
SKIP	51.0-53.0	2.0	* Material discarded *
41	53.0-55.0	2.0	Same as 40.

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Table A-14:
Site LO #E30: Rochester Basin, Lake Ontario
1986 - Sediment Core Description
43°32'16" N - 76°54'03"W
Depth = 213 m

Sample Number	Sediment Interval (cm)	Description
1	0.0-0.5	Tan sediment.
2	0.5-1.0	Tan sediment.
3	1.0-1.5	Tan sediment.
4	1.5-2.0	Tan sediment.
5	2.0-2.5	Sharp boundry, tan above with darker sediment below.
6	2.5-3.0	Dark material and fish bones.
7	3.0-3.5	Dark material and sediment.
8	3.5-4.0	Dark sediment.
9	4.0-4.5	Dark sediment.
10	4.5-5.0	Dark sediment.
11	5.0-5.5	Dark sediment.
12	5.5-6.0	Dark sediment.
13	6.0-6.5	Dark sediment.
14	6.5-7.0	Dark sediment.
15	7.0-7.5	Dark sediment.
16	7.5-8.0	Dark sediment.
17	8.0-8.5	Begining of tan \ black layering.
18	8.5-9.0	Tan \ black sediment layering.
19	9.0-9.5	Tan \ black sediment layering.
20	9.5-10.0	Tan \ black sediment layering.
21	10.0-11.0	Tan \ black sediment layering.
22	11.0-13.0	Tan \ black sediment layering.
23	13.0-16.0	Tan \ black sediment layering.
24	16.0-18.0	Tan \ black sediment layering.

Table A-15:
Site LO #F31 - Rochester Basin, Lake Ontario
1986 - Sediment Core Description
43°35'00" N - 76°48'00" W
Depth = 179 m

Number	Interval (cm)	Thickness (cm)	Description
1	0.0-0.5	0.5	tan and soupy
2	0.5-1.0	0.5	tan and soupy
3	1.0-1.5	0.5	tan and soupy
4	1.5-2.0	0.5	tan and soupy
5	2.0-2.5	0.5	tan and soupy
6	2.5-3.0	0.5	tan grading into darker color.
7	3.0-3.5	0.5	tan grading into darker color.
8	3.5-4.0	0.5	brown/black layering
9	4.0-4.5	0.5	brown/black layering
10	4.5-5.0	0.5	brown/black layering
11	5.0-5.5	0.5	brown/black layering
12	5.5-6.0	0.5	firmer and drier
13	6.0-6.5	0.5	fish bones visible
14	6.5-7.0	0.5	Tan colored sediment, darker around fish bones
15	7.0-8.0	0.5	tan sediment
16	8.0-8.5	0.5	tan sediment
17	8.5-9.5	0.5	tan sediment

Table A-16:
Site LO #G32 - Rochester Basin, Lake Ontario
1986 - Sediment Core Description
43°39'17" N - 76°41'99" W
Depth = 144 m

Number	Interval (cm)	Thickness (cm)	Description
1	0.0-0.5	0.5	Light brownish-gray, soupy.
2	0.5-1.0	0.5	Light brownish-gray sediment
3	1.0-1.5	0.5	Light brownish-gray sediment
4	1.5-2.0	0.5	Light brownish-gray sediment
5	2.0-2.5	0.5	Light brownish-gray sediment
6	2.5-3.0	0.5	Light brownish-gray sediment with irregular dark areas.
7	3.0-3.5	0.5	Gray sediment with small black streaks.
8	3.5-4.0	0.5	Gray with black streaks.
9	4.0-4.5	0.5	Gray with black streaks.
10	4.5-5.0	0.5	Gray with black streaks.
11	5.0-6.0	1.0	Dark gray sediment with black streaks.
12	6.0-7.0	1.0	Dark gray with black streaks.
13	7.0-8.0	1.0	Dark gray with black streaks.
14	8.0-9.0	1.0	Dark gray with black streaks.
15	9.0-10.0	1.0	Dark gray with black streaks.
16	10.0-11.0	1.0	Dark gray with black streaks.
17	12.0-14.0	2.0	Dark gray with black streaks.
18	14.0-16.0	2.0	Dark gray with black streaks.
19	16.0-18.0	2.0	Dark gray with black streaks.
20	18.0-20.0	2.0	Dark gray with black streaks.

APPENDIX B:

Mercury Data

Table B-1:
Site LS #DTL - Duluth Basin, Lake Superior
Mercury Data

Sample	Hg (ng/g)	Hg RSD	HgAdj. (ng/g)	Depth (cm)	Date (crs)	Por. (%)	Inv. ng/cm^2	Accum ng/m^2yr
1	**168**	1.25	96	0.25	1989.3	83.1	21.0912	332164.9
2	**174**	5.35	102	0.75	1986.1	82.4	23.3376	396785.9
3	**188**	3.63	116	1.25	1981.4	82.6	26.2392	382805.7
4	**206**	3.81	134	1.75	1977.1	82.1	31.1818	609709
5	**212**	4.87	140	2.25	1973.7	81.3	34.034	876412.9
6	**256**	3.83	184	2.625	1971.3	80.8	22.9632	1319299
7	**248**	3.39	176	2.875	1969.7	83.3	19.1048	1261939
8	**258**	2.46	186	3.05	1968.6	85.2	7.15728	1205298
9	**292**	2.65	220	3.225	1967.2	81.9	25.883	1267219
10	**356**	4.85	284	3.6	1964.3	80.3	72.7324	1513742
11	**428**	4.21	356	4.1	1960.5	80.9	88.3948	1858347
12	**680**	5.01	608	4.6	1956.6	81.8	143.8528	3271088
13	**340**	12.54	268	5.1	1952.8	81.6	64.1056	1356100
14	**408**	2.60	336	5.6	1947.1	81.8	79.4976	1179377
15	**328**	2.53	256	6.1	1941.3	82.2	59.2384	803851.9
16	**244**	0.92	172	6.85	1931.1	82.2	79.6016	460966.8
17	**158**	2.90	86	7.85	1916.8	81.7	40.9188	212423.1
18	**116**	4.48	44	8.85	1899.3	81.6	21.0496	102961.5
19	**88**	5.04	16	9.85	1879.6	81.5	7.696	32320.48
20	**80**	2.66	8	10.85	-	82.1	3.7232	0
21	**78**	5.23	6	12.85	-	81.9	2.8236	0
22	**64**	4.61	-	14.85	-	82.0	-	-
23	**70**	5.68	-	16.85	-	82.5	-	-
24	**68**	15.20	-	18.85	-	82.0	-	-

Focusing Factor: 1.476
Average Background Concentration: 74.7 ng/g
Mercury Inventory for LS #DTL: 874.6265 ng/cm^2
Focusing Corrected Mercury Inventory: 592.5654 ng/cm^2

Table B-2:
Site LS #SJE-II - Duluth Basin, Lake Superior
Mercury Data

Sample	Hg (ng/g)	Hg RSD	HgAdj. (ng/g)	Depth (cm)	Date (crs)	Por. (%)	Inv. ng/cm^2	Accum ng/m^2yr
1	110	5.98	63	0.25	1988.5	95.0	4.82391	13789.06
2	134	1.04	87	0.75	1983.7	82.3	14.88396	20835.84
3	166	2.38	119	1.25	1977.9	82.5	24.27243	27272.8
4	180	1.01	133	1.75	1972.2	83.1	32.5052	14660.59
5	172	1.77	125	2.25	1965.9	83.2	36.075	11201.43
6	148	0.81	101	2.75	1958	83.7	26.19435	8746.392
7	104	1.05	57	3.25	1947.9	83.9	12.85635	5107.851
8	86	1.95	39	3.75	1935.2	84.0	8.42127	3804.124
9	80	8.83	33	4.125	1926.8	84.2	2.82282	0
10	68	9.56	21	4.275	1921.1	89.8	0.718536	0
11	58	2.24	11	4.75	1911.4	83.4	1.88188	0
12	56	4.13	9	5.125	1902.3	84.2	1.2285	0
13	46	0	-1	5.45	1892	85.6	0	-
14	46	4.39	-1	5.85	1882.3	84.7	0	-
15	55	2.39	-	6.30	1867.4	84.4	-	-
16	46	6.53	-	6.80	1851.4	84.4	-	-
17	42	5.07	-	7.30	1835.4	84.5	-	-
18	47	1.28	-	8.05	-	84.2	-	-
19	53	3.22	-	9.05	-	83.7	-	-
20	50	2.19	-	11.05	-	82.5	-	-
21	48	2.72	-	12.05	-	83.4	-	-
22	50	2.45	-	13.05	-	83.2	-	-
23	44	2.42	-	17.05	-	83.2	-	-
24	40	4.44	-	21.05	-	83.3	-	-

Focusing Factor: 1.261
Average Background Concentration: 47.25 ug/g
Mercury Inventory for LS #SJE-II: 166.6842 ug/cm^2
Focusing Corrected Mercury Inventory: 132.1841 ug/cm^2

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Table B-3:
Site NOAA #3 - Chefswet Basin, Lake Superior
Mercury Data

Sample	Hg (ng/g)	Hg RSD	HgAdj. (ng/g)	Depth (cm)	Date (crs)	Por. (%)	Inv. ng/cm^2	Accum ng/m^2yr
1	**168**	2.09	124	0.25	1988.8	95	8.06	10896.31
2	**184**	1.11	140	0.75	1981.7	93	12.74	12302.28
3	**194**	2.11	150	1.25	1972	92	15.60	13.18102
4	**168**	3.83	124	1.75	1963	91	14.508	10896.31
5	**118**	4.72	74	2.25	1953	91	8.658	6502.636
6	**96**	7.44	52	2.75	1940	90	6.76	4569.42
7	**80**	2.28	36	3.25	1925	90	4.68	3163.445
8	**74**	4.03	30	3.75	1907	89	4.29	2636.204
9	**54**	5.96	10	4.00	1884.9	88	3.12	878.7346
10	**52**	5.33	8	5.125	1857	89	0.572	702.9877
11	**44**	11.15	-	5.375	1849	88	-	-
12	**51**	1.82	-	5.75	1823	88.5	-	-
13	**42**	3.12	-	6.25	1799.9	88	-	-
14	**46**	2.40	-	6.75	1783	87	-	-
15	**44**	4.31	-	7.50	-	88	-	-
16	**45**	4.33	-	8.50	-	88	-	-
17	**43**	0.36	-	14.5	-	-	-	-

Focusing Factor: 1.138
Average Background Concentration: 44 ng/g
Mercury Inventory for NOAA #3: 78.988 ng/cm^2
Focusing Corrected Mercury Inventory: 69.40949 ng/cm^2

Table B-4:
Site LS #1390 - Isle Royale Basin, Lake Superior
Mercury Data

Sample	Hg (ng/g)	Hg RSD	HgAdj. (ng/g)	Depth (cm)	Date (crs)	Por. (%)	Inv. ng/cm^2	Accum ng/m^2yr
1	158	4.80	117.7	0.5	1981.7	84	48.9632	14300
2	106	3.76	65.7	1.5	1976.5	84	27.3312	7572.897
3	68	1.07	27.7	2.5	1967.4	82	14.404	1898.442
4	52	4.81	11.7	3.25	1958.2	80	2.5857	874.7664
5	48	5.02	7.7	3.75	1946	81	1.7017	407.7882
6	36	0.00	-	4.25	1931.9	83	-	-
7	44	4.82	-	5.0	1873.8	82	-	-
8	44	7.02	-	6.0	1819.3	81	-	-
9	42	8.00	-	7.5	1698.2	80	-	-
10	42	14.51	-	9.5	-	76	-	-
11	40	9.08	-	11.5	-	80	-	-
12	42	10.45	-	13.5	-	79	-	-
13	44	9.58	-	16.0	-	-	-	-
14	38	3.21	-	19.0	-	-	-	-
15	32	2.33	-	22.5	-	-	-	-
16	44	8.54	-	26.5	-	-	-	-
17	40	1.86	-	30.5	-	-	-	-
18	36	7.18	-	34.5	-	-	-	-

Focusing Factor: 3.21
Average Background Concentration: 40.30769 ng/g
Mercury Inventory for LS #1390: 94.9858 ng/cm^2
Focusing Corrected Mercury Inventory: 29.59059 ng/cm^2

Table B-5:
Site LS #1391 - Isle Parisienne Basin, Lake Superior
Mercury Data

Sample	Hg (ng/g)	Hg RSD	HgAdj. (ng/g)	Depth (cm)	Date (crs)	Por. (%)	Inv. ng/cm^2	Accum ng/m^2yr
1	**88**	1.08	72	0.5	1980.7	90	18.72	8044.693
2	**72**	2.07	56	1.5	1965.2	87	18.928	7821.229
3	**72**	2.47	56	2.5	1944.6	81	27.664	5318.436
4	**31**	2.76	15	3.25	1925.9	80	3.9	1508.38
5	**21**	13.16	5	4.0	1902.2	76	3.12	530.7263
6	**16**	2.31	0	5.0	1867.4	74	0	0
7	**22**	6.43	6	6.0	1794.8	74	4.056	536.3128
8	**13**	1.86	-	7.5	-	71	-	-
9	**12**	16.05	-	9.5	-	72	-	-
10	**14**	2.37	-	11.0	-	71	-	-
11	**17**	5.12	-	12.5	-	72	-	-
12	**18**	1.55	-	15.5	-	72	-	-
13	**17**	9.29	-	18.5	-	71	-	-
14	**15**	2.15	-	21.5	-	72	-	-
15	**15**	5.08	-	26.5	-	72	-	-

Focusing Factor: 1.79
Average Background Concentration: 15.93 ng/g
Mercury Inventory for LS #1391: 76.388 ng/cm^2
Focusing Corrected Mercury Inventory: 42.67486 ng/cm^2

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Table B-6:
Site LM #70m - North Algoma Basin, Lake Michigan
Mercury Data

Sample	Hg (ng/g)	Hg RSD	HgAdj. (ng/g)	Depth (cm)	Date (cf/cs)	Por. (%)	Inv. ng/cm^2	Accum ng/m^2yr
1	132	2.01	109.81	0.25	1990.8	95.2	6.456828	7743.013
2	132	2.95	109.81	0.75	1985.1	94.5	7.344642	7743.013
3	132	2.29	109.81	1.25	1978.4	93.6	8.568749	7743.013
4	142	1.75	119.81	1.75	1970.9	92.8	10.58192	8448.141
5	128	0.35	105.81	2.25	1962.2	91.8	10.68046	7460.962
6	128	0.94	105.91	2.75	1952.4	90.8	11.89886	7460.962
7	108	0.73	85.81	3.25	1941.6	89.9	10.59582	6050.705
8	108	2.53	85.81	3.75	1929.8	89.0	11.56290	6050.705
9	108	2.22	85.81	4.25	1917.2	88.3	12.28821	6050.705
10	114	0.75	91.81	4.75	1903.7	87.6	13.88971	6473.782
11	94	0.91	71.81	5.25	1889.7	87.2	11.23342	5063.526
12	98	1.04	75.81	5.75	1875.2	87.1	12.02631	5345.577
13	58	6.81	35.81	6.25	1860.8	86.8	5.641328	2525.064
14	36	4.23	13.81	6.75	1846.5	85.9	2.233077	973.7821
15	30	4.34	7.81	7.25	1831.3	85.0	1.348982	550.7051
16	24	11.55	1.81	7.75	1815.0	84.3	0.332587	127.6282
17	25	3.68	2.81	8.25	1797.9	84.0	0.540777	198.141
18	21	7.07	-	8.75	1779.9	84.3	-	-
19	23	3.15	-	9.25	-	83.9	-	-
20	20	5.28	-	9.75	-	-	-	-
21	22	6.63	-	10.5	-	-	-	-
22	21	6.22	-	11.5	-	-	-	-
23	21	1.79	-	12.5	-	-	-	-
24	23	5.57	-	13.5	-	-	-	-
25	23	3.31	-	14.5	-	-	-	-
26	22	1.45	-	15.5	-	-	-	-
27	19	6.15	-	16.5	-	-	-	-
28	20	3.35	-	17.5	-	-	-	-
29	18	7.50	-	18.5	-	-	-	-
30	29	3.61	-	19.5	-	-	-	-
31	19	8.85	-	20.5	-	-	-	-
32	22	13.41	-	21.5	-	-	-	-
33	20	1.40	-	25.5	-	-	-	-
34	24	4.51	-	29.5	-	-	-	-
35	25	3.81	-	33.5	-	-	-	-
36	25	8.66	-	37.5	-	-	-	-

Table B-6: Continued

Focusing Factor: 1.56
Average Background Concentration: 22.191 ng/g
Mercury Inventory for LM #70m: 137.2246 ng/cm^2
Focusing Corrected Mercury Inventory: 87.96447 ng/cm^2

Table B-7:
Site LM #68k - Algoma Basin, Lake Michigan
Mercury Data

Sample	Hg (ng/g)	Hg RSD	HgAdj. (ng/g)	Depth (cm)	Date (cf/cs)	Por. (%)	Inv. ng/cm^2	Accum ng/m^2yr
1	212	2.36	177.2	0.25	1991.4	98.0	4.3414	39160.22
2	216	4.17	181.2	0.75	1989.3	96.6	7.54698	40044.20
3	228	2.55	193.2	1.25	1986.6	95.6	10.41348	42696.13
4	240	4.36	205.2	1.75	1983.4	94.7	13.32261	45348.07
5	244	3.70	209.2	2.25	1980.1	94.0	15.3762	46232.04
6	272	0.94	237.2	2.75	1976.8	93.8	18.01534	52419.89
7	292	2.09	257.2	3.25	1973.0	94.1	18.58913	56839.78
8	280	1.70	245.2	3.75	1968.7	93.3	20.12479	54187.85
9	260	2.55	225.2	4.50	1962.3	93.5	35.8631	49767.96
10	244	3.01	209.2	5.50	1953.4	94.2	29.72732	46232.04
11	240	2.00	205.2	6.50	1944.0	93.9	30.66714	45348.07
12	208	1.99	173.2	7.50	1934.6	94.9	21.64134	38276.24
13	142	2.24	107.2	8.50	1925.2	93.6	16.80896	23690.61
14	64	1.02	29.2	9.50	1915.6	92.8	5.15088	6453.039
15	48	2.86	13.2	10.5	1905.7	93.8	2.00508	2917.127
16	64	7.25	29.2	11.5	1895.9	92.0	5.7232	6453.039
17	44	11.66	9.2	12.5	1886.0	94.0	1.3524	2033.149
18	34	7.17	-0.8	13.5	1876.0	92.6	-	-
19	34	2.35	-0.8	14.5	1866.0	92.6	-	-
20	36	2.99	1.2	15.5	1855.7	94.0	-	-
21	34	2.43	-0.8	16.5	1845.1	91.6	-	-
22	42	5.03	7.2	17.5	-	93.3	-	-
23	34	10.10	-0.8	18.5	-	93.9	-	-
24	30	6.17	-4.8	19.5	-	91.5	-	-

Focusing Factor: 1.267
Average Background Concentration: 34.857 ug/g
MercuryInventory for LM #68k: 256.6694 ug/cm^2
Focusing Corrected Mercury Inventory: 202.5804 ug/cm^2

Table B-8:
Site LM #47s - Algoma Basin, Lake Michigan
Mercury Data

Sample	Hg (ng/g)	Hg RSD	HgAdj. (ng/g)	Depth (cm)	Date (cf/cs)	Por. (%)	Inv. ng/cm^2	Accum ng/m^2yr
1	**194**	3.64	164	0.25	1991.6	98.4	3.2144	32362.66
2	**207**	5.95	177	0.75	1988.8	97.3	5.854275	33158.00
3	**202**	2.71	183	1.25	1986.0	97.5	5.604375	33184.00
4	**219**	6.45	189	1.75	1983.0	97.0	6.94575	32886.00
5	**210**	4.69	180	2.25	1979.7	96.6	7.497	29760.00
6	**192**	1.72	162	2.75	1976.3	96.7	6.54885	25596.00
7	**190**	5.17	160	3.25	1972.7	95.4	9.016	25280.00
8	**182**	2.64	152	3.75	1969.2	95.2	8.9376	25637.33
9	**186**	2.64	156	4.50	1962.0	94.9	19.4922	28704.00
10	**189**	1.19	159	5.50	1956.7	94.1	22.98345	33602.00
11	**177**	4.91	147	6.50	1949.5	94.2	20.8887	36554.00
12	**155**	6.68	125	7.50	1942.2	92.1	24.19375	31083.00
13	**136**	5.77	106	8.50	1934.4	92.7	18.9581	22966.67
14	**96**	4.10	66	9.50	1926.1	93.1	11.1573	13244.00
15	**64**	7.61	34	10.5	1918.1	91.4	7.1638	6981.33
16	**52**	10.20	22	11.5	1812.8	93.4	3.5574	5133.33
17	**41**	4.24	11	12.5	1795.8	92.3	2.07515	3124.00
18	**36**	5.53	6	13.5	1778.8	93.2	0.9996	1704.00
19	**36**	4.07	6	14.5	1761.6	93.3	0.9849	1380.00
20	**34**	1.68	4	15.5	1744.1	93.6	0.6272	781.33
21	**32**	1.36	2	16.5	-	93.3	0.3283	360.00
22	**31**	5.81	-	17.5	-	91.6	-	-
23	**31**	4.44	-	18.5	-	90.8	-	-
24	**28**	7.42	-	19.5	-	91.2	-	-

Focusing Factor: 1.34
Average Background Concentration: 19.2 ng/g
Mercury Inventory for LM #47s: 275.07 ng/cm^2
Focusing Corrected Mercury Inventory: 183.38 ng/cm^2

| عدد الصفحات | | |

Table B-9:
Site LM #11 - Southern Basin, Lake Michigan
Mercury Data

Sample	Hg (ng/g)	Hg RSD	HgAdj. (ng/g)	Depth (cm)	Date (cf/cs)	Por. (%)	Inv. ng/cm^2	Accum ng/m^2yr
1	108	11.86	91.56	0.5	1970.5	84.6	34.54559	7361.608
2	102	5.23	85.56	1.5	1938	82.4	36.89347	6879.196
3	114	8.23	97.56	2.5	1915.3	82.2	42.54592	7844.02
4	108	10.21	91.56	3.5	1895	79.5	45.98601	7361.608
5	102	9.18	85.56	4.5	1877	79.2	43.60138	6879.196
6	52	6.32	35.56	5.5	1858	77.8	19.34108	2859.095
7	28	2.07	11.56	6.5	1838.4	77.2	6.457416	929.4472
8	14	7.05	-2.44	7.5	1817.3	73.6	-	-
9	18	9.39	1.56	8.5	1794.2	73.3	-	-
10	14	10.99	-2.44	9.5	1770.1	73.0	-	-
11	14	13.98	-2.44	10.5	1745.1	66.3	-	-
12	14	9.87	-2.44	11.5	-	67.5	-	-
13	18	2.41	1.56	12.25	-	68.4	-	-
14	18	5.87	1.56	13.0	-	64.9	-	-
15	18	3.73	1.56	14.0	-	61.4	-	-
16	14	8.61	-2.44	14.75	-	64.0	-	-
17	14	15.71	-2.44	15.25	-	66.5	-	-
18	14	9.60	-2.44	16.0	-	65.8	-	-
19	14	18.03	-2.44	17.0	-	63.6	-	-
20	14	13.27	-2.44	18.0	-	64.9	-	-
21	16	3.87	-0.44	19.5	-	66.7	-	-
22	18	5.21	1.56	21.5	-	66.7	-	-
23	22	4.54	5.56	23.5	-	65.8	-	-
24	22	6.76	5.56	25.5	-	64.4	-	-
25	20	4.18	3.56	27.5	-	66.6	-	-

Focusing Factor: 1.999
Average Background Concentration: 16.44 ng/g
Mercury Inventory for LM #11: 229.3709 ng/cm^2
Focusing Corrected Mercury Inventory: 115.2617 ng/cm^2

Table B-10:
Site LM #18 - Southern Basin, Lake Michigan
Mercury Data

Sample	Hg (ng/g)	Hg RSD	HgAdj. (ng/g)	Depth (cm)	Date (cf/cs)	Por. (%)	Inv. ng/cm^2	Accum ng/m^2yr
1	192	0.95	158.7	0.5	1989.7	94.2	22.55127	25428.51
2	204	1.43	170.7	1.5	1984.4	93.1	28.85684	27351.27
3	212	2.12	178.7	2.5	1977.8	91.5	37.21428	28633.11
4	220	0.88	186.7	3.5	1970.8	90.5	43.45443	29914.95
5	228	0.16	194.7	4.5	1963.4	89.8	48.65553	31196.8
6	214	1.19	180.7	5.5	1956.1	89.3	47.37051	28953.57
7	194	1.97	160.7	6.8	1945.6	89.2	63.89994	25748.97
8	184	1.59	150.7	8.0	1938.3	89.2	40.02291	24146.67
9	164	1.92	130.7	9.0	1931.0	89.1	34.77535	20942.07
10	140	2.71	106.7	10.0	1923.8	88.3	30.55941	17096.55
11	114	3.34	80.7	11.0	1916.5	87.5	24.71438	12930.57
12	58	3.64	24.7	12.0	1856.5	87.6	7.479654	1826.623
13	42	7.87	8.7	13.0	1793.0	87.3	2.700611	643.3854
14	44	3.05	10.7	14.0	1821.6	87.2	3.358142	791.2901
15	44	11.59	10.7	15.0	-	87.0	3.40795	791.2901
16	34	6.80	-	16.0	-	-	-	-
17	36	5.71	-	17.0	-	-	-	-
18	32	12.39	-	18.0	-	-	-	-
19	28	10.97	-	19.0	-	-	-	-
20	36	5.95	-	20.0	-	-	-	-
21	34	3.08	-	21.0	-	-	-	-
22	28	1.90	-	22.0	-	-	-	-
23	28	1.47	-	23.0	-	-	-	-
24	28	1.94	-	24.0	-	-	-	-
25	32	8.04	-	25.0	-	-	-	-
26	34	4.12	-	26.5	-	-	-	-
27	34	7.81	-	28.5	-	-	-	-
28	32	2.27	-	32.5	-	-	-	-
29	38	1.56	-	34.5	-	-	-	-
30	28	7.15	-	38.5	-	-	-	-
31	40	6.55	-	40.5	-	-	-	-
32	30	5.13	-	44.5	-	-	-	-
33	26	4.94	-	48.5	-	-	-	-

Table B-10: Continued

Focusing Factor: 2.434
Average Background Concentration: 33.3 ug/g
Mercury Inventory for LM #18: 439.0212 ug/cm^2
Focusing Corrected Mercury Inventory: 180.3702 ug/cm^2

Table B-11:
Site LM #19 - Southern Basin, Lake Michigan
Mercury Data

Sample	Hg (ng/g)	Hg RSD	HgAdj. (ng/g)	Depth (cm)	Date (cf/cs)	Por. (%)	Inv. ng/cm^2	Accum ng/m^2yr
1	202	6.46	179.9	0.5	1989.8	94.2	25.56379	3399901
2	186	1.34	163.9	1.5	1983.9	93.1	27.7073	30975.4
3	150	3.45	127.9	2.5	1972.2	91.5	26.63518	24171.7
4	148	5.80	125.9	3.5	1956.4	90.5	29.30323	23793.8
5	168	2.07	145.9	4.5	1939.2	89.8	36.46041	27573.5
6	110	11.02	87.9	5.5	1918.1	89.3	23.04299	16612.2
7	40	6.27	17.9	6.5	1891.7	89.0	4.82405	3382.9
8	16	4.18	-	7.5	-	63.8	-	-
9	15	8.59	-	8.5	-	61.4	-	-
10	26	2.83	-	9.5	-	66.4	-	-
11	24	13.15	-	10.5	-	63.9	-	-
12	27	10.18	-	11.5	-	70.3	-	-
13	28	5.16	-	12.5	-	73.1	-	-
14	21	5.27	-	13.5	-	72.1	-	-
15	18	10.41	-	14.5	-	71.8	-	-
16	22	3.95	-	15.5	-	71.6	-	-
17	24	8.03	-	16.5	-	71.9	-	-
18	25	5.83	-	17.5	-	71.2	-	-
19	21	6.113	-	18.5	-	73.6	-	-
20	19	5.94	-	19.5	-	75.1	-	-
21	21	-	-	21.0	-	66.7	-	-
22	23	2.38	-	23.0	-	68.2	-	-
23	23	3.46	-	25.0	-	68.2	-	-
24	23	4.19	-	27.0	-	65.6	-	-
25	22	-	-	29.0	-	67.8	-	-

Focusing Factor: 1.217
Average Background Concentration: 22.12 ng/g
Mercury Inventory for LM #19: 173.5369 ng/cm^2
Focusing Corrected Mercury Inventory: 142.594 ng/cm^2

Table B-12:
Site LO #19 - Niagara Basin, Lake Ontario
Mercury Data

Sample	Hg (ng/g)	Hg RSD	HgAdj. (ng/g)	Depth (cm)	Date (cf/cs)	Por. (%)	Inv. ng/cm^2	Accum ng/m^2yr
1	1151	5.75	1117	0.5	1989.4	89.3	158.7399	315588.6
2	1279	1.30	1246	1.5	1983.8	87.7	238.1106	352003.7
3	1560	1.49	1527	2.5	1976.9	87.7	340.4446	431388.2
4	1940	2.84	1907	3.5	1969.5	87.7	439.1821	538740.9
5	2670	2.24	2637	4.5	1961.8	86.3	620.2224	744971
6	3080	3.15	3047	5.5	1952.9	83.3	903.2831	860798.9
7	1650	1.95	1617	6.5	1941.9	79.6	594.2475	456813.8
8	266	0.80	233	7.0	1920	79.6	48.52225	17436.86
9	70	2.71	37	7.5	1891.1	79.7	8.24915	2768.943
10	42	6.38	9	8.5	1838.1	78.8	3.6162	673.5267
11	34	3.33	1	9.5	-	77.4	0.37975	74.8363
12	28	10.14	-5	10.5	-	78.3	-	-
13	32	6.27	-1	11.5	-	77.6	-	-
14	34	2.54	1	12.5	-	77.3	-	-
15	34	9.34	1	13.5	-	78.4	-	-
16	36	4.72	3	14.5	-	77.8	-	-
17	37	9.14	4	15.5	-	77.9	-	-
18	34	5.86	1	16.5	-	76.5	-	-
19	31	3.95	-2	17.5	-	76.4	-	-
20	36	4.75	3	18.5	-	77.9	-	-
21	35	3.42	2	19.5	-	76.1	-	-
22	34	2.84	1	21.5	-	76.6	-	-
23	38	6.00	5	23.5	-	76.2	-	-
24	34	2.61	1	25.5	-	76.9	-	-
25	35	1.49	2	27.5	-	77.4	-	-
26	33	5.94	0	29.5	-	77.8	-	-
27	32	6.95	-1	31.5	-	76.7	-	-
28	34	2.53	1	35.5	-	-	-	-
29	35	5.22	2	37.5	-	-	-	-
30	33	4.92	0	39.5	-	-	-	-

Table B-12: Continued

Focusing Factor: 1.07
Average Background Concentration: 33.95 ng/g
Mercury Inventory for LO #19: 3354.998 ng/cm^2
Focusing Corrected Mercury Inventory: 3138.45 ng/cm^2

Table B-13:
Site LO #40a - Niagara Basin, Lake Ontario
Mercury Data

Sample	Hg (ng/g)	Hg RSD	HgAdj. (ng/g)	Depth (cm)	Date (cf/cs)	Por. (%)	Inv. ng/cm^2	Accum ng/m^2yr
1	352		311.8	0.5	1990.9	95.9	31.32031	116849.6
2	610		569.8	1.5	1988.7	92.4	106.0968	213537.2
3	660		619.8	2.5	1985.6	91.4	130.5919	232275.1
4	830		789.8	3.5	1981.7	88.7	218.6561	295983.9
5	1100		1059.8	4.5	1977.7	90.1	257.0545	397168.6
6	1340		1299.8	5.5	1974.1	91.1	283.4214	487110.6
7	1640		1599.8	6.5	1970.6	91.2	344.9169	599537.9
8	2220		2179.8	7.5	1967.1	91.1	475.3054	816897.7
9	1860		1819.8	8.5	1963.7	90.9	405.7244	681984.8
10	1620		1579.8	9.5	1959.9	90.1	383.1805	592042.8
11	1740		1699.8	10.5	1955.8	88.7	470.5896	637013.8
12	1440		1399.8	11.5	1951.4	87.5	428.6888	524586.4
13	800		759.8	12.5	1946.8	87.7	228.9657	284741.2
14	500		459.8	13.5	1936.9	87.9	136.3077	79819.84
15	416		375.8	14.5	1927.4	88.6	104.9609	65237.70
16	308		267.8	15.5	1917.6	88.2	77.42098	46489.24
17	204		163.8	16.5	1907.6	87.7	49.36113	28435.17
18	140		99.8	17.5	1897.3	88.5	28.11865	17324.97
19	104		63.8	18.5	1886.6	87.0	20.3203	11075.48
20	80		39.8	19.5	1876.1	87.3	12.38377	6909.155
21	62		21.8	20.5	-	88.8	5.98192	3784.412
22	60		19.8	21.5	-	-	-	3437.218
23	52		11.8	22.5	-	-	-	2048.443
24	52		11.8	23.5	-	-	-	2048.443
25	48		7.8	24.5	-	-	-	1354.056
26	44		3.8	25.5	-	-	-	659.6681
27	-		-	26.5	-	-	-	-
28	-		-	27.5	-	-	-	-
29	52		-	28.5	-	-	-	-
30	42		-	30.5	-	-	-	-
31	40		-	32.5	-	-	-	-
32	40		-	34.5	-	-	-	-
33	42		-	36.5	-	-	-	-
34	36		-	38.5	-	-	-	-
35	36		-	40.5	-	-	-	-
36	34		-	42.5	-	-	-	-

Table B-13: Continued

Focusing Factor: 1.71
Average Background Concentration: 38.6 ng/g
Mercury Inventory for LO #40a: 5665.75 ng/cm^2
Focusing Corrected Mercury Inventory: 3322.83 ng/cm^2

Table B-14:
Site LO #E30 - Rochester Basin, Lake Ontario
Mercury Data

Sample	Hg (ng/g)	Hg RSD	HgAdj. (ng/g)	Depth (cm)	Date (cf/cs)	Por. (%)	Inv. ng/cm^2	Accum ng/m^2yr
1	590	5.63	560	0.25	1989.6	92.95	48.363	182823.5
2	710	5.57	680	0.75	1988.1	92.58	64.974	222000.0
3	830	7.10	800	1.25	1987.4	92.20	80.36	261176.5
4	1100	6.81	1070	1.75	1985.7	91.80	107.4815	349323.5
5	1260	7.25	1230	2.25	1984.3	91.53	127.6217	401558.8
6	1420	7.95	1390	2.75	1982.5	91.36	147.1176	453794.1
7	2430	7.29	2400	3.25	1980.8	91.25	257.25	783529.4
8	2790	8.61	2760	3.75	1979.4	91.25	295.8375	901058.8
9	2440	10.61	2410	4.25	1977.9	91.18	260.3885	786794.1
10	2440	4.86	2410	4.75	1976.2	91.29	257.1410	786794.1
11	2240	5.51	2210	5.25	1974.8	91.53	229.3041	721500.0
12	2850	3.53	2820	5.75	1972.3	91.67	287.7599	920647.1
13	2600	5.68	2570	6.25	1971.3	91.67	262.2492	839029.4
14	2560	6.67	2530	6.75	1969.9	91.57	261.2668	825970.6
15	2160	5.50	2130	7.25	1968.5	91.50	221.7863	695382.4
16	1410	7.43	1380	7.75	1966.8	91.36	146.0592	450529.4
17	1280	8.00	1250	8.25	1965.4	91.11	136.1282	408088.2
18	1060	8.10	1030	8.75	1963.3	90.57	118.9830	336264.7
19	960	6.30	930	9.25	1961.9	90.52	108.0010	303617.7
20	760	10.52	730	9.75	1960.1	90.20	87.6365	238323.5
21	640	6.00	610	10.5	1957.7	89.72	153.6346	199147.1
22	650	1.42	620	12.0	1951.1	88.56	347.5472	202411.8
23	300	6.66	270	14.5	1940.6	88.14	235.3617	88147.06
24	122	3.55	92	17.0	1929.7	87.97	54.23124	30035.29

Focusing Factor: 2.04

Mercury Inventory for LO #E30: 4252.71 ng/cm^2
Focusing Corrected Mercury Inventory: 2084.66 ng/cm^2

Table B-15:
Site LO #F31 - Rochester Basin, Lake Ontario
Mercury Data

Sample	Hg (ng/g)	Hg RSD	HgAdj. (ng/g)	Depth (cm)	Date (cf/cs)	Por. (%)	Inv. ng/cm^2	Accum ng/m^2yr
1	900	5.20	864	0.25	1988.5	94.2	61.3872	155720.9
2	960	0.80	924	0.75	1987	92.2	88.2882	166534.9
3	1020	5.88	984	1.25	1984	90.9	109.6914	177348.8
4	1180	2.48	1144	1.75	1982.2	90.6	131.7316	206186.0
5	1380	4.92	1344	2.25	1979.5	90.4	158.0544	242232.6
6	1760	1.01	1724	2.75	1977.5	87.9	255.5399	310720.9
7	1950	2.87	1914	3.25	1974	85.0	351.6975	344965.1
8	2550	2.50	2514	3.75	1972.2	83.0	523.5405	453104.7
9	2880	7.14	2844	4.25	1969	81.8	634.0698	512581.4
10	2880	3.02	2844	4.75	1967	83.6	571.3596	512581.4
11	2720	3.76	2684	5.25	1964	84.5	509.6245	483744.2
12	2560	1.97	2524	5.75	1963.5	85.1	460.6931	454907.0
13	1600	3.84	1564	6.25	1960.5	84.5	296.9645	281883.7
14	1110	1.71	1074	6.75	1958.5	84.3	206.5571	193569.8
15	-	-	-	7.25	1965.5	84.7	-	-
16	760	2.02	724	7.75	1955.5	84.0	141.904	130488.4
17	710	3.01	674	8.25	1953.8	84.7	126.3245	121476.7
18	570	12.14	534	8.75	1952	84.3	102.7016	96244.19
19	510	5.99	474	9.25	1950	84.4	90.5814	85430.23
20	-	-	-	9.75	1948.5	84.5	-	-
21	440		404	10.25	1947	84.1	78.6891	72813.95
22	260		224	11.25	1942	83.9	88.3568	40372.09
23	172		136	12.25	1939	83.9	53.6452	24511.63
24	102		66	13.25	1936	83.9	26.0337	11895.35

Focusing Factor: 1.72

Mercury Inventory for LO#F31: 5002.33 ng/cm^2
Focusing Corrected Mercury Inventory: 2452.12 ng/cm^2

Table B-16:
Site LO #G32 - Rochester Basin, Lake Ontario
Mercury Data

Sample	Hg (ng/g)	Hg RSD	HgAdj. (ng/g)	Depth (cm)	Date (ef/cs)	Por. (%)	Inv. ng/cm^2	Accum ng/m^{2}yr
1	**540**	5.20	500	0.25	1989.8	91.6	51.45	199754.9
2	**660**	0.80	620	0.75	1988.6	90.3	73.6715	247696.1
3	**660**	5.88	620	1.25	1987.5	89.0	83.545	247696.1
4	**740**	2.48	700	1.75	1985.2	88.2	101.185	279656.9
5	**840**	4.92	800	2.25	1984.1	88.4	113.68	319607.8
6	**1800**	1.01	1760	2.75	1982.3	88.5	247.94	703137.3
7	**1230**	2.87	1190	3.25	1980.7	88.4	169.099	475416.7
8	**1260**	2.50	1220	3.75	1979.6	88.3	174.8565	487402.0
9	**1320**	7.14	1280	4.25	1977.9	89.0	172.48	511372.5
10	**1290**	3.02	1250	4.75	1976.6	89.3	163.8438	499387.3
11	**1890**	3.76	1850	5.5	1974.4	89.7	466.8475	739093.1
12	**2280**	1.97	2240	6.5	1970.7	89.7	565.264	894902.0
13	**2700**	3.84	2660	7.5	1967.6	89.6	677.768	1062696
14	**3560**	1.71	3520	8.5	1964.6	89.3	922.768	1406275
15	**2750**	3.33	2710	9.5	1961.7	89.7	683.8685	1082672
16	**3050**	2.02	3010	10.5	1958.3	88.8	825.944	1202525
17	**3100**	3.01	3060	11.5	1955.1	90.1	742.203	1222500
18	**1400**	12.14	1360	12.5	1951.2	87.8	406.504	543333.3
19	**870**	5.99	830	13.5	1947.2	87.7	250.1205	331593.1
20	**540**	4.15	500	14.5	1933.3	82.5	214.375	199754.9

Focusing Factor: 2.20

Mercury Inventory for LO#G32: 7107.413 ng/cm^2
Focusing Corrected Mercury Inventory: 3230.77 ng/cm^2

APPENDIX C:

Lead-210 Analysis Information

Table C-1:
Site LS #DTL - Duluth Basin, Lake Superior
Lead-210 Dating Information

(Analysis by Dan R. Engstrom, The University of Minnesota)

Top of Interval (cm)	Base of Interval (cm)	Cum. Dry Mass (g/cm^2)	Unsup. Activity (pCi/g)	Error of unsup.act (+,- S.D.)	Cum.Act. below int. pCi/cm^2	Age:Base of int. (year)	Error of Age (+,- S.D.)	Date A.D.	Sed. Accum. g/cm2yr
0	0.25	0.0482	20.3548	0.4485	21.8901	1.41	0.91	1989.3	0.0342
0.5	0.75	0.1679	16.2453	0.4116	19.8379	4.57	0.94	1986.1	0.0390
1.0	1.25	0.3292	17.0157	0.3139	17.1236	9.29	1.02	1981.4	0.0327
1.5	1.75	0.5049	10.6059	0.1721	15.0110	13.52	0.96	1977.1	0.0455
2.0	2.25	0.7063	6.8211	0.1177	13.4722	17.00	0.93	1973.7	0.0631
2.5	2.75	0.9325	5.0530	0.0877	12.2379	20.08	0.95	1970.6	0.0772
3.0	3.25	1.1532	6.1781	0.1372	10.9405	23.68	0.99	1967.0	0.0568
3.5	3.75	1.3640	6.0684	0.1081	9.6557	27.69	1.07	1963.0	0.0512
4.0	4.50	1.6452	5.0003	0.1307	8.1889	32.98	1.18	1957.7	0.0538
4.5	5.00	1.8377	4.6951	0.1136	7.2853	36.74	1.28	1953.9	0.0513
5.0	5.50	2.0250	5.8839	0.1468	6.1832	42.01	1.45	1948.7	0.0356
6.0	6.50	2.3925	5.2301	0.1324	4.2022	54.41	1.96	1936.3	0.0278
7.0	7.50	2.7595	3.7437	0.1127	2.7012	68.60	2.47	1922.1	0.0252
8.0	8.50	3.1389	2.4300	0.0825	1.6656	84.13	3.14	1906.5	0.0242
9.0	9.50	3.5826	1.4959	0.0495	0.9105	103.52	4.53	1887.1	0.0224
9.5	10.50	3.8021	1.2511	0.0526	0.6359	115.05	6.43	1875.6	0.0190

Number of Supported Samples: 2
Supported Lead-210: 1.1788 +/- 0.0278 pCi/g
Cumulative Unsupported Lead-210: 22.8717 pCi/cm^2
Unsupported Lead-210 Flux: 0.741 pCi/cm^2yr

Table C-2:
Site LS #SJE-II - Duluth Basin, Lake Superior
Lead-210 Dating Information

(Analysis by Dan R. Engstrom, The University of Minnesota)

Top of Interval (cm)	Base of Interval (cm)	Cum. Dry Mass (g/cm^2)	Unsup. Activity (pCi/g)	Error of unsup.act ($+_{r}$- S.D.)	Cum.Act. below int. pCi/cm^2	Age:Base of int. (year)	Error of Age ($+_{r}$- S.D.)	Date A.D.	Sed. Accum. g/cm2yr
0	0.25	0.0589	22.0403	0.2646	18.2439	2.21	1.24	1988.5	0.0267
0.5	0.75	0.1905	18.0352	0.2120	15.7510	6.92	1.32	1983.7	0.0283
1.0	1.25	0.3474	16.2601	0.1993	13.1359	12.76	1.47	1977.9	0.0264
1.5	1.75	0.5354	10.1032	0.2978	10.9898	18.48	1.43	1972.2	0.0354
2.0	2.25	0.7577	8.4456	0.1606	9.0280	24.80	1.61	1965.9	0.0351
2.5	2.75	0.9572	10.3956	0.3274	7.0620	32.69	1.89	1958.0	0.0226
3.0	3.25	1.1310	11.1172	0.2718	5.1619	42.75	2.45	1947.9	0.0157
3.5	3.75	1.2971	9.8405	0.3707	3.4762	55.45	3.47	1935.2	0.0122
4.0	4.25	1.4287	7.2962	0.3071	2.4319	66.92	4.72	1923.7	0.0113
4.5	5.00	1.6389	4.5723	0.2360	1.3716	85.31	7.94	1905.4	0.0114
5.5	6.00	1.9494	2.0845	0.1405	0.5626	113.93	16.32	1876.7	0.0107
7.0	8.00	2.6280	0.3008	0.0484	0.0777	177.50	11.15	1813.2	0.0127

Number of Supported Samples: 2
Supported Lead-210: 1.1788 +/- 0.0278 pCi/g
Cumulative Unsupported Lead-210: 19.5415 pCi/cm^2
Unsupported Lead-210 Flux: 6332 pCi/cm^2yr

Table C-4:
Site LS #1390 - Isle Royale Basin, Lake Superior
Lead-210 Dating Information

(Analysis by Steve J. Eisenreich, The University of Minnesota)

Top of Interval (cm)	Base of Interval (cm)	Cum. Dry Mass (g/cm^2)	Unsup. Activity (pCi/g)	Error of unsup.act ($+_r$- S.D.)	Cum.Act. below int. pCi/cm^2	210Pb Total (pCi/g)	210Pb Error (pCi/g)	Date A.D.	Sed. Accum. g/cm2yr
0.00	0.50	0.208	34.42	-	42.57	36.02	1.01	1981.7	0.039
0.50	1.00	0.208	30.61	-	36.21	32.21	0.83	1976.5	0.037
1.00	1.50	0.234	38.06	-	27.30	39.66	1.24	1967.4	0.022
1.50	2.00	0.260	26.16	-	20.50	27.76	0.78	1958.2	0.024
2.00	2.50	0.247	26.31	-	14.00	27.91	0.56	1946.0	0.017
2.50	3.00	0.221	22.51	-	9.03	24.11	0.46	1931.9	0.012
3.00	4.00	0.468	16.12	-	1.48	17.72	0.50	1873.8	0.003
4.00	5.00	0.494	2.45	-	0.27	4.05	0.13	1819.3	0.003
5.00	6.00	0.520	0.51	-	0.01	2.11	0.08	1698.2	0.000
6.00	7.00	0.624	0.01	-	0.00	1.61	0.06	-	0.000
7.00	8.00	0.520	-	-	-	1.35	0.03	-	-
8.00	9.00	0.546	-	-	-	1.22	0.03	-	-

Cumulative Unsupported Lead-210: 49.73 pCi/cm^2
Unsupported Lead-210 Flux: 1.55 pCi/cm^2yr

Table C-5:
Site LS #1391 - Isle Parisienne Basin, Lake Superior
Lead-210 Dating Information

(Analysis by Steve J. Eisenreich, The University of Minnesota)

Top of Interval (cm)	Base of Interval (cm)	Cum. Dry Mass (g/cm^2)	Unsup. Activity (pCi/g)	Error of unsup.act ($+_{/-}$ S.D.)	Cum.Act. below int. pCi/cm^2	210Pb Total. (pCi/g)	210Pb Error (pCi/g)	Date A.D.	Sed. Accum. g/cm2yr
0.00	0.50	0.130	35.53	-	23.13	36.08	1.00	1980.7	0.020
0.50	1.00	0.169	23.42	-	19.17	23.97	0.65	1974.6	0.025
1.00	1.50	0.182	26.87	-	14.28	27.42	0.79	1965.2	0.017
1.50	2.00	0.195	18.70	-	10.63	19.25	0.55	1955.7	0.018
2.00	2.50	0.247	12.62	-	7.52	13.17	0.35	1944.6	0.019
2.50	3.00	0.247	8.91	-	5.31	9.46	0.24	1933.4	0.019
3.00	3.50	0.273	6.74	-	3.47	7.29	0.21	1919.8	0.016
3.50	4.00	0.312	4.69	-	2.01	5.24	0.17	1902.2	0.013
4.00	5.00	0.676	1.97	-	0.68	2.52	0.077	1867.4	0.011
5.00	6.00	0.676	0.90	-	0.07	1.45	0.048	1794.8	0.002
6.00	7.00	0.754	0.09	-	0.00	0.664	0.022	-	-
7.00	8.00	0.728	-	-	-	0.519	0.017	-	-
8.00	9.00	0.754	-	-	-	0.517	0.021	-	-
9.00	10.0	0.728	-	-	-	0.495	0.019	-	-
10.0	12.0	1.456	-	-	-	0.568	0.024	-	-
12.0	14.0	1.508	-	-	-	0.555	0.022	-	-

Cumulative Unsupported Lead-210: 27.75 pCi/cm^2
Unsupported Lead-210 Flux: 0.86 pCi/cm^2yr

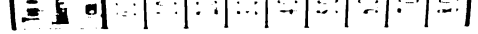


Table C-6:
Site LM #70m - N. Algoma Basin, Lake Michigan
Lead-210 Dating Information

(Analysis by Dan R. Engstrom, The University of Minnesota)

Top of Interval (cm)	Base of Interval (cm)	Cum. Dry Mass (g/cm^2)	Unsup. Activity (pCi/g)	Error of unsup.act (+,- S.D.)	Cum.Act. below int. pCi/cm^2	Age:Base of int. (year)	Error of Age (+,- S.D.)	Date A.D.	Sed. Accum. g/cm2yr
0.0	1.0	0.1260	22.4932	0.7177	21.2990	4.01	0.62	1989.6	0.0314
1.0	2.0	0.2920	23.9861	0.6631	17.3173	10.66	0.67	1983.0	0.0250
2.0	3.0	0.5080	18.5635	0.6288	13.3075	19.12	0.72	1974.5	0.0255
3.0	4.0	0.7670	18.6753	0.5475	8.4707	33.62	0.86	1960.0	0.0179
4.0	5.0	1.0640	15.1387	0.5628	3.9745	57.92	0.97	1935.7	0.0122
5.0	6.0	1.3830	8.5649	0.2918	1.2423	95.27	1.49	1898.4	0.0085
6.0	7.0	1.6970	2.6704	0.1265	0.4038	131.38	3.07	1862.3	0.0087
7.0	8.0	2.0540	0.8450	0.0654	0.1021	175.51	9.54	1816.1	0.0081
8.0	9.0	2.4500	0.1689	0.0698	0.0352	209.71	11.32	1783.9	0.0116

Number of Supported Samples: 6
Supported Lead-210: 0.7743 +/- 0.0192 pCi/g
Cumulative Unsupported Lead-210: 24.1331 pCi/cm^2
Unsupported Lead-210 Flux: 0.7659 pCi/cm^2yr

Table C-7:
Site LM #68k - Algoma Basin, Lake Michigan
Lead-210 Dating Information

(Analysis by Dan R. Engstrom, The University of Minnesota)

Top of Interval (cm)	Base of Interval (cm)	Cum. Dry Mass (g/cm^2)	Unsup. Activity (pCi/g)	Error of unsup.act (+/- S.D.)	Cum.Act. below int. pCi/cm^2	Age:Base of int. (year)	Error of Age (+/- S.D.)	Date A.D.	Sed. Accum. g/cm2yr
0	0.5	0.030	-	-	-	1.1	-	1991.4	0.028
0.5	1.0	0.089	-	-	-	3.2	-	1989.3	0.028
1.0	1.5	0.164	-	-	-	5.9	-	1986.6	0.028
1.5	2.0	0.256	-	-	-	9.1	-	1983.4	0.028
2.0	2.5	0.348	-	-	-	12.4	-	1980.1	0.028
2.5	3.0	0.440	-	-	-	15.7	-	1976.8	0.028
3.0	3.5	0.546	-	-	-	19.5	-	1973.0	0.028
3.5	4.0	0.665	-	-	-	23.8	-	1968.7	0.028
4.0	4.5	0.845	-	-	-	30.2	-	1962.3	0.028
5.0	6.0	1.095	-	-	-	39.1	-	1953.4	0.028
6.0	7.0	1.357	-	-	-	48.5	-	1944.0	0.028
7.0	8.0	1.620	-	-	-	57.9	-	1934.6	0.028
8.0	9.0	1.884	-	-	-	67.3	-	1925.2	0.028
9.0	10.0	2.153	-	-	-	76.9	-	1915.6	0.028
10.0	11.0	2.429	-	-	-	86.8	-	1905.7	0.028
11.0	12.0	2.706	-	-	-	96.6	-	1895.9	0.028
12.0	13.0	2.983	-	-	-	106.5	-	1886.0	0.028
13.0	14.0	3.262	-	-	-	116.5	-	1876.0	0.028
14.0	15.0	3.543	-	-	-	126.5	-	1866.0	0.028
15.0	16.0	3.832	-	-	-	136.8	-	1855.7	0.028
16.0	17.0	4.128	-	-	-	147.4	-	1845.1	0.028

Date Sampled: 1992.5

Sedimentation Rate: Constant at 0.028 g/cm^2yr.

Table C-8:
Site LM #47s - Algoma Basin, Lake Michigan
Lead-210 Dating Information

(Analysis by Dan R. Engstrom, The University of Minnesota)

Top of Interval (cm)	Base of Interval (cm)	Cum. Dry Mass (g/cm^2)	Unsup. Activity (pCi/g)	Error of unsup.act ($+_r$- S.D.)	Cum.Act. below int. pCi/cm^2	Age:Base of int. (year)	Error of Age ($+_r$- S.D.)	Date A.D.	Sed. Accum. g/cm2yr
0.0	0.5	0.030	21.160	-	-	0.9	-	1991.6	0.035
0.5	1.0	0.128	20.078	-	-	3.7	-	1988.8	0.035
1.0	1.5	0.226	18.995	-	-	6.5	-	1986.0	0.035
1.5	2.0	0.333	17.746	-	-	9.5	-	1983.0	0.035
2.0	2.5	0.449	16.331	-	-	12.8	-	1979.7	0.035
2.5	3.0	0.568	14.904	-	-	16.2	-	1976.3	0.035
3.0	3.5	0.692	13.466	-	-	19.8	-	1972.7	0.035
4.0	5.0	0.816	12.086	-	-	23.3	-	1969.2	0.035
5.0	6.0	1.068	10.103	-	-	30.5	-	1962.0	0.035
6.0	7.0	1.253	7.889	-	-	35.8	-	1956.7	0.035
7.0	8.0	1.505	6.345	-	-	43.0	-	1949.5	0.035
8.0	9.0	1.760	5.151	-	-	50.3	-	1942.2	0.035
9.0	10.0	2.033	4.061	-	-	58.1	-	1934.4	0.035
10.0	11.0	2.324	3.089	-	-	66.4	-	1926.1	0.035
11.0	12.0	2.603	2.211	-	-	74.4	-	1918.1	0.016
12.0	13.0	2.875	1.302	-	-	179.7	-	1812.8	0.016
13.0	14.0	3.147	0.717	-	-	196.7	-	1795.8	0.016
14.0	15.0	3.419	0.457	-	-	213.9	-	1778.6	0.016
15.0	16.0	3.695	0.265	-	-	230.9	-	1761.6	0.016
16.0	17.0	3.975	0.143	-	-	248.4	-	1744.1	0.016

Date Sampled: 1992.5

Sedimentation Rate: 0.035 g/cm^2yr to 10.5 cm
0.016 g/cm^2yr below 10.5 cm.

Table C-9:
Site LM #11 - Algoma Basin, Lake Michigan
Lead-210 Dating Information

(Analysis by Dan R. Engstrom, The University of Minnesota)

Top of Interval (cm)	Base of Interval (cm)	Cum. Dry Mass (g/cm^2)	Unsup. Activity (pCi/g)	Error of unsup.act (+,- S.D.)	Cum.Act. below int. pCi/cm^2	Age:Base of int. (year)	Error of Age (+,- S.D.)	Date A.D.	Sed. Accum. g/cm2yr
0	0.5	0.3395	-	-	-	21.2	-	1970.5	0.0160
0.5	1.5	0.8599	-	-	-	53.7	-	1938.0	0.0160
1.5	2.5	1.2218	-	-	-	76.4	-	1915.3	0.0160
2.5	3.5	1.5469	-	-	-	96.7	-	1895.0	0.0160
3.5	4.5	1.8352	-	-	-	114.7	-	1877.0	0.0160
4.5	5.5	2.1387	-	-	-	133.7	-	1858.0	0.0160
5.5	6.5	2.4524	-	-	-	153.3	-	1838.4	0.0160
6.5	7.5	2.7911	-	-	-	174.5	-	1817.3	0.0160
7.5	8.5	3.1062	-	-	-	197.5	-	1794.2	0.0160
8.5	9.5	3.5448	-	-	-	221.6	-	1770.1	0.0160
9.5	10.5	3.9451	-	-	-	246.6	-	1745.1	0.0160

Date Sampled: 1991.7

Sedimentation Rate: Constant at 0.0160 g/cm^2yr.

Table F-10:

Table C-10:
Site LM #18 - Southern Basin, Lake Michigan
Lead-210 Dating Information

(Analysis by Dan R. Engstrom, The University of Minnesota)

Top of Interval (cm)	Base of Interval (cm)	Cum. Dry Mass (g/cm^2)	Unsup. Activity (pCi/g)	Error of unsup.act ($+_{r}$- S.D.)	Cum.Act. below int. pCi/cm^2	Age:Base of int. (year)	Error of Age ($+_{r}$- S.D.)	Date A.D.	Sed. Accum. g/cm2yr
0.0	1.0	0.1572	19.1135	0.3239	34.7265	2.66	0.77	1989.0	0.0590
2.0	3.0	0.6711	18.0787	0.4305	25.3217	12.81	0.90	1978.9	0.0480
4.0	5.0	1.2502	17.1464	0.4357	15.2597	29.07	1.26	1962.6	0.0320
5.0	6.0	1.5290	12.8776	0.3955	11.6694	37.69	1.56	1954.0	0.0324
6.0	7.0	1.8033	9.4609	0.2585	9.0743	45.76	1.94	1945.9	0.0340
8.0	9.0	2.3423	6.2175	0.1988	5.3238	62.89	1.88	1928.8	0.0306
10.0	11.0	2.9414	4.6568	0.1164	2.3219	89.53	2.80	1902.2	0.0200
11.0	12.0	3.2531	3.3232	0.1678	1.2861	108.51	4.83	1883.2	0.0164
12.0	13.0	3.5648	1.8365	0.0660	0.7137	127.42	8.62	1864.3	0.0165
14.0	15.0	4.1867	0.5726	0.0440	0.1888	170.12	7.52	1821.6	0.0146

Date Sampled: 1991.7

Supported Pb-210: 1.0684 +/- 0.0244 pCi/g

Unsupported Pb-210: 37.7311 pCi/g

Sedimentation Rate: 0.040 g/cm^2yr to 11.5 cm. *cf:cs determined*

0.018 g/cm^2yr below 11.5 cm. *cf:cs determined*

Table C-11:
Site LM #19 - Southern Basin, Lake Michigan
Lead-210 Dating Information

(Analysis by Dan R. Engstrom, The University of Minnesota)

Top of Interval (cm)	Base of Interval (cm)	Cum. Dry Mass (g/cm^2)	Unsup. Activity (pCi/g)	Error of unsup.act ($+_r$- S.D.)	Cum.Act. below int. pCi/cm^2	Age:Base of int. (year)	Error of Age ($+_r$- S.D.)	Date A.D.	Sed. Accum. g/cm2yr
0.0	1.0	0.044	15.245	-	-	1.9	-	1989.8	0.023
1.0	2.0	0.180	14.765	-	-	7.8	-	1983.9	0.023
2.0	3.0	0.449	14.924	-	-	19.5	-	1972.2	0.023
3.0	4.0	0.813	13.565	-	-	35.3	-	1956.4	0.023
4.0	5.0	1.208	9.308	-	-	52.5	-	1939.2	0.023
5.0	6.0	1.693	4.960	-	-	73.6	-	1918.1	0.023
6.0	7.0	2.299	1.808	-	-	100.0	-	1891.7	0.023

Date Sampled: 1991.7

Sedimentation Rate: Constant at 0.023 g/cm^2yr.

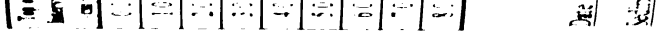


Table C-12:
Site LO #19 - Niagara Basin, Lake Ontario
Lead-210 Dating Information

(Analysis by Dan R. Engstrom, The University of Minnesota)

Top of Interval (cm)	Base of Interval (cm)	Cum. Dry Mass (g/cm^2)	Unsup. Activity (pCi/g)	Error of unsup.act (+,- S.D.)	Cum.Act. below int. pCi/cm^2	Age:Base of int. (year)	Error of Age (+,- S.D.)	Date A.D.	Sed. Accum. g/cm2yr
0.0	1.0	0.0712	-	-	-	2.36	-	1989.4	0.0302
1.0	2.0	0.2382	-	-	-	7.89	-	1983.8	0.0302
2.0	3.0	0.4457	-	-	-	14.76	-	1976.9	0.0302
3.0	4.0	0.6721	-	-	-	22.25	-	1969.5	0.0302
4.0	5.0	0.9046	-	-	-	29.95	-	1961.8	0.0302
5.0	6.0	1.1706	-	-	-	38.76	-	1952.9	0.0302
6.0	7.0	1.5031	-	-	-	49.77	-	1941.9	0.0302
7.0	8.0	1.9101	-	-	-	100.65	-	1891.1	0.0302
8.0	9.0	2.3337	-	-	-	153.60	-	1838.1	0.0080

Date Sampled: 1991.7

Sedimentation Rate: 0.0302 g/cm^2yr to 8.0 cm.

0.0080 g/cm^2yr below 8.0 cm.

Table C-13:
Site LO #40a - Mississagua Basin, Lake Ontario
Lead-210 Dating Information

(Analysis by Dan R. Engstrom, The University of Minnesota)

Top of Interval (cm)	Base of Interval (cm)	Cum. Dry Mass (g/cm^2)	Unsup. Activity (pCi/g)	Error of unsup.act (+,- S.D.)	Cum.Act. below int. (pCi/cm^2)	Age:Base of int. (year)	Error of Age (+,- S.D.)	Date A.D.	Sed. Accum. g/cm2yr
0.0	1.0	0.1018	13.1975	0.3559	25.0861	1.68	1.06	1990.0	0.0608
1.0	2.0	0.2896	11.9703	0.4619	22.8381	4.69	1.11	1987.0	0.0623
2.0	3.0	0.4999	14.3500	0.5185	19.8203	9.24	1.19	1982.5	0.0462
3.0	4.0	0.7769	10.3115	0.3912	16.9640	14.24	1.30	1977.5	0.0554
4.0	5.0	1.0193	10.6597	0.3311	14.3801	19.55	1.46	1972.2	0.0457
6.0	7.0	1.4635	8.5725	0.3382	10.3449	30.12	1.73	1961.6	0.0408
8.0	9.0	1.9037	6.6556	0.2591	7.2167	41.69	2.15	1950.0	0.0371
10.0	11.0	2.4301	5.0514	0.1962	4.3688	57.80	3.06	1933.9	0.0310
12.0	13.0	3.0212	3.2408	0.1738	2.2124	79.65	4.44	1912.1	0.0257
14.0	15.0	3.5897	1.4996	0.0953	1.1358	101.06	5.23	1890.6	0.0277
16.0	17.0	4.1815	0.6467	0.0738	0.6395	119.51	6.78	1872.2	0.0353
18.0	19.0	4.8101	0.4366	0.0763	0.3333	140.44	12.23	1851.3	0.0284
19.0	20.0	5.1202	0.3633	0.0741	0.2206	153.69	18.16	1838.0	0.0234

Number of Supported Samples: 2
Supported Lead-210: 1.551 +/- 0.0329 pCi/g
Cumulative Unsupported Lead-210: 26.4296 pCi/cm^2
Unsupported Lead-210 Flux: 0.8821 pCi/cm^2yr

Table C-14:
Site LO #E30 - Rochester Basin, Lake Ontario
Lead-210 Dating Information

(Analysis by Dan R. Engstrom, The University of Minnesota)

Top of Interval (cm)	Base of Interval (cm)	Cum. Dry Mass (g/cm^2)	Unsup. Activity (pCi/g)	Error of unsup.act ($+_r$- S.D.)	Cum.Act. below int. pCi/cm^2	Age:Base of int. (year)	Error of Age ($+_r$- S.D.)	Date A.D.	Sed. Accum. g/cm2yr
0.0	1.0	0.0879	-	-	-	1.32	-	1989.3	0.0666
1.0	2.0	0.2733	-	-	-	4.10	-	1986.5	0.0666
2.0	3.0	0.4762	-	-	-	7.15	-	1983.4	0.0666
3.0	4.0	0.6886	-	-	-	10.34	-	1980.2	0.0666
4.0	5.0	0.904	-	-	-	13.57	-	1977.0	0.0666
5.0	6.0	1.1143	-	-	-	16.73	-	1973.9	0.0666
6.0	7.0	1.3182	-	-	-	19.79	-	1970.8	0.0666
7.0	8.0	1.5252	-	-	-	22.90	-	1967.7	0.0666
8.0	9.0	1.7402	-	-	-	26.13	-	1964.5	0.0666
9.0	10.0	1.968	-	-	-	29.55	-	1961.0	0.0666
10.0	11.0	2.2118	-	-	-	33.21	-	1957.4	0.0666
11.0	12.0	2.4758	-	-	-	37.17	-	1953.4	0.0666
12.0	13.0	2.7559	-	-	-	41.38	-	1949.2	0.0666
13.0	14.0	3.0415	-	-	-	45.67	-	1944.9	0.0666
14.0	15.0	3.3304	-	-	-	50.01	-	1940.6	0.0666
15.0	16.0	3.6213	-	-	-	54.37	-	1936.2	0.0666
16.0	17.0	3.9134	-	-	-	58.76	-	1931.8	0.0666
17.0	18.0	4.2085	-	-	-	63.19	-	1927.4	0.0666
18.0	19.0	4.5088	-	-	-	67.70	-	1922.9	0.0666
19.0	20.0	4.8164	-	-	-	72.32	-	1918.3	0.0666
20.0	22.0	5.2948	-	-	-	79.50	-	1911.1	0.0666

Date Sampled: 1990.6

Sedimentation Rate: Constant at 0.0666 g/cm^2yr.

Table C-15:
Site LO #F31 - Rochester Basin, Lake Ontario
Lead-210 Dating Information

(Analysis by Dan R. Engstrom, The University of Minnesota)

Top of Interval (cm)	Base of Interval (cm)	Cum. Dry Mass (g/cm^2)	Unsup. Activity (pCi/g)	Error of unsup.act (+,- S.D.)	Cum.Act. below int. pCi/cm^2	Age:Base of int. (year)	Error of Age (+,- S.D.)	Date A.D.	Sed. Accum. g/cm2yr
0	1	0.2553	12.1051	0.1798	23.5381	3.96	1.16	1986	0.0019
2	3	0.9006	10.5786	0.1579	16.4894	15.39	1.38	1976	0.0019
4	5	1.6183	10.3980	0.1524	8.9954	34.85	2.22	1965	0.0018
6	7	2.0871	7.7364	0.1323	5.0228	53.56	3.00	1957.7	0.0019
8	9	2.5133	4.4728	0.1265	2.8173	72.13	3.53	1951	0.0022
10	11	2.9586	2.1623	0.0789	1.6295	89.71	3.64	1944	0.0028
12	13	3.4317	1.5727	0.0755	0.8201	111.76	6.53	1936.6	0.0034
14	15	4.0028	0.8750	0.0666	0.2321	152.30	18.60	1927.6	0.0051
16	17	4.6275	0.1315	0.0765	0.0461	204.20	40.05	-	0.0155

Number of Supported Samples: 2
Supported Lead-210: 1.4882 +/- 0.0449 pCi/g
Cumulative Unsupported Lead-210: 26.6285 pCi/cm^2
Unsupported Lead-210 Flux: 0.8605 pCi/cm^2yr

Table C-16:
Site LO #G32 - Rochester Basin, Lake Ontario
Lead-210 Dating Information

(Analysis by Dan R. Engstrom, The University of Minnesota)

Top of Interval (cm)	Base of Interval (cm)	Cum. Dry Mass (g/cm^2)	Unsup. Activity (pCi/g)	Error of unsup.act (+,- S.D.)	Cum.Act. below int. (pCi/cm^2)	Age:Base of int. (year)	Error of Age (+,- S.D.)	Date A.D.	Sed. Accum. g/cm2yr
0	1	0.2070	10.5466	0.1840	27.8030	2.43	1.28	1988.2	0.0853
2	3.5	0.8184	8.7637	0.1595	22.2256	9.62	1.43	1981.0	0.0848
4.5	5.5	1.3487	8.2691	0.1489	17.7838	16.78	1.65	1973.8	0.0711
6.5	7.5	1.8742	7.4954	0.1458	13.7446	25.05	2.00	1965.5	0.0611
8.5	9.5	2.3797	6.3349	0.2434	10.3992	34.01	2.48	1956.6	0.0549
10.5	11.5	2.9201	3.7590	0.1603	8.0622	42.18	2.83	1948.4	0.0710
12.5	13.5	3.5362	3.4366	0.1671	5.8979	52.22	3.75	1938.4	0.0583
14.5	15.5	4.2257	2.3448	0.1380	4.1094	63.82	5.10	1926.8	0.0599
16.5	17.5	4.9585	1.3619	0.1003	2.9466	74.50	6.78	1916.1	0.0730
18.5	19.5	5.7221	1.0673	0.0894	2.0775	85.73	9.51	1904.9	0.0664
20.5	22	6.7559	0.7696	0.0855	1.2171	102.90	16.03	1887.7	0.0585

Number of Supported Samples: 2
Supported Lead-210: 1.4882 +/- 0.0449 pCi/g
Cumulative Unsupported Lead-210: 29.9861 pCi/cm^2
Unsupported Lead-210 Flux: 0.9723 pCi/cm^2yr

APPENDIX D:

Solutions Preparation and Analysis Methods

Table D-1:

Solutions Preparation

(FIAS)

Stock Solution Preparation:

Hg: In a 100 ml flask add: - 100 ul of reagent std. (1000 ppm).
- 10 ml of concentrated HNO_3.
- Dilute up to 100 ml with DDW.

Standard Solutions:

Hg: 0.5 ppb std.
- 50 ul of reagent std. (1000 ppm).
- 10 ml of concentrated HNO_3.
- Dilute up to 100 ml with DDW.

1.0 ppb std.
- 100 ul of regent std. (1000 ppm).
- 10 ml of concentrated HNO_3.
- Dilute up to 100 ml with DDW.

FIAS Carrier Solutions:

0.2% $NaBH_4$: - 3 pellets NaOH & 1.0g $NaBH_4$ into 500 ml flask.
- Dilute up to 500 ml with DDW.

3.0% HCl:
- 80 ml reagent strength HCl into 1000 ml flask.
- Dilute up to 1000 ml with DDW.
* Prepare acid under hood and wear goggles.

**** These solutions must be made fresh for each run. ****

Inert Gas & Air settings:

Ar gas: - Pressure must be set to 40psi.

O_2: - Pressure must be set to 80psi.

SRM Values:

Hg: 1.40 - 1.54 ug/l.

Table D-2:

FIAS-200 Conditions for Mercury Analysis

Spectrometer:

Technique..... Flow Injection
Lamp..... Hg-EDL
Wavelength..... 253.7 nm
Slit Width..... 0.7 nm (low)
Signal Type..... AA
Signal Measurement..... Peak Height (5)
Read Time..... 15 sec.
Read Delay..... 0 sec.
BOC Time..... 2 sec.

Calibration:

Solution	ID standard	Conc.	Sample Location	Volume	Dilutant Volume	Modifier Vol. #1	Modifier Vol. #2
Blank	Calib. B	--------					
S1	1.0 ppb	1.00					
Reagent		--------					
Samples	--------	--------					

Calibration Equation..... Non-Linear
Calibration Units..... µg/L
Sample Units..... µg/L

FIAS Conditions:

Step	Time (sec)	Pump #1 (rpm)	Pump #2 (rpm)	Valve Position *Fill*	Valve Position *Inject*	Read	Amalgam Events *Heat*	Amalgam Events *Cool*	Amalgam Events *Argon*
Prefill	10	100	40	X					X
1	15	100	40	X				X	
2	10	0	120		X			X	
3	10	0	40	X				X	
4	10	0	40	X		X	X		
5	10	0	40	X					X
6	1	0	0						

Cell Temperature..... 100° C
Sample Volume..... 1000 µL

Protocol for Nitric Acid Microwave Digestion of Sediments

*** Prior to starting a digestion, all vessels should be cleaned (liners washed with nitric acid, lids scrubbed with DDW; both soaked for at least 24 hrs. in DDW bath) and assembled with rupture membranes.**

1.) Remove the samples to be digested from the freezer and allowed to thaw in a refrigerator for 24 hrs. Approximately 1 hour prior to running the digestion, remove the samples from the refrigerator.

2.) Take a clean watch glass and, using the mettler scale, record its weight. Using a teflon rod, homogenize the sample and weigh out 3-5 g of sample. Record the weight of the watch glass + the wet sample. Three sample subsplits should be conducted on two samples; one within the first six samples toward the top of a core and one from the bottom. For example, sample number 4A, 4B, 4C, and 15A, 15B, 15C.

3.) Place watch glass in oven and dry at 50° C for 24 hours.

4.) Re-weigh dried sample. Place the sample into a ceramic mortar and grind up into a fine power. Carefully weigh out exactly 0.500 g of ground sample into a teflon digestion vessel liner.

5.) Weigh out exactly 0.500 g of SRM (Buffalo River sediment) into a teflon digestion vessel liner.

6.) To each sample, add 10 ml HNO_3. Make sure no sample remains on sides of the liner. Use one vessel for an acid blank, containing only 10 ml of acid with no sample. Screw lids on tight enough so that the teflon leads do not rotate. The pressure monitor should be placed on any sample which is not a blank. * A blank should be prepared each time a suite of samples is run through the microwave.

7.) Attach the pressure hose to the pressure monitor. Make sure that the hose is pushed all the way into the teflon lead.

8.) Set up the microwave: fix the exhaust hose in the fume hood, make sure that it is secure. Plug microwave into outlet. Switch the microwave and pressure gage "on". Make sure that the valve on the pressure gage is set to "netural". Set the program as follows:

<1500> for time
<enter>
<100> for % power
<enter>
<program>
<2000> for cooling time in 0000 min
<enter>
<reset>
<start>

9.) After the digestion has ended and cooled, vent the microwave.

10.) To each sample add 90 ml of DDW.

11.) Filter each sample through a 0.4 μ Nuclepore. Prep the syringe with 10 ml DDW and filter with 5 ml leachate. Filter 60 ml for Hg. Add 600 μL $HAuCl_4$ to each Hg sample (10 μL / 1.0 ml sample). Filter the remaining leachate for other trace metals.

12.) Place vessels immediately into DDW bath. Place syringes and filter heads in separate DDW bath.

13.) At the end of the digestion, flush the microwave. Aline the valve on the pressure gage with the "Flush" direction. Place pressure hose into beaker of DDW. Using syrange, inject DDW three times into syrange. Leave syrange full. Return valve to "neutral" position. Remove exhause hose from fume hood and unplug microwave.

APPENDIX E

Quality Assurance & Quality Control

Quality Assurance - Quality Control (QAQC results)

The acceptable level of uncertainty for concentration data and accumulation rates is 20% for all the metals. Procedural blanks are included in every sediment core analyized.

Precision: Method precision will be monitored by the analysis of 5% of the sediment samples split into two equal fractions after homogenization and each analyzed as a separate sample (see method precision table).

Accuracy: Accuracy will be monitored by metal recovery from NIST standerd reference sediments - NIST Bufflo River Sediment #2704 (see SRM results).

Blanks: Procedural blanks will be used to monitor any contamination caused by analysis (see blanks results).

Sensitivity: The method detection limit (MDL) is the minimum concentration above which you have confidence the analyte was present or not. The MDL will be determined once for the study for each analyte, and is determined by: $\mathbf{MDL = 3\sigma}$

Table E-1:
Remark codes used to describe why a data value is flagged.

MDL Method Dection Limit, Sample value is less than or equal to the analytical limit of detection.

NSQ Not Sufficient Quanity, There was not sufficient quanity of the matrix to conduct an analysis.

LAC Laboratory Accident, There was an accident in the lab that destroyed the sample or rendered it unsuitable for analysis.

NAI Not Analyzed due to Interference, Because of uncontrollable interference, the analysis for the analyte of interest was not conducted.

RIN Re-Analyzed, The reported value was generated from a re-injection of the same sample abstract.

REX Re-Prepared, The reported value was generatedfrom a re-preparation of the same sample.

FBX Found in Blank, The analyte was found in the procedural blank for that set of runs at greater than acceptable criteria, thus, the reported value may be an overestimate.

n/a Sample Not Availiable, There is no reported value because a sample was not analyized.

Table E-2: QAQC
Sediment Core Sub-split Analysis for Mercury

* The method precision will be monitored by the analysis of at least 5% of the sediment samples split into two equal fractions after homogenization and each analyzed as seperate samples. RSD values must be below 20%.

* RSD values are reported as a percentage (%).

Lake Superior Cores:

Core Site	Concentration (ng/g)	RSD	Concentration (ng/g)	RSD
LS#DTL	*#5:* LAC	——	*#10:* LAC	-----
LS#SJE-II	*#5:* **172, 216, 188**	**9.5**	*#15:* **55, 56, 58**	**2.2**
NOAA#3	*#4:* **168, 160, 164**	**2.0**	n/a	——
LS#1383	*#8:* **44, 46, 46**	**2.1**	n/a	——
LS#1391	*#7:* **22, 21, 23**	**3.7**	n/a	——

Lake Michigan Cores:

Core Site	Concentration (ng/g)	RSD	Concentration (ng/g)	RSD
LM#70m	*#25:* **19, 22, 25**	**11.1**	n/a	——
LM#68k	*#10:* **248, 264, 244**	**3.4**	*#17:* **44, 38, 40**	**6.1**
LM#47s	*#4:* **219, 213**	**1.4**	*#7:* **190, 187**	**0.8**
LM#11	*#18:* **26, 44, 48**	**11.7**	n/a	——
LM#18	*#18:* **30, 20, 20**	**20.2**	*#32:* **33, 21, 21**	**22.6**
LM#19	*#23:* NSQ	-----	*#30:* NSQ	-----

Lake Ontario Cores:

Core Site	Concentration (ng/g)	RSD	Concentration (ng/g)	RSD
LO#19	*#15:* **30, 26, 37**	**14.7**	*#30:* **33, 33, 34**	**1.4**
LO#40a	*#20:* **80, 76, 74**	**3.3**	*#41:* NSQ	-----
LO#E30	*#4:* **1100, 1020, 1040**	**3.2**	*#17:* **1660, 1240, 1280**	**13.6**
LO#F31	*#5:* **1380, 1360, 1420**	**1.8**	*#12:* **2360, 2560, 2560**	**3.8**
LO#G32	*#5:* **840, 840, 820**	**1.1**	*#17:* LAC	-----

Table E-3: QAQC
Replicate Sample Analysis for Mercury

* SRM values attained by NIST Buffalo river sediment #2704.
* Spotchecked and original sample values must be within 20% of each other,

Lake Superior Cores:

Site Number	Samples Run	Std.	Original (ng/g)	Std.	Spotcheck (ng/g)
LS# 2055	#1, 19, 20	0.031	**168, 88, 80**	0.043	**118, 68, 58**
LS #2059	#2, 4, 12	0.038	**134, 180, 56**	0.043	**112, 152, 50**
NOAA#3	#7, 9, 10	0.039	**80, 54, 52**	0.042	**76, 50, 54**
LS #1383	#1, 2, 3	0.043	**158, 106, 68**	0.044	**156, 108, 70**
LS #1391	#1, 2, 3	0.043	**88, 72, 72**	0.044	**86, 64, 64**

Lake Michigan Cores:

Site Number	Samples Run	Std.	Original (ng/g)	Std.	Spotcheck (ng/g)
EPA #11	#3, 12, 14	0.028	**114, 14, 18**	0.042	**150, 24, 20**
EPA #18	#11, 12, 18	0.033	**114, 58, 32**	0.042	**82, 50, 30**
EPA #19	#2, 3, 4	0.044	**178, 188, 148**	0.044	**164, 164, 136**
LM #47s	#3, 6, 13	0.043	**173, 164, 168**	0.043	**155, 150, 152**
LM #68k	#14, 15, 16	0.035	**64, 48, 64**	0.043	**60, 44, 56**
LM #70m	#1, 8, 11	0.044	**132, 108, 94**	0.043	**134, 112, 88**

Lake Ontario Cores:

Site Number	Samples Run	Std.	Original (ng/g)	Std.	Spotcheck (ng/g)
LO#19	#8, 10, 11	0.042	**266, 42, 34**	0.043	**180, 44, 30**
LO #40a	#22, 23, 24	0.043	**60, 52, 52**	0.042	**64, 56, 62**
LO #E30	#1, 2, 5	0.041	**590, 710, 1260**	0.044	**570, 760, 1260**
LO #F31	#2, 6, 14	0.042	**960, 1760, 1110**	0.044	**1020, 1760, 1080**
LO #G32	#1, 3, 20	0.044	**540, 660, 540**	0.044	**560, 560, 560**

Table E-4: QAQC
Method Detection Limits for Mercury

*** MDL is defined as 3σ of seven injections of a representive sample blank.**

Mercury MDL:	**Replicate 1:**	**0.03 ug/l**	
	Replicate 2:	**0.02 ug/l**	
	Replicate 3:	**0.03 ug/l**	**mean conc. = 0.02 ug/l**
	Replicate 4:	**0.02 ug/l**	**σ = 0.013**
	Replicate 5:	**0.00 ug/l**	**MDL = 0.039 ug/l**
	Replicate 6:	**0.02 ug/l**	
	Replicate 7:	**0.00 ug/l**	

Table E-5: QAQC

Accuracy Table: Standard Reference Material Analysis

NIST Buffalo River Sediment #2704

Site	Hg (ng/g)	Recovery (%)
LS-DTL	1.20	81.6
LS-SJE2	1.68	114.3
NOAA 3	1.64	111.6
LS-1390	1.24	84.4
LS-1391	1.42	96.6
LM-70M	1.24	84.4
LM-68K	1.94	131.9
LM-47S	1.52	103.4
LM-11	1.40	95.2
LM-18	1.40	95.2
LM-19	1.24	84.4
LO-19	1.53	104.1
LO-40a	1.34	91.1
LO-E30	1.22	82.9
LO-F31	1.60	108.8
LO-G32	1.36	92.5

QAQC Specifications:

	Hg (ng/g)	Recovery (%)
NIST	1.40 - 1.54 ng/g	95% - 105%
Project	1.03 - 1.76 ng/g	70% - 120%

Table E-6: QAQC
Sample Blanks Analysis

Site	Mercury (ng/g) Blank 1	Mercury (ng/g) Blank 2	Mercury (ng/g) Blank 3
LS-DTL	0.02	0.02	0.00
LS-SJE2	0.00	0.00	0.00
NOAA 3	0.02	0.01	n/a
LS-1390	0.01	0.01	n/a
LS-1391	0.00	0.00	n/a
LM-70m	0.00	0.00	0.00
LM-68k	0.02	0.02	0.02
LM-47s	0.00	0.00	n/a
LM-11	0.03	0.01	n/a
LM-18	NSQ	NSQ	NSQ
LM-19	NSQ	NSQ	NSQ
LO-19	0.01	0.02	0.02
LO-40a	0.01	0.02	0.01
LO-E30	0.01	0.00	0.00
LO-F31	0.02	0.00	n/a
LO-G32	0.01	0.00	0.00

APPENDIX 2

APPENDIX 2A:

Arsenic Data

Table 2A-1:
Site LS# DTL - Duluth Basin, Lake Superior
Arsenic Data

Sample	As (ug/g)	As RSD	AsAdj. (ug/g)	Depth (cm)	Date (crs)	Por. (%)	Inv. ug/cm^2	Accum ug/m^{2}yr
1	**21.27**	4.66	12.40	0.25	1989.3	83.1	2.72428	90.13536
2	**22.96**	4.75	14.09	0.75	1986.1	82.4	3.223792	115.1484
3	**23.80**	4.14	14.93	1.25	1981.4	82.6	3.377166	103.5073
4	**23.87**	3.37	15.00	1.75	1977.1	82.1	3.4905	143.3838
5	**23.60**	4.31	14.73	2.25	1973.7	81.3	3.580863	193.72
6	**23.36**	3.35	14.49	2.625	1971.3	80.8	1.808352	218.2654
7	**32.53**	1.21	23.66	2.875	1969.7	83.3	2.568293	356.3947
8	**215.51**	6.24	206.64	3.05	1968.6	85.2	7.951507	2813.11
9	**105.66**	3.84	96.79	3.225	1967.2	81.9	11.38734	1171.252
10	**39.10**	7.80	30.23	3.6	1964.3	80.3	7.741903	338.5032
11	**16.08**	4.65	7.21	4.1	1960.5	80.9	1.790243	79.06844
12	**19.99**	5.40	11.12	4.6	1956.6	81.8	2.630992	125.6853
13	**17.49**	6.75	8.62	5.1	1952.8	81.6	2.061904	91.63369
14	**19.12**	9.19	10.25	5.6	1947.1	81.8	2.42515	75.58374
15	**15.98**	5.06	7.11	6.1	1941.3	82.2	1.645254	46.90257
16	**13.50**	10.11	4.63	6.85	1931.1	82.2	2.142764	26.06833
17	**11.20**	8.33	2.33	7.85	1916.8	81.7	1.108614	12.09067
18	**10.02**	5.91	1.15	8.85	1899.3	81.6	0.55016	5.653418
19	**9.26**	3.33	0.39	9.85	1879.6	81.5	0.18759	1.655059
20	**9.87**	4.26	1	10.85	-	82.1	0.4654	-
21	**8.74**	6.71	-	12.85	-	81.9	-	-
22	**8.16**	5.79	-	14.85	-	82.0	-	-
23	**9.13**	10.45	-	16.85	-	82.5	-	-
24	**8.08**	4.72	-	18.85	-	82.0	-	-

Focusing Factor: 1.476
Average Background Concentration: 8.87 ug/g
Arsenic Inventory for LS #DTL: 62.86207 ug/cm^2
Focusing Corrected Arsenic Inventory: 42.58948 ug/cm^2

Table 2A-2:
Site LS #SJE-II - Duluth Basin, Lake Superior
Arsenic Data

Sample	As (ug/g)	As RSD	AsAdj. (ug/g)	Depth (cm)	Date (crs)	Por. (%)	Inv. ug/cm^2	Accum ug/m^2yr
1	**26.31**		20.51	0.25	1988.5	95.0	1.570451	4489.104
2	**25.86**		20.06	0.75	1983.7	82.3	3.431865	4804.219
3	**23.83**		18.03	1.25	1977.9	82.5	3.677579	4132.173
4	**18.32**		12.52	1.75	1972.2	83.1	3.059888	1380.079
5	**15.08**		9.28	2.25	1965.9	83.2	2.678208	831.594
6	**12.00**		6.20	2.75	1958	83.7	1.60797	536.9072
7	**10.62**		4.82	3.25	1947.9	83.9	1.087151	431.927
8	**9.01**		3.21	3.75	1935.2	84.0	0.693135	313.1086
9	**8.43**		2.63	4.125	1926.8	84.2	0.22497	0
10	**23.30**		17.5	4.275	1921.1	89.8	0.59878	0
11	**4.23**		-1.57	4.75	1911.4	83.4	-0.26859	0
12	**17.45**		11.65	5.125	1902.3	84.2	1.590225	0
13	**65.64**		59.84	5.45	1892	85.6	13.06906	0
14	**48.05**		42.25	5.85	1882.3	84.7	0	-
15	**20.84**		15.04	6.30	1867.4	84.4	0	-
16	**9.37**		3.57	6.80	1851.4	84.4	0	-
17	**4.66**		-	7.30	1835.4	84.5	-	-
18	**5.48**		-	8.05	-	84.2	-	-
19	**5.12**		-	9.05	-	83.7	-	-
20	**5.34**		-	11.05	-	82.5	-	-
21	**5.89**		-	12.05	-	83.4	-	-
22	**6.27**		-	13.05	-	83.2	-	-
23	**7.10**		-	17.05	-	83.2	-	-
24	**7.05**		-	21.05	-	83.3	-	-

Focusing Factor: 1.261
Average Background Concentration: 5.87 ug/g
Arsenic Inventory for LS #SJE-II: 33.02068 ug/cm^2
Focusing Corrected Arsenic Inventory: 26.18611 ug/cm^2

Table 2A-3:
Site NOAA #3 - Chefswet Basin, Lake Superior
Arsenic Data

Sample	As (ug/g)	As RSD	AsAdj. (ug/g)	Depth (cm)	Date (crs)	Por. (%)	Inv. ug/cm^2	Accum ug/m^2yr
1	**4.32**	3.04		0.25	1988.8	95		
2	**3.80**	6.66		0.75	1981.7	93		
3	**3.91**	2.36		1.25	1972	92		
4	**3.31**	9.62		1.75	1963	91		
5	**3.30**	2.04		2.25	1953	91		
6	**2.85**	4.29		2.75	1940	90		
7	**2.79**	1.75		3.25	1925	90		
8	**2.70**	13.13		3.75	1907	89		
9	**2.09**	4.45		4.00	1884.9	88		
10	**2.04**	7.35		5.125	1857	89		
11	**2.07**	11.64		5.375	1849	88		
12	**2.30**	8.28		5.75	1823	88.5		
13	**21.11**	0.99		6.25	1799.9	88		
14	**1.29**	9.28		6.75	1783	87		
15	**1.77**	12.07		7.50	-	88		
16	**1.49**	2.17		8.50	-	88		
17	**1.61**	9.35		14.5	-	-		

Focusing Factor: 1.138
Average Background Concentration: ug/g
Arsenic Inventory for NOAA #3: ug/cm^2
Focusing Corrected Arsenic Inventory: ug/cm^2

Table 2A-4:
Site LS #1390 - Isle Royale Basin, Lake Superior
Arsenic Data

Sample	As (ug/g)	As RSD	AsAdj. (ug/g)	Depth (cm)	Date (crs)	Por. (%)	Inv. ug/cm^2	Accum ug/m^2yr
1	**7.77**	6.20	4.18	0.5	1981.7	84	1.73888	507.8505
2	**6.66**	2.22	3.07	1.5	1976.5	84	1.27712	353.8629
3	**5.09**	12.97	1.50	2.5	1967.4	82	0.78	102.8037
4	**3.77**	7.12	0.18	3.25	1958.2	80	0.03978	13.45794
5	**3.37**	3.65	0	3.75	1946	81	0	0
6	**15.08**	4.25	11.49	4.25	1931.9	83	2.68866	429.5327
7	**3.28**	6.24	-	5.0	1873.8	82	-	-
8	**3.24**	9.04	-	6.0	1819.3	81	-	-
9	**3.77**	7.62	-	7.5	1698.2	80	-	-
10	**3.75**	4.42	-	9.5	-	76	-	-
11	**3.39**	2.11	-	11.5	-	80	-	-
12	**4.24**	10.46	-	13.5	-	79	-	-
13	**3.46**	8.84	-	16.0	-	-	-	-
14	**3.21**	13.58	-	19.0	-	-	-	-
15	**3.99**	9.69	-	22.5	-	-	-	-
16	**8.49**	3.95	-	26.5	-	-	-	-
17	**3.80**	8.30	-	30.5	-	-	-	-
18	**4.27**	10.85	-	34.5	-	-	-	-

Focusing Factor: 3.21
Average Background Concentration: 3.59 ug/g
Arsenic Inventory for LS #1383: 6.52444 ug/cm^2
Focusing Corrected Arsenic Inventory: 2.032536 ug/cm^2

Table 2A-5:
Site LS #1391 - Isle Parisienne Basin, Lake Superior
Arsenic Data

Sample	As (ug/g)	As RSD	AsAdj. (ug/g)	Depth (cm)	Date (crs)	Por. (%)	Inv. ug/cm^2	Accum ug/m^2yr
1	**14.42**	9.09	11.56	0.5	1980.7	90	3.0056	1291.62
2	**11.62**	2.84	8.78	1.5	1965.2	87	2.96764	1226.257
3	**11.02**	1.60	8.18	2.5	1944.6	81	4.04092	776.8715
4	**7.43**	10.22	4.59	3.25	1925.9	80	1.1934	461.5642
5	**28.03**	2.28	25.19	4.0	1902.2	76	15.71856	2673.799
6	**2.32**	9.25	-	5.0	1867.4	74	-	-
7	**1.77**	6.06	-	6.0	1794.8	74	-	-
8	**4.15**	7.71	-	7.5	-	71	-	-
9	**1.77**	7.18	-	9.5	-	72	-	-
10	**1.62**	16.39	-	11.0	-	71	-	-
11	**3.68**	9.26	-	12.5	-	72	-	-
12	**4.27**	8.21	-	15.5	-	72	-	-
13	**2.81**	8.05	-	18.5	-	71	-	-
14	**3.00**	8.43	-	21.5	-	72	-	-
15	**3.03**	6.11	-	26.5	-	72	-	-

Focusing Factor: 1.79
Average Background Concentration: 2.84 ug/g
Arsenic Inventory for LS #1391: 26.92612 ug/cm^2
Focusing Corrected Arsenic Inventory: 15.04253 ug/cm^2

Table 2A-6:
Site LM #70m - North Algoma Basin, Lake Michigan
Arsenic Data

Sample	As (ug/g)	As RSD	AsAdj. (ug/g)	Depth (cm)	Date (cf/cs)	Por. (%)	Inv. ug/cm^2	Accum ug/m^2yr
1	**18.44**	0.11	14.59	0.25	1990.8	95.2	0.857892	1028.782
2	**18.45**	0.21	14.60	0.75	1985.1	94.5	0.976521	1029.487
3	**18.10**	1.91	14.25	1.25	1978.4	93.6	1.111963	1004.808
4	**19.14**	1.14	15.29	1.75	1970.9	92.8	1.350451	1078.141
5	**18.99**	1.70	15.14	2.25	1962.2	91.8	1.528232	1067.564
6	**18.68**	0.53	14.83	2.75	1952.4	90.8	1.667708	1045.705
7	**18.25**	1.08	14.40	3.25	1941.6	89.9	1.778112	1015.385
8	**18.00**	1.97	14.15	3.75	1929.8	89.0	1.906713	997.7564
9	**14.34**	1.14	10.49	4.25	1917.2	88.3	1.502194	739.6795
10	**8.59**	2.84	4.74	4.75	1903.7	87.6	0.717103	334.2308
11	**5.89**	13.26	2.04	5.25	1889.7	87.2	0.319122	143.8462
12	**4.48**	5.01	0.63	5.75	1875.2	87.1	0.099942	44.42308
13	**3.99**	8.23	0.14	6.25	1860.8	86.8	0.022055	9.871795
14	**5.80**	4.07	1.95	6.75	1846.5	85.9	0.315315	137.5000
15	**13.76**	1.51	9.91	7.25	1831.3	85.0	1.711705	698.7821
16	**10.84**	0.96	6.99	7.75	1815.0	84.3	1.284413	492.8846
17	**8.94**	2.96	5.09	8.25	1797.9	84.0	0.979558	358.9103
18	**11.54**	4.82	7.69	8.75	1779.9	84.3	1.505356	542.2436
19	**10.28**	2.38	6.43	9.25	-	83.9	1.237437	0
20	**4.58**	4.24	0.73	9.75	-	-	0.144243	0
21	**4.41**	13.28	0.56	10.5	-	-	0	0
22	**3.64**	6.38	-	11.5	-	-	-	-
23	**3.20**	2.14	-	12.5	-	-	-	-
24	**3.29**	1.63	-	13.5	-	-	-	-
25	**2.93**	6.75	-	14.5	-	-	-	-
26	**3.04**	4.25	-	15.5	-	-	-	-
27	**2.93**	4.75	-	16.5	-	-	-	-
28	**4.26**	11.51	-	17.5	-	-	-	-
29	**3.57**	10.89	-	18.5	-	-	-	-
30	**3.48**	4.65	-	19.5	-	-	-	-
31	**3.60**	5.43	-	20.5	-	-	-	-
32	**4.11**	7.36	-	21.5	-	-	-	-
33	**3.88**	4.51	-	25.5	-	-	-	-
34	**4.64**	0.75	-	29.5	-	-	-	-
35	**4.66**	3.88	-	33.5	-	-	-	-
36	**5.25**	2.51	-	37.5	-	-	-	-

Table 2A-6: Continued

Focusing Factor: 1.56
Average Background Concentration: 3.85 ug/g
Arsenic Inventory for LM #70m: 18.129 ug/cm^2
Focusing Corrected Arsenic Inventory: 11.62115 ug/cm^2

Table 2A-7:
Site LM #68k - Algoma Basin, Lake Michigan
Arsenic Data

Sample	As (ug/g)	As RSD	AsAdj. (ug/g)	Depth (cm)	Date (cf/cs)	Por. (%)	Inv. ug/cm^2	Accum ug/m^2yr
1	**20.46**	0.98	13.55	0.25	1991.4	98.0	0.331975	2994.475
2	**20.24**	2.37	13.33	0.75	1989.3	96.6	0.555195	2945.856
3	**21.41**	2.09	14.50	1.25	1986.6	95.6	0.78155	3204.420
4	**26.81**	4.24	19.90	1.75	1983.4	94.7	1.292007	4397.79
5	**31.98**	1.04	25.07	2.25	1980.1	94.0	1.842645	5540.331
6	**24.36**	0.42	17.45	2.75	1976.8	93.8	1.325328	3856.354
7	**15.07**	5.18	8.61	3.25	1973.0	94.1	0.589764	1803.315
8	**13.88**	2.52	6.97	3.75	1968.7	93.3	0.572063	1540.331
9	**18.80**	4.11	11.89	4.50	1962.3	93.5	1.893483	2627.624
10	**17.52**	5.50	10.61	5.50	1953.4	94.2	1.507681	2344.751
11	**14.61**	4.43	7.70	6.50	1944.0	93.9	1.150765	1701.657
12	**12.60**	1.23	5.69	7.50	1934.6	94.9	0.710965	1257.459
13	**10.35**	0.98	3.44	8.50	1925.2	93.6	0.539392	760.221
14	**7.10**	3.70	0.19	9.50	1915.6	92.8	0.33516	41.98895
15	**7.79**	14.86	0.88	10.5	1905.7	93.8	0.133672	194.4751
16	**6.80**	11.09	-	11.5	1895.9	92.0	-	-
17	**7.02**	4.00	-	12.5	1886.0	94.0	-	-
18	**6.29**	9.81	-	13.5	1876.0	92.6	-	-
19	**6.41**	10.53	-	14.5	1866.0	92.6	-	-
20	**7.86**	2.60	-	15.5	1855.7	94.0	-	-
21	**6.86**	8.93	-	16.5	1845.1	91.6	-	-
22	**7.77**	2.97	-	17.5	-	93.3	-	-
23	**7.17**	3.52	-	18.5	-	93.9	-	-
24	**6.42**	9.69	-	19.5	-	91.5	-	-
25	**5.46**	10.61	-	20.5	-	-	-	-

Focusing Factor: 1.267
Average Background Concentration: 6.913 ug/g
Arsenic Inventory for LM #68k: 13.26 ug/cm^2
Focusing Corrected Arsenic Inventory: 10.46567 ug/cm^2

Table 2A-8:
Site LM #47s - Algoma Basin, Lake Michigan
Arsenic Data

Sample	As (ug/g)	As RSD	AsAdj. (ug/g)	Depth (cm)	Date (cf/cs)	Por. (%)	Inv. ug/cm^2	Accum ug/m^2yr
1	**29.16**	0.71	24.17	0.25	1991.6	98.4	0.473732	84596.27
2	**38.18**	0.71	33.19	0.75	1988.8	97.3	1.097759	116166.7
3	**31.37**	0.68	26.38	1.25	1986.0	97.5	0.807888	92331.38
4	**18.88**	1.14	13.89	1.75	1983.0	97.0	0.510458	48615.73
5	**12.01**	4.61	7.02	2.25	1979.7	96.6	0.292383	24570.37
6	**11.33**	2.53	6.34	2.75	1976.3	96.7	0.256294	22190.33
7	**9.72**	0.81	4.73	3.25	1972.7	95.4	0.266535	16555.25
8	**8.67**	0.23	3.68	3.75	1969.2	95.2	0.216384	12880.19
9	**9.07**	4.62	4.08	4.50	1962.0	94.9	0.509796	14280.21
10	**9.16**	3.14	4.17	5.50	1956.7	94.1	0.602774	14595.22
11	**8.68**	7.74	3.69	6.50	1949.5	94.2	0.524349	12915.19
12	**7.77**	3.22	2.78	7.50	1942.2	92.1	0.538069	9730.146
13	**6.94**	4.48	1.95	8.50	1934.4	92.7	0.348757	6825.102
14	**6.98**	3.38	1.99	9.50	1926.1	93.1	0.33641	6965.104
15	**5.08**	10.8	0.09	10.5	1918.1	91.4	0.018963	315.0047
16	**4.18**	1.06	-	11.5	1812.8	93.4	-	-
17	**4.23**	8.19	-	12.5	1795.8	92.3	-	-
18	**4.75**	8.85	-	13.5	1778.8	93.2	-	-
19	**5.34**	6.69	-	14.5	1761.6	93.3	-	-
20	**4.27**	11.65	-	15.5	1744.1	93.6	-	-
21	**4.43**	8.59	-	16.5	-	93.3	-	-
22	**5.08**	4.24	-	17.5	-	91.6	-	-
23	**6.97**	0.52	-	18.5	-	90.8	-	-
24	**5.59**	4.96	-	19.5	-	91.2	-	-
25	-	3.89	-	23.5	-	-	-	-

Focusing Factor: 1.34
Average Background Concentration: 4.99 ug/g
Arsenic Inventory for LM #47s: 6.800551 ug/cm^2
Focusing Corrected Arsenic Inventory: 5.075038 ug/cm^2

Table 2A-9:
Site LM #11 - Southern Basin, Lake Michigan
Arsenic Data

Sample	As (ug/g)	As RSD	AsAdj. (ug/g)	Depth (cm)	Date (cf/cs)	Por. (%)	Inv. ug/cm^2	Accum ug/m^2yr
1	12.5	3.00	8.29	0.5	1970.5	84.6	3.127817	666.5327
2	12.8	1.36	8.59	1.5	1938.0	82.4	3.704008	690.6533
3	12.5	0.78	8.29	2.5	1915.3	82.2	3.615269	666.5327
4	14.0	1.09	9.79	3.5	1895.0	79.5	4.917028	787.1357
5	11.8	0.70	7.59	4.5	1877.0	79.2	3.867864	610.2513
6	9.7	3.47	5.49	5.5	1858.0	77.8	2.986011	441.407
7	13.7	6.27	9.49	6.5	1838.4	77.2	5.301114	763.0151
8	4.0	6.92	-0.21	7.5	1817.3	73.6	-	-
9	3.3	9.02	-0.91	8.5	1794.2	73.3	-	-
10	2.3	16.68	-1.91	9.5	1770.1	73.0	-	-
11	2.3	13.21	-1.91	10.5	1745.1	66.3	-	-
12	3.0	20.14	-1.21	11.5	-	67.5	-	-
13	6.5	10.27	2.29	12.25	-	68.4	-	-
14	5.8	4.31	1.59	13.0	-	64.9	-	-
15	3.3	9.94	-0.91	14.0	-	61.4	-	-
16	7.2	13.21	2.99	14.75	-	64.0	-	-
17	4.1	7.26	-0.11	15.25	-	66.5	-	-
18	2.1	9.24	-2.11	16.0	-	65.8	-	-
19	3.9	13.76	-0.31	17.0	-	63.8	-	-
20	4.6	7.69	0.39	18.0	-	64.9	-	-
21	4.9	4.88	0.69	19.5	-	66.7	-	-
22	5.0	5.87	0.79	21.5	-	66.7	-	-
23	7.1	4.58	2.89	23.5	-	65.8	-	-
24	2.7	5.67	-1.51	25.5	-	64.4	-	-
25	3.7	10.36	-0.51	27.5	-	66.6	-	-

Focusing Factor: 1.999
Average Background Concentration: 4.211 ug/g
Arsenic Inventory for LM #11: 27.51911 ug/cm^2
Focusing Corrected Arsenic Inventory: 13.8287 ug/cm^2

Table 2A-10:
Site LM #18 - Southern Basin, Lake Michigan
Arsenic Data

Sample	As (ug/g)	As RSD	AsAdj. (ug/g)	Depth (cm)	Date (cf/cs)	Por. (%)	Inv. ug/cm^2	Accum ug/m^2yr
1	**13.4**	2.76	6.25	0.5	1989.7	94.2	0.888125	1001.438
2	**15.4**	5.76	8.25	1.5	1984.4	93.1	1.394663	1321.898
3	**14.7**	3.04	7.55	2.5	1977.8	91.5	1.572288	1209.737
4	**22.3**	2.02	15.15	3.5	1970.8	90.5	3.526163	2427.486
5	**38.5**	1.59	31.35	4.5	1963.4	89.8	7.834365	5023.213
6	**10.5**	11.23	3.35	5.5	1956.1	89.3	0.878203	536.7707
7	**7.5**	1.93	0.35	6.8	1945.6	89.2	0.139172	56.08053
8	**7.7**	1.43	0.55	8.0	1938.3	89.2	0.146069	88.12654
9	**8.3**	1.05	1.15	9.0	1931.0	89.1	0.305981	184.2646
10	**6.6**	6.75	-0.55	10.0	1923.8	88.3	-	-
11	**6.6**	11.67	-	11.0	1916.5	87.5	-	-
12	**4.9**	10.06	-	12.0	1856.5	87.6	-	-
13	**4.2**	1.81	-	13.0	1793.0	87.3	-	-
14	**3.9**	9.99	-	14.0	1821.6	87.2	-	-
15	**5.3**	3.68	-	15.0	-	87.0	-	-
16	**8.0**	2.24	-	16.0	-	-	-	-
17	**8.4**	12.83	-	17.0	-	-	-	-
18	**12.0**	3.65	-	18.0	-	-	-	-
19	**5.7**	6.53	-	19.0	-	-	-	-
20	**7.7**	1.71	-	20.0	-	-	-	-
21	**12.0**	6.16	-	21.0	-	-	-	-
22	**3.5**	3.69	-	22.0	-	-	-	-
23	**3.8**	5.43	-	23.0	-	-	-	-
24	**3.0**	2.57	-	24.0	-	-	-	-
25	**3.2**	10.57	-	25.0	-	-	-	-
26	**6.8**	7.34	-	26.5	-	-	-	-
27	**11.0**	4.79	-	28.5	-	-	-	-
28	**6.7**	8.36	-	32.5	-	-	-	-
29	**14.5**	10.72	-	34.5	-	-	-	-
30	**8.3**	18.02	-	38.5	-	-	-	-
31	**16.3**	37.82	-	40.5	-	-	-	-
32	**3.6**	51.3	-	44.5	-	-	-	-
33	**5.1**	6.49	-	48.5	-	-	-	-

Table 2A-10: Continued

Focusing Factor: 2.434
Average Background Concentration: 7.15 ug/g
Arsenic Inventory for LM #18: 16.68503 ug/cm^2
Focusing Corrected Arsenic Inventory: 6.854982 ug/cm^2

Table 2A-11:
Site LM #19 - Southern Basin, Lake Michigan
Arsenic Data

Sample	As (ug/g)	As RSD	AsAdj. (ug/g)	Depth (cm)	Date (cf/cs)	Por. (%)	Inv. ug/cm^2	Accum ug/m^2yr
1	**19.0**	1.80	13.77	0.5	1989.8	94.2	1.956717	2602.383
2	**17.6**	1.50	12.37	1.5	1983.9	93.1	2.091149	2337.798
3	**17.8**	1.42	12.57	2.5	1972.2	91.5	2.617703	2375.596
4	**15.7**	1.37	10.47	3.5	1956.4	90.5	2.436893	1978.718
5	**10.6**	2.56	5.37	4.5	1939.2	89.8	1.341963	1014.873
6	**10.7**	2.85	5.47	5.5	1918.1	89.3	1.433961	1033.772
7	**4.5**	8.16	-0.73	6.5	1891.7	89.0	-	-
8	**1.8**	6.87	-3.43	7.5	-	63.8	-	-
9	**1.3**	13.03	-3.93	8.5	-	61.4	-	-
10	**6.0**	4.11	0.77	9.5	-	66.4	-	-
11	**7.1**	1.98	1.87	10.5	-	63.9	-	-
12	**6.7**	6.76	1.47	11.5	-	70.3	-	-
13	**7.0**	4.48	1.77	12.5	-	73.1	-	-
14	**7.5**	2.17	2.27	13.5	-	72.1	-	-
15	**8.3**	1.48	3.07	14.5	-	71.8	-	-
16	**67.3**	0.87	62.07	15.5	-	71.6	43.18831	0
17	**7.5**	5.70	2.27	16.5	-	71.9	-	-
18	**2.4**	10.60	-2.83	17.5	-	71.2	-	-
19	**2.4**	7.57	-2.83	18.5	-	73.6	-	-
20	**8.5**	2.05	3.27	19.5	-	75.1	-	-
21	**32.7**	1.60	27.47	21.0	-	66.7	44.8228	0
22	**26.1**	1.48	-	23.0	-	68.2	32.51963	0
23	**17.2**	3.62	-	25.0	-	68.2	18.65165	0
24	**14.3**	2.16	-	27.0	-	65.6	15.28839	0
25	**8.3**	5.04	-	29.0	-	67.8	-	-

Focusing Factor: 1.217
Average Background Concentration: 5.2375 ug/g
Arsenic Inventory for LM #19: 11.87838 ug/cm^2
Focusing Corrected Arsenic Inventory: 9.760381 ug/cm^2

Table 2A-12:
Site LO #19 - Niagara Basin, Lake Ontario
Arsenic Data

Sample	As (ug/g)	As RSD	AsAdj. (ug/g)	Depth (cm)	Date (cf/cs)	Por. (%)	Inv. ug/cm^2	Accum ug/m^2yr
1	**21.1**	2.97	10.67	0.5	1989.4	89.3	1.516207	3014.35
2	**23.3**	13.59	12.87	1.5	1983.8	87.7	2.459457	3635.865
3	**36.3**	2.35	25.87	2.5	1976.9	87.7	5.767716	7308.457
4	**11.8**	2.14	1.37	3.5	1969.5	87.7	0.315511	387.0346
5	**18.2**	7.80	7.77	4.5	1961.8	86.3	1.827504	2195.08
6	**21.2**	2.48	10.77	5.5	1952.9	83.3	3.192766	3042.601
7	**28.2**	1.78	17.77	6.5	1941.9	79.6	6.530475	520.15
8	**88.6**	2.93	78.17	7.0	1920	79.6	16.27890	5849.953
9	**512.4**	0.52	501.97	7.5	1891.1	79.7	-	-
10	**13.9**	3.27	3.47	8.5	1838.1	78.8	-	-
11	**2.5**	8.17	-7.93	9.5	-	77.4	-	-
12	**6.3**	2.33	-4.13	10.5	-	78.3	-	-
13	**18.6**	1.27	8.17	11.5	-	77.6	-	-
14	**41.7**	3.49	31.27	12.5	-	77.3	-	-
15	**27.2**	2.03	16.77	13.5	-	78.4	-	-
16	**4.4**	11.47	-6.03	14.5	-	77.8	-	-
17	**4.8**	7.04	-5.63	15.5	-	77.9	-	-
18	**3.9**	5.23	-6.53	16.5	-	76.5	-	-
19	**5.5**	10.98	-4.93	17.5	-	76.4	-	-
20	**4.7**	7.80	-5.73	18.5	-	77.9	-	-
21	**7.4**	3.46	-3.03	19.5	-	76.1	-	-
22	**7.5**	7.03	-2.93	21.5	-	76.6	-	-
23	**7.9**	5.16	-2.53	23.5	-	76.2	-	-
24	**13.5**	1.08	3.07	25.5	-	76.9	-	-
25	**12.9**	0.50	2.47	27.5	-	77.4	-	-
26	**7.6**	2.13	-2.83	29.5	-	77.8	-	-
27	**8.0**	2.33	-2.43	31.5	-	76.7	-	-
28	**7.9**	4.30	-2.53	35.5	-	-	-	-
29	**7.9**	2.60	-2.53	37.5	-	-	-	-
30	**8.5**	6.07	-1.93	39.5	-	-	-	-

Table 2A-12: Continued

Focusing Factor: 1.07
Average Background Concentration: 10.435 ug/g
Arsenic Inventory for LM #19: 111.9142 ug/cm^2
Focusing Corrected Arsenic Inventory: 104.5927 ug/cm^2

Table 2A-13:
Site LO #40a - Niagara Basin, Lake Ontario
Arsenic Data

Sample	As (ug/g)	As RSD	AsAdj. (ug/g)	Depth (cm)	Date (cf/cs)	Por. (%)	Inv. ug/cm^2	Accum ug/m^2yr
1	**26.3**	1.44	19.46	0.5	1990.9	95.9	1.954757	7292.792
2	**29.3**	1.81	22.46	1.5	1988.7	92.4	4.182052	8417.066
3	**14.2**	2.26	7.36	2.5	1985.6	91.4	1.550752	2758.220
4	**15.9**	1.03	9.06	3.5	1981.7	88.7	2.508261	3395.308
5	**14.0**	2.03	7.16	4.5	1977.7	90.1	1.736658	2683.268
6	**22.0**	5.93	15.16	5.5	1974.1	91.1	3.305638	5681.333
7	**19.5**	5.15	12.66	6.5	1970.6	91.2	2.729496	4744.437
8	**17.9**	3.83	11.06	7.5	1967.1	91.1	2.411633	4144.824
9	**16.5**	2.08	9.66	8.5	1963.7	90.9	2.153697	3620.163
10	**16.9**	7.82	10.06	9.5	1959.9	90.1	2.440053	3770.066
11	**22.4**	1.62	15.56	10.5	1955.8	88.7	4.307786	5831.236
12	**21.2**	1.87	14.36	11.5	1951.4	87.5	4.397750	5381.526
13	**12.8**	2.84	5.96	12.5	1946.8	87.7	1.796046	2233.558
14	**9.2**	4.12	2.36	13.5	1936.9	87.9	0.699622	409.6886
15	**10.4**	1.00	3.56	14.5	1927.4	88.6	0.994308	618.0048
16	**10.9**	3.94	4.06	15.5	1917.6	88.2	1.173746	704.8032
17	**8.2**	2.29	1.36	16.5	1907.6	87.7	0.409836	236.0917
18	**7.7**	5.36	0.86	17.5	1897.3	88.5	0.242305	149.2933
19	**7.1**	4.44	0.26	18.5	1886.6	87.0	0.082810	45.13518
20	**5.9**	5.99	-0.94	19.5	1876.1	87.3	-	-
21	**7.4**	3.24	0.56	20.5	-	88.8	-	-
22	**6.7**	2.34	-0.14	21.5	-	-	-	-
23	**8.0**	1.53	1.16	22.5	-	-	-	-
24	**8.4**	5.14	1.56	23.5	-	-	-	-
25	**6.0**	1.84	-0.84	24.5	-	-	-	-
26	-	-	-6.84	25.5	-	-	-	-
27	-	-	-6.84	26.5	-	-	-	-
28	**6.9**	4.70	0.06	27.5	-	-	-	-
29	**6.7**	5.72	-0.14	28.5	-	-	-	-
30	**6.7**	2.42	-0.14	30.5	-	-	-	-
31	**6.9**	3.68	0.06	32.5	-	-	-	-
32	**7.8**	3.38	0.96	34.5	-	-	-	-
33	**7.2**	2.04	0.36	36.5	-	-	-	-
34	**5.6**	6.58	-1.24	38.5	-	-	-	-
35	**6.6**	2.57	-0.24	40.5	-	-	-	-
36	**5.8**	4.10	-10.4	42.5	-	-	-	-

Table 2A-13: Continued

Focusing Factor: 1.71
Average Background Concentration: 6.98 ug/g
Arsenic Inventory for LO #40a: 39.077206 ug/cm^2
Focusing Corrected Arsenic Inventory: 22.852167 ug/cm^2

Table 2A-14:
Site LO #E30 - Rochester Basin, Lake Ontario
Arsenic Data

Sample	As (ug/g)	As RSD	AsAdj. (ug/g)	Depth (cm)	Date (cf/cs)	Por. (%)	Inv. ug/cm^2	Accum ug/m^2yr
1	**35.12**	1.84	28.12	0.25	1989.6	92.95	2.428513	792.8382
2	**27.62**	0.52	20.62	0.75	1988.1	92.58	1.970241	643.2257
3	**19.66**	1.98	12.66	1.25	1987.4	92.20	1.271697	415.1717
4	**13.40**	5.22	6.40	1.75	1985.7	91.80	0.64288	209.8814
5	**20.36**	1.76	13.36	2.25	1984.3	91.53	1.3862	452.5536
6	**32.80**	1.46	25.80	2.75	1982.5	91.36	2.730672	891.4841
7	**31.42**	2.23	24.42	3.25	1980.8	91.25	2.617519	854.5429
8	**29.94**	6.24	22.94	3.75	1979.4	91.25	2.458881	802.7524
9	**25.08**	2.13	18.08	4.25	1977.9	91.18	1.953454	637.7451
10	**27.58**	1.62	20.58	4.75	1976.2	91.29	2.195835	716.8754
11	**26.76**	4.65	19.76	5.25	1974.8	91.53	2.050248	669.3457
12	**26.86**	1.55	19.86	5.75	1972.3	91.67	2.026564	661.6136
13	**20.86**	9.82	13.86	6.25	1971.3	91.67	1.414309	461.7303
14	**19.52**	1.63	12.52	6.75	1969.9	91.57	1.292909	422.0968
15	**17.84**	5.11	10.84	7.25	1968.5	91.50	1.128715	368.4923
16	**21.72**	2.03	14.72	7.75	1966.8	91.36	1.557965	508.6297
17	**22.24**	7.86	15.24	8.25	1965.4	91.11	1.659674	541.8348
18	**24.28**	4.24	17.28	8.75	1963.3	90.57	1.996142	651.6818
19	**18.96**	1.52	11.96	9.25	1961.9	90.52	1.388915	453.4398
20	**15.58**	7.21	8.58	9.75	1960.1	90.20	1.030029	336.2742
21	**17.08**	1.01	10.08	10.5	1957.7	89.72	2.538749	828.8268
22	**18.34**	9.95	11.34	12.0	1951.1	88.56	6.35675	2075.292
23	**18.48**	1.60	11.48	14.5	1940.6	88.14	10.00723	3267.067
24	**13.58**	3.27	6.58	17.0	1929.7	87.97	3.878713	1266.286

Focusing Factor: 2.04

Arsenic Inventory for LO #G32: 57.9828 ug/cm^2
Focusing Corrected Arsenic Inventory: 28.42294 ug/cm^2

Table 2A-15:
Site LO #F31 - Rochester Basin, Lake Ontario
Arsenic Data

Sample	As (ug/g)	As RSD	AsAdj. (ug/g)	Depth (cm)	Date (cf/cs)	Por. (%)	Inv. ug/cm^2	Accum ug/m^2yr
1	**21.1**	2.97	10.67	0.25	1988.5	89.3	0.758103	3094.2
2	**23.3**	13.59	12.87	0.75	1987	87.7	1.22973	3732.18
3	**36.3**	2.35	25.87	1.25	1984	87.7	2.88386	7502.06
4	**11.8**	2.14	1.37	1.75	1982.2	87.7	0.157755	397.287
5	**18.2**	7.8	7.77	2.25	1979.5	86.3	0.913752	2253.23
6	**21.2**	2.48	10.77	2.75	1977.5	83.3	1.59638	3123.2
7	**28.2**	1.78	17.77	3.25	1974	79.6	3.26524	5153.13
8	**88.6**	2.93	78.17	3.75	1972.2	79.6	16.2789	22668.6
9	**211.0**	0.52	200.57	4.25	1969	79.7	44.7171	-
10	**13.9**	3.27	3.47	4.75	1967	78.8	-	-
11	**2.5**	8.17	-7.93	5.25	1964	77.4	-	-
12	**6.3**	2.33	-4.13	5.75	1963.5	78.3	-	-
13	**18.6**	1.27	8.17	6.25	1960.5	77.6	-	-
14	**41.7**	3.49	31.27	6.75	1958.5	77.3	-	-
15	**27.2**	2.03	16.77	7.25	1965.5	78.4	-	-
16	**4.4**	11.47	-6.03	7.75	1955.5	77.8	-	-
17	**4.8**	7.04	-5.63	8.25	1953.7	77.9	-	-
18	**3.9**	5.23	-6.53	8.75	1952	76.5	-	-
19	**5.5**	10.98	-4.93	9.25	1950	76.4	-	-
20	**4.7**	7.80	-5.73	9.75	1948.5	77.9	-	-
21	**7.4**	3.46	-3.03	10.25	1947	76.1	-	-
22	**7.5**	7.03	-2.93	11.25	1942	76.6	-	-
23	**7.9**	5.16	-2.53	12.25	1939	76.2	-	-
24	**13.5**	1.08	3.07	13.25	1936	76.9	-	-

Focusing Factor: 1.72

Table 2A-16:
Site LO #G32 - Rochester Basin, Lake Ontario
Arsenic Data

Sample	As (ug/g)	As RSD	AsAdj. (ug/g)	Depth (cm)	Date (cf/cs)	Por. (%)	Inv. ug/cm^2	Accum ug/m^2yr
1	**30.32**	0.70	23.32	0.25	1989.8	91.6	2.399628	9316.569
2	**29.52**	0.91	22.52	0.75	1988.6	90.3	2.675939	8996.961
3	**24.70**	3.43	17.70	1.25	1987.5	89.0	2.385075	7071.324
4	**19.96**	2.45	12.96	1.75	1985.2	88.2	1.873368	5177.647
5	**16.12**	4.28	9.12	2.25	1984.1	88.4	1.295952	3643.529
6	**13.72**	5.50	6.72	2.75	1982.3	88.5	0.94668	2684.706
7	**14.52**	8.76	7.52	3.25	1980.7	88.4	1.068592	3004.314
8	**17.36**	4.37	10.36	3.75	1979.6	88.3	1.484847	4138.922
9	**20.26**	2.43	13.26	4.25	1977.9	89.0	1.786785	5297.5
10	**23.10**	1.41	16.10	4.75	1976.6	89.3	2.110308	6432.108
11	**26.06**	0.49	19.06	5.5	1974.4	89.7	4.809791	7614.657
12	**27.06**	0.80	20.06	6.5	1970.7	89.7	5.062141	8014.167
13	**27.10**	1.22	20.10	7.5	1967.6	89.6	5.12148	8030.147
14	**30.60**	2.15	23.60	8.5	1964.6	89.3	6.18674	9428.431
15	**24.66**	0.55	17.66	9.5	1961.7	89.7	4.456501	7055.343
16	**24.82**	1.62	17.82	10.5	1958.3	88.8	4.889808	7119.265
17	**22.56**	1.91	15.56	11.5	1955.1	90.1	3.774078	6216.373
18	**23.64**	1.40	16.64	12.5	1951.2	87.8	4.973696	6647.843
19	**19.40**	2.66	12.40	13.5	1947.2	87.7	3.73674	4953.922
20	**21.22**	3.41	14.22	14.5	1933.3	82.5	6.096825	5681.029

Focusing Factor: 2.20

APPENDIX 2B:

Cadmium Data

Table 2B-1:
Site LS #DTL - Duluth Basin, Lake Superior
Cadmium Data

Sample	Cd (ug/g)	Cd RSD	CdAdj. (ug/g)	Depth (cm)	Date (crs)	Por. (%)	Inv. ug/cm^2	Accum ug/m^2yr
1	**1.86**	0.39	1.36	0.25	1989.3	83.1	0.298792	318.8076
2	**1.72**	0.23	1.22	0.75	1986.1	82.4	0.279136	321.5312
3	**1.72**	1.31	1.22	1.25	1981.4	82.6	0.275964	272.7642
4	**2.04**	1.01	1.54	1.75	1977.1	82.1	0.358358	474.729
5	**1.68**	1.51	1.18	2.25	1973.7	81.3	0.286858	500.4607
6	**1.12**	2.46	0.62	2.625	1971.3	80.8	0.077376	301.1789
7	**2.70**	0.56	2.20	2.875	1969.7	83.3	0.23881	1068.699
8	**1.20**	2.23	0.70	3.05	1968.6	85.2	0.026936	307.3171
9	**0.96**	0.75	0.46	3.225	1967.2	81.9	0.054119	179.5122
10	**2.02**	0.95	1.52	3.6	1964.3	80.3	0.389272	548.8889
11	**2.02**	1.12	1.52	4.1	1960.5	80.9	0.377416	537.561
12	**2.20**	1.08	1.70	4.6	1956.6	81.8	0.40222	619.6477
13	**1.60**	0.64	1.10	5.1	1952.8	81.6	0.26312	377.1003
14	**1.92**	1.08	1.42	5.6	1947.1	81.8	0.335972	337.6829
15	**1.66**	2.45	1.16	6.1	1941.3	82.2	0.268424	246.7751
16	**1.40**	1.87	0.90	6.85	1931.1	82.2	0.41652	163.4146
17	**0.86**	1.24	0.36	7.85	1916.8	81.7	0.171288	60.2439
18	**0.88**	3.31	0.38	8.85	1899.3	81.6	0.181792	60.2439
19	**0.34**	3.61	-	9.85	1879.6	81.5	-	-
20	**0.46**	4.39	-	10.85	-	82.1	-	-
21	**0.50**	3.47	-	12.85	-	81.9	-	-
22	**0.24**	11.47	-	14.85	-	82.0	-	-
23	**0.50**	3.06	-	16.85	-	82.5	-	-
24	**0.44**	4.83	-	18.85	-	82.0	-	-

Focusing Factor: 1.476
Average Background Concentration: 0.41 ug/g
Cadmium Inventory for LS #DTL: 4.702373 ug/cm^2
Focusing Corrected Cadmium Inventory: 3.18589 ug/cm^2

Table 2B-2:
Site LS #SJE-II - Duluth Basin, Lake Superior
Cadmium Data

Sample	Cd (ug/g)	Cd RSD	CdAdj. (ug/g)	Depth (cm)	Date (crs)	Por. (%)	Inv. ug/cm^2	Accum ug/m^2yr
1	**1.30**	0.56	0.85	0.25	1988.5	95.0	0.065085	2346.03
2	**1.29**	2.26	0.84	0.75	1983.7	82.3	0.143707	2536.832
3	**1.28**	1.12	0.83	1.25	1977.9	82.5	0.169295	2398.73
4	**1.23**	0.38	0.78	1.75	1972.2	83.1	0.190632	1084.214
5	**1.16**	1.27	0.71	2.25	1965.9	83.2	0.204906	802.3101
6	**1.97**	0.91	1.52	2.75	1958	83.7	0.394212	1659.861
7	**1.27**	0.98	0.82	3.25	1947.9	83.9	0.184951	926.6117
8	**0.54**	2.03	0.09	3.75	1935.2	84.0	0.019434	110.7014
9	**0.51**	0.41	0.06	4.125	1926.8	84.2	0.005132	-
10	**0.31**	1.66	0	4.275	1921.1	89.8	0	-
11	**0.70**	2.52	0.25	4.75	1911.4	83.4	0.04277	-
12	**0.55**	2.17	0.1	5.125	1902.3	84.2	0.01365	-
13	**0.25**	4.29	-	5.45	1892	85.6	-	-
14	**0.57**	1.20	-	5.85	1882.3	84.7	-	-
15	**0.43**	0.88	-	6.30	1867.4	84.4	-	-
16	**0.59**	1.89	-	6.80	1851.4	84.4	-	-
17	**0.21**	0.74	-	7.30	1835.4	84.5	-	-
18	**0.53**	7.33	-	8.05	-	84.2	-	-
19	**0.29**	4.93	-	9.05	-	83.7	-	-
20	**0.53**	0.92	-	11.05	-	82.5	-	-
21	**0.33**	1.60	-	12.05	-	83.4	-	-
22	**0.59**	0.44	-	13.05	-	83.2	-	-
23	**0.48**	0.75	-	17.05	-	83.2	-	-
24	**0.33**	3.71	-	21.05	-	83.3	-	-

Focusing Factor: 1.261
Average Background Concentration: 0.45 ug/g
Cadmium Inventory for LS #SJE-II: 1.433774 ug/cm^2
Focusing Corrected Cadmium Inventory: 1.137013 ug/cm^2

Table 2B-3:
Site NOAA #3 - Chefswet Basin, Lake Superior
Cadmium Data

Sample	Cd (ug/g)	Cd RSD	CdAdj. (ug/g)	Depth (cm)	Date (crs)	Por. (%)	Inv. ug/cm^2	Accum ug/m^2yr
1	**1.36**		1.02	0.25	1988.8	95	0.0663	89.63093
2	**1.35**		1.01	0.75	1981.7	93	0.09191	88.7522
3	**1.28**		0.94	1.25	1972	92	0.09776	82.60105
4	**1.15**		0.81	1.75	1963	91	0.09477	71.1775
5	**1.00**		0.66	2.25	1953	91	0.07722	57.99649
6	**1.02**		0.68	2.75	1940	90	0.0884	59.75395
7	**0.88**		0.54	3.25	1925	90	0.0702	47.45167
8	**0.81**		0.47	3.75	1907	89	0.06721	41.30053
9	**0.57**		0.23	4.00	1884.9	88	0.07176	20.2109
10	**1.21**		0.87	5.125	1857	89	0.062205	76.44991
11	**0.82**		0.48	5.375	1849	88	0.03744	42.17926
12	**0.30**		-0.04	5.75	1823	88.5	-	-
13	**0.27**		-0.07	6.25	1799.9	88	-	-
14	**0.48**		0.14	6.75	1783	87	-	-
15	**0.26**		-0.08	7.50	-	88	-	-
16	**0.42**		0.08	8.50	-	88	-	-
17	**0.31**		-0.03	14.5	-	-	-	-

Focusing Factor: 1.138
Average Background Concentration: 0.34 ug/g
Cadmium Inventory for NOAA #3: 0.787735 ug/cm^2
Focusing Corrected Cadmium Inventory: 0.69221 ug/cm^2

Table 2B-4:
Site LS #1390 - Isle Royale Basin, Lake Superior
Cadmium Data

Sample	Cd (ug/g)	Cd RSD	CdAdj. (ug/g)	Depth (cm)	Date (crs)	Por. (%)	Inv. ug/cm^2	Accum ug/m^2yr
1	**2.56**	0.95	1.874	0.5	1981.7	84	0.779584	227.6822
2	**2.08**	0.62	1.394	1.5	1976.5	84	0.579904	160.6791
3	**1.34**	1.44	0.654	2.5	1967.4	82	0.34008	44.82243
4	**1.66**	1.24	0.974	3.25	1958.2	80	0.215254	72.82243
5	**1.06**	2.16	0.374	3.75	1946	81	0.082654	19.80685
6	**0.30**	5.01	-	4.25	1931.9	83	-	-
7	**0.88**	0.66	-	5.0	1873.8	82	-	-
8	**0.52**	7.43	-	6.0	1819.3	81	-	-
9	**0.80**	1.23	-	7.5	1698.2	80	-	-
10	**0.58**	5.86	-	9.5	-	76	-	-
11	**0.82**	0.55	-	11.5	-	80	-	-
12	**0.78**	0.08	-	13.5	-	79	-	-
13	**0.72**	2.81	-	16.0	-	-	-	-
14	**0.66**	3.32	-	19.0	-	-	-	-
15	**0.74**	4.30	-	22.5	-	-	-	-
16	**0.64**	7.60	-	26.5	-	-	-	-
17	**0.68**	14.49	-	30.5	-	-	-	-
18	**0.80**	6.03	-	34.5	-	-	-	-

Focusing Factor: 3.21
Average Background Concentration: 0.69 ug/g
Cadmium Inventory for LS #1390: 1.997476 ug/cm^2
Focusing Corrected Cadmium Inventory: 0.622267 ug/cm^2

Table 2B-5:
Site LS #1391 - Isle Parisienne Basin, Lake Superior
Cadmium Data

Sample	Cd (ug/g)	Cd RSD	CdAdj. (ug/g)	Depth (cm)	Date (crs)	Por. (%)	Inv. ug/cm^2	Accum ug/m^2yr
1	**0.92**	1.30	0.803	0.5	1980.7	90	0.20878	89.72067
2	**0.70**	0.45	0.583	1.5	1965.2	87	0.197054	81.42458
3	**0.89**	0.55	0.773	2.5	1944.6	81	0.381862	73.41341
4	**0.24**	3.13	0.123	3.25	1925.9	80	0.03198	12.36872
5	**0.15**	4.35	0.033	4.0	1902.2	76	0.020592	3.502793
6	**0.07**	5.71	-	5.0	1867.4	74	-	-
7	**0.15**	8.02	-	6.0	1794.8	74	-	-
8	**0.08**	5.55	-	7.5	-	71	-	-
9	**0.06**	13.9	-	9.5	-	72	-	-
10	**0.16**	2.17	-	11.0	-	71	-	-
11	**0.13**	1.78	-	12.5	-	72	-	-
12	**0.09**	6.80	-	15.5	-	72	-	-
13	**0.11**	13.03	-	18.5	-	71	-	-
14	**0.11**	3.84	-	21.5	-	72	-	-
15	**0.16**	6.42	-	26.5	-	72	-	-

Focusing Factor: 1.79
Average Background Concentration: 0.12 ug/g
Cadmium Inventory for LS #1391: 0.840268 ug/cm^2
Focusing Corrected Cadmium Inventory: 0.469423 ug/cm^2

Table 2B-6:
Site LM #70m - North Algoma Basin, Lake Michigan
Cadmium Data

Sample	Cd (ug/g)	Cd RSD	CdAdj. (ug/g)	Depth (cm)	Date (cf/cs)	Por. (%)	Inv. ug/cm^2	Accum ug/m^2yr
1	**1.78**	2.06	1.36	0.25	1990.8	95.2	0.079968	95.89744
2	**1.66**	7.47	1.24	0.75	1985.1	94.5	0.082937	87.4359
3	**1.58**	10.62	1.16	1.25	1978.4	93.6	0.090518	81.79487
4	**2.08**	6.32	1.66	1.75	1970.9	92.8	0.146615	117.0513
5	**1.90**	3.67	1.48	2.25	1962.2	91.8	0.149391	104.359
6	**1.82**	1.72	1.40	2.75	1952.4	90.8	0.157437	98.71795
7	**1.86**	2.26	1.44	3.25	1941.6	89.9	0.177811	101.5385
8	**1.88**	3.29	1.46	3.75	1929.8	89.0	0.196735	102.9487
9	**1.66**	3.04	1.24	4.25	1917.2	88.3	0.177571	87.4359
10	**1.48**	4.75	1.06	4.75	1903.7	87.6	0.160365	74.74359
11	**1.14**	3.69	0.72	5.25	1889.7	87.2	0.112631	50.76923
12	**1.36**	3.46	0.94	5.75	1875.2	87.1	0.149119	66.28205
13	**1.68**	2.20	1.26	6.25	1860.8	86.8	0.198494	88.84615
14	**0.42**	2.95	0	6.75	1846.5	85.9	0	0
15	**0.82**	4.67	0.40	7.25	1831.3	85.0	0.06909	28.20513
16	**0.18**	12.39	-	7.75	1815.0	84.3	-	-
17	**0.14**	9.97	-	8.25	1797.9	84.0	-	-
18	**0.28**	10.80	-	8.75	1779.9	84.3	-	-
19	**0.24**	8.36	-	9.25	-	83.9	-	-
20	**0.90**	4.07	-	9.75	-	-	-	-
21	**0.24**	8.58	-	10.5	-	-	-	-
22	**0.36**	10.44	-	11.5	-	-	-	-
23	**0.32**	2.73	-	12.5	-	-	-	-
24	**0.42**	10.24	-	13.5	-	-	-	-
25	**0.40**	3.71	-	14.5	-	-	-	-
26	**0.26**	13.86	-	15.5	-	-	-	-
27	**0.52**	3.20	-	16.5	-	-	-	-
28	**0.58**	4.22	-	17.5	-	-	-	-
29	**0.26**	7.34	-	18.5	-	-	-	-
30	**0.46**	5.70	-	19.5	-	-	-	-
31	**0.36**	12.35	-	20.5	-	-	-	-
32	**0.32**	6.97	-	21.5	-	-	-	-
33	**0.64**	10.67	-	25.5	-	-	-	-
34	**0.44**	3.76	-	29.5	-	-	-	-
35	**0.58**	2.76	-	33.5	-	-	-	-
36	**0.62**	8.94	-	37.5	-	-	-	-

Table 2B-6: Continued

Focusing Factor: 1.56
Average Background Concentration: 0.42 ug/g
Cadmium Inventory for LM #70m: 1.9487 ug/cm^2
Focusing Corrected Cadmium Inventory: 1.2492 ug/cm^2

Table 2B-7:
Site LM #68k - Algoma Basin, Lake Michigan
Cadmium Data

Sample	Cd (ug/g)	Cd RSD	CdAdj. (ug/g)	Depth (cm)	Date (cf/cs)	Por. (%)	Inv. ug/cm^2	Accum ug/m^2yr
1	**2.79**	2.67	2.464	0.25	1991.4	98.0	0.060368	544.5304
2	**2.92**	0.61	2.594	0.75	1989.3	96.6	0.10804	573.2597
3	**2.92**	1.83	2.594	1.25	1986.6	95.6	0.139817	573.2597
4	**2.95**	3.23	2.624	1.75	1983.4	94.7	0.170363	579.8895
5	**3.15**	1.72	2.824	2.25	1980.1	94.0	0.207564	624.0884
6	**3.07**	3.84	2.744	2.75	1976.8	93.8	0.208407	606.4088
7	**3.38**	2.12	3.054	3.25	1973.0	94.1	0.220728	674.9171
8	**3.53**	0.70	3.204	3.75	1968.7	93.3	0.262968	708.0663
9	**3.19**	3.51	2.864	4.50	1962.3	93.5	0.456092	632.9282
10	**2.38**	2.57	2.054	5.50	1953.4	94.2	0.291873	453.9227
11	**2.59**	2.31	2.264	6.50	1944.0	93.9	0.338355	500.3315
12	**1.96**	0.64	1.634	7.50	1934.6	94.9	0.204168	361.1050
13	**1.08**	2.35	0.754	8.50	1925.2	93.6	0.118227	166.6298
14	**0.58**	7.82	0.254	9.50	1915.6	92.8	0.044806	56.1326
15	**0.40**	3.04	0.074	10.5	1905.7	93.8	0.011241	16.35359
16	**0.55**	5.68	0.224	11.5	1895.9	92.0	0.043904	49.50276
17	**0.30**	8.51	-	12.5	1886.0	94.0	-	-
18	**0.35**	1.86	-	13.5	1876.0	92.6	-	-
19	**0.26**	2.87	-	14.5	1866.0	92.6	-	-
20	**0.44**	3.77	-	15.5	1855.7	94.0	-	-
21	**0.31**	2.67	-	16.5	1845.1	91.6	-	-
22	**0.38**	3.31	-	17.5	-	93.3	-	-
23	**0.26**	1.85	-	18.5	-	93.9	-	-
24	**0.31**	3.64	-	19.5	-	91.5	-	-
25	**0.35**	-	-	20.5	-	-	-	-

Focusing Factor: 1.267
Average Background Concentration: 0.32625 ug/g
Cadmium Inventory for LM #68k: 2.886921 ug/cm^2
Focusing Corrected Cadmium Inventory: 2.278548 ug/cm^2

Table 2B-8:
Site LM #47s - Algoma Basin, Lake Michigan
Cadmium Data

Sample	Cd (ug/g)	Cd RSD	CdAdj. (ug/g)	Depth (cm)	Date (cf/cs)	Por. (%)	Inv. ug/cm^2	Accum ug/m^2yr
1	**3.43**	1.17	3.052	0.25	1991.6	98.4	0.059819	712.1333
2	**3.62**	1.59	3.242	0.75	1988.8	97.3	0.107229	756.4667
3	**3.06**	2.65	2.682	1.25	1986.0	97.5	0.082136	625.8000
4	**3.25**	2.62	2.872	1.75	1983.0	97.0	0.105546	670.1333
5	**3.37**	1.07	2.992	2.25	1979.7	96.6	0.124617	698.1333
6	**3.83**	0.50	3.452	2.75	1976.3	96.7	0.139547	805.4667
7	**3.13**	0.59	2.752	3.25	1972.7	95.4	0.155075	642.1333
8	**3.06**	1.37	2.682	3.75	1969.2	95.2	0.157702	625.8000
9	**3.02**	0.60	2.642	4.50	1962.0	94.9	0.330118	616.4667
10	**2.78**	0.31	2.402	5.50	1956.7	94.1	0.347209	560.4667
11	**2.47**	0.10	2.092	6.50	1949.5	94.2	0.297273	488.1333
12	**2.18**	0.54	1.802	7.50	1942.2	92.1	0.348777	420.4667
13	**1.72**	4.79	1.342	8.50	1934.4	92.7	0.240017	313.1333
14	**1.24**	1.95	0.862	9.50	1926.1	93.1	0.145721	201.1333
15	**0.58**	3.23	0.202	10.5	1918.1	91.4	0.042561	47.13333
16	**0.34**	7.75	-	11.5	1812.8	93.4	-	-
17	**0.36**	6.29	-	12.5	1795.8	92.3	-	-
18	**0.36**	5.31	-	13.5	1778.8	93.2	-	-
19	**0.39**	9.05	-	14.5	1761.6	93.3	-	-
20	**0.34**	4.87	-	15.5	1744.1	93.6	-	-
21	**0.34**	9.93	-	16.5	-	93.3	-	-
22	**0.35**	3.90	-	17.5	-	91.6	-	-
23	**0.36**	12.61	-	18.5	-	90.8	-	-
24	**0.36**	6.49	-	19.5	-	91.2	-	-

Focusing Factor: 1.34
Average Background Concentration: 0.378 ug/g
Cadmium Inventory for LM #47s: 2.683348 ug/cm^2
Focusing Corrected Cadmium Inventory: 2.002499 ug/cm^2

Table 2B-9:
Site LM #11 - Southern Basin, Lake Michigan
Cadmium Data

Sample	Cd (ug/g)	Cd RSD	CdAdj. (ug/g)	Depth (cm)	Date (cf/cs)	Por. (%)	Inv. ug/cm^2	Accum ug/m^2yr
1	**1.81**	0.91	1.633	0.5	1970.5	84.6	0.616131	131.2965
2	**1.89**	1.36	1.713	1.5	1938	82.4	0.738646	137.7286
3	**2.00**	1.32	1.823	2.5	1915.3	82.2	0.79501	146.5729
4	**1.96**	1.32	1.783	3.5	1895	79.5	0.895512	143.3568
5	**1.90**	1.46	1.723	4.5	1877	79.2	0.878041	138.5327
6	**1.05**	1.54	0.873	5.5	1858	77.8	0.474825	70.19095
7	**0.38**	1.32	0.203	6.5	1838.4	77.2	0.113396	16.32161
8	**0.21**	8.43	0.033	7.5	1817.3	73.6	0.021344	2.653266
9	**0.32**	3.14	0.143	8.5	1794.2	73.3	0.093543	11.49749
10	**0.28**	2.14	0.103	9.5	1770.1	73.0	0.068135	8.281407
11	**0.20**	3.85	0.023	10.5	1745.1	66.3	0.01899	1.849246
12	**0.19**	11.23	0.013	11.5	-	67.5	0.010351	0
13	**0.16**	4.70	-0.017	12.25	-	68.4	-	-
14	**0.17**	4.63	-0.007	13.0	-	64.9	-	-
15	**0.16**	3.17	-0.017	14.0	-	61.4	-	-
16	**0.20**	4.53	0.023	14.75	-	64.0	-	-
17	**0.16**	2.60	-0.017	15.25	-	66.5	-	-
18	**0.20**	4.56	0.023	16.0	-	65.8	-	-
19	**0.16**	2.42	-	17.0	-	63.6	-	-
20	**0.14**	3.94	-	18.0	-	64.9	-	-
21	**0.12**	5.79	-	19.5	-	66.7	-	-
22	**0.11**	14.52	-	21.5	-	66.7	-	-
23	**0.13**	11.03	-	23.5	-	65.8	-	-
24	**0.15**	5.13	-	25.5	-	64.4	-	-
25	**0.13**	4.16	-	27.5	-	66.6	-	-

Focusing Factor: 1.999
Average Background Concentration: 0.177 ug/g
Cadmium Inventory for LM #11: 4.723923 ug/cm^2
Focusing Corrected Cadmium Inventory: 2.373831 ug/cm^2

Table 2B-10:
Site LM #18 - Southern Basin, Lake Michigan
Cadmium Data

Sample	Cd (ug/g)	Cd RSD	CdAdj. (ug/g)	Depth (cm)	Date (cf/cs)	Por. (%)	Inv. ug/cm^2	Accum ug/m^2yr
1	**1.96**	2.90	1.581	0.5	1989.7	94.2	0.22466	253.3237
2	**2.24**	1.36	1.861	1.5	1984.4	93.1	0.314602	298.1882
3	**2.26**	4.98	1.881	2.5	1977.8	91.5	0.391718	301.3928
4	**2.14**	2.36	1.761	3.5	1970.8	90.5	0.409873	282.1652
5	**2.26**	1.40	1.881	4.5	1963.4	89.8	0.470062	301.3928
6	**2.64**	3.77	2.261	5.5	1956.1	89.3	0.592721	362.2802
7	**2.59**	2.83	2.211	6.8	1945.6	89.2	0.879171	354.2687
8	**2.26**	2.74	1.881	8.0	1938.3	89.2	0.499556	301.3928
9	**2.56**	1.04	2.181	9.0	1931.0	89.1	0.580299	349.4618
10	**1.77**	3.57	1.391	10.0	1923.8	88.3	0.398389	222.88
11	**1.38**	1.80	1.001	11.0	1916.5	87.5	0.306556	160.3903
12	**0.46**	3.90	0.081	12.0	1856.5	87.6	0.024528	5.99014
13	**0.32**	2.92	-	13.0	1793.0	87.3	-	-
14	**0.25**	4.15	-	14.0	1821.6	87.2	-	-
15	**0.27**	2.45	-	15.0	-	87.0	-	-
16	**0.30**	4.92	-	16.0	-	-	-	-
17	**0.27**	5.63	-	17.0	-	-	-	-
18	**0.26**	9.33	-	18.0	-	-	-	-
19	**0.41**	3.55	-	19.0	-	-	-	-
20	**0.30**	1.37	-	20.0	-	-	-	-
21	**0.32**	2.98	-	21.0	-	-	-	-
22	**0.30**	1.33	-	22.0	-	-	-	-
23	**0.31**	0.33	-	23.0	-	-	-	-
24	**0.30**	2.65	-	24.0	-	-	-	-
25	**0.30**	3.18	-	25.0	-	-	-	-
26	**0.37**	0.27	-	26.5	-	-	-	-
27	**1.35**	4.16	-	28.5	-	-	-	-
28	**0.35**	3.25	-	32.5	-	-	-	-
29	**0.42**	2.78	-	34.5	-	-	-	-
30	**0.41**	0.76	-	38.5	-	-	-	-
31	**0.41**	1.12	-	40.5	-	-	-	-
32	**0.35**	1.71	-	44.5	-	-	-	-
33	**0.33**	1.32	-	48.5	-	-	-	-

Table 2B-10: Continued

Focusing Factor: 2.434
Average Background Concentration: 0.379 ug/g
Cadmium Inventory for LM #18: 5.092136 ug/cm^2
Focusing Corrected Cadmium Inventory: 2.092085 ug/cm^2

Table 2B-11:
Site LM #19 - Southern Basin, Lake Michigan
Cadmium Data

Sample	Cd (ug/g)	Cd RSD	CdAdj. (ug/g)	Depth (cm)	Date (cf/cs)	Por. (%)	Inv. ug/cm^2	Accum ug/m^{2}yr
1	**1.33**	1.70	1.167	0.5	1989.8	94.2	0.165831	220.5505
2	**1.46**	1.14	1.297	1.5	1983.9	93.1	0.219258	245.1191
3	**1.49**	0.67	1.327	2.5	1972.2	91.5	0.276348	250.7888
4	**1.38**	4.08	1.217	3.5	1956.4	90.5	0.283257	230.0000
5	**1.36**	4.01	1.197	4.5	1939.2	89.8	0.29913	226.2202
6	**0.80**	2.40	0.637	5.5	1918.1	89.3	0.16699	120.3862
7	**0.51**	4.13	0.347	6.5	1891.7	89.0	0.093517	65.57929
8	**0.09**	6.46	-0.073	7.5	-	63.8	-	-
9	**0.1**	5.39	-0.063	8.5	-	61.4	-	-
10	**0.07**	1.58	-0.093	9.5	-	66.4	-	-
11	**0.06**	8.74	-0.103	10.5	-	63.9	-	-
12	**0.24**	9.62	0.077	11.5	-	70.3	-	-
13	**0.14**	4.34	-0.023	12.5	-	73.1	-	-
14	**0.11**	6.39	-0.053	13.5	-	72.1	-	-
15	**0.16**	3.50	-0.003	14.5	-	71.8	-	-
16	**0.35**	0.37	0.187	15.5	-	71.6	-	-
17	**0.08**	0.51	-0.083	16.5	-	71.9	-	-
18	**0.23**	3.27	0.067	17.5	-	71.2	-	-
19	**0.22**	2.30	0.057	18.5	-	73.6	-	-
20	**0.13**	4.92	-0.033	19.5	-	75.1	-	-
21	**0.17**	5.45	0.007	21.0	-	66.7	-	-
22	**0.22**	4.60	0.057	23.0	-	68.2	-	-
23	**0.20**	4.49	0.037	25.0	-	68.2	-	-
24	**0.20**	7.25	0.037	27.0	-	65.6	-	-
25	**0.17**	0.76	0.007	29.0	-	67.8	-	-

Focusing Factor: 1.217
Average Background Concentration: 0.1633 ug/g
Cadmium Inventory for LM #19: 1.504329 ug/cm^2
Focusing Corrected Cadmium Inventory: 1.236096 ug/cm^2

Table 2B-12:
Site LO #19 - Niagara Basin, Lake Ontario
Cadmium Data

Sample	Cd (ug/g)	Cd RSD	CdAdj. (ug/g)	Depth (cm)	Date (cf/cs)	Por. (%)	Inv. ug/cm^2	Accum ug/m^2yr
1	**2.62**	3.36	2.36	0.5	1989.4	89.3	0.335356	666.7166
2	**2.86**	0.51	2.60	1.5	1983.8	87.7	0.49686	734.5182
3	**2.84**	4.25	2.58	2.5	1976.9	87.7	0.575211	728.8681
4	**3.28**	2.14	3.02	3.5	1969.5	87.7	0.695506	853.1712
5	**3.78**	1.13	3.52	4.5	1961.8	86.3	0.827904	994.4247
6	**3.35**	3.25	3.09	5.5	1952.9	83.3	0.91603	872.9467
7	**1.98**	2.64	1.72	6.5	1941.9	79.6	0.6321	485.9121
8	**0.87**	1.36	0.61	7.0	1920	79.6	0.127033	45.65014
9	**0.66**	1.42	0.40	7.5	1891.1	79.7	-	-
10	**0.20**	2.62	-0.06	8.5	1838.1	78.8	-	-
11	**0.33**	3.08	0.07	9.5	-	77.4	-	-
12	**0.27**	4.33	0.01	10.5	-	78.3	-	-
13	**0.37**	5.23	0.11	11.5	-	77.6	-	-
14	**0.26**	4.05	0.00	12.5	-	77.3	-	-
15	**0.25**	0.96	-0.01	13.5	-	78.4	-	-
16	**0.25**	4.12	-0.01	14.5	-	77.8	-	-
17	**0.27**	5.01	0.01	15.5	-	77.9	-	-
18	**0.25**	6.47	-0.01	16.5	-	76.5	-	-
19	**0.20**	8.23	-0.06	17.5	-	76.4	-	-
20	**0.25**	5.20	-0.01	18.5	-	77.9	-	-
21	**0.24**	0.20	-0.02	19.5	-	76.1	-	-
22	**0.25**	0.92	-0.01	21.5	-	76.6	-	-
23	**0.26**	1.82	0.00	23.5	-	76.2	-	-
24	**0.25**	5.13	-0.01	25.5	-	76.9	-	-
25	**0.29**	0.72	0.03	27.5	-	77.4	-	-
26	**0.25**	1.13	-0.01	29.5	-	77.8	-	-
27	**0.25**	2.23	-0.01	31.5	-	76.7	-	-
28	**0.27**	2.99	0.00	35.5	-	-	-	-
29	**0.26**	4.02	0.00	37.5	-	-	-	-
30	**0.25**	3.75	-0.01	39.5	-	-	-	-

Table 2B-12: Continued

Focusing Factor: 1.07
Average Background Concentration: 0.260476 ug/g
Cadmium Inventory for LO #19: 4.606 ug/cm^2
Focusing Corrected Cadmium Inventory: 4.304 ug/cm^2

Table 2B-13:
Site LO #40a - Niagara Basin, Lake Ontario
Cadmium Data

Sample	Cd (ug/g)	Cd RSD	CdAdj. (ug/g)	Depth (cm)	Date (cf/cs)	Por. (%)	Inv. ug/cm^2	Accum ug/m^2yr
1	1.80	2.19	1.565	0.5	1990.9	95.9	0.157204	586.4964
2	2.30	4.33	2.065	1.5	1988.7	92.4	0.384503	773.8754
3	2.21	3.87	1.975	2.5	1985.6	91.4	0.416133	740.1472
4	2.64	0.79	2.405	3.5	1981.7	88.7	0.665824	901.2932
5	2.83	2.37	2.595	4.5	1977.7	90.1	0.629417	972.4972
6	3.15	1.97	2.915	5.5	1974.1	91.1	0.635616	1092.419
7	3.30	3.68	3.065	6.5	1970.6	91.2	0.660814	1148.634
8	3.42	3.99	3.185	7.5	1967.1	91.1	0.694489	1193.605
9	3.09	5.40	2.855	8.5	1963.7	90.9	0.636522	1069.934
10	2.62	3.61	2.385	9.5	1959.9	90.1	0.578482	893.7980
11	2.05	2.98	1.815	10.5	1955.8	88.7	0.502483	680.1859
12	1.88	1.39	1.645	11.5	1951.4	87.5	0.503781	616.4770
13	1.54	0.96	1.305	12.5	1946.8	87.7	0.393262	489.0592
14	1.34	2.76	1.105	13.5	1936.9	87.9	0.327577	191.8245
15	1.22	4.66	0.985	14.5	1927.4	88.6	0.275111	170.9929
16	0.84	0.81	0.605	15.5	1917.6	88.2	0.174906	105.0261
17	0.52	1.29	0.285	16.5	1907.6	87.7	0.085885	49.47510
18	0.41	4.11	0.175	17.5	1897.3	88.5	0.049306	30.37945
19	0.31	5.61	0.075	18.5	1886.6	87.0	0.023888	13.01976
20	0.27	3.08	0.035	19.5	1876.1	87.3	0.010890	6.07589
21	0.22	4.88	-0.015	20.5	-	88.8	-	-2.60395
22	0.23	3.95	-0.005	21.5	-	-	-	-
23	0.22	2.61	-0.015	22.5	-	-	-	-
24	0.22	3.78	-0.015	23.5	-	-	-	-
25	0.21	2.11	-0.025	24.5	-	-	-	-
26	-	-	-0.235	25.5	-	-	-	-
27	-	-	-0.235	26.5	-	-	-	-
28	0.24	2.33	0.005	27.5	-	-	-	-
29	0.24	4.39	0.005	28.5	-	-	-	-
30	0.27	3.83	0.035	30.5	-	-	-	-
31	0.26	0.53	0.025	32.5	-	-	-	-
32	0.25	6.09	0.015	34.5	-	-	-	-
33	0.26	6.35	0.025	36.5	-	-	-	-
34	0.23	0.48	-0.005	38.5	-	-	-	-
35	0.24	7.06	0.005	40.5	-	-	-	-
36	0.20	6.69	-0.035	42.5	-	-	-	-

Table 2B-13: Continued

Focusing Factor: 1.71
Average Background Concentration: 0.235 ug/g
Cadmium Inventory for LO #40a: 7.806092 ug/cm^2
Focusing Corrected Cadmium Inventory: 4.5780846 ug/cm^2

Table 2B-14:
Site LO #E30 - Rochester Basin, Lake Ontario
Cadmium Data

Sample	Cd (ug/g)	Cd RSD	CdAdj. (ug/g)	Depth (cm)	Date (cf/cs)	Por. (%)	Inv. ug/cm^2	Accum ug/m^2yr
1	**2.76**		2.56	0.25	1989.6	92.95	0.221088	835.7647
2	**3.40**		3.20	0.75	1988.1	92.58	0.30576	1044.706
3	**3.74**		3.54	1.25	1987.4	92.20	0.355593	1155.706
4	**3.98**		3.78	1.75	1985.7	91.80	0.379701	1234.059
5	**4.04**		3.84	2.25	1984.3	91.53	0.398429	1253.647
6	**4.04**		3.84	2.75	1982.5	91.36	0.406426	1253.647
7	**5.58**		5.38	3.25	1980.8	91.25	0.576669	1756.412
8	**5.24**		5.04	3.75	1979.4	91.25	0.540225	1645.412
9	**5.14**		4.94	4.25	1977.9	91.18	0.533742	1612.765
10	**3.68**		3.48	4.75	1976.2	91.29	0.371307	1136.118
11	**3.34**		3.14	5.25	1974.8	91.53	0.325799	1025.118
12	**3.26**		3.06	5.75	1972.3	91.67	0.31225	999.0000
13	**2.90**		2.70	6.25	1971.3	91.67	0.275515	881.4706
14	**2.78**		2.58	6.75	1969.9	91.57	0.26643	842.2941
15	**2.68**		2.48	7.25	1968.5	91.50	0.25823	809.6471
16	**2.24**		2.04	7.75	1966.8	91.36	0.215914	666.0000
17	**1.94**		1.74	8.25	1965.4	91.11	0.18949	568.0588
18	**1.82**		1.62	8.75	1963.3	90.57	0.187138	528.8824
19	**1.74**		1.54	9.25	1961.9	90.52	0.17884	502.7647
20	**1.60**		1.40	9.75	1960.1	90.20	0.16807	457.0588
21	**1.36**		1.16	10.5	1957.7	89.72	0.292158	378.7059
22	**1.20**		1.00	12.0	1951.1	88.56	0.56056	326.4706
23	**0.78**		0.58	14.5	1940.6	88.14	0.505592	189.3529
24	**0.44**		0.24	17.0	1929.7	87.97	-	-

Focusing Factor: 2.04
Average Background Concentration: 0.2 ug/g
Cadmium Inventory for LO #G32: 7.824925 ug/cm^2
Focusing Corrected Cadmium Inventory: 3.835748 ug/cm^2

Table 2B-15:
Site LO #F31 - Rochester Basin, Lake Ontario
Cadmium Data

Sample	Cd (ug/g)	Cd RSD	CdAdj. (ug/g)	Depth (cm)	Date (cf/cs)	Por. (%)	Inv. ug/cm^2	Accum ug/m^2yr
1	**2.62**	3.36	2.36	0.25	1988.5	89.3	0.167678	684.378
2	**2.86**	0.51	2.60	0.75	1987	87.7	0.24843	753.976
3	**2.84**	4.25	2.58	1.25	1984	87.7	0.287605	748.176
4	**3.28**	2.14	3.02	1.75	1982.2	87.7	0.347753	875.772
5	**3.78**	1.13	3.52	2.25	1979.5	86.3	0.413952	1020.77
6	**3.35**	3.25	3.09	2.75	1977.5	83.3	0.458015	896.071
7	**1.98**	2.64	1.72	3.25	1974	79.6	0.31605	498.784
8	**0.87**	1.36	0.61	3.75	1972.2	79.6	0.127032	176.894
9	**0.66**	1.42	0.40	4.25	1969	79.7	-	-
10	**0.20**	2.62	-0.06	4.75	1967	78.8	-	-
11	**0.33**	3.08	0.07	5.25	1964	77.4	-	-
12	**0.27**	4.33	0.01	5.75	1963.5	78.3	-	-
13	**0.37**	5.23	0.11	6.25	1960.5	77.6	-	-
14	**0.26**	4.05	0.00	6.75	1958.5	77.3	-	-
15	**0.25**	0.96	-0.01	7.25	1965.5	78.4	-	-
16	**0.25**	4.12	-0.01	7.75	1955.5	77.8	-	-
17	**0.27**	5.01	0.01	8.25	1953.7	77.9	-	-
18	**0.25**	6.47	-0.01	8.75	1952	76.5	-	-
19	**0.20**	8.23	-0.06	9.25	1950	76.4	-	-
20	**0.25**	5.20	-0.01	9.75	1948.5	77.9	-	-
21	**0.24**	0.20	-0.02	10.25	1947	76.1	-	-
22	**0.25**	0.92	-0.01	11.25	1942	76.6	-	-
23	**0.26**	1.82	0.00	12.25	1939	76.2	-	-
24	**0.25**	5.13	-0.01	13.25	1936	76.9	-	-

Focusing Factor: 1.72

Table 2B-16:
Site LO #G32 - Rochester Basin, Lake Ontario
Cadmium Data

Sample	Cd (ug/g)	Cd RSD	CdAdj. (ug/g)	Depth (cm)	Date (cf/cs)	Por. (%)	Inv. ug/cm^2	Accum ug/m^2yr
1	**2.10**	1.64	1.70	0.25	1989.8	91.6	0.17493	679.1667
2	**2.12**	2.91	1.72	0.75	1988.6	90.3	0.204379	687.1569
3	**2.22**	2.00	1.82	1.25	1987.5	89.0	0.245245	727.1078
4	**2.42**	2.31	2.02	1.75	1985.2	88.2	0.291991	807.0098
5	**2.46**	2.55	2.06	2.25	1984.1	88.4	0.292726	822.9902
6	**3.04**	5.08	2.64	2.75	1982.3	88.5	0.37191	1054.706
7	**3.20**	1.74	2.80	3.25	1980.7	88.4	0.39788	1118.627
8	**3.04**	0.49	2.64	3.75	1979.6	88.3	0.378378	1054.706
9	**3.14**	2.00	2.74	4.25	1977.9	89.0	0.369215	1094.657
10	**3.36**	0.39	2.96	4.75	1976.6	89.3	0.387982	1182.549
11	**3.92**	3.62	3.52	5.5	1974.4	89.7	0.888272	1406.275
12	**3.92**	1.14	3.52	6.5	1970.7	89.7	0.888272	1406.275
13	**4.06**	2.55	3.66	7.5	1967.6	89.6	0.932568	1462.206
14	**4.72**	1.53	4.32	8.5	1964.6	89.3	1.132488	1725.882
15	**3.66**	2.57	3.26	9.5	1961.7	89.7	0.822661	1302.402
16	**2.82**	2.39	2.42	10.5	1958.3	88.8	0.664048	966.8137
17	**2.80**	1.80	2.40	11.5	1955.1	90.1	0.58212	958.8235
18	**2.96**	0.93	2.56	12.5	1951.2	87.8	0.765184	1022.745
19	**1.54**	6.9	1.14	13.5	1947.2	87.7	0.343539	455.4412
20	**1.20**	4.18	0.80	14.5	1933.3	82.5	0.343	319.6078

Focusing Factor: 2.20

Cadmium Inventory for LO#G32: 10.47679 ug/cm^2
Focusing Corrected Cadmium Inventory: 4.762177 ug/cm^2

APPENDIX 2C:

Lead Data

Table 2C-1:
Site LS# DTL - Duluth Basin, Lake Superior
Lead Data

Sample	Pb (ug/g)	Pb RSD	PbAdj. (ug/g)	Depth (cm)	Date (crs)	Por. (%)	Inv. ug/cm^2	Accum ug/m^2yr
1	**44.60**	4.27	33.10	0.25	1989.3	83.1	7.27207	7759.214
2	**46.80**	1.46	35.30	0.75	1986.1	82.4	8.07664	9303.32
3	**54.04**	4.24	42.54	1.25	1981.4	82.6	9.622548	9510.976
4	**57.48**	0.57	45.98	1.75	1977.1	82.1	10.69955	14174.05
5	**59.40**	0.68	47.90	2.25	1973.7	81.3	11.64449	20315.31
6	**66.40**	1.17	54.90	2.625	1971.3	80.8	6.85152	26668.9
7	**53.40**	1.68	41.90	2.875	1969.7	83.3	4.548245	20353.86
8	**48.92**	1.14	37.42	3.05	1968.6	85.2	1.439922	16428.29
9	**55.12**	0.81	43.62	3.225	1967.2	81.9	5.131893	17022.44
10	**63.64**	2.54	52.14	3.6	1964.3	80.3	13.35305	18828.33
11	**68.64**	3.89	57.14	4.1	1960.5	80.9	14.18786	20208.05
12	**67.72**	2.87	56.22	4.6	1956.6	81.8	13.30165	20492.11
13	**61.28**	3.16	49.78	5.1	1952.8	81.6	11.90738	17065.50
14	**51.88**	1.24	40.38	5.6	1947.1	81.8	9.553908	9602.561
15	**46.36**	0.73	34.86	6.1	1941.3	82.2	8.066604	7416.016
16	**40.28**	1.66	28.78	6.85	1931.1	82.2	13.31938	5225.637
17	**32.72**	1.13	21.22	7.85	1916.8	81.7	10.09648	3551.043
18	**24.16**	10.36	12.66	8.85	1899.3	81.6	6.056544	2007.073
19	**20.44**	0.71	8.94	9.85	1879.6	81.5	4.30014	1223.496
20	**14.96**	3.78	3.46	10.85	-	82.1	1.610284	0
21	**14.84**	8.27	3.34	12.85	-	81.9	1.571804	0
22	**13.84**	1.90	2.34	14.85	-	82.0	-	-
23	**12.88**	6.80	1.38	16.85	-	82.5	-	-
24	**12.52**	4.98	1.02	18.85	-	82.0	-	-

Focusing Factor: 1.476
Average Background Concentration: 13.808 ug/g
Lead Inventory for LS #DTL: 172.612 ug/cm^2
Focusing Corrected Lead Inventory: 116.9458 ug/cm^2

Table 2C-2:
Site LS #SJE-II - Duluth Basin, Lake Superior
Lead Data

Sample	Pb (ug/g)	Pb RSD	PbAdj. (ug/g)	Depth (cm)	Date (crs)	Por. (%)	Inv. ug/cm^2	Accum ug/m^{2}yr
1	**57.76**	1.04	43.76	0.25	1988.5	95.0	3.350703	9577.922
2	**59.12**	0.51	45.12	0.75	1983.7	82.3	7.71913	10805.9
3	**70.20**	2.06	56.20	1.25	1977.9	82.5	11.46311	12880.1
4	**70.36**	0.96	56.36	1.75	1972.2	83.1	13.77438	6212.561
5	**73.68**	0.76	59.68	2.25	1965.9	83.2	17.22365	5348.01
6	**62.20**	1.71	48.20	2.75	1958	83.7	12.50067	4174.021
7	**50.08**	0.99	36.08	3.25	1947.9	83.9	8.137844	3233.18
8	**39.56**	1.92	25.56	3.75	1935.2	84.0	5.519171	2493.164
9	**32.08**	4.40	18.08	4.125	1926.8	84.2	1.546563	0
10	**25.40**	6.54	11.40	4.275	1921.1	89.8	0.390062	0
11	**26.76**	4.23	12.76	4.75	1911.4	83.4	2.182981	0
12	**15.64**	4.43	1.64	5.125	1902.3	84.2	0.22386	0
13	**9.88**	7.04	-	5.45	1892	85.6	-	-
14	**12.20**	11.89	-	5.85	1882.3	84.7	-	-
15	**14.08**	5.15	-	6.30	1867.4	84.4	-	-
16	**14.02**	12.05	-	6.80	1851.4	84.4	-	-
17	**12.36**	9.04	-	7.30	1835.4	84.5	-	-
18	**14.96**	12.92	-	8.05	-	84.2	-	-
19	**14.52**	8.94	-	9.05	-	83.7	-	-
20	**15.40**	7.60	-	11.05	-	82.5	-	-
21	**15.24**	4.66	-	12.05	-	83.4	-	-
22	**14.00**	2.15	-	13.05	-	83.2	-	-
23	**15.12**	7.05	-	17.05	-	83.2	-	-
24	**15.24**	7.88	-	21.05	-	83.3	-	-

Focusing Factor: 1.261
Average Background Concentration: 14.05 ug/g
Lead Inventory for LS #SJE-II: 84.03213 ug/cm^2
Focusing Corrected Lead Inventory: 66.63928 ug/cm^2

Table 2C-3:
Site NOAA #3 - Chefswet Basin, Lake Superior
Lead Data

Sample	Pb (ug/g)	Pb RSD	PbAdj. (ug/g)	Depth (cm)	Date (crs)	Por. (%)	Inv. ug/cm^2	Accum ug/m^2yr
1	**114.0**		87.5	0.25	1988.8	95	5.6875	7688.928
2	**116.8**		90.3	0.75	1981.7	93	8.2173	7934.974
3	**114.0**		87.5	1.25	1972	92	9.1	7688.928
4	**102.4**		75.9	1.75	1963	91	8.8803	669.596
5	**71.2**		44.7	2.25	1953	91	5.2299	3927.944
6	**57.2**		30.7	2.75	1940	90	3.991	2697.715
7	**55.2**		28.7	3.25	1925	90	3.731	2521.968
8	**48.8**		22.3	3.75	1907	89	3.1889	1959.578
9	**47.6**		21.1	4.00	1884.9	88	6.5832	1854.13
10	**27.6**		1.1	5.125	1857	89	0.07865	96.66081
11	**24.0**		-	5.375	1849	88	-	-
12	**37.6**		-	5.75	1823	88.5	-	-
13	**20.0**		-	6.25	1799.9	88	-	-
14	**32.4**		-	6.75	1783	87	-	-
15	**25.2**		-	7.50	-	88	-	-
16	**24.0**		-	8.50	-	88	-	-
17	**22.8**		-	14.5	-	-	-	-

Focusing Factor: 1.138
Average Background Concentration: 26.57143 ug/g
Lead Inventory for NOAA #3: 54.68775 ug/cm^2
Focusing Corrected Lead Inventory: 48.05602 ug/cm^2

Table 2C-4:
Site LS #1383 - Isle Royale Basin, Lake Superior
Lead Data

Sample	Pb (ug/g)	Pb RSD	PbAdj. (ug/g)	Depth (cm)	Date (crs)	Por. (%)	Inv. ug/cm^2	Accum ug/m^2yr
1	**120.88**	1.68	101.01	0.5	1981.7	84	42.02016	12272.24
2	**77.12**	1.03	57.25	1.5	1976.5	84	23.816	6598.91
3	**48.68**	2.03	28.81	2.5	1967.4	82	14.9812	1974.517
4	**26.08**	1.92	6.21	3.25	1958.2	80	1.37241	464.2991
5	**24.00**	6.47	4.13	3.75	1946	81	0.91273	218.7227
6	**17.64**	8.78	-	4.25	1931.9	83	-	-
7	**18.92**	1.87	-	5.0	1873.8	82	-	-
8	**19.20**	4.96	-	6.0	1819.3	81	-	-
9	**18.24**	2.38	-	7.5	1698.2	80	-	-
10	**17.80**	5.65	-	9.5	-	76	-	-
11	**18.40**	0.87	-	11.5	-	80	-	-
12	**20.08**	2.91	-	13.5	-	79	-	-
13	**18.32**	6.36	-	16.0	-	-	-	-
14	**36.72**	2.29	-	19.0	-	-	-	-
15	**19.64**	4.46	-	22.5	-	-	-	-
16	**17.48**	4.87	-	26.5	-	-	-	-
17	**16.72**	3.47	-	30.5	-	-	-	-
18	**19.24**	3.53	-	34.5	-	-	-	-

Focusing Factor: 3.21
Average Background Concentration: 19.87 ug/g
Lead Inventory for LS #1390: 83.1025 ug/cm^2
Focusing Corrected Lead Inventory: 25.88863 ug/cm^2

Table 2C-5:
Site LS #1391 - Isle Parisienne Basin, Lake Superior
Lead Data

Sample	Pb (ug/g)	Pb RSD	PbAdj. (ug/g)	Depth (cm)	Date (crs)	Por. (%)	Inv. ug/cm^2	Accum ug/m^2yr
1	**60.7**	0.46	56.1	0.5	1980.7	90	14.5756	6263.687
2	**48.3**	1.26	43.7	1.5	1965.2	87	14.7706	6103.352
3	**39.4**	0.38	34.8	2.5	1944.6	81	17.1912	3305.028
4	**14.4**	3.01	9.78	3.25	1925.9	80	2.5428	983.4637
5	**4.34**	0.93	-	4.0	1902.2	76	-	-
6	**5.12**	7.08	-	5.0	1867.4	74	-	-
7	**4.86**	2.50	-	6.0	1794.8	74	-	-
8	**3.76**	13.66	-	7.5	-	71	-	-
9	**2.62**	5.37	-	9.5	-	72	-	-
10	**3.76**	12.03	-	11.0	-	71	-	-
11	**5.76**	9.77	-	12.5	-	72	-	-
12	**5.20**	4.05	-	15.5	-	72	-	-
13	**4.44**	7.89	-	18.5	-	71	-	-
14	**3.84**	8.84	-	21.5	-	72	-	-
15	**5.36**	5.33	-	26.5	-	72	-	-

Focusing Factor: 1.79
Average Background Concentration: 4.46 ug/g
Lead Inventory for LS #1391: 49.0802 ug/cm^2
Focusing Corrected Lead Inventory: 27.41911 ug/cm^2

Table 2C-6:
Site LM #70m - North Algoma Basin, Lake Michigan
Lead Data

Sample	Pb (ug/g)	Pb RSD	PbAdj. (ug/g)	Depth (cm)	Date (cf/cs)	Por. (%)	Inv. ug/cm^2	Accum ug/m^2yr
1	**120.8**	1.79	110.2	0.25	1990.8	95.2	6.47976	7770.513
2	**117.6**	1.00	107.0	0.75	1985.1	94.5	7.156695	7544.872
3	**122.4**	0.66	111.8	1.25	1978.4	93.6	8.724034	7883.333
4	**122.8**	0.58	112.2	1.75	1970.9	92.8	9.909784	7911.538
5	**121.6**	0.63	111.0	2.25	1962.2	91.8	11.20434	7826.923
6	**115.2**	0.50	104.6	2.75	1952.4	90.8	11.76279	7375.641
7	**109.6**	0.96	99.0	3.25	1941.6	89.9	12.22452	6980.769
8	**103.6**	2.19	93.0	3.75	1929.8	89.0	12.53175	6557.692
9	**95.2**	1.47	84.6	4.25	1917.2	88.3	12.11493	5965.385
10	**88.8**	0.53	78.2	4.75	1903.7	87.6	11.83068	5514.103
11	**78.8**	1.89	68.2	5.25	1889.7	87.2	10.6687	4808.974
12	**77.6**	1.43	67.0	5.75	1875.2	87.1	10.62871	4724.359
13	**52.8**	1.98	42.2	6.25	1860.8	86.8	6.647977	2975.641
14	**25.2**	1.87	14.6	6.75	1846.5	85.9	2.36082	1029.487
15	**18.4**	7.06	7.8	7.25	1831.3	85.0	1.347255	550.000
16	**14.8**	7.69	4.2	7.75	1815.0	84.3	0.77175	296.1538
17	**12.4**	10.15	1.8	8.25	1797.9	84.0	0.346406	126.9231
18	**10.4**	11.47	-0.2	8.75	1779.9	84.3	-	-
19	**10.8**	7.31	0.2	9.25	-	83.9	-	-
20	**11.6**	3.52	1.0	9.75	-	-	-	-
21	**10.0**	6.52	-	10.5	-	-	-	-
22	**12.0**	10.32	-	11.5	-	-	-	-
23	**10.4**	2.99	-	12.5	-	-	-	-
24	**11.2**	6.36	-	13.5	-	-	-	-
25	**9.6**	13.81	-	14.5	-	-	-	-
26	**10.0**	5.09	-	15.5	-	-	-	-
27	**10.0**	3.89	-	16.5	-	-	-	-
28	**9.2**	14.40	-	17.5	-	-	-	-
29	**9.2**	13.89	-	18.5	-	-	-	-
30	**12.8**	3.02	-	19.5	-	-	-	-
31	**11.2**	8.21	-	20.5	-	-	-	-
32	**15.4**	2.53	-	21.5	-	-	-	-
33	**8.4**	2.64	-	25.5	-	-	-	-
34	**9.8**	2.09	-	29.5	-	-	-	-
35	**14.8**	3.45	-	33.5	-	-	-	-
36	**10.4**	4.97	-	37.5	-	-	-	-

Table 2C-6: Continued

Focusing Factor: 1.56
Average Background Concentration: 10.6 ug/g
Lead Inventory for LM #70m: 136.7109 ug/cm^2
Focusing Corrected Lead Inventory: 87.6352 ug/cm^2

Table 2C-7:
Site LM #68k - Algoma Basin, Lake Michigan
Lead Data

Sample	Pb (ug/g)	Pb RSD	PbAdj. (ug/g)	Depth (cm)	Date (cf/cs)	Por. (%)	Inv. ug/cm^2	Accum ug/m^2yr
1	**122.12**	1.41	104.21	0.25	1991.4	98.0	2.553268	23030.94
2	**128.28**	0.32	110.37	0.75	1989.3	96.6	4.597119	24392.27
3	**129.56**	1.35	111.65	1.25	1986.6	95.6	6.018205	24675.14
4	**135.56**	2.06	117.65	1.75	1983.4	94.7	7.638751	26001.10
5	**136.84**	1.31	118.93	2.25	1980.1	94.0	8.741723	26283.98
6	**150.32**	0.72	132.41	2.75	1976.8	93.8	10.05692	29262.98
7	**158.00**	1.34	140.09	3.25	1973.0	94.1	10.12537	30960.22
8	**151.64**	0.57	133.73	3.75	1968.7	93.3	10.97630	29554.70
9	**134.08**	0.70	116.17	4.50	1962.3	93.5	18.50087	25674.03
10	**105.56**	0.57	87.655	5.50	1953.4	94.2	12.45578	19371.27
11	**95.68**	0.80	77.775	6.50	1944.0	93.9	11.62347	17187.85
12	**83.56**	0.91	65.655	7.50	1934.6	94.9	8.203592	14509.39
13	**53.88**	1.12	35.975	8.50	1925.2	93.6	5.64088	7950.276
14	**28.96**	0.92	11.055	9.50	1915.6	92.8	1.950102	2443.094
15	**22.00**	0.77	4.095	10.5	1905.7	93.8	0.622031	904.9724
16	**32.32**	3.36	14.415	11.5	1895.9	92.0	2.825340	3185.635
17	**22.36**	4.95	4.445	12.5	1886.0	94.0	0.654885	984.5304
18	-	5.56	-	13.5	1876.0	92.6	-	-
19	**17.36**	2.78	-	14.5	1866.0	92.6	-	-
20	**22.44**	4.55	-	15.5	1855.7	94.0	-	-
21	**16.64**	2.48	-	16.5	1845.1	91.6	-	-
22	**22.88**	6.73	-	17.5	-	93.3	-	-
23	**17.36**	4.92	-	18.5	-	93.9	-	-
24	**20.12**	4.06	-	19.5	-	91.5	-	-
25	**13.68**	-	-	20.5	-	-	-	-
26	**12.76**	-	-	21.5	-	-	-	-

Focusing Factor: 1.267
Average Background Concentration: 17.905 ug/g
Lead Inventory for LM #68k: 123.1846 ug/cm^2
Focusing Corrected Lead Inventory: 97.22541 ug/cm^2

Table 2C-8:
Site LM #47s - Algoma Basin, Lake Michigan
Lead Data

Sample	Pb (ug/g)	Pb RSD	PbAdj. (ug/g)	Depth (cm)	Date (cf/cs)	Por. (%)	Inv. ug/cm^2	Accum ug/m^2yr
1	**132.0**	0.89	115.67	0.25	1991.6	98.4	2.267132	34238.32
2	**137.2**	4.55	120.87	0.75	1988.8	97.3	3.997775	33964.47
3	**143.6**	1.50	127.27	1.25	1986.0	97.5	3.897644	34617.44
4	**161.2**	0.88	144.87	1.75	1983.0	97.0	5.323973	37811.07
5	**150.0**	0.52	133.67	2.25	1979.7	96.6	5.567356	33150.16
6	**144.8**	9.51	128.47	2.75	1976.3	96.7	5.193400	30447.39
7	**139.6**	1.60	123.27	3.25	1972.7	95.4	6.946264	29214.99
8	**140.8**	0.52	124.47	3.75	1969.2	95.2	7.318836	31490.91
9	**118.0**	0.66	101.67	4.50	1962.0	94.9	12.70367	28060.92
10	**106.8**	1.69	90.47	5.50	1956.7	94.1	13.07744	28678.99
11	**95.2**	1.22	78.87	6.50	1949.5	94.2	11.20743	29418.51
12	**81.2**	1.32	64.87	7.50	1942.2	92.1	12.55559	24196.51
13	**70.8**	0.51	54.47	8.50	1934.4	92.7	9.741959	17702.75
14	**54.0**	0.85	37.67	9.50	1926.1	93.1	6.368114	11338.67
15	**36.4**	2.09	20.07	10.5	1918.1	91.4	4.228749	6181.56
16	**28.8**	0.38	12.47	11.5	1812.8	93.4	2.016399	4364.50
17	**33.2**	1.84	16.87	12.5	1795.8	92.3	3.182526	7186.62
18	**28.4**	2.36	12.07	13.5	1778.8	93.2	2.016399	5141.82
19	**19.6**	2.93	3.27	14.5	1761.6	93.3	0.536771	1128.15
20	**15.2**	3.66	-	15.5	1744.1	93.6	-	-
21	**12.0**	8.50	-	16.5	-	93.3	-	-
22	**14.4**	6.55	-	17.5	-	91.6	-	-
23	**17.6**	6.31	-	18.5	-	90.8	-	-
24	**19.2**	1.21	-	19.5	-	91.2	-	-

Focusing Factor: 1.34
Average Background Concentration: 16.33 ug/g
Lead Inventory for LM #47s: 118.1419 ug/cm^2
Focusing Corrected Lead Inventory: 88.165597 ug/cm^2

Table 2C-9:
Site LM #11 - Southern Basin, Lake Michigan
Lead Data

Sample	Pb (ug/g)	Pb RSD	PbAdj. (ug/g)	Depth (cm)	Date (cf/cs)	Por. (%)	Inv. ug/cm^2	Accum ug/m^2yr
1	**140.8**	2.10	118.0	0.5	1970.5	84.6	44.5214	72924
2	**152.0**	0.66	129.2	1.5	1938	82.4	55.71104	60982.4
3	**151.2**	3.45	128.4	2.5	1915.3	82.2	55.99524	39932.4
4	**158.0**	1.99	135.2	3.5	1895	79.5	67.9042	27580.8
5	**145.2**	3.83	122.4	4.5	1877	79.2	62.37504	16524
6	**62.8**	1.04	40.0	5.5	1858	77.8	21.756	4600
7	**37.2**	3.17	14.4	6.5	1838.4	77.2	8.04384	2275.2
8	**26.0**	6.59	3.2	7.5	1817.3	73.6	2.06976	784
9	**24.8**	3.12	2.0	8.5	1794.2	73.3	1.3083	724
10	**25.6**	4.06	2.8	9.5	1770.1	73.0	1.8522	935.2
11	**22.8**	2.77	0.	10.5	1745.1	66.3	0	0
12	**27.6**	12.33	4.8	11.5	-	67.5	3.822	0
13	**24.4**	6.23	1.6	12.25	-	68.4	0.61936	0
14	**22.8**	4.84	0	13.0	-	64.9	0	0
15	**22.4**	3.36	-0.4	14.0	-	61.4	-	-
16	**22.4**	13.06	-0.4	14.75	-	64.0	-	-
17	**20.4**	5.60	-2.4	15.25	-	66.5	-	-
18	**21.2**	6.45	-1.6	16.0	-	65.8	-	-
19	**20.8**	6.00	-2.0	17.0	-	63.6	-	-
20	**20.4**	7.88	-2.4	18.0	-	64.9	-	-
21	**22.0**	3.23	-0.8	19.5	-	66.7	-	-
22	**21.6**	11.37	-1.2	21.5	-	66.7	-	-
23	**21.6**	4.57	-1.2	23.5	-	65.8	-	-
24	**24.4**	5.83	1.6	25.5	-	64.4	-	-
25	**23.2**	6.66	0.4	27.5	-	66.6	-	-

Focusing Factor: 1.999
Average Background Concentration: 22.85 ug/g
Lead Inventory for LM #11: 325.9784 ug/cm^2
Focusing Corrected Lead Inventory: 163.8082 ug/cm^2

Table 2C-10:
Site LM #18 - Southern Basin, Lake Michigan
Lead Data

Sample	Pb (ug/g)	Pb RSD	PbAdj. (ug/g)	Depth (cm)	Date (cf/cs)	Por. (%)	Inv. ug/cm^2	Accum ug/m^2yr
1	**130.0**	2.02	118.2	0.5	1989.7	94.2	16.79622	72929.4
2	**139.2**	0.98	127.4	1.5	1984.4	93.1	21.53697	71598.8
3	**145.8**	2.74	134.0	2.5	1977.8	91.5	27.9055	67938.0
4	**148.6**	1.58	136.8	3.5	1970.8	90.5	31.8402	60192.0
5	**152.2**	1.47	140.4	4.5	1963.4	89.8	35.08596	50544.0
6	**158.4**	0.89	146.6	5.5	1956.1	89.3	38.43119	47058.6
7	**116.8**	0.56	105.0	6.8	1945.6	89.2	41.75167	35700.0
8	**101.2**	1.79	89.4	8.0	1938.3	89.2	23.74285	28876.2
9	**86.0**	0.37	74.2	9.0	1931.0	89.1	19.74239	22705.2
10	**78.2**	2.69	66.4	10.0	1923.8	88.3	19.01729	16799.2
11	**53.6**	2.35	41.8	11.0	1916.5	87.5	12.80125	8318.2
12	**26.8**	0.60	15.0	12.0	1856.5	87.6	4.5423	2475.0
13	**19.4**	0.99	7.6	13.0	1793.0	87.3	2.359154	1254.0
14	**19.0**	2.43	7.2	14.0	1821.6	87.2	2.259684	1116.0
15	**19.4**	6.82	7.6	15.0	-	87.0	2.4206	1109.6
16	**14.0**	1.78	-	16.0	-	-	-	-
17	**11.2**	9.29	-	17.0	-	-	-	-
18	**11.0**	2.13	-	18.0	-	-	-	-
19	**12.8**	3.47	-	19.0	-	-	-	-
20	**12.4**	2.35	-	20.0	-	-	-	-
21	**11.6**	3.09	-	21.0	-	-	-	-
22	**10.8**	3.03	-	22.0	-	-	-	-
23	**11.0**	4.62	-	23.0	-	-	-	-
24	**11.4**	5.15	-	24.0	-	-	-	-
25	**11.4**	4.94	-	25.0	-	-	-	-
26	**11.8**	3.23	-	26.5	-	-	-	-
27	**13.4**	2.61	-	28.5	-	-	-	-
28	**14.0**	2.34	-	32.5	-	-	-	-
29	**13.0**	3.03	-	34.5	-	-	-	-
30	**12.4**	7.03	-	38.5	-	-	-	-
31	**10.4**	3.82	-	40.5	-	-	-	-
32	**9.2**	3.65	-	44.5	-	-	-	-
33	**8.2**	10.29	-	48.5	-	-	-	-

Table 2C-10: Continued

Focusing Factor: 2.434
Average Background Concentration: 11.87059 **ug/g**
Lead Inventory for LM #18: 300.2332 **ug/cm^2**
Focusing Corrected Lead Inventory: 123.3497 **ug/cm^2**

Table 2C-11:
Site LM #19 - Southern Basin, Lake Michigan
Lead Data

Sample	Pb (ug/g)	Pb RSD	PbAdj. (ug/g)	Depth (cm)	Date (cf/cs)	Por. (%)	Inv. ug/cm^2	Accum ug/m^2yr
1	**177.2**	3.45	165.82	0.5	1989.8	94.2	23.56231	31337.26
2	**189.4**	0.69	178.02	1.5	1983.9	93.1	30.09344	33642.93
3	**176.8**	0.71	165.42	2.5	1972.2	91.5	34.44767	31261.67
4	**161.8**	1.26	150.42	3.5	1956.4	90.5	35.00909	28426.83
5	**152.2**	1.37	140.82	4.5	1939.2	89.8	35.18967	26612.53
6	**76.2**	1.27	64.82	5.5	1918.1	89.3	16.99125	12249.34
7	**26.6**	3.39	15.22	6.5	1891.7	89.0	4.100443	2875.472
8	**6.2**	8.29	-5.19	7.5	-	63.8	-	-
9	**6.2**	9.38	-5.19	8.5	-	61.4	-	-
10	**6.2**	12.21	-5.19	9.5	-	66.4	-	-
11	**6.2**	7.32	-5.19	10.5	-	63.9	-	-
12	**10.4**	6.53	-0.99	11.5	-	70.3	-	-
13	**13.2**	4.93	1.82	12.5	-	73.1	-	-
14	**12.8**	3.68	1.42	13.5	-	72.1	-	-
15	**15.4**	6.18	4.02	14.5	-	71.8	-	-
16	**12.6**	2.74	1.22	15.5	-	71.6	-	-
17	**16.8**	4.64	5.42	16.5	-	71.9	-	-
18	**14.8**	5.10	3.42	17.5	-	71.2	-	-
19	**12.2**	3.65	0.82	18.5	-	73.6	-	-
20	**13.8**	1.20	2.42	19.5	-	75.1	-	-
21	**13.8**	4.67	2.42	21.0	-	66.7	-	-
22	**14.2**	7.71	2.82	23.0	-	68.2	-	-
23	**14.6**	5.52	3.22	25.0	-	68.2	-	-
24	**14.2**	5.42	2.82	27.0	-	65.6	-	-
25	**14.6**	3.66	3.22	29.0	-	67.8	-	-

Focusing Factor: 1.217
Average Background Concentration: 12.12 ug/g
Lead Inventory for LM #19: 179.3939 ug/cm^2
Focusing Corrected Lead Inventory: 147.4066 ug/cm^2

Table 2C-12:
Site LO #19 - Niagara Basin, Lake Ontario
Lead Data

Sample	Pb (ug/g)	Pb RSD	PbAdj. (ug/g)	Depth (cm)	Date (cf/cs)	Por. (%)	Inv. ug/cm^2	Accum ug/m^2yr
1	**109.6**	1.09	88.23	0.5	1989.4	89.3	12.53748	30262.89
2	**130.8**	2.59	109.43	1.5	1983.8	87.7	20.91207	33157.29
3	**141.6**	1.02	120.23	2.5	1976.9	87.7	26.80528	31380.03
4	**151.6**	0.61	130.23	3.5	1969.5	87.7	29.99197	30083.13
5	**166.8**	1.03	145.43	4.5	1961.8	86.3	34.20514	29086
6	**152.0**	1.29	130.63	5.5	1952.9	83.3	38.72526	22076.47
7	**86.0**	2.69	64.63	6.5	1941.9	79.6	23.75153	8272.64
8	**22.8**	4.65	1.43	7.0	1920	79.6	0.297797	131.56
9	**8.0**	8.03	-13.37	7.5	1891.1	79.7	-	-
10	**14.8**	6.57	-6.57	8.5	1838.1	78.8	-	-
11	**18.8**	4.70	-2.57	9.5	-	77.4	-	-
12	**19.6**	6.10	-1.77	10.5	-	78.3	-	-
13	**19.6**	5.59	-1.77	11.5	-	77.6	-	-
14	**22.8**	10.55	1.43	12.5	-	77.3	-	-
15	**24.8**	5.08	3.43	13.5	-	78.4	-	-
16	**20.8**	12.82	-0.57	14.5	-	77.8	-	-
17	**22.0**	5.88	0.63	15.5	-	77.9	-	-
18	**21.2**	4.31	-0.17	16.5	-	76.5	-	-
19	**19.6**	8.95	-1.77	17.5	-	76.4	-	-
20	**20.4**	7.48	-0.97	18.5	-	77.9	-	-
21	**23.2**	2.66	1.83	19.5	-	76.1	-	-
22	**22.4**	5.76	1.03	21.5	-	76.6	-	-
23	**20.0**	6.13	-1.37	23.5	-	76.2	-	-
24	**22.0**	2.76	0.63	25.5	-	76.9	-	-
25	**24.0**	13.99	2.63	27.5	-	77.4	-	-
26	**22.4**	3.53	1.03	29.5	-	77.8	-	-
27	**24.8**	12.45	3.43	31.5	-	76.7	-	-
28	**24.8**	9.74	3.43	35.5	-	-	-	-
29	**27.2**	3.63	5.83	37.5	-	-	-	-
30	**25.6**	6.99	4.23	39.5	-	-	-	-

Table 2C-12: Continued

Focusing Factor: 1.07
Average Background Concentration: 21.374 ug/g
Lead Inventory for LO #19: 187.2265 ug/cm^2
Focusing Corrected Lead Inventory: 174.9780 ug/cm^2

Table 2C-13:
Site LO #40a - Niagara Basin, Lake Ontario
Lead Data

Sample	Pb (ug/g)	Pb RSD	PbAdj. (ug/g)	Depth (cm)	Date (cf/cs)	Por. (%)	Inv. ug/cm^2	Accum ug/m^2yr
1	**54.8**	1.44	26.8	0.5	1990.9	95.9	2.69206	10043.52
2	**86.0**	0.92	58.0	1.5	1988.7	92.4	10.7996	21735.97
3	**93.4**	2.15	65.4	2.5	1985.6	91.4	13.77978	24509.18
4	**123.4**	2.12	95.4	3.5	1981.7	88.7	26.41149	35751.92
5	**146.6**	2.65	118.6	4.5	1977.7	90.1	28.76643	44446.31
6	**161.4**	1.73	133.4	5.5	1974.1	91.1	29.08787	49992.73
7	**176.8**	3.62	148.8	6.5	1970.6	91.2	32.08128	55764.00
8	**162.6**	7.31	134.6	7.5	1967.1	91.1	29.34953	50442.44
9	**153.8**	4.62	125.8	8.5	1963.7	90.9	28.04711	47144.57
10	**145.6**	2.54	117.6	9.5	1959.9	90.1	28.52388	44071.55
11	**126.6**	1.70	98.6	10.5	1955.8	88.7	27.29741	36951.15
12	**113.8**	6.80	85.8	11.5	1951.4	87.5	26.27625	32154.24
13	**87.8**	2.36	59.8	12.5	1946.8	87.7	18.02073	22410.53
14	**68.2**	8.87	40.2	13.5	1936.9	87.9	11.91729	6978.594
15	**73.0**	8.24	45.0	14.5	1927.4	88.6	12.5685	7811.859
16	**59.2**	3.30	31.2	15.5	1917.6	88.2	9.01992	5416.222
17	**42.0**	2.22	14.0	16.5	1907.6	87.7	4.2189	2430.356
18	**35.2**	0.90	7.2	17.5	1897.3	88.5	2.0286	1249.897
19	**30.4**	1.21	2.4	18.5	1886.6	87.0	0.7644	416.6325
20	**25.6**	1.61	-	19.5	1876.1	87.3	-	-
21	**30.4**	2.25	-	20.5	-	88.8	-	-
22	**27.2**	2.94	-	21.5	-	-	-	-
23	**28.4**	1.55	-	22.5	-	-	-	-
24	**28.4**	7.80	-	23.5	-	-	-	-
25	**24.0**	4.89	-	24.5	-	-	-	-
26	-	-	-	25.5	-	-	-	-
27	-	-	-	26.5	-	-	-	-
28	**22.8**	6.73	-	27.5	-	-	-	-
29	**36.8**	6.81	-	28.5	-	-	-	-
30	**22.0**	3.66	-	30.5	-	-	-	-
31	**24.8**	3.04	-	32.5	-	-	-	-
32	**23.2**	3.55	-	34.5	-	-	-	-
33	**23.2**	3.43	-	36.5	-	-	-	-
34	**40.8**	3.86	-	38.5	-	-	-	-
35	**18.0**	1.93	-	40.5	-	-	-	-
36	**27.6**	10.10	-	42.5	-	-	-	-

Table 2C-13: Continued

Focusing Factor: 1.71
Average Background Concentration: 27.576471 ug/g
Lead Inventory for LO #19: 341.65103 ug/cm²
Focusing Corrected Lead Inventory: 199.79592 ug/cm²

Table 2C-14:
Site LO #E30 - Rochester Basin, Lake Ontario
Lead Data

Sample	Pb (ug/g)	Pb RSD	PbAdj. (ug/g)	Depth (cm)	Date (cf/cs)	Por. (%)	Inv. ug/cm^2	Accum ug/m^2yr
1	**90.72**	1.21	75.72	0.25	1989.6	92.95	6.539368	24720.35
2	**114.20**	0.29	99.20	0.75	1988.1	92.58	9.47856	32385.88
3	**125.76**	1.12	110.76	1.25	1987.4	92.20	11.12584	36159.88
4	**145.64**	1.06	130.64	1.75	1985.7	91.80	13.12279	42650.12
5	**149.20**	0.98	134.20	2.25	1984.3	91.53	13.92426	43812.35
6	**159.24**	0.58	144.24	2.75	1982.5	91.36	15.26636	47090.12
7	**194.48**	0.81	179.48	3.25	1980.8	91.25	19.23801	58594.94
8	**201.04**	0.38	186.04	3.75	1979.4	91.25	19.94116	60736.59
9	**185.12**	0.88	170.12	4.25	1977.9	91.18	18.38062	55539.18
10	**156.56**	0.70	141.56	4.75	1976.2	91.29	15.10410	46215.18
11	**143.60**	1.75	128.60	5.25	1974.8	91.53	13.34321	41984.12
12	**134.48**	0.95	119.48	5.75	1972.3	91.67	12.19204	39006.71
13	**124.12**	1.19	109.12	6.25	1971.3	91.67	11.13488	35624.47
14	**114.68**	1.87	99.68	6.75	1969.9	91.57	10.29370	32542.59
15	**111.72**	1.37	96.72	7.25	1968.5	91.50	10.07097	31576.24
16	**108.36**	1.21	93.36	7.75	1966.8	91.36	9.881222	30479.29
17	**100.28**	2.33	85.28	8.25	1965.4	91.11	9.287205	27841.41
18	**95.72**	1.92	80.72	8.75	1963.3	90.57	9.324573	26352.71
19	**98.20**	0.81	83.20	9.25	1961.9	90.52	9.662016	27162.35
20	**94.28**	1.45	79.28	9.75	1960.1	90.20	9.517564	25882.59
21	**88.60**	1.34	73.60	10.5	1957.7	89.72	18.53690	24028.24
22	**80.12**	1.10	65.12	12.0	1951.1	88.56	36.50367	21259.76
23	**56.80**	2.81	41.80	14.5	1940.6	88.14	36.43748	13646.47
24	**29.12**	5.20	14.12	17.0	1929.7	87.97	8.323316	4609.765

Focusing Factor: 2.04

Lead Inventory for LO #G32: 346.6298 ug/cm^2
Focusing Corrected Lead Inventory: 169.9166 ug/cm^2

Table 2C-15:
Site LO #F31 - Rochester Basin, Lake Ontario
Lead Data

Sample	Pb (ug/g)	Pb RSD	PbAdj. (ug/g)	Depth (cm)	Date (cf/cs)	Por. (%)	Inv. ug/cm^2	Accum ug/m^2yr
1	**109.6**	1.09	88.23	0.25	1988.5	89.3	6.26874	4132.06
2	**130.8**	2.59	109.43	0.75	1987	87.7	10.456	5478.44
3	**141.6**	1.02	120.23	1.25	1984	87.7	13.4026	6019.23
4	**151.6**	0.61	130.23	1.75	1982.2	87.7	14.996	6519.87
5	**166.8**	1.03	145.43	2.25	1979.5	86.3	17.1026	7280.85
6	**152.0**	1.29	130.63	2.75	1977.5	83.3	19.3626	6539.9
7	**86.0**	2.69	64.63	3.25	1974	79.6	11.8758	3235.66
8	**22.8**	4.65	1.43	3.75	1972.2	79.6	0.297797	71.5919
9	**8.0**	8.03	-13.37	4.25	1969	79.7	-	-
10	**14.8**	6.57	-6.57	4.75	1967	78.8	-	-
11	**18.8**	4.70	-2.57	5.25	1964	77.4	-	-
12	**19.6**	6.10	-1.77	5.75	1963.5	78.3	-	-
13	**19.6**	5.59	-1.77	6.25	1960.5	77.6	-	-
14	**22.8**	10.55	1.43	6.75	1958.5	77.3	-	-
15	**24.8**	5.08	3.43	7.25	1965.5	78.4	-	-
16	**20.8**	12.82	-0.57	7.75	1955.5	77.8	-	-
17	**22.0**	5.88	0.63	8.25	1953.8	77.9	-	-
18	**21.2**	4.31	-0.17	8.75	1952	76.5	-	-
19	**19.6**	8.95	-1.77	9.25	1950	76.4	-	-
20	**20.4**	7.48	-0.97	9.75	1948.5	77.9	-	-
21	**23.2**	2.66	1.83	10.25	1947	76.1	-	-
22	**22.4**	5.76	1.03	11.25	1942	76.6	-	-
23	**20.0**	6.13	-1.37	12.25	1939	76.2	-	-
24	**22.0**	2.76	0.63	13.25	1936	76.9	-	-

Focusing Factor: 1.72

Table 2C-16:
Site LO #G32 - Rochester Basin, Lake Ontario
Lead Data

Sample	Pb (ug/g)	Pb RSD	PbAdj. (ug/g)	Depth (cm)	Date (cf/cs)	Por. (%)	Inv. ug/cm^2	Accum ug/m^{2}yr
1	**77.08**	1.91	57.08	0.25	1989.8	91.6	5.873532	48689.24
2	**87.32**	1.17	67.32	0.75	1988.6	90.3	7.999299	57289.32
3	**89.08**	1.23	69.08	1.25	1987.5	89.0	9.30853	58787.08
4	**93.88**	1.18	73.88	1.75	1985.2	88.2	10.67935	62871.88
5	**104.96**	0.42	84.96	2.25	1984.1	88.4	12.07282	72300.96
6	**121.28**	1.00	101.28	2.75	1982.3	88.5	14.26782	86088.00
7	**132.44**	0.60	112.44	3.25	1980.7	88.4	15.97772	95349.12
8	**126.60**	0.39	106.60	3.75	1979.6	88.3	15.27845	88797.80
9	**128.24**	0.85	108.24	4.25	1977.9	89.0	14.58534	86483.76
10	**138.84**	0.27	118.84	4.75	1976.6	89.3	15.57695	90437.24
11	**155.04**	0.87	135.04	5.5	1974.4	89.7	34.07734	96013.44
12	**150.80**	1.40	130.80	6.5	1970.7	89.7	33.00738	86328.00
13	**162.72**	4.86	142.72	7.5	1967.6	89.6	36.36506	87344.64
14	**191.52**	0.27	171.52	8.5	1964.6	89.3	44.96397	99653.12
15	**158.32**	0.53	138.32	9.5	1961.7	89.7	34.90505	76076
16	**137.60**	0.80	117.60	10.5	1958.3	88.8	32.26944	73852.8
17	**135.08**	1.00	115.08	11.5	1955.1	90.1	27.91265	81476.64
18	**148.04**	1.67	128.04	12.5	1951.2	87.8	38.27116	83226
19	**102.40**	0.60	82.4	13.5	1947.2	87.7	24.83124	48121.6
20	**98.28**	0.65	78.28	14.5	1933.3	82.5	33.56255	46341.76

Focusing Factor: 2.20

Lead Inventory for LO#G32: 461.7857 ug/cm^2
Focusing Corrected Lead Inventory: 209.9026 ug/cm^2

APPENDIX 2D:

Arsenic, Cadmium, and Lead Analysis Information

Table 2D-1:

Graphite Furnace Conditions for Arsenic Analysis

Spectrometer:

Technique..... Atomic Absorption
Lamp..... As-EDL
Wavelength..... 193.7 nm
Slit Width..... 0.7 nm (low)
Signal Type..... Zeeman AA
Signal Measurement..... Peak Area
Read Time..... 5 sec.
Read Delay..... 0 sec.
BOC Time..... 2 sec.

Calibration:

Solution	ID standard	Conc.	Sample Location	Volume	Dilutant Volume	Modifier Vol. #1	Modifier Vol. #2
Blank	Calib. B	--------	37	20		10	
S1	50 ppb	50.00	1	20		10	
Reagent		--------					
Samples	--------	--------	--------	20		10	

Calibration Equation..... Linear
Calibration Units..... µg/L
Sample Units..... µg/L

Furnace Conditions:

Step	Temp. (C°)	Ramp Time	Hold Time	Int. Flow
Dry Step	120	5	50	300
Thermal Pretreatment	1100	1	30	300
Cool Down	20	1	15	300
Atomization	2100	0	5	0
Clean Out	2600	1	5	300

Injection Temperature..... 100° C
Pipet Speed..... 100 %
Ramp and Hold Times..... seconds

Table 2D-2:

Graphite Furnace Conditions for Cadmium Analysis

Spectrometer:

Technique..... Atomic Absorption
Lamp..... Cd-EDL
Wavelength..... 228.8 nm
Slit Width..... 0.7 nm (low)
Signal Type..... Zeeman AA
Signal Measurement..... Peak Area
Read Time..... 5 sec.
Read Delay..... 0 sec.
BOC Time..... 2 sec.

Calibration:

Solution	ID standard	Conc.	Sample Location	Volume	Dilutant Volume	Modifier Vol. #1	Modifier Vol. #2
Blank	Calib. B	--------	37	20		10	
S1	2.0 ppb	2.00	1	20		10	
Reagent		--------					
Samples	--------	--------	--------	20		10	

Calibration Equation..... Non-Linear
Calibration Units..... µg/L
Sample Units..... µg/L

Furnace Conditions:

Step	Temp. (C°)	Ramp Time	Hold Time	Int. Flow
Dry Step	120	1	50	300
Thermal Pretreatment	850	1	30	300
Cool Down	20	1	15	300
Atomization	1650	0	5	0
Clean Out	2600	1	5	300

Injection Temperature..... 100° C
Pipet Speed..... 100 %
Ramp and Hold Times..... seconds

Table 2D-3:

Graphite Furnace Conditions for Lead Analysis

Spectrometer:

Technique..... Atomic Absorption
Lamp..... Pb-EDL
Wavelength..... 283.3 nm
Slit Width..... 0.7 nm (low)
Signal Type..... Zeeman AA
Signal Measurement..... Peak Area
Read Time..... 5 sec.
Read Delay..... 0 sec.
BOC Time..... 2 sec.

Calibration:

Solution	ID standard	Conc.	Sample Location	Volume	Dilutant Volume	Modifier Vol. #1	Modifier Vol. #2
Blank	Calib. B	--------	37	20		20	
S1	50.0 ppb	50.00	1	20		20	
Reagent		--------					
Samples	--------	--------	--------	10		20	10

Calibration Equation..... Non-Linear
Calibration Units..... µg/L
Sample Units..... µg/L

Furnace Conditions:

Step	Temp. (C°)	Ramp Time	Hold Time	Int. Flow
Dry Step	130	5	50	300
Thermal Pretreatment	900	1	30	300
Cool Down	20	1	15	300
Atomization	1800	0	5	0
Clean Out	2600	1	5	300

Injection Temperature..... 100° C
Pipet Speed..... 100 %
Ramp and Hold Times..... seconds

Table 2D-4: Solutions Preparation
(Graphite Furnace)

Stock Solution Preparation:

As, Cd, Pb: In a 100 ml flask add
- 100 ul of reagent std. (1000 ppm).
- 1 ml of concentrated HNO_3.
- Dilute up to 100 ml with DDW.

Standard Solutions:

As: 50 ppb std.
- 5 ml of As stock solution.
- 1 ml of concentrated HNO_3.
- Dilute up to 100 ml with DDW.

Cd: 1 ppb std.
- 100 ul of Cd stock solution.
- 1 ml of concentrated HNO_3.
- Dilute up to 100 ml with DDW.

Pb: 50 ppb std.
- 1.25 ml Pb stock solution.
- 125 ul of concentrated HNO_3.
- Dilute up to 25 ml with DDW.

Matrix Modifiers:

Cd & Pb: 2g $(NH_4)H_2PO_4$ diluted with 50 ml DDW.
0.1g $Mg(NO_3)_2$ diluted with 50 ml DDW.

**** 1:1 mixture of solutions ****

As: 0.2g $Ni(NO_3)_2$ diluted with 100 ml DDW.

SRM Values:

As: 23.0 - 23.8 ug / l.

Cd: 3.23 - 3.67 ug / l.

Pb: 144 - 178 ug / l.

APPENDIX 2E:

Arsenic, Cadmium, Lead, and Mercury Comparison Data

Table 2E-1:
Site LS #DTL - Duluth Basin, Lake Superior
Trace Metal Concentration Data Comparison

Sample	Depth (cm)	Thickness (cm)	As (ug/g)	Cd (ug/g)	Pb (ug/g)	Hg (ug/g)
1	0.0-0.5	0.5	21.27	1.86	44.60	0.168
2	0.5-1.0	0.5	22.96	1.72	46.80	0.174
3	1.0-1.5	0.5	23.80	1.72	54.04	0.188
4	1.5-2.0	0.5	23.87	2.04	57.48	0.206
5	2.0-2.5	0.5	23.60	1.68	59.40	0.212
6	2.5-2.75	0.25	23.36	1.12	66.40	0.256
7	2.75-3.0	0.25	32.53	**2.70**	53.40	0.248
8	3.0-3.1	0.1	**215.51**	1.20	48.92	0.258
9	3.1-3.35	0.25	105.66	0.96	55.12	0.292
10	3.35-3.85	0.5	39.10	2.02	63.64	0.356
11	3.85-4.35	0.5	16.08	2.02	**68.64**	0.428
12	4.35-4.85	0.5	19.99	2.20	67.72	**0.680**
13	4.85-5.35	0.5	17.49	1.60	61.28	0.340
14	5.35-5.85	0.5	19.12	1.92	51.88	0.408
15	5.85-6.35	0.5	15.98	1.66	46.36	0.328
16	6.35-7.35	1.0	13.50	1.40	40.28	0.244
17	7.35-8.35	1.0	11.20	0.86	32.72	0.158
18	8.35-9.35	1.0	10.02	0.88	24.16	0.166
19	9.35-10.35	1.0	9.26	0.34	20.44	0.088
20	10.35-11.35	1.0	9.87	0.46	14.96	0.080
21	12.35-13.35	1.0	8.74	0.50	14.84	0.078
22	14.35-15.35	1.0	8.16	0.24	13.84	0.064
23	16.35-17.35	1.0	9.13	0.50	12.88	0.070
24	18.35-19.35	1.0	8.08	0.44	12.52	0.068
background			***8.87***	***0.41***	***13.81***	***0.075***

* **Bold concentration values reported are the maximum concentration values per core.**

Table 2E-2:
Site LS #SJE-II - Duluth Basin, Lake Superior
Trace Metal Concentration Data Comparison

Sample	Depth (cm)	Thickness (cm)	As (ug/g)	Cd (ug/g)	Pb (ug/g)	Hg (ug/g)
1	0.0-0.5	0.5	26.31	1.30	57.76	0.110
2	0.5-1.0	0.5	25.86	1.29	59.12	0.134
3	1.0-1.5	0.5	23.83	1.28	70.20	0.166
4	1.5-2.0	0.5	18.32	1.23	70.36	**0.180**
5	2.0-2.5	0.5	15.08	1.16	**73.68**	0.172
6	2.5-3.0	0.5	12.00	**1.97**	62.20	0.148
7	3.0-3.5	0.5	10.62	1.27	50.08	0.104
8	3.5-4.0	0.5	9.01	0.54	39.56	0.086
9	4.0-4.25	0.25	8.43	0.51	32.08	0.080
10	4.25-4.40	0.15	23.30	0.31	25.40	0.068
11	4.5-5.0	0.5	4.23	0.70	26.76	0.058
12	5.0-5.25	0.25	17.45	0.55	15.64	0.056
13	5.25-5.65	0.4	**65.64**	0.25	9.88	0.046
14	5.65-6.05	0.4	48.05	0.57	12.20	0.046
15	6.05-6.55	0.5	20.84	0.43	14.08	0.055
16	6.55-7.05	0.5	9.37	0.59	14.02	0.046
17	7.05-7.55	0.5	4.66	0.21	12.36	0.042
18	7.55-8.55	1.0	5.48	0.53	14.96	0.047
19	8.55-9.55	1.0	5.12	0.29	14.52	0.053
20	9.55-10.55	1.0	5.34	0.53	15.40	0.050
21	10.55-11.55	1.0	5.89	0.33	15.24	0.048
22	11.55-12.55	2.0	6.27	0.59	14.00	0.050
23	16.55-18.55	2.0	7.10	0.48	15.12	0.044
24	20.55-22.55	2.0	7.05	0.33	15.24	0.040
background			***6.25***	***0.44***	***14.05***	***0.047***

* **Bold values in the data table are the maximum trace metal concentration values.**
* **The shaded area within the data table represents the background concentration depth.**

Table 2E-3:
Site NOAA #3 - Chefswet Basin, Lake Superior
Trace Metal Concentration Data Comparison

Sample	Depth (cm)	Thickness (cm)	As (ug/g)	Cd (ug/g)	Pb (ug/g)	Hg (ug/g)
1	0.0-0.5	0.5	4.32	**1.36**	114.0	0.168
2	0.5-1.0	0.5	3.80	1.35	**116.8**	0.184
3	1.0-1.5	0.5	3.91	1.28	114.0	**0.194**
4	1.5-2.0	0.5	3.31	1.15	102.4	0.168
5	2.0-2.5	0.5	3.30	1.00	71.2	0.118
6	2.5-3.0	0.5	2.85	1.02	57.2	0.096
7	3.0-3.5	0.5	2.79	0.88	55.2	0.080
8	3.5-4.0	0.5	2.70	0.81	48.8	0.074
9	4.0-5.0	1.0	2.09	0.57	47.6	0.054
10	5.0-5.25	0.25	2.04	1.21	27.6	0.052
11	5.25-5.5	0.25	2.07	0.82	24.0	0.044
12	5.5-6.0	0.5	2.30	0.30	37.6	0.051
13	6.0-6.5	0.5	**21.11**	0.27	20.0	0.042
14	6.5-7.0	0.5	1.29	0.48	32.4	0.046
15	7.0-8.0	1.0	1.77	0.26	25.2	0.044
16	8.0-9.0	1.0	1.49	0.42	24.0	0.045
17	14.0-15.0	1.0	1.61	0.31	22.8	0.043
background			***1.54***	***0.34***	***26.7***	***0.047***

* **Bold concentration values reported are the maximum concentration values per core.**

Table 2E-4:
Site LS #1390 - Isle Royale Basin, Lake Superior
Trace Metal Concentration Data Comparison

Sample	Depth (cm)	Thickness (cm)	As (ug/g)	Cd (ug/g)	Pb (ug/g)	Hg (ug/g)
1	0.0-1.0	1.0	7.77	**2.56**	**120.88**	**0.158**
2	1.0-2.0	1.0	6.66	2.08	77.12	0.106
3	2.0-3.0	1.0	5.09	1.34	48.68	0.068
4	3.0-3.5	0.5	3.77	1.66	26.08	0.052
5	3.5-4.0	0.5	3.37	1.06	24.00	0.048
6	4.0-4.5	0.5	**15.08**	0.30	17.64	0.036
7	4.5-5.5	1.0	3.28	0.88	18.92	0.044
8	5.5-6.5	1.0	3.24	0.52	19.20	0.044
9	6.5-8.5	2.0	3.77	0.80	18.24	0.042
10	8.5-10.5	2.0	3.75	0.58	17.80	0.042
11	10.5-12.5	2.0	3.39	0.82	18.40	0.040
12	12.5-14.5	2.0	4.24	0.78	20.08	0.042
13	14.5-17.5	3.0	3.46	0.72	18.32	0.044
14	17.5-20.5	3.0	3.21	0.66	36.72	0.038
15	20.5-24.5	4.0	3.99	0.74	19.64	0.032
16	24.5-28.5	4.0	8.49	0.64	17.48	0.044
17	28.5-32.5	4.0	3.80	0.68	16.72	0.040
18	32.5-36.5	4.0	4.27	0.80	19.24	0.036
background			-	***0.69***	***20.57***	***0.040***

* Bold concentration values reported are the maximum concentration values per core.

Table 2E-5:
Site LS #1391 - Isle Parisienne Basin, Lake Superior
Trace Metal Concentration Data Comparison

Sample	Depth (cm)	Thickness (cm)	As (ug/g)	Cd (ug/g)	Pb (ug/g)	Hg (ug/g)
1	0.0-1.0	1.0	14.42	**0.92**	**60.7**	**0.088**
2	1.0-2.0	1.0	11.62	0.70	48.3	0.072
3	2.0-3.0	1.0	11.02	0.89	39.4	0.072
4	3.0-3.5	0.5	7.43	0.24	14.4	0.031
5	3.5-4.5	1.0	**28.03**	0.15	4.34	0.021
6	4.5-5.5	1.0	2.32	0.07	5.12	0.016
7	5.5-6.5	1.0	1.77	0.15	4.86	0.022
8	6.5-8.5	2.0	4.15	0.08	3.76	0.013
9	8.5-10.5	2.0	1.77	0.06	2.62	0.012
10	10.5-11.5	1.0	1.62	0.16	3.76	0.014
11	11.5-14.5	3.0	3.68	0.13	5.76	0.017
12	14.5-16.5	2.0	4.27	0.09	5.20	0.018
13	16.5-19.5	3.0	2.81	0.11	4.44	0.017
14	19.5-23.5	4.0	3.00	0.11	3.84	0.015
15	23.5-28.5	5.0	3.03	0.16	5.36	0.015
background						

* **Bold concentration values reported are the maximum concentration values per core.**

Table 2E-6:
Site LM #70m - Algoma Basin, Lake Michigan
Trace Metal Concentration Data Comparison

Sample	Depth (cm)	Thickness (cm)	As (ug/g)	Cd (ug/g)	Pb (ug/g)	Hg (ug/g)
1	0.0-0.5	0.5	18.44	1.78	120.8	0.132
2	0.5-1.0	0.5	18.45	1.66	117.6	0.132
3	1.0-1.5	0.5	18.10	1.58	122.4	0.132
4	1.5-2.0	0.5	**19.14**	**2.08**	**122.8**	**0.142**
5	2.0-2.5	0.5	18.99	1.90	121.6	0.128
6	2.5-3.0	0.5	18.68	1.82	115.2	0.128
7	3.0-3.5	0.5	18.25	1.86	109.6	0.108
8	3.5-4.0	0.5	18.00	1.88	103.6	0.108
9	4.0-4.5	0.5	14.34	1.66	95.2	0.108
10	4.5-5.0	0.5	8.59	1.48	88.8	0.114
11	5.0-5.5	0.5	5.89	1.14	78.8	0.094
12	5.5-6.0	0.5	4.48	1.36	77.6	0.098
13	6.0-6.5	0.5	3.99	1.68	52.8	0.058
14	6.5-7.0	0.5	5.80	0.42	25.2	0.036
15	7.0-7.5	0.5	13.76	0.82	18.4	0.030
16	7.5-8.0	0.5	10.84	0.18	14.8	0.024
17	8.0-8.5	0.5	8.94	0.14	12.4	0.025
18	8.5-9.0	0.5	11.54	0.28	10.4	0.021
19	9.0-9.5	0.5	10.28	0.24	10.8	0.023
20	9.5-10.0	0.5	4.58	0.90	11.6	0.020
21	10.0-11.0	1.0	4.41	0.24	10.0	0.022
22	11.0-12.0	1.0	3.64	0.36	12.0	0.021
23	12.0-13.0	1.0	3.20	0.32	10.4	0.021
24	13.0-14.0	1.0	3.29	0.42	11.2	0.023
25	14.0-15.0	1.0	2.93	0.40	9.6	0.023
26	15.0-16.0	1.0	3.04	0.26	10.0	0.022
27	16.0-17.0	1.0	2.93	0.52	10.0	0.019
28	17.0-18.0	1.0	4.26	0.58	9.2	0.020
29	18.0-19.0	1.0	3.57	0.26	9.2	0.018
30	19.0-20.0	1.0	3.48	0.46	12.8	0.029
31	20.0-21.0	1.0	3.60	0.36	11.2	0.019
32	21.0-22.0	1.0	4.11	0.32	15.4	0.022
33	25.0-26.0	1.0	3.88	0.64	8.4	0.020
34	29.0-30.0	1.0	4.64	0.44	9.8	0.024

Table 2E-6: Continued

Sample	Depth (cm)	Thickness (cm)	As (ug/g)	Cd (ug/g)	Pb (ug/g)	Hg (ug/g)
35	33.0-34.0	1.0	4.66	0.58	14.8	0.025
36	37.0-38.0	1.0	5.25	0.62	10.4	0.025
background			***3.85***	***0.42***	***10.6***	***22.1***

*** Bold concentration values reported are the maximum concentration values per core.**

Table 2E-7:
Site LM #68k - Algoma Basin, Lake Michigan
Trace Metal Concentration Data Comparison

Sample	Depth (cm)	Thickness (cm)	As (ug/g)	Cd (ug/g)	Pb (ug/g)	Hg (ug/g)
1	0.0-0.5	0.5	20.46	2.79	122.12	0.212
2	0.5-1.0	0.5	20.24	2.92	128.28	0.216
3	1.0-1.5	0.5	21.41	2.92	129.56	0.228
4	1.5-2.0	0.5	26.81	2.95	135.56	0.240
5	2.0-2.5	0.5	**31.98**	3.15	136.84	0.244
6	2.5-3.0	0.5	24.36	3.07	150.32	0.272
7	3.0-3.5	0.5	15.07	3.38	**158.00**	**0.292**
8	3.5-4.0	0.5	13.88	**3.53**	151.64	0.280
9	4.0-5.0	1.0	18.80	3.19	134.08	0.260
10	5.0-6.0	1.0	17.52	2.38	105.56	0.244
11	6.0-7.0	1.0	14.61	2.59	95.68	0.240
12	7.0-8.0	1.0	12.60	1.96	83.56	0.208
13	8.0-9.0	1.0	10.35	1.08	53.88	0.142
14	9.0-10.0	1.0	7.10	0.58	28.96	0.064
15	10.0-11.0	1.0	7.79	0.40	22.00	0.048
16	11.0-12.0	1.0	6.80	0.55	32.32	0.064
17	12.0-13.0	1.0	7.02	0.30	22.36	0.044
18	13.0-14.0	1.0	6.29	0.35	-	0.034
19	14.0-15.0	1.0	6.41	0.26	17.36	0.034
20	15.0-16.0	1.0	7.86	0.44	22.44	0.036
21	16.0-17.0	1.0	6.86	0.31	16.64	0.034
22	17.0-18.0	1.0	7.77	0.38	22.88	0.042
23	18.0-19.0	1.0	7.17	0.26	17.36	0.034
24	19.0-20.0	1.0	6.42	0.31	20.12	0.030
25	20.0-21.0	1.0	5.46	0.35	13.68	-
26	21.0-22.0	1.0	-	-	12.76	-
background			***6.91***	***0.33***	***17.9***	***0.035***

* **Bold values in the data table are the maximum trace metal concentration values.**
* **The shaded area within the data table represents the background concentration depth.**

Table 2E-8:
Site LM #47s - Algoma Basin, Lake Michigan
Trace Metal Concentration Data Comparison

Sample	Depth (cm)	Thickness (cm)	As (ug/g)	Cd (ug/g)	Pb (ug/g)	Hg (ug/g)
1	0.0-0.5	0.5	29.16	3.43	132.0	0.194
2	0.5-1.0	0.5	**38.18**	3.62	137.2	0.207
3	1.0-1.5	0.5	31.37	3.06	143.6	0.202
4	1.5-2.0	0.5	18.88	3.25	**161.2**	**0.219**
5	2.0-2.5	0.5	12.01	3.37	150.0	0.210
6	2.5-3.0	0.5	11.33	**3.83**	144.8	0.192
7	3.0-3.5	0.5	9.72	3.13	139.6	0.190
8	3.5-4.0	0.5	8.67	3.06	140.8	0.182
9	4.0-5.0	1.0	9.07	3.02	118.0	0.186
10	5.0-6.0	1.0	9.16	2.78	106.8	0.189
11	6.0-7.0	1.0	8.68	2.47	95.2	0.177
12	7.0-8.0	1.0	7.77	2.18	81.2	0.155
13	8.0-9.0	1.0	6.94	1.72	70.8	0.136
14	9.0-10.0	1.0	6.98	1.24	54.0	0.096
15	10.0-11.0	1.0	5.08	0.58	36.4	0.064
16	11.0-12.0	1.0	4.18	0.34	28.8	0.052
17	12.0-13.0	1.0	4.23	0.36	33.2	0.041
18	13.0-14.0	1.0	4.75	0.36	28.4	0.036
19	14.0-15.0	1.0	5.34	0.39	19.6	0.036
20	15.0-16.0	1.0	4.27	0.34	15.2	0.034
21	16.0-17.0	1.0	4.43	0.34	12.0	0.032
22	17.0-18.0	1.0	5.08	0.35	14.4	0.031
23	18.0-19.0	1.0	6.97	0.36	17.6	0.031
24	19.0-20.0	1.0	5.59	0.36	19.2	0.028
background			***4.99***	***0.38***	***16.33***	***0.031***

* **Bold values in the data table are the maximum trace metal concentration values.**
* **The shaded area within the data table represents the background concentration depth.**

Table 2E-9:
Site LM #11 - Southern Basin, Lake Michigan
Trace Metal Concentration Data Comparison

Sample	Depth (cm)	Thickness (cm)	As (ug/g)	Cd (ug/g)	Pb (ug/g)	Hg (ug/g)
1	0.0-1.0	1.0	12.5	1.81	140.8	0.108
2	1.0-2.0	1.0	12.8	1.89	152.0	0.102
3	2.0-3.0	1.0	12.5	**2.00**	151.2	**0.114**
4	3.0-4.0	1.0	**14.0**	1.96	**158.0**	0.108
5	4.0-5.0	1.0	11.8	1.90	145.2	0.102
6	5.0-6.0	1.0	9.7	1.05	62.8	0.052
7	6.0-7.0	1.0	13.7	0.38	37.2	0.028
8	7.0-8.0	1.0	4.0	0.21	26.0	0.014
9	8.0-9.0	1.0	3.3	0.32	24.8	0.018
10	9.0-10.0	1.0	2.3	0.28	25.6	0.014
11	10.0-11.0	1.0	2.3	0.20	22.8	0.014
12	11.0-12.0	1.0	3.0	0.19	27.6	0.014
13	12.0-12.5	0.5	6.5	0.16	24.4	0.018
14	12.5-13.5	1.0	5.8	0.17	22.8	0.018
15	13.5-14.5	1.0	3.3	0.16	22.4	0.018
16	14.5-15.0	1.0	7.2	0.20	22.4	0.014
17	15.0-15.5	0.5	4.1	0.16	20.4	0.014
18	15.5-16.5	1.0	2.1	0.20	21.2	0.014
19	16.5-17.5	1.0	3.9	0.16	20.8	0.014
20	17.5-18.5	1.0	4.6	0.14	20.4	0.014
21	18.5-20.5	2.0	4.9	0.12	22.0	0.016
22	20.5-22.5	2.0	5.0	0.11	21.6	0.018
23	22.5-24.5	2.0	7.1	0.13	21.6	0.022
24	24.5-26.5	2.0	2.7	0.15	24.4	0.022
25	26.5-28.5	2.0	3.7	0.13	23.2	0.020
background			***4.21***	***0.18***	***22.8***	***0.016***

* **Bold values in the data table are the maximum trace metal concentration values.**
* **The shaded area within the data table represents the background concentration depth.**

Table 2E-10:
Site LM #18 - Southern Basin, Lake Michigan
Trace Metal Concentration Data Comparison

Sample	Depth (cm)	Thickness (cm)	As (ug/g)	Cd (ug/g)	Pb (ug/g)	Hg (ug/g)
1	0.0-1.0	1.0	13.4	1.96	130.0	0.192
2	1.0-2.0	1.0	15.4	2.24	139.2	0.204
3	2.0-3.0	1.0	14.7	2.26	145.8	0.212
4	3.0-4.0	1.0	22.3	2.14	148.6	0.220
5	4.0-5.0	1.0	**38.5**	2.26	152.2	**0.228**
6	5.0-6.0	1.0	10.5	**2.64**	**158.4**	0.214
7	6.0-7.5	1.5	7.5	2.59	116.8	0.194
8	7.5-8.5	1.0	7.7	2.26	101.2	0.184
9	8.5-9.5	1.0	8.3	2.56	86.0	0.164
10	9.5-10.5	1.0	6.6	1.77	78.2	0.140
11	10.5-11.5	1.0	6.6	1.38	53.6	0.114
12	11.5-12.5	1.0	4.9	0.46	26.8	0.058
13	12.5-13.5	1.0	4.2	0.32	19.4	0.042
14	13.5-14.5	1.0	3.9	0.25	19.0	0.044
15	14.5-15.5	1.0	5.3	0.27	19.4	0.044
16	15.5-16.5	1.0	8.0	0.30	14.0	0.034
17	16.5-17.5	0.5	8.4	0.27	11.2	0.036
18	17.5-18.5	1.0	12.0	0.26	11.0	0.032
19	18.5-19.5	1.0	5.7	0.41	12.8	0.028
20	19.5-20.5	1.0	7.7	0.30	12.4	0.036
21	20.5-21.5	1.0	12.0	0.32	11.6	0.034
22	21.5-22.5	1.0	3.5	0.30	10.8	0.028
23	22.5-23.5	1.0	3.8	0.31	11.0	0.028
24	23.5-24.5	1.0	3.0	0.30	11.4	0.028
25	24.5-25.5	1.0	3.2	0.30	11.4	0.032
26	25.5-27.5	2.0	6.8	0.37	11.8	0.034
27	27.5-29.5	2.0	11.0	1.35	13.4	0.034
28	31.5-33.5	2.0	6.7	0.35	14.0	0.032
29	33.5-35.5	2.0	14.5	0.42	13.0	0.038
30	37.5-39.5	2.0	8.3	0.41	12.4	0.028
31	39.5-41.5	2.0	16.3	0.41	10.4	0.040
32	43.5-45.5	2.0	3.6	0.35	9.2	0.030
33	47.5-49.5	2.0	5.1	0.33	8.2	0.026

Table 2E-10: Continued

	As (ug/g)	*Cd (ug/g)*	*Pb (ug/g)*	*Hg (ug/g)*
background	***7.2***	***0.38***	***11.9***	***0.033***

* **Bold values in the data table are the maximum trace metal concentration values.**
* **The shaded area within the data table represents the background concentration depth.**

Table 2E-11:
Site LM #19 - Southern Basin, Lake Michigan
Trace Metal Concentration Data Comparison

Sample	Depth (cm)	Thickness (cm)	As (ug/g)	Cd (ug/g)	Pb (ug/g)	Hg (ug/g)
1	0.0-1.0	1.0	19.0	1.33	177.2	**0.202**
2	1.0-2.0	1.0	17.6	1.46	**189.4**	0.186
3	2.0-3.0	1.0	17.8	**1.49**	176.8	0.150
4	3.0-4.0	1.0	15.7	1.38	161.8	0.148
5	4.0-5.0	1.0	10.6	1.36	152.2	0.168
6	5.0-6.0	1.0	10.7	0.80	76.2	0.110
7	6.0-7.0	1.0	4.5	0.51	26.6	0.040
8	7.0-8.0	1.0	1.8	0.09	6.2	0.016
9	8.0-9.0	1.0	1.3	0.10	6.2	0.015
10	9.0-10.0	1.0	6.0	0.07	6.2	0.026
11	10.0-11.0	1.0	7.1	0.06	6.2	0.024
12	11.0-12.0	1.0	6.7	0.24	10.4	0.027
13	12.0-13.0	1.0	7.0	0.14	13.2	0.028
14	13.0-14.0	1.0	7.5	0.11	12.8	0.021
15	14.0-15.0	1.0	8.3	0.16	15.4	0.018
16	15.0-16.0	1.0	**67.3**	0.35	12.6	0.022
17	16.0-17.0	1.0	7.5	0.08	16.8	0.024
18	17.0-18.0	1.0	2.4	0.23	14.8	0.025
19	18.0-19.0	1.0	2.4	0.22	12.2	0.021
20	19.0-20.0	1.0	8.5	0.13	13.8	0.019
21	20.0-22.0	2.0	32.7	0.17	13.8	0.021
22	22.0-24.0	2.0	26.1	0.22	14.2	0.023
23	24.0-26.0	2.0	17.2	0.20	14.6	0.023
24	26.0-28.0	2.0	14.3	0.20	14.2	0.023
25	28.0-30.0	2.0	8.3	0.17	14.6	0.022
background			***5.24***	***0.16***	***12.12***	***0.022***

* Bold values in the data table are the maximum trace metal concentration values.
* The shaded area within the data table represents the background concentration depth.

Table 2E-12:
Site LO #19 - Niagara Basin, Lake Ontario
Trace Metal Concentration Data Comparison

Sample	Depth (cm)	Thickness (cm)	As (ug/g)	Cd (ug/g)	Pb (ug/g)	Hg (ug/g)
1	0.0-1.0	1.0	21.1	2.62	109.6	1.151
2	1.0-2.0	1.0	23.3	2.68	130.8	1.279
3	2.0-3.0	1.0	36.3	2.84	141.6	1.560
4	3.0-4.0	1.0	11.8	3.28	151.6	1.940
5	4.0-5.0	1.0	18.2	**3.78**	**166.8**	2.670
6	5.0-6.0	1.0	21.2	3.35	152.0	**3.080**
7	6.0-7.0	1.0	28.2	1.98	86.0	1.650
8	7.0-7.5	0.5	88.6	0.87	22.8	0.266
9	7.5-8.0	0.5	**512.4**	0.66	8.0	0.070
10	8.0-9.0	1.0	13.9	0.20	14.8	0.042
11	9.0-10.0	1.0	2.5	0.33	18.8	0.034
12	10.0-11.0	1.0	6.3	0.27	19.6	0.028
13	11.0-12.0	1.0	18.6	0.37	19.6	0.032
14	12.0-13.0	1.0	41.7	0.26	22.8	0.034
15	13.0-14.0	1.0	27.2	0.25	24.8	0.034
16	14.0-15.0	1.0	4.4	0.25	20.8	0.036
17	15.0-16.0	1.0	4.8	0.27	22.0	0.037
18	16.0-17.0	1.0	3.9	0.25	21.2	0.034
19	17.0-18.0	1.0	5.5	0.20	19.6	0.031
20	18.0-19.0	1.0	4.7	0.25	20.4	0.036
21	19.0-20.0	1.0	7.4	0.24	23.2	0.035
22	20.0-22.0	2.0	7.5	0.25	22.4	0.034
23	22.0-24.0	2.0	7.9	0.26	20.0	0.038
24	24.0-26.0	2.0	13.5	0.25	22.0	0.034
25	26.0-28.0	2.0	12.9	0.29	24.0	0.035
26	28.0-30.0	2.0	7.6	0.25	22.4	0.033
27	30.0-32.0	2.0	8.0	0.25	24.8	0.032
28	34.0-36.0	2.0	7.9	0.27	24.8	0.034
29	36.0-38.0	2.0	7.9	0.26	27.2	0.035
30	39.0-41.0	2.0	8.5	0.25	25.6	0.033

Table 2E-12: Continued

	As (ug/g)	*Cd (ug/g)*	*Pb (ug/g)*	*Hg (ug/g)*
background	***10.4***	***0.26***	***21.4***	***0.034***

* **Bold values in the data table are the maximum trace metal concentration values.**
* **The shaded area within the data table represents the background concentration depth.**

Table 2E-13:
Site LO #40a - Mississagua Basin, Lake Ontario
Trace Metal Concentration Data Comparison

Sample	Depth (cm)	Thickness (cm)	As (ug/g)	Cd (ug/g)	Pb (ug/g)	Hg (ug/g)
1	0.0 - 1.0	1.0	26.3	1.80	54.8	0.352
2	1.0 - 2.0	1.0	29.3	2.30	86.0	0.610
3	2.0 - 3.0	1.0	14.2	2.21	93.4	0.660
4	3.0 - 4.0	1.0	15.9	2.64	123.4	0.830
5	4.0 - 5.0	1.0	14.0	2.83	146.6	1.100
6	5.0 - 6.0	1.0	22.0	3.15	161.4	1.340
7	6.0 - 7.0	1.0	19.5	3.30	**176.8**	1.640
8	7.0 - 8.0	1.0	17.9	**3.42**	162.6	**2.220**
9	8.0 - 9.0	1.0	16.5	3.09	153.8	1.860
10	9.0 - 10.0	1.0	16.9	2.62	145.6	1.620
11	10.0 - 11.0	1.0	22.4	2.05	126.6	1.740
12	11.0 - 12.0	1.0	21.2	1.88	113.8	1.440
13	12.0 - 13.0	1.0	12.8	1.54	87.8	0.800
14	13.0 - 14.0	1.0	9.2	1.34	68.2	0.500
15	14.0 - 15.0	1.0	10.4	1.22	73.0	0.416
16	15.0 - 16.0	1.0	10.9	0.84	59.2	0.308
17	16.0 - 17.0	1.0	8.2	0.52	42.0	0.204
18	17.0 - 18.0	1.0	7.7	0.41	35.2	0.140
19	18.0 - 19.0	1.0	7.1	0.31	30.4	0.104
20	19.0 - 20.0	1.0	5.9	0.27	25.6	0.080
21	20.0 - 21.0	1.0	7.4	0.22	30.4	0.062
22	21.0 - 22.0	1.0	6.7	0.23	27.2	0.060
23	22.0 - 23.0	1.0	8.0	0.22	28.4	0.052
24	23.0 - 24.0	1.0	8.4	0.22	28.4	0.052
25	24.0 - 25.0	1.0	6.0	0.21	24.0	0.048
26	25.0 - 26.0	1.0	-	-	-	0.044
27	26.0 - 27.0	1.0	-	-	-	-
28	27.0 - 28.0	1.0	6.9	0.24	22.8	-
29	28.0 - 29.0	1.0	6.7	0.24	36.8	0.052
30	29.0 - 30.0	1.0	6.7	0.27	22.0	0.042
31	30.0 - 31.0	1.0	6.9	0.26	24.8	0.040
32	31.0 - 32.0	1.0	7.8	0.25	23.2	0.040
33	32.0 - 33.0	1.0	7.2	0.26	23.2	0.042
34	33.0 - 34.0	1.0	5.6	0.23	40.8	0.036

Table 2E-13: Continued

Sample	Depth (cm)	Thickness (cm)	As (ug/g)	Cd (ug/g)	Pb (ug/g)	Hg (ug/g)
	34.0 - 35.0	1.0	6.6	0.24	18.0	0.036
	35.0 - 36.0	1.0	5.8	0.20	27.6	0.034
	36.0 - 37.0	1.0	-	-	-	0.036
	37.0 - 38.0	1.0	-	-	-	0.040
background			-	***0.24***	***27.1***	***0.040***

* Bold concentration values reported are the maximum concentration values per core.
* The shaded area within the data table represents the background concentration depth.

Table 2E-14:
Site LO #E30 - Rochester Basin, Lake Ontario
Trace Metal Concentration Data Comparison

Sample	Depth (cm)	Thickness (cm)	As (ug/g)	Cd (ug/g)	Pb (ug/g)	Hg (ug/g)
1	0.0 - 0.5	0.5	35.12	2.76	90.72	0.590
2	0.5 - 1.0	0.5	27.62	3.40	114.20	0.710
3	1.0 - 1.5	0.5	19.66	3.74	125.76	0.830
4	1.5 - 2.0	0.5	13.40	3.98	145.64	1.100
5	2.0 - 2.5	0.5	20.36	4.04	149.20	1.260
6	2.5 - 3.0	0.5	32.80	4.04	159.24	1.420
7	3.0 - 3.5	0.5	31.42	**5.58**	194.48	2.430
8	3.5 - 4.0	0.5	29.94	5.24	**201.04**	2.790
9	4.0 - 4.5	0.5	25.08	5.14	185.12	2.440
10	4.5 - 5.0	0.5	27.58	3.68	156.56	2.440
11	5.0 - 5.5	0.5	26.76	3.34	143.60	2.240
12	5.5 - 6.0	0.5	26.86	3.26	134.48	**2.850**
13	6.0 - 6.5	0.5	20.86	2.90	124.12	2.600
14	6.5 - 7.0	0.5	19.52	2.78	114.68	2.560
15	7.0 - 7.5	0.5	17.84	2.68	111.72	2.160
16	7.5 - 8.0	0.5	21.72	2.24	108.36	1.410
17	8.0 - 8.5	0.5	22.24	1.94	100.28	1.280
18	8.5 - 9.0	0.5	24.28	1.82	95.72	1.060
19	9.0 - 9.5	0.5	18.96	1.74	98.20	0.960
20	9.5 - 10.0	0.5	15.58	1.60	94.28	0.760
21	10.0 - 11.0	1.0	17.08	1.36	88.60	0.640
22	11.0 - 12.0	1.0	18.34	1.20	80.12	0.650
23	12.0 - 13.0	1.0	18.48	0.78	56.80	0.300
24	13.0 - 14.0	1.0	13.58	0.44	29.12	0.122
25	14.0 - 15.0	1.0	-	-	-	-
Estimate	***background***	***levels→***	***7.0***	***0.20***	***15.0***	***0.030***

* **Bold values in the data table are the maximum trace metal concentration values.**

Table 2E-15:
Site LO #F31 - Rochester Basin, Lake Ontario
Trace Metal Concentration Data Comparison

Sample	Depth (cm)	Thickness (cm)	As (ug/g)	Cd (ug/g)	Pb (ug/g)	Hg (ug/g)
1	0.0 - 0.5	0.5	21.1	2.62	109.6	0.900
2	0.5 - 1.0	0.5	23.3	2.86	130.8	0.960
3	1.0 - 1.5	0.5	36.3	2.84	141.6	1.020
4	1.5 - 2.0	0.5	11.8	3.28	151.6	1.180
5	2.0 - 2.5	0.5	18.2	**3.78**	**166.8**	1.380
6	2.5 - 3.0	0.5	21.2	3.35	152.0	1.760
7	3.0 - 3.5	0.5	28.2	1.98	86.0	1.950
8	3.5 - 4.0	0.5	88.6	0.87	22.8	2.550
9	4.0 - 4.5	0.5	211.0	0.66	8.0	**2.880**
10	4.5 - 5.0	0.5	13.9	0.20	14.8	**2.880**
11	5.0 - 5.5	0.5	2.5	0.33	18.8	2.720
12	5.5 - 6.0	0.5	6.3	0.27	19.6	2.560
13	6.0 - 6.5	0.5	18.6	0.37	19.6	1.600
14	6.5 - 7.0	0.5	41.7	0.26	22.8	1.110
15	7.0 - 7.5	0.5	27.2	0.25	24.8	-
16	7.5 - 8.0	0.5	4.4	0.25	20.8	0.760
17	8.0 - 8.5	0.5	4.8	0.27	22.0	0.710
18	8.5 - 9.0	0.5	3.9	0.25	21.2	0.570
19	9.0 - 9.5	0.5	5.5	0.20	19.6	0.510
20	9.5 - 10.0	0.5	4.7	0.25	20.4	-
21	10.0 - 10.5	0.5	7.4	0.24	23.2	0.440
22	10.5 - 11.5	1.0	7.5	0.25	22.4	0.260
23	11.5 - 12.5	1.0	7.9	0.26	20.0	0.172
24	12.5 - 13.5	1.0	13.5	0.25	22.0	0.102
Estimate	*background*	*level→*	-	-	-	-

* Bold values in the data table are the maximum trace metal concentration values.

Table 2E-16:
Site LO #G32 - Rochester Basin, Lake Ontario
Trace Metal Concentration Data Comparison

Sample	Depth (cm)	Thickness (cm)	As (ug/g)	Cd (ug/g)	Pb (ug/g)	Hg (ug/g)
1	0.0 - 0.5	0.5	30.32	2.10	77.08	0.540
2	0.5 - 1.0	0.5	29.52	2.12	87.32	0.660
3	1.0 - 1.5	0.5	24.70	2.22	89.08	0.660
4	1.5 - 2.0	0.5	19.96	2.42	93.88	0.740
5	2.0 - 2.5	0.5	16.12	2.46	104.96	0.840
6	2.5 - 3.0	0.5	13.72	3.04	121.28	1.800
7	3.0 - 3.5	0.5	14.52	3.20	132.44	1.230
8	3.5 - 4.0	0.5	17.36	3.04	126.60	1.260
9	4.0 - 4.5	0.5	20.26	3.14	128.24	1.320
10	4.5 - 5.0	0.5	23.10	3.36	138.84	1.290
11	5.0 - 6.0	1.0	26.06	3.92	155.04	1.890
12	6.0 - 7.0	1.0	27.06	3.92	150.80	2.280
13	7.0 - 8.0	1.0	27.10	4.06	162.72	2.700
14	8.0 - 9.0	1.0	30.60	**4.72**	**191.52**	**3.560**
15	9.0 - 10.0	1.0	24.66	3.66	158.32	2.750
16	10.0 - 11.0	1.0	24.82	2.82	137.60	3.050
17	11.0 - 12.0	1.0	22.56	2.80	135.08	3.100
18	12.0 - 13.0	1.0	23.64	2.96	148.04	1.400
19	13.0 - 14.0	1.0	19.40	1.54	102.40	0.870
20	14.0 - 15.0	1.0	21.22	1.20	98.28	0.540
Estimate	***background***	***levels→***	***7.00***	***0.40***	***20.0***	***0.040***

* **Bold values in the data table are the maximum trace metal concentration values.**

Appendix 2F

Quality Assurance - Quality Control (QAQC results)

The acceptable level of uncertainty for concentration data and accumulation rates is 20% for all the metals. Procedural blanks are included in every sediment core analyzed.

Precision: Method precision will be monitored by the analysis of 5% of the sediment samples split into two equal fractions after homogenization and each analyzed as a separate sample (see method precision table).

Accuracy: Accuracy will be monitored by metal recovery from NIST standerd reference sediments - NIST Bufflo River Sediment #2704 (see SRM results).

Blanks: Procedural blanks will be used to monitor any contamination caused by analysis (see blanks results).

Sensitivity: The method detection limit (MDL) is the minimum concentration above which you have confidence the analyte was present or not. The MDL will be determined once for the study for each analyte, and is determined by: $\mathbf{MDL = 3\sigma}$

Table 2F-1: QAQC
Remark codes used to describe why a data value is flagged.

MDL Method Dection Limit, Sample value is less than or equal to the analytical limit of detection.

NSQ Not Sufficient Quanity, There was not sufficient quanity of the matrix to conduct an analysis.

LAC Laboratory Accident, There was an accident in the lab that destroyed the sample or rendered it unsuitable for analysis.

NAI Not Analyzed due to Interference, Because of uncontrollable interference, the analysis for the analyte of interest was not conducted.

RIN Re-Analyzed, The reported value was generated from a re-injection of the same sample abstract.

REX Re-Prepared, The reported value was generatedfrom a re-preparation of the same sample.

FBX Found in Blank, The analyte was found in the procedural blank for that set of runs at greater than acceptable criteria, thus, the reported value may be an overestimate.

Table 2F-2:
Method Precision Table for Arsenic: QAQC

*The method precision will be monitored by the analysis of at least 5% of the sediment samples split into two equal fractions after homogenization and each analyzed as seperate samples.

*Sediment sample increments are in italic.

Lake Superior Cores:

Core Site	Concentration (ug/g)	avg.	Concentration (ug/g)	avg.
LS#DTL	*#5:* **23.2, 22.4, 23.6**	**23.1**	*#10:* **29.9, 37.9, 39.1**	**35.6**
LS#SJE-II	*#5:* **30.2, 31.7, 28.2**	**30.0**	*#15:* **41.7, 35.7, 39.5**	**38.9**
NOAA#3	*#4:* **16.5, 16.9, 17.7**	**17.0**		
LS#1383	*#8:* **2.64, 3.12, 3.45**	**3.07**		
LS#1391	*#7:* **1.77, 2.18, 2.55**	**2.17**		

Lake Michigan Cores:

Core Site	Concentration (ug/g)	avg.	Concentration (ug/g)	avg.
LM#70m	*#25:* **2.93, 2.82, 2.82**			
LM#68k	*#10:* **17.1, 17.5, 16.7**	**17.1**	*#17:* **7.07, 7.75, 7.02**	**7.28**
LM#47s	*#4:* **18.9, 20.2**	**19.6**	*#7:* **9.72, 9.99**	**9.89**
LM#11	*#18:* **2.1, 2.5, 2.5**	**2.5**		
LM#18	*#18:* **12.0, 13.0, 12.5**	**12.5**	*#32:* **3.6, 3.5, 3.4**	**3.5**
LM#19	*#23:* **7.08, 6.94, 6.39**	**6.80**	*#30:* **8.42, 7.88, 8.28**	**8.19**

Lake Ontario Cores:

Core Site	Concentration (ug/g)	avg.	Concentration (ug/g)	avg.
EPA#19	*#23:* **7.9, 9.6, 9.7**	**9.1**	*#30:* **8.5, 10.4, 10.5**	**9.8**
EPA#40a	*#20:* **5.9, 6.6, 7.2**	**6.6**	*#41:* **6.6, 7.4, 7.7**	**7.2**
LO#E30	*#4:* **13.4, 12.8, 12.1**	**12.8**	*#17:* **22.4, 25.3, 25.2**	**24.3**
LO#F31	*#5:* **16.7, 17.5, 18.1**	**17.4**	*#12:* **15.2, 15.3, 15.4**	**15.3**
LO#G32	*#5:* **16.1, 16.9, 15.7**	**16.2**	*#17:* **22.6, 25.6, 20.1**	**22.8**

Table 2F-3:
Replicate Sample Analysis for Arsenic: QAQC

* SRM values attained by NIST Buffalo river sediment #2704.

* Spotchecked and original sample values must be within 20% of each other, if they fall out side this range then the samples are flaged.

Lake Michigan Cores:

Site Number	Samples Run	Original (ug/g)	Spotcheck (ug/g)	% Diff.
LS#70m	#6, 20, 23	18.7, 4.6, 3.2	17.7, 4.2, 2.9	5,9,9
LS#68k	#2, 10, 17	20.2, 17.5, 7.0	16.5, 17.5, 7.1	18, 0,1
LS#47s	#5, 6, 7	12.0, 11.3, 9.7	11.5, 11.0, 9.9	4,3,2
EPA #11	#1, 8, 18	12.5, 4.0, 2.3	12.9, 4.0, 2.5	3,0, 8
EPA #18	#1, 5, 13	13.4, 38.5, 4.2	12.4, 40.8, 4.1	7,6,2
EPA #19	#1, 2, 17	19.0, 17.6, 7.5	20.3, 19.4, 6.8	6,9,9

Lake Superior Cores:

Site Number	Samples Run	Original (ug/g)	Spotcheck (ug/g)	% Diff.
LS#DTL	#1, 4, 6	21.3, 23.9, 23.4	18.7, 19.3, 18.6	12,19,20
LS#SJE-II	#6, 8, 9	12.0, 9.0, 8.4	11.8, 7.1, 7.2	2,20,14
NOAA#3	#2, 5, 10	12.2, 7.9, 5.3	12.0, 8.5, 5.5	2,7,4
LS#1383	#3, 8, 15	5.1, 3.2, 4.0	6.3, 3.7, 4.8	19,14,17
LS#1391	#3, 5, 15	11.0, 28.0, 3.0	11.5, 24.3, 2.6	4,13,13

Lake Ontario Cores:

Site Number	Samples Run	Original (ug/g)	Spotcheck (ug/g)	% Diff.
LO#19	#3, 10, 30	36.3, 13.9, 8.5	38.5, 14.2, 8.4	6,2,1
LO#40a	#10, 11, 13	16.9, 22.4, 12.8	17.3, 19.3, 11.5	2,14,10
LO#E30	#5, 10, 20	20.4, 27.6, 15.6	17.3, 23.2, 16.3	15,16,4
LO#F31	#9, 10, 14	14.5, 14.5, 13.9	15.4, 16.6, 14.8	6,13,6
LO#G32	#1, 2, 5A	30.3, 29.5, 16.1	26.5, 28.5, 14.5	12,3,10

Table 2F-4:
Method Precision Table for Cadmium: QAQC

*The method precision will be monitored by the analysis of at least 5% of the sediment samples split into two equal fractions after homogenization and each analyzed as seperate samples.

*Sediment samples are in italic.

Lake Superior Cores:

Core Site	Concentration (ug/g)	avg.	Concentration (ug/g)	avg.
LS#DTL	*#5:* **1.46, 1.68, 1.52**	**1.55**	*#10:* **1.92, 2.02, 1.90**	**1.95**
LS#SJE-II	*#5:* **1.16, 1.14, 1.13**	**1.14**	*#15:* **0.43, 0.35, 0.35**	**0.38**
NOAA#3	*#4:* **1.15, 1.16, 1.18**	**1.16**		
LS#1383	*#8:* **0.26, 0.25, 026**	**0.26**		
LS#1391	*#7:* **0.15, 0.12, 0.14**	**0.14**		

Lake Michigan Cores:

Core Site	Concentration (ug/g)	avg.	Concentration (ug/g)	avg.
LM#70m	*#25:* **0.40, 0.54, 0.40**	**0.45**		
LM#68k	*#10:* **2.38, 2.40, 2.30**	**2.36**	*#17:* **0.30, 0.44, 0.35**	**0.36**
LM#47s	*#4:* **3.25, 3.25**	**3.25**	*#7:* **3.13, 3.35**	**3.24**
LM#11	*#18:* **0.20, 0.17, 0.17**	**0.18**		
LM#18	*#18:* **0.26, 0.37, 0.33**	**0.32**	*#32:* **0.35, 0.38, 0.39**	**0.37**
LM#19	#23: **0.25, 0.18, 0.18**	**0.20**	#30: **0.18, 0.19, 0.18**	**0.18**

Lake Ontario Cores:

Core Site	Concentration (ug/g)	avg.	Concentration (ug/g)	avg.
LO#19	*#23:* **0.26, 0.32, 0.33**	**0.31**	*#30:* **0.25, 0.34, 0.34**	**0.31**
LO#40a	*#20:* **0.72, 0.59, 0.59**	**0.63**	*#41:* **0.51, 0.57, 0.54**	**0.54**
LO#E30	*#4:* **2.77, 2.92, 2.26**	**2.65**	*#17:* **1.03, 1.09, 1.09**	**1.07**
LO#F31	*#5:* **1.79, 1.78, 1.78**	**1.78**	*#12:* **1.21, 1.22, 1.21**	**1.21**
LO#G32	*#5:* **3.18, 3.08, 3.22**	**3.16**	*#17:* **2.78, 3.10, 3.04**	**2.97**

Table 2F-5:
Replicate Sample Analysis for Cadmium: QAQC

* SRM values attained by NIST Buffalo river sediment #2704.

* Spotchecked and original sample values must be within 20% of each other,

Lake Michigan Cores:

Site Number	Samples Run	Original (ug/g)	Spotcheck (ug/g)	% Diff.
LS#70m	#1, 6, 23	1.78, 1.82, 0.32	1.60, 1.78, 0.30	10,2,6
LS#68k	#2, 8, 12	2.92, 3.53, 1.96	2.96, 3.52, 2.20	1,1,11
LS#47s	#5, 6, 23	3.37, 3.83, 0.36	3.16, 4.12, 0.38	6,7,5
EPA #11	#1, 2, 6	1.81, 1.89, 1.05	2.22, 2.08, 0.94	18,9,10
EPA #18	#1, 5, 13	1.96, 2.26, 0.32	1.78, 2.20, 0.34	9,3,6
EPA #19	#1, 2, 17	1.33, 1.46, 0.08	1.12, 1.20, 0.08	16,18,0

Lake Superior Cores:

Site Number	Samples Run	Original (ug/g)	Spotcheck (ug/g)	% Diff.
LS#DTL	#1, 4, 6	1.86, 2.04, 1.12	1.72, 1.72, 1.04	7,16,7
LS#SJE-II	#3, 4, 6	1.28, 1.23, 1.97	1.24, 1.20, 1.74	3,2,12
NOAA#3	#2, 4A, 16	1.35, 1.15, 0.42	1.26, 1.18, 0.42	7,2,0
LS#1383	#3, 8, 15	0.67, 0.26, 0.37	0.68, 0.24, 0.36	2,8,3
LS#1391	#4, 5, 12	0.30, 0.20, 0.11	0.30, 0.24, 0.10	0,16,10

Lake Ontario Cores:

Site Number	Samples Run	Original (ug/g)	Spotcheck (ug/g)	% Diff.
LO#19	#3, 23, 30	2.84, 0.25, 0.25	2.66, 0.25, 0.19	6,0,20
LO#40a	#2, 10, 12	2.30, 2.63, 1.88	2.68, 3.34, 1.82	14,20,3
LO#E30	#5, 10, 20	4.04, 3.68, 1.6	4.18, 3.78, 1.7	3,3,6
LO#F31	#9, 10, 14	3.72, 3.16, 1.68	3.30, 2.62, 1.32	11,17,21
LO#G32	#1, 2, 5A	2.1, 2.12, 2.46	2.04, 2.14, 2.68	3,1,8

Table 2F-6:
Method Precision Table for Lead: QAQC

* The method precision will be monitored by the analysis of at least 5% of the sediment samples split into two equal fractions after homogenization and each analyzed as seperate samples. RSD values must be below 20%.

* RSD values are reported as a percentage (%).

Lake Superior Cores:

Core Site	Concentration (ug/g)	RSD	Concentration (ug/g)	RSD
LS#DTL	*#5:* **59.4, 65.6, 60.2**	**4.5**	*#10:* **63.6, 62.4, 61.6**	**1.3**
LS#SJE-II	*#5:* **18.4, 18.7, 18.7**	**0.8**	*#15:* **3.52, 3.72, 3.41**	**3.6**
NOAA#3	*#4:* **102.4, 96.0, 92.8**	**4.1**	———	———
LS#1383	*#8:* **19.2, 18.5, 19.8**	**2.8**	———	———
LS#1391	*#7:* **4.86, 4.82, 4.94**	**1.0**	———	———

Lake Michigan Cores:

Core Site	Concentration (ug/g)	RSD	Concentration (ug/g)	RSD
LM#70m	*#25:* **9.6, 8.0, 9.4**	**7.9**	———	———
LM#68k	*#10:* **106.8, 101.0, 105.6**	**2.4**	*#17:* **23.8, 22.6, 22.4**	**2.7**
LM#47s	*#2:* **129.6, 139.2**	**3.6**	*#7:* **153.6, 139.2**	**4.9**
LM#11	*#18:* **5.3, 7.1, 7.5**	**14.4**	———	———
LM#18	*#18:* **5.3, 6.1, 5.7**	**5.7**	*#32:* **3.6, 3.6, 4.4**	**9.8**
LM#19	*#23:* **13.6, 16.0, 14.4**	**6.8**	*#30:* **14.4, 14.4, 16.0**	**5.1**

Lake Ontario Cores:

Core Site	Concentration (ug/g)	RSD	Concentration (ug/g)	RSD
LO#19	*#23:* **11.7, 9.4, 9.5**	**10.4**	*#30:* **10.3, 9.6, 10.1**	**2.9**
LO#40a	*#20:* **12.8, 15.9, 14.8**	**8.9**	*#41:* **7.3, 8.0, 7.9**	**4.0**
LO#E30	*#4:* **204.1, 153.1, 149.2**	**14.8**	*#17:* **100.3, 142.1, 113.4**	**14.7**
LO#F31	*#5:* **139.8, 139.4, 139.1**	**0.2**	*#12:* **115.9, 118.3, 115.9**	**0.9**
LO#G32	*#5:* **104.9, 107.4, 106.3**	**0.9**	*#17:* **118.0, 135.1, 133.1**	**5.9**

Table 2F-7:
Replicate Sample Analysis for Lead: QAQC

* SRM values attained by NIST Buffalo river sediment #2704.

* Spotchecked and original sample values must be within 20% of each other.

Lake Michigan Cores:

Site Number	Samples Run	Original (ug/g)	Spotcheck (ug/g)	% Diff.
LS#70m	#6, 20, 23	**115.2, 11.6, 10.4**	**112.8, 12.0, 12.8**	2,3,19
LS#68k	#2, 8, 12	**128.3, 151.6, 83.6**	**127.2, 153.6, 84.0**	1,1,0.5
LS#47s	#5, 6, 21	**150.0, 144.8, 118.0**	**163.6, 156.8, 99.2**	8,8,16
EPA #11	#1, 2, 6	**140.8, 152.0, 62.8**	**137.2, 157.4, 58.0**	3,3,8
EPA #18	#4, 13, 19	**148.6, 19.4, 12.8**	**156.6, 19.4, 13.4**	5,0,4
EPA #19	#1, 2, 17	**177.2, 189.4, 16.8**	**165.2, 163.6, 18.4**	7,14,9

Lake Superior Cores:

Site Number	Samples Run	Original (ug/g)	Spotcheck (ug/g)	% Diff.
LS#DTL	#1, 4, 6	**44.6, 57.5, 66.4**	**50.4, 56.0, 61.2**	12,3,8
LS#SJE-II	#3, 4, 6	**70.2, 70.4, 62.0**	**75.2, 67.6, 73.2**	7,4,15
NOAA#3	#2, 4A, 16	**116.8, 102.4, 24.0**	**116.2, 106.8, 28.8**	0.5,4,17
LS#1383	#3, 8, 15	**48.7, 18.5, 19.6**	**40.8, 17.2, 18.4**	16,7,6
LS#1391	#3, 5, 8	**39.4, 4.3, 3.7**	**36.8, 4.4, 4.4**	7,2,16

Lake Ontario Cores:

Site Number	Samples Run	Original (ug/g)	Spotcheck (ug/g)	% Diff.
LO#19	#4, 7, 27	**151.6, 86.0, 24.8**	**170.4, 98.8, 22.0**	11,13,11
LO#40a	#10, 11, 13	**156.0, 144.0, 100.4**	**142.0, 139.2, 100.4**	9,3,0
LO#E30	#5, 10, 20	**149.2, 156.6, 94.3**	**151.2, 151.2, 96,8**	1,3,3
LO#F31	#9, 10, 14	**167.2, 141.3, 97.6**	**161.6, 138.4, 97.6**	3,2,0
LO#G32	#1, 2, 5A	**77.1, 87.3, 104.9**	**80.8, 87.6, 103.6**	5,0.3,1

Table 2F-8:

Method Detection Limits for Arsenic, Cadmium, and Lead: QAQC

* MDL is defined as 3σ of seven injections of a representive sample blank.

Arsenic MDL:	Replicate 1:	0.81 ug/l	
	Replicate 2:	1.05 ug/l	
	Replicate 3:	0.97 ug/l	mean conc. = 1.11 ug/l
	Replicate 4:	1.05 ug/l	σ = 0.189
	Replicate 5:	1.28 ug/l	**MDL = 0.567 ug/l**
	Replicate 6:	1.30 ug/l	
	Replicate 7:	1.29 ug/l	
Cadmium MDL:	Replicate 1:	0.02 ug/l	
	Replicate 2:	0.02 ug/l	
	Replicate 3:	0.01 ug/l	mean conc. = 0.02 ug/l
	Replicate 4:	0.02 ug/l	σ = 0.003
	Replicate 5:	0.01 ug/l	**MDL = 0.01 ug/l**
	Replicate 6:	0.02 ug/l	
	Replicate 7:	0.02 ug/l	
Lead MDL:	Replicate 1:	0.63 ug/l	
	Replicate 2:	0.54 ug/l	
	Replicate 3:	0.44 ug/l	mean conc. = 0.56 ug/l
	Replicate 4:	0.52 ug/l	σ = 0.100
	Replicate 5:	0.63 ug/l	**MDL = 0.30 ug/l**
	Replicate 6:	0.72 ug/l	
	Replicate 7:	0.47 ug/l	

Table 2F-9:

Accuracy Table: Standard Reference Material Analysis

NIST Buffalo River Sediment #2704

Site	As (ug/g)	recovery (%)	Cd (ug/g)	recovery (%)	Pb (ug/g)	recovery (%)	Hg (ng/g)	recovery (%)
LS-DTL	25.6	91.4	3.76	108.9	176.9	109.9	1.20	81.6
LS-SJE2	22.7	97.0	3.35	97.1	163.4	101.5	1.68	114.3
NOAA3	26.5	113.2	3.36	97.4	156.2	97.0	1.64	111.6
LS-1383	22.9	97.9	3.44	99.7	172.1	106.9	1.24	84.4
LS-1391	23.6	100.9	3.07	88.9	154.2	95.8	1.42	96.6
LM-70m	22.6	96.6	3.40	98.6	161.6	100.3	1.24	84.4
LM-68k	23.9	102.1	3.64	105.5	153.7	95.5	1.94	131.9
LM-47s	23.9	102.1	3.50	101.4	159.2	98.9	1.52	103.4
LM-11	21.0	89.7	3.68	106.7	157.6	97.9	1.40	95.2
LM-18	21.3	91.0	3.36	97.4	156.0	96.9	1.40	95.2
LM-19	22.1	94.4	3.56	103.2	159.2	98.9	1.24	84.4
LO-19	23.6	100.9	3.58	103.8	150.4	93.4	1.53	104.1
LO-40a	21.9	93.6	3.66	106.1	160.6	99.8	1.34	91.1
LO-E30	23.7	101.3	3.38	97.9	170.8	106.1	1.22	82.9
LO-F31	23.8	101.7	3.42	99.1	167.5	104.0	1.60	108.8
LO-G32	21.7	92.7	3.44	99.7	170.8	106.1	1.36	92.5

QAQC Specifications

	As	Cd	Pb	Hg
NIST	23.0 - 23.8 ug/g	3.23 - 3.67 ug/g	144 - 178 ug/g	1.40 - 1.54 ng/g
Project	16.4 - 28.1 ug/g	2.42 - 4.14 ug/g	113 - 195 ug/g	1.03 - 1.76 ng/g

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