96-28

CCIW
DEC 3 2007
LIBRARY

NATIONAL WATER RESEARCH INSTITUTE

INSTITUT NATIONAL de RECHERCHE sur les EAUX

^{210}Pb Dating of Sediments from the St. Lawrence River (Core 087, Station TCT1) Ontario

L.J. Turner

NWRI Contribution No. 96-28

TD
226
N87
No. 96-
28

^{210}Pb dating of sediments from the St. Lawrence River (Core 087, Station TCT1), Ontario.

L.J. Turner

CONTRIBUTION 96-28
July 1996

National Water Research Institute
Canada Centre for Inland Waters
Burlington, Ontario L7R 4A6

Turner, L.J., 1996. ^{210}Pb dating of sediments from the St. Lawrence River (Core 087, Station TCT1), Ontario. National Water Research Institute, Burlington, Ontario. NWRI CONTRIBUTION 96-28, 27p.

Summary

A sediment core was dated from the St. Lawrence River, Ontario. The ^{210}Pb profile of the sediment core was used to determine the chronological age of the sediment as well as the sedimentation rate. The mean specific gravity was determined to be 2.505 $g \cdot cm^{3}$. The sedimentation rate was calculated to be 0.80 $cm \cdot yr^{-1}$ for core 087 using a CIC model. The average mass sedimentation rate was determined to be 0.20 $g \cdot cm^{-2} \cdot yr^{-1}$ using the CIC1 model, 0.22 $g \cdot cm^{-2} \cdot yr^{-1}$ using the CIC2 model, and 0.22 ± 0.020 $g \cdot cm^{-2} \cdot yr^{-1}$ using the CRS model.

INTRODUCTION

In this study, a core (087) taken from the St. Lawrence River (station TCT1), was dated using a ^{210}Pb method (Eakins and Morrison, 1978). The core was collected by Technological Operations personnel (National Water Research Institute, Burlington) and submitted for analysis by H. Biberhofer (CCIW, NWRI, Study LTSS-95). Other eastern Canadian cores have been dated using this method (Turner and Delorme, 1988a-b, 1989a-g, 1990, 1992; Turner, 1990a-e, 1991a-g, 1992a-c, 1993a-d, 1994a-b, 1995a-g, 1996a).

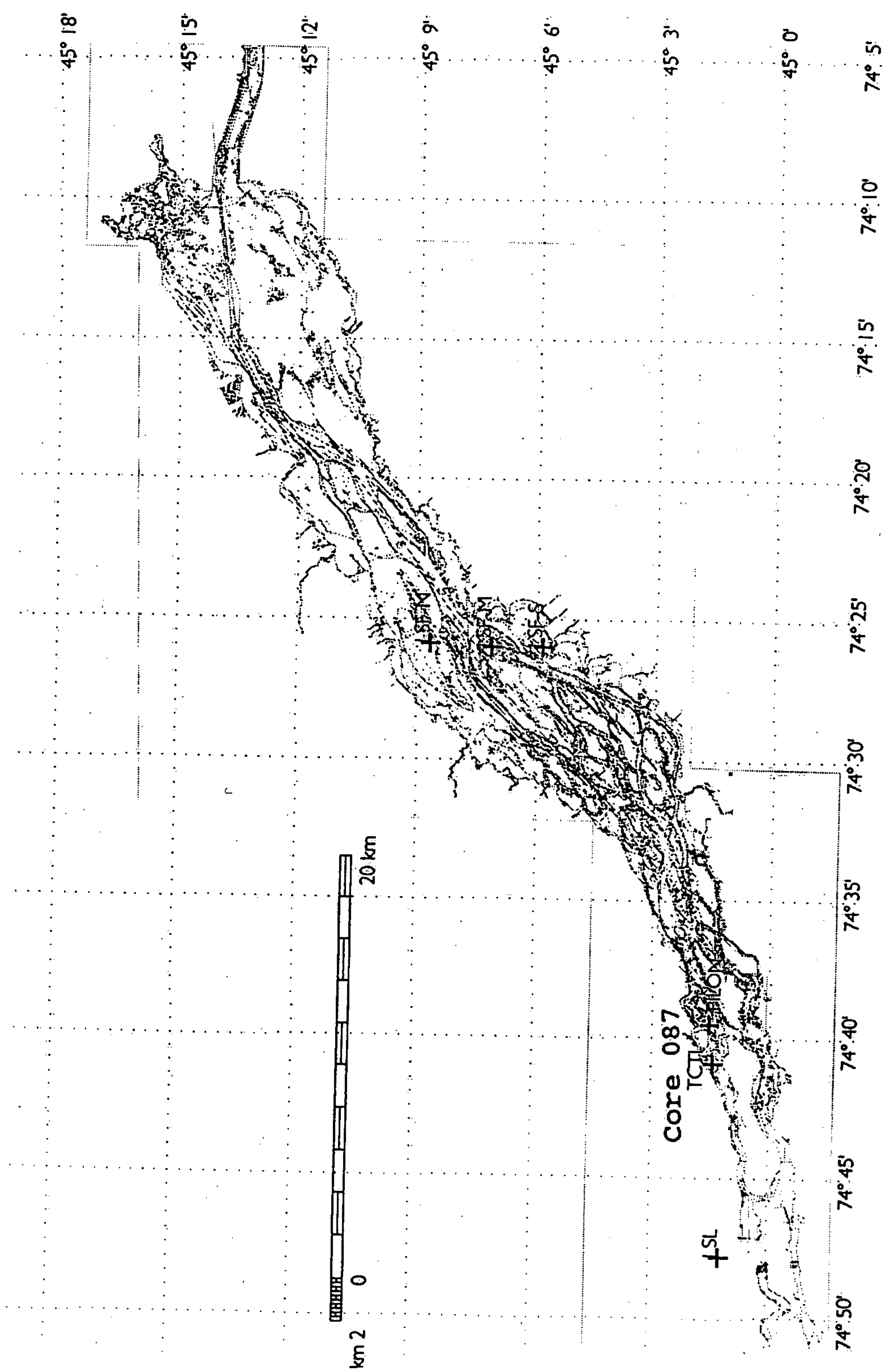
LOCATION AND CORE PREPARATION

The location of the sample site from which the core was taken (Station TCT1; 45.02°N, 74.68°W) is shown in Figure 1. On February 17, 1996, the St. Lawrence River was cored using a lightweight corer (10.16 cm diameter) at a water depth of 12 m. Core 087 was transported to Burlington, Ontario and placed in cold storage. On March 27, 1996, the core was subsectioned into 1-cm intervals giving fifty-two (52) samples. The samples were weighed, freeze-dried, and then re-weighed. These weights were used to calculate porosity and the uncompacted depth (see Appendices A - B, Delorme, 1991).

A plot of porosity versus uncompacted mid-depth and cumulative dry weight for core 087 is shown in Figure 2. Regions of decreased porosity for two sections of the core (samples 16-23 and 49-52) may indicate changes in lithology.

Specific Gravity was determined using an automated Accupyc pycnometer (Micromeritics, 1992). Mean specific gravity for the sediments of core 087 is 2.505 ± 0.052 $g \cdot cm^{-3}$ based on 11 samples and 55 determinations (see Appendix C this report).

Figure 1. Location map of the sampling site for core 087, St. Lawrence River, Ontario.



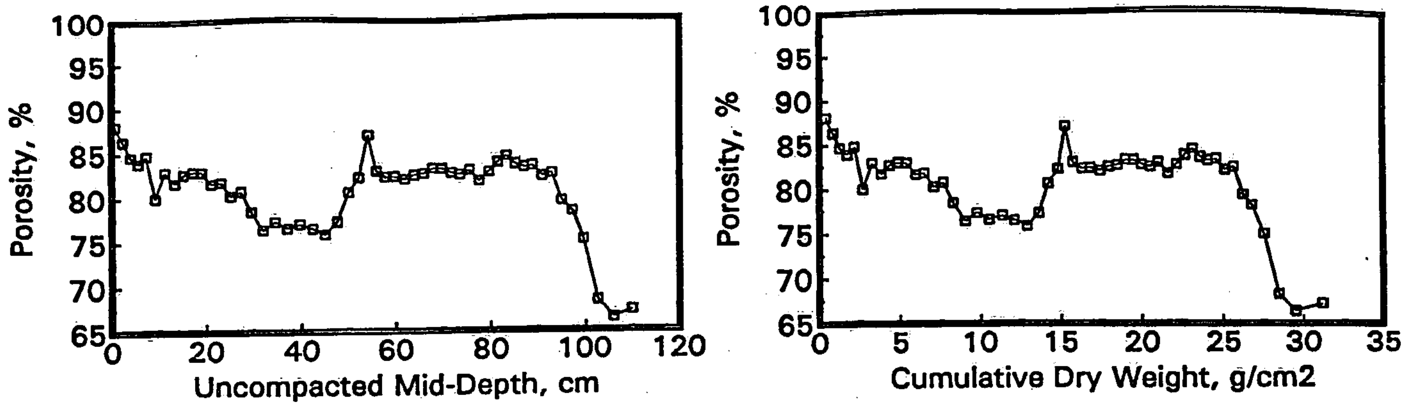


Figure 2. Distribution of porosity with uncompacted mid-depth or cumulative dry weight for core 087.

METHOD

Laboratory Procedures

Homogeneous portions of 24 samples (Table 1, including 2 sets of replicates) from core 087 were treated using a variation on the Eakins and Morrison (1978) polonium distillation procedure. Details of the laboratory procedure are found in a laboratory manual (Turner, 1990).

Following grinding and homogenizing, 1 g (upper core) to 3 g (lower core) of sediment were treated with concentrated HCl to remove carbonate materials, then mixed with approximately 10 dpm ml^{-1} of ^{209}Po spike in a test tube. The ^{209}Po spike was prepared on September 6, 1991 at 6.07 dpm/ml activity. The test tube and contents were then placed in an oven at 110°C until dry.

After cooling, glass wool plugs (one to hold the sediment at the bottom of the tube, one dampened to catch polonium at the opening of the tube) were inserted, then the tubes were placed into a tube furnace and heated to 700°C for ½ hr to distill the polonium from the sediments. At this temperature, polonium passes easily from the sediment, through the dry wool plug and does not condense until reaching the wet wool plug outside the furnace.

After cooling, the tube was cut, and the upper part containing the damp glass wool (condenser) was digested in concentrated HNO_3 under reflux (to destroy organic material). The residue was then filtered and the filtrate boiled down and digested with two HCl treatments to remove any remaining traces of HNO_3.

The polonium was then plated from the remaining solution onto a finely polished silver disk. The disk was counted in an alpha spectrometer. ^{209}Po was identified by its 4.88 MeV alpha particle, and ^{210}Po by its 5.305 MeV alpha particle. The ^{210}Po counts obtained from the spectrometer were compared to the ^{209}Po counts (of known activity) to determine the activity of ^{210}Po in the sediment sample.

Sediment Dating Theory

Dating of lacustrine sediments has been actively pursued for several decades (Robbins and Edgington, 1975; Matsumoto, 1975; Appleby and Oldfield, 1978; and Farmer, 1978). Sedimentation rates are derived using either the CIC (constant initial concentration of unsupported ^{210}Pb; Robbins and Edgington, 1975; Matsumoto, 1975) or the CRS (constant rate of supply; Appleby and Oldfield, 1978) model. The CIC model assumes a constant sedimentation rate over the time period in which unsupported ^{210}Pb is measured. The CRS model assumes a variable sedimentation rate. Both models assume a constant flux of unsupported ^{210}Pb to the sediment/water interface. Depth can be corrected for sediment compaction in the CIC model using sediment porosity measurements, otherwise cumulative dry weight is used. Sediment compaction is accounted for in the CRS model by dealing with cumulative dry weight instead of sediment depth.

The profile of ^{210}Pb in a sediment core can be described as follows:

$$A_{Tx} = (A_{U_0}) e^{-\lambda t} + A' \qquad (1a)$$

where A_{Tx} is the total activity of ^{210}Pb in the sample in $pCi{\cdot}g^{-1}$ dry wt at depth x, and of age t.

A' is the activity of ^{210}Pb supported by ^{226}Ra in $pCi{\cdot}g^{-1}$ dry wt (represented by constant ^{210}Po activities attained at depth),

A_{U_0} is the unsupported activity of ^{210}Pb at the sediment/water interface in $pCi{\cdot}g^{-1}$ dry wt,

λ is the radioactive decay constant for ^{210}Pb ($0.693/22.26\ yr^{-1} = 0.0311\ yr^{-1}$),

And since $A_{Ux} = A_{Tx} - A'$ then $A_{Ux} = (A_{Uo})e^{-\lambda t}$ (1b)

where A_{Ux} is the unsupported activity of ^{210}Pb in the sample in $pCi \cdot g^{-1}$ dry wt at depth x,

<u>The Constant Initial Concentration (CIC) Model</u>:

In the following derivations, equations which refer to the usage of cumulative dry weight instead of uncompacted depth in the CIC model are designated with an 'a'.

In the CIC model, uncompacted mid-depth, z, can be used instead of natural depth, x, to compensate for sediment compaction. Otherwise cumulative dry weight is used. The uncompacted mid-depth is calculated from uncompacted thickness (Delorme 1991).

$$t_{ui} = \{(\phi_o - \phi_i)/(1 - \phi_o)\} + (TV_i * V_q) \quad (2)$$

where t_{ui} is the uncompacted thickness of the i^{th} sample,

ϕ_i is the porosity of the i^{th} sample expressed as a percentage,

ϕ_o is the porosity at the sediment-water interface calculated by regressing the top four sample porosities (ϕ_i) against natural mid-depth, and ϕ_o = y intercept,

TV_i is the total volume of the i^{th} sample,

V_q is the volume of a cylinder 1 cm high and surface area equal to either the inside of the core tube or the stainless steel extrusion ring, whichever is appropriate.

The CIC model assumes a constant sedimentation rate (or mass sedimentation rate) over the time period in which unsupported ^{210}Pb is measured, thus

$$t = z/S_o \quad (3)$$

$$t = c/\omega \quad (3a)$$

where S_o is the sedimentation rate in $cm \cdot yr^{-1}$ at the sediment/water interface,

z is uncompacted mid-depth,

c in cumulative dry weight in $g \cdot cm^{-2}$,

ω is the mass sedimentation rate in $g \cdot cm^{-2} \cdot yr^{-1}$.

The total ^{210}Pb activity at the sediment water interface is:

$$A_{To} = (P/\omega) \quad (4)$$

where P is the flux of ^{210}Pb at the sediment water interface in $pCi \cdot cm^{-2} yr^{-1}$, (assumed constant).

Substituting equations (3) [and (3a)] and (4) into equation (1a) gives:

$$A_{Tz} = (P/\omega) e^{-z\lambda/S_o} + A' \quad (5)$$

or

$$A_{Tx} = (P/\omega) e^{-c\lambda/\omega} + A' \quad (5a)$$

Equation (5) or [5(a)] can be simplified using natural logarithms:

$$\ln(A_{Tz} - A') = \ln(P/\omega) - (\lambda/S_o) z \quad (6)$$

$$\ln(A_{Tx} - A') = \ln(P/\omega) - (\lambda/\omega) c \quad (6a)$$

The form of the equation is $y = b + (m)\ x$

A graphical solution for P/ω (the y-intercept) and λ/S_o [or (λ/ω)] (the slope of the line) is possible from a plot of x and y {z vs $\ln(A_z - A')$} [or c vs $\ln(A_x - A')$] (see Figure 4). As λ is known, then S_o [or ω] can be calculated.

$$S_o = \lambda/\text{slope} = \lambda/(m) \quad (7)$$

$$\omega = \lambda/\text{slope} = \lambda/(m) \quad (7a)$$

When using uncompacted depth, the mass sedimentation rate ω ($g \cdot cm^{-2} \cdot yr^{-1}$) is represented by:

$$\omega = S_o\ (1 - \phi_o)\ \rho_s = S_i\ (1 - \phi_i)\ \rho_s \quad (8)$$

where ρ_s is the density of the solid phase of the sample (assumed constant),

S_i is the sedimentation rate ($cm \cdot yr^{-1}$) at a given uncompacted mid-depth z.

The flux at the sediment/water interface P ($pCi \cdot cm^{-2} \cdot yr^{-1}$) can be calculated from the y-intercept and mass sedimentation rate.

$$P = \omega \, (e^{b}) \qquad (9)$$

Using equation (6) [or (6a)] the time 't' in years since the sample was deposited is given by:

$$t = \frac{\ln\,(A_{Tz} - A') - \ln(P/\omega)}{(-\lambda)} = \frac{z}{S_o} \qquad (10)$$

or

$$t = \frac{\ln\,(A_{Tx} - A') - \ln(P/\omega)}{(-\lambda)} = \frac{c}{\omega} \qquad (10ai)$$

which can be written as:

$$t = -\frac{1}{\lambda} \ln \frac{(A_{Tz} - A')}{A_{To}} = \frac{z}{S_o} \quad \text{or} = \frac{c}{\omega} \qquad (10aii)$$

The uncompacted mid-depth (cm) divided by the sedimentation rate ($cm \cdot yr^{-1}$) [or cumulative dry weight, ($g \cdot cm^{-2}$) divided by mass sedimentation rate ($g \cdot cm^{-2} \cdot yr^{-1}$)] gives t.

The Constant Rate of Supply (CRS) Model:

Since the CRS model assumes a constant rate of supply, then

$$P = A_{Ui} * \omega_t \qquad (11)$$

where P is the flux of ^{210}Pb at the sediment water interface in $pCi \cdot cm^{-2} \cdot yr^{-1}$, (assumed constant)

A_{Ui} is the initial activity of unsupported ^{210}Pb in sediment of age t

ω_t is the dry Mass Sedimentation Rate ($g \cdot cm^{-2} \cdot yr^{-1}$) at time t.

Sediment laid down during time period δt occupies a layer of thickness (δx):

$$\delta x = \frac{\omega_t}{\rho_x} \, \delta t \qquad (12)$$

were ρ_x is the dry mass/unit wet volume of the sample ($g \cdot cm^{-3}$) at depth x.

$$\rho_x = \frac{d\omega}{dx} \qquad (13)$$

The rate of change of depth is

$$x' = \frac{\omega}{\rho_x} \tag{14}$$

where ′ denotes differentiation with regards to t.

and $$x' \rho_x = \omega = x'_o \rho_o \tag{15}$$

Equation (15) combines with (1b) to give

$$x' \rho_x A_{Ux} = x'_o \rho_o (A_{Uo}) e^{-\lambda t} \tag{16}$$

Let $$B(x) = \int_x^\infty \rho_x * A_{Ux}\, dx = \int_x^\infty A_{Ux}\, d\omega \tag{17}$$

represent the total residual or cumulative unsupported ^{210}Pb beneath sediments of depth x,

and $$B(0) = \int_0^\infty \rho_o * A_{Uo}\, dx = \int_0^\infty A_{Uo}\, d\omega \tag{18}$$

represent the total residual unsupported ^{210}Pb in the sediment column, then

$$B(x) = B(0) e^{-\lambda t} \tag{19}$$

The age of layer at depth x is thus:

$$t = -\frac{1}{\lambda} \ln \frac{B(x)}{B(0)} \tag{20}$$

where B(x) and B(0) are calculated by direct numerical integration of the ^{210}Pb profile (the plot of unsupported activity versus cumulative dry weight).

The mass sedimentation rate is calculated by dividing the change in the mid-sample cumulative dry weight by the difference of time in years for the sample analyzed.

The mean ^{210}Pb supply rate (flux) is calculated from

$$P = \lambda B(0) \tag{21}$$

Quality Assurance/Quality Control

Quality Assurance: Collection and Preparation of Core Samples

The samples for core 087 were collected using a lightweight corer.

When the core was extruded, the outer smeared portion was removed using a stainless steel ring to prevent contamination of sediments from above (following the procedure outlined by Delorme, 1991). The samples were freeze-dried using a standard procedure. Minimum loss of water from each sample was achieved by keeping tight lids on the vials before weighing and freeze drying. There was no transfer of sediments from the vials until freeze-drying was complete and the dry weights obtained.

Test runs for quality control on the alpha spectrometry equipment were last done in June, 1996.

Quality Control: Contamination and Method Checks

Blanks (no sample, no spike), were run through the same analytical procedures as samples, to determine if there was contamination from analytical reagents. Blanks, prepared at the same time as the sediment samples, exhibited a background activity of 0.03 dpm when run in all detectors, an activity comparable to empty sample holders.

Yield tracer solutions (no sediment sample) were also run through the analytical procedure. No counts above background were detectable in the ^{210}Po region of the spectra for disks prepared using only the spike (no sample), indicating no polonium (^{210}Po) contamination in the analyses from spike solutions.

Quality Assurance: System Checks

The alpha spectrometer has been monitored since May of 1988. Sample chambers are examined on a monthly basis for contamination. Empty sample holders give a background count rate of 0.01 dpm which equals the equipment specifications.

RESULTS

Table 1 lists the ^{210}Po activities for the 24 samples prepared for core 087. Figure 3 depicts the ^{210}Po activity profile with depth and cumulative dry weight. The symbols used in figure 3 indicate which detector was used during sample analysis. Circles represent detector 3, triangles represent detector 2, and squares represent detector 1.

Table 1. Activity of ^{210}Po in Core 087 Sediment.

Sample	Cum. Dry Wt. g/cm2	Uncomp. Mid Depth cm	210Po dpm/g	DET No.
1	0.41	0.78	11.0	2
3	1.28	4.03	10.8	1
5	2.17	7.41	11.2	2
6	2.70	9.25	6.5 ± 0.4	1/2/3
6R	2.70	9.25	6.3 ± 0.3	1/2/3
6R2	2.70	9.25	6.2 ± 0.2	1/2/3
7	3.26	11.28	8.4	3
9	4.34	15.28	6.8	2
10	4.85	17.14	8.1	1
11	5.40	19.06	7.1	3
13	6.50	23.08	6.2	2
15	7.67	27.27	5.5	3
17	9.50	31.92	5.1	1
20	11.32	39.65	4.6	3
23	13.61	47.64	3.8	2
25	14.81	52.16	5.3	1
30	17.40	61.79	5.1	1
35	19.99	71.62	4.6 ± 0.1	1/2/3
35R	19.99	71.62	4.6 ± 0.0	1/2/3
35R2	19.99	71.62	4.7 ± 0.1	1/2/3
40	22.63	81.55	4.5	2
45	25.12	90.87	4.6	3
50	28.46	102.57	5.6	1
52	31.16	109.87	2.3	2

Reproducibility of Results

Two slices from core 087 were chosen to have the analysis for ^{210}Po repeated. These are listed in Table 2. The ^{210}Po activities are given in Table 1.

Table 2 Reproducibility of Core 087 analyses.

Core	Sample	Uncompacted Mid Depth	^{210}Po activity Mean ±Std Deviation
087	6	9.3	6.3 ± 0.1
	35	71.6	4.6 ± 0.0

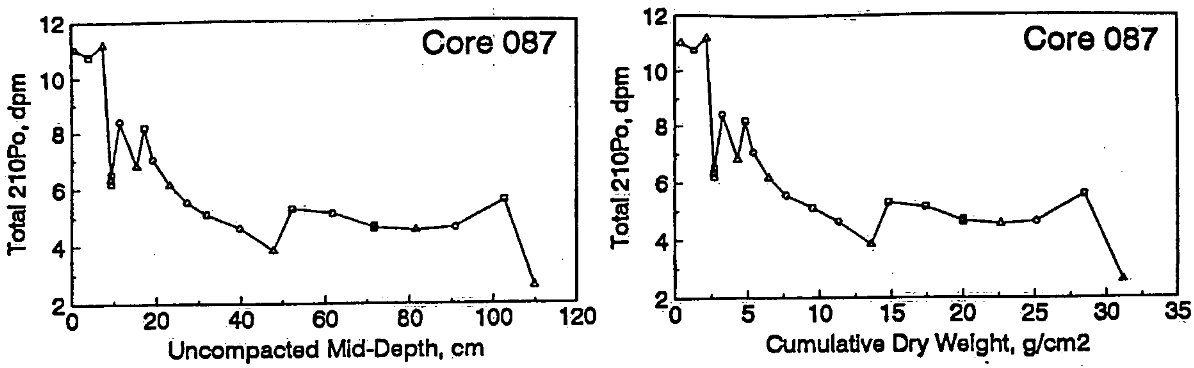


Figure 3. Distribution of Total ^{210}Po activity in $dpm \cdot g^{-1}$ in relation to uncompacted mid-depth and cumulative dry weight for core 087.

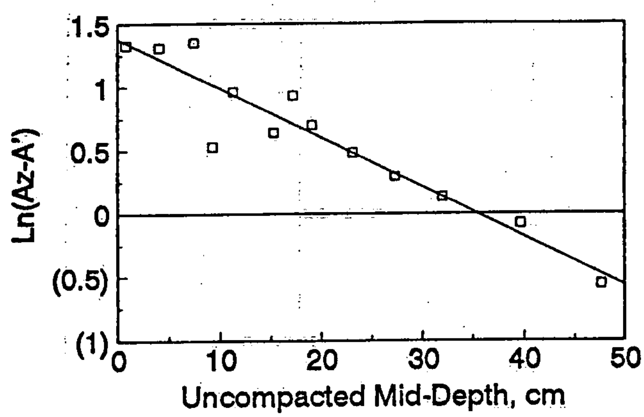


Figure 4. The distribution of uncompacted mid-depth against $\ln(A_z - A')$ for core 087. The y intercept of the regression line = 1.3799, the slope = -0.0391.

^{210}Pb Analysis of St. Lawrence River core 087, using the CIC model.

For the first CIC model, the unsupported activity is plotted against uncompacted mid-depth (Figure 4) using the expanded equation (6). Based on the graphical solution, the y-intercept is $\ln(P/\omega) = 1.3799$ and the slope of the line (λ/S_o) is -0.0391 (see Appendix D). Samples 1 to 13 were used to calculate an average sedimentation rate of 0.80 $cm \cdot yr^{-1}$, an average mass sedimentation rate of 0.20 $g \cdot cm^{-2} \cdot yr^{-1}$ and a flux of 0.79 $pCi \cdot cm^{-2} \cdot yr^{-1}$. The mean dates calculated for each core section, based on a division of the uncompacted mid-depth by the sedimentation rate (equation 3), are given in Appendix G. The '±' values are two standard deviations based on data calculated for the top, bottom, and mid-depth of the sample.

For the second CIC model, the unsupported activity is plotted against cumulative dry weight (Figure 5) using the expanded equation (6a). Based on the graphical solution, the y-intercept is $\ln(P/\omega) = 1.3626$ and the slope of the line (λ/ω) is -0.1408 (see Appendix E). Samples 1 to 13 were used to calculate an average mass sedimentation rate of 0.22 $g \cdot cm^{-2} \cdot yr^{-1}$ and a flux of 0.86 $pCi \cdot cm^{-2} \cdot yr^{-1}$. The dates calculated for each core section, based on a division of the cumulative dry weight by the mass sedimentation rate (equation 3a) are given in Appendix G. The '±' values are two standard deviations based on data calculated for the top, bottom, and mid-section of the sample.

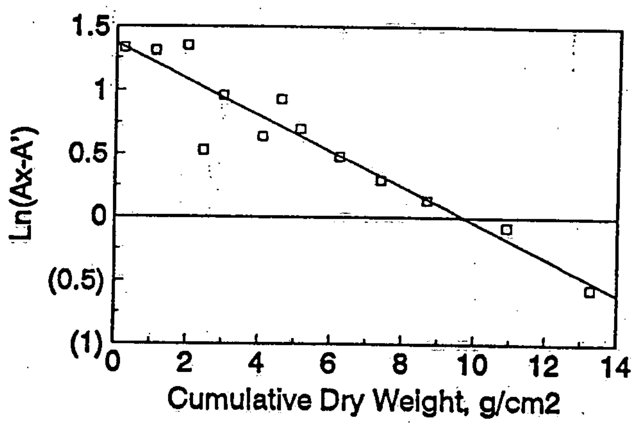


Figure 5. The distribution of cumulative dry weight against $\ln(A_x - A')$ for core 087. The y intercept of the regression line = 1.3626, the slope = -0.1408.

Ideally, the CIC1 and CIC2 models should give almost identical results. A difference in the mass sedimentation rates and atmospheric fluxes determined from the CIC1 and CIC2 models may indicate a problem in the calculation of uncompacted mid-depth. It may indicate a change in lithology that was not completely accounted for by porosity or specific gravity measurements.
A comparison of the mass sedimentation and atmospheric flux rates for this core shows good agreement.

^{210}Pb Analysis of St. Lawrence River core 087, using the CRS model.

For the CRS model, the unsupported activity is plotted against cummulative dry weight (Figure 3). The profile is integrated to determine B(0) and B(x) and calculate time (see Appendix F) according to equation 20. Since not all samples were analyzed for ^{210}Pb activity, a multiple regression analysis was performed to obtain the dates for each core section as given in Appendix G. Samples 1 to 14 were used in this example to calculate an average mass sedimentation rate of 0.22 ± 0.02 $g \cdot cm^{-2} \cdot yr^{-1}$ and flux of 0.88 $pCi \cdot cm^{-2} \cdot yr^{-1}$. The variation in mass sedimentation rate in core 087 is illustrated in figure 6.

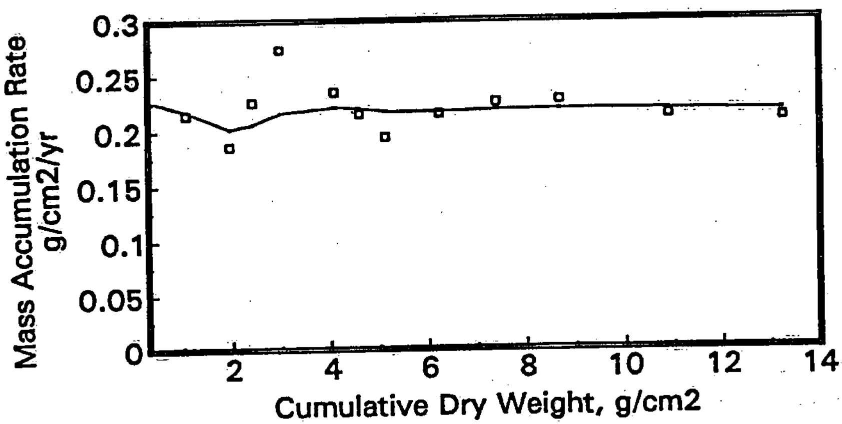


Figure 6. Plot of mass sedimentation rate versus cumulative dry weight for core 087. Points represent mass sedimentation rates determined from integrated area defined by activity and cumulative dry weight for the sample, the line represents the running mean of the mass sedimentation rate.

Comparison of CIC and CRS ^{210}Pb Analysis of Core 087.

Table 3 lists mass sedimentation and atmospheric flux rates as calculated from the CIC and CRS models. The rates are in good agreement with the CIC2 and CRS models agreeing more closely. The year corresponding to individual core sections (Appendix G) as determined by the CIC and CRS models are plotted against cumulative dry weight in Figure 7. Figure 7 shows a very close agreement between the two models. This indicates that the assumption of a 'constant sedimentation rate' for the CIC model was an acceptable one.

Table 3. Summary of Mass Sedimentation Rate and Atmospheric Flux.

Model	Average Mass Sedimentation Rate $g \cdot cm^{-2} \cdot yr^{-1}$	Atmospheric Flux $pCi \cdot cm^{-2} \cdot yr^{-1}$
CIC1	0.20	0.79
CIC2	0.22	0.86
CRS	0.22 ± 0.020*	0.88

* Based on incremental mass sedimentation rates (Appendix F)

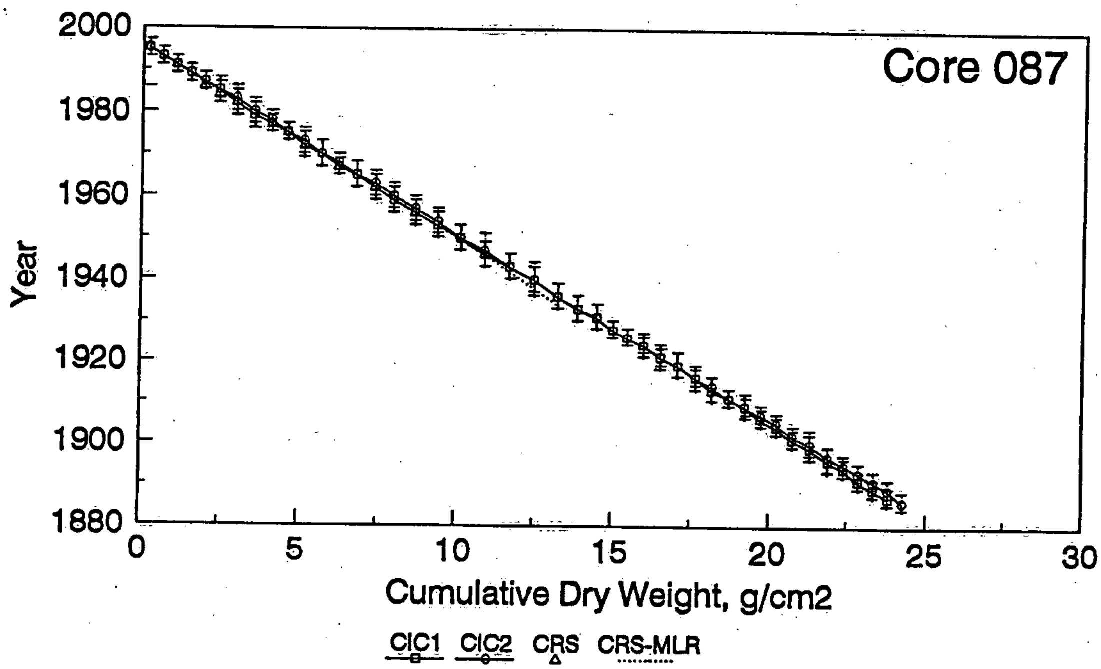


Figure 7. Plot of the Year determined from CIC (squares and circles)/CRS (triangles) models versus cumulative dry weight for St. Lawrence River Core 087.

REFERENCES

Appleby, P.G. and F. Oldfield. 1978. The calculation of ^{210}Pb dates assuming a constant rate of supply of unsupported ^{210}Pb to the sediment. Catena 5:1-8

Delorme, L.D. 1991. The preparation of lacustrine sediment samples from cores for use in dating and paleolimnology. National Water Research Institute, Burlington, Ontario, Contribution 92-188, 18p.

Eakins, J.D. and R.T. Morrison. 1978. A new procedure for determination of lead-210 in lake and marine sediments. International Journal of Applied Radiation and Isotopes 29:531-536.

Farmer, J.G. 1978. The determination of sedimentation rates in Lake Ontario using the ^{210}Pb dating method. Canadian Journal of Earth Sciences 15:431-437.

Matsumoto, E. 1975. ^{210}Pb geochronology of sediments from Lake Shinji. Geochemical Journal 9:167-172.

Micromeritics 1992. Automated Accupyc pycnometer 1330, for determining skeletal density and volume of powders, porous materials, and irregularly shaped solid objects. Operators Manual V2.01, Micromeritics Instrument Corporation, Norcross, Georgia.

Oldfield, F. and P.G. Appleby. 1984. Emperical testing of ^{210}Pb dating models for lake sediments IN Lake Sediments and Environmental History (Eds. E.Y. Harworth and J.W.G. Lund). University of Minnesota Press, Minneapolis. pp 93-124.

Robbins, J.A. and D.N. Edgington. 1975. Determination of recent sedimentation rates in Lake Michigan using Pb-210 and Cs-137. Geochimica et Cosmochimica Acta 39:285-304.

Turner, L.J. 1996a. ^{210}Pb dating of lacustrine sediments from Lake Erie (Core 083, Station 351), Ontario. National Water Research Institute, Burlington, Ontario. NWRI Contribution 96-02, 31p.

Turner, L.J. 1995a. ^{210}Pb dating of lacustrine sediments from Irondequoit Bay, Lake Ontario (Core 065, Station IB-94-2), New York. National Water Research Institute, Burlington, Ontario. NWRI Contribution 95-100, 30p.

Turner, L.J. 1995b. ^{210}Pb dating of lacustrine sediments from Hamilton Harbour (Core 066, Station JPC94HHD4), Lake Ontario. National Water Research Institute, Burlington, Ontario. NWRI Contribution 95-108, 24p.

Turner, L.J. 1995c. ^{210}Pb dating of lacustrine sediments from Mud

Lake (Core 068), Ontario. National Water Research Institute, Burlington, Ontario. NWRI Contribution 95-109, 37p.

Turner, L.J. 1995d. ^{210}Pb dating of lacustrine sediments from Preston Lake (Core 074), Ontario. National Water Research Institute, Burlington, Ontario. NWRI Contribution 95-110, 32p.

Turner, L.J. 1995e. ^{210}Pb dating of lacustrine sediments from Hamilton Harbour (Core 071, Station HH93-2; Core 072, Station HH93-8; Core 073, and Station HH93-11), Lake Ontario. National Water Research Institute, Burlington, Ontario. NWRI Contribution 95-113, 35p.

Turner, L.J. 1995f. ^{210}Pb dating of lacustrine sediments from Lake Erie (Core 077, Station 348), Ontario. National Water Research Institute, Burlington, Ontario. NWRI Contribution 95-119, 27p.

Turner, L.J. 1995g. ^{210}Pb dating of lacustrine sediments from Lake Erie (Core 082, Station 348), Ontario. National Water Research Institute, Burlington, Ontario. NWRI Contribution 95-277, 27p.

Turner, L.J. 1994a. ^{210}Pb dating of lacustrine sediments from Lake Erie (Core 055, Station 84-1), Ontario. National Water Research Institute, Burlington, Ontario. NWRI Contribution 94-116, 25p.

Turner, L.J. 1994b. ^{210}Pb dating of lacustrine sediments from Big Creek Marsh (Core 058, Station 173) and Coletta Bay (Core 059, Station 174), in Inner Bay, Lake Erie, Ontario. National Water Research Institute, Burlington, Ontario. NWRI Contribution 94-127, 32p.

Turner, L.J. 1993a. ^{210}Pb dating of lacustrine sediments from Hamilton Harbour (Core 047, Station 37-1; Core 051, Station 22-D; and Core 052, Station 20-C), Lake Ontario. National Water Research Institute, Burlington, Ontario, Technical Note RAB-TN-93-42, 41p.

Turner, L.J. 1993b. ^{210}Pb dating of sediments from Malden Creek (Core 053) and Muddy Creek (Core 054), Ontario. National Water Research Institute, Burlington, Ontario, Technical Note RAB-TN-93-43, 16p.

Turner, L.J. 1993c. ^{210}Pb dating of lacustrine sediments from Humber Bay (Core 048, Station 42-D1), Lake Ontario. National Water Research Institute, Burlington, Ontario, Technical Note RAB-TN-93-53, 15p.

Turner, L.J. 1993d. ^{210}Pb dating of lacustrine sediments from Hamilton Harbour (Core 049, Station STP-D1; and Core 050, Station

STP-BEN1), Lake Ontario. National Water Research Institute, Burlington, Ontario, Technical Note RAB-TN-93-52, 19p.

Turner, L.J. 1992a. ^{210}Pb dating of lacustrine sediments from Hamilton Harbour Station 33 (Core 031, Box 1; Core 032, Box 2; Core 33, Box 4; and Core 034, Benthos 1), Ontario. National Water Research Institute, Burlington, Ontario, Technical Note RAB-92-07, 30p.

Turner, L.J. 1992b. ^{210}Pb dating of lacustrine sediments from Brewer Lake (Core 035) and Costello Lake (Core 036) in Algonquin Park, Ontario. National Water Research Institute, Burlington, Ontario, Technical Note RAB-92-10, 25p.

Turner, L.J. 1992c. ^{210}Pb dating of lacustrine sediments from Humber Bay (Station H27, Core 041; Station H14a, Core 042; and Station H2a, Core 043), Lake Ontario. National Water Research Institute, Burlington, Ontario, Technical Note RAB-92-18, 21p.

Turner, L.J. 1991a. ^{210}Pb dating of lacustrine sediments from the Saguenay River (Core 011, Station S90-103), Quebec. National Water Research Institute, Burlington, Ontario, Technical Note RAB-91-04, 13p.

Turner, L.J. 1991b. ^{210}Pb dating of lacustrine sediments from Adolphus Reach (Core 012, Station C-2) and the North Channel (Core 013, Station C-4) of Lake Ontario. National Water Research Institute, Burlington, Ontario, Technical Note RAB-91-06, 25p.

Turner, L.J. 1991c. ^{210}Pb dating of sediments from the St. Lawrence River Estuary (Core 014, Station E_{90}-551 and Core 015, Station E_{90}-552), Quebec. National Water Research Institute, Burlington, Ontario, Technical Note RAB-91-11, 20p.

Turner, L.J. 1991d. ^{210}Pb analysis of sediments from the St. Lawrence River Estuary (Core 016, Station LE, Core 017, Station 134A; Core 018, Station 145B; Core 019, Station 168 and Core 020, Station 174), Quebec. National Water Research Institute, Burlington, Ontario, Technical Note RAB-91-13, 13p.

Turner, L.J. 1991e. ^{210}Pb analysis of lacustrine sediments from East Lake (Core 021, Station 158 and Core 022, Station 159), Ontario. National Water Research Institute, Burlington, Ontario, Technical Note RAB-91-16, 24p.

Turner, L.J. 1991f. ^{210}Pb analysis of lacustrine sediments from the Bay of Quinte (Core 023, Station 875 and Core 024, Station PM1), Ontario. National Water Research Institute, Burlington, Ontario, Technical Note RAB-91-22, 23p.

Turner, L.J. 1991g. ^{210}Pb analysis of lacustrine sediments from the

Bay of Quinte (Core 025, Station D and Core 026, Station F), Ontario. National Water Research Institute, Burlington, Ontario, Technical Note RAB-91-26, 25p.

Turner, L.J. 1990. Laboratory Determination of ^{210}Pb-^{210}Po using alpha spectrometry, Second Edition. National Water Research Institute, Burlington, Ontario. Technical Note LRB-90-TN-07, 63p.

Turner, L.J. 1990a. ^{210}Pb dating of lacustrine sediments from Hamilton Harbour (Core 001, Station 31A), Ontario. National Water Research Institute, Burlington, Ontario, Technical Note RAB-90-10, 21p.

Turner, L.J. 1990b. ^{210}Pb dating of sediments from the St. Lawrence River (Core 007, Station E90-540; Core 008, Station E90-541; Core 009, Station E90-550), Quebec. National Water Research Institute, Burlington, Ontario, Technical Note RAB-90-17, 28p.

Turner, L.J. 1990c. ^{210}Pb dating of lacustrine sediments from East Lake (Core 002, Station 155; Core 003, Station 156), Ontario. National Water Research Institute, Burlington, Ontario, Technical Note RAB-90-21, 40p.

Turner, L.J. 1990d. ^{210}Pb dating of lacustrine sediments from East Lake (Core 004, Station 157; Core 005, Station 160; and Core 006, Station 161), Ontario. National Water Research Institute, Burlington, Ontario, Technical Note RAB-90-22, 54p.

Turner, L.J. 1990e. ^{210}Pb dating of sediments from the St. Lawrence River (Core 010, Station E90-542), Quebec. National Water Research Institute, Burlington, Ontario, Technical Note RAB-90-23, 17p.

Turner, L.J. and L.D. Delorme. 1992. ^{210}Pb dating of lacustrine sediments from Hamilton Harbour Station 26 (Core 027, Box 1; Core 028, Box 2; Core 029, Box 4; and Core 030, Benthos 2), Ontario. National Water Research Institute, Burlington, Ontario, Technical Note RAB-92-06, 38p.

Turner, L.J. and L.D. Delorme. 1990. ^{210}Pb dating of sediments from the St. Lawrence River (core 155, Station E7-510; core 156, Station E7-520; and core 157, Station E7-530), Quebec. National Water Research Institute, Burlington, Ontario, Technical Note LRB-90-TN-04, 32p.

Turner, L.J. and L.D. Delorme. 1989a. ^{210}Pb dating of lacustrine sediments from Lake St. George (core 122), Ontario. National Water Research Institute, Burlington, Ontario, Technical Note LRB-89-13, 26p.

Turner, L.J. and L.D. Delorme. 1989b. ^{210}Pb dating of lacustrine sediments from Round Lake (Core 106), Ontario. National Water

Research Institute, Burlington, Ontario, Technical Note LRB-89-15, 24p.

Turner, L.J. and L.D. Delorme. 1989c. ^{210}Pb dating of lacustrine sediments from the Bay of Quinte (core 151), Ontario. National Water Research Institute, Burlington, Ontario, Technical Note LRB-89-28, 16p.

Turner, L.J. and L.D. Delorme. 1989d. ^{210}Pb dating of lacustrine sediments from the Bay of Quinte (cores 149 and 150), Ontario. National Water Research Institute, Burlington, Ontario, Technical Note LRB-89-29, 25p.

Turner, L.J. and L.D. Delorme. 1989e. ^{210}Pb dating of lacustrine sediments from Hamilton Harbour (cores 152, 153, 154), Ontario. National Water Research Institute, Burlington, Ontario, Technical Note LRB-89-30, 18p.

Turner, L.J. and L.D. Delorme. 1989f. ^{210}Pb dating of lacustrine sediments from Grenadier Pond (Core 145), Ontario. National Water Research Institute, Burlington, Ontario, Technical Note LRB-89-31, 28p.

Turner, L.J. and L.D. Delorme. 1989g. ^{210}Pb dating of lacustrine sediments from Turkey Point Marsh (Core 146), Ontario. National Water Research Institute, Burlington, Ontario Technical Note LRB-89-32, 17p.

Turner, L.J. and L.D. Delorme. 1988a. ^{210}Pb dating of lacustrine sediments from Hamilton Harbour (cores 137, 138, 139, 141, 142, 143). National Water Research Institute, Burlington, Ontario, Technical Note LRB-88-9, 42p.

Turner, L.J. and L.D. Delorme. 1988b. ^{210}Pb dating of lacustrine sediments from Lake St. Clair, (cores 140 and 144). National Water Research Institute, Burlington, Ontario, Technical Note LRB-88-10, 13p.

Appendices

Appendix A: Wet and dry weights for core 087.

087 Core Number Station TCT1
2.5051 Specific Gravity $g \cdot cm^{-3}$
81.0734 Surface area cm^2, 10.16 cm Tube diameter
49.5144 Surface area cm^2, 7.94 cm Cutter diameter
0.7961 Rate of sedimentation $cm \cdot yr^{-1}$
0 NUMBER OF SAMPLES BELOW THE SURFACE BEFORE THE DIAMETER CHANGES TO CUTTER DIAMETER

Sample Number	Wet** Wt.	Dry** Wt.	Vial Wt.	Spec. Grav.
1	102.745	43.521	23.348	2.51*
2	99.911	45.136	23.313	2.51
3	92.043	45.115	23.708	2.52
4	94.074	47.097	24.379	2.52
5	91.669	45.252	24.174	2.53*
6	92.888	50.435	23.715	2.53
7	104.981	51.987	24.282	2.54
8	102.907	52.348	23.629	2.54
9	95.091	49.098	24.558	2.54
10	97.615	49.540	24.362	2.55*
11	103.661	51.611	24.305	2.55
12	102.090	52.623	24.287	2.54
13	95.868	49.789	23.642	2.54
14	101.338	53.920	24.322	2.54
15	99.354	52.252	23.718	2.54*
16	99.814	55.479	24.560	2.54
17	108.991	61.577	24.374	2.54
18	104.897	58.164	23.316	2.54
19	107.518	60.309	23.645	2.54
20	119.516	65.440	24.354	2.54*
21	109.434	61.556	24.370	2.53
22	114.638	64.423	24.283	2.51
23	108.542	59.976	24.179	2.50
24	101.070	52.506	23.326	2.49
25	110.811	54.444	24.178	2.47*
26	102.976	45.652	24.308	2.48
27	94.303	47.926	24.162	2.48
28	103.462	52.000	24.277	2.49
29	98.478	49.879	23.717	2.49
30	105.671	52.836	23.729	2.49*
31	100.392	50.246	23.628	2.48
32	99.499	49.478	23.337	2.47
33	98.446	48.339	23.326	2.46
34	103.071	50.670	24.578	2.44
35	97.434	49.053	24.320	2.43*
36	96.947	49.131	24.288	2.43
37	98.532	48.470	23.321	2.43
38	109.564	54.358	24.285	2.43
39	101.438	49.649	23.313	2.43
40	99.462	48.274	24.183	2.43*
41	97.992	47.180	24.352	2.43
42	95.971	47.163	23.643	2.44
43	92.092	46.722	24.273	2.45
44	104.749	50.821	24.322	2.45
45	105.372	52.563	24.372	2.46*
46	100.106	50.031	23.631	2.48
47	97.949	53.111	24.169	2.50
48	91.909	51.830	23.723	2.52
49	102.983	59.951	23.641	2.55
50	108.484	70.117	24.556	2.57
51	114.619	75.222	23.698	2.59
52	171.069	106.455	24.288	2.61*

**Includes Vial Weight

*Measured specific gravity. Other values calculated by linear regression.

Appendix B: Calculation of porosity and uncompacted depths given sample wet and dry weights, (Delorme, 1991) and specific gravity for core 087. Time in years calculated from CIC1 sedimentation rate data.

Samp Numb	Wet Wt. g	Dry Wt. g	Cumm. Dry Wt g/cm2	Water Cont. cm3	Sed. Vol. cm3	Total Vol. cm3	Comp. Thick cm	Comp. Depth cm	Comp. Mid-pt cm	Sample Poros. %	Uncomp Thick. cm	Uncomp Depth cm	Uncomp Mid-pt cm	Time B.P. Years
1	79.40	20.17	0.41	59.22	8.04	67.27	1.36	1.36	0.68	88.05	1.55	1.55	0.78	0
2	76.60	21.82	0.85	54.78	8.68	63.46	1.28	2.64	2.00	86.32	1.65	3.20	2.38	2
3	68.34	21.41	1.28	46.93	8.50	55.43	1.12	3.76	3.20	84.66	1.65	4.85	4.03	5
4	69.70	22.72	1.74	46.98	9.01	55.99	1.13	4.89	4.32	83.91	1.74	6.59	5.72	7
5	67.50	21.08	2.17	46.42	8.34	54.76	1.11	6.00	5.44	84.76	1.63	8.22	7.41	9
6	69.17	26.72	2.70	42.45	10.56	53.01	1.07	7.07	6.53	80.08	2.06	10.28	9.25	11
7	80.70	27.71	3.26	52.99	10.93	63.92	1.29	8.36	7.71	82.90	2.00	12.28	11.28	14
8	79.28	28.72	3.84	50.56	11.31	61.87	1.25	9.61	8.98	81.72	2.07	14.35	13.32	16
9	70.53	24.54	4.34	45.99	9.65	55.64	1.12	10.73	10.17	82.66	1.85	16.20	15.28	19
10	73.25	25.18	4.85	48.08	9.88	57.95	1.17	11.90	11.32	82.95	1.87	18.07	17.14	21
11	79.36	27.31	5.40	52.05	10.72	62.77	1.27	13.17	12.54	82.92	1.97	20.04	19.06	23
12	77.80	28.34	5.97	49.47	11.14	60.60	1.22	14.39	13.78	81.62	2.06	22.10	21.07	26
13	72.23	26.15	6.50	46.08	10.28	56.36	1.14	15.53	14.96	81.75	1.96	24.06	23.08	28
14	77.02	29.60	7.10	47.42	11.65	59.07	1.19	16.72	16.13	80.27	2.16	26.22	25.14	31
15	75.64	28.53	7.67	47.10	11.24	58.34	1.18	17.90	17.31	80.73	2.10	28.32	27.27	34
16	75.25	30.92	8.30	44.33	12.18	56.52	1.14	19.04	18.47	78.45	2.29	30.61	29.47	37
17	84.62	37.20	9.05	47.41	14.66	62.07	1.25	20.30	19.67	76.39	2.61	33.22	31.92	40
18	81.58	34.85	9.75	46.73	13.73	60.46	1.22	21.52	20.91	77.29	2.49	35.71	34.47	43
19	83.87	36.66	10.49	47.21	14.44	61.65	1.25	22.76	22.14	76.57	2.58	38.29	37.00	46
20	95.16	41.09	11.32	54.08	16.19	70.26	1.42	24.18	23.47	76.96	2.72	41.01	39.65	49
21	85.06	37.19	12.08	47.88	14.72	62.60	1.26	25.45	24.82	76.48	2.61	43.62	42.32	53
22	90.36	40.14	12.89	50.22	15.98	66.19	1.34	26.78	26.12	75.86	2.75	46.37	45.00	56
23	84.36	35.80	13.61	48.57	14.32	62.89	1.27	28.05	27.42	77.22	2.54	48.91	47.64	59
24	77.74	29.18	14.20	48.56	11.74	60.30	1.22	29.27	28.66	80.54	2.16	51.07	49.99	62
25	86.63	30.27	14.81	56.37	12.24	68.61	1.39	30.66	29.97	82.16	2.17	53.24	52.16	65
26	78.67	21.34	15.24	57.32	8.62	65.94	1.33	31.99	31.32	86.93	1.64	54.88	54.06	67
27	70.14	23.76	15.72	46.38	9.58	55.95	1.13	33.12	32.55	82.88	1.84	56.72	55.80	70
28	79.19	27.72	16.28	51.46	11.15	62.62	1.26	34.38	33.75	82.19	2.04	58.76	57.74	72
29	74.76	26.16	16.81	48.60	10.51	59.11	1.19	35.58	34.98	82.22	1.97	60.73	59.75	75
30	81.94	29.11	17.40	52.84	11.67	64.51	1.30	36.88	36.23	81.91	2.11	62.84	61.79	77
31	76.76	26.62	17.93	50.15	10.73	60.87	1.23	38.11	37.50	82.38	1.99	64.83	63.84	80
32	76.16	26.14	18.46	50.02	10.59	60.61	1.22	39.33	38.72	82.53	1.97	66.80	65.82	82
33	75.12	25.01	18.97	50.11	10.18	60.29	1.22	40.55	39.94	83.11	1.90	68.70	67.75	85
34	78.49	26.09	19.49	52.40	10.67	63.08	1.27	41.83	41.19	83.08	1.96	70.66	69.68	87
35	73.11	24.73	19.99	48.38	10.17	58.55	1.18	43.01	42.42	82.63	1.92	72.58	71.62	89
36	72.66	24.84	20.50	47.82	10.22	58.04	1.17	44.18	43.59	82.39	1.93	74.51	73.55	92
37	75.21	25.15	21.00	50.06	10.35	60.41	1.22	45.40	44.79	82.87	1.93	76.44	75.48	94
38	85.28	30.07	21.61	55.21	12.38	67.59	1.37	46.77	46.08	81.68	2.19	78.63	77.54	97
39	78.13	26.34	22.14	51.79	10.85	62.64	1.27	48.03	47.40	82.68	1.99	80.62	79.63	100
40	75.28	24.09	22.63	51.19	9.93	61.12	1.23	49.26	48.65	83.75	1.86	82.48	81.55	102
41	73.64	22.83	23.09	50.81	9.38	60.19	1.22	50.48	49.87	84.41	1.77	84.25	83.37	104
42	72.33	23.52	23.57	48.81	9.64	58.45	1.18	51.66	51.07	83.51	1.83	86.08	85.17	106
43	67.82	22.45	24.02	45.37	9.17	54.54	1.10	52.76	52.21	83.18	1.78	87.86	86.97	109
44	80.43	26.50	24.55	53.93	10.80	64.73	1.31	54.07	53.42	83.32	1.97	89.83	88.85	111
45	81.00	28.19	25.12	52.81	11.46	64.26	1.30	55.37	54.72	82.17	2.08	91.91	90.87	114
46	76.48	26.40	25.66	50.07	10.64	60.71	1.23	56.59	55.98	82.48	1.98	93.89	92.90	116
47	73.78	28.94	26.24	44.84	11.56	56.40	1.14	57.73	57.16	79.50	2.19	96.08	94.99	
48	68.19	28.11	26.81	40.08	11.13	51.21	1.03	58.77	58.25	78.26	2.20	98.28	97.18	
49	79.34	36.31	27.54	43.03	14.26	57.29	1.16	59.92	59.35	75.11	2.64	100.92	99.60	
50	83.93	45.56	28.46	38.37	17.75	56.11	1.13	61.06	60.49	68.38	3.29	104.21	102.57	
51	90.92	51.52	29.50	39.40	19.90	59.30	1.20	62.25	61.66	66.44	3.55	107.76	105.99	
52	146.78	82.17	31.16	64.61	31.48	96.09	1.94	64.20	63.23	67.24	4.21	111.97	109.87	

Appendix C. Specific gravity determination.

The specific gravities ($g \cdot cm^{-3}$) of Core 087 sediments were determined using an automated Accupyc pycnometer (Micromeritics, 1992).

Sample	No. of Tests	Uncompacted Mid Depth	Specific Gravity	Mean
1	5	0.78	2.509 ± 0.003	
5	5	7.41	2.526 ± 0.002	
10	5	17.14	2.548 ± 0.006	
15	5	27.27	2.538 ± 0.001	
20	5	39.65	2.538 ± 0.002	
25	5	52.16	2.473 ± 0.001	
30	5	61.79	2.494 ± 0.001	
35	5	71.62	2.432 ± 0.003	
40	5	81.55	2.426 ± 0.002	
45	5	90.87	2.461 ± 0.005	
52	5	109.87	2.610 ± 0.002	2.505 ± 0.052

Appendix D. Lead Sedimentation Rate Analysis, CIC1 Model.

$\ln (A - A') = \ln (3.975) - 0.039 (Z) \quad R = -0.949$

where $(A - A')$ = unsupported ^{210}Pb in $pCi \cdot g^{-1}$,
and Z = uncompacted depth in cm.
based on data from lines 1 to 13

Specific Gravity = 2.505 $g \cdot cm^{-3}$ $\quad P/\omega = 3.975 \quad \omega = 0.200$

The initial porosity at the sediment/water interface is 89.98

Atmospheric flux rate at the time of collection 1996.129 is 1.763 $dpm \cdot cm^{-2} \cdot yr^{-1}$ or 0.794 $pCi \cdot cm^{-2} \cdot yr^{-1}$

Supported ^{226}Ra activity = 1.161 $pCi \cdot g^{-1}$ or 2.578 $dpm \cdot g^{-1}$

Sedimentation Rate = 0.796 $cm \cdot yr^{-1}$

Mass Sedimentation Rate = 0.200 $g \cdot cm^{-2} \cdot yr^{-1}$

SUMMARY OF ^{210}Pb ANALYSES

Uncomp Depth cm.	Porosity	Total ^{210}Pb $dpm \cdot g^{-1}$	Total ^{210}Pb $pCi \cdot g^{-1}$	Unsupp. ^{210}Pb $dpm \cdot g^{-1}$	Unsupp. ^{210}Pb $pCi \cdot g^{-1}$	Sed. Rate $cm \cdot yr^{-1}$	Years (*)
0.78	0.8805	11.009	4.959	8.431	3.798	0.7607	1996
4.03	0.8466	10.766	4.850	8.188	3.688	0.7660	1991
7.41	0.8476	11.176	5.034	8.598	3.873	0.7686	1986
9.25	0.8008	6.349	2.860	3.771	1.699	0.7709	1984
11.28	0.8290	8.398	3.783	5.820	2.621	0.7232	1981
15.28	0.8266	6.809	3.067	4.231	1.906	0.7598	1976
17.14	0.8295	8.182	3.686	5.604	2.524	0.7477	1973
19.06	0.8292	7.055	3.178	4.477	2.016	0.7244	1970
23.08	0.8175	6.162	2.776	3.584	1.615	0.7514	1965
27.27	0.8073	5.545	2.498	2.967	1.336	0.7367	1959
31.92	0.7639	5.106	2.300	2.528	1.139	0.7054	1951
39.65	0.7696	4.624	2.083	2.046	0.922	0.6631	1936
47.64	0.7722	3.842	1.731	1.264	0.569	0.7003	1928
52.16	0.8216	5.297	2.386	2.719	1.225	0.6980	1921
61.79	0.8191	5.137	2.314	2.558	1.152	0.7157	1910
71.62	0.8263	4.650	2.094	2.071	0.933	0.7472	1900
81.55	0.8375	4.544	2.047	1.966	0.886	0.7423	1886
90.87	0.8217	4.640	2.090	2.062	0.929		
102.57	0.6838	5.576	2.512	2.998	1.350		
109.87	0.6724	2.578	1.161	0.000	0.000		

(*) Year calculated using the sedimentation rate of the sample

Appendix E. Lead Sedimentation Rate Analysis, CIC2 Model.

$\ln (A - A') = \ln (3.906) - 0.141 (X)$ $R = -0.948$

where $(A - A')$ = unsupported ^{210}Pb in $pCi \cdot g^{-1}$,
and X = cumulative dry weight in $g \cdot cm^{-2}$
based on data from lines 1 to 14

Specific Gravity = 2.505 $g \cdot cm^{-3}$ $P/\omega = 3.906$ $\omega = 0.221$

The initial porosity at the sediment/water interface is 89.98

Atmospheric flux rate at the time of collection 1996.129 is 1.918 $dpm \cdot cm^{-2} \cdot yr^{-1}$ or 0.864 $pCi \cdot cm^{-2} \cdot yr^{-1}$

Supported ^{226}Ra activity = 1.161 $pCi \cdot g^{-1}$ or 2.578 $dpm \cdot g^{-1}$

Mass Sedimentation Rate = 0.221 $g \cdot cm^{-2} \cdot yr^{-1}$

SUMMARY OF ^{210}Pb ANALYSES

MidSam Cum. DryWt. $g \cdot cm^{-2}$	Porosity	Total ^{210}Pb $dpm \cdot g^{-1}$	Total ^{210}Pb $pCi \cdot g^{-1}$	Unsupp. ^{210}Pb $dpm \cdot g^{-1}$	Unsupp. ^{210}Pb $pCi \cdot g^{-1}$	Years (*)
0.20	0.8805	11.009	4.959	8.431	3.798	1996
1.07	0.8466	10.766	4.850	8.188	3.688	1991
1.96	0.8476	11.176	5.034	8.598	3.873	1987
2.43	0.8008	6.349	2.860	3.771	1.699	1985
2.98	0.8290	8.398	3.783	5.820	2.621	1983
4.09	0.8266	6.809	3.067	4.231	1.906	1978
4.60	0.8295	8.182	3.686	5.604	2.524	1975
5.13	0.8292	7.055	3.178	4.477	2.016	1973
6.23	0.8175	6.162	2.776	3.584	1.615	1968
7.39	0.8073	5.545	2.498	2.967	1.336	1963
8.68	0.7639	5.106	2.300	2.528	1.139	1957
10.90	0.7696	4.624	2.083	2.046	0.922	1947
13.25	0.7722	3.842	1.731	1.264	0.569	1936
14.51	0.8216	5.297	2.386	2.719	1.225	1931
17.10	0.8191	5.137	2.314	2.558	1.152	1919
19.74	0.8263	4.650	2.094	2.071	0.933	1907
22.38	0.8375	4.544	2.047	1.966	0.886	1895
24.83	0.8217	4.640	2.090	2.062	0.929	
28.00	0.6838	5.576	2.512	2.998	1.350	
30.33	0.6724	2.578	1.161	0.000	0.000	

(*) Year calculated using the mass sedimentation rate of the sample

Appendix F. Lead Sedimentation Rate Analysis, CRS Model.

Depth Uncomp Mid-Pt cm	Cum. Dry Wt g/cm2	MidScn Cum. Dry Wt g/cm2	Unsupp. Activity pCi/g	Area pCi/cm2	Cum. Area pCi/cm2	Time B.P.* Years	Cum.Avg Mass SedRate g/cm2/yr	Date	Mass SedRate g/cm2/yr
0.78	0.41	0.20	3.798	0.779	0.779	0.897	0.229	1995	0.229
4.03	1.28	1.07	3.798	3.219	3.997	4.895	0.218	1991	0.215
7.41	2.17	1.96	3.688	3.365	7.362	9.686	0.202	1986	0.186
9.25	2.70	2.43	3.873	1.337	8.699	11.808	0.206	1984	0.226
11.28	3.26	2.98	1.699	1.177	9.876	13.799	0.216	1982	0.274
15.28	4.34	4.09	2.621	2.513	12.389	18.514	0.221	1977	0.235
17.14	4.85	4.60	1.906	1.119	13.508	20.859	0.220	1975	0.215
19.06	5.40	5.13	2.524	1.203	14.711	23.588	0.217	1972	0.194
23.08	6.50	6.23	2.016	2.015	16.726	28.752	0.217	1967	0.215
27.27	7.67	7.39	1.615	1.697	18.423	33.853	0.218	1962	0.225
31.92	9.05	8.68	1.336	1.596	20.020	39.528	0.219	1956	0.227
39.65	11.32	10.90	1.139	2.297	22.317	49.994	0.218	1946	0.213
47.64	13.61	13.25	0.922	1.748	24.065	61.137	0.217	1934	0.210
							0.216	Mean	0.220
							0.006	StdDev.	0.020

*B.P. = 1996
Based on data from lines 1 to 14
Total Area equals 28.281

Atmospheric flux rate at the time of collection 1996.129 is 0.88 $pCi \cdot cm^{-2} yr^{-1}$

Appendix G. Mean date calculated for each core slice.

Sample	Uncompacted Mid Depth in cm	Cum. Dry Wt. g·cm^{-2}	Cum. Dry Wt. Mid Sam	CIC1 Year	CIC2 Year	CRS* Year
1	0.78	0.41	0.20	1995 ± 2	1995 ± 2	1994
2	2.38	0.85	0.63	1993 ± 2	1993 ± 2	1992
3	4.03	1.28	1.07	1991 ± 2	1991 ± 2	1990
4	5.72	1.74	1.51	1989 ± 2	1989 ± 2	1988
5	7.41	2.17	1.96	1987 ± 2	1987 ± 2	1986
6	9.25	2.70	2.43	1985 ± 3	1985 ± 2	1984
7	11.28	3.26	2.98	1982 ± 3	1983 ± 3	1981
8	13.32	3.84	3.55	1979 ± 3	1980 ± 3	1979
9	15.28	4.34	4.09	1977 ± 2	1978 ± 2	1976
10	17.14	4.85	4.60	1975 ± 2	1975 ± 2	1974
11	19.06	5.40	5.13	1972 ± 3	1973 ± 3	1972
12	21.07	5.97	5.68	1970 ± 3	1970 ± 3	1969
13	23.08	6.50	6.23	1967 ± 2	1968 ± 2	1967
14	25.14	7.10	6.80	1965 ± 3	1965 ± 3	1964
15	27.27	7.67	7.39	1962 ± 3	1963 ± 3	1962
16	29.47	8.30	7.99	1959 ± 3	1960 ± 3	1959
17	31.92	9.05	8.68	1956 ± 3	1957 ± 3	1956
18	34.47	9.75	9.40	1953 ± 3	1954 ± 3	1952
19	37.00	10.49	10.12	1950 ± 3	1950 ± 3	1949
20	39.65	11.32	10.90	1946 ± 3	1947 ± 4	1945
21	42.32	12.08	11.70	1943 ± 3	1943 ± 3	1941
22	45.00	12.89	12.49	1940 ± 3	1940 ± 4	1937
23	47.64	13.61	13.25	1936 ± 3	1936 ± 3	1934
24	49.99	14.20	13.90	1933 ± 3	1933 ± 3	
25	52.16	14.81	14.51	1931 ± 3	1931 ± 3	
26	54.06	15.24	15.02	1928 ± 2	1928 ± 2	
27	55.80	15.72	15.48	1926 ± 2	1926 ± 2	
28	57.74	16.28	16.00	1924 ± 3	1924 ± 2	
29	59.75	16.81	16.55	1921 ± 3	1921 ± 2	
30	61.79	17.40	17.10	1919 ± 3	1919 ± 3	
31	63.84	17.93	17.67	1916 ± 3	1916 ± 2	
32	65.82	18.46	18.19	1913 ± 3	1914 ± 2	
33	67.75	18.97	18.72	1911 ± 2	1911 ± 2	
34	69.68	19.49	19.23	1909 ± 3	1909 ± 2	
35	71.62	19.99	19.74	1906 ± 2	1907 ± 2	
36	73.55	20.50	20.24	1904 ± 2	1905 ± 2	
37	75.48	21.00	20.75	1901 ± 2	1902 ± 2	
38	77.54	21.61	21.31	1899 ± 3	1900 ± 3	
39	79.63	22.14	21.88	1896 ± 3	1897 ± 2	
40	81.55	22.63	22.38	1894 ± 2	1895 ± 2	
41	83.37	23.09	22.86	1891 ± 2	1893 ± 2	
42	85.17	23.57	23.33	1889 ± 2	1891 ± 2	
43	86.97	24.02	23.80	1887 ± 2	1889 ± 2	
44	88.85	24.55	24.28		1886 ± 2	

* Calculation based on a Multiple Linear Regression with an R^2 of 0.9997 and a Standard Error of 0.3251.

LIBRARY, CANADA CENTRE FOR INLAND WATERS
3 9055 1013 0216 3

DATE DUE
REMINDER

30 AUG 2005

Please do not remove
this date due slip.

NATIONAL WATER RESEARCH INSTITUTE
P.O. BOX 5050, BURLINGTON, ONTARIO L7R 4A6

Environment Canada Environnement Canada

Canada

INSTITUT NATIONAL DE RECHERCHE SUR LES EAUX
C.P. 5050, BURLINGTON (ONTARIO) L7R 4A6

Think Recycling!

Pensez à recycler !