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COASTAL
MANAGEMENT
PROGRAM

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NA170Z0338-01

TOXIC ORGANIC CONTAMINANTS IN THE SEDIMENT OF THE MILWAUKEE HARBOR ESTUARY

Grant recipient:

UNIVERSITY OF WISCONSIN
(MILWAUKEE)

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COLLEGE OF ENGINEERING AND APPLIED SCIENCE

THE UNIVERSITY OF WISCONSIN–MILWAUKEE
EDUCATION
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COLLEGE OF ENGINEERING AND APPLIED SCIENCE

Toxic Organic Contaminants in the Sediments of Milwaukee Harbor Estuary

P.O.# ADB00474

Final Report

to

Wisconsin Coastal Management Program

Department of Administration

September 1, 1992

by

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The Wisconsin Coastal Management Program, part of the Wisconsin Department of Administration, was established in 1978 to preserve, protect and and develop the resources of the Lake Michigan and Lake Superior coastline for this and future generations. The Wisconsin Coastal Management Program analyzes state policy on Great Lakes issues, coordinates government programs that affect the coast, and provides grants to stimulate better state and local coastal management.

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Measurements of Priority Organics

The results of chemical analysis on 4 cores , including VC-7, VC-9, VC-12 and VC-36, are presented in this report. The target compounds of the analysis are PAHs, including 16 PAHs which are listed as priority pollutants by EPA, total PCBs and 18 PCB congeners, lindane, chlordane, mirex, methoxychlor and 2,4-dinitrophenol.

Concentrations of PCBs represented by aroclor 1242, 1254 and 1260 as well as total PCBs is illustrated by bar chart graphics for each core analyzed. Concentrations of PAHs represented by benz(a)anthracene [BaA], benzo(a)pyrene [BaP], chrysene [Chr], and other PAHs out of a total of 16 PAHs have also been demonstrated by bar chart graphics.

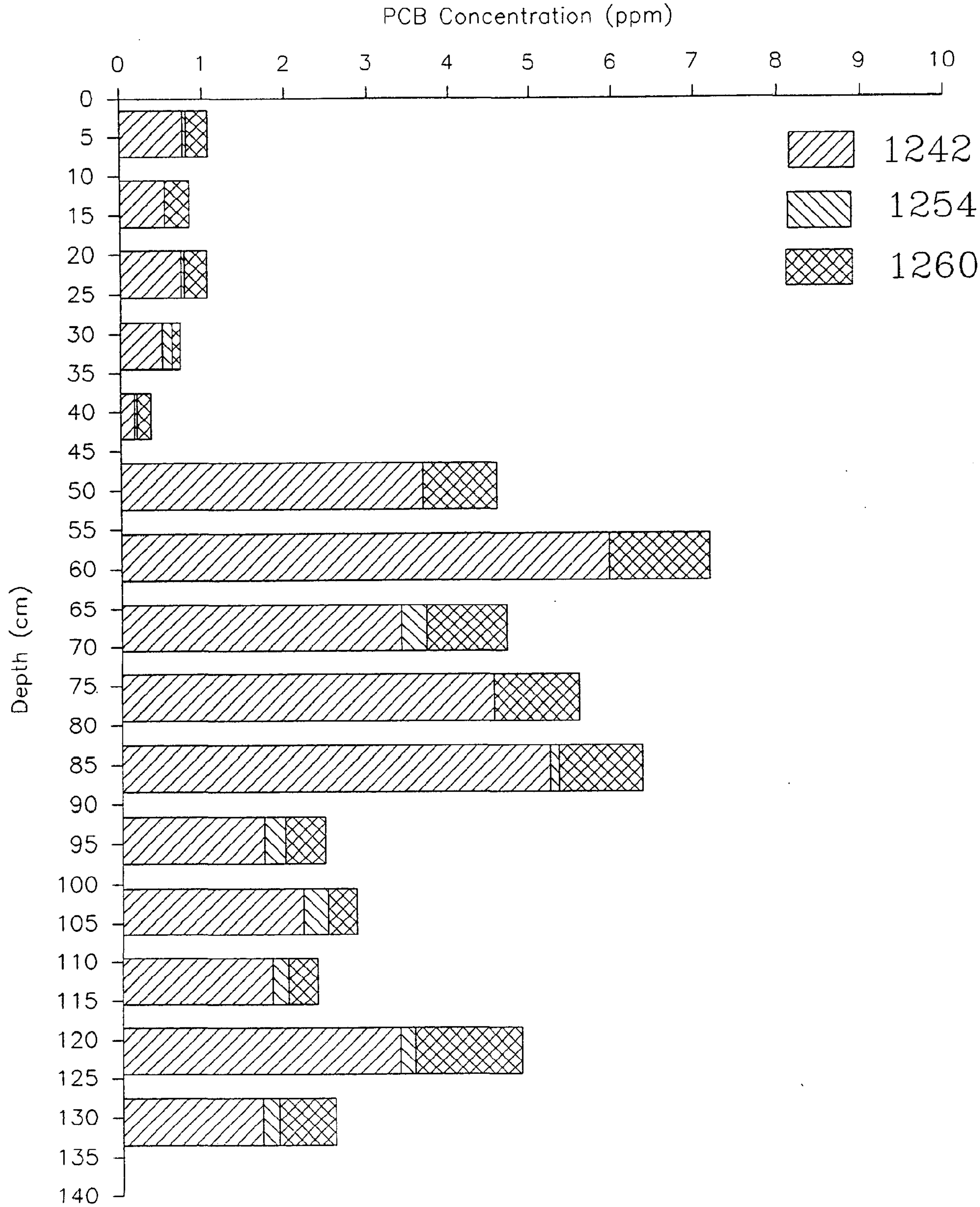
The information obtained from VC-7 is very interesting. Layer 5 containing the most sandy material at the depth of 36-45 cm, has the lowest level of both PCB and PAH. Layer 9 and layer 15 which is the bottom layer of the core, have the highest level of PAH, at 354 ppm and 359 ppm respectively. The 7th layer of the core has the highest total PCB level of 7.18 ppm, which is also the highest level of total PCB among all cores analyzed in this laboratory from 1991 to 1992. The Pb-210 measurement indicates that layer 7 is probably at the age of late 60's, which is around the peak period of PCB consumption. The fact that the deepest layer of core VC-7 still contains very high level of PAH and medium level of PCB may suggest that the deeper core than the current one is necessary to be taken for further study.

Overall, the core VC-9 has relatively lower level of either PAH and PCB, particularly for the last six layers of the core. The 7th and 8th layers of the core have the highest level of total PCB, at 3,56 ppm and 3.08 ppm respectively, as well as total PAH, at 140 ppm and 190 ppm respectively. Pb-210 and Cs-137 measurements indicate that two layers are probably at the age of early to late 60's.

Relatively slow sedimentation rate has been discovered by both Pb-210 and Cs-137 measurements for VC-12. The highest level of total PCBs is found at the 4th layer, which is at the age of the 60's. That almost constant total PAH concentration across the core may suggest a constant supply of PAH from upstream of the rivers and the Inner Harbor to VC-12, which is located in the Outer Harbor.

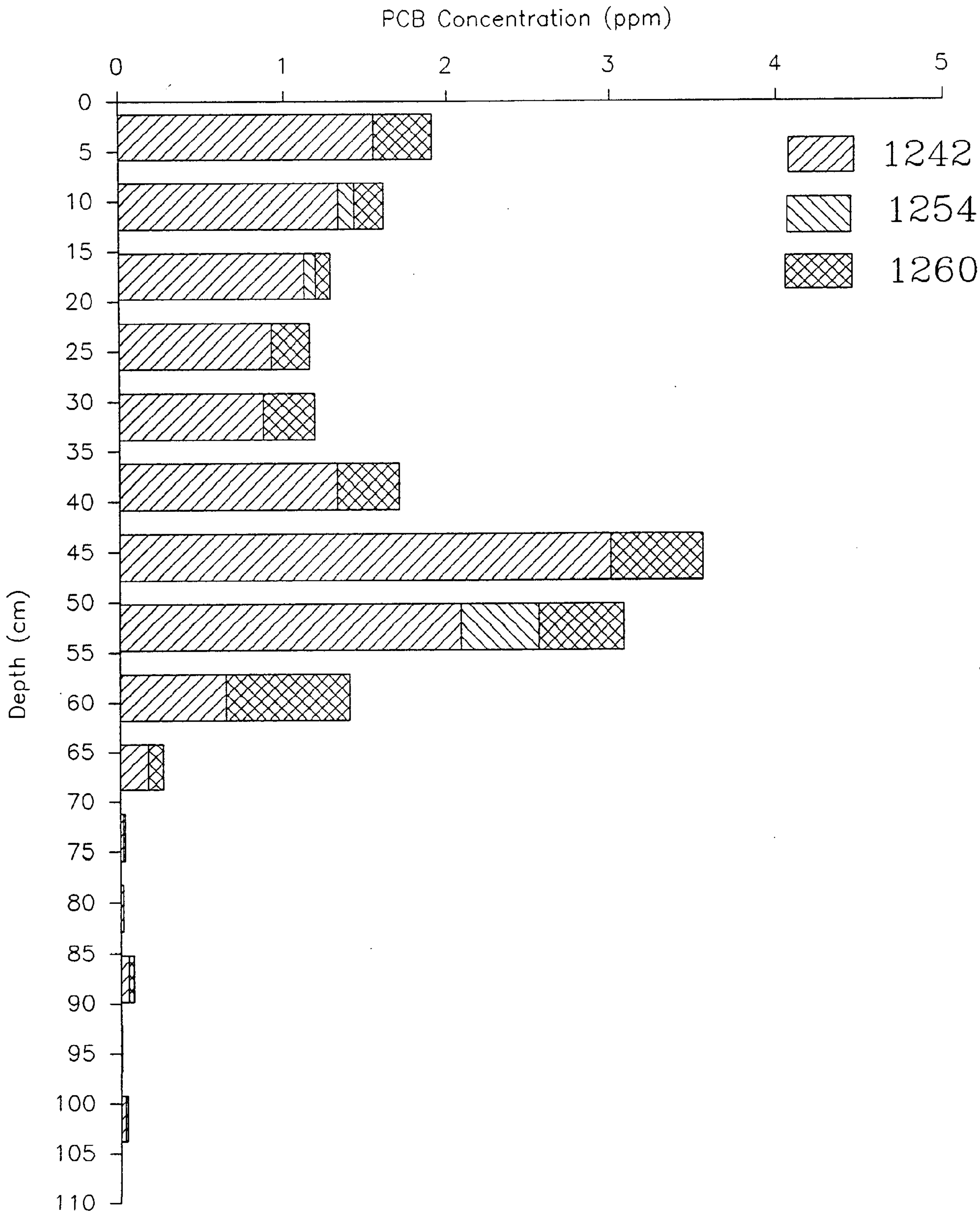
The top 12 layers (almost 120 cm deep) of VC-36 has a relatively stable and low concentration of total PCBs. The layer 7, 8 and 9 contain the highest level of total PAH in the core.

VC-7

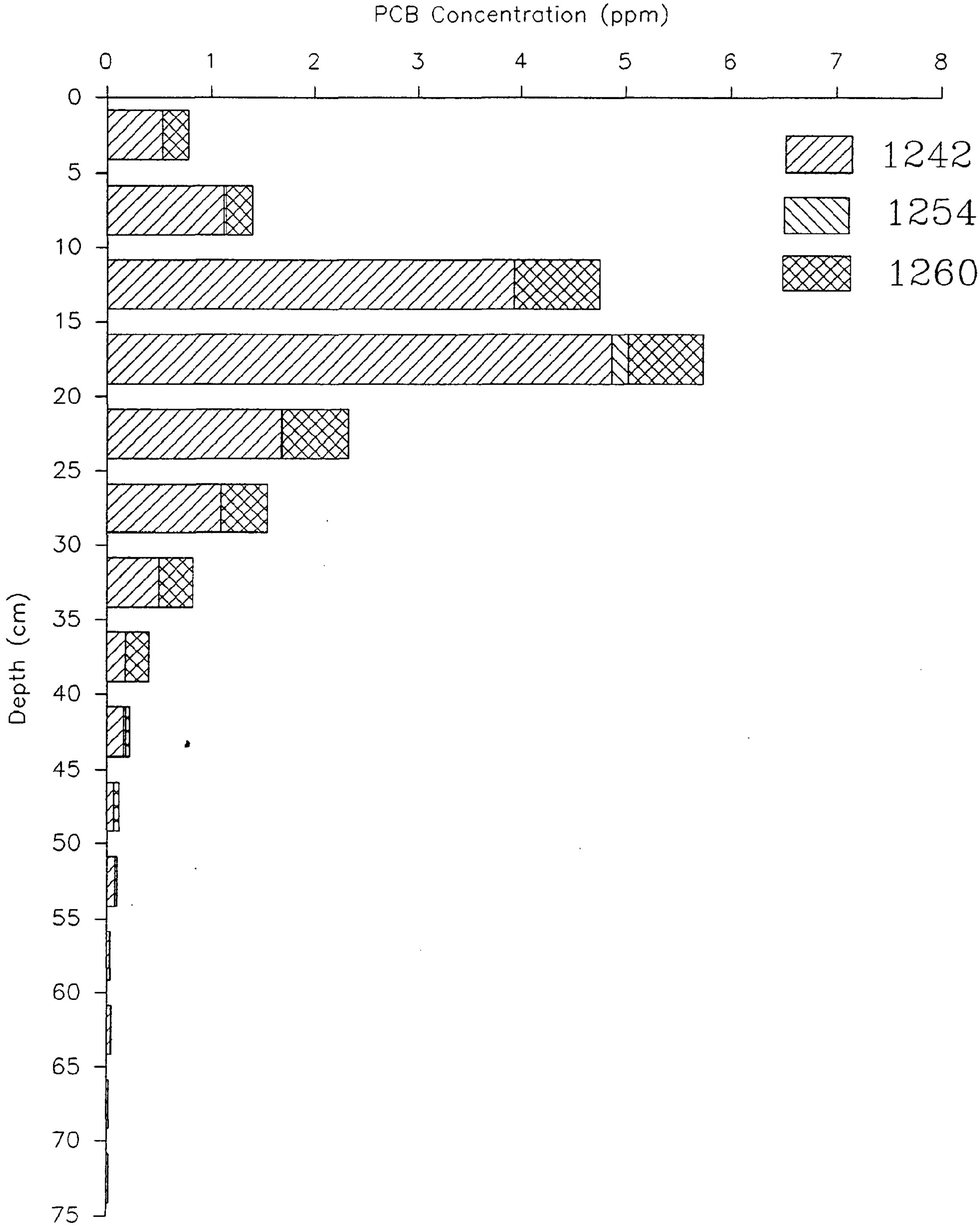


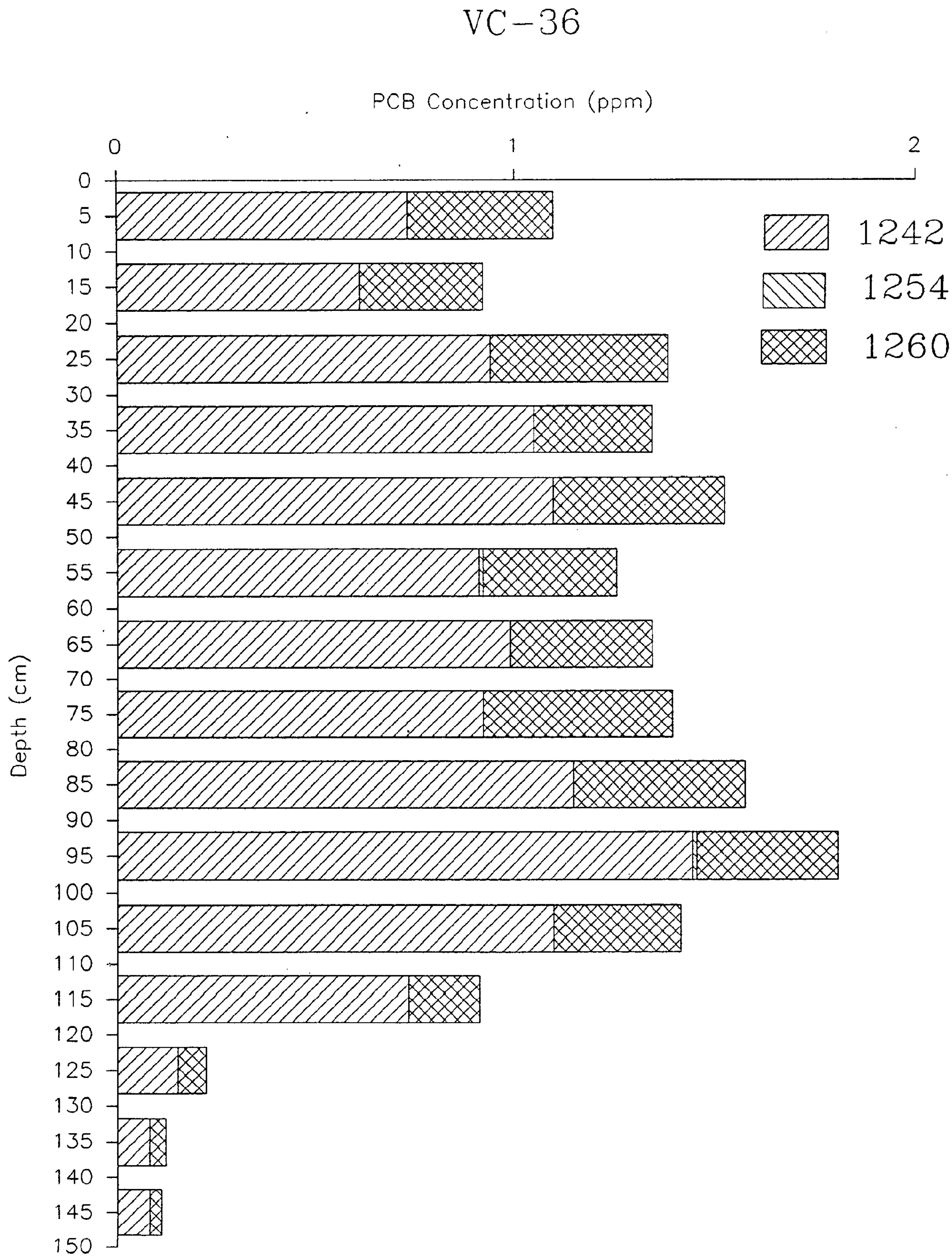
PCB Concentration (ppm)
0
1
2
3
4
5
6
7
8
9
10
Depth (cm)
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
75
80
85
90
95
100
105
110
115
120
125
130
135
140
1242
1254
1260

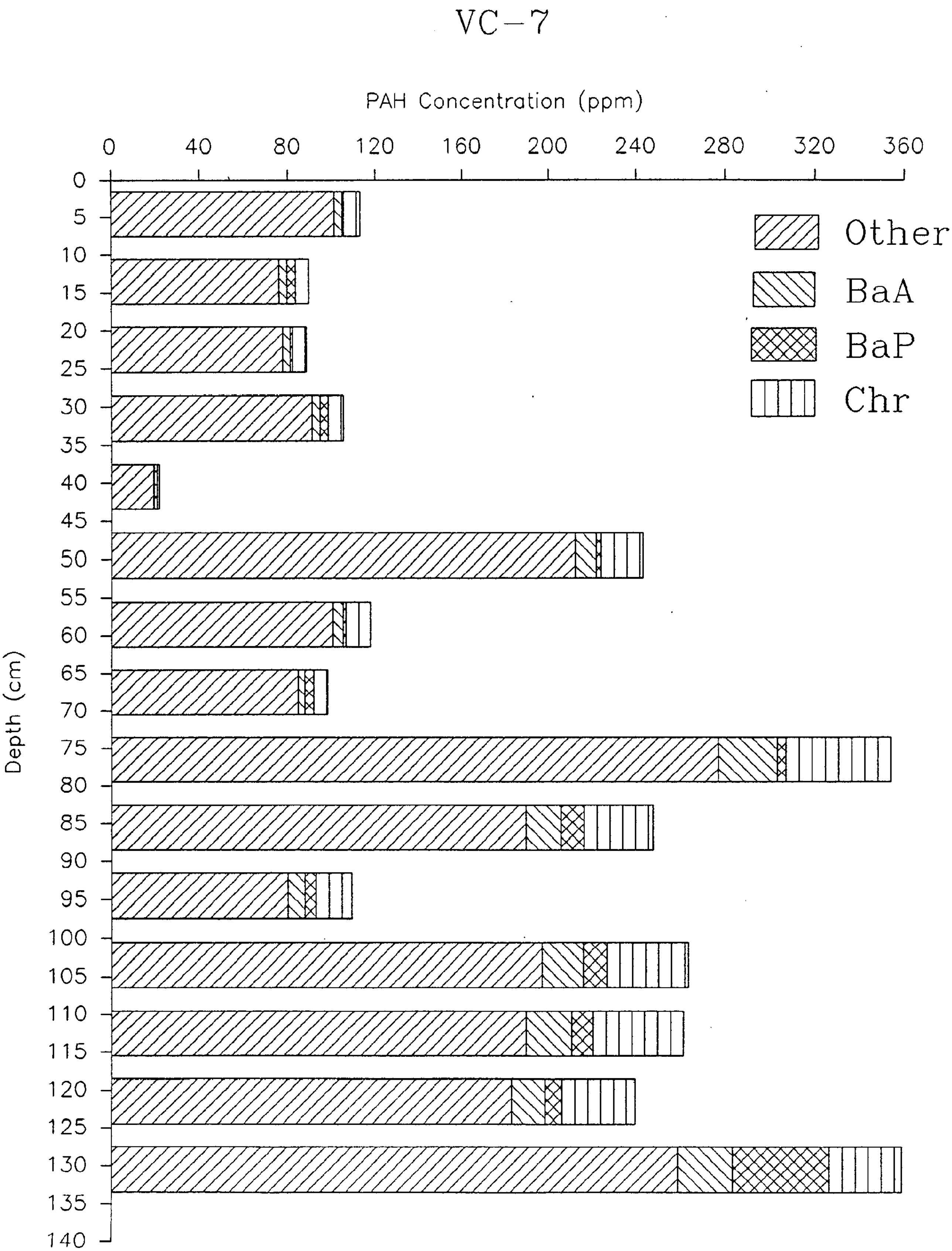
VC−9


PCB Concentration (ppm)
0
1
2
3
4
5
Depth (cm)
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
75
80
85
90
95
100
105
110
1242
1254
1260

VC-12

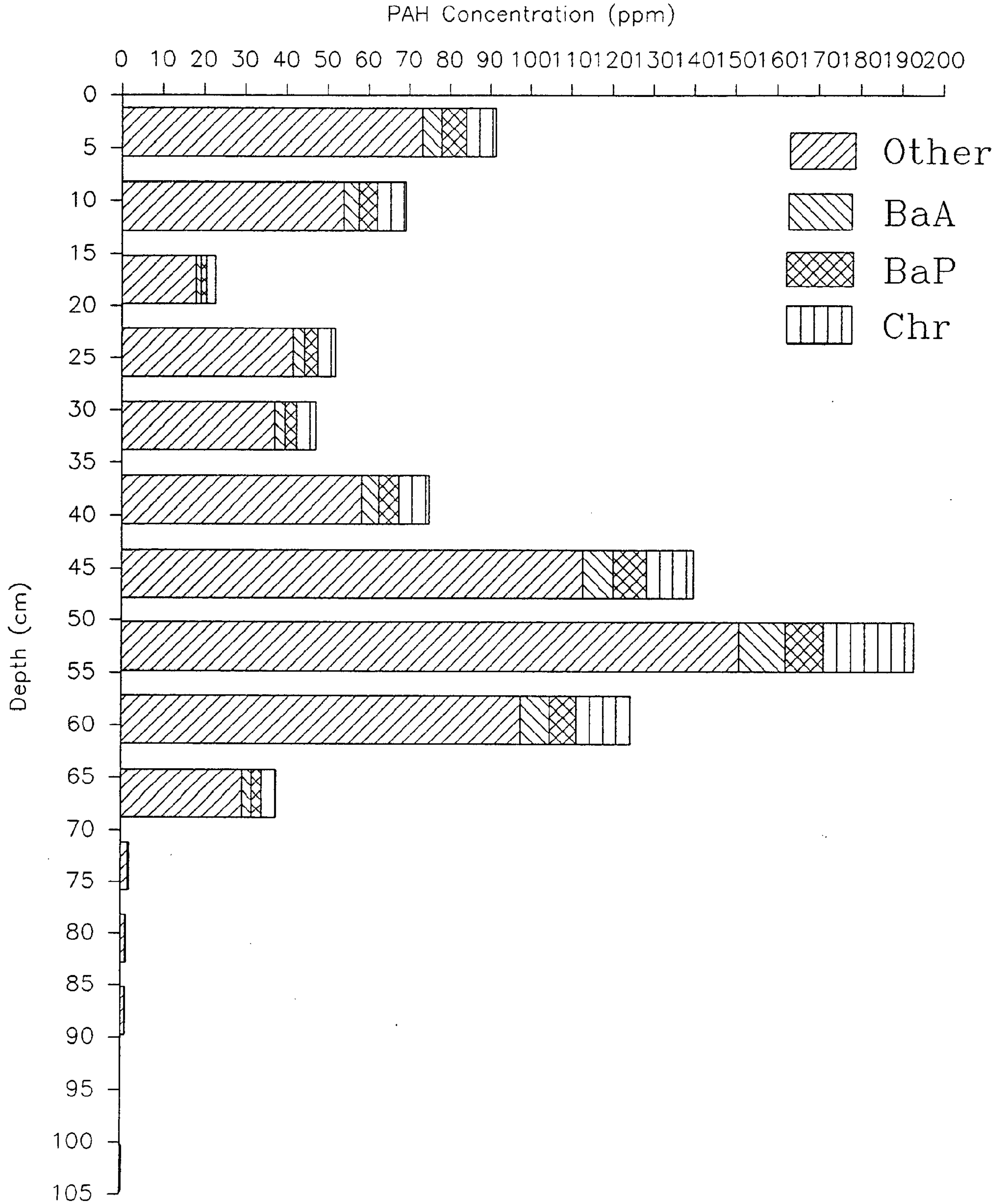

PCB Concentration (ppm)
0
1
2
3
4
5
6
7
8
Depth (cm)
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
75
1242
1254
1260


VC-36
PCB Concentration (ppm)
0
1
2
Depth (cm)
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
75
80
85
90
95
100
105
110
115
120
125
130
135
140
145
150
1242
1254
1260

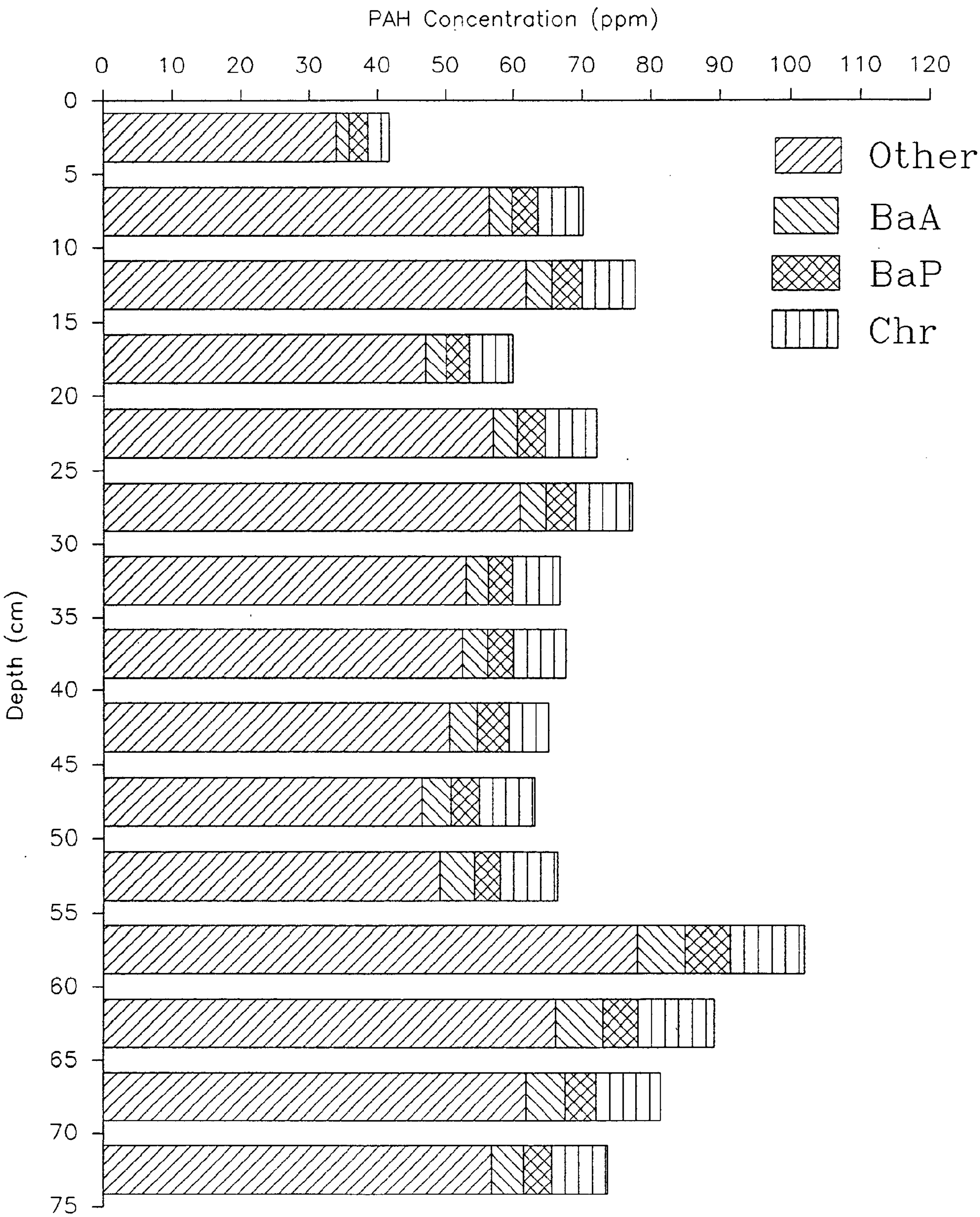


VC-7
PAH Concentration (ppm)
0
40
80
120
160
200
240
280
320
360
Depth (cm)
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
75
80
85
90
95
100
105
110
115
120
125
130
135
140
Other
BaA
BaP
Chr

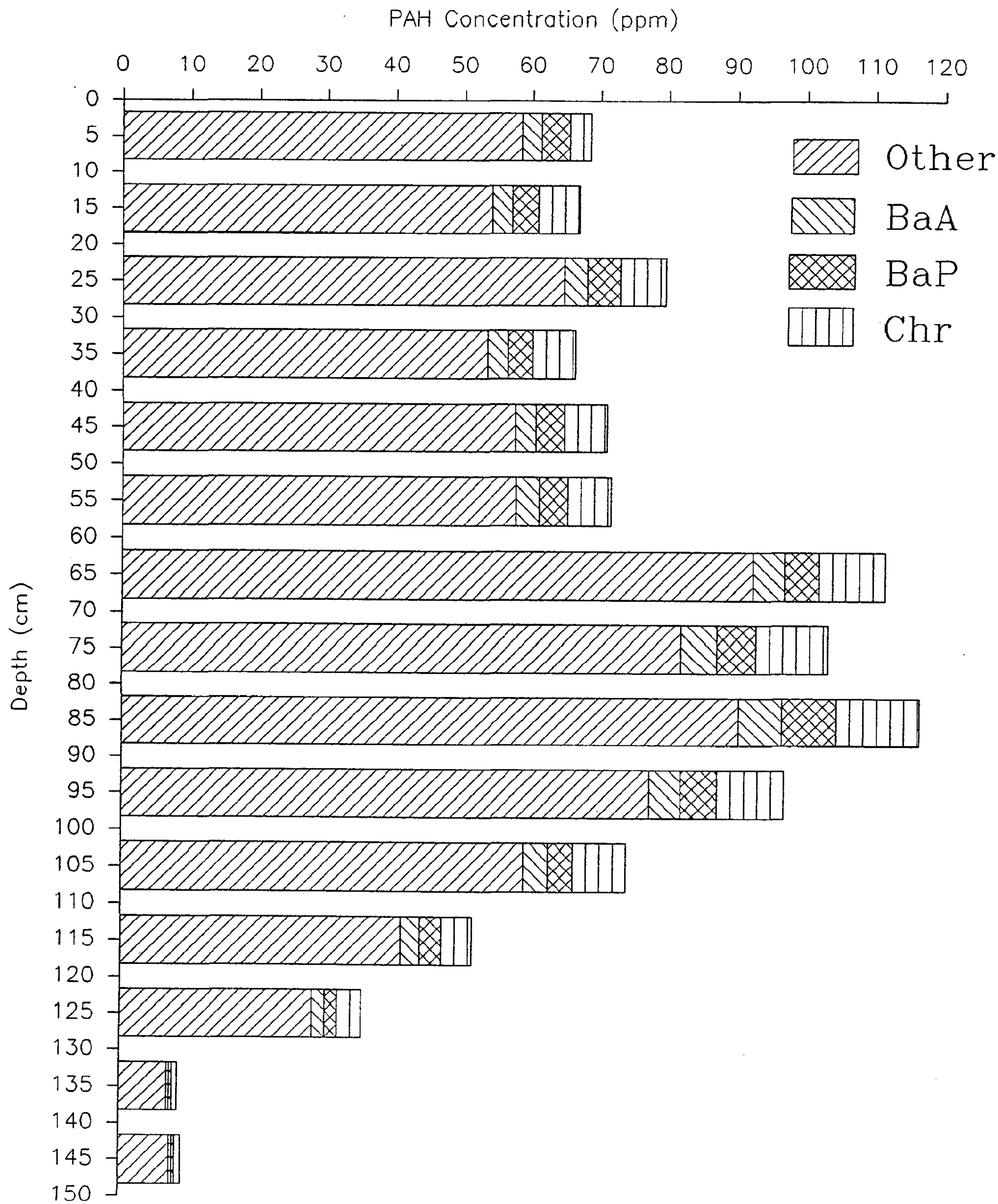
VC-9


PAH Concentration (ppm)
0 10 20 30 40 50 60 70 80 90 100 110 120 130 140 150 160 170 180 190 200
Depth (cm)
0 5 10 15 20 25 30 35 40 45 50 55 60 65 70 75 80 85 90 95 100 105
Other
BaA
BaP
Chr

VC-12


PAH Concentration (ppm)
0 10 20 30 40 50 60 70 80 90 100 110 120
Depth (cm)
0 5 10 15 20 25 30 35 40 45 50 55 60 65 70 75
Other
BaA
BaP
Chr

VC-36


PAH Concentration (ppm)
0 10 20 30 40 50 60 70 80 90 100 110 120
Depth (cm)
0 5 10 15 20 25 30 35 40 45 50 55 60 65 70 75 80 85 90 95 100 105 110 115 120 125 130 135 140 145 150
Other
BaA
BaP
Chr

VC7-1

PAH

Naphthalene 0.04 ppm
Acenaphthylene 0.16 ppm
Acenaphthene 1.26 ppm
Fluorene 2.47 ppm
Phenanthrene 17.55 ppm
Anthracene 3.02 ppm
Fluoranthene 32.59 ppm
Pyrene 21.28 ppm
B(a)anthracene 3.68 ppm
Chrysene 7.56 ppm
B(b)fluoranthene 1.84 ppm
B(k)fluoranthene 1.25 ppm
B(a)pyrene 0.63 ppm
Indeno(1,2,3-cd)pyrene 11.42 ppm
Dibenzo(a,h)anthracene 0.52 ppm
Benzo(g,h,i)perylene 7.72 ppm

PCB (ppm)

1242	1254	1260	TOTAL
0.77	0.04	0.26	1.07

PCB Congeners (ppb)

#1	#5	#29	#50	#87	#154	#188	#200	#209
19.89		2.29		24.53				2.16

#44	#52	#77	#101	#118	#126	#138	#153	#180
84.83	102.87	98.74	56.41	18.56	7.10	36.40	29.38	40.78

CL-HC (by MSD)

Lindane ND < .05 ppm
Chlordane ND < .5 ppm
Mirex ND < .1 ppm
Methoxychlor ND < .1 ppm

2,4-dinitrophenol

ND < 10 ppm

VC7-2

PAH

Naphthalene 0.33 ppm	Acenaphthylene 0.36 ppm
Acenaphthene 1.06 ppm	Fluorene 2.35 ppm
Phenanthrene 14.13 ppm	Anthracene 3.19 ppm
Fluoranthene 25.20 ppm	Pyrene 16.57 ppm
B(a)anthracene 3.65 ppm	Chrysene 6.05 ppm
B(b)fluoranthene 5.30 ppm	B(k)fluoranthene 3.60 ppm
B(a)pyrene 3.95 ppm	Indeno(1,2,3-cd)pyrene 2.84 ppm
Dibenzo(a,h)anthracene 0.10 ppm	
Benzo(g,h,i)perylene 0.84 ppm	

PCB (ppm)

1242	1254	1260	TOTAL
0.55	0.00	0.29	0.84

PCB Congeners (ppb)

#1	#5	#29	#50	#87	#154	#188	#200	#209
36.55		22.49		12.88				

#44	#52	#77	#101	#118	#126	#138	#153	#180
51.85	57.23	52.36	37.48	12.15	64.06	25.78	12.62	24.58

CL-HC (by MSD)

Lindane ND < .05 ppm	Chlordane ND < .5 ppm
Mirex ND < .1 ppm	Methoxychlor ND < .1 ppm

2,4-dinitrophenol

ND < 10 ppm

VC7-3

PAH

Naphthalene 0.70 ppm
Acenaphthylene 0.18 ppm
Acenaphthene 1.05 ppm
Fluorene 1.89 ppm
Phenanthrene 16.54 ppm
Anthracene 3.01 ppm
Fluoranthene 31.09 ppm
Pyrene 20.48 ppm
B(a)anthracene 3.43 ppm
Chrysene 6.37 ppm
B(b)fluoranthene 1.44 ppm
B(k)fluoranthene 0.98 ppm
B(a)pyrene 1.01 ppm
Indeno(1,2,3-cd)pyrene ND <.1 ppm
Dibenzo(a,h)anthracene ND < .10 ppm
Benzo(g,h,i)perylene 0.09 ppm

PCB (ppm)

1242	1254	1260	TOTAL
0.74	0.04	0.27	1.05

PCB Congeners (ppb)

#1	#5	#29	#50	#87	#154	#188	#200	#209
23.68		2.73		24.53				2.60

#44	#52	#77	#101	#118	#126	#138	#153	#180
89.77	97.28	94.07	56.97	21.21	5.41	55.27	31.08	35.82

CL-HC (by MSD)

Lindane ND < .05 ppm
Chlordane ND < .5 ppm
Mirex ND < .1 ppm
Methoxychlor ND < .1 ppm

2,4-dinitrophenol

ND < 10 ppm

VC7-4

PAH

Naphthalene 0.01 ppm	Acenaphthylene 0.11 ppm
Acenaphthene 1.52 ppm	Fluorene 2.96 ppm
Phenanthrene 22.05 ppm	Anthracene 4.57 ppm
Fluoranthene 28.69 ppm	Pyrene 18.50 ppm
B(a)anthracene 3.70 ppm	Chrysene 6.76 ppm
B(b)fluoranthene 3.95 ppm	B(k)fluoranthene 2.80 ppm
B(a)pyrene 3.78 ppm	Indeno(1,2,3-cd)pyrene 3.87 ppm
Dibenzo(a,h)anthracene 0.08 ppm	
Benzo(g,h,i)perylene 1.78 ppm	

PCB (ppm)

1242	1254	1260	TOTAL
0.51	0.12	0.10	0.73

PCB Congeners (ppb)

#1	#5	#29	#50	#87	#154	#188	#200	#209
48.07		2.08		22.06				6.07

#44	#52	#77	#101	#118	#126	#138	#153	#180
60.63	76.55	84.91	51.78	18.44	6.80	49.02	24.39	25.90

CL-HC (by MSD)

Lindane ND < .05 ppm	Chlordane ND < .5 ppm
Mirex ND < .1 ppm	Methoxychlor ND < .1 ppm

2,4-dinitrophenol

ND < 10 ppm

VC7-5

PAH

Naphthalene 0.01 ppm
Acenaphthene 0.28 ppm
Phenanthrene 2.74 ppm
Fluoranthene 5.02 ppm
B(a)anthracene 0.51 ppm
B(b)fluoranthene 1.69 ppm
B(a)pyrene 1.08 ppm
Dibenzo(a,h)anthracene 0.22 ppm
Benzo(g,h,i)perylene 1.70 ppm
Acenaphthylene 0.06 ppm
Fluorene 0.50 ppm
Anthracene 0.56 ppm
Pyrene 3.27 ppm
Chrysene 1.04 ppm
B(k)fluoranthene 1.15 ppm
Indeno(1,2,3-cd)pyrene 1.86 ppm

PCB (ppm)

1242	1254	1260	TOTAL
0.17	0.03	0.01	0.21

PCB Congeners (ppb)

#1	#5	#29	#50	#87	#154	#188	#200	#209
3.91		0.36		3.97				

#44	#52	#77	#101	#118	#126	#138	#153	#180
15.42	20.74	17.62	10.53	3.91	21.11	6.91	0.08	5.69

CL-HC (by MSD)

Lindane ND < .05 ppm
Mirex ND < .1 ppm
Chlordane ND < .5 ppm
Methoxychlor ND < .1 ppm

2,4-dinitrophenol

ND < 10 ppm

VC7-6

PAH

Naphthalene 0.45 ppm
Acenaphthylene 0.63 ppm
Acenaphthene 4.44 ppm
Fluorene 9.29 ppm
Phenanthrene 53.06 ppm
Anthracene 9.72 ppm
Fluoranthene 76.65 ppm
Pyrene 48.63 ppm
B(a)anthracene 9.71 ppm
Chrysene 19.11 ppm
B(b)fluoranthene 4.34 ppm
B(k)fluoranthene 2.95 ppm
B(a)pyrene 2.29 ppm
Indeno(1,2,3-cd)pyrene 1.36 ppm
Dibenzo(a,h)anthracene ND < .1 ppm
Benzo(g,h,i)perylene 0.58 ppm

PCB (ppm)

1242	1254	1260	TOTAL
3.67	0.00	0.91	4.58

PCB Congeners (ppb)

#1	#5	#29	#50	#87	#154	#188	#200	#209
48.99		6.02		93.13				1.25

#44	#52	#77	#101	#118	#126	#138	#153	#180
247.19	308.09	260.71	137.50	59.87	16.84	127.37	43.08	91.42

CL-HC (by MSD)

Lindane ND < .05 ppm
Chlordane ND < .5 ppm
Mirex ND < .1 ppm
Methoxychlor ND < .1 ppm

2,4-dinitrophenol

ND < 10 ppm

VC7-7

PAH

Naphthalene 0.45 ppm
Acenaphthene 1.54 ppm
Phenanthrene 23.99 ppm
Fluoranthene 36.83 ppm
B(a)anthracene 4.70 ppm
B(b)fluoranthene 2.79 ppm
B(a)pyrene 1.25 ppm
Dibenzo(a,h)anthracene 0.10 ppm
Benzo(g,h,i)perylene 1.58 ppm
Acenaphthylene 0.21 ppm
Fluorene 4.44 ppm
Anthracene 3.77 ppm
Pyrene 21.59 ppm
Chrysene 11.20 ppm
B(k)fluoranthene 1.89 ppm
Indeno(1,2,3-cd)pyrene 1.18 ppm

PCB (ppm)

1242	1254	1260	TOTAL
5.96	0.00	1.22	7.18

PCB Congeners (ppb)

#1	#5	#29	#50	#87	#154	#188	#200	#209
23.22		9.66		170.88				1.56

#44	#52	#77	#101	#118	#126	#138	#153	#180
574.41	677.28	554.85	239.03	132.23	26.40	176.37	63.84	144.77

CL-HC (by MSD)

Lindane ND < .05 ppm
Mirex ND < .1 ppm
Chlordane ND < .5 ppm
Methoxychlor ND < .1 ppm

2,4-dinitrophenol

ND < 10 ppm

VC7-8

PAH

Naphthalene 0.09 ppm
Acenaphthene 1.03 ppm
Phenanthrene 14.17 ppm
Fluoranthene 23.06 ppm
B(a)anthracene 3.09 ppm
B(b)fluoranthene 12.66 ppm
B(a)pyrene 4.05 ppm
Dibenzo(a,h)anthracene 0.10 ppm
Benzo(g,h,i)perylene 1.65 ppm

Acenaphthylene 0.23 ppm
Fluorene 2.21 ppm
Anthracene 2.26 ppm
Pyrene 15.48 ppm
Chrysene 6.36 ppm
B(k)fluoranthene 8.60 ppm
Indeno(1,2,3-cd)pyrene 2.92 ppm

PCB (ppm)

1242	1254	1260	TOTAL
3.40	0.31	0.99	4.70

PCB Congeners (ppb)

#1	#5	#29	#50	#87	#154	#188	#200	#209
		4.14		230.18				6.01

#44	#52	#77	#101	#118	#126	#138	#153	#180
520.99	655.85	786.96	332.24	199.78	23.88	173.93	67.02	114.88

CL-HC (by MSD)

Lindane ND < .05 ppm
Mirex ND < .1 ppm

Chlordane ND < .5 ppm
Methoxychlor ND < .1 ppm

2,4-dinitrophenol

ND < 10 ppm

VC7-9

PAH

Naphthalene 1.10 ppm	Acenaphthylene 0.76 ppm
Acenaphthene 3.87 ppm	Fluorene 9.94 ppm
Phenanthrene 57.06 ppm	Anthracene 9.08 ppm
Fluoranthene 66.75 ppm	Pyrene 44.83 ppm
B(a)anthracene 26.41 ppm	Chrysene 46.92 ppm
B(b)fluoranthene 22.60 ppm	B(k)fluoranthene 15.09 ppm
B(a)pyrene 3.74 ppm	Indeno(1,2,3-cd)pyrene 27.27 ppm
Dibenzo(a,h)anthracene 2.25 ppm	
Benzo(g,h,i)perylene 16.55 ppm	

PCB (ppm)

1242	1254	1260	TOTAL
4.54	0.00	1.05	5.59

PCB Congeners (ppb)

#1	#5	#29	#50	#87	#154	#188	#200	#209
32.64		1.71		153.95				

#44	#52	#77	#101	#118	#126	#138	#153	#180
429.17	508.50	690.23	219.25	142.81	115.22	144.11	63.20	122.60

CL-HC (by MSD)

Lindane ND < .05 ppm	Chlordane ND < .5 ppm
Mirex ND < .1 ppm	Methoxychlor ND < .1 ppm

2,4-dinitrophenol

ND < 10 ppm

VC7-10

PAH

Naphthalene 0.84 ppm	Acenaphthylene 0.52 ppm
Acenaphthene 2.66 ppm	Fluorene 6.63 ppm
Phenanthrene 30.82 ppm	Anthracene 6.80 ppm
Fluoranthene 45.37 ppm	Pyrene 30.61 ppm
B(a)anthracene 16.09 ppm	Chrysene 31.45 ppm
B(b)fluoranthene 13.38 ppm	B(k)fluoranthene 9.09 ppm
B(a)pyrene 10.64 ppm	Indeno(1,2,3-cd)pyrene 22.07 ppm
Dibenzo(a,h)anthracene 1.87 ppm	
Benzo(g,h,i)perylene 18.89 ppm	

PCB (ppm)

1242	1254	1260	TOTAL
5.23	0.11	1.02	6.36

PCB Congeners (ppb)

#1	#5	#29	#50	#87	#154	#188	#200	#209
87.37		2.42		217.40				

#44	#52	#77	#101	#118	#126	#138	#153	#180
569.14	701.58	910.38	314.04	208.36	163.44	184.26	72.86	121.57

CL-HC (by MSD)

Lindane ND < .05 ppm	Chlordane ND < .5 ppm
Mirex ND < .1 ppm	Methoxychlor ND < .1 ppm

2,4-dinitrophenol

ND < 10 ppm

VC7-11

PAH

Naphthalene 0.29 ppm	Acenaphthylene 0.25 ppm
Acenaphthene 0.74 ppm	Fluorene 1.99 ppm
Phenanthrene 13.03 ppm	Anthracene 2.50 ppm
Fluoranthene 24.51 ppm	Pyrene 16.90 ppm
B(a)anthracene 7.75 ppm	Chrysene 16.36 ppm
B(b)fluoranthene 5.86 ppm	B(k)fluoranthene 4.10 ppm
B(a)pyrene 5.12 ppm	Indeno(1,2,3-cd)pyrene 5.57 ppm
Dibenzo(a,h)anthracene 0.56 ppm	
Benzo(g,h,i)perylene 3.42 ppm	

PCB (ppm)

1242	1254	1260	TOTAL
1.72	0.25	0.49	2.46

PCB Congeners (ppb)

#1	#5	#29	#50	#87	#154	#188	#200	#209
27.78		2.85		101.05				

#44	#52	#77	#101	#118	#126	#138	#153	#180
247.83	326.91	465.14	166.50	101.97	10.53	101.71	52.43	63.37

CL-HC (by MSD)

Lindane ND < .05 ppm	Chlordane ND < .5 ppm
Mirex ND < .1 ppm	Methoxychlor ND < .1 ppm

2,4-dinitrophenol

ND < 10 ppm

VC7-12

PAH

Naphthalene 1.64 ppm	Acenaphthylene 0.82 ppm
Acenaphthene 2.18 ppm	Fluorene 5.57 ppm
Phenanthrene 27.42 ppm	Anthracene 6.43 ppm
Fluoranthene 48.56 ppm	Pyrene 35.82 ppm
B(a)anthracene 18.95 ppm	Chrysene 36.96 ppm
B(b)fluoranthene 16.16 ppm	B(k)fluoranthene 10.98 ppm
B(a)pyrene 10.78 ppm	Indeno(1,2,3-cd)pyrene 26.35 ppm
Dibenzo(a,h)anthracene 1.36 ppm	
Benzo(g,h,i)perylene 13.72 ppm	

PCB (ppm)

1242	1254	1260	TOTAL
2.19	0.30	0.35	2.84

PCB Congeners (ppb)

#1	#5	#29	#50	#87	#154	#188	#200	#209
61.28				111.72				30.67

#44	#52	#77	#101	#118	#126	#138	#153	#180
286.60	360.85	669.47	192.38	142.86	37.66	142.60	47.65	89.37

CL-HC (by MSD)

Lindane ND < .05 ppm	Chlordane ND < .5 ppm
Mirex ND < .1 ppm	Methoxychlor ND < .1 ppm

2,4-dinitrophenol

ND < 10 ppm

VC7-13

PAH

Naphthalene 1.21 ppm
Acenaphthene 1.86 ppm
Phenanthrene 30.13 ppm
Fluoranthene 56.95 ppm
B(a)anthracene 21.05 ppm
B(b)fluoranthene 14.21 ppm
B(a)pyrene 9.77 ppm
Dibenzo(a,h)anthracene 1.21 ppm
Benzo(g,h,i)perylene 9.02 ppm

Acenaphthylene 0.97 ppm
Fluorene 4.87 ppm
Anthracene 8.17 ppm
Pyrene 38.37 ppm
Chrysene 40.98 ppm
B(k)fluoranthene 7.93 ppm
Indeno(1,2,3-cd)pyrene 14.69 ppm

PCB (ppm)

1242	1254	1260	TOTAL
1.82	0.19	0.35	2.36

PCB Congeners (ppb)

#1	#5	#29	#50	#87	#154	#188	#200	#209
82.90		1.84		86.88				0.80

#44	#52	#77	#101	#118	#126	#138	#153	#180
190.30	247.29	436.11	140.41	89.58	109.52	90.55	25.35	42.45

CL-HC (by MSD)

Lindane ND < .05 ppm
Mirex ND < .1 ppm

Chlordane ND < .5 ppm
Methoxychlor ND < .1 ppm

2,4-dinitrophenol

ND < 10 ppm

VC7-14

PAH

Naphthalene 3.25 ppm	Acenaphthylene 0.77 ppm
Acenaphthene 1.39 ppm	Fluorene 5.38 ppm
Phenanthrene 27.45 ppm	Anthracene 6.55 ppm
Fluoranthene 53.70 ppm	Pyrene 36.99 ppm
B(a)anthracene 15.36 ppm	Chrysene 33.29 ppm
B(b)fluoranthene 10.02 ppm	B(k)fluoranthene 7.81 ppm
B(a)pyrene 7.92 ppm	Indeno(1,2,3-cd)pyrene 17.61 ppm
Dibenzo(a,h)anthracene 1.21 ppm	
Benzo(g,h,i)perylene 10.79 ppm	

PCB (ppm)

1242	1254	1260	TOTAL
3.37	0.18	1.32	4.87

PCB Congeners (ppb)

#1	#5	#29	#50	#87	#154	#188	#200	#209
85.03		6.46		258.08				3.35

#44	#52	#77	#101	#118	#126	#138	#153	#180
476.65	635.26	943.83	399.05	258.86	8.13	296.33	47.69	103.71

CL-HC (by MSD)

Lindane ND < .05 ppm	Chlordane ND < .5 ppm
Mirex ND < .1 ppm	Methoxychlor ND < .1 ppm

2,4-dinitrophenol

ND < 10 ppm

VC7-15

PAH

Naphthalene 6.16 ppm	Acenaphthylene 1.37 ppm
Acenaphthene 1.82 ppm	Fluorene 5.80 ppm
Phenanthrene 28.65 ppm	Anthracene 9.21 ppm
Fluoranthene 55.40 ppm	Pyrene 39.09 ppm
B(a)anthracene 24.71 ppm	Chrysene 32.74 ppm
B(b)fluoranthene 33.51 ppm	B(k)fluoranthene 22.70 ppm
B(a)pyrene 43.02 ppm	Indeno(1,2,3-cd)pyrene 34.90 ppm
Dibenzo(a,h)anthracene 14.70 ppm	
Benzo(g,h,i)perylene 5.50 ppm	

PCB (ppm)

1242	1254	1260	TOTAL
1.69	0.20	0.69	2.58

PCB Congeners (ppb)

#1	#5	#29	#50	#87	#154	#188	#200	#209
29.40				126.26				

#44	#52	#77	#101	#118	#126	#138	#153	#180
175.59	249.40	370.14	203.06	126.77	164.00	178.49	60.10	76.35

CL-HC (by MSD)

Lindane ND < .05 ppm	Chlordane ND < .5 ppm
Mirex ND < .1 ppm	Methoxychlor ND < .1 ppm

2,4-dinitrophenol

ND < 10 ppm

VC9-1

PAH

Naphthalene 0.35 ppm
Acenaphthene 0.23 ppm
Phenanthrene 3.68 ppm
Fluoranthene 9.51 ppm
B(a)anthracene 4.67 ppm
B(b)fluoranthene 8.02 ppm
B(a)pyrene 6.10 ppm
Dibenzo(a,h)anthracene 1.66 ppm
Benzo(g,h,i)perylene 12.71 ppm
Acenaphthylene 0.26 ppm
Fluorene 0.61 ppm
Anthracene 1.71 ppm
Pyrene 7.92 ppm
Chrysene 7.27 ppm
B(k)fluoranthene 5.45 ppm
Indeno(1,2,3-cd)pyrene 21.14 ppm

PCB (ppm)

1242	1254	1260	TOTAL
1.55	0.00	0.36	1.91

PCB Congeners (ppb)

#1	#5	#29	#50	#87	#154	#188	#200	#209
16.89		0.91		20.18				3.83

#44	#52	#77	#101	#118	#126	#138	#153	#180
84.30	102.58	83.98	48.94	20.90	36.57	31.83	13.66	21.14

CL-HC (by MSD)

Lindane ND < .05 ppm
Mirex ND < .1 ppm
Chlordane ND < .5 ppm
Methoxychlor ND < .1 ppm

2,4-dinitrophenol

ND < 10 ppm

VC9-2

PAH

Naphthalene 0.22 ppm	Acenaphthylene 0.12 ppm
Acenaphthene 0.35 ppm	Fluorene 0.73 ppm
Phenanthrene 4.75 ppm	Anthracene 1.52 ppm
Fluoranthene 9.57 ppm	Pyrene 8.32 ppm
B(a)anthracene 3.75 ppm	Chrysene 7.00 ppm
B(b)fluoranthene 5.16 ppm	B(k)fluoranthene 2.94 ppm
B(a)pyrene 4.54 ppm	Indeno(1,2,3-cd)pyrene 12.26 ppm
Dibenzo(a,h)anthracene 1.33 ppm	
Benzo(g,h,i)perylene 6.59 ppm	

PCB (ppm)

1242	1254	1260	TOTAL
1.33	0.10	0.18	1.61

PCB Congeners (ppb)

#1	#5	#29	#50	#87	#154	#188	#200	#209
23.46		2.33		33.39				

#44	#52	#77	#101	#118	#126	#138	#153	#180
127.06	153.68	129.76	74.83	28.49	33.61	45.29	20.69	27.48

CL-HC (by MSD)

Lindane ND < .05 ppm	Chlordane ND < .5 ppm
Mirex ND < .1 ppm	Methoxychlor ND < .1 ppm

2,4-dinitrophenol

ND < 10 ppm

VC9-3

PAH

Naphthalene 0.12 ppm
Acenaphthene 0.23 ppm
Phenanthrene 1.97 ppm
Fluoranthene 2.94 ppm
B(a)anthracene 1.24 ppm
B(b)fluoranthene 2.21 ppm
B(a)pyrene 1.42 ppm
Dibenzo(a,h)anthracene 0.42 ppm
Benzo(g,h,i)perylene 1.95 ppm

Acenaphthylene 0.12 ppm
Fluorene 0.45 ppm
Anthracene 0.58 ppm
Pyrene 2.91 ppm
Chrysene 2.13 ppm
B(k)fluoranthene 0.95 ppm
Indeno(1,2,3-cd)pyrene 3.11 ppm

PCB (ppm)

1242	1254	1260	TOTAL
1.12	0.07	0.09	1.28

PCB Congeners (ppb)

#1	#5	#29	#50	#87	#154	#188	#200	#209
16.61		2.89		35.58				0.38

#44	#52	#77	#101	#118	#126	#138	#153	#180
105.06	132.32	108.62	64.69	30.26	47.51	31.22	5.34	16.30

CL-HC (by MSD)

Lindane ND < .05 ppm
Mirex ND < .1 ppm

Chlordane ND < .5 ppm
Methoxychlor ND < .1 ppm

2,4-dinitrophenol

ND < 10 ppm

VC9-4

PAH

Naphthalene 0.22 ppm	Acenaphthylene 0.20 ppm
Acenaphthene 0.45 ppm	Fluorene 0.77 ppm
Phenanthrene 3.08 ppm	Anthracene 1.28 ppm
Fluoranthene 5.97 ppm	Pyrene 5.02 ppm
B(a)anthracene 2.75 ppm	Chrysene 4.31 ppm
B(b)fluoranthene 4.33 ppm	B(k)fluoranthene 2.94 ppm
B(a)pyrene 3.25 ppm	Indeno(1,2,3-cd)pyrene 9.99 ppm
Dibenzo(a,h)anthracene 0.73 ppm	
Benzo(g,h,i)perylene 6.51 ppm	

PCB (ppm)

1242	1254	1260	TOTAL
0.92	0.00	0.23	1.15

PCB Congeners (ppb)

#1	#5	#29	#50	#87	#154	#188	#200	#209
15.39		1.26		19.38				4.39

#44	#52	#77	#101	#118	#126	#138	#153	#180
73.23	92.18	74.28	46.17	19.36	23.48	27.26	13.24	17.16

CL-HC (by MSD)

Lindane ND < .05 ppm	Chlordane ND < .5 ppm
Mirex ND < .1 ppm	Methoxychlor ND < .1 ppm

2,4-dinitrophenol

ND < 10 ppm

VC9-5

PAH

Naphthalene 0.24 ppm	Acenaphthylene 0.19 ppm
Acenaphthene 0.26 ppm	Fluorene 0.78 ppm
Phenanthrene 3.28 ppm	Anthracene 1.09 ppm
Fluoranthene 6.52 ppm	Pyrene 5.74 ppm
B(a)anthracene 2.44 ppm	Chrysene 4.75 ppm
B(b)fluoranthene 3.16 ppm	B(k)fluoranthene 2.16 ppm
B(a)pyrene 2.82 ppm	Indeno(1,2,3-cd)pyrene 8.80 ppm
Dibenzo(a,h)anthracene 0.93 ppm	
Benzo(g,h,i)perylene 3.89 ppm	

PCB (ppm)

1242	1254	1260	TOTAL
0.87	0.00	0.31	1.18

PCB Congeners (ppb)

#1	#5	#29	#50	#87	#154	#188	#200	#209
		1.82		23.44				2.71

#44	#52	#77	#101	#118	#126	#138	#153	#180
94.58	122.13	96.68	58.26	23.49	3.84	33.03	21.38	21.53

CL-HC (by MSD)

Lindane ND < .05 ppm	Chlordane ND < .5 ppm
Mirex ND < .1 ppm	Methoxychlor ND < .1 ppm

2,4-dinitrophenol

ND < 10 ppm

VC9-6

PAH

Naphthalene 0.67 ppm	Acenaphthylene 0.34 ppm
Acenaphthene 0.39 ppm	Fluorene 0.95 ppm
Phenanthrene 4.38 ppm	Anthracene 1.82 ppm
Fluoranthene 8.57 ppm	Pyrene 6.42 ppm
B(a)anthracene 4.20 ppm	Chrysene 7.43 ppm
B(b)fluoranthene 6.56 ppm	B(k)fluoranthene 4.60 ppm
B(a)pyrene 4.89 ppm	Indeno(1,2,3-cd)pyrene 14.17 ppm
Dibenzo(a,h)anthracene 0.59 ppm	
Benzo(g,h,i)perylene 8.93 ppm	

PCB (ppm)

1242	1254	1260	TOTAL
1.32	0.00	0.38	1.70

PCB Congeners (ppb)

#1	#5	#29	#50	#87	#154	#188	#200	#209
		5.52		30.35				16.43

#44	#52	#77	#101	#118	#126	#138	#153	#180
103.19	129.30	110.68	69.88	28.80	31.73	38.77	12.34	34.62

CL-HC (by MSD)

Lindane ND < .05 ppm	Chlordane ND < .5 ppm
Mirex ND < .1 ppm	Methoxychlor ND < .1 ppm

2,4-dinitrophenol

ND < 10 ppm

VC9-7

PAH

Naphthalene 0.46 ppm	Acenaphthylene 0.45 ppm
Acenaphthene 1.04 ppm	Fluorene 2.14 ppm
Phenanthrene 9.90 ppm	Anthracene 3.60 ppm
Fluoranthene 19.17 ppm	Pyrene 14.35 ppm
B(a)anthracene 7.44 ppm	Chrysene 11.48 ppm
B(b)fluoranthene 10.99 ppm	B(k)fluoranthene 7.47 ppm
B(a)pyrene 8.10 ppm	Indeno(1,2,3-cd)pyrene 25.29 ppm
Dibenzo(a,h)anthracene 2.82 ppm	
Benzo(g,h,i)perylene 15.21 ppm	

PCB (ppm)

1242	1254	1260	TOTAL
3.00	0.00	0.56	3.56

PCB Congeners (ppb)

#1	#5	#29	#50	#87	#154	#188	#200	#209
49.11		3.14		86.58				5.64

#44	#52	#77	#101	#118	#126	#138	#153	#180
223.50	283.21	288.99	136.58	74.95	41.31	90.46	36.26	46.13

CL-HC (by MSD)

Lindane ND < .05 ppm	Chlordane ND < .5 ppm
Mirex ND < .1 ppm	Methoxychlor ND < .1 ppm

2,4-dinitrophenol

ND < 10 ppm

VC9-8

PAH

Naphthalene 0.38 ppm	Acenaphthylene 0.26 ppm
Acenaphthene 1.74 ppm	Fluorene 4.85 ppm
Phenanthrene 22.45 ppm	Anthracene 4.65 ppm
Fluoranthene 33.92 ppm	Pyrene 24.56 ppm
B(a)anthracene 11.00 ppm	Chrysene 21.72 ppm
B(b)fluoranthene 12.29 ppm	B(k)fluoranthene 8.35 ppm
B(a)pyrene 9.26 ppm	Indeno(1,2,3-cd)pyrene 26.43 ppm
Dibenzo(a,h)anthracene 0.63 ppm	
Benzo(g,h,i)perylene 10.46 ppm	

PCB (ppm)

1242	1254	1260	TOTAL
2.08	0.48	0.52	3.08

PCB Congeners (ppb)

#1	#5	#29	#50	#87	#154	#188	#200	#209
42.65		4.51		178.60				5.11

#44	#52	#77	#101	#118	#126	#138	#153	#180
230.22	333.57	517.12	241.74	128.16	27.19	195.63	60.86	73.02

CL-HC (by MSD)

Lindane ND < .05 ppm	Chlordane ND < .5 ppm
Mirex ND < .1 ppm	Methoxychlor ND < .1 ppm

2,4-dinitrophenol

ND < 10 ppm

VC9-9

PAH

Naphthalene 1.14 ppm	Acenaphthylene 1.01 ppm
Acenaphthene 0.89 ppm	Fluorene 2.11 ppm
Phenanthrene 9.30 ppm	Anthracene 3.38 ppm
Fluoranthene 14.94 ppm	Pyrene 12.86 ppm
B(a)anthracene 7.22 ppm	Chrysene 13.34 ppm
B(b)fluoranthene 7.56 ppm	B(k)fluoranthene 5.13 ppm
B(a)pyrene 6.51 ppm	Indeno(1,2,3-cd)pyrene 22.23 ppm
Dibenzo(a,h)anthracene 2.60 ppm	
Benzo(g,h,i)perylene 14.41 ppm	

PCB (ppm)

1242	1254	1260	TOTAL
0.64	0.00	0.75	1.39

PCB Congeners (ppb)

#1	#5	#29	#50	#87	#154	#188	#200	#209
55.89		1.32		99.88				16.36

#44	#52	#77	#101	#118	#126	#138	#153	#180
100.23	163.18	272.87	154.01	65.82	73.82	122.04	25.89	59.96

CL-HC (by MSD)

Lindane ND < .05 ppm	Chlordane ND < .5 ppm
Mirex ND < .1 ppm	Methoxychlor ND < .1 ppm

2,4-dinitrophenol

ND < 10 ppm

VC9-10

PAH

Naphthalene 0.66 ppm	Acenaphthylene 0.34 ppm
Acenaphthene 0.30 ppm	Fluorene 0.70 ppm
Phenanthrene 2.71 ppm	Anthracene 1.24 ppm
Fluoranthene 3.91 ppm	Pyrene 3.64 ppm
B(a)anthracene 2.32 ppm	Chrysene 3.60 ppm
B(b)fluoranthene 2.50 ppm	B(k)fluoranthene 1.46 ppm
B(a)pyrene 2.28 ppm	Indeno(1,2,3-cd)pyrene 6.67 ppm
Dibenzo(a,h)anthracene 0.63 ppm	
Benzo(g,h,i)perylene 4.58 ppm	

PCB (ppm)

1242	1254	1260	TOTAL
0.17	0.00	0.09	0.26

PCB Congeners (ppb)

#1	#5	#29	#50	#87	#154	#188	#200	#209
45.51		2.61		7.69				84.51

#44	#52	#77	#101	#118	#126	#138	#153	#180
11.54	23.11	25.28	20.51	8.26	14.39	14.37	5.03	8.32

CL-HC (by MSD)

Lindane ND < .05 ppm	Chlordane ND < .5 ppm
Mirex ND < .1 ppm	Methoxychlor ND < .1 ppm

2,4-dinitrophenol

ND < 10 ppm

VC9-11

PAH

Naphthalene ND <.10 ppm	Acenaphthylene ND <.10 ppm
Acenaphthene ND <.10 ppm	Fluorene ND <.10 ppm
Phenanthrene 0.14 ppm	Anthracene 0.03 ppm
Fluoranthene 0.29 ppm	Pyrene 0.20 ppm
B(a)anthracene 0.10 ppm	Chrysene 0.18 ppm
B(b)fluoranthene 0.11 ppm	B(k)fluoranthene 0.08 ppm
B(a)pyrene 0.10 ppm	Indeno(1,2,3-cd)pyrene 0.48 ppm
Dibenzo(a,h)anthracene 0.02 ppm	
Benzo(g,h,i)perylene 0.36 ppm	

PCB (ppm)

1242	1254	1260	TOTAL
0.02	0.01	0.00	0.03

PCB Congeners (ppb)

#1	#5	#29	#50	#87	#154	#188	#200	#209
				1.50				1.57

#44	#52	#77	#101	#118	#126	#138	#153	#180
4.93	3.76	5.27	4.56	1.47	3.92	2.24	0.00	1.35

CL-HC (by MSD)

Lindane ND < .05 ppm	Chlordane ND < .5 ppm
Mirex ND < .1 ppm	Methoxychlor ND < .1 ppm

2,4-dinitrophenol

ND < 10 ppm

VC9-12

PAH

Naphthalene ND <.10 ppm	Acenaphthylene ND <.10 ppm
Acenaphthene ND <.10 ppm	Fluorene ND <.10 ppm
Phenanthrene 0.10 ppm	Anthracene 0.02 ppm
Fluoranthene 0.16 ppm	Pyrene 0.14 ppm
B(a)anthracene 0.10 ppm	Chrysene 0.12 ppm
B(b)fluoranthene 0.15 ppm	B(k)fluoranthene 0.05 ppm
B(a)pyrene 0.08 ppm	Indeno(1,2,3-cd)pyrene 0.26 ppm
Dibenzo(a,h)anthracene ND <.10 ppm	
Benzo(g,h,i)perylene 0.23 ppm	

PCB (ppm)

1242	1254	1260	TOTAL
0.02	0.00	0.00	0.02

PCB Congeners (ppb)

#1	#5	#29	#50	#87	#154	#188	#200	#209
				0.95				13.41

#44	#52	#77	#101	#118	#126	#138	#153	#180
2.6	3.04	5.54	5.22	0.87	1.86	0.00	0.00	1.18

CL-HC (by MSD)

Lindane ND < .05 ppm	Chlordane ND < .5 ppm
Mirex ND < .1 ppm	Methoxychlor ND < .1 ppm

2,4-dinitrophenol

ND < 10 ppm

VC9-13

PAH

Naphthalene ND <.10 ppm	Acenaphthylene ND <.10 ppm
Acenaphthene ND <.10 ppm	Fluorene ND <.10 ppm
Phenanthrene 0.04 ppm	Anthracene ND <.10 ppm
Fluoranthene 0.05 ppm	Pyrene 0.04 ppm
B(a)anthracene 0.02 ppm	Chrysene 0.08 ppm
B(b)fluoranthene 0.08 ppm	B(k)fluoranthene 0.06 ppm
B(a)pyrene 0.07 ppm	Indeno(1,2,3-cd)pyrene 0.36 ppm
Dibenzo(a,h)anthracene 0.01 ppm	
Benzo(g,h,i)perylene 0.34 ppm	

PCB (ppm)

1242	1254	1260	TOTAL
0.05	0.00	0.03	0.08

PCB Congeners (ppb)

#1	#5	#29	#50	#87	#154	#188	#200	#209
10.52				0.35				

#44	#52	#77	#101	#118	#126	#138	#153	#180
1.23	1.28	1.28	2.53	0.00	7.34	2.17	0.00	2.63

CL-HC (by MSD)

Lindane ND < .05 ppm	Chlordane ND < .5 ppm
Mirex ND < .1 ppm	Methoxychlor ND < .1 ppm

2,4-dinitrophenol

ND < 10 ppm

VC9-14

PAH

Naphthalene ND <.10 ppm	Acenaphthylene ND <.10 ppm
Acenaphthene ND <.10 ppm	Fluorene ND <.10 ppm
Phenanthrene ND <.10 ppm	Anthracene ND <.10 ppm
Fluoranthene ND <.10 ppm	Pyrene ND <.10 ppm
B(a)anthracene ND <.10 ppm	Chrysene ND <.10 ppm
B(b)fluoranthene 0.01 ppm	B(k)fluoranthene 0.01 ppm
B(a)pyrene ND <.10 ppm	Indeno(1,2,3-cd)pyrene ND <.10 ppm
Dibenzo(a,h)anthracene ND <.10 ppm	
Benzo(g,h,i)perylene ND <.10 ppm	

PCB (ppm)

1242	1254	1260	TOTAL
0.01	0.00	0.00	0.01

PCB Congeners (ppb)

#1	#5	#29	#50	#87	#154	#188	#200	#209
8.66		4.29		0.34				1.22

#44	#52	#77	#101	#118	#126	#138	#153	#180
0.82	1.01	1.03	0.67	0.00	4.99	0.00	0.00	0.00

CL-HC (by MSD)

Lindane ND < .05 ppm	Chlordane ND < .5 ppm
Mirex ND < .1 ppm	Methoxychlor ND < .1 ppm

2,4-dinitrophenol

ND < 10 ppm

VC9-15

PAH

Naphthalene ND <.10 ppm	Acenaphthylene ND <.10 ppm
Acenaphthene ND <.10 ppm	Fluorene ND <.10 ppm
Phenanthrene ND <.10 ppm	Anthracene ND <.10 ppm
Fluoranthene 0.06 ppm	Pyrene 0.05 ppm
B(a)anthracene 0.02 ppm	Chrysene 0.05 ppm
B(b)fluoranthene 0.06 ppm	B(k)fluoranthene 0.04 ppm
B(a)pyrene 0.04 ppm	Indeno(1,2,3-cd)pyrene 0.04 ppm

Dibenzo(a,h)anthracene ND <.10 ppm
Benzo(g,h,i)perylene 0.01 ppm

PCB (ppm)

1242	1254	1260	TOTAL
0.03	0.01	0.00	0.04

PCB Congeners (ppb)

#1	#5	#29	#50	#87	#154	#188	#200	#209
11.61		4.07						

#44	#52	#77	#101	#118	#126	#138	#153	#180
3.10	1.18	1.69	2.51	1.09	0.00	0.00	0.00	0.00

CL-HC (by MSD)

Lindane ND < .05 ppm	Chlordane ND < .5 ppm
Mirex ND < .1 ppm	Methoxychlor ND < .1 ppm

2,4-dinitrophenol

ND < 10 ppm

VC12-1

PAH

Naphthalene 0.20 ppm	Acenaphthylene 0.12 ppm
Acenaphthene 0.35 ppm	Fluorene 0.54 ppm
Phenanthrene 2.32 ppm	Anthracene 0.95 ppm
Fluoranthene 4.45 ppm	Pyrene 3.60 ppm
B(a)anthracene 1.94 ppm	Chrysene 3.11 ppm
B(b)fluoranthene 2.51 ppm	B(k)fluoranthene 1.70 ppm
B(a)pyrene 2.73 ppm	Indeno(1,2,3-cd)pyrene 8.33 ppm
Dibenzo(a,h)anthracene 0.69 ppm	
Benzo(g,h,i)perylene 5.02 ppm	

PCB (ppm)

1242	1254	1260	TOTAL
0.53	0.00	0.25	0.78

PCB Congeners (ppb)

#1	#5	#29	#50	#87	#154	#188	#200	#209
10.79		1.04		10.62				

#44	#52	#77	#101	#118	#126	#138	#153	#180
29.52	47.08	49.13	31.79	13.75	0.00	19.42	8.30	28.04

CL-HC (by MSD)

Lindane ND < .05 ppm	Chlordane ND < .5 ppm
Mirex ND < .1 ppm	Methoxychlor ND < .1 ppm

2,4-dinitrophenol

ND < 10 ppm

VC12-2

PAH

Naphthalene 0.27 ppm	Acenaphthylene 0.19 ppm
Acenaphthene 0.41 ppm	Fluorene 0.69 ppm
Phenanthrene 4.10 ppm	Anthracene 1.26 ppm
Fluoranthene 9.31 ppm	Pyrene 6.93 ppm
B(a)anthracene 3.44 ppm	Chrysene 6.51 ppm
B(b)fluoranthene 4.49 ppm	B(k)fluoranthene 3.04 ppm
B(a)pyrene 3.83 ppm	Indeno(1,2,3-cd)pyrene 15.46 ppm
Dibenzo(a,h)anthracene 1.02 ppm	
Benzo(g,h,i)perylene 9.17 ppm	

PCB (ppm)

1242	1254	1260	TOTAL
1.12	0.02	0.26	1.40

PCB Congeners (ppb)

#1	#5	#29	#50	#87	#154	#188	#200	#209
36.20		2.77		30.42				2.79

#44	#52	#77	#101	#118	#126	#138	#153	#180
99.26	125.57	117.16	63.46	27.56	6.12	45.03	20.15	25.38

CL-HC (by MSD)

Lindane ND < .05 ppm	Chlordane ND < .5 ppm
Mirex ND < .1 ppm	Methoxychlor ND < .1 ppm

2,4-dinitrophenol

ND < 10 ppm

VC12-3

PAH

Naphthalene 0.23 ppm	Acenaphthylene 0.22 ppm
Acenaphthene 0.33 ppm	Fluorene 0.71 ppm
Phenanthrene 4.13 ppm	Anthracene 1.09 ppm
Fluoranthene 9.81 ppm	Pyrene 7.49 ppm
B(a)anthracene 3.78 ppm	Chrysene 7.74 ppm
B(b)fluoranthene 6.66 ppm	B(k)fluoranthene 2.68 ppm
B(a)pyrene 4.37 ppm	Indeno(1,2,3-cd)pyrene 16.84 ppm
Dibenzo(a,h)anthracene 1.64 ppm	
Benzo(g,h,i)perylene 9.98 ppm	

PCB (ppm)

1242	1254	1260	TOTAL
3.93	0.00	0.82	4.75

PCB Congeners (ppb)

#1	#5	#29	#50	#87	#154	#188	#200	#209
45.59		4.75		117.50				2.36

#44	#52	#77	#101	#118	#126	#138	#153	#180
395.08	494.28	416.34	177.97	96.96	19.18	132.85	37.94	68.98

CL-HC (by MSD)

Lindane ND < .05 ppm	Chlordane ND < .5 ppm
Mirex ND < .1 ppm	Methoxychlor ND < .1 ppm

2,4-dinitrophenol

ND < 10 ppm

VC12-4

PAH

Naphthalene 0.44 ppm	Acenaphthylene 0.28 ppm
Acenaphthene 0.29 ppm	Fluorene 0.64 ppm
Phenanthrene 2.66 ppm	Anthracene 1.17 ppm
Fluoranthene 6.50 ppm	Pyrene 5.32 ppm
B(a)anthracene 3.08 ppm	Chrysene 6.55 ppm
B(b)fluoranthene 4.41 ppm	B(k)fluoranthene 3.00 ppm
B(a)pyrene 3.41 ppm	Indeno(1,2,3-cd)pyrene 13.40 ppm
Dibenzo(a,h)anthracene 0.91 ppm	
Benzo(g,h,i)perylene 7.88 ppm	

PCB (ppm)

1242	1254	1260	TOTAL
4.87	0.16	0.71	5.74

PCB Congeners (ppb)

#1	#5	#29	#50	#87	#154	#188	#200	#209
14.95		3.89		153.22				5.76

#44	#52	#77	#101	#118	#126	#138	#153	#180
460.55	572.03	539.02	238.13	137.98	23.13	179.90	38.08	79.95

CL-HC (by MSD)

Lindane ND < .05 ppm	Chlordane ND < .5 ppm
Mirex ND < .1 ppm	Methoxychlor ND < .1 ppm

2,4-dinitrophenol

ND < 10 ppm

VC12-5

PAH

Naphthalene 0.53 ppm	Acenaphthylene 0.38 ppm
Acenaphthene 0.28 ppm	Fluorene 0.76 ppm
Phenanthrene 3.54 ppm	Anthracene 1.17 ppm
Fluoranthene 7.82 ppm	Pyrene 6.37 ppm
B(a)anthracene 3.53 ppm	Chrysene 7.45 ppm
B(b)fluoranthene 6.62 ppm	B(k)fluoranthene 2.71 ppm
B(a)pyrene 4.05 ppm	Indeno(1,2,3-cd)pyrene 15.69 ppm
Dibenzo(a,h)anthracene 1.70 ppm	
Benzo(g,h,i)perylene 9.46 ppm	

PCB (ppm)

1242	1254	1260	TOTAL
1.67	0.01	0.64	2.32

PCB Congeners (ppb)

#1	#5	#29	#50	#87	#154	#188	#200	#209
49.36		1.29		72.74				3.99

#44	#52	#77	#101	#118	#126	#138	#153	#180
157.13	227.45	157.82	145.14	70.67	12.45	114.95	44.93	65.24

CL-HC (by MSD)

Lindane ND < .05 ppm	Chlordane ND < .5 ppm
Mirex ND < .1 ppm	Methoxychlor ND < .1 ppm

2,4-dinitrophenol

ND < 10 ppm

VC12-6

PAH

Naphthalene 0.65 ppm	Acenaphthylene 0.33 ppm
Acenaphthene 0.22 ppm	Fluorene 0.88 ppm
Phenanthrene 4.39 ppm	Anthracene 1.33 ppm
Fluoranthene 9.29 ppm	Pyrene 7.31 ppm
B(a)anthracene 3.79 ppm	Chrysene 8.27 ppm
B(b)fluoranthene 6.94 ppm	B(k)fluoranthene 2.64 ppm
B(a)pyrene 4.29 ppm	Indeno(1,2,3-cd)pyrene 15.59 ppm
Dibenzo(a,h)anthracene 1.64 ppm	
Benzo(g,h,i)perylene 9.72 ppm	

PCB (ppm)

1242	1254	1260	TOTAL
1.09	0.00	0.45	1.54

PCB Congeners (ppb)

#1	#5	#29	#50	#87	#154	#188	#200	#209
35.13		0.81		47.85				3.37

#44	#52	#77	#101	#118	#126	#138	#153	#180
105.96	159.12	174.22	94.15	47.56	7.30	73.61	27.41	42.30

CL-HC (by MSD)

Lindane ND < .05 ppm	Chlordane ND < .5 ppm
Mirex ND < .1 ppm	Methoxychlor ND < .1 ppm

2,4-dinitrophenol

ND < 10 ppm

VC12-7

PAH

Naphthalene 0.61 ppm	Acenaphthylene 0.27 ppm
Acenaphthene 0.28 ppm	Fluorene 0.77 ppm
Phenanthrene 3.48 ppm	Anthracene 1.00 ppm
Fluoranthene 7.70 ppm	Pyrene 6.39 ppm
B(a)anthracene 3.37 ppm	Chrysene 6.88 ppm
B(b)fluoranthene 5.43 ppm	B(k)fluoranthene 2.69 ppm
B(a)pyrene 3.58 ppm	Indeno(1,2,3-cd)pyrene 13.31 ppm
Dibenzo(a,h)anthracene 1.30 ppm	
Benzo(g,h,i)perylene 9.66 ppm	

PCB (ppm)

1242	1254	1260	TOTAL
0.49	0.00	0.33	0.82

PCB Congeners (ppb)

#1	#5	#29	#50	#87	#154	#188	#200	#209
10.07				23.84				

#44	#52	#77	#101	#118	#126	#138	#153	#180
53.12	83.45	96.00	56.79	27.23	4.05	45.76	17.44	27.35

CL-HC (by MSD)

Lindane ND < .05 ppm	Chlordane ND < .5 ppm
Mirex ND < .1 ppm	Methoxychlor ND < .1 ppm

2,4-dinitrophenol

ND < 10 ppm

VC12-8

PAH

Naphthalene 0.67 ppm
Acenaphthylene 0.39 ppm
Acenaphthene 0.22 ppm
Fluorene 0.73 ppm
Phenanthrene 1.49 ppm
Anthracene 1.11 ppm
Fluoranthene 8.19 ppm
Pyrene 6.77 ppm
B(a)anthracene 3.76 ppm
Chrysene 7.61 ppm
B(b)fluoranthene 5.96 ppm
B(k)fluoranthene 2.58 ppm
B(a)pyrene 3.90 ppm
Indeno(1,2,3-cd)pyrene 13.95 ppm
Dibenzo(a,h)anthracene 1.14 ppm
Benzo(g,h,i)perylene 9.15 ppm

PCB (ppm)

1242	1254	1260	TOTAL
0.18	0.00	0.22	0.40

PCB Congeners (ppb)

#1	#5	#29	#50	#87	#154	#188	#200	#209
23.01		2.61		12.28				13.90

#44	#52	#77	#101	#118	#126	#138	#153	#180
27.91	50.97	57.68	39.79	18.97	2.20	39.88	12.27	16.67

CL-HC (by MSD)

Lindane ND < .05 ppm
Chlordane ND < .5 ppm
Mirex ND < .1 ppm
Methoxychlor ND < .1 ppm

2,4-dinitrophenol

ND < 10 ppm

VC12-9

PAH

Naphthalene 0.79 ppm
Acenaphthene 0.40 ppm
Phenanthrene 3.07 ppm
Fluoranthene 6.97 ppm
B(a)anthracene 4.10 ppm
B(b)fluoranthene 5.57 ppm
B(a)pyrene 4.75 ppm
Dibenzo(a,h)anthracene 1.25 ppm
Benzo(g,h,i)perylene 7.81 ppm
Acenaphthylene 0.59 ppm
Fluorene 0.89 ppm
Anthracene 1.22 ppm
Pyrene 6.39 ppm
Chrysene 5.75 ppm
B(k)fluoranthene 3.79 ppm
Indeno(1,2,3-cd)pyrene 11.73 ppm

PCB (ppm)

1242	1254	1260	TOTAL
0.16	0.02	0.04	0.22

PCB Congeners (ppb)

#1	#5	#29	#50	#87	#154	#188	#200	#209
13.83				1.10				14.39

#44	#52	#77	#101	#118	#126	#138	#153	#180
8.28	16.83	19.52	12.67	7.46	0.00	19.61	4.98	10.62

CL-HC (by MSD)

Lindane ND < .05 ppm
Mirex ND < .1 ppm
Chlordane ND < .5 ppm
Methoxychlor ND < .1 ppm

2,4-dinitrophenol

ND < 10 ppm

VC12-10

PAH

Naphthalene 0.72 ppm
Acenaphthene 0.29 ppm
Phenanthrene 3.77 ppm
Fluoranthene 8.24 ppm
B(a)anthracene 4.27 ppm
B(b)fluoranthene 6.08 ppm
B(a)pyrene 4.20 ppm
Dibenzo(a,h)anthracene 1.05 ppm
Benzo(g,h,i)perylene 4.98 ppm
Acenaphthylene 0.60 ppm
Fluorene 1.00 ppm
Anthracene 1.60 ppm
Pyrene 7.19 ppm
Chrysene 8.16 ppm
B(k)fluoranthene 2.67 ppm
Indeno(1,2,3-cd)pyrene 8.22 ppm

PCB (ppm)

1242	1254	1260	TOTAL
0.07	0.00	0.05	0.12

PCB Congeners (ppb)

#1	#5	#29	#50	#87	#154	#188	#200	#209
16.09				0.39				8.12

#44	#52	#77	#101	#118	#126	#138	#153	#180
0.34	11.31	9.90	12.07	7.24	0.82	10.47	2.43	4.27

CL-HC (by MSD)

Lindane ND < .05 ppm
Mirex ND < .1 ppm
Chlordane ND < .5 ppm
Methoxychlor ND < .1 ppm

2,4-dinitrophenol

ND < 10 ppm

VC12-11

PAH

Naphthalene 1.26 ppm	Acenaphthylene 1.24 ppm
Acenaphthene 0.35 ppm	Fluorene 1.04 ppm
Phenanthrene 4.07 ppm	Anthracene 2.69 ppm
Fluoranthene 8.13 ppm	Pyrene 7.99 ppm
B(a)anthracene 5.10 ppm	Chrysene 8.34 ppm
B(b)fluoranthene 4.57 ppm	B(k)fluoranthene 3.10 ppm
B(a)pyrene 3.90 ppm	Indeno(1,2,3-cd)pyrene 8.18 ppm
Dibenzo(a,h)anthracene 0.96 ppm	
Benzo(g,h,i)perylene 5.45 ppm	

PCB (ppm)

1242	1254	1260	TOTAL
0.08	0.00	0.02	0.10

PCB Congeners (ppb)

#1	#5	#29	#50	#87	#154	#188	#200	#209
25.34				1.78				

#44	#52	#77	#101	#118	#126	#138	#153	#180
0.45	8.01	7.33	5.00	3.25	0.00	3.10	0.33	1.38

CL-HC (by MSD)

Lindane ND < .05 ppm	Chlordane ND < .5 ppm
Mirex ND < .1 ppm	Methoxychlor ND < .1 ppm

2,4-dinitrophenol

ND < 10 ppm

VC12-12

PAH

Naphthalene 2.08 ppm
Acenaphthene 0.73 ppm
Phenanthrene 5.58 ppm
Fluoranthene 11.16 ppm
B(a)anthracene 6.97 ppm
B(b)fluoranthene 7.61 ppm
B(a)pyrene 6.46 ppm
Dibenzo(a,h)anthracene 1.88 ppm
Benzo(g,h,i)perylene 10.08 ppm
Acenaphthylene 2.38 ppm
Fluorene 1.63 ppm
Anthracene 3.25 ppm
Pyrene 10.40 ppm
Chrysene 10.54 ppm
B(k)fluoranthene 5.17 ppm
Indeno(1,2,3-cd)pyrene 16.06 ppm

PCB (ppm)

1242	1254	1260	TOTAL
0.03	0.01	0.00	0.04

PCB Congeners (ppb)

#1	#5	#29	#50	#87	#154	#188	#200	#209
24.42				0.71				

#44	#52	#77	#101	#118	#126	#138	#153	#180
0.00	0.00	10.53	4.49	6.15	0.00	6.85	0.00	0.00

CL-HC (by MSD)

Lindane ND < .05 ppm
Mirex ND < .1 ppm
Chlordane ND < .5 ppm
Methoxychlor ND < .1 ppm

2,4-dinitrophenol

ND < 10 ppm

VC12-13

PAH

Naphthalene 1.61 ppm	Acenaphthylene 1.78 ppm
Acenaphthene 0.39 ppm	Fluorene 1.44 ppm
Phenanthrene 5.47 ppm	Anthracene 3.05 ppm
Fluoranthene 10.44 ppm	Pyrene 10.83 ppm
B(a)anthracene 6.85 ppm	Chrysene 10.97 ppm
B(b)fluoranthene 5.80 ppm	B(k)fluoranthene 3.94 ppm
B(a)pyrene 5.16 ppm	Indeno(1,2,3-cd)pyrene 10.73 ppm
Dibenzo(a,h)anthracene 1.35 ppm	
Benzo(g,h,i)perylene 9.28 ppm	

PCB (ppm)

1242	1254	1260	TOTAL
0.04	0.01	0.00	0.05

PCB Congeners (ppb)

#1	#5	#29	#50	#87	#154	#188	#200	#209
51.77				5.02				1.27

#44	#52	#77	#101	#118	#126	#138	#153	#180
0.00	3.03	17.36	1.74	2.22	0.00	6.54	1.08	0.51

CL-HC (by MSD)

Lindane ND < .05 ppm	Chlordane ND < .5 ppm
Mirex ND < .1 ppm	Methoxychlor ND < .1 ppm

2,4-dinitrophenol

ND < 10 ppm

VC12-14

PAH

Naphthalene 0.63 ppm	Acenaphthylene 1.25 ppm
Acenaphthene 0.32 ppm	Fluorene 1.16 ppm
Phenanthrene 4.59 ppm	Anthracene 2.51 ppm
Fluoranthene 8.82 ppm	Pyrene 9.08 ppm
B(a)anthracene 5.76 ppm	Chrysene 9.37 ppm
B(b)fluoranthene 5.10 ppm	B(k)fluoranthene 3.46 ppm
B(a)pyrene 4.47 ppm	Indeno(1,2,3-cd)pyrene 16.59 ppm
Dibenzo(a,h)anthracene 1.73 ppm	
Benzo(g,h,i)perylene 6.50 ppm	

PCB (ppm)

1242	1254	1260	TOTAL
0.02	0.00	0.00	0.02

PCB Congeners (ppb)

#1	#5	#29	#50	#87	#154	#188	#200	#209
9.84								1.12

#44	#52	#77	#101	#118	#126	#138	#153	#180
0.00	0.00	7.07	0.00	0.00	0.00	3.55	0.00	0.00

CL-HC (by MSD)

Lindane ND < .05 ppm	Chlordane ND < .5 ppm
Mirex ND < .1 ppm	Methoxychlor ND < .1 ppm

2,4-dinitrophenol

ND < 10 ppm

VC12-15

PAH

Naphthalene 1.56 ppm
Acenaphthene 0.38 ppm
Phenanthrene 4.14 ppm
Fluoranthene 7.53 ppm
B(a)anthracene 4.81 ppm
B(b)fluoranthene 4.63 ppm
B(a)pyrene 4.07 ppm
Dibenzo(a,h)anthracene 1.62 ppm
Benzo(g,h,i)perylene 6.30 ppm

Acenaphthylene 1.05 ppm
Fluorene 1.09 ppm
Anthracene 2.12 ppm
Pyrene 7.65 ppm
Chrysene 8.08 ppm
B(k)fluoranthene 3.14 ppm
Indeno(1,2,3-cd)pyrene 15.41 ppm

PCB (ppm)

1242	1254	1260	TOTAL
0.02	0.00	0.00	0.02

PCB Congeners (ppb)

#1	#5	#29	#50	#87	#154	#188	#200	#209
25.65								0.91

#44	#52	#77	#101	#118	#126	#138	#153	#180
0.00	0.00	6.36	0.00	0.00	0.00	3.24	0.00	0.00

CL-HC (by MSD)

Lindane ND < .05 ppm
Mirex ND < .1 ppm

Chlordane ND < .5 ppm
Methoxychlor ND < .1 ppm

2,4-dinitrophenol

ND < 10 ppm

VC36-1

PAH

Naphthalene 0.75 ppm	Acenaphthylene 0.20 ppm
Acenaphthene 0.27 ppm	Fluorene 0.82 ppm
Phenanthrene 4.16 ppm	Anthracene 1.28 ppm
Fluoranthene 8.44 ppm	Pyrene 7.93 ppm
B(a)anthracene 2.84 ppm	Chrysene 3.10 ppm
B(b)fluoranthene 4.97 ppm	B(k)fluoranthene 3.38 ppm
B(a)pyrene 4.15 ppm	Indeno(1,2,3-cd)pyrene 15.39 ppm
Dibenzo(a,h)anthracene 1.47 ppm	
Benzo(g,h,i)perylene 9.32 ppm	

PCB (ppm)

1242	1254	1260	TOTAL
0.73	0.00	0.37	1.10

PCB Congeners (ppb)

#1	#5	#29	#50	#87	#154	#188	#200	#209
25.86		1.14		16.18				3.92

#44	#52	#77	#101	#118	#126	#138	#153	#180
63.76	71.08	69.17	51.89	16.07	59.08	33.98	19.76	31.70

CL-HC (by MSD)

Lindane ND < .05 ppm	Chlordane ND < .5 ppm
Mirex ND < .1 ppm	Methoxychlor ND < .1 ppm

2,4-dinitrophenol

ND < 10 ppm

VC36-2

PAH

Naphthalene	0.55 ppm	Acenaphthylene	0.12 ppm
Acenaphthene	0.31 ppm	Fluorene	0.82 ppm
Phenanthrene	3.47 ppm	Anthracene	0.79 ppm
Fluoranthene	8.55 ppm	Pyrene	7.55 ppm
B(a)anthracene	3.02 ppm	Chrysene	6.08 ppm
B(b)fluoranthene	5.45 ppm	B(k)fluoranthene	3.16 ppm
B(a)pyrene	3.80 ppm	Indeno(1,2,3-cd)pyrene	16.26 ppm
Dibenzo(a,h)anthracene	1.03 ppm		
Benzo(g,h,i)perylene	5.93 ppm		

PCB (ppm)

1242	1254	1260	TOTAL
0.61	0.00	0.31	0.92

PCB Congeners (ppb)

#1	#5	#29	#50	#87	#154	#188	#200	#209
65.36		2.15		13.24				3.99

#44	#52	#77	#101	#118	#126	#138	#153	#180
54.67	57.49	50.23	44.53	11.90	1.70	24.88	7.03	24.61

CL-HC (by MSD)

Lindane	ND < .05 ppm	Chlordane	ND < .5 ppm
Mirex	ND < .1 ppm	Methoxychlor	ND < .1 ppm

2,4-dinitrophenol

ND < 10 ppm

VC36-3

PAH

Naphthalene 0.47 ppm	Acenaphthylene 0.12 ppm
Acenaphthene 0.41 ppm	Fluorene 1.41 ppm
Phenanthrene 4.24 ppm	Anthracene 1.22 ppm
Fluoranthene 9.90 ppm	Pyrene 8.14 ppm
B(a)anthracene 3.39 ppm	Chrysene 6.70 ppm
B(b)fluoranthene 5.47 ppm	B(k)fluoranthene 3.71 ppm
B(a)pyrene 4.87 ppm	Indeno(1,2,3-cd)pyrene 17.34 ppm
Dibenzo(a,h)anthracene 1.63 ppm	
Benzo(g,h,i)perylene 10.62 ppm	

PCB (ppm)

1242	1254	1260	TOTAL
0.94	0.00	0.45	1.39

PCB Congeners (ppb)

#1	#5	#29	#50	#87	#154	#188	#200	#209
52.64		5.03		17.00				20.32

#44	#52	#77	#101	#118	#126	#138	#153	#180
59.05	76.35	66.71	48.46	12.95	53.43	31.06	18.54	30.01

CL-HC (by MSD)

Lindane ND < .05 ppm	Chlordane ND < .5 ppm
Mirex ND < .1 ppm	Methoxychlor ND < .1 ppm

2,4-dinitrophenol

ND < 10 ppm

VC36-4

PAH

Naphthalene 0.51 ppm
Acenaphthene 0.33 ppm
Phenanthrene 3.53 ppm
Fluoranthene 8.49 ppm
B(a)anthracene 3.08 ppm
B(b)fluoranthene 5.21 ppm
B(a)pyrene 3.64 ppm
Dibenzo(a,h)anthracene 0.98 ppm
Benzo(g,h,i)perylene 5.36 ppm

Acenaphthylene 0.14 ppm
Fluorene 0.93 ppm
Anthracene 0.95 ppm
Pyrene 7.35 ppm
Chrysene 6.32 ppm
B(k)fluoranthene 3.54 ppm
Indeno(1,2,3-cd)pyrene 16.05 ppm

PCB (ppm)

1242	1254	1260	TOTAL
1.05	0.00	0.30	1.35

PCB Congeners (ppb)

#1	#5	#29	#50	#87	#154	#188	#200	#209
3.98		3.16		21.32				4.70

#44	#52	#77	#101	#118	#126	#138	#153	#180
85.56	104.33	97.91	62.03	21.69	11.38	37.57	31.62	35.25

CL-HC (by MSD)

Lindane ND < .05 ppm
Mirex ND < .1 ppm

Chlordane ND < .5 ppm
Methoxychlor ND < .1 ppm

2,4-dinitrophenol

ND < 10 ppm

VC36-5

PAH

Naphthalene 0.60 ppm	Acenaphthylene 0.15 ppm
Acenaphthene 0.34 ppm	Fluorene 1.14 ppm
Phenanthrene 4.11 ppm	Anthracene 1.01 ppm
Fluoranthene 8.93 ppm	Pyrene 7.47 ppm
B(a)anthracene 3.04 ppm	Chrysene 6.30 ppm
B(b)fluoranthene 4.98 ppm	B(k)fluoranthene 3.39 ppm
B(a)pyrene 4.20 ppm	Indeno(1,2,3-cd)pyrene 14.82 ppm
Dibenzo(a,h)anthracene 1.46 ppm	
Benzo(g,h,i)perylene 9.12 ppm	

PCB (ppm)

1242	1254	1260	TOTAL
1.10	0.00	0.43	1.53

PCB Congeners (ppb)

#1	#5	#29	#50	#87	#154	#188	#200	#209
60.45		3.81		15.18				1.98

#44	#52	#77	#101	#118	#126	#138	#153	#180
51.63	73.92	24.53	37.23	17.93	4.11	39.01	12.22	24.07

CL-HC (by MSD)

Lindane ND < .05 ppm	Chlordane ND < .5 ppm
Mirex ND < .1 ppm	Methoxychlor ND < .1 ppm

2,4-dinitrophenol

ND < 10 ppm

VC36-6

PAH

Naphthalene 0.56 ppm
Acenaphthylene 0.15 ppm
Acenaphthene 0.41 ppm
Fluorene 1.15 ppm
Phenanthrene 4.16 ppm
Anthracene 1.14 ppm
Fluoranthene 9.04 ppm
Pyrene 8.09 ppm
B(a)anthracene 3.41 ppm
Chrysene 6.36 ppm
B(b)fluoranthene 6.89 ppm
B(k)fluoranthene 2.38 ppm
B(a)pyrene 4.24 ppm
Indeno(1,2,3-cd)pyrene 16.85 ppm
Dibenzo(a,h)anthracene 1.07 ppm
Benzo(g,h,i)perylene 5.79 ppm

PCB (ppm)

1242	1254	1260	TOTAL
0.91	0.01	0.34	1.26

PCB Congeners (ppb)

#1	#5	#29	#50	#87	#154	#188	#200	#209
83.57		0.87		17.25				

#44	#52	#77	#101	#118	#126	#138	#153	#180
61.70	85.84	78.10	43.31	15.53	4.65	45.51	13.12	27.10

CL-HC (by MSD)

Lindane ND < .05 ppm
Chlordane ND < .5 ppm
Mirex ND < .1 ppm
Methoxychlor ND < .1 ppm

2,4-dinitrophenol

ND < 10 ppm

VC36-7

PAH

Naphthalene 0.55 ppm	Acenaphthylene 0.30 ppm
Acenaphthene 1.02 ppm	Fluorene 1.85 ppm
Phenanthrene 6.95 ppm	Anthracene 2.05 ppm
Fluoranthene 13.57 ppm	Pyrene 11.37 ppm
B(a)anthracene 4.59 ppm	Chrysene 9.60 ppm
B(b)fluoranthene 6.99 ppm	B(k)fluoranthene 4.75 ppm
B(a)pyrene 5.02 ppm	Indeno(1,2,3-cd)pyrene 18.02 ppm
Dibenzo(a,h)anthracene 1.58 ppm	
Benzo(g,h,i)perylene 23.42 ppm	

PCB (ppm)

1242	1254	1260	TOTAL
0.99	0.00	0.36	1.35

PCB Congeners (ppb)

#1	#5	#29	#50	#87	#154	#188	#200	#209
58.07		2.94		21.74				3.88

#44	#52	#77	#101	#118	#126	#138	#153	#180
77.38	98.55	94.99	60.99	21.14	5.44	51.08	35.55	33.44

CL-HC (by MSD)

Lindane ND < .05 ppm	Chlordane ND < .5 ppm
Mirex ND < .1 ppm	Methoxychlor ND < .1 ppm

2,4-dinitrophenol

ND < 10 ppm

VC36-8

PAH

Naphthalene 1.36 ppm
Acenaphthene 1.19 ppm
Phenanthrene 6.41 ppm
Fluoranthene 13.48 ppm
B(a)anthracene 5.12 ppm
B(b)fluoranthene 8.67 ppm
B(a)pyrene 5.66 ppm
Dibenzo(a,h)anthracene 1.81 ppm
Benzo(g,h,i)perylene 9.86 ppm

Acenaphthylene 0.20 ppm
Fluorene 2.15 ppm
Anthracene 2.03 ppm
Pyrene 11.08 ppm
Chrysene 10.49 ppm
B(k)fluoranthene 5.84 ppm
Indeno(1,2,3-cd)pyrene 18.04 ppm

PCB (ppm)

1242	1254	1260	TOTAL
0.92	0.00	0.48	1.40

PCB Congeners (ppb)

#1	#5	#29	#50	#87	#154	#188	#200	#209
43.97		2.88		13.30				0.38

#44	#52	#77	#101	#118	#126	#138	#153	#180
42.79	61.60	59.60	36.69	17.61	0.00	32.07	17.82	29.69

CL-HC (by MSD)

Lindane ND < .05 ppm
Mirex ND < .1 ppm

Chlordane ND < .5 ppm
Methoxychlor ND < .1 ppm

2,4-dinitrophenol

ND < 10 ppm

VC36-9

PAH

Naphthalene 0.38 ppm
Acenaphthene 0.85 ppm
Phenanthrene 7.72 ppm
Fluoranthene 14.74 ppm
B(a)anthracene 6.23 ppm
B(b)fluoranthene 10.58 ppm
B(a)pyrene 7.94 ppm
Dibenzo(a,h)anthracene 1.88 ppm
Benzo(g,h,i)perylene 11.66 ppm

Acenaphthylene 0.28 ppm
Fluorene 1.89 ppm
Anthracene 2.16 ppm
Pyrene 11.82 ppm
Chrysene 12.05 ppm
B(k)fluoranthene 7.25 ppm
Indeno(1,2,3-cd)pyrene 19.22 ppm

PCB (ppm)

1242	1254	1260	TOTAL
1.15	0.00	0.43	1.58

PCB Congeners (ppb)

#1	#5	#29	#50	#87	#154	#188	#200	#209
53.26		2.96		25.28				3.48

#44	#52	#77	#101	#118	#126	#138	#153	#180
83.96	120.54	97.98	63.01	25.25	4.03	48.47	32.16	27.59

CL-HC (by MSD)

Lindane ND < .05 ppm
Mirex ND < .1 ppm

Chlordane ND < .5 ppm
Methoxychlor ND < .1 ppm

2,4-dinitrophenol

ND < 10 ppm

VC36-10

PAH

Naphthalene 2.53 ppm
Acenaphthene 1.21 ppm
Phenanthrene 7.97 ppm
Fluoranthene 13.60 ppm
B(a)anthracene 4.54 ppm
B(b)fluoranthene 5.68 ppm
B(a)pyrene 5.21 ppm
Dibenzo(a,h)anthracene 1.59 ppm
Benzo(g,h,i)perylene 9.85 ppm

Acenaphthylene 0.36 ppm
Fluorene 2.37 ppm
Anthracene 2.64 ppm
Pyrene 10.45 ppm
Chrysene 9.67 ppm
B(k)fluoranthene 3.85 ppm
Indeno(1,2,3-cd)pyrene 15.48 ppm

PCB (ppm)

1242	1254	1260	TOTAL
1.45	0.01	0.35	1.81

PCB Congeners (ppb)

#1	#5	#29	#50	#87	#154	#188	#200	#209
83.26		7.86		33.57				8.42

#44	#52	#77	#101	#118	#126	#138	#153	#180
83.60	144.11	128.54	67.09	27.79	3.76	49.33	19.40	34.05

CL-HC (by MSD)

Lindane ND < .05 ppm
Mirex ND < .1 ppm

Chlordane ND < .5 ppm
Methoxychlor ND < .1 ppm

2,4-dinitrophenol

ND < 10 ppm

VC36-11

PAH

Naphthalene 0.59 ppm
Acenaphthene 0.74 ppm
Phenanthrene 7.24 ppm
Fluoranthene 10.56 ppm
B(a)anthracene 3.62 ppm
B(b)fluoranthene 5.92 ppm
B(a)pyrene 3.72 ppm
Dibenzo(a,h)anthracene 0.80 ppm
Benzo(g,h,i)perylene 5.35 ppm

Acenaphthylene 0.18 ppm
Fluorene 2.25 ppm
Anthracene 2.45 ppm
Pyrene 7.94 ppm
Chrysene 7.77 ppm
B(k)fluoranthene 2.48 ppm
Indeno(1,2,3-cd)pyrene 12.51 ppm

PCB (ppm)

1242	1254	1260	TOTAL
1.10	0.00	0.32	1.42

PCB Congeners (ppb)

#1	#5	#29	#50	#87	#154	#188	#200	#209
58.60		4.49		25.31				1.15

#44	#52	#77	#101	#118	#126	#138	#153	#180
71.71	102.48	91.76	58.89	21.30	3.78	40.53	18.25	23.42

CL-HC (by MSD)

Lindane ND < .05 ppm
Mirex ND < .1 ppm

Chlordane ND < .5 ppm
Methoxychlor ND < .1 ppm

2,4-dinitrophenol

ND < 10 ppm

VC36-12

PAH

Naphthalene 1.13 ppm
Acenaphthene 0.76 ppm
Phenanthrene 4.11 ppm
Fluoranthene 6.35 ppm
B(a)anthracene 2.77 ppm
B(b)fluoranthene 4.05 ppm
B(a)pyrene 3.14 ppm
Dibenzo(a,h)anthracene 0.72 ppm
Benzo(g,h,i)perylene 5.13 ppm

Acenaphthylene 0.13 ppm
Fluorene 1.53 ppm
Anthracene 1.49 ppm
Pyrene 4.80 ppm
Chrysene 4.48 ppm
B(k)fluoranthene 2.75 ppm
Indeno(1,2,3-cd)pyrene 8.09 ppm

PCB (ppm)

1242	1254	1260	TOTAL
0.73	0.00	0.18	0.91

PCB Congeners (ppb)

#1	#5	#29	#50	#87	#154	#188	#200	#209
62.40		4.65		15.28				

#44	#52	#77	#101	#118	#126	#138	#153	#180
40.95	67.84	59.61	73.82	15.19	0.00	25.37	9.76	23.78

CL-HC (by MSD)

Lindane ND < .05 ppm
Mirex ND < .1 ppm

Chlordane ND < .5 ppm
Methoxychlor ND < .1 ppm

2,4-dinitrophenol

ND < 10 ppm

VC36-13

PAH

Naphthalene 0.02 ppm
Acenaphthene 0.34 ppm
Phenanthrene 4.35 ppm
Fluoranthene 5.38 ppm
B(a)anthracene 1.87 ppm
B(b)fluoranthene 2.07 ppm
B(a)pyrene 1.89 ppm
Dibenzo(a,h)anthracene 0.48 ppm
Benzo(g,h,i)perylene 2.63 ppm

Acenaphthylene 0.09 ppm
Fluorene 1.00 ppm
Anthracene 1.15 ppm
Pyrene 4.23 ppm
Chrysene 3.52 ppm
B(k)fluoranthene 1.40 ppm
Indeno(1,2,3-cd)pyrene 4.87 ppm

PCB (ppm)

1242	1254	1260	TOTAL
0.15	0.00	0.07	0.22

PCB Congeners (ppb)

#1	#5	#29	#50	#87	#154	#188	#200	#209
22.12		2.51		2.12				0.44

#44	#52	#77	#101	#118	#126	#138	#153	#180
3.06	6.83	11.17	8.90	1.89	0.00	3.40	3.06	2.62

CL-HC (by MSD)

Lindane ND < .05 ppm
Mirex ND < .1 ppm

Chlordane ND < .5 ppm
Methoxychlor ND < .1 ppm

2,4-dinitrophenol

ND < 10 ppm

VC36-14

PAH

Naphthalene 0.17 ppm	Acenaphthylene ND <.10 ppm
Acenaphthene 0.15 ppm	Fluorene 0.22 ppm
Phenanthrene 0.65 ppm	Anthracene 0.18 ppm
Fluoranthene 1.26 ppm	Pyrene 0.95 ppm
B(a)anthracene 0.32 ppm	Chrysene 0.75 ppm
B(b)fluoranthene 0.52 ppm	B(k)fluoranthene 0.36 ppm
B(a)pyrene 0.44 ppm	Indeno(1,2,3-cd)pyrene 1.41 ppm
Dibenzo(a,h)anthracene 0.09 ppm	
Benzo(g,h,i)perylene 0.96 ppm	

PCB (ppm)

1242	1254	1260	TOTAL
0.08	0.00	0.04	0.12

PCB Congeners (ppb)

#1	#5	#29	#50	#87	#154	#188	#200	#209
26.14				1.83				

#44	#52	#77	#101	#118	#126	#138	#153	#180
5.05	9.82	8.10	4.02	2.23	0.00	4.71	0.82	2.05

CL-HC (by MSD)

Lindane ND < .05 ppm	Chlordane ND < .5 ppm
Mirex ND < .1 ppm	Methoxychlor ND < .1 ppm

2,4-dinitrophenol

ND < 10 ppm

VC36-15

PAH

Naphthalene 0.19 ppm
Acenaphthene 0.23 ppm
Phenanthrene 0.93 ppm
Fluoranthene 1.24 ppm
B(a)anthracene 0.35 ppm
B(b)fluoranthene 0.55 ppm
B(a)pyrene 0.46 ppm
Dibenzo(a,h)anthracene 0.11 ppm
Benzo(g,h,i)perylene 0.94 ppm

Acenaphthylene 0.01 ppm
Fluorene 0.25 ppm
Anthracene 0.12 ppm
Pyrene 0.96 ppm
Chrysene 0.82 ppm
B(k)fluoranthene 0.37 ppm
Indeno(1,2,3-cd)pyrene 1.44 ppm

PCB (ppm)

1242	1254	1260	TOTAL
0.08	0.00	0.03	0.11

PCB Congeners (ppb)

#1	#5	#29	#50	#87	#154	#188	#200	#209
18.65		2.14						

#44	#52	#77	#101	#118	#126	#138	#153	#180
4.90	9.36	7.91	4.30	1.79	0.00	4.34	1.56	1.98

CL-HC (by MSD)

Lindane ND < .05 ppm
Mirex ND < .1 ppm

Chlordane ND < .5 ppm
Methoxychlor ND < .1 ppm

2,4-dinitrophenol

ND < 10 ppm

Cs-137 Measurements

The results of Cs-137 counting on 6 cores i.e. VC-2, VC-6, VC-7, VC-9, VC-12, VC34/35, and VC-36 are summarized here. Pellets were made for VC-7, VC-12, VC-36, and VC-34/35 during May and June, 1992 and for VC-2, and VC-6 during August 1992.

At VC-2 (Milwaukee River), activity of Cs-137 is maximal at 126 - 135 cm depth and has an increasing trend downwards which agrees with the Pb-210 data (Progress Report # 2) and may suggest that, cores deeper than 135 cm may be needed for further studies. From the Pb-210 data, the bottom of this core is from 1975.

For VC-6 (South Menomonee Canal), activity of the Cs-137 activity is maximal at 0-6 cm depth and could be counted up to 36-42 cm depth, and beyond 42 cm depth no activity could be counted. After 30 cm depth, the sample is mostly pure clay and has low % TOC values. From the Pb-210 data, the bottom of layer 4 is from 1973. Because of the low PB-210 and Cs-137 activities below the fourth layer, it appears likely that the area was dredged around 1973.

VC-7 (Kinnickinnic River) has maximum Cs-137 activity at 90-99 cm depth (1963). Pellets for 36-45 cm depth could not be formed, as the sample consists of pure sand. This layer also contains lowest levels of PCB, PAH, and %TOC values. From the Pb-210 data, the bottom of this core is from 1941.

VC-9 (Harbor Entrance) has the maximum Cs-137 activity at 49-56 cm depth (1963). From the Pb-210 data the bottom of this core is from 1939.

VC-12 (Outer Harbor) has the maximum Cs-137 activity at 20-25 cm depth (1963). The activity profile with depth supports the timing of the PCB concentrations in the core. The bottom of this core (80 cm) is from 1912.

VC-34/35 (Menomonee River) has the maximum Cs-137 activity at 126-135 cm depth. There is a general increase in Cs-137 activity with depth, which agrees with the Pb-210 date at the bottom of 1966.

VC-36 (South Menomonee Canal) has maximum Cs-137 activity at 90-100 cm depth. The decline below layer 9 may be related to dredging around 1970 (Gin, 1992). The Pb-210 activities and %TOC values also drop beyond this layer.

Depth vs activity graphs for VC-2, VC-6, VC-7, VC-9, VC-12, VC-34/35, and VC-36 along with tables of calculations for VC-6, VC-7, VC-34/35, and VC-36 are enclosed. Tables of calculations for VC-9 (Progress Report # 2), VC-12, and VC-36 (Progress Report # 3) have already been submitted in previous reports. Sampling and porosity, LOI, and TOC measurements are described in Progress Report # 1. Information on sources of PAHs may be found in the M.S. Thesis of A.K.Singh (1992).

REFERENCES

Gin, M.F. and E.R.Christensen, December 1991, Sampling Site Location and Measurements of Porosity, LOI, and TOC, Progress Report # 1 to WCMP.

Gin, M.F. and E.R.Christensen, April 1992, Pb-210 and Cs-137 Measurements, Progress Report # 2 to WCMP.

Ni, F., A.K.Singh, and E.R.Christensen, July 1992, Measurements of Priority Organics and Cs-137, Progress Report # 3 to WCMP.

Gin, M.F. 1992, Sedimentation Patterns of the Milwaukee Harbor Estuary Determined from TOC, Pb-210, and Cs-137, M.S. Thesis, Department of Civil Engineering and Mechanics, University of Wisconsin-Milwaukee.

Singh, A.K. 1992, A Source Receptor Method for Determining Non-point Sources of PAHs to Milwaukee Harbor Estuary. M.S. Thesis, Department of Civil Engineering and Mechanics, University of Wisconsin-Milwaukee.

STATION: VC-2
LOCATION: 43 Deg.02.92'N Milwaukee River
87 Deg.54.70'W Cherry Street Bridge
WATER DEPTH: 2.2 m (7.3ft)
CORE TYPE: Push Core
CORE LENGTH: Core pushed 3m down, only a 1.45 m core retrived
DATE SAMPLED: 10/16/91

Core	Area	Depth (cms)	Weight (gms)	Height (cms)	Count Date	η	Correction factor	Cs-137 (dpm/gm)	Uncertainty (dpm/gm)
VC2-1	288	0-9	28.55	0.774	08/07/92	0.011	1.019	0.847	0.071
VC2-2	343	9-18	27.49	0.714	08/08/92	0.011	1.019	1.047	0.077
VC2-3	277	18-27	26.97	0.714	08/09/92	0.011	1.019	0.862	0.071
VC2-4	367	27-36	26.05	0.675	08/10/92	0.011	1.019	1.182	0.077
VC2-5	421	36-45	25.52	0.694	08/11/92	0.011	1.019	1.385	0.085
VC2-6	402	45-54	25.40	0.635	08/12/92	0.011	1.019	1.328	0.081
VC2-7	384	54-63	23.47	0.635	08/13/92	0.011	1.019	1.373	0.095
VC2-8	448	63-72	22.71	0.635	08/14/92	0.011	1.019	1.656	0.098
VC2-9	508	72-81	21.91	0.635	08/15/92	0.011	1.019	1.946	0.109
VC2-10	551	81-90	21.21	0.556	08/16/92	0.012	1.019	1.999	0.104
VC2-11	633	90-99	19.46	0.556	08/17/92	0.012	1.019	2.503	0.114
VC2-12	611	99-108	19.47	0.556	08/18/92	0.012	1.020	2.417	0.117
VC2-13	620	108-117	19.74	0.556	08/19/92	0.012	1.020	2.419	0.117
VC2-14	704	117-126	19.09	0.556	08/20/92	0.012	1.020	2.840	0.124
VC2-15	874	126-135	17.31	0.556	08/21/92	0.012	1.020	3.889	0.149

live time 70000 seconds

STATION: VC-6
LOCATION: 43 Deg. 01.89' N Menomonee River
87 Deg. 54.91'W
WATER DEPTH: 20m
CORE TYPE: Long gravity core
CORE LENGTH: 1m.
DATE SAMPLED: 10/30/91

Core	Area	Depth (cms)	Weight (gms)	Height (cms)	Count Date	η	Correction factor	Cs-137 (dpm/gm)	Uncertainty (dpm/gm)
VC6-1	267	0-6	21.26	0.556	08/22/92	0.012	1.019	0.966	0.083
VC6-2	231	6-12	24.96	0.714	08/24/92	0.011	1.019	0.777	0.077
VC6-3	246	12-18	31.83	0.794	08/25/92	0.011	1.019	0.649	0.059
VC6-4	179	18-24	34.78	0.794	08/26/92	0.011	1.019	0.432	0.046
VC6-5	016	24-30	21.36	0.635	08/27/92	0.011	1.019	0.063	0.056
VC6-6	005	30-36	22.81	0.635	08/29/92	0.011	1.019	0.018	0.055
VC6-7	008	36-42	22.81	0.635	08/31/92	0.011	1.019	0.029	0.053
VC6-8	-20	42-48	22.68	0.635	09/01/92	0.011	1.020	0.000	0.000
VC6-12	-35	66-72	21.88	0.556	09/02/92	0.012	1.020	0.000	0.000

live time 70000 seconds

STATION: VC-7
LOCATION: 43 Deg.00.50'N Kinnickinnic River
87 Deg 54.59'N
WATER DEPTH: 2.8 m 9.8(ft)
CORE DEPTH: Push Core
CORE LENGTH Core pushed 2.25 m down,only a 1.45 m core retrieved
DATE SAMPLED: 10/14/91

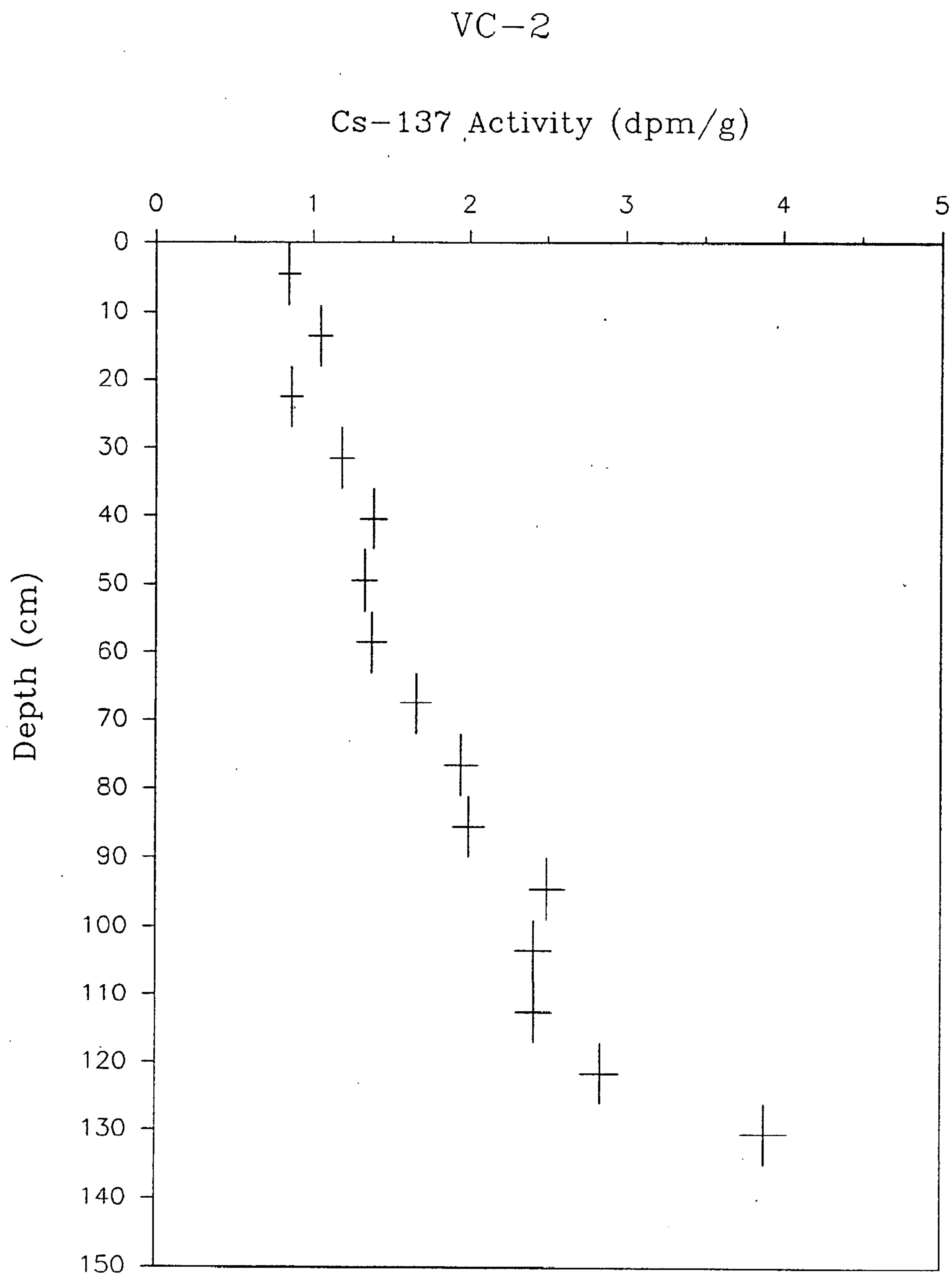
Core	Area	Depth (cms)	Weight (gms)	Height (cms)	Count Date	η	Correction factor	Cs-137 (dpm/gm)	Uncertainty (dpm/gm)
VC7-1	125	0-9	24.84	0.714	07/07/92	0.011	1.017	0.4144	0.0682
VC7-2	161	9-18	25.47	0.714	07/08/92	0.011	1.017	0.5206	0.0557
VC7-3	183	18-27	24.51	0.714	07/09/92	0.011	1.017	0.6149	0.0609
VC7-4	58	27-36	26.12	0.714	07/10/92	0.011	1.017	0.1829	0.0557
VC7-6	479	45-54	22.04	0.635	07/11/92	0.011	1.017	1.7497	0.1010
VC7-7	660	54-63	24.34	0.556	07/13/92	0.012	1.017	2.1341	0.1075
VC7-8	1455	63-72	24.79	0.635	07/15/92	0.011	1.017	4.7263	0.1407
VC7-9	1781	72-81	21.44	0.516	07/16/92	0.012	1.018	6.4651	0.1656
VC7-10	2064	81-90	25.01	0.595	07/17/92	0.012	1.018	6.5711	0.1580
VC7-11	3194	90-99	25.21	0.635	07/18/92	0.011	1.018	10.2043	0.1910
VC7-12	1452	99-108	25.15	0.635	07/19/92	0.011	1.018	4.6502	0.1344
VC7-13	1038	108-117	24.85	0.714	07/20/92	0.011	1.018	3.4425	0.1235
VC7-14	1142	117-126	24.36	0.635	07/21/92	0.011	1.018	3.7765	0.1337
VC7-15	442	126-135	25.09	0.714	07/22/92	0.011	1.018	1.4520	0.0867

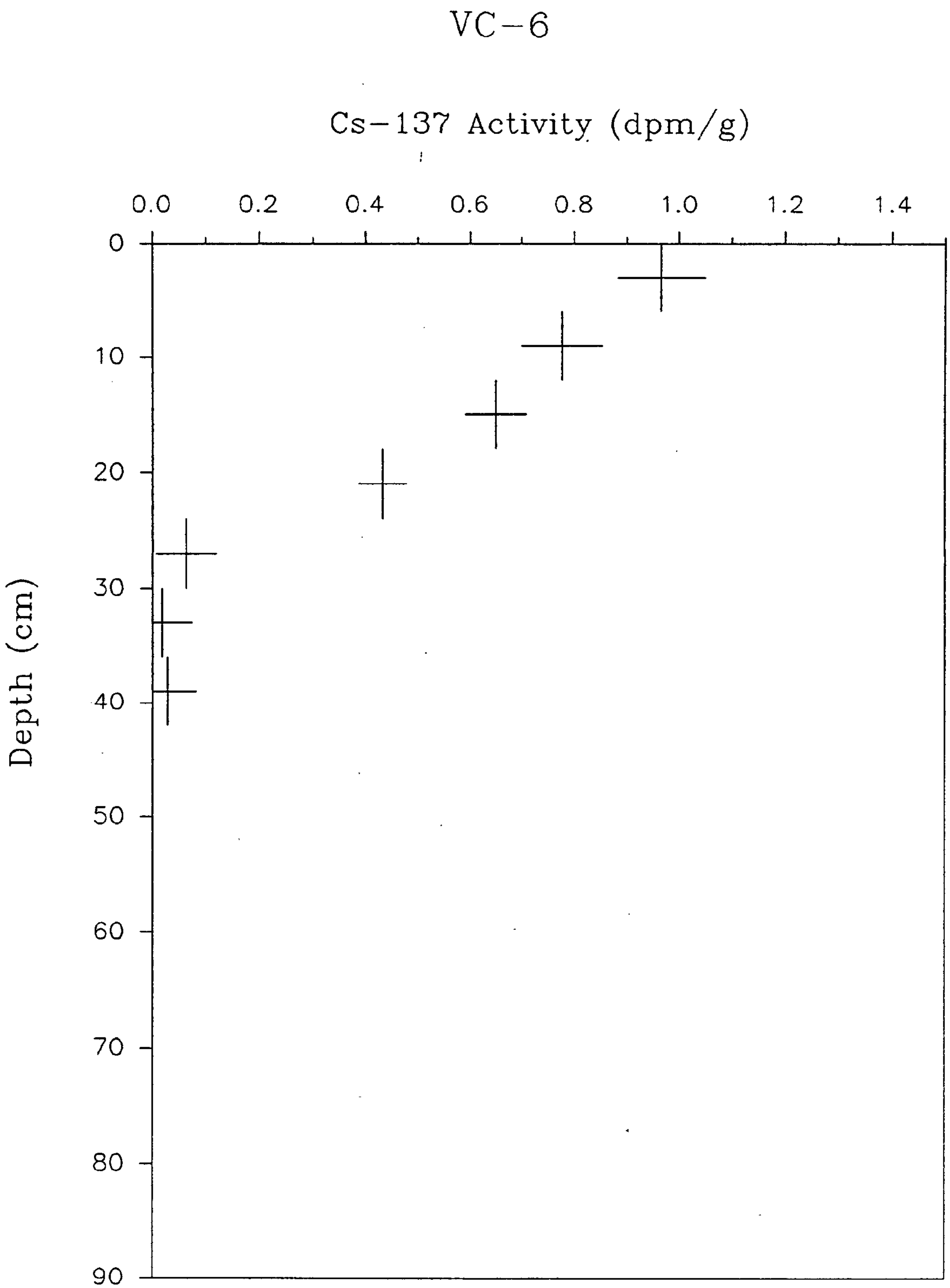
live time 70000 seconds

STATION: VC-34/35
LOCATION: 43 Deg.01.99'N Menomonee River
87 Deg 55.18'N
WATER DEPTH: 5.2 m 17(ft)
CORE DEPTH: Push Core
CORE LENGTH Core pushed 2.25 m down,only a 1.45 m core retrieved
DATE SAMPLED: 10/16/91

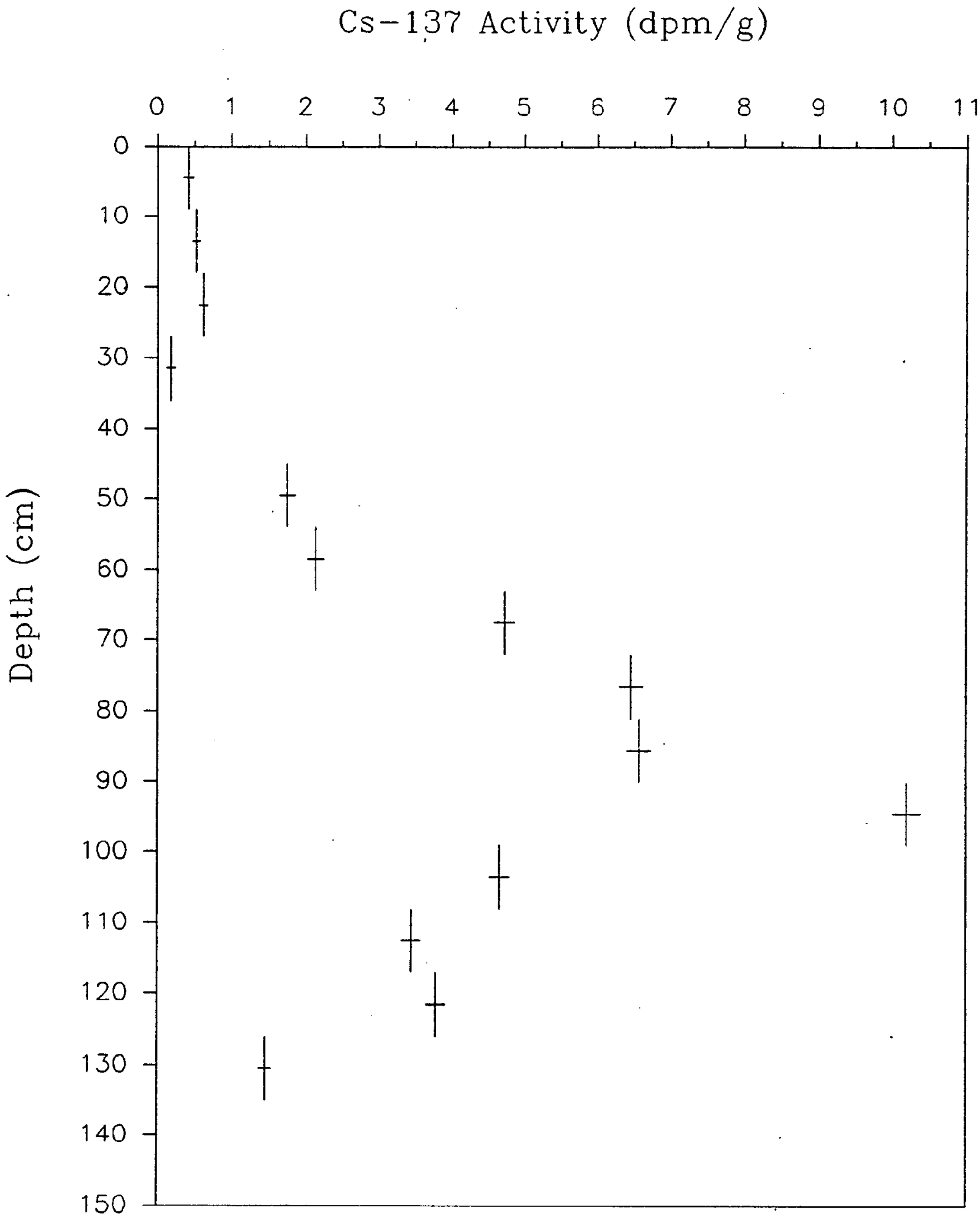
Core	Area	Depth (cms)	Weight (gms)	Height (cms)	Count Date	η	Correction factor	Cs-137 (dpm/gm)	Uncertainty (dpm/gm)
VC34/35-1	302	0-9	26.99	0.714	07/23/92	0.0112	1.018	0.922	0.0750
VC34/35-2	260	9-18	27.99	0.714	07/24/92	0.0112	1.018	0.766	0.0707
VC34/35-3	393	18-27	27.59	0.714	07/25/92	0.0112	1.018	1.174	0.0756
VC34/35-4	358	27-36	28.16	0.794	07/26/92	0.0109	1.018	1.072	0.0785
VC34/35-5	368	36-45	26.57	0.714	07/27/92	0.0112	1.018	1.142	0.0789
VC34/35-6	487	45-54	28.51	0.714	07/28/92	0.0137	1.018	1.408	0.0823
VC34/35-7	445	54-63	29.52	0.794	07/29/92	0.0109	1.018	1.272	0.0795
VC34/35-8	360	63-72	24.76	0.714	07/30/92	0.0112	1.018	1.199	0.0885
VC34/35-9	511	72-81	28.44	0.794	07/31/92	0.0109	1.018	1.516	0.0859
VC34/35-10	797	81-90	32.41	0.794	08/01/92	0.0109	1.018	2.075	0.0850
VC34/35-11	688	90-99	28.52	0.794	08/02/92	0.0109	1.019	2.036	0.0926
VC34/35-12	691	99-108	28.87	0.794	08/03/92	0.0109	1.019	2.020	0.0932
VC34/35-13	722	108-117	25.23	0.714	08/04/92	0.0112	1.019	1.845	0.1085
VC34/35-14	640	117-126	25.12	0.655	08/05/92	0.0114	1.019	2.066	0.0988
VC34/35-15	761	126-135	26.82	0.714	08/06/92	0.0112	1.019	2.341	0.1083

live time 70000 seconds


VC-2
Cs-137 Activity (dpm/g)
0
1
2
3
4
5
Depth (cm)
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150


VC-6
Cs-137 Activity (dpm/g)
0.0
0.2
0.4
0.6
0.8
1.0
1.2
1.4
Depth (cm)
0
10
20
30
40
50
60
70
80
90

VC-7


Cs-137 Activity (dpm/g)
0
1
2
3
4
5
6
7
8
9
10
11
Depth (cm)
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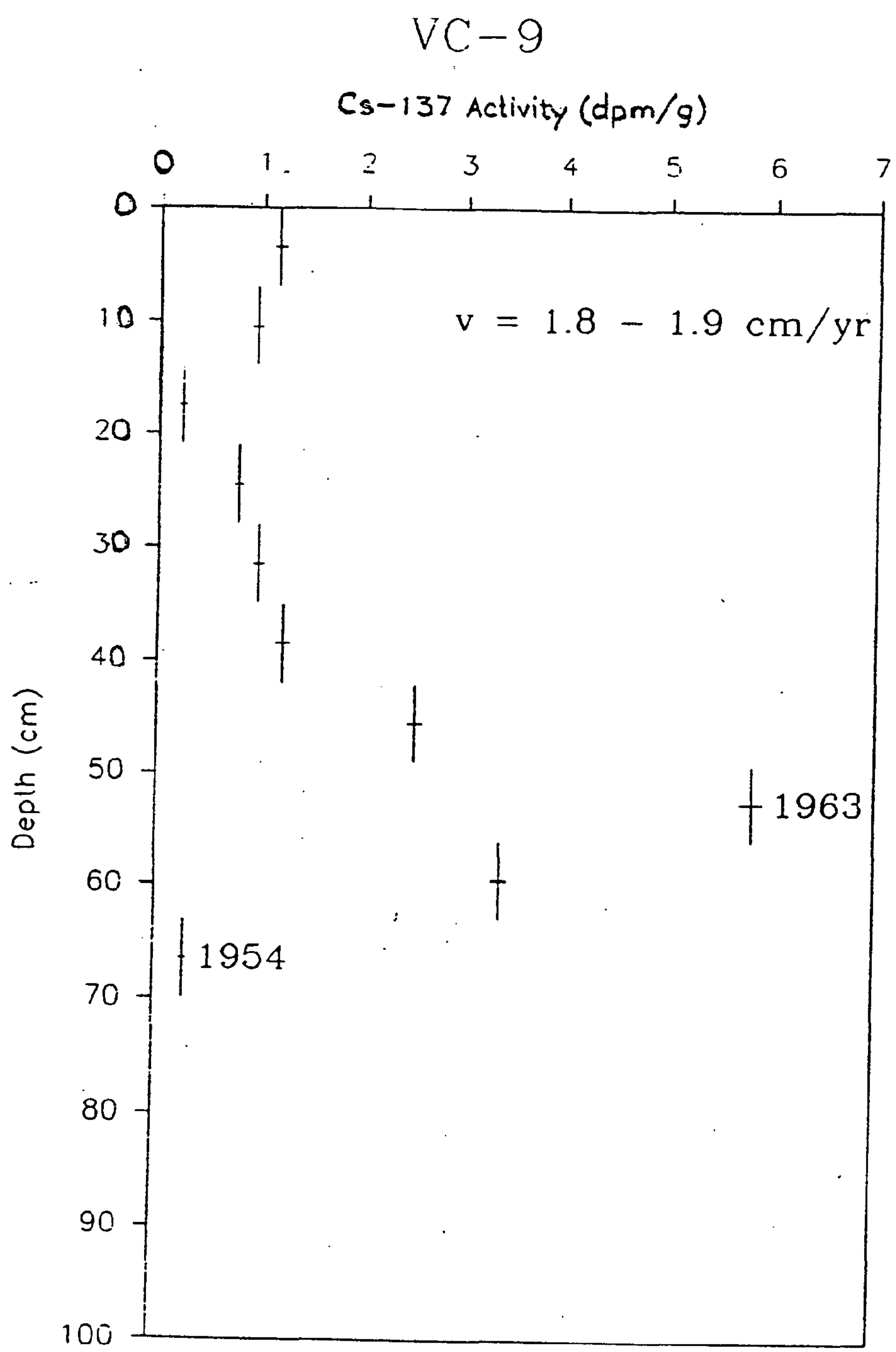
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150


VC-9
Cs-137 Activity (dpm/g)
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1
2
3
4
5
6
7
Depth (cm)
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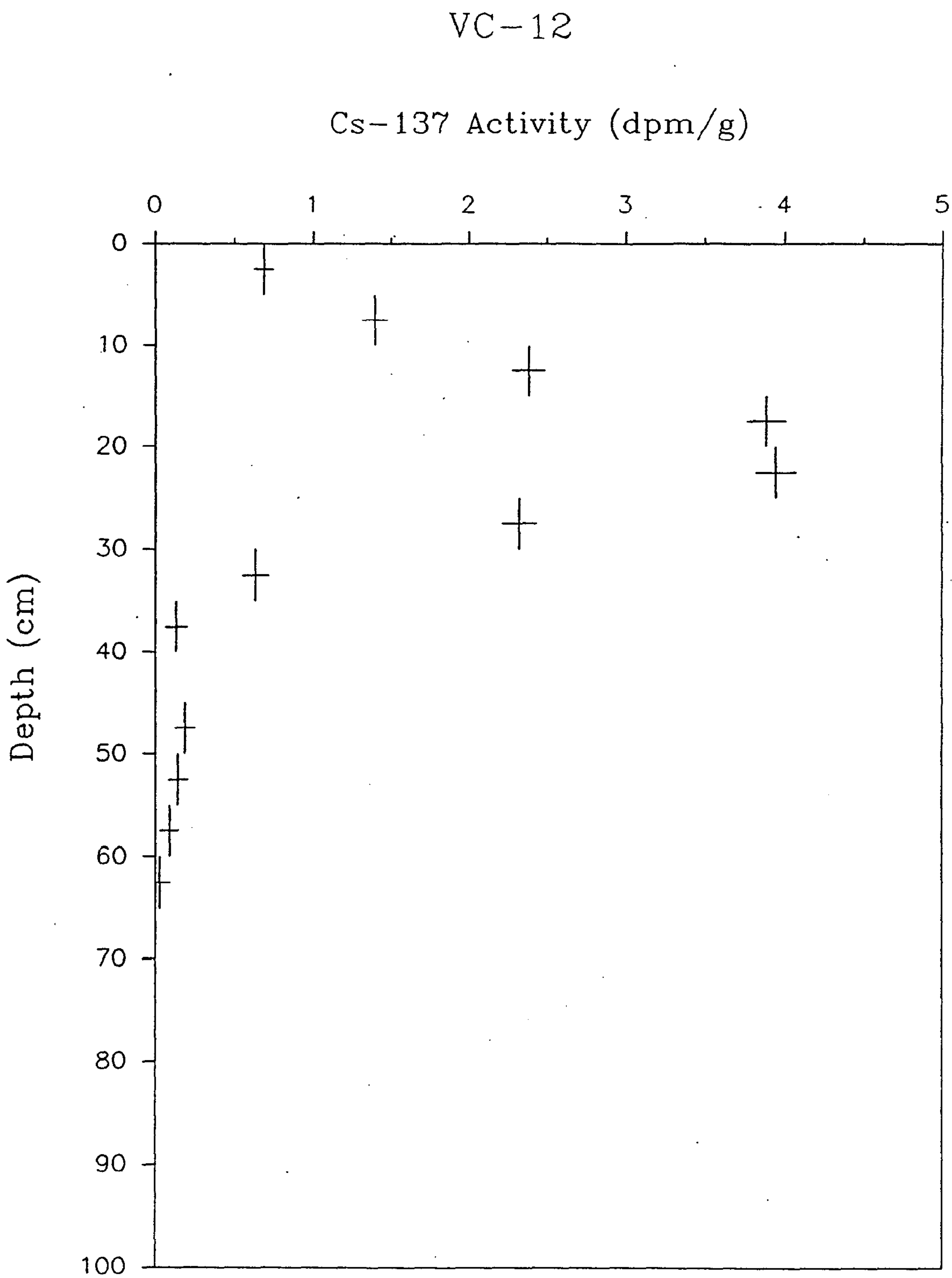
10
20
30
40
50
60
70
80
90
100
v = 1.8 – 1.9 cm/yr
1963
1954



VC-12
Cs-137 Activity (dpm/g)
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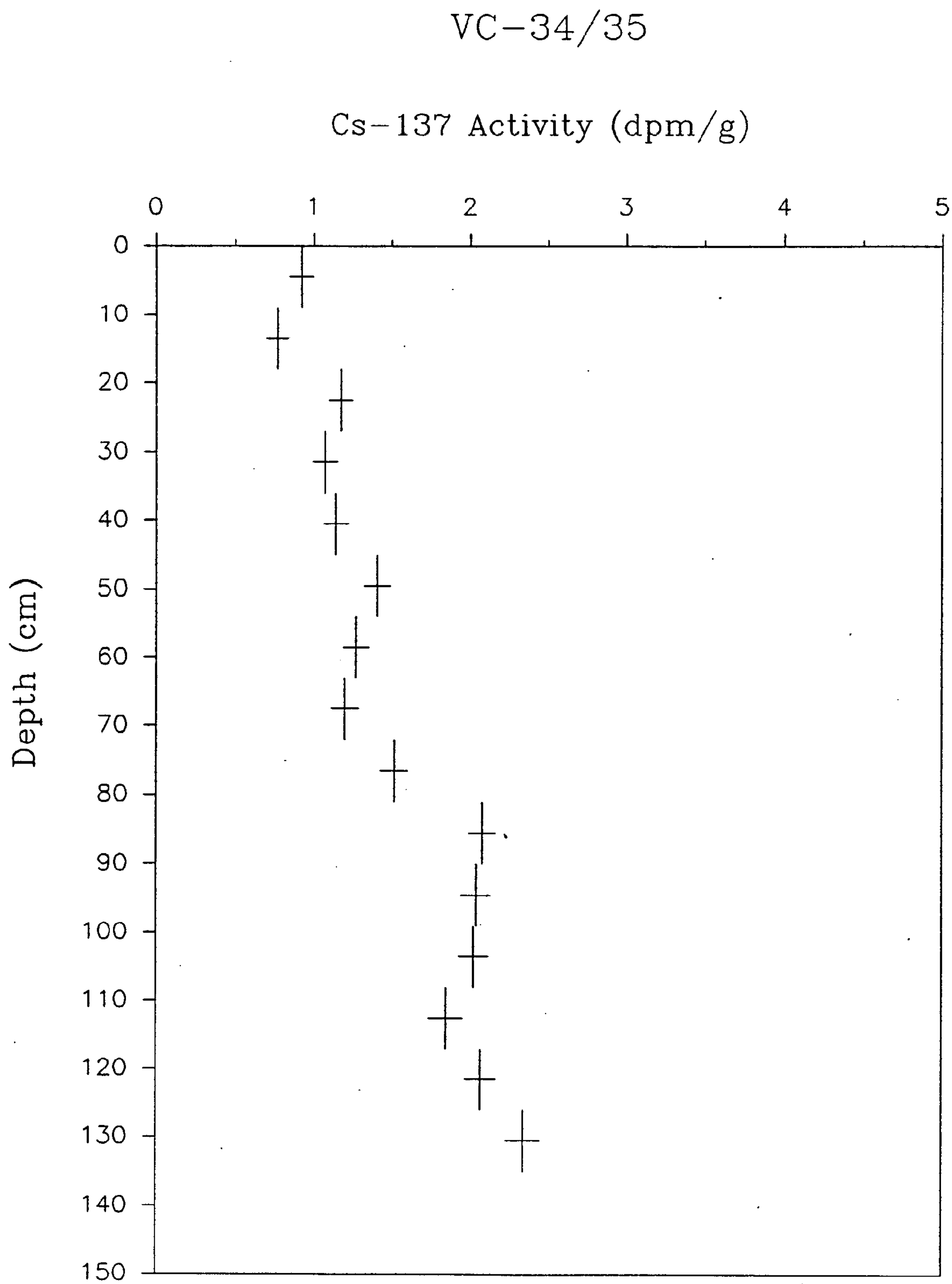
2
3
4
5
Depth (cm)
0
10
20
30
40
50
60
70
80
90
100


VC-34/35
Cs-137 Activity (dpm/g)
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1
2
3
4
5
Depth (cm)
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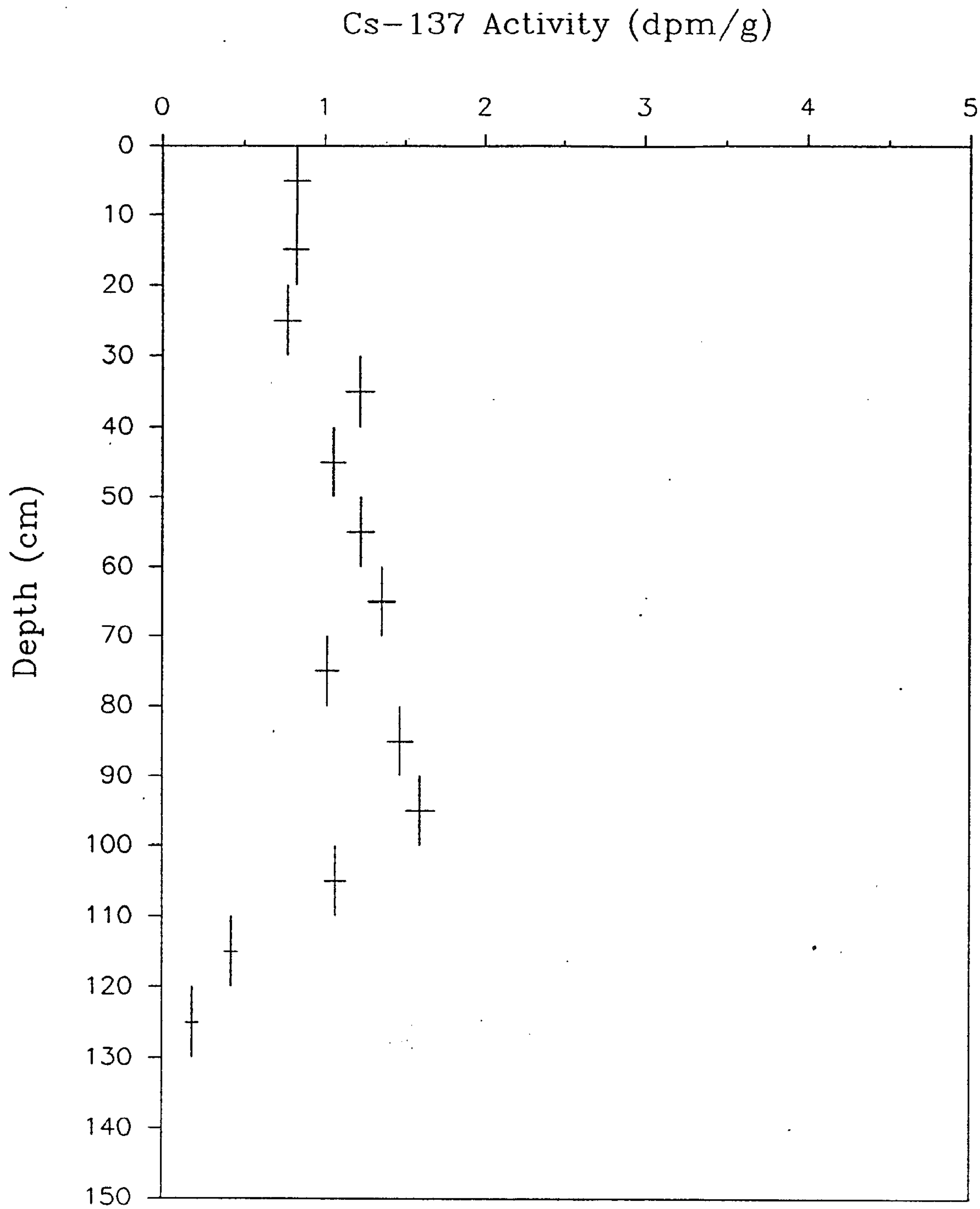
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150

VC-36


Cs−137 Activity (dpm/g)
0
1
2
3
4
5
Depth (cm)
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150

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SEDIMENTATION PATTERNS OF THE MILWAUKEE HARBOR ESTUARY DETERMINED FROM TOC, Pb-210, AND Cs-137 MEASUREMENTS

By

Michael F. Gin

A Thesis Submitted in
Partial Fulfillment of the
Requirements for the Degree of

Master of Science

in Civil Engineering

at

The University of Wisconsin - Milwaukee

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5/1/92

Major Professor Date

Graduate School Approval Date

ABSTRACT

Sedimentation Patterns of the Milwaukee Harbor Estuary
Determined from TOC, Pb-210, and Cs-137 Measurements

By

Michael F. Gin

The University of Wisconsin - Milwaukee, 1992
Under the Supervision of Professor Erik R. Christensen

Thirty sediment cores from the Milwaukee Harbor Estuary were dated by the Pb-210 method. These cores were also analyzed for porosity and for total organic carbon (TOC) by the loss on ignition (LOI) and direct elemental organic carbon methods. The Cs-137 method was successfully employed to confirm the Pb-210 dates of one core (VC-9). This information was used to identify the sedimentation patterns of the system and to determine the vertical and horizontal distribution of organic carbon. Areas of apparent high sedimentation included the Milwaukee River, especially just upstream of the confluence of the Milwaukee and Menomonee Rivers, the Menomonee River and

the South Menomonee Canal, and the Kinnickinnic River near the Great Lakes Research Facility. Furthermore, the outer harbor has been identified as having a relatively small sedimentation rate. This system is quite dynamic and there are many factors that can disrupt normal sedimentation patterns. These factors include dredging and storms besides other contributors to mixing. Therefore the interpretation of Pb-210 activity profiles is often difficult. However, a general picture of the sedimentation patterns in the Milwaukee Harbor Estuary can be seen through the use of TOC, Pb-210 and Cs-137 methods.

A correlation between LOI and TOC was determined ($r \approx 0.68$). Therefore, LOI can be used as a first approximation of total organic carbon. However, if a more accurate value of total organic carbon is desired, the more tedious and costly TOC analysis must be performed.

5/1/92

Major Professor — Date

ACKNOWLEDGEMENTS

I would like to thank Professor Erik R. Christensen for his support and direction during the course of this research. It was a pleasure working with him. I am also grateful for the members of my graduation committee, Professor Hector Bravo and Dr. David N. Edgington, and for their comments and suggestions.

I would also like to thank Gary Reinke and Dave Cleary for their assistance in sampling and in performing the LOI analyses. Also, thanks are extended to the crews of the R/V Pelagos and R/V Neeskay.

Special thanks to my fiance, Jeanne, and my family for their encouragement, support and patience during my graduate studies.

Above all I would like to thank the Lord Jesus Christ for life and the opportunity to do this work.

This work was supported in part by the Milwaukee Metropolitan Sewerage District, Task Order 906, and the Wisconsin Coastal Management Program, P.O. #ADB00474.

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I. INTRODUCTION

Lake sediments are often the ultimate repository for environmental pollutants and therefore are of concern in a toxic substances management plan. Once in the sediments, pollutants may still be available to the biota and cause adverse effects. Toxic substances tend to accumulate in areas where sediments accumulate, which is where the sedimentation rates are high. Therefore an understanding of sedimentation patterns is helpful in identifying areas of concern. Sedimentation patterns can be identified by Pb-210 and Cs-137 dating techniques, as well as by organic carbon content.

Objectives

The objective of this project is to examine the sedimentation patterns of the Milwaukee Harbor estuary. These patterns will be determined primarily from a linear regression analysis of Pb-210 activity measurements. Cs-137, porosity, and total organic carbon measurements will also be used to understand the sedimentation patterns. Total organic carbon content will be calculated by the loss on ignition (LOI) assay and the total organic carbon (TOC) assay. This research is the first step in assessing the state of pollution in the Milwaukee Harbor estuary. This assessment includes the type of contaminant as well as the horizontal and vertical distribution of the pollutants. The information gained by this thesis research, in conjunction with the corresponding priority pollutant organic analyses, will assist in developing an appropriate toxic substances management plan for the Milwaukee Harbor estuary.

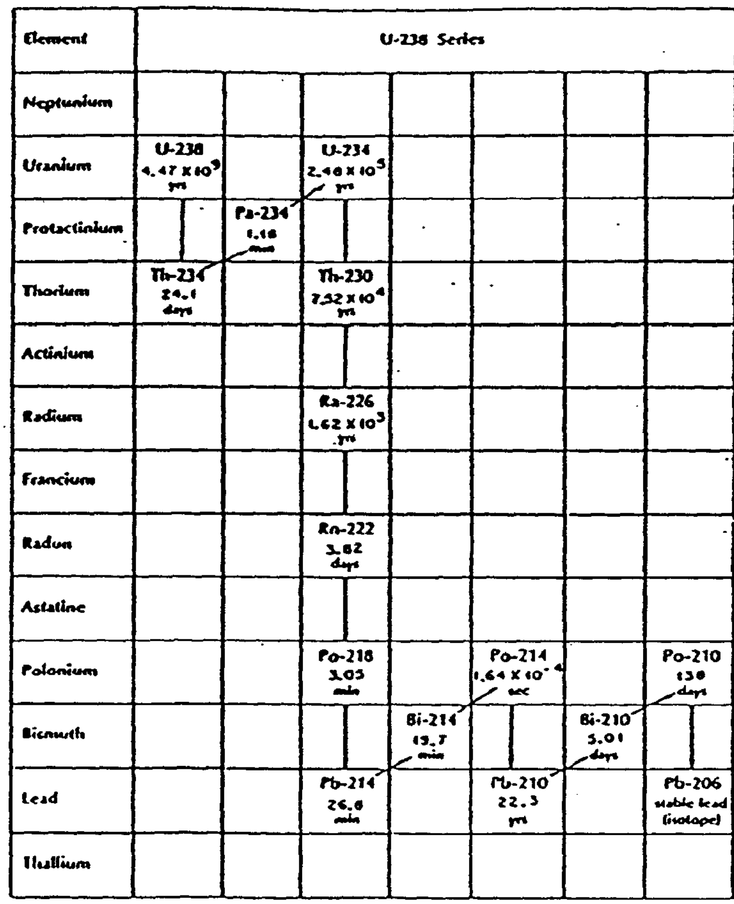
Literature Review

Pb-210

Pb-210 ($t_{1/2}$ = 22.26 years) is a naturally occurring radioisotope that can be used as an environmental tracer. The use of Pb-210 as a geochronological tool of lake and nearshore ocean sediments began in the early 1970's (Krishnaswami, et al., 1971; Koide, et al., 1972; Koide, et al., 1973). Krishnaswami, et al. (1971) concluded that Pb-210 activity is ideal for dating lake sediments ≤100 years old. This conclusion arises from the fact that in water, lead is quickly removed from solution onto particulate matter so that the unsupported or excess Pb-210 activity in the sediments is essentially due to direct atmospheric fallout (Krishnaswami, et al., 1971; Robbins and Edgington, 1975). Supported Pb-210 is due to the existing Ra-226 in the sediment that decays to Pb-210.

Pb-210, along with most natural radioactivity, occurs as a result of the uranium and thorium present in the earth's crust (Robbins, 1978). Uranium-238 decays ultimately to Pb-206, a nonradioactive lead isotope, by a series of α and β emissions with Pb-210 as an intermediate in this decay scheme (Fig. 1).

Figure 1 . Decay Scheme of ^{238}U to Stable Pb. Vertical Arrow is Alpha Decay and Diagonal Arrow is Beta Decay (Broecker and Peng, 1982).



It is only due to several remarkable occurrences that Pb-210 can move through the environment. In the decay series, radon gas (Rn-222) and other chemically inert gases are formed. These gases diffuse out of the earth's crust and are transported by turbulence and advection into the atmosphere. Because the radon decay products are heavy metals, they quickly become attached to natural aerosols. In time, Pb-210 returns to earth through atmospheric scavenging processes, such as rain, snow, and dry fallout (Fig. 2). Once in the water column, Pb-210 is scavenged by settling sediment particles (Robbins and Edgington, 1975). However, Leland, et al. (1973) concluded that organic matter is more important in the complexation of lead in lake water and sediments than adsorption on clays of hydrous oxides. Therefore, Pb-210 activity will be greater in areas of high organic matter.

The decay of uranium is a continuous process. In fact, Robbins, et al. (1978) examined the sediments of the Great Lakes and concluded that Pb-210 is added to the sediments at nearly a constant rate. Because of the constant addition of Pb-210 and the fact of its continuous decay within the sediment, the difference between the Pb-210 activity at the sediment-water interface and at any depth can be used to calculate the approximate age of that layer. Appleby and Oldfield (1978) have discussed a Pb-210 dating model based on this assumption of constant initial concentration (CIC). In this model, the rates of mass sedimentation and unsupported

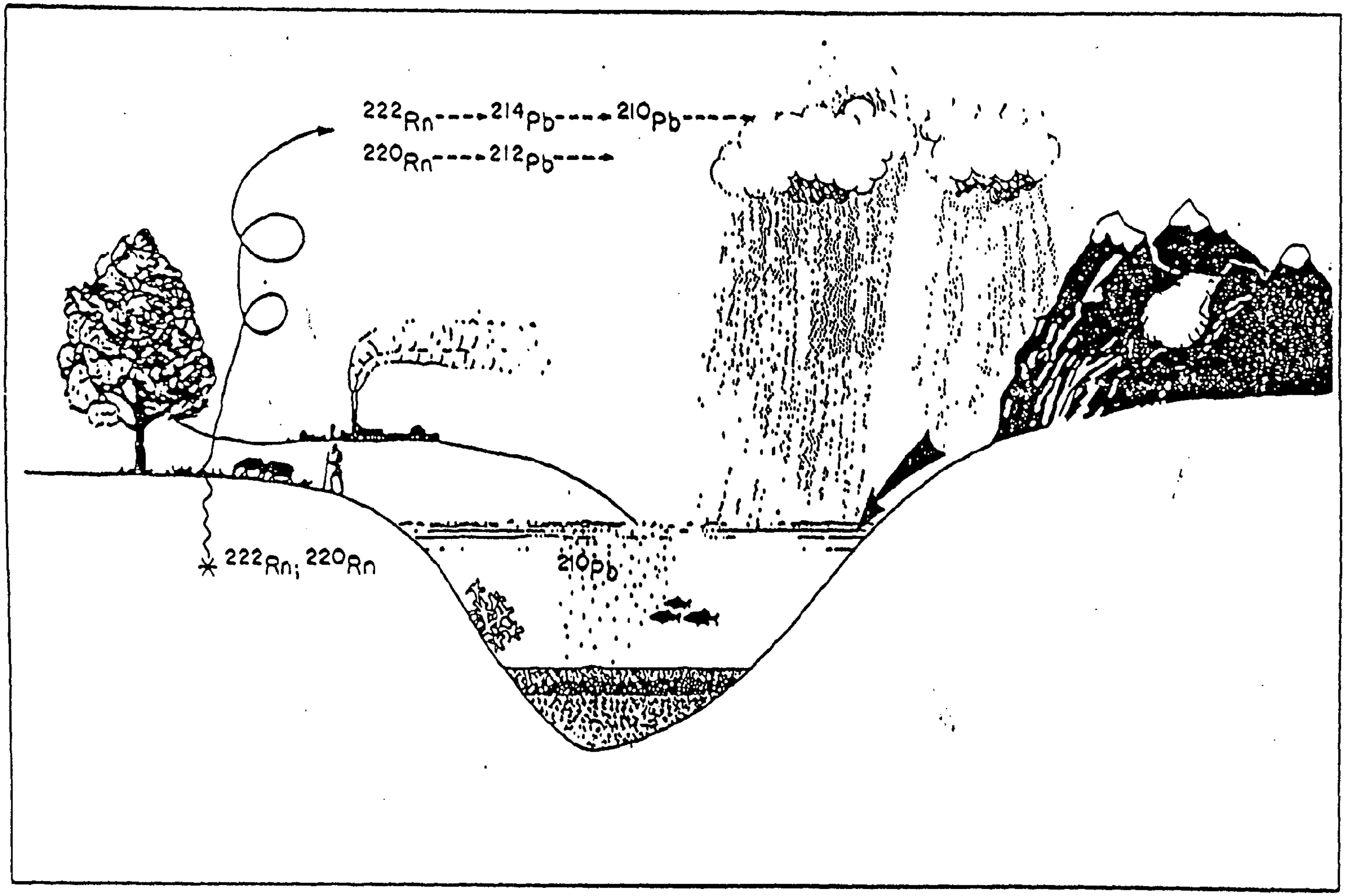


Fig. 2 Environmental pathways of the radioactive lead isotopes. (Robbins, 1978) Used with permission

Pb-210 supply are proportional to one another such that the Pb-210 concentration (activity) always have a constant value at the top of the sediment core. Age t (year) of a layer of depth is given by:

$$t=\frac{1}{\lambda}\ln\left(\frac{s_0}{s_z}\right) \tag{1}$$

where $\lambda = \frac{\ln(2)}{t_{1/2}}$ = *decay constant*

λ for Pb-210 = 0.03114 yr^{-1}

s_0 = Pb-210 activity (dpm/g) at the water-sediment interface

s_z = Pb-210 activity (dpm/g) at a given depth

However, as Robbins, et al. (1978) have noted, under certain conditions, radioactivity profiles may be altered by sediment reworking, storm events, and other processes. These complications raise the question of the reliability of the interpretation of the Pb-210 method. However, by the use of suitable models and alternative dating methods based on pollen and Cs-137, they have successfully used the Pb-210 method to date lake sediments and have attributed anomalies in the profiles to the above processes.

Another method of determining sedimentation rates from Pb-210 data, and the method used in this research, is to determine rates from a linear regression. This approach is based on the CIC analysis in its most restrictive form, a constant initial concentration and a constant sedimentation rate.

Appleby et al. (1979) discussed the constant rate of supply (CRS) model as a third method of determining sedimentation rates. This model assumes that the net supply of unsupported Pb-210 is constant despite variations in the mass sedimentation rate. This method is not used in this research because there is not a constant rate of supply.

Pb-210 decays via weak β and γ (46.5 KeV) emissions and therefore is not usually detected directly. Two indirect methods of measuring Pb-210 activity are detecting the β-decay of Bi-210 ($t_{1/2}$ = 5 days), a daughter product of Pb-210, and detecting the α particles of Po-210 ($t_{1/2}$ = 138 days), a granddaughter product of Pb-210. The Pb-210 activity can be inferred from the ingrowth of Bi-210, or from Po-210 assuming radioactive equilibrium (Robbins, 1978). For this research, alpha spectroscopy is used to measure Pb-210 activity. The overall efficiency (plating and α-detector efficiency) of Po-208 recovery and detection has been checked to be ~17%.

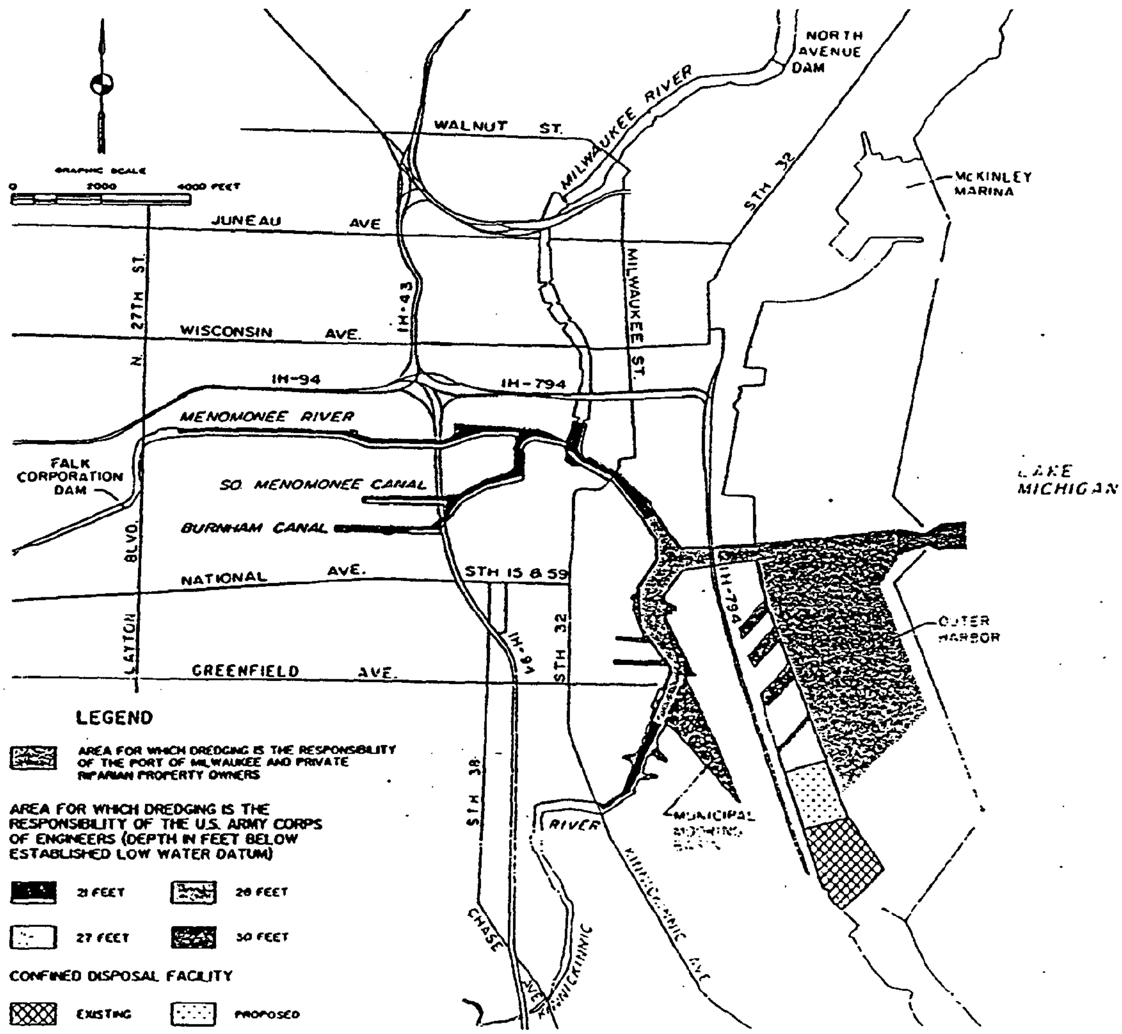
Cs-137

Cs-137 ($t_{1/2}$ = 30.17 years) is an artificial nuclide that has also been exploited as a sediment dating tool and can be used to check Pb-210 data (Robbins and Edgington, 1975; Hermanson and Christensen, 1991). Cs-137 is introduced to the sediment similarly to Pb-210, as it is scavenged by settling sediment particles in the water column (Robbins and Edgington, 1975). However, unlike Pb-210, this method is not applicable in saltwater. Cs-137 is one of the products of nuclear weapons testing, which began in 1954 and peaked in 1963 (Pierson, 1971). Therefore, the earliest occurrence of Cs-137 should correspond to a Pb-210 dated layer of 1954, and the peak Cs-137 activity corresponds to 1963 (Robbins and Edgington, 1975; Hermanson and Christensen, 1991). However, if mixing is an important process, the peak may be broadened or obscured (Christensen and Klein, 1991).

Porosity

Porosity is the ratio of the volume of water over the total volume in a given sample. It can give valuable information about compaction and the type of sediment. A high porosity value is related to silty material, while a low porosity value corresponds to more sandy material. Porosity is also important for determining sedimentation rates and ages of the sediments from Pb-210 data (Robbins and Edgington, 1975; Christensen, 1982). A steady sedimentation rate, which is caused by a constant rate of deposition, should produce a smooth profile in the porosity data, without discontinuities or interruptions (Harley, 1988). Irregularities can be caused by disruptions in sedimentation, such as dredging or a change in flood control practices, or a significant change in the size or composition of the sediment over time (Edgington and Robbins, 1976; Schwetz, 1982). Because the Milwaukee Harbor estuary is dredged regularly for commercial purposes (Fig. 3), smooth profiles should be rare.

RECOMMENDED DREDGING AND DREDGED MATERIALS
DISPOSAL ELEMENT FOR THE MILWAUKEE HARBOR ESTUARY



Source: SEWRPC. 1987c

Fig. 3 Milwaukee Harbor Estuary

Loss on Ignition and Total Organic Carbon

Loss on ignition and total organic carbon are both measurements of the bulk organic carbon content in the sediment. LOI is a simple but fairly crude measurement of organic carbon because when the sample is ignited at 550°C, organic carbon and other volatile compounds like hydrogen and nitrogen are driven off as well. Therefore, LOI is more specifically a measurement of total organic matter (Davis, et al., 1984). Nevertheless, the precision and accuracy of this method has been shown to be comparable to other methods (Dean, 1974). TOC is a more accurate measure of organic carbon because it differentiates between carbon, nitrogen and hydrogen. However, it is a tedious and costly method. Information about the amount of organic carbon in the sediment is important because there is often a correlation between TOC and toxic organic contaminants. Where there is a high toxic organic content, one should expect to find a high TOC content. Therefore, TOC can be used as an indicator for potential toxic organic contamination.

History of the Milwaukee Harbor Estuary

The Milwaukee Harbor estuary has recently received much attention (Southeastern Wisconsin Regional Planning Commission, 1987a). This report describes the historical growth patterns of the area and contains a significant database about sedimentation patterns, dredging, biological and chemical measurements, and various other environmental parameters as well as an action plan to reduce and remediate the pollution in the system.

The first permanent European settlement in the area was established in 1795 east of the Milwaukee River, north of what is now downtown Milwaukee. The rural areas of the watershed experienced major growth between 1840 and 1860. In 1857, the first port development was completed, and the Menomonee Canal system was finished in 1874. Rapid industrial development continued after the completion in 1855 of a railroad connecting the cities of Chicago and Milwaukee. However, with this industrial development, increased pollution of the watershed area occurred as well.

The sources of sediment and pollution in the Milwaukee Harbor estuary include industrial discharges, combined sewer overflows (CSO's), atmospheric deposition, runoff from agricultural fields, feed lots, and urban areas, and effluent discharged into the Outer Harbor from the Jones Island Wastewater Treatment Plant. As a result of these and various other point and nonpoint sources, sedimentation rates in the system are fairly high. Therefore, dredging must be carried out to maintain navigational activity (Fig. 3). However, future sedimentation rates are expected to be reduced because the input of sediments into the system is expected to drop. For example, the number of CSO's will fall dramatically with the completion of the deep tunnel project in 1996, and land management and sediment control measures will be improved over the years. Nevertheless, dredging may still continue at its present rate to clean up the pollutants as much as to maintain navigable waters.

II. MATERIALS AND METHODS

Sampling Sites and Methods

The Milwaukee Harbor estuary is defined as the confluence of the Kinnickinnic, the Menomonee, and the Milwaukee Rivers within the urban area, and the Inner and Outer Milwaukee Harbor (Fig. 3). The estuary area of the three rivers is defined by the Kinnickinnic River north of Chase Avenue, the Menomonee River east of the Falk Corporation dam at 29th Street, and the Milwaukee River downstream of the North Avenue dam.

The estuary was sampled in late September and early October 1990 from the R/V Pelagos, and in October 1991 from the R/V Pelagos and R/V Neeskay. Maps of the sampling locations are found in Figs. 4-5. In 1990, three types of sampling devices were used, a Ponar grab sampler (GR-), a box corer (C-) with inside dimensions of 29.8 cm by 30.5 cm, and a gravity corer (GC-) with a polybutyrate plastic liner (inside diameter = 6.7 cm). The grab samples were immediately transferred to preweighed glass bottles. The box cores were sectioned aboard the ship immediately after core recovery and transferred into preweighed glass bottles. The gravity cores were extruded on shore with an extrusion device and transferred into preweighed glass bottles. The samples were stored in the Great Lakes Research Facility refrigerator room.

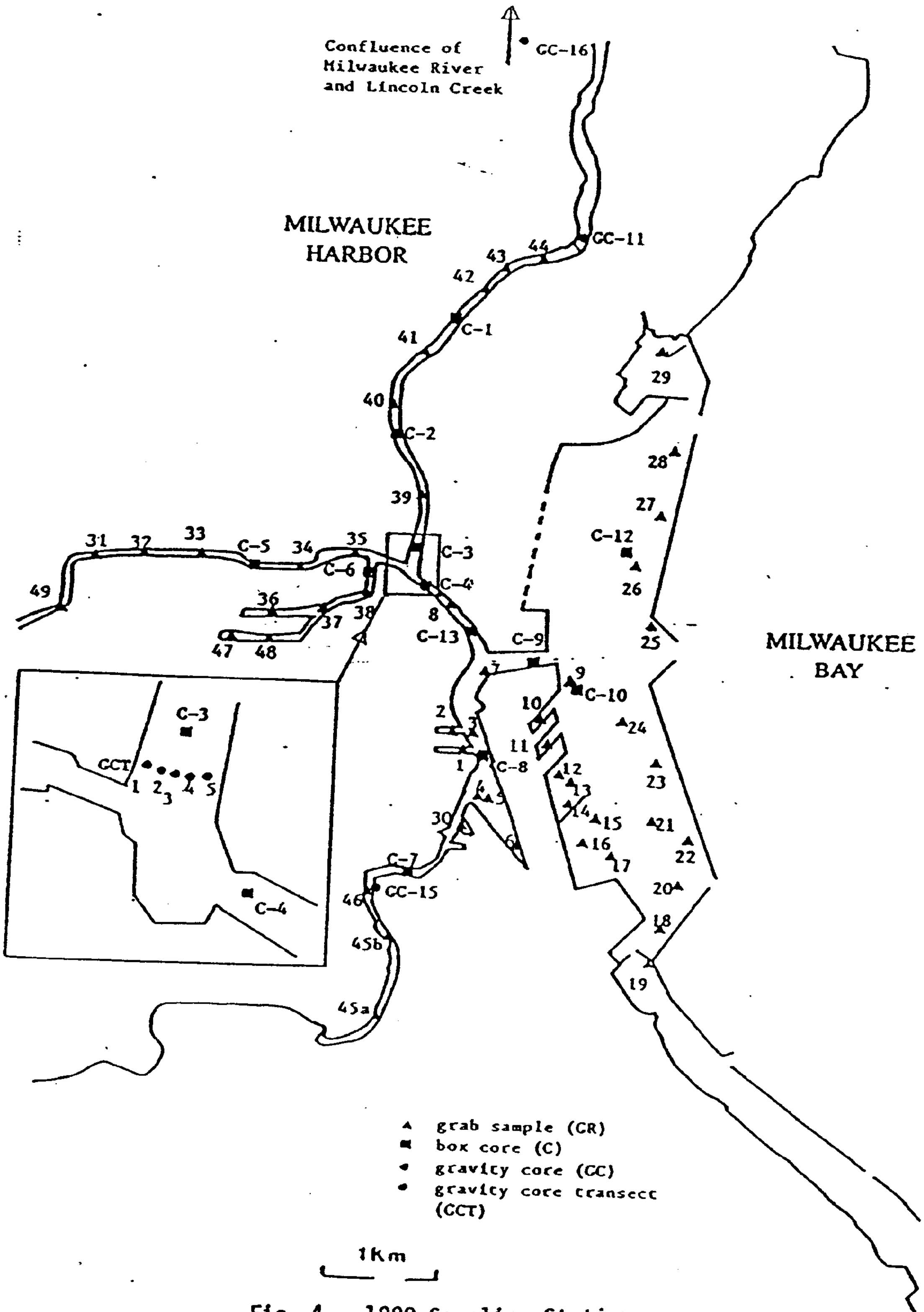


Fig. 4 1990 Sampling Stations

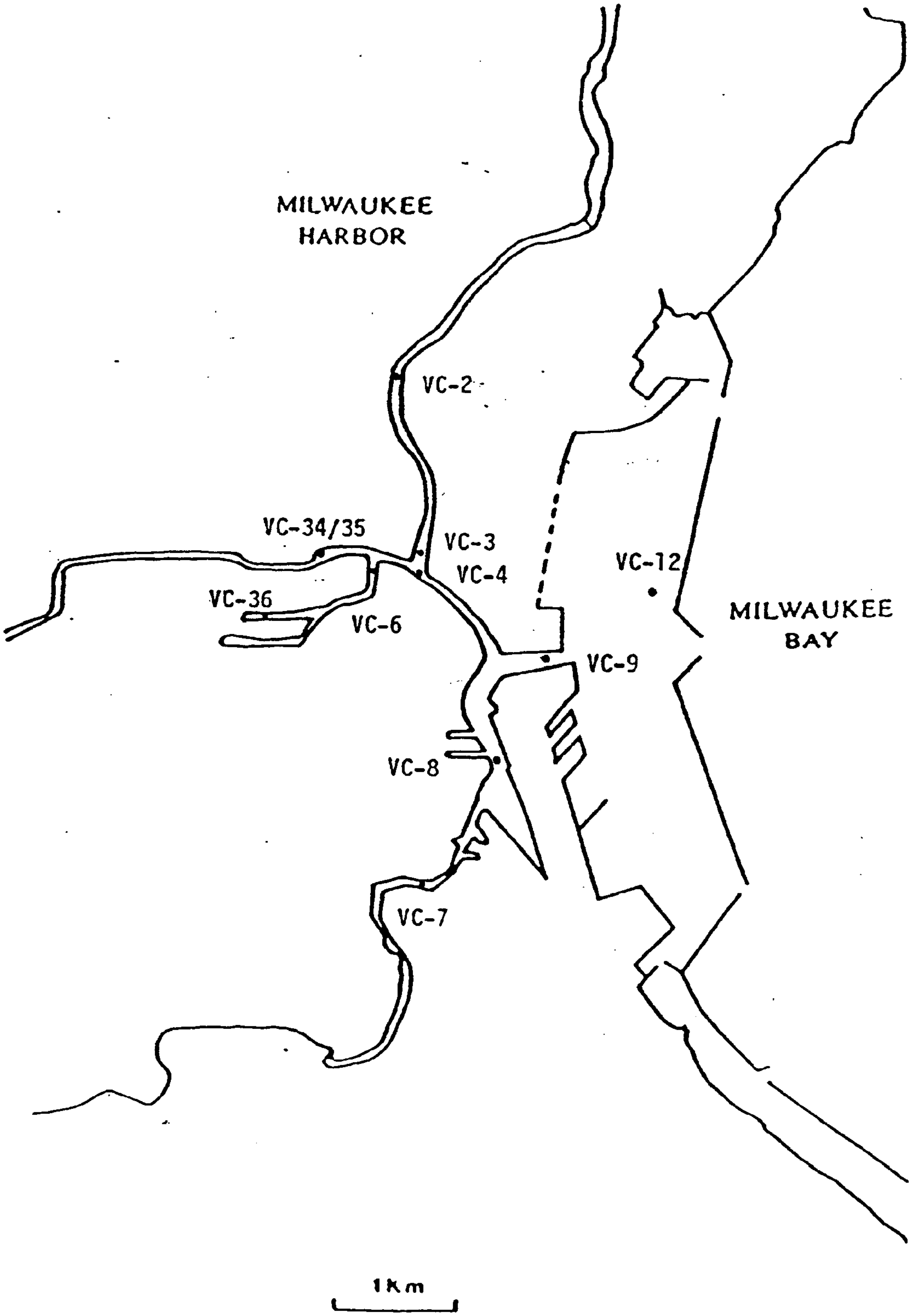


Fig. 5 1991 Sampling Stations

Comments on visual observations of the samples can be found under a separate cover (Christensen, et al., 1990).

In 1991, deeper cores were desired so a vibra corer was to be employed, however, due to technical difficulties, it was unusable. Therefore, cores (VC-) were obtained by a long gravity corer and a push core (aluminum tubing, inside diameter = 7.3 cm). A long gravity core was obtained by placing about 150 lbs. on top of a long gravity core liner and allowing the coring device to free-fall from the water surface. A push core was obtained by manually pushing the aluminum tubing into the sediment after the ship had been secured. Both types of cores were extruded on shore with an extrusion device and transferred into preweighed polyethylene containers. The samples were stored in the Great Lakes Research Facility refrigerator room. Comments on visual observations of the samples can be found in a separate report (Gin and Christensen, 1991).

<u>Porosity</u>

In the laboratory, a portion of each sample was weighed and dried in a convection oven for approximately 3 days at 60°C to a constant weight. The porosity (Φ) of these sediments was determined by the following calculation under the assumption that the density of the sediment was 2.45 g/cm^3:

$$\Phi = \frac{2.45w_i}{1+1.45w_i} \tag{2}$$

where $w_i = \dfrac{\rho_w \Phi}{\rho_w \Phi + (1-\Phi)\rho_s}$

w_i = weight fraction of water

ρ_w = density of water = 1 g/cm^3

ρ_s = density of solids = 2.45 g/cm^3

(Robbins and Edgington, 1975; Christensen, 1982)

The samples were ground with mortar and pestle and stored in glass vials for further analyses.

Loss On Ignition (LOI)

A 0.25 g sample of dried sediment was measured in a pre-weighed crucible, heated at 550°C for 15 minutes and allowed to cool (Davis et al., 1984). When the crucibles reached room temperature, they were reweighed. Organic carbon content was determined by:

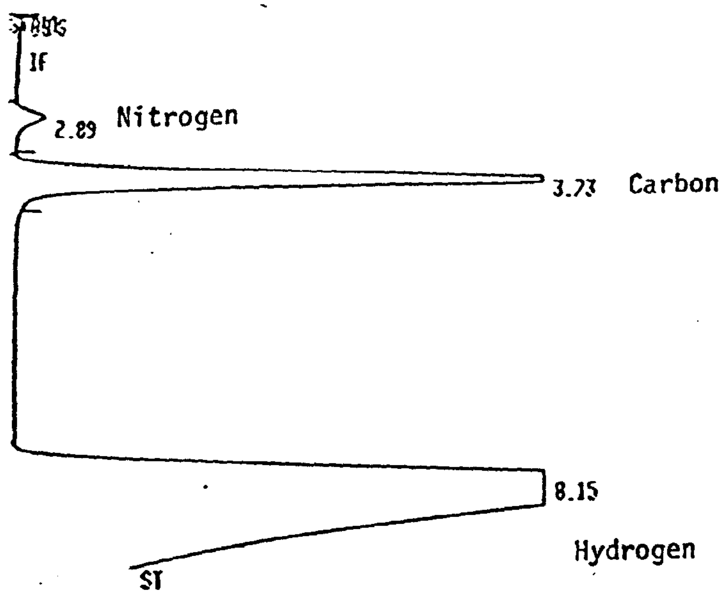
$$\%\ \text{LOI} = \frac{\text{pre oven wt} - \text{post oven wt}}{\text{pre oven wt} - \text{crucible wt}} \times 100 \tag{3}$$

Total Organic Carbon (TOC)

Total organic carbon content was determined by a Carlo Erba Strumentazione Elemental Analyzer - Model 1106 (Carlo Erba, 1981), which is used to analyze dried sediment samples for carbon, nitrogen and hydrogen. A 1.0 to 1.5 mg sample was weighed on a Cahn 29 automatic electrobalance into tin capsules supplied by Carlo Erba instruments. The samples were acidified with 25 μl of 3N H_3PO_4 to drive off any inorganic carbon, such as $CaCO_4$, in the form of CO_2 (Backhus and Gschwend, 1990). The samples were allowed to air-dry overnight and then reshaped to allow proper functioning of the autosampler.

Before analyzing the acidified samples, the autosampler must be stable. This check was accomplished by running air samples until a constant value was obtained. Once the machine stabilized, two blank samples, two standards (0.25 mg acetanilide) and two acid blanks were run. If these remained consistent, the acidified samples were run. A standard was run after every 10 samples to ensure the stability of the instrument. After all the samples had been run, a final blank was run to shut the autosampler off.

A Hewlett-Packard 3390A Integrator printed out the information obtained from the autosampler, which analyzed the oxidized samples. A typical printout can be found in Fig. 6. A chromatogram was produced with peaks corresponding to each of the different elements. The three peaks correspond to the nitrogen, carbon and hydrogen components of the sample, respectively. The retention time for the element as well as



RUN # 162 DEC/07/90 18:34:05

C-13-7A 13907

AREA%

RT	AREA	TYPE	AR/HT	AREA%
2.89	49937	BB	0.215	0.810
3.73	1105400	BB	0.250	17.926
8.15	5010900	I PH	0.903	81.264

TOTAL AREA= 6166300
MUL FACTOR= 1.0000E+00

Fig. 6 A Typical Chromatogram

its corresponding area follow the chromatogram. This information is used to determine TOC content by the following calculations:

$$\% \text{ TOC} = \frac{(A_u - A_{ab}) \times k}{u \text{ mg}} \tag{4}$$

where A_u = area of sample

A_{ab} = area of acid blank

u mg = sample weight

$$k = \frac{(\text{mg std})(\% \text{ C of std})}{(A_{std} - A_{bl})}$$

where A_{std} = area of standard

A_{bl} = area of blank

Pb-210

Secular equilibrium was assumed between Pb-210 and its granddaughter product, Po-210. To ensure this equilibrium, there was at least a two month waiting period between sampling and plating. To measure Pb-210 activity, the following procedure was followed:

DIGESTION

A 0.5 g dried sediment sample, 1.0 ml of Po-208 standard ($t_{1/2}$ = 2.898 years, 9.75 dpm/g, 11/20/89) and ~50 ml of 50% HCl were added to a 125 ml Erlenmeyer flask. About 1 ml 30% H_2O_2 was added to the flask, swirled and placed on a ~95°C hot plate. At thirty minute intervals, the flasks were removed from the heat, allowed to cool briefly and another ~1 ml 30% H_2O_2 added. If there was excessive foaming, a drop of 1-octanol was added. The flasks were returned to the hot plate and the process of heating for 30 minutes, cooling and adding 1 ml H_2O_2 was continued until a total of 5 ml H_2O_2 was added. After the final spike of H_2O_2, the flasks were left on the hot plate until 4 hours total heating time had elapsed. Throughout the digestion process, the total volume in the flasks was maintained at ~50 ml by adding HCl as necessary. Finally, the flasks were removed from the heat, allowed to cool, covered with a watch glass and allowed to stand overnight.

PREPARATION OF COPPER PLATE

Copper plates of 2.2 cm diameter were labeled on the convex side and sprayed with polyurethane. The other side was cleaned with abrasive cleaner and copper polish.

FILTERING AND VOLUME REDUCTION

The sample and rinse was filtered through Whatman #42 filter paper into a clean, labeled 125 ml Erlenmeyer flask. Two boiling chips were added to the rinse and flask, and the flask was placed onto a ~95°C hot plate, where the volume was reduced to ~10 ml. After the volume was reduced, distilled/deionized water was added to return the volume to ~50 ml.

pH ADJUSTMENT

The pH of the solution was adjusted to between 0.45 and 0.55, by adding HCl or NaOH as necessary. About 0.1 g ascorbic acid was added, and the solution was swirled until it completely dissolved. The solution was poured into a labeled 250 ml Nalgene bottle with a labeled copper plate in it, concave (without polyurethane) side up, and the bottle was capped tightly.

PLATING

The bottles were placed in a 90°C oven overnight, and the Po-208 and Po-210 was spontaneously deposited onto the copper disks (MacKenzie and Scott, 1979). After the bottles were removed from the oven, they were turned over so the copper plate would "stick" to the cap by surface tension. The bottles were returned to the upright position, uncapped, and the plates were removed by slapping the cap against the table top. After the plates were removed, they were rinsed with distilled/deionized water and ethanol, allowed to air dry and then placed into a labelled bag. After the plating solution had cooled, it was discarded with copious amounts of water.

COUNTING

The copper plates were placed into an EG&G Ortec 576 Alpha Spectrometer consisting of a dual alpha surface barrier detector and counted for a minimum of 70,000 seconds. The spectrophotometer was connected to an IBM personal computer AT and used EG&G Maestro™ Adcam® 100 Multichannel Analyzer software.

The surface barrier detector detects alpha emissions from Po-208 and Po-210 decay. These emissions are sorted and counted according to energy in the alpha spectrometer and are plotted by number of emissions vs. channel number or alpha energy. The number of emissions per unit time is directly related to the disintegration rate of the sample. Pb-210 (dpm/g) can be calculated from the following equation:

$$Pb\text{-}210\,(dpm/g) = \frac{Po\text{-}210\,area}{Po\text{-}208\,area} \; x \; \frac{Po\text{-}208\,dpm\ initial}{sample\ weight\,(g)} \; x \; c.f. \qquad (5)$$

where Po-208 (dpm initial) = $9.75 \; x \; e^{-\lambda t}$

λ for Po-208 = 0.2392 yr^{-1}

t = count date - reference date

correction factor (c.f.) = $e^{\lambda t}$

where λ for Po-210 = 1.833 yr^{-1}

t = count date - plate date

Replicates samples were run, and the results indicate 95% precision.

The uncertainty of the Pb-210 activity levels was calculated by the Poisson method assuming that the background supported counts was well know from multiple measurements (Friedlander et al., 1949).

$$\delta s = \frac{\sqrt{N_a}}{N_a - N_b} s \qquad (6)$$

where N_a = Po-210 counts

N_b = background supported counts

However, when the excess Pb-210 is much greater than the supported Pb-210 (1990 samples), the equation becomes:

$$\delta s = \frac{1}{\sqrt{N}} s \tag{7}$$

where s = excess Pb-210 (dpm/g)

N = Po-210 counts

CALCULATION OF SEDIMENTATION RATES

The excess Pb-210 activity was plotted vs. cumulative mass and the slope (a), uncertainty (δa) and y-intercept (b) were calculated by a weighted linear regression as follows (Topping, 1965):

$$a = \frac{\sum_{i=1}^{n} w_i \sum_{i=1}^{n} (w_i m_i y_i) - \sum_{i=1}^{n} (w_i m_i) \sum_{i=1}^{n} (w_i y_i)}{\sum_{i=1}^{n} w_i \sum_{i=1}^{n} \left(w_i m_i^2\right) - \left(\sum_{i=1}^{n} w_i m_i\right)^2} \tag{8}$$

where a = slope (cm^2/g)

w_i = Pb-210 (dpm/g)

m_i = cumulative mass (g/cm^2)

y_i = ln(excess Pb-210) (dpm/g)

n = number of data points

$$\delta a = \sqrt{\frac{\sum_{i=1}^{n} w_i \sum_{i=1}^{n} w_i\left(y_i-(am_i+b)\right)^2}{(n-2)\left(\sum_{i=1}^{n} w_i \sum_{i=1}^{n}\left(w_i m_i^2\right)-\left(\sum_{i=1}^{n} w_i m_i\right)^2\right)}} \tag{9}$$

$$b = \frac{\sum_{i=1}^{n}(w_i y_i)\sum_{i=1}^{n}\left(w_i m_i^2\right)-\sum_{i=1}^{n}(w_i m_i)\sum_{i=1}^{n}(w_i m_i y_i)}{\sum_{i=1}^{n} w_i \sum_{i=1}^{n}\left(w_i m_i^2\right)-\left(\sum_{i=1}^{n} w_i m_i\right)^2} \tag{10}$$

where e^b = calculated Pb-210 activity at the sediment-water interface

The mass sedimentation rate (r) was calculated from the ratio of λ and the slope in the following manner:

$$r = \frac{-\lambda}{a \pm \delta a} \tag{11}$$

where r = mass sedimentation rate ($g/cm^2/yr$)

λ for Pb-210 = 0.03114 yr^{-1}

The slope (a), δa, b, and r were calculated using a computer program which can be found in Appendix C.

Velocity (v) was calculated by:

$$v = \frac{r}{\rho f} \tag{12}$$

where v = velocity (cm/yr)

ρ = average bulk density over the interval of interest calculated by:

$\rho = \rho_s(1 - \phi)$

where ρ_s = 2.45 g/cm^3 (solids density)

ϕ = average porosity

$$f = \frac{\text{length of core}}{\text{length of tube pushed into sediment}}$$

Information about compaction (f) was only known for the push cores. Otherwise, f was assumed equal to 1.0.

Cs-137

Pellets were formed by mixing ~40 g dry sediment with PVA solution (1 ml per 10 g sediment) as a binding agent (Klump, personal communication). The sediment and PVA were poured into a hollow cylinder (inside diameter = 53 mm) and placed under a bench-scale hand-operated compressor. The sample was compressed to ~1500 Psi for ~1 minute to form a pellet. A typical pellet was about 1.3 cm thick. The pellet was dried in a 60°C oven overnight, allowed to cool and reweighed.

The pellets were inserted into a plastic bag before being placed on top of the EG&G Ortec HPGE Gem series p-type coaxial detector to prevent contamination of the Ge(Li) detector. They were counted a minimum of 80,000 seconds. The total counts at a particular energy was determined by the EG&G Maestro™ software.

Cs-137 (dpm/g) was calculated by the following equations:

$$Cs\text{-}137 = \frac{Cs\text{-}137area \ x \ 60\,(\text{sec/min})}{\eta \ x \ L.T. \ x \ intensity \ x \ sample\ weight\,(g)} \ x \ c.f. \qquad (13)$$

where L.T = live time (sec), and

$\eta = 0.0004x^2 - 0.0038x + 0.0137$

x = height of pellet (cm)

intensity = 0.946 (Yan, 1991)

$correction factor\ (c.f.) = e^{\lambda\, t}$

where λ for Cs-137 = 0.02297 yr^{-1}

t = count date - sampling date

The uncertainty was calculated by the following equation:

$$\delta s = \frac{\sqrt{2N_b + N_n}}{N_n} s \qquad (14)$$

where s = Cs-137 activity (dpm/g)

N_b = background counts

N_n = net counts

III. RESULTS AND DISCUSSION

Final Values of LOI, TOC, Pb-210 and Cs-137

Tables A1 - A30 of Appendix A are the tables for each core. Each table includes the core name, location, water depth, type of core, core length, date sampled, and porosity, %LOI, %TOC, mass, cumulative mass, bulk density, Pb-210, excess Pb-210, Pb-210 counts, and Cs-137 (where applicable) for each depth interval. Appendix B contains graphical representations of depth vs. porosity, and depth vs. %LOI & %TOC for each 1990 and 1991 sampling site.

Sedimentation Patterns

Tables 1 - 2 are summary tables of the mass sedimentation rate and sedimentation rate for each core, where applicable. Where there was a positive slope and a negative mass sedimentation rate, it was assumed that an apparent high sedimentation rate existed. Table 3 compares the results of this research to SEWRPC (1987b) results. In general, the results compare favorably. Figure 7 is a map of sedimentation rates (cm/yr). The rates from the 1991 samples were used for this map and in places where there was no 1991 sample, the 1990 values were used. Appendix B contains graphical representations of depth vs. excess Pb-210 activity and excess Pb-210 activity vs. cumulative mass for each 1990 and 1991 core, when appropriate.

Most of the Pb-210 activity profiles were not smooth. There were several possible explanations for this occurrence. First, the system is dredged regularly for navigational purposes. Second, because the water is not very deep in this system, the sediments may be resuspended as a result of minor storms or navigational traffic. Finally, the type of sediment often changed with depth so the amount of Pb-210 sorbed to the sediment would vary according to the sediment composition.

Each core was represented by two graphs, depth vs. excess Pb-210 activity and excess Pb-210 activity vs. cumulative mass (see for example Fig. B2). Sedimentation rates were calculated from the excess Pb-210 activity vs. cumulative mass

TABLE 1: SLOPE, SEDIMENTATION RATE & VELOCITY FOR 1990 CORES

CORE	slope (cm^2/g)	r ($g/cm^2/yr$)	v (cm/yr)
C-1 all points	0.0320 ± 0.0206	-0.972 -0.591 to -2.732	*
excluding outlying points	0.0260 ± 0.0120	-1.196 -0.819 to -2.215	*
C-2	-0.0169 ± 0.0131	1.838 1.036 to 8.140	3.7 2.1 to 16.3
C-3	0.0119 ± 0.0121	-2.612 r > 220.235	*
C-4	-0.0166 ± 0.0109	1.876 1.133 to 5.464	4.7 2.9 to 13.8
C-5	0.0189 ± 0.0076	-1.648 -1.177 to -2.747	*
C-6	0.0161 ± 0.0077	-1.936 -1.309 to -3.711	*
C-7	0.0154 ± 0.0177	-2.020 r > 13.558	*
C-8	0.0086 ± 0.0123	-3.614 r > 8.502	*
C-9	-0.0361 ± 0.0119	0.862 0.648 to 1.288	1.9 1.5 to 2.9
C-10 upper 11 cm	-0.2694 ± 0.0533	0.116 0.096 to 0.144	0.18 0.14 to 0.21
C-12 upper 11 cm	-0.2911 ± 0.0647	0.107 0.088 to 0.138	0.18 0.15 to 0.23
all points	-0.0671 ± 0.0230	0.464 0.346 to 0.706	0.75 0.56 to 1.15
C-13	-0.0102 ± 0.0112	3.042 r > 1.46	7.7 v > 3.7

* apparent high sedimentation rate implied

TABLE 2: SLOPE, SEDIMENTATION RATE & VELOCITY FOR 1991 CORES

CORE	slope (cm^2/g)	r ($g/cm^2/yr$)	v (cm/yr)
VC-2	-0.0131 ± 0.0037	2.386 1.856 to 3.340	8.9 7.0 to 12.5
VC-3	0.0053 ± 0.0026	-5.886 -3.941 to -11.619	*
VC-4	undeterminable		
VC-6	-0.0436 ± 0.0147	0.714 0.534 to 1.076	1.3 0.8 to 1.7
VC-7	-0.0178 ± 0.0042	1.749 1.417 to 2.283	2.5 2.0 to 3.2
VC-8	-0.0049 ± 0.0026	6.346 4.127 to 13.73	10.4 6.7 to 22.4
VC-9 all points	-0.0194 ± 0.0130	1.609 0.962 to 4.921	2.4 1.4 to 7.3
first 21 cm	-0.2227 ± 0.0364	0.140 0.120 to 0.167	0.23 0.2 to 0.3
next 49 cm	-0.0182 ± 0.0169	1.706 0.850 to 23.46	2.4 1.2 to 33.2
from Cs-137			1.8 to 1.9
VC-12	-0.0469 ± 0.0086	0.664 0.561 to 0.814	1.0 0.9 to 1.3
VC-34/35 all points	-0.0127 ± 0.0034	2.461 1.942 to 3.358	5.4 4.2 to 7.3
first 63 cm	-0.0171 ± 0.0041	1.824 1.471 to 2.402	4.7 3.8 to 6.2
last 72 cm	-0.0115 ± 0.0112	2.710 1.370 to 124.126	5.2 2.6 to 238
VC-36	-0.0134 ± 0.0026	2.316 1.943 to 2.867	4.9 4.1 to 6.1

* apparent high sedimentation rate implied

TABLE 3: COMPARISON OF V TO SEWRPC

CORE	v (cm/yr)	SEWRPC+ (cm/yr)
C-1	high*	< 12.7
C-2	3.7 (2.1 - 16.3)	< 12.7
C-3	high*	< 12.7
C-4	4.7 (2.9 - 13.8)	< 12.7
C-5	high*	12.7 - 25.4
C-6	high*	< 12.7
C-7	high*	< 25.4
C-8	high*	< 12.7
C-9	1.9 (1.5 - 2.9)	12.7 - 25.4
C-10	0.17 (0.14 - 0.21)	NA
C-12	0.75 (0.6 - 1.2) all points	NA
C-13	7.7 (> 3.7)	12.7 - 25.4
VC-2	8.9 (7.0 - 12.5)	< 12.7
VC-3	high*	< 12.7
VC-6	1.3 (0.8 - 1.7)	< 12.7
VC-7	2.5 (2.0 - 3.2)	< 12.7
VC-8	10.4 (6.7 - 22.4)	< 12.7
VC-9	2.4 (1.4 - 7.3) all points	12.7 - 25.4
VC-12	1.0 (0.8 - 1.3)	NA
VC-34/35	5.4 (4.2 - 7.3) all points	12.7 - 25.4
VC-36	4.9 (4.1 - 6.1)	<12.7

+ SEWRPC, 1987b

* apparent high sedimentation rate

NA = no information available

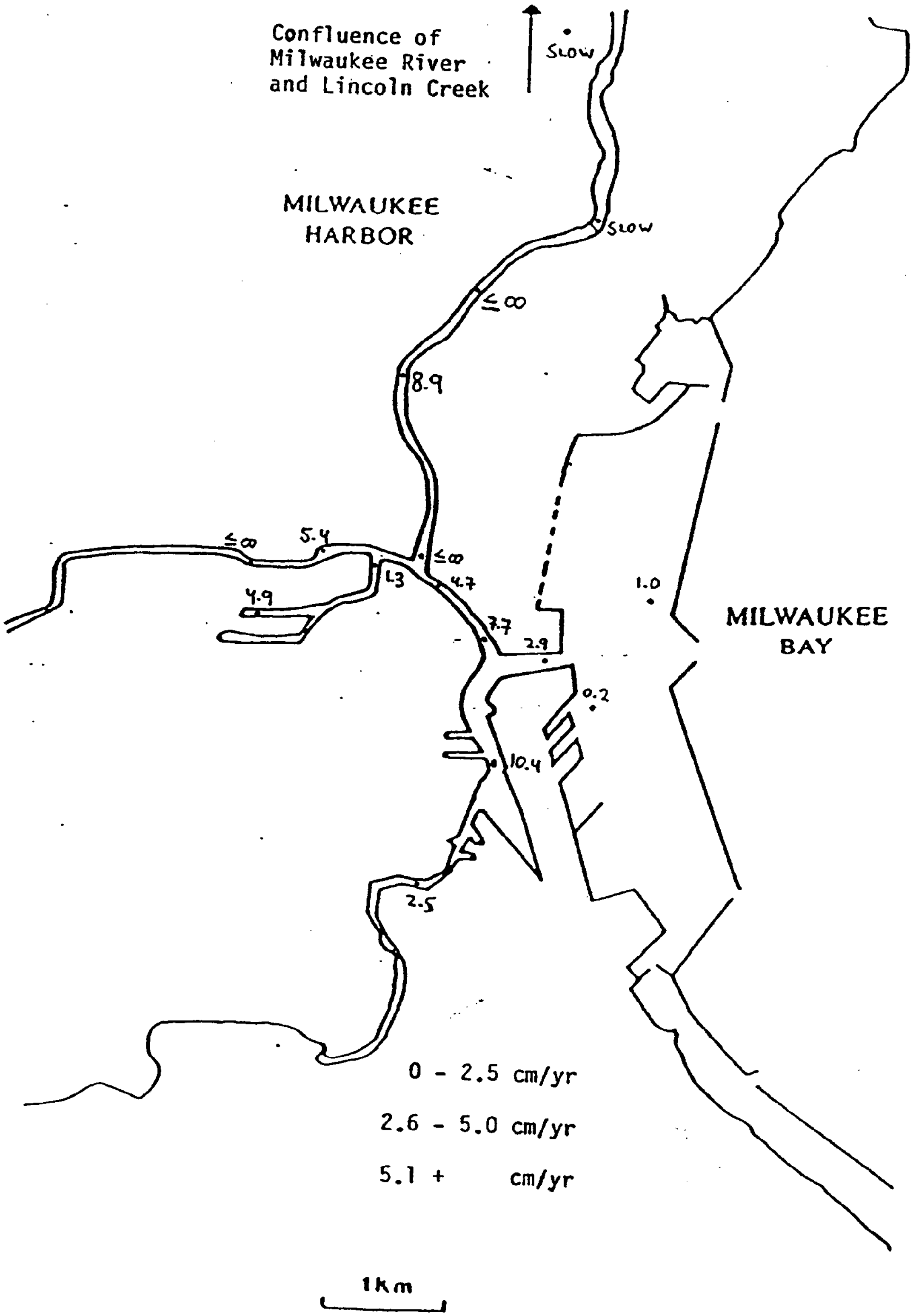


Fig. 7 Map of Sedimentation Rates

graphs when appropriate (C-2, 4, 9, 10, 12 & 13 and VC-2, 6, 7, 8, 9, 10, 12, 34/35 & 36). The graphs for these cores showed a negative slope, which implied that the age of the sediment increased with depth. A negative slope allowed a sedimentation rate (r) to be calculated. This r value ($g/cm^2/yr$) can be converted to a velocity (cm/yr) which can be compared to existing literature values of sedimentation rates at these areas.

Where sedimentation rates could not be calculated because of a zero or positive slope, it was assumed that a high sedimentation rate or much mixing existed at these sites. Deeper cores would be necessary to gain more specific information of the rates at these sites. Furthermore, the inability to calculate a rate under these conditions showed a limitation of the Pb-210 method.

Another possible method of representing the cores is to normalize the Pb-210 values. This would be accomplished by dividing the excess Pb-210 value by the TOC value and plotting it versus cumulative mass. This approach would be useful to see how Pb-210 is related to TOC. However, this method was not chosen for this research.

Excess Pb-210 values were calculated by assuming that the values for Pb-210 at > 5 cm at GC-11 and 15 were supported levels. The average of these nine values is 2.92 dpm/g.

Also, it was assumed that this value was constant throughout the system. Therefore, excess Pb-210 was equal to total Pb-210 (dpm/g) - 2.92 dpm/g. When it was obvious that within a given core, the supported Pb-210 levels were <2.92 dpm/g (VC-6, 8, 9, 12 & 36), an average of the smallest total Pb-210 values was assumed equal to the supported Pb-210 level. The supported Pb-210 levels varied because the composition of the sediment varied.

1990 Sampling Stations

In the Milwaukee River, the results showed that at C-1 and C-3 there was an apparent high sedimentation rate or much mixing because there was recent material throughout the core. However, at C-2, the sedimentation rate was not as high and could be calculated because the Pb-210 activities decreased with depth. This trend implied that the material deeper in the core was older than the material near the top. Sedimentation rates were not calculated at GC-11 and 16 because the Pb-210 activities dropped to the supported levels by the second layer. This trend implied that there was a slow sedimentation rate at these two areas, and the material at greater than 5 cm was quite old. The Pb-210 activity profiles for the transect (GCT-) indicate that there was a fairly even distribution of Pb-210 activity throughout the depth of each core. These profiles implied that there was a fairly high sedimentation rate, similar to the conclusion reached at C-3. Furthermore, this trend implied that the sedimentation occurred fairly uniformly across the river channel. GCT-4 had a slightly different profile, possibly due to a local disturbance such as a sand lens at 5-10 cm depth.

In the Menomonee River, the results from C-5 and 6 showed that there was a high sedimentation rate. There was recent material throughout each core because the Pb-210 activities did not decrease with depth.

At the confluence of the Milwaukee and Menomonee Rivers (C-4), a sedimentation rate could be calculated. However, at the bottom of this core, the Pb-210 activities tended to increase. This trend implied that recent material was overlaid by older material, possibly as a result of dredging or other physical disturbances. The Cs-137 analysis did not give any additional information because the core was not long enough to identify a Cs-137 peak. Downstream of this point (C-13), there was a relatively high sedimentation rate, but a rate was still calculated.

In the Kinnickinnic River, C-7 & 8 and GC-15 showed a high sedimentation rate. The Pb-210 activities did not decrease with depth, so all the material was relatively recent.

At the Harbor Entrance (C-9), a fairly slow sedimentation rate was calculated. There was a general decrease in Pb-210 activity with depth. However, the sample was not deep enough to identify a Cs-137 peak.

Near the Jones Island outfall (C-10), there was a definite decrease in Pb-210 activity with depth over the first 13 cm but then a definite increase in activity over the remaining 10 cm. This trend implied that the most recent material was at the surface and at 25 cm depth, and the oldest material was at 9 - 13 cm. A Pb-210 profile like this one must be caused by some type of mixing.

In the outer harbor (C-12), two sedimentation rates were calculated, one for the first 11 cm and another for the whole core. The rate for the first 11 cm was calculated upon inspection of the activity profile. It seemed as if there was a rate over this interval which did not exist over the whole core. However, the rate for the whole core was calculated after it was determined from the analyses of the priority organics that the highest degree of contamination occurred in the deepest layer (Ni, et al., 1991). Therefore, the material in this layer may be from the early 1960's. CIC analysis indicates that this layer was deposited in approximately 1961 (Table 5).

1991 Sampling Sites

In the Milwaukee River, at VC-2, a sedimentation rate could be calculated. This rate fell within the range of the rate calculated for the 1990 sample. At VC-3, the apparent high sedimentation rate confirmed the conclusion of the 1990 data. The sedimentation rate at this point was either extremely fast or mixing was very important because there was recent material at 105 cm depth.

In the South Menomonee Canal at VC-36, a sedimentation rate was calculated. There was a sharp drop in Pb-210 activity at 90 cm. This drop could be attributed to a change in sediment characteristics, such as an increase in rocky sediment, or to a change in flood control practices or land use in the mid 1950's. The change could also have been caused by dredging activity. In fact, dredging by the U.S. Army Corps of Engineers occurred in the area throughout the 1960's, late 1970's and early 1980's (USACE, 1990). The supported Pb-210 activity level was taken to be equal to 1.62 dpm/g. At VC-6, a fairly slow sedimentation rate was calculated for the first 24 cm. After this point, there was a sudden drop to supported Pb-210 levels. Again, this drop could have been caused by dredging in the early to mid 1970's. The supported Pb-210 level was assumed equal to 1.48 dpm/g. The results from 1990 showed a high sedimentation rate at this point. This difference could be explained by a historically slow rate, followed by a sudden increase due to changes in land use, or a slight difference in sampling locations between the two years. These deep cores integrate over many centimeters, preventing one to differentiate rates over only a couple of centimeters.

In the Menomonee River (VC-34/35), there was a general decrease in Pb-210 activity with depth. However, at depths greater than 54 cm, there were wide fluctuations in the Pb-210 activity profile. These fluctuations may be attributed to physical disturbance or changes in the sediment composition. Three sedimentation rates were calculated, one for the whole core, one for the first 63 cm, and one for the 72 cm. Because the three rates are virtually similar, the rate calculated over the whole core was used for comparison to SEWRPC (1987b).

At the confluence of the Milwaukee and Menomonee Rivers (VC-4), neither excess Pb-210 activity nor Cs-137 activity were detected. This anomaly may be due to the fact that the porosity and %TOC values were quite low, implying sand or clay composition. Pb-210 and Cs-137 does not sorb to either material very well. Recent dredging may have removed much of the organic material. Dredging by the U.S. Army Corps of Engineers took place in the area in 1990 (USACE, 1990).

In the Kinnickinnic River at VC-7, one sedimentation rate was calculated. The 1990 results near this point indicated a high sedimentation rate over the first 25 cm. This anomaly could be explained by the fact that the sedimentation rate was historically slow but has increased in the last several years.

At VC-8, there was a fairly fast rate of sedimentation. Once again, the sudden drop in Pb-210 activity may be accounted by a change in sediment composition as reflected by a change in porosity or by dredging. In fact, dredging occurred in this area in 1983 and 1984 (SEWRPC, 1987a). Supported Pb-210 levels were taken to be equal to 1.75 dpm/g. The calculated velocity is 10.4 cm/yr when the point at 56-64 cm is neglected. However, if this point is included, the velocity becomes 2.9 cm/yr (Fig. B49). These values compares favorably to previous results from the study of the Milwaukee Harbor. Christensen and Lo (1986) calculated a velocity of 1.89 ± 0.58 cm/yr from Pb-210 methods and a velocity of 2.06 ± 0.30 cm/yr from Cs-137 methods at a point between GR-5 and GR-6 (Core 25). Furthermore, Lo (1982) calculated a velocity of 0.25 cm/yr near GR-6 and a velocity of 0.10 cm/yr near GR-5. He was unsure as to the reason for the higher rate at Core 25, but concluded that the relatively higher rate at GR-6 was due to its physical location. GR-6 is at the vertex of the triangularly shaped harbor area and deposits from all three rivers are likely to accumulate there. Nonetheless, it can be concluded that the rate at VC-8 confirms the rate calculated at Core 25. A slightly higher rate may be the result of the different positions in the river channel. VC-8 was in the center of the channel whereas Core 25 was located in a slightly more secluded area.

At the Harbor Entrance (VC-9), there was a sudden drop in Pb-210 activity levels over the first several layers. This drop was also reflected in the porosity values indicating that the drop in Pb-210 activity may be accounted for by a change in sediment composition, not the age of the material. The supported Pb-210 level was taken to be equal to 1.59 dpm/g. Three rates were calculated for this core, one for the whole core, one for the first 21 cm, and one for the next 49 cm. However, the one for the whole core was used for comparison because the one low Pb-210 activity level was considered an outlier. The 1991 rate and 1990 rate were in close agreement which implied a fairly high confidence level. If the Pb-210 activities were normalized to TOC, the rate would have been slightly higher. The Cs-137 (Fig. 8) values reveal a clear maximum occurs at 49-56 cm, indicating that this layer corresponded to 1963. The calculated velocity equaled 1.9 cm/yr. The earliest appearance of Cs-137 occurred at 63 - 70 cm, indicating that this layer corresponded to 1954. The calculated velocity equaled 1.8 cm/yr. These velocities compared quite favorably to the calculated velocity from Pb-210 (2.4 cm/yr). From the Pb-210 velocities, these layers corresponded to 1968-1971 and 1962-1965 respectively. Because there was fairly close agreement between the Pb-210 date and the Cs-137 dates, it can be concluded that this sampling site had not been disturbed by dredging.

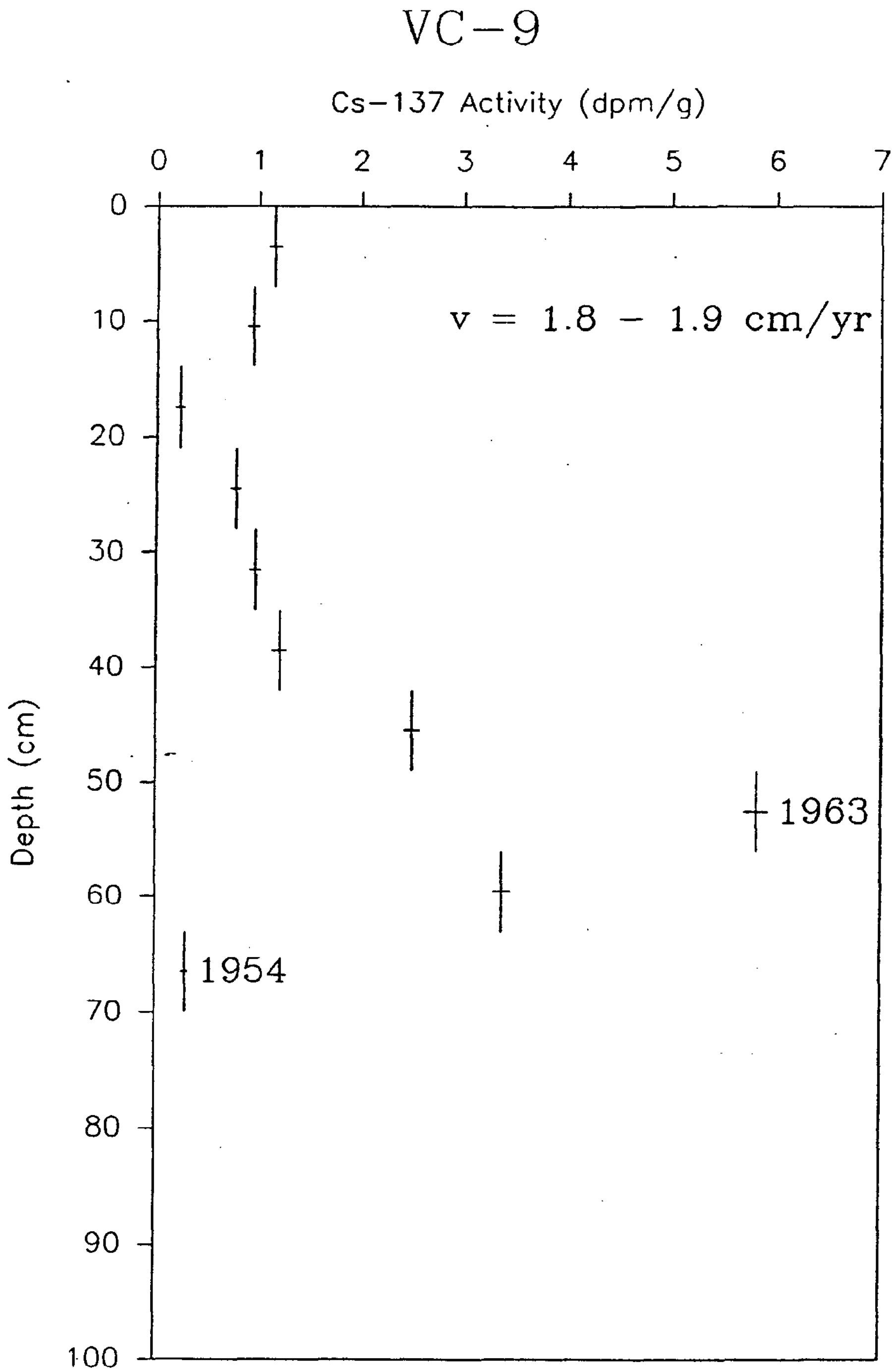


Fig. 8 Depth vs. Cs-137 activity for VC-9

In the Outer Harbor (VC-12), a fairly slow sedimentation rate was calculated. In this area, there was a fairly smooth decrease in Pb-210 activities with depth. This trend implied a slow sedimentation rate and little mixing of the sediments. Occasional departures from a smooth profile could probably be attributed to a storm event.

CIC Results

Results from the CIC calculations can be found in Tables 4-6. CIC dates were calculated on C-7, 8, 10 & 12, GC-16, and VC-9. These sites were chosen because they exhibited the following characteristics: a high sedimentation rate with much scatter (C-7 & 8), a flattening out of the Pb-210 profile or increases in Pb-210 activity at depth (C-10 & 12) and a sharp drop to supported Pb-210 levels (GC-16). CIC dates were not calculated for GC-11 because the measured activity was less than the supported levels, and the CIC model can not handle that situation. CIC dates were calculated at VC-9 to check the Pb-210 and Cs-137 dates.

The CIC dates from VC-9 showed fairly good agreement to the Pb-210 and Cs-137 dates for the 49-56 cm layer but was vastly different at 63-70 cm. The Pb-210 at the 63-70 cm layer was close to the supported level so the CIC model fails. However, the agreement at the 49-56 cm layer was an added measure of confidence to the age of this layer.

C-7

Depth (cm)	excess Pb-210 (dpm/g)	age (year)	approximate year of deposition
0-1	7.01	0.0	1990
1-2	4.37	15.2	1975
2-3	3.27	24.5	1965
3-4	4.32	15.5	1974
4-5	4.72	12.7	1977
5-7	4.85	11.8	1978
7-9	6.47	2.5	1987
9-11	4.44	14.6	1975
11-13	8.10	-4.6	1990*
13-15	7.14	-0.6	1990*
15-17	4.92	11.3	1979
17-19	4.87	11.7	1978

* Since the calculated age is less than the sampling year (1990), the latter year is assumed

GC-16

Depth (cm)	excess Pb-210 (dpm/g)	age (year)	approximate year of deposition
0-5	4.90	0.0	1990
5-10	-0.67	n.d.	n.d.
10-15	0.13	116.2	1874
15-20	1.19	45.4	1945
20-25	0.10	123.9	1866

n.d. = not defined

C-8

Depth (cm)	excess Pb-210 (dpm/g)	age (year)	approximate year of deposition
0-1	5.54	0.0	1990
1-2	6.87	-6.9	1990*
2-3	7.00	-7.5	1990*
3-4	6.44	-4.8	1990*
4-5	4.85	4.3	1986
5-7	4.86	4.3	1986
7-9	4.87	4.1	1986
9-11	2.58	24.5	1965
11-13	3.93	11.0	1979
13-15	4.59	6.1	1984
15-17	6.75	-6.3	1990*
17-19	4.56	6.3	1984
19-21	6.80	-6.6	1990*
21-23	7.68	-10.5	1990*
23-25	6.77	-6.4	1990*

* Since the calculated age is less than the sampling year (1990), the latter year is assumed

Table 4 CIC dates for C-7 & 8, & GC-16

C-10

Depth (cm)	excess Pb-210 (dpm/g)	age (year)	approximate year of deposition
0-1	5.82	0.0	1990
1-2	5.29	3.1	1987
2-3	4.53	8.0	1982
3-4	4.17	10.7	1979
4-5	1.50	43.7	1946
5-7	1.14	52.4	1938
7-9	1.35	47.0	1943
9-11	0.97	57.6	1932
11-13	1.09	53.8	1936
13-15	2.44	27.9	1962
15-17	1.83	37.1	1953
17-19	3.07	20.5	1969
19-21	3.83	13.4	1977
21-23	4.88	5.7	1984

C-12

Depth (cm)	excess Pb-210 (dpm/g)	age (year)	approximate year of deposition
0-1	5.36	0.0	1990
1-2	5.92	-3.2	1990*
2-3	5.05	1.9	1988
3-4	3.99	9.5	1981
4-5	2.79	20.9	1969
5-7	0.85	59.2	1931
7-9	1.80	35.1	1955
9-11	1.10	50.7	1939
11-13	2.01	31.4	1959
13-15	1.62	38.5	1952
15-17	1.70	36.9	1953
17-19	1.59	39.1	1951
19-21	2.24	28.0	1962
21-23	1.96	32.2	1958
23-25	2.20	28.6	1961

* Since the calculated age is less than the sampling year (1990), the latter year is assumed

Table 5 CIC dates for C-10 & 12

VC-9

Depth (cm)	excess Pb-210 (dpm/g)	age (year)	approximate year of deposition
0-7	8.25	0.0	1991
7-14	4.58	18.9	1972
14-21	1.16	63.0	1928
21-28	3.31	29.3	1962
28-35	4.17	21.9	1969
35-42	5.88	10.8	1980
42-49	2.91	33.4	1958
49-56	3.27	29.8	1961
56-63	2.50	38.3	1953
63-70	0.60	83.9	1907
70-77	0.02	196.5	1795
77-84	0.00	n.d.	n.d
84-91	-0.04	n.d.	n.d
91-98	-0.04	n.d.	n.d
98-105	-0.54	n.d.	n.d

n.d. = not defined

Pb-210

Depth (cm)	v (cm/yr)	age (year)	approx year of deposition
49-56	2.4	21.9	1969
63-70	2.4	27.7	1963

Cs-137

Depth (cm)	v (cm/yr)	age (year)	approx year of deposition
49-56	1.9	28	1963
63-70	1.8	37	1954

CIC

Depth (cm)	v (cm/yr)	age (year)	approx year of deposition
49-56	1.8	30	1961
63-70	0.8	84	1907

Table 6 CIC dates and comparison to Pb-210 & Cs-137 for VC-9

%TOC Maps

Figures 9-14 are the %TOC values at different depths. The average TOC over the specified range was used for these figures. From these figures, it was obvious that there were several areas of high TOC content. A high TOC content was probably associated with a high sedimentation rate.

Areas that had a high TOC content throughout the whole core length include the Menomonee River and South Menomonee Canal, the Milwaukee River before it merges with the Menomonee River, and the Kinnickinnic River near the Great Lakes Research Facility. This research confirmed a high sedimentation rate at these areas.

These are areas of concern because dredging is required for navigational purposes in these areas. Because a high TOC content can reflect a high contaminant content, the dredging spoils from these areas may require special handling. Also, because dredging operations may resuspend the sediments, buried contaminants may become bioavailable again.

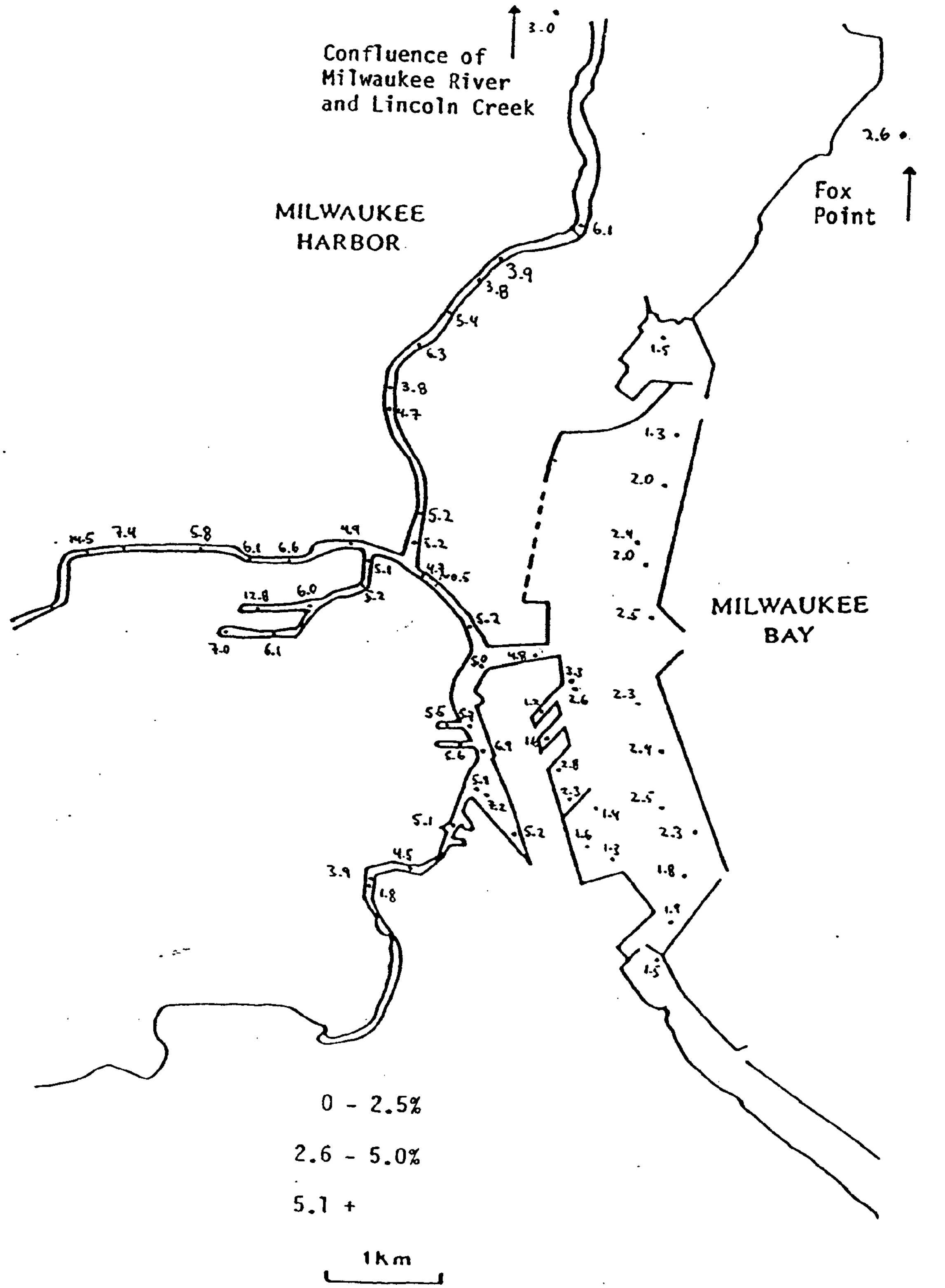


Fig. 9 %TOC at 0-10 cm depth & Grab samples, 1990

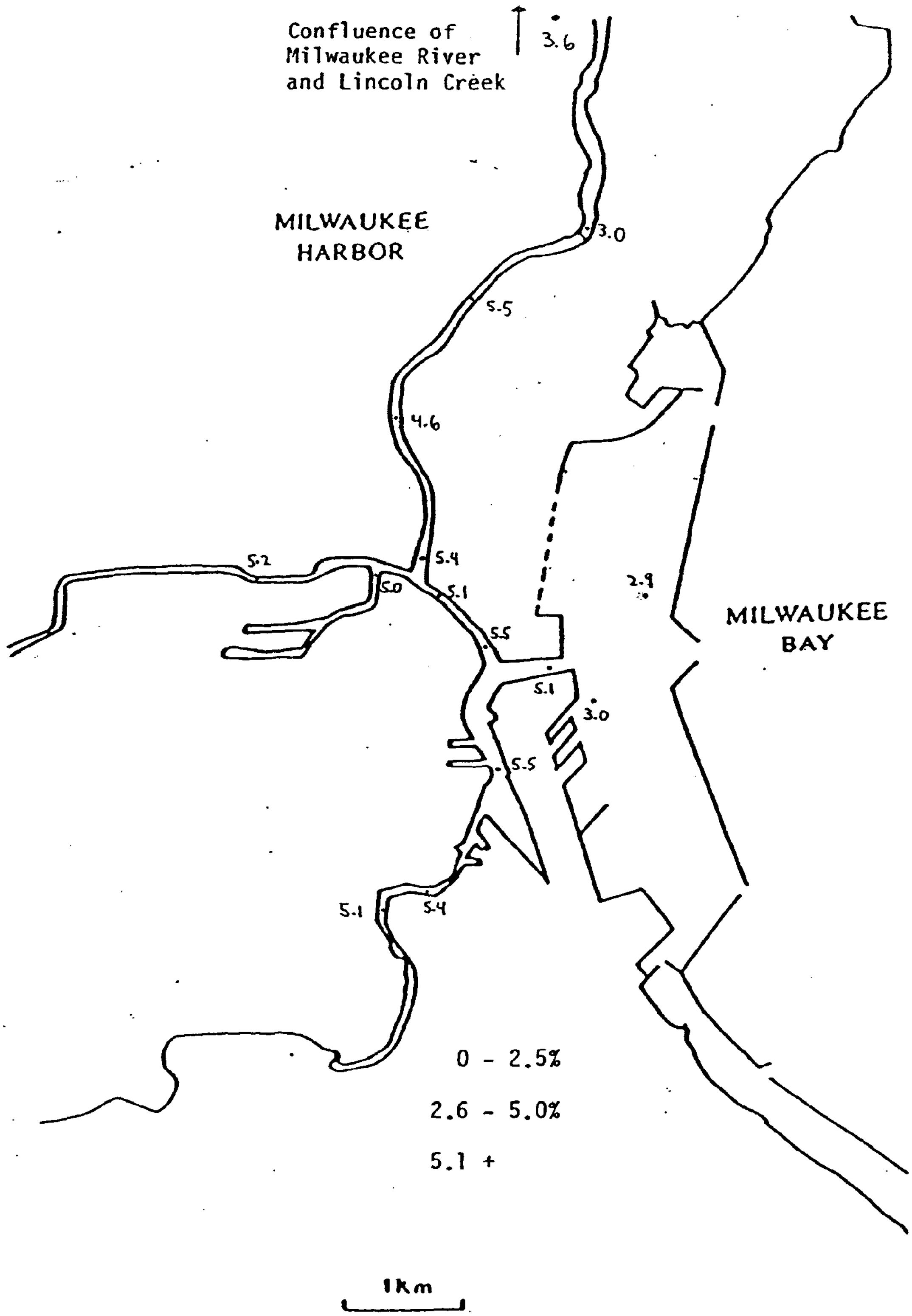


Fig. 10 %TOC at 10-20 cm depth, 1990

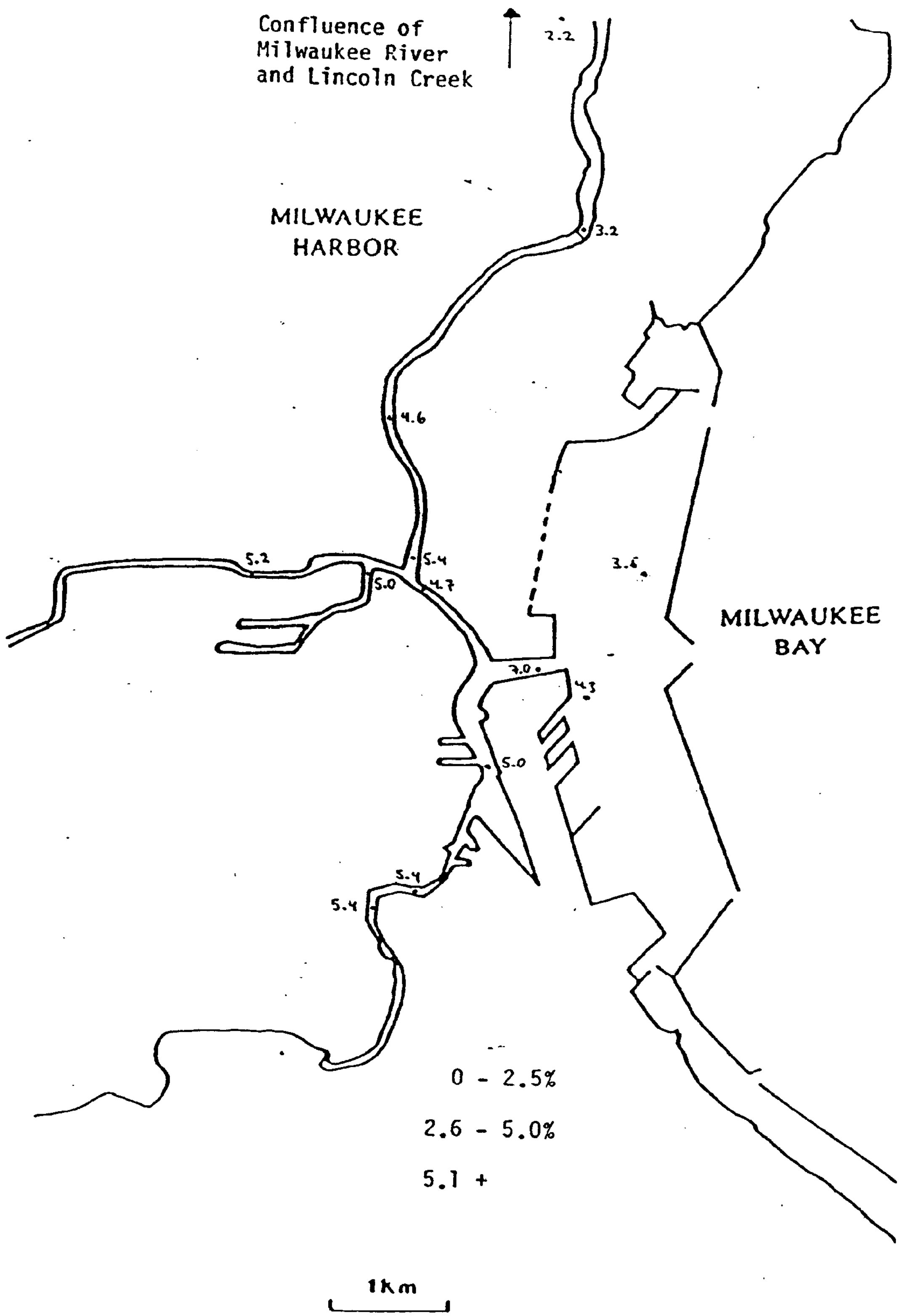


Fig. 11 %TOC at greater than 20 cm depth, 1990

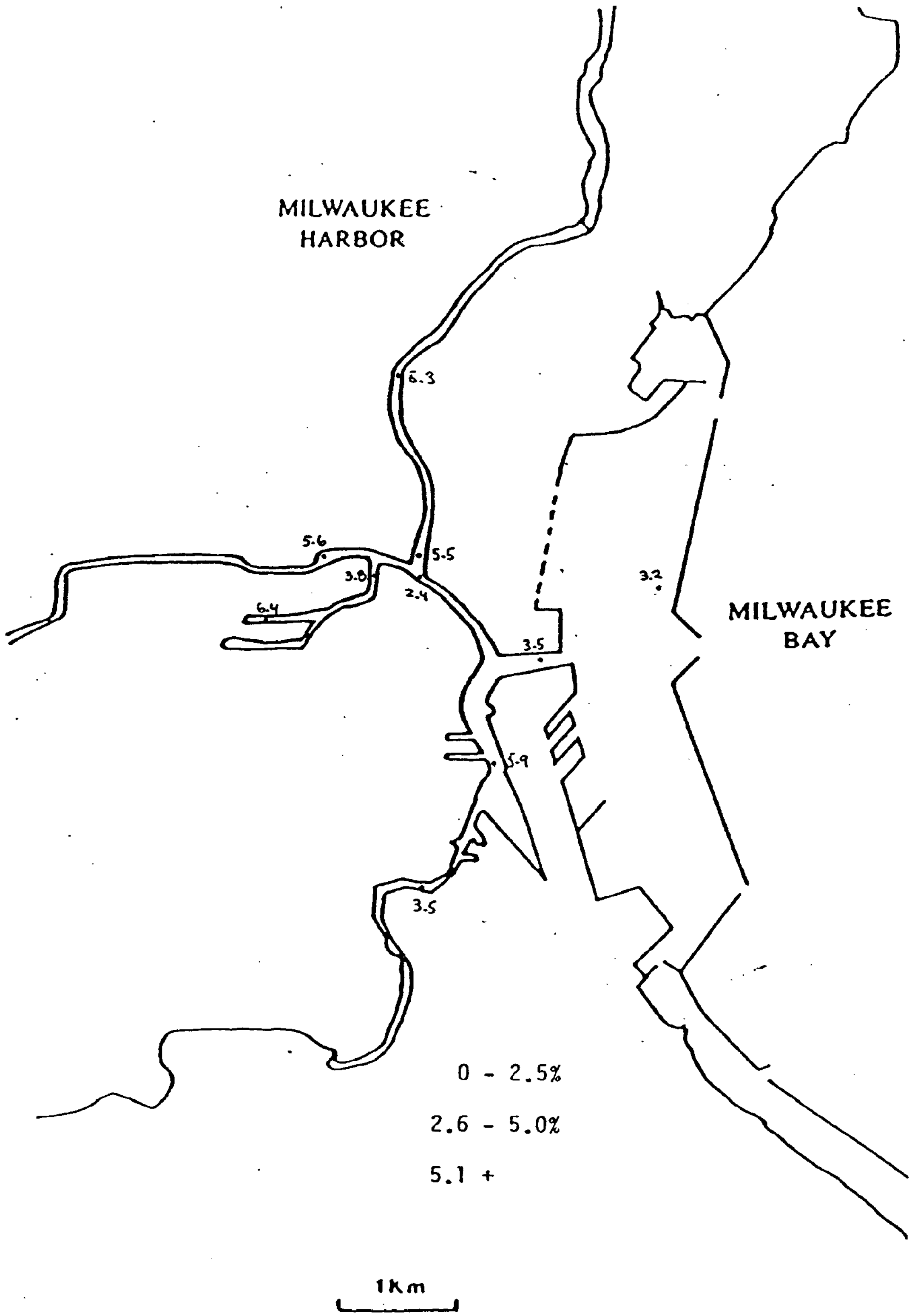


Fig. 12 %TOC at 0-30 cm depth, 1991

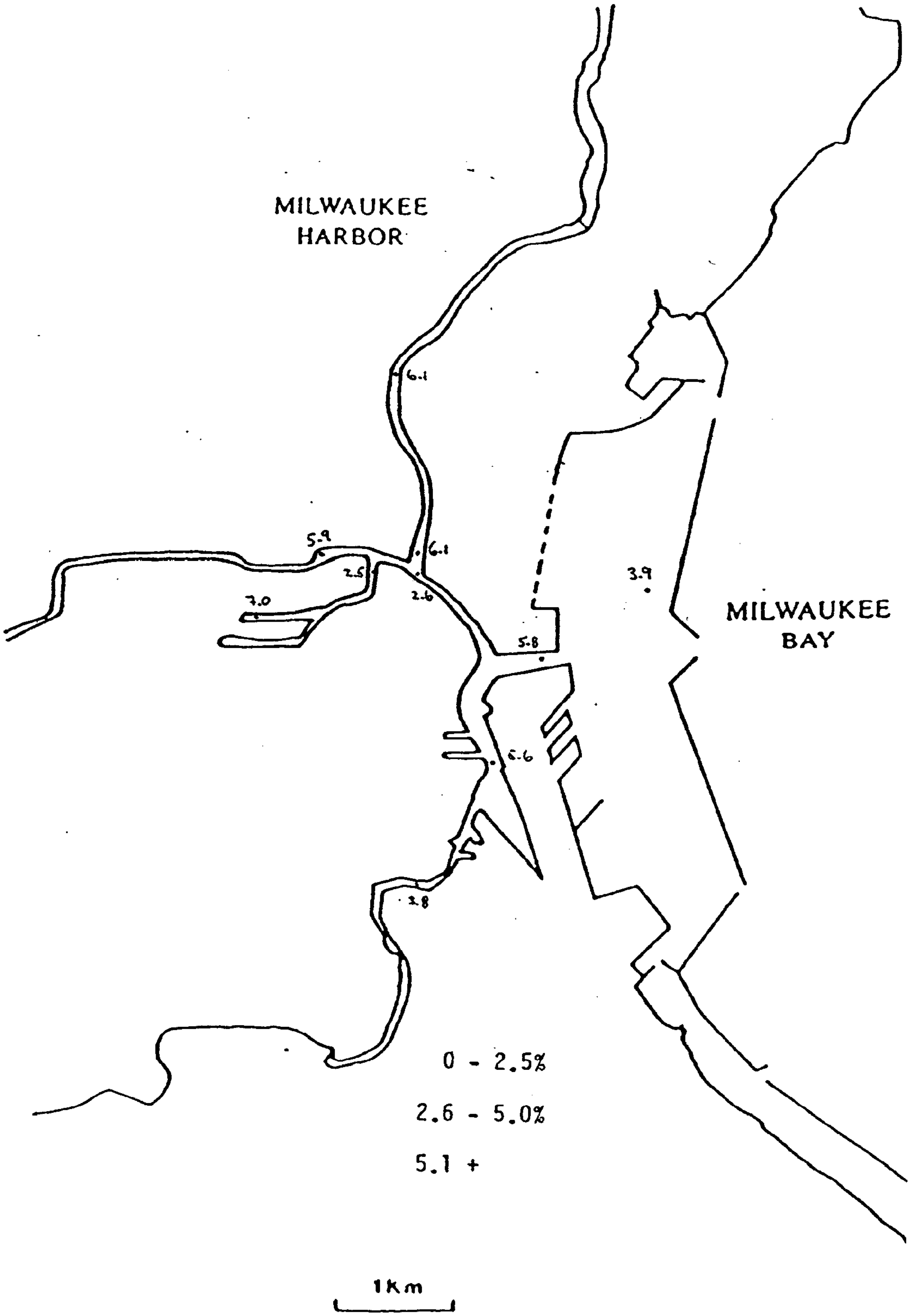


Fig.13 %TOC at 30-60 cm depth, 1991

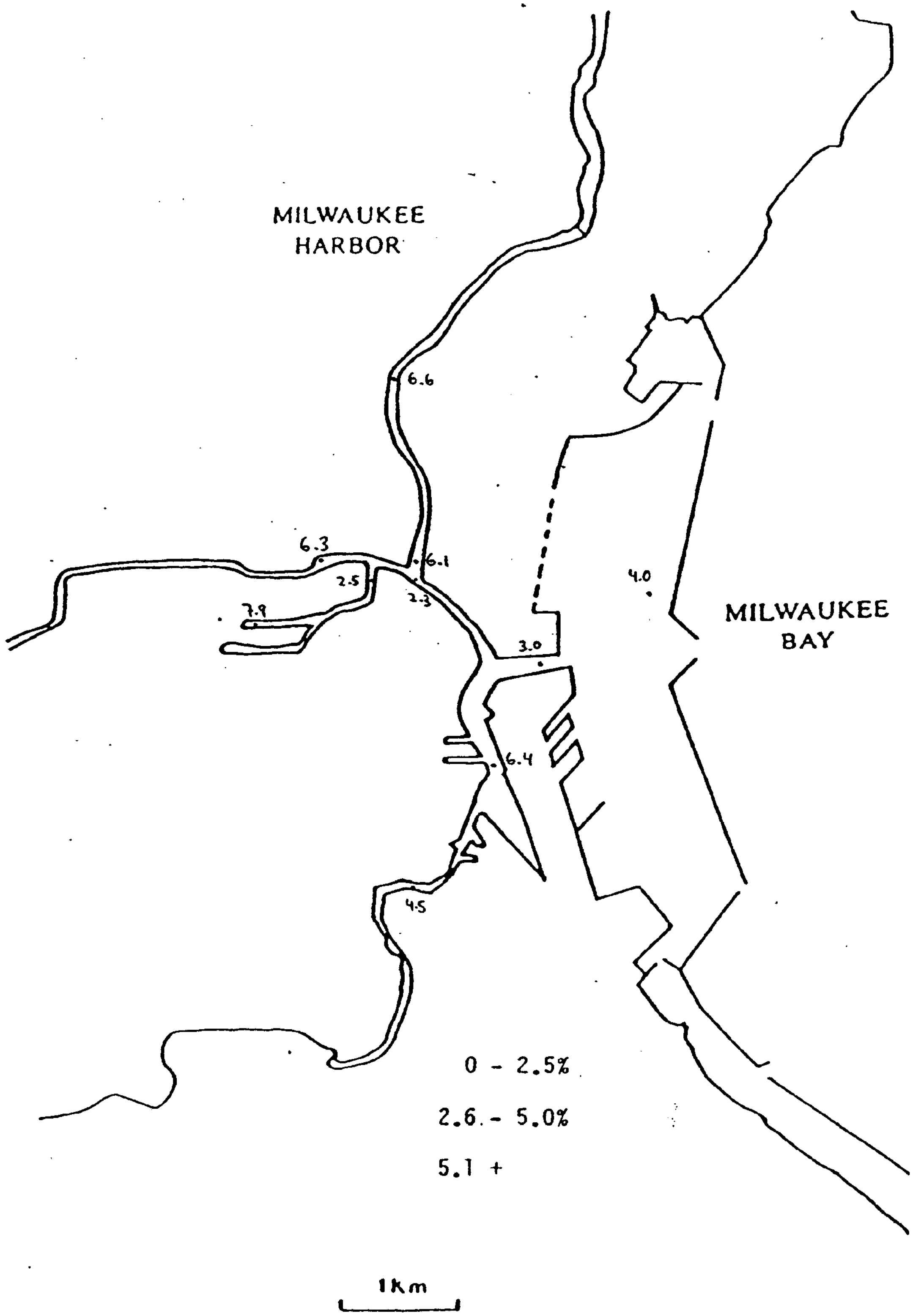


Fig. 14 %TOC at greater than 60 cm depth, 1991

Correlation of TOC and LOI

Fig. 15 (1990 sampling) and Fig. 16 (1991 sampling) are graphical representations of TOC vs. LOI. In general, there was a reasonably strong correlation between the two values. However, for any individual core, the relationship was quite varied.

Because of the correlation between the two values, LOI can probably be used as a rough estimate of total organic carbon. The advantages of performing a LOI test are the following: 1) the test and calculations are quicker and easier to perform, 2) the cost of instrumentation is less, and 3) the overall cost of the test is less. However, if a more accurate value of total organic carbon is desired, the TOC test should be performed.

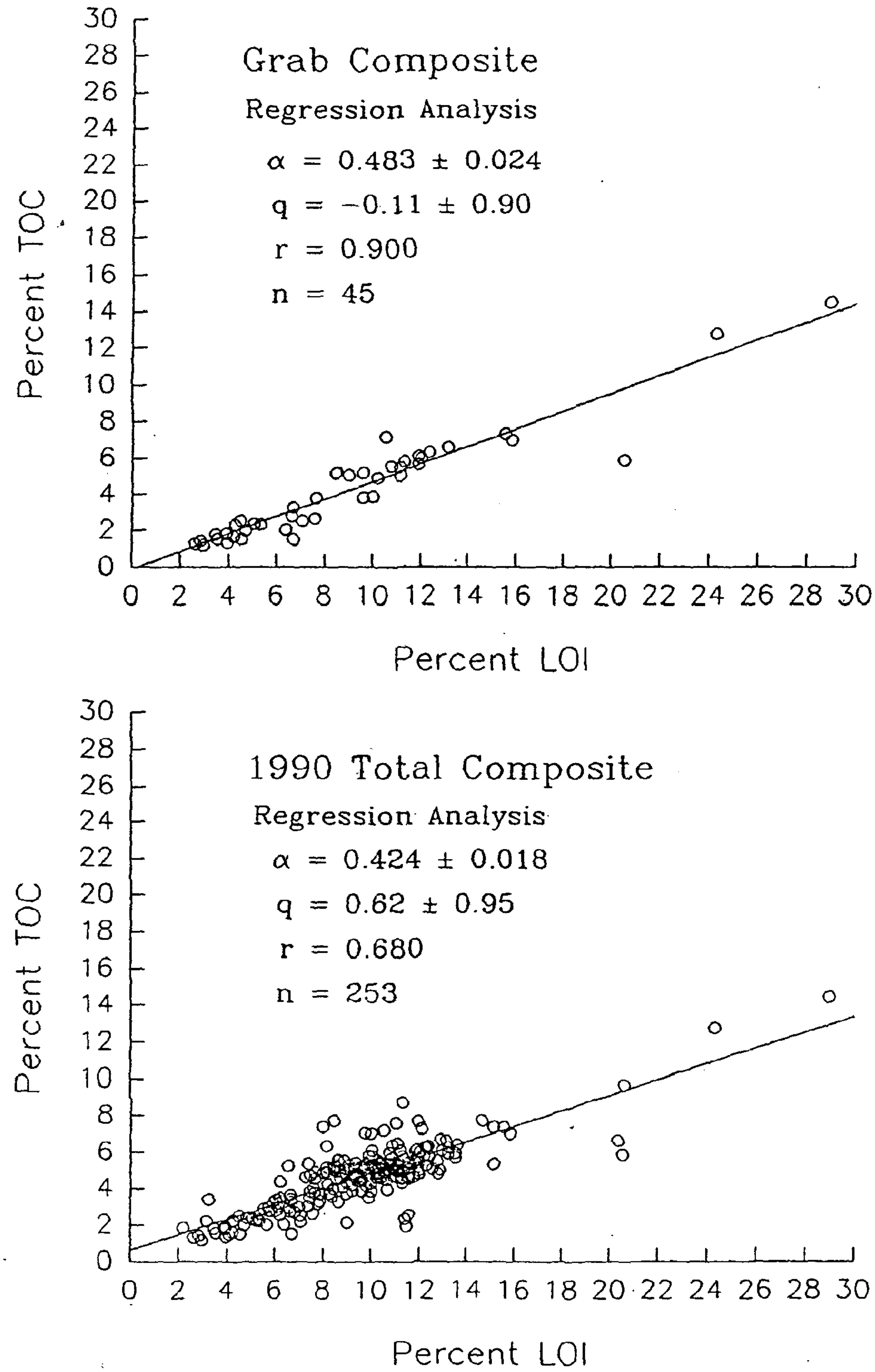


Fig. 15 TOC vs. LOI for Grab and 1990 Total Composites

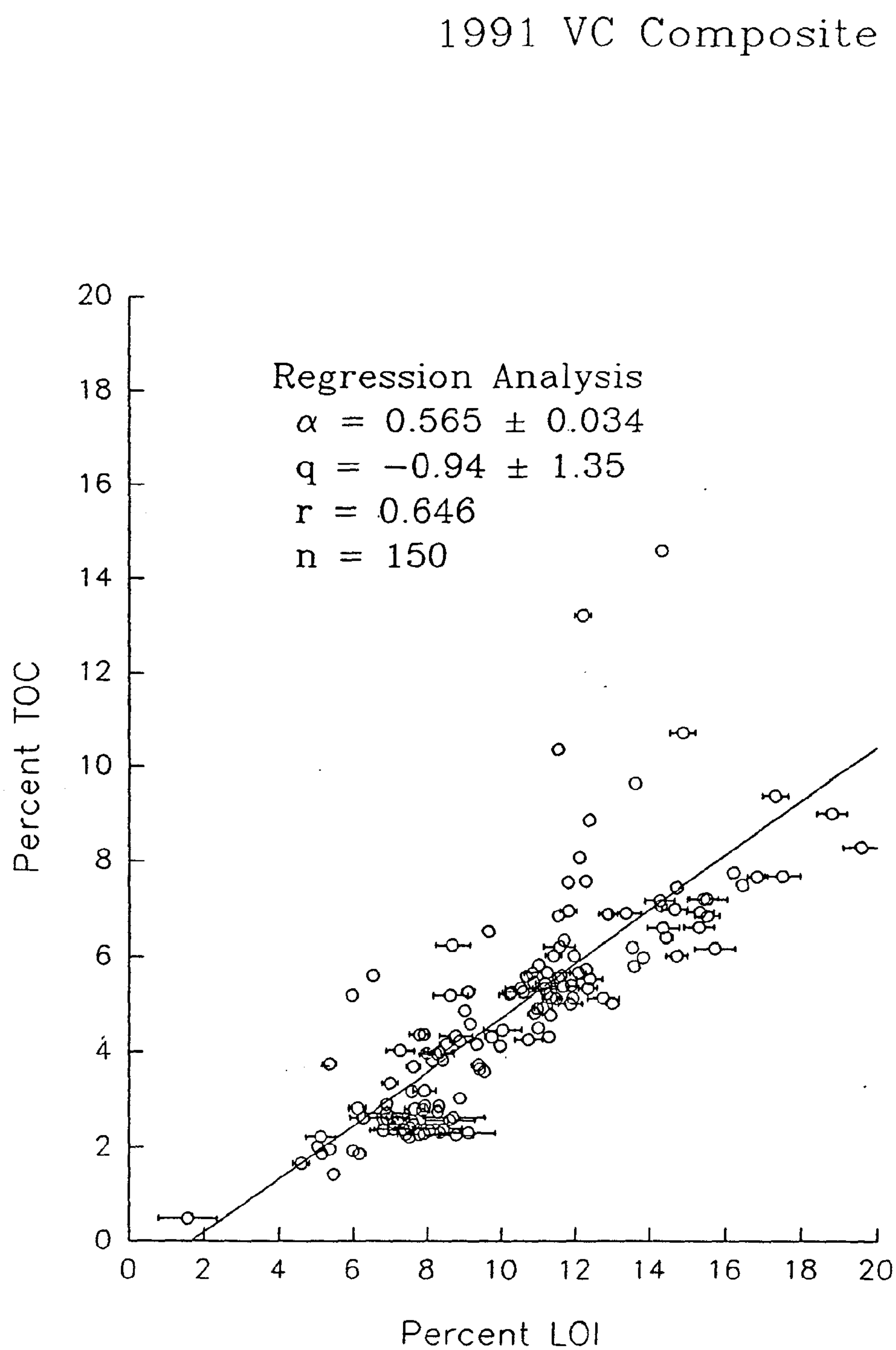


Fig. 16 TOC vs. LOI for 1991 VC Composite

IV. CONCLUSIONS

Sedimentation patterns of the Milwaukee Harbor estuary have been successfully identified by Pb-210. The analysis of Cs-137 has provided additional confirmation of sedimentation rates at VC-9. Furthermore, the vertical and horizontal distribution of %TOC in the system has been determined.

Areas of apparent high sedimentation include the Milwaukee River, especially just upstream of the confluence of the Milwaukee and Menomonee Rivers (C-3 and VC-3), the Menomonee River and the South Menomonee Canal, and the Kinnickinnic River near the Great Lakes Research Facility. Meanwhile, the outer harbor is an area of low sedimentation.

A correlation between LOI and TOC was determined ($r \approx 0.68$). This correlation indicated that LOI can be used as a rough estimate of total organic carbon. However, if a more accurate value of TOC is desired, the more tedious and costly TOC analysis must be performed.

Sedimentation patterns of a dynamic system like the Milwaukee Harbor estuary are often difficult to determine. Many factors can disrupt normal sedimentation patterns. These factors include dredging, storms and other contributors to mixing. Therefore, the interpretation of Pb-210 activity profiles is often difficult. However, this research has confirmed that a general picture of sedimentation patterns can be gained by TOC, Pb-210 and Cs-137 methods.

Analysis of priority organic pollutants and Cs-137 analysis of other VC cores may assist in areas of uncertainty and provide information about mixing. At these areas of apparent high sedimentation, deeper cores would be necessary to gain information about sedimentation rates. Finally, further study of the correlation between Pb-210 and organic carbon would be useful.

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Appendix A

Summary of Porosity, LOI, TOC, Bulk Density, Pb-210, and Cs-137 (if applicable) Measurements

CORE: C-1
LOCATION: 43deg 03.14'N 87deg 54.40'E Milwaukee River
WATER DEPTH: 3.7 m (12 ft)
CORE LENGTH: 19 cm
DATE SAMPLED: 10/04/90

Depth (cm)	Porosity	LOI %	TOC %	g/cm^2	cumulative g/cm^2	bulk density g/cm^3	Pb-210 (dpm/g)	excess Pb-210 (dpm/g)	Pb-210 (total counts)
0-1	0.789	9.75	4.17	0.517	0.517	0.517	8.90	5.98	543
1-2	0.709	9.90	3.52	0.713	1.230	0.713	6.74	3.82	424
2-3	0.723	10.94	5.36	0.679	1.909	0.679	7.30	4.38	391
3-4	0.757	8.16	4.92	0.595	2.504	0.595	9.91	6.99	517
4-5	0.754	8.68	4.55	0.603	3.107	0.603	9.89	6.97	575
5-7	0.762	9.74	5.08	1.166	4.273	0.583	10.67	7.75	580
7-9	0.773	11.26	8.74	1.112	5.385	0.556	12.12	9.20	779
9-11	0.768	10.00	7.06	1.137	6.522	0.568	10.32	7.40	649
11-13	0.771	10.05	5.78	1.122	7.644	0.561	11.01	8.09	609
13-15	0.777	9.62	4.66	1.093	8.737	0.546	10.67	7.75	739
15-17	0.759	7.47	4.73	1.181	9.918	0,590	11.04	8.12	687
17-19	0.727	6.54	5.26	1.338	11.255	0.669	8.63	5.71	486

Table A 1 Summary of Porosity, LOI, TOC, Bulk Density and Pb-210 for C-1

CORE: C-2
LOCATION: 43deg 02.54'N 87deg 54.77'E Milwaukee River
WATER DEPTH: 4.6 m (15 ft)
CORE LENGTH: 25 cm
DATE SAMPLED: 10/04/90

Depth (cm)	Porosity	LOI %	TOC %	g/cm^2	cumulative g/cm^2	bulk density g/cm^3	Pb-210 (dpm/g)	excess Pb-210 (dpm/g)	Pb-210 (total counts)
0-1	0.836	9.37	4.59	0.402	0.402	0.402	7.61	4.69	744
1-2	0.823	9.28	4.61	0.434	0.835	0.434	7.92	5.00	878
2-3	0.810	8.95	4.35	0.465	1.301	0.465	8.39	5.47	841
3-4	0.809	9.09	4.45	0.468	1.769	0.468	8.11	5.19	875
4-5	0.806	10.59	5.32	0.475	2.244	0.475	7.23	4.31	814
5-7	0.800	9.94	4.56	0.980	3.224	0.490	7.58	4.66	712
7-9	0.807	9.69	5.30	0.946	4.170	0.473	7.19	4.27	797
9-11	0.773	8.54	4.49	1.112	5.282	0.556	7.17	4.25	748
11-13	0.786	9.07	4.30	1.049	6.331	0.524	7.49	4.57	735
13-15	0.797	9.62	4.48	0.995	7.326	0.497	8.57	5.65	824
15-17	0.792	9.27	4.70	1.019	8.345	0.510	7.85	4.93	870
17-19	0.807	9.47	4.80	0.946	9.290	0.473	7.93	5.01	766
19-21	0.781	9.86	4.75	1.073	10.364	0.537	8.80	5.88	798
21-23	0.773	10.51	4.51	1.112	11.476	0.556	6.30	3.38	583
23-25	0.739	10.25	4.59	1.279	12.755	0.639	5.53	2.61	460

Table A 2 Summary of Porosity, LOI, TOC, Bulk Density and Pb-210 for C-2

CORE: C-3
LOCATION: 43deg 01.99'N 87deg 54.61'E Milwaukee River
WATER DEPTH: 6.1 m (20 ft)
CORE LENGTH: 25 cm
DATE SAMPLED: 10/04/90

Depth (cm)	Porosity	LOI %	TOC %	g/cm^2	cumulative g/cm^2	bulk density g/cm^3	Pb-210 (dpm/g)	excess Pb-210 (dpm/g)	Pb-210 (total counts)
0-1	0.853	11.05	4.61	0.360	0.360	0.360	8.77	5.85	1031
1-2	0.828	10.72	5.06	0.421	0.782	0.421	9.08	6.16	906
2-3	0.818	10.21	4.59	0.446	1.227	0.446	9.39	6.47	1071
3-4	0.815	11.78	5.44	0.453	1.681	0.453	9.88	6.96	1010
4-5	0.809	8.25	5.07	0.468	2.149	0.468	9.25	6.33	717
5-7	0.794	10.36	5.40	1.009	3.158	0.505	7.68	4.76	666
7-9	0.788	11.09	6.51	1.039	4.197	0.519	8.23	5.31	748
9-11	0.773	9.04	5.30	1.112	5.309	0.556	8.11	5.19	633
11-13	0.767	8.61	5.60	1.142	6.451	0.571	7.13	4.21	683
13-15	0.758	9.88	5.15	1.186	7.637	0.593	7.78	4.86	787
15-17	0.803	9.07	5.11	0.965	8.602	0.483	8.50	5.58	712
17-19	0.802	9.82	5.38	0.970	9.572	0.485	11.65	8.73	929
19-21	0.806	9.91	5.82	0.951	10.523	0.475	9.53	6.61	1024
21-23	0.799	10.92	5.12	0.985	11.508	0.492	10.15	7.23	880
23-25	0.795	10.30	5.13	1.005	12.512	0.502	9.28	6.36	926

Table A 3 Summary of Porosity, LOI, TOC, Bulk Density and Pb-210 for C-3

CORE: C-4
LOCATION: 43deg 01.88'N 87deg 54.58'E confluence of Milwaukee and Menomonee Rivers
WATER DEPTH: 6.7 m (22 ft)
CORE LENGTH: 25 cm
DATE SAMPLED: 10/02/90

Depth (cm)	Porosity	LOI %	TOC %	g/cm^2	cumulative g/cm^2	bulk density g/cm^3	Pb-210 (dpm/g)	excess Pb-210 (dpm/g)	Pb-210 (total counts)	total Cs-137 (dpm/g)
0-1	0.891	9.69	5.16	0.267	0.267	0.267	15.32	12.40	632	2.84
1-2	0.863	9.54	4.36	0.336	0.603	0.336	12.45	9.53	561	----
2-3	0.860	9.97	4.31	0.343	0.946	0.343	14.55	11.63	518	----
3-4	0.839	9.18	4.20	0.394	1.340	0.394	13.17	10.25	584	----
4-5	0.834	8.96	4.85	0.407	1.747	0.407	14.12	11.20	582	----
5-7	0.833	8.54	4.92	0.818	2.565	0.409	15.17	12.25	532	3.12
7-9	0.832	11.05	5.07	0.823	3.388	0.412	12.43	9.51	677	2.15
9-11	0.825	11.24	4.61	0.858	4.246	0.429	11.73	8.81	507	2.85
11-13	0.828	10.69	5.39	0.843	5.089	0.421	11.73	8.81	536	2.89
13-15	0.837	12.26	5.25	0.799	5.887	0.399	11.25	8.33	589	3.01
15-17	0.846	12.32	6.26	0.755	6.642	0.377	10.61	7.69	536	2.59
17-19	0.830	12.81	4.79	0.833	7.475	0.417	12.27	9.35	533	3.84
19-21	0.820	11.26	4.34	0.882	8.357	0.441	12.98	10.06	601	3.68
21-23	0.821	12.88	5.01	0.877	9.234	0.439	13.09	10.17	578	3.45
23-25	0.809	10.17	4.79	0.936	10.170	0.468	13.81	10.89	549	3.48

Table A 4 Summary of Porosity, LOI, TOC, Bulk Density, Pb-210, and Cs-137 for C-4

CORE: C-5
LOCATION: 43deg 01.94'N 87deg 55.68'E Menomonee River
WATER DEPTH: 7.3 m (24 ft)
CORE LENGTH: 25 cm
DATE SAMPLED: 10/02/90

Depth (cm)	Porosity	LOI %	TOC %	g/cm^2	cumulative g/cm^2	bulk density g/cm^3	Pb-210 (dpm/g)	excess Pb-210 (dpm/g)	Pb-210 (total counts)
0-1	0.892	15.13	7.39	0.265	0.265	0.265	18.63	15.71	1436
1-2	0.915	11.82	6.11	0.208	0.473	0.208	17.52	14.60	1565
2-3	0.879	11.35	5.64	0.296	0.769	0.296	19.22	16.30	1460
3-4	0.876	11.92	5.58	0.304	1.073	0.304	17.71	14.79	1570
4-5	0.874	12.25	6.27	0.309	1.382	0.309	19.12	16.20	1458
5-7	0.849	13.60	6.42	0.740	2.122	0.370	17.69	14.77	1570
7-9	0.850	12.94	6.06	0.735	2.857	0.368	16.87	13.95	1302
9-11	0.809	10.26	5.57	0.936	3.793	0.468	16.71	13.79	1272
11-13	0.796	10.16	5.15	1.000	4.792	0.500	16.38	13.46	1294
13-15	0.771	9.32	5.15	1.122	5.914	0.561	22.75	19.83	1529
15-17	0.764	10.43	5.38	1.156	7.071	0.578	18.52	15.60	1625
17-19	0.769	10.35	4.56	1.132	8.203	0.566	21.13	18.21	1623
19-21	0.751	10.43	5.27	1.220	9.423	0.610	22.30	19.38	1513
21-23	0.757	10.16	5.20	1.191	10.613	0.595	18.68	15.76	1628
23-25	0.754	9.96	5.22	1.205	11.819	0.603	21.45	18.53	1616

Table A 5 Summary of Porosity, LOI, TOC, Bulk Density and Pb-210 for C-5.

CORE: C-6
LOCATION: 43deg 01.92'N Menomonee River
87deg 54.86'E
WATER DEPTH: 7.0 m (23 ft)
CORE LENGTH: 19 cm
DATE SAMPLED: 10/02/90

Depth (cm)	Porosity	LOI %	TOC %	g/cm^2	cumulative g/cm^2	bulk density g/cm^3	Pb-210 (dpm/g)	excess Pb-210 (dpm/g)	Pb-210 (total counts)
0-1	0.892	13.53	5.95	0.265	0.265	0.265	14.84	11.92	984
1-2	0.865	15.14	5.34	0.331	0.595	0.331	14.36	11.44	1196
2-3	0.843	12.32	5.30	0.385	0.980	0.385	14.54	11.62	1158
3-4	0.793	10.21	5.07	0.507	1.487	0.507	14.40	11.48	955
4-5	0.818	11.05	4.95	0.446	1.933	0.446	14.33	11.41	978
5-7	0.835	11.98	4.76	0.809	2.742	0.404	16.05	13.13	1096
7-9	0.833	11.57	4.81	0.818	3.560	0.409	15.23	12.31	980
9-11	0.833	11.33	4.99	0.818	4.378	0.409	14.07	11.15	972
11-13	0.823	10.54	4.69	0.867	5.245	0.434	16.02	13.10	1089
13-15	0.807	10.55	4.89	0.946	6.191	0.473	14.58	11.66	914
15-17	0.812	11.09	5.30	0.921	7.112	0.461	15.34	12.42	1057
17-19	0.811	11.52	5.11	0.926	8.038	0.463	17.28	14.36	993

Table A 6 Summary of Porosity, LOI, TOC, Bulk Density and Pb-210 for C-6

CORE: C-7
LOCATION: 43deg 00.49'N 87deg 54.60'E Kinnickinnic River
WATER DEPTH: 2.8 m (9.2 ft)
CORE LENGTH: 19 cm
DATE SAMPLED: 09/27/90

Depth (cm)	Porosity	LOI %	TOC %	g/cm ^ 2	cumulative g/cm ^ 2	bulk density g/cm ^ 3	Pb-210 (dpm/g)	excess Pb-210 (dpm/g)	Pb-210 (total counts)
0-1	0.750	7.58	4.04	0.360	0.360	0.613	9.93	7.01	848
1-2	0.672	6.99	2.97	0.804	1.164	0.804	7.29	4.37	641
2-3	0.605	8.35	3.57	0.968	2.132	0.968	6.19	3.27	547
3-4	0.605	7.85	3.68	0.968	3.099	0.968	7.24	4.32	609
4-5	0.671	9.36	4.77	0.806	3.905	0.806	7.64	4.72	751
5-7	0.693	8.75	4.74	1.504	5.410	0.752	7.77	4.85	832
7-9	0.695	10.06	5.36	1.495	6.904	0.747	9.39	6.47	845
9-11	0.683	9.72	7.08	1.553	8.457	0.777	7.36	4.44	715
11-13	0.713	10.62	5.37	1.406	9.864	0.703	11.02	8.10	1043
13-15	0.692	10.37	5.37	1.509	11.373	0.755	10.06	7.14	773
15-17	0.663	8.17	4.20	1.651	13.024	0.826	7.84	4.92	683
17-19	0.649	8.69	4.96	1.720	14.744	0.860	7.79	4.87	455

Table A 7 Summary of Porosity, LOI, TOC, Bulk Density and Pb-210 for C-7

CORE: C-8
LOCATION: 43deg 01.07'N 87deg 54.08'E Kinnickinnic River
WATER DEPTH: 8.2 m (27 ft)
CORE LENGTH: 25 cm
DATE SAMPLED: 09/27/90

Depth (cm)	Porosity	LOI %	TOC %	g/cm^2	cumulative g/cm^2	bulk density g/cm^3	Pb-210 (dpm/g)	excess Pb-210 (dpm/g)	Pb-210 (total counts)
0-1	0.892	14.65	7.73	0.360	0.360	0.265	8.46	5.54	831
1-2	0.842	20.35	6.61	0.387	0.747	0.387	9.79	6.87	1010
2-3	0.802	11.94	7.66	0.485	1.232	0.485	9.92	7.00	1026
3-4	0.777	12.08	7.28	0.546	1.779	0.546	9.36	6.44	859
4-5	0.748	10.02	6.12	0.617	2.396	0.617	7.77	4.85	731
5-7	0.721	10.04	5.79	1.367	3.763	0.684	7.78	4.86	834
7-9	0.713	10.86	6.39	1.406	5.170	0.703	7.79	4.87	765
9-11	0.702	8.44	7.73	1.460	6.630	0.730	5.50	2.58	635
11-13	0.673	8.13	6.35	1.602	8.232	0.801	6.85	3.93	689
13-15	0.672	7.96	7.39	1.607	9.839	0.804	7.51	4.59	608
15-17	0.675	7.44	3.84	1.593	11.432	0.796	9.67	6.75	1005
17-19	0.663	6.64	3.66	1.651	13.083	0.826	7.48	4.56	754
19-21	0.709	8.80	4.10	1.426	14.509	0.713	9.72	6.80	950
21-23	0.770	11.53	4.66	1.127	15.636	0.564	10.60	7.68	1149
23-25	0.742	11.20	6.14	1.264	16.900	0.632	9.69	6.77	1018

Table A 8 Summary of Porosity, LOI, TOC, Bulk Density and Pb-210 for C-8

CORE:	C-9	
LOCATION:	43deg 01.50'N 87deg 53.82'E	Harbor Entrance
WATER DEPTH:	9.3 m (30.6 ft)	
CORE LENGTH:	25 cm	
DATE SAMPLED:	09/27/90	

Depth (cm)	Porosity	LOI %	TOC %	g/cm^2	cumulative g/cm^2	bulk density g/cm^3	Pb-210 (dpm/g)	excess Pb-210 (dpm/g)	Pb-210 (total counts)	total Cs-137 (dpm/g)
0-1	0.858	11.95	4.97	0.360	0.360	0.348	11.89	8.97	1152	1.03
1-2	0.831	11.55	4.54	0.414	0.774	0.414	11.14	8.22	1181	1.17
2-3	0.837	11.77	4.61	0.399	1.174	0.399	12.39	9.47	1260	1.01
3-4	0.824	10.62	4.45	0.431	1.605	0.431	12.48	9.56	1131	1.09
4-5	0.821	10.29	4.85	0.439	2.043	0.439	10.55	7.63	1115	1.09
5-7	0.834	11.03	5.03	0.813	2.857	0.407	9.71	6.79	1129	1.00
7-9	0.809	12.55	5.09	0.936	3.793	0.468	11.11	8.19	1039	0.87
9-11	0.804	11.57	5.10	0.960	4.753	0.480	9.75	6.83	1063	0.95
11-13	0.789	11.26	4.55	1.034	5.787	0.517	11.08	8.16	1036	1.06
13-15	0.808	10.34	4.84	0.941	6.728	0.470	11.13	8.21	862	1.27
15-17	0.815	11.53	4.93	0.907	7.634	0.453	11.45	8.53	1134	1.26
17-19	0.782	11.55	5.49	1.068	8.702	0.534	7.16	4.24	627	1.02
19-21	0.805	12.75	5.52	0.955	9.658	0.478	9.83	6.91	867	1.17
21-23	0.811	13.53	5.70	0.926	10.584	0.463	9.78	6.86	929	1.23
23-25	0.860	20.64	9.68	0.686	11.270	0.343	8.19	5.27	827	1.07

Table A 9 Summary of Porosity, LOI, TOC, Bulk Density, Pb-210 and Cs-137 for C-9

CORE: C-10
LOCATION: 43deg 01.39'N Jones Island outfall
87deg 53.55'E
WATER DEPTH: 8.5 m (28.0 ft)
CORE LENGTH: 23 cm
DATE SAMPLED: 09/27/90

Depth (cm)	Porosity	LOI %	TOC %	g/cm^2	cumulative g/cm^2	bulk density g/cm^3	Pb-210 (dpm/g)	excess Pb-210 (dpm/g)	Pb-210 (total counts)
0-1	0.848	6.67	3.45	0.360	0.360	0.372	8.74	5.82	533
1-2	0.806	6.16	3.19	0.475	0.835	0.475	8.21	5.29	492
2-3	0.793	6.20	3.47	0.507	1.343	0.507	7.45	4.53	514
3-4	0.758	5.94	3.23	0.593	1.936	0.593	7.09	4.17	404
4-5	0.665	3.17	2.21	0.821	2.756	0.821	4.42	1.50	241
5-7	0.601	2.20	1.83	1.955	4.711	0.978	4.06	1.14	278
7-9	0.586	4.08	1.48	2.029	6.740	1.014	4.27	1.35	280
9-11	0.669	5.67	2.02	1.622	8.362	0.811	3.89	0.97	221
11-13	0.669	5.36	2.22	1.622	9.984	0.811	4.01	1.09	201
13-15	0.711	6.60	2.93	1.416	11.400	0.708	5.36	2.44	272
15-17	0.719	7.77	3.15	1.377	12.777	0.688	4.75	1.83	244
17-19	0.747	8.97	3.72	1.240	14.016	0.620	5.99	3.07	389
19-21	0.759	9.22	3.86	1.181	15.197	0.590	6.75	3.83	356
21-23	0.789	10.88	4.71	1.034	16.231	0.517	7.80	4.88	441

Table A10 Summary of Porosity, LOI, TOC, Bulk Density and Pb-210 for C-10

CORE: GC-11
LOCATION: upstream of North Ave. Dam
WATER DEPTH:
CORE LENGTH: 30 cm
DATE SAMPLED: 10/25/90

Depth (cm)	Porosity	LOI %	TOC %	g/cm^2	cumulative g/cm^2	bulk density g/cm^3	Pb-210 (dpm/g)	excess Pb-210 (dpm/g)	Pb-210 (total counts)
0-5	0.780	11.00	7.61	2.695	2.695	0.539	5.10	2.18	497
5-10	0.631	7.28	4.60	4.520	7.215	0.904	2.76	*0	278
10-15	0.619	5.38	2.59	4.667	11.883	0.933	2.30	*0	220
15-20	0.722	7.85	3.33	3.406	15.288	0.681	2.67	*0	258
20-25	0.741	8.62	3.29	3.173	18.461	0.635	3.35	0.43	318
25-30	0.719	7.38	3.03	3.442	21.903	0.688	2.75	*0	283

Table A11 Summary of Porosity, LOI, TOC, Bulk Density and Pb-210 for GC-11

CORE: C-12
LOCATION: 43deg 01.94'N 87deg 53.23'E Outer Harbor
WATER DEPTH: 6.7 m (22 ft)
CORE LENGTH: 25 cm
DATE SAMPLED: 10/12/90

Depth (cm)	Porosity	LOI %	TOC %	g/cm^2	cumulative g/cm^2	bulk density g/cm^3	Pb-210 (dpm/g)	excess Pb-210 (dpm/g)	Pb-210 (total counts)
0-1	0.864	5.76	2.77	0.360	0.360	0.333	8.28	5.36	591
1-2	0.839	6.08	2.77	0.394	0.755	0.394	8.84	5.92	848
2-3	0.805	5.21	2.25	0.478	1.232	0.478	7.97	5.05	602
3-4	0.775	4.85	2.35	0.551	1.784	0.551	6.91	3.99	682
4-5	0.741	8.99	2.14	0.635	2.418	0.635	5.71	2.79	514
5-7	0.644	11.42	2.35	1.744	4.163	0.872	3.77	0.85	265
7-9	0.672	11.46	1.95	1.607	5.770	0.804	4.72	1.80	387
9-11	0.697	11.55	2.57	1.485	7.254	0.742	4.02	1.10	390
11-13	0.731	5.86	2.77	1.318	8.573	0.659	4.93	2.01	406
13-15	0.727	5.52	2.87	1.338	9.910	0.669	4.54	1.62	405
15-17	0.725	5.73	2.97	1.348	11.258	0.674	4.62	1.70	380
17-19	0.732	6.11	2.99	1.313	12.571	0.657	4.51	1.59	323
19-21	0.758	6.35	3.30	1.186	13.757	0.593	5.16	2.24	456
21-23	0.742	7.44	3.51	1.264	15.021	0.632	4.88	1.96	392
23-25	0.776	8.25	3.73	1.098	16.119	0.549	5.12	2.20	395

Table A12 Summary of Porosity, LOI, TOC, Bulk Density and Pb-210 for C-12

CORE: C-13
LOCATION: 43deg 01.64'N 87deg 54.21'E Milwaukee/Menomonee River
WATER DEPTH: 9.1 m (30 ft)
CORE LENGTH: 21 cm
DATE SAMPLED: 10/02/90

Depth (cm)	Porosity	LOI %	TOC %	g/cm^2	cumulative g/cm^2	bulk density g/cm^3	Pb-210 (dpm/g)	excess Pb-210 (dpm/g)	Pb-210 (total counts)
0-1	0.862	11.13	4.78	0.360	0.360	0.338	11.98	9.06	962
1-2	0.859	11.94	5.13	0.345	0.706	0.345	10.12	7.20	1034
2-3	0.837	11.25	4.98	0.399	1.105	0.399	11.71	8.79	966
3-4	0.837	11.09	5.39	0.399	1.504	0.399	11.37	8.45	985
4-5	0.841	11.73	5.31	0.390	1.894	0.390	12.22	9.30	1073
5-7	0.839	10.84	5.67	0.789	2.683	0.394	12.20	9.28	1027
7-9	0.839	10.76	5.37	0.789	3.472	0.394	13.29	10.37	870
9-11	0.842	10.84	5.32	0.774	4.246	0.387	11.94	9.02	1099
11-13	0.835	10.76	5.97	0.809	5.054	0.404	11.59	8.67	1060
13-15	0.831	11.05	5.36	0.828	5.882	0.414	11.36	8.44	959
15-17	0.826	10.02	5.35	0.853	6.735	0.426	11.88	8.96	1198
17-19	0.828	9.76	5.44	0.843	7.578	0.421	10.13	7.21	926
19-21	0.824	10.38	5.34	0.862	8.440	0.431	10.94	8.02	856

Table A13 Summary of Porosity, LOI, TOC, Bulk Density and Pb-210 for C-13

CORE: GC-15
LOCATION: W. Beecher St., east bank
WATER DEPTH:
CORE LENGTH: 25 cm
DATE SAMPLED: 10/23/90

Depth (cm)	Porosity	LOI %	TOC %	g/cm^2	cumulative g/cm^2	bulk density g/cm^3	Pb-210 (dpm/g)	excess Pb-210 (dpm/g)	Pb-210 (total counts)
0-5	0.609	6.02	3.39	4.790	4.790	0.958	6.38	3.46	647
5-10	0.550	6.22	4.38	5.513	10.302	1.103	5.81	2.89	621
10-15	0.572	8.00	4.86	5.243	15.545	1.049	7.39	4.47	756
15-20	0.581	8.45	5.31	5.133	20.678	1.027	8.14	5.22	816
20-25	0.585	7.36	5.39	5.084	25.762	1.017	6.39	3.47	655

Table A14 Summary of Porosity, LOI, TOC, Bulk Density and Pb-210 for GC-15

CORE: GC-16
LOCATION: confluence of Milwaukee River and Lincoln Creek
WATER DEPTH:
CORE LENGTH: 25 cm
DATE SAMPLED: 10/25/90

Depth (cm)	Porosity	LOI %	TOC %	g/cm^2	cumulative g/cm^2	bulk density g/cm^3	Pb-210 (dpm/g)	excess Pb-210 (dpm/g)	Pb-210 (total counts)
0-5	0.694	6.04	3.40	3.749	3.749	0.750	7.82	4.90	838
5-10	0.540	6.21	2.54	5.635	9.384	1.127	2.25	*0	203
10-15	0.543	6.84	2.71	5.598	14.982	1.120	3.05	0.13	277
15-20	0.617	9.55	4.53	4.692	19.674	0.938	4.11	1.19	430
20-25	0.609	7.06	2.17	4.790	24.463	0.958	3.02	0.10	287

Table A15 Summary of Porosity, LOI, TOC, Bulk Density and Pb-210 for GC-16

CORE: GCT-1
LOCATION: 43deg 01.98'N 87deg 54.61'E — Milwaukee River transect
WATER DEPTH: 5.8 m (19 ft)
CORE LENGTH: 20 cm
DATE SAMPLED: 10/12/90

Depth (cm)	Porosity	LOI %	TOC %	g/cm^2	cumulative g/cm^2	bulk density g/cm^3	Pb-210 (dpm/g)	excess Pb-210 (dpm/g)	Pb-210 (total counts)
0-5	0.831	10.91	5.06	2.070	2.070	0.414	8.82	5.90	922
5-10	0.804	13.23	5.91	2.401	4.471	0.480	9.12	6.20	757
10-15	0.809	11.95	5.38	2.340	6.811	0.468	10.73	7.81	1027
15-20	0.811	13.25	6.25	2.315	9.126	0.463	11.94	9.02	1104

Table A16 Summary of Porosity, LOI, TOC, Bulk Density and Pb-210 for GCT-1

CORE:	GCT-2	
LOCATION:	43deg 01.98'N	Milwaukee River transect
	87deg 54.61'E	
WATER DEPTH:	6.1 m (20 ft)	
CORE LENGTH:	25 cm	
DATE SAMPLED:	10/12/90	

Depth (cm)	Porosity	LOI %	TOC %	g/cm^2	cumulative g/cm^2	bulk density g/cm^3	Pb-210 (dpm/g)	excess Pb-210 (dpm/g)	Pb-210 (total counts)
0-5	0.831	7.66	4.93	2.070	2.070	0.414	9.74	6.82	1046
5-10	0.773	8.63	5.55	2.781	4.851	0.556	7.06	4.14	725
10-15	0.772	8.88	5.55	2.793	7.644	0.559	8.95	6.03	699
15-20	0.802	9.34	5.42	2.425	10.070	0.485	11.00	8.08	1168
20-25	0.795	9.60	5.24	2.511	12.581	0.502	10.46	7.54	991

Table A17 Summary of Porosity, LOI, TOC, Bulk Density and Pb-210 for GCT-2

CORE: GCT-3
LOCATION: 43deg 01.96'N 87deg 54.62'E Milwaukee River transect
WATER DEPTH: 6.7 m (22 ft)
CORE LENGTH: 25 cm
DATE SAMPLED: 10/12/90

Depth (cm)	Porosity	LOI %	TOC %	g/cm^2	cumulative g/cm^2	bulk density g/cm^3	Pb-210 (dpm/g)	excess Pb-210 (dpm/g)	Pb-210 (total counts)
0-5	0.870	8.13	4.89	1.593	1.593	0.319	10.91	7.99	1014
5-10	0.805	7.66	4.55	2.389	3.981	0.478	8.69	5.77	895
10-15	0.791	8.47	5.02	2.560	6.542	0.512	9.97	7.05	973
15-20	0.794	8.87	4.76	2.524	9.065	0.505	10.01	7.09	982
20-25	0.770	8.87	5.14	2.818	11.883	0.564	10.24	7.32	1064

Table A18 Summary of Porosity, LOI, TOC, Bulk Density and Pb-210 for GCT-3

CORE: GCT-4
LOCATION: 43deg 01.97'N 87deg 54.60'E Milwaukee River transect
WATER DEPTH: 7.0 m (23 ft)
CORE LENGTH: 25 cm
DATE SAMPLED: 10/12/90

Depth (cm)	Porosity	LOI %	TOC %	g/cm^2	cumulative g/cm^2	bulk density g/cm^3	Pb-210 (dpm/g)	excess Pb-210 (dpm/g)	Pb-210 (total counts)
0-5	0.845	8.13	5.18	1.899	1.899	0.380	8.97	6.05	803
5-10	0.661	3.23	3.40	4.153	6.052	0.831	3.45	0.53	333
10-15	0.796	11.43	5.23	2.499	8.551	0.500	10.37	7.45	894
15-20	0.738	8.40	4.00	3.210	11.760	0.642	6.61	3.69	634
20-25	0.815	12.20	5.81	2.266	14.026	0.453	13.15	10.23	899

Table A19 Summary of Porosity, LOI, TOC, Bulk Density and Pb-210 for GCT-4

CORE: GCT-5

LOCATION: 43deg 01.98'N   Milwaukee River transect
87deg 54.60'E

WATER DEPTH: 6.7 m (22 ft)

CORE LENGTH: 25 cm

DATE SAMPLED: 10/12/90

Depth (cm)	Porosity	LOI %	TOC %	g/cm^2	cumulative g/cm^2	bulk density g/cm^3	Pb-210 (dpm/g)	excess Pb-210 (dpm/g)	Pb-210 (total counts)
0-5	0.848	10.66	3.94	1.593	1.593	0.319	10.74	7.82	864
5-10	0.795	12.90	6.69	2.389	3.981	0.478	7.53	4.61	712
10-15	0.803	12.40	5.75	2.560	6.542	0.512	9.71	6.79	819
15-20	0.798	10.40	4.61	2.524	9.065	0.505	10.41	7.49	905
20-25	0.749	10.32	5.47	2.818	11.883	0.564	8.01	5.09	596

Table A20   Summary of Porosity, LOI, TOC, Bulk Density and Pb-210 for GCT-5

STATION: VC-2
LOCATION: 43deg 02.92'N Milwaukee River
87deg 54.70'W Cherry Street Bridge
WATER DEPTH: 2.2 m (7.3 ft)
CORE TYPE: push core
CORE LENGTH: core pushed 3 m down, only a 1.45 m core retrieved
DATE SAMPLED: 10/16/91

Depth (cm)	Porosity	% LOI	% TOC	g/cm ^ 2	cumulative g/cm ^ 2	bulk density g/cm ^ 3	Pb-210 (dpm/g)	excess Pb-210 (dpm/g)	Pb-210 (total counts)
0-9	0.810	10.91	4.82	4.180	4.180	0.464	7.07	4.15	550
9-18	0.785	11.24	5.23	4.732	8.912	0.526	6.69	3.77	640
18-27	0.775	11.55	5.56	4.961	13.873	0.551	8.56	5.64	666
27-36	0.772	11.24	5.67	5.026	18.899	0.558	8.76	5.84	712
36-45	0.765	10.98	4.91	5.192	24.090	0.577	8.18	5.26	693
45-54	0.785	12.40	8.85	4.739	28.829	0.527	8.66	5.74	776
54-63	0.784	13.01	5.04	4.763	33.592	0.529	8.81	5.89	906
63-72	0.775	12.09	5.67	4.957	38.549	0.551	8.34	5.42	689
72-81	0.771	13.60	5.81	5.052	43.601	0.561	6.23	3.31	512
81-90	0.770	14.45	6.40	5.065	48.666	0.563	6.94	4.02	564
90-99	0.797	17.53	7.67	4.472	53.139	0.497	5.44	2.52	474
99-108	0.782	15.32	6.61	4.807	57.946	0.534	5.42	2.50	461
108-117	0.689	16.47	7.49	6.848	64.794	0.761	4.34	1.42	351
117-126	0.773	15.54	7.19	5.004	69.797	0.556	5.87	2.95	472
126-135	0.788	15.45	7.21	4.684	74.482	0.520	5.25	2.33	458
				replicate of last layer			6.80		461

Table A21 Summary of Porosity, LOI, TOC, Bulk Density and Pb-210 for VC-2

STATION: VC-3
LOCATION: 43deg 01.98'N Milwaukee River
87deg 54.61'W
WATER DEPTH: 6.1 m (20 ft)
CORE TYPE: push core
CORE LENGTH: 1.1 m
DATE SAMPLED: 10/14/91

Depth (cm)	Porosity	% LOI	% TOC	g/cm^2	cumulative g/cm^2	bulk density g/cm^3	Pb-210 (dpm/g)	excess Pb-210 (dpm/g)	Pb-210 (total counts)
0-7	0.848	10.89	5.47	2.608	2.608	0.373	7.70	4.78	572
7-14	0.820	11.18	5.34	3.086	5.694	0.441	7.87	4.95	617
14-21	0.840	14.74	6.02	2.746	8.440	0.392	8.82	5.90	806
21-28	0.777	11.35	5.14	3.818	12.257	0.545	8.75	5.83	652
28-35	0.780	12.30	5.75	3.779	16.036	0.540	8.29	5.37	612
35-42	0.786	11.95	5.14	3.666	19.702	0.524	8.28	5.36	712
42-49	0.790	13.55	6.20	3.606	23.308	0.515	9.48	6.56	884
49-56	0.814	15.54	6.85	3.197	26.506	0.457	9.31	6.39	683
56-63	0.804	14.37	6.60	3.356	29.861	0.479	11.31	8.39	770
63-70	0.824	16.24	7.74	3.022	32.884	0.432	10.15	7.23	864
70-77	0.788	12.40	5.54	3.633	36.517	0.519	8.01	5.09	697
77-84	0.809	11.98	6.03	3.277	39.793	0.468	10.40	7.48	807
84-91	0.765	11.71	6.35	4.028	43.821	0.575	8.78	5.86	720
91-98	0.780	12.78	5.13	3.771	47.593	0.539	9.56	6.64	792
98-105	0.783	12.35	5.35	3.722	51.314	0.532	9.03	6.11	807
				replicate of last layer			10.24		731

Table A22 Summary of Porosity, LOI, TOC, Bulk Density and Pb-210 for VC-3

STATION: VC-4
LOCATION: 43deg 01.88'N confluence of Milwaukee & Menomonee Rivers
87deg 54.63'W
WATER DEPTH: 18 m
CORE TYPE: long gravity core
CORE LENGTH: 0.7 m
DATE SAMPLED: 10/30/91

Depth (cm)	Porosity	% LOI	% TOC	g/cm^2	cumulative g/cm^2	bulk density g/cm^3	Pb-210 (dpm/g)	excess Pb-210 (dpm/g)	Pb-210 (total counts)	Cs-137 (dpm/g)
0-4.5	0.629	6.82	2.36	4.087	4.087	0.908	1.04	0	80	0
4.5-9.0	0.662	7.27	2.53	3.727	7.814	0.828	1.24	0	91	0
9.0-13.5	0.663	7.22	2.62	3.719	11.533	0.826	1.20	0	102	0
13.5-18.0	0.652	7.09	2.52	3.834	15.368	0.852	1.45	0	99	0
18.0-22.5	0.653	7.92	2.29	3.821	19.189	0.849	1.28	0	108	0
22.5-27.0	0.652	7.42	2.28	3.833	23.021	0.852	1.17	0	103	0
27.0-31.5	0.637	7.10	2.39	4.007	27.028	0.890	1.31	0	118	0
31.5-36.0	0.635	7.63	2.50	4.023	31.051	0.894	1.22	0	80	0
36.0-40.5	0.655	7.89	2.78	3.806	34.857	0.846	1.29	0	94	0
40.5-45.0	0.652	8.46	2.40	3.835	38.692	0.852	1.45	0	101	0
45.0-49.5	0.654	6.28	2.62	3.815	42.507	0.848	1.41	0	118	0
49.5-54.0	0.648	8.32	2.87	3.880	46.387	0.862	1.10	0	80	0
54.0-58.5	0.651	8.72	2.64	3.845	50.232	0.854	1.05	0	76	0
58.5-63.0	0.655	8.80	2.26	3.803	54.035	0.845	1.12	0	81	0
63.0-67.5	0.641	7.78	2.27	3.956	57.991	0.879	1.38	0	126	0
				replicate of last layer			1.46		88	

Table A23 Summary of Porosity, LOI, TOC, Bulk Density, Pb-210 and Cs-137 for VC-4

STATION: VC-6
LOCATION: 43deg 01.89'N Menomonee River
87deg 54.91'W
WATER DEPTH: 20 m
CORE TYPE: long gravity core
CORE LENGTH: 1 m
DATE SAMPLED: 10/30/91

Depth (cm)	Porosity	% LOI	% TOC	g/cm^2	cumulative g/cm^2	bulk density g/cm^3	Pb-210 (dpm/g)	excess Pb-210 (dpm/g)	Pb-210 (total counts)
0-6	0.835	11.00	4.51	2.433	2.433	0.405	10.87	9.39	762
6-12	0.784	10.04	4.47	3.182	5.614	0.530	11.78	10.30	855
12-18	0.698	8.26	3.95	4.435	10.050	0.739	9.16	7.68	711
18-24	0.651	5.36	3.75	5.129	15.179	0.855	7.51	6.03	569
24-30	0.700	9.12	2.31	4.413	19.591	0.735	1.26	*0	93
30-36	0.682	7.36	2.38	4.673	24.265	0.779	1.64	0.16	116
36-42	0.671	8.05	2.35	4.835	29.100	0.806	1.64	0.16	125
42-48	0.667	7.19	2.54	4.901	34.001	0.817	1.81	0.33	130
48-54	0.674	6.90	2.62	4.794	38.795	0.799	1.37	*0	101
54-60	0.674	8.62	2.59	4.795	43.589	0.799	1.23	*0	102
60-66	0.666	8.35	2.31	4.905	48.495	0.818	1.36	*0	124
66-72	0.656	7.51	2.21	5.051	53.546	0.842	1.46	*0	108
72-78	0.676	7.54	2.42	4.756	58.302	0.793	1.42	*0	100
78-84	0.675	7.59	2.57	4.778	63.080	0.796	1.56	0.08	113
84-90	0.679	8.28	2.75	4.712	67.792	0.785	1.54	0.06	126
				replicate of last layer			1.61		111

* negative excess Pb-210 values assumed = 0
Supported Pb-210 = 1.48

Table A24 Summary of Porosity, LOI, TOC, Bulk Density and Pb-210 for VC-6

STATION: VC-7
LOCATION: 43deg 00.50'N Kinnickinnic River
87 deg 54.59'W
WATER DEPTH: 2.8 m (9.3 ft)
CORE TYPE: push core
CORE LENGTH: core pushed 2.25 m down, only a 1.45 m core retrieved
DATE SAMPLED: 10/14/91

Depth (cm)	Porosity	% LOI	% TOC	g/cm^2	cumulative g/cm^2	bulk density g/cm^3	Pb-210 (dpm/g)	excess Pb-210 (dpm/g)	Pb-210 (total counts)
0-9	0.574	6.99	3.35	9.388	9.388	1.043	5.60	2.68	378
9-18	0.552	6.30	2.63	9.871	19.258	1.097	6.01	3.09	468
18-27	0.507	6.12	2.82	10.860	30.118	1.207	4.80	1.88	417
27-36	0.633	5.98	5.20	8.092	38.210	0.899	2.98	0.06	209
36-45	0.359	1.56	0.49	14.142	52.351	1.571	0.55	*0	39
45-54	0.581	8.65	5.19	9.240	61.592	1.027	5.56	2.64	372
54-63	0.579	7.77	4.37	9.292	70.884	1.032	3.85	0.93	312
63-72	0.590	6.90	2.91	9.050	79.933	1.006	3.68	0.76	263
72-81	0.581	7.98	3.97	9.240	89.173	1.027	4.05	1.13	302
81-90	0.591	7.57	3.18	9.016	98.189	1.002	3.12	0.20	238
90-99	0.603	7.92	4.37	8.748	106.937	0.972	3.47	0.55	255
99-108	0.602	9.16	4.60	8.769	115.707	0.974	4.23	1.31	297
108-117	0.591	9.04	4.88	9.012	124.718	1.001	3.11	0.19	222
117-126	0.658	11.83	7.55	7.541	132.259	0.838	3.28	0.36	249
126-135	0.617	11.13	4.93	8.439	140.699	0.938	2.58	*0	195
				replicate of last layer			2.78		199

* negative excess Pb-210 values assumed = 0

Table A25 Summary of Porosity, LOI, TOC, Bulk Density and Pb-210 for VC-7

STATION: VC-8
LOCATION: 43deg 01.07'N Kinnickinnic River
87deg 54.10'W Great Lakes Research Facility
WATER DEPTH: 9.1 m (30 ft)
CORE TYPE: long gravity core
CORE LENGTH: 1.3 m
DATE SAMPLED: 10/30/91

Depth (cm)	Porosity	% LOI	% TOC	g/cm^2	cumulative g/cm^2	bulk density g/cm^3	Pb-210 (dpm/g)	excess Pb-210 (dpm/g)	Pb-210 (total counts)
0-8	0.828	11.58	6.22	3.373	3.373	0.422	10.17	8.42	767
8-16	0.772	11.55	6.85	4.474	7.847	0.559	9.98	8.23	779
16-24	0.763	10.28	5.26	4.651	12.498	0.581	9.82	8.07	823
24-32	0.729	10.53	5.34	5.303	17.801	0.663	9.14	7.39	677
32-40	0.674	8.53	4.18	6.395	24.196	0.799	8.25	6.50	630
40-48	0.743	10.69	5.60	5.045	29.241	0.631	9.04	7.29	676
48-56	0.744	11.02	5.83	5.008	34.249	0.626	9.43	7.68	846
56-64	0.703	11.82	6.95	5.815	40.064	0.727	3.12	1.37	227
64-72	0.652	14.68	6.99	6.819	46.884	0.852	1.83	0.08	128
72-80	0.645	14.90	10.71	6.962	53.846	0.870	2.25	0.50	175
80-88	0.627	14.34	14.58	7.312	61.158	0.914	1.89	0.14	150
88-96	0.644	9.66	6.53	6.979	68.137	0.872	1.95	0.20	144
96-104	0.579	4.60	1.66	8.251	76.388	1.031	1.50	*0	115
104-112	0.607	5.04	2.01	7.712	84.100	0.964	1.62	*0	127
112-120	0.629	5.48	1.43	7.280	91.380	0.910	1.23	*0	106
				replicate of last layer			1.34		

* negative excess Pb-210 values assumed = 0
Supported Pb-210 = 1.67

Table A26 Summary of Porosity, LOI, TOC, Bulk Density and Pb-210 for VC-8

STATION: VC-9
LOCATION: 43deg 01.50'N Harbor Entrance
87deg 53.82'W
WATER DEPTH: 9.8 m (32 ft)
CORE TYPE: long gravity core
CORE LENGTH: 1 m
DATE SAMPLED: 10/30/91

Depth (cm)	Porosity	% LOI	% TOC	g/cm^2	cumulative g/cm^2	bulk density g/cm^3	Pb-210 (dpm/g)	excess Pb-210 (dpm/g)	Pb-210 (total counts)	Cs-137 (dpm/g)
0-7	0.817	11.29	4.33	3.142	3.142	0.449	9.84	8.25	679	1.15
7-14	0.769	10.73	4.26	3.960	7.102	0.566	6.17	4.58	455	0.94
14-21	0.664	6.00	1.92	5.770	12.872	0.824	2.75	1.16	213	0.23
21-28	0.700	7.94	2.88	5.152	18.023	0.736	4.90	3.31	366	0.78
28-35	0.734	9.74	4.33	4.559	22.583	0.651	5.76	4.17	376	0.97
35-42	0.805	19.60	8.28	3.347	25.929	0.478	7.47	5.88	543	1.22
42-49	0.701	11.61	5.61	5.132	31.061	0.733	4.50	2.91	357	2.51
49-56	0.680	10.23	5.22	5.492	36.553	0.785	4.86	3.27	353	5.81
56-63	0.649	10.85	5.66	6.019	42.572	0.860	4.09	2.50	269	3.38
63-70	0.592	8.27	3.95	6.998	49.569	1.000	2.19	0.60	164	0.30
70-77	0.593	5.36	1.96	6.983	56.553	0.998	1.61	0.02	126	0
77-84	0.572	5.17	1.86	7.347	63.900	1.050	1.59	0.00	105	0
84-91	0.628	7.66	2.81	6.384	70.283	0.912	1.55	*0	93	0
91-98	0.579	6.17	1.86	7.220	77.503	1.031	1.55	*0	115	0
98-105	0.605	7.05	2.64	6.772	84.275	0.967	1.05	*0	76	0
				replicate of last layer			1.52		106	

* negative excess Pb-210 assumed = 0
Supported Pb-210 = 1.59

Table A27 Summary of Porosity, LOI, TOC, Bulk Density, Pb-210 and Cs-137 for VC-9

STATION: VC-12
LOCATION: 43deg 01.93'N Outer Harbor
87deg 53.21'W
WATER DEPTH: 7.6 m (25 ft)
CORE TYPE: long gravity core
CORE LENGTH: 0.85 m
DATE SAMPLED: 10/30/91

Depth (cm)	Porosity	% LOI	% TOC	g/cm^2	cumulative g/cm^2	bulk density g/cm^3	Pb-210 (dpm/g)	excess Pb-210 (dpm/g)	Pb-210 (total counts)
0-5	0.716	5.13	2.22	3.482	3.482	0.696	4.15	2.59	300
5-10	0.726	6.92	2.72	3.362	6.844	0.672	3.65	2.09	294
10-15	0.769	8.89	3.03	2.830	9.674	0.566	3.52	1.96	288
15-20	0.767	9.56	3.60	2.850	12.524	0.570	3.69	2.13	244
20-25	0.768	9.38	3.73	2.841	15.365	0.568	3.09	1.53	235
25-30	0.744	9.41	3.66	3.134	18.499	0.627	3.17	1.61	231
30-35	0.753	9.36	4.17	3.023	21.522	0.605	3.24	1.68	236
35-40	0.741	8.90	4.24	3.171	24.693	0.634	2.48	0.92	180
45-50	0.697	7.62	3.71	3.712	28.405	0.742	2.05	0.49	127
50-55	0.701	8.36	3.99	3.665	32.070	0.733	2.33	0.77	193
55-60	0.662	7.92	3.20	4.140	36.210	0.828	1.43	*0	117
60-65	0.672	8.79	4.35	4.023	40.233	0.805	1.63	0.07	124
65-70	0.679	8.43	3.84	3.936	44.169	0.787	1.58	0.02	110
70-75	0.660	8.32	4.00	4.163	48.332	0.833	1.42	*0	111
75-80	0.650	8.13	3.82	4.290	52.621	0.858	1.74	0.18	127
				replicate of last layer			1.79		140

* Negative excess Pb-210 levels assumed = 0
Supported Pb-210 = 1.56

Table A28 Summary of Porosity, LOI, TOC, Bulk Density and Pb-210 for VC-12

STATION: VC-34/35
LOCATION: 43deg 01.99'N Menomonee River
87deg 55.18'W
WATER DEPTH: 5.2 m (17 ft)
CORE TYPE: push core
CORE LENGTH: core pushed 2.25 m down, only a 1.45 m core retrieved
DATE SAMPLED: 10/16/91

Depth (cm)	Porosity	% LOI	% TOC	g/cm ^2	cumulative g/cm ^2	bulk density g/cm ^3	Pb-210 (dpm/g)	excess Pb-210 (dpm/g)	Pb-210 (total counts)
0-9	0.820	11.51	5.13	3.967	3.967	0.441	13.08	10.16	1194
9-18	0.778	11.90	5.41	4.890	8.856	0.543	13.06	10.14	1330
18-27	0.765	11.33	4.78	5.174	14.030	0.575	13.42	10.50	1405
27-36	0.757	12.90	6.90	5.360	19.391	0.596	12.14	9.22	1081
36-45	0.752	14.74	7.44	5.471	24.862	0.608	10.49	7.57	955
45-54	0.723	11.36	5.15	6.103	30.965	0.678	8.68	5.76	758
54-63	0.679	9.98	4.14	7.071	38.036	0.786	9.75	6.83	760
63-72	0.760	11.42	6.03	5.300	43.336	0.589	12.88	9.96	1125
72-81	0.679	10.61	5.27	7.070	50.406	0.786	8.84	5.92	778
81-90	0.650	11.88	5.02	7.716	58.123	0.857	5.37	2.45	466
90-99	0.655	12.22	13.21	7.617	65.739	0.846	4.41	1.49	368
99-108	0.674	8.70	6.25	7.183	72.922	0.798	6.34	3.42	588
108-117	0.706	11.20	5.44	6.477	79.399	0.720	8.64	5.72	703
117-126	0.682	11.70	5.38	7.007	86.406	0.779	6.26	3.34	563
126-135	0.555	6.53	5.61	9.821	96.227	1.091	8.03	5.11	787
				replicate of last layer			8.22		822

Table A29 Summary of Porosity, LOI, TOC, Bulk Density and Pb-210 for VC-34/35

STATION: VC-36
LOCATION: 43deg 01.70'N South Menomonee Canal
87deg 55.37'W
WATER DEPTH: 6.4 m (21 ft)
CORE TYPE: push core
CORE LENGTH: core pushed 2 m down, only a 1.6 m core retrieved
DATE SAMPLED: 10/16/91

Depth (cm)	Porosity	% LOI	% TOC	g/cm^2	cumulative g/cm^2	bulk density g/cm^3	Pb-210 (dpm/g)	excess Pb-210 (dpm/g)	Pb-210 (total counts)
0-10	0.834	15.73	6.17	4.055	4.055	0.406	15.67	14.05	1415
10-20	0.818	13.83	5.99	4.462	8.517	0.446	16.14	14.52	1559
20-30	0.781	14.31	7.06	5.365	13.882	0.537	13.76	12.14	1313
30-40	0.791	13.39	6.90	5.129	19.010	0.513	11.98	10.36	1058
40-50	0.752	14.29	7.17	6.074	25.084	0.607	11.49	9.87	948
50-60	0.769	15.34	6.93	5.653	30.737	0.565	11.34	9.72	1130
60-70	0.779	16.86	7.66	5.405	36.142	0.541	12.25	10.63	1001
70-80	0.747	18.83	8.99	6.192	42.334	0.619	11.28	9.66	951
80-90	0.738	17.33	9.36	6.415	48.749	0.641	8.27	6.65	667
90-100	0.710	13.64	9.63	7.093	55.842	0.709	2.76	1.14	253
100-110	0.649	12.31	7.57	8.599	64.441	0.860	2.67	1.05	265
110-120	0.600	11.55	10.35	9.812	74.253	0.981	1.61	*0	177
120-130	0.613	12.13	8.07	9.469	83.723	0.947	1.71	0.09	130
130-140	0.641	7.27	4.03	8.797	92.520	0.880	1.42	*0	111
140-150	0.632	9.13	5.28	9.023	101.542	0.902	1.74	0.12	148
				replicate of last layer			1.79		132

* negative excess Pb-210 values assumed = 0
Supported Pb-210 = 1.62

Table A30 Summary of Porosity, LOI, TOC, Bulk Density and Pb-210 for VC-36

Appendix B

Graphical Representation for Each Core

- -Depth vs. Porosity
- -Depth vs. %TOC and %LOI
- -Depth vs. Excess Pb-210 Activity
- -Excess Pb-210 Activity vs. Cumulative Mass

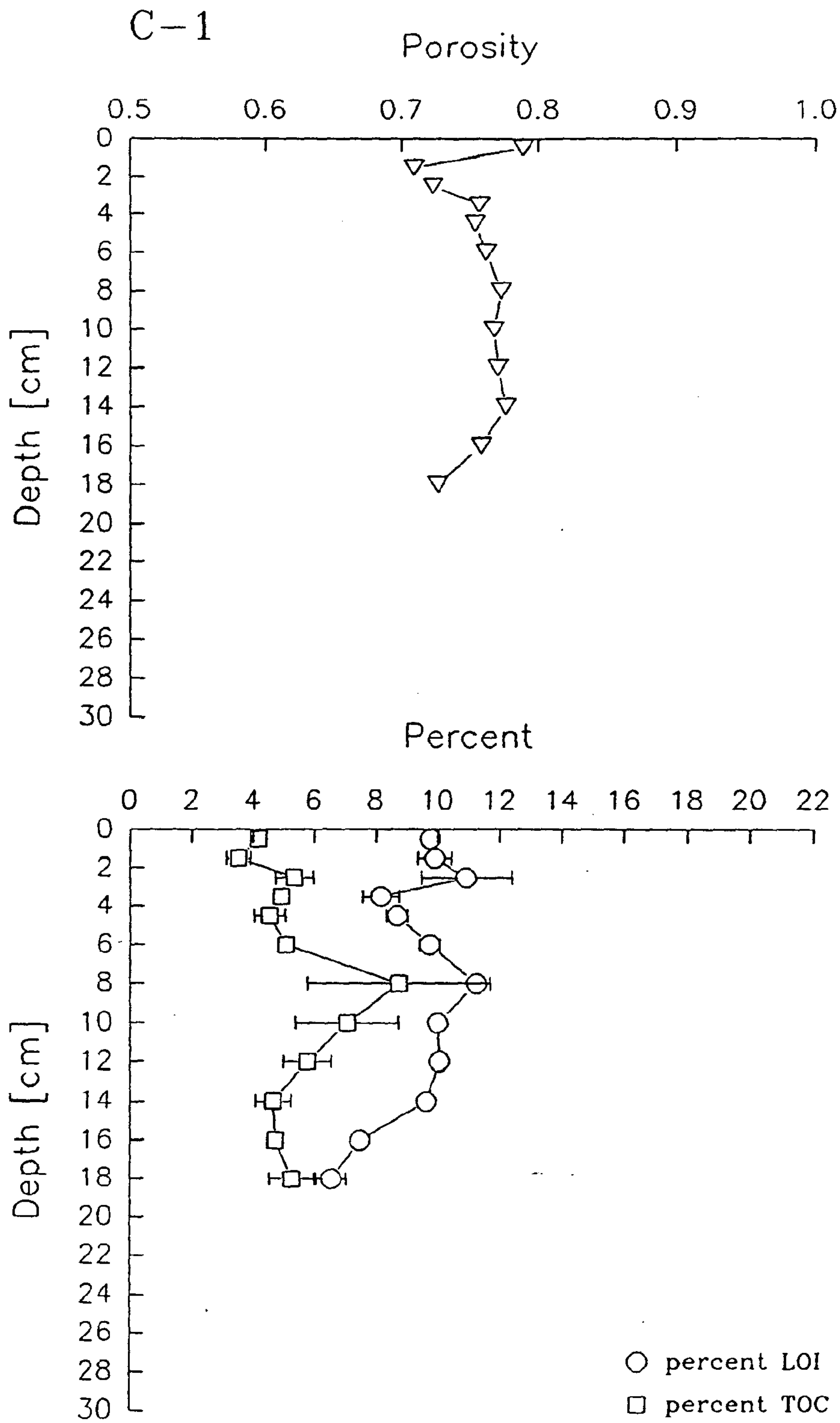


Fig. B 1 Depth vs. Porosity and Depth vs. Percent LOI & TOC for C-1

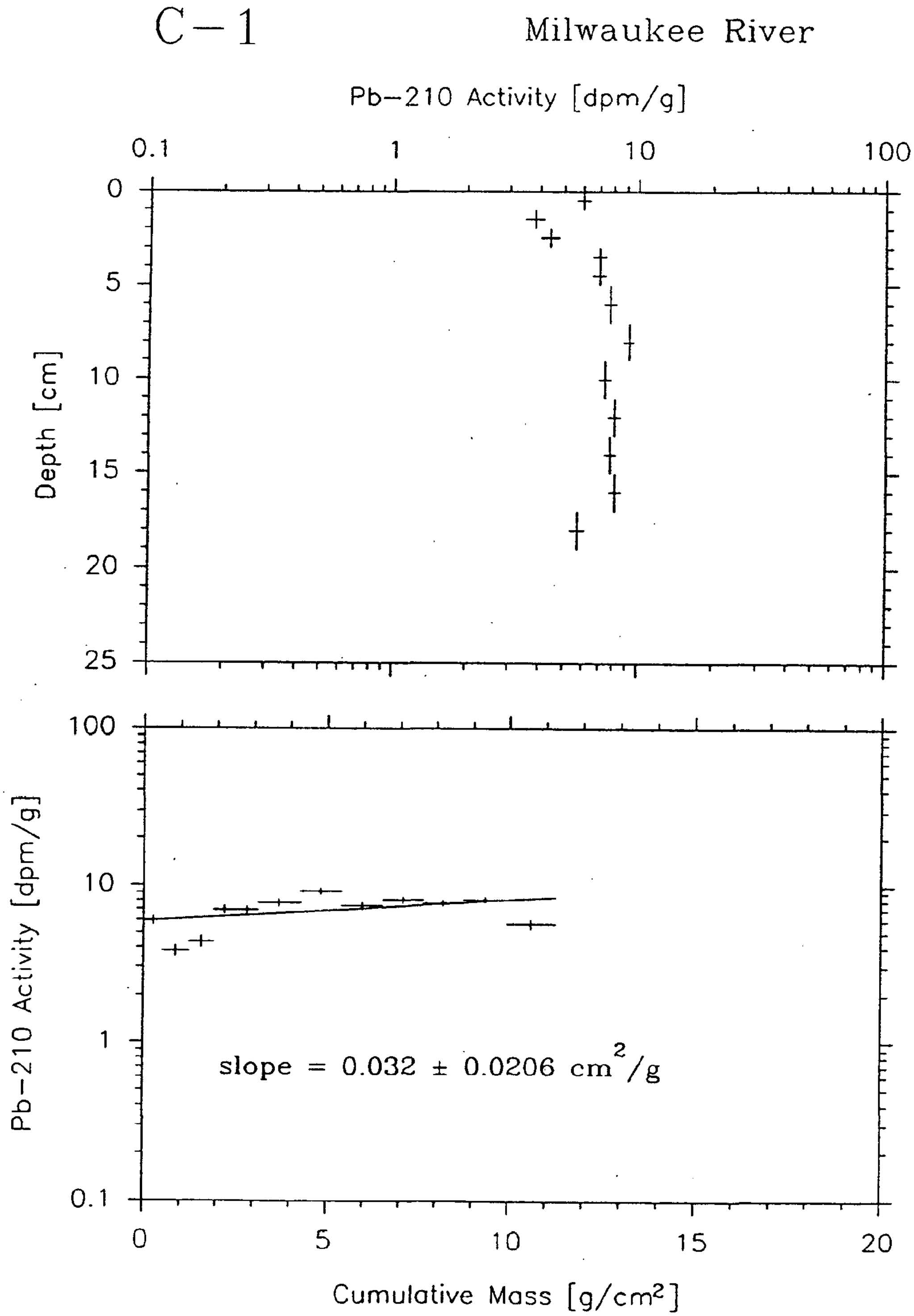


Fig. B 2 Depth vs. Pb-210 activity and
Pb-210 activity vs. Cummulative mass
for C-1

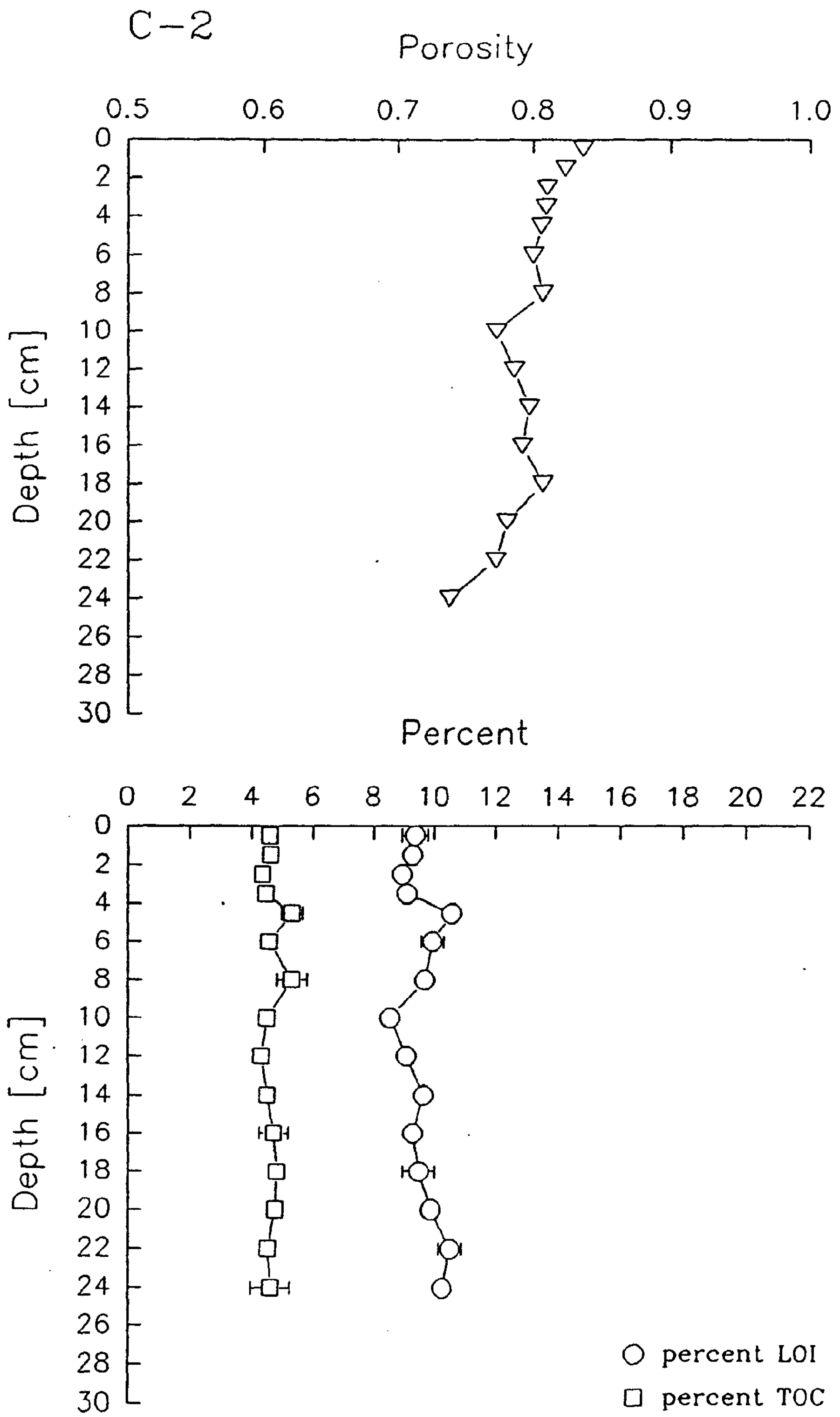


Fig. B 3 Depth vs. Porosity and Depth vs. Percent LOI & TOC for C−2

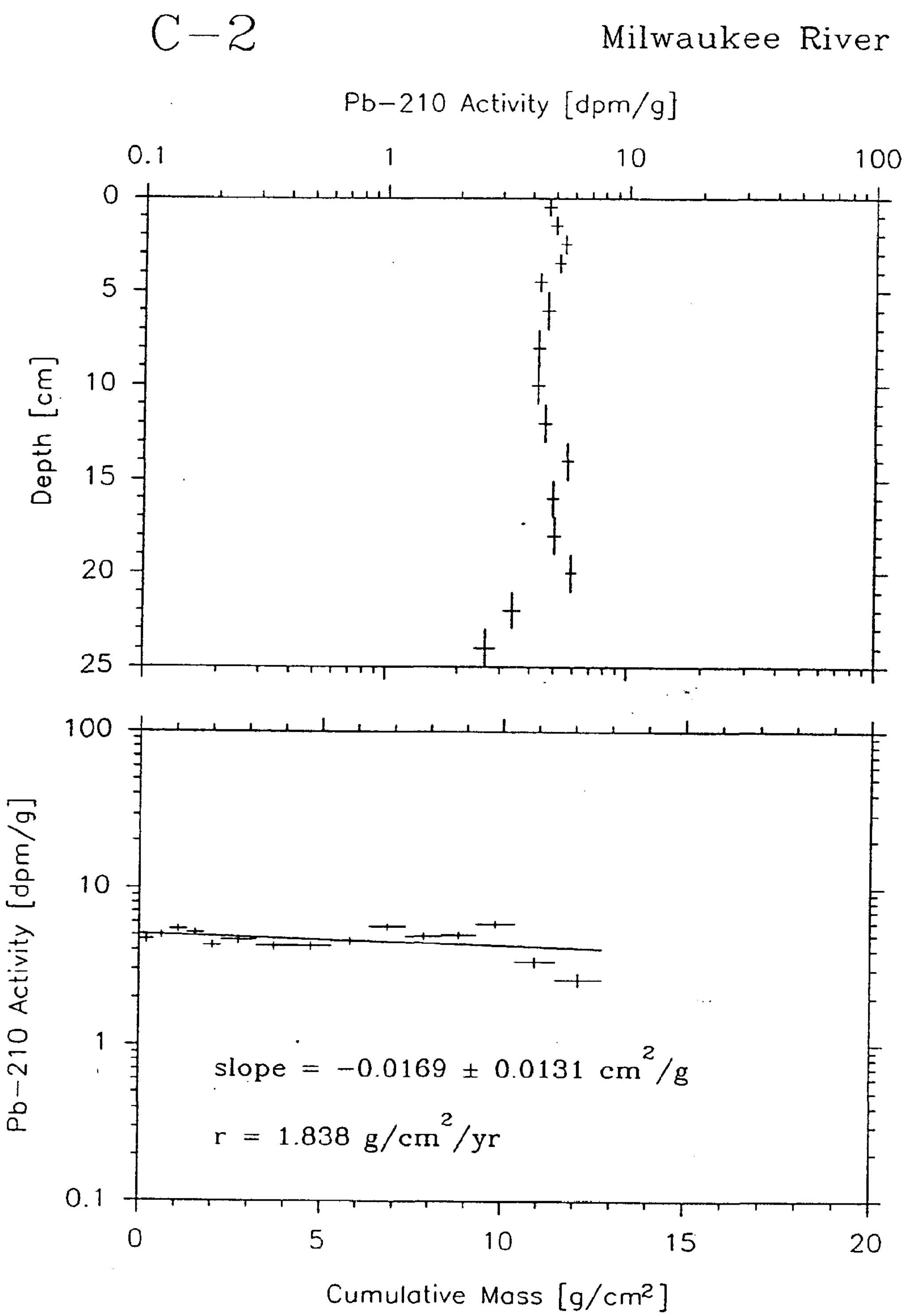


Fig. B 4 Depth vs. Pb-210 activity and Pb-210 activity vs. Cummulative mass for C-2

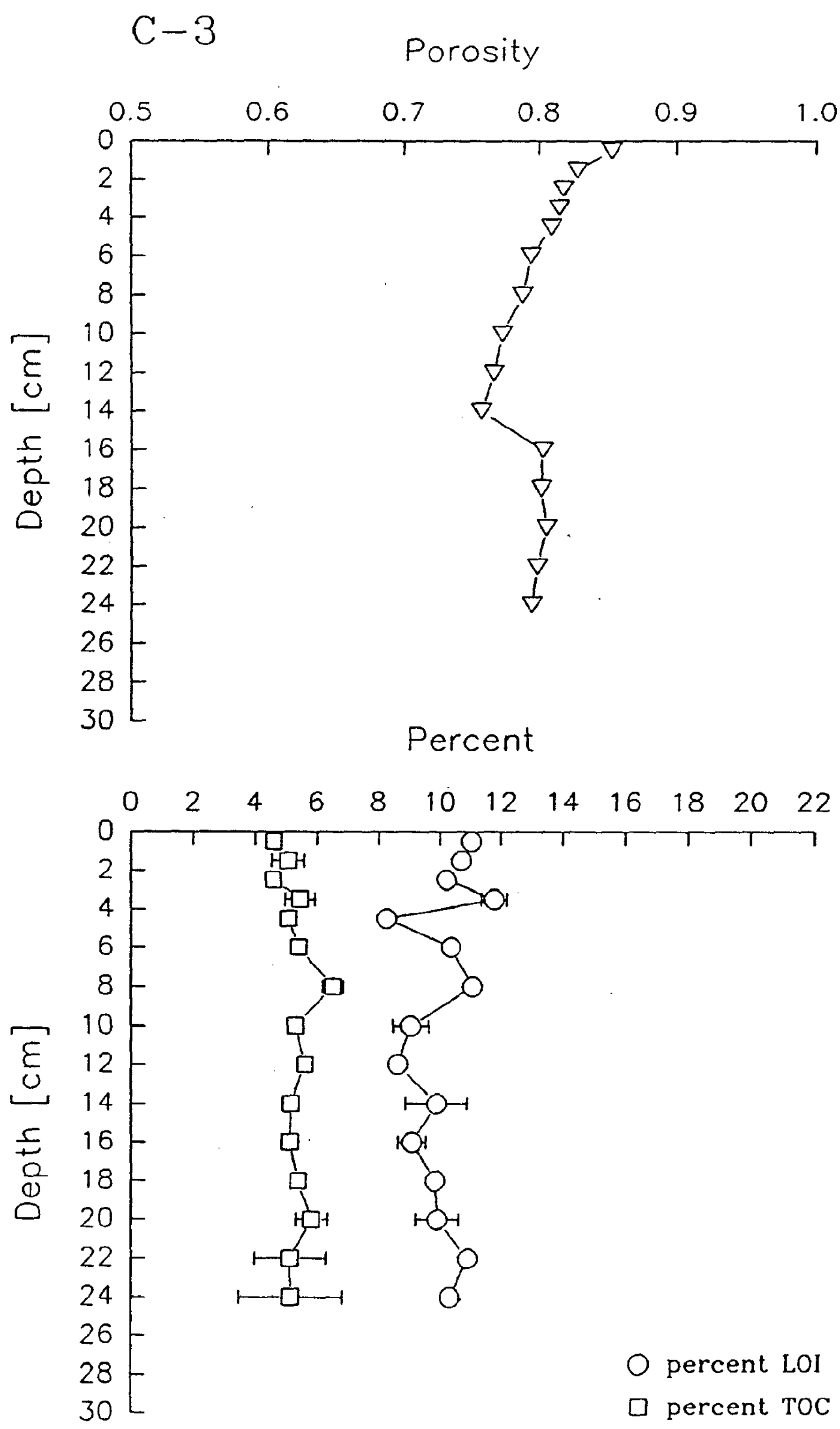


Fig. B 5 Depth vs. Porosity and Depth vs. Percent LOI & TOC for C-3

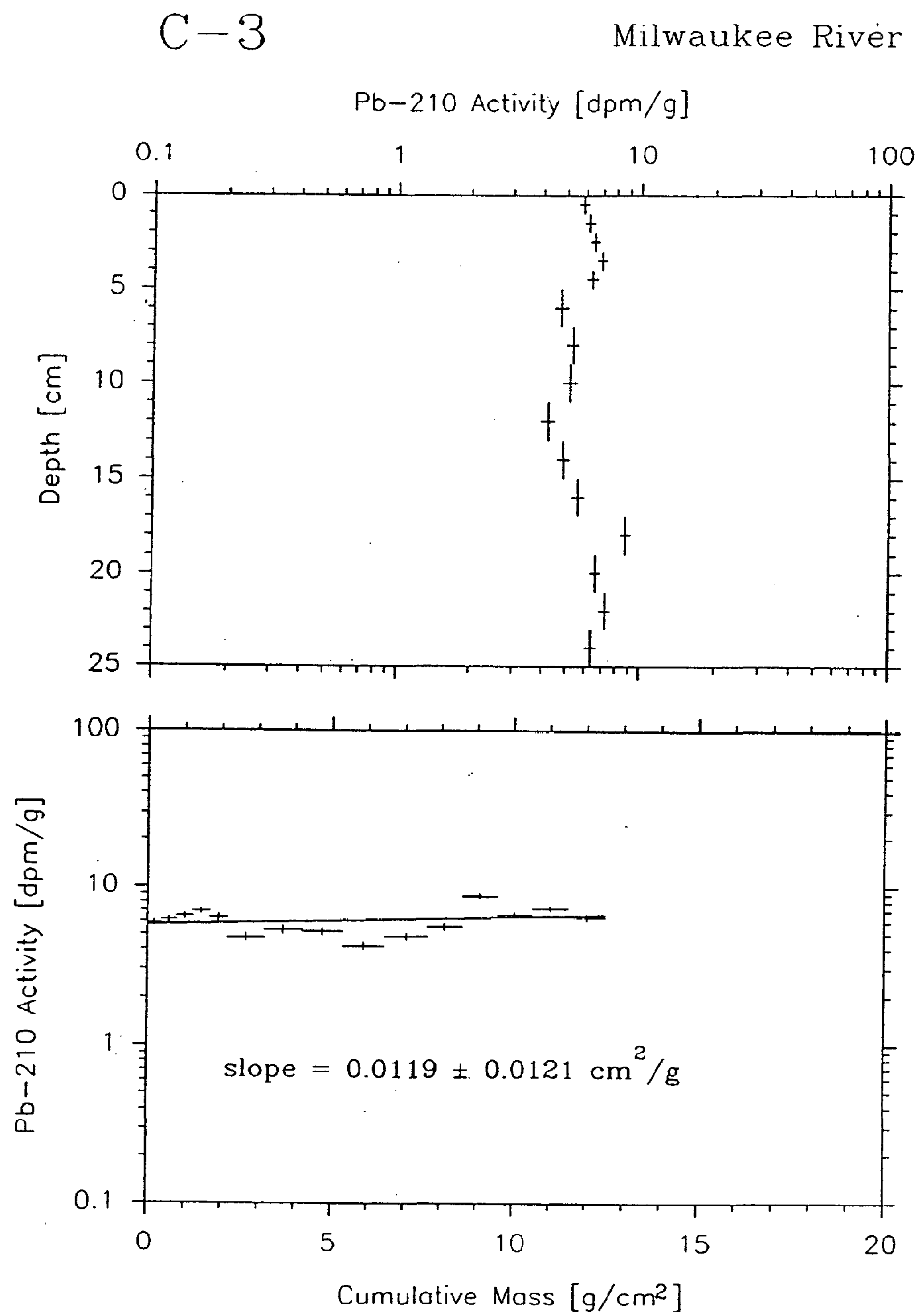


Fig. B 6 Depth vs. Pb-210 activity and Pb-210 activity vs. Cummulative mass for C-3

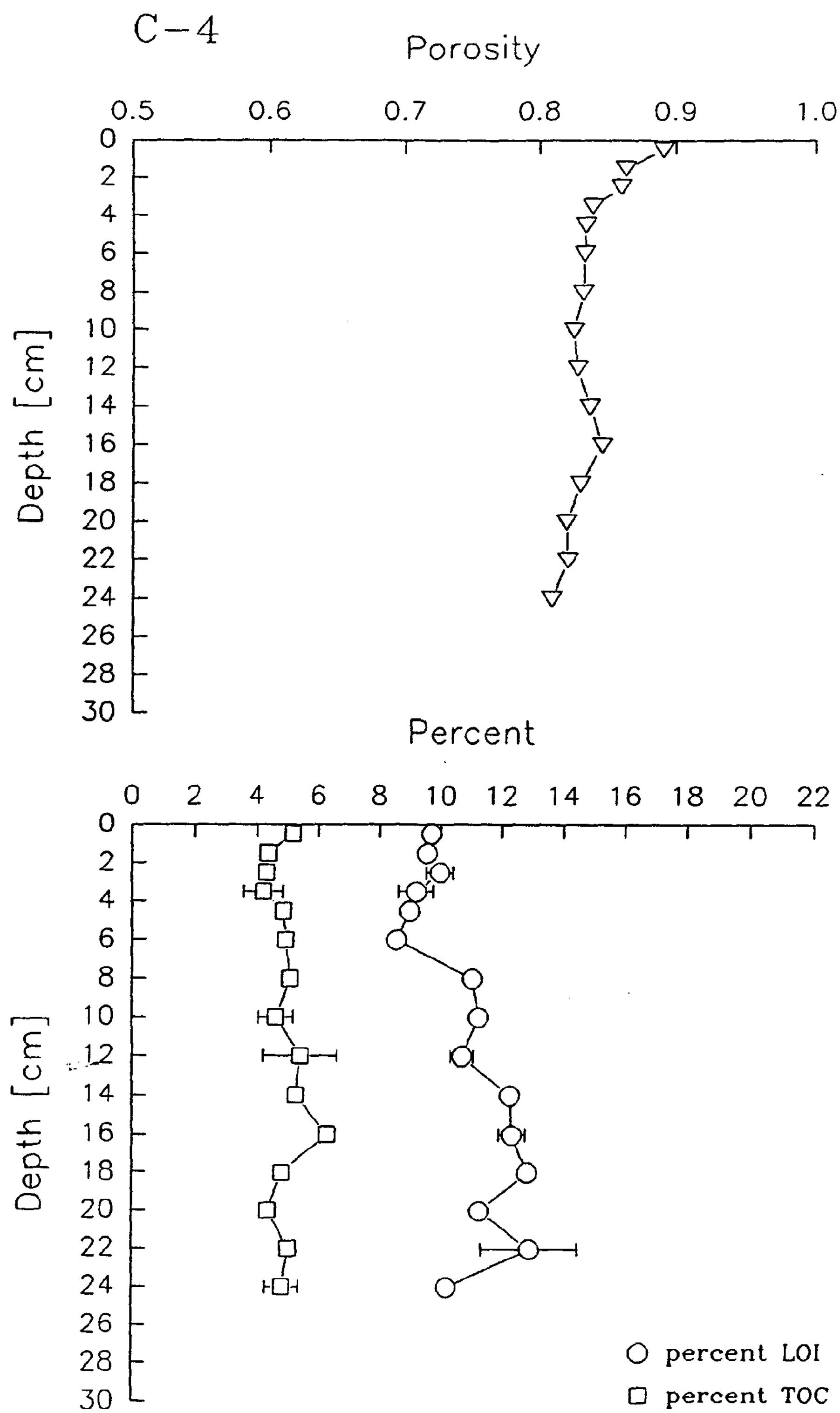


Fig. B 7 Depth vs. Porosity and Depth vs. Percent LOI & TOC for C-4

C−4 Milwaukee/Menomonee River

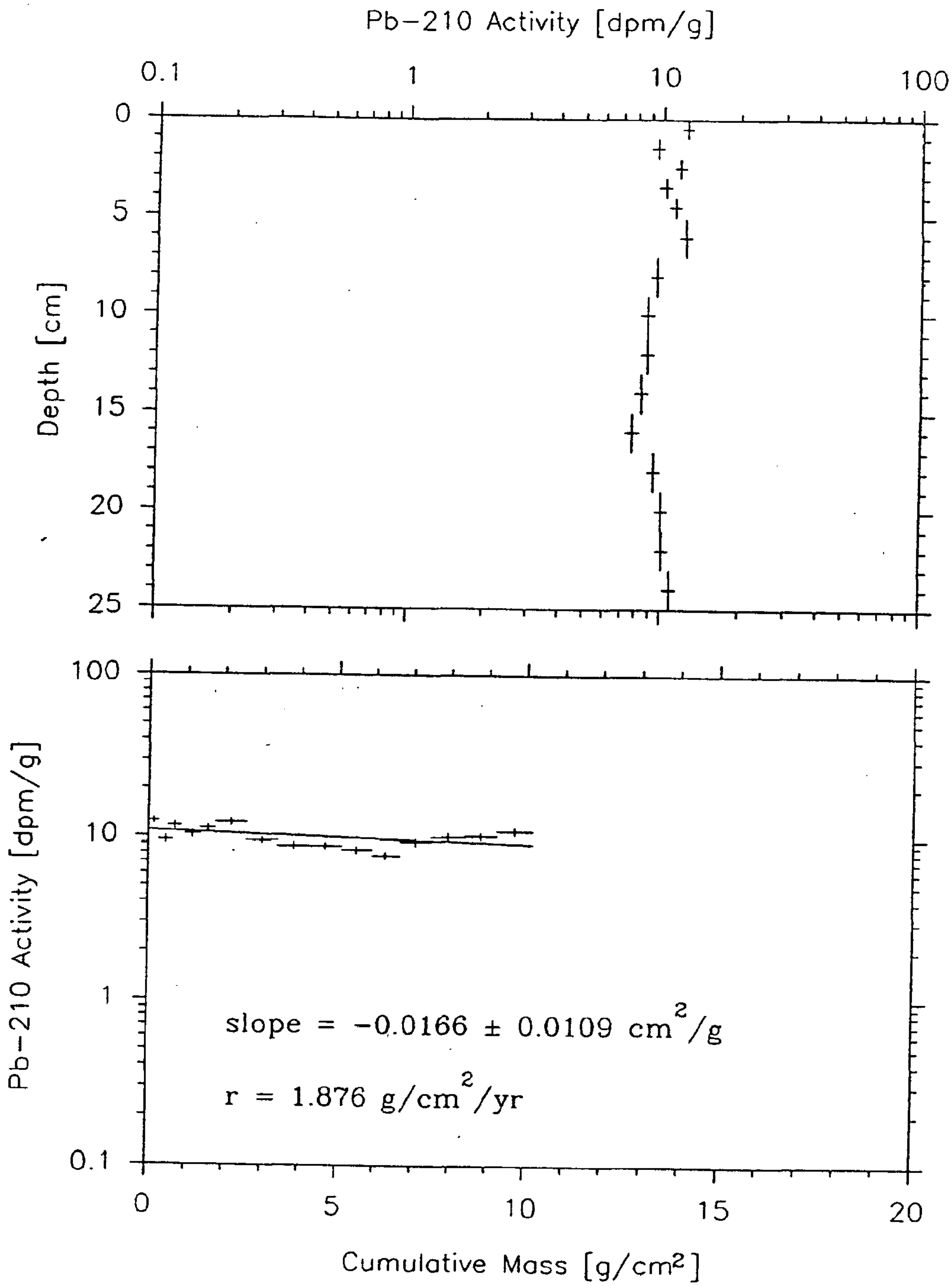


Fig. B 8 Depth vs. Pb−210 activity and Pb−210 activity vs. Cummulative mass for C−4

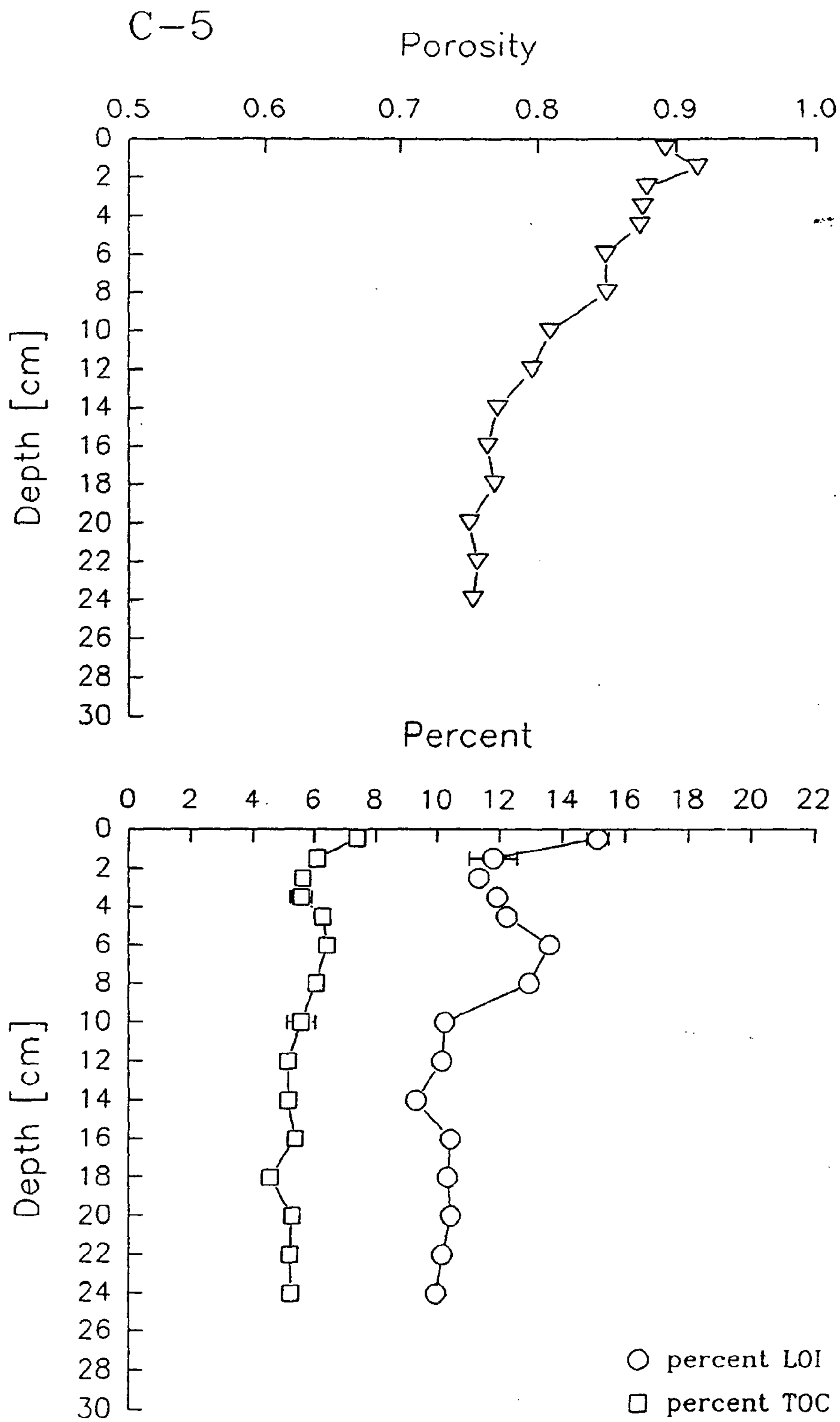


Fig. B 9 Depth vs. Porosity and Depth vs. Percent LOI & TOC for C−5

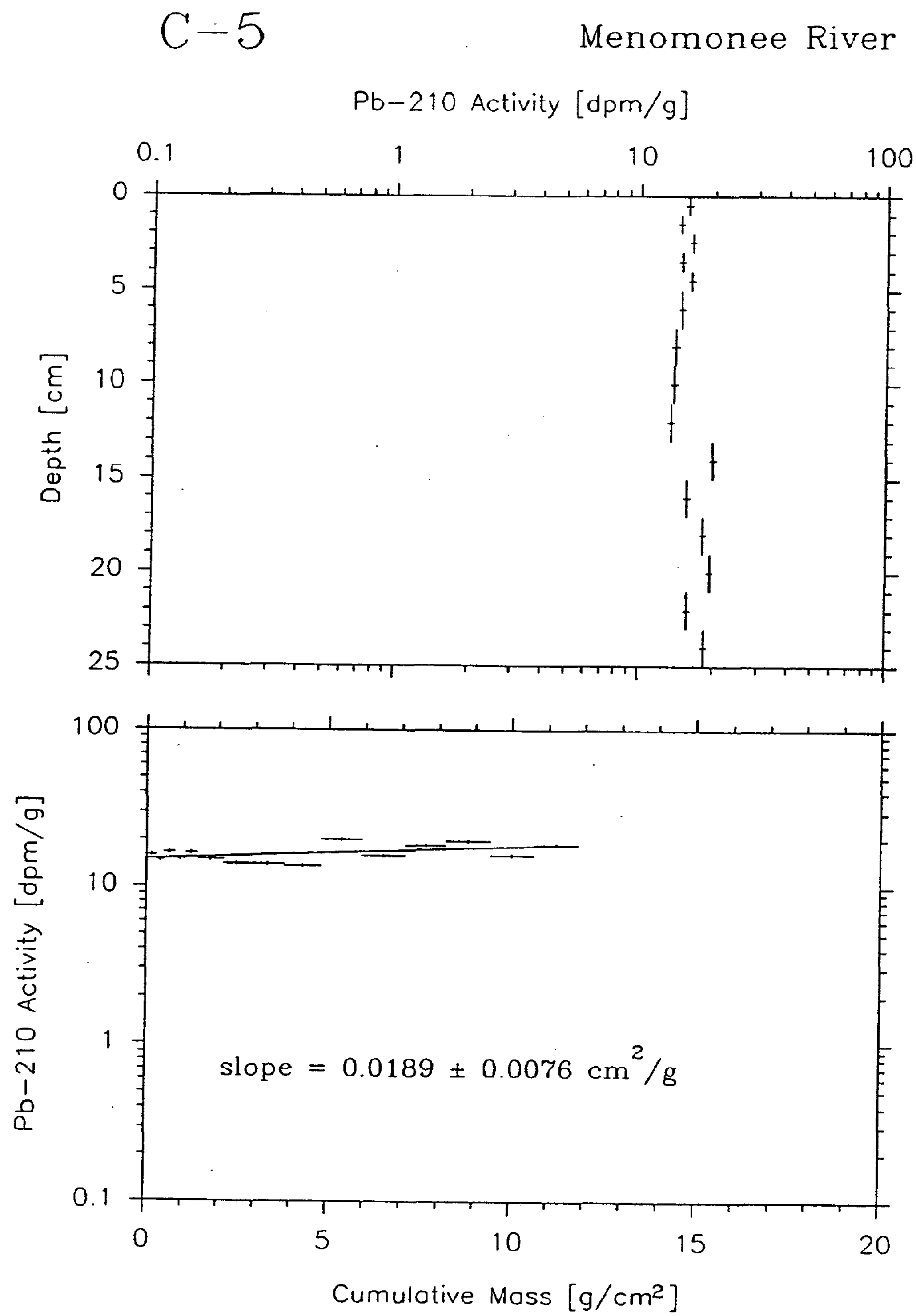


Fig. B 10 Depth vs. Pb-210 activity and Pb-210 activity vs. Cummulative mass for C-5

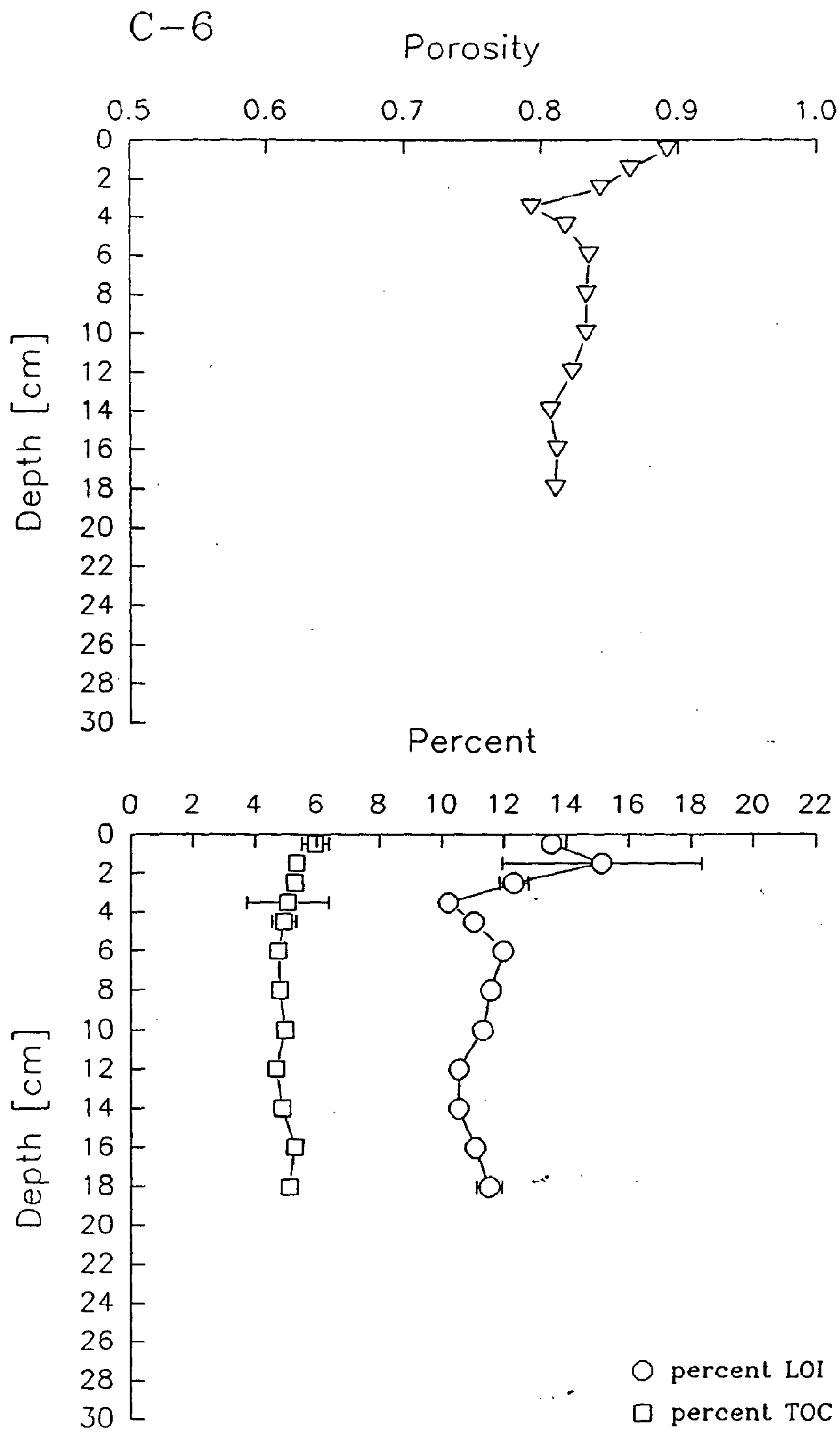


Fig. B11 Depth vs. Porosity and Depth vs. Percent LOI & TOC for C-6

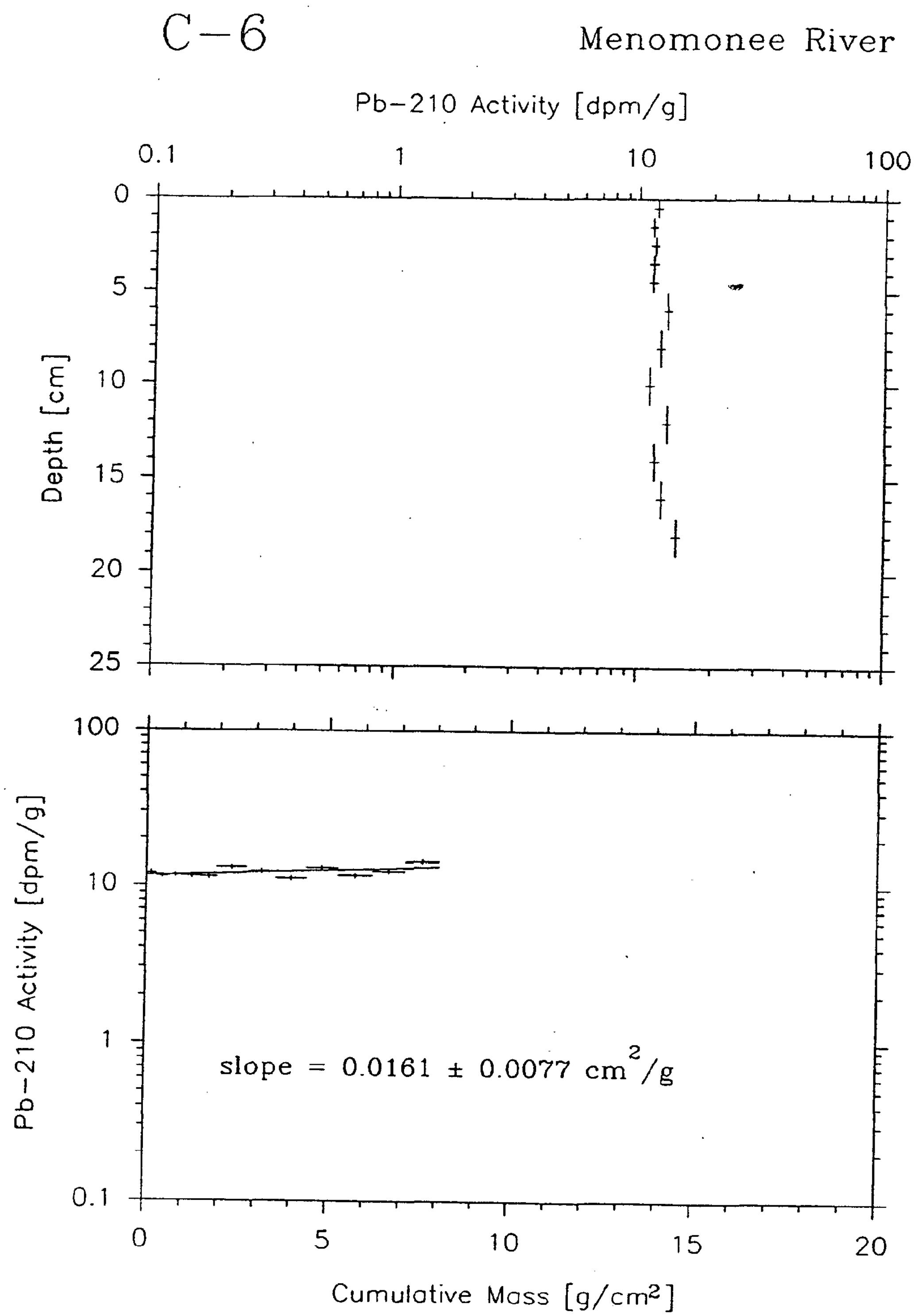


Fig. B12 Depth vs. Pb-210 activity and
Pb-210 activity vs. Cummulative mass
for C-6

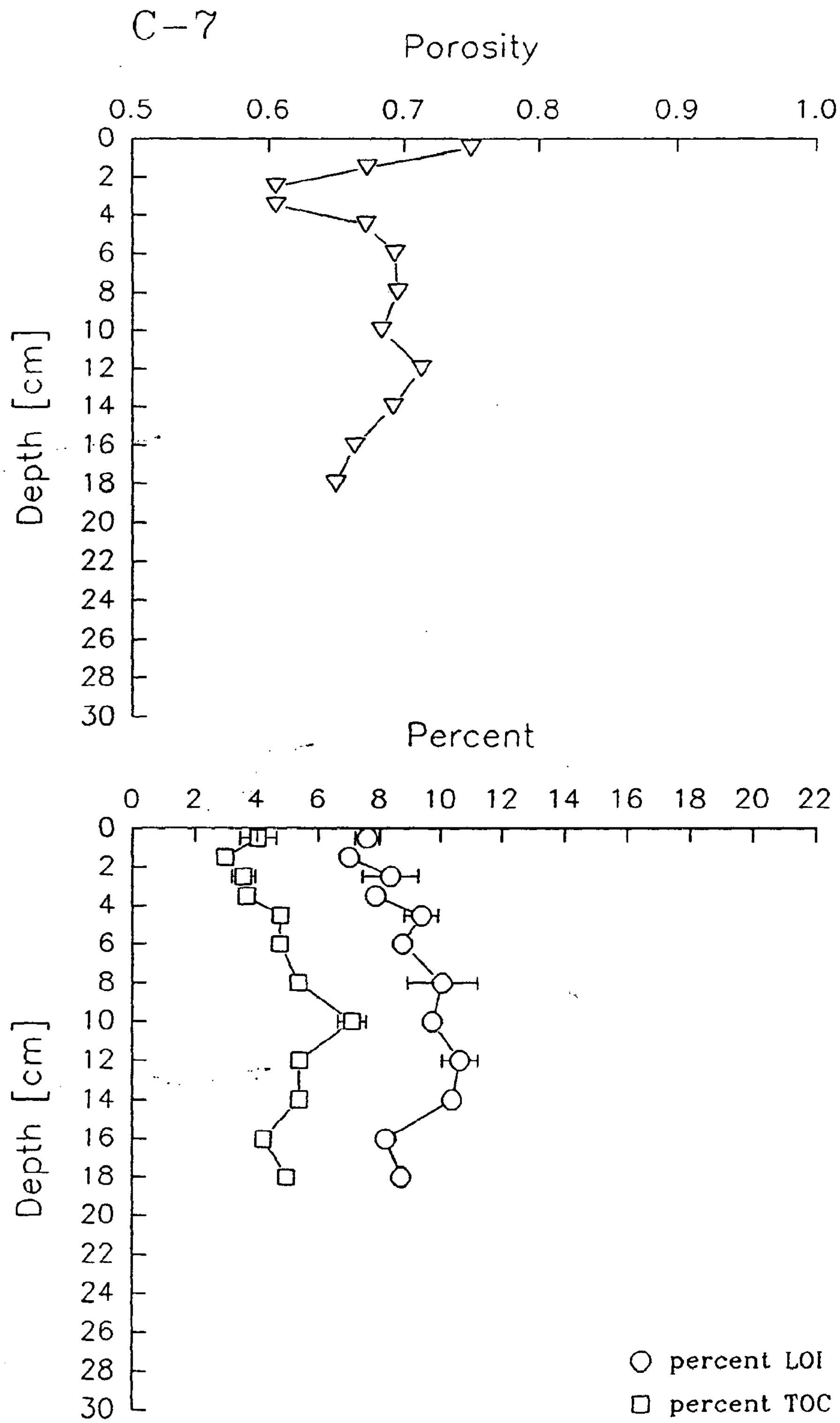


Fig. B13 Depth vs. Porosity and Depth vs. Percent LOI & TOC for C-7

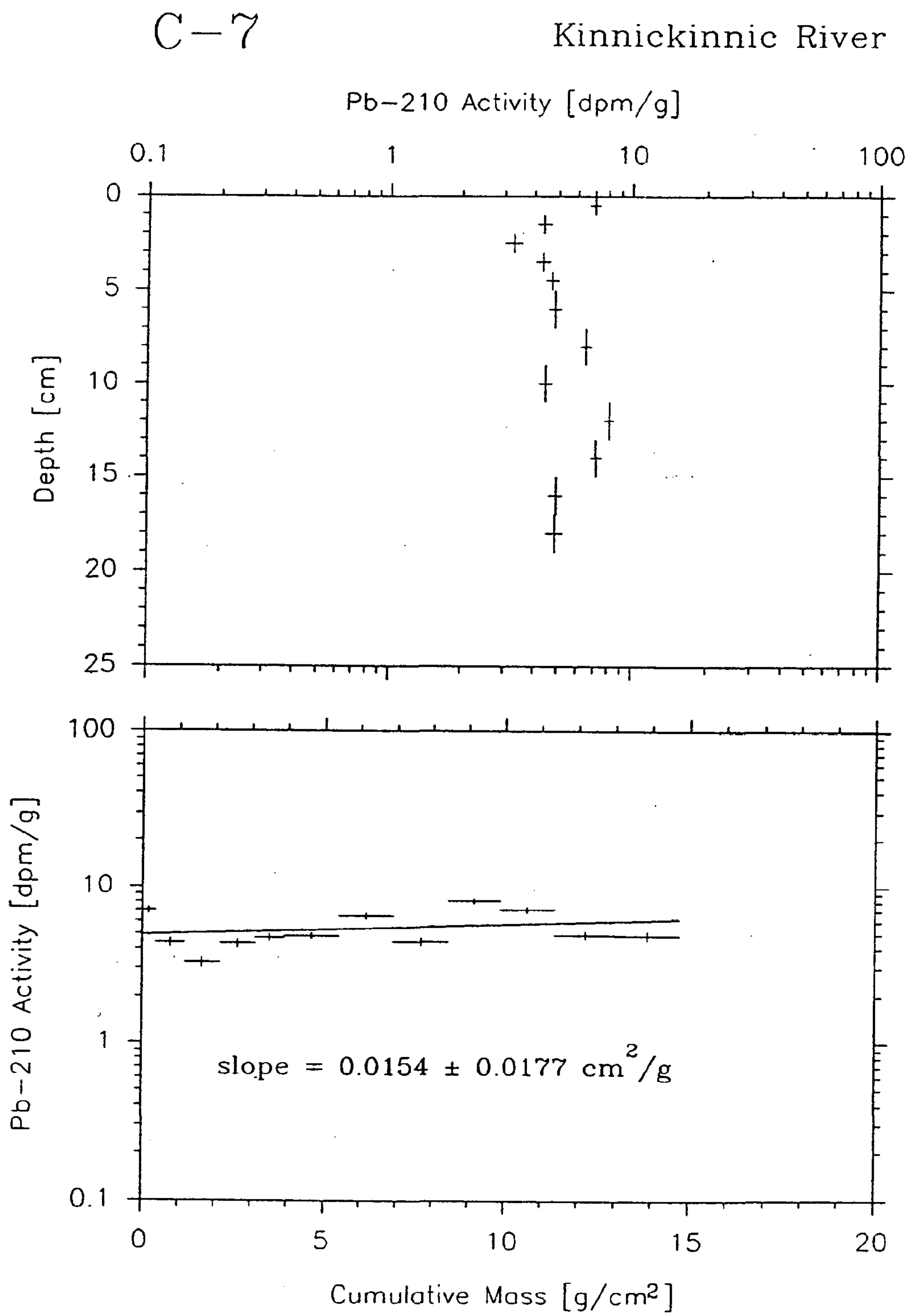


Fig. B14 Depth vs. Pb-210 activity and
Pb-210 activity vs. Cummulative mass
for C-7

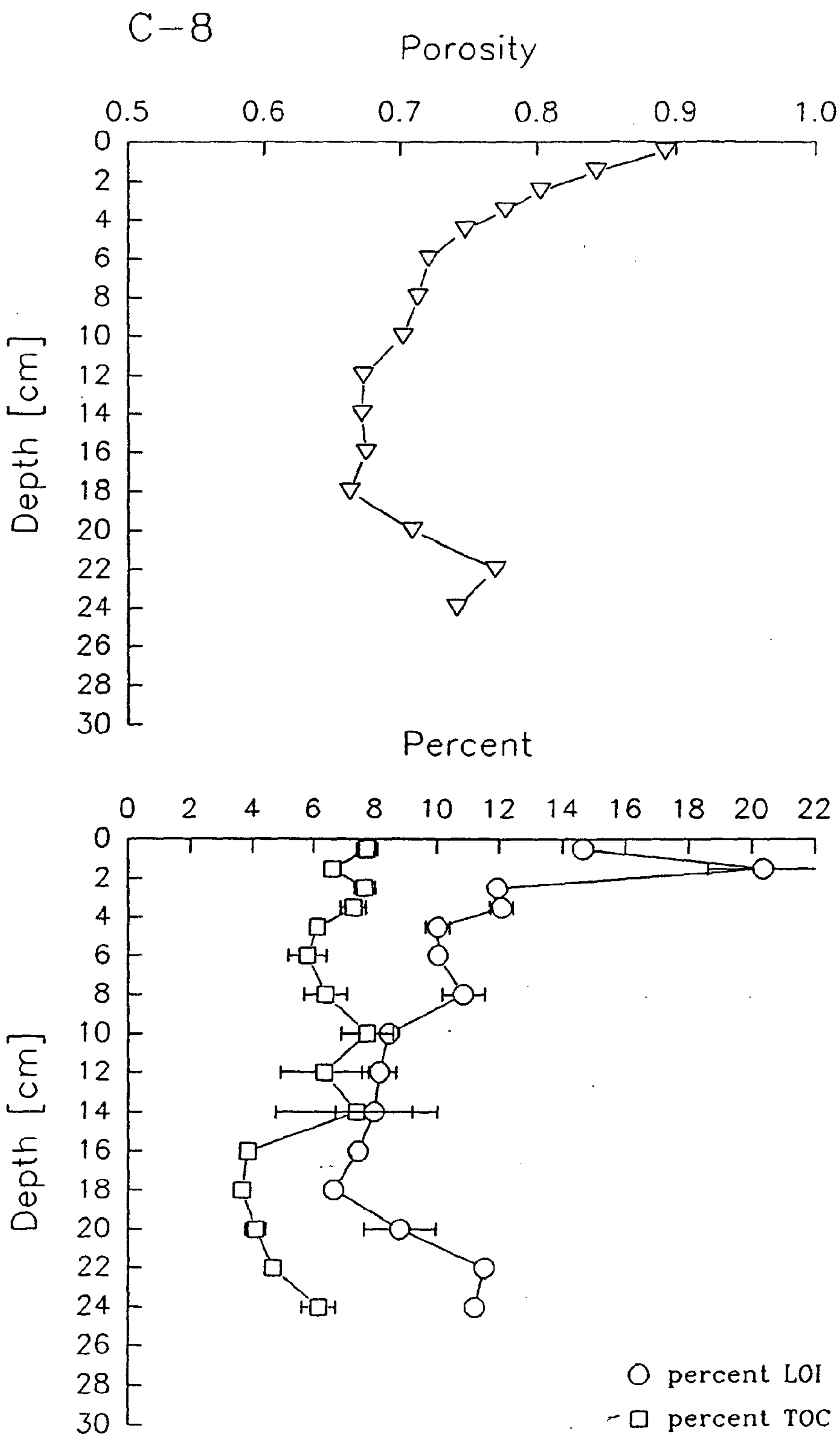


Fig. B15 Depth vs. Porosity and Depth vs. Percent LOI & TOC for C-8

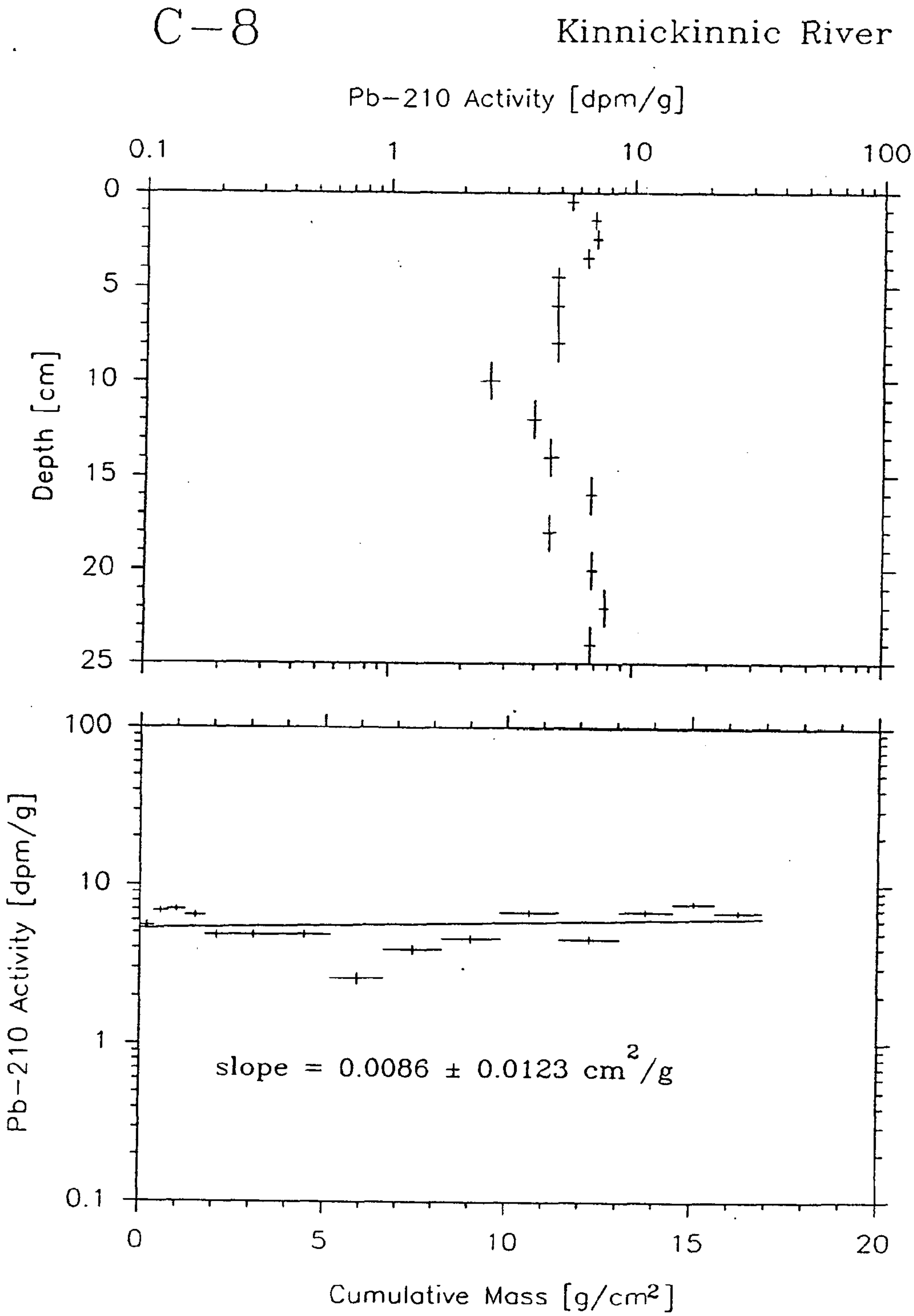


Fig. B16 Depth vs. Pb-210 activity and Pb-210 activity vs. Cummulative mass for C-8

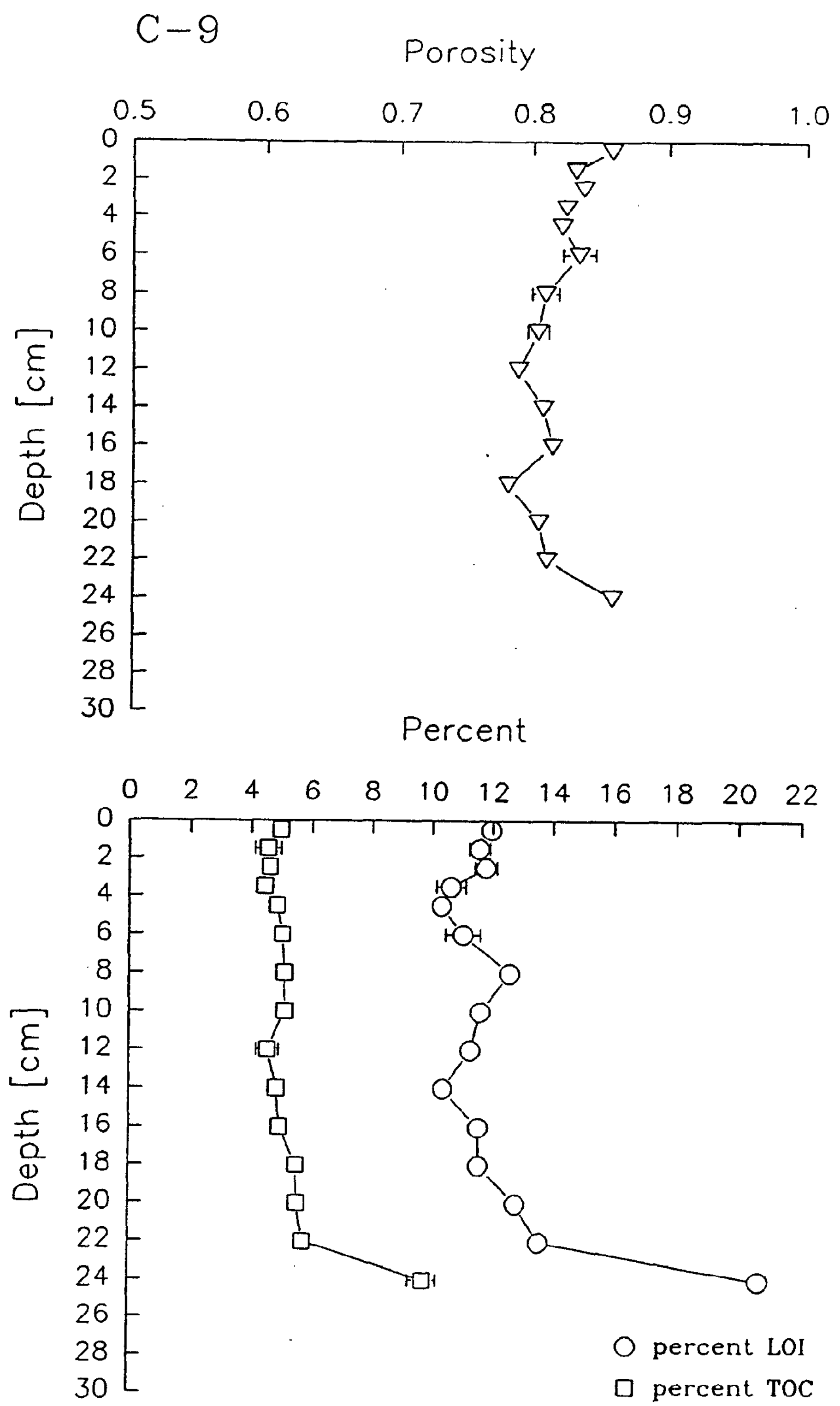


Fig. B17 Depth vs. Porosity and Depth vs. Percent LOI & TOC for C-9

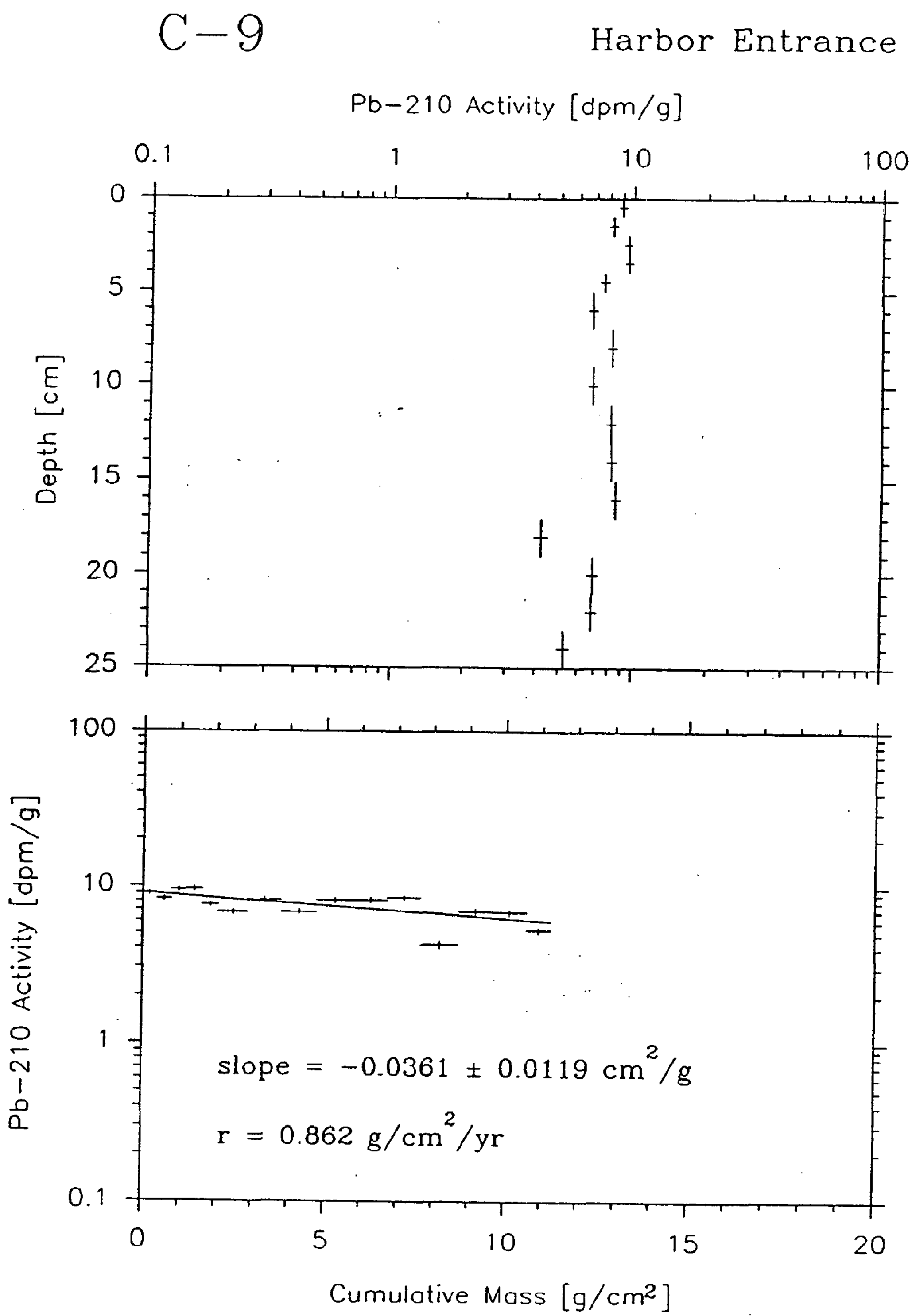


Fig. B18 Depth vs. Pb-210 activity and Pb-210 activity vs. Cummulative mass for C-9

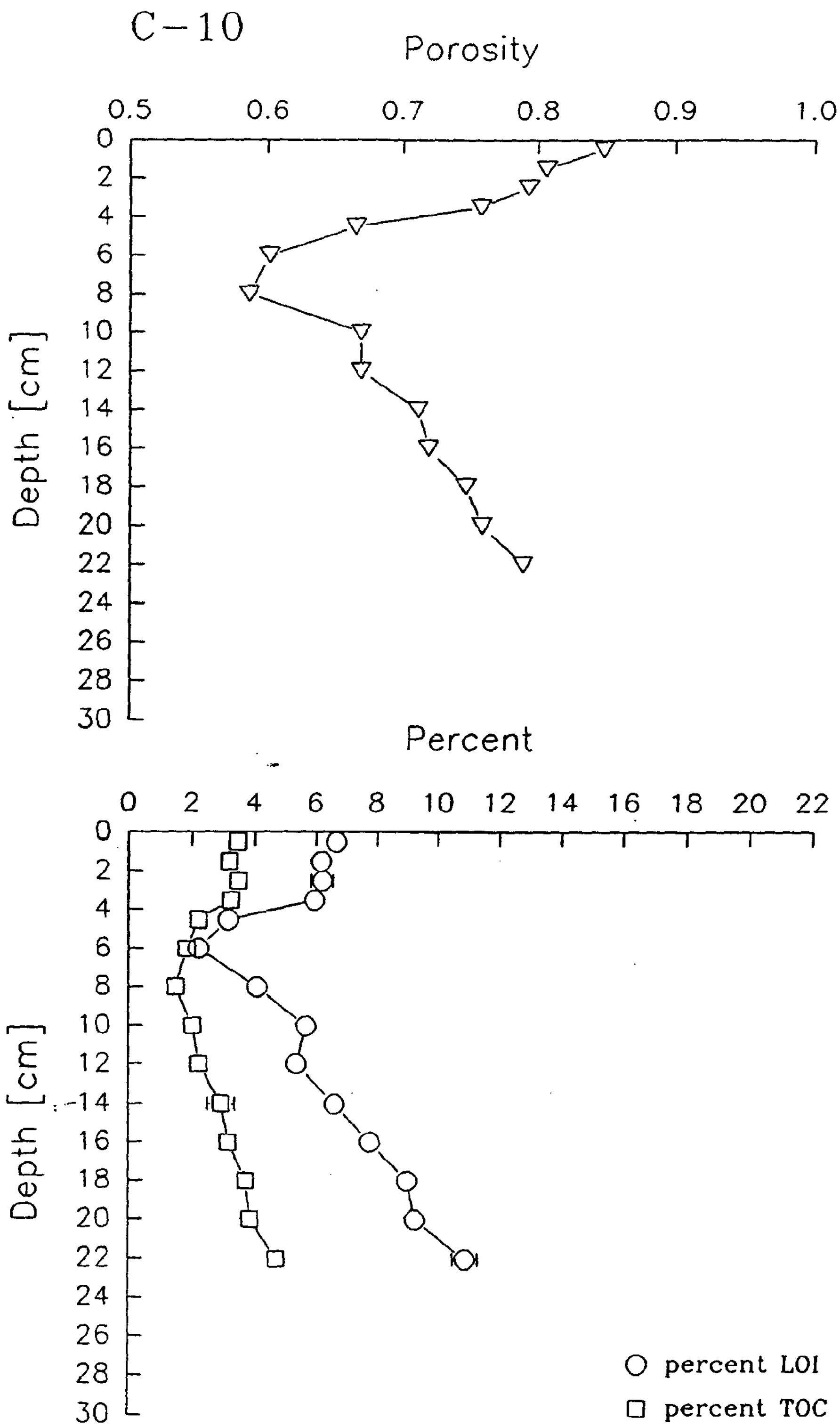


Fig. B19 Depth vs. Porosity and Depth vs. Percent LOI & TOC for C−10

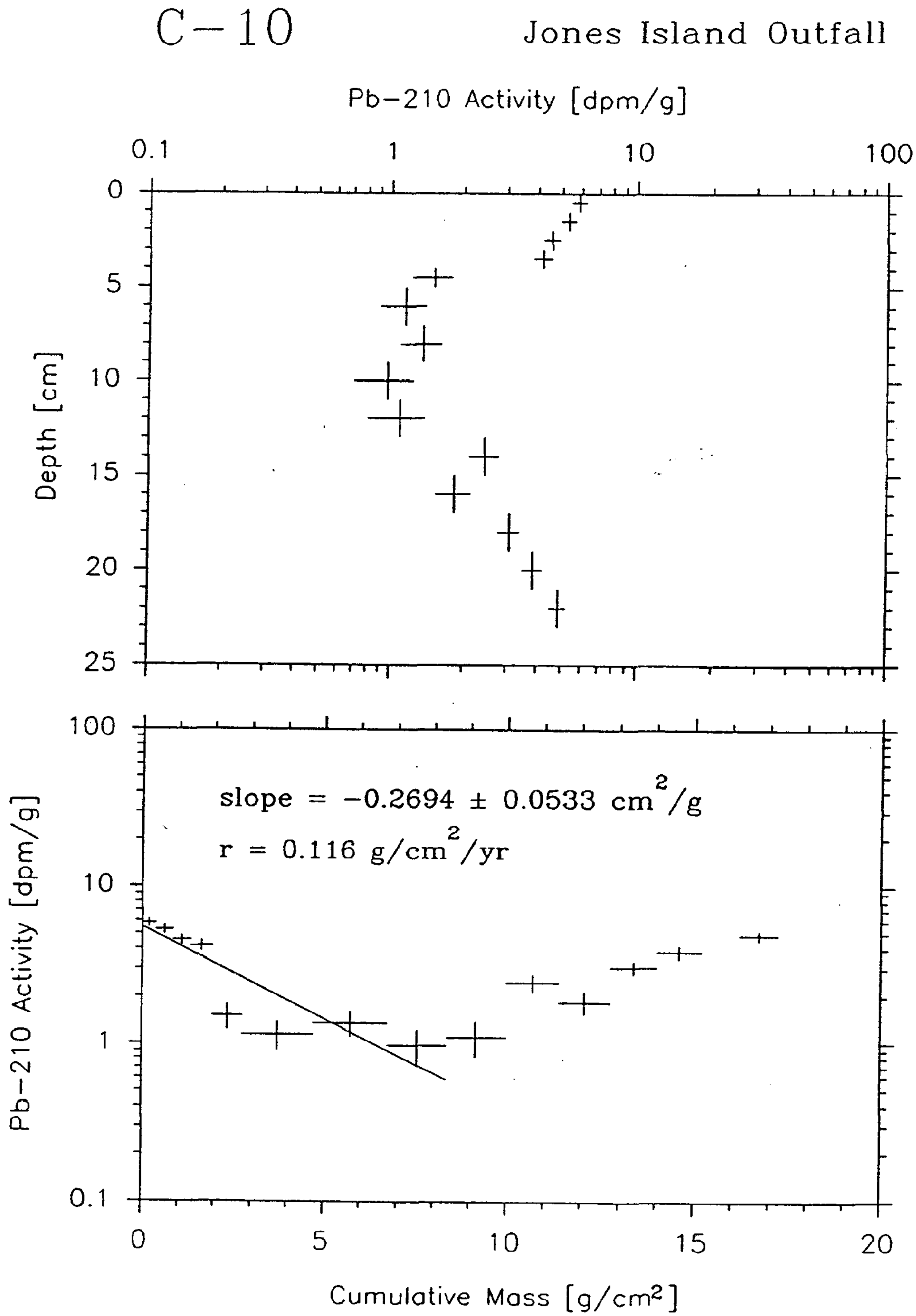


Fig. B20 Depth vs. Pb-210 activity and
Pb-210 activity vs. Cummulative mass
for C-10

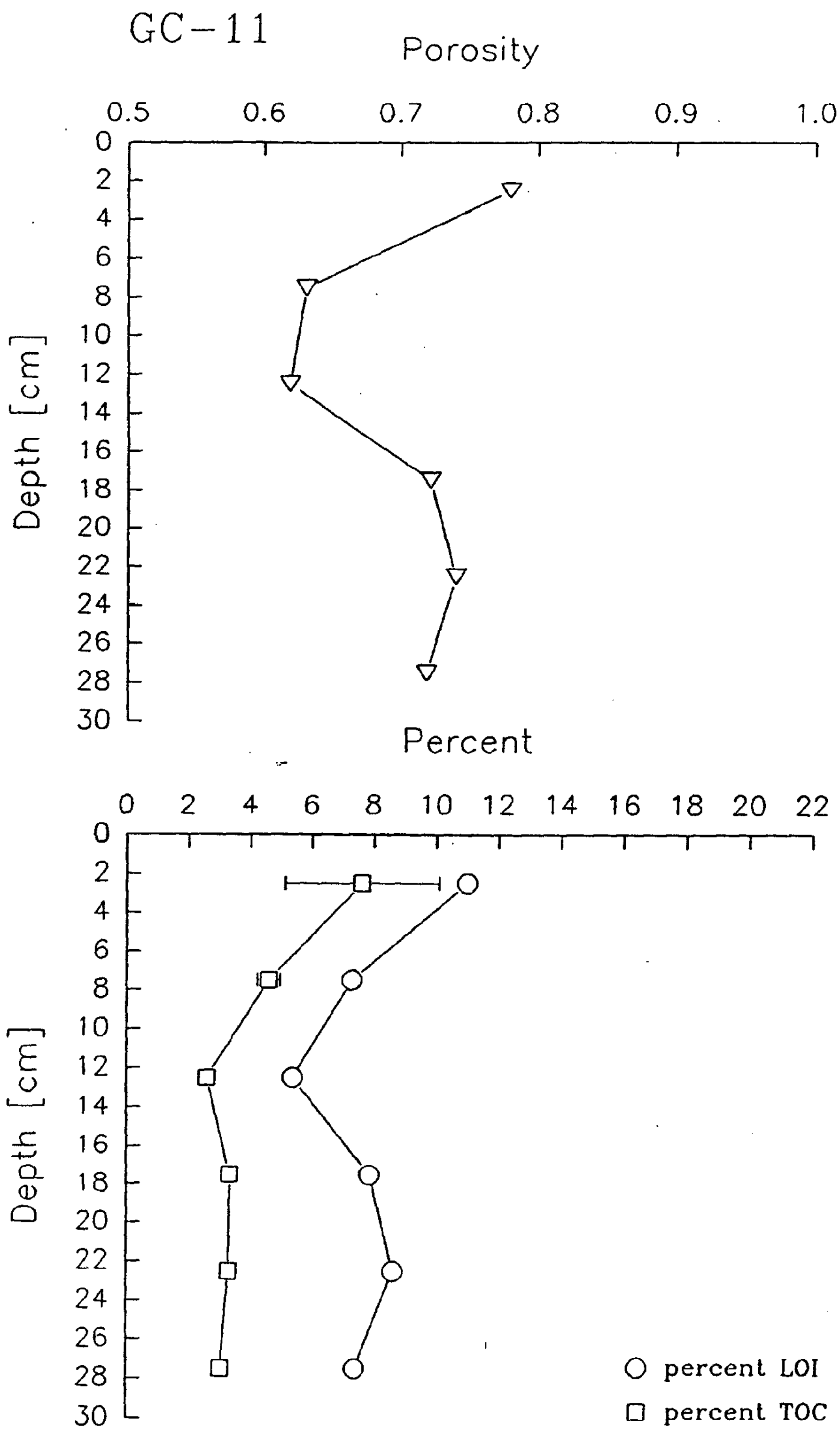
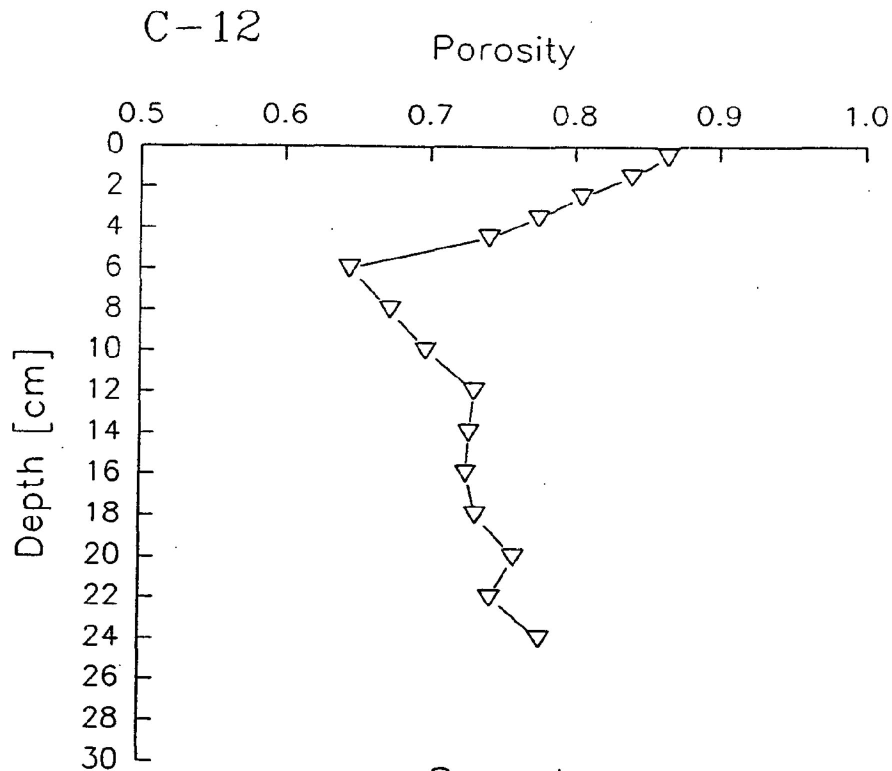


Fig. B21 Depth vs. Porosity and Depth vs. Percent LOI & TOC for GC-11



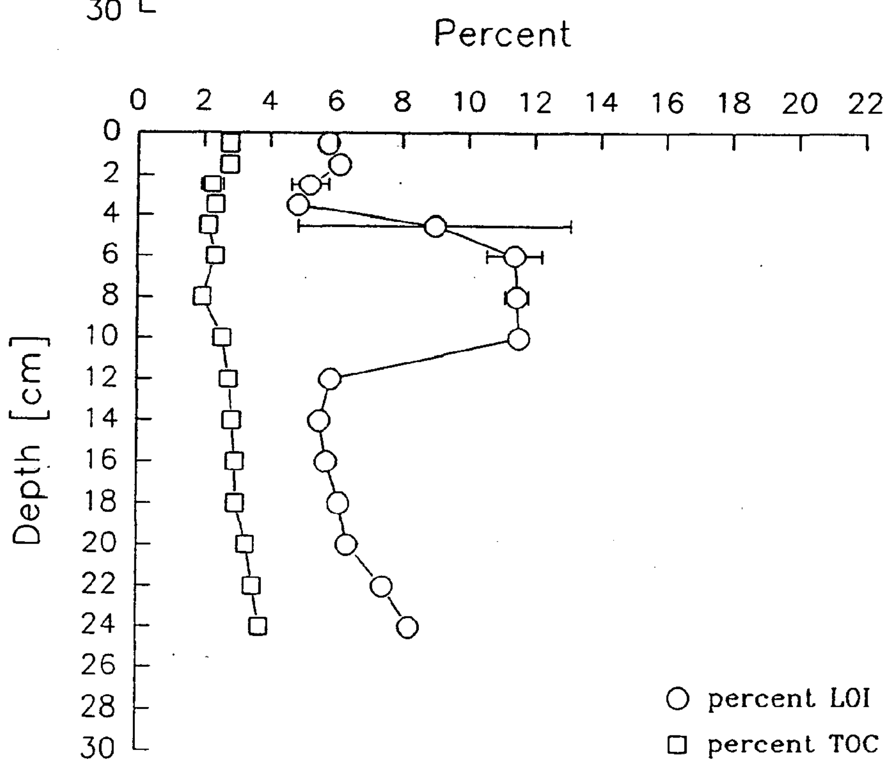


Fig. B22 Depth vs. Porosity and Depth vs. Percent LOI & TOC for C-12

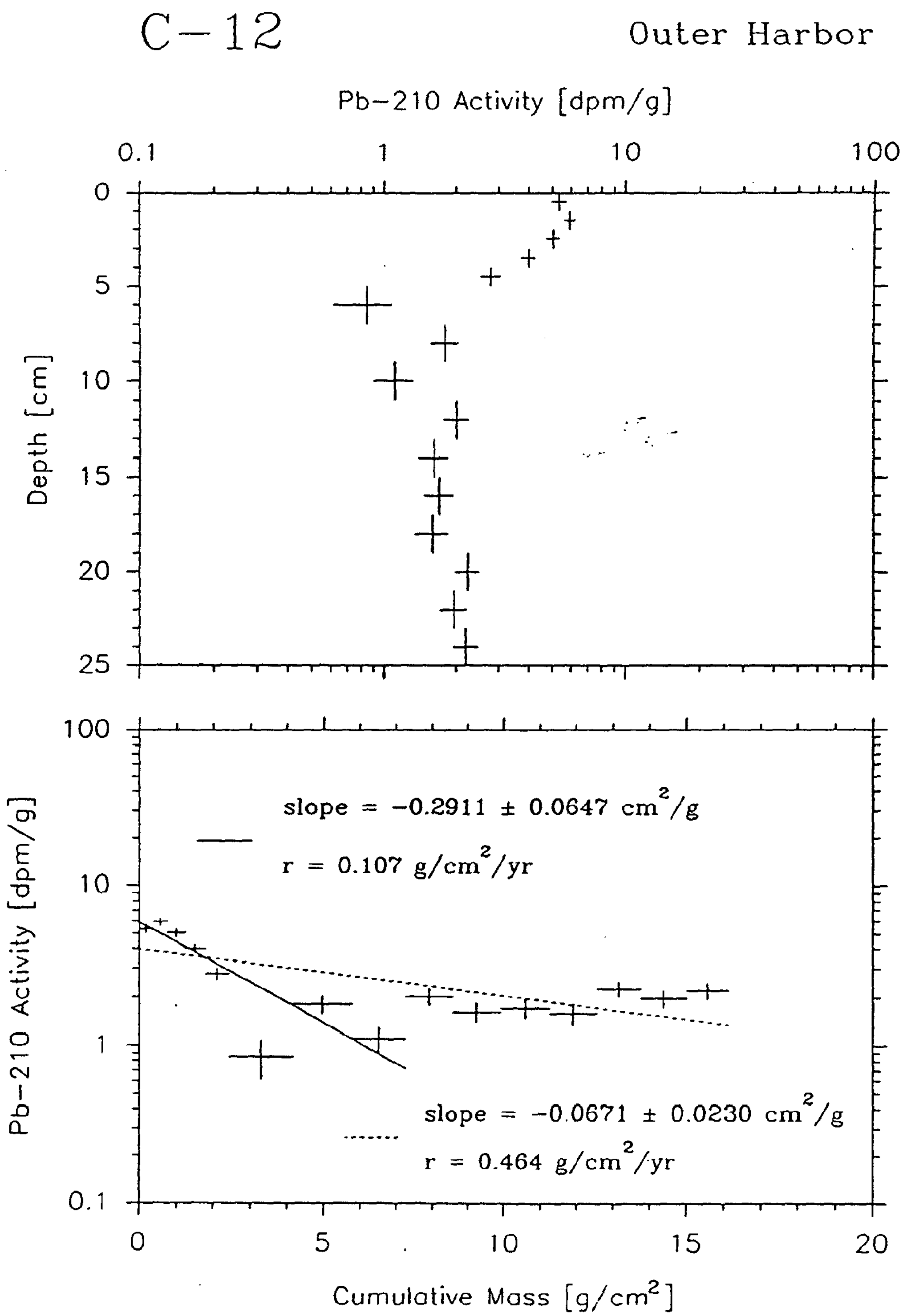


Fig. B23 Depth vs. Pb−210 activity and
Pb−210 activity vs. Cummulative mass
for C−12

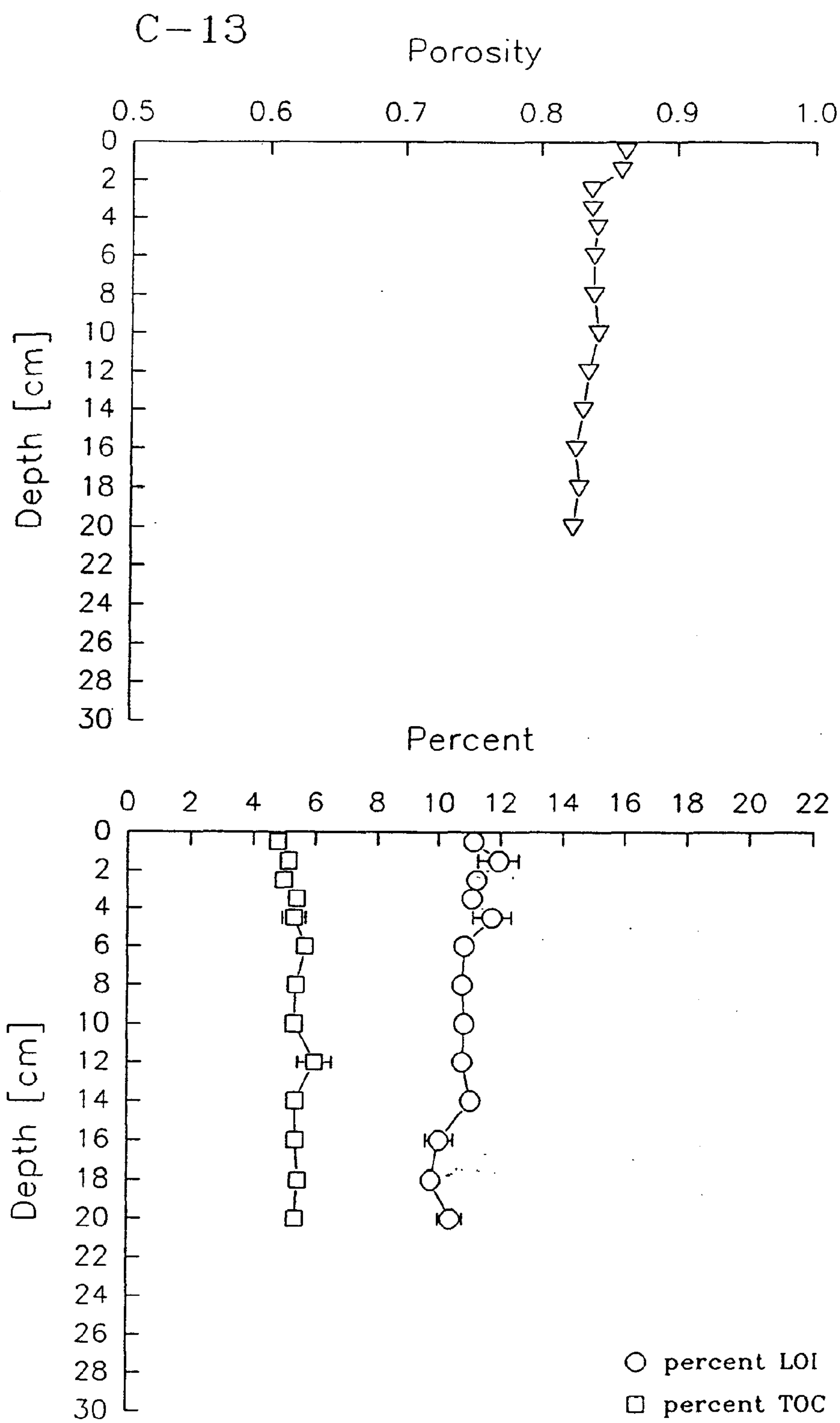


Fig. B24 Depth vs. Porosity and Depth vs. Percent LOI & TOC for C-13

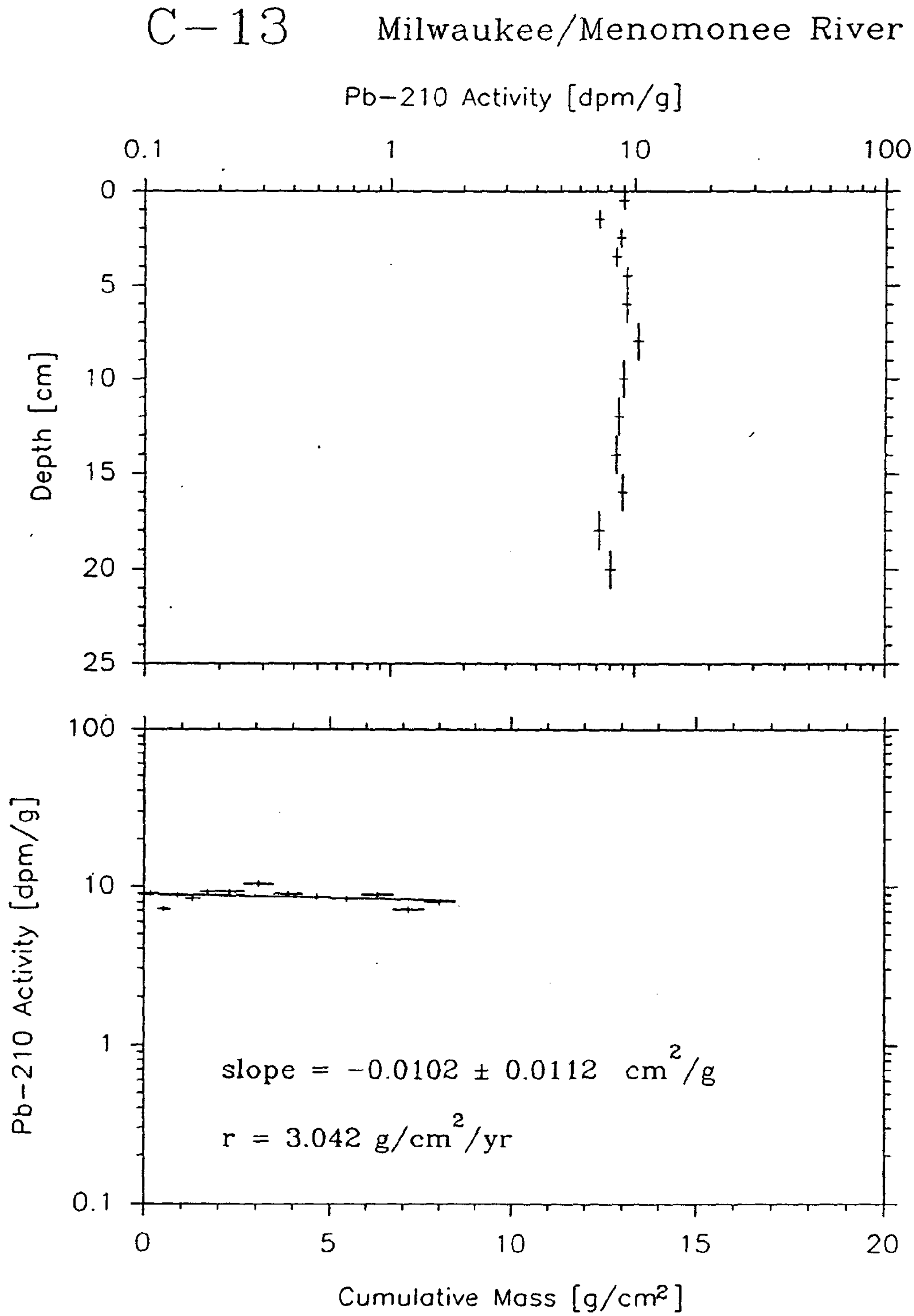


Fig. B25 Depth vs. Pb-210 activity and
Pb-210 activity vs. Cummulative mass
for C-13

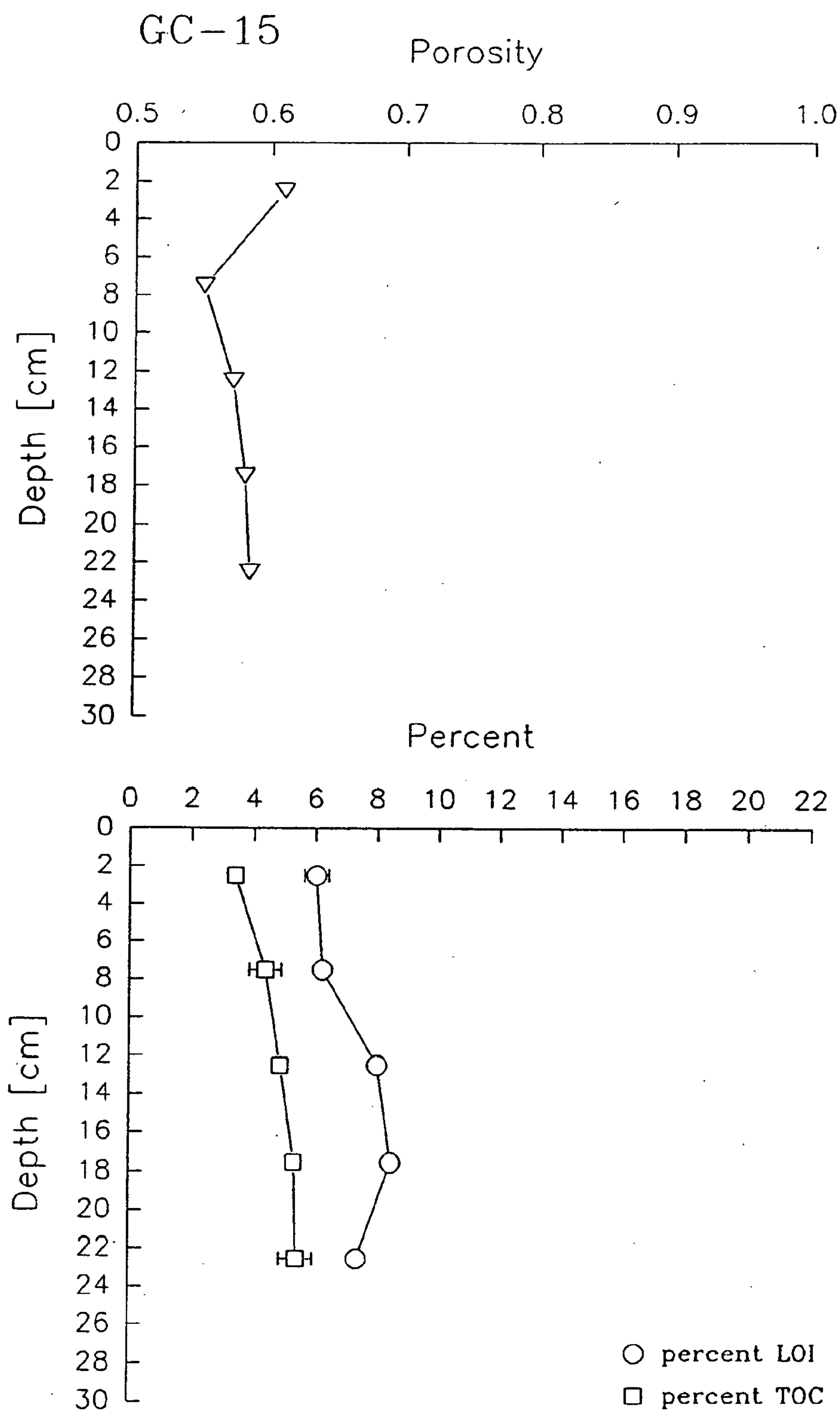


Fig. B26 Depth vs. Porosity and Depth vs. Percent LOI & TOC for GC-15

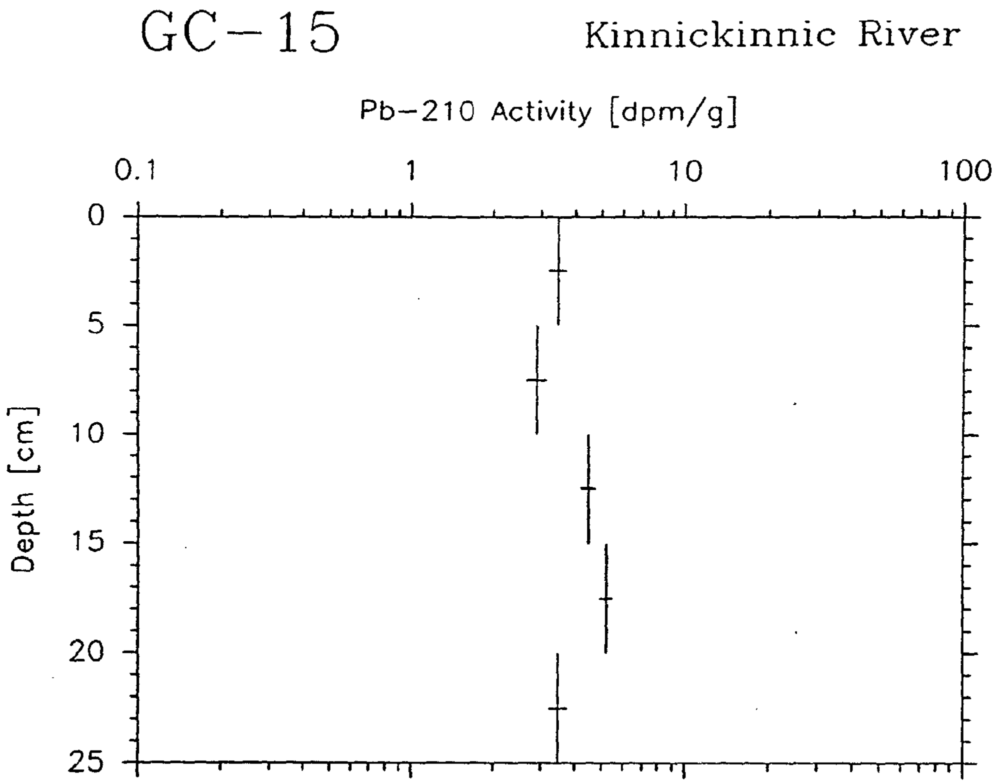


Fig. B27 Depth vs. Pb-210 activity for GC-15

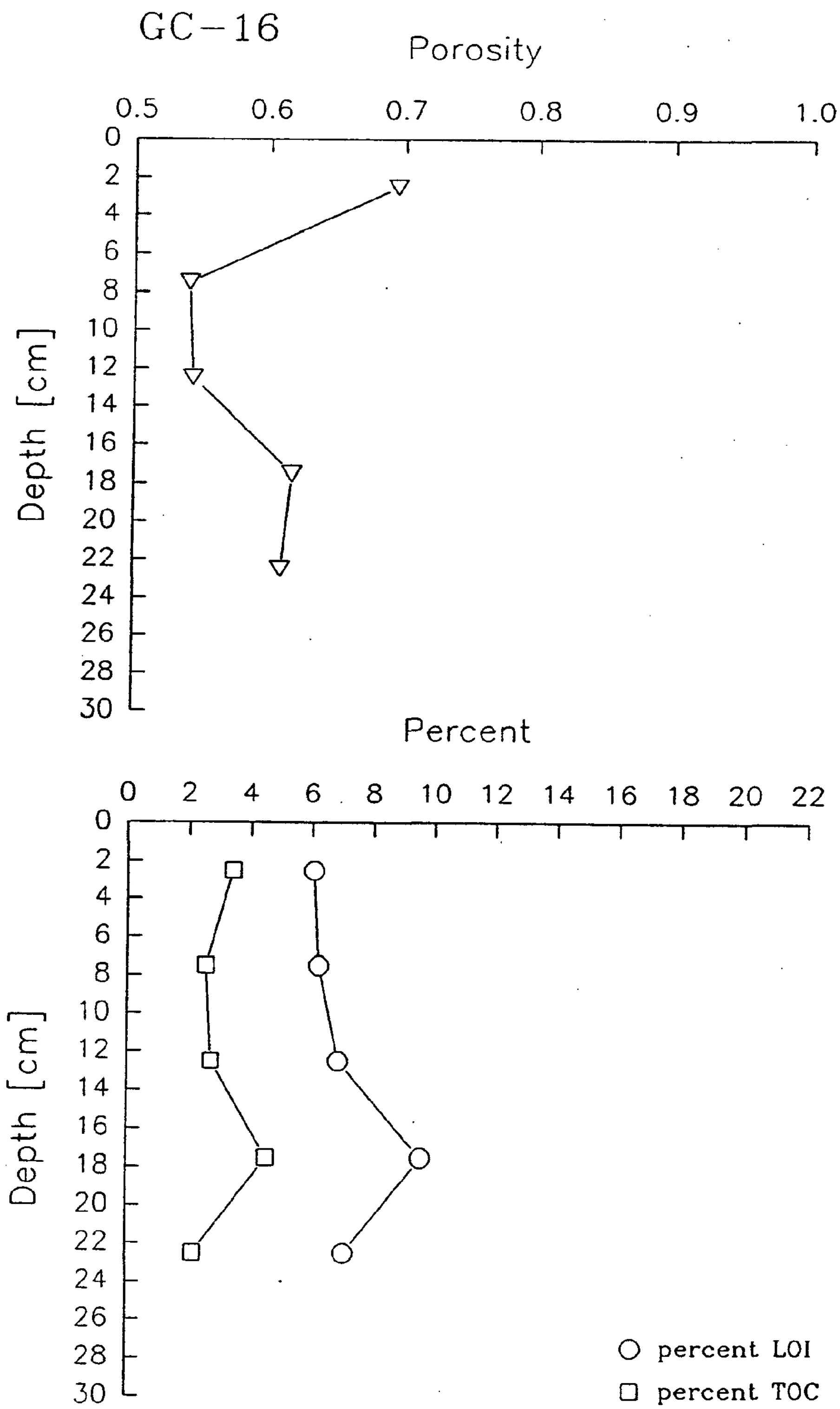


Fig. B28 Depth vs. Porosity and Depth vs. Percent LOI & TOC for GC−16

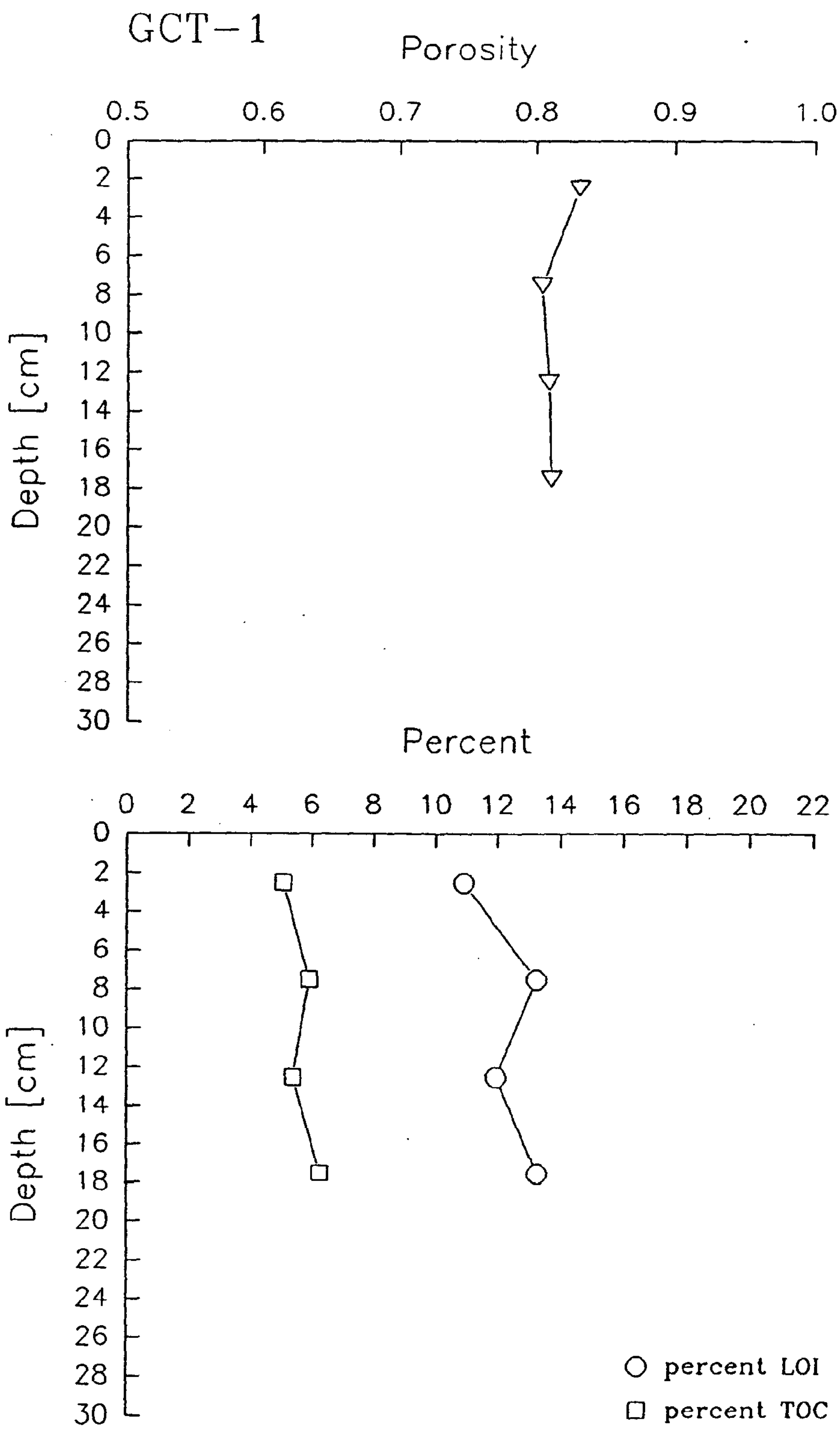


Fig. B29 Depth vs. Porosity and Depth vs. Percent LOI & TOC for GCT-1

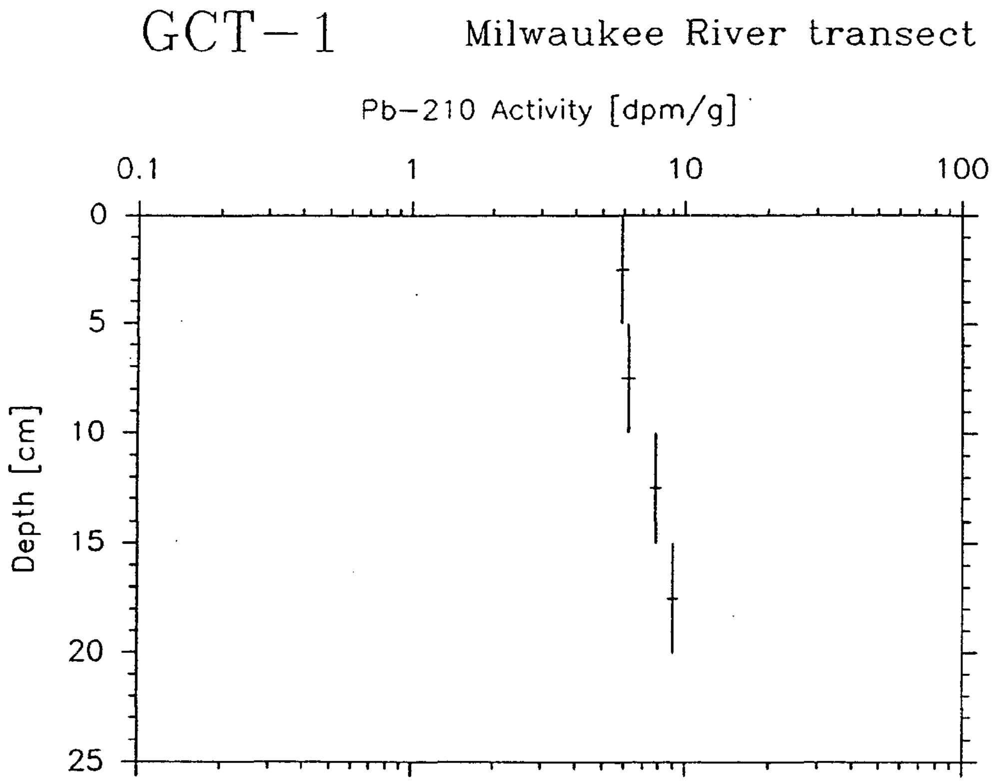


Fig. B30 Depth vs. Pb-210 activity for GCT-1

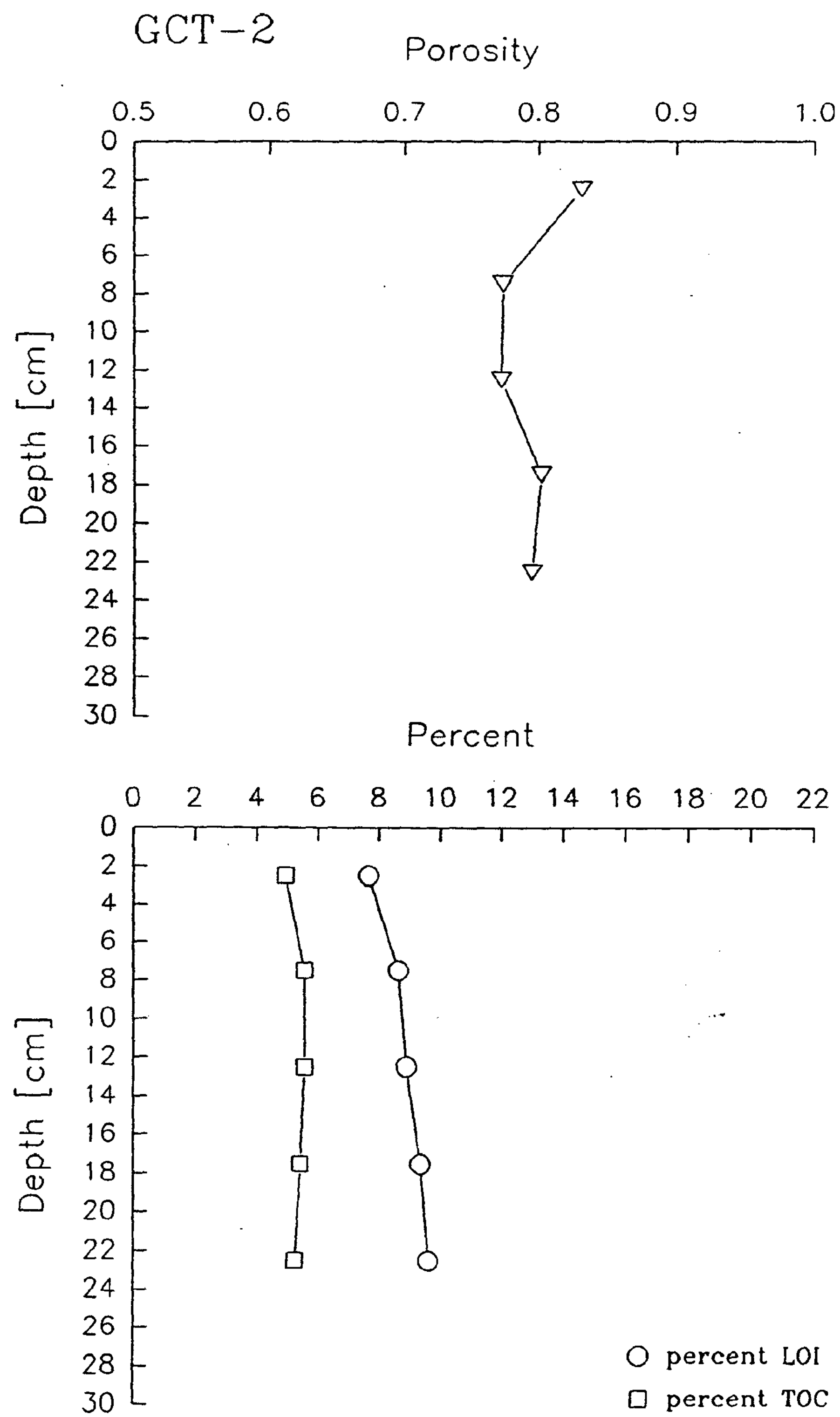


Fig. B31 Depth vs. Porosity and Depth vs. Percent LOI & TOC for GCT-2

GCT−2 Milwaukee River transect

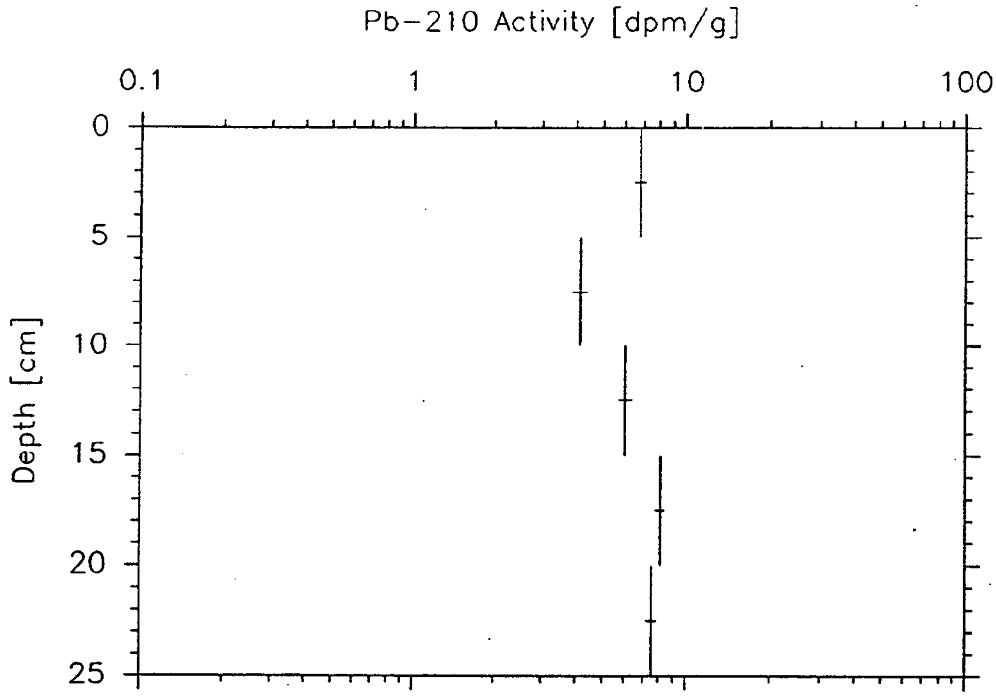


Fig. B32 Depth vs. Pb−210 activity for GCT−2

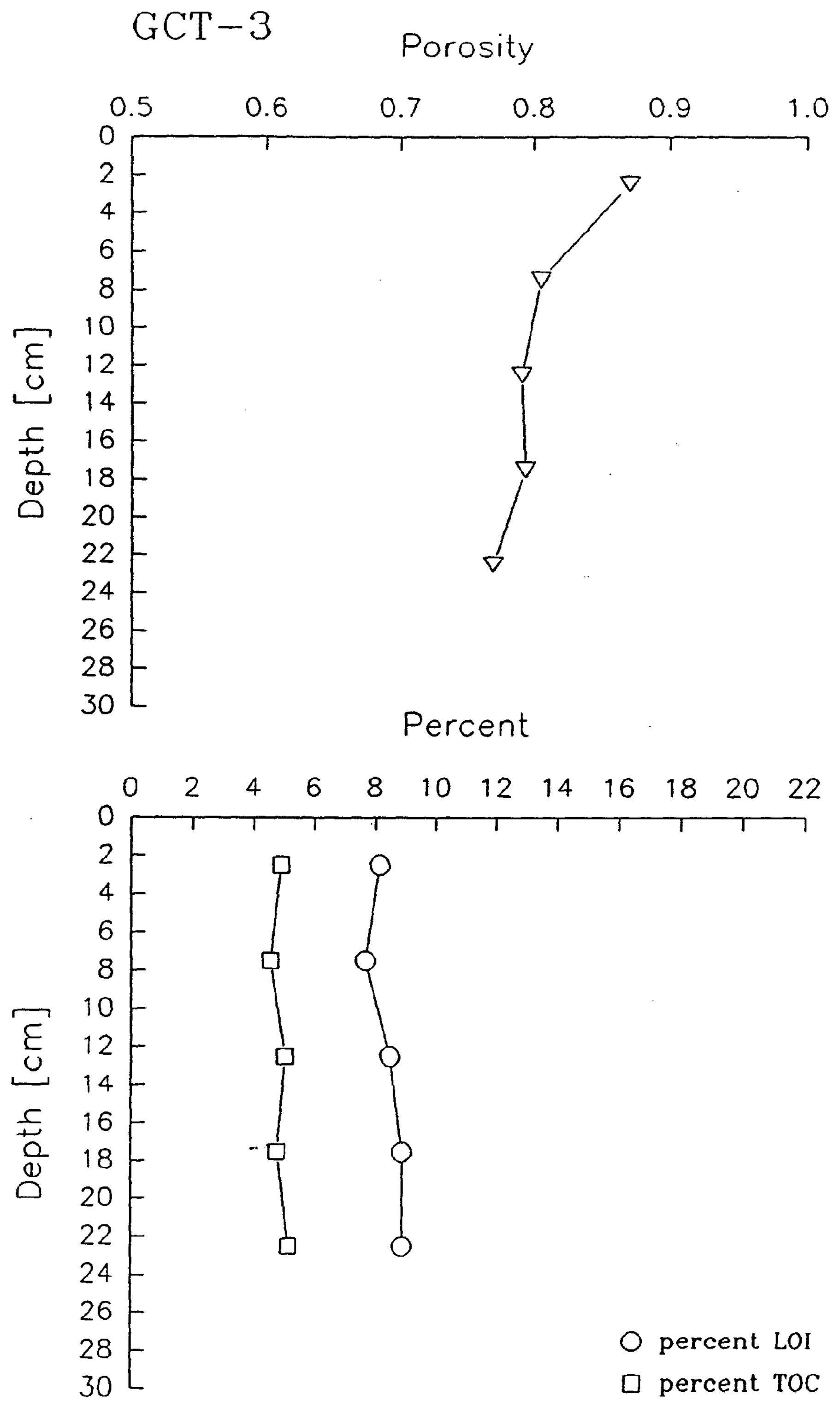


Fig. B33 Depth vs. Porosity and Depth vs. Percent LOI & TOC for GCT-3

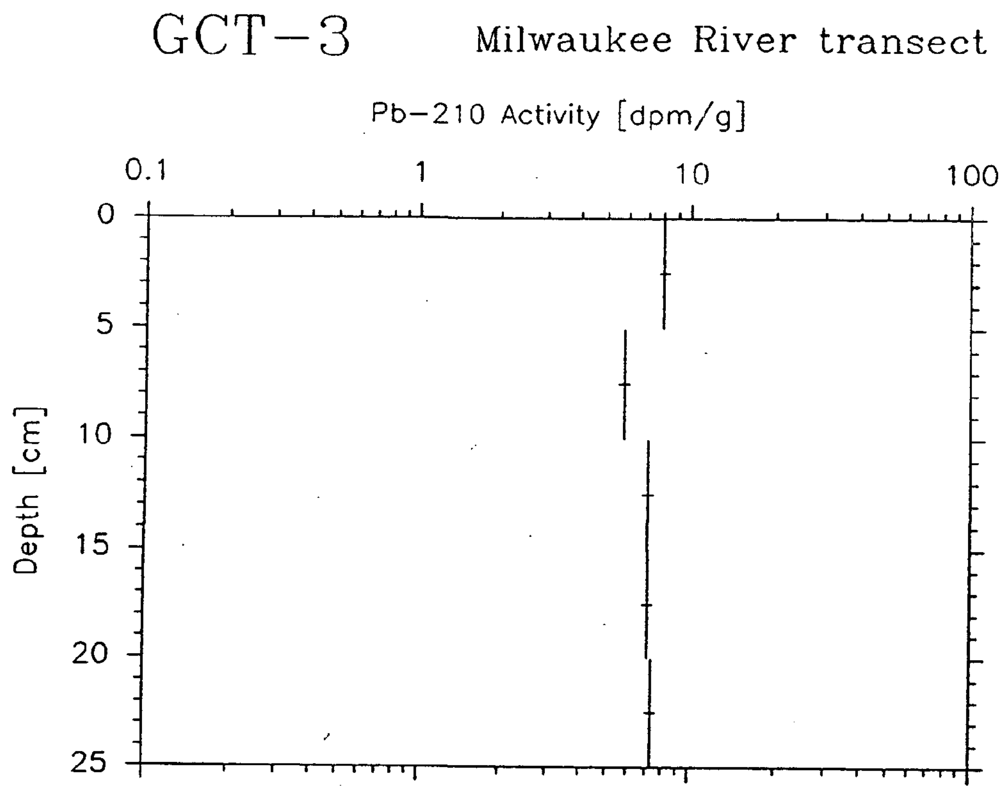


Fig. B34 Depth vs. Pb-210 activity for GCT-3

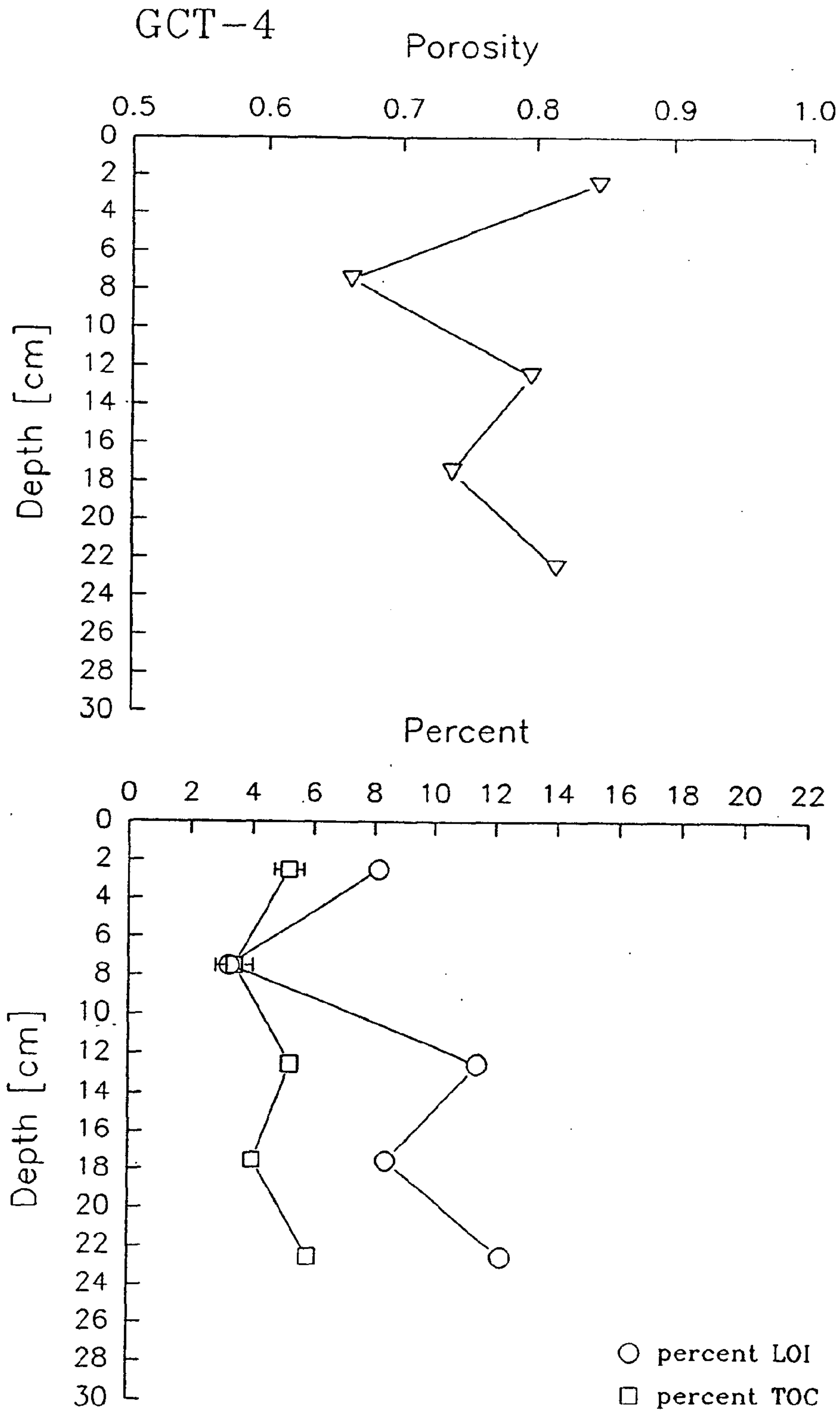


Fig. B35 Depth vs. Porosity and Depth vs. Percent LOI & TOC for GCT-4

GCT−4 Milwaukee River transect

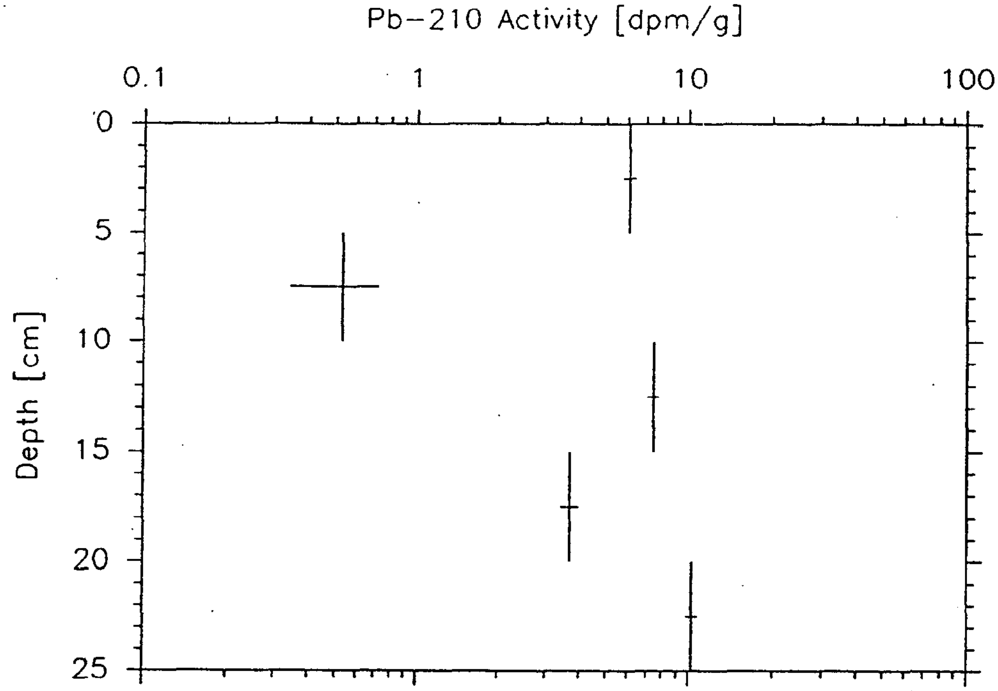


Fig. B36 Depth vs. Pb−210 activity for GCT−4

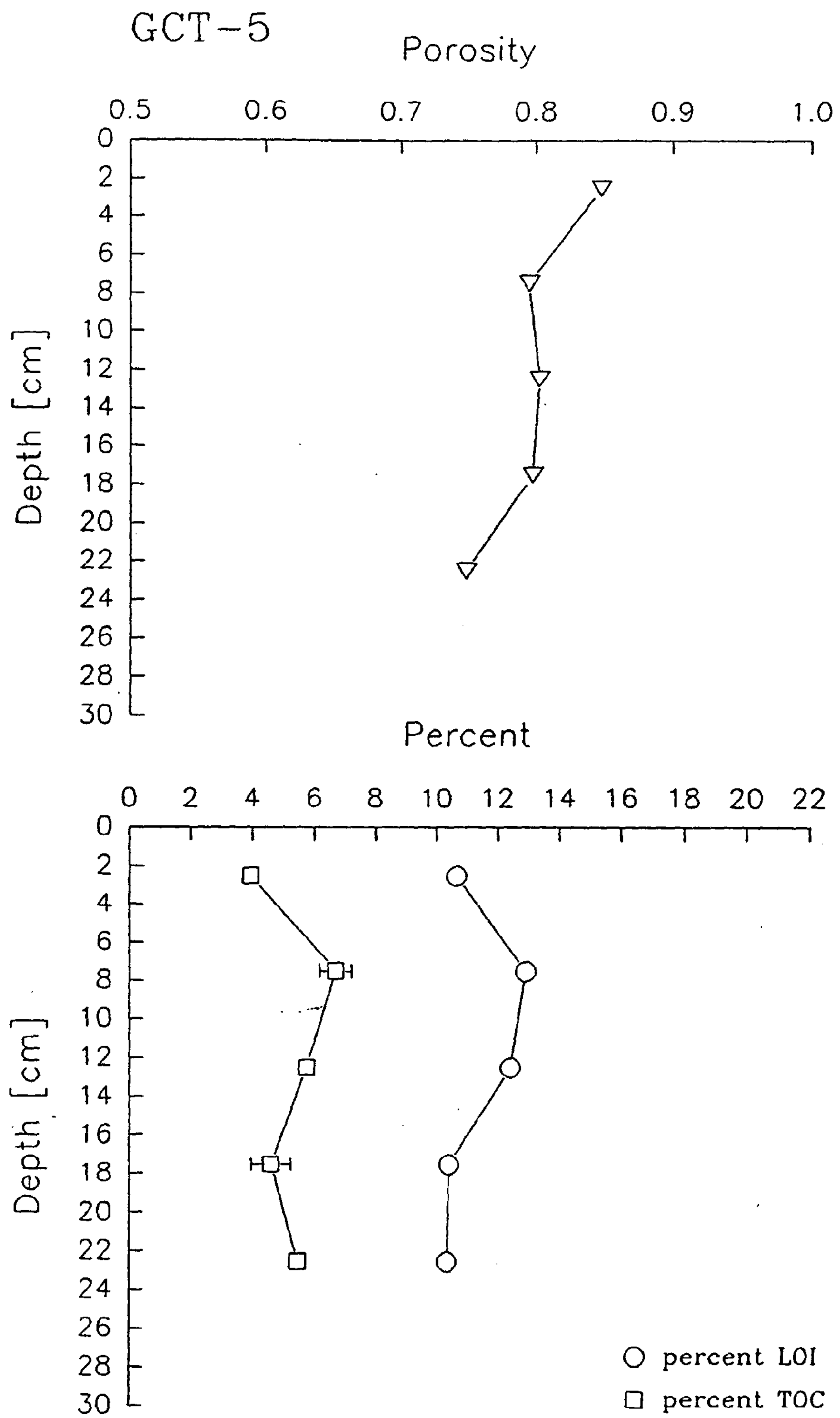


Fig. B37 Depth vs. Porosity and Depth vs. Percent LOI & TOC for GCT-5

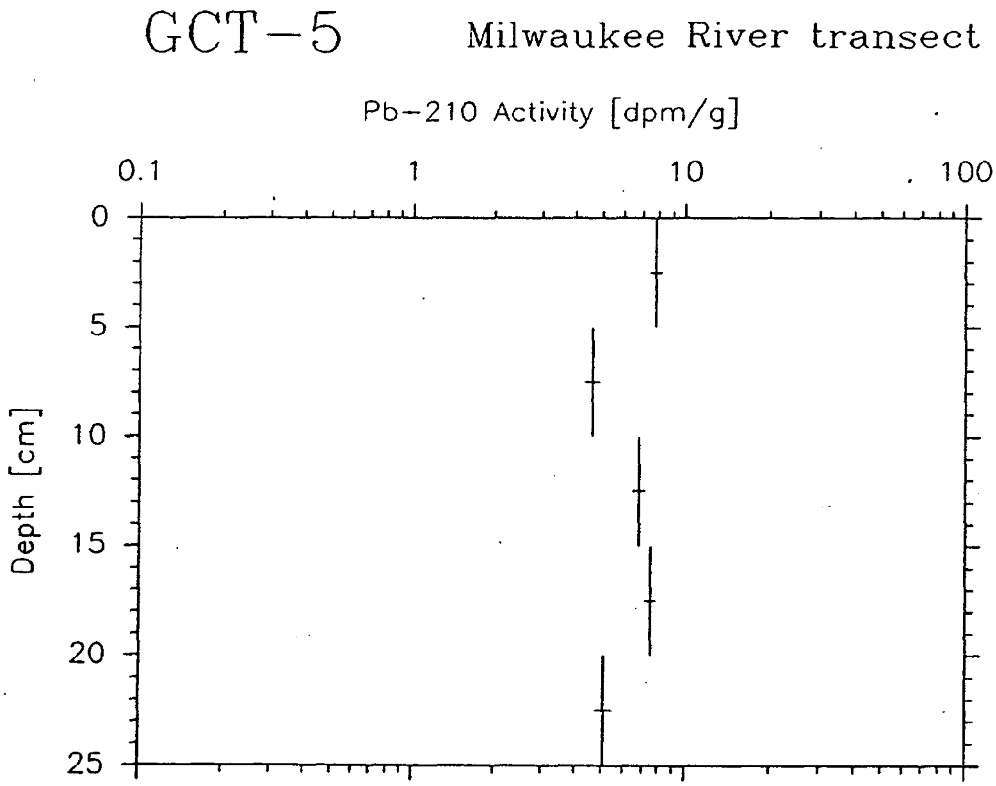


Fig. B38 Depth vs. Pb−210 activity for GCT−5

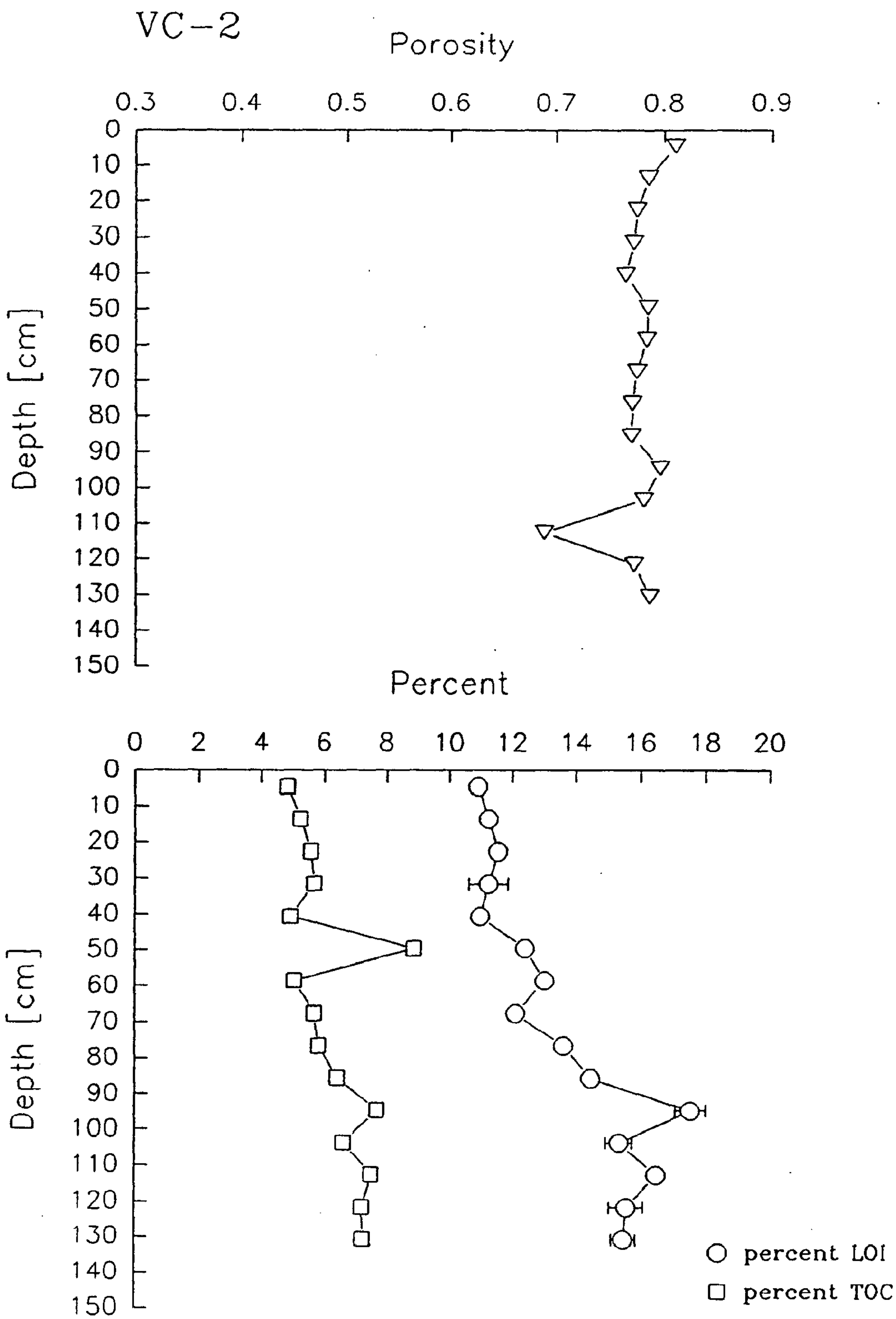


Fig. B39 Depth vs. Porosity and Depth vs. Percent LOI & TOC for VC-2

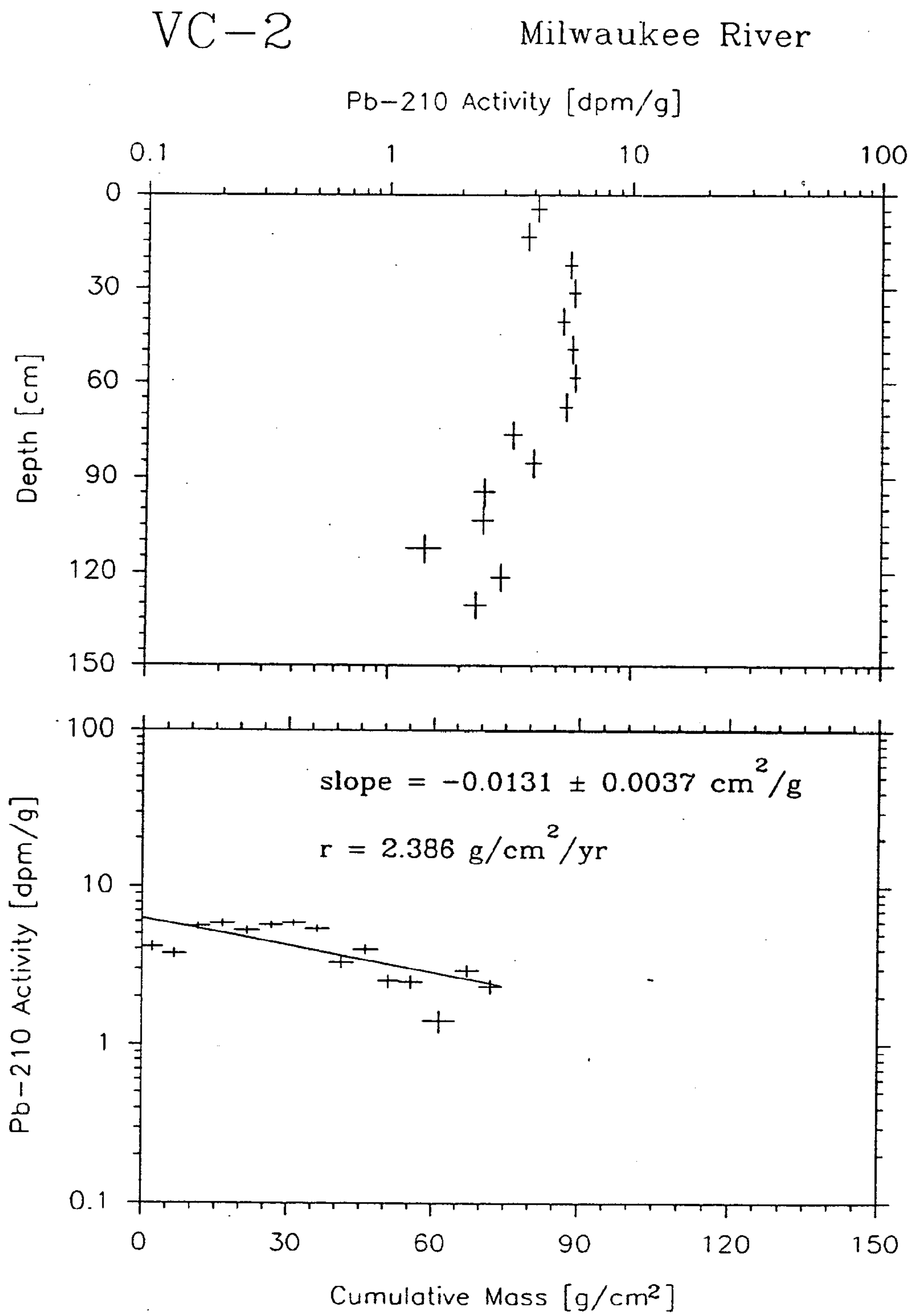


Fig. B40 Depth vs. Pb−210 activity and
Pb−210 activity vs. Cummulative mass
for VC−2

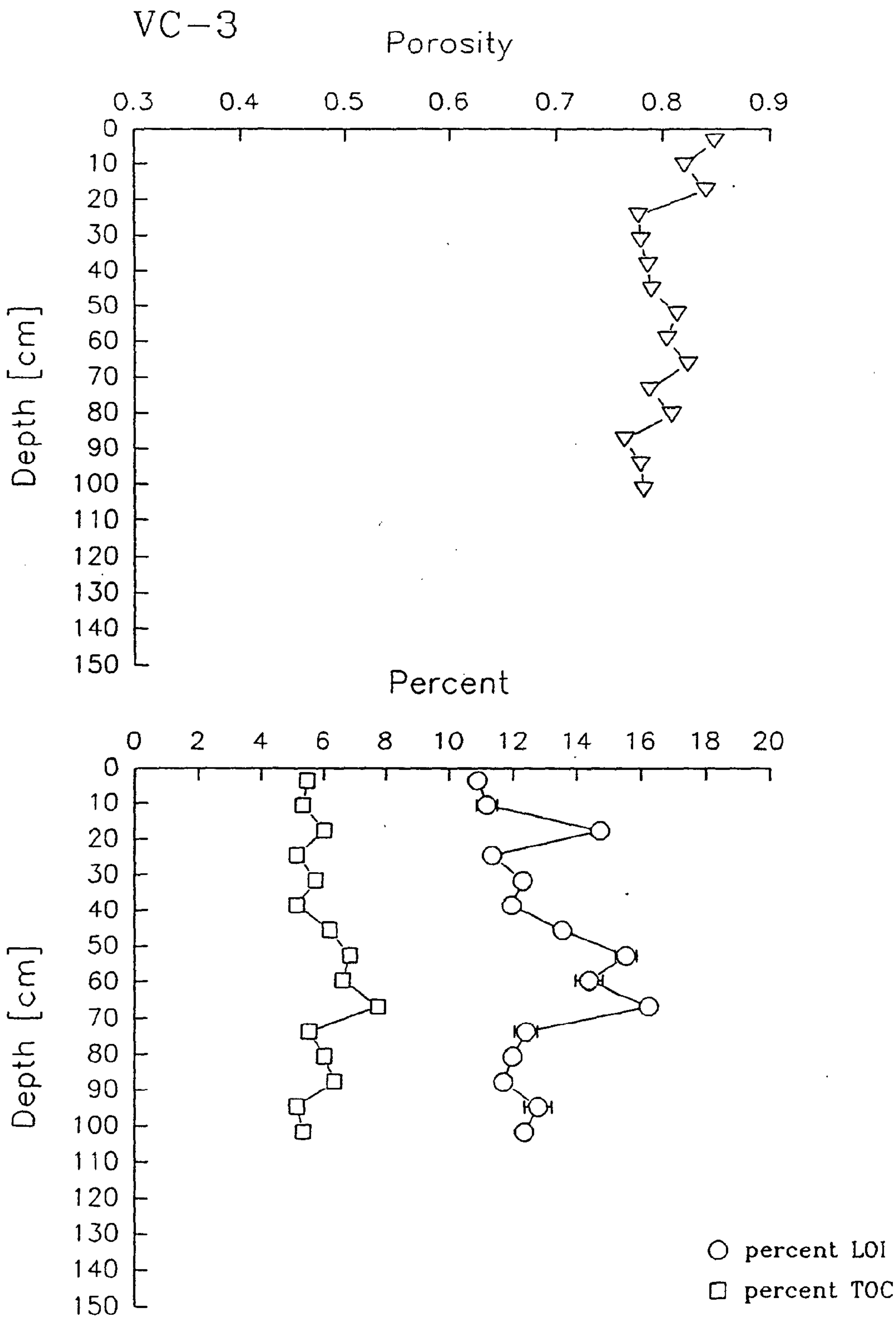


Fig. B41 Depth vs. Porosity and Depth vs. Percent LOI & TOC for VC-3

VC−3 Milwaukee River

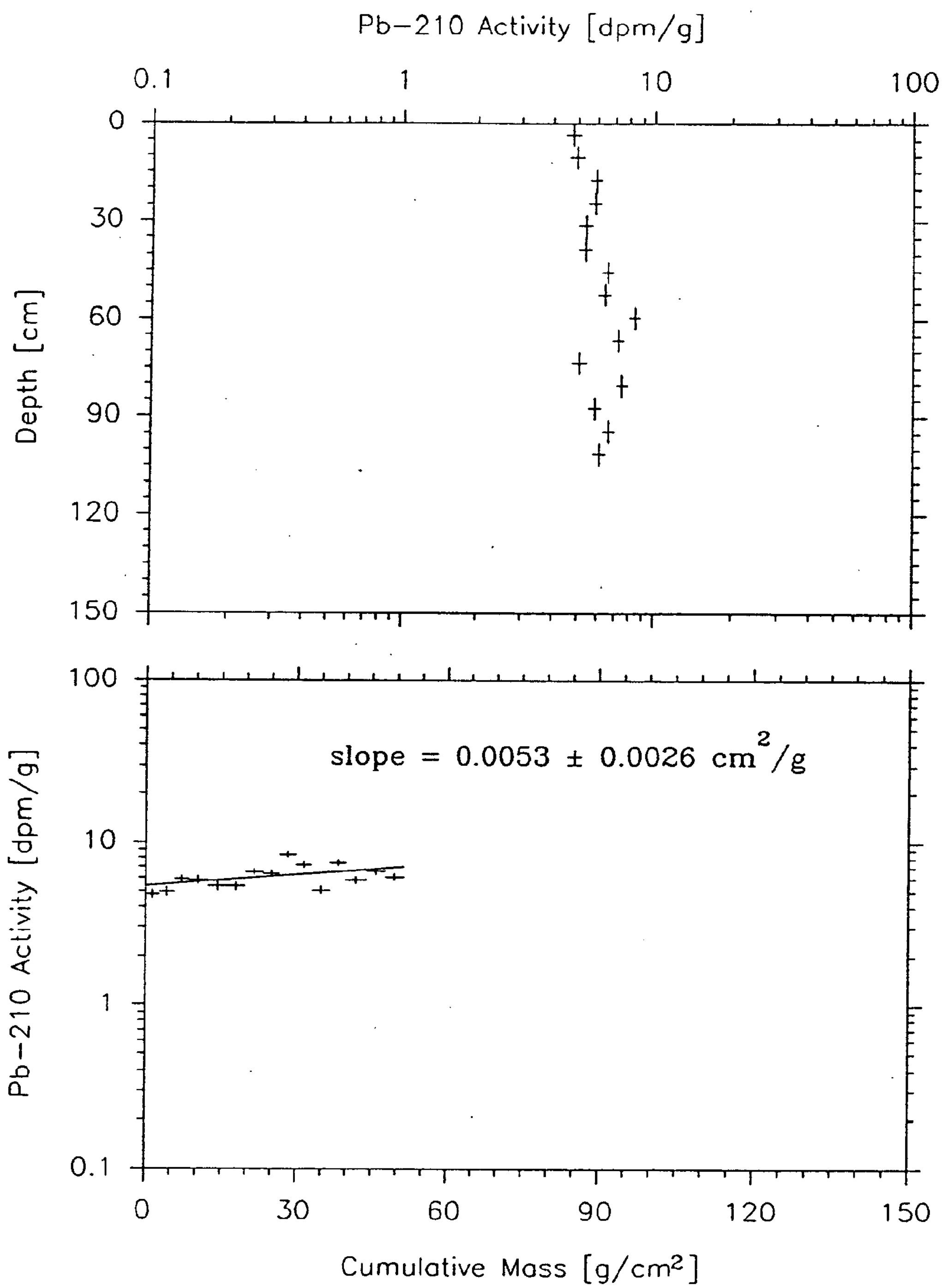


Fig. B42 Depth vs. Pb−210 activity and Pb−210 activity vs. Cummulative mass for VC−3

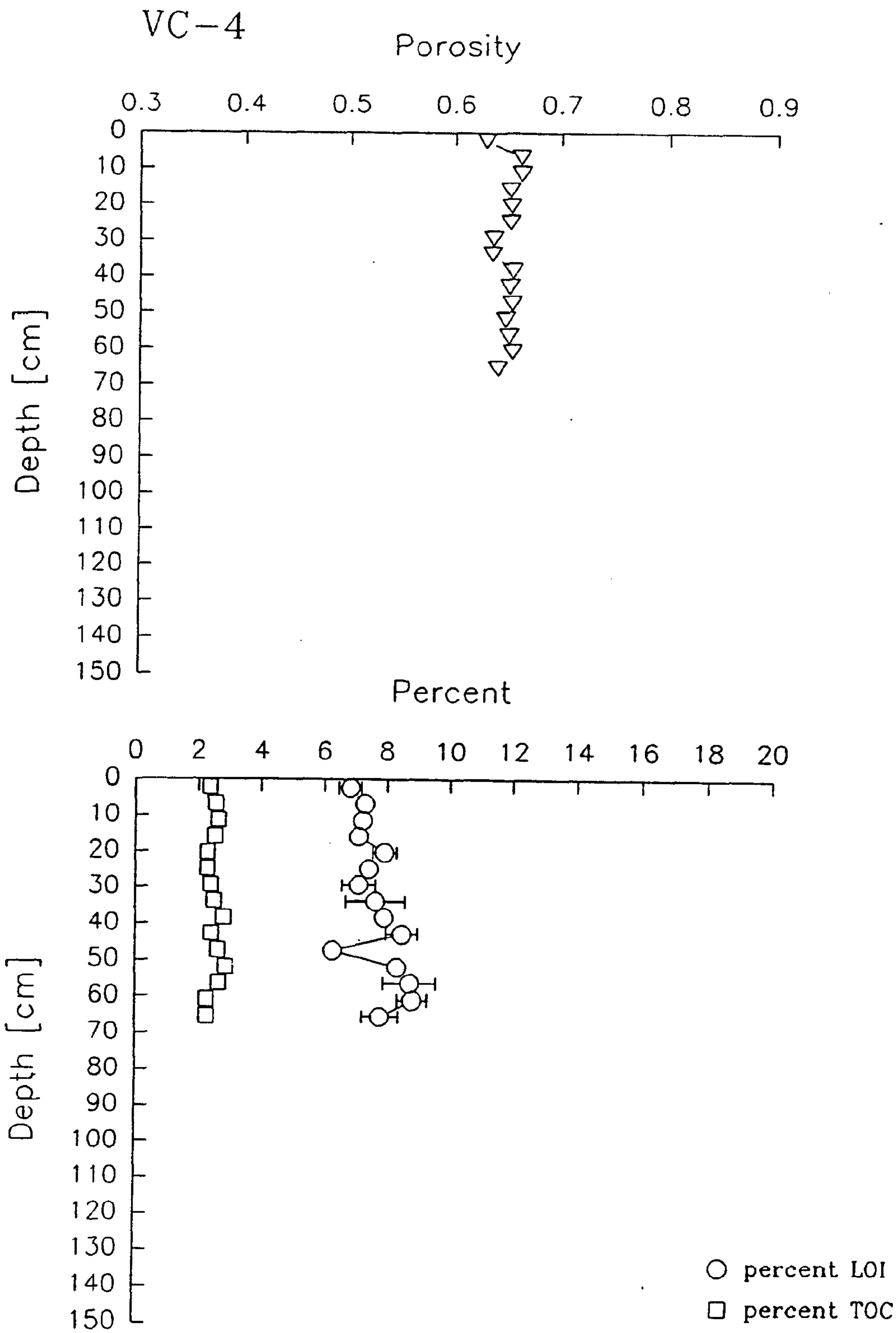


Fig. B43 Depth vs. Porosity and Depth vs. Percent LOI & TOC for VC-4

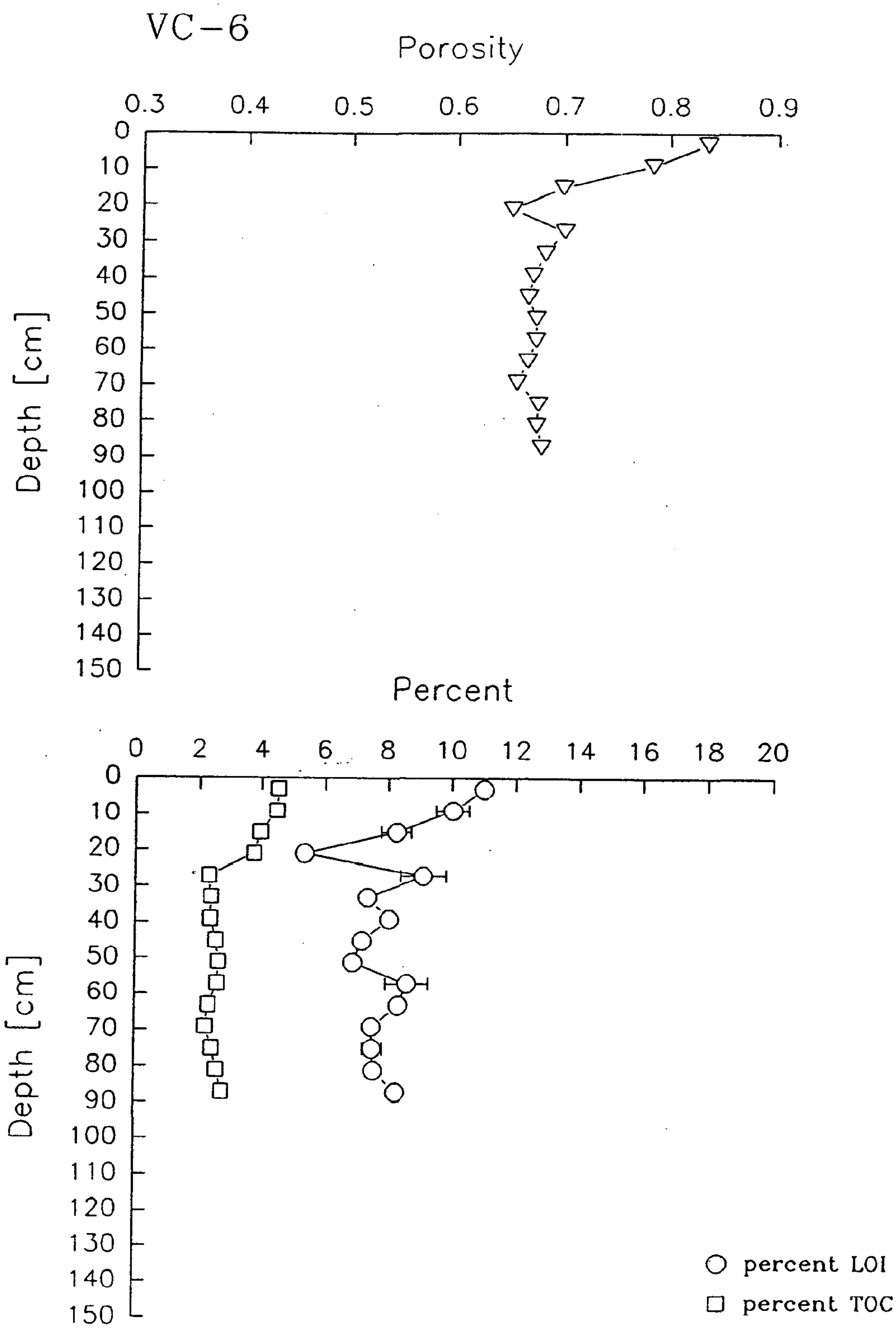


Fig. B44 Depth vs. Porosity and Depth vs. Percent LOI & TOC for VC-6

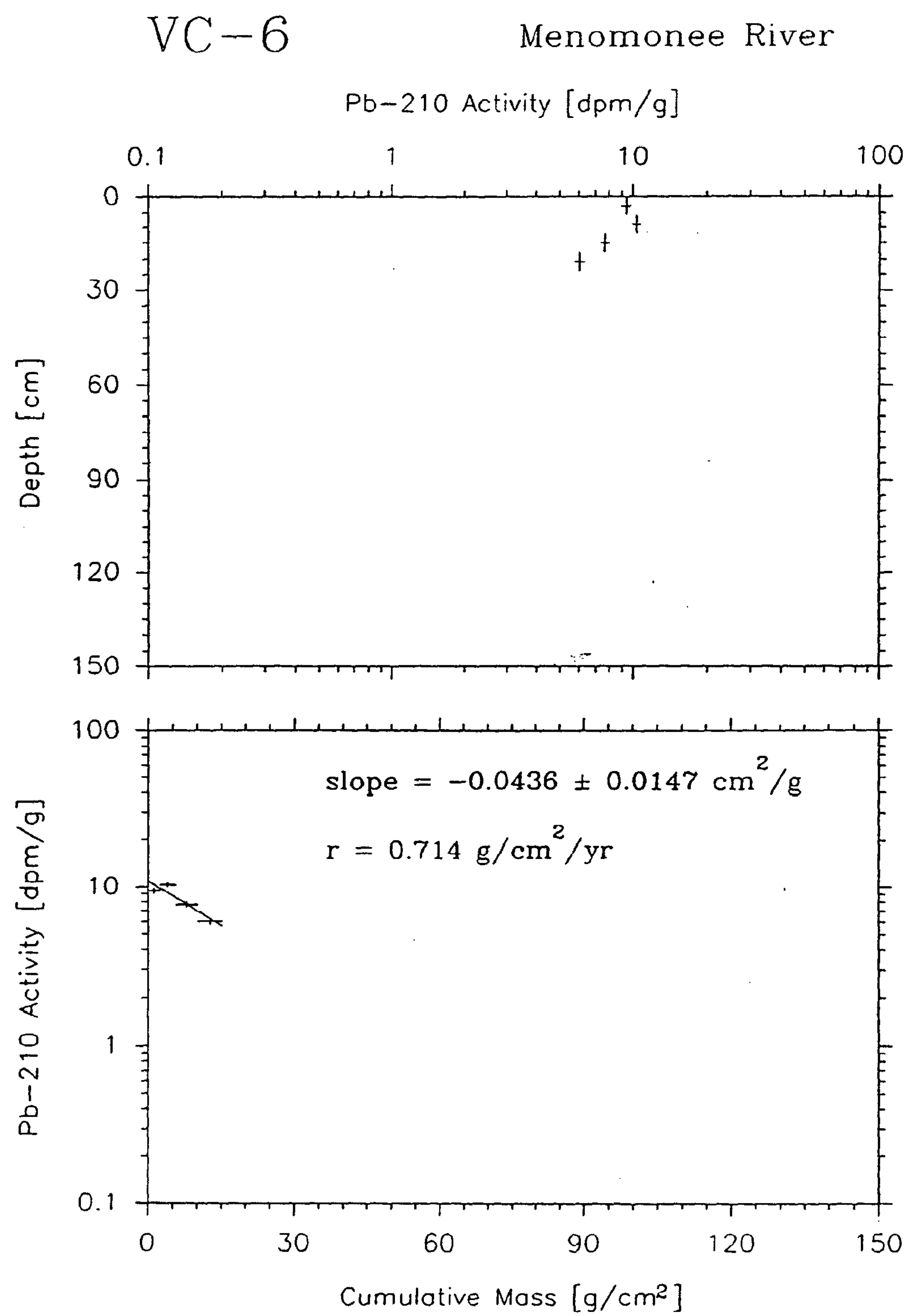
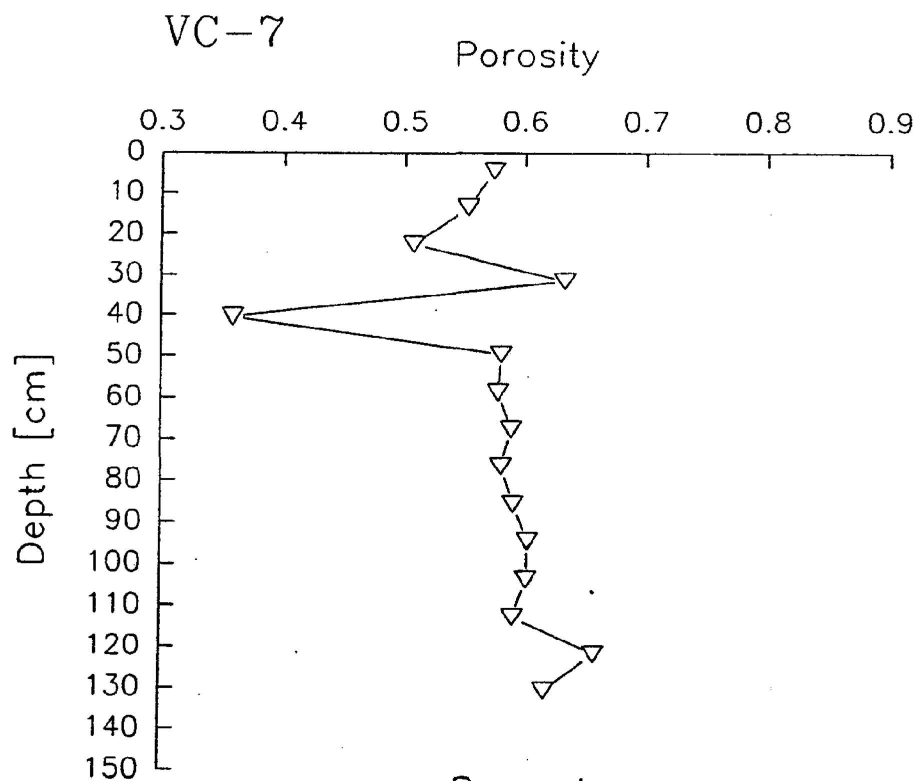


Fig. B45 Depth vs. Pb−210 activity and
Pb−210 activity vs. Cummulative mass
for VC−6



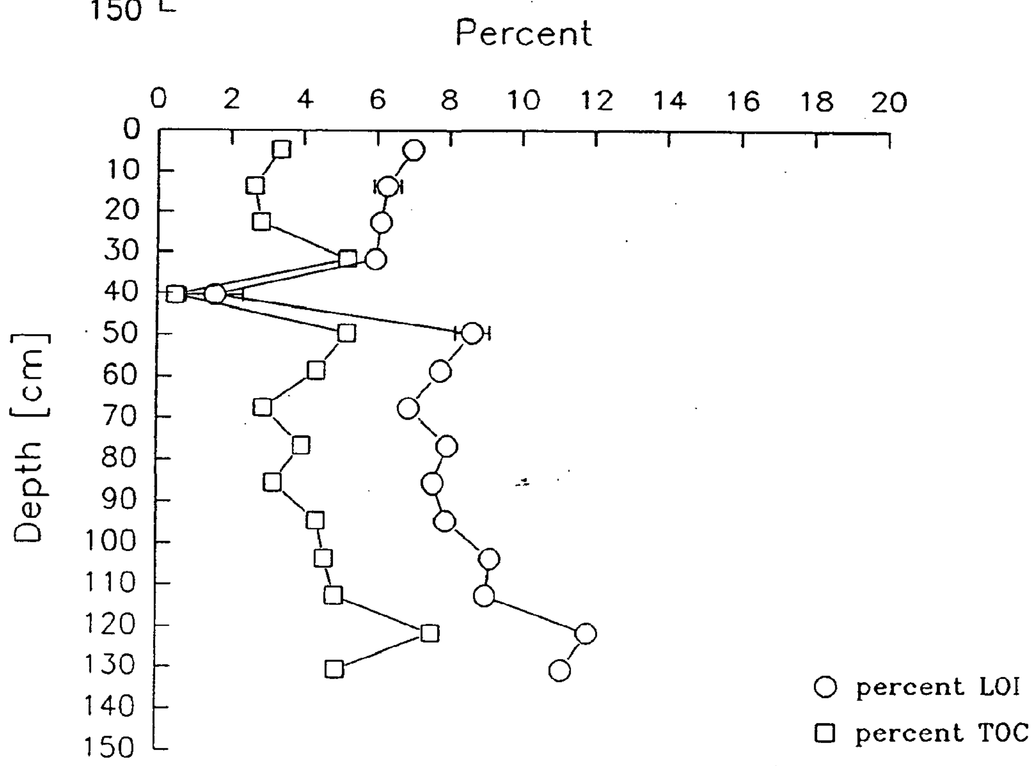


Fig. B46 Depth vs. Porosity and Depth vs. Percent LOI & TOC for VC-7

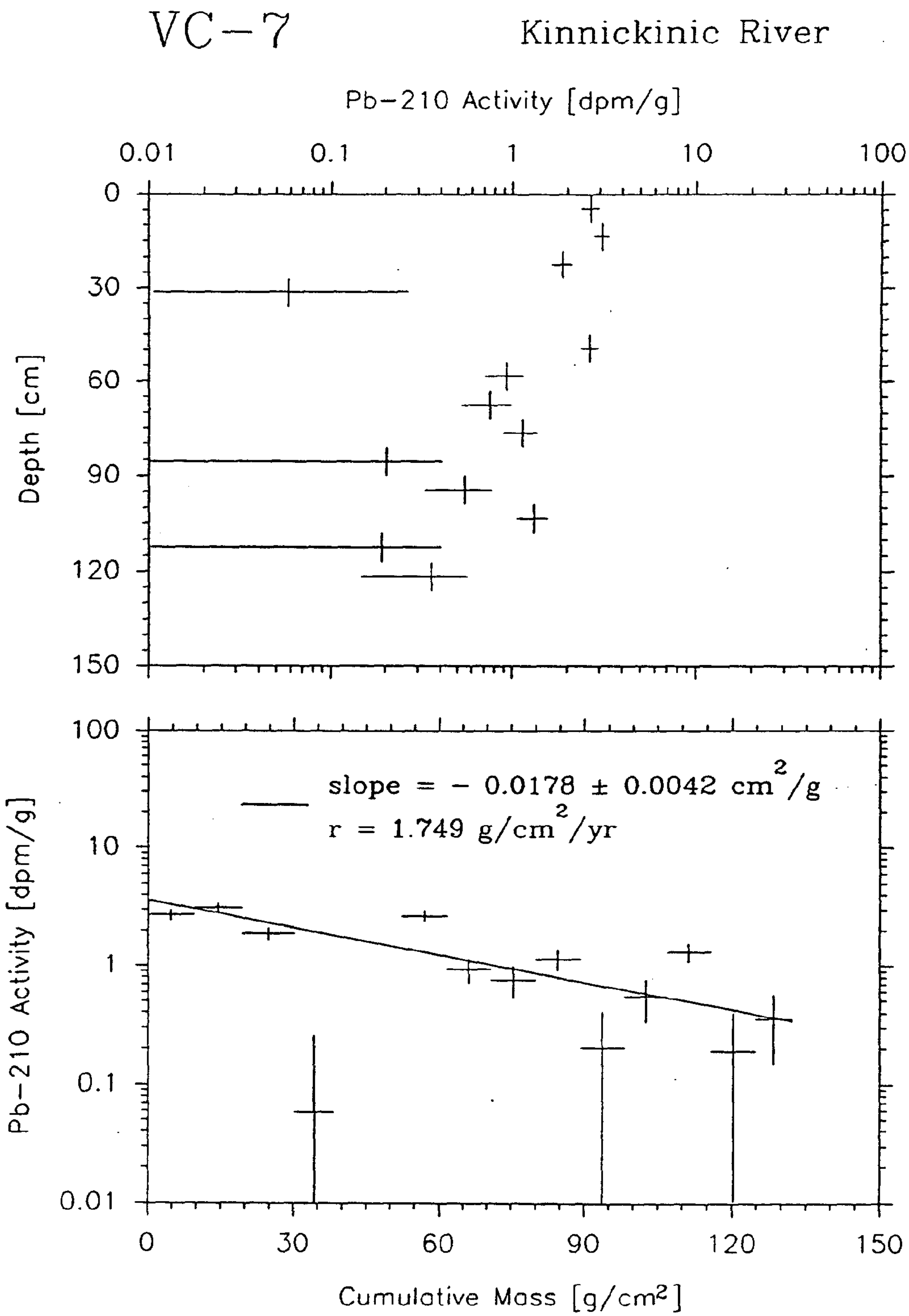


Fig. B47 Depth vs. Pb-210 Activity and
Pb-210 Activity vs. Cummulative mass
for VC-7

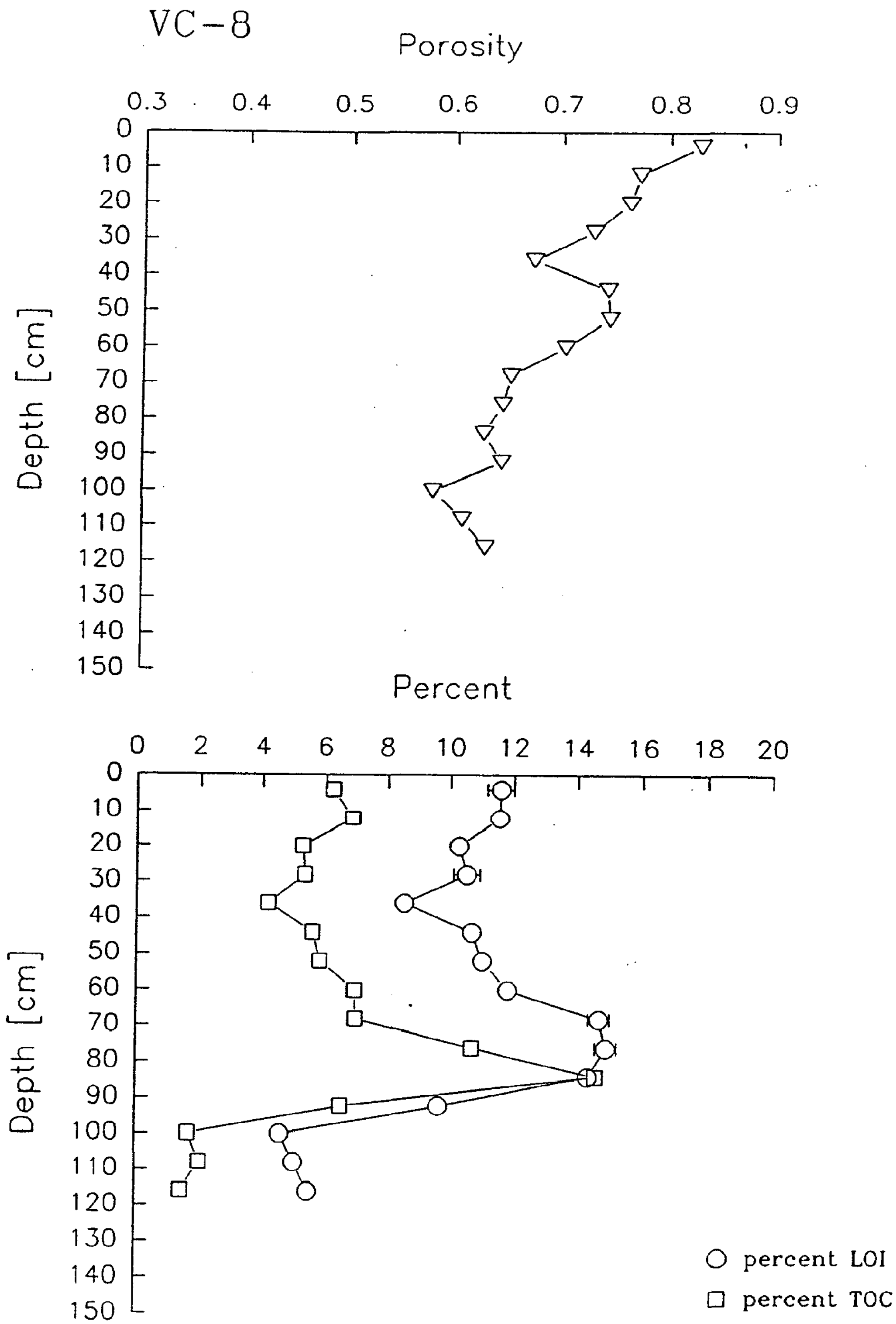


Fig. B48 Depth vs. Porosity and Depth vs. Percent LOI & TOC for VC-8

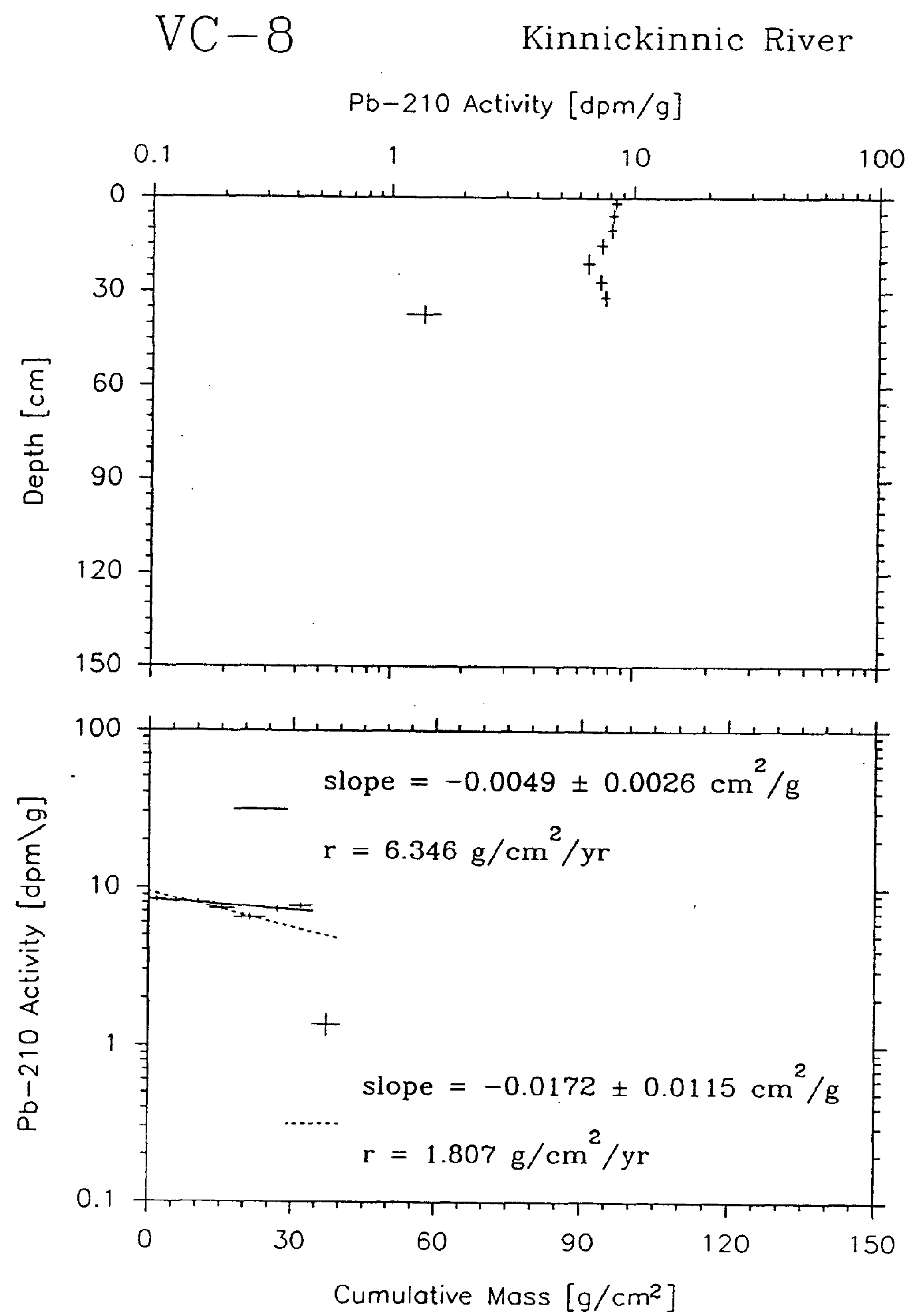


Fig. B49 Depth vs. Pb-210 Activity and
Pb-210 Activity vs. Cummulative mass
for VC-8

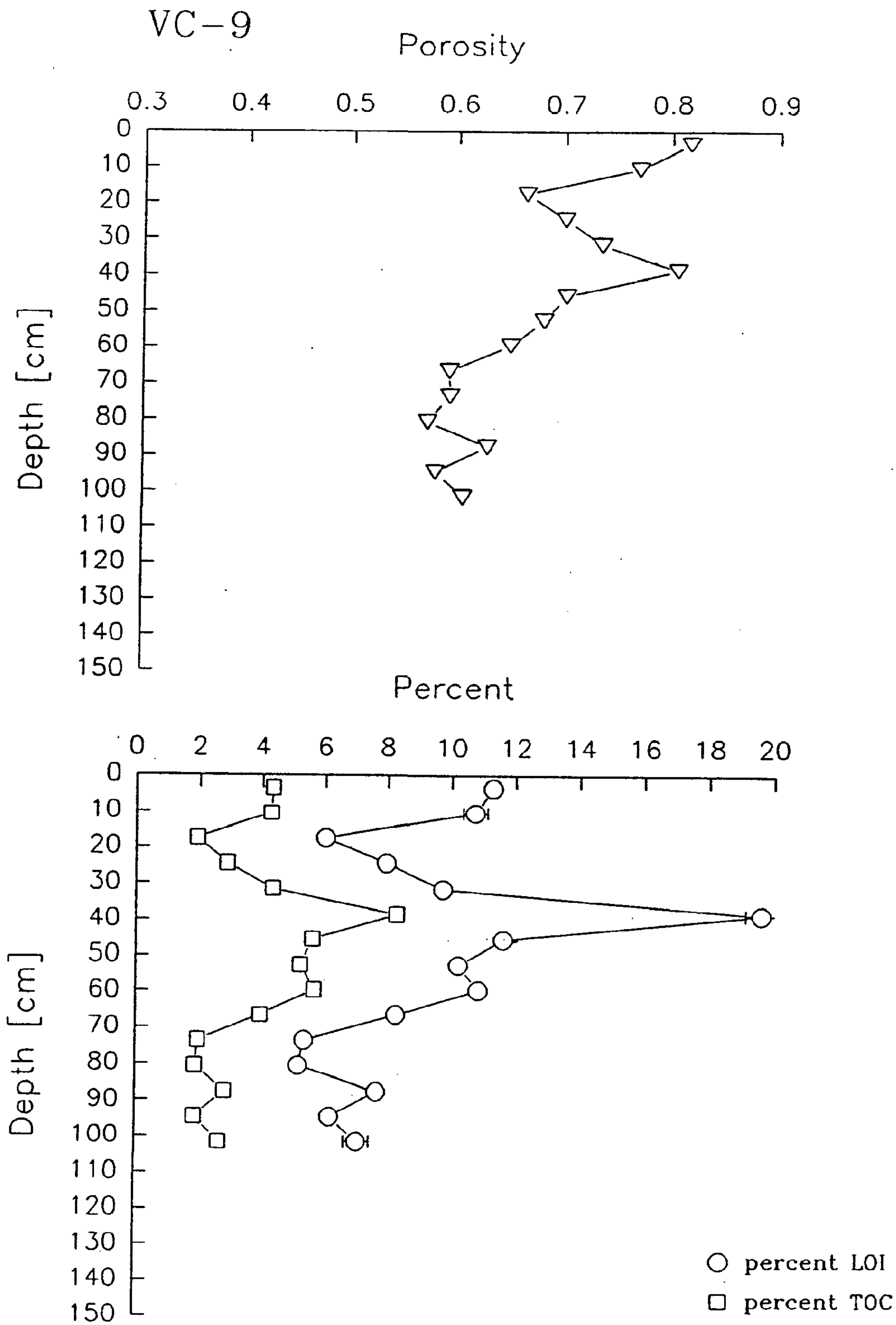


Fig. B50 Depth vs. Porosity and Depth vs. Percent LOI & TOC for VC-9

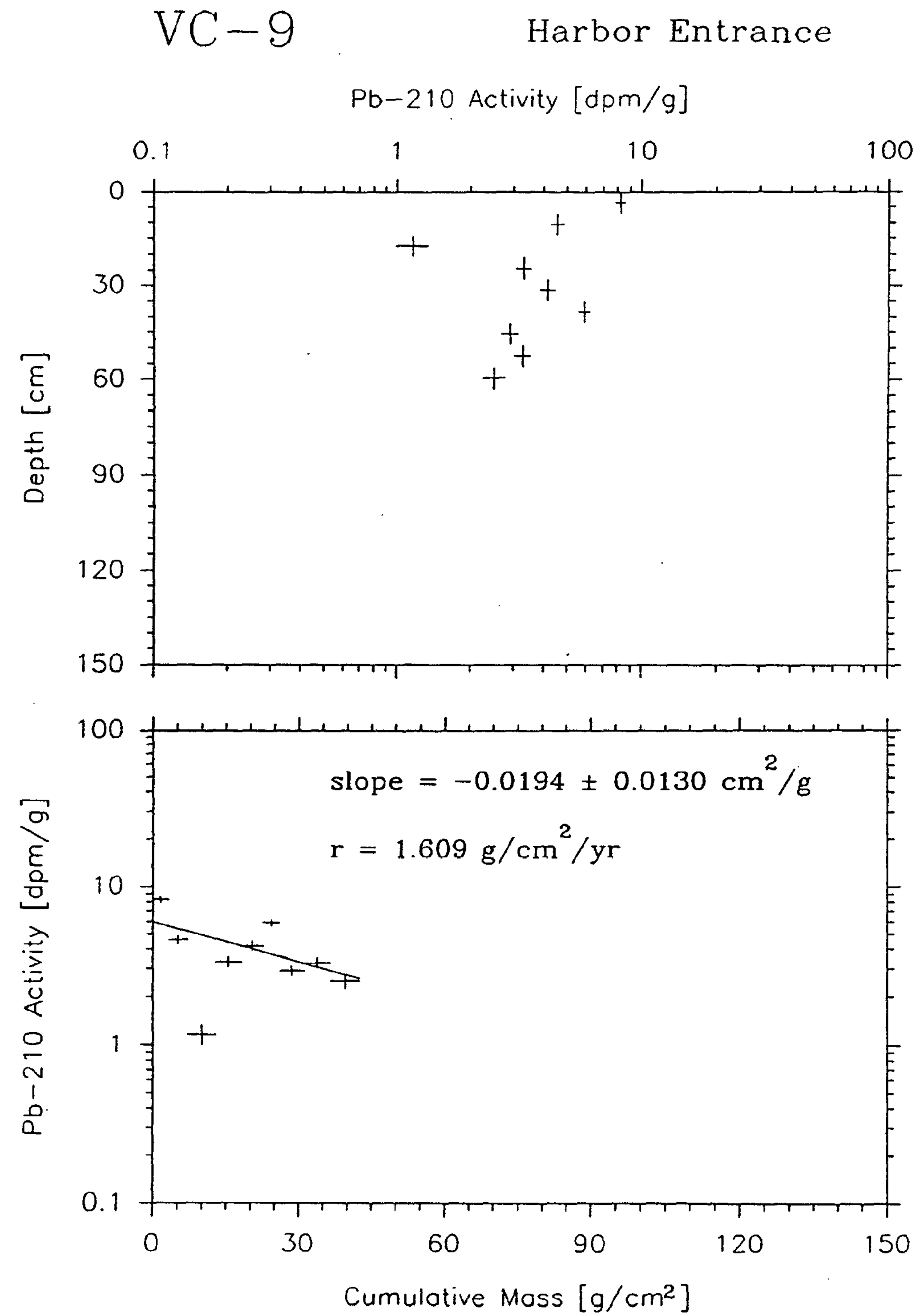


Fig. B51 Depth vs. Pb−210 activity and
Pb−210 activity vs. Cummulative mass
for VC−9

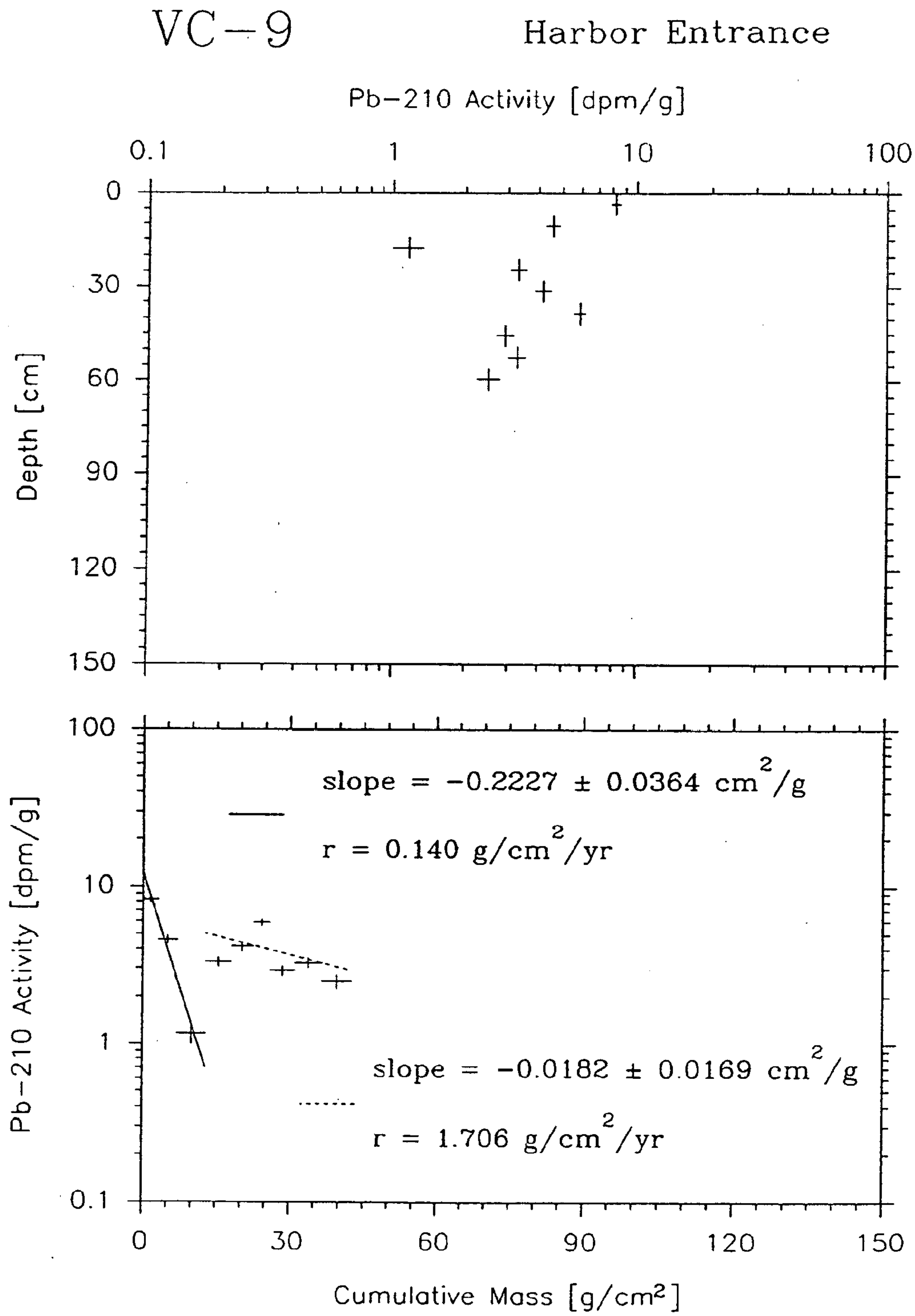


Fig. B52 Depth vs. Pb−210 activity and Pb−210 activity vs. Cummulative mass for VC−9

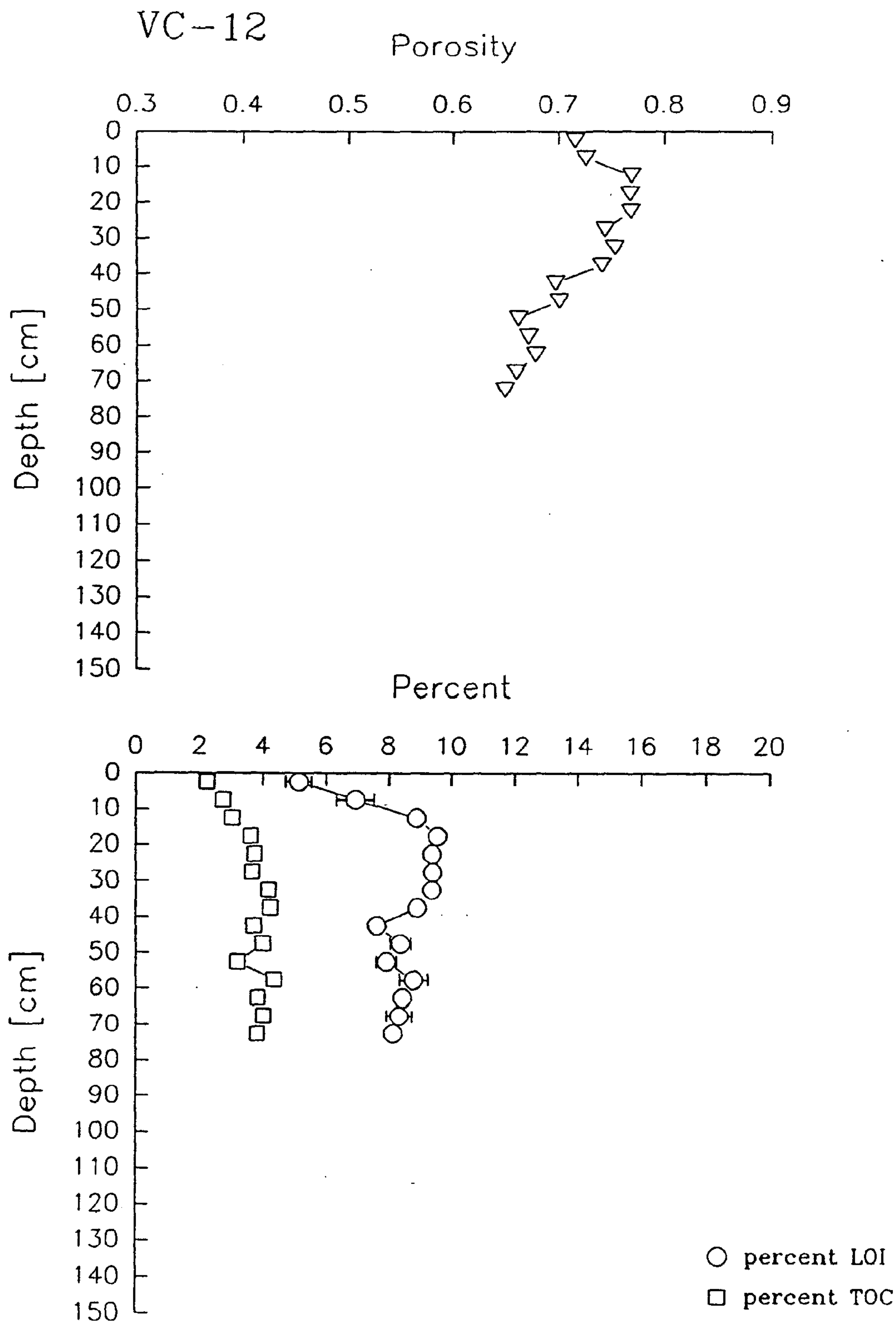


Fig. B53 Depth vs. Porosity and Depth vs. Percent LOI & TOC for VC-12

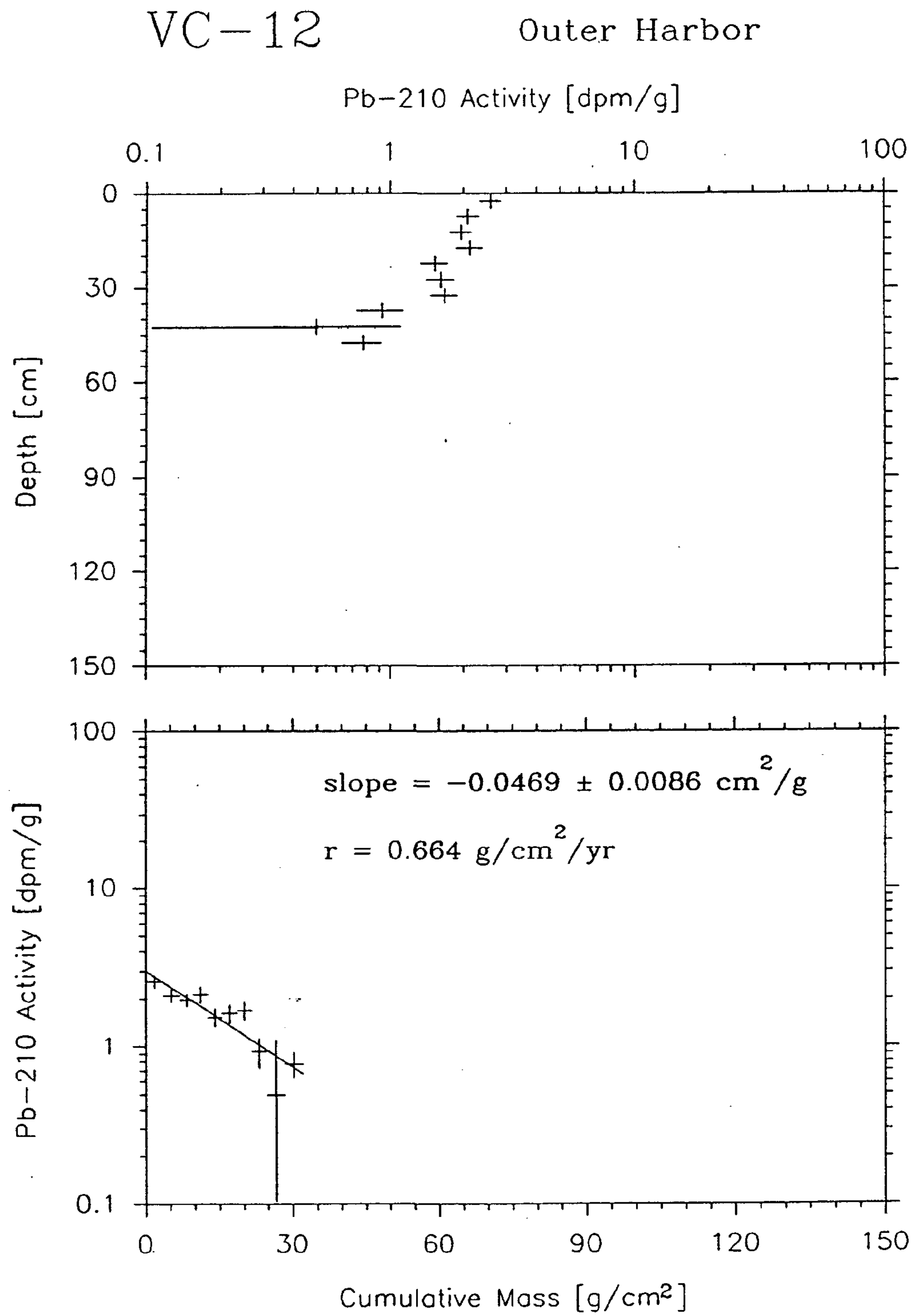


Fig. B54 Depth vs. Pb−210 activity and Pb−210 activity vs. Cummulative mass for VC−12

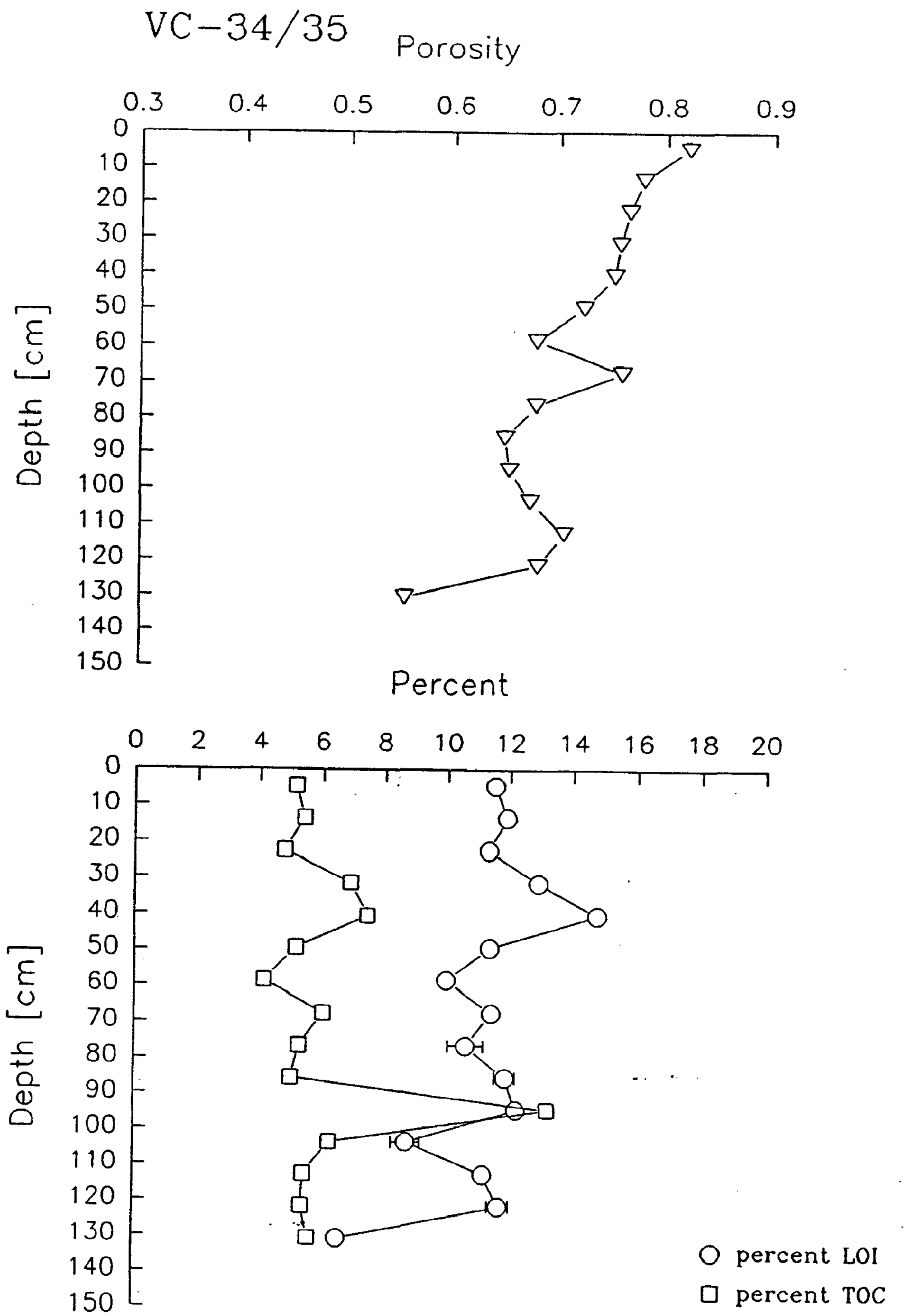


Fig. B55 Depth vs. Porosity and Depth vs. Percent LOI & TOC for VC-34/35

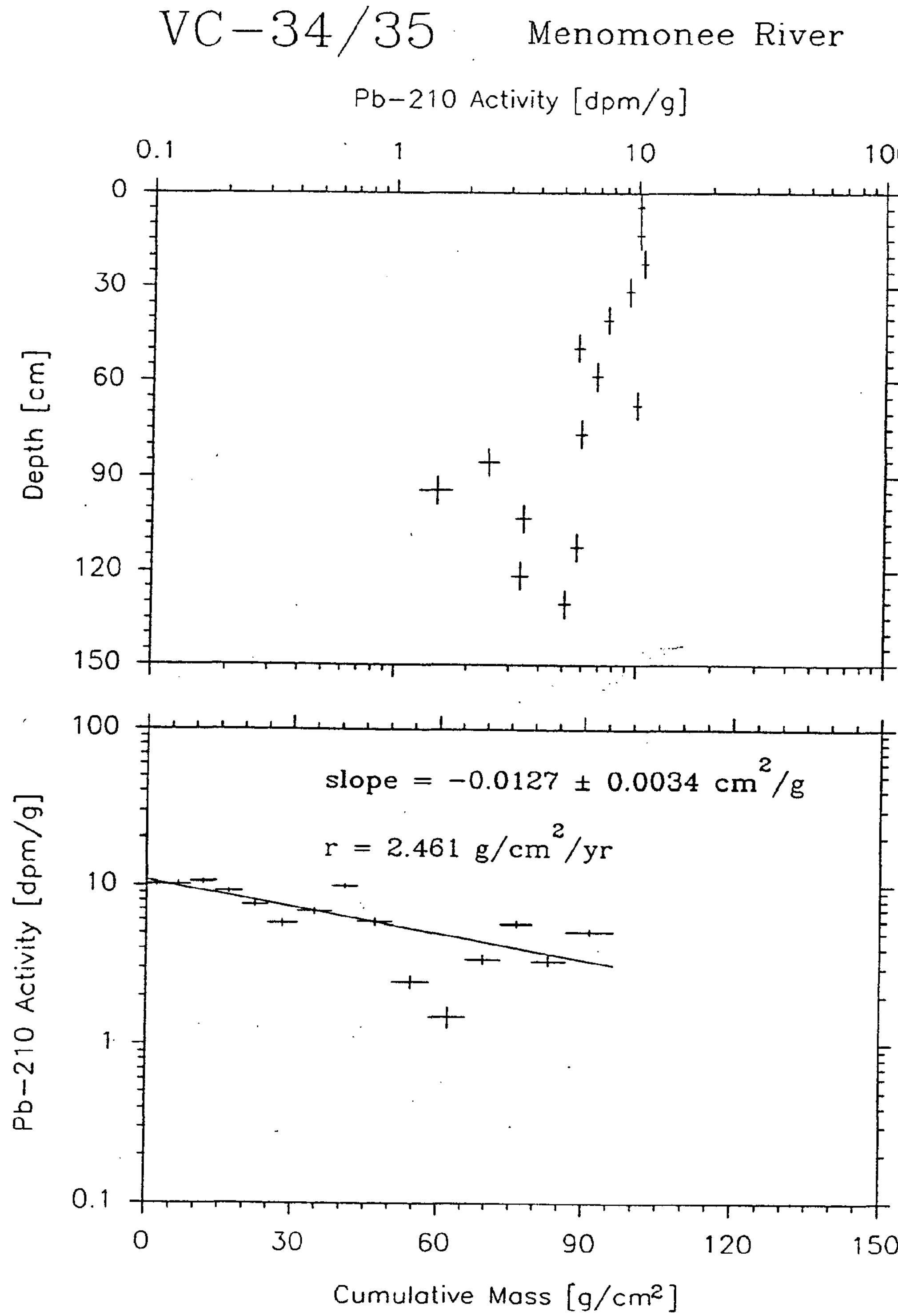


Fig. B56 Depth vs. Pb-210 activity and Pb-210 activity vs. Cummulative mass for VC-34/35

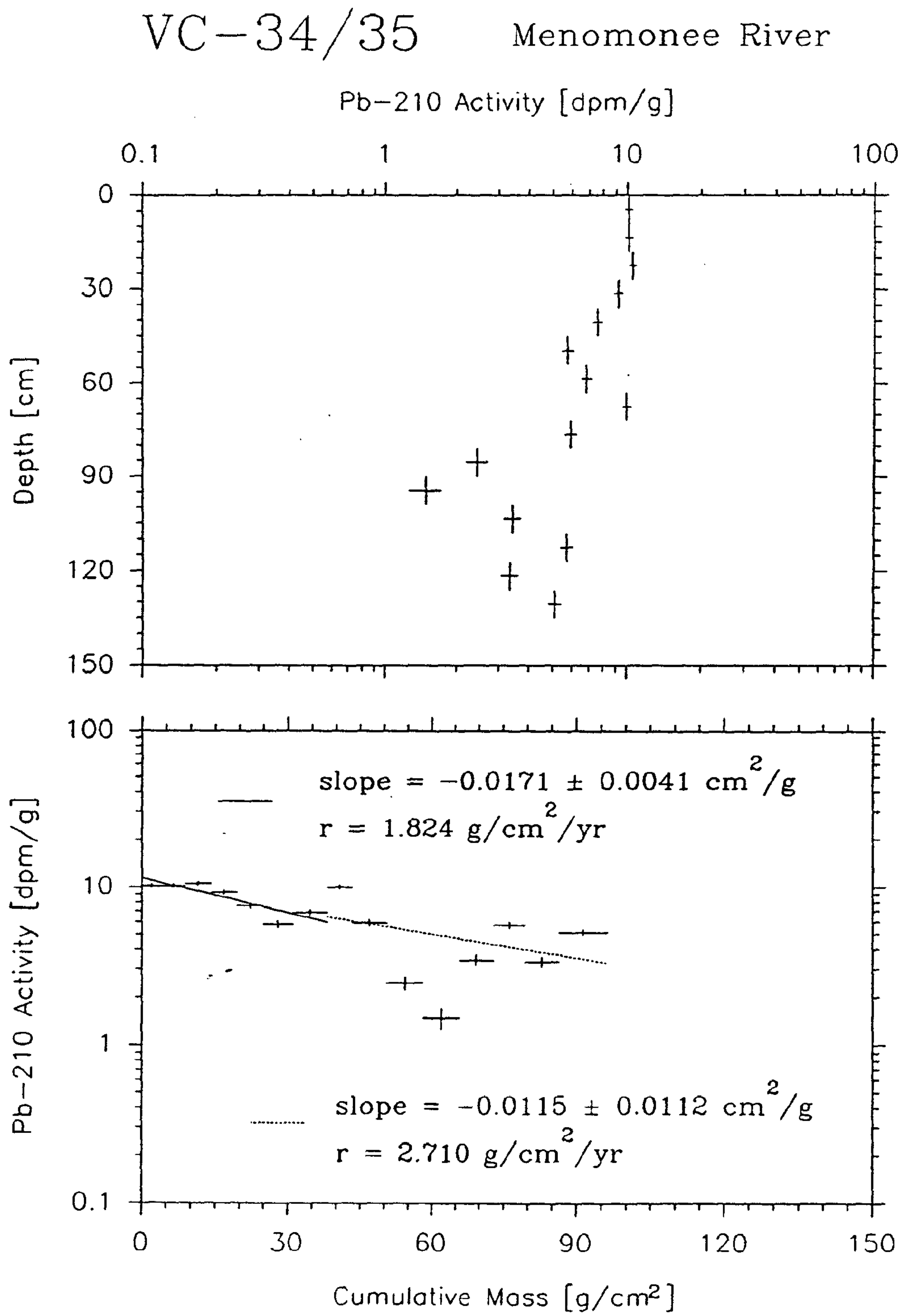


Fig. B57 Depth vs. Pb-210 activity and Pb-210 activity vs. Cummulative mass for VC-34/35

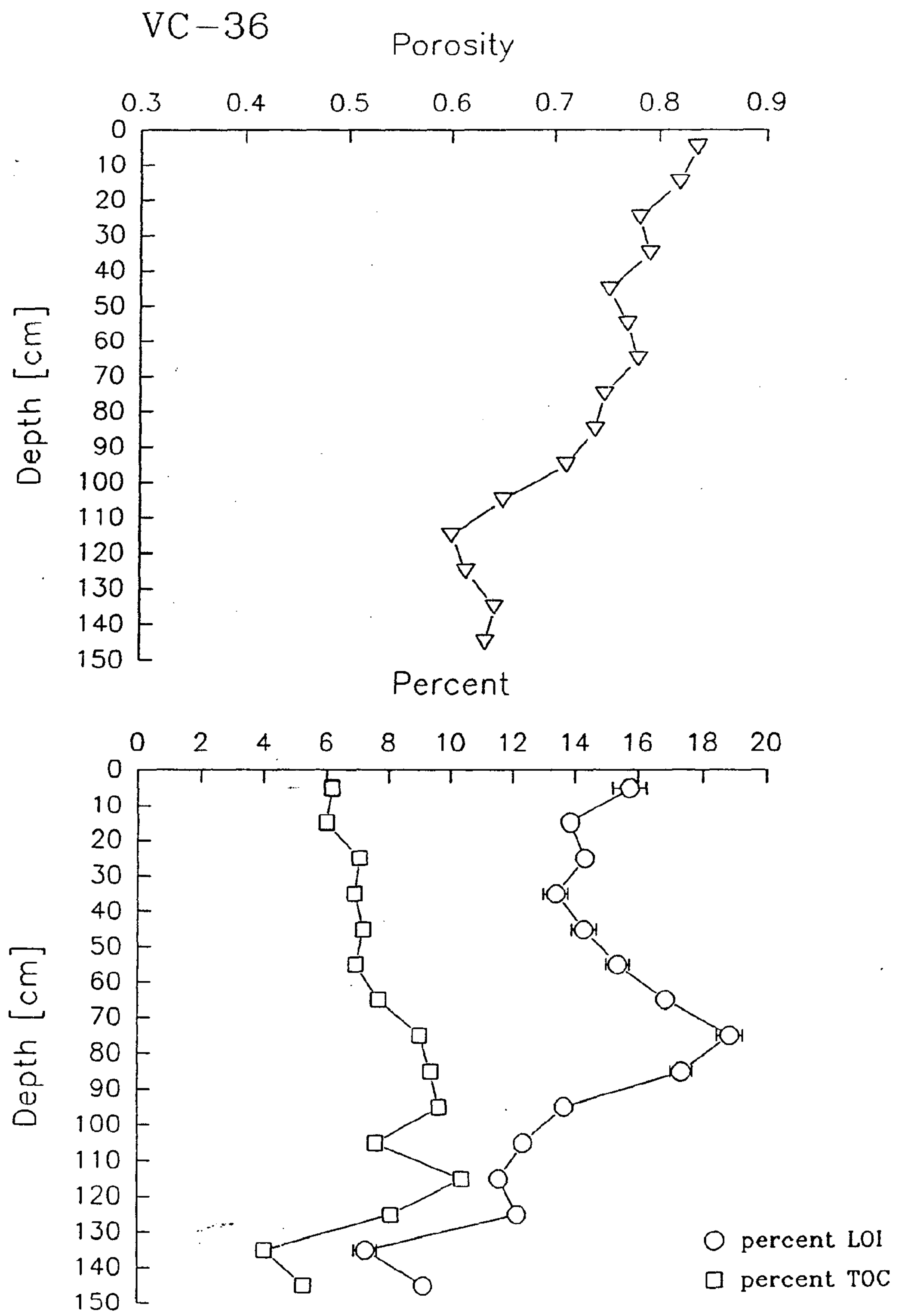


Fig. B58 Depth vs. Porosity and Depth vs. Percent LOI & TOC for VC-36

VC−36 South Menomonee Canal

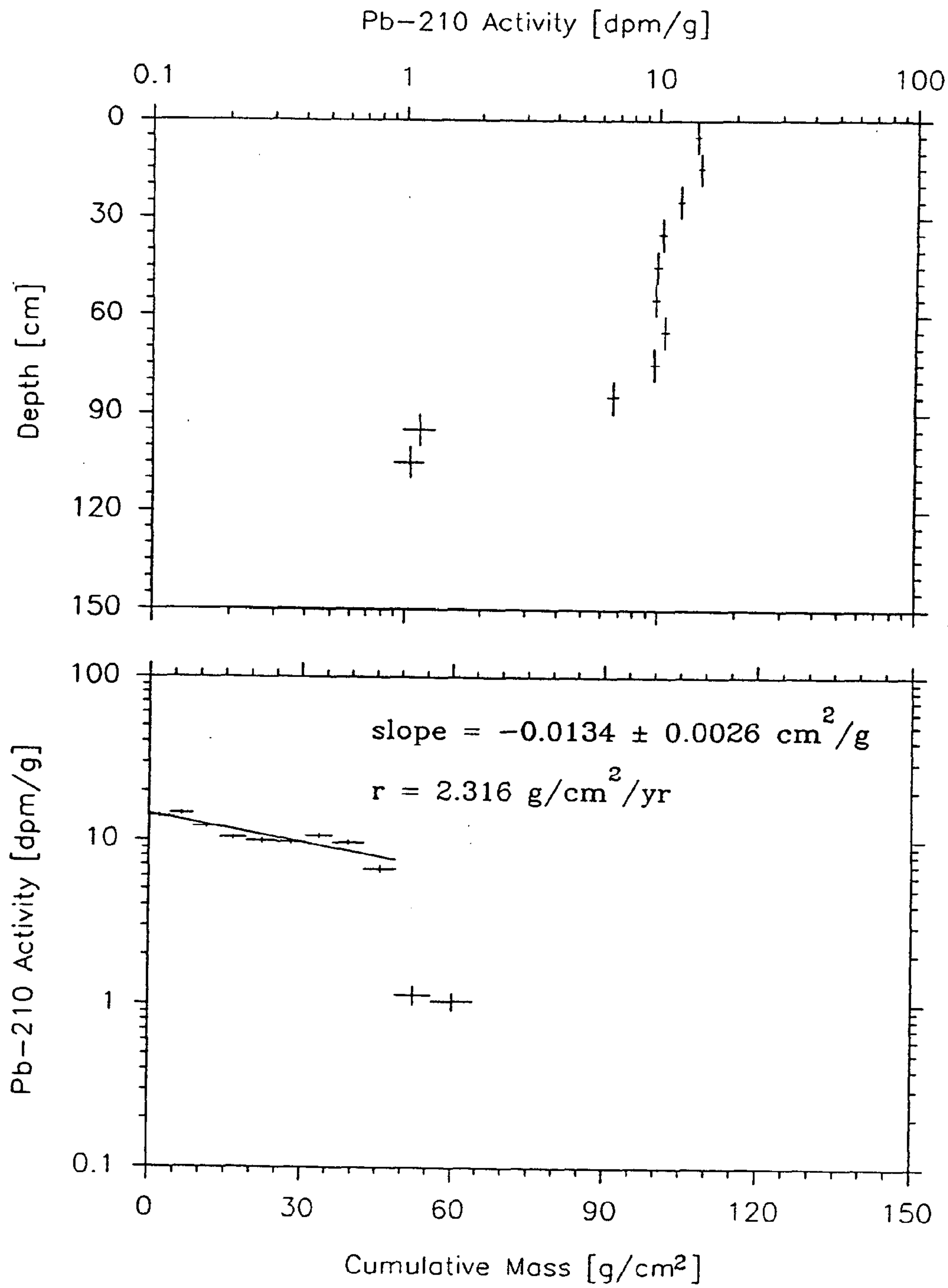


Fig. B59 Depth vs. Pb−210 activity and
Pb−210 activity vs. Cummulative mass
for VC−36

Appendix C

Computer Program for Calculating Slope and Sedimentation Rates

```
c     The program calculates sedimentation rate(r)
c     The data file contain the corename in the 1st line
c     number of data pairs in 2nd line
c     and finally the activity(s) and cumulative mass in the
c     following line

      dimension s(100),cumass(100)
      character core*30

      plamda=0.0311387
      sw=0.0
      swmlns=0.0
      swlns=0.0
      swm=0.0
      swmm=0.0
      swline=0.0

      read(5,20) core
      read*,n
      print 26
      do 8 i=1,n
        read*,s(i),cumass(i)
          write(6,9) s(i),cumass(i)
            sw=sw+s(i)
              swmlns=swmlns+(s(i)*cumass(i)*log(s(i)-2.92))
            swlns=swlns+(s(i)*log(s(i)-2.92))
          swm=swm+(s(i)*cumass(i))
        swmm=swmm+(s(i)*cumass(i)**2)
8     continue

      a=((sw*swmlns)-(swm*swlns))/((sw*swmm)-(swm)**2)
      b=((swlns*swmm)-(swm*swmlns))/((sw*swmm)-(swm)**2 )

      do 10 i=1,n
          swline=swline+(s(i)*(log(s(i)-2.92)-(a*cumass(i)+b))**2)
10    continue

      delta=sqrt(((sw*swline)/((n-2)*((sw*swmm)-swm**2))))
      rp=-plamda/(a+delta)
      rn=-plamda/(a-delta)
       r = -plamda/a

       print*,'***********************************************************'
       print 25,core
       print 21,a
       print 23,delta
       print 22,exp(b)
       print 24,rp,rn
       print 27,r

9      format(2f10.3)
20     format(a30)
21     format(14x,'SLOPE',1x,'=',1x,f10.4)
22     format(15x,'LnSo',1x,'=',1x,f10.3)
23     format(8x,'DELTA SLOPE',1x,'=',1x,f10.4)
24     format(1x,'SEDIMENTATION RATE',1x,'=',1x,f10.3,2x,'OR',1x,f10.3)
25     format(/11x,'CORENAME',1x,':',1x,a30)
26     format(6x,'S',7x,'cumass')
27     format(1x,'SEDIMENTATION RATE',1x,'=',1x,f10.3)

      print*,'sw', sw
      print*,'swlns', swlns
      print*,'swm',swm
      print*,'swmlns',swmlns
      print*,'swmm',swmm
      print*,'swline',swline
      end
```