CHAPTER IV

RESULTS

4.1 Recovery test on the preconcentration techniques

4.1.1 Co-precipitation of As with $Fe(OH)_3$

The influence on the co-precipitation yield of As by acidity, Fe^{3+} concentration, the sample volume, As-concentration and the stirring time was respectively presented in table 4.1–4.5 as well as figure 4.1–4.5.

The optimum conditions were thus obtained as following :-

The pH Value : 4 – 9

Fe^{3+} concentration : $\geqslant$ 20 mg./l.

Volume of sample : $\leqslant$ 100 ml.

As concentration : $\leqslant$ 50 µg.As/l.

The stirring time : $\geqslant$ 2 minutes.

4.1.2 Adsorption of APDC-chelates of Co, Cd, Cr(VI), Mo, Sb, W, Zn, and Hg on activated charcoal

The influence on the adsorption yield of APDC-chelates of these elements by the acidity, APDC-concentration, amount of activated charcoal, the sample volume, the stirring time and the salinity of sample was respectively shown in table 4.6–4.11 as well as in figure 4.6–4.26. The optimum conditions were thus obtained as shown in table 4.12.

Table 4.12 Optimum condition on adsorption of Metal-APDC chelates on activated charcoal.

Element	pH	APDC (mg./l.)	Charcoal (mg.)	Volume (ml.)	Stirring time (min.)	Salinity %.
Co	4–9	20	$\geq$ 5	100–500	no effect	no effect
Cd	6.5–8.5	30	$>$ 5	100–500	no effect	no effect
Cr(VI)	2–3	40	$\geq$ 40	varied	$\geq$ 20	varied
Mo	1–4	20	$\geq$ 20	100–500	no effect	no effect
Sb	0.75–1.25	100	$\geq$ 20	100–500	no effect	no effect
Zn	7.5–8	20	$\leq$ 10	100–500	$\leq$ 20	no effect
Hg	0.5–2	10	$\geq$ 20	100–500	no effect	no effect
W	1–2	20	$\geq$ 20	100–500	$\geq$ 30	no effect

According to the optimum values obtained, the group elemental APDC chelates could be performed as following :-

a) Co, Cd, and Zn at pH 7.5

b) Sb, W, Mo, and Hg at pH $\leq$ 1.0

c) Cr(VI) at pH 2.5

4.1.3 Adsorption of elemental Se on activated charcoal

The influence on the adsorption yield of selenium by acidity, concentration of L-ascorbic acid, amount of activated charcoal, reaction time of reduction of selenite to elemental selenium, the sample volume and salinity was respectively indicated in table 4.13-

4.18 as well as in figure 4.27-4.30. The optimum conditions were thus obtained as following

The pH value	: 2-2.75
Concentration of L-ascorbic acid	: $\geqslant$ 1 mg./ml.
amount of activated charcoal	: $\geqslant$ 75 mg.
the reaction time	: $\geqslant$ 7 min.
the sample volume	: up to 500 ml.
the salinity	: no effect.

4.2 Recovery test on the chemical seperation

4.2.1 Adsorption of ^{76}As on acid Al_2O_3

The recovery yield up to 98.0$\pm$6 % could be obtained according to the data presented in table 4.19.

4.2.2 Seperation of ^{197}Hg from ^{82}Br interference

The recovery yield obtained from the analysis of a Standard Reference Material "Lake Sediment SL-1" as shown in table 4.20 was satisfactory comparison with the recommended value.

4.3 The Riliability test on the developed techniques

The results on the analysis of a biological Standard Reference Material "Orchard leaves SRM 1571" using the developed techniques, as shown in table 4.21 was in agreement with the certified values.

4.4 Some application of the developed techniques

4.4.1 The determination of As in tap- canal- and sea-water

The arsenic contant in tap- canal- and sea-water was shown in table 4.22.

4.4.2 Leaching behaviour of some trace elements from an alkaline ash in contact with sea water

Table 4.23 indicated the trace elements concentration found in sea water where as table 4.24 described the physical property and chemical property as determined by INAA of the ash [23].

Table 4.25 and 4.26 presented the percentage leaching of the ash in sea water and fresh water respectively. The acidity of the leachates was indicated in table 4.27 and also in fig. 4.31.

The leaching behaviour of As, Sb, Se and Mo in sea water as compare with in fresh water was presented in fig. 4.32-4.35 respectively.

4.4.3 The determination of some trace elements in water and related samples from the Western Scheldt estuary.

Table 4.28 presented some physical properties of the water in the estuary at various places as mentioned in fig. 3.6.

The concentration of As, Sb, W and Mo in water samples, fractionated particulate matter and sediment at various sampling stations was shown in table 4.29-4.31 respectively.

Additionally, fig. 4.36 and 4.37 showed the relation between the salinity of the water with acidity and oxygen content. Fig. 4.38–4.41 presented the distribution of dissolved As, Sb, Mo and W in relation with the salinity respectively.

The photographs of the four size-fractions of particulate matter obtained by centrifugation was presented in Fig.4.42.

Fig. 4.43–4.44 showed the distribution of As and Sb in fore size fractionated particulate matter as well as in sediment in relation to the salinity.

Table 4.1 The influence of acidity on the co-precipitation of As with $Fe(OH)_3$.

pH	Count	% Recovery	Standard
2	3340	8.0	40585
3	20929	50.1	42850
4	40229	96.3	41892
5	40565	97.1	$\bar{X}=41775\pm928$
6	41023	98.2	
7	41070	98.3	
8	41150	98.5	
9	40942	98.0	

Table 4.2 The influence of Fe^{3+} concentration on the co-precipitation of As with $Fe(OH)_3$.

Concentration of Fe^{3+} (mg./l.)	counts	% Recovery	Standard ($\overline{X}\pm SD$)
4	20260	48.5	
8	29327	70.2	
10	31754	76.0	
16	38851	93.0	
20	40730	97.5	41775$\pm$928
40	40965	98.1	
60	41072	98.3	

Table 4.3 The influence of the sample-volume on the co-precipitation of As with $Fe(OH)_3$.

Volume of sample (ml.)	counts	% Recovery	Standard ($\overline{X}\pm SD$)
50	41092	98.3	
100	41330	98.9	
150	37723	93.3	
200	27571	66.0	
300	16932	40.5	41775$\pm$298

Table 4.4 The influence of the As-concentration on the co-precipitation of As with $Fe(OH)_3$.

Concentration of As (µg./l.)	counts	% Recovery	Standard ($\overline{X} \pm SD$)
10	41232	98.7	
50	41092	98.3	
75	32751	78.4	41775±298
100	22433	53.7	
150	8856	21.2	

Table 4.5 The influence of the stirring-time on the co-precipitation of As with $Fe(OH)_3$.

Stirring time (min.)	counts	% Recovery	Standard ($\overline{X} \pm SD$)
0	39812	95.3	
2	40688	97.4	
4	40772	97.6	41775±298
6	41023	98.2	
8	40731	97.5	
10	41107	98.4	

Table 4.6 The influence of acidity on the recovery of Metal-APDC chelates by activated charcoal.

Nuclide	Activity of standard (counts)		Activity (counts) and % Recovery							
			The pH Value							
	X	($\bar{X} \pm SD$)	1	2	3	4	5	6	7	8
^{197}Hg	22847 22286 22450	22527±288	22121 98.2 %	21851 97.0 %	19395 86.1 %	17728 78.7 %				
$^{115}Cd(^{115m}In)$	20375 20400 20174	20316±123			7395 36.4 %	11580 57.0 %	16151 79.5 %	18690 92.0 %	19767 97.3 %	19706 97.0 %
^{60}Co	33135 33175 33459	33256±176		15730 47.3 %	27070 81.4 %	32358 97.3 %		32724 98.4 %		32591 98.0 %
^{65}Zn	24903 24747 24961	24870±111			1120 4.5 %	3556 14.3 %	6839 27.5 %	12683 51.0 %	21661 87.1 %	24198 97.3 %
^{51}Cr	22947 22701 22805	22818±123	10838 47.5 %	19486 85.4 %	18254 80.0 %	13941 61.1 %	8784 38.5 %	3263 14.3 %	844 3.7 %	
$^{99}Mo(^{99m}Tc)$	18732 18229 18529	18503±243	17633 95.3 %	17892 96.7 %	17577 95.0 %	17207 93.2 %	11934 64.5 %	241 1.3 %		
^{187}W	14192 14471 14250	1430±147	13674 95.6 %	13216 92.4 %	11543 80.7 %	1359 9.5 %	300 2.1 %			
^{125}Sb	13012 13220 13055	13143±146	pH0.7 12893 98.1 %	pH0.9 13018 99.0 %	pH1.1 12056 91.7 %	pH1.3 11816 89.9 %	pH1.5 10144 77.2 %	pH1.7 7022 53.4 %		

Table 4.7 The influence of APDC-concentration on the recovery of Metal-APDC chelates by activated charcoal.

Nuclide	Activity of standard (counts)		Activity (counts) and % Recovery The Concentration of APDC (mg./l.)							
	X	($\bar{X} \pm SD$)	5	10	15	20	30	50	80	100
^{197}Hg	22847		20756	21918		22324		22189	22279	
	22286	22527 ± 288								
	22450		92.1 %	97.3 %		99.1 %		98.5 %	98.9 %	
$^{115}Cd(^{115m}In)$	20375		10848	16273			19828	19767		19909
	20400	20316 ± 123								
	20174		53.4 %	80.1 %			97.6 %	97.3 %		98.0 %
^{60}Co	33135		21117	32358	32690		32790			
	33175	33256 ± 176								
	33459		63.5 %	97.3 %	98.9 %		98.6 %			
^{65}Zn	24903		23974	23875			22955	22383		22283
	24746	24870 ± 111								
	24961		96.4 %	96.0 %			92.3 %	90.0 %		89.6 %
^{51}Cr	22947		14694	15995		17410	17912	18300	18094	
	22701	22818 ± 123								
	22805		64.4 %	70.1 %		76.3 %	78.5 %	80.2 %	79.3 %	
$^{99}Mo(^{99m}Tc)$	18732		17892	18169		18225		18022	18188	
	18247	18503 ± 243								
	18529		96.7 %	98.2 %		98.5 %		97.4 %	98.3 %	
^{187}W	14192		11743	12916		13517		13846	13889	
	14471	14304 ± 147								
	14250		82.1 %	90.3 %		94.5 %		96.8 %	97.1 %	
^{125}Sb	13012			5020		5927		7623	11920	12919
	13220	13143 ± 146								
	13055			38.2 %		45.1 %		58.0 %	90.7 %	98.3 %

Table 4.8 The influence of amount of charcoal on the recovery of Metal.APDC chelates.

Nuclide	Activity of standard (counts)		Activity (counts) and % Recovery The amount of activated charcoal (mg.)							
	X	($\bar{X}$±SD)	5	10	15	20	25	40	50	60
^{197}Hg	22847		20497	21501	21731	22017		22071		
	22286	22527±288								
	22450		90.9 %	95.4 %	96.5 %	97.8 %		97.9 %		
$^{115}Cd(^{115m}In)$	20375		19645	19808	19909	19970	19828			
	20400	20316±123								
	20174		96.7 %	97.5 %	98.0 %	98.3 %	97.6 %			
^{60}Co	33135		32424	32624	32823	32524	32690			
	33175	33256±176								
	33459		97.5 %	98.1 %	98.7 %	97.8 %	98.3 %			
^{65}Zn	24903		22706	24148	23228	20492	19075			
	24746	24870±111								
	24961		91.3 %	97.1 %	93.8 %	82.4 %	76.7 %			
^{51}Cr	22947		13987	16657		17889		19418		19326
	22701	22818±123								
	22805		61.3 %	73.0 %		78.4 %		85.1 %		84.7 %
$^{99}Mo(^{99m}Tc)$	18732		15579	16930		18096		18133		18188
	18247	18503±243								
	18529		84.2 %	91.5 %		97.8 %		98.0 %		98.3 %
^{187}W	14192		10056	12172		13360		13674		13918
	14471	14304±147								
	14250		70.3 %	85.1 %		93.4 %		95.6 %		97.3 %
$^{125}_{1}Sb$	13012		7675	9620		12631		12893	12709	
	13220	13143±146								
	13055		58.4 %	73.2 %		96.1 %		98.0 %	96.7 %	

Table 4.9 The influence of sample-volume on the recovery of Metal-APDC chelates by activated charcoal.

Nuclide	Activity of standard ($\bar{X} \pm SD$)	Activity (counts) and % Recovery The Volume of sample (ml.)				
		100	200	300	400	600
^{197}Hg	22527±288	22180 98.5 %	21918 97.3 %	21530 95.6 %	21081 93.6 %	20905 92.8 %
^{115}Cd	33256±123	19934 98.1 %	20011 98.5 %	19869 97.8 %	19760 97.3 %	19711 97.0 %
^{60}Co	33256±176	32358 97.3 %	32624 98.1 %	32457 97.6 %	32690 98.3 %	31591 95.0 %
^{65}Zn	24870±111	23990 96.5 %	23751 95.5 %	23871 95.9 %	23620 94.9 %	22380 89.9 %
^{51}Cr	22818±123	18710 82.0 %	16874 73.9 %	15978 70.1 %	13016 57.0 %	12276 53.8 %
^{99}Mo	18503±243	18180 98.3 %	18059 97.6 %	18130 97.9 %	18225 98.5 %	17578 95.0 %
^{187}W	14304±147	13946 97.5 %	13689 95.7 %	13836 96.7 %	13870 97.9 %	13020 91.0 %
^{125}Sb	13143±146	12854 97.8 %	12754 97.1 %	12906 98.2 %	12724 96.8 %	12316 93.7 %

Table 4.10 The influence of the stirring time on the recovery of Metal.APDC chelates by activated charcoal.

Nuclide	Standard ($\overline{X}\pm SD$)	The Stirring Time (min.)				
		10	20	30	50	60
^{197}Hg	22527±288	22071 98.0 %	21918 97.3 %	21810 96.8 %	22031 97.8 %	22014 97.7 %
^{115}Cd	20316±123	19828 97.6 %	19930 98.1 %	19585 96.4 %	19647 96.7 %	19767 97.3 %
^{60}Co	33256±176	32358 97.3 %	32225 96.9 %	32624 98.1 %	32457 97.6 %	32391 97.4 %
^{65}Zn	24870±111	23303 93.7 %	22258 89.5 %	19398 78.0 %	18752 75.4 %	14452 58.1 %
^{51}Cr	22818±123	14718 64.5 %	18962 83.1 %	19167 84.0 %	18596 81.5 %	
^{99}Mo	18503±243	18040 97.5 %	17911 96.8 %	18188 98.3 %	18133 98.0 %	
^{187}W	1430±147	11500 80.4 %	13217 92.4 %	13989 97.8 %	14019 98.0 %	
^{125}Sb	13143±146	12921 98.3 %	12854 97.8 %	12880 98.0 %	12854 97.8 %	

Table 4.11 The influence of the salinity on the recovery of Metal-APDC chelates on activated charcoal.

Nuclide	Activity (counts) and % Recovery Salinity						
	4	8	12	16	20	28	32
^{197}Hg	22099 98.1 %	21964 97.5 %	22031 97.8 %	22144 98.3 %	21964 97.5 %	22212 98.6 %	21874 97.1 %
^{115}Cd	19727 97.1 %	19808 97.5 %	19970 98.3 %	19930 98.1 %	19869 97.8 %	19828 97.6 %	19910 98.0 %
^{60}Co	32426 97.5 %	32191 96.8 %	32624 98.1 %	32458 97.6 %	32691 98.3 %	32225 96.9 %	32492 97.7 %
^{65}Zn	23800 95.7 %	24149 97.1 %	24074 96.8 %	23776 95.6 %	23950 96.3 %	24124 97.0 %	24074 96.8 %
^{51}Cr	20605 90.3 %	19030 83.4 %	18597 81.5 %	18254 80.0 %	18140 79.5 %	18163 79.6 %	18186 79.7 %
^{99}Mo	18151 98.1 %	18077 97.7 %	18188 98.3 %	17929 96.9 %	18003 97.3 %	18151 98.1 %	17855 96.5 %
^{125}Sb	12854 97.8 %	12893 98.1 %	12920 98.3 %	12801 97.4 %	12828 97.6 %	12880 98.0 %	12841 97.7 %
^{187}W	13946 97.5 %	14032 98.1 %	13975 97.7 %	14061 98.3 %	13946 97.5 %	14018 98.0 %	13918 97.3 %

Table 4.13 The influence of acidity on the recovery of Selenium on activated charcoal.

pH	counts	% Recovery	Standard
1.0	1676	5.5	30464
1.5	9344	31.0	30310
1.8	1853	59.7	29912
2.0	26057	86.2	
2.3	29593	97.9	$\overline{X}$= 30228±284
2.5	29654	98.1	
2.8	19400	64.2	
3.0	7155	23.7	

Table 4.14 The influence of L-ascorbic acid concentration on the recovery of selenium on activated charcoal.

Concentration of L-ascorbic acid (mg./ml/)	counts	% Recovery	Standard
0.5	15604	41.7 %	37089
0.75	25496	68.2 %	37975
1.0	30043	98.7	37134
1.25	36658	98.0	$\overline{X}$=37399±499
1.50	35945	96.1	

Table 4.15 The influence of amount of activated charcoal on the recovery of Se.

Amount of charcoal(mg.)	counts	% Recovery	Standard ($\bar{X} \pm SD$)
10	20543	54.9	
25	26931	72.0	
50	31102	83.1	37399±499
75	35914	96.0	
100	36295	97.0	
125	36377	97.3	

Table 4.16 The influence of stirring time on the recovery of Se on activated charcoal.

Stirring time (min.)	counts	% Recovery	Standard ($\bar{X} \pm SD$)
1	32425	86.7	-
3	33435	89.4	
5	34070	91.1	37399±499
7	36576	98.8	
10	36838	98.5	
15	36912	98.7	

Table 4.17 The influence of the sample volume on the recovery of selenium on activated charcoal.

Volume (ml.)	counts	% Recovery	Standard ($\overline{X}\pm SD$)
100	36838	98.5	
200	36690	98.1	37399±499
300	36576	97.8	
400	36651	98.0	
500	36460	97.3	

Table 4.18 The influence of the salinity on the recovery of Se on activated charcoal.

Salinity ‰	counts	% Recovery	Standard ($\overline{X}\pm SD$)
4	32696	97.5	
8	32495	96.9	
12	32897	98.1	33534±904
16	32760	97.7	
20	32361	96.5	
24	32630	97.3	
28	32864	98.0	

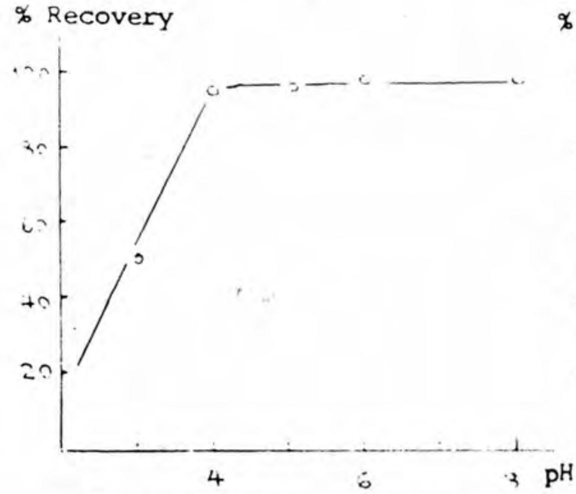


Fig. 4.1 Effect of acidity on the recovery of As by co-precipitation with $Fe(OH)_3$.

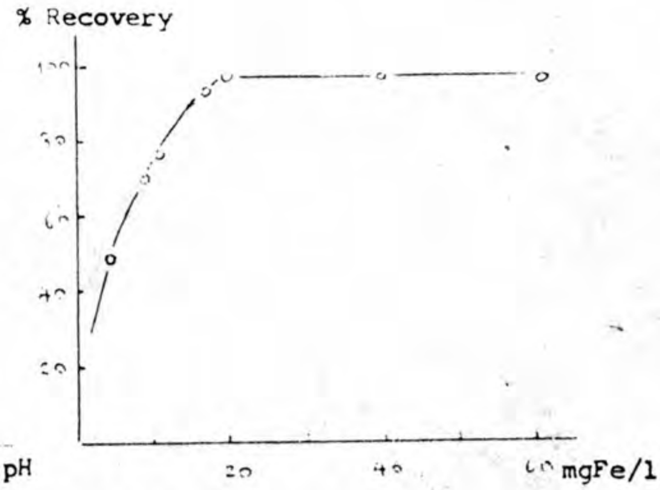


Fig. 4.2 Effect of Fe^{3+} concentration on the co-precipitation of As with $Fe(OH)_3$.

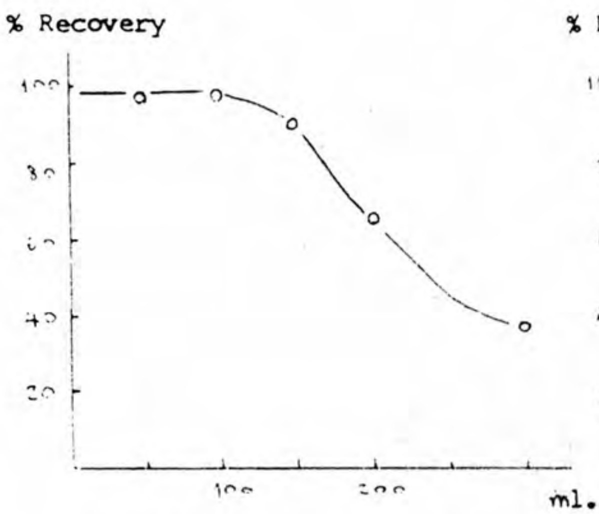


Fig. 4.3 Effect of the sample volume on the co-precipitation of As with $Fe(OH)_3$.

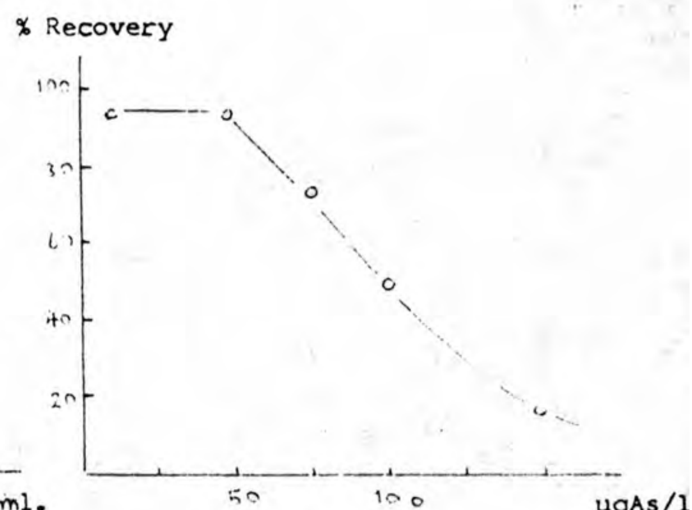


Fig. 4.4 Effect of As concentration on the co-precipitation of As with $Fe(OH)_3$.

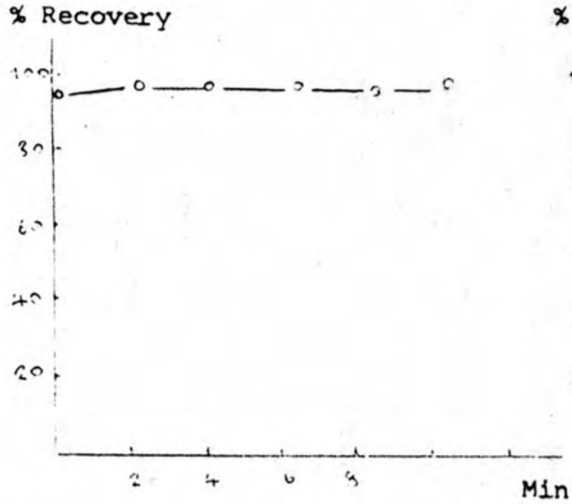


Fig. 4.5 Effect of the stirring time on the co-precipitation of As with $Fe(OH)_3$.

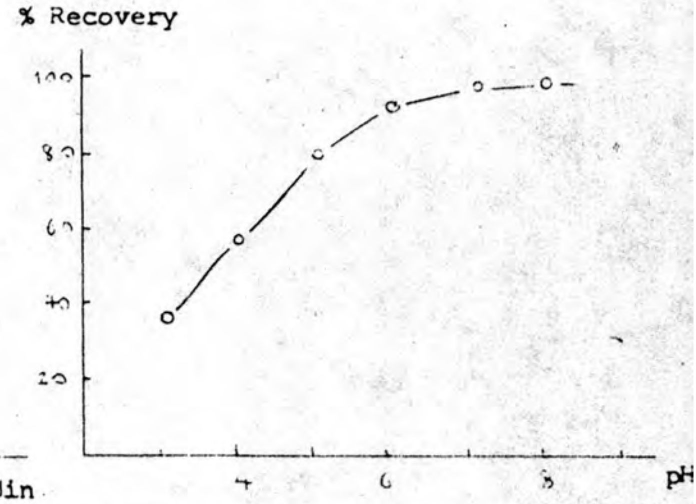


Fig. 4.6 Effect of the acidity on the recovery of Cd-APDC chelate on activated charcoal.

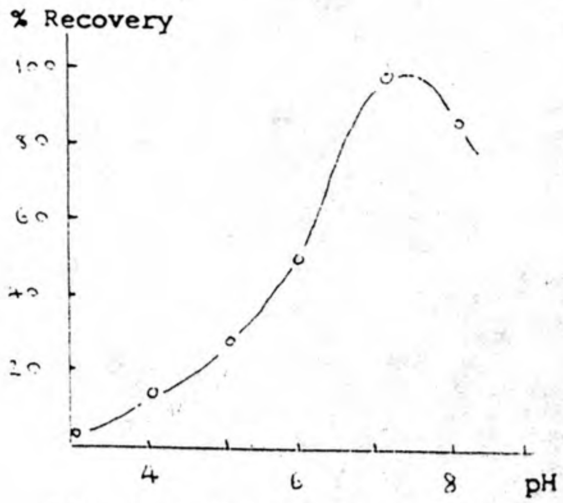


Fig. 4.7 Effect of the acidity on the recovery of Zn-APDC chelate on activated charcoal.

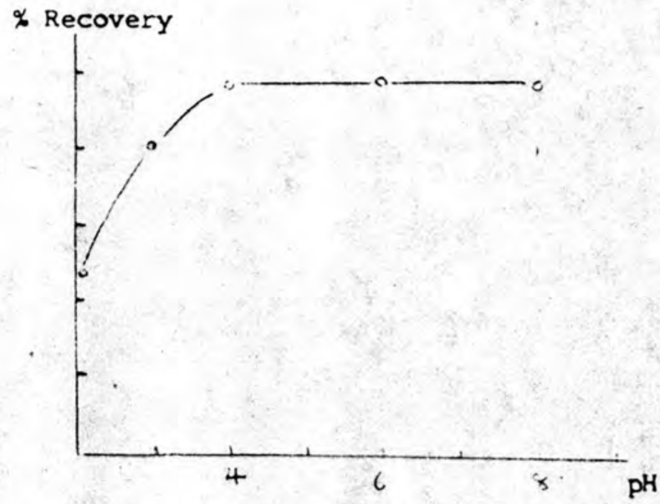


Fig. 4.8 Effect of the acidity on the recovery of Co-APDC chelate on activated charcoal.

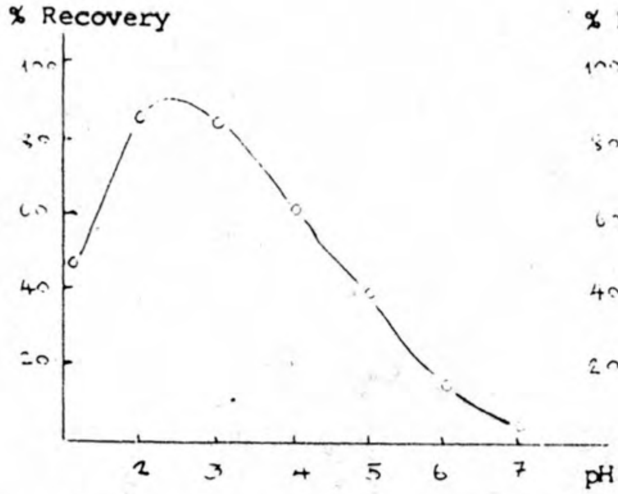


Fig. 4.9 Effect of acidity on the recovery of Cr(VI)-APDC chelate on activated charcoal.

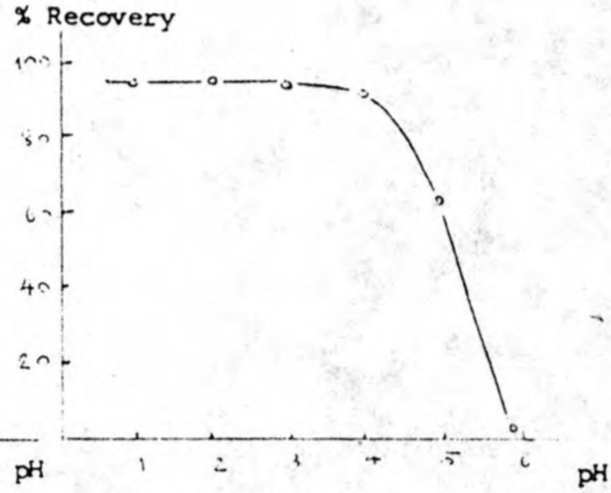


Fig. 4.10 Effect of acidity on the recovery of Mo-APDC chelate on activated charcoal.

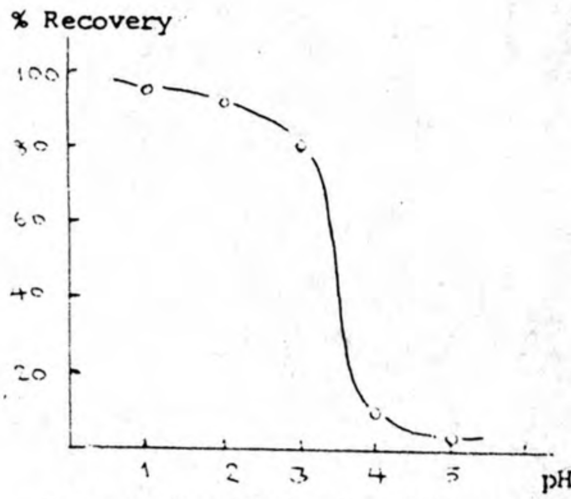


Fig. 4.11 Effect of acidity on the recovery of W-APDC chelate on activated charcoal.

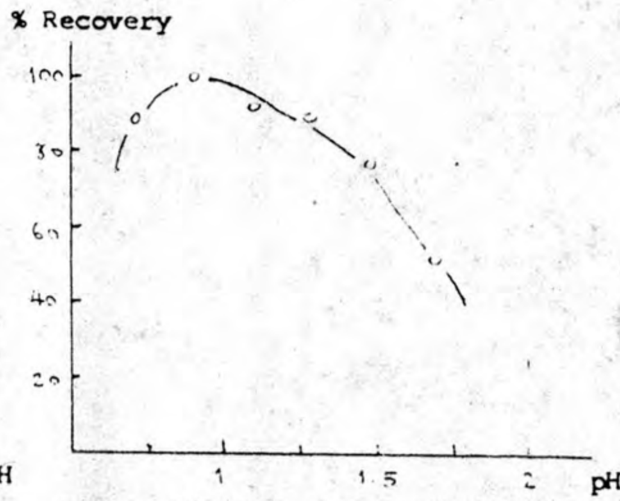


Fig. 4.12 Effect of acidity on the recovery of Sb-APDC chelate on activated charcoal.

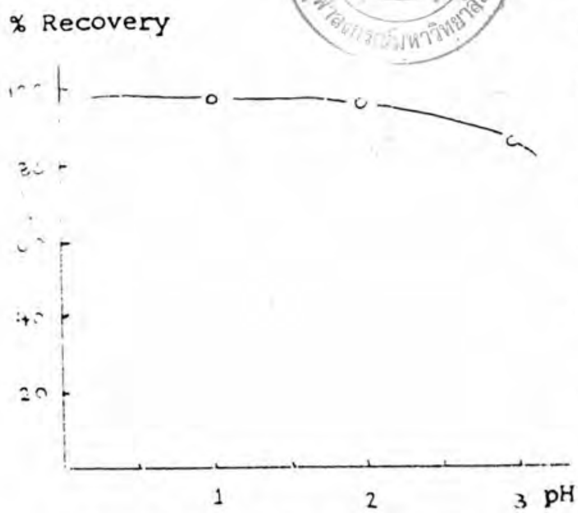


Fig. 4.13 Effect of acidity on the recovery of Hg-APDC chelate on activated charcoal.

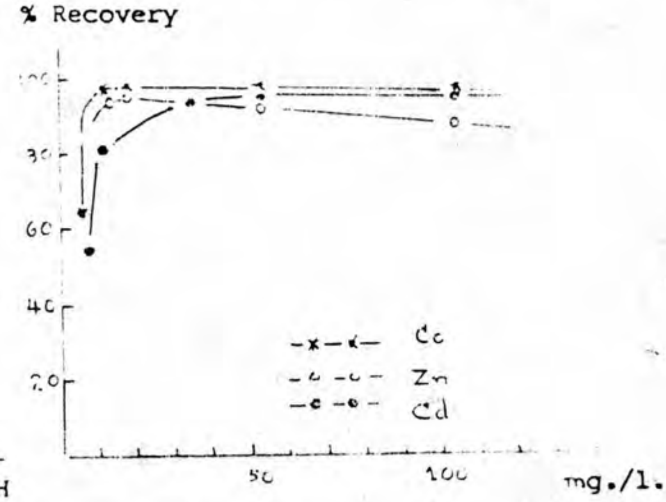


Fig. 4.14 Effect of APDC-concentration on the recovery of Co, Cd, Zn on activated charcoal.

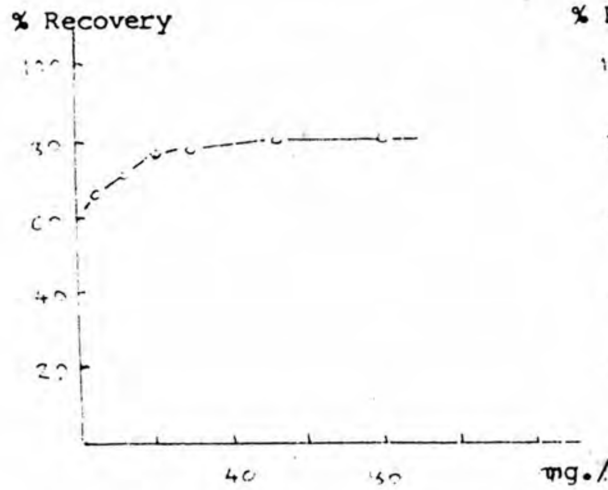


Fig. 4.15 Effect of APDC-concentration on the recovery of Cr(VI) on activated charcoal.

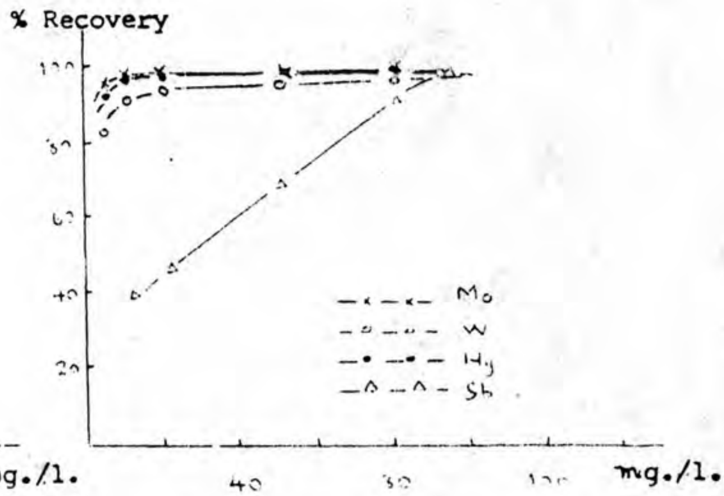


Fig. 4.16 Effect of APDC concentration on the recovery of Sb, Mo, W and Hg on activated charcoal.

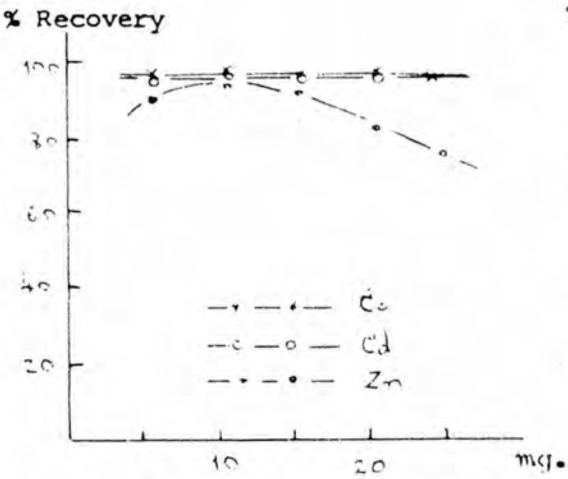


Fig. 17 Effect of amount of charcoal on the recovery of Co, Cd, and Zn chelates.

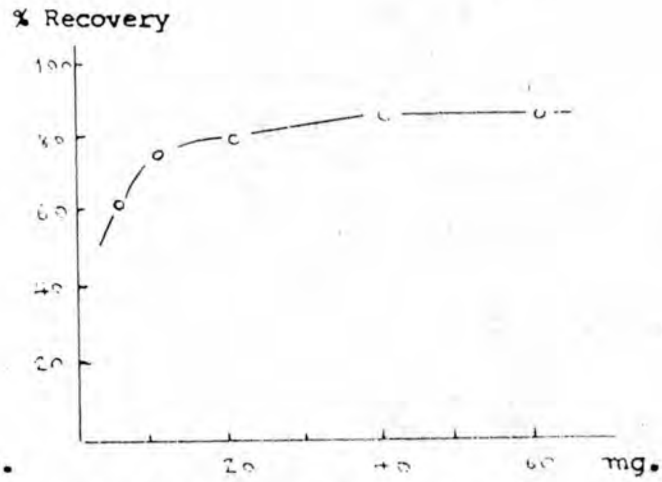


Fig. 18 Effect of amount of charcoal on the recovery of Cr(VI) chelate.

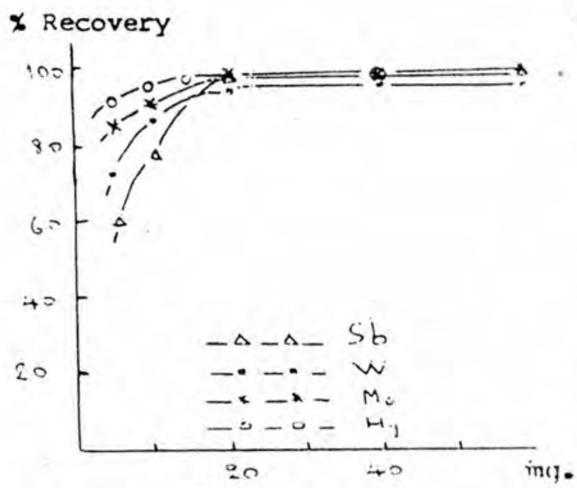


Fig. 19 Effect of amount of charcoal on the recovery of Sb, Mo, W and Hg chelates.

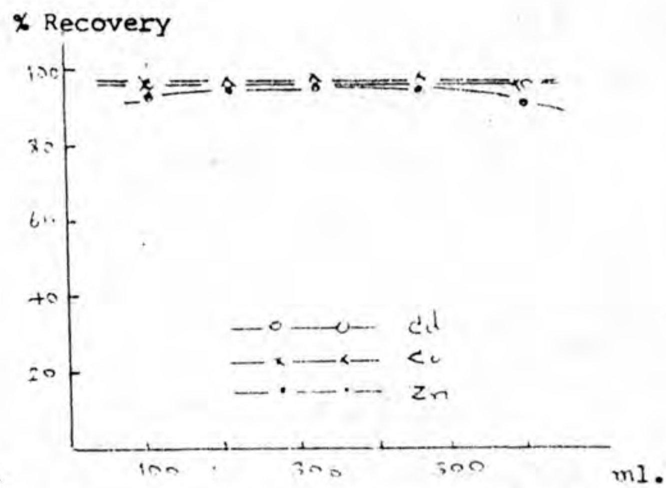


Fig. 20 Effect of the sample volume on the recovery of Co, Zn and Cd chelates on activated charcoal.

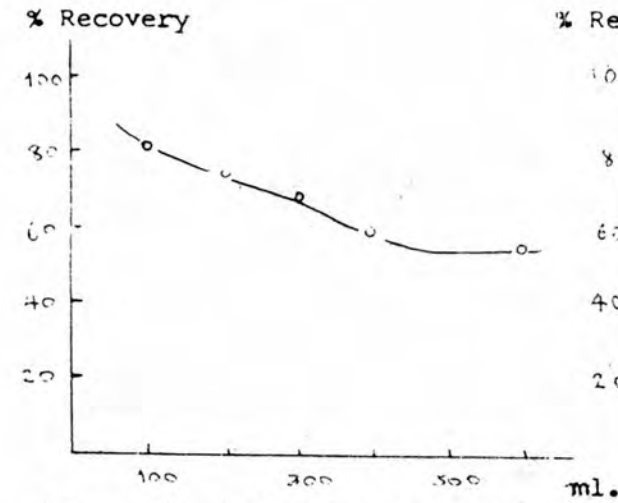


Fig. 4.21 Effect of sample volume on the recovery of Cr(VI)-APDC chelate on activated charcoal.

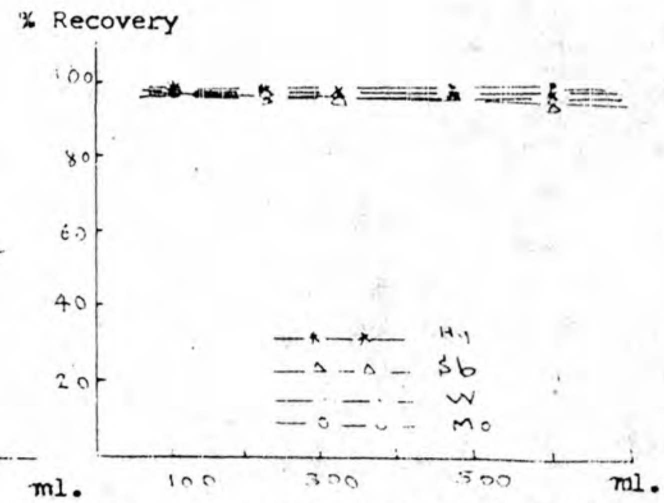


Fig. 4.22 Effect of sample volume on the recovery of Sb, Mo, W and Hg chelates on charcoal.

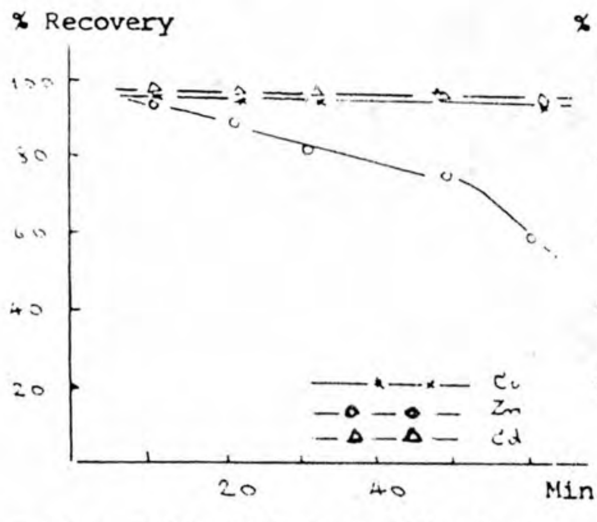


Fig. 4.23 Effect of stirring time on the recovery of Co, Zn and Cd chelates on activated charcoal.

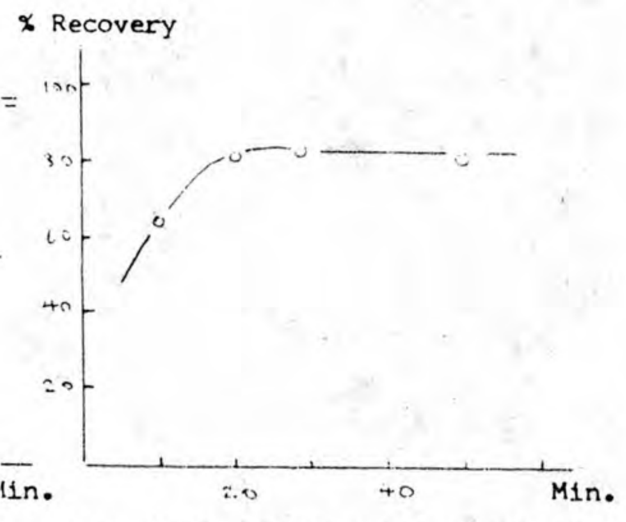


Fig. 4.24 Effect of the stirring time on the recovery of Cr(VI) chelate on activated charcoal.

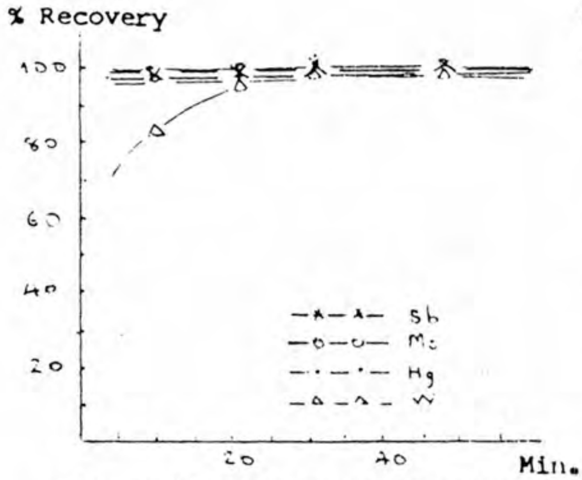


Fig. 4.25 Effect of stirring time on the recovery of Sb, Mo, Hg and W on activated charcoal.

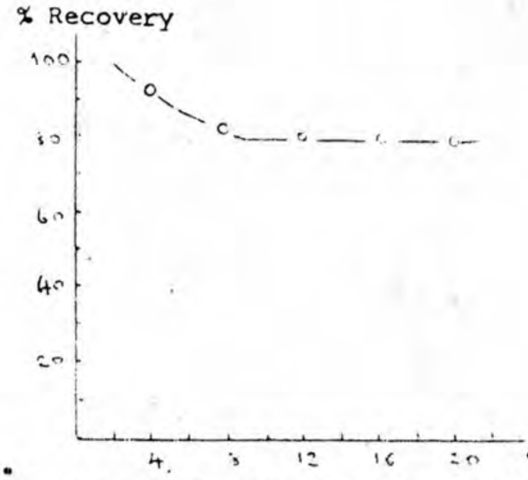


Fig. 4.26 Effect of the salinity on the recovery of Cr(VI)-APDC chelate on activated charcoal.

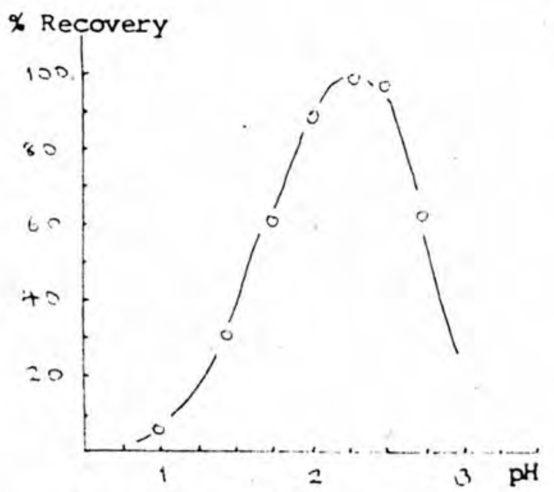


Fig. 4.27 Effect of acidity on the recovery of elemental Selenium on activated charcoal.

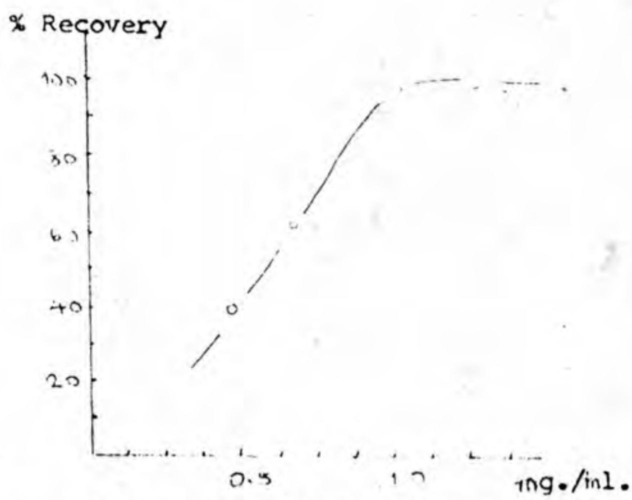


Fig. 4.28 Effect of L-ascorbic acid concentration on the recovery of Selenium on activated charcoal.

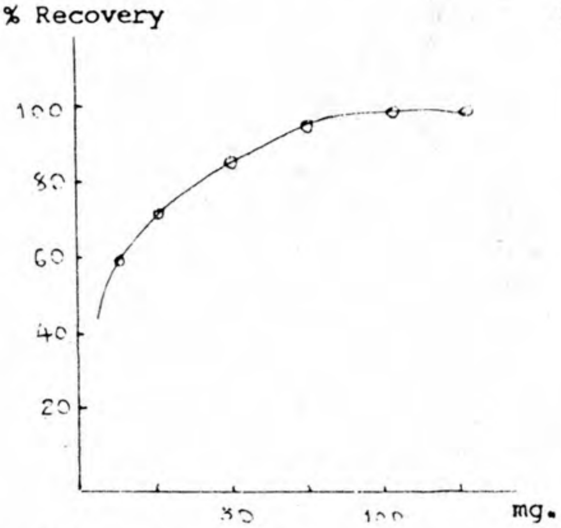


Fig. 4.29 Effect of amount of charcoal on the recovery of elemental Selenium.

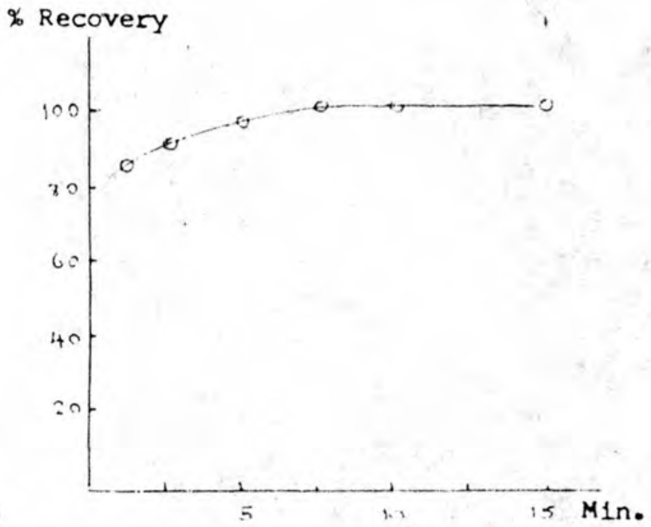


Fig. 4.30 Effect of the stirring time on the recovery of Se on activated charcoal.

Table 4.19 The recovery of ^{76}As on acid Al_2O_3.

	Counts $\overline{X}$	$\overline{X}\pm SD.$	% Recovery
Standard	40585	41775±928	
Standard	42850	(2.2%)	
Standard	41890		98.0±5.9
Sample	39229	40924±1572	
Sample	43016	(3.8%)	
Sample	40528		

Table 4.20 The recovery of ^{197}Hg purification

Identification	Weight (gm)	corrected activity (counts)	
Standard charcoal of 0.995 ppm Hg content	0.41140 0.43755	13443 16565	Specific activity is 35444±2604 counts/µg.Hg
Lake Sediment SL-1 which has the Hg contant of 0.13 ppm [21]	1.01110 0.95830	3960 4878	Concentration of Hg found is 0.127±0.02 ppm

Table 4.21 Data for SRM 1571 Orchard leaves
All in µg./g. (dry weight)

Element	Concentration Found	NBS certified value [22]	Other literature data. [15]
As	9.21±0.01	9.5±1.0	9.94 - 9.76
Hg	0.15±0.04	0.155±0.015	0.09 - 0.19
Zn	24.5±0.8	25±3	23 - 27
W	0.05±0.01	-	0.02
Sb	2.30±0.26	2.9±0.3	2.7 -3.7
Se	0.14±0.09	0.08±0.01	0.08-0.11
Co	0.13±0.02	-	0.1 -0.21
Mo	0.4±0.03	0.3±0.1	0.33

Table 4.23 Concentration of some trace elements found in sea water used on the leaching experiment (all in µg./l/).

Element	Blank value	Concentration found
Zn	8.77 ± 1.37	23.42 ± 3.75
Hg	0.063±0.008	0.172±0.02
Co	0.283±0.04	0.282±0.06
Cr(VI)	14.03 ±1.22	N.D.
W	N.D.	N.D.
Sb	N.D.	0.528±0.025
Mo	N.D.	9.935±0.565
As	N.D.	2.92 ±0.16
Se	N.D.	N.D.

Table 4.24 Physical and chemical composition of the ash.

Bulk density (g/cm^3)	1.12
Porosity	0.45
Ash fusion temperature (^oC)	1350
Ratio ($CaO+MgO/SO_3+0.04\ Al_2O_3$)	4.23

Cumulative weight below particle size (μm.)

54.9 μm	95.5 %	5.0 μm	44.8 %
17.7 μm	76.9 %	1.2 μm	14.9 %
10.5 μm	64.6 %		

Element	Concentration•	Element	Concentration•
Si %	20.6	Ga	45
Al %	10.5	Hf	5.5
Fe %	6.2	Hg	0.62
Ca %	3.6	La	65
Mg %	2.1	Lu	1.15
Na %	0.43	Mn	1050
K %	2.35	Mo	25
Ti %	0.58	Nd	95
S	1.2	Ni	120
As	27	Pb	205
B	215	Rb	140
Ba	1700	Sb	14.5
Be	-	Sc	29
Br	1.4	Se	6.8

Table 4.24 (Cont.)

Element	Concentration*	Element	Concentration*
Ce	176	Sm	15.4
Cd	2.5	Sr	820
Co	56	Ta	1.30
Cr	165	Tb	2.2
Cs	16	Th	26
Cu	170	U	10.2
Dy	-	V	209
Eu	2.5	W	6.0
F	690	Yb	5.1
Cl	< 50	Zn	430

*All concentrations in $\mu g.g^{-1}$ unless stated otherwise.

Table 4.25 Percentage leaching of the ash in sea water.

Time (h)	Element	Solid to liquid ratio			
		1/100	1/20	1/5	1/1
0.5	Cr(VI)	3.4	1.6	1.1	0.32
	Co	0.16	0.035	0.023	0.003
	Sb	7.5	2.9	1.4	0.31
	Se	72.	61.	34.	9.5
	Mo	33.	14.	6.5	3.2
	W	23.	11.	5.9	0.89
	Zn	0.71	0.26	0.14	0.06
	As	13.	2.4	0.16	0.017
	Hg	9.3	4.6	3.4	0.08
5.0	Cr(VI)	2.9	2.0	1.1	0.27
	Co	0.13	0.04	0.023	0.007
	Sb	12.	3.6	1.5	0.02
	Se	94.	52.	9.2	4.4
	Mo	39.	10.6	3.2	5.2
	W	30.	10.7	2.3	0.67
	Zn	0.77	0.25	0.13	0.044
	As	2.5	0.33	0.07	0.04
	Hg	2.4	3.11	0.99	0.06
50.0	Cr(VI)	5.3	6.2	3.4	1.3
	Co	0.08	0.027	0.013	0.0067
	Sb	25.	16.	0.73	0.02
	Se	83.	31.	0.21	0.29
	Mo	44.	18.	7.3	7.5
	W	38.	23.	8.3	0.11
	Zn	0.78	0.21	0.10	0.048
	As	3.8	0.43	0.13	0.036
	Hg	0.87	0.16	0.34	0.03

Table 4.26 Percentage leaching of the ash in fresh water.

Time (h)	Element	solid to liquid ratio					
		1/1000	1/200	1/50	1/20	1/2	1/1
0.5	Cr(VI)					0.68	1.4
	Co					0.14	0.031
	Sb	14.	8.5	5.5	0.23		
	Se		100	66	23.	11.	5.3
	Mo		40.			2.4	2.2
	W				9.0		0.75
	Zn	3.49	0.47	0.29	0.02	0.05	0.015
	As		< 1				0.01
5.0	Cr(VI)	61.	19	7.9		0.85	0.92
	Co					0.46	0.23
	Sb	27.	21	4.5	0.14		
	Se		59.	18.	2.9	0.59	1.32
	Mo				5.1	4.1	4.9
	W						
	Zn	3.5	0.93	0.29	0.05	0.009	0.002
	As		< 1				< 0.01
50	Cr(VI)					0.60	0.12
	Co					0.39	0.18
	Sb	14.	12.	2.0	0.07		
	Se						0.1
	Mo				5.0	2.2	1.6
	W				7.0	13.3	
	Zn	1.2	0.23	0.41	0.02	0.02	0.03
	As		1				0.01

Table 4.27 pH values of the leachates.

The ash in sea water.

Ratio	pH values at various contact time		
	0.5 h	5 h	50 h
1/100	9.5	9.7	9.3
1/20	10.0	10.1	9.2
1/5	10.0	10.2	11.2
1/1	10.3	12.3	12.3
	(pH of untreated sea water = 8.07±0.05)		

The ash in fresh water

Ratio	pH values at various contact time		
	0.5 h	5 h	50 h
1/1000	10.8	10.8	10.8
1/200	11.4	11.3	11.4
1/50	11.7	11.8	11.7
1/10	11.9	12.1	12.2
1/2	12.2	12.3	12.3
1/1	12.3	12.4	12.4

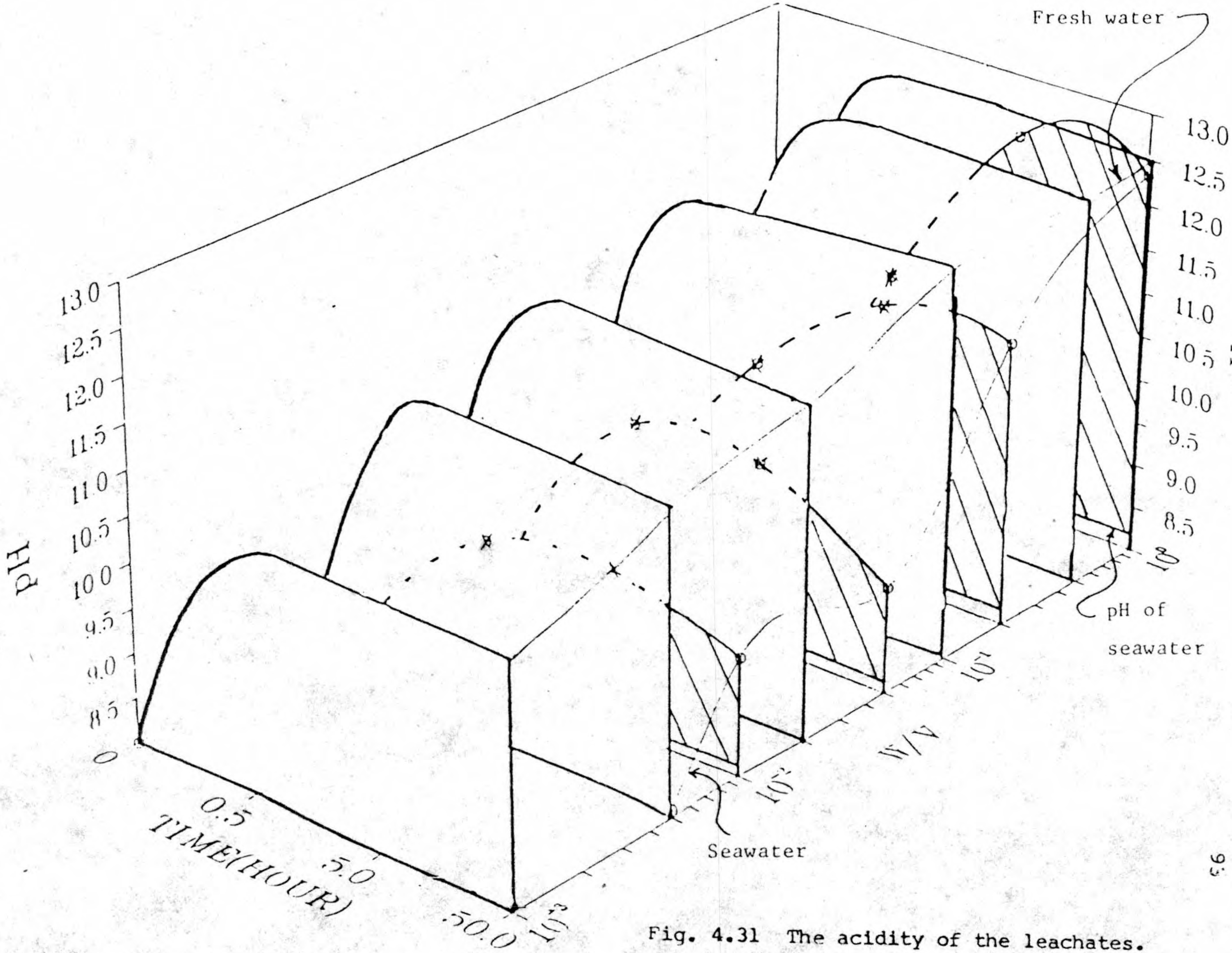


Fig. 4.31 The acidity of the leachates.

ACIDITY

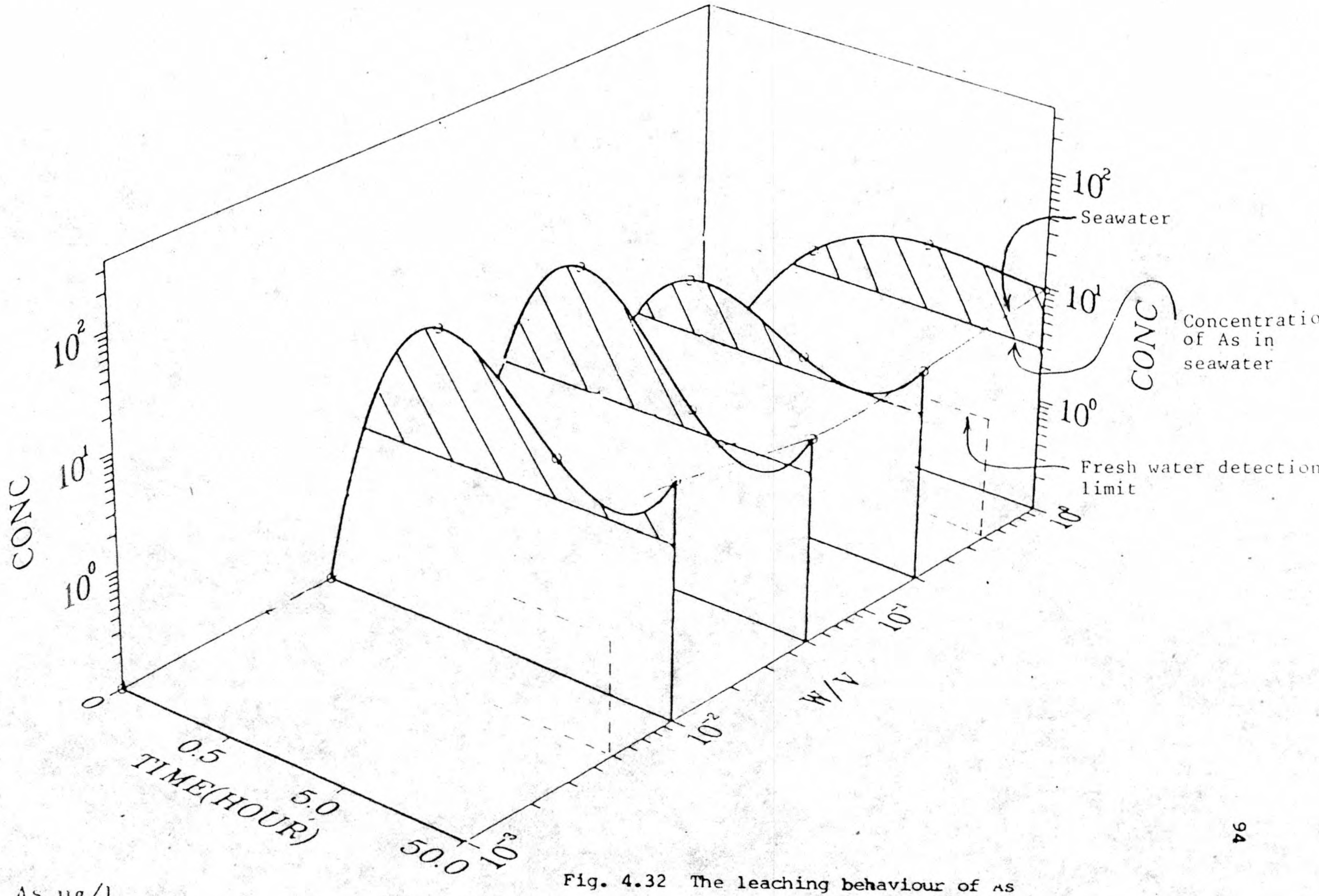


Fig. 4.32 The leaching behaviour of As

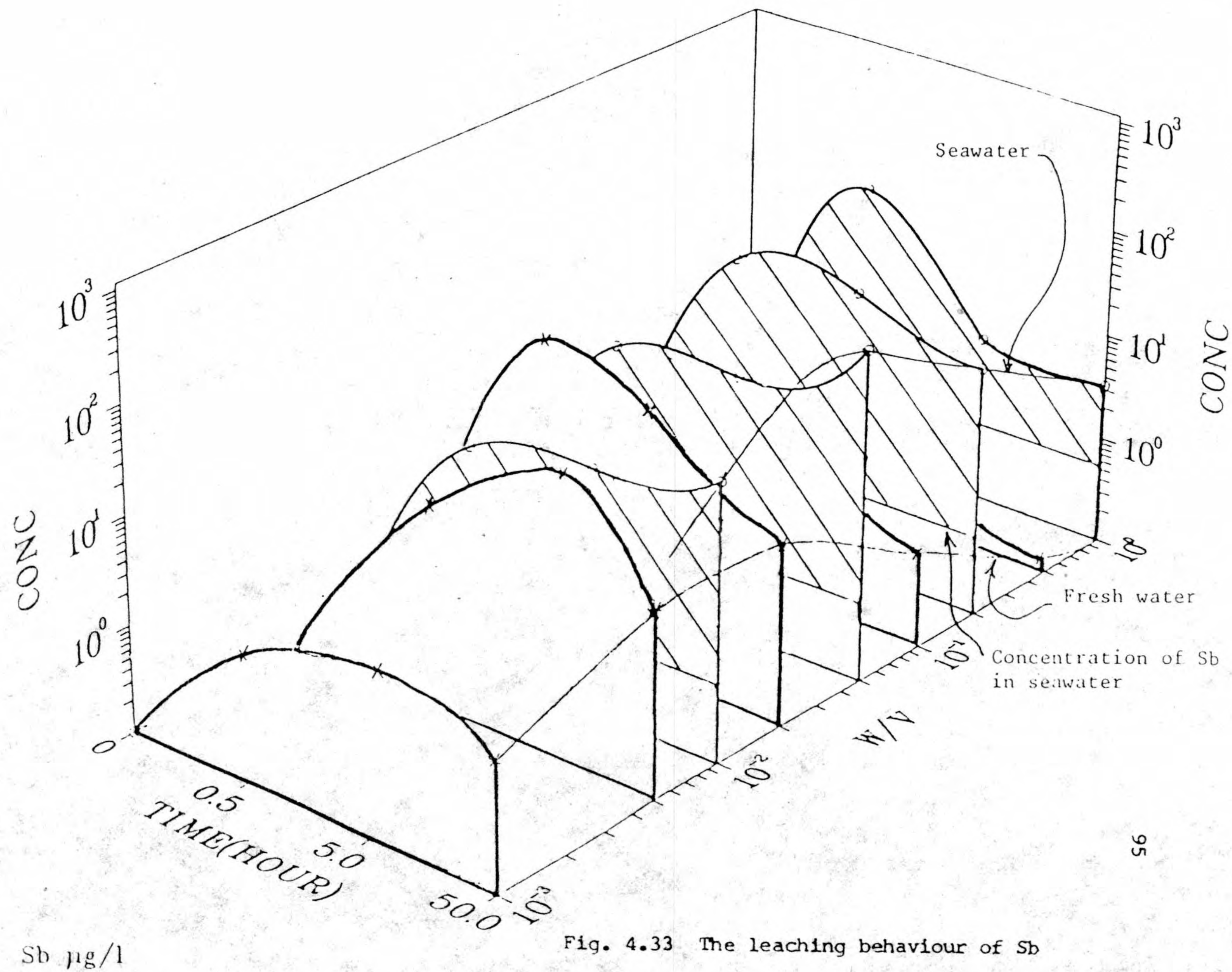
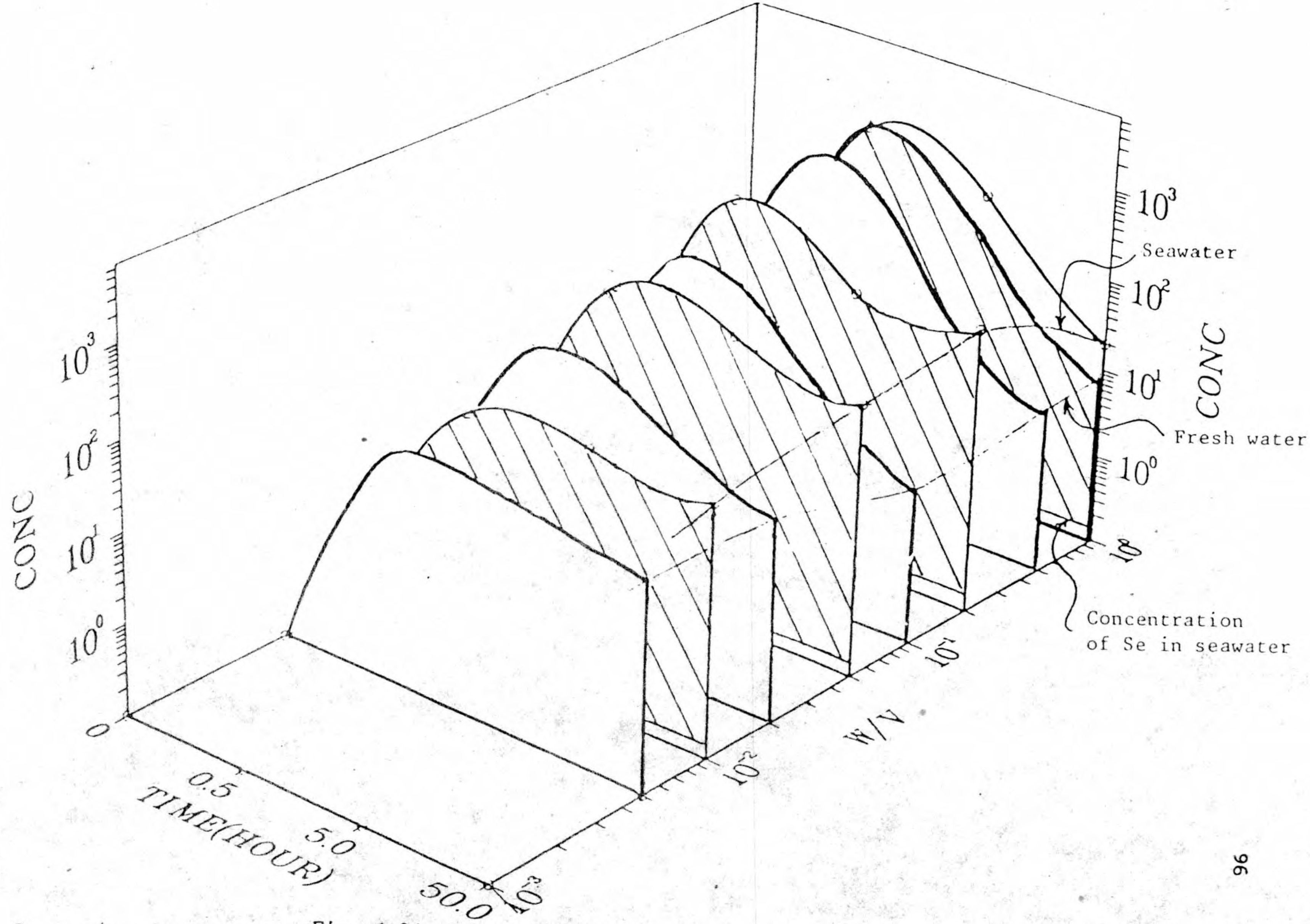


Fig. 4.33 The leaching behaviour of Sb



Se μg/l

Fig. 4.34 The leaching behaviour of Se

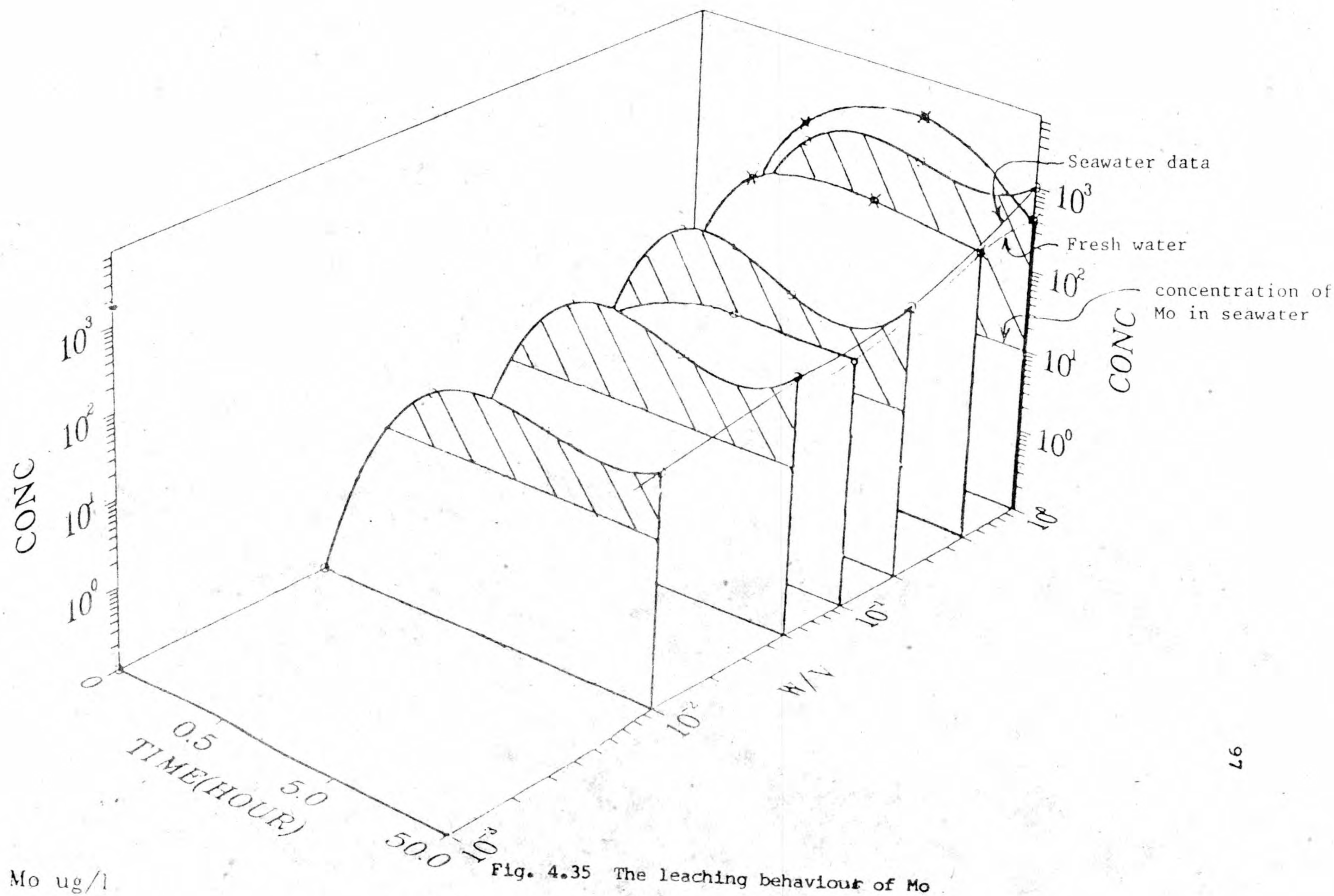


Fig. 4.35 The leaching behaviour of Mo

Table 4.28 Physical properties of sea water in the Western Scheldt estuary.

Station No.	Temperature °C	Salinity ‰	Oxygen content(ppm)	pH
1	17.0	31.3	8.90	8.00
2	17.6	29.0	8.25	7.95
3	17.4	26.8	8.40	7.86
4	17.2	25.2	8.00	7.75
5	17.4	22.6	7.78	7.69
6	17.6	20.0	6.77	7.52
7	17.6	17.6	6.48	7.35
8	17.9	15.7	4.87	7.20
9	18.2	14.0	3.62	7.25
10	18.3	12.1	2.11	7.23
11	18.4	9.6	1.46	7.29
12	18.4	8.0	1.29	7.30
13	18.4	5.6	1.19	7.40
14	18.7	4.0	0.59	7.48
15	18.0	2.0	0.59	7.40
16	*			
17	17.0	1.0	0.68	7.51
18	*			
19	17.2	0.75	1.40	7.55
20	17.4	0.65	0.85	7.56
21	*			
22	17.5	0.60	1.25	7.55
23	*			
24	18.1	0.60	2.00	7.55
25	16.0	32.6	8.90	7.92

*Not measured, only the sediment was taken.

Table 4.29 Concentration of dissolved As, Sb, W and Mo in the Western Scheldt estuary. (All in µg./l.)

Station No.	As (n=1)	Sb (n=2)	W (n=3)	Mo (n=2)
1	3.36	0.44± .005	0.068± .015	8.81±0.5
2	4.84	0.73±0.03	0.087±0.052	9.28±0.07
3	5.06	0.69±0.09	0.065±0.001	7.30±0.36
4	6.06	0.73±0.02	0.057±0.0	7.61±0.42
5	-	1.23±0.05	0.203±0.07	8.44±0.19
6	8.60	0.34±0.004	0.081	8.15±0.36
7	8.64	0.23±0.002	N.D.	7.07±0.49
8	10.30	-	N.D.	-
9	10.10	1.45±0.18	0.76±0.02	7.19±0.11
10	10.40	1.52±0.03	0.83±0.01	6.47±0.13
11	-	2.07±0.05	1.60±0.07	6.41±0.18
12	11.69	1.91±0.10	1.70±0.04	6.30±0.18
13	14.40	1.31±0.11	0.99±0.10	3.36±0.6
14	12.79	0.84±0.09	1.40±0.10	2.93±0.3
15	9.89	0.43±0.02	1.55±0.06	3.42±0.06
17	8.73	0.31±0.02	1.04±0.08	3.00±0.24
20	7.67	1.15±0.01	0.32±0.11	3.00±0.37
22	5.26	1.35±0.06	0.36±0.03	3.89±0.31
24	5.33	1.046±0.0	0.40±0.09	4.13±0.06
25	2.82	0.21±0.08	N.D.	7.00±2.40

- = not determined.

Table 4.30 Concentration of As and Sb in suspended matter from the Western Scheldt estuary. (All in µg./g.)

Station No.	As fraction				Sb fraction			
	1	2	3	4	1	2	3	4
1	34.0	40.1	43.0	32.5	1.47	N.D.	N.D.	N.D.
4	34.0	45.9	54.4	49.2	1.56	1.94	N.D.	N.D.
6	48.7	69.1	76.5	76.1	3.07	2.70	1.97	N.D.
8	61.9	80.3	83.5	87.6	4.31	3.55	3.41	3.67
11	69.4	105.	115.	103.	4.56	5.15	3.67	4.64
13	76.6	160.	158.	135.	5.32	4.99	4.85	4.24
17	66.8	76.2	69.7	83.7	10.9	72.1	10.5	12.2
20	57.2	69.0	67.3	64.5	11.5	12.2	11.4	10.4
22	51.4	57.9	57.4	60.2	8.4	8.21	7.4	7.7
24	31.0	31.7	34.6	32.5	4.7	3.94	4.01	3.8
25	23.3	36.5	38.2	38.2	1.06	N.D.	N.D.	0.71

Table 4.31 Concentration of As, Sb, W, and Mo in sediment sample from the Western Scheldt estuary. (All in µg./g.)

Station No.	As	Sb	W	Mo
1	15.4 ±1.7	0.50±0.2	N.D.	N.D.
2	7.43±0.42	N.D.	N.D.	N.D.
3	9.49±0.53	N.D.	N.D.	N.D.
4	7.73±0.57	0.40±0.13	N.D.	N.D.
5	6.16±0.48	N.D.	N.D.	N.D.
6	22.0 ±2.1	N.D.	N.D.	N.D.
7	-	-	-	-
8	55.7 ±4.0	4.80± .44	3.21±1.14	N.D.
9	6.95±0.44	N.D.	N.D.	N.D.
10	7.2 ±0.48	N.D.	N.D.	N.D.
11	12.1 ±0.5	0.69±0.11	N.D.	2.66±0.81
12	89.2 ±2.8	3.61±0.43	1.49±0.9	6.34±1.86
13	53.0 ±2.5	4.06±0.40	2.53±1.21	N.D.
14	9.05±0.34	1.41±0.12	N.D.	N.D.
15	-	-	-	-
16	12.9 ±0.4	1.86±0.15	0.49±0.29	N.D.
17	47.1 ±2.0	8.23±0.50	2.29±0.96	N.D.
18	6.85±0.21	0.50±0.06	N.D.	N.D.
19	44.8 ±1.7	6.42±0.42	2.33±0.80	N.D.
20	6.91±0.26	0.69±0.10	N.D.	N.D.
21	9.17±0.36	0.79±0.11	N.D.	N.D.
22	97.6 ±2.1	4.27±0.56	1.0 ±0.8	N.D.
23	11.5 ±0.40	1.06±0.13	N.D.	N.D.
24	1.93±0.19	0.25±0.06	N.D.	N.D.
25	18.8 ±1.1	0.57±0.17	N.D.	N.D.

- Not determined.

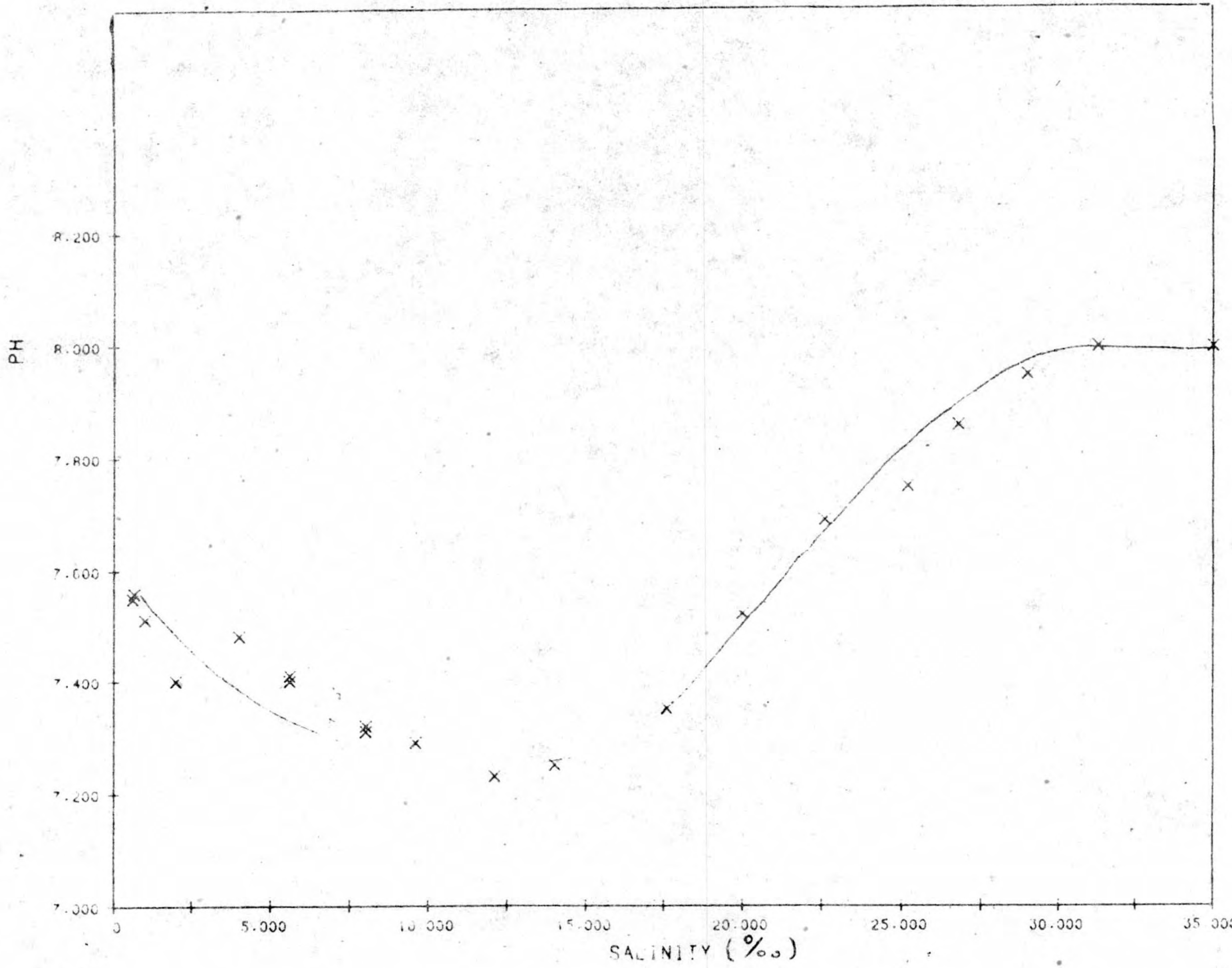


Fig. 4.36 The relation between acidity and Salinity of the water in the Western Scheldt estuary.

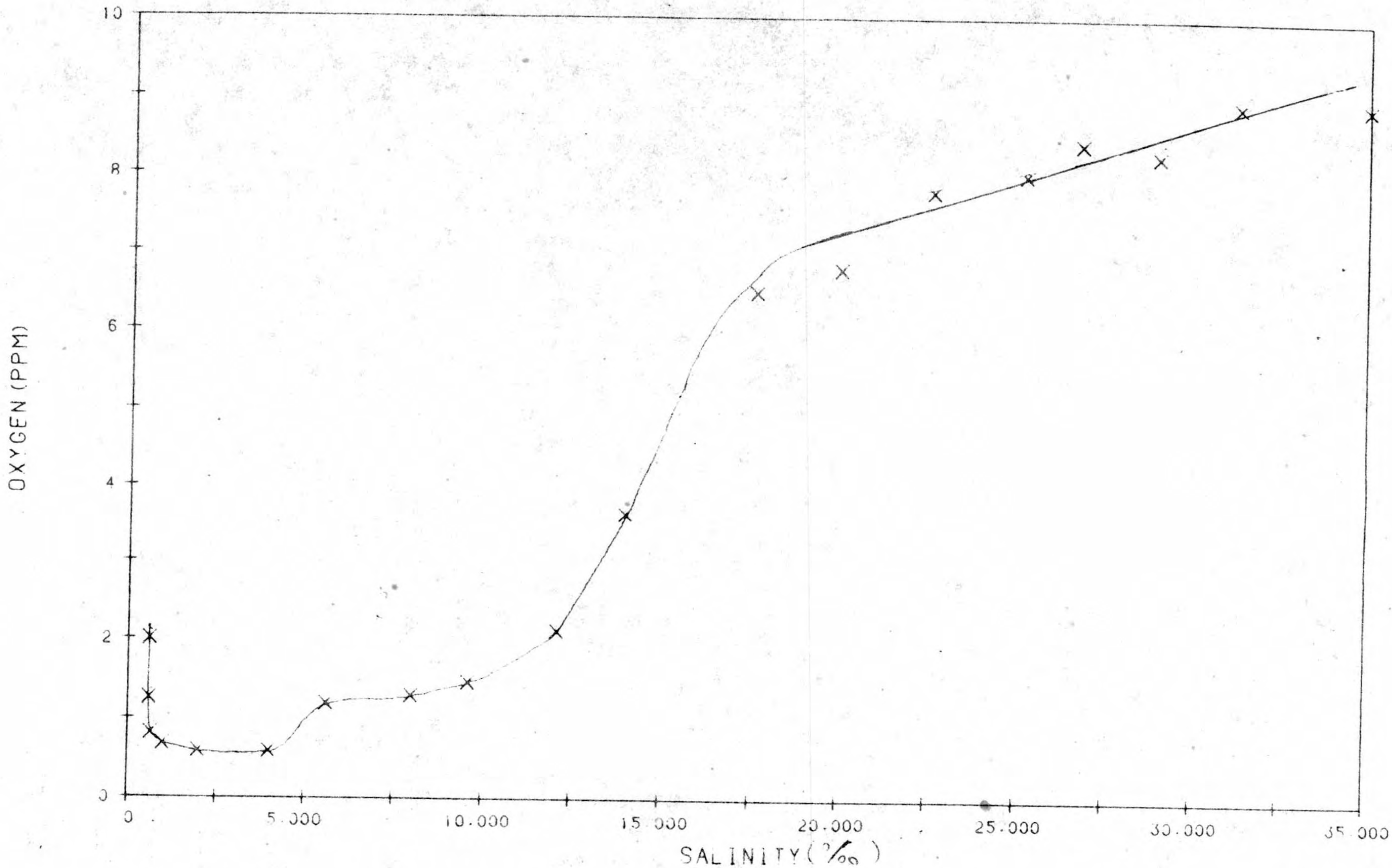


Fig. 4.37 The relation between Oxygen content and Salinity of the water in the Western Scheldt estuary.

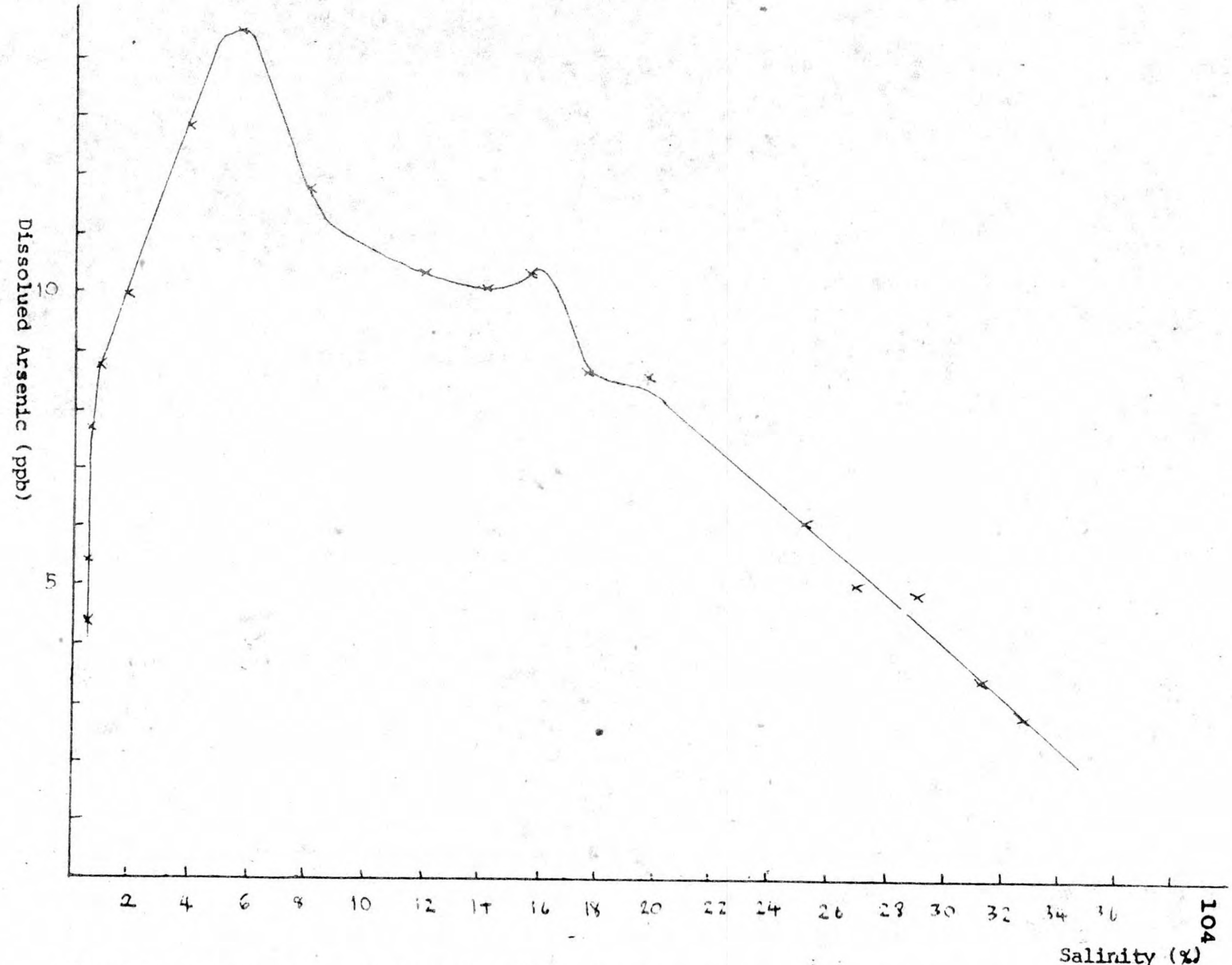


Fig.4.38 Concentration of dissolved Arsenic in the Western Scheldt estuary.

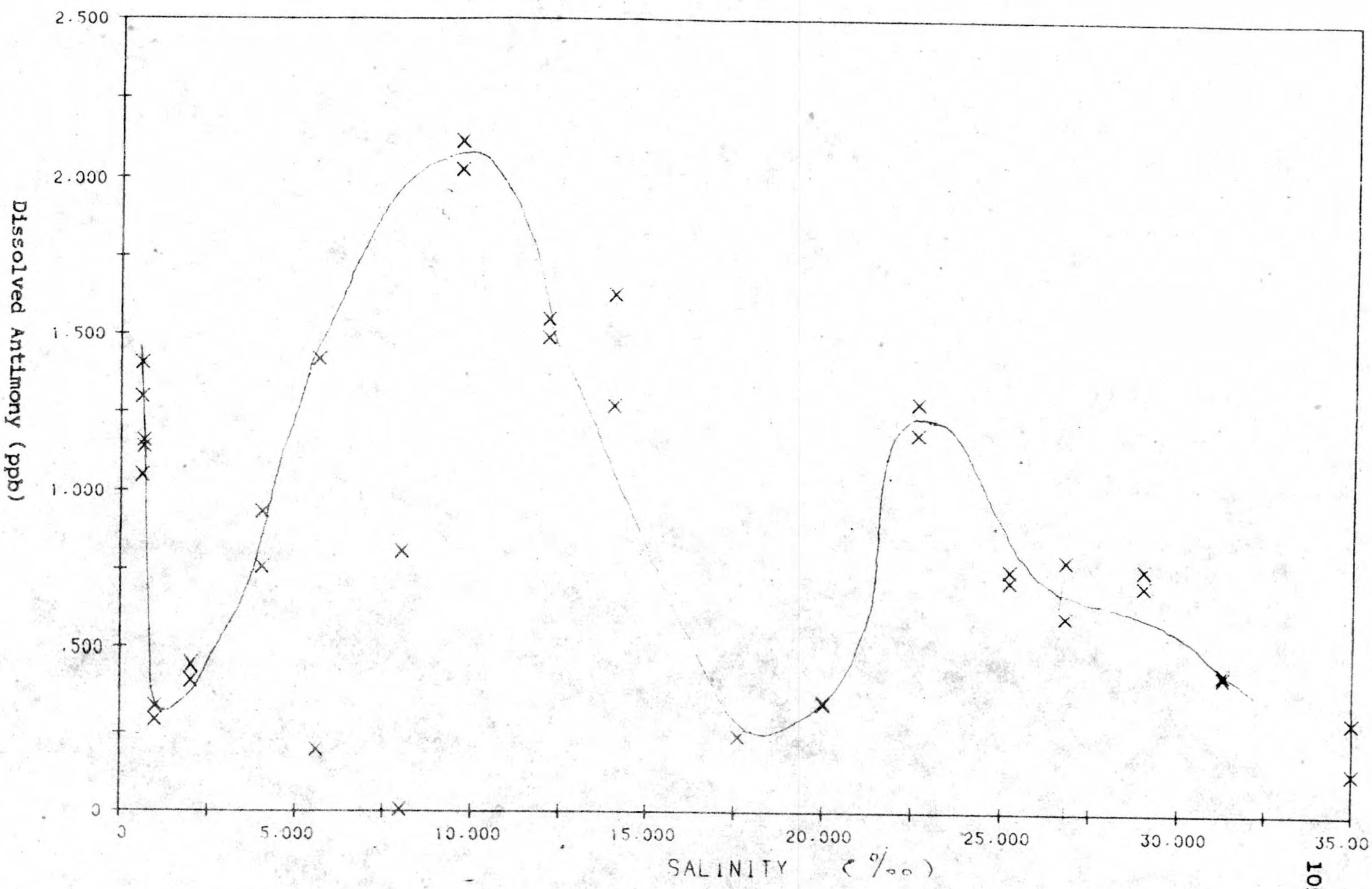
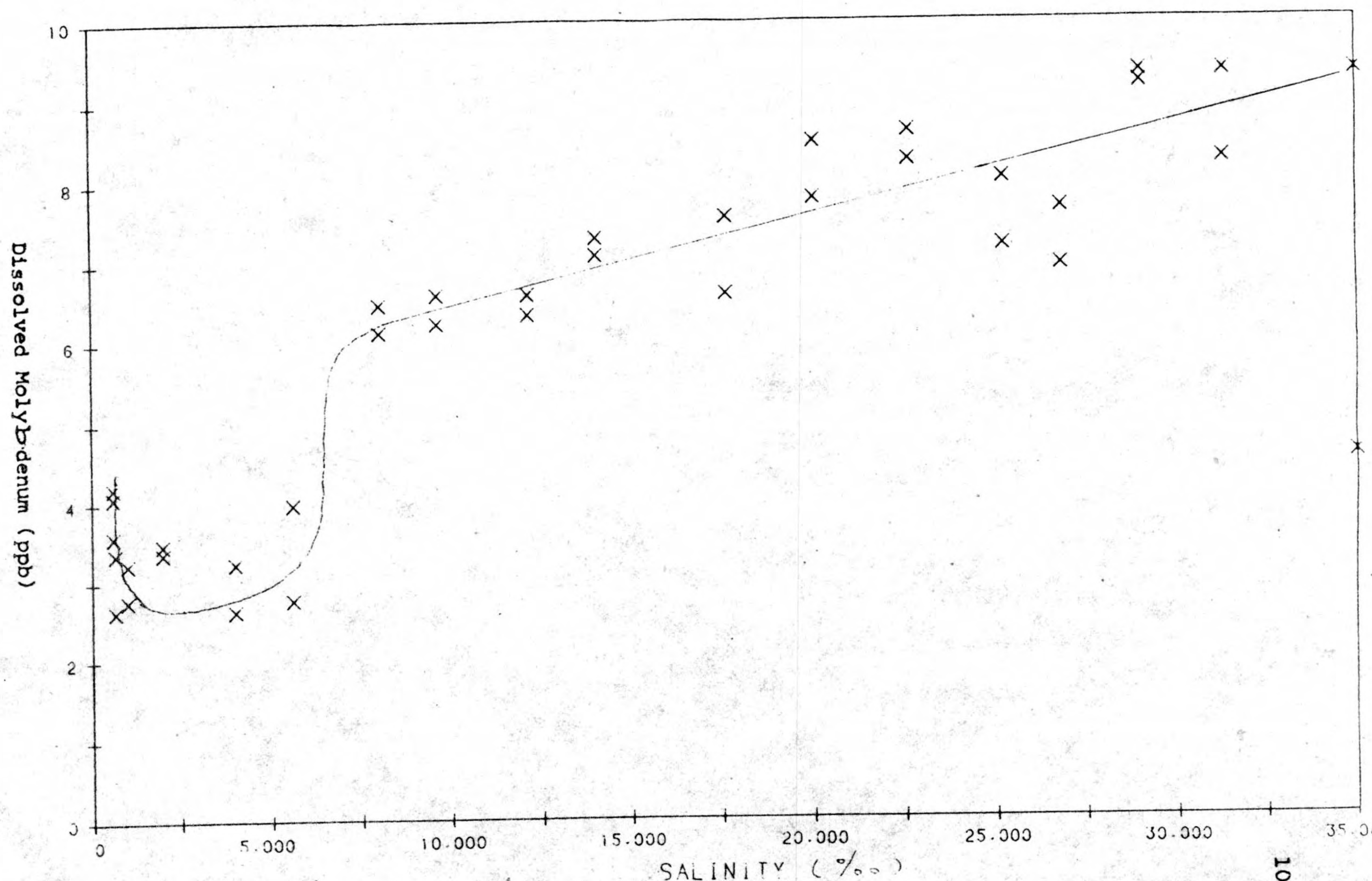


Fig. 4.39 Concentration of dissolved Antimony in the Western Scheldt estuary.



106

Fig. 4.40 Concentration of dissolved Molybdenum in the Western Scheldt estuary.

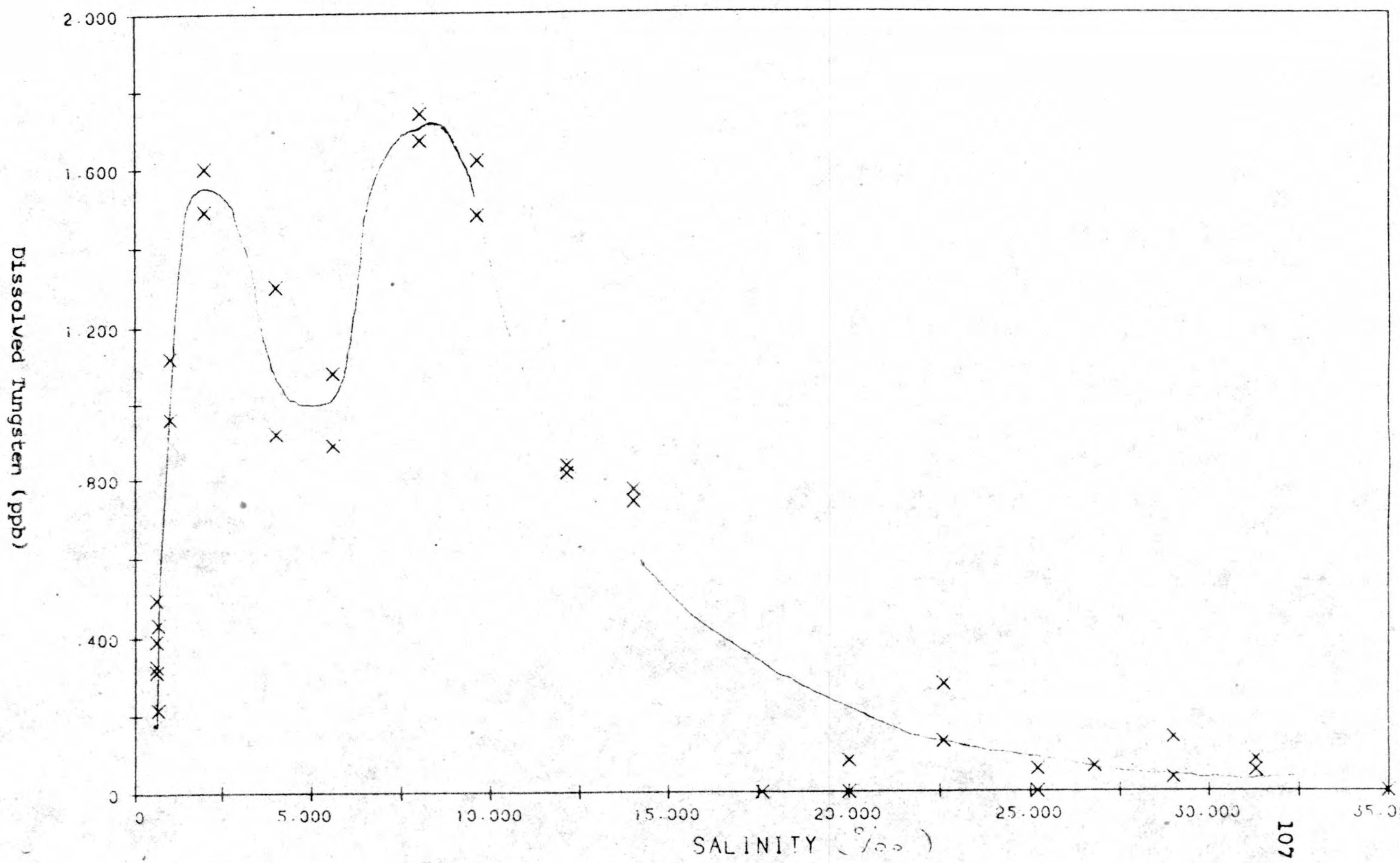


Fig. 4.41 Concentration of dissolved tungsten in the Western Scheldt estuary.

Fig. 4.42 Photographs of the four size-fractions obtained by centrifugation.

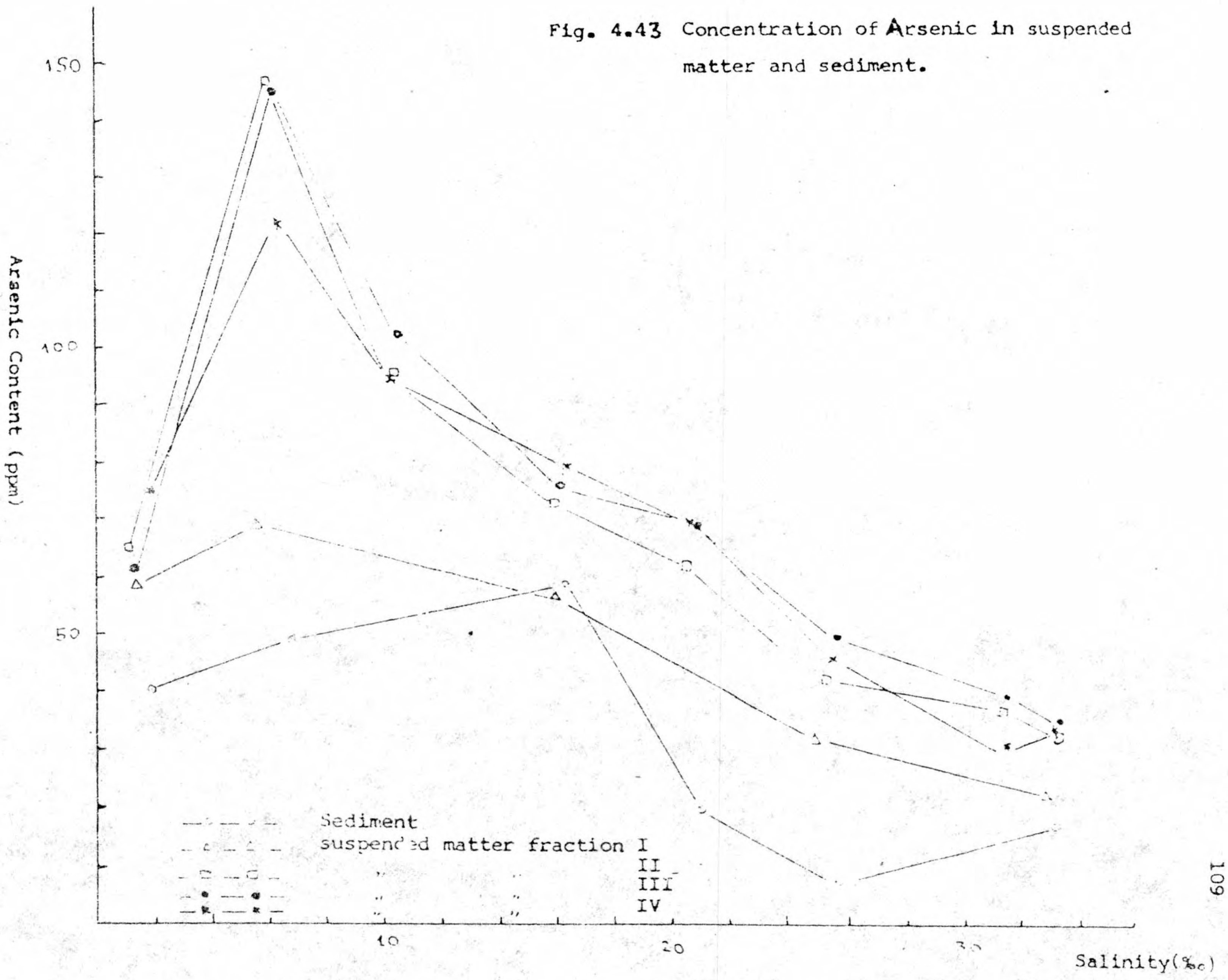


Fig. 4.43 Concentration of Arsenic in suspended matter and sediment.

Fig. 4.44 Concentration of Antimony in suspended matter and sediment.