Garroch Head Sludge Dumping Ground Survey

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GARROCH HEAD SLUDGE DUMPING GROUND SURVEY

Preliminary report on the monitoring survey carried out on 7th - 12th May 1984.

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INTRODUCTION

Sampling was carried out between the 7th and 12th May 1984 from R.V. 'Calanus'. A total of sixty-one sampling stations were occupied where various samples were taken as detailed below. A list of all sampling stations and samples taken is given in Table 1. The station positions were based on the Decca Navigator grid as shown in Figure 1 and are listed in Table 1(a). In addition otter trawl samples were taken over the dumping ground and over a control area some six kilometres to the north west of the dumping ground. Agassiz trawl samples were taken over several locations. Trawl sample areas are marked on Figure 1.

Sediment Redox Potential Survey

Core samples were taken at sixty sampling stations occupied throughout the area and the redox potential (Eh) profile down the core was recorded using standard redox electrodes. The redox levels at 40 mm depth in the sediment have been used for interstation comparisons. Low redox values are indicative of highly reducing conditions in the sediment brought about by the degradation of large amounts of carbonaceous material. Figure 2 shows those areas found to have low redox values.

Reducing conditions (negative redox values) were found around the dumping grounds in an area some 10 Km^2 in extent. Very low redox values were found 1 Km to the north and about 0.5 Km to the south of the centre of the dumping area. A further area of low potentials was found to the north of the designated grounds and some two kilometres south of Garroch Head. This northerly area of low potentials was similar in extent to that observed in May 1983. The area of low redox values in the

centre of the grounds was similar in extent to that seen in 1983. In general redox values in the most affected areas were somewhat higher than in May, 1983.

Oxygen content of overlying water

The oxygen content of the water immediately above the sediment surface was measured at station P1 situated seven kilometres from the centre of the dumping ground and at four stations situated from the edge to the centre of the grounds. The values obtained are given in Table 2 and vary about 8 mg O_2/L i.e. the bottom water over the dumping ground was fully oxygenated.

Transect Survey

The two lines of transect stations sampled during the previous surveys were again occupied. A grab sample was obtained from selected stations and sieved on a 1 mm mesh and the residue examined for large benthic invertebrates. At several of these stations the residue was retained for detailed examination of the macrobenthic fauna. Samples for the analysis of the heavy metal and organochlorine contents of the sediments were obtained from replicate core samples taken at the transect stations. Populations of macrofauna were present in all the samples taken. Numbers found in the centre of the grounds were similar to the low numbers found in 1983. Preliminary visual examination of the samples for the presence or absence of particular large dominant macrofaunal species showed that sedimentary conditions and faunal communities varied in essentially the same manner along both transects. In the centre of the dumping grounds the sediments contained large

quantities of organic material, were black in colour and showed negative redox potential. The fauna in these areas consisted of a few small nematodes, Capitellid and Spionid worms. Total abundance appeared to be similar to those seen in the centre of the grounds in 1983. As distances from the centre of the dumping area increased these small worms were replaced by a more varied fauna of larger polychaetes and molluscs until at the edges of the affected area, some 3.5 Km^2 from the centre, where the sediments were brown/grey in colour, contained little visible organic material and showed positive redox potentials, a diverse community of polychaetes, molluscs, echinoderms and crustacea, similar to that found on soft silt sediments elsewhere in the Firth of Clyde, was found.

Diagrammatic summaries of these various changes along the transects are given in Figures 3 and 4.

Conditions along the northern arm of the N/S transect are slightly more varied than in other areas. In that area redox potentials are more variable and faunal distributions suggest a fluctuating but generally higher input of organic material to the sediments.

Depth of Sludge Deposit

Long core samples were taken by gravity cores from the centre of the dumping ground (station P7), from station P5 at 2 Km west of the centre and from station P1 situated 7 Km west of the centre of the ground. At P7 the upper 13 cm of the sample consisted of a black deposit of sludge. Below 60 cm normal light-brown clay sediment was present. No sludge was obvious in the samples from P1 and P5 (Figure 5).

Trawl Survey

Two ten minute otter trawl hauls were taken, the first across the centre of the dumping ground, the second from station G1 to G3 some 6 Km north-west of the centre of the dumping grounds. Large numbers of Saithe were taken in the trawl from the dumping ground with Cod and Long Rough Dab less numerous than in 1983. Seven other species were present. Ten species were found in the G1/G3 trawl with Norway Pout, Cod and Poor Cod the most numerous species present. There were, however, fewer fish in this area compared with those caught at D11/E12 in 1983. A summary of the species taken in the various hauls is given in Table 3. Specimens of live fish from the centre of the dumping ground and the area to the NE were taken for bacteriological examination.

Agassiz trawl hauls were taken in the areas shown in Table 4. Distributions of large epibenthic species e.g. Nephrops norvegicus (Norway lobster), Crangon allmani (Shrimp), Pandalus montagui (Prawn) and Buccinum undatum (Whelk) were similar to those observed in previous years in most of the areas examined. Near the centre of the dumping area, however, few of these species were obtained in the hauls (see Table 4). Specimens of invertebrates were deep frozen and retained for metal and organochlorine analyses.

Conclusions

Areas of reduced sediment were present in the vicinity of the designated dumping grounds and in an area to the north of the grounds but redox values in these areas were somewhat higher than in 1983. Macrofaunal populations in the centre of the dumping grounds appeared to be similar to those noted in the previous survey in May, 1983. High

populations of Saithe were again taken over the dumping grounds, but the numbers of Cod and Long Rough Dab were considerably less than in 1983.

Table 1. List of stations occupied, sediment type and samples taken.

Station	Depth (m)	Sample Taken*	Sediment Type	Gear
A8	92	Eh,pH	0-10 cm light brown silt, darker below	Corer
C7	76	Eh,pH	0-10 cm light brown silt, black below	Corer
C8	88	Eh,pH	0-10 cm light brown silt, black below	Corer
D7	96	Eh,pH F,HM,OC.	0-4 cm light brown silt with black streaks, black below	Corer Van-Veen Grab
D9	96	Eh,pH	0-10 cm light brown silt brown-black below	Corer
E6	80	Eh,pH	0-10 cm light brown silt, brown-black below	Corer
E7	89	Eh,pH F,HM,OC	0-10 cm light brown silt with black streaks, black below	Corer Van-Veen Grab
E8	100	Eh,pH	0-10 cm light brown silt brown-black below	Corer
F7	84	Eh,pH F,HM,OC	0-10 cm light brown silt with black streaks, black below	Corer
G1	93	Eh,pH F,HM,OC	Light brown silt throughout	Corer Van-Veen Grab
G5	62	Eh,pH	0-7.5 cm dark brown silt	Corer
G6	78	Eh,pH	0-4 cm brown, brown-black below	Corer
G7	80	Eh,pH F,HM,OC	0-10 cm light brown silt, black areas below	Corer Van-Veen Grab
G8	84	Eh,pH	0-4 cm light brown silt, black below	Corer
G9	83	Eh,pH	0-8 cm light brown silt, brown-black below	Corer
I7	80	Eh,pH F,HM,OC	0-10 cm brown silt, brown-black below	Corer Van-Veen Grab
I8	90	Eh,pH	0-3.5 cm light brown silt, occasional black streaks	Corer

Table 1 (continued)

Station	Depth (m)	Sample Taken*	Sediment Type	Gear
J5	88	Eh,pH	Brown silt throughout	Corer
J7	77	Eh,pH	Dark brown silt throughout	Corer
J9	75	Eh,pH	Brown silt throughout	Corer
K7	80	Eh,pH F,HM,OC	0-10 cm brown silt, dark-brown below	Corer Van-Veen Grab
L7	76	Eh,pH F,HM,OC.	0-3 cm brown silt, brown-black below	Corer Van-Veen Grab
M5	92	Eh,pH	Dark brown silt throughout	Corer
M7	74	Eh,pH F,HM,OC.	Dark brown-grey silt throughout with some black streaks	Corer Van-Veen Grab
M9	76	Eh,pH	0-4 cm brown silt, dark-brown below	Corer
M11	76	Eh,pH	0-4 cm brown silt, dark-brown below	Corer
N7	76	Eh,pH F,HM,OC.	Dark-brown-black silt flocculent on surface	Corer Van-Veen Grab
O7	80	Eh,pH	Dark brown-black silt flocculent at surface	Corer
P1	144	Eh,pH,O_2 F,HM,OC.	0-19 cm light brown silt throughout	Corer Van-Veen Grab
P2	154	Eh,pH	0-1 cm light brown silt, brown below	Corer
P3	167	Eh,pH	Light brown silt throughout	Corer
P4	156	Eh,pH F,HM,OC.	Light brown silt, darkening below	Corer Van-Veen Grab
P5	126	Eh,pH,O_2 F,HM,OC.	Light brown silt throughout	Corer Van-Veen Grab
P5.5	110	Eh,pH F,HM,OC.	Dark brown silt throughout	Corer Van-Veen Grab
P6	96	Eh,pH,O_2 F,HM,OC.	0-10 cm dark-brown silt, with black streaks	Corer Van-Veen Grab

Table 1 (continued)

Station	Depth (m)	Sample Taken	Sediment Type	Gear
P6.5	92	Eh,pH	Sludge at surface black below	Corer
P7	86	Eh,pH,O_2 F,HM,OC.	Sludge at surface Black sludge silt below	Corer Van-Veen Grab
P7.5	77	Eh,pH	Sludge at surface black silt below	Corer
P8	74	Eh,pH,O_2 F,HM,OC	Sludge at surface, silt below	Corer Van-Veen Grab
P8.5	68	F		Van-Veen Grab
P9	65	Eh,pH F,HM,OC.	0-4 cm light-brown, dark brown below	Corer Van-Veen Grab
P9.5	80	Eh,pH	Dark brown silt throughout with black streaks	Corer
P10	79	Eh,pH F,HM,OC.	Brown silt at top slightly darker brown below	Corer Van-Veen Grab
P10.5	81	Eh,pH	Brown silt at top slightly darker brown below	Corer
P11	86	Eh,pH F,HM,OC.	Brown silt throughout very slightly darker brown below	Corer Van-Veen Grab
P12	78	Eh,pH F,HM,OC.	Brown silt throughout	Corer Van-Veen Grab
Q7	84	Eh,pH	Dark brown-black throughout	Corer
R7	100	Eh,pH F,HM,OC.	Sludge at surface, black throughout	Corer Van-Veen Grab
S3	116	Eh,pH	0-10 cm dark brown silt throughout	Corer
S5	165	Eh,pH	0-10 cm dark brown silt, some black streaks below	Corer
S7	108	Eh,pH F,HM,OC.	Sludge at surface black throughout	Corer Van-Veen Grab

Table 1 (continued)

Station	Depth (m)	Sample Taken	Sediment Type	Gear
S9	76	Eh,pH	Dark brown silt, black below	Corer
S11	80	Eh,pH	Brown silt throughout, darker brown below	Corer
T7	122	Eh,pH F,HM,OC.	0-5 cm dark brown-grey at surface, flocculent at top (0.5 cm), darker below	Corer Van-Veen Grab
U7	158	Eh,pH	Dark brown silt throughout	Corer
V5	142	Eh,pH	Dark brown silt throughout	Corer
V7	180	Eh,pH F,HM,OC.	Brown silt throughout	Corer Van-Veen Grab
V9	119	Eh,pH	Dark brown silt throughout	Corer
W7	166	Eh,pH	Dark brown silt throughout	Corer
X7	144 m	Eh,pH F,HM,OC.	Dark brown silt throughout	Corer Van-Veen Grab
AZ7	106	Eh,pH F,HM,OC	Brown silt throughout	Corer Van-Veen Grab

* Eh, Redox potential measurements taken at 1 cm intervals down core samples.

pH, Acidity measurememnts taken at 1 cm intervals down core samples.

O_2, Oxygen content of water immediately above the sediment surface measured.

F, Grab sample for faunal analysis taken.

HM, Sediment sample for Heavy Metal Analysis taken.

OC, Sediment sample for Organochlorine Analysis taken.

Table 1(a). Station positions.

Station	Decca co-ordinates		Chart co-ordinates	
	Red	Purple	North	West
A 8	D23.0	J68.0	55°43.25'	4°59.5'
C 7	E 0.0	J66.0	55°42.92'	5°0.55'
C 8	D23.0	J66.0	55°42.72'	4°59.65'
D 7	E 0.0	J65.0	55°42.68'	5°0.30'
D 9	D22.0	J65.0	55°42.32'	4°58.72'
E 6	E 1.0	J64.0	55°42.60'	5°1.57'
E 7	E 0.0	J64.0	55°42.44'	5°0.70'
E 8	D23.0	J64.0	55°42.25'	4°59.72'
F 7	E 0.0	J63.0	55°42.18'	5°0.72'
G 1	E 6.0	J62.0	55°42.95'	5°6.23'
G 5	E 2.0	J62.0	55°42.28'	5°2.62'
G 6	E 1.0	J62.0	55°42.14'	5°1.72'
G 7	E 0.0	J62.0	55°41.95'	5°0.75'
G 8	D23.0	J62.0	55°41.77'	4°59.81'
G 9	D22.0	J62.0	55°41.62'	4°58.80'
I 7	E 0.0	J60.0	55°41.47'	5°0.85'
I 8	D23.0	J60.0	55°41.32'	4°59.95'
J 5	E 2.0	J59.0	55°41.57'	5°2.75'
J 7	E 0.0	J59.0	55°41.25'	5°0.84'
J 9	D22.0	J59.0	55°40.94'	4°59.06'
K 7	E 0.0	J58.0	55°41.00'	5°1.30'
L 7	E 0.0	J57.0	55°40.77'	5°1.36'
M 5	E 2.0	J56.0	55°40.85'	5°2.90'
M 7	E 0.0	J56.0	55°40.52'	5°1.05'
M 9	D22.0	J56.0	55°40.21'	5°0.78'
M11	D20.0	J56.0	55°39.90'	5°2.62'
N 7	E 0.0	J55.0	55°40.29'	5°1.10'
O 7	E 0.0	J54.0	55°40.06'	5°1.15'
P 1	E 6.0	J53.0	55°40.73'	5°6.72'
P 2	E 5.0	J53.0	55°40.58'	5°5.78'

Table 1(a) (continued)

Station	Decca co-ordinates		Chart co-ordinates	
	Red	Purple	North	West
P 3	E 4.0	J53.0	55°40.43'	5°5.12'
P 4	E 3.0	J53.0	55°40.25'	5°3.98'
P 5	E 2.0	J53.0	55°40.11'	5°3.05'
P5.5	E 1.5	J53.0	55°40.02'	5°2.53'
P 6	E 1.0	J53.0	55°39.97'	5°2.14'
P6.5	E 0.5	J53.0	55°39.88'	5°1.68'
P 7	E 0.0	J53.0	55°39.80'	5°1.20'
P7.5	D23.5	J53.0	55°39.74'	5°0.74'
P 8	D23.0	J53.0	55°39.65'	5°0.30'
P8.5	D22.5	J53.0	55°39.58'	4°59.86'
P 9	D22.0	J53.0	55°39.52'	4°59.38'
P9.5	D21.5	J53.0	55°39.43'	4°58.88'
P10	D21.0	J53.0	55°39.35'	4°48.45'
P10.5	D20.5	J53.0	55°39.30'	4°58.00'
P11	D20.0	J53.0	55°39.20'	4°57.70'
P12	D19.0	J53.0	55°39.05'	4°56.60'
Q 7	E 0.0	J52.0	55°39.58'	5°1.25'
R 7	E 0.0	J51.0	55°39.35'	5°1.35'
S 3	E 4.0	J50.0	55°39.70'	5°5.00'
S 5	E 2.0	J50.0	55°39.40'	5°3.18'
S 7	E 0.0	J50.0	55°39.12'	5°1.32'
S 9	D22.0	J50.0	55°38.80'	4°59.56'
S11	D20.0	J50.0	55°38.53'	4°57.70'
T 7	E 0.0	I79.0	55°38.87'	5°1.40'
U 7	E 0.0	I78.0,	55°38.65'	5°1.45'
V 5	E 2.0	I77.0	55°38.67'	5°3.30'
V 7	E 0.0	I77.0	55°38.38'	5°1.50'
V 9	D22.0	I77.0	55°38.12'	4°59.70'
W 7	E 0.0	I76.0	55°38.15'	5°1.53'
X 7	E 0.0	I75.0	55°37.93'	5°1.57'
AZ 7	E 0.0	I71.0	55°36.97'	5°1.77'

Table 2. Oxygen content of the water immediately above the sediment surface (mean values from two samples).

Station	Oxygen Content mg O_2/L
P1	7.8
P5	7.9
P6	8.2
P7	8.0
P8	8.4

(Taken at 10.00 hrs 7.5.84; prior to daily sludge disposal).

Table 3. Species taken in otter trawl hauls.

1. Trawl across dumping ground (07-Q7) 10 minutes on bottom.

Cod,	Gadus morhua	29
Saithe,	Pollachius virens	202
Norway Pout,	Trisopterus esmarki	2
Common Dab	Limanda limanda	1
Long Rough Dab,	Hippoglossoides platessoides	16
Whiting,	Merlangius merlangus	5
Poor Cod,	Trisopterus minutus	13
Haddock	Melanogrammus aeglefinus	2
Plaice,	Pleuronectes platessa	4
Flounder	Platichthys flesus	2

2. Trawl 6 km north-west of dumping ground (G1-G3)
10 minutes on bottom.

Cod	Gadus morhua	6
Norway Pout,	Trisopterus esmarki	27
Long Rough Dab	Hippoglossoides platessoides	3
Whiting	Merlangius merlangus	4
Poor Cod,	Trisopterus minutus	6
Haddock	Melanogrammus aeglefinus	1
Plaice	Pleuronectes platessa	4
Flounder	Platichthys flesus	2
Hake	Merluccius merluccius	5
Gurnard	Eutriglia gurnardus	1

Table 4. Species taken in Agassiz Trawl hauls.

1. E11-D12. 2 trawls of 10 min on bottom.

   Nephrops and Pandalus numerous.

   Buccinum and Crangon also obtained.

2. D7-E7,10 minutes on bottom.

   Specimens of Apphorais pes-pelecani and Buccinum numerous.

   Pandalus and Crangon, common.

   Nephrops occasional.

3. I7-J7. 10 minutes on bottom.

   Specimens of Apphorais pes-pelecani, Buccinum, Pandalus and Crangon, common and collected.

4. Q7-R7

   2 trawls at 10 min on bottom, no macrofauna obtained.

5. Q7-R6 2 trawls at 10 min on bottom.

   A few Buccinum only, mainly cirratulid polychaetes in hauls.

Captions to Figures.

Figure 1. Map showing sampling grid and station positions with trawl positions marked.

Figure 2. Redox potential (Eh) values at 4 cm depth in the sediment.

Figure 3. Variation in redox potential at 4 cm depth in the sediment along the East-West transect compared with the distribution of large macrofaunal species observed in the grab samples.

Key Bl, Brissopsis lyrifera; Ns, Nucula sp.;
Ac, Amphiura chiajei; Sk, Spiophanes kroyeri;
Aa, Abra alba; Lj, Lipobranchius jeffreysi;
Ga, Glycera alba; Tf, Thyasira flexuosa;
Nl, Notomastus latericeus;
Ct, Cirriformia tentaculata; Capitella capitata;
Sf, Scolelepis fuliginosa.

Figure 4. Variation in redox potential at 4 cm depth in the sediment along the North-South transect compared with the distribution of large macrofaunal species observed in the grab samples.

Key as for Fig. 3

Figure 5. Comparison of sediment colour profiles at various points along the East-West transect with estimates of sludge depth.

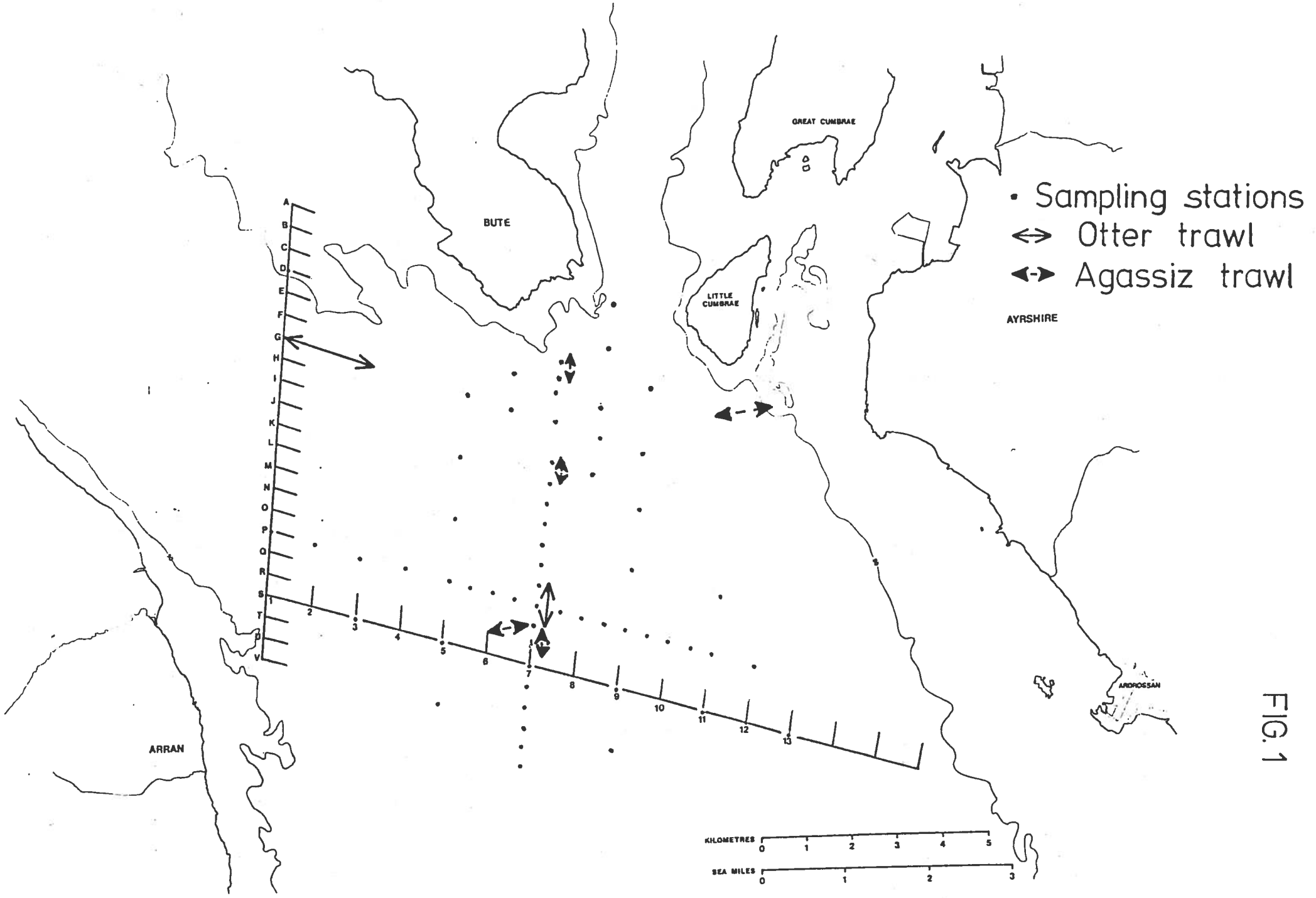

• Sampling stations
⇔ Otter trawl
◂-▸ Agassiz trawl
BUTE
GREAT CUMBRAE
LITTLE CUMBRAE
AYRSHIRE
ARRAN
ARDROSSAN
A
B
C
D
E
F
G
H
I
J
K
L
M
N
O
P
Q
R
S
T
U
V
1
2
3
4
5
6
7
8
9
10
11
12
13
KILOMETRES 0 1 2 3 4 5
SEA MILES 0 1 2 3

FIG. 1

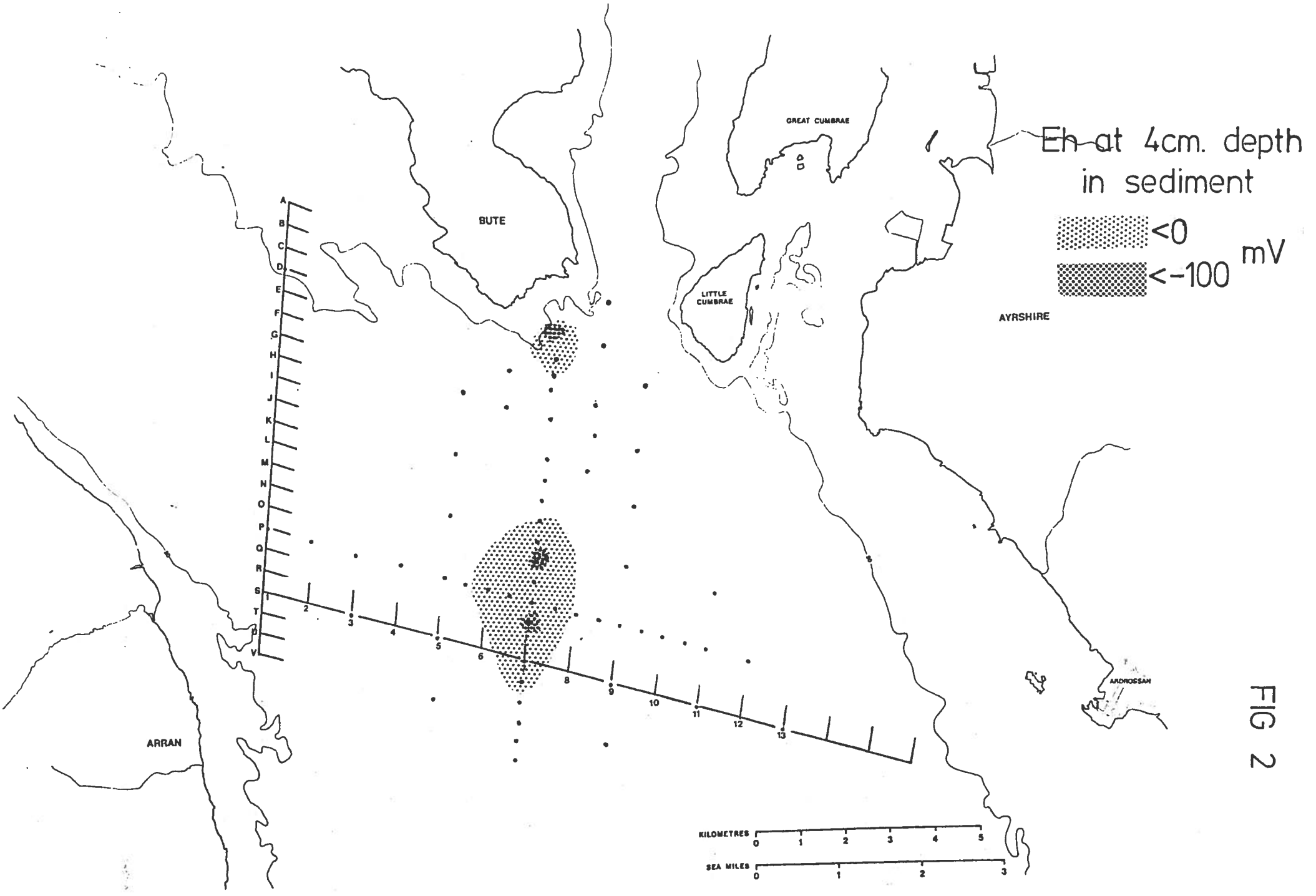

Eh at 4cm. depth
in sediment
<0
<-100 mV
GREAT CUMBRAE
BUTE
LITTLE CUMBRAE
AYRSHIRE
ARRAN
ARDROSSAN
A
B
C
D
E
F
G
H
I
J
K
L
M
N
O
P
Q
R
S
T
U
V
1
2
3
4
5
6
8
9
10
11
12
13
KILOMETRES
0 1 2 3 4 5
SEA MILES
0 1 2 3

FIG 2

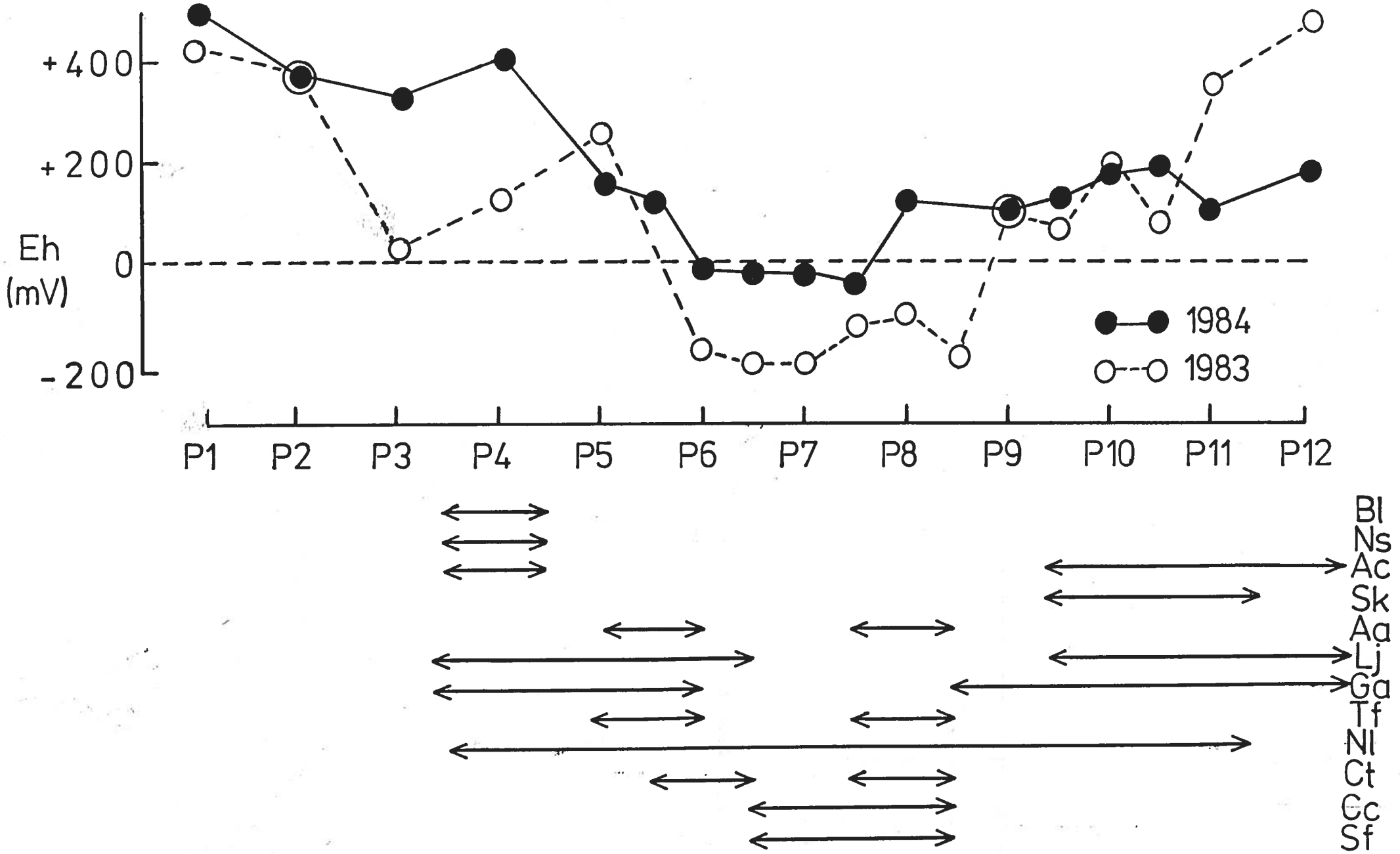

+400
+200
Eh
(mV)
0
-200
1984
1983
P1
P2
P3
P4
P5
P6
P7
P8
P9
P10
P11
P12
Bl
Ns
Ac
Sk
Aa
Lj
Ga
Tf
Nl
Ct
Cc
Sf

FIG 3

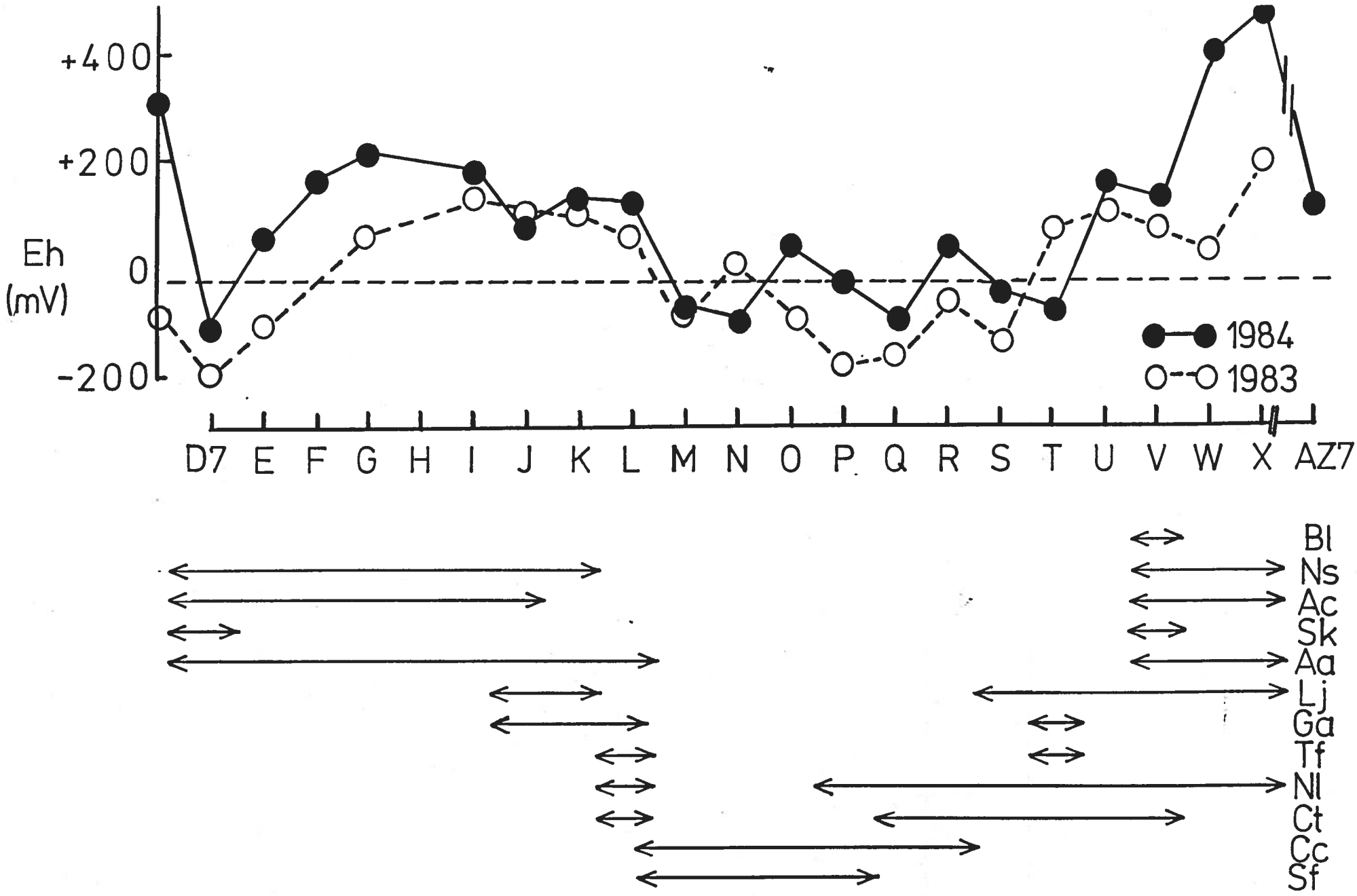
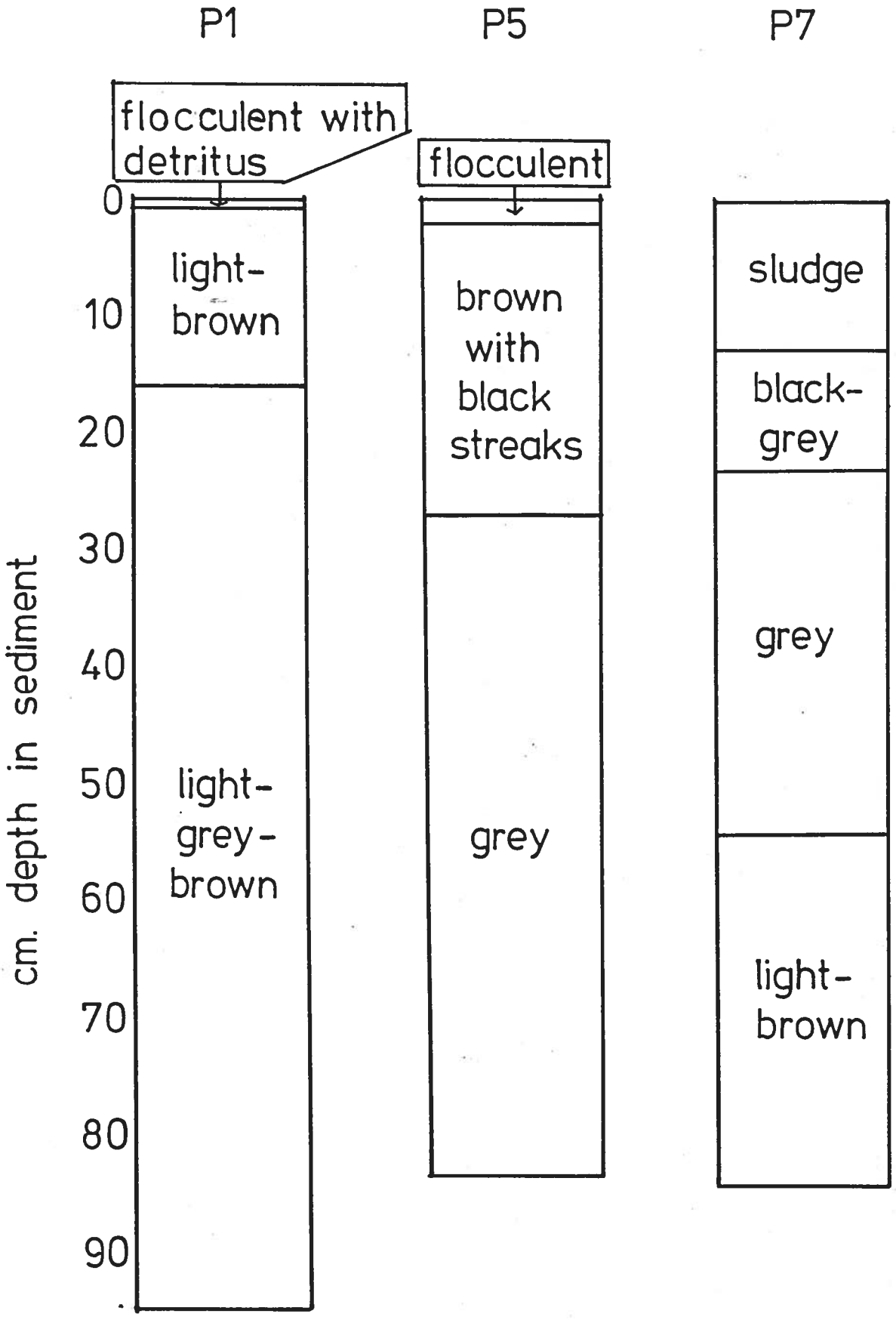

+400
+200
Eh
(mV)
0
-200
1984
1983
D7 E F G H I J K L M N O P Q R S T U V W X AZ7
Bl
Ns
Ac
Sk
Aa
Lj
Ga
Tf
Nl
Ct
Cc
Sf

FIG 4

FIG 5


P1
P5
P7
flocculent with detritus
flocculent
0
10
20
30
40
50
60
70
80
90
cm. depth in sediment
light-brown
light-grey-brown
brown with black streaks
grey
sludge
black-grey
grey
light-brown