P.O.L.

RRS CHALLENGER

CRUISE 84

5-20 SEPTEMBER 1991

CURRENT PROFILES

NORTHERN NORTH SEA

CRUISE REPORT NO. 12

1991

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PROUDMAN OCEANOGRAPHIC LABORATORY

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RRS CHALLENGER

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Current Profiles

Northern North Sea

Principal Scientist

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1991

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ABSTRACT

The objectives of this cruise were

1) To deploy and maintain 22 moorings within 25km of 59° 40'N 1° 00'E.

2) To measure vertical, horizontal and temporal variations of temperature, salinity and currents around the moorings using CTD, SeaSoar and ship ADCP systems.

3) To deploy and recover drogued drifting buoys.

4) To make detailed depths and sea-bed (grab and photographic) surveys in the immediate vicinity of the moorings.

These objectives were extensively achieved.

1) 36 mooring deployments or recoveries were carried out.

2) 101 CTD profiles were obtained; two SeaSoar runs were recorded; the ship ADCP was operated continuously throughout the cruise.

3) All but one of the drogued buoys were recovered; the remaining buoy is being tracked.

4) Grab samples and sea-bed photographs were obtained. No special depth survey was conducted.

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OBJECTIVES AND PLAN

1. To deploy and maintain 22 moorings at 9 sites (A - I, Figure 1 and Table 1) within 25 km of 59° 40'N 1° 00'E.
2. To measure vertical, horizontal and temporal variations of temperature, salinity and currents around the moorings using CTD, SeaSoar and ship ADCP systems.
3. To deploy and recover drogued drifting buoys.
4. To make detailed depth and sea-bed (grab and photographic) surveys in the immediate vicinity of the moorings.

To meet these objectives three phases to the cruise were planned :-

1. Deployment of moorings and drogues. 20 moorings to be deployed consecutively during daylight hours; hourly CTD profiles and ADCP measurements at site A during the night.
2. CTD, SeaSoar, ADCP and sea-bed surveys.
3. Recovery of the drogues and mooring redeployments. 2 moorings to be recovered; 2 moorings deployed; 7 moorings to be recovered and redeployed to obtain the data and to refresh batteries and tapes. Mooring operations to take place during daylight; hourly CTD profiles and ADCP measurements at site A during the night.

Apart from the moorings and drogues the major items of equipment used were:-

CTD

Sensors - temperature, conductivity, pressure, fluorescence, transmittance, dissolved oxygen, upwelling and downwelling irradiance.

Rossette - two 10l Niskin bottles fitted with electronic thermometers.

CTD calibration / check - temperature and salinity only.

Thermosalinograph

Calibration - against CTD measurements.

SeaSoar

Sensors - temperature, conductivity, pressure.

Calibration / check. Against pre- and post-deployment CTD profiles.

Ship ADCP

Set-up - twenty 8m bins; blanking interval 4m; 5 minute sample interval;
error velocity check 0.75m/s.

The data from this equipment were all logged by the shipborne computer system - the thermosalinograph and the ADCP were logged continuously from the beginning to the end of the cruise, as were total surface irradiance, water depth and the navigation data (derived from main chain Decca, Satnav and GPS).

NARRATIVE

Loading of RRS Challenger in Dundee started on **2 September** as soon as the equipment from the preceding cruise, including the clean chemistry container, had been removed. The SeaSoar winch was fitted to the main deck and buoys (surface and subsurface), sea-bed frames, wires, chain and anchor weights were loaded onto the main and winch decks. Challenger cast off on schedule at 09.00 GMT on Thursday **5 September**, arriving at 59° 40'N 1°E at 09.48 on **6 September**; for the cruise track see Figure 2. From 10.00 to 18.45 (nightfall) seven moorings were deployed at site A, in the following order - met. buoy, POL ADCP, VAESAT surface current buoy, RVS (RDI) ADCP, pop-up current meter rig, ETA surface current rig and waverider, see Tables 1 and 2. The first CTD profile (69, Table 4) was recorded at 14.30. Throughout the night from 19.30 to 05.45 at hourly intervals CTD profiles 70 to 81 were recorded at site A.

Between 09.14 and 12.01 on **7 September** the three moorings at site I were deployed (pop-up current rig, POL ADCP and ETA surface current rig), followed by, from 14.13 to 15.56, the three at site H (ETA surface current rig, pop-up current meter rig and POL ADCP) and CTD profile 82. Back at A the DML surface current meter rig was deployed by 18.17. Throughout the night, from 19.00 to 07.00, CTD profiles 83 to 95 were recorded at hourly intervals, whilst STABLE was being assembled on the main deck under the A frame. Since the quality of the CTD's transmissometer record had deteriorated, the sensor was now replaced with a spare. STABLE was deployed at 07.36 on **8 September**, followed by the five thermistor chain rigs, at A (08.51), B (10.36), C (12.54), E (13.53) and D (15.36). Four drogued Argos / Decca

drifting buoys were then deployed (17.04 - 17.39) near 59° 50′N 0° 53′E, the first two with their drogues centred at a depth of 55m and the second two at 10m, Table 3. Phase 1 of the cruise programme had been completed.

Phase 2 started immediately with a CTD survey to determine the proximity of the Norwegian Coastal Current (profiles 96 - 113, Figure 3), proceeding eastward along 59° 48′N as far as 3°E, returning westward along 59° 25′N and arriving back at A at 20.00 on **9 September**. During this survey SeaSoar was tested, from 12.27 to 14.48 on 9 September. The vehicle performed well, profiling from the surface to 90m depth when the ship steamed at 7 knots with 200m of unfaired cable out. There were, however, no conductivity measurements, and so after recovery the sea unit was removed from the vehicle, opened and checked. Despite not finding a fault the sensor was by now working. The system was re-assembled and worked satisfactorily for the rest of the cruise. From 20.18 to 20.52 black-and-white photographs of the sea-bed at site A were obtained with a hopping camera system. The negatives were developed and showed that the sea-bed was reasonably smooth, with some signs of biological activity - urchins, starfish, worms and casts and mound / hollows.

The CTD survey was resumed northward, as far north as 61°N, and westward to the Shetland Islands, continuing to determine the temperature and salinity gradients near the moorings, profiles 114 - 130. Although the track was completed, surface measurements only were obtained during the northern portion because force 7 winds from the northwest stopped CTD operations (five intended CTD profiles were omitted between 07.00 and 14.00 on **10 September**). By 15.14 the wind had moderated and the CTD survey was continued with an excursion southward and further westward toward the Shetland Islands, returning to the vicinity of the moorings by mid-day on **11 September**. At 12.26 SeaSoar was deployed for a south to north run at 7 knots past the moorings at sites A to I. At 17.30 the course was reversed; SeaSoar was recovered at 18.59, Table 5, and CTD profile 131 recorded. Black-and-white photographs were taken of the sea-bed at sites I, G and A between 19.36 and 23.08, followed by a short, triangular CTD survey to the west of the mooring sites (profiles 132 - 138). A fault with the level B computer during profile 136 lead to profile 137 not being recorded by the shipborne computer. Following CTD profile 139 SeaSoar was deployed at 09.33 on **12 September** for a west to east run past sites H to A, the course being reversed

at 14.37. SeaSoar was recovered at 18.55, followed by CTD profile 140. During the recovery two of the cable's armouring strands were observed broken near the vehicle, so 20 m of the cable were cut off and new terminations made. Black-and-white sea-bed photographs were taken at sites H, F and A between 20.14 and 23.36, followed by a CTD survey to the south (profiles 141 - 147) from 23.43 to 12.15 on **13 September**. A fault with the level B computer during profile 143 also led to profile 144 not being recorded by the shipborne computer.

Phase 3 of the programme started with the recovery of two of the Argos/Decca drifting buoys. Since the Argos positions showed that the pair with drogues at 10m depth had stayed together, as had the pair with drogues at 55m depth, one from each pair was recovered. Two problems slowed the recoveries. Firstly, Challenger was unable to contact Argos by telex directly to obtain the latest buoy positions. Instead these had to be obtained via Barry, telexed, somewhat fitfully, to the ship . The second problem concerned the direction finding radio's aerial, which was jammed. Hence, in order to determine a buoy's bearing Challenger itself had to alter course. The search for the first buoy (no.3) started at 14.00 and was successfully concluded at 16.05. The waverider buoy was recovered at 17.20, its logger changed, and redeployed at 17.46. Challenger then steamed east and launched a 10m and a 55m Argos/Decca drifting buoy near 59° 40′N 0° 45′E. During the night colour photographs of the sea-bed near site A were taken (20.42 - 21.23) and hourly CTDs obtained from 22.00 to 04.00 (profiles 148 - 154). The search for the two original 55m drogues commenced at 05.00 on **14 September** and was successful when both buoys were located very close together. During the attempt to recover buoy 8 the sensor head of the ship's e-m log was damaged and the rope connecting the drogue to the buoy cut, so that the drogue was lost. Even so the buoy was recovered at 07.23

There being a moderate sea the day was spent in ADCP recoveries and deployments. Three ADCPs were recovered, turned round and redeployed at the same sites - at A (07.23-10.20), H (12.23-14.00) and I (16.47-18.25) - and ADCPs were deployed at F (14.58) and G (19.38). Hourly CTDs at A started at 21.00 with profile 155. However the wind's strength increased and, at 22.13, during the recovery on profile 156 the CTD hit the side of the ship with sufficient force to damage both the Niskin bottles. CTDs were suspended for the night, whilst winds of up to 40 knots from the southwest were experienced. During the morning the

weather calmed sufficiently for mooring recoveries at site A to take place after midday. The DML rig (AH, two S4 current meters) was recovered at 12.21 on **15 September**, followed by the ETA rig (AF, two S4s and two VMCMs) at 12.53. Since the new Argos beacons fitted to the ETA rig toroids had all failed within a few days of deployment, the beacon on this rig was removed. Inspection showed that seawater had leaked into its case through a bottom seal. It had been hoped to redeploy both of the rigs for a few hours with S4 current meters set to sample frequently (at 1 or 2 Hz), but the medium term forecast was not good and other work had a higher priority. The data were therefore extracted from the S4s on AF and their sample interval left at 10 minutes. The rig, minus the VMCMs as planned, was redeployed at 13.46. (All four S4s, on AF and AH, had recorded good quality data, as had one of the VMCMs. The data recorded by the other (top) VMCM were worthless because of a compass failure.) Since the sea had calmed down further, STABLE was recovered at 14.35. Both sets of acoustics had to be triggered before STABLE came to the surface; subsequent examination showed that one of the six (three duplicated) retractors had not worked because of an open circuit in an electric lead.

The next rig due for servicing was the ETA rig at site H (HB). However before the site was reached a radio call was received from the Peterhead trawler 'Budding Rose'. The trawler had got there first and after much effort recovered the rig, and, it later transpired, the pop-up current meter rig (HC) as well. The trawler was indeed seen with the toroid on its after deck. (All the equipment from both rigs, except for the middle Aanderaa current meter on HC, were subsequently returned to POL.) Challenger returned to site A for hourly CTDs through the night from 19.16 to 06.00 (profiles 157 - 168). Between profiles 158 and 159 two grab samples were obtained showing that the sea bed was composed fine sand / mud with evidence of biological activity, confirming the sea-bed photographs. After profile 168 site I was visited and the ETA rig (IB) recovered (07.55), data extracted from the S4s (no data had been recorded by the bottom S4), the Argos beacon removed and the rig redeployed at 09.13 on **16 September**. A CTD was recorded (169) and a grab sample obtained (there were pebbles here in addition to the fine sand).

The rest of the day was spent recovering the drifting drogued buoys. Since it was not possible to obtain up-to-date positions direct from Argos and since, despite requests, this information

was not forthcoming from Barry, the last known position (1.5 days old) of the first buoy was visited and a box search started. Its df radio signal was eventually located and the drogue and buoy recovered at 13.27. By this time latest positions had been obtained from Barry but the weather was worsening, with up to 30 knot winds from the southeast. The second buoy was recovered at 16.12, although the drogue was shredded by the ship's propeller. The third drogue was recovered at 17.50, again the drogue being shredded by the ship's propeller. However this time the drogue had its revenge as there was a regular clanking sound from the propeller region. Since nothing could shift this sound, Challenger steamed slowly to Lerwick where divers could inspect the propeller. Scientific work was now terminated, leaving one drifting buoy not recovered. When Lerwick was reached at 09.30 on **17 September** the divers immediately inspected the propeller - the drogue's bottom (steel) scaffolding pole was neatly wrapped two and a quarter times round the propeller boss. A couple of hours work with a hacksaw solved this problem.

It was only now that Challenger was informed of its destination and probable refit port (Greenock). Challenger left Lerwick at 13.30 but made slow progress around Cape Wrath because of strong headwinds and also from the Hebrides to the Mull of Kintyre because of strong cross winds. Challenger docked at Greenock at 10.00 on **20 September**.

CONCLUSIONS

The scientific programme had been very largely completed, although operations were curtailed by a day through the mishap with the drogue. No major disasters occurred, the minor technical problems which were encountered have been described in the narrative and were overcome through the use of spares and the skill of the RVS technicians and of the crew and officers. The most irritating problems were the difficulty in locating the drogues, the level B computer failures, the uncertainty concerning Challenger's destination (the refit port), both referred to above, and the attempt by RVS to shift part of the cost of the crew's overtime to POL.

Referring to the cruise's objectives :-

1. 36 mooring deployments or recoveries were carried out, Tables 1 and 2. Two moorings were recovered by a trawler.
2. 101 CTD profiles were obtained, Table 4 and Figure 3; two SeaSoar runs were recorded (one of 6 hours and one of 9 hours duration), Table 5; the ship ADCP was operated continuously throughout the cruise.
3. All the drogued buoys were deployed and one recovered and redeployed, Table 3. At the end of the cruise all but one of the buoys had been recovered, in the process losing three drogues. Although not the intention the track of the remaining buoy will make an interesting study.
4. Grab samples were obtained from sites A and I; black-and-white sea-bed photographs from sites A (2.5 films plus one colour film plus STABLE's film), F, G, H and I; no special depth survey was conducted.

Table 1. Times and positions of rig deployments and recoveries.

Rig	Instrument	Latitude N	Longitude E	Depth (m)	Deployed	Recovered
AA1	ADCP	59 39.92	00 59.70	120	10:25 06/9	08:30 14/9
AA2		59 39.66	00 59.85		10:20 14/9	
AB	STABLE	59 39.91	00 59.26	119	07:36 08/9	14:24 15/9
AC1	Waverider	59 40.08	01 00.14		18:43 06/9	17:20 13/9
AC2		59 39.74	01 00.13		17:46 13/9	
AD	Met. buoy	59 40.15	00 59.30	119	10:04 06/9	
AE	Thermistor	59 39.87	01 00.24		08:51 08/9	
AF1	Surface cm	59 39.84	01 00.75		18:18 06/9	12:40 15/9
AF2		59 39.86	01 00.99	118	13:46 15/9	
AG	Pop-up cm	59 40.13	00 59.82		15:40 06/9	
AH	Surface cm	59 39.97	01 00.75	118	18:17 07/9	12:11 15/9
AI	VAESAT	59 40.03	01 00.34	118	13:00 06/9	
AK	RDI-ADCP	59 39.92	00 59.84	119	13:35 06/9	
BA	Thermistor	59 39.82	00 58.63	120	10:36 08/9	
CA	Thermistor	59 40.36	01 00.10	119	12:54 08/9	
DA	Thermistor	59 40.00	00 54.00	119	15:36 08/9	
EA	Thermistor	59 42.95	00 59.73	118	13:53 08/9	
FA	ADCP	59 39.95	00 49.16	122	14:58 14/9	
GA	ADCP	59 45.51	01 00.00	120	19:38 14/9	
HA1	ADCP	59 40.00	00 32.37	129	15:56 07/9	12:25 14/9
HA2		59 39.98	00 32.48	130	14:00 14/9	
HB	Surface cm	59 39.96	00 32.95		14:28 07/9	Trawled 15/9
HC	Pop-up cm	59 40.01	00 32.66	129	15:47 07/9	Trawled 15/9

Table 1 (ctd).

Rig	Instrument	Latitude N	Longitude E	Depth (m)	Deployed	Recovered
IA1	ADCP	59 53.55	01 00.29	118	10:03 07/9	16:41 14/9
IA2		59 53.58	01 00.31	117	18:24 14/9	
IB1	Surface cm	59 53.41	01 00.88	115	11:59 07/9	07:46 16/9
IB2		59 53.43	01 01.05	115	09:12 16/9	
IC	Pop-up cm	59 53.55	01 00.07	116	09:32 07/9	

Table 2. Equipment on moorings.

Rig	Mooring	Equipment
AA	ADCP	POLDOP 6; Frame 18; Compass 4; WLR 444; Benthos release 6A.
AB	STABLE	Benthos releases 2A and 5B.
AC	Waverider	
AD	Met. buoy	Wind speed & direction; atmospheric pressure; air and sea temperature; solar radiation; relative humidity.
AE	Thermistor	Spar 1; Logger 7; 75m chain 1904, 16-91m below the sea surface.
AF1	Surface cm (ETA)	32" subsurface 28; Toroid 1; Argos beacon 1274; Benthos beacon 4. Current meters - S4 1644, VMCM 604, VMCM 704, S4 1307 at 5, 7, 12, 20m below the sea surface.
AF2	Surface cm (ETA)	32" subsurface 28; Toroid 1; Benthos beacon 4. Current meters - S4 1644, S4 1307 at 5, 15m below the sea surface.
AG	Pop-up cm	40" subsurface 81; Benthos release 063. Current meters - S4 1261, RCM7 9632, RCM8 9680, RCM4 7570 at 92, 75, 50, 10m above the sea bed.
AH	Surface cm (DML)	32" subsurface 9. Current meters - S4 956, S4 958 at 2, 4m below the sea surface.
AI	2m VAESAT	32 " subsurface 81.
AK	RDI-ADCP	Oceano release 1408.
BA	Thermistor	Spar 4; Logger 9; 40m chain 1612, 22-62m below the sea surface.
CA	Thermistor	Spar 5; Logger 11; 50m chain 1756, 22-72m below the sea surface.
DA	Thermistor	Spar 2; Logger 10; 75m chain 1903, 16-91m below the sea surface.
EA	Thermistor	Spar 3; Logger 8; 75m chain 1905, 16-91m below the sea surface.
FA	ADCP	POLDOP 3; Frame 5; Compass 5; Benthos release 2B.
GA	ADCP	POLDOP 7; Frame 23; Compass 2; Benthos release 3B.

Table 2 (ctd).

Rig	Mooring	Equipment
HA	ADCP	POLDOP 9; Frame 15; Compass 3; WLR 10; Benthos release 5A.
HB	Surface cm (ETA)	32" subsurface 1; Toroid 3; Argos beacon 6252; Benthos beacon 3. Current meters - S4 1196, S4 1113 at 5, 15m below the sea surface.
HC	Pop-up cm	40" subsurface 79; Benthos release 8A. Current meters - S4 1119, RCM7 9631, RCM7 9633, RCM4 3277 at 102, 75, 50, 10m above the sea bed.
IA	ADCP	POLDOP 1; Frame 20; Compass 6; WLR 445; Benthos release 4A.
IB	Surface cm (ETA)	32" subsurface 6; Toroid 2; Argos beacon 1275. Current meters - S4 1258, S4 1263 at 5, 15m below the sea surface.
IC	Pop-up cm	40" subsurface 17; Benthos release 2. Current meters - S4 1264, RCM7 9959, RCM8 9652, RCM4 568 at 85, 70, 50, 10m below the sea surface.

Notes

1. Moorings.	ADCPs and STABLE are pop-up sea bed frames. Waverider, Met. buoy, Thermistor chain and Pop-up current meter moorings are single strand. Surface current meter and VAESAT moorings consist of a surface buoy tethered to a moored subsurface buoy; current meters are mounted or suspended beneath the surface buoy .
2. Current meters (cm)	InterOcean S4, EG&G VMCM, Aanderaa RCM4, RCM7, RCM8.
3. Thermistor chains	Seadata loggers and Aanderaa chains.
4. Pressure recorders	Aanderaa WLR.
5. Surface buoys	6m spar; 2m diameter toroid.
6. Subsurface buoys	32" and 40" diameter hollow steel spheres.

Table 3. Drogue deployments and recoveries. The drogues on buoys 8, 10 and the second deployment of 3 were lost during the recovery.

Buoy	Drogue Depth (m)	Deployment Time		Latitude N	Longitude E	Recovery Time		Latitude N	Longitude E
3	10	17:40	8/9	59 50.18	0 53.38	16:05	13/9	59 42.03	0 55.20
7	55	17:08	8/9	59 49.86	0 53.81	13:27	16/9	59 40.88	1 07.20
8	55	17:21	8/9	59 49.95	0 53.59	7:23	14/9	59 44.20	0 58.50
10	10	17:31	8/9	59 50.05	0 53.49	16:12	16/9	59 32.24	1 15.87
3	10	19:18	13/9	59 39.89	0 40.03	17:50	16/9	59 35.20	0 57.60
6	55	19:14	13/9	59 39.92	0 40.05				

Table 4. CTD positions. Sensor serial numbers - CTD 1117; fluorimeter 244; transmissometer (profiles 69 -95) 125; transmissometer (profiles 96 - 169) 103; upwelling irradiance 11; downwelling irradiance 12.

CTD	Start		Finish		Latitude N		Longitude E		Depth (m)	Comments
69	249	14:30	249	14:53	59	40.0	0	58.4	119	A
70	249	19:26	249	19:49	59	40.5	0	59.4	119	A
71	249	20:18	249	20:36	59	40.5	0	58.8	120	A
72	249	20:58	249	21:15	59	40.8	0	60.0	118	A
73	249	21:56	249	22:13	59	40.4	1	0.5	121	A
74	249	23:00	249	23:18	59	40.8	1	1.0	121	A
75	250	00:12	250	00:32	59	40.9	1	1.5	120	A
76	250	01:01	250	01:22	59	41.1	1	1.5	121	A
77	250	02:00	250	02:20	59	41.3	1	1.0	117	A
78	250	02:57	250	03:20	59	41.5	1	0.2	117	A
79	250	04:00	250	04:23	59	41.5	0	59.5	117	A
80	250	05:00	250	05:19	59	41.6	1	0.0	117	A
81	250	05:44	250	06:02	59	40.6	1	0.4	119	A
82	250	16:13	250	16:30	59	40.1	0	31.8	129	H
83	250	19:01	250	19:18	59	40.0	1	1.4	119	A
84	250	19:59	250	20:14	59	39.6	1	1.8	119	A
85	250	20:56	250	21:14	59	39.0	1	2.0	118	A
86	250	22:04	250	22:20	59	39.6	1	1.8	118	A
87	250	22:56	250	23:10	59	38.9	1	1.8	119	A
88	250	23:57	251	00:13	59	38.1	1	1.7	117	A
89	251	01:04	251	01:21	59	37.5	1	1.4	117	A
90	251	02:00	251	02:14	59	37.2	1	1.0	116	A
91	251	03:01	251	03:16	59	37.2	1	0.9	117	A
92	251	04:02	251	04:19	59	37.9	1	1.0	118	A
93	251	05:03	251	05:20	59	39.0	1	1.4	117	A
94	251	06:02	251	06:18	59	39.5	1	1.1	118	A
95	251	06:59	251	07:15	59	39.6	1	1.2	118	A
96	251	18:41	251	18:57	59	48.0	0	60.0	122	G/I
97	251	20:06	251	20:19	59	48.0	1	19.6	107	
98	251	21:31	251	21:46	59	48.2	1	39.9	119	
99	251	22:54	251	23:10	59	47.8	1	59.8	112	
100	252	00:19	252	00:32	59	48.0	2	19.7	111	
101	252	01:46	252	02:06	59	47.9	2	39.7	117	
102	252	03:16	252	03:34	59	48.1	2	59.6	114	
103	252	04:27	252	04:45	59	40.1	2	59.9	110	
104	252	05:52	252	06:11	59	30.1	2	60.0	125	
105	252	06:50	252	07:05	59	25.1	3	0.0	122	
106	252	08:18	252	08:29	59	25.1	2	39.8	122	
107	252	09:41	252	09:54	59	25.0	2	19.8	128	
108	252	11:06	252	11:20	59	24.9	1	59.8	124	
109	252	14:57	252	15:14	59	24.6	1	43.7	119	

Table 4 ctd.

CTD	Start		Finish		Latitude N		Longitude E		Depth (m)	Comments
110	252	16:35	252	16:48	59	24.9	1	19.9	105	
111	252	17:56	252	18:11	59	25.0	0	60.0	112	cf 130,142
112	252	18:45	252	18:59	59	29.9	0	59.9	111	
113	252	20:01	252	20:16	59	39.1	1	1.3	117	A
114	252	20:59	252	21:12	59	39.0	1	3.0	117	A
115	252	22:53	252	23:07	59	52.8	1	0.0	119	I 131,169
116	253	00:05	253	00:20	59	59.7	0	59.6	123	
117	253	02:13	253	02:30	60	14.8	0	59.9	160	
118	253	04:20	253	04:38	60	29.9	0	59.8	145	
119	253	15:10	253	15:28	60	29.9	-0	0.1	116	
120	253	17:04	253	17:20	60	15.0	-0	0.2	121	
121	253	19:02	253	19:19	60	0.1	-0	0.1	150	
122	253	21:17	253	21:29	59	60.0	-0	30.8	127	
123	253	23:16	253	23:30	59	59.9	-1	0.5	116	
124	254	00:58	254	01:12	59	45.0	-1	0.6	131	
125	254	02:16	254	02:29	59	35.0	-1	0.7	129	
126	254	03:38	254	03:52	59	25.1	-1	0.6	132	
127	254	05:49	254	06:01	59	25.1	-0	30.6	130	
128	254	07:47	254	08:02	59	25.1	-0	0.5	135	
129	254	09:59	254	10:12	59	25.0	0	29.9	137	
130	254	11:59	254	12:11	59	25.0	0	59.7	114	cf 111,142
131	254	19:13	254	19:24	59	52.8	0	58.7	120	I 115,169
132	254	23:14	254	23:28	59	40.9	0	59.7	119	A
133	255	00:32	255	00:46	59	46.8	0	45.8	126	
134	255	01:58	255	02:12	59	54.0	0	31.7	127	
135	255	03:21	255	03:30	59	59.8	0	19.8	128	
136	255	04:28	255	04:40	59	54.0	0	5.8	120	
137	255	05:48	255	05:58	59	47.2	-0	8.0	145	Level B failed
138	255	07:14	255	07:26	59	40.1	-0	23.0	129	
139	255	09:13	255	09:25	59	40.1	0	9.3	134	
140	255	19:09	255	19:24	59	40.1	0	20.5	131	
141	255	23:44	255	23:58	59	40.8	1	2.2	119	A
142	256	01:42	256	01:56	59	25.0	1	0.0	114	cf 111,130
143	256	03:38	256	03:49	59	10.1	1	0.2	115	
144	256	05:35	256	05:46	58	55.0	1	0.1	110	Level B failed
145	256	08:19	256	08:31	58	55.1	0	19.3	145	
146	256	10:06	256	10:19	59	10.1	0	19.3	134	
147	256	12:01	256	12:18	59	24.9	0	20.1	140	
148	256	22:02	256	22:17	59	40.2	1	1.9	119	A
149	256	23:12	256	23:28	59	39.7	1	2.6	118	A
150	257	00:01	257	00:42	59	39.6	1	2.8	118	A
151	257	01:02	257	01:15	59	39.2	1	3.7	116	A
152	257	02:02	257	02:18	59	38.6	1	4.3	117	A

Table 4 ctd.

CTD	Start		Finish		Latitude N		Longitude E		Depth (m)	Comments
153	257	03:06	257	03:26	59	39.4	1	3.3	117	A
154	257	04:03	257	04:18	59	39.7	1	2.5	119	A
155	257	21:01	257	21:16	59	40.1	1	1.5	118	A
156	257	22:03	257	22:19	59	39.0	1	1.1	118	A
157	258	19:20	258	19:35	59	40.0	0	57.5	119	A
158	258	20:03	258	20:18	59	40.3	0	56.8	119	A
159	258	21:15	258	21:29	59	40.3	0	57.8	120	A
160	258	22:03	258	22:14	59	40.3	0	57.9	120	A
161	258	23:04	258	23:18	59	40.3	0	58.1	121	A
162	259	00:02	259	00:16	59	40.8	0	57.2	120	A
163	259	01:01	259	01:16	59	40.5	0	57.6	120	A
164	259	02:03	259	02:19	59	40.9	0	57.4	119	A
165	259	03:14	259	03:29	59	40.3	0	57.0	120	A
166	259	04:05	259	04:18	59	40.2	0	57.9	121	A
167	259	05:05	259	05:19	59	40.1	0	57.3	121	A
168	259	06:06	259	06:19	59	40.1	0	57.6	120	A
169	259	09:27	259	09:38	59	53.3	1	1.5	115	I 115,131

Table 5. SeaSoar deployments. CTD serial number 1181.

Run	Time	Latitude N	Longitude E	Course	
0	12:27 9/9				SeaSoar deployed.
	14:48 9/9				Seasoar recovered. Instrument trial to test system and operation of the vehicle. No conductivity data. The vehicle cycled from the surface to 90m and back in 2.5 minutes when towed at 7 knots with 200m of wire out.
1	11:59 11/9	59 25.0	0 59.7		CTD 130
	12:26 11/9	59 25.2	0 59.6	000	SeaSoar deployed.
	17:30 11/9	60 00.5	1 00.8	180	Altered course (took 15 mins).
	18:45 11/9	59 53.7	0 58.9		SeaSoar recovered.
	19:13 11/9	59 52.8	0 58.7		CTD 131
2	09:13 12/9	59 40.1	0 09.3		CTD 139
	09:33 12/9	59 40.3	0 10.8	090	SeaSoar deployed.
	14:37 12/9	59 39.2	1 20.7	270	Altered course.
	18:45 12/9	59 40.0	0 22.1		Seasoar recovered.
	19:09 12/9	59 40.1	0 20.5		CTD 140 Two strands of wire had parted near the vehicle. Wire reterminated.

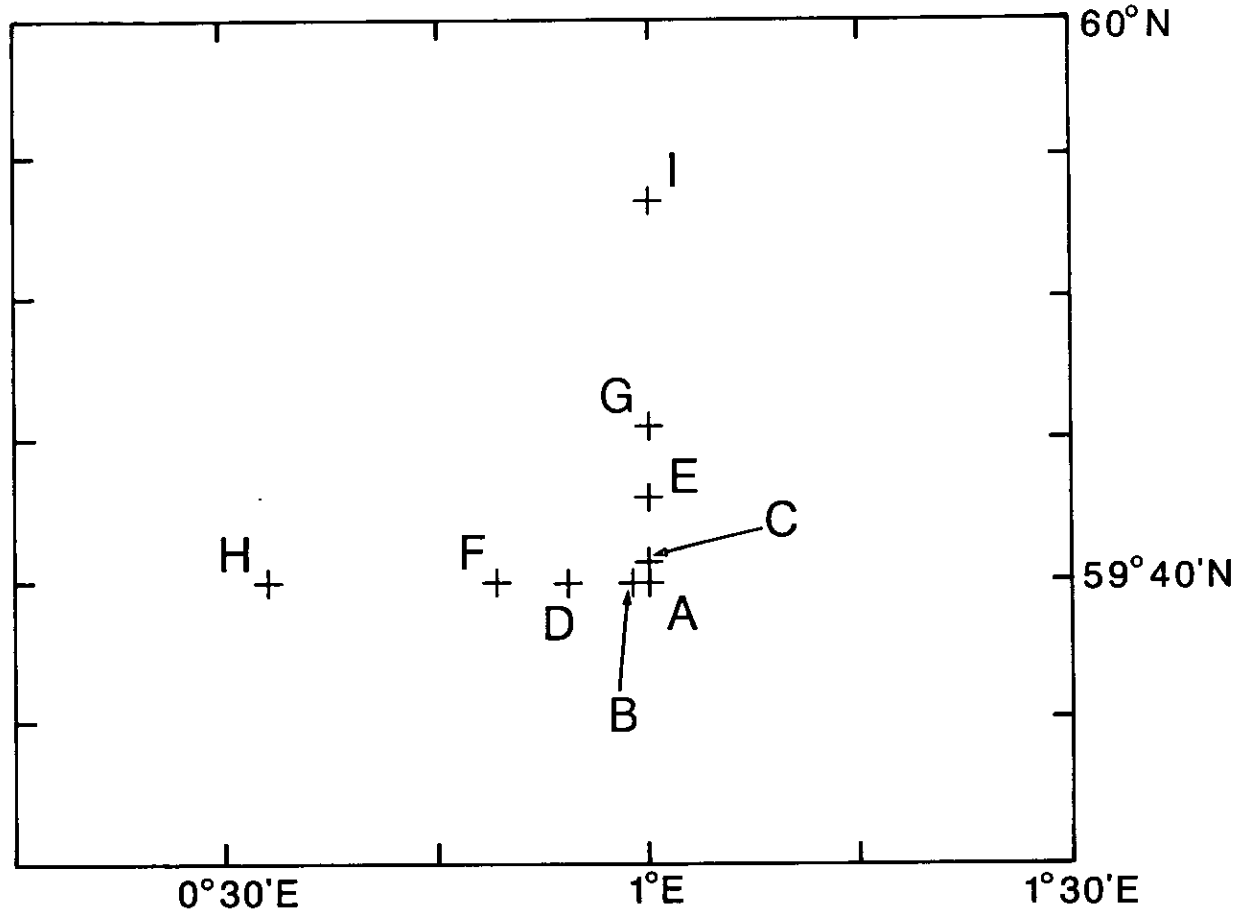

Figure 1. Map of mooring sites.

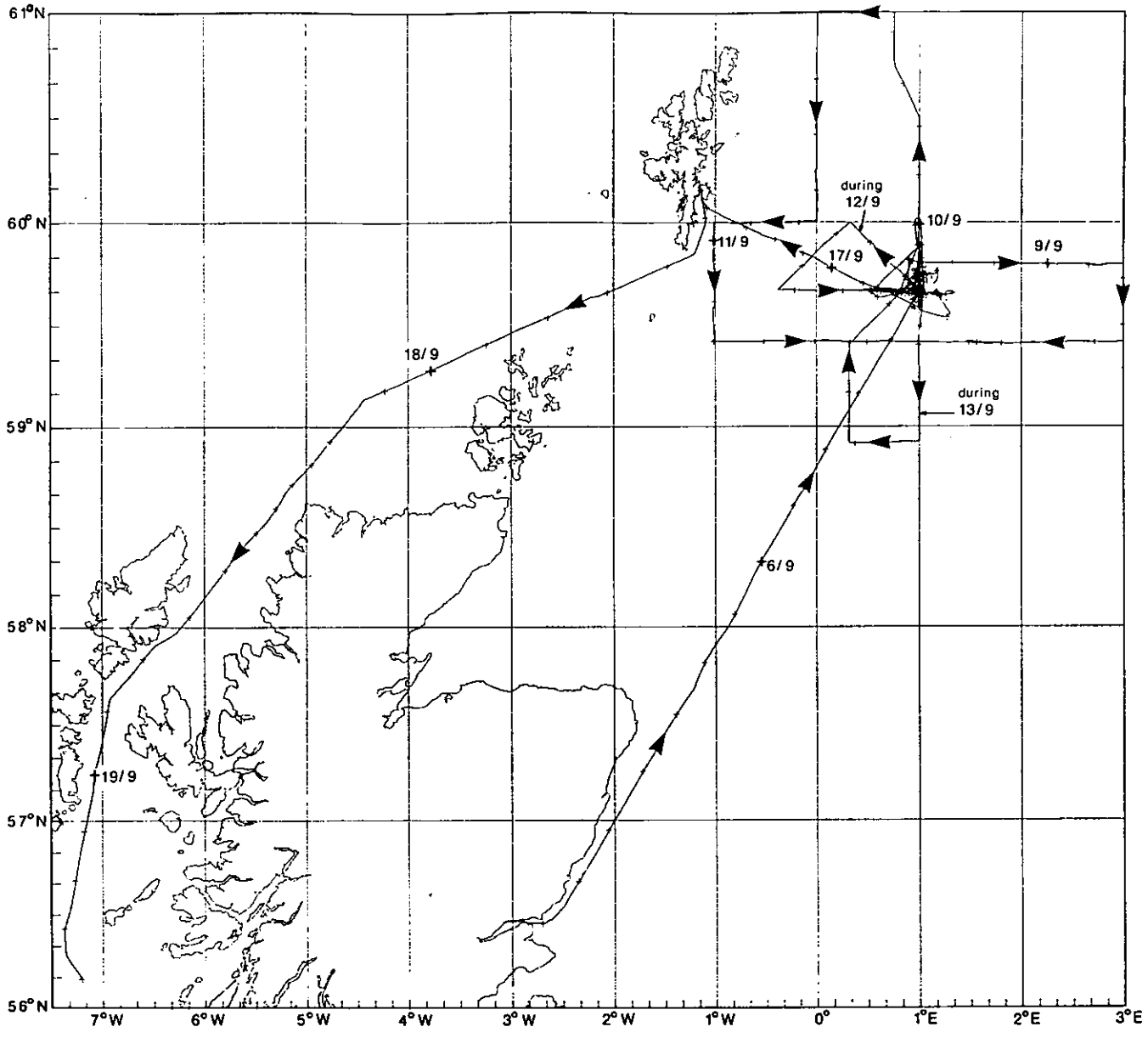

Figure 2. Cruise track. The crosses are every two hours; midnight is marked by a bolder cross and the date.

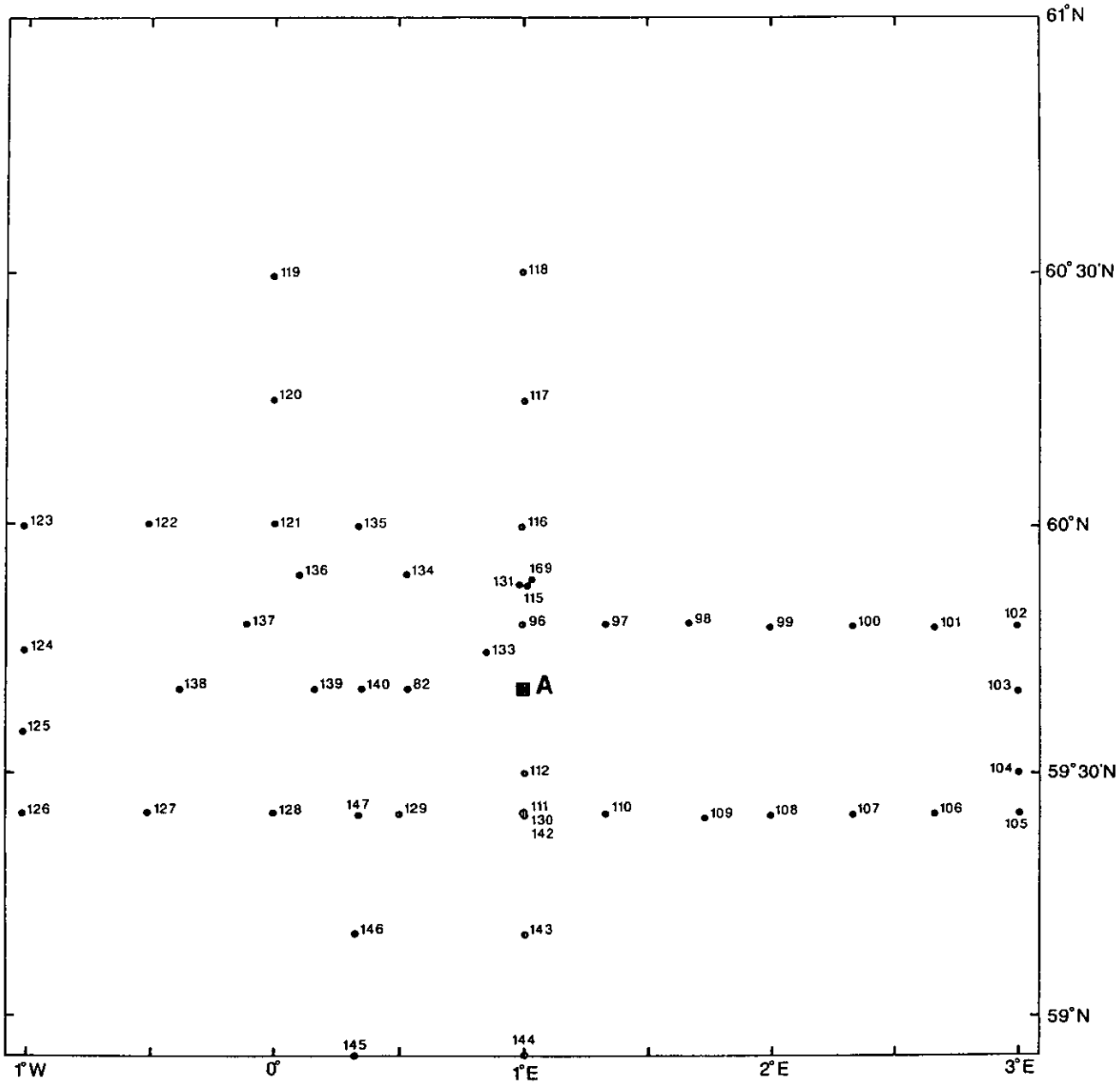

Figure 3. Plot of CTD positions, excluding those recorded at mooring site A.