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I.O.S.

R.R.S. JOHN MURRAY

CRUISES 14/74 (1st leg) 30 OCTOBER – 6 NOVEMBER 1974
AND 16/74 (2nd leg) 6 – 22 DECEMBER 1974

CRUISE REPORT NO 21

1975

NATURAL ENVIRONMENT
INSTITUTE OF OCEANOGRAPHIC SCIENCES
RESEARCH COUNCIL

R.R.S. JOHN MURRAY

Cruises 14/74 (1st leg) 30 October - 6 November 1974
and 16/74 (2nd leg) 6 - 22 December 1974

CRUISE REPORT NO 21

1975

Institute of Oceanographic Sciences
Bidston Observatory
Birkenhead
Merseyside L43 7RA

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DURATION

Leg 1	Sailed Leith	11.00	30 Oct
	Arrived Hull	11.45	6 Nov
Leg 2	Sailed Hull	10.50	6 Dec
	Arrived Barry	21.00	19 Dec

SCIENTIFIC STAFF

Leg 1	G.A. ALCOCK	I.O.S. BIDSTON	
	N.S. HEAPS	" "	(Principal Scientist)
	M.J. HOWARTH	" "	
	A.G. KERR	" "	
	D.L. LEIGHTON	" "	
	R.I.R. PALIN	" "	
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Leg 2	A.M. DAVIES	I.O.S. BIDSTON	
	R.A. FLATHER	" "	
	N. HANSON	" "	
	A.J. HARRISON	" "	(Principal Scientist)
	A.G. KERR	" "	
	D.L. LEIGHTON	" "	
	S. LOCH	" "	

SHIPS OFFICERS

Leg 1

P.	MAW	MASTER
P.	DAVIES	CHIEF OFFICER
J.H.	MORSE	SECOND OFFICER
A.	COVERDALE	THIRD OFFICER
A.	LENNOX	CHIEF ENGINEER
J.	CLARKE	SECOND ENGINEER
R.	PERRIAM	THIRD ENGINEER

Leg 2

P.	MAW	MASTER
P.	MacDOERMOTT	CHIEF OFFICER
A.	NEIL	SECOND OFFICER
A.	COVERDALE	THIRD OFFICER
A.	LENNOX	CHIEF ENGINEER
J.	CLARKE	SECOND ENGINEER
R.	PERRIAM	THIRD ENGINEER

OBJECTIVES OF CRUISE

To determine the tidal elevations and currents in the neighbourhood of the Orkney and Shetland Islands in order to provide data for numerical models of the North Sea and Continental shelf and to level Fair Isle to the Shetland Islands using hydrodynamical equations of motion. To determine the residual circulation of the area and the distribution of temperature, salinity and density.

NARRATIVE LEG 1

After being delayed due to bad weather conditions in the North Sea, and the unexpected transfer to hospital of the Chief Engineer, R.R.S. John Murray sailed from Leith at 11.00 on Wednesday, 30 October. The main objective of the cruise was to lay seven current meter rigs at positions A B. C, D, E, F and G, with three off-shore tide gauges at positions F. E and H, in order to measure tidal currents and elevations in the neighbourhood of the Orkney and Shetland Islands. The data gathered will be used to produce numerical models of the North Sea and to level Fair Isle to the Shetland Islands using the hydrodynamical equations of motion.

In a moderately calm sea, two current meter rigs and one tide gauge were laid at F on Thursday, 31 October. The following day saw the successful laying of a current meter rig and a tide gauge at E, and a tide gauge at H. For this, weather conditions were well nigh perfect, with a calm sea. On Saturday, 2 November, a current meter rig was laid at B but, due to a heavy south-easterly swell developing, no further laying was possible on that day. Again on Sunday, 3rd, weather and sea conditions were poor with south-easterly winds reaching force 8 strength at times. However, the rigs at C and A were laid successfully under difficult conditions. In the evening, shelter was sought in the lee of Fair Isle to allow preparations to proceed for the laying of the final current meter rig at D. After visiting the rigs A, C and B in turn, this laying was done early on the following day, Monday, 4th, and, with a large storm moving towards the area, a course for position F was set immediately. On arrival at F in the early afternoon one of the current meter rigs laid there originally was, as intended, lifted and four hours later was re-laid at position G in darkness. The essential programme of

the cruise having been completed successfully, the ship then set course for Hull arriving there in the morning of Wednesday, 6 November, docking at 11.45.

Throughout the cruise continuous surface sampling was carried out measuring temperature and conductivity using the Bidston surface sampling system. Vertical C.T.D. sections were taken at F, E, H, A and at two positions between H and C. A distinctive thermocline was found at E and H, but this feature was not present at A and F. A deepening and weakening of the vertical thermal structure was noted between H and A.

NARRATIVE LEG 2

The ship sailed from Hull at 10.50 hours on Friday, 6 December. The overside pump was rigged and surface measurements of T & C started at 15.30 hours along a cruise track set for Station G. (see Figs 4 and 6).

At 09.10 hours on Sunday, 8 December the rig at station G was sighted, recovery commenced immediately and was successfully completed by 09.48 hours. A CTD cast was carried out and the ship left the station at 10.02 hours on course for station F, eventually arriving at 12.50 hours to find both the CM and T.G. rig on position at F. Recovery of the CM rig was started at 13.00 hours and successfully completed by 13.29 hours. The T.G. recovery started at 13.37 hours, but due to tangles in the mooring wires at both the surface buoy anchor and the T.G. the recovery was not completed until 14.30 hours. A CTD cast was carried out at 14.44 hours and the ship left the station at 14.41 hours.

The weather throughout the day had been reasonable for working on station with winds force 5 to 6 at station F, but with gales imminent in the area a course was set for the Shetlands to gain shelter. By 20.00 hours the wind was force 10 from the S.W., but, however, by 24.00 hours the ship was in the lee of Sumburgh Head.

All day Monday the 9th December was spent sheltering off Lerwick with winds force 9 to 10. Attempts were made to arrange a berth in Lerwick harbour so that the ship could dock and collect 2 current meters and a S/S buoy which had been recovered by a local fisherman from station C, but this was not possible. In preparation

for docking the pumping system was brought inboard at 11.25 hours and surface measurements suspended.

On Tuesday the 10th December it was expected that there would be an improvement in the weather which could occur later in the day, so in anticipation of this, the ship left the Shetlands at 06.35 hours and made its way through rough seas and force 7/8 winds to station E, arriving at 13.20 hours to find both the CM and T.G. rigs on position. A dummy pass was made on the T.G. surface buoy to test the feasibility of a recovery in the rough seas, but it was decided that the conditions were too dangerous, so the ship hove-to in the vicinity of E. Winds of force 9 were experienced during this period.

By the following morning, Wednesday 11 December, the wind was up to force 10 so we left station E and headed for the Shetlands, arriving in shelter by 20.00 hours after experiencing heavy seas. Throughout the journey from the Shetlands to station E and back again, surface measurements of T & C were not taken since the pump had not been deployed.

At 08.15 hours the following day, Thursday 12 December, the weather had moderated slightly with winds force 7, so it was decided to go and inspect the CM rigs at positions A, B & D. The ship occupied station B at 11.55 hours, but nothing was sighted after a one hour search in rough seas so we left this station and headed for station D, but with rapidly deteriorating weather, failing light and a snow storm, this was abandoned and a course set back to the Shetlands for shelter from the force 9 northerly winds, arriving off Lerwick at 18.45 hours. No surface measurements were taken throughout the day.

A radio message was received from IOS Bidston informing us that the pop-up tide gauge at position H had been recovered by a Danish fishing trawler.

On Friday 13 December the ship put into Lerwick at 13.40 hours and only stayed long enough to collect the 2 current meters and 1 S/S buoy off the dockside, (recovered from station C).

All day Saturday 14 December was spent sheltering (off Lerwick) from a Westerly gale. The pump was re-rigged and made ready for surface sampling and a CTD cast was carried out to calibrate the system.

With an expected lull in the weather the ship left the Shetland at 05.30 hours Sunday 15 December on course for Station E, eventually arriving at 11.40 hours. Both the C.M. & T.G. rigs were found on position, so recovery of the CM rig started at 12.25 hours in a moderate sea but with a heavy swell and winds of 24 knots (12.00 hours, snow squall), the recovery was not completed until 13.23 hours due to tangled mooring lines on the rig which had to be cut. Recovery of the T.G. started at 13.45 hours and was successfully completed by 14.00 hours without difficulty. A C.T.D. cast was carried out at 14.08 hours and the ship left the station at 14.26 hours on a course for station D. On arrival at station D at 20.15 hours the visibility was good although it was dark, there was a light wind and calm sea, but no sign of the rig. The ship continued to station A arriving at 21.00 hours. Using the ships search light the pellets marking the S/S buoy were located on position after a search lasting $1\frac{3}{4}$ hours but there was no sign of the surface buoy. Rather than drag for the rig at night it was decided to stand by on station until morning, but by 24.00 hours the weather started to deteriorate, and with gale warnings for the area the ship made for shelter in the lee of Fair Isle.

At 07.30 hours the following morning, Monday 16 December, with the forecast of further gales and the risk of being delayed in docking on time at Barry, the Captain decided to leave Fair Isle, so a course was set for Barry via the Minches to the Irish Sea. Surface monitoring continued throughout the track until the St. Georges channel, when at 07.30 hours on Thursday 19 December measurements were terminated and the pumping system brought inboard. Bad weather persisted throughout this period until finally docking in Barry at 21.00 hours.

STATION REPORT LEG 1. DEPLOYMENT (DECCA - 6C NORTH SCOTTISH)

Station A.

Current meter rig with 3 meters. Depth: 121m

<u>Surface buoy</u>	<u>Sub-surface buoy</u>	<u>Meters</u>
Toroid No 6 with No 13 flasher	Free-flooding Slingsby No 4	160 Top 531 Mid 212 Bottom
Decca positions (of surface and sub-surface buoys)		
Red -	Green B34.70	Purple D50.90
Red -	Green B34.75	Purple D50.50
Deployment started at	10.11 hours	3 Nov 74
Deployment complete	10.33 hours	

Station B.

Current meter rig with 3 meters. Depth 98m

<u>Surface buoy</u>	<u>Sub-surface buoy</u>	<u>Meters</u>
Toroid No 4 with No 8 flasher	Solid Slingsby	214 Top 532 Mid 415 Bottom
Decca positions		
Red -	Green B40.51	Purple D74.76
Red -	Green B40.31	Purple D74.42
Deployment started at	9.05 hours	2 Nov 74
Deployment complete	9.34 hours	

Station C.

Current meter rig with 2 meters. Depth 82 m

<u>Surface buoy</u>	<u>Sub-surface buoy</u>	<u>Meters</u>
Selco No 1	Free-flooding Slingsby No 3	1138 Top 568 Bottom
Decca positions		
Red -	Green C33.52	Purple D59.32
Red -	Green C35.50	Purple D59.35
Deployment started at	7.20 hours	3 Nov 74
Deployment complete	7.44 hours	

Station D.

Current meter rig with 2 meters. Depth 88m

<u>Surface buoy</u>	<u>Sub-surface buoy</u>	<u>Meters</u>
Toroid No 8 with No 7 flasher	Wormley Cigar type, No 2	294 Top 1003 Bottom

Decca positions

Red	Green	Purple	Red	Green	Purple
-	A41.20	D58.40	-	A41.00	D58.38

Deployment started at 7.16 hours 4 Nov 74

Deployment complete 7.34 hours

Station E.

(a) Off-shore tide gauge rig

(b) Current meter rig with 3 meters and 1 thermistor chain.
Depth 153m.

(a) Off-shore tide gauge rig:-

<u>Surface buoy</u>	<u>Dhanbuoy</u>	<u>T.G.</u>
Toroid No 3 with No 6 flasher	2 floats No 2 Pains-Wessex light	Logger 004 Sensor 1/3 VIB Sensor 4/2 O.A.R. Sensor 2/3 S.G.

Decca positions

Red	Green	Purple	Red	Green	Purple
-	B35.28	H54.53	-	B35.24	H54.38

Deployment started at 9.44 hours 1 Nov 74

Deployment complete 10.39 hours

Comments:- Off-shore tide gauge rig positioned 1 mile north of
current meter rig.

(b) Current meter rig:-

<u>Surface buoy</u>	<u>Sub-surface buoy</u>	<u>Meters</u>
Toroid No 2 with No 11 flasher	Free-flooding Slingsby No 2	295 Top (T111 Logger (139 Chain (50m) 567 Mid 1001 Bottom

Decca positions

Red Green Purple Red Green Purple
A01.30 B34.31 H56.14 A01.27 B34.44 H56.04

Deployment started at 13.15 hours 1 Nov 74

Deployment complete 13.51 hours

Station F.

(a) Off-shore tide gauge rig

(b) Current meter rig with 3 meters. Depth 77m

(c) Temporary current meter rig. Depth 80m

(a) Off-shore tide gauge rig:-

<u>Surface buoy</u>	<u>Dhanbuoy</u>	<u>T.G.</u>
Selco No 2	2 floats No 1 Pains-Wessex light	Logger 002 Sensor 1/2 VIB Sensor 4/1 O.A.R. Sensor 2/5 S.G.

Decca positions

Red Green Purple Red Green Purple
A20.3 D42.25 G56.70 A20.25 D42.25 G56.80

Deployment started at 10.16 hours 31 Oct 74

Deployment complete 11.54 hours

Comments:- Off-shore tide gauge rig positioned 5 cables N.E. of permanent current meter rig. The current meter rig at station G was initially deployed at this station for a few days with the meters operating at a fast sampling rate (1 min).

(b) Current meter rig (permanent):-

<u>Surface buoy</u>	<u>Sub-surface buoy</u>	<u>Meters</u>
Toroid No 7 with No 9 flasher	Cosalt No 6	417 Top 1002 Mid 1139 Bottom

Decca positions

Red Green Purple Red Green Purple
A20.45 D41.74 G56.60 A20.65 D41.70 G57.35

Deployment started at 14.12 hours 31 Oct 74

Deployment complete 14.52 hours

(c) Temporary current meter rig. Depth 80m.
(in position at 31 Oct - 4 Nov 1974)

<u>Surface buoy</u>	<u>Sub-surface buoy</u>	<u>Meters</u>
Toroid No 10 with No 4 flasher	Cosalt No 5	570 Top 1140 Bottom

Decca positions

Red	Green	Purple	Red	Green	Purple
A20.02	D41.42	G53.61	A20.1	D41.2	G53.6

Deployment started at 16.04 hours 31 Oct 1974

Deployment complete 16.27 hours

Station G.

Current meter rig with 2 meters. Depth 53m.

<u>Surface buoy</u>	<u>Sub-surface buoy</u>	<u>Meters</u>
Toroid No 10 with No 4 flasher	Cosalt No 5	570 1140 N10 pinger

Decca positions

Red	Green	Purple	Red	Green	Purple
C12.85	B45.15	H71.50	C12.85	B45.05	H71.55

Deployment started at 18.36 hours 4 Nov 74

Deployment complete 18.54 hours

Station H

Off-shore tide gauge - N10 pop-up type with F.M. head
sensor. Depth 135m.

Decca positions

Red	Green	Purple
-	G45.05	F66.44

Deployment started at 17.15 hours 1 Nov 74

Deployment complete 19.00 hours

STATION REPORT LEG 2. RECOVERY (DECCA - 6C NORTH SCOTTISH)

Station A.

Current meter rig with 3 meters No : 160 Top
531 Mid
212 Bottom

Deployed position	Red	Green	Purple
	-	B34.70	D50.90

No equipment recovered from this station

Station B.

Current meter rig with 3 meters No : 214 Top
532 Mid
415 Bottom

Deployed position	Red	Green	Purple
	-	B40.51	D47.76

No equipment recovered from this station

Station C.

Current meter rig with 2 meters No : 1138 Top
568 Bottom

Deployed position	Red	Green	Purple
	-	C33.52	D59.32

The sub-surface buoy with both meters attached was recovered by a small fishing boat off the West coast of Shetland during November 1974. The meter wire had been cut below the bottom meter by a wire rope. Meter No 1138 was undamaged and still operating but meter 568 was extensively damaged and had some sea water inside.

Less than 1 day of useful data was recorded.

No further equipment was recovered from this station.

Station D.

Current meter rig with 2 meters No : 294 Top
1003 Bottom

Deployed position	Red	Green	Purple
	-	A41.20	D58.40

No equipment recovered from this station.

Station E.

(a) Current meter rig with 3 meters and 1 thermistor chain

(b) Off-shore tide gauge rig

(a) Current meter rig:-

Meter No	295 Top	Thermistor chain T111 (logger)
	567 Mid	No 139 50m chain
	1001 Bottom	

Deployed position	Red	Green	Purple
	A01.30	B34.31	H56.14

Recovery position	-	B33.40	H55.42
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Recovery started	12.25 hours	15 Dec 74
Surface buoy on deck	12.32 hours	
Surface buoy anchor on deck	12.45 hours	
Sub-surface anchor on deck	12.58 hours	
Bottom meter on deck	13.00 hours	
Mid " " "	13.08 hours	
Top meter & thermistor chain on deck	13.15 hours	
Sub-surface buoy on deck	13.22 hours	
Recovery complete	13.23 hours	

The mooring wires were tangled at the surface buoy anchor and had to be cut free.

Difficulty was experienced in removing the thermistor chain from the meter wire which had become twisted around each other. All other equipment was recovered undamaged, the instruments were operating normally and in good condition.

(b) Off-shore tide gauge rig:-

Logger 004	Sensor 1/3 VIB
	" 4/2 OAR
	" 2/3 S.G.

Deployed position :	Red	Green	Purple
	-	B35.28	H54.53

Recovery position	A2.20	B34.35	H53.24
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Recovery started at 13.45 hours 15 Dec 74
 Surface buoy on deck 13.48 hours
 Surface buoy anchor
 on deck 13.56 hours
 T.G. on deck & recovery
 complete 14.00 hours

On arrival at the station the Dhanbuoy was missing and when the rig was recovered it was found that the mooring line down to the TG had been cut near to the buoy end. All other equipment recovered in good condition with no evidence of damage to either T.G. sphere or sensors.

Weather condition during recovery, Wind 20 knots, visibility good.
 Sea moderate but with a heavy swell. Occasional snow squalls.

C.T.D. cast No 474 carried out at 14.08 hours.

Station F.

(a) Current meter rig with 3 meters

(b) Off-shore tide gauge rig

(a) Current meter rig:-

	Meter No	417 Top	1002 Mid	1139 Bottom
Deployed position	Red	Green	Purple	
	A20.45	D41.74	G56.60	
Recovery position	A20.58	D41.65	G56.76	
Recovery started at	13.00	hours		
Surface buoy on deck	13.08	"		
Surface buoy anchor on deck	13.13	"		
Sub-surface buoy anchor on deck	13.20	"		
Bottom meter on deck	13.21	"		
Middle meter on deck	13.24	"		
Top meter on deck	13.26	"		
Sub-surface buoy on deck and recovery complete	13.29	"		

On arrival at the station the toroidal surface buoy was found to be floating upside down in the water. All the equipment was recovered in good condition and undamaged. The three current meters were still operating normally.

(b) Off-shore tide gauge rig:-

Logger 002	Sensors	1/2 VIB	
	"	4/1 OAR	
	"	2/5 S.G.	
Deployed position	Red	Green	Purple
	A20.3	D42.25	G56.70
Recovery position	A20.11	D42.00	G55.24
Recovery started at	13.37 hours		8 Dec 74
Surface buoy on deck	13.44	"	
Surface buoy anchor on deck	13.51	"	
T.G. on deck	14.27	"	
Dhanbuoy on deck and recovery complete	14.30	"	

On arrival at the station the Selco surface buoy was found floating on its side, the ballast weight fitted to its lower end to allow it to float in an upright position was missing. Considerable difficulty was experienced in recovering this rig. The ground line and surface buoy line were tangled with the anchor weight and had to be cut. Also as the T.G. was brought to the surface the ground line was found to be tangled with the Dhanbuoy line above the T.G. frame. The radar reflector and flashing light fitted to the Dhanbuoy were both smashed and there was a section of a fisherman's net tangled around the recovery ring.

No evidence of damage to either the T.G. sphere or sensors except that the telemetry lead plug had been pulled from its mating connector on the sphere by the tangle of wires above the T.G.

C.T.D. cast No. 472 carried out at 14.44 hours

Weather conditions during recovery, Wind force 5-6. Sea moderate but with heavy swell, visibility good.

Station G.

Current meter rig with 2 meters No	570 Top		
	1140 Bottom	NIO pinger	
Deployment position	Red	Green	Purple
	C12.85	B45.15	H71.50
Recovery position	C12.60	B45.05	H71.36

Recovery started at	09.23 hours	8 Dec 74
Surface buoy on deck	09.25 "	
Surface buoy anchor on deck	09.30 "	
Sub-surface buoy anchor on deck	09.40 "	
Bottom meter on deck	09.43 "	
Middle meter on deck	09.44 "	
Top meter on deck	09.45 "	
Sub-surface buoy on deck and recovery complete	09.48 "	

All equipment recovered in good condition and meters still operating. On arrival at the station the surface toroidal buoy was found floating upside down in the water.

No acoustic signals were received from the NIO pinger either before or during the recovery. On later investigation it was found that the pressure switch controlling the pinger had not operated.

C.T.D. cast No 471 carried out at 09.58 hours

Station H.

Off-shore tide gauge, NIO pop-up type

Deployment position	Red	Green	Purple
	-	G45.05	F66.44

This T.G. was trawled up by a Northern Denmark fishing trawler after about 17 day of operation.

COMMENTS ON SHIP

Both the main coring winch and the hydrocast winch worked satisfactorily except for the cable pay-out meter being inoperative on the coring winch.

The Lustra phone communications system between the labs and the winches was also defective making it necessary to rig a temporary system.

The ship performed well in the bad weather conditions, achieving as much as could be expected of any ship and giving no cause for concern in the heavy seas.

RECOMMENDATIONS

- i To assist in the recovery of the Selco buoys it is recommended that a recovery ring be fitted to the top of the buoy. This will also provide some protection for the flashing light.

See diagram 1.

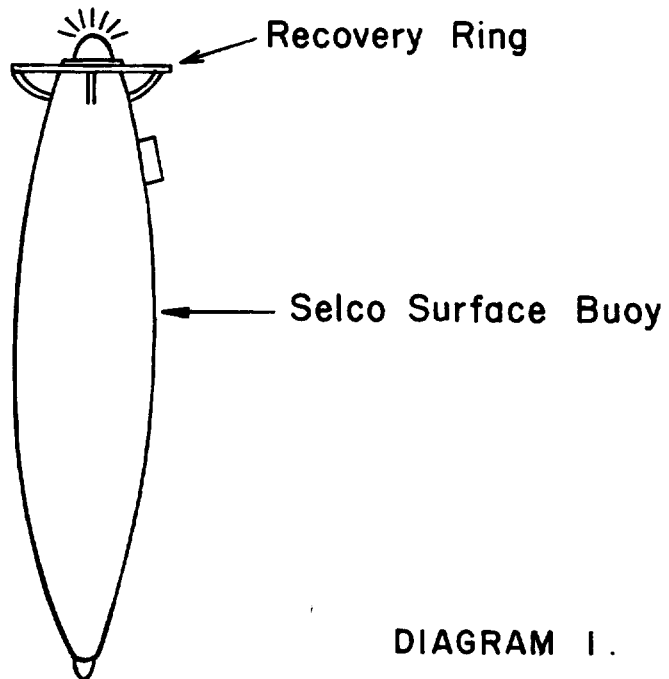


DIAGRAM 1.

- ii To reduce the risk of mooring lines becoming tangled above the T.G. frame it is recommended that the swivel arrangement is fitted as shown in diagram 2.

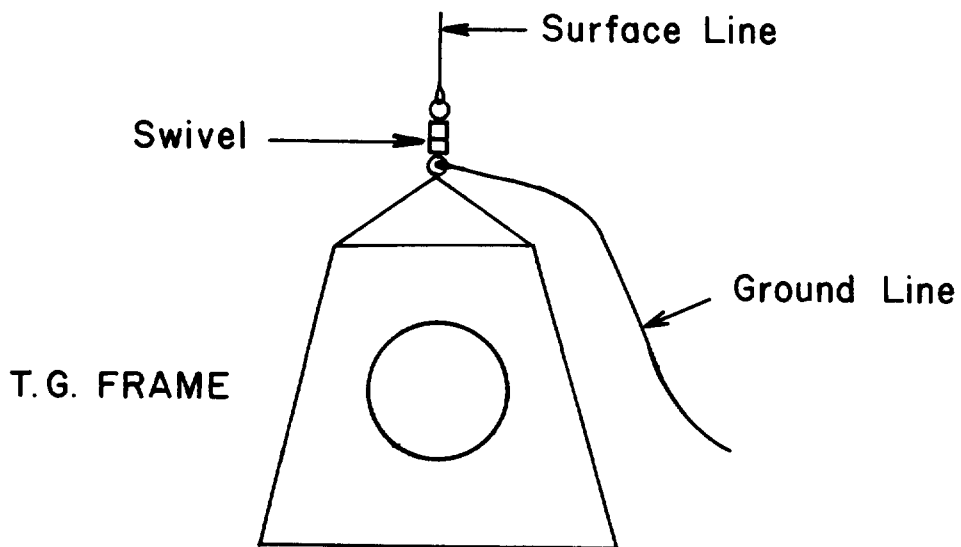
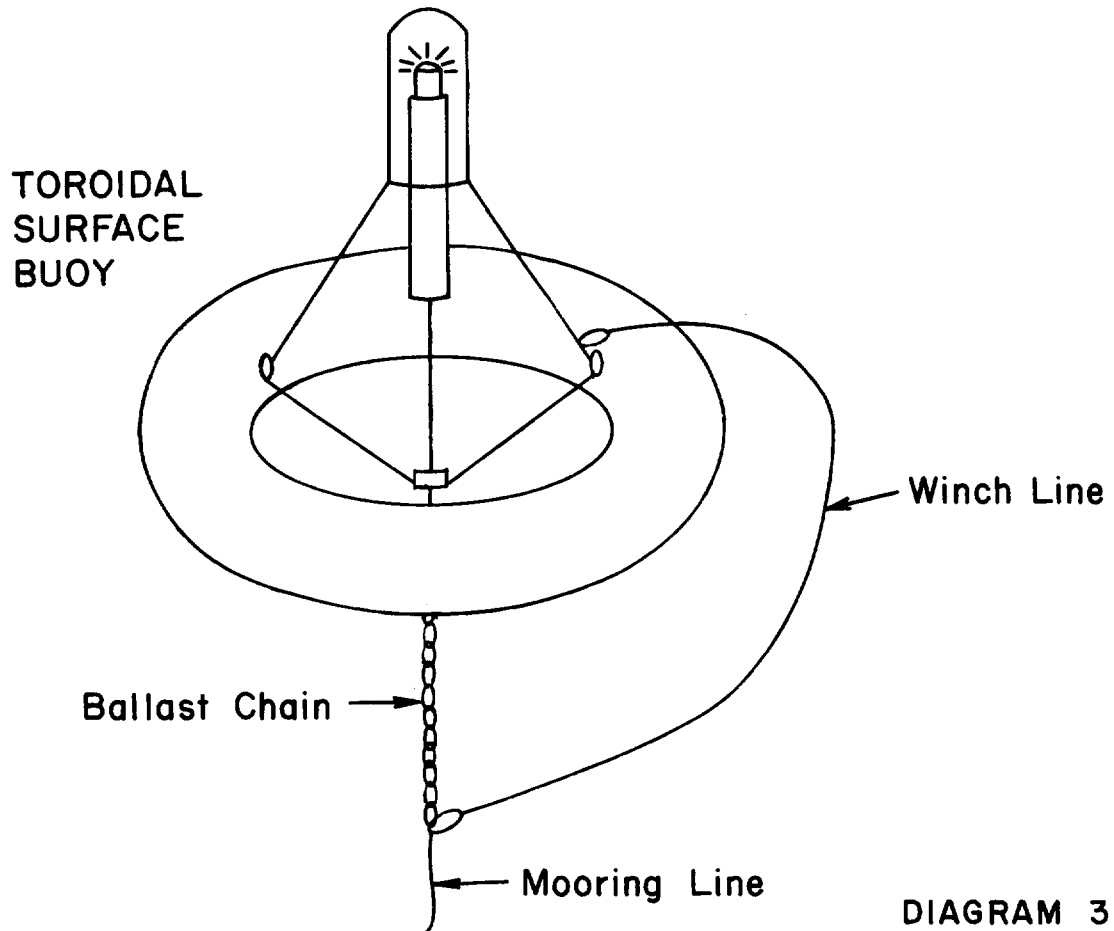


DIAGRAM 2.

- iii To assist in the recovery of the surface toroidal buoys it is recommended that an additional winch line is fitted as shown in diagram 3.

This line can be attached to the ships main winch wire as the buoy comes aboard and take any load off the buoy whilst it is being unshackled from the mooring line.



ACKNOWLEDGEMENT

We would like to thank the Master, Officers and Crew of the John Murray for their co-operation and assistance in taking advantage of the few opportunities the weather presented us with.

TABLE 1

LIST OF STATION POSITIONS AND CORRESPONDING DEPTHS

	LAT. N.	LONG. W.	
A	59 ⁰ 45'	01 ⁰ 36'	Abandoned
B	59 ⁰ 40'	01 ⁰ 18'	"
C	59 ⁰ 47'	01 ⁰ 22'	Recovered by Fisherman
D	59 ⁰ 37.5'	01 ⁰ 32'	Abandoned
E	59 ⁰ 17'	00 ⁰ 05'	Recovered by John Murray
F	58 ⁰ 43'	02 ⁰ 05'	" " " "
G	58 ⁰ 24'	02 ⁰ 37'	" " " "
H	59 ⁰ 47'	00 00'	Recovered by Fisherman

	Estimated Depth below chart datum (m)	Heights of meters above sea floor
A	100	75, 50, 10
B	97	72, 50, 10
C	79	40, 10
D	86	43, 10
E	140	115, 60, 10
F	71	46, 28, 10
G	55	30, 10

50m thermistor chain attached to rig E between 55m and 115m above sea floor.

In all cases the sub-surface buoy will be approximately 5m above the top meter.

TABLE 2

LIST OF EQUIPMENT DEPLOYED

1. Surface buoys
 - (a) Toroidal No 2, 3, 4, 5, 6, 7, 8, 10 Manufactured by Cosalt Ltd. Lowestoft
1.8m dia. 600 kg buoyancy
 - (b) Selco No 1, 2 (fitted with flashing light) Manufactured by Selco Oslo, Norway
 - (c) Dhanbuoy Loaned from IOS Barry
2. Sub-surface buoy
 - (a) Cosalt No 5, 6 Manufactured by Cosalt Ltd., Lowestoft
0.65m dia x 1.1m long
160 kg buoyancy
 - (b) Solid Slingsby Manufactured by Vickers
1m dia sphere
225 kg buoyancy
 - (c) Free-floating Slingsby Manufactured by Vickers
1m dia sphere
225 kg buoyancy
 - (d) Wormley Cigar type No 2 Loaned from IOS Wormley
3. Current meters

No. 160, 212, 214, 294, 295, 415, 417
531, 532, 567, 568, 570, 1001
1002, 1003, 1138, 1139, 1140

Manufactured by Aanderaa Ltd, Norway
Type R C M 4
4. Thermistor chain

Logger No 111
50 m Chain No 139

Manufactured by Aanderaa Ltd, Norway
Type TR-1
5. Off-shore tide gauge
 - (a) Moored T.G. system consisting of data logger, acoustic system and 3 sensor units to measure both pressure and temperature.
Logger 002 & 004 I.O.S. Bidston

Manufactured by Marconi Space & Defence Ltd

Pressure transducer elements

VIB (vibrating wire)	mfd. by Sundstrand Data Control Inc. Washington USA
O.A.R. (vibrating wire)	mfd. by Ocean Applied Research, San Diego, Calif. USA
S.G. (strain gauge)	mfd. by Bell & Howell Ltd., Basingstoke, UK.
(b) Pop-up system consisting of a data logger with acoustic release system and F.M. Head sensor to measure pressure and temperature	I.O.S. Bidston
Logger type 1020	mfd. by N.G.L. Ltd
Pressure/temperature F.M. Head	mfd. by IOS Wormley
6. <u>Flashing lights</u>	
Flasher No 4,6,7,8,9,11,13	mfd. by Stone-Platt Ltd., Crawley
Pains Wessex No 1,2	mfd. by Pains-Wessex Ltd

LIST OF SUPPLEMENTARY DATA

(a)	Two scientific cruise log books	Leg 1 & 2
(b)	Copies of ships cruise log (19 sheets)	" 2
(c)	Barometric charts from laboratory barometer (3 charts)	" 2
(d)	Surface monitoring chart records (1 roll)	" 1 & 2
(e)	Depth record charts	" 2
(f)	Map overlays (14 sheets)	" 1 & 2
(g)	Weather maps	" 2

ABBREVIATIONS

CM	current meter
TG	tide gauge
S/S	sub-surface
CTD	conductivity, temperature, depth

CURRENT METER MOORING SYSTEM
INSTITUTE OF OCEANOGRAPHIC SCIENCES, BIDSTON

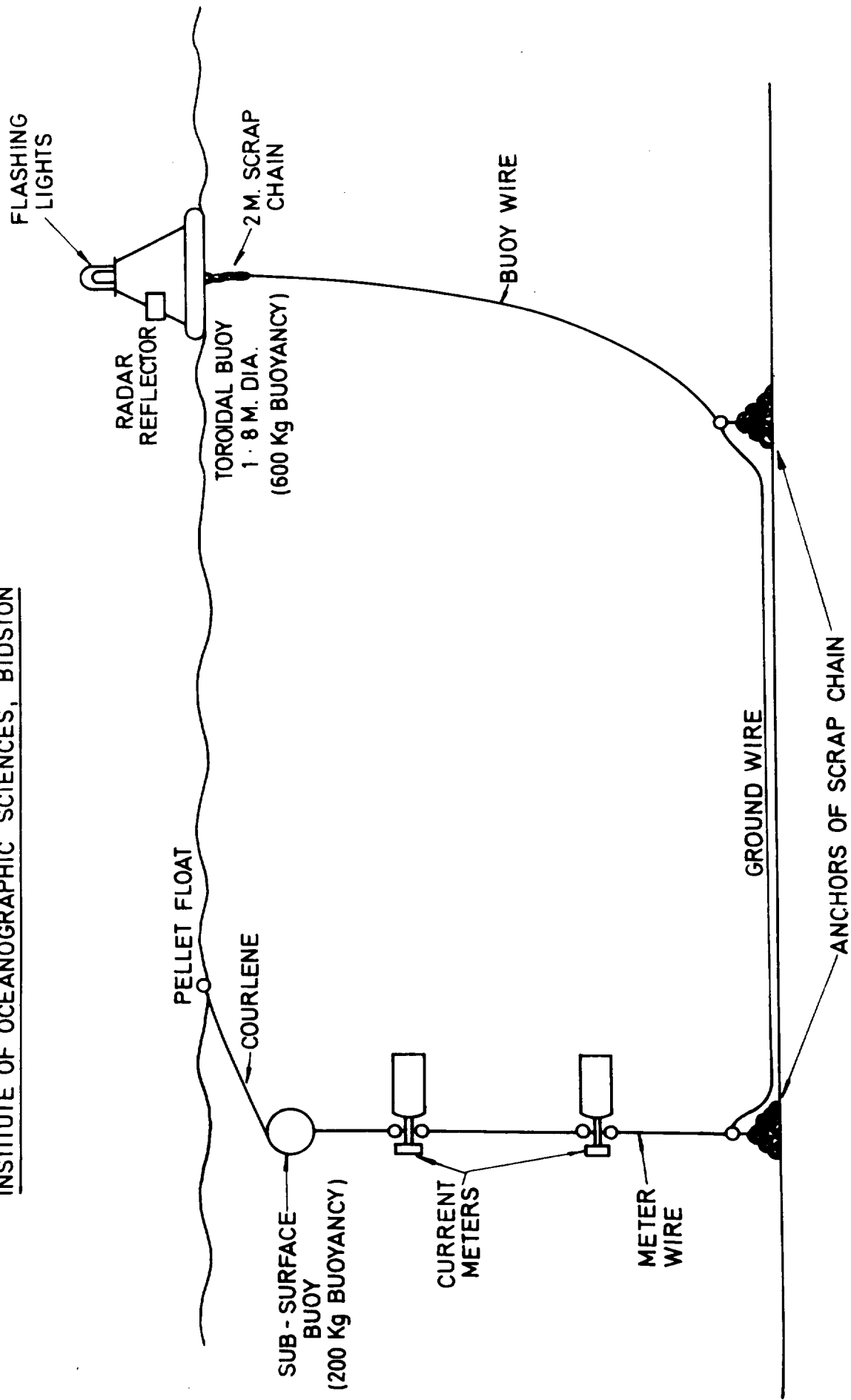


FIGURE 1.

OFF SHORE TIDE GAUGE MOORING SYSTEM
INSTITUTE OF OCEANOGRAPHIC SCIENCES, BIDSTON

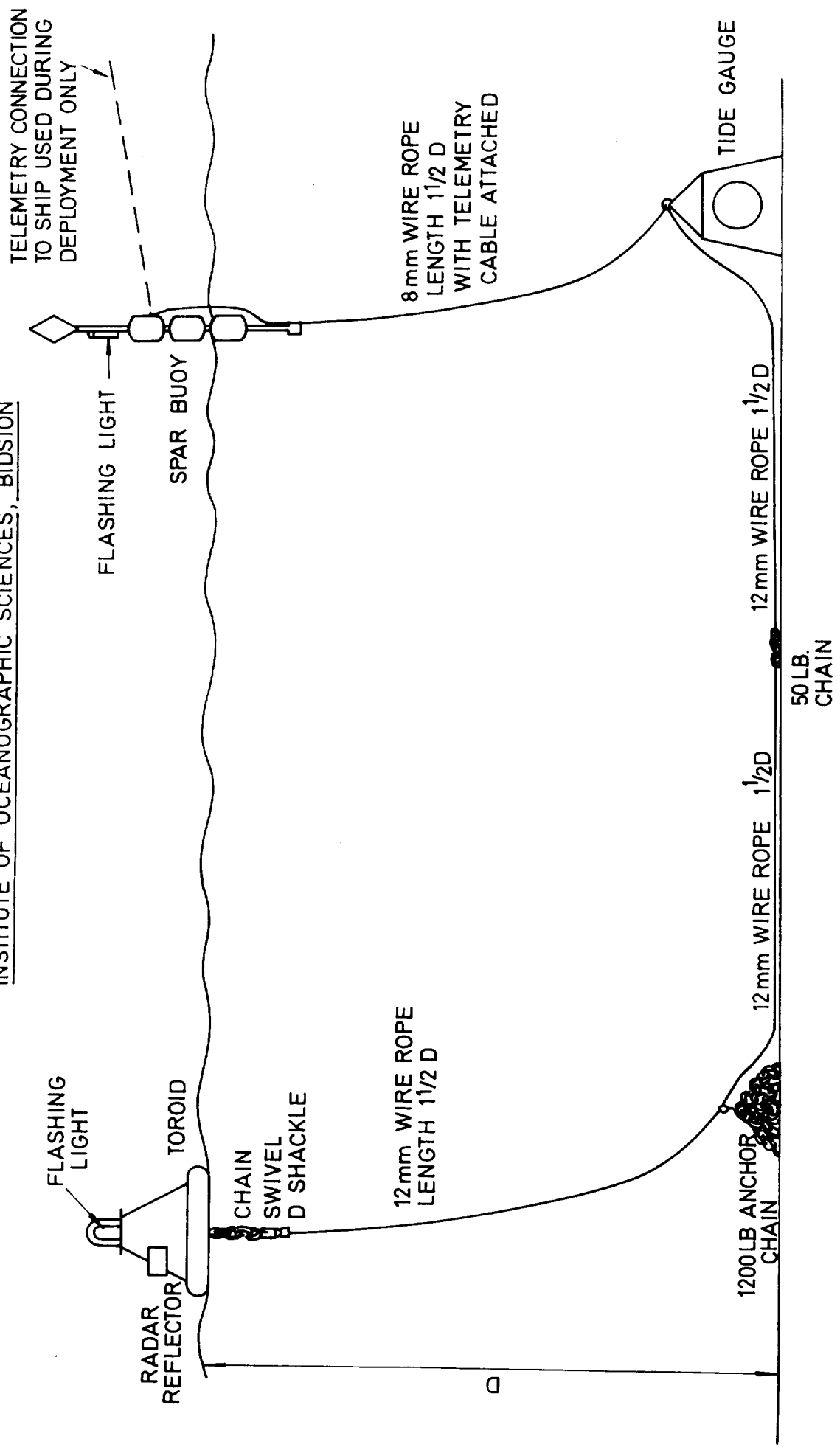
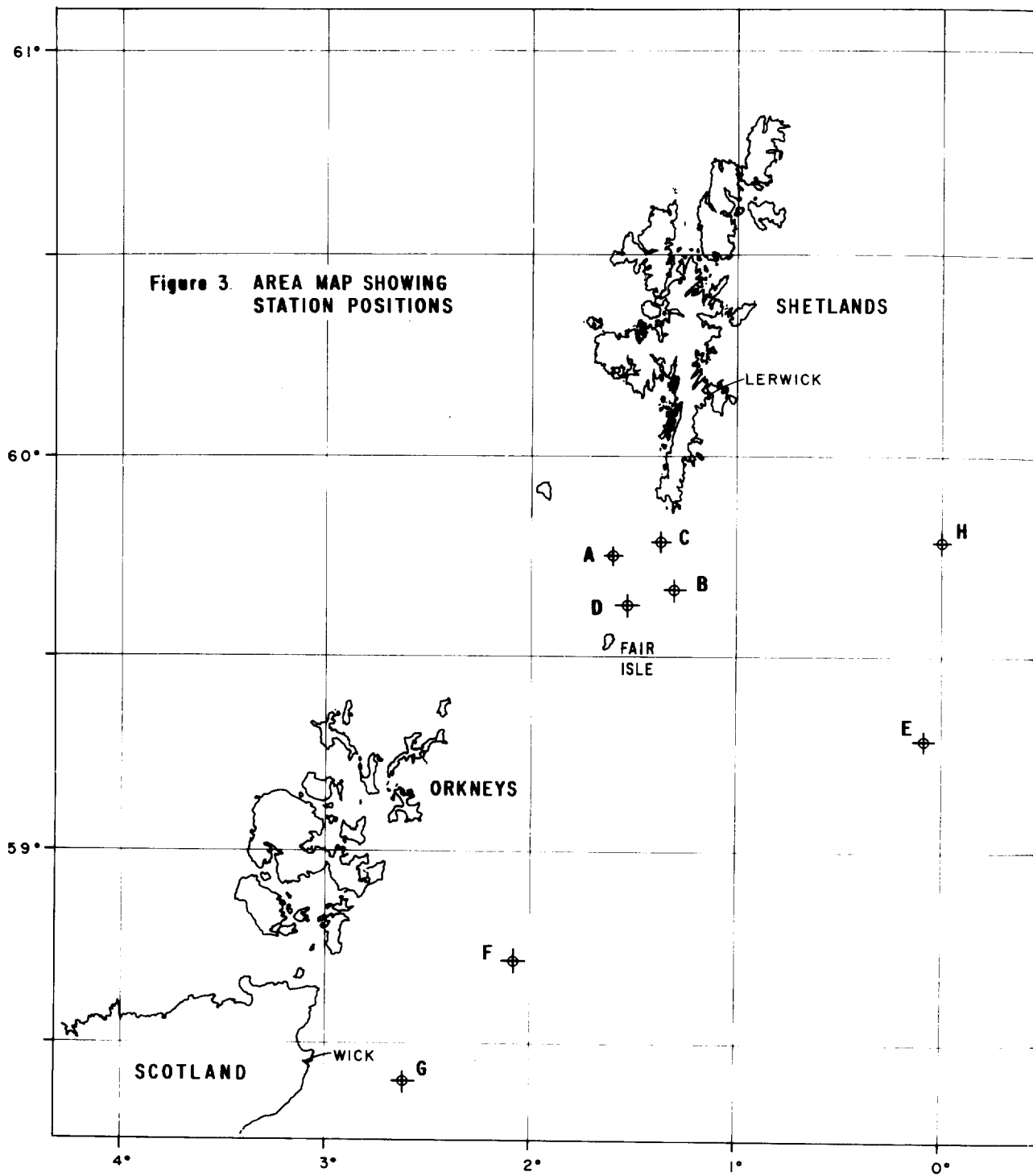


FIGURE 2 .



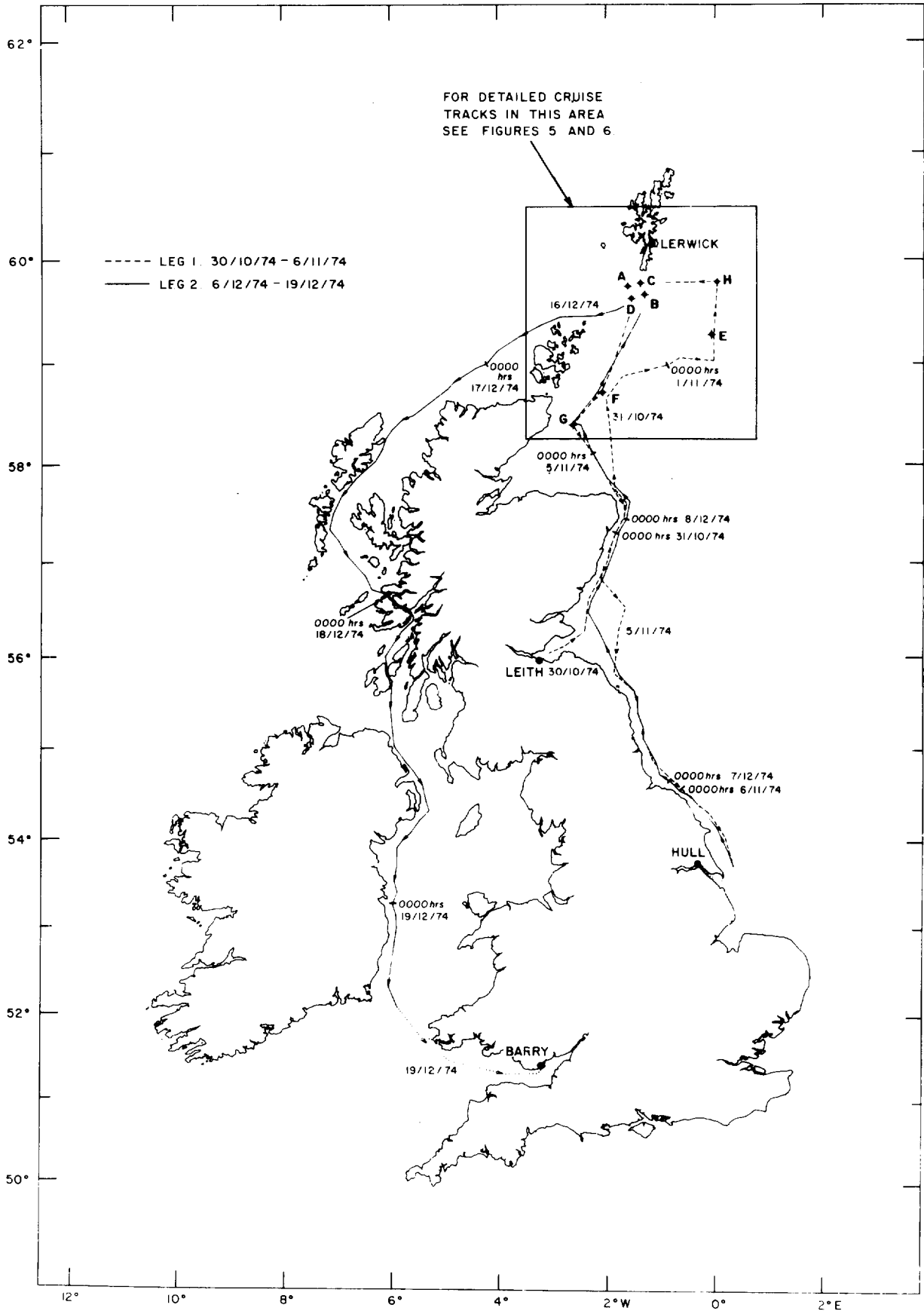


Figure 4. OVERALL CRUISE TRACK.

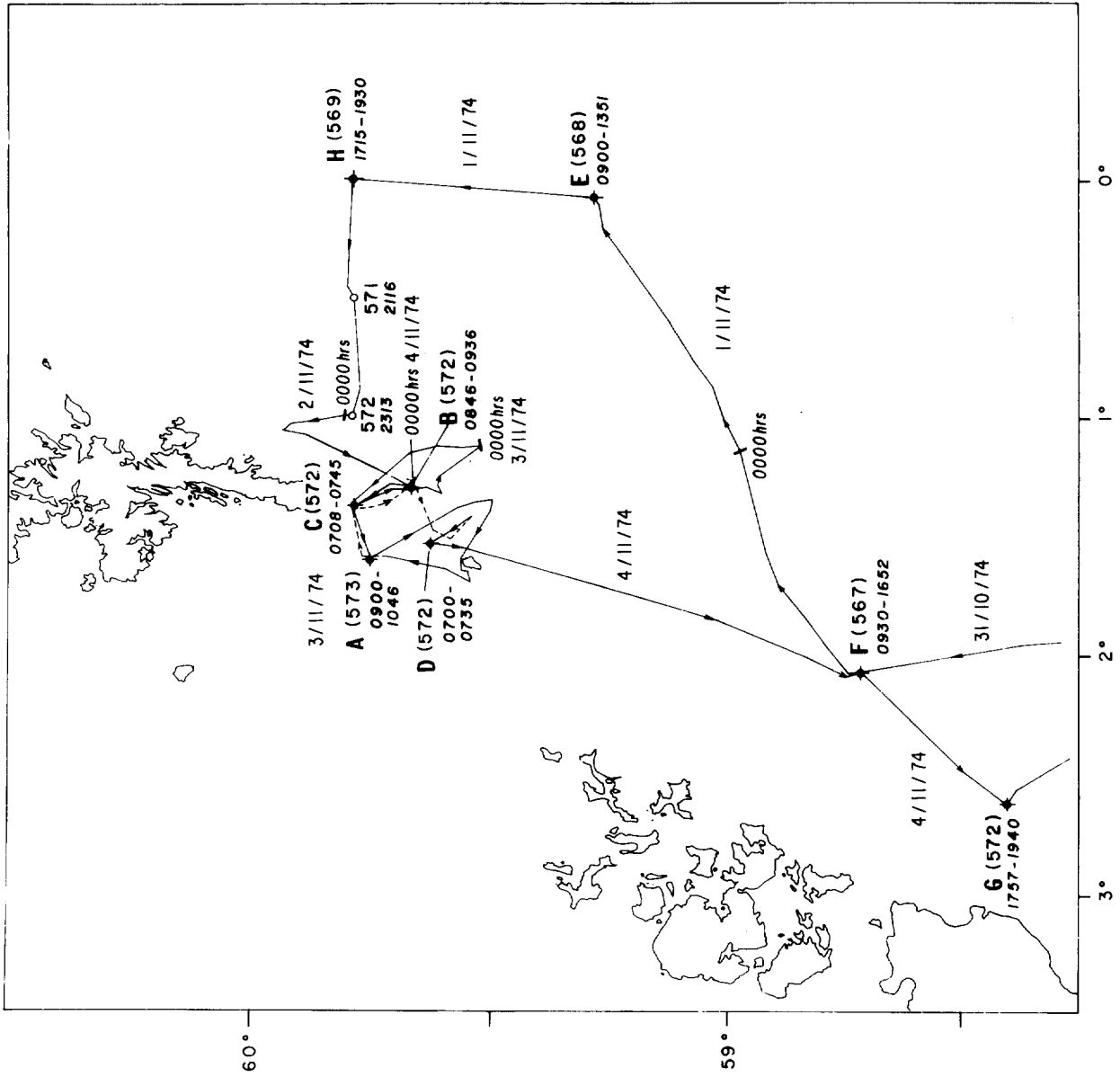


Figure 5. DETAILED CRUISE TRACK LEG I.

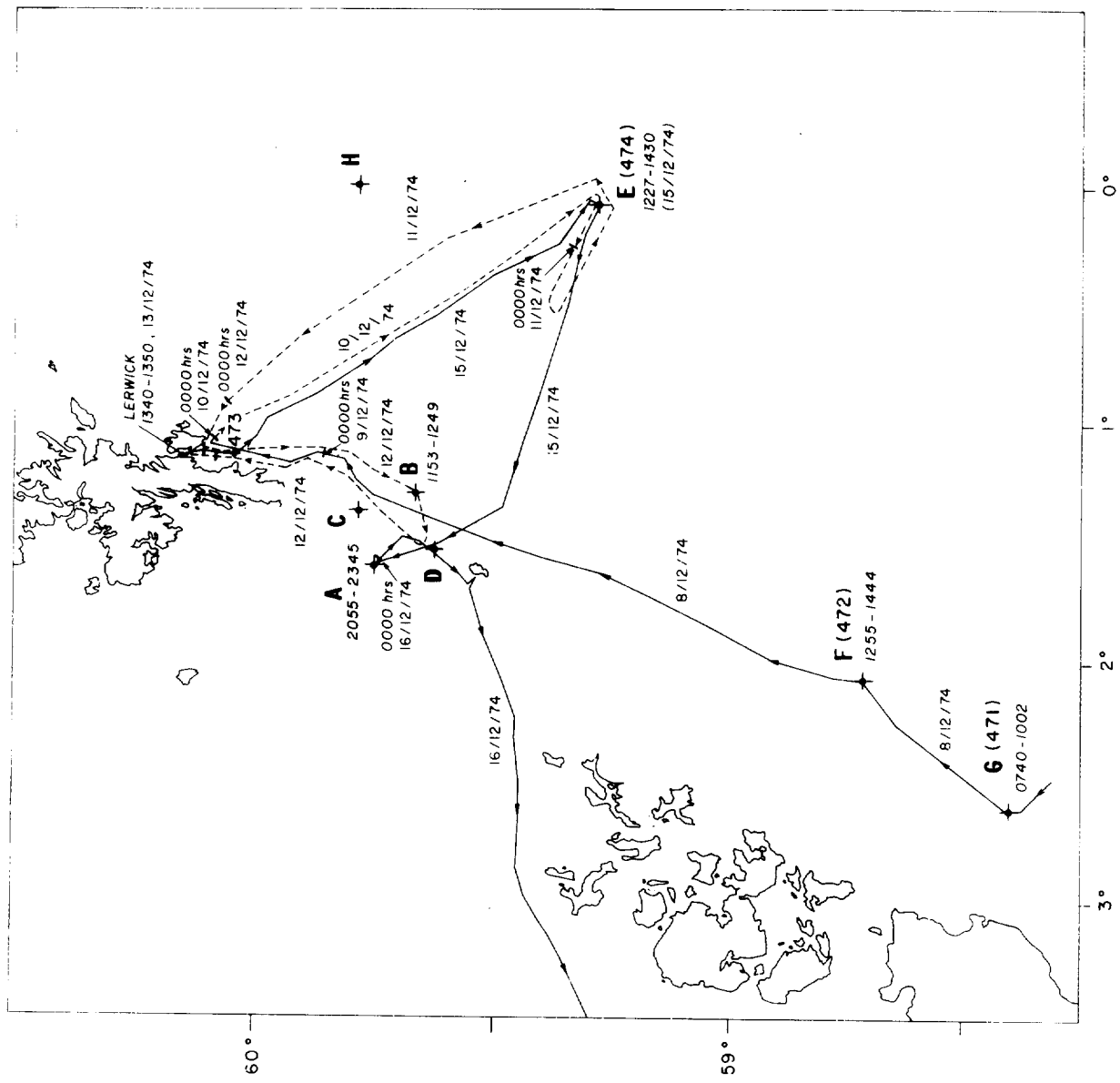


Figure 6. DETAILED CRUISE TRACK LEG 2