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I.O.S.

R R S CHALLENGER

CRUISES 4/76 (1st LEG) : 6-16 MARCH 1976

AND 6/76 (2nd LEG) : 14-22 APRIL 1976

CRUISE REPORT NO 47

1976

**NATURAL ENVIRONMENT
INSTITUTE OF
OCEANOGRAPHIC
SCIENCES
RESEARCH
COUNCIL**

INSTITUTE OF OCEANOGRAPHIC SCIENCES

**Wormley, Godalming,
Surrey, GU8 5UB.
(0428-79-2122)**

(Director: Professor H. Charnock)

**Bidston Observatory,
Birkenhead,
Merseyside, L43 7RA.
(051-653-8633)**

(Assistant Director: Dr. D. E. Cartwright)

**Crossway,
Taunton,
Somerset, TA1 2DW.
(0823-86211)**

(Assistant Director: M.J. Tucker)

**Marine Scientific Equipment Service
Research Vessel Base,
No. 1 Dock,
Barry,
South Glamorgan, CF6 6UZ.
(04462-77451)
(Officer-in-Charge: Dr. L.M. Skinner)**

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R.R.S. CHALLENGER

Cruises 4/76 (1st Leg) : 6-16 March 1976
and 6/76 (2nd Leg) : 14-22 April 1976

CRUISE REPORT NO.47

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Institute of Oceanographic Sciences
Bidston Observatory
Birkenhead
Merseyside L43 7RA

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NOTE:- All times given in this report are in G.M.T.

DURATION

Leg 1	Sailed Greenock	15.00	6 March
	Arrived Aberdeen	14.00	16 March
Leg 2	Sailed Aberdeen	13.00	14 April
	Arrived Aberdeen	07.45	22 April

SCIENTIFIC STAFF

Leg 1	A. O. BANASZEK	IOS	BIDSTON	
	D. FLATT	"	"	
	N. S. HEAPS	"	"	(Principal Scientist)
	A. G. KERR	"	"	
	D. L. LEIGHTON	"	"	
	R.I.R. PALIN	"	"	
	D. PRANDLE	"	"	
	R. SPENCER	"	"	
	W. H. YEE			
Leg 2	A. M. DAVIES	"	"	
	D. FLATT	"	"	
	A. J. HARRISON	"	"	(Principal Scientist)
	A. G. KERR	"	"	
	D. L. LEIGHTON	"	"	
	R.I.R. PALIN	"	"	
	R. McINTYRE	"	"	

SHIPS OFFICERS

Leg 1	P. J. MacDERMOTT	MASTER
	J. D. NODEN	CHIEF OFFICER
	S. JONES	SECOND OFFICER
	T. N. GRAY	THIRD OFFICER
	A. COOMBES	CHIEF ENGINEER
	P. STONE	SECOND ENGINEER
	J. R. RICHARDSON	THIRD ENGINEER
	R. FLETCHER	FOURTH ENGINEER
	F. DUNNING	FISHING SKIPPER
Leg 2	G. H. SELBY SMITH	MASTER
	J. D. NODEN	CHIEF OFFICER
	J. T. MORSE	SECOND OFFICER
	J. J. PRICE	THIRD OFFICER
	J. A. LENNOX	CHIEF ENGINEER
	P. E. STONE	SECOND ENGINEER
	N. R. WALTERS	THIRD ENGINEER
	R. G. WHITCOM	FOURTH ENGINEER
	I. G. MCGILL	EXTRA FOURTH ENGINEER

OBJECTIVES OF CRUISE

To participate in the JONSDAP 76 experiment in the northern part of the North Sea by measuring variations in tidal height at five off-shore stations (numbered 53, 54, 55, 56 and 57, positions listed in Table 1) along the northern boundary of a North Sea numerical model. Also, to measure currents at two of these stations (53, 54). Additionally, to determine the distribution of temperature and salinity, with respect to position and depth, across the northern North Sea, by taking CTD profiles at thirty nine positions (numbered 1-39) between Norway and the Orkney Islands. Further, to supplement this information by continuous surface measurement of temperature and salinity. Also, to measure, specifically, surface temperatures and salinities on passage through the North Channel and the Pentland Firth using the latter type of determination.

NARRATIVE, LEG 1

R.R.S. Challenger sailed from Greenock at 1500 on Saturday, 6 March. The outboard pump was installed, and the associated conductivity/temperature surface sampling system was set up, outside the harbour approaches. After passing southwards through the Firth of Clyde, entry was made into the North Channel of the Irish Sea (Figure 1) in the vicinity of the position ($55^{\circ}00'$, $5^{\circ}33'$). A course was then set towards ($54^{\circ}37'$, $5^{\circ}06'$), a deep water location in the southern part of the Channel. On arrival there, at 4.30 on Sunday morning, 7th March, acoustic and tide gauge tests were carried out.

Subsequently, a return was made along the same track to (55°00', 5°33') near to which the first CTD profile was taken.

During the remainder of the 7th and up to early afternoon on the 8th, the ship steamed northwards up the west coast of Scotland and thence to Thurso on the north coast (Figure 2) where repairs were carried out to the bracket clamping the outboard pump to the side of the ship. Leaving Thurso at 18.20, three passes were made to and fro through the Pentland Firth, as shown in Figure 3, and then the ship entered the North Sea (Figure 4) reaching Station 53 at 2.10 on the morning of Tuesday, 9th March. At this station, acoustic and tide gauge tests were carried out from 2.10 to 4.30, and between 6.38 and 8.47 a bottom mounted current meter/tide gauge was successfully laid and, nearby, a current meter rig with three meters. Some details of these deployments are given in the Station Report.

Course was then set for Station 54 and the ship arrived there at 12.50. A current meter rig with three meters was laid without any trouble between 13.34 and 14.13, following which a Mark II tide gauge with three sensors was laid between 18.52 and 20.10 - after an earlier unsuccessful attempt during the afternoon. The ship then headed for Station 55 and, after tide gauge tests at a position en route, arrived at location 55 at 2.23 on the morning of Wednesday, 10th March. Due to strong southerly winds, exceeding 30 knots, the deployment of a Mark II tide gauge with three sensors was delayed until 13.11 when the weather had moderated. The deployment was completed by 14.00.

It was decided to lay a Mark II tide gauge at Station 56 at first

light on the following day, Thursday 11th March. In the meantime, a surface sampling programme was designed taking a northerly track from Station 55. As it turned out, the winds increased to over 30 knots on the morning of the 11th and the approach to Station 56 was slowed down very considerably. In fact, little headway was made on the 11th, due to the rough sea. The winds increased to over 45 knots from the south east on the 12th and the ship was in almost a 'hove to' situation in the general vicinity of Station 56. However, weather conditions improved quite significantly during the early morning of the 13th and at 5.30, when the ship was by then well to the south-east of Station 56, a course was set for Station 57. The ship reached this station at 9.40 and, by 10.30, a pop-up Mark I tide gauge had been laid there.

During the next three days, 13-15 March, a succession of CTD profiles were taken at various positions across the northern North Sea from Utsira (Norway) to the Orkney Islands. These positions, numbered 1 to 39 (Table 2), are shown in Figure 4 along with the times at which the respective profiles were taken. With the ship sailing along the line of latitude $59^{\circ}20'N$, opportunity was taken to lay a Mark II tide gauge at Station 56: accomplished without difficulty between 01.19 and 2.51 on Sunday 14th March.

The programme of the cruise, in terms of the deployment of off-shore tide gauges and current meter rigs, was thus completed and the ship headed for Aberdeen, docking there at 14.00 on Tuesday, 16th March.

NARRATIVE, LEG 2

The ship sailed from Aberdeen at 13.00 hours on Wednesday, 14 April, to recover the moorings at stations 53, 54, 55, 56 and 57 laid previously on Leg 1 (see Fig.5) and to repeat the CTD section along latitude $59^{\circ}20'N$ at stations 1 to 39 (see Table 2). When the ship was clear of the harbour approaches, the overside pump was installed and surface monitoring of temperature and conductivity commenced at 15.25 hours with a sampling interval of 10 minutes. At the same time the P.E.S. Mk.III overside transducer, for interrogating the command pingers attached to each mooring, was deployed. A course was then set for station 53 which was eventually occupied the following morning, 15 April, at 00.04 hours, and the current meter/tide gauge rig located on position. Recovery started at 05.42 hours and was successfully completed by 06.26 hours with the rig in good condition, although the Dahnbuoy had sunk. CTD profile No.45 was carried out at 06.30 hours then the current meter rig at this station was located by interrogating its command pinger, since the surface buoy had been washed ashore on Orkney during March. Dragging started at 12.15 hours across the ground line position and contact made at 12.30 hours. Recovery commenced and the three current meters were retrieved in good condition by 13.03 hours. CTD profile No.46 was taken at 13.17 hours to complete the work at station 53 and the ship left at 13.30 hours heading for station 54.

At 10.20 hours a message was received from Bidston with the

information that on the 14th April the CM rig at station 54 had been lifted by a fisherman and then dropped back into the sea at a position Green H 31.7, Purple G 70.1, which was within half a mile of its lay position. The Challenger passed through this position at 18.00 hours but no contact was made with the command pinger on the rig and nothing was sighted, so the ship proceeded to the T.G. rig at station 54 where the surface buoy was sighted on position. Recovery started at 18.43 hours and completed by 19.40 hours with the T.G. in good condition, although there was some difficulty with tangled lines. CTD profile No.47 was carried out at 19.55 hours before the ship moved back to the last reported position of the CM rig at this station. A hydrophone search of the area was started which continued until 23.00 hours but without any response from the command pinger. The weather throughout the day had been very good. Dragging commenced at 06.00 hours the following morning, 16th April, across the position reported by the fisherman and also the lay position, supplemented by hydrophone listening. No positive contact was made with the rig during this attempt, so the grapnel was recovered at 11.43 hours and the ship left station 54 with hydrophone monitoring continuing along the cruise track to station 55.

Station 55 was occupied at 18.10 hours but there was no sign of the T.G. rig surface buoys. However, contact was made with the acoustic command pinger on the rig which confirmed that it was on the lay position. Dragging across the ground line commenced at 19.05 hours and was caught at 20.14 hours. The recovery continued

until 20.58 hours when it was successfully completed with the recovery of the T.G. in good condition and undamaged. CTD cast No.48 completed the work at station 55 and the ship left at 21.00 hours on course for station 56, but at 22.45 hours, during the passage from station 55 to 56, a surface buoy (Selco No.7) from the T.G. rig at station 55 was sighted adrift. It was subsequently recovered and found to be in good condition with the mooring wire still attached but cut close to its anchor. The weather had been good all day.

At 06.45 hours Saturday 17th April station 56 was occupied and recovery of the T.G. started from the Dahnbuoy end of the rig since the Selco buoy was missing. The rig recovery was complete by 07.13 hours without difficulty. On inspection of the T.G. frame it was found that one of the outer steel frame uprights had been bent inwards to the extent that it had come into contact with the inner aluminium frame which was also bent. Such damage could only have been caused by a severe blow and would not have gone unnoticed on the deployment or recovery operation, therefore it must have happened during its time on the sea bed.

A CTD cast (No.49) completed the work at station 56 and the ship left at 07.50 hours with a course set for station 57 which was eventually occupied at 13.25 hours. The T.G. at this station was one of the pop-up type, which was located on position and recovered without delay at 14.12 hours after transmission of the release signal. A CTD cast (No.50) was taken at 14.25 hours, then the ship left the station heading

due east, and reached CTD profile station No.1 (see Table 2) at 16.20 hours to commence the CTD section along latitude $59^{\circ}20'N$ in a westerly direction (see Fig.5). This work continued throughout Sunday and Monday 18-19 April and was hampered at times by fog which slowed the speed of the ship and prevented any further recovery attempts at station 54, although hydrophone listening was carried out in its vicinity.

With the CTD section completed, station 54 was reoccupied at 08.00 hours on Tuesday 20th April and dragging/hydrophoning started at once. This continued all day until nightfall when dragging was terminated and a hydrophone box search started over an area 10 miles x 24 miles. Although fog again slowed the progress of the ship during Wednesday, 21st April, the search was completed by 20.30 hours, but without any trace of the current meter rig. With little chance left of finding the rig and the rest of the program completed, the ship returned to Aberdeen and docked at 07.45 hours on Thursday, 22nd April.

A total of 902 miles were covered on the cruise track with approximately 890 miles of T/C surface sampling.

STATION REPORT LEG 1 - DEPLOYMENT

Decca coordinates are in curved brackets and refer to red, green and purple values, respectively, reading from left to right. Latitude and longitude, by satellite fix, are in square brackets.

Station 53 Bottom mounted current meter/tide gauge.
 Designated position : (58°37'N, 2°25'W).
 Depth : 75m.
 Surface buoy Selco No.6.
 Surface Dahnbuoy.

↓ Selco buoy
 ↓ Anchor (----, C37.7, G57.0)
 ↓ Ground line
 ↓ Current meter/
 tide gauge 1747 (----, C37.5, G56.6), [58°37.11', 2°26.25'W]
 ↓ Dahnbuoy

Deployment started 6.38)
 Deployment complete 7.24) 9.3.76

Decca : 6C/MP

Station 53 Current meter rig with meters at 8, 23 and 38m,
 and sub-surface buoy at 45m, from the bottom.
 Designated position : (58°37'N, 2°25'W).
 Depth : 68m.
 Sub-surface buoy No.1.
 Surface buoy Selco No.5.

↓ Sub-surface buoy
 ↓ Current meters : 1867 (top), 1750 (middle), 1749 (bottom).
 ↓ First anchor (----. C36.5, G56.0), [58°36.85', 2°27.32']
 ↓ Ground line lying at 040°/220°
 ↓ Second anchor (----, C36.3, G56.1)
 ↓ Selco buoy

Deployment started 8.19)
 Deployment complete 8.47) 9.3.76

Decca : 6C/MP

Station 54 Current meter rig with meters at 8, 48 and 78m,
 and sub-surface buoy at 85m, from the bottom.
 Designated position : (58°57'N, 1°15'W).
 Depth : 115m.
 Sub-surface buoy No.2.
 Surface buoy Selco No.4.

↓ Sub-surface buoy
 ↓ Current meters : 1509 (top), 1748 (middle), 1866 (bottom)
 ↓ First anchor (----, H30.7, G72.4), [58°58.24', 1°17.84'W]
 ↓ Ground line lying at 205°/025°
 ↓ Second anchor (----, H30.3, G73.0)
 ↓ Selco buoy : sighted 15.3.76 at [58°57.87', 1°16.68']

Deployment started 13.34)
 Deployment complete 14.13) 9.3.76

Decca : 6C/MP

Station 54 Mark II tide gauge No.002 with three sensors.
 Designated position : (58°57'N, 1015'W)
 Depth : 113m.
 Surface buoy Selco No.1.
 Surface Dahnbuoy.

↓ Selco buoy
 ↓ Anchor (----, G47.5, G75.2)
 ↓ Ground line lying at 165°/345°
 ↓ Tide gauge (----, G47.4, G76.0)
 ↓ Dahnbuoy

Deployment started 18.52)
 Deployment complete 20.10) 9.3.76

Decca : 6C/MP

Station 55 Mark II tide gauge No.004 with three sensors.
 Designated position : (59°20'N, 0°15'E)
 Depth : 135m.
 Surface buoy Selco No.7.
 Surface Dahnbuoy.

↓ Selco buoy : sighted 14.3.76 at [59°20.575', 00°14.867']
 ↓ Anchor (----, B43.6, H62.7)
 ↓ Ground line lying at 155°/335°
 ↓ Tide gauge (----, B43.5, H62.9)
 ↓ Dahnbuoy (----, B43.6, H62.8), [59°19.18', 00°15.06']

Deployment started 13.11)
 Deployment complete 13.55) 10.3.76

Decca : 6C/MP

Station 56 Mark II tide gauge No.001 with three sensors.
 Designated position : (59°20'N, 2°45'E)
 Depth : 119m.
 Surface buoy Selco No.8.
 Surface Dahnbuoy.

↓ Selco buoy
 ↓ Anchor (----, D36.5, 170.7), [59°19.916', 2°44.64']
 ↓ Ground line lying at 155°/335°
 ↓ Tide gauge (----, D36.3, 171.4), [59°19.505', 2°46.68']
 ↓ Dahnbuoy

Deployment started 01.19)
 Deployment complete 02.51) 14.3.76

Decca : OE/MP

Station 57 Pop up Mark I tide gauge No.15 in GRP sphere
with two sensors.
Designated position : (59°20'N, 4°30'E)
Depth : 271m

Tide gauge : (----, G37.7, A57.3), [59°20.438', 4°30.649']

Deployment started 10.24)
Deployment complete 10.30) 13.3.76

Decca : OE/MP

STATION REPORT LEG 2. RECOVERY (DECCA CHAIN 6C/MP)

Station 53

(a) Bottom mounted current meter/tide gauge rig.

(b) Current meter rig with 3 meters.

(a) Bottom mounted rig :-

Current meter No.1747

Pressure sensor, Digiquartz S/No.280

Command pinger No.3

Deployed position	Red	Green	Purple
	-	C37.5	G56.6
Recovery position	J10.12	C37.58	G56.58

Recovery started at	05.42 hours	15 April 76
Surface buoy on deck	05.55 "	
Surface buoy anchor on deck	06.06 "	
Bottom CM/TG on deck	06.20 "	
Sunken dahnbuoy on deck and recovery complete	06.26 "	

On arrival at the station only the Selco buoy was visible on the surface but it was found when the recovery was completed that the dahnbuoy had sunk. The acoustic command pinger attached to the rig was switched on during the recovery and worked normally.

The bottom CM/TG was recovered undamaged and working normally.

(b) Current meter rig :-

Current meter	No.1867 Top
	1750 Mid
	1749 Bottom

Command pinger	No. CR 224
----------------	------------

Deployed position	Red	Green	Purple
	-	C36.5	G56.0
Recovery position	J11.9	C35.3	G56.2

Rig recovered by dragging.

Recovery started	12.15 hours	15 April 76
Rig caught by grapnel	12.30 "	
First anchor on deck	12.47 "	
Second " " "	12.56 "	
Bottom meter on deck	12.58 "	
Mid " " "	12.59 "	
Top " " "	13.00 "	
Sub-surface buoy on deck and recovery complete	13.03 "	

All meters recovered in good condition and working. On arrival at the station the pellets marking the sub-surface buoy were not visible and the Selco surface buoy had been recovered previously on Orkney. The command pinger worked normally.

CTD cast No.46 carried out at 13.17 hours.

Station 54

(a) Mark II off-shore tide gauge rig

(b) Current meter rig with 3 meters

(a) Off-shore tide gauge rig :-

Logger 002	Sensors	1/6 VIB
	"	5/1 DIG
	"	2/7 S.G
Command pinger No.1		

Deployment position	Red	Green	Purple
	-	G47.4	G76.0
Recovery position	-	G47.5	G75.0

Recovery started at	18.43 hours	15 April 76
Surface buoy on deck	19.05 "	
Surface buoy anchor on deck	19.17 "	
T.G. on deck	19.33 "	
Dahnbuoy on deck and recovery complete	19.40 "	

All equipment recovered in good condition and working normally.

CTD cast No.47 carried out at 19.55 hours.

(b) Current meter rig :-

Current meter No.1509 Top
 No.1748 Mid
 No.1866 Bottom

Command pinger No. CR 226

Deployment position	Red	Green	Purple
	-	H30.3	G73.0

No equipment was recovered from this station.

A fisherman reported that on the 14 April he lifted the rig in his trawl but dropped it back into the sea when he could not take it aboard. He gave his position as :

Green	H31.7
Purple	G70.1

Station 55

Mark II off-shore tide gauge rig :-

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

Command pinger No. CR 228

Deployment position	Red	Green	Purple
	-	B43.5	H62.9
Recovery position	-	B43.5	H62.8

Rig recovered by dragging.

Recovery started at	20.14 hours	16 April 76
Surface buoy anchor on deck	20.55 "	
T.G. on deck and recovery complete.	20.58 "	

The T.G. was in good condition on recovery and everything working normally.

Both surface buoys were missing from this rig but the Selco buoy was found two hours later, adrift.

COMMENTS ON THE SHIP

A portable diesel/hydraulic winch was fitted to the main after deck of the ship to deploy and recover the moorings since the ship's own winches cannot handle the couplings and shackles in the mooring wires.

The noise from this winch makes communication over the ship telephones between the after deck and the bridge difficult. This could be improved by using portable UHF radios as used on other NERC vessels.

The degree of control over the ship when deploying and recovering moorings is greatly assisted by the use of the bow thruster and makes the ship well suited to this work.

The ship's equipment associated with the CTD system, namely the hydrographic winch, performed satisfactorily but however, on leg 1 of the cruise, one of the shoes securing the surface sampling pump to the ship's side came away at the weld, which made it necessary to go into port for repairs.

ACKNOWLEDGEMENT

We would like to thank the Master, Officers and crew of the Challenger for their co-operation and assistance. Every effort was made on their part which resulted in a very successful cruise.

TABLE 1

LIST OF IOS STATION POSITIONS

Station No.	Lat.	Long.
53	58 ⁰ 37'N	02 ⁰ 25'W
54	58 ⁰ 57'N	01 ⁰ 15'W
55	59 ⁰ 20'N	00 ⁰ 15'E
56	59 ⁰ 20'N	02 ⁰ 45'E
57	59 ⁰ 20'N	04 ⁰ 30'E

TABLE 2

CTD PROFILE SAMPLING STATIONS

Station No.	Latitude	Longitude
1	59 ⁰ 20'N	05 ⁰ 02'E
2	59 ⁰ 20'	04 ⁰ 56'
3	59 ⁰ 20'	04 ⁰ 50'
4	59 ⁰ 20'	04 ⁰ 40'
5	59 ⁰ 23' Leg 1	59 ⁰ 20' Leg 2
6	59 ⁰ 20'	04 ⁰ 20'
7	59 ⁰ 20'	04 ⁰ 11'
8	59 ⁰ 20'	04 ⁰ 02'
9	59 ⁰ 20'	03 ⁰ 51'
10	59 ⁰ 20'	03 ⁰ 41'
11	59 ⁰ 20'	03 ⁰ 32'
12	59 ⁰ 20'	03 ⁰ 22'
13	59 ⁰ 20'	03 ⁰ 13'
14	59 ⁰ 20'	03 ⁰ 04'
15	59 ⁰ 20'	02 ⁰ 54'
16	59 ⁰ 20'	02 ⁰ 45'
17	59 ⁰ 20'	02 ⁰ 31'
18	59 ⁰ 20'	02 ⁰ 15'
19	59 ⁰ 20'	02 ⁰ 00'
20	59 ⁰ 20'	01 ⁰ 44.5'
21	59 ⁰ 20'	01 ⁰ 19'
22	59 ⁰ 20'	01 ⁰ 00'
23	59 ⁰ 20'	00 ⁰ 40'
24	59 ⁰ 20'	00 ⁰ 20'
25	59 ⁰ 20'	00 ⁰ 00'
26	59 ⁰ 20'	00 ⁰ 20'W
27	59 ⁰ 20'	00 ⁰ 39'
28	59 ⁰ 20'	00 ⁰ 59'
29	59 ⁰ 20'	01 ⁰ 19'
30	59 ⁰ 20'	01 ⁰ 38'
31	59 ⁰ 20'	01 ⁰ 56'
32	59 ⁰ 20'	02 ⁰ 14'
33	59 ⁰ 12'	00 ⁰ 25.5'
34	59 ⁰ 04.8'	00 ⁰ 50.5'
35	58 ⁰ 57.6'	01 ⁰ 16'
36	58 ⁰ 50'	01 ⁰ 42'
37	58 ⁰ 42.6'	02 ⁰ 08'
38	58 ⁰ 35'	02 ⁰ 33'
39	58 ⁰ 30'	02 ⁰ 51'

Note on Table 2

The positions given in this table are nominal, being prescribed before the commencement of the cruises; actual positions of the CTD profiles are recorded with the logged data.

The CTD station numbers recorded with the logged data are different from those given in Table 2. These CTD station numbers, with their corresponding locations, are as follows:-

<u>CTD Station No.</u>	<u>Location</u>
1.	North Channel.
2.	T.G. station 53.
3.	C.M. station 53.
4.	T.G. station 54.
5.	T.G. station 55.
6.-44.	Stations 1-39 in Table 2, excepting 16 for which there is no data.
45.	T.G. station 53.
46.	C.M. station 53.
47.	T.G. station 54.
48.	T.G. station 55.
49.	T.G. station 56.
50.	T.G. station 57.
51.-89.	Stations 1-39 in Table 2.

TABLE 3

LIST OF EQUIPMENT DEPLOYED

1. Surface buoys

(a) Selco No. 1, 4, 5, 6, 7, 8.
(fitted with flashing light)

Manufactured by Selco, Oslo, Norway.
3m overall, 450 kg buoyancy.

(b) Dahnbuoy

Loaned from IOS Barry.

2. Sub-surface buoy

(a) Hollow steel sphere.
No. 1, 2.

Manufactured to IOS design.
0.8m dia. 175 kg buoyancy.

3. Current meters

No. 1509, 1747, 1748, 1749, 1750,
1867, 1866.

Manufactured by Aanderaa
Ltd., Norway. Type RCM4.

4. Off-shore tide gauge

(a) Moored T.G. system consisting
of data logger and 3 sensor
units to measure both pressure
and temperature.

IOS Bidston.

Data logger 001, 002 and 004.

Manufactured by Marconi
Space & Defence Ltd.

Pressure transducers elements
VIB (vibrating wire)

Manufactured by Sundstrand
Data Control Inc.
Washington, USA.

OAR (vibrating wire)

Manufactured by Ocean
Applied Research, San Diego,
California, USA.

S.G. (strain gauge)

Manufactured by Bell &
Howell Ltd., Basingstoke,
U.K.

Digiquartz (quartz crystal)
S/N 275.

Manufactured by Paroscien-
tific Inc., Washington USA.
Model 2400A.

(b) Pop-up T.G. capsule consisting of a data logger, acoustic release system with 2 pressure sensors and 1 temperature sensor.

IOS Bidston.

Logger type 1020

Manufactured by N.G.L. Ltd.

Pressure transducer element
S.G. (strain gauge)

Manufactured by Bell & Howell Ltd., Basingstoke, U.K.

5. Bottom mounted current meter/tide gauge.

Moored CM/TG system consisting of a current meter with direction vane and 1 pressure sensor.

IOS Bidston.

Current meter No.1747

Manufactured by Aanderaa Ltd., Norway. Type RCM4.

Pressure transducer element
Digiquartz (quartz crystal)
S/N 280.

Manufactured by Paroscientific Inc., Washington USA. Model 2400A.

6. Acoustic Command pinger.

Pinger No.1, 3, 224, 226,
227, 228.

IOS Bidston/Wormley.

7. Flashing light.

Pains Wessex

Manufactured by Pains-Wessex Ltd., U.K.

ABBREVIATIONS

IOS	Institute of Oceanographic Sciences.
CM	Current meter.
T.G.	Tide gauge.
S/S	Sub-surface buoy.
T/C	Temperature, conductivity.
CTD	Conductivity, temperature, depth.
P.E.S.	Precision Echo sounder.

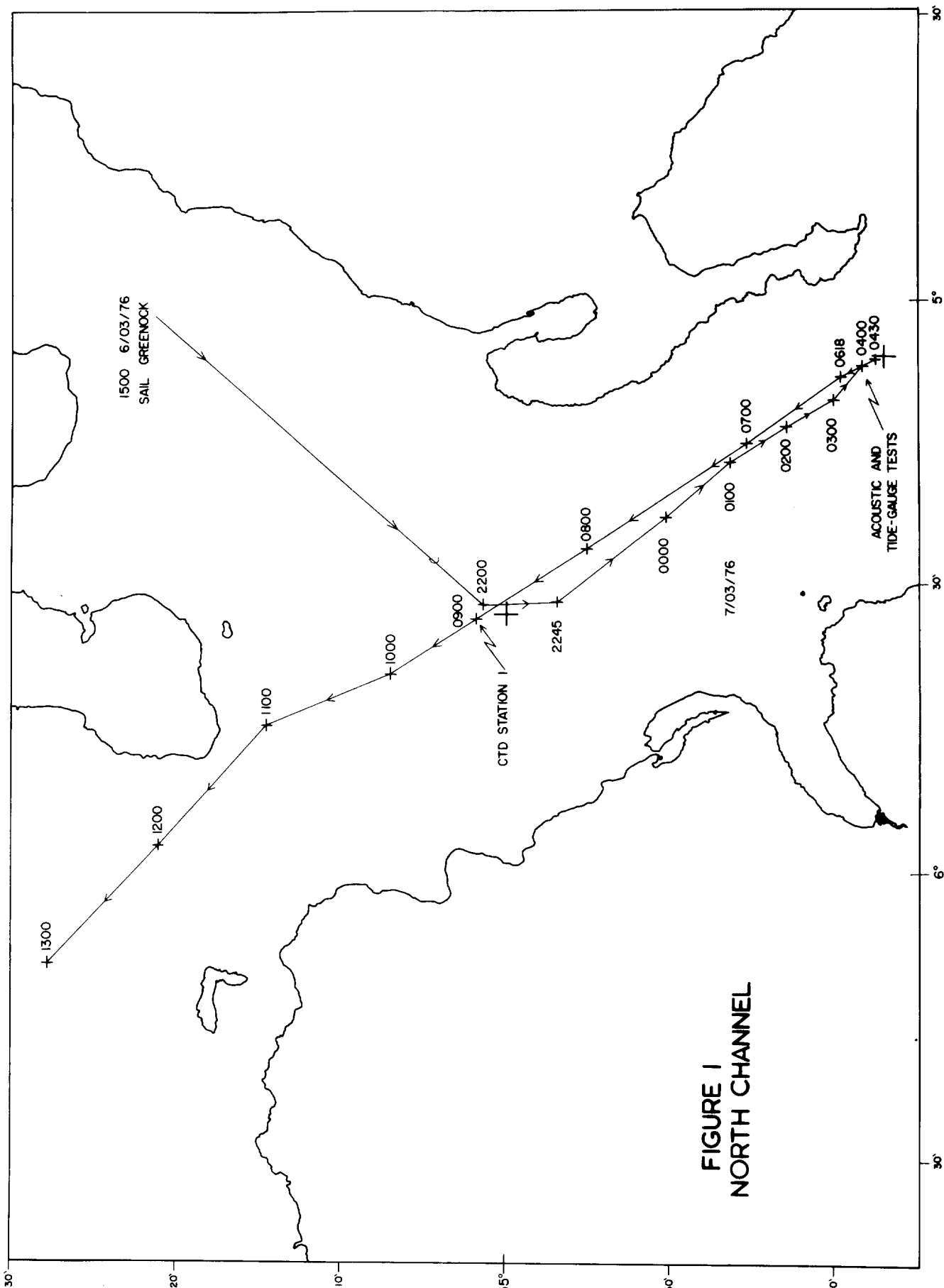


FIGURE 1
NORTH CHANNEL

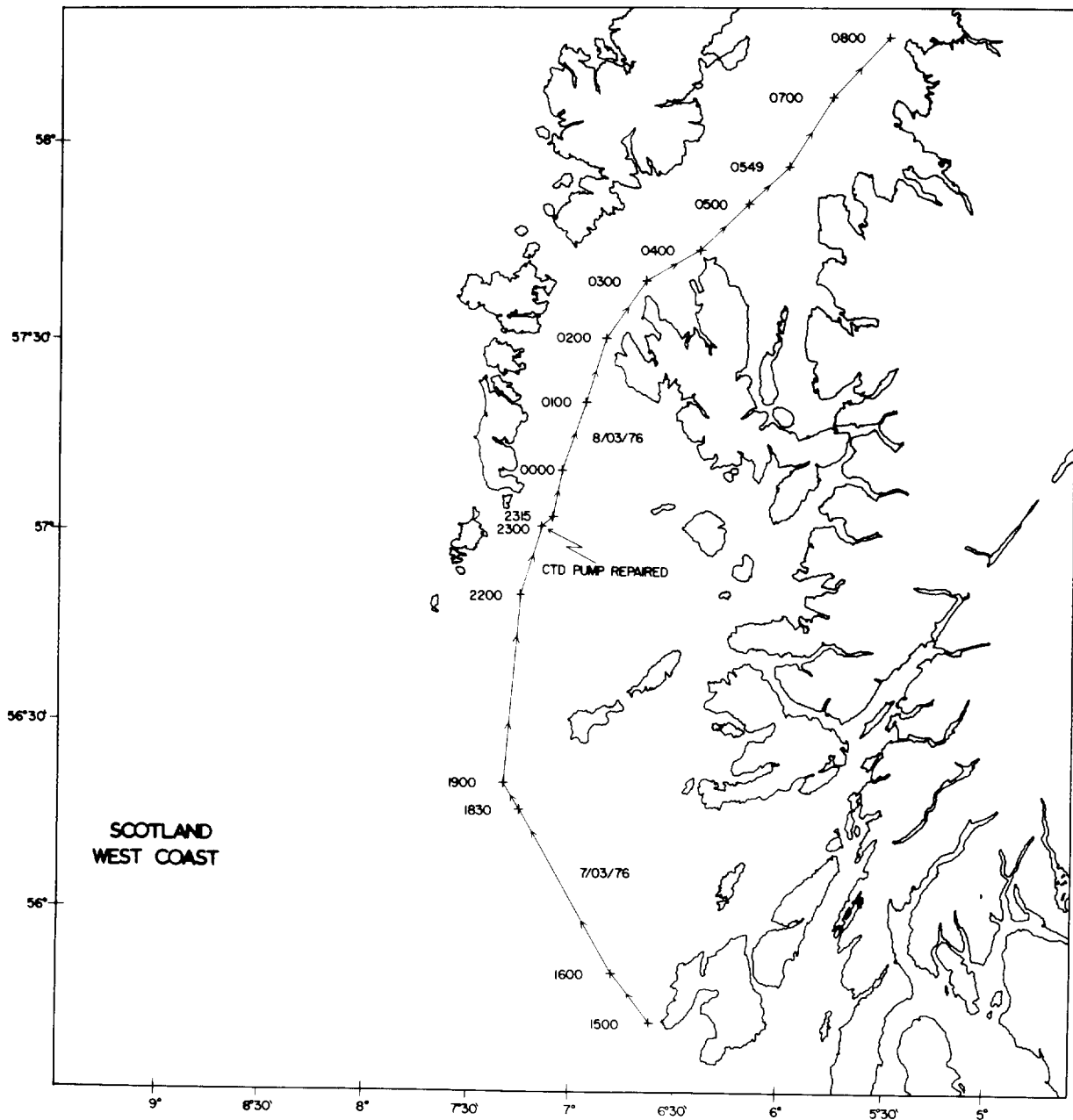
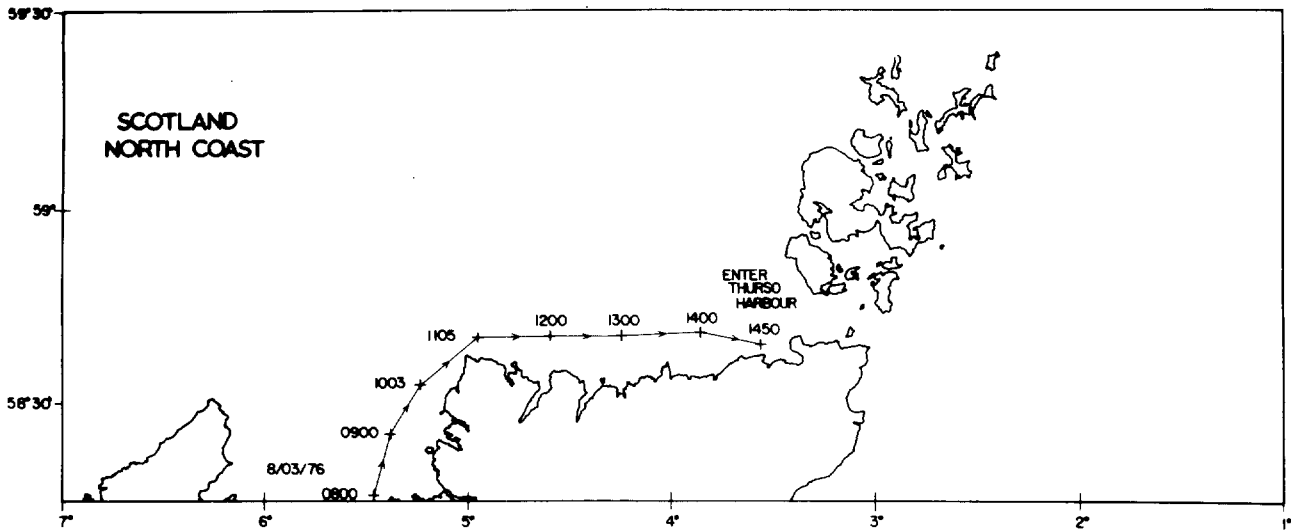


FIGURE 2 SCOTLAND NORTH AND WEST COASTS

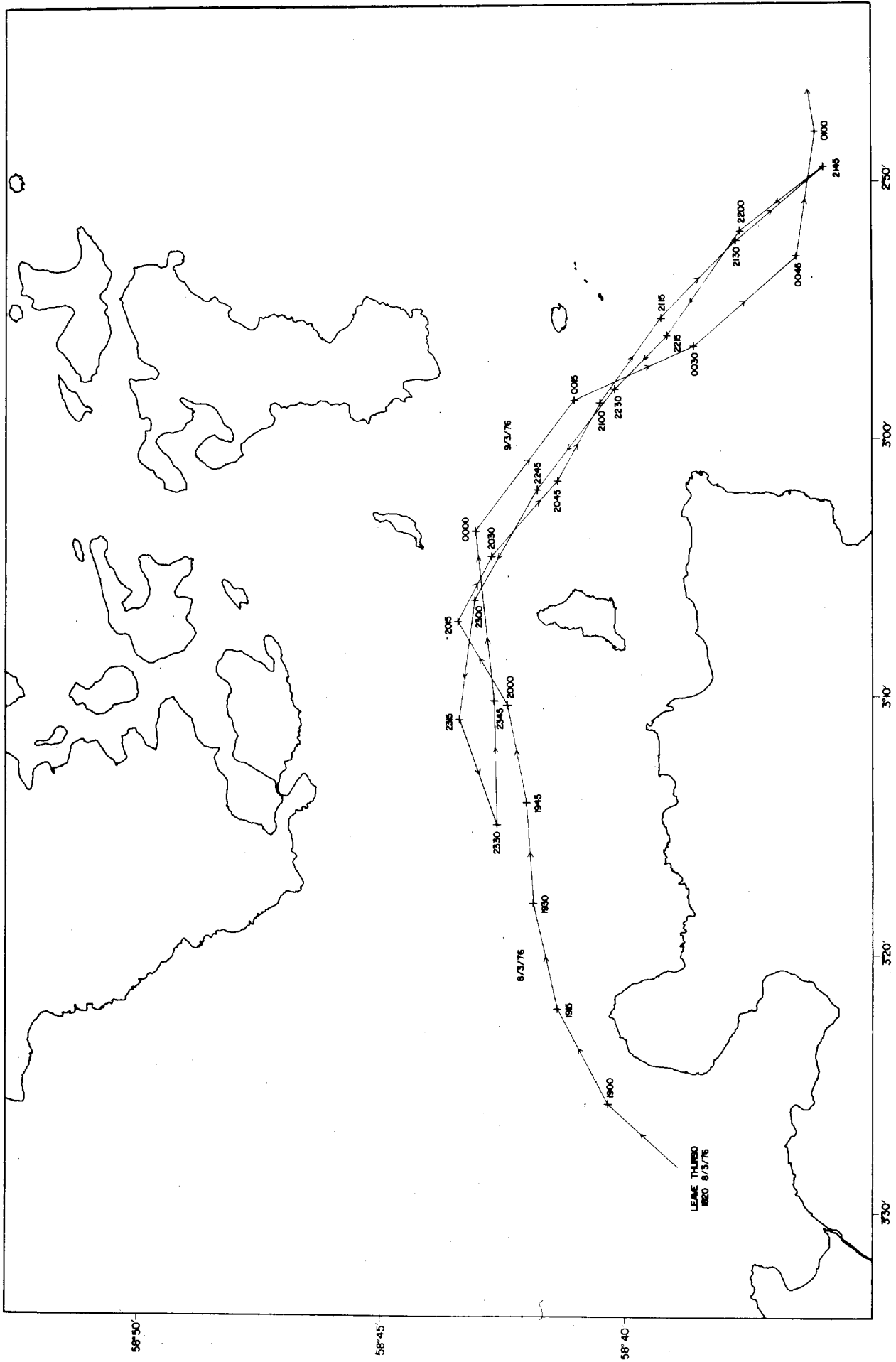


FIGURE 3 PENTLAND FIRTH

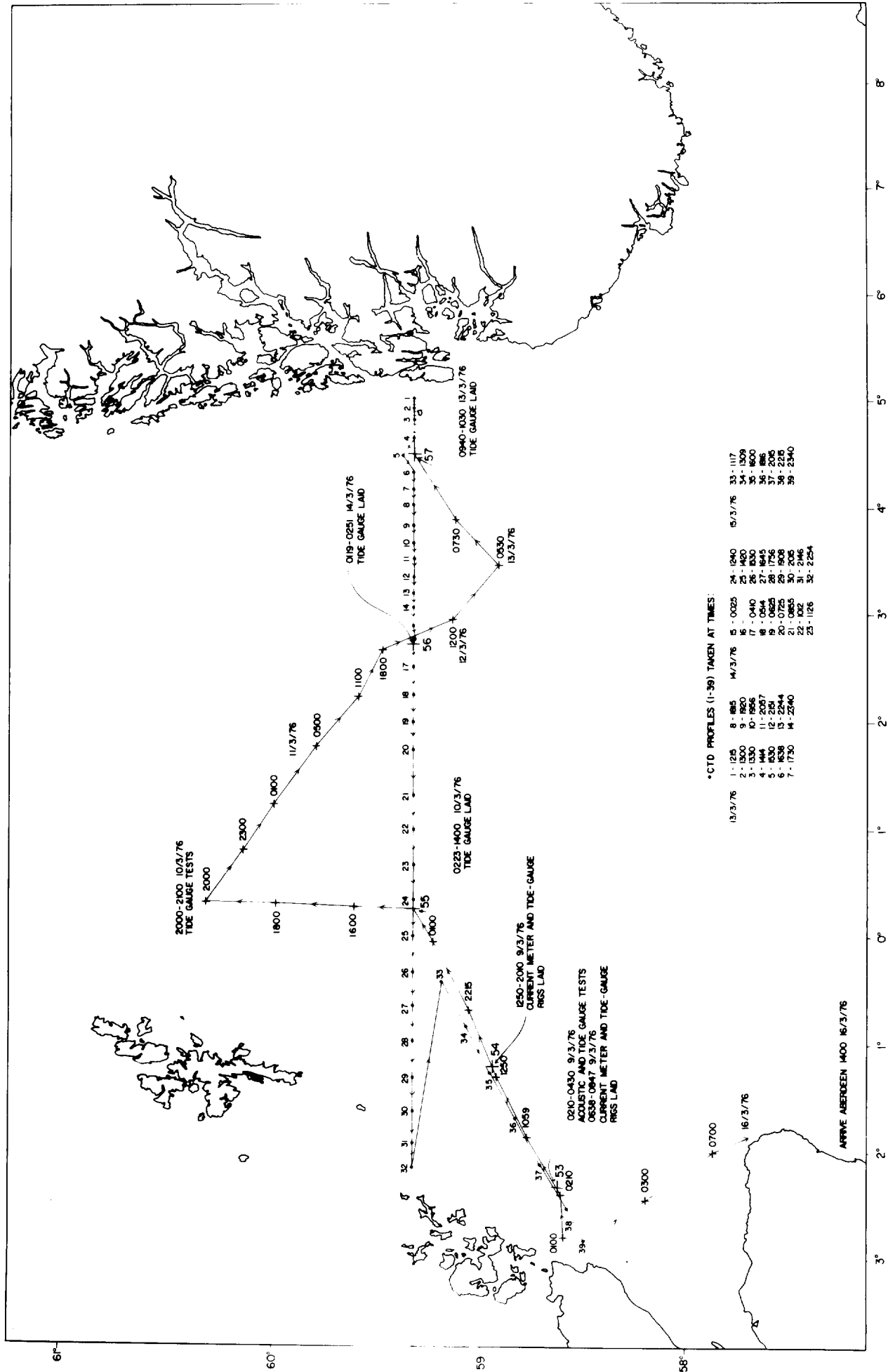


FIGURE 4 NORTHERN NORTH SEA (LEG 1)

CURRENT METER MOORING SYSTEM

INSTITUTE OF OCEANOGRAPHIC SCIENCES BIDSTON

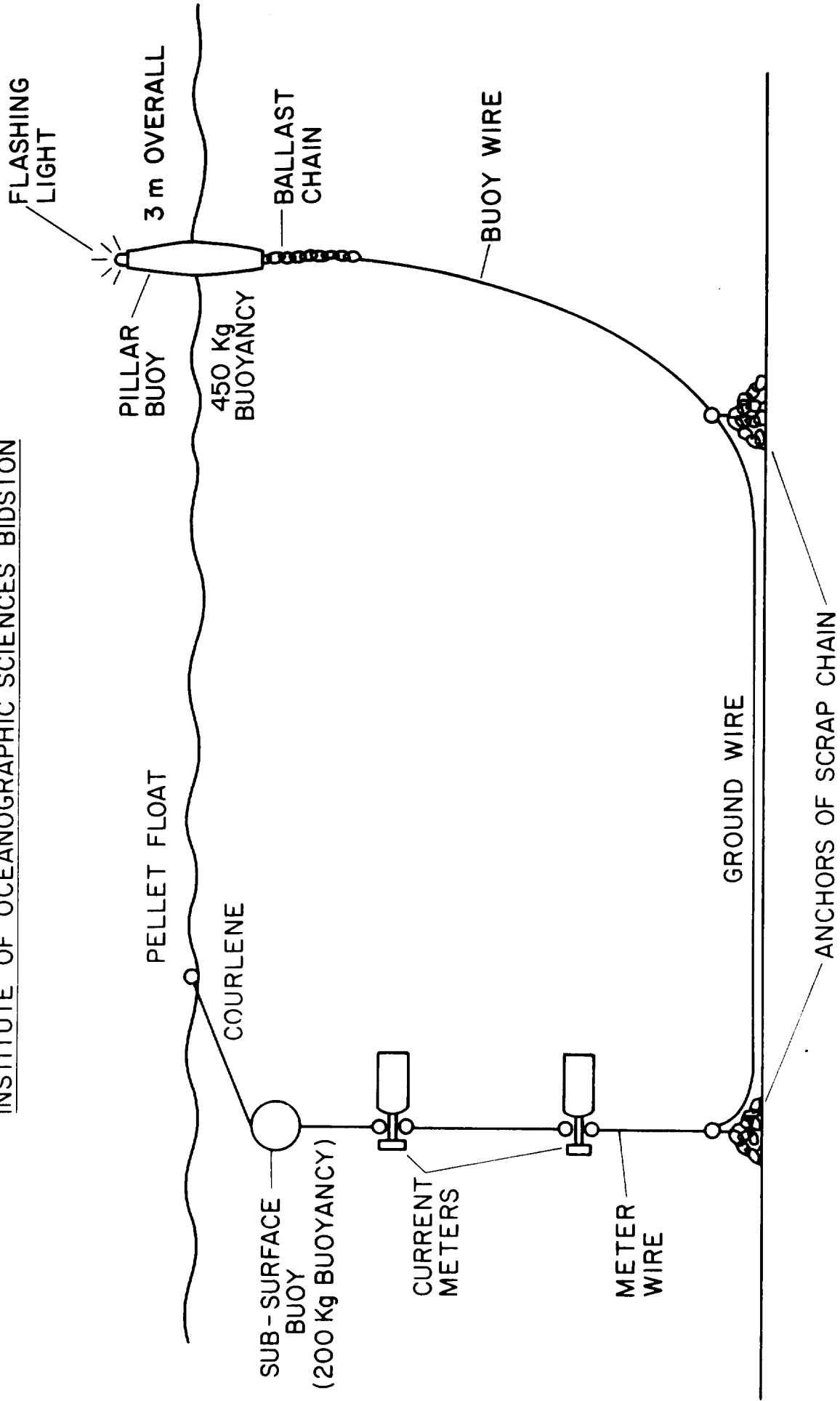


FIGURE 6

OFF SHORE TIDE GAUGE MOORING SYSTEM

INSTITUTE OF OCEANOGRAPHIC SCIENCES BIDSTON

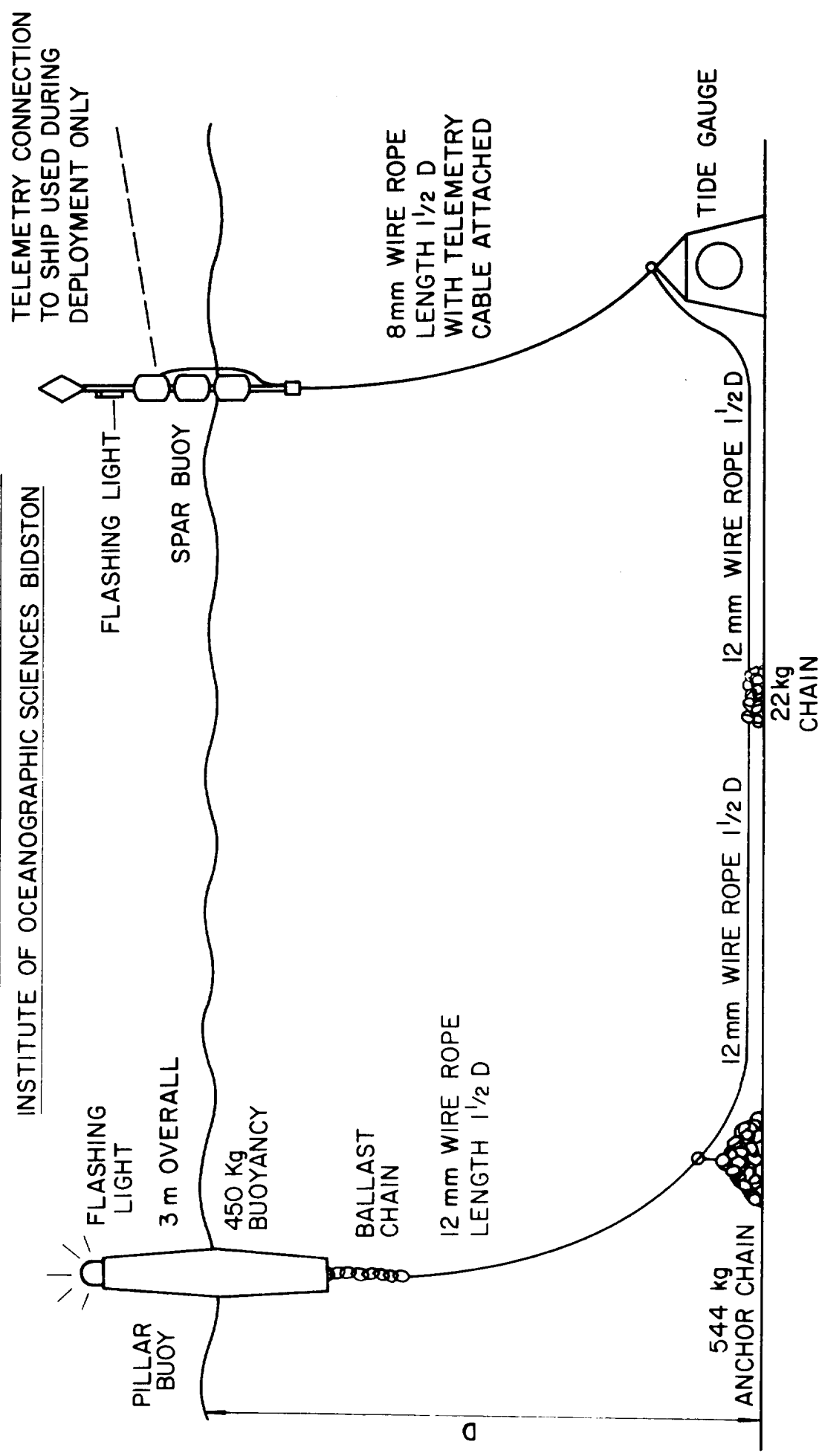


FIGURE 7

BOTTOM MOUNTED CURRENT METER / TIDE GAUGE MOORING SYSTEM

INSTITUTE OF OCEANOGRAPHIC SCIENCES BIDSTON

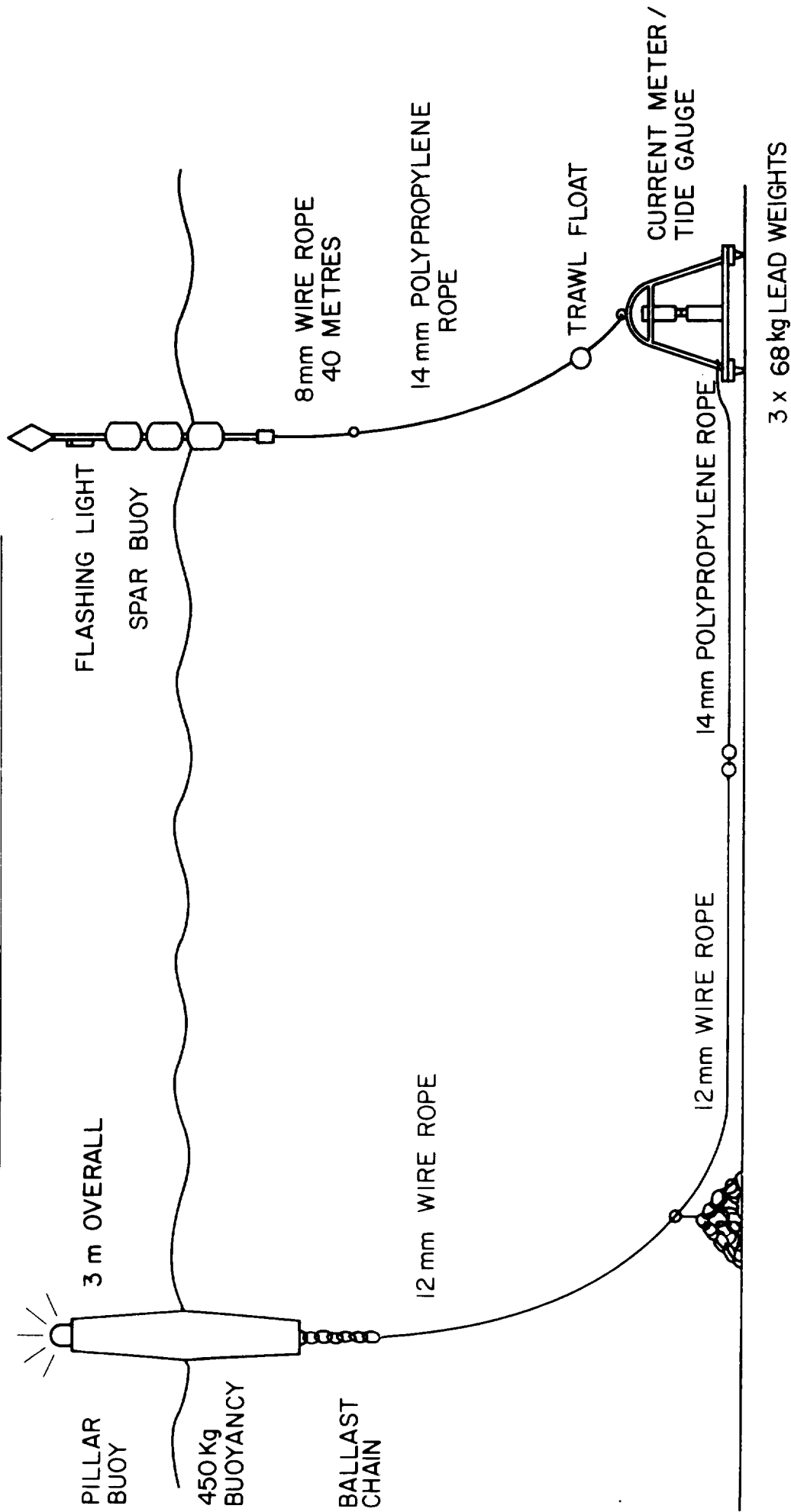


FIGURE 8

CRUISE REPORTS

CRUISE No. and/or DATE REPORT No.

R.R.S. "DISCOVERY"

1	(International)	Published and
2	(Indian Ocean)	distributed by the
3	(Expedition)	Royal Society
		NIO CR ¹
4	February-March 1965	4
37	November-December 1970	37
38	January-April 1971	41
39	April-June 1971	40
40	June-July 1971	48
41	August-September 1971	45
42	September 1971	49
43	October-November 1971	47
44	December 1971	46
45	February-April 1972	50
46	April-May 1972	55
47	June-July 1972	52
48	July-August 1972	53
49	August-October 1972	57
50	October 1972	56
51	November-December 1972	54
52	February-March 1973	59
53	April-June 1973	58
		IOS CR ²
54	June-August 1973	2
55	September-October 1973	5
56	October-November 1973	4
57	November-December 1973	6
58	December 1973	4
59	February 1974	14
60	February-March 1974	8
61	March-May 1974	10
62	May-June 1974	11
63	June-July 1974	12
64	July-August 1974	13
65	August 1974	17
66	August-September 1974	20
68	November-December 1974	16
73	July-August 1975	34
74	Leg 2)	
74	Leg 1 & 3)	
75	October-November 1975	33
		35
		43

¹NIO CR National Institute of Oceanography, Cruise Report.

²IOS CR Institute of Oceanographic Sciences, Cruise Report.

CRUISE REPORTS

CRUISE No. and/or DATE REPORT No.

R.R.S. "CHALLENGER"

August-September 1974 IOS CR 22

R.V. "EDWARD FORBES"

October 1974 IOS CR 15*
 January-February 1975 IOS CR 19
 April 1975 IOS CR 23
 May 1975 IOS CR 32
 May-June 1975 IOS CR 28
 July 1975 IOS CR 31
 July-August 1975 IOS CR 36
 August-September 1975 IOS CR 41

R.R.S. "JOHN MURRAY"

April-May 1972 NIO CR 51
 September 1973 IOS CR 7
 March-April 1974 IOS CR 9
 October-November & December 1974 IOS CR 21
 April-May 1975 IOS CR 25
 April 1975 IOS CR 39
 October-November 1975 IOS CR 40

N.C. "MARCEL BAYARD"

February-April 1971 NIO CR 44

M.V. "RESEARCHER"

August-September 1972 NIO CR 60

R.V. "SARSIA"

May-June 1975 IOS CR 30
 August-September 1975 IOS CR 38

R.R.S. "SHACKLETON"

August-September 1973 IOS CR 3
 January-February 1975 IOS CR 18
 March-May 1975 IOS CR 24
 February-March 1975 IOS CR 29
 July-August 1975 IOS CR 37

M.V. "SURVEYOR"

February-April 1971 NIO CR 38
 June 1971 NIO CR 39*
 August 1971 NIO CR 42*

D.E. "VICKERS VOYAGER" and "PISCES III"

June-July 1973 IOS CR 1

*Not distributed