

R R S CHALLENGER

CRUISES 5/78 Leg 1 : 22 March - 4 April 1978

8/78 Leg 2 : 12 May - 24 May 1978

Celtic Sea Observation Programme

CRUISE REPORT No 72

1978

HATURAL

INSTITUTE OF OCEANOGRAPHIC SCIENCES

YONNOO HOUNTS

INSTITUTE OF OCEANOGRAPHIC SCIENCES

Wormley, Godalming, Surrey, GU8 5UB. (0428 - 79 - 4141)

(Director: Dr. A.S. Laughton)

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)

On citing this report in a bibliography the reference should be followed by the words UNPUBLISHED MANUSCRIPT.

R R S CHALLENGER

CRUISES 5/78 Leg 1 : 22 March - 4 April 1978

8/78 Leg 2 : 12 May - 24 May 1978

Celtic Sea Observation Programme

CRUISE REPORT No 72

1978

Institute of Oceanographic Sciences Bidston Observatory Birkenhead Merseyside L43 7RA

CONTENTS

| • | |
|--|------|
| | Page |
| Duration | 1 |
| Scientific staff | 1 |
| Ship's Officers | 2 |
| Objectives of cruise | 3 |
| Narrative - Leg 1 | 4 |
| - Leg 2 | 6 |
| Station Report - Leg 1 | 11 |
| - Leg 2 | 20 |
| Equipment losses | 32 |
| Comments on ship | 33 |
| Acknowledgements | 33 |
| Tables & Diagrams | |
| Table 1 - Nominal station positions and measured depth | 34 |
| Table 2 - List of CTD profiles and Water bottle stations | 35 |
| Table 3 - list of equipment used | 37 |
| Abbreviations | 39 |
| Figures | |

NOTE: All times are in GMT.

DURATION

Deployment leg - sailed from Barry 0730 22 March 1978 (5/78) arrived at Barry 0630 4 April 1978

Recovery leg - sailed from Barry 0900 12 May 1978 (8/78) arrived at Barry 1930 24 May 1978

SCIENTIFIC STAFF

Leg l
A.D. Banaszek
J. Casson
D. Flatt
P. Foden
I.D. James
A.G. Kerr
D.L. Leighton
R.I.R. Palin
D.T. Pugh (Principal scientist)
R. Spencer
K.R. Thompson

Leg 2

G.A. Alcock

J. Bolton

D. Flatt

P. Foden

A.J. Harrison

M.J. Howarth

P. Foden
A.J. Harrison (Principal scientist)
M.J. Howarth
I.D. James
A.G. Kerr
D.L. Leighton
R.I.R. Palin
K. Taylor
J. Wolf

SHIPS OFFICERS

| - | | _ |
|----|---|-----|
| Lе | a | - 1 |
| | | |

G. Long Master P. Coombs Chief Officer S. Jones Second Officer K. George R. Hagley Third Officer Extra Third Officer

P. Stone Chief Engineer J. Jack Second Engineer J. Richardson Third Engineer D. Hornsby Fourth Engineer

Recovery leg

Master

P. Maw
P. Coombs
S. Jones
P. Pepler Chief Officer Second Officer Third Officer Chief Engineer P. Stone I. McGill Second Engineer J. O'Keeffe Third Engineer J. Landry Fourth Engineer

SUMMARY OF THE SCIENTIFIC OBJECTIVES OF THE CRUISE

The programme consisted of two cruises, the first to deploy tide gauges, current meters and thermistor chains in a pattern within the Celtic Sea, with an extension over the edge of the continental shelf, and the second to recover the equipment after a recording interval of some 50 days. Although the data is to be used for many purposes, the experiment was specifically designed to study:-

- A. The coherence of non-tidal coastal water level changes around the Celtic Sea over a year, relating level changes to changes in the weather and to the water density. Also, the relationship between these coastal water levels and off-shore currents.
- B. The details of tidal propagation from the deep Atlantic through the Celtic Sea, and in particular the region of anomalous tidal ageing and of the anomalous S_2/M_2 current amplitude ratio.
- C. Internal tides near the continental margin (Station I)
- D. Thermocline development (March-May is the critical time for establishing the Summer thermocline)
- E. Fluxes of mass, momentum, energy, salt and heat into and through the Celtic Sea.

NARRATIVE, LEG 1

It was planned to deploy equipment at ten stations, as shown in Figure 1. Throughout the cruise, however, continuing heavy seas and bad weather made work difficult and resulted in many delays. Eventually equipment was deployed at all except Station K.

March, 1978. Following tests on the SIMRAD logging equipment course was set for Station A. The CTD pump was put outboard at 1100. Because of worsening weather course was altered for shelter in Lundy Roads. Thursday, 23 March, was spent behind Lundy in winds up to 50 kts. Challengersailed from Lundy at 1300 on Friday 24 March and rigs were deployed at Station A during the afternoon. The current meter rig was found to have snagged the ship on first laying and it was necessary to recover and check the instruments before relaying. Rigs were deployed at Station B early on Saturday 25 March and, in worsening weather, rigs were laid at C during the afternoon. Challenger then returned to Lundy for shelter, where she remained until sailing for Station D at 1600 on Sunday 26 March.

On reaching Station D at first light on Monday 27 March conditions were too bad for rig deployment. Periodic CTD casts were made throughout the day while hove to, to observe the combined effects of strong insolation (measured) and strong winds on stratification. The rig at D was laid at first light on Tuesday 28 March and course was set for Station E. At E the sea was too rough for work and so Challenger hove to throughout Wednesday 29 March. The rig at E was laid at first light on Thursday 30 March and two rigs were laid at F during the afternoon, the tide gauge rig having the cruciform frame as ballast. Rigs at G were deployed at first light on Friday, 31 March.

Course was then set directly to Station I as this was given higher priority than H.

During the night of <u>Saturday 1 April</u> conditions again deteriorated to the extent that it became necessary to turn and set course back towards land and shelter. Fortunately, conditions improved slowly during the morning and deployment at H was possible during the afternoon; to make deployment easier, the current meter/thermistor chain rig was changed from a U-shaped mooring to a pop-up mooring. Course was again set for Station I as the weather continued to improve. Following a bathymetric survey, a suitable depth was found for working. Acoustic tests were made through the night on the deep tide gauge. The current meter rig was laid without difficulty before dawn. However, because the deep STD system was broken it was necessary to make two water bottle casts to determine the temperature/salinity profiles to 2000m. Following modifications as a result of the earlier tests the deep tide gauge was deployed at 1100 on <u>Sunday 2 April</u>.

Because of the time lost due to bad weather, it was not possible to proceed to Station K. Instead course was set for Barry. The CTD continuous surface sampler pump failed during the night of Monday 3 April. A final CTD cast was made at 1215 in calm conditions.

Challenger arrived in Barry at 0630 on <u>Tuesday 4 April</u>. Figure 2 shows approximate cruise tracks for this deployment leg.

NARRATIVE LEG 2

R.R.S. Challenger sailed from Barry at 0900 on Friday 12 May 1978 to recover 16 moorings which had been deployed previously on cruise 5/78, (See Fig. 1) and to carry out a CTD and surface water sampling survey. (See Table 2.)

With the ship clear of the harbour entrance the overside pump was installed and monitoring of surface water temperature and conductivity started at 1126 hours with a sampling interval of 3 minutes. was set for Station A which was eventually occupied at 1810 to find the surface buoy and pellet floats on position (see Fig. 4). started at 1845 and was complete by 1919 without difficulty. ship then moved to the current meter/tide gauge location and the surface buoy was found on position. Recovery started at 1927 but when the surface buoy anchor was brought on board it was found that the ground line to the CM/TG had been detached at the anchor and was missing (see Fig. 5). The remaining shackles at this point had all been stripped of their seizing wire and were only hand-tight. acoustic search of the area made no contact with the pinger on the mooring so the ship left station A at 2330 after carrying out CTD profile No. 21 and proceeded to station B which was eventually occupied at 0740 the following morning, Saturday 13 May. current meter/tide gauge mooring was located with the surface buoy and pellet floats on position so recovery started at 0826 but again when the surface buoy anchor was brought on board the ground line was not attached. However on this occasion the pellets floats at the CM/TG end of the mooring could be grappled and so the recovery was successfully completed by 0906. When the ship moved to the lay position of the current meter mooring nothing was sighted, but the

acoustic pinger on the mooring was then located about 1 mile off position.

Dragging started at 0938 and by 1115 the mooring was successfully recovered including the sunken surface buoy. CTD profile no. 22 completed the work at this station and the ship left at 1120 heading for station C and on route CTD profile no. 23 was taken.

When station C was occupied at 1500 the tide gauge/thermistor mooring was located on position, recovery started at once and was successfully completed by 1600 with all the equipment in good condition. CTD profile no. 24 was taken, then the pop-up current meter mooring at this site released and subsequently recovered to find the top meter tangled in the meter wire. With the work completed at station C the ship left at 1750 heading for station E and taking CTD profiles Nos. 25, 26 and 27 along the way. following morning, Sunday 14 May at 0615, station E was occupied and the tide gauge/current meter mooring sighted on position. started immediately and was completed without difficulty at 0655 except that the top current meter was again tangled in the meter wire. CTD profile no. 28 was carried out at 0800 then the ship left the site heading for station F taking CTD profiles Nos. 29, 30 and 31 on Station F was occupied at 1410 and the thermistor mooring route. sighted on position. CTD profile no. 32 was carried out and then recovery of the mooring was carried out without difficulty and eventually completed at 1515. A second CTD profile, No. 33 was then taken at 1615 prior to deploying an experimental mooring which was completed without difficulty at 1650. The pop-up current meter/ tide gauge mooring at this site was then located by means of its command pinger but all attempts to operate its release pinger failed.

At 1900 an attempt was made to drag the mooring but the drag caught on something first and the Gifford grapnel was lost. Transmission of the release signal continued thoughout the night and at OllO the following morning, Monday 15 May the release finally operated and the mooring surfaced. Recovery got underway at first light and was successfully completed at O630 when the ship left station F heading for station D.

At station D, which was occupied at 1155, there was no sign of the surface buoy making the tide gauge/current meter mooring (the subsurface buoy and two current meters from this site had been recovered by a fisherman during April). An acoustic search using the PDR fish and dragging across the lay position failed to make contact with the mooring so the ship left station D heading for station G at 2000.

On <u>Tuesday 16 May</u> at 0740 in calm sea conditions station G was occupied and the pop-up TG pinger located. CTD profile no. 34 was taken then the TG released from the sea bed and recovered successfully at 0850. The pop-up current meter/thermistor mooring was also located and after release was recovered satisfactorily in good condition at 0942. The ship then left the site and headed for station H which was eventually occupied at 1515 and the pop-up TG recovered without difficulty at 1645. CTD profile no. 35 was carried out and then attempts were made to recover the pop-up current meter/thermistor mooring which had been located by its pinger, but after several operations of the release sequence the mooring failed to surface. Attempts were made to drag for the mooring but when no contact was made the pinger was switched off and the ship left the site heading for station I.

On the approach to the continental edge bathymetric recording started and continued throughout the deep water passage. At 0600 on Wednesday 17 May station I was occupied and a deep CTD profile no. 37 was carried out in 3800m (uncorrected) of water which was followed by a shallow CTD profile no. 38 to 300m depth. The pop-up TG at this site was released and recovered at 1104 followed by the deep pop-up current meter mooring which was recovered complete by 1547. A bathymetric survey of the site was carried out and also some of the scrap mooring wires were dumped at Austell Spur. The results of this and the survey on the previous leg are charted in Figure 11. The ship left station I at 1930 to start a CTD section through station H and carrying out profiles nos. 39 to 44 on route.

At 0550 on Thursday 18 May station H was re-occupied in a final attempt to recover the missing current meter mooring but after 12 hrs of dragging the mooring was abandoned and with the completion of CTD profile no. 45 the ship left the site and headed for station F via station G continuing the CTD section with profiles nos. 46 to 53 on route. Station F was re-occupied at 1040 on Friday 19 May to find the experimental mooring on position and in good condition, so the recovery was carried out at 1237 in calm sea conditions. ship then left station F and continued the CTD section through station C to station A taking profiles Nos. 54 to 61 on route. When the ship re-occupied station A at Ol3O on Saturday 20 May an acoustic box search was started to try to locate the missing CM/TG mooring but after 15 hrs when no contact had been made the search was called off and CTD profile no. 62 was taken before the ship left station A heading for station D which was eventually re-occupied at 2314 in thick fog. An acoustics box search started at once and quickly located the pinger on the tide gauge. Marker pellets were deployed to fix the

position which was about half a mile from the lay position and then the ship stood off until daylight the following morning, Sunday 21 May. Due to thick fog dragging was delayed until 1215. The mooring wires on the rig were grappled and recovered, but the remaining current meter and the tide gauge were not attached and evidence showed that they had been broken from the mooring and so remained on the sea bed. for the TG continued for the rest of the day using the TG pinger as a beacon but was ended at 2030 without success. CTD profile no. 66 was taken then the ship carried out two further CTD profiles Nos. 67 and 68 on a line towards station C before returning to station D at 0700 the following morning, Monday 22 May, to continue dragging. techniques were used throughout the day in an attempt to grapple the TG frame but all failed, so reluctantly, it was abandoned and the ship left station D at 2334 heading for station A. Similar dragging techniques were used at station A throughout Tuesday 23 May but no positive contact with the CM/TG was made.

On <u>Wednesday 24 May</u> an acoustic search was carried out during the morning but nothing was found so this mooring was also abandoned when the ship left the site at 1128. Surface monitoring was ended at this time and the overside pump and PDR fish were brought inboard in preparation for docking at Barry which took place at 1930 the same day.

STATION REPORT. LEG 1 - DEPLOYMENT

Times in GMT throughout. Decca coordinates are for Chain 1B - S.W. British in sequence Red, Green, Purple.

Station A

Designated position: (51°16'N, 05°15'W)

Depth: 74m

Tide gauge and current meter (Figure 5)

Surface buoy : SELCO No. 10

Gauge position: (---, H43.1, H62.8)

Anchor position: (---, H43.1, H.62.8)

Deployment started 1515) 24.3.78

Deployment completed 1543

Meters: CM/TG No. 2 (1507)

Current meter rig, second deployment. (first deployment recovered - see narrative)
(Figure 4)

Surface buoy: SELCO No. 8

Subsurface buoy: 32" sphere, No. 7

Subsurface buoy position: (---, H45.20, H63.59)

Surface buoy profile : (---, H45.73, H.63.53)

Deployment started 1833)

) 24.3.78

Deploymen t finished 1849)

Meters: 2573 (35m)

Station B

Designated position: (51°45'N, 06°38'W)

Depth : 74m

Tide gauge and current meter (Figure 5)

Surface buoy : SELCO No. 7

Gauge position : (J23.94, B30.68, H76.08)

Anchor position : (J23.89, B30.07, H76.12)

Deployment started 0735) 25.3.78

Deployment finished 0802)

Meters: CM/TG No. 1 (1747)

Current meter rig (Figure 4)

Surface buoy : SELCO No. 3

Subsurface buoy : 32" sphere, No. 11

Subsurface buoy position : (J23.88, B30.95, H76.63)

Surface buoy position : (J23.90, B30.16, H76.54)

Deployment started 0900)

) 25.3.78

Deployment finished 0918)

Meters: 1139 (20m), 1508 (40m)

```
STATION C
```

Designated position: (51°21'N, 06°30'W)

Depth: 94m

Tide gauge and thermistor chain

(Figure 6)

Surface buoy : SELCO No 11

Subsurface buoy: 32" sphere, No 3

Subsurface buoy position: (---, B41.75, G72.20)

Surface buoy position : (---, B41.16, G71.78)

Deployment started 1340) 25.3.78

Deployment finished 1438

Meters: TG2A 64, Thermistor chain No 212, Logger No. 178 - first sample timed for 1230 4.4.78 (25m - 75m)

Pop-up current meter rig

(Figure 10)

Subsurface buoy 32" sphere, No. 2

Anchor position: (---, B44.86, G69.47)

Deployment started 1543) 25.3.78

Deployment finished 1551

Meters: 1506 (15m), 3277 (40m), 567(60m)

STATION D

Designated position : (50°35'N, 06°10'W)

Depth : 94m

Tide gauge and current meters

(Figure 6)

Surface buoy : SELCO No 1

Subsurface buoy : 32" sphere No 8

Subsurface buoy position : (A9.22, C45.36, E57,82)

Surface buoy position : (A9.28, C45.12, E58.16)

Deployment started : 0611)

) 28.3.78

Deployment finished: 0650)

Meters: Marconi logger no. 2; 2969 (15m), 568 (40m), 1750 (65m)

STATION E

Designated position : (51°26'N, 07°55'W)

Depth : 87m

Tide gauge and current meters (Figure 6)

Surface buoy : SELCO No 13

Subsurface buoy : 32" sphere No 4

Subsurface buoy position : (A2.96, D41.94, G66.50)

Surface buoy position : (A3.94, D42.18, G66.10)

Deployment started : 0605)

) 30.3.78

Deployment finished: 0633

Meters: Marconi logger No 4; 2971 (15m), 1002 (40m), 1867 (60m)

STATION F

Designated position : (50°33'N, 7°26'W)

Depth : lllm

Pop-up tide gauge and current meters (Figure 9)

Subsurface buoy : 32" sphere No 1, cruciform ballast

Anchor position : (A17.03, F41.14, E61.93)

Deployment started : 1320)

Deployment finished: 1340)

Meters : Experimental strain gauge and Aanderaa 280 : 2576 (25m),

2757 (65m)

(Figure 8)

30.3.78

Thermistor chain

Surface buoy : SELCO No 12

Subsurface buoy : 32" sphere No 9

Subsurface buoy position : (Al7.57, F42.39, E61.07)

Surface buoy position : (A17.62, F42.51, E61.01)

Deployment started : 1421)

) 30.3.78

Deployment finished: 1445)

Meters: Thermistor chain No. 260, logger No. 245 - first sample

timed for 1210 9.4.78 (45m - 95m)

STATION G

Designated position : (49°38'N, 08°30'W)

Depth : 144m

Pop-up current meters and thermistor chain rig (Figure 10)

Subsurface buoy : 32" sphere No 10

Anchor position : (B23.24, G45.42, D50.52)

Deployment started: 0614)

Deployment finished: O622) 31.3.78

Meters: 1865 (30m), 2970 (104m); Thermistor chain No 220,

logger No 206 - first sample timed for 1800 9.4.78, (52m - 102m).

Pop-up tide gauge

Position when gauge : (B22.89, G45.48, D50.71)

reaches sea floor

Deployment started: 0540)

) 31.3.78

Deployment finished: 0551

Meter: Mark I, No 9.

STATION H

Designated position : (48°55'N, 09°19'W)

Depth : 164m

Pop-up current meters and thermistor chain rig (Figure 10)

Subsurface buoy : 40" sphere No 13

Anchor positions : (C20.06, G43.52, C62.32)

Deployment started : 1257)

Deployment finished: 1308)

Meters : 2574 (29m), 1746 (119m); Thermistor chain No 334,

logger No 294 - no time delay, (43m - 118m)

Pop-up tide gauge

Position when gauge : (C19.99, G42.55, C62.50) reaches sea floor : (SAT NAV. $48^{\circ}54.8^{\circ}N$ $9^{\circ}22.3^{\circ}W$)

Deployment started : 1313)

Deployment finished: 1323)

Deployment finished: 1323

Meter: Mark I, No 14

STATION I

Designated approximate: 47°45'N 10°32'W, 3850m true depth

position

Pop-up current meter rig (Figure 10)

Subsurface buoy : 48" sphere no 16

Anchor position : (D23.23, G35.03, B74.77)

(SAT NAV 47°48.1'N, 10°18.3'W)

Actual depth : 3905m uncorrected

(3913m corrected)

Deployment started : 0400)

) 2.4.78

Deployment finished: 0547)

Meters: 3261 (260m), 3260 (760m), 3259 (1260m),

3258 (1960m), 3257 (2660m), 1749 (3360m)

Pop-up tide gauge

Position when gauge : (D21.6, G35.5, B75.8)

released (SAT NAV 47°51.1'N, 10°22.6'W)

Depth : 3855m uncorrected

(3862m corrected)

Gauge released : 1058 2.4.78

Meter : Deep sea tide gauge no 17 (Mk III with Mk IV inside)

STATION REPORT, LEG. 2 - RECOVERY

Times given in GMT throughout

Decca coordinates for chain 1B - SW British,

in sequence Red, Green, Purple.

STATION A

Tide gauge and current meter

Current meter No 1507

Pressure sensor, Digiquartz S/No 275

Command pinger No 1

Deployed position (Al.OO, H43.1, H62.8)

Only the surface buoy was recovered from this position.

Current meter rig

Current meter No 2573

Command pinger No 4

Deployment position (AO.88, H45.20, H63.59)

Recovery position (Al.O5, H45.64, H63.62)

Recovery started at 1845 12 May 78

Surface buoy on deck 1855

Surface buoy anchor

on deck 1905

CM on deck/acoustics 1916

Sat surface buoy on

deck and recovery 1919

complete

All equipment recovered in good condition and operating except for a bent CM spindle.

CTD profile no 21 carried out at 2115 12 May 1978

STATION B Tide gauge and current meter

Rig No 1

Current meter No 1747

Pressure sensor, Digiquartz No 280

Command pinger No 2

| Deployment position | (J23.94, B30.68, H76.08) |
|---|--------------------------|
| Recovery position | (- , B30.01, H76.12) |
| Recovery started at | 0826 13 May 78 |
| Surface buoy on deck | 0833 |
| Surface buoy anchor on deck | 0840 |
| Pellets grappled | 0855 |
| CM/TG on deck | 0900 |
| Ground line recovered and recovery complete | 0906 |

All equipment recovered in good condition and operating but the ground line had been detached from the surface buoy anchor.

Current meter rig

Current meter No 1508 top 1139 bottom

Command pinger No 5

| Deployed position | (J23.88, B30.95, H76,63) |
|---|--------------------------|
| Recovery position | (J23.99, B30.16, H76.14) |
| Rig recovered by draggin | ng |
| Recovery started at | 0938 13 May 78 |
| Meter wire caught by grapnel | 1018 |
| Bottom CM on deck | 1023 |
| Top CM on deck and sub- surface buoy | 1025 |

surface buoy anchor on deck 1106

sunken surface buoy on deck
and recovery complete 1110

All equipment in good condition and operating except for wrecked surface buoy.

CTD profile No 22 carried out at 1115 13 May 78

STATION C

Tide gauge and thermistor chain rig

Aanderaa TG-2A No 64

Thermistor logger No 178, Chain No 212

Command pinger No 3

Deployment position (AO.55, B41.75, G72.20)

Recovery position (AO.68, B41.15, G72.03)

Recovery started at 1516 13 May 78

Surface buoy on deck 1523

Surface buoy anchor

on deck 1531

TG on deck 1538

Subsurface buoy anchor

on deck 1556

Subsurface buoy and thermistor chain on deck recovery complete 1600

All equipment recovered in good condition

Pop-up current meter rig

Current meters No 567 Top

3277 Mid

1506 Bottom

Release pinger No CR221

Deployment position (AO.84, B44.86, G69.47)

Recovery position (- , B44.83, G69.51)

Recovery started at 1720 13 May 78

Subsurface buoy on deck 1738

3 current meters on deck and recovery complete 1745

All equipment recovered in good condition except for top current meter which was tangled with the meter wire.

CTD profile No 24 carried out at 1655 13 May 78

STATION D

Mk II Off-shore tide gauge and current meter rig with 3 meters

Logger 002 Sensor 1/5 VIB

2/6 S.G.

2/11 S.G. (Exp)

2/12 S.G. (Exp)

6/2 DIG

Command pinger No CB220

Current meters No 1750 Top
568 Mid
2969 Bottom

Deployment position (A9.22, C45.36, E57.82)

Pinger located at (A9.22, C45.90, E59.00)

at 2342 on 20 May 1978 but no instruments were recovered from this station during the cruise. A fisherman recovered the sub-surface buoy and two current meters Nos. 1750 and 568 during April at position (A6.0, B46.10, E69.54)

The TG was recovered in good condition and complete at 0225 on 13 September 78 by Naval divers from the M.V. Seaforth Clansman on charter to the Royal Navy.

CTD profiles No 66 carried out at 2104 21 May 78.

STATION E

Mk II off-shore tide gauge and current meter rig with 3 meters

Logger 004 Sensor: 1/4 VIB

2/7 S.G.

6/1 DIG

Command pinger No CB 231

Current meters No 1867 Top

1002 Mid

2971 Bottom

Deployment position (A2.96, D41.94, G66.50)

Recovery position (A3.19, D40.18, G66.40)

Recovery started at 0625 14 May 1978

Surface buoy on deck 0630

Surface buoy and anchor

on deck 0635

Tide gauge on deck 0643

Sub-surface buoy on 0649

deck

3 meters and sub-surface buoy on deck, recovery complete 0655

All equipment in good condition but top meter tangled in meter wire.

CTD profile No 28 carried out at 0700 14 May 78

STATION F

- a) Thermistor chain rig
- b) Pop-up current meter/tide gauge rig with 2 meters
- c) Experimental bottom mounted current meter and tide gauge

Thermistor chain rig

Thermistor logger No 245

Chain No 260

Command pinger No 6

| Deployment position | (A17.57, | F42.39, E61.07) |
|---------------------------------|----------|-----------------|
| Recovery position | (A17.80, | F42.79, E61.04) |
| Recovery started at | 1444 | 14 May 78 |
| Surface buoy on deck | 1447 | |
| Surface buoy anchor on deck | .1454 | |
| Sub-surface buoy anchor on deck | 1508 | |
| Thermistor chain on deck | 1512 | |
| Sub-surface buoy on | | |

Pop-up current meter/tide gauge rig

Current meter No 2575 Top 2576 Bottom

deck and recovery complete 1515

Release pinger No CR 223

Aanderaa SG/TG No 280

Aanderaa SG/TG No 281

Deployment position A17.03, F41.14, E61.93
Recovery position A16.81, F41.25, E62.10

| Release operated | 0105 | 15 May 78 |
|---------------------------------|------|-----------|
| Sub-surface buoy on sea surface | 0110 | |
| Recovery started at | 0610 | |
| Sub-surface buoy on deck | 0620 | |
| 2 current meters on deck | 0627 | |
| Recovery complete | 0628 | |

Experimental bottom mounted current meter and tide gauge

Current meter No EX 302

EXP Aanderaa SG/TG No 282

| Deployment position | (A17.86, F42.91, E60.86) |
|----------------------|--------------------------|
| Deployment depth | 110m |
| Deployment started | 1626 14 May 78 |
| Deployment complete | 1650 |
| Recovery started at | 1200 19 May 78 |
| Surface buoy on deck | 1210 |
| Surface buoy anchor | |
| on deck | 1216 |
| CM & TG on deck and | 1230 |
| Recovery complete | 1233 |

All the equipment recovered from this station was in good condition and operational

CTD profile No 32 carried out at 1417 14 May 78 " " 1615

STATION G

Mk I Pop-up tide gauge

TG No 9 in ALU sphere with SG pressure sensor No 1/19

" sensor No 1/21

and platinum resistance temperature sensor No 1/T9

Deployment position (B22.89, G45.48, D50.71)

Recovery position (B22.76, G45.38, D50.45)

Release operated 0830 16 May 78

Recovery started 0845

Recovery completed at 085

Pop-up current meter/thermistor chain rig

Current meter No 2970 Top

1865 Bottom

Thermistor logger No 206, chain No 220

Release pinger No CR 227

Deployment position (B23.24, G45.42, D50.52)

Recovery position (B22.95, - D50.44)

Release operated 0903 16 May 78

Sub-surface buoy

on surface 0914

Recovery started at 0926

Top CM & thermistor

logger on deck 0937

Bottom CM & Pinger on

deck & recovery complete 0942

All the equipment recovered from this station was in good condition and operational but the pellet line attached to the subsurface buoy on the CM rig was tangled with the meter wire below the subsurface buoy but not to the CM rotor.

CTD profile No 34 carried out at 0805 16 May 78

STATION H

Mk I Pop-up tide gauge

TG No 14 in ALU sphere with SG pressure sensors No 1/13

and platinum resistance temperature sensor No 1/22

Deployment position (C19.99,G42.55, C62.50)

Recovery position (C20.00, - C62.39)

Release operated 1623 16 May 78

Recovery started 1635

Recovery complete 1645

The TG was in good condition and operational.

Pop-up current meter/thermistor chain rig

Current meter No 1746 Top 2574 Bottom

Thermistor logger No 294, chain 334

Release pinger No CR 230

Deployment position (C20.06, G43.52, C62.32)

Pinger located at the above position at 1717 16 May 78 but nothing was recovered during the cruise. A French fisherman later recovered the floating subsurface buoy and the top current meter.

CTD profile No 35 carried out 1652 16 May 78

STATION I

Pop-up tide gauge

TG No 17 in ALU sphere with SG pressure sensor No D1/78 $\,$

" " D2/78

" " D3/78

DIG " " 2262

Platinum resistance temperature sensor 2/Tl0

Deployment position (D21.6, G35.5, B75.8)

Recovery position (D21.67, G35, 38, B75.53)

(SAT NAV 47°49.40'N, 10°20.46'W)

Release operated 0946 17 May 78

Recovery started 1058

Recovery complete 1104

Pop-up current meter rig

Current meter No 1749 Top

3257

3258

3259

3260

3261 Bottom

Release pinger No CR 228 and CB 235C

Deployment position (D23.23, G35.03, B74.77)

Recovery position (D23.11, G34.91, B74.43)

(SAT NAV 47°46.95'N, 10°19.10'W)

Release operated 1348 17 May 78

Sub-surface buoy on 1354

surface

Recovery started 1400

Recovery complete 1547

All the equipment was recovered in good condition and operational.

DEEP CTD profiles No 37 at 0700 17 May 1978 SHALLOW CTD profiles No 38 at 1020 SHALLOW CTD profiles No 39 at 1615

EQUIPMENT LOSSES

| | | . S | TATION |
|-------------------------|--------------------|--------------------------|-------------|
| Current meters | Aanderaa type RCM4 | No. 1507 2574 2969 | A H D |
| Thermistor chains | Aanderaa type TR-1 | No. 294/33 | 4 H |
| Pressure sensor | Digiquartz | No. 275 | Α |
| Acoustic command pinger | | No. CR230 CP1 | H A |
| Surface buoy | Selco | No. 1 | D |

COMMENTS ON THE SHIP

During the difficult conditions of LEG 1 Challenger proved suitable for our work in all but the most extreme seas.

This was the first cruise on this ship since the deck winches had been modified to take mooring wires and shackles. Both winches worked well and control from the console was satisfactory. However, the lack of spooling gear meant that the wire had to be guided on by hand and this led to problems at times.

Challenger is well suited to deployment and recovery of the type of mooring used during manoeuverability and control.

ACKNOWLEDGEMENT

We would like to thank the Masters, Officers and crew of the RRS Challenger for their cooperation and assistance during these cruises.

The role played by the MOD (Navy) and the SEAFORTH CLANSMAN in the recovery at station D is also gratefully acknowledged.

Table 1

Summary of Station positions and equipment deployed.

| | | | | | | | | | | | | | | | | | 3360 |
|-----------|------------|------------|----------|------------|----------|------------|------------|-------|------------|----------|------------|----------|------------|----------------------|----------|------------|------------------------|
| | | | | | | | | | | | | | | | | | 2660, |
| | | | | | | | | | | | | | | | | | 1960, |
| | | | | | | 09 | 65 | | 09 | | | | | | | | 1260, |
| | | | | 40 | | 40, | 40, | | 40, | | 65 | | 104 | | 119 | | 760, |
| _ | | 35 | | 20, | | 15, | 15, | | 15, | | 25, | | 30, | | 29, | | 260, |
| Depth (m) | 74 | 7.4 | 74 | 74 | 94 | 94 | 94 | 87 | | 111 | 111 | 144 | 144 | 164 | 1.64 | 3848 | 3897 |
| | 5° 14.3'N | 50 7.0'W | 6° 39'W | 60 37.8'W | 60 33'W | 60 34.8'W | 60 8.1'W | | 7° 50.4'W | 70 31'W | 7° 28.7'W | 8° 30'W | 80 35.5'W | 90 15'W | 90 15'W | 10° 21.5'W | 10 ⁰ 18.7'W |
| | 57° 15.6'N | 510 17.3'N | 510 45'N | 51° 43.5'N | 510 19'N | 510 19.0'N | 50° 35.5'N | | 510 27.5'N | 50° 31'N | 50° 32.0'N | 490 39'W | 49° 37.3'N | 48 ^O 55'N | 480 55'N | 47° 50'N | 470 47.2'N |
| | CM/TG | CM | CM/TG | CM | TG/TC | CM | CM/TG | CM/TG | | TC | CM/TG | TG , | CM/TC | TG 4 | CM/TC 4 | TG 4 | CM 4 |
| Station | A | \$ | α | 1 | ر |) | D | բ | 1 | Ĺ | 1 | ئ |) | þ | • | F | |

| PROFILE | DATE | TIME | POSITION | RIG |
|----------|----------------------|----------------|--|---------|
| NUMBER | | STARTED | LATITUDE LONGITUDE | |
| 1 | 24/ 3/78 | 19.30 | N 51 17.6 W 5 18.1 | A |
| 2 | 24/ 3/78 | 22.10 | N 51 24.7 W 5 23.2 | |
| 3 | 25/ 3/78 | 1.50 | N 51 35.1 W 5 46.8 | |
| 4 5 | 25/ 3/78 | 5.20 9.14 | N 51 59.8 W 6 44.3 N 51 45.3 W 6 39.3 | В |
| 6 | 25/ 3/78 25/ 3/78 | 11.20 | N 51 43.3 W 6 33.8 | ь |
| 7 | 26/ 3/78 | 21.35 | N 50 55.5 W 5 16.3 | |
| , ვ | 27/ 3/78 | 9.15 | N 50 34.5 W 6 0.6 | |
| 9 | 27/ 3/78 | 12.50 | N 50 25.9 W 6 27.9 | D |
| 10 | 27/ 3/78 | 16. 2 | N 50 23.5 W 6 38.5 | |
| 1 1 | 27/ 3/78 | 18.41 | N 50 23.6 W 6 38.4 | |
| 1 2 | 28/ 3/78 | 7.10 | N 50 35.5 W 6 10.4 | D |
| 1 3 | 30/ 3/78 | 6.30 | N 51 27.0 W 7 50.8 | E |
| 1 4 | 30/ 3/78 | 10.10 | N 50 57.5 W 7 34.0 | |
| 15 | 30/ 3/78 | 14.50 | N 50 31.1 W 7 30.5 | F |
| 16 | 30/3/78 | 18.20 | N 50 13.9 W 8 1.0 | |
| 1.7 | 31/3/78 | 6 • 28 | N 49 37.0 W 8 35.5 | G |
| 18 | 1/4/78 | 13.35 | N 48 54.5 W 9 20.5 | H |
| 19 20 | 2/ 4/78 3/ 4/78 | 8.50 12.5 | N 47 50.5 W10 23.6 N 50 27.2 W 5 56.0 | I |
| 21 | 12/ 5/78 | 20.57 | N 51 16.7 W 5 15.5 | Λ |
| 22 | 13/ 5/78 | 11.10 | N 51 44.7 W 6 37.4 | В |
| 23 | 13/ 5/78 | 13.16 | N 51 30.0 W 6 33.3 | Б |
| 24 | 13/ 5/78 | 16.54 | N 51 20.7 W 6 35.0 | С |
| 2.5 | 13/ 5/78 | 20. 9 | N 51 20.7 W 6 50.0 | • |
| 26 | 13/ 5/78 | 23. 3 | N 51 22.4 W 7 13.3 | |
| 2 7 | 14/ 5/78 | 2.20 | N 51 23.6 W 7 33.0 | |
| 2.8 | 14/ 5/78 | 6.55 | N 51 25.4 W 7 48.0 | E |
| 29 | 14/ 5/78 | 8.40 | N 51 14.9 W 7 43.1 | |
| 30 | 14/ 5/78 | 10.22 | N 51 2.3 W 7 39.8 | |
| 31 | 14/ 5/78 | 12.16 | N 50 16.8 W 7 33.9 | |
| 32 | 14/ 5/78 | 14.17 | N 50 31.1 W 7 32.1 | F |
| 33 | 14/ 5/78 | 16. 4 | N 50 30.1 W 7 29.8 | F |
| 34 35 | 16/ 5/78 16/ 5/78 | 8. 0 16.50 | N 49 90.0 W 8 31.5 N 48 54.2 W 9 21.9 | G II |
| 43 | 18/ 5/78 | 2.39 | N 48 31.1 W 9 43.4 | (1 |
| 44 | 18/ 5/78 | 4.56 | N 48 43.5 W 9 30.0 | |
| 45 | 18/ 5/78 | 18.25 | N 48 54.1 W 9 20.9 | Н |
| 46 | 18/ 5/78 | 20.30 | N 49 5.1 W 9 7.5 | 11 |
| 47 | 18/ 5/78 | 22.20 | N 49 15.5 W 8 56.1 | |
| 48 | 19/ 5/78 | 0. 5 | N 49 26.8 W 8 44.0 | |
| 49 | 19/ 5/78 | 2 • 5 | N 49 38.7 W 8 36.2 | G |
| 50 | 19/ 5/78 | 4. () | N 49 48.7 W 8 18.1 | |
| 51 | 19/ 5/78 | 6.28 | N 50 5.2 W 7 59.9 | |
| 52 | 19/ 5/78 | 8.54 | N 50 16.3 W 7 42.6 | |
| 53 | 19/ 5/78 | 10.45 | N 50 29.3 W 7 31.7 | F |
| 54 55 | 19/ 5/78 | 14.18 | N 50 42.8 W 7 15.0 | |
| 5 6 | 19/ 5/78 19/ 5/78 | 15.48 17.15 | N 50 51.8 W 7 4.9 N 51 1.3 W 6 53.9 | |
| 5 7 | 19/ 5/78 | 18.45 | N 51 1.3 W 6 53.9 N 51 9.5 W 6 43.6 | |
| 58 | 19/ 5/78 | 20.22 | N 51 19.5 W 6 30.0 | С |
| 59 | 19/ 5/78 | 22. 2 | N 51 18.0 W 6 12.9 | O |
| 60 | 19/ 5/78 | 23.42 | N 51 18.0 W 5 53.1 | |
| 61 | 20/ 5/78 | 1. 0 | N 51 17.3 W 5 35.3 | |
| 62 | 20/ 5/78 | 16.20 | N 51 12.7 W 5 19.7 | Α |
| 63 | 20/5/78 | 17.45 | N 51 6.3 W 5 28.0 | |
| 64 | 20/5/78 | 19.28 | N 50 56.6 W 5 39.8 | |
| 65 | 20/5/78 | 21. 7 | N 50 47.4 W 5 54.1 | _ |
| 66 67 | 21 / 5 / 7 8 | 21.37 | N 50 36.6 W 6 8.7 | D |
| 67 68 | 22/ 5/78 22/ 5/78 | 0 • 5 2 • 8 | N 50 47.8 W 6 12.8 N 51 0.3 W 6 20.0 | |
| 0.0 | 441 3/10 | 2. 0 | N 51 0.3 W 6 20.0 | |

Table 2(b)

| 1 | 1020 | 31.3.78 | 49 ⁰ 15'N | 8 ⁰ 57'W | |
|---|------|---------|----------------------|----------------------|-----------|
| 2 | 1020 | | 11 | п | |
| 3 | 0745 | 1.4.78 | 48 ⁰ 52'N | 8°51'N | |
| 4 | 0910 | 2.4.78 | 47 52'N | 10 ⁰ 25'W | Station I |
| 5 | 0915 | | 11 | n | 11 |

Water bottling

STATION F

CAST A Sample depths, 600m, 900m, 1200m, 1500m, 1800m

CAST B Sample depths 450m, 750m, 1050m

TABLE 3

List of Equipment Deployed

1. Surface buoys

SELCO No. 1, 3, 7, 10, 12, 13 Manufactured by Selco, (fitted with flashing light) Oslo, Norway.

2. Sub-surface buoys

Hollow steel sphere Manufactured to IOS design 32" diameter No. 1, 4, 7, 8, 9, 175kg
10, 11 buoyancy
40" diameter No. 13

48" diameter No 16

3. Current Meters

No. 567, 568, 1002, 1139, Manufactured by Aanderaa, 1506, 1508, 1746, 1749, Bergen, Norway. Type 1750, 1865, 1867, 2573, 2574, 2575, 2576, 2969, 2970, 2971, 3257, 3258, 3259, 3260, 3261, 3277.

4. Thermistor Chain/Logger

No. 212/178 Manufactured by Aanderaa, 220/206 Bergen, Norway. Type TR-1. 334/294

5. Off-Shore tide gauges

a) MkI Pop-up TG consisting of a data logger, acoustic release system, 2 pressure sensors and 1 temperature sensor IOS, Bidston

Logger TYPE 1020

Pressure transducer element Strain gauge

Manufactured by N.G.L.
Manufactured by Bell &

Howell, Basingstoke, UK.

b) MkII Moored TG consisting of a data logger with 3 or 5 pressure/temperature sensors IOS, Bidston

Logger 002, 004

Manufactured by Marconi

Space & Defence

Pressure Transducer

elements VIB (Vibratory wire) Manufactured by Sundstrand Data Control

Washington USA

S.G. (strain gauge)

Manufactured by Bell & Howell

Basingstoke, UK

Digiquartz Depth sensor

(quartz crystal)

Manufactured by Paroscientific

Washington, USA

c) Mk III Pop-up TG consisting of a data logger, 4 pressure sensors and 1 temp. sensor

IOS Bidston

d) Moored TG incorporating Aanderaa Water Level recorder Instruments, Victoria TG-2A S/No. 64

Manufactured by Aanderaa Canada

Logger Type 610

Sea data Corporation Massachusetts, USA

Pressure transducer elements

Strain gauge

Manufactured by Bell & Howell, Basingstoke, UK

Digiquartz (quartz crystal) S/No. 2262

Manufactured by Paroscientific Washington, USA Model 75K-002

6. Bottom mounted CM/TG

> Moored CM/TG system consisting of a current meter, direction vane and pressure sensor

IOS Bidston

Current meter No 1507, 1747

Manufactured by Aanderaa Norway, Type RCM4

Pressure sensor element Digiquartz (quartz crystal) No. 275, 280

Manufactured by Paroscientific Washington, USA Model 2400A.

7. Acoustic Command Pinger

> Pinger Nos. CP 1, 2, 3, 4, 5, 6 CB 220, CR 221, CR 223 CR 227, CR 228, CR 230

IOS Bidston/Wormley

CB 231, CB 235C.

<u>Abbreviations</u>

IOS Institute of Oceanographic Sciences

CM Current meter

CM/TG Current meter/tide gauge

TG Tide gauge

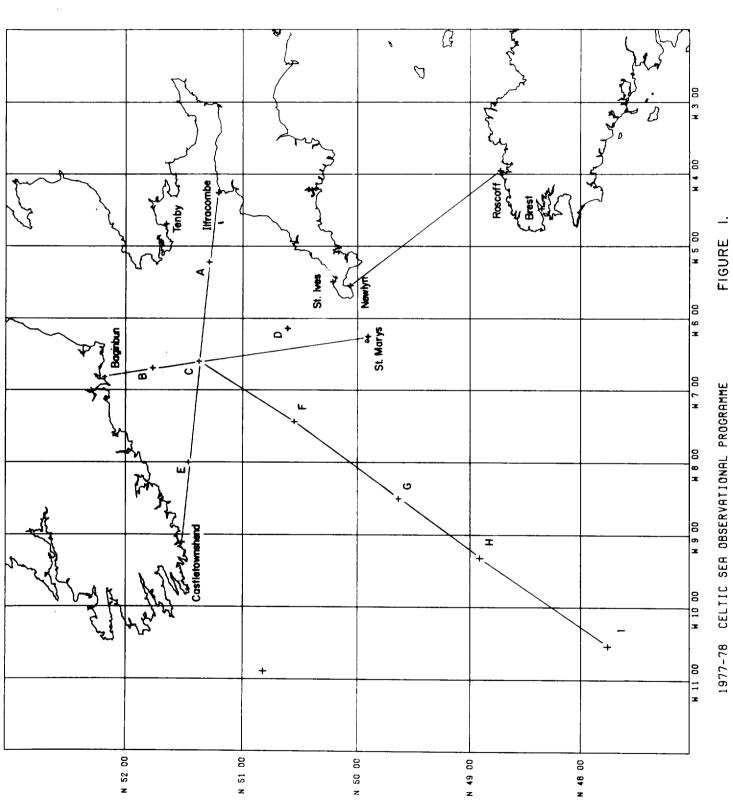
S/S Sub-surface buoy

T/C Temperature/conductivity

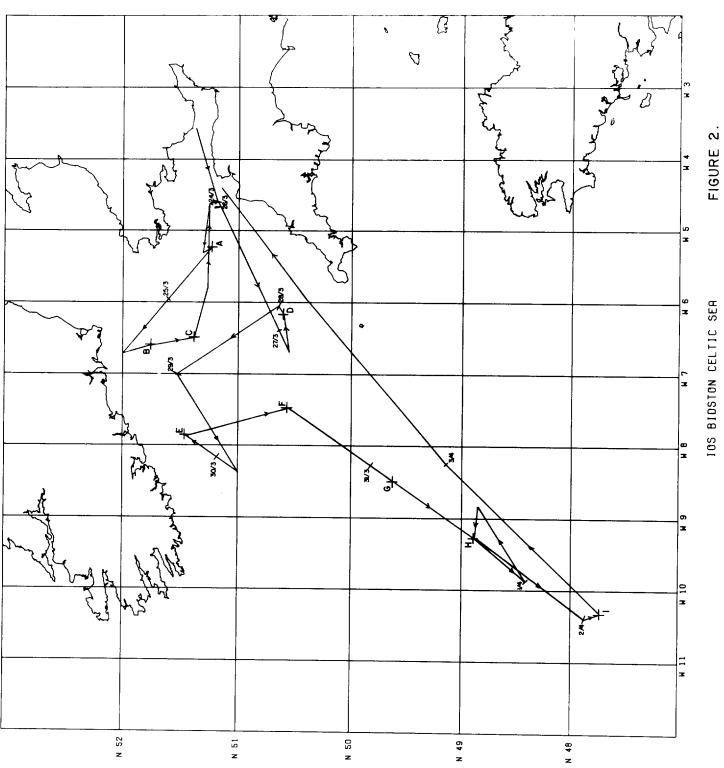
CTD Conductivity, Temperature, Depth

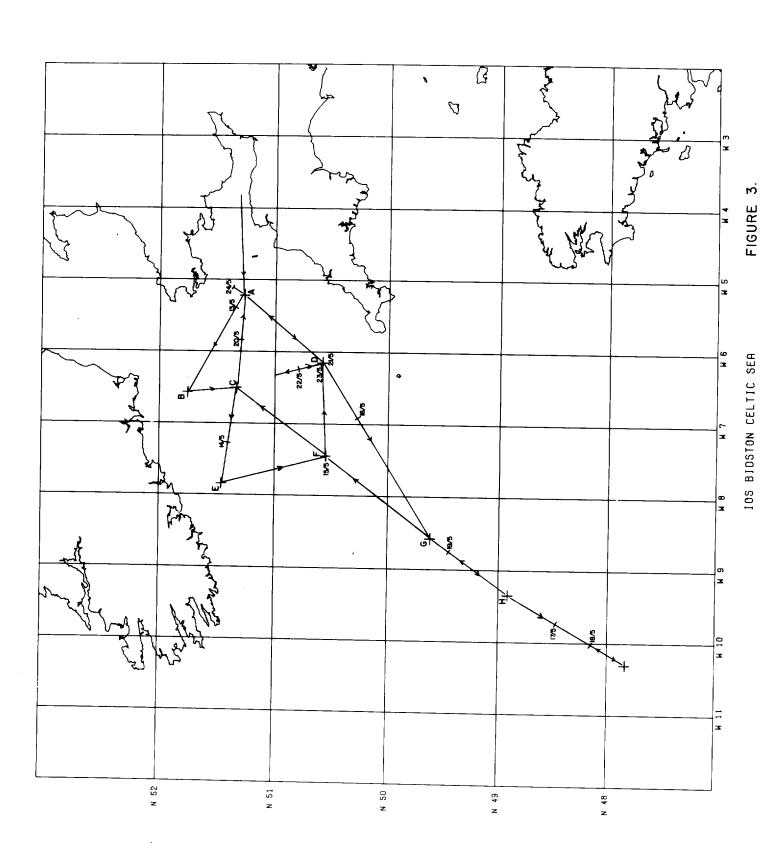
TC Thermistor chain





1977-78 CELTIC SER OBSERVATIONAL PROGRAMME





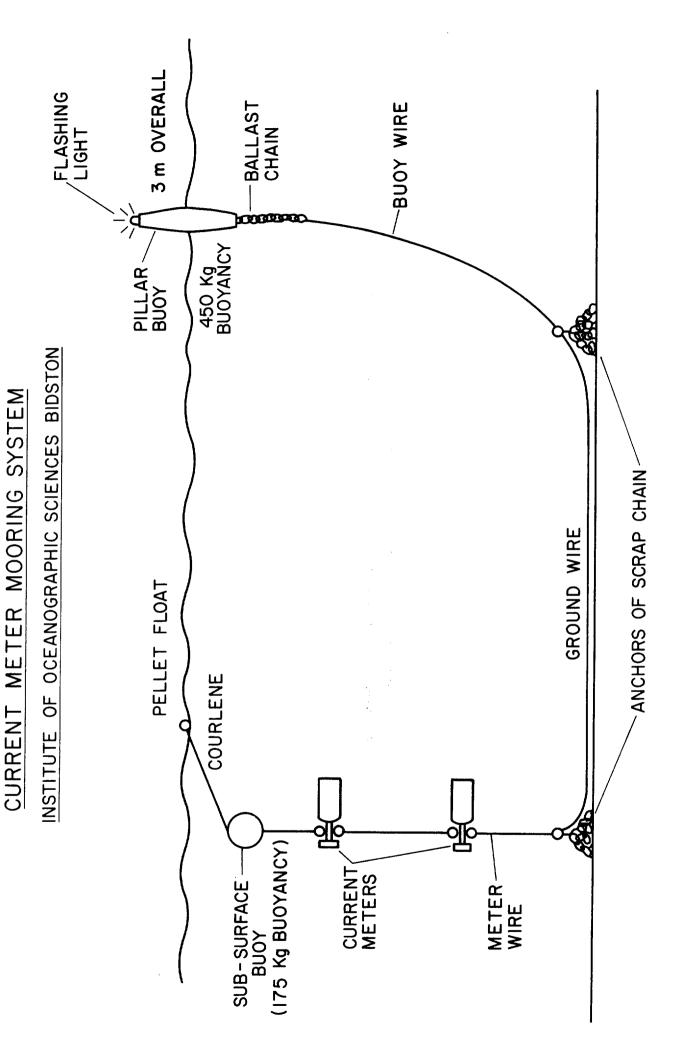


FIGURE 4

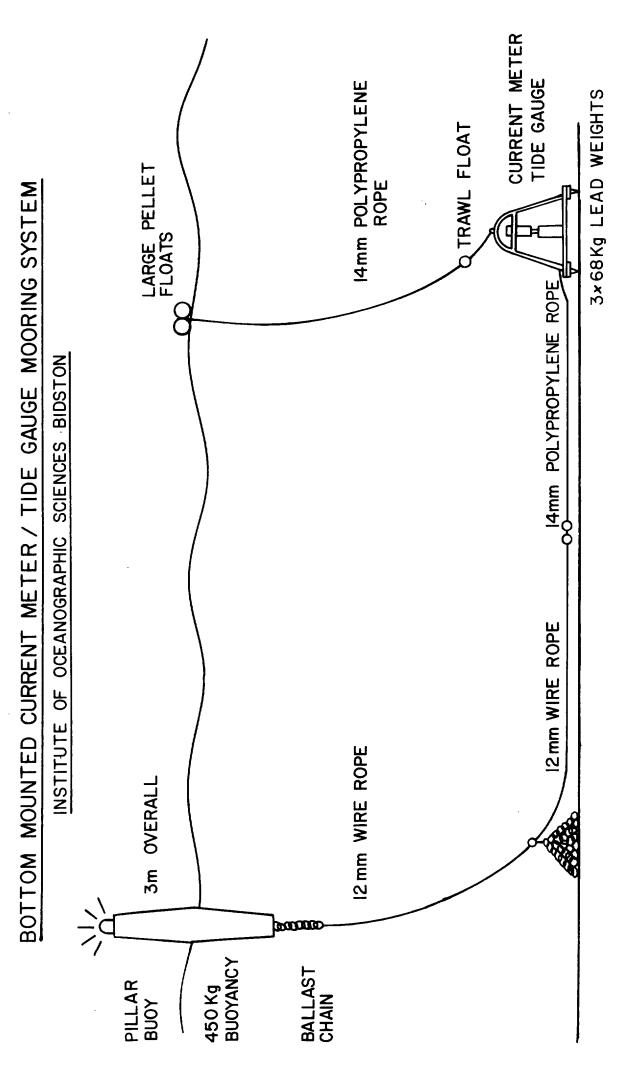


FIGURE 5

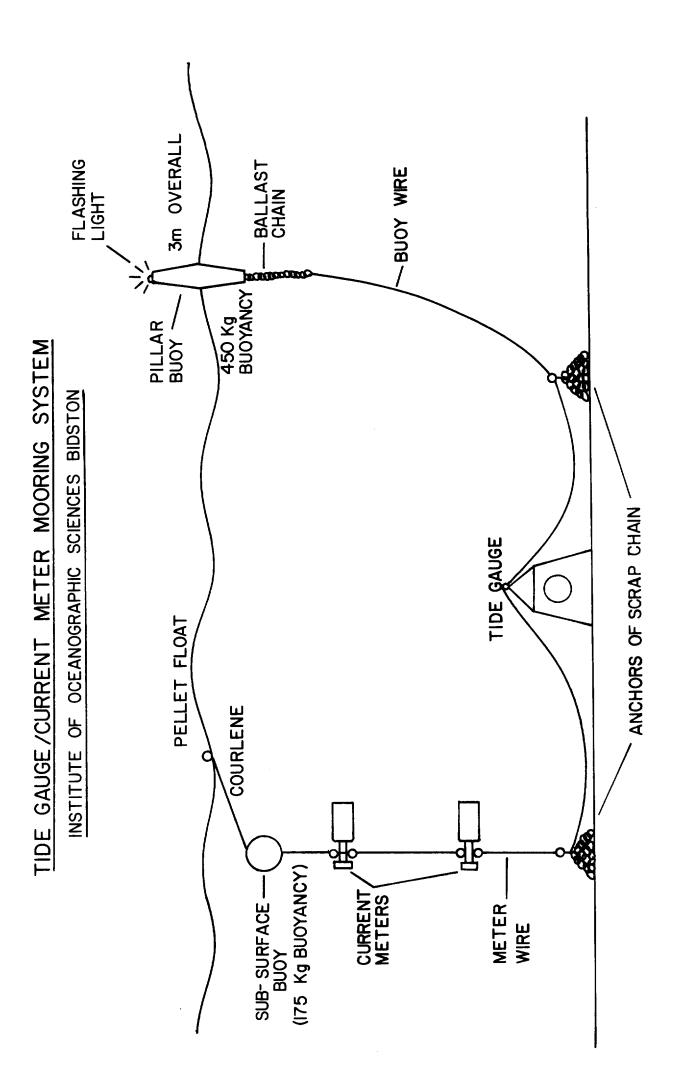


FIGURE 6

TIDE GAUGE / THERMISTOR CHAIN MOORING SYSTEM

FIGURE 7

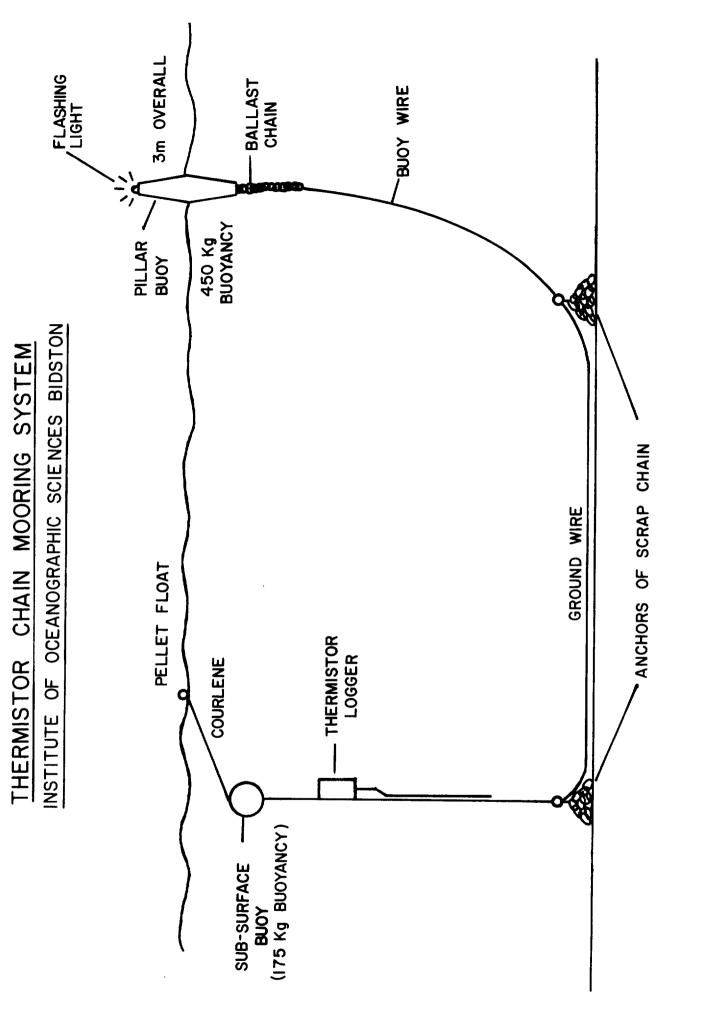


FIGURE 8

POP-UP CURRENT METER/TIDE GAUGE MOORING SYSTEM INSTITUTE OF OCEANOGRAPHIC SCIENCES BIDSTON

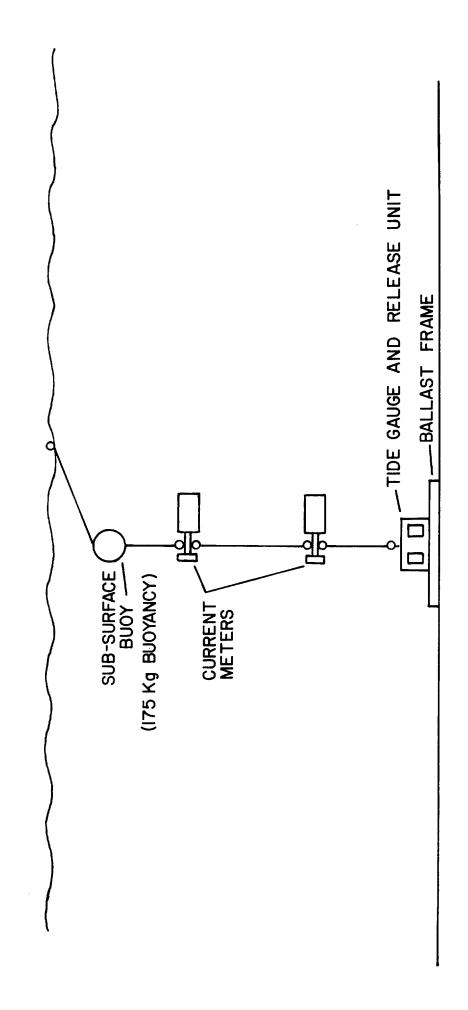


FIGURE 9

POP-UP CURRENT METER MOORING SYSTEM INSTITUTE OF OCEANOGRAPHIC SCIENCES BIDSTON

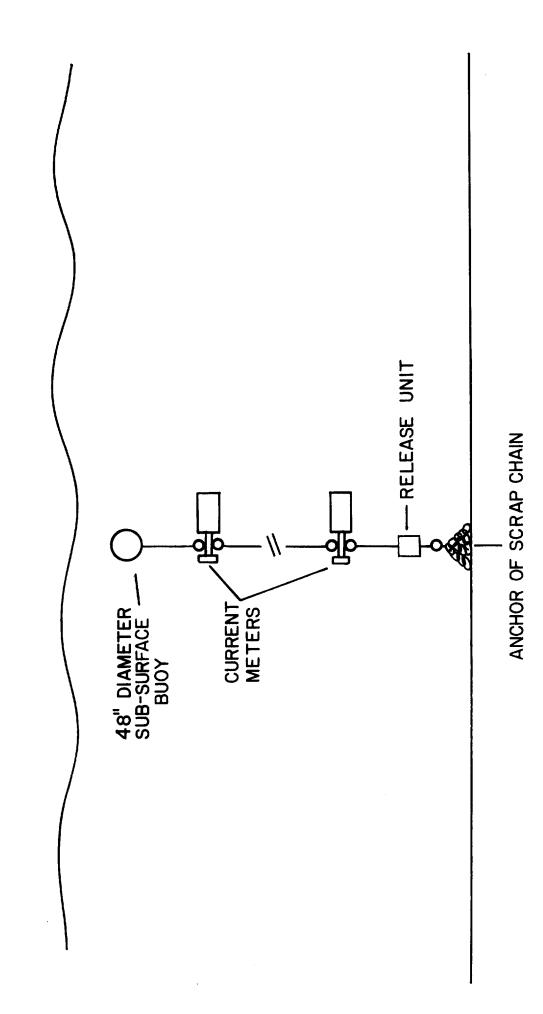
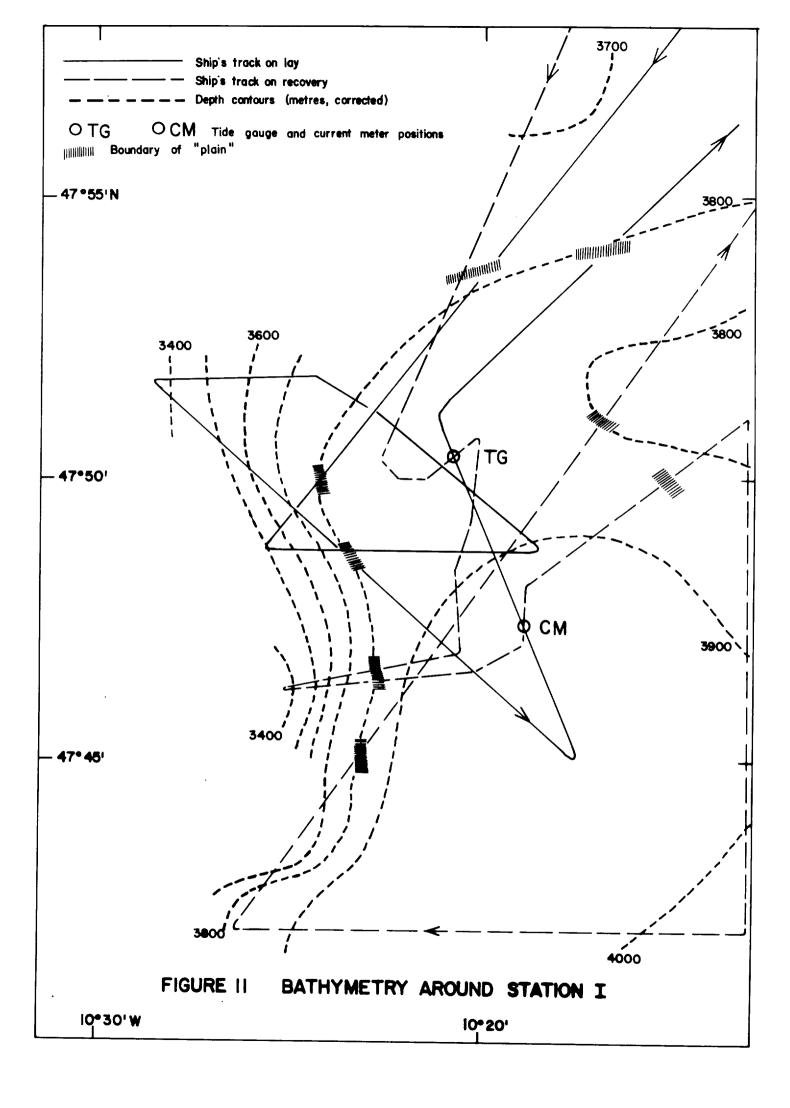


FIGURE 10



| | · | | |
|--|---|--|--|
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |

CRUISE REPORTS

RRS DISCOVERY

| CPUISF | NO | | | | | | REPORT NO |
|----------|-----|-------|---|------|----------|------|-----------|
| 1 | | JUN | | AUG | 1963 | | 1* |
| 2 | | | | | 1963 | | 2* |
| 3 | | DEC | 1 | 963 | - SEP | 1964 | 3* |
| | | | | | | | NIO CR## |
| 4 | | FEB | _ | MAR | 1965 | | 4 |
| TO | | | | TO | • - 1, - | | TO |
| 37 | | NOV | - | DEC | 1970 | | 37 |
| 38 | | JAN | • | APR | 1971 | | 41 |
| 39 | | | | | 1971 | | 40 |
| 40 | | | | | 1971 | | 48 |
| 41 | | | - | SEP | 1971 | | 45 |
| 42 | | SEP | | | 1971 | | 49 |
| 43 44 | | | • | NUV | 1971 | | 47 |
| 45 | | DEC | _ | 400 | 1971 | | 46 |
| 46 | | | | | 1972 | | 50 |
| 47 | | JUN | _ | 3111 | 1972 | | 55 |
| 48 | | | | | 1972 | | 52 53 |
| 49 | | | | | 1972 | | 57 |
| 50 | | OCT | | ••• | 1972 | | 56 |
| 51 | | NOV | - | DEC | 1972 | | 54 |
| 52 | | | | | 1973 | | 59 |
| 53 | | APR | • | JUN | 1973 | | 58 |
| | | | | | | | Ins CR** |
| 54 | | | | | 1973 | | 2 |
| 55 56 | | | | | 1973 | | 5 |
| 57 | | | | | 1973 | | . 4 |
| 58 | | DEC | • | DEC | 1973 | | 6 |
| 59 | | FEB | | | 1973 | | 4 |
| 68 | | | | MAR | 1974 | | 14 |
| 61 | | | | | 1974 | | 8 10 |
| 62 | | | | | 1974 | | 11 |
| 63 | | | | | 1974 | | 15 |
| 64 | | JUL | • | AUG | 1974 | | 13 |
| 65 | | AUG | | | 1974 | | 17 |
| 66 | | | | | 1974 | | 20 |
| 68 69 | | | | | 1974 | | 16 |
| 73 | | | | | 1975 | | 51 |
| 74/ | 1+3 | | | | 1975 | | 34 35 |
| 74/ | · | SEP | - | OCT | 1975 | | |
| 75 | • | 067 | _ | NO. | | • | 33 |
| 77 | | JUL | | | 1975 | | 43 |
| 78 | | SEP | _ | ne t | 1076 | | 46 |
| 79 | | OCT | - | NOV | 1976 | | 52 |
| 82 | | MAR | - | MAY | 1977 | | 54 59 |
| 83 | , | MAY | - | JUN | 1977 | | 59 61 |
| 84 | • | JUN | - | JUL | 1977 | | 6Ø |
| 86 | | SEP | | | 1977 | | 57 |
| 87 | | OCT | | | 1977 | | 58 |
| 86 | | OCT | • | NOV | 1977 | | 65 |
| 89 | | NOV | - | DEC | 1977 | | 67 |
| 98 | | JAN | • | | | | 68 |
| 91 92 | | MAR | | | 1978 | | 69 |
| 46 | | APR . | • | MAY | 1978 | | 70 |

 $[\]star$ REPORTS 1 TO 3 WERE PUBLISHED AND DISTRIBUTED BY THE ROYAL SOCIETY FOLLOWING THE INTERNATIONAL INDIAN OCEAN EXPEDITION

^{**} NIO CR: NATIONAL INSTITUTE OF OCFANOGRAPHY, CRUISE REPORT

^{***} IOS CR: INSTITUTE OF OCEANOGRAPHIC SCIENCES, CRUISE REPORT

CRUTSE REPORTS

| CRUISE DATES | REPORT NO | |
|---------------------------------------|------------------------|---|
| RRS "C'IALLENGER" | | |
| AUG - 9EP 1974 MAR - APR 1976 | IOS CR 22 IOS CR 47 | |
| PV "FD TARD FORBES" | | |
| OCT 1974 | 108 CR 15 | X |
| JAN = FER 1975 APR 1975 | IOS CR 19 IOS CR 23 | |
| MAY 1975 | 105 CR 32 | |
| MAY = 7UN 1975 JUL 1975 | IOS CR 28 IOS CR 31 | |
| JUL - AUG 1975 | 108 CR 36 | |
| AUG - SEP 1975 AUG - SEP 1975 | IOS CR 41 IOS CR 44 | |
| FEB - APR 1976 | 105 CR 48 | |
| APR = TUN 1976 MAY 1976 | 108 CR 58 108 CR 53 | |
| RRS #JTHN MURRAY# | | |
| APR - MAY 1972 | NIO CR 51 | |
| SEP 1973 MAY w APR 1974 | 105 CR 7 | |
| OCT - INV | | |
| \$ DEC 1974 APR = MAY 1975 | IOS CR 21 IOS CR 25 | |
| APR 1975 | 108 CR 39 | |
| OCT = NOV 1975 AUG = OCT 1975 | IOS CR 40 IOS CR 42 | |
| OCT - VOV 1976 | 108 CR 53 | |
| MAR = APR 1977 | 108 CR 66 | |
| NC "MARCEL BAYARD" | | |
| FEB = APR 1971 | NIO CR 44 | |
| MV "RESEARCHER" | | |
| AUG - SEP 1972 | NIO CR 60 | |
| RV "SARSIA" | | |
| MAY = JUN 1975 | 108 CR 30 | |
| AUG = 9EP 1975 Mar = 4PR 1976 | IOS CR 38 IOS CR 44 | |
| RRS "SHACKLETON" | | |
| AUG - SEP 1973 | IOS CR 3 | |
| JAN - FEB 1975 Mar - May 1975 | IOS CR 18 IOS CR 24 | |
| FEB = '4AR 1975 | 105 CR 29 | |
| JUL = AUG 1975 Jun = Jul 1976 | IOS CR 37 | |
| DCT - MOV 1976 | 108 CR 49 | |
| JUL 1977 | IO8 CR 62 | |
| MV "SURVEYOR" | | |
| FEB = APR 1971 JUN 1971 | NIO CR 38 NIO CR 39 | |
| AUG 1971 | | X |
| DE "VICKERS VOYAGER" AND "PISCES III" | | |
| JUN = JUL 1973 | IOS CR 1 | |

X NOT DISTRIBUTED