

I.O.S.

INSTITUTE OF OCEANOGRAPHIC SCIENCES

RRS JOHN MURRAY

CRUISES 2/77 LEG 1 : 10 — 26 MARCH 1977
4/77 LEG 2 : 16 — 29 APRIL 1977

M. I. A. S.

09 JUN 1980

(BIDSTON)

CRUISE REPORT NO. 66

1977

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NATURAL ENVIRONMENT
RESEARCH COUNCIL

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R.R.S. JOHN MURRAY

Cruises 2/77 Leg 1 : 10-26 March 1977

4/77 Leg 2 : 16-29 April 1977

Cruise Report No 90

1977

Institute of Oceanographic Sciences

Bidston Observatory

Birkenhead

Merseyside L43 7RA

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CRUISE REPORTS

RRS DISCOVERY

CRUISE NO

REPORT NO

1 JUN - AUG 1963
 2 AUG - DEC 1963
 3 DEC 1963 - SEP 1964

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4 FEB - MAR 1965
 TO TO
 37 NOV - DEC 1970
 38 JAN - APR 1971
 39 APR - JUN 1971
 40 JUN - JUL 1971
 41 AUG - SEP 1971
 42 SEP 1971
 43 OCT - NOV 1971
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 46 APR - MAY 1972
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 51 NOV - DEC 1972
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54 JUN - AUG 1973
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 56 OCT - NOV 1973
 57 NOV - DEC 1973
 58 DEC 1973
 59 FEB 1974
 60 FEB - MAR 1974
 61 MAR - MAY 1974
 62 MAY - JUN 1974
 63 JUN - JUL 1974
 64 JUL - AUG 1974
 65 AUG 1974
 66 AUG - SEP 1974
 68 NOV - DEC 1974
 69 JAN - MAR 1975
 73 JUL - AUG 1975
 74/1+3 SEP - OCT 1975
 74/2 OCT - NOV 1975
 75 JUL - AUG 1976
 77 SEP - OCT 1976
 79 OCT - NOV 1976
 86 SEP 1977

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** NIO CR: NATIONAL INSTITUTE OF OCEANOGRAPHY, CRUISE REPORT

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CRUISE REPORTS

CRUISE DATES	REPORT NO
RRS "CHALLENGER"	
AUG - SEP 1974	IOS CR 22
MAR - APR 1976	IOS CR 47
RV "EDWARD FORBES"	
OCT 1974	IOS CR 15 X
JAN - FEB 1975	IOS CR 19
APR 1975	IOS CR 23
MAY 1975	IOS CR 32
MAY - JUN 1975	IOS CR 28
JUL 1975	IOS CR 31
JUL - AUG 1975	IOS CR 36
AUG - SEP 1975	IOS CR 41
AUG - SEP 1975	IOS CR 44
FEB - APR 1976	IOS CR 48
APR - JUN 1976	IOS CR 50
MAY 1976	IOS CR 53
RRS "JOHN MURRAY"	
APR - MAY 1972	NIO CR 51
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MAY - APR 1974	IOS CR 9
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APR 1975	IOS CR 39
OCT - NOV 1975	IOS CR 40
AUG - OCT 1975	IOS CR 42
OCT - NOV 1976	IOS CR 53
NC "MARCEL BAYARD"	
FEB - APR 1971	NIO CR 44
MV "RESEARCHER"	
AUG - SEP 1972	NIO CR 60
RV "SANSIA"	
MAY - JUN 1975	IOS CR 30
AUG - SEP 1975	IOS CR 38
MAR - APR 1976	IOS CR 44
RRS "SMACKLETON"	
AUG - SEP 1973	IOS CR 3
JAN - FEB 1975	IOS CR 18
MAR - MAY 1975	IOS CR 24
FEB - MAR 1975	IOS CR 29
JUL - AUG 1975	IOS CR 37
JUN - JUL 1976	IOS CR 45
OCT - NOV 1976	IOS CR 49
MV "SURVEYOR"	
FEB - APR 1971	NIO CR 38
JUN 1971	NIO CR 39 X
AUG 1971	NIO CR 42 X
DE "VICKERS VOYAGER" AND "PISCES III"	
JUN - JUL 1973	IOS CR 1

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

DURATION

Leg 1	Sailed from Barry	00.00	15 March 1977
	Arrived at Liverpool	13.30	25 March 1977
Leg 2	Sailed from Liverpool	10.30	16 April 1977
	Arrived at Barry	11.30	28 April 1977

SCIENTIFIC STAFF

Leg 1	A. O. BANASZEK	IOS	BIDSTON	(First part, Leg 1)
	D. FLATT	"	"	
	N. S. HEAPS	"	"	(Senior Scientist)
	J. E. JONES	"	"	(Second part, Leg 1)
	A. G. KERR	"	"	
	D. L. LEIGHTON	"	"	
	R. I. R. PALIN	"	"	
Leg 2	R. PROCTOR	"	"	
	A. O. BANASZEK	"	"	(Second part, Leg 2)
	D. FLATT	"	"	
	A. J. HARRISON	"	"	(Senior Scientist)
	J. E. JONES	"	"	
	A. G. KERR	"	"	
	D. L. LEIGHTON	"	"	
R. I. R. PALIN	"	"	(First part, Leg 2)	
R. PROCTOR	"	"		

SHIPS OFFICERS

Leg 1	P. WARNE	MASTER
	A. L. MOORE	CHIEF OFFICER
	J. S. JONES	SECOND OFFICER
	J. T. MORSE	EXTRA SECOND OFFICER
	A. E. COOMBES	CHIEF ENGINEER
	C. P. TOOTLE	SECOND ENGINEER
	H. G. DAVIES	THIRD ENGINEER

Leg 2	P. WARNE	MASTER
	J. J. MORAN	CHIEF OFFICER
	J. S. JONES	SECOND OFFICER
	J. T. MORSE	EXTRA SECOND OFFICER
	C. P. TOTTLE	CHIEF ENGINEER
	H. G. DAVIES	SECOND ENGINEER
	I. G. M ^C GILL	THIRD ENGINEER

OBJECTIVES OF CRUISE

The main objective of the cruise was to determine the field of residual currents in the Eastern Irish Sea by taking simultaneous measurements of current, over a period of a month or so, with an array of current meter rigs deployed over the area at stations numbered 1, 2, 3, 6, 8, 9, 11, 13, 15, 16, 19, as indicated in Figure 1.

Another aim was to calculate tidal friction at various depths at station 11 using measurements of tidal height and bottom current obtained, over the same period, from bottom-mounted tide gauge/current meter units located at stations 10 and 12 (7.5 n.mi on either side of station 11 to the east and to the west respectively).

Further objectives involved the deployment - again for the same period - of off-shore tide gauges at stations 34 and 35 to determine tidal heights for Earth Tide studies, and the deployment of an off-shore tide gauge at station 33 in St. George's Channel to obtain tidal boundary data for a numerical model of the Irish Sea.

A list detailing actual deployment positions of the rigs is given in Table 1.

Additionally, it was required to determine the horizontal density structure of the Eastern Irish Sea by continuous surface sampling (from the moving ship) of conductivity and temperature, and by taking a limited number of C.T.D. profiles in the area, particularly at rig locations.

Narrative, Leg 1

R.R.S. John Murray sailed from Barry at midnight on Monday, 14 March, departure being delayed by some four days due to a strike of dock-gate men at Barry Dock. During the morning of Tuesday the 15th, the ship made its way through rough seas along the coast of South Wales, heading for the Irish Sea. The outboard pump for continuous conductivity/temperature sampling, the Simrad depth recorder, and the MS 38 fish for acoustics, were installed between 7.30 hours and 8.15 hours at a position off Caemarthan Bay. These systems were all operational soon

afterwards. The ship rounded St. David's Head and entered the Irish Sea between 13.00 hours and 14.00 hours. In a south-westerly gale, conditions were judged to be too rough to lay the tide gauge at station 33 and therefore it was decided to make for Liverpool Bay where most of the rigs were to be laid. During the remainder of the 15th the ship progressed northwards through the Irish Sea passing Cardigan and Caernarvon Bays; it entered Liverpool Bay at 8.00 hours on Wednesday, 16 March (Figure 2). Station 3 in the Bay was reached at 9.30 hours and, between this time and 11.00 hours, a current meter rig with one meter was successfully laid there. Also, a CTD profile was taken (CTD profile 1). Taking advantage of reasonably calm conditions, rigs were subsequently laid at positions 9, 6, 10 and 11 in succession, taking a CTD profile at each location (Figure 3). Thus, between 13.20 hours and 14.29 hours a current meter rig with one meter 6m above the seabed was deployed at station 9 followed by CTD profile 2, between 15.43 hours and 16.29 hours a current meter rig with two meters 8 and 18m above the bottom was deployed at station 6 followed by CTD profile 3, between 18.15 hours and 19.33 hours a bottom-mounted current meter/tide gauge was deployed at station 10 followed by CTD profile 4, and between 20.49 hours and 22.06 hours a current meter rig with three meters 8, 16 and 25m above the bottom was deployed at station 11 followed by CTD profile 5. The ship then set course towards station 12 arriving there at 23.17 hours. After taking a CTD profile (No.6), the laying of a bottom-mounted current meter/tide gauge began with the deployment of a surface buoy and its anchor. Then, however, in paying out ground line, the polypropylene part of it was caught under the stern chute and was cut. With the sea state becoming increasingly rough, it was decided to temporarily abandon operations. The outboard pump failed at 23.40 hours and therefore continuous conductivity/temperature sampling came to an end at that time. With weather conditions deteriorating rapidly, shelter was sought in Redwharf Bay, where the ship remained, in south to south-west winds exceeding 50 knots, until

early the next afternoon (Thursday, 17 March). Since there was no sign of any improvement in the weather, it was then decided to put into Liverpool - in order to take the remaining rigs on board and replace the outboard pump. The ship docked in Liverpool at 21.15 hours on the same day.

Departure from Liverpool was at 18.00 hours the next day, Friday the 18th. Station 1 was reached at 23.37 hours and there CTD profile No. 7 was taken and a current meter rig with one meter 5m above the sea bed was deployed. Bad weather thwarted our intention to lay a rig at Station 2 next. Rather, the ship took a course to Station 12 arriving at 9.35 hours on the morning of Saturday the 19th; the flashing lights of rigs 9, 6, 10 and 11 were sighted en route (Figure 4). Under conditions of steadily improving weather a bottom-mounted current meter/tide gauge was laid at Station 12 (9.46 hours - 11.45 hours), followed by a current meter rig with two meters 8 and 35m above the sea bed at Station 8 (13.50 hours - 14.17 hours), followed by a current meter rig with two meters 8 and 35m above the sea bed at Station 16 (16.35 hours - 16.54 hours), followed by a current meter rig with two meters 8 and 51m above the sea bed at Station 19 (20.25 hours - 21.14 hours). In the latter case, an extensive search had to be made for a suitable laying site in an area of submarine canyons. CTD profiles Nos. 8, 9, 10 and 11 were taken at Stations 12, 8, 16 and 19 respectively. Overnight, the ship then took a course to Station 2, passing rigs 16, 8 and 12, arriving at 7.16 hours the next morning, Sunday the 20th. A current meter rig with one meter 11m above the sea bed was laid at Station 2 (7.13 hours - 7.37 hours), followed by a current meter rig with one meter 8m above the sea bed at Station 13 (13.15 hours - 13.29 hours), followed by a current meter rig with two meters 8 and 24m above the sea bed at Station 15 (17.45 hours - 17.55 hours). Again CTD profiles were taken at each station : Nos. 12, 13 and 14 respectively. It was then decided to make for Station 35 overnight. For continuous water sampling purposes, the course was designed to cover as much of the north-eastern Irish Sea as possible (Figure 4).

Unfortunately the outboard pump for this sampling had failed again soon after leaving Liverpool, but it had proved possible to use the ship's fire pump instead - for much of the time. Arrival at Station 35 was at 08.00 hours on Monday the 21st. An off-shore tide gauge was laid there (8.53 hours - 9.46 hours) and some tests with a telemetering buoy, connected to the gauge, were successfully carried out. Also, CTD profile No. 15 was taken. The ship then headed direct for Station 34 arriving there at 16.40 hours. An off-shore tide gauge was laid at this location (16.58 hours - 17.15 hours) which meant that the entire array of rigs in the eastern part of the Irish Sea had been deployed. At 17.30 hours the ship set a course towards Station 33 in St. George's Channel arriving there at 12.42 hours the next day, Tuesday the 22nd (Figure 2). A tide gauge was laid (12.51 hours - 13.22 hours) and CTD profile No. 17 was taken. All the rigs had then been deployed and the ship sailed northwards (Figure 2) coming to Station 35 - after taking CTD profile No. 18 south of the Mull of Galloway - at 14.30 hours the next day, Wednesday the 23rd, (Figure 5). The dahn buoy of the rig was missing and therefore another was laid nearby to replace it. During the next 48 hours, all the rigs in the Eastern Irish Sea were visited in a cruise track ending at Liverpool at 13.30 hours on Friday the 25th (Figure 5). CTD profiles 19 - 24 were taken at regular intervals (Table 2). All the rigs were sighted and judged to be satisfactory apart from rigs 2 and 19. In the former case, the toroid was upsidedown in the water and had to be turned upright. In the latter case the sub-surface buoy was found on the surface; the rig had clearly been laid in water which was too shallow. It was therefore recovered completely and relaid (14.15 hours - 18.28 hours on the 24th) at a nearby position where the depth was greater. During this operation, the main winch failed and its repair caused some delay in completing the re-deployment.

NARRATIVE, LEG 2

John Murray sailed from Liverpool at 10.30 hours on Saturday 16th April in ideal weather conditions and proceeded to the Bar light where the pilot left the ship at 12.25 hours. Course was set for Station 3 (see Figure 6) and was occupied about 1 hour later at 13.15 hours to find the CM rig on position. CTD profile No. 25 was carried out at 13.23 hours and recovery of the CM rig started at 13.50 hours. By 14.20 hours the recovery was successfully completed with all the equipment in good conditions and operational. The overside pump was installed and surface monitoring of temperature and conductivity started at 15.04 hours with a sampling interval of 3 minutes. The Simrad echo sounder was also rigged at this stage, then the ship left Station 3 heading for Station 6.

Station 6 was occupied at 15.57 hours and the CM rig located on position. CTD profile No. 26 was taken at 16.02 hours. Recovery of the CM rig started at 16.49 hours and was successfully completed by 17.07 hours but with the loss of the surface buoy anchor weight, all the equipment recovered was in good condition and operating. With all the work completed at this Station the ship left at 17.08 hours on course for Station 9 which was eventually occupied at 18.12 hours. There was no sign of the rig on the surface since the buoy from this station had been washed ashore at Blackpool during March, so the grapnel was rigged and dragging started at 18.42 hours (see Figure 9). After several passes over the ground line without contact, dragging was terminated for the night at 19.55 hours. CTD profile No. 27 was carried out at 20.00 hours. Throughout the dragging acoustic signals were transmitted to the pinger on the rig but without any response. The acoustic search was continued until 22.00 hours but failed to make contact with the rig so the ship left station 9 to inspect the rigs at Stations 13, 15 and 16 through the night and arrived at Station 12 for first light.

Station 12 was occupied at 04.40 hours on Sunday 17th April and the rig found on position and in good order, so preparations were made for deployment of an

experimental mooring (see Figure 11) within $\frac{1}{4}$ mile of the existing mooring. The deployment started at 06.22 hours and was successfully completed by 06.35 hours at which point the ship left Station 12 heading for Station 11.

The ship arrived at Station 11 at 07.30 hours but there was no sign of the CM rig, so CTD profile No. 28 was carried out at 07.47 hours and an acoustic search started at 09.00 hours in the vicinity of the rig. After $\frac{1}{2}$ an hour of transmission there had been no contact with the rig so the search was terminated and a course set for Station 10. The weather had been good up to this stage but the wind was freshening to 35 knots.

Station 10 was occupied at 10.29 hours and the rig found on position. Recovery started at 10.35 hours and was successfully completed by 11.00 hours with the retrieval of a bottom mounted CM/TG in good condition and still operating. A CTD profile No. 29 was taken at 11.03 hours to complete the work on Station 10 and the ship left at 11.13 hours heading for Station 1.

The rig at Station 1 was sighted on position at 14.12 hours and in good condition, so recovery commenced at 14.34 hours and was completed by 14.52 hours without difficulty, all the equipment recovery was in good order and operating normally. CTD profile No. 30 was obtained at 15.02 hours and the ship then left Station 1 at 15.13 hours heading for Station 2 which was inspected at 15.42 hours and the toroid surface buoy found to be capsized but otherwise the rig was in good condition. It was not intended to recover Station 2 at this stage since it had not been in position for the required number of days, so a course was set for Station 8.

Station 8 was occupied at 18.07 hours but the surface buoy was missing although the pellets marking the sub-surface buoy were visible and on position. The grapnel was rigged and dragging started at 18.12 hours, but after several runs without success it became too dark to continue so the dragging was terminated at 19.45 hours. CTD cast No. 31 was taken at 19.55 hours then the ship left Station 8 and inspected the rigs at Stations 12, 16

and 19 during the night while carrying out a surface sampling section (see Figure 6).

Station 12 was re-occupied at first light the following morning, Monday 18th April, and both rigs were found on position. CTD profile No. 32 was carried out at 05.06 hours then recovery of the CM/TG rig started at 05.26 hours and eventually completed at 05.45 hours without difficulty. Recovery of the experimental mooring started at 06.11 hours and was completed by 06.40 hours. All the equipment recovered was in good conditions and operational. With the spell of good weather continuing the ship left Station 12 at 06.42 hours and a course set for Station 16.

When the ship arrived at Station 16 at 08.52 hours the rig was found on position and recovery started at once. In spite of a strong tide running at the time, the operation was completed at 09.48 hours with all the equipment in good condition except for the bottom CM which had a bent spindle and was tangled with the ground line. CTD profile No. 33 at 09.40 hours completed the work at this station and the ship left at 09.50 hours heading for Station 8.

Station 8 was re-occupied at 11.50 hours and the pellet floats found still on position, so dragging started at 11.55 hours and contact made with the rig at 12.34 hours. The recovery continued until 13.06 hours when it was successfully completed with the recovery of all the equipment in good condition and operating with the exception of the surface buoy. The ship left Station 8 at 13.10 hours on course for Station 11. At 15.06 hours Station 11 was re-occupied and dragging started at 16.07 hours supplemented by acoustic monitoring. However after several runs in the vicinity of the laid position there was no contact with the rig so the search was called off for the night at 20.30 hours and the ship left the station to inspect the rigs at Stations 15, 13 and 9 and carry out a surface sampling section (see Figure 6).

On Tuesday, 19th April, at 05.00 hours Station 9 was re-occupied and a further attempt to drag for the CM rig was started at 05.08 hours. By 07.20

hours contact was made with the rig and recovery commenced but was hampered by tangled wires, making it necessary to cut the meter wire and allow both anchor weights to fall to the sea-bed. All the equipment on the CM wire was recovered but the fin assembly on the CM had been damaged by the drag wire and there were also cable marks on the sub-surface buoy and acoustic pinger, but these had been made previous to the recovery attempt. With the recovery completed at 08.19 hours the ship left Station 9 on course for Station 11.

Station 11 was again re-occupied at 11.42 hours and a further attempt to locate the CM rig was made. Dragging and acoustic monitoring started at 11.48 hours and continued but without success until 15.10 hours when the ship left the Station heading for Station 2. On arrival at Station 2 at 18.10 hours the rig was located with the surface torodial buoy still capsized. Recovery started at once and was successfully completed by 18.31 hours although the current meter fin was cracked and the spindle bearing had collapsed. CTD profile 34 was taken at 18.40 hours to complete the work on this station then the ship left to commence a surface monitoring run through the night (see Figure 6).

At 05.00 hours the following morning, Wednesday, 20th April, the ship hove to in the vicinity of the Bar Light to collect a Pilot and bring the Simrad and overside pump inboard in preparation for docking in Liverpool. By 09.07 hours the ship had docked and unloading of the equipment got under way at once. With the transfer complete, the ship left Liverpool at 15.00 hours to start the final part of the recovery leg and by 17.04 hours was in the vicinity of the Bar Light again where the pilot disembarked. The overside pump and Simrad echo sounder were both rigged at this stage and monitoring started at 17.40 hours along a course set for Station 19 (see Figure 7). The MAFF rig at ST 7, along this track, was inspected at 20.00 hours and found on position, but by this stage the weather had deteriorated to the point

where it was necessary to change course to the south west and head for shelter in the lee of Moelfre Bay.

The following morning, Thursday, 21st April, at 08.00 hours, with a slight improvement in the weather, the ship left the shelter of the land heading for Station 19, CTD profile No. 35, 36 and 37 were taken at 09.50 hours, 12.10 hours and 13.50 hours respectively along the cruise track and Station 19 occupied at 18.40 hours. The rig was found on position but the weather was too bad to attempt a recovery so the ship headed for the Isle of Man and shelter. Bad weather with south easterly gale force winds persisted throughout Friday, 22nd April, preventing any further recovery attempts, however by 03.19 hours on Saturday, 23rd April, there was an improvement so the ship left the sheltering position and headed north to ST 35 arriving at 07.14 hours. The rig was located on position but again it was considered too dangerous to attempt a recovery due to the rough state of the sea, so the ship headed for shelter in Wigtown Bay on the Scottish coast, arriving at 09.35 hours. Later in the day the weather moderated enough to allow the ship to leave the shelter of the land and for a CTD survey of the area to be carried out through the night (see Figure 7). CTD profile Nos. 38, 39, 40, 41, 42, 43 and 44 were carried out at 19.24 hours, 20.32 hours, 22.00 hours, 23.07 hours, 00.07 hours, 01.05 hours and 02.25 hours respectively.

At 05.00 hours, Sunday 24th April, Station 35 was re-occupied and the Selco buoy marking the rig was located. The weather conditions were still far from ideal for a recovery attempt, with winds of 30 knots, and it was not until 08.56 hours that a start could be made, when the wind had decreased to 25 knots. The Selco buoy was grappled at 09.01 hours and the T.G. eventually brought on deck, in good condition, at 09.17 hours after cutting off the Selco buoy anchor chain to aid the recovery, neither of the two dahn buoys deployed on this rig were recovered. CTD profile No. 45 carried out at 09.30 hours completed the work on this Station and the ship left at

09.35 hours heading south for Station 34.

The Selco buoy at Station 34 was sighted on position at 13.08 hours and the Station occupied at 13.27 hours with the weather much improved and winds down to 15 knots. Recovery started from the dahn buoy end of the rig at 13.33 hours but immediately became entangled with the overside pump. After removal of the pump the recovery continued unhindered until all the equipment was successfully recovered in good condition at 14.15 hours. The pump was re-fitted, CTD profile No. 46 was taken at 14.30 hours to complete the work on this Station, then the ship left and headed for Station 15.

With the wind down to 10 knots, Station 15 was occupied at 16.07 hours and the pellets marking the sub-surface buoy were located but the toroidal buoy was missing, so the grapnel was rigged and dragging started at 16.30 hours. After several passes over the ground line without contact, the ship circled around the rig and 600m of wire was payed out on to the sea bed then hauled in. Contact was made at 18.20 hours and the rig brought to the surface at 19.10 hours for the successful recovery of both current meters. The surface buoy anchor was not recovered since it was not attached to the end of the ground line, although the ground line was not damaged in any way. It is likely that the connecting shackle was removed by a fisherman as the missing toroidal float was later landed at Port Penrhyn by a trawler. CTD profile No. 47 was carried out at 19.30 hours and the ship left the Station at 19.35 hours heading for Station 19.

Station 19 was re-occupied at 00.01 hours the following morning, Monday 25th April, and the toroidal buoy located floating upside down. The wind had again increased to 30 knots and prevented any recovery attempt, so the ship hove to until 08.30 hours when, at slack water, the wind had decreased to 25 knots and the recovery could be started although the sea was still rough. The recovery was successfully completed by 09.12 hours with the recovery of both current meters in good condition but without the surface buoy anchor, from the

condition of the broken wire this was lost some time before the recovery. CTD profile No. 48 at 09.25 hours completed the work at Station 19 and the ship left at 09.32 hours heading for the shelter of Redwharf Bay, eventually arriving at 14.50 hours (see Figure 7).

By the following morning, Tuesday 26th April, the weather had improved so the ship moved to Station 13 arriving at 04.25 hours to find the rig on position but the toroidal buoy floating upside down. With the wind speed down to 10 knots, recovery started at 05.20 hours but immediately ran into difficulties when the toroidal buoy became tangled with the overside pump. The pump was removed from the side of the ship and the recovery completed without further delay at 06.03 hours. The current meter was working normally and in good condition although the pellet buoy line was tangled with the meter wire, but the sub-surface buoy had been hit by something which had put two dents in the sphere. CTD profile No. 49 was taken at 06.25 hours, the pump re-rigged at 06.40 hours and the ship left the Station at 06.45 hours heading for Station 11.

Station 11 was again re-occupied at 09.00 hours for a final attempt to locate the CM rig but first it was decided to try to recover a ship's anchor lost at this site on a previous cruise a month earlier. However, after 2 hours dragging for the ship's anchor and then 4 hours dragging for the CM rig, nothing was recovered, so the ship left the Station and headed south to St. George's channel and Station 33 (see Figure 8).

Station 33 was occupied at 09.35 hours on Wednesday, 27th April, in very bad weather with southerly winds of 35/40 knots and very rough seas. There was no sign of the dahn buoy on the surface, the Selco buoy from this Station had been recovered previously by the Swansea Pilot boat, so the grapnel was prepared for dragging. A hydrophone search failed to make contact with the 'H' type command pinger fitted to the TG on the rig, as had been the case on all other rigs fitted with this type of command pinger on this cruise. With

little improvement expected in the weather during the next 24 hours, a dragging attempt was made at 10.58 hours with the ship circling round the rig (see Figure 10) and paying out 830m of wire into the sea bed, then with the ship hove to the wire was hauled in slowly. Contact was made with the rig at 11.30 hours and the TG was finally brought to the surface at 13.00 hours in a tangle of wires which made it necessary to cut off the surface buoy anchor with it still in the sea. The operation was completed at 13.16 hours with the recovery of the sunken dahn buoy. CTD profile No. 50 was carried out at 13.50 hours and the ship left Station 33 at 14.00 hours heading north to start on CTD section through St. George's channel from north to south. The first of these CTD profiles, No. 51, was taken at 15.10 hours (see Figure 8) but due to the very bad weather conditions, only allowing very slow progress south, this work had to be abandoned. So with all the other work completed and no prospect of an improvement in the weather within the next 24 hours, the ship returned to Barry and docked at 11.30 hours on Thursday, 28th April.

STATION REPORT LEG 1 - DEPLOYMENTC.M. Station 1

Current meter rig with one meter at 5m
from the bottom

Sub-surface buoy No. 3

Surface buoy (toroid) No. 12

Sub-surface buoy

Current meter : 416

First anchor (D05.75, D37.85, ----)

Ground line

Second anchor (D05.78, D37.00, ----)

Toroid

Deployment started 00.05) 18.3.77

Deployment complete 01.00)

Depth on deployment : 26m

Surface buoy sighted at 7.25 hours on 25.3.77

Decca : 3B/MP

C.M. Station 2

Current meter rig with one meter at 11m
from the bottom.

Sub-surface buoy No. 4

Surface buoy (toroid) No. 4

Sub-surface buoy

Current meter : 1749

First anchor (D12.32, C44.00, ----)

Ground line
lying at 120°/300°

Second anchor (D12.00, C44.58, ----)

Toroid

Deployment started 07.13) 20.3.77

Deployment complete 07.37)

Depth on deployment : 24m

Surface buoy recovered, set upright, and
re-deployed, from 6.30 - 6.50 hours on
25.3.77

Decca : 3B/MP

C.M. Station 3

Current meter rig with one meter at 8m
from the bottom.

Sub-surface buoy No. 2

Surface buoy (toroid) No. 5

Sub-surface buoy

Current meter : 2576

First anchor (C15.80, D45.05, ----)

Ground line
lying at $95^{\circ}/275^{\circ}$

Second anchor (C15.85, D45.00, ----)

Toroid

Deployment started 09.32) 16.3.77

Deployment complete 09.55)

Depth on deployment : 26m

Surface buoy sighted at 8.40 hours on
25.3.77 at (C15.75, D44.73, ----)

Decca : 3B/MP

C.M. Station 6

Current meter rig with two meters at 8 and
18m from the bottom

Sub-surface buoy No. 9

Surface buoy (toroid) No. 10

Sub-surface buoy

Current meters : 236 (top), 406 (bottom)

First anchor (C6.82, B45.35, ----)

Ground line
lying at $30^{\circ}/210^{\circ}$

Second anchor (C6.65, B45.20, ----)

Toroid

Deployment started 15.57) 16.3.77
Deployment complete 16.12)

Depth on deployment : 33m

Surface buoy sighted (flashing) at
00.39 hours on 25.3.77

Decca : 3B/MP

C.M. Station 8

Current meter rig with two meters at 8 and 35m from the bottom, and with a clamped tiltmeter.

Sub-surface buoy No. 5

Surface buoy (toroid) No. 2

Sub-surface buoy

Current meters : 566 (top, 1139 (bottom)

Tilt meter : 2574 (middle)

First anchor (D22.10, J40.10, ----)

Ground line

Second anchor (D22.30, J39.80, ----)

Toroid

Deployment started 13.50) 19.3.77

Deployment complete 14.17)

Depth on deployment : 51m

Surface buoy sighted (flashing) at
21.25 hours on 24.3.77

Decca : 3B/MP

C.M. Station 9

Current meter rig with one meter at 6m
from the bottom.

Sub-surface buoy No. 10

Surface buoy (toroid) No. 3

Sub-surface buoy

Current meter : 1867

First anchor (B19.3, B45.05, ----)

Ground line
lying at $105^{\circ}/285^{\circ}$

Second anchor (B19.3, B45.15, ----)

Toroid

Deployment started 13.20) 16.3.77

Deployment complete 14.06)

Depth on deployment : 14m

Surface buoy sighted (flashing) at
01.35 hours on 25.3.77

Decca : 3B/MP

C.M.T. Station 10

Bottom-mounted current meter/tide
gauge

Selco buoy No. 2

Selco buoy

Anchor (C8.02, A40.42, ----)

Ground line
lying at $100^{\circ}/280^{\circ}$

Current meter/
tide gauge No 1 (C7.88, A40.62, ----)
(CM 1747)

Two surface
pellets

Deployment started 19.04) 16.3.77
Deployment complete 19.16)

Depth on deployment : 41m

Selco buoy sighted (flashing) at
23.52 hours on 24.3.77

Decca : 3B/MP

C.M. Station 11

Current meter rig with three meters at
8, 16 and 25m from the bottom

Sub-surface buoy No 11
(40" dia. steel sphere)

Surface buoy (toroid) No. 9

Sub-surface buoy

Current meters : 2573 (top), 568 (middle), 1001 (bottom)

First anchor (C16.90, J46.55, ----)

Ground line
lying at 150°/330°

Second anchor (C16.91, J46.73, ----)

Toroid

Deployment started 21.22) 16.3.77
Deployment complete 21.42)

Depth on deployment : 44m

Surface buoy sighted (flashing) at
23.08 hours on 24.3.77

Decca : 3B/MP

C.M.T. Station 12

Bottom-mounted current meter/tide
gauge.

Selco buoy No. 8

Selco buoy

Anchor

(D2.85, J34.85, ----)

Ground line
lying at

20°/200°

Current meter/
tide gauge
No. 2 (CM 1507)

(D2.85, J34.75, ----)

Pellets

Deployment started 09.46) 19.3.77
Deployment complete 11.45)

Depth on deployment : 48m

Surface buoy sighted (flashing) at
22.29 hours on 24.3.77

Decca 3B/MP

C.M. Station 13

Current meter rig with one meter at
8m from the bottom.

Sub-surface buoy No. 8

Surface buoy (toroid) No. 8

Sub-surface buoy

Current meter : 2575

First anchor (B17.95, A32.18, ----)

Ground line

Second anchor (B17.94, A32.26, ----)

Toroid

Deployment started 13.15) 20.3.77

Deployment complete 13.29)

Depth on deployment : 26m

Surface buoy sighted at 05.12 hours on
24.3.77 in the position (B18.00,
A32.45, A73.92)

Decca 3B/MP

C.M. Station 15

Current meter rig with two meters at
8 and 24m from the bottom.

Sub-surface buoy No. 6

Surface buoy (toroid) No. 1

Sub-surface buoy

Current meters : 1508 (top), 1865 (bottom)

First anchor (B23.93, H42.46, ----)

Ground line
lying at $163^{\circ}/343^{\circ}$

Second anchor (B23.80, H42.25, ----)

Toroid

Deployment started 17.45) 20.3.77

Deployment complete 17.55)

Depth on deployment : 38m

Surface buoy sighted at 07.14 hours on
24.3.77 in the position (B23.75,
H41.40, A61.30).

Decca 3B/MP

C.M. Station 16

Current meter rig with two meters at
8 and 35m from the bottom.

Sub-surface buoy No. 1

Selco surface buoy No. 1

Sub-surface buoy
(no pellets)

Current meters : 1750 (top), 1506 (bottom)

First anchor (D10.52, H38.29, ----)

Ground line
lying at $65^{\circ}/245^{\circ}$

Second anchor (D10.50, H38.29, ----)

Selco buoy

Deployment started 16.35) 19.3.77
Deployment complete 16.54)

Depth on deployment : 57m

Selco buoy sighted at 09.50 hours on
24.3.77. No pellets

Decca 3B/MP

C.M. Station 19

Current meter rig with two meters at
8 and 51m above the bottom.

Sub-surface buoy No. 7

Surface buoy (toroid) No. 13

First deployment

Sub-surface buoy

Current meters : 567 (top), 570 (bottom)

First anchor (E10.40, H40.78, ----)

Ground line
lying at 88°/268°

Second anchor (E08.96, H41.55, ----)

Toroid

Deployment started 20.25) 19.3.77

Deployment complete 21.14)

Depth on deployment : 59m

Re-deployment

Sub-surface buoy

Current meters

First anchor (E11.65, G42.13, A50.55)

MAIN WINCH FAILS : REPAIR TAKES 3 HOURS

Second anchor (E12.85, G41.82, A50.58)

Toroid

Ground line
lying at 70°/250°

Note: only second anchor position is reliable due to drift of the
ship with partially deployed rig

Deployment started 14.15) 24.3.77

Deployment complete 18.28)

Depth on deployment : 68m

Decca 3B/MP

O.T.G. Station 33

Selco surface buoy No. 3

Dahn buoy

Selco buoy

First anchor (A4.66, I41.73, J64.00)

Ground line
lying at 30°/210°

Tide gauge (A4.66, I41.65, J64.15)

Second anchor (A4.67, I41.64, J64.15)

Dahn buoy

Deployment started 12.51) 22.3.77

Deployment complete 13.22)

Depth on deployment : 95m

Decca : 1B/MP

O.T.G. Station 34

Selco surface buoy No. 9

Dahn buoy

Selco buoy

First anchor (B06.90, H32.95, A72.53)

Ground line
lying at 70°/250°

Tide gauge (B06.83, H32.78, A72.55)

Second anchor (B06.90, H32.77, A72.45)

Dahn buoy

Deployment started 16.58) 21.3.77

Deployment complete 17.15)

Depth on deployment : 29m

Selco buoy sighted (flashing) at
00.30 hours on 24.3.77

Decca : 3B/MP

O.T.G. Station 35

Selco surface buoy No. 7

Dahn buoy

Selco buoy

First anchor

(A1.52, C38.40, B60.56)

Radio buoy

Ground line
lying at

140°/320°

Tide gauge

(A1.50, C38.30, B60.83)

Second anchor

(A1.50, C38.31, B60.85)

Dahn buoy

Deployment started 08.53) 21.3.77

Deployment complete 09.46)

Depth on deployment : 32m

14.30 hours, 23.3.77

Selco buoy sighted, but Dahn buoy missing. New
marker Dahn buoy laid, about 1 cable from the
Selco buoy directly to the west of the latter,
at (----, C38.20, B60.64)

Decca : 3B/MP

STATION REPORT LEG 2. RECOVERY (DECCA CHAIN - 3B/MP)

Station 1

Current meter rig with 1 meter No. 416

	Red	Green	Purple
Deployed position	D5.75	D37.85	-
Recovery position	D6.12	D35.68	A60.25
Recovery started at	14.34	hours	17th April 77
Surface buoy on deck	14.40	"	
Surface buoy anchor on deck	14.46	"	
CM on deck	14.49	"	
Sub-surface buoy on deck	14.51	"	
Recovery complete	14.52	"	

All equipment in good condition and operating normally

CTD profile No. 30 carried out at 15.02 hours, 17th April 1977.

Station 2

Current meter rig with 1 meter No. 1749

	Red	Green	Purple
Deployed position	D12.32	C44.00	-
Recovery position	D11.87	C45.15	-
Recovery started at	18.10	hours	19th April 77
Surface buoy on deck	18.14	"	
Surface buoy anchor on deck	18.19	"	
Sub-surface buoy anchor on deck	18.25	"	
CM on deck	18.27	"	
Sub-surface buoy on deck	18.31	"	
Recovery complete	18.32	"	

On arrival at the station the toroidal surface buoy was found floating upside down. The current meter fin was found to be cracked and the spindle bearing assembly had collapsed.

CTD profile No. 34 carried out at 18.40 hours, 19th April 1977.

Station 3

Current meter rig with 1 meter No. 2576

Command Pinger No. CP3

	Red	Green	Purple
Deployed position	C15.80	D45.05	-
Recovery position	C15.71	D45.07	A67.68
Recovery started at	13.50 hours		16th April 77
Surface buoy on deck	13.53	"	
Surface buoy anchor on deck	14.04	"	
Sub-surface buoy anchor on deck	14.15	"	
CM on deck	14.16	"	
Sub-surface buoy on deck	14.19	"	
Recovery complete	14.20	"	

All equipment in good condition and operating normally

CTD profile No. 25 carried out at 13.23 hours, 16th April 1977.

Station 6

Current meter rig with 2 meters, Nos. 236 (top) and 406 (bottom)

Command pinger No. CP6

	Red	Green	Purple
Deployed position	C6.82	B45.35	-
Recovery position	C6.55	B45.10	A69.20
Recovery started at	16.49 hours		16th April 77
Surface buoy on deck	16.53	"	
Sub-surface anchor on deck	17.05	"	
Bottom CM on deck	17.05	"	
Pinger on deck	17.06	"	
Top CM on Deck	17.06	"	
Sub-surface buoy on deck	17.07	"	
Recovery complete	17.08	"	

The surface buoy anchor was missing from the rig and may have been broken off during the recovery. All the other equipment was in good condition and operating normally.

CTD profile No. 26 carried out at 16.02 hours, 16th April 1977.

Station 8

Current meter rig with 2 meters and one tilt meter

Meter No. 566 Top
Tilt meter No. 2574 Mid
Meter No. 1139 Bottom

Command pinger, 'H' type No. CR217

	Red	Green	Purple
Deployed position	D22.10	J40.10	-
Recovery position	D22.74	J39.39	A51.60

Rig recovered by dragging

Recovery started	12.34 hours	18th April 77
Surface buoy anchor on deck	12.40 "	
Sub-surface anchor on deck	12.59 "	
Bottom CM on deck	13.00 "	
Pinger and tilt meter on deck	13.04 "	
Top CM on deck	13.06 "	
Sub-surface buoy on deck	13.06 "	
Recovery complete	13.07 "	

The surface buoy mooring line was cut about 5m above its anchor, (the surface buoy was recovered later by a small boat and landed at Meols).

All equipment in good condition and operating normally.

CTD profile No. 31 carried out at 19.55 hours, 17th April 1977.

Station 9

Current meter rig with 1 meter No. 1867

Command Pinger, 'H' type, No. CR228

	Red	Green	Purple
Deployed position	B19.3	B45.05	-
Recovery position	B18.92	B45.80	-

Rig recovered by dragging

Recovery started	08.05 hours	19th April 77
Sub-surface buoy on deck	08.13 "	
CM and pinger on deck	08.16 "	
Meter wire cut	08.19 "	

Both anchor weights were lost. The current meter fin assembly was badly damaged during the recovery but the instrument is still operating. Some cable marks on S/S buoy and shackles which were done prior to recovery. The surface toroidal buoy from this station was washed ashore on Blackpool beach.

CTD profile No. 27 carried out at 20.00 hours, 16th April 1977.

Station 10

Bottom mounted current meter/tide gauge rig No. 1

Current meter No. 1747

Pressure sensor, Digiquartz S/No 280

Command Pinger No. CP1

	Red	Green	Purple
Deployed position	C7.88	A40.62	-
Recovery position	C8.00	A40.50	A65.08
Recovery started		10.35 hours	17th April 77
Surface buoy on deck		10.45 "	
Surface buoy anchor on deck		10.55 "	
Bottom CM/TG on deck		11.00 "	
Surface pellets on deck and recovery complete		11.02 "	

The Selco surface buoy on this station was fitted with an experimental radar reflector which gave improved range. The bottom CM/TG was recovered undamaged and working normally including the acoustics equipment.

CTD profile No. 29 carried out at 11.03 hours, 17th April 1977.

Station 11

Current meter rig with 3 meters, Nos. 2573 (top), 568 (middle) and 1001 (bottom).

Command pinger, 'H' type No. CR208.

	Red	Green	Purple
Deployed position	C16.90	J46.55	-

No equipment was recovered from this station during the cruise but on 6th May 1977 a fisherman recovered the sub-surface buoy and two current meters (Nos. 2573 and 568) $1\frac{1}{4}$ miles off Windscale. The toroidal surface buoy was landed at Kircudbright by the fishing vessel Fredwood.

CTD profile No. 28 carried out at 07.47 hours, 17th April 1977.

Station 12

- (a) Bottom mounted current meter/tide gauge rig No. 2
(see Figure 11)
- (b) Temporary bottom mounted current meter rig.

- (a) Bottom mounted CM/TG No. 2 (permanent):-

Current meter No. 1507

Pressure sensor, Digiquartz S/No. 275

Command pinger No. CP5

	Red	Green	Purple
Deployed position	D2.85	J34.75	-
Recovery position	D2.77	J34.85	-
Recovery started		05.26 hours	18th April 77
Surface buoy on deck		05.29 "	
Bottom CM/TG on deck		05.36 "	
Surface pellets on deck and recovery complete		05.45 "	

The bottom CM/TG was recovered in good condition and working normally except for some seaweed caught around the top bearing and the rotor and cruising drag. The acoustic equipment also worked normally.

- (b) Temporary bottom mounted current meter rig (see Figure 11)
(in position from 17th April to 18th April 1977)

Depth of water 41m

Current meter No. EX302 (30 sampling rate).

Toroidal buoy with experimental spherical radar reflector.

Experimental dahn buoy.

	Red	Green	Purple
Deployed position	D3.24	J35.00	A54.58
Deployment started at		06.16 hours	17th April 77
Deployment complete		06.33 "	
Recovery position	D3.13	J35.00	-

Station 12 (continued)

Recovery started at	06.11 hours	18th April 77
Surface buoy on deck	06.13 "	
Surface buoy anchor on deck	06.22 "	
Bottom CM on deck	06.31 "	
Dahn buoy on deck and recovery complete	06.40 "	

All the equipment was recovered in good condition and operating normally. The experimental radar reflector gave a good echo at a range of 2ML.

CTD profile No. 32 carried out at 05.06 hours, 18th April 1977.

Station 13

Current meter rig with 1 meter No. 2575

Command pinger, 'H' type No. CR 227

	Red	Green	Purple
Deployed position	B17.95	A32.18	-
Recovery position	B18.05	A32.30	A74.05
Recovery started	05.20 hours		26th April 77
Surface buoy on deck	05.40	"	
Surface buoy anchor on deck	05.55	"	
Sub-surface buoy anchor on deck	05.59	"	
CM on deck	06.01	"	
Sub-surface buoy on deck and recovery complete	06.03	"	

The surface buoy became entangled with the overside pump during recovery. Sub-surface buoy pellet line tangled with meter wire but not the meter. The sub-surface buoy had two dents in the surface which were done prior to recovery.

CTD profile No. 49 carried out at 06.25 hours, 26th April 1977.

Station 15

Current meter rig with 2 metres Nos. 1508 (top), 1865 (bottom).

Command pinger, 'H' type No. CR222

	Red	Green	Purple
Deployed position	B23.93	H42.46	-
Recovery position	B23.99	H42.46	A61.31

Rig recovered by dragging

Recovery started	18.20 hours	24th April 77
Sub-surface buoy anchor on deck	19.06 "	
Bottom CM and pinger on deck	19.10 "	
Top CM on deck	19.11 "	
Sub-surface buoy on deck and recovery complete	19.15 "	

Both current meters were recovered and in good condition and operating normally. The surface buoy anchor weight was not recovered although the ground line was still in one piece, the shackle was missing from the end! The surface toroid was later recovered and landed at Port Penrhyn by the fishing vessel Jacob Johannis.

CTD profile No. 47 carried out at 19.30 hours, 24th April 1977.

Station 16

Current meter rig with 2 meters, Nos. 1750 (top), 1506 (bottom).

Command pinger No. CP4

	Red	Green	Purple
Deployed position	D10.52	H38.29	-
Recovery position	D10.43	H38.33	A51.16
Recovery started	08.55	hours	18th April 77
Surface buoy on deck	09.00	"	
Surface buoy anchor on deck	09.10	"	
Sub-surface buoy anchor on deck	09.27	"	
Bottom CM on deck with acoustics	09.31	"	
Sub-surface buoy on deck and recovery complete	09.34	"	

All equipment recovered complete and in working order except for the bottom current meter which was tangled with the ground line.

CTD profile No. 33 carried out at 09.40 hours, 18th April 1977

Station 19

Current meter rig with 2 meters, Nos. 567 (top), 570 (bottom)

Command pinger No. CP010

	Red	Green	Purple
Deployed position	E12.85	G41.82	A50.58
Recovery position	E13.25	G41.60	A50.69
Recovery started	08.30 hours		25th April 77
Surface buoy on deck	08.38	"	
Sub-surface buoy anchor on deck	09.01	"	
Bottom CM on deck	09.05	"	
Top CM on deck	09.09	"	
Sub-surface buoy on deck and recovery complete	09.12	"	

All equipment recovered in good condition and operating normally but surface buoy anchor was missing.

CTD profile No. 48 carried out at 09.25 hours, 25th April 1977.

Station 33 (Decca chain:- 1B/MP)

Mark II off-shore tide gauge rig

Logger 005 Sensors 1/6 VIB
 2/6 S.G.
 2/9 S.G. (Thin film)

Command pinger, 'H' type No. CR218

	Red	Green	Purple
Deployed position	A4.66	I41.65	J64.15
Recovery position	A4.52	I42.22	J63.40

Rig recovered by dragging

Recovery started	11.30 hours	27th April 77
T.G. on deck	13.00 "	
Sunken dahn buoy on deck and recovery complete	13.16 "	

The recovery was made difficult by heavy seas with the result that the TG was recovered in a mass of tangled wires making it necessary to cut off the anchor weight whilst still in the sea. The TG and acoustics were undamaged. The surface buoy was recovered by the Swansea pilot boat.

CTD profile No. 50 carried out at 13.50 hours, 27th April 1977.

Station 34

Aanderaa off-shore tide gauge rig.

Aanderaa T.G.-2A S/No 64

Command pinger No. CP2

	Red	Green	Purple
Deployed position	B6.83	H32.78	A72.55
Recovery position	B6.78	H32.78	A72.54
Recovery started		13.33 hours	24th April 77
Dahn buoy on deck		13.52 "	
TG on deck		14.04 "	
Surface buoy on deck and recovery complete		14.15 "	

Both the TG and acoustics unit were recovered undamaged and operating normally but the surface buoy anchor was missing. The recovery was hampered by the dahn buoy mooring wire becoming tangled with the overside pump.

CTD profile No. 46 carried out at 14.30 hours, 24th April 1977.

Station 35

MkII off-shore tide gauge rig

Logger 002 sensors 1/5 VIB
 2/7 S.G.
 6/1 DIG
 2/8 S.G. (Exp)
 2/4 S.G.

Command pinger, 'H' type No. CR213

	Red	Green	Purple
Deployed position	A1.50	C38.30	B60.83
Recovery position	-	C38.32	B60.85
Recovery started		08.56 hours	24th April 77
Surface buoy on deck		09.05 "	
T.G. on deck		09.17 "	
Recovery complete		09.27 "	

The surface buoy anchor was cut off during the recovery due to the rough sea. There was no sign of either of the two dahn buoys deployed on this rig. The T.G. was in good condition and operating normally.

CTD profile No. 45 carried out at 09.30 hours, 24th April 1977.

EQUIPMENT LOSSES

Current meter	Aanderaa type RCM4 S/No 1001
Acoustic command pinger	S/No CR208
2 Dahn buoys	

COMMENTS ON THE SHIP

The ship is well suited for laying and recovering the type of rigs used and has been used many times in the past for this type of cruise. Some difficulty was experienced however when there was a breakdown of the main winch which was aggravated by poor communications between the winch operators.

ACKNOWLEDGEMENTS

We would like to offer our thanks to the Master, Officers and crew of the RRS John Murray for their co-operation and assistance in carrying out the work of these cruises and helping to achieve a very high data recovery rate. Also our grateful thanks are due to Mr. R. A. Smith for constructing the figures and to Mrs. L. Parry for typing the manuscript.

Table 1

List of actual station positions and corresponding depths

Station No.	DECCA			Latitude (N)	Longitude (W)	Chart depth (m)	rig des.	Height of meters above sea bed in m.
	R	G	P					
1	D 5.75	D37.85	-	53° 23.60'	3° 45.65'	17.1	CM(1)	5
2	D12.32	C44.00	-	53° 23.75'	3° 55.40'	19.8	CM(1)	11
3	C15.80	D45.05	-	53° 28.95'	3° 29.30'	21.6	CM(1)	8
6	C 6.82	B45.35	-	53° 41.50'	3° 32.20'	32.4	CM(2)	8, 18
8	D22.10	J40.10	-	53° 39.00'	4° 21.80'	46.8	CM(2)	8, 35
9	B19.30	B45.05	-	53° 46.25'	3° 17.70'	15.6	CM(1)	6
10	C 7.88	A40.62	-	53° 46.40'	3° 42.50'	36.0	CM/TG	
11	C16.90	J46.55	-	53° 46.20'	3° 55.90'	37.8	CM(3)	8, 16, 25
12	D 2.85	J34.75	-	53° 46.40'	4° 8.10'	41.4	CM/TG	
13	B17.95	A32.18	-	53° 53.60'	3° 30.10'	19.8	CM(1)	8
15	B23.93	H42.46	-	54° 1.40'	3° 55.40'	36.0	CM(2)	8, 24
16	D10.52	H38.29	-	53° 53.90'	4° 24.20'	56.4	CM(2)	8, 35
19	E12.85	G41.82	A50.58	53° 53.70'	4° 46.20'	54.0	CM(2)	8, 51
33	H 4.66	I41.65	J64.15	52° 4.10'	5° 47.00'	93.6	OSTG	
34	B 6.83	H32.78	A72.55	54° 9.20'	3° 40.25'	30.6	OSTG	
35	A 1.50	C38.30	B60.83	54° 38.95'	3° 54.60'	28.0	OSTG	

TABLE 2. LIST OF CTD PROFILES

PROFILE NUMBER	DATE	TIME STARTED	POSITION		RIG
			LATITUDE	LONGITUDE	
1	16/ 3/77	9.29	N 53 29.1	W 3 28.8	3
2	16/ 3/77	13.20	N 53 46.3	W 3 17.7	9
3	16/ 3/77	15.43	N 53 41.1	W 3 32.2	6
4	16/ 3/77	18.15	N 53 46.3	W 3 42.5	10
5	16/ 3/77	20.49	N 53 46.4	W 3 55.6	11
6	16/ 3/77	23.17	N 53 46.1	W 4 8.5	12
7	18/ 3/77	23.37	N 53 23.8	W 3 43.8	1
8	19/ 3/77	9.35	N 53 45.6	W 4 7.5	12
9	19/ 3/77	13.40	N 53 38.6	W 4 21.3	8
10	19/ 3/77	16.41	N 53 53.7	W 4 23.9	16
11	19/ 3/77	18.30	N 53 48.2	W 4 40.3	19
12	20/ 3/77	7.16	N 53 23.5	W 3 55.4	2
13	20/ 3/77	12.54	N 53 53.5	W 3 29.2	13
14	20/ 3/77	17.21	N 54 1.1	W 3 55.6	15
15	21/ 3/77	8. 0	N 54 38.9	W 3 54.7	35
16	21/ 3/77	16.40	N 54 8.7	W 3 42.3	34
17	22/ 3/77	12.52	N 52 4.2	W 5 47.3	33
18	23/ 3/77	11.35	N 54 35.4	W 4 30.5	
19	23/ 3/77	16.30	N 54 43.8	W 3 49.3	
20	23/ 3/77	20.30	N 54 19.0	W 4 4.4	
21	24/ 3/77	8.45	N 53 57.2	W 4 13.2	
22	24/ 3/77	14.15	N 53 53.8	W 4 45.4	19
23	24/ 3/77	20.30	N 53 42.8	W 4 28.5	
24	25/ 3/77	6.12	N 53 22.5	W 3 55.0	
25	16/ 4/77	13.25	N 53 28.6	W 3 29.3	3
26	16/ 4/77	16. 0	N 53 41.6	W 3 32.2	6
27	16/ 4/77	20. 0	N 53 46.5	W 3 17.4	9
28	17/ 4/77	7.47	N 53 46.0	W 3 54.5	11
29	17/ 4/77	11. 6	N 53 46.1	W 3 41.9	10
30	17/ 4/77	15. 0	N 53 34.7	W 3 58.8	1
31	17/ 4/77	19.50	N 53 38.8	W 4 22.0	8
32	18/ 4/77	5. 0	N 53 46.1	W 4 8.5	12
33	18/ 4/77	9.40	N 53 53.9	W 4 24.2	16
34	19/ 4/77	18.40	N 53 23.8	W 3 54.8	2
35	21/ 4/77	9.44	N 53 29.2	W 4 14.9	
36	21/ 4/77	12. 0	N 53 37.6	W 4 25.0	
37	21/ 4/77	13.54	N 53 44.8	W 4 35.2	
38	23/ 4/77	19.20	N 54 36.9	W 4 25.5	
39	23/ 4/77	20.30	N 54 30.3	W 4 24.1	
40	23/ 4/77	22. 0	N 54 29.5	W 4 6.0	
41	23/ 4/77	23. 7	N 54 28.9	W 3 53.1	
42	24/ 4/77	0. 7	N 54 28.5	W 3 43.1	
43	24/ 4/77	1. 5	N 54 35.1	W 3 42.1	
44	24/ 4/77	2.25	N 54 41.9	W 3 49.4	
45	24/ 4/77	9.26	N 54 39.0	W 3 54.9	35
46	24/ 4/77	14.25	N 54 9.4	W 3 41.9	34
47	24/ 4/77	19.25	N 54 0.3	W 3 54.1	15
48	25/ 4/77	9.21	N 53 53.3	W 4 46.6	19
49	26/ 4/77	6.10	N 53 54.3	W 3 31.0	13
50	27/ 4/77	13.50	N 52 4.6	W 5 47.1	33
51	27/ 4/77	15.12	N 52 12.0	W 5 36.6	

Table 3

LIST OF EQUIPMENT DEPLOYED

1. Surface buoys
 - (a) Selco No. 1, 2, 7, 8, 9
(fitted with flashing light) Manufactured by Selco, Oslo, Norway
 - (b) Toroidal No. 1, 2, 3, 4, 5, 8, 9, 10, 12, 13 Manufactured by Cosalt Ltd., Lowestoft.
1.8m dia. 600 kg buoyancy.
 - (c) Dahnbuoy Loaned from IOS Barry.

2. Sub-surface buoy
 - (a) Hollow steel sphere Manufactured to IOS design.
No. 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11. 0.8m dia. 175 kg buoyancy.

3. Current meters

No. 236, 406, 416, 566, 567, 568, 570, 1001, 1139, 1506, 1507, 1508, 1747, 1749, 1750, 1865, 1867, 2573, 2575, 2576. Manufactured by Aanderaa Ltd., Norway. Type RCM 4

4. Off-shore tide gauge
 - (a) Moored T.G. system consisting of data logger and sensor units to measure both pressure and temperature. IOS Bidston

Data logger 002 and 005. Manufactured by Marconi Space & Defence Ltd.

Pressure transducer elements VIB (vibrating wire) Manufactured by Sundstrand Data Control Inc. Washington, USA.

S.G. (strain gauge) Manufactured by Bell & Howell Ltd., Basingstoke, U.K.

Digiquartz Depth sensor (quartz crystal) S/No 587 Manufactured by Paroscientific Inc., Washington USA.
 - (b) Moored T.G. system incorporating Aanderaa water level recorder TG-2A S/No 64. Manufactured by Aanderaa Instruments Ltd. Canada.

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. 1507, 1747

Manufactured by Aanderaa
Ltd., Norway. Type RCM 4.

Pressure transducer element
Digiquartz (quartz crystal)
S/N 275, 280

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

6. Acoustic Command pinger

Pinger CP 1, 2, 3, 4, 5, 6, 010
CR 208, 213, 217, 218, 222, 227,
228.

IOS Bidston/Wormley

7. Flashing light

Power flash

Manufactured by Stone-Platt
Ltd., Crawley.

Pains Wessex

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

ABBREVIATIONS

IOS	Institute of Oceanographic Sciences.
CM	Current meter.
O.S.T.G.	Off-shore tide gauge.
CM/TG	Current meter/tide gauge.
S/S	Sub-surface buoy.
T/C	Temperature, conductivity.
CTD	Conductivity, temperature, depth.

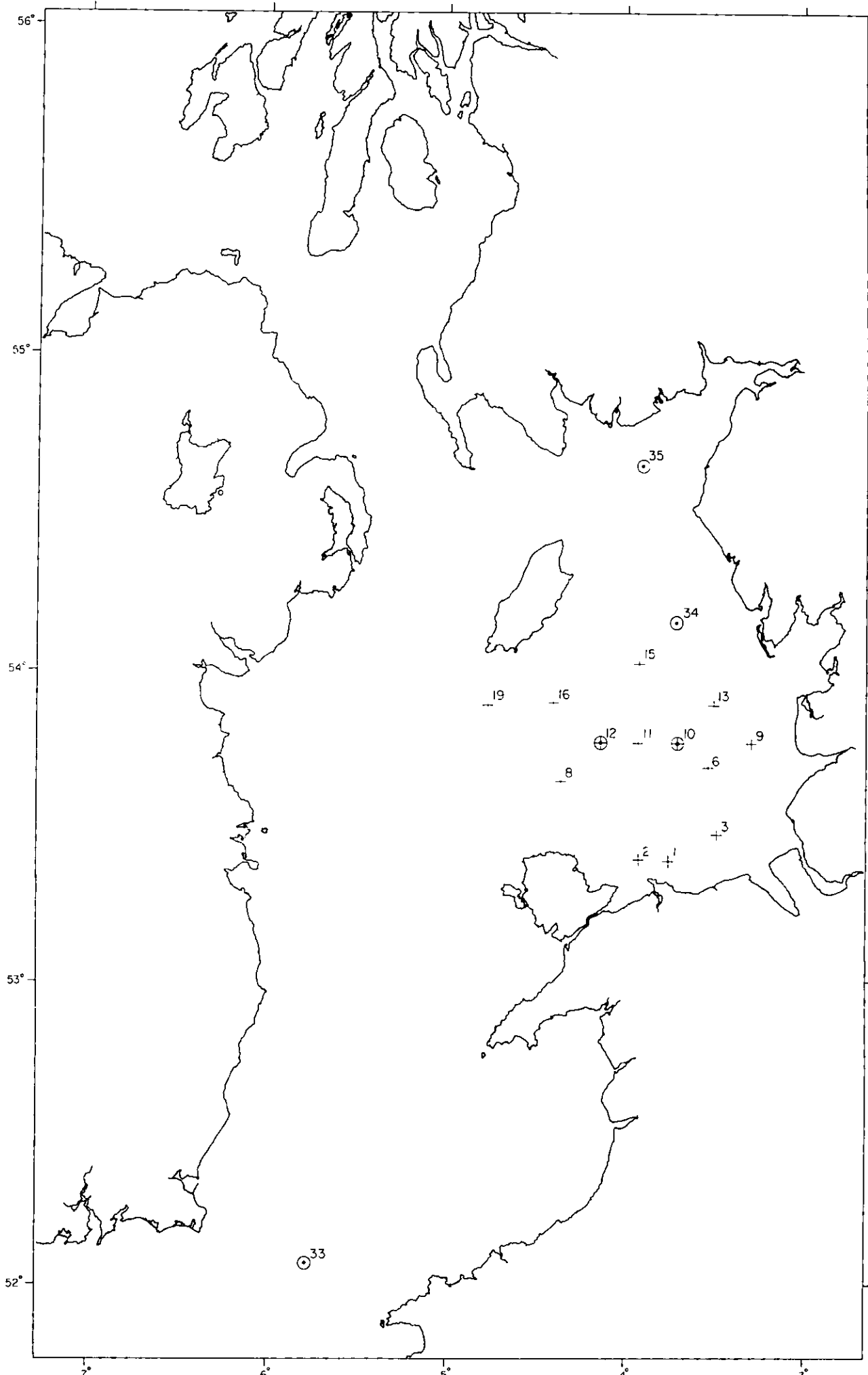


FIGURE 1. IRISH SEA DEPLOYMENT INDICATING STATION NUMBERS.
 KEY : + CURRENT METER RIG, ◉ TIDE GAUGE, ⊕ BOTTOM MOUNTED
 CURRENT METER / TIDE GAUGE

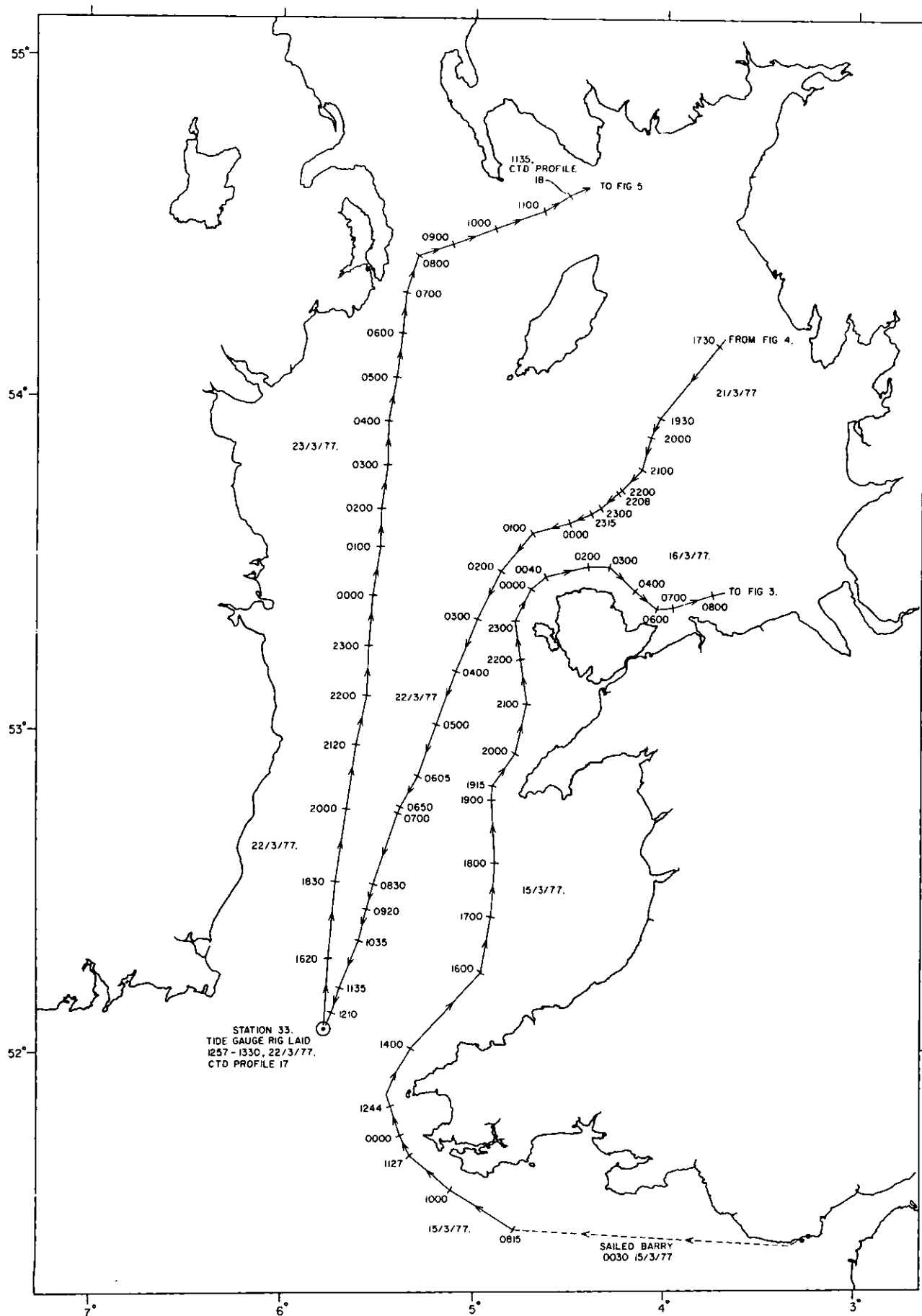


FIGURE 2. CRUISE TRACK, LEG I, IRISH SEA.

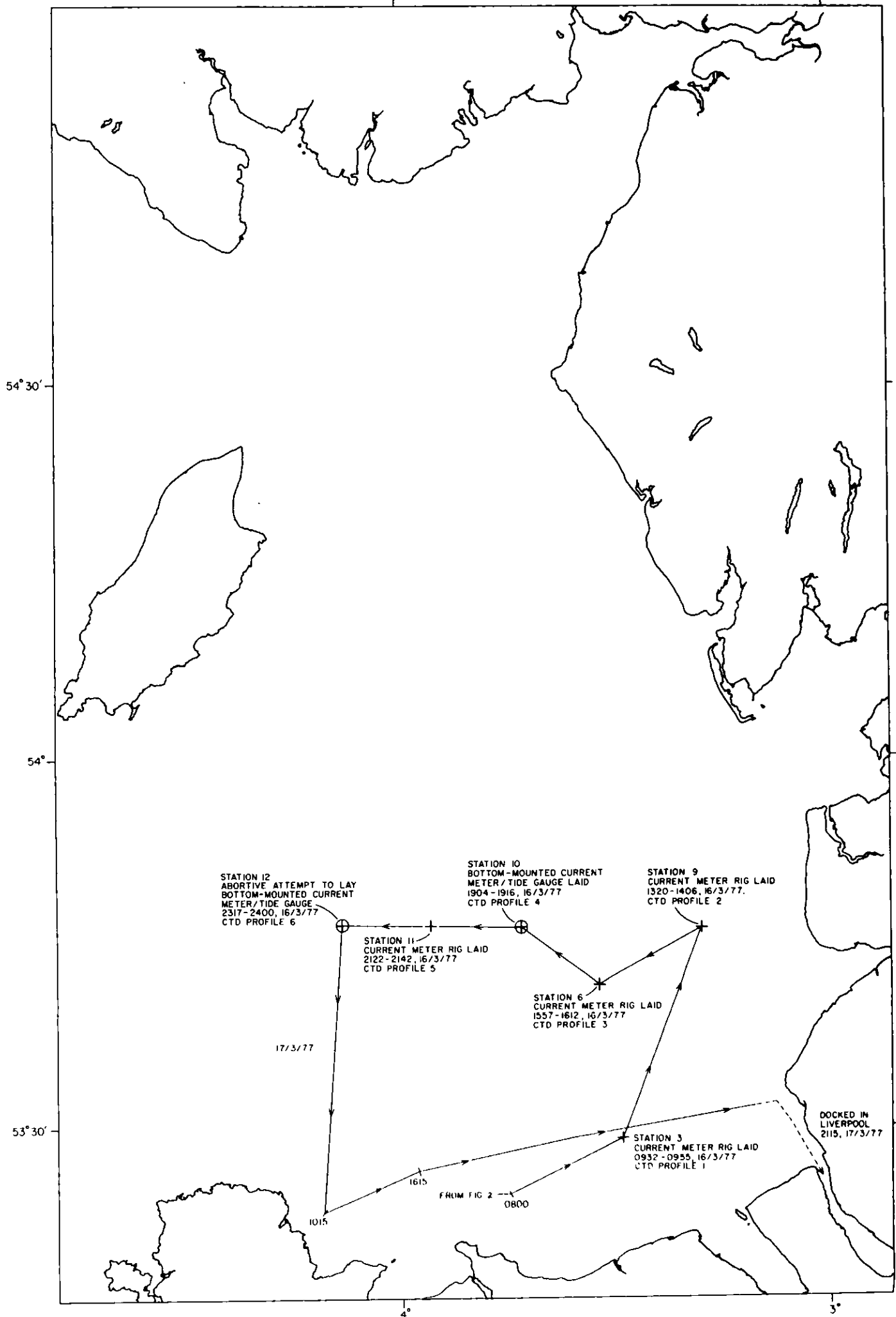


FIGURE 3. CRUISE TRACK, LEG I, LIVERPOOL BAY.

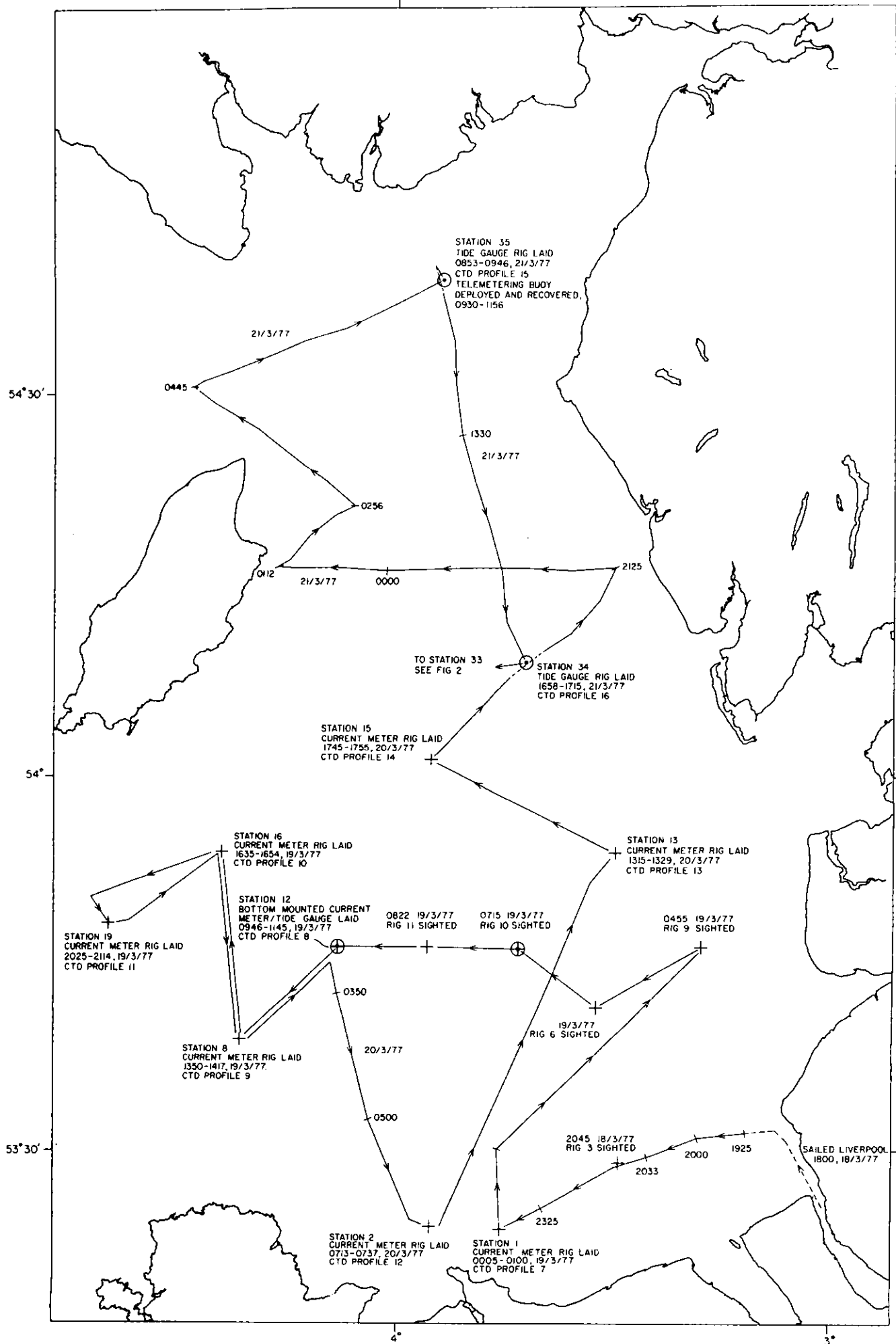


FIGURE 4. CRUISE TRACK, LEG I, EASTERN IRISH SEA.

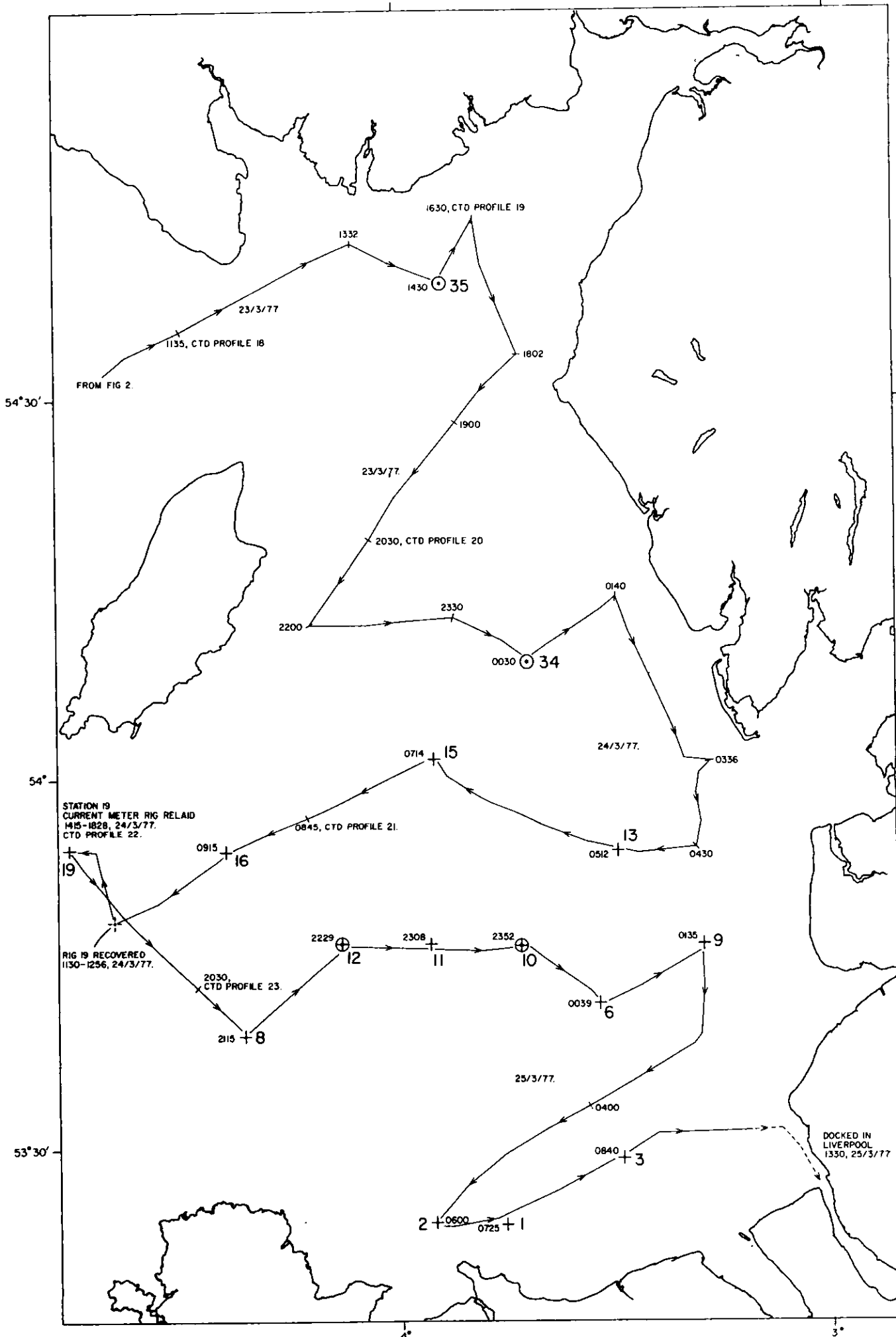


FIGURE 5. CRUISE TRACK, LEG I, EASTERN IRISH SEA.

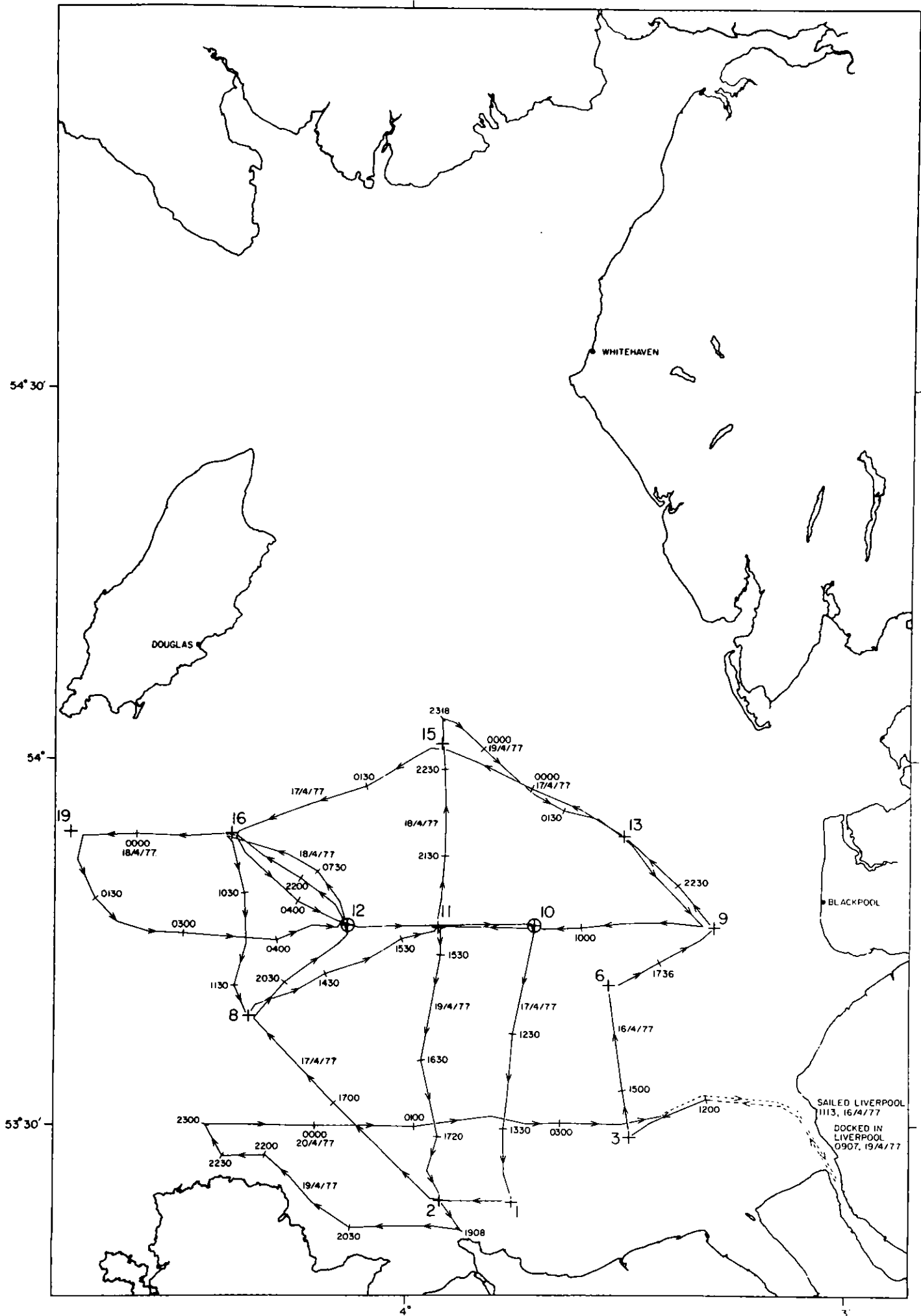


FIGURE 6. CRUISE TRACK, LEG 2, LIVERPOOL BAY.

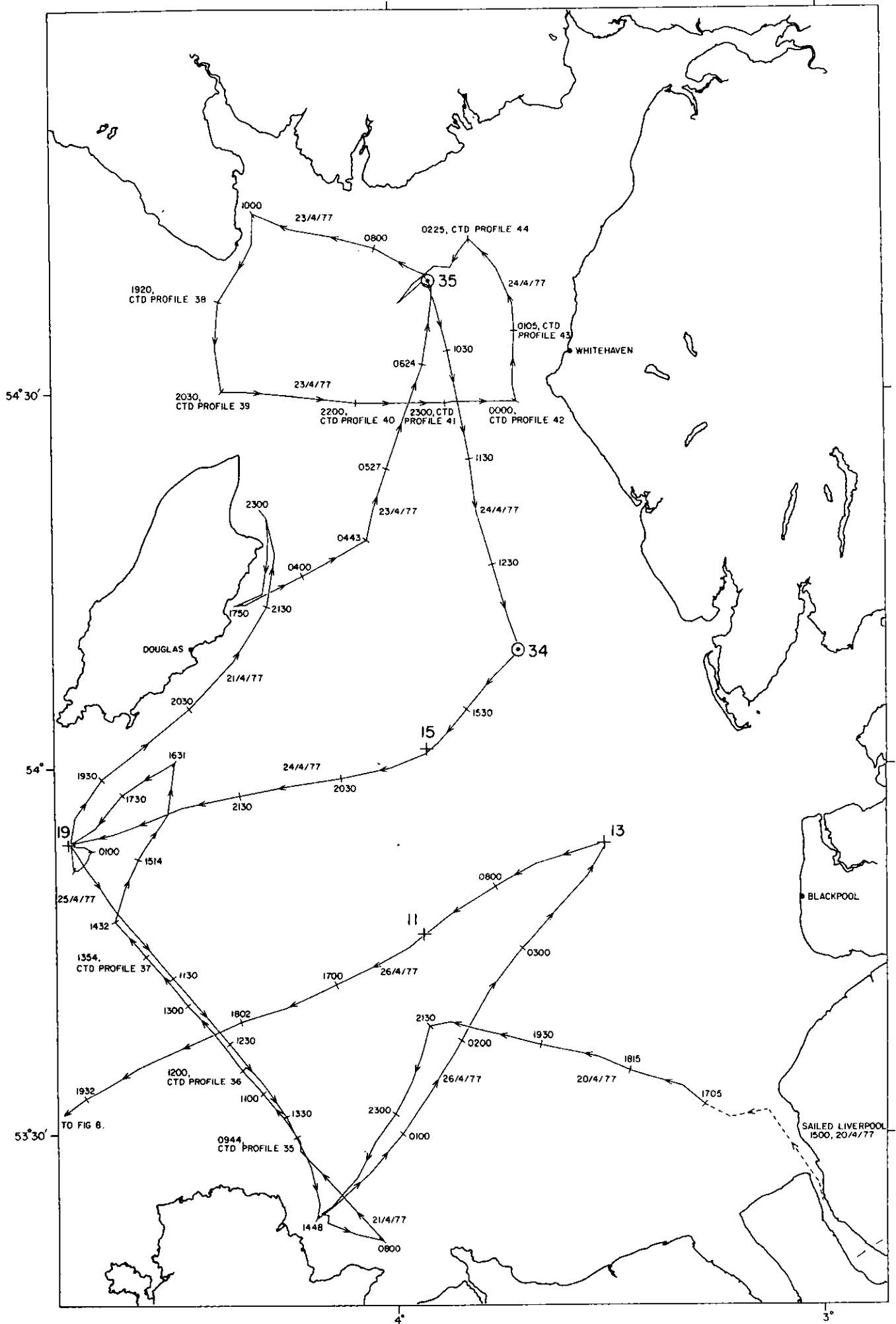


FIGURE 7. CRUISE TRACK, LEG 2, EASTERN IRISH SEA.

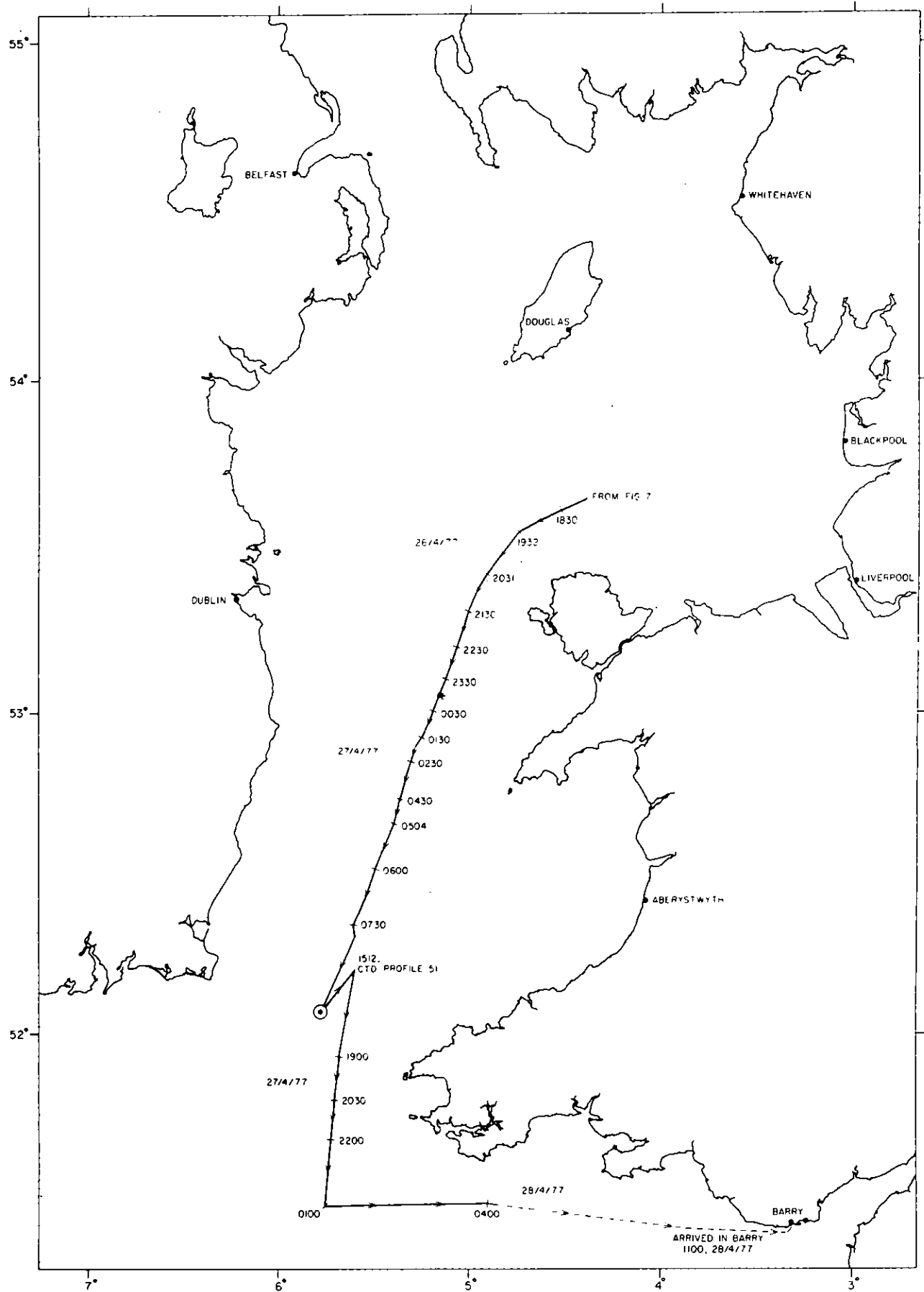


FIGURE 8. CRUISE CHART, LEG 2, ST. GEORGES CHANNEL.

CURRENT METER MOORING SYSTEM
INSTITUTE OF OCEANOGRAPHIC SCIENCES, BIDSTON

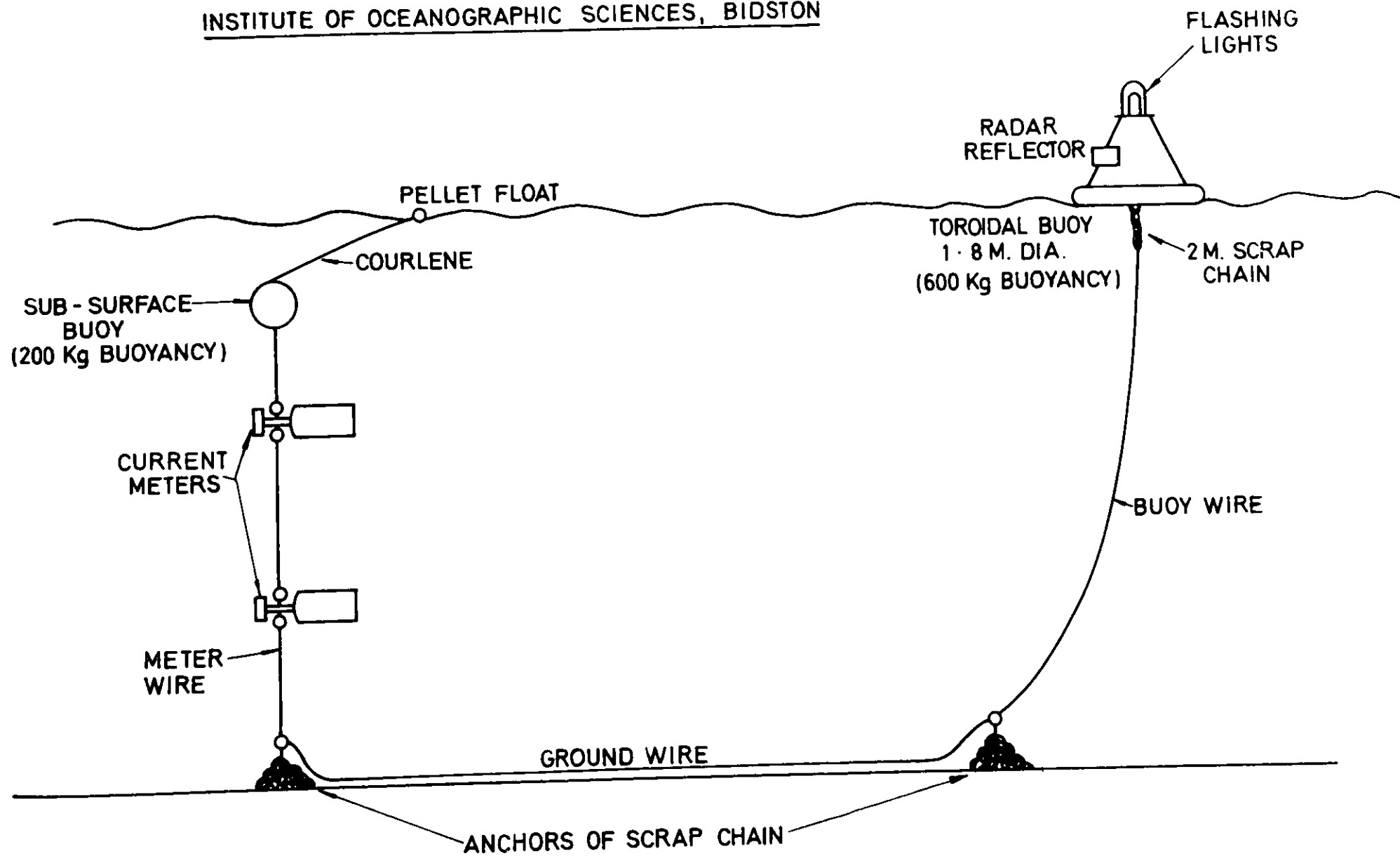


FIGURE 9.

OFF SHORE TIDE GAUGE MOORING SYSTEM

INSTITUTE OF OCEANOGRAPHIC SCIENCES BIDSTON

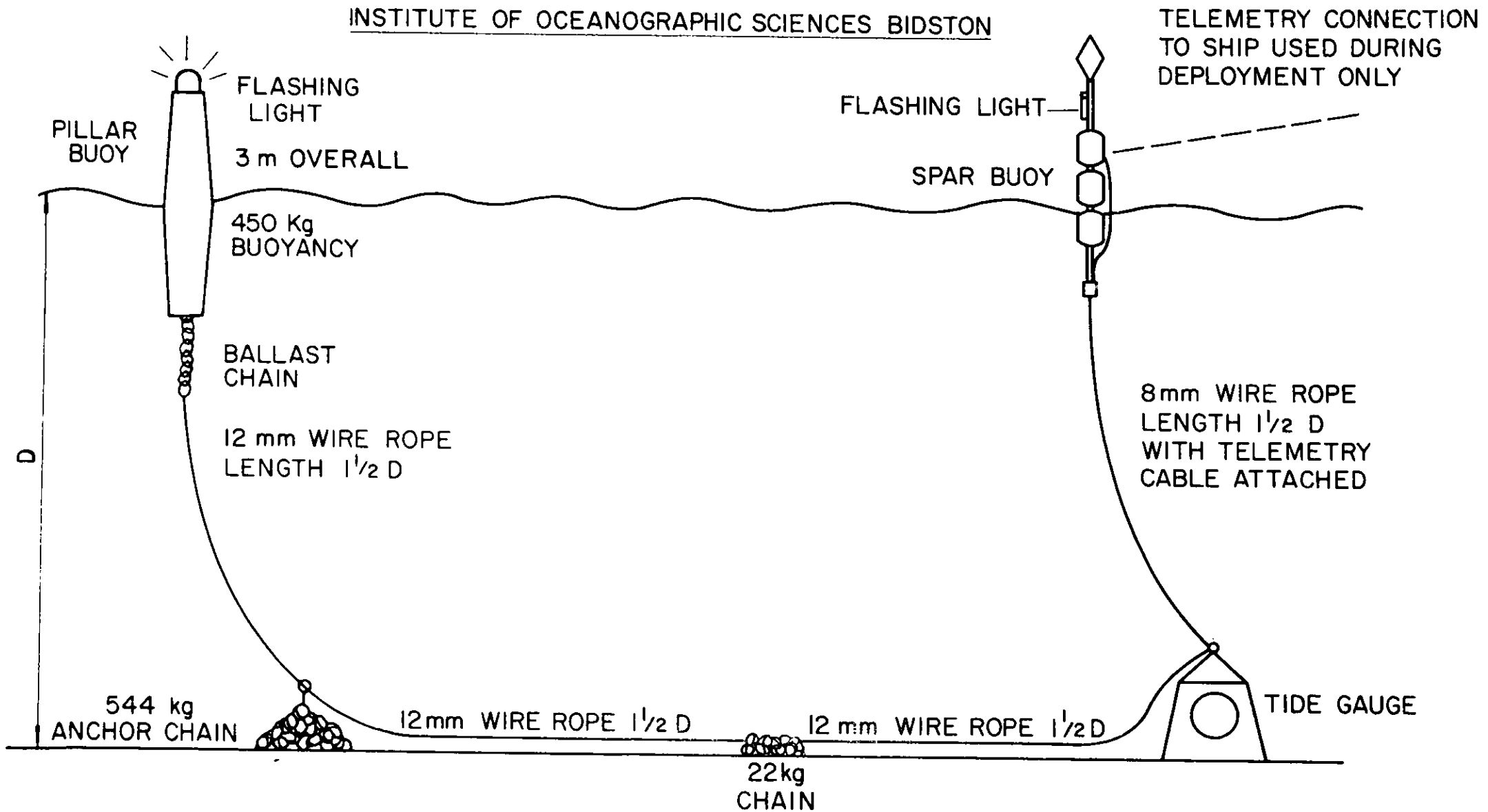


FIGURE 10.

BOTTOM MOUNTED CURRENT METER/TIDE GAUGE MOORING SYSTEM
INSTITUTE OF OCEANOGRAPHIC SCIENCES BIDSTON

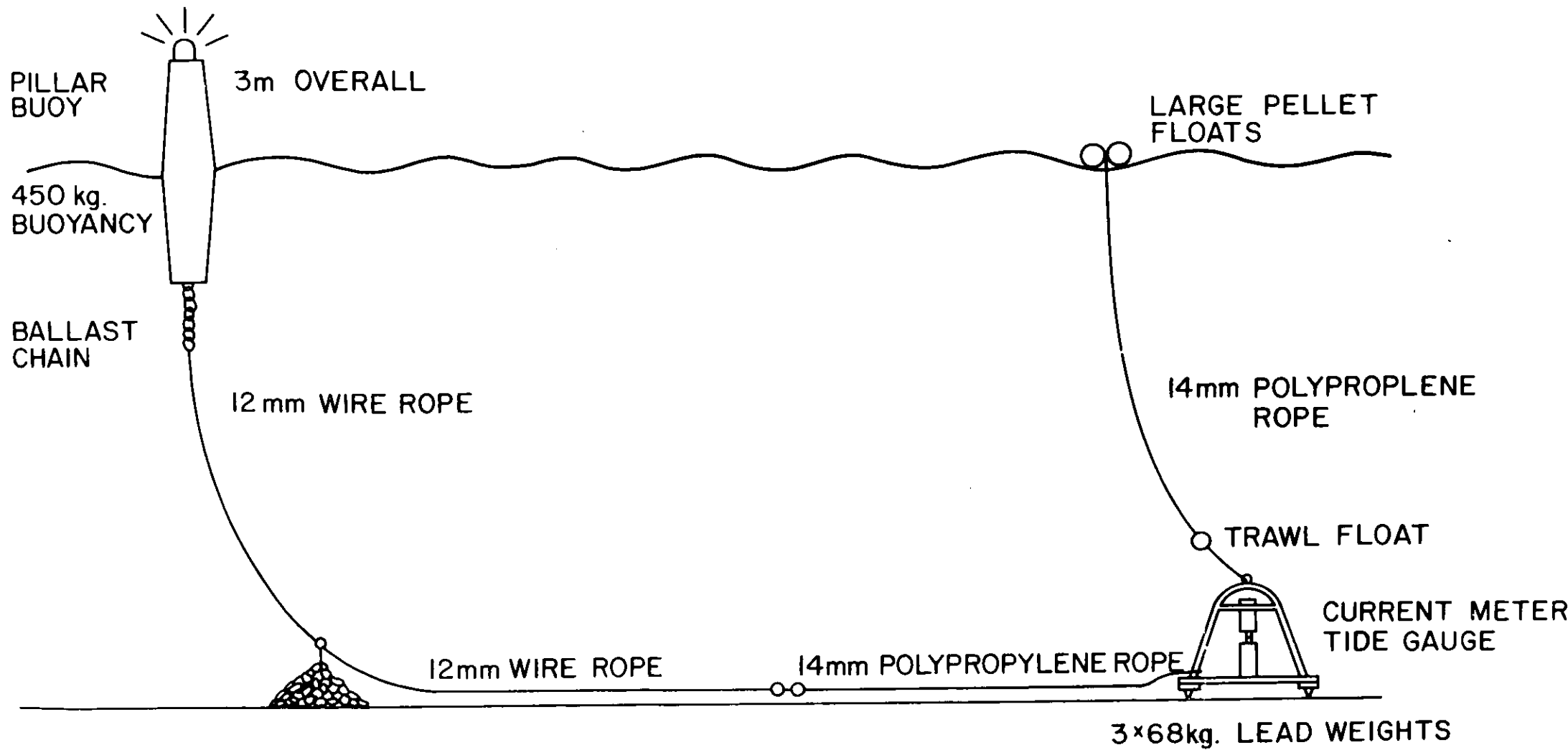


FIGURE II.