THE UNIVERSITY OF SOUTHAMPTON

DEPARTMENT OF OCEANOGRAPHY

RRS DISCOVERY

CRUISE 173
29 APRIL - 9 MAY 1988

R.R.S. DISCOVERY CRUISE 173

29 April - 9 May 1988

(Lisbon to Barry)

RECOVERY OF MOORINGS OFF THE WEST SLOPE OF THE PORCUPINE BANK AND OTHER WORK

A joint cruise between

THE DEPARTMENT OF OCEANOGRAPHY
SOUTHAMPTON UNIVERSITY

and the

INSTITUTE OF OCEANOGRAPHIC SCIENCES DEACON LABORATORY

R.R.S. DISCOVERY CRUISE 173

29 April - 9 May 1988

Principal Scientist - S.A. Thorpe (SUDO)

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R.R.S. DISCOVERY
CRUISE 173

29 April - 9 May 1988

Lisbon to Barry

Participants

Scientific Party

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J. Fall	Electrocraft Consultants
P. Hall	SUDO
A. Harris	IOSDL
N. Hooker	IOSDL
G. Knight	RVS
G. Lake	IOSDL
G. Phillips	IOSDL
K. Robertson	RVS
W. Smith	RVS
S. Thorpe	SUDO (Princ. Scientist)
M. Tsimplis	SUDO
J. Waddington	IOSDL

Ships Officers

P. Warne	Master
G. Harries	Chief Officer
R. Ellison	2nd Officer
M. Attwell	3rd Officer
S. Kirkwell	Radio Officer
I. Bennett	Chief Engineer
P. Byrne	2nd Engineer
B. Gillett	3rd Engineer
C. Phillips	3rd Engineer
B. Smith	Elect. Engineer
F. Williams	Bosun
M. Harrison	Bosun's Mate

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1. Cruise Objectives

1. To recover current meter moorings deployed from Discovery during Cruise 169 off the southwest slope of the Porcupine Bank.

2. To make CTD-Transmissometer stations to look for the presence of a nepheloid layer observed on Discovery Cruise 169.

3. To test the IOS MK IV Precision Echo Sounder.

4. To collect seawater for the Standard Seawater Service.

2. Acknowledgements

The Scientific Party wishes to thank the Master and Crew for their efficient and cheerful running of the ship and for their cooperation and help, without which it would have been impossible to achieve the scientific objectives.

3. Summary of work completed

5 current meter moorings were recovered from the array of 7 deployed in August 1987 SW of the Porcupine Bank (see Table 1).

11 full depth CTD/transmissometer casts were made, extending information about the extent of the deep intermediate nephloid layers SW of the Bank.

110 10 gallon bottles of seawater were filled near 46° 45′N, 15° W, for the Standard Seawater Service.

The IOS MK IV Precision Echo Sounder was tested.

4 current meter moorings on the edge of the Porcupine Sea Bight were interrogated acoustically.

Some 60 Samples of plankton were taken from the pumped non-toxic water supply for ketone analysis.

10 XBT's were shot.

4. Summary of Proceedings (All times GMT, 1988)

1500 29/4 (day 120)	Sailed Lisbon. Filming of departure by RVS personnel from a tug
0700-1014 2/5 (day 123)	105 10 gallon water containers filled for Standard Seawater Service
0929 3/5 (day 124)	Recovered mooring 449
1010-1323 3/5	Search made for mooring 447. No response from acoustic beacon
1724 3/5	Recovered mooring 446
1800-1932 3/5	Further search for mooring 447
1932-2227 3/5	Acoustic inspection of moorings 442, 446, 441 and 448
0018-0530 4/5 (day 125)	CTD stations 11719, 11720
0908 4/5	Recovered mooring 448
1112 4/5	Recovered mooring 441
1339 4/5	Recovered mooring 442
1346-1800 4/5	Attempts to release mooring 445 acoustically
1846 4/5 to 0333 5/5 (day 126)	CTD stations 11721 to 11723
1100 5/5 to 0130 6/5 (day 127)	Dragging for mooring 445
0728-0830 6/5	Further search for mooring 447
0918-1745 6/5	CTD stations 11724 to 11727
2339 6/5 - 0524 7/5 (day 128)	CTD stations 11728 and 11729
1450-1550 7/5	Lowering two 450m thermister chains to remove twists
1719 7/5	Acoustic interrogation of mooring 454 (mooring normal)
1812-1922 7/5	Acoustic transmission to mooring 455 (not found)
0002/0008 8/5 (day 129	Acoustic interrogation of mooring 453 (mooring normal)
0044/0202 8/5	Acoustic interrogation of mooring 452 (Release on its side)
1055 9/5 (day 130)	Docked Barry

5. Narrative

The cruise track, main station and mooring positions, are shown in Figures 1-4, and positions given in Tables 1 and 2.

Sailed Lisbon 1400 (all times GMT) 29 April. Some filming of the ship from a tug by RVS personnel completed 1540 in the month of the Tagus.

Severe weather, especially on 1 May, with wind averaging 30 knots, caused some reduction in progress towards the position of the first mooring to be recovered (449). One hundred and five ten gallon containers were filled with sea water via the ship's fire hydrant on 2nd May in passage between 46° 32.6′N, 15° 04′W and 46° 59′N 15° 01'W.

Mooring 449 was recovered with no difficulty early on 3rd May in good weather (force 4-5), but no acoustic response could be obtained from mooring 447. Mooring 446 was recovered, again with no difficulty. Moorings 442, 446, 441, 448 were interrogated in turn and responded well at ranges of 2-3 miles.

Two CTD/transmissometer stations were made during the night of 4-5 May. The northeasterly of the two showed the presence of a nephloid layer at the depth of the extensive deep intermediate nephloid layer surveyed in August 1987, but at a position some 7 km further from the slope. The second CTD station, some 7 km SW of the first, found no sign of the layer.

Moorings 448, 441 and 442 were recovered easily in good weather conditions on 4th May, but prolonged attempts to release 445 failed. (Similar problems had been found in August 1987. The command pinger could be locked on, but the release failed to fire.)

Preparations had already been made to drag for the mooring, and after three CTD stations overnight to investigate further the extent of the nephloid layer, the dragging gear was deployed in daylight on 5th May (see Figure 5 and Sections 6.2 and 7.4) during a period when GPS gave good position fixes. Two close passes of the mooring were made and in a third pass at about 0116 6th May it was noticed that no bottom echo was now visible from the command pinger on the mooring, suggesting it might be at the surface. At about the same time tension on the towing cable rose sharply, and signal from a pinger (Pinger B, Figure 5) attached to the end of the 2km drag line was lost. The drag line on recovery was found to be broken (a strain break) about 110m from the foot of the main warp (at A in Figure 5) with the loss of grapnels and pinger (see Section 7.5). On return to the mooring position it was found that the mooring was still in place, with a bottom echo visible showing that it was still upright and on the sea bed. Later examination of the Waverley recorder (see Section 9) showed that the top pinger had lifted off the bottom about 100m at the time at which high tension was reported.

A further unsuccessful acoustic search was made for mooring 447, and a CTD/transmissometer cast made.

Further dragging for either of the missing moorings appeared to be pointless. Only 1km of drag line was available and insufficient to provide reasonable chance of success. The use of the main warp as a drag line was considered ill advised for fear of tangling and possibly losing part of it, and the hope of recovering 447 with no acoustic beacon for reference seemed, in any case, slight. It was decided to abandon further attempts to recover the moorings, and instead to complete a

CTD/transmissometer survey along a section worked in August 1987, and to extend observations some 100 km along the Slope to the NW. This was done, continuing overnight on 4-5 May, and finding that the deep nephloid layer was present near the Slope both in the section surveyed previously and to the NW. At the NWly positions a strong intermediate nephloid layer is also present at 600-1000m depth as previously observed by Dickson and McCave.

Course was set for Barry passing the location of, and inspecting acoustically, 4 mooring laid by Dr Pingree. Of them only two (454 and 453) were satisfactory. One (455) could not be found and the fourth (452) appears to have lost its buoyancy. XBT's were made to obtain temperature data near the mooring positions (see Section 11 and Table 3). A brief stop was made to lower two twisted thermister chains so that they may easily be deployed in a later cruise (see Section 12).

Ship docked at Barry at 1055 9th May after an easy passage.

6. Moorings (I. Waddington)

6.1 Recovered moorings

Five mooring recoveries were carried out using the IOS Double Barrelled Capstan (DBC), reeler and forward 'A' frame.

On recovery all the mooring hardware was carefully inspected and was found to be in excellent condition.

The current meters recovered were 8 Aanderaa RCM modified with Inconel end caps and 5 EG & G VACM 610.

Of the 8 Aanderaas all appear to have run full data tapes, with one unit (7946; see Table 1) having a jammed encoder unit. Upon inspection and from the evidence of good battery voltage this fault most probably occured during recovery. Timing errors on all units were found to be within specification.

EG & G 610 units had all run and, from the time-word data and post deployment tests, appear to have performed correctly.

No tape decoding could be done for further analysis due to the failure of the old ACM tape decoder and unavailability of the SEA DATA systems decoder.

All the instruments were thoroughly checked onboard and routine maintenance carried out.

6.2 Dragline Mooring 445

The mooring 445 could not be released by acoustic command and a dragline recovery was attempted.

The dragline devised (see Figure 5) used a stepped wire design with increasing wire diameters as drag load increased. The maximum size drag wire was kept below the breaking load of the main warp, to prevent damage to the ship's coring warp.

The mooring anchor chain was 320kg and by calculation if this anchor was picked up by the dragline the minimum safety factor would be 4.97, well within safe working tolerance.

The draglines were tensioned onto the auxiliary winch barrels aft from wooden drums by hand. Prior to dragline deployment these wires were paid out with a 100kg weight on the end to tension the drag back onto the drums. This was to prevent damage due to wire loading of loose turns with the grapnel chain combination.

Deployment went without any problem changing from warp to warp using the brake-clutch configuration of the winch barrels. The auxiliary winch barrels used were the starboard and centre as from calculation it was not considered within specification to use the port cantilever drum for this operation. This limitation meant that only 2km of dragline could be wound onto the barrels along with the associated fittings.

The dragline was recovered upon completion of the dragging operation. It had broken in the 200m 6 x 19 wire upper end. This had been suspected after sudden build-up and subsequent fall in cable tension. The break was approximately 1m from the hand splice (at A, Figure 5) and exhibited typical overload break characteristics with the individual broken strands having the cup and cone form.

6.3 Missing Instruments

The following instruments were on the moorings which could not be recovered. (For positions see Table 1)

Mooring 445

Acoustic Release ref. 2397 VACM ref 0668 Aanderaa CM ref. 8009
Buoyancy: 6 x 17" glass spheres, 1 x 16" glass sphere

Mooring 447

Acoustic Release ref. 2105 VACM ref. 0673 Aanderaa CM;s ref. 5207, 3630 and 5206.
Buoyancy: 6 x 17" glass spheres, 2 x Bentos floats, 1 x 16" glass sphere

7. Mooring Acoustics (G.R.J. Phillips)

7.1 The recovered moorings

All 5 of the units successfully recovered were easily operated at ranges exceeding 3 nautical miles. Two units were released perfectly normally. The other three exhibited different symptoms attributable to differental ageing in key sections of the decoding circuitry. Two were trivial to overcome, the third required a small modification to the shipborne interrogation system. In all cases, once identified and compensated for, the units responded quickly and correctly.

7.2 Mooring 447 (D), which was not located

The command release used on this mooring was one of the oldest and most versatile owned by IOS. It was fully overhauled in the spring of 1987 and taken to sea on Challenger Cruise 15/87 where it performed totally successfully at -1°C on a ten day deployment in the Norwegian Sea

(IOS 431). It was then dispatched as a front line unit for Discovery CR 169. An extensive box was worked in the area of the mooring both with the standard and the modified shipborne interrogation systems on 3rd May.There have been very few losses of this type in the history of IOS mooring work. Several of those have been positively identified as due to mechanical failure of mooring components below the acoustic unit.

7.3 <u>The incooperative mooring 445 (G)</u>

This is the first failure of its type. The acoustic command unit has an excellent operating bandwidth on both location and release channels and the greatest sensitivity of the 6 units used on this cruise (3.5 nautical miles being regularly achieved). The unit has been used successfully on many moorings in the past and was successfully wiretested prior to deployment. Failure can be pinpointed to a small area of the relay operating circuit. The unit was transmitted to for many hours both on Discovery Cruise 169 and on this, covering all the known techniques for recovering remotely from plausible failure scenarios.

7.4 <u>Dragging for mooring 445</u> (A sketch of the drag line is given in Figure 5)

Dragging for equipment lost in deep water is beset with many major problems and hence not often attempted. We were fortunate on this cruise that three of the most common were not as severe as normal. The weather was good and did not hamper ship manoeuvres in any way. There was plenty of time available; 16 hours is the minimum required for a first effort and we had up to 48 hours available. Real time ship navigation (GPS) of an accuracy required by the scales of operation was available for a reasonable proportion of the dragging attempt. These three factors enabled us to make a sensible attempt at ensnaring the mooring. The use of precision beacons to monitor each end of the drag line was invaluable. These allowed us to make realistic estimates of where the ship's manoeuvres had left the line as changes in ships heading were made. There were two remaining problems that combined to frustrate our efforts. The gross uncertainty in towing warp catenary affected our ability to accurately position the front of the drag line. The relatively short length of the drag line (2 km) would have made it difficult to operate even with better knowledge of the catenary. The limited drag length was determined by the inability of the ships auxiliary wenches to handle greater length and associated loads. Improved knowledge of the catenary might be achieved by an analytical study and by real time monitoring using one or more of existing IOS monitoring techniques.

7.5 <u>Lost drag line beacon</u> (Pinger B in Figure 5)

IOS dragging beacon number 3 comprised: Standard IOS 10KHz Acoustic beacon as described in IOS design 5243 except:

1. power output increased to 60 watts; and

2. angle bar and wire clamp assembly replaced by Stainless Steel command beacon bar assembly as described in IOS 5156.

8. Operation of IOS deep C.T.D., Transmissometer and Digidata logging system (N. Hooker)

The instruments used were the same as on cruise Discovery 169 and described in the report of that cruise, so all measurements between the two cruises are compatible.

During the cruise 11 C.T.D. stations were occupied, numbers 11719 to 11729, with water depths between 2450m and 4130m.

One C.T.D. cast was performed at each station, to near full water depth, guided by a 10KHz pinger on the instrument frame.

Each of the eleven C.T.D. casts were successfully completed, providing - Pressure, Temperature, Conductivity and Transmittance data.

All data was transferred in real-time to the shipboard computer for logging and backed up by the Digidata logging system.

9. Precision echo sounder MK 4 (A.J.K. Harris and J.P. Fall)

The PES MK 4 system consists of Precision echo sounder, remotely controlled beam steering, Acoustic command/release and a video waterfall display.

The main purpose for operating PES MK 4 on this cruise was to test the new video waterfall display.

The PES MK 4 system was operated continuously for a period of 8 out of the 9 days at sea, providing echo sounding, C.T.D. monitoring and transponder location on a Waverley paper recorder.

The video waterfall display provided high resolution bathymetric and transponder monitoring information in real time. Depth measurement was accurate to 1m in 5000m on a 2 second sweep using the mouse driven cursor.

The software for the video waterfall display is menu driven, and at present runs on an IBM AT computer. Twin mouse driven cursors are menu selectable for time measurement between two traces, as with the depth this will be a 4 figure number in the top data line. Currently time resolution is 1 part in 750 irrespective of phase. The resolution will be improved by fitting the 1024 pixel graphics card.

The Beam Steering unit was used to steer whilst locating moorings, steering on the quarters was not as effective as port/st'bd, fore/aft. The acoustic command/release module (which now controls the PES MK 4 trigger) although transmitting FM had a problem with the modulator - thus it was not possible to turn on acoustic beacons or release moorings from the PES MK 4 on this cruise.

Other achievements on this cruise were: (i) To test the new PES MK 4 TVG and dating circuits successfully. (ii) Compare the new Acoustic Command and Release receiver with both the PES MK 3 and 4 receivers, demonstrating again the low noise advantages of a differential design. (iii) To record analogue bathymetric data on a RACAL STORE 4 - this will provide invaluable raw signal data replay for further development of the video waterfall display software.

10. Water Sampling (Isabelle Dias Organic Geochemistry Unit, University of Bristol, Supervisors: Prof G. Eglinton, OGU, Bristol and Dr P.M. Holligan, MBA Plymouth)

10.1 Introduction

The main aim of this cruise was to test and refine a working hypothesis that some species of phytoplankton biosynthesise certain biolipids which can be used as biological marker compounds. Previous studies in Bristol have shown that changes occur in the extent of unsaturation of a particular series of very long chain ketones with temperature. The ketones in question are the C37 - C39 di-, tri-, and tetra - unsaturated forms , at present found only in the ubiquitous species Emiliania huxleyi. The extent of unsaturation of these ketones is dependent on the ambient temperature at which these organisms live. The compounds are not degrated as they pass through the water column and the food chain, and are perfectly preserved in bottom sediments. They can therefore be used as biological marker compounds and as indicators of palaeoclimate, giving us information about seawater temperatures from 100,000 years ago to the present day. The data from this cruise will be used to extend a project which already has phytoplankton and sediment samples from the North Sea, the Rockall Trough and the Equatorial Atlantic.

10.2 Sampling Strategy

A total of some 60 samples were collected, as follows:

1. 50L water samples were collected from a pumped non-toxic water supply, and filtered through Millipore filtration apparatus. The filters were stored in organic solvent at -18 centigrade until detailed lipid investigation using GC, HPLC and GCMS could be carried out at Bristol.

2. 10L water samples were filtered and stored in petri-slides at -18 centigrade. These samples will be analysed for total pigments upon return to Bristol.

3. Phytoplankton were collected and stored in Lugol's iodine and/or neutralised formalin solution, so that the species identification could be carried out. (Perhaps proving that species other than E. huxleyi can synthesise long chain ketones).

4. Overnight collection of zooplankton using 64 micron nets. These samples were collected mainly at dawn and dusk when the zooplankton are known to rise to the surface waters to feed. The animals were kept alive in aquaria for 12 hours, during which time their faecal pellets were collected for lipid analysis. These samples were collected to show changes in lipid abundance and distribution at the first stages in the food chain.

5. Phytoplankton and particulate samples were collected using a 5 micron plankton net on a daily basis. These samples were preserved in formalin and are to be sent to Dr D. Harbour at MBA for his own research project.

6. Routine recording of water temperature data was also carried out.

11. XBT sections (I. Waddington)

Two sections of XBTs were completed between mooring positions 452 to 453 and 454 to 455 deployed by Challenger 18/87 (see Table 3). The Bathy systems logger and T7 and T4 probes used. Drops were arranged to coincide with bathymetry determined from the PES Mark IV.

Logging onto magnetic tape cassette with expanded plots and isotherms was completed with no probe failures. The data is to be further analysed by PML.

12. Thermistor Chain tensioning (I. Waddington)

Two 450m long thermistor chains were successfully retensioned on the forward DBC to remove twisting induced on mooring 451 (Challenger 18/87).

This was achieved by carefully winding on the thermistor chains through the DBC onto the reeler under hand tension. It is worth noting that the 'shiny' surface plastic cable tends to ride to the inboard end of the winch barrels under low load. The chains were paid outboard with a swivelled 50kg steel weight attached.

The chains were observed to untwist on pay out and with a tap attached swivel almost all cable twist was removed. The thermistor chains were then rereeled for further testing at IOSDL.

13. General Mechanical Scientific and Deck Equipment (G. Lake)

Four winches were operated during this cruise,

1. The double barrel capstans (DBC) and A frame for mooring retrieval.

2. The midships winch for CTD work

3, 4. The traction and auxiliary winches aft for dragging.

All these systems were run successfully after the Fwd ring main hydraulic oil level switch which had which had a fault, was overridden.

A non-toxic sea water supply was maintained for the duration of the cruise. The hydraulic oil cooler was replaced on the forward crane and tested. Finally all gear was freed and greased to ensure continued operation.

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Mooring No.	Position Lat.deg.N	Long.deg.W	Water Depth (m)	Mooring Laid Day 1987	Mooring Recovered Day 1988	Comments/Instruments and Number
441 "A"	50°30.78'	14°38.26'	3347	226 (14 Aug)	125 (4 May)	V0666 A4738
442 "C"	50°25.25'	14°44.72'	3697	226 (14 Aug)	125 (4 May)	A2109 V0130 A2107
445 "D"	50°27.92'	14°41.89'	3565	239 (27 Aug)	-	Mooring not recovered. Command pinger activated and locked on but no release 1346-1800, day 125 Dragging, with command locked on, made 1117/126 to 0120/127, unsuccessfully
446 "E"	50°20.15'	14°53.10'	3964	239 (27 Aug)	124 (3 May)	A7948 V0627 A7946 Encoder jammed, probably on recovery
447 "G"	50°14.42'	15°00.71'	4127	239 (27 Aug)	-	Mooring not found. Searches made 1010 to 1323 and 1800-1932, day 124, and 0728-0930, day 127
448 "B"	50°25.48'	14°35.60'	3552	240 (28 Aug)	125 (4 May)	V0629 A8010
449 "F"	50°13.35'	14°50.23	4026	240 (28 Aug)	124 (3 May)	A5205 V0430 A5204

Table 1: Moorings V = Vector Averaging Current Meter
A = Aanderaa Current Meter

All instruments appear to have wound on their tapes normally.

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Stn. No	Day 1988	Time (GMT) Start	End	Position Lat deg. N	Long deg W	Water Depth (m) at start	End Dist. off bottom (m)	Sounding at closest approach (m)	Transect Line Section Number
11719	125	0018	0226	50°19.6'	14°41.6'	3760	0	3805	T6
11720	125	0327	0530	50°18.7'	14°47.3'	3937	25	3949	T7
11721	125	1842	2030	50°26.6'	14°36.1'	3510	17	3505	T4
11722	125	2122	2309	50°23.9'	14°38.9'	3590	12	3600	T5
11723	126	0127	0333	50°12.0'	14°54.2'	4100	30	4099	T9
11724	127	0918	1117	50°09.8'	14°58.0'	4150	25	4151	T10
11725	127	1213	1418	50°15.9'	14°49.9'	4010	27	4014	T8
11726	127	1612	1745	50°26.9'	14°35.6'	3485	17	3487	T4
11727	127	1846	2000	50°30.4'	14°30.7'	2454	12	2452	T3
11728	127-8	2339/127	0114/128	50°54.6'	14°58.9'	3138	35	3081	-
11729	128	0353	0526	51°18.3'	15°15.4'	3245	13	3240	-

Table 2: CTD Stations.

Positions determined from Satnav fixes except for station 11726 for which GPS was used.

Discovery Cruise

No.	Day	Time	Position Lat N	Long W	Comments XBT type
1	128	1253	49°24.5'	14°34.3'	Test, T-4
2	128	1722	51°40.6'	12°03.1'	T-7
3	128	1740	51°42.1'	11°56.9'	T-7
4	128	1808	51°44.1'	11°48.7'	T-7
5	128	1833	51°46.5'	11°43.1'	T-4
6	129	0008	50°48.0'	11°24.8	T-7
7	129	0016	50°47.1'	11°23.4'	T-7
8	129	0034	50°48.0	11°21.6	T-7
9	129	0043	50°48.5	11°20.5	T-4
10	129	0058	50°49.0'	11°19.0'	T-4

Table 3: XBT's positions (Waddington)

Figure 1: The cruise track, Lisbon to Barry. Positions shown are at midnight of respective days (day number shown)

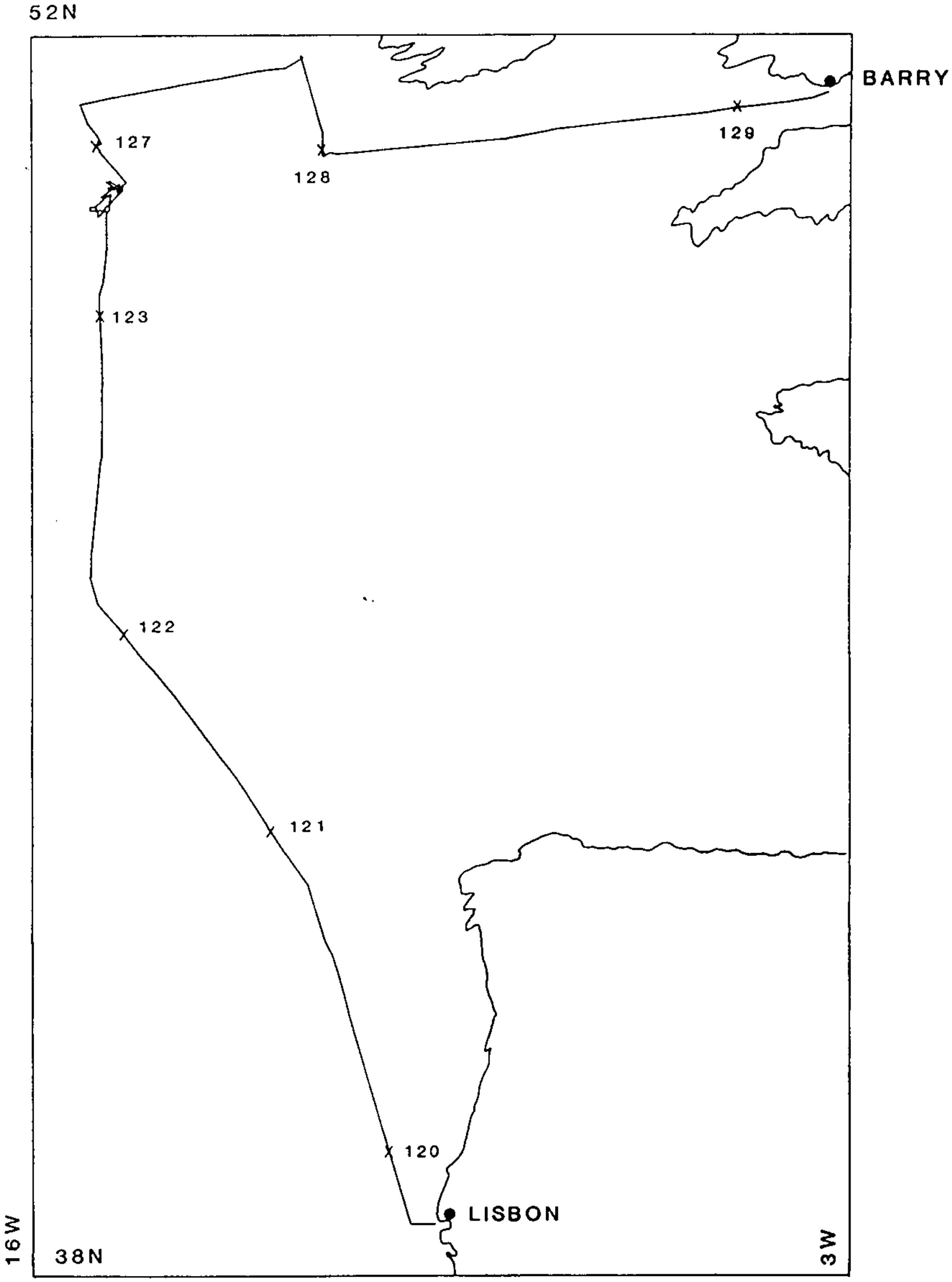

FIGURE 1. CRUISE TRACK, DISCOVERY CRUISE 173

Figure 2: Day by day track plots, from best Satnav and GPS, showing CDT tranmissometer stations (by station number) and mooring recoveries (by mooring number). Positions mrked every 10 minutes and labelled every hour.

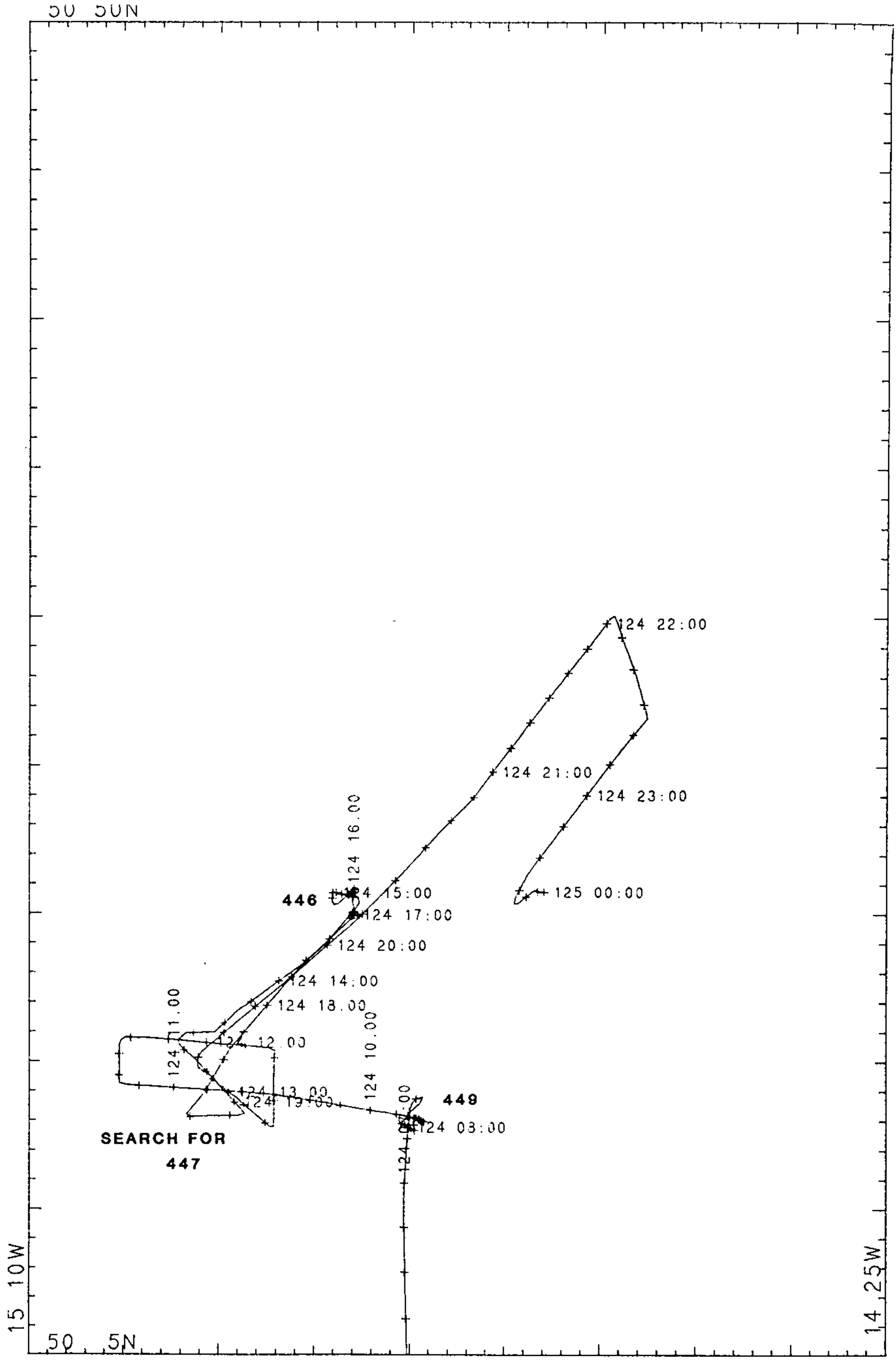

FIG. 2a DAY 124 (3rd MAY '88)

MERCATOR PROJECTION

SCALE 1 TO 500000 (NATURAL SCALE AT LAT. 0)

INTERNATIONAL SPHEROID PROJECTED AT LATITUDE 41

GRID NO. 1
TRACK NO. 1

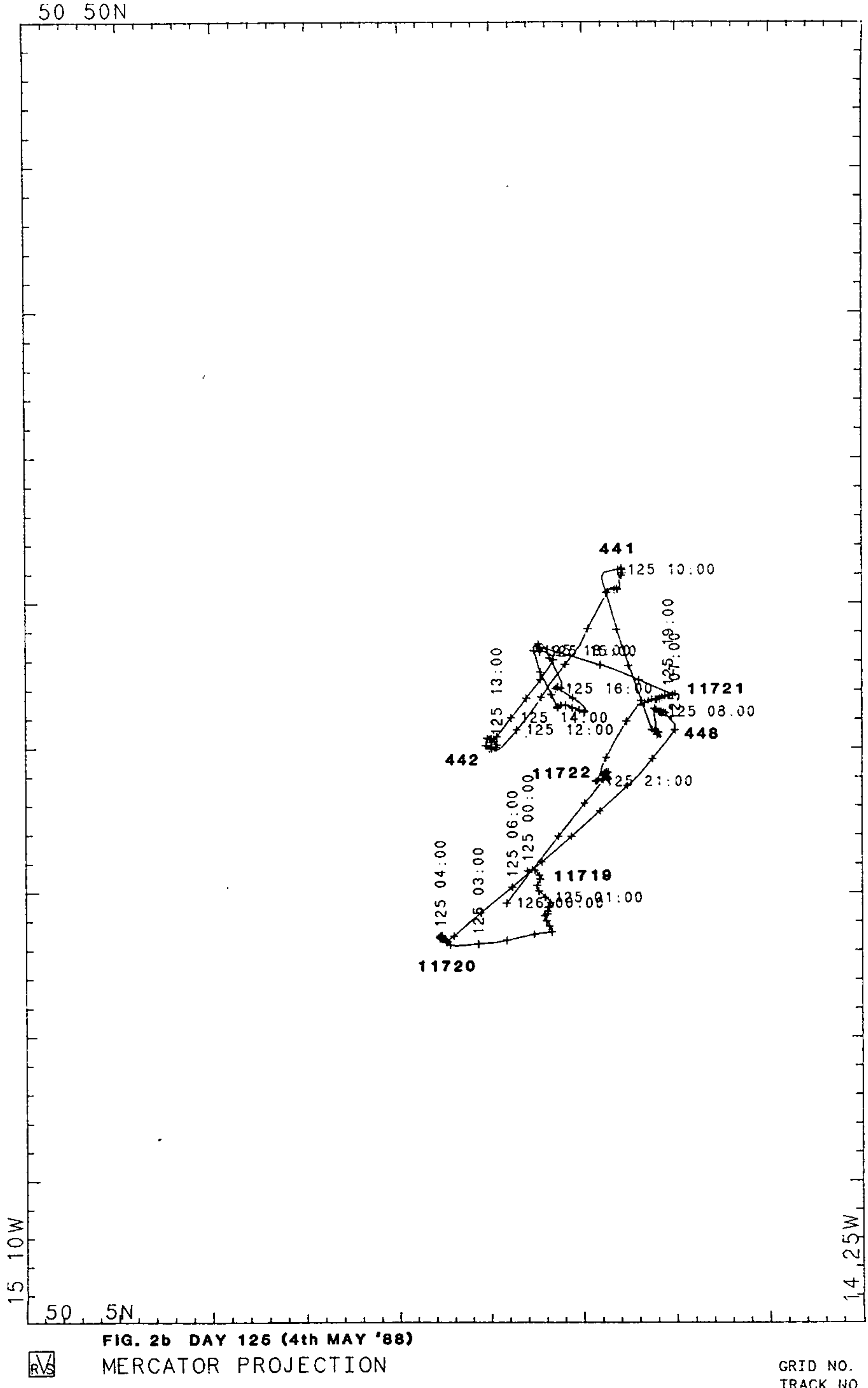

FIG. 2b DAY 125 (4th MAY '88)

MERCATOR PROJECTION

SCALE 1 TO 500000 (NATURAL SCALE AT LAT. 0)

INTERNATIONAL SPHEROID PROJECTED AT LATITUDE 41

GRID NO. 1
TRACK NO. 1

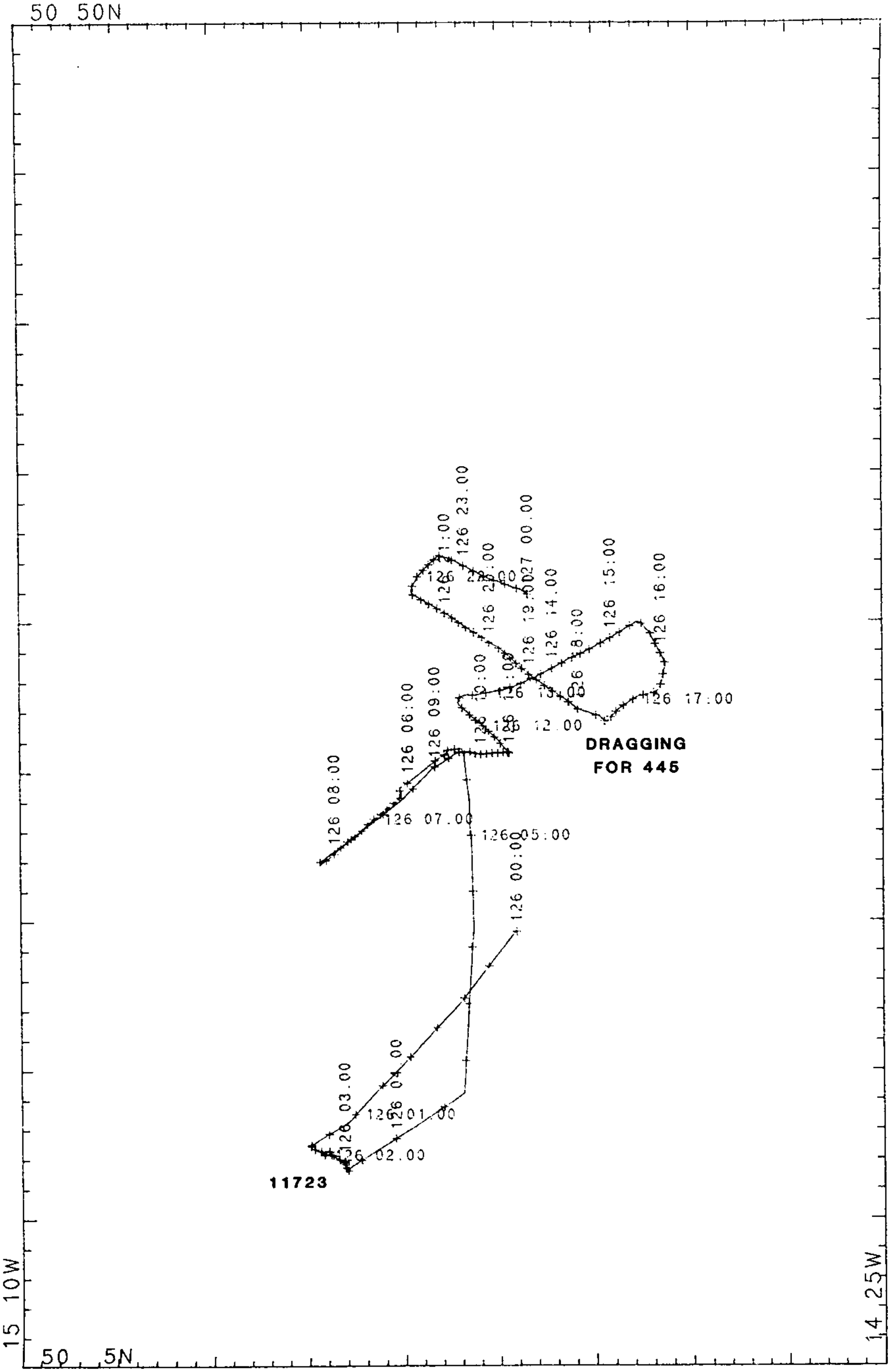

FIG. 2c DAY 126 (5th MAY '88)

MERCATOR PROJECTION

SCALE 1 TO 500000 (NATURAL SCALE AT LAT. 0)

INTERNATIONAL SPHEROID PROJECTED AT LATITUDE 41

GRID NO. 1
TRACK NO. 1

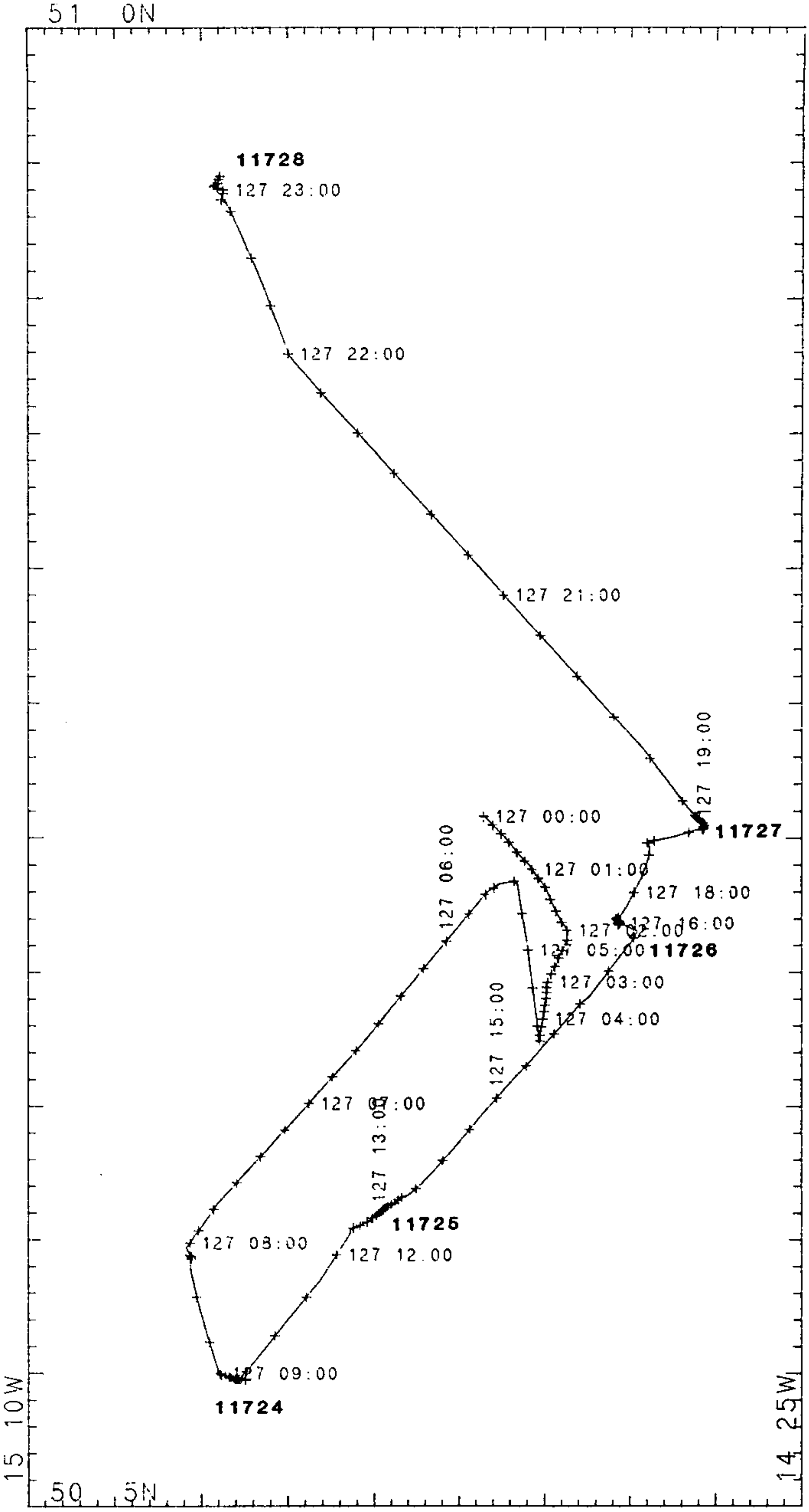

FIG. 2d DAY 127 (6th MAY '88)

RVS MERCATOR PROJECTION

SCALE 1 TO 650000 (NATURAL SCALE AT LAT. 0)

INTERNATIONAL SPHEROID PROJECTED AT LATITUDE 41

GRID NO.
TRACK NO.

Figure 3: Mooring positions

Circle: Recovered
Cross: Not recovered

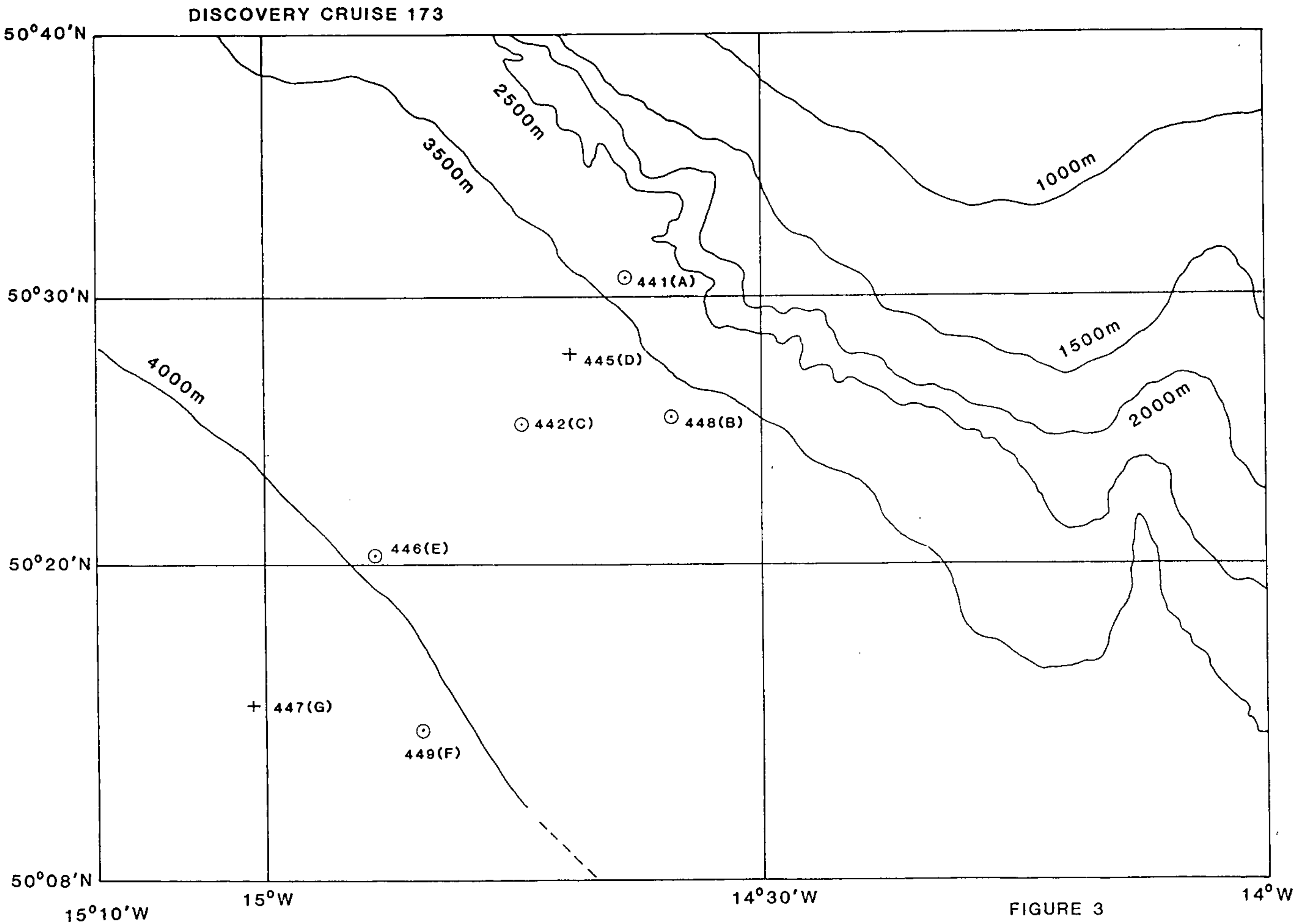
DISCOVERY CRUISE 173
50°40'N
50°30'N
50°20'N
50°08'N
15°10'W
15°W
14°30'W
14°W
1000m
1500m
2000m
2500m
3500m
4000m
441(A)
445(D)
442(C)
448(B)
446(E)
447(G)
449(F)

FIGURE 3

Figure 4: Positions of CTD/ transmissometer stations near the moorings. Add 11700 to numbers to obtain station number. Two further station were made to the NW - see Figure 2.

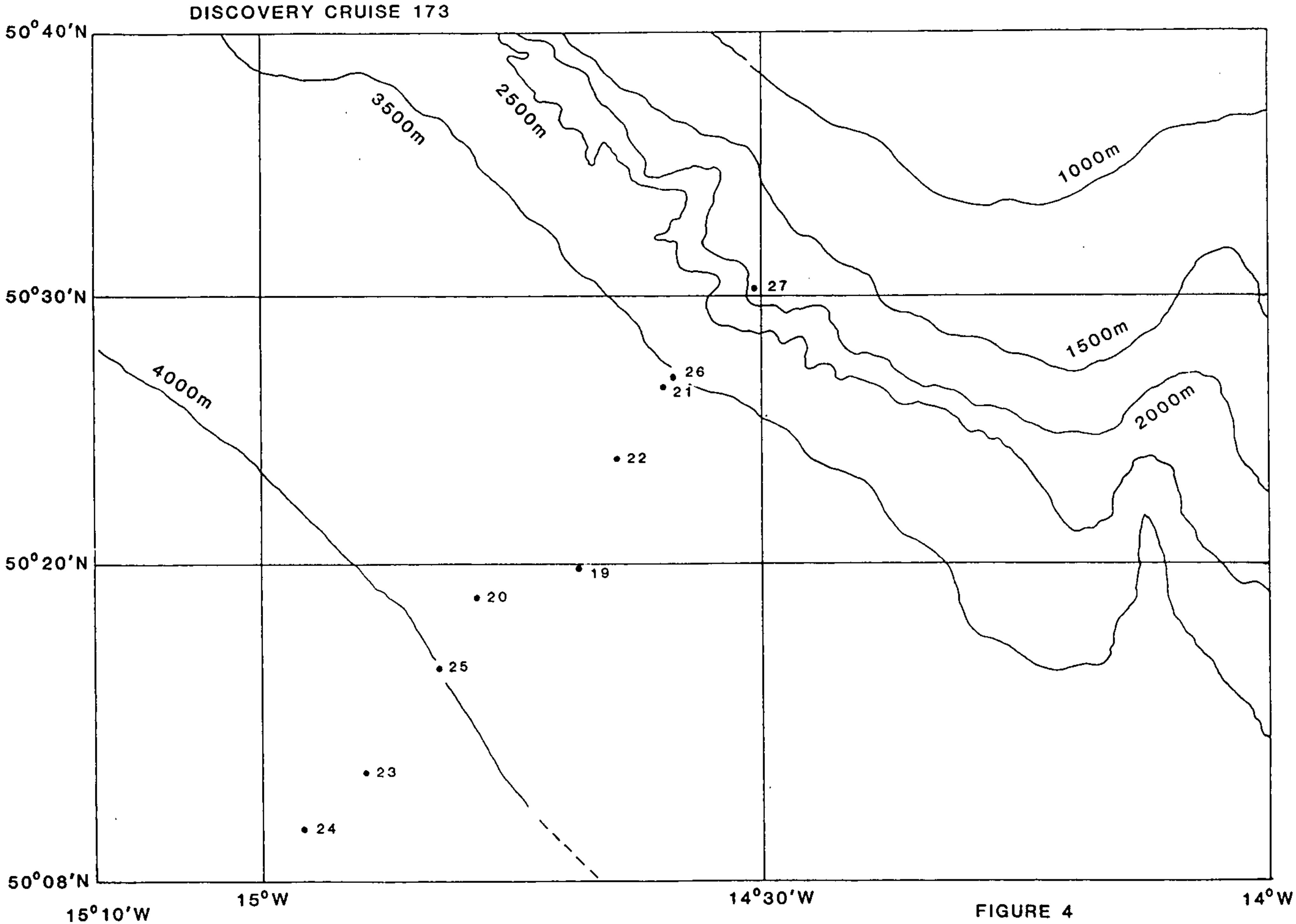
DISCOVERY CRUISE 173
50°40'N
50°30'N
50°20'N
50°08'N
15°10'W
15°W
14°30'W
14°W
3500m
2500m
1000m
1500m
2000m
4000m
27
26
21
22
19
20
25
23
24

FIGURE 4

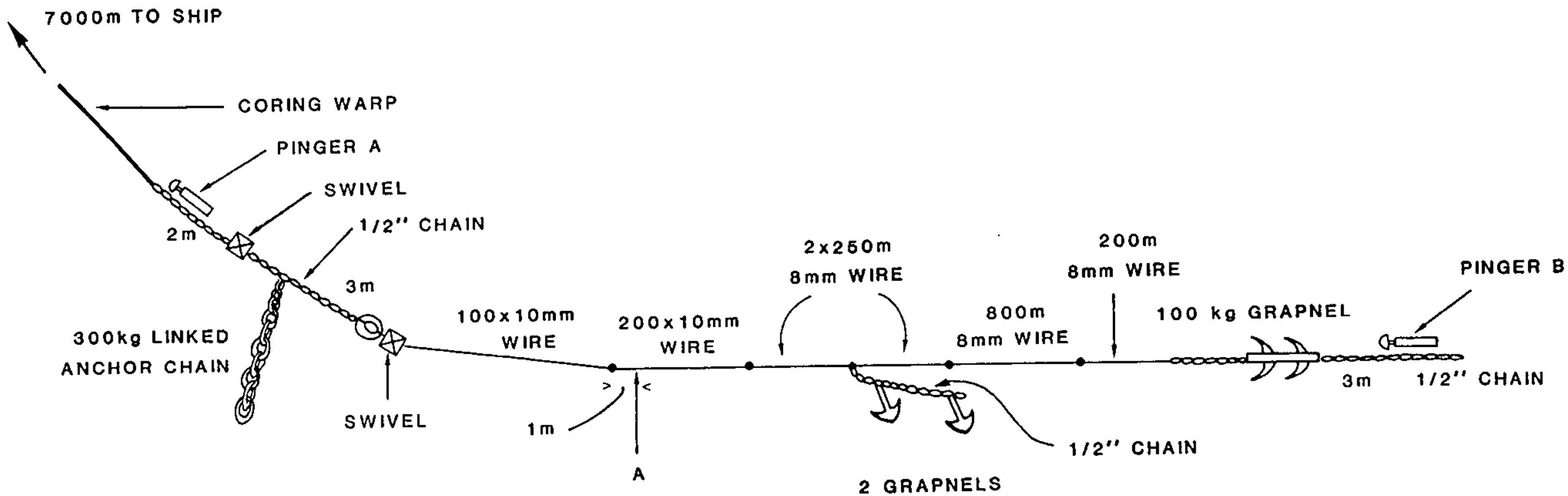

FIGURE 5. THE DRAG LINE