NATIONAL INSTITUTE OF OCEANOGRAPHY
Wormley, Godalming, Surrey.

R.R.S. DISCOVERY
Cruise 38
22 January - 7 April 1971

Moored Current Meters and Hydrographic Sections on the Continental Slope and Physical Oceanographic Work in the Mediterranean Outflow.

N.I.O. Cruise Report No. 41
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CONTENTS

AIMS

For the first six weeks of the cruise the primary aim was to study the fluctuating currents on the continental slope off the western end of the English Channel, by setting out an array of moored current meters and by making TSD sections to define the hydrographic conditions in the area. This latter work was greatly enhanced by use of the computer for logging the TSD output and providing rapid plots of the vertical distribution of temperature, salinity and density. A related aim was to test the new hydrographic winch.

Three weeks were then devoted to measuring currents and collecting intensive series of temperature and salinity observations in the Mediterranean outflow in the Gulf of Cadiz. On the return passage, the mooring site on the continental slope was again visited, and three moorings were left out intended for recovery on a later cruise.

NARRATIVE *

Left Barry	1130 Z/22	Jan.
arr. continental slope area	1800/24	"
left " " "	0700/14	Feb.
arr. Plymouth	0730/15	"
left "	0900/18	"
arr. continental slope area	0800/19	"
left " " "	1730/5	Mar.
call at Cascais	1000-1200/8	"
arr. Med. outflow area	0400/9	"
arr. Gibraltar	0700/13	"
left "	1300/16	"
left Med. outflow area	1430/29	"
call at Cascais	0900-1045/30	"
arr. continental slope area	0720/2	Apr.
left " " "	1930/5	"
arr. Barry	0600/7	"

The cruise had been intended to start on 21 Jan., but sailing was delayed to allow the new gyro to be tested overnight before leaving. Arriving in the neighbourhood of mooring 070, left out from cruise 37 (Dec. '70), in heavy weather in the evening of 24 Jan, it seemed inadvisable to attempt recovery or even interrogation, and 40-50 knot winds continued till p.m. 25th. It then became necessary to land the Chief Engineer with broken ribs at Falmouth. On returning to the working area early on 28th Jan. in better weather the first task was to test acoustic releases needed for moorings. These did not work (gain too low) and had to be modified. The TSD and its interface to the computer were tested, and the long-term mooring 070 was interrogated successfully.

Further acoustic tests during 29 Jan. were more successful, and a mooring (071) with six current meters was laid in 4156m depth on 30 Jan. The original plan had been to lay an array of 7 moorings, but in view of the difficulties with the acoustic equipment this was reduced to 4, one of which was to be a long-term mooring. A TSD section up the slope through the position of mooring 071 was begun on 31 Jan. but had to be abandoned in worsening weather, and an echo-sounding survey was resumed.

* The exact positions of stations mentioned in the narrative are given in the station list.

Mooring 072 was laid on 1st Feb. in shallow water at the top of the continental slope, and the long-term mooring 070 was recovered. Further acoustic units were tested, and the TSD section through mooring positions 071-072 was resumed, but had to be broken off early on 2nd Feb. to land a sick Chief Steward at Falmouth.

Returning to the working area a.m. 4th Feb., mooring 073 was laid in ca. 1000m depth using part of the 8mm wire recovered from mooring 070. A TSD section was worked through the positions of moorings 071 and 072, and a new mooring, 074, was laid in 2000m depth near where 070 had been. This completed the pattern of 4 moorings in the reduced array. Another TSD section was occupied, the moorings were interrogated successfully, and on 7th Feb. a sequence of 2-hourly dips was started near mooring 074. These continued until mid-day 9th Feb. On starting a TSD section then through 074 position towards 073, it was noticed that 074's release and command pinger were both switched on. Not being sure whether they had turned on spontaneously, a quick check was made to ensure that the other moorings were undisturbed, and it was decided to leave mooring 074 down. TSD sections were resumed, up and down the slope through the mooring positions, with sounding runs between sections. Water bottle casts were made at the deeper stations to supplement the TSD dips, which did not go deeper than 2000m. Before leaving the working area for Plymouth on 14th Feb., three TSD dips were made in a canyon in the continental slope between moorings 072 and 073.

Returning to the mooring area on 19 Feb, the four moorings were interrogated successfully, and TSD sections resumed. Trawlers had been previously noticed working on the shelf near mooring 072 and this became worse so that on 22 Feb. it seemed best to recover that mooring, though it had only been in place for 3 weeks. The next TSD section, past mooring 071, was continued down into deeper water, 4800m, and a new length of 4mm wire was wound on the new winch (repaired in Plymouth) and paid out and tightened. A 10-litre sample of deep water was collected for mercury analysis and more soundings were taken in the neighbourhood of the deepest mooring, 071.

No response was obtained from the command pinger of mooring 074 on attempting to interrogate it on 25 Feb., and instead of starting another TSD section next day it was decided to attempt recovery of that mooring. The release fired normally and the only unusual incident was finding the uppermost of the six current meters fouled by a piece of old fishing net. With good weather and a poor forecast, the opportunity was taken to recover the other deep mooring, 071, with six current meters on it, and on 27 Feb. a new mooring, 075, was laid in 2000m depth in place of 074 but with only two current meters in it, to be left out with mooring 073, until the end of the cruise. Six sections of combined TSD and water bottle casts were then worked, from top to bottom of the continental slope in the mooring area and NW and SE of it. These were completed a.m. 5th March and after interrogating the two remaining moorings course was set towards Lisbon.

With better weather than had been forecast, a fast passage was made across the Bay of Biscay and there was time in hand for three TSD stations in Nazaré Canyon before going in to Cascais a.m. 8th March. Dr. S. Thorpe, Mr. D. Gaunt and Mr. A. Fiüza joined, and passage was resumed southwards towards the Mediterranean outflow area SE of Cape St. Vincent.

The main objective of this part of the cruise was to obtain information about the velocity structure of the Mediterranean Outflow and to supplement the TSD series made during Discovery Cruise 31 in March 1970. This series of TSD profiles had been made at 36° 12'N, 8° 02'W (position I, depth about 1520m) where the salinity maximum is off the bottom.

Two moorings (076, 077) with subsurface buoyancy and each carrying 5 Bergen current meters were laid close to position I on 9th March. The positions of the two moorings were carefully fixed relative to a surface dan buoy which was recovered after good satellite fixes had been made on it. A series of nine TSD profiles from the surface to the bottom was then made along 08° 02'W from 36° 00'N to 36° 52'N to give an overall picture of the nature of the outflow in the area. Five further stations on a bearing 139°T from 36° 52'N, 08° 02'W were made before strong winds on the evening of 10th March prevented further TSD work. The interruption continued until early on 12th when mooring 078, with a single current meter 11m off the bottom, was laid at the request of Mr. Stride at 35° 56'N, 07° 02'W in an area in which the structure of the sea floor suggests that there may be strong currents. A force 8 gale was blowing at the time, but this soon moderated, and soon after midday it was again possible to use the TSD and four more profiles were made along the 139°T section continuing it S.E. as far as 35° 24'N, 06° 30'W.

The ship put in to Gibraltar on the morning of 13th and sailed at 1300 on 16th. One TSD profile (station 7630) was made to check the computer operation and to familiarise the newcomers to the system of data collection.

On arrival near mooring 078 in the early morning of 17th a TSD profile was made and the T-S tube was lowered to obtain a calibration before its later use with a tripod. Mooring 078 was recovered and four more stations on the 139°T section were made to fill the gap in the section which had been left earlier when the weather was poor. Four further TSD stations were made on 36° 12'N during the approach to position I.

The moorings (076, 077) were checked and a tripod carrying a camera and T-S tube, arranged to sample currents, Temperature and Salinity every 5 mins near the sea floor, was laid on the evening of 17th. This mooring carried a surface dan which was used for radar fixes for a TSD series (vertical profiles every 2 hrs) begun early on 18th. On the evening of 18th mooring 079 with a single Bergen current meter was laid some miles to the N.W. of the position I with the intention of obtaining information about the spatial coherence of the flow in the area.

High winds on 19th again prevented the use of the TSD and made radar fixing on the dan impossible because of clutter, but they moderated on 20th and a series of four more TSD stations were made on 08°02'W augmenting the previous series on this line. Radar fixes became possible again on the morning of 21st and the TSD series at position I was recommenced.

On the afternoon of 23rd the second tripod mooring to measure bottom currents was laid and the sphere carrying an E.M. flow meter was launched at 2052. The TSD series was continued during the night of 23rd and the second tripod and sphere recovered on 24th. Both appeared to have operated satisfactorily.

After a total of 52 up and down profiles, the TSD series was ended at 0900 24th, moorings 076, 077 and 079 were all checked acoustically, and the first tripod mooring with surface dan was recovered.

The remainder of the TSD work was made at position II near 36° 15'N, 07° 22·5'W (depth about 970m) where the salinity maximum is on the bottom and the outflow appears to be concentrated in a submarine canyon running NE - SW. On arrival at position II on 24th, a tripod mooring was laid to get some idea of the speed of the currents near the sea floor before other moorings were put out. At 1800 a TSD series was begun with vertical profiles from surface to sea floor every two hours. A marker dan was laid on the morning of 25th and the tripod mooring recovered. The currents were variable in magnitude though mostly about 1 knot to the SW down the canyon. The E.M. sphere was launched at 1700 (mooring 081). The tripod with T-S tube and two Bergen current meters were laid on a mooring (082) the following morning in order to measure the vertical shear in the outflow. The sphere was recovered on the morning of 27th. The TSD series was ended at 0900 on 28th after 36 up and down profiles, and mooring 082 and the surface marker dan were recovered immediately afterwards as it was necessary for the ship to go to Gibraltar to land a sick man.

On the morning of 29th, the ship returned to position I and by midday both moorings 076 and 077 had been recovered. The last mooring in the area, 079, was recovered in the early afternoon and course was set for Cascais. Arriving there a.m. 30th March, Dr. Thorpe and Mr. Fiúza were landed, and passage resumed northwards. The intention was to recover and replace the two moorings left out on the continental slope, and to work another TSD section. Arriving in the mooring area a.m. 2nd April, nothing could be heard from the command pinger of mooring 075, but mooring 073 was recovered successfully, and re-laid using the same wire (mooring 083). Returning to mooring 075, its release was turned on and fired but nothing came up. From the appearance of the acoustic signal, it was clear that the release was on the bottom, and either the mooring had broken apart or the subsurface float had leaked. A new mooring (084) was laid, 5 mls E. of the 075 position, and a section of TSD + water bottle stations was occupied, starting in 4300m depth to the SW of the mooring area. Gale force winds interrupted that section p.m. 3rd - a.m. 4th April. On reaching the 2000m bathymetric contour, a near-bottom mooring (085) was laid near mooring 084. The section was resumed and finished by 0900/5th April. After interrogating and fixing the positions of moorings 084 and 085, an unsuccessful attempt was made at dragging for the lost mooring 075. Using a transponder (made up on board from a spare command pinger circuit) the drag was manoeuvred to within 200m of the acoustic release of mooring 075, but time did not permit further attempts to be made. The release pinger was switched off, mooring 085 was interrogated, and course was set for Barry.

LIST OF SCIENTIFIC PARTICIPANTS

Mr. T.R. Barber	N.I.O.	22 Jan.	- 15 Feb.
Mr. J.R. Berry	"	16 Mar.	- 7 Apr.
Mr. F. Bilimoria	"	22 Jan.	- 15 Feb.
Mr. J.W. Cherriman	"	18 Feb.	- 7 Apr.
Dr. C.H. Clayson	"	22 Jan.	- 15 Feb.
Mr. M.D. Conquer	"	16 Mar.	- 7 Apr.
Mr. I. Crofts	Menai Bridge	16 Mar.	- 7 Apr.
Mr. R. Dobson	N.I.O.	22 Jan.	- 13 Mar.
Mrs. P. Edwards	"	18 Feb.	- 13 Mar.

Mr. A. Fiüza	Inst. Hidrografico, Lisbon	8 - 30 Mar.
Dr. A.E. Gargett	N.I.O.	16 Mar. - 7 Apr.
Mr. D.I. Gaunt	"	8 Mar. - 7 Apr.
Mr. W.J. Gould	"	22 Jan. - 15 Feb.
Mr. D. Grohamnn	"	22 Jan. - 13 Mar.
Mr. A.J. Hall	"	22 Jan. - 15 Feb.
		16 Mar. - 7 Apr.
Mr. M.J. Harris	"	22 Jan. - 15 Feb.
Mr. A. Hethershaw	Menai Bridge	16 Mar. - 7 Apr.
Miss R. Howarth	N.I.O.	22 Jan. - 7 Apr.
Mr. D. Mattingley	"	16 Mar. - 7 Apr.
Mr. M.J. McCartney	"	18 Feb. - 13 Mar.
Mr. G.K. Morrison	"	22 Jan. - 15 Feb.
		16 Mar. - 7 Apr.
Mr. J.R.G. Phillips	"	22 Jan. - 13 Mar.
Dr. R.T. Pollard	Univ. of Southampton	22 Jan. - 15 Feb.
Mr. T. Sankey	N.I.O.	22 Jan. - 3 Feb.
		18 Feb. - 13 Mar.
Mr. J. Sherwood	"	22 Jan. - 13 Mar.
Dr. J.C. Swallow	" Principal Scientist	22 Jan. - 7 Apr.
Dr. S.A. Thorpe	"	8 - 30 Mar.

Notes on Equipment and observations

For further details beyond these brief notes, the persons named should be consulted.

1. Current meter moorings (Cherriman, Gaunt, Gould, Harris, Swallow)

Particulars of these are given in Table 2.

Although smaller than had been planned, the current meter array that was set out on the continental slope during February was the most extensive yet attempted by the N.I.O. (4 moorings in depths ranging from 167m to 4156m and using a total of 15 current meters).

The two closely spaced moorings 076 and 077 involved the most intense use of current meters yet made by the N.I.O., with 10 instruments disposed within less than 1 km. vertically and horizontally. Although one mooring with two current meters was lost, in general their performance was successful. Of the 30 current meter recoveries made during the cruise, all but two yeilded apparently satisfactory records. ("Apparently satisfactory" because they could not be read on board, but only checked that the tapes were approximately the right length and had data on them). Only a few of the records from the array have been processed so far; they show several abrupt changes in the long-period current (i.e. averaged over several tidal cycles) which may be related to the passage of storms through the area.

Despite the difficulties with releases and command pingers at the beginning of the cruise, due to low gain of the modified circuits, after further modification and re-testing the acoustic equipment worked reliably. The accidental turning-on of the release and command pingers on mooring 074 was explainable as due to tests inadvertently made too close to the mooring site (approx. 5 miles range) during the repeated STD station 7520. Occasionally, command pingers were reluctant to turn on or off, and sometimes could be made to switch more readily at lower interrogating power. The loss of mooring 075 was not ascribable to any acoustic fault and was almost certainly a failure of either the wire or the subsurface float, or possibly fouling by fishing gear.

The near-bottom moorings 078, 079 and 085 were laid using a 28" dia. thick walled aluminium sphere as deep buoyancy. This type of mooring seems likely to be particularly suitable for long-term use, being less exposed to any other activities in the sea and having a much higher factor of safety on the mooring wire.

2. TSD recorders and water sampling (Miss Howarth, McCartney, Morrison, Sankey, Swallow)

The 9040 sea unit was used in the early part of the cruise, calibrated usually by means of one or more water bottles on the same wire or, on one occasion, with the multisampler. The latter worked successfully but was inconvenient to use from the midships winch. It was hoped that the new winch could be brought into use, which would have simplified handling of the combined assembly of TSD and multi-sampler, but troubles on the new winch prevented that. The calibration of the 9040 unit was erratic, and the noise level of its salinity output increased excessively, so that for the second and third parts of the cruise the 9006 sea unit was used almost exclusively. This had a steadier calibration, but occasionally suffered from spiky noise, and was incompatible with the multisampler as noticed previously (salinity signal disappearing when multisampler was operated, and not reappearing afterwards). In the station list, on those marked 'TSD' either one or two water bottles were attached for calibration just above the sea unit. On those marked 'WB, TSD' up to 9 bottles were used on the TSD wire, and in depths greater than 2500m a separate deep cast was made.

All TSD lowerings were logged by the computer via the interface tested during cruise 37. Outputs were obtained in the form of paper tape lists and graphical plots of mean values of potential temperature, salinity, and potential density at intervals of 20 decibars of pressure. The mean values were obtained by averaging five successive samples of the T and S signals nearest to the nominal pressure value and, at the usual sampling and lowering rates, represented averaging through approximately ± 1½ metres of depth. This considerably reduced the effect of spiky noise in the salinity circuit.

Duplicate salinity samples were drawn from each water bottle and measured on board on the N.I.O. thermostat salinometer.

Progress was made with the problem of how best to combine the raw TSD data with observations from water bottle and the multisampler, but the most convenient way of getting the best out of the high resolution but short-term stability of the salinity sensor of the STD, in combination with stable but less precise individual salinities from water bottles, has not yet been settled. Most probably, consistent use of the multisampler will be the answer.

3. Computer and continuous observations (Berry, Bilimoria, Mrs.Edwards, Sherwood)

For most of the offshore work, navigation was based on satellite fixes, using the 2-component E.M. log output for interpolation. D.R. positions were printed out at 10 minute intervals and lists of revised positions interpolated between satellite fixes. In the work on the Mediterranean Outflow, positions of the repeated TSD stations were fixed by radar from dan buoys attached to the tripod moorings, and the mean positions of the dan buoys determined from satellite fixes. Observations of relative wind, wet and dry bulb temperatures, and sea surface temperature were logged and printed out

every 10 mins. along with the D.R. positions. The surface currents deduced from each pair of consecutive satellite fixes combined with the D.R. were weak and irregular in the area of the mooring array but could to some extent be related to the local wind. Their systematic relationship to the ship's heading made it seem necessary to apply a small correction to the assumed calibration and orientation of the 2-component log.

4. Bottom Tripods (Thorpe, Hall)

Two tripods about 14' high and constructed of aluminium scaffold poles each carry an underwater camera and flash. The film used is 16 mm and the cameras have a capacity of over 2000 frames. The cameras are pointed vertically downwards and are parallel to a wire, which carries two vanes which indicate the direction of the current, and a third which indicates its magnitude about 2m off the sea floor. The tripods also carry two bottles which release fluorosine dye, a pinger which switches off if the tripods tilt by more than about 15° from the vertical, and a compass and pendulum which are photographed and show the orientation and tilt of the tripod. The tripods were used as follows:

Stn. 7640; launched 2300, 17/3; recovered 1100, 24/3; near position I.

The tripod used at this station carried the T-S tube, and the camera operation was controlled by a clock in the tube. Photographs were taken every 5 mins. for about 3 days until a fault developed in the camera control circuit. The measured currents were mainly weak, less than 10 cm/sec, and variable in direction.

Stn. 7659; launched 1400, 22/3; recovered 1000, 23/3; near position I.

The camera operated at 15 sec. intervals for about 10 hrs. This tripod was used to obtain measurements of the currents for comparison with those measured by the E.M. sphere (mooring 080).

Stn. 7669; launched 1500, 24/3; recovered 1100, 25/3; near position II.

The camera operated at 15 sec. intervals for about 10 hrs. The measured currents were about 50 cm/sec to S.E., but rather variable in magnitude.

Stn. 7678 (mooring 082); launched 1000, 26/3; recovered 1000 28/3; near position II.

The camera operated at 15 sec. intervals until all the film had been wound through. This tripod carried the T-S. tube but camera and tube operated independently. There was some evidence from the pinger that the tripod occasionally tilted, but it did not appear to have dragged along the bottom. Part of the record overlaps with that of the E.M. sphere (mooring 081) and will be used for comparison. A sample of the sediment found in one of the tripod legs was kept for analysis, and fine sandy sediment was found at about 1·5m up the framework.

The tripods were moored on 6mm wire supported by subsurface floats, nominally at 50m depth, from which 100m of buoyant line led to dan buoys at the surface. Extra buoyancy was provided at the surface in the last two moorings, in case they had been dragged down slope.

No signs of dragging were observed, however.

5. E.M. Flowmeter Sphere (Thorpe, Hall, Gaunt)

The method of measuring the flow of sea water by the E.M.F. which is produced when the conducting sea water moves in a magnetic field has been developed at the N.I.O. and has been used mainly to measure the speed of a ship through the water, that is as a ship's log. The E.M. sphere is an instrument which allows the continuous measurement of current at great ocean depths.

This is a buoyant 28 inch diameter aluminium sphere attached to, and supported on, a tripod frame. Above the sphere is mounted a pinger scroll and flashing light, and the head of the E.M. flow meter on a stalk with the plane of the coil and electrodes horizontal. A further pinger scroll is mounted in a vertical plane in the angle between the base and one tripod leg. Below the sphere is a device which records the tilt and orientation of the sphere when a corrosive link parts. The tripod is launched attached to a heavy sinker base by a modified van Dorn release. This can be triggered, and the base discarded, by either firing a pyro release acoustically from the surface or by a second pyro release which is operated by a pre-set clock housed within the sphere. The sphere containes the power supply, electronics for the E.M. log and a S.F.I.M. recorder on which the two components of current are recorded continuously for about 4 mins in each hour up to a (present) total running time of about 36 hours. During the 4 min recording cycle the pinger is switched off to avoid interference.

The sphere was used at the following stations (moorings):

Stn. 7661 (080); released 2052, 22/3; recovered 1650 23/3: near position I.

The sphere was launched by releasing it from the crane slip hook and allowed to free fall (at about 1m/sec) from the surface. It appeared to operate quite normally until recovered and continued to switch off the pinger during recording periods. The base was released acoustically and the sphere rose to the surface at about 0·7m/sec. It was recovered by the ship's rubber boat manned by the Second Officer and two scientists who towed the sphere to the ship's side and hooked a line onto the crane which then lifted the sphere inboard. The record showed that the currents were variable, but of magnitude about 20cm/sec.

Stn. 7674 (081); released 1703, 25/3; recovered 0640 27/3; near position II.

The sphere was launched as at Stn. 7661 and operated normally whilst on the bottom. The base was again released acoustically with no difficulty, but the sea was too rough to put out the rubber boat and so the sphere was recovered on a hook and line held on a long pole and lifted inboard by the crane. It is possible that some damage may have been caused to the E.M. head before it was lifted clear of the ship's side, although no superficial damage is apparent. The sphere appeared to have operated satisfactorily and the records showed strong currents of about 100cm/sec. which were very variable in magnitude but consistently to the S.W.

6. New Hydrographic Winch (Clayson, Dobson)

This new electric winch with two drums for 4mm and conductor-cored 7mm wire, and designed to compensate for the effect of the ship's heave on instruments lowered over the side, had been fitted in the lower forward hold during the refit preceding this cruise. Several small modifications were made, and the winch appeared to be operating satisfactorily apart from a defective clutch, which was repaired at Plymouth. A stronger davit was fitted at the same time. A length of 4mm wire was wound on, and three lowerings were made to 4000m, with some tests of acoustic equipment. The winch worked satisfactorily on manual control but with automatic velocity control loose turns developed on the drum when hauling with a light load. Then during an attempt to calibrate the wire tension meter by lifting a known load, the winch picked up suddenly, and then dropped the load on deck, fortunately without causing any damage. The wire was found to have parted near the winch drum, and there were many loose turns, two of which had caught round the traverse rollers and caused the break. With the wire secured round the drum, it was found that the drum rotated at full speed in the lowering direction whichever way the control lever was moved. After this alarming failure in the control circuit, the new length of conducting cable was wound on to the midships winch instead of the new winch as had been planned. Some protection against recurrence of such faults will be needed before risking valuable equipment on it.

7. Echo-sounder (Swallow)

Except when hove to on station or in bad weather, or during interrogation of moorings, the echo sounder was run continuously whilst in depths exceeding 100fm. Opportunities were taken to fill in the bathymetric survey of the continental slope area in which the array of moored current meters was set, which had been begun during cruise 37.

8. T-S profiler (Morrison, Sankey, Swallow)

The E/S fish in use was the one fitted with temperature and salinity sensors by Mr. J. Moorey. Their outputs were recorded as an analogue trace throughout the cruise. Although there was little contrast of surface properties within the areas being studied, the instrument worked reliably and many checks on its calibration were obtained when
CR 41 calibrating the TSD at shallow depth.

List of Tables and Figures

TABLE I

CRUISE 38 STATION LIST

Stn. No.	Date	Time (GMT)	Lat.N.	Long.W.	Gear Used
7496	28/1	0552 0646	46°54'·9	6°03'·2	TSD
7497	29/1	0340 0528	47°09'·2	7°48'·2	TSD
7498		1717 1928	47°20'·5	7°42'·2	TSD
7499	30/1	0933 1437	47°17'·8	7°39'·7	Mooring 071
7500	31/1	0055 0223	47°13'·5	7°41'·9	TSD
7501		0353 0533	47°22'·4	7°37'·2	TSD
7502	1/2	0923 1009	47°39'·6	7°14'·2	Mooring 072
7503		1731 1905	47°30'·6	8°27'·1	TSD
7504	2/2	0533 0720	47°14'·9	7°43'·4	TSD, Multisampler
7505	4/2	1048 1255	47°43'·2	8°07'·6	Mooring 073
7506		1855 2018	47°43'·4	7°09'·5	TSD
7507		2124 2205	47°36'·4	7°21'·2	TSD
7508	4-5/2	2308 0048	47°28'·5	7°29'·7	TSD
7509	5/2	0157 0344	47°21'·0	7°37'·2	TSD
7510		0441 0620	47°14'·8	7°44'·0	TSD
7511		1155 1430	47°31'·4	8°27'·9	Mooring 074
7512	6/2	1055 1228	47°15'·5	7°44'·4	TSD
7513		1404 1529	47°21'·9	7°35'·0	TSD
7514		1616 1742	47°25'·4	7°32'·0	TSD
7515		1835 2010	47°23'·9	7°28'·0	TSD
7516		2114 2231	47°33'·1	7°23'·3	TSD
7517		2328 2400	47°36'·8	7°18'·1	TSD
7518	7/2	0111 0129	47°39'·4	7°13'·7	TSD
7519		0225 0244	47°42'·0	7°11'·5	TSD
7520		1030 1159	47°27'·0	8°33'·6	TSD Dip 1
		1230 1353	47°26'·2	8°35'·5	2
		1430 1549	47°28'·2	8°34'·1	3
		1630 1757	47°28'·0	8°36'·4	4
		1830 1955	47°29'·3	8°34'·0	5
		2032 2156	47°28'·5	8°33'·3	6
		2238 2400	47°28'·3	8°30'·7	7
CR 41	8/2	0030 0201	47°28'·5	8°32'·0	8
		0230 0358	47°28'·0	8°32'·0	9
		0430 0554	47°27'·8	8°32'·6	10
		0630 0751	47°29'·5	8°32'·5	11

7520	8/2	0830	0952	47°29'·1	8°32'·7	TSD	Dip 12
		1030	1156	47°28'·4	8°32'·8		13
		1232	1356	47°28'·5	8°32'·6		14
		1430	1559	47°28'·3	8°33'·6		15
		1630	1755	47°29'·2	8°32'·7		16
		1830	1957	47°29'·2	8°33'·2		17
		2030	2150	47°28'·8	8°31'·9		18
		2230	2356	47°28'·9	8°33'·2		19
	9/2	0030	0153	47°28'·8	8°32'·4		20
		0230	0355	47°28'·8	8°32'·6		21
		0430	0554	47°29'·2	8°33'·2		22
		0630	0757	47°29'·3	8°33'·0		23
		0830	0956	47°29'·2	8°32'·6		24
		1030	1150	47°29'·1	8°32'·0		25
7521		1308	1618	47°23'·1	8°43'·0	TSD	(2 dips)
7522		1736	1859	47°29'·5	8°31'·7	TSD	
7523	10/2	1112	1236	47°34'·1	8°22'·6	TSD	
7524		1335	1434	47°38'·6	8°15'·9	TSD	
7525		1532	1623	47°42'·2	8°10'·1	TSD	
7526		1736	1818	47°46'·3	8°03'·1	TSD	
7527		1904	1934	47°48'·4	7°58'·8	TSD	
7528		2020	2041	47°50'·8	7°54'·5	TSD	
7529	11/2	0037	0059	47°42'·2	7°11'·2	TSD	
7530		0205	0228	47°39'·2	7°15'·2	TSD	
7531		0337	0404	47°34'·2	7°18'·6	TSD	
7532		0505	0613	47°32'·2	7°23'·6	TSD	
7533		0714	0840	47°28'·4	7°27'·3	TSD	
7534		0945	1119	47°25'·1	7°31'·7	TSD	
7535		1216	1340	47°21'·4	7°35'·8	TSD	
7536		1458	1629	47°13'·9	7°44'·8	TSD	
7537		1752		47°20'·6	7°34'·0	WB, TSD	
	13/2		0030	47°19'·7	7°31'·1		
7538		0155		47°15'·1	7°45'·0	WB, TSD	
			0750	47°15'·7	7°46'·5		
7539	14/2	0158	0302	47°46'·3	7°40'·0	TSD	
7540		0356	0458	47°48'·9	7°40'·6	TSD	
7541		0621	0716	47°50'·8	7°41'·9	TSD	
7542	20/2	1044	1115	47°53'·7	7°48'·0	TSD	
7543		1223	1249	47°49'·5	7°56'·7	TSD	
7544		1343	1435	47°45'·3	8°05'·0	TSD	
7545		1536	1630	47°41'·1	8°12'·3	TSD	

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7546	20/2	1752	1913	47°34'·5	8°22'·4	TSD
7547		2020	2150	47°28'·3	8°32'·4	TSD
7548	20-21/2	2248	0014	47°23'·5	8°42'·0	TSD
7549	21/2	0935	1000	47°43'·9	7°09'·7	TSD
7550		1039	1100	47°39'·7	7°16'·8	TSD
7551		1143	1212	47°34'·8	7°19'·7	TSD
7552		1324	1425	47°31'·9	7°24'·7	TSD
7553		1528	1647	47°28'·0	7°26'·5	TSD
7554		1812	1944	47°25'·4	7°31'·5	TSD
7555	22/2	1540	2115	47°22'·2	7°38'·5	WB, TSD
7556	23/2	1228	2125	46°35'·0	8°28'·5	WB, TSD
7557	24/2	0540	1030	46°59'·7	7°59'·6	WB, TSD
7558		1232	1710	47°15'·4	7°44'·0	WB, TSD
7559		1927	2105	47°22'·5	7°34'·6	WB
7560	25/2	1322	1532	47°22'·1	7°36'·[illegible]	WB
7561	27/2	0737	0810	47°54'·1	7°48'·0	WB, TSD
7562		0906	0934	47°50'·0	7°54'·7	WB, TSD
7563		1025	1103	47°47'·0	8°00'·0	WB, TSD
7564		1209	1308	47°43'·4	8°04'·7	WB, TSD
7565		1545	1717	47°31'·5	8°28'·5	Mooring 075
7566		1908	2012	47°41'·7	8°09'·8	WB, TSD
7567	28/2	0900	1030	47°38'·6	8°14'·4	WB, TSD
7568		1216	1346	47°33'·2	8°23'·4	WB, TSD
7569		1510	1636	47°28'·2	8°32'·8	WB, TSD
7570		1738	2036	47°23'·0	8°43'·1	WB, TSD
7571	28/2 - 1/3	2157	0130	47°16'·7	8°53'·3	WB, TSD
7572	1/3	1232	1252	48°5[illegible]'·1	10°35'·0	WB, TSD
7573		1356	1448	48°47'·6	10°34'·7	WB, TSD
7574		1553	1711	48°41'·1	10°35'·5	WB, TSD
7575		1815	1930	48°36'·0	10°40'·2	WB, TSD
7576		2020	2154	48°30'·6	10°41'·8	WB, TSD
7577	1-2/3	2245	0122	48°24'·4	10°43'·2	WB, TSD
7578	2/3	0213	0514	48°1[illegible]'·2	10°45'·3	WB, TSD
7579		1009	1030	48°33'·2	9°36'·7	WB, TSD
7580		1112	1144	48°30'·5	9°40'·6	WB, TSD
7581		1228	1328	48°24'·5	9°48'·2	WB, TSD
7582		1429	1539	48°21'·0	9°53'·1	WB, TSD
7583		1639	1804	48°15'·9	9°59'·7	WB, TSD
7584		1900	2137	48°11'·3	10°06'·6	WB, TSD
7585	2-3/3	2230	0138	48°07'·4	10°12'·6	WB, TSD

7586	3/3	0641 0701	48°23'·0	8°54'·9	MB, TSD
7587		0823 0852	48 14'·2	8°57'·9	MB, TSD
7588		0948 1041	48°08'·5	9°01'·7	MB, TSD
7589		1135 1306	48°02'·7	9°05'·9	MB, TSD
7590		1403 1659	47°56'·4	9 09'·9	MB, TSD
7591		1750 2058	47 51'·2	9 13'·5	MB, TSD
7592	3-4/3	2155 0056	47 47'·1	9°18'·8	MB, TSD
7593	4/3	1236 1254	47°27'·8	6°23'·7	MB, TSD
7594		1336 1411	47°22'·1	6°29'·3	MB, TSD
7595		1443 1610	47°19'·9	6°30'·6	MB, TSD
7596		1654 1828	47 14'·6	6°35'·7	MB, TSD
7597		1905 2220	47°11'·0	6°39'·4	MB, TSD
7598	4-5/3	2310 0230	47°05'·2	6°42'·7	MB, TSD
7599	5/3	1150 1314	47°33'·7	8°25'·2	MB, TSD
7600		1404 1552	47°38'·3	8°17'·5	MB, TSD
7601		1632 1736	47°41'·4	8°11'·0	MB, TSD
7602	6/3	1006 1022	44°46'·6	9°10'·0	Surface water sample
7603		1908 1918	43°12'·3	9°36'·4	Surface water sample
7604	7/3	0932 0945	40°42'·1	9°30'·6	Surface water sample
7605		1812 1938	39°31'·6	9°34'·6	MB, TSD
7606		2032 2204	39°33'·3	9°26'·5	MB, TSD
7607		2300 2351	39°36'·8	9°17'·5	MB, TSD
7608	9/3	0344 0442	36°11'·3	8°01'·4	TSD
7609		1056 1216	36°12'·4	8°01'·8	Mooring 076
7610		1534 1657	36°12'·6	8°02'·4	Mooring 077
7611		2006 2110	35°58'·8	8°01'·7	TSD
7612		2218 2317	36°07'·8	8°02'·0	TSD
7613	10/3	0032 0144	36°11'·7	8°02'·0	TSD
7614		0224 0327	36°16'·3	8°02'·5	TSD
7615		0423 0520	36°24'·9	8°03'·6	TSD
7616		0637 0715	36°34'·0	8°03'·9	TSD
7617		0822 0859	36 42'·6	8°01'·7	TSD
7618		0944 1019	36 48'·1	8°01'·4	TSD
7619		1052 1108	36°52'·2	8 01'·1	TSD
7620		1149 1216	36°49'·5	7°57'·1	TSD
7621		1336 1412	36 40'·5	7°48'·2	TSD
7622		1540 1612	36°32'·3	7°40'·3	TSD
7623	10/3	1740 1821	36°26'·4	7°35'·6	TSD
7624		2016 2101	36 20'·3	7°27'·8	TSD
7625	12/3	0709 0722	35°56'·2	7°02'·0	Mooring 078
7626		1331 1412	35 55'·5	7 01'·8	TSD

7627	12/3	1556 1640	35°42'·9	6°49'·1	TSD
7628		1800 1833	35°33'·1	6°38'·7	TSD
7629		1950 2016	35°23'·6	6°29'·4	TSD
7630	16/3	2121 2144	35 56'·8	6°25'·6	TSD
7631	17/3	0009 0103	35 55'·4	7 03'·4	TSD
7632		0751 0849	36 00'·9	7°07'·4	TSD
7633		0930 1016	36°04'·1	7°10'·0	TSD
7634		1101 1148	36°09'·1	7°15'·5	TSD
7635		1235 1324	36°14'·9	7°21'·3	TSD
7636		1424 1513	36°11'·5	7°26'·0	TSD
7637		1558 1640	36°11'·4	7°33'·9	TSD
7638		1731 1815	36°12'·9	7°41'·2	TSD
7639		1914 2005	36°11'·9	7°51'·6	TSD
7640		2143 2353	36°12'·7	8°00'·4	Bottom current tripod
7641	18/3	0234 0805	see note (a)		TSD (3 dips)
7642		0830 1358	" " "		TSD (3 dips)
7643		1433 1901	" " "		TSD (3 dips)
7644		2055 2125	36°16'·1	8°09'·0	Mooring 079
7645	18-19/3	2226 0335	see note (a)		TSD (3 dips)
7646	19/3	0408 0910	" " "		TSD (3 dips)
7647		1004 1338	" " "		TSD (3 dips)
7648		1325 1957	" " "		TSD
7649	20/3	1051 1209	35°51'·4	8°05'·2	TSD
7650		1254 1403	35 55'·5	8°02'·4	TSD
7651		1522 1636	36 04'·4	8°02'·5	TSD
7652	21/3	0000 0055	36°21'·8	8°01'·0	TSD
7653		0159 0731	see note (a)		TSD (3 dips)
7654		0757 1329	" " "		TSD (3 dips)
7655		1407 1928	" " "		TSD (3 dips)
7656	21-22/3	1958 0142	" " "		TSD (3 dips)
7657	22/3	0203 0720	" " "		TSD (3 dips)
7658		0800 1137	" " "		TSD (2 dips)
7659		1332 1417	36°12'·9	8°01'·4	Bottom current tripod
7660		1520 1942	see note (a)		TSD (3 dips)
7661		2053 2116	36°13'·0	8°01'·5	Mooring 080
7662	22-23/3	2201 0327	see note (a)		TSD (3 dips)
7663	23/3	0406 0750	" " "		TSD (3 dips)
7664		0806 0904	" " "		TSD
7665		1052 1501	" " "		TSD (3 dips)

7666	23/3	1713 2243	see note (a)		TSD (3 dips)
7667	23-24/3	2307 0430	" " "		TSD (3 dips)
7668	24/3	0457 0905	" " "		TSD (3 dips)
7669		1552 1636	36°15'·9	7°22'·2	Bottom current tripod
7670		1826 2329	see note (b)		TSD (3 dips)
7671	25/3	0000 0557	" " "		TSD (4 dips)
7672		0832 0925	" " "		TSD
7673		1140 1602	" " "		TSD (3 dips)
7674	25/3	1703 1718	36°15'·8	7°22'·4	Mooring 081
7675		1853 2339	see note (b)		TSD (3 dips)
7676	26/3	0009 0608	" " "		TSD (3 dips)
7677		0650 0904	" " "		TSD (2 dips)
7678		1008 1050	36°16'·0	7°22'·5	Mooring 082
7679		1123 1423	see note (b)		TSD (2 dips)
7680		1454 2032	" " "		TSD (3 dips)
7681	26-27/3	2102 0059	" " "		TSD (3 dips)
7682	27/3	0132 0505	" " "		TSD (3 dips)
7683		0717 0920	" " "		TSD
7684		0957 1212	" " "		TSD (2 dips)
7685		1238 1335	" " "		TSD
7686		1426 1521	" " "		TSD
7687		1634 1721	" " "		TSD
7688		1827 2359	" " "		TSD (4 dips)
7689	28/3	0031 0336	" " "		TSD (2 dips)
7690		0403 0452	" " "		TSD
7691		0602 0650	" " "		TSD
7692		0801 0838	" " "		TSD
7693	2/4	1215 1416	47°44'·3	8°07'·7	Mooring 083
7694		1940 2051	47°31'·2	8°21'·5	Mooring 084
7695	2-3/4	2359 0420	47°16'·2	8°53'·5	WB, TSD
7696	3/4	0723 1252	47°21'·3	8°45'·2	WB, TSD (2 dips)
7697	4/4	1000 1151	47°25'·6	8°38'·6	WB, TSD
7698		1244 1500	47°28'·1	8°33'·8	WB, TSD
7699		1603 1742	47°32'·2	8°26'·4	WB, TSD
7700		1848 1903	47°31'·7	8°22'·2	Mooring 085
7701		2041 2220	47°34'·3	8°21'·7	WB, TSD
7702	4-5/4	2308 0034	47°36'·1	8°15'·7	WB, TSD
7703	5/4	0123 0234	47°40'·3	8°09'·9	WB, TSD
7704		0329 0427	47°44'·9	8°04'·7	WB, TSD
7705		0528 0605	47°48'·0	7°58'·3	WB, TSD

7706	5/4	0711 0741	47°49'·6	7°54'·6	WB, TSD
7707		0826 0855	47°52'·9	7°47'·5	WB, TSD

Notes: (a) These stations were within 1 mile of 36°12'·9N, 8°03'·5W.

(b) These stations were within 1 mile of 36°17'·5N, 7°20'·4W.

Table 2

Cruise 38 Current Meter Moorings

Notes (1) abbreviations - A: Aanderaa B: Brancon
(2) times are GMT

N.I.O. Mooring No.	Stn. No.	Water Depth (m)	Time/Date Set	Time/Date Released	Current Meter	Depth (m)	Remarks
070	-	2040	1542/13.XII.70	1548/1.II.71	..219	469	Set during Cruise 37
071	7499	4156	1437/30.I.	1513/26.II	..153	110	
					..156	526	
					..154	1100	
					..281	1613	Short record - battery failure
					B111	2121	
					B112	3141	
072	7502	167	1009/1.II	1136/22.II	A75	54	
					A155	105	Short record - battery failure
073	7505	1024	1301/4.II	0956/2.IV	A73	110	
074	7511	2008	1420/5.II	0908/26.II	A74	91	Netting caught on meter but not fouling rotor
					A222	292	
					A224	492	
					A225	990	
					A221	1487	
					A282	1986	
075	7565	1999	1717/27.II	-	A224	300	Mooring lost, see narrative.
					A225	1491	
076	7609	1541	1216/9.III	0948/29.III	A279	510	
					A280	924	
					A301	1191	
					A302	1388	
					A304	1398	
077	7610	1539	1657/9.III	0838/29.III	A306	760	
					A309	1077	
					A310	1303	
					A311	1402	
					A312	1480	
078	7625	910	0722/12.III	0606/17.III	A305	900	
079	7644	1449	2125/18.III	1246/29.III	A305	1397	
080	7661	1482	2116/22.III	1554/23.III	(EMCM sphere)		
081	7674		1718/25.III	0544/27.III	(EMCM sphere)		
082	7678	921	1050/26.III	0932/28.III	A75	668	Tripod at bottom
					A281	894	
	083	7693	1007	1416/2.IV	left out	A156	82
CR 41	084	7694	2012	2051/2.IV	left out	A303	280
	085	7700	2004	1925/4.IV	left out	A270	1988

Fig.1 DISCOVERY CRUISE 38 Noon Positions

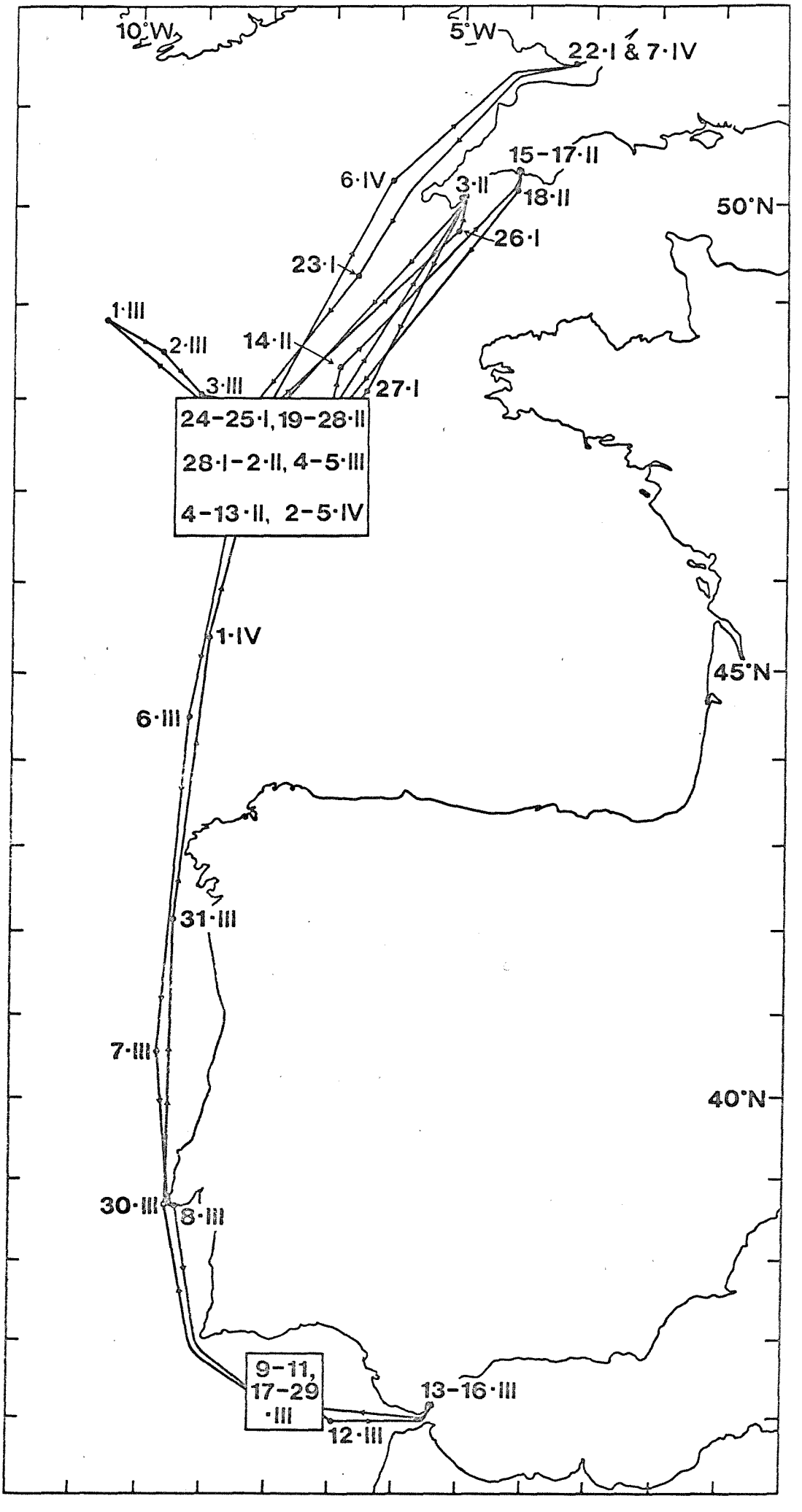


Fig. 2a Stations on the continental slope of the Bay of Biscay

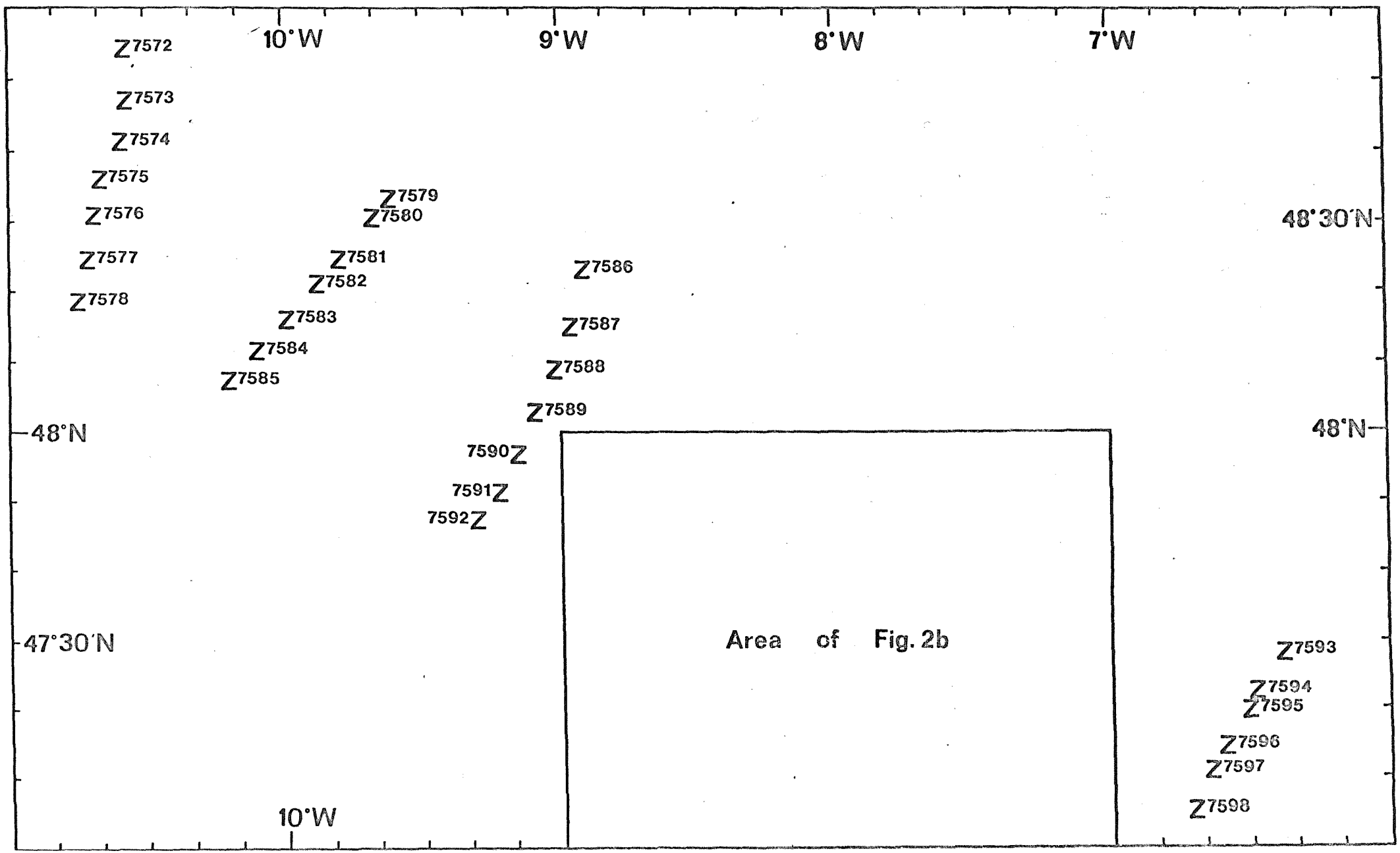
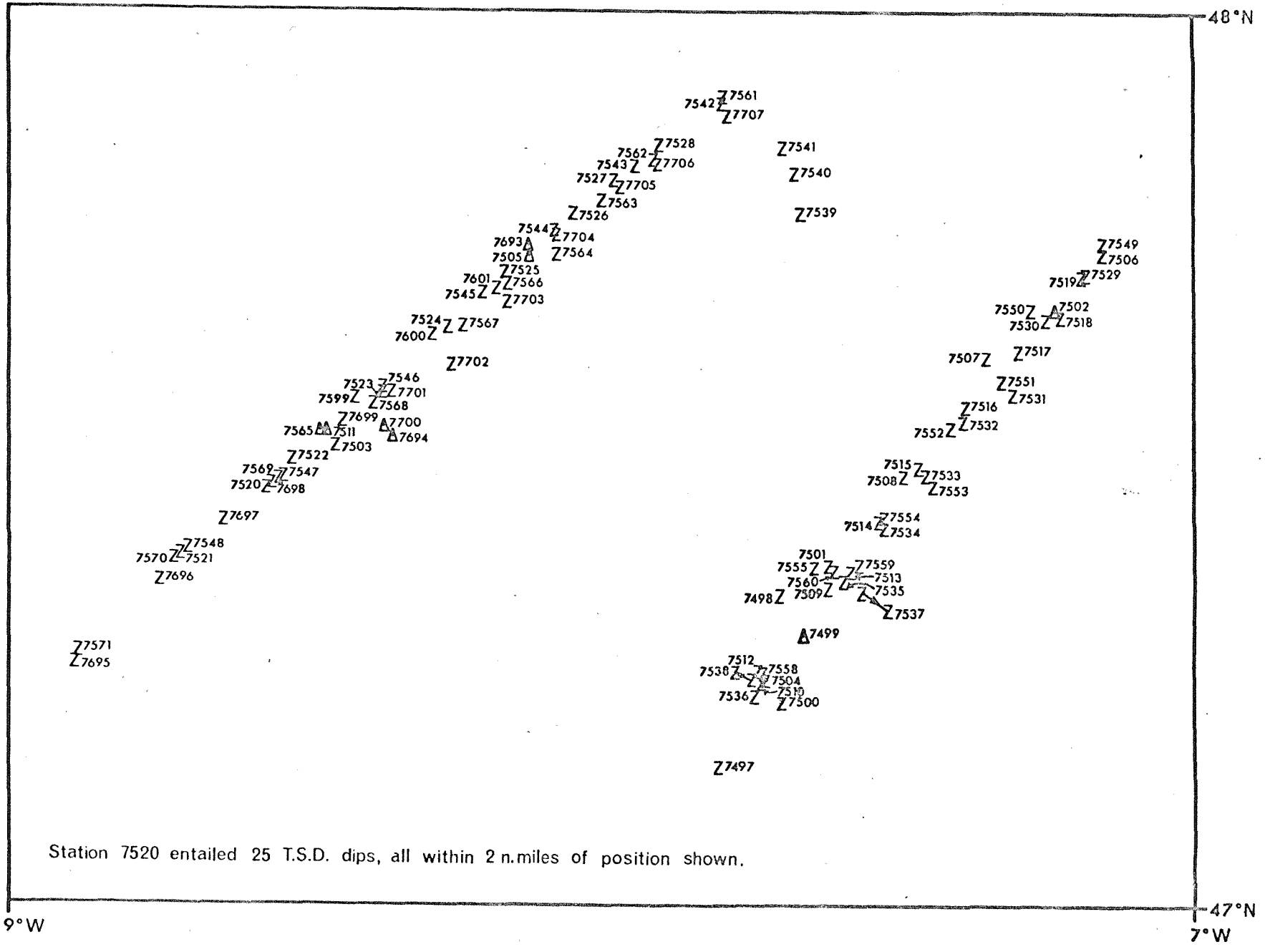


Fig. 2b

Stations on the continental slope of the Bay of Biscay



Station 7520 entailed 25 T.S.D. dips, all within 2 n.miles of position shown.

Fig.3 Stations in the Mediterranean Outflow