PROUDMAN OCEANOGRAPHIC LABORATORY

CRUISE REPORT NO. 9

RRS CHALLENGER

Cruise 66b/90

3-17 June 1990

Measuring the Flux of Contaminants Through the Dover Straits

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ABSTRACT

This cruise formed part of a study to measure the flow of contaminants entering the North Sea over a complete year. Shore-based H.F. Radar stations, deployed from May '90 to May '91, will measure sea-surface currents over most of the Strait. A mooring in mid-channel, (A in Fig. 1), is to be maintained continuously over the same period instrumented with a bottom-mounted ADCP, transmissometer and DRCM.

The cruise objectives were:

i) to provide a basis for lateral and vertical extrapolation of the above measurements
ii) to interpret the transmissometer measurements in terms of both concentrations and particle size distribution
iii) to obtain samples for chemical analyses for subsequent calculation of contaminant fluxes.

For one month, co-incident with the cruise, two additional moorings (B and C) were deployed-instrumented as for position A. These were to measure spatial gradients and relate them to forcing phenomena.

Some 232 CTD dips were made, each measuring temperature, salinity, 0_2, transmittance, irradiance and fluorescence. Filtration of 800 bottle samples provided data for subsequent determination of sediment concentrations. Some 30 measurements of settling velocities were made and 170 determinations of particle size spectra.

A total of 132 samples were taken for trace metal analyses while samples for analyses of organics consisted of 40 dissolved and particulate together with 20 bed sediments.

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CRUISE REPORT CHALLENGER 66 3-18 JUNE 1990

Measurement of Fluxes through the Dover Strait

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1 SUMMARY

This cruise formed part of a study to measure the flow of contaminants entering the North Sea over a complete year.Shore-based H.F.Radar stations ,deployed from May '90 to May '91,will measure sea-surface currents over most of the Strait.A mooring in mid-channel ,(A in Fig.1),is to be maintained continuously over the same period instrumented with a bottom-mounted ADCP,transmissometer and DRCM.

The cruise objectives were:
i) to provide a basis for lateral and vertical extrapolation of the above measurements.
ii)to interpret the transmissometer measurements in terms of both concentrations and particle size distribution.
iii) to obtain samples for chemical analyses for subsequent calculation of contaminant fluxes.

For one month,co-incident with the cruise,two additional moorings(B and C) were deployed-insrumented as for position A.These were to measure spatial gradients and relate them to forcing phenomena.

The cruise followed immediately after a two-week survey of the southern North Sea - following the pattern of earlier North Sea Project survey legs.The moorings A,B and C were laid during this cruise.En-route from Hull to the Dover Strait, 7 stations associated with this survey leg were completed.

The RRS Challenger made continuous underway measurements of : vertical current profiles, temperature,salinity, transmittance and fluorescence....

A wider-area regional survey was first made extending 50 km west and east of the Strait.CTD dips were made at 8 km intervals measuring T,S,O2,transmittance,irradiance and fluorescence with a rossette bottle sampler for both chemical and calibration samples.
This regional survey provided a description of the waters likely to be sampled subsequently.In addition it provided useful data for fine-tuning of the cruise strategy.

A 50-hour cross-sectional survey followed following the line shown in figure 2 (a route determined by navigational considerations).Ten stations along this track were systematically monitored.Additional measurements included: grab,settling tube and chemical samples.

For the next three days ((8-11/06), 25h long stations were completed alongside each of the moorings B,A and C respectively.CTD measurements were made at half-hourly intervals with additional occasional settling tube and chemical samples.Succesful box cores were taken at B and A.

A second 50 hr cross-sectional survey was completed with a revised sampling strategy involving fewer stations.On westerly transects 5 stations were sampled, concentrating on near-coastal stations to define this region of enhanced sediment concentrations.No stations were sampled on easterly transects.

A detailed survey of the near-shore region along the English coast was then made .Rig B was recovered with a concurrent 10 hr

station.A survey of the French near-shore region followed with recovery of rig C en-route.

Rig A was recovered early on 15/06 and re-laid,concurrently bathymetric surveys were made using the ship's echo sounder,grab samples and the box corer.

Rigs G and H relating to the preceding North Sea survey were recovered on 16/06 en-route to docking in Yarmouth. Attempts to recover rig F on the 17/06 failed.

2 DIARY

JUNE 3

Sailed from Hull 0700 (GMT)

Continuous (throughout the cruise) underway monitoring of temperature,salinity,downwelling irradiance, transmittance,vertical current profiles.

CTD* dips at North Sea survey positions AA,AK,AL,AM,AN,AO and AP (3141 to 3147)

*All dips measure T,S,O2,irradiance,transmittance & fluorescence

JUNE 4

11.45 REGIONAL SURVEY

CTD dips at 5 mile intervals (3148 to 3178)

JUNE 6

04.00 CROSS SECTIONAL TRANSECTS (through station B)

CTD dips at 10 stations across the Strait (3181 to 3244)

Rosette bottles & settling tube samples at selected stations.Grab samples once at each station.

JUNE 8

03.30 STATION B (25HR) (3245 to 3289)

CTD dips half-hourly

Rosette bottles & settling tube samples at selected times.Grab samples and 1 box core.

JUNE 9

08.00 STATION A (25HR) (3290 to 3335)

Schedule as station B

JUNE 10

12.00 STATION C (25HR) (3336 to 3379)

Schedule as station B (no box core)

JUNE 11

14.00 CROSS SECTIONAL TRANSECTS (3380 to 3418)

Repeat of earlier strategy but with fewer dips, namely stations 10,9,6,2 and 1 on westerly transects, no stations on easterly transects.

JUNE 13

14.24 IN-SHORE SURVEY (ENGLISH COAST)

(3419 to 3426)
CTD dips,grab samples at 5km intervals,one box core.

JUNE 13

22.30 STATION B

(3427 to 3446)
CTD dips half-hourly,settling tube samples hourly.
Rig recovered at 09.00

JUNE 14

12.00 IN-SHORE SURVEY (FRENCH COAST)

(3447 to 3455)
CTD dips,grab samples at 5km intervals.
Station C recovered (16.00),one box core.

JUNE 15 STATION A

(3456 to 3476)
00.30
Bathymetric survey,CTD dips half-hourly,settling tubes hourly.
10.00
Recover and relay rig A

JUNE 16

08.00 Recover Mooring G

16.00 Recover Mooring H

JUNE 17

08.00 Failed to recover Mooring F

16.00 Dock Yarmouth

3 SEDIMENTS

The primary objective of this study is to measure depth/cross-section/time integrated sediment concentration fluxes through the Dover Strait over a period of one year. The instrument employed for this purpose is a 25cm path-length 660nm transmissometer,which is capable of high resolution sampling in space and time.
Transmittance is directly related to suspended particulate concentration for a given particle size and refractive index:however, natural suspended sediment contains a distribution of both size and composition so empirical calibration in the area of interest is of great importance.

This cruise presented an opportunity for investigation of spatial and temporal variability in suspended particulate concentration and composition, in order to interpret the single point year-long time-series planned at Site A. It also enabled measurement of parameters for incorporation into sediment flux models which require concentration profiles, settling velocity and critical erosion stress, generally as functions of particle size. The specific objectives of the sediments group were therefore:

(1) Measurement of spatial (lateral/vertical/longshore) and temporal (tidal/lunar) variability in transmittance, suspended particulate concentration and composition (size distribution, organic/inorganic content, mineralogy).
(2) Measurement of settling velocity distributions.
(3) Assessment of the resuspension potential of bottom sediments.

A total of six transmissometers were involved: all instruments were intercalibrated during the cruise. Self-logging UCNW versions were deployed at 5m above the bed for 28 days at Sites A,B, and C: Sea Tech instruments were used aboard ship. Two deck-mounted units gave continuous underway measurements of surface transmittance from the non-toxic supply, whilst the CTD-mounted instrument gave profiles extending from the surface to within 4m of the sea bed. Both instruments were calibrated regularly by filtration of water samples through pre-weighed GF/C and/or GF/F filters for determination of total, inorganic and organic particulate concentrations. In addition, near-bed concentrations were determined at selected stations using specially designed samplers to extend vertical coverage to 1m from the sea bed.

Large scale spatial variability was assessed during the regional survey, and an intercomparison between GF/F and GF/C calibrations was performed. During the first cross-sectional survey, calibration sampling was timed to coincide with maximum flood, ebb and slack water at each station, although full coverage was not achieved at all stations (19 sets of samples were processed, including at least one from each station). Concentration and

particle size distribution (using an Elzone 180 particle sizer) were determined from the top and bottom of the CTD cast, and from near-bed samples. During the second cross-sectional survey, settling velocity distributions were determined from undisturbed samples at 7m below the surface and 1m above the sea-bed during maximum flow at Stations 1,2,6,9 and 10 using UCNW versions of a settling tube originally designed by I.N McCave (University of Cambridge). Large volume samples were also collected at these stations and filtered for mineralogical analysis. At stations 2 and 6 the relationship between near-bed settling velocity and particle size was investigated by running parallel particle sizing/ settling velocity distribution determinations. 26 samples, covering all stations, were also filtered (using GF/Fs) for calibration of the CTD/Deck-mounted fluorometers.

Enhanced concentrations observed in the French and English nearshore zones were investigated, gravimetric calibrations being performed at each station.

Tidal variability was monitored at Sites A, B and C for 25 hours. Every two hours, samples were collected from top and bottom of the CTD cast for gravimetric calibration and particle sizing. In addition, settling velocity distributions were determined at maximum flood and ebb flow at 7m below the surface and 1m above the sea bed. A second 10 hour station was maintained at Sites A and B one week later to assess lunar variability. Hourly near-bed samples were also collected during these stations to monitor the tidal variability of near-bed concentration profiles.

A grab sample was recovered from all stations along cross-section and near-shore surveys for qualitative description and, where representative samples were recovered, particle size analysis.

Box-cores were obtained from Sites A and B in order to obtain more representative samples for quantitative analysis and to investigate sedimentary structures. Five replicate cores were taken in the vicinity of Site A, in conjunction with a bathymetric survey, for assessment of spatial variability. The rocky sea floor at Site C prevented retrieval of a box-core. One core was also taken from the nearshore zone off both French and English coasts.

PERSONNEL.

S Jones (UCNW):
Moored transmissometer/current meter strings at Sites A,B, C
Maintenance of CTD transmissometer/fluorometer
Gravimetric calibration of transmissometer (GF/F - 221 samples)
Near-bed concentrations (71 samples)
Settling velocity distributions (30x10 samples)
Bottom sediments (35 samples)

T Moffatt (PSW):
Maintainance of deck mounted transmissometers/fluorometer

Gravimetric calibration of transmissometer - (GF/C - 122 samples)
Particle sizing (170 samples)
Mineralogical analysis (6 samples)

A Nield (UCNW):
Maintenance of settling velocity tubes
Servicing/turnaround of transmissometer moorings

4 ORGANIC CHEMISTRY

Objectives

The main objective of the participation of the Liverpool group on this cruise was to collect a series of samples (water,suspended solid and sediment) from the Dover Straits area for analysis for trace organic contaminants. The results of these analyses will be used, in the first instance, to design an appropriate sample collection strategy for participation in the year long DOE Taskforce/EC MAST programme. This programme is intended to measure the importance of the fluxes of contaminants through the Dover Straits to the southern North Sea.

Samples collected on the cruise were stored and will be analysed at Liverpool as soon as possible. Analytes will include:- saturated hydrocarbons, PAHs, chlorinated pesticides and PCBs. The main analytical technique to be employed will be gas chromatography-mass spectrometry using positive and negative ion/electron impact or chemical ionisation methods as appropriate.

Results

A total of 40 samples were collected for analyses of dissolved and particulate analysis. A further 20 sediment samples were collected using either the box corer or the grab. These samples were preserved using acid treatment and cold storage (liquids) or freezing (solids). All handling of aqueous and suspended partices samples was conducted in the clean chemistry container and in a laminar flow hood. Details of the samples collected are given in the attached tables.

Sample data for transect 1

Sample No	Date	Time (GMT)	Position	Total Depth	Bottle Depth (db)
T1.1	6/6/90	0246	50°58.11 01°2.38E	23m	12
T1.4	6/6/90	0510	50°51.76 01°9.31E	37m	15.9
T1.9	6/6/90	0852	50°44.68 01°27.46E	54m	12.6
T1.10	6/6/90	0947	50°44.68 1°31.21E	20m	12.3
T2.6	6/6/90	1250	50°46.78 1°15.56E	32m	12.6
T2.3	6/6/90	1509	50°54.50 1°6.53E	33m	12.7

Grab samples for all of the above stations plus site 1.5
1 core sample from box corer at station B

Sample data for transect 2

Sample No	Date	Time (GMT)	Position	Total Depth	Bottle Depth (db)
2T1.10	11/6/90	1427	50°44.70 01°31.28E	23m	12.3
2T1.9	11/6/90	1509	50°44.61 01°27.37E	52m	12.0
2T1.6	11/6/90	1644	50°48.82 01°12.57E	32m	12.3
2T1.2	11/6/90	1807	50°56.13 01°04.80E	32m	12.0
2T1.1	11/6/90	1842	50°58.10 01°02.54E	26m	12.6
2T6.3	11/6/90	1035	50°54.61 01°06,40E	34m	12.8

Sample data for tidal cycle station A

Sample No CTD/REF	Date	Time	Position	Total depth	Bottle depth
3291/A2	9/6/90	0836	50°55.24 01°16.81E	34m	12.8
3295/A6	9/6/90	1036	50°55.24 01°16.81E	40m	12.8
3299/A10	9/6/90	1236	50°55.24 01°16.81E	40m	12.5
3302/A13	9/6/90	1439	50°55.24 01°16'.81E	38m	12.4
3305/A16	9/6/90	1639	50°55.24 01°16.81E	34m	8.4
3309/A20	9/6/90	1856	50°48.80 01°16.77E	32m	12.3
3312/A23	9/6/90	2036	50°48.80 01°16.77E	34m	12.6
3316/A27	9/6/90	2236	50°48.80 01°16.77E	38m	12.6

5 DISSOLVED AND PARTICULATE TRACE METALS

The object of this cruise was to investigate the concentrations and distributions of a range of dissolved and particulate trace metals (Al, Cd,Co, Cr, Cu, Fe, Mn, Ni, Pb, Zn) in waters of the Straits of Dover, and to estimate, using detailed physical and sedimentological measurements made during the cruise, the net transport of these constituents into the North Sea over the duration of the study. This investigation therefore provides one of the first opportunities to quantify net fluxes of these materials in this shelf sea area.

To aid in the interpretation of trace metal behaviour, samples were taken at a majority of stations for subsequent laboratory determination of dissolved phosphate and dissolved silicon.

Samples were taken during two 50 hour multiple transects of the Dover Straits (at 10m and bottom depth at 6 and 7 stations respectively), at two tidal cycle stations (one sample per hour at 5m depth at A; two samples per hour,at 5m and bottom, at C), and during a regional survey encompassing the eastern English Channel, the Dover Straits and the southern most North Sea (21 stations; one sample per station at 10m depth).

Samples were collected using 10 l. Go-Flo bottles, modified to minimise contamination, deployed on a CTD-rosette fitted with a transmissometer and fluorimeter. Initial sample processing (pressure filtration through 0.4um Nuclepore polycarbonate membranes) was carried out in the RVS Clean Chemistry container. Samples were preserved for onshore processing by either freezing (dissolved Al, Si, PO4, particulate material) or acidification to pH 2 (remaining dissolved trace metals).

Clean techniques were used at all stages of sample collection and handling, and all critical steps (filter membrane handling and acidification) were carried out in a laminar flow cabinet.

Dissolved trace metals will be determined by either graphite furnace atomic absorption spectrophotometry following carbamate-complexation and separation and back extraction into 4% nitric acid (Cd, Co, Cu, Fe, Mn, Ni,Pb, Zn) or fluorimetric measurement of its lumogallion complex (Al).

Metals in the particulate phase will be measured by flame or GFAAS following leaching of the particulate material by a strong mineral acid.

The nutrient samples will be analysed using standard colorimetric methods.

A total of 132 samples were taken for the analysis of dissolved trace metals (including 25 samples for dissolved aluminium), 107 for particulate analysis (including 24 large volume filtrations through pre-weighed membranes),107 for dissolved phosphate and 80 for dissolved silicon.

6 DATA PROCESSING

The computer system aboard Challenger for this cruise consisted of the RVS 'ABC' system.

Data were logged from various instruments: em log, gyro, Decca navigator, MX1107 satellite navigator, light meters, solar integrator, thermosalinograph, fluorescence ,transmittance and temperature,Simrad depth recorder , Acoustic Doppler Current Profiler and the CTD. Further processing of navigation and CTD data was carried out.

Multiple plots were produced of each CTD dip and contours were generated of various transects of CTD dips. Plots of the surface samples (temperature, salinity, transmittavce and fluorescence),light sensor readings and depth records were produced daily.
Various charts of track and station positions were produced as required.

All aspects of the ABC logging system worked well, although there was some concern over the quality of the ADCP data. This was not resolved during the cruise, however as the data are collected in an 'off-line' manner for this particular instrument the ability to re-process the data exists.

APPENDIX 1 INSTRUMENTATION

1 On-board continuous monitoring:
Current Profiles RDI ADCP 16 4m bins,4 min samples,2 pings/min.
Transmissometers (2) Sea-tech (25cm)
Fluorimeter Aqua-tracker
Temperature &
Salinity Grundy Env.Systems,Model 6620 thermosalinograph
Soli and Lumen Sensors

2 CTD Neill-Brown EG&G Mk.IIIB
25 cm Seatech transmissometer
Chelsea Instruments Fluorimeter
2 PI PAR irradiance meter
GO 12 bottle rosette,10L GO-FLOW bottles
2 SIS RTM 4002 digital thermometers
10 kHz beacon

3 Particle size analyser Elzone 180 XY
Sediment gravimetry GF/F and GF/C
RVS 50cm square box corer
day grab sampler
UCNW settling tubes
Mineralogy 0.45 micron Sartorius membranes

4 Moorings POL 1mHz ADCP,20 1m bins,10 min samples 180 pings
UCNW 25cm transmissometer
Aanderaa RCM4

APPENDIX 2 MOORINGS

station depth	rig	instrument		position	recovered
A 15/6/90	ADCP 30m	poldop	4a	50:55:78N	0935
		WLR	1038	01:16:31E	
15/6/90	pop-up	transmissometer	6	50:55:95N	1012
		RCM4	3308		
B 14/6/90	ADCP 24.6m	poldop	9a	50:46:71N	0835
		WLR	1042	01:13:91E	
14/6/90	pop-up	transmissometer	5	50:46:79N	0800
		RCM4	5229	01:13:91E	
C 14/6/90	ADCP 33m	poldop	10a	50:52:08N	1510
		WLR		01:32:00E	
14/6/90	pop-up	transmissometer	4	50:51:84N	1540
		RCM4	5913	01:31:67N	
F	U shape	S4	1306	RIG NOT RECOVERED	
		S4	1308		
		RCM7	9960		
G 16/6/90	U shape ??	S4	1195	52:38:	0725
		RCM7	9633	03:46	
H 16/6/90	ADCP 32m	poldop	7	53:29:89N	1348
		RCM7	9631	03:00:35E	
16/6/90	single pt.	thermistor	SN7		1438
		chain 20m	118		

REDEPLOYMENT OF A

A 15/6/90	ADCP	poldop	10a	50:55:87N	1218
		WLR	1042	01:16:47E	

WLR water level recorder,RCM4&7 Aanderaa current meter,S4 inter-ocean
current meter,SN7 sea data thermistor logger, ADCP Acoustic Doppler
Current Profiler.

START STOP TIMES POL INSTRUMENTS

ADCP	START	STOP
poldop 4a	0840 22/5/90	??
poldop 7	0550 24/5/90	1530 16/6/90
poldop 9a	??	0830 14/6/90
poldop 10a	1430 22/5/90	1510 14/6/90
poldop 10a	??	still deployed
WLR		
WLR 915	1320 21/5/90	2020 14/6/90
WLR 1038	1440 21/5/90	1600 15/6/90
WLR 1042	1410 21/5/90	0920 14/6/90
WLR 1042	1000 14/6/90	still deployed
AANDERAA RCM		
RCM7 9631	1310 23/5/90	1140 21/6/90
RCM7 9633	1400 20/5/90	1110 21/6/90
RCM7 9960	1430 20/5/90	lost
S4		
1195	0330 21/5/90	1330 21/6/90
1306	2040 20/5/90	lost
1308	2100 20/5/90	lost
SEADATA THERMISTOR LOGGER		
SN7	1415 23/5/90	1937 16/6/90

APPENDIX 3 TECHNICAL PROBLEMS

There were no major problems encountered with the organic chemistry programme however the following minor difficul ties were encountered:-

i) On arrival it was found that the clean chemistry container was being used for storage and contained, amongst other things, a spare hull-mounted ADCP transducer in a large wooden crate, another wooden crate, a spare box corer box and knife and a lot of stray polystyrene packing. The container therefore required extensive cleaning. This practice of misusing the container should be halted.

ii) For the present work it was requested that there be two laminar flow cupboards installed in the container. To achieve this it was necessary to remove the laminar flow hood from the fish lab. Because this hood is slightly (ca.1.5cm) too tall to fit on the container benches it was necessary to install it sideways. It would be helpful if in future a further laminar flow cupboard be available so that it is possible for the one in the wet lab to be regarded as a permanent installation.

iii) Once again the blue box corer was found to be in less than a fully satisfactory state. This corer is badly in need of a major service with particular attentiion being placed on the swinging arm where the pivot holes are so worn that on landing the corer on the deck, unless tension is maintained on the wire,the blade drops away from the box and the sample falls out.

Other comments

The bosun and crew on this cruise were nearly all new to the ship and to the kind of work that was required. Both they and the officers deserve much credit for the very short time that it took for everything to settle down and we should like to express our gratitude to them for helping to make this cruise such a successful exercise for us. We should also like to express our thanks to the Officers of the ship for all the cooperation and guidance that they gave us when working in such a difficult area as the Dover Straits.

Faults with ships equipment.

1/ Position of container on deck made retrieval of moorings difficult,more so because the majority of the crew were new to the ship.

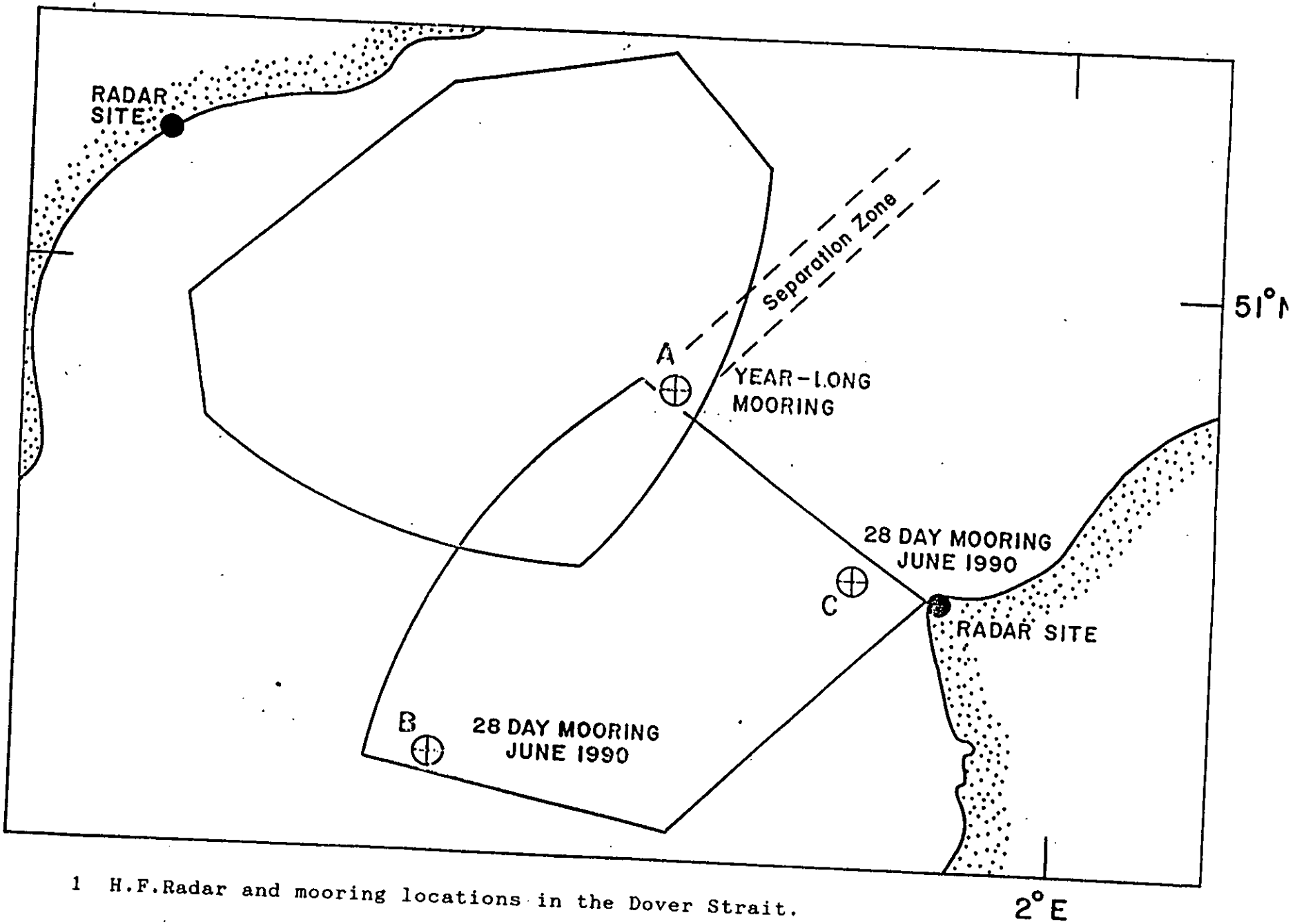
2/ Mufax in the main lab. unreliable for retrieval of popup moorings because of jumping of trace.

3/ Old cable on hydro winch snaped almost resulting in loss of scientific gear.The cable was subsequently rethreaded incorrectly over the meter block only.This led to the wire jumping out of the block and snapping on a later cast ,again the scientific gear was saved. Would suggest a label on the hydro gantry for the correct rigging of the blocks.

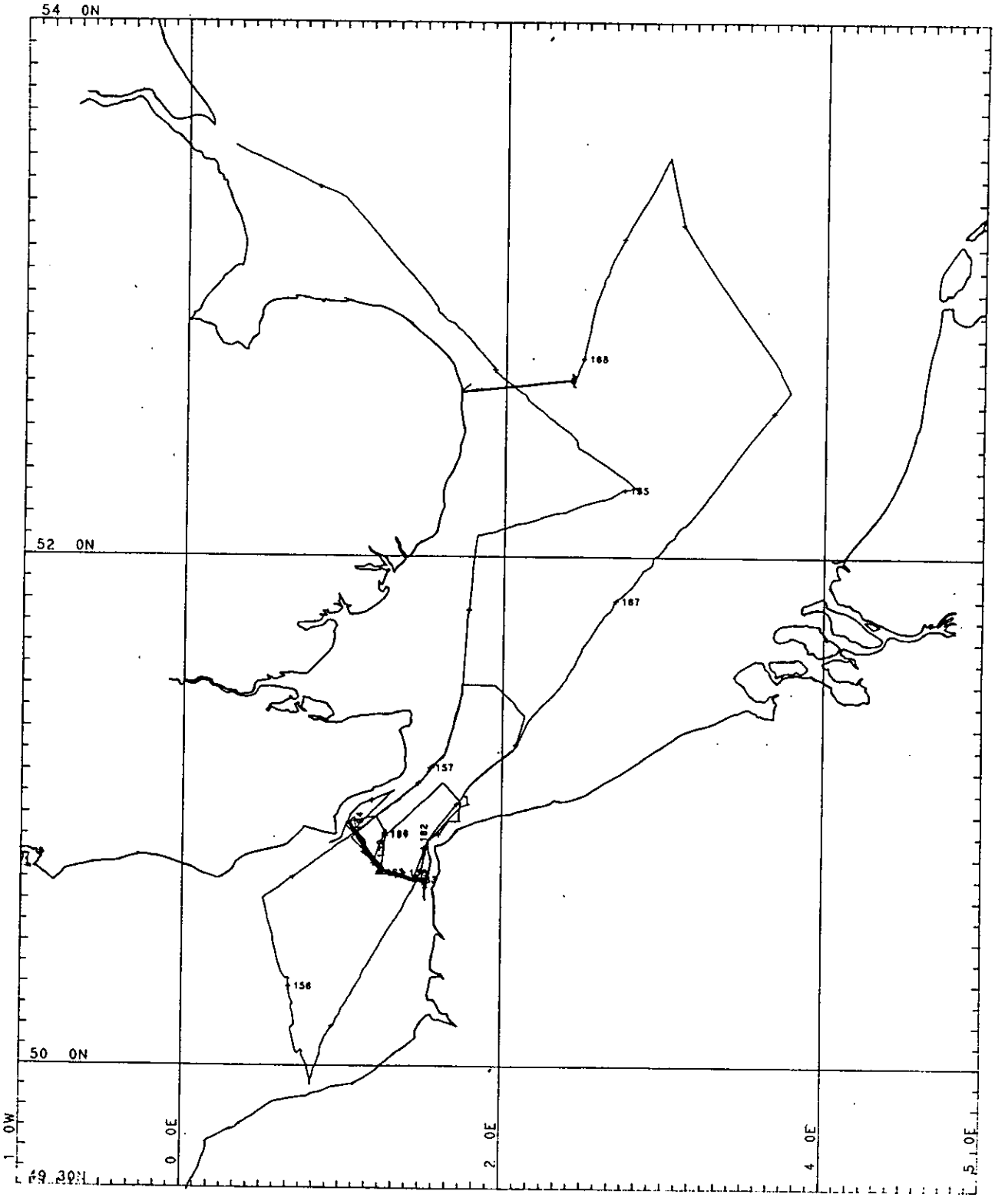
4/ Room to store recovered mooring equipment was severly restricted because of 1) the chemistry container on the main deck. 2) the clutter on the winch deck. This resulted in equipment being stored on what should be the working area on the aft deck.

5/ The design of the new CTD gate is such that,whilst loose wire was being fed back to the winch a byte caught the gate and almost pulled it out. The gate was bent out of shape and was held in place with rope for the rest of the cruise.

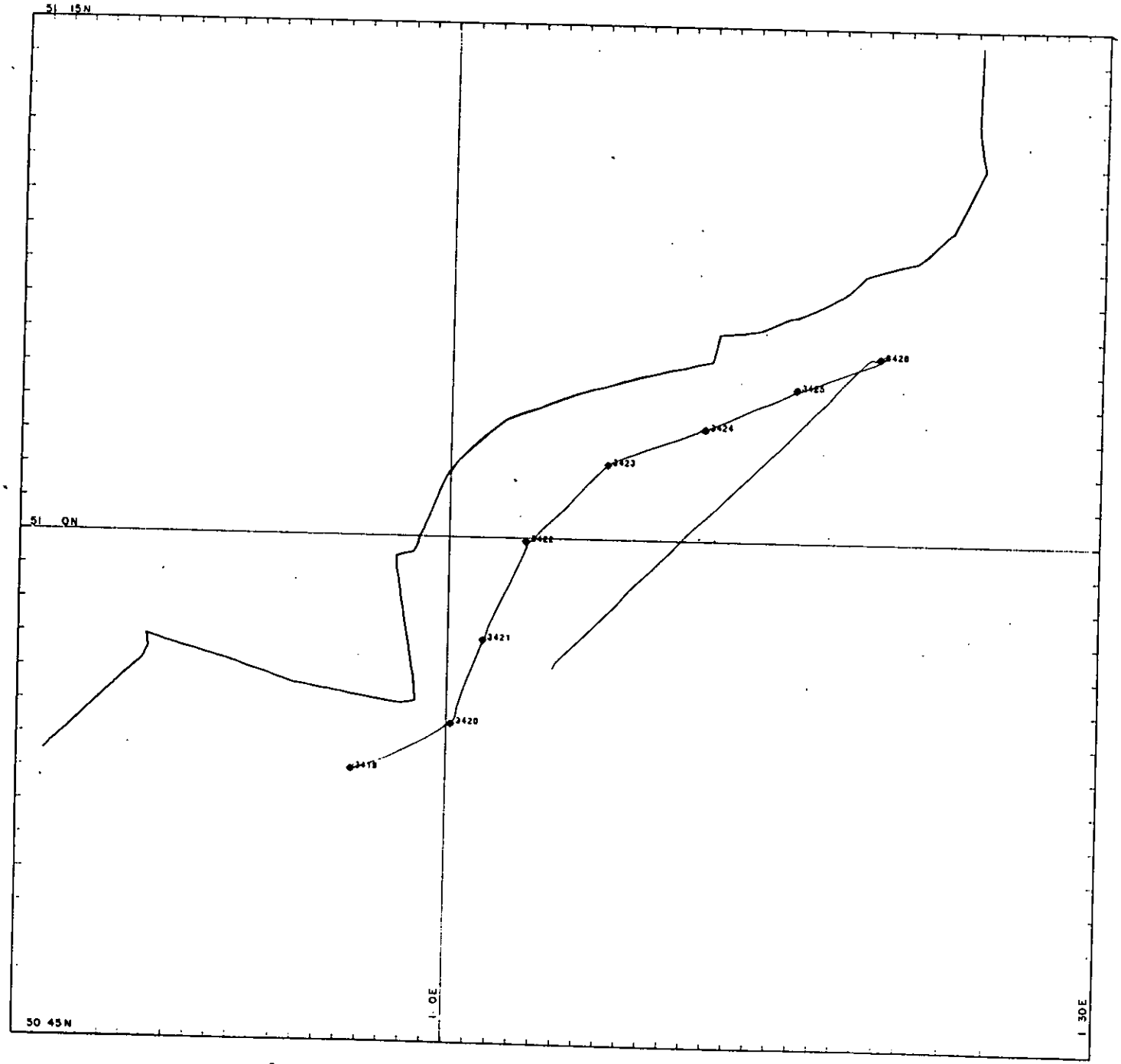
6/ The winch readouts were unreliable in the winch cab.



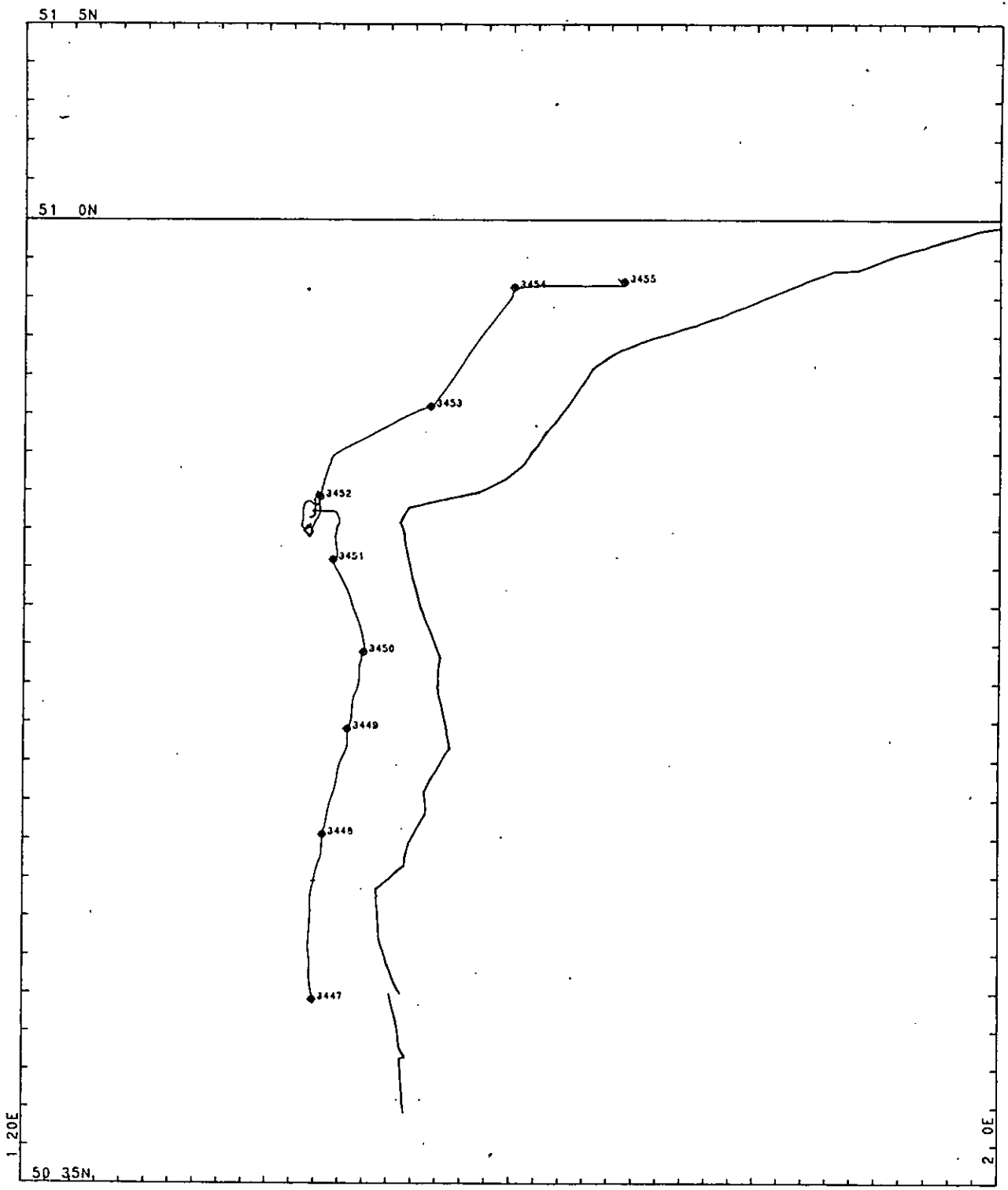
1 H.F.Radar and mooring locations in the Dover Strait.



2 Ship's track, from Hull,regional survey,cross-sections.



3 In-shore survey - English Coast.



4 In-shore survey - French Coast.