NATIONAL INSTITUTE OF OCEANOGRAPHY
Wormley, Godalming, Surrey.

"DISCOVERY" CRUISE 31 REPORT

(21st January - 12th March 1970)

DEEP WATER FORMATION IN NW MEDITERRANEAN
("MEDOC 1970")
AND
OBSERVATIONS IN MEDITERRANEAN OUTFLOW

CR 31

N.I.O. CRUISE REPORT No. 31
(Issued May 1970)

CONTENTS

Purpose of Cruise 31

This cruise had two main purposes. Up to 24th February, the aim was to observe the formation of deep water in the N.W. Mediterranean, in cooperation with the "Jean Charcot". This work was a continuation of a similar project undertaken last year (MEDOC 1969 - "Discovery" Cruise 25) and was designated MEDOC 1970.

The second main purpose of the cruise was to study the Mediterranean outflow, at a point in the Gulf of Cadiz where the outflowing water was clear of the bottom, by means of repeated TSD dips and a variety of current measuring devices.

Narrative

Left Barry 21st January
Arr. "MEDOC" area 29th January
Arr. Toulon 12th February
Left " 14th "
Left "MEDOC" area 24th February
Arr. Gibraltar 27th February
Left " 27th "
Arr. Med. Outflow area 28th February
Left " " " 7th March
Arr. Southampton 12th March

"Discovery" sailed from Barry in the evening of 21st January towards La Chapelle Bank where it was intended to lay a tide gauge. Bad weather prevented that, and passage continued towards the NW Mediterranean, with routine echo-soundings and surface temperatures being recorded. South of C. Finisterre the weather improved, and on approaching the "MEDOC" area on 28th January trial dips were made with three of the four TSD sea units on board. Work began next day with combined TSD dips and water sampling on a fairly coarse grid (Stns 7142-66) covering a region of high surface density delineated by the "Origny" earlier in the month (Fig.2). For the first section, northwards on 4°E, three TSD lowerings were made on each station, with six water bottles on each cast, with dissolved oxygen and duplicate salinity samples being drawn from each bottle. In the evening of 30th January, approaching the N. end of the 4°E section, the wind increased to 50 kts and station work was held up for about 36 hrs. Three more bottles were modified for use on the TSD cable, and when work was resumed on 1st February the stations consisted of two TSD dips with nine water bottles on each. Going southwards on 4½°E, station 7149 at 42°N had almost constant potential temperature to below 1000m and was the best indication of deep mixing in these early sections. During the night of 2nd - 3rd February work was again held up by strong winds, from the NW as before and still not particularly cold. A few of the stations near 42°N, 4½°E had surface densities greater than σ_t = 29·00, but the lack of any completely uniform layers suggested that mixing might have occurred earlier (possibly in December) and that we were looking at a slowly decaying or nearly static situation. The "Jean Charcot" sailed from Toulon on 5th February and made a rendezvous with "Discovery" that evening for exchange of recent results, after which "Discovery" continued the coarse survey with a final section on 6°E whilst the "Charcot" extended the area surveyed to the westwards. The most promising region for more detailed investigation was that near 42°N, 4½°E, and after reoccupying one station (7160/7166) where a cast of bottles had apparently pre-tripped, "Discovery" worked a 10-mile grid of nine stations

(7167-75) centred on that position. Most of these were single casts to 1350m, with occasional deep stations. This more closely spaced grid was extended to the southwest with four more stations, and then another nine stations (7180-88) were worked at 10 mile spacing centred on 42°N, $5\frac{1}{2}$°E. At the same time, the "Charcot" began a pattern of closely spaced stations centred on 42°N, 5°E. Nothing more promising than the region around 42°N, $4\frac{1}{2}$°E was revealed by these more closely spaced stations, which were completed early on 10th February, and "Discovery" returned to longitude $4\frac{1}{2}$°E to work stations spaced only 5 mls apart between 42° 08'N and 41° 47'N (7189-93). Duplicate lowerings were made with the NIO and Lowestoft 9040 TSD units on one of these stations (7191). Four more TSD stations, at 5 mile spacing on either side of the two southernmost on $4\frac{1}{2}$°E, were all that could be done before setting course towards Toulon. Two of these closely spaced stations (Nos. 7193 and 7197) showed signs of mixing having occurred some time previously to depths of about 1300m.

The "Jean Charcot" was in port during most of the "Discovery's" stay in Toulon, and several discussions took place about the results obtained and future plans. "Discovery" sailed at 1700/14th Feb. in rapidly worsening weather, and hove to in 50-knot winds before reaching the most favourable area near 41°55'N, 4° 25'E. The strong winds continued until the afternoon of 16th Feb., with quite low air temperatures (wet bulb 2·3°C). TSD work was resumed with a section northwards at 5 mile spacing, starting at 41° 40'N, 4° 30'E, single casts with 10 water bottles per station. The cold strong winds had produced new well-mixed layers extending to 1300-1400m. Stratified water was encountered at 42° 05'N and another section was started, going southwards on 4° 10'E. In the meantime "Charcot" had occupied a section on 4° 20'E, and had launched a float measuring vertical motion in the mixed water.

The 4° 10'E section, being mostly in stratified water, had closed off the western edge of the newly formed well mixed patch. Our intention was to make further sections to delineate its full extent, but work was again interrupted by strong winds during 18th Feb. Starting again on the 19th, the 4° 30'E section was extended southwards to 41° 25'N, followed by a section northward on 4° 40'E.

This third section showed quite deep mixing, with very uniform water to 1700m at Stn 7219, and the northern boundary near 42° 05'N as before. Further progress was again interrupted by strong winds overnight 21st - 22nd Feb. With only part of two days remaining available for work in the "MEDOC" area, the rest of the stations were placed so as to define the eastern limit of the patch of mixed water. Its northern boundary seemed to be associated with a sharp rise of surface temperature of about 0·2 deg. C and this surface temperature discontinuity was tracked eastwards during 23rd Feb. in weather unsuitable for TSD work. By the time that the "Discovery" had to leave the area, in the evening of 24th Feb., the extent of the patch of mixed water had been fairly well defined, despite continuing bad weather.

Course was then set for Gibraltar and preparations made for work in the outflowing Mediterranean water SE of Cape St. Vincent. The shear probe had already been tested once, on a wire, and another test lowering was made before arrival at Gibraltar.

Leaving Gibraltar before noon 27th Feb., "Discovery" reached the chosen area for the outflow study late that night, and after a brief echo-sounding survey laid a mooring with 7 current meters, subsurface buoyancy and a surface dan buoy in the morning of 28th Feb. A series of TSD dips was then started, about 3 mls upstream (in the outflow) from the buoy. Lowerings through the core of the Mediterranean water were made at 2-hourly intervals, recovering the TSD and manoeuvring back into position after every 3 lowerings. The routine was broken occasionally to permit other observations to be made. The shear probe was launched and recovered four times in this area, the bottom current tripod was put down twice on a separate mooring, and the EM current meter sphere was put down and recovered once. The latter instrument was laid a second time on 4th March but could not be released, and the TSD dips were concluded by midday 6th March to allow time for dragging for it. The dragging continued until 1000/7th March without success, and the command pinger in the EM current meter sphere, still working, was turned off. An even more serious loss occurred soon afterwards, when the current meter mooring was being recovered. The wires attached to the subsurface buoy had somehow become twisted and the lower one broke when it was lifted, causing the loss of all 7 current meters.

"Discovery" then set course towards Southampton, towing a streamlined fish containing a T-S probe instead of the usual echo-sounding fish for most of the homeward passage. The shear probe was tried again near the continental slope in the northern part of the Bay of Biscay, and the tide gauge was laid on La Chapelle Bank in the afternoon of 10th March. With favourable weather, "Discovery" arrived at Southampton before noon on 12th March.

List of Scientific Participants

1-3	Mr. D. Brown	(N.I.O.)	
1-3	Mrs. P. Edwards	"	
1-3	Miss R. Howarth	"	
1-3	Mr. J.A. Moorey	"	
1-3	Mr. G.K. Morrison	"	
1-3	Mr. T. Sankey	"	
1-3	Dr. J.C. Swallow	"	Principal Scientist
1,3	Mr. R. Spencer	"	
1-2	Mr. M.J. McCartney	"	
1	Mr. G.N. Crisp	"	
1	Mr. J. Sherwood	"	
1	Prof. H. Charnock	(Univ. of Southampton)	
1-3	Mr. P.K. Taylor	(" " ")	
1-3	Mr. A.J. Elliott	(Univ. of Liverpool)	
1	Dr. R. Dickson	(Lowestoft)	
1	Mr. J. Bedwell	(")	
2-3	Mr. D.I. Gaunt	N.I.O.	
2-3	Mr. D. Grohmann	"	
2-3	Dr. S.A. Thorpe	"	
2-3	Dr. J. Simpson	(UCNW/NIO)	
2-3	Mr. A. Roberts	(U.C. of North Wales)	

1 Barry to Toulon
2 Toulon to Gibraltar
3 Gibraltar to Southampton

Notes on Equipment and Observations

1. TSD Probes (Sankey, Morrison, Swallow)

A total of four Bissett-Berman TSD sea units and two sets of deck equipment were available on this cruise. The Liverpool University 9006 sea unit had been borrowed as a spare in case the NIO 9006 gave trouble, then just before the cruise it was arranged that the Lowestoft 9040 system should be brought for comparison, and at the last minute the NIO 9040 sea unit was returned from being repaired by Bissett-Berman. Both NIO units worked satisfactorily for most of the time but developed intermittent noise particularly on the salinity trace, which in one case seemed to be due to humidity in the sea unit but in other cases was more obscure. The NIO 9040 was lowered 125 times and the 9006 unit 54 times. Two lowerings were made with the Lowestoft instrument for evaluation.

During the outward passage, the digital logger and interface between TSD and computer were worked on, but were not operating satisfactorily by the time TSD observations began, and further work on them would have interrupted the analogue records. So these records were read and punched manually on to paper tape for off line processing. The observed periods were first converted to nominal values of pressure, temperature and salinity and stored on a disk file for future correction. Initially only depth corrections were applied and superimposed graphs of water bottle data and TSD data, from the same cast, were plotted. From these, the appropriate T and S corrections for the TSD data could be estimated.

2. Water Sampling and Analysis (Moorey, McCartney, Swallow)

All the water sampling was done simultaneously with the TSD, on the same wire, except for samples at 10m depth which were collected separately when the TSD probe was at the same depth. In the Mediterranean, oxygen and duplicate salinity samples were drawn from each bottle. Phosphate samples were measured on 13 stations and silicate at 10 stations in the initial survey of the "MEDOC" area. Salinities were measured on the NIO thermostat salinometer, duplicates being done on separate standardizations to reduce the risk of systematic error.

3. Meteorological Records (Mrs. Edwards)

In addition to the usual met. log kept by the deck officers, continuous analogue records were taken on the Met. Office Speedomax Recorder of the output from the solarimeter and of the dry and dry-wet bulb temperatures given by the resistance thermometers in screens on the upper bridge deck. Readings to check and calibrate the latter were taken at about four-hourly intervals with an Assmann psychrometer and the mercury-in-glass thermometers mounted in screens on the bridge deck, and further series of readings using two Assmann psychrometers were taken to compare temperatures on the two decks. Wind speed and direction were also recorded at the same interval i.e. about every four hours or whenever a station was being worked.

Calibrations for the resistance thermometers were derived empirically, and the dry- and wet-bulb readings sampled by the computer at 2 second intervals; a mean reading (over two minutes) of dry-bulb, wet-bulb and humidity was then printed out every

30 minutes. Solarimeter readings were data-logged in a similar manner.

4. Surface Temperature Records (Morrison, Mrs. Edwards)

A quartz crystal temperature sensor was mounted in a spar extending 18" below the asdic plate, together with three thermistors and a platinum resistance element each of which was arranged to vary the frequency of a separate oscillator circuit. Another thermistor, similarly connected, was attached directly to the asdic plate itself. The frequencies of these oscillators and the signal from the quartz thermometer were recorded throughout the cruise, providing a surface temperature record and material for evaluation of the long term stability of the various temperature sensors. Intercalibrations were made on four occasions between another quartz thermometer, the TSD temperature sensor, the Met. Office bucket, the Met. Office limpet thermometer, the Crawford bucket and a leather bucket and surface thermometer, and comparisons between some of these were made on seven other occasions.

5. Navigation Aids (Brown, Sherwood, Swallow)

Navigation depended about equally on satellite fixes and celestial observations. The dead reckoning programme and computation of surface currents, using the 2-component log output combined with satellite fixes, worked well but was limited by failure of the gyro compass. This was out of action for much of the cruise despite an attempt at repair in Toulon. The Loran-C receiver hired from Decca suffered badly from interference and was only occasionally used.

6. Measurement of Current near the Sea Floor (Thorpe)

(1) E.M. flow meter sphere

An electromagnetic flow meter with electronics and recorder housed inside a sphere was used to measure currents near the sea floor. The sphere used is identical to those used previously by Whitmarsh for seismic studies. The head of the flow meter was supported in a near horizontal position above the sphere and at a height of about 2m above the sea floor. The two horizontal components of current were recorded simultaneously for 4 mins in each hour by means of a photographic SFIM recorder. The orientation and inclination of the sphere was measured by a simple pendulum and magnet arrangement which was jammed in position by a spring some time after the sphere had reached the sea floor. The sphere was allowed to free fall to the sea floor and was designed to be recovered after acoustically firing a pyro release after three corrosive supports had parted between the sphere and its base plate. The acoustics had a supporting clock mechanism housed inside the sphere. A pinger operated when the sphere was submerged (except during the 4 minute recording periods when it was switched off to avoid interference) and a second "recovery" pinger operated when the sphere was on its side or at the surface.

During the first use of the sphere at Station 7242 the recorder and E.M. electronics functioned satisfactorily. However in spite of repeated attempts it was not found possible to release the sphere from the sea floor as intended on 1st March and it was not until the next day that the sphere returned to the surface and was recovered some $3\frac{1}{2}$ miles to the NW of the launch position after tracking by hydrophones.

It was thought that the corrosive links had not parted as quickly as predicted (6-8 hrs), possibly because they were partly shielded from the current by cups arranged to catch the bubbles released during corrosion. Part of one of the links was still attached to the sphere on recovery. The cups were raised well above the links and reduced in size before the second launch.

The sphere was lost on the second launch, Station 7262. It did not rise from the sea floor when the pyro release was acoustically operated or when the release was due to be operated by the clock. The electronics were apparently satisfactory since the pinger continued to switch off during the recording cycle, at least for about 30 hrs after which the batteries operating the E.M. flowmeter circuit were expected to run down. Flooding of the sphere seems therefore unlikely. About 18 hrs were spent in dragging for the sphere without success. The most likely explanation for the failure to release the sphere from the sea floor appears to be that the recovery line or the line to the "recovery" pinger had become caught up on the base plate, but it is recommended that tests should be made on the decay of corrosive links under pressure.

(2) Tripod

The tripod carried a camera and flash unit which took photographs on 16 m.m. ciné film of vanes, dye and a compass which together indicated the current direction and magnitude close to the sea floor at regular intervals. The tripod was put out on a mooring with subsurface buoyancy and a surface dan buoy.

The first leg was at Station 7242 in a position very close to the E.M. flow meter sphere with which a comparison will be made. Photographs were taken every 15 secs for about 8 hours and the camera appears to have operated well.

The second lay was at Station 7256 with photographs every one second. The take-up spool in the camera failed to operate properly and only a few frames were exposed whilst the camera was on the sea floor. These are sufficient to determine the current magnitude and direction, but do not provide information over a tidal cycle as had been hoped.

7. Microstructure Probe (Simpson)

Preliminary trials were made of a new free fall device designed for the measurement of small scale velocity and temperature fluctuations. A small, neutrally buoyant vane is suspended below a slowly falling body of high static stability. Vertical changes in current cause displacements of the vane which are sensed electrically by two pairs of electrodes and recorded by a small photographic recorder. The depth and fall speed are obtained from a strain gauge pressure transducer. Two other channels are used for recording temperature and temperature gradient.

After falling to a predetermined depth at between 10 and 20 cm/sec., ballast is dropped by a hydrostatic pressure release and the probe returns to the surface. A pinger and flashing light are provided to assist recovery.

Five releases to depths between 250 and 500 metres were made during the cruise.

8. <u>Midwater Current Meter Mooring</u> (Swallow, Gaunt)

One current meter mooring was laid during the cruise (Station 7237) with four Bergen and three Braincon meters in the depth range 400 to 1400m, i.e. through the core of the Mediterranean outflow. The mooring had a subsurface float at a nominal depth of 100m and enough surface buoyancy to float the whole mooring including sinkers in case it dragged into deeper water. It showed no signs of dragging; out of 35 satellite + radar fixes, 29 were within 0·2 ml. of the mean position. Unfortunately, on attempting to recover the mooring after 7 days in the water the current meters were lost as mentioned in the narrative above.

9. <u>Towed Temperature and Salinity Profiler</u> (Moorey)

An attempt had been made, on the previous cruise, to use a simple temperature and salinity probe underway mounted on the echo-sounding fish, but the extra cable and fairing had made it tow badly. This time, the probe was tried on its own, using the towing cable normally used for the echo sounder. A record was obtained for the 2 day passage from C. St. Vincent to La Chapelle Bank. Water samples were collected for salinity calibration (Stations 7273 and 4).

Tables and Figures

Table I Station List
Abbreviations - TSD: temperature-salinity-depth probe
WB: water sampling
EMCM: electromagnetic current meter

Fig.1. Track Chart
showing noon positions and working areas.

Fig.2. Stations in MEDOC area 29 Jan — 11 Feb
Stns. 7142-7197

Fig.3. Stations in MEDOC area 16 - 24 Feb.
Stns. 7198-7235.

TABLE I

CRUISE 31 STATION LIST

Stn. No.	Date	Time (GMT)	Lat.	Long.	Gear Used
7141	28/1	1322-2030	39°06'·4N	0°44'·0E	TSD trials
7142	29/1	1312-2030	41°10'·0N	4°02'·0E	TSD,WB
7143	29-30/1	2242-0337	41°30'·2N	4°03'·0E	TSD,WB
7144	30/1	0550-1037	41°51'·2N	3°56'·2E	TSD,WB
7145	30/1	1230-1706	42°09'·8N	3°59'·5E	TSD,WB
7146	1/2	0400-0520	42°29'·8N	4°00'·0E	TSD,WB
7147	1/2	0753-0916	42°37'·0N	4°30'·0E	TSD,WB
7148	1/2	1057-1407	42°20'·0N	4°22'·5E	TSD,WB
7149	1/2	1626-1944	42°00'·0N	4°30'·0E	TSD,WB
7150	1-2/2	2140-0224	41°40'·0N	4°30'·0E	TSD,WB
7151	2/2	0425-0828	41°20'·0N	4°30'·0E	TSD,WB
7152	2/2	1050-1420	41°33'·0N	5°00'·0E	TSD,WB
7153	2/2	1610-2028	41°50'·3N	5°00'·2E	TSD,WB
7154	4/2	0622-1100	40°10'·5N	5°03'·0E	TSD,WB
7155	4/2	1340-1628	42°30'·6N	4°58'·5E	TSD,WB
7156	4/2	1914-2050	42°47'·8N	4°55'·4E	TSD,WB
7157	5/2	0015-0133	42°58'·0N	5°30'·8E	TSD,WB
7158	5/2	0315-0627	42°40'·2N	5°30'·4E	TSD,WB
7159	5/2	0844-1200	42°20'·0N	5°30'·2E	TSD,WB
7160	5/2	1357-1700	42°01'·6N	5°28'·7E	TSD,WB
7161	5-6/2	2112-0059	41°40'·7N	5°30'·0E	TSD,WB
7162	6/2	0308-0703	41°41'·5N	6°02'·0E	TSD,WB
7163	6/2	0908-1402	41°59'·2N	6°02'·0E	TSD,WB
7164	6/2	1603-1928	42°20'·1N	5°59'·2E	TSD,WB
7165	6-7/2	2138-0059	42°38'·5N	5°57'·0E	TSD,WB
7166	7/2	0506-0615	41°58'·5N	5°28'·0E	TSD,WB
7167	7/2	0939-1054	42°11'·0N	4°41'·0E	TSD,WB
7168	7/2	1218-1334	41°59'·8N	4°39'·3E	TSD,WB
7169	7/2	1513-1718	41°50'·1N	4°46'·2E	TSD,WB
7170	7/2	1906-2112	41°50'·0N	4°28'·0E	TSD,WB
7171	8/2	0005-0137	41°58'·5N	4°28'·1E	TSD,WB
7172	8/2	0313-0445	42°07'·8N	4°28'·9E	TSD,WB
7173	8/2	0612-0736	42°10'·5N	4°15'·0E	TSD,WB
7174	8/2	0911-1025	41°57'·7N	4°13'·8E	TSD,WB
7175	8/2	1157-1320	41°48'·5N	4°14'·3E	TSD,WB

7176	8/2	1434-1553	41°40'·3N	4°16'·2E	TSD,WB	
7177	8/2	1717-1850	41°29'·5N	4°18'·2E	TSD,WB	
7178	8/2	2005-2130	41°29'·7N	4°30'·2E	TSD,WB	
7179	8-9/2	2306-0025	41°40'·5N	4°30'·8E	TSD,WB	
7180	9/2	0336-0506	41°50'·0N	5°15'·3E	TSD,WB	
7181	9/2	0640-0800	41°50'·5N	5°31'·5E	TSD,WB	
7182	9/2	0930-1050	41°51'·0N	5°44'·0E	TSD,WB	
7183	9/2	1207-1326	42°00'·0N	5°44'·7E	TSD,WB	
7184	9/2	1454-1621	42°09'·5N	5°44'·0E	TSD,WB	
7185	9/2	1746-2000	42°09'·5N	5°31'·5E	TSD,WB	
7186	9/2	2123-2341	41°59'·0N	5°29'·0E	TSD,WB	
7187	10/2	0123-0327	41°59'·9N	5°14'·2E	TSD,WB	
7188	10/2	0502-0741	42°08'·0N	5°16'·0E	TSD,WB	
7189	10/2	1640-1850	42°08'·0N	4°27'·0E	TSD,WB	
7190	10/2	1927-2134	42°04'·7N	4°26'·7E	TSD,WB	
7191	10-11/2	2225-0322	41°59'·0N	4°30'·8E	TSD,WB	
7192	11/2	0403-0616	41°52'·8N	4°30'·0E	TSD,WB	
7193	11/2	0700-0910	41°47'·2N	4°30'·0E	TSD,WB	
7194	11/2	1000-1141	41°48'·0N	4°36'·0E	TSD,WB	
7195	11/2	1233-1424	41°52'·5N	4°35'·5E	TSD,WB	
7196	11/2	1615-1824	41°45'·3N	4°21'·3E	TSD,WB	
7197	11/2	2000-2158	41°50'·8N	4°24'·0E	TSD,WB	
7198	16/2	1734-2104	41°39'·0N	4°29'·5E	TSD,WB	
7199	16-17/2	2156-0049	41°44'·0N	4°29'·4E	TSD,WB	
7200	17/2	0158-0423	41°49'·5N	4°29'·9E	TSD,WB	
7201	17/2	0524-0739	41°55'·0N	4°28'·7E	TSD,WB	
7202	17/2	0833-1036	41°59'·8N	4°27'·9E	TSD,WB	
7203	17/2	1122-1323	42°05'·0N	4°28'·0E	TSD,WB	
7204	17/2	1446-1625	42°05'·7N	4°08'·6E	TSD,WB	
7205	17/2	1716-2013	42°00'·0N	4°11'·2E	TSD,WB	
7206	17/2	2013-2217	41°54'·3N	4°12'·5E	TSD,WB	
7207	17-18/2	2315-0120	41°48'·7N	4°10'·3E	TSD,WB	
7208	18/2	0204-0358	41°43'·5N	4°08'·6E	TSD,WB	
7209	18/2	0450-0736	41°38'·6N	4°07'·5E	TSD,WB	
7210	19/2	0854-1049	41°34'·5N	4°09'·2E	TSD,WB	
7211	19/2	1239-1500	41°40'·4N	4°28'·0E	TSD,WB	
7212	19/2	1541-1834	41°35'·1N	4°32'·0E	TSD,WB	Shear Probe
7213	19/2	1912-2113	41°29'·8N	4°32'·0E	TSD,WB	
7214	19-20/2	2159-0007	41°23'·1N	4°29'·4E	TSD,WB	

7215	20/2	0106-0302	41°25'·0N	4°39'·8E	TSD,WB
7216	20/2	0408-0550	41°30'·9N	4°41'·0E	TSD,WB
7217	20/2	0722-0935	41°36'·7N	4°40'·5E	TSD,WB
7218	20/2	1025-1245	41°41'·2N	4°39'·9E	TSD,WB
7219	20/2	1326-1524	41°44'·9N	4°39'·8E	TSD,WB
7220	20/2	1607-1810	41°49'·7N	4°39'·8E	TSD,WB
7221	20/2	1756-2049	41°53'·9N	4°40'·2E	TSD,WB
7222	20/2	2158-2346	41°58'·5N	4°41'·4E	TSD,WB
7223	21/2	0550-0803	42°05'·0N	4°40'·3E	TSD,WB
7224	21/2	0922-1122	42°04'·2N	4°49'·0E	TSD,WB
7225	21/2	1210-1418	41°59'·5N	4°48'·5E	TSD,WB
7226	21/2	1459-1727	41°54'·8N	4°50'·0E	TSD,WB
7227	21/2	1831-2042	41°54'·8N	4°58'·0E	TSD,WB
7228	22/2	1448-1645	41°47'·4N	4°57'·0E	TSD,WB
7229	22/2	1756-1958	41°47'·7N	5°06'·5E	TSD,WB
7230	22/2	2115-2324	41°55'·0N	5°09'·8E	TSD,WB
7231	23/2	0850-1052	41°43'·0N	5°25'·8E	TSD,WB
7232	23/2	1658-1848	41°29'·8N	5°09'·4E	TSD,WB
7233	23/2	2006-2205	41°34'·9N	5°24'·8E	TSD,WB
7234	23-24/2	2330-0126	41°39'·7N	5°10'·0E	TSD,WB
7235	24/2	0333-0525	41°54'·5N	5°23'·2E	TSD,WB
7236	28/2	0221-0344	36°13'·8N	8°00'·4W	TSD,WB
7237	28/2	0431-0937	36°14'·2N	8°05'·1W	Current meter mooring (051)
7238	28/2	1004- 1347	36°12'·0N 36°12'·3N	8°00'·9W 8°01'·1W	TSD Dip 1 " Dip 2
7239	28/2	1349-1518	36°12'·9N	8°01'·2W	TSD Shear probe
7240	28/2	1530- 2130	36°12'·1N 36°12'·2N 36°12'·3N	8°01'·25W 8°02'·5W 8°02'·7W	TSD Dip 1 " Dip 2 " Dip 3
7241	28/2-1/3	2158- 0556	36°12'·3N 36°12'·3N 36°12'·5N 36°12'·5N	8°01'·0W 8°01'·0W 8°01'·2W 8°01'·4W	TSD Dip 1 " Dip 2 " Dip 3 " Dip 4
7242	1/3	0605- 0836	36°13'·2N 36°13'·1N	8°03'·0W 8°03'·1W	EMCM Sphere(mooring 052) Tripod mooring (053)
7243	1/3	0900- 1452	36°12'·0N 36°12'·0N 36°12'·3N 36°12'·5N	8°01'·0W 8°01'·0W 8°01'·1W 8°01'·2W	TSD Dip 1 " Dip 2 " Dip 3 " Dip 4
7244	1/3	2034-2140	36°12'·2N	8°01'·1W	TSD

7245	1-2/3	2200-	36°11'·7N	8°01'·3W	TSD Dip 1
			36°12'·2N	8°01'·0W	" Dip 2
		0254	36°12'·0N	8°01'·0W	" Dip 3
7246	2/3	0400-	36°12'·1N	8°01'·1W	TSD Dip 1
		0747	36°12'·15N	8°01'·0W	" Dip 2
7247	2/3	0757-1112	36°12'·0N	8°00'·8W	TSD recover tripod
7248	2/3	1133-1320	36°12'·0N	8°01'·0W	TSD
7249	2/3	1343-1508	36°12'·0N	8°00'·9W	TSD
7250	2/3	1738-	36°12'·0N	8°00'·6W	TSD Dip 1
			36°12'·1N	8°00'·6W	" Dip 2
		2251	36°12'·4N	8°00'·2W	" Dip 3
7251	2-3/3	2311-	36°12'·0N	8°00'·9W	TSD Dip 1
			36°12'·1N	8°00'·2W	" Dip 2
		0518	36°12'·4N	7°59'·6W	" Dip 3
7252	3/3	0553-	36°12'·5N	8°00'·9W	TSD Dip 1
			36°12'·4N	8°01'·0W	" Dip 2
		1040	36°12'·7N	8°01'·0W	" Dip 3
7253	3/3	1133-	36°11'·9N	8°00'·7W	TSD Dip 1
		1445	36°12'·1N	8°00'·2W	" Dip 2
7254	3/3	1445-1533	36°12'·1N	8°00'·1W	Abyssal Pisa
7255	3/3	1550-1700	36°12'·0N	8°01'·1W	TSD
7256	3/3	1727-1910	36°12'·7N	8°02'·6W	Tripod mooring (054)
7257	3-4/3	1920-	36°12'·3N	8°00'·7W	TSD Dip 1
			36°12'·3N	8°01'·0W	" Dip 2
		0118	36°12'·1N	8°01'·6W	" Dip 3
7258	4/3	0136-	36°11'·6N	8°01'·0W	TSD Dip 1
			36°11'·8N	8°01'·2W	" Dip 2
		0727	36°11'·7N	8°01'·1W	" Dip 3
7259	4/3	0750-	36°12'·0N	8°00'·9W	TSD Dip 1
			36°11'·9N	8°01'·1W	" Dip 2
		1309	36°11'·6N	8°01'·6W	" Dip 3
7260	4/3	1327-1514	36°12'·1N	8°00'·8W	Shear Probe
7261	4/3	1528-	36°11'·9N	8°00'·6W	TSD Dip 1
		1848	36°11'·7N	8°00'·7W	" Dip 2
7262	4/3	1926-2020	36°14'·2N	7°59'·2W	EMCM Sphere (mooring 055)
7263	4-5/3	2056-	36°11'·6N	8°00'·9W	TSD Dip 1
			36°11'·5N	8°01'·0W	" Dip 2
		0100	36°11'·4N	8°01'·0W	" Dip 3
7264	5/3	0200-	36°11'·7N	8°00'·6W	TSD Dip 1
			36°11'·5N	8°00'·8W	" Dip 2
		0648	36°11'·5N	8°00'·3W	" Dip 3
7265	5/3	0941-1235	36°11'·8N	8°01'·0W	TSD Recover tripod mooring (054)
7266	5/3	1404-1538	36°11'·4N	8°01'·1W	TSD Shear probe

7267	5/3	1555–1650	36°12'·0N	8°00'·7W	TSD
7268	5/3	1810–1919	36°12'·1N	8°00'·7W	TSD
7269	5–6/3	2150–	36°11'·7N	8°01'·4W	TSD Dip 1
		0054	36°11'·7N	8°01'·4W	" Dip 2
7270	6/3	0232–	36°12'·0N	8°00'·9W	TSD Dip 1
			36°12'·1N	8°00'·8W	" Dip 2
		0647	36°12'·1N	8°00'·9W	" Dip 3
7271	6/3	0813–1009	36°11'·6N	8°01'·2W	TSD Shear probe
7272	6/3	1020–1135	36°12'·2N	8°00'·8W	TSD
7273	7/3	1850–1910	37°09'·8N	9°05'·8W	WB (10m)
7274	8/3	1001–1019	39°46'·6N	9°37'·8W	WB (10m)
7275	10/3	0900–1100	47°27'·0N	7°23'·5W	Shear Probe
7276	10/3	1509–1548	47°39'·9N	7°15'·5W	Laying Tide Gauge (mooring 056)
7277	11/3	1330–1413	49°51'·6N	3°11'·0W	Pisa (2 dips)

DISCOVERY CRUISE 31 'MEDOC 70' Noon Positions

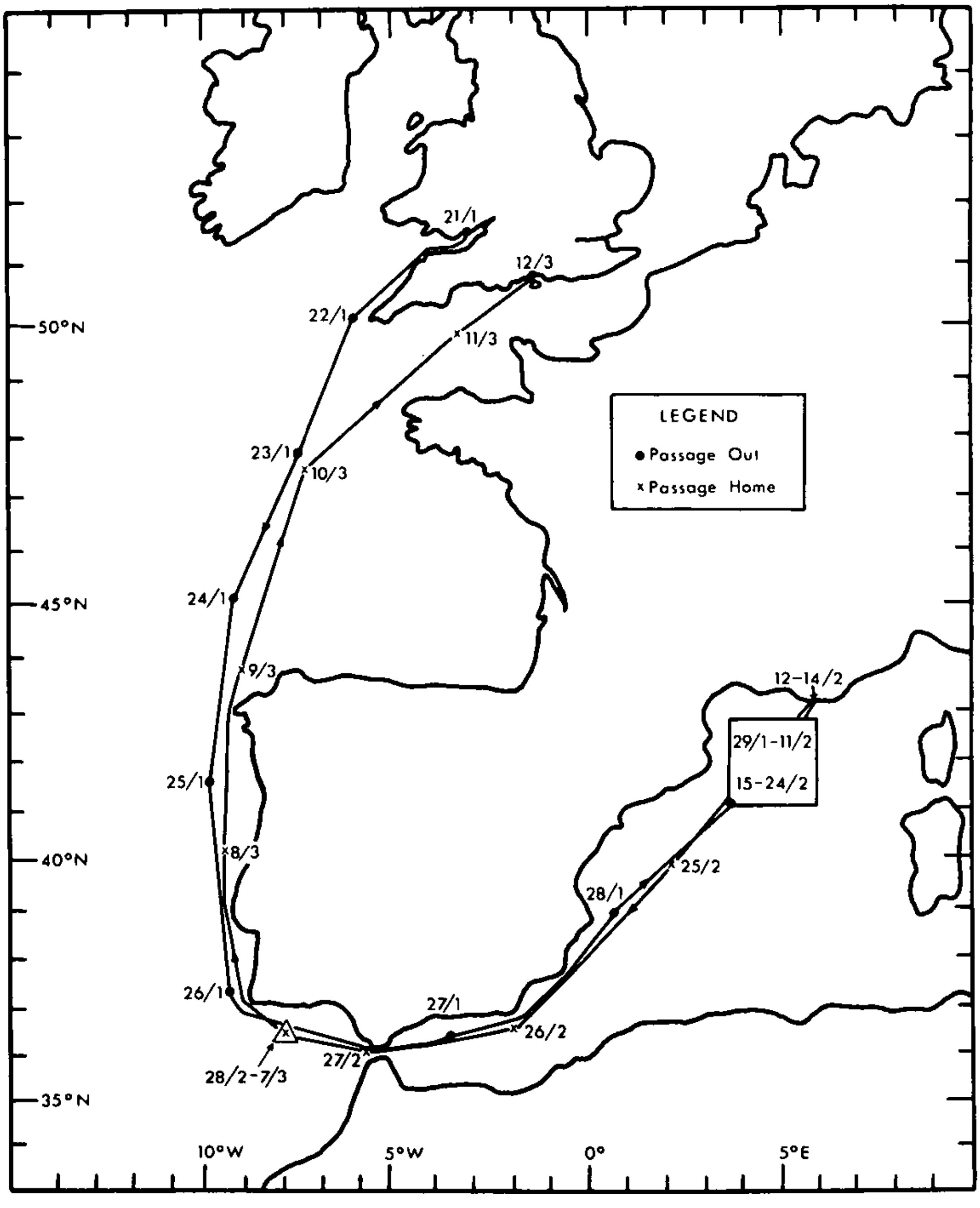

Fig. 2 Stations 29 Jan. — 11 Feb.

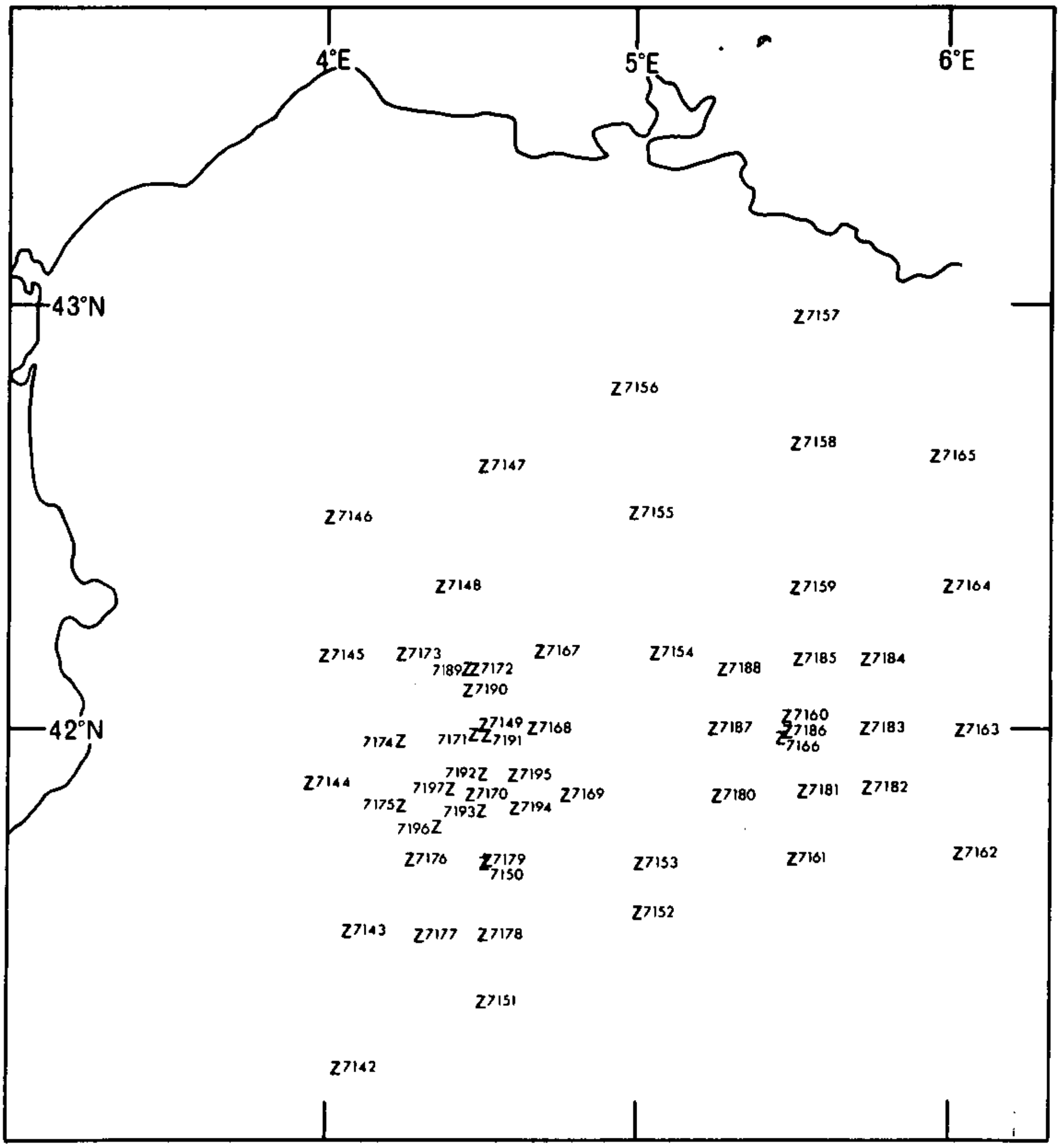

Fig. 3 Stations 16 — 24 Feb.