NATIONAL INSTITUTE OF OCEANOGRAPHY
Wormley, Godalming, Surrey.

"DISCOVERY" CRUISE 10 REPORT

(15th February - 6th April, 1966)

INSTRUMENT TRIALS AND OCEANOGRAPHIC OBSERVATIONS

N.I.O. CRUISE REPORT SERIES: CR 10

CONTENTS

INTRODUCTION

This was primarily an equipment-testing cruise. The following instruments, either new or still to some extent under development, were used:

1. Thermistor chain and helical warping capstan.
2. Pop-up buoy mooring including current meters.
3. Instrumented fish for towed body stability study.
4. Two-component electromagnetic log.
5. Near-surface thermistor spar.
6. Modified Pisa bottom current indicator.
7. Air gun sound source (Cambridge)
8. Deep moored magnetometer (Cambridge)
9. Pressure cases for bottom seismic gear (Cambridge)
10. Recording current meter (Plessey Co.)
11. Sound velocity meter (Plessey Co.)
12. Temperature-depth probe (Lowestoft)

Besides trials of the above instruments, some deliberate observations were made. These included:

13. Pressure recording on Seine Bank
14. Near-bottom water sampling and temperature gradient measurement.
15. A study of patchiness of Mediterranean water.

The above items are described in more detail below. In addition, routine echo-soundings were taken throughout the cruise, and a magnetometer was towed for part of the time.

ITINERARY (see track chart)

"Discovery" left Millbay Dock p.m. 15th February and sailed from Plymouth Sound a.m. 16th, but had to return later the same day to land a sick 3rd. mate. Sailing again in the morning of the 18th, slow progress was made in poor weather, with thermistor chain trials on passage. The plan was to work southwards to Seine Bank by way of isolated deep holes near $43\frac{1}{2}^{O}$N, $15\frac{1}{2}^{O}$W, and $39\frac{1}{2}^{O}$N, 13^{O}W, where near-bottom water samples were taken and "Pisa" current measurements were made.

Seine Bank was reached p.m. 26th February and a dan buoy anchored in 100 fms. depth. Bad weather delayed the bathymetric survey but pressure recording was possible the next day. Work continued on the Bank until p.m. 28th. February.

CR.10 The abyssal plain area near 32^{O}N, 15^{O}W had been chosen as a suitable place for trying the deep magnetometer and pop-up buoy mooring, and work started there a.m. 1st. March. This continued until mid-day 7th, with various projects being worked on, and a buoy anchored for the last 4 days of the period. On completion, course was set for Funchal, Madeira, with air gun and thermistor chain trials on passage. The vessel arrived at Funchal a.m. 8th March, leaving again a.m. 12th. The departure was delayed due to the accidental death ashore of one of the stewards. Seven scientists left at Funchal, and one joined.

The first task in the second half of the cruise was the survey of the 50-mile square bounded by latitudes 34°10'N, 35°N and longitudes 19°W, 20°W. A 10-mile grid of stations for water sampling, velocimeter and temperature-depth probe observations was occupied, in a study of the patchiness of Mediterranean water. This had to be broken off in order to land the Chief Steward at Madeira to return home for compassionate reasons. Navigation in the 50-mile square was greatly aided by the new Azores-Maderia- Cape St. Vincent Loran A chain. Limited areas were surveyed in closer detail with the velocimeter, and further current measurements and other experimental work were undertaken in that area until mid-day 29th. March.

A section was then started towards Cape St. Vincent, with velocimeter dips every 20 miles and water-sampling in the Mediterranean water every 60 miles. This was completed late on 1st. April.

A quick passage northward along the coast of Portugal gave time for some further near-bottom observations and air-gun profiling in the Bay of Biscay, and further thermistor chain trials on the continental slope. "Discovery" anchored in Plymouth Sound late on 5th. April and entered Millbay dock next morning.

SCIENTIFIC PERSONNEL

(a)	Mr. D.G. Bishop	N.I.O.
	Dr. J.N. Carruthers	N.I.O.
	Lt. D. Clifford, R.N.	Naval Weather Service
	Mr. J. Crease	N.I.O.
	Mr. R. Dobson	N.I.O.
(a)	Miss E. Eady	Plessey Co.
(a)	Mr. L.H. Flavill	Geophysics Dept. Cambridge
(b)	Mr. G. Fox	Fisheries Laboratories, Lowestoft
	Mr. J. Francis	Resident Scientist
	Mr. D.I. Gaunt	N.I.O.
	Mr. W.J. Gould	Marine Science Laboratory, Menai Bridge
	Mr. E.J.W. Jones	Geophysics Dept. Cambridge
	Mr. D.T. Pugh	Geophysics Department Cambridge
(a)	Mr. N.D. Smith	N.I.O.
	Dr. R.L. Smith	Oregon State University/N.I.O.
(a)	Mr. J. Sunderland	Geophysics Department Cambridge
(c)	Dr. J.C. Swallow	N.I.O.
(a)	Mr. S.A. Thorpe	N.I.O.
(a)	Mr. R. Whitmarsh	Geophysics Department Cambridge
	Mr. T. Vertue	Geophysics Department Cambridge

(a) left at Madeira
(b) joined at Madeira
(c) principal scientist

SCIENTIFIC PROJECTS

The following brief notes outline the progress made with each project during the cruise. The persons named should be consulted for fuller details.

1. Thermistor chain and helical warping capstan (Dobson, Bishop).

The chain suffered from many minor troubles - leakage into the cable ends, weakness of the rubber fairing, electrical defects in the control circuits for the capstan - and much effort had to be devoted to overcoming these. Of a total accumulated towing time of about a week, temperature records were taken for a total of about 80 hours. Very little variation of temperature was apparent. The capstan itself worked well, but its versatility would be improved by having interchaneable storage reels for the take-up winch.

2. Pop-up buoy mooring and current meters (Gaunt, Crease, Swallow)

A mooring was laid near 32°N, 15°W on 3rd. March, in 4400m. depth, with the acoustic release gear at 2400m. and three current meters (Geodyne, Braincon and Plessey) spaced 10m. apart at 1500m. depth. Flotation was provided by 3 submerged buoys at 200m. depth, attached by 400m. of wire to a surface dan buoy. Two neutrally buoyant floats were laid, loaded for 1500m. depth, for comparison with the current meters, and acoustic markers were laid on the sea bed to provide a check on dan buoy movement. The whole mooring was recovered on 7th. March. Of the three current meters, the Geodyne had worked for only part of the time, the Plessey meter suffered from electrical noise on the tape which rendered its record useless, and the Braincon gave a satisfactory record which from preliminary analysis agreed well with the neutrally buoyant float observations. The acoustic switch could be operated at ranges up to 1 mile. For the purpose of this trial it was not fitted with the electrically fired explosive release.

A second mooring was laid on 20th. March, near the middle of the 50-mile square, with the acoustic release, and two current meters at 1200m. and 1000m. While recovering this mooring on 23rd. March, a shackle got jammed on the winch frame, the wire parted, and both current meters and the acoustic release were lost. Indications were that the acoustic release had operated successfully before recovery.

Besides the comparison of current meters and the tests of range of the acoustic switching, it should be possible from the results of the first mooring to learn something about fluctuating motion of the mooring itself.

3. Instrumented fish (N. Smith)

A towed fish (similar to that used for echo-sounding) had been fitted with a gyro and means of recording its angular motion when towed at various speeds and depths. The motion of the fish was recorded in the data logger via a multicore towing cable. Observations were made at speeds of 5 knots and 10 knots, with immersed towing cable lengths of 20, 40, 60 and 80 ft., with ship motion being recorded at the same time. The records will show to what extent the fish motion is coupled to that of the ship, an important consideration in planning to use narrow beam transducers in towed bodies.

4. Two-component electromagnetic log (N. Smith, Swallow)

This instrument was made up from an electrode flowmeter borrowed from the University of Liverpool. It was fitted into a gland on the asdic plate. The sensing head gave output signals from which the magnitude and sign of the flow, in two directions at right angles, could be obtained. Preliminary tests showed the instrument to be reasonably stable, and it could be aligned accurately in the fore-and-aft line of the ship. Calibration runs relative to dan buoys were made on 2nd. and 28th. March. For the second half of the cruise, the two outputs from the flowmeter (forward speed and leeway) were recorded on a Speedomax, together with a ship's heading signal. Hourly time marks were put on from the E/S clock, and this record proved very useful in working out the detailed tracks during the survey of the 50-mile square and subsequent work in that area.

Towards the end of the cruise, the instrument began to drift badly, with zero errors of the order of a knot. Since the sensing head works on 50 c/s A.C., with about 50 ft. of cable between it and the amplifier, it seemed that varying A.C. pick-up was the most likely source of trouble. The results obtained with the instrument even in its present crude form were sufficiently promising to warrant active development of a more reliable system.

5. Near-surface thermistor spar (Crease)

A few tows were made with a short vertical array of thermistors, attached to a neuston-net sledge, to observe the thermal structure in the top few tens of centimetres of water. The instrument carried a capacitance wire wave recorder as well. In the isothermal conditions existing, very little fluctuation of temperature was seen, during tows of a few hours duration. However, the development of the equipment into a practical system for near surface sampling is quite feasible.

6. Modified Pisa current indicator (Carruthers)

The delayed clamping arrangement for the abyssal Pisa had been re-designed, using a piston and water-filled cylinder with an adjustable slow leak. It worked successfully on the first two lowerings, but then various troubles developed which were eventually overcome. In all, seventeen lowerings were made, about half of which were successful. A near-bottom current measurement was made with a neutrally buoyant float fitted with a polythene drogue and a wire tail (like a seabed drifter) which was fixed at intervals from 22nd. to 27th. March. It moved in various directions at speeds of 1 to 2 cm/sec.

7. Air gun sound source (Jones, Flavill)

The air gun is a towed body in which a piston driven by compressed air generates low frequency sound for continuous seismic reflection profiling. During the cruise, comparisons were made of the performance of two air guns and two different towed receiving hydrophone arrays, at various speeds. Satisfactory bottom echoes could be obtained at speeds up to 6 knots, and in some cases sub-bottom echoes could be seen clearly, e.g. in the small hill in the Biscay abyssal plain near 45°N, 8°W. CR.10

8. Deep-moored magnetometer (Sunderland)

This instrument was tested from the forward winch on 1st. March and appeared to be working satisfactorily. It was then prepared for laying in a buoy mooring, using non-magnetic sinkers (600 lb. wt. of sand in bags) and, for the first part of the mooring, phosphor bronze wire. Unfortunately the wire used was much weaker than the alleged breaking strain and the magnetometer was lost.

9. Pressure cases for bottom seismic gear (Whitmarsh)

These were glass spheres (Corning Glass Co.), one of them 16" in diameter. They were pressure tested by lowering on a wire to 4000m., and tests were made with a flashing light and radar responder for use with the bottom seismic equipment.

10. Recording current meter (Miss Eady)

This was the prototype of the Plessey version of the Bergen current meter. It was tested by lowering over the side with the vessel lying-to, in comparison with a Kelvin-Hughes direct reading current meter, and was laid in a mooring from 3rd. to 7th. March, at 1500m. depth. There were no signs of corrosion, fouling or mechanical damage, but, as mentioned above, the record was spoiled by electrical noise.

11. Sound velocity meter (Miss Eady, Crease, Swallow)

Further comparison was made between the Plessey velocimeter and sound velocities from water sampling; besides that, the velocimeter was used extensively in examining the structure of the Mediterranean water. A total of 89 velocimeter lowerings was made during the cruise; the only fault that appeared was due to a bent lead-through plug which could easily be repaired. The lack of a depth transducer restricts the use of the instrument somewhat.

12. Temperature-depth probe (Fox)

This instrument was also used, along with the velocimeter, in studying the Mediterranean water. Interference sometimes occurred when both instruments were used together on the same 4-core cable, since the frequency ranges of the A.C. output signals overlapped to some extent. Thirty-three lowerings were made.

13. Pressure Recording on Seine Bank (N. Smith, R. Smith)

The purpose of these observations was to see whether there were any trapped waves associated with this isolated seamount. After a brief survey to outline the shape of the top of the bank, an f.m. pressure recorder was laid in about 90 fathoms on 27th. February, and the ship kept hove-to connected to the instrument by an electric cable, without disturbing the pressure recorder, for 6 hours. Further observations were made at 2 more places next day. It was not possible to tell by visual inspection whether the expected trapped waves were present or not.

14. Near-bottom water sampling and temperature gradient measurement (Pugh)

These observations were made in an attempt to study the stability of the water close to the sea floor, being heated from below. Closely spaced water samples were taken in the bottom 100 metres in various places, some in isolated holes and some in more open situations. Temperature gradients in the bottom water were measured at the same time using the Cambridge heat flow apparatus. The observations could not have been made without the type D pinger, which worked satisfactorily throughout the cruise. Twelve casts were made, but in some of them there were suspected malfunctions possibly due to the close bottle spacing.

15. Patchiness of Mediterranean water (Crease, Swallow)

In planning to make deep current measurements in the eastern north Atlantic, one needs to have some idea of the likely length scales of variability, and the Mediterranean water is well known to be particularly patchy, though existing station data are too sparse to be much use. The 50-mile square centred on 34°35'N, 19°30'W was chosen as being an area of fairly typical deep water, well out into the Atlantic, and well covered by the Santa Maria -Porto Santo-Cape St. Vincent Loran A chain.

A 10-mile grid of stations, with water sampling to 1500m. and dips with the velocimeter and temperature-depth probe, showed that many substantial features were uncorrelated even at that close spacing. Some were examined on a 3-mile grid using the velocimeter, and three neutrally buoyant floats were used at the same time. The extent to which this patchiness of temperature and salinity influences the field of motion is still to be worked out.

CRUISE 10 STATION LIST

(Stations 5829 - 5935)

Abbreviations:

WB	Water sampling
WB(B)	Near-bottom water sampling
VM	Velocimeter
TD	Temperature-depth probe
Pisa	Pisa bottom current indicator
FNB	Neutrally buoyant float
CM	current meters
BT	bathythermograph

Station No.	Date (1966)	Time (GMT)		Lat. N	Long. W	Gear Used
5829	22/2 23/2	2224	 0650	43°37'.5	15°41'.7	Pisa W B(B)
5830	24/2 25/2	1610	 0025	39°24'	12°47'	Pisa, WB(B)
5831	26/2 28/2	2115	 1918	33°45'.1	14°22'.0	F.M. pressure recorder, Pisa, CM. (position is that of DB I)
5832	1/3 7/3	0812	 1339	(31°55', (32°00'	15°05', (DBII) 14°59' (WB)	WB, CM, VM, FNB
5833	13/3	0400	0715	34°07'.3	18°57'.2	WB, VM, TD.
5834	13/3	0922	1300	34°08'.8	19°11'.9	WB, VM, TD, BT
5835	13/3	1410	1642	34°09'.6	19°22'.5	WB, VM, TD, BT
5836	13/3	1756	1945	34°09'.8	19°31'.4	WB, VM, TD, BT
5837	13/3	2113	2355	34°08'.9	19°47'.8	WB, VM, TD, BT
5838	14/3	0106	0336	34°08'.6	20°00'.3	WB, VM, TD, BT
5839	14/3	0452	0809	34°18'.1	19°59'.8	WB, VM, BT (TD erratic)
5840	14/3	0917	1133	34°18'.5	19°48'.6	WB, VM, BT (TD being repaired)
5841	14/3	1238	1459	34°19'.4	19°35'.8	WB, VM, BT
5842	14/3	1609	1828	34°20'.4	19°21'.1	WB, VM, BT
5843	14/3	1915	2152	34°21'.1	19°11'.0	WB, VM, TD, BT
5844	14/3 15/3	2254	 0301	34°24'.1	18°59'.3	WB, TD, BT (VM erratic)
5845	15/3	0400	0656	34°32'.8	18°58'.9	WB, TD, BT (VM being repaired)
5846	15/3	0813	1044	34°33'.1	19°08'.9	WB, TD, VM, BT
5847	15/3	1210	1452	34°34'.0	19°21'.3	WB, VM, BT (TD defective)
5848	15/3	1622	1912	34°33'.6	19°34'.0	WB, TD, VM, BT
5849	15/3	2037	2306	34°32'.0	19°46'.7	WB, TD, VM, BT
5850	16/3	0023	0327	34°30'.8	19°59'.9	WB, TD, VM, BT
5851	16/3	0422	0643	34°38'.6	19°57'.2	WB, TD, VM, BT
5852	16/3	0730	1018	34°37'.9	19°49'.4	WB, TD, VM, BT
5853	16/3	1130	1426	34°37'.3	19°36'.2	WB, TD, VM, BT
5854	16/3	1532	1809	34°39'.0	19°22'.0	WB, TD, VM, BT

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Station No.	Date (1966)	Time (GMT)		Lat. N.	Long. W.	Gear Used
5855	16/3	1903	2134	34°39'.9	19°11'.3	WB, TD, VM, BT
5856	16/3 17/3	2237	0152	34°40'.4	19°00'.7	WB, TD, VM, BT
5857	17/3	0255	0514	34°51'.2	19°01'.0	WB, TD, VM, BT
5858	17/3	0630	0857	34°51'.3	19°14'.2	WB, TD, VM, BT
5859	17/3	1000	1223	34°50'.5	19°23'.3	WB, TD, VM, BT
5860	17/3	1323	1528	34°49'.8	19°33'.4	WB, TD, VM, BT
5861	19/3	0015	0248	34°58'.8	19°35'.5	WB, VM, BT, VM + TD
5862	19/3	0400	0735	34°47'.6	19°44'.2	WB, VM, BT, VM + TD
5863	19/3	0900	1246	34°50'.0	19°59'.7	WB, VM, BT, VM + TD
5864	19/3	1705	1802	34°38'.9	19°36'.7	VM
5865	19/3	1826	1926	34°38'.8	19°33'.2	VM
5866	19/3	1952	2056	34°35'.6	19°32'.8	VM
5867	20/3	0037	0239	34°34'.8	19°31'.6	Pisa
5868	20/3	0306	0750	34°38'.2	19°30'.3	Pisa (2 dips)
5869	20/3	0805	0900	34°39'.0	19°29'.1	VM
5870	20/3 23/3	0951	1717	34°39'.5	19°31'.3	CM (lost) (position is that of DB III)
5871	20/3	2035	2137	34°35'.3	19°29'.1	VM
5872	20/3 21/3	2309	0015	34°41'.9	19°28'.9	VM
5873	21/3	0058	0150	34°41'.8	19°32'.6	VM
5874	21/3	0230	0319	34°41'.7	19°36'.2	VM
5875	21/3	0419	0538	34°44'.5	19°32'.2	VM
5876	21/3	0600	0718	34°44'.5	19°27'.9	VM
5877	21/3	0736	0856	34°44'.5	19°25'.8	VM
5878	21/3	0924	1334	34°42'.3	19°24'.4	VM, WB(B)
5879	21/3	1701	1812	34°47'.5	19°32'.7	VM
5880	21/3	1850	2251	34°50'.3	19°32'.4	VM, WB(B)
5881	21/3 22/3	2335	0030	34°53'.9	19°32'.2	VM

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Station No.	Date (1966)	Time (GMT)		Lat. N.	Long. W	Gear Used
5882	22/3	0123	0218	34°50'.0	19°27'.1	VM
5883	22/3	0322	0408	34°50'.0	19°36'.1	VM
5884	22/3	0541	0757	34°39'.7	19°29'.6	FNB(B) laid, Pisa
5885	22/3	1305	1828	34°41'.1	19°27'.2	WB(B), Pisa
5886	22/3 23/3	2200	 0050	34°40'.9	19°34'.2	WB(B)
5887	23/3	0511	1050	34°39'.5	19°30'.2	WB(B), Pisa
5888	23/3	2017	2325	34°43'.7	19°31'.7	WB(B)
5889	23/3 25/3	1930	 0923	34°39'.7	19°26'.5	Pisa (4 dips)
5890	25/3	2024	2118	34°41'.5	19°35'.5	VM
5891	25/3	2202	2254	34°45'.8	19°35'.1	VM
5892	25/3 26/3	2336	 0020	34°49'.7	19°35'.0	VM
5893	26/3	0100	0221	34°53'.6	19°34'.7	VM
5894	26/3	0305	0400	34°57'.6	19°34'.2	VM
5895	26/3	0500	0553	34°53'.3	19°29'.1	VM
5896	26/3	0650	0737	34°49'.0	19°28'.7	VM
5897	26/3	1032	1240	34°39'.1	19°27'.9	Pisa
5898	26/3	1333	1412	34°45'.6	19°25'.3	VM
5899	26/3	1524	1607	34°52'.5	19°39'.5	VM
5900	26/3	1650	1731	34°52'.5	19°44'.0	VM
5901	26/3	1743	2123	34°52'.2	19°43.2	FNB's laid (position is that of DB IV)
5902	26/3 27/3	2200	 0010	34°52'.6	19°40'.7	Pisa
5903	27/3	0454	0635	34°52'.4	19°40'.5	WB, VM
5904	27/3	0635	0722	34°52'.1	19°39'.7	WB
5905	28/3 29/3	2000	 0044	34°51'.5	19°42'.9	WB(B), Pisa
5906	29/3	0100	0358	34°49'.7	19°41'.1	WB(B)
5907	29/3	0410	0707	34°49'.1	19°40'.7	VM, WB

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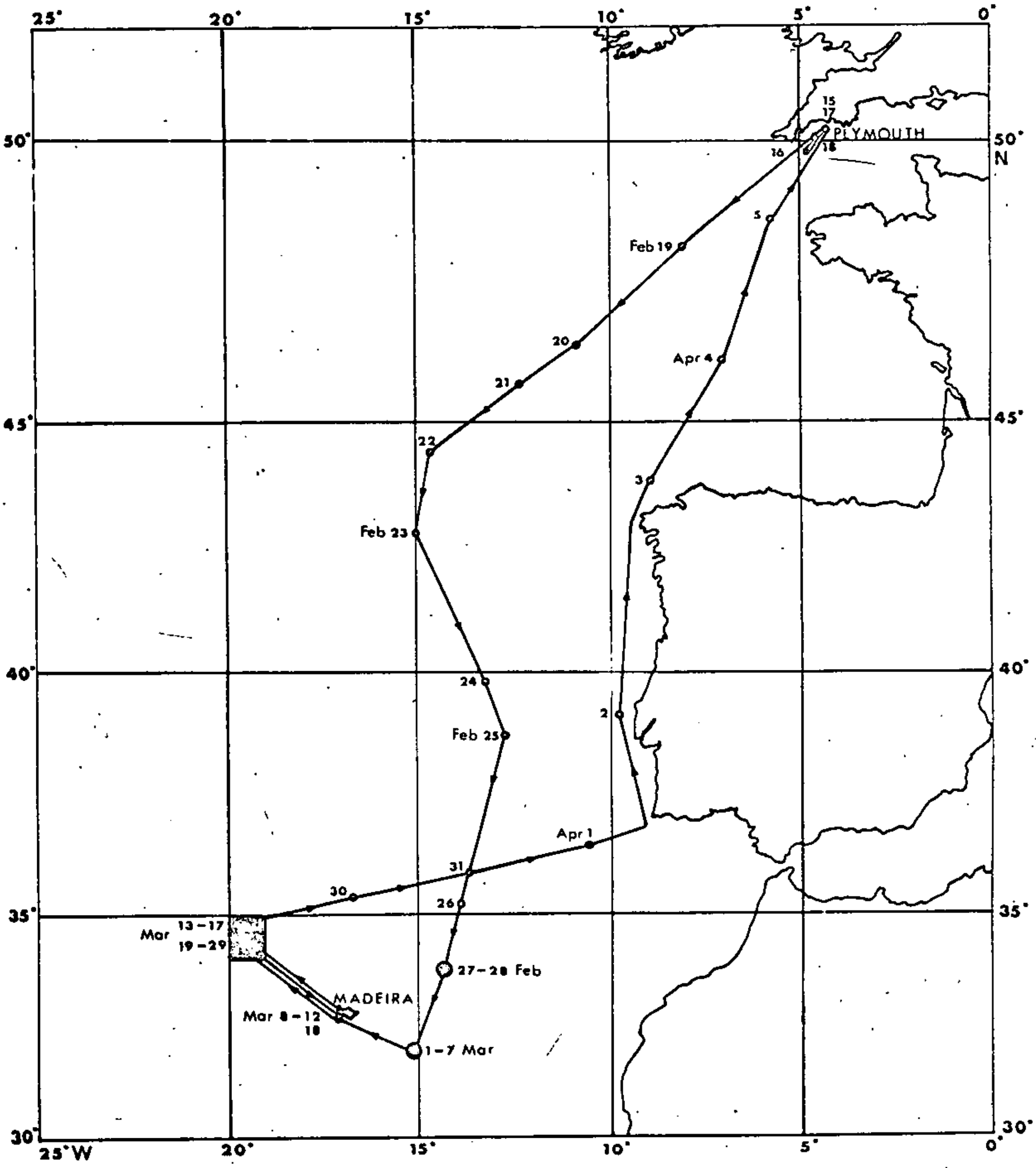
Station No.	Date (1966)	Time (GMT)		Lat. N.	Long. W.	Gear Used
5908	29/3	1425	1508	34°51'.2	19°15'.7	VM
5909	29/3	1736	1825	34°56'.4	18°53'.1	VM
5910	29/3	2037	2203	35°01'.5	18°27'.8	VM,WB
5911	30/3	0003	0055	35°05'.7	18°06'	VM
5912	30/3	0304	0346	35°10'	17°42'.5	VM
5913	30/3	0553	0730	35°14'.8	17°19'.5	WB, VM
5914	30/3	0937	1117	35°19'.8	16°54'.6	VM, TD
5915	30/3	1316	1352	35°22'.5	16°32'	VM
5916	30/3	1606	1743	35°27'.5	16°05'	WB, VM
5917	30/3	1934	2104	35°32'	15°43'	VM, TD
5918	30/3	2309	2342	35°37'	15°19'.5	VM
5919	31/3	0200	0340	35°42'.5	14°54'	WB, VM
5920	31/3	0543	0630	35°46'	14°34'	VM
5921	31/3	0840	0949	35°50'.5	14°07'.5	VM, TD
5922	31/3	1136	1250	35°55'	13°44'	WB, VM
5923	31/3	1454	1531	35°59'	13°19'	VM
5924	31/3	1728	1802	36°03'.5	12°56'	VM
5925	31/3	2006	2226	36°08'.5	12°31'.5	WB, VM, TD
5926	1/4	0040	0120	36°12'.5	12°06'	VM
5927	1/4	0320	0356	36°17'	11°42'.5	VM
5928	1/4	0558	0730	36°21'.5	11°19'	WB, VM
5929	1/4	0929	1043	36°26'	10°54'	VM, TD
5930	1/4	1236	1314	36°30'	10°30'	VM
5931	1/4	1500	1612	36°36'.5	10°06'	WB, VM
5932	1/4	1808	1900	36°41'.5	9°43'	VM
5933	1/4 2/4	2015	 0012	36°43'.5	9°31'.5	WB, Pisa (2), VM, TD
5934	3/4 4/4	2336	 0425	45°25'.5	7°36'.5	WB(B), Pisa
5935	4/4	0430	0730	45°26'.5	7°35'.5	WB(B)



DISCOVERY CRUISE 10, NOON POSITIONS