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R. R. S. DISCOVERY CRUISE 87

8 OCTOBER (281) - 19 OCTOBER (292) 1977

INSTRUMENT TESTING WEST OF PORTUGAL

CRUISE REPORT NO 58

1977

NATURAL ENVIRONMENT RESEARCH COUNCIL

INSTITUTE OF
OCEANOGRAPHIC
SCIENCES

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CRUISE OBJECTIVES

The main objectives of the cruise were to carry out instrumented towing trials of the rectangular mid-water 1 m^2 and 8 m^2 trawl nets (RMT 1+8), to test a prototype pop-up bottom seismometer (PUBS Mk. II) and to experiment with the deployment and simultaneous operation of two airguns and a towed array. Consequently cruise planning proceeded mainly on a day to day basis, as demanded by the various tests required and, except for a call at Lisbon, the ship's track was chosen to minimise steaming within the area of operation for which permission to work had been applied for.

NARRATIVE

We sailed from Barry at 1300/281 and set course for a point off NW Spain. Scientific watchkeeping was begun 24 hours later when we were at the shelf edge. The following day (282) three lowerings of a 320 kHz echo-sounder were carried out on the electric hydrographic winch. At 0900/283 the magnetometer was streamed for the remainder of the passage to the working area.

The first net test was begun at 1330/284 and ended at 1930. After steaming for $1\frac{1}{2}$ hours we hove to for a wire test of the prototype Phillips transponder down to 2082 metres.

Early the following morning the PES fishes were changed, since the first one had a very high noise level, later discovered to be due to a loose towing arm, and then at 0700 hours an attempt was made to carry out the two-airgun experiment. This was soon temporarily abandoned due to a fault in a compressor regulator valve. Instead a short test of the Phillips transponder was carried out on the 4mm wire. By 1120 hrs the compressor valve had been cleaned and reassembled and the two-airgun experiment was resumed. The 40 ins^3 and 1000 ins^3 guns were fired at different rates near the maximum capabilities of the two compressors. Following this the nets were again shot at 1610 and when the tests were finished we steamed into deeper water.

At 2245/285 a lowering of the PUBS to 3500 m on the 6mm wire of the electric hydrographic winch was begun. Successful operation of the transponder and acoustic release system was achieved. When the PUBS was inboard we set course for Lisbon where we were informed a Portuguese observer would be embarked.

The ship anchored off Lisbon at 1050/286 only to learn from the ship's agents that an observer was not being sent to the ship. We set out to sea again and after re-launching the PES fish and doing a short near surface test of the 320 kHz echo-sounder we proceeded to 37°47'N, 10°18.5'W where the first PUBS lay was to be attempted.

A survey of the lay position was begun at 1844 and the PUBS was laid at 1958 hours. We then steamed a cross-shaped pattern, intersecting at the PUBS, to measure the maximum slant range at which the transponder could be detected. Shortly after midnight the 1000 ins^3 airgun was streamed but the gun was not fired until 0149/287 because of triggering difficulties. A 20 mile long profile was shot to the SSW. On returning to the PUBS three "projectiles" were dropped within 1300 metres of the PUBS. The PUBS was released acoustically and surfaced close to the ship at 1245. Net trials followed and continued until midnight.

We then set course for Ormonde Seamount, a possible site for near bottom trawling. On arrival a short test of the 320 kHz echosounder was carried out followed by a $3\frac{1}{2}$ hours search of the top of the seamount for a seabed sufficiently smooth for trawling. At 1044 nets were shot over the flanks of the seamount but within an hour a bolt sheared on the net monitor package causing the top bar of the net system to break. While repairs were being carried out we got under way to the second PUBS lay position on the SE flank of the seamount. On the way nets were relaunched and these tests continued until 1900. The ship arrived at the PUBS position around 2130 hours and a small survey was carried out. The PUBS was dropped at 2346 and the 1000 ins^3 airgun was launched and firing by 0105/289. Again a 20 mile profile was shot, this time to NNE. On return to the PUBS a fourth "projectile" was dropped but further drops were precluded by the worsening weather and difficult station keeping. The PUBS was released at 1110 hours, but some difficulty was had in relocating it at the sea surface and it was not landed until 1400 hours.

At 1430 hours a deep lowering of the 320 kHz echo-sounder was begun. By 1640 hours, when it was back inboard, the weather was too bad for further work and we lay to until 1900 hours. Then nets were shot twice until 0330/290 when the weather again made it too dangerous to operate and we lay to till morning.

The following morning the decision was made to start a magnetometer survey until the weather abated. This in fact happened quite quickly and fishing was resumed at 1030 hours. On completing a series of tests at 1615 hours we set off for an area of flat sea bed for some near bottom net trials but almost immediately it was discovered that once again a bolt in the net monitor had sheared, this time causing the loss of the release gear.

Since further such losses would have jeopardised work on the following leg, the magnetometer survey was recommenced. Shortly afterwards the Captain informed the Principal Scientist that one of the main engines needed repair and this might take longer than the time available during the Gibraltar port stop. Consequently, since the scientific programme had essentially been completely and successfully carried out, it was agreed to enter port 12 hours early.

The following morning we stopped for a last test of the 320 kHz echo-sounder followed by a short tow of a set of closed nets. After swapping echo-sounder fishes, in order to assess repairs made to one of them, the magnetometer was again streamed.

The magnetics survey was completed at 1745 and at 2000 hours the PES was switched off. At midnight the 1800 computer was also closed down.

The ship docked at Gibraltar the following day at 1800/292.

PROJECT REPORTS

(1) Navigational aids

Satellite fixes were used as the prime navigational aid for this cruise. The HP 2100 was down for a few hours apparently due to overheating. The problem was overcome by directing cool air into the computer space. Generally the IBM 1800 system software can be relied upon to pick the best set of fixes and to reject the bad ones. There is still a need however for software which calculates a "least squares" track through the error ellipse of each fix rather than forcing the track through the calculated position each time.

Only the port e/m log was used for navigation and, except for a period of a few hours when the head may have been fouled by flotsam, it behaved well. No problem was experienced with the gyrocompasses.

R. B. W.

(2) IBM 1800 computer and data logger

The principal requirements placed on the IBM 1800 system were to provide accurate navigation, live track plots and daily plots of the ship's track at various scales, together with the normal logging of meteorological instruments, bathymetry and magnetics. The cruise was remarkably free from system faults in the computer operating programs and in the engineering equipment.

J. B., T. C., G. Y.

(3) PUBS, Mk II

Preliminary tests of a transponder, similar to a prototype built by G. Phillips for the PUBS, were carried out on the electric hydrographic winch 4mm wire using a 6 inch end cap mounted on the end of a normal pressure tube. These tests enabled the gain and threshold levels to be set up and demonstrated that a 10. 0 kHz listening and 10. 6 kHz replying system was feasible when combined with an IOS Mk III PES. The electrical output power could be set as high as 40W with only minimal sing around problems.

Two wire tests of the PUBS themselves were then carried out, the primary purpose being to test the new acoustic release and transponder circuits and the performance of the 4 inch end cap transducer mounted on top of the PUBS sphere.

During the first wire test the PUBS was lowered to 2000 m. At this depth the transponder signal was very weak and the transmit dead time facility failed to work. The PUBS was retrieved and onboard investigation revealed that the transponder 10 kHz carried was defective and the dead time monostable had failed.

A second wire test was conducted to a depth of 2500 m with a completely instrumented PUBS. The transponder signal was clearly observed at maximum depth but the dead time facility still worked erratically. Acoustic sing around occurred due to surface reflections but it was felt that with an accurately set dead time and a slight modification of the transponder reactivation threshold level this would not be a problem during a normal PUBS lay. The release receiver was activated from the surface to check the PUBS release electronics. On recovery it was found that the PUBS package had functioned correctly.

Two PUBS deployments were then performed, the first at a depth of 3425 m. The transponder was monitored as the PUBS fell to the bottom and a series of traverses were then performed over the PUBS to determine the maximum horizontal range of the transponder. This was 5.5 km. A seismic profile was then executed, to a range of about 35 km, using a 1000 in^3 airgun as sound source. Upon return to the PUBS three free-fall "projectiles", supplied by Dr. Francis of I. O. S. (Blacknest), were dropped at ranges from the PUBS between 600 and 1300 metres. The PUBS was relocated on the sea bed and released without trouble. The PUBS direction finding radio transmitter failed to work at the surface, so the PUBS had to be located visually. It was found on recovery that the instrument package had worked completely satisfactorily, although some damage was discovered in the electronics, presumably due to salt water falling from the hemispherical lid when the sphere was opened to inspect the instrument package. A brief observation of the recorded data showed that the airgun water wave could be detected to the maximum range of about 35 km.

The PUBS was deployed for a second lay, this time at a depth of 2915 m. The tape recorder programming logic, not used in the previous lay, was set so that the impact of the PUBS on the sea floor would be recorded in an attempt to determine the resonant frequency of the PUBS and to check the tape recorder cycling facility. A cover was placed over the top of the instrument package to prevent the entry of water drops on opening the sphere. The 1000 in^3 airgun was again used as a sound source, to a maximum range of about 35km. Upon return to the PUBS only one "projectile" was dropped. The PUBS was released normally. The radio beacon proved invaluable in the location of the PUBS at the surface.

The recovered data showed that the impact of the PUBS on the sea floor had been recorded but the tape recorder cycling facility could not be checked completely due to failure of the clock. This was caused by the entry of a few drops of salt water onto the clock circuit board, probably at the sea bed.

To summarise, mounting an end cap transducer at the top of the PUBS sphere does not present unduly difficult sing around problems, even at acoustic output levels of 30W, if a reply frequency of 10.6 kHz is used. The instrument package performed very well, the only outstanding serious problems are the poor wow and flutter performance of the modified Nagra tape recorder and the pick-up of mechanical vibrations from the tape-recorder motor. Surface stability of the PUBS is good, even in 30 knot winds and Force 7 seas. The automatic deployment of the strayline on leaving the sea bed also functioned well.

J. J. L.

(4) Pneumatic sound sources

An experiment was carried out to determine the practicability and optimum firing rate of a 2 gun tow system. The system consisted of a 1000 ins^3 gun, to be used as the sound source along the PUBS refraction profile, and a 40 ins^3 gun firing at a faster rate to give a simultaneous seismic reflection profile along the same track.

In this particular experiment, the 40 ins^3 gun was towed from the starboard 'A'-frame, and the 1000 ins^3 gun from the stern roller using the ship's crane to lift it over the stern rail. A certain amount of difficulty was met in altering the tow position of the hydrophone array, which would normally have been over the stern roller. It was finally towed from a snatch-block attached to the drum on the ship's capstan with the cable passing over the counter mid-beam. This was not very satisfactory because of the tight bend in the cable, and a special roller will be needed if this is to be the final tow position.

The maximum sustainable firing rate for the 2 gun system was 2 minutes for the 1000ins^3 gun, and 12 seconds for the 40 ins^3 gun, corresponding to a delivery rate of only 38 ft^3/min from the compressors. This is well below the specification for the two compressors. On the last day of the cruise a completely blocked sintered bronze air filter was discovered in compressor No. 1 and this can probably explain their poor performance.

The 1000 ins^3 gun was used again during two PUBS lays and was towed from the starboard 'A'-frame for convenience.

D. G. B.

(5) Bottom sound sources

A number of free-fall bottom sound sources (projectiles), built by I. O. S. (Blacknest), were dropped close to a sea-bed PUBS at two sites.

The sound sources have been developed to investigate the shallow seismic structures of the sea bed. Each projectile consists of a large tubular mass of steel and concrete with a free-fall speed of about 17 m. s. $^{-1}$. The kinetic energy of the device is partly converted into seismic compressional waves on contact with the sea bed. The instant of contact is measured by timing the implosion of a small glass sphere which is broken on impact.

Three projectiles were dropped at horizontal ranges of between 600 and 1300 metres in about 3440 metres of water, and one projectile was dropped at a horizontal range of 800 metres in 2930 metres depth. Just before each drop the ship's bow-thruster and screw were stopped to increase the chance of hearing the imploding sphere on the echo-sounder. The echo-sounder "audio" signal was also displayed on a chart recorder alongside the PUBS clock trace.

On the first occasion the wind was 10-20 knots and little difficulty was had in holding the ship at the required range from the PUBS.

On the second occasion the wind was about 30 knots and great difficulty was had in holding the ship on station. As soon as the screw and bow-thruster were stopped, we were rapidly blown off station and had great difficulty in regaining our position, especially to obtain horizontal ranges of only a few hundred metres from the PUBS. It is doubtful whether the implosion would have been heard had a projectile been dropped underway at slow speeds. Consequently the second projectile experiment was terminated at this point.

Implosions were recorded for all four projectiles dropped, both on the echo-sounder Mufax and on the chart recorder. PUBS records have yet to be searched to see whether any recognisable signal was recorded on the sea bed.

R. B. W.

(6) Biological net tests

The objectives of the biological net tests were to evaluate the feasibility of using a new multiple combination net system, the RMT 1+8M, to measure the angles from the vertical of this and the normal RMT 1+8 net system at various towing speeds and lengths of warp out, to measure the photometer angle at various depths and speeds, and to test the new high frequency echosounder, designed to facilitate fishing close to the bottom. With the partial exception of the echosounder all these objectives were very successfully achieved.

RMT 1+8M

This system incorporates three RMT 1 and three RMT 8 nets opening and closing sequentially from a four-jaw release gear. It was tested for the first time on this cruise and used six times, on each occasion successfully. There was no sign of any of the bridles hanging up, the first net was opened at the surface three times to check this, and the system proved remarkably easy to rig between hauls. The net was assembled face upwards with the weight bar at the capstan, and brough inboard in this way - the opposite to the conventional RMT 1+8. The monitor and release gear rested upside down on a stand at the aft rail with the Marsh and Marine plug of the release gear rotated to face upwards, thus preventing damage when being placed in the stand.

Angular measurements showed that the system as a whole was more stable in the water than the conventional RMT 1+8, and that the angles of each net varied less with changes in ship's speed between 1 and 3 knots than those of the RMT 1+8. The system pivots about the centre bar and the angle of the RMT 1 is not the same as that of the RMT 8 at any given speed. The angle of all three RMT 1s is similar at any given speed, as is that of the RMT 8s. Warp length apparently makes little difference to the net angle but the system is much more stable when being hauled in than when being payed out.

RMT 1+8

As with the RMT 1+8M there was a pivot at the centre bar so that the angles of the RMT 1 and RMT 8 differed. The system was relatively unstable compared with the multi-net and angular variations with ship's speed were marked. Again the nets were more stable when being hauled in than when payed out. The angles of the RMT 1 were measured with and without the dinoflagellate net (DN) fitted, and generally the DN tends to reduce the angle of the RMT 1.

Photometer Angle

This was measured by placing the clinometer in the photometer fin on the monitor for both net systems. With the RMT 1+8 it was tried with and without the DN. As in the preceding trials angular changes were greater with the RMT 1+8 but in all cases they should be within the acceptable limits of the light collector on the photometer.

The success of these angular measurements was due to the new clinometer built by R. Wild. This system uses a pendulum driven potentiometer with inertial damping. Angular variations produce frequency changes which are conducted to the net monitor and thence telemetered to the ship. Throughout all these trials dynamometer records were taken and these will be analysed together with the angular records.

The gear suffered some damage during the trials. On the last multi-net haul the release gear fixing bolt sheared, the release gear fell and broke the top net bar but was recovered attached to the bridles. It was thought that the failure was due to the increased loading on the bolt and the rotatory movements as the nets opened and closed. A similar failure occurred on test 11 with the RMT 1+8 but this time the release gear was lost.

A. de C. B. ,H. S. J. R.

(7) 320 kHz telemetering echosounder

The echosounder was tested seven times in water depths ranging from 9 to 3000 metres. Initially the echosounder was tested at Barry Dock in a water depth of 9 metres. This test demonstrated that it was possible to resolve a change in water depth of 3 cms.

In the subsequent wire tests the echosounder worked correctly in depths up to 3000 m (maximum depth tested). Unfortunately the poor weather conditions made it inadvisable to check the minimum range of the echosounder, which is probably less than 1 metre.

To fit the echosounder on the trawl for which it was designed, it would be useful to be able to mount the housing containing the 10 kHz telemetry link to one of the trawl's side wires, and the 320 kHz transducer to the centre of the head line. This would require a 36 foot electrical cable to link the two units. With the echosounder in its present design state the additional impedance of a 36 foot cable introduces a noise problem. It should be possible to overcome this by inserting a suitable interface between the two units.

Table of Wire Tests

Day No.	Test No.	Water depth (m)	Remarks
281	1	9	At Barry Dock - Resolution 3 cms.
282	2	200	Continuous echo was received off its own sinker.
282	3	200	Indicated minimum range due to partially flooded 320 kHz transducer.
286	4	1400	Insufficient time available to reach sea bed.
287	5	115	Satisfactory but rough weather prevented close approach to sea bed.
289	6	3000	As test no. 5.
291	7	3000	Using 36 foot linking cable - signal remained locked on max. range i. e. 28m even though echo-sounder was only 15m off sea bed.

M. J. H.

(8) Magnetometer

The magnetometer was towed whenever the ship was on passage for more than a few hours. There were no instrumental problems. Data were logged by the IBM 1800 computer.

A small survey was begun in the magnetic "quiet zone" over the Tagus Abyssal Plain but was curtailed by the necessity to enter port early.

R. B. W.

SCIENTIFIC PERSONNEL

R. B. Whitmarsh	I. O. S. (Wormley)	Principal Scientist
A. de C. Baker	"	Biology
D. G. Bishop	"	Airguns
R. N. Bonner	"	Airguns
D. Grohmann	"	PUBS
M. J. Harris	"	Acoustic telemetry
R. E. Kirk	"	PUBS
J. J. Langford	"	PUBS
H. S. J. Roe	"	Biology
D. M. Shale	"	Biology
R. A. Wild	"	Mechanical engineering
T. R. S. Wilson	"	Chemistry
C. Woodley	"	Watchkeeper/Met. Obs.
J. Burnham	I. O. S. (Barry)	Computer support
T. Colvin	"	"
G. Yarwood	"	"

SHIP'S OFFICERS

M. Harding	Master
P. McDermott	Chief Officer
S. Jones	Second Officer
N. Jonas	Third Officer
A. Lennox	Chief Engineer
P. Stone	Second Engineer
C. Phillips	Third Engineer
C. Harman	Fourth Engineer
T. Harris	Radio Officer
L. Wilson	Electrical Officer

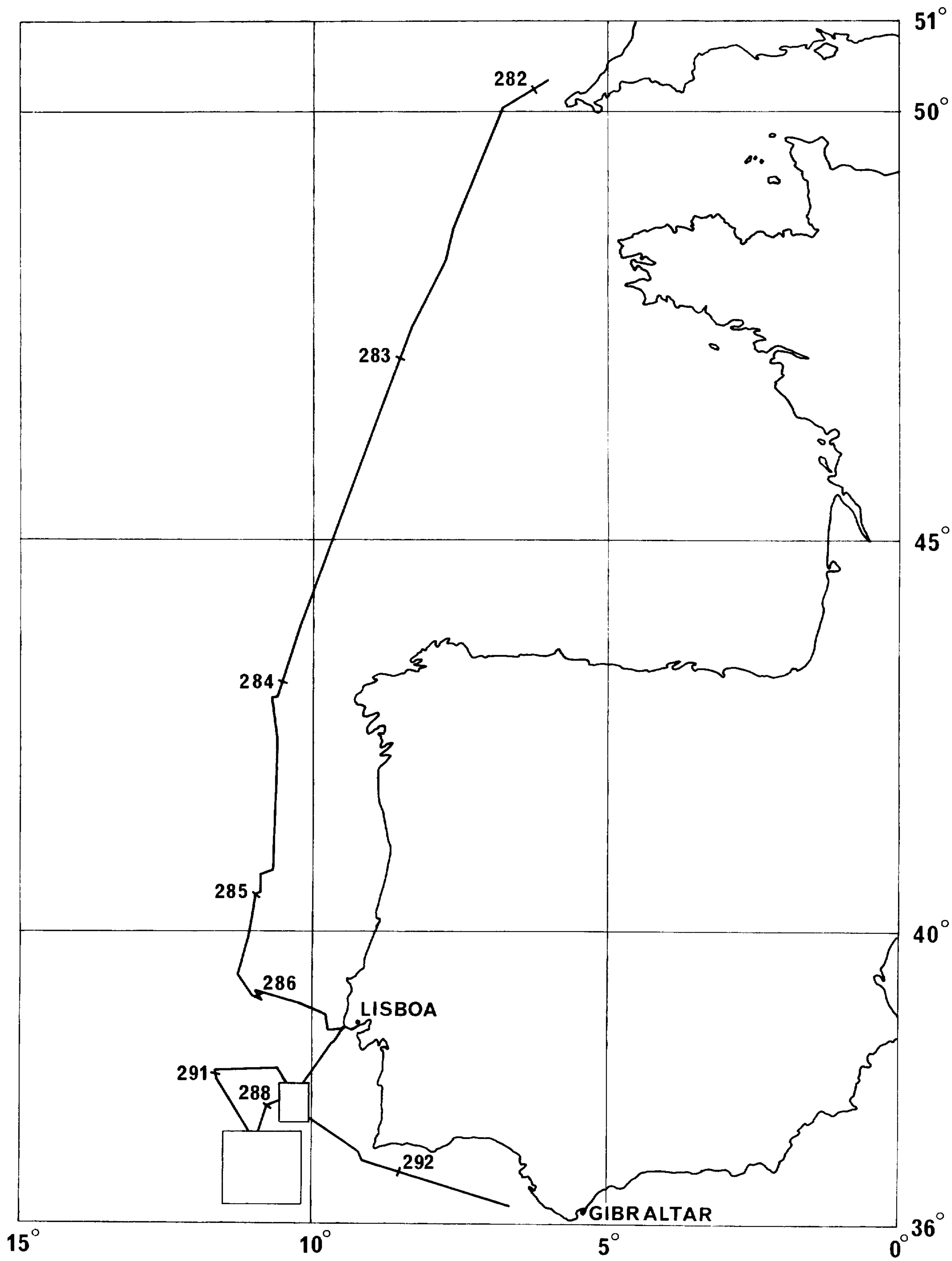

Fig. 1. Track chart for Cruise 87. The two boxes enclose areas within which the track is too complex to show on the small scale chart.