I.O.S.

RRS DISCOVERY

CRUISE 157

26 MARCH - 9 APRIL 1986

EQUIPMENT AND INSTRUMENT TRIALS

CRUISE REPORT NO. 181

1986

NATURAL ENVIRONMENT RESEARCH COUNCIL

INSTITUTE OF OCEANOGRAPHIC SCIENCES

INSTITUTE OF OCEANOGRAPHIC SCIENCES

Wormley, Godalming, Surrey, GU8 5UB.

(042 - 879 - 4141)

(Director: Dr A.S. Laughton FRS)

Bidston Observatory,

Birkenhead, Merseyside, L43 7RA.

(051 - 653 - 8633)

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WORMLEY

RRS DISCOVERY

Cruise 157

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Equipment and instrument trials

Principal Scientist

J.S.M. Rusby

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ITINERARY

Departed Southampton 1130 GMT 27th March 1986

Arrived Falmouth 0930 BST 9th April 1986

SHIP'S COMPLEMENT

Warne	Philip H.	Master
Coverdale	William D.	Chief Officer
Oldfield	Philip T.	2nd Officer
Evans	Philip A.	3rd Officer
Robinson	Colin T.	Radio Officer
Bennett	Ian R.	Chief Engineer
Jago	Paul E.	2nd Engineer
McDonald	Bernard J.	3rd Engineer
March	Paul F.	4th Engineer
Groody	William E.	Elect. Engineer
Williams	Frank S.	C.P.O. (Deck)
Biggs	Philip	P.O. (Deck)
Francis	Stephen C.	Seaman 1A
Hambly	Charles A.	Seaman 1A
Jones	Peter R.	Seaman 1A
McElwee	Malcolm	Seaman 1A
King	Kenneth L.	Seaman 1B
Crabb	Gary	Seaman 1B
Saleh	Muhammed	Motorman 1A
Hawkins	Wanford	Cook/Steward
Hubbard	Colin	Ship's Cook
Acton	Peter C.H.	2nd Steward
Coleman	John T.	Steward
Peters	Colin	Steward
Brigham	Paul	Steward
Rusby	J. Stuart M.	Pr. Scientist
Aldred	Robert G.	Scientist
Beney	Martin G.	Scientist
Birch	Keith G.	Scientist

Collar	Peter G.	Scientist
Edge	David	Scientist
Fern	Adrian M.	Scientist
Gray	Alan W.	Scientist
Hall	Alan J.	Scientist
Hart	Brian H.	Scientist
Nash	Richard W.E.	Scientist
Packwood	Alan R.	Scientist
Pascal	Robin W.	Scientist
Perrett	Michael A.	Scientist
Potter	Kay E.	Scientist
Roe	Howard S.J.	Scientist
Taylor	Peter K.	Scientist
Waddington	Ian	Scientist
Wild	Roy A.	Scientist
Wright	Leslie H.	Scientist

OBJECTIVES

The purpose of the cruise was to test all scientific equipment and machinery on the recommissioning of the ship, and to carry out trials and deployments of a range of scientific gear. The latter included trials of new 1m² nets to be towed a few metres off the sea floor in conjunction with a modified echo sounder fish, the hydrodynamic trials of a new 25m² net system, and the deployment of four moored instruments near DB2 in the SW Approaches. In addition it was planned to carry out further hydrodynamic and scientific trials of the catamaran supported thermistor spar and to begin the evaluation of new meteorological sensors and mast for the more precise measurement of meteorological parameters at sea. If time allowed the automatic listening station (ALS) at 44° 50'N, 15° 4'W would be recovered and a replacement ALS deployed. During the cruise the third generation computer system was commissioned by RVS staff.

NARRATIVE

RRS 'Discovery' slipped from Southampton at 1130 on 27th March 1986 with the expectation of strong to galeforce westerly winds in the Channel. Slow progress was made to DB2 in the SW Approaches near 45°N 9°W where the ship arrived at 1800 on the 29th March. Apart from carrying out a shallow water wire test on two releases, it was not possible to do any work on station due to the inclement weather, this was unfortunate as it had been hoped to lay the two current buoys, a doppler sonar spar buoy and ARIES beside DB2 before moving south to the Tagus Abyssal Plain to test the nets. After waiting hove-to in the region until 1100 on the 31st March, the ship was turned south towards Cape Finistere. With a reducing westerly wind on the beam and three engines on test, 'Discovery' made good progress south at 12 knots.

At 0900 on the 1st April the southerly course was altered to 204° to track to 41°N 13°W, a position 200 miles west of Oporto in 5300 metres water depth. Work went on during the 1st April to clear the poop for the deployment of the multiple 1m² net system in readiness for the ship's arrival at this position on the following morning. During the 2nd April a number of net deployments were successfully carried out and the new meteorological platform was hoisted up the specially rigged mast on the foredeck for the first time. The following day was taken up with trials of the catamaran supported thermistor spar and further 1m² net trials.

At 0100 on Friday 4th April the ship was turned WNW for a run of 260 miles to the ALS position. The wind was NE 30-35 knots on the beam and the ship's motion was very unpleasant. By 1730 it was decided to head into the worsening seas on a course of 030° which reduced the ship's speed to 3 knots against a wind which had increased to 40-50 knots. At 1800 on the 5th the ship was turned west to run down to the ALS position at 10 knots with a quartering sea. The ALS was detected and released at sunrise on the 6th and recovery completed by 1000 hours. Everything had been previously made ready to speed the deployment of the replacement ALS mooring, and this was successfully accomplished by 1300 hours on the same morning. Unfortunately progress to the next station at DB2 was slow as the course lay into wind and sea. During the night of the 6th April one engine was shut down due to brush gear damage. This was put right after an all night session by the ship's engineering staff so that 'Discovery' made better progress on the 7th April into a still heavy sea. DB2 was reached at 0530 on 8th April and during the ensuing 6 hours the satellite buoy, ARIES and the spar buoy with the doppler sonar were laid about ½ mile from the data buoy. With a considerable swell running it was decided not to lay the multi-level current sensor buoy due to its relative fragility.

At 1200 on the 8th April 'Discovery' left the DB2 position and arrived in Falmouth at 0930 on the 9th April.

PROJECT AND EQUIPMENT REPORTS

1. Testing of installed scientific machinery and equipment

During the period of the cruise all the scientific machinery was checked and run. The aft hydraulic system initially showed a fluctuation in boost pressure which was particularly noticeable on No. 2 pump. This was accompanied by the occasional locking of the forward winch barrel and hydraulic noise. It was thought to be due to binding of the forward brake on the winch, but was eventually found to be caused by hunting of No. 2 motor due to severe brush wear on the outboard slipring. As a result, all 6 brushes in each of the three motors were checked. No excessive wear was detected on No. 3 (30 HP) motor but two brushes were changed in each of the two 50 HP motors. Later in the cruise it was found that the pedestal sheave in the Schat crane davit was loose. It appeared that the open ball races had seized and arrangements were made to replace the bearings in

Falmouth. This did not prevent the remainder of the work at sea being carried out. The forward hydraulic system was also used and tested, and no problems were found in operating the associated midships winch and twin-drum capstan. The former was used to 510C metres and spooled perfectly with a new cable, and the latter was used to retrieve the ALS mooring. Tests were also carried out on the electric winch which was found to be in good condition. The 4mm wire was used for wire tests on two deep sea releases taken to 4500 metres. No problems were experienced in hauling. Both cranes were operated on a number of occasions during the cruise and performed satisfactorily.

A.W. Gray, J.S.M. Rusby and R.A. Wild

2. Third generation computer installation

This cruise has seen the successful completion of the installation of the third generation of computer logging and processing systems on RRS 'Discovery'. This system is modular at its basic interfacing with the equipment and builds up through a central logging computer to a central processing system.

Each particular type of equipment and navigational aid has its own micro-based intelligent interface, known as a Level A, which is capable of accepting incoming data at a variety of sampling rates, checking for out of range conditions and performing any necessary calibration before time-stamping and outputting the data in a standard form known as the Ship Message Protocol (SMP). Each Level A in its basic form can accept parallel (TTL) and serial (V24) data but there is provision for the addition of an equipment specific interface board to match the requirements of any type of equipment that does not provide standard signals. A variety of parameters associated with each Level A can be changed via a Terminal connected to its Local Terminal port. These include the sampling rate, the baud rate of serial data, the calibration constants and the out of range conditions. All output to the logging system can be viewed and controlled via the Local Terminal port which can also act as a hardcopy printout in a 'standalone' situation. The Level A contains its own time-keeping which can be synchronised to an external clock via a serial clock input. The data out from a Level A is passed to the central logging system, the Level B, as a serial message string which is self-identifying to the Level B and subsequent Level C.

The Level B accepts data from all the Level As and can store the data message in its original form on both magnetic tape and/or Winchester. A local console is used to monitor and control the output of the Level B. The console shows the state of each Level A from which it has received messages and raises an alarm if any of the Level As fail to communicate within a specified time. It also monitors and displays alarm messages from Level As. A second console is provided for the watchkeeper.

The link between the Level As and the Level B can either be direct or via the Cambridge Ring Network or both. Similarly the link from Level B to Level C can be either direct or via the Cambridge Ring Network, but not both. At present all the Level As, B and C are situated in the computer room but a link for the Cambridge Ring has been installed through to the Plot. Provision has also been made for extending to other parts of the ship when necessary.

The main processing computer is the Level C which accepts all the data messages from Level B and passes them into their correct files. Processing of the data can be done automatically as it comes into the Level C thus providing continuous updates for such programs as Live Navigation plots.

The ship's scientific clock has been moved into the computer room with slave units available around the ship. This clock and its slaves also provide the central time-keeping for the Level As.

During the cruise, the ship's speed, heading and navigational data was logged and tested, in particular the ship's new Omega/Loran/Decca and Transit Satellite receiver (MNS2000). Navigation plots were produced as required.

M. Beeney, A. Fern and K. Potter

3. Near Bottom Plankton Sampler

The near bottom plankton sampler was tested for the first time on this cruise. It comprises three RMT1 nets - as in the RMT 1+8M system, with the addition of a weight bar totalling 109 kg and a heavy (32 kg) towing bar. The nets, release gear and standard mechanical flow meter are carried on a towing triangle. The acoustics and electronics are towed in a modified PES fish coupled to the towing triangle via a 7m-long conducting cable. A digital flowmeter is mounted in the tail of the PES fish.

The system is deployed in two lifts. The nets and conducting cable are lifted outboard via the ship's crane, and the PES fish and main warp swung out on the Schat davit. The conducting cable is clipped to the undersurface of the fish, electrical connections made, and the complete system paid out on the main warp.

Various handling difficulties became apparent which may be resolved by using the capstan.

After an initial visual check on the towing characteristics of the fish, the system was deployed to a depth of about 900m. The nets operated successfully but the near bottom echo sounder (NBES) was locked onto the nets throughout the trial. The rate of water flow through the PES tail was about double the rate above the nets. Before the third deployment the 'dead time' of the NBES was increased to 15m, so that it would not 'see' the net, and the response rate of the digital flowmeter slowed by one half. An attempt was then made to fish the system close to the bottom. During paying out the NBES operated correctly and useful comparative data were obtained from the two flowmeters until the digital system failed at a depth of about 1900m - apparently due to pressure. Acoustic reception from the mushroom transducer was poor, and the haul was terminated at a depth of 4000m. This poor reception was due partly to the shallow angle at which the transducer is mounted in the PES fish, and partly to the steep towing angle of the main warp, giving a scope of about 1.5:1. An attempt to improve the acoustics was made by substituting the mushroom with a ceramic ring transducer. This failed on the final deployment because the Marsh and Marine plug on which it was mounted leaked at a depth of 2000m.

These trials were clearly not totally successful. However, they were sufficiently encouraging to suggest that the system is viable given some fine tuning.

Planned trials with an RMT25 were abandoned due to a lack of time caused by bad weather.

R.G. Aldred, D. Edge, H.S.J. Roe and R.A. Wild

4. Thermistor Spar Trial

The spar was rigged and deployed on the 3rd April at 1000 hrs. The weather was good on deployment, the sea calm and winds light. The deployment lasted approximately 5 hours during which time the weather worsened considerably. On recovery the wind was 10 kts and estimated wave height was 1.5-2m.

For this cruise the spar was fitted with 12 thermistors, 2 inclinometers measuring lateral and trail angles and a pressure transducer. In addition a forward looking narrow beam 1MHz sonar was fitted 3.9m down the spar. A BBC micro C system monitored the system's 32 channels and generated means and standard deviations for each channel plus certain channels in calibrated real units i.e. lateral and trail angles and depth.

For this trial the spar was fitted with a 100mm extension to the trailing edge in an attempt to improve its towing performance at 4 kts. Following deployment, the device was towed at a range of speeds from 2-4 kts and was towed first into wind. It was found that at speeds over 3.5 kts the spar began to lift to port. At 3.6 kts it was at about 30° and by 4 kts about 40°. On reaching 40° the ship was slowed to 2 kts and the spar recovered to more acceptable angles. The behaviour of the catamaran did not seem to be unduly affected by the spar performance and at no time did the situation get out of control.

The impression was gained that the spar, although exhibiting a similar instability to that observed on previous occasions, was more controllable with careful speed control. The rate of change of spar angle with speed appeared to be less than noted previously.

Following the speed trial, the spar was towed around a square at a speed of 3-3.5 kts, each leg lasting approximately 3/4 hour, turns being always made to starboard. On all courses the spar and catamaran appeared to tow reasonably well. The catamaran did show a tendency to pitch nose up on leaving the crest of a wave. This was most likely due to the drag of the trailing recovery line, which appeared to be considerable. The catamaran was very close to the spilling breakers generated by the ship's bow wave. On slowing to 2 kts the catamaran moved further out and forward clearing the bow wave. It was presumed that the drag of the spar and recovery line at the higher speeds was dragging the catamaran back into the wave wake.

Our conclusions were that the system tows well and clear of the wave wake at speeds of 2 kts. At higher speeds the catamaran was dragged back close to the wave wake of the ship. If the drag of the recovery line could be reduced or some other launch and recovery scheme devised, this may improve the situation. Large spar angles were still observed at 4 kts but the unstable behaviour was less precipitous and more controllable than on previous occasions. Either the instrument should be limited to 3 kts maximum speed or even larger fins should be fitted to try to reduce the large observed spar angles.

During the tow all channels worked correctly with the exception of the monitoring channel which was excessively noisy. This appeared to cure itself during the last hour of the tow. The results from the 1MHz sonar appeared to be excellent, very clear returns were back scattered from the bubble clouds ahead of the spar. The performance of the sonar was an important objective.

Waves coming over the shelter deck bulwark during a severe storm on the night of April 5th knocked the spar off its stand and tore off 3 sensors which were later recovered on the poop deck. The 5m transit case was also quite badly damaged but could still be used to stow the spar when it is dismantled.

A.J. Hall and A.R. Packwood

5. Meteorological Instrument System Trial

IOS has, with support from the Department of Trade and Industry, begun development of a meteorological instrument system which may be deployed on research ships, merchant ships of opportunity, or moored buoys. The aim on this cruise was to test two main components of the system, a 10m meteorological mast and a data processor and recorder unit. Experience was also gained with several instrument types not previously used by IOS.

The 10m high meteorological mast was erected on the bow in Southampton and survived the strong winds and rough seas experienced during the cruise without damage. The movable instrument carriage was raised to the masthead during measurement periods but kept at the upper shrouds during storm conditions. Vibrations of the mast and carriage system were measured by accelerometers and correlated with apparent wind fluctuations detected by a fast response propeller vane anemometer.

The CMOS 1802 microprocessor-based data logging system performed well during the cruise with data both recorded on cassette tape and connected to two BBC microcomputer systems for display and analysis. Considerable software development was possible although occasional incompatibility was discovered between the various disk filing systems and specialized software being used.

Meteorological instruments tested included anemometers and wind vanes (manufactured by Vector Instruments and RM Young Co.), psychrometers and humidity sensors (Delta-T Devices, Vector Instruments and Vaisala), shortwave radiation monitors (Kipp and Zolen) and a rain detector (Didcot Instruments). Considering that this was the first trial, the overall instrument performance was generally satisfactory. Calibration offsets were detected in the psychrometer data. These were apparently constant during the cruise, however extensive investigation failed to reveal the cause. The rain detector did not perform well in the shipboard environment and further trials will be necessary.

A new sea surface temperature device consisting of a bead thermistor embedded in a length of "Divers line" rope performed well at first but then failed, probably due to mechanical damage.

In summary, substantial development of the meteorological instrument system was possible during the cruise. The rough weather restricted the scope and nature of the sensor validation experiments which could be performed but allowed a stringent test of the ability of the mast and sensors to survive in the marine environment.

K.G. Birch, B.H. Hart, R.W. Pascal, P.K. Taylor, L.H. Wright

6. Deployment of moored instrumentation at the DB2 site for the upper boundary layer study programme

The cruise presented a useful opportunity to test instruments and techniques for measuring near-surface current shear within the wider programme studying processes in the upper ocean boundary layer. Arrangements were made to deploy four moorings close to the position near (48° 43'N, 08° 58'W) occupied by the data buoy DB2. This site has great value for instrument trials: it is in a scientifically interesting position close to the shelf edge, and it has good exposure, while DB2 itself provides a source of meteorological and wave data. Moreover the long term presence of a large buoy at this position appears to afford some protection from the hazards presented by intensive fishing activities.

The four moorings comprised two surface following discus buoys of 1.6m diameter, a spar buoy and the sub-surface ARIES (Autonomously Recording Inverted Echo Sounder). One discus buoy measures and records in situ the current at 1m depth. In addition, it transfers data via the Argos satellite-based telemetry system, through which its position can be obtained. The second buoy carries an experimental electro-magnetic sensor which provides measurements of currents at depths of 10, 20 and 30 cm beneath the instantaneous surface. This was to be the first trial of a more durable arrangement of this instrument. These two instruments were thus intended to detect shear within the uppermost metre of the water column. The spar buoy carried beneath it an upward looking 1 MHz doppler sonar. Since the spar should provide reasonably good decoupling of the sensor from all but the longest wavelengths it was hoped that the range gated backscattered signals would provide evidence of any shear existing in the uppermost 20 metres or so. This, again, was a new technique, though it represented a natural progression from some encouraging results previously obtained using a subsurface-moored sonar. ARIES previously deployed on a number of occasions, essentially complemented these instruments. In detecting acoustic scattering at 248 kHz due to the intensity of the bubble cloud created at any particular depth by the breaking wind waves, ARIES provides a measure of the turbulent diffusion which may be related to the downward transfer of horizontal momentum from the surface.

The original intention had been to lay the moorings in the outward passage of the cruise and to recover them immediately prior to returning to port. However, on arrival at the site at 1800 hrs on the 29th March the weather conditions precluded any mooring work. After heaving-to overnight conditions were found to be no better on the following morning, and the prognosis was poor. The attempt was therefore abandoned for the time being and course was set for the more southerly working area.

On the homeward journey on the 8th April conditions had eased sufficiently for three of the four moorings to be successfully deployed at the positions noted below, in anticipation of their recovery at the beginning of the next cruise (Discovery Cr. 158).

Mooring	Range from DB2	Bearing from DB2
Surface discus buoy (1m current measurement)	0.53m	151°
Spar buoy	0.46m	202°
ARIES	0.85m	161°

P.G. Collar and I. Waddington

7. Wire testing of command releases and recovery and redeployment of an automatic listening station (ALS)

Four command releases were successfully wire tested during the cruise:

Release	Depth Metres	Frequency Hz	Period Secs
CR2412	100	317-327 456-465	1.06
CR2413	100	314-328 355-367	1.08
CR2384	4500	314-327 293-306	1.02
CR2387	4500	315-327 374-386	1.08

An autonomous listening station (ALS) was recovered and redeployed with release No. CR2387 at position 44° 48.6'N 15° 07.8'W in a corrected depth of 4347 metres, using pyros. The recovered release 2411 had operated only one pyro. On inspection the Marsh Marine pins on the failed pyro had been sheared off and remained in the plug.

Release No. CR2413 was deployed on the ARIES mooring position 48° 43.2'N 8° 57.5'W in a depth of 165 metres using pyros.

D. Edge and I. Waddington

ACKNOWLEDGEMENTS

Despite the bad weather, a major part of the planned work was accomplished. We are grateful for the support of the Master, officers and ship's company who made this possible.

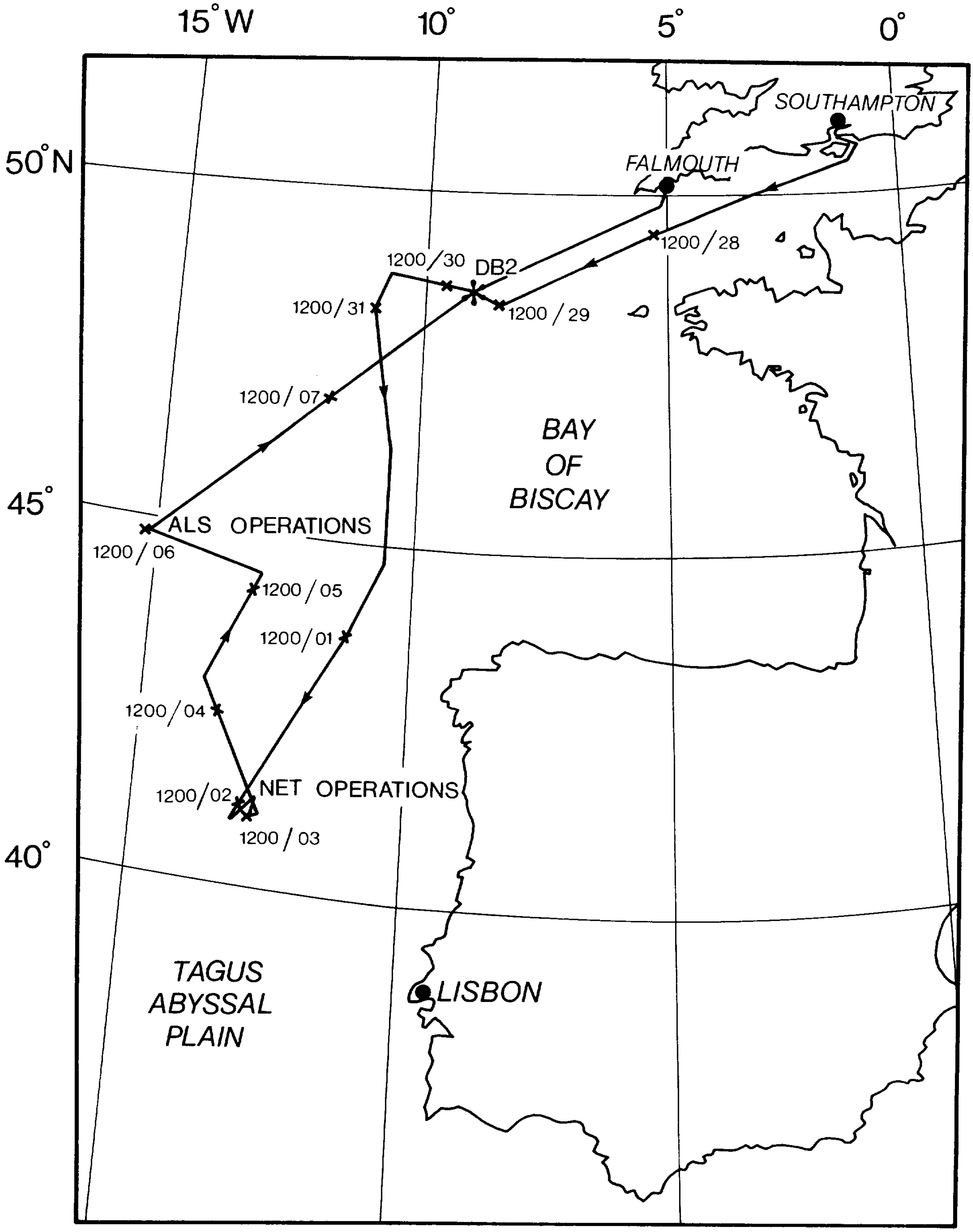

Fig.1. TRACK OF CRUISE 157