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RRS DISCOVERY

CRUISE 152

4 — 15 OCTOBER 1984

EQUIPMENT TRIALS, INCLUDING MEASUREMENTS OF THE HYDRODYNAMIC PERFORMANCE OF TOBI (TOWED BOTTOM INSTRUMENT)

CRUISE REPORT NO. 170
1984

NATURAL ENVIRONMENT RESEARCH COUNCIL
INSTITUTE OF OCEANOGRAPHIC SCIENCES

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INSTITUTE OF OCEANOGRAPHIC SCIENCES

WORMLEY

RRS DISCOVERY

Cruise 152

4 - 15 October 1984

Equipment trials, including measurements of the hydrodynamic performance of TOBI (Towed Bottom Instrument)

Principal Scientist

J.S.M. Rusby

CRUISE REPORT NO. 170

1984

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ITINERARY

Departed Falmouth 0915 GMT 4th October 1984

Arrived Falmouth 0900 GMT 15th October 1984

SCIENTIFIC PERSONNEL

R.J. Babb
K.G. Birch
D.G. Bishop
R.N. Bonner
M.P. Burnham
E.P. Collins
E.B. Cooper - RVS (Computer)
A.J. Hall
B.H. Hart
R.B. Lloyd - RVS (Computer)
B.S. McCartney
A.R. Packwood
J.S.M. Rusby - PSO
K.H. Scrimshaw
N.T. Timmins
K. Tipping
R.J. Walker
C.H. Woodley
L.H. Wright

All from I.O.S. Wormley, except E. Cooper and R. Lloyd from RVS Barry.

SHIP'S OFFICERS AND PETTY OFFICERS

S.D. Mayl	Master
A.L. Moore	Chief Officer
S. Sykes	2nd Officer
G.P. Harries	3rd Officer
I.R. Bennett	Chief Engineer
R.E. Hagger	2nd Engineer
A. Greenhorn	3rd Engineer
B.J. Hayter	4th Engineer
J.G.S. Bray	5th Engineer
N. Davenport	Extra 5th Engineer
B.J. Regan	Electrical Engineer
R.M. Morris	Purser/Catering Officer
J.G.L. Baker	Radio Officer
R. Macdonald	C.P.O. Deck (Bosun)
C.A. Hambly	P.O. Deck
M.A. Harrison	P.O. Deck

OBJECTIVES

It was originally intended that the cruise should be a 'shake-down' and instrument trials cruise following the 1984 refit, but due to changes in ship programming, it took place over a month after the completion of the refit.

The objectives were to:

test all installed scientific machinery and equipment,
conduct hydrodynamic trials of TOBI (Towed Bottom Instrument)
conduct trials of the towed thermistor spar,
lay a current measuring discus buoy near DB2,
and recover the ARIES (Autonomous Recording Inverted Echo-Sounder) mooring near DB2.

NARRATIVE

Discovery left Falmouth at 0915 on Thursday 4th October and proceeded to DB2 in the SW Approaches at position $48^{o}43.2$'N, $8^{o}56.4$'W arriving there at 0730 on 5th October (see track chart, Fig. 1). Unfortunately, the weather was too poor to attempt to lay the current measuring discus buoy or to recover ARIES. However ARIES was contacted acoustically and found to lie close to the reported lay position. At 1000 hours Discovery left the area and proceeded on a direct course of 188^{o}T for the Tagus Abyssal Plain off Lisbon. At 2100 hours that night the ship was stopped for half an hour so that wind and wave observations could be made for comparison with the sensors fitted on the space shuttle 'Challenger' which had been launched earlier that day. These measurements were repeated further south at 0700 the following morning on the 6th October, and on completion the ship continued south arriving in the trials area at midday on the 7th October.

The first deployment of TOBI was made that afternoon, using the 100 metre-long umbilical, and the vehicle was successfully towed at depths down to 1500 m. Recovery took place at 1830 and this was followed by a period when the midships winch CTD wire was pretensioned by paying out and recovering 5700 m of wire. It was estimated that there was about 6300 m of wire available and this was confirmed by subsequent use of the winch when TOBI was towed at greater depths.

The following morning, on the 8th October, the towed thermistor spar was deployed for the first time, on a variety of courses relative to the wind and at speeds up to 4 knots. In the afternoon, the catamaran and spar were recovered and TOBI was deployed for the second time. It was left out overnight and towed at a variety of speeds up to 3 knots at depths down to 1500 m. TOBI was retrieved next morning at

0900. After retrieval, certain alignment problems were found with the bow thruster mechanism so that a second deployment of the spar was delayed until the afternoon.

Over the next two days both the spar and TOBI were each deployed on two further occasions. No significant problems occurred during the launch and recovery phases and useful information was obtained on the best methods of handling both systems. The opportunity was also taken on slow runs to lower and retract the sonar platform. At the end of the period a ½-tonne weight was lowered to 4500 m to exercise the traction winch. At 1330 on Thursday 11th October Discovery left the Tagus Abyssal Plain area under orders to proceed to Lands End and await instructions. It was decided to go via DB2 again so that a second opportunity would be given to lay the discus buoy and recover ARIES. The weather had been excellent during the five-day period of trials in the Tagus Abyssal Plain area and remained good during the subsequent passage north.

Discovery arrived near DB2 on Saturday 13th October at 1700 hours. The weather was good with a swell from the west so it was decided to immediately recover the ARIES mooring while light remained. This was successfully accomplished, using the rubber dinghy and crew to split the surfaced components and secure a recovery line from the forward 'A' frame in turn to recover first the instrument and then the sub-surface float and mooring. On completion, attention was turned to the after end of the ship where the current measuring buoy and its mooring tackle had previously been assembled. This mooring was then laid and completed in the dark. The Argos transmissions were monitored during the following night.

Next morning a brief visit was made by rubber boat to DB2 to check on the security of sensors and after this Discovery set course for Falmouth since orders had been received that this was to be the end of cruise destination. The weather remained good on the way in through the SW Approaches with a long well from WSW. Discovery made fast alongside at 0900 on 15th October.

PROJECT AND EQUIPMENT REPORTS

1. Testing of installed scientific machinery and equipment

During the cruise all scientific machinery and equipment was run up and tested. The electric winch was tested when it was used to wire test the acoustic release required for the current measuring buoy deployment. The CTD winch was tested when it was first used to pretension some 5700 m of wire prior to towing the TOBI depressor weight and vehicle. It was subsequently used with TOBI on four deployments of the vehicle, on two of which 6000 m of wire was paid out leaving only 300 m on the barrel. As a result of this tensioning, and an adjustment to the scroll shaft, the CTD wire was found to wind perfectly over its full length. At the end of the TOBI deployments in the Tagus Abyssal Plain, a fault developed on the electrical input to the DC motor of the forward hydraulic pump set supplying both the CTD winch and the double-barrelled capstan. This was traced to dirty contacts on either the pedestal controller or the main contactor. Both were cleaned by the ship's electrician and no further trouble occurred. The forward double-barrelled capstan was used to pre-tension the 100 m neutrally-buoyant cable prior to its use with TOBI and was employed during the recovery of ARIES. During the deployment of TOBI, and also the thermistor spar and current measuring buoy, the Schat crane-davit was in continuous use and behaved well. The auxiliary winch was also an important component in this work, it performed equally well, and the remote control of this winch from the Schat davit proved to be a most useful feature in all deployments. Finally, the main traction winch was also exercised by lowering a ½-tonne weight to 4500 m depth at speeds up to 1.8 m/s and recovering it at a mean speed of 1.2 m/s. No problems were experienced in this deployment.

In addition to the testing of the above machinery, all installed sensors and electronic circuits were tested, including the EM logs and the navigational and meteorological inputs to the computer. Both the hull-mounted and overside precision echo-sounders were in use during different periods of the cruise.

J.S.M.R.

2. Shipboard computer

For the duration of the cruise navigational and meteorological data was sampled, processed and reduced to one minute values using the 1800 Interim system, i.e. two PDP 11/34 computers operating under RSX -11M. The dead reckoning derived from EM log and gyro was corrected to Satellite Navigator fixes. During the cruise the software was run under normal operating conditions and no problems were encountered. In addition, the digitiser programme was installed, modified and tested. All data collated during the cruise was plotted in the form of track charts and stored on magnetic tape in merge-merge format.

E.B.C.
R.B.L.

3. Side-scan sonar platform

Prior to the installation of the side-scan sonar platform into Discovery several mechanical changes were made during the refit period. These included:

1. The removal of the rubber and nylatron main gland, through which the streamlined strut has to pass during deployment and retraction, and its replacement by an aluminium-bronze gland containing two 'D'-shaped 'O' rings. It was believed that the previous gland had caused problems on retraction due to distortion.
2. The installation of two plastic pipes, positioned in the bottom of the side-scan pod and running to an outlet in the top junction box. These will enable the pod to be pumped dry in the event of a failure in the compressed air supply and a water leak developing, until the air supply can be restored.
3. The installation of an exterior plastic bleed pipe which will remove air trapped in the sonar pod recess when aerated water is swept under the bows. Inclusion of air in this recess has also led to retraction difficulties in the past.
4. A new emergency lifting arrangement has also been installed, which can be used to free the pod if it should become jammed in the deployed position.

In addition to these mechanical modifications, certain electrical ones were also made. These included additional protection circuits which were incorporated in the electrical control system, to prevent H.P. pump damage following a possible loss of hydraulic oil from the main reservoir, or oil contamination of expensive electrical components located in the pod area.

Throughout the cruise the sonar platform was subjected to a regular programme of deployment and retraction to simulate operation over a range of sea temperatures. During this period the opportunity was also taken to monitor the performance of a new type of 115 volt 400 Hz power supply unit. All the equipment performed normally throughout, and there was no occurrence of the retraction difficulties experienced in the past.

B.H.H.
E.P.C.

4. Project TOBI (Towed Bottom Instrument)

1. Deployment procedure

The TOBI vehicle was rigged on the poop deck, lined up fore and aft, the umbilical passing round the Schat davit to figure of eight coils on the deck and then to the towed weight by the starboard scupper (see Fig. 2). A breakout recovery line was attached from straps on the lifting lugs on the vehicle, via the front of the frame down onto and along the umbilical; most of the attachments were made with two turns of plastic tape at two feet intervals, except for the last ten feet for which plastic cable ties were looped through the polypropylene braid of the umbilical. Lift of the vehicle for launch was via a separate continuous strop 9 m long through the lifting lugs to the auxiliary winch wire on the main Schat davit block, but with the BRE hydraulic cutter rigged to release it once submerged.

The CTD cable, led aft from the midships winch via heel block and hull side rollers, passed over a 12 ton towing block hung under the left side of the davit to the top of the towed weight via the slip ring assembly. Prior to launch, sufficient slack of CTD wire was needed to allow the davit to slew round over the stern to plumb the vehicle on deck. A slip rope was looped through the vehicle fender at its starboard aft corner.

With the ship speed at ½ to 1 knot on the bow propellor, wind on starboard side, and after removing the stern rail chains, launch began by deploying the 53 m long polypropylene tail rope (an old mooring rope). Using the auxiliary winch wire controlled from the davit position, the vehicle was raised a few inches up off the deck so that the strops and cutter were lifted almost to the block allowing very little pendulum arm. The davit was slewed anti-clockwise, the vehicle going aft and over the stern, rotating as it went so that the umbilical was to port and the slip line to starboard. The vehicle was lowered quickly into the water, hydraulic cutter operated and slip line released in short succession. The umbilical was then manhandled away by the crew over the stern fairlead on the starboard quarter. Meanwhile the davit was slewed round to plumb the weight and the slack in the CTD wire taken in. With one bight of the umbilical to go, the weight was lifted over the rail and into the water and the umbilical bight thrown over. The whole latter part of this operation was managed by the Schat davit operator in constant communication with the CTD winch driver, using an electrical cable link with headsets. Finally, the CTD wire was paid out to the required scope, the davit slewed to starboard and propulsion returned to the main propellor. Scope and vehicle depth were very dependent on oceanographic conditions, there being strong evidence of current shear at times.

Recovery followed essentially the same process in reverse: speed 1 knot on bow propellor, weight inboard by CTD winch after raising the weight to the block as the davit slewed inboard, umbilical manhandled into fairlead and then on to the capstan to be coiled in a figure of eight on the deck to the starboard of the main crane. Meanwhile the davit was slewed to face aft, the CTD wire being kept slack. As the cable ties on the umbilical came inboard they were cut to free the recovery line which was then shackled to the auxiliary winch wire. With the vehicle close to the stern, the umbilical bight was passed to the port quarter and the snatch hook clipped to the vehicle starboard aft fender as a steadying line using a removable bamboo pole. The vehicle was raised quickly out of the water to the Schat davit block by the davit operator carefully watching the right moment, and then slewed inboard rotating the vehicle to land fore and aft on the deck.

Five successful deployments and recoveries were made, in daylight and at night without any major difficulty. The vehicle forward starboard fender was slightly bent during the first launch in which the umbilical was swung to starboard before it was realised that this orientation gave insufficient clearance by the body of the davit. Sea conditions were always good for these trials, 1 m swell and 1 m sea waves at maximum. However the technique appears sound, is well under control at all stages and with care should be practical in worse weather. Launch preparation time is about one hour, launch and recovery about ½ an hour each, excluding the time to pay out the CTD wire scope.

2. Towing configurations tested

The various configurations tested were as follows:

(a) 600 kg depressor weight, 100 m umbilical, 17.6 kg lead trim weight on rear of vehicle, towed on the lowest tow point.

(b) as (a) but with 53 m tail rope (5 cm diameter) attached to the rear of the vehicle.

(c) as (b) but with 200 m umbilical replacing the 100 m length and a 2 kg shackle added trim at the rear.

(d) as (c) but with a smaller depressor weight, approximately 200 kg.

Note that only a partial recovery, that of the depressor weight, was necessary to change from configuration (c) to (d). Configuration (a) was tested twice. The total time over the side was approximately 60 hours.

During the course of these deployments the vehicle was tested for towing stability at depths ranging from 500 m to 3000 m (wire out 1500 m to 6000 m) and at tow speeds between 1 and 3 knots. The response of the system to various ship manoeuvres and winch induced motions were investigated including a 180 degree turn at 2 degrees per minute, small heading changes, and winch haul and veer of relatively small amounts of wire (10 to 25 m).

The vehicle response as tested in configuration (a) was found to be promising, but the yaw response was deemed unacceptable showing periodic angular variations of $\frac{2}{3}$ degree. This response in particular was improved in going first to configuration (b) then (c). The roll stability was found to be exceptionally good in all configurations. Pitch oscillations coupled with forward speed fluctuations (surge) were found to be quite strong (± 2 degrees) in response to some manoeuvres or speed changes. This was not so marked in configuration (c). The move to configuration (d) in general produced a deterioration in the performance. In all configurations the vehicle towed about 4 to 6 degrees nose down, but hopefully this may be improved with additional trimming weights. A more detailed objective analysis of the chart and tape records has yet to be undertaken.

3. Instrumentation

The TOBI vehicle and its motion sensing instrumentation were completed at sea. The vehicle telemetry system and shipboard motion sensing package operated satisfactorily from the start, but there were initial difficulties with some of the sensors. By the third deployment, all the instruments were operating within their limitations. We are confident that the indicated outputs represent true motions, except that the digital compass and pendulum roll sensor seemed unable to respond to changes of less than 1 degree, presumably because of stiction. All instrument outputs were displayed on paper recorders and on magnetic tapes, though there were difficulties in the replay of the tapes, apparently due to poor quality (cheap) tapes.

B.S.M., A.R.P., R.J.B., J.S.M.R.

5. Towed thermistor spar

The spar and catamaran were deployed 3 times during the cruise for about 4 hours on each occasion, in good weather during daylight hours. The new 200 kg swinging davit had been erected in the wrong position for deploying the spar and could not be utilised. Instead a sheave was suspended from the aft diesel crane jib over the rail and run via a small deck sheave to the capstan. For deployment, the bottom weight was lifted using block and tackle over the rail and the load transferred onto a slip rope which was used to lower the spar to the vertical once the catamaran was lifted over the side. The crane davit lifted the catamaran using the auxiliary winch warp. The spar was lowered with the catamaran held outboard against the ship's rail on the crane davit. Once the spar was vertical and the rope slipped, the catamaran was turned through 180° to face forward and lowered into the water. Slack on the tow wire was then taken up on the Lebus winch mounted under the forward 'A' frame and slack paid out on the auxiliary winch wire until the spar was in the required position. Recovery was almost a reverse of this process except that the weight was recovered on a break out line secured down the spar trailing edge and passed to a polypropylene line through the sheaves which was winched onto the capstan. Both procedures were undertaken with the ship on bow thruster, at ½ knot, and the wind on the starboard bow. This method was found to be most successful. Two modifications were made in the later deployments:

1. 100 m of 20 mm polypropylene line was used on the auxiliary winch to launch and recover the catamaran instead of the auxiliary winch tail. This produced less drag on the catamaran when towing.
2. A shackle and line were put round the tow rope near the forward 'A' frame so that the towing wire could be gradually drawn in to the ship to draw the catamaran alongside for recovery.

During the deployments, the spar was towed on four legs of a square relative to the wind/waves at speeds ranging from 2 - 4 knots. The spar was found to be unstable at 4 knots making very large excursions to starboard so as to bring the catamaran into the ship's side. The spar definitely made contact with the catamaran. At 3 knots however, the system behaved very well with lateral spar angles between 10° - 20° to starboard. The tendancy to swing to starboard seems to be an artifact of the offset tow from the port side of the catamaran, although this instability has yet to be analysed in detail. On the second deployment, the catamaran was towed for a short time about 30 m directly astern in the ship's wake on an equal length bridle. This showed spar angles of $> 30^{\circ}$ to both port and starboard at speeds of 2 - 3 knots.

The spar was equipped with five thermistors, one noise monitoring resistor, a pressure sensor and two inclinometers. This instrumentation worked without any problems with the exception of one thermistor which failed during the third tow. The temperature sensors showed much thermal structure, some of it quite coherent over two or three thermistors, that is over spatial scales of up to 3 metres. The temperature resolution was limited by noise to about 1 millidegree C. Four Sea Data tapes were used resulting in approximately 200,000 readings over a total towing period of 15 hours.

No damage or serious wear and tear could be seen on the catamaran/spar combination on completion of the trials.

A.J.H., A.R.P.

6. Mooring of current measuring discus buoy

The buoy and the mooring hardware were prepared on the poop deck prior to the launch near DB2. Unfortunately the weather was too severe to carry out the deployment on the 5th October when the ship left the U.K. via the data buoy site. However, a wire test of the acoustic release was successfully carried out.

The change of cruise destination from Lisbon to Falmouth provided a second opportunity to lay the mooring on the return north on the 13th October. The mooring deployment procedure was 'anchor last' with the anchor being lowered on a separate disposable wire which was to be cut after the anchor had reached the bottom (see mooring design in Fig. 3). This method was proposed because the 1·5 tonne chain anchor clump, needed to resist high drag forces, would severely overload the mechanical release in a conventional 'anchor first' deployment. The release mechanism had been somewhat strengthened, however, to prevent damage due to induced dynamic loading from the movement of the subsurface buoyancy sphere at a depth of only 30 m.

The surface buoy was lowered into the water by the aft crane, unfortunately the eye of the buoy's lifting strop parted when the buoy was nearly at the sea surface allowing it to fall the last metre or so. The chain and polypropylene rope were then payed out while the ship stemmed the tide on the bow propellor and kept station relative to the data buoy using radar. The subsurface buoyancy, more wire and the release were then passed over the stern and the 1.5 tonne of anchor chain shackled up. Using 8 mm lowering wire on the auxiliary winch, the crane davit lifted the weight and lowered it into the water; with 50 m paid out the wire snagged on a shackle and snapped at the auxiliary winch drum. Fortunately again no harm was done as the anchor rapidly pulled the mooring into position sinking at about 2.5 m/s; the release seemed to survive this since the command pinger responded normally.

The ship stood by overnight allowing the monitoring ARGOS receiver on board to confirm that the buoy was transmitting correctly, and to log the first few hours of data. Current data measured seemed reasonably sensible, though the time word appeared to jump occasionally. This should not matter as the data is sequentially received.

Mooring details are as follows:

Station No.	11167
Mooring position	48°43.3'N, 8°57.3'W
DB2 bearing and range	320°T, 0.93NM
Acoustic release No.	229C

Acoustic release period	0.92S
Acoustic release pinger frequency	318 Hz
Acoustic release frequency	312 to 324 Hz
Pinger timeout	15 min
Argos identification channel	1C 239
Buoy in water at	287/1817
Moored to sea bed at	287/1900
Corresponding time word	222

Discovery lay within ½ mile to 1 mile from DB2 during the night of the 13th/14th October and the opportunity was taken to average the position fixes of the buoy made by satellite and radar during this period. The mean position of DB2 was found to be 48°44.0'N, 8°58.2'W, which is within 0.2NM of the position obtained on the way out from the U.K. on the 5th October. This position is some 2NM from the charted value.

M.P.B., B.S.M.

ACKNOWLEDGEMENTS

We are grateful to the Master, officers and ship's company for their co-operation in making this cruise so productive and enjoyable. Thanks to everyone's efforts all the planned work was successfully completed within the short time scale.

STATION LIST

Station	Date Day No.	Position	Remarks
11157	5/10 279	46°49.0'N 9°29.0'W	Wave and wind observations for comparison with space shuttle radar.
11158	6/10 280	45°01.3'N 9°44.2'W	Wave and wind observations for comparison with space shuttle radar.
11159	7/10 281	39°41.0'N 11°17.0'W	Deployment of TOBI vehicle to 1500 m depth.
11160	8/10 282	38°29.0'N 12°31.0'W	Deployment of towed thermistor spar.
11161	8/10 282	38°30.3'N 12°33.3'W	Deployment of TOBI vehicle to 1500 m and 3000 m depths.
11162	9/10 283	38°14.7'N 12°56.0'W	Deployment of towed thermistor spar.
11163	9/10 283	38°27.3'N 12°46.2'W	Deployment of TOBI vehicle to 3000 m depth.
11164	10/10 284	38°36.3'N 12°51.0'W	Deployment of towed thermistor spar.
11165	10/10 284	38°39.1'N 12°47.5'W	Deployment of TOBI vehicle to 3000 m depth.
11166	13/10 287	48°42.2'N 8°52.6'W	Recovery of ARIES (Autonomous Recording Inverted Echo-Sounder)
11167	13/10 287	48°43.5'N 8°57.5'W	Laying near-surface current measuring buoy near DB2.

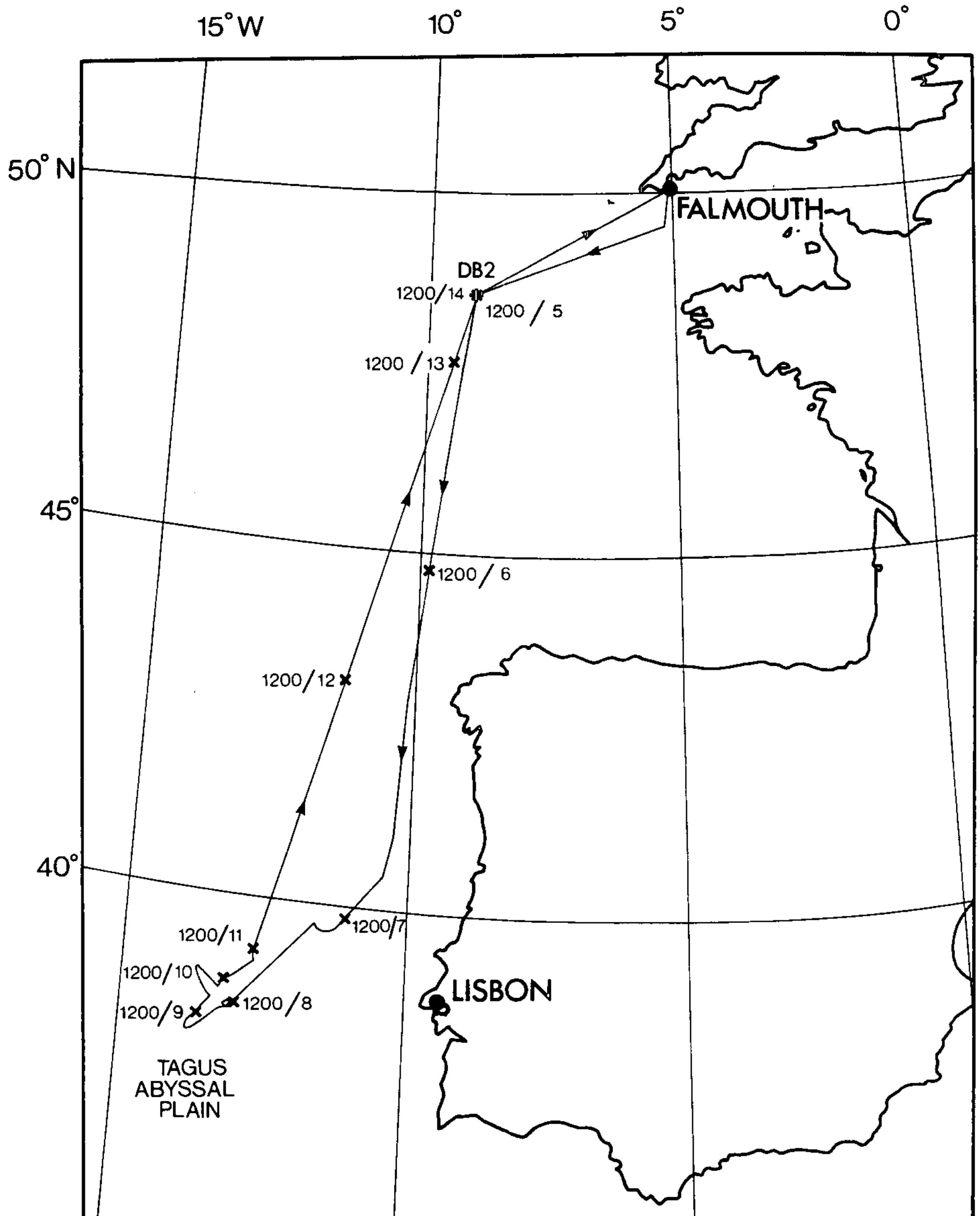

Fig. 1. TRACK OF CRUISE 152.

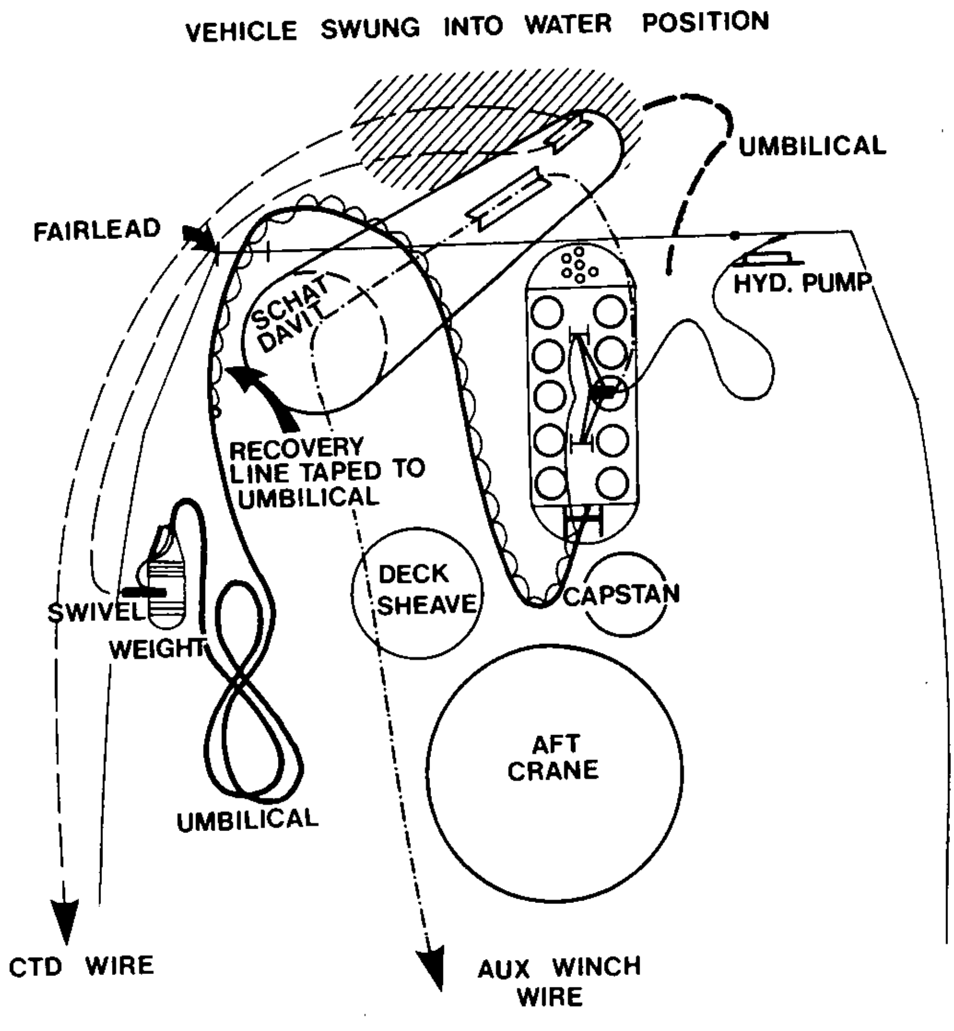

Fig. 2. RIG FOR DEPLOYMENT OF THE TOBI VEHICLE ON THE POOP OF DISCOVERY.

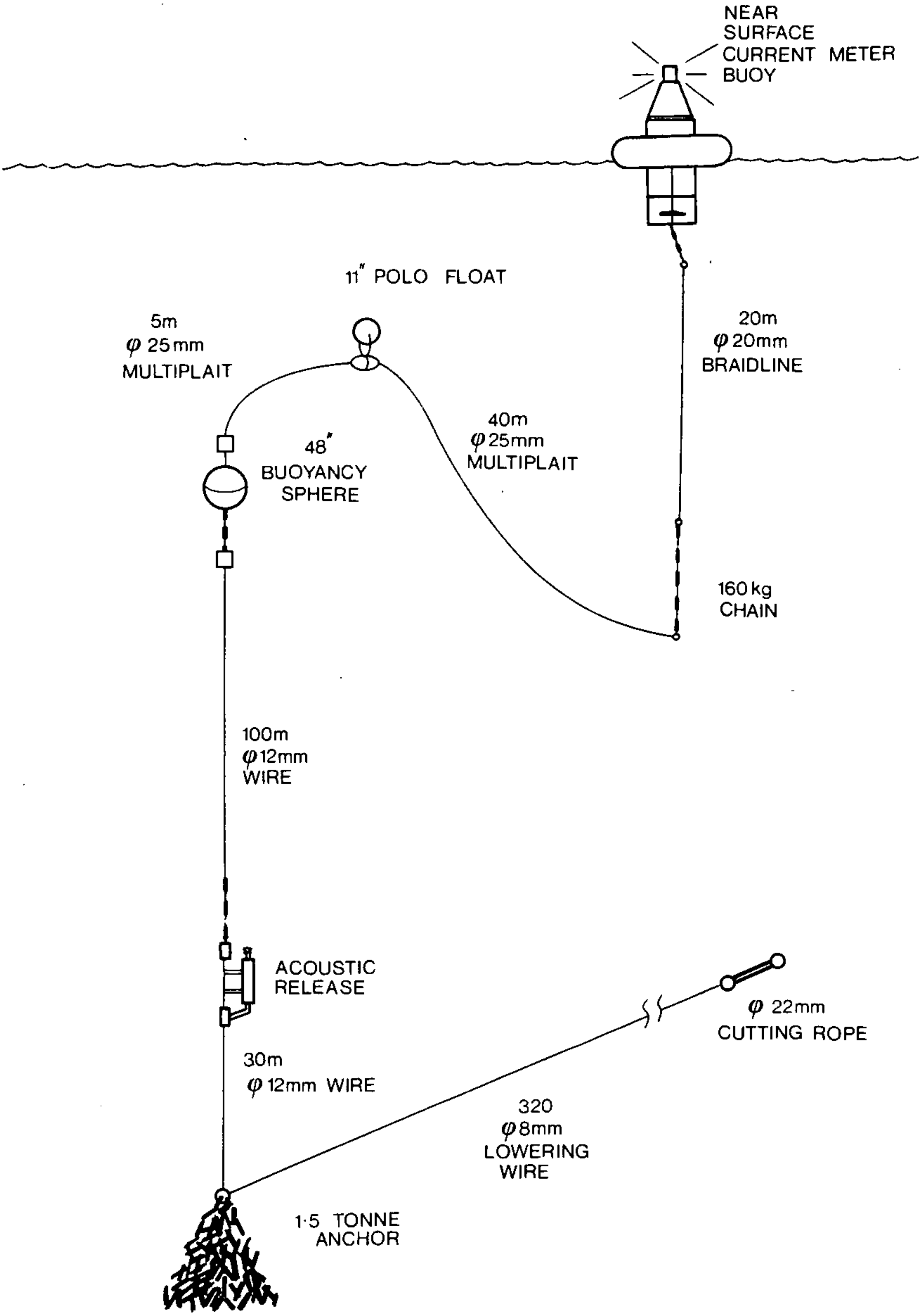

Fig. 3. SCHEMATIC REPRESENTATION OF MOORING FOR NEAR - SURFACE CURRENT METER BUOY.