I.O.S.

RRS DISCOVERY

CRUISE 170

4 – 23 SEPTEMBER 1987

INSTRUMENT TRIALS

CRUISE REPORT NO. 199

1987

NATURAL ENVIRONMENT RESEARCH COUNCIL

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Natural Environment Research Council

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Instrument trials

Principal Scientists

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1987

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DOCUMENT DATA SHEET

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ABSTRACT

This report describes deep water instrument trials undertaken jointly by the Institute of Oceanographic Sciences and the Bullard Laboratories, University of Cambridge, in September 1987. The trials were carried out from the research ship *Discovery* off the north Portuguese coast in water depths from 2000 to 5000 metres, and also in the Porcupine Sea Bight to the SW of Ireland. A wide variety of new gear was tested including the Cambridge Electromagnetic Sounding System, motorised sediment traps, deep particle pumps and a new precision echo-sounding system. Tests were also carried out on new methods of deploying bottom charges and the use of autoretractors to initiate box corer sampling at oceanic depths.

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ITINERARY

Departed Falmouth 1730 4th September 1986
Arrived Barry 10.30 23rd September 1986

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Mason, M.		University of Cambridge
Nash, R.W.E.		IOSDL
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Phillips, G.R.J.		IOSDL
Price, J.D.		RVS
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Wedlock, L.M.		RVS
Withey, S.P.		IOSDL
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SHIP'S PERSONNEL

McCurry, R.J.	Master
Richardson, B.M.	Chief Officer
Oldfield, P.T.	2nd Officer
Ginger, R.H.	3rd Officer
Donaldson, B.	Radio Officer
Jago, P.E.	Chief Engineer
McDonald, B.J.	2nd Engineer
March, P.F.	3rd Engineer
Melrose, C.M.M.	3rd Engineer
Lutey, W.D.	Chief Electrician
MacDonald, R.	C.P.O. Deck
Carew, J.	C.P.O. Deck
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Yeomans, A.R.	Seaman
McHugh, J.	Seaman
Robinson, C.A.	Seaman
Kunold, K.	Seaman
Lock, G.B.	Seaman
Pratley, K.J.H.	Motor Mechanic
Williams, R.L.	Cook/Steward
Welch, G.A.	Cook
McKeown, J.	2nd Steward
Chilcott, R.	Steward
Stanworth, D.J.	Steward
Chattaway, D.A.	Steward

OBJECTIVES

This was a joint cruise between the Department of Earth Sciences, University of Cambridge, and the Institute of Oceanographic Sciences. The objective of the Cambridge party was to carry out trials of a new electromagnetic deep tow sounding system; that of the IOS group was to test new instrumentation including midwater particle sampling equipment, a deep sea precision echo sounder and an FSK telemetry system. The opportunity was also taken by IOS to carry out seismic explosive trials and to recover and relay a bathysnap instrument. If time allowed it was also hoped to attempt the recovery of certain equipment in the Porcupine Sea Bight area. Unfortunately the cruise had to be shortened by one day leaving very little time for salvage activities.

NARRATIVE

R.R.S. 'Discovery' left Falmouth at 1730 on the 4th September 1987 with the expectation of strong winds and heavy seas to the west. In fact by the evening it was clear from the weather forecasts that a succession of gales were due for the Porcupine Sea Bight area so it was decided to turn left and set course for Cape Finisterre. The use of an extensive trials area, south of 41°N, had previously been agreed with the Portuguese authorities, in case weather off Ireland precluded the testing of the new equipment. In fact this arrangement proved most valuable, and for the period from the 7th to the morning of the 17th September the ship was able to operate over a variety of depths in sea states always less than force 5. Most of the time the wind was less than 15 knots and the sea state was 1-3, ideal for such activities. In the area to the west of Ireland the weather continued very poor until about the 16th September.

The first station was occupied in 5000 metres depth at 1100 on the 7th September about 150 miles west of Oporto, in order to wire test the main pressure cases used on the Cambridge electromagnetic deep tow transmitter, and on the autonomous receiver used in conjunction with it. Over the next 10 days the ship remained in the latitude band 40° to 41°N and moved between the above deep water site and continental slope depths of 2-3000 metres within 30 miles of Portugal. During this period trials of the Cambridge system were successfully

carried out, as well as tests of the new IOS equipment. At no time were operations held up by the weather and a most productive period ensued for both parties.

In order to leave reasonable time for work in the Porcupine Sea Bight area, the ship left Portuguese waters during the morning of the 17th September and set course for 49° 30'N, 12° 58'W, to first recover a bathysnap instrument laid in the Porcupine Sea Bight. On arrival in the Bight on the morning of the 19th September the bathysnap instrument was located acoustically and released. After recovery 'Discovery' proceeded to 51° 04'N, 12° 55'W to attempt to recover a 4-year old bathysnap instrument. A 'box' search pattern was undertaken but no sign of the acoustic pinger response could be detected. The ship then moved 10 miles east of this position to deploy the IOS box corer fitted with autoretractors. Later in this same area the previously recovered bathysnap was relaid, for a further period of some 10 months, and the ship then moved north to 51° 32'N, 12° 55'W to attempt to salvage a corer/respirometer instrument lost two years earlier. A request had been made to bring 'Discovery' in one day early so little time remained for the corer/respirometer salvage operation. An attempt was made during a 12-hour period to encircle the target, but with the limited navigational precision available the exercise proved unsuccessful.

'Discovery' left the Porcupine Sea Bight area at midnight on the 21st September, arriving at Barry 1030 on the 23rd. The track for the cruise is shown in Figure 1.

PROJECT AND EQUIPMENT REPORTS

1. Cambridge electromagnetic sounding system

The objective of the Cambridge party was to carry out trials of a new electromagnetic sounding system comprising an autonomous sea-bottom receiver, a deep-towed transmitter and a shipboard power supply for the transmitter.

In the alternative work area west of Portugal three deployments of the EM

receiver were made and two underwater tests of the deep-towed transmitter. Despite some problems on one of the two recording channels, the sea-bottom receiver appeared to have worked well. The first deep tow test threw up a number of unexpected problems with the transmitter, and several modifications were made before its second deployment. Several technical areas were identified in which the instrumentation will require further development and modification, but it is nevertheless clear that in most respects the prototype system is very much along the right lines. Later in the cruise, when the ship was in the Porcupine Sea Bight area, the transmitter antenna array was streamed astern to measure its dipole impedance in seawater.

MCS

2. **Sediment trap trials**

The objective of these trials was to test the performance of the new single sample traps (SST), the time series traps (TST), and to compare both with the large Kiel funnel trap. It had been hoped to lay two moorings for a period of about ten days each in about 2000 metres of water, but due to setting-up problems with the TSTs it was decided to combine the tests in one mooring. Before this short term mooring was laid, preliminary tests were made to check that the traps were functioning correctly.

On the 11th September a suitable site at a depth of 2600 metres was surveyed, at 40° 34.2'N, 9° 45.8'W, and the short-term mooring consisting of a Kiel trap, two SSTs and 2 TSTs was laid (see Figure 2). This mooring was monitored acoustically over the next three days to check that the carousel rotations in the TSTs were occuring at the correct times. On the 15th September the mooring was recovered and the samples sealed for analysis ashore. Both SSTs had closed correctly, activated by timing circuits firing IOS autoretractors.

The first TST had operated correctly, stepping round three positions in the four day deployment, but the carousel in the second TST had failed to complete the three steps. It had jammed at the second position when a switching magnet had dislodged.

The tests had shown that the magnetic switching in the TSTs was not reliable, and that a sealed magnet of the correct strength and form was necessary to ensure long-term reliable switching. Because of this it was decided that no TSTs should be included in the long-term moorings laid in the Porcupine Sea Bight (see Figure 3). This mooring was laid on the 20th September at 51° 04.2'N, 12° 33.1'W, in a depth of 2000 metres and consisted of three SSTs timed to close in June 1988.

GRJP, IFC

3. **Stand Alone Pump (SAP)**

This equipment consists of a pump which draws sea water through a filter in order to collect particulate matter from the water column, and is derived from the FIDO instrument. Unlike the FIDO system both the batteries and motor are in pressure cases at 1 atmosphere, rather than being pressure-balanced in oil. This improves the conversion efficiency. Coupling to the pump shaft is via a magnetic coupling through a high strength titanium window. The equipment is timer-controlled, and is intended to be used on short term moorings or on hydrographic wires.

During these trials the unit was deployed from the midships winch, and some eighteen deployments took place at depths ranging from 200 to 2000 metres. Pumping time was usually from 1-2 hours and the volume of water filtered was recorded on a mechanical flow meter. At the start of the trials it was clear that the limiting driving torque through the window was being exceeded on occasions by the initial shaft acceleration. This was overcome by adding a ramp circuit to raise the starting voltage in a more gradual manner. The opportunity was taken in the trials to take samples with a variety of filters, both in the filter 'top-hat' and through an in-line filter cartridge. It was found that with the GFC filters 1000 litres could be filtered in an hour, and in one case 2400 litres was filtered in about 2 hours. Samples were taken for both IOS and IMER in the Iberian Abyssal Plain and the Porcupine Sea Bight, the latter at the same station as a box corer was deployed.

LHW

4. Test of bottom charges

A large number of bottom shots will be fired during a commissioned research cruise on 'Discovery' in June 1988. Since the proposed design of these charges, and rate of firing, is different from that used before, it was felt prudent that some trials should be conducted beforehand. The explosive used in both the test firings was ICI Powerprime 400 in packages containing 7 and 14 cylinders, each containing 400 grammes. These were suspended below a timer on conducting wire, with a high pressure electrical detonator inserted in the explosive packages. The shots were fired at 3000 metres depth and recorded on the ship via a calibrated hydrophone and Store 4 tape recorder. The signals were played back using a storage oscilloscope and X-Y plotter. The overall response of the system was checked by using a step-function input signal.

As a result of the tests some improvement in the method of arming and deployment are being considered, in order to reduce the shot firing interval to about 7-8 minutes.

JDP, RHE

5. Mark 4 Precision echo sounder and beam steering

The new Mark 4 PES was taken to sea for the first time on this cruise and was used successfully for some 17 days in conjunction with the hull and overside fish transducers. From the start a significant improvement in signal to noise ratio was observed due to the differential front-end amplifier. The common mode rejection proved effective in reducing the background electrical interference which is such a problem on 'Discovery'.

Although the new PES system is designed to be compatible with any facsimile recorder, the Waverley 3700 thermal line scan recorder was chosen for initial trials. The 3700 has a 12-inch chart, as compared with the 18-inch Mufax, but depth resolution was well within the 2 metres in 5000 metres required. The opportunity was also taken to test the new beam steering unit, in conjunction with the 9-transducer array in the overside fish. This appeared to work well. The acoustic command and monitoring system (ACMS) is also incorporated into the

Mark 4 system and includes depth-phase identification for waterkeepers.

At present the Mark 4 system shows promise as a replacement for the Mufax-based Mark 3 echo-sounder, but there are still some problems to overcome. A major one is the fact that the Waverley recorder cannot be viewed directly as it is writing, so it will be necessary to use a VDU to see real-time signals for command and telemetry work. Another difficulty is that the internal sweep is not crystal locked so that at present it is not possible to track an external signal by line-to-line correlation. Waverley Electronics are investigating solutions to this last problem.

The cruise was particularily helpful in the development of the Mark 4 PES because of the varied nature of the work. This allowed a good comparison between the old and the new systems. One especially revealing experiment was to drive the Mufax purely as a chart recorder from the Mark 4 receiver. This produced a clearer record where signals previously unavailable to the Mark 3 could be seen.

AJKH

6. **Box corer deployment with autoretractors**

An acoustically commanded release has been fitted to the IOS box corer for the past two years to overcome premature closing of the corer due to warp resonance in midwater, typically occurring in the depth range 2500 - 3500 metres. This addition has enabled good samples to be obtained at great depths but it does require the use of a gas retractor in the release mechanism, which adds to the cost and time involved. With the advent of the IOS autoretractor there is now a tailor-made devise for such a repetitive task. The retractor consists of an enclosed solenoid and levers and the device can be fitted as a direct replacement for the IOS gas retractor or pyro system. It is reusable and may be reset within a few seconds by applying current from a battery. Two deployments were made to test the performance of the autoretractor with the box corer.

Unfortunately the first deployment in 5000 metres in the Iberian Abyssal Plain was not successful due to the large grain size of the sediments. The box corer would not enter the sediment and lay over on its side shielding the pinger transducer so that the release could not be fired. A second deployment was made in finer sediments at 51° 04.5'N 12° 39.0'W in the Porcupine Sea Bight in 2000 m which was successful. The autoretractor was fired with the corer upright on the sea floor, and a good sediment core was obtained. The core was sub-sampled on deck using small cylindrical core tubes for a radiochemical analysis of bioturbation.

RHE, GRJP, AWG

7. Corer-Respirometer salvage attempt

Two years ago the IOS corer-respirometer was lost in 1500 metres in the Porcupine Sea Bight when it was being wire-tested to check the release mechanism. Unfortunately dummy releases were fitted in the test so that it was not possible to acoustically command the release after the failure. The instrument was the culmination of two years development and a great deal of effort and money so it was decided to make a salvage attempt.

The 1500 metres drag line on the sea floor consisted of a number of wire sections reducing from 14 to 10 mm in diameter, and connected by chain. Two specially made grapnels were fitted, one at the extreme end of the line and one 500 metres in from the end. A swivel was fitted between the end of the trawl warp and the start of the drag line, and pingers were placed at each end of the line.

The corer-respirometer was located at 51° 31.8'N, 12° 55.4'W, at 1600 hours on the 21st September. Due to the request for 'Discovery' to return to Barry one day earlier than planned only 7 hours were available for a salvage attempt. The ship approached from the east with both pingers on the sea floor. Navigation was by Navstar, with relatively poor correlation between fixes. From the beacon on the corer-respirometer it was possible to tell when the ship was abeam, but the range was not known because of navigational inaccuracies, and it

was difficult to ascertain which side the target lay. The idea was to try and pass the target about 500 metres to port and to continue on the same westerly course into wind until it was estimated that the start of the drag line had come abeam the target. The ship would then rotate to starboard to wind the drag line around the corer. Use of the new beam steering on the echo-sounder did suggest that the ship passed correctly to port, and the time of closest approach of the start of the line was estimated. After this time had elapsed the ship turned to starboard to steer on a reciprocal course so that it would pass to port of the target in the opposite direction. Unfortunately it became clear from beam-steering indications that the ship had drifted too far downwind in the turn and was about to pass to starboard. A correction was made but it was left too late to ensure that the correct sea-floor geometry was maintained. By this point the available time had run out and the line was recovered - sans target.

Such an instrument, without any attached vertical or horizontal lines, is always going to be a problem to salvage. However, certain prerequisites are necessary to improve the long odds of achieving success. These should include: some form of target range measurement, unambiguous left/right target bearing information and improved ship navigation, i.e. GPS. The first of these could be by transponder fitted to the target or through use of scanning sonar on the salvage line. The latter has been used most successfully in the Pacific, in conjunction with an electro-mechanical tow cable.

GRJP, AWG, JSMR

8. **Scientific handling machinery**

During the cruise checks were made on the performance and condition of the scientific handling machinery on 'Discovery'. No problems were experienced with the machinery aft, which includes the traction winch system, auxiliary winch and Schat crane-davit. Both the electromechanical cable and trawling warp were used to 5000 metre depth. The auxiliary winch was also used, to handle the drag line; it worked satisfactorily but is in need of servicing and maintenance. There had been reports that the midships CTD winch was not reeling well due to a slight cable kink at about 3000 metres in from the free end. After exercising

the winch cable on a number of deployments, particularly when using the stand-alone pump system, the kink was straightened and reeling followed the Lebus pattern correctly. However cable diameter measurements showed that the outboard 500 metres was oversize due to a build-up of rust and the low cable tension experienced. This effects the spooling on the top two layers only.

At the forward end of the ship the hydraulic main worked well. Both rams on the forward A-frame leaked badly and will be renewed. The console for the double-barrelled winch on the fore-deck is extremely badly corroded and it is intended to rebuild this during the maintenance period.

JSMR

ACKNOWLEDGEMENTS

Thanks are due to the Master, officers and ship's company for their cooperation in making this instrument trials cruise so productive. This was the first time that IOS and Cambridge project team had worked together at sea and both groups enjoyed the opportunity to learn from each other. It was a pleasure to have Kevin Barton on board from University College Galway, who spoke excellent Portuguese with a Gaelic accent.

STATION LIST

Station No.	Date	Position	Task
11705	7/9/87	40°30.1'N, 11°59.9'W	Wire test of Cambridge components
	8/9/87	40°31.9'N, 12°03.8'W	SA pump trials
		29.1'N, 02.4'W	Cambridge receiver deployment
		29.8'N, 03.3'W	Wire test of acoustic releases
		30.9'N, 05.5'W	100 metre test of sediment traps
	9/9/87	30.8'N, 05.5'W	SA pump trials
		30.7'N, 12.5'W	Sediment trap trials
		31.2'N, 14.5'W	SA pump trials
	10/9/87	28.9'N, 01.9'W	Cambridge receiver recovery
		29.7'N, 00.1'W	Calibration of pressure unit
11706	10/9/87	40°35.3'N, 11°11.0'W	SA pump trials
11707	11/9/87	40°34.2'N, 9°46.0'W	Tension sediment trap mooring ropes
11708	11/9/87	40°33.1'N, 9°46.4'W	Lay sediment trap mooring
11709	12/9/87	40°33.3'N, 10°17.5'W	Shot firing trials
11710	12/9/87	40°31.8'N, 9°48.3'W	Test interrogation of sediment trap mooring
11711	13/9/87	40°33.1'N, 9°47.7'W	SA pump trials
		32.2'N, 47.3'W	Trials of near-bottom echo sounder
11712	14/9/87	40°19.8'N, 11°50.1'W	Cambridge receiver deployment
		19.5'N, 52.5'W	Trials of near-bottom echo sounder
		18.9'N, 53.4'W	Box corer deployment
		18.3'N, 53.9'W	SA pump trials
(11708)	15/9/87	40°32.8'N, 9°46.4'W	Sediment trap mooring recovery
		32.5'N, 10°01.8'W	Trials of FSK telemetry system
		31.8'N, 01.9'W	SA pump trials

Station No.	Date	Position	Task
11713	16/9/87	40°20.0'N, 11°49.3'W	SA pump trials
		17.9'N, 45.7'W	Cambridge deep tow deployment
	17/9/87	19.1'N, 51.8'W	Cambridge receiver recovery
11714	19/9/87	49°30.3'N, 12°57.9'W	Bathysnap recovery
11715	19/9/87	50°14.6'N, 12°53.5'W	Measurement of Cambridge aerial impedance
		14.6'N, 53.5'W	Wire test of acoustic releases
11716	20/9/87	51°04.5'N, 12°39.4'W	Box corer deployment
		04.4'N, 38.7'W	SA Pump trials
		04.2'N, 36.5'W	Measurement of Cambridge aerial impedance
		04.5'N, 35.3'W	Wire test of acoustic releases
11717	20/9/87	51°04.3'N, 12°33.9'W	Lay sediment trap mooring
		02.4'N, 29.8'W	SA pump trials
11718	21/9/87	51°06.7'N, 12°37.9'W	Lay Bathysnap
11719	21/9/87	51°31.8'N, 12°55.4'W	Corer-respirometer salvage attempt

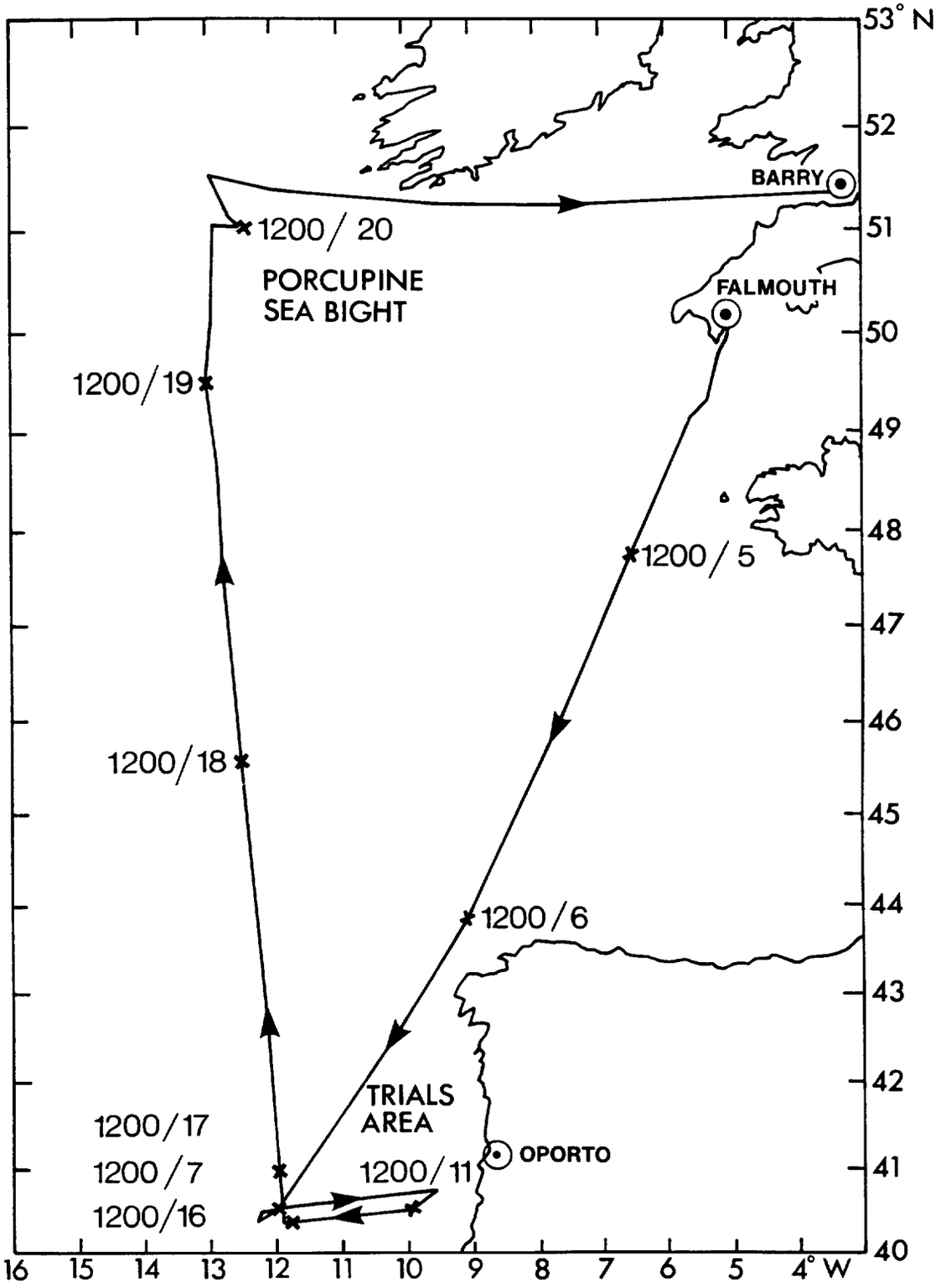

Fig.1 Track Chart : RRS Discovery Cruise 170,
4-23 September 1987

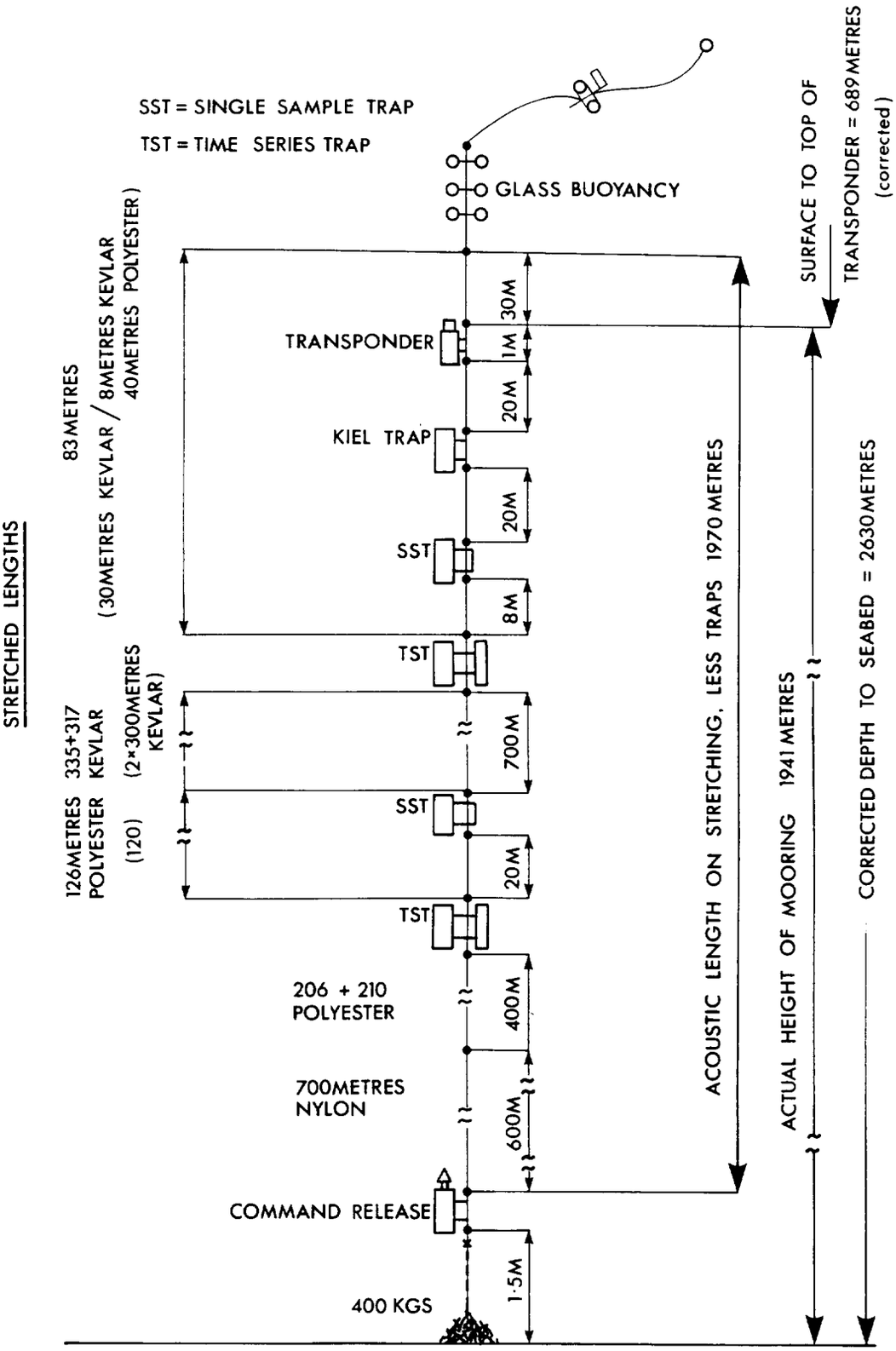

Fig. 2 SEDIMENT TRAP MOORING FOR TESTS.

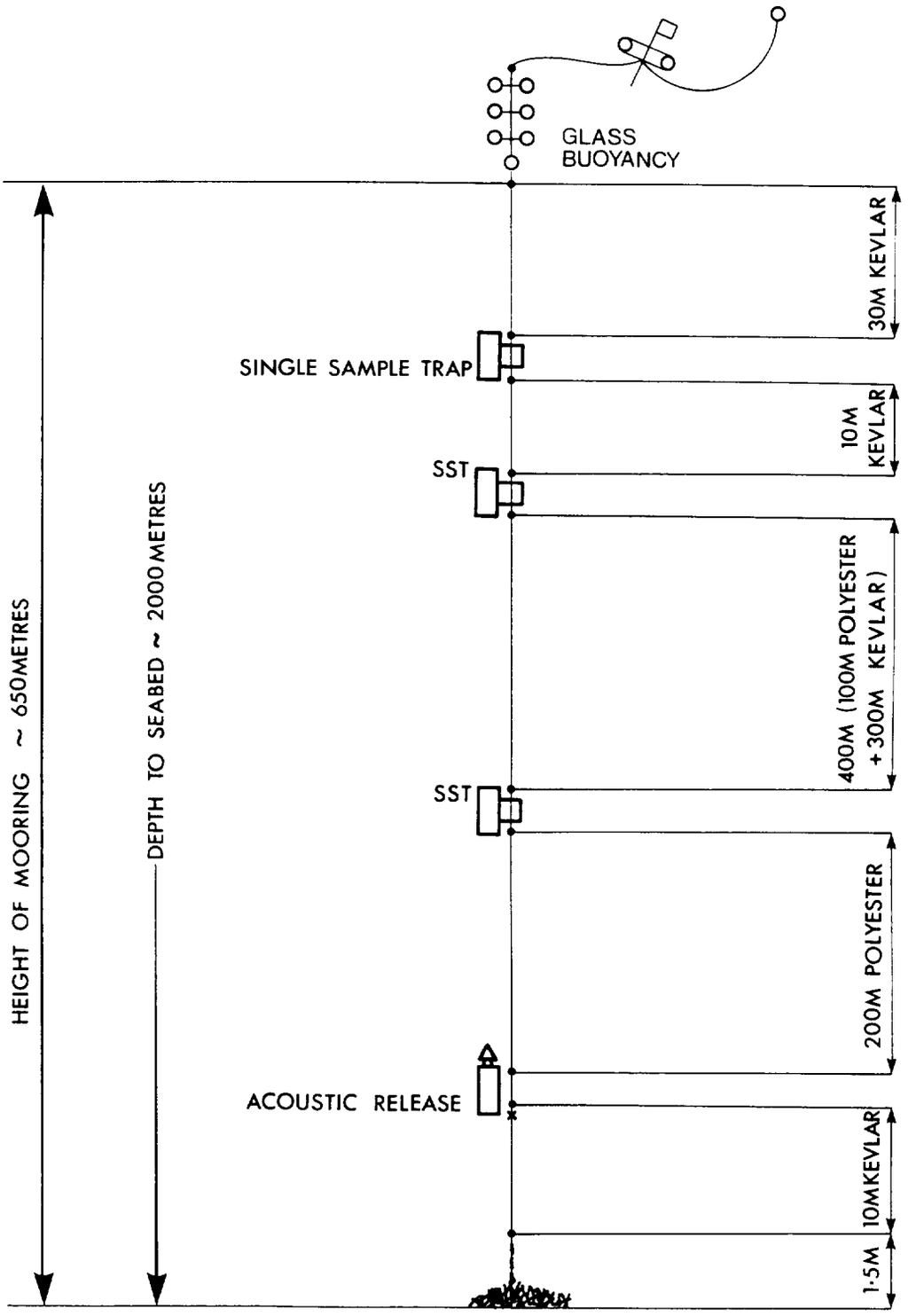

Fig.3 SEDIMENT TRAP MOORING LAID IN PORCUPINE SEA BIGHT.