I.O.S.

RRS CHARLES DARWIN

CRUISE 6/85

9 - 27 AUGUST 1985

INSTRUMENT DEVELOPMENT INCLUDING FURTHER POREWATER SAMPLER AND TOBI TRIALS, WITH SEISMIC REFRACTION LINE, PORE PRESSURE RECORDER DEPLOYMENTS AND TIDE GAUGE RECOVERY

CRUISE REPORT NO. 179

1986

NATURAL ENVIRONMENT RESEARCH COUNCIL

INSTITUTE OF OCEANOGRAPHIC SCIENCES

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When citing this document in a bibliography the reference should be given as follows:-

McCARTNEY, B.S. *et al* 1986 RRS *Charles Darwin* Cruise 6/85: 9 - 27 August 1985. Instrument development including further porewater sampler and TOBI trials, with seismic refraction line, pore pressure recorder deployments and tide gauge recovery. *Institute of Oceanographic Sciences, Cruise Report*, No. 179, 25pp.

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WORMLEY

RRS CHARLES DARWIN
Cruise 6/85
9 - 27 August 1985

Instrument development including further porewater sampler and TOBI trials, with seismic refraction line, pore pressure recorder deployments and tide gauge recovery

Principal Scientist

B.S. McCartney

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ITINERARY

Departed Falmouth	1700 BST	9th August 1985
Arrived Funchal	1600 GMT	27th August 1985

SCIENTIFIC PERSONNEL

R.J. Babb	IOS, Wormley	
R.N. Bonner	IOS, Wormley	
R.H. Edge	IOS, Wormley	
P.R. Foden	IOS, Bidston	
N.J. Griffin	IOS, Wormley	
D.E. Gunn	IOS, Wormley	
A.J.K. Harris	IOS, Wormley	
R.E. Kirk	IOS, Wormley	
B.S. McCartney	IOS, Wormley	(Principal Scientist)
S.D. McPhail	IOS, Wormley	
C.J. Paulson	RVS, Barry	
R.A. Phipps	RVS, Barry	
A.D. Robinson	RVS, Barry	
J.S.M. Rusby	IOS, Wormley	
J.D. Taylor	RVS, Barry	
C.H. Woodley	IOS, Wormley	
L.H. Wright	IOS, Wormley	

SHIP'S OFFICERS AND PETTY OFFICERS

G.M. Long	Master
K. Avery	Chief Officer
G. Harries	Second Officer
A. Louch	Third Officer
J. Baker	Radio Officer
C. Storrier	Chief Engineer
D. Anderson	Second Engineer
A. Grattidge	Third Engineer
P. Edgell	Electrician
R. Macdonald	Chief Petty Officer Deck
W. Hawkins	Cook/Steward

REVISED OBJECTIVES

1. To deploy and test 3 digital ocean bottom seismometers (D.O.B.S.).

2. To use the DOBS and 4 air-guns for refraction lines to the SW of the UK; as far as possible (1) and (2) to be simultaneous.

3. In the absence of the 13.5 mm Rochester cable, to check the suitability of the CTD cable, and its winch reeving for limited depth, limited tension work.

4. Using the above cable and winch to deploy and test TOBI (a Towed Ocean Bottom Instrument), working towards an operational instrument for Darwin Cruise 9/85.

5. To deploy in GME and recover, then deploy again 2 off PUPPI (Pop-Up Pore Pressure Instruments) for recovery on Darwin Cruise 9/85 for an in-situ experiment to measure sediment porosity, for which the deep ocean tide signal provides the cyclical excitation pressure.

6. To test acoustic releases, including those for objectives 5 and 8.

7. To recover from GME a deep ocean tide gauge.

8. To deploy an inverted echo sounder for a few days and to recover.

9. To deploy and tow at a range of speeds a revised sea surface temperature/ pressure fish, checking sensors and towing position and stability.

10. To test the Pore Water Sampler (P.W.S.) using the torque balanced coring warp, with camera and sensors fitted but no water sampling tubes.

11. To do range tests on a miniature radar transponder (belonging to S.P.R.I.) mounted on a pitch-roll buoy float.

12. Calibrations and intercomparison of the electromagnetic and doppler logs fitted to the ship were not possible because the Level A interface of the doppler log was not working.

NARRATIVE

The cruise which was programmed to begin on 6th August was late starting because of a long list of fitments undertaken at Falmouth following Cruise 5/85; these included items for later cruises such as the stern roller for the multi-channel hydrophone, corer davits and bucket, a small winch for the heat flow probe, a deck frame for same, deck bases for an O.R.E. winch. Also, but required on this cruise, were Lebus scrolls and a slip ring assembly on the former dredge winch drum, and winding on of the recently purchased armoured conductor cable from Rochester Corporation. There was never the slightest chance that all this could be achieved in the time allowed. It must be stressed that this is no reflection on the RVS staff whose task it was; on the contrary they worked long and hard for days on end. Rather it is an indictment of the system of planning and programming.

In the event it was the cable winding which caused the longest delay. First the 12 km length had to be wound from the supplier's reel under low tension to a winch fitted with a brake standing on the quay; this required the fitment first of a faster hydraulic motor to the winch, and the rigging of the wire via blocks on the ship to give a long lead to the winch. This winding began at 1900 on Wednesday 7th and was completed at 0300 8th. By the afternoon of the 8th the cable had been led from the quay winch to the ship's midships A frame, from there to the aft A frame, back to the spurling pipe and down to the dredge winch. It was soon discovered that the cable entry to the winch shaft was too sharp and further work was needed to machine it out. Winding began at 1800 and another late night was in prospect. By 2100 however it became clear that the Lebus scroll and the cable diameter did not match, even under tension. The major objective of the cruise, testing TOBI, was thus in jeopardy. After long discussions between RVS, Lebus and IOS staff, it was decided to leave the Rochester cable behind, to utilise the ship's CTD cable for the testing purpose, by leading it aft via a deflector sheave, and to leave arrangements for fitting the new cable at a later date but in time for cruise 9/85 on which it was required for IOS commissioned research in GME. As far as the current cruise was concerned the implications of using the reduced strength CTD cable were a severe limitation on operating depth for TOBI, a weather limitation for dynamic loading and, most serious of all a reduced bandwidth cable. With cancellation of the cruise the only other alternative, these limitations were reluctantly agreed. The dockyard welded on the divertor sheave and also side cheeks to the A frame block the next morning and after loading explosives for Cruise 7/85 the ship finally left Falmouth at 1700 on the 9th, three days late.

Course was set for the seismic refraction line site off the shelf edge near Goban Spur. Overnight the weather deteriorated and the vessel began to pitch heavily head into wind and swell. Weather forecasts were carefully monitored for the improvement necessary to do the experiment, but by 1800 it was clear that DOBS and air-gun deployment and recovery would be extremely hazardous, and sighting the DOBS on the surface chancy. There being no slack time to await weather moderation, later forecasts in fact giving worsening or continuing gales, we altered course for the second choice site beyond the Tore Seamount NE of Josephine Bank. The swell remained but the weather improved as we went South. It was noted that the Magnavox Doppler log breaks through onto the PES Mufax when the latter is connected to the hull transducer. The PES fish was deployed at 1030 on the 12th and towed without any problem for the whole cruise. The opportunity was also taken to stream the SST fish at speeds ranging from 6 to 12 knots as we proceeded on course.

We arrived at the first DOBS position on 13th and after a good Satfix deployed at 0910, using the midships A frame for overboarding, a small Rexroth winch for the lift and lowering and a greasy bar release. DOBS 2 was deployed at 1148 and DOBS 3 at 1418 in identical fashion, to give an 80 km baseline. Air-guns were then streamed, towing 2 x 1000 cu. in. guns on each of two bridles attached to the large A frame aft. At 4 kts the gun depths were estimated between 10 and 15 metres depth. The run over the line took from 1705 to 0447 on the 14th, after which the air-guns were recovered and the ship made for the DOBS 3 position to effect acoustic release at 0530. The unit surfaced and was inboard at 0710. Recoveries of the other two DOBS also went very well and they were inboard at 1150 and 1530 respectively. The whole 33 hour operation had gone so smoothly that it was a terrible disappointment to discover on opening the DOBS that no data had been recorded, due to an internal interference fault during the setting up operation. By this time we were on course for the GME area at full speed, except for another short period streaming the SST fish.

Once the Madeira 200NM limit had been crossed some wire tests beginning at 0842 on the 16th using the coring warp and midships A frame were done: the TOBI compass sphere was tested at 200 m for leaks and then the PUPPI acoustic releases, followed by the IES acoustic releases all to 5000 m. One minor problem on a PUPPI release was revealed and put right, retesting to confirm and then passage was resumed at 1935.

The course was chosen to pass over a long life 10 kHz transponder laid by IOS from a recent cruise of the M. Dufresne. This was observed as expected at 0900 on 17th and in fact a second transponder was located 5 miles away. These proved useful as a navigational baseline later on.

A standard PUPPI was deployed at the centre of the GME study area for recovery in December, Cruise 9/85. It also should provide a reference for another PUPPI with increased sensitivity to be laid later this cruise. The specially designed frame bolted to the deck under the midships A frame proved to be workable and essential due to the length of the probe.

After considerable discussion and several false starts a method of launching and recovering TOBI was derived. This involved the rigging, slung down from the aft A frame, of a lifting block which was also stayed to the A frame uprights to give some lateral stability. A rope passed over this block and led via the spurling pipe sheave to the dredge winch drum used as a hauling capstan. For deployment TOBI was lifted by a strop to this combination, overboarded by the A frame and released when in the water by a hydraulic cutter acting on the strop. The tail drag rope is paid out first, then TOBI, then the umbilical cable is handed out and finally the towed weight lifted on its CTD cable and overboarded by the A frame. This last operation is the most difficult due to the very high towing block height under the A frame. On this cruise the weather was not too severe during the deployments but there was always a swell running. It is clear that the handling arrangements are by no means ideal and until some better facility is provided on this ship it will be a fair weather operation. The first deployment started at 1900 on 17th and was completed 2 hours later. Due to an internal fault the system then had to be recovered and it was inboard by 2345.

The Inverted Echo Sounder in a tide gauge frame was then deployed safely and, after checking for correct operation of its acoustics on landing, the ship steamed away 5 miles for some more testing of acoustic releases at 0109. These were completed at 0800 when course was set for a position within a mile of the first PUPPI in order to drop the second at 1132.

By this time the faulty leaking and tracking plugs and sockets on TOBI had been located and rectified. It was noticed that the spooling of the CTD wire on the midships winch drum was poor, so it was streamed with a 500 lbs weight out to more than 3000 metres and then carefully hauled in adjusting the spooling sheave at several places. On completion of this at 2225, preparations began for TOBI again, the deployment this time between 2235 and 2325 being a good deal slicker. The CTD wire was then paid out first to 200 metres, at which point winch control was transferred to the remote unit in the main laboratory, and then to 3000 metres scope for the hydrodynamic trials. As found on last year's tests the whole system takes several hours to settle and the first run at 2 knots began at 0330 on the 19th. Other runs, also lasting 45 minutes, the length of a tape record, were made at ship speeds of 1.6, 1.2, and 2.5 knots by 1155 and hauling began. Pen recordings of wire tension were kept continuously throughout TOBI operations and remained within the 2 ton limit, including dynamic loading. Recovery starting at 1400 was complete by 1430, again the weight causing the most concern.

The pore water sampler (PWS) was tested next using the torque balanced coring warp from the midships A frame and lowering at 30 metres per minute to within 100 metres of the sea bed (5400 m approx.). The unit was then carefully lowered to land on the sea bed, the first time acting according to the pinger telemetry. Four attempts at different lowering speeds were tried with variable results before hauling in by 2236. Using the same warp two more acoustic releases were tested at 5000 metres wire out, completed at 0304 on 20th.

The difficulty with the PWS was believed to be a result of ship drift relative to ground, so it was decided to carry out the next test within range of the two transponders mentioned earlier in order to monitor drift.

In the meantime detective work in the lab. had uncovered the likely cause of the DOBS problem, so one modified unit was prepared and, after fitting to a spare IES ballast frame, deployed at 1117 on 20th, within range of the transponders; this DOBS which also has a commanded transponder channel thus became the third in a network.

At 1334 the PWS began its second lowering, the ship drift this time being practically zero according to the transponders. Indeed the unit sat upright and seemed to function the first time and less certainly the second. On recovery inboard at 2105 the film was unloaded and developed, but operation of the carriage was not observed due to obscuring sediment stirred up on landing.

Two more acoustic releases were then successfully tested by 0155 on the 21st and course set for the DOBS, released at 0350 and inboard by 0600. By chance the DOBS release signal had also released the Tide Gauge which was next to be recovered anyway and it was soon inboard before setting off to the PUPPI site, reached at 1000. The command signal to cut the pipe of the experimental PUPPI with a retractor driven blade was transmitted successfully as indicated by telemetry.

A wave-buoy float fitted with a radar transponder belonging to SPRI and with a standard VHF radio beacon was floated off. The ship steamed off to determine the ranges for both systems. The radio bearing could be determined out to about

5 miles but the radar transponder performance was disappointing and the buoy was recovered. The spare radar transponder was unpacked and tests on the ship showed that its tuning was some way off for the ship's actual (as contrasted with its nominal) frequency. The original was retuned and the trial repeated, resulting in a reliable range of 5 miles. However, this represents the limit for an object so low in height above the sea surface, which had about 0.5 m waves and a 2 m swell. When lifted by the sea at this range the signal on the radar was very strong suggesting that a longer range would be likely on a higher platform, something we did not have time to confirm.

In order to give the PWS camera a chance in stiffer sediment, course was set to the East on the basis of published IOS work, arriving at 2330 on the 21st. Two lowerings were made, the first including an experimental conductivity probe, the second with a core tube added as well. When all inboard at 0750 on the 22nd, course was set for the IES.

Like all the other equipment released acoustically on this cruise it behaved well and was inboard at 1838 on the 22nd. The experimental PUPPI was then released and inboard by 2150, the night recovery aided by radio beacon and flashing light. The ship then remained on station whilst this PUPPI was readied for redeployment, this time for recovery on Cruise 9/85 with the nearby standard PUPPI. We departed this site by 0212 on the 23rd.

Because of the tension limited scope of the CTD cable used for TOBI, in order to test its acoustic system we had to find an area of shallower topography. The Hyeres Sea Mount to the North of the much shallower Great Meteor Bank looked a possibility, having a large area of nearly uniform depth at 1750 metres on its eastern flank. On arrival in the area at 1400 on the 23rd a PES box survey was made to confirm the detailed bathymetry. Our concerns about the limited bandwidth of the CTD cable were confirmed as it proved very difficult to get enough signal-to-noise ratio to separate trigger pulses from sonar data and from telemetry of housekeeping data such as depth of the vehicle and compass. In desperation the transmitter was wired up to pulse on a free running basis from an internal clock. Deployment began at midnight on the 24th in the best area indicated by the PES survey. A 10 kHz transponder was fitted to the TOBI frame to give height off bottom in the absence of the depth signal.

Because of strong surface currents and one suspects shear too, it proved difficult to maintain the intended track at 2 knots, but we remained within the surveyed area. The vehicle approached within 150 metres of the bed but no sonar signals were received and recovery was initiated at 0330 on the 25th, all inboard by 0545.

The ship then set course for Funchal into a stiff headwind. On arrival at 1500 on the 27th, permission was obtained to make a final acoustic test of TOBI in the harbour by hanging it from the stern. Despite an off-putting oil-slick in the harbour the test was undertaken successfully and indicated that acoustic transmission, signal echoes and harbour noise above system noise were being received through the cable to the laboratory recorder.

Equipment for use on Cruise 9 was packed and put down to the hold, other returning equipment loaded to the hired container, which was lifted ashore at 0900 on the 28th. The tide gauge release electronics and a pen recorder were air-freighted back to the UK. Personnel left the ship at 1600 hrs on the 28th.

PROJECT AND EQUIPMENT REPORTS

1. Digital Ocean Bottom Seismographs (D.O.B.S.)

The DOBS are microprocessor controlled seismic data loggers. Work on these instruments began in September 1982. Three instruments have now been built and a total of three deployments have been made during two previous cruises. Results acquired so far have been encouraging despite teething problems with the instrument.

The aims of this cruise were to test the DOBS in their working environment and to record a refraction line to the S.W. of the U.K.

Bad weather on leaving Falmouth prevented shooting of the intended line so an alternative line was shot further South. Three DOBS were deployed and an 85 km line was shot using four one thousand cubic inch airguns. The guns were fired for over twelve hours without breakdowns and instrument release and recovery were carried out in the minimum of time.

Upon recovery of the three instruments it was discovered that the microprocessor programs had become corrupted during pre-launch preparation of the DOBS. Sadly this meant that no useful data had been recorded in any of the first three deployments.

Tests were immediately carried out to trace the cause of this program corruption. These tests indicated that a latching relay in the instrument was generating high voltage spikes during preparation of the instrument. Modifications to the DOBS circuitry and wiring, and a change to the instrument launch preparation procedure were made to eliminate this problem.

A further single instrument deployment was made to check the effectiveness of the modifications. This test was successfully carried out and the instrument recorded over five hundred records on tape, in total almost seventeen megabytes of data.

Modifications to the instrument since previous cruises included the use of Lithium batteries to power the cartridge recorder instead of rechargeable cells, and the fitting of Novatech 150 MHz radio beacons for instrument location on surfacing. The new beacons replaced IOS units which could no longer be produced economically.

The loss of data during the perfectly executed refraction line was a great disappointment, however no instruments were lost and much operational experience has been gained which will be of great value in future cruises.

R.E.K.

2. Pop Up Pore Pressure Instrument (P.U.P.P.I.)

PUPPI is a pop-up instrument designed to measure pore pressures within deep sea sediments. It free falls and penetrates the sea bed sediments with a 4 metre long lance. A port in the tip of the lance allows the pore pressure at this depth to be recorded.

Several deployments have been made on Geophysics Cruises aboard RRS Discovery, providing much useful data. PUPPI was taken on this cruise to test out several refinements. These are:

A pipe cutter, acoustically commanded to cut the pipe which connects the differential pressure transducer and the port in the lance tip. This is designed to give a good 'in-situ' zero reference at the end of the experiment.

Previously, the zero pressure reference was obtained when the instrument released from the sea bed, but this is prone to error because of flow effects on the transducer.

A data logger capable of recording from two differential pressure transducers. This will allow measurements from a port half way down the lance, as well as at the tip.

More sensitive differential pressure transducers: 1 bar instead of 5 bar full scale.

Previous deployments had recorded a small amplitude sinusoidal pressure signal of period 12.5 hours, apparently of tidal origin. These tidal signals are sensed by the pressure transducer because there is a time delay between a pressure change at the top surface of the sediment, and at the lance tip. The components producing the time delay are thought to be a function of the permeability of the sediment and the compliance of the pressure transducer. Using a transducer with greater compliance should test this theory, and a more sensitive transducer will record the cycles with greater fidelity.

The first PUPPI to be launched was a standard type with a single 5 bar transducer and no cutter. This is to be used as a control and will be recovered in December 1985 on Charles Darwin Cruise 9. The deployment went without incident, and telemetry indicated that the penetration was full and the angle of tilt less than 10 degrees.

The experimental PUPPI with two, 1 bar transducers and a pipe cutter was deployed at a site close to the first, again with good indications by telemetry. Three days later the release was switched to the release channel to fire the pipe cutter and then switched back to the beacon channel to effect a time out of the beacon. A day later it was released without difficulty. The radio direction finding and flashing light helped in the night time recovery. The EPROMs holding the data were removed, and the data inspected. PUPPI was re-rigged and successfully redeployed, again close to the first. It will also be recovered in December. Data from the deployment confirms the operation of the pipe cutter and shows in good detail six tidal cycles.

An IOS Bidston tide gauge and experimental Inverted Echo Sounder (capable of measuring tides) were deployed close to the PUPPI sites throughout the PUPPI deployments. Their records will be valuable in analysing the results of the PUPPI deployments.

S.D.McP.

3. Inverted Echo-Sounder

This was the first deployment at full ocean depth of the Inverted Echo-Sounder (IES) and is one of two units recently purchased by IOS Bidston. The IES is a bottom moored recording instrument intended to measure long-term changes in the integrated sound velocity profile related to the vertical water-column temperature profile. The logger is contained inside a Benthos glass sphere and hard hat with the acoustic transducer fitted externally. A Mk IV pressure recorder frame has been modified to accept the IES in the centre, surrounded by four Benthos glass spheres to provide buoyancy and two standard IOS releases.

The acoustic transducer is mounted on a plastic disc bolted to the top of the frame. The IES operating parameters are preset at the Institute by means of an RS 232C terminal and are as follows:-

Burst length	= 40 pings
Bursts/hr	= 4
Ping length	= 6ms
Ping interval	= 10 secs
Lockout time	= 3.1 secs
Mode of operation	= URI (University of Rhode Island).

It is activated and reset on board the ship by shining a flashlight through the glass sphere. The IES was launched on 18/8/85 at 0108 GMT in 5394 m (corr.), position 31°21.4'N, 25°07.3'W in good sea conditions. Working at 10 kHz acoustic transmission frequency, the instrument could be heard and seen operating on the PES Mufax recorder and was monitored all the way to the sea-bed.

The IES was recovered on 22/8/85 at 1838 GMT and took just 14 minutes from surfacing to being safely inboard. The ascent from the ocean floor took 1.5 hours. The instrument was in good condition except for the OAR flashing light which refused to work.

On checking the IES ping interval it was found to have gained 2 secs, indicating that the internal clock had been running fast. The cassette tape had advanced but will have to be returned to Bidston to replay the data.

P.R.F.

4. Deep Sea Pressure Recorder (Mk IV)

The Mk IV pressure recorder was deployed by IOS Wormley on the Darwin Cruise 1/85 (26/2/85) at GME, 31°30.8'N, 24°46.2'W at a depth of 5438 m.

The logger was a standard IOS Bidston instrument containing three pressure sensors and one temperature sensor (one Paroscientific Digiquartz and two strain-gauge types). The temperature sensor is a new design using a temperature sensitive quartz crystal. The data is recorded at 800 bpi on a Seadata recorder once every 15 minutes.

The unit was popped up prematurely when the DOBS instrument was released from a test deployment. Fortunately the Mk IV was to have been the next thing to be released. The flashing light was noticed nearby and the pressure recorder promptly brought on board albeit a few hours sooner than anticipated. The recorder was in good condition and showed very little signs of corrosion. The scan time was noted and the tape cassette removed for translation back at Bidston.

P.R.F.

5. Wire Testing of Acoustic Units

Ten sets of acoustic releases were wire tested to 5000 m (wire depth) by using the coring warp and winch. Two of the releases were for use on the IES instrument and six other units for use on three pressure recorders to be launched from the SA AGULHAS in October/November 1985. It is not possible to wire test them on the AGULHAS so this opportunity was taken to test their performance at operating depth.

All these eight releases worked well and six are to be air freighted back to the UK and put in a container for transfer to the AGULHAS.

Problems were found on one of the two acoustic releases used on the PUPPI instrument, the symptom being failure to stay in the release mode. This was found to be caused by the PPA pulses travelling up the receiver input wires where they are damped by two back-to-back diodes. The pulses were being picked up by other leads going to the relay board. This caused the unit to jump to the beacon mode all the time.

The problem was cured by resiting the diodes and the resistor directly on the PPA transformer together with the 5K6 series input resistor, effectively damping the pulses before they reached the wiring harness.

P.R.F.

6. Mk 3 Porewater Sampler

The objectives of these engineering trials were to confirm that modifications to the ram and valve system had overcome previously experienced problems with the carriage descent during operation. Problems of tilting and delayed lift-off had also caused the core tube to tear off.

A pull-through wire indicator was added to the frame to confirm carriage descent, and a Mk 4 underwater camera fitted to photograph the operation on the sea-bed.

A probe designed to give a conductivity profile for the first 60 cm of sediment, was also fitted. This records data in a solid state memory. The carriage movement is sensed by a reed relay/magnet assembly, giving a resolution of 2 cm.

The PWS was deployed using the torque-balanced coring warp from the midships winch and "A" frame.

In total four deployments were carried out. The first three without the core tube fitted, the last one with. In all cases but the last multiple landings were attempted. All tests were in water exceeding 5300 metres depth.

In the first deployment an extra telemetered ping indicated that the carriage had operated correctly. However, a shift in the accelerometer trace suggested that the unit had fallen over, possibly obscuring the infra-red light sensor, causing a "carriage down" indication. On return to the ship the sides of the unit were streaked with mud, as was the camera which did not present any photographic evidence to confirm success. The wire indicator however showed that there had been carriage movement.

For the second deployment two bottom positioned transponders, one of which was a previously deployed DOBS, were used to enable the ship's deviation from position to be known and allow corrective action to be taken to prevent dragging the unit over. The results from this deployment were similar to the first one, the extra pinger pulse indicating the infra-red probe into sediment on the first landing, but not on any of the others, accelerometer shift suggesting reduced tilting and the pull wire suggesting correct operation. The photographs did not include the required pictures, but did show what appears to be the moment of impact on the sea bed with clouds of fine sediment obscuring the camera's view.

This suggested that the area in which these tests had been carried out, 32°00'N, 24°54.634'W, might have sediments so soft that landing square was more difficult than need be for our purposes. It was therefore decided to try further deployments in an area known to have firmer sediments.

Before the next deployment the accelerometer was calibrated in order to quantify the angular deviation from vertical experienced by the unit on the sea-bed.

The third deployment was in the area 31°09.897'N, 23°45.963'W. The conductivity probe was added to the unit at this stage. The telemetry on initial landing suggested success and accelerometer shift indicated an angular movement of 15 degrees, this being less than previously achieved, thus justifying the move to firmer ground. On return to the ship a core tube was fitted and deployment four began. This did not result in a successful landing, the photographs confirming little carriage movement and the core tube contained no sediment, though there was sediment external to the core tube. This implies that the corer water release valve had not functioned and the corer had acted to decelerate the carriage before full penetration.

The conductivity probe gave some results on the last two deployments, but the reed/magnetic assembly does not seem to have worked reliably, and so the number of data points recorded was much less than expected. However, the conductivity measurement, and data recording electronics functioned properly.

7. Sea Surface Temperature/Pressure Sensor

Towing Trials The SSTPS is an instrument to provide near surface (<5 m) temperature information while the ship is steaming between stations. The sensor is mounted in a streamlined towed body, the fish, and towed from an extended boom mounted on a forward position of a ship. For this cruise the mounting boom was fixed to the deck on the port side, the pole being at deck-level passing through a scupper, and extending over the side by approximately 5 m. To prevent the pole from flexing, three steel guy ropes are connected to the end of the pole and clamps bolted to the top rail.

The two sensors, pressure and temperature, are mounted in a 6.25 cm dia. by 46.5 cm long tube within the fish and are coupled to the deck unit by the conducting, armoured, sea cable and four core screened deck cable.

The format of the data is a frequency modulated wave form where the change in frequency is a function of the parameter being measured. For a 10 m change in depth the pressure sensor output frequency range is in the order of 800-1400 Hz, the temperature sensor frequency shift is from 1500-2200 Hz for a temperature range of 20 degrees Celsius. For these tests the deck-unit was connected to a frequency counter and a chart recorder.

The fish was towed at different times using varied lengths of tow cable between itself and the towing boom, and the ship speed varied from what was considered to be a safe deployment speed, 6 knots, and the highest speed endured before the fish was either skimming the surface or towing in the foam of the ship's wake, usually between 10 to 12 knots. The position of the fish relative to the ship's wake was noted as it would be desirable to tow outside the wake. However during these trials this was not the case, an extension of the boom by 5 m would be needed to achieve this.

The cable length to give optimum towing conditions was 15 m and this was the first length tried, followed by 10 m, 8 m and 17 m. Throughout these tests the depth of the fish at the various ship speeds was recorded. The angle of the wire and the stability of the fish was noted and generally seen to be acceptable. During these tests temperature data were recorded and confirmed by comparison with the ship's hull mounted temperature transducer data.

L.H.W.

8. TOBI

Summary of deployments The system was deployed three times. The first, intended as a vehicle stability test, failed because various underwater connectors in the vehicle broke down as a result of seawater leakage and applied high voltage. This difficulty was overcome before the second attempt simply by replacing the connectors which had failed, and disconnecting the high voltage supplies, which fortunately were not needed for the hydrodynamic instruments.

The second deployment was successful, and indicated, at least tentatively, that vehicle yaw stability has been improved by the addition of fins and stabilising panels.

The third deployment, attempted only after numerous electronic vicissitudes, was intended to test the side-scan system, but failed completely. A post-mortem showed that the line driver gain control in one of the underwater tubes had been set to zero.

Further details of the work carried out at sea follow.

Tow cable The Rochester tow cable intended for TOBI was delivered to Falmouth on August 5th. Several days of valiant effort by RVS personnel failed to see it wound on its drum, and we eventually decided that its outside diameter, under reasonable load, was too large for the Lebus scrolls specially produced for it, apparently because the armour wires were slightly oversize. We decided to fit the cable at a later data using new scrolls of appropriate pitch, and to use Darwin's 8.5 mm OD CTD wire for this cruise, accepting its limitations on cable scope and operating depth.

A new diverter sheave was fitted aft of the CTD winch, to enable the wire to be led aft to the towing sheave on the A-frame, and we finally sailed on Friday August 9th. On sailing, new fittings for the end of the CTD wire were made up, and termination of the wire to the TOBI swivel/slipring unit proceeded as usual.

Deployment procedures This exercised us considerably. The final arrangement involved a vehicle lifting sheave positioned half-way up the A-frame using a strop from the top of the frame, with side stays to the small winches on the A-frame legs. A 5-ton rope was run from the main winch drum, up the spurling pipe, down to a snatch block attached to the deck close to the starboard A-frame leg, and finally up to the sheave suspended from the A-frame.

Apart from this, deployment and recovery procedures were similar to those used previously on Discovery, except that a break-out stray line was attached to the rear of the vehicle, and laid up along the umbilical together with the usual break-out recovery strop.

This arrangement worked reasonably well in fine weather, the main difficulty being controlling the pendulum motion of the weight on recovery. We plan to use a similar method on Cruise 9, except that we shall use a twin-drum capstan for lifting the vehicle, rather than the main winch as on this cruise.

Vehicle Assembly and Sidescan Transducers Vehicle assembly proceeded as planned, except that when the sidescan transducers were fitted it became apparent that their radiating faces were not sufficiently coplanar. This was overcome by fitting shims behind them as necessary.

Three transducers (out of a total of five required for a complete sidescan array) were delivered to Falmouth. Tests of their electrical characteristics while at sea showed that some elements had become disconnected. Dismantling them showed that the cause was dry joints in the internal busbar connections; all joints in all three transducers were remade.

Hydrodynamic instrumentation Several difficulties were encountered in setting up and testing the hydrodynamic instruments and telemetry system.

One rate gyro was found to have failed completely, and the compass was inoperative. The gyro was abandoned, but the compass sphere was opened up and the compass repaired and modified. Operation of the compass was checked by waving small ferrous objects in its vicinity. This showed that it can indeed detect 1 bit changes, though the response is very heavily damped at room temperatures, and may be excessively so at deep ocean temperatures. In the absence of a vacuum pump, the compass sphere was resealed successfully using a domestic vacuum cleaner, an emergency measure other glass sphere users may care to note.

Some time was spent trying to rectify an intermittent logic fault in the underwater telemetry logic, unfortunately without success. The FIDO FSK decoder was modified to improve the jitter performance of its phase-locked clock extraction circuit.

After this work, operation of the instruments on the second deployment was reasonably satisfactory. The only general fault was a tendency to spurious spikes on the analogue pen recorder outputs, no doubt due to corrupted bits in the data stream. There was a suspicion, but no more, that these spikes were associated with energetic rotation of the swivel.

The e/m log failed to produce convincing, or at least, understandable, records on this deployment. The cause is thought to be intermittent cores in its many-cored connecting lead.

For the hydrodynamic runs, the vehicle was deployed in the previous "best" configuration, i.e. with 200 m umbilical and 50 m tail rope, and with added stabilising fins on both weight and vehicle. First impressions are that stability was improved by the added fins, but a clearer impression will have to await computer integration of the yaw rate gyro output.

Sidescan electronics The sidescan transmitters had been designed for 5kW electrical input into a 50Ω load. The transducers delivered presented a 25Ω load for 3 in parallel, and were limited to 600W power input (200W each).

During the first few days, a new amplifier capable of providing the required power into 25Ω and run from the main vehicle supply of +350V was designed and bench tested.

After the failure of the first hydrodynamic tow, it became apparent that passing the 350V supply between the two electronics tubes via 24 pin connectors was an unacceptable risk, so the 350V powered sidescan amplifier was scrapped, and a new design run from the 20V vehicle low voltage supplies was begun. This change was only possible because of the 600W limit on sidescan transducer power input. This design was tested satisfactorily, though efficiency was poor, and it was duly installed in the sidescan tube, together with a large bank of capacitors to store power for its output pulse.

The TOBI telemetry system as designed involves sending trigger pulses down the wire in the form of tone bursts at 80 and 100 kHz. At the bottom end of the wire, these tones have to be separated from upgoing signals by a combination of a hybrid network and filtered. The hybrid requires a network which simulates the characteristic impedance of the tow cable at various frequencies; its design cannot begin until the cable has been measured.

We spent several days measuring the cable and designing a suitable hybrid network. Unfortunately, when the hybrid was installed in the vehicle, it proved to be insufficiently effective in suppressing up-going signals. As a result, the trigger detector in the vehicle would not operate satisfactorily in the presence of up-going signals, whether from sidescans, telemetry FSK, or profiler.

More time was spent trying to overcome this deficiency, but without much success. One hour before the deadline for the last deployment, we decided to abandon the trigger decoder, and make the sidescan transmitter free run from a crystal clock. This scheme was implemented, and the vehicle duly launched. Unfortunately no signals were received up the cable. Tests after retrieval showed that, in our desperate attempts to make the decoder work, we had reduced the gain of the up-line signal drive amplifier to zero, and had forgotten to reset it when we changed to the free-running scheme.

It is clear that, by some means, the trigger decoder will have to be redesigned so that it depends less on the balance of the hybrid, since there will be very little chance to measure the Rochester cable, or to test the telemetry on it. On the credit side, the sidescan data transmission system was shown to operate successfully on a real CTD wire on a real ship. The sidescan electronics (transmitter and receiver) was also demonstrated successfully, installed in the vehicle and driving a dummy load representing the transducers we actually have.

An acoustic test with the vehicle suspended in mid water over the stern at Funchal gave the expected signal returns with the receiver line driver gain properly set and confirmed the sonar does work.

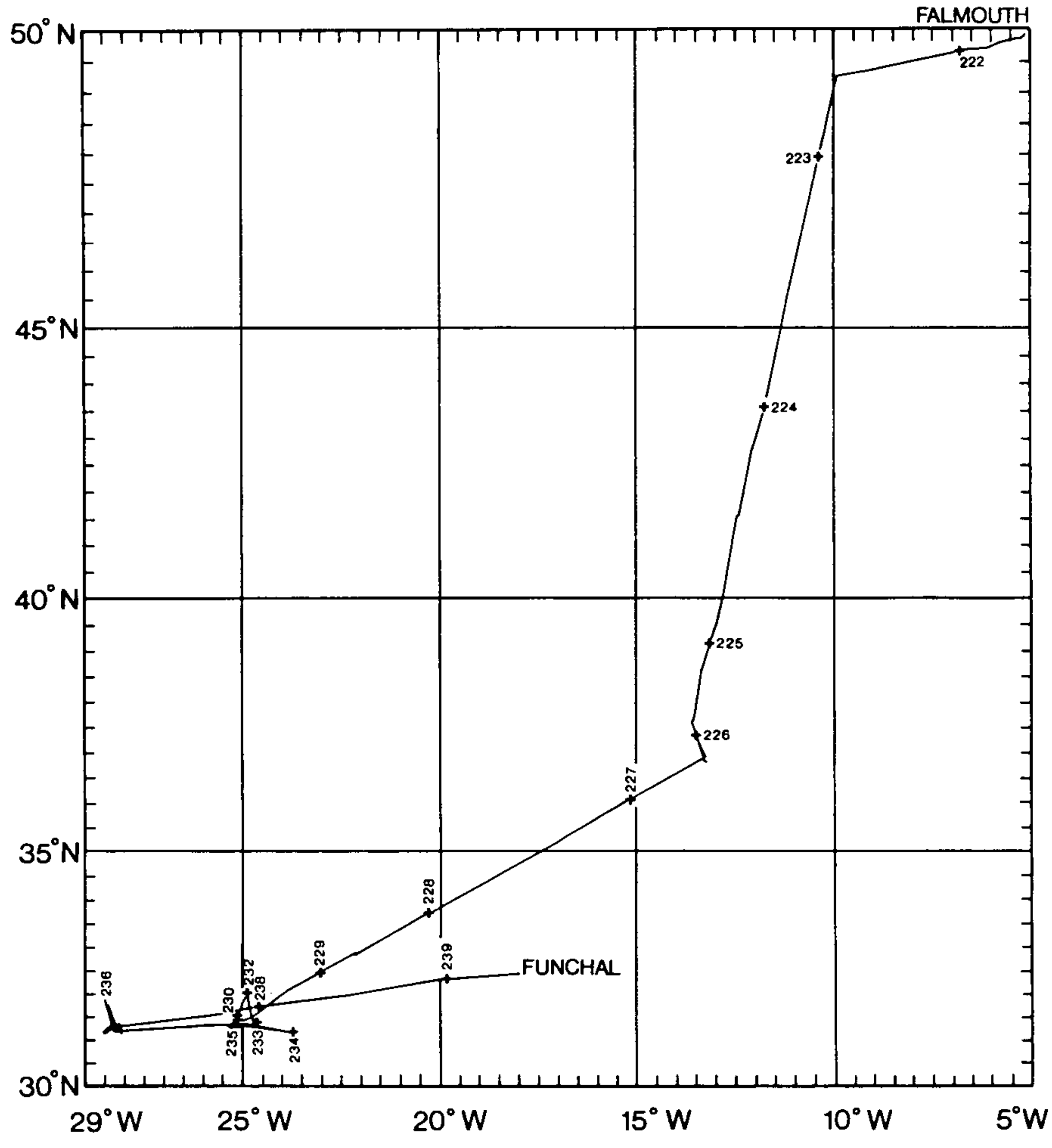
R.J.B.

ACKNOWLEDGEMENTS

The willing assistance of the Master, Officers and Crew is gratefully acknowledged. The hard work of the scientific personnel including the RVS and IOS shore personnel before the cruise, already mentioned in the narrative, is worthy of repetition and acknowledgement here.

STATION LIST

Time/Day/Year	Latitude	Longitude	Instrument
09.10/225/85	37°36.44'N	13°37.11'W	DOBS 1
11.48/225/85	37°14.63'N	13°27.55'W	DOBS 2
14.20/225/85	36°53.13'N	13°17.79'W	DOBS 3
09.00/229/85	31°29.91'N	24°45.12'W	Transponder
10.16/229/85	31°27.88'N	24°52.87'W	Transponder
13.41/229/85	31°17.55'N	25°19.82'W	PUPPI 1
01.09/230/85	31°21.36'N	25° 7.23'W	I.E.S.
11.32/230/85	31°18.87'N	25°19.78'W	PUPPI 2
11.17/232/85	31°29.73'N	24°48.20'W	DOBS



MERCATOR PROJECTION

INTERNATIONAL SPHEROID PROJECTED AT LATITUDE 0

Charles Darwin 6/85