I.O.S.

RRS DISCOVERY

CRUISE 141

26 OCTOBER – 17 NOVEMBER 1983

MOORING RECOVERIES, INSTRUMENTATION TRIALS AND ENGINEERING TESTS

CRUISE REPORT NO. 156

1983

NATURAL ENVIRONMENT RESEARCH COUNCIL

INSTITUTE OF OCEANOGRAPHIC SCIENCES

INSTITUTE OF OCEANOGRAPHIC SCIENCES

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INSTITUTE OF OCEANOGRAPHIC SCIENCES

WORMLEY

RRS DISCOVERY

Cruise 141

26 October - 17 November 1983

Mooring recoveries, instrumentation trials and engineering tests

Principal Scientist

B.S. McCartney

CRUISE REPORT NO. 156

1983

CONTENTS

ITINERARY

Depart South Shields: 14.15 hrs, 26th October 1983

Arrive Dakar, Senegal: 16th November 1983

SCIENTIFIC PERSONNEL

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C.G. Flewellen	" "
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P.J. Schultheiss	I.O.S., Wormley
M.A. Squires	" "
I. Waddington	" "
C.H. Woodley	" "

SHIP'S OFFICERS

S.D. Mayl	Master
G. Long	Chief Officer
M. Putman	2nd Officer
G. Harries	3rd Officer
C. Langley	Radio Officer
R.M. Cridland	Purser and Catering Officer
D.C. Rowlands	Chief Engineer
I. Bennet	2nd Engineer
C. Phillips	3rd Engineer
G. Parker	4th Engineer
N. Davenport	5th Engineer
P. Edgell	Electrical Engineer
P. Sharpe	Electrical Engineer
F. Williams	Bosun

CRUISE OBJECTIVES

(i) To recover 3 ALS and 2 Moored Sources, part of the Sofar Float Programme, which were deployed from Discovery Cruise 138, June 1983.

(ii) To recover 7 Current Meter Moorings on the Madeira Rise, which were deployed from Discovery Cruise 139, July 1983.

(iii) To deploy, test and recover a new Digital OBS, for which it will be necessary to tow an air-gun for a short run of a few hours.

(iv) To deploy, test and recover PUPPI, a new instrument designed to log pore pressures in ocean sediments.

(v) To deploy and test a dummy penetrometer with its telemetering transponder in the Great Meteor East area.

(vi) To listen to the Francis Beacon at 47°N 11°W on passage out, if timing convenient.

(vii) To check out and work up scientific equipment modified onboard during 1983 Refit (e.g. midships winch console, Hiab extension to aft davit, main winch traction drums and reeving gear, auxiliary winch brakes, sonar platform).

CRUISE NARRATIVE

The vessel sailed as planned from Middle Docks, South Shields, on Wednesday 26th October, and after swinging the compass and dropping the Pilot, sailed south down the North Sea in favourably calm conditions. Scientists set up equipment and prepared for later work during the lengthy but relatively uneventful passage down the English Channel and then across the Bay of Biscay. A following wind helped the ship to make over 11 knots on two engines.

In view of time constraints it was not felt prudent to stop and wait until the Francis Beacon switched on and course was continued for the site of the first Automatic Listening Station. PES watches began at 0400 on 29th October and the bioluminescence recorder was also set up. In the meantime faults on standing equipment, developed during, or as a result of, refit, came to light and were gradually sorted out. These included the Mimco communication system, clean sea water pumps, PES sockets, digital clock, conducting cable ends, slip rings, A frame block, A frame lights, wire counter and many other similar irritations.

For a while 3 engines were used, the ship reaching 12.4 kts but a tacho-generator fault limited its duration. Thanks to this speed and surprisingly good weather, the ALS 1 site was reached with sufficient daylight for release on

Tuesday 1st November, but it was not to be. Contact with the mooring could not be made despite a thorough box survey of the area. Premature release was suspected, since the mooring had been laid on Cruise 138 during which a batch of faulty pyro-leases were found, but only after this mooring had been laid. Tests of the mid-ships winch in the early hours of 2nd were over in time for a visual sector search at first light, just in case the mooring had released without its beacon responding. The search proved fruitless and so this was a disappointing start to a cruise on which so many moorings were to be released. In order to fit in two deployments of PUBS and PUPPI the original sequence of picking up the westernmost ALS before the current meter array on the Madeira Rise was reversed: after the moorings the two bottom instruments would be laid midway on a course towards ALS 2, and within short steaming distance of the first moored source, in order to allow the instruments about 48 hours on the sea bed.

The first current meter mooring A6 was successfully interrogated at 0100 on the 3rd so the vessel steamed off 5 miles for testing work overnight on wires. On this occasion the PUPPI release and a 5 kHz bottom transponder were to have been tested on the midships hydraulic winch, which had undergone a successful test the previous night. With only four hundred metres of wire out a major fault arose on the winch, making grinding noises once per revolution inside the motor. The wire was recovered, the winch work postponed, pending dissembly and detailed examination of the hydraulic motor and valves.

The ship then spent the night steaming through the current meter mooring array interrogating all the moorings, with the exception of A1 which was too far to the west; by 06.45 we were in position to release the southern mooring A4, which surfaced at daybreak and was all inboard by 08.11. The VACM mooring was released with much relief at 08.55 and was all inboard by 12.23; on the surface with so much distributed buoyancy there was the danger of a snarl up, so a rubber boat was launched and stood by, though in the event it did not need to intervene. Mooring A5 was released at 13.07, all inboard 14.23, then A6 was released and all inboard by 16.44. All the buoyancy, current meters, releases, hardware and rope seemed to be in good condition and it had been a good day's work after the previous disappointment. The pattern of winch work overnight, mooring release at daybreak and recoveries in daylight continued.

During the night of 3rd/4th the main winch aft was set up and worked well with a 1½ ton weight lowered to within a few hundred metres of the bottom in 4000 metres. The PUPPI release and the 5 kHz transponder were tested this time using the electric winch and its 6 mm conducting cable. The 5 kHz transponder passed its test, but after two deep tests the PUPPI release looked as though it needed further adjustment. Overnight the wind speed increased considerably.

By first light on the 4th, mooring A3 was released and was recovered by 08.48 with some difficulty because of the heavy swell and sea, but the only loss was a hard hat, blown off by the wind. Mooring A2 was then re-located and put through the usual acoustic release cycle. The beacon signals indicated that the release command had been received and activated but the mooring stayed on the bottom. Leaving the A2 site, mooring A1 was located and released at 12.08, being all inboard by 13.30. The vessel returned then to A2 in case the release had unjammed, but the beacon indicated the mooring was still down. The ship stayed on site for a few more hours allowing the PES fish No. 6 to be exchanged for No. 3 because of low impedance on the former causing interference. The 3.5 kHz profiler fish was also deployed from the new starboard boom which is a successful improvement from the refit. The electric winch was used to test the PUPPI spare release successfully, and also the 3.5 kHz transponder later to be fitted in the penetrator. Course was set for position P1, the PUBS and PUPPI test site at $33^{\circ}30'$N, $22^{\circ}59'$W. On passage PES, 3.5 kHz and bioluminescence records were watched. Slower progress at 7 kts was made against the wind and heavy swell from the NW, so the position was reached late afternoon on 5th instead of early morning as planned, but nevertheless both PUPPI at 17.02 and PUBS at 18.21 were deployed in daylight. Problems were encountered with the hydraulic cutter intended to release PUPPI and a knife had to cut the supporting strop instead. The hydraulic cutter was maladjusted. Once on the sea bed the PUPPI pinger telemetry indicated that penetration, though not the complete 3 m of the probe, was nevertheless vertical. The ship could thus steam away towards ALS 2 at 8 knots firing a 1000 cu. inch air-gun at 2000 p.s.i. once every 2 minutes to provide a signal for the new digital PUBS to record. Precise timing of the air-gun trigger was derived from the satellite synchronised clock. This was on board to synchronise the Sofar floats and ALS receivers and is useful to time PUBS because the Watesta digital clock after years of good service is now completely unreliable and must be retired. Pitching caused by the 25 knot headwind spoilt the appearance of the 3.5 kHz record.

The ALS 2 mooring was located and released at 17.01 on 6th, the air-gun and 3.5 kHz fish being recovered before recovering the ALS; the A frame and crane were used to good effect for the long ALS hydrophone. All mooring was inboard by 19.32 in good condition, the 3.5 kHz fish was re-deployed and course set back to P1 making faster progress with the following wind. PUBS was located, released and inboard by 14.25 on the 7th, followed by PUPPI by 17.30. Course was set for the first moored Sofar source, MS1, reached at 00.30 its beacon being commanded on as we steamed by at 8.5 knots to do wire testing 5 miles further on overnight. The 3.5 kHz transponder and a new digital acoustic release were tested using the electric winch to 5300 metres. This was followed by further tests on the main winch and a warp with the streamlined weight. The MS1 mooring was released and all inboard by 10.30 on 8th.

The vessel then steamed to the Great Meteor East area to position P2 (31°23.7'N, 24°46.3'W) reached at 20.30 at which time PUPPI was released, the hydraulic cutter working satisfactorily this time. The PUPPI descended to about 4000 metres at which time the beacon signal indicated that PUPPI was coming back up as the weight had pre-released, due it was later discovered, to a faulty pyro coming unglued. This unplanned return to the surface meant a night time recovery; location proved no problem with its strong flashing light, radio beacon and the ship's searchlight, but its stray line was not free because the soluble links holding it had not yet dissolved. Meanwhile PUBS was deployed at 23.00 for its second test. Then grappling PUPPI took time, but it was eventually inboard at 23.20, to be prepared for a second attempt at this site using the last probe and set of lead weights. The final wire test of the 3.5 kHz transponder had to be made using the main winch because the forward hold, where the electric winch is situated, was under 6 inches of water caused by failure there of the cooling water pump for the forward hydraulic ring main. The water was pumped away and the space later mopped out, no damage having been done otherwise. By 03.30 on 9th PUPPI was put over the side again using the after crane, but before the instrument reached the water the rope strop chafed through on the cutter edge, the instrument released prematurely from 3 metres above the surface; on impact the mechanical release was overstressed, so the lever freed away probe and lead, leaving PUPPI floating on the surface and a forlorn team to grapple a second time for a tied-up stray line. All was inboard by 04.05 at which time the air-gun was deployed for the second PUBS refraction test line, returning by 10.00 to the PUBS site. The PUBS transponder was commanded on in order to navigate to within 1 to 2 km range for the penetrator deployment.

A doubled block was put on the forward crane to lift the penetrator tail loaded with the 3.5 kHz transponder and the hydraulic release worked well to launch it at 11.36/43 secs. Sadly the 3.5 kHz transponder was not heard after the first second or two. Possible causes are the 'O' seal surface which was faulty on delivery but had been repaired as much as possible, or damage to the transducer under such high drag. A frustrating period came to an end when PUBS released immediately and was all inboard by 14.36/9th.

Course was set for ALS 3, keeping a 3.5 kHz and PES watch. The vessel diverted to a ship 12 n.m. away seen to fire 3 red flares. It was a Russian tanker bound for Cuba but was not in distress apparently. Just short of the ALS 3 position the ship hove to for further overnight work on the main winch using the fishing warp, enabling tests of another 5 kHz bottom transponder for Cruise 142 and of the prototype digital command system. ALS 3 was released at 07.00/10th and all inboard by 10.14, course then being set for the second moored Sofar source at MS2. PES and 3.5 kHz watches were kept. MS2 was reached at 09.45/11th, released and all inboard by 11.26. The 3.5 kHz fish which had been recovered for each mooring was not deployed again, as course was set towards Dakar.

At 13.30 speed was reduced to deploy an open RMT8 net and its telemeter for careful drag measurements at different speeds with a shallow tow and in good weather. These measurements were completed by 16.05, and the vessel steamed on passage overnight.

At 09.00 on 12th a sound velocimeter station 10949 began, using the electric winch conductor cable. Despite working in the lab sink the velocimeter gave errors until a depth of 400 metres, at which point it functioned as it should to 2000 metres. No fault could be found with the instrument on recovery at 12.18 and earthing problems with the cable are suspected.

Passage continued until 14.00 when the first of two 10 kHz transponder set for 10 m depth with light surface buoyancy was deployed. The second was deployed a mile upwind; these became the baseline under continuous measurement for 10 runs at a range of speeds between 3 and 10 knots in order to calibrate both port and starboard EM logs, as logged by the computer.

All runs were completed in excellent conditions, ending with a drift for 20 mins with an 8½ knot wind on the port beam to calibrate the leeway component. The transponders were recovered, the last one well after sunset homing in by acoustics and then using the searchlight.

The vessel made good passage overnight and at 09.15 on 13th the radio beacon supported by two glass buoyancy spheres, and with a 10 kHz transponder hung below, was deployed for ranging tests. Direction finding on the aerial was possible to

3 km but not reliable further. Acoustic range to the transponder was in excess of 3 km using the beam-steered PES fish but less than 2 km using the dolphin at 6 kts.

At 13.30 the electric winch was used to test the third 3.5 kHz transponder and at 17.40 passage was resumed. The next few days were to be spent demounting equipment, loading the Sofar container and preparing for the next cruise.

On 14th at 19.00 the ship hove-to to test the Sonar Platform which was satisfactorily exercised a few times and left deployed overnight to test the acoustics in the echo-sounding mode as the vessel made passage towards Dakar, continuing in the same way on 15th. The Sofar container was loaded with equipment returning to UK and the computer staff kept working at the HDLC linking the SI system and the user computer. At midnight on 15th the Sonar Platform retracted half way then stuck as has happened before and a chain block was needed to move it, final retraction being completed by 02.06 on 16th.

The vessel completed its passage to Dakar where the Pilot boarded. The voyage ended at 06.30 on 16th, a day earlier than planned in order to make time for engineering work to replace the hydraulic motor of the midships winch. Had this not been necessary a third deployment of PUBS and a third air-gun run were planned. The scientific party completed the loading of the IOS container and of another provided by the agent by 20.00 on the 16th.

PROJECT REPORTS

1. Sofar Floats and Autonomous Listening Stations (ALS)

The objectives were to recover the 3 Autonomous Listening Stations and also the 2 moored Sofar floats laid by Discovery on Cruise 138/139.

The position of ALS 10 was approached on day 304 but contact was not made in time for a daylight recovery. An acoustic search was conducted overnight without success, and the ship returned to the nominal position at first light for a final attempt at its release. This was followed by a visual search which ended with a negative result. There is an amount of circumstantial evidence to suggest that its loss was the result of a mechanical failure of one or both pyroleases.

ALS 11 and ALS 12 were recovered on days 310 and 314 without any hitches, although in the case of ALS 12 it was found that the release unit used had leaked but luckily, it had worked well enough to effect the release.

Visual inspection of the listening stations showed them to be in very good condition, their processors were running and they responded to all commands through the SAIL (Serial Ascii Instrument Loop). A preliminary inspection of the Sea Data tapes showed them to contain good data.

The two moored floats were recovered on days 312 and 315 without any problems. A visual inspection showed there to be enough corrosion to cause concern but none around the important areas of entry through the glass instrument housing.

The clock on float 1 was found to have lost 6.45 seconds whilst the clock on float 3 lost 0.22 seconds.

Battery voltages, which start with 51 volts with end life of 37 volts, were measured to be 49.4 for 1 and 47.7 for 3. The difference can be attributed to a fault on 3, before launch, which caused it to transmit continually for several hours.

N.W.M.

2. Bottom Transponder Wire Tests

The objective was to complete the assembly and then to test 3 bottom transponders housed in glass buoyancy spheres and a remote interrogator pinger. The remote interrogator is a device to be used to interrogate bottom transponders from a position remote from the ship, e.g. a camera sledge. It is designed to transmit for a predetermined number of 8 sec periods and then remain silent allowing the ship to interrogate. It has a very good clock which is synchronised with a clock on board so that the pinger's time of arrival relative to the onboard clock can be used to give its distance from the ship. The device was lowered to 4500 metres on the electric winch and there was no measurable drift (using an EPC recorder) between the two clocks at the end of the test. At the bottom of the test, signals from the interrogator were a bit weak due to the transducer null which would suggest that the addition of a slow wave guide would be an advantage.

All three bottom transponders were lowered to at least 4000 metres. Signal levels were good, the false trigger rate was acceptable and in all cases the release switched, firing the test 'Puffer'.

N.W.M.

3. Current Meter Moorings

All moorings with the exception of mooring 339 (ALS and 1 Aanderaa CM) and 349 (2 Anderaa CMs) were recovered successfully and without difficulty. Mooring 339 was not located in its expected position and an immediate acoustic box search failed to locate it. Mooring 349 was located acoustically; all appeared well with the mooring in position and upright, and it indicated it had received the release command, but it refused to leave the sea bed.

Without doubt the new forward 'A' frame made a successful recovery of all other moorings much easier. The extra height available enabled the VACM mooring (343) to be recovered without using the crane. One possible improvement would be to turn the box containing the control lever through 180^{o} to make control available to the personnel under the 'A' frame.

All Aanderaa current meters recovered had run full tapes with the exception of the bottom meter on mooring 350. This meter developed a leak but had recoverable data of approximately 21 days.

From the 9 VACMs laid on mooring 343, 6 provided full tapes; of the other three V-0666 developed a leak and failed after 85 days. This was the first deployment of this instrument and as far as can be ascertained at this stage it appeared to be a manufacturing fault in the top end cap. V-0155 had a battery failure with no retrievable data and V-0156 had an electronic failure after several days of retrievable data. All data has been copied onto 9-track tape using the Digidata transport and interface.

Proof of splicing techniques on unbraided Kevlar rope looks promising. Using the traction winch several samples of splices made up by two different people were broken; in all cases the rope broke in the middle and not at the splices and again in all cases failure was greater than or equal to the breaking load of the rope.

J.W.C., I.W.

4. Digital Pop-Up Seismometers (DPUBS)

Two deployments of a microprocessor-controlled digitally recording ocean bottom seismograph were made during the cruise. This instrument has been developed to record geophone and hydrophone signals at software controlled times, rates and sensor configurations. A digital tape recording system in the PUBS records data, stored in memory, in high speed bursts. Work throughout the cruise can be divided into three phases:

(i) Completion of wiring and assembly of the instrument. Testing, debugging the hardware and software and checking instrument performance on the ship.

(ii) Two deployments were made using a time programmed mode. A 1000 cu. in. air-gun was used as a sound source from close by the instrument to 80 miles range.

Also a 'penetrator' was dropped within 1750 m of the PUBS, which it was hoped, would record any surface waves generated by the penetrator's impact into the sediment.

(iii) Software developments and hardware modifications were made based upon experience gained during the cruise.

A fault on a crystal oscillator and voltage regulator were discovered during the cruise and rectified. A more difficult and still outstanding problem concerns interference between the release electronics and the microprocessor. This problem may be overcome by screening or rewiring the acoustic transponder and release cards inside the PUBS. Data during the penetrator drop was lost due to the acoustic cards affecting the PUBS recording program.

Programs were developed on the cruise to enable the PUBS to transcribe its own cartridge tape data to a 9 track ½" tape recorder via a parallel interface. It is also possible to use the PUBS 'lab computer' to print out and list various tape record parameters as a guide to the contents of data tapes. A system enabling data to be translated and displayed aboard ship is being developed for use on future cruises.

R.E.K.

5(a) Pop-Up Pore Pressure Instrument (PUPPI)

The objectives during this cruise were to test the mechanical, electrical and acoustic systems of this instrument. PUPPI is designed to free-fall through the water column, penetrate the sediments to a depth of up to three metres and record the differential pore pressure at the tip of the probe relative to the hydrostatic pressure. On release a pipe cutter severs the nylon pipe (connecting the transducer to the probe) and the buoyant package returns to the surface for recovery. The probe and lead weights are left behind in the sediment. A knowledge of differential pore pressure, together with permeability and porosity (measured from core samples) should enable natural advective fluxes to be quantified.

PUPPI was assembled vertically over the aft hold, with the 3 m probe extending down into the hold. The lead weights and the rest of the instrument were supported by a modified hatch cover.

Station 10943 (33°31.5'N 22°58.05'W) PUPPI was launched using the crane and released by cutting the rope strop with a knife after the hydraulic cutter had failed to operate. It reached a terminal velocity of 2.5 ms^{-1} on descent, taking 36 minutes to reach the bottom in 5407 m of water. The acoustic telemetry indicated angles during descent and after penetration of less than 10^{o}. Mercury tilt sensors provide delayed acoustic pulses at inclinations of 10, 15, 20, 30 and 60 degrees from the vertical. The penetration rod was not pushed up after penetration (as indicated by another delayed acoustic pulse), hence it was concluded that whilst the instrument had not fully penetrated it was close to vertical and stable in the sea-floor. After 45½ hours on the sea-floor the instrument was released by acoustic command and ascended at 0.76 ms^{-1}. Tilt pulses (up to 15^{o}) indicated some oscillation of the device for a short period at approximately 400 m from the sea-floor. Apart from this the instrument remained stable throughout its ascent. The V.H.F. radio transmitter mounted on PUPPI proved valuable for locating the instrument when it had surfaced. PUPPI was recovered, using the stray line, through the forward 'A' frame.

An excellent differential pore pressure record was obtained from the solid state EPROM logger for the complete duration of the experiment. It recorded a maximum differential pore pressure of 26kPa as the probe was inserted which had decayed to 1.2kPa just prior to the pipe being cut. A smooth discontinuity occurs in the decay record at around 65 minutes which has yet to be explained. The zero pressure reading was obtained just after the pipe was cut which provides an in-situ calibration of the zero offset caused by temperature and pressure effects on the transducer. The current sensitivity of the transducer (0.05kPa) is sufficient if this type of record becomes typical.

A vertically mounted 1g accelerometer and non-volatile RAM logger recorded the deceleration of the instrument during penetration. Decelerations in excess of 1g were recorded as the instrument penetrated to a final burial depth of only 1.4 m. The quality of the data obtained could be improved by using a less sensitive accelerometer capsule which would exhibit a higher resonant frequency. This station was considered extremely successful; it was the first deployment of PUPPI in deep water.

Station 10945 ($31^{o}23$'N $24^{o}47$'W) PUPPI was reassembled and launched as previously; this time the hydraulic cutter operated without mishap. The instrument descended at around 2.5 ms^{-1} until at 4000 metres (still in the water column) it released the lead weights and probe and ascended to the surface. On recovery it was found that a faulty pyro was to blame, it had 'pulled out'. Pinned pyros were used on the next assembly and the instrument launched again. However, whilst outboard, and above the water, the probe swung and the rope strop was prematurely cut against one blade of the cutter. The consequent impact of PUPPI with the water overstressed the mechanical release mechanism (the long lever bent) parting the two sections. The instrument was recovered concluding the PUPPI trials.

Despite one mishap and an element of bad luck the trials were a success. Apart from a few minor modifications to the instrument it is the launching system which requires the most attention.

P.T.S., S.D.McP.

5(b) Radio Range Trial

The aim of the test was to find the maximum range at which PUPPI could be located by radio direction finding.

The 150 MHz, 1 watt transmitter and a flashing light were attached to the PUPPI buoyancy, and an acoustic transponder suspended 200 m below for range finding. A rotatable 6 element Yogi, mounted 12 m from sea level, and an Eddystone U.H.F. receiver were used for directing finding. The maximum usable range was found to be a disappointing 3 km.

The system could be improved by mounting the radio transmitter higher out of the water; use of signal modulation and/or crystal receiver control for better signal from noise discrimination; a better signal strength display, possibly based on the detected level of a modulation tone, would also be helpful.

S.D.McP.

6. Instrumented Penetrator

The instrument package consists of a microprocessor controlled transponder with pulse interval telemetry of a modest number of channels, in this case received signal level and temperature.

When the 1800 kgm steel penetrator was inspected at sea it was found that the 'O' ring face which seals the instrument package in had not been properly finished; in fact there was a punch mark and a radial scratch across the 'O' ring position. This was then filled with epoxy resin and rubbed down. The thread on the transducer end-cap had to be rubbed down as well to make it fit.

During the first wire test of the electronics in a 6 inch tube it was discovered that the signal receiver was too noisy and not sufficiently sensitive, but otherwise the transponder behaved well. The telemetry of received signal strength was very useful. Before the second and third wire tests the receiver gain was increased and its noise figure improved so that it was possible to trigger data transmissions at 5300 metres with only 2 watts transmitted from the 3.5 kHz fish which is capable of transmitting up to 2 KW. During the third wire test the repetition rate of the Raytheon recorder was slowed from 2 to 2.5 seconds to simulate an extreme doppler shift. The transponder obediently switched to a single pulse transpond-only mode. Bow-prop noise during this test made it impossible to do a false trigger count as had been hoped.

With fresh batteries the transponder was loaded into the end of the penetrator, and at 11.36 on the 9th the penetrator was released using a hydraulic cutter. After erratic pinging at the surface nothing more was heard from the transponder although the siren-like whistle of the penetrator could be heard all the way to the bottom. From the doppler shift between this and its bottom echo the terminal velocity was calculated as 55 m/s.

The transponder probably lasted only a few seconds before, it is suggested, the rubber boat of the transducer was torn off by ½ ton of drag. There is also a slight chance that it leaked but this would not have happened so rapidly.

Conclusions The results of the wire tests were very satisfactory, and only a few small modifications will be necessary. The noise figure of the receiver can still be improved and the microprocessor should be given control of the gain so that the false trigger rate can be kept to a minimum. It would be desirable for the instrument to be a precision pinger during the descent since the transponder would trigger off its own bottom echo and that from the 3.5 kHz fish. Clearly, the back end of the penetrator must be faired and the transducer mounted within its own 6 inch tube deeper in the body of the penetrator; however, there will still be a lot of flow noise to upset a transponder. A digital data transmission to duplicate each signal channel with a well protected binary code is also being considered for later trials.

C.G.F.

7. Aft Hydraulic Winches and Davit

At the refit overhaul of the traction winch, crane davit and storage drum traverse gear was undertaken together with the fitting of the new Hiab crane on the davit pedestal.

During the cruise all the machinery was run up, under load if possible. Both main warps were deployed using the traction winch and crane davit to a depth of 5000 m at payout speeds of up to 1.8 m/s and a maximum load of 7.7 tonnes. The new automatic back tension control was set up to maintain motor pressures at a nominal 50 bar when veering. Rope tensions through the winch were obtained to check the operation of the new drums.

The auxiliary winch with the new brake was tested by lowering a 300 kgf weight to 1000 m and the Hiab crane was used to deploy a radio beacon. The Hiab is slow when lowering unloaded, but this is to be remedied by the replacement of the existing main piston with a double acting version.

After initial setting up and minor post refit problems the system ran smoothly.

M.P.B.

8. RMT 8 Drag Measurements

In preparation for the possible production of a multiple RMT 25 net system, direct measurements of hydrodynamic drag on an RMT 8 net are required. Loads expected on the larger net can then be predicted with more confidence.

To obtain virtually direct drag measurements an RMT 8 net was attached to a light rectangular frame which held the net mouth open. The net was front towed from a standard cross, to which was attached a 50 kgf depressor weight and a net monitor. Four strops fixed the towing angle of the net mouth at 45^{o}.

The net was towed at a depth of 100 m between 1.5 and 2.5 knots with 200-320 mwo. The drag was determined from the winch dynamometer with corrections for the depressor weight and warp loads. Speed through the water was taken from the ship's E.M. log since the net monitor's temperature/flow pulse failed.

The net drag variation with speed appears to be linear:

Ship's speed (knots)	1.5	2.0	2.5
Net drag (kgf)	205	355	505

This relationship cannot be accounted for by the change in the net angle with speed since the method of towing restricts the variation of angle within this speed range to approximately 6^{o}. The net mesh drag theory based on the velocity squared assumption seems to be inappropriate in this case.

M.P.B.

9. Digital Acoustic Command Telemetry

The performance of the present generation Acoustic Command System has been well proven over the last eight years. This is well illustrated by the number and variety of instrument packages that have used it on this cruise. However, it has a major restriction in that only 12 command channels are available. This restriction has reduced the flexibility of some scientific experiments and could become a handicap. The digital acoustic command system has been developed over the last three years as an extension to the present system - removing the restriction while retaining the performance.

The technique used is a form of frequency shift keying, in which two frequency modulated channels at a centre frequency of 10 kHz are used to give a positive '1' and positive '0' code. The key burst length is determined by the bandwidth of the receiving system. The burst separation is a compromise between speed of response and avoidance of multipath restrictions. The number of bursts was chosen to give a large number of commands for each pair of channels and direct microprocessor compatibility as standard.

The prototype sea unit (and probable standard version) comprise a standard CR200 receiver card, a standard transponder pulse power amplifier card, a new transponder and timing card (also incorporating features to improve shallow water performance), a new detector and decoder card, and an applications card. The applications card (not yet in its standard version) was configured to replay the digital code received back to the ship (as a series of precisely repeating pulses in the frequently used pulse interval sequence). The sea unit was also used to test the performance of a 10 kHz ceramic ring transducer manufactured by Bell Electronics and a new 'safer' type of high energy density Lithium based battery manufactured by Venture technology.

The deck system used a special coding board and two standard Mk III deck units. The Mk III units provided the two uncoded FM signals, the 5V supply and the transmission amplifier driving a single element of the standard PES fish array. The coding board was programmed to multiplex the FM signal by 8 two way switches. The board then drove the power amplifier through its FM input socket.

The sea unit decoder requires one channel to be present during all listening periods, if none or both are present the code is rejected. After receipt of first signal the decoder listens for 400 msecs every two seconds for 14 seconds. About 150 msecs of good signal must be detected to be accepted for decoding. The second listening period starts 1.8 seconds after receipt of the first signal allowing comfortably for the approximately 50 msecs rise time of the receiver circuits.

Two wire tests were carried out. The first to 5300 metres proved the system to be quite practical. The only code losses occurred at depths where interference occurred due to the bottom reflected transmission signal. The second wire test was used to confirm the reason for code loss. The unit was stopped at depths where code loss occurred. Codes were then transmitted such that the bottom echo was on the same channel as the direct signal - these codes were accepted. Other codes were then transmitted and obviously rejected because signal was present on both channels. With moored or free units relative motion will quickly take the signal through unfavourable positions and with attached systems burst separation could be changed.

The 10 kHz ceramic ring performed faultlessly although it requires 4 times the power to match the signal levels of the mushroom transducer received from these depths. The Lithium batteries performed as required and a further 18 cells (10AH) were used to power the digital PUBS without problem. The latter 18 were then fully discharged - the worst case cells giving better than 90% claimed capacity.

Acoustic Release Performance (and Pyroleases) There were 13 standard CR200 releases deployed on 12 moorings laid on Cruises 138 and 139. Of these one was lost without trace, one was cycled successfully and appeared upright but the mooring would not release, the other 11 all operated successfully. However, of these 11, two were partially flooded - there was no obvious reason but faulty Marsh and Marine connectors are suspected. Both these units had fired pyros while a salt water path existed between connector pins. The worst flooded of these units (¼ pint) did not fire one pyro because an electrical return path caused by the salt water had severely corroded the 2 pins of a connector (only possible on one of the two connectors).

Of the two special versions of CR200 prepared for PUPPI one had developed a low temperature fault, so the back-up unit was used. One of the two faulty PUPPI deployments was caused by part of the pyrolease becoming unstuck; this unit had been test loaded (~20 lbs). All subsequent pyroleases were pinned as should be all pyros from the suspected faulty batches (February, March, April 1983).

The version of the CR200 fitted to the digital PUBS operated without problem for its two recoveries.

The versions of the CR200 fitted to the three 5 kHz bottom transponders wire tested and fired their test charges successfully.

10 kHz Acoustic Transponders Two transponders were used 20 m under a low windage float system to successfully calibrate the E.M. logs. The PES beam steering unit was used to obtain ranges to 2.5 km.

One of these transponders was used 250 m below a radio beacon float arrangement to range during direction finding trials. This rig was then used to check the 'dolphin' towed ceramic ring system. A range of about 1500 m was obtained using the Mk III deck units own 100 watt pulse. The PES transmission was then used to interrogate the transponder out to 2.5 km, thus confirming that a deck unit power limitation is the reason for the dolphin's limited range.

G.R.J.P.

10. Computer Support

Engineering Prior to sailing the Winchester disc drive removed during refit was reinstalled on the S1 logging system. Throughout the cruise this was used as the main bulk storage medium with no failures. Both the S1 and the USER systems proved to be fault-free for the duration of the cruise though the ship's power was intermittent for the first two or three days; both systems required re-booting several times.

The Digital Transmission System (DTS) analogue cards for the EM log were not originally working and investigation proved that the onboard regulators had failed. A repair was accomplished and no further problems occurred. The DTS out-station for the barometer was found to have a connector fault that was corrected.

The Watesta clock was found to be running fast and required re-setting several times a day. This caused the S1 alarm to sound as the Watesta's 100 kHz is used by the S1 for timing purposes. After the Watesta was replaced by an IOS produced clock a separate 100 kHz was temporarily arranged since the new clock's signal proved to unsuitable.

EM log calibration trials were performed towards the end of the cruise and, to enable both port and starboard units to be logged simultaneously, two DTS analogue out-stations were made available.

The Satellite Navigation system suffered from the intermittent power problem at the beginning of the cruise and the MXUN program had to be reloaded several times. Later a problem occurred with the TV monitor; the connector at the CRT driver end suffered a broken contact. Vibration was probably the cause and the opportunity was taken to lengthen the cable. The Silent 700 terminal in the Plot gave trouble for the entire cruise due to a faulty power supply unit. A repair was attempted but the improvement was only marginal.

Software Routine data processing was affected by our inability to implement new software to exploit the High Speed Data Link (HDLC). Both systems were run under known software from the previous cruise using the slow speed V24 data transfer link.

Enhancements to the systems revealed a number of faults. The depth input program was corrected to prevent GOOD status being written on null data and depth checking was improved by provision of a plotting option in the program DEPCHEK. The navigation and met. instrument logging program RAWDR, although configured to record both EM logs, failed; the problem was traced to inadequate provision of workspace in the initialisation phase. The corrected program worked successfully.

Data from the EM log calibration runs was transferred to the USER machine and a program written to average the one second values. Investigation of the calibration program CALDR on the S1 system revealed the lack of full polynomial correction; in fact there is no provision for offsets or differing misalignment angles for port and starboard EM logs. Time and the complex nature of the program precluded any attempt to rewrite it.

The PES tracking (PEST) system was interfaced to the USER computer and read very successfully by a temporary program. The integration of PEST data with the manual depth entry program DEEP has not yet been accomplished. The shortage of DTS out-stations and the necessity to hold spare boards for the navigation logging meant the interface of the bioluminescent data had to be postponed.

In general the state of the two systems leaves much to be achieved. Considerable documentation still needs to be done particularly in the field of user guides. Program complexity is on the increase with the introduction of the programming language 'C' and new standards for form filling and database access.

T.C.E.P., R.B.L.

11. E.M. Log Calibrations

Both logs were deployed for the calibrations and the transponders were easily deployed in excellent weather conditions with little swell, slight sea and a gentle 8.5 knot breeze from 310°T. The PES fish was used to interrogate the transponders and with the beam steered fore or aft to the further transponder acoustic contact was never lost during the calibrations. The same technique as on Cruise 116 described in Cruise Report No. 109 was used, but this time runs were able to be made with and against the wind at nominal speeds of 6, 8, 10 and 4 knots followed by a 3 knots run with and 7 knots against. Finally the duration of the drift run was restricted to 20 minutes due to failing light and the need to recover the transponders. Thanks to the weather and good ship handling beam-on offsets were kept to a minimum improving accuracy. The computer logged 1 second values for gyro and both components of both logs, and average speeds calculated. From the PES record transponder ranges were measured at times when beam-on at one, at the equidistant point and at beam-on to the second transponder giving three estimated lengths of baseline for each run. The time history of baseline length indicated that the transponders were separating smoothly at 3.8 cm/s, so that taking the average of the three introduces less than 1% error for the slowest run and less for the faster ones; for the latter timing errors might approach 1%, reducing for slower runs. An overall measurement accuracy of order 1% is thus expected. Readings errors on the PES amounting to less than 5 m in over 2000 are not significant. The results given in Table 3 lead to the regression coefficients of voltage on F/A speed giving the slope required and a small intercept with a very high correlation. From the 20 min drift run the measured vector speed 0.271 m/s was used to give a calibration of the athwartships component of each log after vectorial subtraction of the fore aft component which was relatively small in this case. Using the new athwart sensitivity the correlation of athwartships speed with forward speed gives a measure of misalignment angle amounting to -3° for the port and -2° for the starboard logs. There is always the possibility that the ship was steaming with a mean yaw of -2° but this seems unlikely as wind conditions were fairly low and runs with and against would be expected to show opposite leeway. Finally the calibrations were converted to give kts/volt for all four channels and the equivalent speed for the internal calibration voltage calculated.

B.S.M.

ACKNOWLEDGEMENTS

Grateful thanks are due to Captain Mayl, his Officers and Crew for their most excellent co-operation throughout and for their high standard of performance in meeting the scientific requirements. From its filthy post-refit state the decks soon became ship shape and it was a pleasure to work aboard. The Bosun, Mr F. Williams, and his team made a significant contribution in getting equipment handled properly.

Appreciation is also due to Mr A.E. Fisher and his ship liaison team both for the preparatory work during refit and for the smooth handling of all logistics associated with the containers and shipyard work at Dakar.

B.S.M.

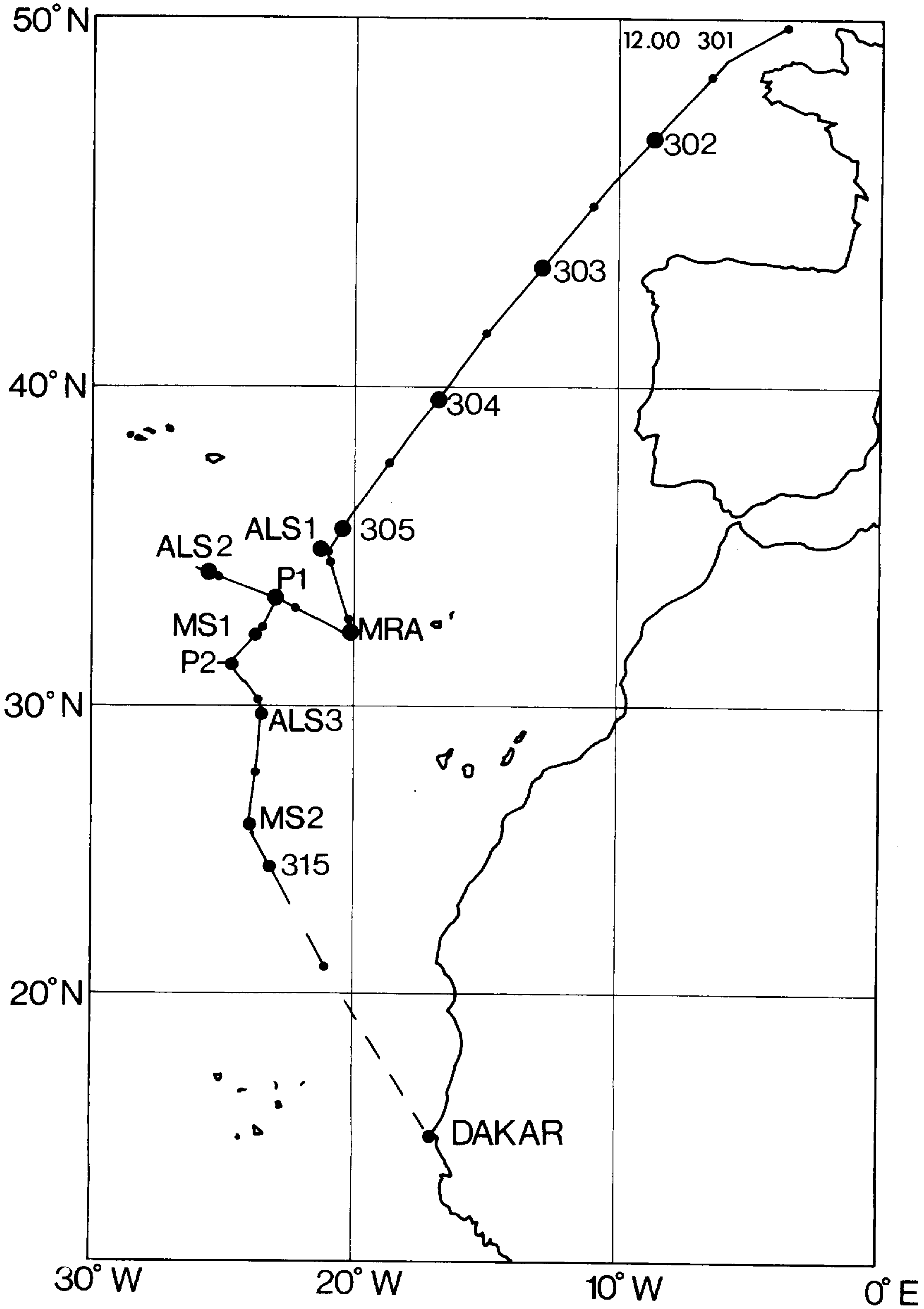

FIGURE 1
CRUISE TRACK

TABLE 1 STATION LIST

Stn. No.	Time	Date	Lat. N	Long. W	Details
10943	1706	5-XI	33°31.0'	22°58.4'	PUPPI launched.
	1512	7-XI			PUPPI released.
10944	1921	5-XI	33°30.8'	22°58.5'	Digital PUBS deployed.
	1150	7-XI			Digital PUBS released.
10945	2048	8-XI	31°23.2'	24°46.3'	PUPPI launched.
	2120	8-XI			PUPPI pre-released.
	0332	8-XI	31°22.6'	24°46.9'	PUPPI launched and prematurely released.
10946	2300	8-XI	31°22.8'	24°46.4'	DPUBS deployed.
	1212	9-XI			DPUBS released.
10947	1136	9-XI	31°23.3'	24°46.3'	1.8 tonne penetrator launched.
10948	1342	11-XI	25°44.6'	23°50.7'	RMT deployed, various speeds for drag measurements.
	1607	11-XI	25°43.8'	23°53.5'	RMT recovered.
10949	0900	12-XI	23°08.8'	22°21.4'	Sound velocimeter
	1218	12-XI	23°07.4'	22°21.3'	to 2000 m.

TABLE 2 MOORING LIST

Mooring No.	Discovery Stn.	Date Deployed	Time Deployed	Lat.	Long.	Water Depth	Instruments	Site Reference	Date/Time Recovered or Comment	Date/Time Released or Comment
339	10974	25-VI	1506	35°01.3'	21°01.4'	5198	ALS "IOS 10" + 1 Aa	ALS 1	Not located	
340	10800	27-VI	1937	34°29.0'	26°02.4'	5050	ALS "IOS 11" + 1 Aa	ALS 2	6-XI/1701	
341	10806	1-VII	1603	30°00.6'	23°31.5'	5268	ALS "IOS 12" + 1 Aa	ALS 3	10-XI/0738	
342	10808	3-VII	0006	32°30.9'	23°30.9'	5410	Float 4 at 4000 m	MS 1	8-XI/0844	
343	10811	5-VII	1428	32°20.5'	20°11.1'	4676	8 VACM	VACM	3-XI/0855	
344	10812	5-VII	1804	32°35.6'	20°06.0'	4661	2 Aa	A6	3-XI/1531	
345	10814	6-VII	1152	32°15.9'	20°13.3'	4669	2 Aa	A4	3-XI/0645	
346	10815	6-VII	1455	32°25.9'	20°09.5'	4664	2 Aa	A5	3-XI/1307	
347	10816	6-VII	1708	32°23.0'	20°20.8'	4728	2 Aa	A1	4-XI/1208	
349	10818	6-VII	1937	32°21.7'	20°14.8'	4711	2 Aa	A2		Did not release 4-XI/0702
350	10819	6-VII	2127	32°19.4'	20°08.3'	4626	2 Aa	A3		
355	10857	27-VII	1848	26°00.6'	24°00.6'	5100	Float	MS 2	11-XI/1014	

TABLE 3 E.M. LOG CALIBRATION RESULTS

Run No.	Nominal Heading (deg)	Nominal Speed (kts)	Speed Acoustic Measurements (m/s)	Log Outputs (averages over run) Computer Readings (volts) Stbd Log		Port Log	
				FA	PS	FA	PS
1	130	6	3.254	1.6026	-0.0412	1.6026	-0.0412
2	310	6	3.608	1.7845	-0.0710	1.7845	-0.0710
3	130	8	4.473	2.2266	-0.0563	2.2648	-0.0793
4	310	8	4.797	2.3473	-0.0676	2.3921	-0.0895
5	130	10	5.306	2.5978	-0.0710	2.6418	-0.0964
6	310	10	5.036	2.4927	-0.0628	2.5348	-0.0863
7	130	4	2.214	1.0839	-0.0234	1.0916	-0.0232
8	310	4	2.281	1.1224	-0.0369	1.1553	-0.0405
9	130	3	1.831	0.8889	-0.0064	0.8898	-0.0025
10	310	7	3.331	1.6329	-0.0492	1.6592	-0.0714
			X	Y_1	Y_2	Y_3	Y_4
		Correlation X on Y	Slope	:2.0187	-56.696	1.9761	-37.500
			Intercept	:0.0348	0.9499	0.0529	1.358
			r	:0.9997	0.9318	0.9996	0.9409

ABBREVIATIONS

ACM or Aa	Aanderaa Current Meter
ALS	Autonomous Listening Station
DPUBS	Digital Pop-Up Seismometer Buoy
Digital OBS	Same as DPUBS
DTS	Digital Transmission System
E.M. Log	Electromagnetic Log
EPROM	Erasable Programmable Read Only Memory
HDLC	High Speed Data Highway Linking Computers
MS	Moored Sofar Source
PES	Precision Echo Sounder (10 kHz)
PEST	Precision Echo Sounder Tracker
PUPPI	Pop-Up Pore Pressure Instrument
RAM	Random Access Memory
RMT	Rectangular Midwater Trawl
SAIL	Serial Ascii Instrument Loop
VACM	Vector Averaging Current Meter (AMF)