

I.O.S.

RRS DISCOVERY
CRUISES 112 AND 115

3 – 18 AUGUST AND
4 – 17 DECEMBER 1980

TIDE RECORDING BETWEEN GRAND BANKS
OF NEWFOUNDLAND AND WEST BISCAY

CRUISE REPORT NO 112

1981

NATURAL ENVIRONMENT
INSTITUTE OF
OCEANOGRAPHIC
SCIENCES
RESEARCH
COUNCIL

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Institute of Oceanographic Sciences
Bidston Observatory
Birkenhead

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ITINERARY

Cruise 112: St. John's 4-8-80 to Middlesbrough 18-8-80

Cruise 115: Ponta Delgada 4-12-80 to Barry 17-12-80

PERSONNEL

Cruise 112 - Master E. M. Bowen

D.E. Cartwright	IOS	Principal Scientist
J.B. Rae	"	
R. Spencer	"	
J.M. Vassie	"	
B. Hughes	"	
A. Kerr	"	
P. Foden	"	
J. Graff	"	
J. Sherwood	RVS	Computer Services
C. Jackson	"	" "
G. Knight	"	" "
C. O'Reilly	Bedford I.O.	(Canada)
J. Smetham	Student	

Cruise 115 - Master P. J. McDermott

D.E. Cartwright	IOS	Principal Scientist
J.B. Rae	"	
R. Spencer	"	
J.M. Vassie	"	
B. Hughes	"	
P. Foden	"	
K. Parry	"	
M. Beney	RVS	Computer Services
R. Lloyd	"	" "
D. DeWolfe	Bedford I.O.	(Canada)

OBJECTIVES

The principal objective was to lay a chain of sea-bed pressure recorders at chosen positions from the Grand Banks of Newfoundland to a site west of the Bay of Biscay including a large triangle spanning the Azores area, and to recover them after about four months, in order to:

- (a) link the IOS circuit of tidal stations in the NE Atlantic to the Canadian tidal shelf network off Nova Scotia and Newfoundland,
- (b) obtain more material for the study of sub-tidal oscillations, their coherence across the ocean and their spatial gradients about the mid-Atlantic Ridge,
- (c) establish the first IOS 1-year oceanic pressure record at the west Biscay station, for high tidal resolution and low frequency comparison with standard tide gauges at Newlyn, Brest and Cascais.

Incidental recording on passage was made of surface salinity and temperature, with special interest in the Labrador current/Gulf Stream boundary region, bathymetry and magnetic field. (Cruise 112 only - no magnetometer was available for Cruise 115.) About 106 15-gallon plastic containers were carried for filling with sea water on behalf of the Standard Seawater Service.

LATE ALTERATIONS TO CRUISE SCHEDULES

Cruise 112 started with the strange situation of not knowing at which UK port it would finish. This made planning of time available uncertain because at least two extra days were needed to reach say Aberdeen instead of say Southampton. Luckily weather was rarely a hindrance, and with the judicious use of three engines the ship managed to reach Middlesbrough (named six days before the end) within the allotted schedule.

Cruise 115 was originally scheduled like Cruise 112 as a 15-day run from St John's to UK. Ending in Barry gave a little more latitude against the likelihood of bad weather, and as an additional precaution it was arranged for the A4 capsule to be recovered by the previous cruise party, saving the long detour south of the Azores. Later, it was thought inappropriate for Cruise 114 to have to make the long northwesterly trek to St. John's after their work was finished, and a changeover was arranged at Ponta Delgada, with three extra days given to Cruise 115 to cover the 1200 miles to the Grand Banks. When a national holiday and gales round the Azores reduced this advantage to one day it became hazardous whether it would be possible to recover all the capsules in the turbulent weather conditions prevailing, but again extraordinary luck with following winds allowed the cruise to complete most of its objectives with omission of only one station and practically continuous use of three engines, finally arriving at Barry four days early.

NARRATIVE - CRUISE 112

'Discovery' left St. John's Harbour at 1040 (local time) 3 August, (day 216) and headed SSE towards a shallow site B0 suitable for deployment of one of the Bedford IO instruments. We had expected to be slowed by fog which had prevailed throughout the previous Cruise, but this had now thinned to a light haze which scarcely affected progress. Once clear of Newfoundland, a log was kept of the LORAN-C readings from the recorder on the bridge because the BIO team wanted LORAN positions for their moorings. The readings proved to be hopelessly erratic and were abandoned after about 24 hours. Since LORAN reception is considered normal in that area, it

is probable that the ship's receiver was in poor condition, but nobody on board knew enough about it to be able to investigate. In any case, satellite navigation was in good stead, after a slight initial hiatus.

We had made arrangements for the IOS surface salinity/temperature recorder to be on board for observing the Labrador Current/Gulf stream interference(s) but this had not arrived owing to a trivial misunderstanding at Wormley. Instead, we noted the Hull Temp. recorder which is normally logged. No conventional thermometer could be found on board to check its calibration, but agreement between two independent thermistors satisfied us that the usual recorder was behaving satisfactorily. (A note was made to bring our own thermometer on future cruises).

Tidal station BO on the southern Grand Banks was reached in good time at 10h/217 in calm weather. BIO wished to put the mooring close to a wreck marked on the large scale Canadian chart, in order to minimise hazards from trawlers, but the Captain preferred to keep within 5' of the charted position to avoid any possibility of fouling the hull. The BIO moorings all used an Aanderaa capsule lightly packed (with bread) in a well made in a concrete block which acted as ballast. The capsule was attached by rope to a compacted polystyrene float via an "AMF" release system. It was intended to lower this assembly to within 10m of the bottom before releasing from a trip-hook, but in this as in the two subsequent BIO moorings, the assembly slipped off the hook soon after immersion. It was thought that the hook was not the one normally used in BIO practice.

As with all bottom-mounted moorings, care was taken to wait for

confirmatory satellite fixes before mooring on to the next station, and to note the depth.

Later in day 217, the acoustic package for the first IOS mooring (A1) was lowered from the CTD winch to 600m for testing. A second package was lowered when the first one showed a fault. IOS station A1 was near the summit of "Beothuk Knoll", a name recently given to an elongated mount between the Grand Banks and Flemish Cap. A suitable site at depth 515m was reached at 0800/218 and the capsule was soon released in the normal manner with free fall at 1 m/s from the surface.

The BIO mooring B1 was to be close to A1 for comparison of recording, but we steamed 7' away to avoid any acoustic interference (depth 697m). The hook was attached to the trawl warp for smoother transit, but it again slipped soon after immersion. (On recovery, neither B1 nor B2 had suffered from the long free-fall). After disabling the acoustic system and waiting for another good satellite fix, we left B1 at 1130/218.

On entering deep water, and outside Canadian territorial waters, the Magnetometer was launched at the request of D Roberts (IOS) and watches kept along with bathymetry until approaching the Biscay area. An early fault around pm/218 was cured by drying out the plug connection on the poop and then replacing a pre-amplifier card.

An attempt was made pm/218 to lower acoustic gear on the CTD wire for tests at 4000m, but on finding several metres of broken strands in the armouring in very rusty condition at 1770m, the wire was considered unfit for use and brought in carefully, without loss of gear. Subsequent acoustic tests were carried out on the 4mm wire

from the same winch.

A Force 8 easterly gale on day 219 caused loss of speed and eventual heaving-to, but the gale died down quickly pm, and there was no subsequent hindrance to progress from the weather.

A small trough corresponding to the "northwest mid-ocean canyon" showed up in the abyssal plain at 2330/219. (There was no sign of this canyon except for a faint sub-bottom profile on passing the corresponding place about 60' to the north on cruise 115).

A suitable seamount depth 3410m in the area vaguely designated on modern bathymetric maps as 'Milne seamount' was reached 0150/220 and IOS mooring A2 was dispatched and acoustics switched off by 0325. Another mount at depth 2380m was then found 23' to the east and the third BIO mooring B2 was released there, similarly to B1, at 0628/220.

On following the descent of the next IOS capsule, A3, (at the northwest corner of the Azores triangle) on the Mufax, the Mufax motor suddenly stopped. A blown fuse was diagnosed and repaired just in time to see the capsule reach bottom, but a succession of heavier fuses blew on the same motor later in the day. A new motor was inserted, but it was found to lack torque and appeared to be of wrong specification. Eventually a workable Mufax was produced by cannibalisation of various spare parts, and this served the purposes of the rest of the cruise.

Position A3, completed by 0850/221, was a critical point for deciding whether there was sufficient time to make the long detour to A4, the southern point of the Azores triangle. This decision was made more difficult by the uncertainty about the final port of

destination. However, scientific priority was finally honoured, permission being granted from RVS for three engines to be used in the prevailing good weather. The three engines produced speeds around 12.5 knots.

During the afternoon of day 222, around 37°N, 31°W, the 100-odd 15 gallon containers were filled with seawater for the Standard Seawater Service, the water being deemed tolerably clean, clear of shipping lanes etc. The fire-hose was used, after running water through it for about an hour. Some small specks of oil were however visible on the surface of the water in some containers.

On reaching the most southerly position A4 (in good time) in the morning of day 223, large clumps of yellow Sargasso weed were seen floating all around. After some final lowering of pingers to 3450m, the capsule at A4 was moored normally by 1500 and the position well fixed by satellite. 'Discovery' then proceeded towards the north-easterly corner of the Azores triangle, A5. Two engines were used because the weather was very calm and in order to reduce the heat in the engine room. Typical speed was then 10-11 knots.

The magnetometer was switched off for a few hours on skirting São Miguel island during day 224, as a precaution against infringeing international protocol. Later in the afternoon the message came through from Barry that the port of destination was Middlesbrough. Timing seemed quite possible with continuing good weather and some further use of three engines in cooler waters.

The Azores triangle was completed by the mooring A5 in the early hours of day 226. Position D11 (West Biscay), completed by 0800/227 had been occupied by a similar recorder on a previous cruise, but the records had then proved faulty. It was intended to be the first of

our long-term moorings, to be recovered and immediately re-laid on Cruise 115. On completion of D11, the PES fish was brought inboard and the magnetometer stowed away, as further bathymetric and other logging was of no interest in this region.

It had been intended, if possible, to listen to a special transmitter laid by the Geophysics group at about 47°N , 11°W , which was easily on our course, but it proved impossible to be at this position on one of the three days of the week when it transmits. 'Discovery' proceeded up the Channel and into the North Sea in calm weather to reach Middlesbrough Roads on the evening of day 230. Since the pilot had not been alerted, we waited outside the port until the following morning. Smith's Dock was entered at 0930Z on 18th August, as per schedule.

NARRATIVE - CRUISE 115

As mentioned under "alterations", Cruise 115 left Ponta Delgada 2 days later than planned. After several days of strong gales, the weather was initially fairly calm, but because of uncertainty for the future it was decided to head for the nearest station to the northwest, A3, and recover that mooring followed by B2, A2, B1, A1, B0 as reached in that order, rather than steam all the way to the Grand Banks without stopping and then recover the moorings in the order in which they were laid.

There was no magnetometer on board, but watches were kept most of the time on the PES and the 'Moorey' S/T Fish, towed from a small boom on the port side of the fore deck. (The S/T fish worked fairly well, except that it was found necessary to add 1°C to its readings in order to obtain agreement to about 0.1° with bucket samples, for reasons unknown).

The assembly at A3 was reached about 18h/341 and recovered on board by 1935. The Canadian position B2 was reached the following afternoon, after some malfunctioning of the sat.nav. which made our position uncertain by 2'-3'. Luckily, the acoustic assembly responded at once with a strong signal, so we were confident of the position before the new oscillator inserted into the sat.nav. settled to give reliable readings again. The assembly surfaced in darkness, but was soon spotted from its light and from its radio transmitter. Bringing inboard took longer than usual because of lack of a stray-line in the Canadian assemblies and very little for a grappling hook to grip on to. After two sessions alongside the float, it was eventually brought inboard by 2036/342. The nearby IOS mooring A2 was reached about 80 minutes later and recovered by midnight (GMT) in fairly good weather.

On day 343 the fair weather in which we had travelled from the Azores broke up rapidly, and some 30 hours were spent in gale force winds which greatly reduced the ship's speed. The temperature also dropped from 16° to 6° in 12 hours as we passed out of the Gulf Stream water into the Labrador current. The depression moved through rapidly however, and on reaching position B1 - Beothuk Knoll, the wind had dropped to Force 4 with a confused swell. The Canadian rig was quickly contacted, released and brought inboard by 1500/344, followed shortly afterwards by the IOS mooring A1, inboard by 1700/344.

All weather forecasts now confirmed an imminent westerly gale, which would have caused us at least two days' delay in reaching the westernmost Canadian mooring B0 in the shallows of the Grand Banks, followed by likely further delay in waiting for a calm period to release it. On top of the delays already experienced and the hazardous weather to be encountered on the way back east - there were still some 2100 miles

to go - we reluctantly decided to abandon B0 and turn back towards mooring A5, the Canadian representative having expressed confidence in being able to recover B0 by a hired ship from St. John's in April.

A great circle course was taken to A5. Prolonged heavy quartering seas caused heavy rolling but did not greatly hinder progress. During day 346 the S/T fish was brought inboard to investigate a fault, causing lack of salinity signal, and later, temperature signal too. No easily diagnosed fault being found, the fish was washed down and stored for the rest of the voyage. (The automatically logged "Hull Temperature" had proved to be good to 0.2° .)

A5 was reached near noon of day 348 and brought inboard by 1445/348. On proceeding towards the final mooring D11, a small detour was taken to avoid duplicating PES records taken between the two stations during cruise 112. The detour took us across Peake Deep.

D11 was reached in evening twilight and 33 knot westerly winds causing much rolling and surging. Although we were now in good time, messages had been sent from RVS urging a return to Barry as early as possible (with 3 engines) in order to get some action started towards repairing the trawl winch before the Christmas close-down. Accordingly, we set about releasing D11 despite bad weather and darkness. In fact, the capsule was soon spotted from its flashing light when it reached surface, and after some careful manoeuvring was brought safely inboard by 2005/349.

There remained the deployment of the long-term pressure recorder at about the same site as D11. A more suitable depth, over 3000m, had been seen on the PES about 5' to the southwest, and we returned to this to lay the final mooring, calling the new station Y1. After awaiting a good satellite fix, the assembly was released from the surface at

2219, reached bottom at 2319 and was completely switched off acoustically by 2341/349. This completed the scientific work of the cruise, so a course was immediately taken for Barry. No further PES watches were kept, but the computer was left on to log the meteorology until 2400/350. As on Cruise 112, timing was unsuitable for listening to one of the twice-weekly emissions of the abyssal pinger at 47°N , 11°W , which was in fact passed on a Monday, p.m.

REPORTS ON PROJECTS

Tidal pressure recorders - I.O.S.

Six of our 'Mk IV' tide gauge capsules were deployed and recovered at the positions A1-A5 and D11. Capsules at A1, A3, A4, A5 also had back-up Aanderaa type tide gauges in addition to the main units. Data logging was on a Sea Data cassette system recording the integrated outputs of 3 pressure sensors and 2 temperature sensors every $3\frac{1}{2}$ minutes. The acoustic release and location system used two IOS series 200 units connected to a standard release mechanism and ballast frame. All these operations were performed without problems.

The logger systems transported and translated correctly, but the record from position A2 was spoilt due to a fault causing perturbations in the integration time. Although this system did not have a back-up, a Canadian gauge near gave a good record.

Some of the other records also showed this type of error to a lesser extent, but results have shown that they can probably be removed during the data processing.

All the Mk IV capsules incorporated our new temperature sensor that appears to have worked well.

R. Spencer.

Tidal pressure recorders - Bedford I.O.

Three moorings were laid using essentially the same configuration but with two types of pressure recorders.

The general layout of the "pop-up" moorings consisted of an AMF 325 transponding release encircled with syntactic foam flotation collars, to which were attached both a flashing light and a VHF radio beacon, manufactured by OAR. The pressure recorder was positioned in the concrete anchor and secured to the top of the release by a line. Releasing the package caused it to invert and surface with the hydrophone and tide gauge submerged and the light and beacon visible, to facilitate location by ranging, DF, and visual.

At position B0 was moored our standard shallow water package with a 400m flotation package and an Aanderaa WLR-5 pressure recorder equipped with a Paroscientific 270 db sensor. Temperature was also recorded using a Fenwell GA51L9 thermistor with a calibrated range of -2 to 20°C.

The deep versions of the package were placed at positions B1 and B2. They are essentially the standard package but with 4000m rated syntactic foam flotation and the Aanderaa WLR-6 pressure recorder with a 3500 db pressure sensor. The B1 mooring logged both pressure and temperature while the mooring at B2 logged pressure only. As in B0, the temperature at B1 was recorded using a Fenwell thermistor.

The deployment of the moorings (cruise 112) took place routinely except that the self-releasing hook, which releases the package at the bottom, prematurely tripped near the surface and as a result the moorings "free-fell" to the bottom. This particular hook was not the original, which we have used successfully many times.

On the recovery phase the packages at B1 and B2 were contacted and were released routinely. Happily, the acoustics, DF(xmitter & receiver), and light worked normally and as a result the packages were on board quickly and without major difficulty. Position B0 was not attempted due to constraints of weather and time.

All equipment recovered functioned normally, there being no leaks or corrosion, and both B1 and B2 produced full data sets. Clock rates were better than 1 sec/month.

The mooring at B0 will be recovered from B10 in the spring of 1981.

I wish to express thanks to the scientific staff for helpful constructive criticism concerning our techniques, and to the officers and crew of RRS DISCOVERY for making flawless recoveries.

D. DeWolfe.

Surface salinity/temperature profiling

The main interest in S/T profiling was to record the frontal structure near the Gulf Stream/Labrador Current boundary. For Cruise 112, the Moorey fish has been inadvertently left at Wormley, but the automatically logged hull temperature gave a fair indication.

The Moorey fish was on board for Cruise 115, although it had apparently not been thoroughly checked for some time previously. It had been briefly tested by M J Harris on Cruise 114 and reported to be usable but not too reliable in calibration. On Cruise 115 the fish was towed from a light boom lashed to the port side of the fore deck, and gave useful records from 5 to 11 December. However, it was found necessary to add 1°C to the readings at all settings of the temperature knob to obtain temperatures agreeing to about 0.1°C with bucket samples and an accurate thermometer.

For a large region NW of the Azores typical readings were $S = 35-36$ ppt, $T = 15^{\circ}-17^{\circ}$ (December). These did not substantially alter until passing the region of $45\frac{1}{2}^{\circ}\text{N}$, $44\frac{1}{2}^{\circ}\text{W}$, when values changed rapidly to about $S = 33-34$ ppt, $T = 5^{\circ}-7^{\circ}$. On leaving the cold water region in a westward direction, the same front was passed at about 46°N , 43°W , although there was also a cold water pocket at about 46°N , 42°W with $S = 34-35$ ppt, $T = 8^{\circ}-9^{\circ}$.

Towards the end of day 345 the salinity sensor stopped recording, and the fish was brought inboard. All parts and plugs were cleaned, but the fault whatever it was, could not be cured without taking the electronics apart.

For comparison of summer surface temperatures in the same regions, on Cruise 112 the Hull Thermometer read $11^{\circ}-13^{\circ}$ in the cold region changing rapidly to $18^{\circ}-20^{\circ}$ around $45\frac{1}{2}^{\circ}\text{N}$, $44\frac{1}{2}^{\circ}\text{W}$ (the same position as in December), rising more slowly to $22^{\circ}-23^{\circ}$ in the region of 45°N , $42\frac{1}{2}^{\circ}\text{W}$, a fall to $19^{\circ}-20^{\circ}$ in the region of Milne ($44\frac{1}{2}^{\circ}\text{N}$, 41°W), then rising steadily to $25^{\circ}-26^{\circ}$ as the ship progressed southwest to A4 (34°N , 29°W). On reaching the Bay of Biscay region, sea surface temperatures had fallen slowly to typically $18^{\circ}-19^{\circ}$.

D E Cartwright

Computer Engineering - Cruise 112

The IBM 1800, PDP 11/04 and Satellite Navigator systems worked satisfactorily throughout the cruise with only minor hardware problems.

Routine navigation and meteorological data logging was performed on the IBM 1800, with the live track plot used near the tide gauge sites. Tide gauge test cassettes were verified using the PDP 11/04 system.

Improved software was developed to achieve better communication between the two computers.

J Sherwood

C Jackson

C Knight

Computer Engineering - Cruise 115

The IBM 1800 system satisfactorily performed routine data collection. Live track plots were generated when required during the recovery of tide gauges.

The Satellite Navigation system gave problems and some boards were replaced. The air-conditioning to the Sat. Nav. room was inoperative for most of the time. There were hardware errors on both the 1800 Video terminals; a fan unit was replaced and a spare board used to give one operational unit for the cruise. One data disc became unserviceable and was withdrawn although no data loss occurred. The disc drives continued to give occasional errors ("address modify") but these were recoverable. Data transfers were made to the 1800 from the PDP 11/04 Front End although Camac hardware errors caused many problems until three modules were replaced. The 11/04 was used to copy tide gauge cassettes to magnetic tape.

M G Beney

R B Lloyd

STATION LIST FOR MOORINGS DEPLOYED IN CRUISES 112 AND 115

Position Number	Station Number	Name	Latitude	Longitude	Depth (corrected)	Time on bottom 1980	Time Released
BO	10207	Grand Banks	44° 44' .1 N	50° 13' .0 W	48 M	217/1040 Z	
A1	10208	Beothuk Knoll	46° 03' .8 N	46° 34' .4 W	515 M	218/0820 Z	344/1607 Z
B1	10209	Beothuk South	45° 59' .1 N	46° 26' .7 W	697 M	218/1051 Z	344/1407 Z
A2	10210	Milne West	44° 30' .0 N	40° 52' .9 W	3410 M	220/0255 Z	342/2217 Z
B2	10211	Milne East	44° 29' .5 N	40° 30' .0 W	2380 M	220/0629 Z	342/1805 Z
A3	10212	Azores NW	43° 06' .4 N	35° 11' .1 W	3460 M	221/0813 Z	341/1801 Z
A4	10213	Azores South	34° 12' .7 N	28° 54' .5 W	3525 M	223/1446 Z	329/0659 Z
A5	10214	Azores NE	43° 01' .5 N	21° 51' .6 W	2480 M	226/0138 Z	348/1325 Z
D11	10215	Biscay West	45° 01' .2 N	15° 24' .7 W	2830 M	227/0753 Z	349/1832 Z
Y1	10254	Biscay Year	44° 56' .5 N	15° 34' .6 W	3160 M	349/2319 Z	

TRACK CHART FOR
"DISCOVERY" CRUISES
112 AND 115

