Canaries to England.

RRS JOHN MURRAY

REPORT on CRUISE 68/2

February 1968

D.H. Matthews.

Cambridge Geophysical Instrument Trials.

D.H.M.
April 1968.

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DATES

(Flew to Canaries		Sat	Feb 10)
(Joined ship	p.m.	Weds	Feb 14)
Sailed from Las Palmas	1300 hrs	Thurs	Feb 16
Arrived Plymouth	0700 hrs	Weds	Feb 28
(returned to Cambridge)	a.m.	Thurs	Feb 29)
Time at sea	11 days	18 hrs	
Scientific station time including airgun traverses	3 days	5 hrs	(77 hrs)

SCIENTIFIC PERSONNEL

Dr. D.H. Matthews

Mr. T. Owen

Mr. G.A. Day

Dr. J. Jones

Mr. A.T. Merzer

Mr. R. Theobald

SHIP'S OFFICERS

Capt. M.J. Perry	Master
Mr. J.E. Higham	Mate
Mr. P.H.P. Maw	2nd Officer
Mr. G.M. Brown	3rd Officer
Mr. M. Jobling	Chief Engineer
Mr. C.H. Lear	2nd Engineer
Mr. D.T. Williams	3rd Engineer
Mr. M.T. Williams	Bosun

CRUISE INTENTIONS

The distance Canaries - Plymouth by a suitable track is 1530 nautical miles, for which we allowed 7½ days at 200 miles per day. This left about 4 days (96 hours) for station work. It was our principal intention during this time to obtain one or two records of near vertical incidence reflections from explosive charges fired near a newly constructed vertical hydrophone array suspended beneath a buoy containing a d.r. tape recording system. We also intended to make a tape recording of the output from the towed (horizontal) array whilst the ship steamed around an anchored danbuoy firing the airgun, to see if deeper penetration could be achieved by adding the signals from successive shots. Both sets of records were intended for a study of deep crustal reflections (ideally from the Moho) and will be subjected to computer analysis.

Subsidiary objectives of the cruise were to evaluate improvements made to the airgun profiling system, to test-run a tape recorder intended for f.m. recording in a buoy, and to pressure test some sealed glass spheres intended for pop-up flotation.

NARRATIVE

We joined the ship as soon as She came into harbour at 1730 on Feb 14th and began to install our apparatus and to float the hydrophone array. This was done by midday the 16th and at 1300 we sailed from Las Palmas. We launched the newly constructed array buoys for flotation trials in calm and sunny weather that afternoon.

The only other calm day, with wind less than force 4, was Feb 20th. The three junior scientists, half the party, were seasick for the rest of the voyage; in spite of Dr. Jones' devotion to duty this fact undoubtedly accounts for our lack of better success with the airgun experiments. From Feb the 23rd onwards we encountered gales from ahead which slowed the ship down. These cost us the final 24 hours of station time which would have been devoted to another airgun reflection experiment. In spite of this we entered Plymouth on time at 0700 Feb 28th with all our major objectives achieved. Some details of the experiments will be found in the next section and in the Station List.

The general plan of the cruise was to steam northwards at night and to stop for station work by day. This we did, except that on the night 19/20th we steamed slowly southwards in order to avoid getting too rapidly north towards the worse weather. The echo sounder was run continuously from the morning of the 19th and the magnetometer from the afternoon of the 24th, but in order to save energy for the essential programme we set no continuous watch, contenting ourselves with visiting the instruments at least once every two hours.

The first three days at sea were spent in preliminary experiments, but by Feb 20th we were ready for an attempt to carry out the deep reflection experiment in earnest. We moored a danbuoy in fine weather, laid the array buoy, and fired 35 charges. Unfortunately, on recovery we found

that the tape had stopped running only a few minutes after the buoy was launched - the only failure experienced with this apparatus. Later we obtained two hours of tape recording of airgun shots while steaming slowly around the danbuoy. However this record is of doubtful quality due to inexperience with the tape recorder and to trouble with the airgun.

Next day we had a successful run with the array buoy and on the following day (the 22nd) we laid another danbuoy intending to repeat the experiment of the 20th. Once again we had success with the array buoy but had to abandon the airgun experiment in deteriorating weather in the evening when the gun managed to trap the hydrophone cable in its piston. This was a remarkable mischance as the piston only protrudes from the gun for a few milliseconds on each shot. During the days that followed we got the system properly set up to record the airgun but we had no time to stop and lay another buoy. However as we returned to Plymouth with two excellent tapes from the array buoy and one tape from the airgun we were well pleased. We are thoroughly grateful to the ship's company for their active participation in our work.

PROJECT REPORTS

1. Deep-reflection programme.

The vertical array buoy was constructed for this experiment during the weeks immediately prior to the cruise and was fully assembled for the first time in the Canaries. The electronics were built by Mr. T. Owen and it is very greatly to his credit that the whole system worked so well with so few teething troubles. The recordings were made on half inch tape in a direct recording tape recorder run at $\frac{1}{4}$ inch per second, and played back at $7\frac{1}{2}$ inches per second into a loudspeaker or ultra violet galvanometer recorder. The first two stations, 319, 322 served to find out the correct gain settings for the recorder, and to effect a minor modification of the clock circuit (the frequency of the time mark signal was at first too high for the speeded-up playback). The third station, intended as a full scale experiment, failed because a minute piece of dirt stopped the tape recorder. The two final stations, 331 and 333, both made in rough weather, were completely successful. At the time of writing the tapes have been played out and we are considering details of their digitisation.

In a typical station the clocks in the lab (used for recording the absolute time of shots) and in the buoy were synchronised and the buoy was then laid, array first, over the stern. Some fifteen shots were fired while steaming around the buoy in a circle of half mile radius and additional shots for wider angle reflections were fired while steaming up to 6 miles away from the buoy. The radar reflector fastened to the buoy at a height of about 3'6" above sea level was not a success: in the prevailing weather conditions it could only be seen up to a maximum of 3 miles range. The buoy was then recovered over the stern and the clocks checked for synchroneity.

The airgun deep-reflection programme was unexpectedly less successful. Two hours of poor record were obtained while steaming slowly round a moored danbuoy on Feb 20th. This station (330) was made before the elastic was added to the array towing cable. A second attempt was abandoned on Feb 22nd (Station 334) and there was no opportunity to repeat it. The tape that we did get will be digitised and the shots added to look for deeper reflections.

2. Airgun profiling.

The following modifications had been made to the airgun and array since it was last used in 1967.

1. a solenoid valve had been fitted for electrical firing.
2. a restricting orifice had been introduced in the H.P. line replacing an oscillatory valve intended to prevent loss of air each time the gun was fired.
3. modifications had been made to the preamplifier to allow tapering of the array.
4. a second recorder had been modified for use so that two records could be produced simultaneously at different filter settings.

It was the intention on this cruise to test all these features.

After initial difficulties the transducer pairs in the array were simply added to save the battery power required for the emitter followers used in the tapering circuit, and the gun was allowed to fire freely. A single hydrophone was used to trigger the recorder scan. The optimum size of restricting orifice was found by trial on the 18th and a record was produced with 1 second penetration while steaming at two knots in a slight sea. This penetration was halved at $4\frac{1}{2}$ knots, and the record was completely swamped by noise at 8 knots (Station 325). On the 21st a 30 foot length of elastic cord was lashed across a bight of the array towing

cable and the noise decreased considerably. It was then possible to see some penetration at 10 knots. During this station, 332, the solenoid firing valve was used but the echos on the record were fuzzy and it was deduced that the time taken for the valve to open was not sufficiently consistent, so this method of firing was abandoned.

The tapered array was set up on the 24th but by this time rough weather had robbed us of further experimenting time. However a record showing one sub-bottom echo was obtained over the Biscay Seamounts while steaming at 7 knots into a rough sea on the 25th, and the next day another poor record was obtained across the continental rise at $8\frac{1}{2}$-9 knots in rough weather. During this station (335) the second recorder was ~~fired~~ tried and found to work well.

3. F.M. tape recorder in buoy.

On the morning of the 19th a Uher tape recorder was placed in the buoy with a Levell oscillator to check the effect of the buoy motions on the tape speed. The experiment was repeated with the recorder in another attitude in the buoy. The wind was force 6 with moderate swell and rather rough sea. The tapes have been played back into a loudspeaker and it is clear that flutter and wow are small.

4. Pressure tests of glass spheres.

Two Corning sealed glass spheres 10" in diameter withstood one lowering to 2400 fathoms (4390m). A second lowering to 3000 fm was cancelled due to bending of the hydrographic davitt.

5. Explosive charge trials.

We fired a series of charges of weights up to 300 lbs. to find their effect on the ship. Results and recommendations appear in sections 4 and 5 of the appended "Report on Ship's and Scientific Equipment".

6. Gravimeter.

The Cambridge gravimeter and gyro had been lent to the Imperial College group for Cruise 1968/1 and had been landed in Las Palmas by them. Unfortunately the meter had been left with the heaters connected to a battery and the battery had discharged. When heated again the inner thermostat failed to cycle and so the instrument was not put into use at all.

It was stowed on board suspended by elastic cord to prevent damage while firing charges. Three days out from Plymouth the meter was mounted on the platform, the gyro run up, and the platform switched on. It did not stabilise in the pitch axis and it was not possible to balance the gyro amplifier in either channel. After 24 hours running, the rotor current became too high, and the gyro was switched off, Since returning to Cambridge the gravimeter thermostats have been replaced. So far the gravimeter appears to be unharmed. The gyro has been returned to Germany.

7. Soundings and magnetics.

Soundings have been plotted on 1:1 million sheets and submitted to the Hydrographic Department and to N.I.O. Magnetic field observations will be read and added to the Cambridge collection.

Dan Buoy Positions

Area	D/B	Position	Laid	Recovered
100' NE from Maderia	I	33°55'N 15°09'W	0900/20	1930/20
SW Iberia. Plain	II	38°14'N 15°05'W	1230/22	1900/22

Key to Station List and Station Summary

SR(V)	Seismic reflection using explosives and vertical array buoy	5 stations
SR(H)	Seismic reflection using airgun and towed horizontal array	2 "
SRP	Seismic reflection profile (airgun)	8 "
trial	trial of gear	3 "
-	firing large charges	3 "

Stations occupied 316 - 335

UCF	uncorrected fathoms at 800 fm/sec
CF	corrected fathoms

Station No.	Type	Date Feb	Time GMT from	to	Lat N & Long W / to Lat N & Long W	Depth UCF	Depth CF	Comment
NORTHERN SLOPES OF CANARIES								
316	trial	16	1600	1930	28°20' 15°00'		C.1700	Steel buoy and array watertight, plastic buoy not.
RISE BETWEEN SALVAGE IS AND DACIA BANK								
317	SRP	17	0730	0940	29°55' 15°00' 30°05' 14°58'		C.1800 C.1620	Troubles!
318		17	1320	1340	30°31' 14°54'		C.1750	Fired two trial charges.
319	SR(V)	17	1430	1600	30°40½' 14°54'		C.1850	8 shots at ½ mile range recorded to choose gains.
NORTHERN PART MADIERA PLAIN								
320	trial	18	0900	1030	32°12' 15°01.5'	2330	2404	Two Cornings glass spheres lowered; both O.K.
321	SRP	18	1030	1500	32°13' 15°04' 32°31' 15°04'		C.2400 C.2400	No results.
322	SR(V)	18	1530	1800	32°33' 15°04'		C.2390	12 shots recorded but no time marks.
323	SRP	18	2000	2140	32°50' 15°01.5' 32°56' 15°00.5'		C.2310 C.2250	No results with taped array.
SOUTHERN HORSESHOE SEAMOUNTS								
324	trial	19	0930	1145	34°28' 14°48'	1940	1997	fm tape recorder and oscillator run in buoy.
325	SRP	19	1245	1530	34°28' 14°48' 34°39' 14°48'	1855 1510	1909 1552	Record from untapered array at speeds less than 3 knots.
326		19	1600	1700	34°36' 14°45' 34°31' 14°38'	1635 1000	1680 1028	Fired five trial charges 50 - 250 lbs.
(325)	SRP	19	1830	2115	34°37' 14°47'	1560	1603	Record obtained without tapering the array.
					34°27' 14°47'	1990	2049	

Station No.	Type	Date Feb	Time GMT from	to	Lat N & Long W to Lat N	Long W	Depth UCF	CF	Comment
SWALE TOPOGRAPHY BETWEEN MADIERA AND HORSESHOE SEAMOUNTS. D/BI.									
327	SR(V)	20	0950	1250	33°55'	15°09'	2040	2101	35 shots. No records: tape jammed.
329	-	20	1400	1430	- do -		- do -		Fired one 300 lb. trial charge.
330	SR(H)	20	1445	1915	- do -		- do -		Two hours of record while circling D/B at ½ mile
WESTERN END OF HORSESHOE PLAIN/N. HORSESHOE SEAMOUNTS									
331	SR(V)	21	0955	1140	35°31'	14°33'	2325	2398	25 shots at range 4 ca. Good records.
332	SRP	21	1550	2050	35°58' 36°27'	14°35' 14°36.5'	2185 638	2252 656	Records with electrical firing and elastic in towing cable at speeds up to 10 knots.
SOUTHWESTERN CORNER OF IBERIA PLAIN. D/B II.									
333	SR(V)	22	1300	1600	38°14'	15°05'	2912	3018	23 shots. Good records in force 6.
334	SR(H)	22	1645	1800	- do -		- do -		Abandoned: gun swallowed cable!
BISCAY SEAMOUNTS									
-	SRP	25	1630	1845	44°32' 44°42'	11°54' 11°42½'	2550 2240	2634 2308	Obtained record at 7 knots, pitching heavily; array tapered.
LOWER CONTINENTAL RISE									
335	SRP	26	1910	2400	46°31½' 46°58'	9°14' 8°35'	2515 2150	2597 2214	Poor record at speed 8½ - 9 knots; pitching.

LAS PALMAS TO PLYMOUTH, 16th - 28th February, 1968

Report on Ship's and Scientific Equipment

1. ECHO SOUNDER

A continuous record of soundings was obtained from February 19th (when the sounder was started) until the 100 fm. line was reached on February 27th. Contact was maintained with the bottom even in depths of 3,000 fms. except for some six hours in heavy weather over the group of Seamount in the Bay of Biscay. In spite of this the record is poor, the reflection weak and the bottom appears (entirely spuriously) "spiky" with "grass" preceeding the echo by as much as 15 fms. In the circumstances the time mark arrangements were generally useless, the breaks in the scale lines being obscured by noise on the record.

The alternative paper speeds do not appear to work. The handbook is pitifully inadequate and surely cannot be complete. What do the polarity switches do? We could not find any spare bands or blades. An outboard transducer should be borrowed and tried.

2. THE VARIAN MAGNETOMETER

When we joined in Las Palmas both fishes and the "Anaconda" inboard cable were lying on deck, their ends flooded with salt water. I struck one fish down below and it will need its plug replaced before it can be used. The other fish was brought into use on February 25th and it gave a record thence all the way home. It was necessary to change the plugs and remove some of the cable; the plugs appeared to have been wrongly connected. When this was done the instrument worked perfectly, even with the firing cable brought right into the laboratory and then connected to the whole coil of inboard cable, (far too long for this ship), which was stored under the magnetometer cabinet. The ship must be very much less noisy than before.

Minor troubles were experienced with the recorder pen (the ink flow kept stopping) and more seriously, the calibration of the chart recorder is subject to sudden jumps which can induce an error of $\geq 40\gamma$ in the record. This trouble almost certainly arises in the D/A converter.

Recommended towing arrangements.

The magnetometer cable must not be turned round any drum $<$ 15 inches in diameter. It is imperative that the practice of turning this cable up around the cleats on the gallows should never reoccur. We have towed and handled it from the large new drum of the motor bollard which is of an ideal size. I recommend that a fixed drum of the same diameter as the drum of the motor bollard should be welded to the square pedastal of the bollard so that ropes and cables can be easily secured around it if the drum is wanted, for example the magnetometer cable might be secured so while handling the airgun array.

Discussion with the ships officers and the Bosun indicates that the bollard is insufficiently powerful (even with its own small drum) for working the ships warps. I therefore recommend that you fasten a small diameter drum above the present large drum and that you increase the torque and power of the motor as much as the diameter of the driving shaft will allow.

I suggest that the plug end of the magnetometer towing cable be passed into the laboratory through one of the pipes and that you there connect it to a short length of suitable (see Varian handbook) inboard cable long enough to reach from the pipe to the instrument cabinet. The instrument cabinet should be re-sited away from the door of the laboratory. It is imperative that the plug connections be kept in the dry at all times: corrosion in these plugs will rapidly obscure the precession signal.

3. AIRGUN

Towing and handling arrangements are fine; so was the compressor after

it had been unseized. The low pressure air regulator valve must be re-sited since it is at present necessary to climb on to the running compressor to reach it. This is the most frequent adjustment (every half hour or so) and is at present dangerous. An additional light is also needed near the compressor.

4. CHARGE FIRING

A sequence of charges of weights increasing by 50 lbs. steps to 300 lbs. was fired to find the effect on the ship. The larger charges were fired with fuses producing a delay of 65 seconds, the ship steaming at full speed $8\frac{1}{2}$ knots.

The 200, 250 and 300 lb. shots all blew off the steering motor. The 250 and 300 lb. shots caused all the engine room breakers to fall off with a temporary loss (10 seconds) of electric power, including a.c. power in the laboratory, which would interfere with seismic recording. The gyro compass was supplied direct from the Lister generator and was unaffected by the shooting (although the Lister voltage regulator subsequently gave trouble). (See Section 5).

It is clear that precautions will have to be taken to maintain a.c. power in the laboratory for seismic recording instruments. Doubts were expressed about the effects of the shocks on the gyro itself.

5. GRAVIMETER

We were unable to run the gravimeter as it became in need of repair before we reached the ship. However we did run the platform in order to check the gyro. The gravimeter compartment must be fitted with a thermostatically controlled air extractor fan in place of the uncontrolled air injector fan recently fitted. If the space is to be used to stow empty beer barrels it is essential that something should be provided to lash them to, because if one rolled under the platform and jammed it the system would be damaged.

The question of power supplies that do not go off when starting main engines, or swapping from shore to ships power, or fall off when firing charges, is essential to gravimeter operation. We suggest that the gravimeter D.C. (2 KW) supply for the gravimeter room be taken direct from the Lister board and that in addition two D.C. plugs be provided in the main laboratory from the Lister board from which we can run two static D.C./A.C. inverters to supply the gravimeter heaters and linograph (200 VA) and the ultra violet recorder (360 VA) when doing seismics. The Chief Engineer agreed that this scheme is feasible and will do what is required.

The Paxman generator, which it was impossible to seat on shock-mountings, entirely prevents gravity measurements when it is running. (We observed this in December).

6. HYDROGRAPHIC DAVITT

Opportunity was taken to lower two glass spheres for pressure testing to 2,400 fms. At this depth the inboard upper block began to twist away from the upright and the wire rubbed on its face. When hauling in the accumulator spring was entirely compressed whenever more than 1,500 m. of wire were out.

In view of this it was decided to be unwise to lower the spheres in 3,000 fms. of water. This performance is inadequate.

7. A NUMBER OF LESSER POINTS

(a) Much higher bunk boards are needed.

(b) The chain across the break in the bulwarks aft (the taffrail) should be shortened so as to run between the inside edges of the two roller fairleads so that cables can be run through the fairleads without unbuttoning the chain.

(c) The scientists lavatory and bathroom aft is a slum. It should have a receptacle for paper towels.

(d) The cupboard doors in the main laboratory are insufficiently robust and they keep coming open even when locked if the ship is rolling. There is a broken bookcase fiddle.

(e) Higher chairs are needed in the laboratory to make it easier to work sitting at the benches.

(f) The Bosun has a good suggestion about leading blocks on the quarterdeck.

8. The laboratory radar and its associated plotting system are wholly excellent. We recommend that you buy a number of spare copies of the instruction books of this and of all other instruments carried on the ship, which can be made available to senior scientists several weeks before they join the ship. It was two days before I had time to find out how to switch on the echo sounder.

9. Last but by no means least, the ship should not be allowed to sea again without a portable diesel hull and fire pump. There was no portable pump of any kind available to pump out the flooded steering gear compartment on February 24th and if the drains to the engine room had become blocked the position would quickly have become serious. Moreover there is no means whatever of fighting an engine-room fire or of pumping out after one.

Doctor D. Matthews
Senior Scientist

27th February, 1968

In spite of the gloomy sound of this, all these points are minor ones and I thought the ship and her crew unexpectedly excellent; much easier to work from than DISCOVERY is.

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D.H.M.
April 24th 1968