R.R.S. JOHN MURRAY

CRUISE REPORT 7/69

UNIVERSITY OF BIRMINGHAM

Celtic Sea.

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UNIVERSITY OF BIRMINGHAM
DEPARTMENT OF GEOLOGY WITH GEOPHYSICS

R.R.S. JOHN MURRAY CRUISE 7/ 69 29th AUGUST - 22nd SEPTEM.

Personnel:

Dr D.J. Blundell	Senior Scientist
Mrs M.P. Blundell	
Mr S.A.D. Bamford	
Mr P. Broom	
Mr F.J. Davey	
Mrs J. Davey	
Mr R. Handley	
Mr R. Livesey	
Mr K. Nunn	
Mr W. Walker	
Mr P. Worthington	

Equipment

(a) R.V.U.: E.G. and G. Sparker seismic profiling system
Varian Proton magnetometer
Muirhead P.D.R.

(b) Birmingham:
Bradley sonobuoy seismic system
Cambridge Consultants proton magnetometer

Scientific objectives:

The central feature of the cruise was a seismic experiment to determine crustal structure in which HMS Hecla fired seventy depth charges along lines westwards from the Pembrokeshire coast to the continental margin southwest of Ireland. Along with R/V Prince Madog, R.R.S. John Murray occupied sonobuoy recording stations and in addition acted as communications centre to liase between the other ships and the eleven stations set up ashore in Ireland, Wales and Southwest England. This experiment has been designed to provide a detailed cross section of the crust near to the western margin of Europe and it is hoped that both refractions and reflections from the Moho and other crustal boundaries have been recorded.

In order to provide detailed information of the near surface structures in the region of the depth charges and to extend the area of survey made in Cruise 4/67 further west, a major objective of the rest of the cruise has been a systematic geophysical survey with sparker and magnetometer.

The interpretation of the crustal experiment is dependent on a good knowledge of seismic velocities within the upper layers so that the other principal aim of Cruise 7/69 was to undertake a series of short range seismic refraction lines in certain critical areas of particular importance to the crustal experiment.

In addition, HMS Hecla made gravity traverses along the lines of depth charges and extended the gravity survey made during RRS John Murray Cruise 4/69 along the full length of the south coast of Ireland.

All these experiments are parts of an integrated study of the region west of Wales and south and southwest of Ireland using a variety of geophysical techniques.

The crustal experiment was timed to take place during the second week of the cruise. The intention during the first week was to carry out sonobuoy seismic refraction lines during daylight hours whenever the sea was sufficiently calm, with sparker/magnetometer traverses overnight. The final week would be taken up with completing any refraction work left over from the first week but otherwise concentrating on systematic sparker/magnetometer survey. In addition several minor experiments were scheduled for the final week:-

(a) the collection of surface sea water samples at two stations S.W. of Ireland for MAFF, Lowestoft.

(b) trials of oceanographic logging equipment for Mr D.J. Smith, University of Southampton.

(c) trials with a sonobuoy and the sparker and an airgun source to obtain wide angle reflections and refractions from interfaces beneath the sea bed.

Narrative

(a) First week, Barry to Milford Haven, via Cork

The ship sailed from Barry at 10.00 BST on 29th August with a television camera crew aboard in addition to the seven scientists. Equipment trials were carried out in Swansea Bay for our own as well as the television crew's benefit, during which time Mr Jones of R.V.U. demonstrated to us the NERC equipment aboard. Mr Jones and the television crew departed at Swansea and soon after geophysical work began with a sparker/magnetometer traverse 69/1 westwards from St. Gowan Head to a point 15 miles south of Galley Head. This was reached by 07.50 on 31st August when work commenced on the first sonobuoy refraction line. On this first day, two free floating sonobuoys were put overboard 5 miles apart. Difficulty was encountered in receiving good radio signals from them, which was traced to the directional properties of the two aerials put up on board especially for the purpose. Good reception was obtained, however, using the aerial mast for the Kestrel radio. This and other minor faults in the recording equipment caused delays so that only one line of 10 shots was fired that day and some time had to be spent in searching for the sonobuoys which had drifted several miles from where they were launched. Sparker/magnetometer traverse 69/2 was made overnight, southwards and back along a parallel track. The following day, four sonobuoy lines were fired using just one buoy, firing away to either side of it 9 charges at 3 minute intervals. Again a sparker/magnetometer traverse (69/3) was started in the evening but after a short while the recorder began writing intermittantly and eventually failed to write at all. After a good deal of searching the fault could not be traced so thetraverse was abandoned for the night. On 2nd September a further four sonobuoy lines were fired, but this time two buoys were laid half a mile apart with shots fired on either side before moving them on 5 miles to provide continuous reversed coverage along a section of the depth charge line. Meanwhile the sparker receiver was stripped down and the fault traced to dirt around the carbon brush contacting the helix drum which caused the signal to short to earth. After cleaning things, the recorder worked again and we were able to continue overnight

with sparker/magnetometer traverse 69/4 to take us to the second area where we wanted refraction lines, about 20 miles south of Mine Head. Four sonobuoy lines were fired there during the day and again an overnight sparker/magnetometer traverse 69/5 was begun in the evening, south and back on parallel traverse. The paper recording again became intermittant during the middle of the traverse and although it was continued through until the morning not a great deal of useful information was obtained. By this time, too, the Varian magnetometer was suffering increasingly from noise which, although not obliterating the signal, made it difficult to read. The P.D.R. had also been found not to work so a request was made to R.V.U. for someone to come to Cork to help us sort out the equipment. On the morning of 4th September we fired two more sonobuoy lines to complete the short range refraction programme and virtually empty the magazine. We then made for Cork, arriving there at 18.00. The weather had been perfect throughout this first period at sea.

Mr Knights travelled overnight from Swansea to Cork and with his help and advice the P.D.R. and Varian magnetometer were put in full working order. The sparker was repaired as far as possible and made to work. The alternative, short hydrophone array was also made up ready to try out in comparison with the longer one used up to now. R/V Prince Madog arrived during the morning and some time was spent aboard her, bringing up the sonobuoy equipment borrowed from Imperial College to full working order. The second Decca navigator equipment was serviced and the sea search receiver for HMS Hecla, on loan from Decca, was delivered.

Dr Khan and Dr King visited the ship to report that their seismometer stations near Castletownbere and Bandon were both set up and ready for the crustal experiment, as were all the other stations in Ireland operated by Dublin Institute for Advanced Studies.

At 07.00 on 6th September we sailed from Cork, bound for Milford Haven, with Mr Knights aboard. During the crossing trials were held with the sparker using the short hydrophone array and with the P.D.R and Varian magnetometer, all of which worked satisfactorily. The sonobuoy equipment was modified in

preparation for the crustal experiment. We arrived in Milford Haven at 23.30 when Mr Knights left to return home. I was also able to have a short meeting with Dr B. Jacobs (I.G.S. Edinburgh) who was operating the seismometer station at St. David's and acting as co-ordinator for the English and Welsh stations. He was able to report that all stations were prepared and ready.

(b) Second Week. The Crustal Experiment

We sailed from Milford at 02.10 on 7th September to rendezvous with HMS Hecla to hand over the sea search receiver. When we met up, however, HMS Hecla had to put into Milford urgently and the rendezvous was postponed. Meanwhile, trials were held of the shot firing broadcast routines which took some time to put right. After reports of only moderate reception from the shore stations the second trial was held at 18.00 and this proved entirely satisfactory. Thereafter reception was good throughout the experiment.

The rendezvous took place at 16.00, off the Smalls, and after this we proceeded to lay dahnbuoys to assist HMS Hecla to locate the shot positions the following day. We took up position at station S1 and laid two sonobuoys on moorings at 05.30 on 8th September. At 06.30 HMS Hecla commenced test broadcasts and at 07.30 fired the first shot. Thereafter, 32 more shots were fired and two, the final two, were misfired. All broadcasts for these shots were received and recorded with shot times calibrated to GMT. Ground waves were recorded from shots within about 30 miles range but at greater distances only the water wave was observed. Firing was completed by 19.00 when the sonobuoys were recovered. Next the dahnbuoys were recovered and we made for Bantry Bay, towing the magnetometer only. In worsening sea conditions we arrived in Bantry Bay during the evening of 9th September, decided it would be futile to start a sparker traverse westwards in the gale that was blowing and sheltered behind Bear Island for the night. During the day we had checked with the shore stations that they had received signals satisfactorily the day before and arranged to re-fire one of the shots which had misfired. At 07.00 on 10th September we left our anchorage and commenced sparker/magnetometer

traverse 69/7 towards Porcupine Seabight. By this time the wind had dropped to reasonable proportions although there was a heavy swell running. The night sheltering behind Bear Island was the only time throughout the cruise when weather conditions were too bad for us to work. Line 69/7 was completed by 02.15 on 11th September when we turned back to reach station S5 to launch two sonobuoys by 06.30. The sonobuoys were moored in about 700 fthm of water and later in the day when the wind rose to force 7 they dragged and eventually broke adrift. HMS Hecla began firing at 09.00 and continued until 18.00 with a total of 19 shots. We had to recover the sonobuoys at 16.00 but by this time the shots were beyond our range to receive ground waves. All broadcasts were recorded and calibrated to GMT. We made for station S4 at full speed to get there in time to record the following day's shots. By 07.30 on 12th September, two sonobuoys had been moored and station S4 set up. HMS Hecla began firing at 09.00 and continued to fire 15 shots by 15.00. The sonobuoys were recovered at 14.00 when the shots were out of range. All the broadcasts were recorded. Ground waves from two of the nearer shots were missed because of a faulty contact. At 14.30 Magnetometer traverse 69/8 was commenced as we made at full speed for Milford Haven. That evening HMS Hecla successfully fired the repeat of the misfire and concluded the programme. The shore stations reported they had all received excellent signals and that the experiment had gone exceptionally well. We were most fortunate to have calm weather throughout the shooting periods and noise levels ashore were low. Milford Haven was reached on 13th September at 07.30.

(c) Third week. Milford Haven to Barry via Porcupine Seabight

Mr D.J. Smith, University of Southampton, arrived in Milford to join the cruise but the equipment that he intended to test had not arrived by British Rail by the time we were due to sail. Regretfully, he decided to return home. We sailed on 14th September at 18.45 and made for the South Bishop to commence sparker/magnetometer traverse 69/9 along the eastern part of the depth charge line. This was completed by 10.00 on 15th September when speed was increased and the magnetometer

only was trailed to the far end of line 69/4. Here the sparker was re-started and traverse 69/10 was commenced, out to Porcupine Seabight and return along a parallel track to the north. On this and the earlier traverse to the southwest of Ireland, power was increased to 7,000 joules which gave between ½ and 1 sec. penetration of the sea bed at depths greater than 700 fthm. At this higher power spurious trigger pulses occurred after a while which probably resulted from overheating in the spark gap unit. When at the position of S4 and again at the furthest position west along the traverse, surface sea water samples were collected for M.A.F.F., Lowestoft using the non-toxic supply line to the Biological Lab. On returning to Mizzen Head at 19.10 on 17th September, line 69/11 was commenced southwards to return on a parallel track to the east. This was completed at 13.30 on 18th September at the position of the first group of sonobuoy refraction lines, south of Galley Head. Trials were held with a free floating sonobuoy and the spark array and an airgun source to find out how far wide angle reflections and refractions could be observed. With the spark source, multiple sea bed reflections tended to obscure any sub-bottom reflections and only very weak refracted arrivals were found to ranges of two miles. The airgun data was difficult to assess because of the lack of a suitable mufax recorder on board but data was recorded on magnetic tape for playback in the lab. At 19.30 sparker/magnetometer line 69/12 was commenced. This formed a series of parallel tracks, approximately north and south, working eastwards along the south coast of Ireland. This was continued until 20.00 on 21st September when, off St. Gowan Head, the equipment was brought inboard and the ship made at full speed for Barry. The cruise ended at Barry on 22nd September at 03.00.

Project Report

(a) Sonobuoy refraction lines

Nine lines were fired in the area south of Galley Head along the line of depth charge shots where they were spaced 3 km apart. Six lines were fired south of Mine Head where again closely spaced depth charge shots were fired. Using two buoys half a mile apart and firing out from either side before moving spread to "reverse" the lines appeared to be the most effective method in practice. Charges were fuse fired at 3 minute intervals, steaming away from the buoys. The maximum charges used were 20 lb geophex.

(b) Sparker survey

Most of the traverses made south of Ireland were with 1,000 J power, 1 sec. firing, recording with ½ sec. helix sweep and 80 to 200 hz bandpass filter. To the south west of Ireland the power was increased to 7,000 J with subsequent increases in firing intervals and sweep times. The quality of the records has been excellent throughout. Judging from the wavelength of the structures observed the network of intersecting traverses should be sufficient to produce a general map of the area. A total of 1,500 miles of traverse were obtained during the cruise.

(c) Magnetometer survey

The magnetometer was operated whenever the sparker was working and on two additional tracks when the ship had to make full speed, thus providing 1,700 miles of traverse altogether. Over much of the area, magnetic anomalies are absent or gradients are low. Only in two restricted regions, one near the south west of Ireland and the other in Dungarvon Bay, were there any local anomalies of any magnitude. In these regions anomalies of several hundred gamma were observed.

(d) Crustal Experiment

All broadcasts from HMS Hecla were received and recorded so that shot instants were timed to GMT. The sonobuoys worked reasonably well and recorded ground arrivals observed on the direct paper records at ranges up

to 30 miles. Playback of the tape recordings with subsequent processing may increase the range. It is difficult to assess the experiment until the data from the shore stations is examined but reports from them at the time indicated that the results were exceptionally good. Communications and timetable worked out well and we were blessed with good weather. In addition to the main explosion experiment, the detailed survey work scheduled for RRS **JOHN MURRAY** was successfully completed and HMS HECLA was able to make more gravity traverses than were originally scheduled.

(e) Sea Water Sample collection

Samples were collected at the positions requested by MAFF to their specification.

Conclusions

The exceptionally calm weather throughout the cruise has allowed us to complete successfully all the work that had been planned. Only 10 hours were lost through bad weather during the cruise and only a further 10 hours were lost through instrument failure. Station time occupied more than 80 per cent of the time at sea. That things went so well is due very much to the efficient and skilful handling of the ship and the scientific equipment by Captain Higham, his officers and crew for whom I have the highest praise. It is also in no small measure due to the preparations made in Barry by R.V.U. and to Mr Knights who came to our help in Cork. I would like to thank all on board RRS John Murray, who have made it a pleasure and privilege to be on this cruise.

D.J. Blundell,
Department of Geology,
University of Birmingham.

Track chart attached.