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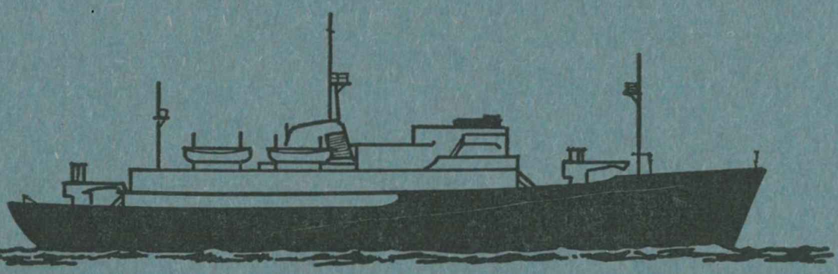

# R.R.S. DISCOVERY

## CRUISE 40

JUNE - JULY 1971

GEOLOGICAL EXPLORATION OF THE
MEDITERRANEAN RIDGE

N.I.O. CRUISE REPORT No. 48
(Issued May 1972)

# N. I. O. CRUISE REPORTS

| CRUISE No. and/or DATE | | REPORT No. |
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| | **R. R. S. "DISCOVERY"** | |
| 1 | International Indian Ocean Expedition | Published and distributed by the Royal Society |
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| 4 | February – March 1965 | 4 |
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| | **N. C. "MARCEL BAYARD"** | |
| | June, August, September | 44 |

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NATIONAL INSTITUTE OF OCEANOGRAPHY
Wormley, Godalming, Surrey

R. R. S. DISCOVERY

Cruise 40

June-July 1971

# GEOLOGICAL EXPLORATION OF THE MEDITERRANEAN RIDGE

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Scientific Staff

| | Southampton to Iraklion | Iraklion to Barry |
|---|---|---|
| Mr. T. Akal (SACLANT ASW Research Centre Italy) | - | x |
| Mr. R.H. Belderson | x | x |
| Dr. H.O. Berktay (Electrical Engineering Dept., Birmingham University) | - | x |
| Mr. S.V. Bicknell | x | - |
| Mr. F. Bilimoria | x | x |
| Mr. R.N. Bonner | x | x |
| Dr. R.M. Carson | x | - |
| Mr. R. Dobson | x | x |
| Mr. R.H. Edge | x | x |
| Dr. M.J. Fasham | x | - |
| Mr. P.G. Fearnhead | x | x |
| Mr. N.H. Kenyon | x | x |
| Mr. V.A. Lawford | x | - |
| Mr. C.D. Pelton | x | x |
| Mr. R.D. Peters | x | x |
| Mr. J. Revie | x | x |
| Dr. J.S.M. Rusby (Leader of Gloria team) | x | x |
| Mr. M.L. Somers | x | x |
| Dr. A.H. Stride (Principal Scientist) | x | x |
| Mr. A.R. Stubbs | x | x |
| Mr. M.J. Tucker | - | x |
| Mr. S.K. Willis | - | x |
| Mr. P.G. Woods | x | x |
| Totals | 19 | 19 |

Dates

| | | |
|---|---|---|
| Saturday 19th June | - | Depart Southampton |
| Thursday 8th July | - | Arrive Iraklion, Crete |
| Saturday 10th July | - | Depart Iraklion |
| Monday 26th July | - | Arrive Barry |

Equipment Used

Gloria, Side-scan Asdic, Echo-sounder Mark III, Velocimeter.

Scientific Projects

1. Sea Trials of GLORIA

Some modification to the system used in 1970, were tried on this cruise, both on the hydrodynamic and acoustic sides. These are briefly discussed below.

(a) Towing System (Dr. J. S. M. Rusby)

On the hydrodynamic side it had been found in 1970 that the pellet float system above the main float, which acts effectively as a flexible spar, was subject to considerable horizontal oscillations, no doubt produced by the ship's wake. This year we did away with these small floats and relied on the dynamic equilibrium of the main float, when under tow, to ensure a constant depth. Since this equilibrium is lost when the ship stops we added an emergency system which automatically inflated a flexible spar if the float depth exceeds about 115 feet. Static equilibrium is maintained by the spar.

Towing trials of the modified system were carried out at speeds between 3 and 7 knots. Towing loads and the attitude and depth of the float were measured and it was found that the system was in dynamic equilibrium over this speed range. The system gave excellent decoupling against the ship's heave, so that live loading between the float and vehicle was negligible. Float depths varied from 85 feet at about 3 knots to 45 feet at 7 knots, with the float trim employed. The float also gave good decoupling so that the vehicle's yaw was usually less than $\pm \frac{1}{2}°$ over the pulse period. This allowed the $\frac{1}{2}°$ resolution of the new towed hydrophone to be used. The flexible spar, in the form of a hose, close packed on top of the float, was 'fired' by the dinghy while Discovery was moving at a speed of 2 knots so as to simulate deployment in an emergency. It streamed well,with low frequency oscillations of small amplitude,and also gave the required static equilibrium.

(b) Acoustic Experiments (Mr. M. Somers)

Two pieces of equipment were available on this cruise in addition to the normal GLORIA acoustic equipment. These were (i) a linear correlator, kindly lent by A. R. L. and (ii) a line receiving hydrophone constructed at N. I. O. The linear correlator with its associated electronics generates a long pulse with a linear frequency sweep, and in the receive mode it cross correlates the sonar returns with a replica of the outgoing pulse. The operation is similar to that performed by the

DELTIC correlator already installed, but with the crucial difference that it retains the amplitude of the returns. A few minor modifications to both the GLORIA receiver and the linear correlator equipment were necessary to make them compatible, and fortunately the pulse generated by this equipment was suitable for the DELTIC. It was possible to compare both systems of correlation with each other and with the conventional short pulse transmission. In addition,the linear correlator had an A. G. C. facility, as well as the T. V. G. imposed on all signals.

The line receiving hydrophone consisted of 120 barium titanate spheres occupying a 60 foot active length of paraffin-filled polythene hose. The active length was divided into two 30 foot lengths each provided with a pre-amplifier. The signals could be selected individually or added together at the ship and coupled to either the existing GLORIA receiver or to the linear correlator receiver for use with the FM pulses. Thus, the comparison outlined in the previous paragraph could also be made on the line array.

The results are recorded on about 30 miles of magnetic tape covering about 270 hours of recording. Arrangements are in hand to replay certain portions of record so as to make detailed qualitative comparisons for either the same ground or very similar ground of (a) Short pulse versus both linear correlator and DELTIC; (b) Line hydrophone versus vehicle array on both short pulse and FM transmissions; (c) A. G. C. versus fixed gain settings of linear correlator receiver. Full conclusions regarding the acoustic results of the cruise cannot be drawn before these replayed records have been carefully studied. However it is possible to make one or two preliminary statements. First, the advantages of working with the very high signal to noise ratios of the linear correlator are so obvious that virtually the whole survey was done with FM tranmissions. Second, the lack of directivity in the vertical plane of the line hydrophone array resulted in much stronger bottom echoes, three of which were frequently visible. The greater horizontal angular resolution did not result in a very obviously different record and further study of replayed records will be required. Finally, the major surprise of the cruise was the success of the A. G. C. facility available on the linear correlator. Under certain circumstances A. G. C. could produce a distinct improvement on fixed gain, but under other conditions A. G. C. can disguise the fact that bad recordings are being made. It is hoped to report more fully on the acoustic results at a later date.

## 2. Geological Observations In the Eastern Mediterranean

### (a) GLORIA Survey

GLORIA was put out and recovered in quiet waters, generally in the vicinity of a good lee, should one be required. Conditions near the mid-south coast of Crete varied from impossible to good, even within a few miles, so that an acceptable site could take some time to find. The sonographs obtained were best when wind and sea were minimal and worst when there was a beam sea. Bad conditions were not experienced but would probably lead to rather valueless records. GLORIA was towed for about 1,500 miles, which for a range of about 7 nautical miles, gives a total coverage of about 11,000 nautical miles. Much of this was on the Mediterranean Ridge, with some coverage on the abyssal hills near to the Nile delta and on the continental slope south-east of Italy and Sicily.

### (b) Narrow Beam Echo-sounder Profiles

The side-scan asdic equipment was used as a narrow beam sounder ($11° \times 2\frac{1}{2}°$) in order to obtain detail about the sea floor relief, particularly of the Mediterranean Ridge. The equipment was able to provide a far truer profile of the relief than could be obtained by means of a more conventional echo-sounder (even Mk III with a conical beam of only 15°) as parabolic echoes were eliminated. The profiles obtained were invaluable on their own account, as well as for interpreting the GLORIA records, because the relief was sufficiently realistic to be interpretable in terms of known types of geological structures.

### (c) The Mediterranean Ridge

GLORIA has provided a mass of unique data about the relief of the Mediterranean Ridge and neighbouring ground, that will help to indicate its mode of deformation by compression between Eurasia and Africa. It is apparent that there are one or more sets of linear or curvilinear features on much of the ridge, but their spacing shows considerable variation, and while some features lie parallel with the ridge axis there are others which even lie at right angles to it.

## 3. Side-scan Asdic Survey

In addition to the side-scan asic survey carried out on shallow floors around Crete, the equipment was also used while on passage through the Sicilian Channel (especially for Mr. Akal) and on the shoals lying west of it. Further attention was also paid to the continental slope near Algiers and in the Gulf of Cadiz in order to complete previous studies. Opportunity was also taken to fill substantial gaps in our coverage of the continental shelf of western Europe. Data recorded on tapes was used to obtain higher quality sonographs.

4. An Investigation into the Effects of the Variation of the Source-level in a Deep Water Echo-sounder (Dr. O. Berktay)

The object was to assess, albeit subjectively, the effects of a reduction in the source-level on the performance of the Precision Echo-sounder Mark III. In this way, it was hoped to get a "feel" as to the source-level requirements for a narrow-beam echo-sounder, the development of which is being considered. By including attenuator pads in the path of the transmitted signals, the source-level could be varied by -2.9 dB, -7.4 dB, -9.0 dB or by -12.5 dB. (These values were determined by monitoring the signal voltages at the input to the transducer cable.) These attenuations also affected the strength of the received signals, but this variation could be removed by altering the attenuator setting in the P. E. S. receiver. Recordings were obtained at the various values of the source-level at a depth of about 2,600 fathoms in the Bay of Biscay, for ship speeds of 10 and 13.5 knots. After a preliminary study of the results it was apparent that a narrow-beam echo-sounder (capable of much higher ranges, use on steep slopes and for varying reflectivities) must have an effective source-level within a few dBs of that of the present P. E. S. Mark III to be fully satisfactory.

5. Electrical Interference on R. R. S. Discovery (Mr. M. J. Tucker)

Interference picked up in electronic equipment on the ship, has spoilt the quality of certain scientific records. The most damaging interference was produced by radio transmissions, but there was also some which appeared to come from the A. C. mains.

On the bridge deck the newer bulkheads are made of melamine-faced chipboard, so that there is no screening between the radio transmitter with its aerial feeders and the equipment in the adjacent plotting office. It was mostly (though not entirely) equipment with repeaters on the bridge deck which suffered from this interference. Thus, the first step in reducing the radio interference is to screen the radio cabin. A possible way of doing this would be to replace the present bulkheads by aluminium-faced plywood. This may not entirely cure the trouble, but should result in a great improvement.

The source of the other interference was more difficult to locate. From the patterns it produces on the sonars it seemed to be tied to the phase of the A. C. supply. Examination of the A. C. showed that there were pulses of about the right sort of frequency on the wave-form at a level of a few millivolts, and they were particularly visible between neutral and earth. They were presumably produced by the commutator on either the exciter or the drive motor of the alternator. However, the large capacitor fitted between the phase points and neutral appeared to reduce the high-frequency pulses between these wires without reducing the interference on the sonars. Investigation showed that the neutral of the alternators was earthed inside the machine (which is most undesirable but presumably would be difficult to undo). Fortuitous earths on the neutral line at other points could produce large circulating earth currents which could be the main cause of interference in the sonars. The system should be checked for such earths at the next opportunity.

6. A Sound-velocity Profile North of Cornwall (Mr. P. G. Fearnhead)

Poor side-scan sonar conditions in the Celtic Sea on 25 July 1971 were investigated near the Cornish coast (Discovery Station 7721) by means of a Plessey Velocimeter, while the ship was on station. A strong density gradient was indicated at depths between 20 and 40 m (Figure 1), which must have been due to the summer thermocline. The corresponding ray diagram (Figure 2), obtained by using a standard NIO computer programme, indicated quite clearly why it was so difficult to obtain distant echoes with the side-scan sonar. The associated pattern of wavy bands, occuring on the sonographs, was investigated by leaving the velocimeter at a depth of 30 m for three quarters of an hour, and taking readings every 20 seconds. The observed variation in sound velocity with time (Figure 3) is attributed to motion of the thermocline, resulting from the presence of internal waves. Those of low amplitude appear to have a period of about 3 minutes, while the longer ones may have a period of about 28 minutes, so far as can be told from so short a record.

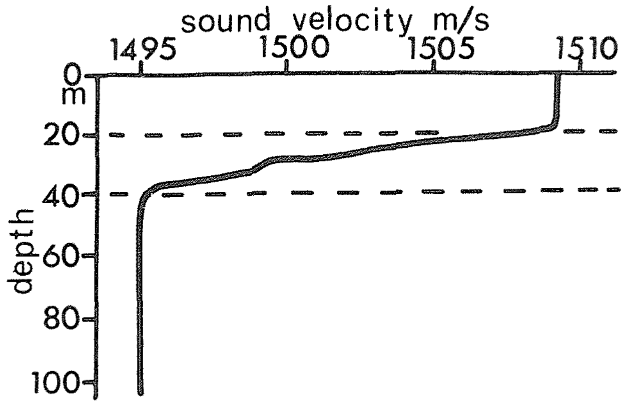


Fig.1

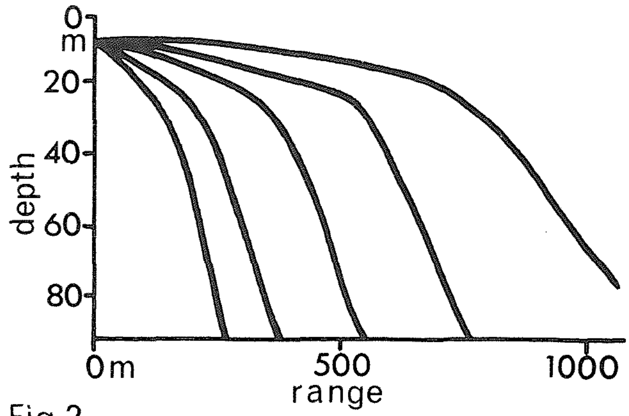


Fig.2

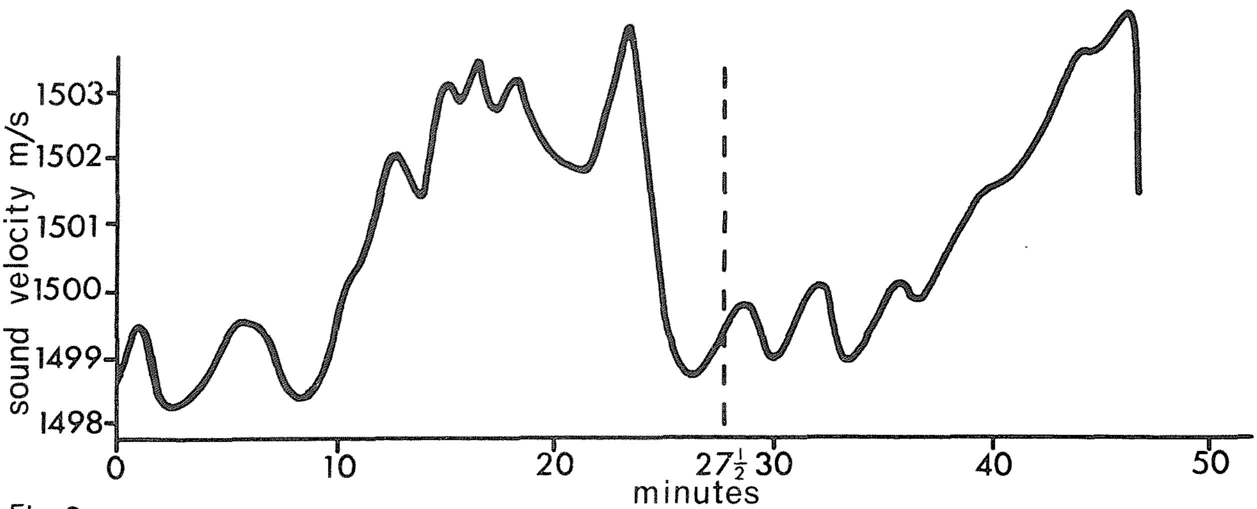


Fig.3

Fig. 1. A sound velocity profile at Discovery Station 7721.

Fig. 2. A ray diagram for Discovery Station 7721, assuming a stationary thermocline.

Fig. 3. Variation of sound velocity with time at a depth of 30m for Discovery Station 7721.

Discovery Station List

| Station Number | Latitude | Longitude | Date | Gear Used |
|---|---|---|---|---|
| 7720 | 35° 13.5' N | 20° 28' E | 27.6.71 | Velocimeter |
| 7721 | 50° 19.6' N<br>to<br>50° 19.0' N | 06° 06.7' W<br>to<br>06° 06.5' W | 1000<br>to<br>1137<br>25.7.71 | Velocimeter |