FILE

I.O.S.

R.R.S. DISCOVERY
CRUISE 55

SEPTEMBER – OCTOBER 1973

GEOLOGICAL RECONNAISSANCE WITH GLORIA AND AIR-GUN IN THE EASTERN MEDITERRANEAN

CRUISE REPORT NO. 5

1974

NATURAL ENVIRONMENT RESEARCH COUNCIL

INSTITUTE OF
OCEANOGRAPHIC
SCIENCES

INSTITUTE OF OCEANOGRAPHIC SCIENCES

R. R. S. DISCOVERY

CRUISE 55

September-October 1973

Geological reconnaissance with GLORIA and air-gun in the eastern Mediterranean

I. O. S. Cruise Report No. 5

(Issued 1974)

CONTENTS

SCIENTIFIC STAFF

	Barry to Cyprus	Cyprus to Southampton
Mr A. G. Andrews	x	x
Mr B. J. Barrow	x	-
Mr R. H. Belderson	x	x
Mr J. R. Berry	-	x
Mr S. V. Bicknell	-	x
Mr F. Bilimoria	x	-
Mr R. N. Bonner	x	x
Dr S. E. Calvert	-	x
Mr R. Dobson	x	x
Mr R. H. Edge	x	-
Mr C. G. Flewellen	x	x
Mr P. G. Fearnhead	x	x
Mr N. H. Kenyon	x	x
Mr D. Morley	-	x
Mr R. J. Morris	x	-
Mr C. D. Pelton	x	x
Mr R. D. Peters	x	x
Mr J. Revie	x	x
Mr M. L. Somers	x	x
Dr A. H. Stride (Principal Scientist)	x	x
Mr S. K. Willis	x	x

NARRATIVE

The ship sailed from Barry on 8th September, a day later than planned, owing to a last minute failure of the after crane. A further day's survey time in the Mediterranean was lost because one engine failed on the outward passage, so increasing journey time.

The GLORIA fish was launched in the open sea south-west of Crete and towed for eight days with good results. Fair weather allowed its recovery to be made in the open sea south of Cyprus.

A two day call was made at Famagusta, from 27th to 29th September. This allowed the ship's third engine to be put into service again and repairs to be made to the cooling system of the GLORIA amplifier.

The GLORIA fish was then launched in the open sea west of Greece and towed for a further eight days to good advantage, being recovered near the toe of Italy, where we had retreated in case a lee was required from troublesome wind and swell.

Good use was made of the air gun, both while the side-scan sonar was in use and also while the ship was on homeward passage through the Gulf of Cadiz. The vessel docked at Southampton on 19th October.

EQUIPMENT USED

GLORIA, P. E. S. (Mk IV), Velocimeter, Neuston Net, Wide Bore Corer, Air-Gun.

EQUIPMENT PERFORMANCE

1. GLORIA (M. L. S.)

(a) The Equipment

Towing Arrangement - The GLORIA equipment used on Cruise 55 was substantially the equipment taken to sea in 1970 and 1971, and differed in only one minor respect from that used on Cruise 54.

The array of acoustic elements is housed in the main vehicle together with a large number of services. This vehicle, which flooded and submerged weighs approximately 3.5 tons, is suspended by its armoured and faired towing cable about 300 feet below a hard streamlined float of almost exactly the same buoyancy. The float is towed from the ship by means of an auxiliary rope from which the main cable is loosely suspended at intervals of a few feet. The whole system is designed so that the float is towed submerged at a depth of about 30 feet and the tow rope makes an angle of about 25° with the horizontal. This not only decouples the vehicle from movements of the ship's stern but places the float out of the major influence of surface waves. The result is an easy towing system which places very little shock-loading on the cable or vehicle. The main disadvantage of this system is the time and effort involved in deploying it, but with practice and a certain amount of streamlining this has been steadily reduced. Another disadvantage is that the system relies for its stability on hydrodynamic forces, so that if the ship stops the float will sink to the full scope of the towing rope, a condition which cannot be allowed. On the other hand if the float had excess buoyancy it would be impossible to sink it in the first place. In 1970 a solution was sought with a string of pellet floats towed behind the main float, but these proved to be too delicate for satisfactory operation. In 1971 and on Cruise 54 the pellet floats were replaced by a hose that was stowed in a box atop the float. An air bottle and depth trigger were provided to inflate the hose at a pre-determined depth. The equipment differed on the present cruise in that the emergency system was discarded, with a consequent improvement in the streamlining of the float. That this could be done successfully was due to two reasons, first on sinking from the surface the vehicle ends up containing sufficient air to produce a buoyancy of about 400 lbs, which leaves the float comfortably on the surface. Thus, the vehicle can be sunk with the ship stopped and the float can then be submerged with the ship under way, so that the hydrodynamic forces take over smoothly from the hydrostatic ones. The second reason is that the hydrostatic balance is quite close, so that if the ship stops, only a very small part of the vehicle's reserve of compressed air is required to bring the float to the surface, so that this procedure can be carried out several times, while still leaving sufficient compressed air to bring the vehicle to the surface at the end of each leg. There is a central tube in the float which can either be flooded or sealed, and on this cruise it was for the first time flooded. This, together with some extra weights added to the tail section of the vehicle to improve the trim, gave the system a just about perfect balance. Accordingly all the weights that were used have been marked up so that the same result can be achieved again, if necessary.

Launch and Recovery - The amount of work the swimmers have to do in the water has been steadily reduced, with a consequent increase in the speed of the whole operation. However, with the present system this work would seem to have reached the irreducible minimum, so that with everybody knowing his job and no major snags occurring the launch and recovery times were each just over two hours. The first launch went without a hitch starting at 0830, and the sonar was operating before 1100. After 8 days towing the recovery was started at 0815. A failure on the main cable winch caused a delay of one hour, and the workboat engine blew a gasket so that the ship's lifeboat had to be launched in support. In spite of these setbacks the recovery was complete by 1130.

On the second leg the launch was very smooth, being completed by 1045. Again the lifeboat was in support, as the large outboard motor had been stolen at Famagusta. Recovery on the second leg was attended by an unforeseen snag. The ship was actually stopped as the vehicle surfaced and instead of lying horizontally in the water the vehicle ended up vertical with the tail shroud about a foot clear of the water and it proved surprisingly difficult to dislodge it from this orientation. The solution eventually found was to tow the whole system at 1.5 knots while the motor lifeboat pulled astern on a line attached to the tail and the painter attached to the nose was hauled in on the capstan. Once the vehicle was horizontal again the recovery proceeded smoothly, and indeed the total time was only just over two hours.

The crew were brought into the operations as much as possible, a seaman being made coxswain of the boat and another being put on the stern platform. It was found convenient to have one man acting as attendant to the workboat, and another as a communications number. Also the trawl winch was controlled by voice, via the netman, so freeing the main cable winch driver from any fear of ambiguity.

At the end of Leg 2 the weather got up to a steady Force 6 rising to nearly Force 7 for short periods. This blow lasted for some 30 hours immediately preceding recovery and for most of the time the weather was ahead or fine on the bow. The towing speed had to be reduced to 6 knots and at times it momentarily fell a further knot. The effect of this on the vehicle behaviour is mentioned later, suffice it to say that the towing equipment survived this, its toughest test to date, remarkably well. On recovery it was found that the nylon towing line was chafed in places to such an extent that it could not be used again, although it was by no means in a dangerous condition. One eye of the forward Kellems grip had parted, but this happened also on Leg 1. Six lengths of fairing were adrift, but this may be associated with the quarter mile or so of longline caught up in the tow. Three of the Norwegian floats had broken adrift. Otherwise there was no damage. The tension in the towing rope was monitored at half hour intervals. While towing in calm weather at 8 knots it would range from 5500 lbs to about 6000. During the blow, when speed was reduced, the tension would vary typically from 2500 lbs to 6500, but did at least once surge from 1000 lbs to 7000.

Vehicle Services - All the blowing and venting valves behaved faultlessly throughout the cruise. The rate of leakage from the compressed air system seems to be less than 10 pounds per square inch per week. When charging for the first launch some serious leaks were discovered in the cap seals of the two forward bottles. The O-rings, which had suffered severe chemical attack, were replaced. The cause of the attack has not been identified beyond doubt but it is believed to be due to a water repellent spray sealed into the O-ring crevice on the previous cruise. Possibly the repellent had not fully evaporated.

On submerging the vehicle to a depth of 300 feet, the cooler water causes the air pressure to drop according to Boyles law at approximately 10 pounds per square inch per °C, but it is interesting to note how long it takes for the temperature to fall. During the first leg the air pressure fell by 120 pounds altogether, taking 6 hours for the first 40 pounds, 16 pounds for the next 40 and three days for the final 40. Thereafter for the next 4 days the loss was less than 10 pounds.

The depth gauge, having been repaired and calibrated at Wormley, again gave trouble. It read consistently, but at about 70% of its proper sensitivity. Knowing this error, it proved to be no great handicap.

The yaw gyro, which was the spare (the original having burnt out on cruise 54), worked without trouble but it appears to have a much higher drift rate than the old one. It also had a higher yaw-synchro-excitation voltage. The pitch gyro output was as reliable as ever, but the roll output was missing due to a damaged potentiometer. This, as it happens, was a pity as will become clear when the vehicle behaviour is discussed.

The rudder system is a continual source of trouble. It is likely that the stresses induced by the passage of water past the enlarged rudder blade, as the vehicle comes to the surface stern first, are too great for certain parts of the system, notably the keying of the pair of bevel gears which transfer the horizontal drive to the vertical rudder stocks. Certainly during this cruise and the previous one the rudder system gave no trouble while submerged but each time on surfacing was found to have excessive play, and one or other of the bevel gears needed attention. On the latter leg of this cruise the servo system was modified to hold the rudders actively centralised while surfacing, but although the servo remained centralised the rudders were offset. If the present system is taken to sea again it will be necessary to modify the rudders.

The rotation of the array has again been perfectly satisfactory, but there is a certain amount of play. This does not apparently have any adverse effect on the records.

The water level gauges need a slight modification to be fully reliable. The sensing wire is in the form of a loop, the two ends of which are sealed into a camera plug. It is this seal which causes trouble by allowing the ingress of sea water which corrodes the copper sensing wire to breaking point. What is needed is a better means of making the seal without two wires entering the same camera plug sleeve. Apart from this the water level gauges were very satisfactory.

Sonar Equipment - The major difference in the array between Cruise 54 and all previous ones was in the use of the vertical shading switch. The reliability of the new cable and the new module has at last made it possible to use the shading switch. However, it has not been used quite as originally intended, but rather to switch between the situation where the whole array is equally excited and that where only the centre two rows are driven. This gives a vertical beam width of 30° instead of the 10° previously used. Operation of the switch was sometimes hesitant but always reliable. The results of this switching trial were necessary in the design of a possible replacement for the present vehicle. This aspect of the operations will be discussed in a later section.

The sonar beam steering which stabilises the received beam (in the horizontal plane) in the direction of pulse transmission, again worked faultlessly. This device is an essential part of the system in view of the behaviour of the steering system discussed below.

The Transducers - In past cruises it has been quite common for considerable numbers of transducers to blow fuses in the course of a cruise, and the cause of the trouble has frequently been voltage breakdown at the transducer plug.

On this cruise, during the first leg, amplifier trouble kept the power for the most part below 1 kilowatt, and only the two centre rows were in use. Only one transducer failed. The power density was approximately 15 watts output per element. On the second leg, when the power density was about 150 watts per element there were three additional failures and oddly enough two failures in the outer undriven rows. The main power amplifier is apt to trip out at odd intervals and it is not known whether it is the actual power density, or surges associated with the amplifier trip, which cause transducer failure, or more accurately plug and socket failure leading to a blown fuse.

The Power Amplifier - The Derritron 60 KVA amplifier has always been one of the weak links in the whole system and with the wisdom of hindsight it is not difficult to see the pitfalls. On the present cruise amplifier cooling has been the problem. On the first leg the 30,000 BTU Chrysler air conditioner, which cools the amplifier cabinet, failed when the compressor burnt out. The spare compressor was fitted but the filter had become choked with oil and no spare was available. Thus, for the want of a component costing a pound or two the whole amplifier system was immobilised. It is not a sufficient criticism to say that a spare should have been carried, though obviously it should, for it might just as easily have been the output transformer which failed, and this weighs three tons, so that even if a spare could be carried it could hardly be installed at sea. The real lesson is that spare systems must be available, and in any future design the power amplifier must be replaced by a modular system.

The Chrysler unit was repaired at Famagusta but amplifier cooling was still a problem and cooling arrangements in the compartment will have to be radically altered before any improvement can be expected. Ventilation and cooling are also required in the forward hold for the motor-alternator and hydro winch, and the ventilation of the AC generator room is scarcely adequate. As far as the amplifier compartment is concerned the Chrysler unit is working at a disadvantage in that the cooling air is drawn from the hot compartment and across the even hotter exhaust ducting which consists of 30 or more square feet of thin sheet metal. Normally the system is just able to cope because the compartment is cooled by two Norris Voyager water-cooled air conditioners, but on this cruise one of these broke down, and the amplifier temperature rose inexorably in spite of some asbestos lagging being applied to the Chrysler exhaust ducting. It is also suspected that the Chrysler unit is losing gas since the temperature differential it was able to maintain across the amplifier fell from 13°C at the start of leg 2, to 10°C at the end.

Fortunately these troubles had very little effect on the results, as a Savage 1 kw amplifier was available which produced results nearly as good as the main amplifier. It is only in low back-scattering regions where the extra power is necessary.

Signal Processing and Recording Equipment - In 1971 use was made of a linear correlator, processing linear frequency modulated pulses of large time-bandwidth product. The effect of this is, for a given peak transmitter power, to enhance the signal to noise ratio without prejudice to the range resolution. Alternatively, the transmitter power can be reduced without a reduction in signal to noise ratio. In 1971 only one linear processor was available and there was also a digital processor. The linear processor could either have fixed gain throughout or automatic gain control up to the processor input. For the cruises in 1973 the digital processor was discarded on the evidence of the 1971 trials, and, a second linear processor fortunately being available, it was included in the equipment set-up. So for Cruise 54 and 55 fixed and AGC processing channels were run in parallel, the output of both channels being tape-recorded, together with a reference signal and transmission pulse.

For quick-look presentation, as the survey proceeds, the Alden wet paper recorder was replaced by two Teledeltos recorders, one for each of the processors. Unfortunately the paper advance mechanism of one of these machines was intermittently faulty but not quite badly enough to demand immediate action. As it happens this did not matter as the high quality photographic system was in operation on board, producing prints from the tape-recordings. In this system the tapes are replayed at a speed-up ratio of 8 times on to a Muirhead photographic line picture receiver. This uses photographic paper and a focused light source, intensity modulated in sympathy with the signal, to produce high quality prints with good definition and wide dynamic range, but with a cross-range to down-range scale distortion in the region of 4 to 1. This scale distortion is then removed in a continuous flow anamorphic camera producing a negative on 35 mm film which is the main record for archival purposes. The film could be printed at any suitable scale for geological interpretation. Due to the speed-up in replaying the tapes, it was possible to produce scaled prints of one processing channel with a delay which never exceeded 24 hours after the data was obtained.

Modifications to the recording technique on Leg 2 reduced the failure rate on replay to the point where a trained man, available full time, would be able to produce AGC and fixed gain prints within the day.

Some auxiliary tapes of processor input data were also taken for laboratory experiment with digital correlators. These experiments as well as being interesting in their own right, have a significance in the choise of an eventual replacement for the present linear processors.

For the whole of Cruise 55 a two second 100 Hz pulse was used instead of the previous 4 second 100 Hz pulse. This made better use of the time available at a cost of 3 decibels effective signal.

Double Hydrophone Telesounder Arrangement - Two hydrophones were produced for this experiment, which it was hoped to conduct on Cruise 55. The hydrophones were line arrays of spheres mounted in rigid glass reinforced epoxy tubes that were filled with paraffin. The tubes were to be cantilevered from the top and bottom of a vertical strut attached to the vehicle tail shroud. The hydrophones thus consisted of two horizontal arrays 13 feet in length in line with the vehicle, and with a vertical separation of 12 feet. This arrangement constitutes an interferometer of about 18 orders of interference or vertical beams. Provided the roll angle is known and the beams can be identified, the depth of points remote from the ship may be measured. Such an experiment has been successfully carried out with other equipment in shallow water, where it has obvious hydrographic applications. The value of the experiment in deep water is less obvious, and on this cruise where the vehicle roll output from the gyro was missing the experiment could never have been more than a feasibility study. It might also be noted that it is, in deep water, necessary to know the sound velocity structure to a fair degree of accuracy.

For these reasons the experiment was considered to be of low priority and was not to be allowed to jeopardise the conventional results. Thus it was left to the last leg of Cruise 55 to make the attempt. However, the theft of the powerful dinghy motor at Famagusta made the rigging of the hydrophones a much more chancy affair, and when the hydrophones came to be wired it was found that the pre-amplifiers were not working. To put this right would have meant removing the vehicle tail and getting into the cable entry box, which so shortly before the launch could not be justified on the rather dubious value of the experiment. For these reasons the attempt was abandoned in favour of the surer course of conventional survey.

As it happens the violence with which the GLORIA vehicle surfaces (sufficient to damage the rudders) and the difficulty of righting the vehicle on the second leg recovery would, between them, have made damage to the vehicle tail almost a certainty.

(b) Results - 96 tapes were recorded lasting just about 4 hours each, a total on both legs of about 15 days recording. The records supplement those of Cruise 40 in 1971 and have certain aspects which require comment from the sonar point of view.

Wide Beam (Vertical) - The use of the wider beam undoubtedly provides a more even coverage of the ground, and this is very obvious with a fixed gain record, as comparison between the results of Cruises 40 (1971) and 55 will show. To a very large extent AGC will take out this shading with the narrow beam but since the fixed gain and AGC records have a different quality it is useful to have them both with even coverage. It is doubtful whether there is much advantage in making the vertical beam much wider than 20°, because refraction usually limits the useful vertical aperture to about this value.

A notable and objectionable feature of a large proportion of the records in 1971, as well as this year, is the occurrence of a second and sometimes a third bottom-echo. This feature is so inconvenient that it is worthwhile considering whether there is any way of removing it. Obviously if the vertical beam pattern could be so shaped that no sound was transmitted vertically downwards the problem would be solved. This problem is discussed later in this section. An attractive notion is to measure the bottom-echo, in delay and amplitude, and to inject an artificial second-bottom echo to cancel the real one, in much the same way as is done in seismic prospecting. This ought to be investigated but it must be said that conditions are very different in the two cases. In any case the question of multiple bottom echoes merits careful attention in any subsequent long range side-scan design.

There is no convincing evidence that the multiple bottom-echoes are worse with the wide beam than with the narrow one, though triple bottom-echoes could be said to be more common on Cruise 55 than on Cruise 40. This is consistent with the theoretical 10 dB advantage of the narrow beam component with the wide one for bottom-echoes. It seems that if there is any region of the bottom which presents a specular, even though rough, facet to the transducer this will have a very much higher target strength than mere back-scattering from however rough a surface. The bottom-echo impinges on such a large area of sea surface that this always gives rise to specular reflection, albeit with an obvious loss of coherence on each reflection. It is interesting that the roughness of the sea surface had no effect on the strength of the second bottom-echo. On the other hand bottom slope and roughness have a very profound effect, the second bottom-echo disappearing over steeply sloping ground or very rough floor. It seems that second bottom-echoes will always be a problem with long range side-scan sonar since the physical aperture required to suppress side lobes in an adequate manner is very much larger than that which controls the main beam. For instance, if instead of driving only the centre two rows of transducer elements we had driven the array with the original shading of 1:2:1 there would have been only a 6 dB improvement against bottom echoes at the expense of approximately halving the beam width, i. e. from 38° between half power points to 22°, while driving the whole array equally reduces the beam width to 16° for a further 4 dB gain against bottom-echoes. These figures serve to show that a very wide vertical aperture is required to exercise effective control of the side lobes in the direction of the bottom.

Roll and Yaw - The rudder system has a filter built in which eliminates any tendency to correct for long term fluctuations of heading, the cut-off period being about 2 minutes. Thus, the vehicle is at the mercy of varying current shear between the surface and its operating depth, except in so far as the heading is prevented from rapidly following an abrupt change of shear. There is a resultant long term yaw which was quite serious over the Mid-Atlantic Ridge on Cruise 54 but was less obvious in the Mediterranean. The result is that oblique targets on the record appear to have a stepped nature, though in individual cases the diagnosis is complicated by not knowing for certain that a particular target is not stepped. It would, for instance, be very odd if all targets showed up as straight lines.

For the two cruises of 1973 the vehicle was fitted with a larger pair of partially balanced rudder blades, which resulted in a much more sensitive response to helm. In fact it eventually appeared that the yaw was almost at the point of being over-compensated. This was not apparent on Cruise 54, where the long period current shear effects had a dominant effect on the records, but in the quieter Mediterranean waters the onset of instability could be seen much more clearly. The periods of instability were characterised by frequent large rudder movements and strong evidence on the records of rolling at a period of about 10 minutes, and appeared to be triggered off by the ship either pitching in a head sea or undulating about her course. When this instability occurred it was possible, by switching off the rudders, to get rid of the roll, at the expense of increased short term yaw. On the second leg the rudder response was adjusted to provide less correction and subsequently there was no evidence of roll, though yaw records show a slight increase in short-term yaw.

The second leg ended with a blow at a steady Force 6 for over 24 hours into which the ship had to drive, with resultant heavy pitching. Under these conditions the rudders, even at reduced sensitivity, had to be switched off.

Recorders and Processing - As has been mentioned already one of the Teledeltos recorders had a faulty paper advance mechanism but apart from this defect they were in every way satisfactory and a great improvement on the Alden wet paper recorder. Unfortunately, a supply of heat treated paper of low smudge characteristic was not delivered in time for the cruise.

The Muirhead recorder provided satisfactory replays, but in rough weather some trouble was experienced with the trays of developer and stabiliser chemicals. Nevertheless, by suspending the entire machine from the deckhead and restraining the feet with shock cord, this was for the most part overcome.

The difficulties anticipated with the anamorphic camera being influenced by the ship motion simply failed to materialise, so that the arrangements used on this and the previous cruise provided the Principal Scientist (at sea) with records the promptness and quality of which could only with difficulty be improved by subsequent processing on land.

2. Air-gun (C. G. F. and R. N. B.)

The hydrophone and an air-gun with a 40 cubic inch chamber were deployed mid-morning on the 19th September and recordings were started on tape as well as on the Mufax and (wideband) on the E. P. C. recorder.

For the first few days we were beset by hum pick-up and radio transmission interference problems. It was found that one of the supply leads to the hydrophone pre-amplifier had a leak to the sea and this was introducing hum on to the input of the pre-amplifier. It was therefore necessary to manhandle that hydrophone on to the boat-deck and stream the spare one. This produced a noticeable improvement and was retained for the rest of the cruise.

In the meantime a pre-amplifier was modified to provide a balanced input and this was used in the original hydrophone for the third and fourth runs. Prior to the third run all mains earths were removed from the electronics, bar one on the tape-recorder. Either or both of these changes made a remarkable improvement in signal cleanliness. It is worth noting that since Cruise 54, mains smoothing capacitors were mounted in the electronics laboratory and some twenty amps of mains harmonics were measured on the earth return, only a few feet from the main console.

The E. P. C. record was on average poor, due partly to hum and partly to the inexperience of the operators. Mechanically, the E. P. C. gave no trouble on the eight-second sweep but was a source of frustration on the one-second sweep during tape replays.

The Mufax, although switched on well in advance of the start of the first run, took several days to achieve the correct humidity. Just after the beginning of run three, one of the fork driving valves failed and the whole system collapsed for the lack of the 1 kHz drive. An external oscillator was used during repairs.

From the start a motor-drive signal from the E. P. C. was recorded in place of the 1 hour time-mark. A lash-up circuit was used to multiplex trigger pulses and time-marks on to the same channel, but overnight on the 21st September echo-sounder signals mysteriously appeared on the one hour time-mark line from the digital clock. The circuit was abandoned.

Just after the beginning of run 3 it was discovered that the accumulators powering the hydrophone were flat-down to 8 v from two 12 v batteries in series. The spare pair were also failing fast, so there followed several days of charging.

The Williams and James compressor was operated for a total of 321 hours out of the 384 hours of air-gun use. There were six breakdowns in this time, all of which were in the first leg of the cruise. All of the faults were due to two main factors, either excessive vibration or excessive oil being delivered through the system, due to worn compression rings on the third stage. The vibration problem was overcome by fitting clamps to vibrating pipework while the oil problem was cured by an overhaul of the 3rd stage, which included renewing the worn rings and replacing the small end bearings, and which took $1\frac{1}{2}$ days to complete. During the breakdowns, use was made of the smaller Reavell compressor which prevented any loss of record during repairs.

On the second leg the air-guns were fitted with a larger air chamber of 160 cu. ins. The increased air requirement meant that the compressor was working at full capacity and was maintaining a pressure of 1000 p. s. i. instead of 3000 p. s. i. as before. This considerably reduced vibration and stopped its need to frequently dump excess air. Some of the vibration problems encountered could have been avoided if the compressor had been mounted on a resilient base when it was installed. Also a drain pipe for dumped air and water needs to be fitted to take the waste down to the ship's bilges, instead of dumping it on the compressor compartment floor.

After the end of run 4, thirteen tapes were replayed at 15"/sec on to the E. P. C. with a one second sweep. The tape signal was filtered from 100 Hz to 500 Hz and then passed through a fractional power-law amplifier with a noise threshold. With noise just marking the paper it was possible to bring out more detail and yet avoid burning the paper with strong signals.

There were no major mishaps during the cruise and nearly 400 hrs of useful record were produced. The use of the 160 cubic inch gun and the non-linear amplifier are to be recommended for future cruises.

3. Wide bore corer (S. E. C. and R. J. M.)

Trials of a new 4-inch bore gravity corer, designed to sample fine-grained sediment, were conducted at 5 stations, 4 in the eastern basin of the Mediterranean and 1 in the Gulf of Cadiz. These were only partially successful due mainly to the improper seating of the upper and lower valves of the corer, but also because of insufficient total weight. After minor modification and further testing, the corer will be used for routine sediment sampling in all water depths.

4. Computer (J. R. B. and F. B.)

In general the system performed well, although there were a few problems.

Air Conditioning - After initial water circulating problems had been solved the system worked well, although there were occasional pressure falls which caused the AC units to cut out.

Digital Clock - On sailing the digital clock was found to be approximately 5 minutes fast; the reason was not apparent.

EM Logs - The port EM log, at 9 knots, was found to be 1 knot high and gave an average reading of about 0.3 knot to port; it had to be recalibrated. The starboard log was found to be unstable in the athwarts-ship component and the log was not accommodated in the computing set up. It has therefore been proposed that in future the computer be used as an Analog to Digital Interface between the log electronics and a set of digital indicators.

Plotter Programs - The Charp programme is so long winded as to be impracticable for handling more than one day's plot at a time: border plotting wastes time due to unnecessary movement; when chaining the program always needs plotting variables; the plot can write over "itself" when there are course changes; one is unable to chain between data files and the program places the pen at the far end of the plot when finished. The program, therefore, needs to sort through the plot period to determine and acquire files and data from the I/P period and to work out the required Latitude and Longitude scales to be plotted.

The plotter also failed to raise the pen on several occasions thereby ruining some plots, and also failed to return exactly to its baseline on some occasions. If charp was aborted then plots that were run afterwards often gave unusual results.

Gyros - The digital gyro hung up twice on this cruise, the fault lay either in the demand latch on board 8, or the two delay reset monostables on board 7. Board 6 has now been designed to replace board 6, 7 and 8 and notes are now available for the circuit which gives a ready back signal to CPU.

5. Meteorological Instruments (C. D. P.)

Daily maintenance of the ship's Meteorological Instruments was carried out throughout the cruise. The performance of the automatically logged instrument system was checked by daily comparison with the Meteorological Office system; this will facilitate the subsequent production of a data quality assessment.

GEOLOGICAL OBSERVATIONS

The main purpose of the cruise was geological, aimed at providing new data about the shape and origin of the Mediterranean Ridge. The air-gun provided profiles showing the structure underlying about 5600 km of track, while GLORIA provided plan-view coverage of more than 70,000 km^2 of floor, much of it eminently suitable for examination by such a method. Not only does the new data add substantially to that obtained in the eastern Mediterranean in 1971, but it also provides sonographs of substantially higher quality that facilitate their interpretation in geological terms. At the present time, however, it is only possible to draw some rather tentative geological conclusions.

It was unfortunate that narrow beam echo-sounder profiles of the Ridge could not be obtained in 1973, owing to loss of the equipment on the preceding cruise of that year.

1. Fine structure of the Mediterranean Ridge

Much new information has been obtained about the relief of the Mediterranean Ridge, together with some useful data about its internal structure. The main structural trend is clearly parallel with the Ridge axis but cross trends are well developed in some areas. It is now apparent that along the southern edge of the Ridge the structural trend can vary substantially so as to follow the edge of adjacent continental margin. Eastwards from Crete a well defined trend curves around gently so as to pass south of the island shoal of Cyprus, and probably dying out further east. West of Crete the structural trend of the Ridge continues up to a 'y' shaped junction, where it unites with a ridge extending along the northern side of the Messina abyssal plain, and lies parallel to the Calabrian arc of south-western Italy and Sicily. This newly discovered branch is called the Calabrian Ridge.

2. Deformation of Nile cone sediments

Valuable new data has been obtained about the surface relief and internal structure of the Nile cone; the tensional origin of these is in marked contrast with the origin of the Mediterranean Ridge. This new information provides little support for the north-westerly trending ridges shown on some bathymetric charts of the cone.

3. Seamounts near the Messina abyssal plain

Search was made for a line of small seamounts shown on bathymetric charts as extending eastwards from the Messina abyssal plain on to the southern flank of the Mediterranean Ridge. No trace of them was found, in spite of considerable GLORIA coverage in the vicinity. It is, therefore, tentatively concluded that the earlier suggestion of their existence must have been based on poor soundings.

The large magnetic seamounts extending eastwards from the Malta escarpment were found to have a very different style of relief from that of the young volcanoes of the Tyrrhenian Sea, examined by means of GLORIA in 1970.

4. Gulf of Cadiz

Opportunity was taken on the homeward journey to obtain new information about the internal structure of the large mud bodies that are such a feature of the Gulf of Cadiz.

ORGANIC CHEMISTRY (R. J. M.)

Samples of the organic film on the sea surface, together with samples of the sub-surface emulsions and near-surface zooplankton were taken at various stations in the eastern Mediterranean. It is hoped that the results of analyses of these samples will give some indication of:-

1) the amount and composition of organics at the sea surface in the eastern Mediterranean, and hence the possible effects on air/sea interactions,

2) the ratio of natural-product-organics to pollutant-organics in the surface layers,

3) the extent to which pollutant-organics are being taken up and stored by upper-water plankton.

STATION LIST FOR DISCOVERY CRUISE 55

Station	Date	Latitude N	Longitude E	Gear used
8444	18. 9. 73	35°18. 1'	22°04. 9'	Surface film
8445	19. 9. 73	33°07. 8'	22°56. 4'	Neuston Net
8446	20. 9. 73	32°58. 8'	25°51. 9'	Neuston Net
8447	20. 9. 73	33°11. 0'	27°11. 0'	Neuston Net
8448	21. 9. 73	33°05. 0'	29°00. 0'	Neuston Net
8449	21. 9. 73	32°34. 9'	30°31. 2'	Neuston Net
8450	23. 9. 73	33°26. 8'	31°15. 2'	Neuston Net
8451	24. 9. 73	35°43. 9'	31°45. 0'	Neuston Net
8452	25. 9. 73	34°36. 6'	31°44. 1'	Neuston Net
8453	26. 9. 73	34°26. 0'	33°10. 0'	Surface film
8454	26. 9. 73	34°05. 0'	33°35. 0'	Wide Bore Corer
8455	29. 9. 73	34°35. 5'	33°18. 0'	Wide Bore Corer
8456	1. 10. 73	34°48. 2'	23°29. 0'	Wide Bore Corer
8457	1. 10. 73	36°00. 0'	22°08. 9'	Wide Bore Corer
8458	10. 10. 73	36°56. 4'	15°41. 2'	Velocimeter
		N	W	
8459	15. 10. 73	35°53. 0'	07°28. 0'	Wide Bore Corer

Discovery Cruise 55