ANNEX IV

THE ROYAL SOCIETY

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1. R.R.S. DISCOVERY AND H.M.S. OWEN. Indian Ocean, August December 1963 by Dr. M.N. Hill, Department of Geodesy and Geophysics. Cambridge.

On 23 August R.R.S. DISCOVERY (owned by the National Institute of Oceanography) sailed from Aden on the second stage of the work she is undertaking as part of the International Indian Ocean Expedition. (A brief report of the first stage, the first biological cruise, will appear shortly.)

This part of the work, which will be completed in early December, will be largely concerned with the geology and geophysics of the Ocean floor in the Arabian Sea. Ten scientists from the Department of Geodesy and Geophysics, Cambridge University and eight scientists from the National Institute of Oceanography will be taking part. The Principal Scientist will be Dr. M.N. Hill, F.R.S., from Cambridge.

The solution of several problems will be sought. These problems have been set by the reconnaissance surveys which have been possible thanks to the assistance given by the Hydrographer of the Navy in providing H.M.S. OWEN (Commander G.P.D. Hall, R.N., and subsequently Commander D.W. Haslam) during two seasons' work in the area.

(a) General

The main purpose of the expedition will be to obtain more evidence as to movements, during geological time, of the floor of the ocean and of continental blocks over this floor. Until recently it was generally accepted, although it was realized that considerable vertical movements of the crustal rocks of the Earth had occurred, that the rocks forming the crust of the Earth did not move far laterally. Now, more and more evidence is being collected showing that, in fact, there have been great sideways shifts within the sea floor itself and of continental masses across the sea floor. In the Arabian Sea there is a great opportunity of finding out more about these movements; indeed there is nowhere else where there is greater opportunity since such a wide variety of processes seem to have been operating in the area.

(b) The Carlsberg Ridge

This mountain ridge which is one of the most conspicuous features of the floor of the Arabian Sea is part of a world-wide system of mid-ocean ridges and is joined with the mid-Atlantic ridge round the south of Africa. It also joins with a ridge extending to the south and east to encircle Australia. Near its crest this ridge sticks up some 10,000ft above the sea floor on either side, but nowhere does it come closer than 2,000 to 3,000 ft from the surface of the sea. It is

usual to find in the centre of the ridge (and indeed other ridges) a medium valley; this valley which is usually about ten miles wide has steep slopes and in places its floor lies as much as 10,000 ft below the peaks on the sides. It is also usual to find the Earth's magnetic field in the vicinity of the valley is highly disturbed and that the flow of heat from the inside of the Earth is higher through the floor of the valley than is usual elsewhere in the oceans.

What forms these mid-ocean ridges, how old are they and why do they parallel the continental boundaries in so many parts of the world? How is it that at the northern end, the Carlsberg Ridge at first sight appears to disappear in Arabia?

These are some of the problems about which DISCOVERY hopes to gain information while working in the Carlsberg Ridge. Already we have many clues from OWEN's work. For example, it has been shown that big forces have dislocated the ridge near its northern end with horizontal displacements as much as a few hundred miles; there are strong suggestions that, towards the north, the ridge bends sharply to the west and passes into the Gulf of Aden and perhaps thence up the axis of the Red Sea. To date, however, we have not sampled the rocks of this part of the ridge although we believe that we shall find they are basalts and that the rugged relief of the ridge is largely caused by volcanoes and lava flows. We have to obtain an adequate collection of samples for petrological study and for age determination; we must also photograph the sea floor to find the distribution of the rock outcrops. Information will be obtained about the distribution of heat flow coming from the interior of the Earth at a number of points from the median valley outwards.

All this information could assist with confirming or otherwise the intriguing current, but somewhat speculative hypothesis that the mid-ocean ridges are lines along which rocks from deep down in the Earth flow towards the surface. Thence, sweeping all before them slowly move (say at a speed of 1 cm/yr) across the ocean basins to the continental boundaries where they sink again deep into the Earth.

(c) The Continental Borderland of Kenya and Tanganyika

Geologists, aided by information obtained from the oil companies, have long known that there is a great thickness (tens of thousands of feet) of sedimentary formation at the shoreline of East Africa. It now appears from the results obtained by OWEN during the past two years that this thick layer may be the result of the downwarping of the continental boundary during geological time. Indeed, it may be that the original continental boundary was originally several hundred miles seaward of where it is now. It is hoped that the joint work of DISCOVERY and OWEN using the seismic method of exploration (which involves firing chemical explosives in the sea and recording, at a distance, the waves from these explosions which have travelled through the sea floor) will be able to find more evidence as to whether or not this strip of ocean, which extends about half-way to the Seychelles, consists of foundered continental rocks. OWEN will be using 100 depth charges for this joint operation, and DISCOVERY will use 10 tons of explosive for single-ship and shorter range seismic operations.

Combined with this work, there will be coring of the soft sediments of the relatively smooth area between the Seychelles and the mainland, bottom photography, heat flow measurements and dredging of rocks from seamounts sticking up through the soft sedimentary cover.

(d) The Seychelles Bank

The rocks - to a large extent granite - outcropping on the Seychelles are unlike those found on ordinary oceanic islands; this characteristic has long been recognized and it has been suggested that these rocks, which are commonplace on land, perhaps represent a fragment of a continental block which at some geological time drifted through the western Indian Ocean. Dating of these granites by Dr. J.A. Miller and others at Cambridge shows them to be Pre-Cambrian. This is geologically very aged; about 500 million years have elapsed since they were emplaced whereas they had previously been supposed to be less than 100 million years old. This result is intriguing since no oceanic rocks as old as this have ever been found; again it suggests that in this region of the Indian Ocean processes which can be highly instructive about the past history of the Earth can be studied.

The Seychelles Bank is also of interest from the point of view of recent calcareous sedimentation taking place on it and samples will be collected to be studied by Professor J.H. Taylor of King's College, London.

(e) Manganese and Phosphoritic Nodules

During the expedition efforts will be made to find, by photography and dredging, the distribution of manganese and phosphoritic nodules which are likely to form on the sea floor in this area of the ocean. If present in abundance these nodules could have an important commercial value; the minerals in them contain elements of considerable rarity in this part of the world. Professor J.S. Webb of Imperial College will be studying the results obtained from this preliminary survey.

(f) The scientific work will be the joint responsibility of the National Institute of Oceanography and of the Department of Geodesy and Geophysics, Cambridge. This co-operation would be impossible if it were not for the magnificent facilities provided by the National Institute of Oceanography and the Hydrographer of the Navy in the two ships, DISCOVERY and OWEN.

2. GEOPHYSICAL RECONNAISSANCE IN THE ARABIAN SEA BY HM SHIPS OWEN AND DALRYMPLE
By D.H. Matthews, Department of Geodesy and Geophysics. Cambridge.

The reconnaissance survey carried out by HM ships OWEN and DALRYMPLE is complete. The tracks of the two ships are shown in the accompanying figure. Both ships have made continuous records of soundings - of magnetic field. OWEN has made continuous measurements of gravity as well. Coverage is 90% complete on the tracks shown. DALRYMPLE's work has been confined to the Murray Ridge area in the Gulf of Oman and to passages thence to Aden and Addu Atol. The remaining tracks are those of HMS OWEN.

Profiles of bathymetry, gravity and magnetic field strength obtained by HMS OWEN during the season 1961-1962 have been published as Admiralty Marine Sciences Publication Number 4 Pt. 2 (Profiles). Part 1 (Text) will be published during September. The profiles have a horizontal scale of 1:1,000,000. Copies may be obtained from the Department of Geodesy and Geophysics, Cambridge University. Bathymetric and magnetic profiles obtained by OWEN during the season 1962-1963 have been drawn. Photocopies can be obtained from Dr. D.H. Matthews, Cambridge. Photocopies of detailed bathymetric and magnetic surveys of two areas of the Carlsberg Ridge (scale 1:100,000) are also available. Results obtained by HMS DALRYMPLE on passage are being prepared in a comparable form at the Imperial College of Science and Technology (Mr. P. Barker).

Results of more detailed work by HMS OWEN in the vicinity of the Seychelles, Aldabra and Agalega Atolls have not yet been worked up.

Publications:

Matthews, D.H. A major fault scarp under the Arabian Sea displacing the Carlsberg Ridge near Socotra. Nature. 198 pp. 950-952. 1963.

Vine, F.J. and Matthews, D.H. Magnetic anomalies over oceanic ridges. Nature. (in proof).

3. N.W. INDIAN OCEAN BATHYMETRIC CHARTS. By Dr. A.S. Laughton, National Institute of Oceanography

The following contoured 1:1,000,000 charts of the bathymetry of the N.W. Indian Ocean have been produced and a limited number distributed.

131,158,159,188,189,219,220,249,250,251,279,280.

These charts have all been revised in August 1963 and supersede those previously circulated. They are based on the July 1963 issue of the Collected Sounding Sheets of the Hydrographic Department, Admiralty, which now include some cruises of R.V. ATLANTIS, VEMA, EASTWIND and VITYAS as well as the 1962-1963 cruises of HMS OWEN and HMS DALRYMPLE and other British ships.

A mosaic of a photographically reduced version of these charts is being prepared (1:3,500,000).

The chart of the Gulf of Aden very clearly shows the N.E. - S.W. faults first noticed by the John Murray expedition. The topography strongly suggests that the major fault is transcurrent with a N.E. displacement of the eastern side of about 70 miles.

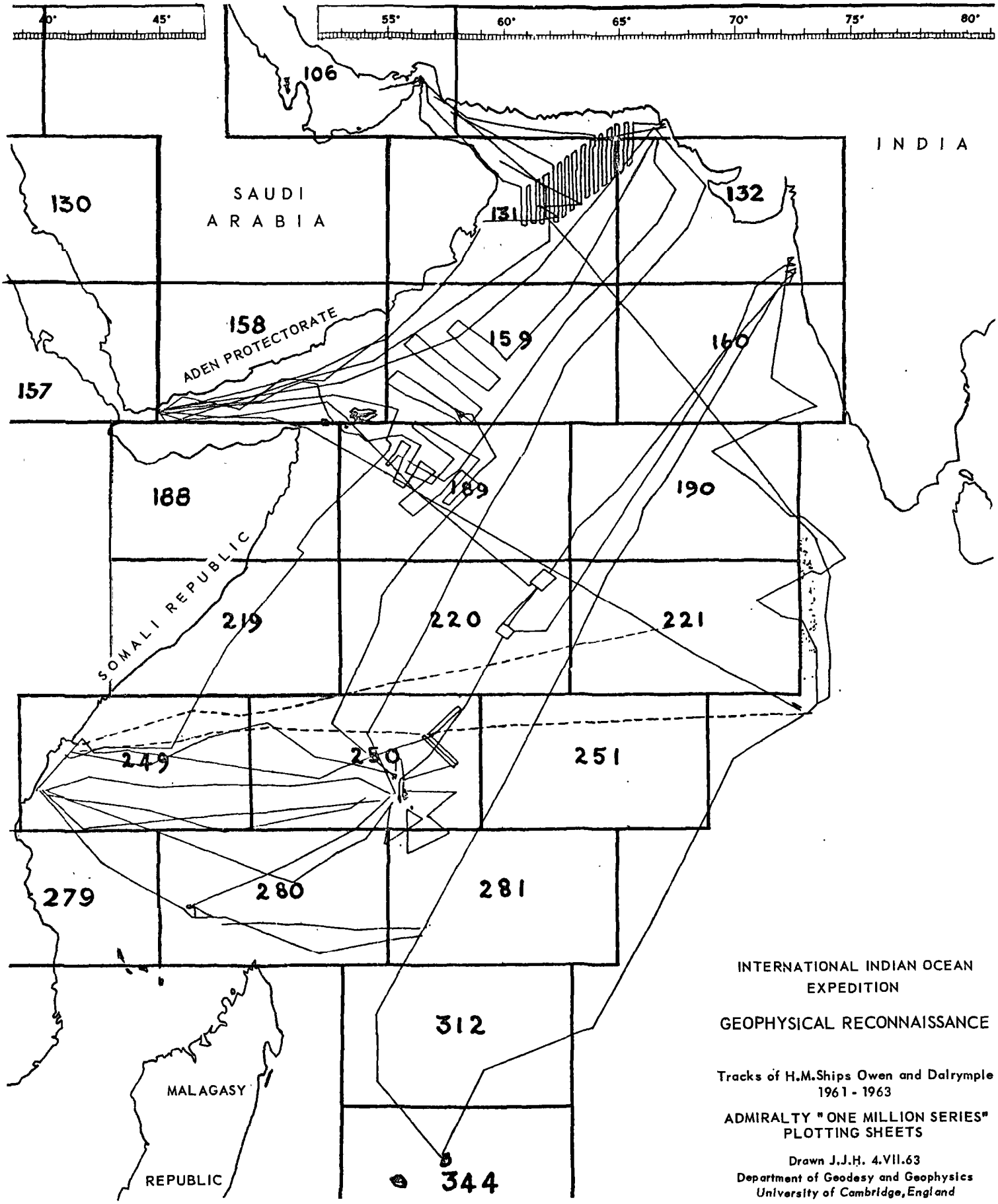
The Amirantes Trench is now shown to be at least 250 miles in length, some of it being filled with sediment and showing as a negative gravity anomaly.

The survey by HMS OWEN of the N.W. end of the Carlsberg Ridge has shown the continuation of the fault suggested by Matthews (Nature, 198 950-952, 1963) across the ridge dividing an essentially magnetic ridge from non-magnetic continental seamounts. The survey by HMS DALRYMPLE has shown how the John Murray Ridge connects with Matthews' fault.

Another feature of interest is the sounding of 3173 fathoms (corrected), in a small trench on the line of this fault. This is the deepest sounding yet obtained in the N.W. Indian Ocean.

The northeast flank of the Carlsberg Ridge appears to be bordered by a trough of considerable length.

Further copies of the 1:1,000,000 charts will not be available from N.I.O. until January 1964 since the master copies will be at sea. However, the copies of the reduced chart will be available.



INTERNATIONAL INDIAN OCEAN EXPEDITION

GEOPHYSICAL RECONNAISSANCE

Tracks of H.M.Ships Owen and Dalrymple
1961 - 1963

ADMIRALTY "ONE MILLION SERIES"
PLOTTING SHEETS

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