GEOPHYSICAL SURVEYS IN THE MEDITERRANEAN AND RED SEAS DURING THE PERIOD 1961-64

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The Saclant ASW Research Centre at La Spezia, Italy was commissioned in May 1959 and its Oceanography Group formed the following year. The group's programme included a project on Submarine Geophysics and it is the work carried out in this field which will be summarised here.

In April 1960 R/V « Aragonèse », a 293-feet freighter displacing 3000 tons, was chartered by the Centre and work started immediately in converting her into a research ship suitable for the Centre's requirements. Radar, gyrocompass, precision depth recorder and other essential instruments were installed initially. An electromagnetic log and Loran C receiver were fitted later.

The number of scientific personnel directly involved with the programme of geophysics was small and it was decided to increase the project's effectiveness by co-operating, as far as possible, with other research establishments. Contact was made with the Osservatorio Geofisico sperimentale, Trieste, and an agreement was reached on a joint programme of gravity, magnetic and bathymetric survey work. The gravity meter, a Graf-Askania, was bought by the Osservatorio and has been operated by its scientists during all of our cruises. The magnetic and depth measurements and the navigation have been the responsibility of the Centre.

In the period July 1961 to July 1964 ten cruises have been completed. Although most of the time has been spent on gravity and magnetic surveys of selected areas, some work has also been carried out on coring, measurements of heat flow and sub-bottom reflection profiling.

Work has been confined to the Mediterranean and Red Seas where a total of 50,000 miles of track has been made. Figure 1 shows the tracks in the Mediterranean and figure 2 in the Red Sea.

The gravity values have been mostly tabulated at 15-minute intervals. The accuracy of the free-air gravity values depends not only on the performance of the meter and stabilised platform but also on the accuracy of the Eötvos correction term which is calculated from the ship's speed and course. Poorly controlled navigation can therefore introduce errors in the free-air value. In this respect, the Mediterranean has presented fewer problems than those found in the Oceans. In the earlier cruises radar sights on numerous islands provided good control and, for most of the work, the probable error in position was $\pm$ 1/4 mile. For the later surveys, in areas remote from land, Loran C positions proved reliable to at least $\pm$ 1/2 mile.

The magnetometer used was the nuclear-spin model described by HILL (1) and manufactured by BRUCE Peebles Ltd. It has a sensitivity of $\pm$ 1/2 γ. Readings were taken every 30 seconds and recorded on punched paper tape for reduction on the Centre's computer. The greatest inaccuracy in the measurement of the absolute value of the field lay in the uncertain knowledge of the diurnal variation.

Depth was recorded on a precision depth recorder which can be read to $\pm$ 1 fathom. Corrections were made using the tables of MATTHEWS (2).

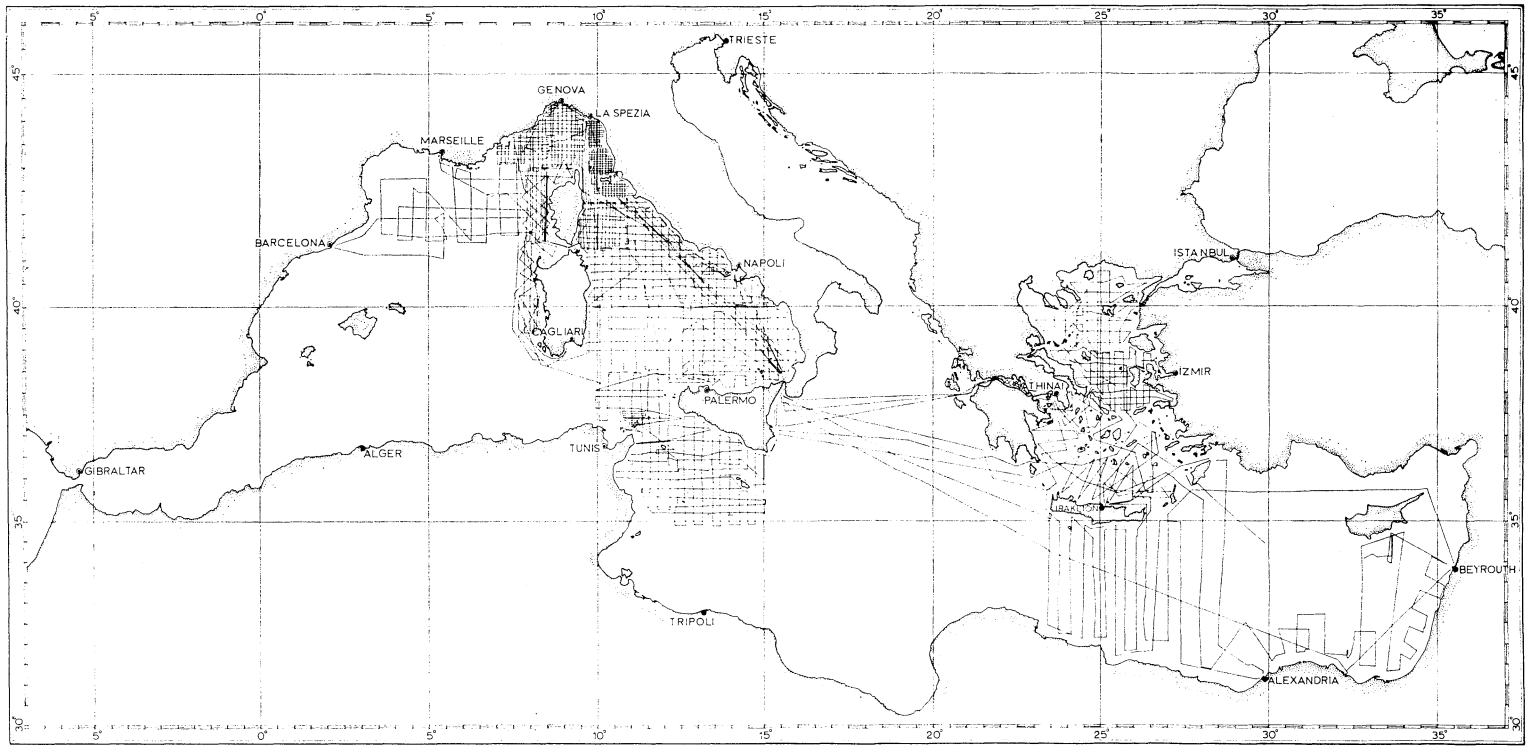

FIG. 1. — *Profiles over which gravity, magnetic field and depth have been measured in the Mediterranean.*

In cruise Cossack, the first of the project's cruises, a comparison was made between the LaCoste-Romberg and Graf-Askania gravity meters in three areas between La Spezia and Sicily where existing bottom gravity readings provided a valuable control. These tests involved the co-operation of the Osservatorio Geofisico sperimentale, the A and M College of Texas

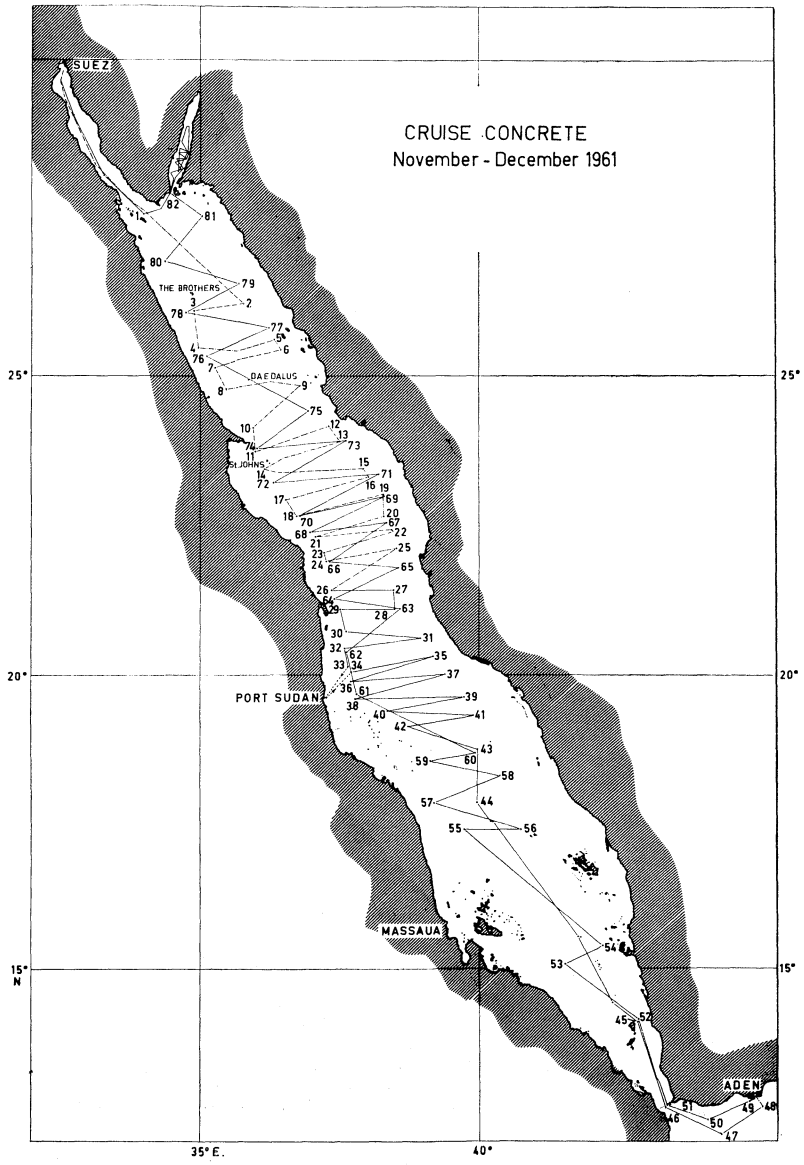

FIG. 2. — *Profiles made in the Red Sea.*

and the U.S. Office of Naval Research. An account of the comparison has been published (3). Figure 3 shows a histogram of the discrepancies of the two meters for 1 176 cases.

Cruise Corsair (September 1961) was a 3-week cruise entirely devoted to gravity and magnetic surveys of the areas adjacent to Corsica and Sardinia.

A survey of the Red Sea and gulf of Aqaba was made between October and December 1961. A second Graf-Askania gravity meter, supplied and operated by scientistsof the German

Hydrographic Institute and the Bundesanstalt fur Bodenforschung was embarked for this cruise and provided a good opportunity of comparing the performance of two meters of the same type. Over most of the cruise the agreement was excellent.

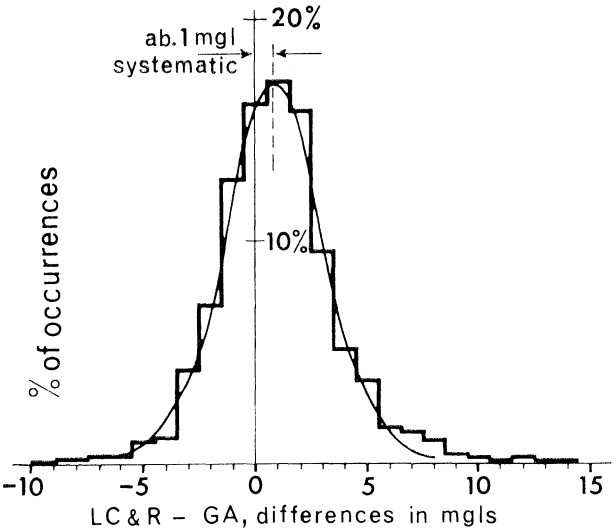

FIG. 3. — *Comparison of the La Coste-Romberg and Graf-Askania gravity meters made on the first of the Centre's geophysical cruises.* 3rd + 4th cruise, july 21 to august 8 1962. Total 1176 cases.

A preliminary magnetic survey of the Red Sea made by HMS « Dalrymple » in 1959 (4) had shown the existence of a magnetic anomaly associated with a steep-sided medial valley about 30 miles wide. This anomaly was studied in much more detail during the 1961 cruise. A total of fifty-four transverse crossings were made.

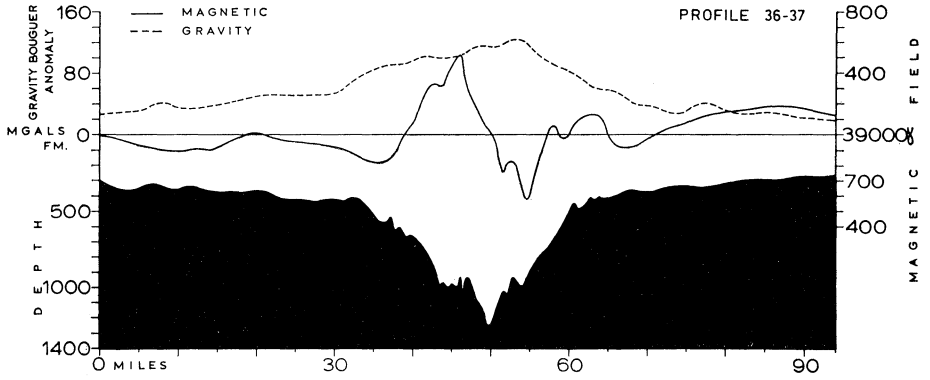

FIG. 4. — *Typical profile of the anomaly in gravity and magnetic field across the central rift of the Red Sea.*

A typical crossing of the rift (at latitude 20° N) is shown in figure 4.

Two cruises were made in 1962 — one to the Strait of Sicily (September) and the other to the Eastern Mediterranean (October-November). Prof. K.O. EMERY, Woods Hole Oceanographic Institute, took part in the later cruise during which a physiographic chart of the sea floor was prepared by interpreting the type of bottom from the nature of echoes on the PDR records.

The survey work extended the previous preliminary study south of Crete and also covered the southern part of the Aegean Sea. The Edgerton Boomer and Towed Asdic, kindly lent by the National Institute of Oceanography and the British Petroleum Co. respectively, were used along some of the profiles in an attempt to follow the sub-bottom structure.

Cruise Concord (February 1963) was planned to extend the coverage in the Aegean Sea. The whole cruise was devoted to survey work. A profile of the free-air gravity anomaly, the absolute total magnetic field and the bathymetry along the meridian 26° E from the African coast to the Central Aegean is shown in figure 5.

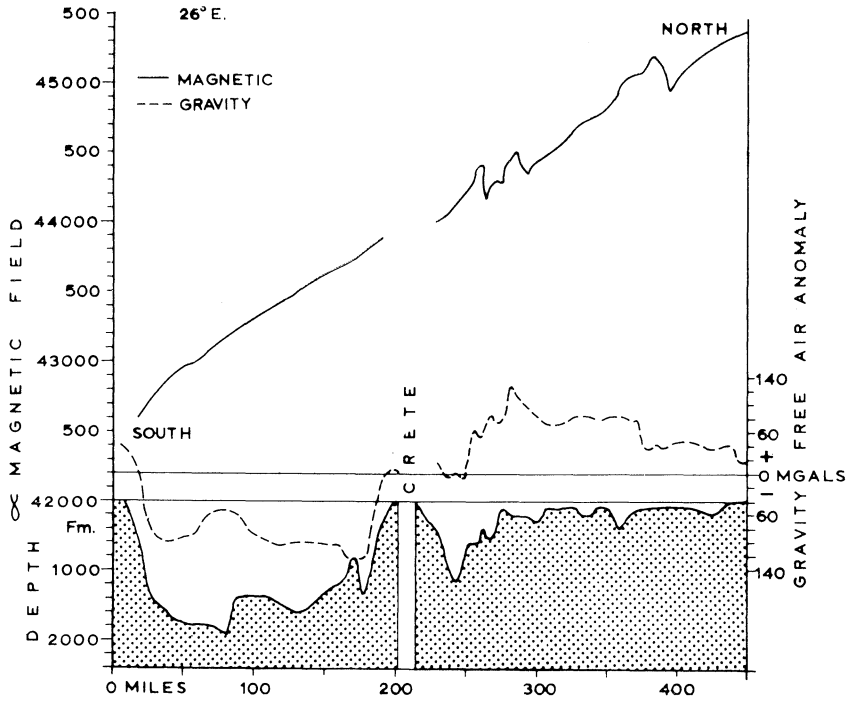

FIG. 5. — *Profile through Crete from the African coast to the Centre of the Aegean Sea. Note the negative gravity values and the smooth magnetic field south of Crete compared to the positive gravity and irregular magnetic field in the Aegean.*

During Cruise Coran, which followed in March 1963, tests were made on a gravity corer designed to accomodate a thermal gradient recorder which was under construction at the Centre. Four cores were taken in the Ligurian Sea. The cruise was primarily concerned with a detailed survey of the Ligurian Sea and the results of this work will be presented separetely.

A further two cruises were made in August and November 1963 to the Tyrrhenian Sea. During these cruises Loran C provided an excellent navigational control which, because of the long distance between Sardinia and the Italian mainlaud, would have been impossible to achieve with radar signals. The probable error in position throughout the whole of the survey of the Tyrrhenian Sea is less than ½ mile.

The last cruise was made in June of this year to complete the survey of the Aegean Sea. Several cores were taken and 3 heat flow measurements made.

There is now a fairly good coverage of measurements over two main areas in the Eastern and Western Mediterranean although much of the data reduction and analysis remains to be done.

REFERENCE

(1) HILL (M.N.), 1959. — *Deep Sea Research*, **5** : 209-311.
(2) MATTHEWS (D.J.), 1939. — *Hydrographic Dept., Admiralty* H.D., 282.
(3) ALLAN (T.D.), DEHLINGER (P.), GANTAR (C.), MORELLI (C.), PISANI (M.) and HARRISON (J.C.), 1962. — *J. Geophys. Res.*, **67** : 5157-5162.
(4) ALLAN (T.D.), 1964. — *Boll. Geofis. Teor. ed App.*, **6** (23) : 199.