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Phil. Trans. R. Soc. Lond. A 1952 **244**, 533-559
doi: 10.1098/rsta.1952.0014

GRAVITY MEASUREMENTS IN THE EASTERN MEDITERRANEAN

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(*Communicated by Sir Gerald Lenox-Conyngham, F.R.S.—Received* 19 *December* 1951)

During 1950 measurements of gravity at sea were made in H.M. Submarine *Talent* in the eastern Mediterranean. Forty-six stations were occupied in the neighbourhood of Malta and Pantelleria, seventy-three stations in the part of the basin east of a line from Cape Matapan to Benghazi and in the southern part of the Aegean sea, and six stations on two east-west lines between Malta and Crete. Measurements were also made in the harbours of Malta, Tunis, Famagusta and Candia and at six sea stations which had been occupied by previous observers. A critical discussion is given of the accuracy of the results, which are presented both in tabular form and as maps of isostatic anomalies. No attempt is made in this paper to interpret their significance.

1. Introduction

(*a*) *Objectives*

There are several geological problems connected with the Mediterranean whose solution would be advanced if adequate gravity information were available. The western part of the area has been surveyed with considerable thoroughness by Marti (1935) and by Cassinis (1935). Their results, together with a few due to Vening Meinesz (1932) have been reduced and discussed by Coster (1945). A number of stations near Sicily and in the Ionian Sea were occupied in 1931 by Cassinis (1935), who also occupied forty-nine stations in the eastern Mediterranean in 1935 (1942); there are here also a few isolated stations occupied by Vening Meinesz (1948). Several surveys have been conducted on the adjacent coastal areas, but these have not been reduced on a common basis.

The first of the outstanding problems concerns the islands of Malta and Pantelleria, which occupy isolated positions near the edge of a shallow platform south of Sicily. Malta consists of Tertiary limestones and sandstones which dip gently away from the edge of the platform. The south-south-west coast presents a steep face to the sea and is almost certainly a fault. Parts of Malta and Gozo and the intervening sea have been down-faulted along a series of north-east–south-west faults but few other signs of tectonic activity are apparent. Borings made on Malta have not penetrated below the Tertiary beds. An area of positive anomalies in south-eastern Sicily (Morelli 1946*a*) appears to continue as far south as Malta: a detailed survey would show whether Malta was an independent tectonic unit or a vestigial feature of an extension of the Ragusa plateau.

Pantelleria is a volcano which last erupted in 1891 (Washington 1909). It can be seen from the Admiralty Chart (no. 165) that Pantelleria, though very close to the edge of the platform, is separated from it by water at least 200 fathoms deep, whereas between Malta and Sicily no such channel exists. It is, therefore, possible that the volcanism of Pantelleria indicates the existence of a line of crustal weakness which runs in a north-west—south-east direction, skirting Malta to the south-west, and that Malta represents the vestiges of a large area of Tertiary cover which has been inundated by the sea.

Eastwards from Malta the next area of special interest is Crete and the southern Aegean. Cassinis's measurements (1942) showed that negative free-air anomalies up to −150 mgals existed south of Crete, but that large positive anomalies characterized the southern Aegean, especially near the volcano of Santorin (+100 mgals). It seems very likely that the Peloponnesus and the islands of Kithera, Crete, Scarpanto and Rhodes form an island arc joining the mountain chains in Dalmatia to the Taurus mountains in Anatolia. It is tempting to make an analogy with the island arcs of the East and West Indies, but this analogy is by no means complete. For example, although the depth of the sea south of Crete exceeds 2000 fathoms, there are no features apparent from the existing charts which could be called 'deeps', nor is there a chain of volcanoes running through the islands. Earthquakes of intermediate depth (mean depth 130 km) occur both inside and just outside the arc; there are, however, no signs of a dipping plane of shear such as has been clearly shown for the East Indian and Japanese foci.* However, there is sufficient resemblance to suggest that is a less strongly developed feature of the same type. It was proposed to throw light on this by making a number of radial traverses south of Crete. Only a few stations were planned in the south Aegean, because it was considered that Cassinis's work had already given a satisfactory picture of the gravity field on the inside of the arc.

One of the most outstanding problems in the eastern Mediterranean is the existence, in Cyprus, of the largest known positive isostatic anomalies in the world (Mace 1939). In a discussion of this paper, Bullard has already pointed out that the material of the island itself would be insufficient to account for the large values measured (over +150 mgals), and that the island must be underlain by a great thickness of dense rock, possibly equal to the whole thickness of the crust. The anomalies on the island diminish rapidly towards the north, south and west, and these strong gradients are believed to be partly responsible for the discrepancies between the geodetic and astronomical differences of position of stations on the coast of the island. The impression is formed that the mass responsible for the anomalies has only small lateral extent except possibly towards the east or north-east. The Kyrenia range, which runs along the north coast of Cyprus and extends in a narrow peninsula for some 40 miles to the east-north-east, is also a feature of considerable interest. It was considered, therefore, that several stations should be occupied in the Gulf of Iskanderun and between Cyprus and the Syrian coast, as well as at several points round the island some 20 or 30 miles from the coast. Gravity measurements have been made in Syria and the Levant by Lejay (1938) and discussed by De Cizancourt (1948). It is unfortunate that no gravity data are available in Turkey. Apart from the geological interest of the results, the gravity data would be of great value in helping to determine the geodetic co-ordinates of Cyprus.

The last principal objective of the survey was a study of the continuation of the gravity field of the Nile Delta northward into the sea. There are some pendulum stations on the delta itself (Cole 1944) and a harbour station of Vening Meinesz at Alexandria. It was believed that a detailed survey of the delta itself was being made by a prospecting company, and that these results would eventually be available for consideration together with the results of the present survey. The study of deltaic areas affords a useful opportunity to

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* See, for example, Gutenberg (1949).

assess the resistance offered by the earth's crust to a steadily increasing load of sediments. In addition, this particular delta lies near the junction of the Red Sea rift and the Jordan Valley rift and may have special characteristics. Two measurements were made at sea by Vening Meinesz to the north-west of Alexandria, and it was proposed to extend these by two more radial lines of stations to the north of Damietta and to the east-north-east of Port Said.

Although there are many more problems in the eastern Mediterranean it was clear that the solutions of these four would be useful pointers in studying the general tectonic picture. The results would further be useful in guiding additional work of a similar nature. Any future reconstruction of the geological history of the area must clearly be capable of explaining the gravity data. Apart from the purely geological objectives of the survey, the results would provide additional connexions between the various coastal surveys, and give useful data for studying the geoid.

Submarine gravity work in the eastern Mediterranean would be favoured by the prevalence of calm water and the low velocities of surface currents. There are several harbours which may be visited for routine maintenance of the apparatus, renewal of stores, and development of the photographic records but few of these are sufficiently sheltered for base-station swings except under unusually calm conditions. There are no navigational aids, and the charting of some of the land may be inaccurate. Soundings, except near shipping lanes, are sparse, but could be supplemented by further data obtained during the cruise. Despite these drawbacks it was considered that the experience gained during the three previous British submarine gravity surveys would ensure success.

(*b*) *Organization*

The proposal that the survey should be undertaken was made by the Department of Geodesy and Geophysics of the University of Cambridge to the Royal Society in 1949. It was given full support, and the Society agreed to make the necessary funds available. The matter was referred to the Defence Services Research Facilities Committee under the Chairmanship of Sir David Brunt. The Board of Admiralty allocated H.M. Submarine *Talent* for the work, which was successfully carried out during the summer of 1950.

Two of the authors (R. I. B. C. and P. L. W.) took part in the expedition, which was based on Malta, where the submarine was due to complete her refit in April 1950. A preliminary visit was made in March to give instructions for the fitting of the auxiliary equipment, particularly the special deep echo-sounder. As a result of the excellent co-operation received from H.M. Dockyard all was ready when the gravity apparatus arrived in H.M. Fleet Auxiliary *Bacchus* at the end of April. During May the equipment was installed, base-station swings were made, and a number of local measurements and trials carried out. Mr B. C. Browne flew out from England to take part in these operations.

At 10.00 h on Friday, 2 June, *Talent* set sail for Tunis, taking in all the stations of the Malta-Pantelleria area. A landing was made on Pantelleria by boat, and the opportunity was taken to collect fresh geological specimens for specific-gravity determinations.

Further base-station swings were made at Malta, which showed that the lengths of the pendulums had not changed significantly during the first fifty measurements. Some delay was caused by the failure of the crystal-controlled frequency standard, and a spare was flown out from England. It was possible to sail on the second part of the cruise, however, at 16.00 h on Thursday, 22 June. This part of the expedition included calls at Melos, Samos, Rhodes, Beirut, Famagusta and Candia. In Cyprus the authors had the good fortune to meet Mr Burdon, the chief geologist to the Irrigation Department, who very kindly took them by motor-car to collect specimens for specific-gravity determinations from sites widely distributed on the island, and he also gave considerable help in identifying the rocks. Further specimens were collected at Melos, Samos and Crete. The submarine returned to base at Malta at 14.00 h on Sunday, 23 July, and after the completion of satisfactory base-swings, the apparatus was dismantled and returned to England.

Altogether 119 new measurements were made. Harbour swings were made at four bases and, in addition, five stations of Cassinis and one of Vening Meinesz were reoccupied as checks. This brings the total number of gravity measurements at sea in the area to 205, so that some progress may now be made with the geological interpretation.

2. Apparatus and technique

(a) *General*

The observations followed in general the procedure formerly described (Browne & Cooper 1950, 1952). Parts of the equipment have been described separately (Cooper 1949). The measurements of gravity were made with a stabilized Vening Meinesz three-pendulum apparatus, the pendulums being timed by means of a quartz-crystal controlled frequency standard, which was rated in turn against the time signals from Rugby (GBR). It was not possible on this occasion to compare the fundamental crystal frequency (100 kc/s) with any standard broadcast frequency, since the Mediterranean is not within radio range of Droitwich (200 kc/s) and the signals emitted from WWV (10, 15, 20 and 25 mc/s) are of an unsuitable form for the apparatus. Two crystals were, however, standardized at a number of steady temperatures before and after the cruise, one being intended as a spare, and the temperature in the frequency standard was read during each observation on a mercury-in-glass thermometer. A thermograph recorded the temperature inside the submarine continuously so as to detect any rapid variations which might have caused a difference between the temperature of the thermometer and that of the crystal in the frequency standard. Some further remarks on the timing are reserved to a later subsection (§2 (*b*)).

The pressure of the air in the boat was read from two portable survey aneroids which were tested before departure at the National Physical Laboratory over a wide range of temperatures and pressures. Their readings were compared with those at the Meteorological station at Luqa airport, while in Malta, but checks were not possible elsewhere. The differences between their readings, after applying the corrections recommended by the N.P.L., never exceeded 0·5 mm Hg, and on return they were found to agree within 0·5 mm Hg with a single check against a standard mercury barometer.

The acceleration recorder was carried and one or two records were taken, but at our usual diving depth of 90 ft. there was never enough disturbance to make the records worth reading. The depth of the submarine was continuously recorded during each run, but the depth-keeping was so good that only four first-order acceleration corrections were significant.

In most places the water was too deep to make it possible to use taut-wire gear to determine the speed of the submarine over the bottom. It had, therefore, to be estimated from the log, which was calibrated before the cruise during a submerged run and on the surface over a measured mile at Malta. Allowance was made for the drift due to surface currents by comparing astronomical or land fixes with dead-reckoning. The positions of the observation stations were determined by astronomical methods and by land-fixes when available. Some further remarks on navigation are made below (§2 (*c*)). The depth of the water below the keel in shallow areas was recorded by the Admiralty pattern echo-sounding set normally fitted in T-class submarines, and in deep areas by a specially installed deep echo-sounder similar to that used in 1946.

The pendulum apparatus was stabilized so that the centre pendulum acquired only a very small amplitude during each observation. In this way the time required to compute the results of the survey was reduced to about one-third of its normal value. Moreover, consistent results were obtained under very 'bumpy' conditions in the harbours of Famagusta and Candia, where a simple trial showed that unstabilized observations were impossible. The measurement at Famagusta has since been checked by a gravimeter connexion with Nicosia and found to be within 0·7 mgal of the more reliable value (see §3 (*c*) below). Conditions in the harbours of Rhodes and Beirut, where continuous strong winds were blowing into the harbour mouth, proved too severe, however, for stabilized observations to be possible.

Trouble was again experienced due to rotation of the pendulums while swinging on their agate planes (Browne & Cooper 1952). This is discussed in more detail in §2 (*d*) below.

(*b*) *The timing system*

As explained above, the rate of the crystal in the frequency standard was deduced from the temperature measured by the thermometer inside it, making use of a calibration curve taken in the laboratory. The following figures show that this procedure was generally satisfactory:

period	mean rate ($\times 10^{-7}$)	mean temp. (° C)	expected rate ($\times 10^{-7}$)
1 July 20.00 h to 7 July 12.00 h	50·8	37·9	51
15 July 12.00 h to 23 July 12.00 h	51·5	37·4	52

The mean rates were calculated from the time signals received from Rugby (GBR), and the mean ambient temperature was read from the continuous record given by the thermograph. It was found that the temperature inside the frequency standard exceeded the ambient temperature by a constant amount for the ranges and for the rates of change of temperature experienced.

The reliability of the instantaneous rates depends on the consistent operation of the dividing circuits, which generate the 1000 c/s supplies for the clock motors from the 100 kc/s frequency of the crystal. Considerable trouble was experienced with the dividing circuits in the frequency standard during this voyage. After leaving Malta for the first part of the cruise, one of the two clocks, which were run continuously from the frequency standard in order to obtain the comparison with the time signals, stopped frequently. At first a mechanical fault was suspected, since only one clock was affected, and since the motor, responsible for interrupting the recording light beam in the pendulum apparatus and also driven from the frequency standard, ran successfully throughout each observation. During station no. 115, however, this motor stopped but the clocks did not. After this, the precaution was taken of operating the second shutter (minute mark shutter) from the contacts of a clockwork sidereal chronometer instead of from the contacts of one of the clocks. This chronometer had been regularly wound and rated at the same time as the crystal-controlled clocks from the very beginning of the work. Its instantaneous rate could not be relied upon to better than about 0·5 part in 10^5 (equivalent to 10 mgals). No observations were lost, except no. 119, where the chronometer was not wound the previous evening owing to an oversight.

Attempts were made to locate the cause of the trouble but were unsuccessful until the laboratory facilities of H.M.S. *Forth*, the submarine depot ship, became available after *Talent*'s return to Malta. It was found possible for a small change in tuning of the harmonic generating circuits to cause division by factors other than ten. It was, therefore, possible for the circuits to become very sensitive to small alterations in the operating conditions, such as, for example, changes in h.t. voltage. Sudden changes of phase of the 1000 c/s voltage with respect to the 100000 c/s voltage would then occur at random. This slipping seemed to take place mainly in the circuit producing division from 10000 to 1000 c/s. As a result of this experience it was considered that, even after careful inspection and accurate alinement of the circuits, no great confidence could be placed in the continuous operation of the standard. A spare was accordingly flown from England. The spare crystal was installed, and both frequency standards were taken on the second part of the cruise.

Before setting off, a beat counter was constructed aboard H.M.S. *Forth* which recorded the beats at 1000 c/s between the two standards. The clicks of this counter could be heard about every $2\frac{1}{2}$ min, and a slip in either set of dividing circuits would instantly draw attention if it occurred during an observation. The mechanical operation of the counter was, however, not sufficiently reliable for it to be possible to be sure that no slips occurred when the apparatus was not being watched. The rate of the beats was counted during each observation and afforded a further useful check on the rates of each standard.

This system was in operation for all stations between no. 140 and no. 182 and, after this, although the dividing circuits in the spare frequency standard failed and could not be brought into adjustment, the original continued without interruption until the end of the voyage. It is therefore considered that the timing at all the stations after no. 140 may be relied upon to 1 part in 10^7.

In the Malta-Pantelleria area individual consideration is necessary for stations nos. 115 to 139. It has already been pointed out that a sudden slip in the dividing circuits did not necessarily stop all the motors run from the frequency standard. Therefore, even if the interrupter motor giving timing marks did run throughout an observation, it was still possible that one or more slips had occurred. A slip of 1×10^{-3} s in an observation of about half an hour's duration would give an error of about 1 mgal. Even if the clocks ran all day, it still did not guarantee that there were no slips during an observation although it reduced the probability very greatly. It is possible to argue statistically, however, in the following way.

During the period from 11.00 h on 5 June (departure from Pantelleria) until 19.00 h on 6 June (arrival at Tunis) one clock at least continued to run. Its mean rate during this interval, obtained from the time signals, was $(59{\cdot}8 \pm 2{\cdot}0) \times 10^{-7}$, and the mean rate expected from the recorded temperatures was $(58{\cdot}5 \pm 1{\cdot}0) \times 10^{-7}$. The difference is not significant, and we may further assert that no systematic difference greater than about 3×10^{-7} could have been present. Since slipping may cause either an apparent gain or loss of the clock, then during any one observation occupying half an hour the amount of slipping would be about $\sqrt{\frac{1}{64}}$ times as great as the amount in 32 h, or about $4{\cdot}3 \pm 10^{-3}$ s; this is equivalent to an error of only ±4 mgals in the value of g calculated from the measured period. For the period 11.00 h on 9 June (departure from Tunis) until 11.00 h on 11 June (arrival in Malta) the two estimates of mean rate show a similar agreement. This argument assumes that the slips occur at random and are not specifically caused by the operation of the rest of the apparatus. Since the clocks were never observed to stop during an observation this seems justifiable.

In the case of those records where minute marks were provided from the sidereal chronometer but where the interrupter driven from the frequency standard ran continuously, it was possible to compute the instantaneous rate of the sidereal chronometer in terms of the rate assumed for the crystal from a knowledge of its temperature. This was done for stations nos. 113, 120 to 123 and 130 to 139, and it was found that the instantaneous rates of the sidereal chronometer so determined differed from the mean rates by as much as one-third of a second per day. The mean difference for all fifteen stations was, however, only one-thirtieth of a second per day. This suggested either that the sidereal chronometer was disturbed by the waves while on the surface or that it had a large winding correction. Some experiments were done with a view to determining the winding correction after return to Cambridge. The drift of rate of the instrument under laboratory conditions prevented any precise conclusions. It is therefore evident that these calculations did not afford any useful check on the behaviour of the dividing circuits during these observations.

From our former arguments, however, it seems that for all stations for which the interrupter motor or either clock ran continuously it is reasonable to assume that the rate was that to be expected from the temperature noted in the frequency standard within 2 parts in 10^6. This leaves only stations 116, 119 and Tunis doubtful. Station 119 is almost certainly to be disregarded for the reason mentioned, station 116 is probably within ±20 mgals, and Tunis is separately discussed later.

(*c*) *Navigation*

Standard astronomical methods were used to determine the positions of the stations. As far as possible stations were occupied at times close to those at which observations of position were made, to avoid errors in dead-reckoning. These times were just after sunrise, midday, and just before sunset. For those stations near enough to land, fixes could be obtained by bearings on conspicuous landmarks.

In the Aegean and near the coast of Crete and Turkey it was often found that the astronomical positions were 2 or 3 miles different from those fixed off the land, using the standard Admiralty charts. Under the excellent conditions which usually prevailed, it was considered unlikely for errors of observation to exceed 1 mile, and they were usually found to be in the same sense for a number of points on the same chart. The possibility of errors in the charts themselves was therefore considered.

It was further noticed that the positions on the Admiralty Charts did not always agree with the positions of the maps in the International 1:1000000 series. Fortunately, all the discrepancies turned out to involve the longitude only, and therefore the values of γ_0' to be assumed for the stations are not affected. Comparisons were made between Admiralty charts 2606, Crete to Alexandretta, etc.; 2836*a*, Grecian Archipelago-Southern Sheet, and Maps NJ35, Aegean; J36, Ankara; G20, Heraklion; G18, Scarpanto-Rhodes. If we accept the maps, which were all later publications than the charts, as being correct, then the following corrections should be applied to the charts:

Rhodes Light, Cape Marmoris, Cape Khelidonia—*reduce* longitudes by 3·0′ E.

Cape Sidero, Koupho Nisi Island, Unio Nisi Island—*reduce* longitudes by 1·3′ E.

These corrections are closely in agreement with the observations by Lt.-Commander Stanbury. We have been informed by the Hydrographer of the Navy that Admiralty Charts in this part of the Mediterranean are in process of being revised, when many of these differences, none of them navigationally dangerous, will disappear. In certain cases the charts contain notes about longitude errors. Comparisons between the maps and charts in the west of the southern Aegean did not reveal any discrepancies, although the observations suggested reductions of latitude here by 1·7′ N.

The procedure adopted in deciding on the positions of the stations to be quoted in this paper was therefore as follows:

(1) For stations nos. 98 to 144 and 222, for stations nos. 145 to 148 and nos. 217 to 221 and for stations nos. 160 to 164, 166 to 204 and 210 to 216 no corrections are required to the original figures.

(2) For stations nos. 149 to 157 the mean of the astronomical and land-fixed positions has been taken where both are available; if only one or the other method was used the position has been accepted without correction.

(3) For stations nos. 158, 159 and 165 the land-fix has been corrected by −3·0′ E longitude.

(4) For stations nos. 205 to 209 the land-fix has been corrected by −1·3′ E longitude, and then the mean taken of this and the astronomical position where both methods were used.

In this way it is believed that the uncertainty of the positions quoted may be taken to be ±1′ in latitude and ±1·5′ in longitude.

(*d*) *Rotation of the pendulums*

This phenomenon has already been described (Browne & Cooper 1952). In that paper it is stated that, after remounting the apparatus so that the pendulums swung in a fore-and-aft plane, no further trouble was experienced. This way of mounting was therefore adopted when installing the apparatus for the present cruise. Nevertheless, the phenomenon again made its appearance but only on certain stations, and no clearly definable set of conditions appeared to govern it. The trouble was never bad enough to cause the light beams to fail to record, and no observations were lost in this way. There is, however, no means of knowing whether the observed values of gravity were affected.

During the Malta-Pantelleria section the phenomenon occurred at the following stations: nos. 117, 128 to 132 and 136. At station no. 132 the effects of altering the engine revolutions and of diving to 150 ft. were investigated without improvement. In the second section of the cruise, stations nos. 141, 145 and 146 were affected; a brass plate was then fixed between the pendulum box and the outer gimbal cradle to increase the rigidity of the mounting in the athwartships direction. This appeared to have cured the trouble until the effect reappeared on station no. 158. Small coils of 1 in. rope were then placed under the feet of the apparatus to insulate it against vibration. This again seemed to effect a temporary cure until station no. 173 was reached. Stations nos. 173, 175 and 177 to 181 were all affected. During this period, experiments showed that the effect was not caused by any machinery in the boat unless it were the main motors, not even by the generators supplying power to the apparatus, which were mounted immediately below the adjacent deck covers. Unstabilized runs were made without rotation occurring, while the apparatus was running from batteries only during stations nos. 182 and 183. Upon closer inspection it was found that the spacing between the stabilizer magnet and the armature attached to the pendulum frame had become much less than its normal setting. By consulting the diary which was kept for all maintenance checks it was discovered that this had last been inspected after station no. 168. After resetting the spacing no further trouble was experienced.

The conclusion seems to be that the pendulums rotate so easily on their agate planes that very slight changes in the conditions of disturbance can move them. Increasing the rigidity of the apparatus in its frame and insulating it against vibration reduces the chances of rotation but cannot guarantee that it will not occur. A reduction in the gap between the stabilizer magnet and its armature would increase the chances of instability. Tests made on previous occasions (Cooper 1949) have shown that the stabilizer does not cause rotation when it is correctly adjusted. The exact nature of the disturbances which are involved remains obscure, because its occurrence is not apparently correlated with, for example, the roughness of the sea, the depth of the dive, or the speed of the boat.

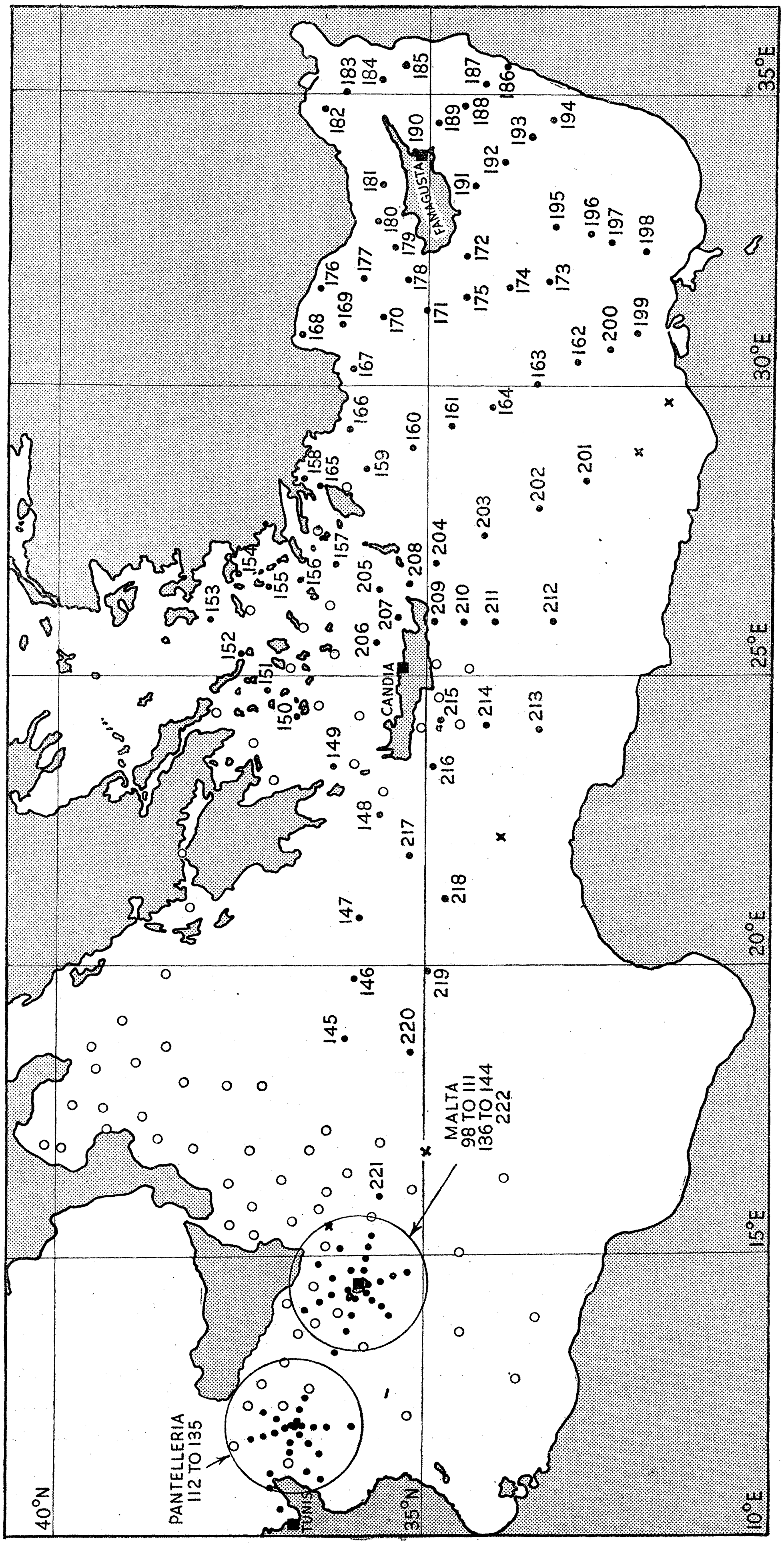
Eighteen stations in all were affected during the present survey. At four of these, two runs were completed at the same station, rotation occurring on all of them. The results are self-consistent, as table 1 shows.

TABLE 1. DOUBLE STATIONS WITH ROTATION

(free air anomalies in mgals)

station no.	first result	second result
132	+ 20·3	+ 24·9
145	+ 11·8	+ 13·4
146	− 67·0	− 64·7
175	−111·7	−114·8

This consistency does not exclude the possibility that both observations are wrong by nearly the same amount. In the survey of the English Channel (Browne & Cooper 1952) it was found that at station no. 52, for example, consistent runs were taken with rotation which were 10 mgals lower than consistent runs taken when no rotation occurred. Although the trouble at this station was more severe and the measurements with rotation were made



Map 1. Positions of gravity stations at sea in the eastern Mediterranean. ● present survey; ○ Cassinis 1931 and 1935; × Vening Meinesz.

while swinging the pendulums athwartship, it must be conceded that the values of gravity quoted for the eighteen stations just cited are open to objection. They, nevertheless, fit in smoothly with the general trend of the anomalies.

The anomalies quoted in table 5 for the stations in table 1 are the means of the above values except for station no. 132. Here the first result is based on half an hour's observation under standard conditions and the second on only a quarter of an hour under different conditions of engine speed; the first result has been used alone.

3. The gravity values

All values are based on

$$g \text{ (Pendulum House, Cambridge)} = 981{\cdot}265 \text{ cm/s}^2.$$

This value has been chosen because nearly all previous gravity surveys based on Cambridge have used it and it has now been accepted as the basis for the gravity survey of the British Isles. The connexions between this value and the Potsdam standard are uncertain (Jeffreys 1948), but no definite conclusions have been reached.* The uncertainty in the value has been assumed to be ±0·7 mgal r.m.s. error, as suggested by Bullard & Jolly (1936). It is worth considering, however, what the effect of a change in the base value would be. It would not affect the comparisons made at Malta, Tunis or Famagusta, because these values are reliably connected to Cambridge, but it would affect the present survey relative to some others in the area, notably that of Cassinis.

The positions of the stations and of all other previously occupied sea stations in the area are shown on map 1.

(a) *Changes in the lengths of the pendulums*

Base-station swings were made at Cambridge before and after the cruise, and on three separate occasions at Malta, where a reliable value of gravity is now known from subsequent measurements (Harding 1950). These results are summarized in table 2.

The agreement between the swings taken at Lazaretto Creek on 14 May with those taken on 24 July is good. The swings taken on 20 June are not so reliable as the others. One of them (result enclosed in brackets) was interrupted by the passage of a motor-boat, and the period was computed from readings of coincidences in the slow-running portion. This observation has been given one-third of the weight of the other two in calculating the means. One of the other observations has rather a small value for the difference in periods of the two pendulums. The evidence for a real change in the lengths during the middle of the cruise is, therefore, not compelling, and we shall assume that no such change occurred.

The value of gravity at no. 3 Dock obtained by Harding and corrected for elevation was 979·8872 cm/s^2, and this was based on a value of gravity at Commerce Base, Washington, D.C., U.S.A., of 980·1190 cm/s^2. We therefore write

$$g \text{ (Commerce Base)} - g \text{ (no. 3 Dock)} = +0{\cdot}2318.$$

To obtain the value at no. 3 Dock on the system in use in this paper, we note

$$\begin{aligned} &g \text{ (Pendulum House)} &&- g \text{ (N.P.L.)} &&= +0{\cdot}0722 \pm 0{\cdot}0005 \\ &g \text{ (N.P.L.)} &&- g \text{ (Bureau of Standards)} &&= +1{\cdot}0967 \pm 0{\cdot}0002 \\ &g \text{ (Bureau of Standards)} &&- g \text{ (Commerce Base)} &&= -0{\cdot}0192 \pm 0{\cdot}0001. \end{aligned}$$

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* But see footnote on p. 547.

Therefore

g (Pendulum House) $-g$ (no. 3 Dock) $= 1\cdot3815.$

Therefore g (no. 3 Dock) $= 981\cdot265 - 1\cdot382$

$= 979\cdot883$ cm/s^2.

The connexion between the National Physical Laboratory, Teddington, England (N.P.L.) and Pendulum House is a little uncertain. The value quoted here is the mean of that given by Woollard (1950) and by Cook (1950). The connexion between N.P.L. and the Bureau of Standards at Washington is that by Browne & Bullard (1940) and seems

Table 2. Base-station observations

date	T_1 (s)	T_3 (s)	diff. (10^{-7} s)	$\frac{1}{2}(T_1+T_3)$ (s)
Pendulum House, Cambridge, $g = 981\cdot265$ cm/s^2; latitude 52° 13′ N; longitude 0° 06′ W; height 82 ft.				
7. ii. 50	0·503,9072,3	0·503,9020,3	52·0	
	9077,2	9016,5	60·7	
	9082,3	9019,9	62·4	
	9071,0	9012,6	58·4	
mean	0·503,9075,7	0·503,9017,3	58·4	**0·503,9046,5**
Lazaretto Creek, Malta, $g = ?$; latitude 35° 54·0′ N; longitude 14° 29·9′ E; height 0 ft.				
14. v. 50	0·504,2628,0	0·504,2572,0	56·0	
	2629,6	2567,6	62·0	
	2629,0	2567,9	61·1	
mean	0·504,2628,9	0·504,2569,2	59·7	0·504,2599,0
No. 3 Dock, Malta, $g = 979\cdot883$ cm/s^2†; latitude 35° 52·8′ N; longitude 14° 31·0′ E; height 0 ft.				
17. v. 50	0·504,2619,4	0·504,2569,1	50·3	
	2617,5	2571,8	45·7	
mean	0·504,2618,5	0·504,2570,4	48·1	0·504,2594,4
Lazaretto Creek				
20. vi. 50	(0·504,2625,5)	(0·504,2569,2)	(56·3)	
	2611,0	2575,5	35·5	
	2622,2	2572,9	49·3	
mean	0·504,2617,9*	2573,5*	44·4*	0·504,2595,7*
Lazaretto Creek				
24. vii. 50	0·504,2620,8	0·504,2574,9	45·9	
	2622,8	2571,0	51·8	
	2630,4	2573,2	57·2	
	2635,1	2561,9	73·2	
	2628,2	2570,8	57·4	
mean	0·504,2627,5	0·504,2570,4	57·1	0·504,2599,0
Pendulum House				
16. viii. 50	0·503,9071,1	0·503,9014,6	56·5	
	9070,5	9012,6	57·9	
	9070,6	9013,7	56·9	
mean	0·503,9070,7	0·503,9013,6	57·1	**0·503,9042,2**
mean of $\frac{1}{2}(T_1+T_3)$ at Cambridge				0·503,9044,4
$\frac{1}{2}(T_1+T_3)$ expected at Cambridge, based on g (no. 3 Dock)				0·503,9042,4
mean value assumed at Cambridge for computing results				**0·503,9043,7**
All swings stabilized.				

† Harding (1950).

* Mean weighted in accordance with the recommendations in the text.

to be very reliable. The connexion between the Bureau of Standards and Commerce Base is given by Woollard.

It appears from the results that the changes in the lengths of the pendulums, which are equivalent to $-4{\cdot}3\times10^{-7}$ s change in the mean period, occurred mainly on the way out from England to Malta. It has seemed wisest, however, to take a straightforward mean of the three sets of observations. The r.m.s. error in the results, due to uncertainty in the period to be assumed, is then ±1·0 mgal.

(*b*) *Temperature and pressure coefficients*

These were taken to have the same values as had been determined prior to the work carried out in 1948, namely,

pressure coefficients of all pendulums	$670{\cdot}0\times10^{-7}$ s/atm	
temperature coefficient of pendulum no. 1	$48{\cdot}0\pm0{\cdot}3$	$\times10^{-7}$ s/° C.
temperature coefficient of pendulum no. 2	$43{\cdot}6\pm0{\cdot}1$	
temperature coefficient of pendulum no. 3	$47{\cdot}9\pm0{\cdot}1$	

The mean temperature coefficient of pendulums nos. 1 and 3 was redetermined after the cruise and found to be 48·2. Only two temperatures were used, and since the main source of error in such determinations lies in the variations of ambient temperature during the measurements in the heated room, the uncertainty of this value can only be estimated. It is probably about 1 %. There seems no reason not to accept the values formerly obtained by carefully repeated experiments.

(*c*) *Accuracy of the observations*

The accuracy of a single observation at sea of g on the Potsdam standard reduced to sea-level may be studied by means of table 3*a*. In latitude 35° N the Eötvös correction amounts to 6·1 mgals/knot east-west. Surface sets of as much as 1 knot were detected on rare occasions in this area, but it was never possible to know what currents operated at a depth of 90 ft. The allowance of 2·5 mgals r.m.s. error for this cause is only an estimate. Errors in the log were eliminated by running all stations on a north-south course, except where the proximity of the land made this unsafe; in this case the speed could be checked accurately by fixes taken on the land before and after diving.

The r.m.s. error in a single free-air anomaly is greater than the r.m.s. error in g due to the uncertainty in latitude. If this be taken as ±1·0′, equivalent to ±1·5 mgals, we obtain ±3·4 mgals r.m.s. error in a free-air anomaly.

The r.m.s. error in a single Bouguer anomaly depends both on the error in measuring the depth of water at the station itself and on the error in estimating the depth of water in the vicinity. The r.m.s. error in measuring the depth may be taken to be no greater than ±12 fathoms, equivalent to ±1·0 mgal. On the other hand, the error in finding the mean depths of the nearer zones depends on a number of factors and can only be estimated in particular cases. In areas of moderate relief it is usually very small. We, therefore, obtain ±3·6 mgals r.m.s. error in a single Bouguer anomaly.

The r.m.s. error in a single isostatic anomaly is greater still by the error involved in the reduction. For this area with its dearth of soundings it is considered that this may amount to ±3 mgals. The r.m.s. error in a single isostatic anomaly may therefore be ±4·6 mgals.

The r.m.s. error in a single measurement of g in harbour can be found by eliminating the irrelevant errors from table 3*a*, to be ±1·6 mgals. This assumes steady conditions, but the principal real source of error in such measurements lies in the presence of components of acceleration near to the pendulum periods, brought about by the bumping of the boat against the side. The action of the stabilizer reduces this effect, but it is not known to what extent. ±1·6 mgals is probably an under-estimate of the error to be expected at Famagusta and Candia but may apply to Malta and Tunis. The swings in no. 3 Dock at Malta were taken in dry dock with the submarine jacked up and, therefore, effectively on land.

The r.m.s. error of one sea station observation of g relative to another may also be found from table 3*a* to be ±2·8 mgals. The dominance of the error due to uncertainties in the Eötvös correction makes the relative accuracy of any of the anomalies much the same as their individual accuracy. Certain stations at which the sidereal chronometer only was in operation, or at which rotation of the pendulums occurred, have greater r.m.s. errors, and notes to this effect are given in the table of gravity values.

The above conclusions are summarized in table 3*b*.

TABLE 3*a*. ROOT MEAN SQUARE ERRORS IN A SEA-STATION OBSERVATION OF g RELATIVE TO POTSDAM

uncertainty	mgals	mgals^2	reference
in g at base	±0·7	0·49	§ 3
in period at base	±1·0	1·00	§ 3 (*a*)
in computing period	±1·0	1·00	Cooper (1949)
in Eötvös correction	±2·5	6·25	see text
in depth correction	±0·2	0·04	Browne & Cooper (1950)
in first order correction	±0·6	0·36	Browne & Cooper (1952)
in second order correction	±0·5	0·25	Browne & Cooper (1950)
sum of squares of errors		9·39	
total r.m.s. error	±3·1		

TABLE 3*b*. ROOT MEAN SQUARE ERRORS OF THE VARIOUS TYPES OF OBSERVATION

r.m.s. error	mgals
in g at sea, relative to Potsdam	±3·1
in free-air anomalies at sea	±3·4
in Bouguer anomalies at sea	±3·6
in isostatic anomalies at sea	±4·6
in g in harbour, relative to Potsdam, under quiet conditions	±1·6
in g at sea, relative to another station at sea	±2·8

(*d*) *Comparison with measurements by other observers*

Observations were made at five of Cassinis's sea-stations, at one of Vening Meinesz's sea-stations and in harbour at Tunis and Famagusta. The results of these determinations are shown in table 4.

Since all the positions of our stations are less than 1 mile from the check stations, with the exception of the station in Tunis quoted by Lagrula, it has been thought satisfactory to compare free-air anomalies. At Tunis, since the topography in the neighbourhood of both stations is not very irregular, Lagrula's Bouguer anomaly without terrain correction should be comparable with our free-air anomaly.

Inspection of this table reveals that only two stations, namely, *Talent* no. 153 and Famagusta, agree within the expected limits of experimental error. There does not seem to be any possibility of gross differences in the base values assumed for the various surveys.* Cassinis's stations were based on Genoa, $g = 980{\cdot}557$ cm/s², which agrees with the conclusions of Morelli (1946*b*), who made a careful adjustment of many European gravity connexions, including three ties to Genoa. Vening Meinesz's stations are based on De Bilt, $g = 981{\cdot}268$ cm/s², which cannot be in doubt by more than 1 or 2 mgals; Lagrula's value is based on Bouzarea (Observatory), $g = 979{\cdot}917$ cm/s² (Lagrula 1935). Harding's value at Tunis has been adjusted to the Pendulum House base by a similar process to that of § 3 (*a*) above. The value obtained by the Iraq Petroleum Company at Famagusta, which was measured specially at the authors' request and which they are allowed to publish by the courtesy of the company, is based on Nicosia, $g = 979{\cdot}847$ cm/s², which is the value obtained by Mace (1939) based on Pendulum House, Cambridge. Other possible sources of error should, therefore, be considered.

Cassinis's work in 1931 was carried out with two clockwork sidereal chronometers which were carefully rated by two methods against time signals from three radio stations. Variations of rate of as much as ±2 s/day were observed, but the rates usually varied smoothly. Nevertheless, the difference between the mean periods of the pendulum estimated from the two chronometers was occasionally more than 50×10^{-7} s (for example, station no. 75).

At station no. 66 the estimate differed by 14×10^{-7} s and at station no. 70 by 21×10^{-7} s. During 18 September 1931, when station no. 66 was occupied, the rates of both chronometers seemed fairly steady, but during 20 September, when station no. 70 was occupied, the instantaneous rates of both were changing rather rapidly, the one from 2 s/day loss early in the morning to more than 2 s/day gain in the evening, the other from a very small loss in the morning to more than 1 s/day loss in the evening. It seems possible to attribute an r.m.s. error of about ±10 mgals to these causes, but even then the discrepancies at these stations are rather large and both are of the same sign.

Cassinis's work in 1935 was carried out with an extra chronometer, but has not been reported in sufficient detail for any criticism of the results to be possible. At stations nos. 9 and 38 there is also a large difference in the depths of the water recorded by him and by us and some errors in navigation may be involved. The very large error at station no. 38 is difficult to explain; our value seems to fit in well with the general trend of the neighbouring anomalies. Vening Meinesz's measurements were also made with clockwork chronometers; he estimates his probable error at station no. 41 as ±15 mgals but at Tunis as only ±2 mgals. The latter harbour he visited twice on different voyages, in October 1923 and November 1926, obtaining values which were only 3 mgals different from each other (Vening Meinesz 1932). Nevertheless, it seems best to assume that Harding's value here is the most reliable of the three. Our value is not very reliable because of the difficulties

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* Recent pendulum measurements by Cook have suggested that the Cambridge base value on the Potsdam scale is some 0·004 cm/s² too low. This helps to reduce the discrepancies with Vening Meinesz and with Cassinis but not by very much.

TABLE 4. COMPARISON OF RESULTS (UNITS MGALS)

Talent station					check station					diff.	
station no.	lat. N	long. E	depth (fathoms)	free-air anomaly	station no.	lat. N	long. E	depth (fathoms)	free-air anomaly	*Talent* minus check	reference
222	36° 01·3′	14° 45·3′	72	+ 42	66	36° 01·2′	14° 45·5′	87	+ 59	−17	Cassinis (1935)
111	36° 14·5′	13° 17·8′	308	+ 10	70	36° 15·4′	13° 18·2′	301	+ 31	−21	Cassinis (1935)
102	35° 25·1′	14° 37·0′	252	− 6	9	35° 25·0′	14° 37·0′	196	+ 13	−19	Cassinis (1942)
209	34° 54·4′	25° 56·3′	580	− 28	38	34° 53·9′	25° 59·1′	501	+ 64	−92	Cassinis (1942)
153	37° 59·2′	25° 58·0′	183	+ 46	42	38° 00·7′	25° 57·8′	179	+ 51	− 5	Cassinis (1942)
220	35° 12·0′	18° 31·0′	2125	+ 6	41	35° 13′	18° 31′	1980	− 22	+28	Vening Meinesz (1948)
Tunis	36° 47·5′	10° 11·5′	0	+ 4	Tunis	36° 47·6′	10° 11·4′	0	+ 28	−24	Vening Meinesz (1932)
						36° 47·8′	10° 10·3′	+89 ft.	+ 28*	—	Lagrula (1935)
						36° 47·5′	10° 11·5′	0	+ 11	− 7	Harding (1950)
Famagusta	35° 07·4′	33° 56·6′	0	+138	Famagusta	35° 07·4′	33° 56·6′	—	+137	+ 1	Iraq Petroleum Co.

* Bouguer anomaly without terrain correction.

experienced with the crystal-controlled frequency standard. Only two of the five observations taken were successful. During these two, the frequency standard appeared to be operating satisfactorily, the temperature in the boat was steady, and the disturbance of the waves was imperceptible. The results agreed within less than 1 mgal, and it is the mean of these which is quoted in tables 4 and 5.

A check was also made on the internal consistency of our own measurements at sea. Station no. 162 was occupied twice, once on 1 July between stations nos. 161 and 163 and once on 15 July between stations nos. 200 and 201. The values obtained differed by only 3·0 mgals; the mean is quoted in table 5. Since the uncertainties in position and changes in the lengths of the pendulums are involved in this comparison, the result supports our estimates of error.

(*e*) *The isostatic reductions*

The reductions of stations nos. 97 to 144 and 222 were carried out by one of the authors (J. C. H.), and the remaining stations were reduced by the Isostatic Institute at Helsinki through the courtesy of Dr W. A. Heiskanen and Dr E. Niskanen.

In addition, the forty-nine stations of Cassinis (1942), which have not been reduced before, were reduced by J. C. Harrison and are included in this work for the sake of completeness (table 6). The stations occupied by Cassinis in 1931 have been reduced by Coster (1945) and need not be quoted again.

The Airy-Heiskanen hypothesis with crustal thickness $T=30$ km has been used because it has been found to fit best in many other areas. The results obtained give a clear picture of the important features of the area. It is immediately evident that no isostatic hypothesis could reduce the range of anomalies much below 300 mgals and, therefore, no reductions for alternative hypotheses are given here.

The maps used for determining the mean heights of the zones were the International 1:1000000 series, Monaco charts 1:6000000 and Admiralty charts. These were supplemented by the soundings taken on the present expedition, by soundings taken by the *Discovery* and by soundings taken by various American vessels and kindly made available to us by the U.S. Navy through the British Admiralty.

(*f*) *The gravity anomalies*

The full details of the gravity determinations, including the free-air, Bouguer and isostatic anomalies, are given in table 5. The details of the reductions may be consulted on application to the authors. The isostatic anomalies are shown also on maps 2 and 3. Our values only are shown at the check stations mentioned in §3 (*d*) above.

4. Technical conclusions

It is evident that the measurement of gravity at sea is still a task of some difficulty despite recent advances in technique. This is principally because so much apparatus is involved that its maintenance is a serious strain on the resources of two observers. No more than two can be carried without overcrowding the accommodation.

The stabilizer appears to offer advantages well worth the small extra trouble required to maintain it. The acceleration recorder might safely be dispensed with in areas where

TABLE 5. THE GRAVITY VALUES AND THE ANOMALIES

station no.	lat. N	long. E	depth of water (fathoms)	pressure (mm Hg)	temp. (° C)	T_1-T_3 (10^{-7} s)	mean T (s)	g (cm/s^2)	corrections to g (0·001 cm/s^2)		g_0'' (cm/s^2)	γ_0' (cm/s^2)	$g_0''-\gamma_0'$ (mgals)	Bouguer anomaly (mgals)	isostatic anomaly (mgals)	notes
									depth	Eötvös						
							0·504,	979·			979·	979·				
Malta I	35° 53·8′	14° 30·2′	—	—	—	—	—	—	—	—	—	·8220	+ 60	+ 62	+ 33	Table 1
Malta II	35° 52·9′	14° 31·0′	—	—	—	—	—	—	—	—	—	·8207	+ 63	—	—	
98	35° 50·0′	14° 44·3′	47	765·0	26·50	31·4	2655,6	·8598	− 6·1	0	·8537	·8165	+ 37	+ 44	+ 11	
99	35° 48·4′	14° 57·0′	49	764·7	26·88	60·5	2633,4	·8684	− 6·1	0	·8623	·8143	+ 48	+ 56	+ 17	
100	35° 47·5′	14° 28·3′	57	766·6	25·08	33·7	2689,2	·8468	− 6·1	+ 14·6	·8553	·8130	+ 42	+ 50	+ 17	
101	35° 36·5′	14° 32·8′	207	766·6	25·18	43·6	2804,2	·8020	− 6·1	0	·7959	·7973	− 1	+ 25	− 12	
102	35° 25·1′	14° 37·0′	252	767·0	25·87	49·7	2860,7	·7801	− 6·1	+ 1·3	·7753	·7810	− 6	+ 27	− 11	
103	35° 13·5′	14° 41·5′	286	765·3	25·95	27·0	2917,1	·7583	− 6·1	0	·7522	·7646	− 12	+ 24	− 15	
104	35° 29·5′	13° 55·5′	342	765·3	25·40	43·4	2863,4	·7791	− 6·1	0	·7730	·7873	− 14	+ 29	− 8	
105	35° 35·0′	14° 05·0′	282	764·5	25·40	42·1	2821,1	·7955	− 6·1	0	·7894	·7951	− 6	+ 30	− 7	
106	35° 43·5′	14° 12·8′	470	766·6	25·40	38·5	2851,2	·7836	− 6·1	0	·7775	·8073	− 30	+ 27	− 11	
107	35° 50·2′	14° 21·6′	87	769·9	25·20	36·9	2680,5	·8501	− 6·1	+ 12·4	·8564	·8168	+ 40	+ 59	+ 25	
108	35° 56·8′	14° 16·0′	105	762·0	26·22	51·4	2624,1	·8720	− 6·1	0	·8659	·8264	+ 40	+ 53	+ 20	
109	36° 00·0′	13° 56·5′	487	760·0	26·60	44·5	2776,3	·8124	− 6·1	0	·8063	·8308	− 24	+ 36	− 4	
110	36° 04·0′	13° 40·0′	537	758·7	26·33	31·5	2753,4	·8220	− 6·1	0	·8159	·8365	− 21	+ 45	+ 2	
111	36° 14·5′	13° 17·8′	308	761·0	25·87	35·3	2631,0	·8692	− 6·1	− 1·5	·8616	·8515	+ 10	+ 50	+ 8	
112	36° 43·4′	12° 01·2′	150	762·5	24·78	48·0	2430,5	·9473	− 6·1	− 16·2	·9250	·8930	+ 32	+ 57	+ 20	
113	36° 30·3′	11° 59·6′	227	761·5	24·47	49·7	2557,9	·8978	− 6·1	− 2·5	·8892	·8742	+ 15	+ 45	+ 11	
114	36° 20·7′	11° 59·0′	157	766·8	24·35	61·8	2583,1	·8879	− 6·1	− 2·5	·8793	·8604	+ 19	+ 39	+ 10	
115	36° 08·0′	11° 58·0′	144	761·7	24·20	43	2642	·865	− 6·1	− 2·5	·856	·842	+ 14	+ 33	+ 8	*T*
(116)	36° 27·2′	11° 31·4′	140	763·3	24·20	45	2600	·881	− 6·1	− 2·5	·872	·870	+ 2	+ 19	− 3	*S*
117	36° 36·1′	11° 41·0′	162	765·0	24·80	51·8	2539,8	·9048	− 6·1	0	·8987	·8825	+ 16	+ 37	+ 9	*TR*
118	36° 42·6′	11° 50·0′	367	762·0	24·33	47·0	2541,7	·9045	− 6·1	+ 1·5	·8999	·8919	+ 8	+ 53	+ 20	*T*
(119)	36° 50·1′	12° 01·2′	303	766·3	23·67	36	2500	·920	− 6·1	− 16·2	·898	·903	− 5	+ 33	+ 1	*X*
120	37° 01·8′	12° 08·5′	66	766·3	23·73	36·0	2358,5	·9753	− 6·1	0	·9692	·9196	+ 50	+ 58	+ 31	*T*
121	37° 13·7′	12° 14·2′	42	767·3	23·88	45·5	2373,8	·9694	− 6·1	0	·9633	·9369	+ 26	+ 32	+ 12	*T*
122	37° 23·5′	11° 45·0′	51	763·0	23·95	18·6	2304,1	·9965	− 6·1	0	·9904	·9510	+ 39	+ 46	+ 19	*T*
123	37° 13·3′	11° 49·0′	102	765·8	24·17	35·1	2386,8	·9643	− 6·1	0	·9582	·9362	+ 22	+ 35	+ 12	*T*
124	37° 04·0′	11° 52·0′	102	764·8	24·45	35·3	2440,3	·9435	− 6·1	0	·9374	·9228	+ 15	+ 27	+ 4	*T*
125	36° 55·2′	11° 57·1′	297	765·3	24·52	27·4	2495,0	·9223	− 6·1	0	·9162	·9101	+ 6	+ 42	+ 14	*T*
126	36° 50·0′	11° 42·5′	323	765·0	24·55	41·6	2511,5	·9157	− 6·1	0	·9096	·9026	+ 7	+ 47	+ 22	*T*
127	36° 51·3′	11° 31·9′	152	764·8	24·85	48·2	2492,3	·9234	− 6·1	0	·9173	·9044	+ 13	+ 32	+ 11	*T*
128	36° 37·4′	11° 11·2′	45	765·0	24·78	51·5	2572,2	·8922	− 6·1	0	·8861	·8844	+ 2	+ 7	− 5	*TR*
129	36° 25·6′	11° 02·9′	38	764·0	24·80	43·4	2633,8	·8683	− 6·1	0	·8622	·8675	− 5	− 1	− 8	*TR*

Tunis *a*	36° 47·5′	10° 11·5′	—	759·0	30·30	70·0	2543,3	·9034	—	0	·9034	·8988	+ 4	+ 6	+ 9	
Tunis *b*	36° 47·5′	10° 11·5′	—	758·7	30·65	65·7	2545,5	·9026	—	0	·9026	·8988				
130	36° 57·9′	10° 29·6′	40	763·0	26·05	32·7	2467,1	·9331	− 6·1	0	·9270	·9139	+ 13	+ 18	+ 13	*TR*
131	37° 08·0′	10° 44·0′	66	759·7	26·38	44·4	2407,2	·9564	− 6·1	0	·9503	·9286	+ 22	+ 30	+ 17	*TR*
132	37° 07·9′	11° 09·2′	88	760·2	26·30	55·8	2411,7	·9547	− 6·1	0	·9486	·9284	+ 20	+ 31	+ 12	*TR*
133	36° 45·4′	12° 04·7′	298	762·5	25·60	62·2	2460,4	·9357	− 6·1	+ 3·6	·9332	·8960	+ 37	+ 75	+ 40	*T*
134	36° 41·2′	12° 17·0′	737	762·3	25·53	44·4	2587,4	·8863	− 6·1	+ 3·6	·8838	·8899	− 6	+ 83	+ 41	*T*
135	36° 39·0′	12° 28·6′	717	761·7	25·53	41·5	2626,7	·8711	− 6·1	+ 3·6	·8686	·8867	− 18	+ 68	+ 25	*T*
136	36° 39·5′	14° 03·7′	493	765·0	25·60	44·4	2648,0	·8629	− 6·1	+ 3·4	·8602	·8874	− 27	+ 31	− 3	*TR*
137	36° 26·6′	14° 11·2′	390	763·8	25·60	41·5	2659,5	·8584	− 6·1	+ 3·4	·8557	·8689	− 13	+ 33	0	*T*
138	36° 17·0′	14° 19·1′	295	764·5	25·77	46·6	2685,0	·8483	− 6·1	0	·8422	·8551	− 13	+ 24	− 9	*T*
139	36° 04·0′	14° 24·0′	87	763·3	25·80	23·5	2600,2	·8814	− 6·1	0	·8753	·8365	+ 39	+ 50	+ 21	*T*
140	36° 16·3′	14° 37·3′	79	764·5	29·02	51·3	2601,5	·8809	− 6·1	0	·8748	·8540	+ 21	+ 33	+ 4	
141	36° 09·5′	15° 06·2′	60	760·7	28·20	37·5	2555,3	·8988	− 6·1	0	·8935	·8444	+ 49	+ 58	+ 9	*FR*
142	36° 28·5′	14° 51·5′	63	761·5	28·90	19·7	2487,2	·9253	− 6·1	0	·9192	·8716	+ 48	+ 58	+ 28	
143	35° 43·3′	15° 21·2′	167	759·7	27·38	34·7	2671,7	·8535	− 6·1	0	·8474	·8070	+ 40	+ 63	+ 4	
144	35° 46·5′	15° 09·0′	63	762·5	27·22	23·0	2638,3	·8666	− 6·1	0	·8617	·8115	+ 50	+ 59	+ 12	*F*
145*a*	36° 05·8′	18° 46·0′	2027	757·9	28·65	38·9	2662,6	·8570	− 6·1	0	·8509	·8391	+ 13	+272	+ 32	*R*
145*b*	36° 07·1′	18° 46·0′	2057	758·3	28·65	78·9	2653,7	·8604	− 6·1	0	·8543	·8409				*R*
146*a*	36° 00·5′	19° 47·0′	1727	758·4	28·85	67·9	2885,4	·7706	− 6·1	0	·7645	·8315	− 66	+154	− 54	*R*
146*b*	35° 58·7′	19° 47·0′	1736	756·9	28·93	59·1	2876,0	·7742	−10·0	0	·7642	·8289				*R*
147	35° 54·6′	20° 50·0′	1566	759·2	29·03	63·7	3003,8	·7245	−10·0	0	·7145	·8230	−108	+ 92	−101	
148	35° 39·2′	22° 36·2′	2040	757·4	27·60	52·9	3308,7	·6063	−10·0	0	·5963	·8011	−205	+ 24	−154	
149	36° 18·4′	23° 26·2′	344	757·2	26·85	54·0	2558,9	·8974	− 6·1	0	·8913	·8572	+ 34	+ 84	+ 32	
150	36° 49·9′	24° 17·7′	264	757·7	28·73	36·8	2317,0	·9914	− 6·1	0	·9853	·9024	+ 83	+116	+ 85	
151	37° 14·0′	24° 46·5′	140	757·4	29·23	77·3	2281,4	·0051*	− 6·1	0	·9990	·9372	+ 62	+ 80	+ 62	
152	37° 35·4′	25° 21·5′	356	756·2	28·20	60·5	2346,9	·9799	− 6·1	0	·9738	·9683	+ 6	+ 49	+ 31	
153	37° 59·2′	25° 58·0′	183	756·4	26·90	45·5	2153,3	·0551*	− 6·1	0	·0490*	·0029*	+ 46	+ 70	+ 51	
154	37° 35·3′	26° 47·1′	48	760·0	26·37	33·9	2292,6	·0009*	− 2·7	0	·9982	·9682	+ 30	+ 37	+ 34	
155	37° 11·6′	26° 33·4′	155	760·5	26·88	58·3	2366,4	·9723	− 6·1	0	·9662	·9338	+ 32	+ 52	+ 40	
156	36° 45·3′	26° 39·4′	303	757·9	26·15	50·5	2390,5	·9629	− 6·1	0	·9568	·8959	+ 61	+ 99	+ 76	
157	36° 15·7′	26° 53·6′	162	756·7	26·83	61·1	2381,6	·9664	− 6·1	0	·9603	·8533	+107	+131	+ 91	
158	36° 42·3′	28° 24·2′	121	754·1	25·32	61·3	2761,0	·8190	− 6·1	0	·8129	·8915	− 79	− 61	− 62	*R*
159	35° 51·0′	28° 34·0′	2400	756·4	26·78	39·6	3346,1	·5915	− 6·1	0	·5854	·8179	−233	+ 49	−109	
160	35° 14·0′	28° 56·6′	1700	755·7	27·20	50·1	3163,6	·6624	− 6·1	0	·6563	·7653	−109	+102	− 68	
161	34° 40·6′	29° 19·0′	1330	757·9	27·35	29·7	3272,0	·6202	− 6·1	0	·6141	·7183	−104	+ 66	− 91	
162	32° 53·4′	30° 25·2′	1230	755·9	25·90	44·0	3435,2	·5570	−10·0	0	·5470	·5694	− 22	+132	+ 1	
162	(second visit)		—	753·1	28·28	60·6	3442,8	·5540	−10·0	0	·5440	·5694	− 25			
163	33° 28·5′	30° 01·7′	1550	756·9	26·58	44·2	3372,1	·5815	−10·0	− 1·8	·5697	·6177	− 48	+146	− 16	
164	34° 05·7′	29° 38·3′	1730	755·1	27·20	49·5	3339,9	·5941	−10·0	− 1·8	·5823	·6694	− 87	+120	− 55	
165	36° 28·9′	28° 13·8′	260	760·0	26·62	24·7	2790,2	·8075	− 6·1	0	·8014	·8722	− 71	− 37	− 66	
166	36° 06·1′	29° 15·8′	750	754·6	27·75	31·3	2783,8	·8101	− 6·1	− 6·0	·7980	·8395	− 42	+ 63	− 40	
167	36° 03·2′	30° 17·6′	1640	755·1	28·18	46·5	3161,5	·6631	− 6·1	0	·6570	·8355	−179	+ 6	− 77	

TABLE 5 (*cont.*)

station no.	lat. N	long. E	depth of water (fathoms)	pressure (mm Hg)	temp. (° C)	T_1-T_3 (10^{-7} s)	mean T (s)	g (cm/s²)	corrections to g (0·001 cm./s²) depth	Eötvös	g_0'' (cm/s²)	γ_0' (cm/s²)	$g_0''-\gamma_0'$ (mgals)	Bouguer anomaly (mgals)	isostatic anomaly (mgals)	notes
							0·504,	979·			979·	979·				
168	36° 45·6′	30° 52·8′	110	753·6	29·70	63·0	2663,3	·8568	− 6·1	0	·8507	·8963	− 46	− 26	− 3	
169	36° 13·2′	31° 04·5′	1370	751·6	28·53	55·8	2888,5	·7693	− 6·1	− 0·9	·7623	·8497	− 87	+ 83	− 14	
170	35° 38·1′	31° 11·3′	1420	755·9	28·17	39·5	3187,9	·6529	− 6·1	− 3·0	·6438	·7995	−156	+ 19	−111	
171	35° 02·2′	31° 18·2′	1270	755·1	28·40	58·6	3239,2	·6330	− 6·1	0	·6269	·7487	−122	+ 36	− 98	
172	34° 28·8′	32° 15·2′	1520	752·3	28·58	59·7	3305,6	·6075	− 6·1	0	·6014	·7015	−100	+ 75	− 36	
173	33° 18·0′	31° 48·4′	1020	755·1	28·05	69·9	3367,8	·5832	− 6·1	0	·5771	·6032	− 26	+104	− 14	*R*
174	33° 52·2′	31° 41·6′	1450	753·9	27·80	49·8	3175,7	·6576	− 6·1	0	·6515	·6506	+ 1	+176	+ 37	
175*a*	34° 29·0′	31° 32·0′	1330	752·1	28·02	53·3	3334,1	·5963	− 6·1	0	·5902	·7019	−113	+ 52	− 83	*R*
175*b*	34° 30·8′	31° 32·0′	1345	750·1	28·07	74·1	3335,0	·5958	− 6·1	0	·5897	·7045				*R*
176	36° 30·6′	31° 41·5′	810	755·1	28·80	52·8	2762,0	·8183	− 6·1	− 3·0	·8092	·8824	− 73	+ 31	+ 19	
177	35° 55·5′	31° 51·5′	1400	752·9	28·77	53·1	2971,3	·7371	− 6·1	− 3·0	·7280	·8243	− 96	+ 75	− 20	*RU*
178	35° 17·0′	31° 50·5′	1330	749·6	29·17	15·8	3079,6	·6950	− 6·1	0	·6889	·7696	− 81	+ 86	− 32	*RU*
179	35° 28·4′	32° 21·6′	1070	751·8	28·83	−13·8	2829,4	·7924	− 6·1	0	·7863	·7858	+ 1	+135	+ 50	*RU*
180	35° 42·0′	32° 51·0′	730	753·9	28·70	71·9	2783,6	·8100	− 6·1	0	·8039	·8051	− 1	+ 91	+ 48	*R*
181	35° 38·6′	33° 27·0′	570	753·6	28·38	12·1	2812,2	·7991	− 6·1	+ 1·1	·7941	·8002	− 6	+ 66	+ 38	*RU*
182	36° 26·2′	34° 46·2′	80	754·9	29·50	18·7	2852,4	·7834	− 6·1	0	·7773	·8683	− 91	− 80	− 71	*U*
183	36° 10·2′	35° 01·5′	160	753·9	30·00	6·2	2752,6	·8224	− 6·1	0	·8163	·8454	− 29	− 8	− 13	*U*
184	35° 48·5′	35° 14·7′	710	755·9	29·98	84·6	2881,7	·7720	− 6·1	0	·7659	·8144	− 49	+ 36	+ 10	*U*
185	35° 20·7′	35° 30·1′	570	755·1	29·97	55·2	3011,0	·7217	− 6·1	0	·7156	·7838	− 68	+ 4	− 27	
186	33° 55·4′	35° 29·1′	170	756·4	27·70	40·5	3073,8	·6973	− 6·1	−18·0	·6732	·6552	+ 18	+ 47	+ 44	
187	34° 13·1′	35° 10·5′	980	751·1	28·83	65·8	3293,6	·6122	−10·0	0	·6022	·6797	− 78	+ 44	− 14	
188	34° 30·3′	34° 49·1′	970	746·5	29·43	45·3	3240,9	·6323	−10·0	0	·6223	·7076	− 85	+ 34	− 45	
189	34° 52·6′	34° 31·1′	630	746·0	29·30	45·3	3044,1	·7088	−10·0	0	·6988	·7351	− 36	+ 43	− 18	
Famagusta *a*	35° 07·4′	33° 56·6′	—	753·1	27·55	72·9	2561,4	·8964	—	0	·8964	·7560	+138	+140	+115	
Famagusta *b*	35° 07·4′	33° 56·6′	—	753·1	27·23	63·2	2570,5	·8929	—	0	·8929	·7560				
Famagusta *c*	35° 07·4′	33° 56·6′	—	752·6	26·92	51·0	2569,8	·8932	—	0	·8932	·7560				
190	35° 12·2′	33° 58·5′	120	762·0	25·37	46·9	2594,6	·8839	− 6·1	0	·8778	·7628	+115	+132	+108	
191	34° 21·0′	33° 25·0′	590	755·9	28·53	49·6	3223,3	·6391	− 6·1	+ 3·0	·6360	·6907	− 55	+ 24	− 48	
192	33° 55·3′	33° 51·0′	1200	753·1	28·67	52·8	3345,4	·5919	− 6·1	+ 3·0	·5888	·6548	− 66	+ 83	− 23	
193	33° 32·3′	34° 17·5′	1070	756·9	29·23	41·1	3379,0	·5789	− 6·1	+ 3·0	·5758	·6229	− 47	+ 85	− 9	
194	33° 14·5′	34° 34·5′	855	757·9	29·17	52·9	3405,1	·5687	− 6·1	+ 3·0	·5656	·5984	− 33	+ 74	+ 4	
195	33° 12·0′	32° 46·3′	820	756·2	28·40	45·6	3358,6	·5868	− 6·1	+ 1·8	·5825	·5950	− 13	+ 94	− 1	
196	32° 42·4′	32° 38·0′	730	756·5	28·58	39·9	3440,9	·5548	− 6·1	+ 1·8	·5505	·5544	− 4	+ 88	+ 10	
197	32° 20·5′	32° 28·5′	565	754·9	28·68	35·7	3589,2	·4971	− 6·1	+ 1·8	·4928	·5246	− 32	+ 40	− 18	
198	31° 53·4′	32° 19·0′	55	755·1	28·75	39·4	3584,0	·4991	− 6·1	+ 1·8	·4948	·4880	+ 7	+ 14	− 15	
199	32° 00·6′	30° 56·0′	75	756·9	28·60	48·5	3403,0	·5695	− 6·1	0	·5634	·4977	+ 66	+ 77	+ 39	
200	32° 24·2′	30° 38·4′	815	751·6	28·52	40·6	3462,5	·5464	− 6·1	0	·5403	·5296	+ 11	+112	+ 29	

201	32° 43·5′	28° 23·0′	1630	756·9	27·40	38·2	3547,5	·5134	− 6·1	0	·5073	·5559	− 49	+155	− 23	
202	33° 24·1′	27° 54·2′	1735	755·1	27·73	(46·4)	3604,0	·4932	− 6·1	0	·4826	·6117	−126	+ 85	− 99	*Z*
203	34° 11·5′	27° 26·1′	1430	756·5	28·20	54·6	3536,9	·5175	− 6·1	0	·5114	·6775	−166	+ 14	−145	
204	34° 52·4′	26° 57·0′	1595	757·7	28·48	32·5	3355,7	·5879	− 6·1	0	·5818	·7349	−153	+ 29	− 92	
205	35° 40·5′	26° 27·7′	970	756·1	27·53	35·4	2835,6	·7900	− 6·1	0	·7839	·8030	− 19	+ 97	+ 27	
Candia *a*	35° 20·5′	25° 08·3′	—	757·2	29·60	92·4	2700,3	·8423	—	0	·8423	·7750	+ 66	+ 70	+ 41	
Candia *b*	35° 20·5′	25° 08·3′	—	757·2	29·45	42·9	2706,5	·8398	—	0	·8398	·7750				
206	35° 43·1′	25° 33·9′	470	757·7	26·77	28·7	2529,9	·9089	− 6·1	0	·9028	·8067	+ 96	+157	+ 96	
207	35° 24·5′	26° 00·0′	400	755·6	29·35	71·5	2805,1	·8018	−10·0	0	·7918	·7802	+ 12	+ 63	+ 10	
208	35° 15·2′	26° 35·0′	305	756·9	28·77	31·9	2913,6	·7596	−10·0	0	·7499	·7671	− 17	+ 27	− 44	*F*
209	34° 54·4′	25° 56·3′	580	755·1	27·50	41·7	3039,5	·7158	− 6·1	0	·7097	·7376	− 28	+ 44	− 21	
210	34° 29·1′	25° 55·8′	1645	756·0	27·80	47·9	3394,6	·5728	− 6·1	0	·5667	·7020	−135	+ 61	− 78	
211	34° 02·2′	25° 56·2′	1540	755·4	28·20	41·9	3430,5	·5588	− 6·1	0	·5527	·6645	−112	+ 77	− 84	
212	33° 12·6′	25° 56·2′	1310	753·9	28·42	39·5	3544,7	·5144	− 6·1	0	·5083	·5958	− 88	+ 80	− 74	
213	33° 24·8′	24° 04·0′	1080	755·1	28·82	47·1	3466,8	·5447	− 6·1	0	·5386	·6127	− 74	+ 61	− 59	
214	34° 10·5′	24° 08·8′	930	755·4	28·15	45·6	3449,6	·5514	− 6·1	0	·5453	·6761	−131	− 4	−128	
215	34° 48·7′	24° 14·0′	240	753·8	27·72	33·6	2914,7	·7593	− 6·1	0	·7532	·7297	+ 24	+ 64	− 21	
216	34° 54·2′	23° 27·6′	1640	754·4	27·52	35·2	3391,6	·5739	− 6·1	0	·5681	·7374	−169	+ 32	−123	*F*
217	35° 13·6′	21° 54·2′	1830	752·1	27·03	31·2	3255,5	·6268	− 6·1	0	·6207	·7647	−144	+ 85	−119	
218	34° 43·0′	21° 11·0′	1400	754·3	27·20	37·8	3137,1	·6726	− 6·1	0	·6665	·7216	− 55	+125	− 68	
219	34° 54·7′	19° 55·8′	1650	756·2	28·18	37·3	2969,3	·7379	− 6·1	0	·7318	·7381	− 6	+202	+ 1	
220	35° 12·0′	18° 31·0′	2125	759·5	29·75	44·6	2876,0	·7742	− 6·1	0	·7681	·7625	+ 6	+266	+ 27	
221	35° 37·0′	16° 01·7′	1940	759·5	28·93	34·9	2999,8	·7261	− 6·1	0	·7200	·7980	− 78	+142	− 4	
222	36° 01·3′	14° 45·3′	72	763·5	24·40	57·1	2602,3	·8805	− 6·1	0	·8744	·8326	+ 42	+ 54	+ 22	

Notes. g''_0 = value of gravity at the station, reduced to sea-level.

γ'_0 = value of gravity at sea-level at the station given by the International Gravity Formula.

$g''_0 - \gamma'_0$ = free-air anomaly.

F = first order correction for poor depth-keeping has been applied between g and g''_0 columns. Station no. 141, +0·8 mgal; no. 144, +1·2 mgals; no. 208, +0·3 mgal; no. 216, +0·3 mgal.

R = rotation of the pendulums occurred. See text, p. 543.

S = sidereal chronometer only in use. Uncertainty ±20 mgals.

T = dividing circuits may have been slipping. See p. 538. r.m.s. error in g ±5 mgals.

U = unstabilized observation.

X = sidereal chronometer only in use and not wound. Unreliable.

Z = apparatus bumped accidentally. Only one pendulum recorded, difference assumed to be the same as the mean for other stabilized observations at sea.

* = these figures to be preceded by 980.

TABLE 6. ISOSTATIC REDUCTION OF GRAVITY STATIONS OCCUPIED BY CASSINIS IN 1935. AIRY-HEISKANEN HYPOTHESIS $T=30$ KM

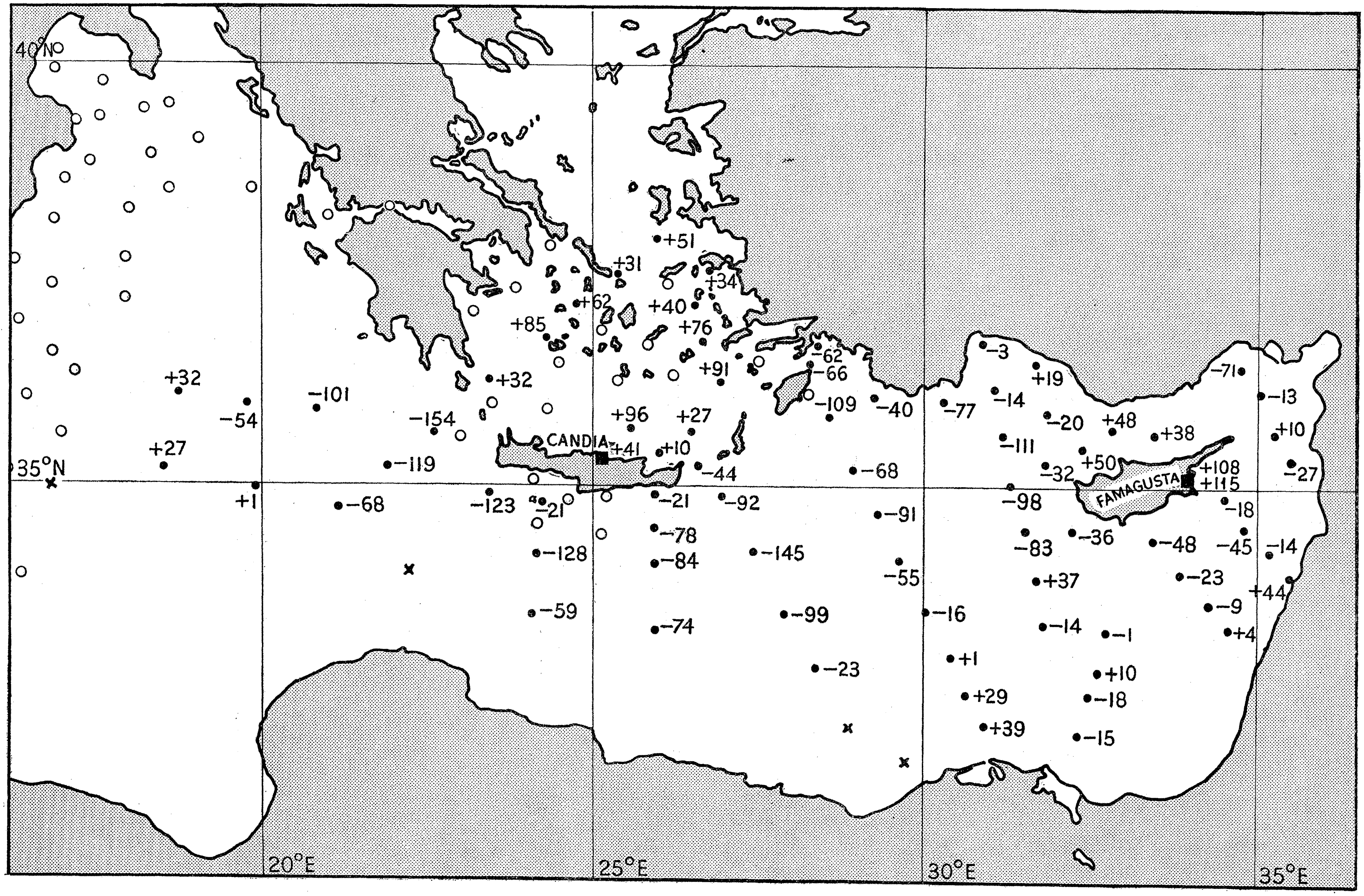
				corrections to theoretical gravity in units of 10^{-4} gal			anomalies (in mgals)		
station no.	lat. N	long. E	depth of water (fathoms)	top $A-O$	comp. $A-O$	top+comp. 18−1	free-air	Bouguer	isostatic
Cagliari	39° 12·6′	09° 06·9′	4	+ 17	− 133	− 108	+ 16	+ 18	− 6
1	39° 02·2′	09° 05·8′	19	+ 24	− 243*	− 100	+ 3	+ 5	− 29
2	37° 46·0′	10° 00·0′	331	+ 415	− 259	− 72	+ 4	+ 46	+ 12
3	36° 51·5′	11° 20·4′	85	+ 104	− 119	− 56	+ 21	+ 13	+ 14
4	35° 12·0′	12° 08·0′	30	+ 38	− 78	− 39	+ 16	+ 20	+ 8
5	33° 40·0′	12° 47·0′	87	+ 110	− 58	− 21	− 15	− 4	− 12
Tripoli	32° 54·3′	13° 11·0′	4	+ 5	+ 58	− 17	+ 8	+ 9	+ 13
6	33° 24·6′	13° 55·0′	246	+ 309	− 214	− 42	− 16	+ 15	− 11
7	34° 31·5′	15° 04·0′	164	+ 206	− 300	− 98	+ 28	+ 49	+ 9
8	34° 30·0′	13° 39·0′	230	+ 288	− 275	− 60	+ 18	+ 47	+ 13
9					see tables 4 and 5				
10	35° 50·2′	13° 22·7′	169	+ 499	− 355	− 60	+ 19	+ 69	+ 27
11	36° 30·0′	13° 49·5′	194	+ 248	− 265	− 89	+ 3	+ 28	− 8
12	36° 55·0′	14° 12·0′	153	+ 191	− 35	−101	+ 13	+ 32	+ 19
13	36° 48·7′	15° 34·6′	1580	+1752	− 965	−108	− 63	+112	+ 5
Augusta	37° 13·8′	15° 14·3′	4	+ 33	− 275	−106	+123	+126	+116
14	37° 21·5′	15° 21·5′	1104	+1196	− 465	−106	− 32	+ 88	+ 31
15	36° 21·0′	16° 05·8′	1815	+2276	−1769	−103	− 45	+183	− 5
16	35° 07·6′	16° 09·2′	831	+ 940	− 692	−113	− 10	+ 84	+ 4
17	33° 50·9′	16° 20·8′	869	+1092	− 913	−105	− 24	+ 85	− 17
Taranto	40° 29·0′	17° 15·0′	5	+ 10	+ 48	− 37	+ 53	+ 54	+ 55
18	39° 56·5′	17° 38·2′	347	+ 786	− 296	− 65	+ 35	+114	+ 78
19	39° 25·2′	18° 14·7′	667	+ 838	− 600	− 65	− 25	+ 59	− 8
20	38° 21·5′	21° 55·8′	150	+ 189	+ 373	− 91	−142	−123	− 95
21	37° 56·9′	22° 57·1′	15	+ 43	+ 160	− 76	+ 2	+ 6	+ 15
22	37° 55·9′	22° 58·3′	4	+ 16	+ 160	− 76	0	+ 2	+ 10
Athens	37° 56·3′	23° 38·3′	4	+ 9	+ 39	− 60	+ 83	+ 84	+ 82
23	37° 23·0′	23° 49·3′	194	+ 244	− 139	− 73	+ 93	+117	+ 96
24	37° 06·5′	23° 11·8′	205	+ 258	− 37	− 85	+ 70	+ 96	+ 84
25	36° 30·0′	24° 30·5′	262	+ 330	− 259	− 80	+113	+146	+112
26	36° 53·0′	25° 08·0′	77	+ 96	− 134	− 50	+121	+131	+112
27	36° 44·0′	25° 51·0′	309	+ 388	− 219	− 47	+ 98	+137	+110

Leros	37° 07·6′	26° 51·4′	7	+ 8	− 20	− 16	+ 95	+ 96	+ 92
28	36° 22·6′	26° 14·0′	273	+ 343	− 280	− 57	+116	+150	+117
29	36° 17·9′	25° 23·8′	164	+ 206	− 336	− 73	+131	+152	+111
30	35° 56·9′	24° 20·0′	525	+ 659	− 473	− 91	+ 84	+150	+ 94
31	36° 00·1′	23° 30·5′	722	+ 913	− 542	− 96	− 32	+ 59	− 5
32	35° 35·2′	23° 02·1′	1143	+1435	−1235	−106	−100	+ 44	− 91
33	35° 03·8′	24° 08·4′	798	+ 947	− 510	−108	− 59	+ 36	− 26
34	34° 32·0′	24° 11·0′	1673	+1942	−1108	−100	−151	+ 43	− 78
35	34° 50·9′	24° 38·9′	1378	+1517	− 956	−115	−108	+ 44	− 63
36	34° 25·0′	25° 07·8′	875	+1100	−1089	−112	− 15	+ 95	− 25
37	34° 52·1′	25° 12·2′	957	+1122	− 594	−103	− 41	+ 71	+ 2
38					see tables 4 and 5				
39	36° 09·0′	28° 14·1′	506	+ 655	− 616	− 58	− 51	+ 15	− 53
Rhodes	36° 27·0′	28° 16·3′	3	+ 6	− 295	− 49	− 19	− 18	− 53
40	36° 32·2′	27° 31·4′	342	+ 429	− 192	− 47	− 8	+ 35	+ 11
41	37° 27·6′	26° 06·3′	328	+ 412	− 130	− 17	+ 26	+ 67	+ 53
42					see tables 4 and 5				
43	37° 21·0′	24° 57·7′	55	+ 69	− 135	− 40	+ 86	+ 93	+ 75
44	37° 53·9′	24° 21·7′	63	+ 79	− 105	− 40	+ 70	+ 78	+ 63
45	38° 15·2′	20° 58·8′	52	+ 65	− 116	− 97	− 83	− 76	− 98
46	38° 33·2′	19° 52·5′	1044	+1336	−1108	− 90	− 61	+ 73	− 47
47	38° 32·8′	18° 37·8′	1695	+2072	−1533	− 92	− 73	+134	− 28
48	39° 19·5′	17° 12·2′	415	+ 522	− 198	− 83	− 44	+ 8	− 20
49	40° 08·2′	16° 55·6′	317	+ 398	− 30*	− 74	− 39	+ 1	− 10

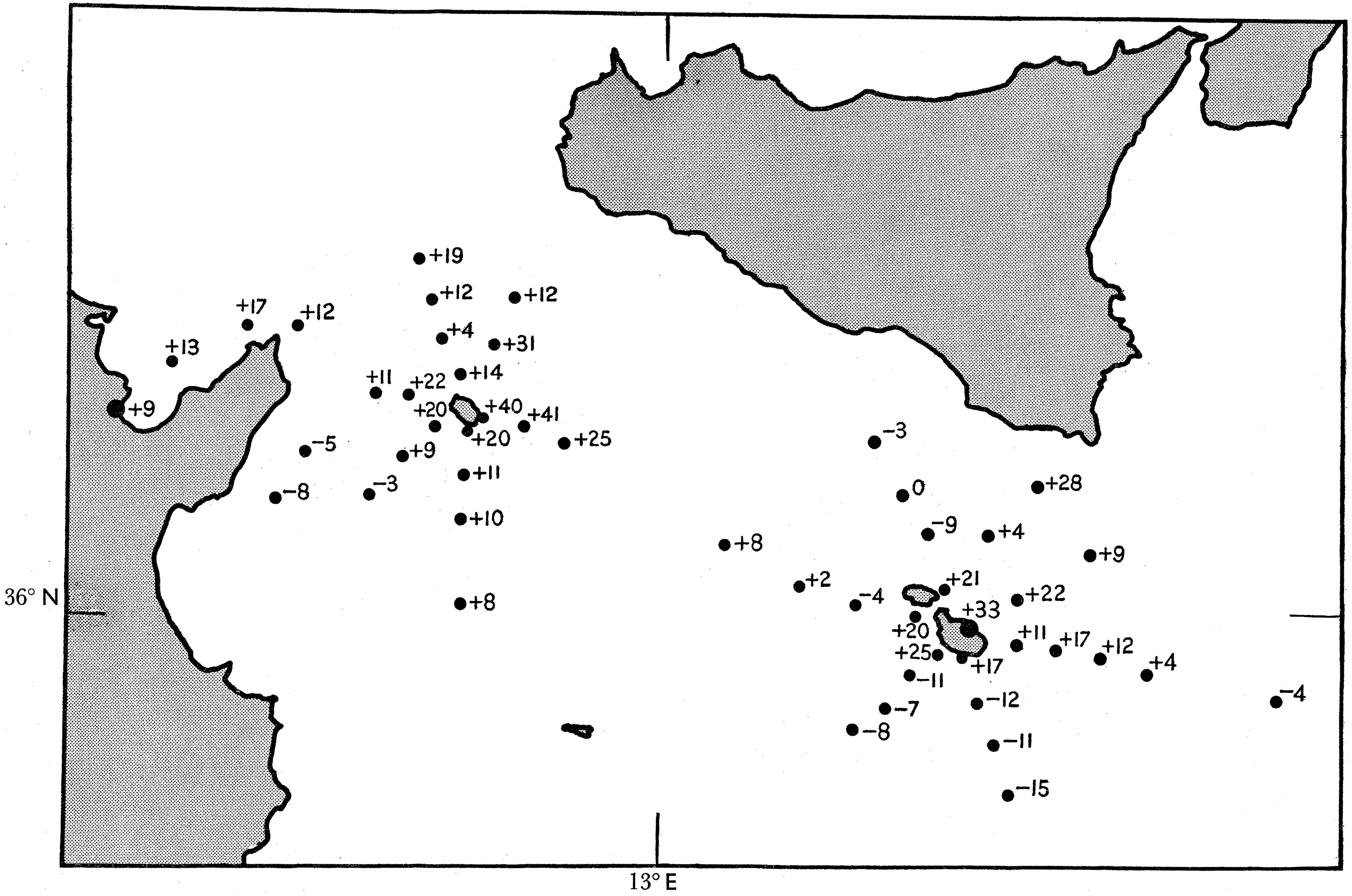
* Interpolated value, less accurate than computed reduction.

Cagliari and Taranto were reduced by Coster (1945).

All gravity values based on g (Genoa, Istituto Idrografico) $= 980{\cdot}557$ cm./s^2



Map 2. Isostatic anomalies in the eastern Mediterranean. Units mgals. Airy-Heiskanen hypothesis with $T = 30$ km.
● present survey; ○ Cassinis 1931 and 1935; × Vening Meinesz.



Map 3. Isostatic anomalies in the Malta-Pantelleria area. Units mgals. Airy-Heiskanen hypothesis with $T=30$ km.

it is fairly certain that no storms of great size are likely to be encountered during the period of the cruise. The automatic depth-recorder requires careful handling but is probably worth retaining for measurements being made in the fore-ends of the submarine.

There is evidently room for improvement in the design of the dividing circuits in the frequency standard which was used, and it is clearly unwise to rely on a single standard only. A reliable beat counter should be installed between two 1000 c/s outputs to ensure that no slips occur at any time without being noticed.

The uncertainty in the Eötvös correction remains the principal source of error in deep water away from land. No satisfactory method of overcoming this defect has so far been proposed. Although the vibration gravimeter described by Gilbert (1949) offers considerable advantages for submarine work, it appears from this work that the Vening Meinesz pendulum apparatus is as accurate as is necessary when all other sources of error, affecting all types of gravity-measuring instruments, are taken into account. It is not clear that the vibration gravimeter and its electrical equipment would be any less bulky or that the problem of its maintenance would be any easier. On the other hand, it would present the advantage of immediateness of reading and of being less affected by wave disturbance, on account of its much higher frequency (1000 c/s).

The interpretation of the results will be discussed in a separate paper.

Our thanks are primarily due to the Royal Society for sponsoring and financing the expedition; to the Lords Commissioners of the Admiralty for allocating H.M. Submarine *Talent* to undertake the work, and to Professor N. E. Nørlund and the Danish Geodetic Institute for lending us once again their Vening Meinesz pendulum apparatus. Special mention must be made of the Hydrographer of the Navy, the Flag Officer Submarines, the Admiral in charge of Malta Dockyard and the Captain of H.M.S. *Forth* and their staffs, both naval and civilian. Lt.-Cdr F. W. Challis, D.S.O., R.N., who was in command of H.M. Submarine *Talent*, and all his officers and men contributed much to the success of the expedition by their co-operation. The specialist navigating officer, Lt.-Cdr (N) R. N. Stanbury, D.S.O., R.N., was untiring in his careful and accurate observations.

Professors W. A. Heiskanen and E. Niskanen arranged for the calculation of many of the isostatic reductions in the International Isostatic Institute at Helsinki. Special measurements of gravity were made at Malta by arrangement with Dr G. P. Woollard and at Famagusta by the Iraq Petroleum Company, to confirm that the lengths of the pendulums had not changed during the survey. Dr H. F. P. Herdmann, of the British Museum of Natural History, made extensive soundings in the area during the summer cruise of R.R.S. *Discovery*.

One of the authors (R. I. B. C.) wishes to thank the General Board of Cambridge University for granting him leave of absence to conduct the expedition. J. C. Harrison is receiving a grant from the Department of Scientific and Industrial Research and Dr P. L. Willmore is the holder of an Imperial Chemical Industries Research Fellowship. All the authors acknowledge with gratitude the advice and assistance which they have received from Mr B. C. Browne.

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