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RECORD NO. 1968/5

SUB-BASE NETWORK FOR DETAILED GRAVITY SURVEY EAST OF COOTAMUNDRA,

NEW SOUTH WALES 1967

by

R.J.S. COOKE

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SUMMARY

A sub-base network to control a detailed gravity survey in the Cootamundra area is described, and the measured gravity intervals are tabulated. These intervals were observed with respect to Cootamundra Railway Station, which has a gravity station tied into the Isogal datum. A contoured Bouguer anomaly map based upon the sub-base stations and existing helicopter stations shows that the helicopter reconnaissance survey had defined the anomaly quite accurately.

Discrepancies between intervals measured with La Coste and Romberg gravity meter G101 and Worden meter 61 are investigated and discussed in an appendix. These meters were used respectively for establishing the sub-base network and the detailed survey. The larger discrepancies are usually attributable to insufficient control of Worden 61 following resetting. However, remaining discrepancies are still generally greater than expected.

1. INTRODUCTION

From 9th to 12th January 1967, the author visited the gravity party that was carrying out a detailed survey in the area immediately east of Cootamundra in New South Wales. The object of this detailed survey was to investigate an unusually high Bouguer anomaly discovered during the 1966 Helicopter Gravity Training Survey (Lodwick and Flavelle, in preparation). On the 9th and 10th January, the author worked with the party, reading a number of traverses with Worden gravity meter 61. On 11th and 12th January, working independently, he carried out his main object of establishing a number of sub-base stations within the planned network, using La Coste and Romberg gravity meter G101, which was brought from Canberra for the purpose. The existing gravity station at Cootamundra Railway Station served as primary base. This station, 5904.0013, was established on the Isogal datum by van Son (1966). On 16th February 1967, a further visit was made to Cootamundra to read some additional useful stations, including some not marked by the Department of the Interior at the time of the earlier visit.

As a secondary object this sub-base network could itself be reduced to gravity anomalies as an experiment in resolution with station spacing intermediate between that of the helicopter reconnaissance survey and the detailed survey. Several additional stations, not immediately useful as sub-bases, were read to provide more uniform ground coverage for this purpose. Altogether 27 stations (Plate 1) were tied directly to the Railway Station base.

2. OBSERVED GRAVITY INTERVALS

Table 1 shows adopted gravity intervals between each of the 27 stations and Cootamundra Railway Station.

The 14 stations indicated (*) were tied twice, and the others once. As an indicator of reading accuracy, the histogram of the differences between the two values of a repeated tie is shown below (Figure 1).

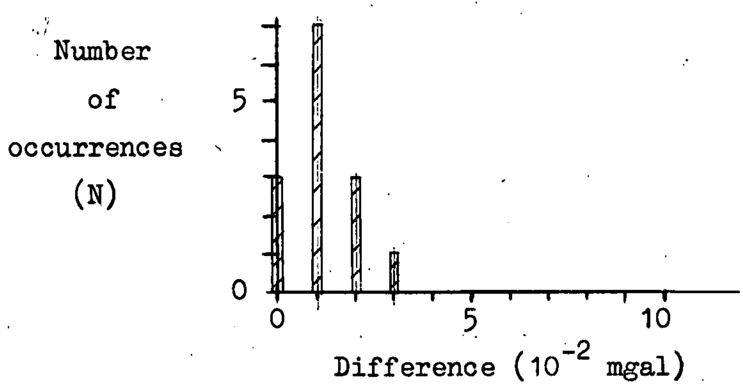


Figure 1

This implies that all adopted intervals for doubly-tied stations are reliable to 0.01 or 0.02 mgal, and by extension, all other adopted intervals also, assuming no misreadings.

However, on comparison of these gravity intervals with those measured by Worden meter 61, discrepancies of up to about ± 0.20 mgal are apparent. These are discussed in the Appendix.

3. GRAVITY ANOMALIES

Using the May 1965 Isogal datum value of gravity at Cootamundra Railway Station of 979, 615.84 mgal, the present data were reduced to Bouguer anomalies for an assumed density of 2.67 g/cm^3. Elevation control by spirit level was provided by the Department of the Interior. Latitudes were obtained by scaling from Australian military maps of the 1:50,000 series, R753. Normal gravity values were based on the 1930 International Ellipsoid (Heiskanen and Vening Meinesz, 1958, p74). Terrain corrections are not applied, these being assumed small for this type of area.

Plate 1 shows the contoured Bouguer anomalies derived solely from the helicopter survey. Plate 2 shows Bouguer anomaly contours derived from both the sub-base survey and helicopter station data. Station spacing from the helicopter survey in this area was about 1 per 30 square miles (cf. nominal value 1 per 50 square miles for idealised helicopter survey), as against a spacing of about 1 per 10 square miles for the combined surveys. Both these surveys are quasi-uniform in station spacing. The detailed survey cannot be compared in areal spacing, as it consisted of line traverses of stations at ¼-mile intervals, with the lines from 3 to 7 miles apart.

Comparison of Plates 1 and 2 shows that the prominent north-south anomaly feature is not much better defined by the additional stations. This is partly a result of chance, in that two helicopter stations happened to be near the peak of the anomaly, but it is also a good indicator of the capacity of the BMR helicopter type of regional survey in detecting features of these dimensions (cf. Vale, 1962).

No geological interpretation or discussion of this gravity feature will be attempted here, as this will be given by Watts (in preparation) on the basis of the detailed survey.

4. REFERENCES

BARLOW, B.C.	1965	The calibration of Gravity Meters. Paper presented to ANZAAS, 1965.
HEISKANEN, W.A., and VENING MEINESZ, F.A.	1958	THE EARTH AND ITS GRAVITY FIELD. McGraw-Hill Book Co., New York.
LODWICK, G.D., and FLAVELLE, A.J.		Preliminary report on 1966 helicopter gravity training survey. Bur. Min. Resour. Aust. Rec. (in preparation).

VALE, K.R.	1962	Reconnaissance gravity surveys using helicopters for oil search in Australia. Bur. Min. Resour. Aust. Rec. 1962/130.
Van SON, J.R.H.	1966	Regional gravity traverses, South-Eastern NSW 1966. Bur. Min. Resour. Aust. Rec. 1966/184.
WATTS, M.D.		Detailed gravity survey east of Cootamundra, NSW. Bur. Min. Resour. Aust. Rec. (in preparation).
WEISSEL, J.K.		Long-term Drift of La Coste and Romberg gravity meters G20 and G101. Bur. Min. Resour. Aust. Rec. (in preparation).

TABLE 1

Gravity intervals relative to Cootamundra Railway Station

Station No.	Gravity interval relative to Station 5904.0013 (mgal)
6619.0001	19.90
.0019	17.51
.0036	16.26
.0067*	48.94
.0094*	23.81
.0125	7.94
.0153*	12.79
.0157	18.97
.0171	-0.44
.0199*	8.06
.0218*	27.65
.0231*	20.90
.0248*	8.06
.0318*	16.62
.0348*	-10.94
.0366	-23.40
.0385	-22.46
.0405	-21.77
.0425*	-21.05
.0506	-16.18
.0529*	-22.62
.0530*	-4.31
.0550*	-5.65
.0568	-18.17
.0583*	-12.95
.0620	6.28
.0684	-12.99

* These stations were tied twice.

TABLE 2

Interval comparisons between Worden 61 and La Coste & Romberg G101 and their relationship with Worden meter drift

Flight No.	Residual drift (10^{-2} mgal)	Drift rate (10^{-2} mgal/hr)	Between-meter discrepancy (10^{-2} mgal)	Station interval compared **
1	*-44½	-18	-21	<u>RS</u> - 318
2	- 4½	- 4	- 8	<u>318</u> -231
3	+ 2	+ 1½	- 7	<u>231</u> -248
4	+ 5	+ 3	+8,+1	<u>231</u> -218,<u>231</u>-199
5	- 5	- 2	-	-
6a	0	0	-	-
6b	*-39	-18	+16	<u>199</u> - 425
7	- 8	- 4	-	-
8	- 3½	- 1½	+ 5	<u>318</u> - 530
9	+ 2	+ 1	-6,-15	<u>231</u>-94, 231-248
10	*-24	-12	+18	<u>67</u> - 94
11	-20½	-10½	- 9	<u>67</u> - 36
12	NDC	-	- 3,0	36 - 19, 19 - 1
13	+ 9	+ 3½	+22,+3,+5	<u>1</u>-171,<u>1</u>-153,<u>1</u>-157
14	- ½	- ½	-	-
15	- 8½	- 8	-	-
16/17	NDC	-	+6,-3,+1	199-153,153-125, 125-67
18/19	*+10	+ 2½	+11,+15,-7	348-366,366-385, 385-405
20	- 8	- 3	+ 2	506-529
21	+ 2½	+ 1	+ 5,-14	550-568,550-583
21a	*+ 5	- 5	-	-

* Reset immediately preceding

** Underlined station used for drift control

NDC No Drift Control

APPENDIX

Interval discrepancies between gravity meters W61 and G101

Twenty-four intervals measured directly by Worden meter 61 in the course of the detailed survey may be compared with intervals measured by La Coste and Romberg meter G101. The distribution of the discrepancies is shown below (Figure 2).

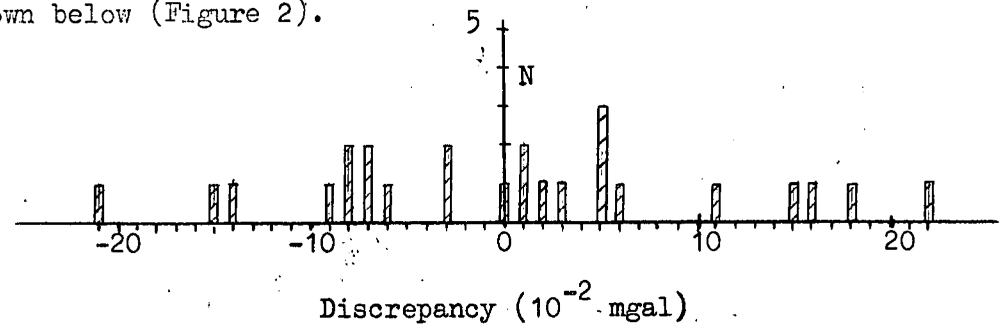


Figure 2

The mean of this distribution, $+0.36 \times 10^{-2}$ mgal, is not significantly different from zero. However, the standard deviation of about 0.10 mgal is much higher than expected in view of the reading accuracies of the instruments, (cf. Fig, 1; the reading accuracy of Worden type instruments is generally about the same as that of the La Coste and Romberg type). A standard deviation nearer to about 0.02 mgal would be anticipated. To test the randomness of these discrepancies, they are plotted against the gravity mean value and interval measured by G101 (Plate 3). No correlation is apparent, indicating that the discrepancies are apparently random, and that the two instrument mean calibration factors are compatible. The latter is also suggested by the zero mean of the discrepancies.

It is well known that La Coste and Romberg gravity meters are subject to very small drift effects. The drift of G101 during an eighteen-month period has been investigated by Weissel (in preparation) and shown to be extremely small and regular. The drift of G101 during the sub-base survey was typically so. The drift of Worden 61 is investigated as a possible contributing cause of the large discrepancy range. The 19 drift-control loops ('flights' in Table 2) measured with Worden 61 are corrected for tidal gravity variation (using annual tables published by the Society of Exploration Geophysicists). The total residual drift, the drift rate, and the between-meter discrepancies observed during each flight are tabulated in Table 2.

Four flights (Nos. 1, 6b, 10, and 11) show extremes of residual drift (see Figure 3).

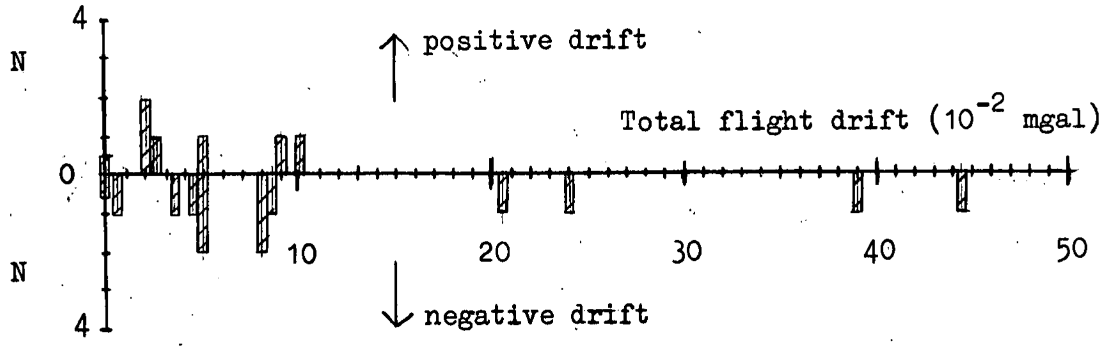


Figure 3

Three of these four abnormal drifts are observed immediately after the resetting of Worden 61, indicating that the meter was not adequately 'shaken down' after the reset. The two other resets (where shakedown was carried out) were not followed by abnormal drifts.

Grouping of between-meter discrepancies without regard to sign (see figure 4) indicates that probably most of the seven discrepancies of 14 x 10^{-2} mgal or greater, are 'abnormal'.

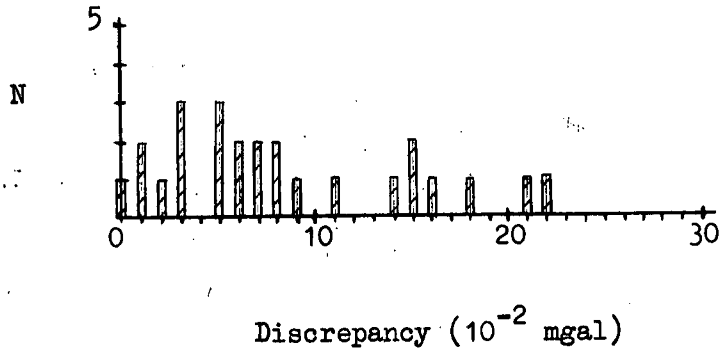


Figure 4

Of these seven, three are associated with the three abnormal drifts of Worden 61 following reset, and in each of these three cases only one interval within the Worden flight could be compared with a G101 value. The other four 'abnormal' discrepancies are, in each Worden flight, associated with other comparison intervals whose discrepancies fall within the normal range (see Table 2). Some of these latter cases may involve a meter reading error on either meter, since only a single reading was made with each. Alternatively, a minor station mislocation may be involved.

Thus 'abnormal' discrepancies between the meters seem to be strongly correlated with abnormal drift in Worden 61.

Association of most of the larger, and probably some of the medium-scale discrepancies, with insufficient drift control, implies that with better drift control, the standard deviation of between-meter discrepancies should be markedly reduced. It seems unlikely though that the expected value of about 0.02 mgal will be even nearly reached. These so far unaccountable discrepancies have been observed previously, and are attributed, at least in part, to an 'environmental effect' by Barlow (1965).

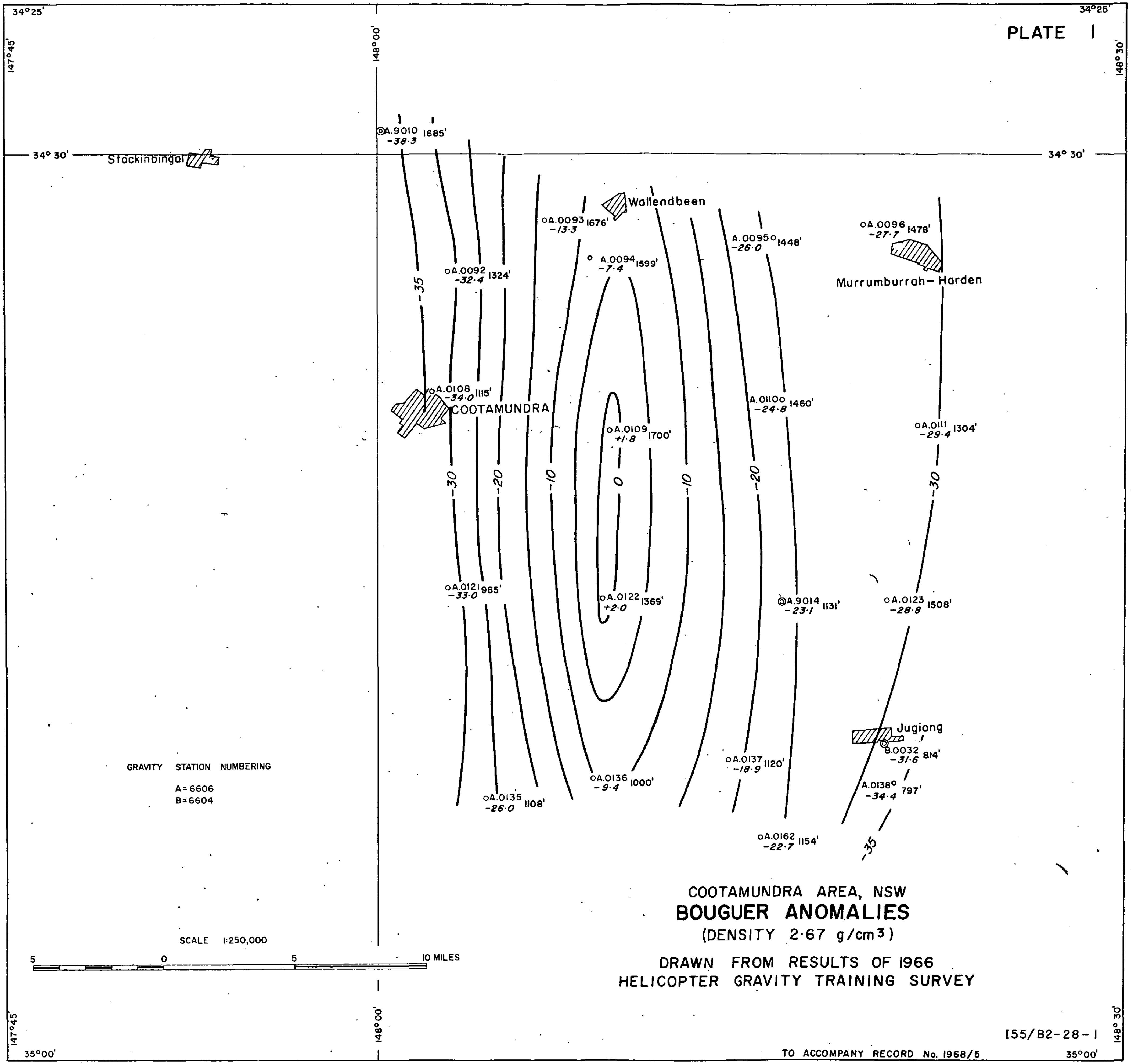
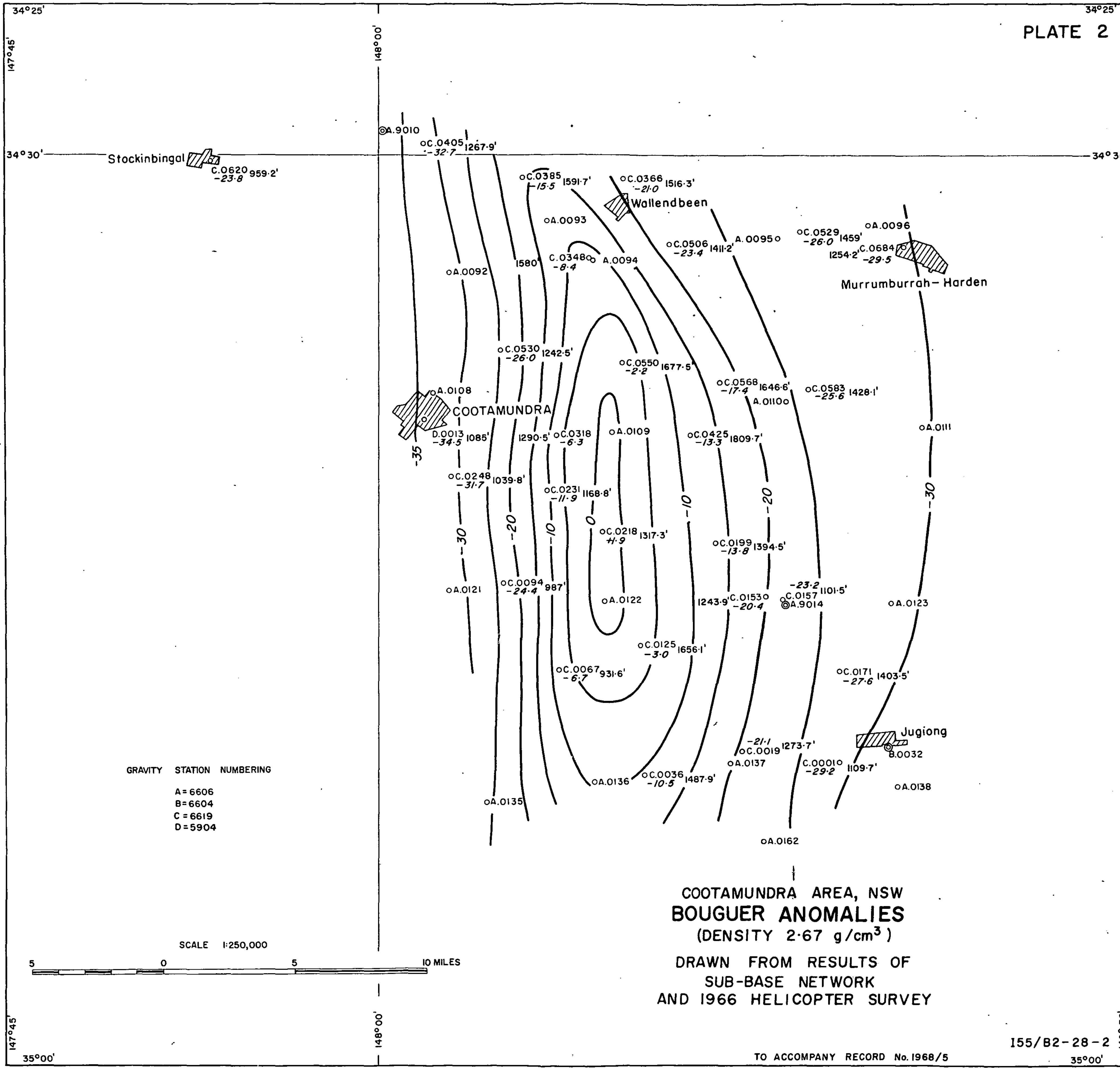


PLATE 1
34°25'
147°45'
148°00'
148°30'
34° 30'
35°00'
Stockinbingal
Wallendbeen
Murrumburrah- Harden
COOTAMUNDRA
Jugiong
A.9010 1685' -38.3
A.0093 1676' -13.3
A.0094 1599' -7.4
A.0095 1448' -26.0
A.0096 1478' -27.7
A.0092 1324' -32.4
A.0108 1115' -34.0
A.0109 1700' +1.8
A.0110 1460' -24.8
A.0111 1304' -29.4
A.0121 965' -33.0
A.0122 1369' +2.0
A.9014 1131' -23.1
A.0123 1508' -28.8
B.0032 814' -31.6
A.0137 1120' -18.9
A.0138 797' -34.4
A.0136 1000' -9.4
A.0135 1108' -26.0
A.0162 1154' -22.7
-35
-30
-20
-10
0
-10
-20
-30
-35
GRAVITY STATION NUMBERING
A=6606
B=6604
SCALE 1:250,000
5 0 5 10 MILES
COOTAMUNDRA AREA, NSW
BOUGUER ANOMALIES
(DENSITY 2.67 g/cm3)
DRAWN FROM RESULTS OF 1966
HELICOPTER GRAVITY TRAINING SURVEY
I55/B2-28-1
TO ACCOMPANY RECORD No. 1968/5



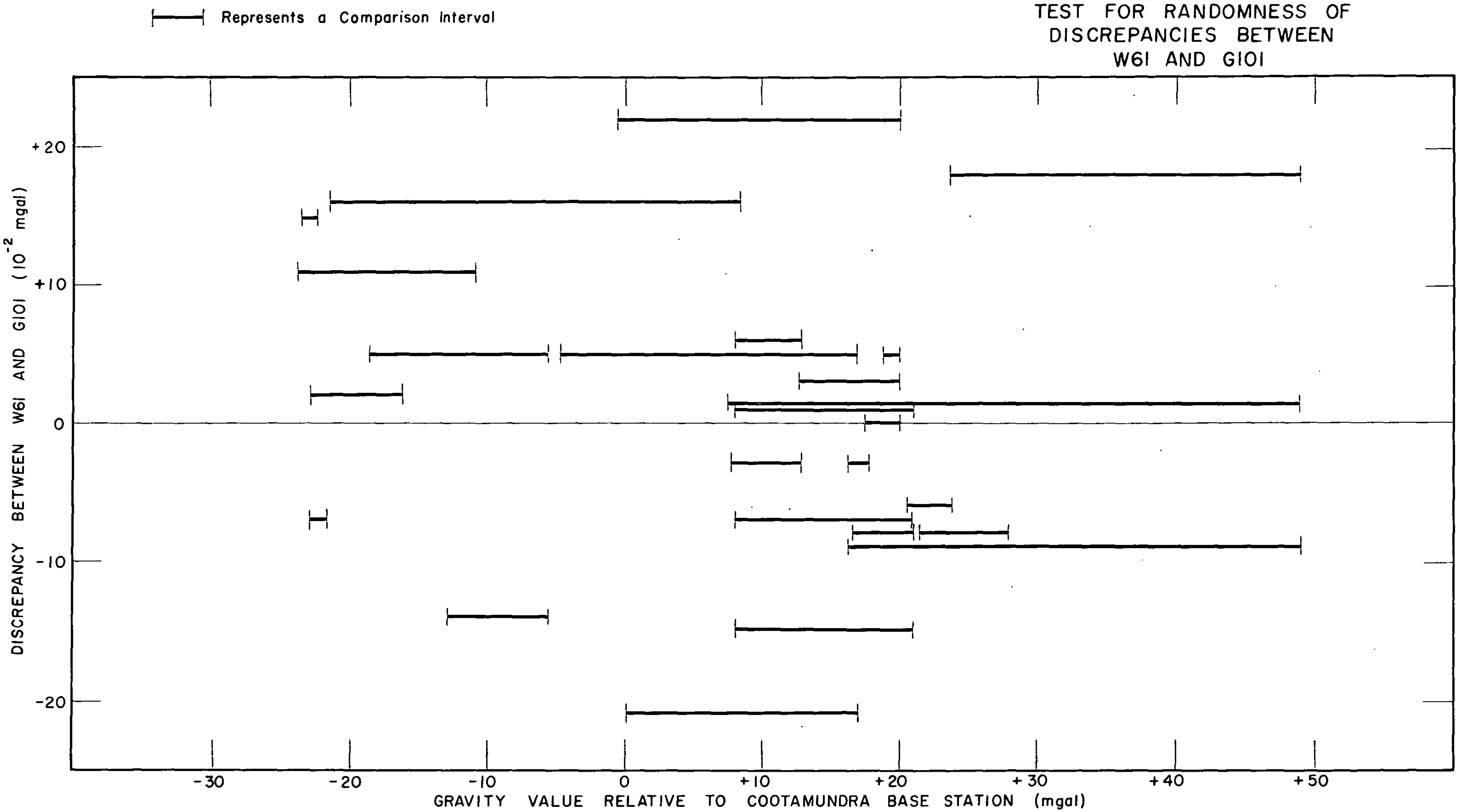
COOTAMUNDRA AREA, NSW

BOUGUER ANOMALIES

(DENSITY 2·67 g/cm³)

DRAWN FROM RESULTS OF SUB-BASE NETWORK AND 1966 HELICOPTER SURVEY

COOTAMUNDRA SURVEY
TEST FOR RANDOMNESS OF DISCREPANCIES BETWEEN W61 AND G101



TO ACCOMPANY RECORD No. 1968/5

155-B2-34

PLATE 3