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BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS

Record No. 1969 / 34

Detailed Gravity Survey, Canberra, December 1967 to February 1968

by

J.R.H. van Son

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ILLUSTRATION

SUMMARY

A detailed gravity survey of the northern part of the Australian Capital Territory and some of the adjacent parts of New South Wales was initiated for the purpose of training university students during their summer vacations. Between December 1967 and February 1968 about 400 stations were read in the city and most of the northern suburbs of Canberra at benchmarks established by the Department of the Interior.

The method of training the students is described, followed by a brief description of certain safeguards made to ensure the accuracy of the readings. Recommendations are made which should improve the training of future students and consequently increase the field production.

1. INTRODUCTION

In December 1967 the Bureau of Mineral Resources started a project to obtain detailed gravity coverage of the northern part of the Australian Capital Territory and adjacent areas of New South Wales. Fieldwork and computations will be carried out entirely by summer vacation students under the guidance of a BMR officer, who will act as party leader. The main objective of the survey is to train students firstly in gravity fieldwork and, after sufficient gravity data have been obtained, in the geological interpretation of the field results.

The area to be covered is ideal for training purposes because of its large variety of topographic features, its relatively small size, and its good geological mapping. During a later stage of the survey special projects can be started such as the study of the effect (if any) of various environmental features on the different types of gravity meters, the study of terrain correction, and the study of the deflection of the vertical.

As the fieldwork and the processing of the data will be carried out only during the summer vacation periods the project will take several years. This report deals with the first stage of the survey, which took place from mid-December 1967 until the end of February 1968. The area covered in this period is the built-up area of Canberra between the northern shoreline of Lake Burley Griffin and the northernmost suburb, Watson.

Over the years a large number (over 1200) of benchmarks, at intervals of approximately 900 feet, have been established by the Department of the Interior in the suburbs of Canberra. These benchmarks are obvious locations for gravity sites. Good detailed maps of Canberra suburbs at scales of 600 feet to the inch and 1000 feet to the inch are also available from the Department of the Interior. Because of this abundance of topographic control in the built-up area of Canberra, it was decided to make this area the starting point of the survey.

Eight gravity meters were available for the survey (see Appendix 1) and two vehicles should have been available but one of them was inoperative for most of the time. Eight students took part in the work (see Appendix 1) under the supervision of J.R.H. van Son.

2. FIELD WORK

Before fieldwork could commence the location of the benchmarks (future gravity stations) were marked on the maps to be used for the survey. The eastings and northings were then scaled off and converted into latitudes (for the normal gravity calculation) and longitudes. This conversion and the normal gravity calculation was done by A.D.P.

The fieldowrk was organised to allow for the students' probable lack of previous experience in working with gravity meters. Therefore, prior to commencing fieldwork, each student had to be trained in the use of the different types of gravity meter. It was fortunate that two of the students had had some experience in the use of a Worden gravity meter. In the training of the students and the initial stage of the fieldwork these two students proved to be a big help in guiding the other six through the initial difficulties.

After the students were familiar with the gravity meters, they tested their abilities by running the instruments several times over the Canberra calibration range. The results they obtained gave some indication of their reading accuracy. However, a few successful readings over a known gravity interval does not necessarily qualify a beginner as a reliable observer. Therefore, to guard against incorrect readings of the dial of the gravity meter (a common mistake for the beginner) each gravity station was observed simultaneously by at least two observers, each with a gravity meter. If a mistake was not noticed in the field by a comparison of readings, it would show up in the plotting of the field observations. In case of a large discrepancy in the measured intervals ($>$ 0.1 mgal) a re-run had to be made with at least two instruments.

In the area between the northern shoreline of Lake Burley Griffin and the suburb of Watson seven gravity sub-bases were established by multiple meter observations made in direct runs between the bases, by-passing all intermediate future gravity sites. The purpose of these sub-bases was to serve as starting points and reference values for the reading of gravity stations in their vicinity. Also the station number of each of the sub-bases would be an indication of the area. For instance 'area 6718.0254, traverse 6' means the 6th sequence of stations which started off from the sub-base 6718.0254. Appendix 2 shows the seven sub-bases and the Isogal stations to which the survey is connected.

The station numbers for the gravity sites were obtained by adding 6718.0000 to the existing benchmark number; for instance, gravity station 6718.0147 is located at the benchmark 147. The location of this benchmark is to be found from the list of benchmarks obtained from the Department of the Interior. A copy of this list is now in the filing system of the BMR . Gravity Section (see Appendix 2).

3. OFFICE WORK

The fieldwork done during one day was computed the following day in the office by a separate group of students. The results for the gravity intervals were entered on 'comparison sheets', which show at a glance how the results for different instruments used in the multiple instrument runs compare. Since every run starts at a sub-base with a known observed gravity value the observed gravity value for each station is also shown in the comparison sheets. In another file the gravity values obtained were entered opposite the station number concerned and the final observed gravity was obtained by means of a weighted mean; all obviously incorrect readings were rejected. Latitudes, longitudes, and normal gravity values are listed opposite the station numbers in another file. Another file contains the Bouguer anomaly computations. The file numbers are listed in Appendix 2.

The field crew and the office crew were interchanged periodically. Because of the multiple meter system used in the field a more than normal amount of computation per station had to be carried out. The computations were made with hand-operated calculating machines as normally used in the field by BMR gravity parties. The simple hand-calculating machine was preferred to A.D.P. in order to make the students familiar with the step by step calculations required to obtain the Bouguer anomaly for a given density.

With the exception of a dozen stations for which no elevation was listed, Bouguer anomalies were calculated for all observed gravity stations. A preliminary Bouguer anomaly map was prepared using a density of 2.67 g/cc (Plate 1). No attempt has yet been made to give a geological interpretation of the gravity data. This will be done by students in subsequent years.

4. PRODUCTION AND ACCURACY

As most members of the field crew were, at the start, unfamiliar with gravity meters, the total number of stations read during the survey was small, only about 400. The multiple gravity-meter runs also contributed to a reduced production rate.

There was a striking improvement in the performance during the second half of the survey. The better quality of fieldwork is mainly a result of improved accuracy in instrument reading. However, during the first part of the survey difficulties with readings were experienced because of a large earthquake (December 1967) and very strong winds.

The skill required for the proper reading of a gravity meter is underestimated by the beginner, which leads to a certain amount of over-confidence in his ability. Nearly all the discrepancies occurring early in the survey could have been prevented by on-the-spot comparison between multiple instrument readings, thus obviating the need for re-runs. This comparison, however, was often omitted, and an accumulation of errors occurred while the party leader was on recreation leave for a month. During this period the office work lagged behind the fieldwork; hence errors remained undetected for some time. The reading accuracy improved substantially after the errors had been pointed out and their causes had been explained to the observers concerned.

5. RECOMMENDATIONS

During the first stage of this training survey certain weaknesses in the organisation showed up. These were mainly in the training of the students in the use of the instruments and in the daily control of the work carried out by the students. The original plan was to give each of the students a gravity meter and let him find out for himself (under supervision) if the instrument was properly adjusted, and to adjust it if necessary. This approach was not very successful. Too much time was spent on fixing unadjusted instruments prior to actual fieldwork. It is therefore recommended that, for the benefit of future stages of this project, a simple training manual be compiled dealing briefly with:

1) The use of a properly adjusted gravity meter, with references to certain sections of the instrument manual; the maintenance and adjustment of meters to follow at a later stage.

2) The drawing of drift sheets for gravity runs with single and multiple drift control.

3) The calculation of Bouguer anomalies and the drawing of Bouguer anomaly maps.

This will cover the requirements for most students during their first summer vacation period with BMR. Then the training manual should touch on subjects such as terrain corrections, regional trends, residual gravity, and geological interpretations, and list references to these subjects. Such a manual would help to save time for students and instructing staff.

Thorough and continuous control of field and office work carried out by trainees can only be achieved when the party leader is continuously present. It is therefore recommended that on future training surveys the party leader should not be away for any length of time.

It is recommended that students should carry out a particular activity, or a logical sequence of activities, for a continuous period of some weeks, as frequent interruptions with unrelated tasks lead to frustration and loss of interest.

APPENDIX 1

PERSONNEL AND INSTRUMENTS

Personnel

J. van Son	Party leader	11-12-67 to 20-12-67; 25-1-68 to end.
N. Mohamed	Student	11-12-67 to 23-2-68
C. Jones	Student	11-12-67 to 26-1-68
G. Michalk	Student	11-12-67 to 20-2-68
P. Spraggon	Student	11-12-67 to 19-1-68
J. Varghese	Student	29-12-67 to 23-2-68
K. Moriarty	Student	Only a few days on survey
W. Maw	Colombo Plan (Burma)	22-1-68 to end
S. Myint	Colombo Plan (Burma)	15-12-67 to 19-1-68

Fieldwork stopped on 19-2-68.

Office work stopped on 23-2-68

Gravity meters

La Coste & Romberg :	G20, G101, G132	K:	as per maker's calibration tables
Worden :	W61	K:	0.09057 mgal/d.d.
:	W140	K:	0.10220 mgal/d.d.
:	W169	K:	0.10109 mgal/d.d.
:	W260	K:	0.10871 mgal/d.d.
Canadian :	Sharpe 145	K:	0.10656 mgal/d.d.

K = calibration factor of gravity meter

APPENDIX 2

GRAVITY BASES AND LIST OF FILES

Isogal stations to which the survey is connected

Stat. N°	Lat(S)	Long(E)	Elev(ft) (M.S.L.)	Obs. grav.
6491.0104	*)	*)	*)	979.620.29
6491.0304	*)	*)	*)	979.615.92

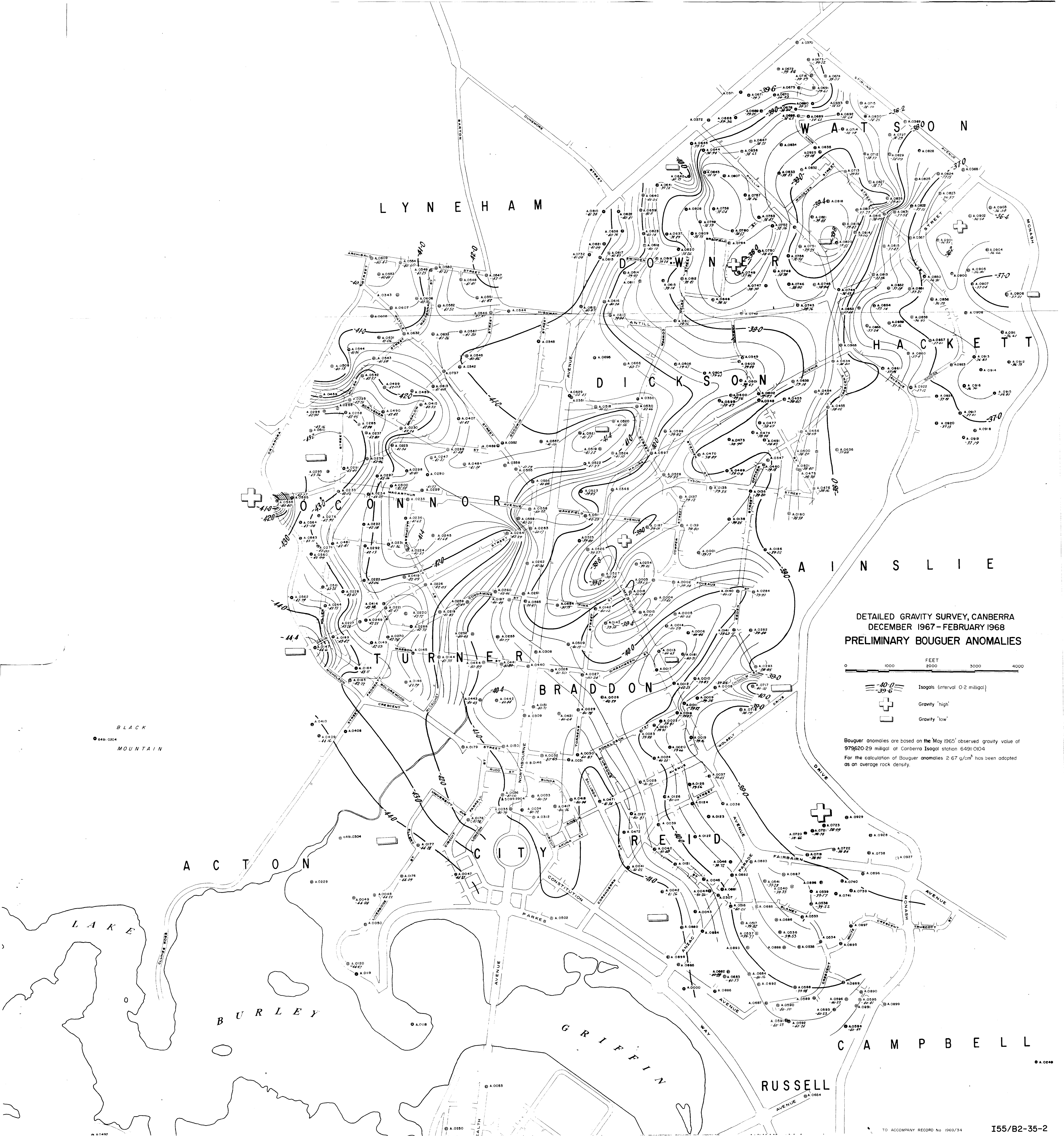
Established gravity sub-bases

Stat. N°	Lat(S)	Long(E)	Elev(ft) (M.S.L.)	Obs. grav.
6718.000	35°17.55'	149°08.21'	*)	979.617.83
6718.0147	36°16.24'	149°06.73'	1934.28	979.607.91
6718.0254	35°15.93'	149°08.25'	1893.11	979.614.60
6718.0609	35°14.91'	149°07.23'	1980.57	979.607.23
6718.0716	35°14.08'	149°09.08'	1926.88	979.610.62
6718.0739	35°17.19'	149°09.24'	*)	979.610.36
6718.0920	35°15.41'	149°09.66'	2020.80	979.609.03

*) not yet available.

List of files

	File No.
Canberra Tourist Map showing location of gravity sub-bases, list of benchmarks	6718.1
Gravity sub-base runs, field/drift sheets, loop closures, observed gravity values for sub-bases	6718.2
Detail gravity runs, field/drift sheets	6718.3
Comparison sheets	6718.4
Obtained and final observed gravity values	6718.5
Latitude, longitude, normal gravities	6718.6
Bouguer anomalies	6718.7


DETAILED GRAVITY SURVEY, CANBERRA
DECEMBER 1967 – FEBRUARY 1968
PRELIMINARY BOUGUER ANOMALIES
FEET
0 1000 2000 3000 4000
Isogals (interval 0·2 milligal)
Gravity 'high'
Gravity 'low'
Bouguer anomalies are based on the 'May 1965' observed gravity value of 979620·29 milligal at Canberra Isogal station 6491·0104
For the calculation of Bouguer anomalies 2·67 g/cm³ has been adopted as an average rock density.
LYNEHAM
WATSON
DOWNER
DICKSON
HACKETT
AINSLIE
O'CONNOR
TURNER
BRADDON
REID
CITY
ACTON
CAMPBELL
RUSSELL
BLACK MOUNTAIN
LAKE BURLEY GRIFFIN
NORTHBOURNE AVENUE
TO ACCOMPANY RECORD No. 1969/34
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