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BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS

Record No. 1968 / 85

Helicopter Gravity Training Survey,

A.C.T. and Southern NSW 1966

by

G.D. Lodwick and A.J. Flavelle

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SUMMARY

In 1966, the Bureau of Mineral Resources carried out a regional reconnaissance gravity survey of the Australian Capital Territory and part of southern New South Wales. Stations were positioned on a seven-mile grid, the standard error in height observations being 11 ft and in observed gravity 0.1 mgals. The area has been tentatively divided into two gravity provinces, the Monaro Regional Gravity Complex and the Hume Regional Gravity Complex. In the former, the Bouguer anomaly trend is parallel to the coast and is considered to be related to the oceanic thinning of the crust; in the latter the trend of Bouguer anomaly contours is parallel to the structural trend of the Tasman Geosyncline.

1. INTRODUCTION

In February and March 1966, the Bureau of Mineral Resources carried out a regional reconnaissance gravity survey of the Australian Capital Territory and a part of southern New South Wales, covering the 1:250,000 map areas of GOULBURN, ULLADULLA, CANBERRA, COOTAMUNDRA, and part of WAGGA. A description of the technique of gravity surveying by helicopter is given by Vale (1962) and Hastie and Walker (1962).

The major objective of the survey was to train new personnel in the techniques of gravity surveying by helicopter. In addition, the regional reconnaissance gravity coverage of Australia was extended, thereby assisting in the delineation of major geological structure.

The multiple-base technique of barometric heighting was tested. In view of the various well-defined geographical and meteorological provinces covered (the coastal plain, the inland tablelands, and the Kosciusko plateau) as well as the extensive elevation range from sea level to 6000 ft, it was expected that limitations in accuracy of the present single-base method of barometer levelling would be revealed. The results of this investigation are described in a separate report (Lodwick, in prep).

Appendices 2 and 3 describe work carried out in conjunction with the Division of National Mapping. During the course of the survey ties were made to points established by the National Mapping elevation meter. The results are presented in Appendix 2. Appendix 3 describes investigations carried out to determine the best way of obtaining positive identification on the aerial photographs of the station positions.

Investigation into special operational techniques which may be required in difficult terrain, such as the clearing of helipads, was also carried out. This work is described in Appendix 4.

This report is only a preliminary assessment of the results of the survey.

2. GEOLOGY

The survey covered parts of two distinct geological provinces: the Tasman Geosyncline and the Sydney Basin.

The Tasman Geosyncline

Lower Palaeozoic rocks cover most of the survey area. After deposition and up to the end of the Silurian period these rocks were faulted, folded, and subjected to regional metamorphism. In the late Silurian and Devonian, extensive granitic intrusions with associated contact metamorphism stabilised the geosyncline. Prominent faults such as the Goodradigbee and Murrumbidgee are parallel to the granite intrusions which trend NNW. Granites of Devonian and Silurian age occur extensively in the Tasman Geosyncline. Serpentine crops out in east COOTAMUNDRA and WAGGA along a narrow north-trending zone. From Yass, south through the A.C.T., widespread acid lava flows of middle Palaeozoic age occur. The region was stable during the Mesozoic, but uplift, erosion, and subsidence during the Cainozoic were associated with considerable flows of basalt. The sequence of rock types to be found in the Tasman Geosyncline is summarised in Table 1.

TABLE 1

Geological sequence - Tasman Geosyncline

System	Rock unit	Lithology	Comments	Thickness (ft)
Quaternary	Alluvium beach and swamp deposit sand	Silt, sand clay, laterite, and travertine	Apparently undisturbed	0-600
Tertiary	Basalt	Fine grained olivine basalt	Flows	-
Devonian	Metamorphosed sediments and volcanic rocks	Shale, quartzite basalt, dolomites arkose, minor serpentine	Generally gently folded	12000+
Devonian	Granite and rhyolite	Acid granites and flows of rhyolite	-	-
Silurian	Granite	Acid granite	Pluton	-
Ordovician	Metamorphosed sediments	Phyllite, slate shale, quartzite	Intensely folded and cleaved	-

The Sydney Basin

In the southern part of the Sydney Basin the Triassic cover is absent. Table 2 shows the stratigraphy of the Sydney Basin.

TABLE 2

Geological sequence - Sydney Basin (southern part)

System	Rock unit	Lithology	Comments	Thickness (ft)
Quaternary	Alluvium	Sand and swamp deposits	Undisturbed	-
Tertiary	Sediments	Sand, gravel etc.	Flat lying	20
	Basalt	Olivine basalt	Flows	~300
Permian	Milton Monzonite	Monzonite porphyry	Laccolithic intrusion	-
	Termeil Essezite	No data	No data but most likely intrusive	-
	Shoalhaven Group	Sandstone, siltstone, and conglomerate basalt	Intruded by a basalt flow Low east dip	2400
	Clyde Coal	Sandstone, shale, and lenticular coal seams	Occupy isolated pockets in the basement	135±
Ordovician (basement)	Metamorphosed sediments	Folded slates, phyllites, and quartzites	Intensely folded and cleaved	-

Tables 1 and 2 are derived from McElroy and Rose (1962) and Hall (1959).

A narrow Permian basin extends northwards from the Batemans Bay area and underlies the Triassic Cumberland Basin west of Sydney. Formations of the Permian Shoalhaven Group (formerly the Upper Marine Series) crop out north from Batemans Bay. These sediments generally rest unconformably on Lower and Middle Palaeozoic rocks, which crop out south along the coast from Batemans Bay. Coal-bearing strata are known to exist in places at the base of the Shoalhaven Group.

3. PREVIOUS GEOPHYSICAL SURVEYS

The survey described in this Record was the first comprehensive geophysical investigation of the region. Earlier work discussed below were of limited extent and generally aimed at the solution of specific problems in the field of oil and mineral exploration.

The Tasman Geosyncline

Aeromagnetic surveys. The Bureau of Mineral Resources carried out a survey of CANBERRA in 1958, and one of GOULBURN in 1965. Long line traverses also cross the survey area. These are Melbourne-Canberra, Canberra-Sydney, Melbourne-Dubbo, Canberra-Dubbo. The results of these surveys are in the form of total magnetic intensity profiles.

Seismic surveys. The Department of Geophysics of The Australian National University has performed seismic crustal investigations in conjunction with the Bureau of Mineral Resources and the Snowy Mountains Hydro-Electric Authority. An approximate figure of 37 kilometres was obtained for the depth to Mohorovocic discontinuity along the line between Lake Eucumbene and the Warragamba Dam (Doyle et al, 1959). A later investigation (Doyle et al, 1966), in which depth charges detonated in the sea off Sydney were recorded by a number of stations in the Snowy Mountains region, gave an average depth to the Mohorovicic discontinuity of 40 kilometres and produced evidence of the Conrad discontinuity at 21 kilometres. Indications are that onshore, in the survey area, the depth of sediments is not great (approximately 1 to 2 kilometres).

A detailed seismic refraction survey of the Lake George area (Polak and Kevi, 1964) investigated the origin and structure of Lake George and obtained information on seismic velocities and basement configuration.

Gravity surveys. The Bureau of Mineral Resources has completed regional gravity traverses throughout the area. Some localised gravity observations have been made in the Snowy Mountain region in connection with engineering projects and in the Lake George area (Kevi, 1964) and at Captains Flat (Sedmik, 1961).

The Department of Geology and Geophysics, University of Sydney, has completed traverses from Bega to Spencers Creek and from Yass to Wallendbeen (Marshall and Narain, 1954), which indicate a normal correlation between negative Bouguer anomalies and granite. The New South Wales Department of Mines has made observations along roads in the western part of the area in a programme designed to establish a statewide network of gravity readings.

The Sydney Basin

Aeromagnetic surveys. The onshore coastal strip from Sydney to Batemans Bay was traversed by L.H. Smart Oil Exploration Pty Ltd. The results are available in a total intensity contour map, and basement depth estimates have been made. The depth estimate values indicate that basement becomes shallower from north to south.

Seismic surveys. L.H. Smart Oil Exploration Pty Ltd undertook a seismic survey in south WOLLONGONG and north ULLADULLA in 1961. This work was abandoned when no useful results were obtained.

Gravity surveys. A semi-detailed gravity survey was performed for L.H. Smart Oil Exploration Pty Ltd in the Jervis Bay area in 1962. The report on this survey has not been published. Most of the work was done in WOOLONGONG and the data for ULLADULLA have not been used as yet.

Boreholes. A number of bores have been drilled near Jervis Bay for the exploration of coal. These include Huskisson No. 1 (840 ft T.D.) Huskisson No. 2 (1900 ft T.D.), and Wandandian (1423 ft T.D.).

4. DESCRIPTION AND INTERPRETATION OF GRAVITY DATA

The Bouguer anomaly map of the area and regional Bouguer anomaly map based on 15-minute means are presented in Plates 3 and 4 respectively at a scale of 40 miles to the inch. The subject area has been tentatively divided into two gravity provinces:

(1) The Monaro Regional Gravity Complex (labelled "A" in Plate 3 and 4).

(2) The Hume Regional Gravity Complex (labelled "B" in Plate 3 and 4).

The -20 milligal Bouguer anomaly contour, with an approximate north-south trend, passing through Goulburn and about 20 miles to the east of Canberra approximates to the boundary between the two provinces. To the east of this the contours have a marked north-north-east trend, while to the west the trend varies north to north-north-west and is conformable with the geological trend in the area.

Monaro Regional Gravity Complex

In the Monaro Regional Gravity Complex, the values of the contour values reduce smoothly from a maximum of +50 mgals at the coast to -20 mgals in south-east GOULBURN. This large regional effect masks out local features, which, however, might be delineated on a residual map. It is postulated that the significant trend parallel to the coast is caused by the oceanic thinning of the crust.

Hume Regional Gravity Complex

The Hume Regional Gravity Complex contains a number of smaller Bouguer anomaly features:

The George Gravity High (B1 on Plate 3). This is a marked positive Bouguer anomaly feature, centred about 3 miles to the north-east of Lake George. It is considered that the feature is caused by basic intrusives, metamorphosed to amphibolite (Kevi, 1964). The feature correlates in its central part with basic intrusive rocks metamorphosed to amphibolite and it is postulated that feature B1 delineates the extent of these rocks.

The Canberra Gravity Low (B2). This is a large arcuate feature with a minimum Bouguer anomaly value of less than -40 mgals, which occupies the western part of CANBERRA. The western boundary of the feature is clearly defined by a decrease in Bouguer anomaly of 20 milligals in 4 miles. The centre of the gradient parallels the Goodradigbee Fault, which is offset about four miles to the east. The eastern edge of the 'low' is less well-defined, but correlates generally with the Deakin Fault in the north and the Queanbeyan and Murrumbidgee Faults further south. It is postulated that the cause of this 'low' is related to the large granite mass known as the Murrumbidgee Batholith. In contrast it should be noted that extensive outcrops of granite in south-east CANBERRA do not correlate with Bouguer anomaly 'lows'.

The Cootamundra Gravity High (B3). This 'high' consists of two elongated Bouguer anomaly 'highs', the eastern one of which is south-east of Cootamundra and continues less markedly south along the western border of CANBERRA; the western 'high' trends north-north-west from north-central WAGGA. The most positive parts of the Bouguer anomaly correlate with mapped areas of serpentine and it is therefore postulated that feature B3 delineates subsurface basic intrusions.

Gravity 'lows' have been mapped on south-west COOTAMUNDRA (B4), central COOTAMUNDRA (B5), central-east WAGGA (B6), and north-central GOULBURN (B7). It is postulated that features B4, B5, and B6 are caused by acid igneous rocks and B7 by relatively light metamorphosed sediments. All four features appear to have their major development outside the survey area and therefore have not been named.

5. CONCLUSIONS

Throughout the area, mapped areas of basic and ultrabasic rocks correlate with Bouguer anomaly 'highs', whereas the relation between Bouguer anomalies and known granite masses is rather ambiguous. The Murrumbidgee Batholith appears to correlate with a large negative Bouguer anomaly feature, but in other parts of the survey area, various granites show no such correlation. This may indicate a fundamental difference in the origin of granitisation, rather than of batholithic origin.

On a regional scale the Bouguer anomaly pattern correlates well with the observed geology and crustal structure derived from seismic evidence. Near the coast where the crust may be expected to become thinner as the deep ocean comes close to land the positive regional Bouguer anomaly increase from west to east is consistent with this hypothesis. Further inland the trend of the Bouguer anomaly contours is parallel to the regional structure within the Tasman Geosyncline. It is therefore concluded that the regional structure in the Tasman Geosyncline is reflected in the Bouguer anomaly pattern.

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APPENDIX 1

Survey statistics

Helicopter hours:	206.01	
Total days:	57.50	
Unserviceability days:	18.25	
a. Mechanical	Nil)	
b. Stand-down (Mandatory BMR days off).	8.00)	18.25
c. Other	Nil)	
d. Weather	10.25)	
Days not required:	2.00	
Days traversing - useful:	30.25)	
Days traversing - work abandoned:	1.75)	
Days miscellaneous usage: (e.g. work connected with helipad cutting, long transits, micro-barometer tests)	5.25)	
Loops:	83	
Loops re-flown:	3	
Tie flights:	4	
Follow-up flights:	2	
Total equivalent loops:	92	
Area covered:	20,000 sq. miles	
Trainees - party members:	Townsend, D. (1/2 - 11/2) Lodwick, G. (7/2 - 30/3) Kirby, K. (1/2 - 30/3) Shirley, J. (1/2 - 30/3) McAvoy, W.J. (1/2 - 30/3)	
Trainees - long term:	Hopkins, A. (5/2 - 19/2) Student Mathews, J. (16/2-17/2) (22/2-2/3) Helicopter Utilities Pty Ltd Milsom, J. (15/3 - 24/3) Whitworth, R.(15/3 - 24/3) Branson, J. (21/3 - 25/3) Heyland, P. (21/3 - 29/3) Helicopter Utilities Pty Ltd Jones, B. (25/3 - 31/3)	

Trainees - short term:		
	Brown, W.	(1/3 - 2/3)
	Moss, J.	(7/3 - 9/3)
	Robertson, C.	(7/3 - 9/3)
	Turpie, A.	(15/3-18/3)
	Allen, G.	(15/3-18/3)
	Jones, P.	(24/3-26/3)
	Brown, A.	(24/3-26/3)

APPENDIX 2

Comparison of barometric and elevation meter heights

During the course of the survey, ties were made to some of the gravity stations with the National Mapping elevation meter. The elevation meter work was done by J. Maddern of the Division of National Mapping and was a separate project.

Table 3 sets out elevation values obtained by the barometer and by the elevation meter. The elevations of stations 6606/0235 and 66 06.9009 will be field checked. A standard deviation for (elevation meter elevation - barometer elevation) was calculated and found to be 19.0 ft. If station 6606.0235 is omitted and the bracketed value of 6606.0820 is used then the standard deviation is 9.3 ft. Since the standard deviation of the elevation meter values is of the order of 2 to 3 ft and that of the barometer values is by network analysis 11.0 ft then the result of 9.3 ft is considered reasonable.

TABLE 3

EM Station Number	BMR Gravity Station Number	Elevation Meter Value (feet) A	Barometer Value (feet) B	A-B (feet)	Comments
EM/C65/8	6606/9028	3153	3143	10	
C65/9	" 0262	2466	2460	6	
C65/11	" 0244	1771	1773	-2	
C66/1	" 9035	1885	1896	-11	
C68/1	" 9026	2571	2575	-4	* This station will
C69/1	" 0235	*2650	2728	-78	be field checked
C69/2	" 9025	2273	2271	2	
C70/2	" 9033	2024	2006	18	
C70/7	" 0820	**2019	2060 (2026)	-41 (-7)	
C71/2	" 0816	1419	1418	+1	**Bracketed values (2026)
C71/3	" 0631	2190	2205	-15	and (-7) obtained if
C72/1	" 9027	1855	1845	+10	a smoother diurnal curve
C73/1	" 0243	1817	1818	-1	used. The actual
C73/2	" 9024	1536	1526	+10	diurnal shows large
C74/1	" 0257	1677	1671	+6	pressure changes from
C74/2	" 9011	***1480	1537	-57	reading to reading and
C75/2	" 0160	1199	1193	+6	it is suspected that
C75/3	" 0161	981	983	-2	the instrument was faulty.
C75/5	" 0103	1081	1092	-11	***The stations were not
C75/6	" 9009	****981	1004	-23	at the same point.
C75/9	" 9013	955	955	0	****This station will be
C75/10	" 9014	1137	1131	+6	field checked.
C75/12	" 0108	1105	1115	-10	
C76/2	" 0057	1083	1092	-9	
C76/3	" 0056	973	968	+5	
C76/4	" 0164	833	824	+9	
C76/5	" 9006	803	792	+11	
C76/6	" 0053	982	980	+2	
C77/1	" 9007	1325	1335	-10	

APPENDIX 3

Station photography

The elevation data collected on helicopter gravity surveys are used by the Division of National Mapping for the compilation of topographic maps. The usefulness of this data is enhanced if the position of each station as identified on aerial photographs can be positively checked.

When the station is occupied by the gravity observer its position is marked on an aerial photograph by means of a pin prick. The investigations by the Division of National Mapping were directed towards devising a second and more positive means of station identification on the aerial photographs. A report by K. Leppart of the Division of National Mapping describing the investigation is attached:

INVESTIGATION IN METHODS OF OBTAINING A PHOTOGRAPHIC RECORD OF THE POSITION OF BMR GRAVITY STATIONS

K. Leppart

The aim of the investigation is to work out an economic method of recording the positions of BMR gravity stations by photographic means in order to transfer them to high altitude survey photographs.

Three methods have been investigated:

Method 1. At time of helicopter gravity survey, each gravity station in a 1:250,000 area, or part thereof, to be marked uniquely with reasonably permanent material. On completion of the gravity survey of this area all marked stations to be photographed with a 35-mm camera from a fixed-wing aircraft. Photographs to be taken near-vertically from an altitude which will bring the scale of the 35-mm photography within the range of a differential stereoscope in order to transfer the marked station position stereoscopically from the 35-mm photographs to the survey photographs.

Method 2. Use of Polaroid camera. A polaroid exposure to be taken of the selected unmarked station site from a height of 500 ft before landing at the station. The exact position of the gravity station is then pricked on the print after landing and the station number written on the back of it. The transfer of the position of the gravity station from the Polaroid print to the survey photograph can be done by inspection only. A stereoscopic transfer is not possible owing to the large difference in scale of the two photographs, which is outside the range of a differential stereoscope.

Method 3. Use of 35-mm camera with f = 30 mm at time of helicopter gravity survey. The gravity station is to be marked by temporary marking material (paper towel, white calico) at time of observation. After take-off, the helicopter is to rise to not less than 500 ft above ground and a near-vertical photograph is to be taken of the marked station. Transfer of marked position from enlarged exposure to survey photograph by inspection of detail.

Appraisal of methods

Method 1. This is the best of the three methods, but is very costly. Marking material per station is approximately $4. Lost helicopter flying time is between 5 and 15 minutes per station because of marking method. A special photo-flight has to be arranged at the end of the survey. This method would give the best results because a stereoscopic transfer of the marked station could be obtained. The failure rate would be very low. Expenditure per station is estimated to be in excess of $20. This method is not recommended on economic grounds.

Method 2. The application of this method would result in only one print without a negative. Polaroid cameras with f = 100 mm are not available. The area photographed by a polaroid camera is smaller than one taken with an f = 28 mm, 35 x 24 mm camera. It is rather a messy procedure to fix and dry the polaroid print in a crowded helicopter. Misidentifications of the unmarked gravity stations are to be feared. The cost would be about 30 cents per print. This method is not recommended because of an anticipated high incidence of misidentification of stations.

Method 3. This involves the temporary marking of the gravity station at the time of the survey with cheap material in a unique pattern. This can either be done by the helicopter pilot at no loss of flying time or by the observer with little loss of time. Tests conducted on the Canberra 4 Blue Loop have shown that an L-shaped marker of paper towelling can be pinned to the ground in about one minute. Material costs would be about 10 cents per station plus the costs of film, developing, and two enlargements, which amount to 20 cents, making a total of 30 cents per station. The time it takes a helicopter to reach 500 ft above ground varies considerably owing to wind conditions, height above sea level, and weight of load. On the average it may take one minute. The total loss in flying time due to delay while pinning down the marking material and due to rising to 500 ft above the station may amount to $2 per station. This brings the total expenditure per station to $2.30*. For a 1:250,000 map area with 200 stations, the application of this method would cost approximately $500. This method is recommended for adoption by the BMR Gravity Section.

Details of recommended method

Type of camera. Any camera with a focal-plane shutter, with f = 30 mm, and using a negative size of 35 mm x 24 mm.

Marking material. White paper towel $7\frac{3}{4}$ inches wide is used to form an L or V of dimensions as shown in Figure 1 below. The paper to be pinned down by at least six roofing nails with cardboard or other soft material washers between the paper and the head of the nail. The corner of the L or V to point north.

* Experience has shown that the cost of photography by method 3 is very much less than the $2-30 estimated by Mr. Leppart. A.J.F.

Film. Any brand 35-mm black and white film with an ASA rating of 300. In adverse conditions faster films could be used. There should be one film for each loop contained in its own film cassette.

Exposure time. Maximum time for exposures taken from the helicopter to be 1/200 of a second.

Altitude of helicopter at time of exposure. The exposure to be taken from not less than 500 ft above ground.

Exposure log. A log is to be kept of the exposures on each film; it should state 1:250,000 map area name, the number of the 30-minute square, and loop colour. It should list the exposures in the right sequence with gravity station number as well as any pertinent remarks. A sample log sheet is shown below.

Identification of films. Before a loop is commenced, a photograph should be taken of a blackboard on which the sheet name, the 30-minute square number, and the loop colour is written in white chalk. This should be the first exposure on each film. (See Figure 2 below).

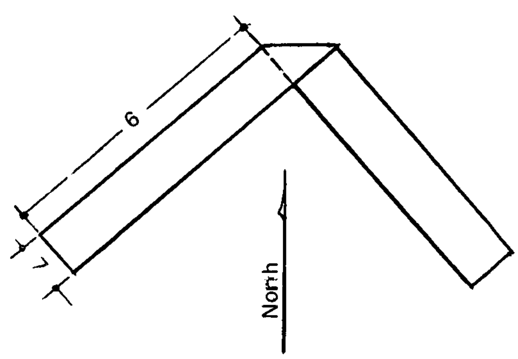


Figure 1

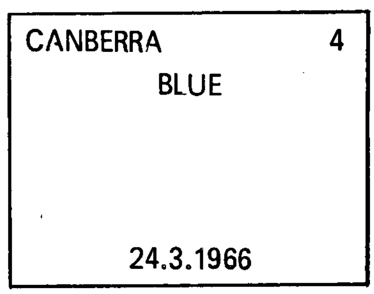


Figure 2

It is essential that the photograph of the marked gravity station is taken as near-vertical as possible. This can be achieved by flying straight at the mark and banking the helicopter at the moment it is above the mark and then taking the photograph at that time.

On completion of the loop, the film cassette containing the exposed film is to be clearly labelled with the map area name, number of 30-minute square, and loop colour. There will be four films per 30-minute square and 24 films per 1:250,000 map area.

The points and other points common to two or more loops should be photographed every time a reading is taken. This will ensure that the sequence in the gravity reading records and the film exposures is the same.

The films need not be developed in the field if the aforementioned procedures are adhered to.

After the films have been developed the numbers of the gravity stations are to be written on the negatives in accordance with the film log. This can be done with black drawing ink or black Chinagraph or Omnichrom pencil.

Two enlarged prints of each exposure including the blackboard one are to be made. Minimum size of enlargement to be 3 x 4 inches; maximum size is to be 4 x 6 inches.

The Division of National Mapping is to be supplied with one set of prints and a list of heights of stations. They will arrange for copying of information marked on the survey photographs by the BMR observer, i.e. the position of the pricked hole denoting the supposed station position and the station number.

Sample of film exposure log

Map area: CANBERRA

Loop: 4

Loop colour: Blue

Date: Thursday, 24th March 1966

Time: 1430 hrs - 1730 hrs

Camera: Nikon, f = 28 mm

Exposure	Station	Remarks
1	Blackboard	
2	Blank	
3	0887	
4	9066	
5	0872	Near fence
6	Blank	
7	0873	
8	0874	
9	0889	Mark in shade of tree
10	Blank	
11	9087	
12	0888	
13	0887	

APPENDIX 4

Establishment of helicopter landing pads

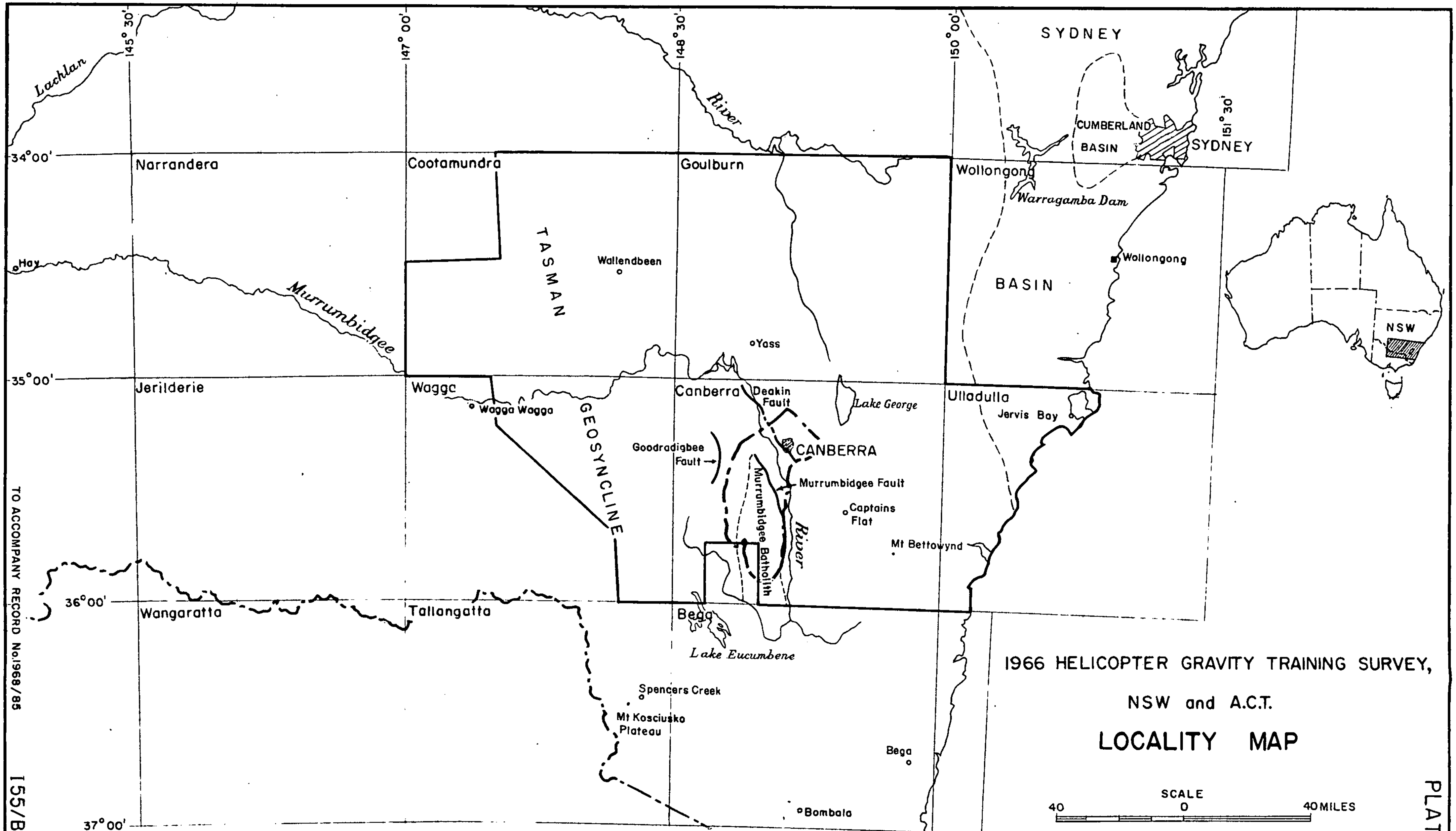
In south-east CANBERRA (on flight 6) the only fixed elevation point near the cell centre was the Mount Bettowynd trig. station. This point was unsuitable for gravity purposes because of the large terrain factor. However, the surrounding area is extremely rugged and its disadvantage as a gravity point was considered to be outweighed by the amount of elevation control it would provide.

An examination of the aerial photographs of the point showed that heavy timber would preclude a landing by helicopter. In addition, the steepness of the slope was such that it would not be feasible to land nearby and walk in. It was therefore decided to provide access to the point by constructing a helipad.

Mount Bettowynd is essentially a linear east-west trending ridge, some five miles long. The clumination on which the trig. point is sited is at the western end. The western slope of the ridge is gentle, heavily timbered, and about four miles long.

The helipad was to be about 50 ft wide and 250 ft long, extending north-south across the ridge. The work was to be done by two people using a chain saw. It was anticipated that the slope up the mountain would be too steep for the people to carry a chain saw and fuel and at the same time make reasonable progress. This equipment was therefore lowered to the ground from a hovering helicopter.

An acceptable helipad took 2½ days to construct (i.e. 40 man-hours). One person operated the power saw while the other one dragged branches and sawn-up tree trunks out of the area. The conclusion derived from this exercise is that the construction of helipads in heavily timbered areas consume a large amount of time and labour and should only be made for access to control stations.



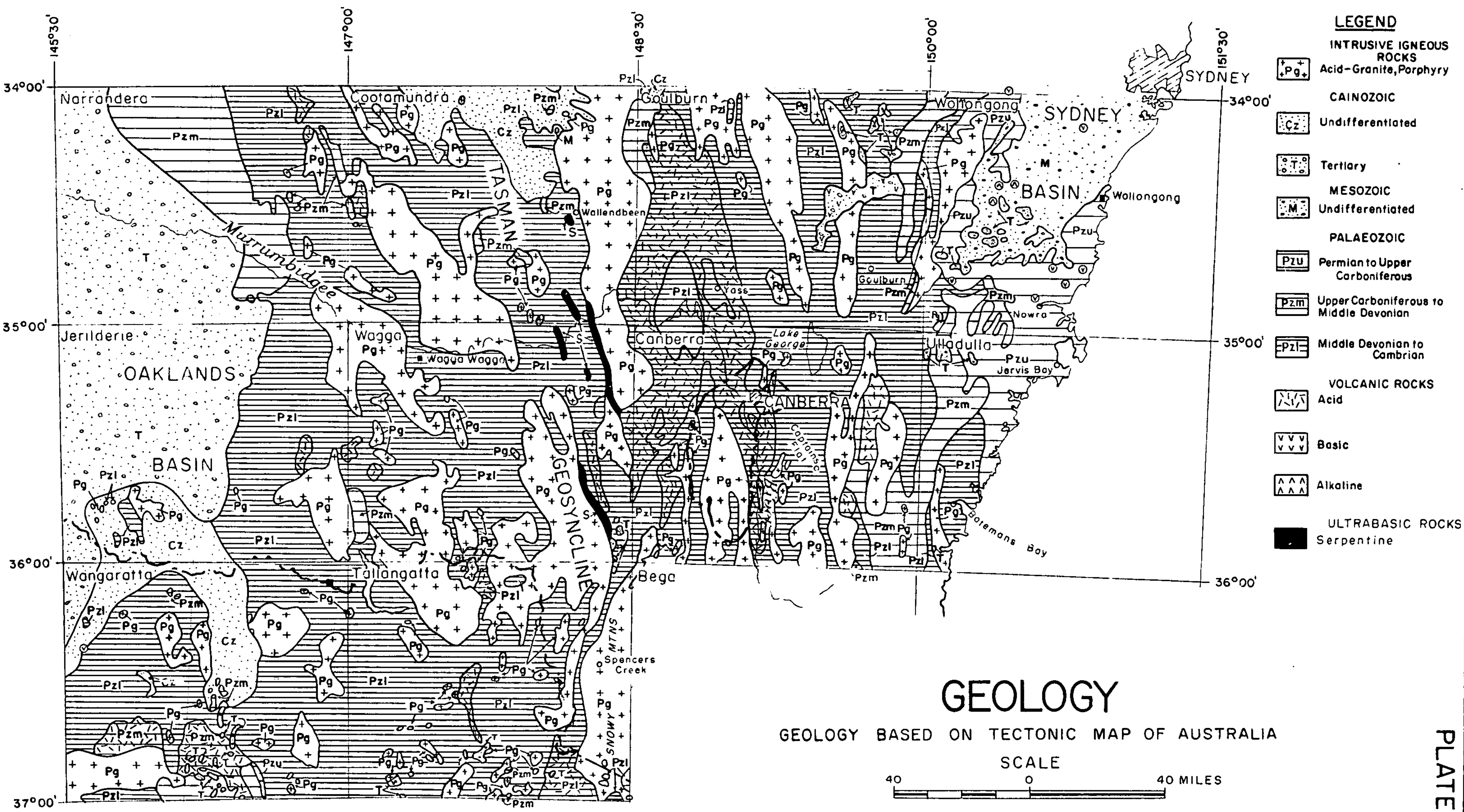
1966 HELICOPTER GRAVITY TRAINING SURVEY, NSW and A.C.T.

LOCALITY MAP

PLATE 1

TO ACCOMPANY RECORD No.1968/85

155/B2-30



GEOLOGY

GEOLOGY BASED ON TECTONIC MAP OF AUSTRALIA

SCALE

40 0 40 MILES

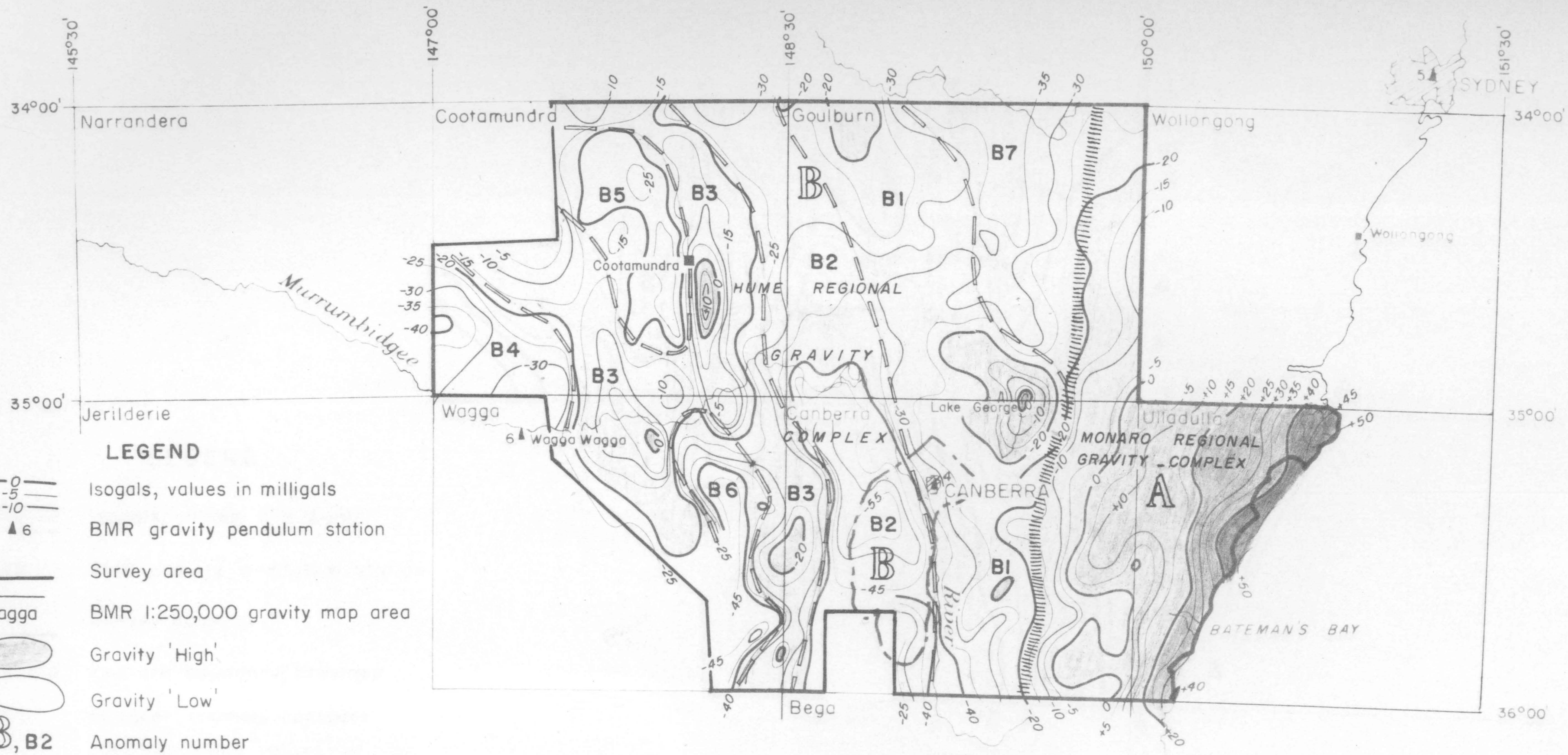
TO ACCOMPANY RECORD No.1968/85

155/B2-21

PLATE 2

TO ACCOMPANY RECORD No.1968/85

155/B2-18-5



LEGEND

- Isogals, values in milligals
- BMR gravity pendulum station
- Survey area
- Wagga — BMR 1:250,000 gravity map area
- Gravity 'High'
- Gravity 'Low'
- B, B2 — Anomaly number
- Feature boundary, province
- Feature boundary, unit

Reduction Density 2·20 g/cm^3

Bouguer anomalies are based on the observed gravity values at BMR pendulum and isogal stations:

No.4 Canberra	979,620·29 milligals	
No.6 Wagga	979,672·56	„

Elevation datum: NSW Standard Datum

BOUGUER ANOMALIES WITH SHADING EMPHASIS

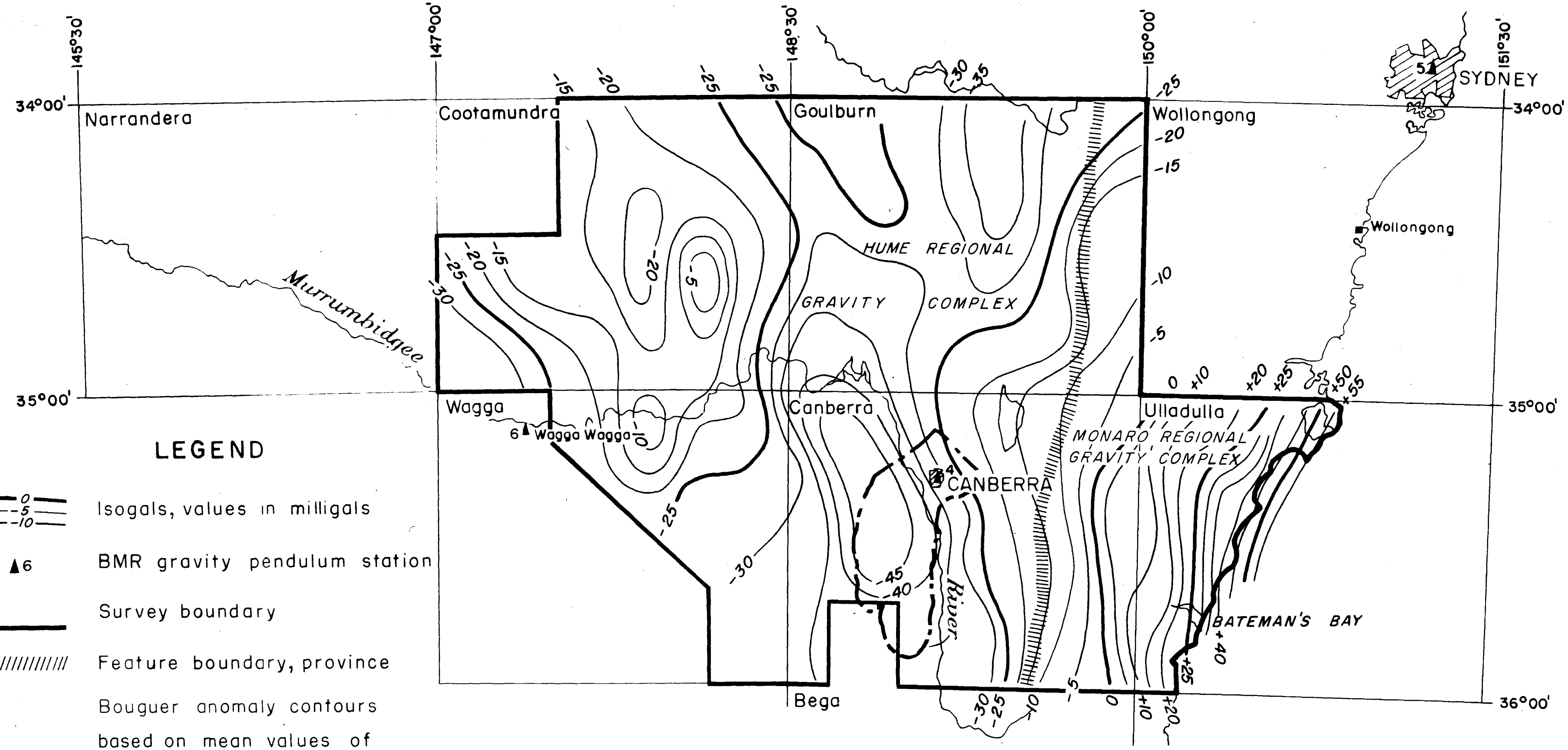
SCALE

40 0 40 MILES

REFERENCE: DIVISION OF NATIONAL MAPPING 40 MILES TO 1 INCH TOPOGRAPHIC MAP

PLATE 3

BASED ON 155/B2-18-1



LEGEND

Isogals, values in milligals (0, -5, -10)

▲6 BMR gravity pendulum station

Survey boundary

//////////////// Feature boundary, province

Bouguer anomaly contours based on mean values of stations with 15' blocks with zero overlap.

Reduction density 2·20 gm/cm^3

MEAN BOUGUER ANOMALIES

SCALE

40 0 40 MILES

PLATE 4

TO ACCOMPANY RECORD No. 1968/85

155/B2-18-2