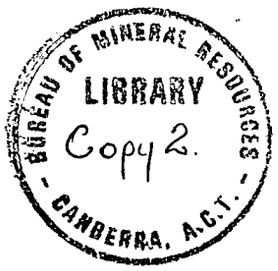
COMMONWEALTH OF AUSTRALIA

DEPARTMENT OF NATIONAL DEVELOPMENT

BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS



RECORD No. 1965/212

HELICOPTER GRAVITY SURVEY BY CONTRACT.

NORTHERN TERRITORY AND QUEENSLAND 1965

PART 1

by

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SUMMARY

This progress report presents the preliminary results of the first part of the 1965 helicopter gravity survey done in the Northern Territory and Queensland by contract for the Bureau of Mineral Resources, Geology and Geophysics.

An extremely large gravity low named the Lander Regional Gravity Low, centred on LANDER RIVER has been mapped and it is suggested that it is caused by a major sedimentary basin in that area. Other new major gravity features which were mapped during the course of the survey are the Napperby Regional Gravity Low, the Willowra Regional Gravity Ridge, the Coomarie Regional Gravity Complex, the Renner Regional Gravity Plateau and the Buchanan Regional Gravity Platform. Although in the subject area geological mapping is not complete, on current knowledge the gravity - geological correlation is nowhere anomalous or contradictory.

1. INTRODUCTION

During the current (1965) field season the Bureau extended its regional - reconnaissance gravity coverage of the Northern Territory and Queensland. This progress report is a preliminary assessment of the results of the first half of the survey covering the central part of the Northern Territory (see Plate 1).

Reconnaissance coverage over much of Western Queensland, the southern Northern Territory and the northern part of Western Australia has been completed and the reader is referred to the various reports which describe this work. (Flavelle and Goodspeed, 1962; Langron, 1962; Lonsdale and Flavelle, 1963; Gibb, 1965(a), 1965(b); Barlow 1964, and Vale, 1965).

The field work was carried out by a private geophysical contractor (Wongela Geophysical) who used helicopters for transporting the gravity meters. The operation was supervised by the author.

2. GEOLOGY

The geology of the area dealt with in this report has been summarised in the Preview Report, (Flavelle, 1965) and covers a number of major structural elements of the Northern Territory. They are :-

A. Victoria River Basin (Upper Proterozoic - Lower Palaeozoic).

B. Tanami - Granites area of Lower Proterozoic rocks.

C. Ngalia Trough (Upper Proterozoic - Lower Palaeozoic).

D. Davenport and Warramunga Geosynclines (Lower Proterozoic).

E. Georgina Basin (Lower Palaeozoic).

F. Wiso Basin (? Upper Proterozoic - Lower Palaeozoic).

G. Arunta Block (? Lower Proterozoic).

Sedimentary development which is of Upper Proterozoic age or younger is believed to be intracratonic in nature.

It is inferred that the largest structural unit in the area is the Wiso Basin. This is a little known feature which could be in fact be more than one structural unit. It extends over west BONNEY WELL, LANDER RIVER, GREEN SWAMP WELL, east MT. SOLITAIRE, east TANAMI EAST, south east WINNECKE CREEK and south west SOUTH LAKE WOODS. Most of the area is devoid of outcrop but it is possible that a considerable thickness of sediments lie beneath the sand cover. This area is at present being mapped by Bureau geologists.

Structure

Brief comments on the structural elements tabulated above are given below.

A. The Victoria River Basin lies mainly to the north west of the area. The relation between the Upper Proterozoic sediments in the basin and those of the McArthur Basin is masked by a veneer of Mesozoic Rocks on DALY WATERS and TANUMBIRINI. In addition the south easterly extent of both Upper Proterozoic and Lower Palaeozoic rocks is masked by sand cover on NEWCASTLE WATERS, south east WAVE HILL and WINNECKE CREEK.

B. The Tanami-Granites area which extends over parts of TANAMI, TANAMI EAST, THE GRANITES and BIRRINDUDU consists of tightly folded, metamorphosed greywackes and siltstone of lower Proterozoic age. The folding is along a south easterly axis. The relation which this area bears with the Warramunga and Davenport Geosynclines to the east and the Halls Creek Mobile zone to the north west is unknown. The easterly extent of the zone is concealed beneath sand cover on TANAMI EAST and GREEN SWAMP WELL, while to the north west Upper Proterozoic and Lower Palaeozoic sediments onlap the older rocks on north west BIRRINDUDU and east GORDON DOWNS.

C. The Ngalia Trough consists of up to 11,000 feet of Upper Proterozoic and Lower Palaeozoic sediments which crop out along a relatively narrow east trending zone on NAPPERBY, MT. DOREEN and LAKE MACKAY. The sediments have some lithological similarities with rocks of the Amadeus Basin, however the structural relation between the two basins is not known.

D. The Lower Proterozoic rocks of the Davenport and Warramunga geosynclines extend in a south easterly direction from NEWCASTLE WATERS to ELKEDRA. The rocks are moderately to highly metamorphosed and in places intruded by granites.

E. The Georgina Basin which infringes on the eastern margin of the area consists of flat lying Lower Palaeozoic sediments. The relation between the Georgina Basin and the Wiso and Victoria River Basins is unknown. The sediments are flat lying and outcrops are sparse, and therefore there is little information on the thickness, distribution and structure of the sediments of the Georgina Basin.

F. The Wiso Basin is the name given to the area between Tennant Creek and the Granites (Hossfeld, 1954). Systematic mapping of the area by the Bureau has commenced this year (1965). Very little is known about the area.

G. Arunta Block. The extensive area of Lower Proterozoic igneous and metamorphic rocks which crop out north of the Amadeus Basin is called the Arunta Block. Its northerly extent and relationship with the Wiso Basin is unknown.

Stratigraphy

Typical stratigraphic sections of the Davenport and Warramunga Geosynclines (table 1) and the Georgina Basin (tables 2 and 3) are shown.

TABLE 1.

DAVENPORT AND WARRAMUNGA GEOSYNCLINES

Davenport and Murchison Range area

(after Smith et al 1961)

AGE	GROUP OR FORMATION	MAXIMUM THICKNESS	LITHOLOGY
Quarternary		-	Sand, alluvium.
Tertiary		? +50'	Limestone
	UNCONFORMITY		
Middle Cambrian	Un-named Group	250' (est.)	Quartz sandstone, conglomerate, shale, limestone, chert.
	UNCONFORMITY		
? Upper Proterozoic		150'	Conglomerate, Sandstone.
	UNCONFORMITY		
Lower Proterozoic	Hatches Creek Group	18 - 25,000'	Quartzite sandstone, shale, greywacke, pebble conglomerate, siltstone, interbedded acid volcanics.
	UNCONFORMITY		
Lower Proterozoic	Warramunga Group		Quartz sandstone, greywacke, shale siltstone.

The Lower Proterozoic rocks are intruded by granite, quartz-feldspar porphyry and acid intrusions.

TABLE 2

GEORGINA BASIN

Barkly Tableland area

(after Randal and Nichols, 1963).

AGE	FORMATION	THICKNESS	LITHOLOGY	AREA OF OUTCROP
Cambrian	Camooweal Dolomite	800'	Crystalline, and pelletic dolomite, dolomitic limestone and quartz sandstone.	Ranken, Avon Downs, Camooweal, Mt. Isa
Lower Middle Cambrian	Ranken	Unknown, but may exceed a few hundred feet.	Fragmetal and crystalline limestone, silicified limestone.	Ranken, Avon Downs.
Lower Middle Cambrian	Fum Ridge Formation	45'	Fossiliferous limestone, chert, siliceous shale and shale.	Tennant Creek, Frew River.
Lower Middle Cambrian	Burton Beds	+ 300	Fossiliferous limestone, shale, and silicified limestone.	Mount Drummond, Ranken.
Lower Middle Cambrian	Wonorah Beds	+ 450	Fossiliferous siltstone, chert, silicified shale and silicified oolitic limestone.	Ranken, Alroy, Avon Downs.
Lower (?) Middle Cambrian	Anthony Lagoon Beds	+ 700	Dolomite, dolomitic sponge and algal limestone, quartz siltstone and sandstone, chert and silty micaceous limestone.	Brunette Downs, Walhallow.
Lower Middle or Upper Lower Cambrian	Top Springs	+ 30	Fine grey and black foetid limestone, coarse crystalline limestone and dolomitic limestone.	Walhallow

TABLE 3.

GEORGINA BASIN AREA

Sandover River - Tobermory area.

(after Nichols 1964)

AGE	FORMATION	MAXIMUM THICKNESS	LITHOLOGY
Cainozoic	-	-	Alluvium, soil, gravel etc.
"	Austral Downs Limestone	+ 44'	Limestone, calcilutite.
Mesozoic	-	+ 20	Conglomeratic sandstone.
Devonian	Dulcie Sandstone	± 2000'	Cross bedded quartz sandstone, siltstone and pebble conglomerate. Outcrops on ALCOOTA and HUCKITTA.
Cambro-Ordovician	Ninmaroo Formation	+ 425'	Dolutite, algal dolomite, dolarenite, some sandstone and siltstone.
Cambro-Ordovician	Tomahawke Beds	200' +	Pelletal dolarenite, dolutite, quartz sandstone and siltstone.
Upper to Middle Cambrian	Meeta Beds	1036 +	Dolutite, dolarenite, quartz sandstone.
	Camooweal Dolomite	2' +	Crystalline dolomite, pelletal dolarenite.

3. DESCRIPTION AND INTERPRETATION OF GRAVITY DATA

Description

The Bouguer Anomaly map of the area is presented on plate 4 at a scale of 40 miles to the inch. The subject area has been divided tentatively into gravity provinces. In addition gravity units recognized in areas of previous coverage and infringing on the survey area are briefly described, and shown.

The following gravity units and provinces are described or mentioned in this chapter :-

1. Papunya Regional Gravity Ridge (province - Lonsdale and Flavelle, 1963).
2. Napperby Regional Gravity Low (province - new name).
3. Willowra Regional Gravity Ridge (province - new name).
4. Lander Regional Gravity Low (province - new name).
5. Coomarie Regional Gravity Complex (province - new name).
6. Ooratipra Gravity High (Barlow 1964) (unit of the Georgina Regional Gravity Shelf. Vale, 1965).
7. Renner Regional Gravity Plateau (province - new name).
8. Ammaroo Gravity Depression (Barlow 1964) (unit of the Georgina Regional Gravity Shelf, Vale 1965).
9. Caroline Gravity Ridge (Barlow 1964) (unit of the Illogwa Regional Gravity High, Vale 1965).
10. Buchanan Regional Gravity Platform (province - new name).

The format used for describing the various units and provinces is adopted from that used by Vale (1965).

Province or Unit Name	Description and Geological Correlation	Possible Geological Significance
Papunya Regional Gravity Ridge	On NAPPERBY and HERMANNSBURG both the northern and southern margins of the Ridge have been mapped and although it has not been completely delineated it is apparently approximately 350 miles long and 60 miles wide. The maximum bouguer value along its axis is +50 mgals while to the north and south values of -100 mgals and -140 mgals respectively have been mapped. The elevation contrast associated with these extremes of bouguer anomaly is practically zero and nowhere exceeds 200-300 feet. In places the elevation correlation is reversed. The northern margin of the Ridge on NAPPERBY is a steep gravity gradient with a relief of 150 mgals over a distance of 35 miles i.e. a gradient of about 4 mgals per mile.	Although the Ngalia Trough is partially within the Papunya Gravity Ridge its gravitational effect is not apparent. Detailed gravity work on MT. DOREEN (Pacific American Oil Company, 1965) has shown that the gradient extends westwards from NAPPERBY and that the development of sedimentary structure in the Ngalia Trough is expressed in the gravity pattern despite the large regional provided by the gradient. Therefore because of the position of the Ngalia Trough it is considered that the gradient which forms the northern margin of the Ridge is not caused by a basement of sedimentary contact but by a fundamental density change within the crust.
Napperby Regional Gravity Low	Only the eastern portion of this Low has been mapped i.e. from south central ALCOOTA to the western margin of NAPPERBY. Its northern and southern boundaries are intense gravity gradients. On NAPPERBY and south MT. PEAKE its width is 80 miles. The lowest bouguer anomaly recorded over the Low is -105 mgals and it is bordered to the north and south by gravity ridges with maximum values of -10 mgals and +50 mgals respectively. The Ngalia Trough correlates with the southern margin of the Low but not with its central culmination defined by the -100 mgal contour line. The central portion of the Low which has its axis running from west central NAPPERBY to north central ALICE SPRINGS correlates with a band of outcrop of granite. Likewise a secondary culmination, defined by a -100 mgal contour line on south central MT. PEAKE and north west NAPPERBY corresponds with granitic outcrops.	Because of the correlation of the two low culminations with granitic outcrops it is postulated that the low is primarily caused by low density granite. The degree to which other causes could make significant contributions to the low such as crustal thickening and/or the sedimentary development of the Ngalia Trough in association with over thrusting can only be determined by quantitative analysis which is outside the scope of this report.

Province or Unit Name	Description and Geological Correlation	Possible Geological Significance
Willowra Regional Gravity Ridge	The Willowra Regional Gravity Ridge extends westwards from central BARROW CREEK. Its western part has not been mapped. Its northern and southern margins are gravity gradients. On MT. PEAKE and south LANDER RIVER it has a maximum bouguer value of zero mgals and is flanked to the north and south by lows of -80 mgals and -100 mgals respectively. Its width on west MT. PEAKE and LANDER RIVER is 60 miles. On central BARROW CREEK the Ridge correlates with mineralized metamorphic and igneous rocks of Lower Proterozoic age.	It is considered that the Ridge outlines a zone of igneous and metamorphic rocks of the Arunta Block which are relatively more dense rocks than those to the south and north. Because on BARROW CREEK there is close areal correlation with a mineralized zone it is postualted that the high, outlines an extensive zone of mineralization extending west from BARROW CREEK.
Lander Regional Gravity Low	The Lander Regional Gravity Low is a large feature extending from north central BARROW CREEK in the east to west TANAMI EAST in the west, and north to southwest central SOUTH LAKE WOODS. Its southern boundary on LANDER RIVER, BONNEY WELL and BARROW CREEK is an intense gravity gradient, while the western margin is defined by a change in anomaly trend. The gravity gradient which defines the northwest margin of the low is weak and discontinuous. A central area of culmination is defined by the -60 mgal contour. The area covered by the low is at present being investigated by Bureau geologists. It is shown on the Tectonic map of Australia as a sand covered area, devoid of outcrop.	It is highly significant that the gradients which define the southern and north eastern boundaries of the Low also correspond with Cainozoic - Lower Proterozoic contracts. In particular the gradient which constitutes the southern boundary of the Low is intense and must mark a large horizontal density change. It has been called the Hanson Gravity Gradient. The Low could be caused by :- A. Crustal thickening B. An extremely large, near surface granite C. An accumulation of relatively light sedimentary rocks.

Province or Unit Name	Description and Geological Correlation	Possible Geological Significance

An assessment of the above three possibilities is given below :-

A. The steep gradient forming the southern margin suggests a density discontinuity which is close to the surface and the possibility of the low being caused wholly by crustal thickening is therefore discounted.

B. The possibility of the low being caused by a granite is lessened by the following factors.

(1) A granitic intrusion is usually symmetrical and enclosed on all sides by relatively steep gravity gradients. This does not occur.

(2) One would expect a granitic intrusion into the older Lower Proterozoic metamorphics, be a structural high and for outcrop to show up. Currently no outcrops of granite have been reported in the area.

C. The above two points are negative factors and do not preclude the existence of a large sheet like intrusion of granite, however there are positive factors which suggest that the low is caused primarily by sediments.

They are :-

(1) The south east extremity of the Low, towards the eastern side of the southern boundary of BONNEY WELL correlates with outcrops of Lower Palaeozoic sediments and by extrapolation it is suggested that the Low, as it extends across LANDER

Province or Unit Name	Description and Geological Correlation	Possible Geological Significance
		RIVER and MT. SOLITAIRE will correlate with an extension of the same sediments. (2) A core hole (GRG 18, see plate 2) near the north central boundary of BARROW CREEK (plate 2) drilled into Lower Palaeozoic limestone at shallow depth, thus confirming the extrapolation of sediments holds for at least 20 miles. Although the geological evidence is meagre it favours the supposition that the Low is caused by sediments but does not rule out the possibility of it being caused by granite or by it being caused partially by crustal thickening. The presence of Lower Palaeozoic sediments on GREEN SWAMP WELL, BONNEY WELL, SOUTH LAKE WOODS and in the core hole GRG 18 on north central BARROW CREEK suggests that any deep sedimentation in the area will be of the same age. It is postulated that the zone of deep sedimentation is defined by the -60 mgal contour line and while a low of maximum intensity of -80 mgals suggests the existence of relatively light sediments it is possible that horizontal density variations occur and the area of thick sedimentation extends north onto TANAMI EAST and GREEN SWAMP WELL. This possibility must be borne in mind because much of the section in the Georgina Basin comprises of relatively dense limestones and dolomites. The presence of a thick section of Upper Proterozoic sediments cannot be ruled out, but no evidence for its existence or otherwise in this area can be found.

Province or Unit Name	Description and Geological Correlation	Possible Geological Significance
Coomarie Regional Gravity Complex	The gravity pattern on TANAMI, THE GRANITES and west MT. SOLITAIRE consists of a series of relatively intense north-east trending anomalies. On north west TANAMI an east-west trend shows up. The bouguer values range from +5 mgals to -50 mgals. The area correlates with the outcropping area of the Lower Proterozoic rocks of the Tanami-Granites area.	The sharp intense north east trending anomalies suggest that the density discontinuities also trend north east. However the folding in the metamorphics trends north west and this folding which is evident at the surface is obviously not deep seated. The fact that the major trend in the area is parallel with the trend of the Halls Creek Mobile Zone suggests that the rocks of the Lower Proterozoic Tanami area are more closely related in a structural sense to those at Halls Creek than, the metamorphics and granites found at Tennant Creek.
Ooratipra Gravity High	A gravity high on ELKEDRA has been described as a unit of the Georgina Regional Gravity Shelf. Mapping on BARROW CREEK, BONNEY WELL, TENNANT CREEK, GREEN SWAMP WELL and SOUTH LAKE WOODS suggest that this feature extends onto these areas. In this report the name Ooratipra Gravity High has been retained although it would appear that its name and classification as a gravity unit will be reviewed in the final report. The area covered by the high corresponds in general with the zone of metamorphic rocks extending from NEWCASTLE WATERS to ELKEDRA. The south west margin of the feature where it adjoins the Lander Regional Gravity Low is a weak gravity gradient. The north east margin where mapped is also a weak gravity gradient. The feature has not been completely mapped. Although it is flanked on the south west by relatively low bouguer anomalies, the bouguer anomalies to the north on HELEN SPRINGS are relatively high. It would seem therefore that the feature could more appropriately be called a platform rather than a high.	The general correlation of the feature with the zone of metamorphics suggests that the boundaries of the feature delineate the extent of these Lower Proterozoic metamorphics. However the transition to more positive but less intense bouguer anomalies from TENNANT CREEK to HELEN SPRINGS suggest that the subject province boundaries should be drawn using trend as a major criteria. The dominant structural trend in the area is north west which is also the trend of the bouguer anomalies.

Province or Unit Name	Description and Geological Correlation	Possible Geological Significance
Renner Regional Gravity Plateau	The area of rather weak gravity anomalies covering all of HELEN SPRINGS and north east TENNANT CREEK has been tentatively called the Renner Gravity Plateau. The bouguer anomaly values range from -20 mgals to zero mgals. No definite trend can be recognized. Only the south west boundary of this feature has been mapped.	The weak gravity pattern within the feature indicates that no density discontinuities of high value or large areal extent exist close to the surface. The area correlates with sediments of the Georgina Basin but the sedimentary - metamorphic contact is not characterised by a steep gravity gradient. The following comments may be made :- A. The south west boundary of the feature marks the north eastern-most extent of the characteristic north west trending anomalies of the Ooratipra Gravity High. Therefore it is possible that the boundary between the feature is the boundary between two different structural units within the Lawer Proterozoic. If this is the case then the higher bouguer anomalies could be generated by a denser basement overlain by a thin veneer of sediments the density of which would not significantly effect the pattern. B. However it is possible that rocks causing the north west trending gravity pattern of the Ooratipra Gravity High form the basement beneath the sediments on HELEN SPRINGS. If this is so then a considerable thickness of sediments would be required to mask any north west trending anomalies generated by the basement. Any thick sedimentary sequence in the area would be composed either of Lower Palaeozoic sediments alone or a combination of Lower Palaeozoic and Upper Proterozoic sediments.

Province or Unit Name	Description and Geological Correlation	Possible Geological Significance
Ammaroo Gravity Depression	The Ammaroo Gravity Depression, a unit of the Georgina Regional Gravity Shelf has been described previously by Barlow (1964) and Vale (1965). This years work served to define its northern boundary where it extends onto south BARROW CREEK.	It is considered that the Depression is caused by a relatively thick sequence of Lower and Middle Palaeozoic sediments.
Caroline Gravity Ridge	The Caroline Gravity Ridge, a unit of the Illogwa Regional Gravity High is shown as extending onto south east MT. PEAKE.	The north westerly extent of the Ridge suggests that it is joined to the Willowra Regional Gravity Ridge.
Buchanan Regional Gravity Platform	This feature is an area of intermediate bouguer anomaly values on north central TANAMI EAST, WINNECKE CREEK and east BIRRINDUDU. It is only partially mapped and only its southern and a portion of its eastern and western boundary areas have been defined. The part of the province which has been mapped does not have an apparent correlation with any regional geological feature.	Very little is known about the geology of the area. The gradient which forms the platform's southern boundary with the Lander Regional Gravity Low could delineate a zone where sedimentary thickness decreased rapidly from south to north. Therefore the area defined by the Platform is possibly a marginal one containing relatively thin sediments overlying a fairly uniform basement.

4. CONCLUSIONS

The table in chapter 3 contains a description of the various gravity provinces and units and also lists possible causes of the features. The cause postulated as most probable for each feature is listed below :-

(1) The Napperby Regional Low delineates a large granitic batholith which crops out and is also evidently deep seated.

(2) The Willowra Regional Gravity Ridge delineates a zone of relatively dense metamorphic and igneous rocks.

(3) The Lander Regional Gravity Low delineates a thick sequence of relatively light sediments. By areal extrapolation it is further postulated that the sediments are of Lower Palaeozoic age.

(4) The Ooratipra Gravity High currently ~~regarded~~ treated as a unit of the Georgina Gravity Platform delineates a zone of metamorphic and igneous rocks which includes the Tennant Creek and Hatches Creek mineral fields.

(5) The Coomarie Regional Gravity Complex delineates the Tanami Granites area of metamorphic rocks. Although the surface folding trends north west, the major density discontinuities trend north east suggesting that the Lower Proterozoic rocks in this area are related to the rocks of the Halls Creek Mobile Zone.

(6) Only a small part of the province tentatively called the Renner Regional Gravity Plateau has been mapped. The gravity pattern is such that it is not possible to confidently predict the thickness of the outcropping sediments or the type of basement present.

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APPENDIX A

SURVEY STATISTICS

New readings		2703
Grid stations		2284
Control stations		
(i) Elevation		156
(ii) Gravity		28
Loops		345
Area covered		94,250 sq. miles.
Total helicopter days		217
Days lost		
(i) helicopter U/S		63¾
(ii) not required		-
(iii) weather		3¾
(iv) other		9¾ (incl. 5 due to non-availability of gravity meter)
Helicopter days available for traversing		139¾
% helicopter unserviceability	X	34%
Loop per day		2.5
Stations approximately positioned (due mainly to poor and/or old photography)		151

APPENDIX B

SURVEY METHOD

The field operations were carried out by a private geophysical contractor, Wongela Geophysical Pty. Ltd. of Brisbane. The method of operation was similar to procedures adopted by the BMR on previous helicopter gravity surveys. All traversing was done by the cell method described by Hastie and Walker (1962). The general operational procedures used on helicopter parties are described by Vale (1962).

Preliminary bouguer anomaly values were produced in the field using "short-cut" computing techniques. The Bouguer anomaly difference between two stations is given by the following:-

$$BA_1 = OG_1 + \alpha h_1 - TG_1$$

$$BA_2 = OG_2 + \alpha h_2 - TG_2$$

$$BA_2 - BA_1 = \Delta BA = (OG_2 - OG_1) + \alpha (h_2 - h_1) + (TG_1 - TG_2)$$

where BA_1 and BA_2 are the bouguer anomaly values at the first and second stations respectively. OG_1 and OG_2 are observed gravity values h_1 and h_2 are elevations, TG_1 and TG_2 are theoretical gravity values, and α is the combined bouguer correction (=0.06599 for density = 2.2 gm/cc.). If Worden gravity meters of scale factor approximately 0.1 mgals per scale division and barometers measuring pressure in millimetres of mercury (1 mm = 40') are used in latitudes where northings and southings in theoretical gravity are 6/7 mgal/mile, then;

$$OG_2 - OG_1 \simeq \frac{S_2 - S_1}{10} \text{ mgals}$$ (S is the scale reading of the gravity meter)

$$(h_2 - h_1) \simeq \frac{(P_1 - P_2)}{3} 8 \text{ mgals}$$ (P is the pressure reading in mm of mercury)

and $$(TG_1 - TG_2) \simeq \frac{6M}{7} \text{ mgals}$$ (M is change northings in miles).

and $$\Delta BA = \frac{(S_2 - S_1)}{10} + \frac{(P_1 - P_2)}{3} 8 \pm \frac{6M}{7}$$

where $+\frac{6M}{7}$ is used if the second station is to the north of the first; $-\frac{6M}{7}$ is used if it is to the south of the first station and $\frac{6M}{7} = 0$ if both stations are at the same latitude.

In the subject survey the theoretical station positions as specified in the flight plan were used. The maximum error for any one station would be :-

1. Gravity. No drift correction made and approximate scale factor used, therefore standard deviation is probably close to 0.5 mgal.

2. Elevation. No correction for diurnal variations or air temperature and humidity are made therefore standard deviation is approximately 3 mgals.

3. Station position. The actual station could be up to 3 miles away from its theoretical position. Therefore standard deviation is approximately 1 mgal.

The standard deviation for the bouguer anomaly at each station would therefore be

$$\sqrt{(0.5)^2 + (3)^2 + (1)^2} = \underline{3.2 \text{ mgals}}.$$

This method of calculation enables preliminary bouguer anomalies to be calculated rapidly in the field. However the resultant 1:250,000 maps are not sufficiently accurate to provide a basis for follow-up.

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APPENDIX C

PARTY ORGANIZATION

Set out below are some details concerning the party organization:-

STAFF (Wongela Geophysical Pty. Ltd.)

Project Supervisor	-	G.F. Lonsdale
Party Leader	-	F. Darby
Party Manager	-	M.T. Brulhart
Meter Readers	-	T. Magub, W. Lowndes, J. Almekinders L. Coremans, P.V. Harmann
Computers	-	2 computers used.
Draftsmen (in Brisbane)	-	Drafting services supplied by Mapping System Pty. Ltd. of Brisbane.

Casual staff comprised of 2 cooks, 1 mechanic and 1 scout.

BUREAU REPRESENTATIVE - A.J. Flavelle

EQUIPMENT 1 x Worden No. 708

1 x Worden No. 592

1 x La Coste No. GEO

5 x Mechanisms microbarometers calibrated in millimeters.

5 x Hygrometers

HELICOPTERS 2x Bell 47G3B, AHF and AHH
1 x Bell 47G2, WHS
1 x Hiller 12 C, THA
} Supplied by Rotor Work of Sydney.

Not more than three helicopters were used at any one time.

VEHICLES 1 x International 3 ton 2 x 2

4 x Toyota "Landcruisers" 30 cwt 4 x 4

1 x Landrover long wheel base 4 x 4.

PLATE I

1965 HELICOPTER GRAVITY SURVEY, QLD-NT (BY CONTRACT)

LOCATION MAP

SCALE

200 100 0 200 400 MILES

Area of survey

Area covered in this report

NMP/59/151·1

E53/B2-40-1

1965 HELICOPTER GRAVITY SURVEY, QLD-NT
GEOLOGY

LOCATION

Cz Cainozoic	▲35 BMR gravity pendulum station
T Tertiary	Alcoota BMR 1:250,000 gravity map area
M Mesozoic	Fault
Pzu Pzℓ Palaeozoic	Fault, indefinite
Pu Upper Proterozoic	Anticlinal axis
Pℓ Lower Proterozoic	Synclinal axis
A Archaean	State boundary
+ + + Granite	Survey boundary
V V V Volcanics, undifferentiated	Area covered in this report
	✧ Well

40 0 40 80 MILES

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PLATE 3

1965 HELICOPTER, GRAVITY SURVEY, QLD-NT

PROVISIONAL BOUGUER ANOMALIES

GULF OF CARPENTARIA

AUSTRALIA TERRITORY

NORTHERN TERRITORY

WESTERN AUSTRALIA

NORTHERN QUEENSLAND

Delamere · Larrimah · Hodgson Downs · Mt Young · Pellew

Waterloo · Victoria River Downs · Daly Waters · Tanumbirini · Bauhinia Downs · Robinson River · Mornington · Cape Van Diemen · Galbraith

Limbunya · Wave Hill · Newcastle Waters · Wallhallow · Calvert Hills · Westmoreland · Burketown · Normanton

Birrindudu · Brunette Downs · Mt Drummond · Lawn Hill · Donors Hill · Croydon

Alroy · Ranken · Camooweal · Dobbyn · Millungera

Frew River · Avon Downs · Mt Isa · Cloncurry

Highland Rocks · Mt Theo · Lake Mackay · Mt Doreen · Mt Rennie · Glenormiston · Boulia · Mackunda

Lake Amadeus · Henbury · Rodinga · Hale River

Beetaloo · Helen Springs · South Lake Woods · Winnecke Creek · Tennant Creek · Green Swamp Well · Tanami · Tanami East · Lander River · Bonney Well · Mt Solitaire · The Granites · Mt Peake · Barrow Creek · Elkedra · Urandangi · Mc Henry · Huckitta · Tobermory · Alcoota · Napperby · Mt Wedge · Alice Springs · Willowra · Sandover · Mt Liebig · 35 Alice Springs

BUCHANAN REGIONAL GRAVITY PLATFORM

RENNER REGIONAL GRAVITY PLATEAU

COOMARIE REGIONAL GRAVITY COMPLEX

LANDER REGIONAL GRAVITY LOW

CORATIPRA GRAVITY RIDGE

WILLOWRA REGIONAL GRAVITY RIDGE

CAROLINE AMMAROO GRAVITY RIDGE

NAPPERBY REGIONAL GRAVITY LOW

SPRATT RIDGE

GEORGINA REGIONAL GRAVITY SHELF

SANDOVER GRAVITY LOW

TOBERMORY GRAVITY SHELF

HAY GRAVITY LOW

WILLOWRA REGIONAL GRAVITY HIGH

HALE GRAVITY PLATFORM

PAPUNYA REGIONAL GRAVITY RIDGE

AMADEUS REGIONAL GRAVITY LOW

DEPRESSION

LOCATION

NT · QLD

Province boundary

Unit boundary

Area covered in this report

Gravity 'High'

Gravity 'Low'

Isogals, values in milligals

▲56 BMR gravity primary station

Tanami BMR 4-mile gravity map area

Rock density of 2·2 g/cm³ used for computations

Rock density of 1·9 g/cm³ used for computations

SCALE 40 20 0 40 80 MILES

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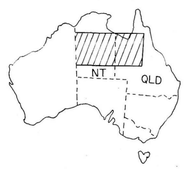
WATERLOO
VICTORIA RIV. DOWNS
DALY WATERS
TANUMBIRINI
BAUHINIA DOWNS
ROBINSON RIV.
MORNINGTON
CAPE VAN DIEMAN
GALBRAITH
WALSH
LIMBUNYA
WAVE HILL
NEWCASTLE WATERS
BEETALOO
WALLHALLOW
CALVERT HILLS
WESTMORELAND
BURKETOWN
NORMANTON
RED RIVER
BIRRINDUDU
WINNECKE CREEK
SOUTH LAKE WOODS
HELEN SPRINGS
BRUNETTE DOWNS
MT DRUMMOND
LAWN HILL
DONORS HILL
CROYDON
GEORGETOWN
TANAMI
TANAMI EAST
GREEN SWAMP WELL
TENNANT CREEK
ALROY
TANKEN
CAMOOWEAL
DOBBYN
ILLUNGERA
GILBERTON
THE GRANITES
MT SOLITAIRE
LANDER RIVER
BONNEY WELL
FREW RIVER
AVON DOWNS
MT ISA
CLONCURRY
JULIA CREEK
RICHMOND
HIGHLAND ROCKS
MT THEO
MT PEAKE
BARROW CREEK
ELKEDRA
SANDOVER RIV.
URANDANGI
DUCHESS
McKINLAY
MANUKA
LAKE MACKAY
MT DOREEN
NAPPERBY
ALCOOTA
HUCKITTA
TOBERMORY
GLENORMISTON
BOULIA
MAC KUNDA
WINTON
MT RENNIE
MT LIEBIG
HERMANNSBURG
ALICE SPRINGS
ILLOGWA CREEK
HAY RIV.
MT WHELAN
SPRINGVALE
BRICHTON DOWNS
MANEROO

Timber Ck
Auvergne
Newry
Victoria Riv Downs
Top Springs
Nutwood Downs
Tanumbirini
Daly Waters
Borroloola
O.T. Downs
Macarthur Riv
"Mallapunyah Springs" H.S.
Robinson Riv
Wollogorang
Westmoreland
Calvert Hills
Gorinda H.S.
Doomadgee Mission
Burketown
Normanton
Wave Hill
Beetaloo
Newcastle Waters
Eva Downs
Anthony's Lagoon
Creswell Downs H.S.
Benmara H.S.
Hooker Creek
Banka Banka
Brunette Downs
Rockhampton Downs
Alexandria Downs H.S.
Lawn Hill H.S.
Vaughn Strip
Tennant Creek
Alroy Downs H.S.
Gallipoli H.S.
Dalmore Downs H.S.
Camooweal
Kamilerai
Levelled
Goolullah
Tanami
Wauchope Hotel
Hatches Creek
Elkedra
Willowra H.S.
Central Mt Stuart
Taylor Well
Annitowa H.S.
Jake Nash
Urandangi
Mt Isa
Yelvertoft
Cloncurry
Dajarra
Duchess
Malbon
Mckinlay
Julia Creek
Oorindi
Nelia
Gilliat
Richmond
Woodgreen
Mac Donald Downs
Lucy Ck
Tobermory
Linda Downs
Carandotta
Glenormiston
Boulia
Hamilton
Lucknow
Cannington
Dagworth
Ayrshire
Winton
Mt Riddock
Mount Dennison H.S.
Mt Whelan
Springvale
Brighton Downs
Maneroo

129°00'
144°00'
16°00'
23°00'



1965 Survey area
Gravity control traverse (existing)
Elevation control traverse (proposed and existing)
Gravity control station
A, AA Segments

GRAVITY AND ELEVATION CONTROL
1965 HELICOPTER GRAVITY SURVEY, QLD-NT

SCALE
40 20 0 40 80

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