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RECORD No. 1965/96

GEORGINA BASIN RECONNAISSANCE GRAVITY SURVEY, NT AND QLD 1959

by

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SUMMARY

A ground reconnaissance gravity survey was made in the Georgina Basin, Northern Territory, to serve as a control for future, more extensive, helicopter gravity surveys. The results of the survey have been incorporated with those of later work and are not included in this Record.

A useful method for barometric levelling of ground gravity traverses is described.

1. INTRODUCTION

In 1957 and 1958, the Bureau of Mineral Resources (BMR) made several gravity surveys in south-west Queensland, including parts of the Georgina Basin and some of its marginal areas. These gravity surveys were successful in delineating structural trends in the area. Further work was carried out in Queensland during 1959, both by ground parties and by a party using helicopter transport to facilitate the establishment of a regular grid of gravity stations.

In order that helicopter gravity coverage could be later established in the Northern Territory over the remainder of the Georgina Basin, a ground reconnaissance gravity survey was made in 1959. This survey, which is described in this record, provided a regional network of control traverses over seven 4-mile map areas, namely Elkedra, Sandover River, Huckitta, Tobermory, Alice Springs, Hay River, and Urandangi (Plate 1). 322 new gravity stations were read along 1200 miles of traverse in an area of about 40,000 square miles. The survey was made between 30th July and 11th November 1959.

At the time the survey was made, the detailed geology of many parts of the survey area was not well known. More recent geological and gravity surveys have since added considerably to this knowledge. In this record some general comments regarding the physiography and regional geology of the area are given in Sections 3 and 4.

The results of the survey are discussed briefly in Section 6, but the discussion does not extend to a presentation and interpretation of the regional Bouguer anomaly pattern obtained solely from the results of the ground survey. The data obtained were sparsely distributed over a very wide area and have since been incorporated in the BMR Bouguer anomaly maps, which are based on the results of the helicopter gravity surveys, during which a regular grid of gravity stations was established in the area. The results and interpretation of the complete gravity coverage is given in a report by Barlow (in preparation).

During the survey, nearly one hundred gravity stations, at four to five mile intervals, were levelled experimentally using a single microbarometer. The method used and the results obtained are briefly discussed in Appendix D.

Other field work carried out by the author during the period 10th July to 4th December 1959 is summarised in Appendix A.

2. OBJECTIVES OF THE SURVEY

The objectives of the survey were as follows:

(i) To establish a regional network of gravity traverses to serve as elevation and observed gravity control for the later helicopter gravity survey over the same area.

(ii) To provide information as to the maximum and minimum Bouguer anomaly values and the steepness of gravity gradients which might be encountered in the area.

(iii) To assess the degree of correlation which could be expected between the results of gravity surveys and regional geology in the area.

(iv) To establish gravity stations at one-mile intervals over suspected faults west and south of Old Huckitta Homestead and east of Elkedra Homestead (at the request of the Geological Branch of the BMR). These portions of the traverses are shown in Plate 1.

(v) To assess suitable locations for base camps and flycamps, investigate access and supply routes, and obtain other background knowledge of the area to assist in planning the later helciopter survey.

3. PHYSIOGRAPHY

Some of the more important physiographic features in, and marginal to, the survey area are shown in Plate 1.

In general, the area consists of a tilted plateau rising gradually from an elevation of about 500 feet in the valley of the Georgina River and increasing westerly to an elevation of about 1800 feet near Alice Springs. The plateau is also gently tilted down to the south. On the surface of the plateau,low rocky hills, mainly buttes and mesas, are common in many regions.

Several mountain chains occur in the area, although none is particularly high. The Macdonnell Ranges extend over a distance of nearly 200 miles and pass east-west through Alice Springs. About 40 to 50 miles further north, the Strangways Range lies to the east of the Stuart Highway. The Harts Range, about 100 miles north-east of Alice Springs, is extensive in area and contains peaks rising to 1500 feet above the plateau to elevations of more than 3000 feet. Further still to the north-east are the smaller Dulcie and Jervois Ranges. In the extreme north-west of the survey area is the Davenport Range. In the south-eastern region of the area the Toko and Tarlton Ranges mark the north-eastern and northern limits of the Simpson Desert.

The southern portion of the survey area forms part of the Simpson Desert, a monotonous expanse of parallel sand-dunes, which trend north-north-west and are continuous over considerable distances. Parallel sand-dunes also occur further north in areas near the Sandover River. Claypans are numerous in these semi-arid regions, the largest being Lake Caroline, which is about 2½ miles long and 1½ miles wide.

The river beds are broad and sandy. The rivers rarely flow, and then only after exceptional rain, which may be expected in the area only every few years. Drainage is to the south towards Lake Eyre.

Natural waterholes and springs are rare, although soaks can be established in many stretches of the river beds. The few surface dams are generally dry, and the only water then available is that pumped from sub-artesian bores. All of the bore water is suitable for stock, and nearly all of it is fit for human consumption, it being free from odour and comparatively low in salt content. The climate varies from very dry in the northern and western parts of the area, where the annual rainfall is about ten inches, to semi-arid in the Simpson Desert, where the annual rainfall is less than five inches. Most of the rainfall occurs during December and January or April and May. The weather is generally hot during the day, but the nights may be cold during the winter. Dust storms are frequent, particularly from August to October.

Vegetation is limited to spinifex, saltbush, gidyea, mulga, and other species that are suited to the dry climate, but is plentiful even in the Simpson Desert, although the growth is very stunted. Larger trees such as bloodwood, carobean, and ghost gums occur along the river-courses. In spite of the lack of water in the area, indigenous wildlife, such as kangaroos, dingoes, emus, and lizards, is plentiful. A great variety of birds, including galahs, cockatoos, budgerigars, and various types of hawks, can be seen near the dams and bores.

The area is sparsely populated and includes about 250 white people living in twenty homesteads scattered throughout the area and less than 1000 aborigines attached to these homesteads. Alice Springs, with a population of about 4000, is the only town in the area.

Transport facilities from Adelaide to Alice Springs are reasonably good, but from Alice Springs into the survey area, the only means of transport are the weekly service by Connellan Airways or by vehicle along poor-to-fair graded roads.

All the homesteads are connected to the Royal Flying Doctor Service based at Alice Springs.

4. REGIONAL GEOLOGY

The area traversed was mainly in the southern part of the Georgina Basin. The Great Artesian and Amadeus Basins are marginal to the survey area, and the Arunta Block forms the western part of the area.

Since 1956, geological parties of the BMR have been investigating the area, and consequently the geological knowledge of the region has been considerably advanced. The results of these geological surveys will be referred to in more detail in the final report on the gravity results (Barlow, in preparation).

The following brief description of the regional geology (Plate 2) is mainly based on the geological notes in explanation of the Tectonic Map of Australia (BMR 1962).

Georgina Basin

In the Georgina Basin, flat-lying Cambrian and Ordovician sediments, consisting mainly of limestone and dolomite (Opik, 1957), thicken towards the south-east. These are conformably underlain by Upper Proterozoic rocks consisting of boulder beds, arkose, sandstone, red siltstone, and dolomite, which are about 3000 feet thick near Huckitta and about 7000 feet thick in the Field River area, further to the south-east.

The extent of the Georgina Basin is defined by the trangressive Cambrian sediments and the boundaries of the basin are marked in the east and north-east by Precambrian rocks of the Cloncurry Fold Belt and in the west and south-west by Precambrian and early Cambrian rocks (Casey et al, 1960). These boundaries are shown in Plate 2. The Georgina Basin extends north-west of the survey area into the region known as the Barkly Tableland. In the south-east, Lower Palaeozoic beds, including Cambrian and Ordovician sediments of the Georgina Basin, occupy the Toko Syncline and may continue further to the south-east under a cover of Mesozoic sediments of the Great Artesian Basin (BMR, 1960).

Middle Cambrian sedimentation in most of the Georgina Basin began with the deposition of siltstone, chert, dolomite, and sandstone, followed by carbonate rocks containing chert nodules. In the south, micaceous red sandstone, greywacke, and dolomite were the first Cambrian units deposited. The sequence is about 1000 feet thick and is presumed to be fairly uniform over the area.

From the Middle Cambrian to the Lower Ordovician, gentle subsidence, interrupted by periodic emergence, prevailed, and mainly carbonate sediments with some sandstone and shale were laid down. This contrasts with the clastic sediments that followed in the Middle Ordovician. During the Upper Cambrian, about 1500 feet of largely carbonate sediments were laid down in the Huckitta and Tobermory areas. The clastic Middle Ordovician is about 1000 feet thick. It crops out only in the Toko, Tarlton, and Dulcie Ranges and forms mesa cappings near Barrow Creek. Like the underlying sequences, it thickens to the south-east.

A long period of stability ensued after the Middle Ordovician and there is no further record of sedimentation until the Upper Devonian. 2100 feet of Devonian sandstone with calcareous siltstone interbeds have been measured in the Dulcie Range. There is no angular unconformity between these sediments and the underlying Ordovician clastics.

In general, the outcropping Palaeozoic strata are very gently folded and in places faulted. Faulting with some steepening of depositional dip occurs in places where the strata abut older rocks on the eastern margin of the basin. The western side of the Toko Syncline is bounded by the Pulchera Fault, which extends south-south-east from Twin Hills and possibly extends well into the Bedourie 1:250,000 map area. In the Elkedra area, Cambrian rocks, which overlap the heavily intruded Precambrian sediments (Warramunga and Hatches Creek Groups) of the Davenport Range area, do not appear to have been affected by post-depositional movements. The structure of the Palaeozoic rocks in areas covered by more recent sediments is unknown.

Also included in the Georgina Basin is the area referred to by Mackay and Jones (1956) as the Ammaroo Basin. Recent geological and gravity surveys have indicated that this area should be considered a sub-basin of the Georgina Basin. The Dulcie Syncline lies within this sub-basin and contains the sedimentary succession of maximum known thickness in the region.

Great Artesian Basin

Extensive Mesozoic sediments form the Great Artesian Basin, and although there has been sedimentation in the area of this basin since Proterozoic time, little is known of the distribution, stratigraphy, and structure of the pre-Mesozoic sequence. A major pre-Mesozoic unconformity cuts across Permian, Carboniferous, Devonian, Cambro-Ordovician, and Proterozoic sediments, granite, and metamorphic rocks in various parts of the basin. It has been suggested that these sediments are most likely underlain by metamorphic and granitic basement rocks of Archaean age.

The Mesozoic basin is developed as a downwarp subdivided by structural 'highs' into many sub-basins (BMR, 1960). Mesozoic sediments, including Jurassic and Triassic sediments followed by lower Cretaceous marine and fresh water sediments, are thicker over the areas of the sub-basins and thinner over the basement ridges.

In the Boulia area, the Precambrian and Lower Palaeozoic rocks of the Mount Isa/Cloncurry region form a shelf (the Boulia Shelf) that extends south-south-west to a latitude of about 24°S. The Boulia Shelf extends as a well-expressed gravity anomaly feature to the east and south-east of the survey area.

In the southern part of the survey area the Mesozoic sediments of the Great Artesian Basin overlap the Cambrian sediments of the Georgina Basin. They are covered by a monotonous veneer of Cainozoic sand dunes, and the extent of various formations under the Simpson Desert is unknown.

Amadeus Basin

The Amadeus Basin contains Upper Proterozoic and Palaeozoic sedimentary rocks. The total thickness of sediments deposited in this basin is about 35,000 feet.

Sedimentation commenced with 1500 feet of Upper Proterozoic beds of the Heavitree Quartzite followed by 2000 feet of Bitter Springs gypsum, limestone, dolomite, and sandstone, which in turn are overlain by the Proterozoic Areyonga Formation (mainly composed of sandstone with some shale) and shales of the Pertatataka Formation. These sediments are overlain conformably by Cambrian sediments including the Arumbera Greywacke (may be Lower Cambrian or Upper Proterozoic) and the Jay Creek Limestone and Goyder Formation.

In the western part of the Amadeus Basin, Ordovician rocks are represented by the Pacoota, Horn Valley, Stairway, and Stokes Formations, comprising mainly alternate sandstones and shales. A major unconformity separates these sediments from the Upper Palaeozoic Mareenie Sandstone, which is unconformably overlain by the continental Pertnjarra Formation, also of Upper Palaeozoic age.

The Amadeus Basin is an asymmetric east-west trough, bounded to the north by the Archaean rocks of the Arunta Block, which is in faulted conjunction with the sediments contained in the trough area. In the south, diapiric structure and thrusting is known to occur. The basin rises gradually to the Archaean outcrops of the Musgrave Block, which forms the southern boundary of the basin.

The Ngalia Trough, north of the Amadeus Basin, has a tectonic environment similar to that of the Amadeus Basin, but little is known of the stratigraphic sequence and the structure.

Arunta Block

The Arunta Block is a vast triangular area of complex lithology, but mainly including Archaean rocks, which extend north and northwest from the Alice Springs - Harts Range region over a distance of about 300 miles. This block forms the northern margin of the Amadeus Basin and the south-western margin of the Georgina Basin.

The gneissic and schistose rocks that form the block are referred to as the Arunta Complex. It has been suggested that the parent rocks included greywacke of great thickness, sandstone, shale, limestone, and basic flows or sills. These rocks were transformed by intense regional metamorphism and metasomatism into gneiss, schist, amphibolite, and quartzite. Later, the metamorphic rocks were intruded by acid (?Proterozoic granite and pegmatite), intermediate (granodiorite), and basic (gabbro and dolerite) igneous rocks. Major intrusions of acid rocks occur in the area between the Jervois and Harts Ranges.

In some areas, the rocks of the Arunta Block are strongly folded into a complex structural pattern, but the tectonic history is not clear even in the area of the Harts Range, which has been mapped in detail by Joklik (1955). The lineation and intense small-scale folding, commonly trending north-north-east, are probably Archaean, but the major east-trending folds and faults are similar in style and trend to those further south in the Amadeus Basin, and, like these, are probably of Middle Palaeozoic age.

Minerals occur in several parts of the Arunta Block, and particularly in the Harts Range - Plenty River (Huckitta) area, where excellent mica has been mined from the pegmatite veins mentioned above. Only a few of the mica mines were still operating in 1959 and these have since closed down as they were unprofitable. Gold has been mined in the Harts Range area at intermittent periods.

Copper carbonate ore occurs in a ridge of quartz-mica schist on the south-eastern side of the Jervois Range. Test quantities of this ore have been mined and an acid leaching plant was partly constructed near the mine. Neither the mine nor the plant is operating.

5. PREVIOUS GEOPHYSICAL SURVEYS IN AREA

Extensive reconnaissance gravity surveys were made by the Bureau of Mineral Resources over areas of western Queensland, adjoining the present survey area on its eastern margin. Ground traverses along existing roads and tracks were read during 1957 and 1958 (Neumann, 1959a & b). During 1959, this ground work was supplemented and a grid pattern of gravity stations was established over a wide area by a BMR gravity party using helicopter transport (Gibb, in preparation).

Regional gravity traverses were surveyed along the Stuart Highway, north of Alice Springs, and along the railway line and various roads south and south-west of Alice Springs by Marshall and Narain (1954). The results of this survey indicated a very deep gravity 'low' just south of Alice Springs and bounded to the north by a very steep east-west gravity gradient across the Stuart Highway. This gradient attains a maximum value of 6 milligals per mile, with a total change in Bouguer anomaly of about 100 milligals over a horizontal distance of about 24 miles, nearly all of which occurs over outcrops of the Arunta Complex. A regional gravity survey by the BMR over some of the roads south-west of Alice Springs in 1957 confirmed the existence of a gravity 'low' with Bouguer anomaly values as low as -120 milligals in that area.

A regional gravity survey using commercial airlines was made by the BMR in 1959 (Radeski, 1962). Isolated gravity stations were established at twenty homestead airstrips throughout the area of the survey described in this record, but the stations are too widely scattered to give a useful picture of the Bouguer anomaly contours.

The only previous aeromagnetic work in this area consists of two traverses over the extreme south-eastern corner (Jewell, 1960). These traverses run from Dajarra to Alice Springs and from Dajarra to The Curralulla and extend at both ends over shallow basement. The profiles are disturbed over their whole length, which indicates that the basement is shallow. Estimates place the maximum basement depth at about 3300 feet, near Tarlton Downs Homestead. The traverses are shown in Plate 2.

No previous seismic work had been done in this area or in any of the neighbouring areas.

No deep bores had been drilled in the area, but numerous shallow water bores had been put down at the various homesteads. Gas flowed into the Cherry Creek bore on the Ammaroo Station at a depth of 135-173 feet (Mackay and Jones, 1956). The gas occurs in Middle Cambrian limestone where it has probably been trapped by thinly interbedded shale. In connexion with the search for oil, bores have recently been drilled at Lake Nash, New Ooratippra, and Ammaroo. The drilling results will be considered in a later report when assessing the gravity results.

6. FIELD WORK AND REDUCTION OF RESULTS

During the 1959 survey, gravity observations were made at 322 new gravity stations, distributed along 1200 miles of traverse, at intervals of four to five miles. Several short sections of traverse were read at station intervals of about one mile at the request of the Geological Branch of the BMR.

Topographic surveying

Marking, levelling, and positioning of the gravity stations was carried out by several survey crews provided by the Commonwealth Department of the Interior. All stations were identified on air photos except for part of Traverse 64 south-east of Annitowa Homestead. The station sites were permanently marked and numbered. All elevations were referred to mean sea level and tied to the Queensland State Datum. Some of these stations were also measured experimentally by barometric methods (See Appendix D).

During the course of the survey, additional stations were read as required; the elevations of these were all determined barometrically, although some stations were later levelled precisely by the surveyors.

Observed gravity

The eastern portion of the 1959 survey was tied to earlier Queensland reconnaissance gravity surveys at three points, viz. Urandangi (Traverse 3, Station 10), Tobermory (Traverse 13, Station 13), and Robinson's Dry Bore (Traverse 43, Station 3). These earlier Queensland surveys had previously been tied to the BMR pendulum stations at Longreach (PS54), Cloncurry (PS55), Boulia (PS56), and Birdsville (PS57). The western portion of the 1959 survey was tied to the BMR pendulum station at Alice Springs (PS35), where the tying error was 0.06 milligal.

When considered in conjunction with various parts of the Queensland traverses, the traverses of the 1959 survey form five closed loops and two single-ended traverses. Loop misclosures were 0.01, 0.02, 0.14, 0.23, and 0.34 milligals. It is thought that the larger misclosures arise mainly from observations made with Worden 274 (See Appendix C) and the errors were distributed accordingly. Misclosure corrections are small because of the large number of stations involved in each loop (the 0.34 milligal error is spread over 107 station intervals).

Ten regional gravity stations, which had been established earlier in 1959 at various homestead aerodromes by Radeski (1962), were re-occupied. The observed gravity values and elevations obtained during 1959 ground survey supersede the earlier values.

Provisional Bouguer anomaly values

A rough calculation of the Bouguer anomaly was made in the field as soon as each new station was read. If the results showed that the variation in the Bouguer anomaly was more than 10 milligals in relation to the value calculated at the last station, then an intermediate station was established between the original pair. No additional travelling time was involved as the new station was read when returning down the traverse to the normal drift-control station. In this way, additional gravity data were obtained on those sections of the traverse where the gravity gradient was in excess of 2 milligals/mile. A gradient of this magnitude must result from a reasonably abrupt change in the density of the underlying rocks, and geologically can often be interpreted as a fault. The additional station established in this way determines more exactly the position of the gravity gradient and hence the position of the fault.

The procedure is worth following in future surveys but it is felt that the criterion should be reduced to about 1.5 milligals/mile.

Final Bouguer anomaly values

As for earlier gravity surveys in the Georgina Basin, a uniform density of 1.9 g/cm^3 was assumed for the near-surface rocks in reducing the observations. This density was also used on earlier gravity surveys in the Georgina Basin. It is probable that a higher density would be more appropriate in areas of older rocks, particularly those near Alice Springs. Stations in the Alice Springs 4-mile map area were also computed using a density of 2.2 g/cm^3 to enable these results to be shown together with other data obtained in the marginal areas of the Amadeus Basin, for which a density of 2.2 g/cm^3 appears to be preferable.

From the results of this survey, a preliminary contour map of the regional Bouguer anomalies of the area was drawn to guide the later helicopter gravity survey.

The results of the 1959 survey have been incorporated in the Bouguer anomaly contour maps of later helicopter gravity surveys (Barlow, in preparation).

7. CONCLUSIONS

In general, the objectives of the survey were achieved. The data and experience obtained were sufficient to enable suitable planning of the later helicopter gravity survey.

A regional network of gravity traverses was established in the area. The network was tied to BMR pendulum stations and adjusted in closed loops. The results were sufficiently accurate to serve as control for the later helicopter survey.

The range of Bouguer anomaly values (assuming a rock density of 1.9 g/cm3) varied from a maximum of +14 milligals near New Ooratippra to a minimum of -110 milligals at the Alice Springs pendulum station.

The steepest gravity gradient measured was 6 milligals per mile on Traverse 68, about twenty miles north of Alice Springs. Other steep gravity gradients were detected on Traverse 68 between New Huckitta and the Jervois Range copper mine. These steep gravity gradients occur over areas of Precambrian Arunta Complex.

The results of the 1959 survey indicated the possibility of correlating gravity data with known geology in the area. However, the interpretation of the gravity results in those parts where little is known geologically is complicated, because the Georgina Basin is largely filled with high-density Cambrian limestones that have little or no density contrast with the basement and because of possible density reversals in the sediments.

The gravity results obtained at one-mile intervals over those portions of traverse shown in Plate 1 did not provide evidence to confirm suspected faults. It must be consluded that either there is little density contrast across the faults or the suspected faults do not exist on those portions of traverse.

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APPENDIX A

Summary of additional gravity work done by B.C. Barlow during the 1959 field season

The main text of this record refers to a ground reconnaissance gravity survey over part of the Georgina Basin made between 30th July and 11th November 1959. Other gravity work done by the author before and after this survey is summarised below.

Preparation of the 1959 helicopter gravity survey

The author was responsible for the preparation of the 1959 helicopter gravity survey. The helicopter party departed from Melbourne on 10th July and arrived in Cloncurry on 29th July when it was handed over to Mr. S. Waterlander, who was party leader during the actual field operations.

En route to the field, short gravity loops had been made from the Brisbane and Roma pendulum stations to tie in to a regional gravity survey described by Radeski (1962).

Mr Waterlander had been carrying out a ground reconnaissance gravity survey similar to that described in this record and his party was taken over by the author, who then made a forty-mile traverse involving fourteen new gravity stations along the railway line between Malbon and Selwyn, Queensland, using level data supplied by the railway. This work was done to assist in the control of the 1959 helicopter survey. The results of this traverse are included in a report on that survey by Gibb (in preparation).

Alice Springs detailed survey

At the conclusion of the Georgina Basin survey, a brief detailed gravity survey was made in the area immediately south of Alice Springs to assist in delineating a fault repetition in the area. Forty-seven new gravity stations were read along fifteen miles of traverse in an area extending from the town of Alice Springs south through Heavitree Gap to the aerodrome between 12th and 25th November 1959. The majority of these gravity stations were sited at benchmarks established by the Lands and Survey Branch, Alice Springs; the remaining stations were levelled barometrically. The results of this work are described by Neumann (in preparation).

During this period, a brief inspection visit was made to Gosses Bluff, about eighty miles west of Alice Springs. The gravity pattern over this structure had been established by a private company and was suggestive of a salt dome. Eight gravity stations were read, and levelled barometrically. The results verified essential features shown in the gravity anomaly pattern over the centre and rim of the structure.

APPENDIX B

Staff

As the organisation of the ground reconnaissance survey and helicopter survey of 1959 overlapped considerably, the staffing of each of these surveys is listed below.

(i) 1959 helicopter gravity party

S. Waterlander	Geophysicist, Party Leader (replacing B.C. Barlow)
J.J. Hussin	Geophysicist
K.A. Mort	Mechanic
P. Clarke	Cook (field assistant)

(ii) 1959 ground reconnaissance gravity party

B.C. Barlow	Geophysicist, Party Leader (replacing S. Waterlander)
C. Bannerman	Mechanic
K. Warnecke	Cook (field assistant)

The position of cook on this party was declared redundant on 2nd October 1959 and Mr Warnecke was flown back to Melbourne.

Visitors to this party were Mr K.R. Vale, Supervising Geophysicist, (24th September to 1st October 1959) and Dr F.J.G. Neumann, Senior Geophysicist, (10th to 21st November 1959).

APPENDIX C

Performance of equipment

As the organisation of the ground reconnaissance survey and the helicopter survey of 1959 overlapped and equipment was interchanged between the parties, a resume of the performance of the equipment on each party is given below.

Gravity meters

Worden 140 was used for various regional gravity ties in Queensland and its performance was good. This meter was later used by S. Waterlander on the 1959 helicopter gravity survey.

Worden 274 was used for the helicopter control traverse in Queensland and for the first quarter of the reconnaissance survey in the Northern Territory. This instrument was on loan to the BMR from Frome-Broken Hill Co. Pty Ltd. Although the meter had been operated successfully by Mr S. Waterlander, it behaved unsatisfactorily from the time it was transferred to the author. The meter exhibited a cyclic daily drift that had an amplitude of about thirteen scale divisions; it was clear that the temperature compensator was damaged. To control the drift, the 'two stations forward and one back' method of traversing was used to give repeat-readings every 30 to 40 minutes and all stations were read at least three times. Usable results were obtained, although several sections of traverses had to be repeated. Worden 274 was replaced as soon as possible.

Worden 260 was then used for the remainder of the Northern Territory reconnaissance survey and for the Alice Springs and Gosses Bluff detailed surveys. Performance was good except for severe sticking on the stops. All stations were read twice to obtain accurate drift control.

Microbarometers

Askania microbarometers, type Gb5, were used at various times to obtain elevation data.

Microbarometer 562696 was used extensively throughout the earlier stages of the survey to obtain pressure variation curves, which, it was thought, might help in correcting for the extreme drift of Worden 274. The results were used to calculate experimental barometric levels as set out in Appendix D. This microbarometer was also used in conjunction with Microbarometer 5112473 to obtain levels during the Alice Springs and Gosses Bluff detailed gravity surveys. Both instruments performed well.

Microbarometer 562699 was carried by the party, but not used. It was transferred to the helicopter gravity party.

Vehicles

The following vehicles were used on the 1959 helicopter gravity survey:

C90121 3-ton International truck 4 x 2, type AA 160

C84168 3-ton International truck 4 x 2, type A5160

C89882 1-ton International truck 4 x 4, type AA 120 (long wheel-base)

C80444 Combined kitchen-office caravan

Two Carapark 4-berth all-metal caravans (on hire)

Performance of the trucks (up to 29th July) was good except for a blown out windscreen in C90121 and faulty gearbox and door mechanism in C89882. Both vehicles were new. The kitchen-office caravan performed very badly and required welding of its chassis and towbar at intervals of approximately 500 miles even on bitumen highways. The Carapark caravans rode well and gave no trouble.

The following vehicles were used by the 1959 ground reconnaissance party :

C85984 3-ton International truck 4 x 4, type ASW 160

C89823 Landrover (short wheel-base) with all-metal canopy

C89824 Landrover (short wheel-base) with all-metal canopy

Performance of C85974 was good except for minor breakdowns. This vehicle had been fitted with single rear wheels and oversize (11:00 x 20) tyres throughout and the changeover from dual rear wheels proved advantageous in loose sand. C89824 was a new vehicle and performed well apart from a burnt-out clutch. C89823 was also a new vehicle but performed badly and it was necessary to rail this vehicle to Adelaide for a complete engine overhaul after only 17,000 miles.

Radio

A Traegar transceiver, type 51MA, was permanently mounted in one of the Landrovers. Although apparently properly shock-mounted, it broke down frequently and often left the party out of communication with the Flying Doctor Network.

Camping

The general camping equipment used by the party was satisfactory and required only minor repairs during the survey except for the kerosene-operated aladdin stove, which broke down repeatedly.

APPENDIX D

A method of obtaining barometric levels using one microbarometer during ground gravity traversing

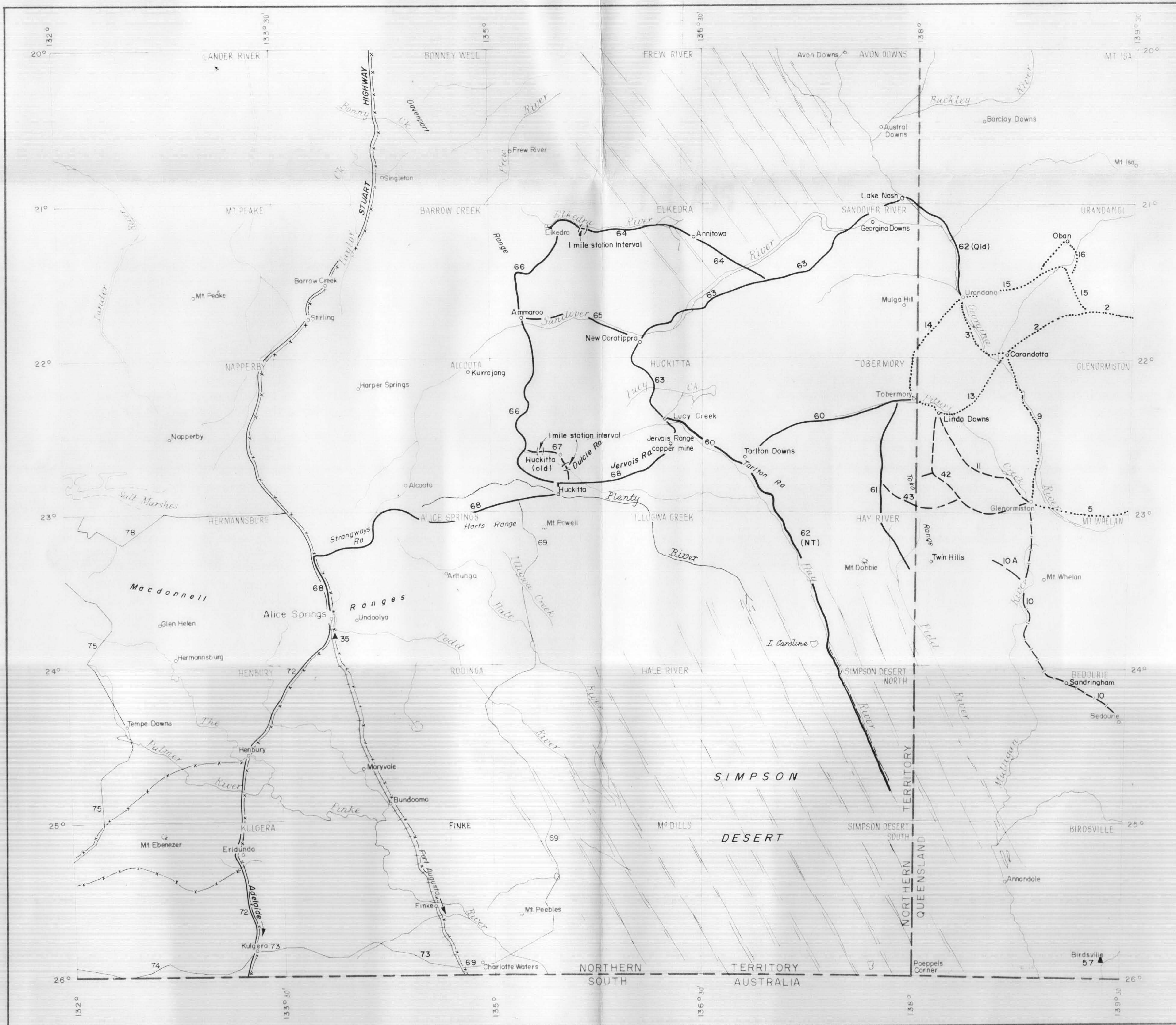
During the 1959 Georgina Basin ground reconnaissance gravity survey, a number of stations were levelled with Askania microbarometer 561696. The instrument was used to obtain pressure variation curves, which it was thought might help in correcting for the extreme drift of Worden 274 and also for experimental purposes to determine whether the levelling results obtained by the method used would be acceptable for gravity reconnaissance work. This appendix covers the results obtained with the microbarometer for ninety-two stations that had been precisely levelled by surveyors from the Department of the Interior. The stations were spaced at approximately five-mile intervals along Traverses 62, 63, 65, and part of Traverse 68.

The 'two up and one back' method of traversing was used. Each station was read three times at intervals of approximately twenty to thirty minutes, and in no case did the interval exceed forty minutes. Only one microbarometer was used and there was no base instrument such as is required by other methods of barometer levelling. The method can be operated by one man. Each stretch of road is covered three times as is usually the case for a gravity traverse. When the method is used in conjunction with gravity work the extra time involved is only that required for reading the microbarometer and for making more frequent 'turn-arounds'.

The microbarometer readings were treated in the same way as gravity meter readings to form drift curves. Although the temperature was noted at each station, temperature effects were ignored. The interval (in scale divisions) between stations was multiplied by a constant scale-factor to convert to feet. The empirical value used was - 3.82 feet per scale division, which checked satisfactorily with results for Traverse 63, Stations 1 to 40, where there was a known total difference in elevation exceeding 540 feet.

The results obtained were compared with the accurate values determined by surveyors using precise methods of levelling. A brief statistical analysis showed that the errors are distributed normally with a standard deviation of 4.3 feet. This means that 95% of the results may be expected to be within ± 8.4 feet, and 99% within ± 11.0 feet. However, if four of the results are rejected on the grounds that the associated drift curves were not acceptable (and would normally have led to the re-occupation of the stations in question), the standard deviation is only 2.3 feet, which means that 95% of the results will be within ± 4.5 feet and 99% within ± 5.9 feet.

This method of barometric levelling is suggested for use where levels are required quickly and precise accuracy is not essential, such as when extra traverses or additional stations are required to investigate a steep gravity gradient and there is no opportunity for precise levelling. In these cases, errors up to five feet in the elevations of the stations can often be tolerated.

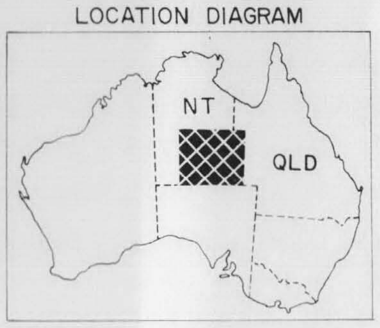


▲35	BMR gravity pendulum station
MT ISA	1:250,000 map area
┼┼┼┼	Railway
	Sand dune area
68	Department of the Interior surface control traverse

Previous surveys:

—×—×—	Gravity ground traverse	1954 (Marshall & Narain, 1954)
....	" " "	1957 (Neumann, 1959 a)
— — —	" " "	1958 (Neumann, 1959b)
—·—·—	" " "	1959 (Gibb, in preparation)
———	" " "	1959

LOCATION DIAGRAM



GEORGINA BASIN
RECONNAISSANCE GRAVITY SURVEY
NT AND QLD, 1959
LOCATION OF TRAVERSES

(TRAVERSE POSITIONS ARE ONLY APPROXIMATE)

SCALE IN MILES

40 0 40 80 120

Reference - Division of National Mapping 40 miles to 1 inch topographic map

COMPILED AND DRAWN MARCH 1961

GEOPHYSICAL BRANCH, BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS
TO ACCOMPANY RECORD No 1965/96

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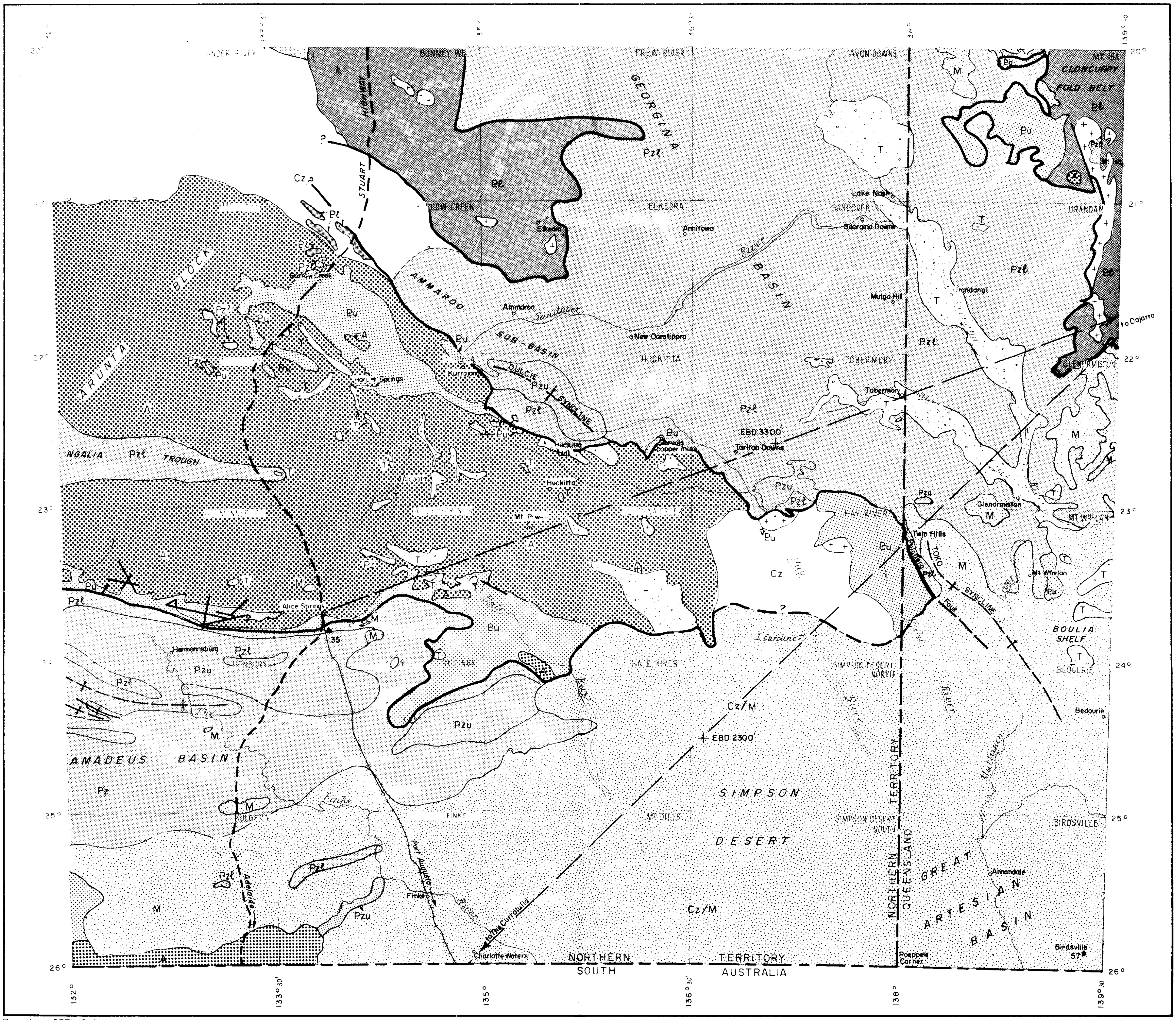

Based on G371-12-0

Cz	Cainozoic
T	Tertiary
Cz/M M	Mesozoic
Pz Pzu Pzl	Palaeozoic
Pu	Upper Proterozoic
Pl	Lower Proterozoic
A	Archaean
+ + +	Granite
▲ 35	BMR gravity pendulum station
KULGERA	1 : 250,000 map area
	Fault
	Fault, indefinite
	Anticlinal axis
	Synclinal axis
	BMR aeromagnetic flight line
+ EBD	Estimated basement depth
	Basin boundary (Precambrian against younger sediments)

GEORGINA BASIN

RECONNAISSANCE GRAVITY SURVEY

NT AND QLD, 1959

REGIONAL GEOLOGY

SCALE IN MILES

40 0 40 80 120

Reference - Division of National Mapping 40 miles to 1 inch topographic map and BMR Tectonic map of Australia

COMPILED AND DRAWN MARCH 1961

GEOPHYSICAL BRANCH, BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS F53/B2-20

To Accompany Record No 1965/96