COMMONWEALTH OF AUSTRALIA
DEPARTMENT OF NATIONAL DEVELOPMENT
BUREAU OF MINERAL RESOURCES,
GEOLOGY AND GEOPHYSICS

RECORDS 1959, No. 72

REPORT OF A

RECONNAISSANCE GRAVITY SURVEY

IN THE

DARWIN-KATHERINE AREA,

NORTHERN TERRITORY, 1955-57

by

P. M. STOTT and W. J. LANGRON

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A B S T R A C T

A reconnaissance gravity survey has been carried out over a Precambrian geosyncline in the Darwin-Katherine area during portions of three field seasons.

The results obtained reveal a considerable relief in the gravity profiles, especially in the central and eastern portions, with a range of over 50 milligals. Certain minor features on the profiles may be accounted for on present information; a noticeable feature is the association of gravity "lows" with outcropping granite and the association of some minor "highs" with basic intrusives. There is little evidence, either from density measurements or field observations, to show whether or not there is any marked variation in the composition of the basement or of any significant density difference between the basement rocks and Proterozoic sediments. It is concluded that the major gravity features are related to changes in depth to the earth's basaltic layer and by inference, to changes in the level of the "basement complex".

The gravity results indicate three distinct zones, an eastern and a western trough separated by an intermediate zone marked by granite intrusions and comparatively shallow basement. Although the western trough is covered by later sediments in the Daly River Basin it is considered that the eastern trough contains the greater depth of Proterozoic sediments.

Gravity features, in general, have a north-westerly strike and thus follow the dominant structural grain of the geosyncline.

Some further traverses are recommended for gravity survey. These traverses will provide essential data for contouring and test the opinion that mineralization is often associated with steep gravity gradients.

1. INTRODUCTION.

The gravity method of surveying is particularly suited to the investigation of large-scale structural problems. Generally, such problems are of immediate economic interest in oil search, which commonly involves the study of structures of considerable dimensions in rocks which, on a small scale, are not much disturbed. For this reason, gravity surveys are an essential part of modern oil prospecting. The structures associated with metalliferous deposits are usually on a relatively small scale and are often extremely complex, so that gravity surveys are not economically justified. However, as regional geological mapping over the Pre-Cambrian rocks in the Darwin-Katherine region of the Northern Territory had led to certain conclusions regarding large scale geological structures in that area and because of the interest in uranium prospecting in the Northern Territory, it was suggested by the Geological Section of the Bureau that the gravity method be used along selected traverses, to test its suitability for structural investigations in rocks of this type. Two detailed gravity traverses over the "embayment" area at Rum Jungle (Langron, 1956) had already indicated the possibilities of this method in part of the area under consideration.

The regional gravity survey was made by the authors and G.F. Clarke, geophysicist of the Darwin Radio-active Group. Field work was commenced in June, 1955, and the initial programme was completed in that season. The gravity results were sufficiently encouraging to warrant further investigation, and in consultation with the Geological Section several other gravity traverses were planned. The work was also extended westward to tie in with gravity readings made by a private company which was prospecting in the Bonaparte Gulf area.

This report deals with the results of all gravity surveys made in the Darwin-Katherine area up to the end of 1957. The report also includes some of the results from an underwater gravity survey conducted in 1958.

2. PHYSIOGRAPHY.

The area investigated lies between longitudes 130°E and 133°E and between latitudes 12°S and 14°30'S. It is described by Noakes (1949).

The climate is dry monsoonal (Koppen classification AW). The average rainfall ranges from about 30 inches in the south to more than 60 inches in the north. The rain falls almost entirely between October and April and during this period it is generally not possible to perform field work at any great distance from the bitumen highway.

Noakes (1949) describes the region lying north and west of Katherine as "a maturely dissected tableland with a maximum relief of approximately 1,000 feet". The main divide runs in a north-westerly direction through the centre of the region but swings to the north at the head of the Adelaide River. The

Northern Plains lie between the main divide and the northern coastline; they comprise flat and gently undulating country bounded on the west by a series of low ridges up to 400 feet in elevation and on the east by the Arnhem Land Plateau with its broken sandstone escarpment 500 to 600 feet high. The Northern Plains are bounded on the south by foot hills which lead back to the main divide on which, south of Adelaide River township, isolated mesas attain an elevation of up to 1,000 feet above sea level.

The Western Plains extend inland from the western coastline for distances up to 60 miles where they terminate abruptly against prominant north-south ridges; large areas of these plains are covered by swamp. In the south-west corner of the region is the incised tableland which forms the divide between the Daly and the Fitzmaurice Rivers.

The largest river is the Daly and its principal tributary the Katherine River; these streams are perennial. Other streams such as the Moyle, Reynolds and Finnis which flow into Bonaparte Gulf, and the Adelaide, Mary and the three Alligator Rivers which flow northward into van Dieman Gulf, usually carry insufficient water to maintain surface flow to the sea throughout the year.

Vegetation consists of grass and scattered timber with extensive open alluvial flats bordering the rivers and patches of dense paper barks and palms in the wetter parts. Towards the coast, areas of timber and swamp restrict vehicular movement.

3. OPERATIONS AND TECHNICAL DETAILS.

The Gravity Survey was usually made by a party consisting of a geophysicist and a field assistant, with one Land Rover.

All the land observations were made with a Heiland gravity meter type GSc2; instrument No.58 was used in 1955, No.53 in 1956 and No.58 again (after repair) in 1957. A scale value of 0.112 milligals per dial division was used in the reduction of the 1955 data, but tests in 1957, between Footscray and Kallista, Victoria, indicated a scale value of 0.1106 milligals per dial division for meter No.58. As the previous test over this gravity interval was in 1953, (when the scale value 0.112 was obtained), it was decided to reduce all data during the 1955 and 1957 seasons using a scale value of 0.1106 milligals per dial division. A scale value of 0.087 milligals per dial division was used for meter No.53. The under water gravity readings were made with a North American meter, type AGI-147, using a scale value of 0.12665 milligals per dial division. [Stations were occupied at intervals of approximately 2 miles along the traverses, which are shown on Plate 1. Progress along each traverse was by means of loops, with a return to the initial station of the loop after about an hour; this took care of instrument drift. Loops were later interconnected. Each station in the survey has been related to the Bureau's pendulum station at Darwin and to a station established by

Muckenfuss (Woollard, et al, 1952) at Katherine, so that absolute values have therefore been obtained.

As far as possible, use was made of the levels along the section of the railway line between Darwin and Katherine. Surveying and levelling of the remaining traverses were carried out by surveyors from the Department of Interior. All levels have been reduced to mean sea level (Darwin). Traverses (which are shown on Plate 1) are located as follows :-

(i) Railway Traverse from Darwin to Katherine. Readings were taken at nearly all even-numbered mile posts along the North Australian Railway (200 miles).

(ii) Cannon Hill Traverse from Pine Creek Railway Station to Cannon Hill. Stations G1 to G76 (160 miles).

(iii) Burrundie Traverse from Station G45 on Traverse 2 to Burrundie Railway Station. Stations B1 to B38 (80 miles).

(iv) (a) Daly River Traverse from west of the Fletcher's Gully road (near Daly river) to Fountain Head (on the North Australian Railway). Stations D1 to D48 (100 miles).

(b) Daly River (Extended) Traverse from D11 on Traverse 4(a) to the Permian rocks west of Hermit Hill. Stations D51 to D68 (35 miles).

(v) Port Keats Traverse from D61 on Traverse 4(b) to Station 11 established on a traverse from Port Keats by Mines Administration Pty. Ltd. in 1956. Stations K1 to K26 (60 miles).

(vi) Marrakai Traverse from Adelaide River Railway Station to Woolner. Stations M1 to M41 (85 miles).

(vii) Coirwong Traverse from Station M23 on Traverse 6 to Station B12 on Traverse 3 near the Kunkamoula crossing of the South Alligator River. Stations C1 to C36 (80 miles).

(viii) Point Stuart Traverse from Station B37 on Traverse 3 to Point Stuart, crossing Traverse 7 at C13. Stations S1 to S47 (100 miles).

(xi) Darwin Harbour Traverse from Southport siding on the railway line to Delissaville. Stations H1 to H15 (30 miles).

(x) Finniss Traverse from the 54-mile post on the railway line to Archean rocks west of Bamboo Creek. Stations E1 to E14 (40 miles).

Nearly all the traverses are along unformed tracks and the gravity meter was inevitably subjected to some shocks on this account. Much time was also lost because of vehicle breakdowns. The survey along the railway line between Adelaide River and Katherine was made possible by the provision of a trolley and operator by the Commonwealth Railways.

Underwater gravity readings were made from a boat in an average depth of 12 fathoms of water. The position of each station was fixed by compass bearing and by using a horizontal sextant and sighting on known coastal features. All gravity values have been reduced to mean sea level, using a density value of 1.03 for sea water. No stations at sea were reoccupied and the drift of the instrument was determined on returning to Darwin. The traverse was connected to the B.M.R. pendulum station at Darwin.

4. GEOLOGY

The progress geological map NTG33/6, which was issued by the Geological Section of the Bureau late in 1957, has been used to prepare Plate 2.

Folded Lower Proterozoic geosynclinal deposits rest on an Archean basement. To the east, the Archean rocks forming the Nanambu complex (since named Magela Metamorphics) consist mainly of schists and banded amphibolite which have been intruded by garnetiferous granite of Proterozoic age. In the west, the Hermit Hill complex, of Archean age, is of similar composition although there seems to be more abundant granodiorite and migmatite on the western side. Derrington (1957) has found diorite in the Moyle River area and similar rock crops out near Station K5. An outcrop of altered basaltic lavas, called the Stag Creek Volcanics, occurs along the South Alligator River; these greenstones are considered by the geologists to be of Archean age.

Geosynclinal deposits of Lower Proterozoic age lie in two main troughs on either side of the South Alligator River Archean outcrops. The eastern trough is bounded on its eastern side by the basement Nanambu Complex. In its northern portion the western trough is bounded by Archean rocks (the northern continuation of the Hermit Hill Complex) but further south the trough divides; one branch, parallel to the eastern trough, extends beyond Maranboy; the other, a subsidiary branch, trends south-westerly between the Daly River Basin and the Hermit Hill Complex. The Chilling Sandstone, a comparatively narrow belt of Lower Proterozoic rocks separated from the main body, occurs west of Hermit Hill between the basement outcrop and the Permian Port Keats Group, and sporadically as far north as Fog Bay. Southwards, the Chilling Sandstone joins with the Lower Proterozoic sediments of the Hall's Creek area but the relationship is not clear at the time of writing.

Flat lying Upper Proterozoic rocks of the Katherine River Group are extensively distributed north and east of Katherine and over an area south and east of Mudgenbarrie. Other Upper Proterozoic rocks crop out in the south-east portion of the area, particularly south of Fletcher's Gully. The northern edge of the Cambrian basin is crossed by the Daly River traverse. In the west of the area, Permian beds occur inland from Port Keats. Cretaceous rocks are found along the northern coast and as the capping of mesas south of Adelaide River township.

Tertiary laterite is widespread on rocks of all ages.

5. THE GEOPHYSICAL PROBLEM

The principal aims of the gravity survey were (a) to investigate the configuration of the basement rocks and if possible to estimate the depth of sediments within the geosyncline and (b) to provide additional information which would assist in geological interpretation of the area.

Gravity surveys are useful for providing information on the structure of a region provided the formation of the structure has involved the relative displacement of rocks of different densities. In most oil search surveys, the structure is relatively simple and there is usually a distinct density contrast between the "basement" rocks and the sedimentary rocks which fill the basin. However, pre-Cambrian basins such as that of the Darwin-Katherine area differ from basins of the above type in that the sedimentary rocks are folded and metamorphosed to such an extent that there is often little difference between the sedimentary rocks and the "basement" rocks. Wilson (1950) has pointed out that within a region such as the Canadian Shield, rocks described as Lower Proterozoic in one area may in fact be older than rocks described as Archean elsewhere. However, the important point at present is that there will no longer be the clear cut density contrasts between members which can normally be expected with oil and coal search problems.

The gravity work at Rum Jungle (Langron, 1956) showed that at least some sedimentary members were considerably more dense than the granites and granitized sediments and there is little evidence to suppose that normal granites, whatever their age or condition of weathering, will vary greatly in density, from a value of about 2.65. However, with other rock types the density values obtained at the surface, in general, will not be representative of those rocks at depth. Hence in the early stages of the survey it was considered that the density of the basement rocks may be less than the density of the sediments.

Without sufficient geological and drilling information, gravity surveys can only be interpreted qualitatively, since the potential field which is observed can be produced by an infinite number of arrangements of different sources. In other words, the measured field can be expressed as an equation which has an infinite number of solutions. The range of solutions can often be restricted from geological considerations and if drilling data is available to provide exact information at one or more points, the field equation can be solved at these points and when sufficient solutions are available it may be possible to eliminate the unknowns and solve the equation over the whole of the surveyed area.

The position of some geological features such as faults which bring rocks of different densities next to each other can be located accurately by gravity surveys although the magnitude of the throw remains indeterminate without other information. Although it is impossible from a gravity survey alone to relate the anomalies quantitatively to the structure, it is possible to take a postulated structure and to determine whether the observed gravity values fit the hypothesis, and if not, to use modifications to make them fit.

The density values of surface rock samples along some of the traverses, are shown in Tables 1 to 5. Traverses 4a and 2 cover a complete cross section of the Pine Creek geosyncline but samples were not collected east of G44 owing to almost complete absence of suitable outcrops. In Table 5 is included the density values of drill core specimens from Rum Jungle (Langron, 1956, p.10).

In the present survey where no great changes of elevation are encountered it is felt justified to use a density value of 2.67, the accepted value of average density of the earth's crust, for inclusion in the Bouguer correction.

6. REDUCTION OF RESULTS

The Railway Traverse is tied to the N.T.A. Lands and Surveys Bench Mark No.1 at Darwin and to a station originally established by Muckenfuss at Katherine. The B.M.R. Pendulum Station at Darwin Airport could not be reoccupied during the survey but the gravity interval between the Pendulum station and Bench Mark No.1 had been read previously by Bonini. (Woollard, et al, 1952). The values adopted in calculating the observed values of gravity are :-

B.M.R. Pendulum Station, Darwin	978	315.5(0)	milligals
Difference Pendulum Station-B.M.I. (Bonini)		-2.5	"
Bench Mark No.1	978	313.0(0)	"
Difference Darwin Pendulum Station-Muckenfuss Station, Katherine Airport (Bonini)		+28.4	"
Katherine Airport (Muckenfuss Station)	978	343.9(0)	"

After all readings had been corrected for instrument drift, the Railway Traverse was adjusted to close on the Katherine Station; these values remained constant during subsequent adjustments to connecting traverses. The errors around three closed loops were adjusted in the following order :-

(i) Adelaide River/- M23 - C13 - B37 - Burrundie - Adelaide River.

(ii) B37 - C13 - B12 - B37.

(iii) Burrundie - B12 - G45 - Pine Creek - Burrundie.

In no loop did the misclosure exceed 0.5 milligal even if parts of a traverse had been observed using different instruments. The remainder of the curvey consists of open traverses and, excluding gross errors, the observed values should be correct to within 1.0 milligal. Further overall accuracy would be obtained if stations M41, S47, G76 and D12 were connected to Darwin by air, and station H15 connected to Darwin by air or sea.

The Port Keats traverse ends on a station occupied during an oil company's survey which is tied to a Bureau survey in the Keep River Area, which in turn is tied to the Wyndham Pendulum Station. It would be helpful to have a gravity meter tie by air between Port Keats and either Darwin or Wyndham so as to give more accurate control in the centre of this network. In view of the several surveys involved, no attempt has been made to adjust the Darwin-Wyndham line at this stage.

Observed values of gravity have been reduced to Bouguer anomaly values by correcting for elevation (using a figure of 2.67 for the density of thr rocks between each station and sea level) and comparing the value thus obtained with the theoretical values (g_n) on the International Ellipsoid given by the formula :-

$$g_n = 978.049 \; (1+0.005\,288\,4 \sin^2\phi - 0.000\,005\,9 \sin^2 2\phi)$$

where ϕ is the latitude of the station.

Station elevations are based on the North Australian Railway Datum. From the heights obtained, 112.0 feet has been subtracted to reduce the values to Mean Sea Level (Darwin). (See N.T.A. Lands and Survey Branch Trace 112/54 et seq.).

7. RESULTS

The results are presented as anomaly profiles along the Traverses (Plates 3 and 4), and in the form of a contour map (Plate 5). Data obtained from a marine gravity survey (Williams and Waterlander, 1959) has been added to give additional control for the contours on Plate 5.

A study of the results suggests that there is a regional gradient of about +0.1 milligals per mile in a north-easterly direction but no correction for this has been applied. Neither terrain corrections (negligible effect at all stations) nor isostatic anomalies have been calculated.

The principal features are :-

(i) Positive Bouguer anomalies over most of the area.

(ii) High values near Darwin trending west-south-west to about the Wildman River then trending more southerly along the South Alligator Valley.

(iii) High values near Mt. Masson almost surrounded by low values over the Cullen Granite.

(iv) Low values over Yemelba Ridge (G43) and at Woolner (M40).

(v) North-south trending high values west of Hermit Hill.

(vi) High values at Cannon Hill (G76).

(vii) Steep horizontal gradients near Rum Jungle, Mt. Masson, south of Woolner, near the south Alligator River and north of Mudgenbarrie (G70-71).

8. DISCUSSION OF RESULTS

(a) The value of the Bouguer anomalies.

The area under consideration is noteworthy because of the extensive distribution of positive Bouguer anomalies. It is interesting to note that, among the 60 pendulum stations established by the Bureau throughout Australia, (Dooley, et al., 1959) there are few stations with positive Bouguer values, and of these only Geraldton lies on Pre-cambrian rocks, which do not however, form an integral part of the Pre-cambrian shield. Over the remainder of the Pre-cambrian shield, the range is from small negative values to a value of about -125 milligals at Alice Springs.

During a survey over the southern part of the shield (Gunson and van der Linden, 1956), positive values of about 30 milligals were found over the Fraser Range, although the average of all the Bouguer anomalies is -40 milligals. It is considered however, that the positive anomalies are related to the denser mass (Charnockite) of the Fraser Range.

In India, small areas of the Pre-cambrian rocks along the coast between Madras and Calcutta, and inland about 80 miles north-west of Calcutta, show positive Bouguer anomalies up to 20 milligals (Gulatee, 1956a and 1956b). The remaining values vary from zero to below -100 milligals in the region of the Himalayas. Gulatee suggests the use of two different values of depth of compensation (or of thickness of the earth's crust) for north and south India respectively, thus eliminating many of the misleading contrasts which are shown by a gravity anomaly map based on a uniform compensation system. However, this suggestion has not been generally accepted.

Observations over parts of the Canadian Shield show mainly negative anomalies (Innes, 1948; Garland, 1950; and Oldham, 1954). One value of about +10 milligals was obtained 250 miles north of Lake Huron and another value of about +5 milligals was obtained near Parry Sound. Other values range down to -60 milligals.

It is possible that the Darwin area is influenced by the large disturbances of the gravitational field which occur in the Indonesian Archipelago.

Howell (1959, Fig. 19.5) shows that the northern part of the Northern Territory lies on the southern flank of the East Indies gravity "trough" and submarine stations observed in the area by Vening Meinesz (1948) show a positive anomaly about 200 miles north of Darwin.

Other workers (e.g. Marshall and Narain, 1954) have shown that there are other Pre-cambrian areas in Australia (e.g. in the vicinity of Broken Hill and Mt. Isa) in which there is also an extensive distribution of positive Bouguer anomalies. Generally, however, Bouguer anomalies on continental areas are strongly negative (Daly, 1940, p.120); this has been found to be so in Australia, e.g. by Thyer and Everingham (1956), and Gunson and van der Linden (1956). It is felt that the presence of such an extensive region of positive Bouguer anomalies inland from Darwin, whilst not being a unique example, never-the-less merits some special consideration.

(b) Relative Densities of Archean and Proterozoic Rocks.

Tables 1-5 (see appendix) show the values of rock densities as supplied by the Geological Section. This data has been summarized in the following table which shows the range of density values for the various rock types.

Rock Type		Density
Cambrian:	Limestone	2.68
Proterozoic:	Granites	2.64 - 2.66
	Siltstone, Greywacke, etc.	2.68 - 2.72
	Schists (Noltenius Formation)	2.75 - 2.85
	Basic Rocks and B.I.F. (Golden Dyke Formation)	2.85 - 2.95
Archean:	Migmatite and Garnetiferous Granite (Hermit Hill Complex)	2.74 - 2.79
	Stag Creek Volcanics	3.0 - 3.1

A noticeable feature of the list of rock densities is that there seems to be insufficient density contrast between the major rock members to account for the amplitude of the Bouguer anomalies. With the possible exception of the Stag Creek Volcanics, the occurrence of the denser rocks is not extensive and they can often be correlated with local gravity "highs".

However, from the meagre outcrops of Stag Creek Volcanics shown on the geological plan, NTG 33/6 and from the over-all gravity results, it seems extremely doubtful to assume that this rock type is widespread as a "basement" rock, and hence it is not expected that the density of the "basement complex" varies greatly throughout the area.

It should also be noted that in both the north-east and south-west of the Darwin-Katherine area, the highest gravity values are not reached until well beyond the mapped boundary of the Archean rocks.

In at least one portion of the area under consideration (e.g. Rum Jungle) it is known that the density of the sediments filling the "embayment" is markedly greater than the density of the granitic floor, and the gravity profile across the "embayment" clearly reflects this relationship. However, in the regional survey over the Darwin-Katherine area such effects from local detailed gravity surveys become absorbed in the general gravity picture.

The "basement complex" has been intruded by lighter granitic rocks (radioactive determinations give an age of approximately 1.5 x 10^9 years for these granites). Some of the variations in Bouguer values are due to granite intrusions, but these lie in certain restricted zones and it is not likely that granite intrusions occur without some geological evidence of their existence. Plate 6 shows the Bouguer anomaly contours after allowance has been made for the effects due to the Proterozoic granites. By this treatment, the principal gravity features and trends are brought out more distinctly.

In summary, then it may be stated that with the exception of the Stag Creek Volcanics, there is insufficient density contrast between rocks of the Archean and Proterozoic groups to account for the gravity features on Plate 6.

(c) Structural Trends.

Bouguer anomaly profiles (Plates 3 and 4) and the marine gravity data (Williams and Waterlander, 1959) have been used to produce the contours shown on plates 5 and 6. Plate 7 shows the principal gravity and geological trends.

On the gravity profiles on plates 3 and 4, an attempt has been made to allow for the effects of the granite intrusions by drawing in a curve (shown dotted) over whole or part of most of the profiles. The dotted curve may also include some smoothing of effects due to other causes, but no deliberate attempt has been made to smooth the profiles throughout or to apply a "regional" type correction curve. No correction has been made for the Hermit Hill and Cannon Hill Complexes. The density of these rocks is greater than the density of granite and is probably comparable with the average density of the sediments. The contours on plate 6 incorporate the smoothed sections of the profiles, so that with the effects of the granites removed, the dominant trend of the gravity features can be seen more distinctly.

Gravity features show, in general, a north to north-westerly trend and thus follow the dominant structural grain of the geosyncline. However, there are some places where geological trends are in marked contrast to north-westerly gravity trends (e.g. in the north-east portion of the area, and in particular the gravity "high" along the Darwin-Mt. Bundey-Goodparla line.

It is pointed out that Archean trends are obscure and few have been noted on the geological map, but it seems that with the possible exception of the area near Mudgenbarrie this trend is not reflected in the gravity contours.

(d) The Pine Creek Geosyncline.

Formerly it was considered (Noakes, 1951; Traves, 1955) that the Pine Creek Geosyncline was formed between two stable blocks, the Kimberley and Sturtian Blocks. On this basis and on evidence from the geological map, NTG/33, it is necessary to assume that the Darwin-Katherine section which is at present under examination is some form of "embayment" of the Pine Creek Geosyncline shown by Noakes (1951, Plate 1).

However, evidence now being collated (Walpole, B.P., personal communication) suggests that the Pine Creek Geosyncline is a composite trough which has been developed by systematic downfaulting of a block of Archean rocks. Walpole claims to recognise several distinct stages of development of the Geosyncline; these stages are controlled by structures produced chiefly by basement faults developed as a result of forces in the substratum. Factors such as load stress due to accumulation of sediments, are not considered to have had other than local effects in the history of this Geosyncline. The primary structure of the Geosyncline was probably a fairly shallow elongated basin with axis trending south-east; later development included the Western Fault Zone, the Eastern Trough and the Chilling Platform.

The gravity results indicate that the area being examined consists of three distinct zones :-

(i) An eastern trough with axis striking north west, bounded by the Stag Creek Volcanics on the south west (i.e. the western boundary extending from near Mt. Bundey to the southern portion of the South Alligator River) and by the Archean Magela Creek Metamorphics north and east of Mudgenbarrie.

(ii) A western trough the axis of which is parallel to that of the eastern trough and with the greatest depth of sediments now covered by later sediments in the Daly River Basin. This trough is bounded to the north-east by the line of granite cropping out near the Stuart Highway from Pine Creek to Rum Jungle and to the south-west by the Archean Hermit Hill Complex.

(iii) A central zone lying between (i) and (ii) and distinguished principally by granite intrusions and a comparatively thin layer of sediments, e.g. between the Mary and South Alligator Rivers.

The eastern trough (i) has a simple structure and the gravity profile along the Cannon Hill traverse suggests that there is a fairly steep fall in the basement east of the South Alligator River to a maximum depth under Yemelba Ridge, then a more gradual rise to the outcrop of Archean rocks near Mudgenbarrie. Geological opinion is that a thickness of over 10,000 feet of Lower Proterozoic sediments underlie Yemelba Ridge.

The Western trough (ii) is not well covered by traverses, as it was originally thought that the Daly River Basin was not directly related to the Lower Proterozoic geosyncline. Such results as have been obtained indicate that in fact this Cambrian Basin lies over the main western Lower Proterozoic trough.

The central zone (iii) in an area of shallow basement, numerous granite intrusions and is more complex than either of the two troughs. In the region Burrundie Station to B20 the two arms of the Cullen Granite produce minima which have the effect of lowering the intervening high gravity readings by perhaps 15 to 20 milligals. This means that but for the granite intrusions extremely high gravity values would have been obtained here.

(e) Explanation of the major gravity anomalies.

The Bouguer profiles which have been obtained, reflect the mass distribution within the earth's crust and are the composite effect of (1) the variation in the thickness of the crust from place to place above the Mohorovicic (M) discontinuity; (2) the lithologic changes within the crust, e.g. deformations of sialic and simatic boundaries; and (3) the near-surface geological structure and changes in surface geology which involve rock members of different densities.

Bouguer anomalies due to the first effect can be assumed to be of a broad regional type and can be separated from the observed anomaly curves by applying a regional correction which can be obtained by mathematical means (e.g. Vajk, 1951) but which may often be applied by inspection. Marshall and Narain (1954) have applied such a regional correction by arbitrarily drawing a curve through the minimum values of the observed profiles. This treatment has not been applied to the present results, because there is considerable doubt as to the value of the regional effect along many portions of the traverse. Indeed it makes no great difference in the present study to calculate this regional effect, but it is sufficient to realize that it is present, and to examine the gravity relief on the profiles.

The separation of effects (2) and (3) is more difficult but can be attempted if sufficient detailed geological mapping and rock density determinations are available. For lack of both these essential items in sufficient quantity, the present interpretation is limited.

Many workers in regional gravity conclude that the principal gravity relief is associated with a variation in the density of the basement rock but in many areas there seems to be a lack of essential evidence to substantiate this conclusion. For example, in a report on a regional survey in Oklahoma and Kansas, Cook (1956) concludes that the majority of anomalies are "caused principally by variations of density in the Pre-cambrian basement and indicate a basement of complex nature". In the Arkansas Basin (where bore-hole and sub-surface geological data is not so complete as elsewhere in the region under study) Cook suggests that the intense negative anomaly "is probably caused largely - but perhaps not entirely - by down-warping of the basement". Gunson and van der Linden (1956) from the results of their gravity traverses over the southern position of the Western Australian Shield consider that the Bouguer anomalies obtained are "mainly an expression of the density variations in the basement rocks".

However, in the present survey, there is little evidence to suggest that there is any marked variation in density within the "basement complex".

A feature of the gravity profiles shown on Plates 3 and 4 is that outcrops of granite are usually associated with gravity "lows", a general relation which has been noted by other workers (e.g. Marshall and Narain 1954; Woollard 1949; and others). Obvious correlations occur over the Rum Jungle and Waterhouse granites, the Cullen and Prices Springs Granites and the Hermit Hill Granite. Other granites which do not crop out along the traverse (e.g. the Jim Jim Granite and Mt. Bundey Granite) also probably influence the gravity relief along the traverses.

In the case of the Cullen Granite (Pgc) simple calculations show that to produce the mass deficiency to give the observed profile the granite "root" could extend down to about 15 Km. However, this figure would be less if it is assumed that denser subcrustal layers surround the granite, thus giving a larger density contrast. Umbgrove (1949, p.56) suggests that dunite may be pushed up on each side of a subsiding geosyncline. It is suggested that here the existence of two troughs has intensified this effect so that heavy subcrustal material may be nearer the surface in the vicinity of the central zone than on the outer margins of the two troughs.

Outcropping basic (high density) rocks also produce minor effects in the gravity profiles, e.g. the occurrence of basic rocks in the region about G30, of diorite near D44 and dolerite near K21. The major "highs" however, indicate the upwarping of a complex basement which in addition to any dense phase present in the complex (e.g. the Stag Creek Volcanics), also means an approach nearer the surface of the basaltic (simatic) layer of the earth's crust.

The steep rise in gravity readings between G69 and G71 is due to a major geological feature such as a fault, although the shape of the profile in this region may be modified somewhat by the granite rocks which crop out between G60 and G64.

Near Woolner the sharp decrease in gravity values is in an area which the geologists think is approaching the end of the geosynclinal trough. However, the gravity results here indicate either the approach to another sedimentary trough or the presence of a concealed granite intrusion. The complete absence of outcrop makes further interpretation impossible at this stage. Another point which needs elucidating is whether the low gravity values near Yemelba ridge continue through to Woolner. This matter could be resolved by obtaining additional gravity data between the two places.

If the gravity contour map (Plate 6) and the detailed geological map (NT33/6 are compared, it will be seen that the gravity "high" trending south-easterly from Darwin towards Mt. Bundey and thence southward towards Pine Creek, coincides very closely with surface outcrops of Masson and Golden Dyke rocks. This relationship is general throughout the area, and as there is no definite evidence that the rocks involved (except for the basic intrusives of the Golden Dyke Formation) are particularly dense, it is concluded that the main diagnostic value of the Formations is to indicate a near surface basement.

The high gravity values west of Hermit Hill are located on Archean rocks which are exposed beyond the granitic intrusions associated with the western edge of the geosyncline. Drilling carried out earlier this century near Port Keats (Brown 1908, S.A.Parl. Papers 1909, 1910) suggests that there is a rise in the basement complex between Red Cliff and Cliff Head corresponding to the observed increase of gravity values. The Anson Bay No.2 Bor (sited near Red Cliff) was stopped at 1500 ft. whilst still in sediments (presumably Palaeozoic) but the Cliff Head No.1 Bore struck "granite" at 720 feet.

The boundary between the western trough (ii) and the central zone (iii) is indicated by a fairly steep increase in gravity values east of D30 (see Fig.4(a) Plate 3). The western edge of the western trough is indicated similarly in Fig.4(b), Plate 3, by a steep rise in gravity west from D58.

The basin north and east of Rum Jungle shows no evidence of any great depth of sediments. This also applied to the area between the Adelaide and Mary Rivers, north of the Burnside Granite.

The greatest depth of sediments in the western trough appears to lie under the Cambrian Daly River Basin. It is not possible with the present data to distinguish between effects due to the Proterozoic and Cambrian sediments since these two age groups contain rocks of approximately the same average density. It is suggested that one or two traverses to cross the Cambrian Basin further south be surveyed and from geological field data it may be possible to make allowance for the effect of the flat lying, relatively undisturbed Cambrian sediments and hence to determine the trend of Proterozoic sedimentation in the trough.

9. CONCLUSIONS AND RECOMMENDATIONS.

The gravity method applied in the Darwin-Katherine area reveals the presence of large scale variations in Bouguer anomalies and in particular the wide distribution of positive Bouguer anomalies. Detailed interpretation of the gravity results has not been attempted because of insufficient gravity data in most regions and insufficient evidence as to rock densities. However, certain tentative conclusions have been reached and some conditions have been postulated to explain the observed gravity effects.

Certain minor features on the profiles may be accounted for on present information. For example, the local gravity "highs" near stations D44 and G30 coincide with basic intrusives. Another feature which is present on all profiles is the association of decreased Bouguer anomalies with outcropping granite; this association is obvious over the Rum Jungle Granite, the Hermit Hill Granite and the Cullen Granite. An examination of the gravity profile in the region Pine Creek-G15 suggests that the discordant Cullen Granite has a "root" extending in depth to perhaps 15 kilometers.

Major features on the gravity profiles are not so readily explained. The extensive area over which high Bouguer anomalies have been located is probably associated with the Indonesian tectonic zone of

Vening Meinesz (1948). The presence of stable Archean areas around Cannon Hill and south-west of Hermit Hill is indicated by a rise to high positive Bouguer values along traverses 2 and 4B (see Plate 3). The gravity results over the Darwin-Katherine area in general exhibit north-westerly trends and thus follow the dominant structural grain of the geosyncline.

The gravity results over the area could reflect a change both in the depth to and composition of the basement complex. With the exception of the Stag Creek Volcanics, there is little density contrast between the remaining Archean and the Proterozoic rocks. The evidence from the gravity work is that the occurrence of Stag Creek Volcanics is limited; they are probably a relatively minor intrusion into the continental basement rocks. The extensive outcrop of Archean rocks near Hermit Hill and Mudgenbarrie are associated with steep increases in Bouguer values.

Hence it is concluded that a basement complex of fairly uniform density (approximately 2.65 - 2.8) underlies those portions of the area which have been surveyed, and that the possibility remains therefore, in the absence of rock density data to the contrary, that the principal gravity relief is due to variations in the depth to the intermediate (basaltic) layer which is immediately beneath the continental layer of the earth's crust.

The gravity results indicate the presence of three distinct zones, the east and west troughs separated by a central zone. From the work done so far it appears the greater depth of Proterozoic sediments is in the eastern trough (although on Plate 6 the lowest gravity is shown near Hermit Hill it must be remembered that no correction has been made for the granite near Hermit Hill). The western trough also includes Cambrian sediments of approximately the same density as the Proterozoic sediments.

Geological opinion is that geosynclincal deposition terminates in the region near Woolner, and that the strike of the Mt. Partridge beds swings to the north and north-east in the northern portion of the trough. The gravity evidence is that the basement forms a ridge which arcs to the north-west between Woolner and Darwin. The marked depression in the gravity profile near Woolner (see Fig.6, Plate 4) could be due to the presence of a granite intrusion similarly placed in relation to the eastern trough as is the Jim Jim Granite (Pgj on Plate 2) or to a steep plunge of the basement on this side of the gravity "high" with a consequent deepening of sediments. Surface geological mapping is not helpful in this region because of the sand cover and lack of outcrops.

Gravity readings in the vicinity of G70-G71 indicate a major fault at right angles to the traverse. The character of the profile here and the rise to very high Bouguer values towards Cannon Hill strongly suggests that "faulting" extending to the intermediate layer has taken place and that north-east of G71, rocks of the intermediate layer are much closer to the surface than elsewhere over the surveyed area.

The central zone is complicated by granite intrusions but it appears that near-surface basement exists in this zone and that the Cullen (Pgc) and Prices Springs (Pgp) Granites (see Plate 2) have been intruded along the western boundary of the zone where the basement plunges down to the west.

At the present stage of contouring, it appears that the greatest depth of Proterozoic sediments in the western trough lies under the Daly River Basin and that the axis of this trough is parallel to the axis of the Daly River Basin shown on Plate 7. In the region north and east of the mouth of the Daly River the gravity contours will need to be closed more precisely before the region can be examined in detail. The steep increase in gravity values west of Hermit Hill indicates a rise in basement, though in this region the picture is complicated by faulting. Outcrops between station D66 and Cliff Head are poor, but it is possible that some folding took place during Mesozoic to Tertiary time, the low ridge between these stations being a surface expression possibly extending to Peron Island.

The stable Archean blocks have a border of lighter rock basinwards which may be zones where some folding of the basement took place during Lower Proterozoic tectogenisis with the introduction of granite (it has already been pointed out that the highest gravity values are not reached until well onto the mapped Archean outcrops). Since this idea was first mooted, the geologists have adopted, independently, this interpretation in the Nanambu Complex (now renamed Magela Creek Metamorphics) and it is clear from the gravity survey that a similar situation exists near Hermit Hill. It is also obvious that this older rock (migmatite, garnetiferous gneiss, etc.) is denser than the granite.

Another feature which may be significant but which is not brought out clearly because of the station interval, is the possible association of steep gravity gradients with mineralization. In this regard, the high gravity reading at Batchelor siding, the readings in the region of the Evelyn Mine (near G13) and the readings in the region of G40 (where some mineralization occurs) may warrant further consideration. It is also considered significant that the Rum Jungle, South Alligator and Pine Creek mineral fields are located along the flanks of the central zone (iii).

If it is considered that further work is desirable then it is suggested that the following programme would be of immediate value in clarifying some of the present gravity anomalies.

(1) A traverse from Mt. Bundey along the Kapalga track to the coast near the mouth of the South Alligator River, or if possible to connect with the Cannon Hill traverse near Mudgenbarrie. This traverse would investigate whether low gravity values are continuous between Woolner and Yemelba Ridge, and also give information about the eastern trough in this region.

(2) A traverse from Fountain Head or Pine Creek to Ooloo, thence to Fletcher's Gully and possibly K13 or K15. This traverse would give additional information about the behaviour of the basement in this region and

hence of the trend of sedimentation in the western trough. The effect of the Cambrian sediments could be allowed for fairly accurately because the section is structurally undisturbed and the dips of these beds are consistently about 5 degrees.

(3) A traverse by boat from the Daly River Police Station (D11) to the mouth of the Daly River (Stations S3 of the Oil Company's survey) is essential if the true course of the contours in this region is to be established.

(4) A traverse from E14A to S3 to determine the northern limits of the high values between D66 and the mouth of the Daly River.

(5) More detailed gravity information is needed in the region south of Marrakai and between the Marrakai and Point Stuart traverses. A traverse along the track between Grove Hill, S.6, Mt. Masson and connecting with the Burrundie track is necessary. It is also desirable to survey an additional north-south traverse, e.g. from Fountain Head Siding (D48) to Ban Ban thence to join with the track to Mt. Bundey and connect to the Coirwong Traverse.

(6) Opportunity should also be taken to connect H15 with West Point and Darwin and to extend the traverse to Point Charles.

Two further traverses of a more speculative nature are suggested. These are :-

(7) A traverse along the track between Cullen and Dorisvale (or alternatively, westerly from Katherine along the Wyndham Road), to give more data on the trend of sedimentation in the western trough and Cambrian Basin.

(8) A traverse from G22 to Fisher Airstrip to test the hypothesis that mineral deposits are associated with steep gravity-gradients. Such a traverse would test the theory in the South Alligator uranium field, and one should also bear in mind B.M.R. Report 24, p.9 (Condon and Walpole, 1955). As a preliminary investigation, however, it is suggested (a) that gravity readings be made at quarter-mile intervals between the 52-mile and 66-mile posts along the North-Australian Railway, although the presence of the Rum Jungle granite may obscure the issue, and (b) detailed gravity readings (and at the same time, magnetic readings) be made from D44 along the roads to Long and Fenton airstrips in the vicinity of which there is known mineralization and some intense aeromagnetic anomalies.

The region in the vicinity of Woolner and between there and Kapalga should be examined in greater detail by the geologists. Further geological examination should also be made of the regions west and north-west from Hermit Hill, and west from the Finniss Traverse, with particular regard to any indication of the appearance of denser basement rocks.

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TABLE 1

CANNON HILL TRAVERSE (2)

Stn	Rock type	Density	Between Stations	%Rock types along traverse line	Av. Density	Remarks
G1	Siltstone	2.70	0-1	70% Siltstone) 30% Greywacke)	2.70	
G2	Granite	2.63	1-2	20% Siltstone) 80% Granite)	2.65	
G12	Granite	2.63	2-12	100% Granite	2.63	
G13	Limestone	2.72	12-13	70% Granite) 30% Limestone)	2.67	% of granite could be greater underground
G14	Siltstone & Gwke	2.70	13-14	20% Limestone) 60% Chert) 20% Siltstone)	2.67	
G18	Siltstone & Gwke	2.70	14-18	100% Siltstone & Gwke	2.70	
G19	QTZ. Siltstone	2.65	18-19	50% Siltstone) 50% Qtz: Siltstone)	2.67)	Volcanics have max. thickness of 1000'. However densities of volcanic and underlying sediment are similar
G20	Andesite	2.66	19-20	10% Qtz: Siltstone) 90% Andesite)	2.66)	
G21	Qtz:Gwke	2.68	20-21	20% Andesite) 80% Silt & Gwke)	2.68)	
G22	Siltstone	2.70	21-22	10% Basic Rock) 90% Siltstone & Gwke)	2.72	50' thick Cretaceous S'st not allowed for
G23	Siltstone	2.70	22-23	30% Basic Rock) 70% Siltstone & Gwke)	2.75	
G24	Qtz:Gwke	2.68	23-24	100% Siltstone & Gwke	2.70	
G25	Qtz:Gwke	2.68	24-25	100% Siltstone & Gwke	2.70	
G26	Siltstone	2.70	25-26	Siltstone & Gwke	2.70	
G27	Coirwong Gwke	2.66	26-27	80% Silt & Gwke) 20% Qtz: Gwke)	2.69	This section closely underlain by basement (S.G.-3.1, c.f. Table 4)
G28	Basic Rock	2.85	27-28	10% Basic Rock) 90% B.I.F. & Siltstone)	2.95	
G29	Qtz: Siltstone	2.65	28-29	50% Basic Rock) 50% Qtz: Silt)	2.75	
G30	Basic Rock	2.85	29-30	30% Basic Rock) 70% Siltstone)	2.75	
G31	Basic Rock	2.85	30-31	100% Basic Rock	2.85	Possibly some silts near surface beneath basic rock

Stn	Rock type	Density	Between Stations	%Rock types along traverse line	Av. Density	Remarks
G32	Basic Rock	2.85	31-32	70% Basic Rock) 30% Siltstone)	2.80	
G33	B.I.F.	3.00	31-33	10% Basic Rock) 90% Silts & B.I.F.)	2.95	This section covered by alluvium and extent of B.I.F. uncertain
G34	QTZ:Gwke sheared qtz.	2.65	33-34	50% B.I.F. & Silts) 50% QTZ: Gwke	2.82	
G35	Gwke & Siltstone	2.68	34-35	100% Qtz. Gwke & Silts	2.68	
G44	Gwke & Siltstone	2.68	35-44	100% Qtz. Gwke & Silts	2.68	
G44 - G75 Samples for density determinations not available						

TABLE 2

BURRUNDIE TRAVERSE (3)

Stn	Rock type	Density	Between Stations	%Rock types along traverse line	Av. Density	Remarks
B38	Siltstone & Gwke Silt	2.70				
B35	Siltstone & Gwke Silt	2.70	38-35	100% Silt & Gwke Silt	2.70	
B34	Qtz. Silt	2.65	35-34	40% Silt) 60% Qtz. Silt)	2.67	
B33	Qtz. Gwke	2.68	34-33	20% Basic Rocks) 50% Qtz. Silt) 30% Qtz. Gwke)	2.70	
B31	Qtz. Gwke	2.68	33-31	Qtz. Gwke & Silt	2.70	
B30	Silt.metamorphosed	2.70	31-30	40% Basic Rock) 60% Siltstone)	2.70	
B29	Qtz. Gwke	2.75	30-29	90% Qtz. Gwke & Silt) 10% Metamorphics)	2.71	
B28	Granite	2.63	29-28	30% Metamorphics) 70% Granite)	2.67	
B24	Granite	2.63	28-24	100% Granite	2.63	
B23	Qtz. Gwke	2.68	24-23	60% Granite) 40% Qtz. Gwke)	2.65	
B22	Qtz. Gwke	2.68	23-22	50% Qtz. Gwke) 50% Silt.)	2.70)	Avg. density may vary as there is lead in the sediments (Namoona Prospect)
B21	Siltstone	2.76	22-21	100% Silt.	2.76)	
B20	Siltstone	2.76	21-20	100% Silt.	2.76)	
B19	Siltstone	2.70	20-19	50% Qtz. Gwke) 50% Silt.)	2.69	
B18	Siltstone	2.70	19-18	Siltstone	2.70	
B17	Qtz. Gwke	2.68	18-17	50% Qtz. Gwke) 50% Silt.)	2.69	This section is probably closely underlain by basement (S.G.-3.1)
B16	Chert	2.62	17-16	30% Basic Rock) 10% Qtz. Gwke) 60% BIF & Silt.)	2.86	
B15	Basic Rock	2.85	16-15	60% Basic Rock) 40% Cherts)	2.76	
B14	Siltstone	2.70	15-14	20% Basic Rock) 80% Cherty Silt)	2.70	
B13	Siltstone	2.70	14-13	100% Siltstone	2.70	
B12	BIF	3.00	13-12	90% Siltstone) 10% BIF)	2.73	
B11	BIF	3.00	12-11	100% BIF	3.00	
B10	Siltstone	2.70	11-10	20% BIF 80% Siltstone sheared	2.76	
B 9	Siltstone	2.70	10-9)	Siltstone & Qtz. Gwke	2.70	
B 1	Silt. & Qtz. Gwke	2.70	9-1)			

TABLE 3

DALY RIVER TRAVERSE (4a)

Station	Type	Density	Density Between Stations
D1	Igneous Complex	2.75	
D2	" "	2.75	2.75
D3	" "	2.75	2.75
D4	Alluvium (Noltenius Formation)	2.70	2.73
D5	Alluvium	2.70	2.70
D6	(Noltenius) Siltstones, Greywacke, Qtz. Greywacke Pebble Cong.	2.70	2.70
D7	" " "	2.70	2.70
D8 Giant's Fault	" " "	2.70	2.70
D9	" " "	2.70	2.70
D10	" " "	2.70	2.70
Giant's Fault		2.70	2.70
D11 Daly River	" " "		
D12	" " "	2.70	2.70
D13	" " "	2.70	2.70
D14	" " "	2.73	2.72
	Plus some schists, andalusite, mica		2.74
D15	Andalusite, tourmaline mica schists. Sediments as above and granite below surface	2.75	2.75
D16	As D15	2.75	2.75
D17	"	2.75	2.75
D18	"	2.75	
D19	"	2.75	
D20	As D15 metamorphics	2.73	
D21	Depot Sandstone	2.44	The Depot Sandstone (P/Ed) is here 200ft. thick - maximum development elsewhere is 1000ft. The Stray Sandstone (P/Es) is here absent (max. elsewhere = 1000ft.). Cambrian (Emd) max. thickness here is 300ft. Byrne's Creek Volcanics (Pzb) are nowhere more than 100ft thick (density= 2.82).
D22	Volcanics and Depot Sandstone	2.82	
D23	Cambrian Limestone	2.68	
D24 to D37	" "	2.68	

Station	Type	Density	Density Between Stations
D37	Cambrian Limestone	2.68	2.69
D38	Siltstones and Greywacke (Burrell Creek formation)	2.70	
Fault -	(with vertical displacement - West block down)		
D39	Cherts and siltstones and mica schists (Golden Dyke formation)	2.65	
Granite	(Mount Shoebridge)		2.63
D40	Cherts and siltstones and mica schists	2.65	
D41-D43	" " " "	2.65	
D44	Diorite (Golden Dyke formation)	2.86	
	Boundary between Golden Dyke and Burrell Creek formation		
D45-D48	Siltstones and Greywackes	2.70	
DENSITIES used			Weighted average used
	Hermit Hill Complex:		
	Migmatite	2.79)	
	Garnetiferous Granite	2.74)	2.75
	Quartzite	2.65)	
	Noltenius Formation:		
	Siltstone	2.70	)
	Greywacke	2.68(sl.weathered)	) 2.70
	Qtz. greywacke	2.70	)
	Tourmaline Schists	2.86	)
	Andalusite Schist	2.84	) 2.85
	Mica Schist	2.71(weathered)	)
	Granite (Soldiers Creek) (Same type outcropping to south of traverse)	2.64	
	Depot Sandstone	2.44	
	Cambrian Limestone	2.68	
	Byrnes Creek Volcanics	2.82	
	Burrell Creek Formation:		
	Greywacke	2.68	
	Siltstone	2.70	
	Golden Dyke Formation:		
	Chert	2.65	
	Qtz. Siltstone	2.65	
	Diorite	2.86	

TABLE 4.

MISCELLANEOUS SAMPLES

Locality	Type	Density
Stuart Highway between Hayes Creek and Pine Creek	Cullen Granite (probably a marginal phase)	2.57
Yeuralba	Yeuralba Granite at drill depth of 200'	2.50
George Creek Prospect	Greywacke (Noltenius formation) at drill depth 100'	2.86
"	Siltstone (Noltenius formation) at drill depth 100'	2.78
Moyle River (K21) (Similar rock at K3-K5)	Dolerite (? Hermit Hill Complex)	3.08

TABLE 5

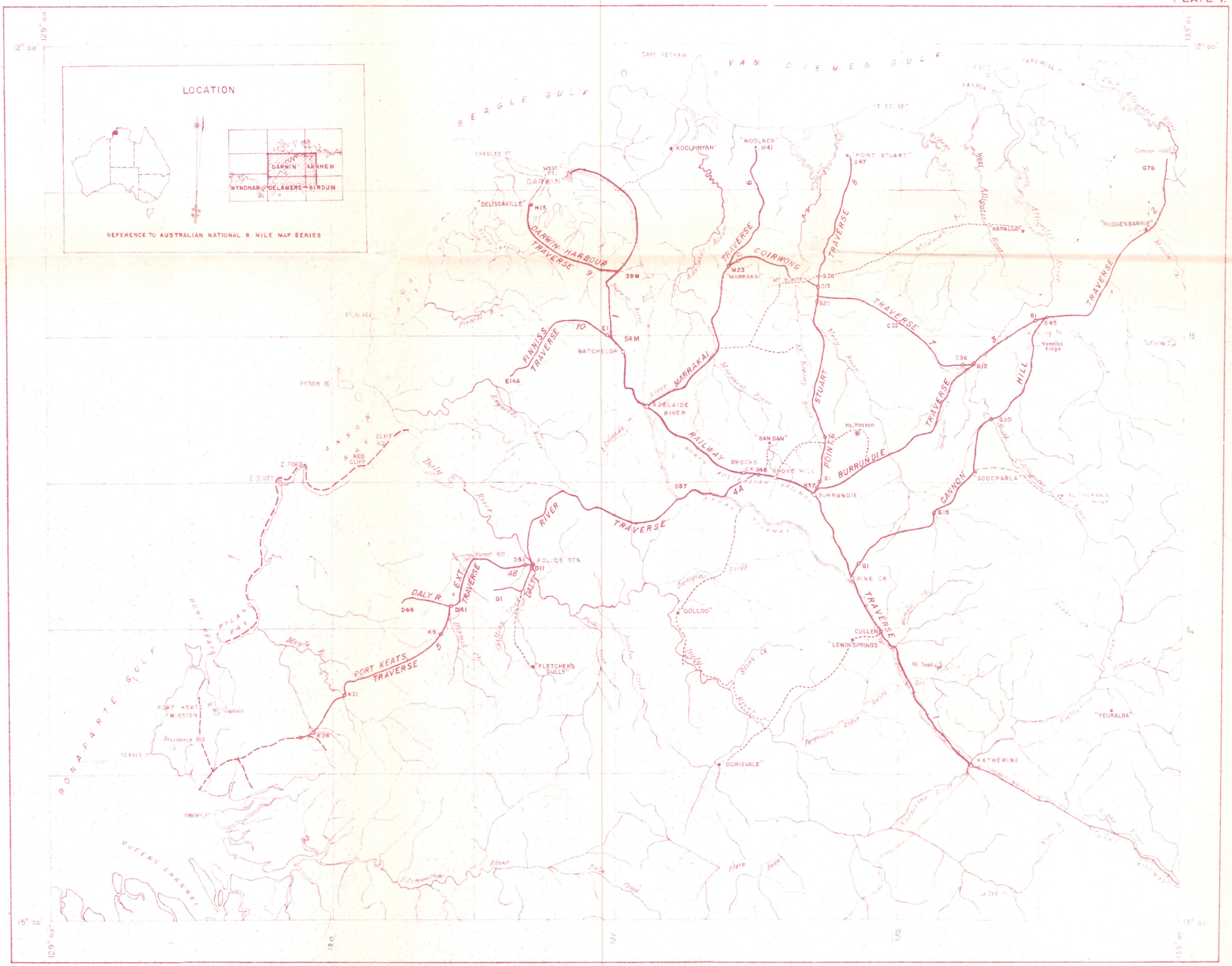
DENSITY DETERMINATIONS OF DRILL CORE SAMPLES FROM BROWN'S DEPOSIT, RUM JUNGLE.

SLATE:

D.D.H. No.	Depth (ft.)	Density
171	99	2.69
	123	2.88
	150	2.83
	165	2.79
	180	2.85
	219	2.77
	283	2.72
	463	2.79
170	417	2.73
160	201	2.75
	300	2.79
163	450	2.94
156	354	2.77
154	57	2.56
157	100	2.78
81	80	2.58
	Average	2.76

LIMESTONE:

D.D.H. No.	Depth (ft.)	Density
170	482	3.06
	505	3.03
171	508	2.95
172	383	3.06
	403	3.00
157	214	2.84
160	390	2.90
	Average	2.98



LEGEND

TOPOGRAPHY

- ROAD
- TRACK
- RAILWAY
- WATERCOURSE
- HOMESTEAD
- TOWN

GRAVITY

- GRAVITY TRAVERSE (BMR)
- " " (AAO)
- K5 GRAVITY STATION NUMBER

SCALE IN MILES

10 0 10 20 30 40 50 60 70

MAP INFORMATION FROM ICAO 1:1,000,000 CHARTS

GEOPHYSICIST

RECONNAISSANCE GRAVITY SURVEY (1955-57)

DARWIN - KATHERINE - PORT KEATS AREA, N.T.

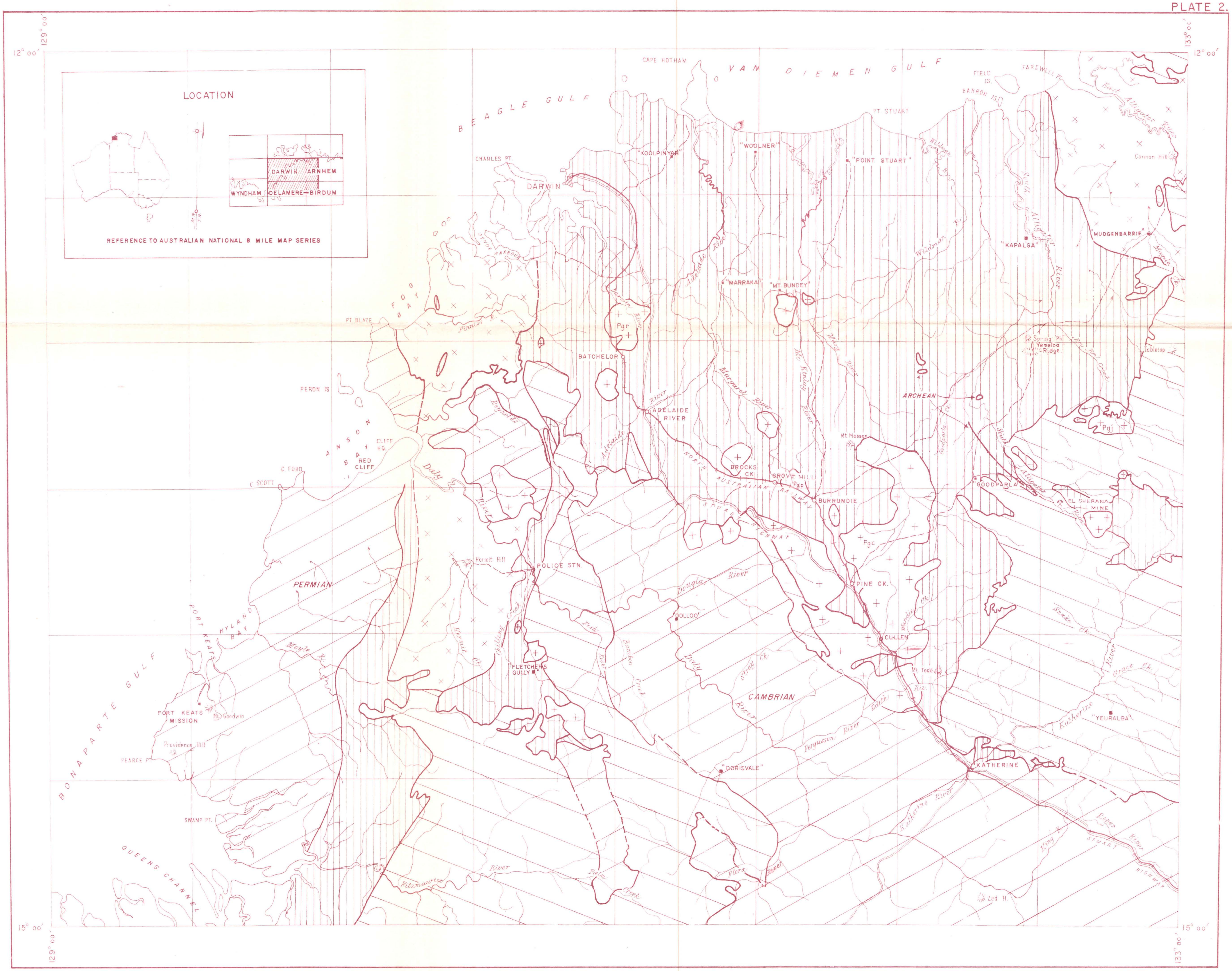
LOCALITY MAP AND GRAVITY TRAVERSES

TO ACCOMPANY RECORDS 1959 No. 72

GEOPHYSICAL SECTION, BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS

G192-19

PLATE 2.



LEGEND

TOPOGRAPHY

ROAD — TRACK — RAILWAY — WATERCOURSE — HOMESTEAD — TOWN

GEOLOGY

PALAEOZOIC
UPPER PROTEROZOIC
LOWER PROTEROZOIC
ARCHEAN
GRANITE (LOWER PROTEROZOIC)
MESOZOIC, TERTIARY AND QUATERNARY ARE OMITTED.

SCALE IN MILES

10 0 10 20 30 40 50 60 70

MAP INFORMATION FROM ICAO 1:1,000,000 CHARTS AND BMR 10 MILES TO 1 INCH PROGRESS MAP OF REGIONAL GEOLOGY AS AT JANUARY 1958.

Peter ... Stott

GEOPHYSICIST

RECONNAISSANCE GRAVITY SURVEY (1955 - 57)

DARWIN — KATHERINE — PORT KEATS AREA, N.T.

REGIONAL GEOLOGY

(GENERALIZED)

GEOPHYSICAL SECTION, BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS **G192-20**

TO ACCOMPANY RECORDS 1959, No 72

PLATE 3.

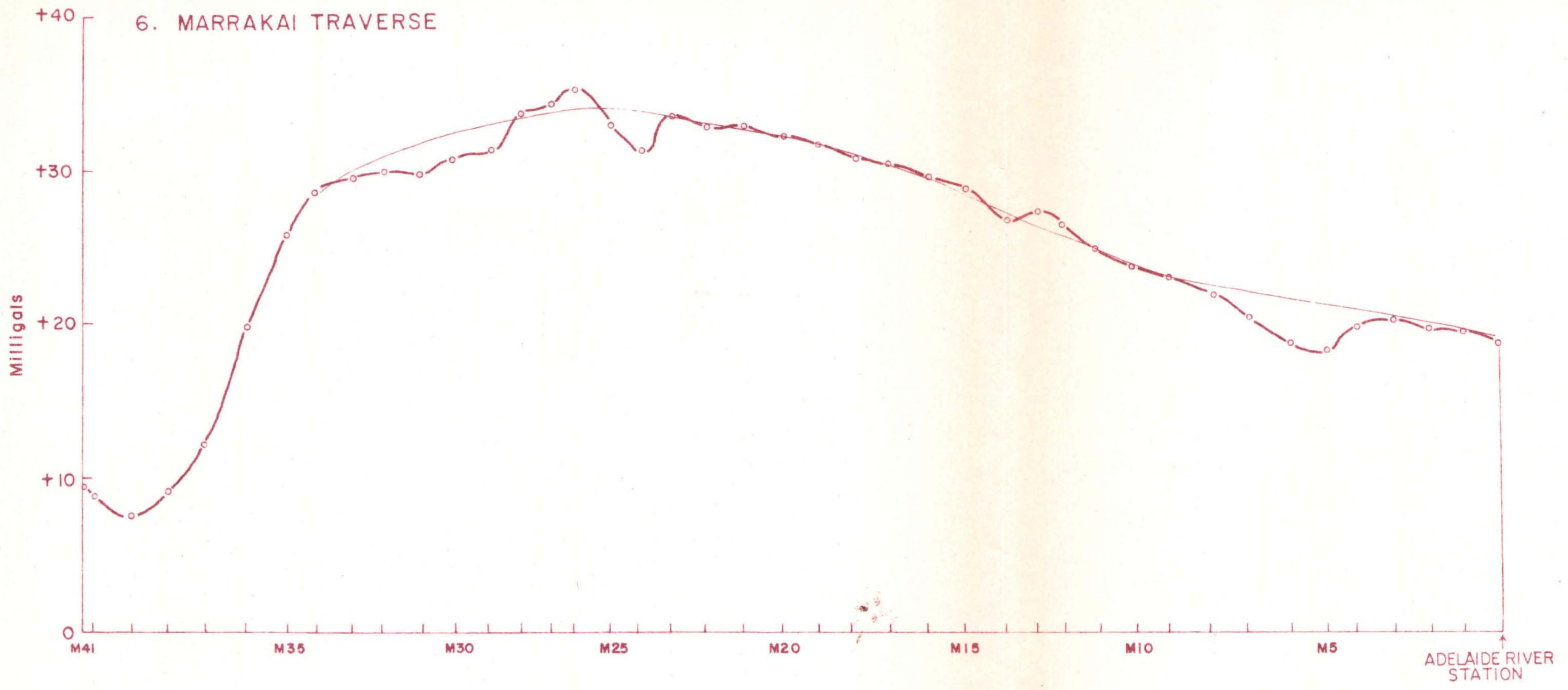
RECONNAISSANCE GRAVITY SURVEY (1955-57), DARWIN-KATHERINE-PORT KEATS AREA, N.T.

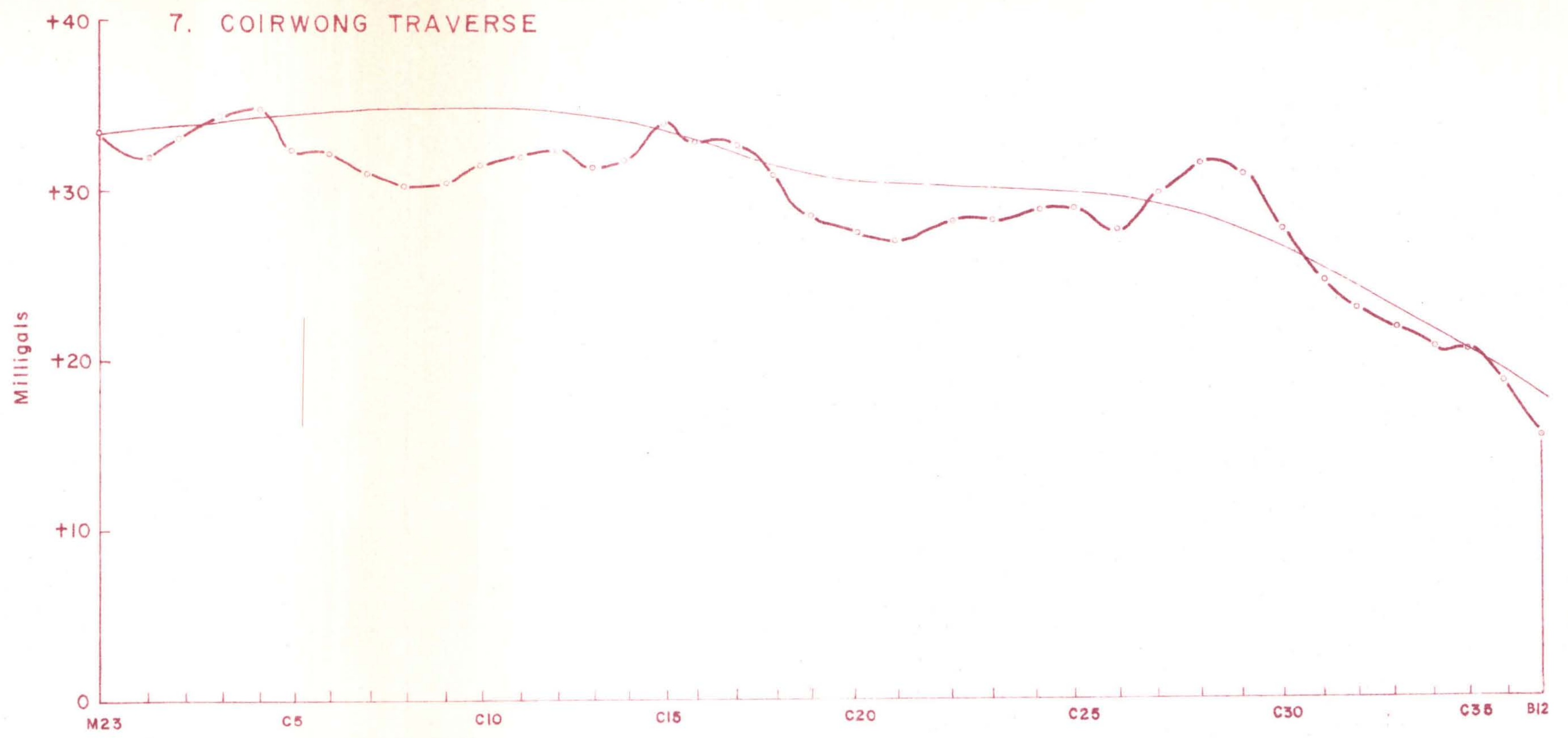
BOUGUER ANOMALY PROFILES AND GEOLOGICAL SECTIONS
(TRAVERSES 1 TO 5)

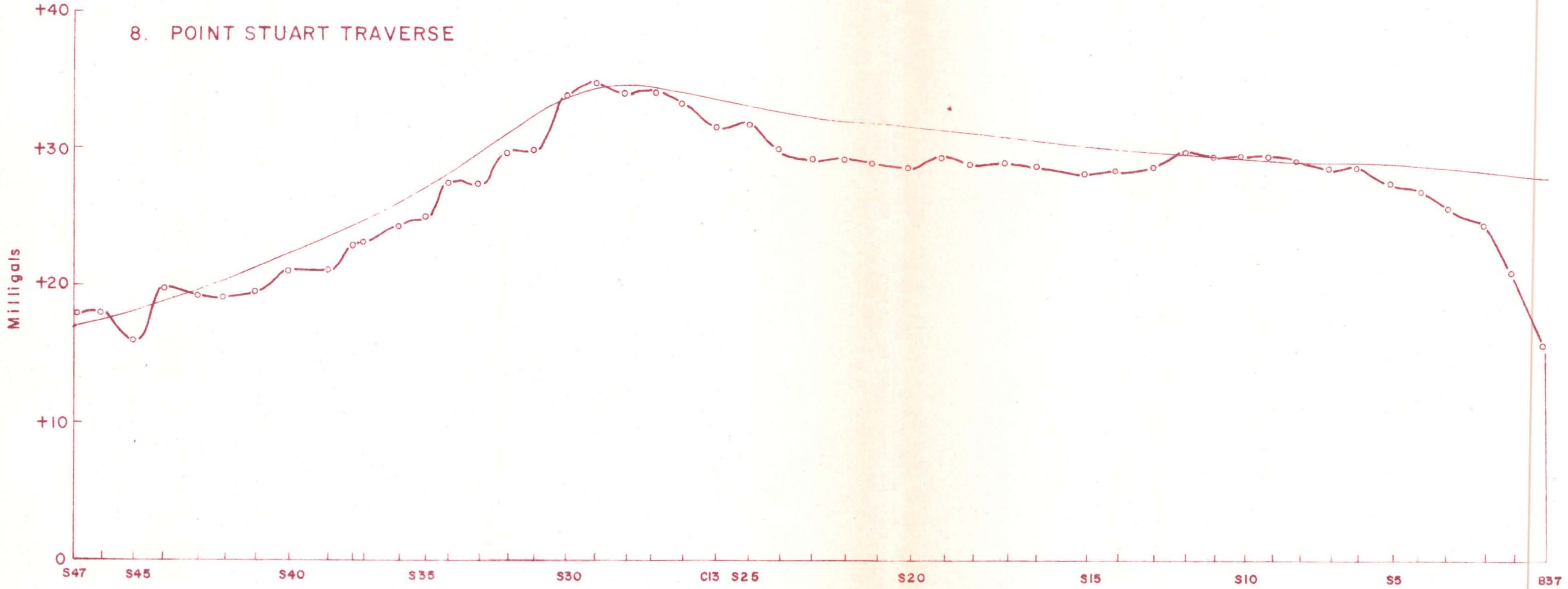
TO ACCOMPANY RECORDS 1959, No 72

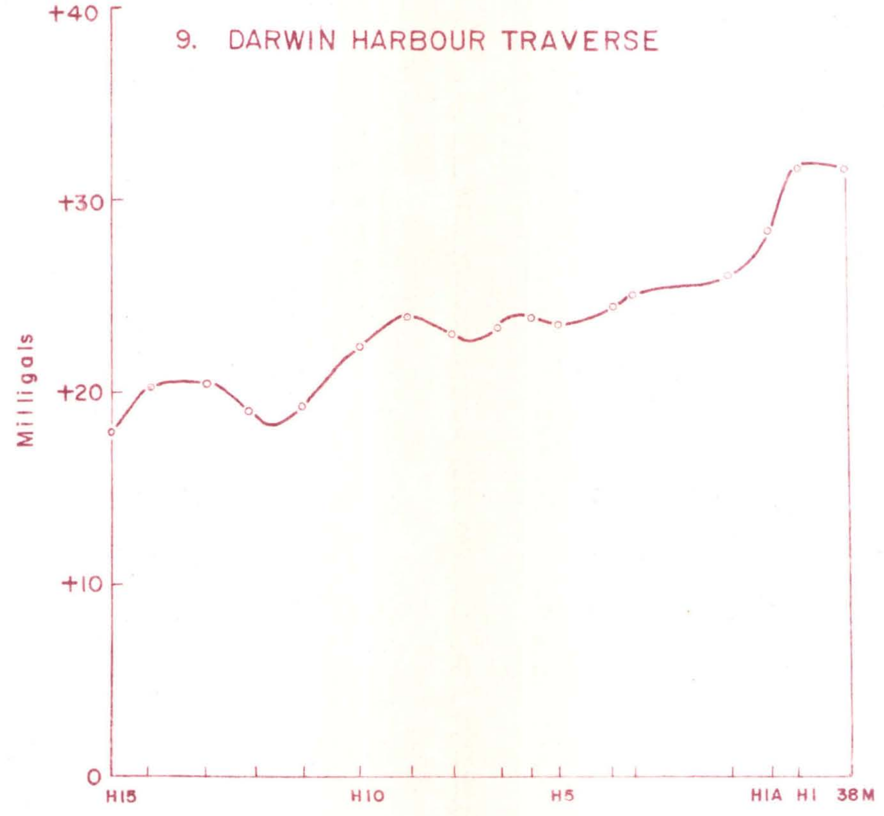
Geophysical Section, Bureau Of Mineral Resources, Geology and Geophysics

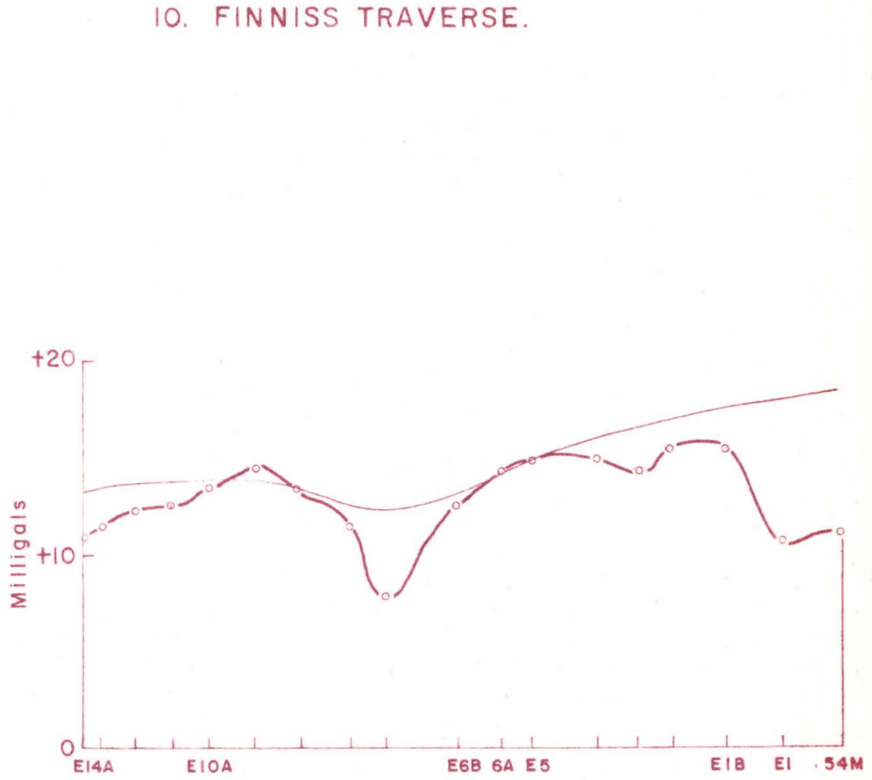
G192-26











W. J. Langron
GEOPHYSICIST

Horizontal scale in miles

8 0 8 16 24 32

PROFILE AFTER ASSUMED EFFECT OF PROTEROZOIC GRANITES REMOVED

RECONNAISSANCE GRAVITY SURVEY (1955-57), DARWIN-KATHERINE-PORT KEATS AREA, N.T.

BOUGUER ANOMALY PROFILES

Vertical scales as shown

TO ACCOMPANY RECORDS 1959, No. 72

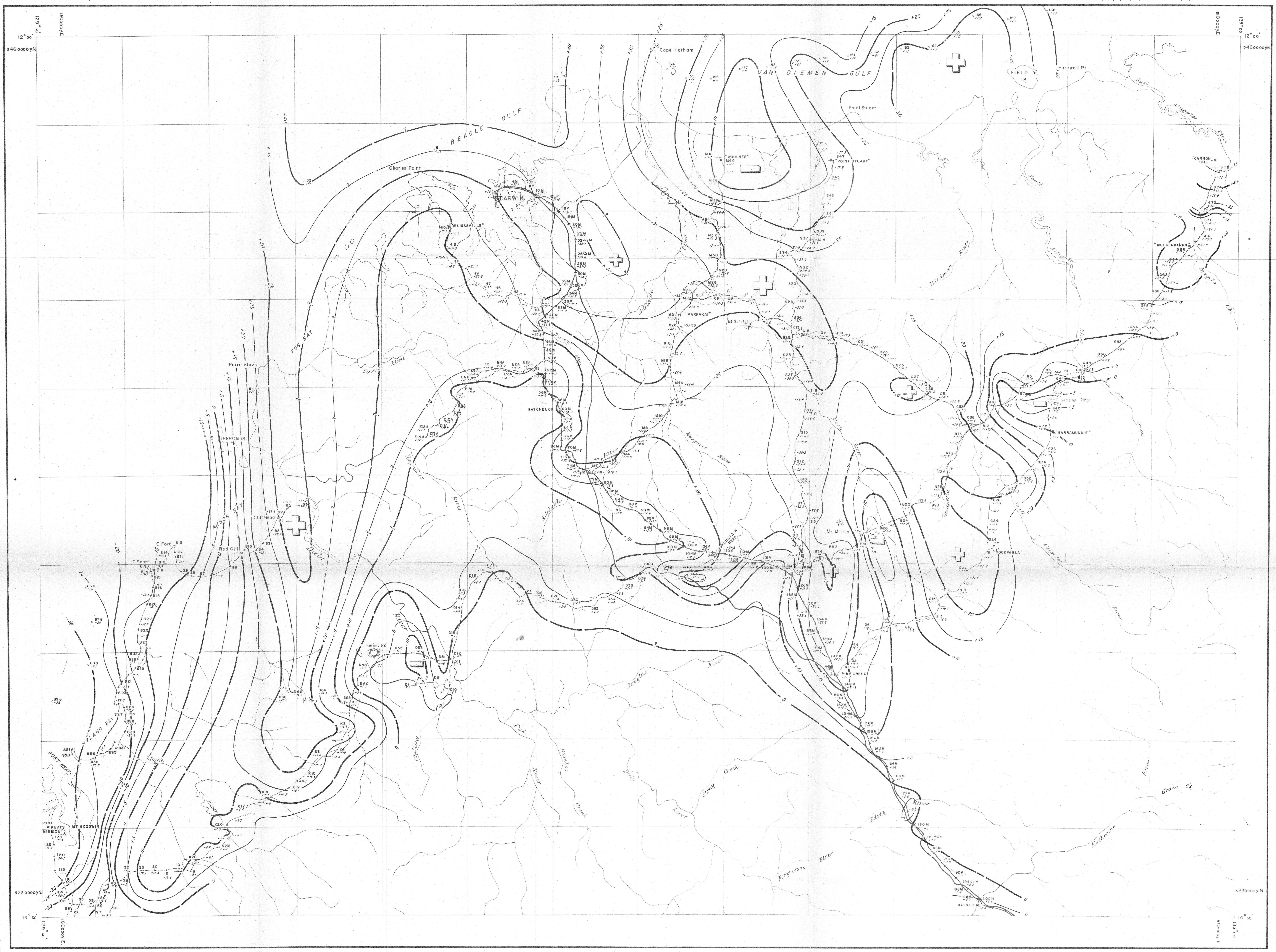
Geophysical Section, Bureau Of Mineral Resources, Geology and Geophysics

G192-25

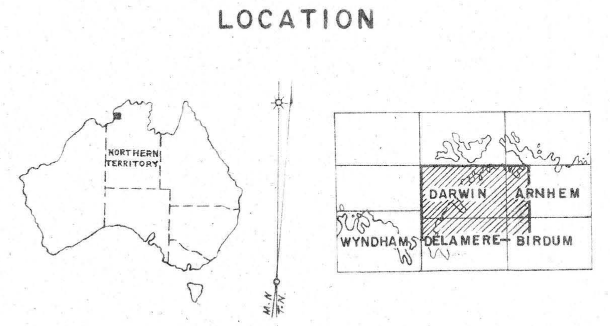
DARWIN (SPECIAL)
NORTHERN TERRITORY

AUSTRALIA 1:506,880

D52/3,4,7,8,11,12 D53/1,5,9 ZONES 4 & 5



LOCATION



REFERENCE TO AUSTRALIAN NATIONAL 8 MILE MAP SERIES

MAP DATA

PROJECTION: TRANSVERSE MERCATOR, AUSTRALIAN SERIES.

CONTROL: DEPARTMENT OF THE INTERIOR ASTRONOMICAL FIXATIONS AND TRAVERSES.

DETAIL: GRID AND GRATICULE COMPUTED, COMPILED AND DRAWN BY THE GEOPHYSICAL DRAWING OFFICE, BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS.

PLANIMETRIC DETAIL FROM DARWIN 1 MILE MILITARY MAP. NATIONAL MAPPING 4 MILE AIR PHOTO MOSAICS, DEPARTMENT OF THE INTERIOR 1 MILE GRAVITY SURFACE CONTROL MAPS.

GEOPHYSICAL DATA FROM B.M.R. GEOPHYSICAL SURVEYS.

RELIABILITY: PLANIMETRIC — SKETCH.
GEOPHYSICAL — GRAVITY RECONNAISSANCE.

RECONNAISSANCE GRAVITY SURVEY (1955-58)
DARWIN-KATHERINE-PORT KEATS AREA, N.T
BOUGUER ANOMALY MAP

SCALE IN MILES

8 4 0 8 16 24 32

TO ACCOMPANY RECORDS 1959, No. 72

LEGEND

TOPOGRAPHY

- WATERCOURSE
- ROAD
- TRACK
- NORTH AUSTRALIAN RAILWAY
- HOMESTEAD
- TRIG STATION
- ASTROFIX

GRAVITY

- B.M.R., A.A.O — GRAVITY STATIONS
- 19C STATION NUMBER
- +12.5 BOUGUER ANOMALY
- GRAVITY CONTOURS IN MILLIGALS
- GRAVITY HIGH ANOMALY
- GRAVITY LOW ANOMALY

EXPLANATION

RELATIVE BOUGUER ANOMALIES ARE SHOWN. AN AVERAGE DENSITY OF 2.67 HAS BEEN ASSUMED FOR ROCKS BETWEEN STATION SITE AND SEA LEVEL IN REDUCTION OF GRAVITY VALUES.

GRAVITY DATUM — B.M.R. NO.32 PENDULUM STATION, DARWIN, N.T. VALUE 978,315.5 MILLIGALS.

ELEVATION DATUM — NORTH AUSTRALIAN RAILWAY DATUM. 112.0 FEET HAS BEEN SUBTRACTED TO REDUCE TO M.S.L.

WATER DENSITY 1·03 HAS BEEN TAKEN FOR THE REDUCTION OF UNDERWATER GRAVITY STATIONS.

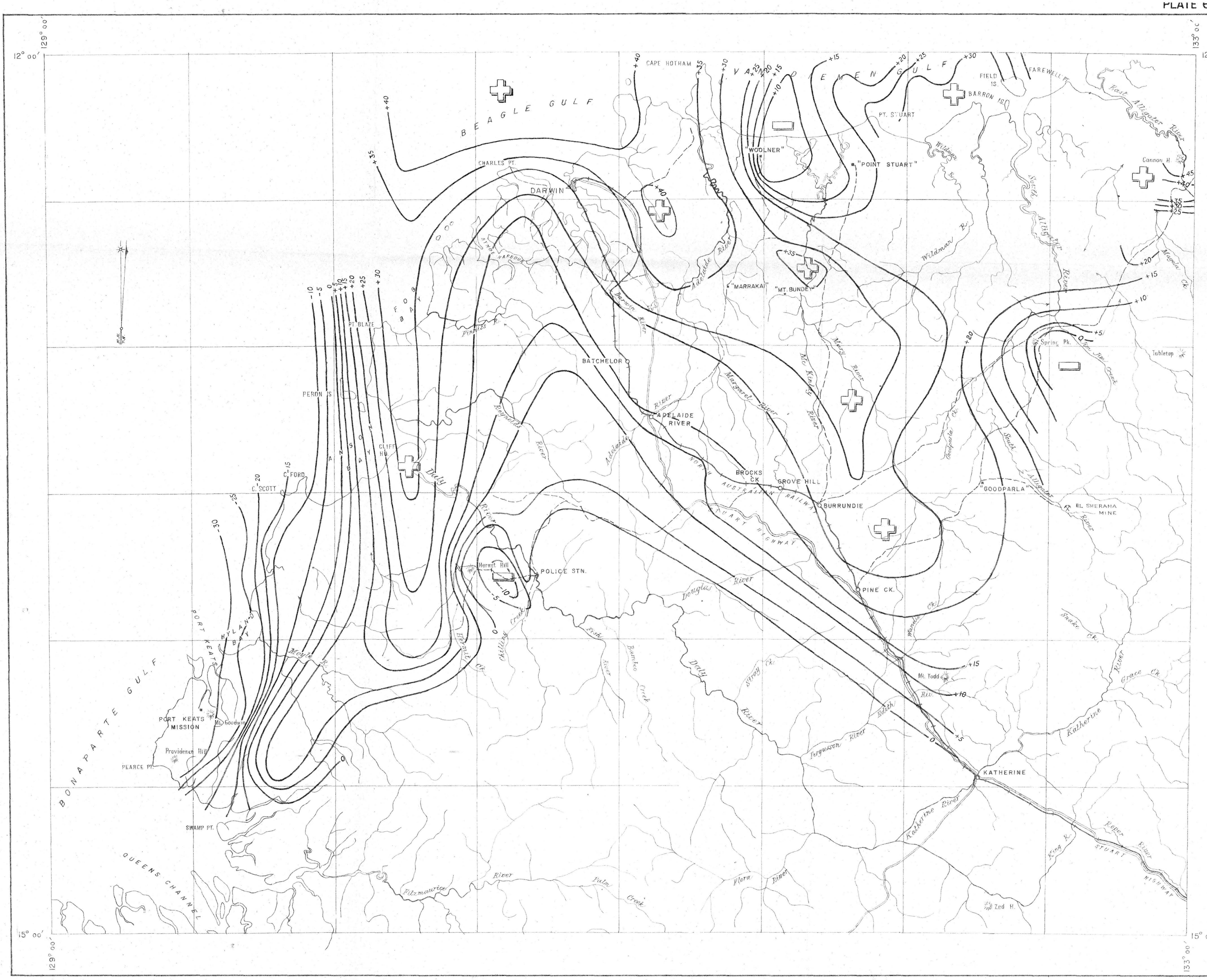
Peter Stott

GEOPHYSICIST

GEOPHYSICAL SECTION, BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS

G192-22

PLATE 6



SCALE IN MILES

10 0 10 20 30 40 50 60 70

MAP INFORMATION FROM I.C.A.O. 1:1,000,000 CHARTS

W. J. Langron
GEOPHYSICIST

RECONNAISSANCE GRAVITY SURVEY (1955-57)

DARWIN – KATHERINE – PORT KEATS AREA, N.T.

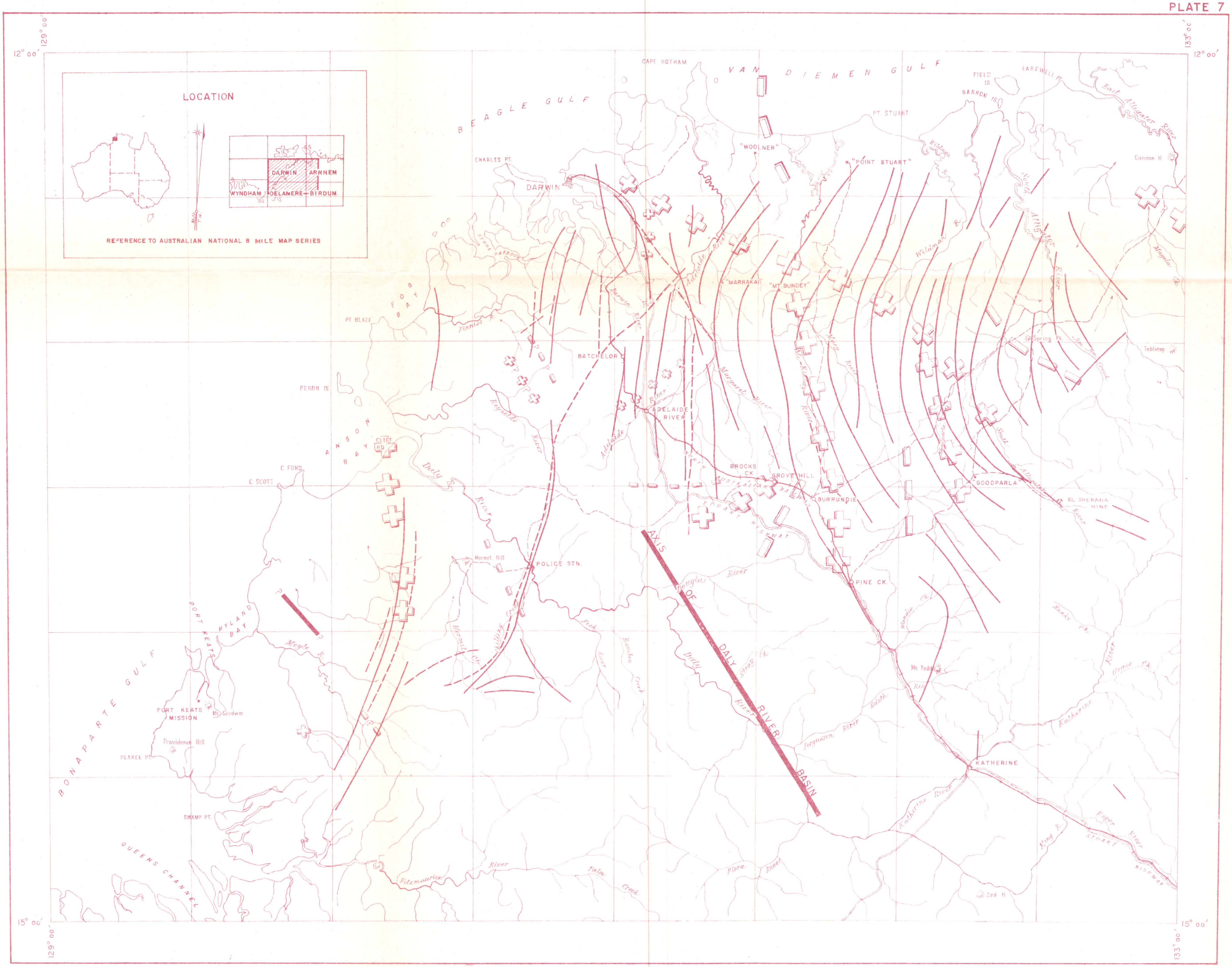
BOUGUER ANOMALY MAP

(WITH EFFECTS OF PROTEROZOIC GRANITES REMOVED)

GEOPHYSICAL SECTION, BUREAU OF MINERAL RESOURCES, GEOLOGY & GEOPHYSICS

(TO ACCOMPANY RECORDS 1959, NO. 72)

G192-27



LEGEND

TOPOGRAPHY	GEOLOGY	GEOPHYSICS
ROAD	LOWER PROTEROZOIC: STRIKE	GRAVITY HIGH
TRACK	LOWER PROTEROZOIC: FAULT	GRAVITY LOW
RAILWAY	PALAEOZOIC STRIKE	PROBABLE TREND
WATERCOURSE		
HOMESTEAD		
TOWN		

SCALE IN MILES

10 0 10 20 30 40 50

MAP INFORMATION FROM ICAO 1:1,000,000 CHARTS

P. W. Stott

GEOPHYSICIST

RECONNAISSANCE GRAVITY SURVEY (1955-57)

DARWIN – KATHERINE – PORT KEATS AREA, N.T

GEOLOGICAL AND GRAVITY TRENDS

GEOPHYSICAL SECTION, BUREAU OF MINERAL RESOURCES GEOLOGY AND GEOPHYSICS G192-21

TO ACCOMPANY RECORDS 1959, No. 72