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Airborne, Magnetic and Radiometric Survey of Belele, Cue, Kirkalocka and the Eastern Parts of Byro, Murgoo and Yalgoo 1:250,000 Sheet Area, Western Australia, 1969

by

D. R. Waller and R. D. Beattie

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SUMMARY

An airborne magnetic and radiometric survey of BELELE, CUE and KIRKALOCKA, and the eastern thirds of BYRO, MURGOO and YALGOO 1:250,000 sheet areas was flown by the Bureau of Mineral Resources in 1969. The aims of the survey were to assist the systematic regional mapping of the Precambrian West Australian Shield and to aid the search for economic mineral deposits.

Interpretation of the magnetic data is primarily qualitative. Geological strikes and the boundaries of major rock units have been interpreted by delineating magnetic trends, subdividing the area into zones of specified magnetic character, and assessing the significance of these zones with reference to mapped geology. Regional structure has been interpreted from a study of anomaly configuration.

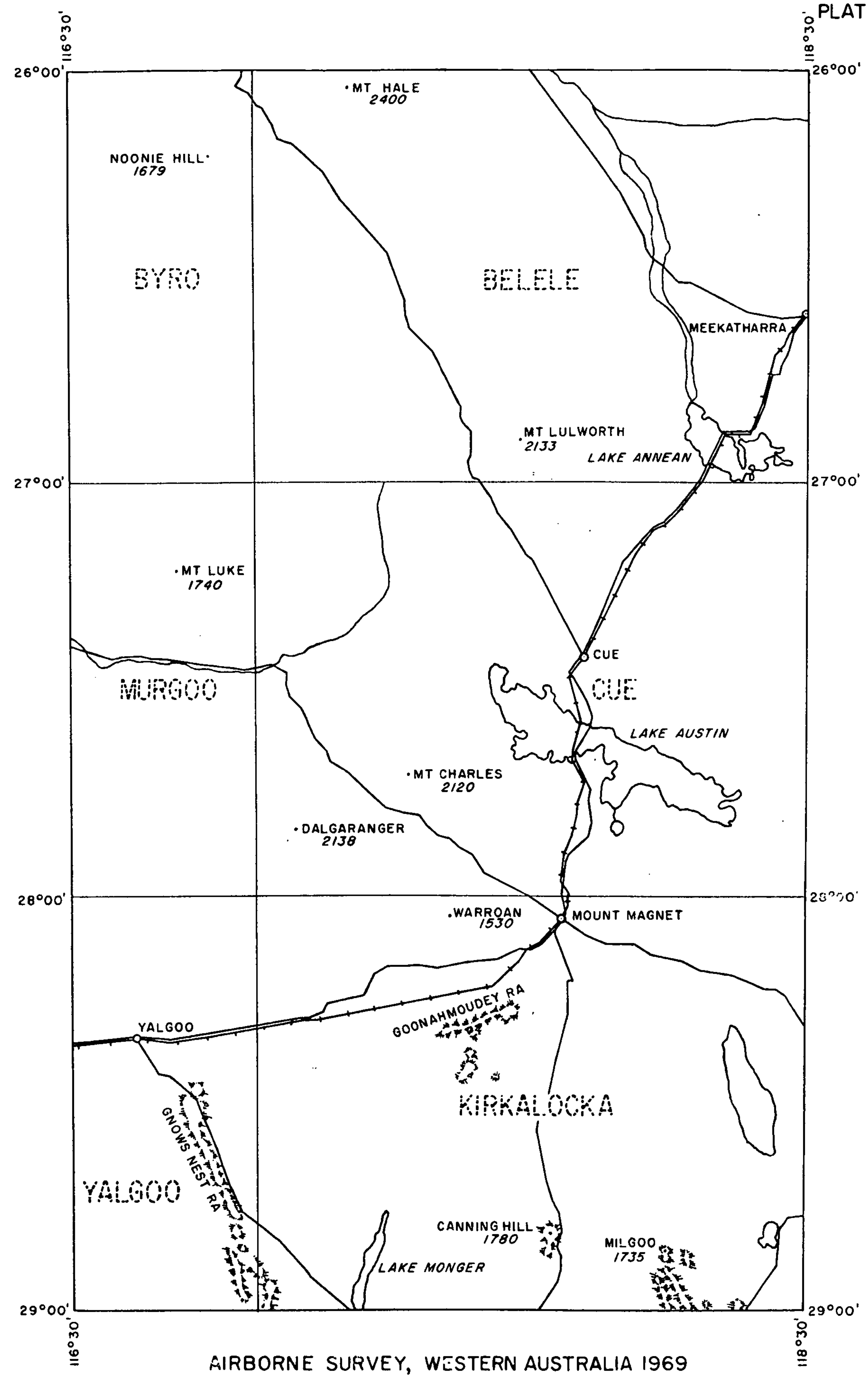
Within the regions mapped as interbedded basic and sedimentary rocks the correlation between the magnetic data and geology is generally good. Several extensions to these areas have been interpreted, and the survey also delineated three additional areas which give rise to magnetic anomalies consistent with the presence of 'greenstones'.

The granites in the survey area display an increase in magnetic anomaly amplitudes away from mapped greenstone areas, and have anomalies ranging up to 500 gammas.

The presence of twenty-three fold axes is postulated from magnetic evidence; the most extensive of these lies in YALGOO, and this fold is recommended for further investigation.

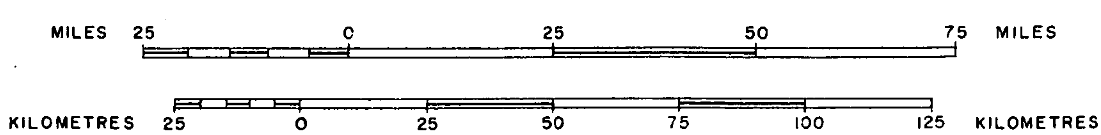
The radiometric data reveals many high-count anomalies, most of which can be correlated with granitic outcrops. Some regions of the granite masses have a significantly greater radioactive content than others.

One hundred and forty-two radiometric anomalies produced by localized sources were detected. Twenty-four of these are considered worthy of further investigation.



AIRBORNE SURVEY, WESTERN AUSTRALIA 1969

LOCALITY MAP



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1. INTRODUCTION

In 1956 the Bureau of Mineral Resources, Geology and Geophysics (BMR) commenced an extensive programme of airborne magnetic and radiometric surveying in the goldfields region of Western Australia at the request of the West Australian Department of Mines. The present survey, flown between March and July 1969, is a continuation of this programme, and covers the BELELE, CUE, and KIRKALOCKA 1:250,000 sheet areas and parts of the BYRO, MURGOO, and YALGOO* areas. The main objectives of this work were to delineate the boundaries of major rock units and determine geological structure.

The survey area, bounded by latitudes 26° and 29° S and longitudes 116°30' and 118°30'E (Plate 1), constitutes a part of the Archaean Yilgarn Block, a subdivision of the Western Australia Shield. The region has been an important gold producing area and is now being actively prospected for nickel deposits, which are sometimes associated with magnetically detectable basic and ultrabasic rocks.

No results of other geophysical investigations in the survey area are available, but the earlier BMR airborne surveys to the west, south-east, and east of the present survey are described in the BMR Records of Spence (1958), Carter (1959), Forsyth (1961), Wells (1962), Young and Tipper (1966), Tipper (1967), Shelley and Waller (1967), and Gerdes et al. (1970).

Interpretation of the magnetic data is based on the approach developed by Young and Tipper (1966) in MENZIES and LEONORA, and extended in the subsequent surveys.

Practically the entire magnetic pattern is attributed to differences in magnetic properties between rock units at or near ground-level. Magnetic trends are delineated and the area is subdivided into zones of specified magnetic character. The main objective of this method is to delineate 'greenstone belts', by establishing relationships between known geology and the magnetic data.

The co-operation of the Geological Survey of Western Australia in compiling the geology for the CUE and MURGOO sheets is gratefully acknowledged.

2. GEOLOGY

The survey area forms part of the Archaean Yilgarn Block, a subdivision of the West Australian Shield. It is essentially a vast mass of granitic rocks enclosing lenticular remnants of older rocks. The granitic rocks were intruded approximately contemporaneously with the folding of the country rocks about NNW to NNE axes. It has been suggested by Sofoulis and Mabbutt (1963) that the granites occupy anticlinal and the country rocks synclinal positions. More detailed discussions of the regional shield geology are given in Forman (1953), Wilson (1958), and Prider (1948, 1954, 1961 and 1965).

The sources used for the compilation of the geological base maps are given in Plates 3, 4, and 5. The main references dealing with the survey area are Johnson (1950), McMath (1953) and Berliat and de la Hunty (1954).

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* Throughout this Record the names of 1:250,000 sheet areas are written in capital letters to distinguish them from ordinary place names.

BYRO and BELELE were mapped on a regional basis during 1958 (Sofoulis & Mabbutt, 1963) and geological coverage is fair. The CUE sheet has been mapped in great detail and is likely to be issued by the WA Geological Survey during the course of 1970. MURGOO is at present being finalized, and geological detail for this sheet is also good. YALGOO and KIRKALOCKA geology is derived from a regional map (Western Australia Department of Mines, 1966); however, little geological detail is available in these areas, except in the vicinity of Mount Magnet, where the mapping of Berliat and de la Hunty (1954) has been used.

The oldest known rocks in the survey area are of mixed basic and ultrabasic igneous, acid volcanic, and sedimentary derivation. The sediments include siliceous and ferruginous banded ironstones (jaspilites) which can form key horizons for structural geological interpretation (Miles, 1953). For convenience elongate areas of predominantly basic rocks are referred to in this Record as 'greenstone belts'.

The granitic rocks are of three main types, namely porphyritic and even-grained intrusive granites, the latter more basic than the former, and a foliated granite (gneiss of earlier workers) apparently produced by granitization on the margins of the intrusive granites (Horwitz, 1966). Minor acid dykes, mainly quartz porphyries and pegmatites, occur near the granite contacts in many areas.

Scattered occurrences of post-folding basic intrusives have been recorded in the survey area.

The strikes of the older Archaean rocks are commonly parallel to the intrusive granite boundaries (Johnson, 1950) and are predominantly NNE to NE, but with local variations of up to 90°. Dips are usually greater than 65°. The major folds commonly plunge steeply to the north or south, with local plunge reversals due to cross-folding. Berliat and de la Hunty (1954) have recorded a plunge of 65°S over most of the length of the Boogardie syncline. Many small-scale folds are present in some areas.

Few major faults have been delineated, but there is much evidence of small-scale faulting, as in the Boogardie area (Berliat & de la Hunty, 1954).

Gold production within the survey area has come mainly from the CUE, Mount Magnet, and Meekatharra districts. The Hill 50 Mine at Mount Magnet is the only major operating mine in the area at this time. Although gold mineralization does occur in sediments, granites, or gneiss, most of the mines are in the basic igneous rocks close to the granite contacts. The CUE district, where metasediments and gneiss are important host rocks, is a noted exception.

According to Berliat and de la Hunty (1954), most of the Mount Magnet auriferous quartz veins occur in overturned jaspilites in basic volcanics and are localized in fault planes which parallel the axial plane of the Boogardie syncline. At CUE, the gold was primarily concentrated in the nose and western limb of an anticline. In the YALGOO area and most other centres, the orebodies parallel the strike of the enclosing 'greenstones', but crosscutting veins have been recorded.

Small amounts of copper (from quartz veins) and cassiterite, wolframite, scheelite, emeralds, bismuthinite, and beryl (from pegmatite veins) have been mined in this area; however, the deposits have been uneconomic.

Although the area is being actively prospected for nickel, to date no commercial deposits have been found.

3. MAGNETIC RESULTS AND INTERPRETATION

General introduction

The magnetic data are shown in Plates 2 to 7. Plates 2, 3, and 4 show all profiles of total magnetic intensity reduced to an east-west scale of 1:250,000 and related to a series of east-west lines which approximate the flight paths. A north-south scale of 1:62,500 has been used to improve data presentation. Control points were plotted along the flight paths at approximately 30-kilometre intervals, and the probable east-west positional error at any point along the flight path does not exceed one-third of a kilometre. The probable north-south positional error is less than 0.8 kilometres. To facilitate correlation, Plates 5, 6, and 7 show every fourth magnetic profile together with the geological mapping.

The interpretation of the magnetic data is given in Plates 8, 9, and 10. Virtually the entire magnetic pattern is attributed to near-surface lithological variations. The area has been divided into eight magnetic zone types as listed below:

Zone type	Anomaly range	Magnetic linearity
1	less than 50 gammas	poor
2	50 to 100 gammas	poor
3	100 to 250 gammas	poor
4	greater than 250 gammas	poor
5	less than 100 gammas	good
6	100 to 250 gammas	good
7	250 to 500 gammas	good
8	greater than 500 gammas	good

The significance of these zone types in terms of the magnetic data and geological correlation has been discussed in detail in the previous survey records for the Yilgarn Block. In summary it may be stated that zones of types 1, 2, and 3 generally indicate increasing basicity in acid igneous masses. Where elongate zones of this type occur adjacent to zones of types 5, 6, 7, or 8, they may indicate sedimentary sequences. Zones of type 4 are attributed to basic or ultrabasic intrusions where they occur in granitic areas, or to greenstone belts of complex structure with no recognizable linearity.

In granitic areas, zones of type 7, 6, and 5 (in order of decreasing basicity) are generally interpreted as basic dykes when they are narrow and as areas where partial assimilation of greenstone belts has taken place when they are broad.

Where zones of type 8 occur, they and any elongate zones associated with them are attributed to greenstone belts. Zones of type 8 are generally indicative of banded iron formations.

When magnetic features (whether "highs" or "lows") recorded on adjacent flight-lines are attributed to the same magnetic body, the line joining the features is referred to as a "trend" or "lineation".

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Comparison of Geophysical Interpretation with Mapped Geology

Based on the zone-type/rock-type correlation discussed above, it is possible to assess the agreement between mapped and interpreted geology and to note the areas where conflicting geological and magnetic data indicate that further geological mapping is desirable.

Reference should be made to Plate 14 for a summary of the magnetic interpretation for the survey area.

BYRO-BELELE area, Plate 8. The northern portion of the BYRO Sheet, west of Jack Hills, is unique for its density of magnetic trends. Anomaly amplitudes range up to 1700 gammas, and the zones with trends are frequently separated by elongate zones of type 2. Although the region is mapped as one of gneissic rocks, the magnetic features are characteristic of greenstone belts of interbedded igneous and seimentary rocks. This area is recommended for ground investigation, with particular attention to the zones of type 8.

An elongate anomaly with an approximate amplitude of 18,000 gammas in the Jack Hills range is interpreted as being produced by banded ironstones, East of Jack Hills three small outcrops of sediments are mapped. The zone of type 4 in this area is indicative of basic rocks, and a greenstone belt is therefore postulated to extend through this region. Its eastern limit may coincide with the zone of type 6 lying north of Judal Homestead.

The region south of Jack Hills, stretching from the western survey boundary to approximately longitude 117°45', is characterized by extensive zones of types 2 and 3. This region is mapped as granite, and the few broad "zones with trends" that occur in it are probably due to relict greenstone structure. Narrow elongate zones with trends also occur. These display random strike directions, and are interpreted as dykes. In the north, around the WSW of Mileura Homestead, this region is more basic. Anomalies range up to 500 gammas, giving rise to a zone of type 4. Although these anomalies are unusually large for granite, the sparsity of distinct magnetic trends renders this unlikely to be a greenstone belt. Another basic area lies on the southern boundary of BYRO, southwest of Kalli Homestead. Trends are more clearly defined here, and anomaly amplitudes are greater. This area and its extension to the south are discussed in detail in the interpretation section on MURGOO-CUE.

A high trend density is apparent in the eastern half of the BELELE area and correlation between the zones with trends and areas mapped as greenstone is good. On the basis of the geological mapping and the magnetic data, it is postulated that greenstone belts stretch from Koonmarra Homestead along the Mingah Range to the Weld Range, and from Abbots Mine through Meekatharra and Nannine. The zonal distributions indicate that the two belts join in the south of BELELE. The magnetic data define numerous areas of prospective interest both in areas mapped as alluvium and in areas of gneiss.

The Weld Range displays similar characteristics to the Jack Hills area, indicating that they are parallel structures on opposite sides of a granitic intrusion. Both are mapped as sediments and both give rise to broad, intense, magnetic anomalies. It is postulated that the rocks of the Weld Range contain banded ironstones in addition to sediments. This interpretation is supported by more recent geological mapping (Jones, 1963) which shows the Weld Range to be composed of dolerite with extensive jaspilite bands.

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A belt of zone type 1, grading in the south to zone type 2, passes through the western part of Lake Annean. This belt overlaps an area mapped as granite, which the magnetic data indicate to be distinct from the western granites in being less basic. The eastern and western shorelines of the lake appear to be geologically controlled, as they are predominantly bounded by zones with trends, interpreted as banded iron formations. A trend zone of type 8 which bisects the lake corresponds with a string of islands.

Between the Mingah Range and Meekatharra greenstone belts, zones of types 1 and 2 predominate. By analogy with the Lake Annean zone, this is interpreted as being a region of acid granites, although only gneissic rock types are mapped. Along the northern boundary of the survey area the preponderance of zones of types 3 and 4 indicates a transition to the basic granite types encountered west of Mingah Range.

<u>MURGOO-CUE area, Plate 9</u>. On the basis of trend characteristics this area can be divided into two blocks by a line striking approximately northeast through Dalgaranger Hill. In the western block, the predominant trend direction is north-south although trends are sparse. In the eastern block, the trend is predominantly NNE, swinging to north in the southern portion of the sheet. The boundary between these areas may coincide with a major structural feature. It is postulated that rocks in the western area are predominantly granitic, whereas to the east, extensive areas of greenstone are surrounded by more acidic granites (see Plate 14).

Zones of types 4, 7, and 8, with individual anomalies rising up to 2000 gammas, occur around Meka Homestead in eastern MURGOO and extend into the south of BYRO. This area is mapped as granite, and is somewhat similar in character to the area postulated as being basic granite around Mileura Homestead in BELELE. However, anomaly amplitudes are greater, and some of the trends are well defined, so that further ground investigation may be warranted. The remainder of the western block is characterized by zones of types 2 and 3 and there can be little doubt that this is a predominantly granitic area. Although geological mapping indicates five different granitic types in this region, the magnetic data do not show any associated differentiation in the rocks' magnetic properties.

In the eastern block, good correlation is obtained between zones with trends and mapped banded ironstones and gabbros. The greenstone belts postulated to lie in southeast BELELE extend into northern CUE. The Weld Range belt terminates near Poona, and to the east, two belts extend from the border southwestwards, one to west of Daydawn and the other to within 6 kilometres of Wanmulla Homestead. These belts are characterized by alternating elongate zones with and without trends. Although the latter zone types are interpreted as representing sedimentary sequences within the greenstone belts rather than granitic bodies, the boundaries of these belts are necessarily uncertain. The southern boundary of the Weld Range belt in particular is poorly defined, but the geological data indicate that it embraces the two zones of type 4 at and to the east of Poona. These are interpreted as basic greenstones striking approximately east, in view of the absence of defined trends. The Daydawn belt embraces the CUE and Big Bell mining areas, and has boundaries defined mainly by zones with trends. Big Bell lies on a zone of type 6, which the magnetic data indicate may have extensions to the north and south. The CUE mining area is delineated by a zone of type 4 indicative of east-striking greenstones. This is borne out by the geological evidence, which shows a gabbro body a few kilometres west of CUE within the zone of type 4. This zone grades in the northeast into a zone of type 6, which crosses an area mapped as granite. No remnant structures have been recorded in this area (de la Hunty, pers. comm.), and virtually complete assimilation may have taken place. The Wanmulla greenstone belt stretches eastward from Tuckanawa to the survey boundary. West of Cullculli Homestead it is similar in character to the Daydawn belt, but east of this, magnetic anomalies of up to 3500 gammas were detected over a broad area. Although this area is mapped as sediments, geological data are sparse (de la Hunty, pers. comm.). The anomalies are attributed to greenstones and are considered worthy of further investigation.

Two other major greenstone belts have been delineated in the CUE area, one around Dalgaranger Hill, and the other from 10 kilometres southeast of Taincrow Homestead through Moyagee and into the KIRKALOCKA sheet area. The Dalgaranger Hill greenstone belt shows two distinct trend directions: one branch runs north to Kylie mine, the other runs northeast. It is probable that extensive folding has taken place in this area. Dalgaranger Hill corresponds to a zone of type 4 showing good correlation with mapped gabbro. Elsewhere in the interpreted belt, granites have been mapped, indicating that some degree of assimilation has taken place. The interpreted belt through Moyagee is rich in jaspilites, which give rise to characteristic zones of types 7 and 8. The extent of this belt under Lake Austin is clearly defined by the magnetic data. A strong negative anomaly striking NNE was detected north of Tuckabianna. The possible cause of this and other similar negative anomalies occurring within greenstone belts is discussed in a later section of the Record.

Four areas have been interpreted as greenstones which have undergone extensive assimilation by the granite. The zone of type 6 twenty-six kilometres west of Big Bell and the area comprising type 4, 6, and 7 zones extending from 10 to 32 kilometres north of Wondinong Homestead lie in areas mapped predominantly as granite in which no relict structures have been recorded. The north-striking band of type 6 and 7 zones near Mount Farmer Homestead is mapped as granite, but occurrences of gneissic rocks have been noted in this region (de la Hunty, pers. comm.), and the amplitude of the anomalies indicates that assimilation is far from complete. A remanently magnetized dyke striking north-west is postulated to pass through Mount Farmer Homestead. This feature parallels postulated fold axes west and south of CUE, and may be genetically related to them. Thirteen kilometres east of Webbs Patch mine two zones of type 6 and a zone of type 4 form a closure over a region mapped as granite. Relict structures are mapped in this area, and the magnetic results suggest the presence of a fold through this feature.

The area in the southeastern corner of the CUE sheet is interpreted as part of a greenstone belt which extends south into KIRKALOCKA. A zone of type 8 coincides with a gabbroic mass. A strong negative magnetic anomaly occurs along the western boundary of this mass.

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YALGOO-KIRKALOCKA area, Plate 10. On the basis of magnetic character, this region can be divided into three distinct areas. The western area, lying in YALGOO, displays well defined elongate greenstone bands. The central region, occupying approximately the western third of KIRKALOCKA, is interpreted as predominantly granite, and the remainder of the KIRKALOCKA sheet is characterized by numerous elongate zones with trends, indicative of partially assimilated greenstone belts.

The dominant feature of the zonal configuration in the YALGOO sheet is an inverted V of zones with trends, which is interpreted as a greenstone belt with apex north of YALGOO township. Although the western limb lies a few kilometres outside the survey boundary for the greater part of its extent, it is shown on the published aeromagnetic map of the western part of YALGOO, and was intersected by many of the flight-lines of the present survey. The eastern limb extends southwards along the Gnows Nest Range to beyond the southern edge of the sheet. It is flanked by a zone of type 1 around the Golden Glove mine. This zone is interpreted as corresponding to acid volcanics or sediments as it correlates with mapped sediments at its southern end. Intense anomalies indicative of banded iron formations were recorded over both limbs of this structure. These anomalies coincide with ridges clearly visible on the aerial photographs.

To the north and east of YALGOO, correlation between magnetic trends and geological strikes (Johnson, 1950) is good. The zonal configuration here is similar to that in the area west of YALGOO. In both areas, zones closing to the north and containing trends indicate fold structures. The margins of the eastern structure have been extensively mined, particularly in the area of the zone of type 6 extending NNE from YALGOO. The near-parallel zone of type 6 on the eastern margin of the western structure is particularly worthy of ground investigation. Although this area is interpreted as predominantly greenstones, zones of type 8 are sparse and few banded iron formations are likely to be present.

South of YALGOO, zones of type 2 and 3 predominate, and this is interpreted as an area of granitic intrusion, with assimilation of country rock virtually complete. The zones of type 2 lie mainly along the boundary of the enclosing greenstone belt, and there thus appears to be a decrease in acidity away from the margins of this postulated granite mass. The numerous basic dykes mapped in the south of this area failed to give rise to significant magnetic anomalies. This is attributed to their small widths and low angles of intersection with the flight-lines.

From the Gnows Nest Range eastward to approximately longitude 117°45' lies an area with few zones that show trends. The eastern and western margins of this region are characterized by zones of type 2, while the central region contains zones of types 3 and 4. This is interpreted as being a granitic region, as indicated by the geology. It thus appears to be generally true throughout the survey area that granitic masses decrease in acidity towards their centres, being most acid at their boundaries with greenstone belts. This feature has also been noted in the region to the east of the present survey (Young, pers. comm.).

A zone of type 6 strikes WNW from Munbinia Homestead, parallel to the similar feature through Mount Farmer Homestead on the CUE sheet. This is interpreted as a cross-cutting remanently magnetized dyke. Several other elongate zones with trends occur in this area, and these also are interpreted as dykes.

Although most of the zones of type 4 are interpreted as being granitic, there are several exceptions. Anomalies of over 1000 gammas occur in an elongated area striking north through Nalbarra Homestead, south of the centre of KIRKALOCKA. The anomalies are similar to those in the zone of type 4 a few kilometres west of Mulermurra Hill in southeast KIRKALOCKA, which is mapped as greenstone. The absence of strong trends in this area render it unlikely that jaspilites are present, and the zones of type 4 and 8 are therefore attributed to basic or ultrabasic intrusions. This area is recommended for extensive ground investigation. The zones of type 7 and 4, thirty kilometres to the west, may be of similar origin but anomaly amplitudes are smaller. In the centre of the southern border of the sheet, a zone of type 4 with anomalies of over 2000 gammas has been delineated. This zone is recommended for investigation as a possible area of basic and ultrabasic rocks, in view of the large-anomaly amplitudes without prominent trend directions and the correlation of part of this area with mapped greenstones.

Around Mount Magnet, correlation between the magnetic data and the jaspilites mapped by Berliat and de la Hunty (1954) is good. As the basic volcanics do not appear to give rise to significant magnetic anomalies, the delineation of these rocks by magnetic data is not feasible. From Mount Magnet southwards, a belt of zones with trends extends to south of Wydgee Homestead. These zones and the zones that lack trends encompassed by them are interpreted as a major greenstone belt. A break in trend continuity occurs about 15 kilometres north of Kirkalocka Homestead. Greenstones crop out in this locality and a granite outcrop was observed by the authors west of the break. The trend break may be due to partial granitic assimilation of the greenstones along an anticlinal crossfold. Around and to the south of Wydgee Homestead a region of greenstone is mapped, thereby supporting the presence of this postulated greenstone belt. It appears from the magnetic data that rock types become more acidic south of Wydgee, and trends could not be delineated.

East of the Great Northern Highway to the eastern survey boundary the zonal configuration is complex and greenstones appear to be more common. Separation of granitic and greenstone rock types on the basis of magnetic data is difficult in this region. Most of the zones with trends are attributed to partially assimilated greenstones, while the extensive areas of zone types 2 and 3 are interpreted as being caused by granites. This granite is more acidic than that in the centre of the sheet. In northeast KIRKALOCKA the area covered by zones of types 4, 7, and 8 is attributed to basic and ultrabasic intrusions, as anomaly types are unlike those produced by known jaspilites and the extension of this belt in CUE is mapped as gabbro. The zone of type 4 on the eastern boundary of KIRKALOCKA south of latitude 28°15' is characterized by broad, intense negative anomalies, which may represent greenstone beds striking at a small angle to the lines of flight, as the photographs of this area exhibit approximately east-west lineations. A few kilometres northwest of Narndee Homestead, a zone of type 4 corresponds approximately to mapped greenstones. In view of the anomaly amplitude and lack of significant trends, this is interpreted as a region of basic and ultrabasic intrusions similar in character to that about Nalbarra Homestead.

Structure

Plate 14 shows fold axes which have been interpreted by consideration of magnetic anomaly forms and zonal configurations. In many cases these axes probably represent generalizations of complex fold systems. It is difficult to determine the sense of a particular fold owing to high dip angles, or overturning, of the greenstone rocks. However, some of the folds mapped geologically can be related to interpreted folds, whilst in others, the degree and location of assimilation give an indication of fold types, as greenstone belts are postulated to occupy synclinal positions (Sofoulis & Mabbutt, 1963). The folds are broadly of two types: major or regional folds striking approximately north and cross-folds striking approximately east.

BYRO-BELELE area, Plate 8. Three major fold axes and one crossfold were interpreted in this area. The fold southwest of Kalli Homestead in southeast BYRO was interpreted from the magnetic profiles. It is only 6 kilometres long and of little significance except as an additional indication that this a greenstone belt. The postulated fold east of Mingah Range lies in a greenstone belt, and has two mines symmetrically placed about its axis. The postulated fold system near Nannine comprises a major fold striking north to NNE and one cross-fold. The position of these folds in relation to known granitic outcrops suggests that they are synclinal and form a basin structure. The mine position indicates that cross-folding may have been significant in localizing mineralization, and the corresponding area on the eastern flank of the major fold is therefore recommended for further investigation.

MURGOO-CUE area, Plate 9. Eight major folds and four cross-folds were interpreted in this area. One of the major folds is a continuation of a fold in southeast BELELE, already discussed, and one extends southwards into the KIRKALOCKA sheet. The Big Bell system comprises one major fold and three cross-folds. The major fold correlates with a geologically mapped anticline plunging to the north, and on this basis the cross-folds are interpreted as anticline, syncline, anticline successively from north to south.

The fold system shown round Moyagee is based on magnetic and geological data. The senses of the major folds shown in Plate 14 are based on geological information. The cross-fold shown is in line with an east-west zone of type 4 which runs through the eastern end of Lake Austin. This type-4 zone may represent a basic dyke intrusion, but magnetic traverses across strike would be required to clarify its form and extent. The fold axes shown east of Dalgaranger Hill and east of Tuckabianna have indications of closure from the magnetic trends at their northern ends, and some form of cross-folding is probably present.

YALGOO-KIRKALOCKA area, Plate 10. Four cross-folds and five major folds (one of which is a continuation of a fold in CUE) have been interpreted. The zonal distribution in YALGOO is consistent with a major north-south fold axis passing three kilometres west of YALGOO. The magnetic profiles are approximately symmetrical about this axis from six kilometres south of Pindathuna Homestead to the southern survey boundary, and a closure is postulated three kilometres west of YALGOO in the zone of type 8. Two further major folds and two cross-folds are postulated at the northern end of this fold to account for the distribution of zones with trends.

On the basis of the magnetic trends and the distribution of the greenstone in relation to the granite, it is tentatively postulated that the major north-south fold is anticlinal and that it is flanked near YALGOO by synclinal folds. The fold system interpreted in this area indicates several areas which should be investigated for mineralization, particularly round the margins of the western postulated synclinal fold.

The fold axis shown west of Boogardie has been geologically mapped and is confirmed by the form of magnetic trends in the area. Farther south in the same greenstone belt, another fold axis is postulated to extend south to near Kirkalocka Homestead.

Remanent magnetization in the greenstone bands

The magnetic anomalies in the greenstone bands are predominantly positive and symmetrical, with pronounced northerly trends. The anomalies indicate that, in general, the magnetization is in the plane of the present geomagnetic field. Rocks of igneous origin within the greenstone bands would be expected to have appreciable remanent magnetization, and if this is so it would imply that the rocks have been remanently magnetized approximately in the plane of the present field after having been folded to their present attitudes.

Susceptibilities calculated from the magnetic anomalies using the methods of Bean (1966) and Gay (1963) ranged up to 0.108 c.g.s. for anomalies attributed to banded ironstones and to 0.015 c.g.s. for anomalies attributed to gabbro. Laboratory measurements of the susceptibilities of three samples of fresh banded ironstone from the Mount Magnet mine ranged from 0.024 to 0.026 c.g.s.; the theoretical range for gabbro is from 68 to 2370×10^{-6} c.g.s. (Dobrin, 1960). It therefore appears that the magnetic anomalies yield susceptibilities of the order of five times too large. The high apparent susceptibilities can be accounted for by remanent magnetization. This evidence suggests that some of the rocks have been heated above their Curie points subsequent to folding, and in view of this and the widespread evidence of partial assimilation among the greenstones, it is probable that virtually all the greenstone bands were heated above their Curie points and are remanently magnetized.

Negative magnetic anomalies

Four anomalous negative areas were detected in the greenstone bands; they are shown in Plate 14. The magnetic anomalies indicate that the rocks are remanently magnetized in a plane close to that of the present magnetic meridian but with a component opposite to the direction of the present field. The amplitude of these negative anomalies appears to be roughly proportional to the amplitude of the adjacent positive anomalies, and where trends are apparent they parallel the known geological structures. These anomalies appear to be distinct from those attributed to the remanently magnetized basic dykes which in places cut across the regional strike, in that they have greater amplitudes and are confined to the greenstone bands.

It is possible that these negative anomalies indicate a process of remagnetization which has taken place during a period of geomagnetic field reversal subsequent to folding. It is necessary to assume that the rocks were heated above their Curie points. The heating could be explained by intrusions occurring after the main granite intrusion and regional folding. The origin of the negative anomalies shown as areas of remagnetization in Plate 14 is uncertain but in view of their rather rare occurrence and the possibility of mineralization associated with post-granitic intrusions, a more detailed investigation could be of considerable interest.

4. RADIOMETRIC RESULTS AND INTERPRETATION

During the first part of the survey, the radiometric data were recorded by two scintillometers: an inboard scintillometer with a 10-second time constant to record regional variations of radiometric intensity to assist geological mapping, and a towed-bird scintillometer with a 2-second time constant to detect localized sources of radioactivity. A fault developed in the latter unit and it was necessary to complete the survey using the inboard detector with both the 10- and 2-second channels (see Appendix 2). Plates 11, 12, and 13 illustrate the radiometric data superimposed on mapped geology.

In the BYRO-BELELE area (Plate 11) radiometric anomalies range to over 300 counts per second (c.p.s.), as compared to a background of approximately 50 c.p.s. In general, radiometric highs show good correlation with mapped granite, whereas the amplitudes over greenstones are low. In particular, the Jack Hills and Weld Range areas show good correlation between mapped geology and 'lows' defined by 50-c.p.s. contours. The central granite gives rise to large anomalies, some of which lie within an area of magnetic zone type 4 around Mileura Homestead. The radiometric data thus support the interpretation of rocks within this area being of intermediate granite composition.

In the MURGOO-CUE area (Plate 12), intense radiometric anomalies which exceed 300 c.p.s. predominate in the west. In the eastern portion of the sheet there is little variation in the recorded radioactivity, amplitudes often being less than 50 c.p.s. It does not appear feasible to differentiate between the different granitic types, as mapped in MURGOO sheet area, by reference to radiometric data since radiometric intensity is primarily controlled by outcrop distribution in granitic areas. The area around Meka Homestead in MURGOO displays intermediate-amplitude radiometric anomalies consistent with the presence of granite or partially assimilated greenstone outcrop. The areas interpreted as assimilated

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greenstones around and thirty kilometres north of Mount Farmer Homestead give rise to anomalies in the region of 100 c.p.s., but that to the northeast of Nannine is not reflected in the radiometric contour pattern. The radiometric data are consistent with the presence of a less radioactive granitic rock type in the east of CUE.

The YALGOO-KIRKALOCKA area (Plate 13) displays similar characteristics to the rest of the survey area, as radiometric anomalies correlate closely with mapped granites. The radiometric data indicate that the interpreted synclinal basin west of YALGOO township has undergone some degree of granitization. The central granite does not give rise to widespread radiometric anomalies. This is probably due to increased soil cover.

Except in the case of a small lake east of Boodanoo Homestead on the eastern boundary of the KIRKALOCKA sheet area, the salt lakes in the survey area (notably Lake Austin and Lake Annean) did not give rise to significant radiometric anomalies. This is attributed to high groundwater levels resulting from rainfall during the survey.

Appendix 1 lists 142 restricted source anomalies recorded during the survey, the classification of which and their recognition have been described by Young and Tipper (1966). Seventy-five type A anomalies were detected, which are significant with respect to the local geological noise, and hence most likely to prove of geological interest. Of these, 24 anomalies are considered worthy of further investigation. These are anomalies 5, 8, 19, 44, 53, 62, 79, 85, 89, 94, 95, 98, 104, 109, 115, 122, 124, and 132 which lie in areas interpreted as granite; anomalies 4, 70, and 88 which lie at or near granite/greenstone boundaries; anomalies 35, 36, and 42 which lie in areas interpreted as greenstones, and may indicate a gneissic rock character; anomaly 101 which is associated with an intense regional radiometric anomaly lying in a greenstone area.

5. CONCLUSIONS AND RECOMMENDATIONS

Greenstone belts interpreted from the magnetic data in general show fair correlation with known geology. This is particularly true in the Jack Hills area in eastern BELELE, in the Mount Magnet area, and in the YALGOO area. Extensions to the boundaries of mapped greenstone units are indicated in the Cue-Big Bell and Dalgaranger Hill areas in CUE and three areas in eastern KIRKALOCKA.

Three areas where geological and geophysical data conflict are recommended for ground investigation. These areas lie west of Jack Hills in northeast BYRO, around and to the north of Meka Homestead in MURGOO, and around Nalbarra in KIRKALOCKA. The first area is the most extensive, and is mapped as gneiss. Numerous pronounced magnetic lineations, zonal configurations, and anomaly amplitudes show features typical of greenstone belts. The magnetic anomaly amplitudes of up to 2000 gammas recorded around Meka Homestead are unlikely to be due to a granitic body as mapped. Magnetic and radiometric anomalies indicate the presence of basic rocks in this area. The third area, in KIRKALOCKA, is very similar in magnetic character to that around Milgoo Hill, where greenstones are mapped. This area is one of poor outcrop, and the probability of finding greenstones is high.

Two known remnant greenstone belt structures preserved in granite, in CUE, are useful in indicating the degree to which magnetic character can be retained by an apparently granitic rock. They lie north of Warroan Hill and northeast of Lake Austin. These areas should not be discounted for economic mineral deposits without detailed surveying.

The granites in the survey area give rise to a wide range of magnetic anomalies with amplitudes approaching 500 gammas. A significant decrease in acidity, as evidenced by an increase in magnetic disturbance, away from the known greenstone belts is apparent. This feature requires further investigation, as it may prove of assistance in assessing the regional distribution of partially assimilated greenstone belts and basic igneous rocks in granitic areas.

Twenty-three fold axes have been interpreted from the magnetic data, the most significant of which is the axis striking north-south through YALGOO. By reference to the locations of mines, zonal configurations, and structural axes, potentially prospective areas can be delineated and fold axes are therefore recommended for investigation.

Magnetic anomaly amplitudes and distributions indicate that remanent magnetization is the rule rather than the exception in the survey area; i.e. that the greenstones cooled to below their Curie points after being folded into vertical beds. Four areas of negative anomalies detected in the greenstone bands are attributed to remagnetization during a period of geomagnetic field reversal.

The radiometric data display good correlation between granite outcrops and anomalous areas; however, it does not appear possible to delineate different granitic types on the basis of these data. One hundred and forty-two radiometric anomalies satisfying the point-source criteria were detected. Of these, 75 are significant with respect to local geological noise, and 24 warranting further investigation.

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APPENDIX 1

RADIOMETRIC ANOMALIES

Anomaly No.	Line No.	Fiducial No.	Half-peak width, sec.	Amplitude, x S.D.	Classi-fication
BYRO-BELELE area					
1	106E	1581.1	6.0	5	A
2	111W	0891.0	7.0	4	A
3	113W	1477.7	7.0	4	A
4	118E	0406.0	7.0	4	A
5	121W	1508.7	6.0	5	A
6	108E	2346.0	7.0	4	A
7	111W	0774.8	7.5	7	D
8	119W	0812.0	6.0	6	A
9	124W	0782.3	6.5	4	A
10	119W	0768.0	6.5	4	C
11	128W	1999.5	5.5	13	D
12	135E	1705.6	7.0	6	B
13	132W	0807.3	7.5	5	C
14	143E	1283.1	6.0	7	B
15	141E	0617.1	7.0	4.5	A
16	143E	1224.7	6.0	11	D
17	146E	0622.0	7.5	5	A
18	147E	1325.9	6.0	5	A
19	144W	1757.8	7.5	6	A
20	150W	0636.9	6.0	4	A
21	152W	1248.8	7.0	8	A
22	166E	1363.8	7.5	9	B
23	164E	0107.1	6.5	5	D
24	162E	0139.6	6.0	9	D
25	155E	0134.8	6.5	13	B
26	152W	1170.6	8.0	17	B
27	164E	0139.1	7.5	4	A
28	158E	1426.4	6.5	4	C
29	153E	0792.5	7.0	13	B
30	157W	1781.3	7.5	15	B

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Anomaly No.	Line No.	Fiducial No.	Half-peak width, sec.	Amplitude, x S.D.	Classification
31	163W	0500.1	6.5	4	A
32	166E	1427.5	7.0	17	D
33	167W	1153.1	7.5	15	D
34	154W	0461.2	8.0	15	B
35	151E	0277.4	6.5	5.5	A
36	153E	0881.3	7.5	4	A
37	163W	0423.0	7.5	8	A
MURGOO-CUE area					
38	184E	1326.1	6.5	6	C
39	178E	1364.2	7.0	15	B
40	174E	0718.0	7.0	6	C
41	179W	1243.0	7.0	4	A
42	175W	0571.5	7.0	5	A
43	178E	1418.3	6.0	4	A
44	174E	0756.2	6.0	7	A
45	174E	0762.7	6.5	11	B
46	174E	0766.7	7.0	9	B
47	174E	0779.6	6.5	11	D
48	177W	1749.1	7.0	15	C
49	182E	0216.0	7.0	4	A
50	193W	0478.6	7.5	4	A
51	194E	0174.5	6.0	7	C
52	194E	0155.5	7.5	12	B
53	188E	0162.4	7.5	8	A
54	185W	1174.0	6.0	3	A
55	185W	1196.3	6.0	4	A
56	186W	0777.2	6.0	4	A
57	187W	0580.0	7.0	4	C
58	193W	0561.8	6.5	4	A
59	194E	0083.0	6.5	4.5	A
60	203W	1310.7	5.5	9	B
61	204E	0710.5	7.0	15	B
62	210E	0786.3	5.5	5.5	A

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Anomaly No.	Line No.	Fiducial No.	Half-peak width, sec.	Amplitude, x S.D.	Classification
63	206E	0174.1	5.0	4	C
64	203W	1206.5	7.0	6	A
65	205W	0533.5	7.0	8	A
66	207W	1802.5	6.0	4	A
67	209W	0510.1	6.0	11	D
68	219W	0527.0	6.5	4	C
69	225W	0531.2	6.5	4	C
70	223W	1225.9	5.5	4	A
71	225W	0567.8	6.0	6	C
72	221W	1901.9	6.0	5	C
73	223W	1278.0	6.5	5	C
74	222E	1406.1	6.0	5	A
75	255W	0625.6	6.5	27	D
76	223W	1294.0	6.5	7	C
77	219W	0621.5	5.0	4.5	A
78	220E	0052.0	6.0	3	A
79	222E	1384.0	6.5	5	A
80	223W	1310.1	5.5	18	D
81	220E	0043.8	6.0	5	C
82	219W	0640.1	5.5	6	A
83	231W	0706.9	6.5	4	A
84	238E	0074.6	6.5	5	A
85	235W	1273.6	6.5	5	A
86	238E	0253.3	7.0	4	C
87	234E	1623.1	6.0	4	C
88	229W	1170.7	6.0	4	A
89	229W	1108.3	7.0	6	A
90	228E	1672.0	7.0	11	B
YALGOO-KIRKALOCKA area					
91	244E	0048.7	6.5	4	C
92	254E	0792.3	6.5	4	C
93	241W	0660.6	7.0	6	C
94	248E	0805.3	6.0	7	A
95	241W	0634.8	6.5	5	A

Anomaly No.	Line No.	Fiducial No.	Half-peak width, sec.	Amplitude, x S.D.	Classi-fication
96	243W	0562.8	6.5	5	A
97	246E	1489.7	5.5	7	C
98	242E	0262.7	5.5	8	A
99	250E	0306.9	6.5	3	A
100	245W	1750.4	4.5	6	A
101	255W	0412.6	6.0	4	A
102	265E	1590.9	6.0	4	C
103	264W	1722.3	6.0	8	C
104	258W	1668.4	6.5	6	A
105	255W	0518.7	6.0	4	A
106	257E	0212.7	6.5	17	D
107	259E	1466.6	7.0	4	A
108	259E	1461.3	5.5	3.5	A
109	261E	0814.4	6.0	5	A
110	267E	0816.3	7.0	5	A
111	268W	0484.0	5.5	15	B
112	273E	0195.2	7.0	3	A
113	279E	0921.0	5.5	5	D
114	275E	0788.3	5.0	3.5	A
115	281E	0212.9	5.5	5	A
116	286W	0587.8	4.5	4	A
117	285E	0794.1	6.0	4	C
118	279E	0871.0	6.5	4.5	A
119	278W	0259.2	6.0	4	A
120	269E	0031.4	7.0	6	A
121	270W	1291.4	6.0	13	D
122	277E	0032.6	5.5	5	A
123	298W	0629.3	5.5	3	A
124	305E	1549.7	6.5	6	A
125	292W	0557.2	6.5	6	C
126	289E	1476.5	5.0	4	C
127	293E	0201.9	5.5	12	D
128	292W	0527.1	5.5	5	A
129	293E	0222.7	5.5	4	C

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Anomaly No.	Line No.	Fiducial No.	Half-peak width, sec.	Amplitude, x S.D.	Classification
130	301E	0909.6	5.5	3	C
131	304W	1852.4	5.0	3	A
132	305E	1549.7	6.5	6	A
133	307E	0886.7	5.5	4	A
134	309E	0238.6	7.0	5.5	A
135	306W	1169.0	4.0	4	D
136	300W	1165.2	5.5	3	C
137	292W	0449.0	6.0	4	A
138	292W	0440.8	5.5	3.5	C
139	287E	0289.6	5.5	7	C
140	285E	0959.4	6.5	11	D
141	280W	0505.2	6.0	7	D
142	280W	0479.5	6.0	6	D

APPENDIX 2

OPERATIONAL DETAILS

Staff

Party Leader	:	D.R. Waller	
Geophysicist	:	R.D. Beattie	
Senior Radio Technician	:	J.M. Swords	
Drafting Officer	:	B. Tink	
Technical Assistants	:	K.A. Mort	
		D. Park	
Pilots	:	Captain F. O'Grady	T.A.A.
		First Officer R. Smith	T.A.A.
		First Officer J.R. Lindsay	T.A.A.
Aircraft Maintenance	:	R. Allen	T.A.A.
		B. Hall	T.A.A.
		G. Ferguson	T.A.A.
		W. Briggs	T.A.A.
		R. McNamee	T.A.A.

Equipment

Aircraft	:	DC.3 - VH-MIN
Magnetometers	:	MFS-5 or MFS-6 saturable-core fluxgate, tail boom installation, coupled to Speedomax recorder. MFD-4 saturable-core fluxgate magnetic storm monitor, ground installation, coupled to Esterline-Angus recorder
Scintillometers	:	Sodium iodide crystals coupled to Hamner electronic modules. Two channels, 10-second and 2-second time constants. Outputs to De Var recorder
Camera	:	35-mm strip camera of BMR design
Radio altimeter	:	Bonzer frequency-modulated type, output to De Var recorder
Air position indicator	:	Track recorded by integration of aircraft heading and airspeed, on De Var recorder

Survey specifications

Altitude	:	600 ft (183 metres) above ground level
Line spacing	:	1 mile (1.6 kilometres)
Line orientation	:	East and west

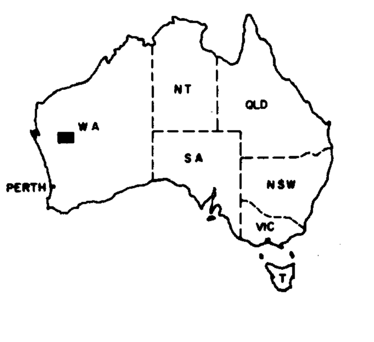
ab

Tie system	:	Single north-south ties spaced 20 miles (32 kilometres) Double ties 20 miles (32 kilometres) from eastern and western boundaries of survey area
Navigation control	:	Aerial photographs
Recorder sensitivities:		MFS-5, MFS-6 100 gammas/inch MFD-4 20 gammas/inch Scintillometers 50 c.p.s./cm Radio altimeter logarithmic
Radiometric	:	10-second channel, obtained from inboard detector 2-second channel, obtained from towed bird detector at 340 ft (103 m) above ground level on lines 311 to 201; obtained from inboard detector on lines 194 to 101. No 2-second channel data obtained on lines 200 to 195.

BYRO - BELELE
WESTERN AUSTRALIA

PLATE 2

LOCATION DIAGRAM

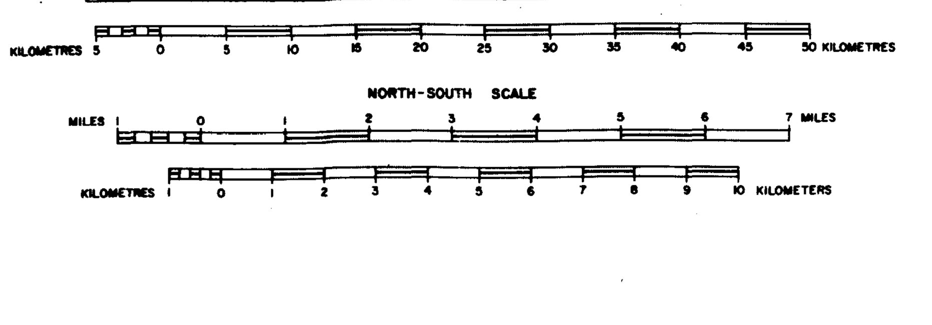


REFERENCE TO 1:250,000 MAP SERIES

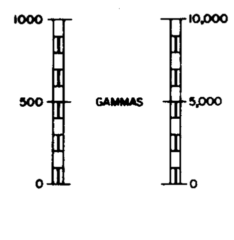
GLENBURGH	ROBINSON RANGE	PEAK HILL
BYRO	BELELE	GLENGARRY
MURGOO	CUE	SANDSTONE

AIRBORNE SURVEY, WESTERN AUSTRALIA 1969

TOTAL MAGNETIC INTENSITY PROFILES



PROFILE SCALE



EXPLANATORY NOTES

THE SURVEY WAS MADE WITH A DC 3 AIRCRAFT AT AN ALTITUDE OF 600 FEET ABOVE GROUND LEVEL ALONG LINES SPACED ONE MILE APART THE FLIGHT-LINES ARE IDEALISED AND SERVE AS BASELINES TO THE PROFILES. THEY APPROXIMATE THE ACTUAL FLIGHT PATH WITH A PROBABLE ERROR OF ± 1/5 MILE.

THE PROFILES HAVE BEEN CORRECTED FOR THE SOUTH COMPONENT OF A REGIONAL GRADIENT IN TOTAL MAGNETIC INTENSITY. THIS COMPONENT AMOUNTS TO 8·0 GAMMAS PER MILE.

THE SYMBOL ·················· INDICATES THAT NO MAGNETIC DATA ARE AVAILABLE.

TO ACCOMPANY RECORD NO. 1971/28

G50/B1-51-1

Geophysical Branch, Bureau of Mineral Resources, Geology and Geophysics

MURGOO-CUE
WESTERN AUSTRALIA

PLATE 3

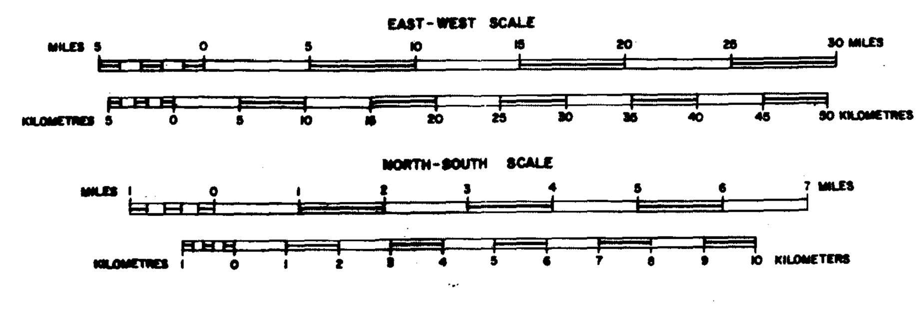
AIRBORNE SURVEY, WESTERN AUSTRALIA 1969

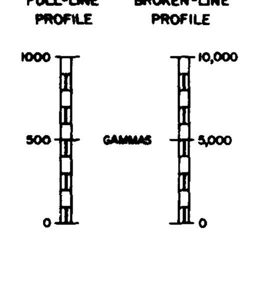
TOTAL MAGNETIC INTENSITY PROFILES

LOCATION DIAGRAM

REFERENCE TO 1:250,000 MAP SERIES

BYRO	BELELE	GLENGARRY
MURGOO	CUE	SANDSTONE
YALGOO	KIRKALOCKA	YOUANMI





EXPLANATORY NOTES

THE SURVEY WAS MADE WITH A DC.3 AIRCRAFT AT AN ALTITUDE OF 600 FEET ABOVE GROUND LEVEL ALONG LINES SPACED ONE MILE APART. THE FLIGHT-LINES ARE IDEALISED AND SERVE AS BASELINES TO THE PROFILES. THEY APPROXIMATE THE ACTUAL FLIGHT PATH WITH A PROBABLE ERROR OF ± 1/5 MILE.

THE PROFILES HAVE BEEN CORRECTED FOR THE SOUTH COMPONENT OF A REGIONAL GRADIENT IN TOTAL MAGNETIC INTENSITY. THIS COMPONENT AMOUNTS TO 8·0 GAMMAS PER MILE.

THE SYMBOL ················ INDICATES THAT NO MAGNETIC DATA ARE AVAILABLE.

TO ACCOMPANY RECORD NO. 1971/28

G50/BI-52-1

Geophysical Branch, Bureau of Mineral Resources, Geology and Geophysics

YALGOO – KIRKALOCKA
WESTERN AUSTRALIA

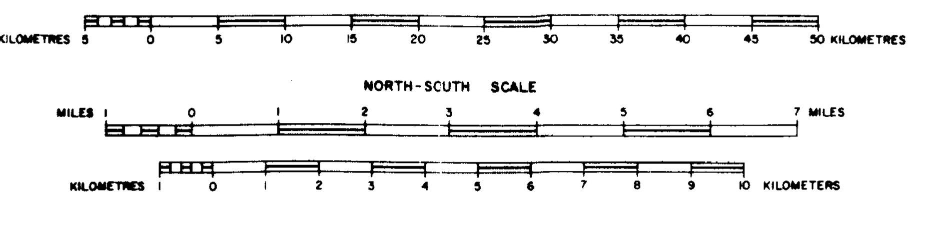
LOCATION DIAGRAM

REFERENCE TO 1:250,000 MAP SERIES

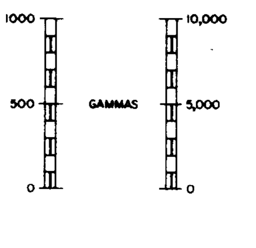
MURGOO	CUE	SANDSTONE
YALGOO	KIRKALOCKA	YOUANMI
PERENJORI	NINGHAN	BARLEE

AIRBORNE SURVEY, WESTERN AUSTRALIA 1969

TOTAL MAGNETIC INTENSITY PROFILES



PROFILE SCALE



EXPLANATORY NOTES

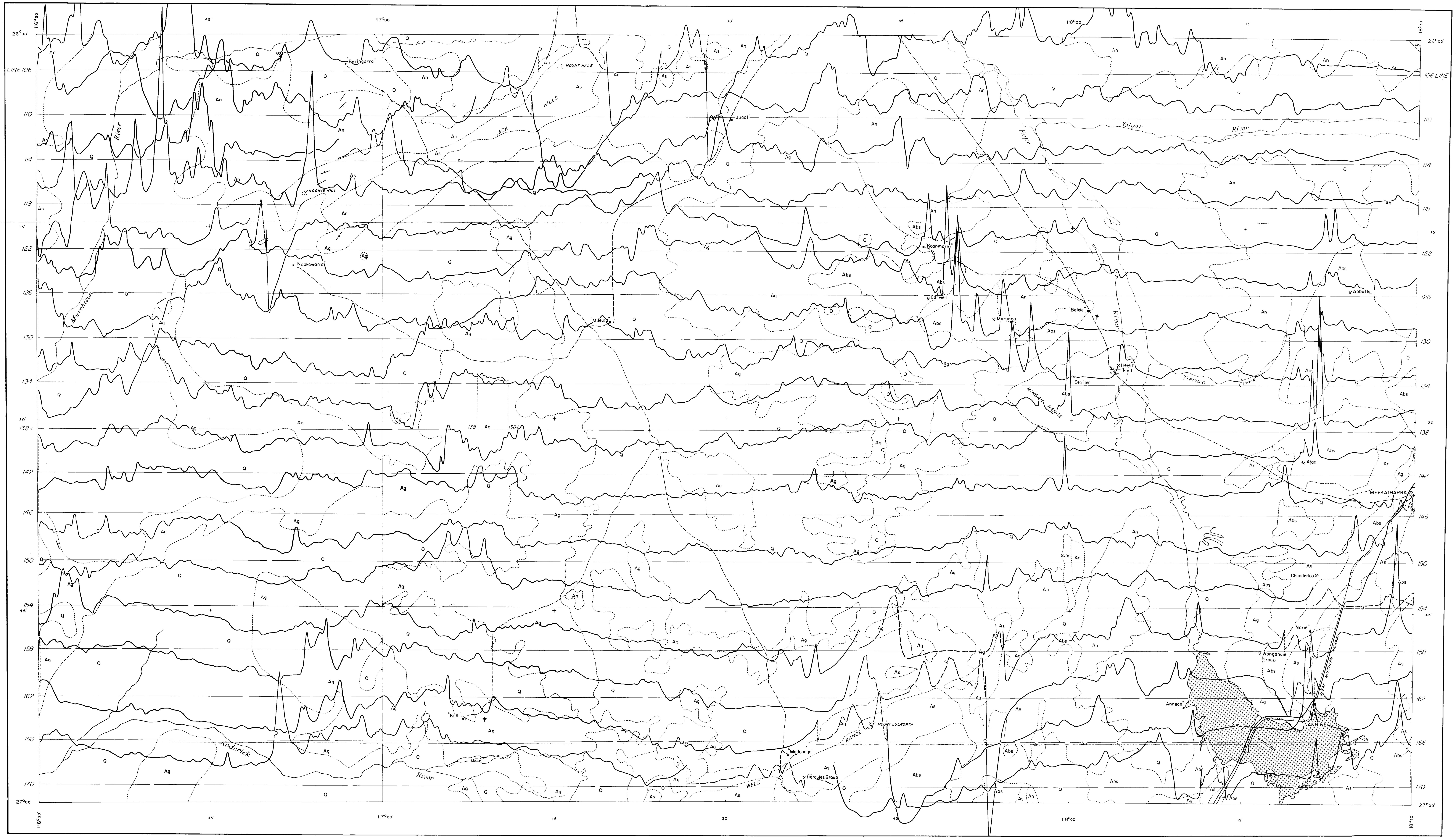
THE SURVEY WAS MADE WITH A DC 3 AIRCRAFT AT AN ALTITUDE OF 600 FEET ABOVE GROUND LEVEL ALONG LINES SPACED ONE MILE APART. THE FLIGHT-LINES ARE IDEALISED AND SERVE AS BASELINES TO THE PROFILES. THEY APPROXIMATE THE ACTUAL FLIGHT PATH WITH A PROBABLE ERROR OF ± 1/5 MILE.

THE PROFILES HAVE BEEN CORRECTED FOR THE SOUTH COMPONENT OF A REGIONAL GRADIENT IN TOTAL MAGNETIC INTENSITY. THIS COMPONENT AMOUNTS TO 8.0 GAMMAS PER MILE.

THE SYMBOL .... INDICATES THAT NO MAGNETIC DATA ARE AVAILABLE.

TO ACCOMPANY RECORD NO. 1971/28 **H50/B1-37-1**

Geophysical Branch, Bureau of Mineral Resources, Geology and Geophysics



GEOLOGICAL LEGEND

TERTIARY, QUATERNARY AND RECENT	Q	*Superficial deposits*
YOUNGER ARCHAEAN	Ag	*Granite*
	An	*Gneiss*
OLDER ARCHAEAN	As	*Sedimentary series*
	Abs	*Greenstone series*

Geological boundary

STRIKE AND DIP OF BEDS

Strike, dip not determinable

83° *Strike, dip measured*

Strike, dip prevailing or unmeasured

Strike, dip vertical

GEOLOGICAL REFERENCE

A	B

A .... After W. Johnson, 1950

B .... After J. Sofoulis and J. A. Mabbutt, 1963

TOPOGRAPHICAL LEGEND

Highway

Road

Track

Mountain or hill

River or creek

Lake

Homestead

Built up area

Named place

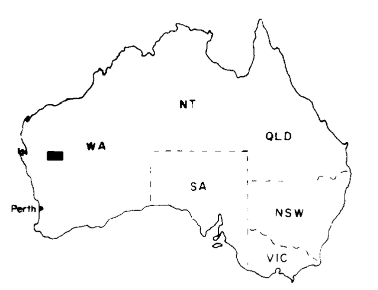
Railway

Mine

Aerodrome or landing ground

(BASED ON G50/B0-27) (BASED ON G50/B0-29) (BASED ON G50/BI-54)

LOCATION DIAGRAM



REFERENCE TO 1:250,000 MAP SERIES

GLENBURGH	ROBINSON RANGE	PEAK HILL
BYRO	**BELELE**	GLENGARRY
MURGOO	CUE	SANDSTONE

AIRBORNE SURVEY, WESTERN AUSTRALIA 1969

TOTAL MAGNETIC INTENSITY PROFILES

AND

GEOLOGY

MILES 5 0 5 10 15 20 MILES

KILOMETRES 5 0 5 10 15 20 25 30 KILOMETRES

APPROX. PROFILE SCALE

FULL-LINE PROFILE: 1000 gammas, 500, 0

BROKEN-LINE PROFILE: 10,000 gammas, 5000, 0

GEOPHYSICAL LEGEND

500 gammas per inch profile

5000 gammas per inch profile

No magnetic data available

EXPLANATORY NOTES

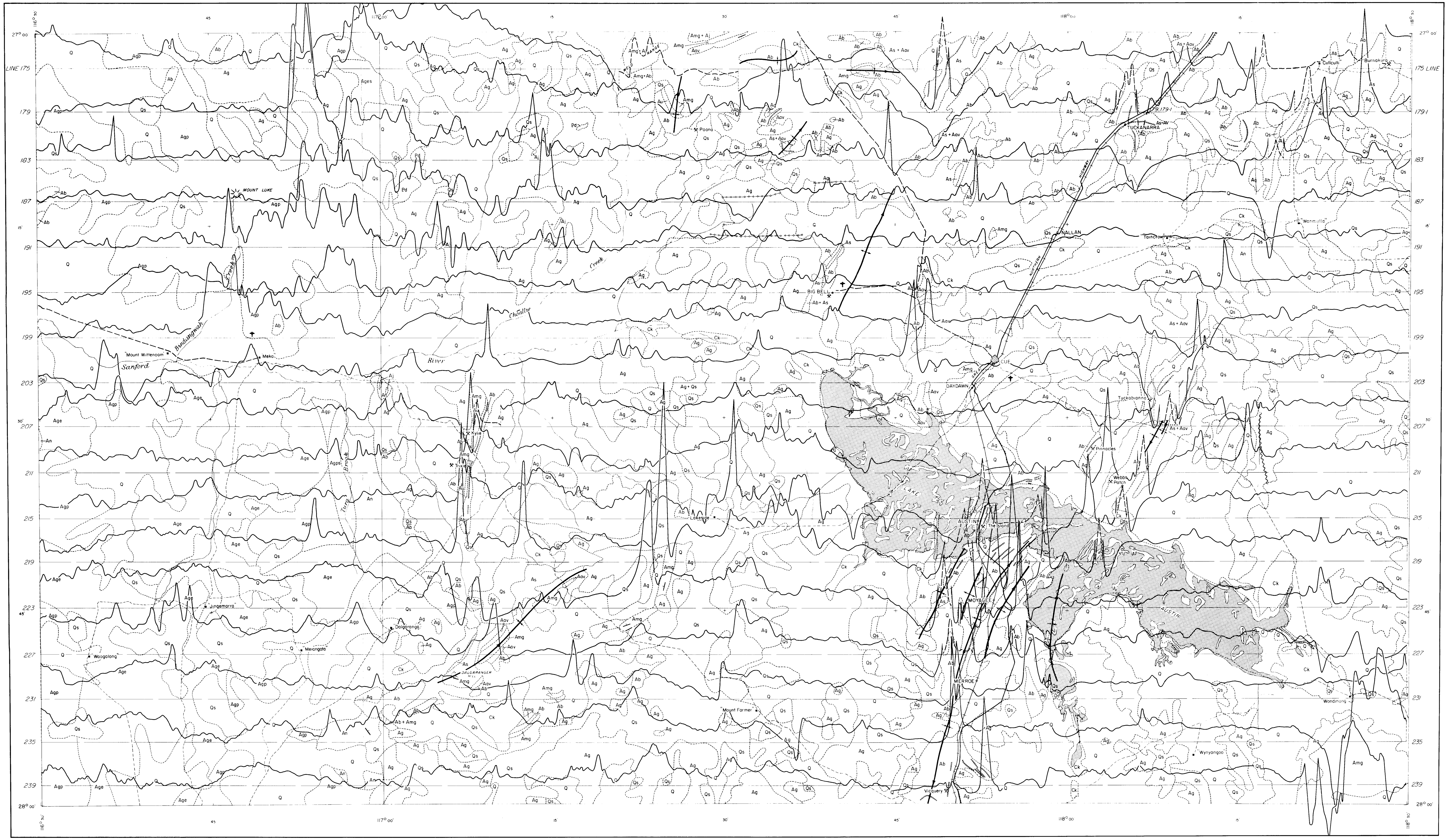
THE SURVEY WAS MADE WITH A DC 3 AIRCRAFT AT AN ALTITUDE OF 600 FEET ABOVE GROUND LEVEL ALONG LINES SPACED ONE MILE APART. THE FLIGHT-LINES ARE IDEALISED AND SERVE AS BASELINES TO THE PROFILES. THEY APPROXIMATE THE ACTUAL FLIGHT PATH WITH A PROBABLE ERROR OF ±1/5 MILE.

THE PROFILES HAVE BEEN CORRECTED FOR THE SOUTH COMPONENT OF A REGIONAL GRADIENT IN TOTAL MAGNETIC INTENSITY. THIS COMPONENT AMOUNTS TO 8·0 GAMMAS PER MILE.

PROFILES RECORDED AT INTERVALS OF FOUR MILES ARE SHOWN ON THE MAP.

Geophysical Branch, Bureau of Mineral Resources, Geology & Geophysics
To accompany record No. 1971/28

G50/BI-64



(BASED ON G50/BO-28) (BASED ON G50/BO-30) (BASED ON G50/BI-55)

GEOLOGICAL LEGEND

RECENT TO SUB-RECENT
- Q — Wash (alluvium, colluvium); Eolian sand bordering Lake Austin
- Qs — Sandplain
- Ck — Calcrete

PERMIAN
- Pd — Dolerite

ARCHAEAN
- Ag — Granite undifferentiated
- An — Gneiss
- Agp — Porphyritic granite
- Agps — Foliated porphyritic granite
- Age — Even grained granite
- Ages — Foliated granite
- Aj — Banded iron formation
- As — Sediments
- Aav — Acid volcanic
- Ab — Basic volcanic
- Amg — Gabbro
- Au — Ultramafic

Geological boundary

Strike, dip prevailing or unmeasured

Anticline axis with plunge direction

Syncline axis

Syncline axis with plunge direction

Geology after 1:250,000 scale preliminary maps of Murgoo and Cue, Geological Surveys, Department of Mines, Western Australia

TOPOGRAPHICAL LEGEND

Highway

Road

Track

Mountain or hill

River or creek

Lake

Homestead

Built-up area

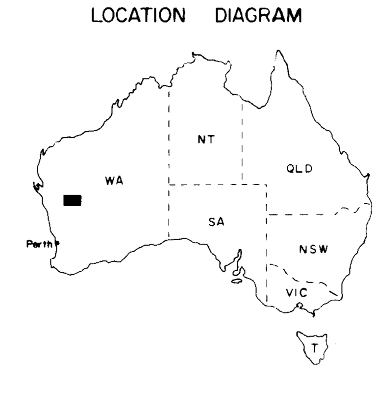
Named place

Railway

Mine

Aerodrome or landing ground

LOCATION DIAGRAM



REFERENCE TO 1:250,000 MAP SERIES

BYRO	BELELE	GLENGARRY
MURGOO	CUE	SANDSTONE
YALGOO	KIRKALOCKA	YOUANMI

AIRBORNE SURVEY, WESTERN AUSTRALIA 1969

TOTAL MAGNETIC INTENSITY PROFILES

AND

GEOLOGY

MILES 5 0 5 10 5 20 MILES

KILOMETRES 5 0 5 10 15 20 25 30 KILOMETRES

APPROX. PROFILE SCALE

FULL-LINE PROFILE — 1000 gammas, 500, 0

BROKEN-LINE PROFILE — 10,000 gammas, 5000, 0

GEOPHYSICAL LEGEND

500 gammas per inch profile

5000 gammas per inch profile

No magnetic data available

EXPLANATORY NOTES

THE SURVEY WAS MADE WITH A DC.3 AIRCRAFT AT AN ALTITUDE OF 600 FEET ABOVE GROUND LEVEL ALONG LINES SPACED ONE MILE APART. THE FLIGHT-LINES ARE IDEALISED AND SERVE AS BASELINES TO THE PROFILES. THEY APPROXIMATE THE ACTUAL FLIGHT PATH WITH A PROBABLE ERROR OF ±1/5 MILE.

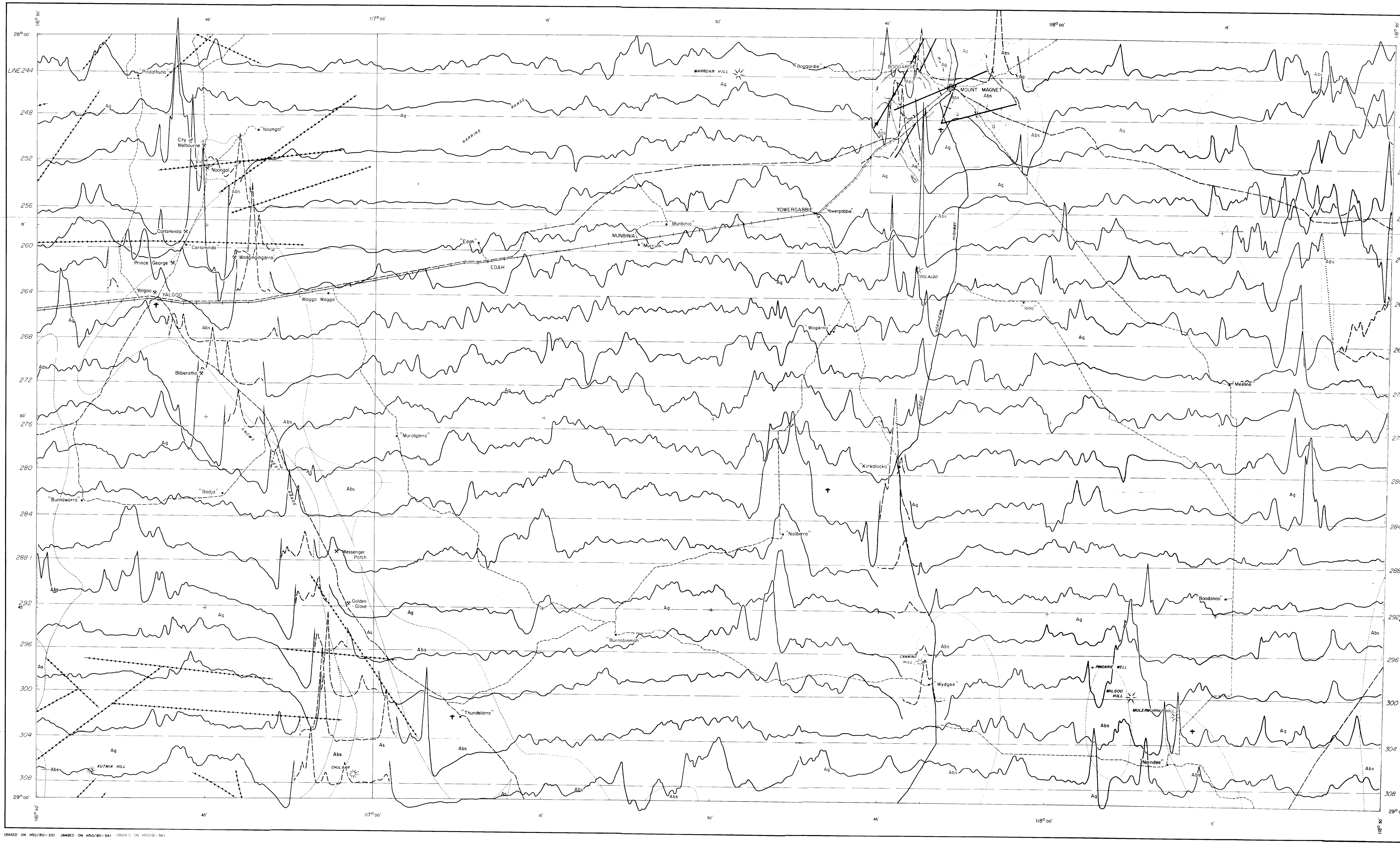
THE PROFILES HAVE BEEN CORRECTED FOR THE SOUTH COMPONENT OF A REGIONAL GRADIENT IN TOTAL MAGNETIC INTENSITY. THIS COMPONENT AMOUNTS TO 8·0 GAMMAS PER MILE.

PROFILES RECORDED AT INTERVALS OF FOUR MILES ARE SHOWN ON THE MAP

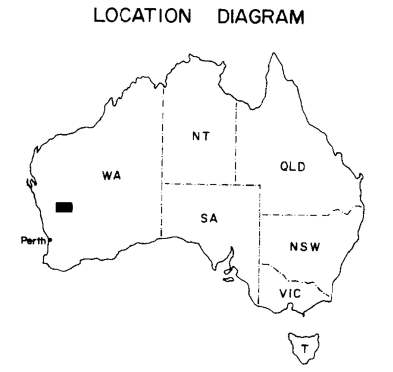
Geophysical Branch, Bureau of Mineral Resources, Geology & Geophysics
To accompany record No. 1971/28

G50/BI-65

PLATE 7



LOCATION DIAGRAM



REFERENCE TO 1:250,000 MAP SERIES

MURGOO	CUE	SANDSTONE
YALGOO	KIRKALOCKA	YOUANMI
PERENJORI	NINGHAN	BARLEE

AIRBORNE SURVEY, WESTERN AUSTRALIA 1969

TOTAL MAGNETIC INTENSITY PROFILES AND GEOLOGY

MILES 5 0 5 10 15 20 MILES

KILOMETRES 5 0 5 10 15 20 25 30 KILOMETRES

APPROX. PROFILE SCALE

FULL-LINE PROFILE — 1000 gammas, 500, 0

BROKEN-LINE PROFILE — 10,000 gammas, 5000, 0

GEOPHYSICAL LEGEND

GEOLOGICAL LEGEND

RECENT TO SUB-RECENT
- Q — *Soil, Alluvium, Laterite*

ARCHAEAN
- Ag — *Granite undifferentiated*
- As — *Sediments*
- Abs — *Greenstone series*
- *Banded iron formation*

PRECAMBRIAN UNDETERMINED
- *Basic dykes and sills*

- *Geological boundary*
- *Fault*
- *Anticlinal axis*
- *Synclinal axis*
- *Synclinal axis with plunge direction*

GEOLOGICAL REFERENCE

A .. After Berliat and de la Hunty, 1954 (modified)

B .. After Geological map of Western Australia 1966

TOPOGRAPHICAL LEGEND

- *Highway*
- *Road*
- *Track*
- *Mountain or hill*
- *Homestead*
- *Built-up area*
- *Named place*
- *Railway*
- *Mine*
- *Aerodrome or landing ground*

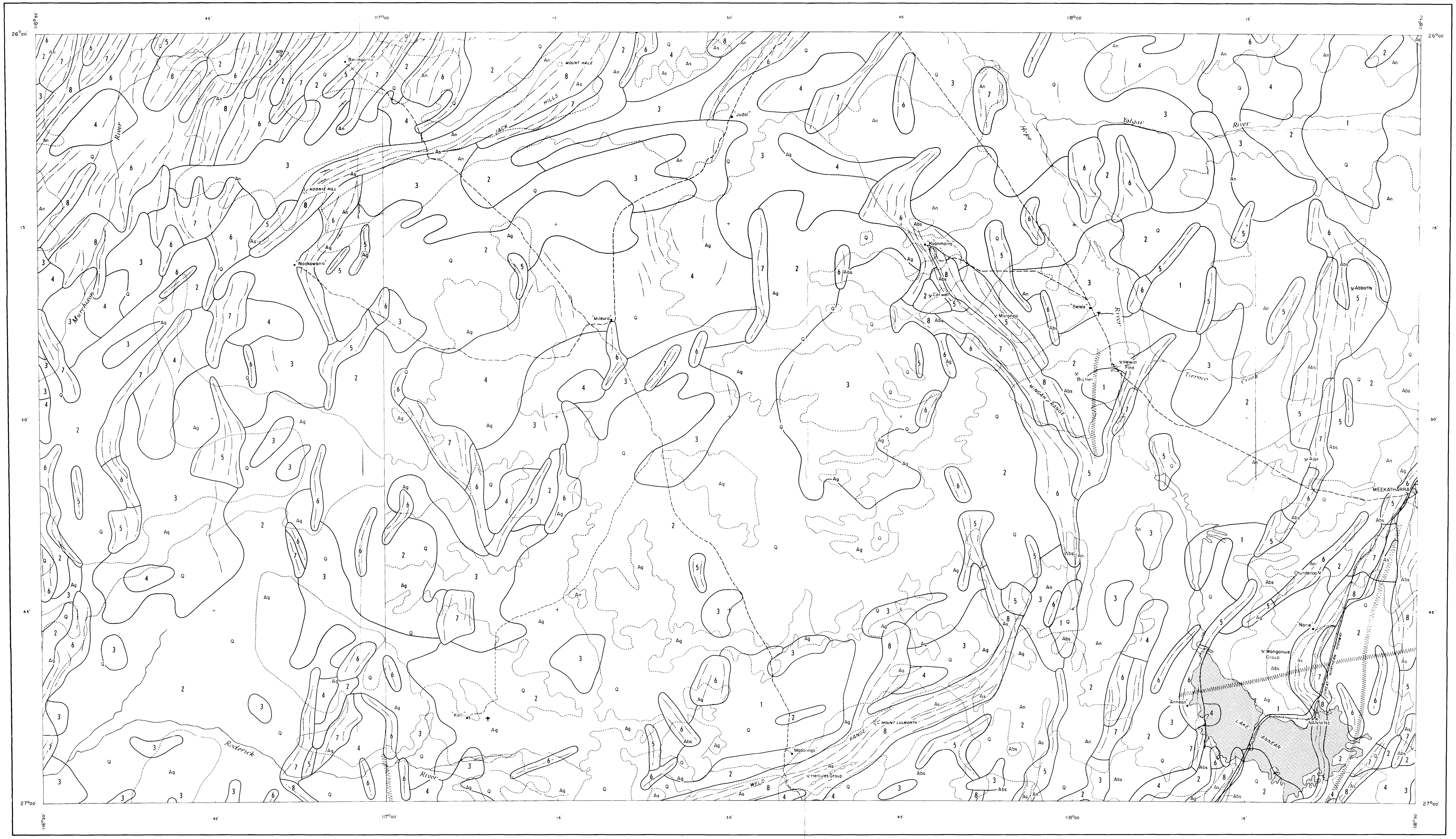
EXPLANATORY NOTES

THE SURVEY WAS MADE WITH A DC3 AIRCRAFT AT AN ALTITUDE OF 600 FEET ABOVE GROUND LEVEL ALONG LINES SPACED ONE MILE APART. THE FLIGHT-LINES ARE IDEALISED AND SERVE AS BASELINES TO THE PROFILES. THEY APPROXIMATE THE ACTUAL FLIGHT PATH WITH A PROBABLE ERROR OF ± 1/5 MILE.

THE PROFILES HAVE BEEN CORRECTED FOR THE SOUTH COMPONENT OF A REGIONAL GRADIENT IN TOTAL MAGNETIC INTENSITY. THIS COMPONENT AMOUNTS TO 8.0 GAMMAS PER MILE.

PROFILES RECORDED AT INTERVALS OF FOUR MILES ARE SHOWN ON THE MAP.

Geophysical Branch, Bureau of Mineral Resources, Geology & Geophysics



(BASED ON G50/BO-27) (BASED ON G50/BO-29) (BASED ON G50/BI-56)

GEOLOGICAL LEGEND

TERTIARY, QUATERNARY AND RECENT	Q	*Superficial deposits*
YOUNGER ARCHAEAN	Ag	*Granite*
	An	*Gneiss*
OLDER ARCHAEAN	As	*Sedimentary series*
	Abs	*Greenstone series*
		Geological boundary

STRIKE AND DIP OF BEDS

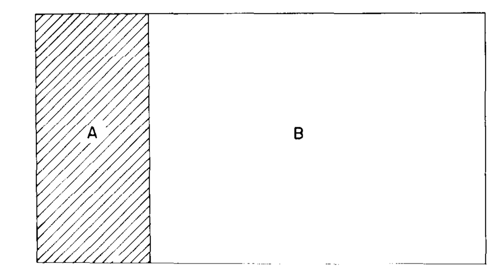
Strike, dip not determinable

83° *Strike, dip measured*

Strike, dip prevailing or unmeasured

Strike, dip vertical

GEOLOGICAL REFERENCE



A.......After W. Johnson, 1950

B.......After J. Sofoulis and J. A. Mabbutt, 1963

TOPOGRAPHICAL LEGEND

Highway

Road

Track

Mountain or hill

River or creek

Lake

Homestead

Built up area

Named place

Railway

Mine

Aerodrome or landing ground

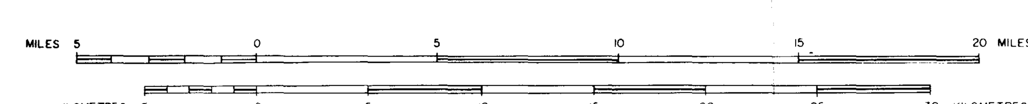
LOCATION DIAGRAM

REFERENCE TO 1:250,000 MAP SERIES

GLENBURGH	ROBINSON RANGE	PEAK HILL
BYRO	BELELE	GLENGARRY
MURGOO	CUE	SANDSTONE

AIRBORNE SURVEY, WESTERN AUSTRALIA 1969

MAGNETIC INTERPRETATION AND GEOLOGY



GEOPHYSICAL LEGEND

Positive magnetic trend

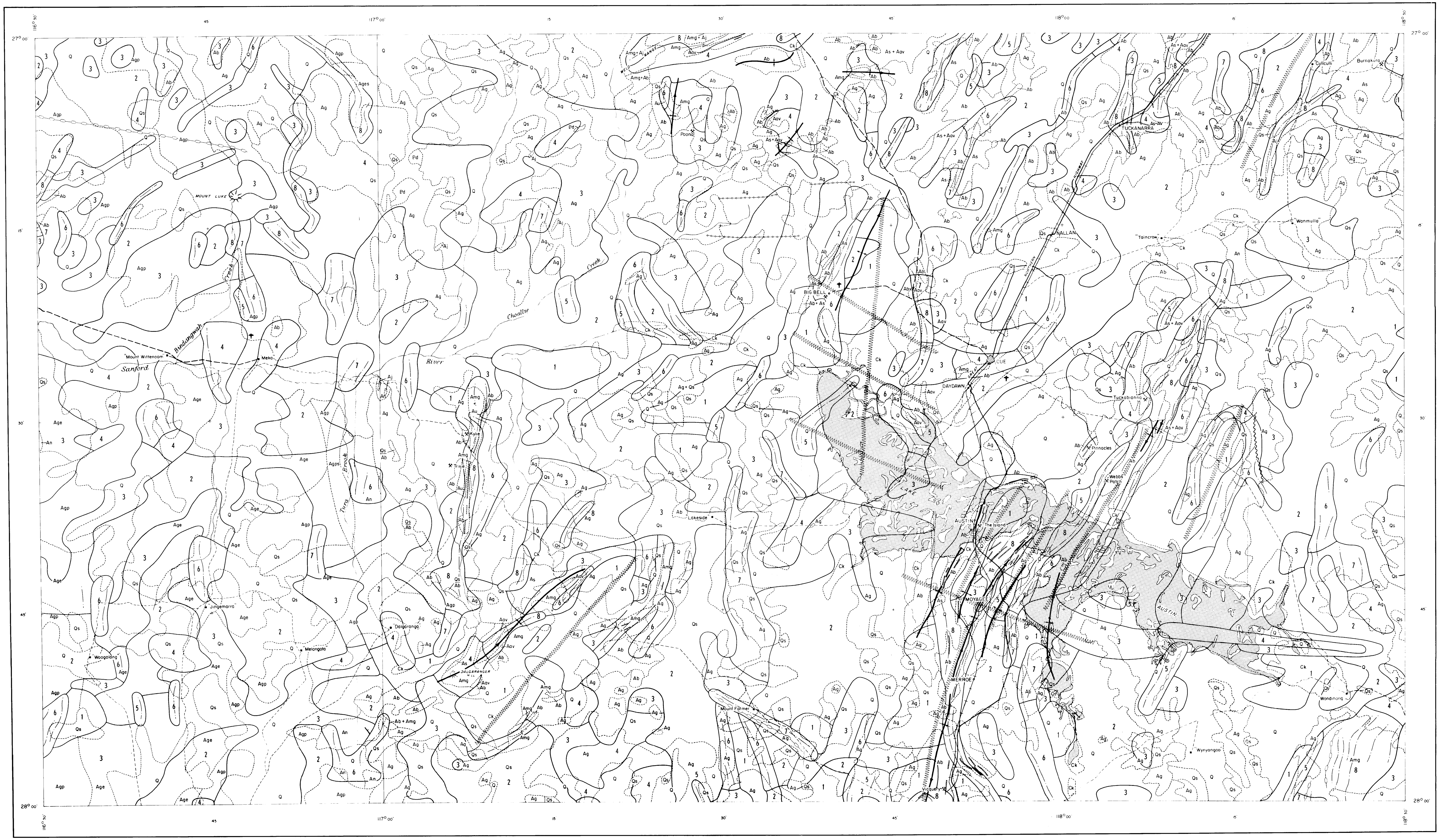
Negative magnetic trend

7 *Magnetic zone*

Fold axis

Geophysical Branch, Bureau of Mineral Resources, Geology & Geophysics
To accompany record No. 1971/28

G50/BI-60



(BASED ON G50/BO-28) (BASED ON G50/BO-30) (BASED ON G50/BI-56)

GEOLOGICAL LEGEND

RECENT TO SUB-RECENT	Q	Wash (alluvium, colluvium) Eolian sand bordering Lake Austin
	Qs	Sandplain
	Ck	Calcrete
PERMIAN	Pd	Dolerite
ARCHAEAN	Ag	Granite undifferentiated
	An	Gneiss
	Agp	Porphyritic granite
	Agps	Foliated porphyritic granite
	Age	Even grained granite
	Ages	Foliated granite
	Aj	Banded iron formation
	As	Sediments
	Aav	Acid volcanic
	Ab	Basic volcanic
	Amg	Gabbro
	Au	Ultramafic

Geological boundary

Strike, dip prevailing or unmeasured

Anticline axis with plunge direction

Syncline axis

Syncline axis with plunge direction

Geology after 1:250,000 scale preliminary maps of Murgoo and Cue, Geological Surveys, Department of Mines, Western Australia

TOPOGRAPHICAL LEGEND

Highway

Road

Track

Mountain or hill

River or creek

Lake

Homestead

Built up area

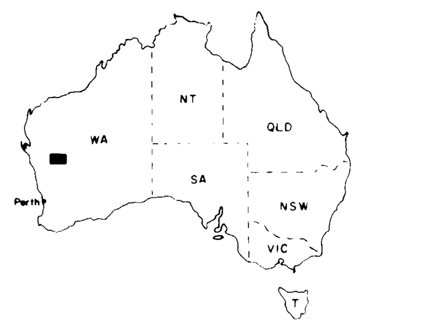
Named place

Railway

Mine

Aerodrome or landing ground

LOCATION DIAGRAM



REFERENCE TO 1:250,000 MAP SERIES

BYRO	BELELE	GLENGARRY
MURGOO	CUE	SANDSTONE
YALGOO	KIRKALOCKA	YOUANMI

AIRBORNE SURVEY, WESTERN AUSTRALIA 1969

MAGNETIC INTERPRETATION AND GEOLOGY

MILES 5 0 5 10 15 20 MILES

KILOMETRES 5 0 5 10 15 20 25 30 KILOMETRES

GEOPHYSICAL LEGEND

Positive magnetic trend

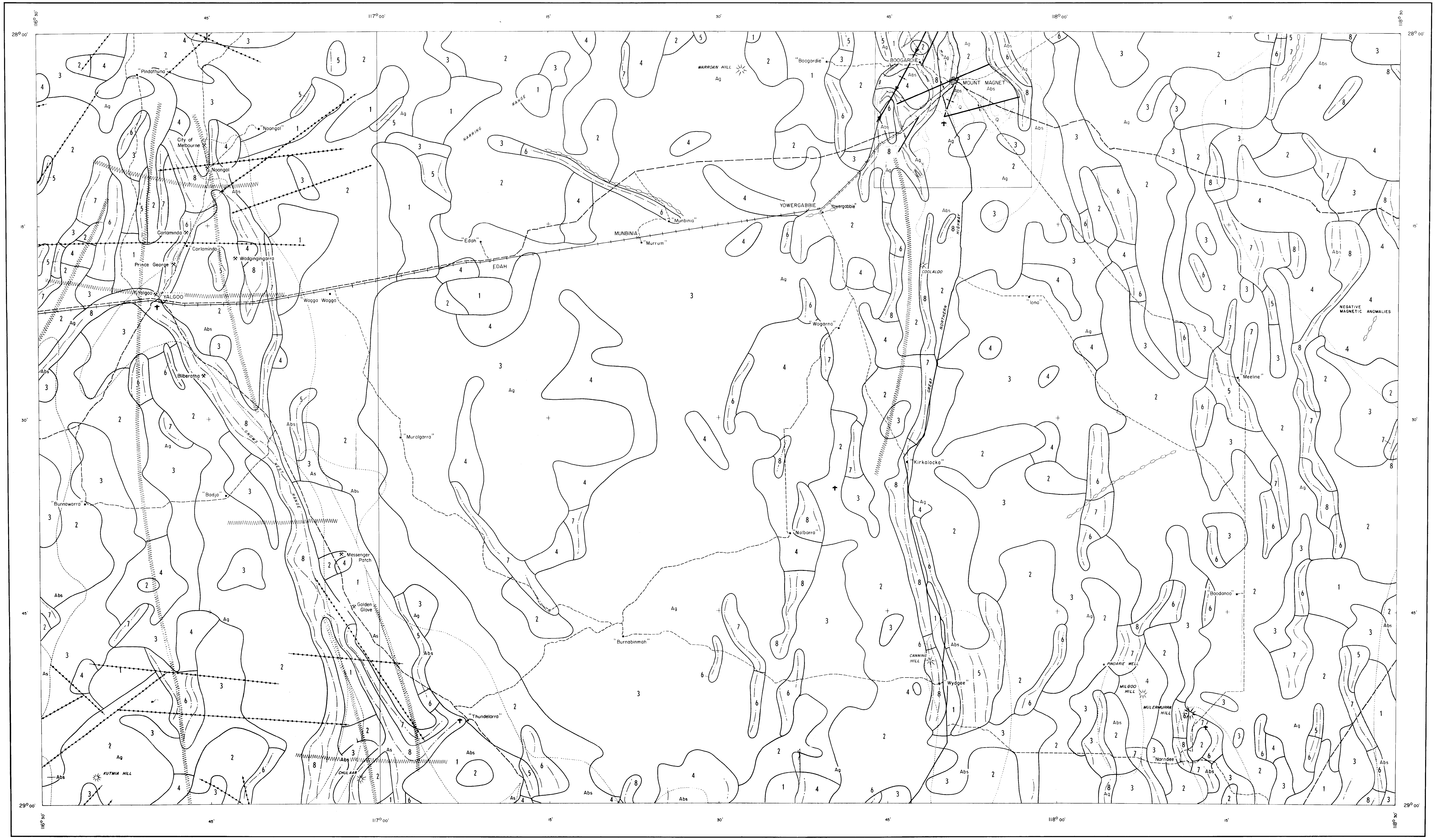
Negative magnetic trend

5 Magnetic zone

Fold axis

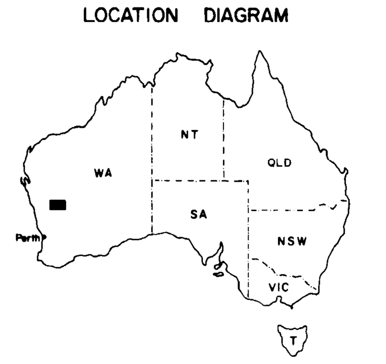
Geophysical Branch, Bureau of Mineral Resources, Geology & Geophysics
To accompany record No. 1971/28

G50/BI-61



(BASED ON H50/BO-33) (BASED ON H50/BO-34) (BASED ON H50/BI-39)

LOCATION DIAGRAM



REFERENCE TO 1:250,000 MAP SERIES

MURGOO	CUE	SANDSTONE
YALGOO	KIRKALOCKA	YOUANMI
PERENJORI	NINGHAN	BARLEE

AIRBORNE SURVEY, WESTERN AUSTRALIA 1969

MAGNETIC INTERPRETATION AND GEOLOGY

MILES 5 0 5 10 15 20 MILES

KILOMETRES 5 0 5 10 15 20 25 30 KILOMETRES

GEOLOGICAL LEGEND

- RECENT TO SUB-RECENT — Q — *Soil, Alluvium, Laterite*
- ARCHAEAN
  - Ag — *Granite undifferentiated*
  - As — *Sediments*
  - Abs — *Greenstone series*
  - *Banded iron formation*
- PRECAMBRIAN UNDETERMINED — *Basic dykes and sills*
- *Geological boundary*
- *Fault*
- *Anticlinal axis*
- *Synclinal axis*
- *Synclinal axis with plunge direction*

GEOLOGICAL REFERENCE

A
B

A .. After Berliat and de la Hunty, 1954 (modified)

B .. After Geological map of Western Australia 1966

TOPOGRAPHICAL LEGEND

- *Highway*
- *Road*
- *Track*
- *Mountain or hill*
- *Homestead*
- *Built-up area*
- *Named place*
- *Railway*
- *Mine*
- *Aerodrome or landing ground*

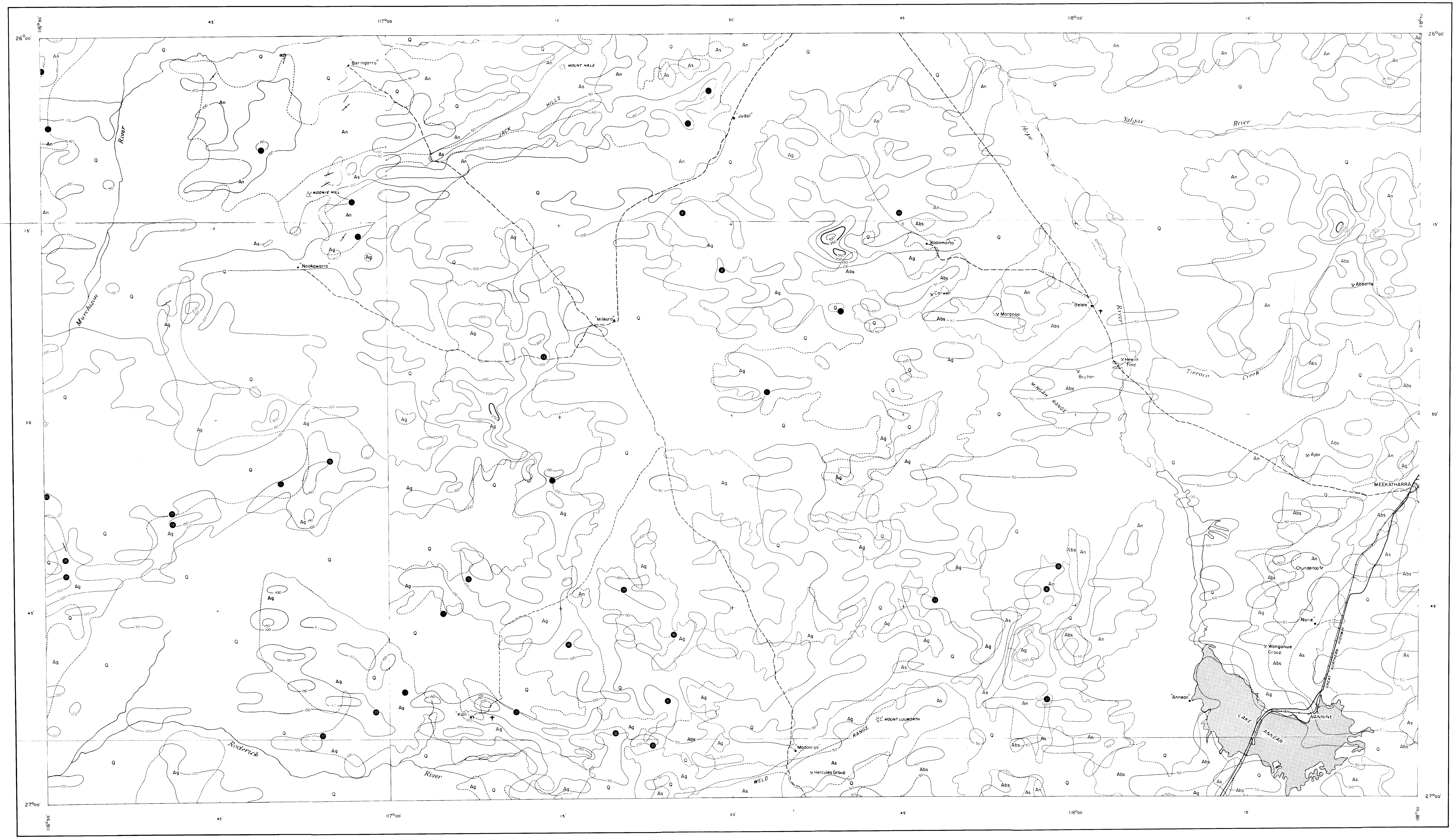
GEOPHYSICAL LEGEND

- *Positive magnetic trend*
- *Negative magnetic trend*
- 4 *Magnetic zone*
- *Fold axis*

Geophysical Branch, Bureau of Mineral Resources, Geology & Geophysics
To accompany record No. 1971/28

H50/BI-42

PLATE II



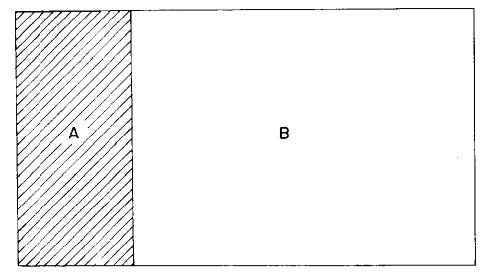
GEOLOGICAL LEGEND

- TERTIARY, QUATERNARY AND RECENT
  - Q — *Superficial deposits*
- YOUNGER ARCHAEAN
  - Ag — *Granite*
  - An — *Gneiss*
- OLDER ARCHAEAN
  - As — *Sedimentary series*
  - Abs — *Greenstone series*
- *Geological boundary*

STRIKE AND DIP OF BEDS

- *Strike, dip not determinable*
- 83° *Strike, dip measured*
- *Strike, dip prevailing or unmeasured*
- *Strike, dip vertical*

GEOLOGICAL REFERENCE



A .... After W. Johnson, 1950

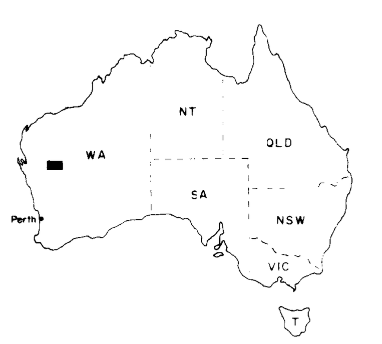
B .... After J. Sofoulis and J. A. Mabbutt, 1963

TOPOGRAPHICAL LEGEND

- *Highway*
- *Road*
- *Track*
- *Mountain or hill*
- *River or creek*
- *Lake*
- *Homestead*
- *Built up area*
- *Named place*
- *Railway*
- *Mine*
- *Aerodrome or landing ground*

(BASED ON G50/BO-27) (BASED ON G50/BO-29) (BASED ON G50/BI-58)

LOCATION DIAGRAM

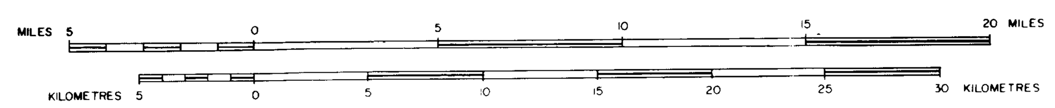


REFERENCE TO 1:250,000 MAP SERIES

GLENBURGH	ROBINSON RANGE	PEAK HILL
BYRO	BELELE	GLENGARRY
MURGOO	CUE	SANDSTONE

AIRBORNE SURVEY, WESTERN AUSTRALIA 1969

RADIOMETRIC RESULTS AND GEOLOGY

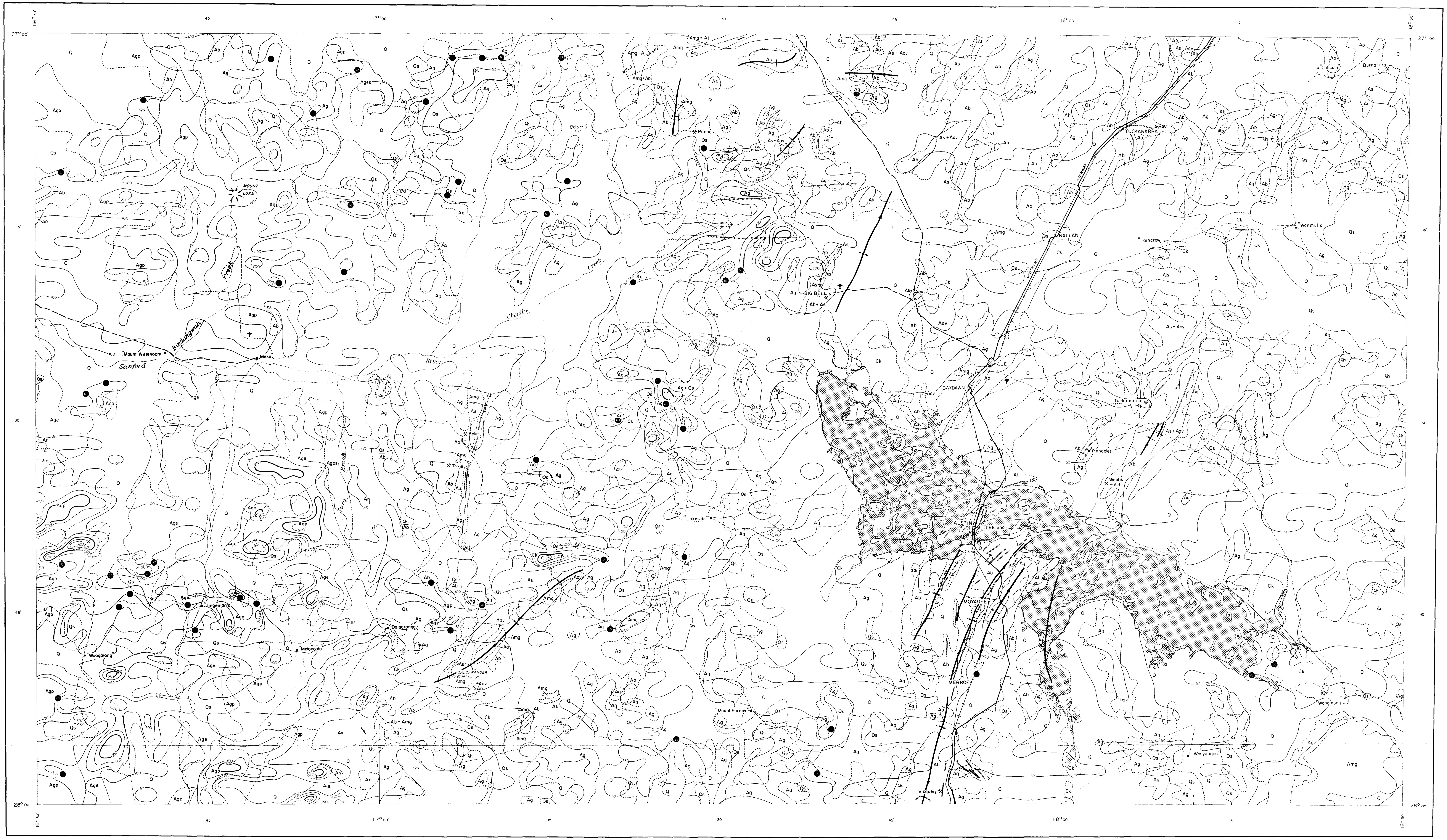


GEOPHYSICAL LEGEND

- 200 / 250 — *Radiometric contours, counts per second*
- 16 — *Radiometric anomaly, restricted source (Anomalies are numbered for reference only)*

Geophysical Branch, Bureau of Mineral Resources, Geology & Geophysics
To accompany record No. 1971/28

G50/BI-62



(BASED ON G50/B0-28) (BASED ON G50/B0-30) (BASED ON G50/B1-59)

GEOLOGICAL LEGEND

RECENT TO SUB-RECENT
- Q — Wash (alluvium, colluvium); Eolian sand bordering Lake Austin
- Qs — Sandplain
- Ck — Calcrete

PERMIAN
- Pd — Dolerite

ARCHAEAN
- Ag — Granite undifferentiated
- An — Gneiss
- Agp — Porphyritic granite
- Agps — Foliated porphyritic granite
- Age — Even grained granite
- Ages — Foliated granite
- Aj — Banded iron formation
- As — Sediments
- Aav — Acid volcanic
- Ab — Basic volcanic
- Gabbro
- Amg
- Au — Ultramafic

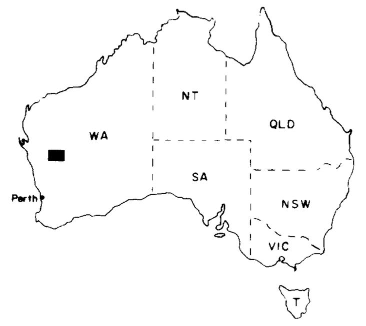
Geological boundary
Strike, dip prevailing or unmeasured
Anticline axis with plunge direction
Syncline axis
Syncline axis with plunge direction

Geology after 1:250,000 scale preliminary maps of Murgoo and Cue, Geological Surveys, Department of Mines, Western Australia

TOPOGRAPHICAL LEGEND

- Highway
- Road
- Track
- Mountain or hill
- River or creek
- Lake
- Homestead
- Built-up area
- Named place
- Railway
- Mine
- Aerodrome or landing ground

LOCATION DIAGRAM



REFERENCE TO 1:250,000 MAP SERIES

BYRO	BELELE	GLENGARRY
MURGOO	CUE	SANDSTONE
YALGOO	KIRKALOCKA	YOUANMI

AIRBORNE SURVEY, WESTERN AUSTRALIA 1969

RADIOMETRIC RESULTS AND GEOLOGY

MILES 5 0 5 10 15 20 MILES
KILOMETRES 5 0 5 10 15 20 25 30 KILOMETRES

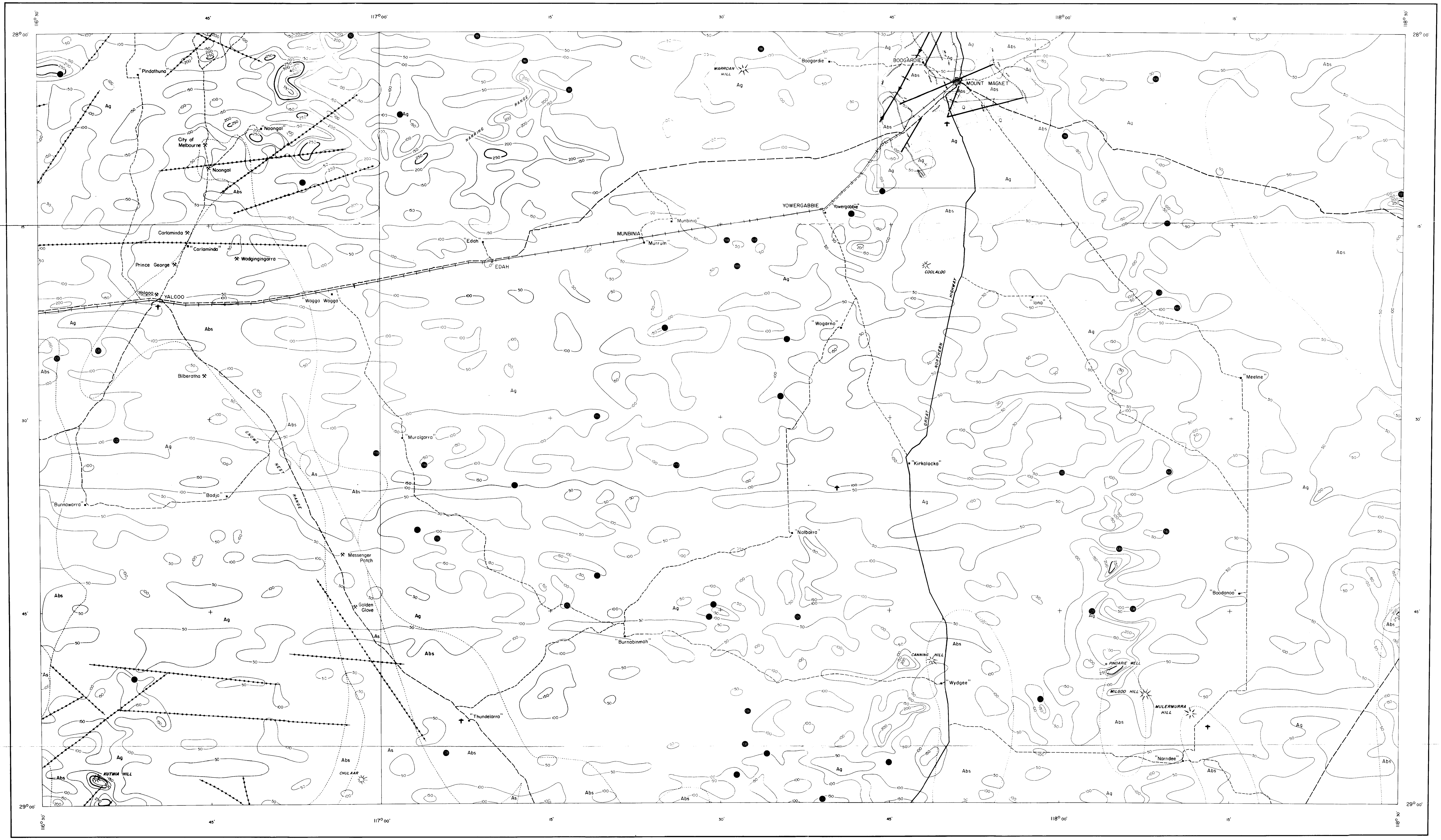
GEOPHYSICAL LEGEND

Radiometric contours, counts per second

Radiometric anomaly, restricted source (Anomalies are numbered for reference only)

Geophysical Branch, Bureau of Mineral Resources, Geology & Geophysics
To accompany record No. 1971/28

G50/B1-63

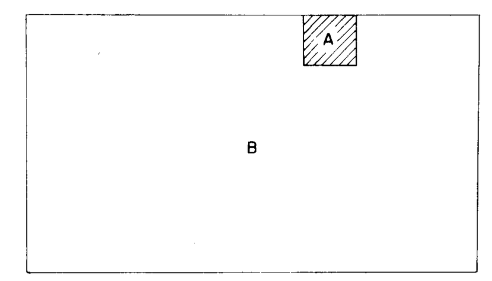


(BASED ON H50/B0-33) (BASED ON H50/B0-34) (BASED ON H50/BI-40)

GEOLOGICAL LEGEND

RECENT TO SUB-RECENT	Q	*Soil, Alluvium, Laterite*
ARCHAEAN	Ag	*Granite undifferentiated*
	As	*Sediments*
	Abs	*Greenstone series*
		Banded iron formation
PRECAMBRIAN UNDETERMINED		*Basic dykes and sills*
		Geological boundary
		Fault
		Anticlinal axis
		Synclinal axis
		Synclinal axis with plunge direction

GEOLOGICAL REFERENCE

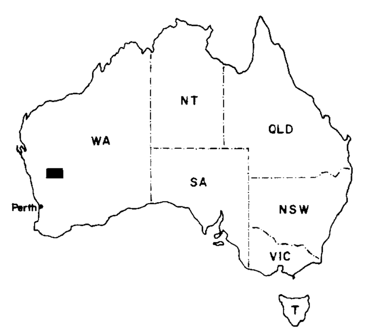


A After Berliat and de la Hunty, 1954 (modified)
B After Geological map of Western Australia 1966

TOPOGRAPHICAL LEGEND

Highway
Road
Track
Mountain or hill
Homestead
Built-up area
Named place
Railway
Mine
Aerodrome or landing ground

LOCATION DIAGRAM



REFERENCE TO 1:250,000 MAP SERIES

MURGOO	CUE	SANDSTONE
YALGOO	KIRKALOCKA	YOUANMI
PERENJORI	NINGHAN	BARLEE

AIRBORNE SURVEY, WESTERN AUSTRALIA 1969

RADIOMETRIC RESULTS AND GEOLOGY

MILES 5 0 5 10 15 20 MILES

KILOMETRES 5 0 5 10 15 20 25 30 KILOMETRES

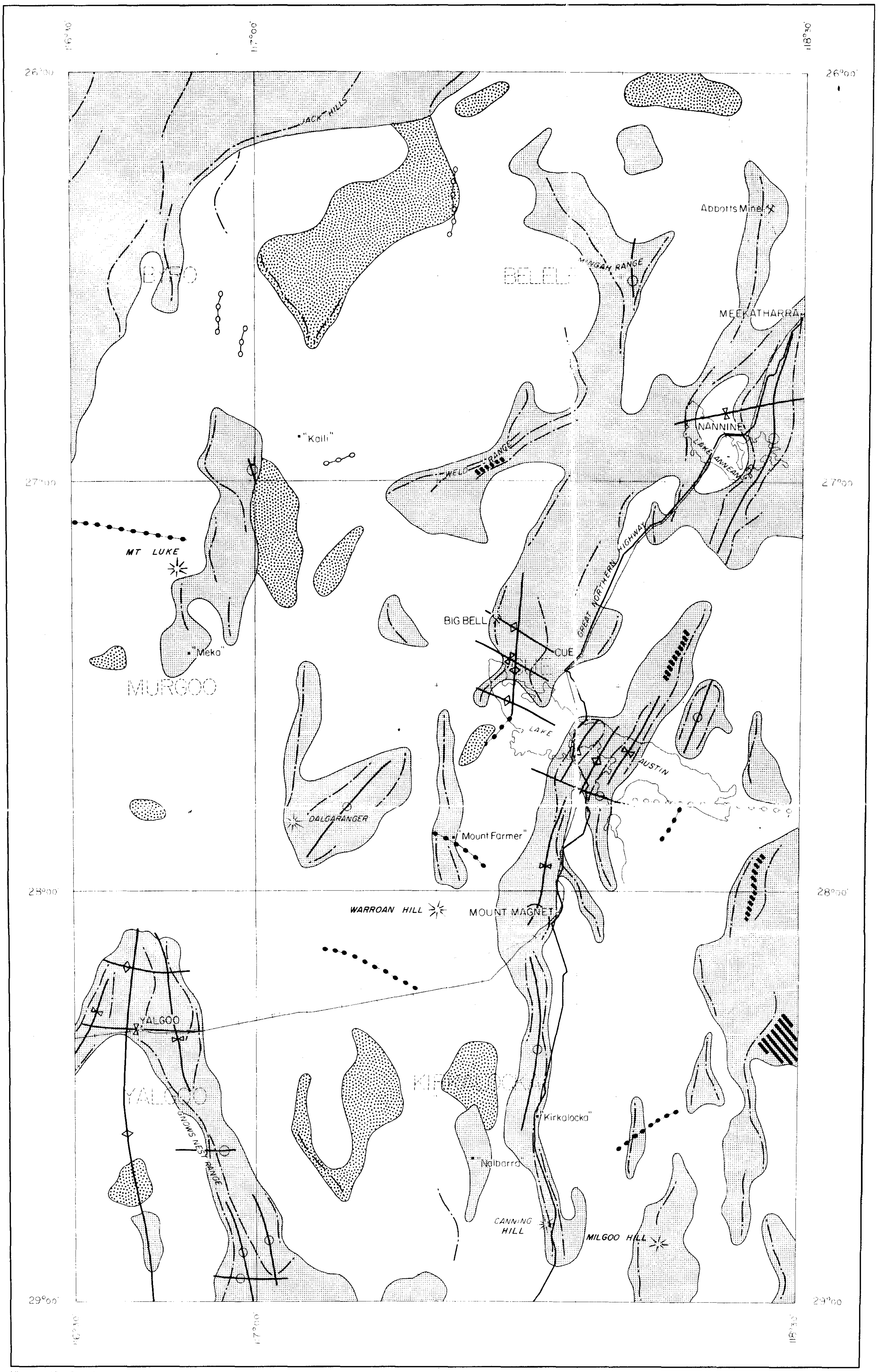
GEOPHYSICAL LEGEND

Radiometric contours, counts per second

Radiometric anomaly, restricted source (Anomalies are numbered for reference only)

Geophysical Branch, Bureau of Mineral Resources, Geology & Geophysics
To accompany record No. 1971/28

H50/BI-43



GEOPHYSICAL LEGEND

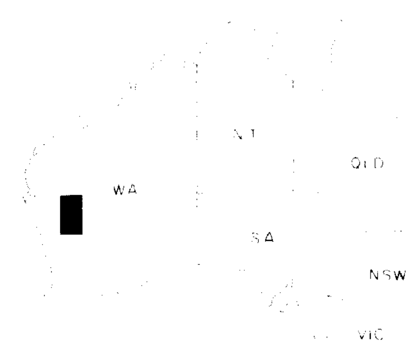
- Magnetic trend
- Fold axis
- Syncline, probable
- Anticline, probable
- Major basic intrusions
- Greenstone
- Dyke, remanent magnetisation
- Dyke, induced magnetisation
- Area of remagnetisation

TOPOGRAPHICAL LEGEND

- Highway
- Road or track
- Mountain or hill
- River or creek
- Lake
- Homestead
- Town
- Railway
- Mine

Based on G50/B0-30
Based on G50/B1-66

LOCALITY DIAGRAM



AIRBORNE SURVEY, WESTERN AUSTRALIA 1969

INTERPRETED REGIONAL GEOLOGY

MILES 10 0 10 20 30 40 50 60 70 MILES

KILOMETRES 10 0 10 20 30 40 50 60 70 80 90 100 110 KILOMETRES

REFERENCE TO 1:250,000 MAP SERIES

BYRO	BELELE	GLENGARRY
MURGOO	CUE	SANDSTONE
YALGOO	KIRKALOCKA	YOUANMI

TO ACCOMPANY RECORD NO 1971/28 G50/B1-67

Geophysical Branch, Bureau of Mineral Resources, Geology & Geophysics