Copy 3

1972/120

3

DEPARTMENT OF
MINERALS AND ENERGY

BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS

503355

BUREAU OF MINERAL RESOURCES LIBRARY Copy 3 CANBERRA, A.C.T.

Record 1972/120

AEROMAGNETIC SURVEY OF THE GLENGARRY, WILUNA AND KINGSTON 1:250 000 SHEET AREAS, W.A. 1970

by

S.S. Lambourn

The information contained in this report has been obtained by the Department of Minerals and Energy
-- part of the policy of the Commonwealth Government to assist in the exploration and development of
.eral resources. It may not be published in any form or used in a company prospectus or statement
 hout the permission in writing of the Director, Bureau of Mineral Resources, Geology and Geophysics.

BMR
Record
1972/120
c.3

1972/120

AEROMAGNETIC SURVEY OF THE GLENGARRY, WILUNA AND KINGSTON 1:250 000 SHEET AREAS, W.A. 1970

by

S.S. LAMBOURN

CONTENTS

PLATES

SUMMARY

An airborne magnetic survey of the GLENGARRY, WILUNA, and KINGSTON 1:250 000 map areas was flown by Geophysical Resources Development Company in 1970 under contract to the Bureau of Mineral Resources. The objectives of the survey were to assist in the systematic regional mapping of the Western Australian Precambrian Shield and in the search for minerals.

Interpretation of the magnetic data is primarily qualitative. Geological strikes and the boundaries of major rock units have been interpreted by delineating magnetic trends, by subdividing the area into zones of specified magnetic character, and by 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 'whitestones' and 'greenstones', the correlation between the magnetic data and geology is generally good. An additional region of 'greenstone' and/or 'whitestone' rocks has been interpreted in the southeast of the KINGSTON area.

Four cross-fold axes have been delineated, one of which has several mines located along it. All four are recommended for further investigation.

1. INTRODUCTION

In 1956, the Bureau of Mineral Resources (BMR) commenced an extensive program of airborne magnetic and radiometric surveys in the goldfields region of Western Australia at the request of the Western Australian Department of Mines. The prime objective of this work was to delineate the boundaries of major rock units, and to determine geological structure. By the end of 1969, twenty 1:250 000 map areas and parts of another three had been surveyed within this region.

This program was continued during October 1970 by the Geophysical Resources Development Company (G.R.D.) under contract to BMR. G.R.D. carried out an airborne magnetic survey of the GLENGARRY, WILUNA and KINGSTON 1:250 000 areas.*

The survey area, bounded by latitudes 26°00' and 27°00'S and longitudes 118°30' and 123°00'E, constitutes a small part of the Archaean Yilgarn Block and the Bangemall Basin which are subdivisions of the Western Australian Precambrian Shield (Plate 1). The Bangemall Basin consists of a series of gently dipping Proterozoic sediments and volcanics, whereas the Yilgarn Block consists essentially of a vast mass of granite and gneiss intruding older lenticular remnants of metamorphic rocks folded about northerly axes. The folding was accompanied by the intrusion of the granite. Mineralization, of which gold has been the most extensively worked, is usually associated with the older folded rocks.

The objectives of this survey were to aid a program of systematic regional geological mapping of the shield and to assist in the search for minerals. Regional mapping by the Geological Survey of Western Australia has been mainly directed towards the determination of the basic structure and mineralization. Recent investigations by mining companies have been focused on a search for nickel deposits which may be associated with magnetically detectable ultrabasic rocks.

The co-operation of the Geological Survey of Western Australia is gratefully acknowledged.

2. REVIEW OF PREVIOUS GEOPHYSICAL INVESTIGATIONS

Geophysical investigations within the survey area have been conducted by mining companies in the search for base metals and gold, but the results are not generally available. During December 1971 BMR conducted a helicopter gravity survey of a large part of the goldfields region, including the GLENGARRY, WILUNA, and KINGSTON areas, and the data are currently being reduced.

---

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

Since Miles (1953) first advocated the use of the airborne magnetometer to determine aspects of geological structure by delineating banded iron formations (jaspilites), BMR has magnetically surveyed an extensive area to the south and west of the GLENGARRY, WILUNA, and KINGSTON areas. Results of these previous airborne magnetic and radiometric surveys are contained in the BMR Records of Spence (1958), Carter (1959), Mulder (1960), Forsyth (1961), Wells (1962), Young & Tipper (1966), Shelley & Waller (1967), Gerdes, Young, Beattie & Cameron (1970), Tipper & Gerdes (1971), and Waller & Beattie (1971). It was determined from a study of the earlier surveys (J.H. Quilty, pers. comm.) that significant geological structure could be outlined from contour maps of total magnetic intensity, the interbedded magnetite-rich rock units being traced as marker beds. A number of major folds and cross-folds were interpreted by Quilty from the arcuate form of the magnetic trends. This interpretation was based on the conclusions of Ellis (1939) who had shown that 'hour-glass' patterns of anticlines and synclines in the jaspilite outcrop in the SOUTHERN CROSS area could be produced by strong folding followed by weaker cross-folding.

Quilty (pers. comm.) also found that many cross-fold axes were outlined by a series of easterly trending anomalies, some of which extend over several hundred kilometres. Two types of cross-trending anomalies were recognized: intense negative anomalies attributed to remanently magnetized near-vertical sheets, and positive anomalies attributed to vertical sheets magnetized in a direction close to that of the Earth's present field. These sheets were interpreted as representing two or more suites of basic intrusives, which possibly occupy tension fissures.

Anomalies caused by interbedded formations were stated by Quilty to be of a form consistent with induced magnetization. This assumption led to the calculation of susceptibility values mainly in the range 0.01 to 0.05 c.g.s. with a few as high as 0.2 c.g.s. Dip angles of the interbedded formations were found to be in the range 80° to 90° in all cases.

The magnetic data from the MENZIES and LEONORA areas (Young & Tipper, 1966), and those obtained for all areas subsequently surveyed in the Eastern Goldfields region, have been interpreted by resolving and analysing magnetic trends and by subdividing the area into zones of specified magnetic character in order to delineate some aspects of regional geological structure (Young, 1971). This approach reduces the inherent subjectivity of magnetic interpretation, and is especially useful in geologically uniform terrains.

Numerous fold axes, cross-fold axes, and dykes, some of which are thought to be remanently magnetized, have been interpreted in the various survey areas, and the degree of continuity from one area to another is marked. North-south trending anomalies of the order of 1000 gammas and calculated to represent susceptibility contrasts in the range 0.002 to 0.003 c.g.s. have been attributed by the BMR authors to ultrabasic serpentinite bodies. Anomalies of larger amplitude, approaching the order of 10,000 gammas, and representing susceptibility values between 0.025 and 0.40 c.g.s. have been attributed to jaspilite. Areas showing a relatively flat magnetic field have been ascribed to near-homogeneous acidic igneous rocks or to non-magnetic sedimentary sequences.

In several areas, ultrabasic intrusions of strong magnetic character are thought to be of economic significance and have been recommended for ground investigation.

3. GEOLOGY

INTRODUCTION

The GLENGARRY, WILUNA, and KINGSTON 1:250 000 areas form part of the Archaean Yilgarn Block and the Bangemall Basin, which are subdivisions of the Western Australian Precambrian Shield. These three areas include parts of the Murchison, East Murchison, and Mount Margaret goldfields.

The following summary of the geology for the three areas is based largely on the work of Sofoulis & Mabbutt (1963), Daniels & Horwitz (1969), and Sanders & Harley (1971).

Most of the area is underlain by a series of Archaean granites and gneisses intruding older metasedimentary and metavolcanic rocks. These older partly metamorphosed rocks appear as a number of narrow, steeply dipping, remnant belts with northerly trends, and are generally referred to as 'greenstones' (predominantly metavolcanic) and 'whitestones' (predominantly metasedimentary). Small units of a younger metasedimentary rock referred to as the 'Mosquito Creek Series' occur in the northwest of GLENGARRY. (This name will be used in this Record despite the doubtfulness of correlation between the Yilgarn Block and the Pilbara Block, where the type 'Mosquito Creek Series' occurs).

Proterozoic volcanic and sedimentary rocks, correlated with the 'Nullagine System' of the Pilbara-Murchison area, occur in GLENGARRY and KINGSTON (Sofoulis & Mabbutt, 1963).

The southern part of KINGSTON contains small amounts of grit and tillite, regarded as Permian in age by Sofoulis & Mabbutt (1963), and as Cretaceous by Talbot (1920, 1926). These units are scattered and superficial, less than 25 m thick, and for the purposes of this magnetic interpretation are undifferentiated from the more widespread Cainozoic alluvial deposits which cover over 50 percent of the total area.

ARCHAEAN BASEMENT

Metamorphic belts

The metamorphic belts form the whitestone and greenstone ranges, which have a maximum width of about 25 km in the south of the area, tapering and becoming discontinuous northwards. The greenstones are regarded as the older phase. Separation of the two phases is not complete everywhere, and thin bands of one phase may be included in the other.

Greenstone Phase. The greenstone assemblages are metamorphic derivatives of volcanic piles, and consist predominantly of metamorphosed basic amphibolitic lava, tuff, and agglomerate, with minor intercalations of metasedimentary lenses, ultrabasic schist, and acid volcanic rock.

Kaolinization and ferruginization of the greenstones was widespread during the Tertiary phase of deep weathering.

Whitestone Phase. The metasediments are largely made up of schists including mica schist, quartz-mica schist, quartz-feldspar schist, and graphitic schist. Higher grades of metamorphism within these belts are indicated by local development of the metamorphic minerals andalusite, garnet, kyanite, and sillimanite. The schist is diversified by interbedded jaspilite and quartzite, which are considerably more resistant than the adjacent bands and which tend to form outstanding strike ridges. Accordingly, the whitestones give rise to more prominent relief.

As with the greenstone, the rocks of this phase are everywhere highly folded with dips greater than 70°. Because of their acid nature, weathering on these rocks has been less general than on the greenstone, but silicified hematitic crusts are particularly prominent on the jaspar bars.

Both Talbot (1920) and Clarke (1916) have grouped the whitestones with the greenstone phase, and where the metasedimentary jaspilites occur in the absence of greenstones, as in the Meekatharra district of the GLENGARRY area, Clarke interpreted them as marking shear zones. Sofoulis & Mabbutt (1963) suggest that the banded ironstone formations and jaspilites are largely confined to the whitestone phase, whereas Miles (1953) regards them as occuring as minor developments in both the metavolcanic and metasedimentary phases. Horwitz (1966) also regards the banded iron formations as being commonly associated with both phases.

Mosquito Creek Series. 'Mosquito Creek Series' is a very small but separate group of metasedimentary schists outside the main metamorphic belts. It consists of quartz-feldspar schist, slate, conglomerate, and minor amphibolitic schist, and is confined to the far northwest of GLENGARRY.

Granite and gneiss

Granite and gneiss are the most extensive of the Archaean basement rocks. The granite is medium to coarse-grained, usually porphyritic and pinkish in colour, and it has a low content of ferromagnesian minerals. The gneiss is usually fine to medium-grained, greyish in colour, exhibits mineral orientation, and has a higher content of ferromagnesian minerals. The gneiss is thought to have been produced by granitization of country rock at the margins of the intrusive granite (Horwitz, 1966).

Small granite bodies within the gneiss have been attributed to local mobilization. The granite and gneiss are intruded by a network of pegmatitic veins and by younger intrusives including quartz bars and rarely dolerite dykes corresponding to jointing and locally to fault planes (Sofoulis & Mabbutt, 1963).

PROTEROZOIC ROCKS

The Proterozoic rocks comprise gently folded sedimentary and volcanic rocks with interbedded quartzite, shale, and dolomite, with minor banded iron formations, greywacke, conglomerate, and limestone. Miles (1953) suggests that the banded iron formation may be more massive in some places.

These rocks unconformably overlie the Archaean basement. They are the southernmost extension of rocks that are widely developed farther north in the Pilbara Goldfield region, where they have been termed the Nullagine System.

TERTIARY AND QUARTERNARY

Since the Proterozoic the GLENGARRY, WILUNA, and KINGSTON areas show no evidence of marine inundation or of significant deformation. The various Tertiary and Quaternary formations are merely superficial, although extensive in area, and for the purposes of this Record they are collectively termed Alluvium.

STRUCTURE

Archaean structure

The metamorphic belts are regarded as synclinorial remnants of Archaean orogenic structures with mainly northerly trends (Sofoulis & Mabbutt, 1963). A superimposed system of subordinate folding, whose axial trend is east-northeast to northeast, is thought to have a significant role in localizing mineralization (Ellis, 1939; McMath, 1953).

The granites occupy broad anticlinal tracts, possibly of domelike form, although elongated along northerly axes. Granite occurs towards the centre of these tracts while gneiss forms peripheral granitized zones with circumferential foliation trends which are also conformable with the strike of the adjacent metamorphic belts. Conformity of structure between the metamorphic and crystalline rocks suggests that granitization occurred simultaneously with the folding (Sofoulis & Mabbutt, 1963).

The granite and gneiss possess two major joint systems, one striking north and the other east. Widespread minor faulting is evident in all the metamorphic belts.

Mineralization is widespread along the margins of the granite bodies, and is associated with the east-striking joint system (Sofoulis & Mabbutt, 1963).

Proterozoic structure

The Proterozoic Nullagine sediments were laid down in fairly shallow basins in the Archaean basement. The initial form and the subsequent deformation of these basins were partly controlled by reactivation of the Archaean structures (Sofoulis & Mabbutt, 1963).

The Nullagine succession nowhere appears to be of great thickness, ranging from 180 m in the west to possibly 300 m in the northeast.

The Proterozoic rocks in the area have undergone only gentle folding; dips seldom exceed 5°.

So far as is known, the Nullagine System rocks of this area have not been intruded by granite and show no evidence of hydrothermal mineralization.

ECONOMIC GEOLOGY

Gold

Gold has been the most extensively worked mineral in the survey area in the Meekatherra and Wiluna districts. The orebodies are usually located in favourable structures in the metamorphic belts at or within 2 km of the granite margins. Concentrations of gold are mainly associated with quartz in the form of quartz reefs, veins, or lodes, the gold itself being in the free state, associated with quartz or with metallic sulphides such as arsenopyrite, pyrite, and pyrrhotite.

Current mining activity is practically at a standstill; the small production which has been recorded in recent years is mainly derived from scavenging of the old 'shows'.

Arsenic and silver

Arsenic and silver minerals were associated with the gold mining.

Copper

Copper is still being mined from a few small deposits in the Meekatharra district.

Nickel

Prospecting for nickel and other base metals is currently taking place in the survey area, but no significant finds have been reported to date.

4. MAGNETIC RESULTS AND INTERPRETATION

The magnetic data are shown in Plates 2 to 5. Plates 3 to 5 show the total magnetic intensity contours at a scale of 1:250 000 superimposed on the topography and geology to facilitate correlation. The flight paths are shown as contour intersections. This enables the total magnetic intensity profiles, shown in stacked form at an east-west scale of 1:500 000 in Plate 2, to be located on the corresponding contour map. The interpretation of the magnetic data is given in Plates 6 to 8.

Virtually the entire magnetic pattern reflects near-surface variations in rock type. Interpretation of the magnetic data is based on the approach developed by Young & Tipper (1966) for the MENZIES and LEONORA 1:250 000 areas. This method has been used for all regional magnetic interpretations carried out by BMR in the Western Australian goldfields since 1964, and it is now employed partly because it is an easily applied, satisfactory method, and partly for the sake of continuity. This method involves analysis of the stacked magnetic intensity profiles to produce a series of magnetic zones and trends. The magnetic parameters used to determine the zone type are the continuity of the anomaly from line to line (linearity) and the dominant amplitude range representative of each zone. The limitations of this classification are discussed in Appendix 1.

Plates 6 to 8 show a large number of magnetic trends superimposed on the geology for each area. Several of these trends are over 60 km long; the more pronounced of these are usually confined to the whitestone and greenstone ranges, with good correlation between the trend directions and the mapped geological strikes. The magnetic results confirm the 'belt-like' formation of the metamorphic rocks, and indicate that they comprise at least two very dissimilar rock groups, which can be traced along strike for many kilometres.

A random selection of anomalies of simple form has been analysed. The analysis indicates that the magnetic bodies have apices within 90 m of the surface, and dip more steeply than 55°. Width estimates ranged from 150 to 1000 m.

Magnetic zones and their significance

Listed below are the zone types and a brief description of their geological significance. The anomaly range quoted for each type includes most, but not necessarily all, of the anomalies in any zone of that type.

Zone type	Anomaly amplitude	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	500 to 6000 gammas	good
9	greater than 6000 gammas	good

Zone types 1 and 2 are interpreted as relatively homogeneous acid igneous masses or non-magnetic sedimentary rocks. Zones of type 1 surrounded by zones of type 2 or 3 are almost certainly due to the igneous masses, whereas elongated zones of type 1 flanked by zones containing magnetic trends are probably due to sedimentary sequences between more magnetic strata. Zones of type 2 probably represent rocks of slightly more basic composition than those of type 1.

Zones of type 3 occurring in regions mapped as granite are probably caused by igneous rocks of more basic composition. These could result from assimilation of pre-existing basic rocks by granitic magma. They may also represent gneissic parts of the granite bodies.

Zones of type 4 are variable in size and have irregular shapes. Where they occur in granite masses they may be attributed to basic and ultrabasic intrusions or inclusions, or both. Those delineated in areas mapped as greenstones and whitestones possibly represent structurally complex basic rocks with no recognizable linearity.

Zone types 5 and 6 cannot be attributed to any specific rock types but probably represent stratigraphic sequences of alternating lavas and sedimentary rocks. The transition between the two zones is not definite, but it is probably due to an increase in basicity from zone type 5 to zone type 6, or perhaps an increase in the width of the magnetic strata. Where narrow zones of these types occur in granites, they may be caused by dykes. Wide zones of types 5 and 6 in granitic regions probably represent areas of partially assimilated greenstone material.

Interbedded basic and ultrabasic rocks and sediments are interpreted as the source of zones of type 7. The proportion of ultrabasic and basic rocks is greater in these zones than in zones of type 5 and 6. Some of the lineations may be due to banded iron formations.

Zones of type 8 and 9 delineate areas containing intense linear anomalies over 500 gammas in amplitude. Zones of type 9 indicate where intensities of more than 6000 gammas occur within zones of type 8. Only one zone of type 9 has been delineated, having a maximum amplitude of 15 500 gammas, situated in the east of GLENGARRY. Zones of type 8 and 9 are associated with banded iron formations and/or basic and ultrabasic rocks. It is difficult to determine from the magnetics whether these zones represent basic rocks and/or banded iron formations; this can be further complicated since anomalies caused by banded iron formations may vary considerably in amplitude along strike, decreasing in places to those of a type 5 zone.

In general, however, long and narrow zones of types 8 and 9 containing only one or two trend lines are probably due to banded iron formations, whereas wider zones with many trends are more likely to represent a variety of rock types including banded iron formations, basic lavas, and basic and ultrabasic intrusives.

<u>Comparison of geophysical interpretation with mapped geology</u>

By using 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.

<u>GLENGARRY area - Plates 3 and 6</u>. In general, the correlation between the relatively intense, northerly trending, linear magnetic anomalies and the mapped whitestones and greenstones is good, although the magnetic results indicate these rocks to be more extensive than previously mapped.

The most extensive greenstone and whitestone belt in GLENGARRY is represented by a belt of zones of types 6, 7, and 8, extending from south of Gabanintha in the southwest of the area, to Karalundi Mission in the northwest. The large number of trend lines contained within these zones suggests that the whitestone and greenstone belt includes a series of basic and ultrabasic rocks in addition to banded iron formations. Extensive gold mining within this belt is indicated by the number of mines in the Meekatharra district.

To the north of Karalundi Mission this belt of anomalies trends northeast and is associated with the 'Mosquito Creek Series' mapped there. The 'Mosquito Creek Series' is less magnetically anomalous than the other Archaean metamorphic rocks because it is predominantly sedimentary.

A marked contrast in trend direction is evident to the north of Karalundi Mission where a northwest trend abuts several northeast trends. Although rocks in this region are schist, gneiss, and basalt, the magnetic intensity and linearity are characteristic of interbedded igneous and sedimentary rocks. Similar differences in trend directions are apparent in the magnetic data of BELELE to the west (Waller & Beattie, 1971).

To the east of Meekatharra, a series of zones of types 5 and 6 extend between Greenwood in the north and Hill View in the south. These zones correlate closely with mapped whitestones and greenstones north of Gnaweeda, and the zones to the south probably represent the partly assimilated remnants of these same rocks contained within the mapped granite.

East of Greenwood, a line of anomalies within zones of types 5 and 6 extends to Mount Merewether in the southeast of the area. This line is over 100 km long and has been interpreted as a dyke with induced magnetism. Four other east-trending anomalies in the central region of GLENGARRY have been similarly interpreted.

South of Hill View, a northwest trending zone of type 6 has been interpreted as part of a whitestone and/or greenstone belt that extends southwards into SANDSTONE for more than 90 km. The zone of type 8 situated 20 km southeast of Hill View probably also represents the most northerly part of a whitestone and/or greenstone belt. Both these belts were interpreted as being rich in banded iron formations by Gerdes et al. (1970).

In the central south of the area, whitestones 20 km west of Noibla correlate closely with a northerly trending zone of type 8. Immediately to the west, a large area surrounding Gum Creek mine and mapped as greenstones has been delineated by a zone of type 4. The area mapped as greenstones to the south, however, appears to be relatively non-magnetic. A series of northerly trending zones of type 5 to the west of Mount Merewether have been interpreted as partly assimilated whitestones and/or greenstones contained within the mapped granite and gneiss. Broad zones of types 1 and 2 elsewhere within the southern half of the area indicate that this granite and gneiss underlies the alluvium in most of the region.

The dominant trend within the eastern half of the area extends from north of Mount Bartle for about 70 km in a southerly direction. It has been interpreted as extending even farther southwards, in a discontinuous manner to the Booylgoo Range in SANDSTONE. Anomalies contained within zones of types 8 and 9 of this trend are the most intense recorded within the three sheet areas, having amplitudes of up to 15 500 gammas. Anomalies with similar amplitudes were recorded in SANDSTONE and YOUANMI to the south (Gerdes et al., 1970). These zones of types 8 and 9 have been interpreted as a banded iron formation contained within the whitestone belt. This belt is mapped as far north as Channings mine but it obviously extends farther into the Kimberley Range beneath the Nullagine sediments. There is no evidence of mining along the granite/whitestone boundary, 6 km west of Channings mine and Joyner Find mine; this area warrants ground geophysical investigation.

The northeast of the area is characterized by an extensive zone of type 1. This correlates with large areas of weathered basalt less than 30 m in thickness and unconformably underlain by gneiss (Sofoulis & Mabbutt, 1963). The overlying basalt is apparently too thin to noticeably disturb the magnetic field, since the intensity of a zone of type 1 is less than expected for this rock type. However, this low magnetic intensity is consistent with the generally more acidic gneiss, and reflects the extent to which it underlies the region.

To the east of Kimberley Range an anomaly within a zone of type 5 probably represents a NNW extension of the whitestone and greenstone belt of the Wiluna district beneath the Nullagine rocks. Depth estimates in this zone indicate a source at approximately 600 m below ground.

WILUNA area - Plates 4 and 7. The magnetic data for this area reveal a large number of short, discontinuous northerly trends which suggest better preservation of the greenstone and whitestone enclaves than in GLENGARRY and KINGSTON. These trends occur mainly in the gneissic regions.

The two most intense, linear, NNW-trending groups of anomalies in WILUNA are contained within the western half of the area. The more westerly of these extends from near Wiluna south-southwest into SIR SAMUEL (Shelley & Waller, 1967). An elongate zone of type 8 immediately to the west of Wiluna delineates the northern part of this trend, and has been interpreted as banded iron formations. However, this zone does not correlate with the northwest trending greenstone belt mapped as passing through Wiluna. The marked reduction in intensity of this trend to the south is typical of the manner in which the amplitude of anomalies caused by banded iron formations varies in intensity along strike. A second zone of type 8 associated with this same trend in the south of the area correlates well with a region mapped as whitestones and greenstones near Mount Way.

Immediately to the east of Mount Lawrence Wells, a small northwest-trending belt of whitestone correlates closely with a zone of type 7. This trend extends to the northwest, delineated by a zone of type 6, and has been interpreted as partly assimilated remnants of this same whitestone belt, overlain by Nullagine rocks. However, not all regions mapped as whitestone are associated with relatively intense anomalies as is shown by those areas 15 km northwest of Mount Way, and west of Mount Lawrence Wells.

Several northwest-trending zones of types 5 and 6 to the west of Wiluna and Lake Way are associated with a region mapped as gneiss and covered largely by alluvium. These zones probably represent scattered remnants of partly assimilated whitestone and greenstone material.

Extensive zones of type 1 characterize the northwest of the area and suggest that the gneiss mapped around Mount Green underlies the alluvium in most of the region. Small scattered zones of types 5 and 6 correlate with areas mapped as gneiss along the northern edge of the area. Zones of types 5, 6, and 7 north of Mount Alice have been interpreted as basic rocks. These zones correlate with the eastern part of a large area mapped as basalt; this basalt, however, is probably too thin to produce a significant anomaly.

The other dominant trend within the western half of WILUNA extends from west of Jundee to the central south of the area. The central part of this zone of type 8, interpreted as banded iron formations, correlates closely with a mapped whitestone belt, but the remainder of the zone correlates only loosely with mapped whitestone and greenstone. A region of greenstone to the east of this zone, and another of whitestone to the southeast, are not indicated by intense magnetic anomalies.

The central north of the area is dominated by relatively intense 'block-type' groups of anomalies trending northwest and consisting of a large number of closely spaced randomly oriented trends. These groups of anomalies have been designated as type 4 zones because of the complexity of their contained trends, and have been interpreted as massive basic rocks. A 'block-type' anomaly situated northwest of Bare Granite Hill in the east of the area and delineated by a zone of type 4 probably represents another massive basic and ultrabasic intrusion.

In the northeast corner of the area a series of strong northwest negative trends correlate closely with the boundary of the Nullagine rocks. These trends, which extend into KINGSTON, range in amplitude from 500 to 1200 gammas and are too strong to be simply associated with positive anomalies to the north. The strong correlation between these trends and the mapped geological boundary suggest a causal relationship. The negative polarity and WNW direction of the trends are uncharacteristic of a greenstone/whitestone belt, and strong overfolding seems unlikely to have occurred as the Nullagine System is everywhere gently folded with dips of less than 5° (Sofoulis & Mabbutt, 1963). A possible interpretation of these trends is a series of reversely magnetized basic or ultrabasic dykes that intruded a fault plane along the Nullagine/gneiss boundary. Partial assimilation of the host rock by these dykes would account for the discontinuous nature of these trends, and a fault along this boundary would account for their overall linearity. Depth estimates were carried out assuming the remanent component to be exactly opposite in direction to the induced component. Values obtained suggest that the interpreted 'dyke-like' sources vary in depth between 30 m and 200 m below ground level, have a width of about 1 km, and have a dip ranging between 60° NE and 60° SW.

Two groups of trends strike northwest through Rose Hills and north through Millrose respectively. They are represented by zones of types 6, 7, and 8. These zones have been interpreted as partly assimilated remnants of two greenstone belts in the typical 'hour-glass' configuration of Ellis (1939). This hour-glass pattern correlates well with mapped greenstone. Greenstone mapped 25 km southwest of Mount Fisher may represent a southerly extension of this feature.

Near the eastern boundary of WILUNA in the Mount Fisher area, a second hour-glass anomaly pattern has been delineated. The centre of this configuration is situated in a region mapped as greenstone, and the eastern limb, in KINGSTON, correlates well with mapped greenstone and whitestone. However, only the southern part of the western limb correlates with mapped whitestone.

The average intensity of these hour-glass anomaly patterns is significantly less than that of other linear anomalies attributed to greenstone and whitestone farther west. This lower intensity has been interpreted as indicating an absence of banded iron formations within these whitestones and greenstones.

Large zones of type 1 in the southeast of WILUNA correlate with several small areas mapped as gneiss, and indicate the extent to which the gneiss underlies the alluvium in the region. These interpreted large gneissic masses situated between the above-mentioned hour-glass anomaly patterns, probably intruded along an anticlinal axis since the gneiss is considered to be younger than the whitestone and greenstone (Sofoulis & Mabbutt, 1963). The absence of short trends within these zones suggests that the assimilation of metamorphic material has been complete.

KINGSTON area - Plates 5 and 8. The series of strong negative northwest trends in the northwest of the area extend as far as Old Windidda, and have been discussed previously. The zones of types 5 and 6 north of this discontinuity have been interpreted as basic intrusions in the Archaean basement beneath the Nullagine rocks. Depth estimates for the two anomalies in zone types 6 and 7 to the south and east of Wongawol, respectively, indicate that these anomalies have sources at depths of about 1500 m.

The anomalies in the type 7 zone, 35 km south-southwest of Old Windidda homestead, have been interpreted as partly assimilated remnants of a whitestone and/or greenstone belt. The large area mapped as gneiss surrounding this zone correlates with a region of zone types 2, 3, 5, and 6 with minor trends of variable orientation. These small anomalies are characteristic of the gneissic regions in WILUNA. The gneiss generally appears to be more basic than the granite mapped farther west in GLENGARRY.

The group of anomalies south-southeast of Old Windidda homestead, represented by zones of types 5, 6, 7, and 8, exhibit a marked Y-shaped configuration. This has been interpreted as a fold and cross-fold axis. The southern part of this anomaly pattern correlates closely with two regions mapped as whitestone, and the magnetic results indicate that this whitestone belt extends to the north and northeast beneath the Nullagine rocks. Each of the two limbs of this Y-shaped anomaly pattern have parallel trends, and the rate of divergence of the limbs suggests that the interpreted cross-folding has been stronger than is usual in this part of the goldfields region of Western Australia. Depth estimates 12 km SSW of Old Windidda indicate a source at about 200 m, while depth estimates 6 km north of Old Windidda indicate a source at about 600 m.

The intense linear anomalies within two zones of type 8 in the southeast of the area have been interpreted as greenstone and/or whitestone belts, although none have been mapped. These linear anomalies extend south and southwest into DUKETON for about 20 km, and their amplitudes suggest that interpreted whitestone and/or greenstone belts may contain banded iron formations. Depth estimates on these anomalies indicate that these interpreted greenstone/whitestone belts extend northwards beneath the Nullagine rocks.

The two large 'block-type' anomalies delineated by zones of type 4 in the Carclew Range and Collurabbie Hills regions are probably associated with fractured parts of the inferred whitestone and/or greenstone belts to the immediate south.

To the east, in the Von Treuer Tableland area, two further 'block-type' anomalies, delineated by a zone of type 4, have been interpreted as massive basic rocks. The anomaly represented by a zone of type 6 extending south between Double Hill and Mount Draper in the northeast of the area, probably represents further basic rocks. A transcurrent fault has been interpreted between this zone and the zone of type 6 near Boondin.

The central north and northeast of the area are characterized by an extensive zone of type 1 which has been interpreted as a large region of non-magnetic sediments. This part of KINGSTON forms a portion of the Bangemall Basin. Depth estimates on the anomaly in the zone of type 6 in the northeast of the area indicate a source at about 2200 m depth, and this probably represents the top of the Archaean within this region.

Structure

Plates 6, 7, and 8 show the interpreted folding and faulting pattern. Where the source of a major magnetic boundary is uncertain it has been indicated only as a magnetic discontinuity. Many of the fold axes may be longer than indicated, but they have only been shown where the evidence seemed strong enough.

GLENGARRY area - Plates 3 and 6. The fold axes delineated in the area are associated with the greenstone and whitestone belts. Because of the steepness of the dips calculated from these anomalies, and the possibility of overturning, it is not possible to determine the sense of the folds.

Two fold axes at right angles have been interpreted in the Meekatharra district, and these represent an anticline/syncline structure. It has not been possible to determine whether the interpreted cross-fold is of anticlinal or synclinal form, but it is significant that most of the gold mining in the Meekatharra district was carried out in this region of interpreted cross-folding.

To the north of Karalundi Mission an ENE trending fold axis has been delineated from a study of the symmetry of the magnetic trends, although it is possible that these trends are caused by a sequence of basic rocks of contrasting magnetic character. Data currently being obtained for PEAK HILL may resolve this.

An extensive magnetic discontinuity has been delineated in the south of the area, continuing some 25 km into SANDSTONE. This discontinuity is marked by the northern limit of anomalies west of Noibla, and by the southern limit of the anomaly belt which passes through Gabanintha. Although this discontinuity was probably caused by faulting, the exact form of this faulting is uncertain. One explanation is that it was caused by a transcurrent fault. This, however, would require a lateral shift of approximately 80 km and there is no geological evidence to support it. A possible explanation is that a normal fault occurred, accompanied by some wrench faulting. The greenstone and whitestone belts causing these anomalies are assumed to have been completely assimilated where they terminate abruptly.

To the west of Noibla, in the central south of GLENGARRY, an arcuate belt of anomalies contained within a zone of type 8 is thought to be associated with another such belt represented by zones of types 8 and 9 in the east of the area. These arcuate zones are indicative of syncline-syncline, or anticline-anticline fold/cross-fold systems, and a northerly trending fold-axis has been interpreted accordingly. Because the axis is situated in a granitic region between two older metamorphic belts it is probably of anticlinal form.

WILUNA area - Plates 4 and 7. A northerly trending fold axis has been interpreted from the symmetry of the magnetic trends along the eastern boundary of Lake Way. This fold axis is present in SIR SAMUEL to the south, and extends SSE for some 40 km (Shelley & Waller, 1967).

In the central region of the area a fault has been delineated striking ENE from a point 12 km north of Mount Cleaver. This interpreted fault marks the southern boundary of a large block-type group of anomalies, delineated by a zone of type 4, in the Lake Ward region. A second normal fault has been interpreted 15 km northeast of Twin Hills; this also marks the southern limit of a large block-type group of anomalies.

Two 'hour-glass' anomaly patterns have been delineated in the southeast of the area, and have been interpreted as a normal fold and cross-fold. Whitestone and greenstone belts are associated with both these anomaly configurations. The similar rate of divergence of the limbs of each anomaly pattern indicates that each underwent a similar degree of cross-folding, and because of their relatively close proximity it further suggests that the sense of each fold/cross-fold system is the same.

In the far northeast of the area the boundary between the Archaean and Upper Proterozoic rocks has been delineated by a magnetic discontinuity. Possible causes for this series of negative trends were discussed earlier in this Record.

KINGSTON area - Plates 5 and 8. The magnetic discontinuity representing the Archaean/Upper Proterozoic contact extends into this area from WILUNA and has been delineated as far as Old Windidda.

In the south of the area a distinctive Y-shaped anomaly configuration has been interpreted as two mutually perpendicular fold axes. Once again it is not possible to determine the sense of the folds, beyond the fact that they form an anticline/syncline system. However, both the geology and depth estimates obtained from the magnetic data suggest that the whitestone belt associated with this Y-shaped anomaly configuration plunges beneath the Nullagine rocks as it extends northwards. This suggests that the interpreted cross-fold is anticlinal in form.

If the interpreted cross-fold associated with this Y-shaped anomaly configuration is the same as those interpreted for the two 'hour-glass' anomaly patterns in the southeast of WILUNA, the latter would also be anticlinal.

In the east of the area three transcurrent faults have been interpreted from a study of anomaly discontinuities. All three have a displacement of north side east.

The normal fault delineated 35 km south of Old Windidda has been interpreted from an examination of anomaly discontinuities in KINGSTON and DUKETON.

5. CONCLUSIONS AND RECOMMENDATIONS

There is good agreement between the magnetic data and the mapped geology within the greenstone and whitestone belts. In GLENGARRY and KINGSTON, the magnetic results indicate that the greenstone and whitestone belts are more extensive than originally thought. In WILUNA, however, the mapped greenstone and whitestone is generally more extensive than is indicated by the magnetic data.

In GLENGARRY the magnetic results indicate a large centrally located granite/gneiss region with north-trending greenstone and/or whitestone belts in the east and west of the area. A further two such belts are indicated in the south.

In WILUNA the magnetic results indicate a series of NNW-trending whitestone and greenstone belts with two large block-type groups of anomalies to the north. The large number of minor trends and anomalies within the area correlate with regions mapped as gneiss, and this suggests that the gneiss is generally more basic than the granite. In the northeast of the area the gneiss/Nullagine rock boundary is clearly delineated.

The magnetic results in KINGSTON indicate an area of contrasting geology. The western half of the area is divided in two by a series of strong negative trends delineating the gneiss/Nullagine rock boundary and extending into the region from WILUNA. A large magnetically undisturbed region in the north of the area is thought to represent non-magnetic sediments, while in the south and west, strong linear anomalies indicate several greenstone and/or whitestone belts. Two such interpreted belts in the southeast of the area are not indicated by the mapped geology and further ground investigation is recommended.

It has not been possible to differentiate between the greenstones and whitestones from their magnetic response. However, the most intense parts of the linear anomalies correlate in general with mapped whitestones rather than greenstones, and this suggests that the banded iron formations are largely confined to the whitestones.

Several extensive structural features are delineated by the magnetics, and the interpretation of these is in broad agreement with accepted theories on the structure of the Western Australian goldfields region.

The results of this survey have satisfied the basic objectives, and they should prove most useful in mapping broad geological features and in the continuing search for minerals.

6. REFERENCES

CARTER, R.M., 1959 - Airborne magnetic and radiometric survey of Kurnalpi and Widgiemooltha areas, W.A. 1959. Bur. Miner. Resour. Aust. Rec. 1959/137 (unpubl.).

CLARKE, E., de C., 1916 - The geology and ore-deposits of Meekatharra, Murchison Goldfield. Bull. Geol. Surv. W. Aust. 68.

DANIELS, J.L., & HORWITZ, R.C., 1969 - Precambrian tectonic units of Western Australia. Ann. Rep. Dep. Min. W. Aust. 1968.

ELLIS, H.A., 1939 - Geology of the Yilgarn Goldfield, south of the Great Eastern Railway. Bull. Geol. Surv. W. Aust. 97.

FORSYTH, W.A.L., 1961 - Boorabbin and Norseman airborne magnetic and radiometric survey, W.A. 1959. Bur. Miner. Resour. Aust. Rec. 1961/55 (unpubl.).

GAY, S.P., 1963 - Standard curves for interpretation of magnetic anomalies over long tabular bodies. Geophysics 28(2), 161-200.

GERDES, R.A., YOUNG, G.A., BEATTIE, R.D., & CAMERON, B.F., 1970 - Sandstone and Youanmi airborne magnetic and radiometric survey, W.A. 1969. Bur. Miner. Resour. Aust. Rec. 1970/2 (unpubl.).

HORWITZ, R.C., 1966 - Notes on the legend of the Geological Map of Western Australia. Ann. Rep. Dep. Min. W. Aust. 1965.

HORWITZ, R.C., & DANIELS, J.L., 1967 - A late Precambrian belt of vulcanicity in Central Australia. Ann. Rep. Dep. Min. W. Aust. 1966.

KOULOMZINE, T., LAMONTAGNE, Y., & NADEAU, A., 1970 - New methods for the direct interpretation of magnetic anomalies caused by inclined dykes of infinite length. Geophysics 35(5), 812-830.

McMATH, J.C., 1953 - The geology of the country about Coolgardie Goldfield, W.A. Part 1 - Regional Geology. Bull. Geol. Surv. W. Aust. 107.

MILES, K.R., 1953 - Banded iron formations in Western Australia. In GEOLOGY OF AUSTRALIAN ORE DEPOSITS. Fifth Empire Min. Metall. Cong.

MULDER, J.M., 1960 - Southern Cross and Kalgoorlie regions airborne radiometric survey, W.A. 1958. Bur. Miner. Resour. Aust. Rec. 1960/120 (unpubl.).

SANDERS, E.C., & HARLEY, A.S., 1971 - Hydrogeological reconnaissance of parts of Nabberu and East Murichison mining areas. Ann. Rep. Dep. Min. W. Aust. 1970.

SHELLEY, E.P., & WALLER, D.R., 1967 - Sir Samuel - Duketon airborne magnetic and radiometric survey, W.A. 1967. Bur. Miner. Resour. Aust. Rec. 1967/136 (unpubl.).

SOFOULIS, J., & MABBUTT, J.A., 1963 - Lands of the Wiluna-Meekatharra area, Western Australia, 1958. Part IV: Geology of the Wiluna - Meekatharra area. CSIRO Land Research Series No. 7, pp 93-106.

SPENCE, A.G., 1958 - Preliminary report on airborne magnetic and radiometric surveys in Kalgoorlie - Southern Cross region, W.A. (1956-1957). Bur. Miner. Resour. Aust. Rec. 1958/45 (unpubl.).

TALBOT, H.W.B., 1920 - The geology and mineral resources of the North-west, Central and Eastern Divisions. Bull. Geol. Surv. W. Aust. 83.

TALBOT, H.W.B., 1926 - A geological reconnaissance in the Central and Eastern Divisions. Bull. Geol. Surv. W. Aust. 87.

TIPPER, D.B., & GERDES, R.A., 1971 - Laverton - Edjudina airborne magnetic and radiometric survey, W.A. 1966. Bur. Miner. Resour. Aust. Bull. 118.

WALLER, D.R., & BEATTIE, R.D., 1971 - Airborne magnetic and radiometric survey of Belele, Cue, Kirkalocka and the Eastern Parts of Byro, Murgoo, and Yalgoo 1:250,000 Sheet areas, W.A. 1969. Bur. Miner. Resour. Aust. Rec. 1971/28 (unpubl.).

WELLS, R., 1962 - Lake Johnston area airborne magnetic and radiometric survey, W.A. 1960. Bur. Miner. Resour. Aust. Rec. 1962/100 (unpubl.).

WESTERN AUSTRALIAN DEPARTMENT OF MINES - 1966 - Geological Map of Western Australia.

YOUNG, G.A., 1971 - Applications of Regional Airborne geophysical data to metals search in Western Australia. Bur. Miner. Resour. Aust. Rec. 1971/78 (unpubl.).

YOUNG, G.A., & TIPPER, D.B., 1966 - Menzies and Leonora airborne magnetic and radiometric survey, W.A. 1964. Bur. Miner. Resour. Aust. Rec. 1966/15 (unpubl.).

APPENDIX 1

INTERPRETATION PROCEDURE

Qualitative magnetic interpretation

The magnetic data have been qualitatively analysed by delineating magnetic trends and zones. A magnetic trend is defined as the line joining the peak positions of anomalies which are attributed to one continuous magnetic body. Except for perfectly symmetrical anomalies, however, a trend will not coincide with the apical axis of the body. This axis will generally be situated towards the negative part of the anomaly by an amount which is a function of the body's dip and strike angles.

Magnetic zones are based on the criteria of the degree of magnetic linearity and dominant amplitude range. Although these criteria are generally satisfactory for distinguishing between contrasting rock types, they do introduce ambiguity in some cases. For example, a series of interbedded lavas and sediments can produce anomalies with amplitudes equal to those produced by irregular masses of ultrabasic rock in granite. Such a case occurs in the central north of WILUNA, where several large groups of intense, randomly oriented trends have been designated as type 4 zones. These zones have been interpreted as massive basic intrusions, but they could represent a series of randomly oriented, interbedded lavas and sediments. The former interpretation is more likely since all known outcrops of interbedded lavas and sediments within this part of the goldfields region possess a high degree of linearity. The magnetic trend criterion will generally differentiate between these two cases, but this is not always possible when more than one strike direction is present in the same region.

The significance of the amplitude criterion should be assessed with the knowledge that amplitude is not only a function of magnetic susceptibility contrasts, but also of width, depth, and strike of the magnetic body. To be able more accurately to equate magnetic zones with rock type, the zones would need to be based on susceptibility values calculated for each anomaly.

Certain structural features have been qualitatively interpreted from the magnetic results. Faults were interpreted from the collinear termination of magnetic zones and trends or by abrupt changes in trend direction. Where a folded sequence contains one or more magnetic horizons, the fold has been interpreted from a symmetrical repetition of zones and/or individual anomalies.

Quantitative magnetic interpretation

Quantitative interpretation involved the determination of depths, widths, and dip angles from selected anomalies. These variables were calculated using the method of Koulomzine, Lamontagne, & Nadeau (1970), and the curve matching technique of Gay (1963). Anomalies were interpreted quantitatively only when the results were of direct significance to the geological and structural interpretation.

APPENDIX 2

OPERATIONAL DETAILS

Contractor

Geophysical Resources Development Company.

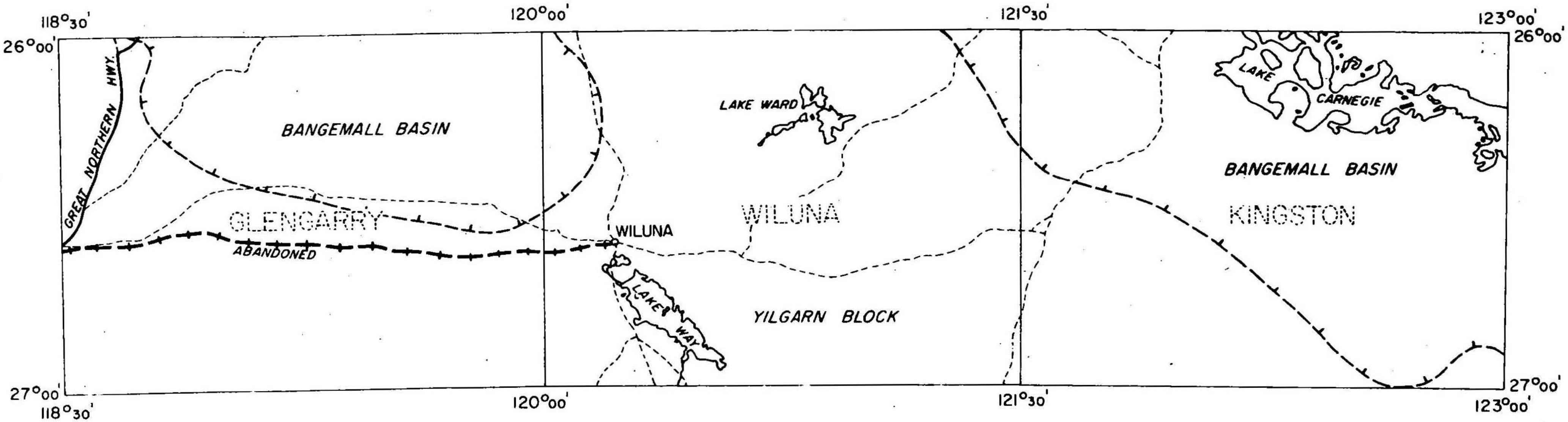
Equipment

Aircraft	:	Beechcraft Baron - VH-ILD
Magnetometers	:	ASQ-10 fluxgate coupled to a Mosely recorder. Modified saturable-core fluxgate storm monitor coupled to an Esterline-Angus recorder.
Camera	:	Flight Research 35-mm single-frame.
Radio altimeter	:	Bonzer TRN-70 coupled to an Esterline-Angus recorder.

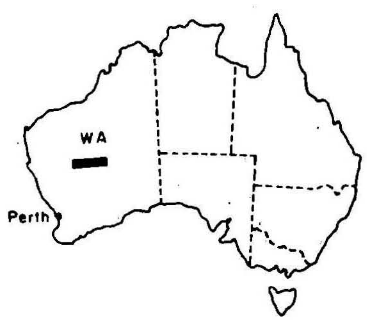
Survey specifications

Altitude	:	150 m (500 ft) above ground level
Line spacing	:	1.6 km (1 mile)
Line orientation	:	East and west.
Tie system	:	Single north-south ties spaced 37.2 km (23.25 miles) apart.
Navigation control	:	Aerial photographs.
Recorder sensitivities	:	ASQ-10 20 gammas/cm (50 gammas/inch) Modified fluxgate 8 gammas/cm (20 gammas/inch)

To accompany Record No. 1972/120



LOCATION DIAGRAM



AIRBORNE SURVEY, WESTERN AUSTRALIA 1970

(CONTRACT)

LOCALITY MAP

KILOMETRES 20 0 20 40 60 80 100 120 140 160 KILOMETRES

MILES 20 0 20 40 60 80 MILES

G51/B1-24A

PLATE 1

PLATE 2

AIRBORNE SURVEY, WESTERN AUSTRALIA, 1970

(CONTRACT)

TOTAL MAGNETIC INTENSITY PROFILES

REFERENCE TO 1:250,000 MAP SERIES

117°00' — 124°30'; 25°00' — 28°00'

ROBINSON RANGE	PEAK HILL	NABBERU	STANLEY	HERBERT
BELELE	GLENGARRY	WILUNA	KINGSTON	ROBERT
CUE	SANDSTONE	SIR SAMUEL	DUKETON	THROSSELL

EAST–WEST SCALE

KILOMETRES 10 0 10 20 30 40 50 60 70 KILOMETRES

MILES 10 0 10 20 30 40 MILES

PROFILE SCALE

FULL–LINE PROFILE: 1000 – 500 – 0 GAMMAS

BROKEN–LINE PROFILE: 10000 – 5000 – 0 GAMMAS

EXPLANATORY NOTES

This survey was flown at an altitude of 150 m above ground level along east–west lines spaced 1·6 km apart.

A correction for the regional gradient in total magnetic intensity has been made for each profile with respect to its base-line.

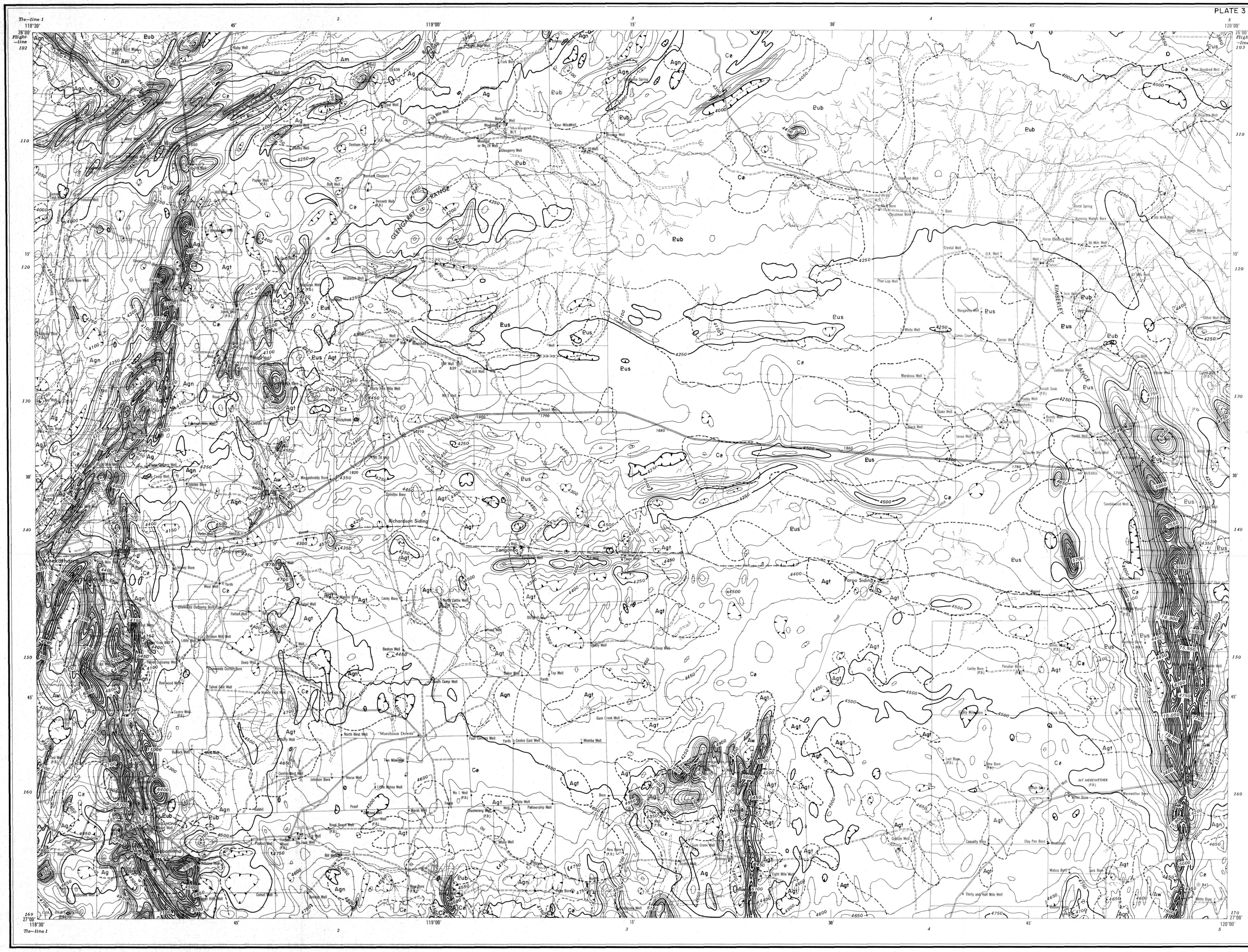
The profiles have been evenly spaced for clarity. The locations of the actual flight–lines are given as contour intersections on Plates 3, 4 and 5.

accompany Record No. 1972/120

G51/B1-

AUSTRALIA 1:250,000

GLENGARRY



LOCATION DIAGRAM

115°30' – 123°; 24° – 29°

MOUNT PHILLIPS SG 50-2	MOUNT EGERTON SG 50-3	COLLIER SG 50-4	BULLER SG 51-1	TRAINOR SG 51-2
GLENBURGH SG 50-6	ROBINSON RANGE SG 50-7	PEAK HILL SG 50-8	NABBERU SG 51-5	STANLEY SG 51-6
BYRO SG 50-10	BELELE SG 50-11	GLENGARRY SG 50-12	WILUNA SG 51-9	KINGSTON SG 51-10
MURGOO SG 50-14	CUE SG 50-15	SANDSTONE SG 50-16	SIR SAMUEL SG 51-13	DUKETON SG 51-14
YALGOO SH 50-2	KIRKALOCKA SH 50-3	YOUANMI SH 50-4	LEONORA SH 51-1	LAVERTON SH 51-2

To accompany Record No. 1972/120

TOPOGRAPHIC LEGEND

- Highway; built-up area
- Road, sealed surface first class; route marker (79)
- Road, sealed surface second class; mileage
- Road, loose surface all weather first class
- Road, loose surface all weather second class
- Road, loose surface dry weather
- Road, unimproved earth
- Bridge road; bridge railway
- Railway multiple track
- Railway single track
- Light railway or tramway
- Station; siding; station with siding
- Telephone line; power transmission line
- Fence; stone wall
- Levee or dyke; quarry
- Mine; windpump; yard
- Building (s); church; school
- Post office; wireless transceiver; cemetery (P.O, W/T)
- Control point major, minor; astronomical
- Spot elevation in feet; accurate; approximate (·750, ·750)
- Bench mark; mud; gravel (BM·750)
- Waterhole; water tank; dam; dry lake
- Lake, river or stream perennial
- Lake, river or stream intermittent
- Dam or weir; falls; rapids
- Drain or ditch perennial, intermittent
- Spring perennial, intermittent; ricefields
- Marsh or swamp;
- Seaplane anchorage; seaplane base
- Breakwater, pier, dock or wharf
- Fathom line; low water mark; lighthouse (LWM)
- Wreck sunken, exposed; vessel anchorage
- Rocks submerged, bare or awash
- Reef, rocky or coral

AIRBORNE SURVEY, WESTERN AUSTRALIA 1970

TOTAL MAGNETIC INTENSITY AND GEOLOGY

SCALE 1:250,000

Kilometres 5 0 5 10 15 20 25 30 Kilometres

Miles 5 0 5 10 15 Miles

MAGNETIC CONTOUR INTERVAL 50 GAMMAS

GEOLOGICAL LEGEND

- - - - - - Geological boundary

CAINOZOIC		Cz	Alluvium, sand, laterite
LOWER PROTEROZOIC	NULLAGINE "SERIES"	Eus	Sandstone, quartzite limestone, shale
LOWER PROTEROZOIC	NULLAGINE "SERIES"	Eub	Basalt
ARCHAEAN		Agt	Granite
ARCHAEAN		Agn	Gneiss
ARCHAEAN	MOSQUITO CREEK SERIES	Am	Metasedimentary schist
ARCHAEAN	WHITESTONE	Aw	Metasedimentary schist jaspilite, quartzite
ARCHAEAN	GREENSTONE	Ag	Metavolcanic rocks, schists amphibolite, norite, basic lavas

MAGNETIC LEGEND

- 4500, 4450 — Magnetic contours (gammas)
- Magnetic "low"
- Contour/flight-line intersections

EXPLANATORY NOTES

This map was compiled from an airborne magnetic survey of part of Western Australian Goldfields made in 1970 by the Geophysical Resources Development Company under contract to the Bureau of Mineral Resources.

The survey was made by an aircraft at a height of 500 feet above ground level along lines spaced one mile apart.

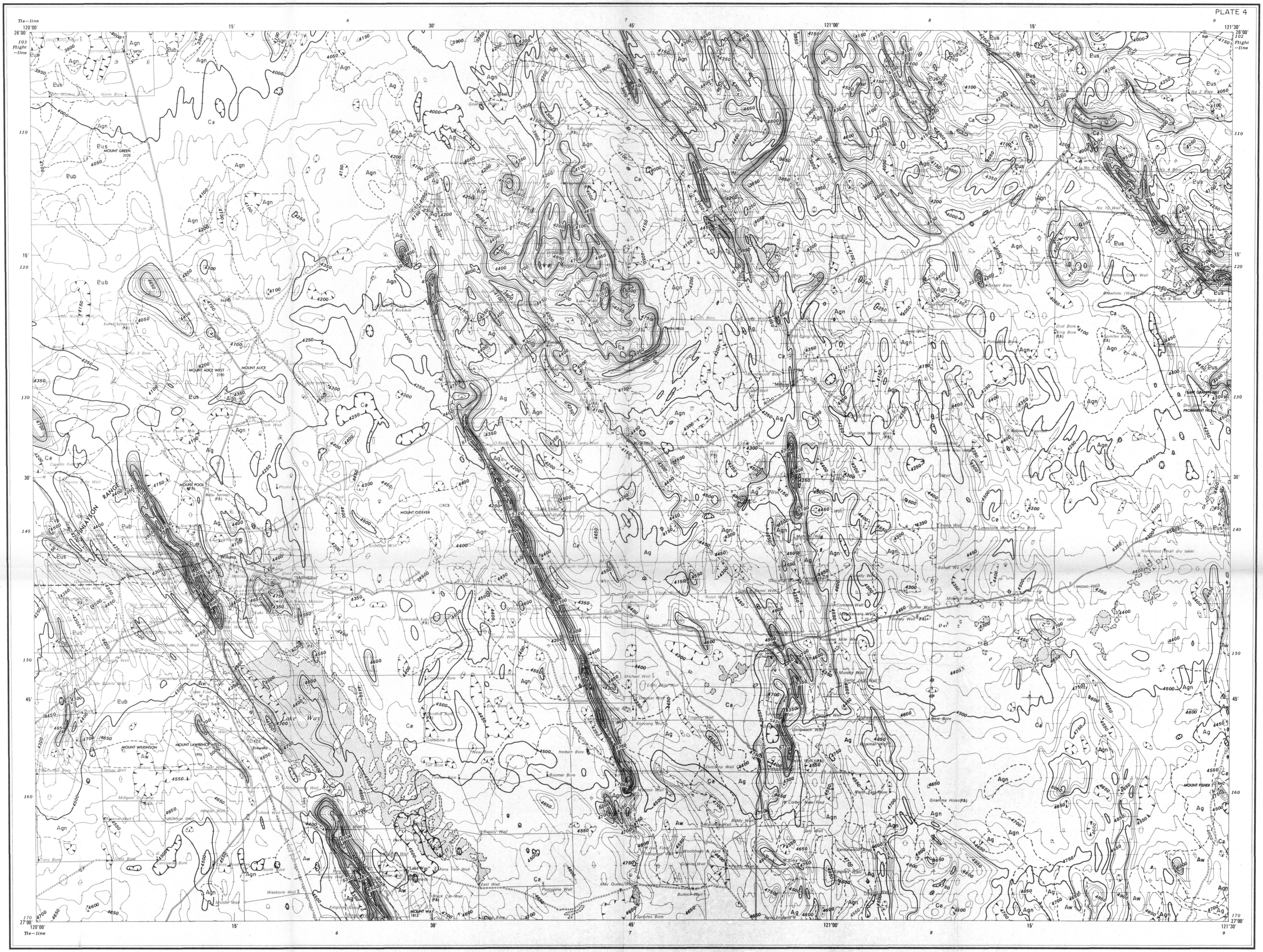
The total magnetic intensity was recorded by an airborne magnetometer and has not been corrected for the regional gradient in total magnetic field.

Geology based on Lands of the Wiluna - Meekatharra Area, WA 1958. (CSIRO Land Research Series No.7, 1963)

G50/B1-83

WILUNA

PLATE 4



LOCATION DIAGRAM

117°00' — 124°30' — 24°00' — 29°00'

MOUNT EGERTON SG 50-3	COLLIER SG 50-4	BULLER SG 51-1	TRAINOR SG 51-2	MADLEY SG 51-3
ROBINSON RANGE SG 50-7	PEAK HILL SG 50-8	NABBERU SG 51-5	STANLEY SG 51-6	HERBERT SG 51-7
BELELE SG 50-11	GLENGARRY SG 50-12	WILUNA SG 51-9	KINGSTON SG 51-10	ROBERT SG 51-11
CUE SG 50-15	SANDSTONE SG 50-16	SIR SAMUEL SG 51-13	DUKETON SG 51-14	THROSSELL SG 51-15
KIRKALOCKA SH 50-3	YOUANMI SH 50-4	LEONORA SH 51-1	LAVERTON SH 51-2	RASON SH 51-3

To accompany Record No. 1972/120

TOPOGRAPHIC LEGEND

- Highway; built-up area
- Road, sealed surface first class; route marker
- Road, sealed surface second class; mileage
- Road, loose surface all weather first class
- Road, loose surface all weather second class
- Road, loose surface dry weather
- Road, unimproved earth
- Bridge road; bridge railway
- Railway multiple track
- Railway single track
- Light railway or tramway
- Station; siding; station with siding
- Telephone line; power transmission line
- Fence; stone wall
- Levee or dyke; quarry
- Mine; windpump; yard
- Building (s); church; school
- Post office; wireless transceiver; cemetery — PO W/T
- Control point major, minor; astronomical
- Spot elevation in feet; accurate; approximate — ·750 ·750
- Bench mark; mud; gravel — BM·750
- Waterhole; water tank; dam; dry lake
- Lake, river or stream perennial
- Lake, river or stream intermittent
- Dam or weir; falls; rapids
- Drain or ditch perennial, intermittent
- Spring perennial, intermittent; ricefields
- Marsh or swamp;
- Seaplane anchorage; seaplane base
- Breakwater, pier, dock or wharf
- Fathom line; low water mark; lighthouse — LWM
- Wreck sunken, exposed; vessel anchorage
- Rocks submerged, bare or awash
- Reef, rocky or coral

AIRBORNE SURVEY, WESTERN AUSTRALIA 1970

TOTAL MAGNETIC INTENSITY AND GEOLOGY

SCALE 1:250,000

Kilometres 5 0 5 10 15 20 25 30 Kilometres

Miles 5 0 5 10 15 Miles

MAGNETIC CONTOUR INTERVAL 50 GAMMAS

GEOLOGICAL LEGEND

Geological boundary

CAINOZOIC		Cz	Alluvium, sand, laterite
LOWER PROTEROZOIC	NULLAGINE "SERIES"	Pus	Sandstone, quartzite limestone, shale
LOWER PROTEROZOIC	NULLAGINE "SERIES"	Pub	Basalt
ARCHAEAN		Agt	Granite
ARCHAEAN		Agn	Gneiss
ARCHAEAN	MOSQUITO CREEK SERIES	Am	Metasedimentary schist
ARCHAEAN	WHITESTONE	Aw	Metasedimentary schist jaspilite, quartzite
ARCHAEAN	GREENSTONE	Ag	Metavolcanic rocks, schists amphibolite, norite, basic lavas

MAGNETIC LEGEND

- 4500 / 4450 — Magnetic contours (gammas)
- Magnetic "low"
- Contour/flight-line intersections

EXPLANATORY NOTES

This map was compiled from an airborne magnetic survey of part of Western Australian Goldfields made in 1970 by the Geophysical Resources Development Company under contract to the Bureau of Mineral Resources.
The survey was made by an aircraft at a height of 500 feet above ground level along lines spaced one mile apart.
The total magnetic intensity was recorded by an airborne magnetometer and has not been corrected for the regional gradient in total magnetic field.

Geology based on Lands of the Wiluna – Meekatharra Area, WA 1958. (CSIRO Land Research Series No.7, 1963)

G51/B1-29

AUSTRALIA 1:250,000

KINGSTON

LOCATION DIAGRAM

118° 30' — 126° 00' — 24° — 29°

COLLIER SG 50-4	BULLER SG 51-1	TRAINOR SG 51-2	MADLEY SG 51-3	WARRI SG 51-4
PEAK HILL SG 50-8	NABBERU SG 51-5	STANLEY SG 51-6	HERBERT SG 51-7	BROWNE SG 51-8
GLENGARRY SG 50-12	WILUNA SG 51-9	KINGSTON SG 51-10	ROBERT SG 51-11	YOWALGA SG 51-12
SANDSTONE SG 50-16	SIR SAMUEL SG 51-13	DUKETON SG 51-14	THROSSELL SG 51-15	WESTWOOD SG 51-16
YOUANMI SH 50-4	LEONORA SH 51-1	LAVERTON SH 51-2	RASON SH 51-3	NEALE SH 51-4

To accompany Record No. 1972/120

TOPOGRAPHIC LEGEND

Highway; built-up area
Road, sealed surface first class; route marker
Road, sealed surface second class; mileage
Road, loose surface all weather first class
Road, loose surface all weather second class
Road, loose surface dry weather
Road, unimproved earth
Bridge road; bridge railway
Railway multiple track
Railway single track
Light railway or tramway
Station; siding; station with siding
Telephone line; power transmission line
Fence; stone wall
Levee or dyke; quarry
Mine; windpump; yard
Building (s); church; school
Post office; wireless transceiver; cemetery — PO W/T
Control point major, minor; astronomical
Spot elevation in feet; accurate; approximate — ·750 ·750
Bench mark; mud; gravel — BM·750
Waterhole; water tank; dam; dry lake
Lake, river or stream perennial
Lake, river or stream intermittent
Dam or weir; falls; rapids
Drain or ditch perennial, intermittent
Spring perennial, intermittent; ricefields
Marsh or swamp;
Seaplane anchorage; seaplane base
Breakwater, pier, dock or wharf
Fathom line; low water mark; lighthouse — LWM
Wreck sunken, exposed; vessel anchorage
Rocks submerged, bare or awash
Reef, rocky or coral

AIRBORNE SURVEY, WESTERN AUSTRALIA 1970

TOTAL MAGNETIC INTENSITY
AND
GEOLOGY

SCALE 1:250,000

Kilometres 5 0 5 10 15 20 25 30 Kilometres

Miles 5 0 5 10 15 Miles

MAGNETIC CONTOUR INTERVAL 50 GAMMAS

GEOLOGICAL LEGEND

- - - - - Geological boundary

CAINOZOIC — Cz — Alluvium, sand, laterite

LOWER PROTEROZOIC — NULLAGINE "SERIES"
- Ꞓus — Sandstone, quartzite limestone, shale
- Ꞓub — Basalt

ARCHAEAN
- Agt — Granite
- Agn — Gneiss
- MOSQUITO CREEK SERIES — Am — Metasedimentary schist
- WHITESTONE — Aw — Metasedimentary schist jaspilite, quartzite
- GREENSTONE — Ag — Metavolcanic rocks, schists amphibolite, norite, basic lavas

MAGNETIC LEGEND

— 4500 — / — 4450 — Magnetic contours (gammas)

Magnetic "low"

Contour/flight-line intersections

EXPLANATORY NOTES

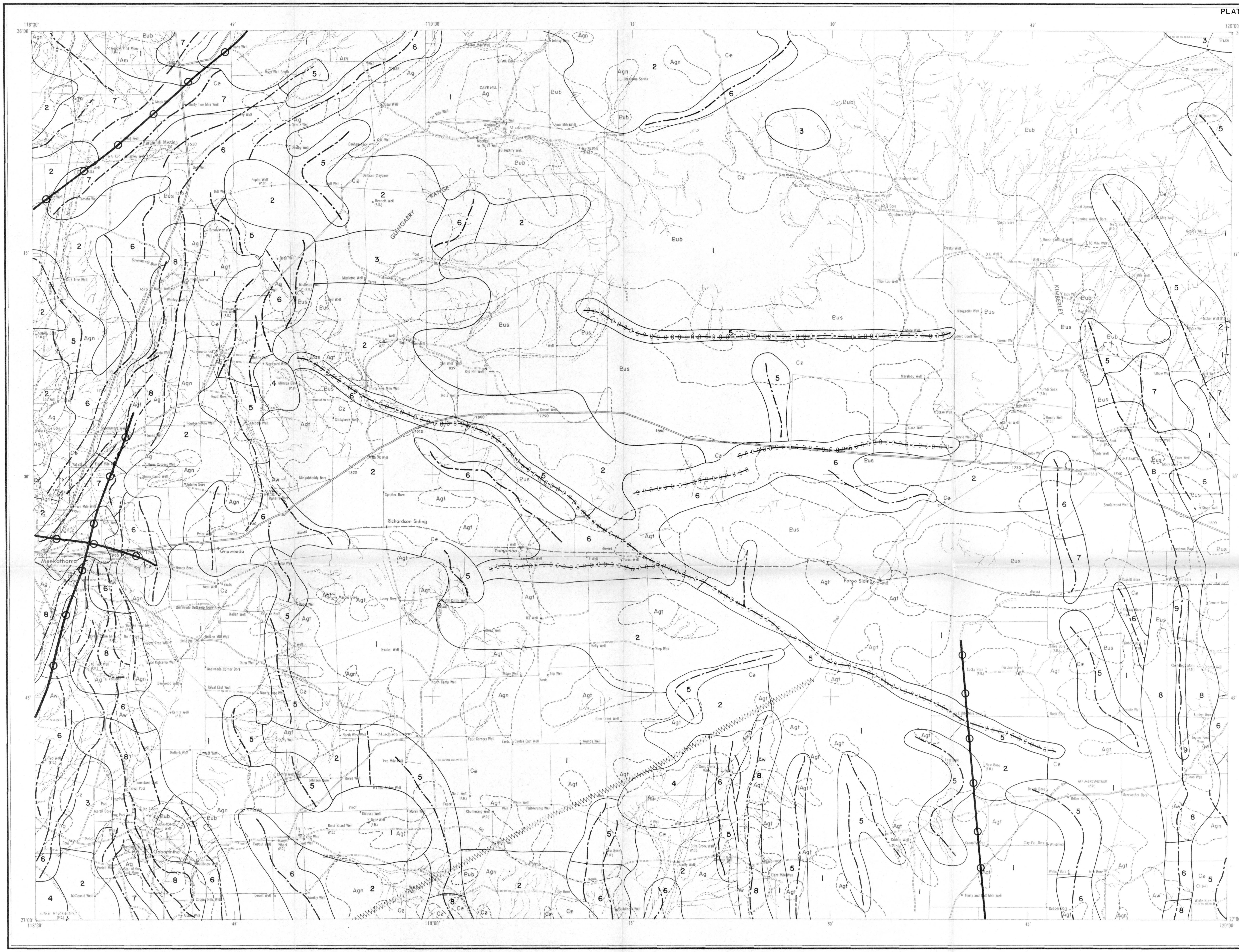
This map was compiled from an airborne magnetic survey of part of Western Australian Goldfields made in 1970 by the Geophysical Resources Development Company under contract to the Bureau of Mineral Resources.
The survey was made by an aircraft at a height of 500 feet above ground level along lines spaced one mile apart.
The total magnetic intensity was recorded by an airborne magnetometer and has not been corrected for the regional gradient in total magnetic field.

Geology based on Lands of the Wiluna - Meekatharra Area, WA 1958. (CSIRO Land Research Series No.7, 1963)

G51/B1-30

AUSTRALIA 1:250,000

GLENGARRY



LOCATION DIAGRAM

MOUNT PHILLIPS SG 50-2	MOUNT EGERTON SG 50-3	COLLIER SG 50-4	BULLER SG 51-1	TRAINOR SG 51-2
GLENBURGH SG 50-6	ROBINSON RANGE SG 50-7	PEAK HILL SG 50-8	NABBERU SG 51-5	STANLEY SG 51-6
BYRO SG 50-10	BELELE SG 50-11	GLENGARRY SG 50-12	WILUNA SG 51-9	KINGSTON SG 51-10
MURGOO SG 50-14	CUE SG 50-15	SANDSTONE SG 50-16	SIR SAMUEL SG 51-13	DUKETON SG 51-14
YALGOO SH 50-2	KIRKALOCKA SH 50-3	YOUANMI SH 50-4	LEONORA SH 51-1	LAVERTON SH 51-2

To accompany Record No. 1972/120

TOPOGRAPHIC LEGEND

Highway; built-up area
Road, sealed surface first class; route marker (79)
Road, sealed surface second class; mileage
Road, loose surface all weather first class
Road, loose surface all weather second class
Road, loose surface dry weather
Road, unimproved earth
Bridge road; bridge railway
Railway multiple track
Railway single track
Light railway or tramway
Station; siding; station with siding
Telephone line; power transmission line
Fence; stone wall
Levee or dyke; quarry
Mine; windpump; yard
Building (s); church; school
Post office; wireless transceiver; cemetery — PO W/T
Control point major, minor; astronomical
Spot elevation in feet; accurate; approximate — 750 750
Bench mark; mud; gravel — BM·750
Waterhole; water tank; dam; dry lake
Lake, river or stream perennial
Lake, river or stream intermittent
Dam or weir; falls; rapids
Drain or ditch perennial, intermittent
Spring perennial, intermittent; ricefields
Marsh or swamp
Seaplane anchorage; seaplane base
Breakwater, pier, dock or wharf
Fathom line; low water mark; lighthouse — LWM
Wreck sunken, exposed; vessel anchorage
Rocks submerged, bare or awash
Reef, rocky or coral

AIRBORNE SURVEY, WESTERN AUSTRALIA 1970

MAGNETIC INTERPRETATION AND GEOLOGY

Kilometres 5 0 5 10 15 20 25 30 Kilometres

Miles 5 0 5 10 15 Miles

GEOLOGICAL LEGEND

- - - - - Geological boundary

CAINOZOIC
Cz — Alluvium, sand, laterite

UPPER PROTEROZOIC — NULLAGINE "SERIES"
Ᵽus — Sandstone, quartzite, limestone, shale
Ᵽub — Basalt

ARCHAEAN
Agt — Granite
Agn — Gneiss
MOSQUITO CREEK SERIES — Am — Metasedimentary schist
WHITESTONE — Aw — Metasedimentary schist, jaspilite, quartzite
GREENSTONE — Ag — Metavolcanic rocks, schists, amphibolite, norite, basic lavas

Geology based on Lands of the Wiluna-Meekatharra Area, WA 1958. (CSIRO Land Research Series N°7, 1963)

GEOPHYSICAL LEGEND

5 — Magnetic zone
Magnetic trend, positive
" " , negative
Magnetic discontinuity
Fold axis
0 0 0 0 — Dyke, Induced magnetisation
Interpreted fault

G50/BI-76

AUSTRALIA 1:250,000

WILUNA

LOCATION DIAGRAM

MOUNT EGERTON SG 50-3	COLLIER SG 50-4	BULLER SG 51-1	TRAINOR SG 51-2	MADLEY SG 51-3
ROBINSON RANGE SG 50-7	PEAK HILL SG 50-8	NABBERU SG 51-5	STANLEY SG 51-6	HERBERT SG 51-7
BELELE SG 50-11	GLENGARRY SG 50-12	WILUNA SG 51-9	KINGSTON SG 51-10	ROBERT SG 51-11
CUE SG 50-15	SANDSTONE SG 50-16	SIR SAMUEL SG 51-13	DUKETON SG 51-14	THROSSELL SG 51-15
KIRKALOCKA SH 50-3	YOUANMI SH 50-4	LEONORA SH 51-1	LAVERTON SH 51-2	RASON SH 51-3

To accompany Record No. 1972/120

TOPOGRAPICAL LEGEND

- Highway; built-up area
- Road, sealed surface first class; route marker
- Road, sealed surface second class; mileage
- Road, loose surface all weather first class
- Road, loose surface all weather second class
- Road, loose surface dry weather
- Road, unimproved earth
- Bridge road; bridge railway
- Railway multiple track
- Railway single track
- Light railway or tramway
- Station; siding; station with siding
- Telephone line; power transmission line
- Fence; stone wall
- Levee or dyke; quarry
- Mine; windpump; yard
- Building (s); church; school
- Post office; wireless transceiver; cemetery — PO W/T C
- Control point major, minor; astronomical
- Spot elevation in feet; accurate; approximate — ·750 ·750
- Bench mark; mud; gravel — BM·750
- Waterhole; water tank; dam; dry lake
- Lake, river or stream perennial
- Lake, river or stream intermittent
- Dam or weir; falls; rapids
- Drain or ditch perennial, intermittent
- Spring perennial, intermittent; ricefields
- Marsh or swamp
- Seaplane anchorage; seaplane base
- Breakwater, pier, dock or wharf
- Fathom line; low water mark; lighthouse
- Wreck sunken, exposed; vessel anchorage
- Rocks submerged, bare or awash
- Reef, rocky or coral

AIRBORNE SURVEY, WESTERN AUSTRALIA 1970

MAGNETIC INTERPRETATION AND GEOLOGY

Kilometres 5 0 5 10 15 20 25 30 Kilometres

Miles 5 0 5 10 15 Miles

GEOLOGICAL LEGEND

- - - - - Geological boundary

CAINOZOIC

- Cz — Alluvium, sand, laterite

UPPER PROTEROZOIC — NULLAGINE "SERIES"

- Ꞓus — Sandstone, quartzite, limestone, shale
- Ꞓub — Basalt

ARCHAEAN

- Agt — Granite
- Agn — Gneiss
- MOSQUITO CREEK SERIES — Am — Metasedimentary schist
- WHITESTONE — Aw — Metasedimentary schist, jaspilite, quartzite
- GREENSTONE — Ag — Metavolcanic rocks, schists, amphibolite, norite, basic lavas

Geology based on Lands of the Wiluna-Meekatharra Area, WA 1958. (CSIRO Land Research Series N°7, 1963)

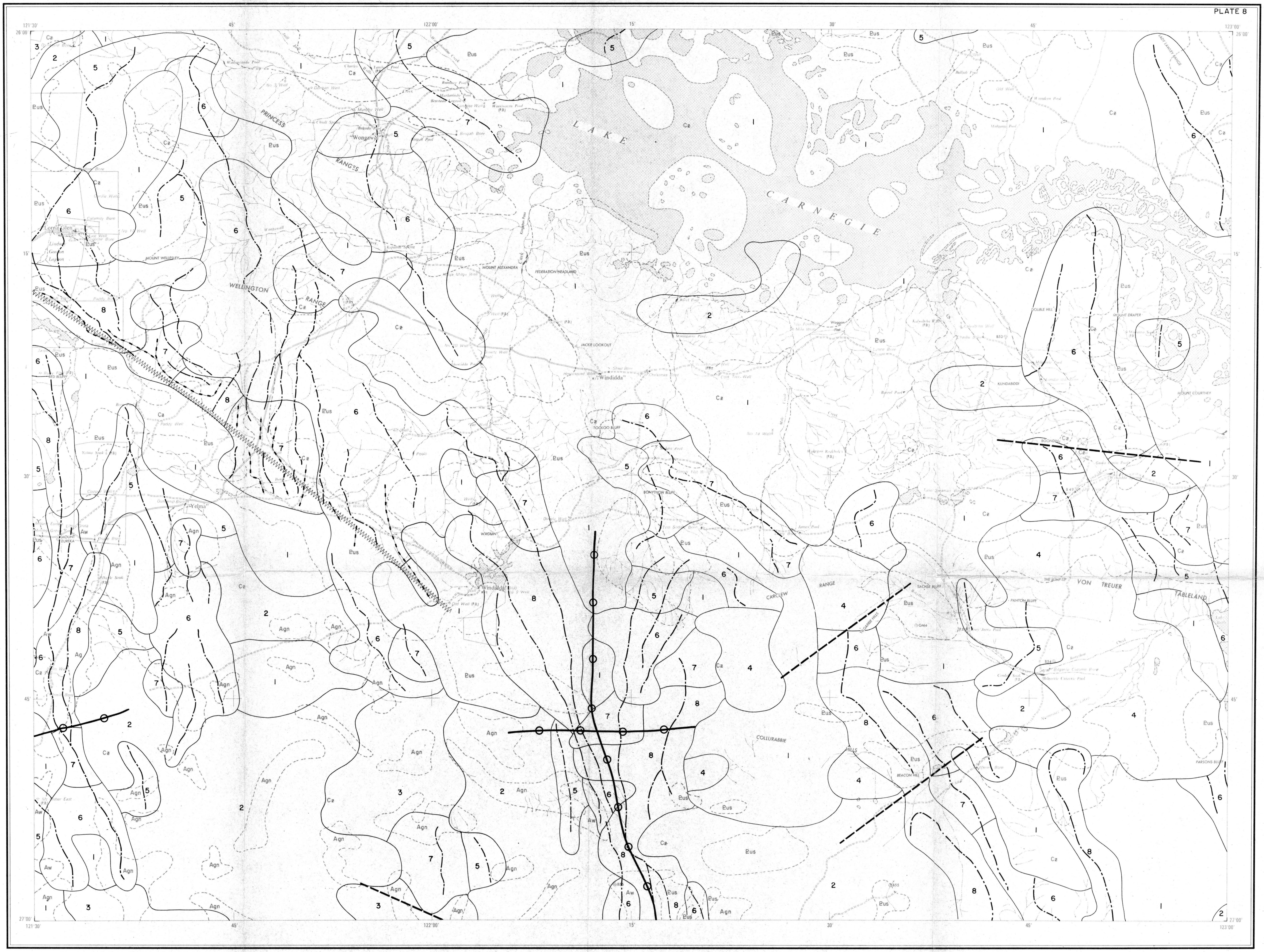
GEOPHYSICAL LEGEND

- Magnetic zone
- Magnetic trend, positive
- " " , negative
- Magnetic discontinuity
- Fold axis
- Dyke, induced magnetisation
- Interpreted fault

G51/B1-26

AUSTRALIA 1:250,000

KINGSTON



LOCATION DIAGRAM

COLLIER SG 50-4	BULLER SG 51-1	TRAINOR SG 51-2	MADLEY SG 51-3	WARRI SG 51-4
PEAK HILL SG 50-8	NABBERU SG 51-5	STANLEY SG 51-6	HERBERT SG 51-7	BROWNE SG 51-8
GLENGARRY SG 50-12	WILUNA SG 51-9	**KINGSTON SG 51-10**	ROBERT SG 51-11	YOWALGA SG 51-12
SANDSTONE SG 50-16	SIR SAMUEL SG 51-13	DUKETON SG 51-14	THROSSELL SG 51-15	WESTWOOD SG 51-16
YOUANMI SH 50-4	LEONORA SH 51-1	LAVERTON SH 51-2	RASON SH 51-3	NEALE SH 51-4

To accompany Record No. 1972/120

TOPOGRAPICAL LEGEND

Highway; built-up area
Road, sealed surface first class; route marker 79
Road, sealed surface second class; mileage
Road, loose surface all weather first class
Road, loose surface all weather second class
Road, loose surface dry weather
Road, unimproved earth
Bridge road; bridge railway
Railway multiple track
Railway single track
Light railway or tramway
Station; siding; station with siding
Telephone line; power transmission line
Fence; stone wall
Levee or dyke; quarry
Mine; windpump; yard
Building (s); church; school
Post office; wireless transceiver; cemetery PO W/T C
Control point major, minor; astronomical
Spot elevation in feet; accurate; approximate ·750 ·750
Bench mark; mud; gravel BM·750
Waterhole; water tank; dam; dry lake
Lake, river or stream perennial
Lake, river or stream intermittent
Dam or weir; falls; rapids
Drain or ditch perennial, intermittent
Spring perennial, intermittent; ricefields
Marsh or swamp
Seaplane anchorage; seaplane base
Breakwater, pier, dock or wharf
Fathom line; low water mark; lighthouse LWM
Wreck sunken, exposed; vessel anchorage
Rocks submerged, bare or awash
Reef, rocky or coral

AIRBORNE SURVEY, WESTERN AUSTRALIA 1970

MAGNETIC INTERPRETATION

AND

GEOLOGY

Kilometres 5 0 5 10 15 20 25 30 Kilometres

Miles 5 0 5 10 15 Miles

GEOLOGICAL LEGEND

- - - - Geological boundary

CAINOZOIC
Cz Alluvium, sand, laterite

UPPER PROTEROZOIC — NULLAGINE "SERIES"
Ɛus Sandstone, quartzite, limestone, shale
Ɛub Basalt

ARCHAEAN
Agt Granite
Agn Gneiss
MOSQUITO CREEK SERIES — Am Metasedimentary schist
WHITESTONE — Aw Metasedimentary schist, jaspilite, quartzite
GREENSTONE — Ag Metavolcanic rocks, schists, amphibolite, norite, basic lavas

Geology based on Lands of the Wiluna – Meekatharra Area, WA 1958. (CSIRO Land Research Series N°7, 1963)

GEOPHYSICAL LEGEND

5 Magnetic zone
Magnetic trend, positive
" " , negative
Magnetic discontinuity
Fold axis
Dyke, induced magnetisation
Interpreted fault

G51/B1-25