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AEROMAGNETIC SURVEY OF GLENBURGH, ROBINSON RANGE, PEAK HILL, NABBERU, AND STANLEY 1:250 000 SHEET AREAS, WESTERN AUSTRALIA, 1972

by

B.W. WYATT

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SUMMARY

An airborne magnetic survey of ROBINSON RANGE, PEAK HILL, NABBERU, STANLEY, and part of GLENBURGH 1:250 000 Sheet areas was flown by Aero Service (Australia) Pty Ltd in 1972 under contract to the Bureau of Mineral Resources. The objectives of the survey were to assist the systematic regional mapping of the Western Australian Precambrian shield and the search for metals.

Interpretation of the magnetic data is primarily qualitative. Geological strikes and boundaries of major structural units have been interpreted by delineating magnetic trends, by dividing the area into zones depending on magnetic character, and by comparing these zones with known geology. Faults and folds have been interpreted from a study of zones and trends.

Geophysical data indicate that the eastern edge of the Carnarvon Basin and the northern margin of the Yilgarn Block are fault-controlled. Greenstone within the Yilgarn Block is widespread and has diverse trends. Within the Bangemall and Nubberu Basins, north of the Yilgarn Block, trends are generally between west and west-northwest except near the margins of the Yilgarn Block, where they are parallel to the margin. Interpreted faults generally strike northeast or northwest. This pattern may be the result of the Bangemall and Nubberu Basins being compressed southwards against the Yilgarn Block.

Banded iron formations give rise to large linear anomalies which indicate structure and possible extensions of known iron ore deposits.

Areas recommended for further work include the fold axes and more anomalous parts of the greenstone belts in the Yilgarn Block, and structurally deformed areas of banded iron formation and anomalous areas in NABBERU and STANLEY.

1. INTRODUCTION

In 1956 the Bureau of Mineral Resources (BMR) commenced an extensive program of airborne surveys in the Archaean Yilgarn Block of Western Australia at the request of the Western Australian Department of Mines. The prime objective was to delineate the boundaries of major rock units and to determine geological structure. By the end of 1970, twenty six 1:250 000 Sheet areas had been surveyed within this region.

This program was continued during 1972 by Aero Service (Australia) Pty Ltd under contract to BMR. Aero Service acquired and processed aeromagnetic data over ROBINSON RANGE, PEAK HILL, NABBERU, STANLEY, NINGHAN, BENCUBBIN, PERENJORI and the eastern third of GLENBURGH, and two thirds of MOORA 1:250 000 Sheet areas*. The data has been contoured by BMR and released to the public.

This Record deals with the interpretation of the five northern Sheet areas - GLENBURGH, ROBINSON RANGE, PEAK HILL, NABBERU, and STANLEY, bounded by latitudes 25°00' and 26°00'S and longitudes 115°30' and 123°00'E. The western two-thirds of GLENBURGH was surveyed by BMR in 1956 and 1957 (Parkinson 1957, Forsyth 1960) as part of the Carnarvon Basin survey; because it includes the western limit of the Precambrian Shield, its magnetic interpretation is included in this Record. The five Sheet areas cover part of the Precambrian shield between the Carnarvon and Officer Basins. The shield contains granites, metasediments, and metavolcanics of the Yilgarn and Gascoyne Blocks in the western part, and Proterozoic sediments and volcanics in the east (Plate 1).

2. PREVIOUS GEOPHYSICAL INVESTIGATIONS

BMR has magnetically surveyed an extensive area to the west and south of the survey area described in this Record. Results of surveys are contained in the BMR Record Series (Parkinson, 1957; Carter, 1959; Mulder, 1960; Forsyth, 1960, 1961; Wells, 1962; Young & Tipper, 1966; Shelley & Waller, 1967; Gerdes, Young, Cameron & Beattie, 1970; Tipper & Gerdes, 1971; Waller &

* In this record, names of 1:250,000 sheet areas are printed in capitals to distinguish them from place names.

Beattie, 1971; Lambourn, 1972; Wyatt, 1975). These surveys provided data for basement depth calculations, delineated the margins of the Perth and Carnarvon Basins, and outlined the geological structure in the Precambrian shield.

The magnetic data from MENZIES and LEONORA (Young & Tipper, 1966), and from all shield areas subsequently surveyed by BMR, 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). Numerous fold axes and cross-fold axes have been interpreted by tracing the anomalies due to interbedded magnetite-rich rock units. Meridional anomalies of the order of 1000 nT, are calculated to be due to susceptibility contrast in the range .025 to .037 SI units, and have been attributed by BMR authors to ultrabasic serpentinite bodies. Anomalies of larger amplitude, approaching 10 000 nT are calculated to be due to susceptibility contrast in the range 0.3 to 5.0 SI units, and have been attributed to jaspilite. Areas having a relatively flat magnetic field have been ascribed to near-homogeneous acid igneous rocks or to non-magnetic sedimentary sequences. In several areas, strongly magnetic ultrabasic intrusions are thought to be of economic significance and have been recommended for ground investigation.

Aero Service (Australia) Pty Ltd made a reconnaissance aeromagnetic survey over the area east and northeast of STANLEY for Union Oil Company of California. This survey outlined an extensive area of short-wavelength anomalies east of STANLEY; these were attributed to lava flows at or near the surface, or to a high degree of shallow intrusion in the form of sills and dykes (Lynch, 1965).

Regional gravity surveys have been made over the area by BMR (Plate 7). The gravity data for the western part of GLENBURGH have been described by Chamberlain, Dooley, & Vale (1954). General reference to the Bouguer anomaly maps is made in the interpretation section of this Record.

Geophysical investigations at Thaduna in PEAK HILL have been described by Rowston (1964).

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3. GEOLOGY

INTRODUCTION

The GLENBURGH, ROBINSON RANGE, PEAK HILL, NABBERU, and STANLEY 1:250 000 areas form part of the great interior plateau of Western Australia, with a general elevation of between 500 and 700 m above sea level. The eastern part has internal drainage terminating in salt lakes, while the western half is drained by the Gascoyne, Murchison, and Wooramel Rivers. The land surface is lateritised, duricrusted, and covered with aeolian sands. Some mesas and buttes are capped with laterite. The resistant rock units such as banded iron formations form prominent ridges with elevations of a few hundred metres.

The geology of the area is not well known. Johnson (1950) made a general reconnaissance in GLENBURGH and ROBINSON RANGE. PEAK HILL and the basin part of GLENBURGH have been mapped at 1:250 000 scale (MacLeod, 1970; Condon, 1962). NABBERU and STANLEY have been described only briefly by Sanders & Harley (1970) and mapped at 1:2 500 000 scale by Horwitz (1975). Mapping of ROBINSON RANGE at 1:250 000 scale is in progress.

The Precambrian shield is bounded to the west by the Carnarvon Basin and to the east by the Officer Basin. The oldest part of the shield is the Archaean Yilgarn Block, which crops out in the southern parts of GLENBURGH, ROBINSON RANGE, PEAK HILL, and NABBERU. The Gascoyne Block adjoins the northwest part of the Yilgarn Block in GLENBURGH. The remainder of the shield is occupied by Proterozoic rocks in the Nabberu and Bangemall Basins (Plate 1).

STRATIGRAPHY

Archaean basement

The Yilgarn Block is the oldest part of the Australian shield. It is made up essentially of gneiss with lenticular areas of greenstone (metavolcanics) and whitestone (metasediments) intruded by dolerite and massive granite (Prider, 1965).

In NABBERU, the metasediments are water-laid acid tuff, sandstone, banded chert, and banded iron formations with minor black shale and greywacke (Sanders & Harley, 1970).

The metasediments of the Yilgarn Block are interbedded with volcanics which range from acid to basic in composition. They are intruded by plugs and semi-concordant sills of metadolerite of considerable extent and thickness.

In GLENBURGH and ROBINSON RANGE, Johnson (1950) has not differentiated between the Yilgarn and Gascoyne Blocks. He recognised quartzite, jaspilite, andalusite-bearing, and kyanite-bearing quartzites, sillimanite-garnet gneiss, quartz mylonite gneiss, muscovite quartzite, hornblende-feldspar quartzite, epidote-diopside hornfels, calcite-feldspar-chlorite hornfels, quartz-mica schist, chert, knotenschiefer, graphite schist, and phyllite.

Most of the present Archaean surface was subjected to two periods of deep weathering: one before the Proterozoic sediments were deposited, and the other after their removal by stripping. Weathering is greater than 150 m in places.

Lower Proterozoic

The Gascoyne Block is shown on the Tectonic Map of Australia and New Guinea (Geological Society of Australia, 1971) as Archaean, but Horwitz (1975, 1976) has referred to it as probably Lower Proterozoic, and has tentatively equated the granites in PEAK HILL with the granitic rocks of the Gascoyne Block.

McLeods's (1970) mapping of PEAK HILL included the units with banded iron formations and the north-northeast-trending granite core as Archaean; he considered that the sediments in the southeast were part of the Bangemall Basin. More recent work by Horwitz (1975) and Hall & Goode (1975) assign all of these to the Lower Proterozoic: MacLeod's Peak Hill Beds are equivalent to the Malmac or Yelma Formation (Nabberu Basin); and the Horseshoe Range Beds Labouchere Beds, and Robinson Range Beds are equivalent to the Frere Formation (Nabberu Basin), which is correlated in a general way with the Hamersley Group.

Hall & Goode (1975) described the Nabberu Basin as follows:

> 'It extends at least 600 km in an ESE-WNW direction and is about 120 km wide in the vicinity of Lake Carnegie. The sediments lie unconformably on an Archaean granite/greenstone basement, and are unconformably overlain by the Middle-Upper Proterozoic Bangemall Group to the

north. In the east, the Nabberu sediments are intruded by dolerites and are partly concealed beneath sediments of the Officer Basin. The Nabberu Basin is thought to be Lower Proterozoic in age on regional grounds, and on limited absolute age dating evidence.

In the least metamorphosed southeastern area, the basin is occupied by about 6000 m of shallow water sediments. Thin quartzose to arkosic clastics (Yelma Formation) at the base rest unconformably on Archaean rocks, and are overlain by chert, shale, banded iron formation and minor carbonate (Frere Formation), and thinly bedded carbonate, shale and sandstone (Windidda Formation). The overlying Wandiwarra Formation (sandstone and shale) is locally transgressive and disconformable, and steps over onto the Frere Formation. The Wandiwarra Formation is conformably overlain by clean supermature sandstones and siltstones (Princess Ranges Quartzite), siltstones and fine sandstones (Wongawol Sandstone), thinly bedded carbonate, shale and fine sandstone (Sholl Creek Formation) and the Kulele Creek Limestone.'

In PEAK HILL the sediments are intruded by dolerites and a layered basic complex, and by extensive areas of granite. The granite contains large rafts of basic and ultramafic rocks (Horwitz, 1975).

Carpentarian

Horwitz (1975) has mapped a unit containing conglomerate, grit, glauconitic sandstone, shale, greywacke, and carbonate beds in the southwest of PEAK HILL and in the south of STANLEY. The unit is unconformable on Lower Proterozoic and Archaean rocks, and in PEAK HILL contains abundant detrital granite fragments believed to be derived from the Lower Proterozoic granites.

Adelaidean or Carpentarian

The northern parts of ROBINSON RANGE, PEAK HILL, NABBERU, and STANLEY are occupied by the southern margin of the extensive Bangemall Basin (Daniels, 1966). The rocks, mainly of sedimentary origin, comprise quartzite, shale, and dolomite, with minor banded iron formation, greywacke, conglomerate and limestone.

The Proterozoic sediments have been intruded by fine to medium-grained dolerite sills, plugs, and dykes. Some sills are up to 70 m thick and can be followed for tens of kilometres. Unlike the Archaean dolerites these rocks are unmetamorphosed.

Sanders & Harley (1970) have reported two sulphide-rich granophyric intrusions on the southwestern side of the Parker Ranges dolerite in STANLEY.

Permian

Some Permian rocks of the Officer Basin are unconformable on Proterozoic rocks in the eastern part of STANLEY. The outcrops are deeply weathered, partly ferruginised shales with occasional erratics mainly of granite and quartzite and localised layers of siltstone and sandstone (Sanders & Harley, 1970).

Condon (1962) has described the Permian rocks in GLENBURGH. These form the Merlinleigh, Bidgemia, and Byro Sub-Basins on the eastern side of the Carnarvon Basin. The total sedimentary thickness is about 3000 m and consists mainly of quartz greywacke and siltstone with some shale, quartz sandstone, and boulder beds.

Tertiary and Quaternary

Most of the area is covered by a veneer of sand plain, lake deposits, desert eolian sands, and alluvial, colluvial, and calcrete valley fill. Ferruginous laterite and siliceous duricrust cap most of the Archaean and Proterozoic schist, gneiss, and basic dykes, and the Permian sediments.

STRUCTURE

Archaean structure

In the Yilgarn Block south of the survey area, belts of granite and metamorphic rock are elongated in a north-northwesterly direction. The metamorphic belts are regarded as synclinorial remnants while the granites occupy broad anticlinal tracts or elongated domes. Gneiss forms peripheral granitised zones with circumferential foliation trends which are also conformable with the strike of the adjacent metamorphic rocks.

Towards the northern part of the Yilgarn Block the trends parallel the margin. In NABBERU the Archaean rocks have a characteristic vertical dip with a northwesterly to northerly strike while in GLENBURGH they trend northeasterly to easterly.

The Gascoyne Block, which lies to the north of the Yilgarn Block and may incorporate parts of it, contains large northeast shear zones and intense northwesterly isoclinal folds (Warren, 1972). Near the Carnarvon Basin the trends are generally east, except in the Carrandibby Range Inlier, where trends are northward. The boundary between the Yilgarn and Gascoyne Blocks is shown in the Tectonic Map of Australia and New Guinea, 1971, as a large northeast-trending fault.

Proterozoic structure

The rocks of the southern margin of the Nabberu Basin dip gently to the north. Deformation increases north across the basin, until along the northern margin large asymmetric folds are slightly overturned southwards, and are accompanied by north-dipping thrusts. The fold belt trends west-northwest across the eastern portion of the basin before swinging to the southwest. To the north and west the Archaean basement becomes increasingly involved in the deformation, and becomes progressively more gneissic as the Lower Proterozoic rocks become more strongly schistose. The sediments are essentially unmetamorphosed in the southeast part of the basin, but become progressively more metamorphosed towards the fold belt, reaching a maximum grade of granulite facies west of the Robinson Range (Hall & Goode, 1975).

Folding and related cleavage in the Bangemall Basin also increases from south to north. Horwitz (1975) observed that the pattern of folding in the Proterozoic sediments on the northern flank of the Yilgarn Block is the mirror image of that on the southern flank of the Pilbara Block, to the north.

Permian structure

Condon (1962) has mapped several north-striking folds within the Carnarvon Basin, but it is not clear whether the numerous linear stratigraphic and structural discontinuities represent unconformities or faults. The contact between Permian sediments and Precambrian schist at Mount Madeline has been shown by drilling to be steeper than 40°.

ECONOMIC GEOLOGY

The Peak Hill area has been the site of important gold, manganese, and copper production and there are substantial reserves of low-grade iron ore in the district.

Gold

7500 kg of gold and 65 kg of silver were produced from Peak Hill to 1967. At Peak Hill the gold occurs in wide persistent lodes in the older sedimentary sequences. The host rocks include thin banded iron formations interbedded with schists. The lodes have been interpreted as fault lines which are the sites of quartz vein intrusion. Elsewhere in the district, gold is usually found in quartz reefs at or near the boundaries of the metadolerite intrusions. Some alluvial gold has been recovered (MacLeod, 1970).

Copper and Zinc

Over 30 000 tonnes of cupriferous ores averaging nearly 8 percent copper have been produced from the Thaduna copper lode and surrounding Green Dragon and Lees deposits. Copper has been mined from Dalgety Downs (12 tonnes) in GLENBURGH and from around Horseshoe (about 100 tonnes to 1960) in ROBINSON RANGE and PEAK HILL.

Blockley (1968) has interpreted the regional structure of the Thaduna copper field as a broad anticlinorium in which the mineralisation occurs in the basal units of the succession exposed in the core of the regional fold. The main lode occupies a northwest-trending fault zone in brecciated greywacke and siltstone.

Copper mineralisation is also associated with gold-bearing quartz reefs, but none appears to be of economic significance (Low, 1963).

Some formations within the Bangemall Group contain unusually high amounts of copper and zinc, but no ore bodies have been found to date (Blockley, 1971).

Manganese

The Horseshoe manganese deposits in PEAK HILL produced about 480 000 tonnes of ore to the end of 1968. The ore contains about 35 to 40 percent manganese and 15 to 20 percent iron. They are classed as bog manganese ores and occupy drainage lines or fossil lakes and swamps. They are derived from sediments of the Horseshoe Range.

Manganese has been produced from near Mount Fraser in ROBINSON RANGE and from near Peak Hill. Abput 200 tonnes of low-grade ore has been recorded near the western edge of NABBERU (de la Hunty, 1963).

Iron ore

The banded iron formations in the Robinson Range Beds in PEAK HILL and ROBINSON RANGE are the host rocks for numerous hamatite deposits. In places, silica leaching has left residual hematite which has been recrystallised to a massive high-grade hematite ore (MacLeod, 1965, 1970; Sofoulis, 1970).

Iron formations have also been reported at Mount Gould (15 000 000 tonnes) and Mount Taylor (150 000-200 000 tonnes; Johnson, 1950) and Mount Fraser (MacLeod, 1970) in ROBINSON RANGE.

During regional folding the banded iron formations tend to thicken at fold crests so that, when the pitch of the fold is near-vertical, supergene enrichment may produce hematite and limonite bodies of economic size (Warren, 1972).

Petroleum

The Permian sequence in the east of GLENBURGH is about 3000 m thick and includes formations of both source-bed and reservoir type. Stratigraphic traps may occur in the anticlines between the three sub-basins or against abutment unconformities to the east of Carrandibby Range and along the eastern margin of the Carnarvon Basin (Condon, 1962).

Graphite

Johnson (1950) reported a small lens of graphic schist on Glenburgh station.

Talc

Johnson (1950) reported a talc lens 70 m long and 3 m wide in the nose of a drag-fold near Mount Taylor in ROBINSON RANGE.

Uranium

Some carnotite deposits occur in calcrete drainages of the area. Subeconomic mineralisation occurs at Lake Nabberu and in the upper Gascoyne drainages (Horwitz 1975).

4. MAGNETIC RESULTS AND INTERPRETATION

The magnetic data are shown in Plates 2 to 6 as total magnetic intensity contours at a scale of 1:250 000. Interpreted faults, fold axes, and magnetic trends and zones are included in these plates. The upper part of Plate 7 is a magnetic interpretation of regional geology at a scale of 1:1 000 000.

The data have been qualitatively analysed by delineating magnetic trends and zones. A magnetic trend is defined as the line joining the maxima or minima of anomalies which are together attributed to one continuous magnetic body. Except for perfectly symmetrical anomalies, the trends do not exactly coincide with the axis of the magnetic bodies. The axis is generally located towards the negative part of the anomaly by an amount which is a function of the body's dip and strike angles.

Magnetic zones have been delineated by considering the character and direction of magnetic trends, including the dominant amplitude range. The boundaries of such zones often coincide with rock type boundaries or faults, or both.

Structural features have been interpreted mainly from the trends and zones. Faults are interpreted from the collinear termination of magnetic trends and zones or by abrupt changes in trend direction. Folds have been interpreted from a symmetric or asymmetric repetition of zones and/or individual anomalies.

Some anomalies have been quantitatively analysed to determine depths and dips of magnetic bodies. These interpretations are based on the methods described by Peters (1949), Grant & Martin (1966), and Koulomzine, Lamontagne, & Nadeau (1970). Most depths are not very accurate because the flight lines parallel the major axes of the anomalies.

The boundaries of the Yilgarn Block have been determined from a consideration of the Tectonic Map of Australia and New Guinea, 1971; the mapping of Horwitz (1975, 1976); and the magnetic data. The characteristics of the various types of magnetic zones within this block are listed in Table 1.

Table 1. CHARACTERISTICS OF MAGNETIC ZONE TYPES

Zone type	Anomaly amplitude (nanoteslas)	Magnetic linearity
1	less than 50	poor
2	50 to 100	poor
3	100 to 250	poor
4	greater than 250	poor
5	less than 100	good
6	100 to 250	good
7	250 to 500	good
8	500 to 4000	good
9	greater than 4000	good

The anomaly range quoted for each type includes most, but not necessarily all, of the anomalies in any zone of that type.

The geological significance of these zone types 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 are next to zones of types 5, 6, 7, or 8, they may indicate sedimentary sequences. Zones of type 4 are attributed to basic or ultra-basic intrusions in granitic areas, or to greenstone belts of complex structure with no recognisable linearity.

In granitic areas, zones of types 7, 6, and 5 (in order of decreasing basicity) are generally interpreted as basic dykes where they are narrow, and as areas of partial assimilation of greenstone belts where 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 9 generally indicate banded iron formations.

No attempt has been made to apply this zonal classification to the north of the Yilgarn Block. Where appropriate, boundaries of anomaly groups have been determined, and zones so formed ascribed an alphabetical reference. The significance of these zones is described individually.

COMPARISON BETWEEN MAGNETICS AND GEOLOGY

Zone A (Plate 2)

This zone corresponds to an area of Precambrian outcrop within the Permian basin. The major anomalies are up to 800 nanoteslas in magnitude and trend north-northeasterly, parallel to the Carrandibby Range. Cross-cutting faults are common. The sharp boundary on the southeastern side of the zone correlates with a steep gravity gradient and is caused by the steep margin to the Byro Sub-basin. The boundary to the north is not so well defined, possibly indicating a shallower basin slope.

Zone B (Plate 2)

Zone B contains anomalies with interpreted depths of 0 to 300 m. It coincides with a positive gravity anomaly and Precambrian outcrop and is part of the Carrandibby Ridge between the Byro and Bidgemia Sub-basins.

Zone C (Plate 2)

The Carnarvon Basin contains broad anomalies of a few hundred nanoteslas amplitude. The eastern edge of the basin is controlled by northwest-trending faults. Interpretation of anomalies indicates depths to magnetic basement of 1000 and 1450 m, north of zone A; 500 and 1350 m east of zone A; and 1850 m southeast of zone A. The deepest part of the basin within GLENBURGH is in the southwest where the thickness of sediments is in the order of 5000 m. Zone C correlates well with a negative gravity anomaly. The Carrandibby and Weedarra Ridges, seperating the Merlinleigh, Bidgemia, and Byro Sub-basins, are indicated by a combination of gravity and magnetic features and mapped geology (Condon, 1962).

Zone D (Plate 2)

Anomalies in this part of the Gascoyne Block range up to 1000 nanoteslas in amplitude and trend either northwest, parallel to the edge of the basin, or northeast. Zone D and the adjoining parts of zones E and F correspond to a gravity high.

Zone E (Plate 2)

Most anomalies in this zone trend easterly and are of a few hundred nanoteslas amplitude. The anomalies are cut by numerous inferred faults which mainly strike northwest.

Zone F (Plates 2,3)

This zone contains anomalies up to 30 km long and about 500 nanoteslas magnitude. The anomalies trend east to northeast. The northern boundary corresponds to the contact between granite (zone H) and metamorphosed sediments. The western boundary coincides with the boundary of the Carnarvon Basin and is controlled by two fault systems striking northwest to west-northwest and northeast to east-northeast. The southern boundary corresponds to the boundary between the Yilgarn and Gascoyne Blocks and is interpreted as a major fault line. One east-trending fold axis has been interpreted.

Zone G (Plates 2,3)

This zone contains east-trending anomalies ranging in amplitude up to 700 nanoteslas. Depths to magnetic sources are in the order of 1000 to 2000 m. The eastern boundary of the zone is not well-defined and has been delineated solely by anomaly amplitude. This boundary approximates the boundary between the Gascoyne Block and the Bangemall Basin as shown on the Tectonic Map of Australia and New Guinea. The western part of this zone is mapped as schist and gneiss, which appear to continue to the east under alluvial cover.

An east-trending fold axis has been interpreted from the symmetrical distribution of anomalies. A west-northwest-trending fault along Jingle Creek has displaced anomalies by about 5 km. Another interpreted fault strikes southwesterly from Mount Gascoyne Creek for about 80 km and coincides with a 20-km-long quartz vein photointerpreted by Condon (1962). This fault line is also collinear with the southeastern boundary of the Carrandibby Range Inlier.

Zone H (Plate 2)

Zone H is magnetically very quiet. The western part of the zone is mapped as granite, which is interpreted to extend east - under alluvium - to the GLENBURG boundary.

Zone I (Plate 3)

Johnson (1950) mapped part of the zone as granitised greenstone and metasediments which have been intruded by fine-grained granite dykes. It contains anomalies of about 1000 nanoteslas with no well-defined trend direction. Interpreted depths to magnetic sources are between 400 and 700 m. The zone boundaries are distinct and are interpreted as fault lines. Magnetic trends in zone J wrap around the northern and western boundaries of zone I. The gravity gradient which is normally associated with the boundary of the Yilgarn block occurs somewhat to the north of the southern edge of the zone.

The simplest explanation for the observed gravity and magnetic data is that Zone I is a downfaulted block of Yilgarn greenstone which has had Bangemall Group sediments deposited over it.

Zone J (Plates 2, 3, 4)

Zone J extends across the northern part of the area from the eastern boundary of GLENBURGH to the granite in PEAK HILL as mapped by MacLeod (1970). The southern boundary has been taken as the sharp change in magnetic character at the northern margin of the Yilgarn Block and zones I and K. The anomalies range up to a few hundred nanoteslas and are generally quite broad. The major trends vary between northeast and east-southeast and appear to be draped round the margin of zones I and K and the Yilgarn. Most interpreted faults strike either northeast or northwest. The fault on the eastern end of the Sawback Range (Johnson, 1950) is extended by the magnetics to the northern survey boundary.

Two north-trending fold axes have been interpreted in ROBINSON RANGE from the symmetric distribution of anomalies. The fold axes in PEAK HILL are in good agreement with mapped geology.

Two broad anomalies of 700 nanoteslas amplitude at the northern edge of PEAK HILL have interpreted depths of about 1500 m.

A number of dolerite dykes and sills have been mapped by MacLeod (1970), but these have no magnetic expression.

Zone K (Plates 3, 4)

Elongated linear anomalies of several thousand nanoteslas magnitude are most prominent and correlate well with mapped outcrops of Robinson Range Beds and Horseshoe Range Beds. Anomalies due to these banded iron formations can be traced from the mapped PEAK HILL into the Mount Fraser area in ROBINSON RANGE. Lewis (1970) has mapped part of this region and found the main structural trend to be east-northeasterly with a north-northeasterly cross-fold direction. The anomalies extending west and north from Mount Padbury are interpreted as due to banded iron formations.

The Horseshoe Range Beds appear to be more extensive than mapped in the area east of Peak Hill.

The Peak Hill Beds are quite anomalous, the larger anomalies indicating the presence of beds of banded iron.

The anomalous zone trending east for 15 km from Mount Fraser homestead probably corresponds to further banded iron formation beneath the Quaternary cover.

Zone L (Plate 4)

Most of this zone corresponds to mapped outcrop of Lower Proterozoic granite. The northwest part of the zone is mapped as Bangemall Group, which may be a relatively thin veneer over a more extensive area of granite.

Zone L contains anomalies with a very persistent northeasterly trend. Anomaly amplitudes are generally less than 100 nT with the exception of one linear band of anomalies near the centre of the zone. These anomalies, with amplitudes up to several thousand nanoteslas, correspond to metasediments or dolerite intrusions within the granite.

Several northwest-trending faults have been interpreted from the collinear termination of low-amplitude anomalies. Two interpreted faults in the adjacent zones J and M parallel the northeast trends and boundaries of zone L and may be genetically related to the granitic intrusion.

Zone M (Plates 4, 5)

This zone is magnetically quiet except for isolated anomalies ranging up to a few hundred nanoteslas, and a north-northwest-trending line of anomalies up to 1000 nT in the west of NABBERU. There are no anomalies related to the mapped dolerite sills and dykes in the southeastern corner of PEAK HILL, but a negative anomaly of 150 nT corresponds to a small dolerite outcrop at $25^{o}06'S$, $119^{o}59'E$.

The line of anomalies which trends north-northwest through Eddie Hill coincides with the flank of a prominent gravity high. A manganese deposit on this line has been briefly described by de la Hunty (1963) as a thin skin of ore on ferruginous laterite. The country rocks are metasediments intruded by quartz in places.

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Zone N (Plate 4)

Zone N contains anomalies of up to a few hundred nanoteslas with well developed northeast trend. Three interpreted faults trend roughly northwest. The zone corresponds to a Bouguer anomaly low and has been mapped as granite.

The age of this granite is given by MacLeod (1970) and Horwitz (1975) as Archaean, and more recently by Horwitz (1976) as Lower Proterozoic. The similarity of the magnetic trend patterns in this zone and zone L suggest a similar source hence a Lower Proterozoic age is favoured.

Zone O (Plates 5, 6)

This is a relatively quiet zone with a few long-wavelength anomalies of up to 500 nT amplitude. These anomalies parallel zone P, which trends westerly and east-southeasterly. Interpreted depths to the anomaly sources are in the range 1200 to 2200 m.

In the western part of Zone O a negative and a positive trend located in the western flank of a Bouguer anomaly high cut across the general trend of the anomalies in this zone and may be related to the northeast fold system mentioned by Sanders & Harley (1970).

Zone P (Plates 5, 6)

This elongated zone extends east-southeast across NABBERU and STANLEY and contains positive anomalies of several thousand nanoteslas amplitude. It corresponds to banded iron of the Frere Formation, near the base of the Nabberu Basin. Structural deformation is apparent near the centre and ends of the zone, but more detailed surveying would be required to interpret this in detail.

Zone Q (Plate 5)

A band of negative anomalies with amplitudes in the range 1000-2000 nT trends east-southeasterly along the Frere Range. These anomalies are due to the southern edge of the banded irons of the Frere

Formation, and are collinear with those of zone R and with similar negative anomalies in WILUNA and KINGSTON to the south (Lambourn, 1972). They indicate the boundary between the Yilgarn Block and the Nabberu Basin.

Zone R (Plate 5)

Zone R contains predominantly negative anomalies over the north, east, and south sides of the Lake Teague Ring Structure. Butler (1974) has mapped a synclinal ring of sediments around a pink leucocratic granite core. He proposed two possible origins for the structure, namely the intrusion of the granite plug or a meteorite impact. The interference of mild folds is proposed by Horwitz (1975) as another hypothesis, but this does not appear sufficient to explain the vertical dips mapped at the sediment-granite contact.

Zone S (Plate 5)

Anomalies in Zone S range from a few hundred to over a thousand nanoteslas and trend roughly east-west. Most anomalies are negative and are due to sources at depths of a few hundred metres. These sources are probably dolerite, gabbro, or granophyre intrusions within the Bangemall Group.

Zone T (Plates 5, 6)

This is a relatively quiet zone corresponding to non-magnetic sediments of the Nabberu Group and possibly part of the Bangemall Group.

Zone U (Plates 5, 6)

This zone is characterised by a distinctive pattern of short-wavelength anomalies with no well-defined trend direction. The area is part of the Bangemall Basin and anomalies are due to a large area of near-surface basic lava flows or to a high degree of shallow intrusion in the form of sills and dykes. About half of the anomalies are due to reversely magnetised sources, and some of the higher-amplitude anomalies (around 1000 nanoteslas) may indicate granophyre intrusions similar to those in zone V.

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Several faults have been interpreted from changes in trend direction and from linear gradients. Most of these strike north-northeasterly, east-northeasterly, or east-southeasterly.

This zone extends into the western half of the adjoining HERBERT Sheet area (Lynch, 1965).

Zone V (Plate 6)

Zone V mainly contains negative anomalies with no distinctive trend direction. The anomalies, of a few thousand nanoteslas amplitude, are due to intrusive complexes of dolerite, gabbro, and granophyre (Sanders & Harley, 1970; Horwitz, 1975).

Yilgarn Block

GLENBURGH area (Plate 2). The boundary of the Yilgarn block is well-defined and indicates a major tectonic feature. It forms an arcuate trend, the strike changing from 40° near the Carnarvon Basin to 70° at the eastern edge of the Sheet area.

There is a high density of anomalies with amplitudes ranging up to 2000 nanoteslas. Most anomalies are oriented between NNW and northeast, but near the margin of the block they swing round to become parallel to the margin.

Although this region is mapped as one of granite and gneissic rocks, the magnetic data show many features characteristic of greenstone belts. The zones of type 2 and 3 probably indicate areas of granite or gneiss.

Two 'hour-glass' anomalies have been interpreted as cross-folds, and several faults are apparent.

ROBINSON RANGE area (Plate 3). Most of this area is anomalous, and trend directions vary from northeast in the southern part, through north and northwest in the centre to become westerly near the northern margin.

Much of the Yilgarn Block in ROBINSON RANGE can be classified as greenstone, with the possible exception of some of the areas of zone types 2 and 3 in the south; these are probably due to granite intrusions.

One fold has been interpreted from the symmetrical distribution of anomalous zones, and several faults are inferred by the collinear termination of zones and trends. The faults generally trend north-northeasterly or north-northwesterly. The northern border of the Yilgarn Block is taken as the arcuate change in magnetic character which trends between 70° in the west to 130° in the east.

A belt of zone types 8 and 9 extends south from Mount Gould to Mount Taylor, then southwest to Mount Hale and the Jack Hills Range in the adjoining BELELE Sheet area. Several known iron ore bodies exist within this region, and the anomalous area south of Mount Taylor is recommended for further investigation. Although considered here as Archaean, this belt may in fact be an extension of the Lower Proterozoic banded iron formations to the east, as indicated by Horwitz (1976).

Zones of type 8 and 9 near Mount Maitland and type 7 west of Red Hill correspond to outcrops of metamorphosed basic lavas and bedded igneous rocks (Johnson, 1950). The magnitude of the anomalies directly north of Mount Maitland indicates banded iron formation.

PEAK HILL area (Plate 4). The metamorphosed intrusive and extrusive basic rocks mapped by MacLeod (1970) in the southwest corner of the Sheet area have no associated magnetic anomalies.

NABBERU area (Plate 5). The western boundary of the Yilgarn Block in NABBERU is a fault interpreted from a magnetic gradient and truncation of anomalies. The northern and eastern boundaries are defined by the large negative anomalies due to banded iron formations in the overlying Lower Proterozoic sediments.

Most of the area is of zone types 2 or 3 which have virtually no magnetic trends. A few zones of type 5, 6, 7, and 8 trend roughly northwest; these may be due to partially assimilated greenstone belts within an area of granite or gneiss, or both.

STRUCTURE

Plate 7 shows the major interpreted faults, folds, magnetic trends, and structural boundaries. Many of these features are probably generalizations of more complex features.

Yilgarn Block

The northern boundary of the Yilgarn Block appears to be fault-controlled in GLENBURGH at its contact with the Carnarvon Basin and Gascoyne Block. In ROBINSON RANGE, a downfaulted block of Yilgarn greenstone may extend from the Yilgarn boundary shown in Plate 7 to the major east-west fault situated to the north. In PEAK HILL and NABBERU the boundary is not well defined and is based on available geology. Quite a few faults have been interpreted within the Yilgarn Block; their strikes range from northwest to north-northeast.

Two cross-folds have been interpreted from 'hour-glass' anomaly patterns in the western part of the block; the fold axes of both trend 65° and 335°. Elsewhere folds have been interpreted by a consideration of magnetic anomaly forms and zonal configurations.

The direction of magnetic trends varies considerably throughout this part of the Yilgarn Block. This is in contrast to the extensive area farther south, where trends are mostly oriented north-northwest. In the southern 15 to 20 km of GLENBURGH and ROBINSON RANGE, anomalies trend between north and northeast. North of this strip the trend direction changes by 90° to become parallel to the northern margin of the Yilgarn Block.

The few anomalies within the Yilgarn in NABBERU trend northwest or west.

The greenstone areas of the Yilgarn Block generally have a more positive Bouguer anomaly than the other structural blocks. There is a difference of 50 mgals across the boundary to the Carnarvon Basin, and 20 to 40 mgals across the boundary to the Gascoyne Block and Bangemall Basin in GLENBURGH and ROBINSON RANGE.

Gascoyne Block

Most anomalies in the main part of the Gascoyne Block trend easterly to east-northeasterly. Near the edge of the Carnarvon Basin and in the Carrandibby Range Inlier the trends are north-northwesterly and north-northwesterly respectively.

Three generalized fold axes within the block trend eastwards. Interpreted faults strike either northeast or northwest, and the southern boundary of the Carnarvon Basin in the survey area appears to be controlled by this fault system. The easterly fold axes and northeasterly and northwesterly faults may be due north-south compression.

The western part of the Gascoyne Block has a positive gravity anomaly and contains a much larger density of magnetic anomalies than in the east. It is faulted, strongly folded, and intruded by acid and basic dykes, and is probably analagous to the greenstone belts of the Yilgarn. The eastern part contains granite, gneiss, and schist under alluvial cover and possibly some sediments of the Bangemall Group.

Bangemall and Nabberu Basins

The dominant trend direction over most of the Bangemall and Nabberu Basins is west to west-northwest. Near the boundaries of the Yilgarn Block and the Bangemall Basin, trends parallel the margins. In PEAK HILL trends are oriented mainly northeast, parallel to the granite ridge. Irregular trends due to extrusive and intrusive basic igneous rocks mask any anomalies originating from the sediments in the northern part of STANLEY.

Interpreted faults strike between west-northwest and north-northwest and between east-northeast and northeast.

5. CONCLUSIONS AND RECOMMENDATIONS

The magnetic data delineate the margins of the Carnarvon Basin, and indicate a maximum thickness of sediments in the order of 5000 m in the southwest of GLENBURGH. The boundary of the basin appear to be fault controlled.

A major tectonic feature has been delineated on the northern margin of the Yilgarn Block in GLENBURGH and ROBINSON RANGE. Within the

Yilgarn Block, extensive areas of greenstone are indicated by the magnetic anomaly pattern. In PEAK HILL there is good correlation between banded iron formations and magnetic anomalies, while the granite is magnetically quiet. Greenstone occupies most of the Yilgarn Block in GLENBURGH and ROBINSON RANGE, with a few areas of granite or gneiss extending into the southern and eastern parts. NABBERU has only a small area of greenstone within the Yilgarn Block.

In general, magnetic trends within the Yilgarn Block are restricted to the greenstone belts. In the survey area, trends are either irregular or parallel to the northern margin of the block. This is in marked contrast to the vast area of the block south of the survey area, where the trends are mostly oriented north-northwest.

North of the Yilgarn Block most trends and fold axes are oriented between west and west-northwest, except near the margins of the block, around which they appear to be draped. Interpreted faults are generally northeast or northwest. This pattern of folds, faults, and trends suggests that the Bangemall Basin has been compressed against the Yilgarn Block from the north.

An extensive area of basic sills, dykes, and flows is indicated in the northern half of STANLEY.

In PEAK HILL the mapped areas of banded iron formation correspond well with large-amplitude linear anomalies. Similar anomalies in ROBINSON RANGE, NABBERU, and STANLEY indicate further extensive areas of banded iron and possibly iron deposits of significance. The areas north of Mount Padbury and south of Mount Taylor are recommended for further investigation, and so is the 250-km-long banded iron formation of zone P. Structural deformation at either end and in the central part of this zone is indicated by the magnetics.

Zone I in ROBINSON RANGE and the zone R in NABBERU are both recommended for further study into their geological structure.

Potentially prospective areas occur mostly in the greenstone areas within the Yilgarn Block. Of particular interest are the culminations of folds and zones of type 8 and 9.

The larger anomalies in zones S and V are worthy of further investigation, for they may indicate more banded iron formations and sulphide-rich granophyres respectively.

It is recommended that any future airborne survey of the MOUNT PHILLIPS, MOUNT EGERTON, COLLIER, BULLER and TRAINOR be flown north-south. These Sheet areas contain mostly Bangemall Basin rocks with east-west trends.

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APPENDIX : OPERATIONAL DETAILS

Contractor: Aero Service (Australia) Pty Ltd

Data Processing Subcontractor: Engineering Computer Services Pty Ltd

Equipment

Magnetometers: Gulf Research and Development Mark III fluxgate coupled to a 25-cm recorder and digital recorder. Gulf fluxgate (magnetic storm monitor).

Camera: Aeropath 35-mm strip camera synchronised with Doppler.

Altimeter: Honeywell radar altimeter

Digital System: Lancer digital logging system

Doppler: Bendix doppler navigation system coupled to digital recorder.

Survey Specifications

Altitude: 150 m above ground level

Line spacing: 1.5 km

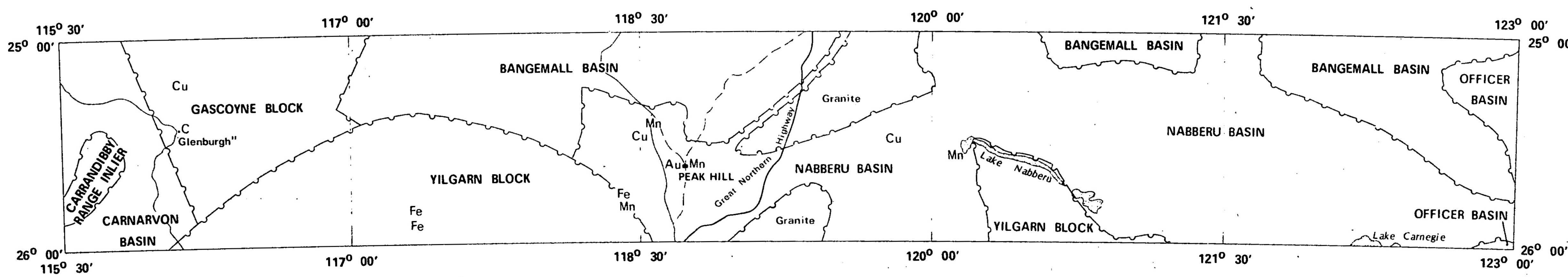
Line orientation: East and west

Tie system: Single north-south ties spaced 30 km apart

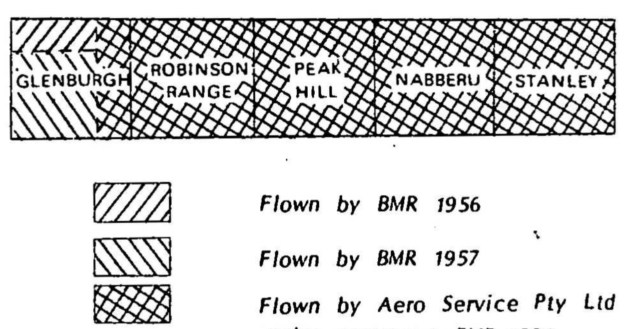
Navigation control: Pure Doppler navigation grid flying

Recorder sensitivities: 20 nanoteslas/cm (airborne)
9 nanoteslas/cm (ground)

1977/35.



SURVEY COVERAGE INDEX



Flown by BMR 1956

Flown by BMR 1957

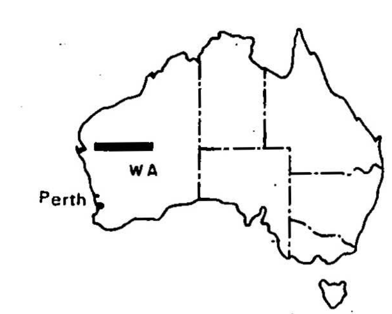
Flown by Aero Service Pty Ltd under contract to BMR 1972

AIRBORNE SURVEY, WESTERN AUSTRALIA 1972

LOCATION OF SURVEY AND MAJOR TECTONIC BOUNDARIES

20 0 20 40 60 80 100 120 140 160 180 200 KILOMETRES

LOCATION DIAGRAM



LEGEND

Major geological boundary
Highway
Secondary road
Road or track
Lake

MINERAL OCCURRENCES

Au	*Gold*
Mn	*Manganese*
Cu	*Copper*
C	*Graphite*
Fe	*Iron*

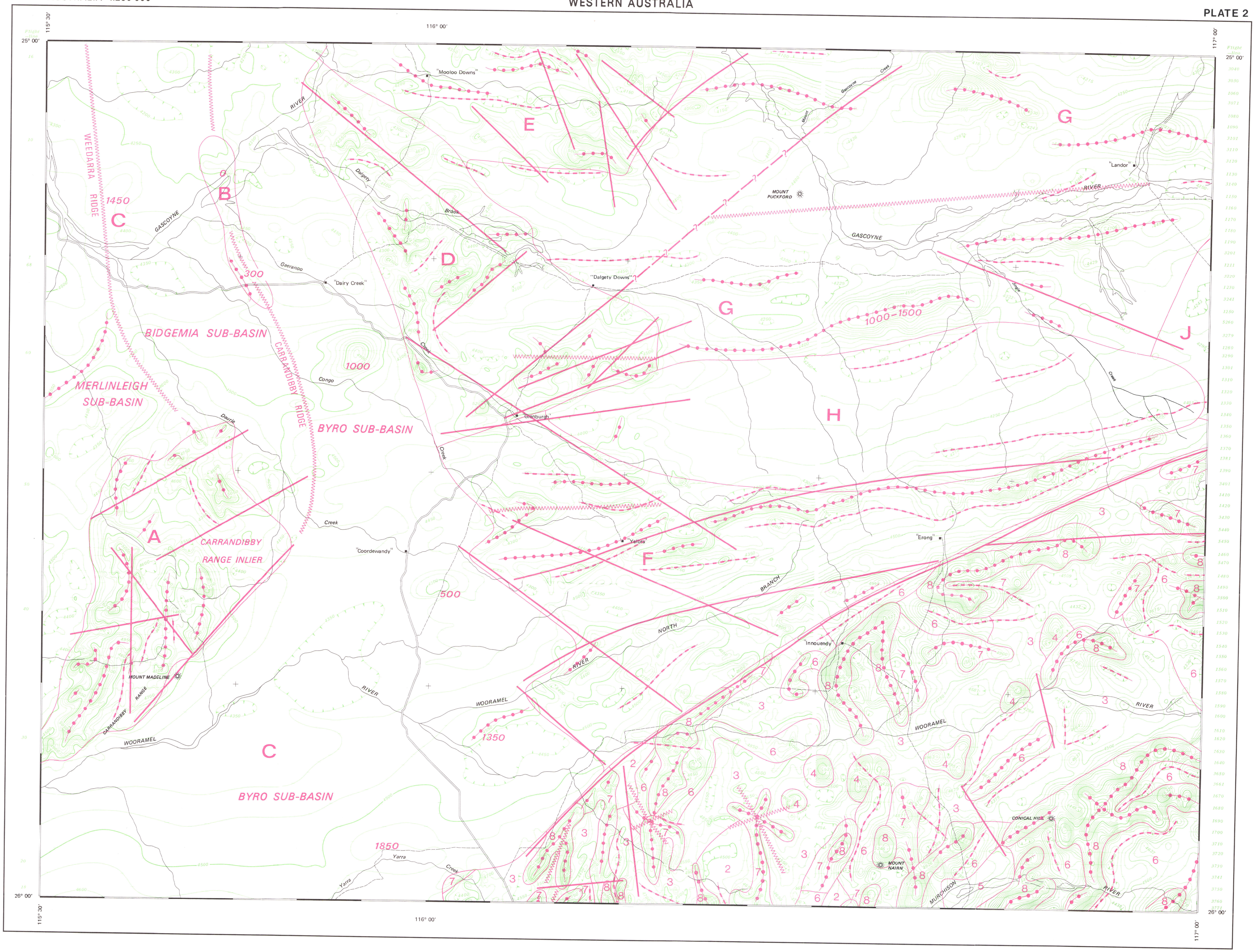
Record number 1977/35

G50/B1-109

AUSTRALIA 1:250 000

GLENBURGH
WESTERN AUSTRALIA

PLATE 2



MAP DATA

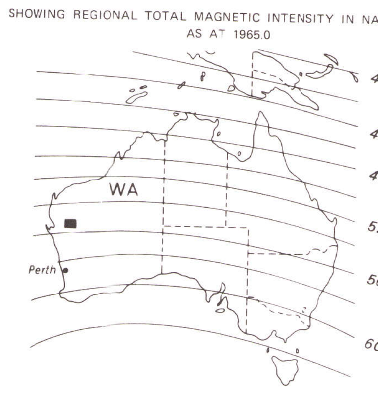
PROJECTION : *Transverse Mercator*

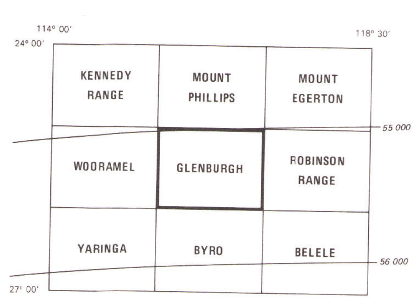
PLANIMETRY : *After Royal Australian Survey Corps 1:250 000 series SG50-6, First Edition planimetric map of the same area.*

FLIGHT-LINES : *Error in position generally less than 300 metres.*

LOCATION DIAGRAM

SHOWING REGIONAL TOTAL MAGNETIC INTENSITY IN NANOTESLAS AS AT 1965.0





TOTAL MAGNETIC INTENSITY
AND
MAGNETIC INTERPRETATION

SCALE 1 : 250 000

KILOMETRES 5 0 5 10 15 20 25 30 KILOMETRES

MAGNETIC CONTOUR INTERVAL 50 NANOTESLAS: DATUM ARBITRARY

LEGEND

TOPOGRAPHIC

- Highway or main road
- Secondary road
- Road or track
- Railway with station
- Built-up area
- Named place
- Homestead
- Aerodrome or landing ground
- Mine
- Fence
- Telegraph line
- River or creek
- Lake
- Swamp
- Saltpan or claypan
- Floodout
- Hill feature
- Reef

MAGNETIC

- 750 / 650 — Magnetic contours
- Magnetic "low"
- Contour/flight-line intersections
- ×5562 — Spot value

GEOPHYSICAL

- Positive magnetic trend.
- Negative magnetic trend.
- Interpreted fault
- Interpreted fold axis
- 1350 — Interpreted depth to magnetic basement in metres
- 2 — Magnetic zones within Yilgarn
- B — Magnetic zones outside Yilgarn

EXPLANATORY NOTES

The western section of this map was compiled from an airborne survey flown by the Bureau of Mineral Resources between 1956 and 1961. The eastern section of the map was compiled from an airborne survey flown in 1972 by Aero Service (Australia) under contract to the Bureau of Mineral Resources. The purpose of the surveys was to obtain information on the depth, structure, and composition of rocks to aid oil and mineral exploration and geological mapping.

The surveys were made at an altitude of 150 metres above ground level along lines spaced 1.5 km apart. The distance from aircraft to ground was measured by a continuously recording radio altimeter. Navigation of the western section was by aerial photographs and a Doppler navigation aid was used for the eastern section. The track of the aircraft was recorded by a 35-mm camera.

The total magnetic intensity was recorded by an airborne magnetometer and the eastern section data processed and contoured by computer. Regional gradient as shown in the location diagram has been removed from the data.

Printed by: Mercury—Walch Pty Ltd., Hobart, Australia

DEPARTMENT OF MINERALS AND ENERGY
BUREAU OF MINERAL RESOURCES, GEOLOGY & GEOPHYSICS
DRAWN IN THE GEOPHYSICAL BRANCH

RECORD NUMBER 1977/35

GLENBURGH, WA
REFER TO THIS MAP AS: G50/B1-96-1
1975

AUSTRALIA 1:250 000

ROBINSON RANGE
WESTERN AUSTRALIA

PLATE 3

MAP DATA

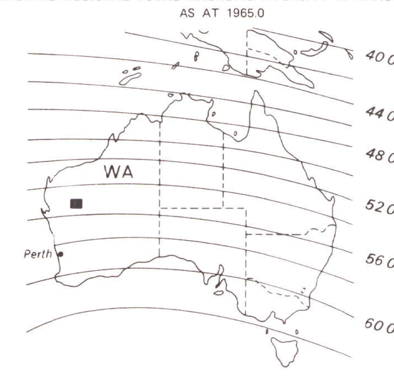
PROJECTION: *Transverse Mercator*

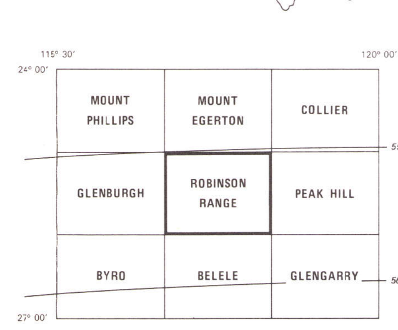
PLANIMETRY: *After Division of National Mapping 1:250 000 series SG50-7, First Edition planimetric map of the same area.*

FLIGHT-LINES: *Error in position generally less than 300 metres.*

LOCATION DIAGRAM

SHOWING REGIONAL TOTAL MAGNETIC INTENSITY IN NANOTESLAS AS AT 1965.0





TOTAL MAGNETIC INTENSITY
AND
MAGNETIC INTERPRETATION

SCALE 1 : 250 000

KILOMETRES 5 0 5 10 15 20 25 30 KILOMETRES

MAGNETIC CONTOUR INTERVAL 50 NANOTESLAS; DATUM ARBITRARY

LEGEND

TOPOGRAPHIC

- Highway or main road
- Secondary road
- Road or track
- Railway with station
- Built-up area
- Named place
- Homestead
- Aerodrome or landing ground
- Mine
- Fence
- Telegraph line
- River or creek
- Lake
- Swamp
- Saltpan or claypan
- Floodout
- Hill feature
- Reef

MAGNETIC

- 750 / 650 — Magnetic contours
- Magnetic "low"
- Contour/flight-line intersections
- ×5562 — Spot value

GEOPHYSICAL

- Positive magnetic trend
- Negative magnetic trend
- Interpreted fault
- Interpreted fold axis
- 1350 — Interpreted depth to magnetic basement in metres
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EXPLANATORY NOTES

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The survey was made at an altitude of 150 metres above ground level along lines spaced 1.5 km apart. The distance from aircraft to ground was measured by a continuously recording radio altimeter. Doppler navigation was used and the track of the aircraft was recorded by a 35-mm camera.

The total magnetic intensity was recorded by an airborne magnetometer and the data processed and contoured by computer. Regional gradient as shown in the location diagram has been removed from the data.

Printed by: Mercury—Walch Pty Ltd., Hobart, Australia

DEPARTMENT OF MINERALS AND ENERGY
BUREAU OF MINERAL RESOURCES, GEOLOGY & GEOPHYSICS
DRAWN IN THE GEOPHYSICAL BRANCH

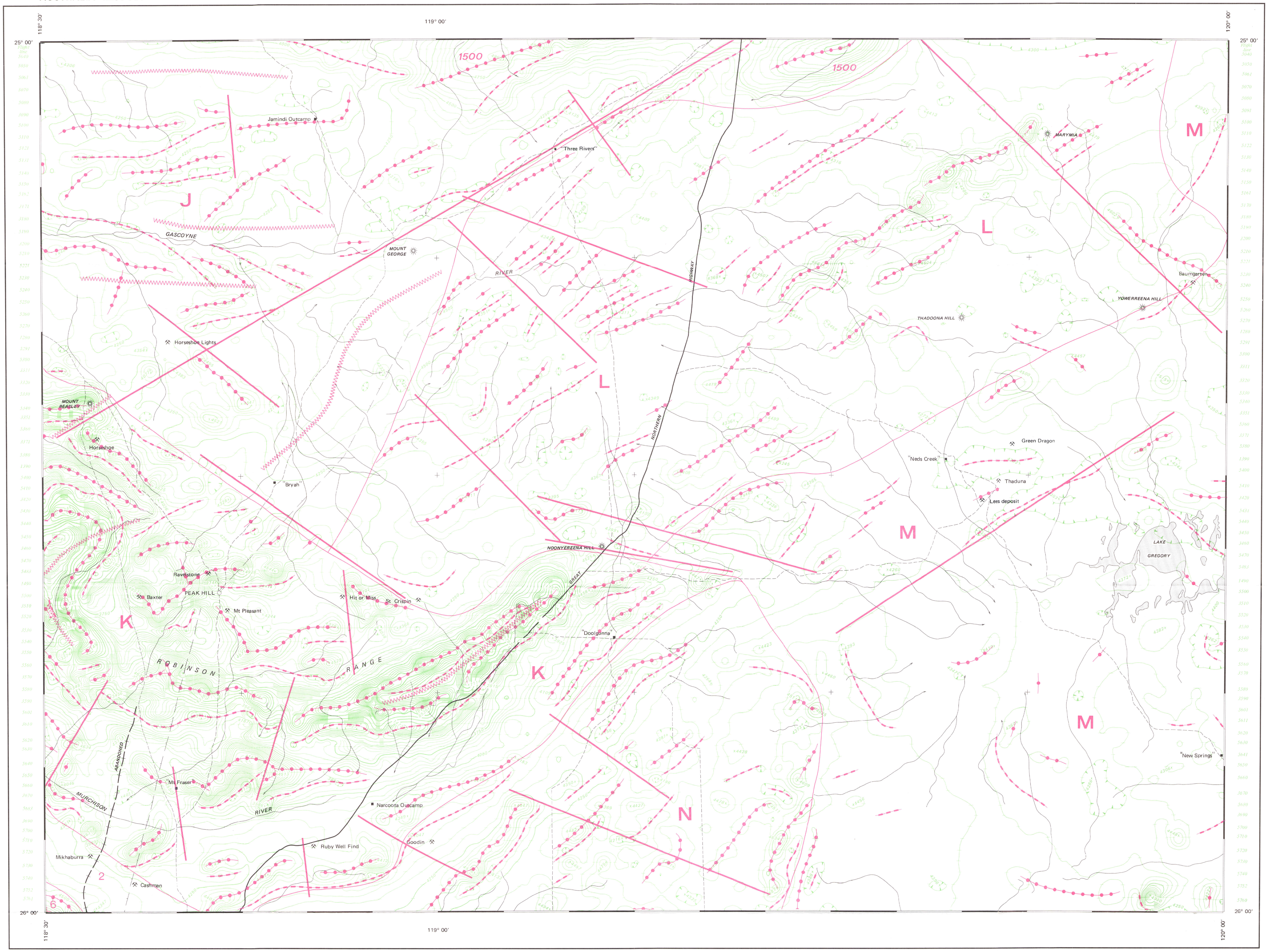
RECORD NUMBER 1977/35

ROBINSON RANGE, WA
REFER TO THIS MAP AS: G50/B1-98-1
1975

AUSTRALIA 1:250 000

PEAK HILL
WESTERN AUSTRALIA

PLATE 4



MAP DATA

PROJECTION : *Transverse Mercator*

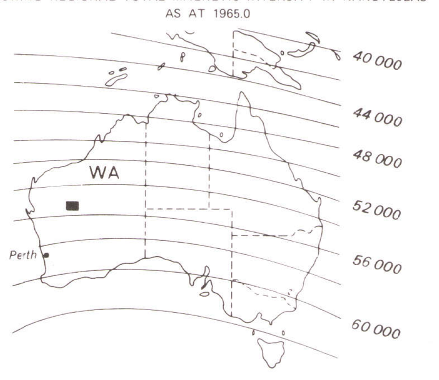
PLANIMETRY : *After Division of National Mapping 1:250 000 series SG50-8, First Edition planimetric map of the same area.*

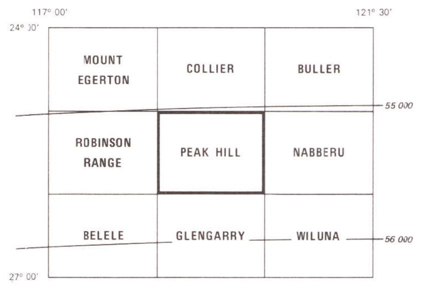
FLIGHT-LINES : *Error in position generally less than 300 metres.*

DEPARTMENT OF MINERALS AND ENERGY
BUREAU OF MINERAL RESOURCES, GEOLOGY & GEOPHYSICS
DRAWN IN THE GEOPHYSICAL BRANCH

LOCATION DIAGRAM

SHOWING REGIONAL TOTAL MAGNETIC INTENSITY IN NANOTESLAS AS AT 1965.0





TOTAL MAGNETIC INTENSITY
AND
MAGNETIC INTERPRETATION

SCALE 1 : 250 000

KILOMETRES 5 0 5 10 15 20 25 30 KILOMETRES

MAGNETIC CONTOUR INTERVAL 50 NANOTESLAS: DATUM ARBITRARY

LEGEND

TOPOGRAPHIC

- Highway or main road
- Secondary road
- Road or track
- Railway with station
- Built-up area
- Named place
- Homestead
- Aerodrome or landing ground
- Mine
- Fence
- Telegraph line
- River or creek
- Lake
- Swamp
- Saltpan or claypan
- Floodout
- Hill feature
- Reef

MAGNETIC

- 750 / 650 — Magnetic contours
- Magnetic "low"
- Contour/flight-line intersections
- ×5562 — Spot value

GEOPHYSICAL

- Positive magnetic trend
- Negative magnetic trend
- Interpreted fault
- Interpreted fold axis
- 1350 — Interpreted depth to magnetic basement in metres
- 2 — Magnetic zones within Yilgarn
- B — Magnetic zones outside Yilgarn

RECORD NUMBER 1977/35

EXPLANATORY NOTES

This map was compiled from an airborne survey flown in 1972 by Aero Service (Australia) under contract to the Bureau of Mineral Resources. The purpose of the survey was to obtain information on the depth, structure, and composition of rocks to aid oil and mineral exploration and geological mapping.

The survey was made at an altitude of 150 metres above ground level along lines spaced 1.5 km apart. The distance from aircraft to ground was measured by a continuously recording radio altimeter. Doppler navigation was used and the track of the aircraft was recorded by a 35-mm camera.

The total magnetic intensity was recorded by an airborne magnetometer and the data processed and contoured by computer. Regional gradient as shown in the location diagram has been removed from the data.

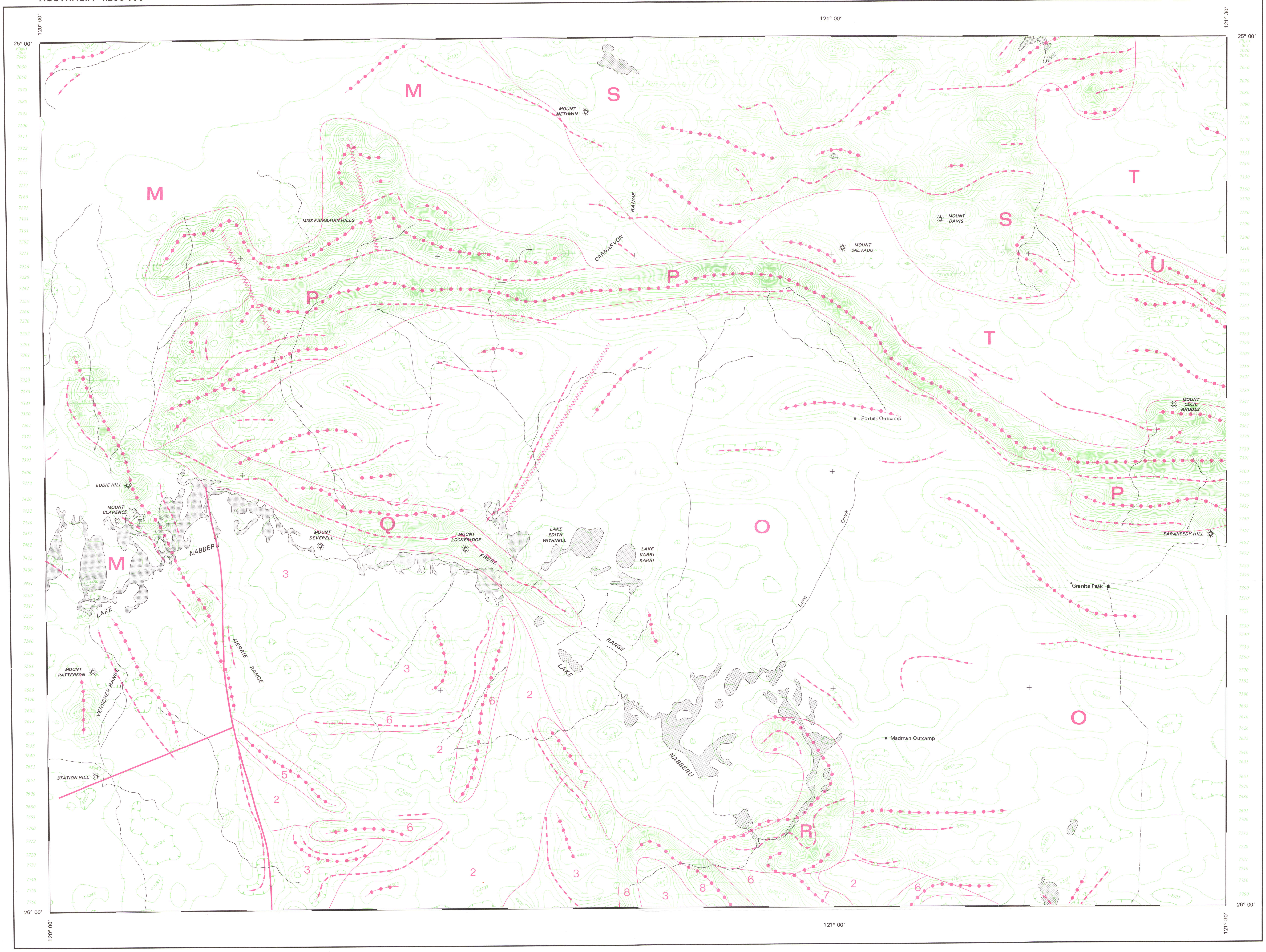
Printed by: Mercury—Walch Pty Ltd., Hobart, Australia

PEAK HILL, WA
REFER TO THIS MAP AS: G50/B1-97-1
1975

AUSTRALIA 1:250 000

NABBERU
WESTERN AUSTRALIA

PLATE 5



MAP DATA

PROJECTION: *Transverse Mercator*

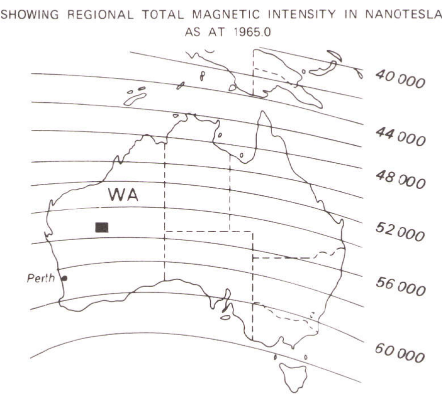
PLANIMETRY: *After Division of National Mapping 1:250 000 series SG51-5, First Edition planimetric map of the same area.*

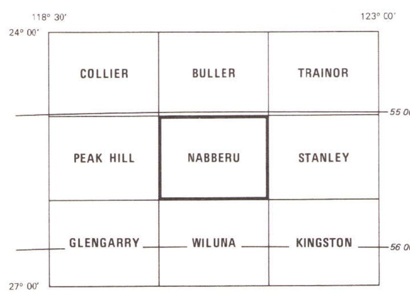
FLIGHT-LINES: *Error in position generally less than 300 metres.*

DEPARTMENT OF MINERALS AND ENERGY
BUREAU OF MINERAL RESOURCES, GEOLOGY & GEOPHYSICS
DRAWN IN THE GEOPHYSICAL BRANCH

LOCATION DIAGRAM

SHOWING REGIONAL TOTAL MAGNETIC INTENSITY IN NANOTESLAS AS AT 1965.0





TOTAL MAGNETIC INTENSITY
AND
MAGNETIC INTERPRETATION

SCALE 1:250 000

KILOMETRES 5 0 5 10 15 20 25 30 KILOMETRES

MAGNETIC CONTOUR INTERVAL 50 NANOTESLAS: DATUM ARBITRARY

LEGEND

TOPOGRAPHIC

- Highway or main road
- Secondary road
- Road or track
- Railway with station
- Built-up area
- Named place
- Homestead
- Aerodrome or landing ground
- Mine
- Fence
- Telegraph line
- River or creek
- Lake
- Swamp
- Saltpan or claypan
- Floodout
- Hill feature
- Reef

MAGNETIC

- 750 / 650 — Magnetic contours
- Magnetic "low"
- Contour/flight-line intersections
- ×5562 — Spot value

GEOPHYSICAL

- Positive magnetic trend
- Negative magnetic trend
- Interpreted fault
- Interpreted fold axis
- 2 — Magnetic zones within Yilgarn
- B — Magnetic zones outside Yilgarn

RECORD NUMBER 1977/35

EXPLANATORY NOTES

This map was compiled from an airborne survey flown in 1972 by Aero Service (Australia) under contract to the Bureau of Mineral Resources. The purpose of the survey was to obtain information on the depth, structure, and composition of rocks to aid oil and mineral exploration and geological mapping.

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The total magnetic intensity was recorded by an airborne magnetometer and the data processed and contoured by computer. Regional gradient as shown in the location diagram has been removed from the data.

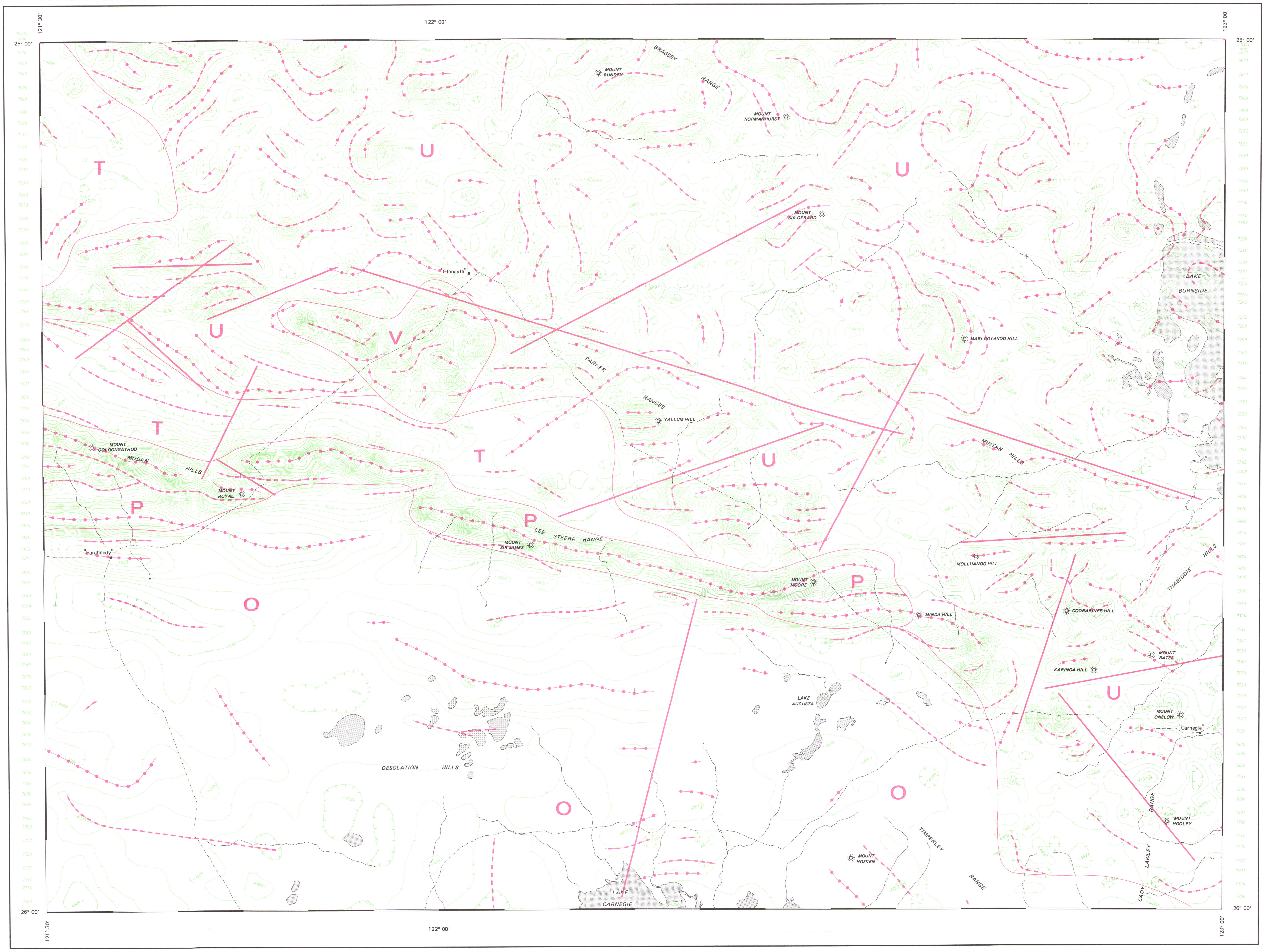
Printed by: Mercury—Walch Pty Ltd., Hobart, Australia

NABBERU, WA
REFER TO THIS MAP AS: G51/B1-60-1
1975

STANLEY
WESTERN AUSTRALIA

AUSTRALIA 1:250 000

PLATE 6



MAP DATA

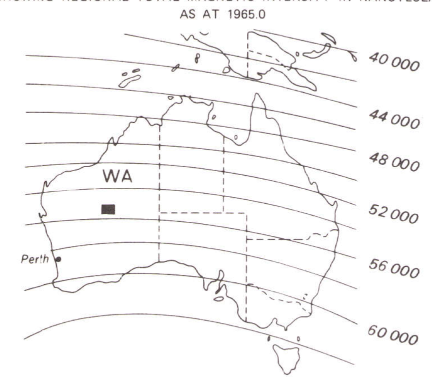
PROJECTION: Transverse Mercator

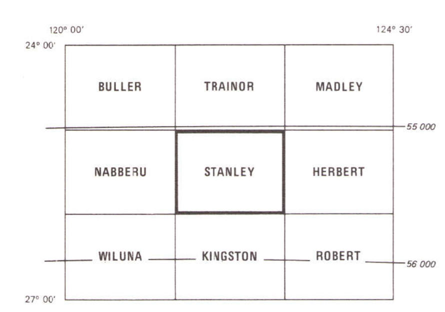
PLANIMETRY: After Division of National Mapping 1:250 000 series SG51-6, First Edition planimetric map of the same area.

FLIGHT-LINES: Error in position generally less than 300 metres.

LOCATION DIAGRAM

SHOWING REGIONAL TOTAL MAGNETIC INTENSITY IN NANOTESLAS AS AT 1965.0





TOTAL MAGNETIC INTENSITY
AND
MAGNETIC INTERPRETATION

SCALE 1:250 000

KILOMETRES 5 0 5 10 15 20 25 30 KILOMETRES

MAGNETIC CONTOUR INTERVAL 50 NANOTESLAS: DATUM ARBITRARY

LEGEND

TOPOGRAPHIC

- Highway or main road
- Secondary road
- Road or track
- Railway with station
- Built-up area
- Named place
- Homestead
- Aerodrome or landing ground
- Mine
- Fence
- Telegraph line
- River or creek
- Lake
- Swamp
- Saltpan or claypan
- Floodout
- Hill feature
- Reef

MAGNETIC

- Magnetic contours
- Magnetic "low"
- Contour/flight-line intersections
- Spot value

GEOPHYSICAL

- Positive magnetic trend
- Negative magnetic trend
- Interpreted fault
- B — Magnetic zones outside Yilgarn

EXPLANATORY NOTES

This map was compiled from an airborne survey flown in 1972 by Aero Service (Australia) under contract to the Bureau of Mineral Resources. The purpose of the survey was to obtain information on the depth, structure, and composition of rocks to aid oil and mineral exploration and geological mapping.

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DRAWN IN THE GEOPHYSICAL BRANCH

RECORD NUMBER 1977/35

STANLEY, WA
REFER TO THIS MAP AS: G51/B1-61-1
1975

1977/35

PLATE 7

MAGNETIC INTERPRETATION

BOUGUER ANOMALIES

Average rock density 2·2 g/cm³

AIRBORNE SURVEY, WESTERN AUSTRALIA 1972

MAGNETIC INTERPRETATION AND BOUGUER ANOMALIES

SCALE : 1 000 000

20 0 20 40 60 80 100 120 KILOMETRES

LEGEND

MAGNETIC

Positive magnetic trend
Negative magnetic trend
Interpreted fault
Interpreted fold axis
Greenstone belts
Major tectonic boundaries

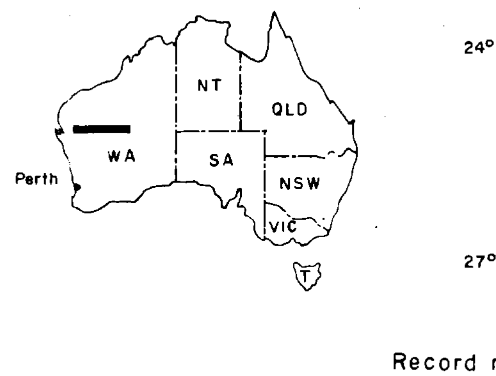
GRAVITY

-20- Isogal
'High' anomaly
'Low' anomaly

TOPOGRAPHY

Highway or main road
Secondary road
Road or track
Named place
Homestead
Mine
River or creek
Hill feature

LOCATION DIAGRAM



REFERENCE TO AUSTRALIA 1:250 000 MAP SERIES

115°30' 24°00' — 123°00' 24°00'

MOUNT PHILLIPS	MOUNT EGERTON	COLLIER	BULLER	TRAINOR
GLENBURGH	ROBINSON RANGE	PEAK HILL	NABBERU	STANLEY
BYRO	BELELE	GLENGARRY	WILUNA	KINGSTON

27°00' 115°30' — 27°00' 123°00'

Record number 1977/35

G50/B1-110