COMMONWEALTH OF AUSTRALIA

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RECORD No. 1965/61

MOUNT BUNDEY DETAILED AEROMAGNETIC SURVEY, NORTHERN TERRITORY 1964

by

J.S. MILSOM and W.A. FINNEY

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SUMMARY

In October and early November 1964, a detailed aeromagnetic survey was made in the Mount Bundey area, 60 miles south-east of Darwin. The object of the survey was to locate any extensions of the known martite-magnetite iron ore body of Pritchards Lode or any similar bodies in the district. An area of about eighty square miles was selected on the results of a previous reconnaissance aeromagnetic survey in the Darwin - Pine Creek area.

The area was flown at a line spacing of one-tenth of a mile. In addition, a small area including Pritchards Lode was flown at a line spacing of one-fifteenth of a mile.

Most of the magnetic anomalies are attributed to metamorphosed country rock on the margins of an intrusive igneous complex, and to sources within the complex, near to the contact with the country rock. Large-amplitude anomalies were found to be associated with the known iron ore, but similar anomalies were not detected elsewhere. However, further investigation of two smaller anomalies is recommended. It also seems probable that there is more iron ore in the north-western part of Pritchards Lode than has been previously estimated.

1. INTRODUCTION

Between the 13th October and the 13th November 1964, a detailed aeromagnetic survey was made by the Bureau of Mineral Resources (BMR) in the far north of the Northern Territory. An area of about eighty square miles was surveyed in the Mount Bundey region, approximately sixty miles south-east of Darwin (Plate 1). Pritchards Lode, a small martite-magnetite iron ore deposit, crops out about two miles north of Mount Bundey, and it was hoped that the detailed survey would detect similar bodies that are not in outcrop.

In 1962, a ground magnetic survey was made by a field party from the Darwin Uranium Group of the BMR (Ashley, 1962). The results of this survey indicated that iron ore deposits of the Mount Bundey type would be detected by an airborne magnetometer; the Mount Bundey 1:63,360 map area was then included in the Darwin - Pine Creek reconnaissance aeromagnetic survey of 1963 (Goodeve, in preparation), which was flown by Adastra Geophysics Pty Ltd under contract to the BMR. The survey revealed several areas of very disturbed magnetic field near Mount Bundey (Plate 4), but the flight-line spacing of half a mile was too large for the accurate delineation of anomalies. In order to resolve the anomalies in the main disturbed areas the detailed aeromagnetic survey described in this Record was programmed. The results are presented in the form of a total magnetic intensity contour map with a contour interval of 50 gammas (Plate 2). The magnetic contours at an interval of 250 gammas are also shown on the geological map (Plate 3).

2. GEOLOGY

In the following description, the general geology of the area (Plate 3) is largely due to Malone (1962).

The iron ore deposits at Mount Bundey are associated with the Mount Bundey Granite/Mount Goyder Syenite igneous complex. These igneous rocks crop out strongly south-east of the old Mount Bundey Homestead and intrude sediments of the Masson, Golden Dyke, and Burrel Creek Formations, all originally laid down in the Lower Proterozoic Pine Creek Geosyncline.

Sedimentary

The oldest rocks cropping out in the survey area belong to the Masson Formation, which is mainly composed of siltstones inter-tongued with lenses of quartz greywacke. The Masson Formation is conformably overlain by the Golden Dyke Formation, which is more generally argillaceous and contains limey and dolomitic beds. Both formations include pyritic siltstones capped in places by hematitic gossans. Siltstones and greywacke of the Burrel Creek Formation conformably overlie the Golden Dyke Formation.

There has been some low-grade regional metamorphism of the sediments, and slates have been developed in some of the silty beds. Contact metamorphism is confined to an aureole, less than a quarter of a mile wide, around the Mount Bundey Granite and the Mount Goyder Syenite.

Igneous

The Mount Bundey Granite and Mount Goyder Syenite together constitute an igneous complex intrusive in Lower Proterozoic rocks. Field and laboratory evidence suggests that the rocks of the complex are co-magmatic and that there is a gradational change from syenite to granite (Hasan, 1958). The original intrusion appears to have been of quartz syenite magma close to the surface. Subsequently, after differentiation in the magma chamber and probable assimilation of sediments into the magma, more granitic rocks were emplaced at deeper levels. The complex is intruded by syenite and aplite dykes, which represent a late stage of the intrusive process.

Iron minerals are common in both the granite and syenite as inclusions in horneblende and biotite; the iron content of the syenite (about 2 - 3%) is generally more than twice that of the granite. Veins of magnetite occur within the syenite near the contacts with country rock and Pritchards Lode.

South of the granite outcrop and north and east of Mount Goyder, the sediments are intruded by intermediate igneous dykes and sills, mainly microdiorite and microsyenite. The sills were emplaced before or during folding and may be genetically related to the granite-syenite complex.

Mineralisation

Pritchards Lode crops out as a prominent ridge on a rounded syenite hill about 100 ft high. The main lode is about 2200 ft long and there are a few minor exposures to the north-west. The outcropping iron ore consists of martite, frequently seen as large well-formed crystals, but magnetite is the dominant mineral below the surface. At depths greater than eighty feet the lode is pyritic, carrying up to 10% of sulphides, with occasional higher concentrations. The pyritic zone has been assayed for copper, but the highest grade recorded was only one-half of one percent. At present, the iron ores of the sulphide zone could not be economically worked.

The only rock type cropping out in the vicinity of the orebody is the Mount Goyder Syenite, but hornfelsic bands within the lode suggest the ore was formed by replacement of a roof pendant of country rock (Dunn, 1964). Lenses of slates and shaley material have been intersected within the lode in pits and diamond-drill holes.

3. INTERPRETATION

Structural

Magnetic source rocks in the detailed survey area are associated with the Mount Goyder Syenite and, to a lesser extent, with the Mount Bundey Granite (Plate 3). Only one of the sources, Pritchards Lode, has been investigated in any detail, and this is not typical of the area. However, the knowledge of the geology and genesis of this deposit contributes to the understanding of the magnetic pattern near Mount Bundey.

The geology of Pritchards Lode and of the Mount Goyder Syenite were briefly discussed in the preceding section and two important facts were noted. Firstly, magnetite-rich bands occur in the syenite, but only near its contact with the country rock. Secondly, the lode itself was formed by replacement of a roof pendant of country rock. This inclusion of metamorphosed country rock in the syenite shows that the present erosion level is very close to the upper surface of the intrusion, at any rate in the north. The distribution of iron minerals in and around the lode suggests that magnetic sources will lie close to the granite/country rock or syenite/country rock contacts, and that large anomalies might come from sources within the aureole of metamorphosed sediments.

This suggestion is confirmed most strikingly in the southern part of the detailed survey area. South of Goose Creek (Plate 3), the magnetic field over the granite mass is comparatively undisturbed and significant anomalies occur only at the eastern and southern margins of the granite. As there is no information available as to the dip of the intrusive contact, the sources could lie within either the granite or the country rock. However, they are shown by the depth estimates to be close to the surface and therefore lie within the country rock unless the contact dip is very small.

South of the granite outcrop and east and north-east of Mount Goyder, intermediate igneous rocks are mapped within the Golden Dyke Formation. None of these crops out sufficiently close to the acid complex to have been metamorphosed, supposing that they pre-date its intrusion, and no magnetic anomalies are associated with the outcrops. However, it is possible that some anomalies do arise from such rocks within the metamorphic aureole. In other parts of the Darwin - Pine Creek area, amphibolite dykes and sills are found within the Golden Dyke Formation. These might be responsible for many of the magnetic anomalies observed (Goodeve, in preparation).

At and near Mount Goyder, in the angle formed by the sharp northward swing of Buffalo Creek, there are a number of exposures of Mount Goyder Syenite (Plate 3). One of these lies wholly within a magnetically anomalous zone, but apart from this, only one other small anomaly coincides with outcropping syenite. Otherwise, the magnetic anomalies form a rough ring round the syenite outcrops and seem most likely to be due to sources within the metamorphic aureole. The south-western syenite outcrop is quite different magnetically from the others, and more detailed geological mapping may disclose lenses of metamorphic rock within this part of the intrusion. This region might also be of minor economic importance, as noted below. Detailed mapping of the region could add appreciably to the understanding of the magnetic pattern throughout the detailed survey area.

The syenite outcrop at Mount Goyder appears to be a roughly circular intrusive boss, distinct from the syenite and granite west of Mary River. The sharp falls in magnetic field at the western margin of the syenite at Mount Goyder and at the eastern margin of the syenite west of Mary River suggest that these margins are faulted.

Such fault zones may have controlled the courses of both Buffalo Creek and Mary River. Between the postulated faults is a minor meridional magnetic 'high', which might indicate a connection at depth between the two syenite outcrops.

The magnetic field west of Mary River and north of Goose Creek is the most complex in the detailed survey area (Plate 2). The most prominent feature is the very large triple anomaly associated with Pritchards Lode; this is discussed below. The anomaly due to the orebody stands on a 'spur' that extends slightly west of south from a pronounced east-west magnetic 'ridge'. This 'ridge' lies north of all the syenite outcrops, in an area covered by Recent alluvium. A second 'spur' extends north from the 'ridge', opposite Pritchards Lode, but the anomalous field is much smaller. West-south-west of Pritchards Lode, there is a large, roughly triangular anomaly, the south-east side of which is parallel to the north-east face of the main syenite outcrop. Both the triangular anomaly and the main magnetic 'ridge' are associated with the syenite/sediment contact, and the sources are most likely to be metamorphic rock. The apparently greater width of the metamorphic aureole in the north might be due to the syenitic, rather than granitic, nature of the intrusion, but is probably due, at least in part, to the intrusive contact dipping at a comparatively small angle. Magnetic contours to the north of both Mount Bundey and Mount Goyder are gently curved parallel to the outcrop of the igneous complex. These suggest that the complex extends a considerable distance to the north at comparatively shallow depths. Depth estimates along the 'spur' that extends north from the magnetic 'ridge' show that the source of this anomaly plunges north at an angle of about only two and a half degrees. The source rocks are probably close to the intrusive contact, which might therefore be expected to have a similar dip.

The sources of many smaller anomalies are concealed beneath Recent alluvium and most of these probably lie in contact metamorphic rocks. Such rocks are usually softer and, owing to differentiated weathering, crop out less strongly than the intrusion they surround. There are also considerable areas of disturbance where syenite and, to a lesser extent, granite are mapped. Both granite and syenite appear to be more magnetic in the east than in the west. The eastern part of the granite outcrop north of Goose Creek is clearly more magnetic than the same rock type to the west, and is in even greater contrast to that immediately to the south. At the boundary between the granite and the syenite, the change in rock type is gradational (Hasan, 1958) and it is possible that the higher magnetite concentrations, noted by Hasan in the syenite, also extend gradationally into the granite in the east. Alternatively, metamorphosed xenoliths and roof pendants of country rock, or the bands of magnetite noted in the syenite near its margins, may be present in this part of the granite.

There is a very definite decrease in magnetic intensity at the approximate boundary between granite and syenite. This is to be expected if the different concentrations of magnetite, noted by Hasan in small specimens, hold throughout the body of the intrusion. Localised high magnetic fields over syenite outcrops may be attributed to sources associated with the contact zone, even where the actual contact has been eroded away.

The intense negative anomaly along the course of Goose Creek is not related to the granitic intrusion. The source of this anomaly does not crop out but the magnetic data show that it lies within a hundred feet of the surface and has been faulted, east block north, in the approximate centre of the granite. Presumably, the source rock is easily eroded and is currently being eroded, as its presence has controlled the course of Goose Creek. Weathered source rock might be expected under a few feet of alluvium along the course of Goose Creek. Deep weathering and consequent oxidation of magnetite to hematite accounts for the drift estimates being in the range 50 - 100 ft below surface.

The reconnaissance survey of the Darwin-Pine Creek area (Goodeve, in preparation) showed linear negative anomalies running south-east parallel to each other for tens of miles, together with a group of positive anomalies trending about S 30° E. One of the negative anomalies apparently crosses the Mount Bundey granite (Plate 4), but cannot be traced through it. The detailed survey shows that this anomaly follows Goose Creek across the granite, the change in strike is about E 15° S in this sector presumably being related to the different competencies of the granite and the sediments. South-east of the granite outcrop, the Mary River also follows the soft source rocks for a few miles; the source rocks are presumably intrusives, possibly in a fault zone, and post-date the granite. Long faults with north-west trends are known to the west, between Mount Bundey and Rum Jungle. It is unlikely that the negative polarisation of the anomaly merely indicates a non-magnetic zone caused by deep leaching of a fault breccia intersecting magnetic rocks, as the amplitude is very large and apparently unrelated to the geological nature of the enclosing country.

Economic

A special flight at reduced line spacing was made over Pritchards Lode with the object of detecting additional magnetite concentrations in the immediate vicinity of the lode, and of providing a standard of comparison for anomalies detected elsewhere. The detailed contour map (inset, Plate 2) is very similar in form to the smoothed ground-contour map previously produced (Ashley, 1962), although amplitudes are smaller by a factor of more than four. There are no large anomalies other than those detected on the ground, but it is noticeable that the north-western anomaly is similar in amplitude and areal extent to the other anomalies. This north-western anomaly corresponds to Ashley's 'Anomaly A' and is shown as such on the inset to Plate 2. Two diamond-drill holes in the area of this anomaly failed to intersect any major deposits of martite-magnetite ore (Dunn, 1964) and the anomaly was therefore not tested further. The aeromagnetic results show that there are large amounts of magnetite in the area and further drilling is recommended, preferably after a more-detailed ground magnetic survey has been made.

No anomalies comparable in amplitude with those at Pritchards Lode were detected in the remainder of the survey area. However, south-west of Mount Goyder, a very sharp anomaly of almost 1000 gammas amplitude was detected in a generally disturbed area just north of Buffalo Creek. It is possible that there is a small deposit of magnetic iron ore in the extreme east of the small syenite outcrop, at a depth of less than 100 ft below surface.

This anomaly (Anomaly B, Plate 2) should be tested by diamond drilling at sites to be selected after a ground magnetic survey. The drilling should also lead to a better understanding of the geological structure of the survey area.

About one mile north of Pritchards Lode (Plate 2) there is the 'spur' previously mentioned that extends N 5° E from the magnetic 'ridge' that is associated with the syenite/sediment contact. The contour pattern of the 'spur' is distorted at the southern end by the magnetic 'ridge', but it can be seen to have an amplitude of about 800 gammas. Depth estimates made at several points along the strike indicate that the source is within 100 ft of the surface at the southern end, and dips gently north to a depth of about 250 ft. The large areal extent of the anomaly, coupled with its rather low amplitude, make it unlikely that the source rock, which lies entirely within the pyritic zone, could be iron ore. However, a drill hole is tentatively recommended to test the source rock because it is near to and trends towards Pritchards Lode, and because the information gained would be relevant to many of the other anomalies in the vicinity.

It is possible that a diamond-drill hole in the bed of Goose Creek would be justified in order to determine the source of the linear extended 'low'. The site for such a hole could only be recommended after the analysis of the results of the reconnaissance survey has been completed. The source rock lies not more than 100 ft below surface.

The detailed survey at Mount Bundey has shown that a much greater proportion of the metamorphic aureole lies near to the surface than is the case with other granites in the Darwin - Pine Creek area. The rocks of such an aureole are frequently mineralised. Gold, uranium, and base-metal deposits have been worked in the aureoles of other granites in the Darwin - Katherine district. It therefore seems possible that further prospecting in the Mount Bundey area could lead to the discovery of non-ferrous ore deposits. In this connection the existence of a zone of sulphide mineralisation at Pritchards Lode should be noted.

4. REFERENCES

ASHLEY, J. 1962 Mount Bundey test magnetic survey, NT 1962. Bur. Min. Resour. Aust. Rec. 1962/185 (unpubl.).

DUNN, P.G. 1964 Geology and drilling results, Pritchards Lode - Mount Bundey area, NT. Bur. Min. Resour. Aust. Rec. 1964/18 (unpubl.).

GOODEVE, P.E. Darwin - Pine Creek aeromagnetic survey, NT 1963. Bur. Min. Resour. Aust. Rec. (in preparation).

HASAN, S.M. 1958 Petrography and petrology of Mount Bundey Granite and Mount Goyder Syenite, NT. Bur. Min. Resour. Aust. Rec. 1958/36 (unpubl.).

MALONE, E.J. 1962 Darwin, NT, 1:250,000 geological series, Bur. Min. Resour. Aust. Explan. Notes.

APPENDIX

Operational details

Survey specifications

Height : Nominally 280 ft above ground level for the aircraft and 250 ft above ground level for the detector (in towed-bird assembly). Aircraft height and bird position relative to aircraft fluctuated considerably over rugged terrain.

Line spacing : Nominally 1/10 mile, except for special flight over Pritchards Lode, which was flown at a spacing of 1/15 mile.

Flight direction : East or west.

Sensitivity : 1000 gammas F.S.D. (10,000 gammas on special flight).

Equipment

Aircraft : Cessna 180

Magnetometer : MNS1 nuclear magnetometer, reading total absolute magnetic field at one-second intervals, fiducial pulses occurring at eight-second intervals.

Recorder : Mosely, chart six-inch rectilinear, chart speed four inches per minute.

Radio altimeter : AN/APN-1 with output to cockpit dial and limit light system, and to recorder.

Recorder for radio altimeter : T.I.C., chart six-inch curvilinear.

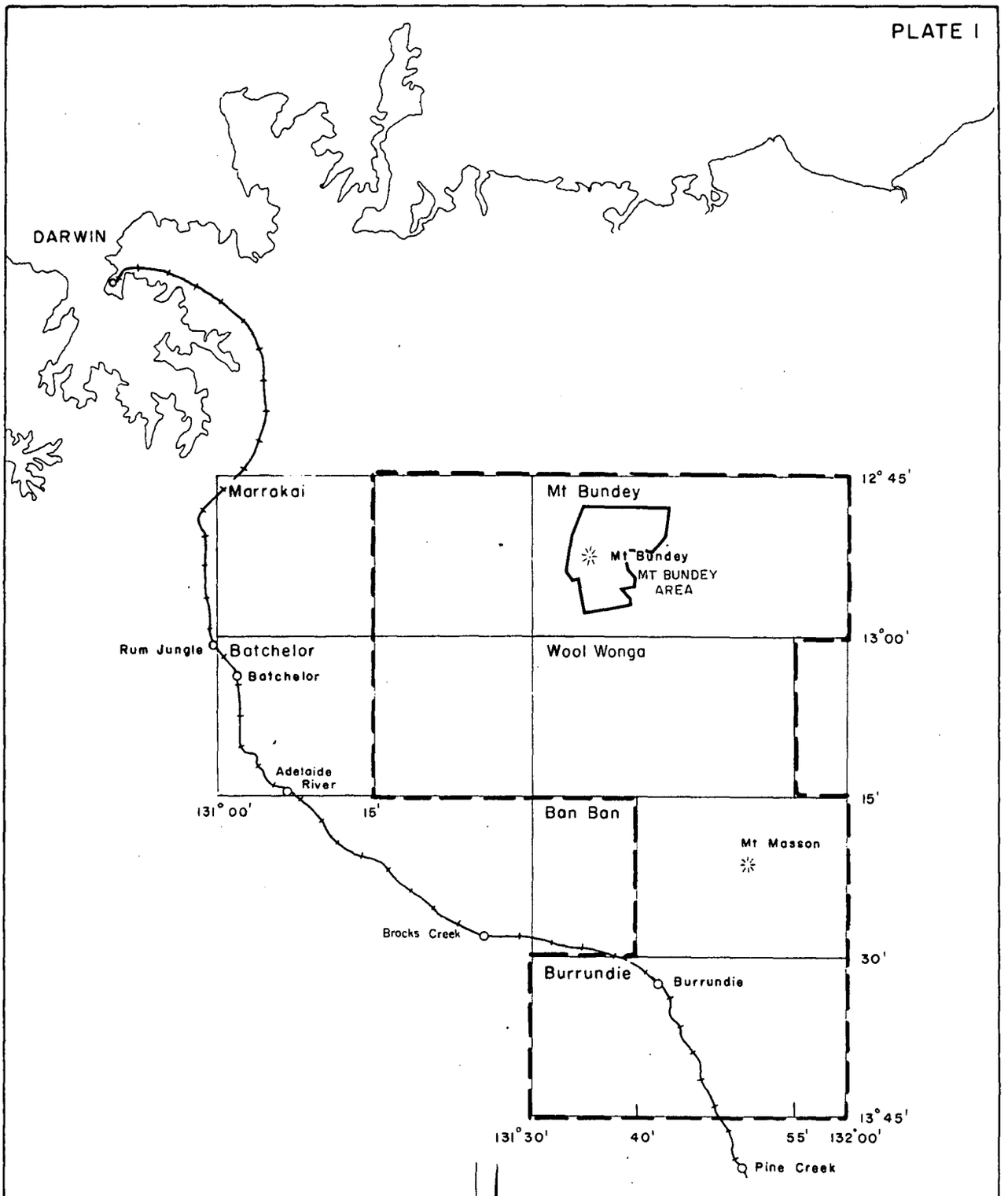
Camera : Modified Vinten with wide-angle (186^{o}) lens. Single exposures on 35-mm film at eight-second intervals.

Personnel

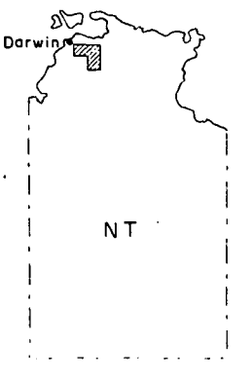
BMR : J. Boyd, C. Braybrook, R. Buckley, W. Finney, J. Milsom, S. Scherl.

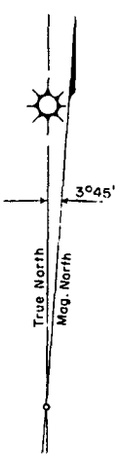
TAA : First Officer G. Litchfield

PLATE I



LOCATION DIAGRAM



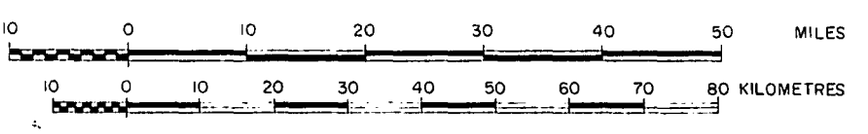


LEGEND

- Railway
- Named place
- Detailed survey area boundary
- Reconnaissance survey area boundary

DETAILED AEROMAGNETIC SURVEY, MOUNT BUNDEY, NT 1964

LOCALITY MAP



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To Accompany Record No. 1965/61

PLATE 2

12°47' 13°32' 35' 40' 13°43' 12°47'

50'

55'

12°58' 13°32' 35' 40' 13°43' 12°58'

SEE INSET

ANOMALY 'A'

ANOMALY 'B'

INSET

13°35' 13°36' 12°51'

MILES 1 0 1 MILES

KILOMETRES 1 0 1 KILOMETRES

CONTOUR INTERVAL 100 GAMMAS

DETAILED AEROMAGNETIC SURVEY, MOUNT BUNDEY, NT 1964

TOTAL MAGNETIC INTENSITY CONTOURS

MILES 1 0 1 2 MILES

KILOMETRES 1 0 1 2 KILOMETRES

CONTOUR INTERVAL 50 GAMMAS

GEOPHYSICAL LEGEND

3°45' True North Magnetic North

6000 Magnetic contours

Magnetic low

Geophysical Branch, Bureau of Mineral Resources, Geology and Geophysics D52/BI-26

To Accompany Record No 1965/61

PLATE 3

Based on D52/80-24

Geology and planimetric mapping from 1:63,360 Scale Geological Series Sheet D52-4-48, First Edition 1959. Bureau of Mineral Resources, Geology and Geophysics. Transverse Mercator Projection.

GEOLOGICAL LEGEND

CAINOZOIC

QUATERNARY

- *Soil and alluvium*
  Undifferentiated. *Laterite*

LOWER PROTEROZOIC

- Mt Bundey Granite
  Biotite-hornblende granite
- Mt Goyder Syenite
  Hornblende syenite
- *Intermediate igneous rocks (sills and dykes)*
- Burrell Creek Formation
  Greywacke, greywacke siltstone, siltstone
- Golden Dyke Formation
  Siliceous siltstone, siltstone, bedded nodular and massive chert
  Chert pebble conglomerate
- Craig Creek Member
  Pyritic carbonaceous dolomitic siltstone with chert nodules
  pyritic siltstone, silicified dolomitic siltstone
  Slump breccia
- Masson Formation
  Quartz greywacke, quartz sandstone, pyritic carbonaceous siltstone, minor carbonaceous siltstone with chert nodules
- Mt Partridge Formation
  Quartz sandstone, siltstone

- *Established boundary, position accurate*
- *Established boundary, position approximate*
- *Indefinite boundary*
- *Probable fault*
- *Joints*
- *Shear zone*
- *Quartz vein*

Strike and dip of strata

- *Inclined*
- *Inclined showing prevailing dip*
- *Vertical*
- *Plunge of minor anticline*
- *Plunge of minor syncline*
- *Trend line from air-photo interpretation*

NOTE: Goose Creek and Buffalo Creek are names used only in this Record; on other maps these creeks are not named.

DETAILED AEROMAGNETIC SURVEY, MOUNT BUNDEY, NT 1964

TOTAL MAGNETIC INTENSITY CONTOURS AND GEOLOGY

MILES 1 0 1 MILES

KILOMETRES 1 0 1 KILOMETRES

CONTOUR INTERVAL 250 GAMMAS

TOPOGRAPHICAL LEGEND

- *River or creek*
- *Road or track*
- *Homestead*

5° 45'

True North
Mag. North

INDEX TO ADJOINING SHEETS

HUMPTY DOO	MARY RIVER	KAPALGA
MARRAKAI	MT BUNDEY	SPRING PEAK
BATCHELOR	WOOL WONGA	MUNDOGIE HILL

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AUSTRALIA 1:63,360

MOUNT BUNDEY
NORTHERN TERRITORY

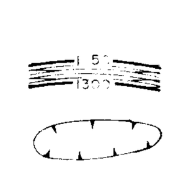
PLATE 4

(BASED ON D 52/B0-4)

INDEX TO ADJOINING SHEETS

HUMPTY DOO	MARY RIVER	KAPALGA
MARRAKAI	MT BUNDEY	SPRING PEAK
BATCHELOR	WOOL WONGA	MUNDOGIE HILL

GEOPHYSICAL LEGEND



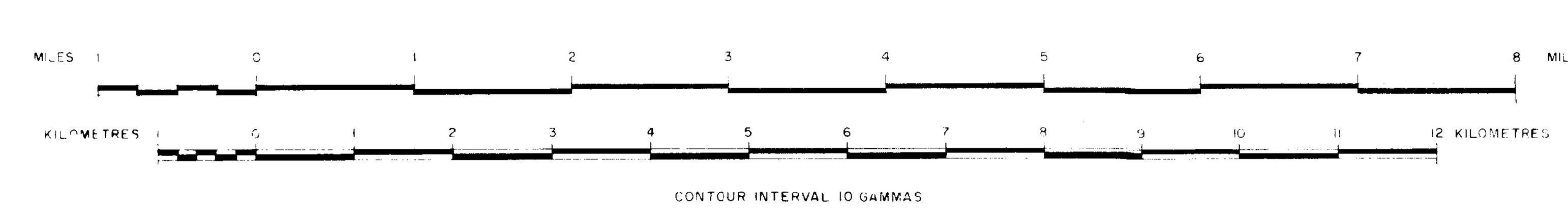
Magnetic contours with flight-line intersections

Magnetic "low"

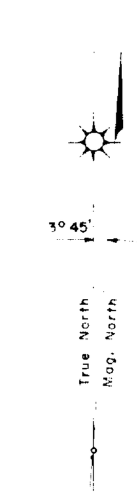
Boundary of 1964 detailed aeromagnetic survey

RECONNAISSANCE AEROMAGNETIC SURVEY, 1963

TOTAL MAGNETIC INTENSITY CONTOURS



CONTOUR INTERVAL 10 GAMMAS



TOPOGRAPHICAL LEGEND

River or creek

Road or track

Hill feature

Homestead

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