COMMONWEALTH OF AUSTRALIA

DEPARTMENT OF NATIONAL DEVELOPMENT

BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS

RECORDS 1960 No. 117

MT. HARDY REGION AIRBORNE MAGNETIC AND RADIOMETRIC SURVEY, N.T. 1958

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R. M. Carter

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ABSTRACT

The results of an airborne geophysical survey are presented as magnetic contour maps showing geological boundaries and sudden changes in radioactivity. The methods are described, and correlation between geology and geophysical results is discussed.

1. INTRODUCTION

This survey was initiated by the Geological and Geophysical Branches of the Bureau. A ground radiometric survey of some of the mine workings had been made by the Bureau in 1956, but no other geophysical work had previously been done in the region. Earlier geological work included surveys of the Mt. Hardy copper field (Kiek, 1941) and the Mt. Doreen wolfram field (A.G.G.S.N.A., 1941).

The Mt. Doreen field was discovered in 1926, and successive applications for mining leases were made in 1929, 1934, and 1938, with intervening lapses. It is situated west-north-west of Mt. Doreen. The Mt. Hardy deposits were discovered in 1935. They lie within the Mt. Doreen pastoral lease in an area east of Mt. Doreen and north of Mt. Hardy. There are several other minor workings, almost all abandoned.

The present survey was undertaken to assist the search for:

(1) areas worthy of further prospecting for metals, and

(2) areas of high radioactivity.

Also it was thought that the magnetic survey might help to solve problems in the structural geology of the region.

The survey was done during July and August 1958 with a DC.3 aircraft (VH-BUR) based at Alice Springs aerodrome. The party consisted of:-

Bureau Staff

R.M. Carter	-	party leader
R. Wells, J.R. Pollard	-	geophysicists
P.M. Sowden	-	radio technician
J.H. Croger	-	geophysical assistant
R. Jones	-	photographer
N. Price	-	draftsman
D.F. Upton	-	clerk

Trans-Australia Airlines staff

P.J. Norris, J.D. Bartlett	-	pilots
M. Gatley	-	engineer.

2. GEOLOGY

Some of the geological features are shown on Plates 2 and 3, but the geological boundaries are only approximate because they were reproduced from a compilation at a very small scale.

The predominant rocks in the area are the paragneiss, schist, and granite gneiss of the Arunta Complex (Noakes, 1953). These rocks are consistently more metamorphosed and more severely folded than other Precambrian rocks in the Northern Territory, and they are believed to be of Archaean age (ibid.). In many places the schist has been intruded by granite.

The rocks of the Arunta Complex constitute the Arunta Block, which is postulated as a stable block composed mainly of Archaean rocks and bounded in the north by the Warramunga Geosyncline (ibid.). In much of the survey area the surface rocks have been covered by Cainozoic sand, laterite, and alluvium.

The main mineralisation is believed to have taken place in Archaean time and is largely confined to pegmatite dykes. In addition there are a few deposits of copper and silver-lead in Upper Proterozoic or Cambrian rocks (ibid.).

At the Mt. Hardy copper field the country rock is a highly contorted schist; the deposits are in the form of intruded reefs of pegmatite and quartz (Kiek, 1941). At the Mt. Doreen wolfram field the predominant rock is a schist of sedimentary origin; there is also some granite and gneiss (A.G.G.S.N.A., 1941).

3. SURVEY METHOD

The area was covered systematically by flying a grid of parallel traverses one mile apart and oriented east-west. The aircraft was flown at a nominal altitude of 500 ft above ground level; under normal flying conditions this height was maintained within 50 ft, but it varied by larger amounts over very rugged terrain.

The differences in magnetic datums of individual flight lines, which normally result from the diurnal variation and instrumental drifts, were measured by flying a series of north-south tie-lines approximately 15 miles apart. The tie-lines were flown only in one direction.

The aircraft was navigated by visual comparison of ground features with detail on mosaics of vertical aerial photographs, upon which were drawn the proposed flight paths. At intervals along each flight line, the pilots marked the photographs to show the approximate position of the aircraft with respect to prominent or recognisable ground features. A continuous vertical photographic record of the track of the aircraft was made during each flight line, to enable the track to be plotted later on the photographic mosaics.

4. EQUIPMENT USED

The magnetic equipment fitted to the aircraft consisted of a saturable-core fluxgate magnetometer, type AN/ASQ-8, the detector head of which was installed at the end of a cylindrical boom projecting from the aircraft tail. This arrangement ensured the least possible disturbance of the magnetic field at the detector head by magnetism of the aircraft; such disturbing effects were further reduced by compensating coils at the detector head.

A Speedomax chart recorder was used to record the output of the magnetometer, in the form of a continuous measurement of the variations in the magnetic field along the flight path.

The radiometric equipment consisted of two M.E.L. scintillation detection heads whose outputs were integrated by a Chalk River ratemeter; the output of this ratemeter was recorded by one channel of a dual-channel T.I.I. "Rectiriter" recorder. The time constant of the whole system was approximately one second.

Navigational equipment consisted of a radio-altimeter, a radio compass, and an air position indicator. Altitude was recorded continuously on a single-channel "Rectiriter" recorder so that height corrections could later be applied to the radiometric data.

A continuous vertical photograph along the flight line was taken with an Aeropath continuous-strip 35-mm camera. On this survey the flight paths were eventually plotted solely from the strip film, and the data from the air position indicator were not used. Correlation between all the records was achieved by counter numbers and periodic fiducial marks.

All the plotting and reduction of magnetic data was done by Adastra-Hunting Geophysics Pty. Limited.

5. RESULTS

Radiometric

Approximately 75 radiometric anomalies were detected and recorded during flights at the normal altitude of 500 ft above ground level. These anomalies were classified by comparing their peak values with the standard deviation (S.D.) of the associated radioactive background. Those which exceed 9 times the S.D. are called first order anomalies; those between 6 and 9 times the S.D. are second order anomalies.

The final classification and plotting of these anomalies has not yet been completed and they are not shown on the accompanying maps (Plates 2 and 3). Instead, an approximate plot has been made of the positions of sharp changes in radioactivity. These changes were selected on the basis of an increase or decrease in radioactivity of not less than six times the S.D., relative to the level on the low side of the change.

Magnetic

The magnetic results have been presented in the form of contours of total field intensity at a contour interval of 20 gammas, superimposed on a plan showing the regional geology and radiometric details (Plates 2 and 3).

6. DISCUSSION OF RESULTS

Radiometric

The boundary lines depict changes in radioactivity, as already defined. The object of producing these radioactive boundaries was to determine whether any correlation could be seen between them and the geological boundaries. Since the boundary lines indicate sharp changes in radioactivity and not absolute levels of radioactivity they are different from contours, and do not necessarily form closed loops.

Some correlation between the radioactive and geological boundaries is evident in the maps, particularly in the extreme east of the area. There the north-west-trending boundary between the granite and the undifferentiated rocks roughly coincides with a change in level of radioactivity. Approximately parallel to this boundary and about 3 to 5 miles to the north-east of it, another sharp change of radioactivity (involving decrease to the north-east) has been plotted along a line which in part roughly corresponds to the boundary between granite and alluvium. The changes in radioactivity shown in the maps appear to be associated in a general way with the granite. Nearly all the areas of high radioactivity fall wholly or partly within areas of granite outcrop.

No significant radiometric anomalies were detected near the Mt. Doreen or Mt. Hardy mining fields.

Magnetic

In the southern part of Plate 2 the magnetic field increases smoothly southward at a rate equal to about twice the normal regional gradient, which here would be about 10 gammas per mile. The cause is probably a deep-seated major geological feature.

No magnetic anomalies were recorded over the Mt. Doreen area, but in the Mt. Hardy field there appears to be a minor magnetic anomaly of about 60 gammas coinciding with the copper prospects. South-east of Mt. Hardy there is a more prominent anomaly which occurs over an area of alluvium between a granite intrusion and the Arunta Complex rocks.

Plate 3 shows a prominent magnetic feature, in the form of a narrow anomaly extending for about 40 miles in a north-westerly direction from near the south-western corner of the surveyed area. This anomaly and two smaller anomalies form a disturbed zone which extends to the northern limit of the survey and indicates a major geological feature. However, the geology of the area is not sufficiently well known to enable a probable cause to be assigned to the magnetic anomalies in this zone.

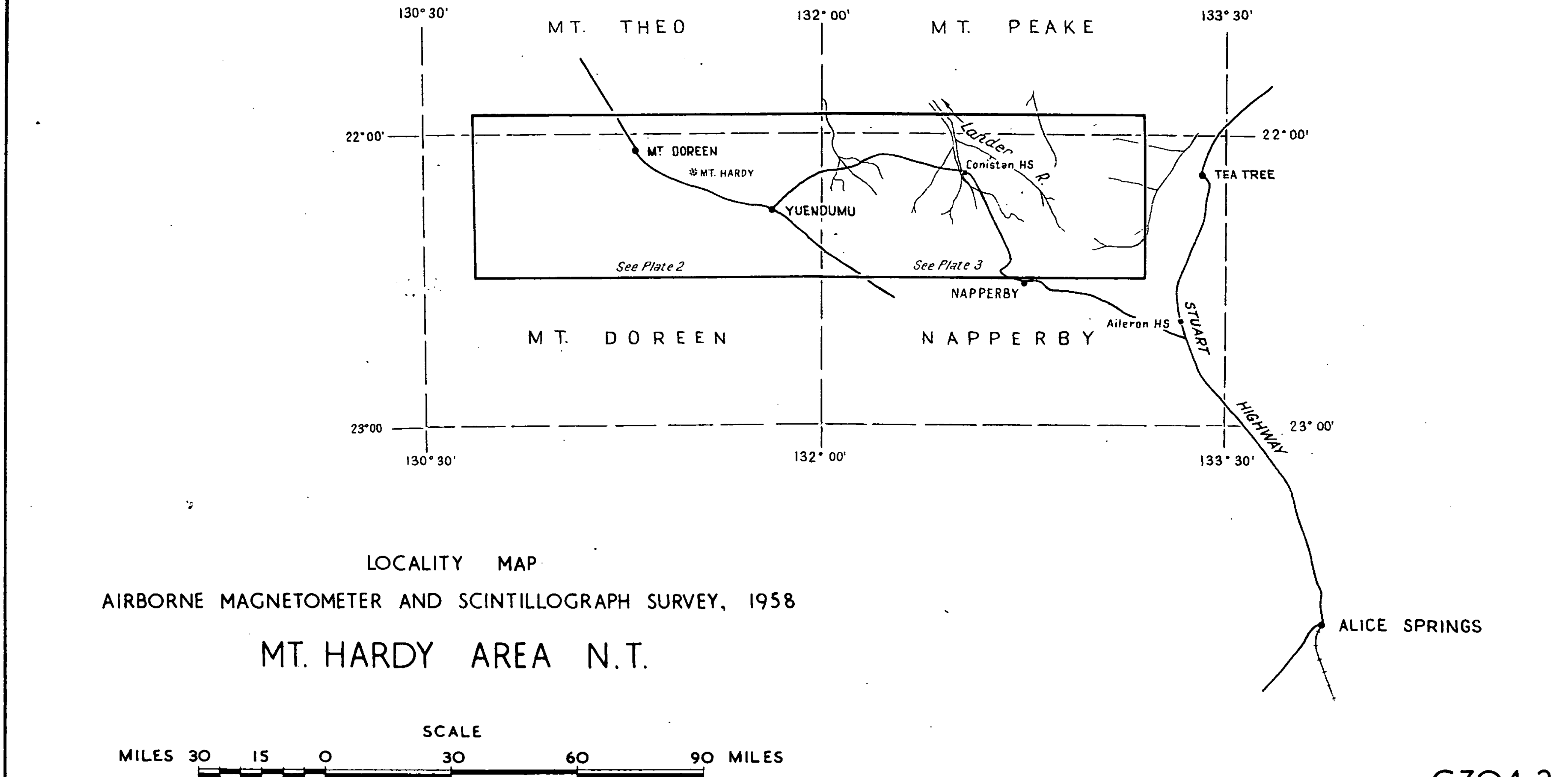
7. CONCLUSIONS

The magnetic results of the survey form a fairly complex pattern of magnetic contours. Current geological maps are not sufficiently detailed to show much correlation between magnetic anomalies and geology. More geological work would have to be done, before the causes of the anomalies, or their possible association with mineral deposits, could be determined. It is expected that the magnetic contour maps would be of considerable assistance to any future geological investigations of the area.

The radiometric results, which have been presented only in preliminary form, indicate that most of the areas of high radioactivity occur over the granite intrusions.

8. REFERENCES

A.G.G.S.N.A.	1941	The Aerial, Geological and Geophysical Survey of Northern Australia. Report for period ending December 31st, 1940.
KIEK, S.N.	1941	The Mount Hardy Copper Field. A.G.G.S.N.A. Report, Northern Territory No. 55.
NOAKES, L.C.	1953	The structure of the Northern Territory with relation to mineralisation. GEOLOGY OF AUSTRALIAN ORE DEPOSITS. Fifth Empire Mining and Metallurgical Congress, Vol. 1, p.284.



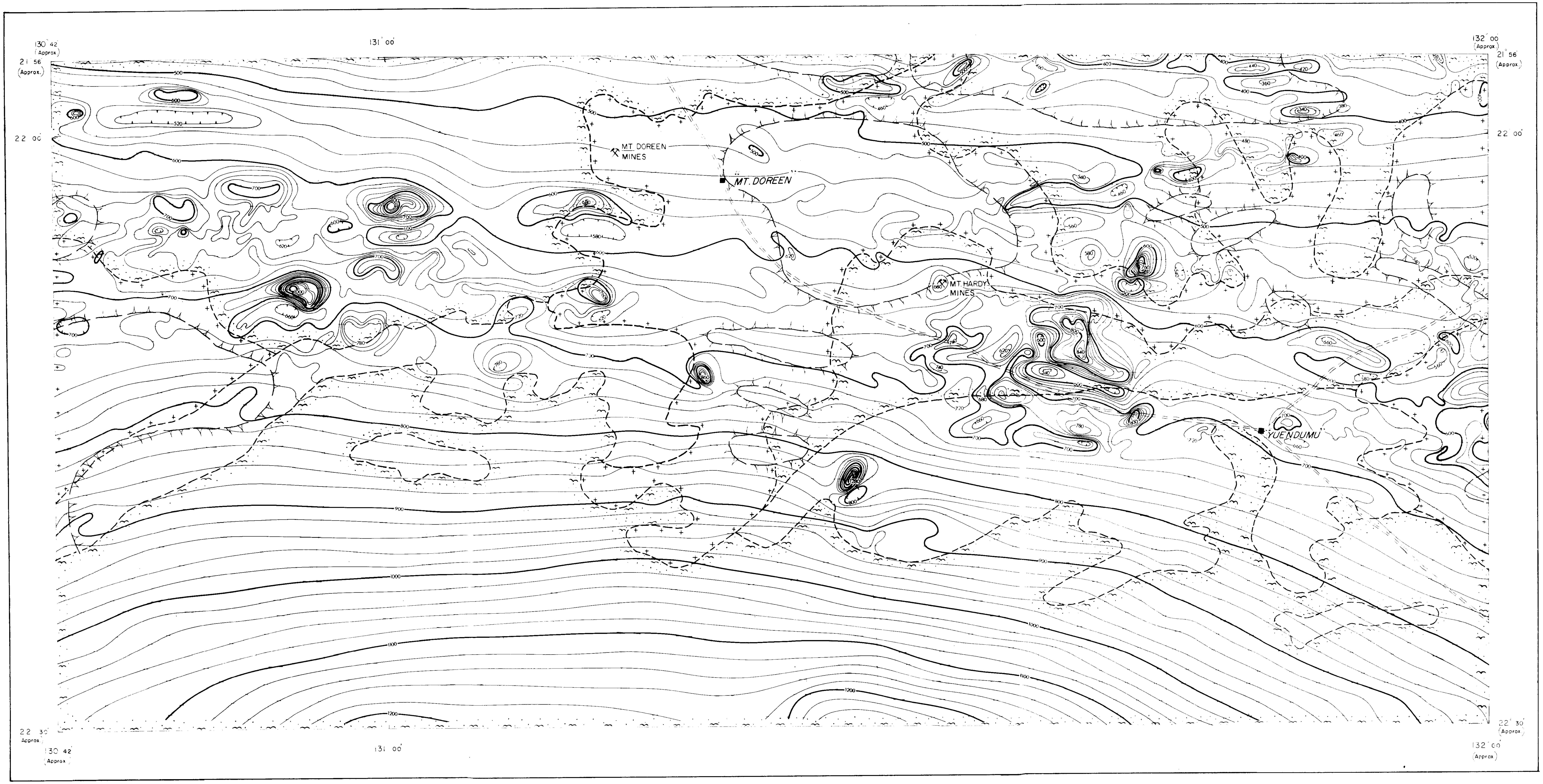
LOCALITY MAP

AIRBORNE MAGNETOMETER AND SCINTILLOGRAPH SURVEY, 1958

MT. HARDY AREA N.T.

Geophysical Branch, Bureau of Mineral Resources Geology & Geophysics. G304-2

To accompany Records 1960/117.



REFERENCE TO AUSTRALIAN NATIONAL 4-MILE MAP SERIES.

130° 30'	132° 00'	133° 30'
MT. THEO	MT. PEAKE	21° 00'
PLATE 2	PLATE 3	22° 00'
MT. DOREEN	NAPPERBY	23° 00'

M.N. T.N. 4½°

AIRBORNE SURVEY OF MT. HARDY AREA N.T. 1958
PRELIMINARY MAP SHOWING
TOTAL MAGNETIC INTENSITY AND CHANGES IN BACKGROUND RADIOACTIVITY

APPROXIMATE SCALE

MILES 4 0 4 8 12 MILES

LEGEND

GEOLOGICAL

- Granite — mainly Archaeozoic
- Undifferentiated — mainly Upper Proterozoic.
- Sand Alluvium, Laterite-Cainozoic
- Geological boundary.

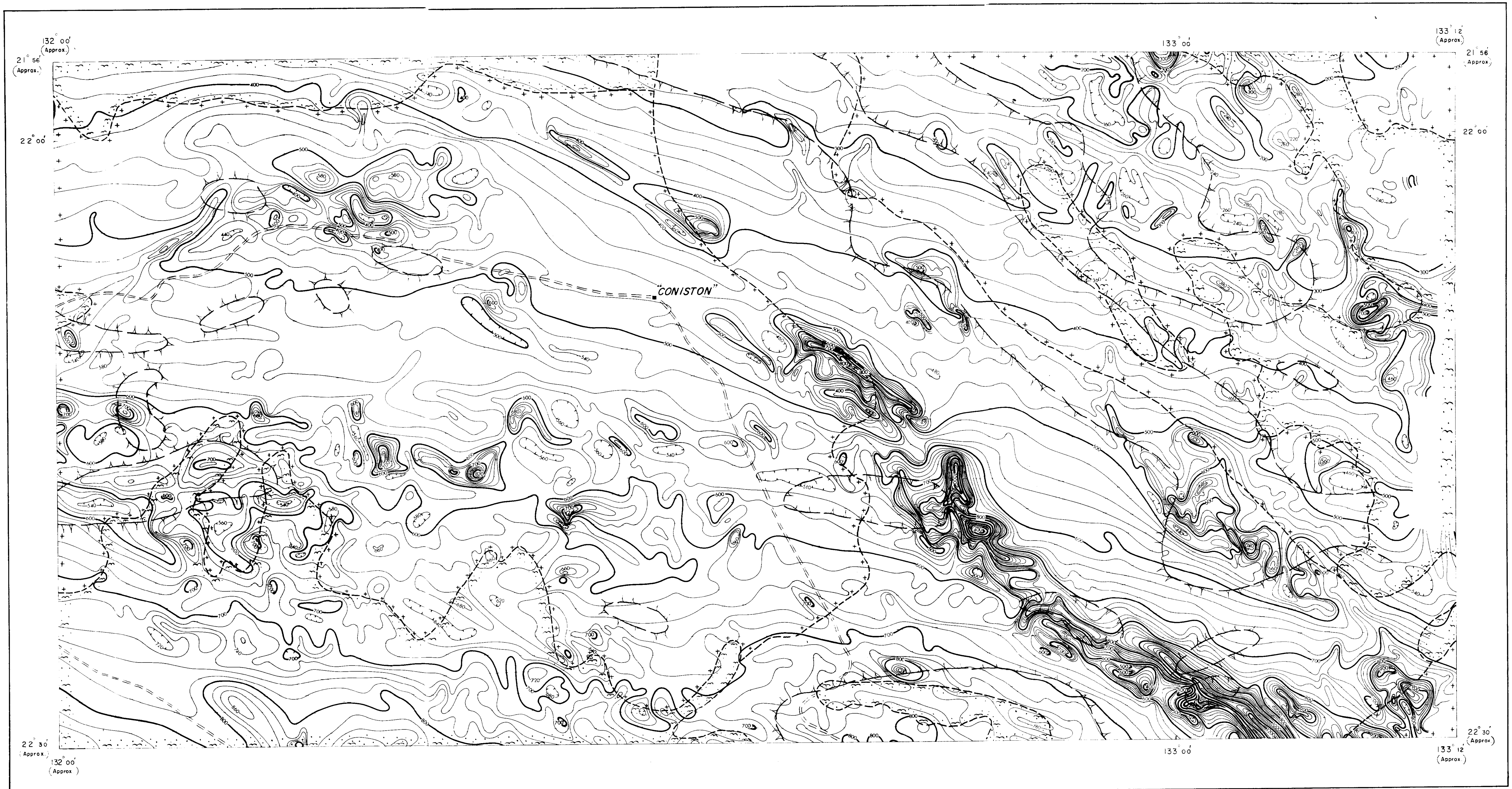
Geological boundaries plotted from Geological Map No. NTG 36-1, compiled by Geological Branch, Bureau of Mineral Resources Geology & Geophysics.

GEOPHYSICAL

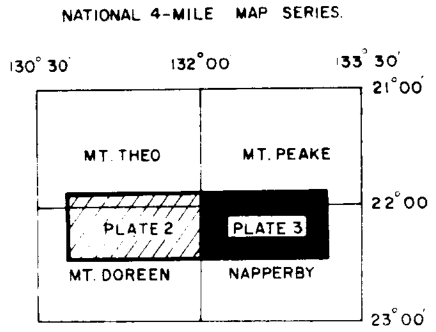
- .... Total magnetic intensity contours, interval 20 gammas, arbitrary datum.
- .... Magnetic low.
- .... Contour/Flight-line intersections.
- .... Change in radioactive intensity equal to or greater than 6× standard deviation on the low side of the change.

Geophysical Branch, Bureau of Mineral Resources Geology & Geophysics
To accompany Records 1960/117.

G 304-3-1



REFERENCE TO AUSTRALIAN NATIONAL 4-MILE MAP SERIES.



AIRBORNE SURVEY OF MT. HARDY AREA N.T. 1958
PRELIMINARY MAP SHOWING
TOTAL MAGNETIC INTENSITY AND CHANGES IN BACKGROUND RADIOACTIVITY

APPROXIMATE SCALE

MILES 4 0 4 8 12 MILES

LEGEND

GEOLOGICAL

- Granite — mainly Archaeozoic
- Undifferentiated — mainly Upper Proterozoic
- Sand . Alluvium . Laterite-Cainozoic
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Geological boundaries plotted from Geological Map No. NTG 36-1, compiled by Geological Branch. Bureau of Mineral Resources Geology & Geophysics.

GEOPHYSICAL

- Total magnetic intensity contours. interval, 20 gammas, arbitrary datum.
- Magnetic low
- Contour/Flight-line intersections.
- Change in radioactive intensity equal to or greater than 6× standard deviation on the low side of the change. (low / high)

Geophysical Branch Bureau of Mineral Resources Geology & Geophysics
To accompany Records 1960/117.

G 304-4-1