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A PRELIMINARY REPORT OF AN AIRBORNE MAGNETIC AND RADIOMETRIC SURVEY OF THE KURNALPIE-WIDGIEMOOLTHA AREAS WESTERN AUSTRALIA, 1958

by

R.M. CARTER

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ABSTRACT.

During 1958, the Commonwealth Bureau of Mineral Resources carried out an airborne magnetometer and scintillograph survey of the Kurnalpi and Widgiemooltha 4-mile map areas, which together comprise a large part of the Eastern Goldfields of Western Australia.

The survey results are presented in preliminary form on sketch maps showing the positions of the principal magnetic anomalies, which range in intensity from 500 to 4000 gammas, and the positions of the first and second order radiometric anomalies.

A large number of magnetic anomalies were recorded over and near the boundaries of the known greenstone areas. It is expected that the complete aeromagnetic data, when presented in the form of final contour maps, will assist in determining the geological boundaries in the area and will provide information concerning the structures in the greenstones.

Investigation of the radioactive anomalies at low level by light aircraft indicates that they are not likely to be associated with uranium mineral deposits.

1. INTRODUCTION.

In 1956, the Commonwealth Bureau of Mineral Resources commenced a programme of airborne surveys of a large area of the Eastern Goldfields of Western Australia comprising the following nine 4-mile military map areas:- Southern Cross, Kalgoorlie, Barlee, Jackson, Kurnalpi, Widgiemooltha, Boorabbin, Norseman and Lake Johnston. This programme was undertaken at the request of the Department of Mines, Western Australia.

Southern Cross was surveyed in 1956, Kalgoorlie, Barlee and Jackson in 1957, and Kurnalpi and Widgiemooltha in 1958. Of the remaining three areas, Norseman and Boorabbin are included in the Bureau's airborne programme for 1959 and Lake Johnston is tentatively planned for 1960.

The area covered by the maps named above, forms part of the West Australian Pre-Cambrian Shield. The greater part of the area consists of acidic rocks - mainly granites, gneisses, schists and granitised sediments. There also occur isolated areas of basic volcanic and intrusive rocks, known as greenstones, and areas of metamorphosed sedimentary rocks known as Whitestones.

The basic intrusives of the greenstone series are the most common host rocks for gold deposits in the Kalgoorlie district and in general there is a tendency for mineralisation in the Shield to be localised in greenstone areas close to the contact with the granitic rocks. Banded iron formations which are strongly magnetic occur in the greenstones of the central and eastern goldfields areas and are associated with gold ore-bodies in many places. The banded iron formations are useful as marker beds in geological mapping and may be traced under soil cover by geophysical magnetic methods.

The regional geology shown in the accompanying sketch maps (Plates 2 and 3) is only approximate and the expanse of acidic rocks indicated is likely to contain unmapped areas of the basic greenstone series.

The airborne surveys carried out by the Bureau take the form of systematic reconnaissance with magnetometer and scintillograph. Anomalies in the magnetic field recorded by the magnetometer are related to differences in the magnetic susceptibilities of the underlying rocks. The aeromagnetic data might therefore assist in establishing the boundaries of the greenstones, whose magnetic susceptibility is higher than that of the surrounding granitic rocks, and in tracing the strongly magnetic banded iron formations. The results of the aeromagnetic surveys, when prepared in the form of magnetic contour maps, are expected to provide considerable assistance in the regional geological mapping, particularly in areas of poor outcrop. The aeromagnetic survey of the Jackson 4-mile area showed intense anomalies associated with the iron ore deposits in the Koolyanobbing Range (Spence, 1958) and a further purpose of the present airborne survey programme is to explore for other similar iron ore occurrences in the region.

Although no deposits of radioactive minerals are known in the region, the survey programme has included scintillograph reconnaissance in order to detect any areas of above average radioactivity which might be of sufficient interest to warrant further investigation by low-level airborne scintillograph survey or by ground methods.

This report describes the survey of the Kurnalpi and Widgiemooltha 4-mile areas which together total approximately 13,000 square miles, bounded by longitudes 121°30' E and 123° E and latitudes 30° S and 32° S. The survey was conducted during May and June, 1958, using the Bureau's D.C.3 aircraft VH-BUR.

The field party which was based at Kalgoorlie comprised the following Bureau personnel: P.E. Goodeve (for early part of the survey only), R.M. Carter, R. Wells, J.R. Pollard, P.M. Sowden, J.H. Croger, R. Jones, N. Price, D.F. Upton and the following personnel from Trans Australia Airlines: P.J. Norriss, J.D. Bartlett, R. Lunniss, R. Furness.

2. SURVEY METHOD.

The survey area was covered by flying a grid of parallel E-W traverses spaced one mile apart. The height of the aircraft was nominally 500 feet but actual height varied by ± 50 feet under normal flying conditions.

Magnetic tie lines were flown in order to correct for differences in magnetic datums of individual flight lines, which might arise from diurnal variation and instrument drift. Different tie-line systems were used in each of the two areas.

In the Widgiemooltha area, the system consisted of N-S tie lines at right-angles to the flight lines and approximately 25 miles apart. Each tie line was approximately 25 miles long and was flown once in each direction.

In the Kurnalpi area, the system consisted of N-S tie lines approximately 15 miles apart, each tie line intersecting all flight lines. Each tie line was flown in one direction only. This system was designed to facilitate the application of a least squares method of reduction to the magnetic data.

The aircraft was navigated by visual comparison of ground features with detail on vertical aerial photographs on which were drawn the pre-determined flight paths. The approximate position of the aircraft determined by reference to recognisable ground features was marked on the photographs at intervals along each flight line. A continuous vertical photographic record of the track of the aircraft was made during each flight to provide for subsequent accurate plotting of the track on photo-mosaics.

3. EQUIPMENT.

The magnetometer consisted of a saturable-core fluxgate magnetometer, type AN/ASQ/8, with the detector head installed at the end of a cylindrical boom projecting from the tail of the aircraft. This arrangement ensured

the least possible disturbance of the magnetic field at the detector head by the magnetism of the aircraft. Effects due to the aircraft's magnetism were further reduced by means of compensating coils at the detector head. The output of the magnetometer, representing a continuous measurement of the intensity of the total magnetic field of the earth, was recorded by a Speedomax recorder.

The aircraft was fitted with two separate scintillograph systems. One consisted of two M.E.L. scintillation detection heads, the combined outputs of which were integrated by a Chalk River radiation monitor and recorded by one channel of a dual-channel Rectiriter recorder. The time constant of this system was approximately 1 second.

The second system consisted of a "towed bird" scintillograph, the principal component being an aerodynamically stable fibreglass shell, trailed below the aircraft by means of a 500 foot cable, controlled by a hydraulic winch. The shell contained a plastic phosphor detector head, a battery operated power unit, and preamplifier, the output of which was connected via the towing cable to an M.E.L. radiation monitor, mounted in the aircraft.

The time constant of this system was approximately $\frac{3}{4}$ second, and the output was recorded on the second channel of the dual-channel Rectiriter recorder.

The towed scintillograph was arranged to fly at a height of approximately 200 feet above ground level, thus giving a second and more sensitive recording of the ground radiation. During this survey, the towed scintillograph was still in the experimental stage and it performed satisfactorily on a few flights only. The use of two detectors at different heights has been adopted in order to obtain a more positive interpretation of the scintillograph data.

Navigational equipment consisted of a radio-altimeter, for continuous and accurate altitude control, radio compass and an air position indicator. An altitude profile was recorded on a single channel Rectiriter recorder in order to enable signal-height corrections to be applied to the radiometric data.

The air position indicator was used to provide an air plot of the progress of the aircraft, along each flight line. The air position was resolved into two components along mutually perpendicular axes and recorded in two ways:-

(a) By having the co-ordinates displayed on two mileage counters which were photographed at regular intervals.

(b) By recording the air position graphically on a single channel Rectiriter recorder, in which one co-ordinate was represented by the chart movement and the other by the pen displacement.

The track of the aircraft was continuously recorded by means of an Aeropath continuous strip 35 mm vertical camera. The track corresponding to each flight was then plotted on air photo mosaics.

Correlation of the various records was achieved by means of fiducial marks on all the recorder charts and counter numbers and fiducial marks on the photographic records.

4. RESULTS

(A) Radiometric.

The preliminary assessment of the radiometric results using only those from the inboard scintillograph, showed that approximately 200 anomalies had been detected during flights at the normal altitude of 500 feet above ground level. These anomalies fall within the 1st, 2nd or 3rd orders of classification according as their peak values exceed, respectively 9, 6 or 3 times the standard deviation of the radioactive background.

In the final assessment of the radiometric results, only the 1st and 2nd order anomalies were retained as being of possible interest. These total 25 and are plotted on the accompanying sketch maps.

The results were examined also for significant changes in the level of radioactivity recorded. In two places, one in the south-western corner of Widgiemooltha, the other in the south-eastern part of Kurnalpi, distinct changes in the level of radio-activity were noted extending over several consecutive flight lines. These level changes are marked on the accompanying maps. The boundaries shown indicate where steep gradients in the observed radioactivity were recorded. They are not related to an absolute intensity level and are, therefore, not the same as contours of equal intensity. Whether or not these boundaries are associated with geological features will not be known until more detailed geological mapping of the areas becomes available.

In July 1958, immediately after the completion of the DC3 surveys of Kurnalpi and Widgiemooltha, the Bureau's Auster aircraft was made available for a limited amount of follow-up scintillograph surveying in these areas. Eighteen of the twenty five plotted anomalies were reflown at 200 feet with the Auster aircraft. Most of the anomalies could be accounted for by the presence of granite outcrops and none of them was considered to warrant any further investigation. In view of these results, and the absence of any known uranium mineralisation in the area, any further follow-up of the DC3 radiometric anomalies is not considered warranted at the present stage.

(B) Magnetic.

The anomalies selected for classification and plotting vary in magnitude between 500 and the maximum of 4000 gammas. The term anomaly has been applied as meaning a pronounced and localised maximum or minimum in the value of the magnetic field.

The anomalies were plotted on the sketch maps at points corresponding to maximum (or minimum) field intensities, the positions having been located approximately by calculating the proportional distance along the flight line corresponding to the fiducial number in each case. The accuracy of this method is approximately $\pm \frac{1}{2}$ mile in an E-W direction, and approximately $\pm \frac{1}{4}$ mile in a N-S direction.

The Kurnalpi and Widgiemooltha areas are magnetically less disturbed than the Kalgoorlie, Barlee and Jackson areas previously surveyed (Spence, 1958) and the magnetic anomalies do not appear to fall into such well defined patterns as in these three areas or in the Southern Cross area.

The anomalies recorded in the present survey fall mainly in or close to the boundary of the greenstones as would be expected from the more basic composition of these rocks compared with the granitic rocks. In the northeast corner of Kurnalpi a short but well defined line of anomalies occurs over a greenstone area and may continue southwards to join another line which crosses Salt Lake and then swings west. The strongest anomalies recorded in Kurnalpi are located in this part of the area.

In Widgiemooltha, a fairly continuous line of anomalies can be recognised trending north-east and then east, from the northern end of Lake Cowan. Another line extends for a shorter distance in a northwest direction from the greenstone area on the southern boundary to the centre of Lake Cowan. These two lines indicate that the greenstones probably extend beyond the present mapped boundaries. In the western part of Widgiemooltha there appears to be a concentration of anomalies in the area south of the Widgiemooltha siding and close to the mapped contact of the greenstones with the granitic rocks. These anomalies may prove of considerable interest as they fall in the zone where there has been previous mining activity and approximately follow the trend of a regional fold line (Forman, 1953, Fig. 1).

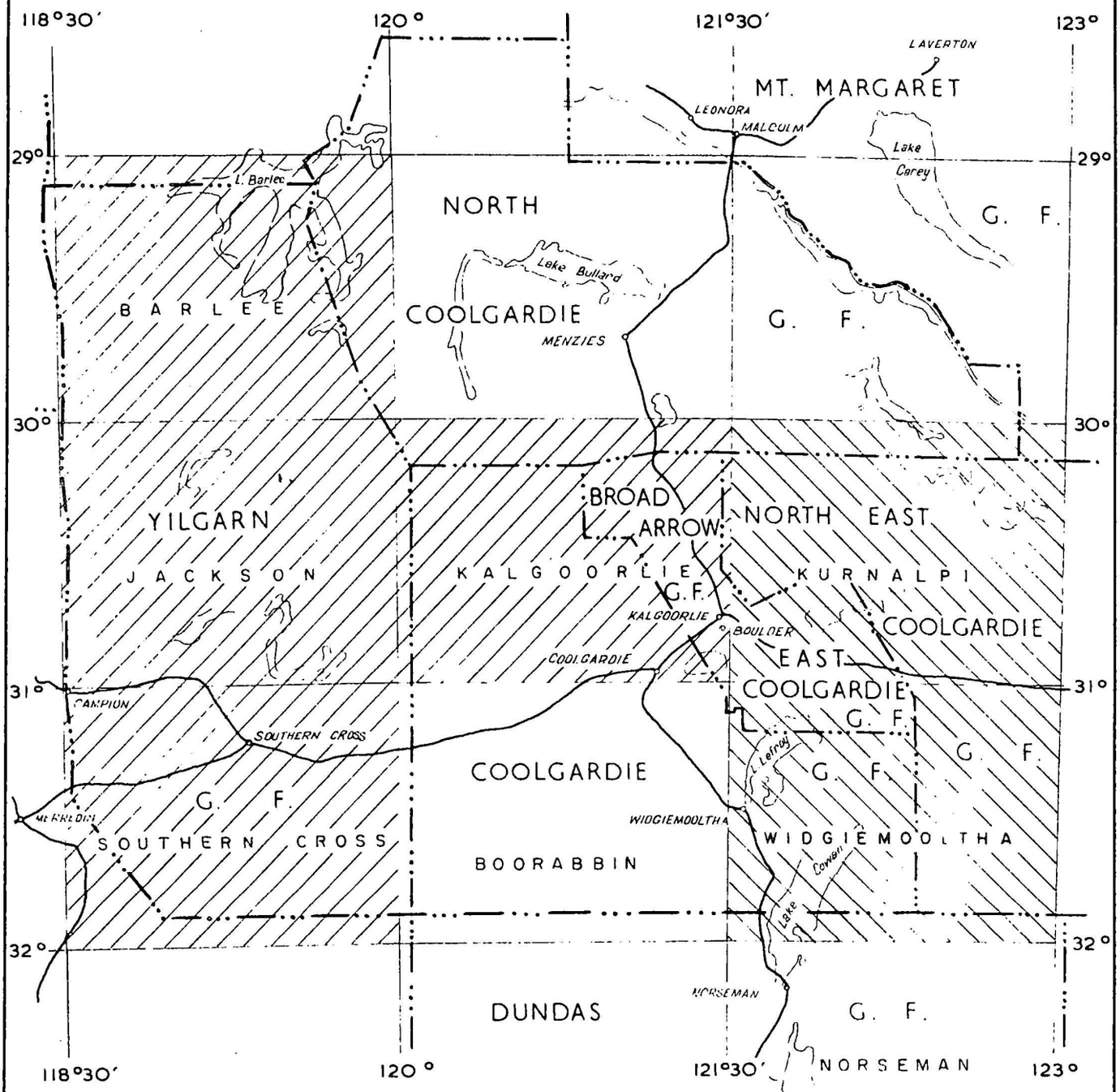
5. CONCLUSIONS.

The method of plotting used in compiling the preliminary maps allows presentation of only the principal features of the magnetic results. The results will be published in final form as magnetic contour maps on a scale of two miles to one inch. These maps will give a more accurate and detailed presentation of the anomalies and are expected to show considerably more features of interest than can be recognised in the preliminary plotting.

The preliminary assessment of the results of the magnetometer survey shows that a large number of magnetic anomalies have been recorded over and near the boundaries of the greenstones and that these anomalies will probably assist in establishing the boundaries more accurately and will provide additional information concerning the structures in the greenstones.

During the survey, the airborne scintillograph detected 25 radioactive anomalies of 1st and 2nd order. Further low-level investigation carried out subsequently with the Bureau's Auster Aircraft has indicated that none of these anomalies is likely to be associated with uranium mineral deposits.

PLATE I



LOCALITY MAP

AIRBORNE MAGNETOMETER AND SCINTILLOGRAPH SURVEY, 1958

KURNALPI – WIDGIEMOOLTHA AREA W. A.

SCALE IN MILES

40 0 40 80 120

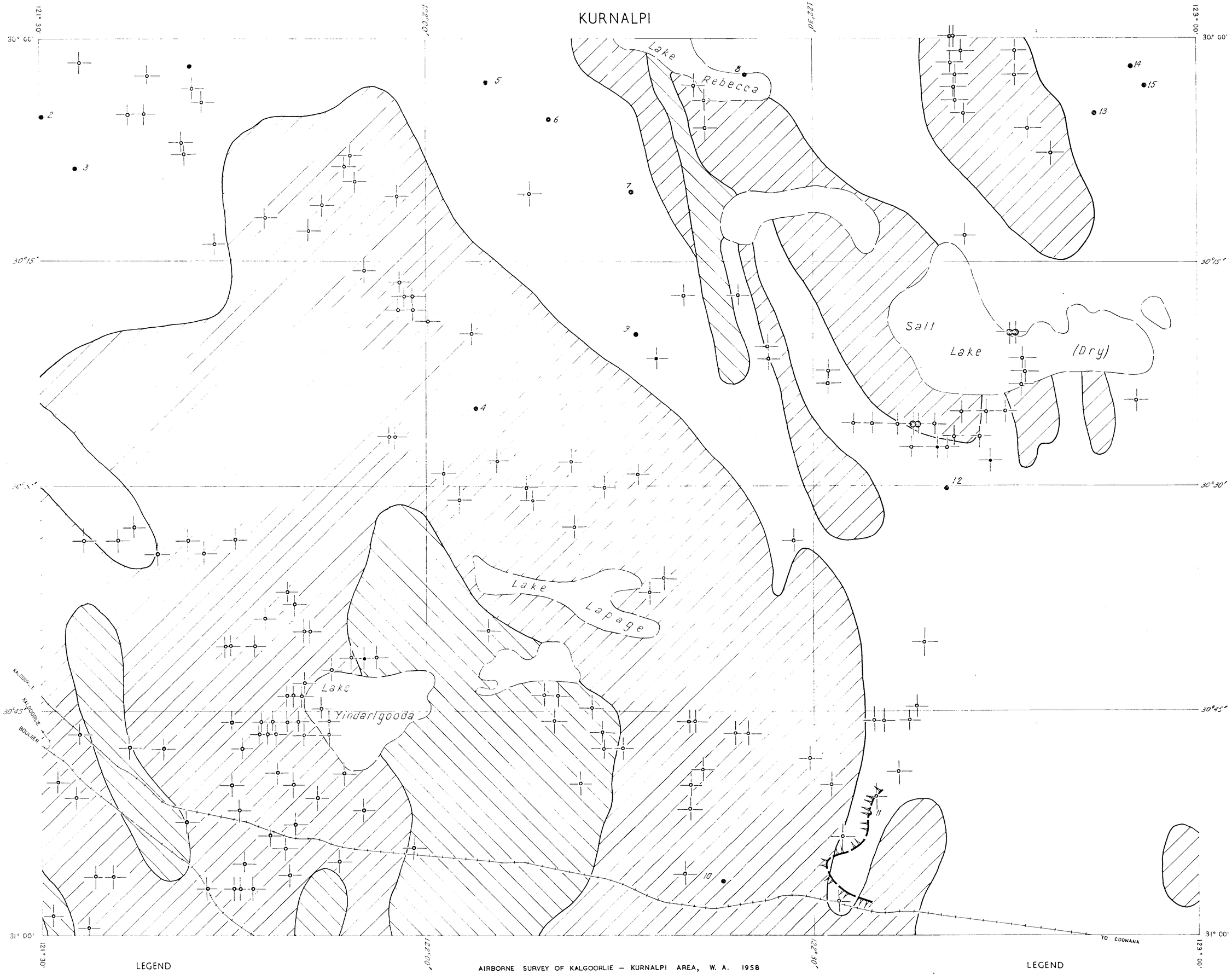
AREA PREVIOUSLY SURVEYED

AREA SURVEYED MAY-JUNE 1958

GOLDFIELDS BOUNDARIES

Geophysical Section, Bureau of Mineral Resources Geology & Geophysics. G 302·2

TO ACCOMPANY RECORDS 1959, No. 137



LEGEND

- Greenstone Series
- Whitestone Series
- Mainly Acid Rocks

} Pre-Cambrian

AIRBORNE SURVEY OF KALGOORLIE – KURNALPI AREA, W. A. 1958

PRELIMINARY MAP SHOWING

MAGNETIC AND RADIOACTIVE ANOMALIES

APPROXIMATE SCALE

MILES 4 0 4 8 12 MILES

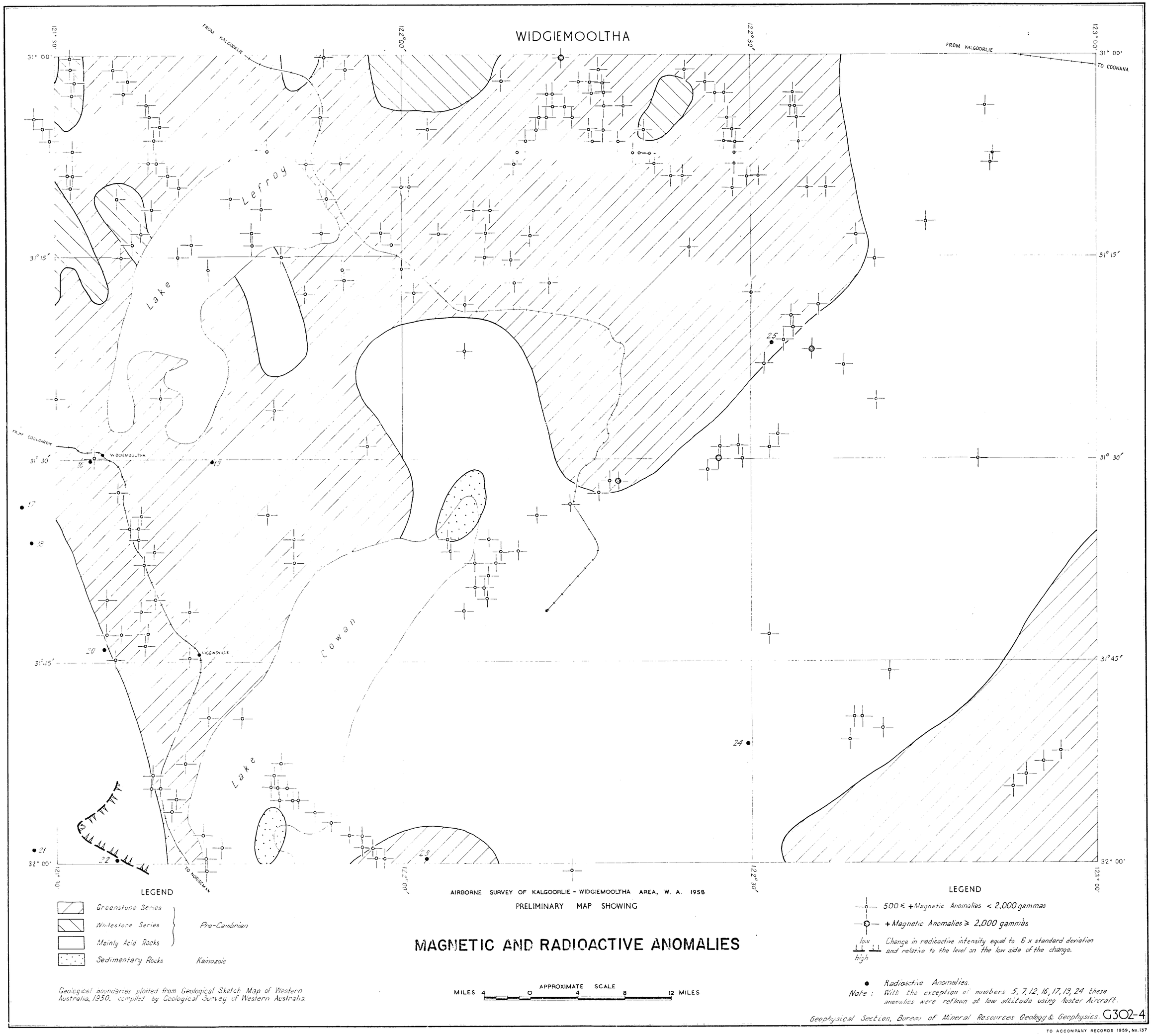
Geological boundaries plotted from Geological Sketch Map of Western Australia, 1950, compiled by Geological Survey of Western Australia.

LEGEND

- Magnetic Anomalies ≥ 500 gammas
- 500 ≤ + Magnetic Anomalies < 2,000 gammas
- + Magnetic Anomalies ≥ 2,000 gammas
- low / high — Change in radioactive intensity equal to 6x standard deviation and relative to the level on the low side of the change.
- ● Radioactive Anomalies.

Note: With the exception of numbers 5, 7, 12, 16, 17, 19, 24 these anomalies were reflown at low altitude using Auster Aircraft.

Geophysical Section, Bureau of Mineral Resources Geology & Geophysics. G302-3


WIDGIEMOOLTHA
FROM KALGOORLIE
FROM KALGOORLIE
TO COONANA
FROM COOLGARDIE
WIDGIEMOOLTHA
HIGGINSVILLE
TO NORSEMAN
Lake Lerroy
Lake Cowan
121° 30'
122° 00'
122° 30'
123° 00'
31° 00'
31° 15'
31° 30'
31° 45'
32° 00'
15
16
17
18
19
20
21
22
23
24
25
LEGEND
Greenstone Series
Waitestone Series
Mainly Acid Rocks
Pre-Cambrian
Sedimentary Rocks
Kainozoic
Geological boundaries plotted from Geological Sketch Map of Western Australia, 1950. Compiled by Geological Survey of Western Australia.
AIRBORNE SURVEY OF KALGOORLIE - WIDGIEMOOLTHA AREA, W. A. 1958
PRELIMINARY MAP SHOWING
MAGNETIC AND RADIOACTIVE ANOMALIES
APPROXIMATE SCALE
MILES 4 0 4 8 12 MILES
LEGEND
500 ≤ + Magnetic Anomalies < 2,000 gammas
+ Magnetic Anomalies ≥ 2,000 gammas
low
high
Change in radioactive intensity equal to 6 x standard deviation and relative to the level on the low side of the change.
Radioactive Anomalies.
Note : With the exception of numbers 5, 7, 12, 16, 17, 19, 24 these anomalies were reflown at low altitude using Auster Aircraft.
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