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DEPARTMENT OF NATIONAL DEVELOPMENT

BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS

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Notes on the results of  
aeromagnetic surveys in the  
Northern Territory

by  
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### ABSTRACT

The results of airborne magnetometer surveys carried out by the Bureau of Mineral Resources in the Northern Territory are discussed, with special reference to the Rum Jungle and Brock's Creek areas, and tentative correlation is made between the known geology and the airborne anomalies, and with ground magnetic results in those areas where ground surveys followed the airborne surveys.

Recommendations for further investigations include an electrical survey around the Waterhouse uranium prospects, additional ground magnetic surveys in the Rum Jungle, Brock's Creek, Brodribb and Cosmopolitan Howley areas, and extension of the airborne magnetometer surveys to other parts of the Northern Territory.

## 1. INTRODUCTION

The main mineralised areas in the northern part of the Northern Territory are Rum Jungle and Brock's Creek. Sullivan and Iten (1952) have commented on the general geological similarity of these areas. In each, mineralisation of various types occurs in beds of schists, generally graphitic, disposed around a central granite mass. Each area has been covered by aeromagnetic survey and the similarity in the magnetic results in the two areas can be described as striking. The purpose of the present notes is to describe the results in general, and to suggest certain tentative conclusions, which may provide a basis for geological investigation, and possibly, at a later date, for geophysical field work and investigation by drilling.

## 2. RUM JUNGLE

In the Rum Jungle area, deposits of uranium, copper and lead minerals occur in beds of graphitic schist around the southern edge of the Rum Jungle granite mass. Beds containing weak thorium mineralisation occur to the north of the mass.

The results of the aeromagnetic survey in the Rum Jungle area are shown on plan G71-92A (Plate 1). The results show very little magnetic relief, except near the Rum Jungle Granite. There, very large anomalies are present, caused by magnetic bodies in the sedimentary rocks, disposed around the edges of the granite mass. A line of large anomalies, due to relatively deep-seated bodies, lies along the northern edge of the granite, bending around the granite at its north-western extremity and extending south for several miles along the western edge. Another line of large anomalies, due to shallower bodies, extends around the southern tip of the granite. The Rum Jungle uranium deposits are close to the southern anomalies.

Another line of anomalies begins about 4 miles east of the Batchelor Airfield, and extends for several miles in a general southerly direction into the Hundred of Waterhouse. Three of the four uranium prospects inspected by the Bureau in the Waterhouse area lie close to this line of anomalies.

Some of the anomalies have been investigated to some extent by ground magnetic surveys. Isolated magnetic traverses were run in connection with the investigation of the four uranium prospects in the Waterhouse area, but the amount of work done was too small to do more than confirm the existence of large anomalies and their close proximity to the uranium prospects. Rather more ground work has been done on the anomalies at the southern tip of the Rum Jungle granite close to Brown's Workings. An area about  $1\frac{1}{2}$  miles long was covered by a reconnaissance survey (Daly, 1953), and a small area was investigated in detail, using both horizontal and vertical magnetometers, in order to locate possible drilling sites (Daly, 1957).

The results of ground surveys near Brown's workings show that the nature of the anomalies is not as simple as would appear from the airborne results. The anomalies are large (up to 6,000 gammas), and the profiles of both vertical and horizontal components are regular in form, and uniform in shape over the area covered by detailed survey, which is over 1,000 feet long. For this reason, the most natural assumption is that the material causing the anomalies is polarised by

## 2.

induction in the earth's magnetic field. However, in the area covered by the detailed survey (Daly, 1957) the vertical component profiles show two maxima, indicating that two magnetic bodies are present.

Detailed suggestions on the interpretation of these results are discussed by Daly (1957). Briefly, the most natural interpretation is that the magnetic formation is folded in a single anticlinal fold at the eastern end of the anomaly. Further west, folding becomes more complex, and ground magnetic work has not been sufficiently detailed to enable definite conclusions to be drawn. It must be remembered, however, that the general structure of the Rum Jungle embayment area appears to be synclinal, and the possibility that the magnetic formation is synclinally folded, although difficult to envisage, cannot be altogether ruled out. Testing by drilling would be necessary to establish this point. However, it appears safe to assume that the magnetic body is folded, and that detailed ground magnetic measurements would be capable of providing a good deal of information on the nature of the folding.

The rocks causing the magnetic anomalies in the Rum Jungle area are not known to have any surface expression. The magnetic formation has been intersected by one diamond drill hole, to the knowledge of the Bureau and, in view of the extensive exploration programme of Territory Enterprises Pty. Ltd. in the area west of Brown's Workings, it is possible that other intersections have been made. The magnetic material is a rock of basic type mineralised with magnetite and pyrrhotite. It contains no mineral of economic value, nor is there any reason to expect that it would. However, the close proximity of the magnetic anomalies to the known sulphide deposits at Rum Jungle suggests the possibility that the two types of mineralisation are connected in some way. The Bureau has no information on this matter, but it is possible that Territory Enterprises Pty. Ltd., in the course of their exploration, have accumulated enough evidence to enable a reasonable theory to be constructed. If this is so, a wide field for exploration would be opened, particularly to the north of the Rum Jungle Granite, and, as will be seen later, near the Cosmopolitan Howley Mine, in both of which areas the magnetic beds are considerably deeper than elsewhere.

The work of Allen (1951) and Langron (1956) in the Rum Jungle area, and of Barlow (1956) near Manton Dam, has shown that the sulphide deposits in the graphitic schists around the Rum Jungle granite are readily detected by electrical prospecting methods. Joklik (1953) remarks on the very close similarity between geological conditions in the Rum Jungle and Waterhouse areas and, as mentioned earlier, a further point of similarity is the presence of magnetic bodies in both areas. It is considered, therefore, that a geophysical survey in the Waterhouse area, using electrical methods, would have a very good chance of discovering deposits of sulphide minerals which might be of economic value.

## 3. BROCK'S CREEK AREA

The geology of the Brock's Creek district has been described by Sullivan and Iten (1952). The results of aeromagnetic surveys are shown on maps covering the following 1-mile sheets :-

G 156-2 : Ban Ban (Plate 2)

G 159-2 : Burnside (Plate 3)

G 170-2 : Tipperary (Plate 4)

No ground magnetic work has been done in this area.

The area covered by the surveys is magnetically featureless in general, except for several major anomalies disposed around the periphery of the Brock's Creek Granite in a manner remarkably similar to the disposition of anomalies surrounding the Rum Jungle Granite. Compared with the Rum Jungle anomalies, the Brock's Creek anomalies are considerably smaller in amplitude, suggesting that the magnetic mineralisation is rather weaker. The association of the known ore bodies with the magnetic anomalies is not as complete in the Brock's Creek area. The anomalies consist of :

- (i) A ring closely surrounding the Brock's Creek Granite. The most important mineral deposit associated with this line is the Mt. Ellison Copper Mine.
- (ii) A line west of (i) closely associated with the northern portion of the Howley Line of mineralisation, as mapped by Sullivan and Iten (1952).
- (iii) A group of deeper-seated anomalies, the alignment of which is not obvious from the aeromagnetic results, associated with the Fleur de Lys and Cosmopolitan Howley Mines and extending southeasterly to Long Airfield. Although these anomalies are relatively deep-seated, their amplitude is at least as great as that of the others in this region, indicating that the formations which cause them are either larger or more strongly mineralised than those causing other anomalies. Other relatively deep-seated features persist to the southern limit of the area surveyed.

As regards Sullivan and Iten's "Howley Line" (1952), the northern portion from the railway line through Mt. Paqualin is closely associated with a rather shallow-seated magnetic anomaly. South of the railway line, the Bridge Creek, Big Howley, and Chinese Howley deposits have no magnetic anomaly near them. The line of anomalies re-commences near the Fleur de Lys Mine. Other mines, such as Zapopan, have no apparent association with the anomalies.

Amphibolite is a persistent associate of the mineral deposits in this area, and Sullivan and Iten (1952) suggest that it is of importance in connection with the source of the mineralisation. It has been suggested that the magnetic anomalies are due to amphibolite. While it seems very probable that the anomalies are connected with basic differentiates related to the Brock's Creek Granite, they cannot be accounted for by outcropping amphibolites for the following reasons :

- (i) The anomalies are larger than those generally caused by amphibolites.
- (ii) Close comparison of the magnetic and geological maps shows that the anomalies are in many places

displaced from the outcropping amphibolite.

- (iii) In many places, amphibolite crops out strongly where there is no magnetic anomaly close to it. In particular, the disposition of the outcropping amphibolite between the Cosmopolitan Howley Mine and Long Airfield is quite unlike the trend shown by the magnetic anomalies.
- (iv) Even where magnetic anomalies coincide in position with outcropping amphibolite, it appears from the contour plans that the anomalies are due to bodies whose depths vary considerably.

In the absence of further evidence it appears safest to suppose that the anomalies are due to basic rocks mineralised in a fashion similar to the magnetic formations at Rum Jungle, though rather less strongly. The possibility should also be investigated that the anomalies are due to the primary portions of bodies whose surface expression is to be found in the extensive development of hematite gossans, described by Sullivan and Iten. This could be checked by carefully comparing the distribution of outcropping gossans with that of the magnetic anomalies; the possibility is rather a remote one however, considering the apparently wide variations in the depths of the anomalies.

The main interest of the anomalies in this region lies in the fact that if a well-based association of magnetic bodies with sulphide mineralisation can be devised in the Rum Jungle area, it might be applied to provide targets for deep drilling near the Cosmopolitan Howley Mine. According to Sullivan and Iten (1952) this mine offers the possibility of providing large tonnages of low grade pyritic gold ore. If a sufficient basis can be worked out for its exploration at considerable depth, reserves might be increased sufficiently to warrant large-scale exploitation.

#### 4. OTHER AREAS

Although a very considerable area has been aeromagnetically surveyed in the northern part of the Northern Territory, no other similar magnetic structures have been found. Anomalies of relatively small extent are present in the Darwin - Anson Bay region (Plan G 226-2) (Plate 5), which are apparently due to isolated plug-shaped bodies; otherwise, the area generally is remarkably free from magnetic anomalies.

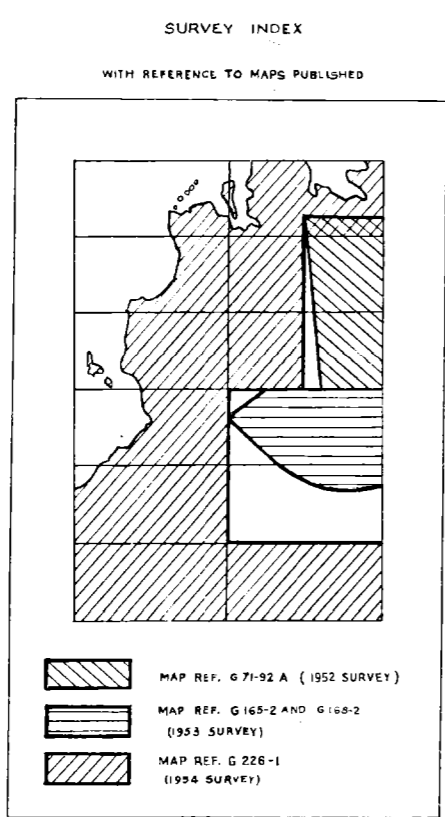
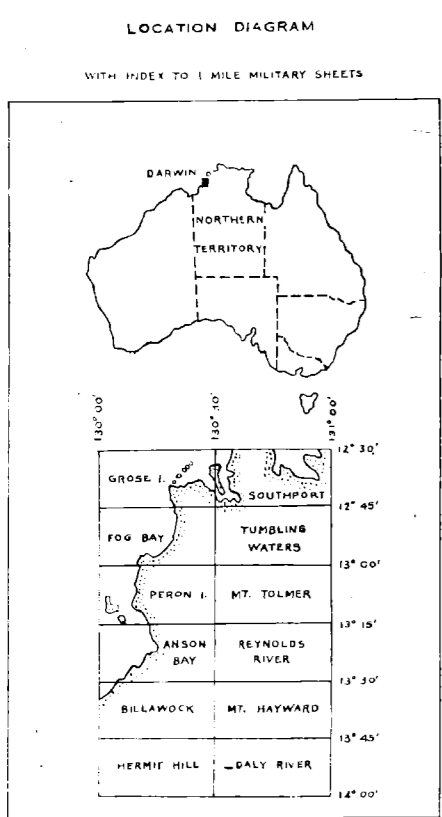
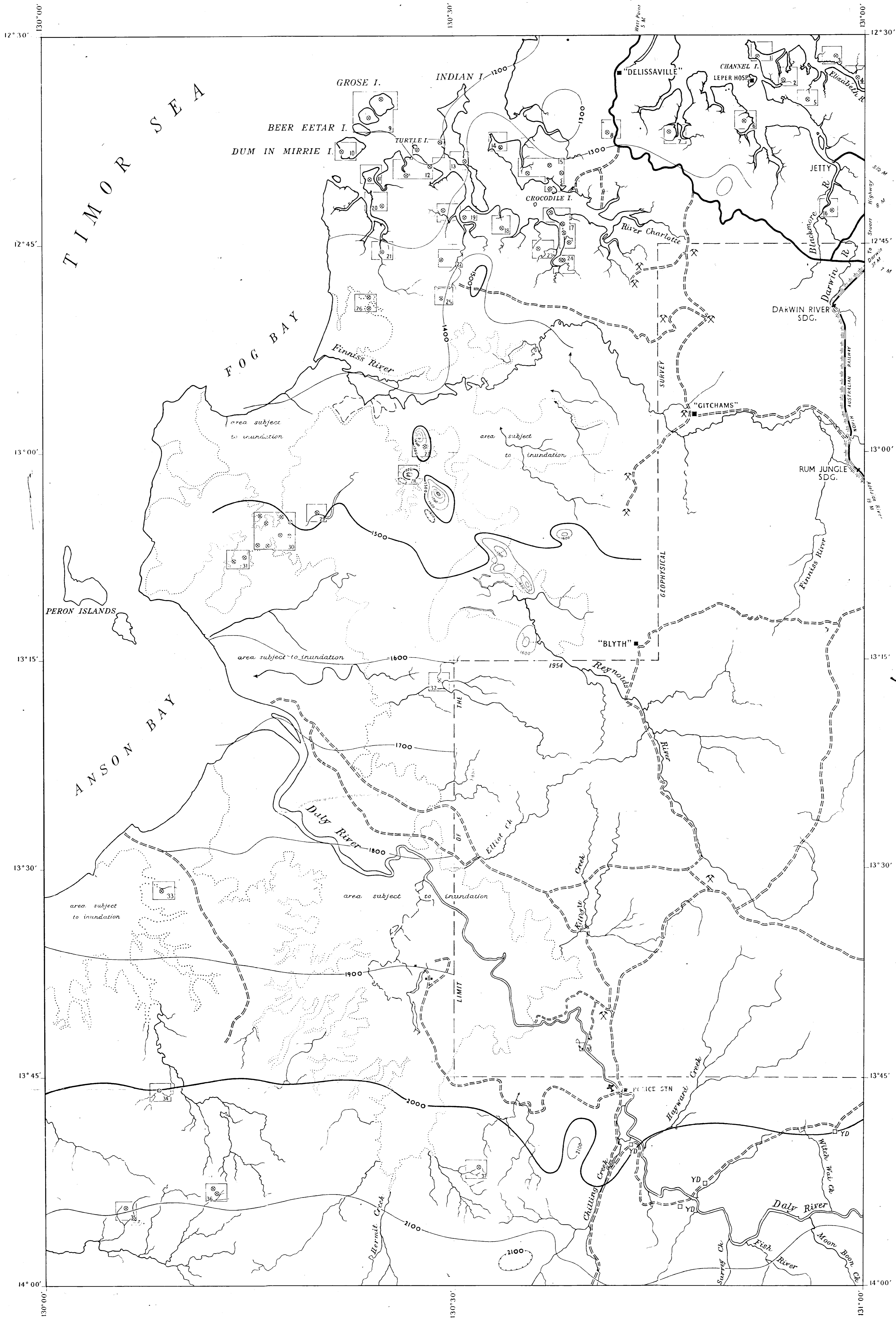
The association of such well-marked magnetic features with the two main mineralised areas of the Katherine-Darwin region cannot be fortuitous, even though it may not prove possible to work out the association in sufficient detail to guide exploration. If it should be found possible to use the magnetic results as a direct guide in drilling for sulphide bodies, it must be remembered that such features if any exist, can be readily detected under the limestone cover south of Katherine and the capping of the Arnhem Land plateau. In this connection, an aeromagnetic survey of the Nicholson River area would be of great interest. If a similar magnetic feature were found there, there would be a reasonable probability that any major mineralised zone which may exist under the Arnhem Land plateau could be detected in this way.

5. CONCLUSIONS

- (i) A geophysical survey using electrical methods over an area around the Waterhouse uranium prospects is an obvious step in the investigation of the mineral possibilities of the Rum Jungle area.
- (ii) It appears that the magnetic formations near Brown's Workings are a useful structural marker, and ground magnetic surveys provide a good deal of evidence on the folding of the rocks. This can be extended as a reasonable probability to the rest of the Rum Jungle and Brock's Creek areas.
- (iii) The possibility of using the magnetic formation as a marker for sulphide mineralisation should be investigated. In this connection it is recommended that Territory Enterprises Pty.Ltd. be approached to make available to the Bureau any of the results of their exploration programme at Brown's that may bear on this problem.
- (iv) If a reasonable solution to (iii) can be envisaged, the possibility should be considered of applying it to exploration at depth in the Brodribb area and around the Cosmopolitan Howley Mine. Such exploration would involve ground magnetic surveys, followed by deep drilling in favourable areas.
- (v) The possibility should be kept in mind of discovering further structures similar to Rum Jungle and Brock's Creek by aeromagnetic survey in areas of the Northern Territory covered by later rocks.

6. REFERENCES

- Allen, M.G., 1951 - Geophysical survey of the Rum Jungle Uranium Field, N.T. Bur. Min. Resour. Aust., Records 1951/56
- Barlow, A.J., 1956 - Geophysical survey in the Manton Dam Catchment Area, N.T. Bur. Min. Resour. Aust., Records 1956/24
- Daly, J., 1953 - A reconnaissance magnetic survey of an area south-west of Brown's Workings, Rum Jungle, N.T. Bur. Min. Resour. Aust., Records 1953/93
- Daly, J., 1957 - Detailed magnetic survey of an area south-west of Brown's Workings, Rum Jungle, N.T. Bur. Min. Resour. Aust., Records C1957/7.
- Joklik, G.F., 1953 - Notes on the Waterhouse Uranium Prospecting Area, N.T. Bur. Min. Resour. Aust., Records 1953/95
- Langron, W.J., 1956 - Geophysical survey in the Rum Jungle Area, N.T. Bur. Min. Resour. Aust., Records 1956/43
- Sullivan, C.J., and Iten, K.W.B., 1952 - The geology and mineral resources of the Brock's Creek District, N.T. Bur. Min. Resour. Aust., Bull. 12.

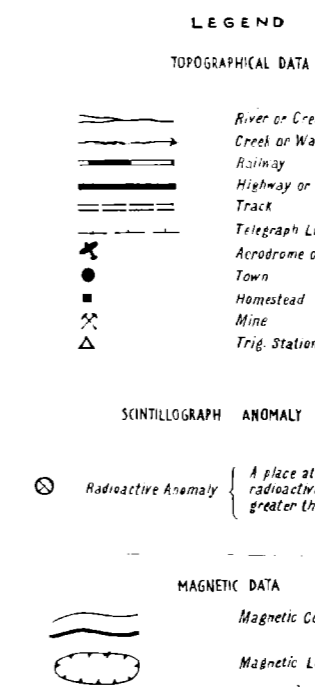


NORTHERN TERRITORY  
DARWIN - ANSON BAY COASTAL REGION

MAP SHOWING  
TOTAL MAGNETIC INTENSITY  
MEASURED BY AIRBORNE MAGNETOMETER  
IN RELATION TO  
RADIOACTIVE ANOMALIES  
DETECTED BY AIRBORNE SCINTILLOGRAPH



MAGNETIC CONTOUR INTERVAL 100 GAMMAS



EXPLANATORY NOTES

This map shows the results of a reconnaissance survey with an airborne scintillograph flown south-easterly with an AN-4501 magnetometer. Reconnaissance maps are made from results in which there is little information concerning uranium occurrences in order to discover areas in which uranium mineralization is likely to occur. The results therefore should be treated only as an initial guide to prospecting.

The scintillograph records continuously the intensity of gamma radiation from the ground over which the aircraft flies. The intensity over any area is generally uniform but shows random variations above and below an average value. Anomalies are noted where the intensity is substantially greater than this average value.

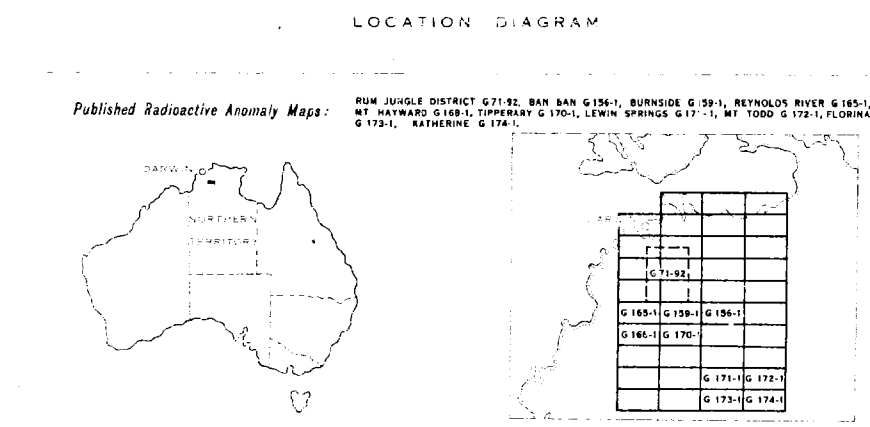
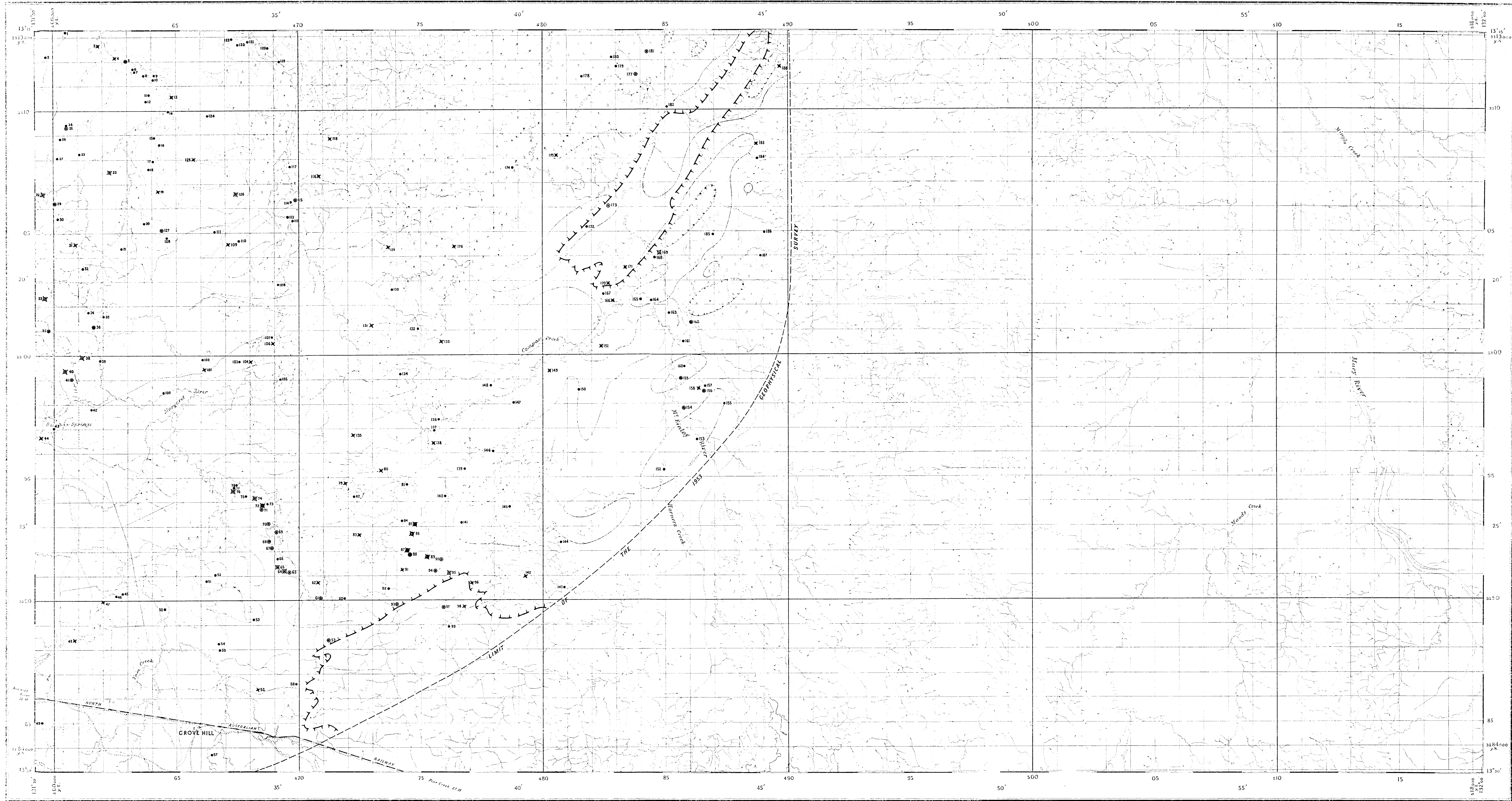
The magnetometer records continuously the magnetic intensity of the total field. The data remain uncorrected for a regional gradient of approximately 4 gammas per mile in a direction of 3° West.

The equipment was flown, where practicable, at a constant height of 100 feet above the ground with a flight-line spacing of one mile. The height of the aircraft was recorded continuously by a radio altimeter which enabled corrections to be made to the scintillograph results for variations in the aircraft's height above the ground. Aerial photographs were used for navigation and a continuously-operated vertical camera recorded each flight-line.

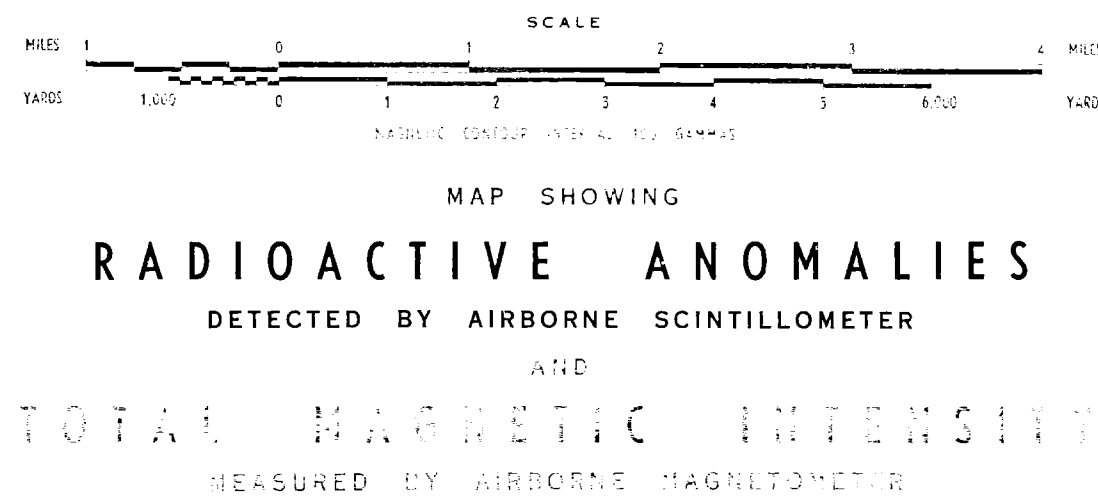
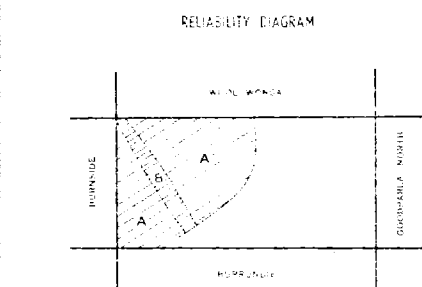
For further information on the radioactive anomalies reference should be made to B.M.P. map No. G 226-1 published February 1956.

MAP DATA

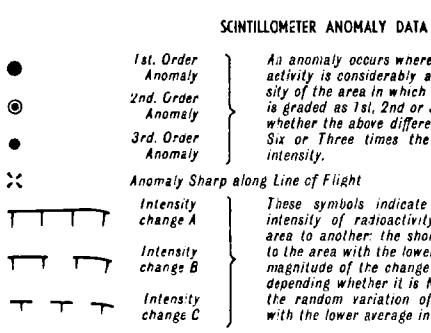
PRODUCTION: Transverse Mercator.  
CONTROL: 1:50,000 air photo mosaic.  
DETAIL: Planimetric detail was compiled from 1:50,000 perimeter controlled dated topographic air photo mosaic published by National Mapping Office, Department of the Interior.  
RELIABILITY: Map detail, reliable sketch.



MAP DATA



LEGEND

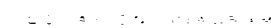


EXPLANATORY NOTES

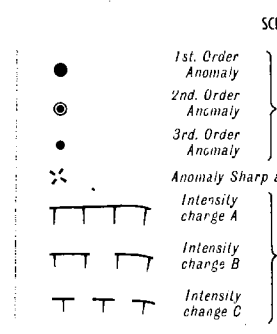
The purpose of this map is to show the location of radioactive anomalies detected by the scintillometer. The anomalies are shown as dots on the map, with numbers indicating their intensity. The map also shows the total magnetic intensity measured by the magnetometer. The anomalies are located in the Northern Territory, near the border with South Australia. The map is a scale of 1:63,360. The anomalies are located in the Northern Territory, near the border with South Australia. The map is a scale of 1:63,360.

## AUSCHLAIN 1005661

## SUMMARY



## 1559

$$E(X) = \frac{1}{2} \quad \text{and} \quad \text{Var}(X) = \frac{1}{3}.$$


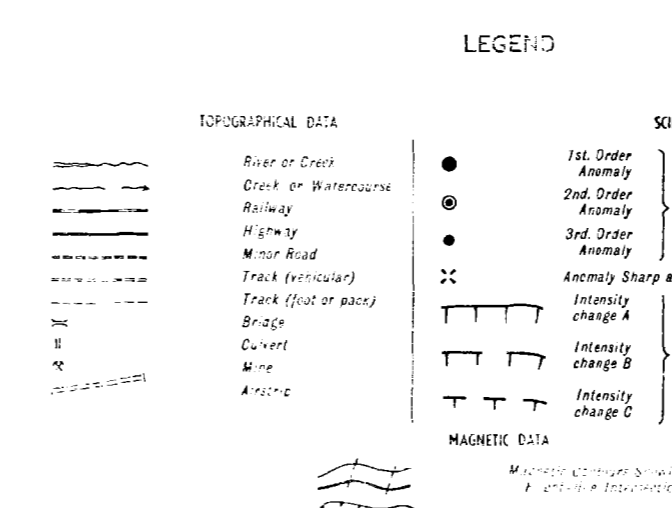
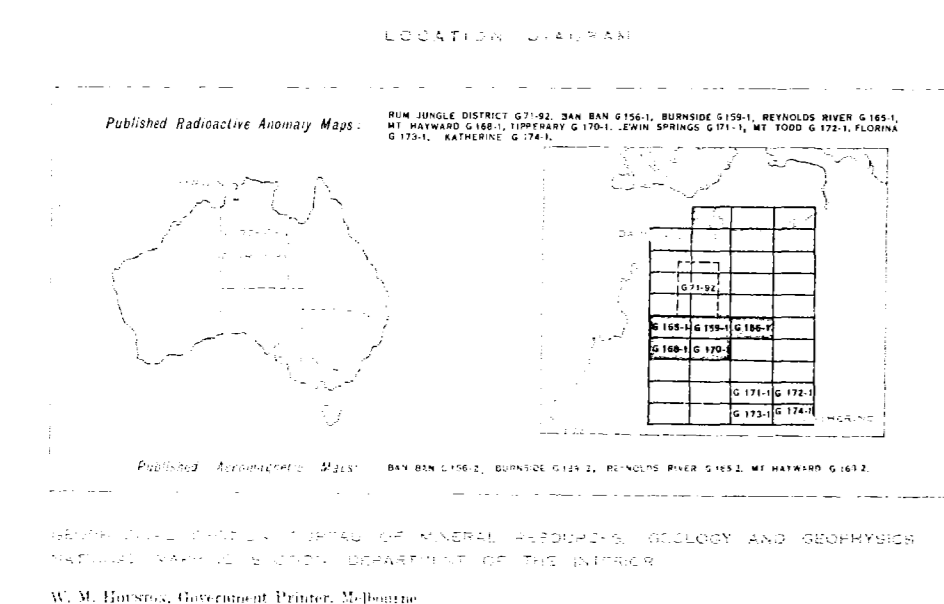
**ANGLE OF FIDELITY**

*An accuracy where the intensity of radioactivity is considerably above the average intensity of the area in which it occurs. An accuracy is said to be of 1st order depending on whether the above difference of intensity is Nine, Six or Three times the random variations of intensity.*

**ANGLE OF FIDELITY**

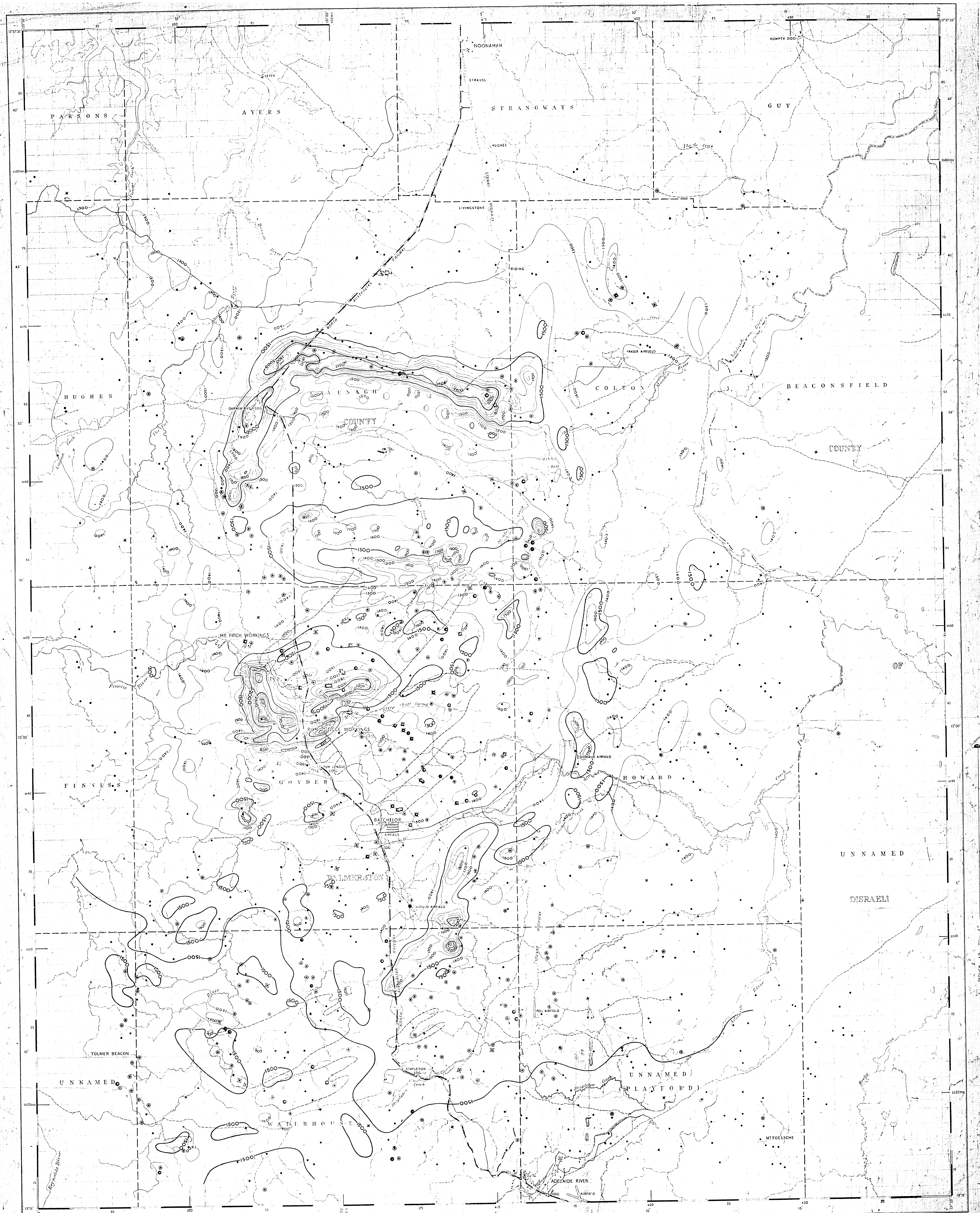
*These symbols indicate a change in average intensity of radioactivity in passing from one area to another: the short horizontal lines point to the area with the lower average intensity. The magnitude of the change is graded as A, B or C depending whether it is Nine, Six or Three times the random variations of intensity of the area with the lower average intensity.*

[illegible][illegible]

[illegible]

Flight line spacing of one-fifth of a mile, used in this survey, complete coverage was not obtained. Under these circumstances some information may be lost and it has been suggested that the degree to which this loss is any way may be anywhere within a radius of 100 to 125 yards. A further investigation of this problem is necessary. The use of a radio altimeter and the position by radio (shoran) navigation aids. Although the altimeter was flown for the most part at 500 feet, it was possible to fly at lower altitudes, and the shoran system is lower below ground level. Such topographical features need to be taken into account for some altitudes, and particularly in low cases a correction has been made for altitude.

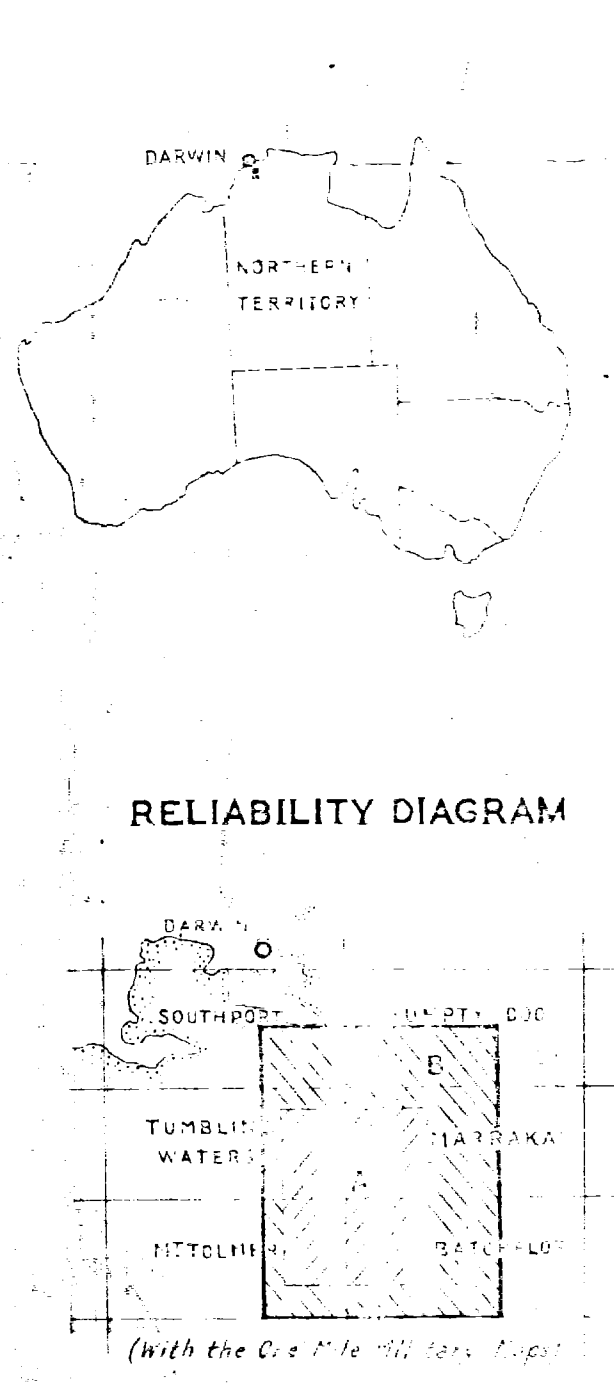
It should be noted that it is only the radioactivity of the ground surface that has been measured because radioactivity may be computed from the radioactivity of the surface. The radioactivity of the surface is the same for this reason and also because the strength of the anomaly depends upon the depth between the altimeter and the surface. Some of these radio anomalies may be as significant as first order ones. No claim is made for every day use of the altimeter, but it is stated that if of economic importance but it is possible that some do. Subsequent investigation on the ground is necessary to determine their significance.



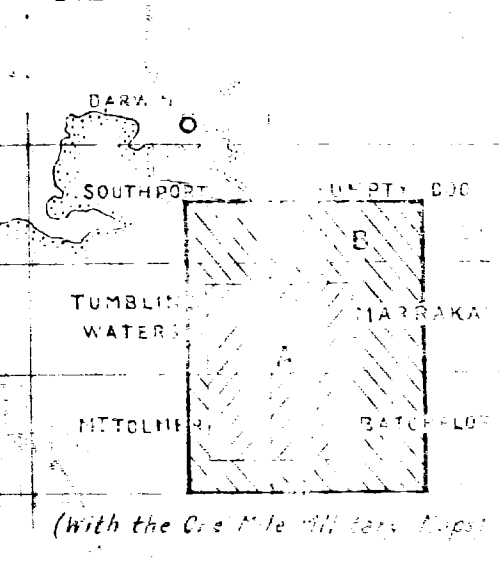
LEGEND

- 1st Order Anomaly. Greater than NINE Times Average Statistical Variation of Intensity.
- 2nd Order Anomaly. Greater than SIX Times Average Statistical Variation of Intensity.
- 3rd Order Anomaly. Greater than THREE Times Average Statistical Variation of Intensity.
- Anomaly Sharp along Line of Flight.
- Plateau Region of Continuous Radioactivity with Average of Second Order Anomaly.
- Isomagnetic Lines.
- 500-100-1000.
- River or Creek.
- Watercourse (non-perennial) and Area Subject to Inundation.
- Railway.
- Highway.
- Minor Road.
- Track (vehicular).
- Track (foot or pack).
- Bridge.
- Culvert.
- Pine.
- Atsip.
- County Boundary (approximate).
- Hundred Boundary (approximate).

LOCATION DIAGRAM



RELIABILITY DIAGRAM



CONTOUR INTERVAL 100 GAMMAS  
SCALE  
0 1 2 3 4 5 MILES

MAP OF  
RUM JUNGLE DISTRICT  
NORTHERN TERRITORY  
SHOWING POSITION OF  
RADIOACTIVE ANOMALIES  
(DETECTED BY AIRBORNE SCINTILLOMETER)  
AND  
TOTAL MAGNETIC INTENSITY  
(MEASURED BY AIRBORNE MAGNETOMETER)

W. S. L. S.  
CHIEF GEOPHYSICIST

COMPILED AND DRAWN BY THE GEOPHYSICAL SECTION,  
BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS.

RADIOACTIVE DATA

The anomalies obtained by the airborne scintillometer indicate areas of high radioactivity and have been classified into three orders which, in decreasing order of intensity, are first, second and third order. The points marked on the map represent the places where the maximum radioactivity was recorded. The source, or sources, of any anomaly may be anywhere within a radius of 500 feet of the point marked. The source of the anomaly may range from small areas of high radioactivity to large areas of lesser radioactivity.

Some anomalies were much sharper and of more restricted length along the lines of flight than others and have been marked with 'X' on the map. They are probably due to localized sources close to the line of flight. Similar sources remote from the line of flight would give broader anomalies of lower relative intensity.

Some areas are shown as plateaus on the map. The radioactivity of the ground was recorded as higher than normal, uniformly throughout the plateau, their order (first, second or third) is determined by the extent of their intensity above the average intensity of the plateau.

The scintillometer was flown, when practicable, at a constant height of 100 feet above the ground. At this height it effectively scanned a strip of ground 1000 feet wide and flight lines were therefore spaced at intervals of one-fifth of a mile apart. The height of the aircraft was controlled by radio altimeter and the position by radar (Shoran) navigation aids. Although the scintillometer was flown for the most part at 100 feet above the ground, local topographical features, e.g. hills, were crossed at a lower height above ground level. Such topographical features could be responsible for some of the anomalies, especially in areas where the country rock has radioactivity slightly higher than normal.

It should be noted that, it is only the radioactivity of the ground surface that has been measured because radioactivity may be completely screened or substantially reduced in magnitude by a few inches of soil. For this reason and also because the strength of the anomaly depends upon the distance between the scintillometer and the source, some third order anomalies may be as significant as first order ones. No claim is made that all or even many of the anomalies correspond to uranium deposits of economic importance, but it is possible that some do. Subsequent investigation on the ground is necessary to determine their significance and possible economic importance.

MAGNETIC DATA

The total magnetic intensity was continuously recorded by an AN/AG-1 airborne magnetometer, operating simultaneously with the scintillometer. The data remain uncorrected for a regional gradient in total field of 11 gamma per mile in a direction S 35° W.

MAP DATA

PROJECTION: Transverse Mercator-Australian Series.

CONTROL: AN/APN-3, AN/CPN-2 Shoran controlled beacon sites near Mt. Tolmer and Mt. Peel (situated outside this map), ranged into Darwin and existing trigonometrical stations and astronomical fixes.

DETAIL: Shoran controlled traverses along road and railway with planimetric detail superimposed from National Mapping Section 1:63,680 scale plotted complete assembly mapping and Royal Australian Survey Corps 1:63,568 standard maps. Geophysical data were plotted from Shoran, controlled circular traverses at approximately one-fifth of a mile separation based on Mt. Peel beacon.

RELIABILITY: Geophysical data, relatively accurate. Geophysical planimetric relationship, shown in reliability diagram: Box (A) Accurate; Box (B) Reliable sketch only.

G 71-92A