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GROUND INSPECTION OF AIRBORNE
RADIOMETRIC ANOMALIES,
CARNARVON BASIN,
WESTERN AUSTRALIA 1961

by

J.E.F. GARDENER* and W.R. JONES**

* Bureau of Mineral Resources, Geology and Geophysics

** Geological Survey of Western Australia

The information contained in this report has been obtained by the Department of National Development as part of the policy of the Commonwealth Government to assist in the exploration and development of mineral resources. It may not be published in any form or used in a company prospectus or statement without the permission in writing of the Director, Bureau of Mineral Resources, Geology and Geophysics.

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CONTENTS

	<u>SUMMARY</u>	<u>Page</u>
1.	INTRODUCTION	1
2.	OPERATIONS	1
3.	RESULTS	2
4.	DISCUSSION OF RESULTS	7
5.	REFERENCES	8

ILLUSTRATIONS

Plate 1.	Northern Area, showing anomaly positions	(F50/B1-11-1)
Plate 2.	Southern Area, showing anomaly positions	(G50/B1-27-1)

SUMMARY

During a ground inspection of airborne radiometric anomalies in the Carnarvon Basin and the adjacent Precambrian shield area of Western Australia, 29 anomaly locations were visited. Two airborne anomalies were not confirmed by ground radiometric gridding. Of the remainder, laterite or laterite derivatives were the source of 17, granite, granite contacts, and granitic sand the source of 9, and calcrete the source of one anomaly.

The sources are all extremely low-grade and offer no prospects of economic uranium mineralisation, with the possible exception of the calcrete, which was found to contain the secondary uranium mineral, carnotite, and may warrant further investigation.

In general, the ground investigation confirmed that radiometric sources of limited aerial extent can be recognised and positioned with reasonable accuracy from interpretation of airborne scintillometer records.

1. INTRODUCTION

In July and August 1961, a ground inspection was made of the locations of radiometric anomalies that had been detected during an airborne survey in 1959 over parts of the Carnarvon Basin and adjacent Precambrian rocks to the east. The airborne survey recorded magnetic and radiometric data along flight lines oriented east-west and spaced one mile apart, using a D.C.3 aircraft of the Bureau of Mineral Resources (Spence, 1961). The radioactive intensity was measured simultaneously at two levels, nominally 500 and 200 ft above the ground surface, by means of two radiometric detectors, one mounted in the cabin of the aircraft and the other in a 'towed bird' suspended by a cable below the aircraft.

Theoretical considerations (Carter, 1960) suggested that the dual-level method of airborne radiometric surveying should provide a more reliable estimate of the size on the ground of the sources of airborne anomalies than the single-level method and hence permit better discrimination between broad deposits of low-grade radioactive material and localised deposits of high-grade material.

Radiometric anomalies recorded by the airborne equipment were classified according to amplitude and width to determine those which may arise from sources of high intensity and small areal extent. Those which satisfied the above criteria were selected for ground inspection to determine the nature of the sources, the geological environment, and possible economic importance.

Those who took part in the ground inspection were J.E.F. Gardener and C.J. Braybrook of the Bureau of Mineral Resources, and W.R. Jones of the Geological Survey of Western Australia.

2. OPERATIONS

In the 1959 airborne survey, two areas were flown :

1. Northern Area, between latitudes $22^{\circ}45'S$ and $23^{\circ}45'S$, and between longitude $116^{\circ}00'E$ and the coastline (Plate 1).
2. Southern Area, between latitudes $26^{\circ}45'S$ and $28^{\circ}00'S$, and between longitude $115^{\circ}30'E$ and the coastline (Plate 2).

On the basis of interpretation of the radiometric records, 52 anomalies (10 in the Northern Area and 42 in the Southern Area) were selected as warranting ground investigation. The interpretation was designed to select anomalies that arise from sources equivalent to circular superficial sources of maximum radius of 300 ft and maximum offset distance from the line of flight of 300 ft.

Very approximate estimates of grade were made on the selected anomalies; in no case was the grade estimated as likely to be high.

During the ground investigation in 1961, it was possible to inspect the locations of 29 of these anomalies, the identifying numbers of which are :

Northern Area : 1, 4, 6, 13, 17, 24, 27:

Southern Area : 6, 9, 12, 15, 17, 18, 36, 38, 39, 40, 41,
42, 43, 44, 45, 46, 47, 48, 49, 54, 56, 57.

Possible errors in the plotting and recording of the airborne anomalies were allowed for in the ground survey, by gridding an area centred on the plotted position of each anomaly for a distance of 1000 ft along the flight line, and 800 ft on either side of the flight line. As the survey progressed, it was found that there was a fairly regular displacement of the anomaly centres on the ground from the plotted airborne position, amounting to several hundred feet or more in the direction opposite to the flight direction; the centre of the area investigated was shifted accordingly.

— Of the 29 anomaly locations visited, all were radiometrically gridded except for Anomaly No. 6 in the Southern Area. Scintillation counters type EA 135S were used. These were calibrated so that a 5-microcurie CAE No. 1628 source produced an increase in count rate of 4000 c.p.h. at a distance of $2\frac{1}{2}$ ft from the detectors.

3. RESULTS

The results of the ground inspection are given below for each of the anomalies inspected. The results briefly describe the geology and size of the source and summarise the count rate data recorded on the ground and in the airborne survey. The flight direction and any discrepancy found between the plotted positions of the airborne anomaly and the actual position on the ground are indicated. Where reference is made to the centre of an anomaly, this means its centre along the line of flight.

Northern Area

Anomaly No. 1. Calcrete, several hundred square feet of which has formed on a creek flat almost on the contact of a tourmaline granite with limestone. The centre of the anomaly was 300 ft east of the plotted position and extended for 400 ft along the flight line, for 150 ft to the south and over 500 ft to the north. The count rate on the anomaly was 13,500 c.p.m. East and west of the anomaly it was 2100 c.p.m. The airborne anomaly amplitudes were : outboard 5700 c.p.m., inboard 1800 c.p.m. Flight direction - west.

A specimen of the calcrete was examined by the Geological Branch of the B.M.R.; the radioactivity is due to the secondary uranium mineral, carnotite, which is distributed fairly uniformly throughout the rock.

Anomaly No. 4. Granitic sand, ill-defined in washes and on claypan flats. The centre of the anomaly was 350 ft west of the plotted position. The anomaly occurred for 700 ft along the flight line and for over 800 ft north and south. The count rate on the anomaly was 3000 c.p.m. East and west it was 2500 c.p.m. The airborne anomaly amplitudes were : outboard 1680 c.p.m., inboard 600 c.p.m. Flight direction - east.

Anomaly No. 6. No anomaly was found. There was a gradual increase in count rate to the east from 2300 c.p.m. at the plotted position to 2800 c.p.m. 500 ft east. The count rate decreased to the west from 2300 c.p.m. to 2200 c.p.m. 500 ft west. The environment showed granitic sand in flats and shallow washes adjacent to eolian sand ridges. This was the second anomaly inspected on the survey and it was not realised at the time that anomalies could be located as much as 1000 ft from the plotted position. A more extensive search may have located an anomaly. The airborne anomaly amplitudes were : outboard 1440 c.p.m., inboard 600 c.p.m. Flight direction - east.

Anomaly No. 13. Feldspar porphyry, coarse-grained, probably a porphyritised sediment in a band about 800 ft wide interbedded with limestone, sandstone, and shale. The centre of the anomaly was 300 ft west of the plotted position and occurred for 600 ft along the flight line and for over 800 ft north and south of the flight line. The count rate on the anomaly was 6000 c.p.m. East and west it was 2800 c.p.m. The airborne anomaly amplitudes were : outboard 2100 c.p.m., inboard 1200 c.p.m. The granite formed a ridge 80 ft high. About 500 ft west of the granite ridge, there was another ridge 200 ft high. The aircraft would presumably be 500 ft above the higher ridge and so the anomaly on the granite ridge was not due to topography. Flight direction - east.

Anomaly No. 17. Hybrid gneiss formed at the contact of a grey granite with mica schists. It is in a strip 50 ft wide striking south-west. The anomaly was centred 150 ft east of the plotted position, was 50 to 100 ft wide and 500 ft long, striking along the contact, i.e. obliquely across the flight line. The count rate was 14,000 c.p.m. on the gneiss and 600 c.p.m. east and west of it. The airborne anomaly amplitudes were : outboard 1800 c.p.m., inboard 480 c.p.m. Flight direction - west.

Anomaly No. 24. Granite, coarse-grained, grey. The granite occurred for 600 ft along the flight line and for 600 ft north and south. The centre of the anomaly was 500 ft east of the plotted position. The count rate was 3500 c.p.m. on the anomaly and 2600 c.p.m. east and west. The airborne anomaly amplitudes were : outboard 2220 c.p.m., inboard 720 c.p.m. Flight direction - east.

There was no variation noted in the rock type, and the airborne anomaly was probably mainly a topographical effect due to a prominent knob about 80 ft high.

Anomaly No. 27. Massive granite. The granite extends for 1500 ft along the flight line and for over 800 ft north and south of it. Its highest point is 80 ft above the nearby gullies and about 200 ft above the Lyndon River to the west.

The centre of the anomaly was 400 ft east of the plotted position. The count rate on the granite was 18,000 c.p.m. The airborne anomaly amplitudes were : outboard 10,800 c.p.m., inboard 2280 c.p.m. Flight direction - west.

The granite formed a topographic high. However, the granite was highly radioactive and the topography would not have been the direct cause of the anomaly, although it would have accentuated the airborne anomaly amplitudes.

Southern Area

Anomaly No. 6. Laterite, several tens of square feet on thin Jurassic sediments. This anomaly was inspected only (by W.R.J.) and not gridded.

Anomaly No. 9. Porphyritic granite, immediately to the west of its sharp contact with gneiss and metasediments. The anomaly was found at the plotted position. The granite occurred for 500 ft along the flight line and for over 500 ft both north and south. The count rate was 5600 c.p.m. on the granite and 3000 c.p.m. east and west of the granite. The airborne anomaly amplitudes were : outboard 4400 c.p.m., inboard 1000 c.p.m. Flight direction - west.

Anomaly No. 12. Laterite, on kaolinised granite. The centre of the anomaly was 450 ft east of the plotted position. The anomaly occurred for 600 ft along the flight line and for over 500 ft both north and south. The count rate was 9000 c.p.m. on the laterite, 3000 c.p.m. west of the laterite and 7000 c.p.m. east. The airborne anomaly amplitudes were : outboard 6000 c.p.m., inboard 1800 c.p.m. Flight direction - west.

Anomaly No. 15. Granite, a few hundred square feet, surrounded by kaolinised granite. The centre of the anomaly was 850 ft west of the plotted position. The granite occurred for 600 ft along the flight line, 350 ft north and over 500 ft south of the flight line. The count rate was 6400 c.p.m. on the granite and 5000 c.p.m. just east and west of the granite. At the plotted position the count was 3400 c.p.m. The airborne anomaly amplitudes were : outboard 4000 c.p.m., inboard 1200 c.p.m. Flight direction - east.

Anomaly No. 17. Lateritic soil, covering several thousands of square feet. The centre of the anomaly was 950 ft east of the plotted position. The anomaly occurred for 200 ft along the flight line and 300 ft north and south. The count rate was 11,000 c.p.m. at the anomaly. West it dropped rapidly to 7200 c.p.m. and then gradually to 4000 c.p.m. East it dropped rapidly to 5800 c.p.m. and then to 4000 c.p.m. The airborne amplitudes were : outboard 6800 c.p.m., inboard 1400 c.p.m. Flight direction - west.

Anomaly No. 18. Laterite covering a few hundred square feet, continuous with granite, clay soil, and lateritic soil. The centre of the anomaly was 1150 ft east of the plotted position. The anomaly occurred for 200 ft along the flight line and 300 ft north and south of the flight line. The count rate was 7600 c.p.m. at the anomaly. East it dropped rapidly to 5600 c.p.m. and then gradually to 4600 c.p.m. West it dropped rapidly to 6000 c.p.m. and then gradually to 3600 c.p.m. The airborne amplitudes were : outboard 9200 c.p.m. inboard 4200 c.p.m. Flight direction - west.

Anomaly No. 36. Lateritic pebbles covering a few hundred square feet, scattered as thin cover, concealing about sixty percent of surface soil. The centre of the anomaly was 950 ft west of the plotted position. The anomaly occurred for 500 ft along the flight line and for 300 ft south and over 500 ft north. The count rate was 7500 c.p.m. at the anomaly. East it dropped rapidly to 6000 c.p.m. and then gradually to 3000 c.p.m. West it was 6000 c.p.m. The airborne amplitudes were : outboard 7600 c.p.m., and 1400 c.p.m. Flight direction - east.

Anomaly No. 38. Lateritic pebbles, dark, probably iron-rich, scattered thinly on pale laterite over several hundreds of square feet. The centre of the anomaly was 550 ft east of the plotted position. The anomaly occurred for 800 ft along the flight line, 250 ft north and over 500 ft south. The count rate was 8100 c.p.m. on the anomaly. East and west it dropped rapidly to 5000 c.p.m. The airborne anomaly amplitudes were : outboard 12,000 c.p.m., inboard 1300 c.p.m. Flight direction - west.

Anomaly No. 39. Sandy loam. No anomaly was found. The area was covered by soil estimated to be 20 ft thick. The airborne anomaly amplitudes were : outboard 4000 c.p.m., inboard 800 c.p.m. Flight direction - west.

Anomaly No. 40. Lateritic gravel. A few hundred square feet of alluvial gravel of reworked laterite in mounds about 5 ft high on soil flats. The centre of the anomaly was 1050 ft east of the plotted position. The anomaly occurred for 400 ft along the flight line, for 200 ft north of the flight line, and for over 500 ft south. The count rate was 6600 c.p.m. on the anomaly. East and west it was 5400 c.p.m. The airborne anomaly amplitudes were : outboard 8000 c.p.m., inboard 1100 c.p.m. Flight direction - west.

Anomaly No. 41. Laterite, on low breakaways of kaolinised granite. The centre of the anomaly was 450 ft east of the plotted position. The anomaly occurred for 200 ft along the flight line and for over 500 ft north and south of the flight line. The count rate was 5500 c.p.m. on the anomaly. It was 5000 c.p.m. immediately east and west and gradually dropped to 3000 c.p.m. The airborne anomaly amplitudes were : outboard 6800 c.p.m., inboard 2100 c.p.m. Flight direction - west.

Anomaly No. 42. Laterite. An oval-shaped area of a few hundred square feet. Sandy soil to east and breakaway country to the west. The centre of the anomaly was 650 ft west of the plotted position. The anomaly occurred for 400 ft along the flight line and for over 500 ft north and south of the flight line. The count rate on the anomaly was 6000 c.p.m. East it dropped rapidly to 3400 c.p.m. and then to 2600 c.p.m. West it dropped rapidly to 4800 c.p.m. and then gradually to 3200 c.p.m. The airborne anomaly amplitudes were : outboard 7200 c.p.m., inboard 1200 c.p.m. Flight direction - east.

Anomaly No. 43. Laterite, in breakaway country. The centre of the anomaly was 400 ft east of the plotted position. The anomaly occurred for 500 ft along the flight line and for over 500 ft north and south. The count rate on the anomaly was 6400 c.p.m. East it was 5500 c.p.m. and west 5000 c.p.m. The airborne anomaly amplitudes were : outboard 7600 c.p.m., inboard 1000 c.p.m. Flight direction - west.

Anomaly No. 44. Laterite, several hundred square feet on granite. The centre of the anomaly was 450 ft east of the plotted position. The anomaly occurred for 600 ft along the flight line and for over 500 ft north and south. The count rate was 6000 c.p.m., on the anomaly. East it was 3600 c.p.m. and west 4800 c.p.m. The airborne anomaly amplitudes were : outboard 8000 c.p.m., inboard 1300 c.p.m. Flight direction - west.

Anomaly No. 45. Laterite covering several hundred square feet and surrounded by lateritic soil and bare breakaways of kaolinised rock. The centre of the anomaly was 950 ft east of the plotted position. The anomaly occurred for 400 ft along the flight line, for over 500 ft north of the flight line, and for 250 ft south of the flight line. The count rate was 6000 c.p.m. on the anomaly. West it dropped sharply to 4000 c.p.m. and then to 2400 c.p.m. East it dropped sharply to 4000 c.p.m. The airborne anomaly amplitudes were : outboard 10,000 c.p.m., inboard 1100 c.p.m. Flight direction - west.

Anomaly No. 46. Laterite. A few thousand square feet with sand to the west and kaolinised granite to the east. The centre of the anomaly was 200 ft west of the plotted position. The anomaly occurred for 300 ft along the flight line and for over 500 ft north and south. The count rate was 9000 c.p.m. on the anomaly. East it dropped rapidly to 7600 c.p.m. and then to 4800 c.p.m. West it dropped rapidly to 5800 c.p.m. The airborne anomaly amplitudes were : outboard 7200 c.p.m., inboard 1900 c.p.m. Flight direction - east.

Anomaly No. 47. Lateritic soil, with breakaway country of kaolinised granite to the east. The centre of the anomaly was 400 ft east of the plotted position. The anomaly occurred for 500 ft along the flight line and for 500 ft north and south. The count rate on the anomaly was 6000 c.p.m. East it was 3500 c.p.m. and west 1800 c.p.m. The airborne anomaly amplitudes were : outboard 9400 c.p.m., inboard 1900 c.p.m. Flight direction - west.

Anomaly No. 48. Lateritic gravel. A few hundred square feet of alluvial gravel of reworked laterite in mounds about 5 ft high on soil flats. The centre of the anomaly was 500 ft east of the plotted position. The anomaly occurred for 700 ft along the flight line and for 250 ft north and 300 ft south of the flight line. The count rate on the anomaly was 6000 c.p.m. East and west it was 3500 c.p.m. The airborne anomaly amplitudes were : outboard 8400 c.p.m., inboard 1800 c.p.m. Flight direction - west.

Anomaly No. 49. Porphyritic granite, in a low whaleback surrounded by sandy soil. The centre of the anomaly was 550 ft west of the plotted position. The granite occurred for 400 ft along the flight line and for 500 ft north and south. The count rate was : 18,000 c.p.m. on the granite and 12,000 c.p.m. east and west. The airborne anomaly amplitudes were : outboard 10,000 c.p.m., inboard 1100 c.p.m. Flight direction - east.

Anomaly No. 54. Biotite granite, very coarse-grained in prominent whaleback about 60 ft high. The centre of the anomaly was 850 ft east of the plotted position. The granite occurred for 1000 ft along the flight line and for over 500 ft north and south. The granite also occurs 300 ft south of the flight line for several hundred feet east and west of the plotted position, but a study of the airborne record shows that the anomaly occurred where the flight line crossed the granite. The count rate on the granite was 8700 c.p.m. and east and west 6000 c.p.m. The airborne anomaly amplitudes were : outboard 10,200 c.p.m., inboard 1800 c.p.m. Flight direction - west.

Anomaly No. 56. Laterite covering several hundreds of square feet on breakaway country of coarse biotite granite and mica schists. The centre of the anomaly was 850 ft east of the plotted position. The anomaly occurred for 600 ft along the flight line and for over 500 ft north and south. Another area of laterite started 850 ft west of the plotted position, and occurred for about 800 ft along the flight line. This agrees with the airborne record. The count rate on the anomaly was 8000 c.p.m. It was 4200 c.p.m. east and west of the anomaly, and 8000 c.p.m. on the western area of laterite. The airborne anomaly amplitudes were : outboard 6000 c.p.m., inboard 1000 c.p.m. Flight direction - west.

Anomaly No. 57. Laterite covering several hundreds of square feet on coarse biotite granite and mica schists. The centre of the anomaly was 500 ft east of the plotted position. The anomaly occurred for 500 ft along the flight line, for 350 ft north and 250 ft south of the flight line. The count rate was 6200 c.p.m. on the anomaly, 2400 c.p.m. west of it, and 3500 c.p.m. east of it. The airborne anomaly amplitudes were : outboard 6400 c.p.m., inboard 800 c.p.m. Flight direction - west.

4. DISCUSSION OF RESULTS

Of the 27 anomalies located, laterite or laterite derivatives are the sources of 17, and granites, granite contacts, and granitic sand are the source of 9. Calcrete is the source of anomaly No. 1 (Northern Area).

The anomalies are, with one exception, caused by extremely low-grade sources. The exception is anomaly No. 1 (Northern Area), from which a sample was examined and the mineral carnotite identified. An X-ray spectrometric analysis showed the sample to contain 0.168% U_3O_8 . This anomaly clearly justifies some further work. There is little possibility that any of the other anomalies inspected are associated with economic uranium mineralisation, and the chances of finding economic uranium mineralisation elsewhere in the survey area appear small.

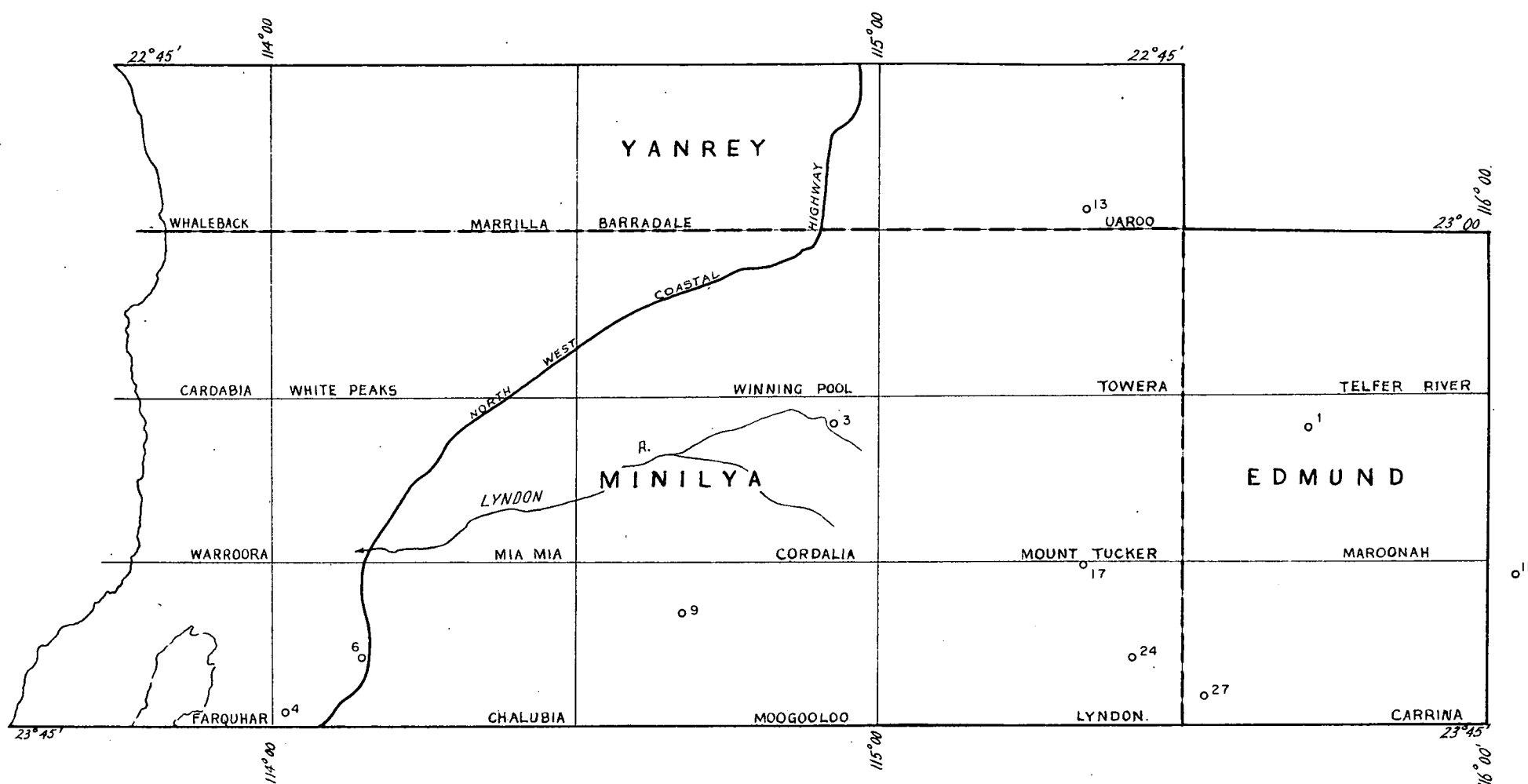
The original interpretation of the radiometric records was designed to select the anomalies that arise from sources equivalent to circular superficial sources of a maximum radius of 300 ft and a maximum offset distance from the line of flight of 300 ft. In fact, twenty-three of the anomalies investigated were found to be due to sources not exceeding 600 ft in horizontal dimensions along the line of flight, though many extended for a greater distance at right angles to the flight line. Taking into account the scan-width on either side of the aircraft track, it may be said that the sources investigated on the ground approximately complied with the 300 ft radius criterion, which was the aim of the selection method in interpretation.

The non-circular nature of many of the sources investigated (their horizontal dimension at right angles to the flight line often exceeded that along the flight line) precludes the reliable determination of offset distance from the line of flight. The concept of offset distance of a circular source obviously has no meaning in these cases.

The conclusions to be drawn from the results of the ground investigation are that radiometric sources of limited aerial extent can be delineated and positioned with reasonable accuracy from an interpretation of the airborne detector records. Discrepancies in actual position of anomaly sources compared with interpreted position are attributable to time lags in the response of the radiometric measuring equipment and possible parallax in photographic and other recording devices. The grade of a radioactive source appears to be difficult to assess reliably from the airborne detector records, mainly because the areal extent frequently does not conform to a circular shape.

5. REFERENCES

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Bureau of Mineral Resources
paper presented to the United Nations Seminary on Aerial Survey Methods and Equipment, Bangkok 1960. |
| SPENCE, A.G. | 1961 | Carnarvon Basin airborne magnetic and radiometric survey, WA 1959.
<u>Bur. Min. Resour. Aust.</u>
<u>Rec. 1961/56.</u> |



LOCATION DIAGRAM



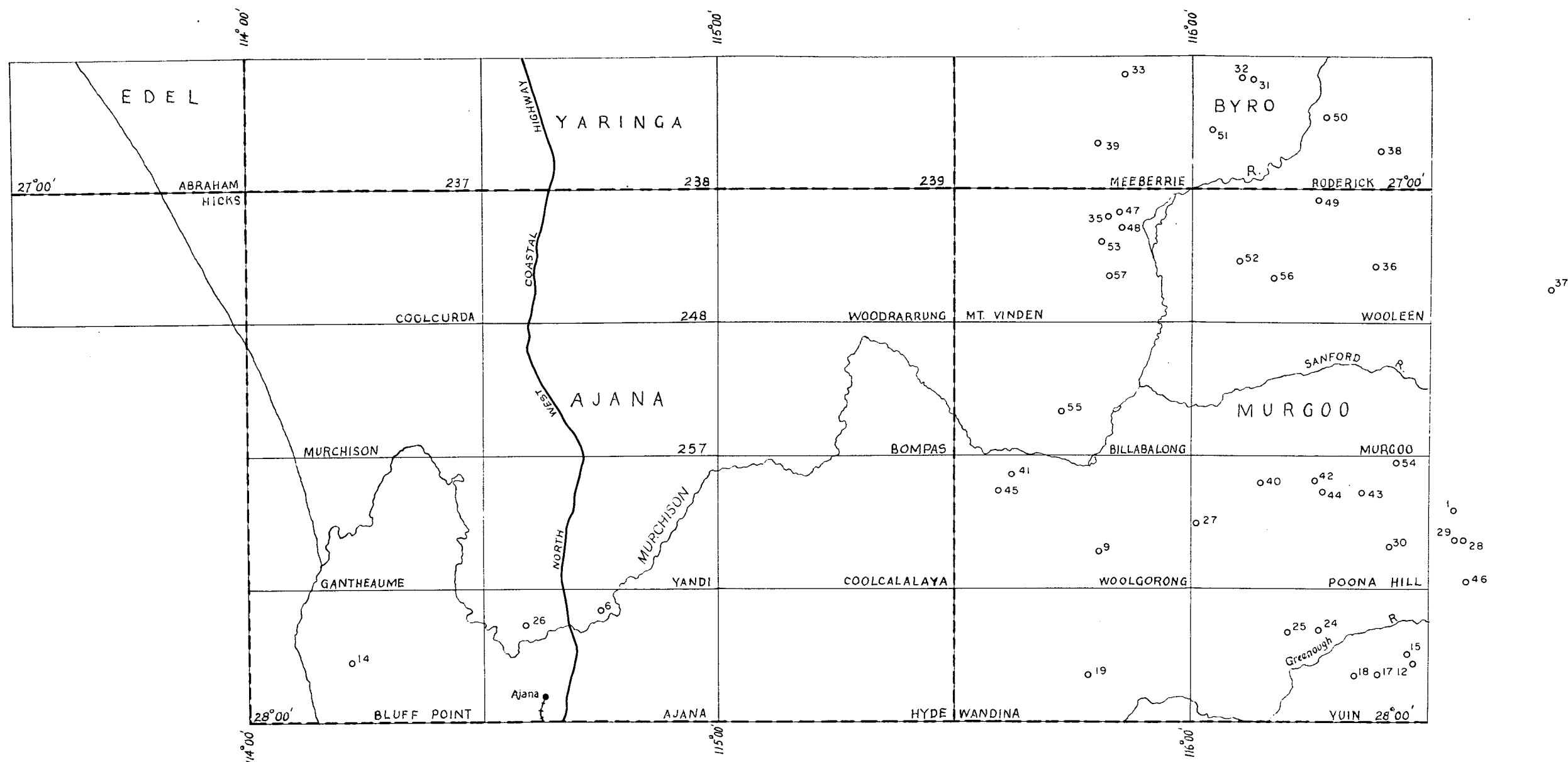
03 Radiometric anomaly

LYNDON 1-mile sheet name

CARNARVON BASIN, 1961, (NORTHERN AREA)

GROUND INSPECTION OF AIRBORNE RADIOMETRIC ANOMALIES





LOCATION DIAGRAM



○⁶ Radiometric anomaly

AJANA 1-mile sheet name

CARNARVON BASIN, 1961, (SOUTHERN AREA) GROUND INSPECTION OF AIRBORNE RADIOMETRIC ANOMALIES

