COMMONWEALTH OF AUSTRALIA

DEPARTMENT OF NATIONAL DEVELOPMENT

BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS

RECORDS 1960 No. 120

SOUTHERN CROSS AND KALGOORLIE REGIONS

AIRBORNE RADIOMETRIC SURVEY, W.A. 1958

by

J.M. Mulder

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ABSTRACT

This report describes a survey, using an Auster aircraft at low level, of radioactive anomalies which had been detected during a DC.3 high-level survey.

The results of the Auster survey indicated that eighty four anomalies should be further investigated on the ground.

1. INTRODUCTION

Airborne magnetic and radiometric surveys of the Barlee, Jackson, Kalgoorlie, and Southern Cross 4-mile military map areas of Western Australia were first conducted by the Bureau of Mineral Resources in 1956 and 1957 (Spence, 1958). In those surveys a DC.3 aircraft was used, flying at 500 ft. above terrain. Many radioactive anomalies were discovered.

The aim of the present survey was to investigate these anomalies in detail with the aid of a light aircraft and to determine, if possible, whether any of the anomalies warrant inspection on the ground. Auster aircraft VH-RES was used, and the survey took place between June and August 1958. The operations were based on Kalgoorlie and Southern Cross.

Bureau officers who took part were geophysicists J.M. Mulder (Party leader) and J.E.F. Gardener, and draftsman A. Crowder. The aircraft was piloted by First Officer K. Dodds of Trans-Australia Airlines.

2. GEOLOGY

Alluvium, soil, lake deposits, sand dunes, and ferruginous laterite, all of Recent Age, cover a series of highly folded metamorphic sedimentary and basic igneous rocks which, in turn, have been intruded by granite. The metamorphic rocks, presumably of Precambrian age, are sub-divided into two series, the whitestones and the greenstones; the greenstones are the older. The remnants of these metamorphic rocks form the long narrow belts of low relief found throughout the area, but scarcity of outcrops makes it difficult to recognise any structures. Granite outcrops occur as low rounded hills in the sand-plain country.

Soil, which in places seems to have been formed in situ by weathering of the underlying rocks, covers almost the entire area. Its thickness varies from zero at the bare granite outcrops and greenstone ridges to about 12 ft over areas of greenstone and metamorphic sedimentary rocks. The composition of the soil is often an indication of the rock type beneath, but the sandy red or yellow loams in the thickly timbered country east of Parkes Range and Mt. Palmer are exceptions; they cannot be correlated with soils that overlie the greenstones, whitestones, or gneissic complex series, and as no outcrops occur and no fragmental rock material can be found, the nature of the underlying formation remains unknown (Ellis, 1939).

3. EQUIPMENT

The scintillograph used on this survey was the Austronic Engineering Laboratories ratemeter and detector head type AS1 coupled to one channel of a Texas Instruments Incorporated dual recording milliammeter.

The detecting element in this equipment is a thallium-activated sodium iodide crystal 4½ in. in diameter and 2 in. thick, optically coupled to a photo-multiplier tube, Dumont type 6364. The photo-multiplier output is fed to a ratemeter which produces a current proportional to the count rate. This current, registered on the recording milliammeter, gives a continuous record of the intensity of gamma radiation at the detecting crystal.

An AN/APN-1 radio altimeter was used to indicate height above ground and also, in conjunction with the second channel of the T.I.I. recorder, to provide a record of this height. The radio altimeter is fitted with limit lights which provide the pilot with an indication when the aircraft is not within the height limits of 185-215 above ground level.

4. OPERATIONS

The radioactive anomalies recorded during the DC.3 survey were re-located with the aid of aerial photographs and photo mosaics, at a scale of 1 in. = 1 mile, on which the anomaly positions had been marked.

Difficulty was experienced in locating some of the anomalies, owing to changes in the appearance of the terrain since the photographs had been taken, or, as in the Kalgoorlie district, owing to featureless terrain. Where possible the air speed was maintained between 75 and 80 knots.

Each anomaly was flown at 200 ft above ground level. At this height a lane approximately 500 ft wide is scanned. The flight lines were 2 to 3 miles long and were spaced about 1/5 mile apart. Two lines were also flown exactly over each plotted position, one in the direction of the main pattern, the other on a heading approximately the same as that flown in the DC.3 This pattern of flying gave a coverage of 50 per cent which was considered adequate for this survey.

As all anomalies occurred in fairly flat country, no sudden changes in ground-to-aircraft distance were recorded, and consequently there was no need to apply height corrections to the count rate.

Flight lines were plotted on K-17 aerial photographs by the observer, and notes were taken on the geological environment associated with each anomaly. The position of each anomaly was obtained by noting the maximum count rate of the recorder and at the same time observing the ground to see where this occurred; the position was then plotted on the photograph. When data were analysed after a flight this plot was checked against the flight line record, and adjustments made if necessary. The final accuracy of positioning is considered to be within 50 yds.

The response and sensitivity of the scintillograph were checked with a small standard source at the beginning and end of each flight. The source was held at a fixed distance from the detector while the aircraft was flown at 2000 ft above the ground. Radiation received from the ground at this height is negligible and the recorded count rate is almost entirely due to cosmic radiation. The increase in count rate due to the source therefore provided a check on the performance of the scintillograph.

Rain, wind, and aircraft unserviceability frequently interrupted operations, causing a loss of approximately 30 to 40 per cent of the total possible flying time.

During the time the aircraft was being overhauled the party examined three anomalies on the ground. An Electronic Associates portable scintillation counter was used to find the areas of highest count rate. Samples of rock were collected at the sites of these anomalies, and later tested at the Bureau's Radiometric Laboratory. Assay results of these tests are given under 6. SURVEY RESULTS.

5. METHOD OF INTERPRETATION

Of the 165 anomalies investigated in this survey, 84 are recommended for ground investigations. These 84 anomalies were selected according to their gamma-ray intensity, their shape, and their geological environment. The criteria adopted for selection were as follows :-

Intensity Only anomalies at least twice the adjacent background count were selected.

Shape To eliminate any anomalies caused by large masses of only very slightly radioactive material, the ones chosen all have a half-rise time of less than six seconds. That is, the flying time between the point half way up and the point half way down the anomaly curve was less than six seconds which corresponds to about 800 ft.

Geological environment

Any anomalies associated with low rounded hills of granitic rock were considered of no importance. However, as the geological environment of most of the anomalies was obscured by soil covering, the selection of many anomalies was based only on geophysical evidence.

6. SURVEY RESULTS

The anomalies considered worthy of further investigation are discussed below. The numbers are those shown on the accompanying maps.

Southern Cross Region: (Plate 1)

1	The anomaly is near the edge of a clay-pan. The soil is of the type derived from the granitic and gneissic complex. A granite outcrop west of the clay-pan is moderately radioactive.
2 to 7	The anomalies are in an area of soil which overlies rocks of granitic composition.
8	The anomaly is in a cultivated field. The soil is red to yellow and suggests derivation from granite. Granite outcrops nearby.
9 & 10	The anomalies occur east and west of a granite outcrop in red soil which may be of granitic origin. The outcrop appeared to be only slightly higher in radioactivity than the average background of the area around it.
11 to 24	The anomalies are in an area of white sandy soil which is probably of granitic origin. Granite outcrops were observed in the area.
25	The anomaly is in an area of sandy soil of the granitic type.
26	Granite outcrops nearby. The anomaly occurs in sandy soil.
27 to 47	The anomalies occur in flat sandy country. The soil appears to be of the type which overlies rocks of granitic composition. Some granite out-crops were observed in the area.
48	The anomaly occurs in sandy soil.
49 to 52	The anomaly occurs in granitic type soil. Some outcrops were observed in area.

53 to 64 The anomalies occur in white sandy soil.

65 to 67 White sandy soil of the granitic type. Large outcrops were observed north-west of anomaly 66. Counting rate over this outcrop was not appreciably higher than background.

68 Granite outcrops about 2 miles distant on either side of the anomaly. White sandy soil covers the area.

69 A granite outcrop was noted west of this anomaly.

70 & 71 White sandy soil with outcrops nearby.

Barlee, Jackson, and Kalgoorlie Region: (Plate 2)

1 to 6 Anomalies occur in a clay-pan on the edge of Lake Barlee. No outcrops were observed in the area.

7 to 10 Occur under similar conditions to above.

11 Occurs in red soil over an escarpment.

12 Occurs in a clay-pan.

13 The anomaly occurs on the eastern edge of a pink granite outcrop.

The large number of granite outcrops and the general appearance of the soil suggest that most anomalies are connected with the granite intrusives. Such rocks often contain a higher concentration of radioactive elements than other rocks. However, records of traverses flown over many bare granite outcrops showed that gamma-ray intensities due to these granites were only slightly higher than the background count and substantially less than the maximum intensity of some of the plotted anomalies. It may be that radioactive minerals have been removed through weathering and leaching.

The most outstanding anomalies recorded are situated near the south-eastern edge of Lake Barlee in flat salt-lake country. These are numbered 1 to 6 on Plate 2. The intensities were 6 to 7 times the immediate background and the widths at half rise were as low as 4 seconds (equivalent to about 480 ft). A ground inspection was attempted of anomaly No.1 on Plate 1, which occurs under similar conditions. Unfortunately heavy rain had inundated much of the area and the actual location of the anomaly could not be reached. However, in isolated spots near the lake's edge, counts of 4 to 5 times the count rate of the soil farther from the lake were observed on the portable scintillation counter. Soil samples of lateritic composition were collected for assay, from a depth of 6 inches.

Two other areas of anomaly were visited. They are shown as Nos. 20 and 38 on Plate 1. The soil at anomaly 20 was of the sandy-loam type that resembles the indeterminable soil described by Ellis (1939) although geological maps show it to overlie granite and allied igneous rocks. No evidence of uranium mineralisation was found. A sample of the soil from a depth of 6 inches was collected for assay. Traverses surveyed with the portable scintillation counter showed count rates of 2 to $2\frac{1}{2}$ times background count over an area within a radius of 50 ft of the position given on the photograph. The soil near anomaly 38 contained white sand with ironstone gravel, and is of the type which overlies granite. A granite outcrop was seen approximately 1 mile south of this position. Traverses across the area showed surface counts 2 to 3 times the background count of the sandy soil. A soil sample from a depth of 6 inches was collected.

Assay Results:

The results of radiometric assays of the soil samples done in the Bureau's laboratory are as follows :-

Anomaly No. 1 — No measurable radioactivity could be detected.

Anomaly No. 20 — Uranium oxide - nil

Thorium oxide - 0.062%

Radium (trace) - 0.003×10^{-7}%

Anomaly No. 38 — Uranium oxide content assayed as 0.002% but is considered doubtful as activity was too low for accurate measurement.

Thorium oxide - 0.04%

Radium (trace) - 0.003×10^{-7}%

7. CONCLUSIONS

The anomalies investigated by the Auster scintillograph survey were those detected during a previous airborne survey with DC.3 aircraft at 500 ft above ground level. In the course of the present survey several of these anomalies showed intensities of low order, and have been discarded as of no further interest. Among those discarded are most of the ones associated with granite outcrops.

The remaining anomalies are shown on Plates 1 and 2. They represent very restricted areas of radioactivity greater than twice background. It must be noted that most of these also may prove to be associated with granite intrusions. However, as soil covers almost the entire area, including the places where the anomalies occur, it is impossible to explain the anomalies with any degree of certainty. A ground investigation would be necessary to determine the cause of the anomalies.

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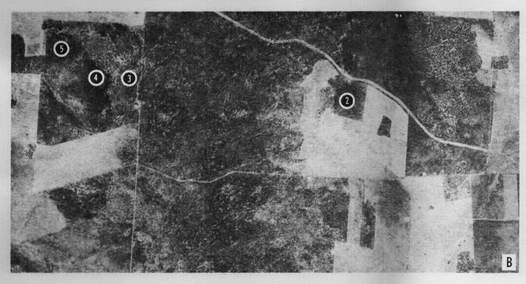

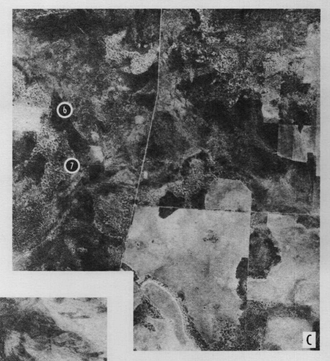

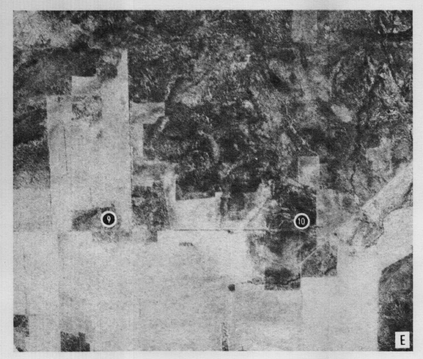

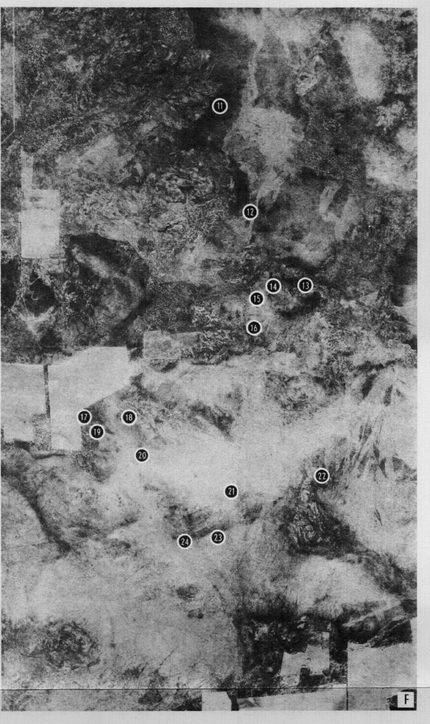

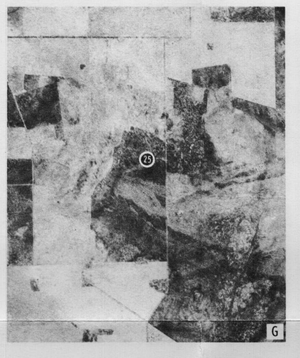

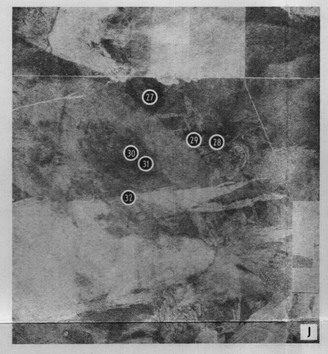

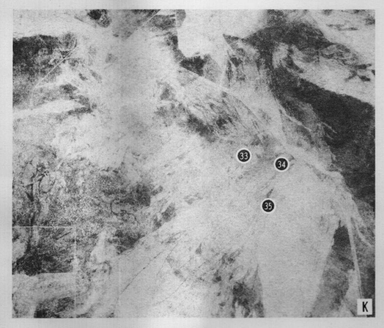

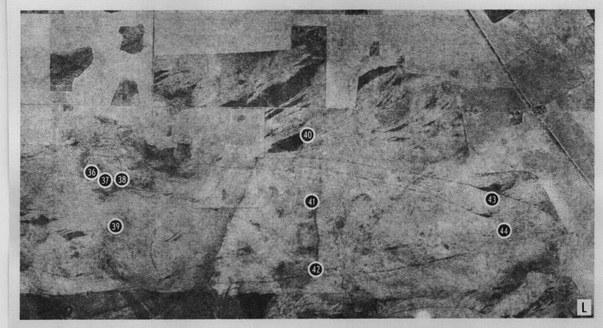

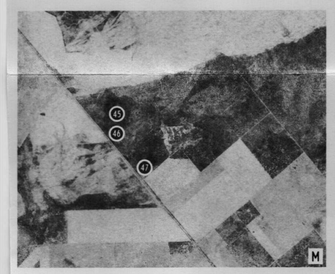

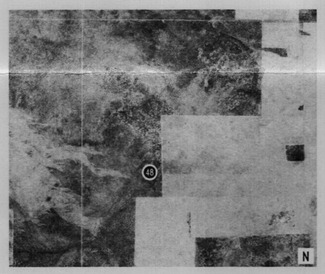

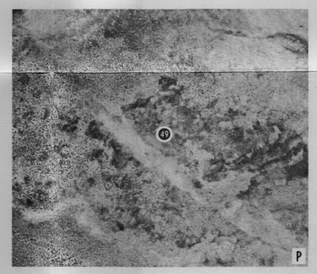

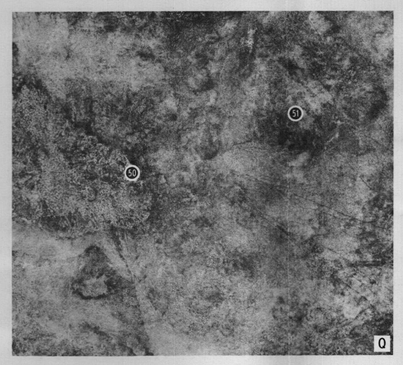

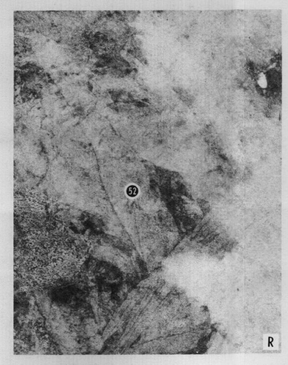

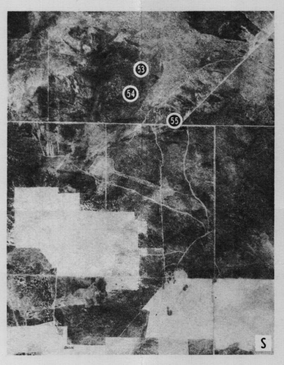

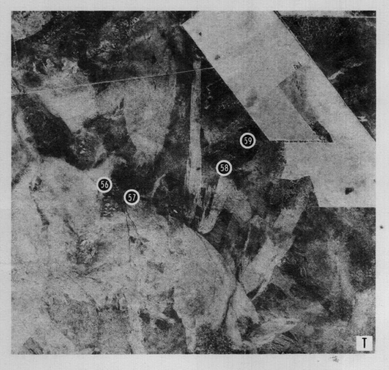

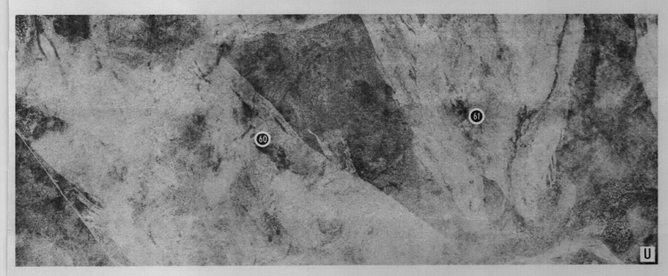

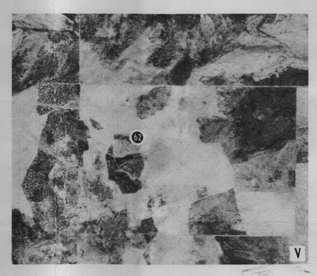

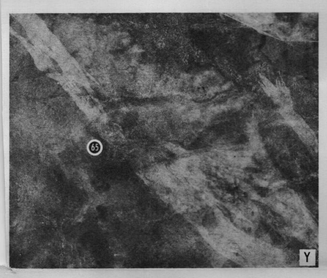

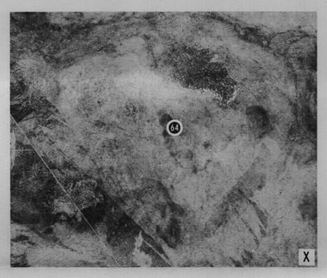

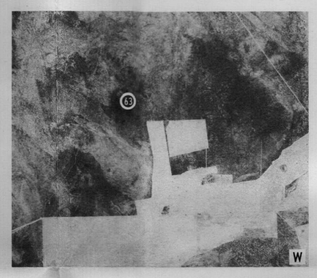

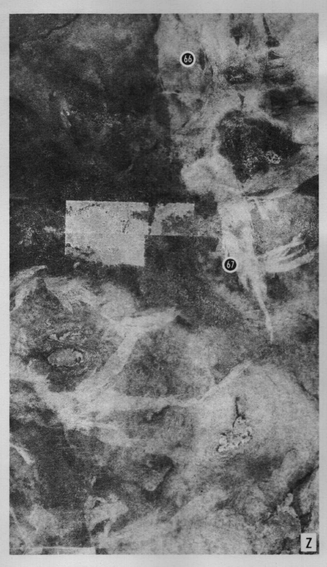

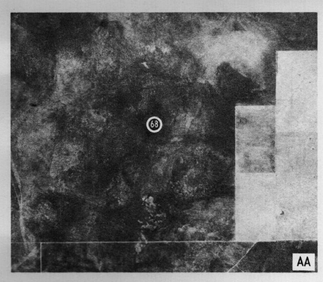

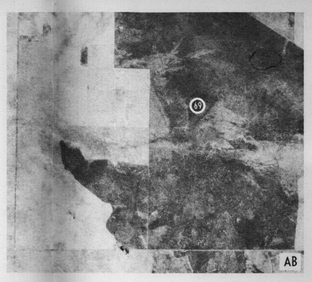

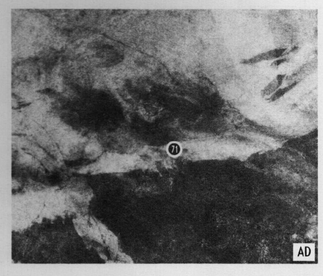

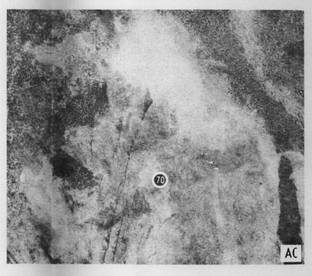

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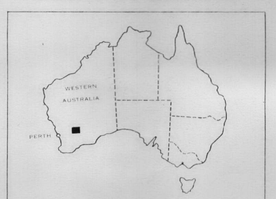
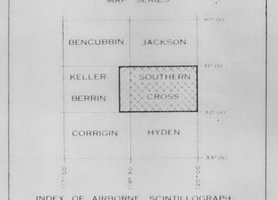


REFERENCE TO 4-MILE AUSTRALIAN NATIONAL MAP SERIES



INDEX OF AIRBORNE SCINTILLOGRAPH SURVEY MAPS PUBLISHED

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SOUTHERN CROSS REGION (1958 FOLLOW-UP SURVEY)

MAP DATA

PROJECTION: TRANSVERSE MERCATOR AUSTRALIAN SERIES

DETAIL: PLANIMETRIC DETAIL WAS REDUCED FROM WESTERN AUSTRALIAN DEPARTMENT OF LANDS AND SURVEYS PHOTO-SCALE MAPS OF **SOUTHERN CROSS** AND FROM ROYAL AUSTRALIAN SURVEY CORPS 1:253,440 MAP OF **KELLERBERRIN**

RELIABILITY: RELIABLE EXCEPT AREA IN **KELLERBERRIN** 4-MILE SHEET WHICH IS SKETCH ONLY

NOTE: IMPERFECTIONS ON AIR PHOTO MAPS ARE DUE TO FAULTS ON ORIGINAL NEGATIVES

COMPILED AND DRAWN BY GEOPHYSICAL SECTION, BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS, DEPARTMENT OF NATIONAL DEVELOPMENT, MELBOURNE.

WESTERN AUSTRALIA

SOUTHERN CROSS REGION

MAP SHOWING

RADIOMETRIC ANOMALIES

DETECTED BY AIRBORNE SCINTILLOGRAPH

JUNE-JULY, 1958

APPROXIMATE SCALE OF PHOTO MAPS

MILES 1 0 1 2 3 MILES

SCALE OF PLANIMETRIC MAP

MILES 8 4 0 8 16 24 32 MILES

LEGEND

TOPOGRAPHICAL DATA

- RIVER OR CREEK
- RAILWAY WITH STATION OR SIDING
- HIGHWAY
- ROAD OR TRACK
- TELEGRAPH LINE
- FENCE
- AERODROME OR LANDING GROUND
- TOWN
- HOMESTEAD
- SHED OR HUT
- MINE

SCINTILLOGRAPH DATA

- ANOMALY (ANOMALIES ARE NUMBERED FOR REFERENCE ONLY)
- LIMIT OF 1956 DC-3 SURVEY

EXPLANATORY NOTES

This map shows the results of a low level airborne scintillograph survey carried out to investigate further the anomalies recorded by a previous high level survey by a DC-3 aircraft.

The airborne scintillograph records continuously the intensity of gamma radiation from the ground over which the aircraft flies. This radiation is due to the presence of the naturally occurring radioactive elements, radium and thorium and their decay products, and to a lesser extent potassium.

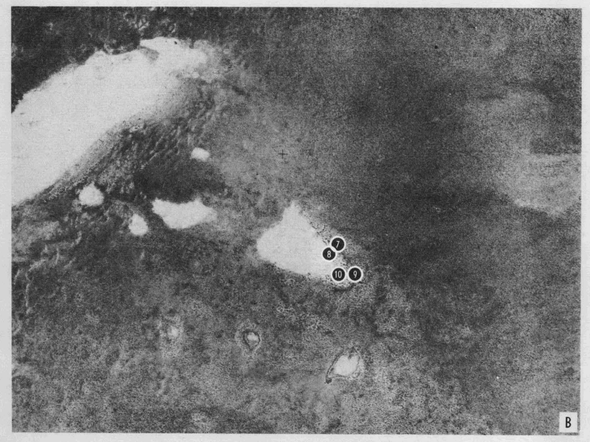
The scintillograph was carried in an AUSTER aircraft which was flown at an average altitude of 200 feet above the ground. The scintillograph effectively scanned a strip of ground approximately 500 feet wide.

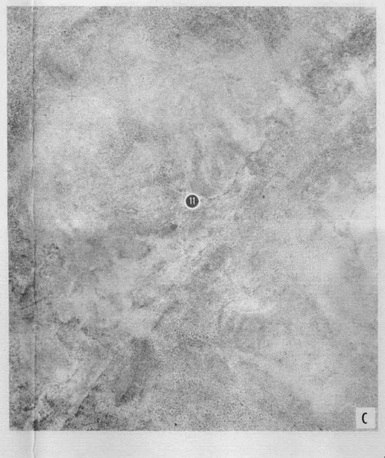
The gamma-ray intensity over an area may show considerable variations, depending on the geology and topography of the area. Anomalies of gamma-ray intensity have been plotted on the map where the intensity showed a significant and localized increase.

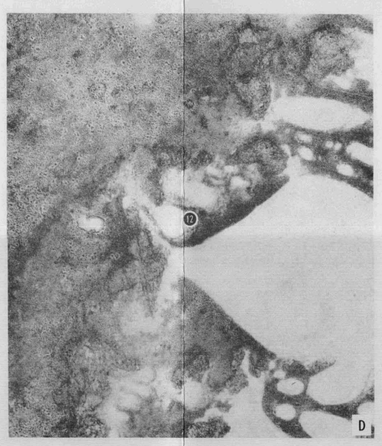
The map shows the position and grouping of the anomalies. To assist in making investigations on the ground, all the anomalies have been reproduced singly or in small groups on aerial photographs. The positioning of these anomalies is considered to be accurate to within 150 feet.

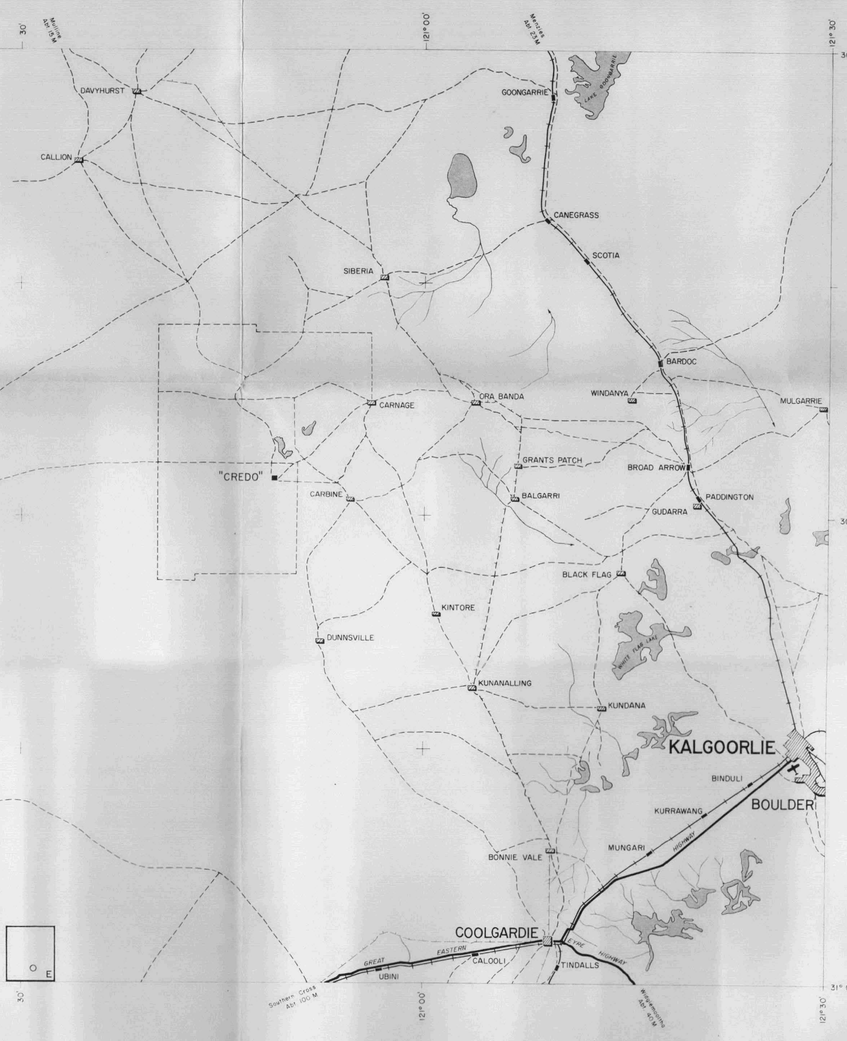
The higher intensities recorded by the scintillograph are not necessarily due to the presence of uranium deposits. Some of the higher intensities may be due to igneous rocks, which contain a slightly higher concentration of the radioactive elements, uranium, thorium and potassium, than other rocks. No claim is made that all, or even any, of the higher intensities correspond to uranium deposits of economic significance, but it is possible that some do.

It should be noted that it is virtually only the radioactivity of the surface of the ground that has been recorded, because the radiation from any buried deposit is substantially reduced by a few inches of soil or rock cover.

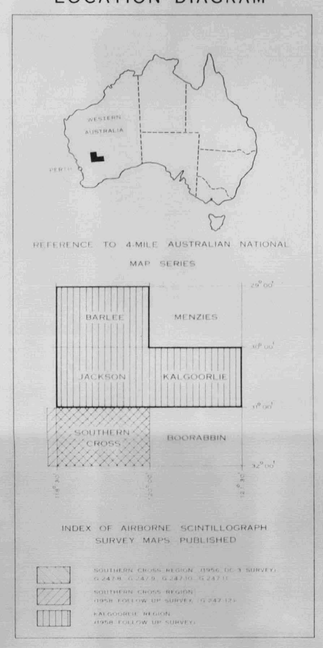








LOCATION DIAGRAM



MAP DATA

PROJECTION: TRANSVERSE MERCATOR, AUSTRALIAN SERIES

DETAIL: PLANIMETRIC DETAIL WAS COMPILED FROM WESTERN AUSTRALIAN DEPARTMENT OF LANDS AND SURVEYS PHOTO SCALE MAPS OF **BARLEE** AND **JACKSON** AND FROM ROYAL AUSTRALIAN SURVEY CORPS 1:253,440 MAP OF **KALGOORLIE**

RELIABILITY: RELIABLE EXCEPT AREA IN **KALGOORLIE** 4-MILE SHEET WHICH IS SKETCH ONLY.

NOTE: IMPERFECTIONS ON AIR PHOTO MAPS ARE DUE TO FAULTS ON ORIGINAL NEGATIVES.

COMPILED AND DRAWN BY GEOPHYSICAL SECTION, BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS, DEPARTMENT OF NATIONAL DEVELOPMENT, MELBOURNE.

WESTERN AUSTRALIA

KALGOORLIE REGION

MAP SHOWING

RADIOMETRIC ANOMALIES

DETECTED BY AIRBORNE SCINTILLOGRAPH

JUNE-JULY, 1958

APPROXIMATE SCALE OF PHOTO MAPS

MILES 1 0 1 2 3 MILES

SCALE OF PLANIMETRIC MAP

MILES 8 4 0 8 16 24 32 MILES

LEGEND

TOPOGRAPHICAL DATA

- RIVER OR CREEK
- RAILWAY WITH STATION OR SIDING
- HIGHWAY
- ROAD OR TRACK
- TELEGRAPH LINE
- FENCE
- AERODROME OR LANDING GROUND
- TOWN
- HOMESTEAD
- SHED OR HUT
- MINE

SCINTILLOGRAPH DATA

(10) ANOMALY (ANOMALIES ARE NUMBERED FOR REFERENCE ONLY)

EXPLANATORY NOTES

This map shows the results of a low level airborne scintillograph survey carried out to investigate further the anomalies recorded by a previous high level survey by a DC-3 aircraft.

The airborne scintillograph records continuously the intensity of gamma radiation from the ground over which the aircraft flies. This radiation is due to the presence of the naturally occurring radioactive elements, uranium and thorium and their decay products, and to a lesser extent potassium.

The scintillograph was carried in an AUSTER aircraft which was flown at an average altitude of 200 feet above the ground. The scintillograph effectively scanned a strip of ground approximately 500 feet wide.

The gamma-ray intensity over an area may show considerable variations, depending on the geology and topography of the area. Anomalies of gamma-ray intensity have been plotted on the map where the intensity showed a significant and localised increase.

The map shows the position and grouping of the anomalies. To assist in making investigations on the ground, all the anomalies have been reproduced singly or in small groups on aerial photographs. The positioning of these anomalies is considered to be accurate to within 150 feet.

The higher intensities recorded by the scintillograph are not necessarily due to the presence of uranium deposits. Some of the higher intensities may be due to igneous rocks, which contain a slightly higher concentration of the radioactive elements, uranium, thorium and potassium, than other rocks. No claim is made that oil, or even any, of the higher intensities correspond to uranium deposits of economic significance, but it is possible that some do.

It should be noted that it is virtually only the radioactivity of the surface of the ground that has been recorded, because the radiation from any buried deposit is substantially reduced by a few inches of soil or rock cover.

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