COMMONWEALTH OF AUSTRALIA

DEPARTMENT OF NATIONAL DEVELOPMENT

BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS

RECORD No. 1963/26

MOUNT ISA AREA, AIRBORNE RADIOMETRIC SURVEY, QUEENSLAND 1962

by

J.M. Mulder

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SUMMARY

A low-level radiometric survey using a Cessna aircraft, was made by the Bureau of Mineral Resources in the Mount Isa area, Queensland, from May to August 1962.

The survey covered 2600 square miles of mainly Lower Proterozoic rock formations.

Six anomalies are recommended for further investigation on the ground.

1. INTRODUCTION

The survey described in this Record was made by the Bureau of Mineral Resources between May and August 1962.

The purpose of the survey was to investigate the Lower Proterozoic rocks, in particular the Eastern Creek Volcanics, from the air for likely deposits of uranium minerals. Similar surveys in the district have been made in 1958 (Gardener, 1961), 1959 (Mulder, 1961a), 1960 (Mulder, 1961b), and 1961 (Gardener, 1962). The present survey completes this investigation.

A Cessna 180-B aircraft equipped with a scintillograph and a radio-altimeter was used. Operations were based on Gregory Downs Homestead where the airstrip was conveniently situated near the area.

Bureau officers who took part were J.M. Mulder (party leader), P. Zerial (drafting officer), and C.I. Parkinson (field assistant). The aircraft was flown by First Officer N.J. Barton of Trans-Australia Airlines. P.E. Goodeve, senior geophysicist, relieved J.M. Mulder during the last two weeks of the survey.

Following the established policy of the previous surveys, the results of this investigation were released to the public through the Mining Warden's Office at Mount Isa.

The map showing the results, which appears as Plate 1 of this Record, is also being issued separately.

2. GEOLOGY

The following notes on the geology have been mainly based on the works of Carter, Brooks, and Walker (1961), Opik, Carter, and Noakes (1961), Brooks (1960), and Carter and Brooks (1960).

The surveyed area comprised the northern section of the Mount Isa highlands. Surface elevations ranged from 1500 ft above sea level in the southern part to practically sea level in the north. The rock types ranged from Precambrian to Cainozoic, although the most common rocks were those of Lower Proterozoic age.

Two granites crop out in the survey area. They are the Weberra Granite (in the Camooweal 1:250,000 area) and the Ewen Granite (in the Dobbyn 1:250,000 area). Carter and Brooks (1960, p.37) describe the Weberra Granite as a red, medium-grained granite, the north-western body of which is muscovite-rich. They describe the Ewen Granite (p.45) as massive and medium to coarse-grained, consisting of red feldspar, quartz, and chlorite (after biotite).

Brooks (1960, p.9) states that uranium minerals have been found associated with derivatives of Precambrian granite intrusions. These are the refractory minerals davidite, brannerite, and absite, and none is of economic importance.

The Lower Proterozoic rocks have been divided into three divisions, viz. the lower, the middle, and the upper division (Brooks, 1960, p.8).

The Leichhardt Metamorphics are a development of acid lavas at the base of the lower division. They are conformably overlain by the Mount Guide Quartzites (Opik et al., 1961 p.8). The latter formations crop out in the Mount Isa area as very rough hills with strong relief. They are strongly folded along a north-south fold axis and are faulted and jointed. The transition to the Eastern Creek Volcanics, which conformably overlie these quartzites is remarkably abrupt. Meta-basalt flows and meta-sediments are thinly interbedded and are generally fine-grained. The Eastern Creek Volcanics are strongly folded and faulted and crop out as very rough hills with strong relief. Important deposits of uranium minerals occur in this formation.

The formations of the lower division of the Lower Proterozoic are overlain by a sequence of calcareous and arenaceous sediments with minor basic volcanics. The principal formations in the surveyed area are the Myally Beds and the Judenan Beds. These formations are strongly folded on a meridional axis and extensively faulted. The Myally Beds crop out as very rough hills with strong relief; the Judenan Beds crop out as gentle hills with a more moderate relief. Uranium mineralisation in both formation is very poor.

The upper division of the Lower Proterozoic consists of shale and dolomite with some siltstone, sandstone, and greywacke. The sedimentation took place mainly along the north-western and western margins of the depositional area. Only minor volcanics occur in the succession.

The Ploughed Mountain Beds which overlie the Myally Beds with local unconformity are penecontemporaneous with the Surprise Creek Beds and jointly with the Paradise Creek Formation and the Gunpowder Creek Formation (Carter et al., 1961, p.102). The last three formations are strongly folded and faulted and they crop out as hills with moderate to strong relief. The Surprise Creek Beds, which generally overlie the Myally Beds conformably, are in turn unconformably overlain by flat-lying freshwater Mesozoic sediments. Such sediments occur in the central western section of the survey area. They consist of conglomerate, pebble beds, coarse and feldspathic sandstone, arkose, siltstone, and shale. The sediments are almost invariably poorly sorted and in places extensively cross-bedded (Carter et al., 1961, p. 126).

The Mount Isa Shale is confined to a narrow meridional belt about the longitude of the town of Mount Isa. Its greatest width is about eight miles and it is generally only three miles wide. It extends from 20 miles south of Mount Isa to 35 miles north of the town. The Mount Isa Shale consists of thin-bedded clay shale, dolomitic shale, siliceous shale, carbonaceous shale and siltstone, claystone, siltstone, sandstone, quartzite, and conglomerate. Some 'greenstone' near Mount Isa may also belong to this formation (Carter et al., 1961, p. 108-109).

The Pilpah Sandstone of the Upper Proterozoic unconformably overlies the Judenan Beds, the Gunpowder Creek Formation, and the Paradise Creek Formation. The sandstone is gently to moderately folded and crops out as gentle hills with fair relief (Carter et al., 1961, p.122)

3. EQUIPMENT

An Austronic Engineering Laboratories scintillograph, type AS-1 was used on the survey; it consisted of a detector head and ratemeter.

The detecting element of the scintillograph was a thallium-activated sodium iodide crystal $4\frac{1}{2}$ in. in diameter and 2 in. thick, The crystal was optically coupled to a Dumont photomultiplier tube, type 6364. The output of the photomultiplier was fed to a ratemeter which produced an output current proportional to the count rate. This output current was registered on an RD-47A dual-channel recording milliammeter to provide a continuous trace of the gamma-ray intensity at the detecting crystal.

An AN/APN-1 radio-altimeter was used to indicate the height of the aircraft above the ground. The output of this instrument was fed to the second channel of the recording milliammeter. A set of limit lights was incorporated in this altimeter to provide the pilot with an indication that he was within predetermined height limits, viz. 180 to 210 ft above ground level.

4. OPERATIONS

The survey party camped at Gregory Downs and used the station airstrip. Except for June, when on a number of occasions high winds prevented survey flights being made, flying conditions were generally very good.

The survey was commenced on 15th May and completed by 13th August 1962.

The aircraft was flown at a nominal height of 200 ft above ground level. The lane width scanned at this height by the scintillograph was about 500ft. The lane width and the response of the equipment to sources on the ground varied with the height of the detector above the terrain. Therefore, for line-to-line correlation of the results it was important that the aircraft height was maintained reasonably accurately. However, variations did occur, particularly in rugged country. The direction of the flight-lines was chosen to suit the geology, the topography, and the time of the flight.

For reasons of geological interest, the preferred flight-line direction was at right angles to fault lines and strikes of formations. However, in places the topography made cross-strike flying impossible and necessitated the adoption of a method of contour flying along the out-crops. Early mornings and late afternoons were often the only time suitable for the low-level flying and where north-striking features were being surveyed it was sometimes necessary to depart from cross-strike flying to avoid interference to the pilot's vision from the sun.

The line separation was determined by the geological formation being sampled. It ranged from five lines per mile over the Eastern Creek Volcanics, and four lines per mile over other Lower Proterozoic rocks, to two or three lines per mile over the Mesozoic and Cainozoic sediments. The speed of the aircraft was kept as closely as possible to 120 m.p.h.

K-17 aerial photographs at a scale of 1:50,000 were used for navigation. Flight-lines and check-points were plotted on these photographs by the observer during the flight. Anomalies considered to warrant a further check were re-flown at a separation of six lines per mile.

The performance of the scintillograph equipment was checked before and after each survey flight by placing a standard radioactive source at a predetermined distance from the detector head. The height at which these tests were done was 2000 ft above ground level where the radiation from the Earth is effectively zero. The increase in the count rate was then attributed to the standard source only.

The radio-altimeter was checked periodically by flying at an altitude of 200 ft above the airstrip and observing the amber limit light and the pen position on the chart of the recorder together with the indication on the barometric altimeter.

At the conclusion of the survey 7300 line-miles had been flown over an area of 2600 square miles.

5. METHOD OF INTERPRETATION

The records were first analysed to determine the background intensity of the gamma radiation for each particular rock type or formation. When these intensities became known during the course of the survey, regional variations in the background count rate could be correlated in some cases with the local geology. The variations were broad in character and easily outlined.

The next inspection was concerned with those variations in the count rate that could not be associated with the broad geological features. Count rates or anomalies most interesting in the search for uranium are those arising from localised and linear sources. Anomalies of this type can be recognised by their definite shape.

Important anomalies are those whose amplitude or maximum count rate are at least 1½ times the background count rate and whose half-rise width did not exceed 9 sec when flown across the strike (i.e. a flying time of 9 sec between points half way up and half way down the anomaly curves; in this survey this would correspond to about 1600 ft of distance travelled).

The amplitude of an anomaly depends on the concentration of radioactive minerals on (or very near) the surface, the distance between source and detector, the speed of the detector over the source (which equals the groundspeed of the aircraft), and the time constant of the scintillograph equipment.

Variations in the source to detector distance have a definite effect on the results. Anomaly amplitudes for point sources are decreased by 34 percent and 52 percent respectively for heights of 50 ft and 100 ft above the survey altitude of 200 ft (Carter, 1960). A close attention had therefore to be paid to the records of the radio-altimeter when anomalies were examined on the chart. Variations in altitude have a much smaller effect on the width of anomaly than on its amplitude.

An average groundspeed of 120 m.p.h. and a time constant of 0.5 sec for the equipment were chosen as the most suitable, considering the altitude of the aircraft above ground level.

All anomalies which satisfied the amplitude/width criteria were further examined. This was done by inspection of the relevant portion of the radio-altimeter record and the aerial photographs. If it could be established that they had been caused by changes in altitude or by topographical features, the anomalies were discarded.

Anomalies due to outcrops of granite or other rocks known to be radioactive were also discarded. These anomalies could usually be identified because they occurred in large numbers and exhibited a characteristic amplitude and shape.

The remaining anomalies were plotted on K-17 photos and geological maps, and the area around such anomalies were re-flown with closer line-spacing. These re-flown records were analysed in a similar manner to the original records, but an exception was made for lines which were flown along the strikes of possible source beds. The limit to the width of such anomalies was raised to 13 sec in order not to overlook linear type sources. These and other anomalies left unexplained were plotted for investigation on the ground.

6. SURVEY RESULTS

Listed below are the anomalies that were considered to warrant further investigation on the ground.

The numbers correspond to those shown on the accompanying plates. Plate 1 shows the positions of the anomalies in the survey area together with K-17 photo reproductions of their immediate surroundings; Plate 2 shows reproductions of the anomaly profiles and the relevant portions of the radio-altimeter records:

No. 1 Anomaly occurs in the Myally Beds close to where these beds are overlain by the Ploughed Mountain Beds. The radio-altimeter profile recorded on reflying is fairly flat and shows that the aircraft height over the anomaly was about 240 ft.

No. 2 Anomaly occurs in the Ploughed Mountain Beds, north-east of the Weberra Granite. Its position is near one of the tributaries of Fiery Creek. The anomaly along flight-line 764 is intense and sharp. Some granite might occur in the Ploughed Mountain Beds, although there is no evidence that this anomaly is due to such igneous intrusives. The record of the radio-altimeter shows that the anomaly recorded on flight-line 764 was flown at a correct height, but that the re-flies were done at a greater height. The shape of the radiometric profile suggests a source restricted in areal extent.

No. 3 Anomaly occurs on a low ridge along a fault or dyke in the Myally Beds. West of the fault or dyke these beds are overlain by the Surprise Creek Beds. The profiles along flight-line 408 as well as along the re-flown lines suggest a source of small areal extent. The radio-altimeter record shows that no topographical features could have contributed to the increase in count rate.

No. 4 Anomaly. This is a group of anomalies that occurs in outcropping Myally Beds. The original anomaly recorded along flight-line 902 was sharp and registered over 500 counts per sec. It became evident from the re-fly that the original anomaly was one of a group of anomalies with high intensities. Only some of the profiles are shown on Plate 2. The radio-altimeter traces show that the country is hilly and that at some points the aircraft height was less than 200 ft. However, the changes in source-to-detector distances were small and they could not have been the cause for these anomalies.

No. 5 Anomaly occurs in Myally Beds. The country is rugged, as can be seen from the radio-altimeter chart. However, the anomaly could not be attributed to a topographical feature. The intensity of the original anomaly recorded on flight-line 795 was over 500 counts per second and for the re-fly the full-scale count rate was reset to 1000 counts per second. Although the re-flies were made at a higher flight level, the recorded peak count-rates were at least 1000 counts per sec. The anomaly profiles indicate that they are associated with a source of restricted areal extent.

No. 6 Anomaly occurs in Myally Beds near where they are overlain by the Surprise Creek Beds. The anomaly was recorded when flight-line 66 was flown across a valley. The re-fly in an identical direction showed a reasonably sharp anomaly of moderate intensity. Profiles along flight-lines parallel to the valley were wide and suggested a source of linear extent. The record of the radio-altimeter showed that none of these anomalies could have been caused by topographical features.

7. CONCLUSIONS

The results of the survey show that there are six anomalies that warrant investigation. Five of these anomalies occur in the Myally Beds, a sedimentary formation belonging to the middle division of the Lower Proterozoic. No uranium occurrences have so far been found in these beds.

The remaining anomaly occurs in the Ploughed Mountain Beds, also a sedimentary formation but belonging to the upper division of the Lower Proterozoic. No uranium occurrences are known to exist in this formation.

As there is no definite proof that any of the anomalies are associated with radioactive ore deposits, a ground investigation would need to be made to evaluate the results.

8. REFERENCES

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CARTER, E.K. and BROOKS, J.H.	1960	North-western Queensland. In THE GEOLOGY OF QUEENSLAND. Melbourne University Press, 21-62.
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GARDENER, J.E.F.	1961	Mount Isa area airborne radiometric survey, Queensland 1958. Bur. Min. Resour. Aust. Rec. 1961/21 (unpubl.)
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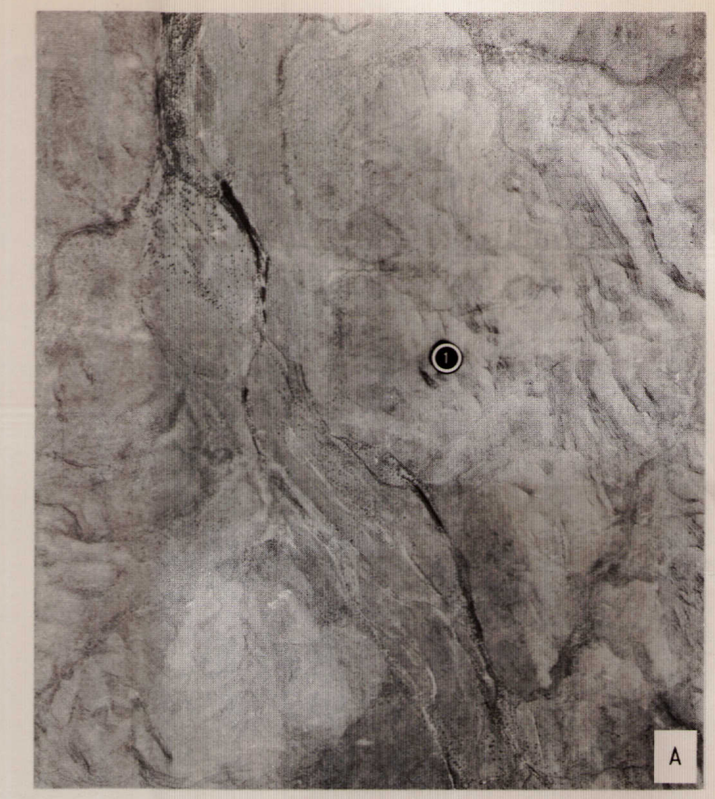
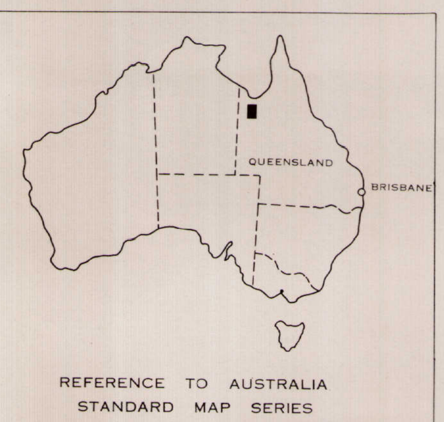
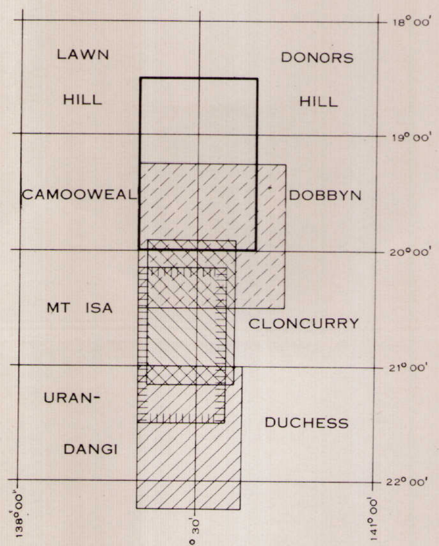
MULDER, J.M.	1961a	Mount Isa area airborne radiometric survey, Queensland 1959. Ibid. 1961/74 (unpubl.)
MULDER, J.M.	1961b	Mount Isa area airborne radiometric survey, Queensland 1960. Ibid. 1961/77 (unpubl.)
ÖPIK, A.A., CARTER E.K., and NOAKES L.C.	1959	Mount Isa - 4-mile geological series. Sheet F54/1 Australian National Grid. Bur. Min. Resour. Aust. Explanatory Notes No. 20



LOCATION DIAGRAM



REFERENCE TO AUSTRALIA STANDARD MAP SERIES



INDEX OF AIRBORNE SCINTILLOGRAPH SURVEY MAPS PUBLISHED

- MT ISA REGION. (1958 SURVEY) G 181-6
- MT ISA REGION. (1959 SURVEY) G 181-10
- MT ISA REGION. (1960 SURVEY) G181-14
- MT ISA REGION (1961 SURVEY) G181-19
- MT ISA REGION (1962 SURVEY)

Department of National Development

BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS

Compiled and drawn in the Geophysical Branch

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 THE 1962 AIRBORNE SURVEY

MAP DATA

PROJECTION: TRANSVERSE MERCATOR, AUSTRALIA SERIES

DETAIL: PLANIMETRIC DETAIL AFTER 4-MILE GEOLOGICAL MAP SERIES, LAWN HILL, CAMOOWEAL, AND DOBBYN COMPILED BY DIVISION OF NATIONAL MAPPING, DEPARTMENT OF NATIONAL DEVELOPMENT AND QUEENSLAND 4-MILE MAP SERIES 4 M 99 PRODUCED BY SURVEY OFFICE, DEPARTMENT OF PUBLIC LANDS, BRISBANE.

RELIABILITY: RELIABLE SKETCH

NOTE: IMPERFECTIONS ON AIRPHOTO MAPS ARE DUE TO FAULTS ON ORIGINAL NEGATIVES

QUEENSLAND

MOUNT ISA REGION

MAP SHOWING

RADIOMETRIC ANOMALIES

DETECTED BY AIRBORNE SCINTILLOGRAPH

MAY - AUGUST 1962

APPROXIMATE SCALE OF PHOTO MAPS

MILES 1 0 1 2 3 MILES

KILOMETRES 1 0 1 2 3 4 5 KILOMETRES

SCALE OF PLANIMETRIC MAP

MILES 8 4 0 8 16 24 32 MILES

KILOMETRES 10 5 0 10 20 30 40 50 KILOMETRES

EXPLANATORY NOTES

The airborne scintillograph continuously records the intensity of gamma radiation from the ground over which the aircraft flies. On this survey the scintillograph was carried in a Cessna aircraft flown at an average altitude of 200 ft above the ground. At that height it effectively scanned a strip of ground approximately 500 ft 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 positions and grouping of the anomalies. To assist in making investigation on the ground, all the anomalies have been reproduced on aerial photographs. The position of these anomalies is considered to be accurate to within 300 ft.

No claim is made that the anomalies are due to uranium deposits. Some anomalies may be due to igneous rocks, which contain a slightly higher concentration of radioactive elements than other rocks. Investigation on the ground would be necessary to determine the significance of the anomalies.

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.

E54/B1-2

TO ACCOMPANY RECORD No. 1963/26

LEGEND

Scintillograph trace

Radio-altimeter trace

RADIOMETRIC ANOMALY PROFILES

HORIZONTAL SCALE IN FEET

5000 0 5000 10,000 15,000

VERTICAL SCALES AS SHOWN

Geophysical Branch, Bureau of Mineral Resources, Geology and Geophysics. E54/B1-3

TO ACCOMPANY RECORD 1963/26