COMMONWEALTH OF AUSTRALIA

DEPARTMENT OF NATIONAL DEVELOPMENT

BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS

RECORD NO. 1957/51

AIRBORNE SCINTILLOGRAPH SURVEY OF THE NICHOLSON RIVER REGION,

NORTHERN TERRITORY AND QUEENSLAND

by

D.F. LIVINGSTONE

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ABSTRACT

During the period September to November, 1956, an Auster aircraft of the Bureau of Mineral Resources carried out a low-level airborne scintillograph survey in the Nicholson River region, on the Northern Territory/Queensland border.

An area of 1,100 square miles was surveyed, and numerous anomalies of gamma-ray intensity were found. Follow-up work on these anomalies by ground parties was limited by difficulties of terrain and weather, but some anomalies are known to coincide with uranium prospects, and others have been reported to correspond to areas of uranium mineralisation. One group of anomalies, to the south of the Westmoreland valley, may well indicate an important deposit.

Contours of gamma-ray intensity have been drawn and serve to indicate the general distribution of radioactivity over the region. Both contours and anomalies appear on the map which is presented with this report.

It is considered that the most favourable formation for investigation by ground survey and prospecting parties is the Westmoreland Conglomerate, a sedimentary formation of Pre-Cambrian age, on which attention was concentrated during the recent survey.

1. INTRODUCTION

During the period September to November, 1956, a low-level airborne scintillograph survey was carried out by the Geophysical Section of the Bureau of Mineral Resources in the Nicholson River region. This region lies on the Northern Territory/Queensland border, and the three areas surveyed lie to the north of the Nicholson River. These areas are shown on Plate 2.

Regional geological mapping in the Northern Territory portion of the Nicholson River region was commenced by the Bureau of Mineral Resources during the period of the airborne survey. The following tentative succession from youngest to oldest formations was supplied by J.B. Firman (1957) :-

Upper Proterozoic	(Masterton Sandstone (Gold Creek Volcanics (Constance Sandstone (Wollogorang Formation (Peter's Creek Volcanics (Westmoreland Conglomerate (Cliffdale Volcanics (Nicholson Granite

Prior to the airborne survey, uranium minerals had been found in shear zones in volcanics near the headwaters of Central Creek; these volcanics have been correlated with the Peter's Creek group. Other prospects, in association with copper mineralisation along a quartz reef occupying a fault in volcanics of Cliffdale age, occur near the upper reaches of Pandanus Creek (Plate 1). These prospects were examined by Lord (1955, 1956).

Attention in the early part of the airborne survey was therefore concentrated on exposures of these volcanics, particularly to zones of faulting and shearing in them. Though some interesting results were obtained, more significant results were obtained towards the end of the survey when attention was concentrated on the Westmoreland Conglomerate.

The survey was directed by D.F. Livingstone (geophysicist) assisted by J.E.F. Gardener (geophysicist), A. Crowder (draftsman) and N.A. Ashmore (driver). The Bureau's Auster aircraft, VH-RES, was piloted by F/O A.H. Worley (Trans-Australia Airlines).

2. EQUIPMENT

The scintillograph used consisted of a detector head and ratemeter, Austronic Engineering Laboratories type A.S.1, coupled to a Texas Instrument Company dual-recording milliammeter, of which only one channel was in use. Operation of the scintillograph was controlled and monitored in flight by a remote control unit.

The detecting element in the scintillograph consists of a thallium-activated sodium iodide crystal, cylindrical in shape, 4½ inches in diameter and 2 inches thick, mounted with its axis vertical. This is optically

coupled to a photomultiplier tube, Dumont type 6364. Gamma radiation impinging on the crystal produces scintillations which are converted to electrical impulses in the photomultiplier. These electrical impulses are integrated in the ratemeter, whose output current, registered on a counting-rate meter, is proportional to the gamma radiation detected over the preceding short interval of time. The recording milliammeter is in series with the counting-rate meter and provides a continuous record of gamma radiation detected, on which record the interpretation of results is based.

3. OPERATIONS

The technique of low-level airborne scintillograph survey has been discussed by Howard (1956) and Livingstone (1957). The conditions governing height of survey and spacing of flight lines are examined therein.

The Nicholson River survey was flown at a height of 200 ft. above ground level. At this height the lane scanned is of the order of 480 ft. in width; the flight-line spacing adopted, 4 to 5 per mile, results in a coverage of 40 to 50 per cent and gives an adequate sample. Whenever possible, the aircraft speed was kept within the range 75 to 80 m.p.h.

Flight lines were plotted during flight by the observer, using K-17 aerial photographs. As far as possible these lines were kept straight, and at right angles to the strike of the geological formations. Anomalies which were deemed significant were re-located wherever possible. The accuracy of positioning is considered to be of the order of ± 300 ft.

The response of the scintillograph to a standard flux of gamma radiation was determined before and after each survey flight by placing a standard radioactive source in a fixed position relative to the detecting element; this response is termed the "standard radiation level". The "instrumental background", resulting from cosmic radiation and radiation originating in the aircraft, was also determined before and after each survey flight, at an altitude of 2,000 ft. above ground level.

Operations were restricted by severe turbulence, which developed at about 9 a.m. to 10 a.m. each day, after which survey flying rapidly became impracticable and often dangerous. As a result of this, and of the distance from base to the survey areas, it was possible to make only one flight per day, taking off at dawn; the duration of each flight averaged 3½ hrs.

The day-to-day direction of the survey was based on available geological evidence, survey results to date and the weather conditions. Liaison with geological parties working in the region enabled some of the anomalies to be examined on the ground by these parties in the later stages of the survey.

The onset of periodic storms towards the end of the survey raised the possibility that operations might have to be discontinued at any time. It was necessary therefore to concentrate on the most favourable areas in the hope of completing the survey of these before curtailment of operations become necessary. Maximum effort was therefore directed to the Westmoreland Conglomerate. The results justified this course of action.

A total area of 1,100 square miles was surveyed.

4. INTERPRETATION PROCEDURE

The interpretation of results obtained in low-level airborne scintillograph surveys has been discussed by Howard (1956) and Livingstone (1957). Results obtained in the present survey were interpreted in terms of anomalies and contours of gamma-ray intensity. This technique is discussed in detail in the report by Livingstone, and is summarised here.

Anomalies were assessed by critical inspection of the record of gamma-ray intensity. Where doubts existed as to the efficiency of altitude control, this inspection was carried out in conjunction with examination of aerial photos. Those anomalies which were then considered significant were plotted on sketch maps, on which the final maps are based.

Contours of gamma-ray intensity were established by application to the scintillograph record of an arbitrary contour interval, based on the "standard radiation level". The "instrumental background" was taken as the zero contour.

5. DISCUSSION OF RESULTS

The survey was directed first towards areas which available geological evidence indicated might be favourable for the occurrence of uranium prospects. Uranium minerals had previously been found near the headwaters of Central Creek (Blackwell's Prospect) and near the upper reaches of Pandanus Creek (Norris's Prospect); these occurrences are in shears in the Peter's Creek Volcanics and Cliffdale Volcanics respectively. In addition to these original discoveries, prospectors of North Australian Uranium Corporation had found uranium minerals in the area between the upper parts of Central Creek and Branch Creek; these prospects also occur in shear zones in the Peter's Creek Volcanics (see Plate 1).

The first survey flights were therefore made in that portion of Area 1 which lies in the Northern Territory (Plate 2). This area extends southwards from Central Creek past the headwaters of Branch Creek and Lagoon Creek, covers the drainage basin of Pandanus Creek and Gorge Creek, and extends westwards between Tin Hole Creek and the escarpment of the China Wall (marked by the headwaters of Fish River).

Results in this portion of Area 1 were encouraging. Groups of anomalies were found south of the China Wall (88 and 89), on the headwaters of a major tributary of Pandanus Creek (76 to 83), near the headwaters of Branch Creek (35 to 38, 46 and 47), near the headwaters of Lagoon Creek (39 to 45) and near the head of that tributary of Central Creek which flows past Blackwell's Prospect (48 and 49). Available geological evidence indicates that many of these anomalies are in volcanics of the Peter's Creek and Cliffdale series. Follow-up work on these groups of anomalies was restricted by difficulty of access, but immediately before the airborne survey terminated, uranium mineralisation was reported from one locality; the prospector responsible did not give clear details of his find (North Australia Uranium Corporation's "White Label"), but it appears that it falls in the locality of anomaly 33.

Scattered anomalies which were considered worthy of investigation were found elsewhere in Area 1, but had not been examined on the ground by the time the airborne survey ended. From evidence obtained in the Queensland portion of Area 1 it would appear that most, if not all, of these are due to outcrops of acid volcanics.

The volcanic series continue across the border into Queensland, forming, with the Nicholson Granite which underlies the Cliffdale Volcanics, the upper part of the Cliffdale Valley (drainage basin of Yellow Waterhole Creek); in the upper part of the Westmoreland valley the Peter's Creek volcanics are largely obscured by alluvium. The survey of Area 1 was therefore continued into the head of the Cliffdale valley. Two anomalies (90 and 91) near Gorge Creek were examined on the ground by field staff of Mount Isa Mines Ltd. and were found to be due to outcrops of acid volcanics. It is probable that the majority of the anomalies at the head of the Cliffdale valley (53 to 58 and 60 to 63) will have a similar origin.

The first results obtained from the eastern exposure of the Westmoreland Conglomerate led to the belief that this formation was of considerable interest. Further work led to the discovery of very significant anomalies (Plate 2), which are discussed in more detail below.

The association of copper and uranium mineralisation in this region (as at some of Norris's finds) led to the survey of two smaller areas (Areas 2 and 3). The formations here are ascribed to the Gold Creek Volcanic series, and show fault zones which it was hoped would be of interest, although it is believed that the copper ores of Redbank occur in necks, not faults. No significant anomalies were found in these two areas (Plate 2).

The contours of gamma ray intensity, though showing a fair diversity, are of secondary importance (Plate 2). They reflect in part the general geology of the areas surveyed, and in part the erosion pattern. However, it is considered that limited "high" areas are always worthy of investigation after the possibilities of the anomalies have been exhausted.

6. THE WESTMORELAND CONGLOMERATE

The Westmoreland Conglomerate is exposed south of Central Creek and extends eastwards into Queensland. It also forms part of the escarpment of the China Wall.

The portion of this formation which afforded the most significant results lies in Queensland, and forms the high ground between the Westmoreland and Upper Cliffdale valleys, a bold plateau to the west and a more broken area, also of high elevation, to the east.

Although discoveries of uranium minerals had been made in the Peter's Creek Volcanics adjacent to the Westmoreland Conglomerate, it was not until the airborne survey was directed to the latter formation that the possibilities of this formation were fully realised.

On 6th November, 1956, a group of anomalies (23 to 27) of considerable amplitude was found in the Westmoreland Conglomerate; this group is centred 15¼ miles from Westmoreland station on a true bearing of 218°. This locality was investigated on 8th November by a field party of Mount Isa Mines Ltd., who reported "torbernite mineralisation in sandstone over a distance of at least 100 yards". This report was treated with due caution, but specimens brought back by this party showed torbernite widely disseminated in a coarse red sandstone (a specimen considered to be below average assayed 0.84 per cent eU_3O_8).

Further survey of this exposure of the Westmoreland Conglomerate resulted in the location of anomalies 3 to 22, which were considered to be very significant though less striking than the major group. It was unfortunately not possible for these to be examined immediately.

The major group of anomalies occurs in or near a deep gorge which probably represents a major joint or fault in the upper of the two members of the formation. The other anomalies appear to occur at the junction of the two members, at the intersection of major joints in the upper member, or where an eroded basin occurs in the upper member. The geological evidence at the time of writing is insufficient to assess the structural disposition of mineralisation, but it appears possible that it occurs over a considerable extent of this formation.

7. CONCLUSIONS

Ninety-one radioactive anomalies (all in Area 1) were found during the course of the airborne survey, the most significant being (a) those in the Westmoreland Conglomerate and (b) those in the volcanics of the Cliffdale and Peter's Creek series.

Although further discoveries of uranium minerals are probable in the volcanic series (uranium prospects have already been found), it is considered that the most important uraniferous horizon in the area is the Westmoreland Conglomerate. In this formation, torbernite has been seen to occur in detrital beds and the location of significant anomalies leads to the belief that this mineralisation may be widespread.

Some of the anomalies in the Westmoreland portion of the area have been examined by ground parties from Mt. Isa Mines Ltd. and others by officers of the Geological Survey of Queensland and geologists of the Bureau of Mineral Resources (Walpole, 1957).

Detailed survey of the Westmoreland Conglomerate by ground parties is strongly recommended.

8. REFERENCES

Firman, J.B., 1957 - Personal communication.

Howard, L.E., 1956 - Airborne scintillograph survey, Tasmania, 1955, Bur. Min. Resour. Aust., Records 1956, No. 99.

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Lord, J.H., 1955 - Report on an inspection of a uranium find on Pandanus Creek, Northern Territory. Bur. Min. Resour. Aust., Records 1955, No. 63.

Lord, J.H., 1956 - Report on an inspection of uranium discoveries in the Calvert Hills Area, Northern Territory. Bur. Min. Resour. Aust., Records 1956, No. 115.

Walpole, B.P., 1957 - Report on inspection of uranium occurrences and airborne radiometric anomalies, Westmoreland area, North-West Queensland. Bur. Min. Resour. Aust., Records 1957, No. 40.

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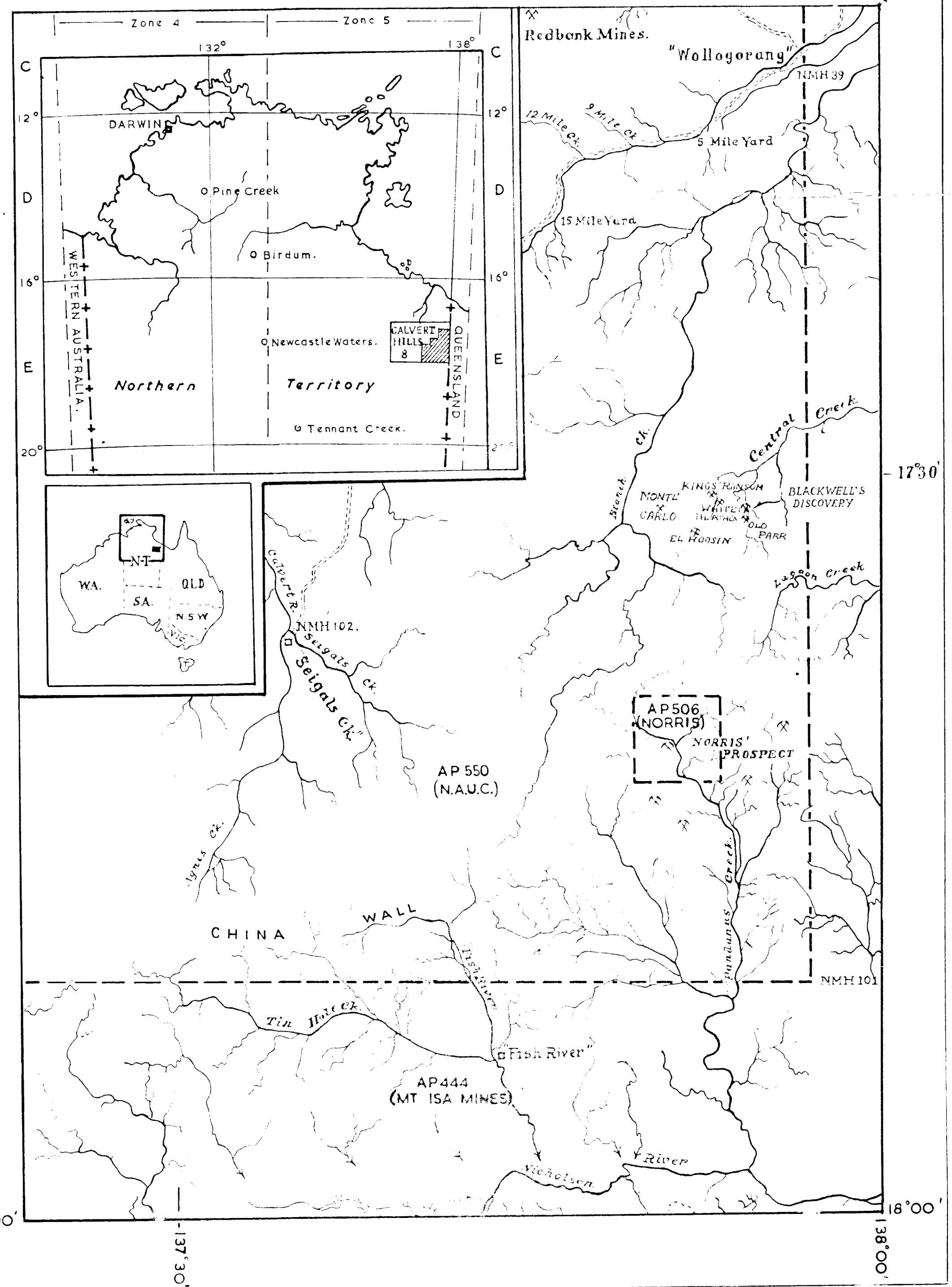
PLATE 1

MAP SHOWING LOCALITY OF URANIUM DISCOVERIES IN THE CALVERT HILLS AREA

NORTHERN TERRITORY.

Scale-4 Miles to Inch.



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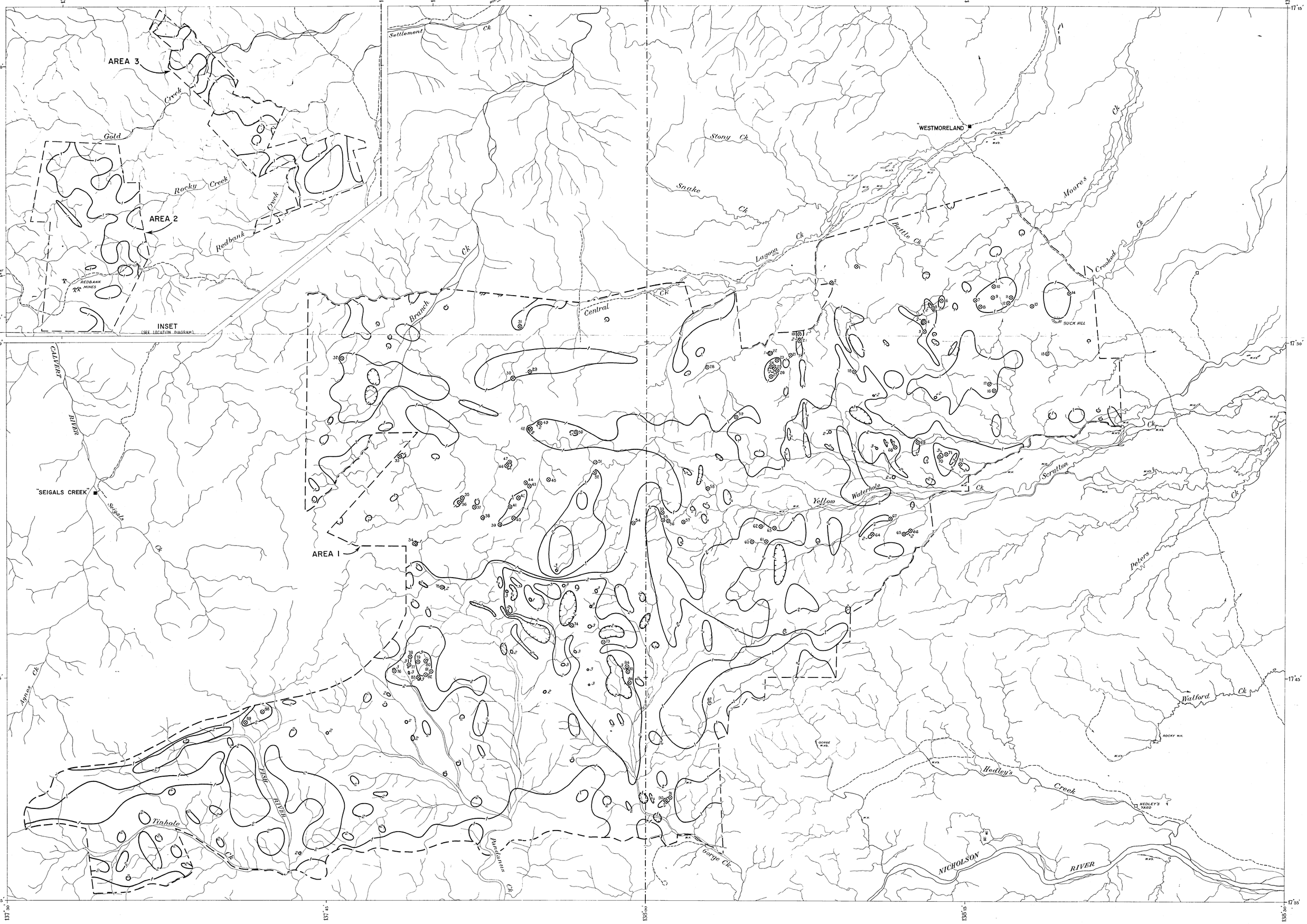
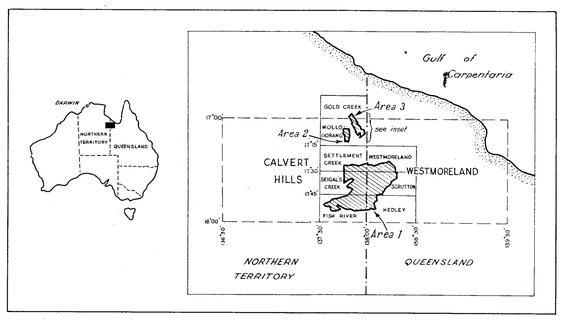


LOCATION DIAGRAM

WITH REFERENCE TO 4 MILE AND 1 MILE AUSTRALIAN MILITARY MAP SERIES



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NORTHERN TERRITORY AND NORTH QUEENSLAND

NICHOLSON RIVER REGION

MAP SHOWING

ANOMALIES AND CONTOURS

OF

GAMMA-RAY INTENSITY

DETERMINED BY AIRBORNE SCINTILLOGRAPH

SEPT.-NOV., 1956

TRUE NORTH
MAGNETIC NORTH

SCALE

MILES 2 1 0 2 4 6 8 10 MILES

LEGEND

TOPOGRAPHICAL DATA

- River or creek
- Road or track
- State boundary
- Water hole
- Swamp
- Homestead
- Yard
- Mine

RADIOMETRIC DATA

- Anomaly and number thereof
- Contour of gamma-ray intensity
- Radiometric low
- Limit of 1956 airborne survey

MAP DATA

PROJECTION: Transverse Mercator.

DETAIL: Planimetric detail was compiled from four-mile mosaics Calvert Hills, N.T. and Westmoreland, Queensland, by Division of National Mapping. A four-mile north-south adjustment strip west of the N.T./Qld border was compiled by Geophysical Section, B.M.R. using slotted template assembly.

RELIABILITY: Sketch map.

EXPLANATORY NOTES

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 160 yards wide. The recorded gamma-ray intensity therefore represents the average intensity within a radius of 80 yards of the aircraft.

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 positioning of these anomalies is considered to be accurate to within 100 yards. Contours have also been drawn on the map to represent the general distribution of gamma-ray intensity. These radiation levels are multiples of an arbitrary unit.

The higher intensities recorded by the scintillograph are not necessarily due to the presence of uranium deposits. Many of the higher intensities may be due to outcrops of igneous rocks, particularly granite, 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.

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