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SUMMARY OF CARBORNE RADIOMETRIC INVESTIGATIONS IN THE NORTHERN TERRITORY, 1955.

BY

W.J. LANGRON.

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FOREWORD.

This report deals with one aspect of an investigation into the occurrence of radioactive deposits carried out by the Geophysical Section of the Bureau of Mineral Resources, in the Darwin-Katherine region, Northern Territory, from 1949 to 1955.

In 1952, following the discovery of uranium mineralisation of economic importance at Rum Jungle, the Bureau initiated airborne radiometric surveys in the Rum Jungle area using a D.C. 3 aircraft equipped with a scintillation counter. The aircraft was flown at a height of 500 ft. along flight paths approximately 1000 ft. apart and a very large number of radioactive anomalies were detected. These were classified into 1st., 2nd. and 3rd. order anomalies (Wood and McCarthy, 1952).

This type of survey was extended in the succeeding years to the surrounding area and ultimately the Australian one-mile Series areas of Ban Ban, Burnside, Reynold's River, Mt. Hayward, Tipperary, Lewin Springs, Mt. Todd, Mundogie Hill, Woolwonga, Florina, Katherine and the composite areas of Moyle River-Muldiva Creek and Darwin - Anson Bay Coastal Regions were covered.

The investigation of the anomalies on the ground commenced soon after the airborne results were available and it became abundantly clear that the great majority of the anomalies were due to widely dispersed radioactivity in the surface materials, principally soil, laterite and granite outcrops and not related to economic deposits of uranium mineralisation. Some were due to thorium mineralisation and others to spare uranium mineralisation which subsequent testing by trenching, drilling and shaft sinking proved to be of no importance.

In order to obtain a better appreciation of the ground sources giving rise to the anomalies detected by the airborne method, work of the kind described in this report was undertaken. Although this work was done primarily to assist the Bureau in its own investigations it is considered that the results would be of interest to others engaged in this type of survey work and for this reason the results are now being issued.

ABSTRACT.

This Record discusses the results of carborne radiometric surveys in the Brodribb and Brock's Creek Areas, N.T. In particular, the surveys were planned to examine the correlation between the results of airborne and carborne surveys.

In the Brodribb area, compensation errors in the compass of the odograph, which was used to plot the carborne surveys, resulted in a systematic directional error in the grid. Several radioactive anomalies were located, but because of the error in location of the grid, it was not possible to make a satisfactory comparison between the airborne and ground results.

Results in the Brock's Creek areas were more satisfactory, and fairly good correlation was obtained between the airborne and ground results. However, there are some carborne anomalies of fair intensity and size which are not associated with airborne anomalies. Most of the anomalies examined are related to the drainage pattern in the area and are due to material derived from the Brock's Creek Granite.

In the areas surveyed, the airborne anomalies had been plotted by means of radar (Shoran) navigational aids, whereas the carborne grids were laid down by reference to aerial photography. It is possible that similar investigations in an area in which airborne anomalies have been plotted by means of vertical photography would be more useful for purposes of comparison.

1. INTRODUCTION.

During the 1955 field season, carborne radiometric surveys were carried out by the Geophysical Section of the Bureau of Mineral Resources over several areas in the northern part of the Northern Territory (Plate 1). The following areas were surveyed:

(A) About 6 square miles around the Brodribb Prospect and extending westwards along the Brodribb Track to the North Australian Railway (see Plate 2).

(B) Three areas near Brock's Creek (see Plate 3).

(i) No. 1 Area : $2\frac{1}{2}$ square miles, immediately north of the Brock's Creek Granite.

(ii) No. 2 Area : $4\frac{1}{2}$ square miles immediately west of the Brock's Creek Granite.

(iii) No. 3 Area : about 2 square miles immediately south of the Brock's Creek Granite.

(C) Some reconnaissance surveying was done in the area covered by the Tumbling Waters and Southport one-mile sheets.

(D) The examination of several airborne anomalies in the Mt. Evelyn area was commenced but because of the onset of the wet season it was not possible to proceed with this work.

The party consisted of R.W.C. Bladworth, geophysicist (Party leader) and M. Stevens, geophysical assistant. The work was under the general supervision of W.J. Langron, and was carried out during the period between 27th. June and 22nd. November, 1955.

2. PURPOSES OF SURVEYS.

The main purposes of the surveys in the Brodribb and Brock's Creek areas were to provide data for comparison with the results of earlier airborne surveys carried out by the Bureau, to establish the cause of each of the anomalies within the selected areas, and, where necessary, to take samples for assay at the Bureau's laboratory in Darwin.

The reconnaissance work in the Tumbling Waters and Southport areas, and the examination of airborne anomalies in the Mt. Evelyn area were done at the request of the Bureau's Senior Geologist, Darwin, and were usually undertaken in company with a geologist from the Darwin office. Results of this work are contained in reports by Lord (1955).

3. TECHNICAL ASPECTS.

The survey was conducted using a Landrover in which was mounted an odograph (for plotting position) and scintillograph unit (for measuring and recording the radioactivity). A brief description of the equipment and the survey technique is given below, but reference should also be made to the report on earlier carborne surveys by Barlow (1956).

A. Odograph.

(i) General. The odograph, which plots the course taken by the vehicle in which it is mounted, consists of three main parts, namely compass, power pack and plotting-unit. The direction taken by the vehicle is determined by means of the compass, which is compensated for the magnetic effects of the iron and steel of the vehicle. Distance is determined by the speedometer drive, and direction and distance are combined mechanically by the plotting-unit. The electrical power source for the apparatus is the vehicle battery, the voltage of which is stepped up by the powerpack.

The odograph can plot to any one of a wide range of scales, that used on the present survey being 1:4800. The heading of the vehicle at any moment is indicated on an azimuth dial. Counters record the distance travelled north or south and east or west from a chosen starting point.

Adjustments made to small movable magnets situated inside the compass correct for deviation caused by permanent magnetism, and small pieces of permalloy, added to attachments provided, correct for the effect of induced magnetism in the material of the vehicle.

Short term compensation of the compass was carried out each morning, and, depending on how much adjustment was necessary, occupied from 20 to 40 minutes. The long-term compensation was carried out once during this survey, about a month after the survey began. Long-term compensation had previously been carried out in Melbourne, before the vehicle left for the Northern Territory.

In order to reduce to a minimum the amount of compass disturbance, certain precautions were taken - such loose iron and steel articles as were required in the vehicle were kept in a fixed place as far away from the compass as possible and the vehicle was parked in an east-west position remote from external sources of disturbance.

(ii) Accuracy. Sources of error are discussed below under the headings of distance and direction.

(a) Distance errors. Distance input is taken from the speedometer drive gear in the vehicle transmission. The measurement of distance is most accurate when travelling on hard surfaces with tyres at the recommended pressure, but even under these conditions it was found that when the odograph was calibrated against known distances there was an error of about one per cent. The factor necessary to correct the odograph distance readings was observed at regular intervals during the survey. Because the odograph records the actual distance travelled, the mileage shown by it during a survey in hilly country is greater than the distance measured on a map, and allowance has to be made for this discrepancy.

(b) Direction error. Direction is controlled by a compass, errors in which are the main sources of inaccuracy in the odograph. It is necessary to standardize magnetic conditions within the vehicle as much as possible and to make a daily compensation check.

The results of the Brodribb survey are subject to a systematic directional error, although daily compensation was sedulously attended to. Long-term compensation, which had been carried out about six weeks previously, should probably have been repeated.

(c) General. In traversing a half-mile square at 200-foot intervals, the distance covered is about 7 miles. The error in closure in this distance varied, but seldom exceeded

300 feet (about one percent). This error in closure was not allowed to accumulate from square to square, as the boundaries of the squares were established first and each individual square was then surveyed separately. The establishment of the boundaries is subject to error in distance and direction, but after the experience gained at Brodribb, this is considered to be less than 2 per cent.

B. Scintillograph.

This consists of a scintillation probe, a ratemeter designed and built at the Bureau's laboratory in Melbourne, and a Kelvin-Hughes continuous recorder. The main precaution necessary was the frequent checking of the ratemeter zero. Rather than make frequent adjustments to the instrument so that the recorder pen registered zero scale divisions for zero counts, it was found more convenient to switch off the E.H.T. occasionally for a few seconds and to observe the zero position thus recorded.

In each area surveyed, the count rate was noted each day at a fixed station, and occasionally a check was made at a site in the Darwin Botanical Gardens; no significant variation was detected.

C. Method of Survey.

A grid was surveyed in the following manner. A point which could be easily identified both on air photographs and on the ground, was selected and used as the origin. Starting from this point, the odograph was then used to fix the corners of half-mile squares. Originally, each half-mile square was outlined separately, but later, the boundaries of larger areas were first established, using air photographs to check the vehicle's position. Traverses were then run across each half-mile square at 200-foot intervals. On completion of each square, any error in the spacing of the traverses was determined and appropriate corrections were applied when the results were plotted.

D. Preparation of Data.

During the traversing a continuous record of radioactivity was obtained at a scale of 1 inch = 440 feet. The results were plotted on a scale of 1 inch = 400 feet by plotting, at intervals of 1.1 inches, the values read off the record at intervals of 1 inch. Contours of counts per second were then drawn for each area at a scale of 1 inch = 800 feet.

4. DISCUSSION OF RESULTS

This discussion is confined to the carborne results in the Brodribb Area and in the three areas near Brock's Creek.

A. Brodribb Area.

This was the first area to be surveyed, and several sources of error in survey technique were discovered. The directional error, which was the most serious, has already been discussed. The carborne survey commenced from the eastern end of the grid but an inaccuracy in position became apparent when the survey reached the railway line, where it was found that the corners of the squares were displaced to the north by about ½-mile from their intended positions. This inaccuracy would have been detected earlier if air photos of the area had been available. Examination of the results and later tests indicated that the error was one of slight translation as well as of rotation. The actual position of the grid was established using measured distances from corners of the squares to the Brodribb track and railway line.

When the discrepancy was found (i.e. when the grid was almost completed) a full compensation of the odograph was made. Subsequent tests showed that this compensation was effective and no further inaccuracy from this source was experienced.

The positions of the airborne anomalies are shown on Plate 2, but because of the errors already described, the relation between the position of the scintillograph anomalies and the carborne grid is subject to some doubt.

A summary of the geology and early radiometric work done in the area, is given by Matheson (1953). Mumme (1958) discusses the results of self-potential and surface radiometric measurements and radiometric bore hole logging conducted near the Brodribb Prospect, i.e. near the 1st. order airborne anomaly near point O.

Local background count over "low" areas was 60 to 70 per second. Background at the testing site in the Darwin Botanical Gardens was 40 counts per second. The contours as shown on Plate 2 could be replotted in terms of multiples of background count (preferably that of the Gardens' site) but it is not thought of advantage to do this.

There is a general correlation betwen some of the airborne and ground anomalies, but there are numerous exceptions to this. The general east-west elongation of the ground contours is in agreement with the strike of beds and there is a similarity in the pattern of the airborne anomalies and the ground "highs" in the western half of the area. The high radioactivity near the centre of square C is probably the source of the 1st, 2nd and 3 rd order airborne anomalies on flight lines 60, 61 and 62 respectively. The 3rd order airborne anomalies on flight lines 51, 52 and 53 are probably due to the relatively high radioactivity on squares W. and M. Airborne anomalies on flight lines 44, 47 and 49 appear to arise from ground radioactivity recorded by the vehicle borne scintillation counter.

It appears that the carborne anomaly extending across the western part of square W and squares X, Y and Z was not detected during the aerial survey. Conversely, the carborne anomaly map provides no explanation for several of the airborne anomalies. However, there is some doubt as to whether the airborne and ground anomalies are plotted on plate 2 in their correct position relative to one another. It can be assumed that the airborne anomalies are plotted in their correct spacial relationship one to another and that except for minor errors in scale the ground anomalies are in their correct position relative to one another. No simple rotation or translation of one set of results as a whole relative to the other set will give a correlation any more satisfactory than that shown on plate 2.

Assay results show that the radioactivity is due to thorium which is associated with pyrite in slate. Other airborne anomalies are due to large patches of ferruginous laterite which give counts of more than five times local background.

B. Brock's Creek District.

Three small areas were surveyed near the Brock's Creek Granite (see Plate 3). The geology of this region has been described by Sullivan and Iten (1952).

The Brock's Creek area was selected for investigation because of an apparent general similarity between the distribution of radioactivity there and at Rum Jungle. In each area, there is a central plateau of high radioactivity, associated with a granite mass, and several anomalies up to first order around the periphery. As well as providing a favourable area for testing vehicle-borne equipment, it might be expected that, if any of the isolated anomalies in the Brock's Creek area were associated with uranium mineralisation, geological conditions might be favourable for the occurrence of a body of economic size, by analogy with the similar conditions at Rum Jungle.

The areas for examination were selected from the map showing radioactive anomalies on the Burnside one-mile sheet (G159-2). Groups of anomalies were chosen lying close to the margin of the radioactive plateau associated with the granite, and within the ring of magnetic anomalies surrounding the granite. If such anomalies were associated with schists or metamorphic rocks, their geological environment would be similar to that of the anomalies associated with the Rum Jungle deposits. However, it appeared that the radioactive plateau, while obviously associated with the Brocks Creek granite, did not extend to the boundaries of the granite. A similar effect was noted over areas of radioactive volcanics in the Bamboo Creek district (Daly, 1957). Due to the presence of the granite, the general background count was high in all areas, which are therefore not as suitable for comparison of airborne and ground results as had been hoped.

The inaccuracies experienced with the odograph in the survey at Brodribb were eliminated before the survey near Brock's Creek was commenced. Constant checking of position by means of air photos enabled the grid to be surveyed with the utmost accuracy. The topography, generally, is suitable for carborne work, but portions of some areas had to be omitted because of ridges or creek wash. The results of the airborne survey were plotted by Shoran and not by vertical photography, so, although the two sets of data can be correlated with greater accuracy than is possible with the Brodribb results, the accuracy is still not sufficient to permit a detailed comparison.

The results obtained in each area are discussed below.

(i) <u>No. 1 Area.</u>

The ground radiometric contours, aircraft flight lines and anomalies are shown on Plate 4. There is fairly good agreement between the airborne anomalies and radioactive "highs" on the ground of greater than 180 counts per second (i.e. 3 times local background). It appears that 180 counts per second on the ground represents the lowest value of radioactivity which the airborne scintillograph can distinguish as an anomaly.

There are two ground anomalies which were not detected from the air, namely :-

(a) the "high" near the centre of square H, which was approached by at least two east-west flight lines, and -

(b) the small intense "high" near the south-western corner of the square K, near which there is at least one flight line.

(ii) <u>No. 2 Area.</u>

The ground radiometric contours, aircraft flight lines and anomalies are shown on Plate 5. Again, there is good general correlation between most of the air and ground results. The principal line of carborne anomalies is along the course of a creek which drains into the Howley Creek (see Plate 3). Most of the anomalies are due to concentrations of radioactive material (which tests showed to be mainly thorium) within the creek bed and the mud flats. The origin of the radioactive material is the Brock's Creek Granite.

There is a pronounced lack of correlation between some air and ground indications. There are no ground anomalies corresponding to airborne anomalies Nos. 258 and 259 (2nd and 1st order, respectively). Conversely, no airborne anomaly was located near the carborne "highs" in squares R and U; the reason may be that the high spots do not stand out sufficiently from a generally high background count in this portion of the area.

(iii) No. 3 Area.

The ground radiometric contours, aircraft flight lines and anomalies are shown on Plate 6. This was the smallest area surveyed and contains an intense magnetic "high", near the centre of square A.

The correlation between air and ground results is not as satisfactory as in areas No. 1 and 2; the main reason for this is that the general level of radioactivity in the area is low. Airborne anomalies Nos. 387 and 401 (each 3rd order) correlate very closely with carborne indications. The relation of anomaly No. 399 (2nd order) to the ground results is not clear and there appears to be no relation between anomaly No. 400 (3rd order) and the ground radiometric contours.

(iv) A fourth area, containing airborne anomalies Nos. 333, 334, 335 and 336 (each 2nd order), was inspected, but the anomalies are near a sharp, steep-sided ridge, which was inaccessible to the vehicle. Some traverses were surveyed at the foot of the ridge and investigations using P.R.M. 200 counters were continued on the slopes. Results were inconclusive for purposes of comparison, and are not included in this report.

Plate 7 shows the correlation between selected airborne profiles and the corresponding ground profiles. The airborne profiles have been enlarged from the original scale of 1 inch : $1\frac{1}{2}$ miles; the carborne profiles have been constructed from the contours on Plates 4 and 5. It will be seen that there is good general correlation between the two sets of results. Such agreement holds for many of the airborne anomalies which were investigated but some marked disagreements have already been noted.

5. CONCLUSIONS.

The carborne work mapped many of the radioactive sources which were detected by airborne scintillograph, but even allowing for slight inaccuracies in correlating the data, there are some marked disagreements between the carborne and airborne results.

However, the discrepancy is not considered to be as serious as it may seem at first because experience has shown that most DC3 anomalies in the northern portion of the Northern Territory are associated with weakly radioactive minerals disseminated over a large area (e.g. as surface soils, laterite, some igneous rocks, etc.). The airborne anomaly detected when the aircraft flies over a particular area of slightly higher than average radioactivity will be shown in the position where the radiation "mass effect" from this area is a maximum. This maximum (i.e. the position of the airborne anomaly shown on the map) may not always coincide in position with the maximum (or any of the individual maxima) located on the ground, and it is for this reason that a strict correlation between the positions of air and ground anomalies cannot always be expected. In fact, such a strict coincidence between air and ground anomaly positions will only be obtained under certain conditions such as when the source is of very high radioactivity as compared to its environment or when the source is of sufficient strength and of small aerial extent.

At Brodribb Prospect, the position of the 1st order airborne anomaly coincides fairly closely with a pronounced carborne anomaly near the Brodribb workings. Eight other airborne anomalies also show some correlation with ground results, but owing to doubts about the relative positions of the anomalies no specific conclusions regarding the correlation of airborne with airborne results is justified.

Most of the anomalies investigated near Brock's Creek are related to the drainage pattern and are due to concentrations of radioactive material derived from the Brock's Creek granite. This material is concentrated in the flats bordering the creeks, rather than in the creek beds. Other anomalies which were investigated are due to outcropping granite.

The lack of correlation between air and ground results may be significant in some places and may indicate a lack of discrimination by the airborne method. However, the absence of evidence on the ground to confirm some airborne anomalies is also puzzling. One may expect, for example, a relation between the difference in position of corresponding airborne and ground anomalies and the direction of the flight line. The best evidence for this suggestion is shown by the results in area No. 2.

The results indicate that the ground radiometric contours must exceed a value of about 180 counts per second before a third order airborne anomaly may be anticipated, and even then the isolation of an airborne anomaly depends on the extent of this plateau and the intensity gradient of the surrounding region.

The carborne results confirm the opinion that the order of the airborne anomaly is not of great significance in the search for radioactive mineral deposits.

Except for compensation errors during the Brodribb survey and minor recording troubles in connection with the odograph, the equipment performed satisfactorily throughout the surveys. The experience of Brodribb showed, however, that a full compensation adjustment should be made within the region to be surveyed, even though it may already have been made before leaving base.

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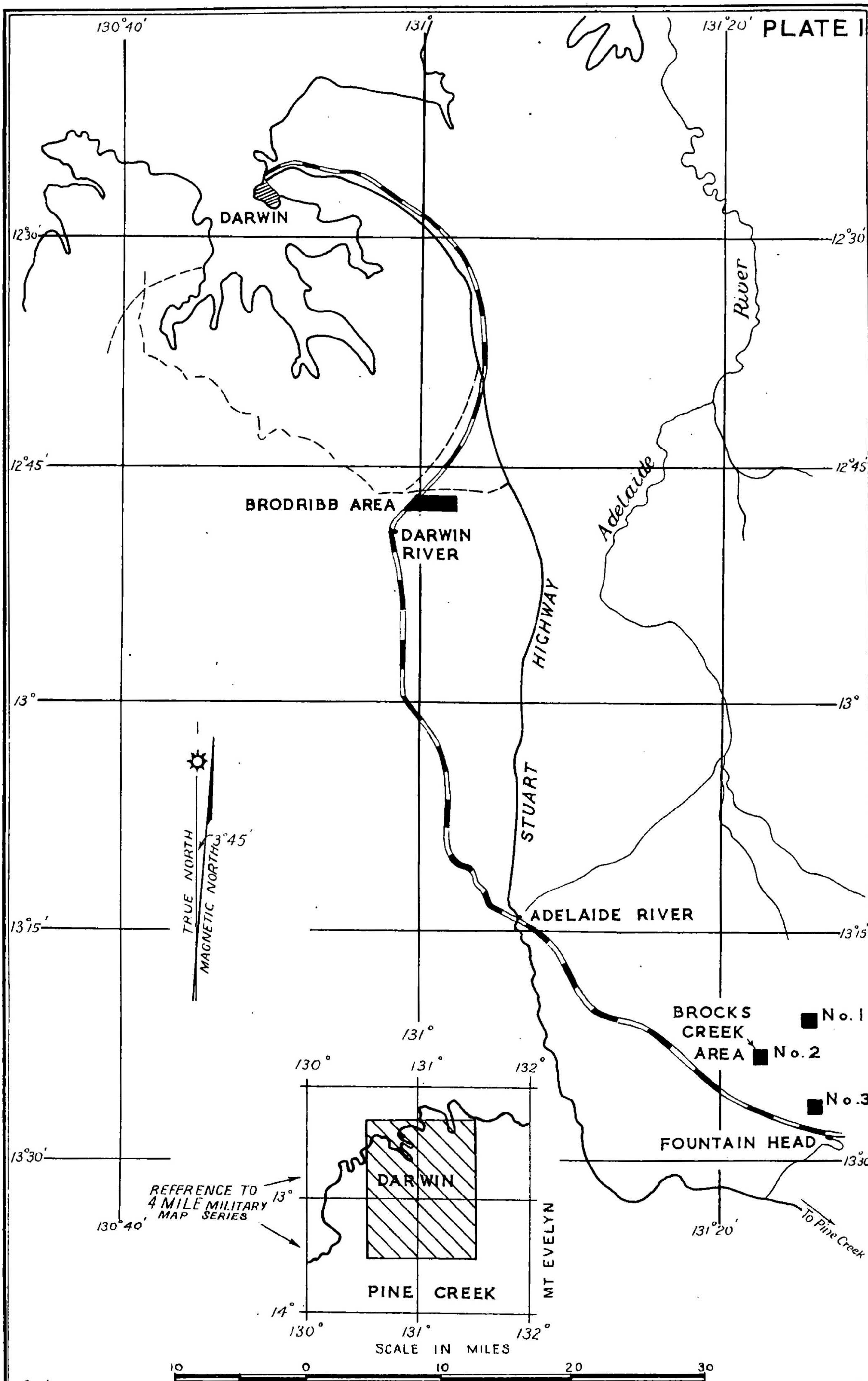

SUMMARY OF CARBORNE RADIOMETRIC SURVEYS IN THE NORTHERN TERRITORY, 1955

LOCALITY MAP

Geophysical Section, Bureau of Mineral Resources, Geology & Geophysics G 271 – I

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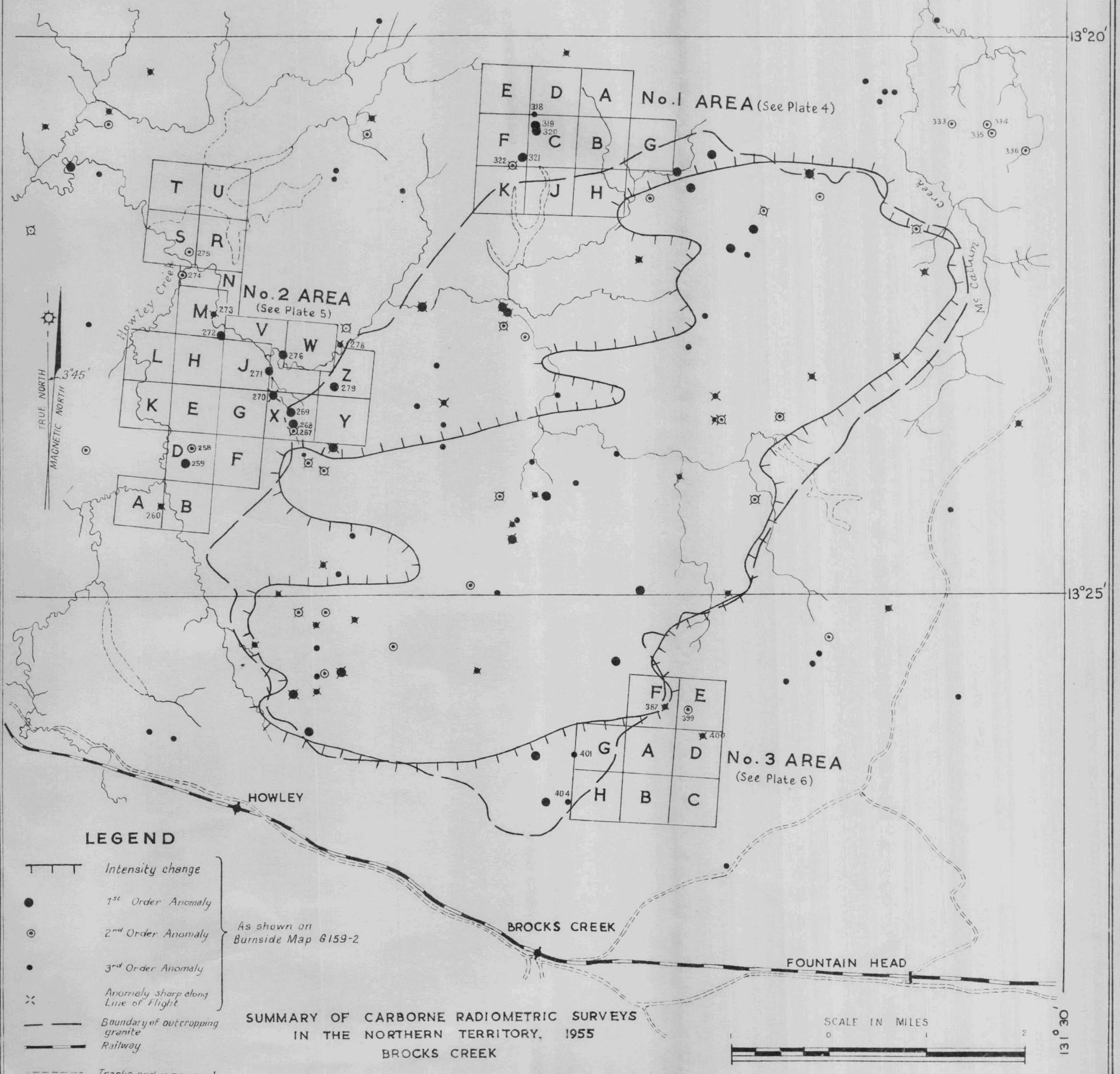

SUMMARY OF CARBORNE RADIOMETRIC SURVEYS IN THE NORTHERN TERRITORY, 1955
BROCKS CREEK

POSITION OF AREAS SURVEYED

Geophysical Section, Bureau of Mineral Resources, Geology & Geophysics G 271-3

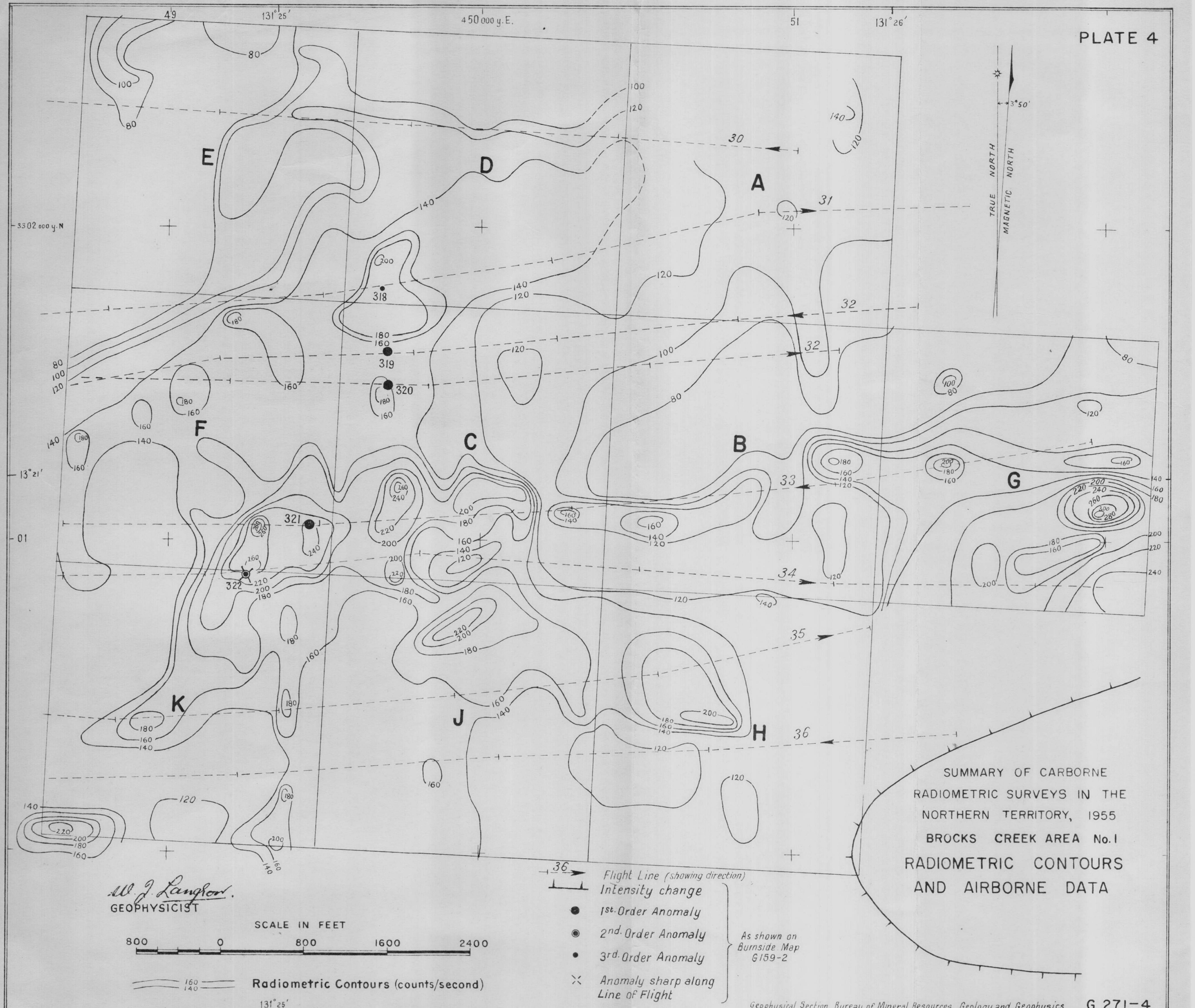
PLATE 4
TRUE NORTH
MAGNETIC NORTH
3°50'
49
131°25'
450 000 y. E.
51
131°26'
3302 000 y. N
13°21'
01
E
D
A
B
C
F
G
H
J
K
318
319
320
321
322
30
31
32
33
34
35
36
Flight Line (showing direction)
Intensity change
1st. Order Anomaly
2nd. Order Anomaly
3rd. Order Anomaly
Anomaly sharp along Line of Flight
As shown on Burnside Map G159-2
SCALE IN FEET
800 0 800 1600 2400
Radiometric Contours (counts/second)
W. J. Langron.
GEOPHYSICIST
SUMMARY OF CARBORNE RADIOMETRIC SURVEYS IN THE NORTHERN TERRITORY, 1955
BROCKS CREEK AREA No. 1
RADIOMETRIC CONTOURS AND AIRBORNE DATA
Geophysical Section, Bureau of Mineral Resources Geology and Geophysics.
G 271-4
TO ACCOMPANY RECORDS 1956, No. 147

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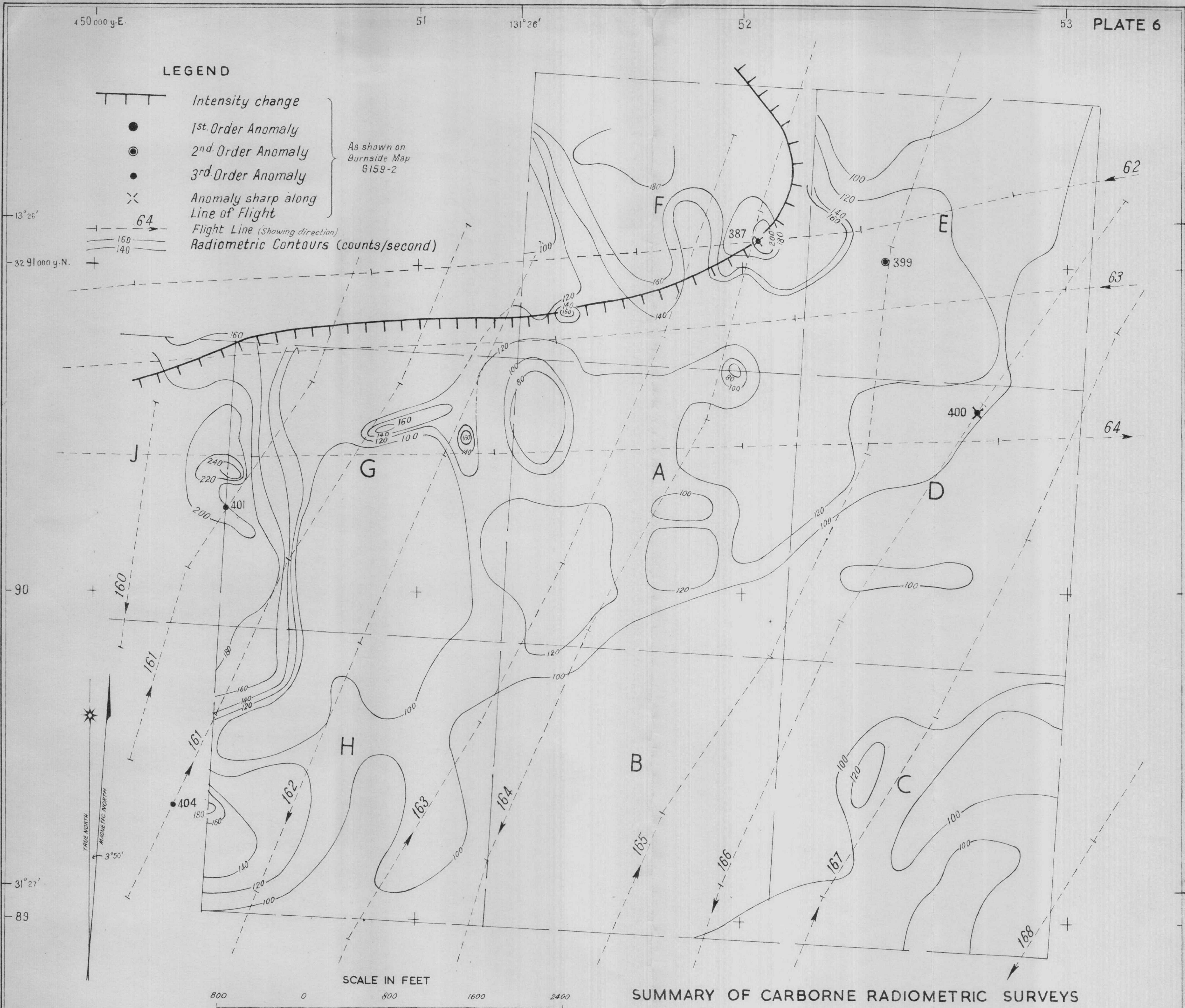
PLATE 6



SUMMARY OF CARBORNE RADIOMETRIC SURVEYS IN THE NORTHERN TERRITORY, 1955.

BROCKS CREEK AREA No 3

RADIOMETRIC CONTOURS AND AIRBORNE DATA

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G 271-6

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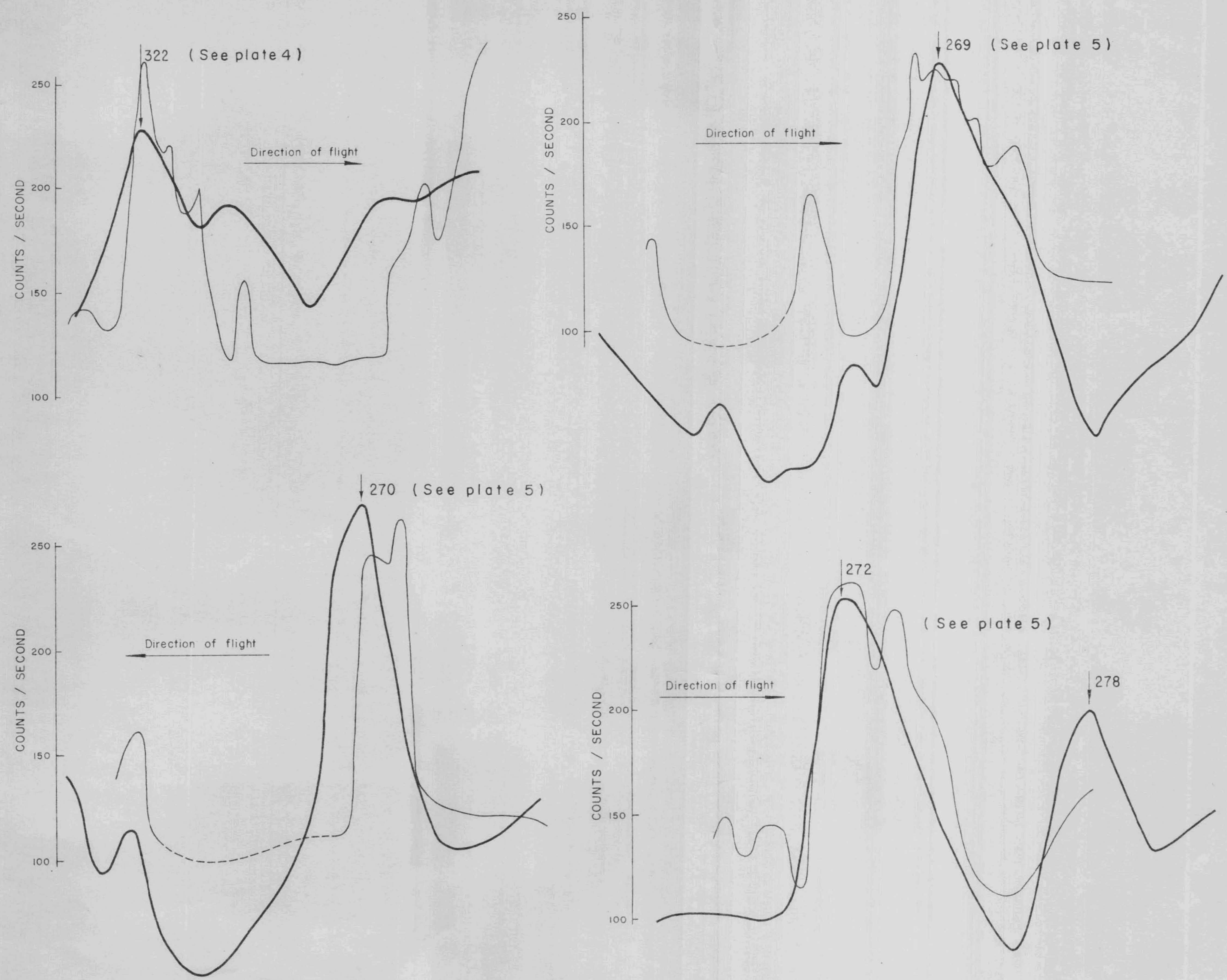

HORIZONTAL SCALE IN MILES

½ 0 ½ 1 1½

VERTICAL SCALE OF AIRBORNE TRACE

≈450 c/m

LEGEND

Carborne Profile

Airborne Trace

SUMMARY OF CARBORNE RADIOMETRIC SURVEYS
IN THE NORTHERN TERRITORY, 1955

COMPARISON BETWEEN AIRBORNE AND CARBORNE PROFILES

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