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BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS

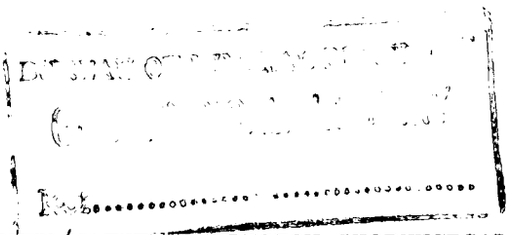
RECORD No. 1963/28

DARWIN/KATHERINE REGION GEOPHYSICAL RECONNAISSANCE SURVEYS, NT 1959

by

J. Daly & W.J. Langron

RECORD No. 1963/28



DARWIN/KATHERINE REGION GEOPHYSICAL RECONNAISSANCE SURVEYS, NT 1959

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J. Daly & W.J. Langron

CONTENTS

ILLUSTRATIONS

SUMMARY

This Record describes the results of some reconnaissance surveys made in the Darwin/Katherine region, NT during the 1959 field season.

At the Rising Tide area, a Turam survey revealed the presence of several good conductors, some of which could be sulphide mineralisation. The results along one traverse were confirmed by the Slingram method. Self-potential results along four traverses were inconclusive. It is recommended that further Turam work be done on this area.

At Mount Ellison, a grid was surveyed but no geophysical survey was done. It is recommended that these traverses be surveyed with the Turam method.

In the immediate vicinity of the Daly River copper mine four traverses were surveyed with the self-potential method. Results were inconclusive. It is recommended that this area be surveyed with the Turam method.

Some regional magnetic traverses were read in the Brocks Creek area and in the vicinity of Brodribb. The results form a basis on which to establish a programme for ground follow-up of aeromagnetic anomalies in the Darwin/Katherine region.

1. INTRODUCTION

The reconnaissance surveys described in the present Record are part of a programme designed by the Bureau of Mineral Resources to test experimentally the application of geophysical methods to certain geological problems. The Bureau's Darwin Uranium Group includes a strong, and reasonably well-equipped, geophysical complement. It is found on occasions that the normal duties in connexion with the search for uranium do not occupy the full time of the geophysical staff, and work such as the present surveys can be undertaken from time to time as opportunity offers.

Darwin is particularly well suited as a base for such an operation, for the following reasons:

(a) as a result of the geological work of the Bureau, the geology on a regional scale is well established,

(b) the area is well mineralised, containing many sulphide deposits of possible economic value. Electrical methods of prospecting, are well suited to detecting deposits of this type,

(c) the area between Darwin and Katherine has been covered almost completely by aeromagnetic surveys; there are strong anomalies whose interpretation raises several interesting problems of possible economic importance.

Based on the results of previous surveys, several problems were selected, which it was considered could be resolved by the use of geophysical methods. This Record describes contributions to the solution of some of these problems, based on field surveys by W.J. Langron, R.J. Goodchild, and L.V. Skattebol during the 1959 field season. The work done was secondary to the requirements of the Bureau's programme in connexion with the search for radioactive minerals. As radioactive investigations made heavy demands on the geophysical staff of the Darwin office during 1959, only short periods could be devoted to general geophysical work. Therefore, the results obtained were preliminary only and are presented for record purposes. However, the bases of the problems attacked, as they are envisaged at present, are discussed in some detail. It is possible that further investigation will lead to changes in detail.

The surveys described refer to the following problems:

(a) the nature and cause of aeromagnetic anomalies in the Darwin/Katherine area,

(b) the search for possible sulphide bodies in the Brocks Creek area,

(c) the search for possible sulphide bodies in the Daly River mining area.

Each of these problems, and the results obtained, will be discussed separately.

2. INVESTIGATION OF AEROMAGNETIC ANOMALIES

General

As mentioned previously, most of the area between Darwin and Katherine has been covered by aeromagnetic survey. Ground surveys have been made over a small area near Rum Jungle, the results of which have been described by Daly (1953; 1957a). Some remarks on the aeromagnetic results in general have been made by Daly (1957b).

The surveys mentioned above have led to the following general conclusions:

(1) rocks of the Brocks Creek Group are generally non-magnetic, except near the Rum Jungle and Brocks Creek Granites,

(2) strong and persistent anomalies exist, disposed in rings around the outcrops of the Rum Jungle and Brocks Creek Granites, with some offshoots,

(3) there are no outcropping rocks that can account for the magnetic anomalies around the Rum Jungle Granite. Around the Brocks Creek Granite, the anomalies agree in position with rocks mapped as amphibolites, but not in every case,

(4) ground work south of the Rum Jungle Granite shows that the shape of the anomalies is not as simple as would appear from the results of airborne surveys. It is possible that information on the structure of the magnetic bodies may be obtained from magnetic surveys, although the position is much more complicated (Daly, Horvath, and Tate, 1962) than was suggested by Daly (1957 a & b),

(5) sulphide mineralisation in each area appears to favor a particular formation of carbonaceous slates, which is closely related to the magnetic bodies. Sullivan and Iten (1952), on the basis of geological mapping in the Brocks Creek area, have remarked on the possible relation of sulphide mineralisation to amphibolite.

It is clear that the magnetic anomalies provide a wide field for study, which is of considerable technical interest and of possible economic importance. The following aspects of the problem are worthy of study:

(a) location of the anomalies on the ground,

(b) investigation of the anomalies to determine whether any evidence of structure is obtainable,

(c) investigation of the magnetic minerals causing the anomalies,

(d) investigation of the connexion between magnetic bodies and sulphide mineralisation.

The results of detailed ground surveys using horizontal and vertical magnetometers bear directly on (a) and (b). The investigation of (c) involves susceptibility and mineragraphic determinations on samples selected on the basis of ground surveys. In the Rum Jungle area, such determinations are restricted to drill cores, as there is no outcrop of the magnetic formation. In the Brocks Creek district there is a considerable amount of amphibolite outcrop; a comprehensive set of samples of both magnetic and non-magnetic amphibolite can be collected. The results of ground surveys also bear indirectly on (d), but the essential information must be obtained from mining exploration or drilling. A large amount of such exploration will be required before any sound conclusions on this aspect are possible.

Work done

The work done consisted of the following four traverses located as shown in Plate 1:

Traverse A in an east-west direction across a sharp aeromagnetic anomaly in the Burnside one-mile map area. Readings of vertical component only were made,

Traverse B, on the Tipperary one-mile map area, extending from the Stuart Highway along the access road to Long airfield. This traverse crossed a wide aeromagnetic anomaly, beginning near the Cosmopolitan Howley mine, and extending south for several miles. Horizontal and vertical magnetic components were measured,

two traverses in the Brodribb area across the large aeromagnetic anomaly that extends in an east-west direction north of the Rum Jungle granite. Horizontal and vertical components were measured.

Traverses were located from aerial photos and the stations were fixed by compass and pacing.

Results

The magnetic results are shown as profiles on Plate 2 (Brocks Creek area) and Plate 3 (Brodribb area). The following conclusions may be drawn:

(a) location. All anomalies were located in positions agreeing with those shown by the aeromagnetic surveys,

(b) shape and aspect of magnetic bodies. The anomaly along Traverse A is due to a narrow body dipping almost vertically, and coming very close to the surface. Basic rocks crop out along the traverse, and it is reasonable to suppose that the anomaly is due to an outcropping dyke.

Traverse B crosses a broad aeromagnetic anomaly which could be due wither to a wide magnetic body close to the surface or to a body at considerable depth. The ground traverse shows clearly that the first explanation is the true one. Some parts of the body causing the anomaly must come close to the surface. Whether the body actually is a single wide one, with local high points, or whether there is a series of discrete narrow bodies such as dykes, could only be resolved by a detailed survey.

The two traverses in the Brodribb area are disturbed by local anomalies due to magnetic material close to the surface, probably associated with laterite. However, the main anomaly on each traverse appears to be due to a single magnetic body. If the body is in the shape of a sphere or a horizontal cylinder, or if it is at a depth that is much greater than its width, the shape of the magnetic profiles will depend only on the depth. If, however, the body is of more complicated shape and at a relatively shallow depth, the shape of the profile will depend also on the dimensions of the body. It is sometimes possible to distinguish between these two situations on the basis of magnetic results, provided the profiles are sufficiently smooth to allow the detecting of minor deviations from theoretical shapes. In the present case, no such distinction may be made because the profiles are much disturbed by effects arising from magnetic material at shallow depth, and very detailed work would be necessary to provide a basis for removing these effects by smoothing.

All that can be said at the present stage is that the main anomaly is due to a body at considerable depth, and that the depth of the body below Traverse 3W is considerably greater than that below Traverse 2W.

3. SULPHIDE BODIES IN THE BROCKS CREEK AREA

General

Until comparatively recent years, the Brocks Creek area has been the main mining centre of the Northern Territory. Its history in this regard was briefly reviewed by Sulluvan and Iten (1952). Ores of gold and base metals have been mined. In general, production has been confined to the oxidised zone.

As in other Australian mining fields, it must be expected that most of the secondary ore of economic value has already been mined. Re-establishment of mining depends on proving adequate reserves of primary ore. Where the primary ore has been examined, it has generally consisted of refractory sulphide ore, so that considerable reserves must be proved to warrant the capital expenditure necessary for treatment plants.

It appears that the prospects of developing such reserves in this area are worthy of investigation, for the following reasons:

(a) geological conditions in the Brocks Creek area are similar to those in the Rum Jungle area as regards rock types and general structure. It is known that large bodies of sulphide are present in the Rum Jungle area,

(b) most of the deposits previously worked in the Brocks Creek area made into primary sulphides which, however, could not be worked economically by the operating companies,

(c) orebodies are generally confined to a particular carbonaceous shale horizon, similar to the host rocks of the Rum Jungle orebodies. Experience suggests that sulphide orebodies in this rock can be readily located by geophysical methods,

(d) the district contains many outcrops of gossan, which may indicate the presence of sulphide mineralisation on a large scale. This point has received particular attention from Sullivan and Iten (1952).

Around the Brocks Creek Granite, geological mapping and aeromagnetic surveys have defined a large area that may be favourable for the presence of sulphide mineralisation, and in which geophysical surveys are warranted. In the first instance, the Rising Tide and Mount Ellison workings were chosen, because previous mining and geochemical testing described by Sullivan and Iten (1952) suggest that, if primary sulphide orebodies exist, they may contain significant copper mineralisation. Owing to lack of time, no work was done at Mount Ellison, and operations were confined to the Rising Tide area.

Description of area and work done

The Rising Tide workings, consisting of the Rising Tide and Hopes shafts, are about one mile north of Brocks Creek siding. So far as is known, there has been no production from these workings.

The geology has been described by Sullivan and Iten (1952) and the geological detail shown on Plate 4 has been based on their map. The main outcrop consists of graphitic slate with a strong gossan. Geochemical testing revealed high copper values in many places, with a concentration of high to very high copper content along the gossan west of a well-marked cross-fault.

Plate 4 shows the geology, results of geochemical testing, and the layout of traverses for the geophysical survey. The geophysical work consisted of:

(a) electromagnetic measurements over the whole layout using the Turam method,

(b) electromagnetic measurements along Traverse 400W using the Slingram method,

(c) self-potential measurements along Traverses 00, 200W, 400W and 500W,

(d) measurements of vertical magnetic intensity along Traverse 00.

As the area covered was small, the time required to lay out a primary loop for the Turam measurements was considered unwarranted. Therefore, the primary cable was laid out along the baseline, and earthed at points about 1000 ft north-east and south-west of the surveyed area. Measurements were made using a coil spacing of 50 ft, and a frequency of 880 c/s.

The Slingram measurements were made using a coil separation of 200 ft and a frequency of 1500 c/s.

Results

The results of the Turam survey are shown as phase and ratio contours on Plate 5. They show a number of strong anomalies which are due to conducting bodies. (It should be noted that, owing to a peculiarity of the instrument used, the sense of the readings is reversed, so that anomalies due to conducting bodies appear as ratio readings less than unity and positive phase readings, instead of ratio readings greater than unity and negative phase readings, as in normal Turam surveys). Plate 6 shows self-potential, magnetic, and Slingram profiles.

The Slingram profile along Traverse 400W shows anomalies corresponding in position to those observed in the Turam profile along the same traverse, indicating that the Slingram method could be used for geophysical reconnaissance in this area. The Turam phase contour plan shows four main anomalies, denoted by Numbers 1, 2, 3, and 4. Anomalies No. 2 and 4 are also well defined by the ratio contours. Anomaly No. 1 corresponds in position with the slate outcrop showing the main geochemical anomaly and Anomaly No. 4 appears to be on the same line. Anomalies No. 2 and 3 are on a parallel line which does not coincide with any outcrop. No well-defined electromagnetic anomalies occur east of the cross-fault, which also limits the geochemical anomaly.

Examination of the results by ratio/phase diagrams (not illustrated in this record) suggests that the bodies causing the anomalies are not as highly conducting as the bodies causing electromagnetic anomalies under similar geological conditions in the Rum Jungle area. However, the significance of this indication is not yet clear, for the following reasons:

(1) the results in the Rum Jungle area have been obtained from surveys using primary field loops, as distinct from the Rising Tide survey, in which grounded cable was used. Therefore, the results of the surveys in the two areas are not strictly comparable,

(2) Smith's percussion drill hole No. 5, the position of which is shown on Plate 4, intersected material carrying up to 15 percent sulphides (mainly pyrite). As this drill hole is in an area remote from anomalies caused by good conductors, it may indicate that the country rock in general contains sufficient sulphide mineralisation to cause it to have an unusually high conductivity. In this case, the conductivity of a zone containing a much higher content of sulphide minerals may not appear relatively very high.

The magnetic profile along Traverse 00 shows only weak anomalies which are due to near-surface magnetic material. The self-potential profiles contain no anomalies sufficiently well-defined to serve as a basis for interpretation.

The following conclusions appear justified at this stage:

(a) the Rising Tide area contains zones of high conductivity, one of which coincides in position with a strong geochemical indication of copper and is bounded by the same geological feature as the geochemical indication is,

(b) geophysical and geochemical indications agree in suggesting that previous workings were not properly placed to test the sulphide mineralisation in a favourable location. The Rising Tide and Hopes shafts are on the wrong side of the cross-fault, and Smith's percussion drill hole No. 5 is too far south.

It is recommended that a Turam survey be made over an area beginning at the cross-fault, and extending south-west for 3000 ft. The primary field should be obtained from a loop, as it will be of theoretical and practical value to have the results on a basis on which they can be compared with the results of similar surveys in the Rum Jungle area. It seems that the geological and geochemical information presented by Sullivan and Iten (1952) is sufficiently favourable to warrant some diamond drilling to test the results of such a survey.

4. SULPHIDE BODIES IN THE DALY RIVER MINING AREA

General

The Daly River mining area, from which copper ore has been mined and in which showings of silver/lead mineralisation occur, lies on the north bank of the Daly River, about 80 miles south of Darwin. The area has been described by Hossfeld (1937; 1938).

Although Hossfeld (1937) has made the only attempt at a detailed evaluation of the deposits, it cannot be regarded as authoritative, owing to the unsatisfactory nature of the information available to him. Geological mapping is difficult owing to scarcity of outcrop. Records of previous mining operations are poor and, as the workings are all inaccessible there is no possibility of checking them. Hossfeld used a nomenclature for formations, and suggested certain correlations that would require further study to reconcile them with later usages. It is considered that the following summary contains all established facts of importance in the present connexion:

(a) the area was the scene of mining operations in the early part of this century. About 6000 tons of ore was produced, containing upwards of 20 percent copper,

(b) the ore occurs in black slate. It is not recorded that they are graphitic,

(c) there is a large outcrop of amphibolites about two miles west of the copper mine area,

(d) all ore mined appears to have been secondary. However, the presence of chalcopyrite on some of the dumps shows that primary ore must have been encountered at some stage of operations. Picked samples of chalcopyrite from the dumps assayed 8 percent copper and upwards,

(e) the Wallaby silver/lead prospect is about 3/4 mile east of the main line of copper workings. No ore has been produced from it. Preliminary investigation and surface sampling suggested that this prospect might be worthy of further investigation (Hossfeld, 1937). However, a small amount of shallow mining development did not support the first favourable impression, and it was concluded that further attention to the prospect could not be recommended (Hossfeld, 1938).

The proposal to test the area by means of a geophysical survey is based on the following considerations:

(1) there is no reason to doubt Hossfeld's conclusion that there is nothing to encourage exploration of the deposits in the secondary zone. The only possibility of re-establishing mining lies in the possible existence of considerable reserves of primary sulphide ore. Apart from the fact that some chalcopyrite is present, previous investigations do not support this possibility, but in view of the incomplete nature of the evidence available, they do not bear strongly against it,

(2) as the ore occurs in black slate, and outcrops of amphibolite occur in the neighbourhood, there is a similarity, at least superficially, between geological conditions here and at Rum Jungle and Brocks Creek. Detailed investigation would be necessary to establish this similarity in detail and it would be premature to conclude that there is an equal probability of the occurrence of extensive sulphide mineralisation in all three areas. However, it seems reasonable to expect that, if large deposits of sulphide minerals exist in the Daly River area, they will be as amenable to detection by geophysical methods as are the sulphide deposits of the Rum Jungle and Brocks Creek areas,

(3) the presence of secondary copper and lead minerals and the high copper assays obtained from the samples of chalcopyrite taken from the dump suggest that indications of large-scale sulphide mineralisation would be well worth testing.

For preliminary investigations, a survey by electromagnetic methods would be desirable, covering the area of the slates as shown by Hossfeld (1937, Plate 1). As the area involved is considerable, a reconnaissance method such as the Slingram should be used initially, followed by a detailed Turam survey in restricted areas if the results warrant it. An aeromagnetic survey of the area could also give information of considerable interest. The aeromagnetic coverage of the Darwin/Katherine area has missed a narrow strip covering the Daly River mining area. Although it is certain that no major magnetic structures are present on a scale comparable with those surrounding the Rum Jungle and Brocks Creek Granites, the presence of outcrops of amphibolite suggests that restricted magnetic anomalies may be present. If such anomalies exist, the fact might have a bearing on the significance of two anomalies appearing near Fog Bay (BMR, 1956). These are well-defined anomalies of restricted extent about 40 miles west of Rum Jungle in an area very difficult of access. If similar anomalies are present near the Daly River area, it would indicate that the area near the Fog Bay anomalies might be favourable for mineralisation, and some testing of the area would be warranted.

Work done and results

Owing to a shortage of time, the work done was confined to four self-potential traverses, the positions of which are shown on Plate 7. Plate 8 shows the results as profiles. The profiles are disturbed, owing to surface effects. The ground was dry and around the electrodes it had to be watered. Under such conditions, it is commonly found that erratic results are obtained. Otherwise, the profiles show no anomalies that could be used as a basis for interpretation.

If well-defined anomalies had been measured, the fact would have had some significance. However, no significance can be attached to the absence of self-potential anomalies, particularly in low-lying swampy country, where groundwater level can be expected to be close to the surface.

5. REFERENCES

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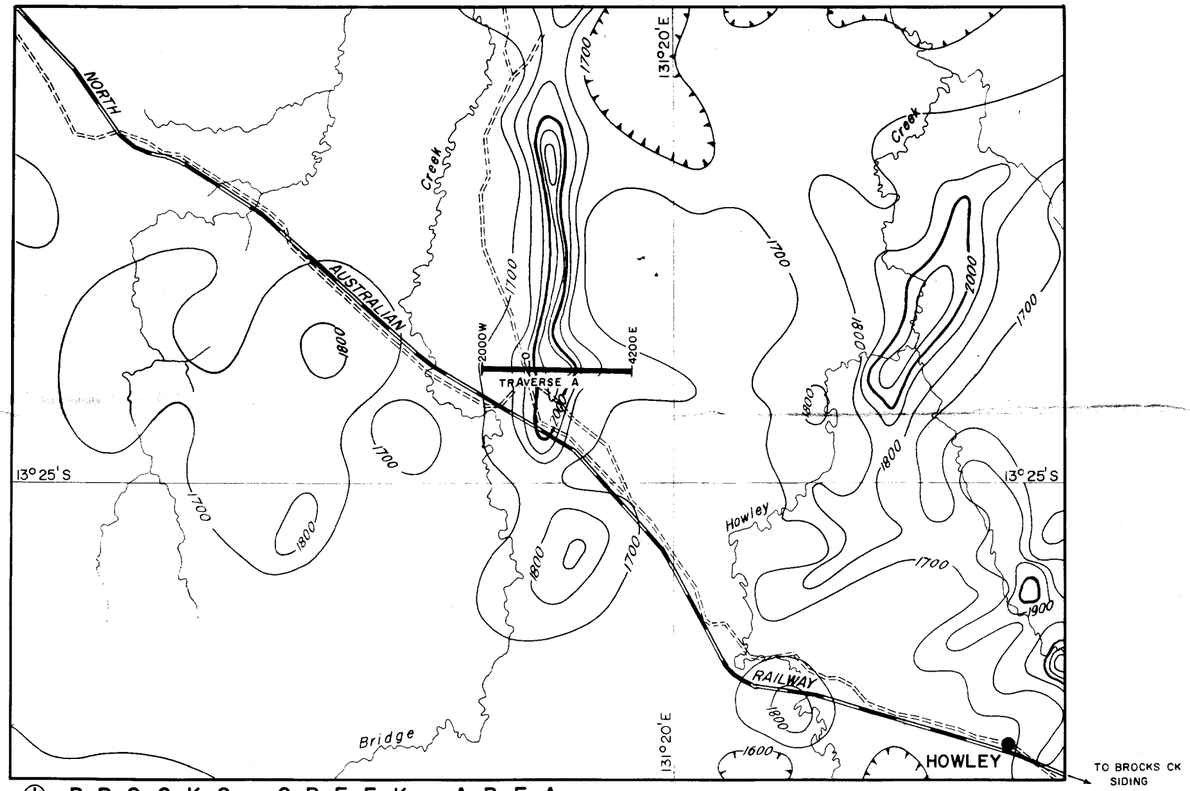
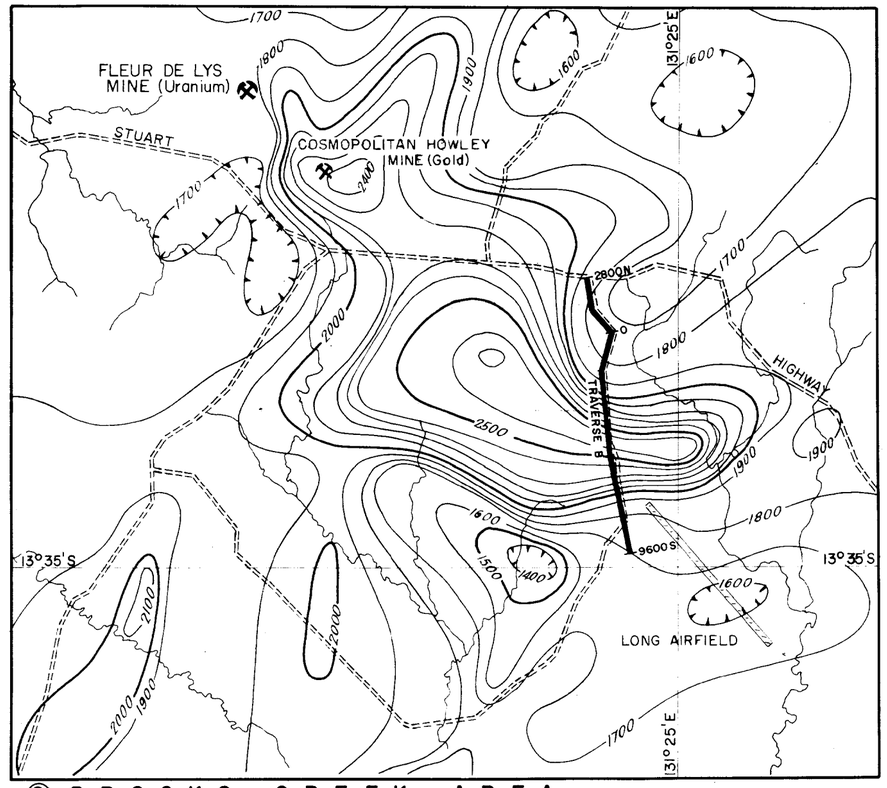


① BROCKS CREEK AREA



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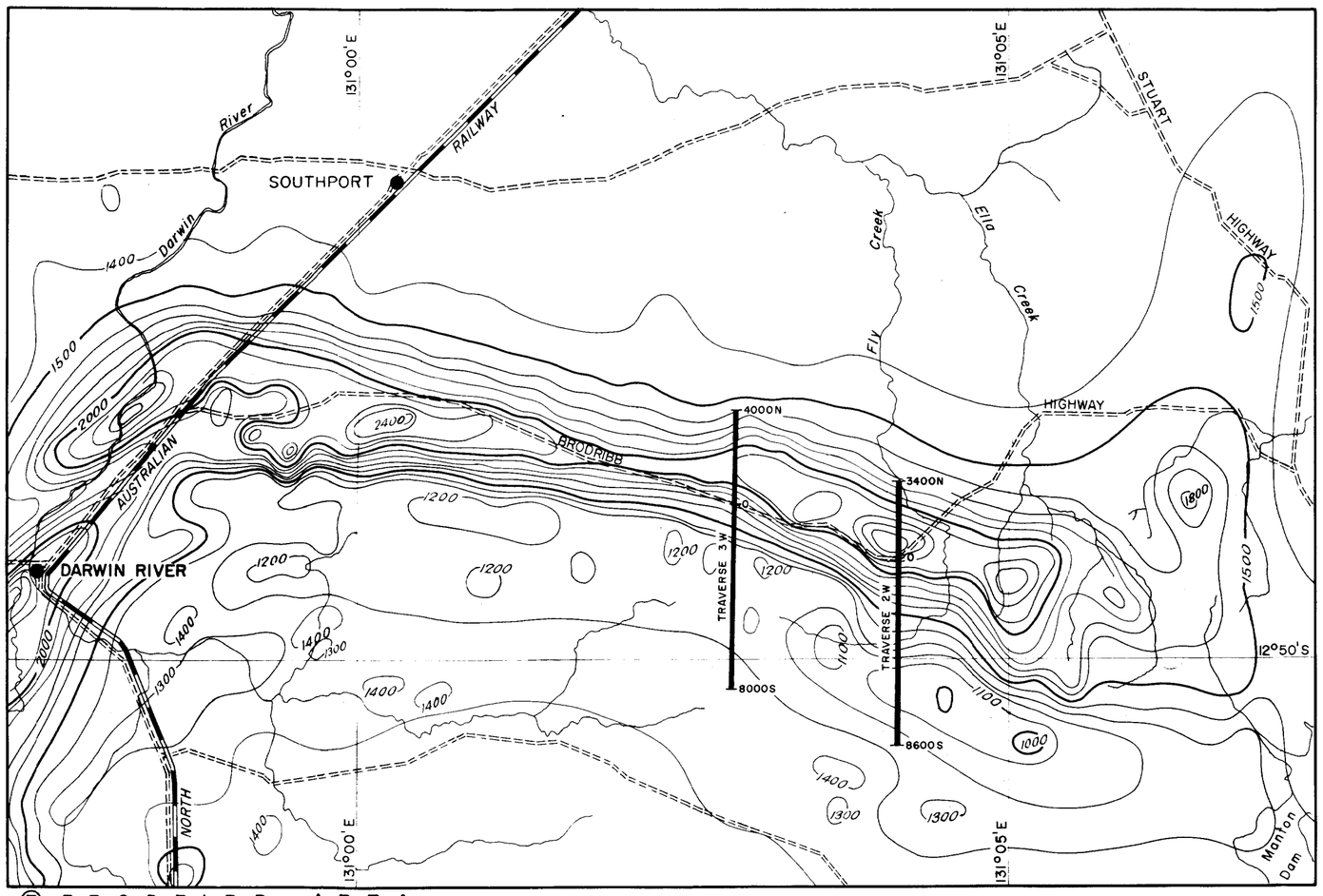
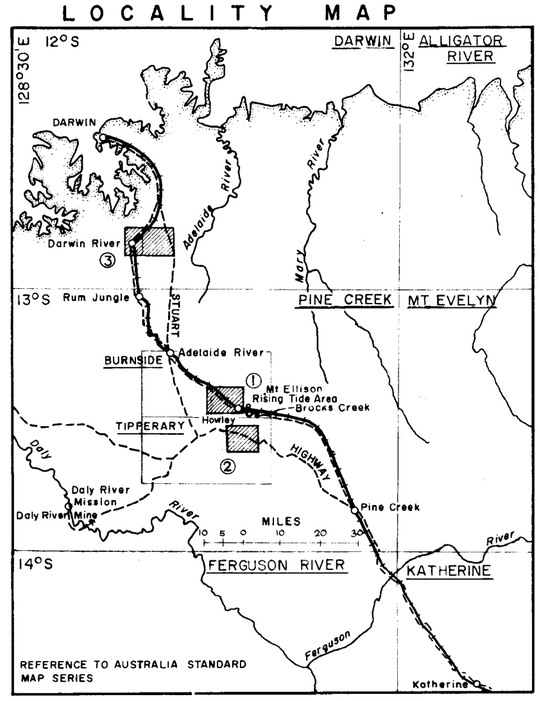


③ BRODRIBB AREA

LOCALITY MAP



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TRAVERSE LAYOUT AND AEROMAGNETIC CONTOURS

MILES
½ 0 1 2 3

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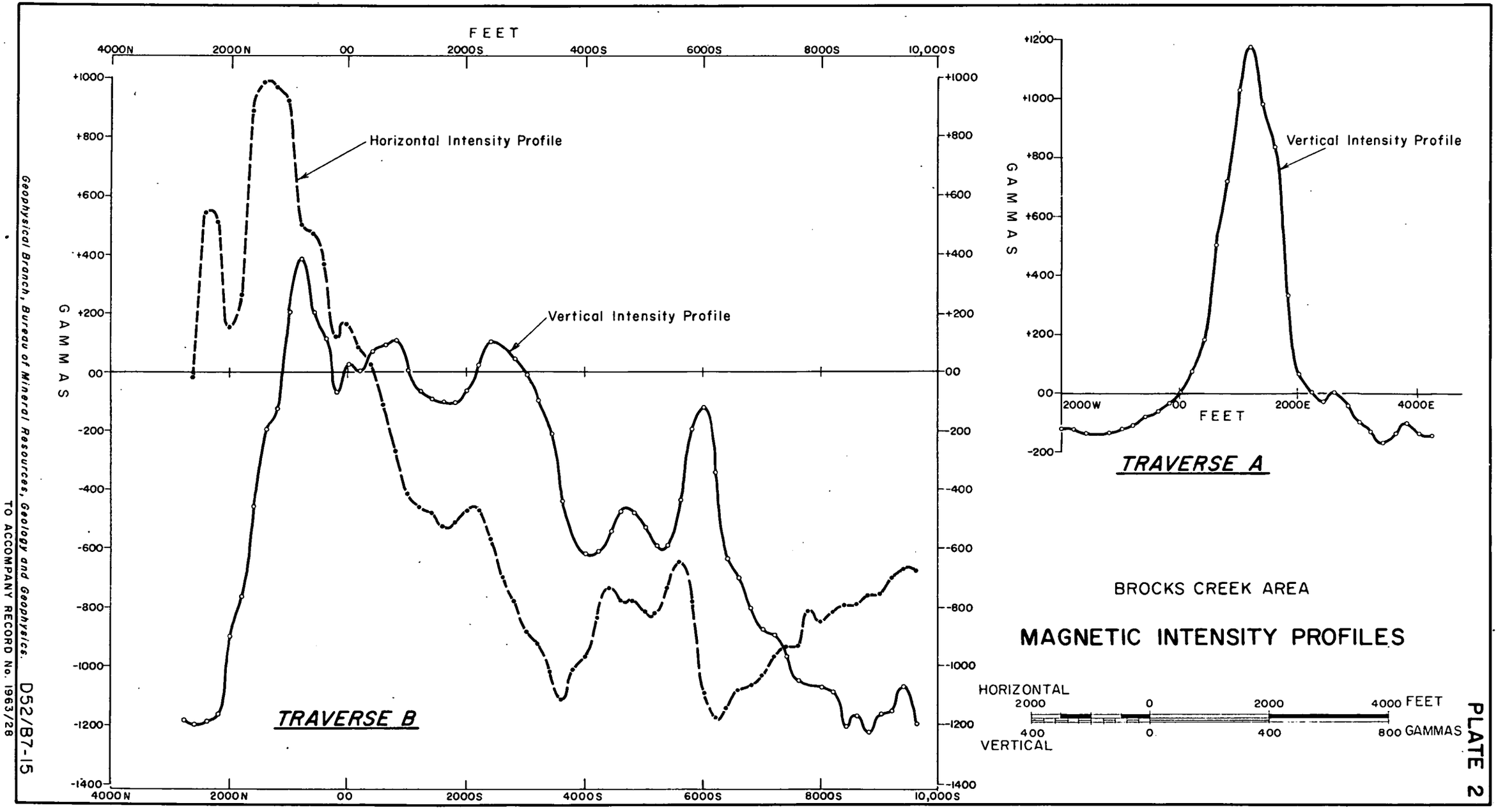

PLATE 2

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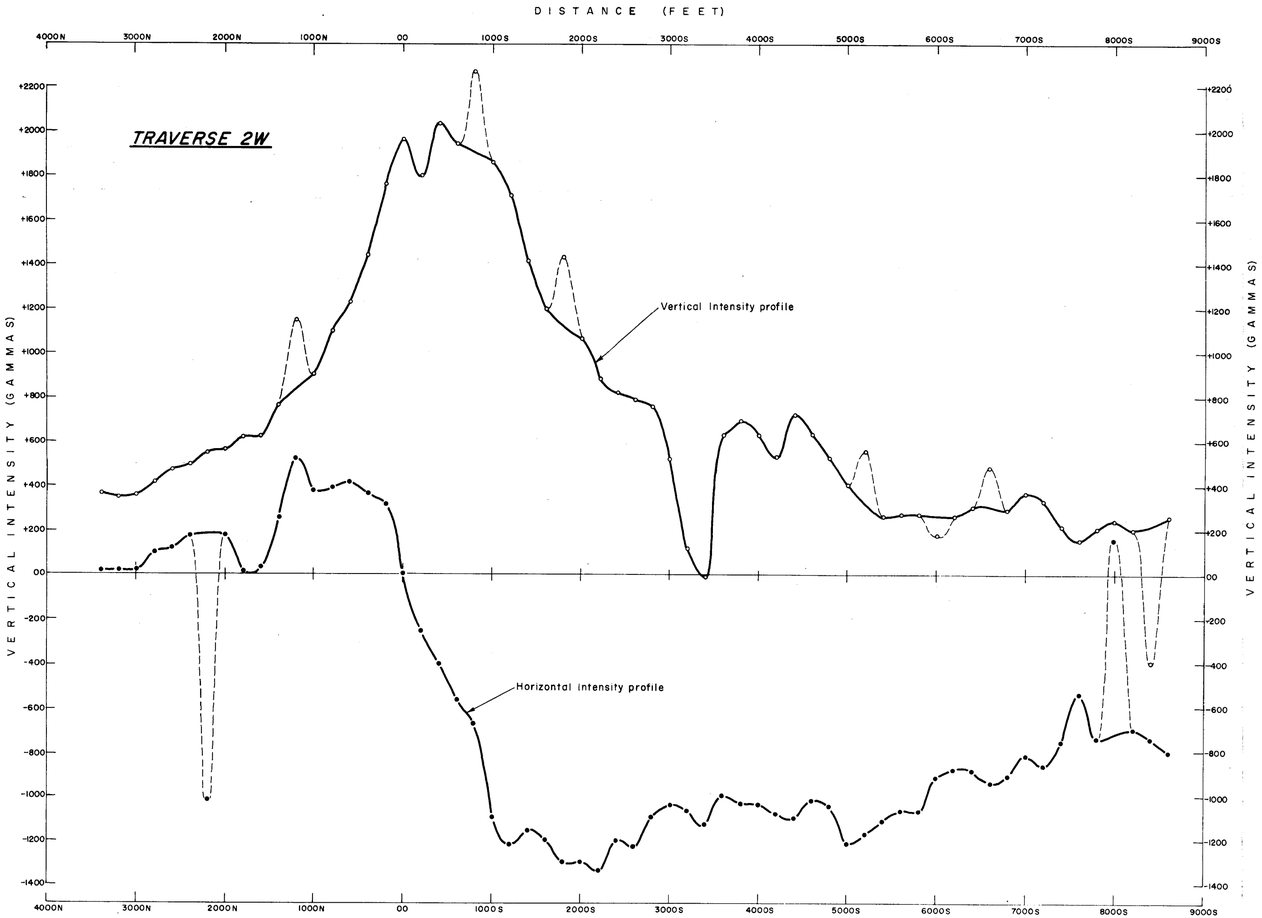
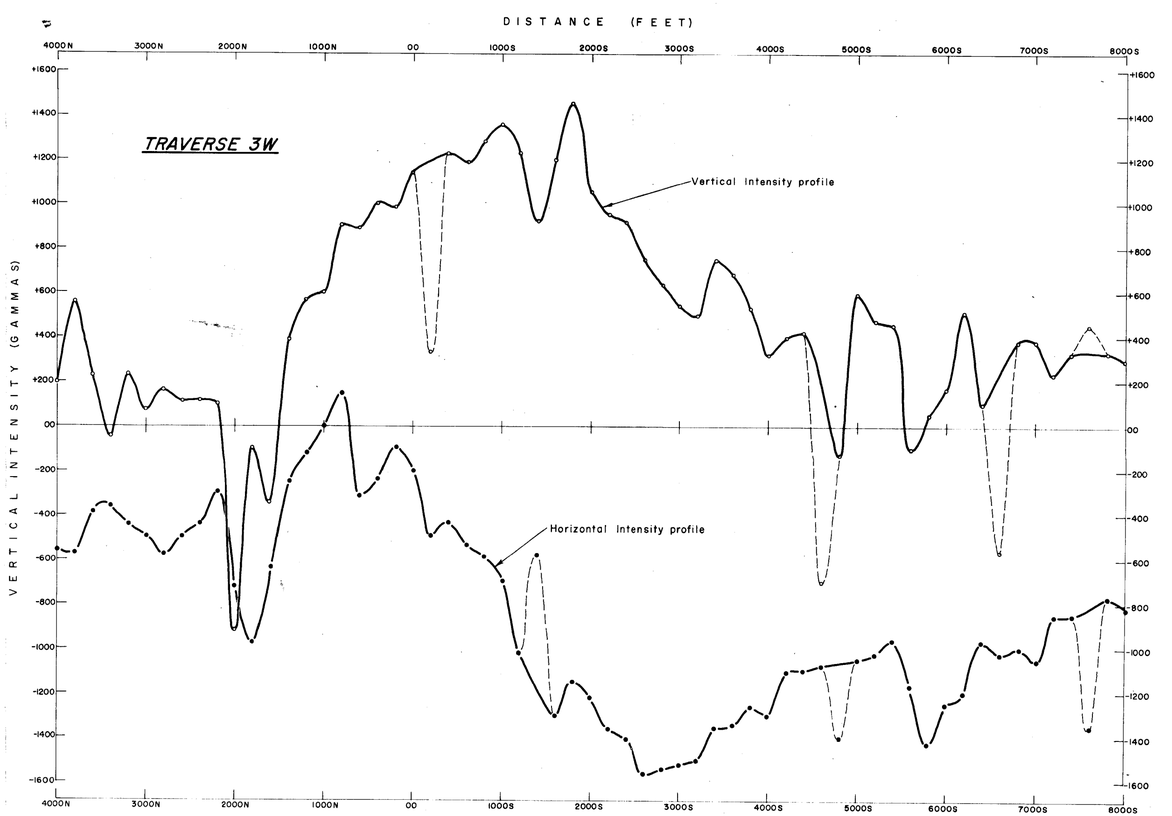
PLATE 3





BRODRIBB AREA

MAGNETIC INTENSITY PROFILES
TRAVERSES 2W AND 3W

HORIZONTAL 1000 — 0 — 1000 — 2000 — 3000 FEET

VERTICAL 400 — 0 — 400 — 800 — 1200 GAMMAS

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PLATE 4

GEOCHEMICAL TESTING

Copper concentrations as shown

- Very high
- High
- Medium
- Low
- Nil
- Boundary of Geochemical anomaly

LEGEND

- Alluvium and soil
- Detritus
- White glassy quartz, lenses of limonite
- Brecciated quartz
- Sugary quartz
- White dense quartz
- Micaceous schist with quartz veins
- Brecciated conglomerate and micaceous schist
- Quartz breccia with limonite in cavities and veins
- Graphitic slate
- Amphibolite
- Geological boundary
- Fault
- 35° Strike and dip of strata
- 80 / 70 Elevation contours in feet
- PDH Percussion drill hole

Old Track

HOPE'S SHAFT

RISING TIDE SHAFT

Smiths No.5 P.D.H.

1200N 1100N 1000N 900N 800N 700N 600N 500N 400N 300N 200N 100N 00

1000W 900W 800W 700W 600W 500W 400W 300W 200W 100W 00 100E 200E 300E 400E 500E 600E

Mag. North 4° True North

RISING TIDE AREA

GEOPHYSICAL GRID, GEOCHEMICAL RESULTS, GEOLOGY AND TOPOGRAPHY

FEET

100 50 0 100 200 300

Geology after Sullivan and Iten(1952). Plan based on BMR drawing NT14-38

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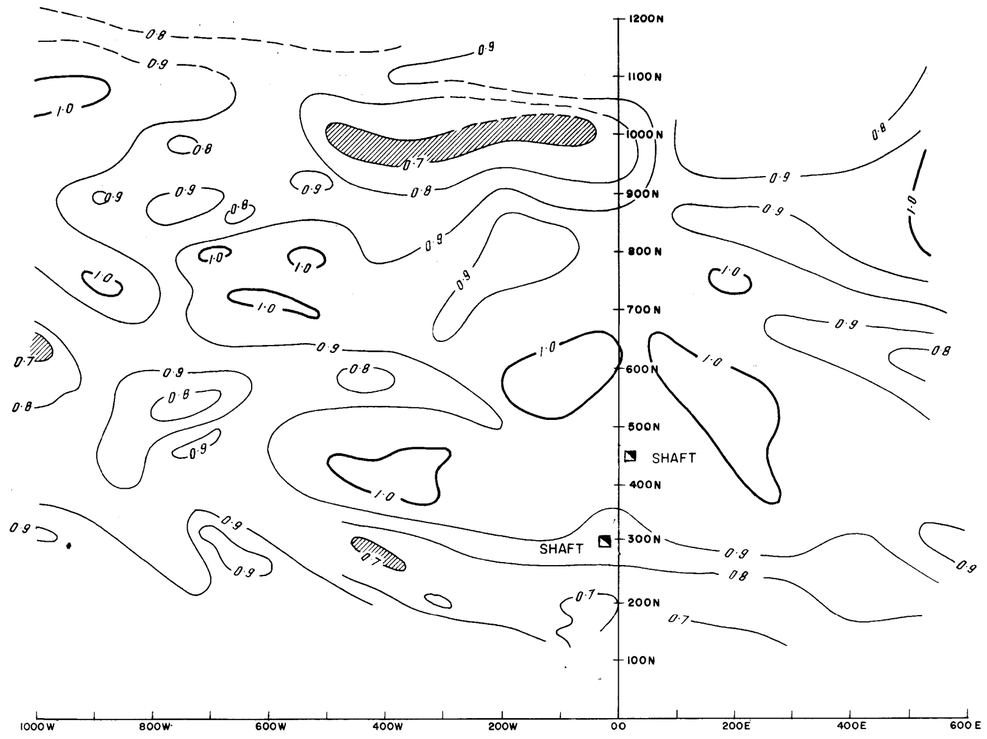
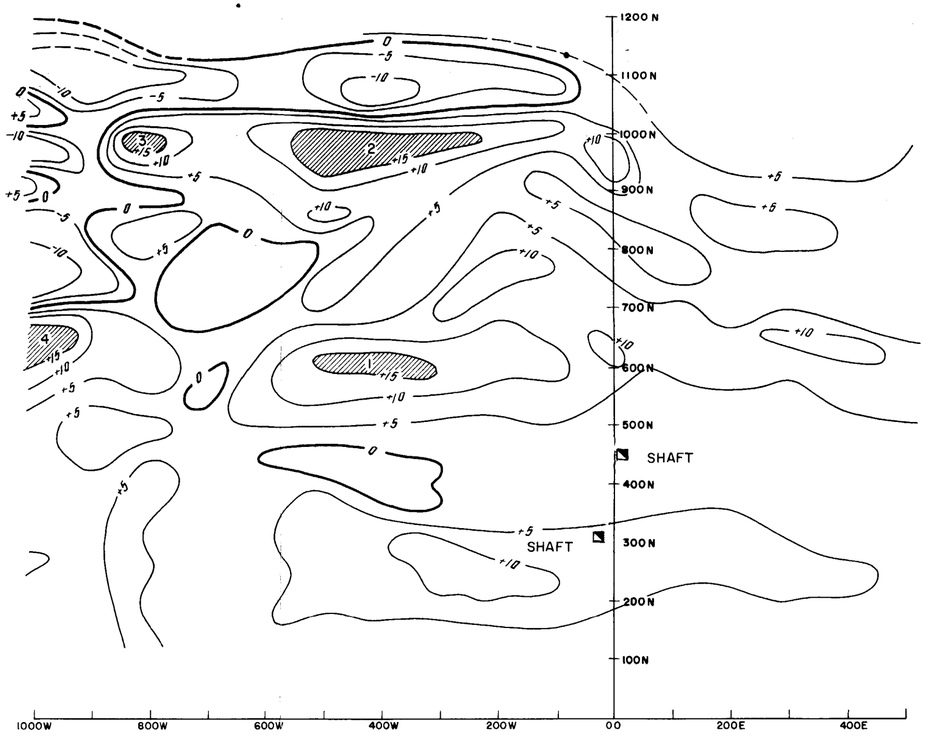
RATIO CONTOURS



PHASE CONTOURS



FEET

200 100 0 200 400 600

Anomalous zones shown thus 2

RISING TIDE AREA

TURAM RATIO AND PHASE CONTOURS

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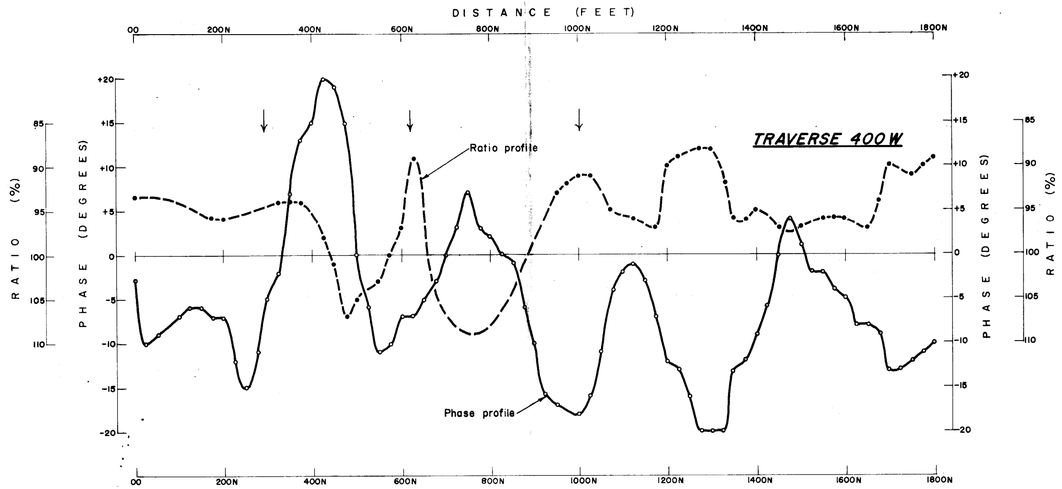
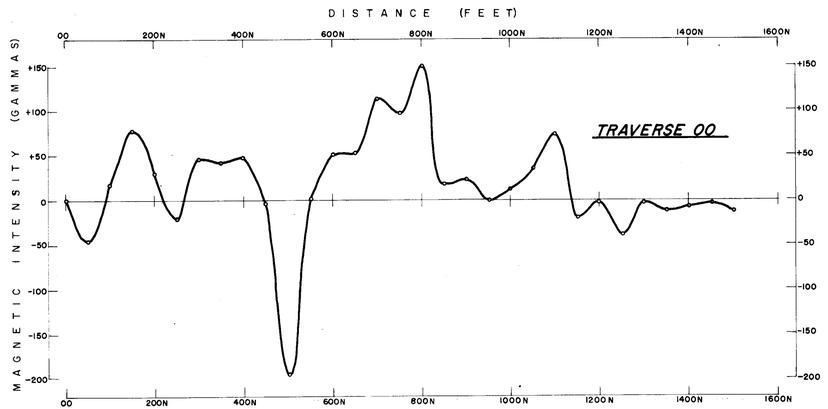


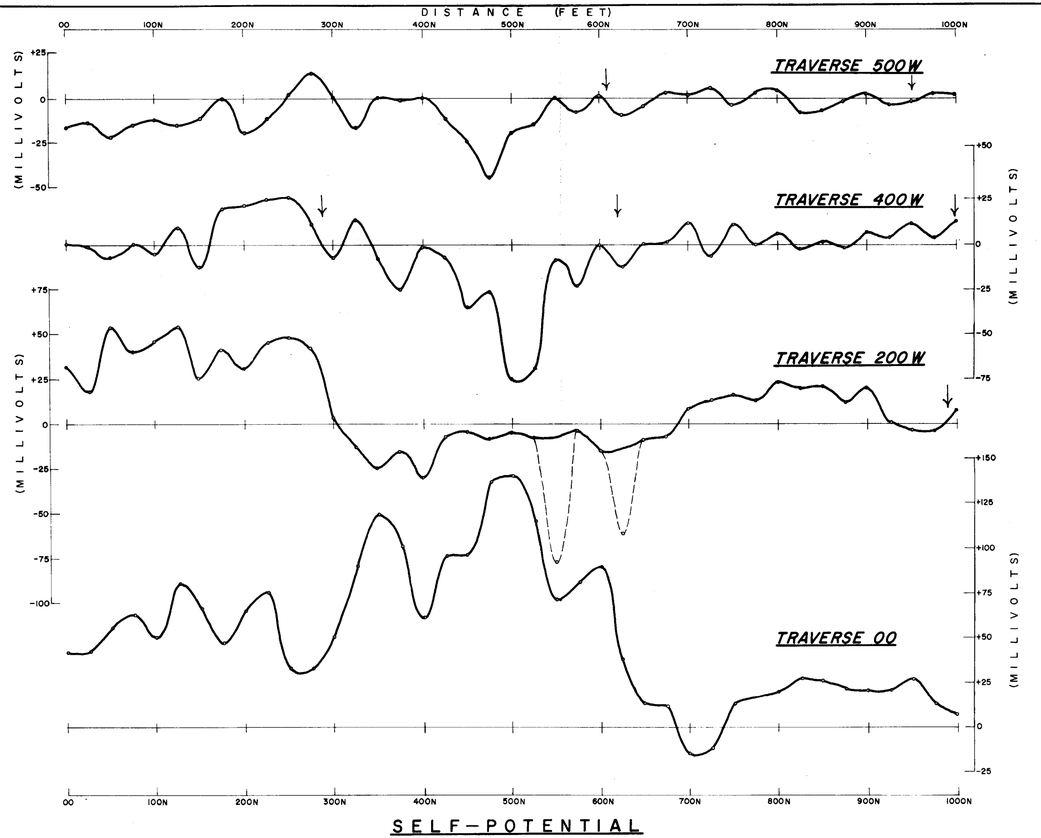
SLINGRAM



MAGNETIC INTENSITY

NOTE: Turam anomaly shown thus ↓

Sense of Turam profiles is reverse of normal – see text



SELF-POTENTIAL

RISING TIDE AREA

SLINGRAM, SELF-POTENTIAL, AND MAGNETIC INTENSITY PROFILES

KATHERINE - DARWIN RECONNAISSANCE SURVEY, N.T. 1959

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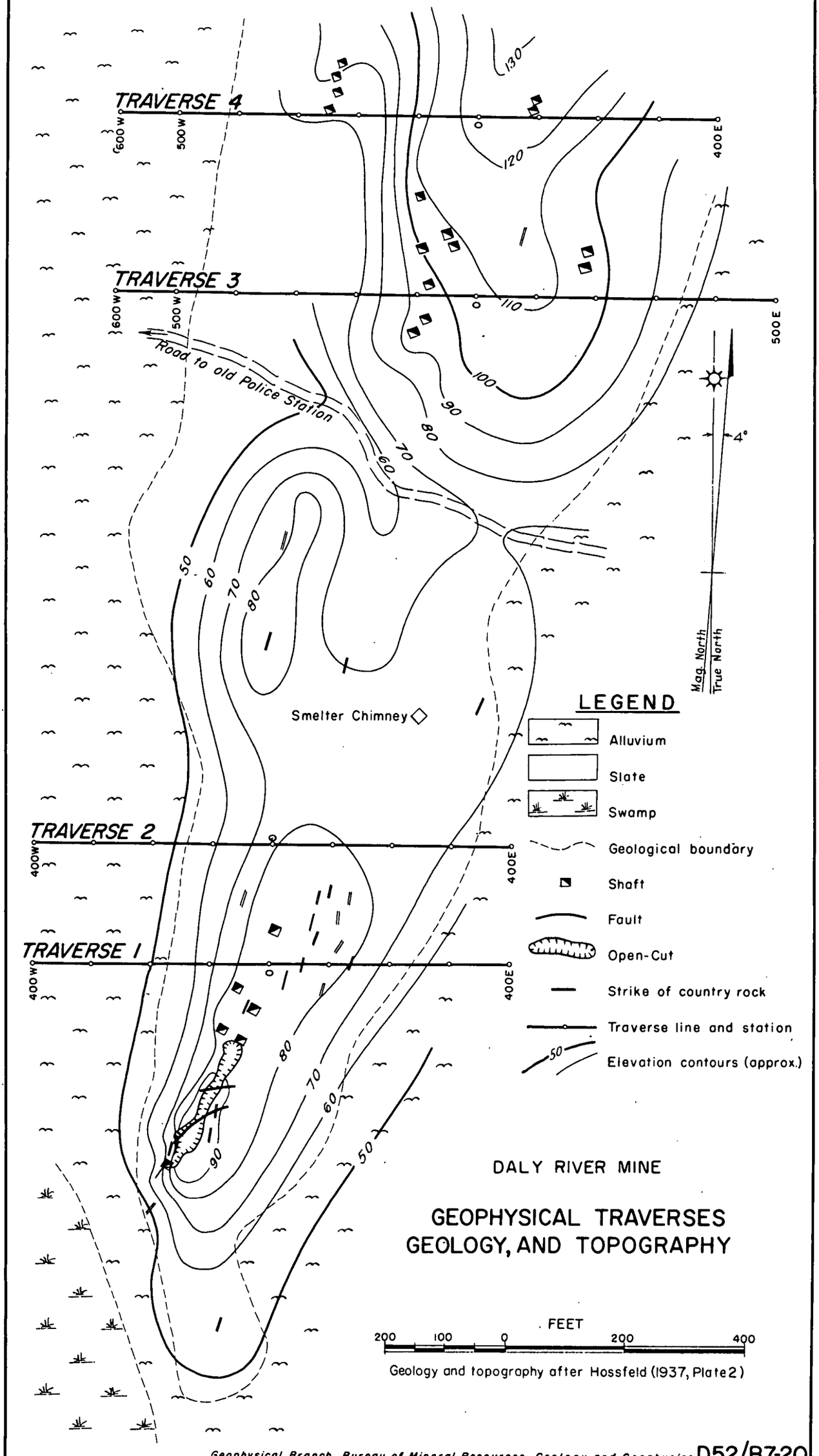
PLATE 7



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KATHERINE - DARWIN REGION GEOPHYSICAL RECON SURVEY, N.T. 1959

PLATE 8

700W 600W 500W 400W 300W 200W 100W 00 100E 200E 300E 400E 500E

TRAVERSE 1

+50 0 -50 MILLIVOLTS

TRAVERSE 2

+50 0 -50 MILLIVOLTS

TRAVERSE 3

+50 0 -50 -100 MILLIVOLTS

+100 +50 0 -50 -100 -150 MILLIVOLTS

TRAVERSE 4

DALY RIVER MINE

SELF-POTENTIAL PROFILES

SCALES

HORIZONTAL 100 50 0 100 200 300 FEET

VERTICAL 50 25 0 50 100 150 MILLIVOLTS

700W 600W 500W 400W 300W 200W 100W 00 100E 200E 300E 400E 500E

KATHERINE - DARWIN RECON SURVEY, N.T. 1959

Geophysical Branch, Bureau of Mineral Resources, Geology and Geophysics. D52/B7-21

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