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COMMONWEALTH OF AUSTRALIA

DEPARTMENT OF NATIONAL DEVELOPMENT

BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS

RECORD No. 1965/50

TENNANT CREEK DETAILED AEROMAGNETIC SURVEY,

NORTHERN TERRITORY 1964

by

J.S. MILSOM and W.A. FINNEY

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ILLUSTRATIONS

SUMMARY

In September 1964, a detailed aeromagnetic survey of three areas in the Tennant Creek mineral field was made by the Bureau of Mineral Resources. The three areas, Aeromagnetic Ridge, North Star, and Gigantic, had been selected by the Geological Branch of the Bureau as being of particular interest. A geochemical party from the Geological Branch was working in parts of the first two areas from May to September 1964.

The detailed aeromagnetic survey delineated several anomalies in the Aeromagnetic Ridge area. Investigations show that only two of them appear to be associated with high copper concentrations and may warrant further investigation; estimates of the depth and type of source rock have been made. Outside the area of the geochemical survey, the interpretation was more difficult, but several other interesting anomalies were noted and a limited interpretation was attempted. The effect on the magnetic contour pattern of the Peko shear was observed.

Large isolated anomalies were found in the North Star and Gigantic areas. The magnetic contour patterns suggest a possible structural similarity between the two areas. Estimates of depths to source rocks were made in each case.

1. INTRODUCTION

A detailed aeromagnetic survey of three areas in the Tennant Creek mineral field was flown by the Bureau of Mineral Resources (BMR) in September 1964. The three areas, Aeromagnetic Ridge, North Star, and Gigantic, were proposed by the Geological Branch of the BMR in collaboration with the Northern Territory Administration (Plate 1).

A considerable amount of ground magnetic surveying had taken place in the Tennant Creek area. Surveys carried out prior to the Second World War by the Aerial, Geological and Geophysical Survey of Northern Australia are described by Daly (1957), and recent surveys by the BMR are described by Daly (1959 a & b), Douglas (1962, 1964a,& 1964b), O'Connor and Daly (1958 & 1962), and O'Connor, Goodchild, and Daly (1959). These, together with various surveys by private companies, have covered many of the most interesting anomalies.

All of the Tennant Creek 1:250,000 map area had already been surveyed by the aeromagnetic method in 1956 and 1960 (BMR, 1958 & Spence, 1962). On the former survey, which covers the areas studied in this report, a D.C.3 aircraft was flown at a nominal height of 500 ft above ground level along Shoran-controlled arcs at intervals of about one-fifth of a mile. In the Peko area the arcs were such that the aircraft was heading roughly north or south. A contour interval of 50 gammas was adoptedto present the magnetic results; the results of part of the area are shown in the locality map (Plate 1).

On the basis of the results of these surveys, together with geological information, a gridded area (Plate 3) on Aeromagnetic Ridge and an area around the North Star mine were selected by the Geological Branch for geochemical surveying from May to September 1964. The geochemical survey covered an area 4000 ft by 30,000 ft in the alluviated flat north of Peko (Plate 3), where the D.C.3 survey of 1956 had shown a broad, east-west elongated magnetic 'high' (aeromagnetic 'ridge'). Samples of weathered rock from below the iron-enriched or silicified upper levels were taken by auger drilling. The depth of the drill holes ranged between 6 ft and 52 ft, but averaged about 22 ft. The holes were sited on roughly north-south lines 400 ft apart, and were spaced along these lines at intervals of 100 or 200 ft. Samples were analysed spectrographically for copper, lead, zinc, nickel, cobalt, and bismuth. In two places where anomalously high copper concentrations were noted, further drilling was carried out,including several holes to a depth of about 100 ft. Results are probably not sufficiently encouraging to warrant further work in the area. Additional drilling and surface geochemical sampling was done in the North Star area, 25 miles north of Tennant Creek. The Mount Woodcock 1:63,360 map area was mapped geologically in conjunction with this programme.

The three areas flown in the detailed aeromagnetic survey described in this Record were selected after consultation with the Geological Branch. First priority was given to the Aeromagnetic Ridge area just north of Peko and second priority to the North Star area. In these areas the survey was aimed at facilitating the interpretation of the geochemical results. It was hoped that the aeromagnetic survey would detect features that may have a bearing on the gold and copper mineralisation. Gold mineralisation at Tennant Creek has been found, with few exceptions, to be associated with ironstone bodies, which are often magnetic. Fewer copper orebodies are known and no satisfactory theory of mineralisation has been developed for them, but it appears that shear zones are a major controlling factor. Consequently an attempt was being made, not only to delineate anomalies more precisely, but also to locate the Peko shear magnetically and in general to obtain more information about the structure of both areas. The third priority area includes the Gigantic mine, where the D.C.3 survey of 1956 detected a localised but intense magnetic anomaly (Plate 1). The mine lies at the north-eastern end of the Peko shear zone and it was hoped that some information about this shear could be obtained.

2. GEOLOGY

The geology of the Tennant Creek mineral field has been described by Ivanac (1954), who includes all the known geology up to 1950, and by Crohn, Ryan, and Oldershaw (1959), Crohn (1963), and Crohn and Oldershaw (1964). Considerable geological work has also been carried out by subsidiaries of Peko-Wallsend Investments Ltd and by Australian Development N.L., but the results are not generally available.

Tennant Creek lies in a geosynclinal fold belt that has been stable since the close of the Lower Proterozoic, apart from limited volcanic activity during the Middle Cambrian. The Warramunga geosyncline developed very early in the Proterozoic about an axis trending north-west and passing to the south of the site of Tennant Creek township; a thick sedimentary sequence was laid down. Orogenic movements succeeded the geosynclinal phase and the Warramunga Group sediments were uplifted, deformed, and intruded by granites. The sediments were probably also affected by orogenic movements associated with the Davenport geosyncline, which later developed to the south. These were the last major tectonic movements in the area and the present land surface results from the dissection of a Tertiary peneplain some 200 ft above the general present-day level.

Stratigraphy

Sedimentary. Archaean rocks do not crop out in the Tennant Creek 1:250,000 map area, but are thought to exist in a magnetically disturbed area (BMR Area No. 3, Plate 1) twenty miles west-south-west of Tennant Creek, where they are overlain by up to 80 ft of unconsolidated grit and sandstone. Diamond-drill cores taken from this area consist of a complex of gneiss and amphibolite, containing magnetite-rich bands associated with granitic and gabbroic intrusions. The observed magnetic anomalies are caused by this magnetite and are not associated with mineralisation.

Most of the rocks cropping out in the Tennant Creek area belong to the Lower Proterozoic Warramunga Group, which contains all the known mineral deposits. The group consists of greywacke, tuffaceous greywacke, siltstone, and shale, with some grit and pebble beds. Classification and subdividion has been hindered by the poorness of outcrop as well as the scarcity of marker beds and the great complexity of structures. Near Mount Cleland a section of about 2500 ft of shale and siltstone, overlain by a rather greater thickness of shale and greywacke, can be traced. A band of hematite shale within the greywacke-shale assemblage has been used as a marker bed and is often associated with ironstone lodes.

Metamorphism of the Warramunga Group is intense only at the margins of the igneous intrusions and in the numerous shear zones, where chlorite, sericite, and talc have been formed. Two distinct classes of shears and faults have been recognised, the more widespread of which is characterised by a main north-westerly trend with associated north-easterly shears, and by quartz infillings, which now give rise to prominent quartz ridges. The largest of these shears extends from Quartz Hill to Rocky Range, dividing the Warramunga Group into two units. To the south and west of the shear, the sediments are sharply folded and dips are generally steep and occasionally vertical, but to the north, folding is less intense and dips rarely exceed 45°. Smaller but more numerous shears post-date the quartz-filled type, differing from them in strike direction and in being infilled with ironstone. These lodes are more fully discussed in the section on mineralisation.

Forty miles north of Tennant Creek, the Warramunga Group is overlain, probably unconformably, by the Ashburton Sandstone. Although rocks of this group crop out strongly just north of the North Star survey area, they are not thought to exist within it.

Upper Proterozoic and Lower Palaeozoic rocks crop out in both the Mount Woodcock and Tennant Creek 1:63,660 map areas, but are not known in any of the parts covered by the detailed aeromagnetic survey. Only one of these younger formations, the Middle Cambrian Helen Springs Volcanics, is likely to be magnetic. In most of the surveyed areas the bedrock is concealed by Recent alluvium and unconsolidated sediments.

Igneous. The Warramunga Group has been intruded by a possibly co-magmatic series of acidic igneous rocks ranging from massive foliated granites and adamellite through quartz feldspar and granite porphyry plugs and dykes to volcanic pipes of welded tuff. The relatively slight contact metamorphism of the sediments and the presence of the tuffs (ignimbrites) are suggestive of a near-surface intrusion. Large granitic complexes crop out a few miles to the north and south of Tennant Creek township, but the porphyries, scattered through the field, and elongated parallel to the west-striking sediments, usually extend over a few square miles only.

Basic igneous rocks occur in a few places and are thought by some of the geologists working in the area to be related to the known mineralisation. However, some at least of the basic rocks post-date mineralisation. Lamprophyre dykes, possibly deriving from a basic stock, crop out in many parts of the area and are seen to intersect both the ironstones and the Upper Proterozoic Rising Sun Conglomerate.

Mineralisation

With the exception of two auriferous quartz veins entirely within porphyry, the known gold mineralisation at Tennant Creek is associated with the ironstone lodes. Below the water table, the lodes are quartz-magnetite bodies, but near the surface the magnetite has been altered to hematite, and any sulphides formerly present have been leached out.

The majority of the economically important ironstones are found close to the hematite shale marker bed. Ironstones may partially replace the shale, but more commonly occur where shear zones intersect it. An important feature is the repetition of ore-shoots, which may occur down-dip or down-pitch from an outcropping quartz hematite lens. Gold is found in the ironstone or in the adjacent brecciated sediments and is invariably more plentiful in the oxidised zone owing to secondary enrichment. It is probable that most of the gold in the sediments came from the ironstones and was transported during erosion. Very few gold deposits have been worked in the primary zone, where the gold is more finely divided and may be associated with sulphides.

Fewer copper deposits are known and the Peko mine is the only considerable producer in the field. The Peko orebody, which has undergone secondary enrichment, resulted from the replacement of the interior of a magnetite pipe by massive sulphides. Structural control appears to have been exercised by two intersecting shear zones, one striking west parallel to the strike of the sediments, and the other striking north-east. The north-east shear (the Peko shear) is a prominent feature on the aerial photographs and can be traced to the south as far as the region of granite outcrop, and to the north at least as far as the Gigantic mine. Other copper deposits also appear to be located at the intersection of major shear zones.

Mineragraphic investigations at Peko have indicated that emplacement of the ironstone was essentially complete before the gold and sulphides were introduced (Edwards, 1955). If the two, or possibly three, phases of mineralisation were distinct, there is no reason to suppose that gold and sulphide deposits are necessarily associated with the ironstones. The observed relations may merely be the result of much of the emplacement being controlled by the same solution channels. The softer shear zones, having eroded more readily than the ironstones, have been less intensively prospected to date.

3. INTERPRETATION

Interpretation of ground magnetic results in the Tennant Creek area has been based on methods described by Daly (1957), using a spherical model of the source. The method used in the present report assumes a source of infinite vertical extent, i.e. a pipe or dyke type of body. Sources are estimated by this method to be rather shallower and further north than they would be if the spherical model were used. Major anomalies detected by airborne methods usually derive from sources of considerable vertical extent and results based on the dyke model have been found to be reasonably satisfactory in other mineral fields.

Aeromagnetic Ridge area

The dominating feature of the aeromagnetic contours to the east of Tennant Creek township is the east-west elongated aeromagnetic 'ridge' (Plates 1 & 3). This 'ridge' is even more pronounced from the detailed survey results (Plate 3) than from the results of the earlier survey in 1956 (Plate 1). It extends from west of the survey boundary near Tennant Creek to an abrupt termination north-east of the Golden Forty anomaly. The western end of the 'ridge' is much less sharply defined, the amplitude falling off westwards from about three miles east of Tennant Creek. From the 1956 survey results, there is a strong north-easterly lineation, the Golden Forty lineation, running close to both the Nobles Nob and Golden Forty mines, the magnetic contour pattern east of the lineation having apparently been shifted south by about one mile. The Peko shear zone (Plates 2 & 3), which is a photo-interpreted feature, runs through the Gigantic and Peko mines parallel to the Golden Forty lineation and, as may be seen from the detailed aeromagnetic contours, disturbs the 'ridge' anomaly. However, the only suggestions of lateral movement along this shear zone are in the magnetic pattern over the granite to the south (Plate 1). There is little or no evidence of lateral movement in the Warramunga Group sediments along the Golden Forty lineation, but there is a definite quartz-filled zone. This suggests that the movement is mainly a basement feature, but that there was some activity in the zone after deposition of the Warramunga Group sediments.

Three main types of magnetic source rock are known in the Tennant Creek mineral field. These are ironstone, basic igneous rock, and pre-Warramunga schist and gneiss. Small magnetic anomalies may also derive from porphyries.

The ironstone (quartz-hematite-magnetite) bodies, which are associated with most of the known economic mineralisation, have been intensively prospected by the magnetic method. Although lodes of this type may be the source of some of the smaller anomalies along the 'ridge', it seems unlikely that they alone could produce such an extensive and continuous feature. In the north-west part of the Aeromagnetic Ridge area, a line of magnetic anomalies striking approximately west-north-west from the 'ridge' is attributed to ironstones, as are a few other anomalies that will be noted later. However, most of the magnetic 'highs' occurring along the 'ridge' are more likely to be due to segregations of magnetic material within igneous or metamorphic rocks at depth.

Basic igneous rocks are possible magnetic sources in the Tennant Creek mineral field. Very few are known at present, but there are some grounds for supposing that they are more widespread than appears from surface mapping. Some theories of the mineralisation postulate basic sources for the mineralising solutions. Lamprophyre dykes are also present in various parts of the field, including at least one in the area of the geochemical grid, and these might derive from a more basic stock at depth. In this connection it is worth noting the close proximity of the 'ridge' to many of the known ironstones and to the very large magnetic anomalies at the Peko and Golden Forty mines.

As noted earlier, a diamond-drill hole put down in the BMR Area No. 3 intersected magnetite-rich schists, gneisses, and gabbro. These rocks could not be correlated with any part of the almost unmetamorphosed Warramunga Group sequence and are tentatively considered to be Archaean. It is possible that the aeromagnetic 'ridge' is caused by a block of similar material faulted into the sediments of the Warramunga Group. The magnetic contour pattern on the 'ridge' in the vicinity of the Peko shear is considerably more complex than at other points, which would seem to indicate that at least some of the shearing movement took place after the faulting in, or intrusion, of the magnetic rocks.

There are considerable obstacles to treating the 'ridge' magnetic field analytically. Basically the 'ridge' is an elongated magnetic 'high' on which a number of roughly circular minor anomalies are superimposed. The isolation of the magnetic effects due to any single source requires a number of simplifying assumptions to be made, very few of which can be justified rigorously. Profiles used for interpretation were obtained either from the flight lines or from special lines flown along tracks selected after contouring was completed, or they were constructed from the contour map. The latter method can be considered satisfactory only where the anomaly amplitude is very much larger than the contour interval.

The anomaly most suitable for full analysis occurs about a third of a mile north of the Susan mine. The three interpretation techniques developed by Moo (in preparation) were each applied to this body and yielded depths to within 5% of each other, of approximately 700 ft below ground level. The Peters factor of 1.3 (Peters, 1949), obtained using Moo's methods, suggests that the source is of very limited extent and consequently is more likely to be an ironstone body than a part of the source of the 'ridge'. The geological map shows ironstone outcropping near the centre of the anomaly. However, there are two reasons for thinking that the source of this anomaly is in fact part of the source of the 'ridge': firstly, a north-south profile across the 'ridge' near this smaller anomaly yielded a similar depth when analysed by the simple method of Peters and secondly, other ironstones in the area, at the Susan and Pinnacles mines, do not affect the aeromagnetic contours. Elsewhere on the 'ridge', source depths appear to range from 1300 ft to as little as 700 ft below the surface. These fluctuations may be due more to the inaccuracy of the assumptions than to real fluctuations in the depth of the source rocks.

North-east of the Peko mine, both within and close to the shear zone, there are a number of small circular magnetic anomalies on the 'ridge'. Near these anomalies, high copper concentrations were detected by the goechemical survey and further investigations may be justified. The northernmost and largest of the magnetic anomalies is centred approximately at geochemical grid coordinates 20,000E/2000N (Plate 3), and is due to a source at a depth of about 500 ft below surface. The anomaly immediately south of it is due to a rather deeper source. Only the most general calculations, liable to large errors, could be made in such a complex area.

South of the eastern end of the 'ridge', lie the Golden Forty, Great Eastern, and Golden Kangaroo mines and prospects. The associated magnetic anomalies have already been delineated on the ground and the results obtained for the Golden Forty and Great Eastern areas have been published (Daly, 1957). Part of the work in the Golden Kangaroo area, by Australian Development N.L., has been described by Douglas (1962). Because of the thorough ground coverage, no attempt was made to 'fill-in' across the peaks of the anomalies, where the flight lines are rather widely spaced; as a result, some of the finer details of the anomalies, which would normally be shown by a detailed aeromagnetic survey, have been missed.

As already noted, the 'ridge' is abruptly terminated at the Golden Forty lineation, which passes through the region between the Golden Forty and Golden Kangaroo mines. The east-west elongated 'high' to the east is possibly caused by a south-faulted extension of the 'ridge' source material, but two anomalies to the west of this 'high' may indicate economically important ironstones. The first, centred about half a mile north-east of the Golden Kangaroo mine, is caused by a body coming to within 800 ft of the surface, whereas the second source, a little less than a mile farther north, is possibly 100-200 ft shallower. The magnetic contour pattern associated with this latter body merges into the aeromagnetic 'ridge', but the source rock is more likely to be an ironstone than an extension of the 'ridge' source material. Both these postulated ironstones are close to the Golden Forty lineation and may therefore justify further investigation, possibly by geochemical methods.

In the south-east of the area, the broad anomaly east of the Joker mine, already detected in ground surveys (Daly, 1957), has been delineated. No explanation of this anomaly has yet been advanced, but the nearby porphyry rocks are a possible source.

In the south-west of the area the dominant magnetic feature is a broad complex anomaly with an amplitude of roughly 150 gammas. The anomaly consists of two major magnetic peaks and is to the east of the ironstones that occur between the Southern Star and Pup mines, and also east of the porphyry outcrop that is just east of the Pup mine. There is no outcrop in the anomalous region. The upper surface of the main source, which is probably pipelike rather than lenticular, is less than 400 ft below ground level. The source of the western peak is possibly slightly nearer the surface.

The source, or sources, of these anomalies must occupy an area similar in size to that occupied by the Peko or Golden Forty lodes. However, the magnetite content must be very much smaller. This would be the case with a number of comparatively small ironstone bodies, but the simple shape of the anomaly suggests a more homogeneous source carrying disseminated magnetite. Porphyry rocks near Tennant Creek usually contain magnetite, some contain amounts that would seem large enough to cause aeromagnetic anomalies (Crohn & Oldershaw, 1964). Such rocks are the most likely source of the anomalies east of the Pup mine.

North Star area

In this area, there is a surprisingly large discrepancy between the detailed aeromagnetic results (Plate 4) and the results of the 1956 survey (Plate 1). Not only is there no indication of the complexity of the anomaly on the contours of the 1956 results, which is to be expected in view of the wider line spacing and the greater survey height, but the magnetic contour pattern in the eastern part is quite different. The low-intensity feature indicated on the detailed map in the south-east corner of the survey area does not extend north along the Stuart Highway, as the earlier contours would suggest. Profiles obtained from the detailed survey show that the North Star/Northern Star anomaly is positioned on a gentle magnetic slope, rising to the west, and not in a trough as shown by the 1956 survey results. No explanation of the discrepancy is apparent at the moment.

The detailed aeromagnetic contours were also compared with the ground magnetic contours obtained by the Aerial, Geological and Geophysical Survey of Northern Australia (Daly, 1957). The ground survey covered the eastern end of the main anomaly and the minor anomaly to the north-east, but profiles near the peak of the aeromagnetic anomaly were too disturbed to allow contouring. As might be expected, the pronounced eastern 'tail' of the main anomaly was resolved into a definite second peak by the ground work.

The position and extent of the main 'low' associated with the 'high' suggest a body dipping fairly steeply to the north. The dip angle cannot be reliably estimated but is probably about 60°. The main source is between 300 and 500 ft below the surface and the source of the smaller anomaly to the north-east is about 350 ft below the surface.

The anomalies are located on the steepest part of a magnetic slope that strikes north-east, which possibly indicates a fault contact in the sediments of the Warramunga Group or in the underlying basement rocks. Such a fault zone could have controlled mineralisation. The dominant geological trend in the North Star area is also north-easterly (D. Dunnet, pers. comm.). No magnetic anomalies are associated with the quartz-hematite bodies cropping out at the southern border of the survey area, due south of the North Star and Northern Star leases.

The geochemical sampling programme at North Star involved the hammer-drilling of forty-four holes, totalling 3000 ft, as well as stream and outcrop sampling. Copper concentrations in drill samples were generally high, up to 10,000 p.p.m. Unfortunately the drilling programme stopped south and east of the peak of the main aeromagnetic anomaly, which is near the Northern Star open cut. The highest copper concentrations were obtained in holes drilled in the ironstone outcrop south-east of the open cut. The orebody mined at Northern Star is faulted out at about 250 ft below surface by an apparently horizontal movement. The ironstone crops out south and east of the open cut and is thought to dip northwards.

The eastern end of the main aeromagnetic anomaly, which is a distinct ground anomaly, has been tested by a number of diamond-drill holes. Good gold ore has been intersected at about 900 ft in one of these holes, and copper ore in another at a similar depth. In view of the previous results in the area, further work on the main aeromagnetic anomaly would seem to be justified.

The north-eastern anomaly has also been investigated, but no significant results are reported.

Gigantic area

The Gigantic anomaly delineated by the 1956 survey results (Plate 1) is resolved by the more detailed survey into two major anomalies (Plate 5). There is general agreement between the results of the two surveys. Such differences as appear are merely evidence of the better resolution obtained by the more detailed survey.

The contour maps for the North Star and Gigantic areas show a remarkable similarity. In both areas the main anomaly is positioned on a gentle magnetic slope, in the case of the Gigantic area, however, the slope is to the north-west. The position and extent of the main 'low' associated with the 'high' suggest, as in the North Star area, a body dipping steeply to the north. Calculation of the dip angle is not considered reliable but it is estimated to be about 60°. Depth estimates on the main 'high' suggest the source is somewhere between 100-150 ft below ground level, and the source of the other major anomaly to the south-east is estimated at about 100 ft below ground level. These are unusually shallow depths for magnetic sources in the Tennant Creek mineral field. The sources may be lenticular rather than dykelike, in which case they would be at greater depths.

The area is shown on the geological map to include outcropping quartz-hematite-magnetite and this is probably the source of the anomaly. No geochemical drilling was carried out in the Gigantic area by the BMR geologists.

The contour map also shows some minor anomalies to the north-east and south-east of the major anomalies and there is, in general, a slight disturbance of the contour pattern around and to the north-east of the major anomalies. This might be due to the Peko shear, which extends as far as the Gigantic mine, but the effect on the contours is by no means as obvious as in the Aeromagnetic Ridge area.

4. CONCLUSIONS

The survey showed that the detailed aeromagnetic method is applicable to the Tennant Creek mineral field and that 'major-type anomalies' (Daly, 1957) are detected and are defined quite closely. A small amount of ground follow-up work, would be necessary in most cases prior to the selection of sites for drill holes.

One of the aims of the detailed survey was to find out to what extent geological structure could be determined from the magnetic results. In general, the Tennant Creek area appears to be too complex for much correlation to be apparent between magnetic contours and the observed geology. Such correlations are possible in the cases of the Peko shear, the Golden Forty lineation, and the magnetic contours that strike north-east in the North Star area. However, although the effects of known shear zones may be noted, it seems unlikely that many new shears will be identified from the magnetic data.

Diamond drilling of anomalies within the aeromagnetic 'ridge' may be justified on academic grounds, but it is unlikely to reveal economic mineralisation. The anomaly at 20,000E/2000N (geochemical grid coordinates) is recommended, if drilling is to be done, as the source is close to the Peko shear and to small geochemical anomalies, and is nearer the surface than most of the other 'ridge' source material. Before drilling, a limited amount of ground magnetic work could be carried out to locate the peak. It is suggested that the drill hole be vertical and situated about 200 ft south of the position of the ground-located magnetic peak to permit intersection of the source, in case it proves to be lenticular rather than prismatic.

Minor anomalies north of the Golden Kangaroo mine might be related to economic mineral deposits. This possibility could be tested firstly by geochemical surveys.

The main aeromagnetic anomaly in the North Star area has not, as far as is known, been tested at depth. Extension of the geochemical survey into this area would be necessary before selecting targets for deep drilling.

No recommendations can be made for the Gigantic area, as it is not known to what extent this prospect has been tested by private companies, but geochemical surveying would seem to be an obvious first step.

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APPENDIX

Operational details

Survey specifications

Height: Nominally 280 ft above ground level for the aircraft and 250 ft above ground level for the detector (in towed-bird assembly).

Line spacing: Nominally 1/10 mile.

Flight direction: East or west. As most flights took place in the early morning, the majority of lines were flown west, away from the sun.

Sensitivity (magnetometer): 100 gammas full scale deflection and 10,000 gammas full scale deflection on separate recorders.

Equipment

Aircraft: Cessna 180.

Magnetometer: MNS1 nuclear precession magnetometer, reading total absolute field at half-second intervals, fiducial pulses occurring at four-second intervals.

Recorders (magnetometer): Two Moseley recorders. Charts, six-inch rectilinear; chart speeds, four inches per minute.

Radio altimeter: AN/APN-1 with outputs to cockpit dial and limit light system, and to recorder.

Recorder (radio altimeter): TIC Chart, six-inch curvilinear.

Camera: Modified Vinten with wide-angle (186°) lens. One exposure on 35-mm film every four seconds.

Personnel

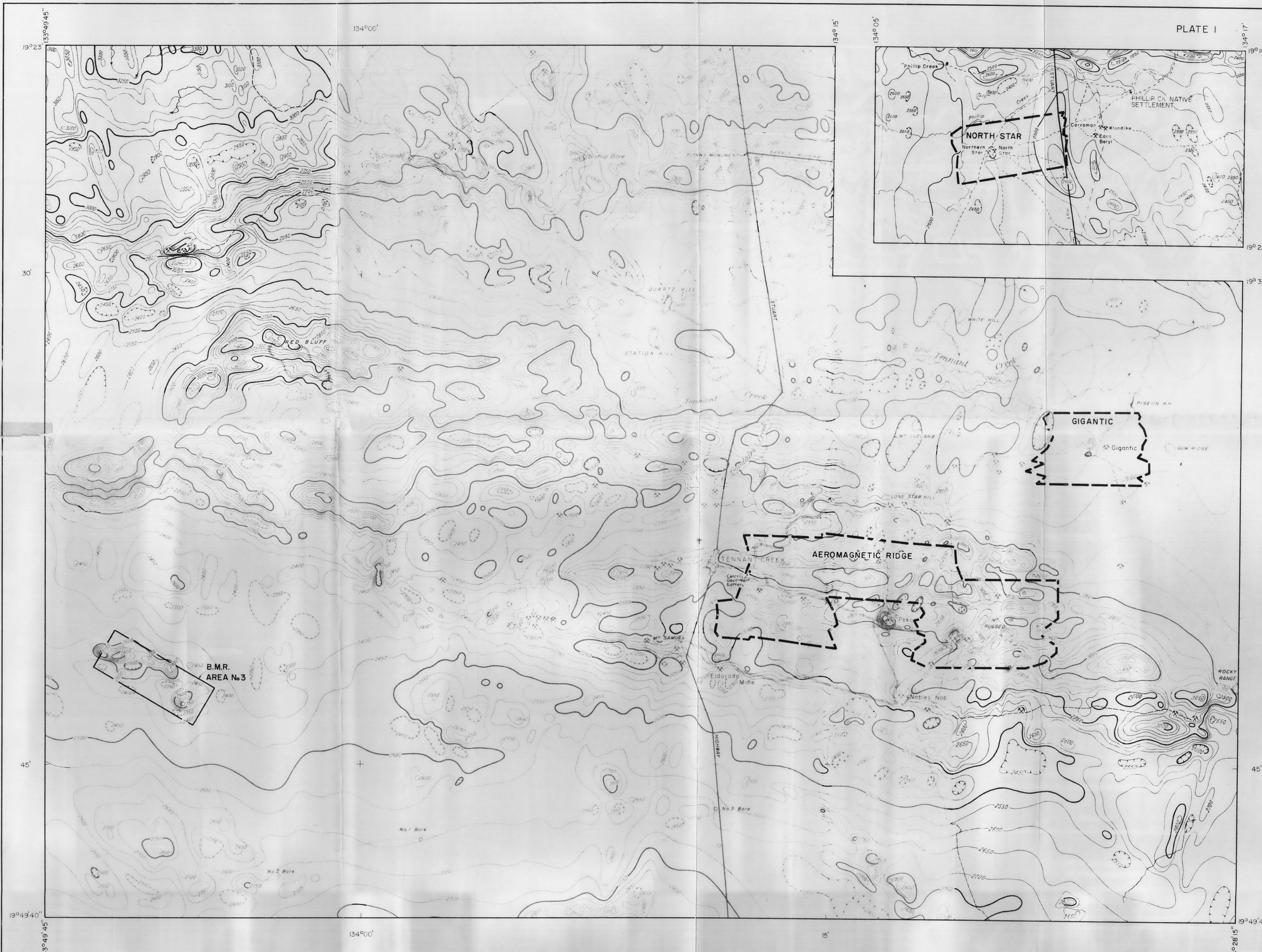
BMR: C. Braybrook, R. Buckley, W. Finney, J. Milsom, S. Scherl, B. Tregellas.

T.A.A.: First Officer G. Litchfield.

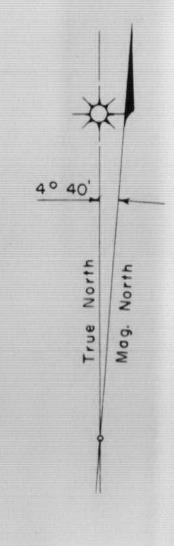
Operations

The road party arrived in Tennant Creek on the 31st August and departed for Batchelor on the 30th September. The aircraft arrived in Tennant Creek on the 1st September and left for a service in Alice Springs on the 28th September.

PLATE I



LOCATION DIAGRAM



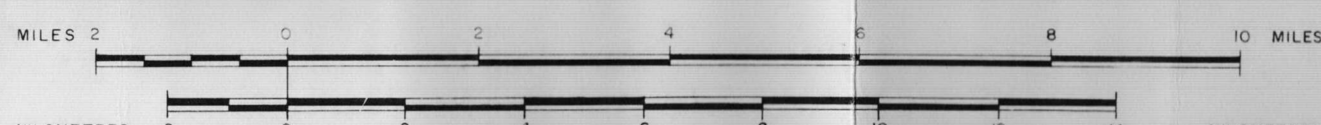
INDEX TO ADJOINING SHEETS

	HAYWARD CREEK	BRUNCHILLY CREEK SOUTH
MARION ROSS	MT WOODCOCK	WARRAMUNGA
RED BLUFF	TENNANT CREEK	GOSSE RIVER
	BOONS	GOSSE RIVER SOUTH

DETAILED AEROMAGNETIC SURVEY, TENNANT CREEK, NT 1964

LOCALITY MAP

TOTAL MAGNETIC INTENSITY CONTOURS. RESULTS OF B.M.R. AEROMAGNETIC SURVEY 1956



(CONTOUR INTERVAL 50 GAMMAS)

LEGEND

TOPOGRAPHICAL DATA

River or creek
Highway or main road
Secondary road
Road or track
Telegraph line
Bore
Mine
Aerodrome or landing ground
Hill feature

MAGNETIC DATA

2000 1900 Magnetic contours
Magnetic "Low"
Detailed Aeromagnetic Survey Boundary

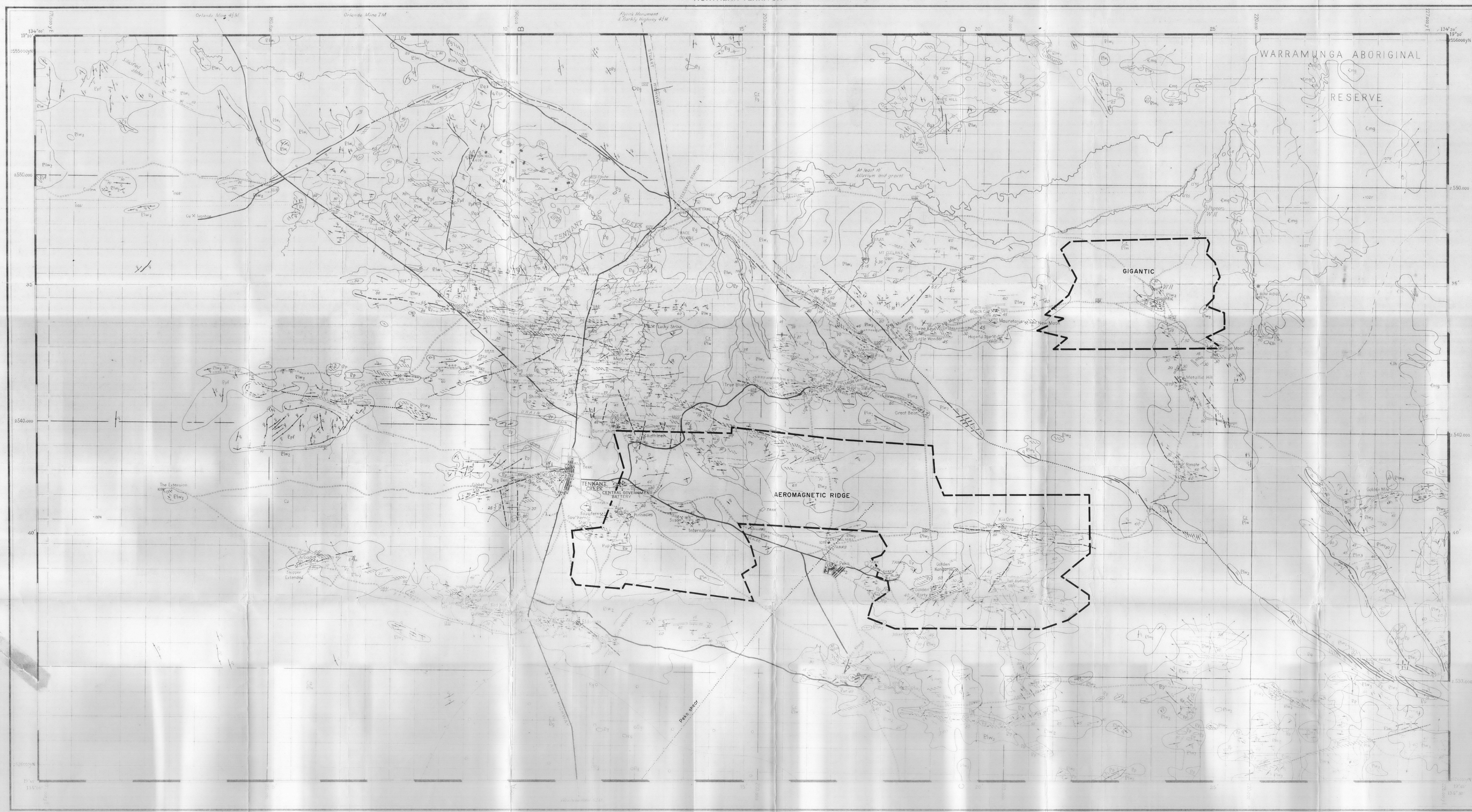
Geophysical Branch, Bureau of Mineral Resources, Geology and Geophysics.
To Accompany Record No 1965/50
E53/B1-15
AFTER MAP G110-30

AUSTRALIA 1:63,360

TENNANT CREEK

NORTHERN TERRITORY

PLATE 2



Reference

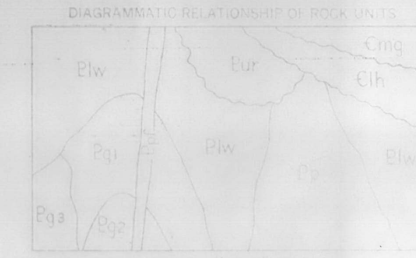
CAINOZOIC				Cz	Alluvium, gravel sand, silt, clay (bulldust)
PALAEOZOIC	CAMBRIAN	MIDDLE	Gum Ridge Formation	€mg	Calcareous sandstone, shale, chert
		LOWER	Helen Springs Volcanics	€lh	Lavas, pyroclasts
PRECAMBRIAN	PROTEROZOIC	UPPER	Rising Sun Conglomerate	Pur	Conglomerate, quartzite, sandstone, shale
		UPPER & LOWER		q	Quartz
				l	Lamprophyre
		LOWER		h	Quartz-hematite-magnetite
				j	Hematite jasper
				p	Porphyry
				fp	Quartz-baveno-porphyry
				d	Dolerite
				di	Diorite
				s	Serpentine
				Pp	Quartz-feldspar-porphyry
				Ppf	Quartz-baveno feldspar-porphyry
				Pg3	Fine-grained granite
				Pg2	Foliated coarse-grained porphyritic granite
				Pg1	Coarse-grained granite
				Pg	Porphyritic granite (foliated in places)
			Warramunga Group	Plw2	Greywacke, shale; Hematite shale
				Plw3	Sandstone, shale, siltstone; Pebble beds
				Plw1	Pebble beds; Shale, some greywacke

- Geological boundary
- Anticline, showing plunge
- Syncline
- Fault

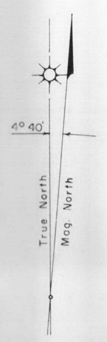
Where location of boundaries, faults and folds is approximate, line is broken; where inferred, queried; where concealed, boundaries and folds are dotted, faults are shown by short dashes

- Strike and dip of strata
- Vertical strata
- Horizontal strata
- Overturned strata
- Trend of bedding, showing direction of dip
- General strike and dip of undulating strata
- Platy flow, vertical
- Platy flow, inclined
- Strike and dip of foliation
- Plunge of dragfold
- Plunge of minor anticline
- Shear zone
- Vertical joint
- Major gold mine
- Gold mine
- Bi Bismuth
- Cu Copper
- Battery
- Bore
- Macrofossil locality
- HIGHWAY Highway
- Road
- Vehicle track
- Telegraph line
- Windpump
- Tank
- Yd Yard
- Building
- Radio mast
- Dam
- WH Waterhole
- •1247 Height in feet, instrument levelled } Datum: mean sea level
- •1097 Height in feet, barometric
- Detailed Aeromagnetic Survey Boundary

DIAGRAMMATIC RELATIONSHIP OF ROCK UNITS



GEOLOGICAL AND PLANIMETRIC MAPPING AFTER 1 MILE GEOLOGICAL SERIES SHEET 238 ZONE 5, BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS.
TRANSVERSE MERCATOR PROJECTION.



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DETAILED AEROMAGNETIC SURVEY, TENNANT CREEK, NT 1964

GEOLOGY

MILES 1 0 1 2 3 4 5 MILES

KILOMETRES 1 0 1 2 3 4 5 6 7 KILOMETRES

Sections

LOCATION DIAGRAM

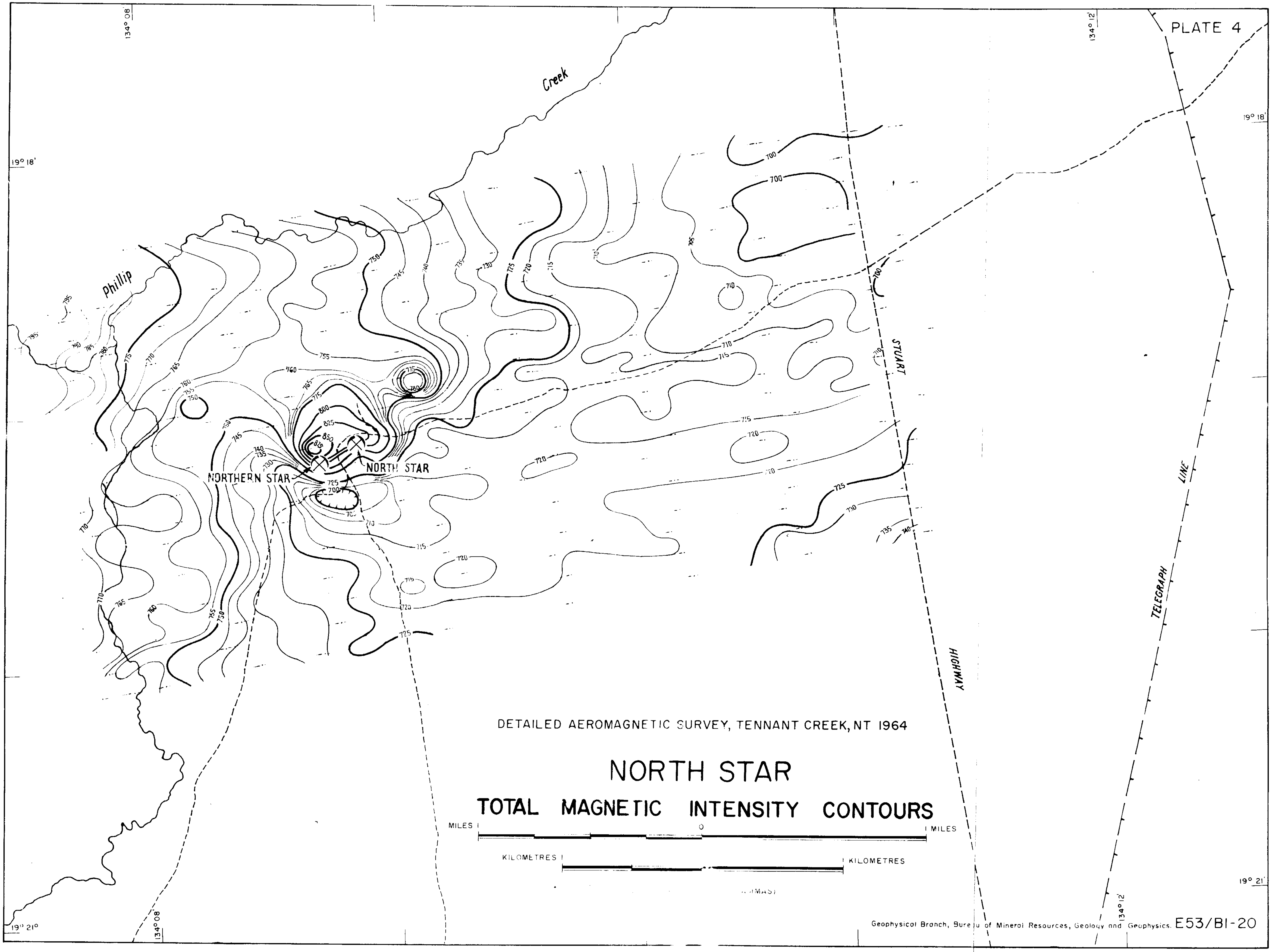
Darwin

GEOLOGICAL RELIABILITY DIAGRAM

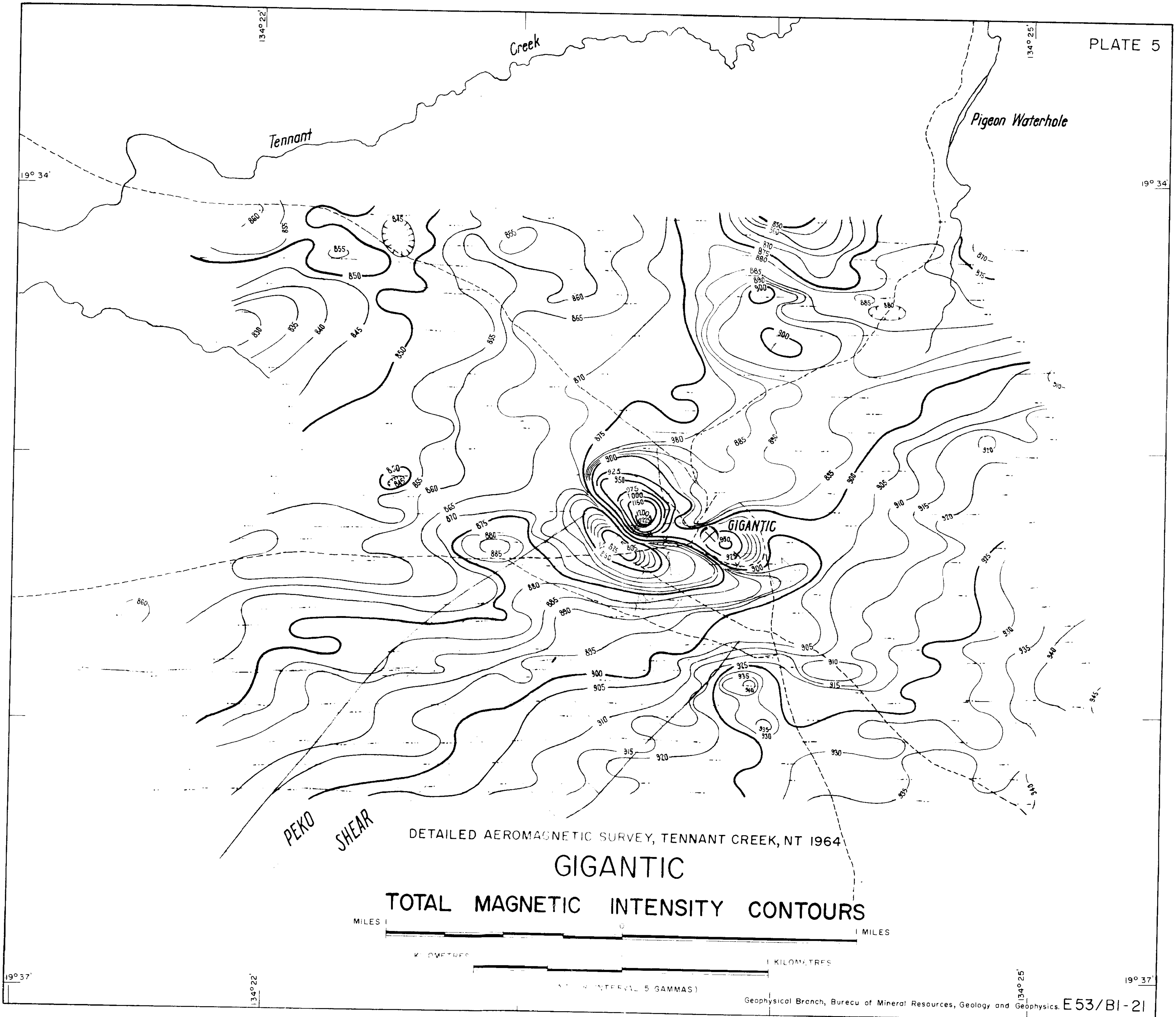
Geophysical Branch, Bureau of Mineral Resources, Geology and Geophysics. E53/B1-23

To Accompany Record No 1965/50

To Accompany Record No 1965/60



To Accompany Record No 1965/50



To Accompany Record No 1965/50