COMMONWEALTH OF AUSTRALIA

DEPARTMENT OF NATIONAL DEVELOPMENT

BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS

REPORT No. 136

Strangways Range detailed aeromagnetic survey Northern Territory, 1965

BY

D. B. TIPPER

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Bureau of Mineral Resources, Geology and Geophysics, Canberra
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DEPARTMENT OF NATIONAL DEVELOPMENT

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ILLUSTRATIONS

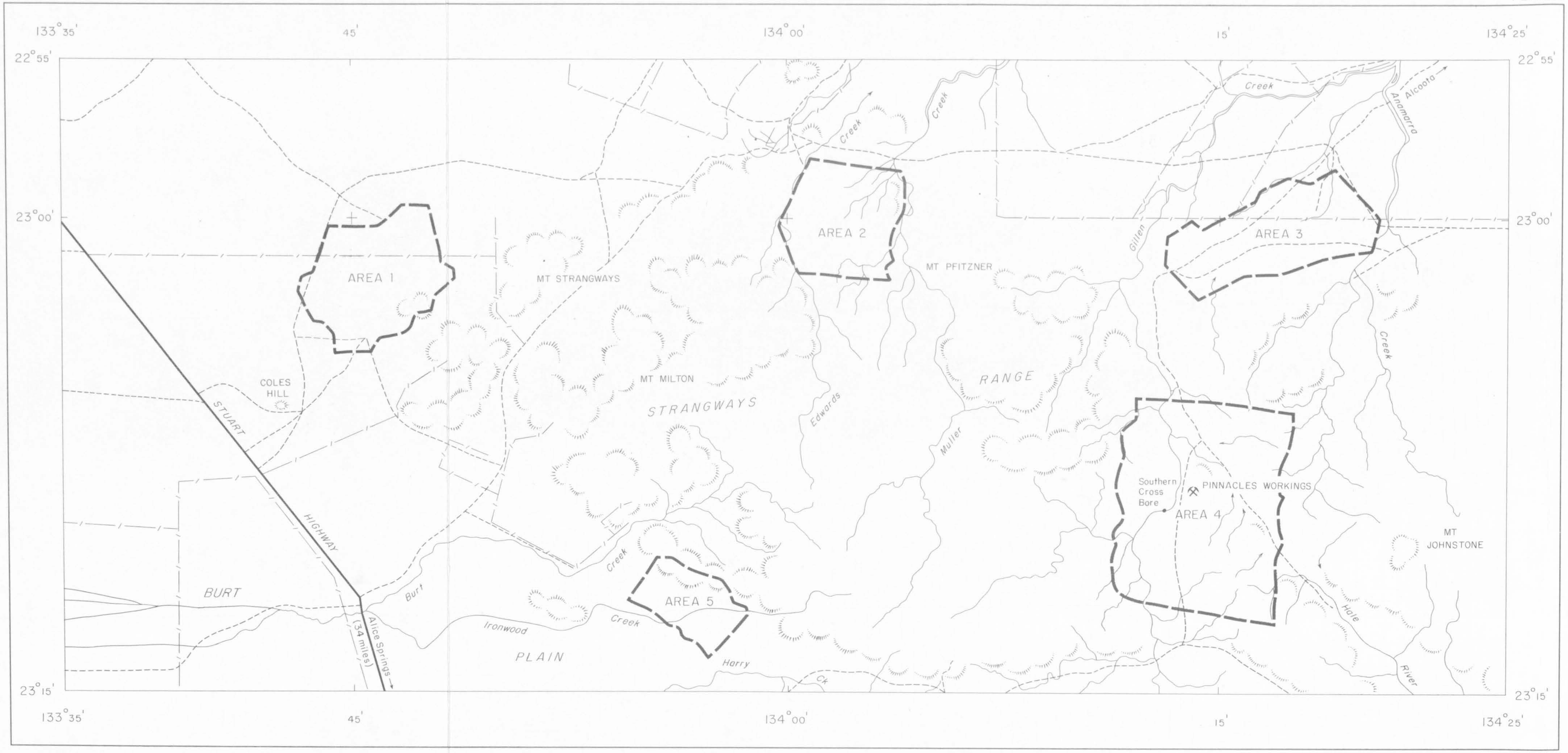
SUMMARY

Between mid-September and mid-November 1965, the Bureau of Mineral Resources flew a detailed aeromagnetic survey over five areas in the Strangways Range, to the north and north-north-east of Alice Springs. A total of 115 square miles was surveyed with the primary purpose of outlining possible extensions to known copper and apatite deposits and discovering any anomalous areas nearby. A secondary aim of the survey was to assist geological mapping.

Regional and local geology are described and previous investigations in the general area are briefly reviewed before presenting and analysing the aeromagnetic data. The operational details of the survey and an outline of the interpretation methods employed are given as appendices.

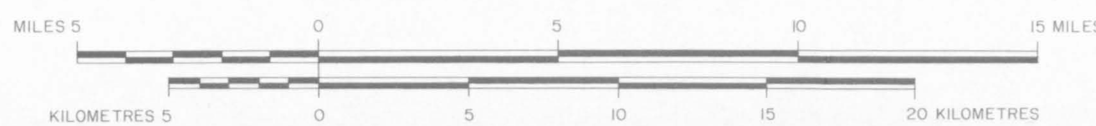
Of the sixteen known mineral occurrences, five were found to have strong magnetic expression, three others are probably correlated with two magnetic anomalies, and a further two occurrences are very close to a fault interpreted from the magnetic data. Further ground investigation is recommended in the vicinity of six of the deposits. Many other anomalies were recorded in all areas, and the majority are due to bodies that either crop out or are within 50 feet of the surface. Many, if not most, of these bodies are believed to be steeply dipping lenses and prismatic bodies of amphibolite interjacent with less magnetic gneissic and schistose rock. Ground investigation is necessary to differentiate between mineralised and non-mineralised magnetic bodies.

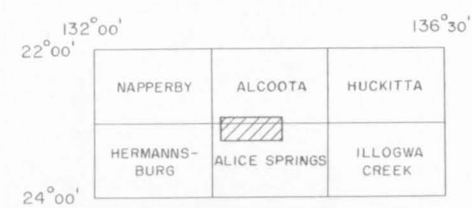
Thirty-one faults have been interpreted, many of which coincide with photo-linear features, and three fold structures have been tentatively proposed.



DETAILED AEROMAGNETIC SURVEY, STRANGWAYS RANGE NT, 1965

LOCALITY MAP





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1. INTRODUCTION

Between 20th September and 16th November 1965, the Bureau of Mineral Resources (BMR) flew a detailed aeromagnetic survey over parts of the Strangways Range area in the Northern Territory. The region surveyed, totalling 115 square miles, comprises five small areas which extend from the northern part of the Alice Springs 1:250,000 map area into the Alcoota map area (see Plate 1).

The survey was requested by the BMR Resident Geologist in Alice Springs with the primary object of outlining possible extensions to known mineral deposits or discovering any new anomalous areas nearby. In Areas 1, 2, 4, and 5, limited copper mineralisation had been found in association with magnetite; in Area 3, three mineral deposits were known, each consisting of magnetite, apatite, and zircon. A secondarz aim of the surveys was to assist geological mapping, especially where the solid geology is obscured by Quaternary alluvium.

Operational details of the survey are given in Appendix 1, and the methods used in interpreting the results are described in Appendix 2.

Several regional investigations have been made in the area. In a paper on the geology of the Northern Territory, Hossfeld (1954) described the metamorphics of the Arunta Complex, which he divided into the older Arunta Series and the younger Riddock Series, the latter forming the Harts Range, which lies to the east of the survey area. The first comprehensive regional map was made by Joklik (1955) during his survey of the Harts Range, but his more detailed mapping, which involved the subdivision of Hossfeld's Riddock Series, did not extend westwards to include the Strangways Range. During 1957 and 1958 the Commonwealth Scientific and Industrial Research Organization made a regional study of an extensive part of the Northern Territory including the Strangways Range. As part of this investigation Quinlan (1962) reported on the geology, Ryan (1962) on the mineral occurrences, and Mabbutt (1962) on the geomorphology. The greater part of each of the Hermannsburg, Alice Springs, and Illogwa Creek 1:250,000 map areas has recently been mapped by Forman, Milligan, and McCarthy (1967).

More detailed mapping of the five survey areas has recently been commenced by BMR Resident Geological Staff in Alice Springs. By photo-interpretation, supported by ground investigation, the rocks have been broadly grouped into lithological sub-divisions of the Arunta Complex, and geological strikes and faults have been delineated. All known mineral occurrences have been inspected in the field. The geology shown in the plates which accompany this report, and the geological descriptions of the five areas, are based on this work. Previous workers have examined some of the mineral deposits: Owen (1944) and Dr H.I. Jensen (pers. comm.) reported on the occurrence of apatite in Area 3, Bell (1953) described the Pinnacles copper workings in Area 4, and Thomson (1950) reported on the copper exposure in Area 5.

In 1961, a BMR helicopter gravity reconnaissance survey was made of much of the Northern Territory. The data obtained from the Amadeus Basin area have been presented by Langron (1962). As this was a reconnaissance survey the gravity pattern was correlated with broad regional features and the degree of resolution was insufficient to be of great assistance to the detailed aeromagnetic survey.

A ground magnetometer survey was made in 1965 by Geopeko Ltd over a chalcopyrite-magnetite deposit 4000 feet north-west of Southern Cross Bore in Area 4, but the results of the survey are not known.

An airborne magnetic and radiometric reconnaissance survey of the Amadeus Basin was flown by BMR in 1965 (Young & Shelly, 1966). The magnetic field was found to be highly disturbed in the northern half of the Alice Springs map area, where many anomalies of over 2000 gammas were detected. Most of the radiometric data were correlated with broad geological features.

2. GEOLOGY

Regional geology

The five survey areas are on the Arunta Block, which is composed of ancient metamorphics of the Arunta Complex. The rocks of the Strangways Range originated as sediments with some interbeds of volcanics. During at least two periods of regional metamorphism these rocks were altered to metamorphosed calcareous sediments, amphibolite, quartzo-feldspathic gneiss, and garnet-mica-feldspar gneiss with some bands and lenses of quartzite (I. Youles, pers. comm.). Various schists have also been found in subordinate amounts. The term 'amphibolite' is applied throughout this report to all unspecified basic igneous rocks known to be metamorphosed. These occur as lenses, plugs, sills, and flows. Small isolated outcrops of ultrabasic intrusives are also known.

At least two orogenies are evident in the north-eastern margin of the Amadeus Basin and there is evidence to suggest that they were preceded by an earlier period of folding and metamorphism. The Arunta Orogeny pre-dated the deposition of the Amadeus Basin sediments and caused the deformation and moderate to high-grade metamorphism of the Arunta Complex. The Complex was isoclinally folded about north-south axes and was later tightly refolded about steeply dipping east-west axes. The later Alice Springs Orogeny caused recumbent folding of the older rocks, possibly with some metamorphism in the Strangways Range area (Forman, Milligan, & McCarthy, 1967).

Faulting, mostly of unknown age, is common throughout the Arunta Block.

Detailed geology

Area 1. This area (see Plate 2), which is mostly soil-covered, has a few scattered outcrops of medium-grained amphibolite, the foliation of which strikes at 070° and dips at 55° northwards. East of Red Rock Bore there is an outcrop of banded quartz-garnet-magnetite rock trending 130° and dipping very steeply north-eastwards; the rock consists of narrow alternating bands of quartz and quartz-magnetite with scattered garnet throughout.

Two mineral deposits, each of magnetite and chalcopyrite, have been found in the centre of the area. The minerals occur in veins which are up to 300 feet long and 10 feet wide and whose strikes appear to be parallel to the regional trend of the foliation. There are also substantial areas where magnetite floaters occur. Weak copper mineralisation has also been observed in a shear at the contact between the amphibolite-rich zone and the gneiss to the north.

Area 2. Almost all the area (Plate 3) is of gneiss and amphibolite, the latter occurring mostly as bands concordant with the gneiss. These bands are generally 10 to 30 feet wide, too narrow to be marked on the geological map. The strike of the foliation is commonly northerly but becomes east-west in the extreme north and south. Many amphibolitic and ultrabasic intrusives, some with associated magnetite, also have exposures too small to be shown.

Faulting of variable strike is common.

A copper exposure in the central part of the area is a secondary ironstone body 500 to 600 feet long and up to 60 feet wide, which strikes due north and dips at 55° east, parallel to the regional trend in the area. The body occurs in metamorphosed limestone. Secondary copper minerals are prominent and smaller amounts of galena and haematite have been noted. It is not known whether the mineralisation is associated with nearby basic intrusives. At the two copper localities in the north-east of the area, secondary copper minerals and limited chalcopyrite have been found in a basic intrusive that is elongated north-south, parallel to the strike of the country rock.

Area 3. Three major rock groups within the Arunta Complex have been recognised in this area (Plate 4). The most important of these economically is a metamorphosed limestone* in which three mineral deposits are known, each consisting of magnetite, apatite, and zircon. The three deposits occur in a belt, one mile long and 500 feet wide, trending north-east. The apatite is believed to have been formed by the pneumatolytic replacement of limestone by fluoride-rich fluids and is present throughout the limestone probably in amounts of the order of 10 per cent; its tonnage is estimated to be 200,000 tons per vertical foot. The attitude of the deposits is not yet known with certainty because of the masking effect of Tertiary weathering. At the eastern outcrop, however, the limestone is overlain, probably conformably, by quartz-muscovite schist, which trends north-north-east and dips at 70° to the west-north-west. In addition, from photo-interpretation supported by ground investigation, the probable strikes of the central and western outcrops are 045° and 085° respectively, and the dips are steep in a northerly direction. Small bodies of pegmatite, consisting almost wholly of feldspar with minor quartz, have intruded the limestone. The largest outcrop measures 24 feet by 10 feet. Small masses of phlogopite have also been seen in the limestone.

The remaining two rock groups consist principally of amphibolite and gneiss. The division is based on the relative amounts of these two components, and there is therefore a gradation between the two groups. The trend of their foliation is variable. In the extreme south this is easterly; in the north-west there is a swing through north-east to north, whereas in the south-east of the area the swing is towards the north-west.

Faulting is common, the dominant trends being north-west and west. North-east faulting has also been observed.

Area 4. The rocks of this area (Plate 5) have been divided into two broad lithological groups: one of gneiss, amphibolite, and schist; the other of marble and hornfels. The two groups are generally well defined and only in the south-east is there any evidence of gradation. The strike of the foliation is very variable, the major changes being either side of fault planes. The long meridional fault in the central west of the area is a good example; to the west, the trends are north-north-west to north-west, whereas on the eastern side they swing from north-north-east to east. In the north-east of the area, the trends are north-north-west, becoming westerly across a fault plane. From the curvature of the trend lines shown, folding has obviously occurred; the major fold axes are believed to strike generally north, but minor cross-folding is thought to exist throughout the area.

Copper mineralisation has been observed at a number of localities. Half a mile north-west of Southern Cross Bore, massive magnetite-chalcopyrite has replaced a lens of metamorphosed limestone occupying an area 40 feet long and 20 feet wide. The magnetite is concentrated in the 'noses' of steeply plunging folds along the contact with gneissic country rock. A small basic boss, heavily stained with secondary copper minerals, has intruded the limestone. The other deposits, including the Pinnacles workings, are found north-east of Southern Cross Bore and are veins of bornite, ankerite, and quartz in marble. The mineralisation occurs in a belt about 1000 feet wide and two miles long trending north-north-west approximately parallel to the strike of the country rock. Included within this belt are two ironstone-capped hills each about 500 feet long and 10 to 20 feet wide. It is thought that the ironstone may have been derived from sulphide deposits, but its significance is not understood. Secondary copper ore has been won from an open cut on the hangingwall of the eastern of these two bodies.

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* Now thought to be carbonatites (P.W. Crohn & D.C. Gellatly; "Probable carbonatites in the Strangways Range area, central Australia."
Bur. Min. Resour. Aust. Rec. 1968/114)

Area 5. The whole area (Plate 6) is of undifferentiated Precambrian rocks which either crop out or are beneath Cainozoic cover. Three faults strike north-west to west-north-west and there is evidence of weaker faulting striking north-east. From photo-interpretation, the rocks north of the central fault and those south of the southern fault are believed to be similar and consist probably of granitic gneiss with banded amphibolite. Between the two southern faults the rocks have different photo-characteristics and are thought to be predominantly schist with some intrusive(?) amphibolite. Tight isoclinal folding about north-westerly axes occurs west and east of the map area, and is believed to be present also within the survey area. There are large open folds and domes of variable trend in the north and east.

A copper prospect in the north-central part of the area was examined by Thomson (1950), who stated that quartz-magnetite-haematite lodes up to 14 feet wide occur in altered sillimanite-sericite schists. The magnetite and haematite are found either as disseminated crystals or with quartz in more clearly defined lode channels. Lodes of both types crop out for approximately 1300 feet along a 115^{o} strike, and dip 80^{o} northwards; they appear to be closely associated with amphibolite sills. The only surface copper mineralisation is sporadic and weak carbonate staining. A pit 12 feet deep has been dug in the centre of the lode. Assay values of 0.5 and 1 percent copper were obtained at depths of 5 and 9 feet respectively.

3. RESULTS AND INTERPRETATION

The aeromagnetic data are presented in Plates 2 to 6 as contour maps of total magnetic intensity. A basic contour interval of 50 gammas has been used for Areas 1, 2, 4, and 5. In Area 3, the relatively low degree of magnetic disturbance, in the eastern part particularly, has allowed for contours at a 10-gamma interval. Corrections have been made for the diurnal variation of the total field but the Earth's regional gradient has not been removed. All intensity values are relative only and are referred to a single arbitrarily chosen datum.

Plates 2 to 6 also show the qualitative interpretation of the magnetic data in the form of magnetic trend-lines, interpreted faults, and zones of magnetic disturbance (see Appendix 2). The geological significance of these magnetic features will be discussed for each area. The zoning is based on differing overall magnetic patterns and, although the zones have geological significance, no implication is made that the zonal boundary exactly reflects a lithological boundary. Positive and negative trend-lines represent the axes of magnetic 'ridges' and 'troughs' respectively. Generally a magnetic body produces a magnetic 'high' with an adjacent magnetic 'low'. It should be noted that the apical axis of an inclined prismatic magnetic body does not generally coincide with either a positive or a negative trend-line; it is usually displaced to the negative side of the positive trend-line.

Selected anomalies have been quantitatively analysed to provide information on the depths of burial and widths of the causative magnetic bodies (see Appendix 2). All five areas have very complex magnetic patterns. The majority of the anomalies are themselves complex, being the resultants of magnetic contributions from more than one source. Consequently, the number of anomalies suitable for accurate analysis represent a small percentage of the total. The contour maps show a series of lines, A-A', B-B', etc., where magnetic profiles, normal to the magnetic strike of the anomalies, have been constructed from the contours. The data obtained by analysing the constructed profiles are given for each area respectively in Tables 1 to 5. Some of the selected anomalies have been further analysed to yield dip angles of bodies and apparent magnetic susceptibility contrasts. The calculated depths are considered accurate to $\pm$15 percent. The calculated widths of bodies can in general be considered to represent maximum values. The magnetic bodies need not necessarily be homogeneous, but may consist of a series of bodies sufficiently narrow and closely spaced that the magnometer was unable even partially to resolve their individual magnetic contributions.

Area 1

This area divides naturally into three zones of contrasting magnetic character (Plate 2). Zone A, in the north, is represented by a major complex anomaly with a maximum amplitude of 2600 gammas. The anomaly is partially resolved into at least two simpler anomalies but its northerly continuation was not covered by the survey. Zone B is characterised by a series of subelongate anomalies with an average amplitude of 100 gammas, although larger anomalies of up to 700 gammas were detected. Zone C, in the south, contains two major anomalies of 4600 gammas and 2250 gammas. Almost all magnetic trends lie between east-north-east and east-south-east.

Data derived by quantitative analysis of constructed profiles (see Plate 2) are tabulated below in Table 1.

Table 1. Analysis of profiles, Area 1

Section	Depth of magnetic body below ground level (in feet)	Half-width of magnetic body (in feet)
A-A'	200	400
B-B'	250 approximate	1200 maximum
C-D	150	600
D-E	50 to 100	500
F-F'	500 maximum	1400 maximum
G-G'	500 maximum	1600 maximum
H-H'	100	400
J-J'	0	400
K-K'	50	500
L-L'	50	600
M-M'	0	700
N-N'	200	200
P-P'	0	100
Q-Q'	less than 50	100

The limited known geology affords some control on the interpretation of zonal significance. The amphibolite-rich zone (use of 'zone' here is geological) in the south-east of the area is clearly reflected by an anomaly of 700 gammas crossed by J-J' (Plate 2). Although the contours suggest a single anomaly, the source-body is probably a series of parallel amphibolitic bands too closely spaced to be resolved by the aeromagnetic method. Similar anomalies in zone B, e.g. those crossed by N-N', P-P', and K-K', are also expected to reflect amphibolitic bands and lenses. The generally smaller amplitudes of these anomalies, compared with the anomaly crossed by J-J', are partially due to the greater depths of burial of the magnetic bodies, but are also thought to signify smaller percentages of amphibolite relative to interjacent strata, probably gneiss. Some of the anomalies in zone B have been analysed to give the apparent susceptibility contrast between the magnetic bodies and the surrounding rock. The average value obtained, of the order of 2.0×10^{-3} CGS, is consistent with the contrast expected between amphibolite and gneiss. As most of the magnetic trends in zone B are generally parallel, both with respect to each other and to geological strikes, the metabasics are concordant with the meta-sediments and were therefore originally lava-flows or sills. Their attitude is near-vertical.

The largest anomaly in zone C was detected over an outcrop of banded quartz-garnet-magnetite rock, which strikes parallel to the anomaly trend. The known outcrop, measuring 750 feet by 1300 feet, appears to extend for a considerable distance beneath Cainozoic cover; the dimensions of the magnetic body causing the anomaly crossed by L-L' and M-M' are slightly more than one mile long and approximately 1400 feet wide. Its dip has been calculated to be 80° to the north-east. This rock-type is probably also responsible for the other anomalies in this zone, although those crossed by sections C-D and D-E are lower in amplitude. In the case of the anomaly crossed by C-D, this can be partially explained by the increased depth of burial of the causative body. The anomaly crossed by D-E is due to a slightly narrower body, and its amplitude is possibly also reduced by the negative effect of the magnetic bodies to the north.

The complex anomaly in zone A is due to at least two magnetic bodies at depths of up to 500 feet below ground level. If the bodies had been in outcrop, their resultant anomalies would have been as great in amplitude as those detected in zone C, and it is more than possible that the magnetic bodies in both zones are of the same rock-type. This could signify a fold structure about an east-west axis such that zones A and C represent the two limbs of the fold. This concept is supported by curvature of both magnetic trend-lines and known geological strikes. In the eastern part of zone B, the curvature is particularly noticeable and in the centre of the area between faults f1 and f2 the positive trend-lines appear to form a closure to the east. If the depth determinations in zone A are reasonably accurate, the suggested fold would have to be synclinal. However, the dip directions shown on the geological map in the vicinity of section P-P' (Plate 2) imply that the fold is anticlinal, but this could be a local fold within a major synclinorium. This fold concept is only tentatively proposed and further mapping is necessary to test its validity. Unfortunately the anomalies in zone A are insufficiently complete to enable reliable dip-angles to be determined, but a southerly dip is indicated.

Three faults have been interpreted from the magnetic data. Fault f1 is based on a displacement of magnetic trend-lines and on the differences in strike and depth of burial of the bodies that cause the anomalies crossed by L-L' and C-D. Both of the known copper prospects occur very close to a second fault f2, which has been interpreted from a displacement of magnetic trend-lines and from the collinear termination of a number of anomalies. The south-eastern part of this fault, and its continuation south-east of the survey boundary, is coincident with a strong photo-linear feature. Further ground investigation should be made where the interpreted fault crosses the large outcrop south-east of the southern copper exposure in order to test for faulting and mineralisation. Any extensions to the known deposits are expected to occur along the fault plane. The northern deposit is also close to, and approximately parallel to, the anomaly crossed by Q-Q'. The significance of this will also be known only by ground investigation, but the anomaly could be due to a basic intrusive associated perhaps with ore-genesis. Fault f3 is interpreted from a change in magnetic trends, but folding could also account for the observed pattern.

Area 2

Four magnetic zones have been delineated in Area 2 (Plate 3). Zone A in the north-west includes a number of ovate anomalies of high amplitude and variable trend. A similar pattern is seen in zone B in the north-east. In the extreme south of the area, zone C represents the northern part of a third region of high magnetic intensity. In the remainder of the area, designated zone D, relatively low-amplitude anomalies of various shapes, trends, and amplitudes constitute a complex magnetic pattern.

Data derived by quantative analysis of constructed profiles are shown below in Table 2. Depth calculations indicate that all magnetic bodies either crop out or lie within 50 feet of the surface.

Table 2. Analysis of profiles, Area 2

Section	Half-width of magnetic body (in feet)
A-A'	130
B-B'	150
C-C'	250
D-D'	400
E-E'	350
F-F'	150
G-G'	350 approximate
H-H'	300 approximate
J-J'	350
K-K'	200
L-L'	200
M-M'	200
N-N'	200 approximate
P-P'	200 approximate
Q-Q'	300 approximate
R-R'	200

The whole area is mapped as amphibolite and gneiss, which either crops out or is beneath a veneer of alluvium; individual bands are too narrow to be shown on the geological map. For these reasons it was particularly necessary to attempt to correlate the magnetic results with features on aerial photographs and to use any observable correlation in the further interpretation of the magnetic pattern. Good correlation was generally found.

Zone A coincides approximately with a dark area on the photographs, which differs from the surrounding country in topography and vegetation. As is known from geological mapping, this dark area is faulted at its southern, north-eastern, and eastern boundaries; the fault along the southern boundary coincides with f5, a fault that has been interpreted from a change in magnetic trend. The western boundary of the zone is clearly seen on the photographs as an abrupt change in rock-type. This change could be due to a fault, but the magnetic evidence is insufficient to confirm this.

The abrupt variations in magnetic trends within the zone signify that other faulting has occurred but they do not indicate the positioning of the faults. All magnetic trends are parallel to known geological strikes. The individual anomalies crossed by G-G', H-H', and J-J' are due to lenses or irregularly shaped masses of basic material, each with a maximum width of 600 to 700 feet. The contrast in magnetic susceptibility between the source rock of the anomaly crossed by G-G' and the rock to the west and east has been calculated to be 3.5×10^{-3} CGS. This is approximately equivalent to a change in magnetite content of 1 percent.

Zone B, similarly correlated with an area of dark hilly country, is confined by a series of faults as shown in Plate 3. The fault along the southern boundary coincides with f8, a fault that has been interpreted from a change in magnetic trend. Trend variations within the zone have enabled two other faults to be interpreted. North-east of fault f10, a number of anomalies trend north-east. The anomaly crossed by Q-Q' is due to a body, parallel to the geological strike, which has a maximum thickness of 600 feet and a minimum length of 3000 feet. The rock type is probably metabasic and similar to that in zone A. West of fault f10, two localities are known where secondary copper minerals have been found in a basic intrusive elongated north-south. The meridional anomaly crossed by sections M-M', N-N', and P-P' is almost certainly due to this basic intrusive. The anomaly, which coincides with a steep ridge on the photographs, is due to a north-south body calculated to have a maximum thickness of 400 feet. The calculated length of 2900 feet is exactly the length of the ridge. The area south of the known exposures is considered worthy of detailed ground investigation. On magnetic evidence, the anomaly that trends north-north-west immediately to the south-east could also be due to a similar basic intrusive, but this i. not supported by any similarity in topographic form. West of fault f9, the magnetic trends revert to a north-easterly direction, and the anomalies are probably due to the same rock type as that in the north-east of the zone.

The boundary of zone C, marking the approximate limit of a third region of high magnetic intensity, coincides with a photo-linear feature which clearly represents an abrupt change in rock-type. The anomalies in zone C have amplitudes similar to those in zones A and B and are probably due to metabasics. The interpreted fault f6, coinciding with a known fault, separates magnetic bodies that trend north-west and north-north-east.

Zone D, comprising the remainder of Area 2, is interpreted as a much-faulted region composed of at least two rock types, probably amphibolite and gneiss, the proportion of amphibolite being lower than in the other zones. A number of anomalies, e.g. those crossed by section F-F', K-K', and L-L', may be directly correlated with dark bands on the aerial photographs. It is expected that most elongated anomalies trending parallel to the geological strie are concordant bands and lenses of amphibolite interjacent with gneiss. Anomalies that cross obliquely to the geological strike are probably basic intrusives occurring as dykes. Two examples of oblique anomalies are seen south of the thrust fault in the centre of the area.

There is no obvious correlation between the magnetic data and the copper exposure in the central part of the area. However, the anomaly immediately to the east could be due to a basic intrusive possibly associated with ore genesis. Zone D includes a number of interpreted faults, many of which merely serve to confirm faults already deduced by photo-interpretation. Most of those interpreted from the magnetic data separate anomalies of differing trends. The exception is f2, which causes the displacement of a number of magnetic trends. This fault is also seen as a photo-linear feature.

Area 3

Four magnetic zones have been delineated in this area (Plate 4). Zone A has a complex magnetic pattern formed by anomalies of variable trends, shapes, and amplitudes. The dominant trend is north-north-east and the average amplitude is approximately 150 gammas, although anomalies of up to 400 gammas were detected. Zone B is a simple magnetic trough which trends 005^{o} and widens towards the north. Zone C includes the three largest anomalies in the area, which have amplitudes of 750, 1000, and 1800 gammas. The western two trend north-easterly and the eastern one trends slightly east of north. Zone D, forming most of the remainder of Area 3, is characterised by a north-westerly trend of anomalies of low amplitude superimposed on a gradually changing field. In the south-east, zone E encloses an east-west anomaly of 250 gammas.

Data derived by quantative analysis of contructed profiles are shown below in Table 3. Depth calculations indicate that all magnetic bodies either crop out or lie within 50 feet of the surface.

Table 3. Analysis of profiles, Area 3

Section	Half-width of magnetic body (in feet)
A-A'	350
B-B'	Not known
C-C'	500
D-D'	700
E-E'	500
F-F'	300
G-G'	500
H-J	300
J-K	150
K-L	400
L-M	250
M-N	200

A general correlation is observed between the zones and known geology. Zone A includes two outcrops of amphibolite with minor amounts of gneiss. Where the geological strike is known, the magnetic trends are near-parallel. Most if not all of the anomalies trending north to north-north-east are therefore interpreted as being due to amphibolitic bands and lenses. Susceptibility calculations on some of the anomalies gave values between 1.7×10^{-3} and 2.4×10^{-3} CGS. The anomalies trending north-west probably reflect discordant basic intrusives or their metamorphic equivalent. The complexity of the contour pattern in this zone could be due in part to basic plugs and irregularly shaped masses of basic material. There is no magnetic indication that deposits of magnetic-apatite-zircon, comparable to those in zone C, occur in zone A. In areas of no outcrop, the thickness of Cainozoic overburden is calculated to be less than 50 feet throughout the zone.

The geological significance of zone B is not fully understood. It clearly reflects a rock of low susceptibility relative to those in zones A and C. Although not shown as such in Plate 4, its western boundary could be a fault contact, parallel to the negative trend-line. Of known rock-types in the Strangways Range, Zone B could represent acidic gneiss or a continuation of the limestone in zone C but without the magnetite. The possibility of an acidic intrusion should not, however, be discounted especially as pegmatite has been observed in zone C to the east. The widening of the trough at its northern part is probably due to the negative effect of a magnetic body to the north in zone A.

Zone C is the most important economically as it encloses the three outcrops of limestone that contain apatite, magnetite, and zircon. Each outcrop is clearly reflected by a positive magnetic anomaly to the north and a negative anomaly to the south. The western anomaly, crossed by F-F', is due to a body 600 feet wide and approximately 1400 feet long which trends parallel to, and midway between, the positive and negative magnetic trend-lines. The dip of the body is calculated to be $80^{o} \pm 5^{o}$ to the north-north-west, and a value of 4.0×10^{-3} CGS was obtained for the magnetic susceptibility contrast between the body and the rocks to the south. The anomaly crossed by E-E' and D-D' is due to a body approximately half a mile long trending north-east. Its width is about 1000 feet in the south-west and increases to 1400 feet to the north-east. The longitudinal axis of the body is approximately midway between the positive and negative trend-lines, and its dip is about 60^{o} to the north-west. The section C-C' crosses the largest anomaly in Area 3. As the anomaly trends almost due north, its positive part coincides more closely with the causative body. This is calculated to be about 1000 feet wide and a third of a mile long, dipping steeply westwards. The dimensions of the known limestone outcrops and those calculated for the magnetic bodies are compared below:

Outcrop	Dimensions of known outcrop (in feet)	Dimensions of magnetic body (in feet)
Western	1800 x 800	1400 x 600
Central	1800 x 500 (average)	2600 x 1200 (average)
Eastern	2000 x 1600 (approximate)	1700 x 1000 (approximate)

It seems apparent therefore that not all the limestone outcrop is magnetic. The central outcrop, being appreciably smaller than the calculated dimensions, is the only one where hitherto unknown extensions could possibly be found beneath Cainozoic cover. The extensions would be towards the north and north-west.

The anomaly in the north-eastern corner of the zone could also be due to a similar rock type. The causative body is near the surface and its relatively low amplitude is indicative of a magnetite content well below that of the three major deposits. If the apatite content is found to be approximately proportional to the magnetite content then this anomaly is not considered worthy of further investigation.

Zone D covers an area known to have a much smaller percentage of amphibolite and a corresponding increase of gneiss. The contact of this group in the east with the more amphibolitic group is believed by geologists to be faulted. The low-amplitude anomalies in zone D are interpreted as being due to localised concentrations of amphibolite, the strike of which is north-west throughout. The zone includes the country south of a major negative trend-line in the south-west of the area. The magnetic gradient in this region is positive to the south, but as it is part of the anomaly to the north, it does not imply an increase in magnetite content towards the south. Nor does it conflict, therefore, with the geological belief that this region represents a transition between rocks predominantly amphibolitic to the north and those predominantly gneissic immediately to the south of the survey area.

Zone E comprises a magnetic anomaly considerably higher in amplitude than any in the surrounding zone D; it is the effect of an east-west body less than 50 feet below ground level. A geologist (I. Youles, pers. comm.) has inspected the site of the anomaly, where he found an outcrop of amphibolite considerably smaller than the apparent dimensions of the magnetic body; it is probable that it was only a part of a much larger basic body that increases in horizontal extent with depth.

Three faults have been interpreted in Area 3 by analysing trend displacements and changes in trends. There can be little doubt that the fault f1 exists. At the fault plane, negative trends meet positive ones, there is an abvious displacement of the major negative anomaly in zone D, and a general change in trend is also apparent. If the relative movement was wholly horizontal, the direction was western block to the north-west. Fault f2 separates the central and eastern limestone outcrops and is based on geological evidence and the change in anomaly trend. Fault f3 is based solely on the large angle between the trend in zone E and that immediately to the north.

Area 4

Plate 5 clearly shows that the magnetic relief varies greatly over the area. As a generalisation the eastern half is considerably more disturbed magnetically than the western half. Seven zones of differing magnetic character have been recognised. Zone A in the north-east is characterised by linear anomalies of up to 2300 gammas. Zones B, D, and E in the south-east quadrant have a magnetic pattern similar to that of zone A, and are separated from zone A by a deep magnetic 'trough' (zone C), which strikes approximately south-east. Zone F in the south-west contains anomalies of about 800 gammas. Zone G, forming the remainder of Area 4, is characterised by relatively low-amplitude anomalies of variable trend.

Data derived by quantative analysis of constructed profiles (Plate 5) are shown below in Table 4. All depth calculations indicate that the magnetic bodies either crop out or lie within 50 feet of the surface.

Table 4. Analysis of profiles, Area 4

Section	Half-width of magnetic body (in feet)
A-A'	700 very approximate
B-B'	500 approximate
C-C'	200
D-D'	350
E-E'	400
F-F'	400
G-G'	650
H-H'	600
J-J'	400
K-K'	100
L-L'	300 approximate
M-M'	200
N-N'	100
P-P'	100
Q-Q'	200
R-R'	100 approximate
S-S'	300
T-T'	150

Over most of the area a good correlation was found between the magnetic data, the mapped geology, and photo-features, and the interpretation which follows is based upon this correlation.

Zone A is characterised by linear, high-amplitude anomalies which are generally only partially resolved from neighbouring anomalies. Magnetic trends and known geological strikes vary from one part of the zone to another, but there is general parallelism between the two. The zone largely coincides with an extensive outcrop of gneiss, amphibolite, and schist, and the magnetic pattern supports the concept of three dominant rock-types. Calculations to determine the magnetic susceptibility contrast between adjacent rock-types gave values between 4×10^{-3} and 8×10^{-3} CGS. These figures are compatible with the contrast expected between amphibolite and either gneiss or schist; the magnetic 'ridges' are therefore believed to be due to bands and lenses of amphibolite; the magnetic 'troughs' reflect interjacent bands of gneiss and/or schist. Some anomalies, e.g. those crossed by C-C' and D-D', may be directly correlated with parallel dark bands on the aerial photographs. Others, particularly in the north-east of the zone, have less obvious correlation.

A number of faults have been interpreted from abrupt changes in the magnetic pattern within the zone. Fault f1 separates north-westerly trends to the south from westerly trends to the north. Similarly f3 separates north-westerly and north-easterly trends. Faults f2 anf f4 were interpreted from the collinear termination of a number of anomalies. All four faults have moderate-to-strong topographic expression.

The curvature of the magnetic trend-lines east of fault f5 clearly reflects the arcuate rock outcrops of alternating light and dark bands as seen on the aerial photographs; both patterns suggest a truncated fold structure.

Zone B, in the south-east corner of the area, has a magnetic pattern similar to that of zone A, i.e. a series of near-parallel, sub-elongate anomalies of high amplitude. However, whereas the highest anomalies in zone A are fairly evenly dispersed, in zone B there is a gradual rise in both magnetic intensity and magnetic 'relief' towards the south-east. A rock-type transition from marble-hornfels to amphibolite-gneiss-schist probably exists in the south-east quadrant of the area (I. Youles, pers. comm.); the gradation in magnetic intensity supports such a concept. The magnetic 'ridges' are again believed to be due to amphibolitic bands and lenses concordant with the country rock. The magnetic trends are seen to swing from northerly through north-east to easterly, parallel to the known geological strike; major folding has obviously occurred in this zone. A number of the trend lines are quite short (down to 400 feet minimum), which suggests either that the amphibolite is very variable in width and pinches out altogether in places, or that the magnetite content is very variable. The former alternative is more feasible as both lava flows and intrusive sills can be expected to be reasonably homogeneous along strike.

The northern and north-eastern boundaries of the zone are almost certainly faulted. That part of fault f8 which forms the northern zonal boundary separates easterly and north-easterly trends; it is also seen as a very strong photo-linear feature. Fault f7 forms the contact between the arcuate trend-lines of zone B and the straight north-westerly trends of zone C. This interpreted fault, also seen as a photo-linear feature, is nearly coincident with a positive north-westerly trend-line, and it is possible that a section of the fault plane is filled with magnetic material. Two other interpreted faults are shown within the zone: fault f9, interpreted from the collinear termination of a number of anomalies, is seen as a photo-linear feature, and f10 was interpreted from an abrupt change in magnetic trends.

Zones A and B are separated by zone C, a strong linear magnetic 'trough', which represents a major geological feature believed to be tectonic in origin. The 'trough' and all anomalies superimposed on it trend consistently at 140°, in contrast to the trends outside the zone. The easterly boundary is probably faulted along its entire length (f14) and, as has already been shown, at least one section of the western boundary is believed to be faulted. The zone is therefore expected to represent a double shear, a graben, or a horst structure. Anomalies within the zone are of relatively low amplitude and average approximately 200 gammas. They are due to parallel bodies which either crop out or are within 50 feet of the surface. In the north-west, the generally simple magnetic pattern within the zone is disturbed by two collinear cross-trending positive anomalies. This disturbance is interpreted as being either a fault (f5) or two basic dykes along a plane of structural weakness.

It is interesting to note that the configuration of zones A, B, and C is reflected by a similar configuration of radiometric anomalies (Young & Shelly, 1966). A region of low radiometric intensity coinciding approximately with zone C separates two radiometric 'highs' that coincide with zones A and B. This radiometric configuration could be partially explained by an increase of overburden in zone C, but it is believed that an abrupt lithological change is also necessary to explain the pattern.

Zone D is a region of high magnetic intensity, which represents the partial resolution of two similar and parallel magnetic bodies that strike 025° and dip very steeply. The zone is correlated with an obvious topographic feature, which appears to be a denuded anticline pitching to the north and south. The two magnetic trends are therefore believed to represent an amphibolitic band which crops out on the two limbs of a fold. The anomaly crossed by H-H' coincides with this band where it strikes and dips north, and the calculated width of 1200 feet represents, not the stratigraphic thickness, but the width of the anticline at its northern end measured between the two outcrops of the magnetic body. The stratigraphic thickness is approximately 400 feet maximum.

Zone E, consisting of a number of linear anomalies, is separated from zone D by a magnetic 'trough', and from zone B by a fault. The causative bodies within the zone crop out and are correlated with parallel bands on the aerial photographs. The similarity of anomaly amplitudes and topographic forms in zones D and E and in the northern part of zone B suggests a similarity of rock type. The magnetic 'trough' between zones D and E could therefore be due to relatively non-magnetic rock within a deep syncline complementary to the anticline of zone D.

The long and narrow zone F includes four anomalies with an average amplitude of 800 gammas; the anomalies are near-circular and are therefore due to bodies with near-circular cross-section. These are possibly basic plugs in a zone of structural weakness.

The remainder of the area, designated zone G, is characterised by relatively low amplitude anomalies of various trends, shapes, and amplitudes. The linear anomalies generally trend parallel to the geological strike, but apart from this there is disappointingly little correlation between the magnetic pattern and the distinct features seen on the aerial photographs. It would seem that the very large areas of dark rock, although possibly more basic, do not have any appreciable increase in magnetic iron. Most linear anomalies are due to steeply dipping prisms of rock with a magnetite content of up to 1 percent greater than the surrounding rock. Their general parallelism with the geological strike implies that they are interbeds of basic material, probably amphibolitic sills and lava flows. Some of the anomalies, e.g. that crossed by T-T' and the one immediately east of fault f12, are directly correlatable with conspicuous bands on the photographs. A few anomalies, e.g. the short anomaly immediately south of the western end of f6, trend obliquely to the known geological strike. Such anomalies are thought to be due either to basic dykes or to irregularly-shaped basic intrusions.

The known copper-magnetite body north-west of Southern Cross Bore is clearly the cause of the anomaly of 1200 gammas crossed by R-R'. The causative body is rather less

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than 1000 feet long and dips almost vertically. The breadth of the body, being less than the terrain clearance, cannot be accurately determined, and the value given of 200 feet probably represents a maximum. The susceptibility contrast of the body with the surrounding rock is approximately 3 x 10^{-2} CGS, which is equivalent to a change in magnetite content of 5 to 10 percent.

The copper exposures north-east of Southern Cross Bore have little, if any, magnetic expression, but this is not surprising considering their geological environment. The western of the two ironstone bodies lies at the northern end of a long anomaly of 300 gammas, and this body could theoretically continue southwards for a considerable distance.

No other anomaly comparable to that crossed by R-R' was detected in zone G.

Three faults have been interpreted from the collinear termination of anomalies, but only f6 has any sign of topographic expression.

Area 5

Three magnetic zones have been delineated, one of which forms most of the area (Plate 6). Zone A, in the north-west, is a small region of high magnetic intensity which includes an anomaly of at least 2000 gammas. Zone C in the south includes a number of anomalies of intermediate amplitude trending east-south-east. Zone B, representing the remainder of Area 5, is a series of parallel linear anomalies of relatively low amplitude trending east-south-east to south-east.

Data obtained by quantitative analysis of constructed profiles are shown below in Table 5. All depth calculations indicate that the magnetic bodies either crop out or lie within 50 feet of the surface.

Table 5. Analysis of profiles, Area 5

Section	Half-width of magnetic body (in feet)
A-A'	300
B-B'	200
C-C'	400
D-D'	600
E-E'	200
F-F'	400 very approximate
G-G'	400 maximum

Zone A represents only a corner of an area of greatly disturbed magnetic field. The southern boundary is well defined by the magnetic contours, which could reflect a fault contact. The zone is part of an area tentatively described as being granitic gneiss with banded amphibolite. The magnetic anomalies are therefore probably due to the different magnetic susceptibilities of these two rocks; the amphibolite is expected to have the greater value. Intra-zonal faulting is also believed to be necessary to explain the magnetic pattern, but its location cannot be deduced because of the incomplete surveying of the anomalous area. In the west of the zone two anomalies trend east and east-north-east. The latter, crossed by A-A', is due to a body up to 600 feet wide and approximately 1300 feet long. To the north-east the magnetic trends are not known with certainty.

However, by referring to the original magnetic profiles, more information was gained than can be shown in Plate 6. The boundary of any survey area represents the limit beyond which the film, used for flight path recovery, could not be accurately plotted owing to the turning attitude of the aircraft. Nevertheless it was possible to ascertain that larger anomalies of up to 3000 gammas are evident immediately north of the survey boundary, and furthermore that the probable magnetic trend in this region approximates to the geological strike shown in Plate 6. A sharp deviation in magnetic trends is therefore apparent between the north and south-west of the zone.

The magnetic pattern in zone C suggests that the source rocks are similar to those in zone A, although in the southern zone they appear to have a greater length-to-width ratio. The anomaly crossed by B-B' and C-C' is due to an east-west body, or possibly to two separate collinear bodies, with a width of 400 feet in the west and up to 800 feet in the east. The combined length is approximately 3000 feet.

Zone B occupies an area tentatively described as predominantly schist with some amphibolite. The magnetic pattern confirms the existence of two interbedded rock-types striking generally east-south-east. The apparent magnetic susceptibility contrast has been calculated to have an average of 0.9×10^{-3} CGS. This value does not include the anomaly crossed by section E-E', which is due to the known copper prospect. The near-vertical causative magnetic body is approximately 400 feet wide and 2000 feet long and its axis is midway between the positive and negative trend-lines. The anomalies crossed by F-F' and G-G' to the east could be due to a folded extension of this body, although the lower amplitude signifies a lower percentage of magnetite.

Most of the anomalies in this zone are due to steeply dipping bodies. Although the magnetic pattern suggests the occurrence of fold axes striking south-east, the dip-angles of bodies cannot be calculated with sufficient accuracy to delineate the folds.

Fault f1 has been interpreted from a displacement of magnetic trend-lines in the south-east of the area.

4. CONCLUSIONS AND RECOMMENDATIONS

The survey had two aims, both of which were partially achieved. The first was to outline any extensions to known mineral deposits or to find any anomalous areas nearby. Sixteen mineral occurrences are known in the region surveyed, and of these:

Five have strong magnetic expression and produce clearly correlatable anomalies (C-C', D-D', E-E', and F-F' of Area 3; S-S' of Area 4; and E-E' of Area 5).

Two are probably correlated with a magnetic 'high' (M-M', N-N', and P-P' of Area 2).

One is tentatively associated with a magnetic 'high' (K-K' of Area 2).

Two occur in, or close to, an interpreted fault (f2 of Area 1).

The remaining six exposures, all in Area 4, have no obvious magnetic effect.

On magnetic evidence, six of the occurrences could have lateral extensions. These are:

Both copper exposures in Area 1 (along the interpreted fault plane).

The southern copper exposure in the north-east of Area 2 (southwards).

The central apatite outcrop in Area 3 (north and north-westwards).

The copper-magnetite deposit in Area 4 (northwards)*

* BMR investigated this possible extension in 1967 and found a zone of induced polarisation anomalies extending north from the known deposit (J. Haigh, pers. comm.).

The copper occurrence in Area 5 (general vicinity but principally north-west, plus the bodies to the south-east).

It is recommended that detailed ground investigation be made around the above six exposures. Drilling will probably be necessary in Areas 1 and 3.

Many other anomalies have been recorded in all areas. Unfortunately all known mineral deposits occur in bodies that strike parallel to the regional trend of the country rock. It is therefore not possible to differentiate between mineralised and non-mineralised magnetic bodies. Ground investigation in anomalous areas is necessary to distinguish between the two.

The secondary aim of the survey was to assist geological mapping especially where the solid geology is obscured by Quaternary alluvium. The aeromagnetic results should be of considerable use in the subsequent mapping of the survey areas. Thirty-one faults have been interpreted, many of which were not already known. Although some may be found to be misinterpretations, most are given with some confidence. The trend of the magnetic disturbance is given in some detail, and as most anomalies are believed to be due to metabasics concordant with the country rock, this information should be of assistance in the structural, as well as the lithological, mapping of the areas. Three fold structures in Areas 1 and 4 have also been tentatively suggested.

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APPENDIX 1

OPERATIONAL DETAILS

Survey specifications

Ground clearance	-	Nominally 280 feet
Detector altitude	-	Nominally 250 feet above ground level
Line spacing	-	One-tenth of a mile
Line orientation	-	East-west (Areas 1, 2, and 4) North-west/ south-east (Areas 3 and 5)
Area surveyed	-	115 square miles

Equipment

Aircraft	-	Cessna 180
Magnetometer	-	MNS-1 proton precession type of BMR design
Recorders	-	1 single-channel Mosely-Autograf, sensitivity 1000 gammas full scale deflection 1 two-channel Devar, sensitivity 10,000 gammas full scale deflection.
Camera	-	Modified Vinten, frame-type, 35 mm, with 186^{o} fish-eye lens.
Radio altimeter	-	AN/APN-1
Storm warning detector	-	MFD-3 fluxgate type of BMR design, sensitivity 100 gammas full scale deflection.

Method

A correction for diurnal variation was determined by flying a pre-selected baseline at the beginning and end of each flight. The baseline was chosen for its ease of precise reflying and relatively flat magnetic field. Each baseline profile was compared with a reference or standard profile, and the diurnal correction was applied by assuming that the variation was linear throughout the flight. This assumption was checked daily by reference to a ground magnetometer, which also served as a magnetic-storm warning device.

The output of the magnetometer is a step function, and the necessary smoothing of the recorded profile also smoothed the 'noise' envelope.

Flight path recovery was made by plotting terrain features from the 35-mm film on to aerial photographs and then on to a photo-scale planimetric base-map of each area. Control points were plotted every 0.7 mile approximately. The aircraft's ground speed was assumed constant between any two adjacent control points. The maximum probable positional error is estimated to be $\pm$ 150 feet.

Personnel

The personnel engaged on the survey were: D.B. Tipper (Geophysicist), A. Crowder (Senior Drafting Officer), I. Heath (Senior Radio Technician), and J. Boyd and A.E. Busuttil (Geophysical Assistants). The aircraft was flown by First Officer J. Lord of Trans-Australia Airlines.

APPENDIX 2

INTERPRETATION METHODS

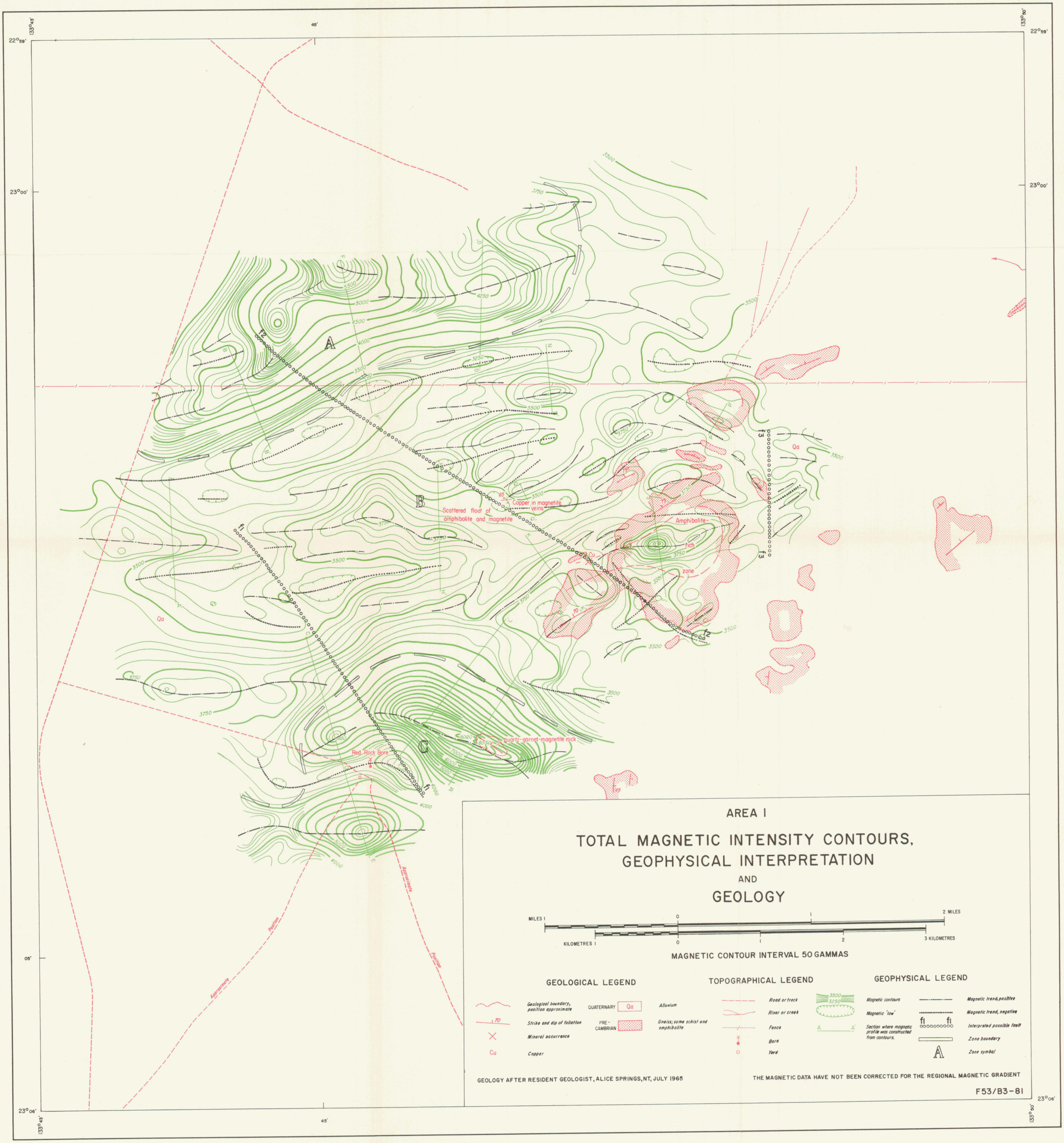
The interpretation methods employed may be conveniently grouped into qualitative and quantitative analyses.

Qualitative interpretation involved the delineation of positive and negative magnetic trend-lines, ie. the axes of magnetic 'ridges' and 'troughs' respectively. This procedure, particularly in the case of displacement of anomaly trend-lines and the collinear termination of positive trend-lines, indicates the strikes of magnetic disturbance, and the significance of the zones is given by reference to known geology. Correlation was also sought between the magnetic pattern and terrain features. Where anomalies were not of ideal shape for quantitative analysis, the approximate attitudes of the causative slab-like bodies of various strikes were obtained by constant reference to series of standard curves given by Gay (1963) and Reford (1964).

The quantitative interpretation involved the determination of depths, widths, dips, and susceptibility contrasts of the magnetic bodies and was based on the assumption that the magnetisation is wholly induced. Depths to magnetic bodies (below detector level) were obtained by more than one method. With anomalies of simple form, i.e. showing no partial resolution, depths were rapidly calculated by the half-maximum-slope technique advocated by Peters (1949) and extended by Moo (1965). Moo has given three independent methods for obtaining the depth of prismatic bodies. The anomaly crossed by F-F' in Area 3 was sufficiently well defined to be analysed by all three of these methods. The values obtained, 230, 250, and 270 feet below detector, give an average of 250 feet ± 8 percent. Most of the other depths quoted are considered to have an accuracy of ± 15 percent.

The majority of anomalies are not of sufficiently simple form to be analysed by measurements on discrete sections of the profiles. A method of matching the whole profile with a series of standard curves was considered more reliable, and those constructed by Gay (1963) were used. The depth of burial of magnetic bodies was in all cases obtained by subtracting the ground clearance of the detector from the calculated total detector-to-body distance. Half-widths were obtained by measuring the horizontal distances between the peak of each anomaly and the position of steepest slope. This method is reasonably accurate where the half-width is greater than the depth of the body below the detector. Where the actual total width of an outcropping body is less than 500 feet, the calculated width represents a maximum. Where possible, more accurate determinations of half-widths were made by reference to Moo (1965).

Susceptibility contrasts were calculated using standard formulae given by Reford (1964), and dip-angles were obtained using the techniques of Gay (1963) and Moo (1965).


22°59'
133°43'
45'
133°50'
23°00'
23°05'
23°06'
A
B
C
f1
f2
f3
Qa
3500
3750
4000
Scattered float of amphibolite and magnetite
Copper in magnetite veins
Amphibolite-rich zone
Cu
quartz-garnet-magnetite rock
Red Rock Bore
Approximate
Pipeline
AREA I
TOTAL MAGNETIC INTENSITY CONTOURS, GEOPHYSICAL INTERPRETATION AND GEOLOGY
MILES 1
0
1
2 MILES
KILOMETRES 1
0
1
2
3 KILOMETRES
MAGNETIC CONTOUR INTERVAL 50 GAMMAS
GEOLOGICAL LEGEND
Geological boundary, position approximate
Strike and dip of foliation
Mineral occurrence
Copper
QUATERNARY
Qa
Alluvium
PRE-CAMBRIAN
Gneiss; some schist and amphibolite
TOPOGRAPHICAL LEGEND
Road or track
River or creek
Fence
Bore
Yard
GEOPHYSICAL LEGEND
Magnetic contours
Magnetic 'low'
Section where magnetic profile was constructed from contours.
Magnetic trend, positive
Magnetic trend, negative
Interpreted possible fault
Zone boundary
Zone symbol
GEOLOGY AFTER RESIDENT GEOLOGIST, ALICE SPRINGS, NT, JULY 1965
THE MAGNETIC DATA HAVE NOT BEEN CORRECTED FOR THE REGIONAL MAGNETIC GRADIENT
F53/B3-81

AREA 2

TOTAL MAGNETIC INTENSITY CONTOURS, GEOPHYSICAL INTERPRETATION AND GEOLOGY

GEOLOGICAL LEGEND

- Geological boundary, position approximate
- 70 Strike and dip of foliation
- Vertical foliation
- Fault
- Thrust
- Mineral occurrence
- Cu Copper
- QUATERNARY Qa Alluvium
- PRECAMBRIAN Gneiss and amphibolite

TOPOGRAPHICAL LEGEND

- Road or track
- River or creek

GEOPHYSICAL LEGEND

- Magnetic trend, positive
- Magnetic trend, negative
- f1 f1 Interpreted possible fault
- Zone boundary
- A Zone symbol
- 3500 3250 Magnetic contours
- Magnetic 'low'
- A A' Section where magnetic profile was constructed from contours.

MILES 1 0 1 2 MILES

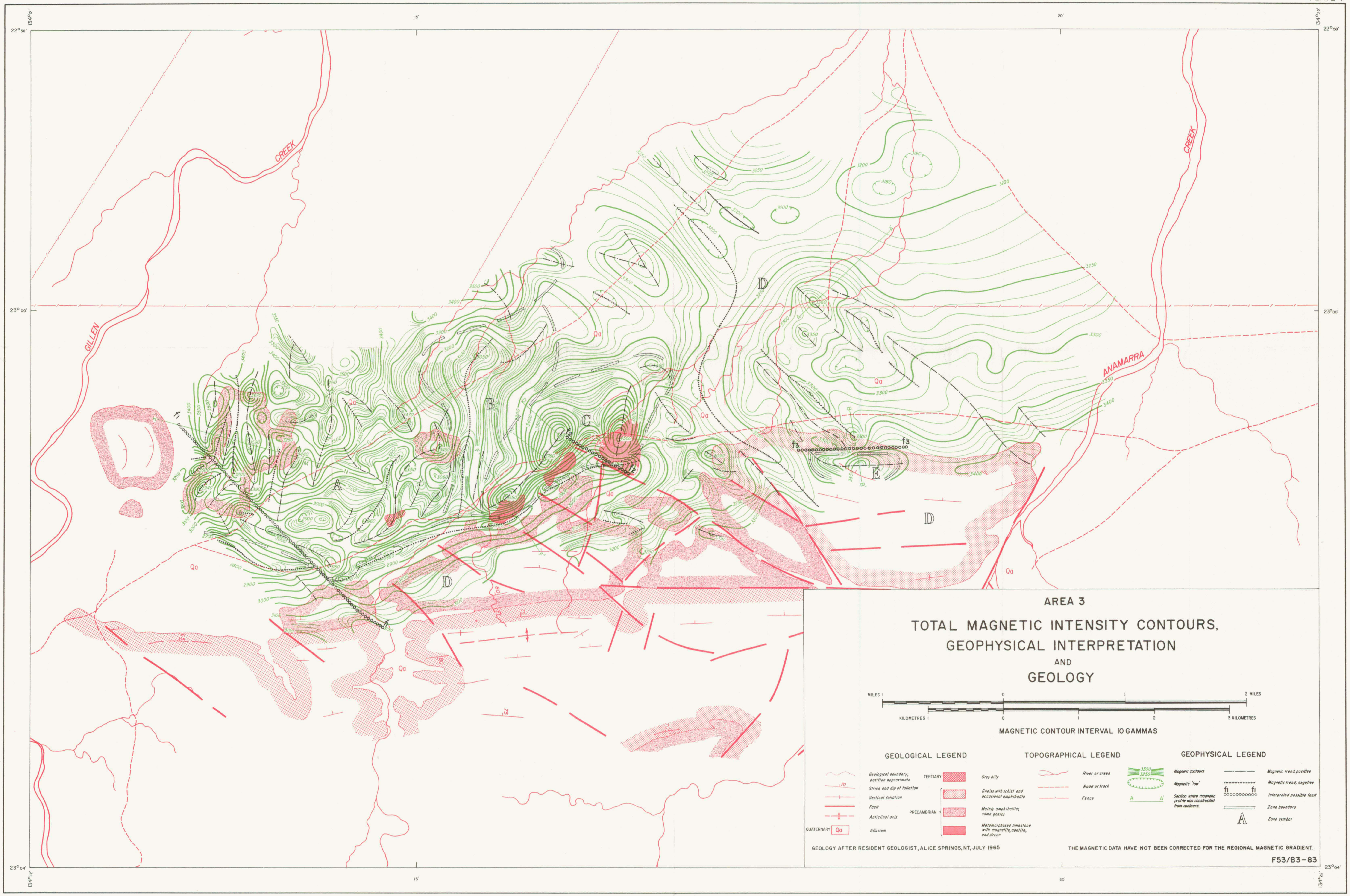
KILOMETRES 1 0 1 2 3 KILOMETRES

MAGNETIC CONTOUR INTERVAL 50 GAMMAS

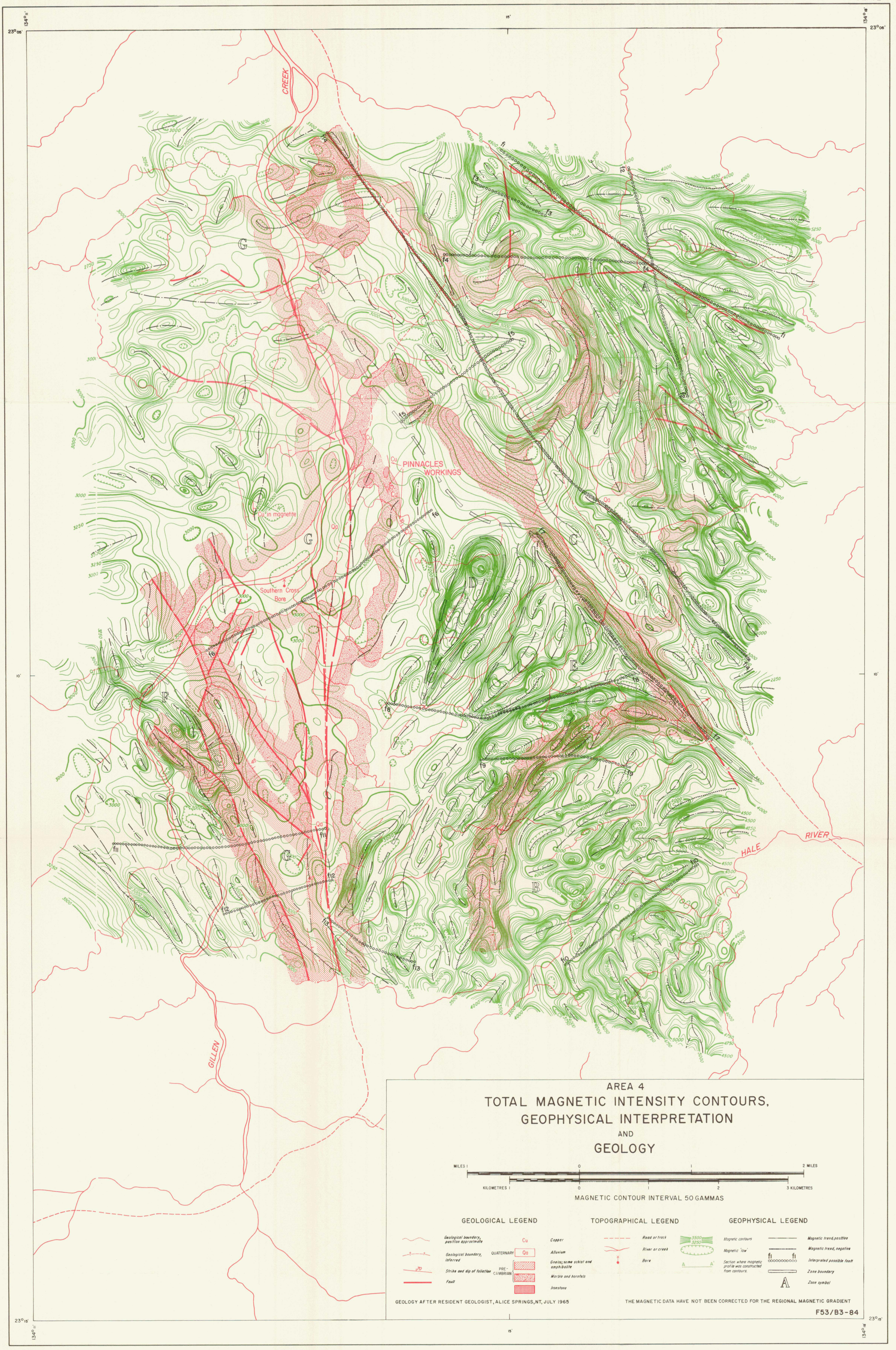
THE MAGNETIC DATA HAVE NOT BEEN CORRECTED FOR THE REGIONAL MAGNETIC GRADIENT.

GEOLOGY AFTER RESIDENT GEOLOGIST, ALICE SPRINGS, NT, JULY 1965

F53/B3-82



22°58'
134°12'
15'
20'
134°22'
23°00'
23°04'
CREEK
GILLEN
ANAMARRA
Qa
A
B
C
D
E
f1
f2
f3
AREA 3
TOTAL MAGNETIC INTENSITY CONTOURS,
GEOPHYSICAL INTERPRETATION
AND
GEOLOGY
MILES 1
0
1
2 MILES
KILOMETRES 1
0
1
2
3 KILOMETRES
MAGNETIC CONTOUR INTERVAL 10 GAMMAS
GEOLOGICAL LEGEND
Geological boundary, position approximate
Strike and dip of foliation
Vertical foliation
Fault
Anticlinal axis
QUATERNARY
Alluvium
TERTIARY
Grey billy
PRECAMBRIAN
Gneiss with schist and occasional amphibolite
Mainly amphibolite; some gneiss
Metamorphosed limestone with magnetite, apatite, and zircon
TOPOGRAPHICAL LEGEND
River or creek
Road or track
Fence
GEOPHYSICAL LEGEND
3300
3250
Magnetic contours
Magnetic 'low'
Section where magnetic profile was constructed from contours.
Magnetic trend, positive
Magnetic trend, negative
Interpreted possible fault
Zone boundary
Zone symbol
GEOLOGY AFTER RESIDENT GEOLOGIST, ALICE SPRINGS, NT, JULY 1965
THE MAGNETIC DATA HAVE NOT BEEN CORRECTED FOR THE REGIONAL MAGNETIC GRADIENT.
F53/B3-83


CREEK
PINNACLES WORKINGS
Cu in magnetite
Southern Cross Bore
HALE RIVER
GILLEN
AREA 4
TOTAL MAGNETIC INTENSITY CONTOURS, GEOPHYSICAL INTERPRETATION AND GEOLOGY
MILES 1 0 1 2 MILES
KILOMETRES 1 0 1 2 3 KILOMETRES
MAGNETIC CONTOUR INTERVAL 50 GAMMAS
GEOLOGICAL LEGEND
Geological boundary, position approximate
Geological boundary, inferred
Strike and dip of foliation
Fault
Cu Copper
QUATERNARY Qa Alluvium
PRE-CAMBRIAN
Gneiss; some schist and amphibolite
Marble and hornfels
Ironstone
TOPOGRAPHICAL LEGEND
Road or track
River or creek
Bore
GEOPHYSICAL LEGEND
Magnetic contours
Magnetic 'low'
Section where magnetic profile was constructed from contours.
Magnetic trend, positive
Magnetic trend, negative
Interpreted possible fault
Zone boundary
Zone symbol
GEOLOGY AFTER RESIDENT GEOLOGIST, ALICE SPRINGS, NT, JULY 1965
THE MAGNETIC DATA HAVE NOT BEEN CORRECTED FOR THE REGIONAL MAGNETIC GRADIENT
F53/B3-84

AREA 5

TOTAL MAGNETIC INTENSITY CONTOURS, GEOPHYSICAL INTERPRETATION AND GEOLOGY

GEOLOGICAL LEGEND

- Geological boundary, position approximate
- Strike and dip of foliation
- Vertical foliation
- Strike of foliation
- Foliation trend
- Fault

QUATERNARY

- Qa — Alluvium

PRECAMBRIAN

- Gneiss; amphibolite with some schist
- Cu — Copper

TOPOGRAPHICAL LEGEND

- River or creek
- Fence
- Bore
- Yard
- Building

GEOPHYSICAL LEGEND

- Magnetic trend, positive
- Magnetic trend, negative
- fl fl — Interpreted possible fault
- Zone boundary
- A — Zone symbol
- 3500 3250 — Magnetic contours
- Magnetic 'low'
- A A' — Section where magnetic profile was constructed from contours.

MILES 1 0 1 2 MILES

KILOMETRES 1 0 1 2 3 KILOMETRES

MAGNETIC CONTOUR INTERVAL 50 GAMMAS

GEOLOGY AFTER RESIDENT GEOLOGIST, ALICE SPRINGS, NT, JULY 1965

THE MAGNETIC DATA HAVE NOT BEEN CORRECTED FOR THE REGIONAL MAGNETIC GRADIENT.

F53/B3-85

DATE DUE

[illegible]			