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RECORD No. 1965/25

MOUNT ISA DETAILED AEROMAGNETIC SURVEY, QUEENSLAND 1963

by

B.A. DOCKERY and D.B. TIPPER

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SUMMARY

Between May and August 1963, a detailed airborne magnetometer survey was made in the vicinity of Mount Isa by the Bureau of Mineral Resources, at the request of Mount Isa Mines Ltd. The object of the survey, over part of the north-west Queensland belt of outcropping Precambrian rocks was the detection of areas of mineralisation within the sediments of the Mount Isa Group.

The total magnetic intensity contours over the survey area show good overall correlation with the geology; minor discrepancies indicate possible revisions of the geological mapping.

A magnetic anomaly occurring over the Mount Isa Group has been attributed to mineralisation along the Mount Novit Fault. Other anomalies detected over the Mount Isa Group have been attributed to Eastern Creek Volcanics or Mount Isa Greenstone that occur at depth within the Mount Isa Group. Detailed surveying of the area of outcrop of the Mount Isa Group, north of Mount Isa township, revealed the presence of a number of low-amplitude magnetic anomalies, which have been attributed to possible mineralisation.

1. INTRODUCTION

At the request of Mount Isa Mines Limited, an airborne magnetometer survey of part of the Leichhardt River valley, centred on Mount Isa, was made during the period May to August 1963 by the Bureau of Mineral Resources (BMR). The selected survey area was bounded approximately by latitudes 20°30'S and 21°01'S and longitudes 139°25'E and 139°37'E and contains within it economic copper and silver-lead-zinc ore deposits. Mining leases and Authorities to Prospect, held by Mount Isa Mines Limited, covered a large part of the area.

A programme of detailed geophysical and geological surveying of their leases is being undertaken by Mount Isa Mines Limited. As part of this programme, the Mount Novit area has been studied using geochemical techniques and vertical-force magnetometer, self-potential, induced polarisation, and resistivity methods, and the Bernborough-Dawn area has been studied using self-potential and vertical-force magnetometer methods. From the vertical-force magnetometer traverses, it was apparent that a contrast existed between the highly magnetic Eastern Creek Volcanics and the Mount Isa Group, which is of uniformly low magnetic susceptibility.

Thus the airborne magnetometer survey was expected to detect any blocks of Eastern Creek Volcanics buried within the Mount Isa Group. This is of importance to the mining industry, as mineralisation of economic importance occurs in the Mount Isa Group and is thus limited by the depth and extent of the Eastern Creek Volcanics within the Group; also, as some geologists believe, there may be an association between the infaulted blocks of Eastern Creek Volcanics and the existence of copper mineralisation.

Another object of the survey was to investigate the possibility of direct detection of orebodies.

Coincident with the airborne survey, and in conjunction with Mount Isa Mines Limited, the BMR made a geochemical survey and a reconnaissance gravity survey within the area dealt with in this Record.

2. GEOLOGY

This section is mainly a summary of the work of Carter, Brooks, and Walker (1961), except for the subsection on the Mount Isa Group, which is due to Battey (in preparation).

General

The survey area (Plates 1 and 2) is a small part of a belt of Precambrian outcrops, which extends nearly 400 miles in a north-north-westerly direction and has a maximum width of 100 miles. The rock types of this belt include granite, metamorphics, and little-altered sediments and lavas, which range in age from probably Archaean to late Upper Proterozoic. There are also irregular patches of Quarternary alluvium.

Two geosynclinal basins, separated by a north-south tectonic welt, developed in the belt during early Proterozoic time. The survey area covers part of the more westerly of these two basins and part of the tectonic welt and includes Lower Proterozoic sediments, volcanics, and intruded granite.

Two major orogenic compressive phases resulted in strong folding and faulting of the Lower Proterozoic strata, the first phase affecting the eastern geosyncline more strongly than the western. Folding was on meridional axes, each orogeny probably being associated with granite emplacement. In general, apart from a portion of the Eastern Creek Volcanics and underlying strata, the rocks of the western belt have been only slightly metamorphosed.

A mining industry has been developed within the belt to exploit the copper and silver-lead-zinc mineralisation and the widespread uranium deposits. The location and size of these orebodies is often related to the deformation pattern that resulted from the orogenic stresses. In addition, a great diversity of other minerals have been found, although not in sufficient quantities to be of economic importance.

A geological map of the survey area, supplied by Mount Isa Mines Limited, forms the basis for the geology and planimetry shown in Plates 4 and 5. The less-detailed geological map shown in Plate 2 was derived from the Mount Isa 4-mile geological series, Sheet F54/1, and the Cloncurry 4-mile geological series, Sheet F54/2.

The stratigraphic relationship of the formations found within the survey area is shown in Plate 3.

Lithology and distribution of formations

The Leichhardt Metamorphics. These consist essentially of an unknown thickness of highly to moderately metamorphosed acid lavas, and some metamorphosed sediments. Associated metamorphics include migmatite, schists, and gneiss. Outcrops are present in a small area to the extreme south-east of the survey area. All specimens from the Leichhardt Metamorphics examined microscopically have shown some unidentified opaque iron mineral. Within the Leichhardt Metamorphics there are flows or sills (now amphibolite) and dolerite dykes (now metadolerite), both containing some iron mineral (see below under 'Basic intrusives').

The Argylla Formation. In the extreme south-east of the survey area outcrops of metamorphosed rhyolite and metadacites of the Argylla Formation conformably overlie the Leichhardt Metamorphics. Specimens examined microscopically contained grains of an opaque iron mineral. The Formation has been intruded by dolerites (now metadolerites), which are described below under 'Basic intrusives'.

Mount Guide Quartzite. This occurs as a broad north-south belt of quartzite, which is feldspathic in part. The formation has a possible thickness of 15,000 ft, of which the lowest 50 to 100 ft is conglomerate. Interbedded metabasalts and an abundance of metadolerite dykes occur within the formation outside the survey area.

<u>The Eastern Creek Volcanics</u>. These outcrop in two bands that strike north and extend almost the full length of the survey area. These bands are separated by the Mount Isa Group and the Judenan Beds. Two inliers of Eastern Creek Volcanics have been faulted into the Mount Isa Group.

The succession of the Eastern Creek Volcanics consists essentially of interbedded metabasalt and metasediments and has a thickness of about 15,000 ft at the type locality, which is between one-and-a-half to five miles from Mount Isa on the Cloncurry road. Throughout the outcrops, there is a remarkable uniformity of lava type. However, the grade of metamorphism, the types and thicknesses of metasediments, and the relative abundance of lava and sediments, vary considerably within the formation. Microscopic examination of specimens of Eastern Creek Volcanics has revealed that 5% to 15% of the rock is iron mineral.

The Eastern Creek Volcanics contain 51% of the uranium deposits of north-western Queensland and these have a substantial amount of associated magnetite. Brooks (1960) states that "The primary uranium mineral in many of the deposits of the Eastern Creek Volcanics ... is closely associated with iron oxide minerals ... magnetite is the most common primary iron mineral". All deposits in the survey area are of the Eastern Creek Volcanics type, where the primary uranium mineral is uranite, brannerite, or uraniferous magnetite.

The eastern outcrop of Eastern Creek Volcanics includes the uranium deposits of the George Creek area, in which magnetite is commonly present. At the Counter deposit, eight miles north-east of Mount Isa, the ore contains abundant euhedral grains of magnetite.

The western outcrop of Eastern Creek Volcanics has been strongly metamorphosed, west and north-west of Mount Isa. Intense fracturing and shearing have produced highly cleaved and schisted metamorphics. West of Mount Isa, thermal effects have been superimposed by the Sybella Granite. The rock types of this western outcrop include quartzite, chlorite and mica-schists, amphibolite, and biotite-quartz-gneiss. The uranium deposits of Spear Creek area contain associated magnetite.

Numerous pegmatites containing beryl, which are the product of the pegmatitic and pneumatolytic stages in the crystallisation of the Sybella Granitic magma, occur in the Eastern Creek Volcanics to the south-west of Mount Isa.

<u>Judenan Beds</u>. These Beds outcrop in a north-south band to the immediate west of the Mount Isa strike fault. However, this is only a small part of the total area of outcrop of the Judenan Beds. The type locality is 33 miles beyond the north-west corner of the survey area.

The Beds consist of quartzite, sandstone, siltstone, shale, argillaceous sandstone, pebble beds and conglomerate, basalt, and some rhyolite. Cleavage is well developed in places. Strata are generally only slightly metamorphosed although, between the Mount Isa Fault and the Sybella Granite quartz-sericite-schist, quartz-mica-schist and quartz-schist have been developed.

Rhyolite and rhyolitic tuff have been recorded in several places, as have basic rocks, probably basalt, some in association with basic tuffs. All these volcanics appear to be near the top of the succession, as in the Myally Beds.

A number of lens-shaped intrusions of metabasalt or metadolerite occur within the Judenan Beds (Carter et al, 1961). Brooks (1961) shows the Judenan Beds as interlaminated quartzite, mica-schist and chlorite-schist containing lenses of chlorite-schist, amphibolite, muscovite-schist, and subordinate hornblende-, biotite-, chlorite-, talc-, and tremolite-schists.

Myally Beds. These beds outcrop to the north-east of Mount Isa and have been affected by a number of strike-slip faults trending north-west. The Myally Beds are essentially of quartz arenite, medium-grained to coarse-grained sandstone, and quartzite, with conglomerate and pebble beds near the base, particularly along the eastern margin of the main outcrop area. Siltstone, argillaceous sandstone, and shale are locally important. Feldspathic sediments are common, particularly in the lower and easterly parts of the succession; elsewhere some sediments are micaceous. In the northern parts of the main area of outcrop, the top of the succession is defined by several hundred feet of volcanics, both basic and acid, associated with agglomerate and, in places, boulder conglomerate. However, these volcanics appear to be absent in the survey area, where a quartzite marker-bed delineates the contact (probably disconformable) between the Myally Beds and the Mount Isa Group.

Mount Isa Group. These beds outcrop as a narrow meridional band extending the full length of the survey area. An alternating succession of shales and siltstones has been distinguished and the Group has been subdivided (Battey in preparation), as follows:

Moondarra Siltstone

Breakaway Shale

Native Bee Siltstone

Urquhart Shale

Spear Siltstone

Kennedy Siltstone

Magazine Shale

Moondarra Siltstone. This extends north from a position 20 miles south of Mount Isa to the vicinity of Lake Moondarra. Generally, the Siltstone lies to the west of the Myally Beds, the contact being probably disconformable. The formation consists of thin-bedded, black (weathering to dark brown) dolomite and siltstone.

Breakaway Shale. The formation trends in a northerly direction over a distance of 34 miles from north of Mount Guide to beyond Spring Creek. It conformably overlies the Moondarra Siltstone and consists of fine-grained, thin-bedded, light-grey shales and siltstones. It has been deeply weathered.

<u>Native Bee Siltstone</u>. From north of Mount Guide, this Siltstone extends north for 34 miles to Spring Creek. It crops out to the immediate west of the Breakaway Shale, by which it is conformably underlain. It is a dolomitic siltstone and in the lower 350 ft, sub-greywackes are predominant.

Distinctive beds, known locally as cross-fractured beds, occur within the Native Bee Siltstone. These beds, considered to be acid tuffs, can often be traced over a considerable length of the formation.

<u>Urquhart Shale</u>. The Urquhart Shale outcrops continuously from Lena Creek in the south to Spring Creek in the north, a distance of 16 miles. It is to the west of the Native Bee Siltstone and is conformably underlain by this formation.

The Shale outcrops as thin-bedded, cream, red and brown, sericitic shale. The interbedded red and brown beds contain hematite and limonite after pyrite. The formation is weathered to a depth of about 200 ft, throughout which the carbonate minerals are being removed by the weathering processes.

The unoxidised Urquhart Shale is predominantly a dark-grey, fine-grained, dolomitic shale, interbedded in some areas with fine-grained pyritic shale. The economic mineralisation at Mount Isa and at the Northern Leases occurs within this formation.

<u>Spear Siltstone</u>. The formation crops out over a northerly strike length of 17 miles, from Lena Creek in the south to Spring Creek in the north and to the immediate west of the Urquhart Shale. It is conformably underlain by the Urquhart Shale. The contact between the Urquhart Shale and the Spear Siltstone has been exposed in underground workings and is gradational over at least 30 ft. The Spear Siltstone consists of dolomitic siltstone and interbedded dolomitic shale.

<u>Kennedy Siltstone</u>. The formation extends from Lena Creek in the south to Spear Creek in the north, a distance of 17 miles. It is to the west of the Spear Siltstone, by which it is conformably underlain. It is a light-grey, massive, dolomitic siltstone.

Oxidation is extremely shallow and is usually less than a quarter of an inch deep, except along faults or joints. There is little apparent change in mineralogical or chemical composition between specimens collected from the surface and those collected down-dip at depths of up to 1000 ft.

<u>Magazine Shale</u>. Lying between the Mount Isa Fault and the Kennedy Siltstone, the Magazine Shale crops out discontinuously from west of Bernborough Mine to west of Tombstone Hill, a distance of 14 miles. At intervals throughout this distance, it is faulted out by the Mount Isa Fault. The formation is conformably underalin by the Kennedy Siltstone. Outcrops of the Magazine Shale are a light-grey to brown-and-red sericitic shale. The formation is weathered to a depth of about 200 ft.

Igneous rocks

Plutonic rocks. Two granite bodies crop out in the survey area, namely the Kalkadoon Granite and the Sybella (or Templeton) Granite.

Kalkadoon Granite. This is found in the extreme south-east of the survey area and intrudes the Leichhardt Metamorphics, the Argylla Formation, and the Mount Guide Quartzite. There are two rock types composing the Kalkadoon Granite within the survey area: a granite rich in microcline, with features suggesting superimposed metamorphism; and a granodiorite, with negligible iron content, which in places has been hybridised by basic material occurring within the Leichhardt Metamorphics (Joplin & Walker, 1960). Both the granite and the hybridised granodiorite have been observed in the survey area on the Mount Isa - Duchess Road, twelve miles south-south-east of Mount Isa.

Sybella (Templeton) Granite. This occupies much of the western boundary of the survey area, intruding Eastern Creek Volcanics and, probably, the Judenan Beds. A number of rock types are present. Coarse, foliated, porphyritic granite appears to surround a core of deeply weathered granite (Joplin & Walker, 1960). Much of the rock in the survey area, mapped as Sybella Granite, is a later intrusion of microgranite, injected during the period of granitic activity after the first orogenic compression. Brooks (1961) described the granite south-west of Mount Isa stating that magnetite is a "common accessory mineral and can sometimes be observed in hand specimens".

Basic intrusives. The basic intrusives of the Precambrian are divided into seven groups (Carter et al, 1961), of which four may be seen in the survey area.

Group 1. This group consists of dykes and sills or flows of amphibolite that intrude the Leichhardt Metamorphics.

Group 2. Dykes of metadolerite and amphibolite crop out mainly in the Leichhardt Metamorphics, Argylla Formation, and Mount Guide Quartzite. Some probably served as feeders for the vulcanicity within the Eastern Creek Volcanics.

Group 5. Intrusives or flows occur in association with the Mount Isa Group and Judenan Beds and are usually referred to loosely as 'greenstones'. The most recent information available on this group is from Zimmerman (1961), and this forms the basis of the following description.

The sequence of schistose greenstones with interspersed metasediments that occur between the Mount Isa Group and the Mount Isa Fault will be referred to here as the Mount Isa Greenstone. This sequence appears adjacent to the Mount Isa Fault, both west of the Black Star orebody and west and north of the Mount Isa airport. However, the Mount Isa Greenstone rarely crops out, as it is covered by rubble from the Judenan Beds outcropping to the immediate west of the fault. Drill holes in the vicinity of the Northern Leases have provided a complete record of the Mount Isa Greenstone sequence for study.

The Mount Isa Greenstone comprises dark-green and grey-green sheared greenstones together with thinner bands of dense quartzites, chlorite and sericite schists, knotted schists, and phyllites and small lenses of dense, comparatively unsheared greenstone. The thickness of the metasediments is extremely variable. No reliable estimate can be made for the overall thickness of the Mount Isa Greenstone. Only one attitude is recorded for the metasediments, namely a strike of 130°E and a dip of 70°W. The Mount Isa Greenstone/Mount Isa Group contact is parallel to the boundaries of the individual units of the Mount Isa Group. A small outcrop of Greenstone is known within the area of outcrop of the Spear Siltstone; in drill holes, anomalous blocks of Mount Isa Greenstone have been detected in the vicinity of the contact between the Urquhart Shale and the Spear Siltstone.

The overall grade of metamorphism of the Mount Isa Greenstone is much higher than that of the Mount Isa Group. The effect of shearing increases appreciably towards the Mount Isa Fault. The schistosity trends north-south and dips almost vertically, as does the Fault zone. It has been estimated that the Mount Isa Greenstone underwent about 30% more compression than the Mount Isa Group.

The Mount Isa Greenstone is considered to be the result of the metamorphism of a sequence formed from submarine basic lavas that were extruded intermittently under quiet conditions associated with contemporaneous arenaceous sedimentation.

The striking difference in the degrees of metamorphism of the Mount Isa Group and the Mount Isa Greenstone suggests that the latter has been subjected to more earth movement and consequently is the older rock unit. There is no evidence of contact metamorphism between the Mount Isa Group and the Mount Isa Greenstone; the anomalous blocks of Mount Isa Greenstone within the Mount Isa Group consist of both greenstone and sedimentary members. Thus the Mount Isa Group/ Mount Isa Greenstone contact would appear to be a fault. No contacts have been studied at the surface, but drilling logs record shearing and quartz-veining in the vicinity of the contact.

It has been suggested that the Mount Isa Greenstone is infaulted Eastern Creek Volcanics. However, the origin of the Mount Isa Greenstone remains a controversial issue.

Group 7. Dolerite dykes invade the Mount Isa Group. A specimen of the rock consisted of sericitised feldspar, biotite, opaque iron mineral, quartz, and rare sphene. The dykes are thoroughly weathered at the surface.

Structure

The complex Mount Isa Fault, which extends for the total length of the survey area, represents the major structural feature within the area. The fault was possibly active during deposition of the Myally and Judenan Beds and again during deposition of the Mount Isa Group. Later, high-angle, reverse faulting accompanied the second orogenic compressive phase and it seems probable that the large resultant displacement was due primarily to a shear or transcurrent movement. This final movement brought together a western block of relatively simple structure and an eastern block that is extensively faulted and moderately folded. The dividing fault plane dips between steeply-west and near-vertical, as in the vicinity of Mount Isa and the Northern Leases.

The western block consists of four major geological units: the Judenan Beds, Eastern Creek Volcanics, Sybella Granite, and undifferentiated schists. Immediately west of the Fault, north-striking Judenan Beds dip west at a high angle and appear to be overturned. Eastern Creek Volcanics have an approximately vertical dip and, coupled with the Judenan Beds, represent the western limb of a major syncline, which has been thrust over and along the eastern block. The outcrop of the Sybella Granite dominates the southern half of the western block and its contact with the adjacent sediments and metamorphics is essentially meridional. A disparity in the grade of metamorphism on the two sides of the fault indicates some post-granite movement.

The eastern block represents the eastern limb of a truncated major syncline which both strikes and pitches to the north. The major geological units includedare the Argylla Formation, Mount Guide Quartzite, Kalkadoon Granite, Eastern Creek Volcanics, Myally Beds, and Mount Isa Group. Regional dip to the west is approximately 60°.

The Mount Guide Quartzite, Eastern Creek Volcanics, and Myally Beds have been extensively ruptured by systems of near-parallel faults, which trend roughly north-east and north-west, and by radial faults distributed about a general north-north west direction. Faults in the latter system are particularly common to Myally Beds and Eastern Creek Volcanics in the vicinity of latitude 20°40'S, and have resulted in a local change of outcrop and strike of the Eastern Creek Volcanics, the strike trending towards the east. Further north, Eastern Creek Volcanics, with strike veering from a north-east to an east-north-east direction, appear to have suffered less faulting.

Outcrops of folded and faulted Mount Isa Group, representing the youngest strata in the truncated syncline, are controlled by the older, west-dipping strata to the east, and by the Mount Isa Fault to the west. Strike-faulting forms one of the most important features in the area of outcrop of the Mount Isa Group. Immediately south of latitude 20° 40'S, individual units within the Mount Isa Group appear to dip westerly at an angle of about 65° and maintain a fairly uniform width of outcrop. In the vicinity of Lake Moondarra, however, the width of outcrop of the Moondarra Siltstone increases considerably and minor synclinal and anticlinal structures occur.

To the south of Mount Isa, an inlier of Eastern Creek Volcanics is bounded by the Crystallena, Leichhardt, and Native Bee Faults, the Crystallena fault distorting the outcrops of the Mount Isa Group succession. Strata of Urquhart Shale, or younger, have not been recognised south of the inlier.

In the extreme north of the survey area, Eastern Creek Volcanics appear to plunge beneath the Mount Isa Shales and Myally Beds. They crop out again to the west, forming a syncline and associated anticline.

<u>Mineralisation</u>

The orebodies may be separated into two, quite distinct types: copper orebodies and silver-lead-zinc orebodies. The main lodes, for both types of mineralisation, are located within a mile or two of Mount Isa township, where all the major economic orebodies occur within the Urquhart Shale, a thin-bedded shale, 3500 ft thick.

Copper mineralisation. At Mount Isa, this occurs in silica-dolomite bodies, which, although locally concordant, occur as a zone that transgresses the bedding of the Urquhart Shale, the host rock for the mineralisation. The silica-dolomite bodies occupy zones of fractured and brecciated shales, which have been impregnated and partly replaced by dolomite and quartz. The copper ore, consisting in the main of chalcopyrite, pyrrhotite, and pyrite, is localised in many fractures induced by shearing. Magnetite is present in very small quantities.

In the Black Star section of the Mount Isa mine, the two orebodies, mineable only below 800 ft from the surface, strike north and dip west at a steeper angle than the surrounding shale. They pitch north at a similar angle to that of the silver-lead-zinc orebodies and successive orebodies occur stratigraphically lower in the shale succession and are to the south of those above. The '500 orebody' occurs stratigraphically below and to the south of the Black Star orebodies.

The Black Rock oxidised orebody, whose surface expression was only a very small outcrop, consists of native copper and copper carbonates, oxides, and silicate. It occurs in the hangingwall of the Black Rock silver-lead-zinc orebodies. An extensive supergene zone of chalcocite and native copper has been proved below this oxidised zone.

Further copper mineralisation is known at several places along the boundary between the Eastern Creek Volcanics and the Mount Isa Group, for example at Cluny, Judy Lyn, Eagles Nest, Copper Conquest, Native Bee, and Stone Axe. Thus the copper mineralisation is not confined to the Urquhart Shale.

Silver-lead-zinc mineralisation. This usually occurs as thin layers (although locally it may be as much as several feet thick) separated by barren shales, giving the ore a banded appearance. The mineralisation follows the bedding of the host rock with minor concentration along fault planes and fractures. The ore minerals are galena, sphalerite, and lesser tetrahedrite with gangue minerals, pyrite, pyrrhotite, quartz, graphite, and carbonate minerals. The minerals are highly altered in the oxidised zone, which extends 175 to 200 ft below the surface. The secondary lead and zinc minerals are cerussite, smithsonite, anglesite, pyromorphite, phosgenite, leadhillite, hydrocerussite, mimetite, and massicot. The pyrite has been altered to goethite and, where massive, has given rise to ferruginous jasper, which generally crops out prominently.

At the time of the aeromagnetic survey, fifteen silver-lead-zinc orebodies were known immediately west of Mount Isa township. Most of these orebodies average 10 to 20 ft in width although 'No.2 orebody' has been worked over a width of 180 ft. The orebodies dip west at 65° and strike north. They terminate at depth against the silica-dolomite bodies, which are the host for the rich copper mineralisation.

The Northern Leases area, twelve miles north of Mount Isa, at latitude 20°36'S and longitude 139°28'E, is another mineralised zone. The mineralisation is at only near-economic grade and information has been mainly derived from drill holes in the area. An account of the Northern Leases mineralisation has been given by Zimmerman (1961) and is based on a detailed study of the drill cores.

Mineralisation at the Northern Leases is known to occur in the top 1375 ft of the Urquhart Shale and may extend over an even greater stratigraphic thickness of this formation. Most of the drill holes were still showing some mineralisation at their greatest depth. The drill cores show irregular variations in the grade of mineralisation, some beds containing high concentrations of lead and zinc up to a few feet thick interspersed with beds of barren shale up to 100 ft thick. The lateral extent of the mineralisation is unknown.

3. RESULTS

Owing to the contrasting lithologies of adjacent formations, the general magnetic contour map (Plate 4) clearly outlines these different formations. The overall agreement between the geology and the total magnetic intensity contours is good; however, when studied in detail some discrepancies between the two are noticeable. A detailed study of the magnetic profiles and the aerial photographs, plus some further geological groundwork would probably enable satisfactory explanations of these discrepancies to be formulated, but only the magnetic profiles and the aerial photographs have been studied for this Record. There is no contrast in susceptibilities between individual units of the Mount Isa Group, as is shown by the detailed contour map (Plate 5). However, there are a number of magnetic anomalies over outcrops of the Mount Isa Group and, as the Mount Isa Group contains important economic mineralisation, a thorough study of the magnetic profiles, the surface geology, and, if possible, the sub-surface geology is necessary to determine the nature of the sources of these anomalies.

General Contours

The discrepancies between the magnetic contours and the surface geology, shown in Plate 4, have been studied by occasional reference to the aerial photographs and the magnetic profiles. An explanation of the discrepancies is given below, with a description of the main features of the general contour map.

Leichhardt Metamorphics - Kalkadoon Granite. Along the southern part of the eastern boundary of the survey area, the Mount Isa Mines Ltd geological map (Plate 4) shows Kalkadoon Granite and Mount Guide Quartzite, whereas Plate 2, based on the 4-mile geological series sheets, shows Leichhardt Metamorphics and Kalkadoon Granite (with some dolerite intrusions) and Mount Guide Quartzite. The amount of magnetic data collected over this area was not sufficient for a distinction to be made between Leichhardt Metamorphics, Kalkadoon Granite, and Mount Guide Quartzite, but these formations can be distinguished from the aerial photographs. The photographs show dyke swarms cutting the Leichhardt Metamorphics and a narrow band of Kalkadoon Granite lying between the Leichhardt Metamorphics and the Mount Guide Quartzites, as is shown in Plate 2. The magnetic data show three anomalies centred at 30,000S/49,500E, 38,500S/45,000E, and 47,500S/43,500E on the Mount Isa Mines Ltd reference grid. From an inspection of the aerial photographs, the anomaly centred at 30,000S/49,500E is apparently due to a large basic dyke intruded between the Mount Guide Quartzite to the north and the Leichhardt Metamorphics to the south. The anomaly centred at 38,500S/45,000E is apparently due to a smaller basic intrusion in the Kalkadoon Granite, whereas the anomaly at 47,500S/43,500E has no apparent surface expression. The similar magnetic features and the apparent lineation of the three anomalies suggests that they are all basic intrusions derived from the one source and of the same geological age.

Immediately north of Rifle Creek Dam, at the eastern contact between the Mount Guide Quartzite and the Kalkadoon Granite, an anomaly centred on 75,000S/48,000E indicates the presence of a basic intrusion. The 1600-gammas contour line practically defines the area of outcrop of this intrusion and a creek runs south into Rifle Creek Dam through this more easily weathered basic rock.

Argylla Formation - Leichhardt Metamorphics. In the south-east corner of the survey area, the only region of outcropping Argylla Formation corresponds to an unusually shaped contour pattern. However, the area of this pattern extends beyond the area defined as outcropping Argylla Formation, suggesting that the Argylla Formation, either as outcrop or covered with a thin layer of alluvium, lies within the boundary roughly indicated by the 1600-gamma contour line. The western boundary of this postulated area of Argylla Formation would extend along the 26,000E reference line southwards from 70,000S. Between this boundary and a line striking south-south-west from 70,000S/26,000E to 96,000S/19,000E, the map shows both Kalkadoon Granite and Mount Guide Quartzite. In this triangle the aerial photographs show dykes striking north-north-east, which give rise to only slight magnetic disturbances on the magnetometer records.

Kalkadoon Granite. The Kalkadoon Granite extending north from the 64,000S reference line is featureless magnetically, as is to be expected from a homogeneous granite mass. No magnetic disturbance appears over the contact between the Kalkadoon Granite and the Mount Guide Quartzite, indicating that these formations have very similar magnetic properties at the contact.

Mount Guide Quartzite. Plate 2 shows two basic dykes intruding the Mount Guide Quartzite about eight miles south-east of Mount Isa. On the Mount Isa Mines Ltd reference grid (Plate 4), one of these dykes would be centred at 25,000S/40,000E and the other would strike north-north-east from 21,000S/44,000E. Although the two dykes are obvious on the aerial photographs, they do not have any expression on the magnetic field profiles. The profiles show a slightly disturbed field over the block of Mount Guide Quartzite to the north-west of the dykes. This is apparently due to magnetic minerals contained in some of the sedimentary beds of this formation. Insufficient magnetic data were collected over this block to make it possible to delineate the beds containing the magnetic minerals.

Eastern Creek Volcanics. The western outcrop of Eastern Creek Volcanics lies along the western boundary of the survey area and was not fully surveyed owing to there being insufficient photo coverage for navigation purposes. The part for which there are magnetic contours shows a disturbed magnetic field of a similar nature to the field over the eastern band of Eastern Creek Volcanics.

A complex pattern exists on the magnetic contour map over the eastern bank of Eastern Creek Volcanics. Only occasionally can the trends on the contour map be related to the strike of the beds on the aerial photographs, so that it is suspected that there are many faults, across the strike of the beds, that give rise to the complex contour pattern shown in Plate 4. The individual beds making up the Eastern Creek Volcanics are too narrow to show up as individual features on the magnetic contour map; this adds to the difficulty of relating magnetic features to geology. An obvious feature within the Eastern Creek Volcanics is the area of low magnetic field that extends from 13,500S/26,000E north to 9500N/28,500E. On the aerial photographs, this is identified as a dyke, cut by a fault at the position where it is crossed by Breakaway Creek. Plate 2 shows it as two separate dolerite dykes, one north and one south of Breakaway Creek. Usually, a dolerite dyke gives rise to a 'high' in the magnetic field, so this dyke either has remanent magnetisation that causes a magnetic 'low' or contains little magnetic mineral in comparison with the adjacent Eastern Creek Volcanics.

Three magnetic 'highs' centred at 75,000S/8000E, 79,000S/6000E, and at 84,000S/5000E would appear to be due to Eastern Creek Volcanics rather than the Mount Guide Quartzite shown in Plate 4.

Epigenetic deposits of uranium mineralisation and associated magnetite are known within the Eastern Creek Volcanics. One of these, the Counter deposit, lies on the eastern boundary of the survey area but does not appear to give rise to a significant feature on the magnetic contour pattern.

<u>Lena Quartzite</u>. Throughout the eastern block of the Eastern Creek Volcanics, the Lena Quartzite generally shows up as bands of relatively low magnetic field amongst the complex 'highs' and 'lows' of the remaining Eastern Creek Volcanics. There are three exceptions to this, and they appear to occur in areas of alluvial cover that have been tentatively mapped as Lena Quartzite. Within the main block of Eastern Creek Volcanics, a magnetic 'high', centred at 36,000S/15,000E over Lena Quartzite, has an amplitude that suggests it is due to underlying Eastern Creek Volcanics rather than Lena Quartzite. The southernmost inlier of Eastern Creek Volcanics in the Mount Isa Group has a magnetic 'high' centred at 45,500S/8000E whose source is considered to be a triangular block of unmapped Eastern Creek Volcanics. The suggested southern boundary of such a block is a continuation of the fault that strikes west-north-west in the adjacent Lena Quartzite. The eastern boundary would correspond to that marked as the boundary of the Lena Quartzite and the north-western boundary would be along the edge of the outcropping Lena Quartzite. Another magnetic 'high' centred at 51,500S/7000E is also suggestive of Eastern Creek Volcanics. The western boundary of the block of Eastern Creek Volcanics immediately to the south probably extends north into the area shown as Lena Quartzite.

<u>Myally Beds</u>. The Myally Beds do not cause any disturbance to the magnetic field, except for three prominent magnetic 'highs'. One of these is adjacent to the Lake Moondarra dam wall, where a tongue of Myally Beds protrudes westwards into Lake Moondarra. The magnetic 'high' centred at 54,500N/34,000E indicates that the outcropping Myally Beds is a capping on a block of Eastern Creek Volcanics, which is estimated to be 200 to 300 ft below ground level.

The other two magnetic 'highs' are similar both in magnetic contour pattern and geological occurrence. One magnetic 'high' is centred at 25,500S/12,500E and the other is further south at 41,000S/13,000E. The magnetic 'highs' are of approximately the same amplitude and both occur over an area mapped as Myally Beds. In each case, conglomerate beds have been mapped, presumably on the ground, so that the identification of Myally Beds should be correct. However, the magnetic features indicate a narrow, north-striking block of Eastern Creek Volcanics at ground level as the source of both features. If this is the explanation of the two magnetic features, then presumably the blocks of Eastern Creek Volcanics have a thin capping of Myally Beds at the surface.

In the north of the survey area, a twin-peaked magnetic 'high' occurs over Eastern Creek Volcanics, Myally Beds, and Moondarra Siltstone. The northern peak is centred at 74,000N/10,500E and its source is estimated to be at a depth of 500 to 700 ft below the surface. The southern peak is centred at 71,500N/11,000E and has a source estimated to be at a depth of 250 to 400 ft below the surface. Corresponding to the magnetic 'high', a radiometric anomaly has been detected (Mulder, 1961), which extends from the centre of the magnetic 'high' westwards for about 4000 ft. The radiometric anomaly was 2.3 times background level when detected at a height of just over 100 ft above ground level. This association of magnetic and radiometric anomalies suggests that there is a common source, namely uranium mineralisation and associated magnetite. The magnetic profiles indicate that the sources are contained within a block or blocks of Eastern Creek Volcanics. The two magnetic peaks have approximately the same amplitude and if they both have the same type of source, then presumably the source for the northern peak is larger in areal extent than that for the southern peak, which is much closer to the surface. No attempt has been made to estimate the areal extent of the sources. The complex structure of the surrounding blocks of Eastern Creek Volcanics cause so much disturbance on the magnetic profiles that no reliable estimate could be derived.

Judenan Beds. Geologically, the Judenan Beds are an obvious north-striking bank on the western side of the survey area. The magnetic contour pattern corresponds well with this band to the north of Mount Isa but not so well to the south.

Features on the contour pattern to the south of the zero reference line do not correlate well with the physical features shown on the aerial photographs. The photographs indicate a complex structure for the Judenan Beds in this region, which apparently is too complex to enable a good correlation to be made between the available magnetic data and the geological features.

A distinctive feature of the Judenan Beds in the north-west section of the survey area is the magnetic 'ridge' between 85,000N/16,000W and 52,000N/4000W. This is tentatively identified as a basic volcanic flow within the sedimentary sequence. These Judenan volcanics are underlain by sedimentary beds of low magnetic susceptibility, which give rise to the low magnetic field shown over the western half of the Judenan Beds. The volcanics are pinched out at 51,000N/3000W between these underlying sediments and the Mount Isa Fault. The contact here is of particular interest, as comparison could be made at this point between the Mount Isa Greenstones that crop out to the immediate east of the Fault and the Judenan volcanics that crop out to the immediate west of the Fault.

The magnetic 'ridge' ends at the point where the Judenan volcanics abut the Mount Isa Fault. Another 'ridge' starts immediately west of this point and strikes south along the centre of the Judenan Beds. This is tentatively identified as a faulted or folded continuation of the Judenan volcanics. This part of the Judenan volcanics is also obvious on the aerial photographs. They extend from about 54,500N/7500W southwards to the vicinity of Spear Creek in accordance with the magnetic 'ridge'. To the south and west of these volcanics the Judenan Beds take on the complex structure that is indicated for the southern half of the Beds within the survey area; again, the magnetic contour pattern cannot be easily related to features on the aerial photographs.

It is apparent from both the aerial photographs and the magnetic contours that there is a marked difference between that part of the Judenan Beds to the north of Spear Creek and that part to the south. The greater complexity of the southern Beds is usually attributed to a higher grade of metamorphism induced by the movement of the Mount Isa Fault. Another possibility is that the northern Beds strike obliquely to the Mount Isa Fault and are sheared off against the Fault. The southern Beds would then be an older formation underlying these northern Beds.

<u>Mount Isa Group</u>. The magnetic contour pattern (Plate 4) shows that the Moondarra Siltstone does not generally cause any disturbance of the magnetic field, as would be expected from a rock of this type. Thus two magnetic 'highs' that were detected over the Moondarra Siltstone are attributed to another rock type. In both cases, a consideration of the amplitude of the magnetic 'high' and the depth of burial of the source led to the hypothesis that the source is a block of Eastern Creek Volcanics. The northernmost magnetic 'high', of the order of 200-gammas amplitude, is centred at 55,500N/14,000E (Plates 4 & 5) and has an estimated source depth of 1400 to 1500 ft below the surface. Assuming a prismatic shape for the source, the north-south extent was estimated to be 3000 ft and the east-west extent was estimated at 2000 ft. The southern magnetic 'high', also of the order of 200 gammas in amplitude, is centred at 13,000S/12,000E (Plate 4) and has an estimated source depth of 1200 to 1300 ft below the surface. The adjacent structures are too complex to enable the size of the source to be estimated.

A magnetic 'high' in the form of a ridge over the Mount Isa Fault is a feature of both Plates 4 and 5. Parts of this feature are better defined in Plate 5 and will be described later. Broadly, the feature is ascribed to the presence of the Mount Isa Greenstone along the eastern side of the Mount Isa Fault from the north-west corner of the survey area to the vicinity of King Gully. No surveying could be done over the Mount Isa Fault from King Gully (15,000N) to about 4000S, but Mount Isa Greenstone crops out along the Fault from 8500N to 9500S. There are no outcrops of Mount Isa Greenstone further south and, although there are magnetic 'highs' associated with the Mount Isa Fault to the south, the presence of Mount Isa Greenstone is not favoured as an explanation of these magnetic features.

The magnetic features associated with the Mount Isa Fault to the south are not well defined in Plate 4. This is due to the fact that the contour interval is too large to define these particular magnetic 'highs'. A study of the original magnetometer records showed that there is a magnetic 'high' in the form of a ridge extending south along the Mount Novit Fault with an occassional 'high' over the Mount Isa Fault. As a general rule, the greater the complexity of the faulting, the greater is the amplitude of the associated magnetic 'high'. An obvious expression of this feature is the magnetic 'high' in Plate 4 centred at 34,500S/2000E. This corresponds to a dark patch on the aerial photographs. Similar dark shading on the aerial photographs is associated with the Mount Novit Fault over its full length; an occassional thin white line is also present. The thin white line is tentatively identified as a quartz dyke and the dark shading is probably due to hematitic iron staining from mineralisation that intrudes the fault and also causes the magnetic 'high'. The magnetic 'ridge' over the Mount Novit Fault has, generally, an amplitude of 20 gammas, but exceeds 100 gammas in some places. It extends from 34,500S to 74,500S.

A magnetic 'high' of 70-gammas amplitude, centred at 30,000S/000, occurs within the Native Bee Siltstone. There is no expression of this feature on the aerial photographs and it could be associated with the Mount Novit mineralisation, the adjacent block of Eastern Creek Volcanics, or the adjacent Judenan Beds.

No further definite magnetic features were detected over the Mount Isa Group south of Mount Isa. A survey flight over the Mount Isa Group between 7000S and 17,000S revealed a number of small-scale magnetic features, but the results of this flight are suspect, so that there is no reliable information on small-scale magnetic features in this area of the Mount Isa Group.

<u>Detailed Contours</u>

The Mount Isa Group to the north of Mount Isa township, like the area of outcrop to the south, is practically featureless on the magnetic contour map shown in Plate 4. The results of the much more detailed survey made over the Mount Isa Group to the north of King Gully are included in the contour map shown in Plate 5. These results were contoured with a 10-gamma contour interval and reveal a number of low-amplitude magnetic features of geophysical interest, which are enumerated in Plate 6.

<u>Feature 1</u>. The feature is a broad magnetic 'high' with a maximum amplitude of about 11 gammas. A rough estimate of the depth of the source is 400 ft below the surface. The 'high' occurs over folded and faulted Breakaway Shale that contains numerous, minor, quartz-filled fissures and faults. The shading in Plate 6 merely shows the general anomalous area and not the definite boundaries of the source. Within this general area, the surface rock has a red-brown colour, presumably due to hematite, which contrasts with the light-grey colour of the surrounding rocks. Differential weathering of the Breakaway Shale has exposed thin sheets or beds of rock, rich in hematite. These appear to be more common in the vicinity of quartz-filled fissures. Hand specimens of the Breakaway Shale usually contain cubic cavities due to the weathering-out of pyrite crystals. Mineralisation associated with the quartz filling of fissures may contain some magnetic minerals that cause the magnetic anomaly; the hematite on the surface could be the weathered product of this mineralisation.

Feature 2. The next magnetic feature of interest is a magnetic 'high' of 40-gammas amplitude over the Breakaway Shale. The depth of the source is estimated to be 600 to 700 ft below the surface. At this depth the limits of the source would be reasonably well-defined by the points of inflection on the magnetic profiles, and these have been used to mark the boundary of the source in Plate 6. The source is estimated to be 2000 ft wide and 4000 ft long. If the Breakaway Shale has a dip of 60° to the west, the source must be contained entirely within this formation. Its southern boundary is marked by a fault across the Breakaway Shale.

From the amplitude of the anomaly, it is unlikely that the source is either Greenstone or Eastern Creek Volcanics, as anomalies 1000 ft above outcrops of the latter are usually of the order of 500 gammas in amplitude and the Greenstone is similar magnetically. The amplitude and shape of the anomaly are consistent with a region of mineralisation (involving pyrrhotite, magnetite, or ilmenite) of the stated dimensions and confined to the Breakaway Shale.

Feature 3. This magnetic feature marked '3' is barely noticeable on the contour map (Plate 5). It appeared on the magnetic profiles as a magnetic 'high' superimposed on the broader features shown by the contours in Plate 5. Plate 6 shows the approximate anomalous area by shading, as the boundaries of the source could not be delineated. The amplitudes of the magnetic 'high' derived from the various magnetic profiles ranged from 7 gammas to 18 gammas with a mean of 11 gammas. Estimates of the depth of the source below the surface ranged in value from 20 to 380 ft with a mean of 170 ft.

The known mineralisation at the Northern Leases was not detected by the magnetometer, but this was to be expected as the magnetic component of the mineralisation is pyrrhotite and the mineralisation occurs in narrow beds between much thicker beds of unmineralised shale. Some type of mineralisation is envisaged as the source of Feature 3 adjacent to the Northern Leases mineralisation but, if pyrrhotite is the magnetic component, it must permeate a much greater thickness of shale than is the case for the known mineralisation. The magnetic feature is locally concordant with the bedding but, overall, transgresses it. These characteristics would not be expected from lead-silver-zinc mineralisation, but might be expected from copper mineralisation as found at Mount Isa. However, the magnetic component of the mineralisation could also be due to the presence of ilmenite or a very low concentration of either magnetite or maghemite.

Feature 4. A minor magnetic 'high', which was present on two adjacent magnetic profiles, is marked '4' in Plate 6. Owing to the small amplitude of this feature (4 to 5 gammas), no estimate could be made for the depth of the source, nor is there anything to indicate what the nature of the source may be.

Feature 5. A dyke striking north-north-east across the Moondarra Siltstone is the source of the magnetic feature marked '5' in Plate 6. The positions of the local maxima and minima, related to this feature and derived from the magnetic profiles, are marked in Plate 6. The minima approximately coincide with the position of the dyke, which implies that the dyke is magnetised in a direction opposite to that of the Earth's magnetic field.

The line of local minima across the Moondarra Siltstone and Breakaway Shale at Spear Creek is presumably the same dyke separated from the mapped section by faulting related to the faulting further west at the Moondarra Siltstone/Breakaway Shale contact. A low-amplitude magnetic feature also occurred on profiles recorded elsewhere over the mapped position of the dyke. However, these profiles were recorded at a low magnetometer sensitivity and, because of the presence of noise on the records, maxima and minima on individual profiles could not be resolved and no attempt was made to plot them in Plate 6.

Feature 6. Although not apparent in Plate 5, a magnetic 'ridge', marked '6' in Plate 6, extends along the Breakaway Shale/Native Bee Siltstone contact from 41,500N to 17,000N, the southern limit of the detailed surveying. The northern half of this feature is of sufficient amplitude to enable depth estimates to be made. Over a number of selected profiles, the amplitude of the magnetic 'high' ranged from 9 gammas to 21 gammas with a mean of 14 gammas. The depth estimates for the depth of the source below the surface range from 160 to 430 ft with a mean of 280 ft. The amplitude of the magnetic 'high' decreases to the south and no depth estimates could be obtained over the southern half of the feature. The points of inflection of the magnetic profiles have been plotted in Plate 6 to indicate the approximate boundaries of the source.

From the plotted points of inflection, it can be seen that the source boundaries are exactly parallel to the Breakaway Shale/ Native Bee Siltstone contact, which in turn is usually exactly parallel to the bedding of these formations. This is indicative of a sedimentary origin for the magnetic mineral causing the anomaly. One possible explanation for the magnetic feature is the presence of lead-silver-zinc mineralisation of the Northern Leases type, but having much thicker mineralised beds so that there would be sufficient concentration of pyrrhotite to cause the observed magnetic anomaly. In support of this is the fact that the Breakaway Shale contains limonite as pseudomorphs after pyrite and this pyrite may be a later generation of bedded, first-generation pyrite. The Native Bee Siltstone also contains cross-fractured beds as does the Urquhart Shale. These indicate that there was volcanic activity during the laying down of the Native Bee Siltstone, which could have provided the mineral-enriched solutions necessary for a Northern Leases type of mineralisation.

Another possible explanation is that sedimentary magnetite or ilmenite has been deposited from the weathering of a basic igneous rock such as a block of Eastern Creek Volcanics. In support of this is the fact that sub-greywackes are predominant in the lower 350 ft of the Native Bee Siltstone.

Mount Isa Greenstone. South of 78,000N a magnetic 'ridge' corresponds with the mapped Mount Isa Greenstone. The magnetic 'high' at 63,500N/3000W in Plate 5 indicates that Greenstone is present below the Magazine Shale, as a small outcrop of Greenstone occurs in the Spear Siltstone to the north-east of this point. On this basis, the magnetic 'high' at 33,500N/1000W occurring over the Magazine Shale is taken to imply that Greenstone is present below the Magazine Shale. Another magnetic 'high' at 33,000N/2000W has about the same amplitude as the anomalies over the Mount Isa Greenstone, but it occurs over the Judenan Beds to the west of the Mount Isa Fault, which is supposed to mark the boundary between the Mount Isa Greenstone and the Judenan Beds.

Thus no identification for the source of this anomaly can be suggested. The magnetic 'high' over 18,500N/250W is also assumed to be due to Greenstone at depth, which shows that the Greenstone continues south along the Mount Isa Fault from the area of outcrop.

From Plates 4 and 5, it is evident that the Mount Isa Greenstone is represented magnetically by a series of 'highs' rather than by a constant-amplitude 'ridge', which indicates that the Greenstone is not a homogeneous body. This is consistent with the description of the Greenstone as a volcanic-sedimentary sequence.

4. CONCLUSIONS

The airborne magnetometer survey showed a general agreement between the magnetic data and the geological map supplied by Mount Isa Mines Limited. Minor discrepancies do exist and these have been enumerated and an attempt has been made to explain them. Some surface features that are not shown on the geological map were detected during the survey. The nature and position of these features have been described.

Sub-surface features detected during the survey have been attributed to two different types of source. Eastern Creek Volcanics and Mount Isa Greenstone form one type of source buried within the Mount Isa Group. The other type has been explained as mineralisation within the Mount Isa Group. Probable mineralisation was detected along the Mount Novit Fault and in faulting of the Breakaway Shale in the very north of the survey area. Possible mineralisation was detected east and south of the Northern Leases and along the Breakaway Shale/Native Bee Siltstone contact east of Mount Isa airport.

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JOPLIN, G.A. and WALKER, K.R.	1960	The Precambrian granites of north-western Queensland. Bur. Min. Resour. Aust. Rec. 1960/50 (unpubl.).
MULDER, J.M.	1961	Mount Isa area airborne radiometric survey, Queensland, 1959. Bur. Min. Resour. Aust. Rec. 1961/74.
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APPENDIX

Operational details

Method

An overall picture of the variation in the magnetic field was obtained by flying east-west reconnaissance lines spaced one mile apart over the survey area using a magnetometer sensitivity of approximately 100 gammas per inch and at a detector altitude of 250 ft above ground level.

The results of the reconnaissance showed that a magnetometer sensitivity of 80 gammas per inch could be used over the Eastern Creek Volcanics, magnetically the most 'active' formation in the survey area. A second set of east-west lines were flown at this sensitivity over the Eastern Creek Volcanics, the Judenan Beds, the Myally Beds, and the Mount Isa Group. The additional lines were positioned midway between the reconnaissance lines.

Better definition of the magnetic field was required over the Mount Isa Group and a third set of east-west lines was flown using a magnetometer sensitivity of 20 gammas per inch, midway between the lines already flown. These lines extended across the Mount Isa Group giving a coverage for this formation of lines spaced one quarter of a mile apart.

The Mount Isa Group crops out as a very narrow band south of Mount Isa and it was decided that further surveying in this area was therefore not warranted. Small-scale magnetic features had been detected in the Mount Isa Group north of Mount Isa and detailed surveying was done over the area of outcropping Mount Isa Group north of Mount Isa, as shown in Plate 1. This consisted of lines flown in a westerly direction, spaced one tenth of a mile apart and using a magnetometer sensitivity of 20 gammas per inch.

Correction for diurnal variations of the Earth's magnetic field were made using a standard baseline. Changes in total magnetic field greater than three gammas in any three-minute period grounded the aircraft. No statistical check of the error in aircraft positioning has been made, but this error has been estimated to be less than 100 ft.

Estimates of the depth of a magnetic source below ground level were made using Peters' half-maximum-slope method (Peters, 1949). A Peters' factor of 1.8 was derived from the magnetic profiles over Feature 2 (Plate 6) and used in depth calculations over the area in which detailed surveying was done. Elsewhere depth estimates were made using a factor of 1.6.

Equipment

Aircraft: Cessna 180

Magnetometer: MNZ1, proton precession, towed bird detector (30 ft below aircraft) coupled to a Westronix recorder and one channel of a TIC recorder; magnetic field recorded every two seconds.

Radio altimeter: AN/APN-1.

Camera: Modified Vinten frame, 35-mm, 186° field of view. Operated once every four seconds.

Storm warning magnetometer: MFD3, transistorised fluxgate; recorded continuously on an Esterline-Angus recorder in fixed direction approximating the total field vector.

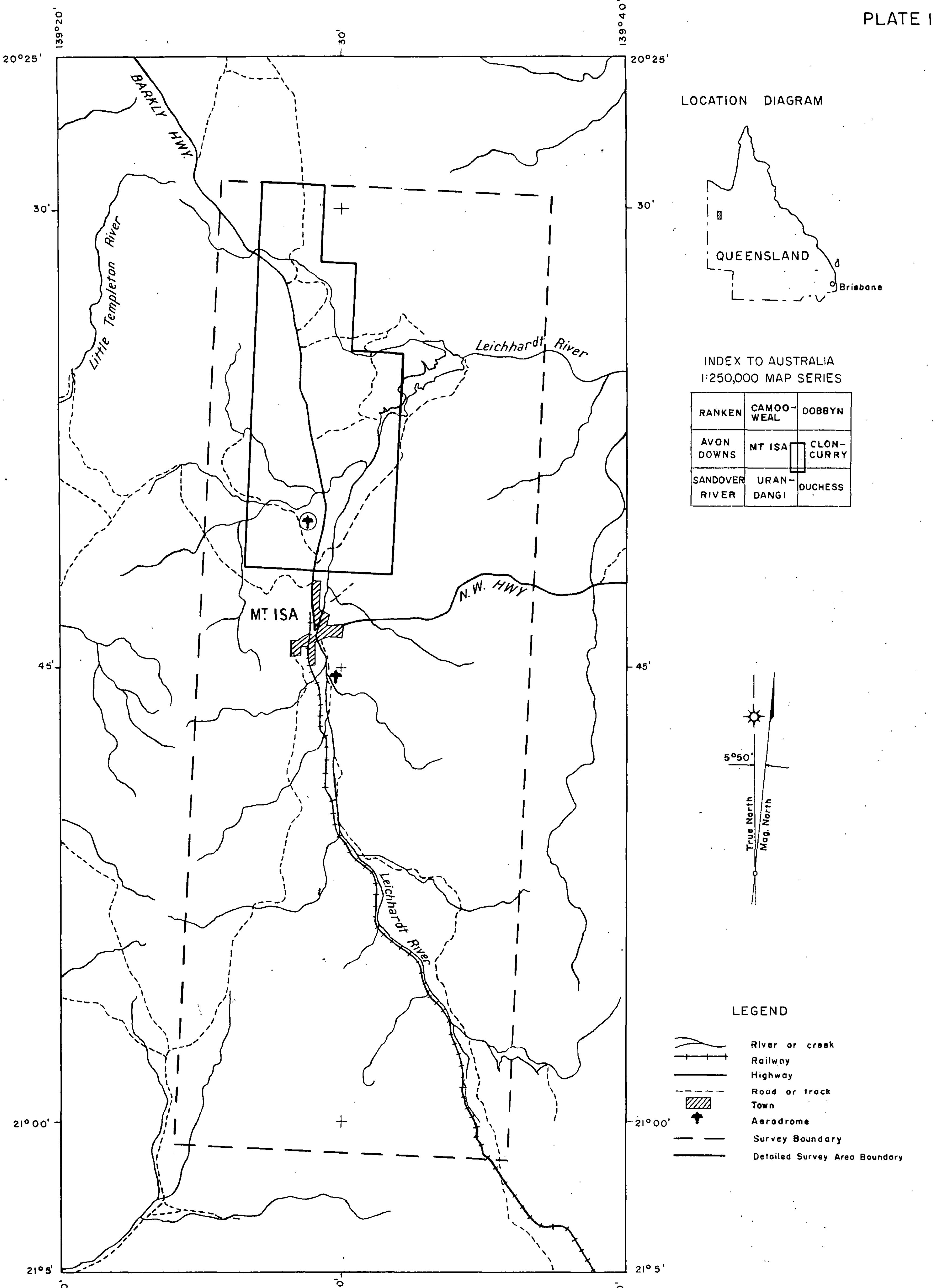
Staff

Personnel engaged in the survey were:

BMR: G.A. Young, B.A. Dockery, D.B. Tipper, J.S. Milsom, A. Crowder, P. Zerial, A.S. Scherl, D. Park.

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

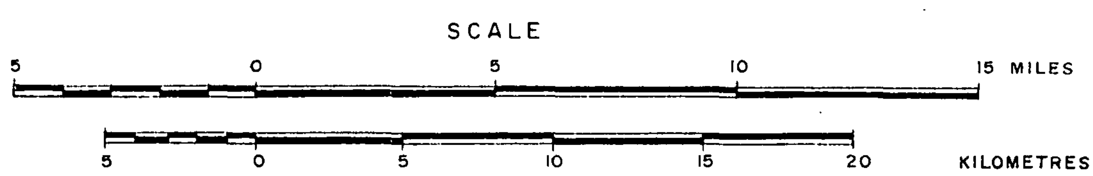
PLATE I



MOUNT ISA MINERAL FIELD QUEENSLAND

AEROMAGNETIC SURVEY 1963

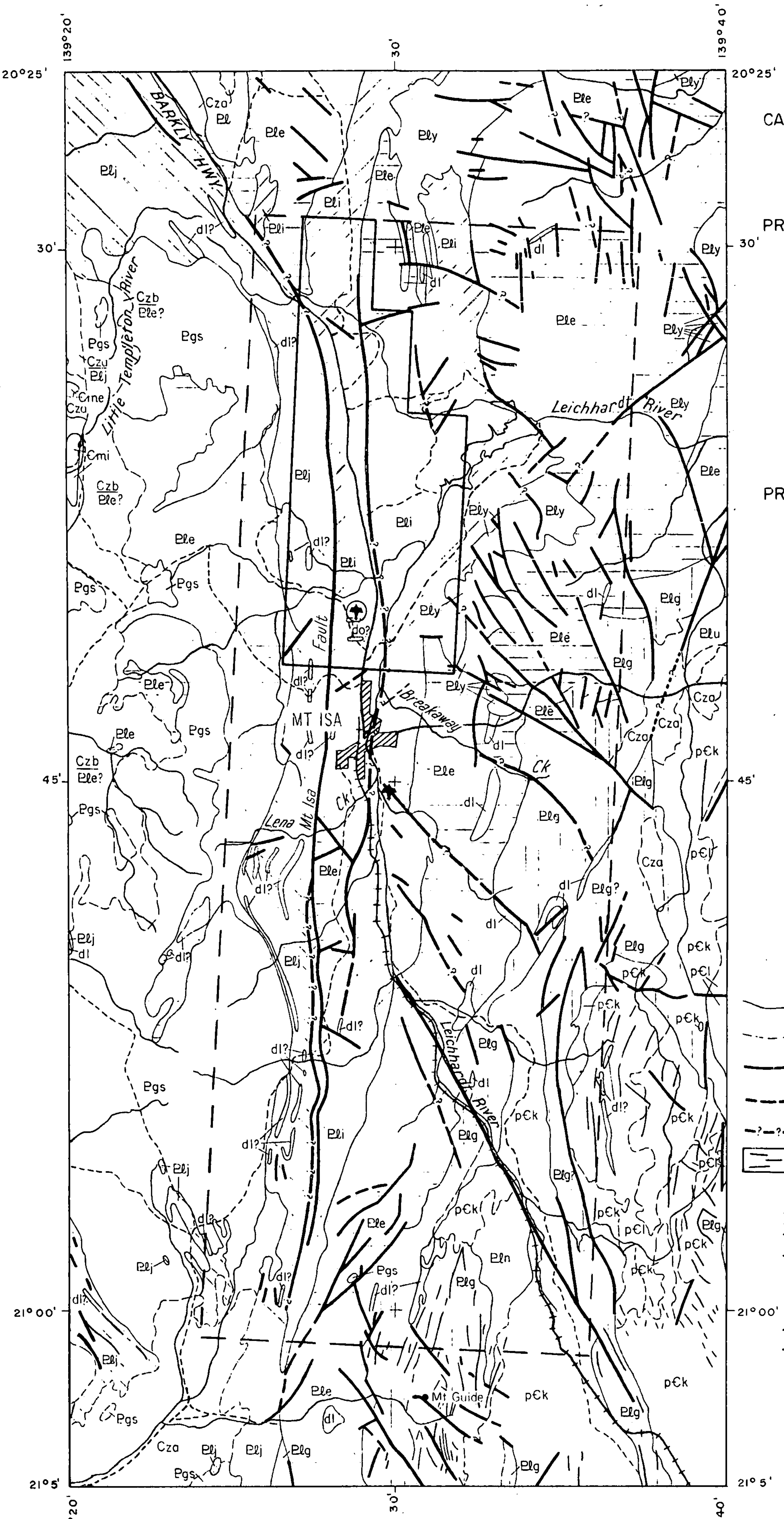
LOCALITY MAP



Geophysical Branch, Bureau of Mineral Resources, Geology and Geophysics. F54/BI-15

To Accompany Record No 1965/25

PLATE 2



REFERENCE

CAINOZOIC	Soil and alluvium	Cza
	Alluvial black soil	Czb
UPPER PROTEROZOIC	Dolerite	do
	Granite emplacement	
LOWER PROTEROZOIC	Metadolerite and gabbro	dl
	Mount Isa Group	Pℓi
	Judenan Beds	Pℓj
	Myally Beds	Pℓy
	Probable granite emplacement	
	Eastern Creek Volcanics	Pℓe
	Mount Guide Quartzite	Pℓg
	Argylla Formation	Pℓn
	Undifferentiated	Pℓ
	Probable granite emplacement	
	Leichhardt Metamorphics	p€l
	Granites	
	Kalkadoon Granite	p€k
	Sybella ("Templeton") Granite	Pgs

These are composite bodies, each probably of two ages in the Proterozoic. The Kalkadoon Granite may also include ? Archaean intrusives.

Established geological boundary, position accurate
Established geological boundary, position approximate
Established fault, position accurate
Established fault, position approximate
Inferred, probable or indefinite fault
Dykes

LEGEND

River or creek
Railway
Highway
Road or track
Town
Aerodrome
Survey boundary
Detailed survey area boundary

Geological and planimetric mapping after 4 mile Geological Series Sheets: F54-1 First Edition 1959; F54-2 First Edition 1958; F54-5 Second Edition 1958; F54-6 First Edition 1961. Bureau of Mineral Resources, Geology and Geophysics. Transverse Mercator Projection.

MOUNT ISA MINERAL FIELD, QUEENSLAND

AEROMAGNETIC SURVEY 1963

REGIONAL GEOLOGY

SCALE

5 0 5 10 15 MILES

5 0 5 10 15 20 KILOMETRES

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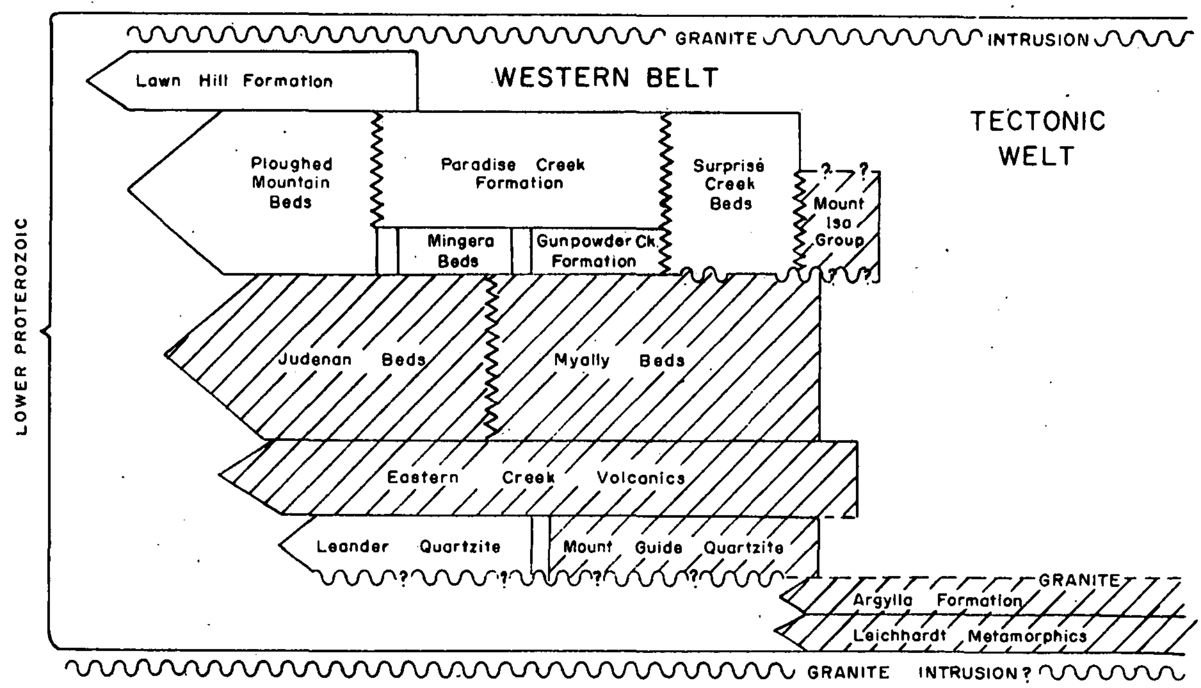
SCHEMATIC REPRESENTATION OF RELATIONSHIPS OF PRECAMBRIAN STRATIGRAPHIC UNITS

[AFTER CARTER, BROOKS, AND WALKER (1961, FIGURE 8)]



LEGEND

(wavy line)	Unconformity
(wavy line with straight segments)	Local unconformity
- - - - - - -	Disconformity
(zigzag)	Transitional or arbitrary boundary between contemporaneous units
(hatched box)	Units cropping out in survey area

AEROMAGNETIC SURVEY, MOUNT ISA MINERAL FIELD, QUEENSLAND, 1963

Geophysical Branch, Bureau of Mineral Resources, Geology and Geophysics. F54/B1-19

To Accompany Record No 1965/25

PLATE 4

AEROMAGNETIC SURVEY, MOUNT ISA MINERAL FIELD, QUEENSLAND, 1963

TOTAL MAGNETIC INTENSITY CONTOURS

(GENERAL)

CONTOUR INTERVAL 100 GAMMAS

True North
Magnetic North
5° 50'

STRATIGRAPHIC COLUMN

MOUNT ISA GROUP
- *Magazine Shale*
- *Kennedy Siltstone*
- *Spear Siltstone*
- *Urquhart Shale*
- *Native Bee Siltstone*
- *Breakaway Shale*
- *Moondarra Siltstone*

JUDENAN BEDS
- *Judenan Beds*

MYALLY BEDS
- *Quartzite Marker*
- *Myally Beds*

EASTERN CREEK VOLCANICS
- *Lena Quartzite*
- *Eastern Creek Volcanics*

MOUNT GUIDE FORMATION
- *Mount Guide Formation*

ARGYLLA FORMATION
- *Argylla Formation*

UNDIFFERENTIATED ROCKS

Undifferentiated Volcanics (Greenstones)
Undifferentiated Quartzites and Schists

GRANITES

Kalkadoon Granite
Sybella Granite

DYKES AND PEGMATITES

Dyke
Pegmatite

GEOLOGICAL BOUNDARIES

Established boundary, Position accurate
Established boundary, Position approximate
Inferred boundary
Anomalous relationship (Unconformity? disconformity? fault?
Outcrop boundary

STRIKE AND DIP OF STRATA

Inclined
Overturned
Vertical
Horizontal
Trend lines

FAULTS

Established fault, Position accurate
Established fault, Position approximate
Inferred fault

CLEAVAGE

Cleavage, inclined
Cleavage, vertical

FOLIATION

Foliation inclined

ROCK TYPES

Breccia
Conglomerate
Pegmatite

MINERAL DEPOSITS

Mine workings
Mineral occurrence
Costean
Drillhole
Shaft
Lease boundary

CULTURAL DETAIL

Railway
Sealed road
Vehicle track
Bridge
Causeway
Powerline
Telegraph line
Fence
Wind pump
Bore
Well

GEOPHYSICAL LEGEND

2000 1500 Magnetic contours with flight-line intersections
Magnetic "low"

NOTE

THE TOTAL MAGNETIC INTENSITY HAS NOT BEEN CORRECTED FOR THE REGIONAL MAGNETIC GRADIENT.

TOPOGRAPHY AND GEOLOGY FROM "GEOLOGICAL MAP OF MOUNT ISA DISTRICT" BY MOUNT ISA MINES LTD.

Feet 5000 4 3 2 1 0 2 4 6 8 10,000 Feet
Miles 1 0 1 2 Miles

Geophysical Branch, Bureau of Mineral Resources, Geology and Geophysics. F54/B1-24

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AEROMAGNETIC SURVEY, MOUNT ISA MINERAL FIELD, QUEENSLAND, 1963

TOTAL MAGNETIC INTENSITY CONTOURS

(DETAILED)

5000 4000 3000 2000 1000 0 2000 4000 6000 FEET

1 0 1 MILES

1 0 1 KILOMETRES

NOTES:-

THE TOTAL MAGNETIC INTENSITY HAS NOT BEEN CORRECTED FOR THE REGIONAL MAGNETIC GRADIENT

IN THE AREAS WHERE FLIGHT-LINE INTERSECTIONS OF CONTOURS ARE SHOWN THE CONTOURS HAVE BEEN DRAWN AT AN INTERVAL OF 20 OR 50 GAMMAS. ELSEWHERE THE FLIGHT-LINES WERE SPACED APPROXIMATELY 1/10 TH MILE AND THE RESULTS CONTOURED AT AN INTERVAL OF 10 GAMMAS.

LEGEND

GEOLOGICAL

MOUNT ISA GROUP
- Magazine Shale
- Kennedy Siltstone
- Spear Siltstone
- Urquhart Shale
- Native Bee Siltstone
- Breakaway Shale
- Moondarra Siltstone

JUDENAN BEDS
- Judenan Beds — Pℓj

MYALLY BEDS
- Quartzite Marker — q
- Myally Beds — Pℓy

EASTERN CREEK VOLCANICS
- Lena Quartzite — Pℓl
- Eastern Creek Volcanics — Pℓe

Undifferentiated Volcanics (Greenstones) — Pℓv

Dyke

Breccia

Conglomerate

Geological Boundaries

- Established boundary, Position accurate
- Established boundary, Position approximate
- Inferred boundary
- Anomalous Relationship (Unconformity? disconformity? fault?)
- Outcrop boundary

Strike and Dip of Strata

- Inclined
- Overturned
- Vertical
- Horizontal
- Trend lines

GEOLOGICAL

Faults

- Established fault, Position accurate
- Established fault, Position approximate
- Inferred fault

Cleavage

- Cleavage, inclined

Mineral Deposits

- Mine workings
- Mineral occurrence — Pb·Cu
- Costean
- Drillhole
- Shaft
- Lease boundary

TOPOGRAPHICAL

- River or creek
- Railway
- Sealed road
- Vehicle track
- Bridge
- Causeway
- Powerline
- Telegraph line
- Fence
- Wind pump
- Bore or Well

GEOPHYSICAL

- Magnetic contours
- Magnetic contours with flight-line intersections
- Magnetic low

TOPOGRAPHY AND GEOLOGY FROM GEOLOGICAL MAP OF MOUNT ISA DISTRICT BY MOUNT ISA MINES LTD.

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PLATE 6
AEROMAGNETIC SURVEY, MOUNT ISA MINERAL FIELD, QUEENSLAND, 1963
AREAS OF GEOPHYSICAL INTEREST
MOUNT ISA FAULT
North Branch
Spear
River
Creek
HIGHWAY
BARKLY
Mount Isa Airport
Doolan's Hope
QUARTZITE No 1 DDH
Pick Hill
Handlebar Hill
Northern
Tombstone Hill
Gidyea Hill
Tarmite Hill
Thirteen Mile Hill
Spring Creek Bore
Spring
Well
Yard
Estimated boundary of source
True North
Mag. North
5°50'
5000 4000 3000 2000 1000 0 2000 4000 6000 FEET
MILES
KILOMETRES
16,000 N
32,000 N
48,000 N
64,000 N
80,000 N APPROX.
20° 30' APPROX.
139° 30' APPROX.
16,000 E APPROX.
LEGEND
GEOLOGICAL
MOUNT ISA GROUP
Magazine Shale
Kennedy Siltstone
Spear Siltstone
Urquhart Shale
Native Bee Siltstone
Breakaway Shale
Moondarra Siltstone
JUDENAN BEDS
Judenan Beds
MYALLY BEDS
Quartzite Marker
Myally Beds
EASTERN CREEK VOLCANICS
Lena Quartzite
Eastern Creek Volcanics
Undifferentiated Volcanics (Greenstones)
Dyke
Breccia
Conglomerate
Geological Boundaries
Established boundary, Position accurate
Established boundary, Position approximate
Inferred boundary
Anomalous Relationship (Unconformity? disconformity? fault?)
Outcrop boundary
Strike and Dip of Strata
Inclined
Overturned
Vertical
Horizontal
Trend lines
GEOLOGICAL
Faults
Established fault, Position accurate
Established fault, Position approximate
Inferred fault
Cleavage
Cleavage, inclined
Mineral Deposits
Mine workings
Mineral occurrence
Pb·Cu
Costean
Drillhole
Shaft
Lease boundary
TOPOGRAPHICAL
River or creek
Railway
Sealed road
Vehicle track
Bridge
Causeway
Powerline
Telegraph line
Fence
Wind pump
Bore or Well
GEOPHYSICAL
(DATA DERIVED AS DESCRIBED IN THE TEXT)
Anomalous area
Inflection points on profiles
Magnetic maximum
Magnetic minimum
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