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AIRBORNE AND GROUND GEOPHYSICAL MAPPING IN THE MOUNT BASEDOW-MOUNT PARTRIDGE RANGE AREA, ALLIGATOR RIVERS REGION, NORTHERN TERRITORY, 1974

by

A.J. Mutton & R.D. Ogilvy

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CONTENTS

Page

PLATES

TABLES

SUMMARY

Between July and October 1974, the Bureau of Mineral Resources (BMR) carried out airborne and ground geophysical surveys in the Mount Basedow-Mount Partridge Range area, Alligator Rivers Uranium Field, Northern Territory. The surveys were designed to investigate stratigraphic and structural relations between the Koolpin Formation and the formation then known as the Koolpin Equivalent Formation (Cahill Formation). The area was initially covered by a detailed airborne magnetic and radiometric survey. Ground magnetic and electrical (resistivity, induced polarisation and self-potential) techniques were used to identify and trace geophysical markers.

The detailed aeromagnetic survey results suggest that a major northwest-trending fault zone, immediately southwest of Jim Jim Creek and some 10 km wide, separates the Koolpin Formation east of Mount Partridge Range from Koolpin Equivalent southeast of Mount Basedow. The magnetic response either side of the fault zone is in general dissimilar owing to the varying influence of metamorphism, structure, and doleritic intrusion in each area. The radiometric results did not provide information relevant to the relation between the Koolpin Formation and Koolpin Equivalent owing to the masking effect of extensive alluvial cover.

Ground magnetic and resistivity marker horizons were detected within both the Koolpin Formation east of Mount Partridge Range and the Koolpin Equivalent Formation southeast of Mount Basedow. However, these markers were dissimilar and no geophysical continuity could be established between the rocks in the two areas. The markers permitted the stratigraphy to be traced for several kilometres in areas of alluvial cover, but this was not possible in structurally complex areas.

Geophysical evidence suggests there is no simple relation and no direct stratigraphic link between the Koolpin Formation east of Mount Partridge Range and the Koolpin Equivalent southeast of Mount Basedow.

1. INTRODUCTION

Between July and October 1974, the Geophysical Branch of the Bureau of Mineral Resources (BMR) carried out airborne and ground geophysical surveys over a section of the Alligator Rivers Uranium Field, Northern Territory. The surveys were requested by the Geological Branch, BMR, to aid geological mapping of Lower Proterozoic rocks within the Jim Jim NW 1:50 000 Sheet area. In particular, it was hoped to determine stratigraphic and structural relations betweek Koolpin Formation rocks east of Mount Partridge Range and rocks which at that time were postulated as their metamorphic equivalents (Koolpin Equivalent) south and east of Mount Basedow (Plate 1). Walpole et al. (1968) believed that a stratigraphic link occurs between these formations. The geophysical surveys were therefore designed with the aim of detecting and mapping geophysical marker horizons within the Koolpin and Koolpin Equivalent Formations.

From 10 to 15 July 1974, the Airborne Sub-section (Geophysical Branch, BMR) flew a detailed airborne magnetic and radiometric survey over the area. The airborne survey was followed by ground geophysical investigations carried out by the Metalliferous Sub-section, Geophysical Branch, BMR, between 19 August and 9 October 1974. Ground methods used were resistivity, induced polarization (IP), self-potential (S-P), and magnetic. Traverses were located on the ground from aerial photographs and surveyed using chain and compass. This procedure permitted rapid reconnaissance coverage and flexibility in tracking irregular and often unpredictable geology. Interpretation of the results of the geophysical surveys was assisted by the measurement of the physical properties of rock samples collected in the survey area during shallow stratigraphic drilling and surface traversing.

2. GEOLOGY

The generalised geology of the survey area, based on mapping by Needham, Smart, & Watchman (1975a, b), is shown in Plate 1. This area occupies part of the eastern margins of the Pine Creek Geosyncline (Walpole et al., 1968) and consists primarily of regionally metamorphosed Lower Proterozoic sediments. Principal geological units within this area are the

Mount Partridge Formation of the Goodparla Group which is overlain by the Koolpin Formation, the formation then known as the Koolpin Equivalent, and the Fisher Creek Siltstone of the South Alligator Group. Zamu Complex dolerite intrudes the Lower Proterozoic rocks as dykes and sills. To the south and east, the Lower Proterozoic rocks are unconformably overlain by the Kombolgie Formation which forms the Arnhem Land Plateau. This formation consists of flat-lying unmetamorphosed Carpentarian sandstone with interbedded volcanics.

Within the survey area, Koolpin Equivalent rocks occur in subsoutcrop southeast of Mount Basedow, and Koolpin Formation rocks crop out east and west of the probable basement high at Mount Partridge Range. Elsewhere the Lower Proterozoic rocks are extensively overlain by Cainozoic sand, alluvium, and laterite. The Koolpin Equivalent and the Koolpin Formation are similar in lithology and appear to occupy equivalent stratigraphic positions in the sedimentary column (i.e. immediately above the Mount Partridge Formation and below and transitional into Fisher Creek Siltstone). Smart et al. (1974) summarised the main constituents of the Koolpin Equivalent as schist, amphibolite, carbonate rock, and chert rocks which may be metamorphic equivalents of the Koolpin Formation, which consists of carbonaceous siltstones and chert beds. Poor exposure make it impossible to trace the Koolpin Formation and Koolpin Equivalent by surface mapping and no direct stratigraphic link has to date been established. Before the 1974 mapping program, the Koolpin Equivalent southest of Mount Basedow was tentatively considered to grade into the Koolpin Formation east of Mount Partridge range, after being tightly folded about a northwest-trending fold axis running parallel to and approximately 10 km southwest of Jim Jim Creek, as shown in Plate 1. A northwest-trending fault along Jim Jim Creek had been defined but there was little evidence of major displacement.

Uranium mineralisation is associated with the Koolpin Formation in the South Alligator area, and with the Koolpin Equivalent in the East Alligator River area. The relations between the Koolpin and Koolpin Equivalent Formations therefore have economic importance.

Recently the Koolpin Equivalent has been formally defined as the Cahill Formation (Needham & Stuart-Smith, 1976).

3. PREVIOUS GEOPHYSICAL INVESTIGATIONS BY BMR

A regional airborne magnetic and radiometric survey flown by BMR in 1971/72 covered the 1:250 000 Sheet areas of ALLIGATOR RIVER, COBOURG PENINSULA, and the northern half of MOUNT EVELYN (Horsfall & Wilkes, 1975). A variable magnetic response associated with both the Koolpin and Koolpin Equivalent Formations was recognised but a response distinctive of either unit could not be defined owing to the close proximity of Zamu Complex dolerite. Several faults were interpreted from the aeromagnetic data, including partial definition of the northwest-trending Jim Jim Fault. The airborne radiometric results delineated several areas of anomalous radioactivity but did not provide any information relevant to the relation between the Koolpin Formation and Koolpin Equivalent.

4. PHYSICAL PROPERTY MEASUREMENTS

Measurements of the electrical, magnetic, and density characteristics of rock samples from the survey area are shown in Appendix 1. Most of the samples were obtained during shallow stratigraphic drilling along a traverse southeast of Mount Basedow which crossed from Mount Partridge Formation type rocks into Koolpin Equivalent Formation rocks (Stuart-Smith & Hone, 1975). Other samples were collected during the ground geophysical surveys.

5. DETAILED AIRBORNE GEOPHYSICS

The detailed airborne survey was undertaken to better define aeromagnetic patterns associated with the Koolpin and Koolpin Equivalent Formations. The survey covered about 1500 km^2 between latitudes $12^o56'$S and $13^o15'$S and longitudes $132^o25'$E and $132^o48'$E. Seventy-one east-west flight-lines spaced at 0.5 km intervals and six north-south tie-lines were flown at an average altitude of 80 m above ground level. Total magnetic intensity was recorded with a BMR-designed fluxgate magnetometer, and radiometric response was recorded with a Hamner four-channel differential gamma-ray spectrometer (survey specifications are included in Appendix 2).

Contoured magnetic and radiometric data from the survey are presented in Plates 2 and 3. Stacked magnetic profiles are shown in Plate 4 and the survey flight path map is included as Plate 5.

Magnetic Results

The aeromagnetic results indicate four distinct magnetic regions (A, B, C, D) which are delineated in Plate 6. These regions are subdivided where necessary into zones, on the basis of trend pattern and anomaly amplitude. The character of these regions and zones is summarised in Table 1 and is described below. The possible sources of magnetic anomalies were assessed by comparing the magnetic results with the geological outcrop pattern (Plate 7) which is based on recent mapping by BMR geologists (Needham et al., 1975a, b).

Region A is magnetically quiet and only a few low-intensity features are evident. The region appears to outline the extent of the Nanambu Complex migmatites which crop out over a broad area to the north of the postulated Jim Jim Fault. Within Region A northwest-trending linear features which link small anomalies of only 5 to 10 nT appear to extend to the southeast into Region D. These features are parallel to the postulated Jim Jim Fault and may reflect additional faulting or intrusives associated with the faulting.

Region B is also relatively undisturbed but exhibits a regional gradient increasing towards the southwest, and contains some small anomalies up to 200 nT amplitude. Arkoses of the Mount Partridge Formation are predominant in this area although minor exposures of Koolpin Formation have been noted at the southern end of the region. The south-striking, steeply dipping Mount Partridge Formation is not apparent in the aeromagnetic data, emphasising the non-magnetic character of the rocks of this formation in this area. A west-trending negative feature in the centre of the region does not appear to be related to the stratigraphy. This feature might be due to intrusive basic dykes which are common in this part of the Pine Creek Geosyncline.

TABLE 1. CHARACTERISTICS OF AEROMAGNETIC ZONES

REGION/ ZONE	OUTCROPPING ROCKS (PRECAMBRIAN)	ANOMALY PATTERN & MAXIMUM AMPLITUDE	TREND PATTERN	INTERPRETATION - SOURCE OF ANOMALIES
A	Nanambu Complex (Blx)	Undisturbed. Few weak anomalies of 20 nT	Weak anomalies show linear NW trends	Blx non-magnetic. Source of weak anomalie may be faulting or intrusives associated with faults
B	Mt Partridge Fm (Blp); minor Koolpin Fm(Blk)	Weakly disturbed. Few anomalies of 200 nT which have negative intensity	Variable overall. Larger anomalies have E-W trends	No anomalies associated with Blp. Source of larger anomalies probably basic dykes
C	Kombolgie Fm (Bhk); Jim Jim Granite (Bgj) Zamu Complex (Bdi); minor Fisher Ck Siltstone (Blf)	Generally undisturbed. Isolated weak anomalies of 50 nT, except anomaly C1 (200 nT). Arcuate zone of anomalies (100 nT) in south of region	Variable overall. Evidence of linear NW trend in weak anomalies similar to Region A	Blf, Bhk, and Bgj non-magnetic. Source o weak anomalies related to structure. Larger anomalies probably related to intrusions, particularly dolerite in south of region
D1	Minor Koolpin Equivalent (Blke)	Moderately disturbed. 250 nT	NW	Probably Blke
D2	Nil	Moderately disturbed. 100 nT	N to NW	Source unknown
D3	Blke; dolerite	Highly disturbed. Intense anomalies up to 1500 nT	Irregular in N of zone trends NE to N to NW. Predominant NE trend overall	Source appears to be magnetite-schists in Blke, although strongest anomalies appear to be at intersection of Blke with dolerit and/or NW shears. Good evidence for NW faulting cutting zone
D4	Nil	Moderately disturbed. 200 nT	NE.	Source probably rocks within Blke, or unit conformable with Blke
D5	Nil	Moderately disturbed. 200 nT	Predominantly NE. Varies to NW in southwest of zone	Source of NE-trending anomalies probably Blke. Source of NW-trending anomalies probably associated with Jim Jim Fault

TABLE 1 (continued)

D6	Nil	Disturbed response. 300 nT	Very irregular	Complex structural pattern in middle of interpreted major NW-trending shear zone
D7	Minor dolerite	Moderately disturbed	Regular N to NW in north; NE in south of zone	Source of some anomalies dolerite
D8	Dolerite	Disturbed response 300 nT	Regular trend predominantly N, continuous over 6 km	Largest anomalies associated with dolerite. Source of linear anomalies probably in Lower Proterozoic sequence (?Blk)
D9	Minor dolerite	Weakly to moderately disturbed. 150 nT	Irregular. Generally N to NW	Structurally complex zone similar to D6. May also contain rocks similar to those in D8
D10	Nil within zone. Blp to S and W	Moderately disturbed. 200 nT	Regular N to NW. Arcuate pattern suggests folding	Anomalies rim outcrop of Blp. Possible source is adjacent to Blk (buried) with some influence due to faulting
D11	Quartz-breccia dykes	Weakly disturbed. 100 nT	Very regular NW trend, continuous over 13 km	Source possibly related to NW-trending shear zone
D12	Nil within zone. Blp to S	Weakly disturbed. 100 nT	Regular NE to NW. Arcuate pattern suggests folding	Source possibly Blk folded around Blp in anticlinal structure, similar to D10
D13	Nil	Moderately disturbed. 250 nT	Predominantly NW	Anomaly patterns suggests source is a fairly magnetic unit as Blk
D14	Nil	Weakly disturbed. 100 nT	Irregular NW to W	NW-trending band of anomalies correlates with Jim Jim Fault. Source of other anomalies not known

Region C is relatively undisturbed. A regional increase in magnetic intensity to the southeast is evident. There appears to be evidence for weak northwest-trending magnetic lineaments. Two rock units crop out over a broad area in this region: Jim Jim Granite in the south, and Kombolgie Formation in the south and southeast, neither of which in general appear to produce magnetic anomalies. An arcuate zone of anomalies up to 100 nT amplitude occurs along the southern boundary of the survey area and coincides with occurrences of granite, Kombolgie Formation, and Zamu Complex dolerite. The dolerites are the likely cause of the anomalies. However, a comparison between outcrop and anomaly pattern shows poor correlation with the dolerite outcrop and suggests that the magnetic response of the Zamu Complex may be quite variable.

In the centre of Region C, where Lower Proterozoic rocks are masked by Cainozoic sediments, one very distinct anomaly (C1) with an amplitude of 200 nT occurs. Computer modelling of possible sources for this anomaly yields a steeply dipping (to south) prism-like body, the top surface of which is about 500 m square at a depth of about 50 m. If the magnetisation is wholly induced, a susceptibility of 12 000 x 10^{-6} SI units is required. However, the same anomaly can also be produced with a low susceptibility (700 x 10^{-6} SI units) source if strong remanent magnetisation is present. Although magnetite-bearing, high-susceptibility, quartz-mica schists similar to those intersected in the Mount Basedow drill traverse (Appendix 1) could be the source of anomaly C1, dolerites which outcrop in the survey area and have a low susceptibility but high remanent magnetisation are a more likely source. This anomaly therefore appears to represent an isolated intrusive plug.

Region D is an extensive Y-shaped region (corresponding to Zone 7 of Horsfall & Wilkes, 1975) of moderate to high magnetic response, which forms a clear division between the weakly magnetic Regions A, B, and C. This region contains the structural features and rock types which are of major interest in determining the relation between the Koolpin Formation and Koolpin Equivalent. Within the region, 14 distinct magnetic zones have been delineated from an analysis of anomaly amplitudes, trend directions, and extent:

Zone D1: This zone contains a single strong anomaly of 250 nT amplitude trending northwest. Isolated outcrops of Koolpin Equivalent have been mapped within and near this anomaly, but the observed general strike direction of the outcropping rocks does not parallel the anomaly trend. The source of this anomaly is thought to be Koolpin Equivalent rocks.

Zone D2: Small-amplitude (100 nT) north-northwest-trending anomalies occur near Nourlangie Creek, but there is no outcrop in this area. This zone may be a continuation of the magnetic rock units in Zone D3 to the south, although the low amplitudes of the anomalies suggest a different source.

Zone D3: This extensive zone contains the anomalies of highest amplitude (1500 nT) in the survey area and generally contains a semi-continuous trend pattern over approximately 25 km in a northeast direction. Very little outcrop is recorded over the whole zone, but there are minor exposures of quartz-mica schists (regarded as part of the Koolpin Equivalent) and dolerites (Zamu Complex), while quartzites typical of the Mount Partridge Formation occur immediately outside the magnetic zone to the northwest. The schists and quartzites appear to be conformable.

The significant trend direction in this zone is northeast, the strongest anomalies being associated with this direction. However, the northern half of the zone exhibits a more irregular trend pattern with several anomalies trending northwest and north. This complexity of the magnetic pattern may result from one or more influencing factors including:

(i) folding of the main northeast-trending rock sequence possibly about northwest fold axes;

(ii) discordant magnetic dykes which cut the main rock sequence at varying angles. Where these dykes intrude the magnetic sequence, the strongest anomalies are recorded;

(iii) structural effects which indicate an overall northwest fault or lineament pattern. This is particularly evident in the centre of Zone D3 where the main anomalous feature is terminated and displaced at various points. These minor displacements are interpreted as being caused by a series of parallel northwest-trending faults or fold axes. The Jim Jim Fault coincides with one of these interpreted faults. A lateral displacement of 1 km across this fault is apparent. However, this fault does not appear to be as important as another parallel fault 2.5 km to the southwest, across which there is little lateral but probably some vertical displacement. Depth determinations indicate an increase in depth from less than 50 m (top of causative body below ground) on the northern side to approximately 200 m on the southern side of the fault, implying down throwing of the southern with respect to the northern side. There is also a decrease in anomaly amplitude (400 nT down to 250 nT) from north to south. The sharp termination of magnetic features along the southwestern boundary of Zone D5 also demonstrates the importance of this fault.

Zone D3 in general is interpreted as outlining the extent of magnetite-bearing schists within the Koolpin Equivalent Formation from an area east of Mount Basedow to about 10 km southwest of Jim Jim Creek. However, possible intrusion by Zamu Complex dolerite (particularly in the north of the zone) and intersection by northwest-trending faults also complicate the magnetic pattern. The continuation of this zone farther south or west is not certain, although the data tend to indicate an abrupt termination of the main magnetic feature within the major shear zone indicated in Plate 6.

Zone D4: This zone is much less disturbed than Zone D3, which it parallels. The zone contains anomalies of moderate amplitude (200 nT) with generally northeast trend directions. The zone possibly results from a different lithological unit than that represented by Zone D3. The geological map suggests that the source of this zone is a younger unit at the top of the Koolpin Equivalent, or within the Fisher Creek Siltstone. There is no outcrop of Lower Proterozoic rocks within Zone D4.

Zone D5: Moderate-amplitude anomalies (200 nT) with variable trend directions occur. In the eastern section of this zone, a distinct northeast-trending anomaly is continuous over 6 km parallel to Zones D3 and D4. This anomaly may represent a lithological unit younger again than those represented in Zones D3 and D4. The only geological correlation possible is with recent sediments which mask the Lower Proterozoic rocks. Along the southwestern margin of the zone, several northwest-trending anomalies appear to correlate with faulting parallel to the Jim Jim Fault. In general, the anomaly trends are very variable in the south of Zone D5, owing to the more complex structure and possible presence of dolerite dykes near the postulated fault zone.

Zone D6: This zone contains some moderate-amplitude anomalies (350 nT maximum) with a very irregular trend pattern. There are no trends continuous over a great distance. This suggests a complex structural pattern, and the likely presence of numerous faults or shears. This zone, which lies wholly within the major shear zone outlined in Plate 6, is interpreted as one of severe structural distortion of rock units caused by faulting and folding. Again there is no outcrop of Lower Proterozoic rocks in the area.

Zone D7: Low to moderate-amplitude anomalies (up to 200 nT) exhibiting long, continuous north trends and shorter northwest trends form an elongate magnetic zone. There is no outcrop except for a small area of Zamu Complex dolerite in the north which correlates with the main anomaly in this zone, and suggests an extension of the dolerite to the south.

Zone D8: This zone is characterised by a series of relatively intense north-trending anomalies of amplitudes up to 300 nT. The distinct continuous trend pattern extends for over 6 km. Again there is no Lower Proterozoic outcrop recorded except for two exposures of dolerite. One outcrop at the very south of Zone D8 produces no appreciable magnetic anomaly, while a massive elongate outcrop at the northern end of this zone appears to correlate directly with a 300 nT anomaly. The slightly arcuate trend of this anomaly parallels exactly the mapped outcrop of dolerite. This relationship was not so apparent in the 1971/72 airborne survey results (Horsfall & Wilkes, 1975). There is no obvious magnetic continuation of the rock units in Zone D8 into those in Zone D3 as postulated by geological interpretation. Zone D6 presents such an irregular pattern between Zones D7, D8, and D3 that the simple stratigraphic correlation of Walpole et al. (1968) as illustrated in Plate 1 appears unlikely.

Zone D9: This zone contains several weak anomalies with an irregular trend-pattern similar to Zone D6, although a general north-northwest trend direction is apparent in this case. Again no Lower Proterozoic outcrop has been mapped, although several small dolerite outcrops have been noted within the zone, and may contribute to the magnetic patterns. Zone D9 may possibly represent a northward continuation of Zone D8, with the magnetic patterns associated with Lower Proterozoic rocks being complicated by the presence of basic intrusions and complex structures such as indicated in Zone D6.

Zone D10: This zone contains several elongate north to northwest-trending anomalies of low amplitude (up to 200 nT, but generally less than 100 nT) which form an arcuate zone stretching around the northern end of the Mount Partridge Range. The southern boundary of this zone coincides with the northern limit of outcrop of Mount Partridge Formation at this location, thus confirming the non-magnetic characteristics of the Mount Partridge Formation. It is probable that Zone D10 outlines a rock unit distinct from but adjacent to the Mount Partridge Formation. Because of the similarity in pattern between Zones D7, D8, and D10, Koolpin Formation rocks are the probable source of the magnetic features constituting Zone D10. The north-west-trending anomalies in the north of Zone D10 may reflect complex folding, faulting, and shearing.

Zone D11: This is a distinct northwest-trending magnetic feature consisting of a continuous low-amplitude anomaly (100 nT maximum) extending for over 13 km. The anomalies forming Zone D11 are similar to those postulated for the Koolpin Formation. However, the feature correlates with a northwest-striking shear zone which is inferred from a series of outcrops of quartz-breccia dykes and the anomalies might reflect this shear zone which is parallel to other postulated faults and shears in the area. There is little evidence that the magnetic feature within Zone D11 extends south of Zone D3 (with which it is discordant), but it may extend north as seen by similar patterns in Zones D12, D13, and D14.

Zone D12: This is a moderately disturbed zone containing anomalies up to 100 nT amplitude, which form an arcuate pattern trending northeast and northwest. The zone contains characteristics of both Zones D10 and D11. No magnetic anomalies are observed over the Mount Partridge Formation which crops out immediately south of the zone. Hence it is likely that the zone indicates the presence of Koolpin Formation which is folded in an anticlinal structure about a north-south fold axis.

Zone D13: This zone contains anomalies up to 250 nT amplitude which have a predominant northwest trend. The intensity of the anomalies suggests the occurrence of fairly magnetic rocks which are possibly part of the Koolpin Formation. The orientation of this zone may be influenced by the major northwest-trending shear zone which is indicated by the faulting and shearing in the region.

Zone D14: Relatively weak anomalies (100 nT) of varying trends (generally northwest to west) occur in this zone. One group of anomalies within the zone form a distinct northwest-trending band which correlates with the Jim Jim Fault. The more irregular anomalies in this zone may indicate the presence of magnetic rock (?Koolpin Formation) similar to that interpreted in Zones D12 and D13. The intensity of these anomalies decreases rapidly on the northern side of the postulated Jim Jim Fault.

Discussion of magnetic results: The detailed aeromagnetic survey of the area between Mount Partridge Range and Mount Basedow does not indicate a simple link between Koolpin Formation rocks in the southwest and Koolpin Equivalent rocks in the northeast. Zones D7 and D8 in the southwest of the area can possibly be attributed to Koolpin Formation rocks, and Zone D3 in the northeast probably correlates with Koolpin Equivalent rocks. Between these zones, however, the magnetic patterns are influenced by a northwest-trending set of faults and shears, which would suggest that any link between the formations is more complex than had been anticipated.

Radiometric results

Total count results: The results of the total count survey are shown as contours at 10 counts per second (cps) intervals in Plate 3.

The total count data show that most of the survey area has a fairly uniform and low response of less than 100 cps. Zones of higher radioactivity are generally associated with areas containing outcropping Lower Proterozoic rocks. However a series of moderately radioactive zones in the northwest of the area occurs within the inferred shear zone parallel to Jim Jim Fault (Plate 6), and do not appear to be directly related to outcrop.

In general the trend directions evident in the total count data reflect the strike of outcropping rocks and magnetic trends. However, it is not possible to use the radiometric data to assist in tracing stratigraphic units beneath the blanketing effects of the alluvial cover.

The total count results indicate that the radioactivity of Mount Partridge Formation rocks in the Mount Partridge Range is much less than similar rocks mapped as Mount Partridge Formation near Mount Basedow.

Spectrometer results: The results of spectrometer data corrected for background, altitude, and Compton scattering are indicated in Plate 3 and Table 2. Plate 3 shows the location and radioelement characteristics of areas having an abnormally high radioactivity or an unusual abundance of uranium relative to thorium. The radioelement characteristics of the various rock units in the survey area are indicated in Table 2.

As was the case with the total count data, the blanketing effects of the overburden throughout most of the area do not permit the spectrometer data to be used for lithological and stratigraphic correlation. However, the results do indicate the significant difference between the Mount Partridge rocks mapped in the Mount Partridge Range and at Mount Basedow. Insufficient data were collected over Koolpin and Koolpin Equivalent rocks for a meaningful assessment of their radioelement characteristics to be made.

Areas of anomalous radioactivity: The location and radioelement characteristics of 25 radiometric anomalies are shown in Plate 3. The characteristics of the anomalies are described by the legend shown in Plate 3 and in general anomalies correspond to areas where the relevant radioelement response is greater than three times the average radiometric response throughout the survey area. As the sources of the radiometric anomalies were not an important consideration in the mapping of various rock units beneath alluvium, none of the airborne radiometric anomalies were located or checked by ground surveys.

Anomalies 1 to 7 occur within an area of rocks mapped as Mount Partridge Formation which occurs near Mount Basedow. These anomalies are predominantly caused by thorium and potassium, but anomaly 1 is a minor uranium anomaly. It is probable that the source of the anomalies is the meta-arkoses and gneisses constituting the Mount Partridge Formation in this area.

TABLE 2. RADIOELEMENT CHARACTERISTICS OF ROCKS

Spectrometer channel	Corrected response in counts per second						
		Mount Partridge Formation					
	Alluvium	Mount Partridge Range	Mount Basedow	Koolpin	Koolpin Equivalent	Jim Jim Granite	Nanambu Complex
Potassium	5 - 10	15 - 20	25 - 30	-	-	25	10 - 15
Uranium	5	5	5 - 10	-	-	5	5
Thorium	5 - 10	5 - 10	5 - 20	-	-	20	5

Anomaly 8 occurs within an area of outcropping Nanambu Complex and is a weak uranium anomaly. The source of this anomaly is not known.

Anomalies 9 to 16 are located over the exposed Jim Jim Granite in the southeast and are predominantly caused by sources relatively enriched in thorium and potassium. Anomaly 12 has a uranium response of 20 cps but the relative abundance of uranium and thorium is not unusual.

Anomalies 17 and 18 occur in an area of no outcrop in the central north of the area to the south of the Jim Jim Fault zone. These anomalies appear to have predominantly thorium sources.

Anomalies 19 to 22 occur as isolated uranium or U/Th highs west of Mount Partridge Range. Anomalies 19 and 20 are of relatively low intensity, having total counts of the order of 150 cps and U/Th ratios of 4 or less. Anomaly 21 appears to be located within arkose of the Mount Partridge Formation but lies about 1 km northwest of Koolpin Formation outcrop. The anomaly shows a total count of 130 cps and a U/Th ratio of 7. This anomaly is probably of little importance but, in view of its proximity to Koolpin Formation rocks, might warrant ground checking. Anomaly 22 has a total count of only 30 cps but a high U/Th ratio of 7. This may be due to an unusual low thorium content rather than a high uranium content.

Anomaly 23 is an isolated and unexplained uranium and U/Th anomaly in the northwest of the survey area in an area of no mapped Lower Proterozoic outcrop.

Anomalies 24 and 25 are potassium anomalies in the Mount Partridge Formation and may be from arkose.

6. GROUND GEOPHYSICS

The ground survey consisted of 30 magnetic traverses, 15 IP/resistivity traverses and one S-P traverse. All traverses were within aeromagnetic Region D, and their positions are shown in Plate 7.

Magnetic results

Magnetic traverses were made with a Geometrics G816, total-field, proton precession magnetometer. Station spacing was 20 m and the detector was mounted 2.5 m above the ground. The results of the magnetic traverses are shown as stacked profiles in Plates 8, 9, and 10.

In an attempt to minimise the effects of near-surface magnetic sources, some of the magnetic data was processed using a rectangular band-pass filter operation designated "BNDPAS2" which is based on the work of Fraser et al. (1966). The relevant filter characteristics are indicated in Plates 8 and 9.

For convenience of discussion, the magnetic traverses are divided into three areas each of which contains several traverses: Area 1 occupies the region to the south and southeast of Mount Basedow; Area 2 lies to the southwest of Jim Jim Creek; and Area 3 lies east of Mount Partridge Range. The location of the areas and a correlation between possible magnetic trends are shown in Plate 7.

Area 1: The ground magnetic profiles for area 1 are shown in Plate 8. Five traverses (GT1, 4, 2, 3, 7) were surveyed on the northern side of Jim Jim Creek and a sixth (GT5) within the alluvial region between two branches of the creek system. These traverses are considered as a group, as the character of the magnetic response was similar. Traverses are not parallel as each was located as near as possible perpendicular to the inferred strike. Geological control in this area was provided by detailed stratigraphic drilling on traverse GT2. Down-hole geophysical and drilling results along this traverse (the Mount Basedow Drill Traverse) are presented in Stuart-Smith & Hone (1975).

The typical pattern observed on these six traverses is:

(i) a relatively flat zone to the northwest with background level of about 46 800 nT;

(ii) a highly magnetic zone consisting of a series of generally six to ten distinct anomalies of amplitudes ranging from 200 to 3000 nT;

(iii) a relatively flat zone with a few low amplitude anomalies of around 46 400 nT.

The quiet zone to the northwest contains only occasional variations of not more than 80 nT on a generally noiseless background. This was surprising as on several traverses large amounts of laterite and lateritic float were present. On traverse GT2 this zone correlates with non-magnetic arkose and quartzite sediments probably of the Mount Partridge Formation as found on Mount Basedow to the northwest. The contact between this non-magnetic zone and the magnetic zone directly to the southeast on each traverse probably defines the boundary between Mount Partridge Formation and Koolpin Equivalent.

The boundary between the zone of magnetic anomalies and the less disturbed zone to the southeast is not so clearly defined, particularly in the northern traverses. However, on most traverses, the sharp drop in background magnetic level is interpreted as the southern boundary of the magnetic zone. Drilling results from GT2 indicate that a change from magnetite-bearing quartz-mica schists interbedded with amphibolites, to non-magnetic schists and amphibolites, occurs near this boundary. The anomalies within the magnetic zone are most likely caused by the magnetite schists. On GT3 between 900S and 1000S a single isolated anomaly (1200 nT amplitude) occurs within this quiet zone, immediately southeast of an outcrop of north-striking dolerite. Similar dolerite bodies (Zamu Complex) crop out at several places throughout Area 1 and their presence suggests there may be more than one source of magnetic anomalies in this area.

The zone of magnetic anomalies occurring between the two zones of relative quiet varies from about 1.2 km to 1.6 km wide. This variation may be due to variation in stratigraphic thicknesses, or to some traverses not being perpendicular to strike. Anomaly amplitudes are greatest on GT4 and GT2 and diminish rapidly to the south on GT7 and GT5. GT5 has a smooth but attenuated response which indicates a greater depth to the magnetic rocks. The increased depths may be the result of faulting parallel to GT5, and the subsequent thickening of the alluvial cover.

The extent and continuity of the magnetic zone is indicated in Plate 7. Within each traverse, the magnetic zone consists of a series of intense anomalies, some very narrow and possibly representing near-surface sources such as laterite nodules in the alluvium. Filtering of this short wavelength noise by computer program BNDPAS2 generally gave six to ten distinct anomalies which were greater than 80 m wide and range in amplitudes from 200 to about 3000 nT. The filtered profiles are superimposed on the original data in Plate 8, and anomalies are numbered for correlation. For example, anomalies 1 to 7 on GT4 correlate reasonably well with similarly numbered anomalies on GT2. Correlation between GT1 and GT4 is not clear owing to a greater distance (2.5 km) between traverses. However, the form of the anomalies on GT1 and GT4 is similar. Correlations between anomalies 4 to 7 on GT2 and GT3 can be made, and similar correlations can be extended to GT7 and GT5.

Area 2: This area contains magnetic traverses GT6, 8, 9, 10, 12, 13, 18, 24, 26, and 27 which are southwest of Jim Jim Creek (Plate 7). Most traverses bear approximately northwest (as in Area 1) but traverses GT8 and 13 bear northeast. Little geological control exists in this area owing to lack of outcrop and poor accessibility for drilling.

Most traverses were located across aeromagnetic Zone D3. As seen in Plate 9, the northwest-trending traverses in Area 2 (GT6, 9, 24, 10, 12, 26, 27, 18) show a similar magnetic pattern as was observed in Area 1; that is, a magnetic zone surrounded by quiet areas to the northwest and southeast, with an associated drop in background level of about 500 nT to the southeast. However several differences are noted in the character of the magnetic zone:

(i) it is narrower, especially south of GT9, being only 0.5 km wide compared with 1.5 km in Area 1;

(ii) the response is attenuated, the maximum anomalies having amplitudes up to 800 nT (GT6) compared with 3000 nT (GT4);

(iii) the anomaly pattern (except GT6) no longer consists of a series of distinct anomalies, but 2 or 3 broad low-amplitude anomalies.

GT6 is an exception to most of the traverses in Area 2, as the profile indicates (after smoothing) six distinct anomalies similar to the characteristic response in Area 1. It is included in Area 2 because the transition from GT5 to GT6 is marked by a displacement of the magnetic zone on GT6 by about 1 km to the northwest. A fault is thus interpreted close to the southern branch of Jim Jim Creek, and this fault coincides with the Jim Jim Fault postulated by Needham et al. (1975a). Traverse GT8 was made across the postulated fault zone but the results indicate no significant magnetic effect associated with the Jim Jim Fault.

Correlation between GT6 and GT9 is difficult. From GT6 to GT9 anomaly amplitudes drop from 800 to 400 nT maximum and the number of anomalies within the magnetic zone decreases. An attempt to trace the anomaly at 1900W on GT6 by a series of six short closely spaced traverses (not shown in Plate 9) between GT6 and GT9 shows this anomaly to exist over a short distance only. The change in character of the magnetic response between traverses GT6 and GT9 coincides with the change in magnetic pattern in the airborne data. This change in pattern is thought to be the result of a major northwest-trending magnetic discontinuity, interpreted to be a fault along which rocks on the southern side are downthrown with respect to those on the northern side.

The pattern on GT9 is basically repeated on every traverse to the south. The magnetic zone recorded on GT9 and traced through to GT27 correlates very well with Zone D3 of the aeromagnetic interpretation. Farther to the south on traverse GT18, the magnetic zone is not clearly defined and the profile shows three broad anomalies with no distinct, undisturbed areas.

A feature observed on all of the traverses was the high noise level possibly caused by lateritic iron nodules within the alluvium. Smoothing of the data using the BNDPAS2 computer program was applied to filter the short-wavelength anomalies. The results proved more useful for interpretation than the original data, although filtering has limitations where noise of large amplitude occurs, e.g. 3000 nT on GT27. In this case, despite a careful choice of filters, a forced fit is apparent in the smoothed response.

An interesting result was obtained where the same rock units, within 200 m of each other, were traversed at different angles at the southern ends of GT10 and GT12. Although the definition of the magnetic zone is similar, the response within this zone is different on the two traverses owing presumably to the variations in anomaly shape over a magnetic body traversed at varying angles, as well as variations in the near-surface noise component. This result illustrates the difficulty that can arise in the correlation of individual anomalies over large distances where accurate strike information or contoured aeromagnetic data are not available. The best correlations that can be made by ground reconnaissance survey appear to be of broad features only.

GT13 was located across aeromagnetic Zone D11, about 6 km northwest of Zone D3. The response was essentially flat apart from the northeastern end of the traverse where a 200 nT anomaly of width 150 m at about 1300 NE correlates with the positive aeromagnetic anomaly in Zsne D11. The cause of this anomaly appears to be a northwest trending quartz breccia dyke which forms part of the shear zone referred to in the interpretation of Zone D11.

The results in Area 2 indicate that the same magnetic rock units in Area 1 continue to the southwest. However, the character of the response within Area 2 has changed owing to major faulting and shearing along a northwest axis. The effects on the ground magnetic response across the interpreted faults is a smoothing and reduction in the intensity of the anomalous zone. Both these factors indicate a greater depth to the magnetic basement in Area 2, possibly a result of downward movement with respect to Area 1. The location of the magnetic zone is indicated in Plate 7.

Area 3: Seven east-west traverses (GT15A, 23, 22, 19, 20, and 14 from north to south) were located across a north-trending aeromagnetic feature (Zone D8) east of, and parallel to, Mount Partridge Range. The aims of these traverses were to:

(i) determine any similarities between the ground response within aeromagnetic Zone D8 and Areas 1 and 2;

(ii) examine closely the magnetic response over outcropping massive dolerite.

Apart from the massive dolerite, there is little outcrop in the area. Koolpin Formation crops out to the south near the Arnhem Land escarpment. Elsewhere the area is extensively covered by alluvium with quartz float, some of which contains magnetic material (probably of lateritic origin) producing some minor magnetic noise.

The magnetic pattern observed in Area 3 (Plate 10) shows a zone of broad low-amplitude (up to 500 nT) anomalies, which can be correlated over 6 km from north to south and well-defined, shallow-source intense anomalies on the eastern end of traverses 15A, 23, and 22. The shallow-source intense anomalies appear to be related to outcrops of the Zamu Dolerite. The location of the zone of broad low-intensity anomalies is shown in Plate 7.

Midway between traverses GT22 and GT14, two close, parallel magnetic traverses GT19 and GT20 (300 m separation) were surveyed to investigate the continuity of features within the magnetic zone. Distinct anomalies are observed within the magnetic zone on traverses GT19 and GT20. Correlation of anomalies (labelled A, B, and C) in the centre of these traverses is possible, but is not straightforward over the entire length of the traverses. Hence for distances greater than 300 m between traverses, the technique of correlating individual anomalies becomes subjective and tentative.

Although the characteristics of the magnetic zone in Area 3 are not totally dissimilar to the characteristics of the magnetic zones observed in Areas 1 and 2, the pattern of a magnetic zone bounded by quieter areas with different background levels is not present. However, the results indicate that the source of aeromagnetic zone D8 is probably Lower Proterozoic rocks of the Koolpin Formation. It is clear from the ground magnetic results that there is no direct link between aeromagnetic zones D8 and D3.

<u>Quantitative interpretation of selected magnetic anomalies</u>: Although a great deal of geophysical information was obtained in the survey, the results and emphasis in interpretation have necessarily been directed towards the regional correlation of geophysical anomalies based on qualitative interpretation. However, several distinct ground magnetic anomalies were obtained and quantitative analyses of these anomalies were carried out in an attempt to define the geometric and physical property characteristics of their magnetic sources. Anomalies selected for quantitative analyses were located at: GT2-1250S, GT15A-100W, GT15A-200E, GT22-200W, GT22-500E, and GT23-400E.

Quantitative interpretation of these anomalies was done by computer modelling based on two-dimensional dyke-like and tabular bodies. Complete curve matching permitted a more exact interpretation than methods based on specific points of the magnetic profile, particularly where principal anomalies were influenced by the effects of adjacent magnetic bodies and high-frequency noise. The results, presented in Plate 11, have a bearing on the problem of stratigraphic correlation based on the magnetic response of the Koolpin and Koolpin Equivalent Formations.

Several of the ground magnetic anomalies (e.g. GT15A-200E, GT22-500E, and GT23-400E) were recorded directly over or adjacent to outcropping dolerite dykes. Laboratory tests on collected samples of outcropping dolerite showed that the dolerite had a low susceptibility (K = (800 to 1000) x 10^{-6} SI units) but strong remanent magnetisation (J_R = 3600 mA/m) giving a high Koenigsberger ratio. Remanent magnetisation appears to be the dominant cause of the distinctive magnetic anomalies associated with the dolerites. The low susceptibility of the dolerites, when combined with a direction of remanent magnetisation not parallel to the present Earth's field, may explain the apparent absence of a magnetic anomaly over some dolerite outcrops. It is apparent from simple inspection that in several places the shape and position of the anomalies are inconsistent with the inferred geometry of the dolerite. Anomaly GT15A-200E for example is offset some 100 m from the main dolerite outcrop and anomaly GT23-400E shows a narrow high-amplitude response but occurs over a dolerite outcrop 180 m wide.

Unfortunately the Zamu Complex dolerites were not drilled during the 1974 survey program owing to access restrictions, and oriented samples of the dolerite were not taken. Nevertheless, assuming that the remanent component was parallel with the Earth's present field and of similar magnitude to the measured value, modelling shows that the anomalies may be readily interpreted in terms of thin sheet-like bodies consistent with the known geological strike and probable dip of the dolerite bodies. It is evident that while a satisfactory curve match was obtained in each case the inferred bodies do not correspond to the known surface extent of the dolerite, but appear to be marginal to known outcrops. In particular, calculations based on arbitrary directions of the total magnetisation vector confirmed that anomaly GT15A-200E could not be reconciled with the main outcrop at 350E irrespective of its subsurface geometry. The modelling suggests that the dolerites are not uniformly magnetised but have considerable lateral variations in their magnetic properties. Although insufficient samples were collected to determine the nature of this variation, a possibility exists that only the margins of the dolerite intrusions are magnetic. The results demonstrate the need for careful and more comprehensive sampling of the Zamu Complex if reliable quantitative interpretations of the ground or aeromagnetic data are to be made.

An interpretation of anomaly GT2-1250S, recorded directly over magnetite schists, is presented in Plate 11 to show that individual anomalies with metasedimentary origins were, in general, indistinguishable in both shape and amplitude from anomalies associated with the Zamu Complex dolerite. Laboratory measurements on core from stratigraphic drilling on GT2 (see Appendix I) showed that the magnetite-bearing quartz-mica schists had high susceptibilities ranging from approximately (10 000 to 150 000) x 10^{-6} SI units, and in general low remanent magnetisation (J_R = 33-920 mA/m). One sample from drill hole JJ30 indicated a value of J_R of 2900 mA/m and suggests that in isolated cases remanence may be significant, depending presumably on the distribution and grainsize of the magnetite. Hence, similar amplitude anomalies could therefore be expected from the dolerites and the magnetite-bearing metasediments.

Electrical results

IP/resistivity profiles are shown in Plates 12, 13, and 14. The traverse locations are shown in Plate 7. The electrical results are grouped into three areas as was done for the ground magnetic results.

Area 1: The results of electrical surveys in Area 1 are shown in Plate 12. Five IP/resistivity traverses (GT1, 4, 2, 7, and 5) were made using overlapping gradient arrays having a current electrode spacing of 1500 m. The profiles so obtained were used to detect possible geo-electric members within the Koolpin Equivalent Formation.

On GT1, a distinct geo-electric response was detected over a sub-outcropping feldspathic quartzite flanked by an interbedded sequence of quartz-mica schists and amphibolites. The quartzite was characterised by high resistivities (>8,000 ohm-m) and moderate chargeabilities (>25 ms); and the quartz-mica schist/amphibolite sequence by resistivities of the order of 200-1000 ohm-m and chargeabilities of 10 ms. Resistivity measurements appeared therefore to be the more diagnostic of the two parameters for reconnaissance stratigraphic mapping. Subsequent profiling on GT4, 2, and 7 showed a similar response pattern and established the quartzite as a well-defined consistent geo-electric marker. Less significant resistivity variations were detected on each of the traverses. On GT2 these minor variations correlate in a general way with the alternating sequence of quartz-mica schist and amphibolite lithologies. However, these minor resistivity anomalies could not be correlated between adjacent traverses and did not provide a basis for reconnaissance stratigraphic mapping.

The IP/resistivity profiling survey in Area 1 does not indicate the presence of carbonaceous schists or graphitic horizons within the Koolpin Equivalent Formation. The resistive quartzite horizon therefore presented the only readily identifiable geo-electric marker for tracking stratigraphy and the location of this marker is shown in Plate 7.

GT5, in the alluvial region of the Jim Jim Creek system, showed a marked attenuation of resistivity values and it was not possible to identify a southerly extension of the quartzite marker.

Area 2: The gradient array profiling survey was continued south of Jim Jim Creek in Area 2. Surveys were made along traverses GT6, 8, 9, 10, 12, 13, 16, and 17. The results of these surveys are shown in Plate 13.

The 4.2 km IP/resistivity profile obtained along traverse GT6 which is south of Jim Jim Creek does not indicate any features which can readily be correlated with the resistive quartzite member observed in Area 1. However, several anomalous features are observed on traverse GT6, notably the IP/resistivity gradient at GT6-2750W, and the resistivity high at GT6-1900W. In the hope that these features might serve as stratigraphic markers in Area 2, an attempt was made to trace these features to the south on traverses GT9, 10, and 12. However, no correlation between this set of traverses is apparent.

As the lack of correlation between traverses might be in part the result of traverses crossing geological strike at oblique angles, the azimuth dependence of the resistivity profiling measurements was determined by rotational soundings carried out on traverses GT6, 9, 10, and 12 with a Schlumberger array. The results of the rotational soundings are shown in Plate 15 as polar plots of apparent resistivity versus electrode orientation.

The results of the rotation soundings indicate anisotropy in the geo-electric section but indicate a compatibility between geo-electric strike, known geological strike, and the orientation of aeromagnetic features in this area. The rotation soundings at GT6-2900W, GT6-1900W, and GT12-00W gave strike directions in general agreement with the observed strike northeast of Jim Jim Creek and with the regional strike inferred from the aeromangetic contours. The soundings at GT9-1900W and GT10-700S, however, indicate a northwest geological strike (314^{o}-330^{o}) and suggest that abrupt changes in strike direction may occur over relatively short distances. Subsequent profiling normal to the pre-determined strike direction on three closely spaced traverses (GT8, 16 and 17) did not improve the correlation between traverses. Hence the electrical results support the aeromagnetic indications that Area 2 is a disturbed geological zone, and in the absence of strong geo-electric markers, IP/resistivity profiling techniques cannot resolve the stratigraphic pattern.

Short IP/resistivity profiles were obtained on traverse GT13 to assist in the characterisation of aeromagnetic Zone D11. Strong IP/resistivity boundaries (Plate 13) were located at GT13-1160SW and GT13-1370NE and may reflect the presence of quartz-breccia associated with northwest-trending faults.

Area 3: Six electrical traverses (GT14, 20, 21, 15A, 15B, and 25) were surveyed in this area to investigate the geo-electric properties of the Koolpin Formation rocks immediately east of Mount Partridge Range (Plate 14).

Traverse GT14 detected a distinct resistivity low (less than 15 ohm-m) centred on 350W. IP measurements could not be obtained owing to synchronisation problems with the IP receiver. Similar and generally more pronounced resistivity lows were encountered on each of traverses GT20, 21, 15, and 25, showing continuity of this particular conductive unit for over 8 km (see Plate 7). The source of the conductor is uncertain but in view of the absence of any magnetic anomaly it may be a carbonaceous or graphitic horizon within the stratigraphic sequence. An S-P traverse on GT20 shows a marked S-P anomaly of -25mV associated with the resistivity low and would tend to support this identification.

7. CONCLUSIONS

The two most significant observations obtained from the interpretation of the ground and airborne geophysical results are:

(a) there is no simple stratigraphic link between the Koolpin Formation east of the Mount Partridge Range and the Koolpin Equivalent southeast of Mount Basedow;

(b) faulting and shearing in a major zone 10 km wide parallel to Jim Jim Creek appears to be of greater importance than previously thought. The structural complexity observed from the geophysical results in this zone (the 'Jim Jim Fault Zone') would tend to eliminate the possibility of simple links between the rocks in this area.

The results establish the Koolpin Formation rocks as having different geophysical and hence physical properties to the Koolpin Equivalent rocks. Geophysical marker horizons were detected within both formations, but these were dissimilar in detailed analyses of both magnetic and electrical results, and no geophysical continuity was found between the two formations. These results do not, however, preclude a stratigraphic relationship. The rocks in the two areas could still be time, facies, and/or metamorphic equivalents, corresponding to the same stratigraphic horizon.

The detailed aeromagnetic survey provided an improved definition of magnetic anomalies and trends than that presented in the regional aeromagnetic data (Horsfall & Wilkes, 1975). Interpretation based on the regional data has been revised to take into account the notable discontinuity of magnetic trends associated with the Jim Jim Fault Zone. The anomalous response either side of the fault zone appears to be dissimilar: the Lower Proterozoic sequence south and southeast of Mount Basedow shows a relatively complex magnetic response which reflects the influence of structural deformations and dislocations as well as intrusion of dolerite; the response associated with the Koolpin Formation rocks east of Mount Partridge is less complex, despite the fact that dolerite also intrudes the Lower Proterozoic sequence in this area. The major source of anomalies in the zone southeast of Mount Basedow appears to be magnetite-bearing quartz-mica schists, which are interpreted to extend semi-continuously for over 30 km in a southwesterly direction before terminating near the inferred southern boundary of the fault zone. The source of anomalies east of Mount Partridge is not certain, although some of the anomalies can be directly attributed to dolerite.

The detailed airborne radiometric results did not provide any information relevant to the relation between the Koolpin Formation and Koolpin Equivalent, owing to the masking effect of extensive alluvial cover.

Ground magnetics provided useful ground control for the aeromagnetic data but found only a limited application in the identification of aeromagnetic zones and in the delineation of stratigraphy utilising individual magnetic markers. Magnetic anomalies associated with Lower Proterozoic metasediments could not be distinguished in the field from anomalies associated with the Zamu Complex dolerite. This dual source of anomalies, combined with a very noisy ground magnetic response due to surface laterite, makes the task of correlation difficult.

The ground electrical results support the conclusions drawn from the magnetic results. Geo-electric marker horizons which could be traced several kilometres in areas of alluvial cover, were detected both southeast of Mount Basedow and east of Mount Partridge. However, these markers exhibit distinctly different properites: a resistive feldspathic quartzite was detected southeast of Mount Basedow, and a highly conductive horizon, representing a probable carbonaceous lithology, was mapped east of Mount Partridge. The two geo-electric markers, although in different lithologies, showed a marked uniformity of response, indicating little if any changes in rock type along strike. No geo-electric markers were detected in the region of the Jim Jim Fault Zone. Resistivity profiling results appear to be adversely affected by a rapid variation in geological strike which is associated with the increased structural complexity within this zone. The azimuth dependence of resistivity measurements was investigated by rotation soundings, which proved to be a viable technique for detecting the geo-electric strike.

It is concluded from the combined geophysical and geological evidence available that there is no simple stratigraphic link between the Koolpin Formation east of Mount Partridge and the Koolpin Equivalent southeast of Mount Basedow. Geophysical mapping was unable to determine whether the two formations are in fact metamorphic equivalents or whether they are completely unrelated.

8. REFERENCES

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APPENDIX 1 - ROCK PROPERTY MEASUREMENTS

Lab. No.	Sampler's No.*	Locality	Depth m	Geological description	Remanence Vector Dip	Remanence Vector Intensity mA/m	Susceptibility $\times 10^{-6}$SI units	Resistivity ohm-m	IP mV/V	Specific Gravity
75/250	JJ25/1	Mt Basedow	11.5	Quartz-mica Schist + magnetite	+ 52	33	12 500			2.76
75/251	JJ25/2	"	11.5	"	+ 42	46	15 000			
75/252	JJ30/1A	"	24	"	+ 21	2900	113 000			2.88
75/253	JJ30/2A	"	24	"	0	76	18 800			
75/254	JJ30/1B	"	24	"	8	86	84 200			2.90
75/255	JJ30/2B	"	24	"	- 29	198	118 000			
75/256	JJ31/1	"	15	"	- 8	590	108 000			2.81
75/257	JJ31/2	"	15	"	- 26	827	59 000			
75/258	JJ53/1	"	18	"	+ 11	70	11 700			2.70
75/259	JJ53/2	"	18	"	+ 10	69	10 200			
75/260	JJ58/1	"	25	"	+ 67	920	163 400			2.96
75/261	JJ58/2	"	25	"	+ 57	900	163 400			
75/279	K_3	East of Mt Partridge	Surface	Zamu Complex dolerite		3400	1 000			
75/280	K_4	"	"	"		3800	940			
74/345	K_1	"	"	"			1 000			
74/246	K_2	"	"	"			880			
75/237	JJ21	Mt Basedow	22.5	Amphibolite			880	480	10	3.03
75/238	JJ2	"	22.5	Biotite-feldspar-quartz schist			500	5500	30	2.78
75/239	JJ6	"	22.5	Amphibolite			1 250	4200	40	2.94
75/240	JJ24	"	17.9	Feldspar-muscovite-biotite schist			15 000	8400	< 10	2.75
75/241	JJ12	"	22.5	Muscovite schist			380	1900	10	2.72
75/242	JJ31	"	14	Feldspar-quartz schist + magnetite			71 600	1900	60	2.86
75/243	JJ15	"	19.8	Feldspar-quartz schist			250	2200	30	2.73
75/244	JJ28	"	20.4	Feldspathic quartzite			250	3700	<10	2.69
75/245	JJ7	"	27	Carbonate-amphibolite-quartz schist			17 600	6000	<10	3.00
75/246	JJ38	"	27	Quartz-mica schist + magnetite			380	690	30	2.74
75/247	JJ67	"	15	Feldspar-quartz gneiss			60	1300	60	2.60
75/248	JJ61	"	15	Graphite-amphibolite-quartz schist			750	3400	160	2.83
75/249	JJ62	"	15	Graphite-amphibolite-carbonate Feldspar-quartz schist			1 250	1800	100	2.84

* JJ3 etc denotes hole No. on Mount Basedow drill traverse.

APPENDIX 2

AIRBORNE SURVEY SPECIFICATIONS

Equipment Specifications

Aircraft	- DH6 Twin Otter VH-BMG
Magnetometer	- BMR MFS7 fluxgate magnetometer, with ASQ-10 tail boom installation (recorded at 1 s intervals)
Gamma-ray spectrometer	- Hamner Harshaw 4 channel system, stabilisation by Cs_{137} source, NaI (Tl) detector, crystal volume 220 in^3 (3605cc) (recorded at 1 s intervals) Channel settings: Channel 1 ("total") 0.84 - 3.0 MeV Channel 2 ("potassium") 1.30 - 1.60 MeV Channel 3 ("uranium") 1.60 - 1.90 MeV Channel 4 ("thorium") 2.40 - 2.80 MeV
Data acquisition system	- Hewlett Packard 2114B 8K computer linked to Kennedy 1600 incremental tape recorder. BMR software.
Timer unit	- BMR prototype NZA1
Dopper Navigation system	- Marconi AD560 (recorded at 10 s intervals)
Radar Altimeter	- Collins Alt 50
Tracking camera	- BMR-modified Vinten 35 mm strip camera

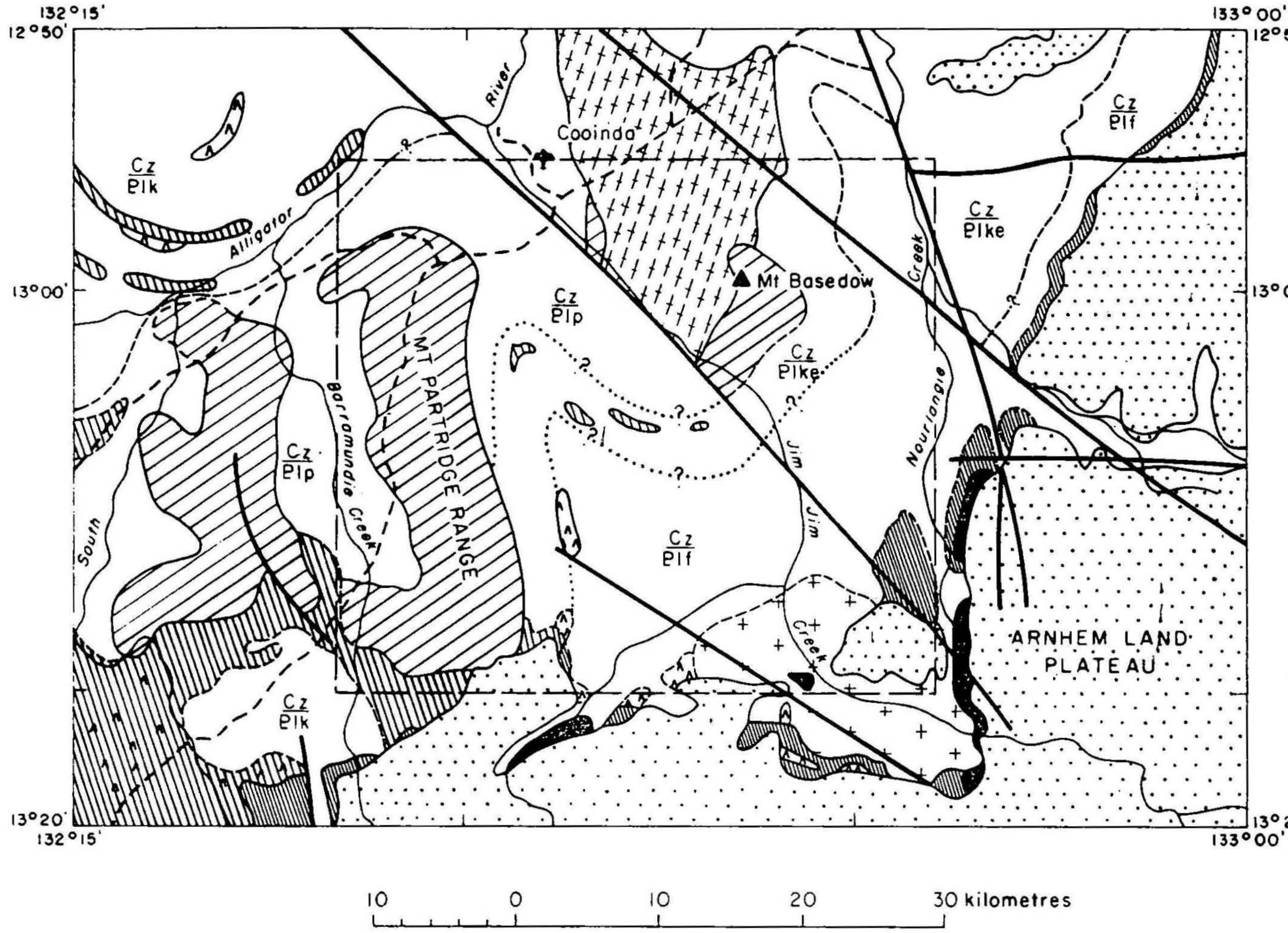
Survey Parameters

Altitude	80 m above ground level
Line spacing	500 m
Line direction	East-west
Aircraft speed	100 knots

Personnel

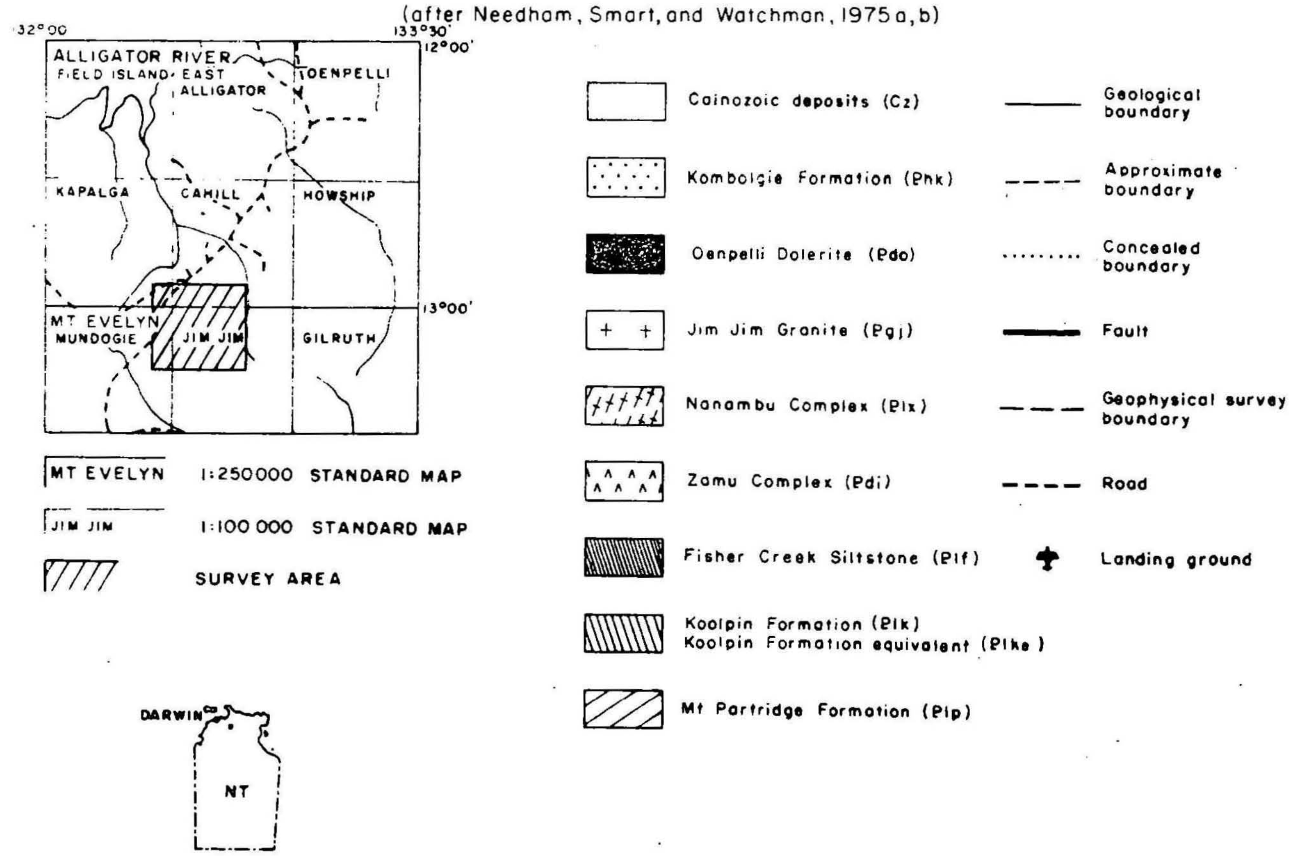
S.S. Lambourn	Geophysicist (Party Leader)
R. Curtis-Nuthall	Technical Officer
K. Mort	Technical Assistant
I. Haigh	)
J. Macey	) T.A.A. Pilots
D. Jenner	)

PLATE 1

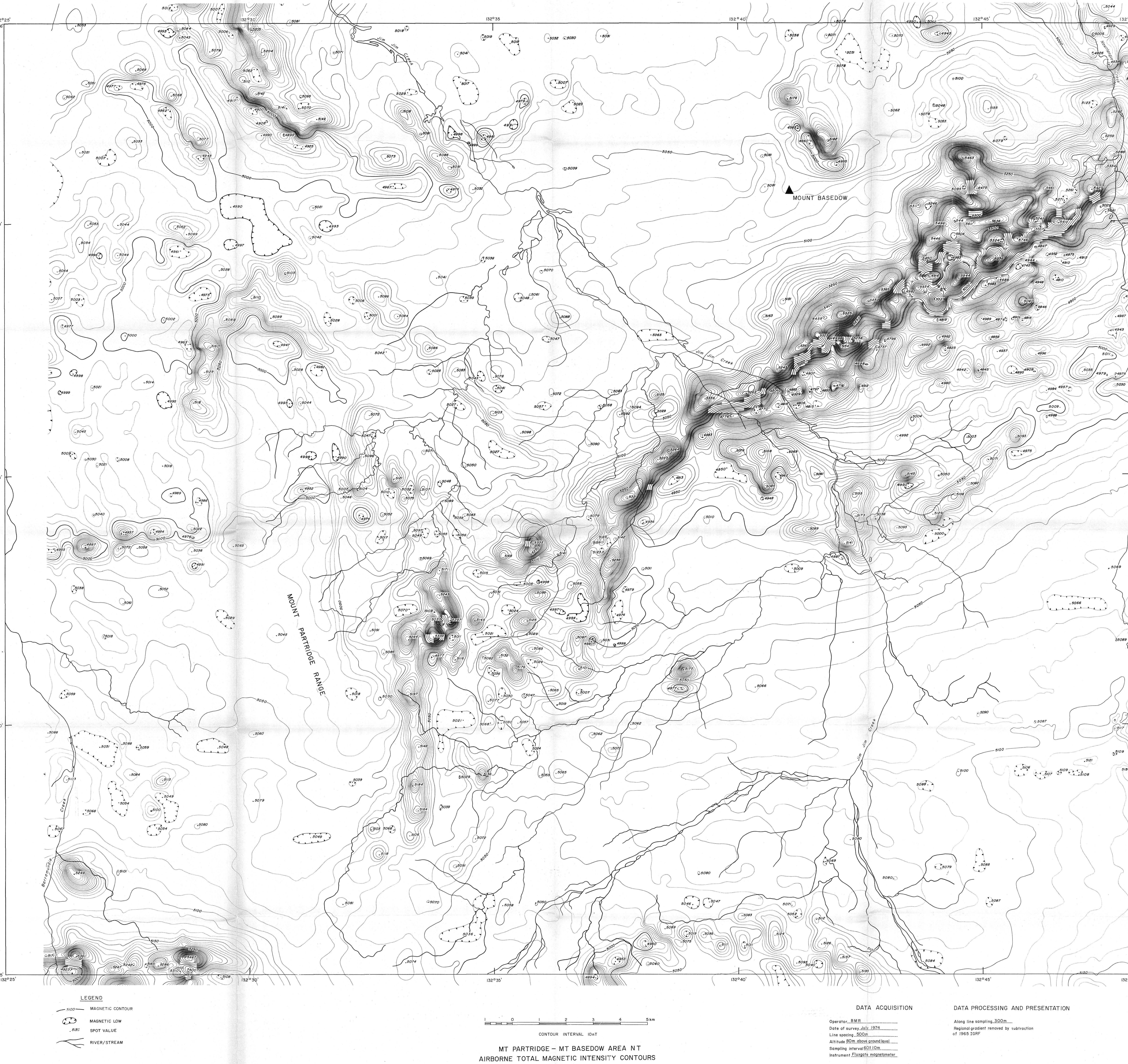


SURVEY LOCALITY AND GENERALISED GEOLOGY

(after Needham, Smart, and Watchman, 1975 a, b)



D53/B7-75A



MT PARTRIDGE – MT BASEDOW AREA NT
AIRBORNE TOTAL MAGNETIC INTENSITY CONTOURS

DATA ACQUISITION

Operator BMR
Date of survey July 1974
Line spacing 500m
Altitude 80m above ground level
Sampling interval 60±10m
Instrument Fluxgate magnetometer

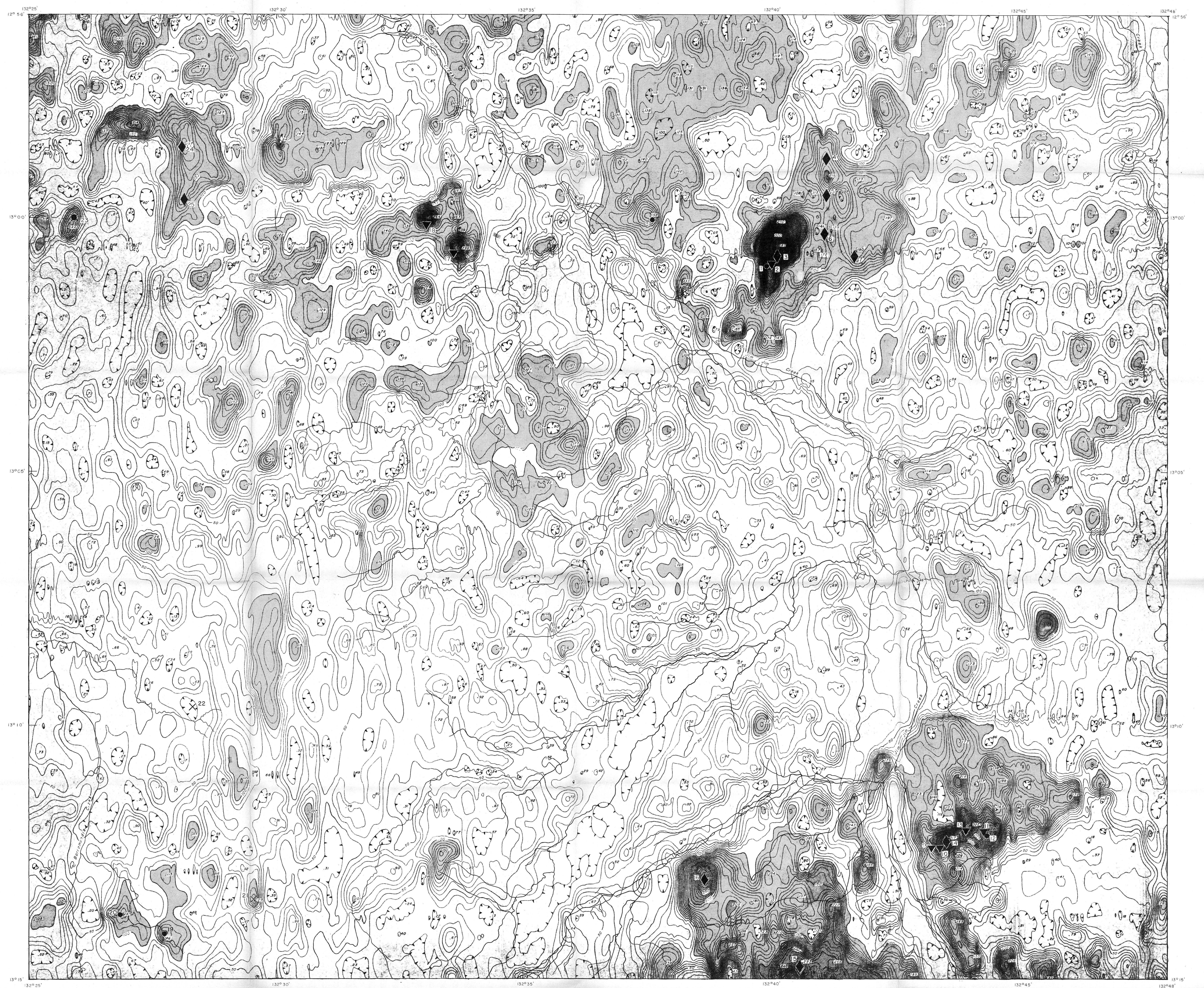
DATA PROCESSING AND PRESENTATION

Along line sampling 300m
Regional gradient removed by subtraction of 1965 IGRF

Record No. 1978/65

D53/B7-76

PLATE 3



—50—	RADIOMETRIC CONTOUR	TOTAL COUNT
(hachured closed contour)	RADIOMETRIC LOW	TOTAL COUNT
.35	SPOT VALUE	TOTAL COUNT
●	"URANIUM" ANOMALY (>15 counts/s)	
◆	"POTASSIUM" ANOMALY (> 4 0 counts/s)	
▼	"THORIUM" ANOMALY (> 3 0 counts/s)	
×	U/TH ANOMALY (>5)	
23	ANOMALY NUMBER	
(wavy line)	RIVER/STREAM	

light stipple	100 – 200 cps
dark stipple	> 200 cps

1 0 1 2 3 4 5 Km

CONTOUR INTERVAL 10 counts/s

MT PARTRIDGE – MT BASEDOW AREA N T

AIRBORNE RADIOMETRIC TOTAL COUNT CONTOURS

DATA ACQUISITION

Operator: BMR

Date of Survey: July 1974

Line Spacing: 0·5km

Altitude: 80m above ground level

Sampling Interval: 60m ± 10m

4-channel differential spectrometer detector volume 3700 cm³

Spectrometer channels: 0·84 – 3·00 MeV ("Total")
1·30 – 1·60 MeV ("Potassium")
1·60 – 1·90 MeV ("Uranium")
1·90 – 2·80 MeV ("Thorium")

DATA PROCESSING AND PRESENTATION TOTAL COUNT CONTOURS

Background Subtraction: applied

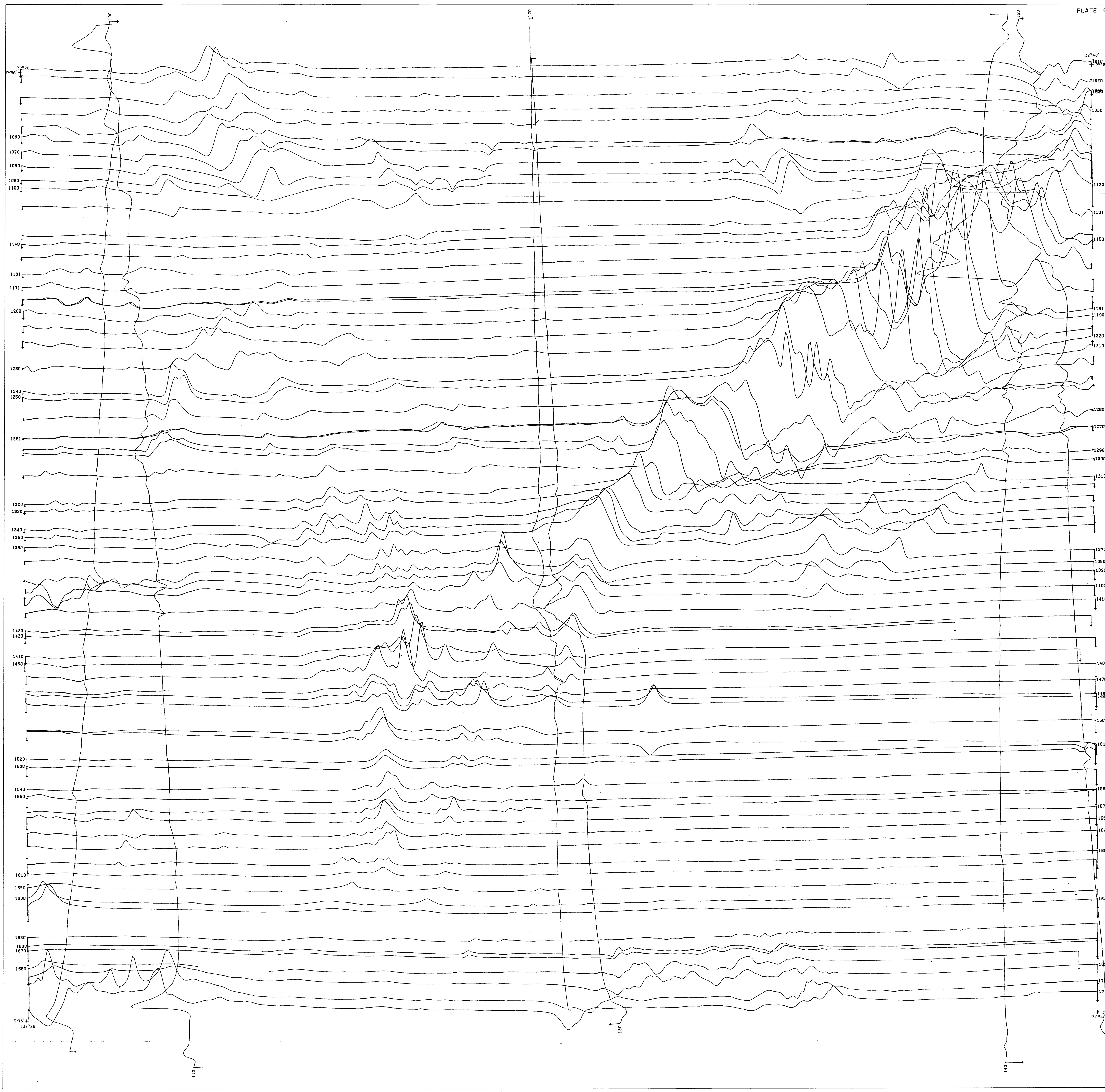
Height corrections: applied

Along-line sampling for contour map: 180m

Record No. 1978/65

D53/87-76

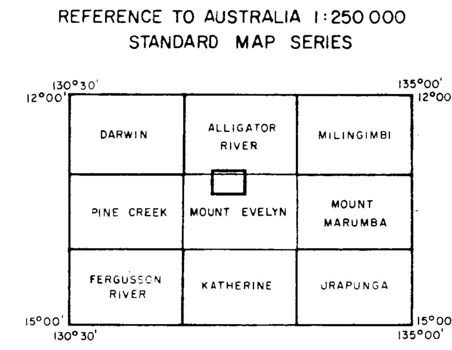
PLATE 4



MT PARTRIDGE – MT BASEDOW AREA N T

AIRBORNE TOTAL MAGNETIC INTENSITY PROFILES

REFERENCE TO AUSTRALIA 1:250 000
STANDARD MAP SERIES



Record No. 1978/65

Kilometres 1 0 1 2 3 4 5 6 Kilometres

DATA ACQUISITION

Operator:	*BMR*
Date of Survey:	*July 1974*
Line spacing:	*0·5 km*
Altitude:	*80m above ground level*
Sampling interval:	*60m ± 10m*

Instrument: Fluxgate magnetometer

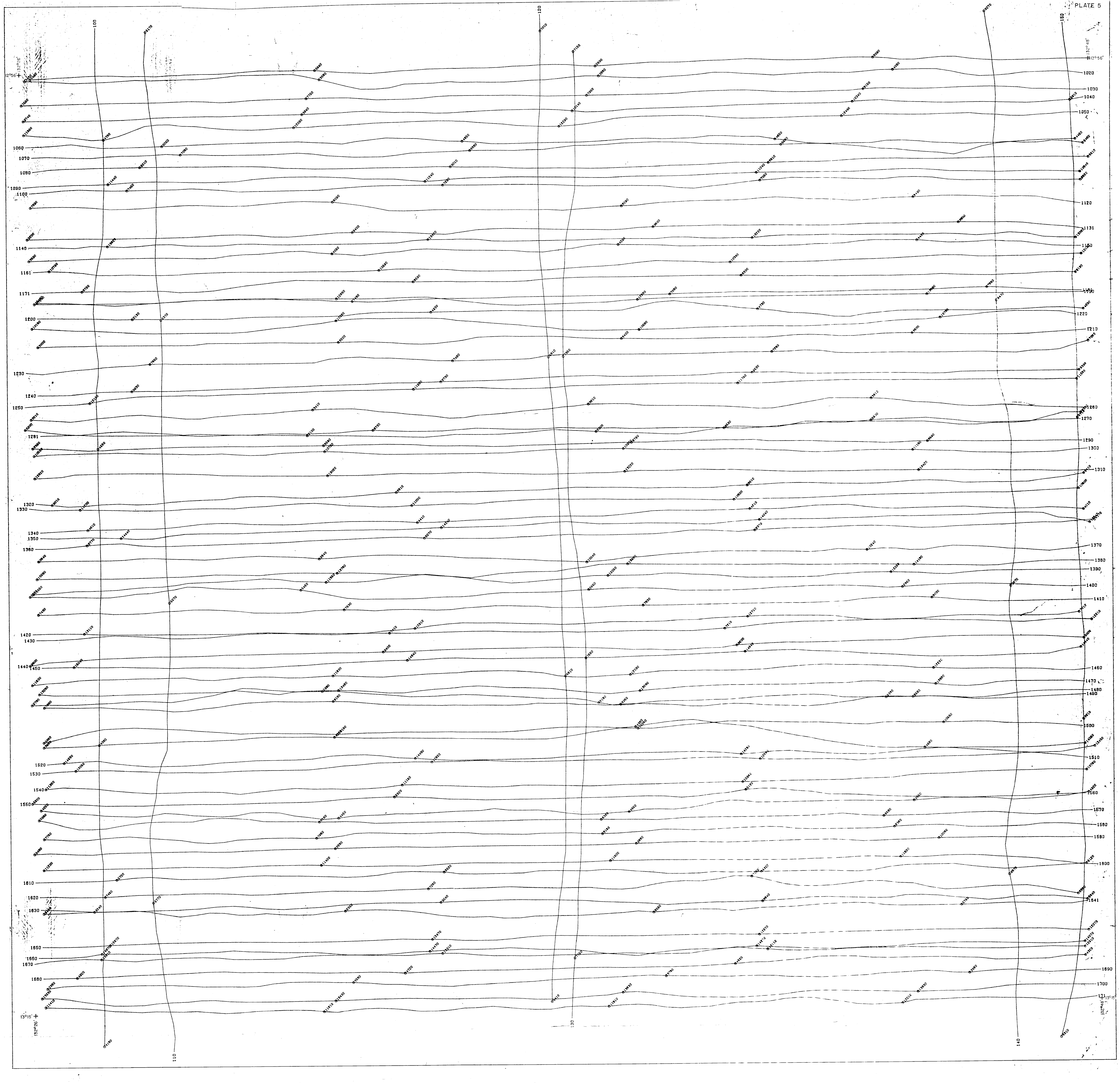
Note The profiles may be positioned by referance to the flight-path map.

DATA PROCESSING AND PRESENTATION

Sampling interval: 60m±10m
Vertical scale: 100nT/cm
Baseline: best-fit flight path
Base value: 5000nT
Flight-line number: 1260
Profile base: +
Regional gradient removed by subtraction of 1965 IGRF

D53/ B1-164
PRELIMINARY EDITION

PLATE 5



MT. PARTRIDGE – MT. BASEDOW AREA N.T.

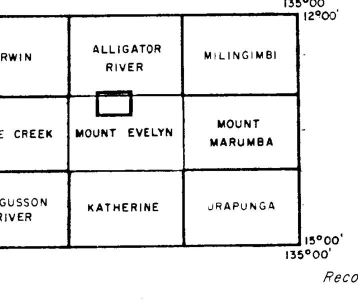
FLIGHT PATH MAP

AIRBORNE MAGNETIC AND RADIOMETRIC SURVEY

SCALE 1:50 000

Kilometres 1 0 1 2 3 4 5 6 Kilometres

REFERENCE TO AUSTRALIA 1:250 000
STANDARD MAP SERIES



Record No 1978/65

DATA ACQUISITION

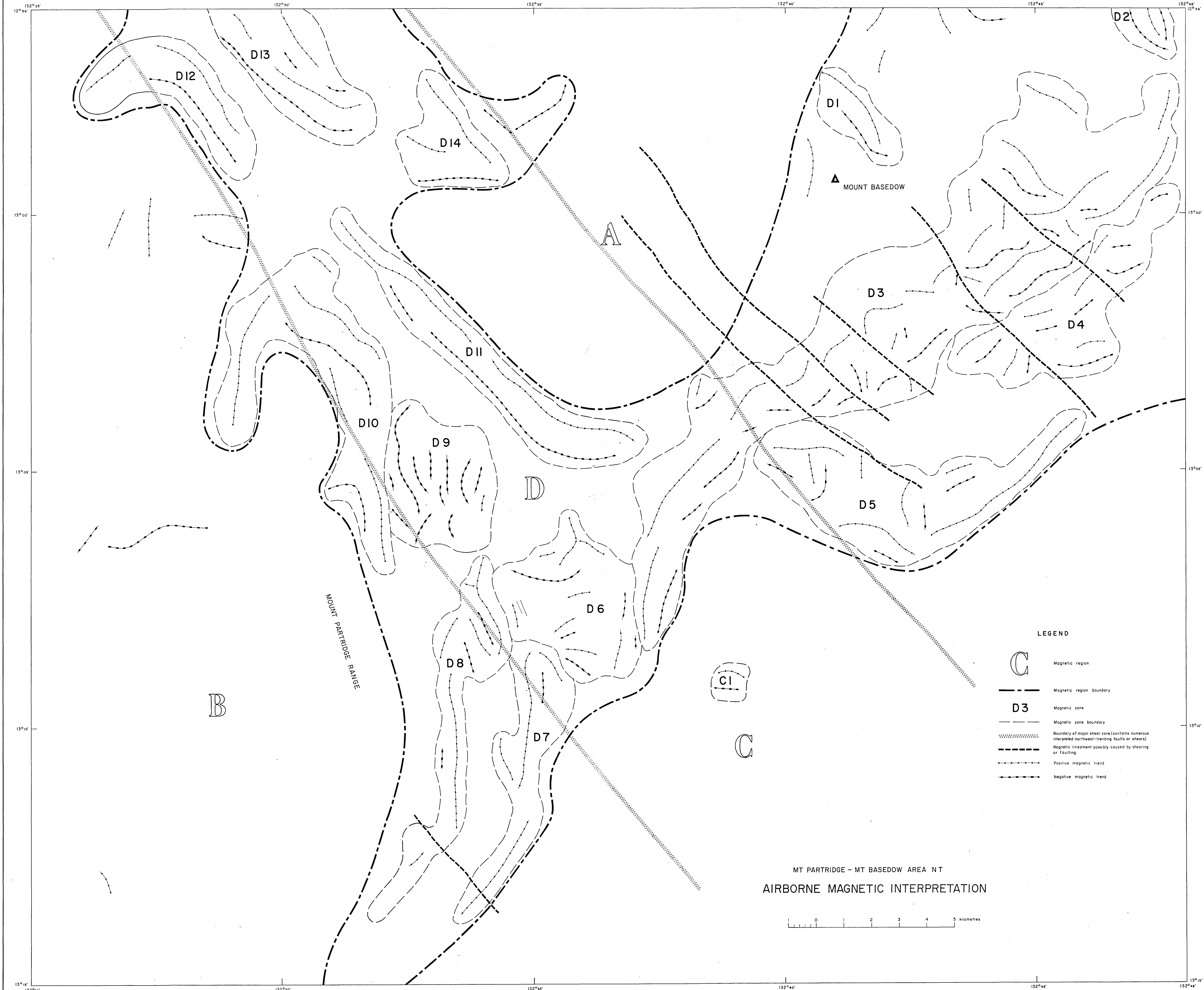
Operator	BMR
Date of Survey	July 1974
Line spacing	0·5 km
Altitude	80m above ground level
Navigation	[illegible]

GEOPHYSICAL LEGEND

[illegible]	Flight line number
[illegible]	Fiducial count

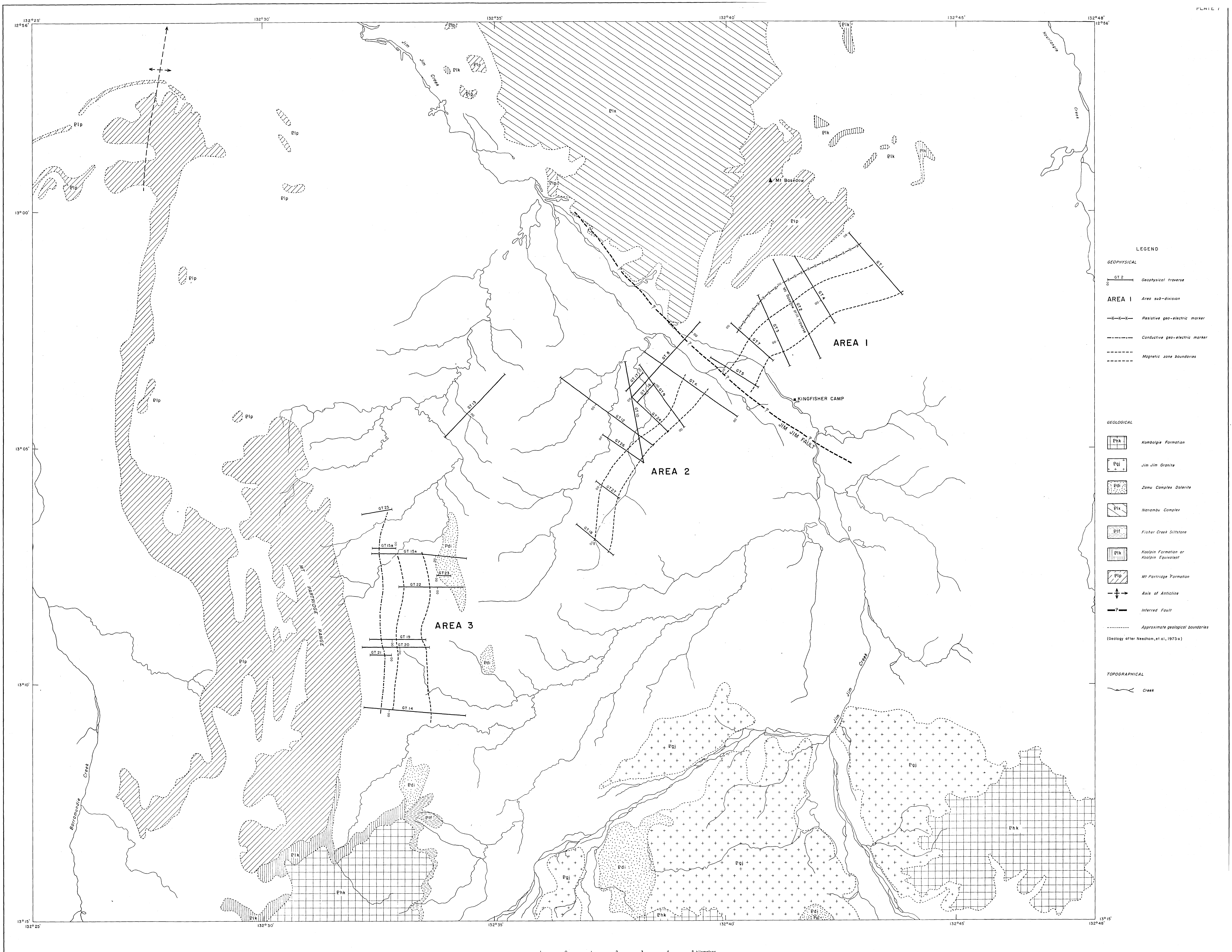
D53/BI-66
PRELIMINARY EDITION

PLATE 6



Record No. 1978/65

D53/B7-77



MT PARTRIDGE – MT BASEDOW AREA N T

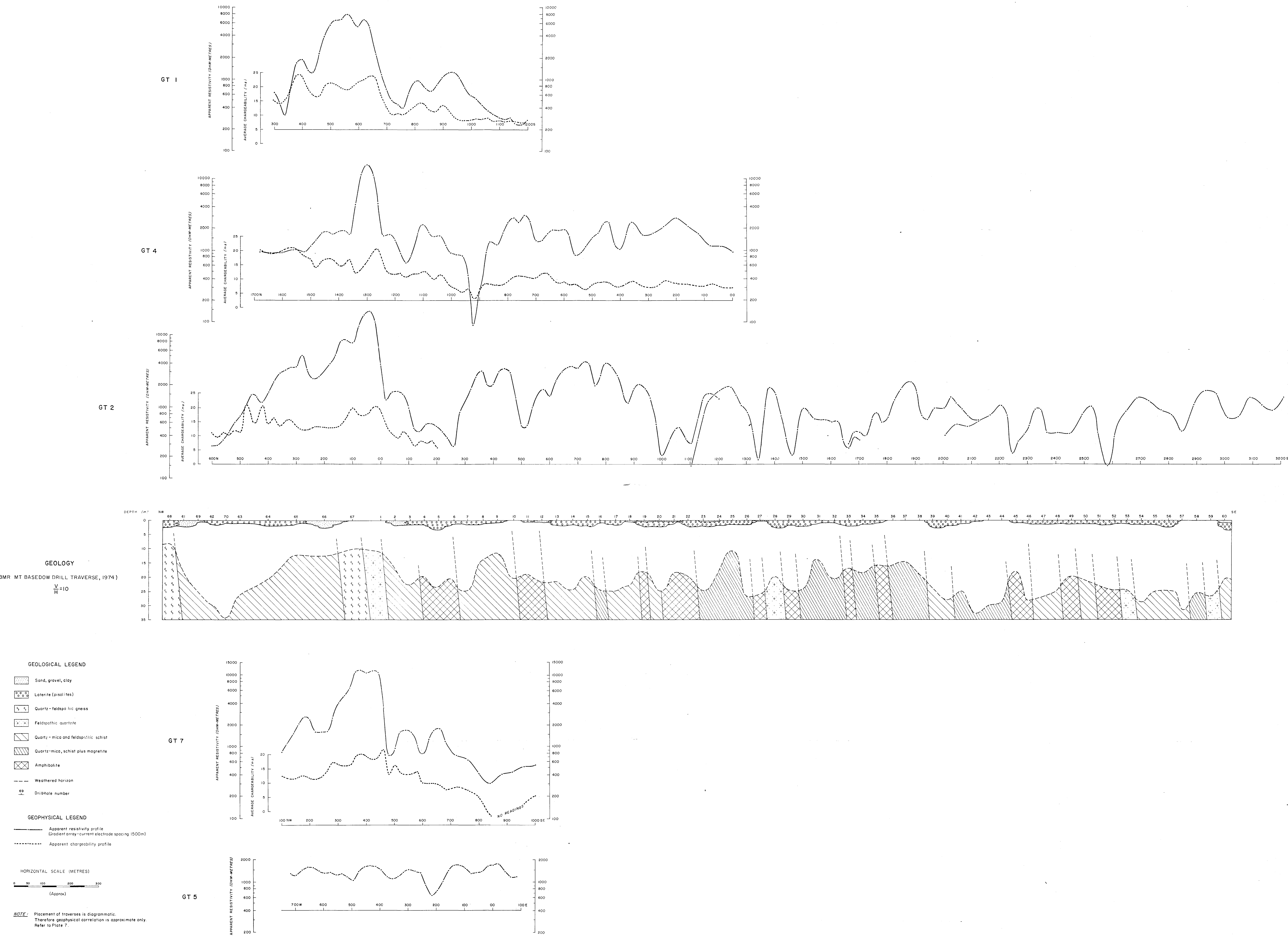
GEOLOGY
GROUND GEOPHYSICAL TRAVERSE LOCATIONS
INFERRED LITHOLOGICAL CORRELATIONS

GROUND MAGNETIC PROFILING RESULTS - AREA 1

GROUND MAGNETIC PROFILING RESULTS – AREA 2

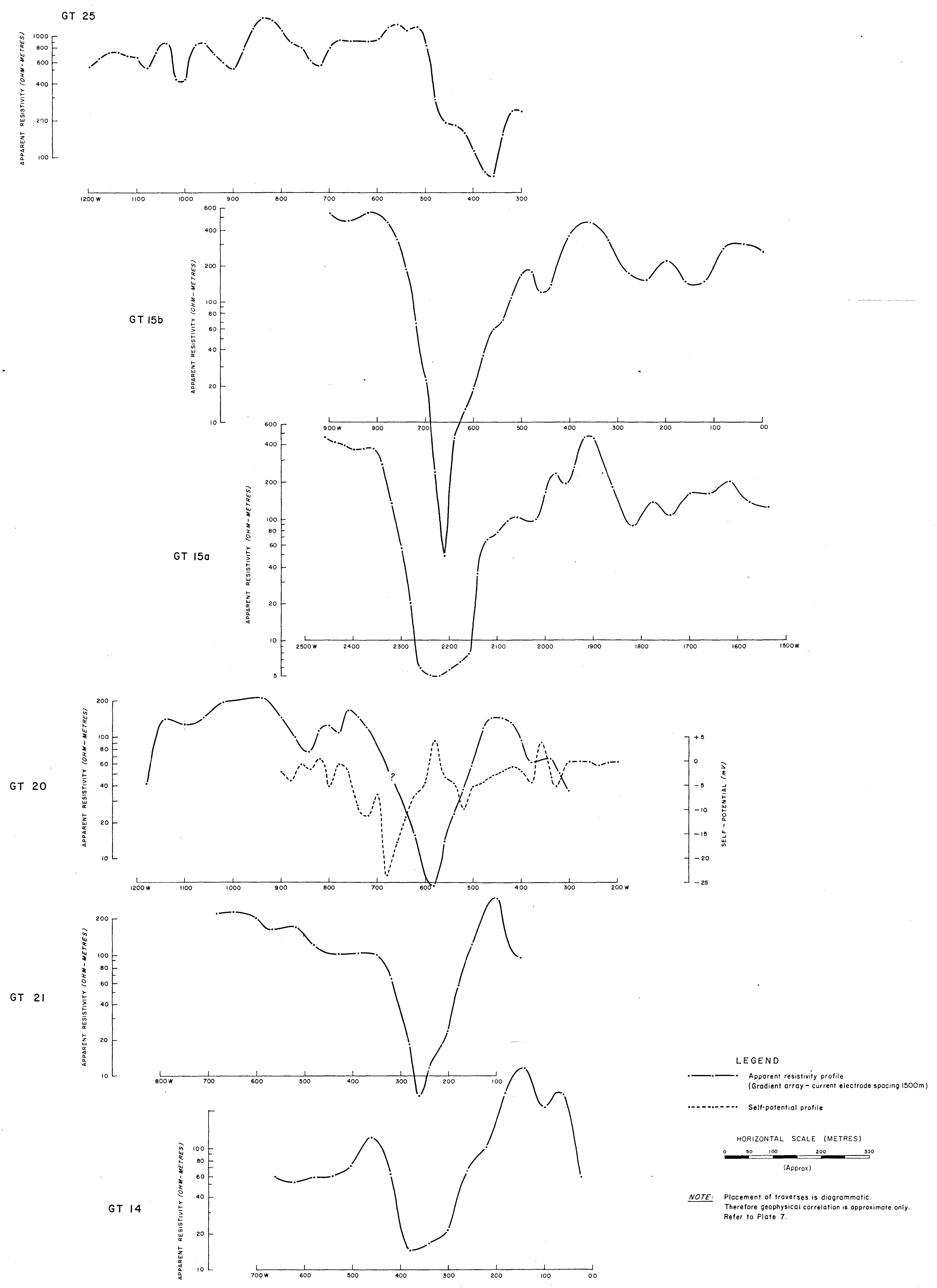
GROUND MAGNETIC PROFILING RESULTS - AREA 3

GROUND MAGNETIC INTERPRETATIONS



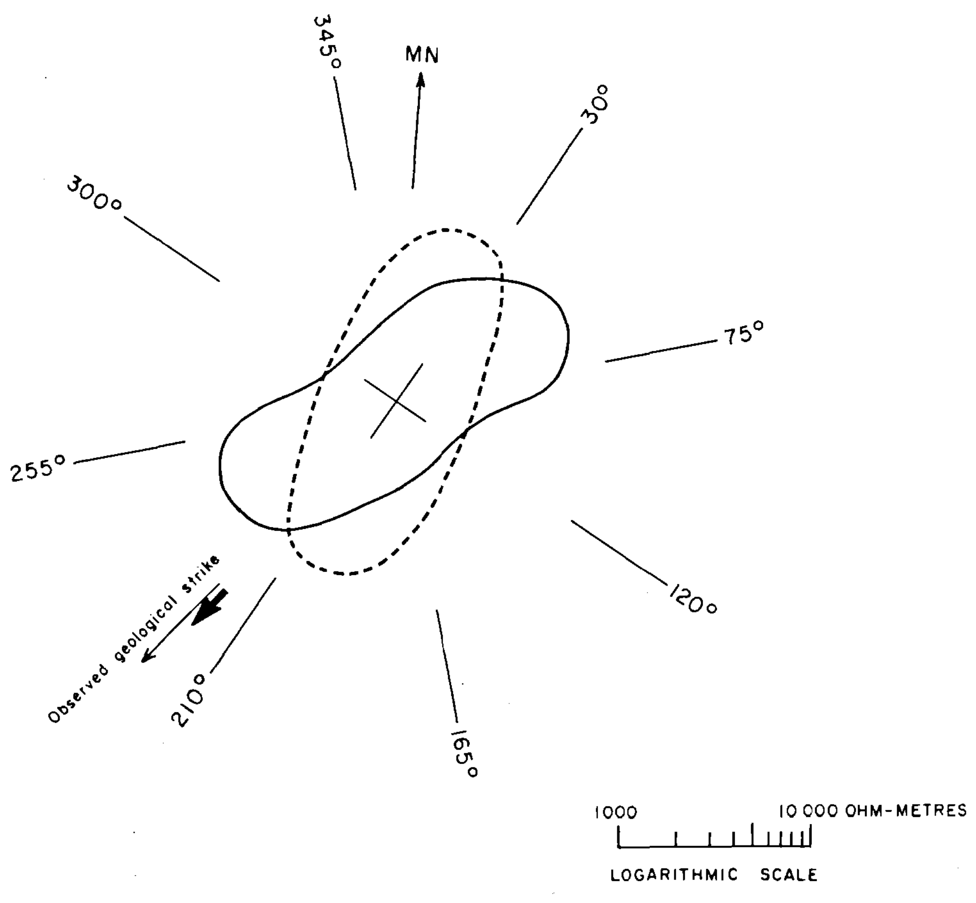
GROUND ELECTRICAL PROFILING RESULTS - AREA 1

GROUND ELECTRICAL PROFILES – AREA 2

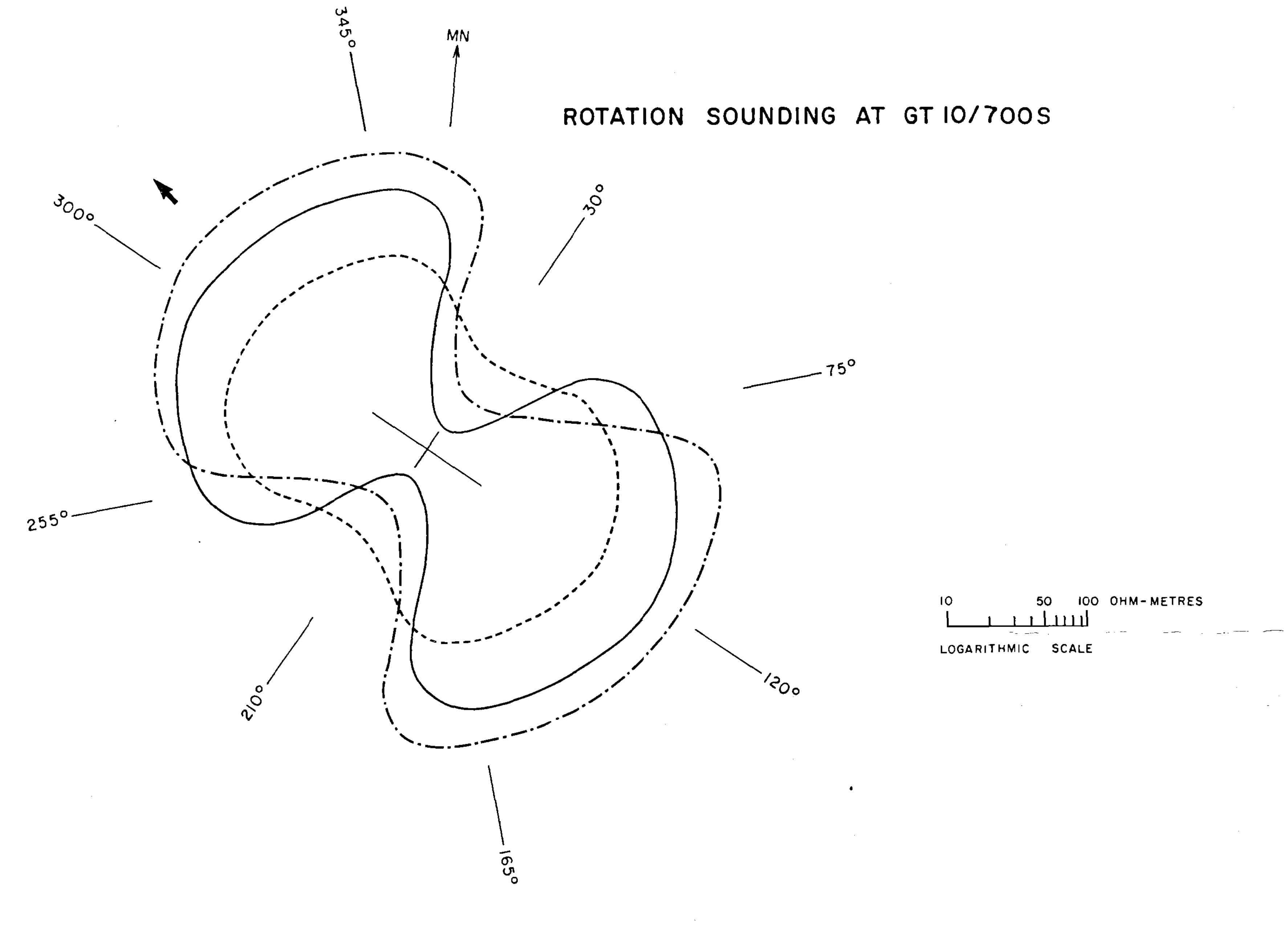


GROUND ELECTRICAL PROFILING RESULTS - AREA 3

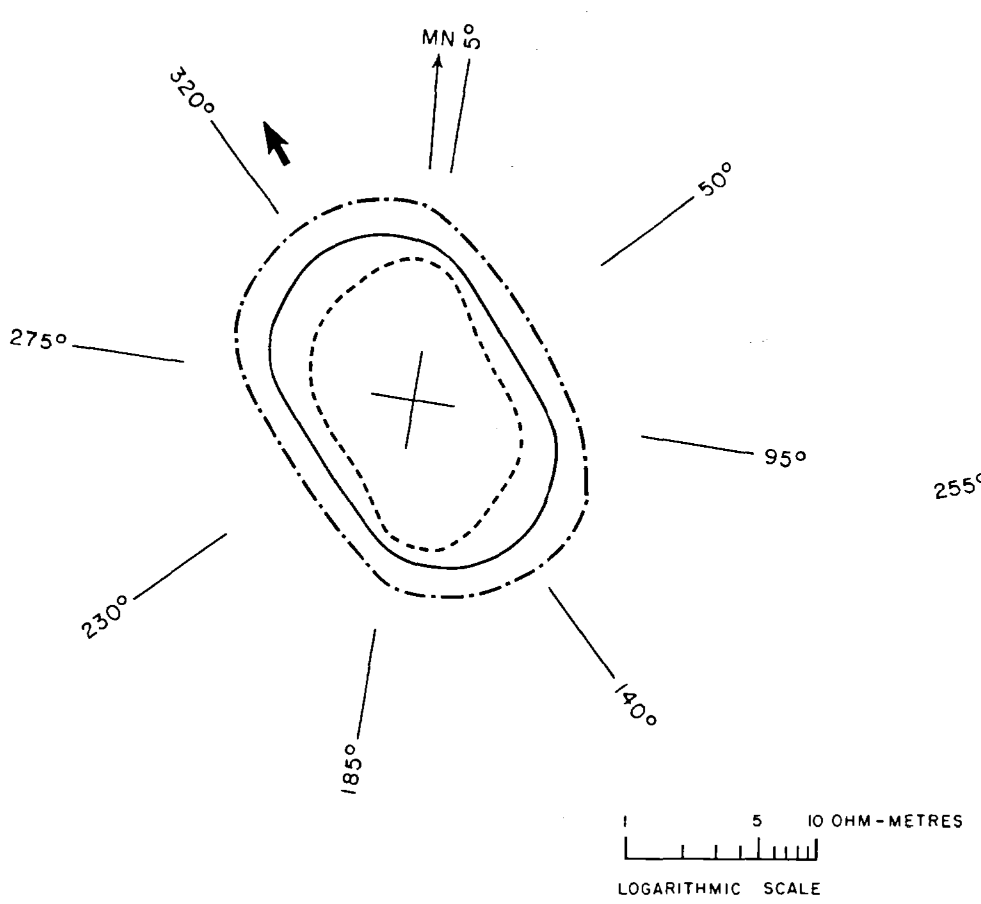
ROTATION SOUNDING AT GT 2/00



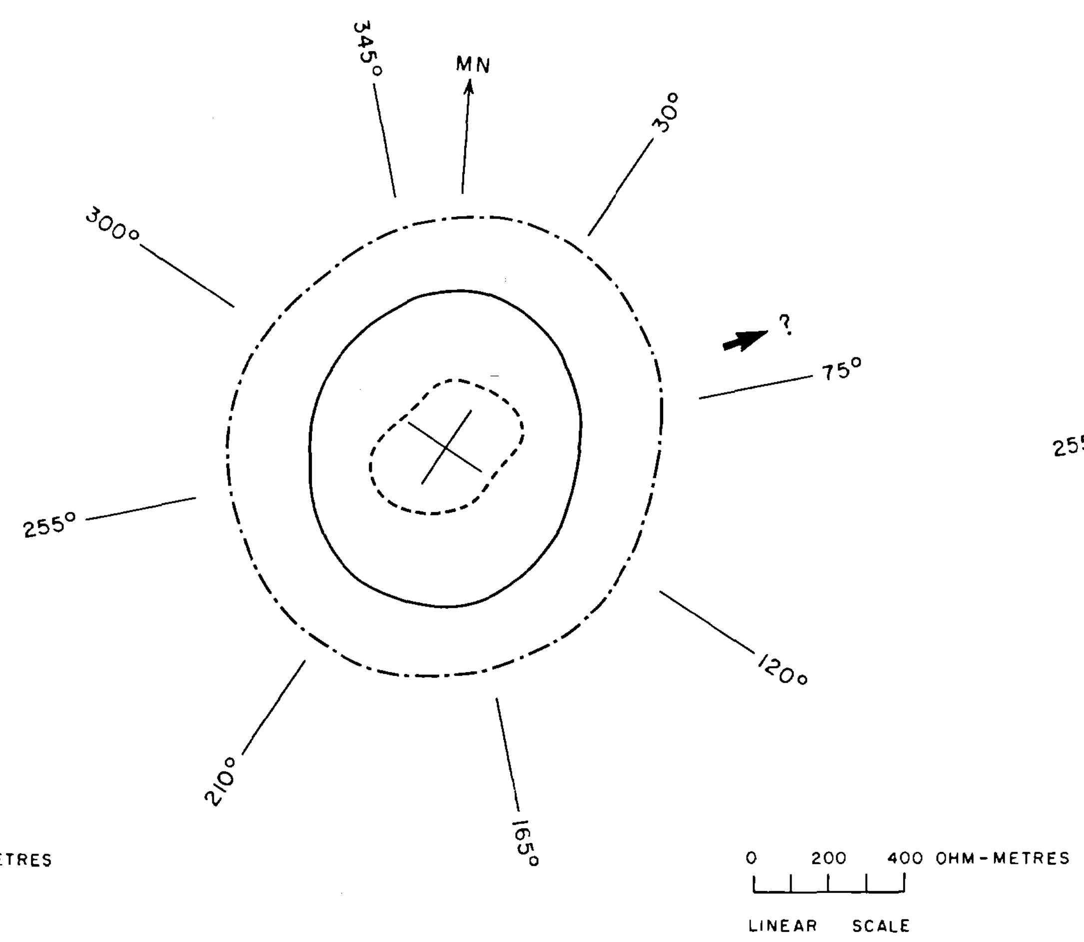
ROTATION SOUNDING AT GT 10/700S



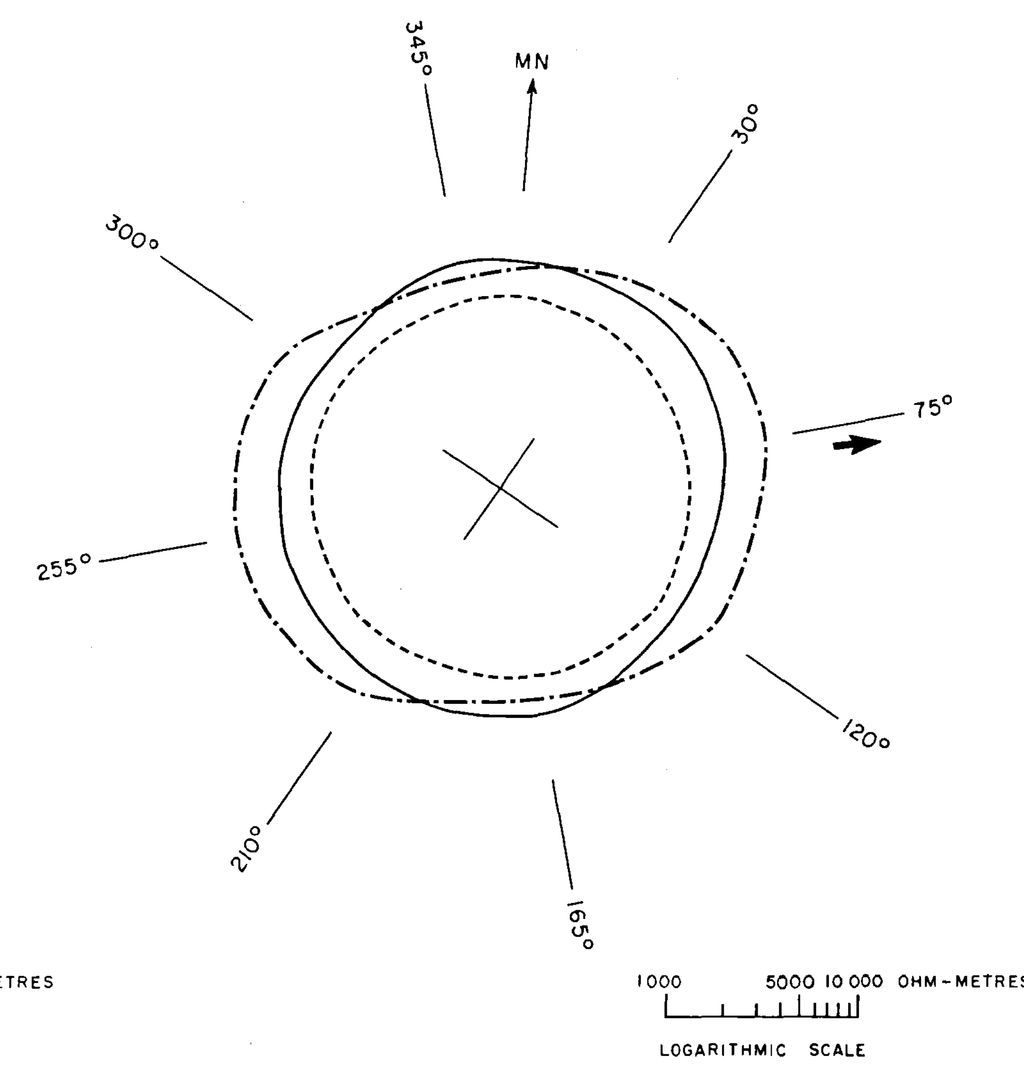
ROTATION SOUNDING AT GT 9/1900W



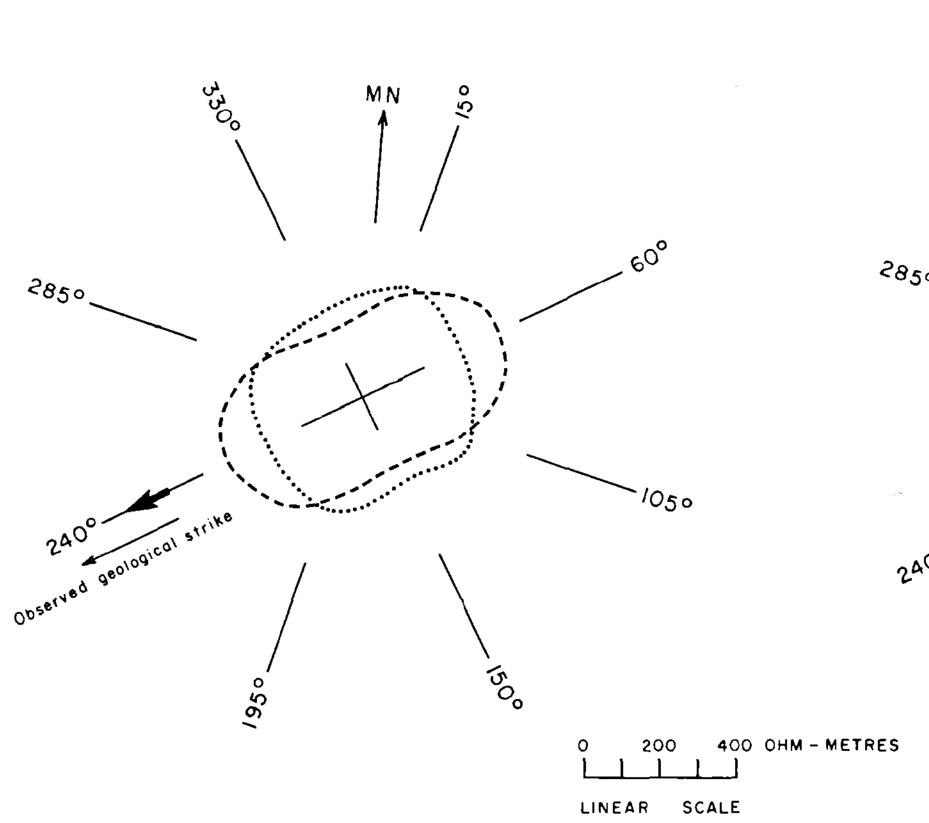
ROTATION SOUNDING AT GT 6/1900W



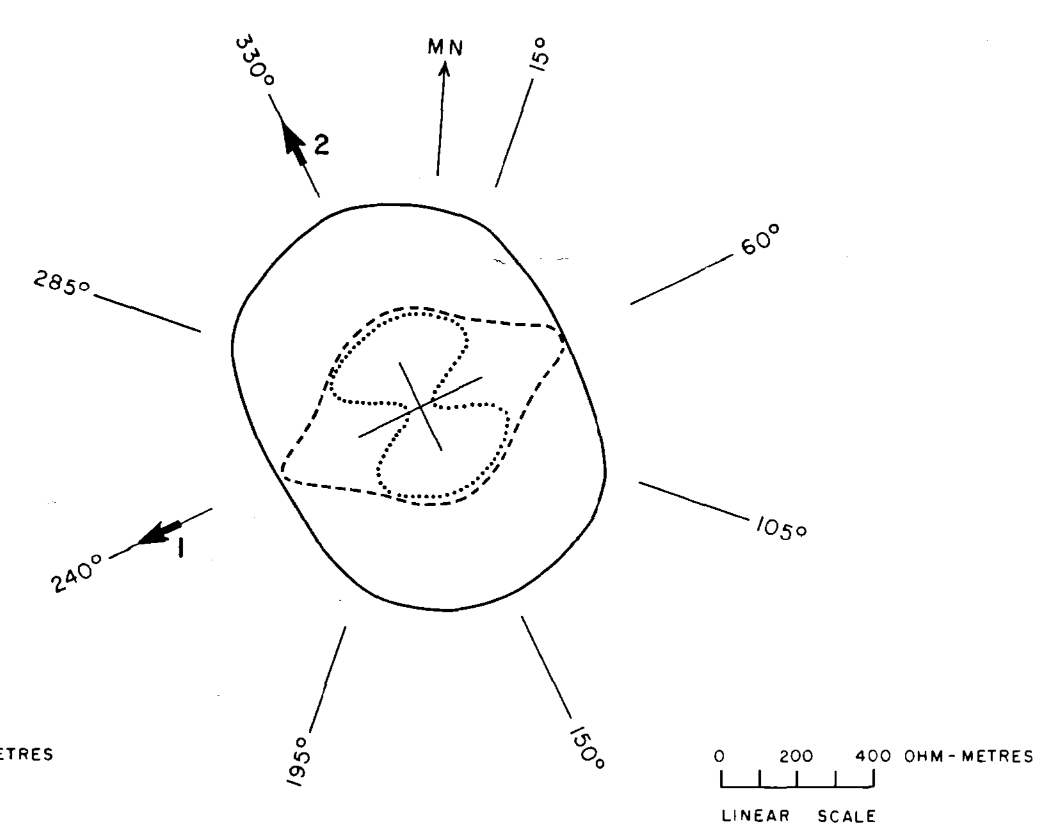
ROTATION SOUNDING AT GT 6/2900W



ROTATION SOUNDING AT GT 12/00



ROTATION SOUNDING AT GT 2/1200S



LEGEND

$\frac{AB}{2}$ = 300 m (Schlumberger electrode spacing)

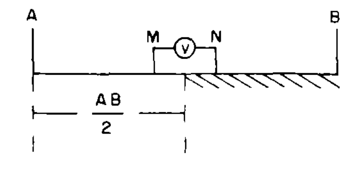
$\frac{AB}{2}$ = 200 m (Schlumberger electrode spacing)

$\frac{AB}{2}$ = 100 m (Schlumberger electrode spacing)

$\frac{AB}{2}$ = 50 m (Schlumberger electrode spacing)

30° Orientation in degrees magnetic

Geo-electric strike direction



Schlumberger array

ROTATION SOUNDING – AREA 2