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REPORT ON

DETAILED GRADIENT EIP SURVEYS

TADPOLE HILL AREA

NEAR ZEEHAN, TASMANIA

ON BEHALF OF

RENISON LIMITED

22 OCT 1982

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PRIVATE AND CONFIDENTIAL

REPORT ON
DETAILED GRADIENT EIP SURVEYS
TADPOLE HILL AREA
NEAR ZEEHAN, TASMANIA
ON BEHALF OF
RENISON LIMITED

BY

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SYDNEY, N.S.W.

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GEOPHYSICAL CONSULTANTS AND CONTRACTORS

SUMMARY

A gradient array survey carried out over the Tadpole Hill Grid centred on National grid co-ordinates 5388000N/360500E, has defined a series of lenticular low amplitude anomalies in four groups designated the eastern, central, western and far western chargeability highs. They are characterised by fast decay forms and shallow source depths of up to 30 metres.

The majority of tourmalinised granite outcrops lie on or in close proximity to chargeability anomalies, but as the chargeability anomalies are more widespread that outcrop, it would be reasonable to infer that the tourmalinisation is more widespread than implied by the surface mapping of the available limited outcrop.

The inference is that where the amplitude of the anomalies is small, and the decay forms rapid, the anomalies are most likely due to mafic mineral content increases and/or to fine grained sulphides. Either way they do appear associated with tourmalinisation, although the precise nexus between the two is yet to be identified.

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DISCUSSION OF RESULTS

The grid consists of some 14 lines each about 1.5 kilometres in length placed approximately every 200 metres in a grid 065° orientation (National grid).

The resulting background observed over the grid varied between 700 and 3000 ohm-metres for the most part, with 'average' being of the order of 2000 ohm-metres ±500 ohm-metres. The chargeabilities observed vary from near zero to 25 millivolts/volt, but the 'average' background lies within the range 8 ±3 millivolts/volt. Both the low chargeability and moderate resistivity lie within the normal range for unoxidised granites which underlie the survey area. Also normal for granites are generally fast decay forms, with ΔMn being of the order of -5% to -20%, indicating a fine grained and/or inefficient source for the chargeable material. While the *absolute* level of the anomalies defined on the grid are invariably of low amplitude (8 to 18 millivolts/volt), and may represent changes in composition of the underlying granites, they may equally represent low grade sulphide concentrations.

The area is discussed from north to south.

LINE 29.5N

The resistivity ranges between 1300 ohm-metres and 2000 ohm-metres. Chargeabilities in the central section (300W to 100E) are very low at 4 to 6 millivolts/volt compared with the ends of the lines. Very local anomalies of 4 millivolts/volt(+) were noted at 075E and 275W, both coincident with local, sharp, resistivity lows. In each case the maximum depth to source is 20 metres.

Comparison with other Geodata

A slight rise in chargeability was seen in the vicinity of the minor tourmaline veining outcrop at 360W. The more significant increase in chargeability at 075W has no geochemical or geological correlatives.

LINE 29N

The range and form of resistivity and chargeability data is similar to that seen on line 29.5N. The flanks of the line have "higher" backgrounds of 10 to 12 millivolts/volt while the central section is 4(±) millivolts/volt. Superimposed on this low background, a local response of 6 millivolts/volt above background was defined at 250W coincident with a resistivity low of 550 ohm-metres against a background of 1000 to 1500 ohm-metres. The maximum depth to source is 15 to 20 metres. The fast decay form ($\Delta Mn = -24\%$) implies a fine grain size to the causative material.

Comparison with other Geodata

The tourmaline outcrop defined at 260W lies close to the significant (against background) response at 250W. A further tourmaline outcrop at 330W has no such similar signature.

LINE 28.5N

The resistivity varies between 800± and 1600± ohm-metres, while the chargeability varies from 4 millivolts/volt on the baseline (00) to 8 to 9 millivolts/volt on the flanks. No significant local maxima were observed.

Comparison with other Geodata

The tourmaline veining recorded at 340W is associated with a 2 millivolts/volt induced polarization response coincident with *higher* apparent resistivities. Normally such a small increase in chargeability would not be considered significant. There appears otherwise to be little correlation between the additional geodata and the low amplitude induced polarization anomalies.

LINE 28N

The resistivities observed vary about the 800± to 1300± ohm-metres level. The chargeability low of 3 millivolts/volt is centred on the baseline with a rise to the west to 10 millivolts/volt(±) at 350W. *There are no significant major or minor anomalies.*

Comparison with other Geodata

There appears to be little significant correlation in any of the parameters, save for a rise in chargeability on the eastern flank of the line (east of 050E) where float containing tourmaline veining was defined.

LINE 27.5N

The form of both the chargeability and resistivity data are similar to line 28N. However, the western section closes off the "formational" anomaly between 450W and 125W. Decay forms are still fast, with ΔMn being of the order of -15%(±) within the higher (6 millivolts/volt±) zones, and -40%(±) in the very low background zones below 6 millivolts/volt.

Two zones of higher background can be recognised - the larger between about 125W and 450W, and the smaller east of 100E and open to the end of the line at 150E. The western flank of the westernmost local high is characterised by lower background resistivities of as low as 600 ohm-metres± between 360W and 475W. These values are anomalously low for granite, and as they are associated with *higher* chargeabilities (albeit of low absolute amplitude), this phenomenon is not associated with weathering, but with compositional change or alteration.

Comparison with other Geodata

The significant outcrop of tourmalinised granite between 190W and 225W is not directly correlated with a *specific* induced polarization response, however, the chargeability between 125W and 450W at 10 millivolts/volt(±) is significantly above the 2 to 3 millivolts/volt background. Perhaps the tourmalinisation is more widespread than mapped. To the east of 100E the chargeability again rises above background by 4 to 5 millivolts/volt, while no tourmalinisation is mapped, there is a single highly anomalous tin value at 100E. As tourmalinisation is inferred to the north, perhaps(?) it is present here also.

LINE 27N

The general form of the chargeability and resistivity data is as seen on the previous two lines. Higher backgrounds were defined east and west of about 075E and 150W respectively.

Within the low background zones of 2 millivolts/volt(±) (which is absnormally low), a narrow zone of higher chargeability (to 10 millivolts/volt) was defined centred at about 085W, associated with a local rise in the 700 ohm-metres resistivities to over 2500 ohm-metres. While the decay form is still slightly faster than normal (ΔMn = -6%) it is much less so than background (-20%±).

The eastern zone of anomalism east of the baseline was defined centred within ±25 metres of 100E where the chargeabilities rise to 6 millivolts/volt above the 2 millivolts/volt background. The western zone is much more substantial and is centred between about 175W and 450W. Within this zone the chargeabilities rise to 12 to 14 millivolts/volt against the 2 millivolts/volt± backgrounds to the east and 6 millivolts/volt to the west. The decay forms are again very fast with ΔMn being -20% to -5%. Only in the extreme west, west of 390W, was the resistivity relatively low at 750 ohm-metres± as compared to the 1300 ohm-metres "average" over the anomaly as a whole.

Comparison with other Geodata

The geologically interpreted tourmaline zone is placed between 200E to about 350W. However, the chargeabilities remain 4 to 8 millivolts/volt between 200W and 450W. Thus the *tourmalinisation* may extend further west by about 100 metres. "Minor" tourmaline nodules at 00, 140W and 500W do not correlate with specific induced polarization responses, but local increases in chargeability were noted at 100E ±40 metres, 082W and west of 540W. Perhaps these sites represent more pervasive tourmalinisation. If the geology is exposed this possibility should be checked.

LINE 26.5N

On this line three distinct chargeability responses were defined. The eastern zone was centred at 100E and was found to extend from about 040E to 120E. The central zone between about 090W and 140W is an extension of the small sharp maximum centred in the chargeability low on line 27N. The western zone is well defined and was recorded between 210W and about 400W, reaching 15 millivolts/volt at 325W.

In detail, the western zone still shows faster than normal decay forms of -10% to -15%, but these are significantly slower than the background which ranges about -25%. A number of the individual chargeability maxima at 335W, 385W and 425W are associated with sharp local reductions in apparent resistivity to well below half the average over the anomaly. The maximum depths to source are invariably less than 10 metres, and the source represents not weathering but a relative conductor carrying a significant local increase in chargeable material.

The central zone reaches up to 10 millivolts/volt above the abnormally low 2 millivolts/volt(±) background. Two distinct maxima at 105W and 125W both allied with an increase in background resistivity to about twice average were recorded. The decay forms of -8%±, while being faster than average, are much less than background. The maximum depth to the disseminated resistive source is of the order of 20 to 25 metres.

The eastern zone was defined between about 025E and 120E and was seen as a series of "higher" ridges of 7 millivolts/volt either side of 100E associated with a sharp change in resistivity from over 4000 ohm-metres at 095E to 1000 ohm-metres at 115E. Thus the eastern section can be considered to be "less resistive" and the western section more resistive. The depth to source is about 20 metres.

Comparison with other Geodata

The interepreted extent of the zone of tourmalinisation is from 240W to 410W.

This correlates well with anomalous induced polarization from 220W to 440W. As significant tin values were recorded over this zone, it is obviously a zone of interest over its entire width. A second zone at, and to the east of 100E correlates well with chargeability increases at 100E. It is suggested that the chargeability high at 100W-140W could also be due to tourmalinisation hitherto unrecognised. As tin values occur down slope, this is a possible zone of economic interest.

LINE 26N

The general form of the profile shows a series of evolutionary changes from that observed on line 26.5N. The western zone is well defined, the central zone slightly depressed, and the eastern zone about the same. An inference of a further zone in the far west (west of 500W) was defined.

The most significant zone remains the western zone - defined between 450W and about 200W. The response rises from an 8 millivolts/volt background (high for the area) to about 18 millivolts/volt (10 millivolts/volt above background) at 325W. Superimposed on this broad response are a series of sharply higher values, implying shallow local increases in chargeable material. Usually, higher local resistivities are seen coincident. The responses at 285W and 355W ±10 metres, have depths to source of about 20 metres. A shaft is recorded at 345W.

Comparison with other Geodata

The geologically interpreted location of the tourmalinisation is between about 1200W (300W) and 1350W(450W). This agrees well with the geophysical data.

Higher chargeabilities between 1000W (100W) and 1075W(175W) have the same characteristics as the tourmalinised zones, and this may in fact indicate the presence of tourmaline. High soil tin values emphasise the interest of this zone, although lying down slope of the Tadpole Hill workings they may also be due to pollution or to a natural down slope halo. This zone should be looked at in the field as a possible zone of economic interest.

A small tourmalinised zone at 920W-930W correlates well with a minor 4 millivolts/volt response at 925W. While higher values of 6 to 8 millivolts/volt above background east of 850E have not been recorded as tourmalinised, although single strong tin values occur east and west of the hilltop on which the anomalous values were recorded. This zone may well also represent a zone of tourmalinisation.

LINE 25.5N

This line is dominated by the western chargeability high. From a 3 millivolts/volt background in the east, and a 6 millivolts/volt background in the west, the chargeability rises to 20 millivolts/volt± at 350W. The anomaly is broad, and extends from about 200W in the east to 450W, showing a series of individual maxima increasing in amplitude towards the centre. The associated resistivities show little material variation from background, remaining at 1700 ohm-metres ±300 ohm-metres for the most part. The central section of the anomaly shows slightly faster than normal decay forms of -2.5%, which represent some of the slowest decay forms in the area. The anomaly itself appears to be multiple sourced in nature, and these individual sources appear to have maximum depths of the order of 20 to 30 metres at most. The western high on this line is one of the most significant in the area.

The far western zone is implied to peak west of 550W. In similar fashion to the western zone, decay forms are only just slightly faster than normal.

Comparison with other Geodata

The main zone of tourmalinisation is geologically interpreted as being between 330W and 400W, while the anomalous induced polarization response was defined between 290W and 400W, with a gradual fall off to 480W. This data implies that tourmalinisation is more widespread than surface mapping has been able to reveal. A distinct chargeability maximum at 265W correlates well with a further outcrop of tourmaline veins and nodules at 270W.

A tourmalinised nodule outcrop at 140W occurs within the general rise towards the main zone between 290W and 400W but shows no distinct anomalis.

On the extreme eastern flank, minor tourmaline nodules at 122E(±) coincide with a much broader above background response of 6 millivolts/volt± which may indicate tourmaline is more widespread than mapped.

LINE 25N

The western chargeability high reaches its maximum amplitude on this line at 325W where the chargeability remains 23 millivolts/volt. The fall-off to the east is rapid, and to the west less so. The anomaly form suggests a multiple source in the west. The anomaly is associated with higher resistivities, the more resistive section being more chargeable (to 3000 ohm-metres). A sharp local decrease to 1300 ohm-metres was noted at 295W. In spite of this, the source is quite definitely disseminated in nature. The decay forms are similar to those observed on line 25.5N, namely only slightly faster than normal to normal. This implies an average grain size to the causative material and contrasts with the background whose decay forms remain fast. The anomaly is most significant between 290W and 330W and any investigation by drilling should first take place within these coordinates.

The far western zone reaches a significant 18 millivolts/volt at 585W from a background of about 4 to 5 millivolts/volt at 500W. Again the resistivities appear to increase in sympathy with increased chargeability. While the decay forms are faster than normal to -7.5%(±), the background values are still faster. The maximum depth to source is of the order of 10 to 20 metres, while the source itself is clearly multiple in nature. This response closes to the south and is open to the north, but is inferred to be present west of the ends of lines 25.5N and 26N.

Comparison with other Geodata

While there is no geological interpretation of the broad tourmalinised zone seen to the north, the significant induced polarization responses between 260W(±) and 450W and particularly between 260W and 380W, would clearly imply the main tourmalinised granite zone crosses this line. It could be that the zone sub-crops below coarser/barren granites. High coincident tin values further enhance the interest of this feature.

The good general correlation would imply that the far western chargeability high centred at 585W but extending from 540W to the end of the line at 645W may also be a site of tourmalinisation although none has been recorded on the mapping. Similarly, peaks at 215W and 00 may have the same source.

LINE 24.5N

This line shows a significant change in form and amplitude to line 25N, although the relationship between the two can still be seen clearly. Essentially the western chargeability high is seen as a well defined response with a clear-cut contact with the enclosing rocks between 390W and 200W. To the east the background varies within about ±2 millivolts/volt of 4 millivolts/volt, while to the east, the background looks to be about 8 millivolts/volt ±2 millivolts/volt.

The western chargeability high has two distinct sections, the western section between 310W and 390W consists of chargeabilities between 16 and 18 millivolts/volt, and the eastern of chargeabilities between 12 and 14 millivolts/volt. The former is characterised by slightly faster than normal decay forms of -2% to -5% over the central part of the response, while the latter is characterised by very fast decay froms of -15% to -20%. Thus the two sources must be differentiated either in composition and/or in grain size. The maximum depth to source is less than 20 to 25 metres over this response. The margins of the anomaly are marked by local sharp resistivity lows at 415W and 175W of 800 ohm-metres as against an average of the order of twice this level. While such boundary resistivity lows are seen on other lines such as 25N, they are most prominent on this line, and may represent a 'halo' or boundary unit. (Field checking is recommended to ascertain the source.)

To the west a small but definite anomaly of about 6 millivolts/volt above background was defined at 475W associated with an increase in resistivity. While this response is terminated to the north, it can be traced for two lines to the south. Two centres are implied at 475W and 445W. In each case the depth to source is less than 20 metres. While decay forms are faster than normal at -6%, they are much less so than background values.

Comparison with other Geodata

The western chargeability high between 390W and 200W referred to above implies a significant anomalous zone, however, only at 350W were tourmaline veins recorded. Perhaps tourmalinisation becomes more significant with depth, depth to source being a shallow 20 to 25 metres. The 'cover' would have to be thin. A distinct chargeability maximum at 475W lies close to tourmalinised granite at 475W, while other tourmaline veins and nodules at 520W, 580W and 650W occur coincident with or close to local chargeability increases in an area of higher than average background.

LINE 24N

The western chargeability high was defined between 1150W and 1365W in two maxima centred at about 1200W and 1350W. The *eastern* maximum (1200W) would appear to be related to the *western* maximum centred at 350W on line 24.5N. To both the east and west the background observed was low, being 2 millivolts/volt(±) and 5 millivolts/volt(±) respectively. The anomaly is bounded by sharp local resistivity lows, as are the two sections within the response. The decay forms are variable, however- there is a tendency for the easternmost section to show slightly faster than normal values (-5% to -8%), and the western peak to show faster values to -20%, implying some compositional changes between these two sources which otherwise appear similar. The maximum depths to source appear to be of the order of 10 to 30 metres at most for all the multiple features within this zone.

West of the main western zone, two sharp narrow sources were defined centred at 1405W and 1465W. Both are about 8 millivolts/volt above the local background and both are associated with a significant doubling in apparent resistivity. Both show slightly slower than normal decay forms of -5% to +6% compared with -20%(±) in the immeidate background. Both sources lie *within* 20 metres of surface.

Comparison with other Geodata

As described above,. the main chargeability response between 1150W± and 1365W is in two distinct sub-zones, the most *significant* of which was logged between 1275W and 1375W which coincides with intense tourmalinisation at 1300W±50 metres. The second maximum at 1200W clearly implies tourmalinisation for ±25 metres of this point also.

In the east tourmalinisation was recorded at 1030W and 1060W. Local 4 to 6 millivolts/volt responses *correlate* well with these points. In the west, tourmaline alteration at 1510W, 1560W and 1615W does not correlate with any specific induced polarization responses, however, two significant chargeability maxima at 1405W(305W) and 1465W(365W) imply tourmalinisation to be present at these locations.

LINE 23.5N

The western chargeability high is centred at 275W as a sharp distinct maximum of 21 millivolts/volt. To the east and west thereof a series of individual maxima of decreasing amplitude occur with the boundary being situated at about 355W and 125W where two significant and narrow resistivity lows were recorded, the former being associated with a local single station chargeability high. The central response at 275W is itself associated with a relatively minor resistivity low of

2000 ohm-metres, implying the chargeable material may lie within a less resistive host. The decay form of -7%, while faster than normal, is nevertheless slower than most others within the anomaly, and much less so than background. The maximum depth to source of this response is about 15 to 20 metres. Other maxima are relatively minor, but show the source of the western chargeability to be multiple in nature.

On this line a significant response from the far western high was recorded from 600W to the end of the surveyed line at 700W. Here the chargeabilities reach over 16 millivolts/volt from a background of 6 to 8 millivolts/volt. The decay forms expressed in terms of ΔMn range from -2% to -7%, slightly faster than normal. The resistivities associated with this feature are high for the area at 4000 ohm-metres to 8000 ohm-metres, and thus the host must be considerably more resistive than the 2000 ohm-metres ±500 ohm-metres background.

Comparison with other Geodata

The western chargeability high has no significant tin values recorded over it, although other values including As and WO_3 centred at 200W(±) and Cu and As at 360W(±) were noted. While no tourmalinisation has been noted in the mapping, this may be due to lack of outcrop.

The far western chargeability high west of 600W(±) showed a single anomalous tin value at 600W, but again no tourmalinisation was noted.

LINE 23N

On this, the most southerly line surveyed, the western chargeability high again shows two distinct sections - one centred at about 350W and the other at 175W/250W. In all cases the maxima are multiple in nature and cannot be correlated with other anomalies in the zone to the north. The eastern maximum 175W/250W is related to *higher* resistivities (4000 ohm-metres±) as is generally the case, while the western peak is associated with *lower* (1000 ohm-metres) resistivities. Therefore there must be compositional differences. The maximum depths to the many multiple sources within these sub-zones are 10 to 20 metres at most. The decay forms observed over the western sub-zone are normal at 0% to slightly faster than normal, which make these some of the slowest observed in the area. Those observed over the most resistive eastern sub-zones are only just faster than this at -7%±.

The far western chargeability high makes its appearance west of 625W with a maximum of 15 millivolts/volt at 675W being associated with a distinct resistivity low of 1700 ohm-metres as against a background of 5000 ohm-metres. The maximum depth to source of this zone is about 15 metres.

Comparison with other Geodata

Little geochem response, and no tourmalinisation was noted over either the western or far western chargeability highs.

THE SIGNIFICANCE OF THE ANOMALIES DEFINED

The geophysical significance of the anomalies located is difficult to assess. The low backgrounds of 2 to 8 millivolts/volt together with their rapid decay forms are typical of those obtained over granites, while the bulk resistivities of 1000 to 2500 ohm-metres are on the low side of the normal range of resistivities observed over non-oxidised granites.

The anomalies defined against these low backgrounds are very definite, even at amplitudes of as low as 6 to 8 millivolts/volt. So from a contrast with background point of view, they are certainly significant. However, their absolute amplitudes against background of 6 to 20 millivolts/volt are considered low, and thus point to only a low bulk volume of sulphides (or sulphide equivalent). Of interest is that in general the decay forms observed are always faster than normal. Within the higher amplitudes the decay forms approach, but rarely ever reach, normal decay forms. This is interpreted as being due to a finely divided source and/or an inefficient source such as mafic minerals. Now, since the amplitudes of the anomalies are generally low, the "anomalous" induced polarization effects could be due to compositional changes within the granites which could be either fundamental or due to tourmalinisation or alteration, etc.

The form of the anomalies is of interest. Firstly they are invariably multiple. The sources are narrow with respect to the 10 metre dipole used, and occur in lenticular clusters. While some features can be traced unambiguously over 200 to 300 metres, many features have a strike length of less than 100 to 150 metres. The clear orientation of all these features is grid 330° to 350° for the most part. The most prominent feature is the western chargeability high which reaches its maximum development between lines 24N and 26N. While a number of grid 030° to 040° 'dislocations' can be positioned to explain the most prominent breaks in the continuity of the chargeability zones, the validity of these features as faults is questioned. What other structural implications they could have is not clear.

Most of the chargeability anomalies defined are associated with local increases in resistivity. This suggests silicification or a greater cementation of the granites in the vicinity of the source. (The *lower* chargeability zones *are not* considered to be due to weathering features.) On a number of occasions *higher* chargeability is accompanied by lower resistivity. This, however, can never be considered to be 'conductive' as such.

From a purely induced polarization point of view then the source of the anomalies as follows, are considered to be of greatest interest.

Line	Station	Maximum Depth
26N	280W ±50 metres	20 metres
25.5N	350W	20 metres
25N	325W	20-30 metres
24N	280W(1350W)	30 metres
23.5N	275W	30 metres

Correlation Between Chargeability Highs and Known Geology

The mapped orientation of the zone of tourmalinisation between 27.5N/250W and 25.5N/425W is approximately (National grid) north south, but the orientation of the western chargeability high associated with the tourmalinisation clearly has a (National grid) 330° orientation. However, the individual outcrops of tourmaline granites recorded in this section do, for the most part, occur in close proximity to anomalous chargeability readings. (With some notable exceptions such as 480W/25.5N). Some of the better chargeability responses, in particular 25N/325W, occur to the south of the main zone of geological interest in areas of relatively low outcrop. Therefore perhaps the zone extends further south than can be mapped. Certainly a number of tourmaline zones occur close to chargeability anomalies. Within the western zone between *about* 300W and 500W and 23.5N and 25.5N, tourmalinisation and low amplitude anomalism correlates well, while to the north and south of these limits, a lack of correlation is noted. This could be due to either a lack of sufficient data due in turn to lack of outcrop, or alternatively, the anomalies being due to a source other than tourmalinisation.

It is possible that the induced polarization sampling large volumes of rock rather than small surface areas (as does surface mapping), will permit a better bulk averaging of the changes brought about during the tourmalinisation. As the sources are considered to be shallow, certainly not in excess of 30 metres, a plunge in the zone of interest to the south is not possible unless the chargeability is a 'halo' effect.

An outcrop of tourmalinisation granite at 120E on 26.5N was associated with a low amplitude response of about 5 to 6 millivolts/volt above background centred at 100E. To the south this anomaly increases in amplitude to 8 millivolts/volt. Thus it is also likely that the eastern chargeability high may also be associated with a zone of tourmalinisation.

CONCLUSIONS

1 The chargeability anomalies while being of low amplitude nevertheless are significant with respect to background. The decay forms are invariably faster than normal and imply either a fine grained source or an inefficient source. Such responses could possibly represent compositional changes within the granites.

2 The chargeability anomalies are congregated into four groups trending about 330°-340°. Four groupings of anomalies across strike can be identifed, namely, eastern high, central high, western high and far western high. Of these the western high is the most significant.

3 The majority of known outcrops of tourmalinised granites occur on, or close to chargeability highs. However, the occurrence of chargeability highs is more extensive than the outcrops. It follows that the tourmalinised granites may be far more extensive than previously thought.

4 It is recommended that the source of the anomalies at 26N/280W (±50 metres), 25.5N/350W, 25N/325W, 24N/280W and 23.5N/275W be investigated in detail by gaining access to the outcrop by trenching rather than by diamond drilling. Attention should be given to covering *area* round the given sites rather than a point source.

5 The total magnetic field data was of no material assistance.

The author looks forward to discussing these results in the near future.

Respectfully submitted on behalf of:

SCINTREX PTY. LTD.

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Geophysicist

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PERSONNEL AND TIMING

The work was carried out under the direction of senior crew leader Mr. R. Bennett with the assistance of second operators Mr. G. Kennedy and A. Hudson. Field hand Mr. P. Eagleton also assisted.

The field work was undertaken between 1st and 9th February, 1982 during which period some 10.6 kilometres of line or 1060 stations were read.

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METHOD AND EQUIPMENT

The method employed was the gradient array. Energisation was effected by a large spaced current dipole placed across strike powered by a Scintrex time domain transmitter employing a 2 second square wave. The power unit was an 8HP 400Hz motor generator.

The resultant primary (resistivity) and secondary (chargeability) electric fields were measured using Scintrex IPR-8 time domain receivers on a two second programme measuring three separate slices under the decay curve as follows:

Slice 1 (M_1) 130 to 650 milliseconds

Slice 3 (M_3) 650 to 1170 milliseconds

Slice 5 (M_5) 1170 to 1430 milliseconds

(Note: each section is of 520 milliseconds duration)

Each integration has been normalised with respect to the standard induced polarization decay curve established by Newmont Exploration Limited (Dolan, W.M., McLaughlin, G.H. (1967) "Considerations Concerning Measurement Standards and Design of IP Equipment" Proceedings of the Symposium on Induced Electrical Polarization, Berkely, University of California, pp. 2-31)

The area was energised in two gradient blocks as follows:

800W and 500E on 28N

Line 29.5N 400W to 150E

Line 29N 400W to 150E

Line 28.5N 400W to 150E

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Line 28N 400W to 110E

Line 27.5N 475W to 150E

Line 27N 550W to 150E

Line 26.5N 550W to 150E

350W and 1900W on line 24N

Line 26N 550W to 150E

Line 25.5N 550W to 150E

Line 24N 650W to 100E

Line 24.5N 640W to 100E

Line 24N 500W to 200E

Line 23.5N 700W to 050E

Line 23N 730W to 050E

In all cases the measuring potential dipole was 10 metres moved at 10 metre intervals.along lines.

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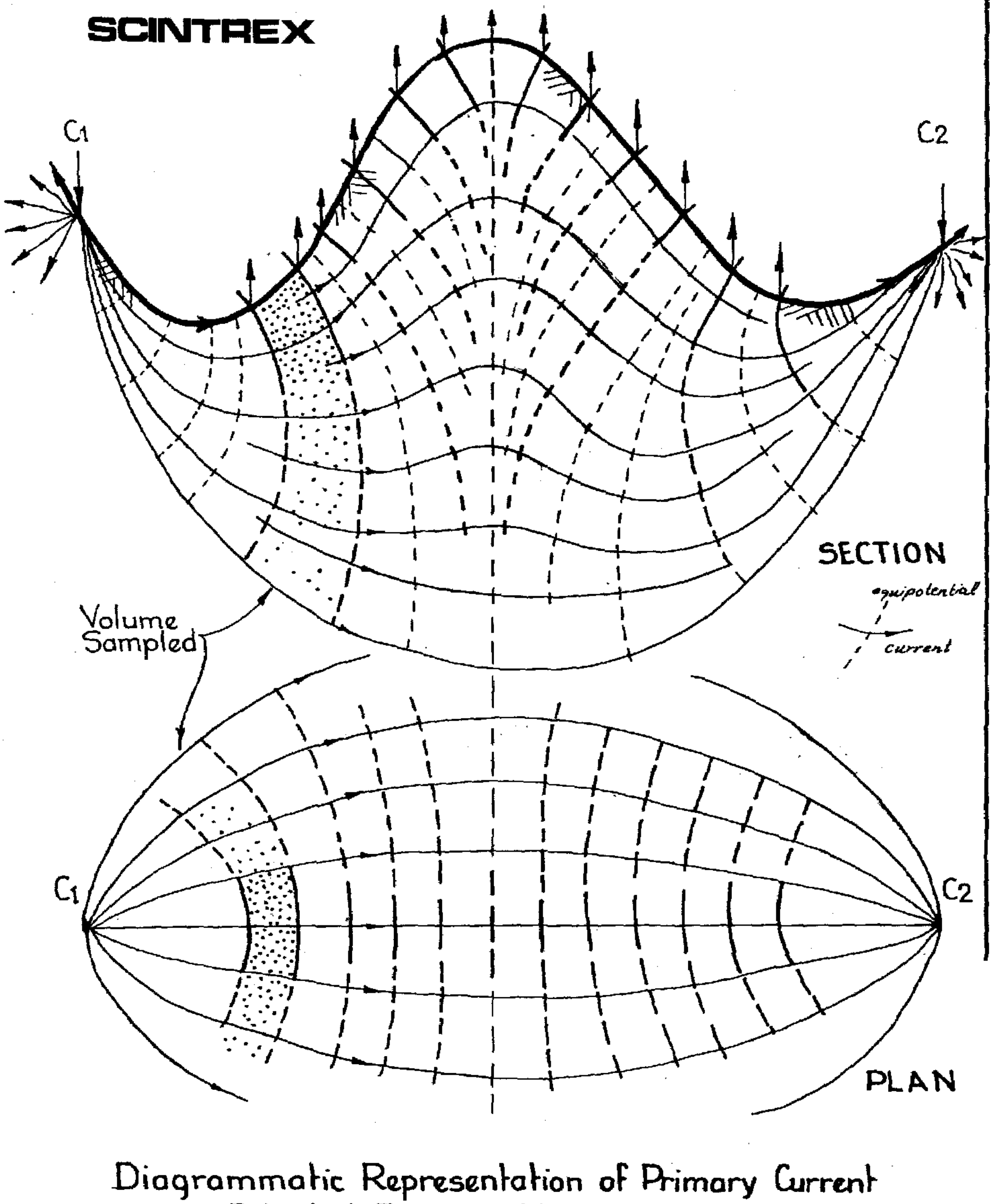


Diagrammatic Representation of Primary Current and Potential Field in Steep Topography.

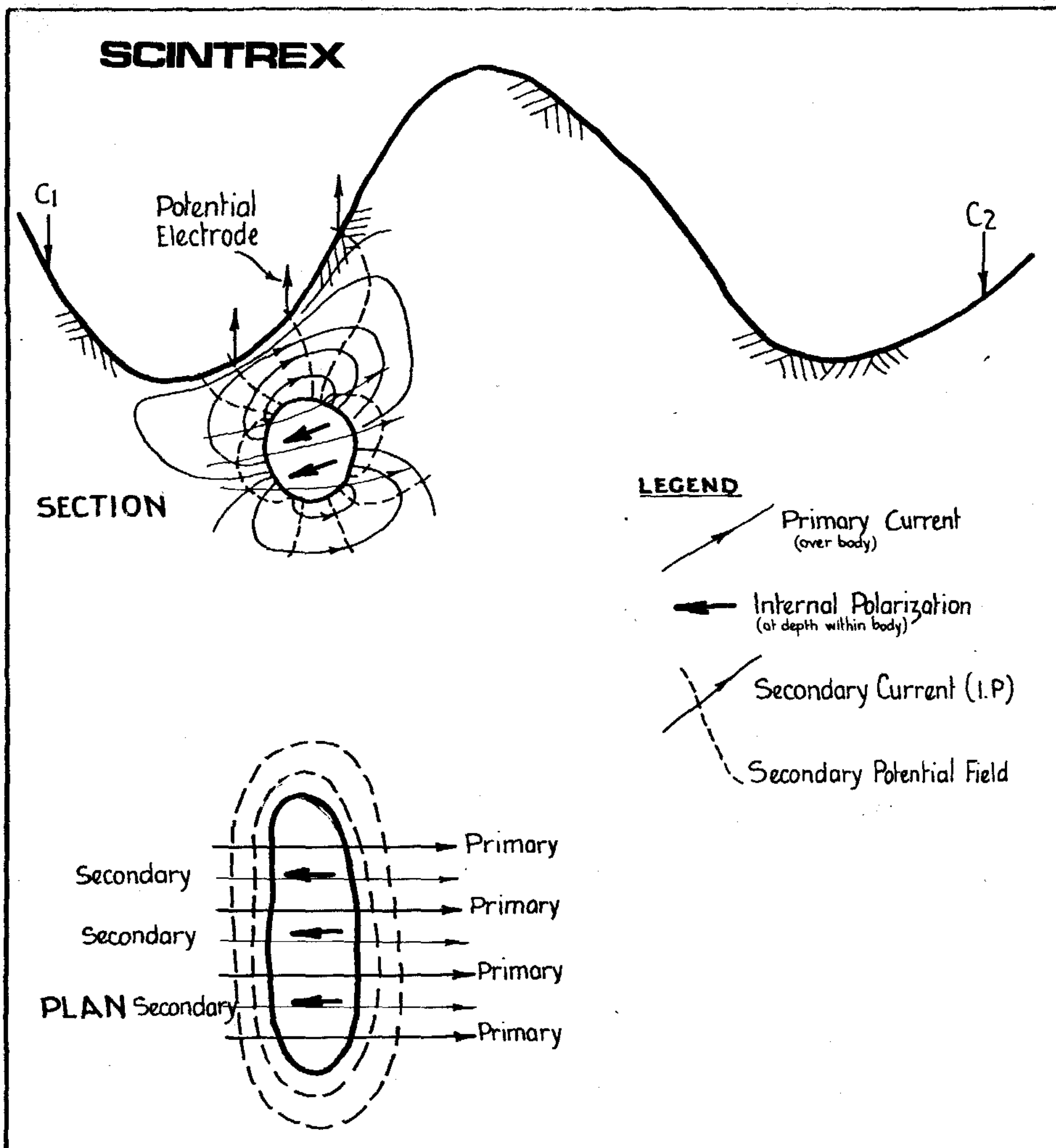
FIGURE 1.

Note particularly that the *source volume* is *normal to slope* and not vertically beneath the potential dipole. Therefore all maximum depths refer to depths below surface *normal to the slope.*

Note also that the volume of material *closest to* the potential electrodes will influence the data most. It is difficult to easily quantify the complex relationship between the volume of material sampled and its distance from the potential dipole.

Figure 2 displays the secondary current pattern generated from the decay of induced polarization effect *within* a chargeable sulphide source, together with the equipotential field generated by that decay. Note that due to the necessarily curved nature of the current flow outside the body, the on-surface manifestation is *wider than* the *source width.* Note also that the volume sampled in the primary potential field (apparent resistivity ρa) is not necessarily the same volume as is the secondary potential field (apparent chargeability *Ma*). This is, of course, true for *any* array.

Dipole-Dipole:- In this array the current dipole is generally small, generally 20 to 100 metres. Figure 3 displays the current pattern in section and in plan for a dipole-dipole array. The equipotential P_1 and P_2 tap a volume as shown in this diagram whose characteristics are read on the $n = 1$ station and plotted as a single point midway between the transmitting dipole C_1 to C_2 and the potential dipole P_1 to P_2. As progressively higher n values are read, a deeper and wider volume of material is sampled, this always being plotted midway between the transmitting and receiving dipole, and at a deeper level in the pseudo-section presentation used in this report. It is *vital* to realise that this data point



Diagrammatic representation of secondary current (I.P. effect) and secondary potential field in steep terrain.

FIGURE 2.

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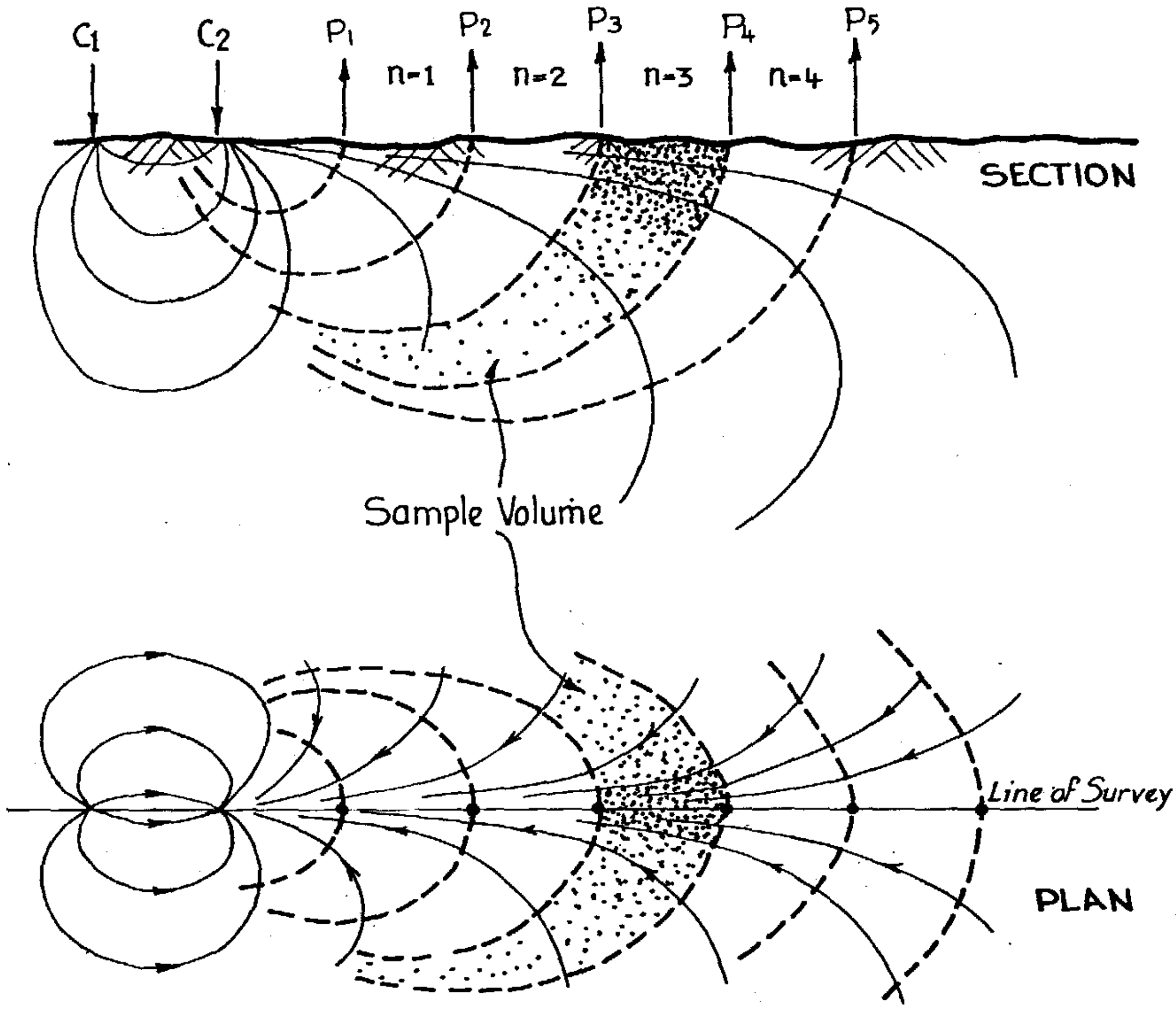

Dipole - Dipole Array
Primary current paths and equipotential field
Showing volumes sampled

FIGURE 3

does not represent the characteristics of the ground at the point plotted, but that of the *total volume* sampled.

A further characteristic of the array is that where the effective spacing ($n \times a$) is greater than the depth to the source, a 'high' (or 'low', depending on characteristics) will occur as each of the dipoles (i.e. transmitting C_1 and C_2 and potential P_1 and P_2) pass over the source of that anomaly. The resultant 45° patterns on the pseudo-section DO NOT represent dip, or even depth extent, but merely represent a complex interference pattern over the source due to the potential and current dipoles. For a single source, this *double peak effect* can be recognised as it tends to have two maxima displaced by ($n \times a + w$) where w is the width of the source. For multiple bodies this is difficult if not impossible to resolve by dipole-dipole arrays alone.

The enclosed Figure 4 shows the discharge of the energy stored in the body. As can be seen, the area sampled in section is tapped between the equipotentials generated by the discharge of the stored energy. These will not necesssarily be of the same form as those for the resistivity data, although they are, for convenience, plotted in the same format as for resistivity. Again, it is vital to note that theyrepresent the volume sampled as shown in Figure 4, *and not* the characteristics of the point at which they are plotted. Double peaks also occur as each of the two sets of electrodes pass over a source, where $n \times a$ is greater than the depth to source. Where $n \times a$ is less than the depth to source, a single maximum will be produced midway between the energising and measuring dipoles C_1/C_2 and P_1/P_2.

Pole-Dipole:- This array is similar in principle to the dipole-dipole array, except that a single electrode is placed 'close' to the potential dipole, with an 'infinite' electrode placed 10 $\times n \times a$ away from the 'pole-dipole' set-up, and, where practical, at right angles to it. The enclosed Figure 5 shows the distribution of current flow in section and in plan, about the pole source C_1. The potential electrodes P_1 and P_2 tap off the volume between them, which is contained between spheres whose centres are the pole source. The primary current reading is normalised for the geometry and plotted in profile or pseudo-section format as per dipole-dipole, namely, midway between the closest potential and current dpoles, which in the pseudo-section format is 45° towards the pole source. The chargeability reading is generated in a similar fashion to that described for dipole-dipole (Figure 4).

As with the dipole-dipole array, a double peak will result when $n \times a$ is greater than the depth to source, however, with pole-dipole it will be asymmetric. This will be true for both major resistivity features as well as for chargeability features. An example of this asymmetry for different depth to spacing arrays is shown for the three-array. (The three-array is a pole-dipole array when $n = 1$ and the a spacing is varied.)

The Choice Between Arrays:- Even after some thirty years of active use of gradient, dipole-dipole and pole-dipole arrays, controversy still reigns as to the relative merit of the various arrays. Much depends on the object of the programme, the terrain, the type of source sought, the type and complexity of the overburden/oxidation. Table 1 shows a comparison between arrays which may be helpful, taken from a fairly recent Canadian Geological Survey publication. In resistive mountainous terrain the author prefers the gradient array as the prime reconnaissance method due to the high productivity (2 *to* 5 *times that for*

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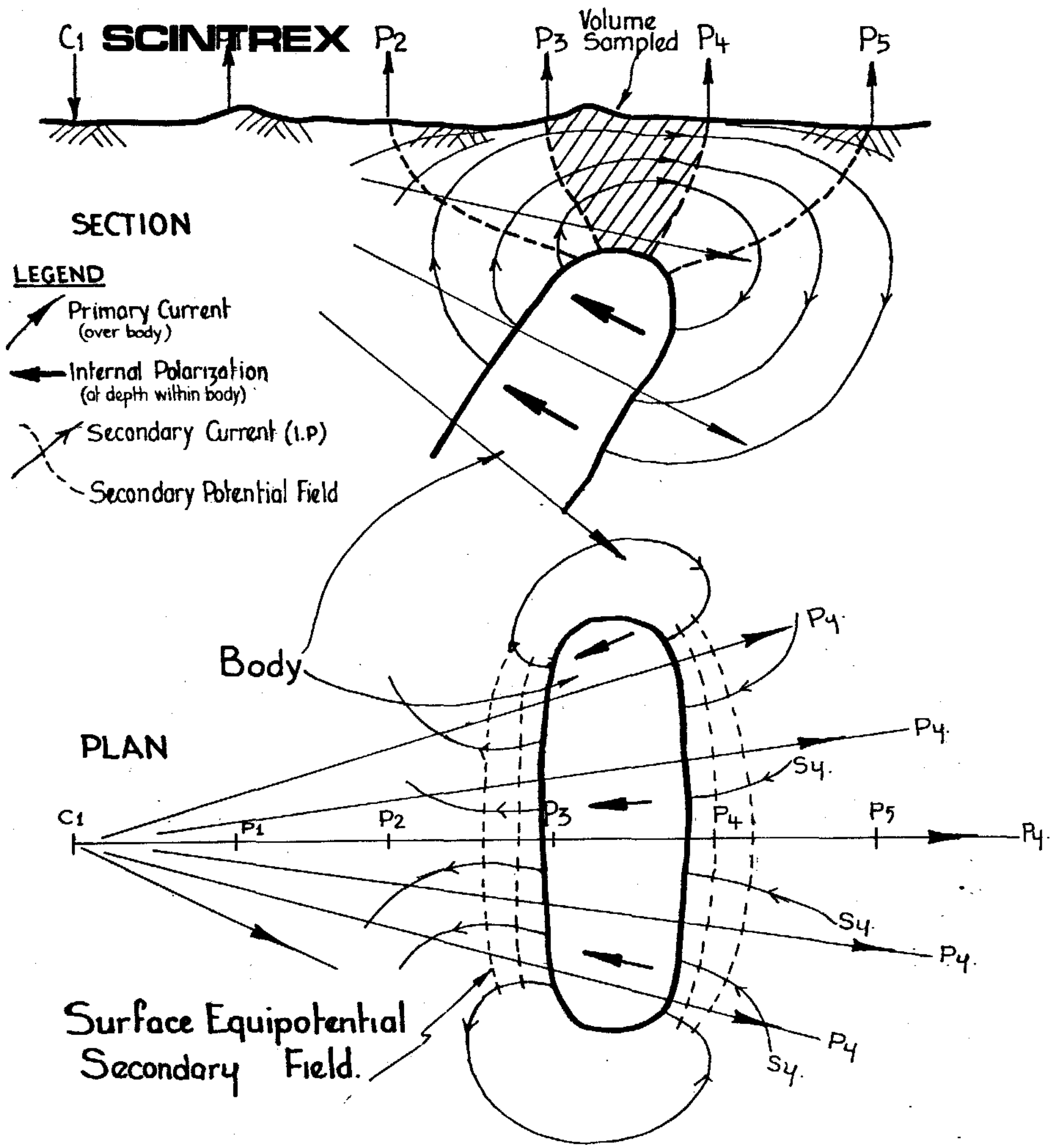
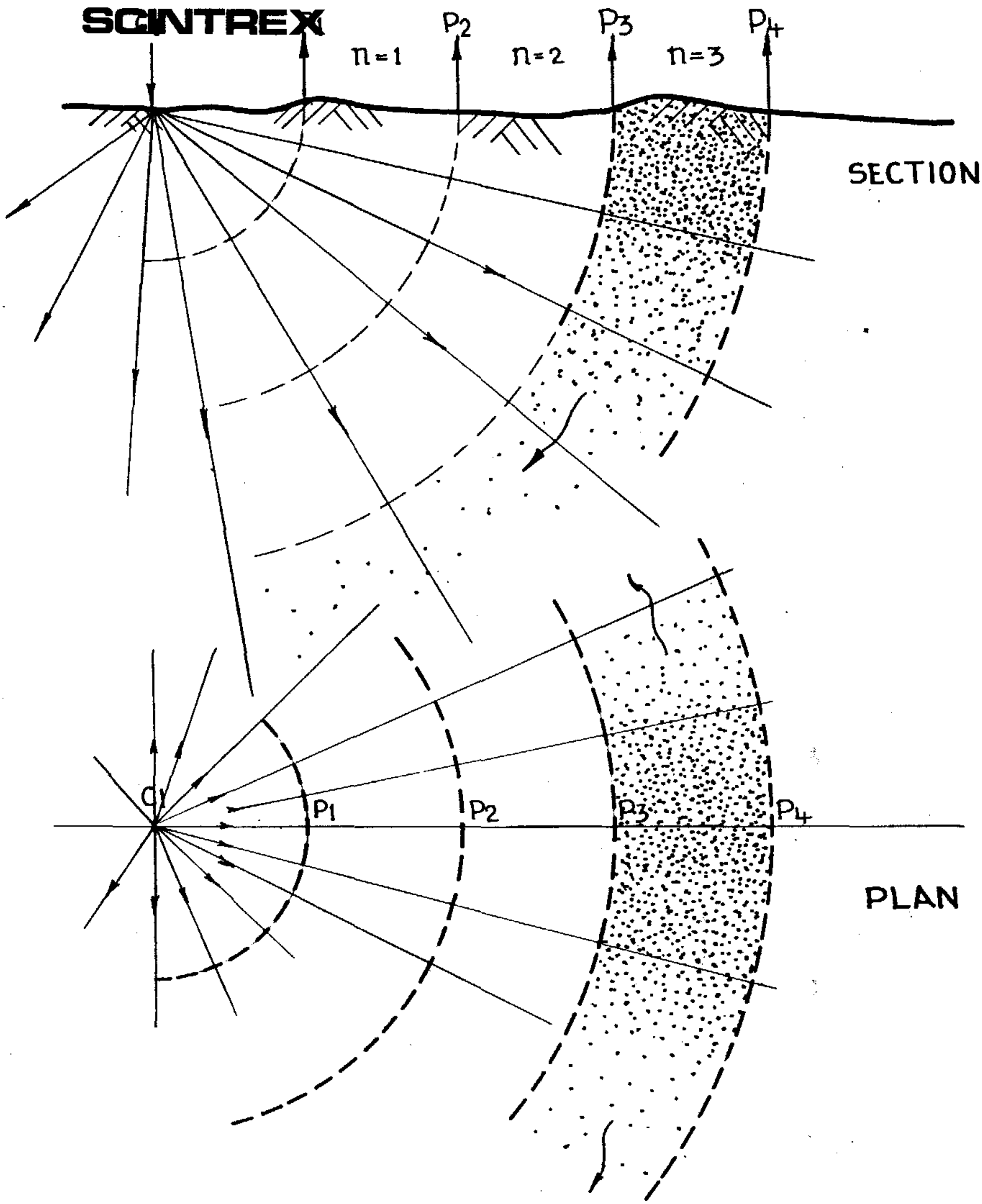


Current path and secondary equipotential field due to discharge of stored energy (I.P. effect) in the case of Pole-Dipole or Dipole-Dipole.

FIGURE 4.



Current Path and Primary Equipotential Field
from Pole-Dipole Array

FIGURE 5

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SPHERE RESPONSE THREE ELECTRODE ARRAY

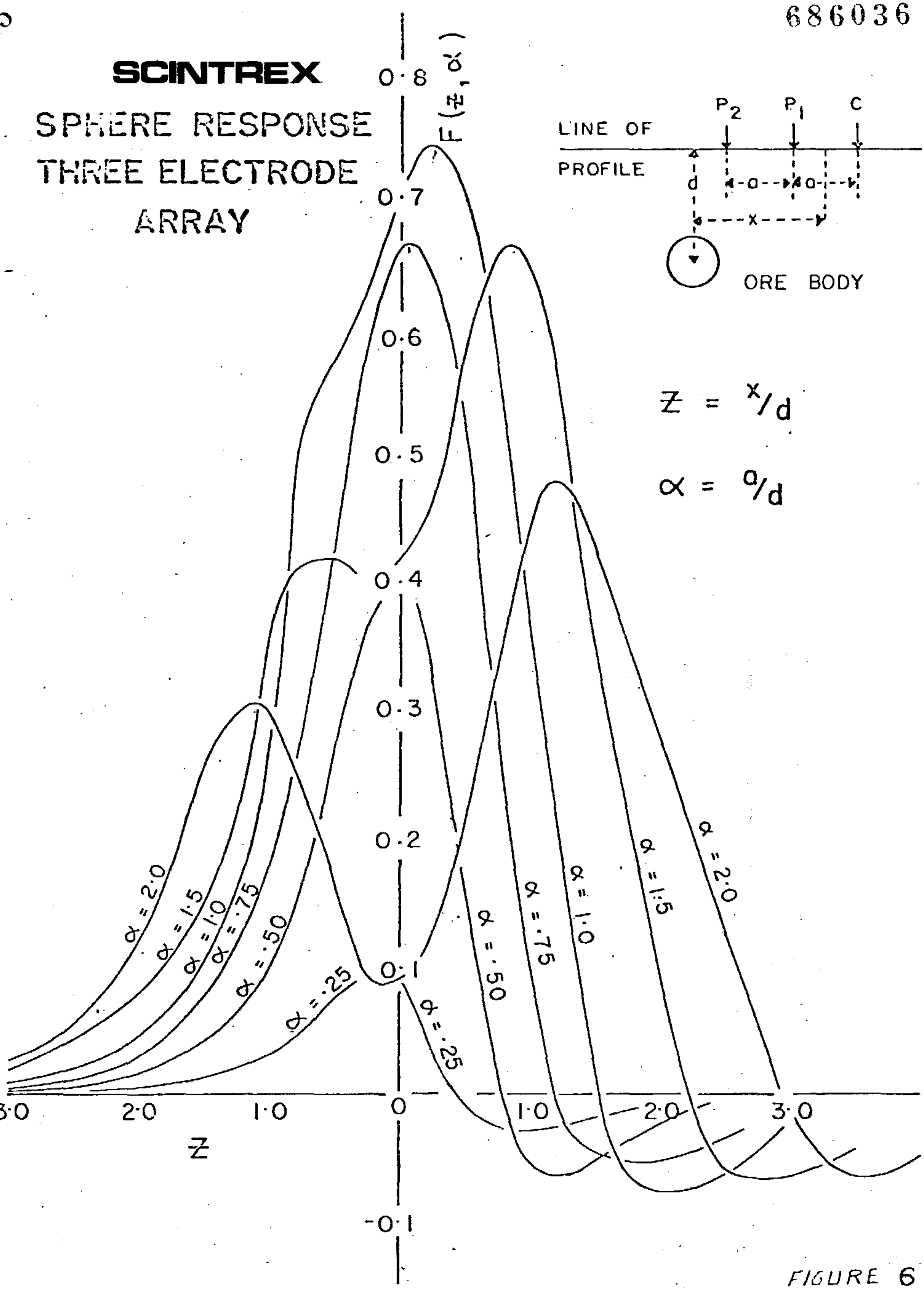

FIGURE 6

dipole-dipole), but this should be followed-up by detailed dipole-dipole or pole-dipole surveys as the gradient array, while giving 'maximum depths', cannot give 'minimum depths' as moving source arrays can. Similarly pole- or dipole-dipole surveys which have complex or muliptle sources can very often be resolved by use of limited gradient array detail. While pole-dipole is more efficient to apply in mountainous terrain, it tends to yield asymmetric double peak anomalies, however, to the trained observer, this is no disadvantage.

Brief Comments on Decay Form:- In most surveys three 'slices' of the decay form for the induced polarization reponse are acquired for each station as shown in Figure 7. While six slices are capable of being measured (M_1 to M_6), they are normally combined into pairs $M_1 + M_2 = M_1$ etc. as shown in Figure 7(C). Each of the slices M_1 to M_6 is normalised for a 'normal' decay form such that should the decay form be 'normal' $M_1 = M_3 = M_5$. Thus the operator can immediately recognise any anomalous decay forms which may arise from one of two major sources. Firstly the type of the source can influence the decay form. Coarse grained efficient sources such as sulphides show *slow* decay forms, magnetic and fine grained sulphides often show *fast* decay forms. This can be shown as $\Delta M = M_5 - M_1$, where positive ΔM infers *slow* decay form and negative ΔM *fast* decay form. A superior parameter is ΔMn where

$$\Delta Mn = \frac{M_5 - M_1}{M_3} \times 100 \text{ (in percent)}$$

which is essentially ΔM normalised for the amplitude of the decay. ΔM and ΔMn are merely short hand ways to profile changes in decay form and are essentially qualitative and relative.

Decay forms can also demonstrate the presence of electromagnetic coupling as Figure 7 shows. This is a regional effect as shown on Figure 7(b). This will

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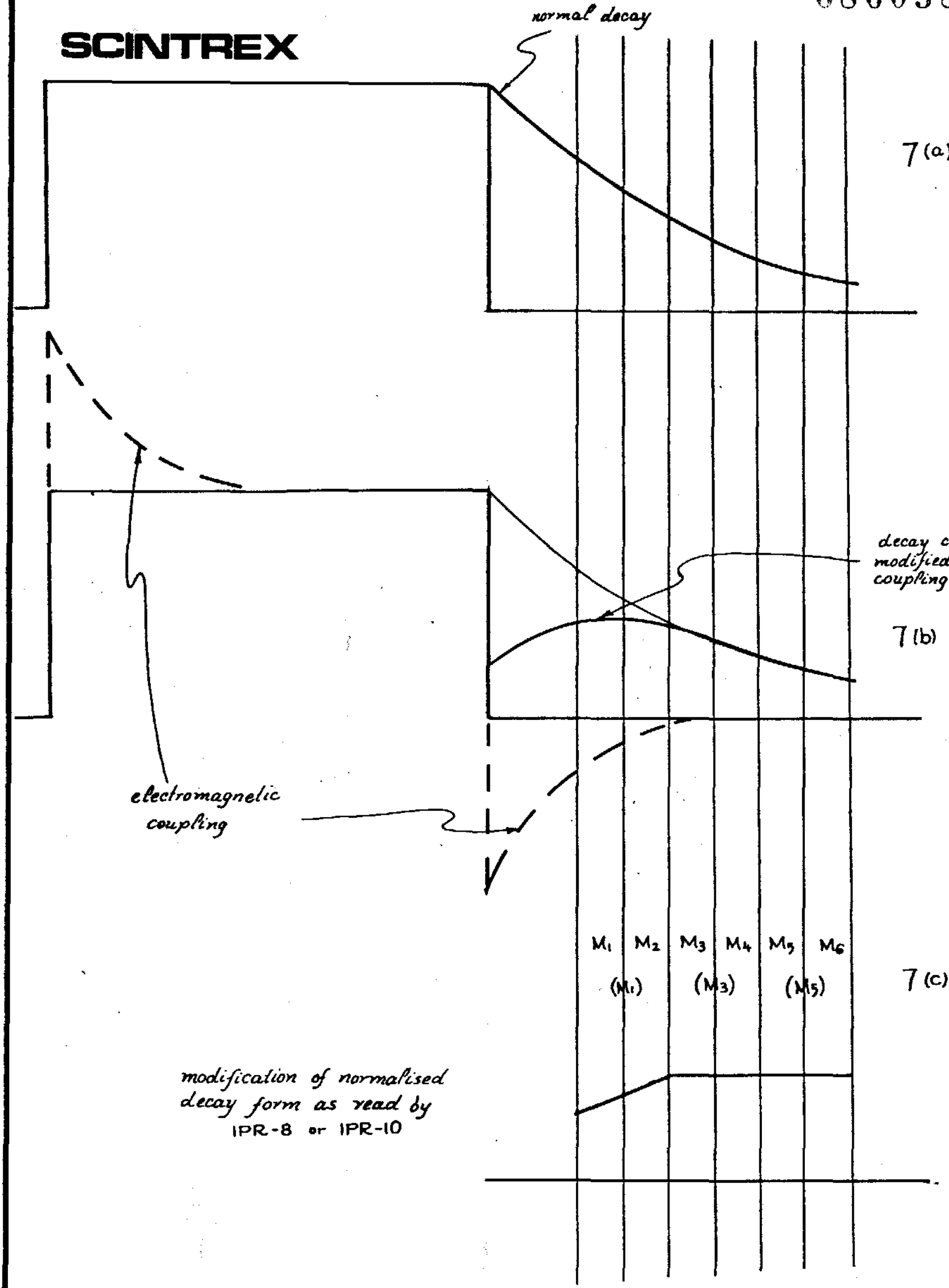

EFFECTS OF ELECTROMAGNETIC COUPLING ON IPR-8/10

Fig. 7

produce a normalised M_1 smaller than either M_3 or M_5.

Conclusion:- The above comments are indeed simplistic, and should be considered as a guide only. The author would be pleased to supply references on additional reading on any of the points commented upon.

A.W. HOWLAND-ROSE,MSc,DIC,AMAusIMM,FGS.

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TABLE 1

(Table 3.1)

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Comparison of IP Survey Electrode Arrays

(after Sumner, 1972)

	Advantages	Disadvantages	Survey Speed	Signal to-Noise	EM Coupling Rejection
Parallel Field Arrays Wenner	Anomalies symmetrical Synchronous detector possible Many case histories available	Requires more wire: larger field crew Poor resolution Unfavourable in capacitive coupling situations	Fair	Good	Fair
Schlumberger	Symmetrical array Synchronous detection possible Fewer men required Works well in layered earth Type curves available	Less horizontal resolution Unsuitable for horizontal profiling Capacitive coupling possible	Fair	Fair	Fair
Gradient	Map interpretation easier Less masking by conductive overburden Penetration good; safer Communications easier Can use two or more receivers Less topographic effect Data easily contoured in plan Useful where difficulty in making good current contacts	Poor resolution with depth Poor in low resistivity areas Geometric factor varies complexly	Good	Fair	Poor
Potential-About-a-Point Three-Array	Good reconnaissance array Fairly good resolution	Asymmetrical More wire needed	Fair	Good	Good
Pole-Dipole, Collinear	Good resolution Good subsurface coverage	Asymmetrical Asymmetrical	Fair	Fair	Fair
Perpendicular Three-Array, Pole-Dipole, Pole-Pole	Virtually eliminates EM coupling	More wire needed	Fair to Poor	Fair	Very Good
Pole-Pole (Two-Array)	Smaller crew needed Less wire needed than for some arrays Good penetration in nonconductive overburden	Susceptible to masking by conductive over-burden	Good	Fair	Poor
PDR (Potential Drop Ratio)	Sensitive to lateral variations "Common mode" noise rejection	Complex interpretation	Fair	Good	Fair
Dipole Field Array Dipole-Dipole Collinear	Symmetrical, good resolution Good penetration Less survey wire needed	Slow unless equipment is portable Resistivity topographic effects Interpretation somewhat involved	Fair	Poor	Fair
Dipole-Dipole, Parallel	Special use for EM coupling interpretation	Not used for routine surveying	Poor	Poor	Fair
Down-the-Hole Arrays Azimuthal Array (One Potential Electrode Down the Hole)	Fair for exploration purposes Useful in finding the best search direction	Interpretation complex Negative anomalies Strong geometric effects Mainly measures changes in resistivity	Fair	Good	Good
Radial Array (One Current Electrode Down the Hole, mise-à-la-masse)	Good for exploration purposes Useful in finding the best search direction Hole need not stay open	Interpretation complex Negative anomalies Not good for obtaining rock properties	Fair	Good	Good
In-Hole Arrays (More than One Electrode in the Hole)	Good for obtaining rock properties Good for assaying Interpretation simple	Current densities may be too large Possible capacitive coupling problems Not designed for exploration purposes Special equipment, expensive	Good	Fair	Good

Extract from: Geological Survey of Canada - Paper 75-31 "Borehole Geophysics Applied to Metallic Mineral Prospecting: A Review"

APPENDIX 3

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DATA PRESENTATION

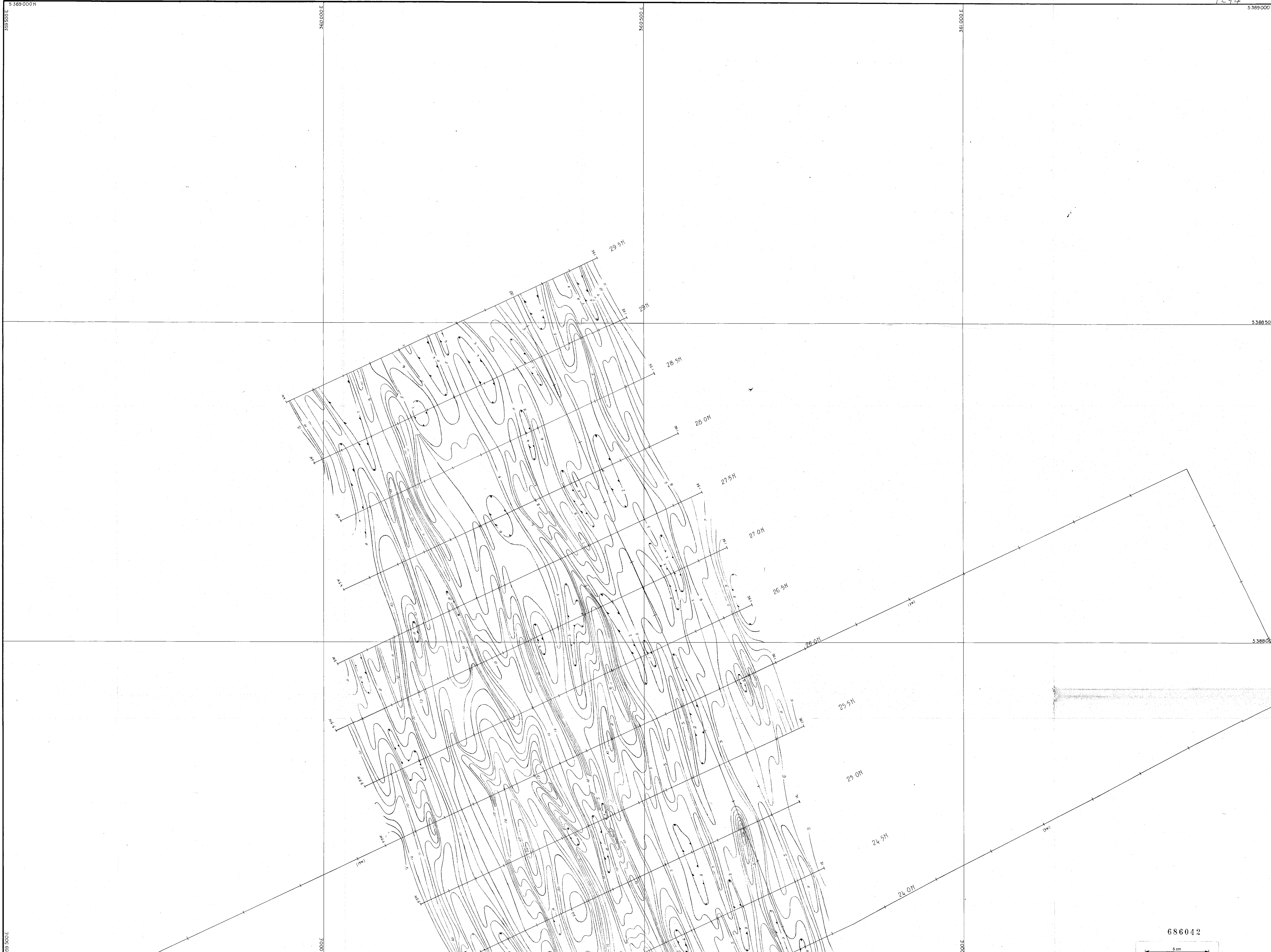
The data was calculated and plotted at the horizontal scale of 1:500 with chargeability being shown at the scale of 1 centimetre = 2 millivolts/volt, with resistivity in ohm-metres being shown on a 10 centimetre log cycle.

While three stations under the decay curve were read, only one slice, M_3, has been plotted.

The chargeability and resistivity have also been contoured and presented on Renison standard sheets at the scale of 1:1000.

Total magnetic field data supplied by Renison has also been contoured and presented on Renison standard sheet at the scale of 1:5000.

1294



SHEET 1
SHEET 2

RENISON LIMITED

TADPOLE HILL

GRADIENT ARRAY EIP - CHARGEABILITY CONTOURS

SURVEYED & COMPILED BY SCINTREX

TAS -097-C

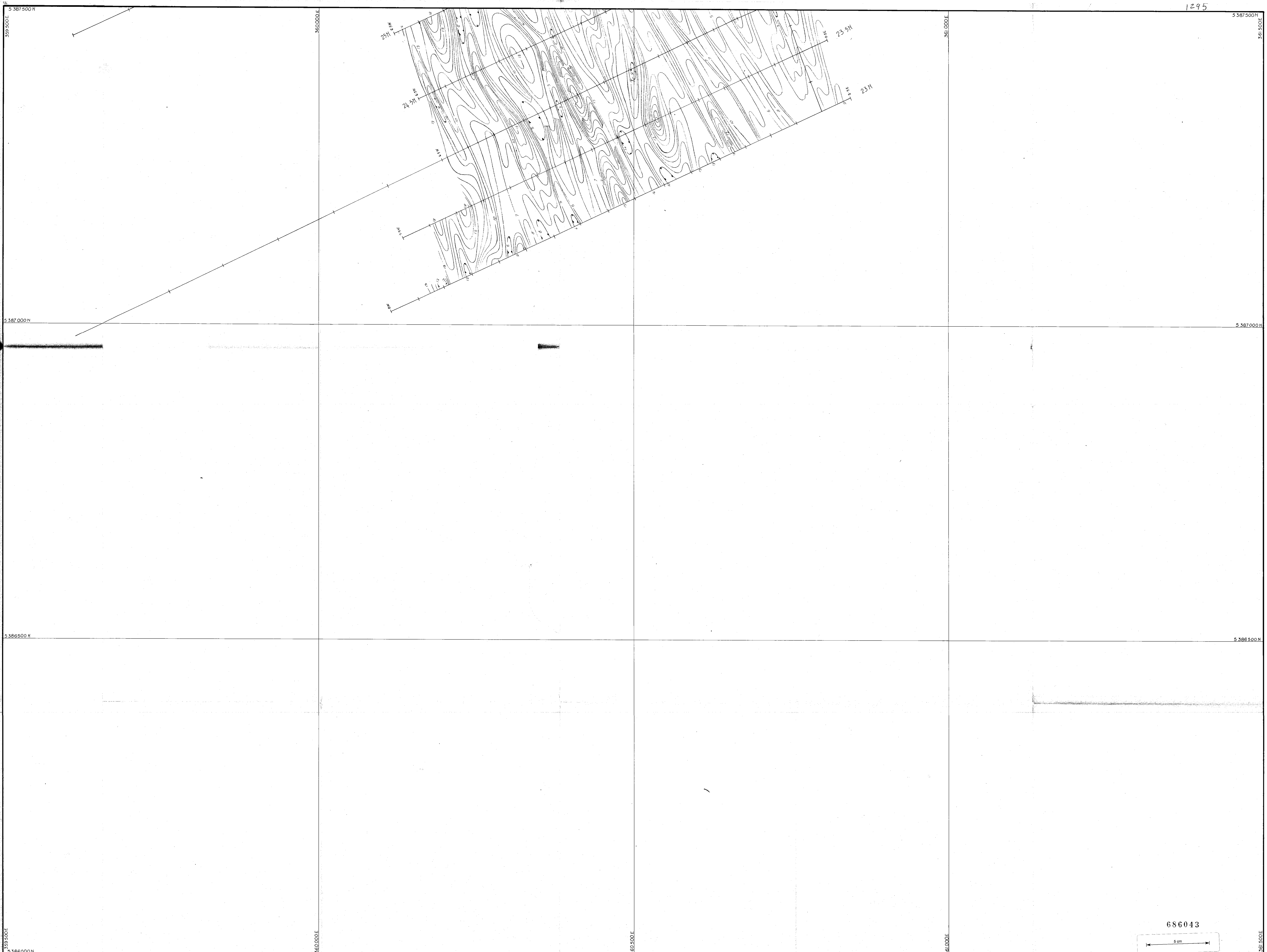
PLATE 1 sht 1 of 2

SCALE 1:2000 m

40 20 0 20 40 60 80

1294

82-1858



RENISON LIMITED

TADPOLE HILL

GRADIENT ARRAY EIP - CHARGEABILITY CONTOURS

SURVEYED & COMPILED BY SCINTREX

TAS - 097 - C

PLATE 1 sht 2 of 2

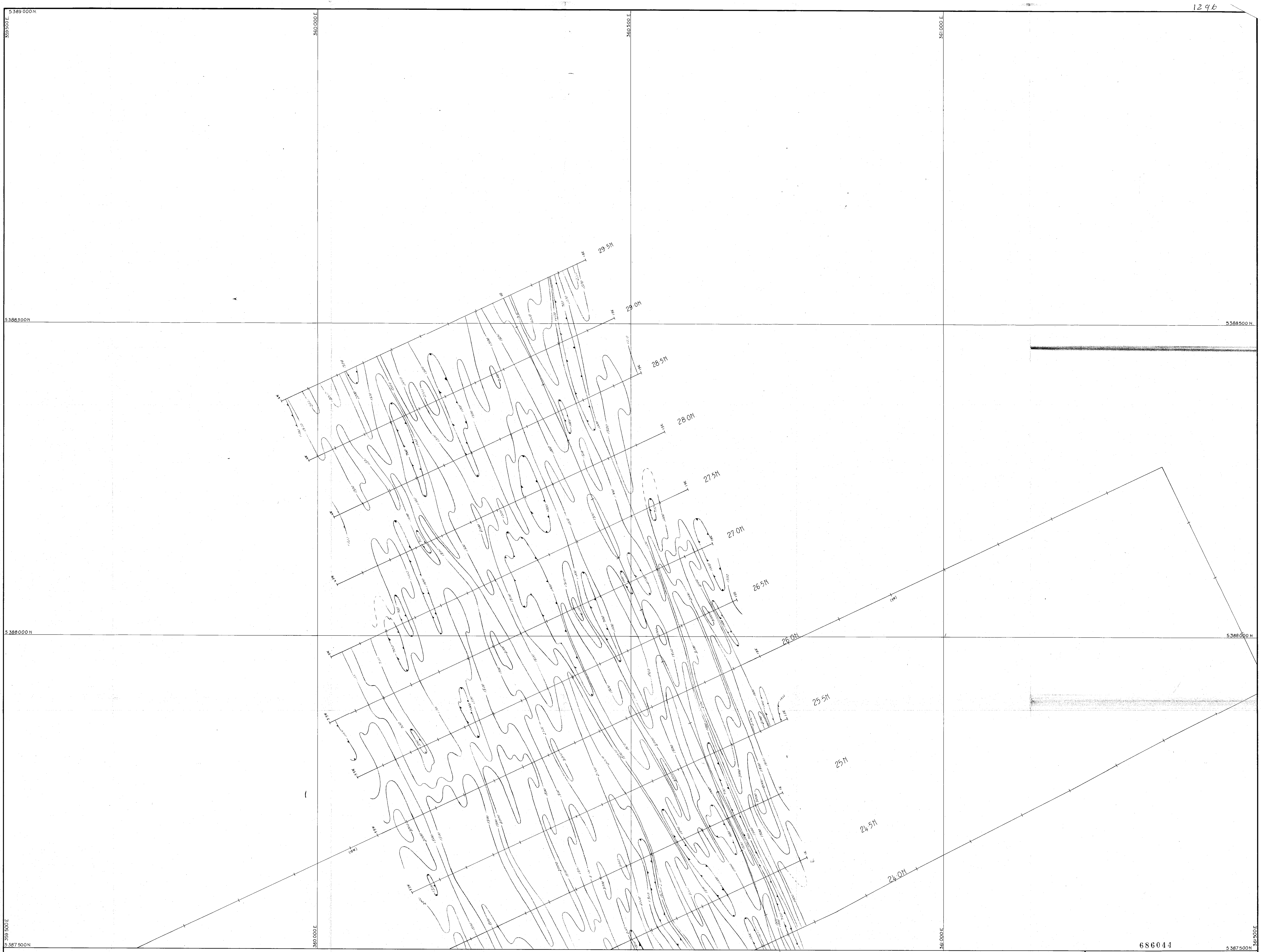
SCALE 1:2000 METRES

40 20 0 20 40 60 80

1295

82-1858

1296



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RENISON LIMITED

TADPOLE HILL

GRADIENT ARRAY EIP - RESISTIVITY CONTOURS

SURVEYED & COMPILED BY SCINTREX

TAS-097-C

PLATE 2 sht 1 of 2

SCALE 1:2000 METRES

40 20 0 20 40 60 80

SHEET 1

SHEET 2

5 cm

1296

82-1858.

686045

RENISON LIMITED

TADPOLE HILL

GRADIENT ARRAY EIP - RESISTIVITY CONTOURS

SURVEYED & COMPILED BY SCINTREX

TAS-097-C

PLATE 2 sht 2 of 2

SCALE 1:2000 METRES

40 20 0 20 40 60 80

5 cm

SHEET 1

SHEET 2

1297

82-1858

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* Surveyed in 1980 (TAS-074-E)
Not repeated in 1981/82 field season
Base level for these lines adjusted
by stacking profiles.

TADPOLE HILL
TOTAL MAGNETIC FIELD CONTOURS
COMPILED BY SCINTREX
TAS-097-C
PLATE 3

RENISON LIMITED

CORINNA D1/2

5 cm

GEOLOGIST	SCALE 1 5000 METRES
DRAUGHTSMAN	100 0 100 200
DATE	
REVISIONS	DRAWING No. 1298

82-1858


29.5N
29N
28.5N
28N
27.5N
27N
26.5N
26N
25.5N
25N
24.5N
24N
23.5N
23N
5 388 500N
5 388 000N
5 387 500N
360 000E
360 500E
Eastern Zone
Western Zone
Central Zone
Far Western Zone
Legend
chargeability axis
axis of high resistivity
axis of low resistivity
most significant I.P. anomalies
areas of high induced polarization background.
dislocations
686047
RENISON LIMITED
TADPOLE HILL
WEST COAST - TASMANIA
GRADIENT ARRAY IP SURVEY
INTERPRETATION PLAN
SURVEYED & COMPILED BY
SCINTREX
FEB. 82
SCALE 1:2000m
Job Nº TAS-097-C
1299
PLATE 4
5 cm

82 - 1858