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A REPORT ON

GRADIENT ARRAY RECONNAISSANCE EIP

AND TOTAL FIELD MAGNETOMETER SURVEYS

OVER THE WHITE SPUR GRID, EL 9/66

NEAR QUEENSTOWN, WEST COAST TASMANIA

ON BEHALF OF

THE MOUNT LYELL MINING AND RAILWAY COMPANY LTD.

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PRIVATE AND CONFIDENTIAL

# A REPORT ON GRADIENT ARRAY RECONNAISSANCE ELECTRICAL INDUCED POLARIZATION AND TOTAL FIELD MAGNETOMETER SURVEYS OVER THE WHITE SPUR GRID, EL 9/66 NEAR QUEENSTOWN, WEST COAST TASMANIA

ON BEHALF OF

THE MOUNT LYELL MINING AND RAILWAY COMPANY LTD.

BY

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SYDNEY, N.S.W.

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**SCINTREX PTY. LTD.**

GEOPHYSICAL CONSULTANTS AND CONTRACTORS

## *SUMMARY*

*A thirty line mile reconnaissance electrical induced polarization survey, using the gradient array, was completed in 20 working days over the White Spur grid. This, together with a total field magnetometer survey, indicated that the western third of the grid was underlain by geological units being of grid north-north-west/south-south-east strike and being on the whole, chargeable (30 ±5 milliseconds) and less resistive (700 to 5000 ohm-metres) than the eastern two-thirds which was found to be very much more resistive (5000 to 20,000 ohm-metres), and of abnormally low chargeability (10 ±2½ milliseconds).*

*The majority of the significant anomalies were defined in the western section (about 26), while some four were defined in the eastern section.*

*Of the approximately thirty induced polarization zones described, some five are considered of primary interest, while some eight are considered of secondary to primary interest.*

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# A REPORT ON GRADIENT ARRAY RECONNAISSANCE ELECTRICAL INDUCED POLARIZATION AND TOTAL FIELD MAGNETOMETER SURVEYS OVER THE WHITE SPUR GRID, EL 9/66 NEAR QUEENSTOWN, WEST COAST TASMANIA ON BEHALF OF THE MOUNT LYELL MINING AND RAILWAY COMPANY LTD.

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## *INTRODUCTION*

At the request of Mr. K. Reid, Chief Geologist for the Mount Lyell Mining and Railway Company Ltd., Scintrex Pty. Ltd. executed reconnaissance gradient array electrical induced polarization surveys over the White Spur grid, EL 9/66.

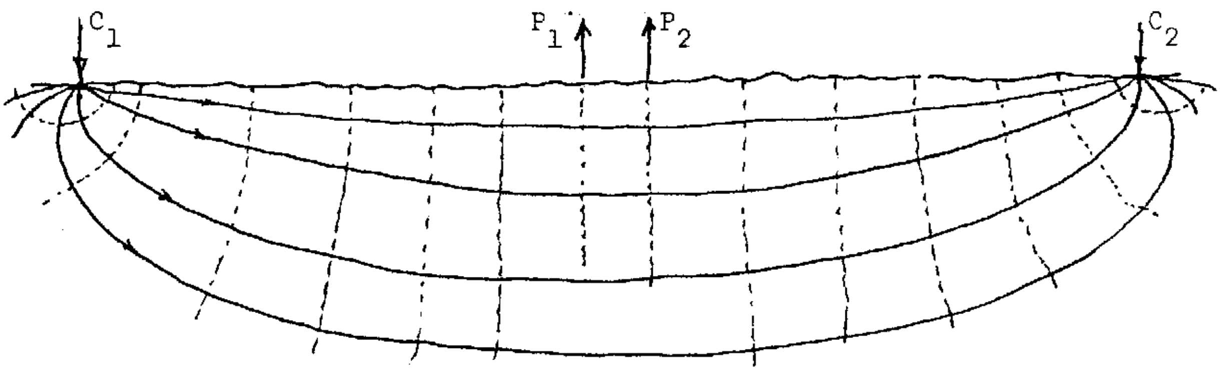
The 30 miles of line were surveyed in 15 double crew production days between 26th November and 22nd December, 1976, and 5 double production days between the 4th and 8th January, 1977. Over the former period there were some 12 standby days lost to bad weather. The Scintrex field party was under senior party leader Mr. R. Lindberg, with assistant operators N. Montgomery and L. Lones, and field hands O. Saeck and G. Price. On site geological supervision was undertaken by Mr. P. Brophy and geophysical supervision by the author.

The total field magnetometer survey covered only the western half of the grid and was conducted by Mt. Lyell personnel using a base station unit read every 10 minutes and two magnetometers

## ELECTRICAL PARAMETERS MEASURED

(A) RESISTIVITY MEASUREMENT

(taken during current 'on' time)



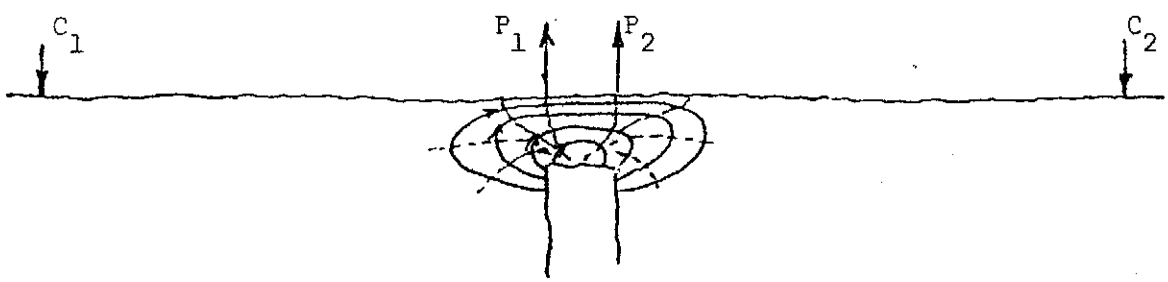

*MEASUREMENT REPRESENTS:*

*ease with which primary current moves through ground*

*primary current flow*
*primary equipotential surface*

(B) CHARGEABILITY (IP) MEASUREMENT

(taken during current 'off' time)




*MEASUREMENT REPRESENTS:*

*discharge of stored energy*

*secondary current flow*
*secondary equipotential surface*

FIGURE 1

on line.

*METHOD AND EQUIPMENT*

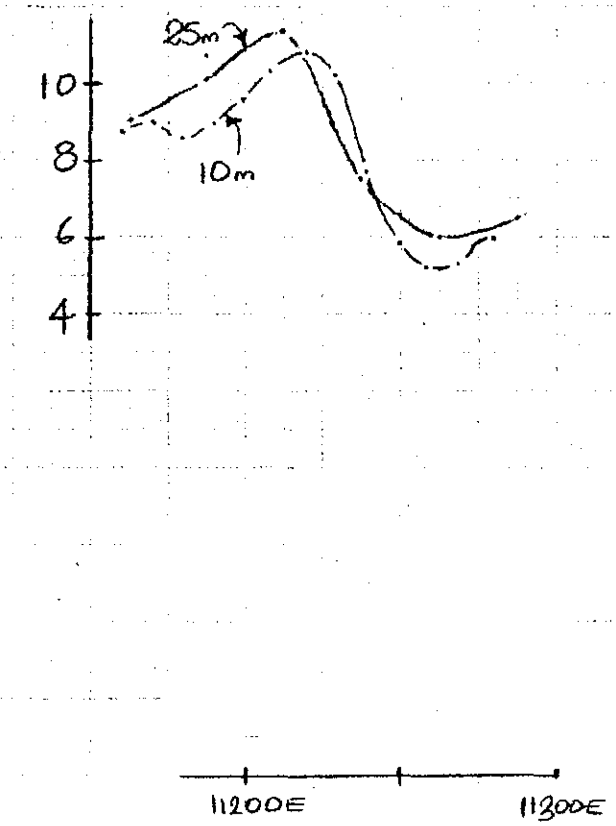
The major components consisted of a 3½KW Scintrex induced polarization transmitter and two Scintrex IPR-7 induced polarization receivers. In order to eliminate breakdown time, each item of equipment was duplicated.

The magnetometers used on the present survey were three Scintrex MP-2 units.

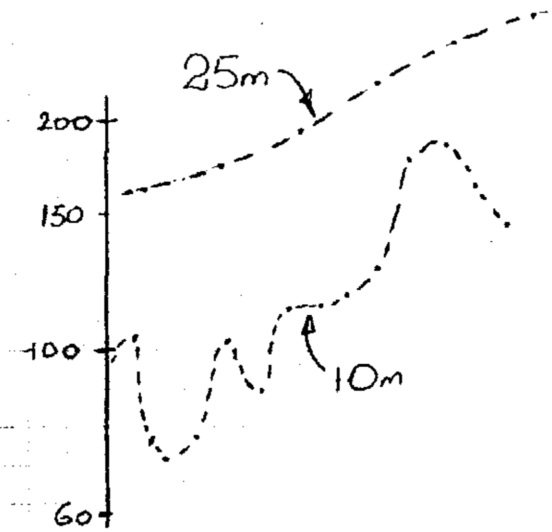
A very simple explanation of the parameters measured in the gradient survey follows. This description is designed specifically for the geologist in order to give a *visual picture* of the parameters measured.

In the case of the gradient array, the potential dipole records the electrical properties of the material defined by the two equipotential *surfaces* tapped by the potential electrodes. This is diagramatically illustrated in Figure 1(A). This diagram represents a *section*, however, it should be realised that the apparent resistivity measurements also record information *sideways*. For a three dimensional picture of the volume sampled, rotate the section *into* and *out of* the plane of the paper by 90°. Within the centre section of the array the data represents the characteristics of the rock units *immediately below* and *immediately at right angles*

IMPORTANCE OF RESOLUTION




*CHARGEABILITY*
*(milliseconds)*




*RESISTIVITY*
*(ohm-metres)*

FIGURE 2

to the survey line. The degree of *resolution* depends on the potential *dipole width*, the smaller the dipole the greater the resolution. Diagram 2 (the resistivity data) demonstrates the much improved resolution for a 10 metre dipole over that obtained from a 25 metre dipole over a sulphide occurrence whose characteristics will be similar to the target mineralisation. It is important to remember when examining the data that only the *gross* properties are "seen". The potential dipole cannot resolve units whose effective width is less than half the size of that dipole.

The criteria affecting the chargeability reading are somewhat different. In diagram 1(B) the decay of a chargeable section is shown. The passage of current during the *current-on* phase, during which the resistivity measurement was taken, carried some energy to be stored in the rocks (and sulphides, etc.), through which it passed. On cessation of this imposed current flow, the energy so stored will discharge (IP). It will set up its own equipotential field as shown in Figure 1(B) which will be detected by the same two potentials which measured the resistivity. It should be noted that any chargeable source will have a width *greater than* the source due to the curvilinear nature of the discharge of the stored energy. It should be further noted that the volume defined by the *secondary potential field* caused by this discharge *is not necessarily identical* to that defined by the primary equipotential field. Figure 2 shows the differences in resolution *for chargeability* (top profile) over a known sulphide occurrence. The *form* is similar, but the positional information is far superior due to the more frequent reading interval.

This array has operational attributes which result in rapid coverage and excellent positional information. However, depth information is not well defined, it being possible only to assess "maximum depths".

With regard to the interpretation of the gradient array data, the following comments may prove to be of assistance.

In the gradient array the source of the reading lies between the two equipotential surfaces tapped by the two potential pots employed. For the most part then, when working in the centre section of a gradient array, the source will be "immediately below" the potential dipole used. The reliability therefore of *positional information* with gradient array is excellent, however, the depth at which the response occurs is difficult to assess with accuracy. The *maximum depth* can be estimated from a consideration of the profile shape, but the accuracy of this approach will depend on a minimal potential dipole length, and of course sharp boundaries to the body. The *resolution* therefore is not better than half of that dipole. Therefore maximum depths of 10 metres may in fact either outcrop or sub-outcrop when a 20 metre potential dipole is used. Some moving source array would be required to obtain an *accurate depth estimate*.

Similarly the width of bodies is not easy to determine for zones having a width less than half the dipole spacing used. Thus, estimated maximum widths are educated guesses at best for narrow zones. However, wider bodies can be resolved more accurately.

The *attitude* of a chargeable zone can really only be gauged with any precision in the centre of the gradient array, and of course where the body has strongly contrasting chargeability and apparent resistivity to that of the *enclosing rock* units.

All field measurements were taken between slope distances along lines. This will, in steep areas, produce errors in the calculated apparent resistivity data. However, these errors will be arithmetic, and as significant changes in resistivity are logarithmic, this source of error is not significant. In assessing the position of the source in areas of extreme terrain, it does not lie vertically below the plotted position, but *normal to the "local slope"*. All positions in the text refer to source positions normal to the local slope.

Each current dipole block should be considered separately. As would be expected, the continuity along strike is generally good, especially in the chargeability data. However, *"end-on"* current dipole blocks cannot be expected to give identical data due to the different base levels of the current dipoles, and in zones close to the current poles, the data will not sample identical volumes on the overlap between current dipoles. This phenomenon will result in more extreme divergence of data as the current dipole is approached. However, these factors are entirely predictable.

*DATA PRESENTATION*

The contour interpretations of the apparent chargeability in milliseconds, apparent resistivity in ohm-metres and the total magnetic field in gammas, are presented at the scale of 1:6000 on Plates 2, 3 and 4 respectively. The data profiles are presented on the eight sheets of Plate 1 at the horizontal scale of 1:2400 (feet) and vertical scales of 1 inch = 10 milliseconds for chargeability and a 2 inch log scale for resistivity, in ohm-metres, while the total magnetic field is presented at 1 inch = 100 gammas. *Note: Due to the irregular grid, a "geophysical baseline" has been drawn through the area and the profiles drafted using this baseline to give "correct" relative positions between lines.* Plate 5 displays the physical properties as interpreted from the three parameters of chargeability, resistivity and total magnetic field.

*DISCUSSION OF RESULTS*

The contour interpretations of the chargeability, resistivity and total magnetic field data are discussed first, then the physical property plan is discussed, and finally the individual induced polarization anomalies are discussed in detail.

*THE CONTOUR INTERPRETATIONS*

The method used to compile the contour interpretations was to first bias the major features of each of the three properties available, namely, apparent chargeability, apparent resistivity and total magnetic field, and then in turn bias those sections of each parameter which showed no clear trend by the strike implied by the most dominant parameter. It should be noted that no geological information whatsoever was used in the establishment of the trends and boundaries in these interpretations.

Each separate gradient dipole is contoured individually for chargeability and resistivity, and the boundaries of each block are clearly shown on the plates.

A compilation of the three parameters is shown in the interpretation plan. On this plate the major geophysical characteristics of the area are interpreted and an attempt made to delineate zones of like physical properties, and from those, ascertain zones of dislocation due to faulting or folding. The contrasts observed in these properties were major and thus it is considered that this plate will represent the general geological strike and structure in the area, together with a number of the major geological boundaries.

The main features of each of the four plates 2 to 5 inclusive, are briefly described below, however, no extensive discussion is entered into as the contour interpretations tend to display the data more meaningfully than can any verbal exposition.

*Chargeability Contour Plan (Plate 2)*

The main feature observed on this plate is a very sharp differentiation between the eastern and western sections of the area. To the west the background chargeabilities are of the order of 30 ± 5 milliseconds, while to the east the background chargeabilities are 10 ±2½ milliseconds. The interpreted strike east of the boundary is grid north-south, while to the west of this boundary the strike is grid north-north-west/south-south-east in the south, and veering to grid north-west/south-east to the north.

The boundary between these two major rock units has an overall grid north-north-west/south-south-east trend. However, major "dislocations" were noted at various sites along the boundary. The dislocations may be due to either faulting (with an apparent sinistral displacement) or perhaps to folding.

In general the area of higher chargeability can be correlated to an area of lower resistivities of the order of less than 5000 ohm-metres, while the area of lower chargeability can be correlated with areas of apparent resistivities above 5000 ohm-metres.

The boundary between the high chargeability background zones to the west and the low chargeability background to the east is as

014



follows.....

| | | |
|---|---|---|
| Line 43 | at | 1400W |
| Line 42 | at | 1800W |
| Line 41 | at | 2250W |
| Line 40 | at | 2000W |
| Line 39 | at | 2000W |
| Line 38 | at | 1650W |
| Line 37 | at | 1650W |
| Line 36 | at | 0800W |
| Line 35 | at | 0400W |
| Line 34 | at | 0000 |
| Line 33 | at | 0500E |
| Line 32 | at | 0200E |
| Line 31 | at | 0200E |
| Line 30 | at | 0600E |
| Line 29 | at | 1600E |
| Line 28 | at | 2200E |

The numerous individual induced polarization maxima within the *high chargeability background* area generally cannot be traced across more than two lines with any certainty, and rarely rise more than 10 to 15 milliseconds above the 30 $\pm 5$ milliseconds background, while within the *low chargeability background* area the rare induced polarization maxima rise about 10 milliseconds above background.

*Apparent Resistivity Contour Plan (Plate 3)*

The western section of the area is characterised by lower apparent resistivities of 500 to 5000 ohm-metres which, in general, cover a similar area to the high chargeability area. The implied strike of the units within this zone is grid north-north-west/south-south-east to grid north-south.

Within the high resistivity zone, apparent resistivities vary between 5000 to 20,000 ohm-metres, and are in general coincident with low background (10 $\pm 2\frac{1}{2}$ milliseconds) chargeabilities. The strike within this area appears to be grid north-south to grid north-north-west/south-south-east. Individual features can rarely be traced over more than two lines.

Within the high background zone, lenticular zones whose resistivities rise to 10,000 to 20,000 ohm-metres have been clearly delineated. The major resistivity highs have been shown in the interpretation plan.

*Total Magnetic Field Contour Plan (Plate 4)*

Only the western section was covered by the magnetometer survey. The background over the area covered is about 62,600 gammas.

A series of distinct highs of from 200 to 300 gamma above background were recorded within the low resistivity, high chargeability zone to the west of the area. The form of the anomalies suggests a series of lensoidal magnetite rich units having a strike conformable to that interpreted from the apparent chargeability and apparent resistivity data. The most significant zone was located over 5000 feet between about 1000W on line 28 and 2000W on line 37. This zone appears to be dislocated along trends at right angles to strike, which are also reflected in the other parameters. The magnetic highs are associated for the most part with *relative* resistivity lows, and more often than not, chargeability highs also. However, the amplitude of the magnetic high does not infer that magnetite is of sufficient quantity to cause the chargeability response observed. Thus, the magnetic material, if magnetite, must be associated with either sulphides and/or graphite - if no magnetite is present, pyrrhotite *could* alone cause both the chargeability and magnetic response observed.

It is perhaps worth noting that pyrrhotite can occur in nature as highs, lows and as magnetic dipoles *along the strike of the same body*. This anomaly does indicate that this *may* occur here.

A series of magnetic highs and lows having limited strike lengths of 500 feet to 1000 feet were located within the resistive/low chargeability zone to the east. The amplitude of these units range from -200 gamma to +300 gamma with respect to the background of 62,600 gamma. Unlike the anomalies located in the western section, these responses are generally associated with high apparent resistivities of up to 20,000 ohm-metres and are thus fundamentally of quite different origin to those in the west. In this case, individual magnetic highs and lows are not associated with significant induced polarization responses.

*Physical Property Interpretation Plan (Plate 5)*

The most striking feature observed in the area is the very strong contrasts between the western and eastern sections of the grid. The contrast between these two sections is rapid and generally takes place over 50 feet.

The *Western Section* is characterised by resistivities below 5000 ohm-metres and for the most part between 500 and 1500 ohm-metres. Chargeabilities within this zone remain a high 25 milliseconds plus, with individual maxima reaching to 50 milliseconds in isolated cases. Within this zone a conformable magnetic unit was located of up to 200 to 300 gammas above background. This zone appears to form a series of lenses conformable to the strike as inferred by the apparent chargeability and apparent resistivity data.

The contrast between the *eastern* and *western* sections is dislocated by a series of faults or perhaps folds which also displace the otherwise continuous nature of the apparent chargeability and apparent resistivity along strike. These zones of dislocation are clearly shown on Plate 5.

It is strongly suggested that the western section is underlain by a series of sediments and perhaps volcanic units, with either higher than normal pyrite or graphite content overall. The magnetic units may represent magnetite bearing sediments or volcanic units, but the magnetite alone does not account for the chargeability maxima which are often coincident. Therefore they must be associated with *additional* sulphides and/or graphite.

Again in contrast with the eastern section, many significant induced polarization responses were located superimposed on the high background observed.

The *Eastern Section* is in complete contrast to the western section in that the apparent resistivities are invariably well above 5000 ohm-metres with about 30% being above 10,000 ohm-metres. Again, in complete contrast with the western section, the background chargeability is about 1/3 that observed within the western section at 10 ±2½ milliseconds. Also of significance is the very uniform chargeability observed, with very few significant responses being recorded above this level. Over the area covered by the magnetic field survey, isolated variations of +200 to -200 gamma with respect to the magnetic field background were logged, which generally have the same trend as the chargeability and resistivity data (i.e. north-north-west/south-south-east), but which have very little if any reflection on them. Certainly the host to the magnetite (or pyrrhotite) source is fundamentally different to that observed within the western section, as it is very much more resistive in the eastern section (usually at least 10 fold more).

It is considered that the eastern section represents an acid to intermediate lava group, which may, over substantial sections, be silicified, and is certainly abnormally low in mafic materials (which are the source of the background chargeability) and also low in other (graphite, sulphide and magnetite) material.

Due to the lack of significant induced polarization responses within the magnetic units recorded in the eastern section, the source of those responses is considered to be due to disseminated magnetite of fairly low (less than 1%) percentage.

*DISCUSSION OF THE MAJOR INDUCED POLARIZATION ANOMALIES*

Each separate induced polarization anomaly is discussed below, and brief conclusions with respect to the merit of each, are given.

*A - Eastern Section*

As discussed above, the eastern section is characterised by high apparent resistivities (above 5000 ohm-metres) and abnormally low (10 $\pm 2\frac{1}{2}$ milliseconds) chargeabilities.

*Zone E1*.......A significant chargeability response of some 1[illegible] to 15 milliseconds was recorded on *line 42* centred at about 150W.

This single reading anomaly was duplicated on the overlap. The apparent resistivity shows a 60% fall to 5,000 ohm-metres. Thus while the host to the chargeable material is slightly *less resistive* than the enclosing rocks, it cannot be considered to be *conductive* as such. The maximum depth to source is 100 feet. As there is no distortion in the magnetic field, the source is considered to be sulphides. To the south a very similar response of 15 milliseconds superimposed on a 10 milliseconds background was recorded at 450W on *line 41*. The host rock to the interpreted sulphide source is again less resistive at 4000 ohm-metres than the enclosing rocks at over 10,000 ohm-metres. The maximum depth to source is 150 feet. On *line 40* a minor 5 milliseconds response on a 12 milliseconds background at 350W is the most southerly manifestation of this zone recorded.

*It is recommended that careful ground geological and geochemical follow-up be carried out over this anomaly.*

*Zone E2*.......A 15 milliseconds above background response associated with no change in the high resistivity of 7000 ohm-metres was noted at 4350E on *line 41*. The maximum depth to source is considered to be less than 100 feet. On *line 40* a more substantial response of 14 milliseconds above an 8 millisecond background was observed centred at 4900E. The maximum depth in this case is considered to be of the order of 150 feet. To the south, the response rises to over 20 milliseconds above the 8 millisecond background, however, in this case there is a material fall in resistivity to

900 ohm-metres from over 10,000 ohm-metres to the west (and north). A second zone, *Zone E3..* again about 20 milliseconds above the low background was recorded at 5050E. As with E2 on this line, (line 39), low resistivities of 900 ohm-metres accompany the increase in chargeability.

On *line 38* a broad zone of 10 to 12 milliseconds above background was noted over the entire section between 4500E and 5500E, which was associated with a fall in apparent resistivities from high 10,000 ohm-metres in the west to 3000 ohm-metres over the anomaly.

*This zone is considered of interest, and the source of the chargeability, which is considered to be sulphides in this case, should be clearly ascertained.*

*Zone E4*.......A single station 12 millisecond response on an 8 millisecond background was located centred at 6950E on *line 35*, and is associated with a minor decrease in the 3000 ohm-metres resistivity. The maximum depth to this narrow, chargeable zone is 100 feet. A very small 5 millisecond response on a 10 millisecond background at 6750E on *line 34 may* be a southern correlative of this zone.

*The source is obviously narrow and of limited strike length. However, bearing in mind the narrowness of the Henty Fault Zone anomaly, and the large spacing between lines, it is recommended that the source of E4 be unambiguously identified. It may prove* *necessary to carry out a minor amount of further induced polarization work to define the strike extent and the position of its most significant signature along strike.*

*B - The Western Section*

*Zone W1*.......At 2100E on *line 28* a 30 milliseconds anomaly above the 15 milliseconds background is associated with a sharp fall off in apparent resistivity to about 300 ohm-metres compared with over 10,000 ohm-metres some 200 feet to the east. The width of the causative zone is less than 40 feet, while the maximum depth is about 100 feet. A very sharp increase in chargeability to 30 milliseconds above background is centred on *line 29* at 1500E. This zone is open to the south, and on line 28 either magnetite and/or pyrrhotite make up part of the causative material as a "dipolar" magnetic response was recorded *over* the induced polarization maxima.

*This most significant induced polarization occurs right on the contact between the western and eastern rock units, and has high chargeabilities and low resistivity. The causative sulphide or graphite may make up to 3% of the host.*

*Zone W2*.......A broad strong 25 milliseconds response was super-imposed on a 22 milliseconds background on *line 29* at 1250E. Coincident with the induced polarization response on this line were low apparent resistivities of 400 ohm-metres and a +50 gamma distortion in the magnetic field. The source is at a maximum depth of 150 feet. It is not clear how this response correlates to higher values to the south, but it *probably* correlates with the station 1450E on line 28.

*The host to the chargeable material is quite obviously much less resistive than the surrounding rocks at 400 ohm-metres. The slight increase in magnetic field of 50 gammas noted on line 28 infers minor magnetite or pyrrhotite to make up part of the source. However, magnetite ALONE is not the source, as some 2½% sulphides (or graphite) are inferred to be present under the induced polarization maxima.*

*Zone W2A*.......An 8 millisecond response superimposed on a 30 milliseconds background to the west, and a 20 milliseconds background to the east, was located at 1500W* on *line 28*. This response is situated on a contact between resistive (20,000 ohm-metres) material to the east, and less resistive (1000 ohm-metres) material to the west. The maximum depth to source is 100 feet.

*The disseminated sulphide or graphite is situated in close proximity to a major rock type change. This anomaly is considered of tertiary interest only.*

*Zone W3*.......A 10 millisecond response superimposed on an 18 millisecond background was defined at 850W on *line 29*, and

* *Note: Approximate only. Due to pegging error, positions scaled off.*

may also be seen at 450W on *line 28*. The apparent resistivity shows no change from its 2500 ohm-metres level over the anomaly, nor does the magnetic field. The source is considered to be at a maximum depth of 100 feet.

*The source is obviously disseminated sulphides or graphite within a resistive host.*

*Zone W4*.......A 14 milliseconds induced polarization response superimposed on an 18 millisecond background was recorded at 1150W on *line 29* and is probably correlated with a similar response on *line 28* at 750W. On line 29 a 60% reduction in apparent resistivity was noted to 1000 ohm-metres together with an increase in total magnetic field of 70 gamma. On line 28 no change in apparent resistivity was noted although a 40 gamma increase in total field was recorded.

On *line 30* at 1250W an 8 millisecond response superimposed on a 20 millisecond background with an associated increase in magnetic field of 120 gammas *may* represent the most northerly extension of this zone.

*This chargeable response infers 1% to 1½% sulphides or graphite by volume, with pyrrhotite or magnetite being present within the source. While the host undergoes a significant decrease in apparent resistivity to 1000 ohm-metres on line 29, the source cannot be considered conductive in the E.M. sense. This response* *should be followed up.*

*Zone W5*.......A single 18 millisecond response over a 21 millisecond background was noted at *060W on line 29* but cannot be traced either south or north with certainty. The maximum depth to source is considered to be of the order of 150 feet.

*This response should be followed up as a secondary priority target.*

*Zone W6*.......A significant 22 millisecond response was recorded on *line 31* at 1600W. This is associated with a 70% drop in apparent resistivity to 1000 ohm-metres, and of significance, a 200 gamma increase in total magnetic field, which is of *identical form* to the chargeability response. The maximum depth to source is interpreted as being of the order of 100 feet.

To the south it *may* continue as W4 (see above) as the magnetic anomaly certainly continues in that direction.

To the north a significant 20 millisecond response on an 18 millisecond background was recorded centred at 1700W on *line 32*. Again apparent resistivity decreases by almost 90% to 700 ohm-metres, and is associated with a +150 gamma magnetic response.

*This is one of the more significant anomalies in the area. The material reduction in apparent resistivity together with the high chargeability, suggests a 2% sulphide (or graphite) content* *within a host resistive to the enclosing rock units. The source either contains magnetite as a minor constituent, or pyrrhotite as a major constituent, or of course a combination of both. This should be followed up as a primary target.*

*Zone W7*.......Peaks of 18 milliseconds were recorded on *line 30* at 250E and 450E, and similar responses on *line 31* at 050E and on *line 32* at 050W. On lines 30 and 32 apparent resistivities fall materially and on *all* lines an associated increase in magetic field of between 40 and 100 gammas was recorded. Maximum depths to source in all cases are about 150 to 200 feet.

*These induced polarization responses are considered worthy of follow-up as a second priority, and either contain minor magnetite or more substantial pyrrhotite within the sulphide or graphite source.*

*Zones W8 and W9*.......Two responses of secondary to secondary/tertiary interest were located on *line 30* at 2350W and 1950W respectively. Both show substantial falls in apparent resistivity of the order of 80%+ to 250 and 400 ohm-metres respectively. The maximum depths to source are about 150 feet. Both contain magnetite. Neither can be clearly traced either north or south.

*These responses should be followed up on a secondary priority basis only. The hosts are conductive and contain minor magnetite and sulphide or graphite to 1½%-2% by volume.*

*Zone W10*.......A substantial increase in induced polarization response to over 25 milliseconds above the low background of 20 milliseconds was noted between 150E and 450E, with two distinct peaks at 250E and 450E on *line 33*. Over this section, apparent resistivities fall from a background of 8000 to 10,000 ohm-metres to 700 ohm-metres. This represents a very material and significant fall. There is no associated increase in magnetic field, therefore the source is either sulphides or graphites (or a combination of both) in origin. The maximum depth to source is considered to be of the order of 100 feet.

*This CONDUCTIVE source which shows anomalously increased chargeability should be followed-up as a target of primary importance. It is not possible to determine whether graphite or sulphide is the predominant source.*

*Zone W11*.......This significant 20 milliseconds response was only clearly defined on *line 33* at 450W, where the apparent resistivity falls some 60% to 2500 ohm-metres. There is no associated magnetic field. The maximum depth is of the order of 150 feet.

*This significant disseminated sulphide or graphite response should be followed up as a target of secondary priority.*

*Zone W12*.......A 12 millisecond response superimposed on a 20 millisecond background was recorded centred at 1250W on *line 33* and is associated with a material decline in apparent resistivity from 3000 ohm-metres to the east and west to less than 300 ohm-metres at 1400W. These two features while not coincident, are obviously related and may infer a west dip to the source.

*This interesting response should be followed up as a target of secondary importance.*

*Zone W13*.......A single point response of about 20 milliseconds seen on two overlapping arrays at 450W on *line 34* is associated with 70% fall in apparent resistivity to about 900 ohm-metres *and* an increase in magnetic field of 160 gammas, which extends *beyond* the boundaries of the chargeable source as inferred by the induced polarization.

It is considered that this anomaly corresponds with the very material response of 25 and 30 milliseconds above background observed on *line 35* at 550W and 650W (either or both). However, both of these anomalies are highly resistive, 5000 ohm-metres. Thus the source is disseminated in this case.

*In spite of this anomaly's limited strike length, careful follow-up as a primary target is recommended due to its similarity to the Henty Fault response.*

*Zone W14*.......This is the first significant response in the western section near the contact with the eastern section, on *line 34*. At 150W an 18 millisecond response on a 12 millisecond background was recorded. There is a small 50% decrease in apparent resistivity to just over 2000 ohm-metres on an 80 gamma distortion in the total magnetic field. The maximum depth to source is difficult to gauge but is estimated between 100 and 200 feet.

It is difficult to correlate this response to similar responses to the north and south because flexures or faults are proposed as shown in Plate 5.

*This response is due to disseminated sulphides or graphite with some magnetite, within a host less resistive than the enclosing rock units. The priority for follow-up is considered to be from secondary to tertiary.*

*Zone W15*.......One of the most significant anomalies in the area was located on *line 36* at 1400W* where a response of over 20 milliseconds was superimposed on a 24 millisecond background. This is accompanied by a truly massive fall in resistivity from 8000 ohm-metres to 200 to 500 ohm-metres within the chargeable zone. The peaks for chargeability (at 1400W*) and conductivity (at 1500W*) are not coincident, but are part of the same geological event. An increase in magnetic field was noted over the anomaly of about 100 gammas and this continues to the west to reach 200

* *Note: Approximate only. Due to pegging error, positions scaled off.*

gamma above background at 1600W*. The source therefore contains some magnetite, but is not uniquely outlined by it. This anomaly continues on to *line 35* at 950W, although a postulated fault lies in close proximity to it on that line and *may* be present at about 2300W on *line 37*, but in much reduced form.

*This response on line 36 is considered of primary interest and should be followed up as a Henty Fault type target.*

*Zone W16*.......A 12 millisecond response on the high 24 millisecond background on line 36 at about 1800W* can be traced north and south where small responses are considered to correlate with it. The resistivity remains a high 1000 ohm-metres over this response while the magnetic field is about 40 gammas above background, but this is due no doubt to the fall-off in the field from the major source at 1600W*. The maximum depth to source is considered to be of the order of 150 feet.

*This response should be followed up as a target of secondary or tertiary importance. The source is considered to be either disseminated sulphides and/or graphite, and may contain minor magnetite.*

*Zone W17*......Significant induced polarization responses of over 20 milliseconds were recorded on *lines 37* and *38* at 1750W and 1850W respectively. The former was associated with lower resistivity (but still high at 3000 ohm-metres in absolute terms)

* *Note: Approximate only. Due to pegging error, positions scaled off.*

and the latter *specifically* with doubled resistivity of about 2000 ohm-metres. The maximum depths to source in both cases are considered to be of the order of 70 to 75 feet, while a slight increase of 20 to 30 gammas in the magnetic field infers the presence of minor magnetite and/or more substantial pyrrhotite.

*This disseminated sulphide or graphite with minor magnetite or more substantial pyrrhotite is considered to be of secondary importance. The volume percent sulphides (or graphite) is considered to be of the order of 2½%.*

*Zone W18*.......A series of significant anomalies were located on *lines 37, 38* and *39* at 3150W, 3400W and 3850W where 22, 32 and 20 millisecond above background were observed. In all cases 2000 ohm-metres resistivities were recorded. Maximum depths of 170 feet, 140 feet and 100 feet were indicated respectively.

*This very substantial induced polarization response is recommended as a primary target for further investigation on lines 38 and 39, and as a secondary target on line 37.*

*Zone W18A*......To the immediate east of zone 18 on *lines 37* and *38* a small 5 milliseconds response was noted at 2950W and 3100W respectively, while not substantial it *may* be related in some way to W18.

*Zone W19.......*To the west of Zone W18 on *lines 37* and *38* at 3450W and 3600W respectively, anomalies of 10 and 22 milliseconds above background within 1000 ohm-metres material were recorded.

*These two anomalies MAY be of tertiary to secondary interest, and the depths to source are estimated at 100 feet and 50 feet respectively.*

*Zone W20.......*This response is best seen on *line 41* at 2350W where a 20 millisecond response was superimposed on the 5 millisecond background of the eastern section. A substantial fall in apparent resistivity of 70% took place but the *absolute* level of 3000 ohm-metres is still highly resistive. An *increase* in the total magnetic field of 80 gammas takes place over this source. The depth to source is estimated at not more than 200 feet.

*The disseminated graphite or sulphide source material contains minor magnetite and/or more substantial pyrrhotite, and is contained within a host less resistive than the enclosing rocks. The total sulphide and graphite content is about 2% by volume. This response is of secondary to primary importance.*

*Zone W21.......*A narrow, significant anomaly was located at 2650W on *line 41* of 20 milliseconds above the 20 millisecond background. This anomaly was located in the vicinity of a creek, and as the resistivity data shows the source to lie on or in close proximity to a major rock type change (from 10,000 ohm-metres to 2500 ohm-metres) the source *may* be sulphides or graphite on or within a fault zone. The maximum depth to source is 100 feet.

*This target is of secondary importance.*

*Zone W22*.......A broad induced polarization response of about 10 milliseconds above the 22 millisecond background was noted on *lines 40* and *41* at 2750W and 3300W respectively. The resistivities in both cases are within 200 ohm-metres of 1000 ohm-metres.

Very slight increases in magnetic field of the order of 20 gammas were noted over this zone, while the maximum depths are estimated to be of the order of 200 feet. However, the broad anomaly is probably due to a *gradational change* in chargeable material, and thus this estimate is no doubt excessive.

*The form of this response suggests a formational origin for the source, and variations of the graphitic and/or pyritic material causes the high regional background in the western section. The anomaly is thus considered of secondary to tertiary interest at this stage.*

*Zone W23*.......On *lines 40* and *41* a 15 millisecond above background response was associated with an 80% drop in apparent resistivity to just over 1000 ohm-metres at 3500W and 3550W respectivley.

There is also a very slight (10 gamma) increase in magnetic field over each anomaly.

*The source is considered to be disseminated sulphide or graphite contained within a host somewhat less resistive than the enclosing rocks. Minor magnetite or pyrrhotite is also present within the chargeable source. The response is considered of secondary interest at best.*

*Zone W24*.......A broad zone of 20 milliseconds above background was noted between 1800W and 2050W on *line 42* which was associated with a 50% fall in apparent resistivity to 2500 ohm-metres. A slight 40 gamma increase in magnetic field was noted over the response, but the magnetic field reaches a maximum of 60 gammas above background at 2100W, some 200 to 300 feet *west of* the response. A broadly similar response was noted on *line 43* centred at 1650W and accompanied by a substantial *but local* increase in magnetic field to 350 gamma. The maximum depth to source is estimated at about 100 to 120 feet.

*The source is considered to be due to disseminated sulphides or graphite together with some magnetite or pyrrhotite within a host generally somewhat less resistive than the enclosing rocks. This anomaly is judged on geophysical parameters to be of secondary importance.*

*Zone W25*.......A sharp single station response was recorded at 2350W on *line 42*. An 80% fall in apparent resistivity to about 1000 ohm-metres shows the host to be more conductive than the enclosing material. The depth is estimated not to exceed 100 feet. This response *may* extend to the north to cross *line 43* at 2100W.

*This response, although of limited strike length is considered of primary or secondary merit. The high chargeability and low resistivity are probably both UNDERSTATED due to the narrowness of the source. Again this response is reminiscent of the Henty Fault zone anomaly, and thus merits close attention.*

*Zone W26*.......A broad zone of induced polarization was noted between 2350W and 2650W on *line 43* and lies open to the north. It probably continues south to cross *line 42* at 3000W also. There is no associated distortion in the magnetic field, on either line. The maximum depth is considered to be of the order of 100 feet, and the source width about 250 feet to 300 feet on line 43 and 100 feet plus on line 42.

*The response is due to disseminated sulphides and/or graphite within a resistive (2500 ohm-metres) source. The anomaly is considered of tertiary or perhaps secondary interest at best.*

*CONCLUSIONS*

1 - The chargeability and resistivity contour interpretations have clearly defined two sections of quite different geophysical characteristics. The western section has low resistivities of less than 5000 ohm-metres, and high chargeabilities above 25 milliseconds, while the eastern section has resistivities in excess of 5000 ohm-metres and background chargeabilities of 10 ±2½ milliseconds.

The western section is considered to be underlain by a sedimentary-volcanogenic sequence carrying ubiquitous pyrite and/or graphite, while the eastern section is considered to be underlain by acid and/or intermediate volcanics deficient in mafic minerals, and devoid of extensive pyritisation, and possibly silicified in parts.

2 - The strike direction within the western section is grid north-north-west/south-south-east to grid north-west/south-east, while the strike direction within the eastern section is considered to veer somewhat more grid north south.

3 - The boundary between the two sections is sharp and generally takes place over 100 feet to 150 feet. The strike direction of the boundary is about grid north-north-west/south-south-east, and is dislocated by a series of sinistral dislocations having strike lengths of hundreds of feet to about a thousand

feet. These dislocations are considered to be faults, but *may* be also due to folding.

It should be noted that there is a "degree of uncertainty" involved in the placement of these supposed dislocations. This in part is due to the "sideways vision" that the gradient method has. This degree of uncertainty has been annotated on Plate 5.

4 - There are a number of magnetic units within the western section. These usually occur either coincident with, or in close proximity to, apparent resistivity lows, and chargeability highs. The cause thereof is either weakly disseminated magnetite or more substantial pyrrhotite. However, the relatively low amplitudes of the distortion in the field of up to 300 gammas, clearly show that the source of the chargeability responses cannot be magnetite alone.

5 - Only a small section of the eastern section was covered by the magnetic survey, but where magnetic units occur, there is no associated chargeability high of significance, and resistivities always remain high. Thus the source in this case is not like that observed in the western section.

6 - A limited number of chargeability responses of significance were located in the eastern section. These are summarised

in detail below.

Their relative priorities have been assessed on *GEOPHYSICAL* criteria. The geological and geochemical correlation is, however, considered to be more important than any merit assessed primarily on geophysical criteria.

Priority rating is as follows...

A = primary interest, B = secondary interest, C = of moderate to minor interest

The resistivity correlation key is as follows....

- \- no resistivity contrast
- HR high resistivity relative to the enclosing rocks
- LR low resistivity relative to enclosing rocks
- VLR very low resistivity relative to enclosing rocks.
- RC chargeability anomaly contained on or in close proximity to a sharp resistivity change.

U magnetic correlation unknown. (not surveyed)

| Zone | Line | Station | Anomaly/ Background | Resistivity Correlation | Magnetic Correlation | Priority | Maximum Depth |
|---|---|---|---|---|---|---|---|
| E1 | 42 | 150W | 15-20/10 | LR | zero | B | 100 feet |
| | 41 | 450W | 15/10 | LR | zero | B | 150 feet |
| | 40 | 350W | 5/12 | LR | zero | C | ? |

| Zone | Line | Station | Anomaly/ Background | Resistivity Correlation | Magnetic Correlation | Priority | Maximum Depth |
|---|---|---|---|---|---|---|---|
| E2 | 41 | 4350E | 15/6 | - | U | B | 100 feet |
| | 40 | 4900E | 14/8 | LR | U | B | 150 feet |
| | 39 | 4800E | 20/8 | VLR | U | B/A | ? |
| E3 | 39 | 5050E | 20/10 | VLR | U | B/A | 150 feet |
| E2/3 | 38 | 4500E-5500E | 10/10 | LR | U | B | 250 feet |
| E4 | 35 | 6950E | 12/8 | - | U | B/C | 100 feet |

7 - The majority of induced polarization anomalies occur within the western section. With such high backgrounds (25 milliseconds) it is often difficult, or indeed impossible, to differentiate between a chargeability high being an "anomaly" or merely a "formational variation" The anomalies are listed below and have been assessed on their geophysical merit. Those which show low to very low apparent resistivity, together with increased chargeability are considered of primary importance. However, in absolute terms, the surface manifestation of pyrite-zinc-lead is not expected to be "conductive" as such, but rather, "low resistivity".

The anomalies located in the western section are summarised as follows....

| Zone | Line | Station | Anomaly/ Background | Resistivity Correlation | Magnetic Correlation | Priority | Maximum Depth |
|---|---|---|---|---|---|---|---|
| W1 | 28 | 2100E | 30/15 | VLR | "dipole" | A/B | 50-100 feet |
| | 29 | 1500E | 30/10 | VLR | - | A/B | 50-100 feet |
| W2 | 29 | 1250E | 25/22 | VLR | +50 gammas | A/B | 150 feet |
| W2A | 28 | 1500W* | 8/30 | - | - | C | 100 feet |
| W3 | 29 | 850W | 10/18 | - | - | C | 100 feet |
| W4 | 29 | 1150W | 14/18 | LR | +70 gammas | B/C | 100 feet |
| | 28 | 750W | 12/15 | - | +40 gammas | B/C | 100 feet |
| W5 | 29 | 060W | 18/21 | - | - | B | 150 feet |
| W6 | 31 | 1600W | 22/20 | LR | +200 gammas | A | 100 feet |
| | 32 | 1700W | 20/18 | LR | +150 gammas | A | 170 feet |
| W7 | 30 | 250E & 450E | 18/21 | LR | +40 gammas | B | 200 feet |
| W8 | 30 | 2350W | 20/18 | VLR | +50 gammas | B/C | 150 feet |
| W9 | 30 | 1950W | 16/20 | VLR | +30 gammas | B/C | 150 feet |
| W10 | 33 | 250E & 450E | 25/20 | VLR | - | B | 100 feet |
| W11 | 33 | 450W | 20/20 | LR | - | B | 150 feet |
| W12 | 33 | 1250W | 12/20 | VLR | - | B/A | 150 feet |
| W13 | 34 | 450W | 20/23 | LR | +160 gammas | A | 50 feet |
| W14 | 34 | 150W | 18/12 | LR | +80 gammas | B/C | 100-200 feet |
| W15 | 36 | 1400W* | 20/22 | VLR/RC | +100 gammas | A | 200 feet |
| W16 | 36 | 1800W* | 12/24 | - | +40? gammas | B/C | 150 feet |
| W17 | 37 | 1750W | 20/13 | LR | +20 gammas | B/A | 70 feet |
| | 38 | 1850W | 24/8 | HR | +30 gammas | B | 75 feet |

| Zone | Line | Station | Anomaly/ Background | Resistivity Correlation | Magnetic Correlation | Priority | Maximum Depth |
|---|---|---|---|---|---|---|---|
| W18 | 39 | 3850W | 20/25 | - | - | A | 100 feet |
| | 38 | 3400W | 32/20 | LR | - | A | 140 feet |
| | 37 | 3150W | 22/30 | RC | - | B/A | 170 feet |
| W19 | 38 | 3600W | 22/20 | LR | - | B | 50 feet |
| | 37 | 3450W | 10/22 | - | - | C | 100 feet |
| W20 | 41 | 2350W | 20/5 | LR | +80 gammas | B/A | 200 feet |
| W21 | 41 | 2650W | 20/20 | RC | -30 gammas | B | 100 feet |
| W22 | 41 | 3300W | 10/22 | LR | +20 gammas | B/C | 200 feet |
| | 40 | 2750W | 10/22 | - | +20 gammas | B/C | 200 feet |
| W23 | 40 | 3500W | 15/20 | LR | +10 gammas | B | 200 feet |
| | 41 | 3550W | 15/20 | LR | +10 gammas | B | 200 feet |
| W24 | 43 | 1650W | 15/10 | LR | +350 gammas | B/C | ? |
| | 42 | 1900W | 20/8 | LR | +40 gammas | B | 100 feet |
| W25 | 42 | 2350W | 16/18 | LR | - | B/A | 100 feet |
| W26 | 43 | 2350W - 2650W | 14/15 | HR | - | B/C | 100 feet |

8 - From an operational point of view, the 30 miles surveyed in 20 working days is considered to demonstrate the cost-effectiveness of the gradient array reconnaissance mode in the West Coast environment.

9 - It is further considered that the one-two on-line magnetometers together with a base station magnetometer proved highly successful in enabling a precise ground total field magnetic

map to be constructed at minimal cost, and with little effort. Relative station accuracy anywhere in the grid is considered to be of the order of ±2 gammas.

The author looks forward to discussing the results of this survey in the near future.

Respectfully submitted on behalf of:

SCINTREX PTY. LTD.

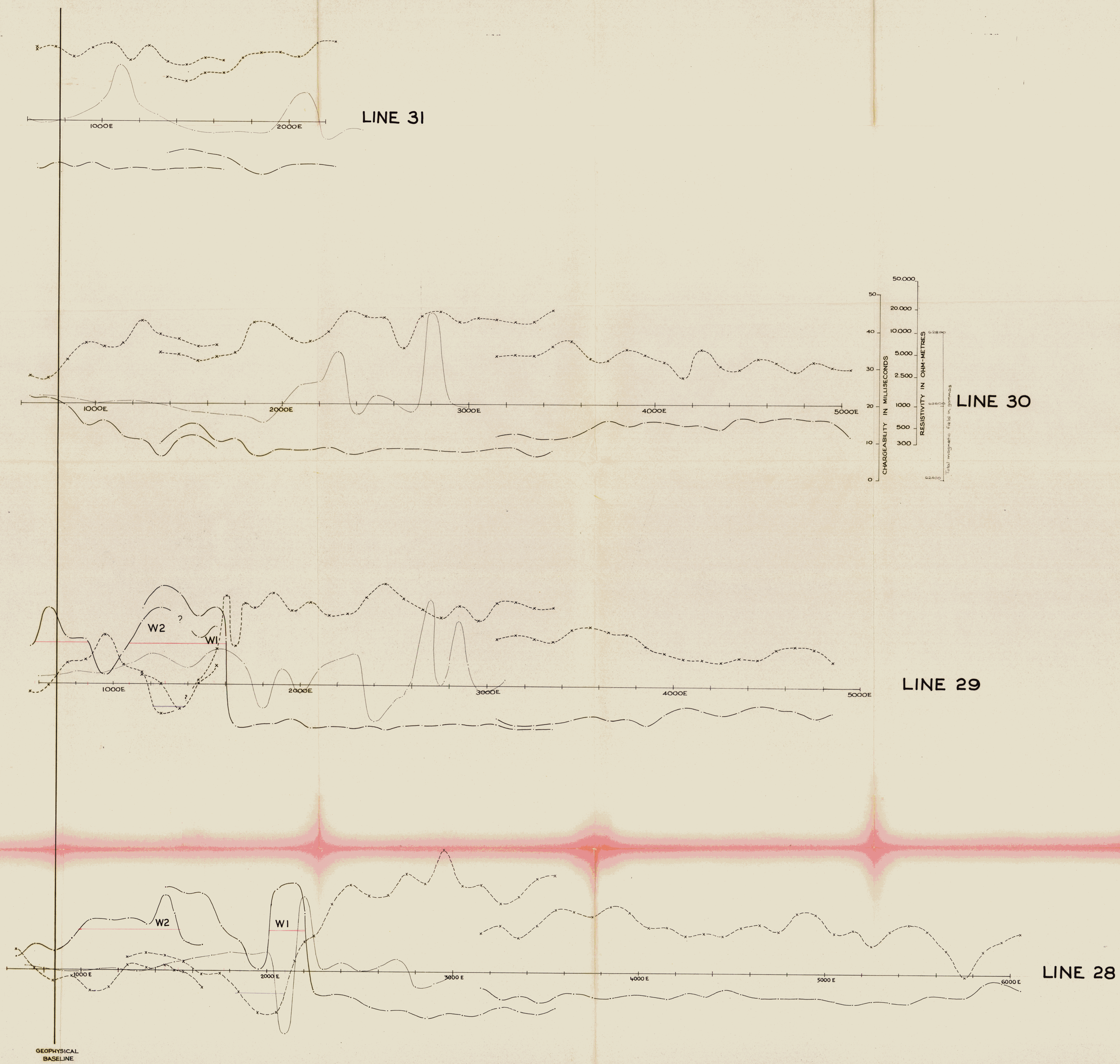
A.W. HOWLAND-ROSE, MSc,DIC,AMAusIMM,FGS.

GEOPHYSICIST

# A REPORT ON GRADIENT ARRAY RECONNAISSANCE EIP AND TOTAL FIELD MAGNETOMETER SURVEYS OVER THE WHITE SPUR GRID, EL 9/66 NEAR QUEENSTOWN, WEST COAST TASMANIA

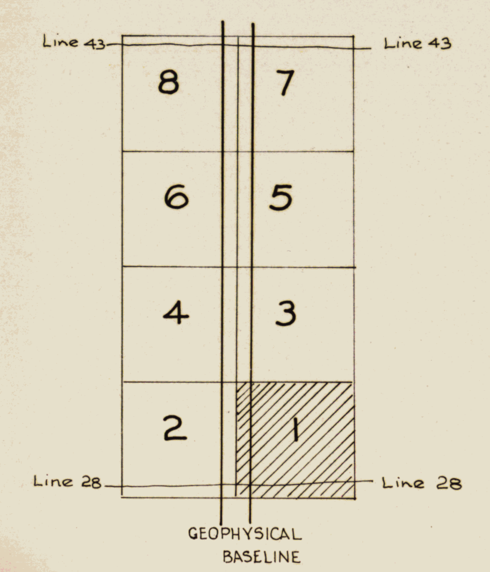
ON BEHALF OF

THE MOUNT LYELL MINING AND RAILWAY COMPANY LTD.




## LEGEND

| | |
|---|---|
| *Chargeability* | *1 inch = 10 milliseconds* <br> *Base Level : 20 milliseconds.* |
| *Resistivity* | *2 inches = 1 logarithmic cycle* <br> *Base Level : 1000 ohm-metres.* |
| *Total Magnetic Field* | *1 inch = 100 gammas* <br> *Base Level : 62600 gammas.* |




# MOUNT LYELL MINING & RAILWAY COMPANY LTD.

WHITE SPUR GRID

(NR.) QUEENSTOWN - WEST COAST TASMANIA

## ELECTRICAL INDUCED POLARIZATION SURVEY
## GRADIENT ARRAY
## DATA PROFILES

SURVEYED & COMPILED BY
SCINTREX PTY. LTD.

NOVEMBER - JANUARY 1976

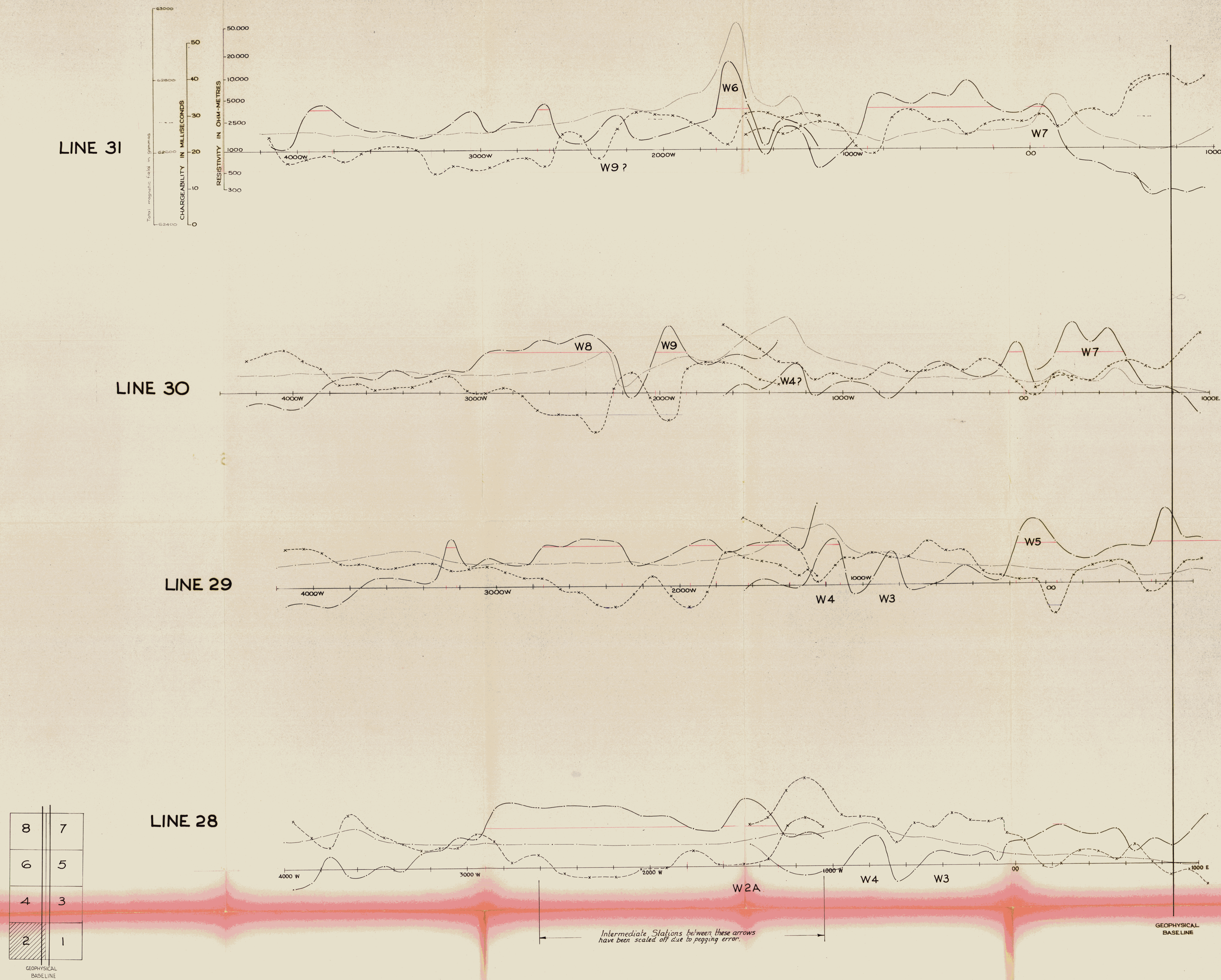
330045

5 cm

200 150 100 50 0 200 400 600 (Feet)
1 : 2400

L 28N - 31N    84-2230 vol 2

JOB Nº TAS-035C    Sheet 1 of 8    PLATE 1. 001

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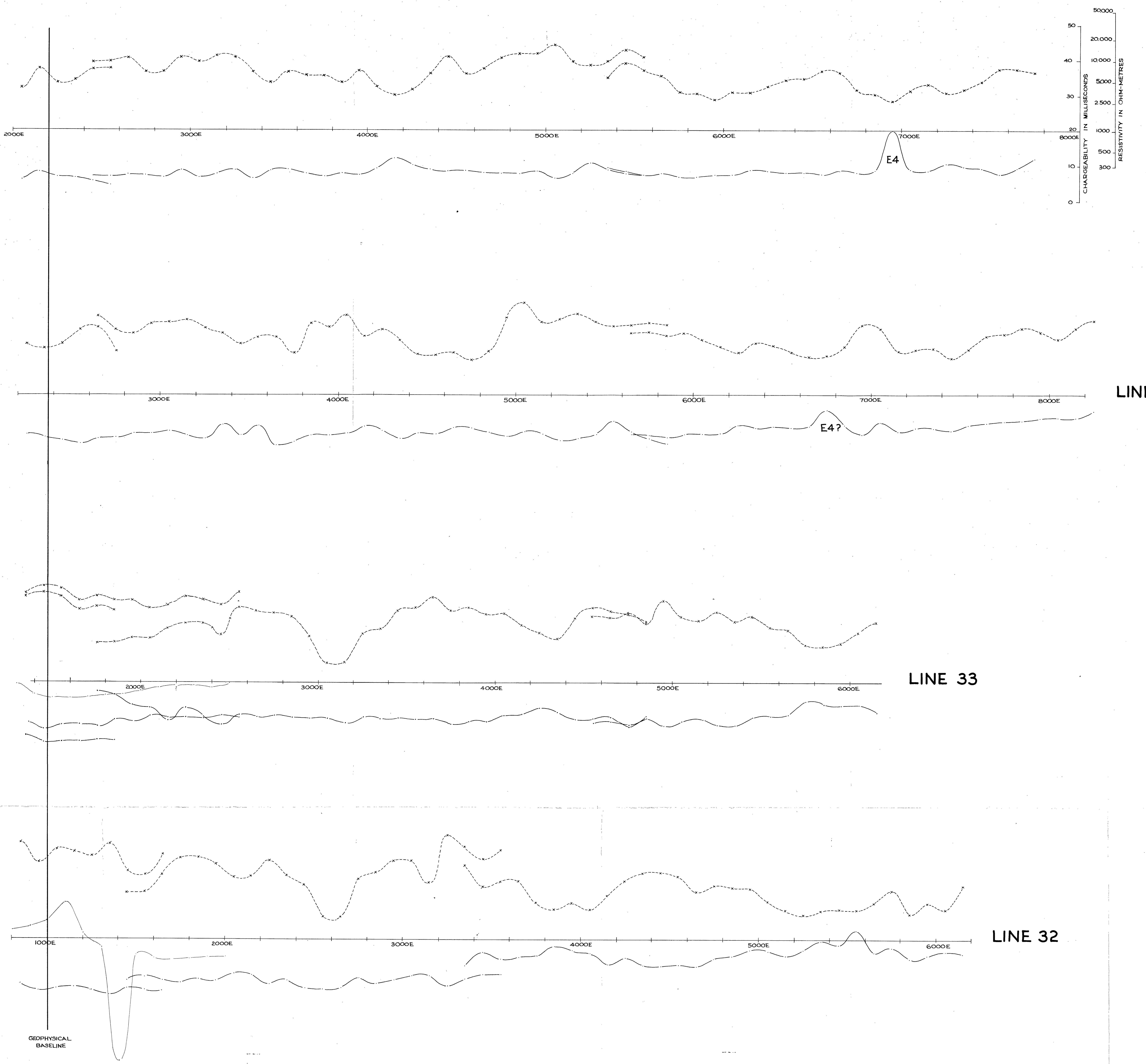
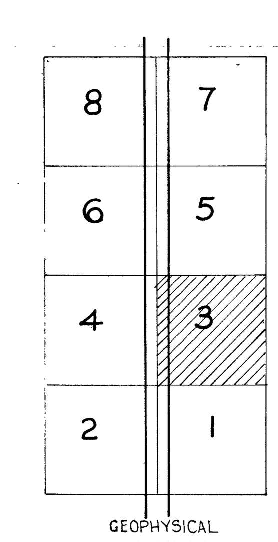
5 cm

002

Job No TAS-035C Sheet 2 of 8 PLATE 1

84-2230 vol 2.



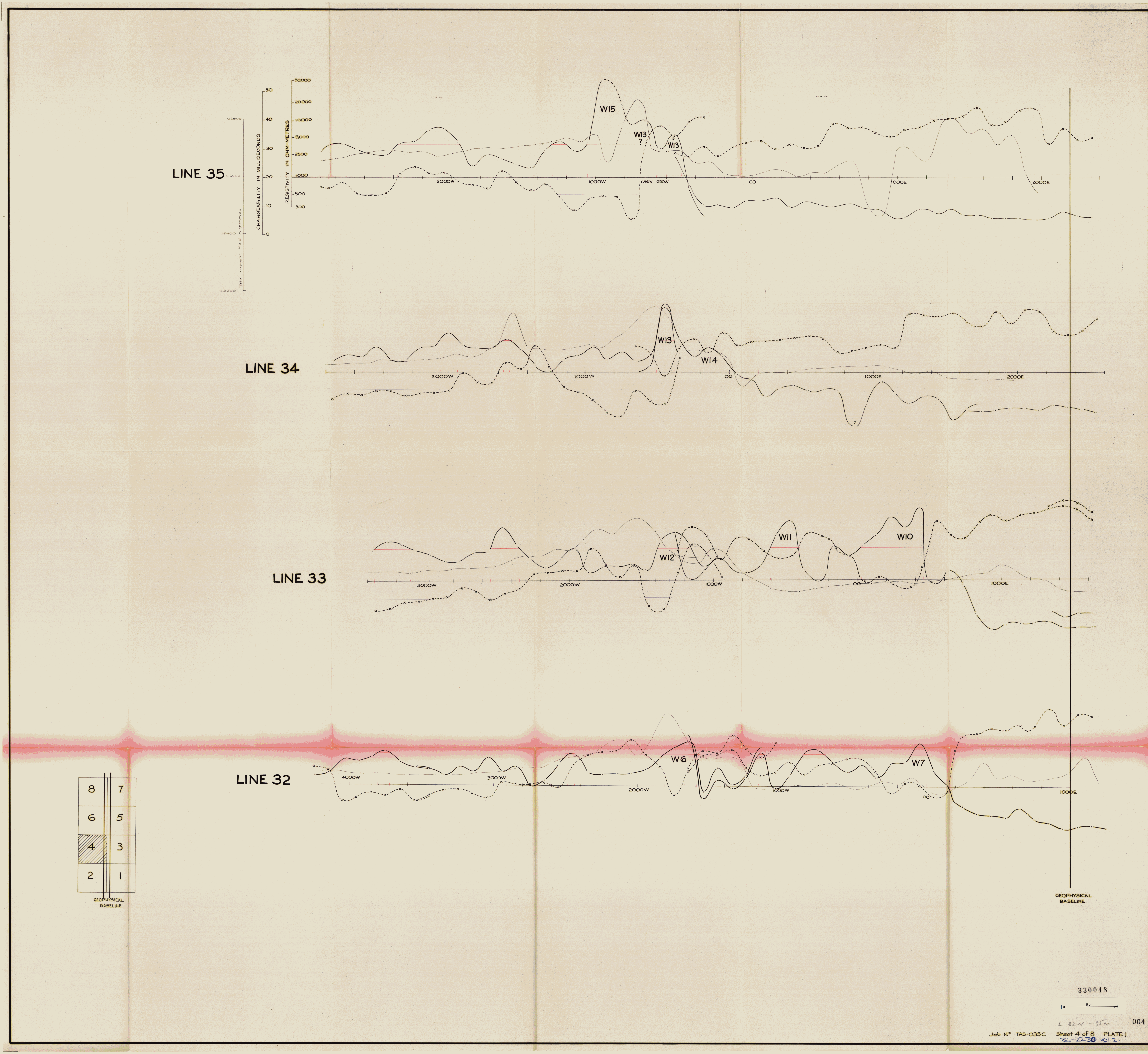



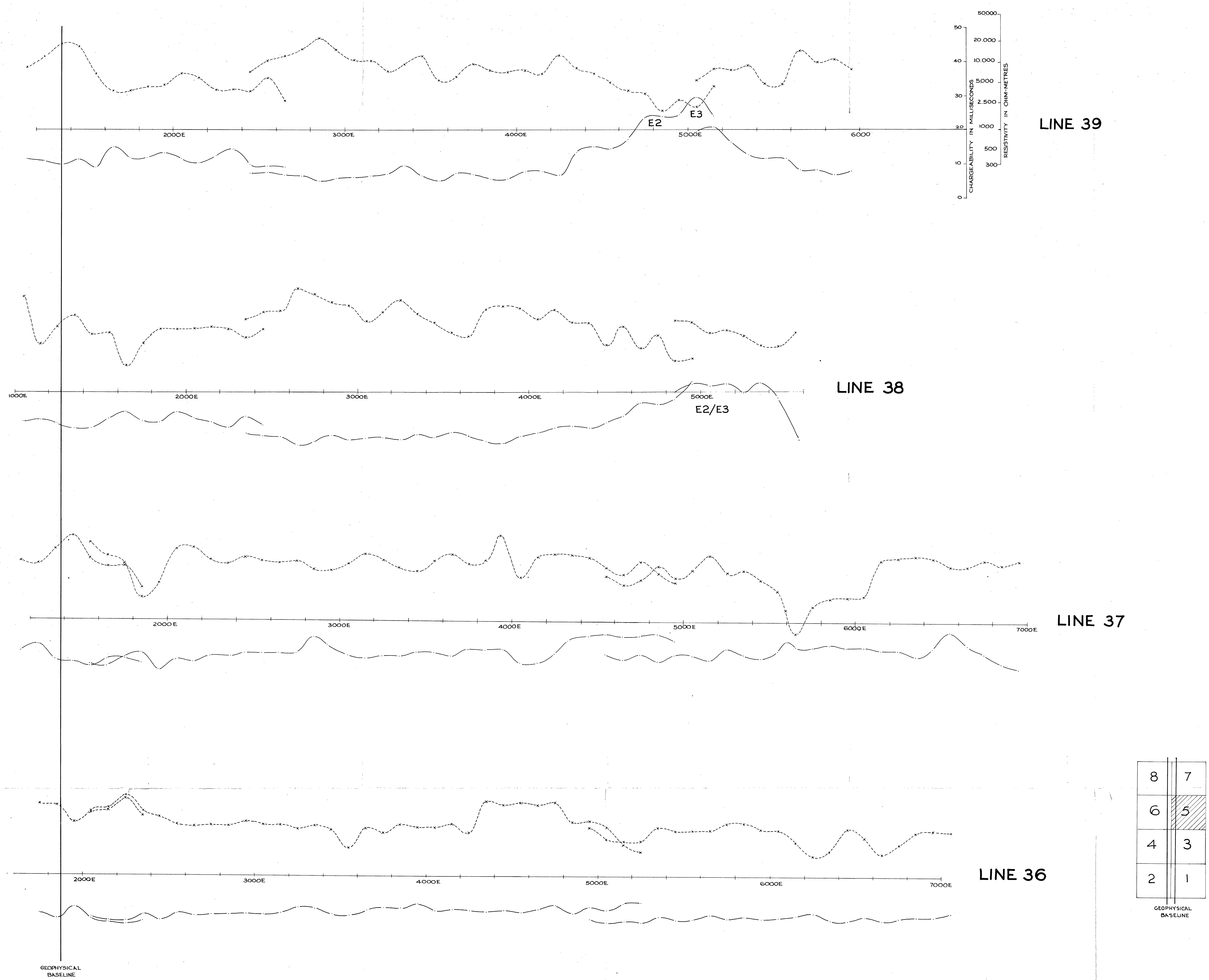

330047

5 cm

003

JOB Nº TAS-035C Sheet 3 of 8 PLATE 1 84-2230 vol 2


LINE 35
LINE 34
LINE 33
LINE 32
RESISTIVITY IN OHM-METRES
50000
20000
10000
5000
2500
1000
500
300
CHARGEABILITY IN MILLISECONDS
50
40
30
20
10
0
W15
W13
W13
W14
W12
W11
W10
W6
W7
2000W
1000W
650W
00
1000E
2000E
3000W
4000W
GEOPHYSICAL BASELINE
8
7
6
5
4
3
2
1
GEOPHYSICAL BASELINE
330048
5 cm
L 32N - 35N
Job No TAS-035C
Sheet 4 of 8
PLATE 1
84-22-30 vol 2
004

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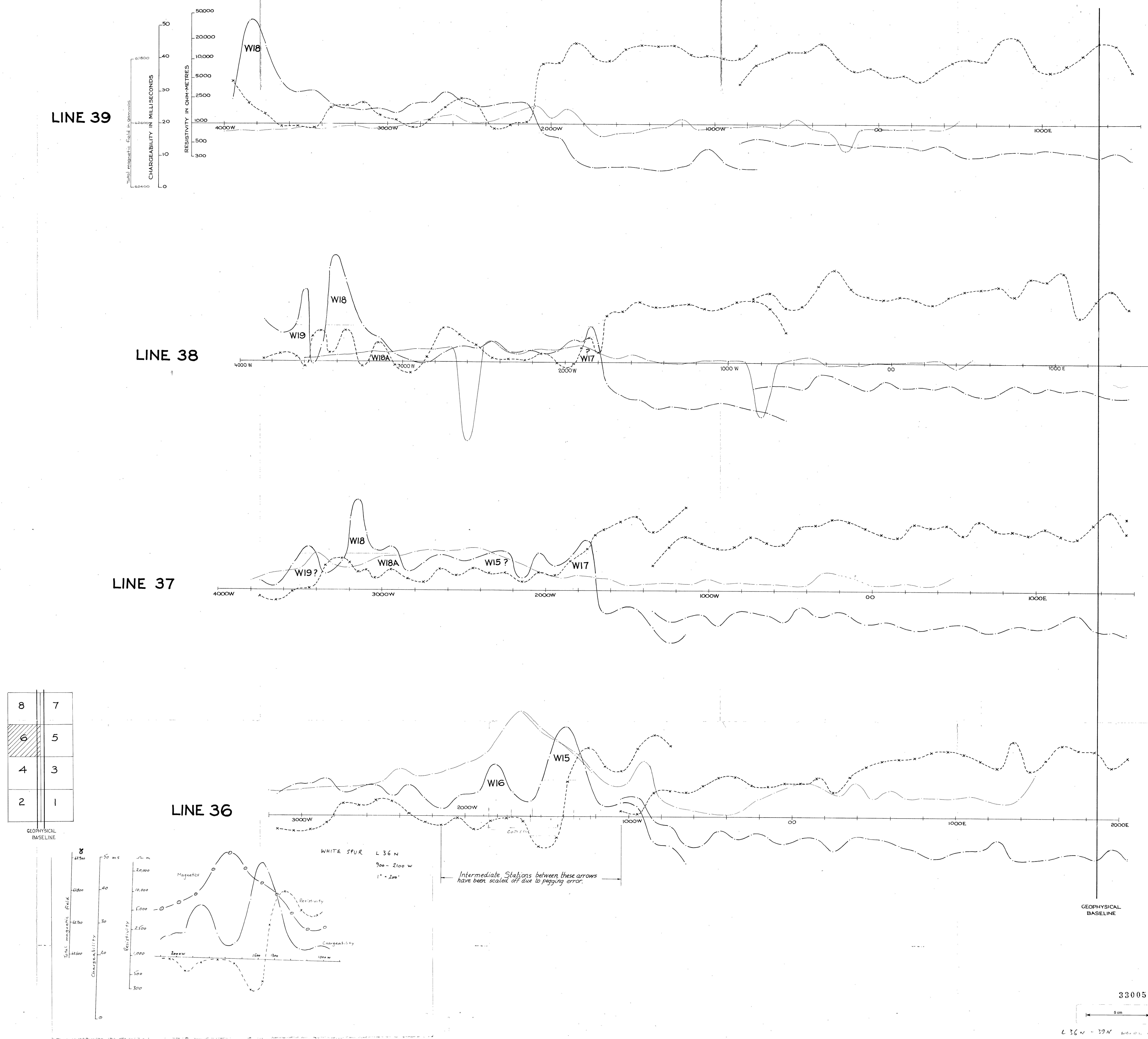
Job Nº TAS-035C Sheet 5 of 8 PLATE 1
8L-2230 vol 2



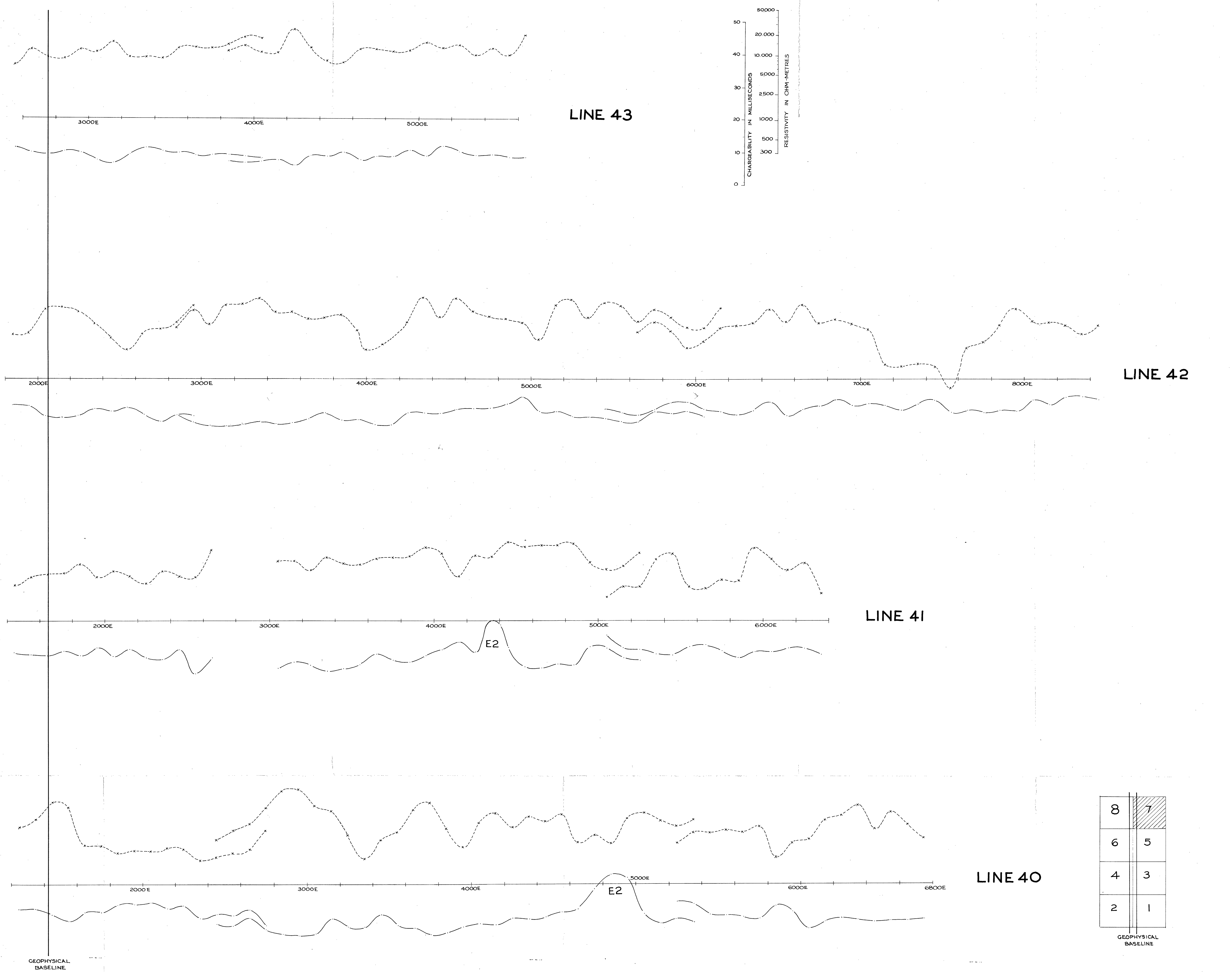

330050

5 cm

006

L 36N - 39N

Job Nº TAS-035C Sheet 6 of 8 PLATE 1
84-2230 VOl 2.




330051

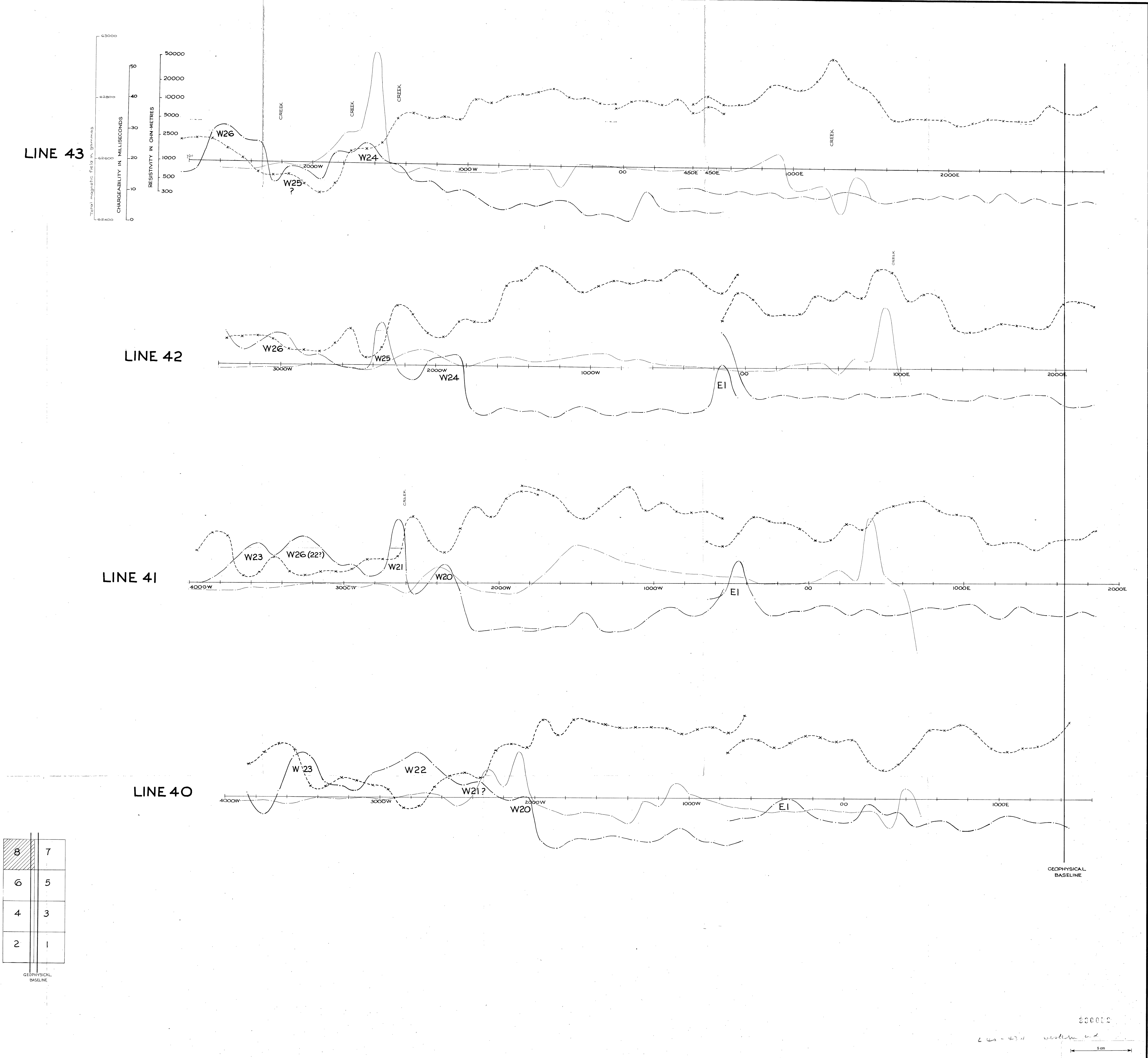
5 cm

L 40 → L 43N

007

JOB No TAS-035C Sheet 7 of 8 PLATE I

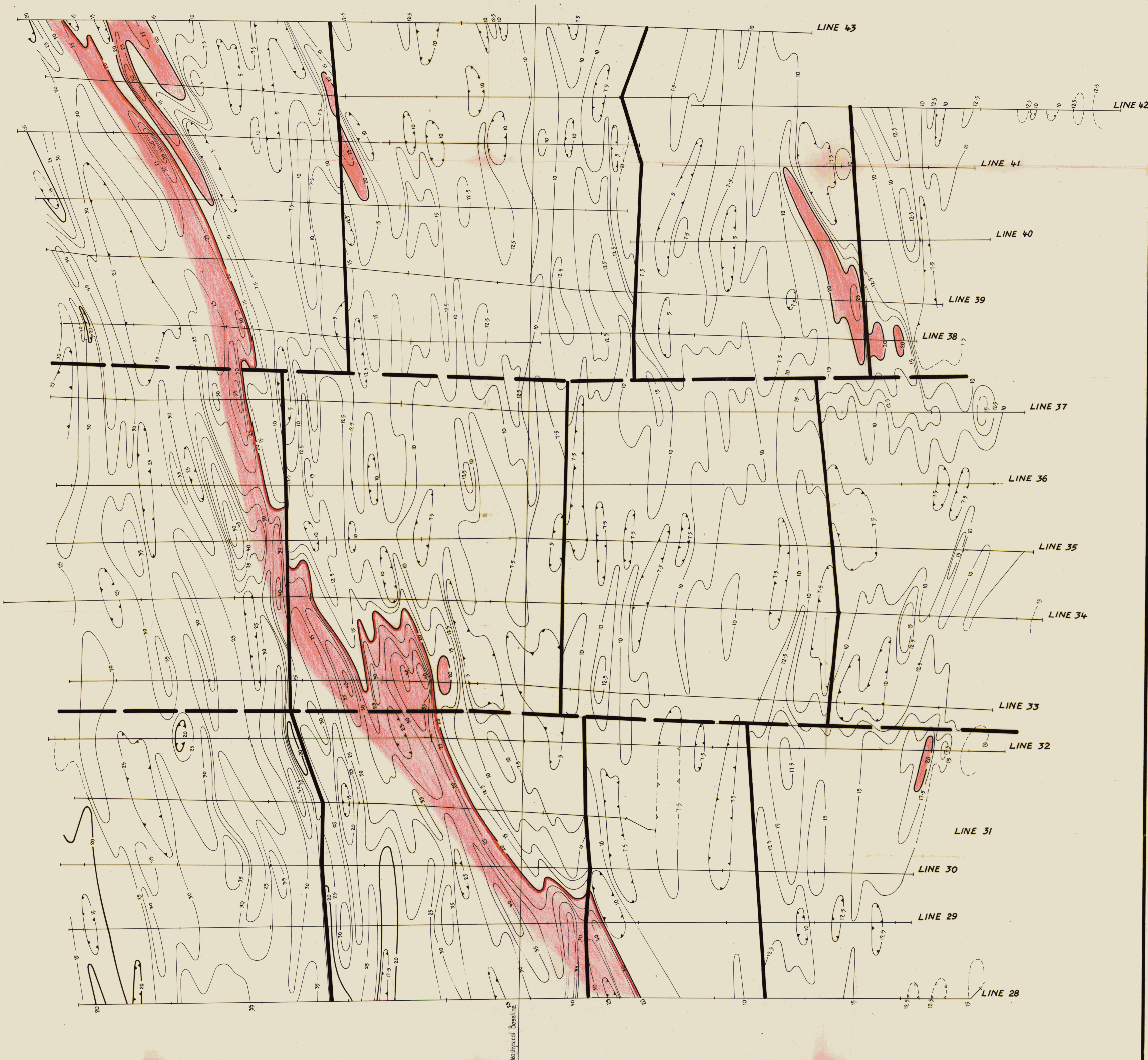
84-2230 vol 2.




Job Nº TAS-035C Sheet 8 of 8 PLATE I

84-2230 vol 2

008




## LEGEND

Chargeability contours in milliseconds

Gradient block boundary

# MOUNT LYELL MINING & RAILWAY COMPANY LTD.

WHITE SPUR

(NR) QUEENSTOWN – WEST COAST – TASMANIA

## ELECTRICAIL INDUCED POLARIZATION SURVEY
## GRADIENT ARRAY
## CHARGEABILITY CONTOUR PLAN

SURVEYED & COMPILED BY
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NOVEMBER – JANUARY 1977

330053

5 cm

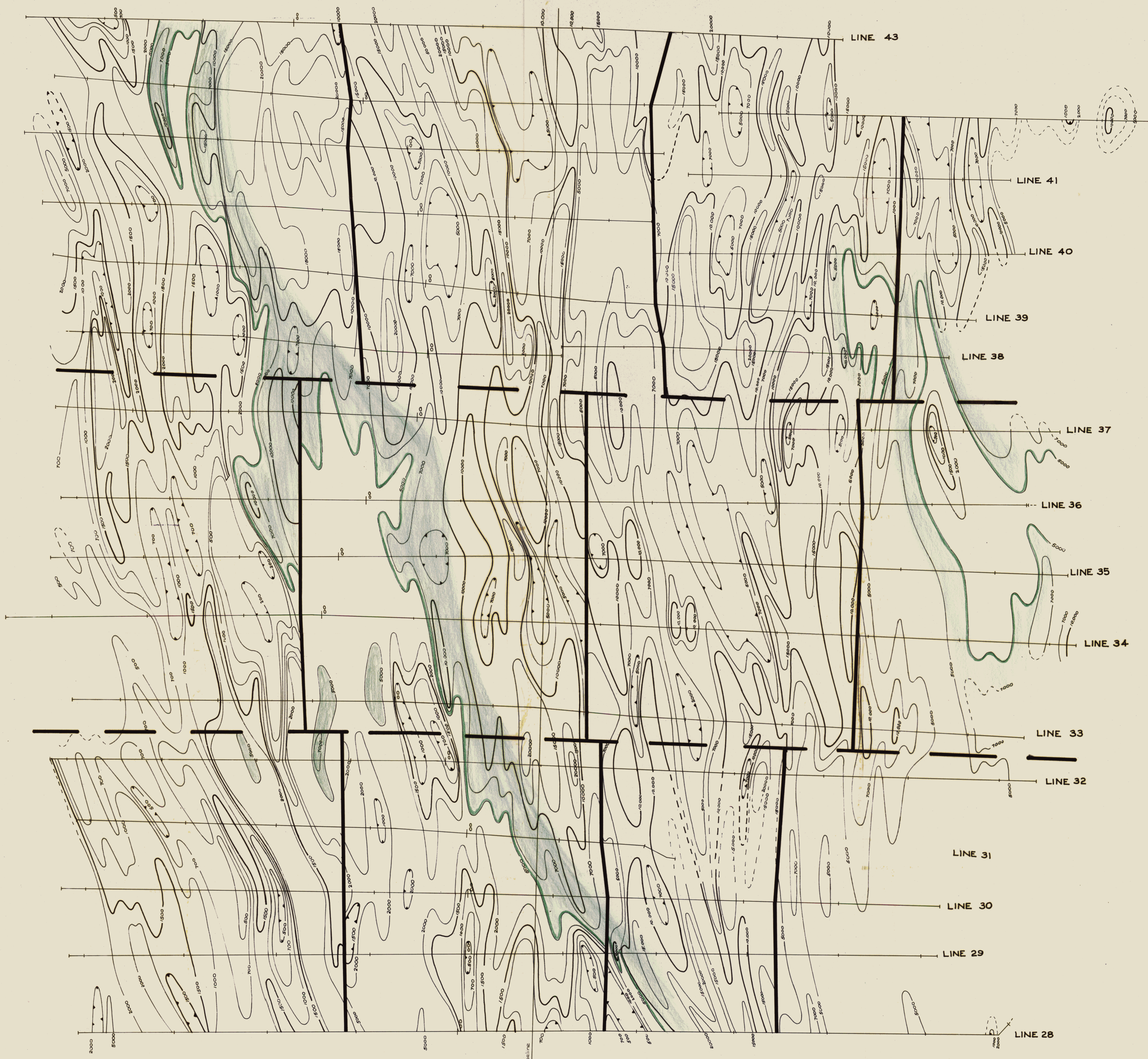
1000 500 250 0 500 1000

1 : 6000 (Feet)

009

Job Nº TAS-035-C Sheet 1 of 1 PLATE 2

84-2230 vol 2.




# MOUNT LYELL MINING & RAILWAY COMPANY LTD

## WHITE SPUR

(NR) QUEENSTOWN - WEST COAST - TASMANIA

## ELECTRICAL INDUCED POLARIZATION SURVEY
## GRADIENT ARRAY
## RESISTIVITY CONTOUR PLAN

**LEGEND**

Resistivity contours in ohm-metres

Gradient block boundary

5 cm

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330054

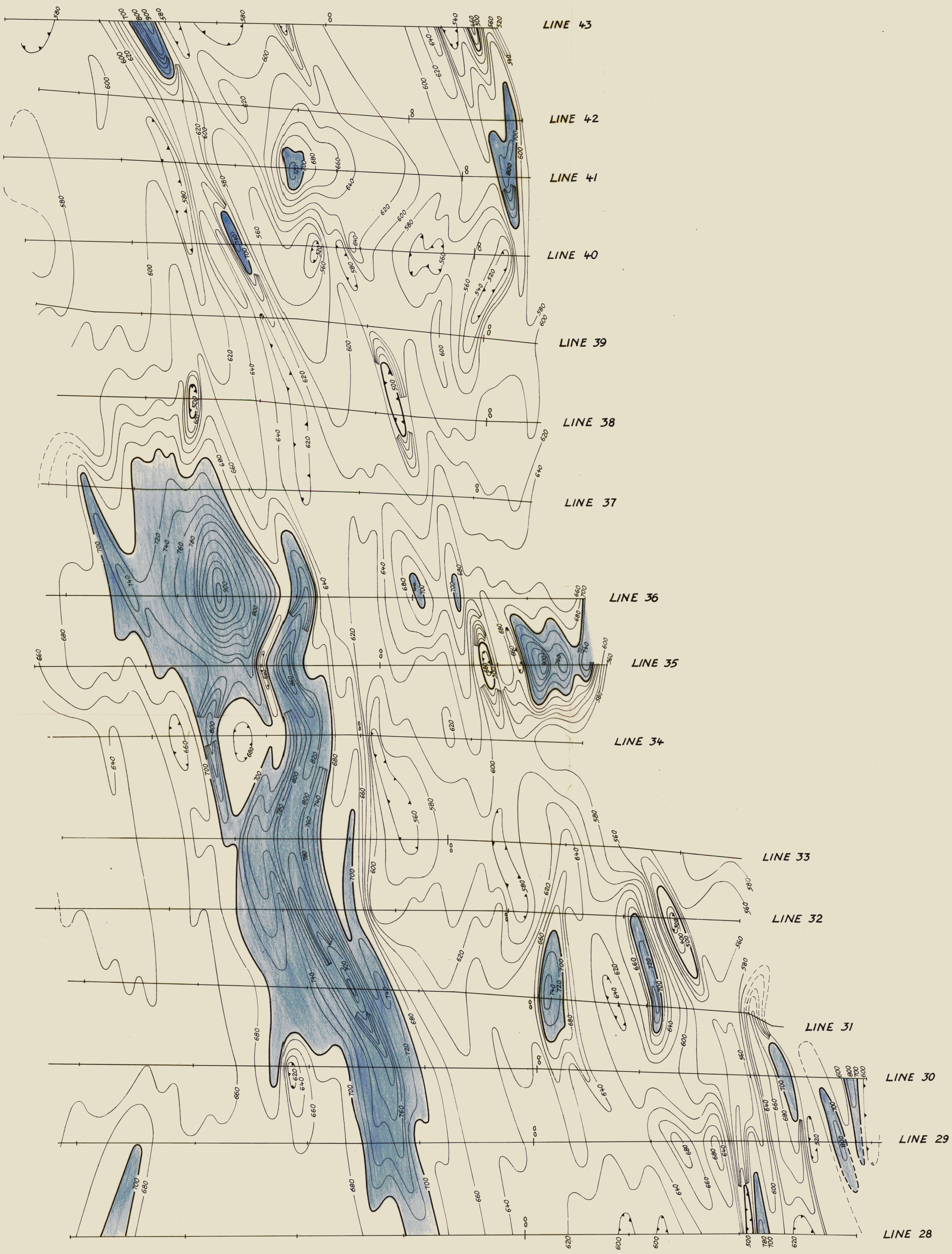
1000 500 250 0 500 1000

1 : 6000 (feet)

010

Job Nº TAS-035-C Sheet 1 of 1 PLATE 3

84-2230 vol 2




Note: For correct total field, add 62,000 gammas to all values.

# MOUNT LYELL MINING & RAILWAY COMPANY LTD.

## WHITE SPUR

(NR.) QUEENSTOWN - WEST COAST - TASMANIA

## TOTAL FIELD MAGNETOMETER SURVEY CONTOUR PLAN

5 cm

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NOVEMBER - JANUARY 1977

330055

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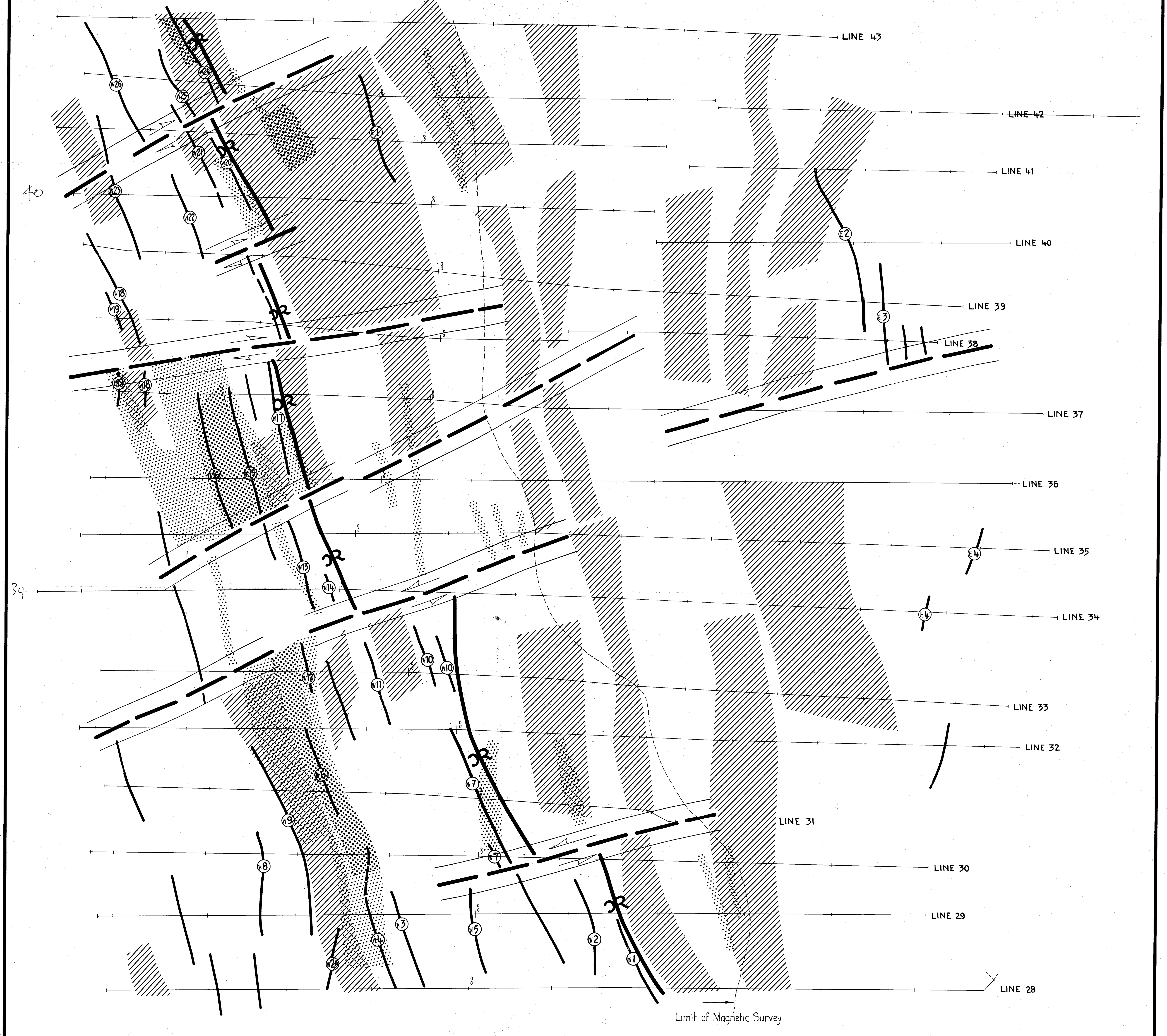
1 : 6000

010

84-2230 vol 2.

JOB Nº TAS-035-C Sheet 1 of 1 PLATE 4




## LEGEND

Relative Induced Polarization Highs

Below 5000 Ωm | Above 5000 Ωm

Major Physical Property Boundary

$10 \pm 2\frac{1}{2}$ms

$30 \pm 5$ms

"Western Sector" "Eastern Sector"

Dislocation (Faults or Flexures)

Direction of Movement

Area of Uncertainty

Weakly Magnetic Units

More Intensely Magnetic Units

Relatively Resistive Units

# MOUNT LYELL MINING & RAILWAY COMPANY LTD.

WHITE SPUR

(NR.) QUEENSTOWN - WEST COAST - TASMANIA

INTERPRETATION PLAN

5 cm

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NOVEMBER - JANUARY 1977

330056

1000 500 00 250 500 1000 (Feet)
1 : 6000

011

Job Nº TAS-035-C Sheet 1 of 1 PLATE 5

84-2230 Vol 2.