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A REPORT ON
APPLIED POTENTIAL (EIP)
AND MAGNETOMETRIC RESISTIVITY (MIP) DOWN HOLE SURVEYS
RED HILLS AREA, NEAR QUEENSTOWN, TASMANIA
ON BEHALF OF
THE MOUNT LYELL MINING & RAILWAY COMPANY LTD.

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A REPORT ON
APPLIED POTENTIAL (EIP)
AND MAGNETOMETRIC RESISTIVITY (MIP) DOWN HOLE SURVEYS
RED HILLS AREA, NEAR QUEENSTOWN, TASMANIA
ON BEHALF OF
THE MOUNT LYELL MINING & RAILWAY COMPANY LTD.

BY

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

SYDNEY, N.S.W.

AUGUST, 1978

TAS-054F

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GEOPHYSICAL CONSULTANTS AND CONTRACTORS

SUMMARY

The limited applied potential and magnetometric resistivity carried out based on the energisation of a mineralised section in DH-5 at 195 metres, infers that the zone extends north of line 40N and south of 00. Additional short traverses to trace the extent of the body and to ascertain its dip (and perhaps pitch), are strongly recommended.

Contrary to the earlier evaluation of the data, it appears that the method worked well at this site, and therefore should be completed.

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INTRODUCTION

On portions of 5th to 8th December, 1977 during the course of a down hole logging programme, these tests were carried out by Mr. R. Bennett of Scintrex Pty. Ltd. The author visited the site during the test period.

The objective of this report is to discuss the methods used and the nature of the results, and to comment on the form of the data observed and possible structural meaning thereof.

The down hole 'at hole' three-array log of RH-5 is discussed on pages 14 to 16 of Report TAS-054E dated July, 1978, while the three-array down hole logging method is discussed on pages 3 to 6 of that report.

APPLIED POTENTIAL METHOD

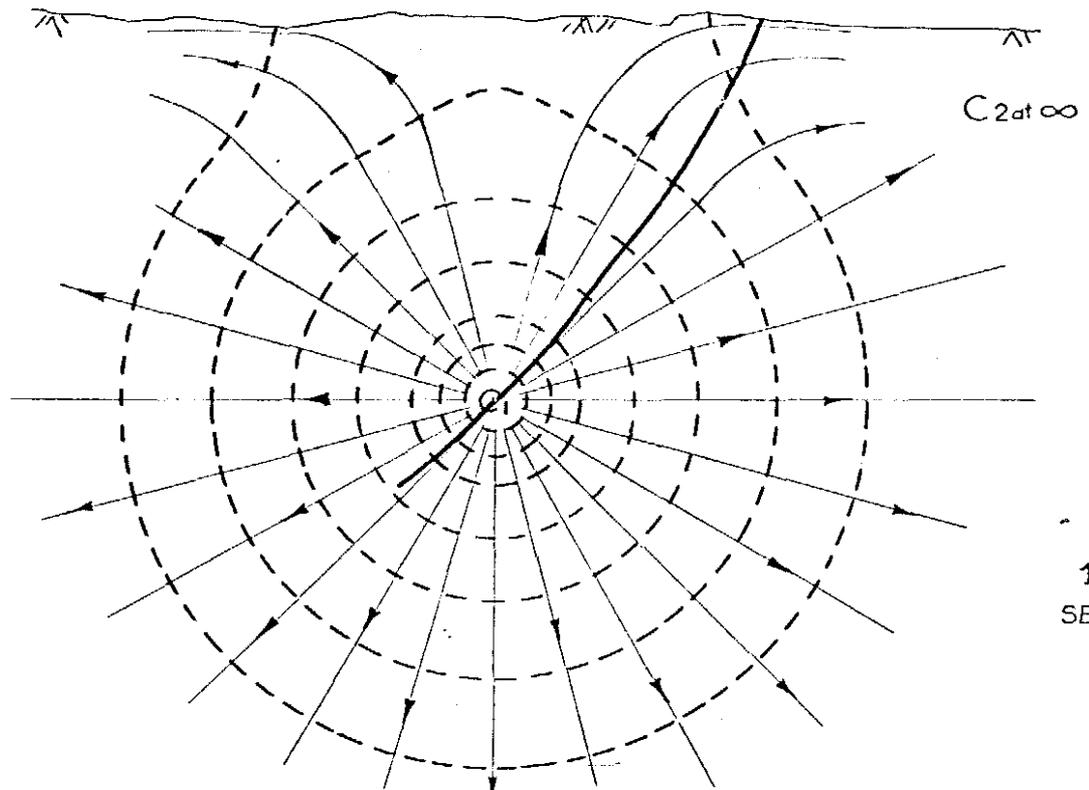
For a single electrode emplaced within resistive rock, the current moves to infinity as shown in Figure 1A. In section, the equipotentials will form a series of equipotential surfaces, essentially spheres, concentric with the emplaced electrode

004

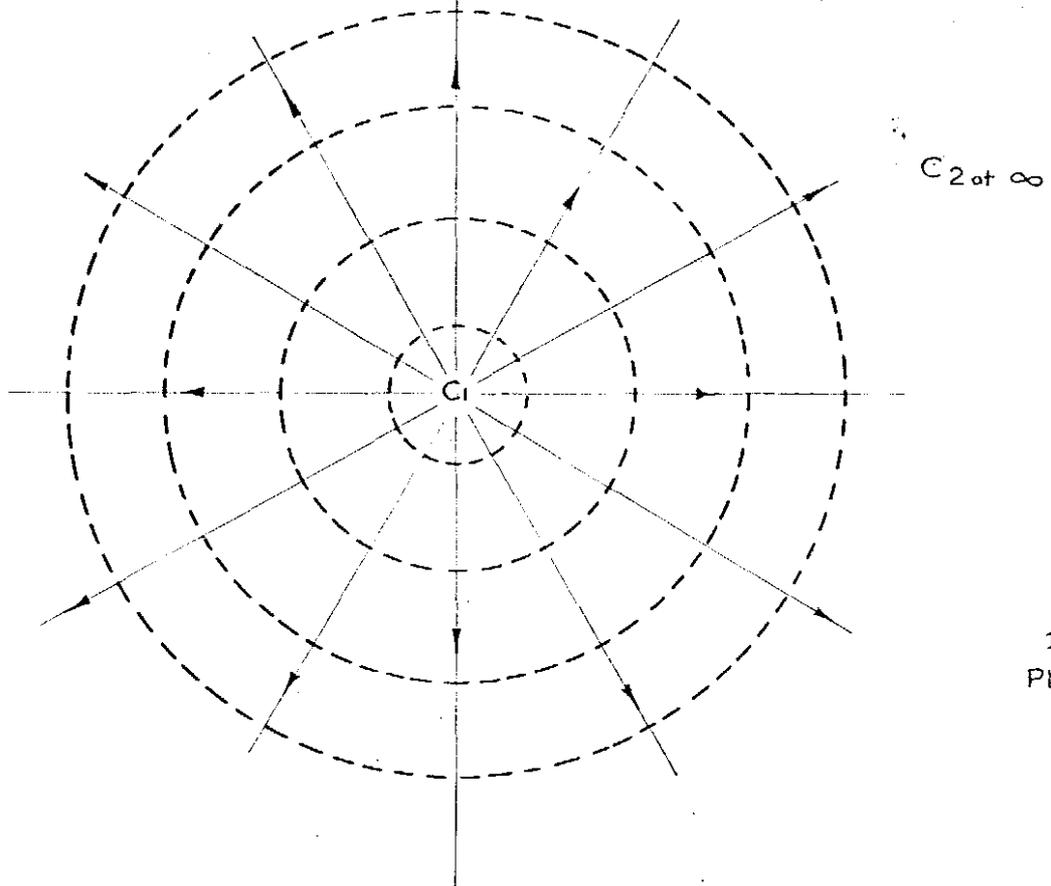
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Current Electrodes Emplaced in a Drill Hole

SCINTREX - homogeneous medium -



1a.
SECTION



1b.
PLAN

Fig 1.

providing the resistivity of the medium is homogeneous. Figure 1B shows a plan of the equipotential in the same situation. On the surface they will form a series of equipotentials concentric about the surface projection of the emplaced electrode.

In the applied potential method the body is made to act as an electrode by an energising current electrode emplaced within the body. For this method to work the body must be significantly less resistive than the enclosing medium. When current is introduced into the body it will give the *whole body* an *equal potential*, and the current will then flow to infinity as shown in Figure 2. It will be noted that the equipotential surfaces will *wrap themselves around the body* as the current will leave the body at right angles. Providing there is a significant contrast between the body and the enclosing rocks, the equipotential gradient will be steeper on the up-dip side of the body. The steepness of the potential field will show the depth. Therefore it should be possible to ascertain the following information from an applied potential survey (providing always that the current is at infinity).

1. Depth to the top of the source
2. Strike length
3. Dip of source
4. The pitch of the source.

One of the procedural problems is that for a conductor of significant strike length (and depth extent) a single electrode cannot be put at

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Current Electrode Emplaced in a Drill Hole

SCINTREX - within a conductor -

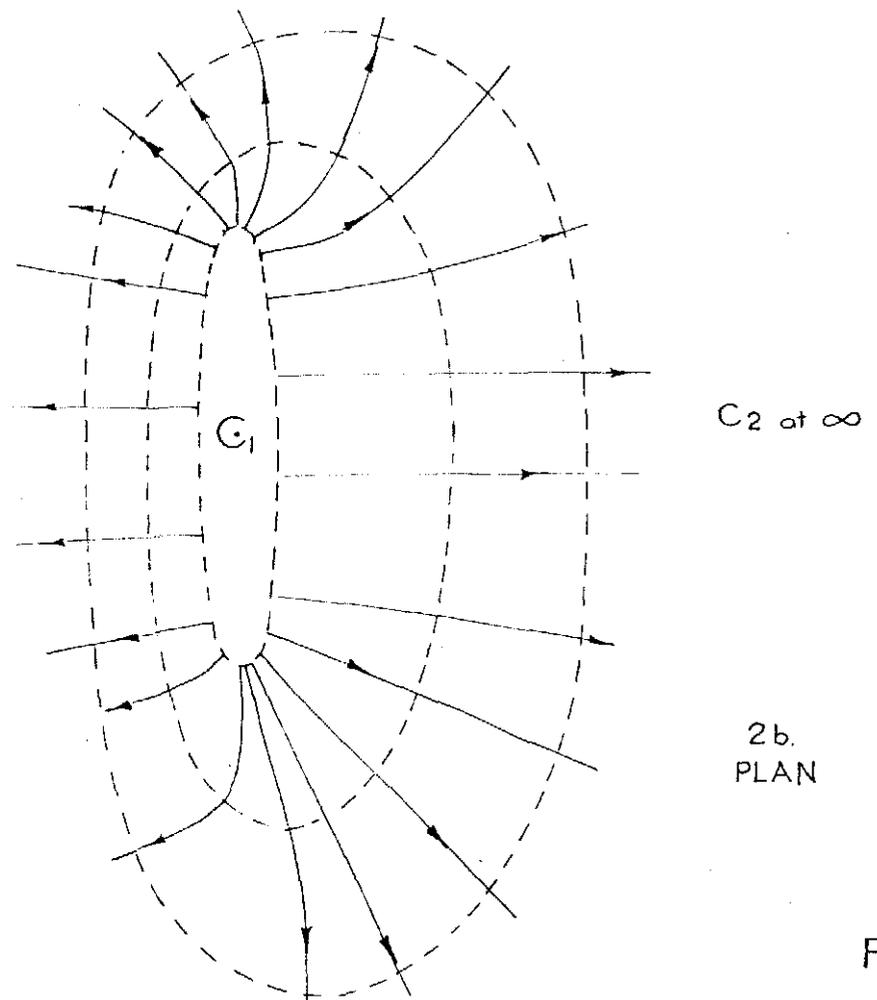
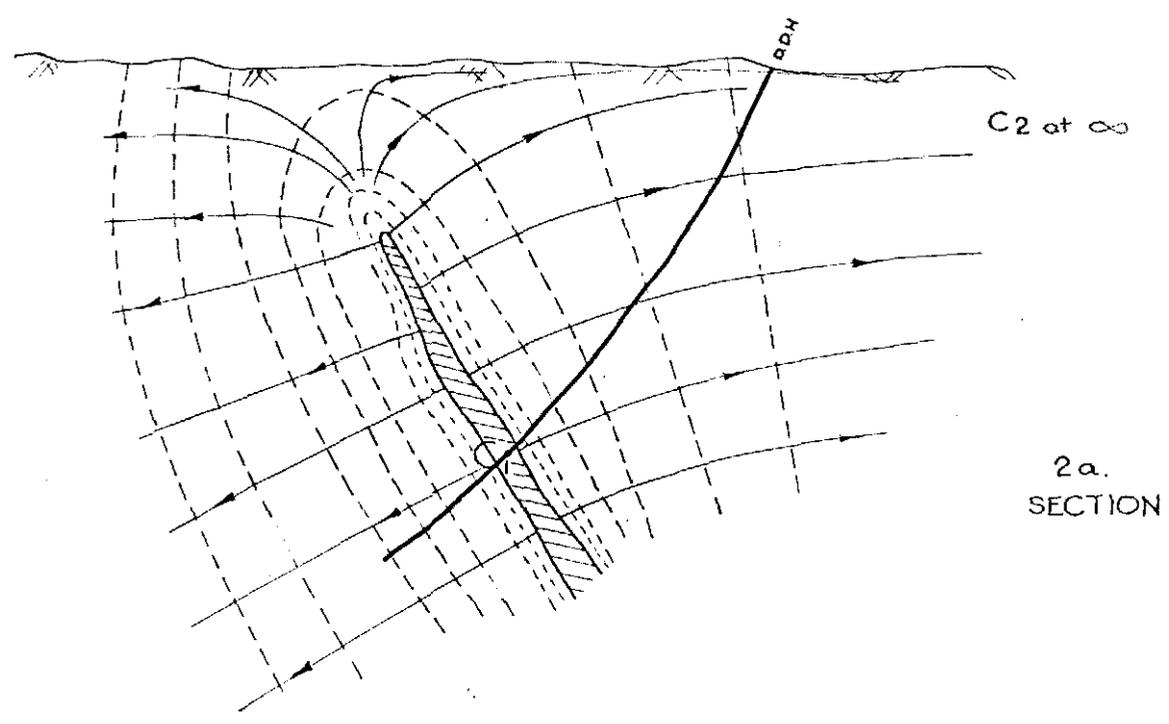


Fig 2.

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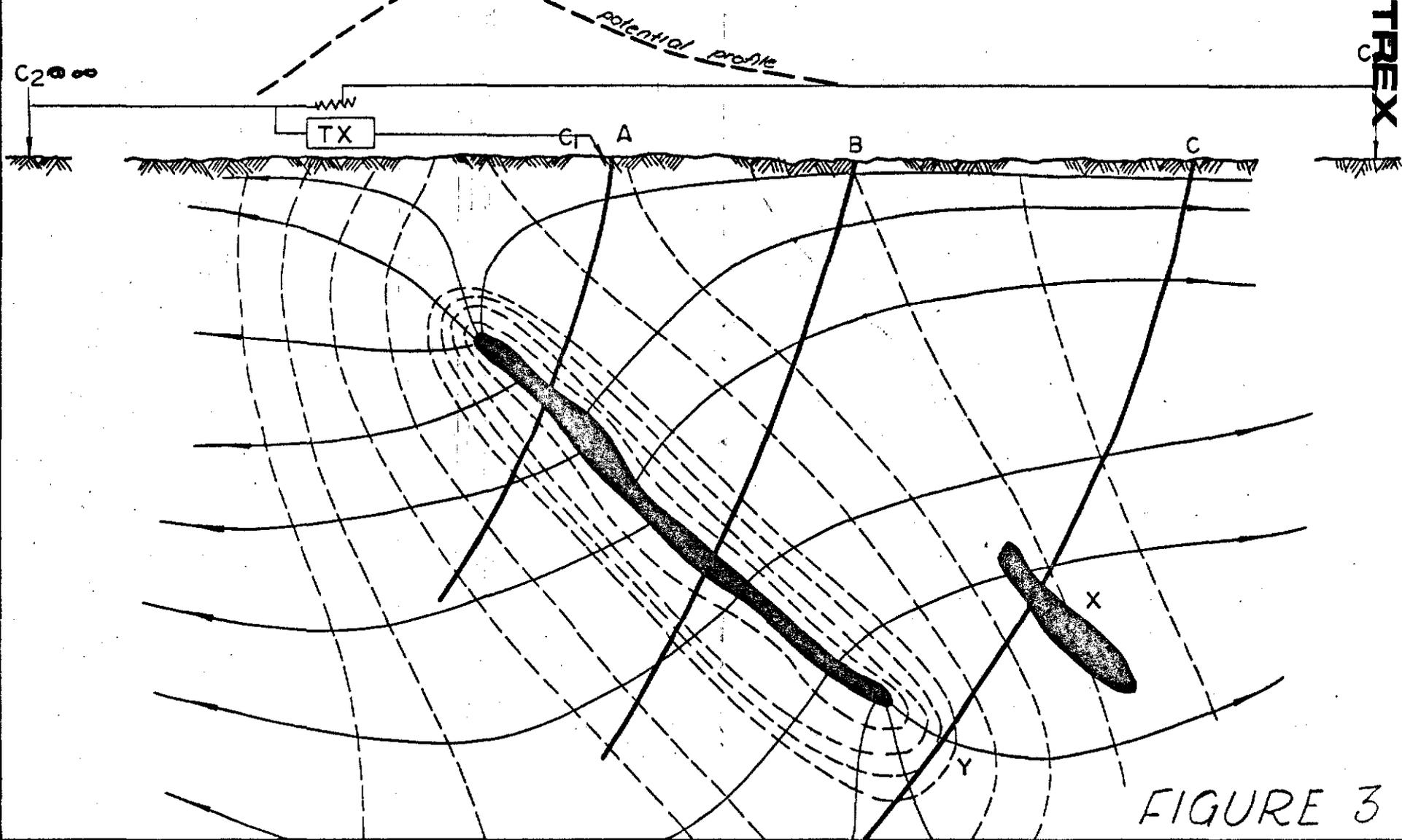
infinity because it cannot be positioned far enough away from the body. One method of overcoming this problem is to emplace *one* electrode (C_1) *within* the body and *two* electrodes (C_2 and C_2') of *opposite pole* across strike as shown in Figure 3. The current flowing through each is equalised, so that the nett effect is to "pull out" the current from the body as if the two "distant" electrodes are in fact at infinity. In this way the steepness of the equipotential gradients can be meaningfully interpreted to yield dip information.

In Figure 3 the salient points to note are (a) the body energised via C_1 emplaced in DDH-A will produce a severe potential gradient when logged down hole 'B' drilled down dip, which should unambiguously show that this hole intersected the same conductor in holes 'A' and 'B'. (This would also be true *along strike* as well as down dip). In DDH-C a change in gradient at 'Y' would indicate the close proximity of the conductor, but the absolute equipotential level indicated would show that the body had been missed. In practice a three-array log at 2 or 3 spacings would then be run to ascertain the distance of the source from the hole.

Down hole 'C', a potential log would show that the sulphide body 'X' was not in electrical continuity with the energised body, and therefore not part of it. In practice this body would be energised and the resultant surface and down-hole (hole 'C') equipotential contour plans would show the extent of the body 'X'.

The shape of the potential field on the surface is ascertained by

EQUIPOTENTIAL DIAGRAM APPLIED POTENTIAL ARRAY



SCINTREX

FIGURE 3

holding a single potential stationary and moving a second over the surface (or down hole) to map the potential field. The resultant potential readings are then contoured. The shape of the contour plan will reflect the shape of the *conductive* source, the position of the distant electrodes C_2 and C_2' if close to the emplaced current electrode C_1 , and also the position of the stationary potential pot P_1 . Diagram 4 will illustrate this last point

a) shows the geological section while b) shows the Vp readings observed, which show a high over the body and also as the electrodes C_1 and $C_2 - C_2'$ are approached.

It is important to realise that the reference pot will be the zero equipotential contour *wherever* it is placed in the field, and the resultant 'low' will not represent a physical property. This is because when the moving potential electrode passes to the one side of the zero contour, the current will move in one sense, and when on the other, it will be in the opposite sense. Diagram 4C is a reconstruction of a profile form when the *sense* of the current flow with respect to the reference pot is taken into account.

For a pipe-like body, multiple balanced infinites can be used which can again allow the dips and plunge of the pipe to be traced.

Figure 5 diagrammatically shows some typical equipotential patterns over bodies energised in the manner outlined above.

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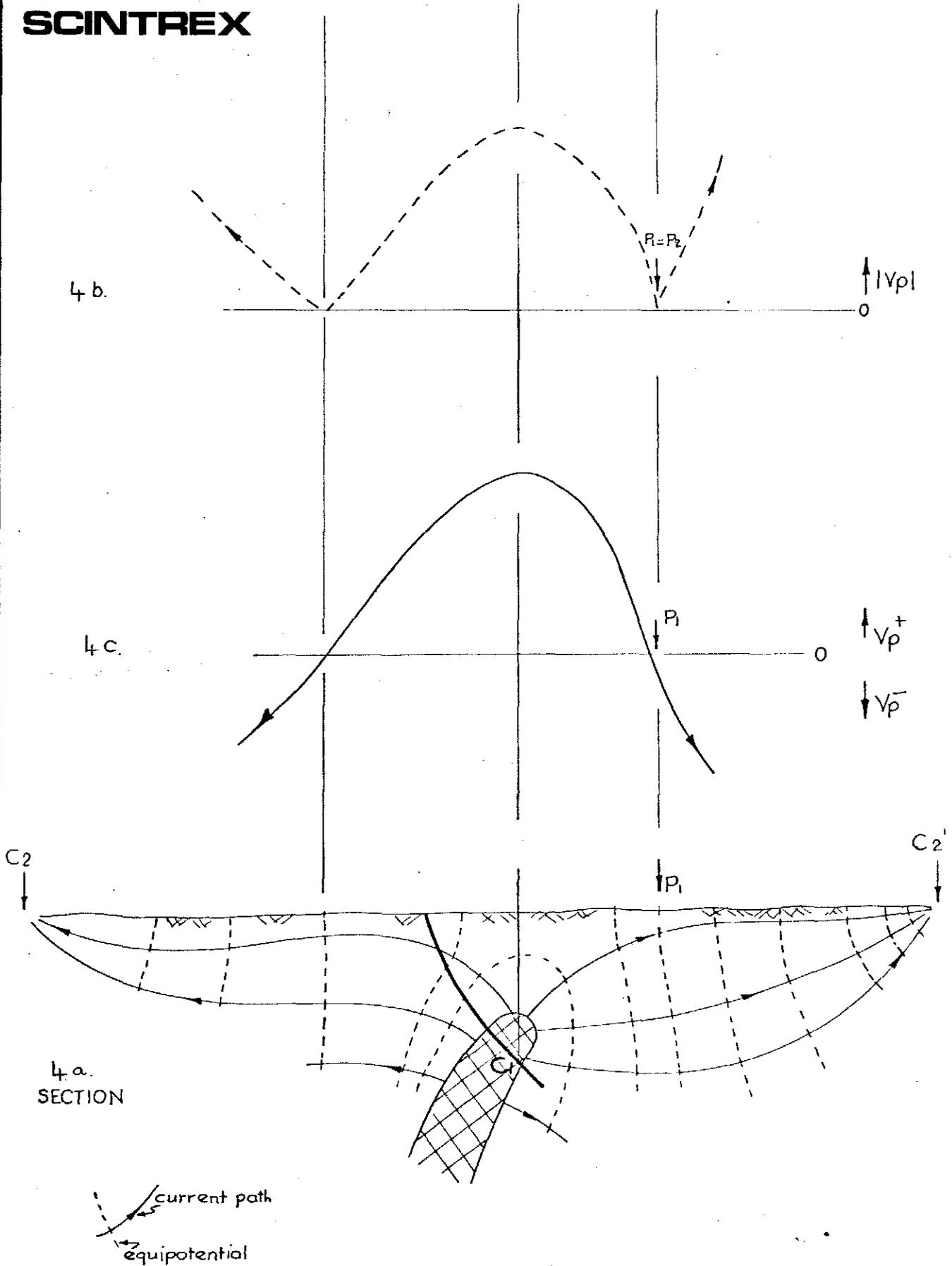
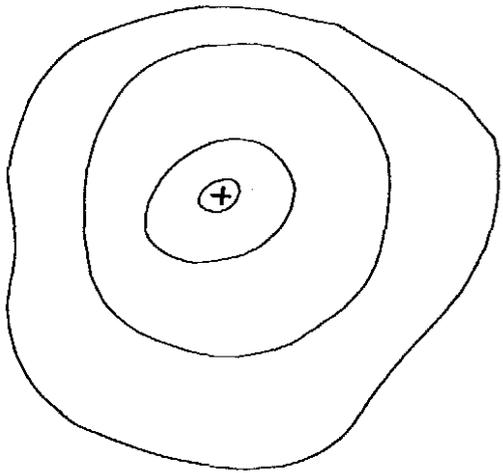


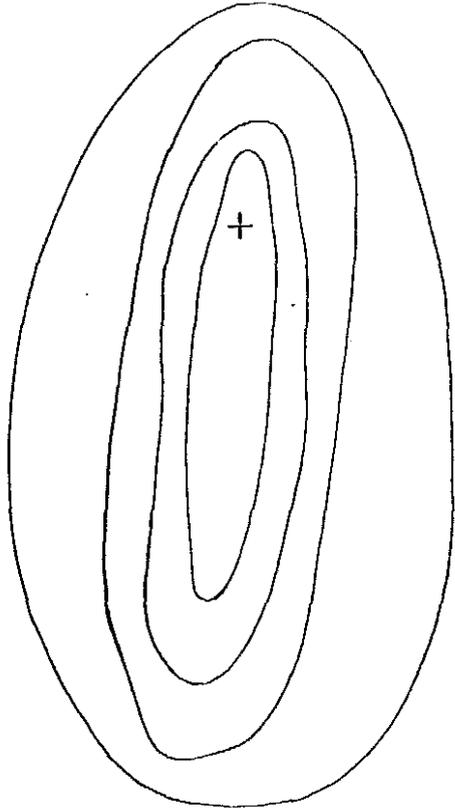
Fig 4

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Typical Applied Potential Patterns

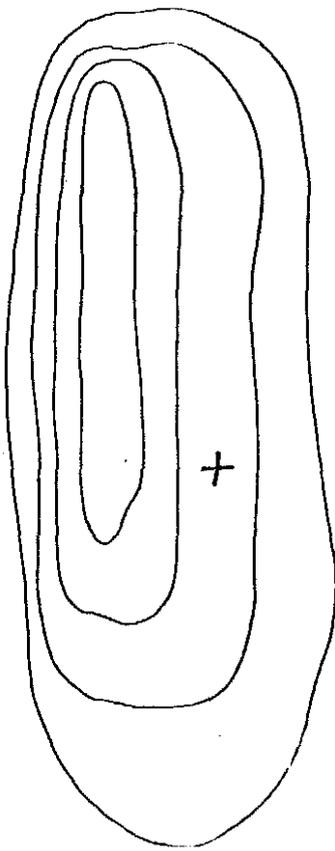


INTERSECTION OF LIMITED EXTENT

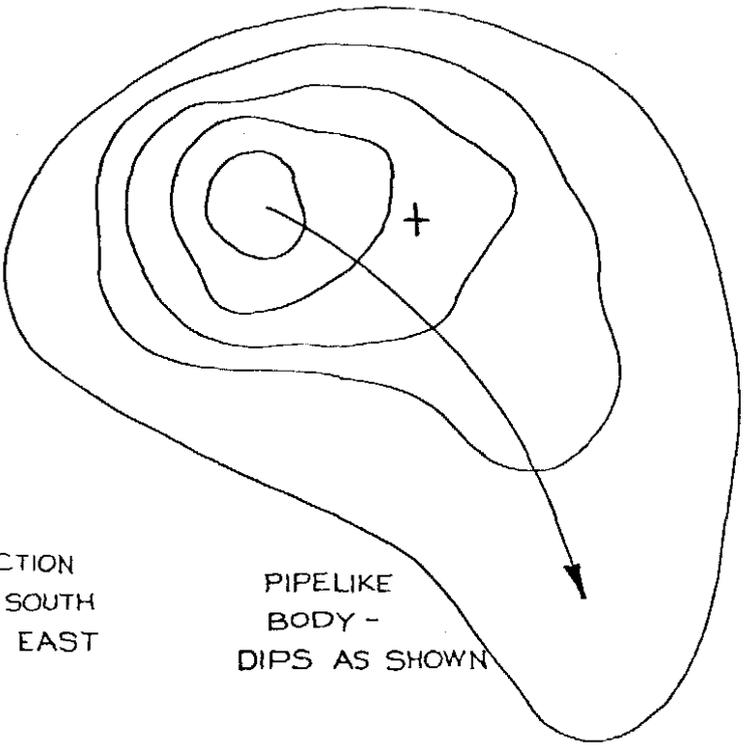


INTERSECTION ELONGATE STEEPLY DIPPING

+ Vertical projection of C_1



INTERSECTION PITCHES SOUTH STRIKES EAST DIPS



PIPELIKE BODY - DIPS AS SHOWN

DISCUSSION OF RESULTS

For completeness, the drill hole electrical log of DDH-5 from Red Hills is re-presented from report TAS-054E. This shows the intersection (P) at 197 metres to be about 30 ohm-metres as against the enclosing rocks of 5000 \pm 1000 ohm-metres. It also shows the shales (N) to have resistivities of the same order as the mineralisation.

Firstly a current electrode (C_1) was emplaced in the 195 metre intersection and short balanced electrodes C_2 and C_2' were placed to the east and west of the collar of the drill hole. The resultant equipotential profile obtained is presented on Plate 1.

The stationary potential electrode was placed about 100 metres grid north for the purpose of this exercise. As the electrodes C_2 and C_2' were too close to the ends of the surveyed line, they were extended out to 150W and 400E so that their proximity would not materially influence the observed gradients. This data is profiled on Plate 2

On these two plates (2 and 3), the modulus of the Vp ($|V_p|$) is plotted in the solid lines, and the dashed lines represent the field readings adjusted for the position of the stationary potential electrode (See Figure 4).

The data shows a most significant anomaly over the emplaced electrode C_1 . The Vp shows a steeper gradient on the eastern flank than the

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western flank, indicating a dip to the west. However, the upper section shows the reverse, i.e. a steeper gradient in the west. This *may* infer a vertical or steep dip east in the upper section, but an overall west dip to the causative source on this line. The depth to source is difficult to assess but appears to be between 60 metres and 100 metres.

The data from line 40N is shown on Plate 3. The potential field shows a very similar picture on this line to that seen on line 00, thus the zone is inferred to strike in that direction and has almost identical electrical properties beneath about 140E +10 metres on that line. The form of the profile suggests the same dip to the source as for line 00.

Plate 4 is a contour representation of the data. Only between the two lines is the contour data real. The heavy dashed line represents the zero contour which passes through the stationary potential electrode p_1 . This clearly infers an extension of the low resistivity zone in that direction for if that were not so, the equipotential pattern would be a series of circular traces with the projected surface position of C_1 being the centre thereof. This contour plan should be compared with Figure 4.

The data clearly demonstrates the very real possibility that the mineralised zone extends to the north and to the south. It is difficult to be positive from just two lines, but it is inferred to be of greater importance to the south.

CONCLUSIONS

- 1 - The mineralised zone encountered in DDH-5 at about 195 metres is not of limited extent and extends at least 40 metres to the north, and perhaps at least as far as 140N judging from the zero potential on lines 00, 40N and P₁. The strike *may?* be slightly grid west of north, north of 40N. (See Plate 4)
- 2 - The form of the profile on lines 00 and 40N suggests a west dip overall, and perhaps (?) a vertical to steep east dip closer to the surface.
- 3 - The maximum depth to source appears to be between 60 metres and 100 metres.
- 4 - Contrary to earlier considerations, it appears that the applied potential survey from DDH-5 will allow the mineralisation, or at least the low resistivity zone associated with it, to be traced north and south of the intersection. Also it looks likely that the dip and pitch can be qualitatively assessed.
- 5 - Contrary to earlier assessment, it appears that the conductive carbonaceous shales have not influenced the data. This is due to the confirmation of the position of the stationary potential electrode.

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RECOMMENDATIONS

- 1 - It is recommended that the survey should be completed to fully delineate the resistivity low associated with the applied potential anomaly located on lines 00 and 40N (*collar of DDH-5 being the origin.*)
- 2 - In order to accomplish this, the following grid should be established:
- a) Survey lines across strike, no closer than 50 metres, for at least 400 metres north and south of the drill hole.
 - b) Across strike to 100 metres west and 250 metres east of the drill hole.
 - c) Pegs at 20 metre intervals with readings at 10 metre intervals.
 - d) The westerly electrode C_2 , of the 'infinite pair' C_2 and C_2' should be placed at about 300 metres west of the drill hole collar and the eastern electrode 500 to 600 metres east of the drill hole collar. This is so the zone can be traced much further north and south without distortion. Note that the distant electrodes do not have to be accurately placed, but must be 'distant'
 - e) The original lines should be re-surveyed.

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- 3 - Contour maps of the equipotential lines should be drawn up on site to ensure that the anomaly has been closed off.
- 4 - All diamond drill holes within the survey area and along strike of it, should be logged with a single potential P_2 , using the same standard potential P_1 . The resultant data should be contoured together with the surface data points to produce equipotential contour sections. These, together with the surface contours will allow a sophisticated three-dimensional interpretation

MAGNETOMETRIC RESISTIVITY METHOD

With this method the electrode C_1 is again emplaced in the drill hole section as for the applied potential method, however the second electrode C_2 is placed *along strike of* the intersection - first up strike, and then subsequently down strike. Figure 6 diagrammatically illustrates this procedure. Figure 6A shows a longitudinal section, and Figure 6B the plan along a mineralised zone. The current electrode C_1 emplaced in the less resistive body ensures that a large proportion of the current is concentrated within it, while C_2 placed along strike ensures that the current is pulled out up strike. As soon as the current leaves the relatively conductive mineralisation, it spreads out into the enclosing rocks as shown in 6B. When a horizontal component fluxgate magnetometer is moved along the section Y, Y' in 6C, it senses directly the current distribution below, and can thus clearly determine the current concentrations within the body as

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Magnetometric Resistivity Survey SCINTREX-energization down-hole -

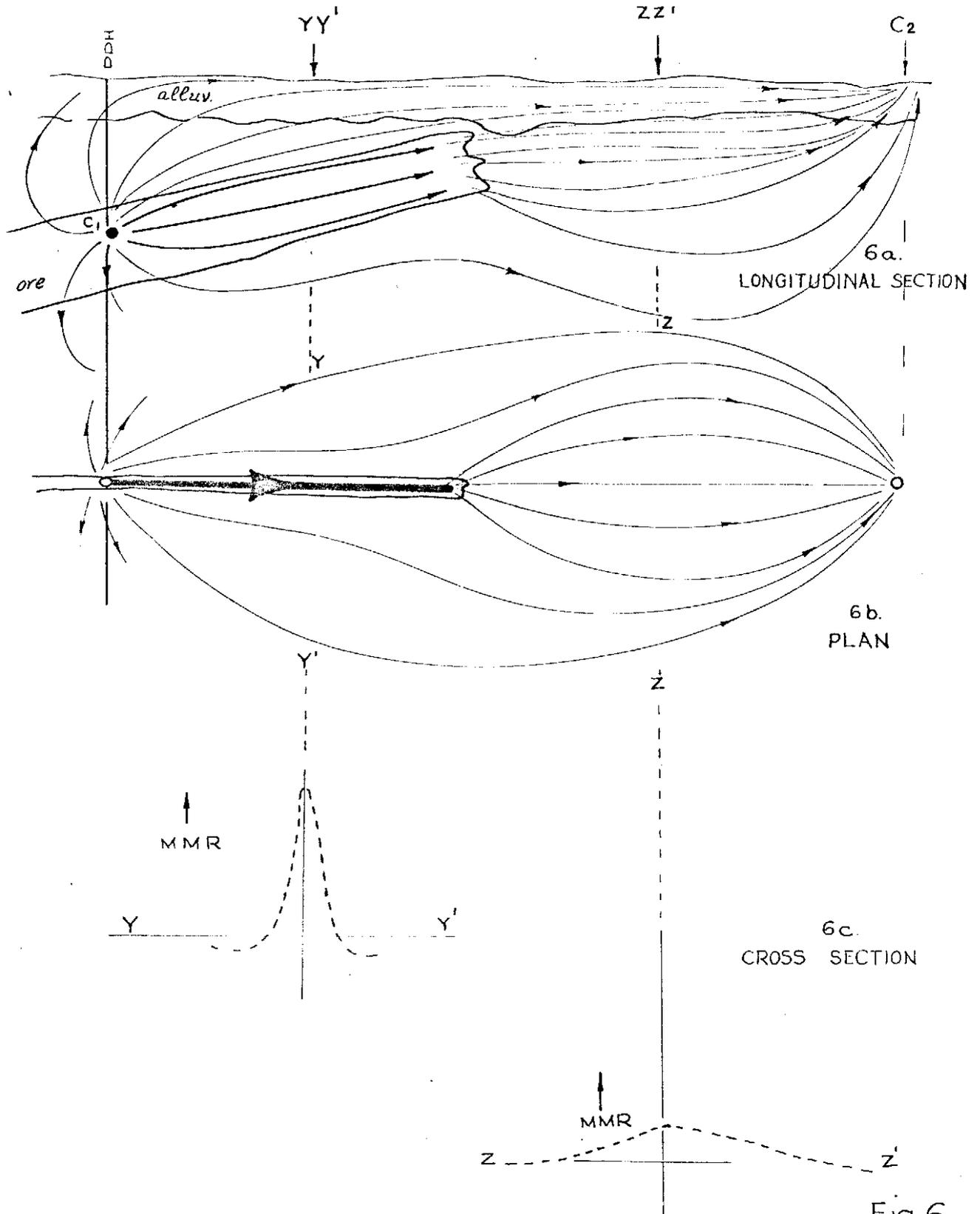


Fig 6

shown in that section. When the current becomes more distributed within the rocks after leaving the mineralised zone, only a slight maximum will be observed as shown in section Z,Z'. It is difficult to obtain meaningful results within a distance along strike from the drill hole equal to the depth of the energised zone beneath the surface, due to the current not flowing horizontally. (Under the energised intersection it will flow *vertically* towards the surface before turning towards the horizontal - see 6A).

The magnetometric resistivity is calculated from the actual horizontal magnetic field recorded, normalised by the position of the electrodes.

This method, as it deals within the horizontal magnetic field due to movement of concentrations of electrons, is much more sensitive than the conventional applied potential method. For a lenticular body the fall-off in signal will be less than $1/d$ where 'd' is the depth to the energised source.

DISCUSSION OF RESULTS

The mineralised section at about 195 metres in DDH RH-5 was energised via C₁ placed within the zone, while C₂ was placed about 250 metres north. The resultant magnetometric resistivity (MMR) data profiles for lines 20N and 40N are displayed on Plates 5 and 6 respectively.

MMR values of zero denote the resistivity from a homogeneous medium OR a

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horizontally stratified medium. Positive values are relatively conductive, while negative values are relatively resistive.

On line 20N a distinct maximum of +115% of normal was defined at 130E and probably marks the near surface traces of the energised section. On line 40N this zone occurs at about 145E.

A second maximum noted at 080E on line 20N may (?) represent a shale horizon.

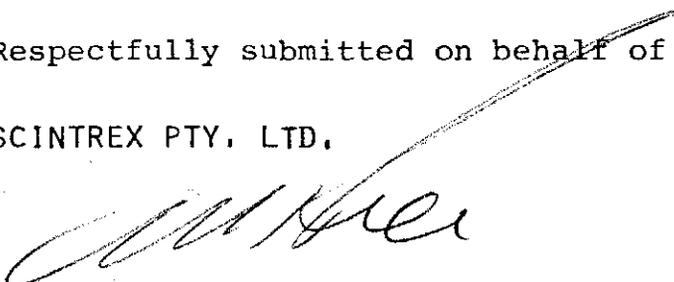
CONCLUSIONS AND RECOMMENDATIONS

As both the above lines were surveyed close to the origin line, the data is subject to geometric distortion and thus cannot be used to make any diagnostic interpretation.

However, it is recommended that lines 50 metres north and south (plus) should be so surveyed as the resolution should be superior for MMR than for applied potential.

Respectfully submitted on behalf of:

SCINTREX PTY. LTD.



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

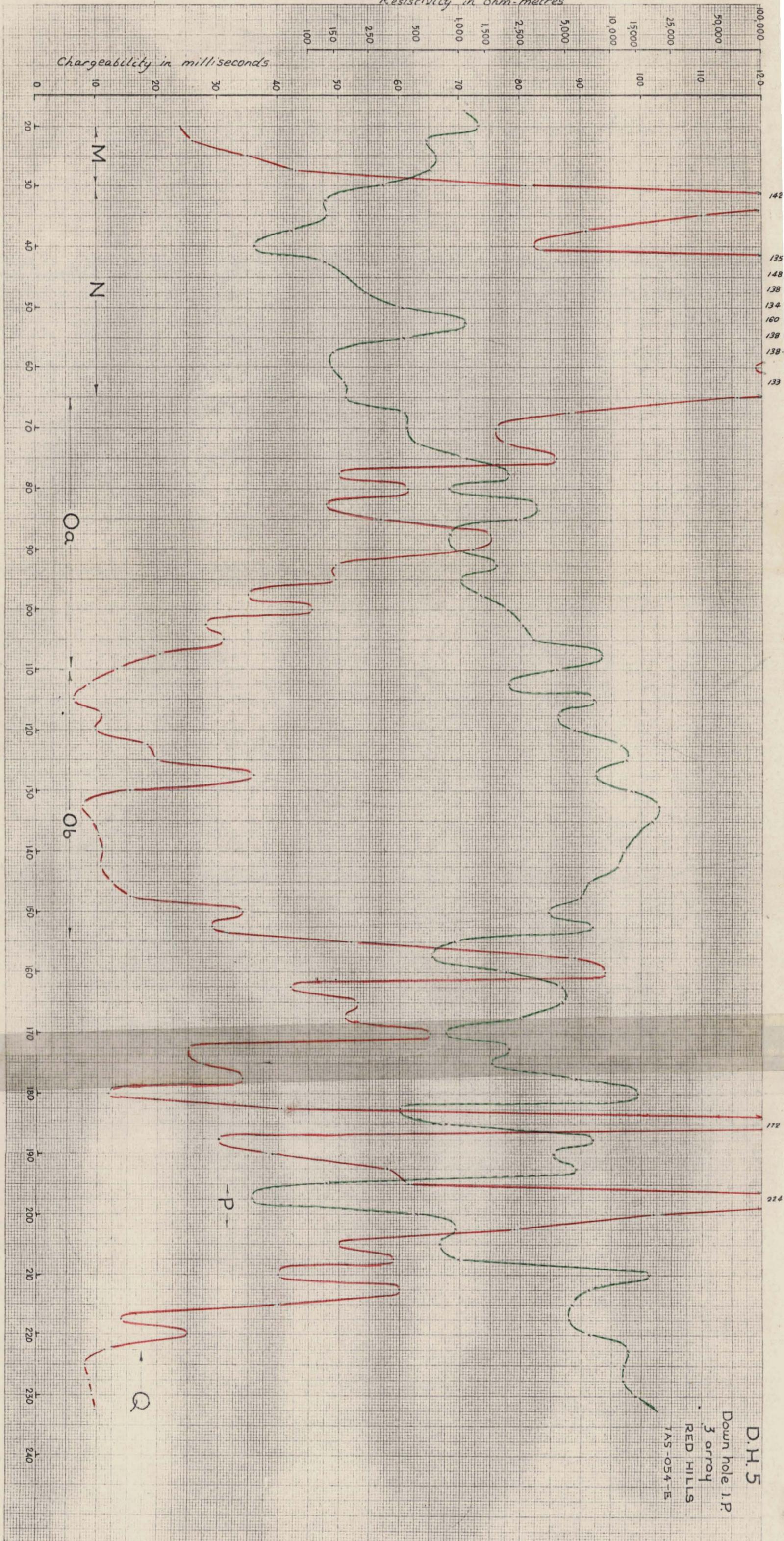
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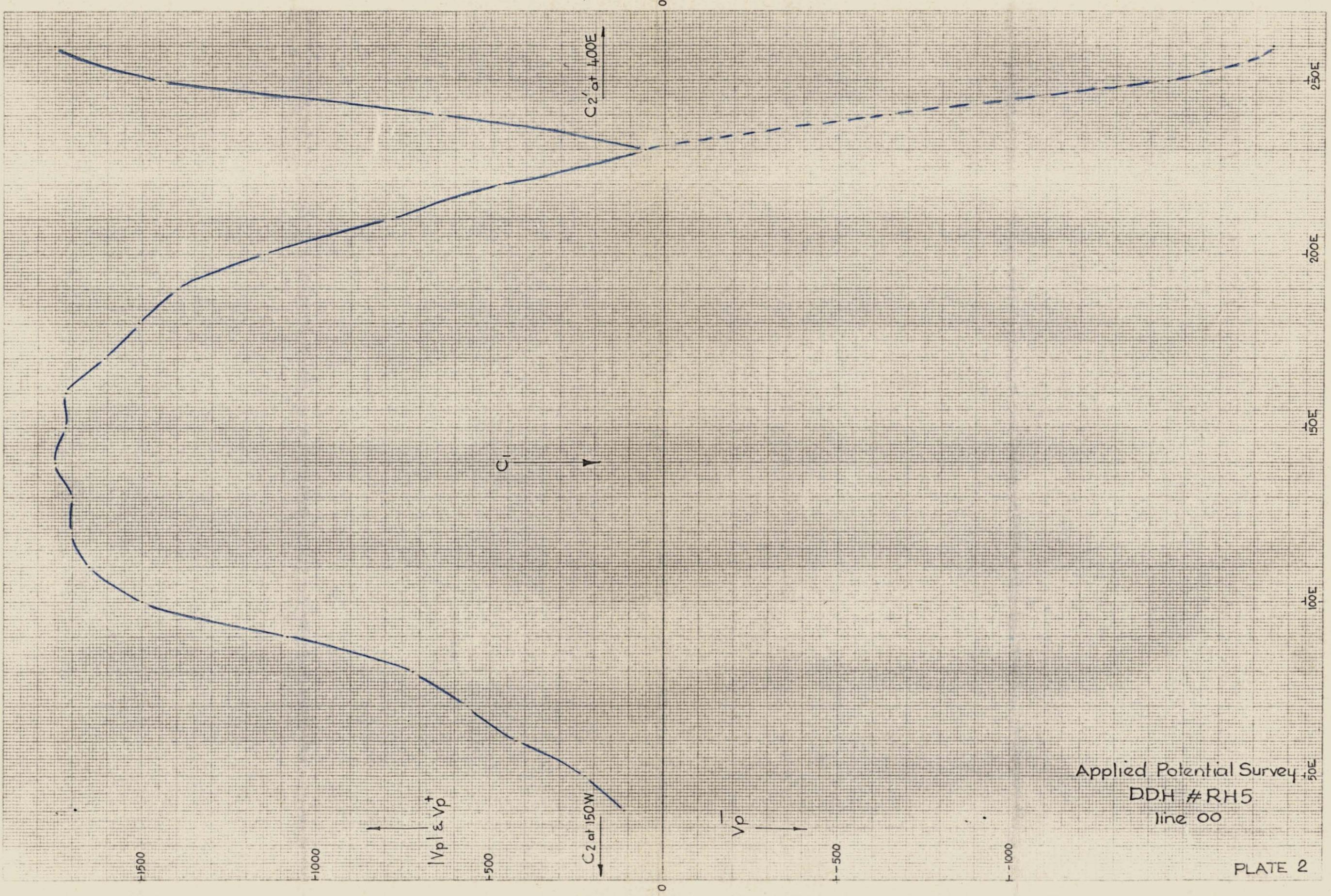
Resistivity in ohm-metres

Chargeability in milliseconds

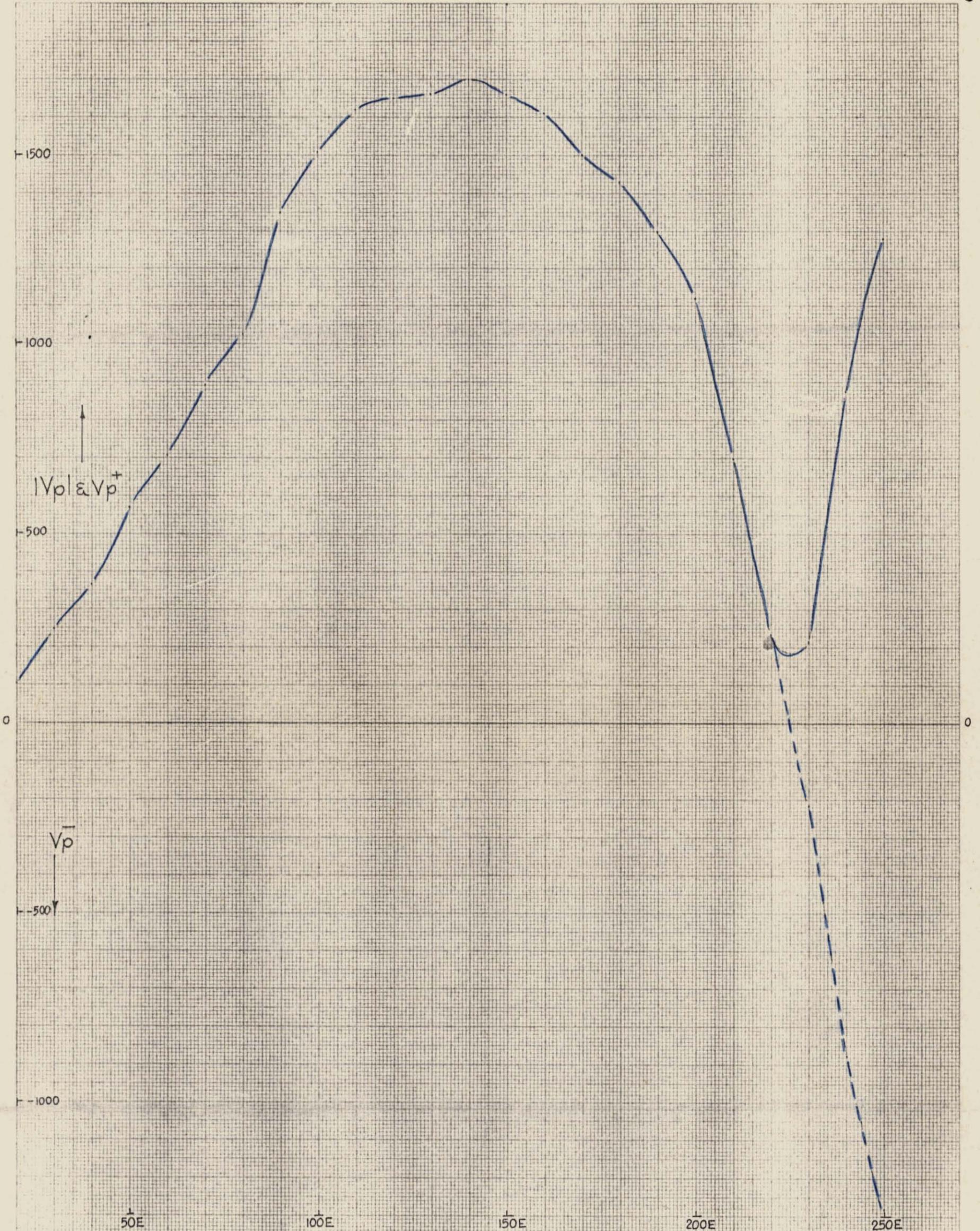


D.H.5
 Down hole I.P.
 3 array
 RED HILLS
 TAS-054-1E

RESISTIVITY
 MADE IN U.S.A.
 10 X 10 TO THE CENTIMETER 47 1217



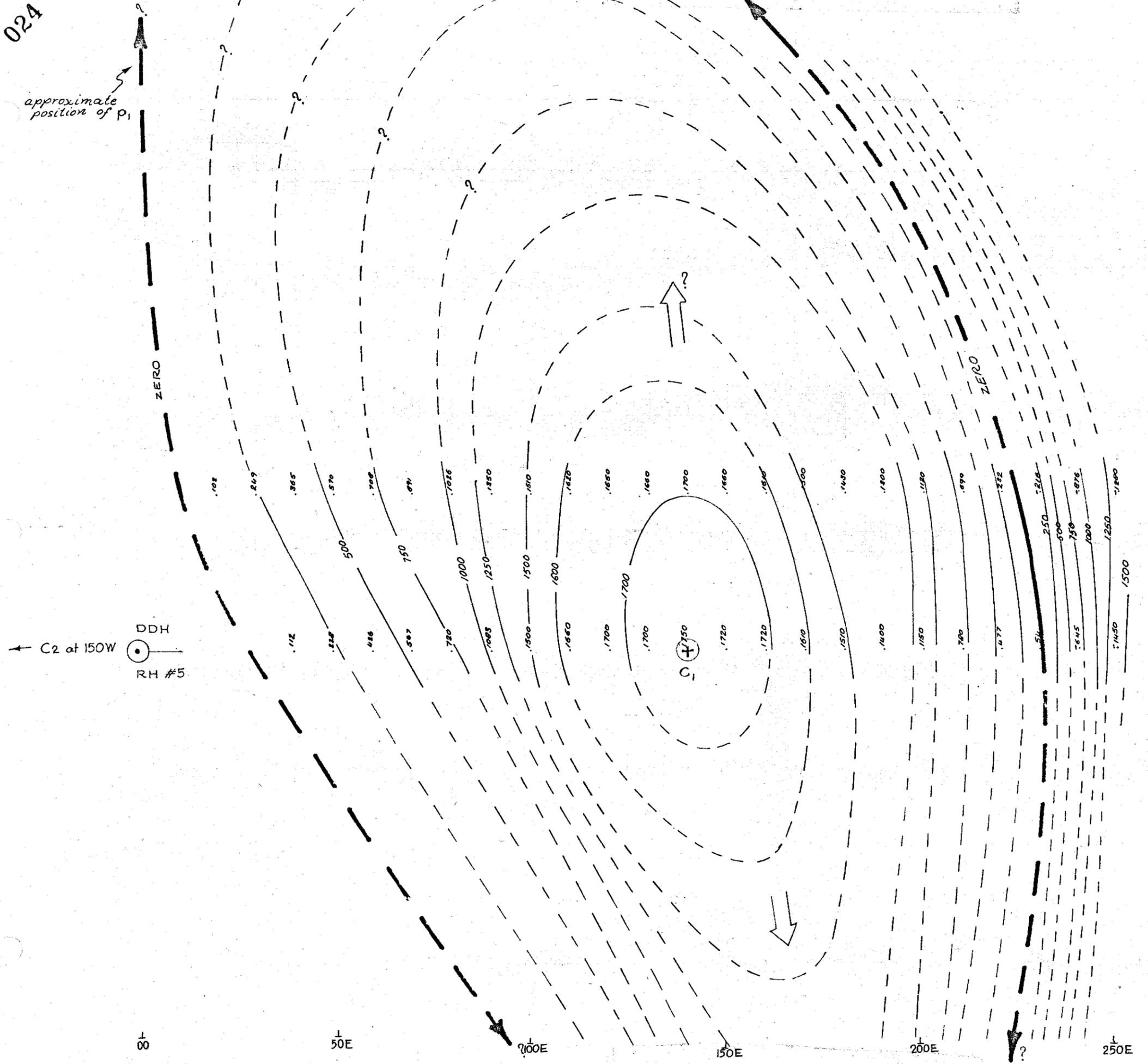
Applied Potential Survey
 DDH #RH5
 line 00



Applied Potential Survey
 DDH # RH5
 line 40N
 PLATE 3.

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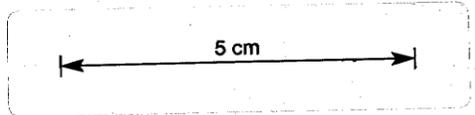


Legend

-  ZERO (P₁) equipotential
-  250 mv equipotentials
-  vertical projection of current electrode C₁

10 N

00 C₂ at 4.00E →



1 : 1000
Surface Equipotential Contours

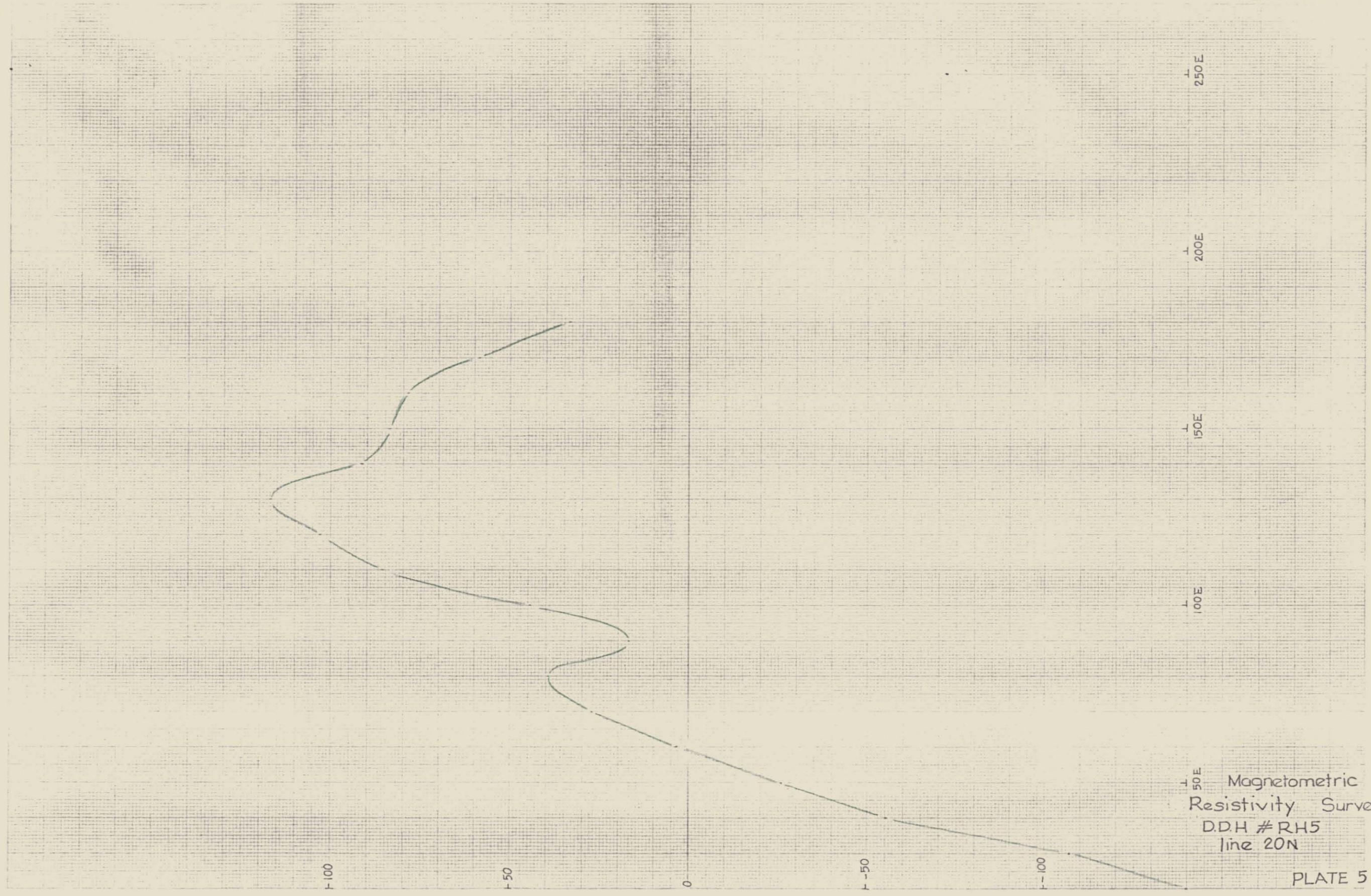
D.D.H # RH5

PLATE 4

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NO. 10 X 10 TO THE CENTIMETERS X 20 CM

VA 121A

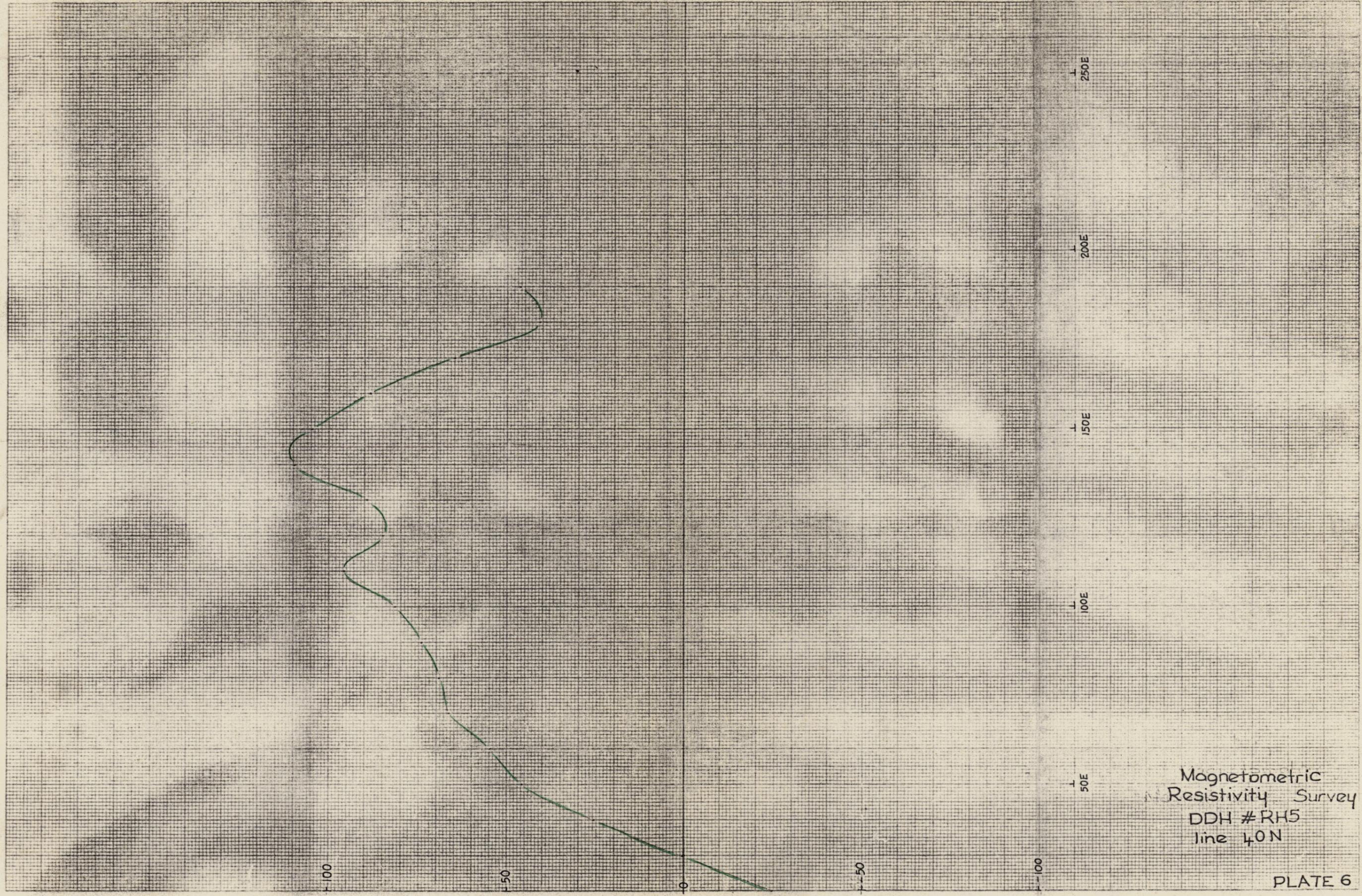


50E Magnetometric
 Resistivity Survey
 D.D.H #RH5
 line 20N

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K.E. KEULY & EGGERS CO. MADE IN U.S.A.
10 X 10 TO THE CENTIMETERS 2 1/2 X 2 1/2 CM

41 121 A



Magnetometric
Resistivity Survey
DDH #RH5
line 40N