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VERY LOW FREQUENCY ELECTROMAGNETIC SURVEY

DUNDAS AREA (E.L. 7/68)

~~NORTH~~WESTERN TASMANIA

Prepared By

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for

TEXINS DEVELOPMENT PTY. LTD.

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TABLE OF CONTENTSVOL I

	<u>Page No.</u>
ABSTRACT	-
I INTRODUCTION	1
II PRINCIPLES OF OPERATION	3
III DATA COLLECTION	9
IV DATA REDUCTION AND INTERPRETATION	11
(A) DEPTH	14
(B) REPEATABILITY	18
V RESULTS OF DUNDAS SURVEY	19
(A) NORTH COMET GRID	20
(B) NORTH COMET WEST GRID	21
(1) Other Geophysical Results in North Comet West Grid	23
(C) RAZORBACK GRID	23
(D) HASSET-GRAVEL PIT GRIDS	24
(1) Other Geophysical Results in Hasset-Gravel Pit Grids	26
(E) PLATT GRID	27
(1) Other Geophysical Results in Platt Grid	29
(F) RED LEAD AND BONANZA GRIDS	29
(1) Other Geophysical Results in Red Lead - Bonanza Grids	34
(G) COMET - KOSMINSKY GRIDS	34
(H) SOUTH COMET GRIDS	39
(1) Other Geophysical Results in Comet - Kosminsky and South Comet Grids	42
(I) AINSLIE GRID	42
(J) EAST SOUTH COMET GRID	46
(K) WEST COMET GRID	47
(L) BROKEN HILL GRID	48

TABLE OF CONTENTS Cont.

(M)	SUMMARY OF MAIN V.L.F. ANOMALIES	49
	(1) North Comet Grid	49
	(2) Hasset-Gravel pit Grids	49
	(3) Platt Grid	49
	(4) Red Lead Grid	49
	(5) Bonanza Grid	50
	(6) Comet - Kosminsky Grids	50
	(7) South Comet Grid	50
	(8) Ainslie Grid	51
VI	CONCLUSIONS	52
VII	SELECTED BIBLIOGRAPHY	53

APPENDIX A

The Polarization Ellipse

APPENDIX B

Field Inspection of V.L.F. Anomalies

VOL II

ENCLOSURES

- 1 Sheet - Central Dundas Area, Gridding, Geology, (1/273)
and V.L.F. Anomalies,
Scale: one inch = 500 feet
- 12 Sheets - First Derivative Contour Maps, (1/270 - 1/281)
Scale: one inch = 100 feet
- 6 Sheets - V.L.F. Profiles,
Scale: one inch = 200 feet (1/284)

VOL III

Geophoto minerals report 1971/20
Very low frequency electromagnetic, magnetic + radiometer survey
SPL 95 West Tasmania - Heemskirk.

ABSTRACT.

A VLF-EM survey using Ronka EM-16 equipment was made over approximately 250,000 linear feet of gridded area in the Dundas region of E.L. 7/68 near Zeehan, Tasmania during February, March and April, 1971. The survey was made along East-West grid lines and readings were taken at 50 foot intervals. Grid line spacing was 200 feet.

A brief description of the theory and operational details of the method is presented. In general, the method is ideal for the geological and other conditions found in the Dundas region. The repeatability of readings was verified by resurveying selected lines under different weather conditions.

The results are presented as a series of 11 first derivative contour maps at scale one inch = 100 feet, and as a series of in-phase and quadrature vertical secondary field profiles at scale one inch = 200 feet on 6 sheets. Each anomaly is analysed for conductivity, depth, and probable nature of overburden, and the 61 most promising anomalies are tabulated. Recommendations for further work are made.

An appendix to the report describes the results of a field inspection of the more attractive V.L.F. anomalies.

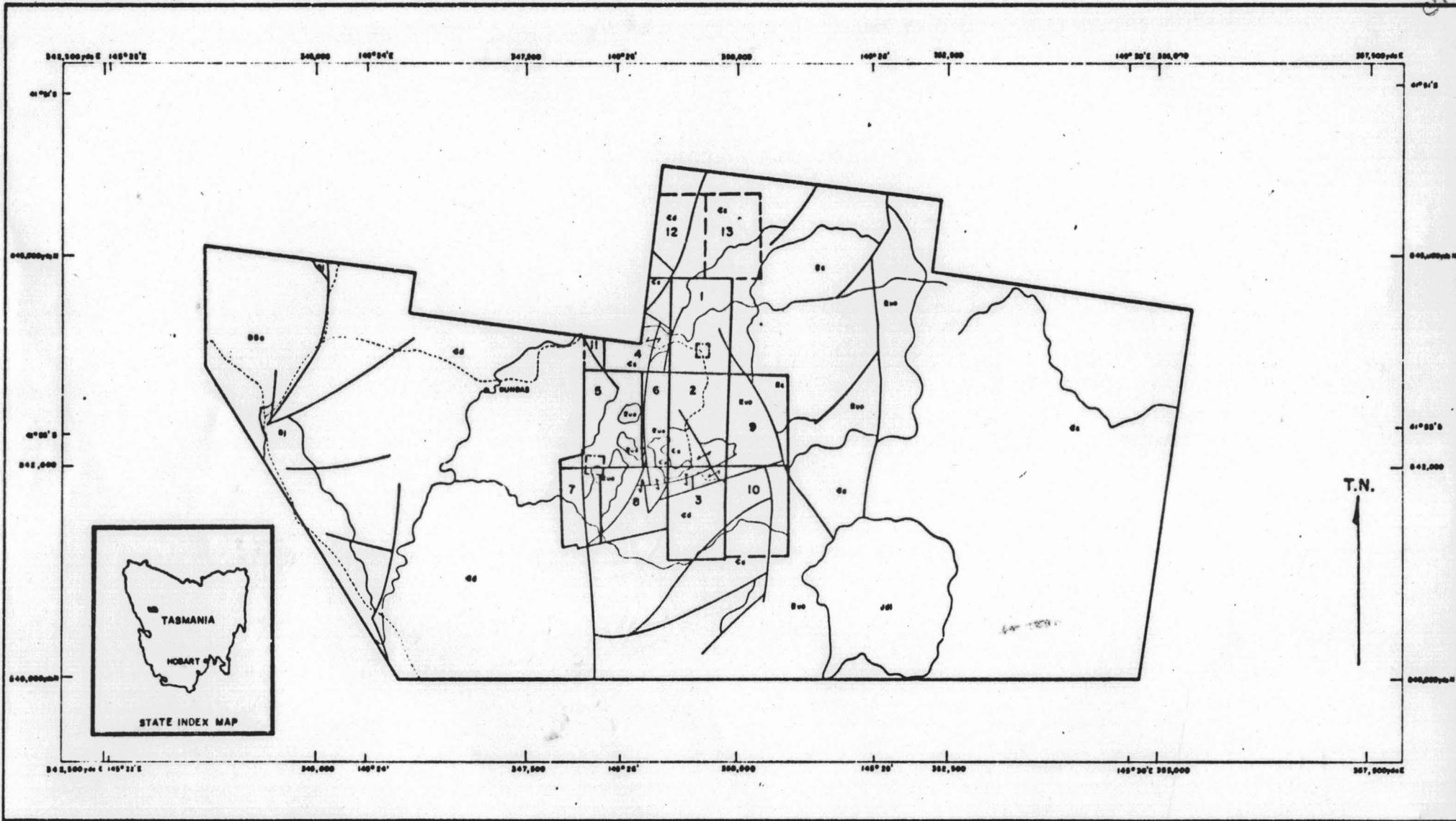
I - INTRODUCTION

Between February 25th and April 30th, 1971 a Very Low Frequency Electromagnetic (VLF-EM16) survey was carried out over the following grids in the Dundas area: Razorback, Hasset-Gravel Pit, North Comet, Platt, Comet-Kosminsky, Ainslie, Red Lead, Bonanza, South Comet and East South Comet. See Plate 1, Page 1a) Successful V.L.F. work was completed in March 1970 by the Bureau of Mineral Resources over lines 14S - 32S of the Comet-Kosminsky grid, and part of this area was repeated in the present survey.

Previously the REM method at Dundas had proved to be very unsatisfactory, mainly due to problems of communication and orientation caused by differences in altitude between transmitter and receiver. The sulphide bodies produced little response, possibly due to lack of power of the transmitter, poor conductivity contrast, or a screening effect caused by the near surface position of the water table. The VLF method has no problem of communication as the transmitter is fixed, and the VLF unit is merely a receiver tuned to the frequency of the transmitter. The test survey carried out by Langron and Gillespie of the B.M.R. (1970) in this area showed an anomalous zone corresponding to the Kosminsky Hill lode, and justified further VLF work. One limitation of the method is that the conductor strike is required to be in the direction of the

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LEGEND.

- | | |
|-------------------------|----------------------|
| 1. NORTH COMET. | 8. BONANZA. |
| 2. COMET-KOSMINSKY. | 9. AINSLIE. |
| 3. SOUTH COMET. | 10. EAST SOUTH COMET |
| 4. HASSET - GRAVEL PIT. | 11. RAZOR BACK. |
| 5. WEST COMET. | 12. CARBINE WEST. |
| 6. PLATT. | 13. CARBINE EAST. |
| 7. RED LEAD. | |

E.L.7/68. DUNDAS DISTRICT TASMANIA.

GRID LOCATION MAP.

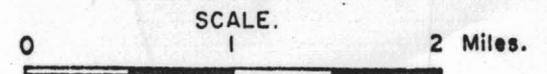
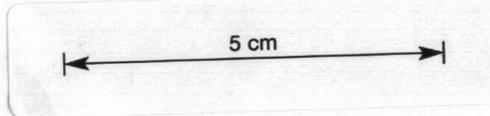


PLATE I

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transmitter; this condition is satisfied in the Dundas region.

The geology of the Dundas region is summarized by Blissett (1962). Mineralization is associated with northerly to northwesterly trending fault zones on the west flank of a major domal structure which exposes the Proterozoic Concert Schist. It is generally believed that the domal structure and associated faults first developed during the Devonian Tabberabberan Orogeny. The mineralization, which is also believed to be Devonian, is mainly confined to the Upper Proterozoic Oonah Quartzite and Schist, and the lower part of the superjacent Cambrian sequence. In Late Cambrian time, sill-like bodies of ultrabasic rock were emplaced in the older Cambrian and possibly the Upper Proterozoic sequences. Dolomitized zones in the ultrabasic rocks are also mineralized.

The generalized areal geology of the study area is shown on Plate 1. In general, mineralization in the eastern part of the surveyed area consists of silver-rich lead ores; whereas galena-sphalerite ores are more important to the west. All rocks are steeply dipping and severely deformed by folds and faults.

II - PRINCIPLES OF OPERATION

The E.M. - 16 unit is a passive instrument working in the VLF range (15-25 kHz) of the radio wave band. The primary VLF signal is obtained from powerful transmitters located around the world which were constructed originally by the United States Navy for communications with submerged submarines. The frequency of these signals is low compared to the normal broadcast band; a low frequency has better penetration through the conductive ocean water. Plug-in units are supplied with the V.L.F. survey instrument for the selection of the transmitting station. Two plug-in units may be accommodated at one time, with a switch for selection. In this survey the North West Cape (N.W.C.) signal was used, which operates at a frequency of 22.3 kHz and has a radiated power of 1,000 Kw. Two other plug-in units were supplied at frequencies 23.4 kHz (Hawaiian station) and 17.4 kHz (Japanese station) but neither gave a satisfactory signal in Tasmania.

The V.L.F. transmitting stations have a vertical antenna, which gives rise to a vertically polarized electromagnetic wave, the electric vector being vertical and the magnetic vector horizontal and concentric around the station. This primary magnetic field will obviously have no vertical component over a uniform earth, but if there is a subsurface conductor present this will give rise

to a secondary magnetic field which will usually be out of phase with and inclined to the primary magnetic field. The resultant field will thus be a rotating vector which describes an ellipse of polarization in the plane of the primary and secondary magnetic fields. This resultant field is equivalent to two oscillating vectors at right angles to each other, one along the major axis of the ellipse and the other along the minor axis. The polarization ellipse is discussed in more detail in the appendix at the end of this report.

The Ronka E.M. - 16 equipment (Figure 1) used in the survey showed a good performance in all weather conditions. The instrument is light (weight 2.5 lbs) easily portable, and simple to operate. The power supply is six size AA (1.5V) alkaline cells, with a life of about 200 hours. The instrument has no warm-up period, and is switched off between readings. There is a battery test button on the control panel of the instrument, which gives a whistling sound in the earphone if the batteries are in a useable condition. There is also a volume control to adjust the noise level for comfortable listening. Readings were taken every 50 feet along the grid traverses and every 25 feet along drill traverses, with the operator always facing in a north-easterly direction.

The E.M. - 16 unit is a sensitive receiver covering the V.L.F. frequency band tuned to a particular frequency by

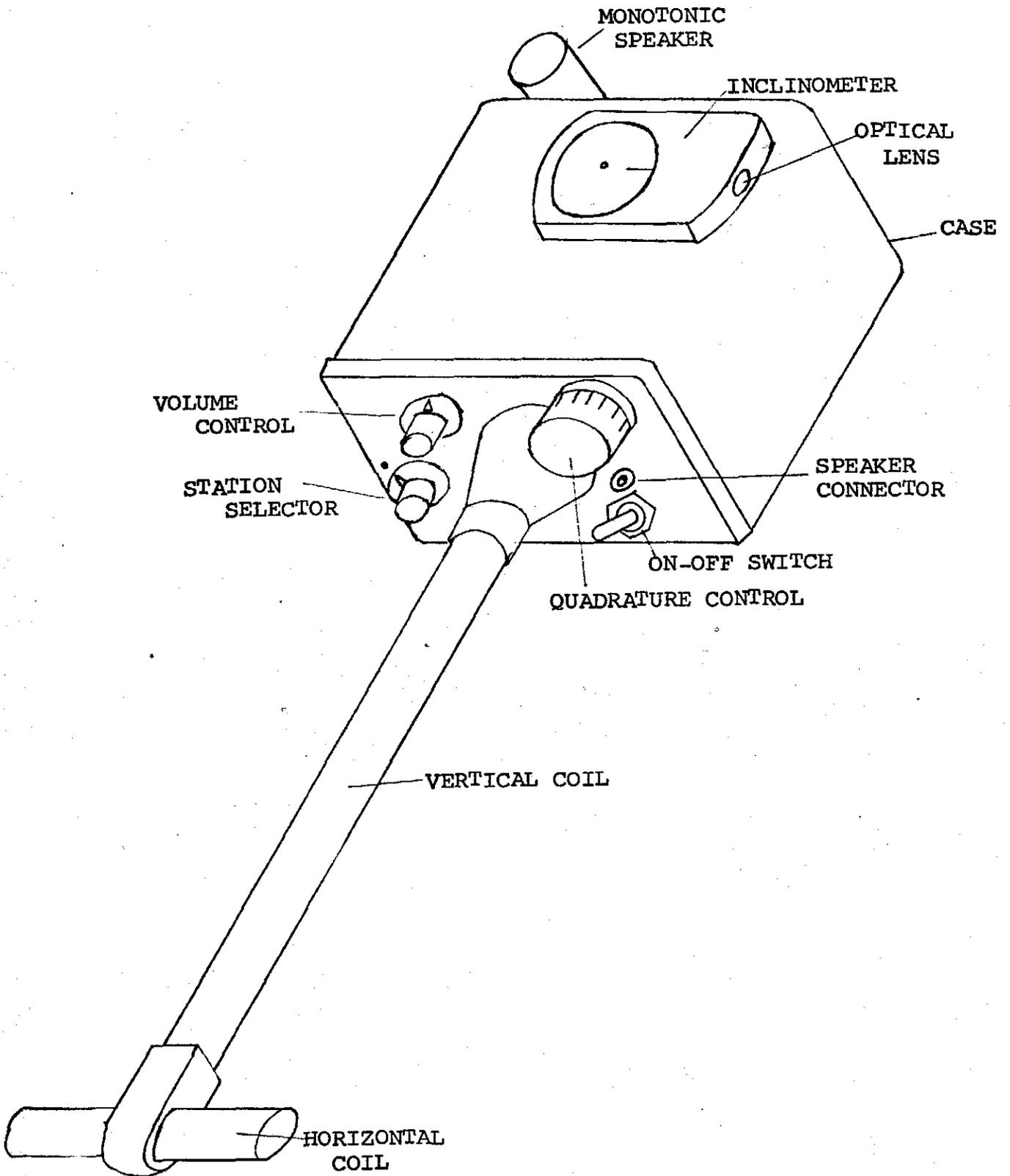


FIG. 1 VLF-EM 16 UNIT

means of the plug-in unit, and measures the vertical in-phase and quadrature components of the secondary fields.

Figure 2 is a block diagram of the EM-16. The signal amplifier has two inputs, one connected to the signal coil and one to the reference channel. The signal from the signal coil is minimized by tilting the coils. The quadrature control in the reference channel reduces any remaining signal to zero. The signal amplifier has zero output when both input signals are equal in amplitude and phase. Thus the setting of the quadrature control for minimum output from the receiver indicates the relative amount of the quadrature signal of the vertical coil. The output is amplified and mixed with a local oscillator signal to give a fixed beat frequency of about 1,500 Hz which is detected with earphones.

The main geological strike of an area to be surveyed with the VLF-EM16 method should be approximately at right angles to the primary magnetic field, i.e. in the direction of the transmitting station; while the survey lines should be along the lines of the primary magnetic field. Thus, the VLF method is particularly suited to work in the Dundas area as the strike here is in a north-westerly direction.

The depth of penetration of this geophysical method

was studied by Langron (1970), who reports that the results of VLF surveys performed by him in the Dundas area indicate that the maximum depth penetration producing reliable anomalies is about 100 feet. The skin depth is given by $3.6\sqrt{\rho}$ meters; where ρ is the resistivity of a homogeneous halfspace in ohm-m, for a frequency of 20 kHz, assuming that the halfspace is magnetically nonpolarizable. For moderately conductive ground $\rho = 10^2$ ohm-m, which gives a skin depth of 36 meters (118'). The secondary field is further attenuated on its way to the surface, thus confirming that 100 feet is a reasonable limit to the depth penetration of the method in this area.

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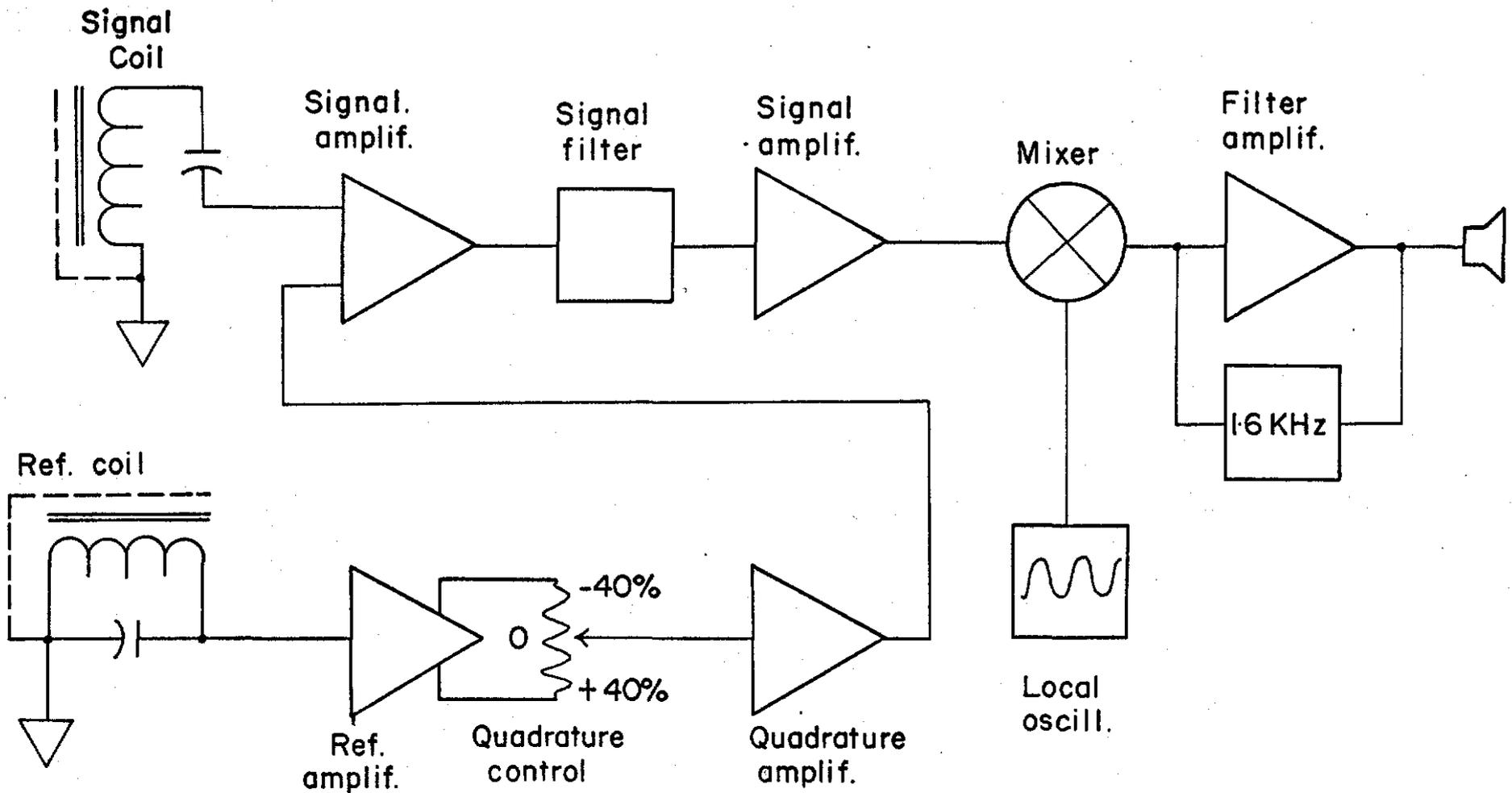


FIG. 2

EM 16 VLF-EM
Block Diagram

III - DATA COLLECTION

The EM-16 unit has two receiving coils which are mutually perpendicular. The signal coil has a vertical axis, while the reference coil has a horizontal axis, both coils are tuned to the same primary signal, but they have separate amplifiers. The signal coil is series tuned, while the reference coil is shunt tuned (i.e. the coil is in a parallel arrangement) in order to introduce a phase difference of 90° between the two signals.

The direction of the primary field is first obtained by holding the signal coil horizontal. The direction of the instrument when minimum sound intensity in the speaker is obtained indicates the direction of the transmitting station. The instrument is then held vertically with the reference coil in a direction at right angles to the transmitter location; thus the flux of the primary field is at a maximum through the reference coil. The instrument is then rotated through the vertical plane about a horizontal axis until a minimum signal is audible. The signal coil is at this point oriented along the minor axis of the ellipse of polarization, and the tilt angle of the instrument is the angle of inclination of the ellipse. The inclinometer on the side of the instrument is calibrated to read the tangent of the tilt angle (multiplied by 100) which is proportional to the ratio

of the in-phase component of the vertical secondary field to the horizontal primary field, for small secondary fields.

With the instrument inclined at this angle, the quadrature knob is rotated until a minimum noise is obtained. The voltage in the reference coil is first phase-shifted by 90°, and then a measured proportion of this voltage is used to compensate the voltage in the signal coil. The calibration of the quadrature knob registers the percentage of the reference signal used in the compensation, thus providing a direct measurement of the ratio of the signal strengths in the two receiver coils. This quantity, the eccentricity of the polarization ellipse, is equivalent to the ratio of the quadrature component of the vertical secondary field to the horizontal primary field, as proved previously.

There are two sets of readings obtainable at each survey point, which are equal but opposite in sign. The correct set is that which gives the conventional negative slope for an anomaly when traversing the profile from left to right. Thus a conductor lying ahead of the operator will cause a positive in-phase component. The instrument was tested, satisfactorily, for symmetry.

IV - DATA REDUCTION AND INTERPRETATION

Readings taken along each traverse are plotted as profiles of the in-phase (shown in the diagrams as solid curves) and quadrature (represented by broken curves) components of the vertical secondary magnetic field. The in-phase data is then filtered and smoothed using a process described by Fraser (1969), and illustrated in Table 1. This filtering procedure gives a plot proportional to the first discrete derivative of the in-phase component, and thus maxima and minima are indicated by zero values, and points of inflexion on the in-phase profile become maxima or minima. A conventional negative slope when traversing the profile from left to right (i.e. from west to east) is converted into a positive filtered value during this operation. Thus only the positive filtered values are contoured, usually in 10 unit intervals.

This filtering procedure has several advantages in that it improves the resolution of the anomalies and makes them easier to recognise. The topography also has an effect on the results as suggested by Whittles (1969) and may produce very large amplitude but extremely slowly varying curves, while anomalies due to mineralization are steeper. The use of the first derivative removes this topographic effect. Fraser also shows that a station spacing of 50 feet is the most suitable

for defining sulphide bodies within a few hundred feet of surface. Station spacing of 100 feet gives a larger response for deeper conductive bodies, but anomalies from near-surface conductors will have poorly defined waveforms and may look like deeper conductors.

Type curves for the in-phase component profiles may be deduced by combining the primary and secondary magnetic fields by the parallelogram law of forces. Figure 3 shows the horizontal primary field in cross section, and assumes the conducting body to have a strike-length perpendicular to the plane of the figure and the secondary induced current in it to be concentrated along the upper edge. The current produces a secondary magnetic field which by the theory of electromagnetic induction opposes the primary. There is most current concentration in the upper edge of the conductor because the return secondary current is more spread due to the diminishing primary field in the conductive rock. Thus the tilt profile is obtained; the resultant field dips below the horizon (positive tilt) on one side of the conductor, and above the horizon (negative tilt) on the other. The conductor is located below the point of inflexion where the tilt is zero.

A vertical sheet type conductor if it comes close to the surface gives a sharp cross-over of large amplitude,

Table 1.EXAMPLE OF FILTER AND SMOOTHING CALCULATIONS

Location	In-phase	Apply sign and form the moving sum of <u>pairs of entries</u>	Take first differ- ences of alternate entries
00	+23	$(+23) + (+14) = 37$	
50' E	+14	$(+14) + 7 = 21$	$37 - 13 = 24$
100' E	+ 7	$(+ 7) + 6 = 13$	$21 - 16 = 5$
150' E	+ 6	$(+ 6) + 10 = 16$	$13 - 21 = -8$
200' E	+10	$+10 + 11 = 21$	$16 - 27 = -11$
250' E	+11	$11 + 16 = 27$	$21 - 20 = 1$
300' E	+16	$16 + 4 = 20$	$27 - (-6) = 33$
350' E	+ 4	$4 + (-10) = -6$	$20 - (-30) = 50$
400' E	-10	$(-10) + (-20) = -30$	$(-6) - (-34) = 28$
450' E	-20	$(-20) + (-14) = -34$	$(-30) - (-21) = -9$
500' E	-14	$(-14) + (-7) = -21$	
550' E	- 7		Drill traverse S.C.1

and slow roll-off on both sides (figure 4).

As with any electromagnetic method, the largest and best conductors give the highest ratio of in-phase to quadrature components. In figure 4, the quadrature component suggests that the body is a poor conductor, while figure 5 shows an anomaly with a small quadrature effect, indicating a body of good conductivity.

The effect of conductive overburden is more noticeable in the quadrature than the in-phase component. A reversed polarity of the quadrature can be due to the conductive overburden on top of an area of better conductivity. (Figure 6)

Figure 7 shows the effect of two adjacent conducting bodies. Body A is large and at depth, thus the in-phase profile A has a relatively large amplitude and does not have nearly as steep a slope as the anomaly due to body B which is smaller and nearer the surface. The combined curve only has one zero cross-over indicating that the steepest gradients of the in-phase profile should be looked for rather than the actual zero crossings.

(A) DEPTH

The determination of depth is generally more reliable than the estimation of the actual dimensions of the conductive

020

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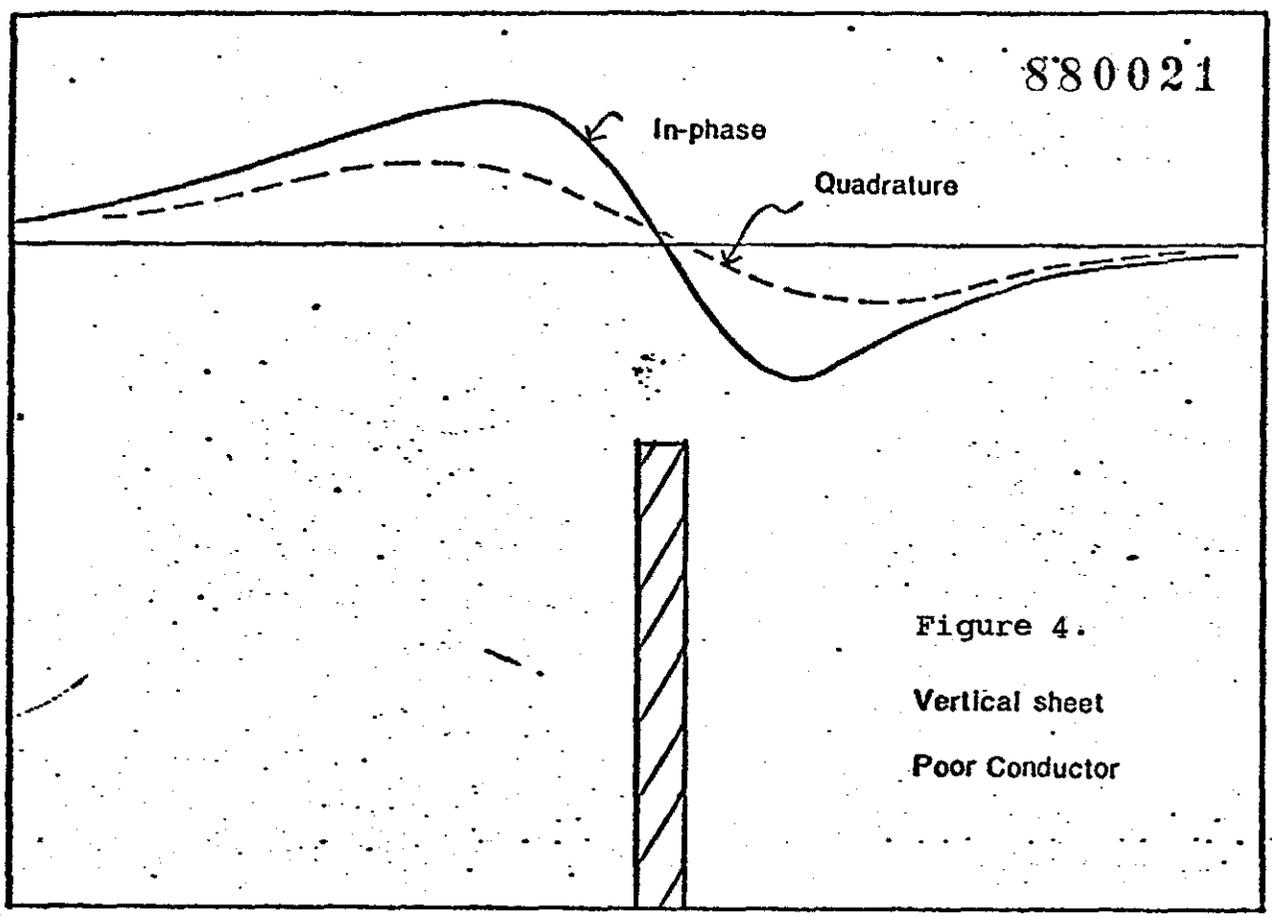


Figure 4.
Vertical sheet
Poor Conductor

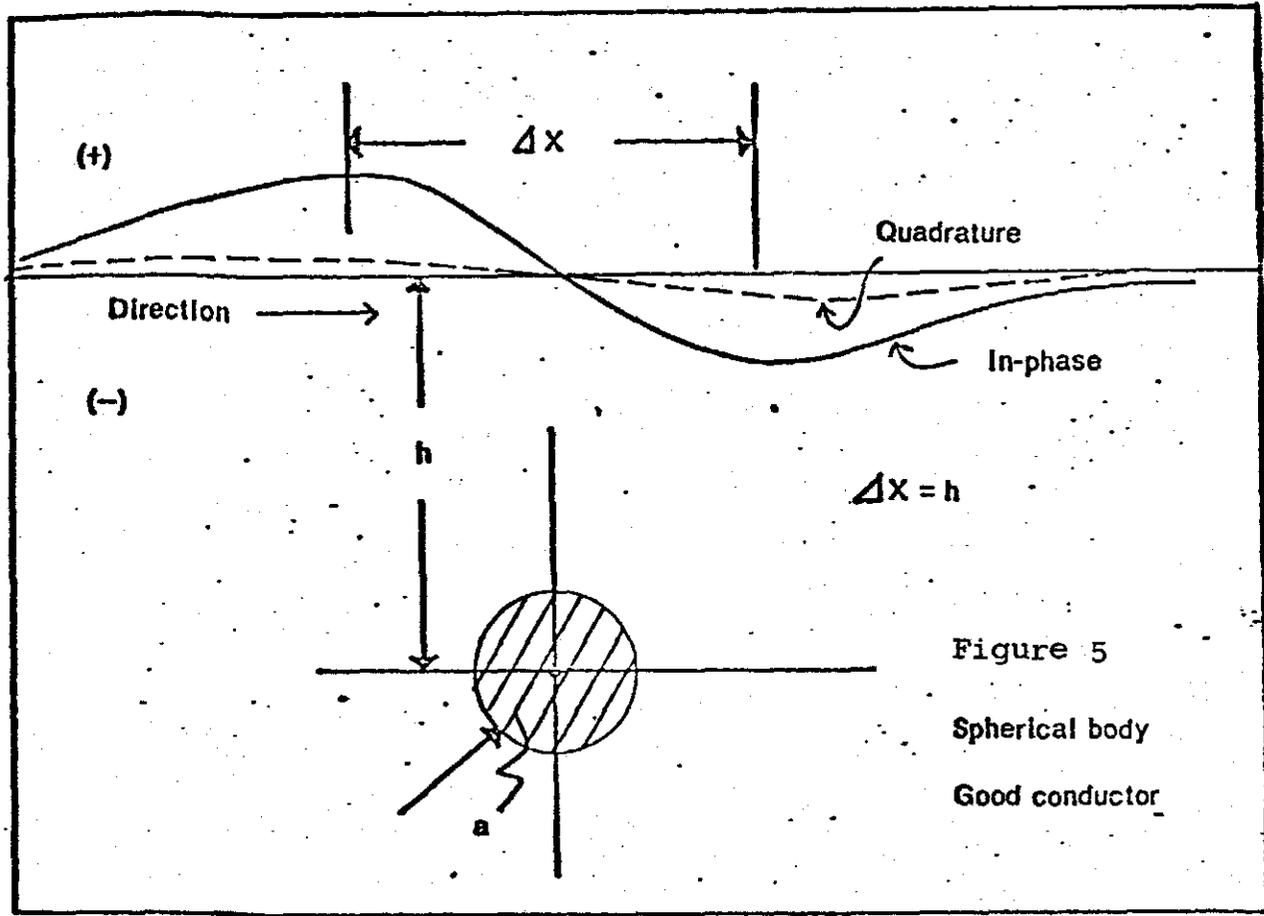
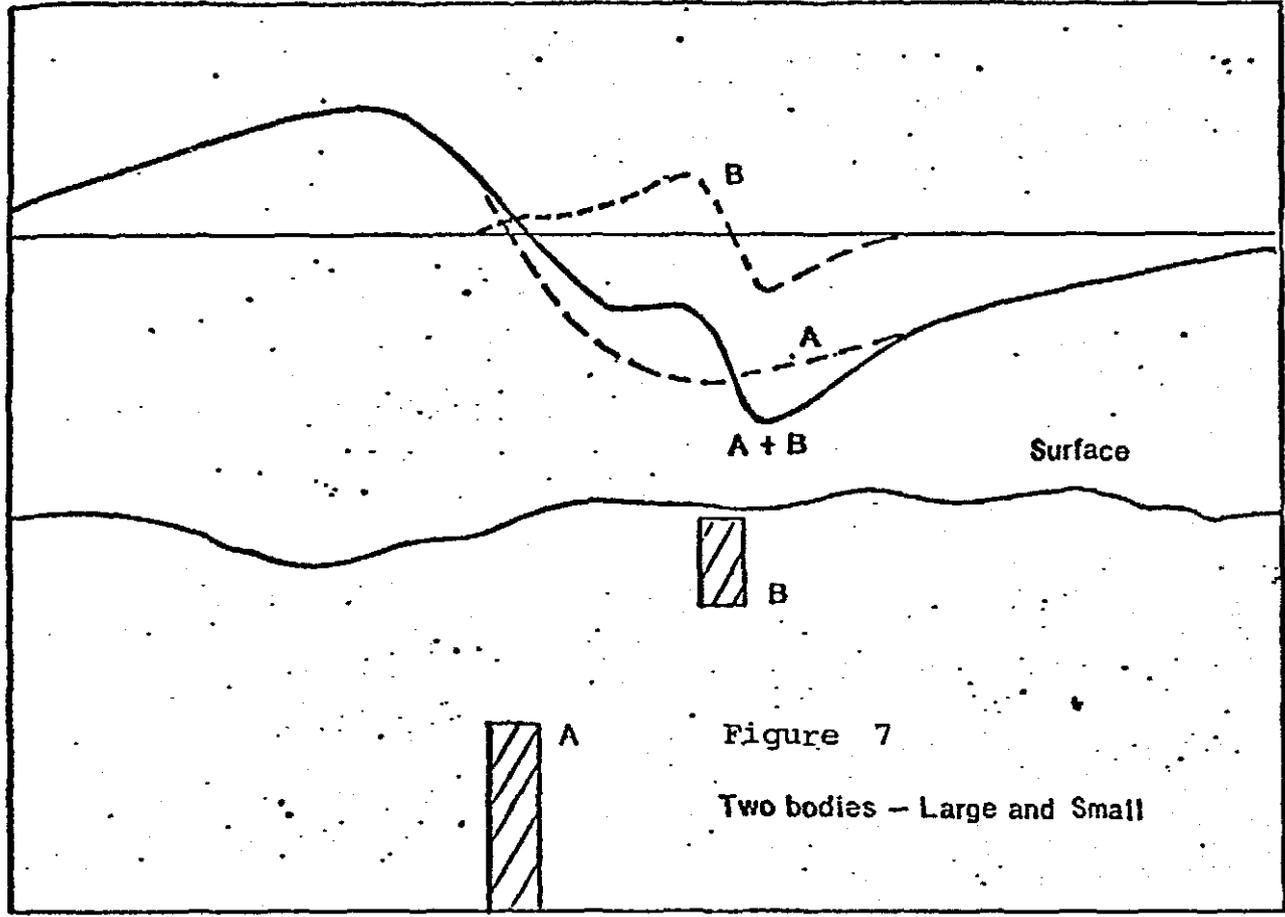
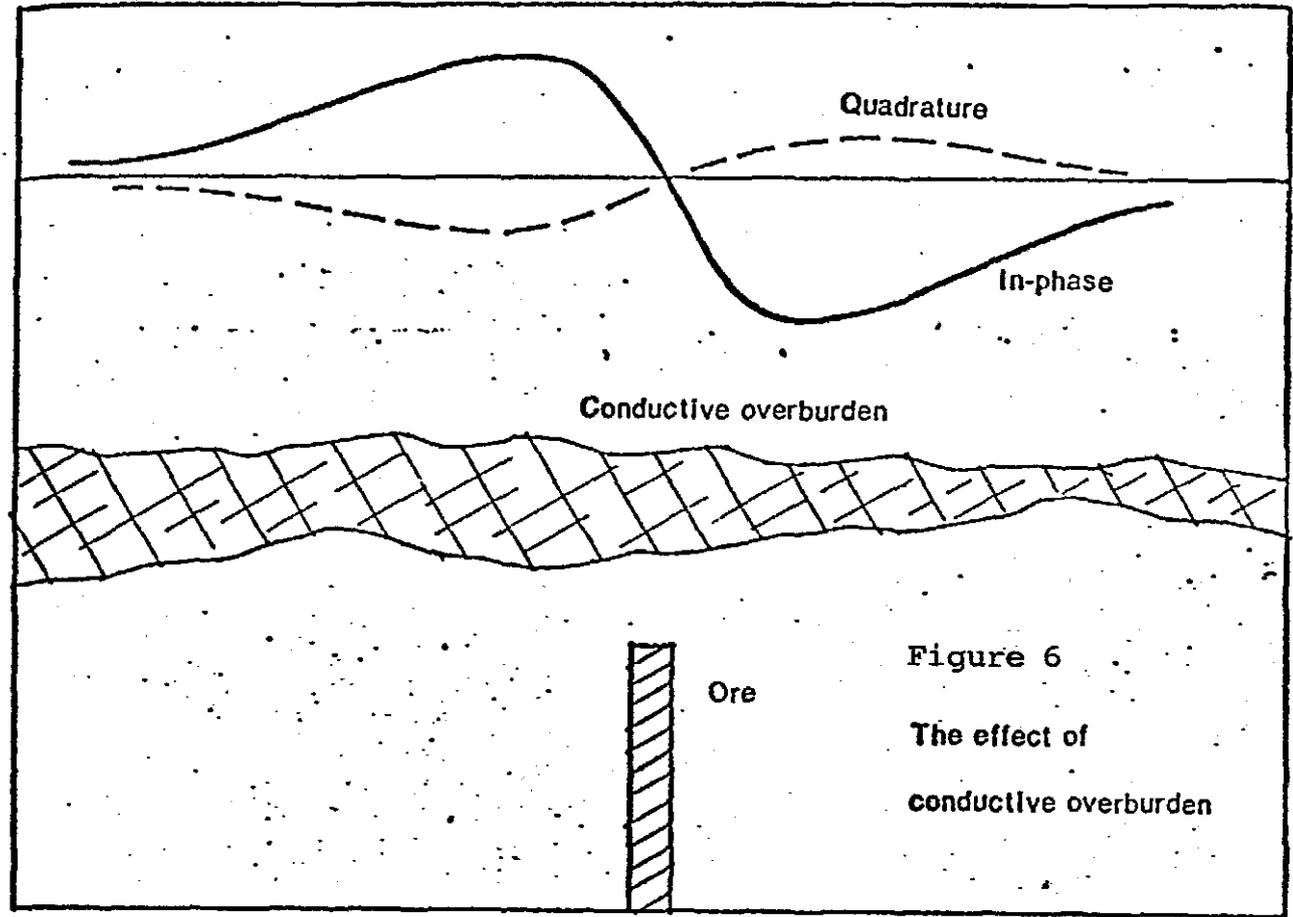


Figure 5
Spherical body
Good conductor

021



(B) REPEATABILITY

Line 14S of the Comet-Kosminsky grid was surveyed three times with the VLF: once by the B.M.R. in March, 1970, once at the beginning of the present survey in the dry weather, and again at the end after there had been about two weeks of rain. In all three cases the results showed very little variation. Line 22S of the Comet-Kosminsky grid and parts of 40S, 42S, 44S and 46S of the South Comet grid were also repeated, and the readings were again found to be reproducible within the limits of measurement error.

022 A

V - RESULTS OF DUNDAS SURVEY

In the discussion of the results a conventional negative slope is referred to as a positive slope V.L.F. anomaly.

The main anomalies are summarised at the end of the section and the numbered anomalies in the discussion refer to these.

The data from each grid is taken separately and each line is treated individually, by studying the respective profiles. An estimate is made (as described in section IV) of the depth and conductivity of the body producing the anomaly. The more interesting anomalies are marked with an asterisk.

The following descriptions of the VLF data along each grid line should be read with enclosed map sheets available for ready reference.

(A) NORTH COMET GRID5.0N

There is a small anomaly on this line between 300' and 450'E and the quadrature component shows some fluctuation. The centre of the body is below 375'E, at a depth of between 75' and 100'. (Anomaly 1)

2.5N

* This line between 300' and 500'E seems to be the centre of this anomalous zone which is probably due to a medium conductor in a non-conductive region, as the quadrature component shows a positive slope of reasonable magnitude. The body on this line is at a depth of about 100' below 500'E. (Anomaly 1)

* Between 1650' and 1700'E there is a very strong anomaly with a fairly small positive quadrature slope, suggesting that this anomaly is due to a large near-surface body of good conductivity. (Anomaly 2)

00

The anomaly between 400' and 600'E is fairly small, and has a positively sloping quadrature component. The body is only weakly - moderately conductive, at a depth of about 100' below 500'E. (Anomaly 1)

* The second anomaly on this line may be due to two bodies. The first is only small between 1250' and 1350' while the second is much larger between 1400' and 1600'E. The latter is centred under about 1550'E at a depth of about 50' to 100'. The conducting body probably dips towards the west as indicated by the long tail on the flank of the cross-over. The quadrature profile shows a reverse slope in the region of this anomaly thus the presence of conductive overburden is likely. (Anomaly 2)

There is another anomaly between 150' and 200' which shows no appreciable quadrature effect. The conductive body appears to be near the surface, but is only small.

2.5S

The anomaly on this line seems to be composed of

024

two parts, the first centred about 1500'E is accompanied by a reverse slope quadrature component indicating the presence of conductive overburden. The second larger anomaly is between 1550' and 1700'E and the quadrature component shows no appreciable variation. However the two anomalies on this line are not very large. (Anomaly 2)

There is another anomaly open to the west, extending to about 100'E along the line. The western extension is worthy of more work - VLF certainly to close this anomaly. (Anomaly 3)

5.S

The above anomaly appears to extend to this line. It is located between 100'W and 100'E. The quadrature component is relatively high and has a positive slope. The conductor is probably moderate and at a depth of about 100'.

7.5S

There is a fairly unimportant anomaly on this line between 650' and 750'E centred below 725'E at about a depth of 50'. The quadrature component shows a positive gradient indicating no overburden. This anomaly appears to continue to line 10S.

10S

The anomaly is between 450' and 650'E and is accompanied by a positive quadrature slope. The anomaly is probably due to a medium conductor at a depth of about 100'. (Anomaly 5)

(B) NORTH COMET WEST GRID

10N

The quadrature component along this line shows a relatively high negative value. The anomaly here is probably due to a weak conductor and is located between 500' - 300'W, at a depth of about 100'.

7.5N

This anomaly extends from 500'W to 200'W. The

gradient is not very large indicating that this conductor lies at depth, approximately 150'. The quadrature component shows a large positive slope, so there is little or no conductive overburden, and the anomaly is probably caused by a medium-weak conductor.

2.5N

Again the fairly wide, gradually sloping anomaly is seen between 450'W and 50'E again accompanied by a positive slope quadrature effect. This anomaly does not appear to be very important.

* There is another anomaly on this line between 1600'W - 1450'W which appears to be important. The reverse slope quadrature component indicates the presence of conductive overburden. The anomalous zone probably lies at a depth of around 50'.
(Anomaly 61)

00

Between 1450'W - 1200'W there is an anomaly with a reverse slope quadrature component. The conducting body is probably at a depth of about 100' under about 1350'W.
(Anomaly 62).

5S

The main anomaly on this line is between 1350' - 1400'W, and appears to be caused by a relatively good conductor near the surface; the quadrature profile has a negative slope in this region suggesting the presence of conductive overburden.
(Anomaly 63).

There is another anomaly between 750' and 700'W which is also near the surface but is weaker than the first. In this region the quadrature component shows a positive slope, and the body is probably only a medium conductor in a non-conductive region.

7.5S

The large anomaly extending from 550'W to 250'W results from possibly two bodies. The first smaller body has an accompanying positively sloped quadrature component

and is probably a medium - weak conductor near the surface. The second anomaly is deeper at a depth of about 75', but has a large quadrature component. (Anomaly 4)

(1) Other Geophysical Results in North Comet West Grid

In general, there is not a very good correlation between the VLF anomalies and I.P. or self-potential anomalies. However there are a few cases where the anomalies do coincide.

There is an S.P. anomaly on line 00 between 1450' and 1500'E, which is very close to V.L.F. anomaly (2). There is also a strong I.P. anomaly on line 2.5S between 1250' and 1550'E which may also be connected with the above anomaly. The results for the area around V.L.F. anomaly (2) justify more work in this region.

V.L.F. anomaly (1) on line 2.5N corresponds with a weak I.P. anomaly at a depth of about 600'.

There is also a fairly strong S.P. anomaly corresponding with anomaly (3) on line 2.5S.

(C) RAZORBACK GRID

10N

There are two small anomalies between 150' and 200'W and 50'W and 50'E. The first is due to a very small, near-surface body of medium conductivity, while the second is also small but at a slightly greater depth of about 50'. This anomaly has a zero quadrature component, so the body has a good conductivity.

08N

* There is a strong anomaly at the west end of this line between 1000' and 950'W. This is probably due to a near-surface, large conductor, and as there is a positive sloped quadrature component, this implies no conductive overburden. (Anomaly 6)

Between 200' and 50'W there is a second anomaly which does not appear to be very important. The quadrature component has a positive slope in this region. The body is at a depth of about 75', small and only moderately conductive.

06N

There appears an anomaly between 900 - 750W which is possibly a continuation of the body on line 8N, and another between 700' and 600'W. The body causing the first anomaly is probably at a depth of about 75' and of moderate conductivity, while the second is slightly nearer the surface.

04N

The anomaly on this line seems to be in three parts, with a fairly large negative quadrature component. The last portion of the anomaly is accompanied by a strong reverse quadrature slope and this might be a good conductor (located between 650' and 600').

There is a second anomaly between 350' - 400'W, although this is fairly small, and near the surface.

02N

The conductor here is at a depth of about 100' or more as the anomaly extends from 825' to 600'W; there is not much variation in the quadrature component and the body does not appear to be very large.

00

The western end of this line should be extended as there appears to be an open anomaly between 1000' and 900'W.

(D) HASSET-GRAVEL PIT GRIDS

10N

The anomaly between 1250' and 1400'E does not appear to be very significant as it is accompanied by a fairly steep positive quadrature gradient, which follows the in-phase profile closely.

028

The anomaly between 2400' and 2450'E does not appear to be particularly important.

08N

The anomaly extends from 50'E to 250'E, and is centred below about 175'E at a depth of 75' or less. The quadrature component shows some variation and the body is probably only a moderate conductor. (Anomaly 7)

An anomaly appears between 1750' and 1850'E with no variation in the quadrature component. The associated conductor is probably at a depth of about 50' but only appears to be small.

The anomaly between 3000' and 3250'E is accompanied by quite a strong positive quadrature gradient. The conducting body is near the surface, and moderately conducting, with a west dip inferred from the long tail on the flank of the cross-over. (Anomaly 9)

06N

Between 100' - 350'E there appears a relatively large anomaly, probably due to a moderately conducting body which is probably at a depth of over 100'. The quadrature component has a large negative value. (Anomaly 7)

There are also two smaller anomalies on this line the first between 750' and 900'E which suggests a fairly weak conductor, and the second between 950'E and 1100E is accompanied by a reverse slope quadrature component, and is probably a continuation of the anomaly on line 04N.

The small anomaly from 08N appears to be extended to this line between 1800' and 1850'E. The quadrature component has a negative slope indicating the presence of overburden; the body causing anomaly is probably near the surface.

There is an anomaly between 4050' and 4100'E which has an associated small quadrature component showing negligible variation. This anomaly is probably due to a relatively good conductor near the surface.

04N

*

There is quite a large anomaly on this line

between 300'E and 450'E; probably coinciding with a body at a depth of about 50' to 75'. (Anomaly 7)

* A second anomaly appears between 950' and 1100'E with a corresponding small negative gradient in the quadrature component, indicating the presence of conductive overburden. This body also lies at a depth of about 75', and is also fairly large. (Anomaly 8)

There is a small anomaly between 2600' and 2800'E, which has a small positive quadrature slope. The body is only moderately conductive at a depth of about 50' to 75' and relatively small.

02N

* This anomaly extends from 1100' - 1400'E and is accompanied by a small positive quadrature slope. The anomaly is due to a medium conductor at a depth of about 150'.

There is a small anomaly between 2150' and 2300'E which has very little expression in the quadrature component.

The body is a good, small conductor at a depth of about 50'.

There appears an anomaly between 3450' and 3550'E which has a reverse quadrature slope indicating conductive overburden. The body is at a depth of about 50'.

00

An anomaly in the in-phase component, lies between 300' and 400'E possibly due to a body at a depth of about 50' below 375'E. The quadrature component has a positive slope, and the body may only have a medium conductivity. (Anomaly 7)

(1) Other Geophysical Results in Hasset-Gravel Pit Grids

The V.L.F. anomaly extending from line 00 (300' - 400'E), through 02N (250' - 400'E) 04N (300' - 450'E) 06N (100' - 350'E) to 08N (50' - 250'E) is coincident with a magnetic "high" running in the same direction.

029-A

There is another magnetic anomaly centred at 1050'E on line 4N which may be associated with the V.L.F. anomaly between 950' and 1100'E on 4N.

There is a self-potential anomaly at the west end of line 8N, coinciding with V.L.F. anomaly (6).

(E) PLATT GRID

02S

There is a steep anomaly, between 500' and 600'E and the body is probably located at a depth of about 25' - 50' below 575'E. There is not much fluctuation in the quadrature component, so that this body is probably a good conductor, although it may not be very large.

04S

There is a small anomaly between 750' and 850'E which has a slight reverse slope quadrature effect indicating the presence of conductive overburden. The body is probably at a depth of about 25' - 50' and is not very large.

06S

There is a large anomaly between 700' and 850'E again with the reverse slope of the quadrature component. This suggests a body at a depth of about 75'. (Anomaly 10).

08S

There is an open anomaly to the west on this line and it extends to 50'E. The quadrature component has a low value and it may be of interest, but it looks relatively small. Between 750' and 850'E there is another anomaly, but this is accompanied by a very large positive gradient in the quadrature component suggesting that the body is one of weak conductivity; it is at a depth of about 50' and is only small. (Anomaly 10)

10S

The anomaly between 400' and 500'E with a corresponding reverse quadrature slope is only small, and suggests a body at about

030

a depth of 50'. The other anomaly between 800' and 900'E is about the same size and depth but probably not a very good conductor. Between 950' and 1100'E there is another anomaly suggesting a small good conductor at a depth of about 75'. However these anomalies are not very interesting.

10.5S

Between 150' and 450'E there appears an anomalous region which might indicate a deep conductor (150') of large dimensions.

There is another anomaly between 1050' and 1150'E which has a positive slope quadrature component associated with it, so the body may not be very conductive; it will probably be at a depth of 25' to 50'. This is the northern extension of the Kosminsky Hill lode anomaly. (Anomaly 20)

12S

There are two anomalies close together on this line. The first is between 300' and 400', and the second between 450' and 500'. Both bodies are near the surface, are only small, and not very conductive. The anomaly open to the east but extending from 1200'E might be interesting if it were continued, although the quadrature component appears to have a steep positive slope, this is part of the Kosminsky Hill V.L.F. anomaly.

14S

The anomaly between 50W and 100'E has a relatively high value for the quadrature component associated with it, but it is a reasonable sized anomaly. The body lies at a depth of about 50' below 50'E.

18S

Between 50' and 250'E there is an anomaly suggesting a small body at a depth of about 75'. The body has only a weak-medium conductivity as the quadrature component has a positive slope.

22S

The anomaly on this line between 750' and 900'E

has a quadrature component which is a high negative value. The body has probably only moderate conductivity but is located at a depth of about 75'.

(1) Other Geophysical Results in Platt Grid

There is an S.P. anomaly on line 085 close to the V.L.F. anomaly between 750' and 850'E. (V.L.F. anomaly 10.)

There are no magnetic anomalies coinciding with any of the V.L.F. anomalies in this area.

(F) RED LEAD AND BONANZA GRIDS

22S

* The main anomaly on this line is between 2050' and 1900'W and the body is large and of medium conductivity at a depth of about 50'. The quadrature component is reasonably large with a positive slope, suggesting that there is no conductive overburden. (Anomaly 36)

There are also anomalies between 2750' and 2600'W, (this has a small negative quadrature slope and is probably caused by a small conductive body at a depth of about 50') and a small good conductor between 2350' and 2250' at a depth of about 50' as there is no variation in the quadrature component. Between 2200'W and 2100'W there is an anomaly with an associated large quadrature component, suggesting that the body is only of medium conductance.

24S

* The relatively large anomaly on this line between 2100'W and 1650'W with accompanying small variation in quadrature suggests that this body is at a depth of about 200', is large and of good conductivity and is definitely worth further investigation. (Anomaly 36)

26S

The first anomaly appears between 2350'W and 2100'W

with a slight variation in the quadrature component, but it always remains small, thus indicating that the body is probably a reasonable conductor at a depth of about 100'. (Anomaly 39)

* There is another large anomaly between 2050'W and 1650'W which is probably due to large deep body (about 200' below the surface) and of moderate conductivity. (Anomaly 36)

Between 1150' and 850' there is another anomaly which shows a slight positive slope in the quadrature component. The body is probably at a depth of about 150' and appears to be a good conductor. (Anomaly 37)

A relatively deep body may be inferred from the anomaly in the in phase component between 100' and 400'E. The quadrature component shows a small reverse gradient, and the body although fairly small is of moderate conductivity at a depth of about 100' below 300'E.

28S

Between 2200' and 2800'W there appears an anomaly with centre below about 2125'W and at a depth of approximately 100'. The body appears to be a good conductor, as the quadrature component has a low value, although a slight positive slope. (Anomaly 39)

There seems to be another anomaly from 1950' to 1600' which again has an associated positive quadrature slope. The body causing the anomaly is again relatively large and deep (over 100') but only moderately conductive.

The anomaly between 1050' and 900'W has a very small quadrature component, and thus is a reasonably good conductor at a depth of about 75', but it is not very large.

The small anomaly between 300' and 150'W has an associated positive quadrature slope which implies that this body is a medium conductor at a depth of about 75', but is not a very large body. (Anomaly 38)

The anomalies between 350' and 900'E both have large quadrature components, so that these anomalies are caused by bodies which are not very conductive, and do not appear to be important.

30S

The anomaly between 2500' and 2350'W with its associated positive slope in the quadrature component suggests a body of poor - moderate conductivity at a depth of about 75' centred under about 2425'W. (Anomaly 40)

* The next anomaly from 1950' to 1700' is probably due to a more conductive body as the quadrature component shows little variation and also remains at a low value. The depth of the body is about 100' and it is probably quite large.

32S

There seems to be two anomalies on this line, neither of which has a steep gradient or a quadrature effect. Thus they may be due to deep small bodies of good conductivity; they are between 2050' - 1850'W and 1800' and 1600'W.

The anomaly between 2950' and 2800'W has a quadrature component with a slight positive slope. The anomaly indicates that the body is small and of only medium conductivity at a depth of about 75' below 2875'W.

Between 750' and 700'E there is a small anomaly suggesting a weakly conductive body near the surface.

34S

* There is a very large anomaly between 1750' and 1500'W due possibly to a large conductive body at a depth of about 100'. (Anomaly 41)

The anomaly between 1050' and 1000'W indicates the presence of a large near-surface body of only moderate conductivity as the quadrature component has a relatively large positive slope. (Anomaly 42)

A small body at a depth of about 50' may be responsible for the anomaly between 500' and 600'E. The quadrature component has a slight reverse slope in this region suggesting the presence of conductive overburden. There is a larger anomaly between 650' and 860'E which has a quadrature component with a positive slope. The body producing this anomaly has reasonable conductivity, size, and is at a depth of about 100'. (Anomaly 43)

36S

There seems to be two bodies indicated by the anomaly between 2050' and 1650'W. The first is due to a body at a depth of about 100' of moderate conductivity, but small, centred under 1950'W. The second is in an area of conductive overburden at a depth of about 50' but is also small.

The anomaly between 1150' and 950' in the in-phase component has a quadrature component with a relatively high positive value, but showing no variation. The anomaly may result from a body at a depth of about 75' to 100' of moderate conductivity.

There are two small anomalies at the east end of this line probably due to small, near-surface conductors around 725'E and 825'E.

38S

Between 1900' and 1800'W there appears relatively large anomaly indicating a body at a depth of about 50' centred below 1850'W. The quadrature component shows a very slight reverse slope and the body may be of interest.

There is a second anomaly from 1350' to 1250'W which also has a large gradient but has a steep positive quadrature slope. The body is probably only poor-moderately conductive, at a depth of about 50' or less. (Anomaly 46)

Between 500' and 650' there appears an anomaly which could be the result of two conductive bodies. The quadrature component does not show much variation suggesting that the bodies are good conductors but quite small, and probably not at a very great depth. (Anomaly 47)

There is another small anomaly between 700' and 800'E, which has a positive quadrature slope associated with it. The body is probably at a depth of between 25' and 50' but is a poor conductor. (Anomaly 48)

40S

The anomaly on this line is between 2100' and 1900'W with an associated reverse slope quadrature component.

035

The body has a reasonable conductivity (in a region of conductive overburden) at a depth of 100' below 200'W.
(Anomaly 45)

Between 1350' and 1150' there appears another anomaly which is accompanied by a small quadrature component, thus indicating a moderately conductive but small body at a depth of about 75'.

42S

The anomaly from 800' to 650'W is caused by moderately conductive body at a depth of about 75'. The quadrature component shows a reasonably high positive value.
(Anomaly 50)

There is another anomaly between 1900' and 1800'W which is indicative of a body at a depth of about 50' and also of moderate conductivity.
(Anomaly 49)

The anomaly from 1400' to 1450'E is accompanied by a very small reverse slope but high valued quadrature effect. The body is very near the surface but only of moderate conductivity. The smaller anomalies between 1700' - 1750'E, 1800' - 1850'E and 1900' - 2000' are also due to bodies near the surface, but they are of higher conductivity. This last anomaly is open to the east.
(Anomaly 51)

44S

There is a small anomaly between 1850'W and 1700'W, which also shows very little variation in the quadrature component, although this has a relatively large value. The body is small, poorly conductive and at a depth of approximately 50' or less.
(Anomaly 49)

* There is a larger anomaly between 750' and 500'W which is accompanied by a large positive quadrature slope. Thus the body is at a depth of about 100', but only moderately conductive.
(Anomaly 50)

There is again the open anomaly at the east end of this line. This body looks deep, but of only moderate conductivity, as the quadrature component has a positive slope.

46S

* The anomaly between 600' and 450'W is accompanied by a steep positive quadrature slope. The body appears to be large but only moderately conductive and at a depth of about 50' - 75'. (Anomaly 51)

The anomaly from 700' to 850'E has an associated slight positive quadrature slope. The conducting body is possibly at a depth of about 75' under about 775'E, but is reasonably small.

Again the open anomaly appears at the east end of the line. The quadrature component shows little variation.

48S

There is an anomaly from 700' to 300'E, with a positive slope in the quadrature component. The body is treated at a depth of about 100' under point 200'E, but is only moderately conductive, and not very large.

50S

Between 500' and 700'E there again appears an apparently deep body (at a depth of about 100') which has a fluctuating quadrature component. The body is only of moderate conductivity, and relatively small.

(1) Other Geophysical Results in the Red Lead - Bonanza Grids

The S.P. and magnetic anomalies do not appear to coincide with any of the V.L.F. anomalies.

(G) COMET - KOSMINSKY GRIDS02.69N

On this line there is an anomaly between 900' and 750'W, which has a quadrature component with mainly a reverse slope. The conductive body is at a depth of 75' below 825'W in a non-conductive region.

037

00

There is an anomaly on this line open to the west and extending to 1800'W. (This anomaly is also seen on line 02S of the Platt grid). The quadrature component has a positive slope, and the conducting body is at a depth of 25' to 50' below 1825'W. (Anomaly 12)

02S

* The anomaly between 1800' and 1650' in the in-phase component is very large, while the quadrature component shows only a small variation, and has a mainly negative slope. The anomaly is due to a large conductor at a depth of 75'. (Anomaly 12)

There is a very small near-surface body in a non-conductive region indicated by the anomaly between 1300' and 1350'N. However this anomaly is not very important.

04S

* The strong anomaly detected on line 02S extends to this line. There is a very large anomaly in the in-phase component between 1850' and 1250', with the quadrature component showing only a small variation, but it does have a relatively high value.

The anomaly is caused by a large conducting body at a depth of 25' to 50'. There is another part of this anomaly between 1600' and 1700'W, but this appears to be smaller than the first and the body is at a depth of 50' below 1650'W. The quadrature component has a negative slope in this region, indicating the presence of conductive overburden. (Anomaly 12)

06S

The anomaly in the in phase component between 1850' and 1550'W may be divided into three parts. The first between 1850' and 1750' is the most important and suggests a near-surface body of moderate conductivity below 1825'W. (Anomaly 12)

There is another anomaly on this line between 800' and 550'W which has a quadrature component with a large positive value but which remains constant.

The body is at a depth of 75' below 700'W but is only moderately conductive. (Anomaly 13)

08S

* There again appears the anomaly at the west end of this line between 1800' and 1600'W accompanied in this case by a very large quadrature component, with a positive gradient. The main part of this anomaly between 1700' and 1600'W has a smaller quadrature component associated with it, and indicates a moderately conductive body at a depth of 50' below 1650'W.
(Anomaly 14)

A body of only moderate size and conductivity and at a depth of 100' is indicated by the anomaly between 1350' and 1150'W. The presence of conductive overburden can be inferred from the reverse slope of the quadrature component.

10S

* There is an open anomaly on the western end of this line and which extends to 1900'W. This anomaly extends to 1200'E on the 12S line of the Platt grid and is part of the Kosminsky Hill lode anomaly. The quadrature component shows some variation, but the anomaly is interesting.
(Anomaly 20)

A second anomaly is observed between 1700' and 1600'W which has an associated quadrature component with a positive slope. The body is only moderately conductive and at a depth of 25' to 50' below 1625'W.
(Anomaly 14)

12S

* The anomaly on this line between 2000' and 1700'W is large and the quadrature component is small with only slight variations. This indicates a body of good conductivity and size, and at a depth of about 150'.
(Anomaly 20)

14S

* There appears to be possibly three conducting bodies causing the anomaly between 2000' and 1650'W on this line. The largest one is indicated by the steep anomaly between 1850' and 1750'W, and is at a depth of about 50'. This may be a region of conductive overburden as the quadrature component has a reverse slope over most of the anomaly.

There is a small anomaly between 250' and 200'W

which is accompanied by a small reverse slope quadrature effect. This anomaly is indicative of a small near surface body in a region of conductive overburden.

16S

The Kosminsky Hill lode anomaly is only small on this line, and located between 1650' and 1550'W. There is a larger anomaly at the eastern end between 150' and 50'W, suggesting a conductive body at a depth of 50' below 100'W, but of only moderate dimensions. (Anomaly 15)

18S

The anomaly between 1450' and 1400'W indicates a relatively small body of moderate conductivity at a depth of 25' below 1425'W. (Anomaly 20)

A deep but only moderately conductive body is suggested by the anomaly in the in-phase component between 650' and 400'W. The quadrature component in this region has a relatively high negative value. The body is at a depth of 125' below about 500'W. There is a steeper anomaly between 250' and 200'W, with a smaller value for the quadrature component. The conductive body is at a depth of 25' or less and of good conductivity. (Anomaly 16)

20S

* The anomaly between 1400' and 1300'W is accompanied by a positive slope quadrature component. The anomaly indicates a body of only moderate conductivity and size at a depth of 50'. (Anomaly 20)

There are two larger anomalies on this line between 650' and 500'W and 300' and 200'W. The first has a quadrature component with a relatively steep slope, which indicates that the body is a poor conductor, although reasonably large and at a depth of 75'. The second anomaly has a smaller quadrature component and the body is at a depth of 50'. (Anomaly 16)

22S

The Kosminsky Hill V.L.F. anomaly is between 1350' and 1200'W on this line and is accompanied by a positively sloping

quadrature component. The anomaly indicates a body at a depth of 50' below 1300'W, and of moderate conductivity.

(Anomaly 20)

The anomalies between 650' and 500'W and 200' and 150'W also have positive sloping quadrature effects, and the bodies producing these anomalies only have a moderate conductivity. The first is at a depth of 75' under 575'W, and the second is a near-surface body under 175'W.

24S

There are two small anomalies on this line, the first between 1350' and 1100'W and the second between 450' and 550'W. The latter anomaly has a reverse slope quadrature effect indicating the presence of conductive overburden. The body causing the anomaly is relatively small and at a depth of about 50' under 525'W. The first anomaly may be due to the presence of two bodies, one near-surface body below 1325'W, and one slightly deeper below 1200'W but relatively small.

26S

* There is a large anomaly on this line between 500' and 300'W in the in-phase component, with an accompanying positive slope of the quadrature. The body is probably at a depth of 75' below 400'W, and of moderate conductivity.

(Anomaly 17)

There is a smaller anomaly between 1050' and 950'W, but this does not appear to be very important as the quadrature component has a relatively high value indicating that the body is only poorly conductive and does not appear very large.

28S

* There are two anomalies on this line of some importance. The first lies between 1050' and 950'W and has a small quadrature component associated with it. The body is at a depth of about 50' under 1000'W and of good conductivity.

(Anomaly 20)

* The anomaly in the in-phase component between 250' and 200'W indicates a large near-surface body under 225'W of medium conductivity.

(Anomaly 18)

30S

Between 1750' and 1350'W there is a relatively large slope of the in-phase profile which possibly indicates a large body at a depth of 200'. The quadrature component has a low value, suggesting that the body has a good conductivity. (Anomaly 19)

There is a smaller near surface anomaly between 1000' and 1050'W with only a small positive quadrature effect indicating a body of reasonably good conductivity. (Anomaly 20)

32S

* The large anomaly of the previous line is extended to this line between 1500' and 1300'W. The quadrature component shows a reverse slope in this region indicating the presence of conductive overburden.

The body appears to be large and at a depth of about 100' below 1400'W. (Anomaly 19)

There is another anomaly between 550' and 600'W which is caused by a near surface body of relatively poor conductivity, as indicated by the large positive quadrature value and slope. (Anomaly 54)

(H) SOUTH COMET GRIDS35S

* The anomaly between 750' and 850'E in the in-phase component has an accompanying slight reverse slope quadrature effect, suggesting the presence of conductive overburden. The conducting body causing the anomaly appears to be reasonably large and at a depth of about 50' below 800'E. (Anomaly 19)

34S

The large anomaly between 750' and 300'W may be split up into two major parts. The first between 750' and 600' indicates a mediumly conductive body at a depth of 50' below

675'W, while the second between 450' and 300' suggests a mediumly conductive body at a depth of 75' below 375'W. (Anomalies 54 & 55)

37S

* The main part of the anomaly on this line is between 850' and 1000'E with a relatively small quadrature component showing little variation. The body is at a depth of 50' or less below 925'E and has a good conductivity. (Anomaly 19)

36S

* There is a large anomaly between 350' and 150'W in the in-phase component with an associated large positive gradient of the quadrature profile. This suggests a large body of only medium conductivity at a depth of about 50' under 200'W. (Anomaly 57)

39S

* The two anomalies on this line both have very small quadrature components. The first between 700' and 750'E is a steeply sloping profile indicating the presence of a near surface body of good conductivity. (Anomaly 52)

* The second between 800' and 1050'E has a less steep in-phase profile and the body is located at a depth of 100' under 950'E and also has good conductivity. (Anomaly 19)

38S

* The most important anomaly on this line is located between 150'W and 0 in the in-phase component. The quadrature profile is very small and shows negligible variation. The body is at a depth of 75' below 75'W, and has a good conductivity. (Anomaly 57)

41S

The anomaly in the in-phase component between 100' and 200'E has a large positive slope quadrature effect associated with it. The body producing this anomaly is poorly conductive, and at a depth of 50' below 150'E. (Anomaly 53)

40S

There are no anomalies of any importance on this line.

42S

There is a small anomaly between 1850' and 1750'W with a large positive slope quadrature component, indicating a poorly conductive small body at a depth of 50' or less below 1775'W.

44S46S

There appears to be no significant anomalies along these lines.

48S50S52S

There are three small anomalies on this line indicating small near-surface bodies of relatively good conductivity. There is also an open anomaly to the east extending from 100'W.

54S

There are no anomalies evident on this line.

56S

The anomaly between 1100' and 700'W is possibly the result of two bodies. The first at a depth of about 50' below 1050'W is of moderate conductivity, while the second is apparently deeper, possibly at a depth of 100' below 800'W, and of poor to moderate conductivity.

58S

There again appear the two close anomalies seen on the previous line. The first between 1150' and 900'W in the in-phase component has an associated quadrature effect which shows a reverse slope in part of this region, suggesting the presence of conductive overburden. The body is at a depth of about 100' below 1000'W.
(Anomaly 58)

The second anomaly extends from 650' to 900'W in the in-phase component, with the quadrature profile showing a small positive slope. The profiles indicate a moderately conductive large body at a depth of 150' below 750'W. (Anomaly 59)

60S

* Between 900' and 800' there is an anomaly in the in-phase component, with the quadrature showing a small positive slope. The body is at a depth of 50' below 850'W, but of medium conductivity.

There is a small near-surface body indicated by the anomaly between 750' and 700'W, and a small but slightly deeper body is indicated by the in-phase profile between 650' and 500'W.
(Anomaly 59)

(1) Other Geophysical Results Comet-Kosminsky and South Comet Grids

There is an S.P. anomaly on line 2S between 1650' and 1750' which is slightly to the east of the V.L.F. anomaly on line 2S. There is also a smaller SP anomaly on line 12S at about 1800'W which may be related to the V.L.F. anomaly of the Comet-Kosminsky Load on line 12S and 14S. These S.P. anomalies are both approximately north-east of the V.L.F. anomalies. The S.P. anomaly on line 24S centred about 1600'W coincides with a V.L.F. anomaly on the geochem traverse 00. On line 32S there is an S.P. anomaly between 1400' and 1450'W which coincides with the V.L.F. anomaly on this line. An open S.P. anomaly appears on line 35S which could be connected with V.L.F. anomaly on the east end of this line.

(I) AINSLIE GRID2.69N

There is a strong anomaly on this line indicating a large near-surface body. The anomaly in the in-phase component is between 500' and 550', the quadrature component shows a large negative gradient thus indicating the presence of conductive overburden. Further work should be done on this anomaly. (Anomaly 21)

There are two other smaller anomalies on this line between 1450' and 1550'E and 1750' and 1800'E. Both these are reasonably small bodies with appreciable quadrature values, so are only moderately conductive. The first is at a depth of about 50', while the second is nearer the surface.

02S

The anomaly on this line extends from 1500 to 1500'E

and is relatively large and steep, indicating a near surface body. The quadrature component does not show any fluctuation, but does have a positive value. The anomaly does not appear to extend to either of the adjacent lines, so it is possibly due to only a small near-surface conductive body. (Anomaly 22)

04S

There are two small anomalies on this line, neither of which appear to be very important.

06S

* There is a very large anomaly between 550' and 700'E, but this is also accompanied by a large quadrature component, although this does not vary. The body producing this anomaly is probably very large and conductive and at a depth of about 50'.
(Anomaly 23)

There is a smaller anomaly between 900' and 1000'E, but this has an exceptionally high quadrature component, indicating that the body causing this anomaly is of very poor conductivity.

08S

* The anomaly extending from 500' to 800'E appears to be in two parts. The first from 500' to 550'E is accompanied by a very slight reverse slope quadrature effect, and suggests a body near the surface, but small. The second part of the anomaly is larger, from 700' to 800' with a slight positive quadrature slope, but high quadrature value. The body is probably at a depth of about 50' and is relatively large.
(Anomaly 24)

10S

There are three anomalies along this line; the first extends from 0' to 100'E and is accompanied by a positive quadrature gradient. The body is probably at a depth of about 50' and only moderately conductive.
(Anomaly 25)

The second lies between 800' and 900'E in the in-phase component, and there again appears a slight positive quadrature slope. Thus the body is at a depth of about 50' and again only moderately conductive. Between 1125' and 1350' lies the third anomaly. This is accompanied by a small reverse

slope quadrature component, indicating the presence of conductive overburden. The conductive body is at a depth of probably at least 100' and appears relatively large.

12S

* There is a strong anomaly extending from 0' to 200'E along this line. It is accompanied by a large reverse slope quadrature effect. The conductive body will probably be at a depth of about 100', and appears to be large.

There is a second anomaly between 1500' and 1750'E, which does not appear quite as important as the first. The quadrature component shows little variation, but the body probably at a depth of about 50' - 75' does not appear to be very large.

14S

* There again appears this very large anomaly at the western end of this line, between 200' and 300'E. The body will probably be at a depth of about 50', and there appears a strong positive quadrature slope, but this anomaly still appears very interesting. (Anomaly 25)

Between 950' and 1050' there is another anomaly again showing a small positive quadrature slope. This body is at a depth of about 50' and is moderately conductive. (Anomaly 27) A third anomaly is present between 1900' and 2000'E which appears to have a good conductivity and at a depth of about 50', but is probably not very large.

16S

There are two large anomalies along this line, the first between 1600' and 1700' has a very small quadrature component, suggesting that the body has good conductivity, and is at a depth of about 50' and is large. The second anomaly extends from 1800' to 2000'E and is accompanied by a small positive quadrature effect, but this body is also large at a depth of about 100'. Both these anomalies appear very interesting.

18S

* The main anomaly on this line is between 150' and 350'E in the in-phase component. The body is probably at a

047

depth of about 100', and over most of the anomaly the quadrature component has a negative slope, indicating the presence of conductive overburden.

20S

There are four anomalies along this line, none of which is very large. Between 200' and 300' there is an anomaly in the in-phase component which has an associated positive slope in the quadrature component. The body is at a depth of about 50', and only weakly-moderately conductive. The anomaly between 1100' and 1200'E also has a positive quadrature slope, and is probably due to a moderately conductive body at a depth of about 25' to 50'. The anomaly between 1550' and 1600'E seems to suggest a small, near surface body. The negative quadrature slope indicates the presence of conductive overburden. Between 1800' and 1950'E there is a small anomaly with a small variation in the quadrature component. The body lies at a depth of about 75', having a moderate conductivity.

22S

* There is a large anomaly between 500' and 650' on this line. The quadrature component over the main part of the anomaly has a positive slope. The conducting body is probably at a depth of about 50' and is fairly large. (Anomaly 31)

* The anomaly between 1650' and 1750'E is also fairly large with a strong reverse slope in the quadrature component, indicating the presence of conductive overburden. The body is probably at a depth of 50' or more, and looks relatively large. (Anomaly 32)

24S

There is a small near-surface anomaly between 1200' and 1250', with a small quadrature component, but this is unimportant.

* There is a large anomaly extending from 1750'E and open to the east which is possible due to two bodies, the first at a depth of about 75' under 1825'E, and with a reverse quadrature slope; the second extending eastward from 2000'E, which has a very small positive slope in the quadrature component. This anomaly looks interesting.

26S

The anomaly between 700' and 950'E might be due to a large body, possibly at a depth of about 100' or more. The quadrature component shows some variation, but does not have a terribly large value. This anomaly might be interesting.
(Anomaly 34)

28S

* There is an anomaly between 850' and 1000' which is accompanied by a positive slope in the quadrature component. The anomaly is probably due to a body at a depth of about 75', which is of good conductivity. This anomaly is worthy of further investigation.
(Anomaly 34)

30S

There are a few small anomalies on this line, but none of these seem very important.

(J) EAST SOUTH COMET GRID

32S

There is an anomaly at the west end of this line, which extends from 00 to 150'E. The quadrature component is low valued, suggesting a small body of good conductivity at a depth of about 50'. Between 300' and 500'E there is another anomaly which has a quadrature component showing no variation. The body is probably at a depth of about 100' and seems relatively large with a good conductivity.
(Anomaly 56)

The third anomaly is not so large, extending from 600' to 750'E in the in-phase component, with a slightly varying but low quadrature component. The body is probably small and at a depth of about 75'.

34S

There are again three anomalies on this line, but none appear to be very important. The first, between 650' - 750'E, will probably be at a depth of about 50', but the body is not large and only moderately conductive, as the associated quadrature

component has a large negative value. The second anomaly between 950' and 1000'E is also small, poorly conductive and near the surface. The third anomaly is between 2000' and 2100'E, and although still small, this has a higher conductivity, and is between 25' and 50' below the surface. The quadrature component in the region of this anomaly is low.

38S

There are no anomalies of any importance along this line.

40S

There appears to be a large anomaly extending from 0 to 100'E on this line. The quadrature component has a positive slope in this region, so the body although reasonably large may only have a medium conductivity. (Anomaly 57)

44S

There is a large anomaly between 100'E and 400'E with only a little variation in the quadrature profile, although this has a reasonably high value. The body is probably centred below about 300'E, and at a depth of 100' or more, and appears to be relatively large. (Anomaly 57)

48S

The anomaly on this line is very large, extending from 200' to 400'E. The quadrature profile shows a reverse slope, indicating the presence of conductive overburden. The body is centred below about 575'E at a depth of about 75' - 100'. (Anomaly 57)

(K) WEST COMET GRID

10S

There are no anomalies of interest along this line.

25S

Between 200' and 1300'W there is an anomaly in the

in-phase component, with the quadrature showing a positive slope. The body is probably at a depth of about 50' and appears to be moderately conductive but only small.

The reverse quadrature slope in the region of the anomaly between 800' and 1000'W indicates the presence of conductive overburden. The anomaly is due to a body at a depth of at least 50', but may not be large but is of good conductivity.

(L) BROKEN HILL GRID

28S

The main anomaly on this line is between 850' and 950'E, and the quadrature component shows only a very slight positive slope. The body has a reasonably good conductivity at a depth of about 50' below 900'E.

There is also a near-surface body indicated by the anomaly between 550' and 600'E. The quadrature component has a very small value in this region, so the body has a good conductivity but is relatively small.

(M) SUMMARY OF MAIN V.L.F. ANOMALIES

<u>Anomaly</u>	<u>North Comet Grid</u>	
1.	2.5N	400 - 450'E
2.	2.5N	1600 - 1700'E
	00	1500 - 1550'E
3.	2.5S	0 - 50'E
4.	7.5S	350'W
5.	10S	550'E
61.	2.5N	1450 - 1600'W
62.	00	1200 - 1450'W
63.	5.0S	1350 - 1400'W

Open to West

Anomaly Hasset - Gravel Pit Grids

6.	8N	950' W	Open to West
	6N	800' - 850'W	
7.	8N	150 - 200'E	
	6N	200 - 250'E	
	4N	350 - 400'E	
	00	350 - 400'E	
8.	4N	950 - 1000'E	
9.	8N	3200 - 3250'E	

Anomaly Platt Grid

10.	6S	750 - 800'W
	8S	800' - 850'W

Anomaly Red Lead Grid

36.	22S	1900' - 2000'W
	24S	1875' - 1925'W
37.	26S	875' - 950'W
38.	28S	200' - 250'W
39.	26S	2100' - 2275'W
	28S	2050' - 2200'W
40.	30S	2350' - 2500'W
41.	34S	1500' - 1700'W
42.	34S	950' - 1150'W
43.	34S	650' - 800'E

44.	38S	1750'	-	1900'W
45.	40S	1950'	-	2050'W
46.	38S	1200'	-	1400'W
47.	38S	500'	-	600'E
48.	38S	750'	-	850'E

Anomaly

Bonanza Grid

49.	42S	1800'W	-	1950'W
	44S	1700'	-	1850'W
50.	44S	450'	-	700'W
	46S	450'	-	650'W
51.	42S	1900'	-	1950'E

Anomaly

Comet - Kosminsky Grids

11	2.69N	800'	-	850'W
12.	2S	1700'	-	1800'W
	4S	1750'	-	1850'W
13.	6S	650'	-	750'W
14.	8S	1600'	-	1750'W
	10S	1600'	-	1700'W
15.	16S	50'	-	100'W
16.	18S	200'	-	300'W
	20S	175'	-	300'W
	22S	150'	-	200'W
17.	26S	350'	-	450'W
18.	28S	175'	-	250'W
19.	30S	1400'	-	1650'W
	32S	1250'	-	1500'W
	35S	750'	-	900'E
	37S	850'	-	1000'E
	39S	850'	-	1000'E
20.	Kosminsky Hill anomaly.			

Anomaly

South Comet Grid

52.	39S	700'	-	800'E
53.	41S	100'	-	200'E
54.	32S	550'	-	600'W
	34S	500'	-	750'W
55.	34S	350'	-	400'W
57	36S	100'	-	300'W

57.	38S	0' - 150'W	
	40S	150'E - 100'W	
	44S	200' - 400'E	
	46S	250' - 400'E	
	48S	200' - 350'E	Open to South
58.	58S	950' - 1050'W	
59.	58S	650' - 800'W	
	60S	700' - 750'W	
60.	60S	750' - 950'W	Open to South

AnomalyAinslie Grid

21	2.69N	500' - 600'E	Open to North
22.	2S	1450' - 1500'E	
23.	6S	525' - 650'E	
	8S	500' - 550'E	
24.	8S	700' - 800'E	
	10S	800' - 900'E	
25.	10S	0' - 100'E	
	12S	50' - 175'E	
	14S	200' - 325'E	
26.	10S	1250' - 1300'E	
27.	14S	950' - 1025'E	
28.	16S	1575' - 1700'E	
29.	16S	1800' - 1950'E	
30.	18S	200' - 350'E	
31.	22S	525' - 700'E	
32.	22S	1600' - 1775'E	
33.	24S	2000'E -	Open to East
34.	26S	750' - 950'E	
	28S	850' - 1000'E	
35.	30S	1000' - 1050'E	
56.	32S	350' - 450'E	

VI CONCLUSIONS

Thus the V.L.F. method of exploration seems to be a nearly ideal electromagnetic method in the Dundas area. The ease of operation, dependability of the instrument, and repeatability of the results make it a very useful piece of equipment.

Further V.L.F. work in this region is recommended, and the method should also be extended to other areas, depending upon the geological strike with respect to the direction of the transmitted V.L.F. signal.

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056

880059

APPENDIX A

APPENDIX AThe polarization ellipse

Assuming the primary magnetic field, \underline{H} is horizontal and of zero phase angle, it may be written:-

$$|\underline{H}| = H \cos wt.$$

The secondary magnetic field, $|\Delta \underline{H}|$ may be written

$$|\Delta \underline{H}| = H \cos (wt. + \phi) \text{ where } \phi \text{ is the phase-shift}$$

Let $\Delta \underline{H}$ be inclined to \underline{H} at an angle α (Figure 1)

Then the components of \underline{H} and $\Delta \underline{H}$ in the horizontal (x) and vertical (y) directions are given by

$$H_x = H \cos wt \quad (1)$$

$$H_y = 0 \quad (2)$$

$$\Delta H_x = \Delta H \cos (wt + \phi) \cos \alpha \quad (3)$$

$$\Delta H_y = \Delta H \cos (wt + \phi) \sin \alpha \quad (4)$$

Adding (1) and (3)

$$\begin{aligned} \text{Let } C_x(t) &= H_x + \Delta H_x \\ &= H \cos wt + \Delta H \cos (wt + \phi) \cos \alpha \end{aligned}$$

Now $\cos (A+B) = \cos A \cos B - \sin A \sin B$

∴ By analogy

$$\begin{aligned} C_x(t) &= H \cos wt + \Delta H \cos wt \cos \phi \cos \alpha - \Delta H \sin wt \sin \phi \cos \alpha \\ &= \cos wt (H + \Delta H \cos \phi \cos \alpha) - \Delta H \sin wt \sin \phi \cos \alpha \end{aligned}$$

$$\text{Now } a \cos x - b \sin x = \sqrt{a^2 + b^2} \cos (x + \delta)$$

$$\text{where } \tan \delta = b/a$$

$$\therefore \text{By analogy } C_x(t) = X \cos (wt + \phi')$$

$$\text{where } \phi' = \tan^{-1} \frac{\Delta H \sin \phi \cos \alpha}{H + \Delta H \cos \alpha \cos \phi} \quad (5)$$

$$\text{and } X = \left[(H + \Delta H \cos \alpha \cos \phi)^2 + (\Delta H \sin \phi \cos \alpha)^2 \right]^{1/2}$$

$$\text{Adding (2) and (4) } C_y(t) = H_y + \Delta H_y$$

$$= H \cos (wt + \phi) \sin \alpha$$

$$\therefore C_y(t) = Y \cos (wt + \phi) \text{ where } Y = H \sin \alpha \quad (6)$$

Eliminate t from (5) and (6) to obtain the locus of $C(t)$, the resultant of the Primary and secondary fields.

Squaring and adding (5) and (6),

$$\begin{aligned} \frac{C_x^2}{X^2} + \frac{C_y^2}{Y^2} &= \cos^2 (wt + \phi') + \cos^2 (wt + \phi) \\ &= 1 + \frac{1}{2} \cos 2(wt + \phi') + \frac{1}{2} \cos 2(wt + \phi) \\ &= 1 + \cos (2wt + \delta + 2\phi) \cos \delta \end{aligned} \quad (7)$$

$$\text{where } \delta = \phi' - \phi$$

$$\begin{aligned} \text{Now } \frac{C_x C_y}{XY} &= \cos (wt + \phi') \cos (wt + \phi) \\ &= \frac{1}{2} \cos (2wt + \delta + 2\phi) + \frac{1}{2} \cos \delta \end{aligned}$$

$$\frac{2C_x C_y}{XY} = \cos (2wt + \delta + 2\phi) + \cos \delta \quad (8)$$

\(\therefore\) Substituting (8) in (7)

$$\frac{C_x^2}{X^2} + \frac{C_y^2}{Y^2} = 1 + \left(\frac{2C_x C_y}{XY} - \cos \delta \right) \cos \delta$$

$$\therefore \frac{C_x^2}{X^2} + \frac{C_y^2}{Y^2} - \frac{2C_x C_y}{XY} \cos \delta = \sin^2 \delta$$

This is the equation of the ellipse whose minor axis is inclined to the vertical by the angle θ where

$$\tan 2\theta = \frac{2XY \cos \delta}{X^2 - Y^2} \quad \text{See Figure 2}$$

Thus the resultant field rotates in space, and describes an ellipse of polarization whose eccentricity ξ is given by

$$\begin{aligned} \xi &= \frac{b}{a} \quad (\text{ratio of minor to major axes}) \\ &= \frac{\Delta H \sin \alpha \sin \phi}{H} \\ &\text{if } \Delta H \ll H. \end{aligned} \quad (7)$$

Thus the eccentricity increases as the phase angle ϕ increases, and thus ξ may be used as a measure of ϕ

If $\Delta H \ll H$, the inclination of the ellipse reduces to

$$\theta = \tan^{-1} \left[\frac{\Delta H}{H} \sin \alpha \cos \phi + \left(\frac{\Delta H}{H} \right)^2 \frac{\sin 2\alpha \sin \phi}{2} \right] \quad (8)$$

Thus the inclination and eccentricity of the ellipse are a measure of the relative field strength and phase of the primary and secondary fields.

$$\text{From above } \theta = \tan^{-1} \left[\frac{\Delta H}{H} \sin \alpha \cos \phi + \left(\frac{\Delta H}{H} \right)^2 \frac{\sin 2\alpha \sin \phi}{2} \right]$$

∴ For small secondary fields,

$$\begin{aligned} \theta &= \tan^{-1} \frac{\Delta H}{H} \sin \alpha \cos \phi \\ &= \tan^{-1} \frac{\Delta H_Y}{H} \quad (\text{real}) \end{aligned} \quad (9)$$

Thus the tangent of the inclination of the ellipse is proportional to the real component of the vertical secondary field, for small fields.

From above
$$\xi = \frac{\Delta H \sin \alpha \sin \phi}{H}$$

$$= \frac{\Delta H_y}{H} \text{ (quadrature)} \tag{10}$$

Thus the eccentricity of the ellipse is proportional to the vertical quadrature component.

(The approximation leads to small errors at large secondary field strengths.)

Thus measurements of inclination and eccentricity are proportional to the real and quadrature vertical components of the secondary field.

This is the theory for primary and secondary fields in the same vertical plane. However the primary and secondary magnetic fields usually have different azimuths so that the plane of the ellipse is inclined. Let the azimuth (horizontal angle) of the secondary field relative to the primary be k as shown in Figure 3.

Equation (7) for the eccentricity of the ellipse,

$$\xi = \frac{\Delta H \sin \alpha \sin \phi}{H}$$

remains unchanged, as the vertical component ($\Delta H \sin \alpha$)

is the only one that affects the eccentricity.

Equation (8) for the inclination of the ellipse is affected slightly in the second term and becomes

$$\theta = \tan^{-1} \left[\frac{\Delta H}{H} \sin \alpha \cos \phi + \left(\frac{\Delta H}{H} \right)^2 \frac{\sin 2\alpha \sin \phi \cos k}{2} \right] \quad (11)$$

From Figure 4.

$$\alpha = \tan^{-1} \left(\frac{-x}{d} \right)$$

Considering the azimuth, this equation becomes

$$\alpha = \tan^{-1} \left(\frac{-x \cos k}{d} \right)$$

Thus the effect of varying the azimuth of the secondary field is to stretch out the anomaly either side of its cross-over and to reduce the strength of both the inclination and eccentricity values roughly in preparation to $\cos k$.

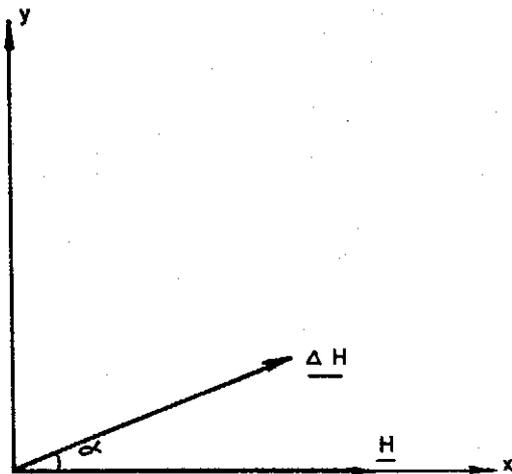


FIG. 1 INCLINATION OF SECONDARY MAGNETIC FIELD

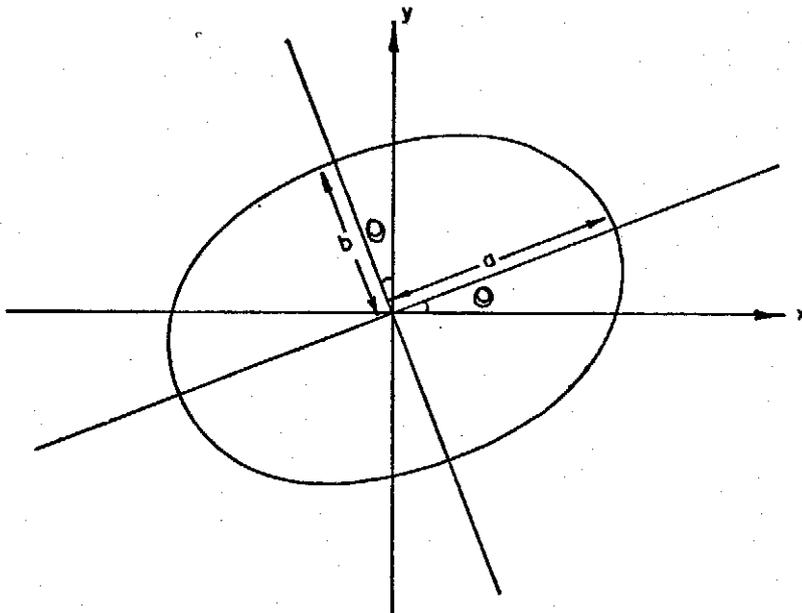


FIG. 2 ELLIPSE OF POLARIZATION

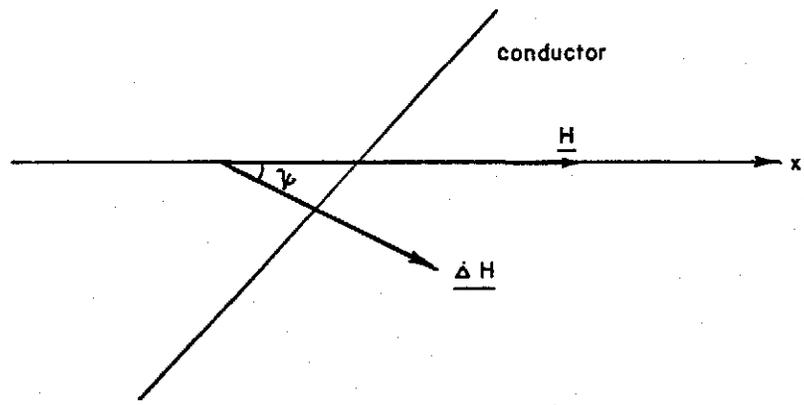


FIG 3 AZIMUTH ANGLE, ψ .

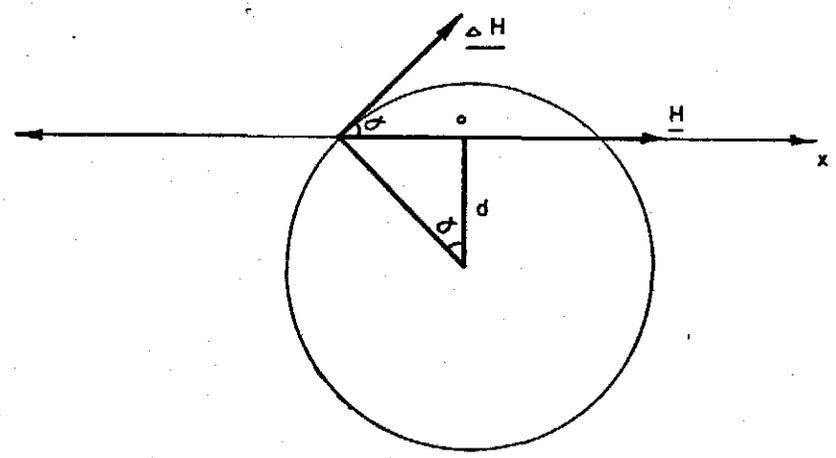


FIG 4 FIELD OVER LINE CURRENT SOURCE.

APPENDIX B

BY

W.S. TURNER

APPENDIX BField Inspection of V.L.F. Anomalies

Field inspection of all V.L.F. anomalies was the next logical step, after the V.L.F. data was reduced, processed and geophysically interpreted. These additional data would provide the next filter for selecting the most meaningful V.L.F. anomalies for a diamond drill testing program.

The field inspection was started by one of Geophoto's Field Geologists, and following are his findings and recommendation for 19 of the V.L.F. anomalies so far inspected. As this work is not yet completed, data available to date is presented in progress report form only.

The location of the respective anomalies is shown on map 1/273 attached to the V.L.F. report.

ANOMALY 15Area Extent

350 feet by 100 feet. Good magnitude and gradient.
Requires detailing in with more closely spaced lines.

Surface Indications

On a line of gossan which coincides with the lode at
20S + 1W + 50 feet N. This line of gossans is most probably
continuous with the Comet Lodes.

Geochem

Gossan assays are not yet at hand. Programmed hand
auger geochem from 16S + 8.25W for 1250 feet along the azimuth
of the proposed hole, at 10 feet intervals except over V.L.F.
anomalies and gossan outcrops, where the sampling interval is
5 feet.

067

880070

Proposal

KHE DDH2.

Targets

1. Mineralized shear located at 16S + 1W and coincident V.L.F. anomaly. Target depth 880 feet.
2. Two second order V.L.F. anomalies, one being at the Buu- ϵ c contact.
3. ϵ c-Puo contact. Target depth 275 feet.

ANOMALY 16

Area Extent

700 feet by 150 feet. Located on ϵ c-Puo contact.
Good magnitude and gradient.

068

880071

Surface Indications

Anomaly may be caused by one or both of the following.

- (a) Mineralization at the Ec-Puo contact.
- (b) Mineralization known to exist in the shear located at 19.5S + 1W and if so, then the shear dips at a lower angle than that indicated at the surface.

A third possibility is that shear zones may be filled with an electrolyte - especially the one between the Ec and the Puo.

Proposals

A test hole KHE DDH1 should be sited to test.

- (1) The shear known to contain Pb-Zn mineralization.
- (2) The Puo-Ec contact.
- (3) The three geochemical anomalies and the two V.L.F. anomalies to the west of the shears.

- (4) And finally to obtain and complete section of that part of the ϵc formation forming the capping on Kosminsky Hill.

ANOMALY 21

Area Extent

Sharp and open to the north.

Surface Indications

Concert Schist, lenses of black graphitic phyllite.

Proposal

Should be looked at in conjunction with the next grid to the north of Ainslie.

070

ANOMALY 22

Location

2S 14.50E - 15.00E.

Area Extent

500 feet by 100 feet. Medium order anomaly extending to north, with broadening to the west.

Surface Indications

Minor gossan rubble 150 feet to the east of the trend. Most rocks are Concert Schist. Programmed hand auger geochem.

2S 12.50E - 16.00E
00 14.00E - 17.50E at 10 feet intervals.

571

880074

ANOMALY 22

Location

2S 14.50E - 15.00E.

Area Extent

500 feet by 100 feet. Medium order anomaly extending to north, with broadening to the west.

Surface Indications

Minor gossan rubble 150 feet to the east of the trend. Most rocks are Concert Schist. Programmed hand auger geochem.

2S 12.50E - 16.00E
00 14.00E - 17.50E at 10 feet intervals.

072

880075

ANOMALY 23 & 24

Location

6S	525 - 650E
8S	500 - 550E
8S	700 - 800E
10S	800 - 900E

Areal Extent

700 feet by 250 feet. Isolated anomalies possibly continuous with anomaly 27. May line up with low order anomaly at 4S + 300 feet - 375 feet E.

Surface Indications:

Poor outcrop. Probably black graphitic phyllite. Gossan outcrop at 4S + 5.5E.

Programmed hand auger geochem. 4S 1E - 7.5E and 6S 3E - 7.5E at 10 feet intervals.

ANOMALY 25Area Extent

750 feet by 150 feet. Lines up with anomalies 26, 28 and 31 of a similar order of magnitude. Broadening of contours to the west indicates a westerly dip. Very high centre at 14S + 2.5E.

Surface Indications

Minor gossans at 00 + 8.5S, 16S + 4E. No rock geochem at hand. Programmed hand augering 14S, 1.5E - 3.5E. The anomaly parallels the shear through 16S + 1W. High V.L.F. recordings may be related to abundant black graphitic phyllite associated with the shear zones.

Proposals

KHE DDH-3 - conditional on favourable results from KHE DDH-2.

074

880077

If favourable results are not met in this hole then a short 400 feet hole of similar azimuth and depression should be sited near 14.5S and 50 feet E.

- Targets :
- (a) V.L.F. anomaly 25 at 750 feet.
 - (b) Mineralized shear and V.L.F. anomaly at 15S + 1.4W. Target depth 250 feet.

ANOMALY 26

Location

10S 1250E - 1300E.

Area Extent

200 feet by 150 feet. Lower order, broad isolated anomaly. May line up with Anomaly 28 or with small anomaly at 6S + 9.5E - 10.25E.

Surface Indications

Outcrop of Concert Schist. No indications of mineralization in immediate vicinity of the anomaly. Gossan outcrop and scree to S.E. on line 12S. Possibly continuous.

Proposal

No present action.

ANOMALY 27Location

14S 950E - 1025E.

Area Extent

300 feet by 100 feet. Possibly a continuation of the low order anomaly at 20S + 11.25E - 12.25E.

07E

Surface Indications

Concert Schist. No surface indications of mineralization.

Proposal

Hand auger geochem 20S 7E to 11E.

ANOMALY 28

Location

16S 1575E - 1700E.

Area Extent

400 feet by 150 feet. Good magnitude and gradient. Anomaly broadens to the west indicating a possible westerly dip.

077

Surface Indications

Outcrop of Concert Schist. No indication of mineralization except for small gossan in adit at 18S + 16E + 70 feet south. Gossan rubble 200 feet to west in soil cover.

Hand auger geochem completed 16S 1350E - 20E. Results not yet at hand (at 10 feet intervals).

Proposal

A.D.D.H. 2.

ANOMALY 29

Location

16S 1800E - 1950E.

Area Extent

450 feet by 200 feet. Isolated high order anomaly.
Good magnitude and gradient.

Surface Indications

Pb, Zn and Pyrite mineralization in dolomitic grey shale in two adits. Associated strong milky quartz veining striking roughly N-3. Anomaly located directly over workings. Most rocks either Puc or Cc. Hand auger geochem completed. 16S 1350 - 2000 feet E. Results not yet at hand (10 feet intervals).

Proposal

A D.D.H. 2. in conjunction with Anomaly 28.

- Targets :
- (1) V.L.F. Anomaly 29. Target depth 700 feet.
 - (2) V.L.F. Anomaly 28. Target depth 400 feet.
 - (3) Weak gossan. Target depth 150 feet.

078

ANOMALY 30

Location

Line 18S 200 feet - 350 feet E (Ainslie).

Area Extent

600 feet by 150 feet. Running in N.N.E. direction.
Good magnitude and gradient. Does not appear to be on a
linear with any other anomalies.

Surface Indications

Chert conglomerate body amongst grey micaceous
quartzite; black graphitic phyllite. The conglomerate may be
faulted into position. Structure uncertain.

Proposal

Should not be drilled at the present time.

ANOMALY 31Area Extent

400 feet by 150 feet. Strong anomaly, broadening to the west. Lines up with Anomaly 25.

Surface Indications

One adit and several pits. Pyrite, Pb, Zn, and Sb mineralization associated with siderodolomite veining. V.L.F. anomaly displaced and broadened to the west of the workings indicating a westerly dip of the conductive body in the adit.

The chert conglomerate outcrop nearby may be faulted into position by a N.N.W. trending fault which lines up with the Comet Mine. Such a fault is indicated on the aerial photo map.

The high order V.L.F. values are probably enhanced by black graphitic phyllite and a probable electrolyte along the sheared zone.

Programmed hand auger geochem on line 24S, 5.5E - 15E.

Shallow depth of weathering.

Proposal

A DDH-1.

- Targets :
- (1) Anomaly 31. Target depth 50 feet to 200 feet.
 - (2) Ainslie Mine ? Lode Target depth 575 feet.
 - (3) V.L.F. Anomaly and narrow mineralized lodes at 810 feet and 875 feet.

ANOMALY 32

Location

22S + 16 - 17.75E.

Area Extent

500 feet by 100 feet. Reasonably high order anomaly

082
30
broadening to the west, indicating a westerly dip. Part of a broad V.L.F. anomaly enclosing anomalies 28, 29 and 33.

Surface Indication

Outcrop of Euo. No visible expression of mineralization.

Proposal

Should be considered for drilling after A D.D.H.-2. Programmed hand auger geochem. 22S 14.5E - 18.5E at 10 feet intervals.

ANOMALY 33

Location

24S 2000 feet E - open to E.

Area Extent

Part of a broad zone of anomalies encompassing anomalies 28, 29, 32 and 33.

Proposal

Should be looked at in conjunction with the next grid to the east of Ainslie.

ANOMALY 34Area Extent

550 feet by 150 feet. Moderately strong anomaly with good gradient.

Surface Indications

No indications of mineralization. Outcropping micaceous

quartzite and black graphite phyllite. Lines up well with Anomaly 31.

Programmed hand auger geochem 28S, 7.5E - 15.5E.

ANOMALY 49

Area Extent

700 feet by 150 feet. Trending NS and open to the west. Possible extension further to the south under thick soil cover.

Surface Indications

Lateritic limonite goethite gossan 350 feet by 50 feet outcropping in swampy area. Abundant coarse milky quartz vein scarce. Probably indications of a fault. Anomalous gossan geochem.

Recommendations

Should be looked at in conjunction with the next grid to the west.

ANOMALY 50

Area Extent

600 feet by 200 feet. General broadening of the contours to the west may indicate a westerly dip. Sharp cut off to the south - either lithologically or fault controlled - possibly both. One of several isolated high order anomalies located within the serpentinite. Possibly on a linear with the Adelaide Mine.

Surface Indications

White quartz vein and goethite limonite jasper gossan.

Three adits driven on the gossan - one with probably considerable underground development. Crocoite abundant in all workings along joints in extremely weathered brown silicified serpentinite.

Weathering at surface to a similar depth to that at the Red Lead Prospect.

Attitudes of gossan veins varies considerably in dip but generally strike 335° - 340° . Dip directions vary from 75° W to 75° E.

White quartz veining strikes N.W. - S.E. and dips N.E. at 20° - 40° .

Proposal

D.D.H. located at 46S + 9W + 50 feet S or thereabouts with azimuth 70° true, depression 55° . Target depth 500 - 550 feet.

This would be conditional on results from the series of D.D.H.'s in the Adelaide Mine.

ANOMALY 51

Area Extent

Part of a broken V.L.F. anomaly 4500 feet in length and from 200 feet to 400 feet wide.

Surface Indications

To the S.E. the V.L.F. pattern parallels that of the quartz gossan outcrop over the south Comet Ridge. This indicates a westerly dip of the ? lode of 65°. Most rocks are Hodge Slates.

Proposal

Three D.D.H.'s should be sited over the South Comet Ridge part of the large anomaly where significant coincident geochemical anomalies exists, prior to drilling of extensions such as Anomaly 51.

ANOMALY 52Location

Ainslie	20S	11.25E	-	12.25E
	24S	12.25E	-	12.5E
	28S	13.25E	-	14.25E

Areal Extent

Strike length 1000 feet. Continuous low order V.L.F. anomaly.

Surface Indications

Along line 20S. Several adits exposing small Pb, Zn, and Sb lodes striking N.N.W. are present. The V.L.F. anomaly is displaced to the west of the workings.

Along lines 24S and 28S. No exposed signs of mineralization. Fresh outcropping rock. Thin skin of weathered rock.

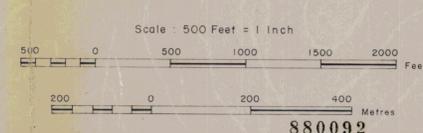
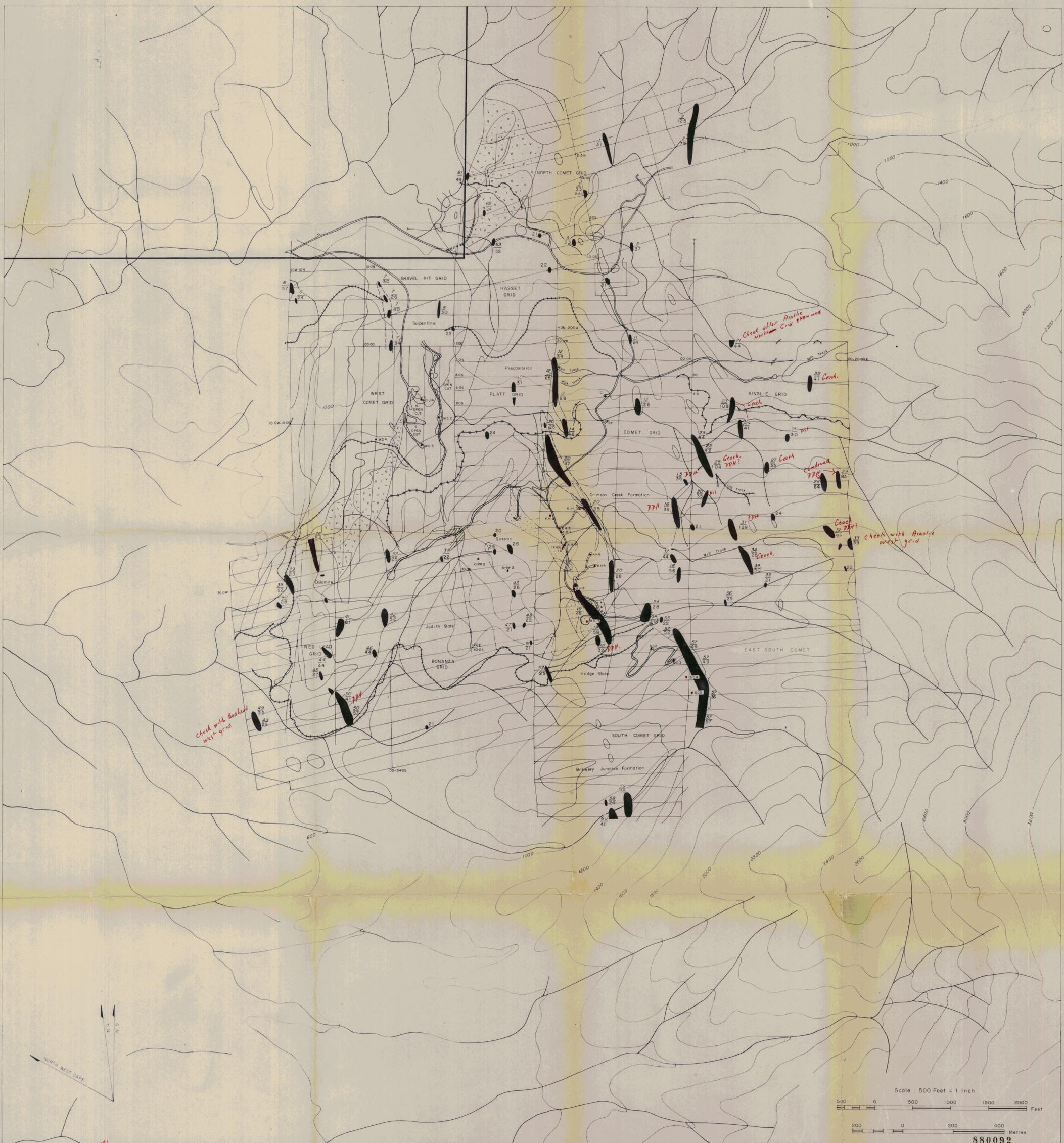
Proposal

A D.D.H.-1. See anomaly 31 proposal.

Expectations

Several narrow lenses of Pb, Zn, Sb protore.

W.S. TURNER



880092

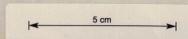
Reference Number:
 VLF Survey Anomalies
 Numerical values indicate
 relative magnitude of anomalies.

- Transition
- Red Lead Conglomerate
- Judith slate and tuff
- Dolomite breccia filling-green stained dolomite
- Serpentine
- Siliceous serpentine contact zones Quartz veined chert etc
- Brewery Junction Formation
- Razorback Conglomerate
- Hodge Slate

LEGEND

- Transition
- Red Lead Conglomerate
- Judith slate and tuff
- Dolomite breccia filling-green stained dolomite
- Serpentine
- Talc Formation
- Basic-intermediate tuffs and lavas. Minor associated acid rocks
- Pyritic red jasper
- Mottled crimson-blotchy limonitic sandstones, grits or tuffs
- Crimson Creek Formation, purple, green, grey mudstone, siltstones, shales and tuffs. Pink, cream grey dolomite and dolomitic siltstones.

- Crimson Creek Formation, cream-khaki weathered siltstones and shales, dolomitic in part.
- Quartzite - dolomite
- Precambrian - quartzite, slates, micaceous shales
- Contact Schist

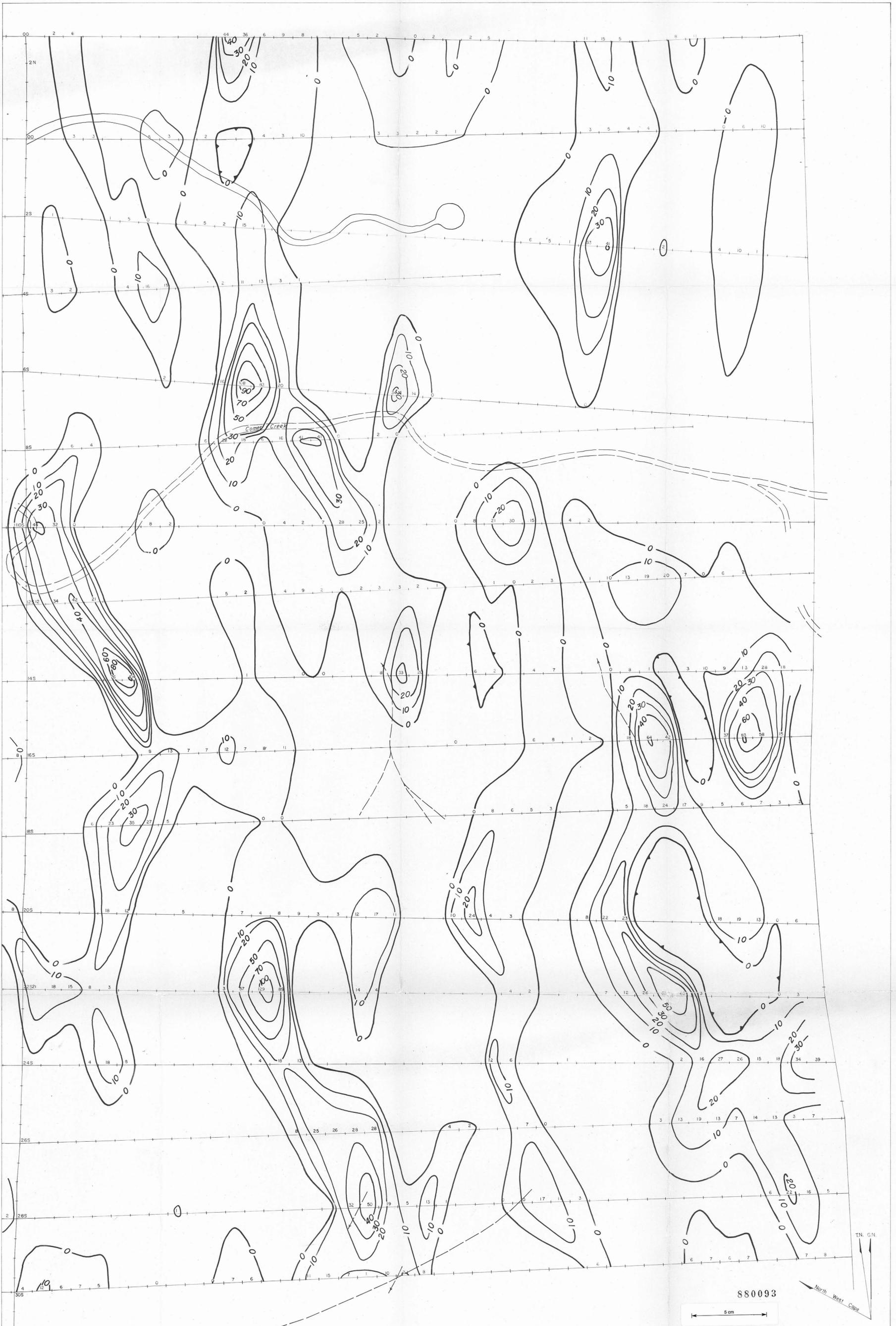


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 E.L. 7/68 DUNDAS DISTRICT TAS.
CENTRAL DUNDAS AREA
GRIDGING, GEOLOGY
AND VLF ANOMALIES

PROJECT 7/68 DATE 25/6/71 DWS NO 1/273
 0/60 / 74

3619



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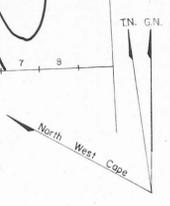


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AINSLIE GRID
V.L.F. FIRST DERIVATIVE CONTOURS

71-760. 3618
DRAWING NO. 1/270

880093
5 cm



50/74

1/271



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COMET-KOSMINSKY GRID
V.L.F. FIRST DERIVATIVE CONTOURS

5074 71-760
3615
DRAWING NO. 17/271

1/271



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BRISBANE

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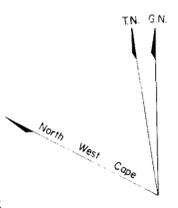
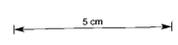


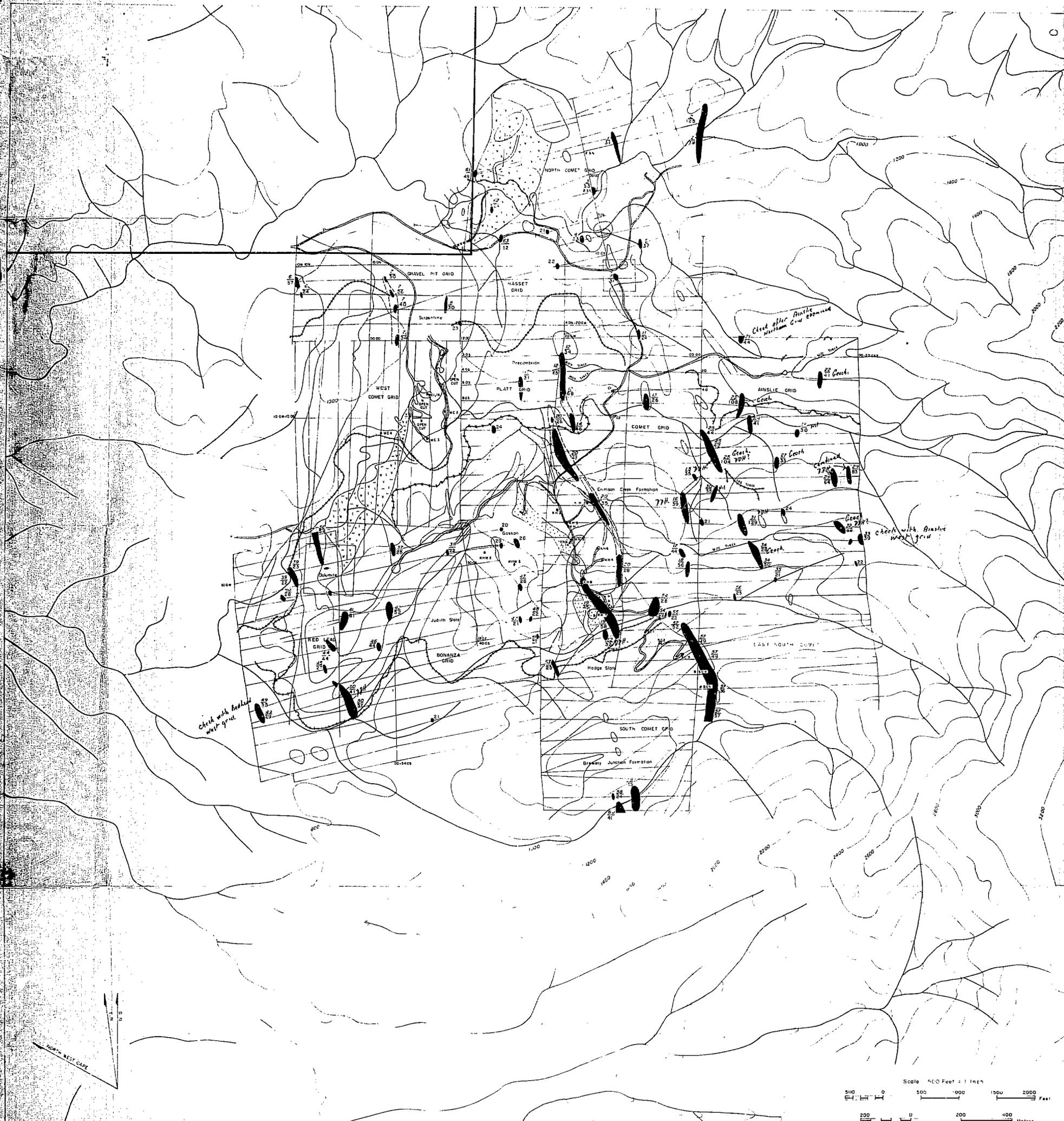
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E.L.7/68 DUNDAS DISTRICT

BONANZA GRID
V.L.F. FIRST DERIVATIVE CONTOURS

71-760
3626
DRAWING NO. 1/272

880095





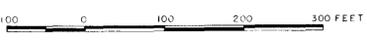
LEGEND

- | | | |
|--|---|---|
| <ul style="list-style-type: none"> Invertebrate Dinosaur Formations (not shown in this map) Siliceous serpentine contact zones (Quartz veined chert etc) Brewery Junction Formation Razorback Conglomerate Hedge Stone | <ul style="list-style-type: none"> Transition Red Lead Conglomerate Judith state and tuff Dolomite breccia fill-in-green stained dolomite Serpentine Talc Formation Basic-intermediate tuffs and lavas
Minor associated acid rocks Pyritic red jasper Mottled crimson-batchy tuffaceous sandstones, grits or tuffs Crimson Creek Formation (quartz, green, grey mudstone, siltstone, sandstone and tuff)
Five, cream grey dolomite and diamicite siltstones | <ul style="list-style-type: none"> Crimson Creek Formation (cream-shale, weathered siltstones and shales, dolomite in part) Quartzite-dolomite Precambrian-quartzite, slates, micaceous shales Concert Schist |
|--|---|---|

Reference Number:
 U.S.P. Survey Anomalies
 Dashed lines indicate
 relative magnitude of anomalies.

Scale 500 Feet = 1 inch
 500 1000 1500 2000 Feet
 200 400 Meters

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CENTRAL DUNDAS AREA
GRIDGING, GEOLOGY
AND VLF ANOMALIES
 7/68 DATE 12/6/71 1/273
 1/30/74



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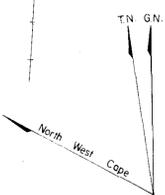
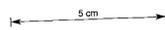


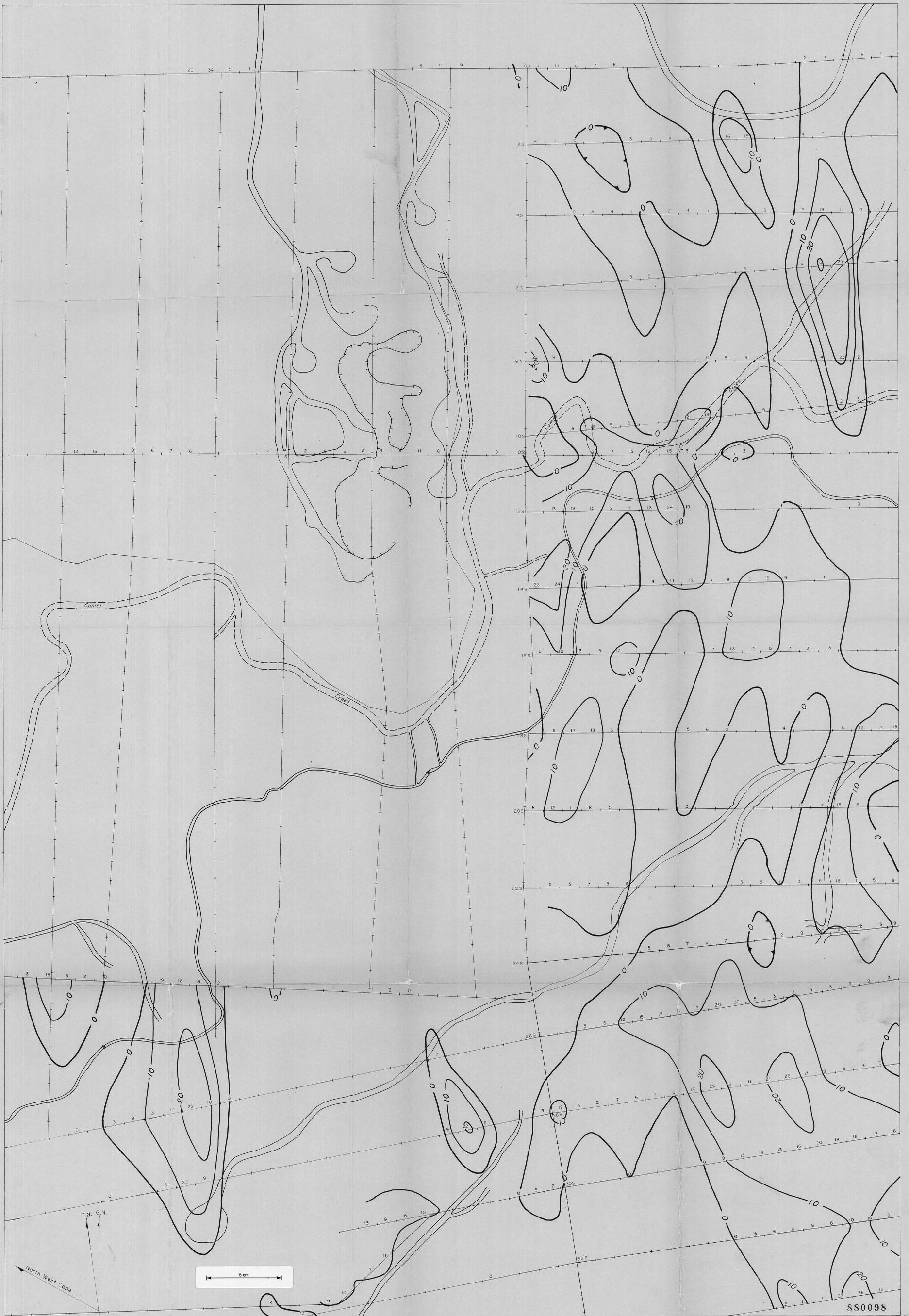
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SOUTH COMET GRID
V.L.F. FIRST DERIVATIVE CONTOURS

3613
50/74 71-160
DRAWING NO. 1/274

880097





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WEST COMET - PLATT GRID
V.L.F. FIRST DERIVATIVE CONTOURS

880098

71-76

0198
50/74

DRAWING NO. 1/275

1/275



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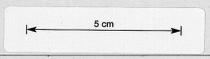
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NORTH COMET GRID
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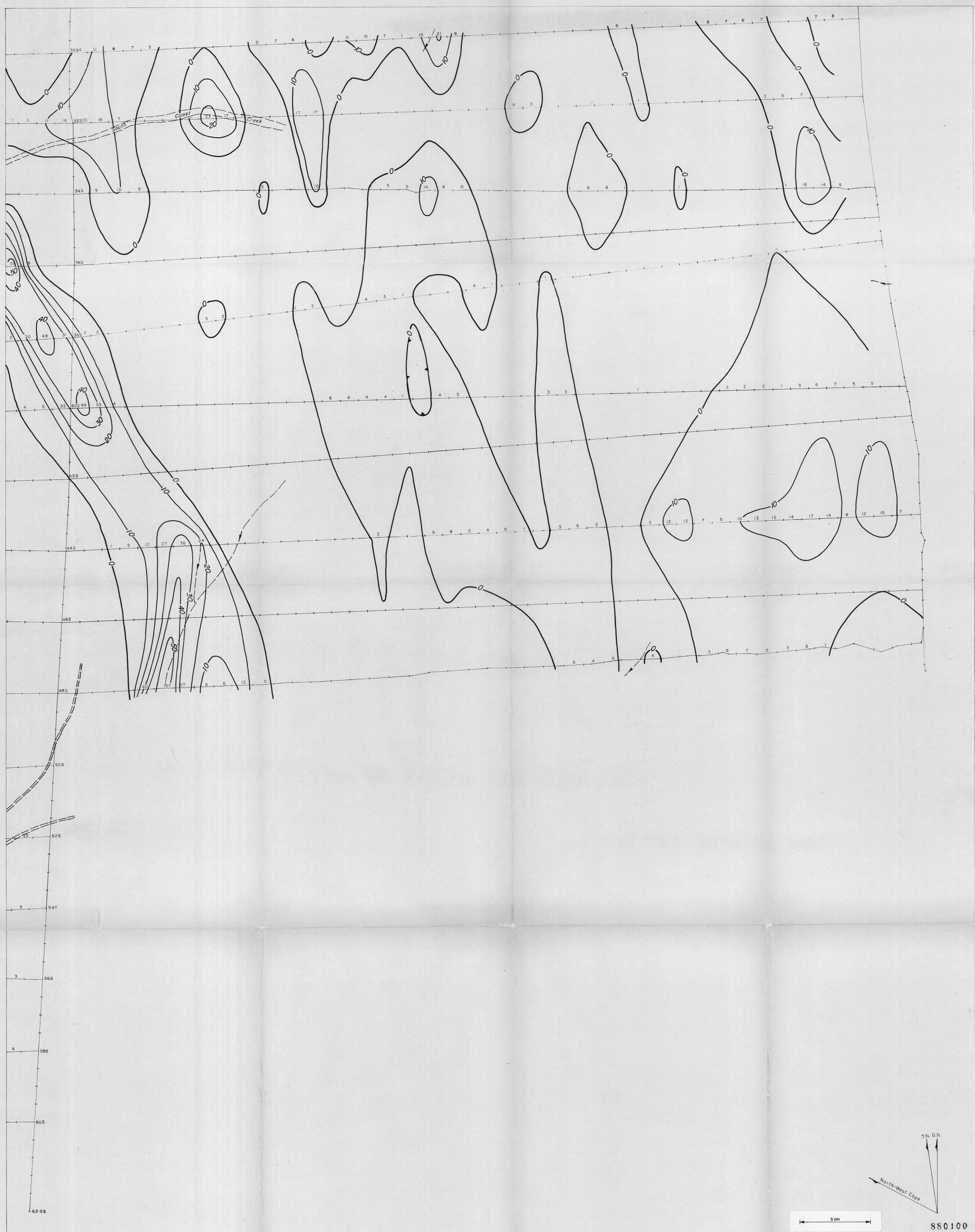
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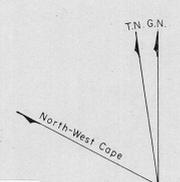
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E.L. 7/68 DUNDAS DISTRICT

EAST SOUTH COMET
V.L.F. FIRST DERIVATIVE CONTOURS

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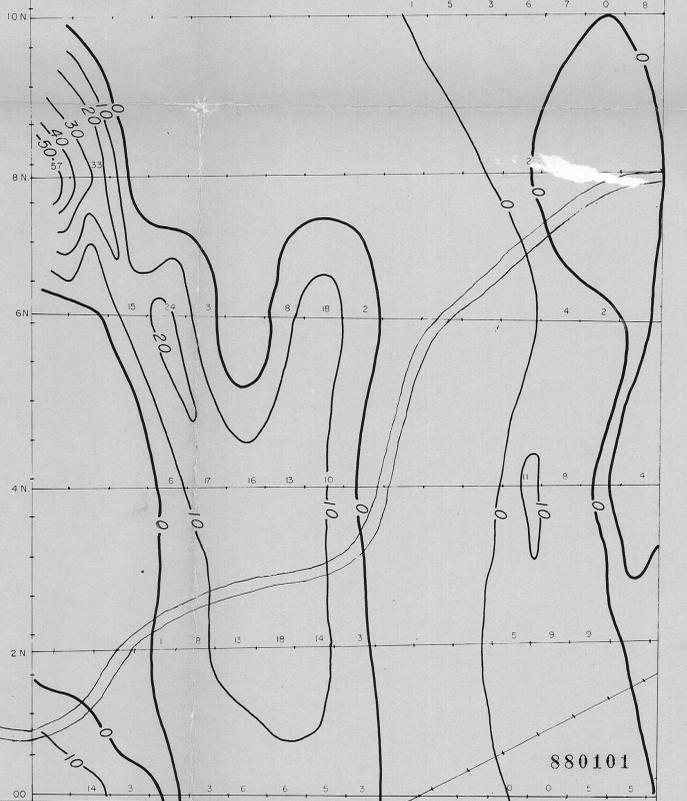
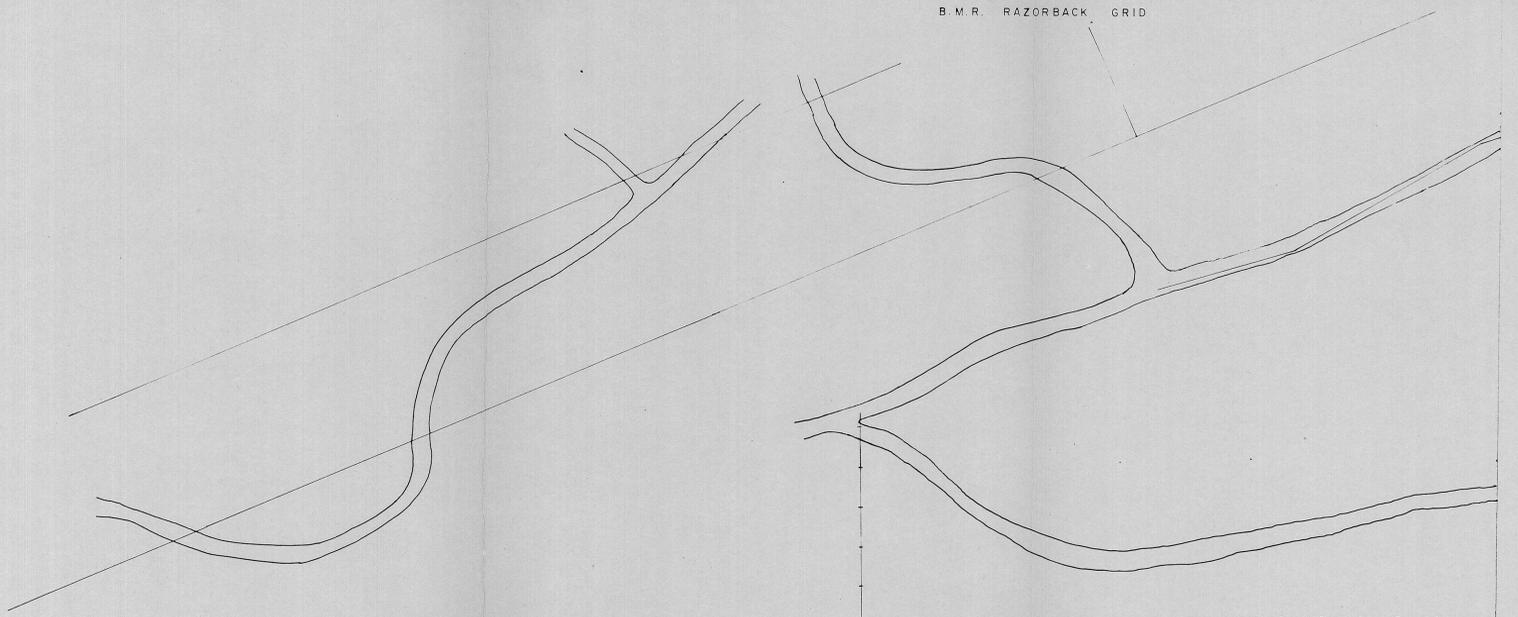


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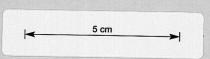
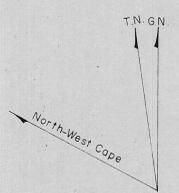
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5074 71-760
DRAWING NO. 1/277

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B.M.R. RAZORBACK GRID



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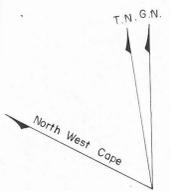
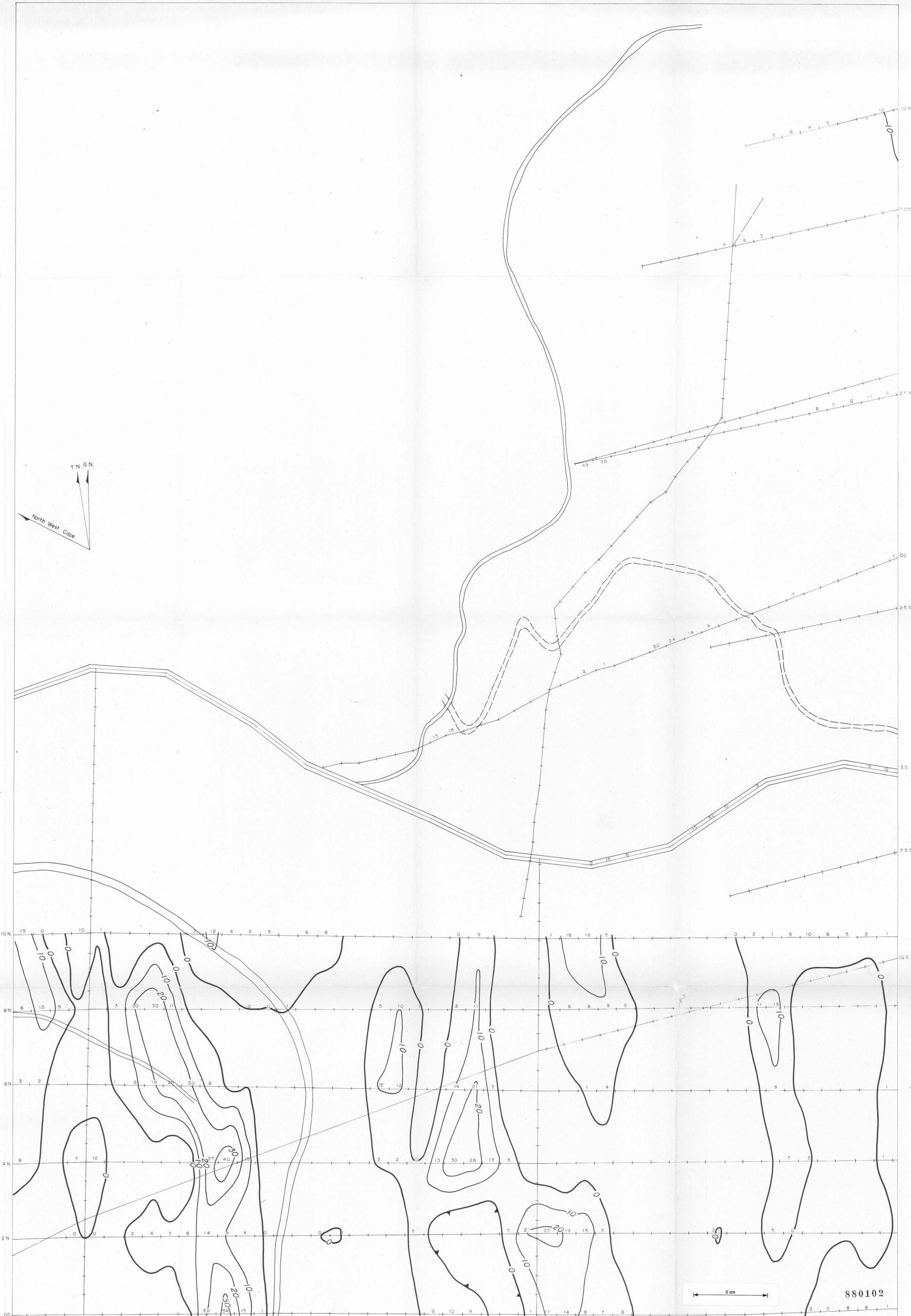


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RAZORBACK GRID
V.L.F. FIRST DERIVATIVE CONTOURS

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DRAWING NO. 1 / 278

5914



0 100 200 300 FEET

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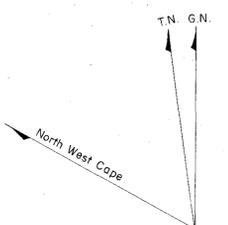
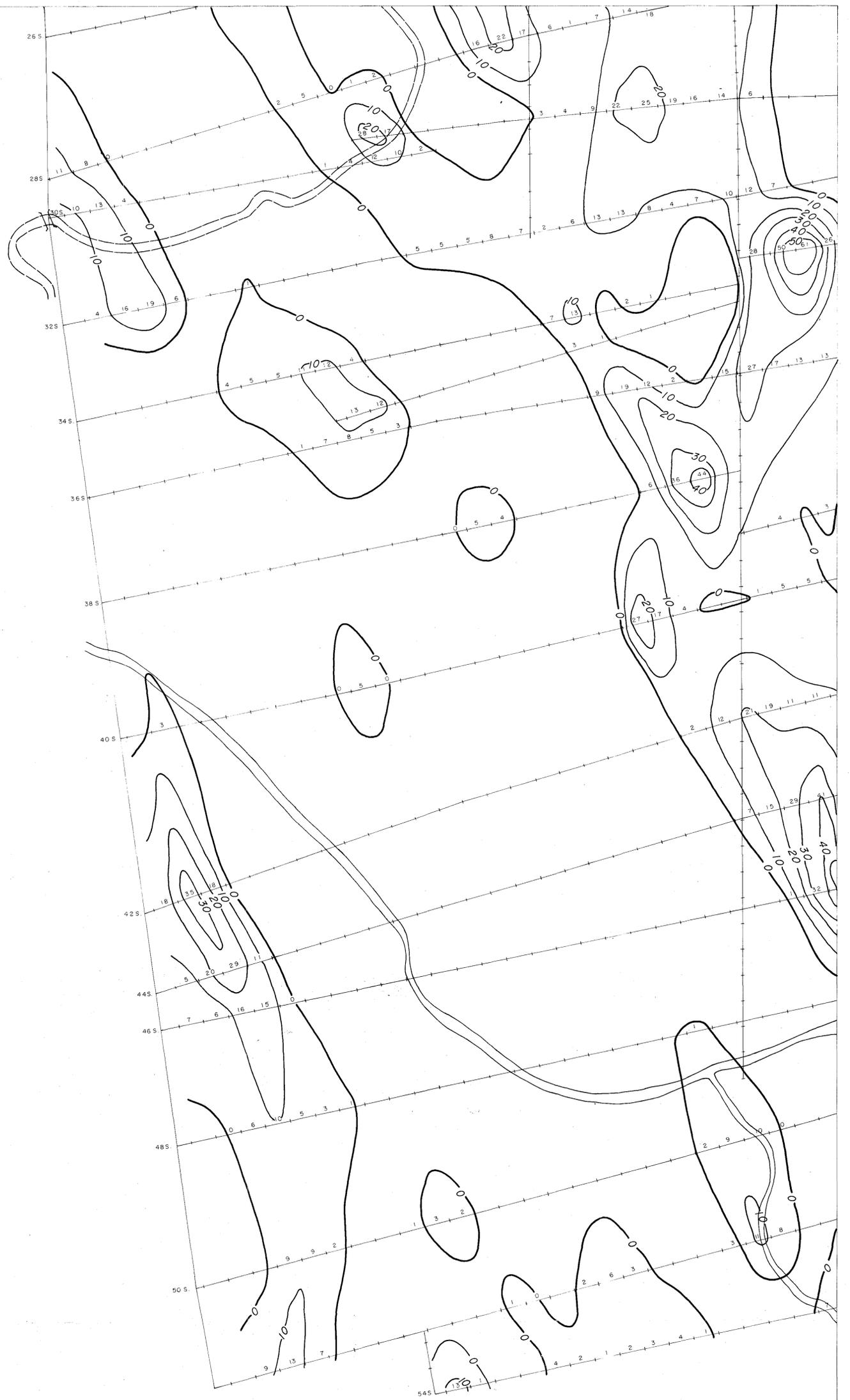
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V.L.F. FIRST DERIVATIVE CONTOURS

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DRAWING NO. 1/279

71-760
3623

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0871



5 cm

880103

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E.L. 7/68 DUNDAS DISTRICT

RED LEAD GRID
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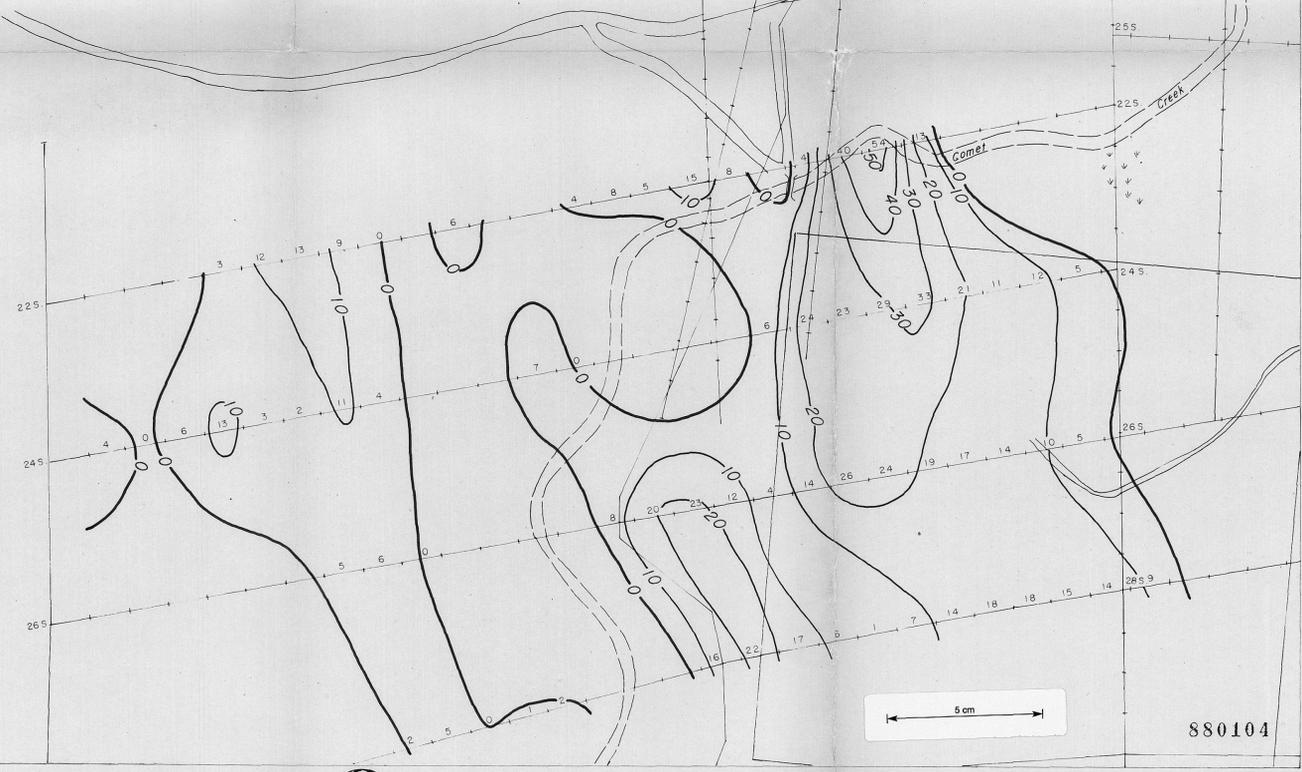
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T.N. G.N.

North West Cape

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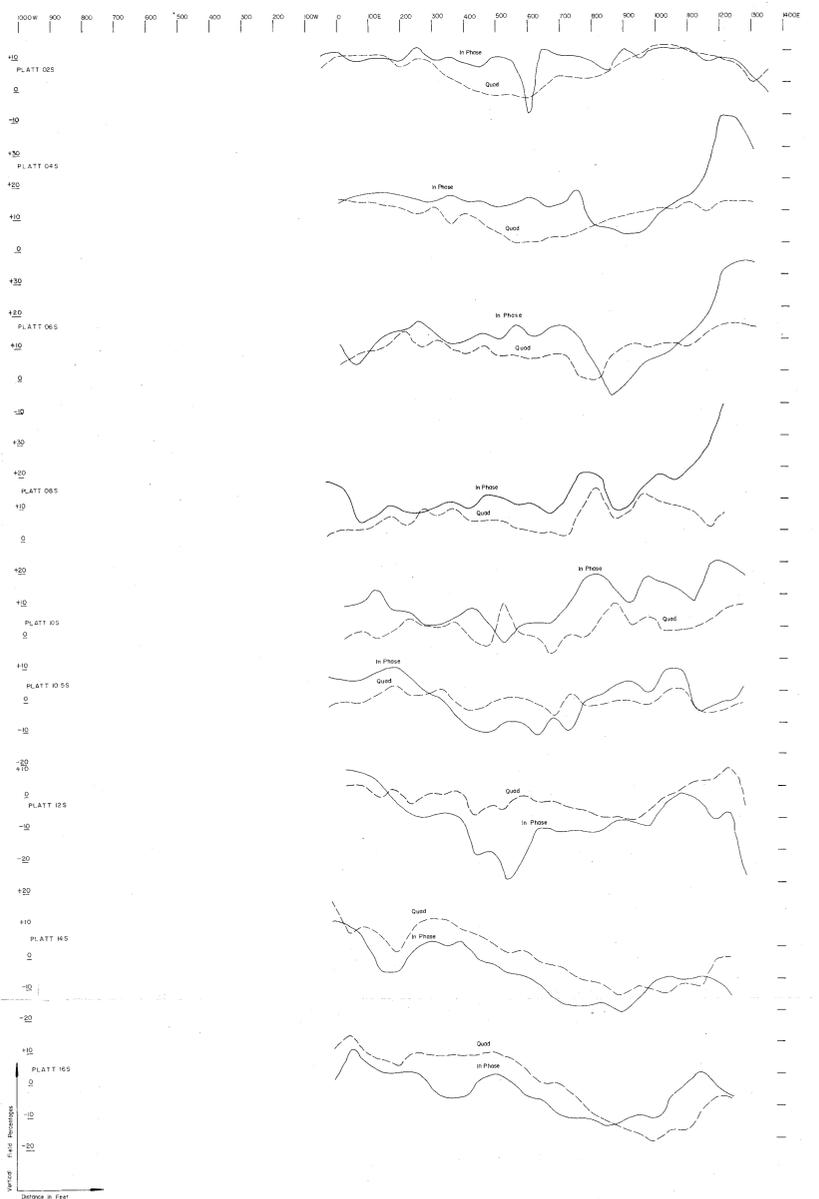
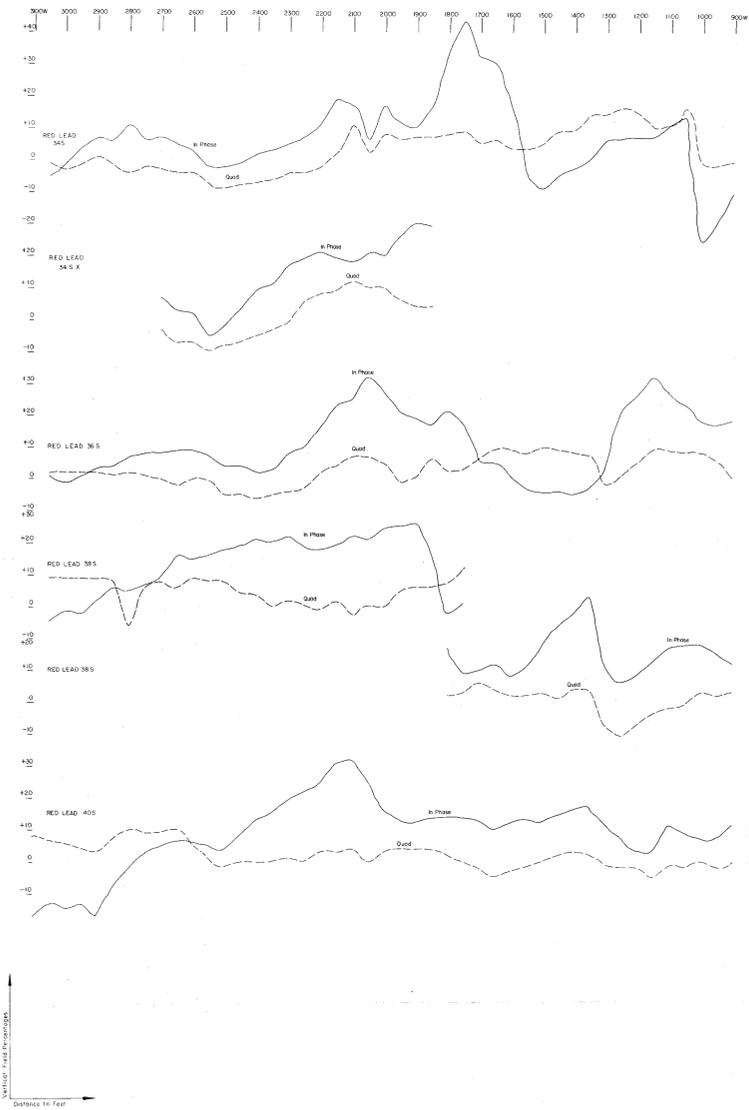
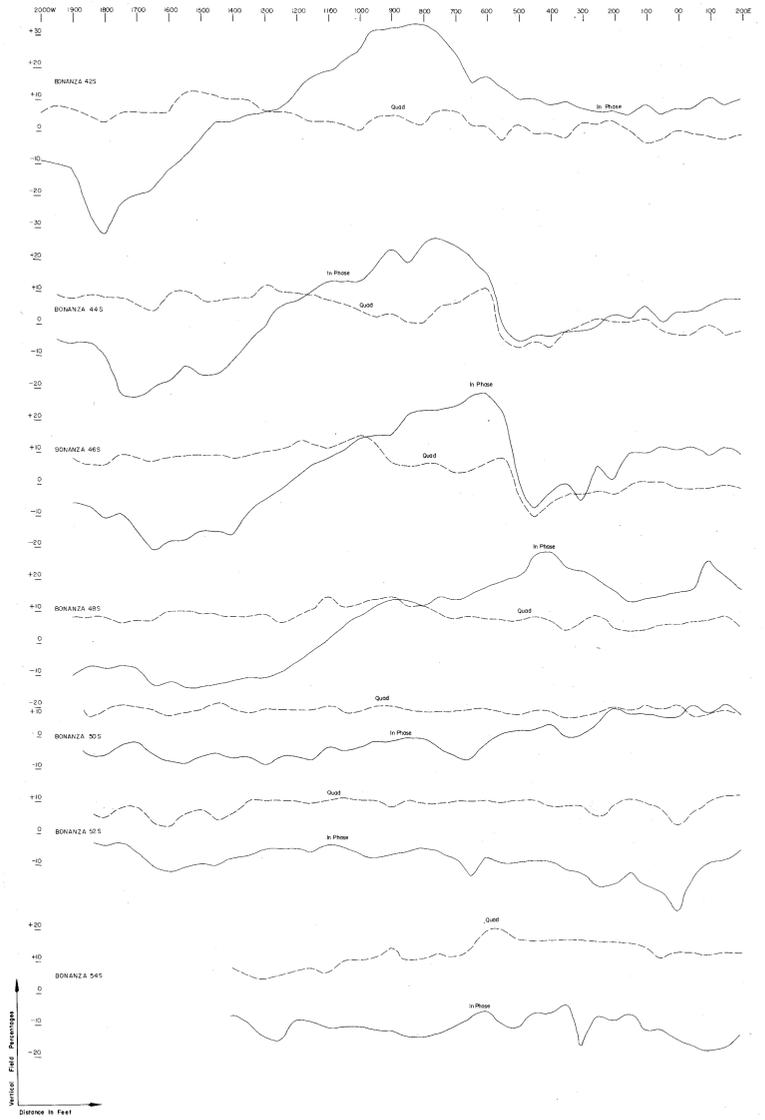
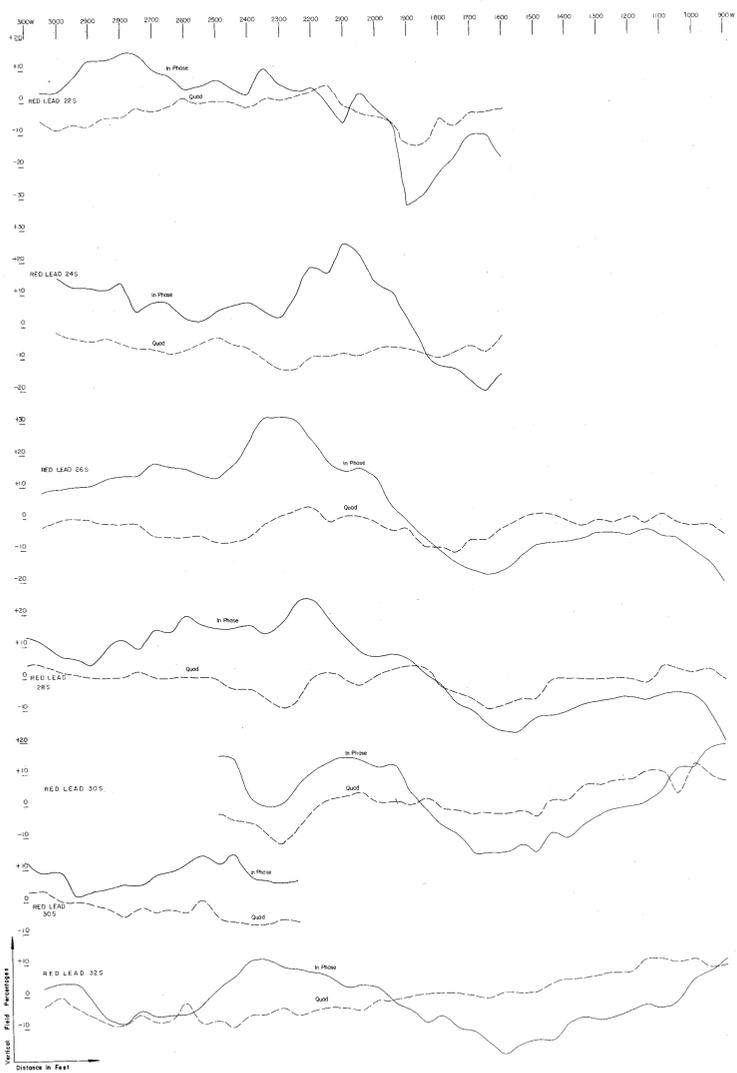


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ADELAIDE GRID V.L.F. FIRST DERIVATIVE CONTOURS

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50/74 71-76 3611 DRAWING NO. 1/281



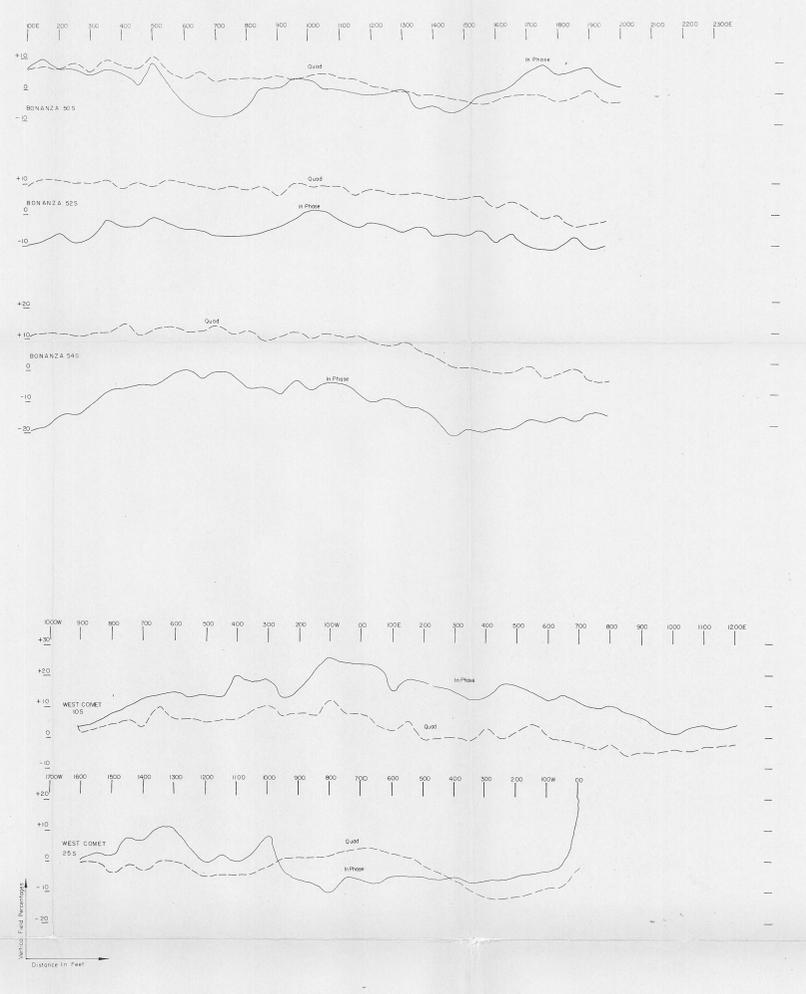
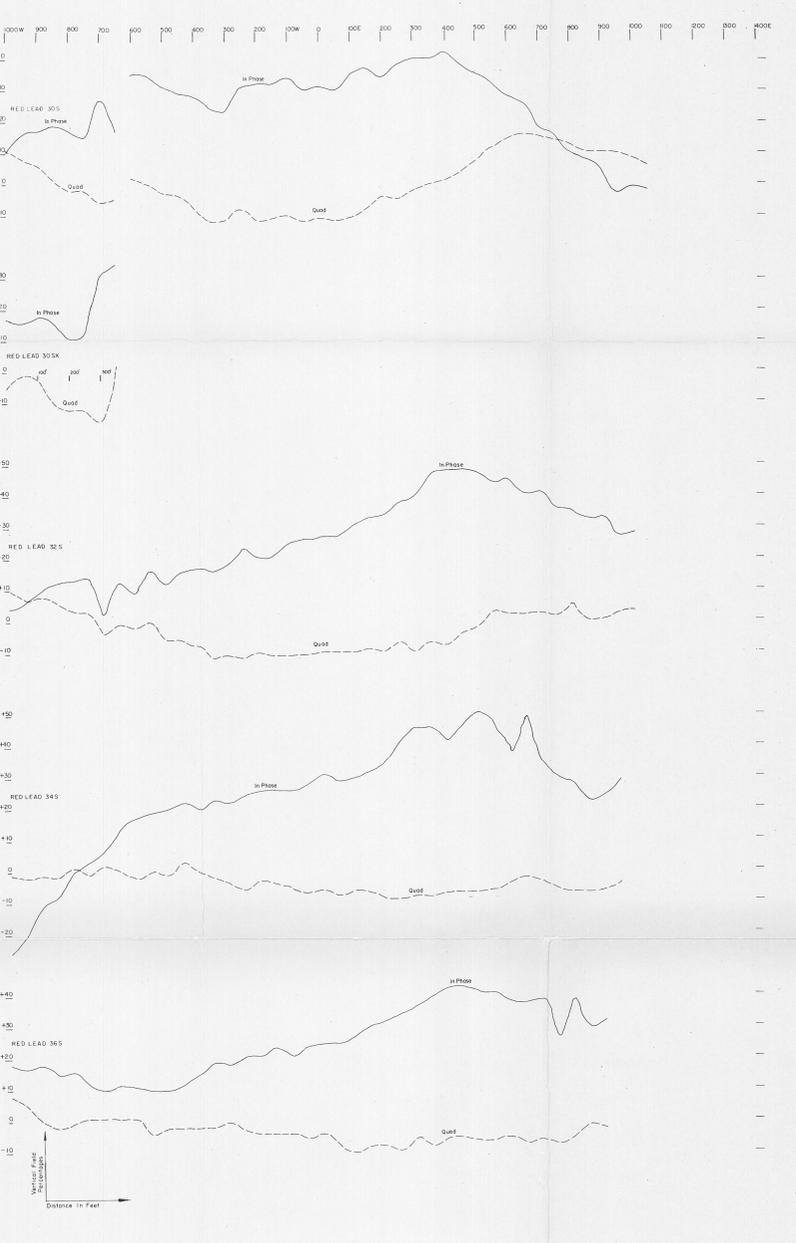
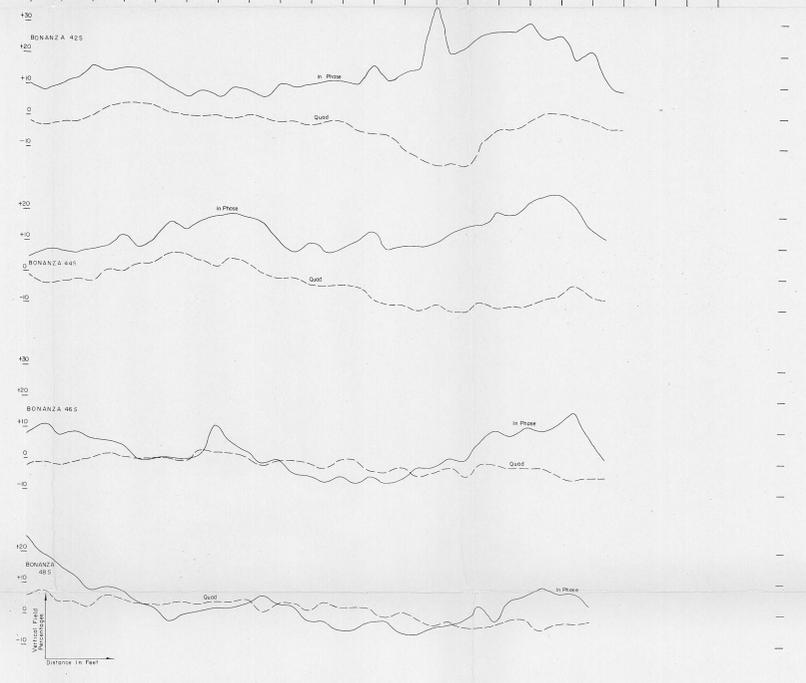
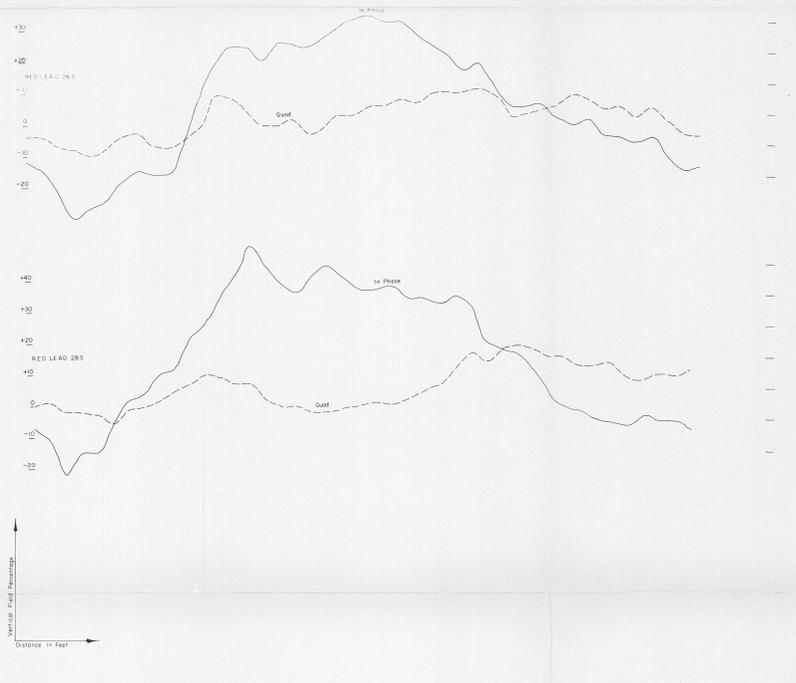
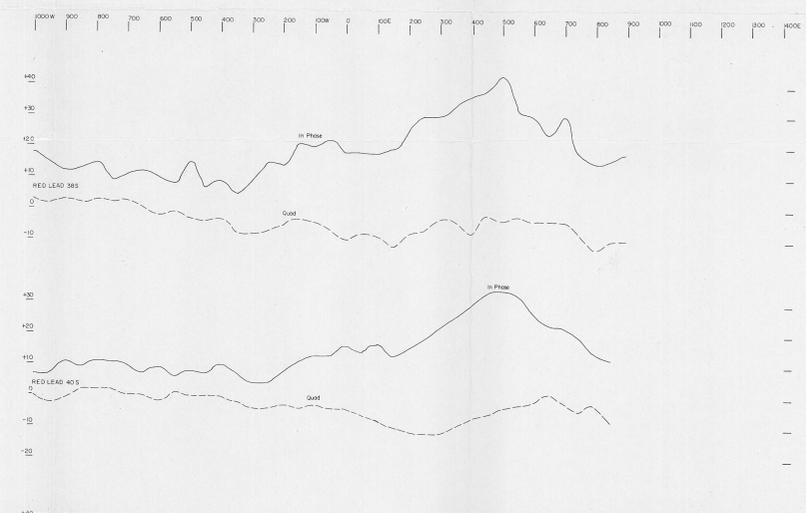
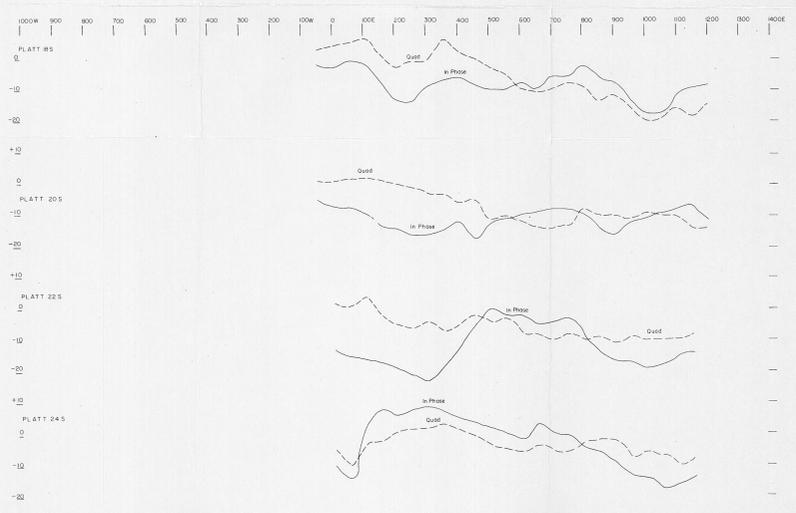
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E.L.7/68 DUNDAS DISTRICT, TASMANIA
RED LEAD, BONANZA, PLATT
V.L.F. PROFILES

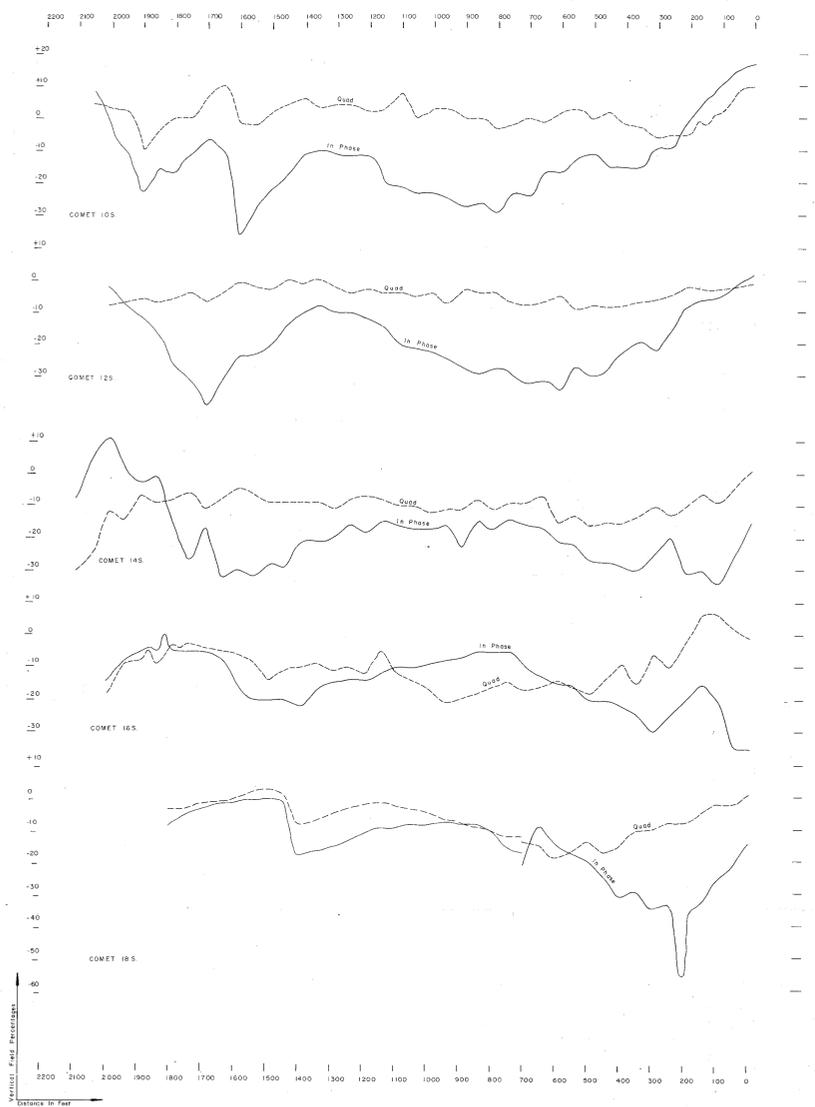
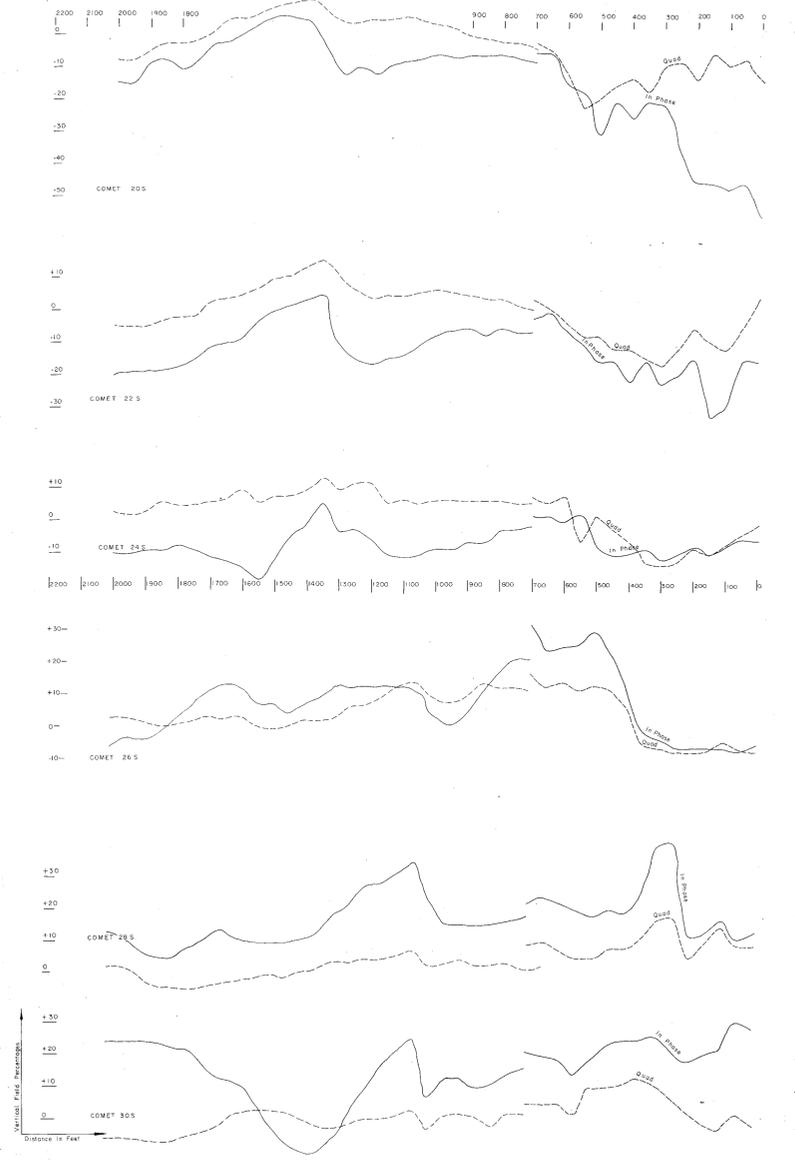
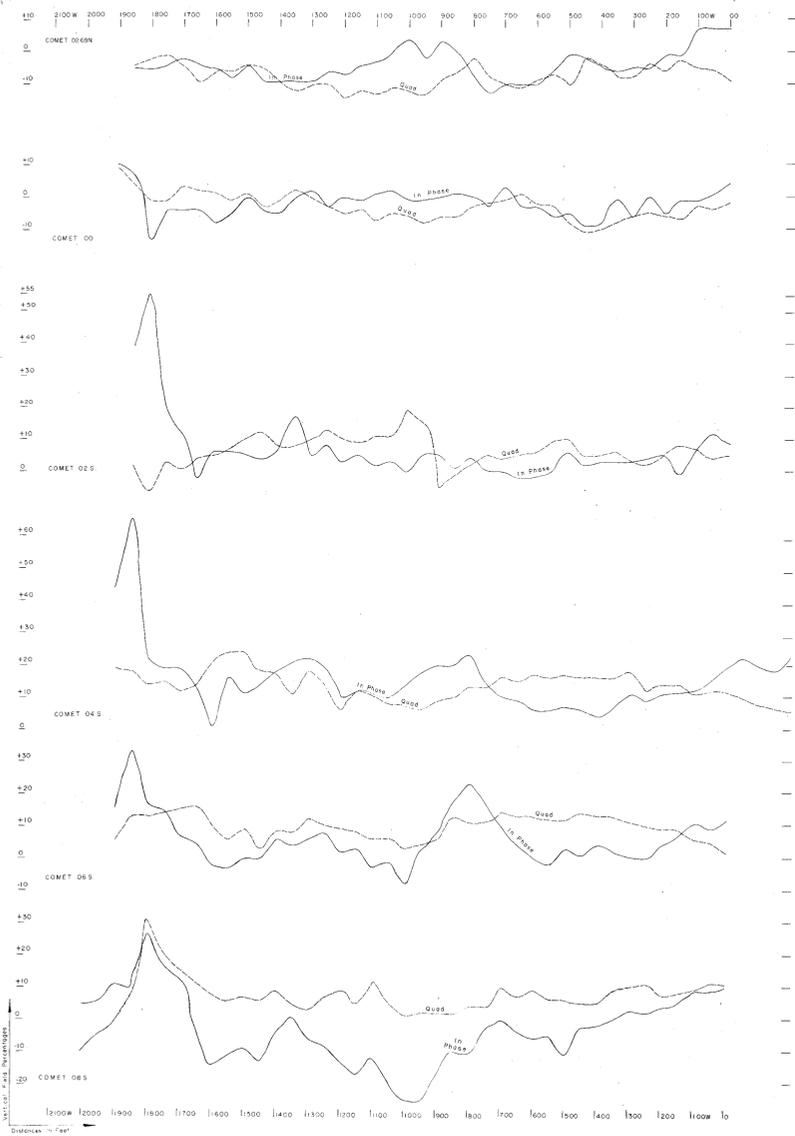


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BRISBANE AUSTRALIA

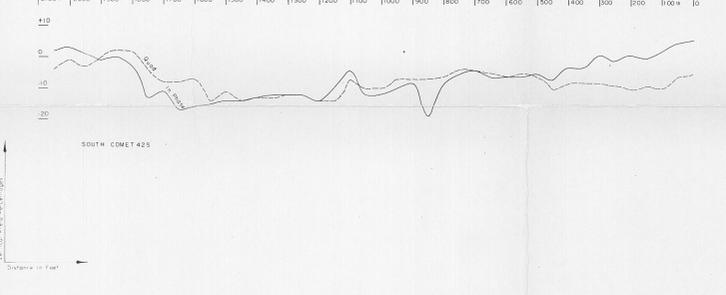
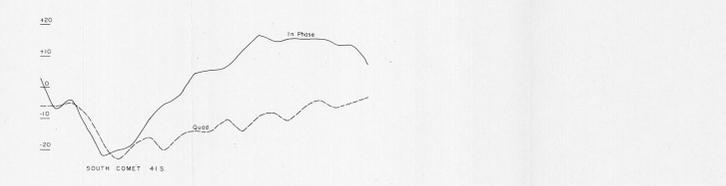
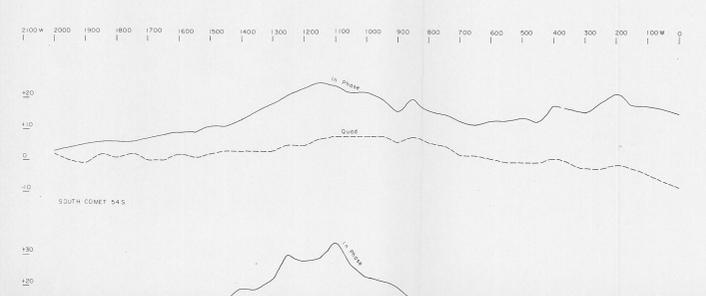
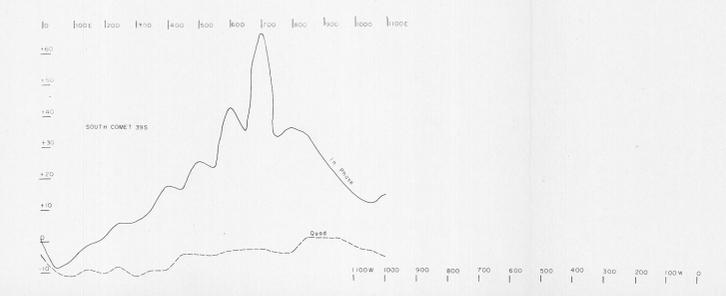
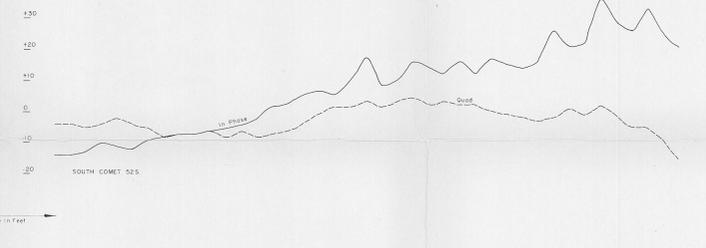
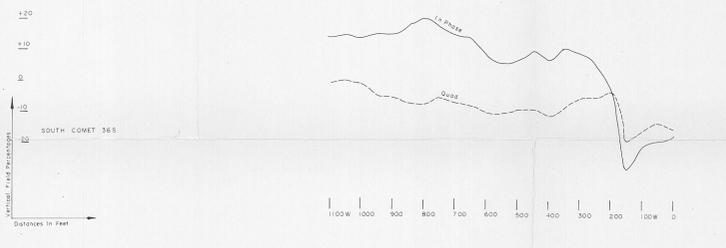
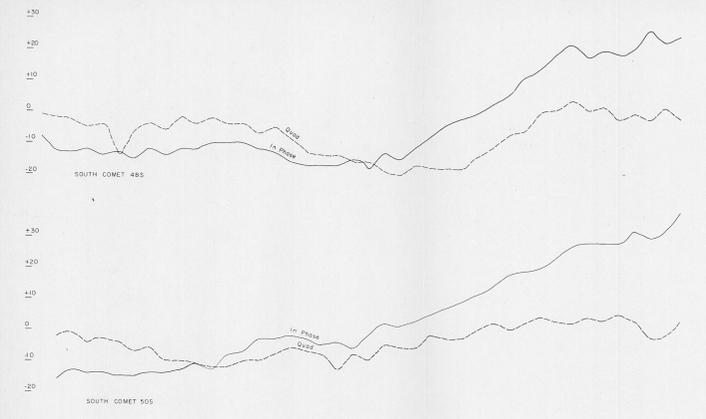
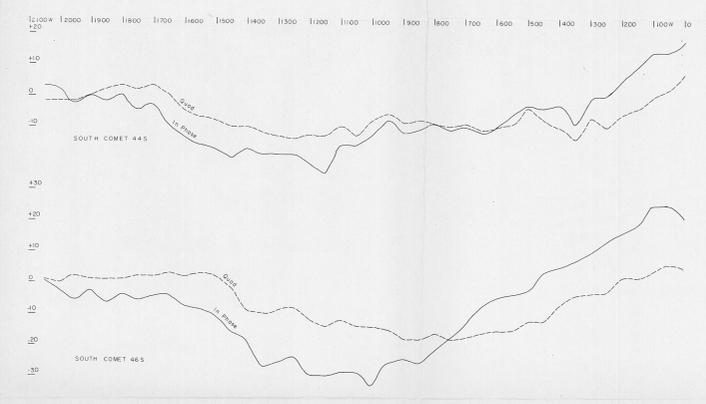
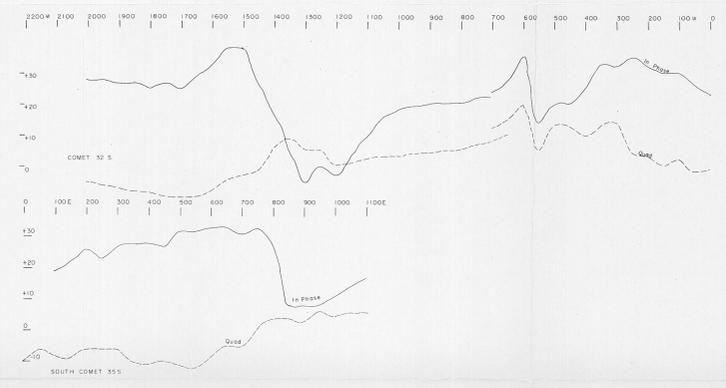
TEXAS DEVELOPMENT PTY. LTD.
EL. 7768 DUNDAS DISTRICT, TASMANIA
**PLATT, RED LEAD,
BONANZA, WEST COMET.
V.L.F. PROFILES**

PROJECT 7/68 DATE 7/77/71 DWG. NO. 1/284



880108
5 cm

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TEXINS DEVELOPMENT PTY. LTD. EL. 7/68 DUNDAS DISTRICT, TASMANIA	
COMET V.L.F. PROFILES	
PROJECT 7/68	DATE 7/77 DWG. NO. 1/284 SHEET 4 OF 4



880109

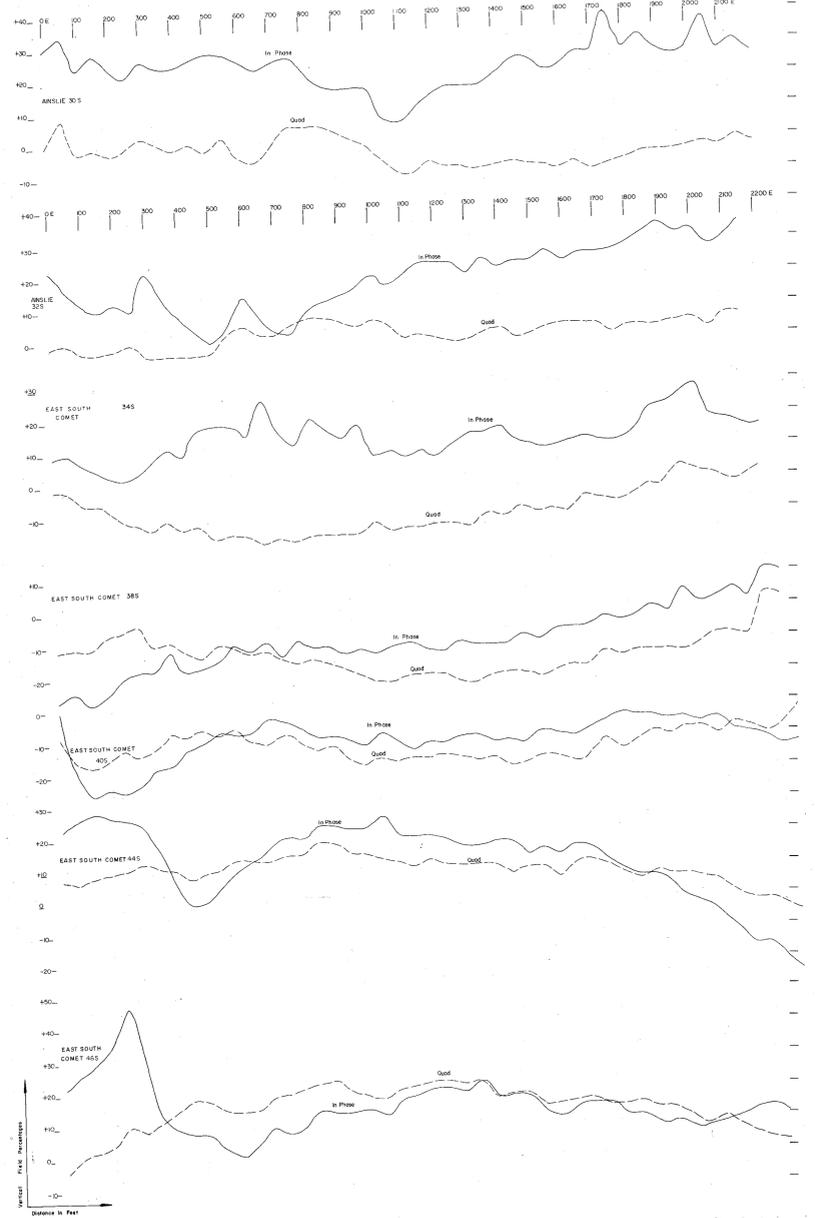
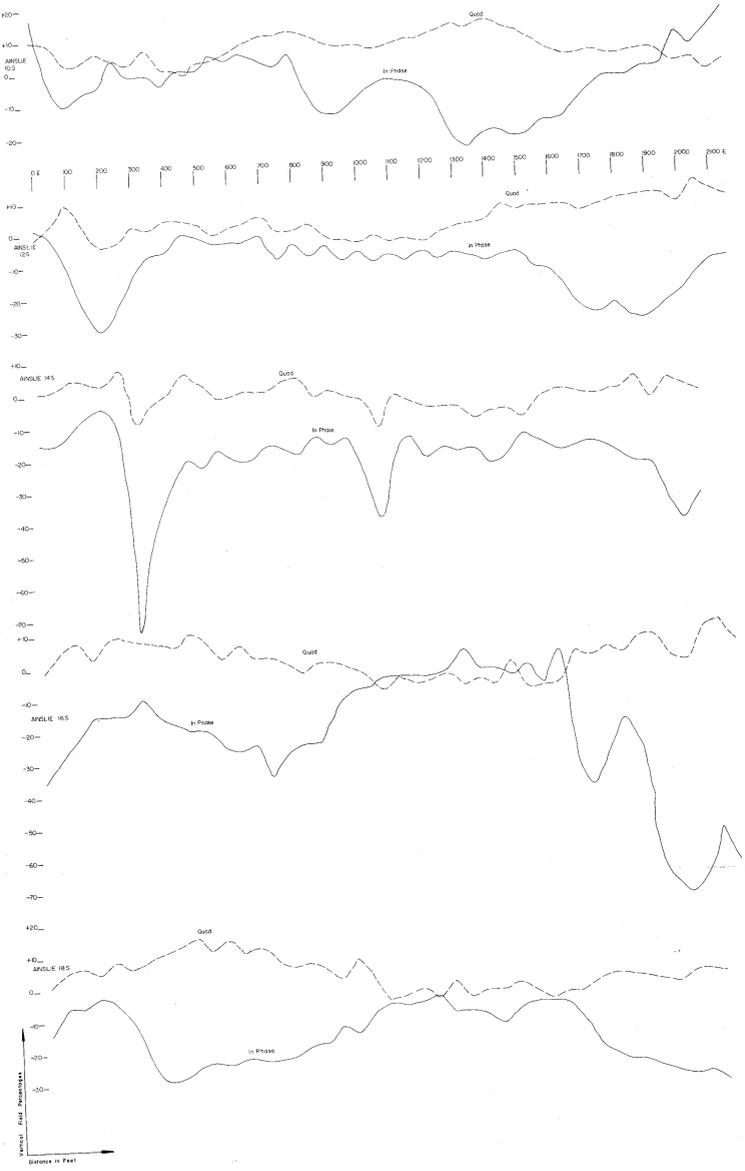
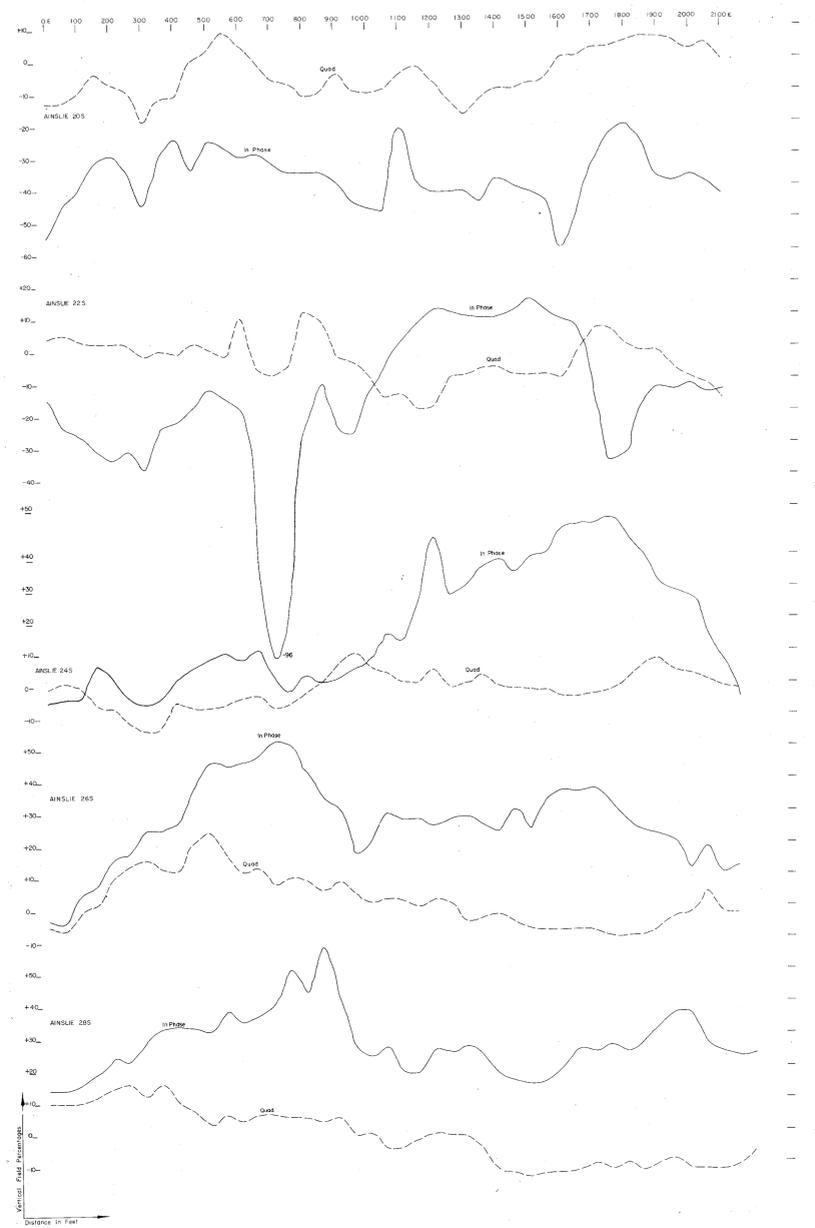
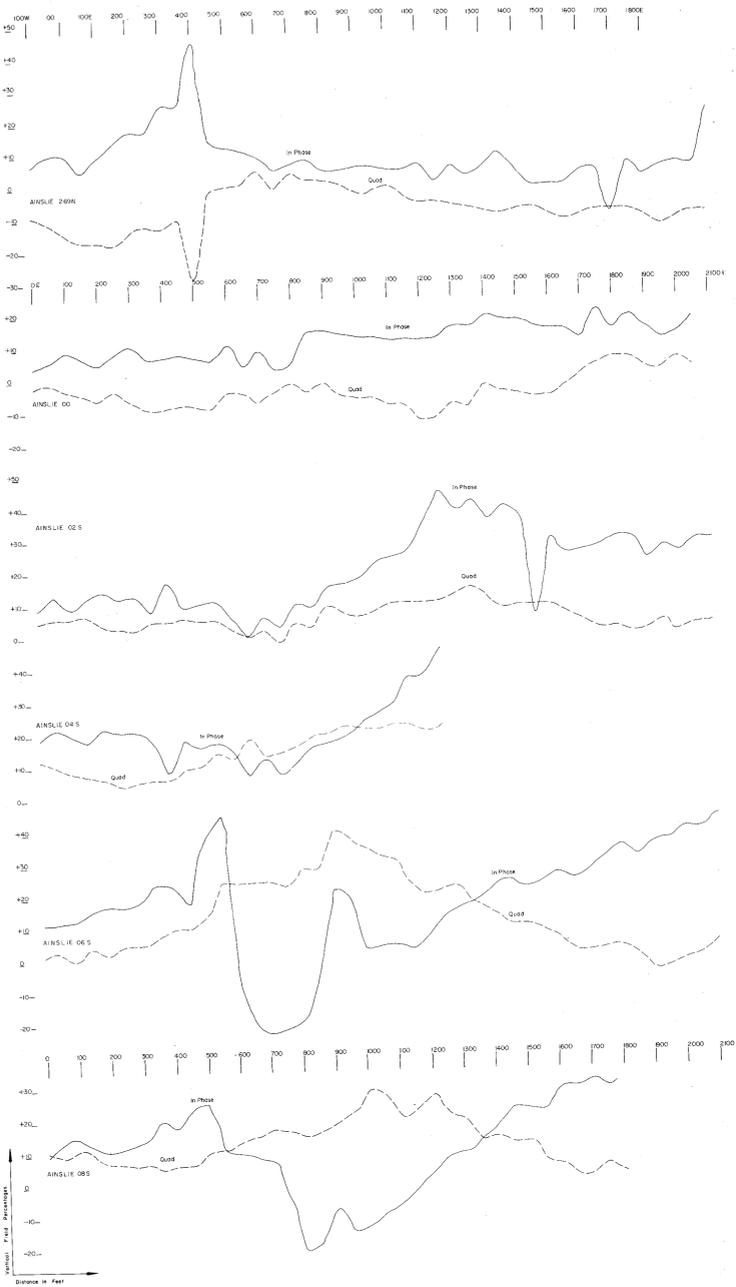


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TEXINS DEVELOPMENT PTY. LTD.
EL. 7/66 DUNDAS DISTRICT, TASMANIA

STH. COMET, COMET
V.L.F. PROFILES 71-760
3025

PROJECT 7/68 DATE 7/77/71 DWG. NO. 1/284
SHEET 5 OF 6



880110

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TEXAS DEVELOPMENT PTY LTD
E.L. 7/68 DUNDAS DISTRICT, TASMANIA
AINSLIE, EAST SOUTH COMET
V.L.F. PROFILES

PROJECT 7/68 DATE 7/77 DWS NR 1/284

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Q50

GEOPHYSICS

GEOPHOTO MINERALS REPORT 1971/20

VERY LOW FREQUENCY ELECTROMAGNETIC,
ACoustic AND RADIOMETER SURVEY

S.P.L. 95, WEST TASMANIA
HEEMSKIRK

Prepared by
GEOPHOTO RESOURCES CONSULTANTS
for
TEXINS DEVELOPMENT PTY. LTD.

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CONTENTS

		<u>PAGE NO.</u>
	ABSTRACT	
I	INTRODUCTION	1
II	GEOLOGY	4
III	PRINCIPLES OF OPERATION OF THE VLF-EM 16 UNIT	9
IV	VLF DATA COLLECTION	15
V	VLF DATA REDUCTION AND INTERPRETATION	17
	(A) Depth	19
	(B) Repeatability	20
VI	RESULTS OF SPL-95 SURVEY	23
	(A) Radiometric Survey	23
	(B) Geochemical Survey	23
	(C) VLF-EM Survey	23
	(D) Magnetic Survey	32
VII	CONCLUSIONS	36
VIII	SELECTED BIBLIOGRAPHY	37

APPENDIX A

The Polarization Ellipse

ENCLOSURES

5 Sheets - VLF and magnetic profiles SPL-95
Scale one inch = 200 feet

ABSTRACT

A VLF-EM, magnetic and radiometric survey was made over 41,650 feet of reconnaissance traverses along roads and walking tracks through SPL-95 Heemskirk, Western Tasmania during May, 1971.

A brief description of the geology of the area is presented together with the theory and operational details of the VLF-EM 16 unit. Thirteen geochem samples were taken during the survey and the results of these are included.

The results are presented as a series of VLF in-phase and quadrature vertical secondary field profiles and vertical magnetic field profiles at scale one inch = 200 feet. Each VLF anomaly is analysed for conductivity, depth and probable nature of overburden.

003

1. INTRODUCTION

Between May 1st and May 7th a geophysical survey was carried out over selected traverses through SPL-95 Heemskirk, Western Tasmania. The geophysical instruments used were the Very Low Frequency - Electromagnetic 16 unit, a magnetometer and a radiometer. The survey party consisted of one geologist, one geophysicist and three field assistants.

The geology of the Heemskirk area is described on Page 4. S.P.L.-95 lies within the granite area, where fairly widespread mineralization has taken place. Cassiterite occurs in quartz-tourmaline or greisen fissure veins, and also within pipes or masses of soft greisenized granite. Many of the veins trend between north-west and north-east, but some irregular veins may occur. The orebodies are low grade, and the cassiterite is fine and disseminated.

The VLF-EM 16 unit had not been previously tested in this type of environment, cassiterite being a poor conductor. However the cassiterite is usually associated with pyrite which has a low electrical resistivity and therefore may be detectable electromagnetically. One limitation of the VLF-prospecting method is that the conductor strike is required to be in the direction of

004

the VLF transmitter, and the surveyed traverses should ideally be perpendicular to the strike direction. The direction of the North West Cape (Western Australia) VLF-transmitting station is thus suitable for use in the Heemskirk area. 41,650 feet of reconnaissance traverses were made along roads and walking tracks through SPL-95. Wherever possible, the traverses were chosen to run in a north-easterly direction. The location of these traverses is shown on Plate 1. VLF readings were taken every 50 feet along the traverses, while magnetic readings were taken at 100 feet spacings the first two days but every 50 feet there after.

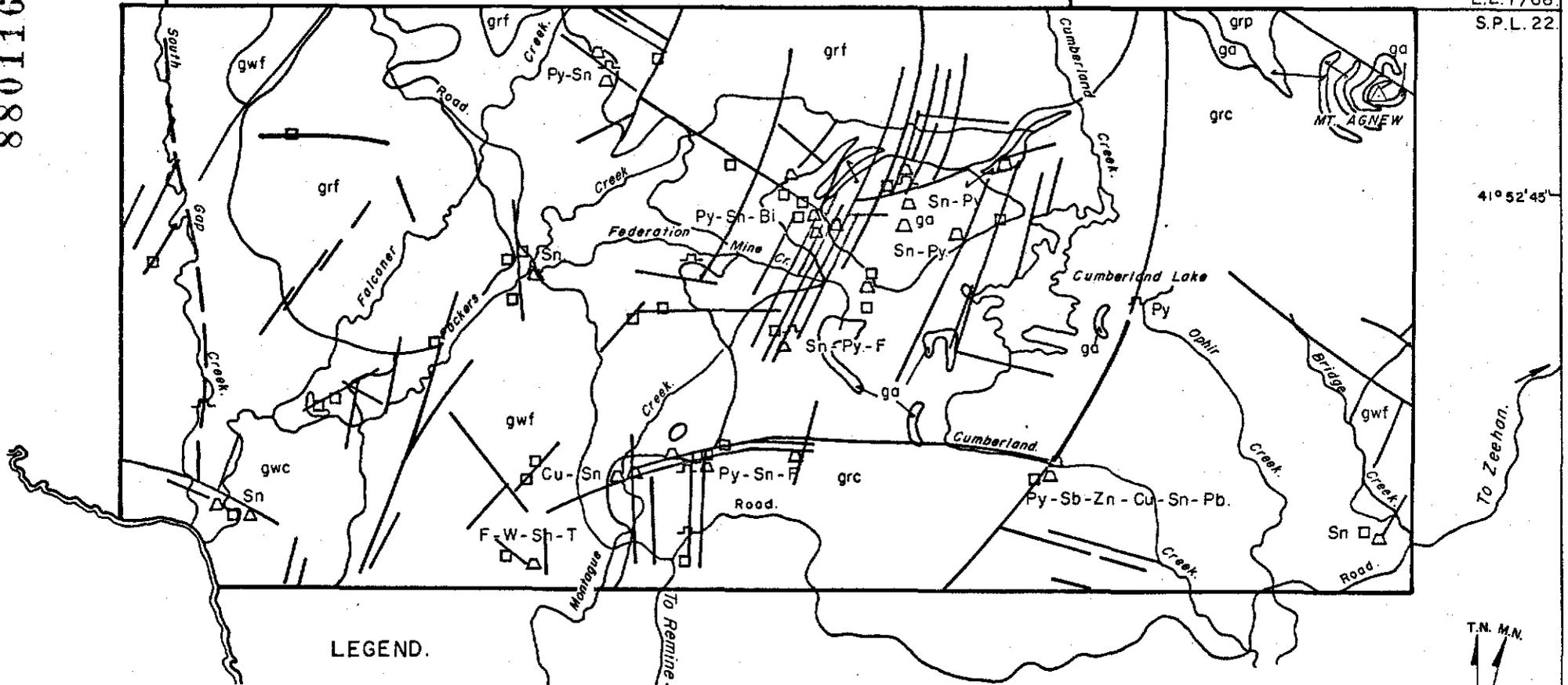
A radiometer was carried over the whole of the surveyed area to detect any abnormally high radiation and to test some airborne radioactive anomalies around the margins of the Cumberland Lake on the high slopes of Mt. Agnew. Granites have a high content of potassium-40. The gamma radiation from the potassium products in the granite produces a radioactive background. Geological notes were taken on any points of interest, and any geophysical anomalies along the traverses were examined in detail for cause. Thirteen geochem samples were taken during the survey, from old prospects and areas of particular geological or geophysical interest. These samples were analysed for Cu, Pb, Zn, Ag, Mo, Bi, Sb, Sn and W.

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145°10'E.

E.L. 7/68.
S.P.L. 22.

41°52'45"



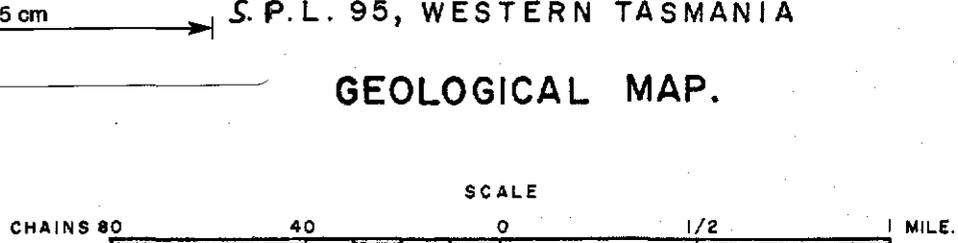
LEGEND.

- | | | | |
|-----|---------------------------------------|-----|---|
| grp | Contaminated porphyritic red granite. | grc | Coarse grained red granite. |
| | Quartz-tourmaline veins | grf | Medium to fine grained red granite. |
| ga | Aplite granite | | Contact. |
| gwf | Medium to fine grained white granite | | Fault, dashed where indefinite. |
| gwc | Coarse grained white granite. | | Adit and shaft, quarry or opencut
Abandoned mines and prospects. |

TEXINS DEVELOPMENT PTY LTD.

S.P.L. 95, WESTERN TASMANIA

GEOLOGICAL MAP.



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II. GEOLOGY

The geology of the Heemskirk region is summarized by Blissett (1962). Earth movements in the Zeehan district were violent and Banks correlated them with the Middle Devonian Tabberabberan Orogeny in Victoria. The Tabberabberan orogeny produced a series of north-west trending synclinoria and anticlinoria with extensive east-west cross-folding, accompanied by a complex fault system along north-north-east and north-north-west trends. In the Zeehan region important mineralization accompanied the Devonian granite intrusions. The intrusions include the Heemskirk Granite Complex and the quartz-porphry sills and dykes on Pine Hill and near Renison Bell.

The Heemskirk Granite Complex covers about 35 square miles west of Zeehan and forms the nucleus of the Heemskirk range. The outcrop is roughly circular, but is cut off to the west by the north-west trending coastline. The intrusion is a large boss emplaced near the southern limb of an anticlinorium of Proterozoic quartzite and slate which are overlain by Cambrian formations to the south.

In the granite cassiterite is the most important mineral and it is associated with tourmaline, pyrite, chalcopyrite and less abundant tetrahedrite, siderite and fluorite. Bismuthinite,

wolfram and molybdenite are rare. On the margins of the granite, cassiterite extends out into the contact-metamorphic zone.

The rock is described as granite, however analysis shows that it is adamellite in which alkali-feldspar and plagioclase each range between one-third and two-thirds of total feldspar. The generalized geology of the area is shown on Plate 2. The most common variety is a coarse holocrystalline pink adamellite composed of pink orthoclase, quartz and albite or oligoclase with some biotite. Accessory minerals include apatite, zircon, magnetite and a little secondary muscovite. Black tourmaline is usually present, especially with quartz in poorly defined aggregates. The pink adamellite merges gradually into belts of white or cream-coloured adamellite which is finer and has no pink orthoclase. Tourmaline is more abundant in this variety and quartz-tourmaline nodules are characteristic. The white adamellite contains most of the cassiterite-bearing orebodies, particularly in the south.

The adamellites are cut by numerous dykes and irregular masses of white "tourmaline-microgranite" formed of orthoclase, albite, oligoclase and quartz. The minor intrusions carry many quartz-tourmaline nodules up to about 6" in diameter some of which may contain fine crystals of cassiterite. Tin is also associated with dykes and veins of porphyritic micro-

granite, aplite and greisen. A number of thin veins of pegmatite occur consisting of coarse orthoclase, quartz and black prismatic tourmaline, but no cassiterite. Quartz-tourmaline veins and dykes are common and occasionally carry cassiterite. Veins of greisen are less abundant.

The adamellite is rarely porphyritic, though there is layering. Tension joints or fissures have played an important part in the subsequent mineralization. They trend chiefly between north-west and north-east and provided zones of weakness along which the late-stage mineralizing fluids were injected. In some areas there has been extensive greisenizing along fissures, forming irregular pipes or masses which may be highly mineralized. Although black tourmaline is abundant in the Heemskirk district, cassiterite appears to be associated rather with the green variety. Small amounts of pyrite, chalcopyrite and arsenopyrite are sometimes present, particularly in the south-east, and bismuthinite occurs at the old Federation Mine. Wolfram and molybdenite are relatively rare. The cassiterite is usually fine and brown or brownish-black, but crystals may sometimes be up to half an inch in diameter.

Most of the old mines and prospects are on the north, south-west and south flanks of the Heemskirk Range. The south Heemskirk mines lie north and north-east of Trial Harbour,

009

about 15 miles by gravelled road south-west of Zeehan. The Federation and Mayne's mines were the chief producers on the South Heemskirk field.

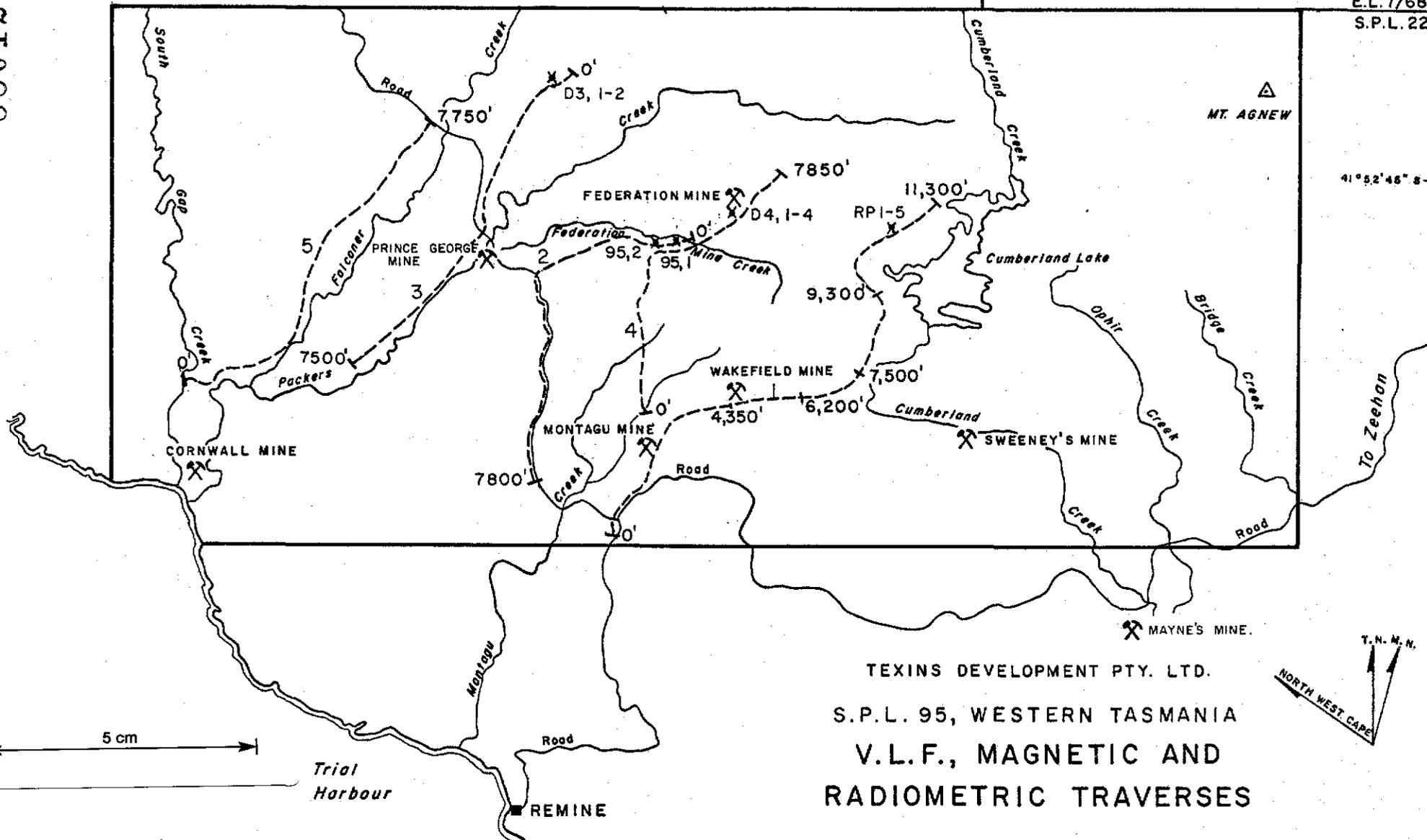
Many lodes carrying cassiterite have been discovered and explored, however rich concentrations are erratic and tend to form relatively short ore-shoots. The orebodies are therefore low-grade, the cassiterite often being fine and disseminated.

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145° 10' E

E.L. 7/68
S.P.L. 22

41° 52' 46" S

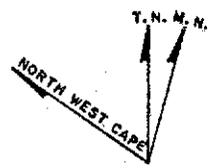


△
MT. AGNEW

To Zeehan

✂ MAYNE'S MINE.

TEXINS DEVELOPMENT PTY. LTD.
 S.P.L. 95, WESTERN TASMANIA
 V.L.F., MAGNETIC AND
 RADIOMETRIC TRAVERSES



5 cm

Trial
Harbour

REMINÉ

0' 3 7750'
 --- Traverse and measured distance.
 RPI-5 X Sample location



010

PLATE I.

DRAWING NO. I-H-100

011

III - PRINCIPLES OF OPERATION OF THE VLF-EM 16 UNIT

The E.M. - 16 unit is a passive instrument working in the VLF range (15 - 25kHz) of the radio wave band. The primary VLF signal is obtained from powerful transmitters located around the world which were constructed originally by the United States Navy for communications with submerged submarines. The frequency of these signals is low compared to the normal broadcast band; a low frequency has better penetration through the conductive ocean water. Plug-in units are supplied with the V.L.F. survey instrument for the selection of the transmitting station. Two plug-in units may be accommodated at one time, with a switch for selection. In this survey the North West Cape (N.W.C.) signal was used, which operates at a frequency of 22.3 kHz and has a radiated power of 1,000 Kw. Two other plug-in units were supplied at frequencies 23.4 kHz (Hawaiian station) and 17.4 kHz (Japanese station) but neither gave a satisfactory signal in Tasmania.

The V.L.F. transmitting stations have a vertical antenna, which gives rise to a vertically polarized electromagnetic wave, the electric vector being vertical and the magnetic vector horizontal and concentric around the station. This primary magnetic field will obviously have no vertical component over a uniform earth, but if there is a subsurface conductor present this will give rise

to a secondary magnetic field which will usually be out of phase with and inclined to the primary magnetic field. The resultant field will thus be a rotating vector which describes an ellipse of polarization in the plane of the primary and secondary magnetic fields. This resultant field is equivalent to two oscillating vectors at right angles to each other, one along the major axis of the ellipse and the other along the minor axis. The polarization ellipse is discussed in more detail in the appendix at the end of this report.

The Ronka E.M. - 16 equipment (Figure 1) used in the survey showed a good performance in all weather conditions. The instrument is light (weight 2.5 lbs) easily portable, and simple to operate. The power supply is six size AA (1.5V) alkaline cells, with a life of about 200 hours. The instrument has no warm-up period, and is switched off between readings. There is a battery test button on the control panel of the instrument, which gives a whistling sound in the earphone if the batteries are in a useable condition. There is also a volume control to adjust the noise level for comfortable listening. Readings were taken every 50 feet with the operator always facing in a north-easterly direction.

The E.M.-16 unit is a sensitive receiver covering the V.L.F. frequency band tuned to a particular frequency by

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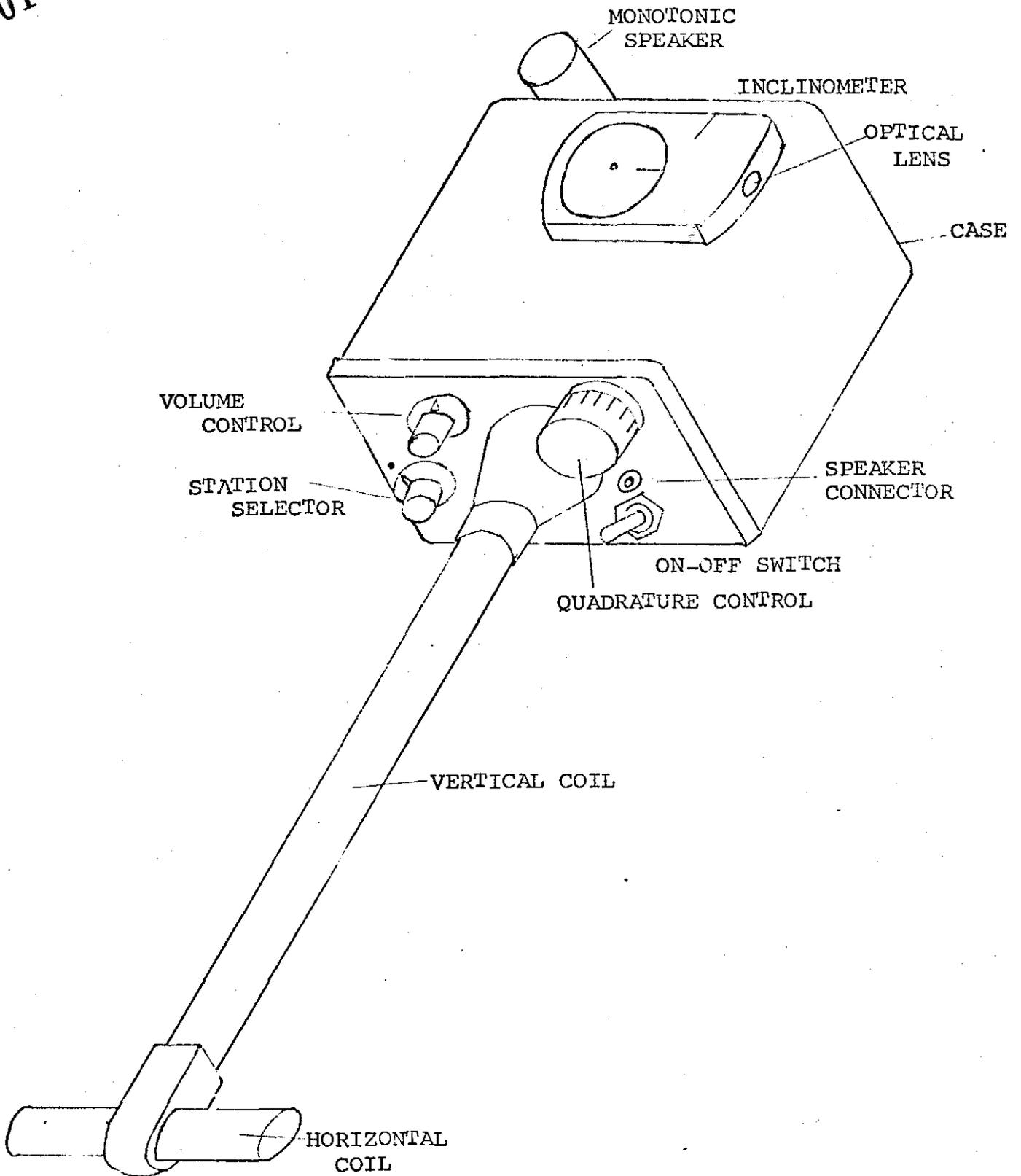


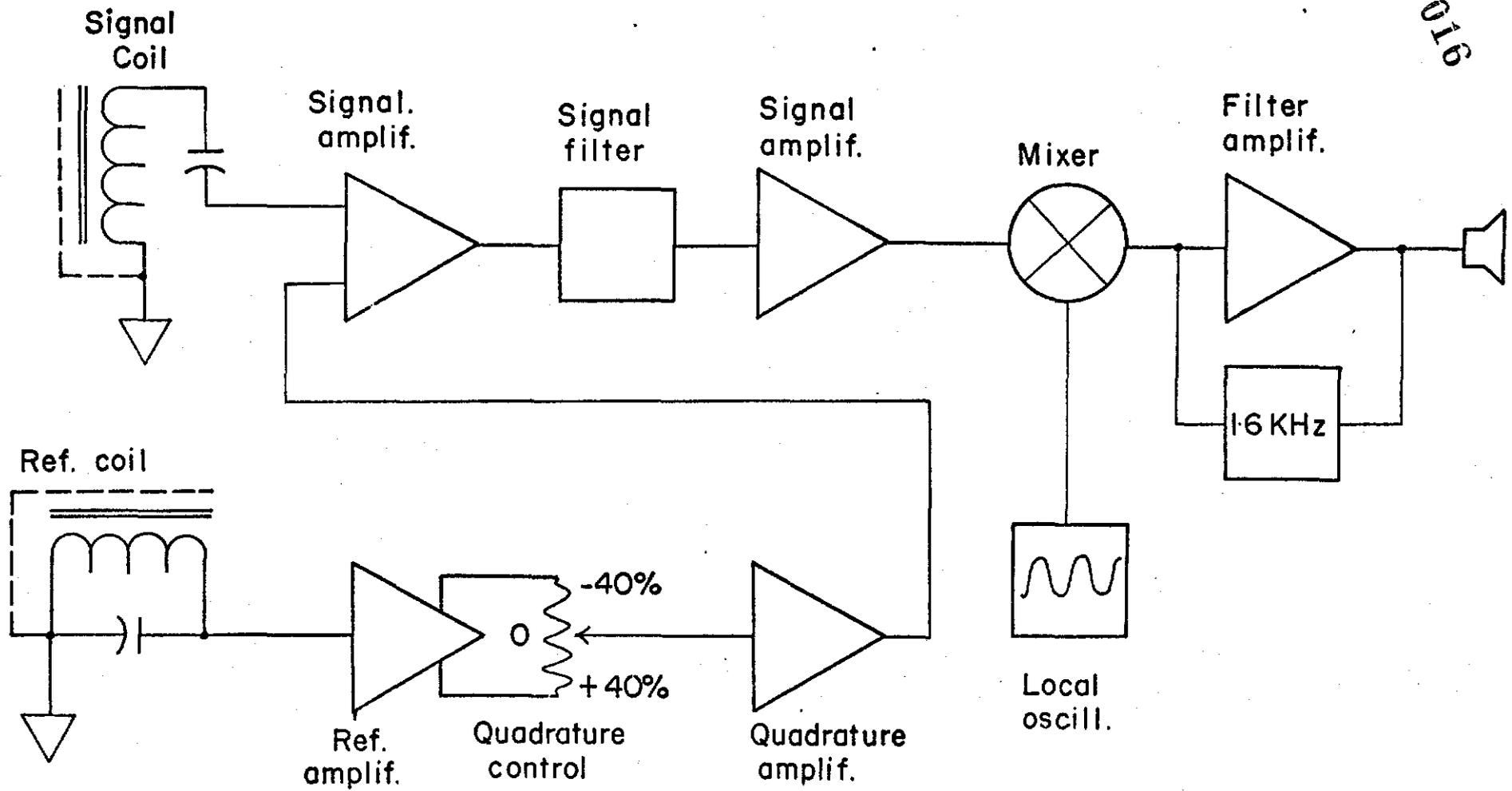
FIG. 1 VLF-EM 16 UNIT

means of the plug-in unit, and measures the vertical in-phase and quadrature components of the secondary field expressed as a percentage of the horizontal primary field.

Figure 2 is a block diagram of the E.M.-16. The signal amplifier has two inputs, one connected to the signal coil and one to the reference channel. The signal from the signal coil is minimized by tilting the coils. The quadrature control in the reference channel reduces any remaining signal to zero. The signal amplifier has zero output when both input signals are equal in amplitude and phase. Thus the setting of the quadrature control for minimum output from the receiver indicates the relative amount of the quadrature signal of the vertical coil. The output is amplified and mixed with a local oscillator signal to give a fixed beat frequency of about 1,500 Hz which is detected with earphones.

The main geological strike of an area to be surveyed with the VLF-EM 16 method should be approximately at right angles to the primary magnetic field, i.e. in the direction of the transmitting station, while the survey lines should be along the lines of the primary magnetic field. Thus, the VLF method is suited to work in this area as the veins strike generally in the N.W. direction.

The depth of penetration of this geophysical method was studied by Langron (1970), who reports that the results of VLF surveys performed by him in the Dundas area indicate that the maximum depth penetration producing reliable anomalies is about 100 feet; it was expected that the depth penetration would be similar over SPL-95. The skin depth is given by $3.6\sqrt{\rho}$ meters, where ρ is the resistivity of a homogeneous halfspace in ohm-m for a frequency of 20 kHz, assuming that the halfspace is magnetically nonpolarizable. For moderately conductive ground $\rho = 10^2$ ohm-m, which gives a skin depth of 36 meters (110'). The secondary field is further attenuated on its way to the surface, thus confirming that 100 feet is a reasonable limit to the depth penetration of the method in this area.



EM 16 VLF-EM
Block Diagram

FIG. 2

IV - VLF DATA COLLECTION

The EM-16 unit has two receiving coils which are mutually perpendicular. The signal coil has a vertical axis, while the reference coil has a horizontal axis, both coils are tuned to the same primary signal, but they have separate amplifiers. The signal coil is series tuned, while the reference coil is shunt tuned (i.e. the coil is in a parallel arrangement) in order to introduce a phase difference of 90° between the two signals.

The direction of the primary field is first obtained by holding the signal coil horizontal. The direction of the instrument when minimum sound intensity in the speaker is obtained indicates the direction of the transmitting station. The instrument is then held vertically with the reference coil in a direction at right angles to the transmitter location; thus the flux of the primary field is at a maximum through the reference coil. The instrument is then rotated through the vertical plane about a horizontal axis until a minimum signal is audible. The signal coil is at this point oriented along the minor axis of the ellipse of polarization, and the tilt angle of the instrument is the angle of inclination of the ellipse. The inclinometer on the side of the instrument is calibrated to read the tangent of the tilt angle (multiplied by 100) which is proportional to the ratio

018

of the in-phase component of the vertical secondary field to the horizontal primary field, for small secondary fields.

With the instrument inclined at this angle, the quadrature knob is rotated until a minimum noise is obtained. The voltage in the reference coil is first phase-shifted by 90° , and then a measured proportion of this voltage is used to compensate the voltage in the signal coil. The calibration of the quadrature knob registers the percentage of the reference signal used in the compensation, thus providing a direct measurement of the ratio of the signal strengths in the two receiver coils. This quantity, the eccentricity of the polarization ellipse, is equivalent to the ratio of the quadrature component of the vertical secondary field to the horizontal primary field, as proved in Appendix A.

There are two sets of readings obtainable at each survey point, which are equal but opposite in sign. The correct set is that which gives the conventional negative slope for an anomaly when traversing the profile from left to right. Thus a conductor lying ahead of the operator will cause a positive in-phase component. The instrument was tested, satisfactorily, for symmetry.

V. - VLF DATA REDUCTION AND INTERPRETATION

VLF readings taken along each traverse are plotted as profiles of the in-phase (shown in the diagrams as solid curves) and quadrature (represented by broken curves) components of the vertical secondary magnetic field expressed as a percentage of the primary horizontal field. The in-phase data may be filtered and smoothed using a process described by Fraser (1969) if the traverses are located on a grid, and the results then contoured. This filtering process gives a plot proportional to the first discrete derivative of the in-phase component, and tends to amplify and improve the resolution of the anomalies. However in this area where the traverses surveyed were only existing walking tracks, this process was unnecessary.

Type curves for the in-phase component profiles may be deduced by combining the primary and secondary magnetic fields by the parallelogram law of forces. Figure 3 shows the horizontal primary field in cross section, and assumes the conducting body to have a strike-length perpendicular to the plane of the figure and the secondary induced current in it to be concentrated along the upper edge. The current produces a secondary magnetic field which by the theory of electromagnetic

induction opposes the primary. There is most current concentration in the upper edge of the conductor because the return secondary current is more spread due to the diminishing primary field in the conductive rock. Thus the tilt profile is obtained; the resultant field dips below the horizon (positive tilt) on one side of the conductor, and above the horizon (negative tilt) on the other. The conductor is located below the point of inflexion where the tilt is zero.

A vertical sheet type conductor if it comes close to the surface gives a sharp cross-over of large amplitude, and slow roll-off on both sides (figure 4).

As with any electromagnetic method, the largest and best conductors give the highest ratio of in-phase to quadrature components. In figure 4, the quadrature component suggests that the body is a poor conductor, while figure 5 shows an anomaly with a small quadrature effect, indicating a body of good conductivity.

The effect of conductive overburden is more noticeable in the quadrature than the in-phase component. A reversed polarity of the quadrature can be due to the conductive overburden on top of an area of better conductivity. (Figure 6).

021

Figure 7 shows the effect of two adjacent conducting bodies. Body A is large and at depth, thus the in-phase profile A has a relatively large amplitude and does not have nearly as steep a slope as the anomaly due to body B which is smaller and nearer the surface. The combined curve only has one zero cross-over indicating that the steepest gradients of the in-phase profile should be looked for rather than the actual zero crossings.

(A) DEPTH

The determination of depth is generally more reliable than the estimation of the actual dimensions of the conductive body. The horizontal distance between the maximum positive and negative readings is about the same as the actual depth from the ground surface to the centre of the effective area of the conductive body. This point is not the centre of the body, but slightly closer to the upper edge. The depth to the conductor is calculated at half the distance between the positive and negative maximums, and is located at the centre of the slope, not at the actual zero-crossing.

022

(B) REPEATABILITY

The VLF-EM 16 unit was tested for repeatability of results by resurveying several traverses in different weather conditions, and at intervals of time up to one year. The readings were found to be reproducible within the limits of measurement error in all cases.

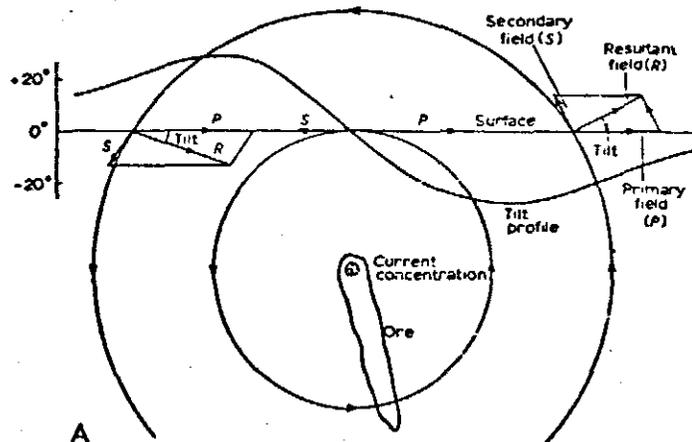


Fig 3.

TILT OF THE EM FIELD

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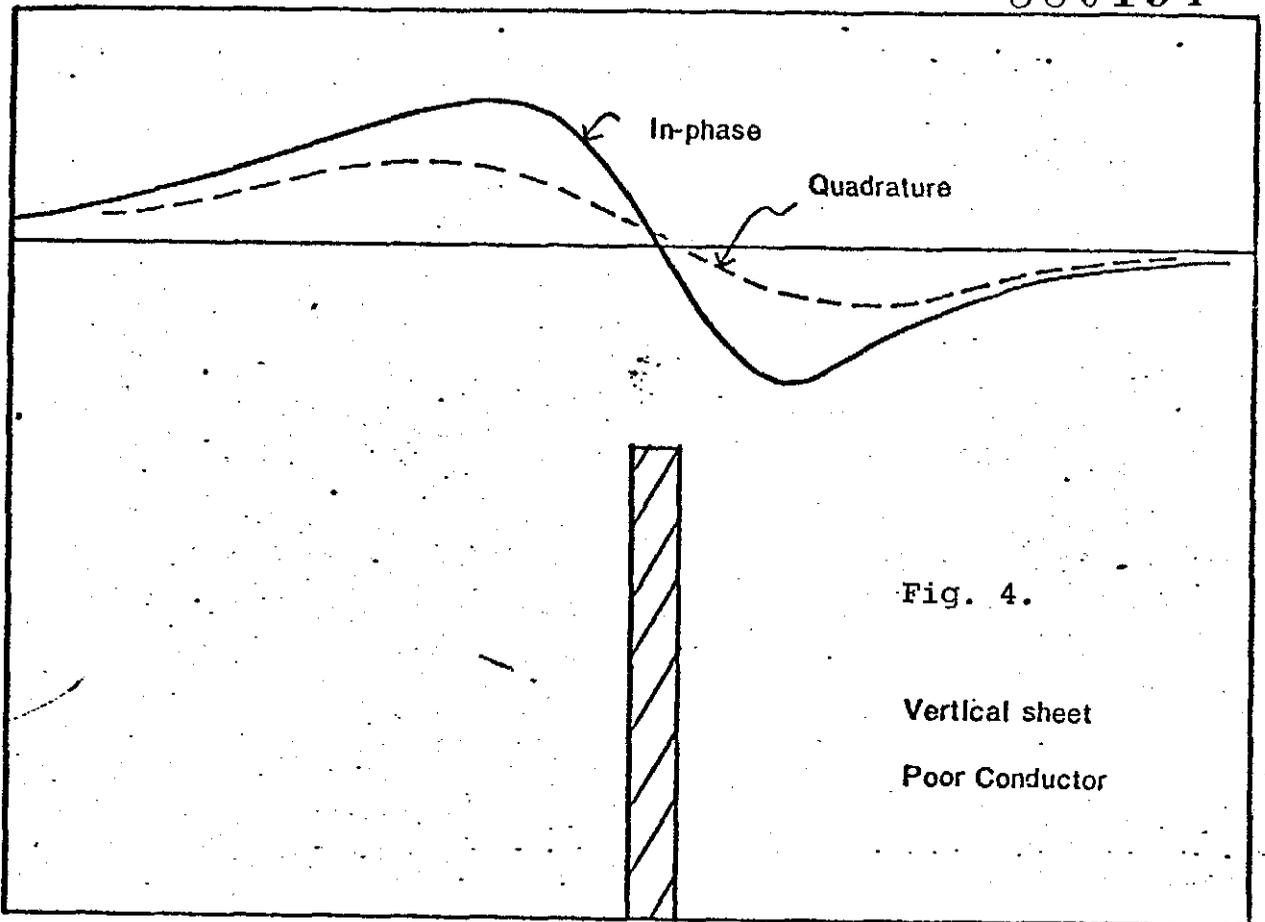


Fig. 4.

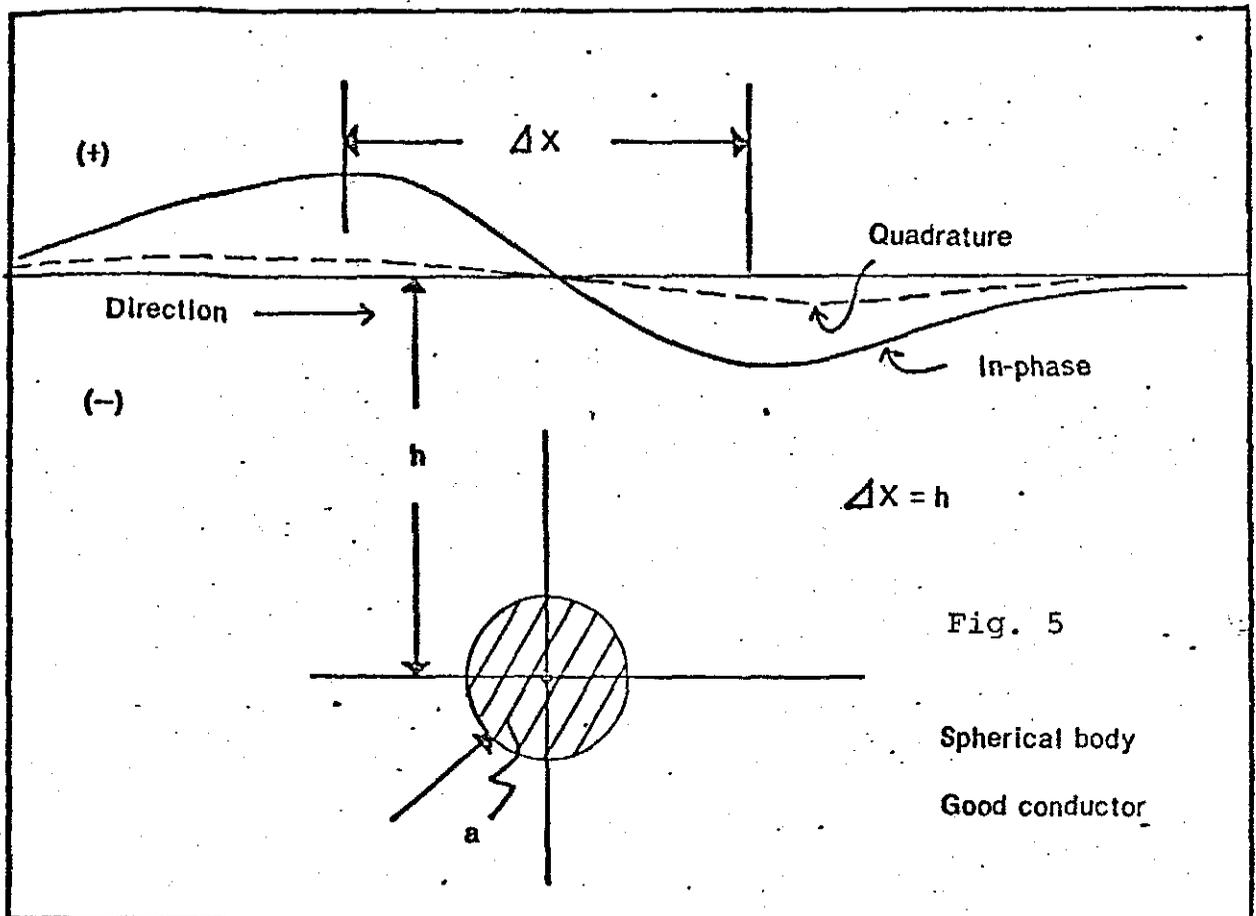


Fig. 5

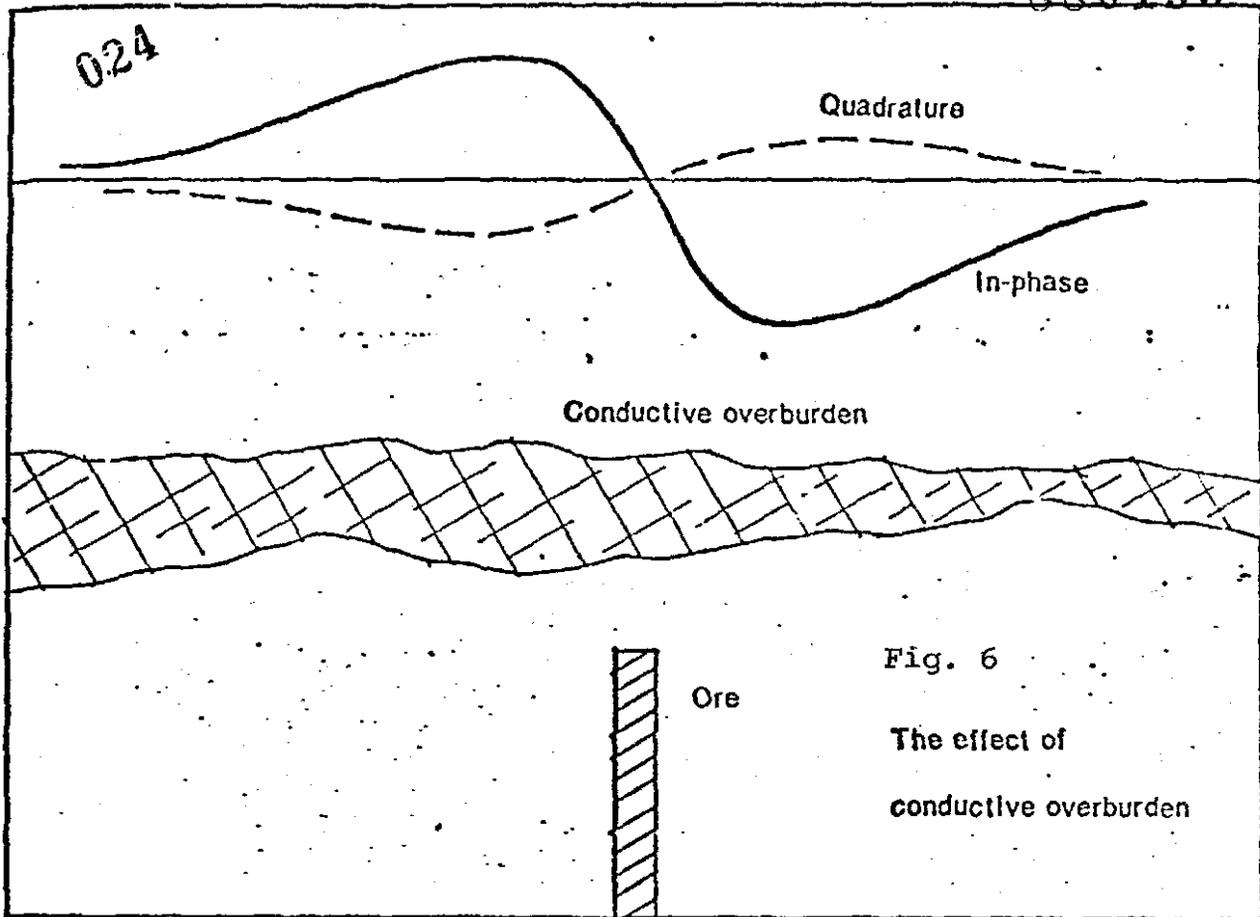


Fig. 6
The effect of
conductive overburden

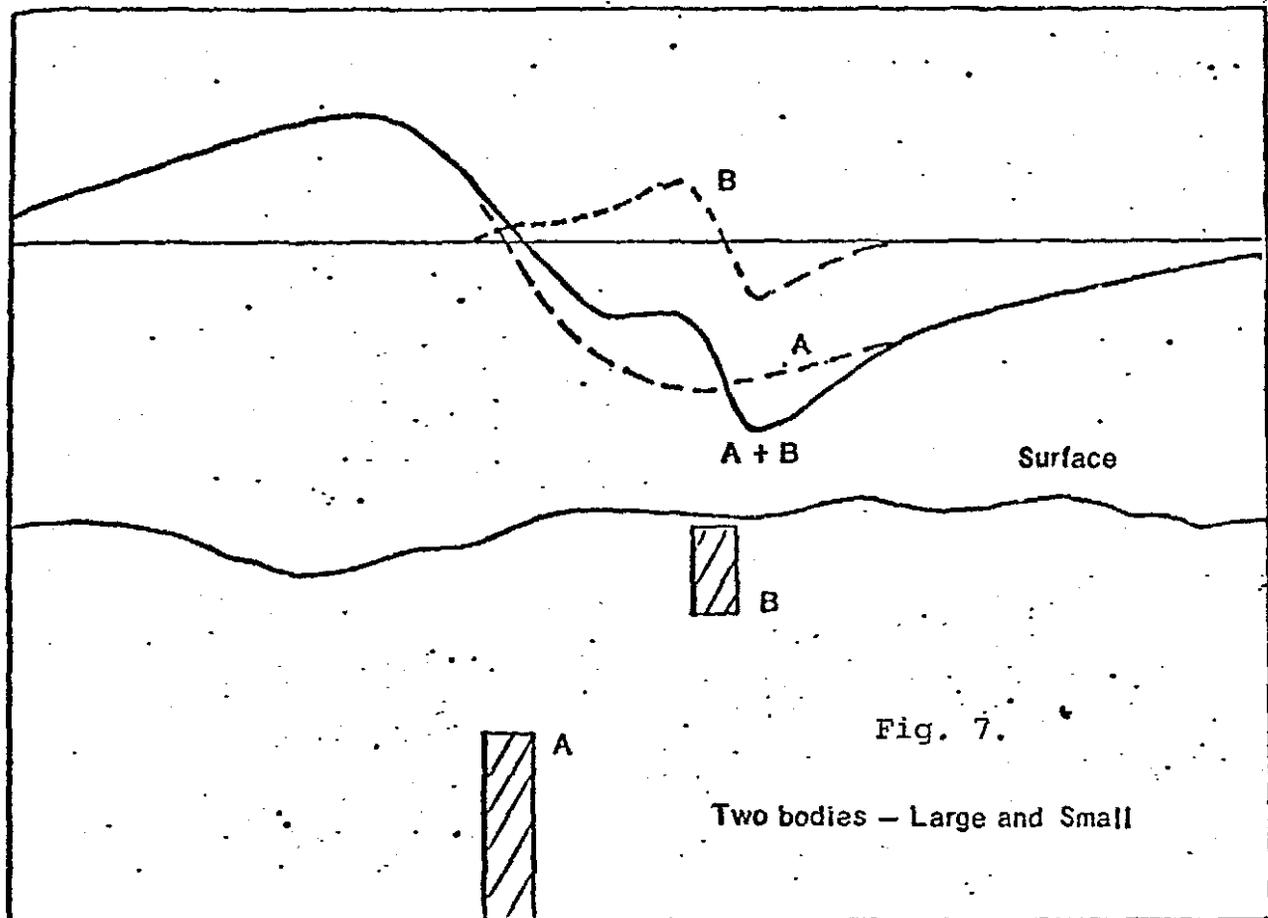


Fig. 7.
Two bodies - Large and Small

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VI - RESULTS OF S.P.L. 95 SURVEY

A. RADIOMETRIC SURVEY

The radiometer results were fairly low, and there were no obvious anomalies. A reading of magnitude three or four times background would be considered significant.

B. GEOCHEMICAL SURVEY

The thirteen samples were analysed for Cu, Pb, Zn, Ag, Mo, Bi, Sb, Sn and W and the analytical results are included in this report together with the field sampling sheets. The assays show some reasonably good tin and zinc values.

C. VLF-EM SURVEY

In the following discussion, a conventional negative slope is referred to as a positive slope V.L.F. anomaly. Each traverse is studied individually and an estimate is made of the depth and conductivity of the body producing the anomaly, as described in section (V). The description of the VLF data along each traverse should be read with the enclosed profiles.

Traverse 1

There is an anomaly in the in-phase component between 800' and 950' along this traverse which has a very small quadrature component. The body causing this anomaly is at a depth of 75'

026

below the point of 875', and has a good conductivity.

Another anomalous zone is between 4000' and 4350' and is probably caused by three small bodies. The quadrature component shows some variation in this region, and has a mainly positive slope. The bodies are relatively small and of only moderate conductivity.

The anomaly between 4950' and 5050' is accompanied by a reverse slope quadrature component, indicating the presence of conductive overburden. This anomaly suggests a small body at a depth of about 50'. Between 6550' and 6850' there is an anomaly accompanied by a small positive quadrature slope. The shape of this anomaly suggests a deep body, at a depth of about 150', of moderate conductivity.

The anomalies between 7050' and 7250' and 8200' and 8400' both have quadrature components showing only small variations, the bodies producing the anomaly are at a depth of about 100'.

Between 10,500' and 10,750' there is an anomaly which appears to be due to a large body at a depth of about 100'. The quadrature component shows little variation, suggesting that the body has a good conductivity.

Traverse 2

Both the in-phase and quadrature components show considerable fluctuation along this traverse. Between 7650' and 7550' there is an anomaly in the in-phase component with an associated quadrature profile showing only a small variation. The anomaly suggests a small body at a depth of 50' below 7,600' of moderate conductivity. The in-phase component shows a steep positive slope between 4300' and 4250' along this traverse. The quadrature component profile has a large positive slope in this region indicating that the body causing the anomaly has a poor conductivity, but is relatively near the surface.

The anomalies in the in-phase components between 4150' and 4050' both have quadrature components showing little variation. The bodies are of similar dimensions and at a depth of less than 50'. Between 3250' and 3200' there appears an anomaly in the in-phase component with no variation in the quadrature component. The anomaly suggests a near surface body of good conductivity and moderate dimensions.

There is a body of good conductivity at a depth of 50' below 2600' indicated by the in-phase anomaly between 2650' and 2550'. Another anomaly extends from 2200' to 2050' which is accompanied by some variation in the quadrature component.

028

This indicates a body of moderate conductivity at a depth of about 50' below 2150' along the traverse. There is a larger anomaly between 1950' and 1900' in the in-phase component; the quadrature profile remaining small in this region. The body causing this anomaly is near the surface and of good conductivity.

The anomaly between 950' and 850' has an associated quadrature component profile showing considerable variation. The body is at a depth of 50' below 900' along the traverse, and of only moderate conductivity. Between 600' and 550' the in-phase anomaly has an accompanying positive slope quadrature component. The anomaly indicates a near-surface body of moderate conductivity. The final anomaly appears between 200' and 100' along the traverse and the quadrature profile shows a large reverse slope in the region. The body is at a depth of 50' below 150', and in an area of conductive overburden.

Traverse 3

There appear to be a number of anomalies along this traverse, which again shows a large amount of fluctuation.

There are two anomalies indicating small near-surface bodies centred under 6,600' and 6500' along the traverse.

Between 6350' and 6300' there is an anomaly with an associated reverse slope quadrature component profile suggesting the presence of conductive overburden. The body is probably relatively small and near the surface. There is a larger anomaly between 6200' and 6100', which is again accompanied by a small reverse slope quadrature effect. The body producing the anomaly is at a depth of 50' below 6150' along the traverse.

Between 5700' and 5600' there appears a large anomaly in the in-phase component with a quadrature profile showing a small reverse slope possibly indicating the presence of conductive overburden. The anomaly suggests a relatively large conducting body at a depth of 50' below 5650' along the traverse. The shape of the in-phase component profile between 5300' and 5150' suggests the presence of two interfering conductive bodies; both are probably at a depth of less than 50', are moderately conductive and of similar dimensions.

A moderately conductive body at a depth of 75' below 4675' along this traverse is indicated by the in-phase anomaly between 4750' and 4600'. The quadrature component shows some variation in this region; the body appears to have moderate dimensions. The anomaly between 4000' and 3950' in the in-phase component is accompanied by a reverse slope quadrature profile suggesting the presence of conductive overburden. The body

producing the anomaly is at a depth of less than 50' below 3975'. The in-phase component anomaly between 3700' and 3600' is accompanied by a large positive quadrature slope. The body is therefore only poorly conductive and is located at a depth of 50' below 3650'.

There is a small in-phase anomaly between 2950' and 2850' indicating a body at a depth of 50' below 2900'. The quadrature component profile shows practically no variation in this region of the profile suggesting that the body has good conductivity. There are two large anomalies between 2750' and 2900', and 2500' and 2450'. The bodies appear to be of a reasonable size near the surface and of good conductivity and located below 2725' and 2475' respectively. Between 1450' and 1350' there is an in-phase anomaly with an associated steady quadrature component. The body is at a depth of 50' below 1400' and of good conductivity.

A large positive slope quadrature component accompanies the in-phase anomaly between 1050' and 1000' along this traverse. The near-surface body is thus probably only poorly conductive. Another anomaly with a large positive slope quadrature component is located between 350' and 300', suggesting a poorly conductive near-surface body. A smaller anomaly appears between

250' and 200', but it has a small steady quadrature component. The body is again near the surface but has a good conductivity.

Traverse 4

The VLF profiles along this traverse again show a great deal of activity. Between 350' and 500' along the traverse there is an anomaly in the in-phase component, with the quadrature component profile showing a mainly positive slope. The profiles indicate a relatively small body of moderate conductivity at a depth of 50' below 450'. There is a second small anomaly between 1950' and 2050' which suggests a body of moderate conductivity also at a depth of about 50'.

The anomalies between 2950' and 3100', and 3150' and 3250' are both accompanied by small positive slope quadrature component profiles. The first anomaly indicates a body at a depth of 75' below 3025', while the second suggests a small body of only moderate conductivity at a depth of 50'.

Two small near-surface bodies are indicated by the anomalies between 5050' and 5100', and 6800' and 6850' along this traverse.

Between 6100' and 6250' there is an anomaly in the in-phase component with an accompanying positive slope quadrature

component profile. The anomaly suggests a poor-moderately conductive body at a depth of 75' below 6175'. There also appears an open anomaly at the end of this traverse from 7200'. The quadrature profile follows the in-phase profile closely in this region, suggesting that the body is only poorly conductive, but the anomaly is relatively large.

Traverse 5

There are a number of clear anomalies along this traverse, although again the profiles show an unusual amount of fluctuation.

Between 750' and 800' along this traverse there is an anomaly in the in-phase component with the quadrature component profile showing a strong positive slope in this region. The body producing this anomaly is of poor conductivity and at a depth of 50' below 750'.

There is a relatively large anomaly between 2300' and 2500' in the in-phase component, accompanied by a small positive slope quadrature effect. The anomaly indicates a body of good size and conductivity at a depth of about 75' to 100' below 2350'.

The anomaly between 2850' and 2950' has a small

positive slope quadrature component associated with it, suggesting a body of good conductivity at a depth of 50' below 2900'. Between 3850' and 4050' there is another in-phase anomaly, with the quadrature component showing some fluctuation in this region. The body producing this anomaly is located at a depth of about 100' below 3950', and appears to be only moderately conductive.

There is a small anomaly between 4950' and 5000' along the traverse. The quadrature component profile shows a mainly reverse slope suggesting the presence of conductive overburden. The body is relatively small, and at a depth of 50' below 4950'.

Between 5500' and 5650', and 5800' and 5950' appear anomalies in the in-phase component profile, both of which have positive slope quadrature components associated with them. Both bodies have only moderate conductivity, and are at a depth of about 75', the first below 5575' and the second below 5875'. They appear to be of similar dimensions. A body of good conductivity and at a depth of 50' below 7600' is indicated by the anomaly between 7550' at 7650'. The quadrature component shows little variation in this portion of the profile.

D. MAGNETIC SURVEY

The magnetometer readings are fairly flat on the whole, although there are several anomalies. However some of these are suspected to be caused by buried old mining equipment.

There is an isolated high of about 1000 γ at 7800', along traverse 1, and another of 995 γ at 10,300'. There do not appear to be corresponding VLF anomalies associated with these magnetic highs, the second magnetic anomaly is possibly due to a pipe in the area.

Traverse 2 again shows very little large scale variation except for an isolated low of 100 γ at 4,600'.

The magnetic profile along traverse 3 shows some fluctuations, but the variations are only of the order of about 100 γ .

Along traverse 4 the magnetic profile shows several anomalies, all of which are probably associated with metal objects present. None of them appear to coincide with any VLF anomalies.

The magnetic profile along traverse 5 shows a little activity but there are no strong anomalies.

035



GEOCHEMICAL FIELD SAMPLING SHEET 880146

DISTRICT: SOUTH HEEMSKIRK
PROJECT: SPL. 95

STATE: TASMANIA
CLIENT:

STATION	FIELD SAMPLE No.	SAMPLER	DATE	MAP GRID OR PHOTO REFERENCE	CHECKS		SAMPLE TYPE (CHECK)						ADJOINING BEDROCK AND REMARKS
					Map. Loc. Plotted	Sample Numbered	Rock	Wet Stream Sediment	Dry Stream Silt	Stream Wash	Residual Soil	Other (State)	
	SPL 95 1	R.W.	4/5/71	260' west of termination of Federation Mine access road	-	-							Loose boulders brown/green gossanous rocks with small vugs
	sp1 95 2	R.W.	4/5/71	500' west of termination of Fed. Mine access road	-	-							Crystalline grey colored rock wit enclosed box structure vugs
	Day 3 S1	R.W.	5/5/71	Unnamed mine 500' S.W. of start of days traverse	-	-							from mine dump purple/grey very soft mineral in decomposed granite.
	Day 3 S2	R.W.	5/5/71	as above	-	-							highly weathered decomposed gran- ite green colore In situ on wall main workings.
	Day 4 S1	R.W.	5/5/71	Federation Mine dump	-	-							green/grey highly weathered granite
	Day 4 S2	R.W.	5/5/71	as above	-	-							dark brown tour- maline gossan. Heavy-possibly tin & sulphides
	Day 4 S3	R.W.	6/5/71	as above	-	-							Heavy tourmalin- ized granite- sulphide color- ation - brown
	Day 4 S4	R.W.	5/5/71	as above	-	-							Tourmalinized granite with assoc sulphide coloration, poss ible wolfram.
	R.P. 1	R.P.	2/5/71	Mullock tip on Ernie Coleman's track	-	-							Tourmalinized granite no defin ite econ. min. C fragment abnormal heavy.
	R.P. 2	R.P.	2/5/71	as above	-	-							Highly weathered fine grained gra ite with small dark xls min ?

00 036



GEOCHEMICAL FIELD SAMPLING SHEET 880147

DISTRICT: SOUTH HEEMSKIRK
PROJECT: SPL 95

STATE: TASMANIA
CLIENT:

STATION	FIELD SAMPLE No.	SAMPLER	DATE	MAP GRID OR PHOTO REFERENCE	CHECKS			SAMPLE TYPE (CHECK)					ADJOINING BEDROCK AND REMARKS	
					Map. Loc. Plotted	Sample Numbered	Rock	Wet Stream Sediment	Dry Stream Silt	Stream Wash	Residual Soil	Other (State)		
	R.P. 3	R.P.	2/5/71	Mullock tip on Ernie Coleman's Track		-	-						Mullock debris	decomposed debris from brea down of fragment on tip
	R.P. 4	R.P.	2/5/71	as above		-	-							Fine grained granite impreg- nated with minut crystals. Abnor- mally heavy.
	R.P. 5	R.P.	2/5/71	as above		-	-							Fine grained dk grey igneous roc Heavy-impregnate with fine tour- maline crystals.

GEOCHEMICAL LABORATORY REPORT

FIELD SHEET No. 003559 PROJECT No. SPL.95 - SOUTH HEEMSKIRK 880148

LAB. SHEET No. 683/1 SAMPLE TYPE ROCK DATE 14th July, 1971.

SAMPLE No.	LAB. No.	Cu ppm	Pb ppm	Zn ppm	Ag ppm	Mo ppm	Bi ppm	Sb ppm	Sn %
SPL 95 1	71-F-908	130	2900	1600	3	15	50	25	BLD
SPL 95 2	71-F-909	15	605	570	1	BLD	20	10	0.04
DAY 3 S 1	71-F-910	5	35	60	1	10	40	10	BLD
DAY 3 S 2	71-F-911	15	40	45	1	10	10	10	0.02
DAY 4 S 1	71-F-912	BLD	15	15	BLD	BLD	10	BLD	0.08
DAY 4 S 2	71-F-913	10	55	100	BLD	15	90	10	BLD
DAY 4 S 3	71-F-914	25	55	155	BLD	20	85	10	BLD
DAY 4 S 4	71-F-915	45	50	215	BLD	100	50	25	1.19
RP 1	71-F-916	20	5	10	BLD	BLD	10	BLD	0.03
RP 2	71-F-917	10	135	6800	1	BLD	15	10	0.03
RP 3	71-F-918	25	445	3.20%	2	10	60	10	BLD
RP 4	71-F-919	BLD	10	380	BLD	BLD	10	10	0.02
RP 5	71-F-920	BLD	15	270	BLD	BLD	5	10	BLD

		W ppm							
SPL 95 1	71-F-908	7000							
SPL 95 2	71-F-909	BLD							
DAY 3 S 1	71-F-910	600							
DAY 3 S 2	71-F-911	BLD							
DAY 4 S 1	71-F-912	BLD							
DAY 4 S 2	71-F-913	BLD							
DAY 4 S 3	71-F-914	BLD							
DAY 4 S 4	71-F-915	BLD							
RP 1	71-F-916	BLD							
RP 2	71-F-917	BLD							
RP 3	71-F-918	BLD							
RP 4	71-F-919	BLD							
RP 5	71-F-920	BLD							

METHODS:

This laboratory is registered by the National Association of Testing Authorities, Australia. The tests reported herein have been performed in accordance with its terms of registration.

- Cu, Pb, Zn, Ag by G.R.C. No. 1
- Mo, Bi by G.R.C. No. 2
- Sb by G.R.C. No. 8
- W by G.R.C. No. 4
- Sn by G.R.C. No. 5

B.L.D. = Below Limit of Detection

Chief Chemist

Ray W. J. ...



038

VII - CONCLUSIONS

The VLF method of exploration seems to be successful in this region. The data from the VLF survey shows a number of anomalies although none of these appear to have any coincident magnetic effects. The radiometric results are also surprisingly low and featureless. The results would be easier to interpret if the survey had been carried out over a regular grid, thus enabling a first derivative map of the in-phase VLF data to be prepared.

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APPENDIX A

APPENDIX AThe polarization ellipse

Assuming the primary magnetic field, \underline{H} is horizontal and of zero phase angle, it may be written:-

$$|\underline{H}| = H \cos wt.$$

The secondary magnetic field, $|\Delta\underline{H}|$ may be written

$$|\Delta\underline{H}| = H \cos (wt. + \phi) \text{ where } \phi \text{ is the phase-shift}$$

Let $\Delta\underline{H}$ be inclined to \underline{H} at an angle α (Figure 1)

Then the components of \underline{H} and $\Delta\underline{H}$ in the horizontal (x) and vertical (y) directions are given by

$$H_x = H \cos wt \quad (1)$$

$$H_y = 0 \quad (2)$$

$$\Delta H_x = \Delta H \cos (wt + \phi) \cos \alpha \quad (3)$$

$$\Delta H_y = \Delta H \cos (wt + \phi) \sin \alpha \quad (4)$$

Adding (1) and (3)

$$\begin{aligned} \text{Let } C_x(t) &= H_x + \Delta H_x \\ &= H \cos wt + \Delta H \cos (wt + \phi) \cos \alpha \end{aligned}$$

Now $\cos (A+B) = \cos A \cos B - \sin A \sin B$

∴ By analogy

$$\begin{aligned} C_x(t) &= H \cos wt + \Delta H \cos wt \cos \phi \cos \alpha - \Delta H \sin wt \sin \phi \cos \alpha \\ &= \cos wt (H + \Delta H \cos \phi \cos \alpha) - \Delta H \sin wt \sin \phi \cos \alpha \end{aligned}$$

$$\text{Now } a \cos x - b \sin x = \sqrt{a^2 + b^2} \cos (x + \delta)$$

$$\text{where } \tan \delta = b/a$$

$$\therefore \text{ By analogy } \underline{C_x(t) = X \cos (wt + \phi)}$$

$$\text{where } \phi' = \tan^{-1} \frac{\Delta H \sin \phi \cos \alpha}{H + \Delta H \cos \alpha \cos \phi} \quad (5)$$

$$\text{and } X = \left[(H + \Delta H \cos \alpha \cos \phi)^2 + (\Delta H \sin \phi \cos \alpha)^2 \right]^{1/2}$$

$$\text{Adding (2) and (4) } C_y(t) = H_y + \Delta H_y$$

$$= H \cos (wt + \phi) \sin \alpha$$

$$\therefore \underline{C_y(t) = Y \cos (wt + \phi)} \text{ where } Y = H \sin \alpha \quad (6)$$

Eliminate t from (5) and (6) to obtain the locus of $C(t)$, the resultant of the Primary and secondary fields.

Squaring and adding (5) and (6),

$$\begin{aligned} \frac{C_x^2}{X^2} + \frac{C_y^2}{Y^2} &= \cos^2 (wt + \phi') + \cos^2 (wt + \phi) \\ &= 1 + \frac{1}{2} \cos 2(wt + \phi') + \frac{1}{2} \cos 2(wt + \phi) \\ &= 1 + \cos (2wt + \delta + 2\phi) \cos \delta \end{aligned} \quad (7)$$

$$\text{where } \delta = \phi' - \phi$$

$$\begin{aligned} \text{Now } \frac{C_x C_y}{XY} &= \cos (wt + \phi') \cos (wt + \phi) \\ &= \frac{1}{2} \cos (2wt + \delta + 2\phi) + \frac{1}{2} \cos \delta \\ \frac{2C_x C_y}{XY} &= \cos (2wt + \delta + 2\phi) + \cos \delta \end{aligned} \quad (8)$$

\therefore Substituting (8) in (7)

$$\frac{C_x^2}{X^2} + \frac{C_y^2}{Y^2} = 1 + \left(\frac{2C_x C_y}{XY} - \cos \delta \right) \cos \delta$$

$$\therefore \frac{C_x^2}{X^2} + \frac{C_y^2}{Y^2} - \frac{2C_x C_y}{XY} \cos \delta = \sin^2 \delta$$

This is the equation of the ellipse whose minor axis is inclined to the vertical by the angle Θ where

$$\tan 2\Theta = \frac{2XY \cos \delta}{X^2 - Y^2} \quad \text{See Figure 2}$$

Thus the resultant field rotates in space, and describes an ellipse of polarization whose eccentricity ξ is given by

$$\begin{aligned} \xi &= \frac{b}{a} \text{ (ratio of minor to major axes)} \\ &= \frac{\Delta H \sin \alpha \sin \phi}{H} \\ &\text{if } \Delta H \ll H. \end{aligned} \quad (7)$$

Thus the eccentricity increases as the phase angle ϕ increases, and thus ξ may be used as a measure of ϕ

If $\Delta H \ll H$, the inclination of the ellipse reduces to

$$\Theta = \tan^{-1} \left[\frac{\Delta H}{H} \sin \alpha \cos \phi + \left(\frac{\Delta H}{H} \right)^2 \frac{\sin 2\alpha \sin \phi}{2} \right] \quad (8)$$

Thus the inclination and eccentricity of the ellipse are a measure of the relative field strength and phase of the primary and secondary fields.

$$\text{From above } \Theta = \tan^{-1} \left[\frac{\Delta H}{H} \sin \alpha \cos \phi + \left(\frac{\Delta H}{H} \right)^2 \frac{\sin 2\alpha \sin \phi}{2} \right]$$

∴ For small secondary fields,

$$\begin{aligned} \Theta &= \tan^{-1} \frac{\Delta H}{H} \sin \alpha \cos \phi \\ &= \tan^{-1} \frac{\Delta H \nu}{H} \quad \text{(real)} \end{aligned} \quad (9)$$

044

Thus the tangent of the inclination of the ellipse is proportional to the real component of the vertical secondary field, for small fields.

$$\begin{aligned} \text{From above} \quad \xi &= \frac{\Delta H \sin \alpha \sin \phi}{H} \\ &= \frac{\Delta H_y}{H} \quad (\text{quadrature}) \end{aligned} \quad (10)$$

Thus the eccentricity of the ellipse is proportional to the vertical quadrature component.

(The approximation leads to small errors at large secondary field strengths.)

Thus measurements of inclination and eccentricity are proportional to the real and quadrature vertical components of the secondary field.

This is the theory for primary and secondary fields in the same vertical plane. However the primary and secondary magnetic fields usually have different azimuths so that the plane of the ellipse is inclined. Let the azimuth (horizontal angle) of the secondary field relative to the primary be λ as shown in Figure 3.

Equation (7) for the eccentricity of the ellipse,

$$\xi = \frac{\Delta H \sin \alpha}{H} \times \sin \phi$$

remains unchanged, as the vertical component ($\Delta H \sin \alpha$)

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is the only one that affects the eccentricity.

Equation (8) for the inclination of the ellipse is affected slightly in the second term and becomes

$$\theta = \tan^{-1} \left[\frac{\Delta H}{H} \sin \alpha \cos \phi + \left(\frac{\Delta H}{H} \right)^2 \frac{\sin 2\alpha \sin \phi \cos k}{2} \right] \quad (11)$$

From Figure 4.

$$\alpha = \tan^{-1} \left(\frac{-x}{d} \right)$$

Considering the azimuth, this equation becomes

$$\alpha = \tan^{-1} \left(\frac{-x \cos k}{d} \right)$$

Thus the effect of varying the azimuth of the secondary field is to stretch out the anomaly either side of its cross-over and to reduce the strength of both the inclination and eccentricity values roughly in preparation to $\cos k$.

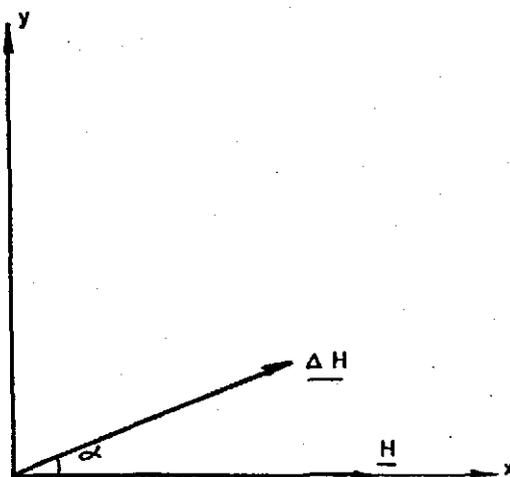


FIG. 1 INCLINATION OF SECONDARY MAGNETIC FIELD

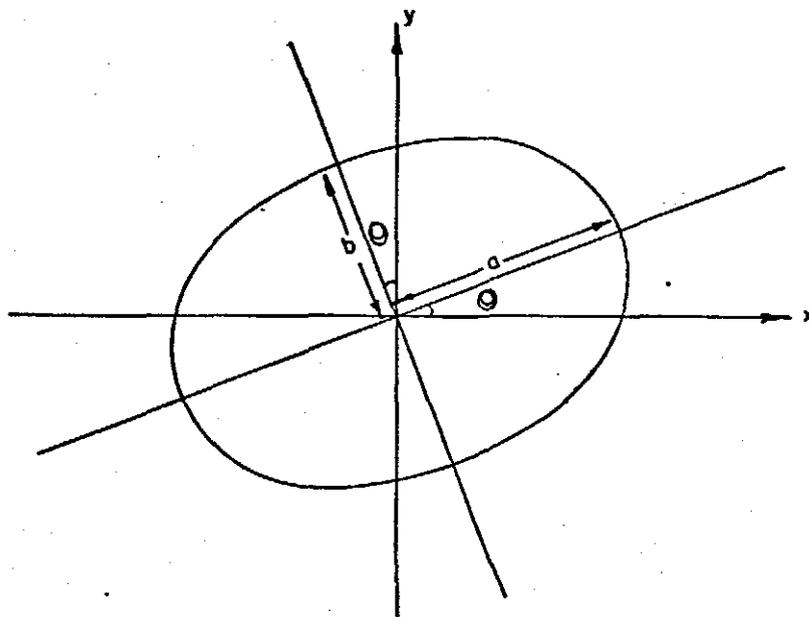


FIG. 2 ELLIPSE OF POLARIZATION

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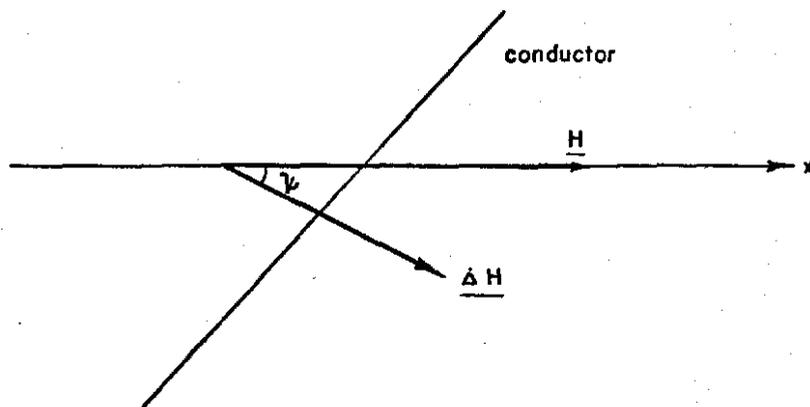


FIG 3 AZIMUTH ANGLE, ψ .

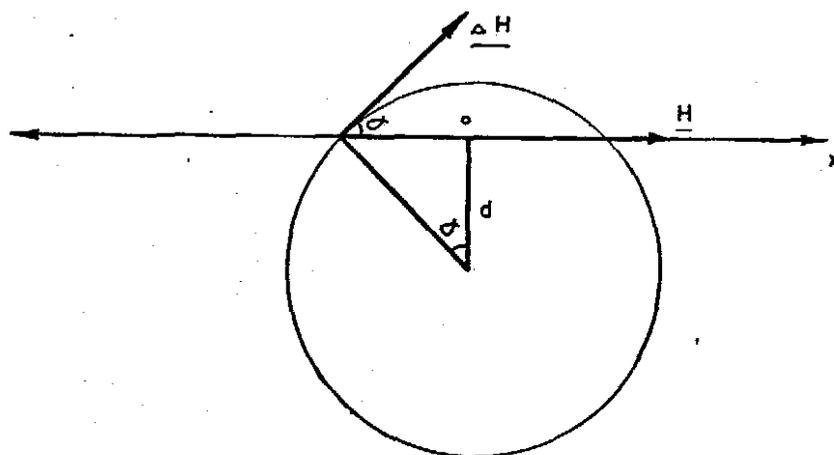
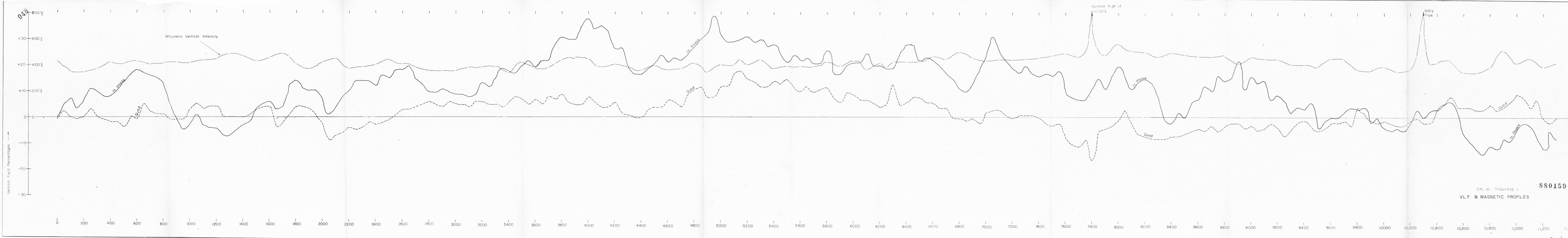


FIG 4 FIELD OVER LINE CURRENT SOURCE.

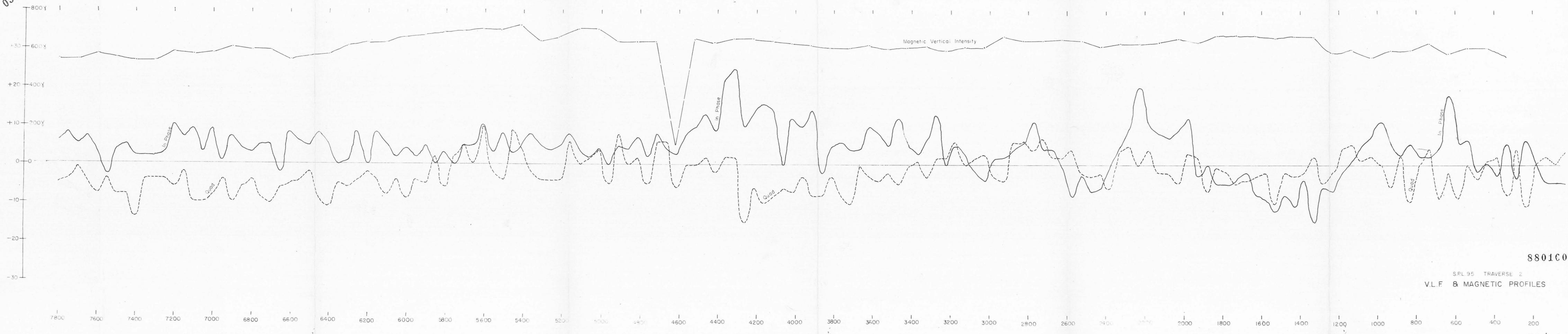


SPL 95 TRAVERSE 1
 V.L.F. & MAGNETIC PROFILES

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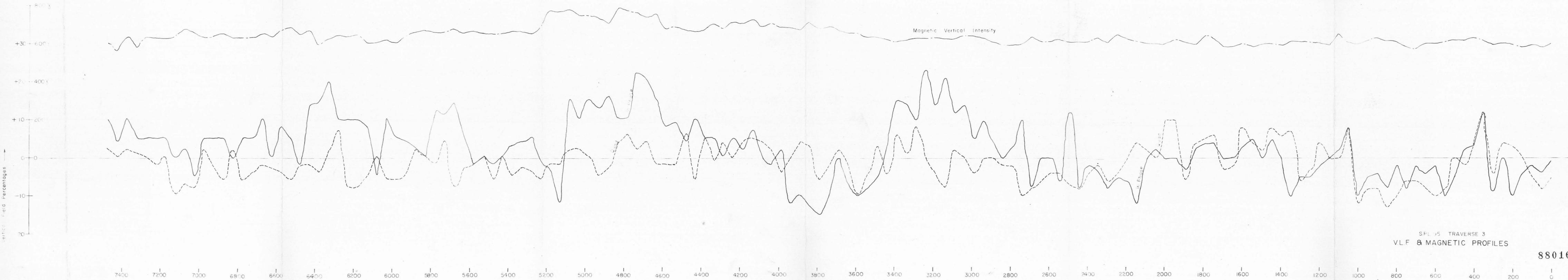


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SPL 95 TRAVERSE 2
V.L.F. & MAGNETIC PROFILES

Q50/75

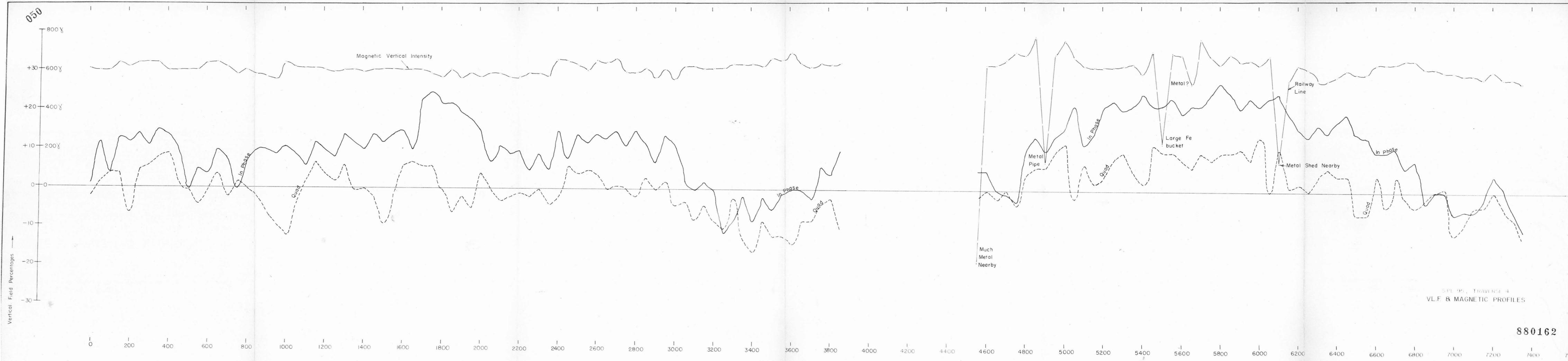
052



SPL 95 TRAVERSE 3
VLF & MAGNETIC PROFILES

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Q60/75

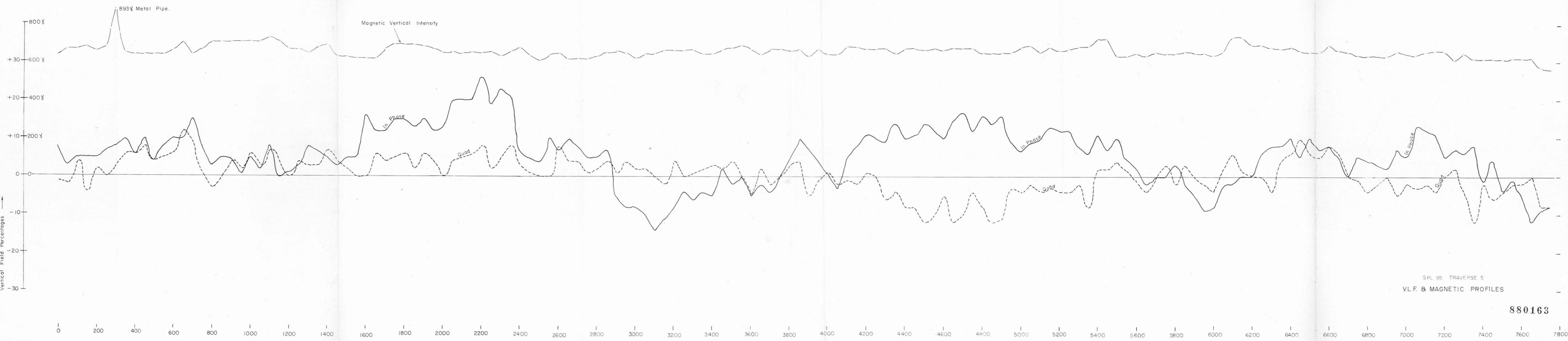


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