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Logistics and Interpretation Report on a UTEM 3 Survey Trolley Line Property Langmuir Township, Ontario

for

Dave Meunier

Rob Langridge M.Sc.

October 1994

INTRODUCTION

A UTEM 3 survey was carried out by Lamontagne Geophysics personnel on the Trolley Line Property for Dave Meunier. The property is located in Langmuir Township, Porcupine Mining Division, District of Cochrane, approximately 29 km southeast of the town of South Porcupine Ontario (Figure 1). The property is to the east of an abandoned barite mine and takes its name from the mine trolley line that cuts across it. The crew included Gerry Lafortune (operator), Mike Mills (field assistant) and Dave Meunier. The crew mobilised to South Porcupine and started work on the survey on October 18th. Access to the property was gained by travelling:

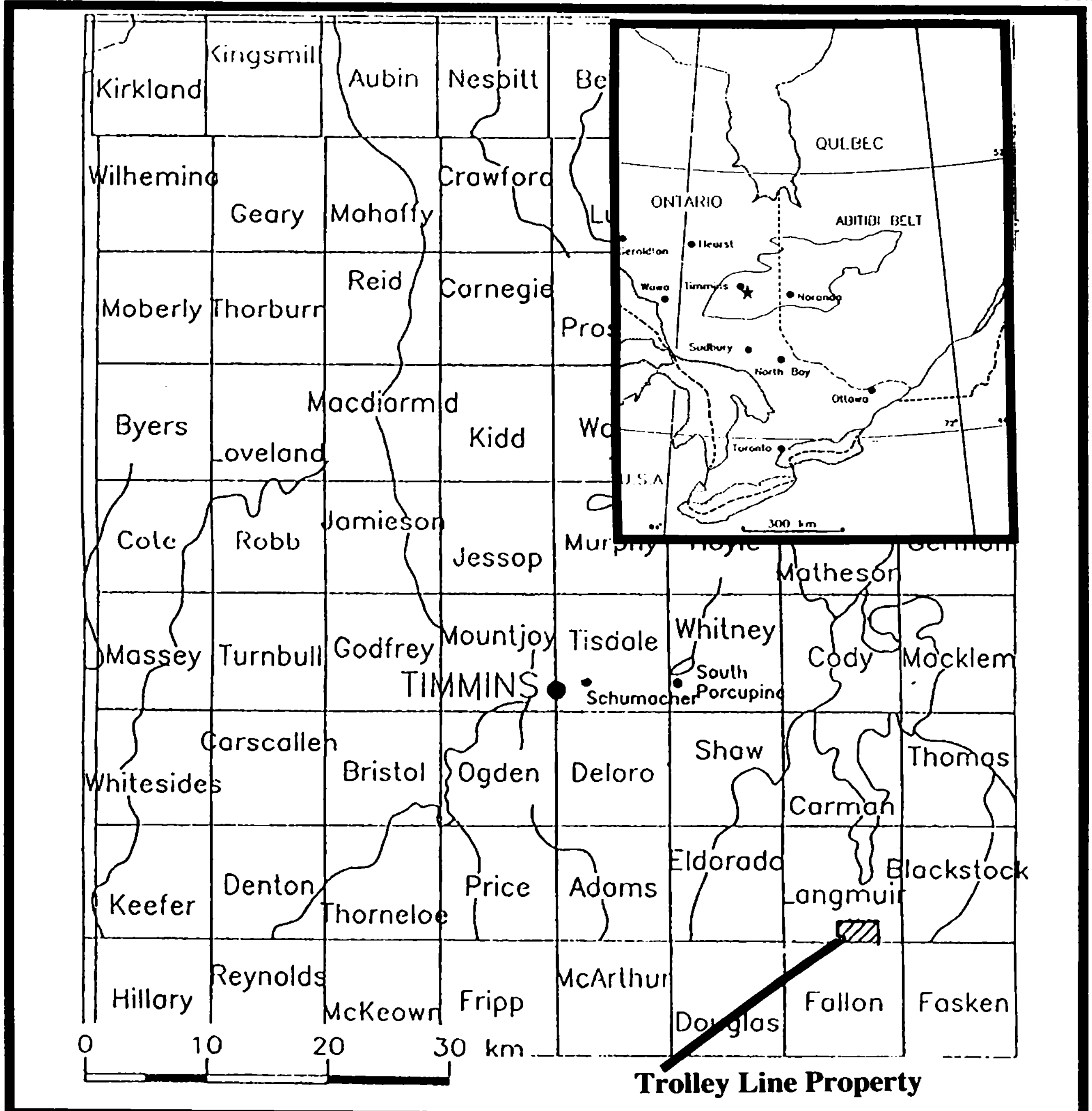
- south on a stretch of road locally referred to as the Springs Road
- 15.4 km south on Stringers Road
- 9.7 km east on Fallon Road to the Night Hawk River
- 4 km by boat north (upstream) along the Night Hawk River.

The work was completed on October 22nd. The job diary is reproduced in Appendix A. This report contains logistical information, the UTEM profiles and an interpretation of the profiles.

UTEM 3 SURVEY

The UTEM 3 survey was conducted in southeastern Langmuir Township (Figure 1). The property lies between an abandoned barite mine, to the east, and the Night Hawk River to the west. A trolley line that serviced the mine, connecting it with the river, cuts across the property. Aside from the trolley line and any other cultural features remaining from the mining operation their are no cultural features in the area that could generate an anomalous response.

The survey was designed to test an airborne electromagnetic anomalies 3220A and 3230A as outlined on the OGS GEOPHYSICAL/GEOCHEMICAL Series Map 81097. Figure 4 shows a section of this map with the anomalies marked by a circle. The anomaly appears on two lines, though at a position where the lines closely approach one another, and it is roughly coincident with the trolley line. An interpretation of the anomaly, however, suggested that the response is complex and



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Trolley Line Property

Langmuir Township

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Location Map

Figure 1

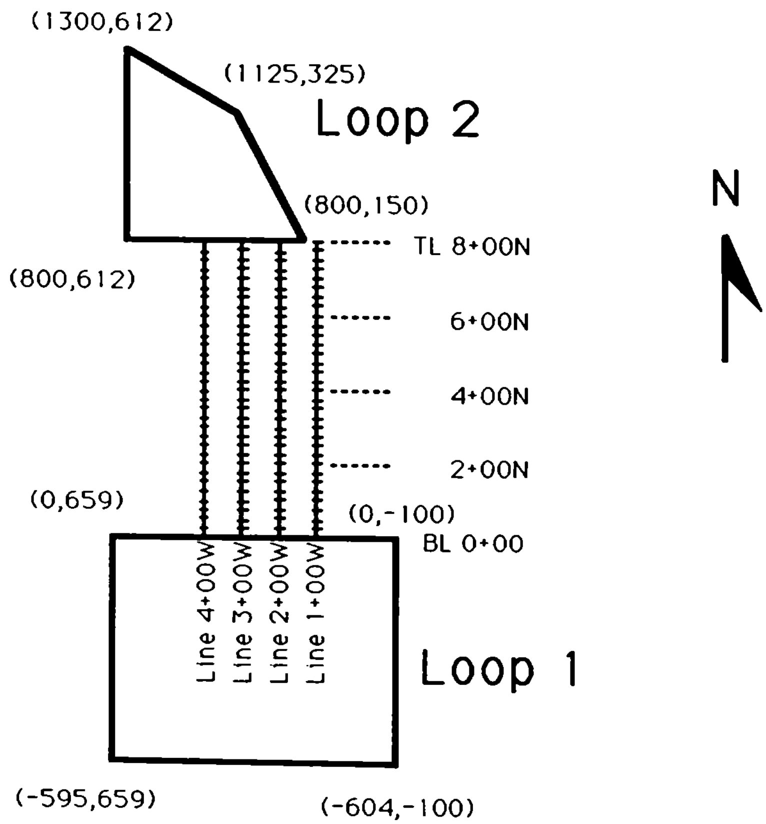
could not be accounted for by the trolley line alone. This interpretation, the geological setting and the proximity of a considerable quantity of barite led to the decision to chase the airborne anomaly with a surface UTEM 3 survey. The goal of the survey being to test the interpretation and to delineate any possible drill targets.

An old grid of the correct orientation existed over the property. This was brushed out and chained. The original line numbering was kept and the lines were chained north from the southern boundary of Langmuir Township (with Fallon Township). Four lines were surveyed - Lines 100,200,300 and 400W - from 0-800N. The grid is shown with the loop locations in Figure 2 and with the claim blocks shown in Figure 3.

Because of the possible complication of a trolley line anomaly two loops - flanking the trolley line to the north and to the south - were used in the survey. The Night Hawk River restricts the size and location of a loop to the north so Loop 1 was laid out to the south. Lines 1-4W (and additional lines if required) could be surveyed from Loop 1. Loop 2 could then be tailored to allow the required lines to be surveyed from the north. Figure 2 shows the grid layout and the loop locations.

The vertical (Hz) magnetic field component was measured a 50 metre intervals with detail surveying carried out at 25m intervals. In addition the horizontal (Hx) magnetic field component was measured along a section of Line 2+00W as surveyed from Loop 1. The UTEM waveform was sampled as ten windows (channels) representing delay times ranging from about 12msec to 25μ sec. A base frequency of 31Hz was used for the entire survey. A minimum of 2,048 half-cyles of the waveform were stacked at each station. More stacking was carried out as required as the receiver-loop separation increased and at noisy stations. Refer to Appendix B for further details of the UTEM 3 system.

The presence of the trolley line led to a modification of survey procedure. In order to test if the trolley line did have an appreciable response Line 2W was surveyed twice from Loop 1. On the first pass the trolley line was left intact - in the condition it would have been in during the airborne survey. The trolley line was then disconnected near L2W - reducing its "size" as a potential anomaly. Line 2W was then resurveyed and the remainder of the survey completed.



Note: Loop coordinates are (N,W)

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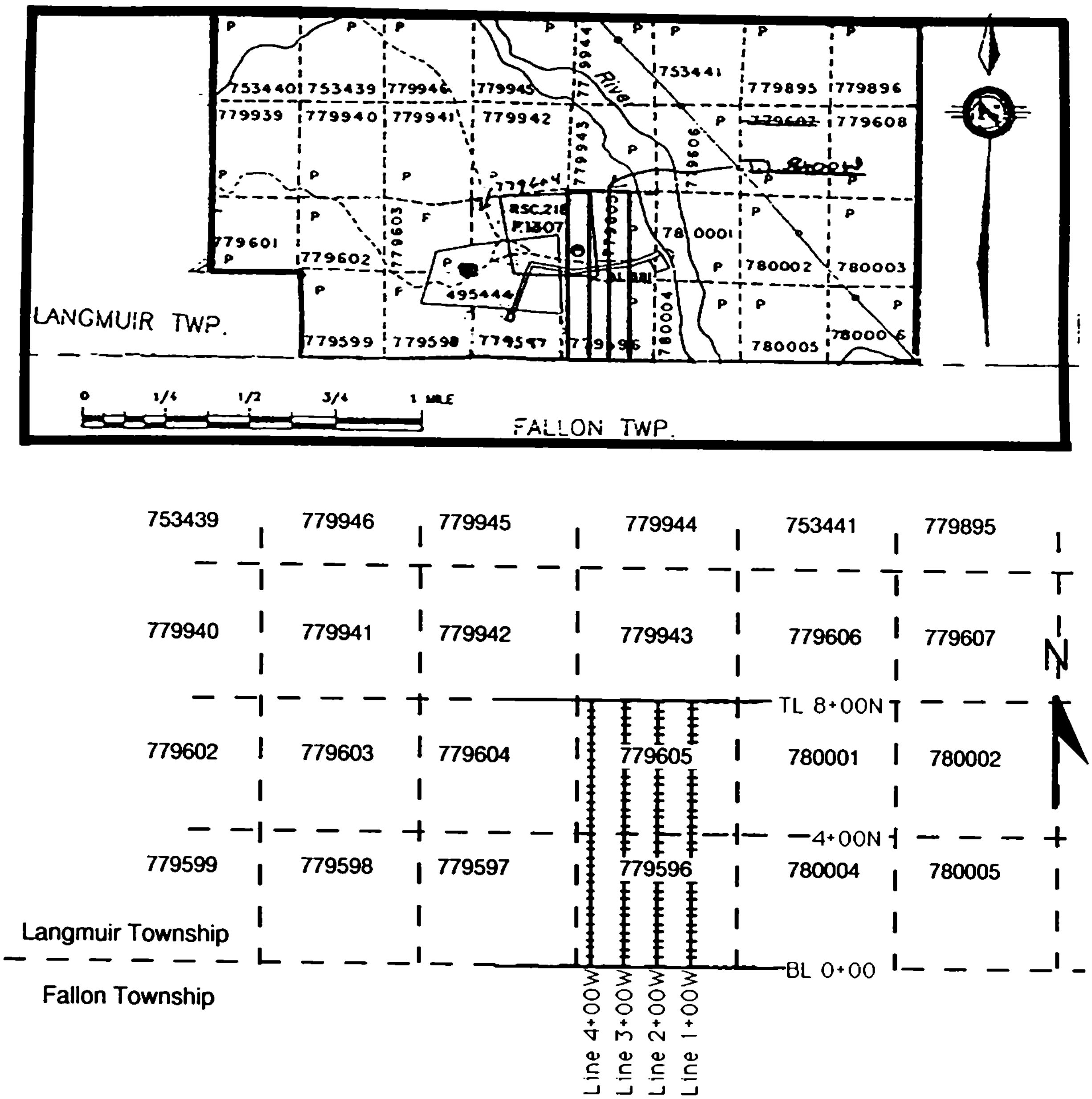
Grid and Loop Map

0 100m 500m 1000m

Figure 2



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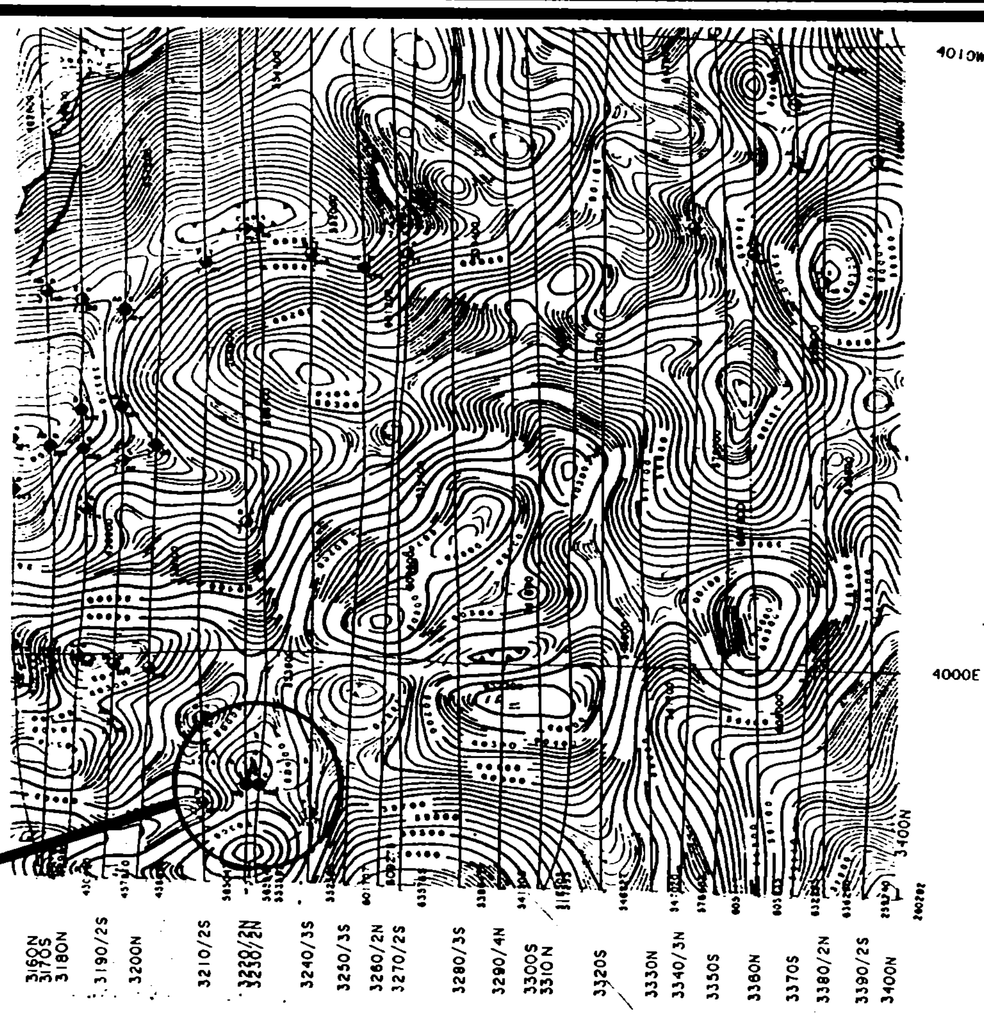
Grid and Claim Location Map

0 100m 500m 1000m

Figure 3



GEOTEM* Peak Response Symbols

1-2 Channel (350, 450 microseconds)
3-4 Channel (550, 670 microseconds)
5-6 Channel (790, 910 microseconds)
7-8 Channel (1050, 1190 microseconds)
9-10 Channel (1350, 1510 microseconds)
11-12 Channel (1680, 1870 microseconds)

Magnetic Contours

Culture Response

SE corner of

Ministry of Northern Development and Mines
Ontario
Sean Conway Minister of Mines

ONTARIO GEOLOGICAL SURVEY
GEOPHYSICAL/GEOCHEMICAL SERIES
MAP 81027

TIMMINS AREA
LANGMUIR TOWNSHIP

Airborne Electromagnetic Survey
Total Intensity Magnetic Survey
DISTRICTS OF COCHRANE AND TIMISKAMING

NTS References 42 A/6, 42 A/7
ODM-GSC Aeromagnetic Map 293 G, 294 G
O.G.S. Geological Compilation Map 2205
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Trolley Line Property

SE corner - Langmuir Township

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Airborne Electromagnetic Survey

Figure 4

STRIPPING of CULTURAL FEATURES

Powerlines, railways and other cultural features raise the local EM noise level and in many cases have associated responses. Increased stacking in the field can overcome the noise at the cost of a slower survey. The responses associated with the feature can be estimated and then removed - stripped - from the data to, hopefully, reveal any underlying anomalies.

The removal (stripping) of responses due to cultural features is accomplished by using LGL in-house software (NEW STRIP). The program requires that a precisely-chained traverse be made across the feature to determine the secondary current flowing within it for each delay time. As well, the precise 3-D path of the conductor is required. The theory of the method is given in Appendix D. The technique is simply to fit the observed data along a short traverse across the cultural conductor to the predicted anomaly shape, derived by integrating a constant current over the known path of the conductor. Done independently for each time channel, this yields an estimate of the induced current within the cultural conductor at each delay time. By computing the effect of the cultural conductor at each survey station, its response can be removed from the data. This removal is only a first order correction since it does not take into account the currents induced within the earth by the localised, induced current in the cultural conductor. This program can handle multiple cultural conductors provided that their responses are independently resolved in the data.[1]

DATA PRESENTATION

The final data are presented in Appendix E as three-axes profiles plotted at a scale of 1:10,000. The data are presented in the following form:

- Hz data
  - i) continuously-normalized
  - ii) point-normalized to a point roughly in the center of the survey area (450N,250W)
- Hx data
  - ii) point-normalized to a point roughly in the center of the survey area (450N,250W)

[1] Ben Polzer, LGL Geophysics 1994

Three-axes profiles of the raw data (continuously-normalized) are presented for the purpose of comparison in Appendix F. The data itself is tabulated in Appendix C. Information on standard UTEM plotting and plotting symbols is presented in Appendix B.

RESULTS and INTERPRETATION

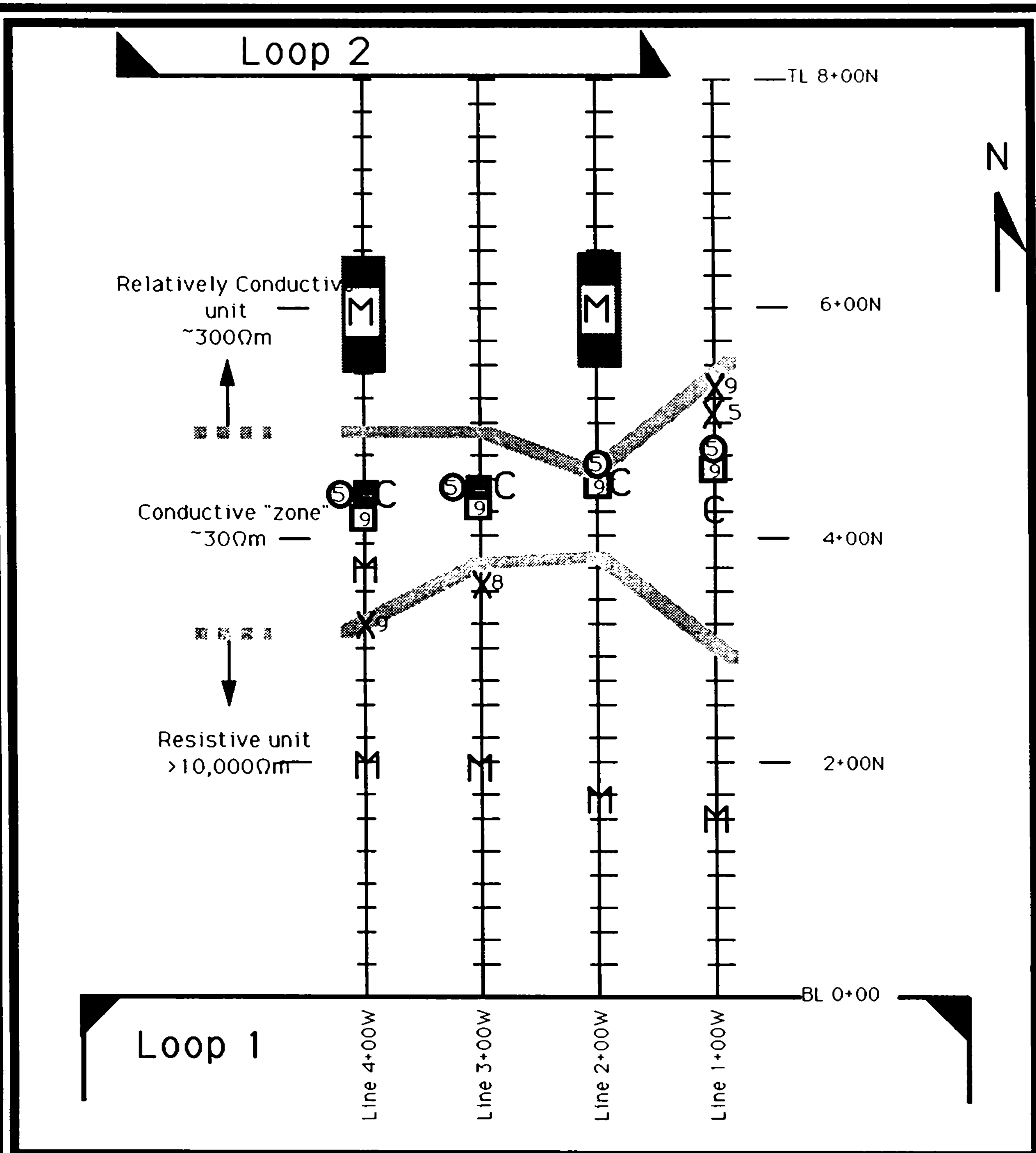
An interpretation of the UTEM 3 data collected during this survey is presented in Figure 5. The principal area of interest proves to be close to and roughly parallel in strike with the trolley line. The anomaly at this location is complex and only to a small extent due to the trolley line. Because of this the interpretation of the data will be discussed in the following order:

1) The trolley line and other cultural features
2) Stripping
3) Geological features and Conductors
4) Magnetic features

1) The trolley line and other cultural features

The results of the trolley line test on Line 2W are shown in Figure 6. The location of the trolley line is marked on both plots - 4+44N. The two profiles are virtually identical on Ch1-7. The response due to the trolley line is limited to the three earliest time-channels - Ch8-10. And after the trolley line was disconnected the response on the earliest channels decreased considerably in amplitude. Further evidence that the major response seen is not due to the trolley line is its location. The response is shifted 20+ meters to the north.

The finding that the trolley line had relatively little response is in agreement with the initial interpretation of the airborne anomaly - that it could not be explained by the trolley line alone. The UTEM 3 profiles for Line 2W and the other lines do, however, show a sharply-defined response that suggests, in some of its features, the presence of a buried cultural feature paralleling and roughly 20m to the north of the trace of the trolley line. Immediate trenching with the aim of locating the cultural feature was recommended. The anomaly character suggested that there was also a geological response. Locating the cultural feature would accomplish two things:
- it would clarify whether a cultural feature did in fact exist
- the location would allows us to strip the response of the cultural feature.



Legend

C current channeling feature

M magnetic feature

top conductor

X9 crossover

9 trolley line

5 pipe

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Trolley Line Property

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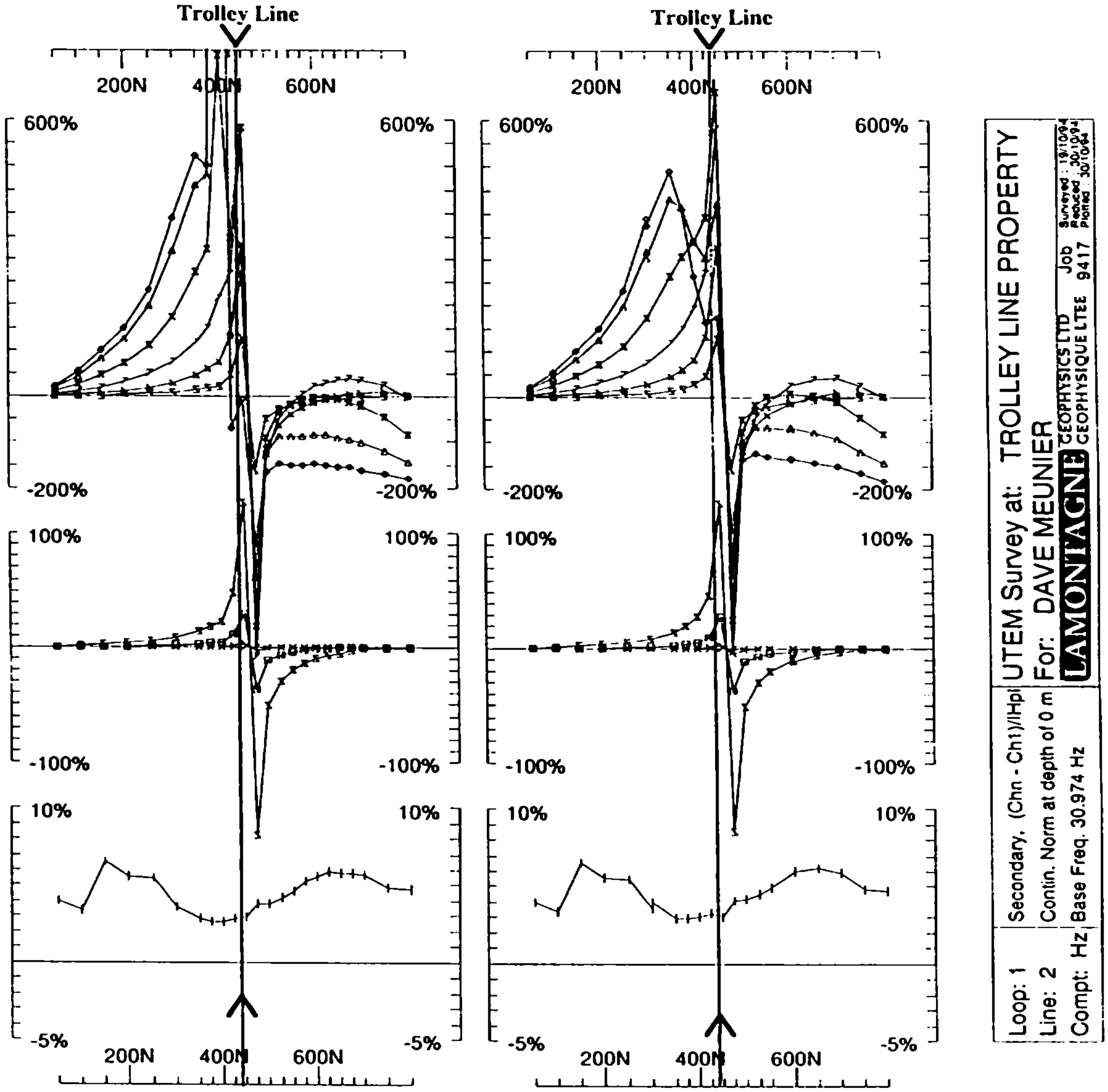
Interpretation Map

0 100m 200m

Figure 5



First pass
with trolley line intact

Second pass
after trolley line disconnected

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Trolley Line Response Test Results

Figure 6

Trenching on Line 2W in the area of the response revealed a buried pipe at a depth of 55cm. This places it at 1m below the center of the coil.

The presence of the buried pipe is evident on the UTEM 3 profiles of all the lines surveyed - Lines 1-4W. The pipe probably supplied Night Hawk River water to the barite mine. The response of the pipe is considerably more significant than that of the trolley line and warrants stripping. It is clear, however, that much of the overall response is of geological origin and it is not entirely due to the pipe, the trolley line or the combination of the two.

2) Stripping

The response of the buried pipe has been stripped from all the final profiles. Pipe locations were estimated for each survey line and then "fine tuned" by the stripping software. The actual location of the pipe as stripped is:

Loop 1	Line 1W	482.9N	(of BL 0+00)
	Line 2W	458.6N	
	Line 3W	441.2N	
	Line 4W	440.0N	
Loop 2	Line 2W	458.8N	
	Line 3W	442.0N	

Note: Northings listed in this chart are absolute distances from L0+00 - the Langmuir/Fallon Township boundary. The coordinates of the pipe relative to a given picket will depend on the absolute distance of the picket from L0+00. These distances are listed in the Line files in Appendix C.

The agreement between the pipe locations from Loops 1 and 2 as "fine tuned" by the stripping software is quite good. It also agrees well with the pipe location as trenched on Line 2W.

To indicate that a profile has been stripped "s" is added after the Loop number, ie. Loop 1s. All of the final profiles presented in Appendix E have been stripped. For reference Appendix F contains the original (unstripped) data profiles.

3) Geological features and Conductors

Eliminating the trolley line as the cause of the anomaly in question and stripping away the response due to the buried pipe leaves only geologic sources. The remaining anomaly is substantial, particularly considering that several drill holes in the area show sphalerite intersections - an indication that any potential ore may not be highly conductive.

The general geologic picture that can be resolved from the UTEM profiles is a series of units that cut east-west across the grid and dip moderately (45^o+/-15^o) to the south. Three units can be outlined:

- A resistive unit that covers the southern section of the grid, generally south of ~375N. This unit has a resistivity of >10,000Ωm.
- A conductive unit that covers the northern section of the grid, generally north of ~475N. This unit has a resistivity of ~300Ωm.
- The most conductive unit. It lies between the other two units and varies in thickness - it is a conductive zone. The zone has a "bow-tie" shape in map view. This agrees with the map pattern of a mafic-to-intermediate metavolcanic unit and with the shape of an anomaly in the Fraser-filtered VLF data. The VLF data probably defines the northern and southern contacts of this unit. Several weak - Ch 8/9 - crossover anomalies in the UTEM data also seem to follow these contacts. The the unit has a resistivity of ~30Ωm but this is variable and is locally enhanced resulting in sharp current-channelling anomalies to Ch 5.

The presence of a conductive feature within the conductive zone is indicated on Lines 3+00W and 4+00W. The sharply defined current-channelling anomaly has decayed away by Ch 4. A dip in the Ch 4 data on these two lines coincident with the current-channelling feature may indicate the presence of a conductive feature. Channels 2 and 3 show some character in this vicinity but the anomaly is clearest on Ch 4. This type of anomaly - a top anomaly - indicates a small shallow conductive zone of very limited depth extent. It is clear on Lines 3+00W and 4+00W. A weaker - Ch 5 - crossover anomaly on Line 1+00W may represent a smaller or less-conductive version of this zone.

The interpretation of this conductor is complicated by its near coincidence with the location of both the current-channelling anomaly and the pipe response. It is shallow, however, and of no discernible dip making it a reasonably easy target to chase.

Details:

Location of the centre of the anomaly:

Line 3+00W	@4+56N(6m north of the 4+50N picket)	est depth 25+/-15m
Line 4+00W	@4+50N picket	est depth 25+/-15m

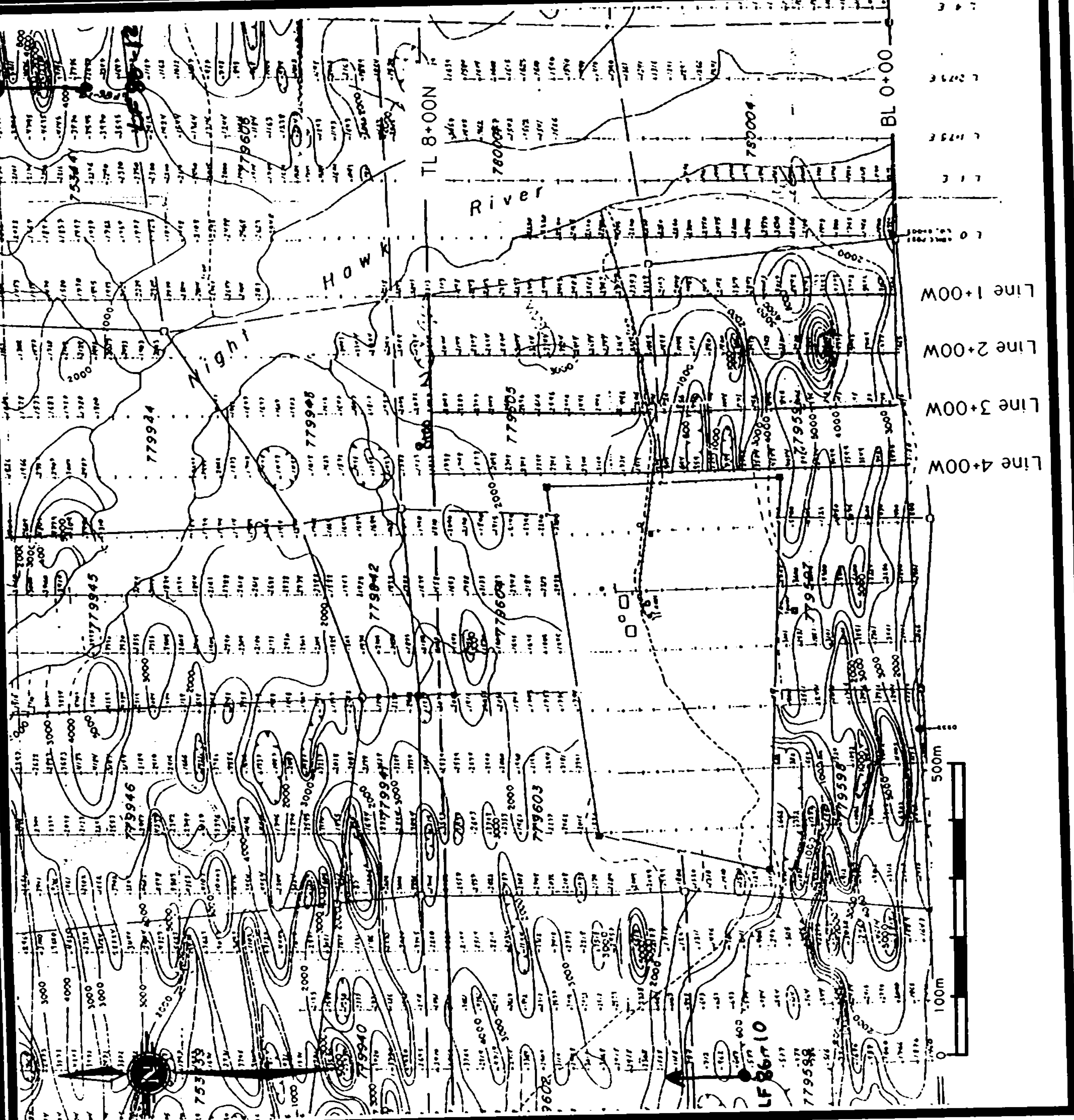
Characteristics:

Strike:	~east west
Dip:	indeterminate, probably flat
Strike length:	125m +
Conductance (est):	120 S

4) Magnetic features

The areas of the survey grid where the data are interpreted to be anomalous due to magnetic features are indicated in Figure 5. Strongly magnetic features appear as positive Ch1 anomalies in Hz data collected outside the transmitter loop. The locations of observed positive Ch 1 anomalies were compared with a magnetics map and the results are shown in the Figure. Remanent magnetism will not result in an anomaly. Strongly magnetic features not correlated with a positive Ch1 anomaly may be due to remanence.

The magnetic features generally cut across the grid in agreement with the local strike. On all survey lines the positive Ch1 anomalies are sharp to the south of the contact zone indicating that the magnetic unit is outcropping or subcropping. To the north the magnetic features are smooth and broad indicating a source at considerable depth. The ultramafic units mapped in this area and presumably responsible for these anomalies may lie beneath a considerable thickness (several hundred meters) of a less-magnetic cover unit. The surface magnetic survey is in agreement with this; it (Figure 7) shows considerable character to the south of the contact zone and very little to the north. Available geologic mapping shows considerable outcrop to the south and none to the north.



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Trolley Line Property

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Surface Magnetics Survey

Figure 7

Conclusions

The following conclusions can be drawn from this interpretation:

1) That the airborne electromagnetic anomalies 3220A and 3230A outlined on the OGS GEOPHYSICAL/GEOCHEMICAL Series Map 81097 represent mainly geological and not cultural features.

2) Stripping of cultural features is useful for clarifying anomalies, particularly in cases where the geological feature and the cultural feature are coincident.

3) That the rock package in the area covered by the survey dips modestly to the south and consists of three units (north -> south):
   - A conductive unit, generally north of ~475N, with a resistivity of ~300Ωm and characterised by broad, gentle magnetic features.
   - The most conductive unit with a resistivity of ~30Ωm; this is variable and is locally enhanced resulting in sharp current-channelling anomalies that persist to Ch 5. This zone as a whole is a possible target.
   - A resistive unit, generally south of ~375N, with a resistivity of >10,000Ωm and characterised by sharp magnetic features.

4) A small shallow conductor of very limited depth is located within most conductive unit. The best responses are on Lines 3+00W and 4+00W. A weaker - Ch 5 - crossover anomaly on Line 1+00W may represent a smaller or less-conductive version of this zone. This is the main target resulting from the survey.

Recommendations

Based on the above interpretation either or both of the following are recommended:

1) A short vertical hole to test the best conductor at either of these locations:

Line 3+00W	@4+56N(6m north of the 4+50N picket)	est depth 25+/-15m
Line 4+00W	@4+50N picket	est depth 25+/-15m

Note: to obtain the location in meters relative to any other picket or to the baseline (Langmuir/Fallon Township boundary) refer to the line files in Appendix C.

2) Trenching in the area of the current channelling anomaly on either Line 3+00W or 4+00W, specifically:

Line 3+00W @4+56N(6m north of the 4+50N picket)
Line 4+00W @4+50N picket

Note: to obtain the location in meters relative to any other picket or to the baseline (Langmuir/Fallon Township boundary) refer to the line files in Appendix C.

The target in this case would be to determine the source of current channelling anomaly and to look for indications of what may be causing the enhanced conductivity at depth.

Appendix A

Production Diary

9417 PRODUCTION DIARY

Date	Rate/Production	Comments
Oct 18	1/2 day MOB 1/2 day Looping	Travel from SUDBURY to SOUTH PORCUPINE Loopers: G. LAFORTUNE, M. MILLS Layed out Loop 1
Oct 19	Prod. - 2500m (2500m Hz) (500m Hx) Loop 1 Layed out	OPERATOR:G.LAFORTUNE COILER: D.MEUNIER LOOPER M.MILLS Production - read Lines: Line 2W - 0 -- 800n Hz Line 2W - 300n -- 800n Hz,Hx Line 3W - 0 -- 800n Hz Line 1W - 400n -- 800n Hz Loop 2
Oct 20	Prod. -2800m Loop 1 Loop 2	OPERATOR:G.LAFORTUNE COILER:D. MEUNIER LOOPER: M.MILLS Production - read Lines: Line 1W - 0 -- 400n Hz Line 4W - 0 -- 800n Hz,Hx Line 3W - 0 -- 800n Hz Line 1W - 400n -- 800n Hz read Lines: Line 2W - 0 -- 800n Hz Line 3W - 0 -- 800n Hz,Hx
Oct 21	Looping Picked up	LOOPER: M.MILLS CHAINING: G.LAFORTUNE, D. MEUNIER Chained and inclinometered grid Loop 1 and Loop 2
Oct 22	DeMOB	G.LAFORTUNE returns to SUDBURY
Nov 1	Stripping	Data processing in Kingston
Nov 2	Reporting	Interpretation and report preparation in Kingston.
Nov 3	Reporting	Interpretation and report preparation in Kingston.

APPENDIX B

The UTEM SYSTEM

The UTEM System

UTEM Data Reduction and Plotting Conventions

Data Presentation

The UTEM SYSTEM

UTEM uses a large, fixed, horizontal transmitter loop as its source. Loops range in size from 300m x 300m up to as large as 4km x 4km. Smaller loops are generally used over conductive terrain or for shallow sounding work. The larger loops are only used over resistive terrain. The UTEM receiver is typically synchronized with the transmitter at the beginning of a survey day and operates remotely after that point. The clocks employed- one in each of the receiver and transmitter- are sufficiently accurate to maintain synchronization.

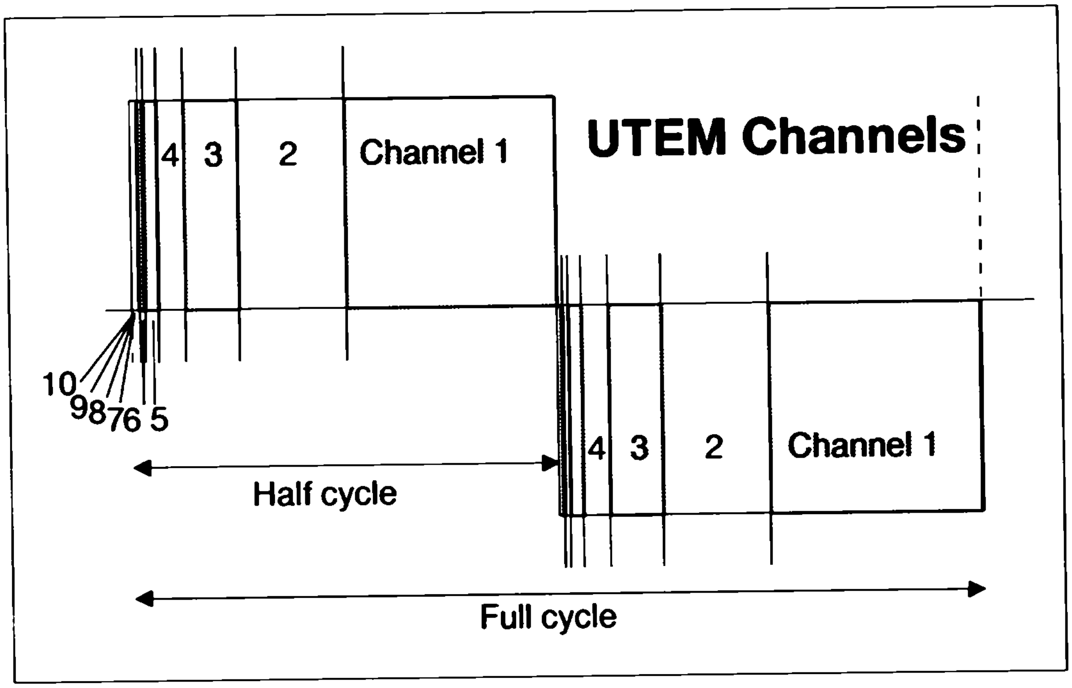
Measurements are routinely taken to a distance of one and one-half to two times the loop dimensions, depending on the local noise levels, and can be continued further. Lines are typically surveyed out from the edge of the loop but may also be read across the loop wire and through the centre of the loop, a configuration used mainly to detect horizontal conductors. BHUTEM (the borehole version of UTEM) surveys have been carried out to depths in excess of 3000 metres.

System Waveform

The UTEM transmitter passes a low-frequency (4 Hz to 90 Hz) current of a precisely regulated triangular waveform through the transmitter loop. The frequency can be set to any value within the operating range of the transmitter. In North America this is usually set at 31 Hz to minimize 60hz power line effects. Since a receiver coil responds to the time derivative of the magnetic field, the UTEM system really "sees" the step response of the ground. By comparison, UTEM is the only time domain EM system which measures the step response of the ground; as all other T.D.E.M systems, known to be currently in use, transmit a modified step current and "see" the (im)Pulse response of the ground at the receiver. In practice, the transmitted UTEM waveform is tailored to optimize signal-to-noise. Deconvolution techniques are employed within the system to produce a close approximation of this conceptual "step response" at the receiver.

System Sampling

The UTEM receiver measures the time variation of the magnetic field in the direction of the receiver coil at various delay times (channels). For most survey applications 10 UTEM channels are spaced in a binary, geometric progression across each half-cycle of the received waveform. Channel **10**, the earliest channel, is $1/2^{10}$ of the waveform half-cycle. Channel **1**, the latest channel, is $1/2^{1}$ of the half-cycle wide (see Figure below). The measurements obtained for each of these 10 channels are accumulated over many half-cycles with the final channel value, as stored, being the average of the measurements for that time channel. The number of half-cycles averaged generally ranges between 2048 (1024 full-cycles, termed a 1K stack) to 32768 (16K stack). The reading interval chosen depends entirely upon the nature of the ambient noise encountered and the signal strength.



System Configurations

For surface work the receiver coil is mounted on a portable tripod and oriented in one of any three primary directions. During a surface UTEM survey the vertical component of the magnetic field (Hz) of the transmitter loop is always measured. Horizontal in-line (Hx) and cross-line (Hy) components are also measured if more detailed information is required. The UTEM System is also capable of measuring the two horizontal components of the electric field, Ex and Ey. A dipole sensor comprised of two electrodes is used to measure these electric field components. Such observations are useful for outlining resistive features, typically associated with in-folded quartz-rich sedimentary units and quartz-rich dykes and vein structures.

BHUTEM surveys employ a smaller receiver coil for operating in environments with hole diameters greater than 1 3/4 in.. The borehole receiver coil forms part of a moveable in-hole receiver package used to measure the axial (along-borehole) component of the magnetic field of the transmitter loop. The observed signal in the BHUTEM coil is transmitted to surface digitally using a kevlar-reinforced fibre-optic cable as a data link. Using a fibre-optic link avoids signal degradation problems and allows surveying of boreholes to depths greater than 3000m. The kevlar-reinforced cable is also very light (specific gravity 1.0 approx.) making the cable handling hardware quite portable.

The EM Induction Process

Any time-varying magnetic field ("primary") when transmitted into the earth induces current flow in conductive regions of the ground below and around the transmitter loop(i.e. in the earth or "half-space"). This current flow produces a measurable EM field, the secondary field, which has an inherent "inertia" that resists the change in primary field direction. This "inertial" effect is called self-inductance; it limits the rate at which current can change and is only dependent on the shape and size of a conductive path.

It takes a certain amount of time, in any AC system, for the transmitted current flow to be redirected (reversed) and reestablished to full amplitude after any polarity change of the primary field direction. This reversal time is measurable and characteristic for a given conductor. The time-varying current causes an "emf" in the sensor that is proportional to the time derivative of the current. This "emf" decays with time, vanishing when the reversal is complete. This characteristic time of the emf decay as measured by the sensor is referred to as the "decay time" of the conductor. A good conductor has a time response that is greater than that of a poor conductor. Similarly where its rate of change is limited by the inductance of the current path, the terminal current level is greater in a good conductor.

The large-scale current which is induced in the half-space by the primary field produces the half-space response as seen in typical UTEM profiles. This background response is influenced by the finite conductivity of the surrounding rock. Other currents may be induced in locally more conductive zones (conductors) that have longer decay times than the half-space response. The responses of these conductors are superimposed upon the background response. The result is that the UTEM receiver detects:

- the primary field waveform, a square-wave
- the half-space (background) response of the surrounding rock
- a highly variable response due to any conductors present.

The result is that in the presence of conductors the primary field waveform is substantially distorted causing anomalies.

UTEM DATA REDUCTION and PLOTTING CONVENTIONS

The UTEM data as it appears in the data files is in total field, continuously normalized form. In this form, the magnetic field data collected by the receiver is expressed as a % of the calculated primary magnetic field vector magnitude at the station. These are total field values - the UTEM system measures during the "on-time" and as such samples both the primary and secondary fields.

For plotting purposes, the reduced magnetic field data (as it appears in the data file) are transformed to other formats as required. The following is provided as a description of the various plotting formats used for the display of UTEM data. A plotting format is defined by the choice of the *normalization* and *field type* parameters selected for display.

NORMALIZATION

UTEM results are always expressed as a % of a normalizing field at some point in space.

In **continuously normalized** form the normalizing factor (the denominator) is the magnitude of the computed local primary field vector. As the primary exciting field magnitude diminishes with increasing distance from the transmitter loop the response is continuously amplified as a function of offset from the loop. Although this type of normalization considerably distorts the response shape, it permits anomalies to be easily identified at a wide range of distances from the loop.

Note: An optional form of continuous normalization permits the interpreter to normalize the response to the magnitude of the primary field vector at a fixed depth below each station. This is useful for surface profiles which come very close to the loop. Without this adjustment option, the normalizing field is so strong near the loop that the secondary effects become too small in the presence of such a large primary component. In such circumstances interpretation is difficult, however; by "normalizing at some depth" the size of the normalizing field, near the loop in particular, is reduced and the resulting profile can be more effectively interpreted to a very close distance from the transmitter wire. The usual choice for this normalization depth is the estimated target depth.

In **point normalized form** the normalizing factor is the magnitude of the computed primary field vector at a single point in space. When data is presented in this form, the point of normalization is displayed in the title block of the plot. Point normalized profiles show the non-distorted shape of the field profiles. Unfortunately, the very large range in magnitude of anomalies both near and far from the loop means that small anomalies, particularly those far from the loop, may be overlooked on this type of plot in favor of presenting larger amplitude anomalies.

Note: Selecting the correct plot scales is critical to the recognition of conductors over the entire length of a point normalized profile. Point normalized data is often used for interpretation where an analysis of the shape of a specific anomaly is required. Point normalized profiles are therefore plotted selectively as required during interpretation. An exception to this procedure occurs where surface data has been collected entirely inside a transmitter loop. The primary field does not vary greatly inside the loop, therefore, the benefits of continuous normalization are not required in the display of such results. In these cases data is often point normalized to a fixed point near the loop centre.

FIELD TYPE

The type of field may be either the **Total field** or the **Secondary field.** In general, it is the secondary field that is most useful for the recognition and interpretation of discrete conductors.

UTEM Results as Secondary Fields

Because the UTEM system measures during the transmitter on-time the determination of the secondary field requires that an estimate of the primary signal be subtracted from the observations. Two estimates of the primary signal are available:

1) UTEM Channel 1

One estimate of the primary signal is the value of the latest time channel observed by the UTEM System, channel 1. When Channel 1 is subtracted from the UTEM data the resulting data display is termed ***Channel 1 Reduced***. This reduction formula is used in situations where it can be assumed that all responses from any target bodies have decayed away by the latest time channel sampled. The Channel 1 value is then a reasonable estimate of the primary signal present during Channels 2....10.

In practice the ***Channel 1 Reduced*** form is most useful when the secondary response is very small at the latest delay time. In these cases channel 1 is indeed a good estimate of the primary field and using it avoids problems due to geometric errors or transmitter loop current/system sensitivity errors.

2) Calculated primary field

An alternate estimate of the primary field is obtained by computing the primary field from the known locations of the transmitter loop and the receiver stations. When the computed primary field is subtracted from the UTEM data the resulting data display is termed ***Primary Field Reduced*** .

The calculated primary field will be in error if the geometry is in error - mislocation of the survey stations or the loop vertices - or if the transmitter loop current/system sensitivity is in error. Mislocation errors from loop/station geometry may give rise to very large secondary field errors depending on the accuracy of the loop and station location method used. Transmitter loop current/system sensitivity error is rarely greater than 2%. ***Primary Field Reduced*** is plotted in situations where a large Channel 1 response is observed. In this case the assumption that the Channel 1 value is a reasonable estimate of the primary field effect is not valid.

Note: When UTEM data is plotted in the ***Channel 1 Reduced*** form the secondary field data for Channel 1 itself are always presented in ***Primary Field Reduced*** form and are plotted on a separate axis. This plotting format serves to show any long time-constant responses, magnetostatic anomalies and/or geometric errors present in the data.

Mathematical Formulations

In the following expressions:

$\mathbf{Rn_j}$ is the result plotted for the n^{th} UTEM channel,

$\mathbf{R1_j}$ is the result plotted for the latest-time UTEM channel, channel 1,

$\mathbf{Chn_j}$ is the raw component sensor value for the n^{th} channel at station j,

$\mathbf{Ch1_j}$ is the raw component sensor value for channel 1 at station j,

$\mathbf{H^P{}_j}$ is the computed primary field component in the sensor direction

$|\mathbf{H^P}|$ is the magnitude of the computed primary field at:
- a fixed station for the entire line (point normalized data)
- the local station of observation (continuously normalized data)
- a fixed depth below the station (continuously normalized at a depth).

Channel 1 Reduced Secondary Fields : Here, the latest time channel, Channel 1 is used as an "estimate" of the primary signal and channels 2-10 are expressed as:

$$\mathbf{Rn_j = (Chn_j - Ch1_j) \,/\, |H^P| \quad x\ 100\%}$$

Channel 1 itself is reduced by subtracting a calculation of the primary field observed in the direction of the coil, H^P as follows:

$$\mathbf{R1_j = (Ch1_j - H^P{}_j) \,/\, |H^P| \quad x\ 100\%}$$

Primary Field Reduced Secondary Fields : In this form all channels are reduced according to the equation used for channel 1 above:

$$\mathbf{Rn_j = (Chn_j - H^P{}_j) \,/\, |H^P| \quad x\ 100\%}$$

This type of reduction is most often used in cases where very good geometric control is available (leading to low error in the calculated primary field, $H^P{}_j$) and where very slowly decaying responses result in significant secondary field effects remaining in channel 1 observations.

UTEM Results as a Total Field

In certain cases results are presented as a % of the **Total Field**. This display is particularly useful, in borehole surveys where the probe may actually pass through a very good conductor. In these cases the shielding effect of the conductor will cause the observed (total) field to become very small below the intersection point. This nullification due to shielding effects on the total field is much easier to see on a separate ***Total Field*** plot. In cases where the amplitude of the anomalies relative to the primary field is small, suggesting the presence of poorly conductive bodies, the ***Total Field*** plot is less useful.

The data contained in the UTEM reduced data files is in ***Total Field,*** continuously normalized form if:

$$\mathbf{Rn_j = Chn_j \,/\, |H^P| \quad x\ 100\%}$$

DATA PRESENTATION

All UTEM survey results are presented as profiles in an Appendix of this report. For BHUTEM surveys the requisite Vectorplots, presented as plan and section views showing the direction and magnitude of the calculated primary field vectors for each transmitter loop, are presented in a separate Appendix.

The symbols used to identify the channels on all plots as well as the mean delay time for each channel is shown in the table below.

UTEM System Mean Delay Times

10 Channel Mode @ 31 hz.(approx.)

(base freq: 30.974 hertz)

Channel #	Delay time (ms)	Plot Symbol
1	12.11	I
2	6.053	\
3	3.027	/
4	1.513	□
5	0.757	⧗
6	0.378	⊿
7	0.189	7
8	0.095	X
9	0.047	Δ
10	0.024	◇

Notes on Standard plotting formats:

10 channel data in ***Channel 1 Reduced*** form - The data are usually displayed on three separate axes. This permits scale expansion, allowing for accurate determination of signal decay rates. The standard configuration is:

Bottom axis - Channel 1 (latest time) is plotted alone in ***Primary Field Reduced*** form using the same scale as the center axis.

Center axis - The intermediate to late time channels, ch5 to ch2 are plotted on the center axis using a suitable scale.

Top axis - The early time channels, ch10 to ch6 and a repeat of ch5 for comparison are plotted on the top axis at a reduced scale. The earliest channels, ch8 to ch10, may not be plotted to avoid clutter.

10 channel data in ***Primary Field Reduced*** form: The data are displayed

using a single axis plot format. Secondary effects are plotted using a Y axis on each data plot with peak to peak values up to 200%.

BHUTEM data plotted as total field profiles: Data are expressed directly as a percentage of the ***Total Field*** value. The Y axis on each single axis data plot shows peak values of up to 100%. These departures are always relative to the measured total field value at the observation station.

BHUTEM data plotted as secondary field profiles: Check the title block of the plot to determine if the data is in ***Channel 1 Reduced*** form or in ***Primary Field Reduced*** form.

Note that on all BHUTEM plots the ratio between the axial component of the primary field of the loop and the magnitude of the total primary field strength (dc) is plotted as a profile without symbols. In UTEM jargon this is referred to as the "primary field" and it is plotted for use as a polarity reference tool.

Appendix C

Reduced Data Files

REDUCED DATA FILES

DATA FILE FORMAT

An example of a standard UTEM data file is:

```
600
 7.823478E2  7.862026E2 7.691314E2  6.781751E2  4.902651E2
 1.514270E2 -2.756569E2 -5.372626E2 -6.270449E2 -6.920210E2
3.543459E-4  1.000000
0 0 0 0 0 0 0 0 0 0

700
 7.630606E2  7.349983E2  6.725795E2  5.313154E2  2.721035E2
-1.168353E2 -4.873122E2 -6.371236E2 -6.258996E2 -6.187860E2
2.491019E-4  1.000000
0 0 0 0 0 0 0 0 0 0

800
.................
```

Each record within these files has the following form:

label
c1 c2 c3 c4 c5
c6 c7 c8 c9 c10
$|H^P|$ dc
i1 i2 i3 i4 i5 i6 i7 i8 i9 i10

A description of the elements of this record follow:

label: An integer value, not to exceed four digits, is used as a station label which along with the line label is used to find the coordinates of the station within the line file.The labels are correlated to the station numbers of the grid surveyed.
Note: In this report all station labels are equal to the northing on the grid line.

c1-c10: All UTEM data are expressed as a percentage of a reference total field value.
As measured by the UTEM coil, the raw observations are time derivatives of the transmitted primary waveform, expressed in volts and amperes, respectively. These raw data are converted to an equivalent magnetic field value that would be measured by a magnetometer sensor if a unit-ampere-square-wave AC-current were present in the transmitter loop. These raw values $\mathbf{Chn_c}$ (n_c=1..10); expressed as the equivalent magnetic field per unit current during the reduction process include a direct signal component from the transmitter loop as well as a secondary component from the presence of conductive bodies.

The ten channel UTEM data (**cn**) stored in the reduced data files are, therefore, ratios of these equivalent total field values normalised to the local computed primary field at the point of observation. Mathematically, these reduced data files are expressed as follows:

$$cn = (Chn_c \,/\, |H^P|) \times 100\% \quad \text{where } n = 1....10$$

In this equation:

$|H^P|$ is the total primary field strength per unit current as computed from the loop vertices and the station location.

dc is the ratio between the component of the primary field of the loop in the direction of measurement i.e. transverse, horizontal in-line or vertical direction for coil orientation and the magnitude of the total primary field strength:

$dc = H^P{}_c \,/\, |H^P|$: this ratio can be either a positive or negative value.

i1-i10 are statistical codes which give estimates of the repeatability of the measurements. These statistical codes are defined as follows:

STATISTIC CODE	ESTIMATED STANDARD DEVIATION
0	No estimate, only a single reading
1	<0.1%
2	0.1%-0.2%
3	0.2%-0.5%
4	0.5%-1.0%
5	1.0%-2.0%
6	2.0%-5.0%
7	5.0%-10.0%
8	10.0%-20.0%
9	>20.0%

Loop/Line Files

The following are the (x,y,z) (North,West,Up) coordinates of the vertices of Loops 1 and 2 and the stations on Lines 1-4W as used in the reduction process.

Loop 1
(33 vertices)

cor #	x(N)	y(W)	z(+UP)
1	0	-97.96	-18.85
2	0	-72.97	-19.51
3	0	-48.05	-17.55
4	0	-23.08	-16.24
5	0	1.73	-13.19
6	0	26.65	-11.24
7	0	51.23	-6.68
8	0	75.77	-1.91
9	0	100.00	-0.00
10	0	124.58	4.56
11	0	149.46	6.95
12	0	174.35	9.34
13	0	199.20	10.87
14	0	224.15	9.34
15	0	249.15	9.56
16	0	274.15	9.99
17	0	294.75	10.17
18	0	319.71	11.48
19	0	344.70	12.13
20	0	369.70	12.57
21	0	391.70	12.95
22	0	416.69	13.39
23	0	441.59	13.61
24	0	466.59	13.39
25	0	491.59	13.83
26	0	516.38	13.39
27	0	541.28	13.61
28	0	566.08	14.04
29	0	590.98	14.04
30	0	615.78	13.61
31	0	649.75	10.64
32	-595	649.75	10.64
33	-604	-97.96	10.64

Loop 2
(17 vertices)

cor #	x(N)	y(W)	z(+UP)
1	795.20	612.00	-7.13
2	795.20	599.80	-7.55
3	795.2	549.82	-8.86
4	795.2	499.91	-11.91
5	795.2	449.91	-11.91
6	795.2	399.92	-12.77
7	795	375.04	-15.16
8	795	350.15	-12.77
9	794.9	325.15	-16.00
10	794.78	299.05	-18.70
11	795	249.17	-22.18
12	795.4	227.32	-17.74
13	795.83	202.72	-16.80
14	795.83	152.72	-16.80
15	795.83	144.92	-16.93
16	1125.00	325.00	-17.00
17	1295.00	612.00	-7.50

Line 1W

station #	x(N)	y(W)	z(+UP)
50	49.34	100.00	0.64
100	98.93	100.00	-2.60
150	148.30	100.00	-9.82
200	198.19	100.00	-10.91
250	247.94	100.00	-13.08
300	297.71	100.00	-14.60
350	347.60	100.00	-15.69
350	347.60	100.00	-15.69
400	397.49	100.00	-16.56
400	397.49	100.00	-16.56
425	422.28	100.00	-17.21
450	447.18	100.00	-17.21
475	472.18	100.00	-17.43
500	497.13	100.00	-18.96
525	522.13	100.00	-18.52
550	546.63	100.00	-20.68
600	596.24	100.00	-20.68
650	645.80	100.00	-20.46
700	695.59	100.00	-19.37
750	745.38	100.00	-23.95
800	794.95	100.00	-21.57

Line 2W

station #	x(N)	y(W)	z(+UP)
50	49.80	200.00	15.90
100	100.09	200.00	19.41
150	150.03	200.00	22.26
200	199.55	200.00	16.77
250	247.82	200.00	3.06
300	296.26	200.00	-8.40
350	345.56	200.00	-11.20
375	370.50	200.00	-12.95
400	395.37	200.00	-14.03
425	420.27	200.00	-14.47
450	445.07	200.00	-14.90
475	469.96	200.00	-15.55
500	494.75	200.00	-15.98
525	519.65	200.00	-15.98
550	544.55	200.00	-15.98
575	569.25	200.00	-16.63
600	593.94	200.00	-16.42
625	618.84	200.00	-16.42
650	643.64	200.00	-16.42
675	668.44	200.00	-17.07
700	693.13	200.00	-16.63
750	742.72	200.00	-16.63
800	792.32	200.00	-16.85

Line 3W

station #	x(N)	y(W)	z(+UP)
50	49.11	300.00	15.35
100	98.68	300.00	18.81
150	148.21	300.00	22.93
200	198.03	300.00	24.45
250	247.65	300.00	19.66
300	296.83	300.00	7.40
350	345.87	300.00	-9.14
375	370.56	300.00	-11.52
400	395.35	300.00	-11.95
425	420.23	300.00	-13.04
450	445.22	300.00	-13.47
475	470.72	300.00	-14.14
500	495.61	300.00	-14.79
525	520.50	300.00	-15.45
550	545.39	300.00	-15.88
600	595.09	300.00	-16.31
650	644.79	300.00	-16.75
700	694.42	300.00	-19.35
750	744.97	300.00	-20.66
800	794.78	300.00	-18.70

Line 4W

station #	x(N)	y(W)	z(+UP)
50	49.52	400.00	19.05
100	98.65	400.00	25.08
150	148.38	400.00	30.08
200	198.30	400.00	35.12
250	248.24	400.00	34.90
300	297.56	400.00	26.87
350	346.12	400.00	14.75
400	393.94	400.00	-6.04
425	418.86	400.00	-8.00
450	443.76	400.00	-7.78
475	468.46	400.00	-8.00
500	493.26	400.00	-8.21
550	543.03	400.00	-9.74
600	592.92	400.00	-9.96
650	642.91	400.00	-10.83
700	692.70	400.00	-11.48
750	742.70	400.00	-11.92
800	792.20	400.00	-12.77

L1sL1C3 Loop 1stripped Line 1W Component 3 - Hz

50
1.0141970e+2 1.0142097e+2 1.0144286e+2 1.0155320e+2 1.0191512e+2
1.0312299e+2 1.0676781e+2 1.1503313e+2 1.2756712e+2 1.3578235e+2
2.673e-3 9.911e-1
1 1 1 1 1 1 1 1 1 1
100
1.0270323e+2 1.0264464e+2 1.0268517e+2 1.0290270e+2 1.0387242e+2
1.0690060e+2 1.1598887e+2 1.3747878e+2 1.7020140e+2 1.9241663e+2
1.116e-3 9.912e-1
1 1 1 1 1 1 1 1 1 1
150
1.0248130e+2 1.0244289e+2 1.0257620e+2 1.0300579e+2 1.0490877e+2
1.1090581e+2 1.2872696e+2 1.6953578e+2 2.3967450e+2 2.7980881e+2
6.315e-4 9.868e-1
1 1 1 1 1 1 2 2 3 1
200
1.0484275e+2 1.0484715e+2 1.0497977e+2 1.0571109e+2 1.0899530e+2
1.1885719e+2 1.4870833e+2 2.1767560e+2 3.3011386e+2 3.7766479e+2
4.057e-4 9.889e-1
1 1 1 1 1 1 2 2 3 3
250
1.0324755e+2 1.0315044e+2 1.0338430e+2 1.0446876e+2 1.0888719e+2
1.2352511e+2 1.6789888e+2 2.6476221e+2 3.9649921e+2 4.1865063e+2
2.817e-4 9.893e-1
1 1 1 1 1 1 1 1 3 3
300
1.0266036e+2 1.0265571e+2 1.0285364e+2 1.0438055e+2 1.1040066e+2
1.3013802e+2 1.9319905e+2 3.2498483e+2 4.2935513e+2 4.0175906e+2
2.057e-4 9.899e-1
1 1 1 1 1 1 3 1 3 1
350
1.0212376e+2 1.0208762e+2 1.0235938e+2 1.0394401e+2 1.1082667e+2
1.3539923e+2 2.1484412e+2 3.4400775e+2 3.8193735e+2 2.3214070e+2
1.558e-4 9.905e-1
1 1 1 1 2 2 1 2 4 3
350
1.0219791e+2 1.0206067e+2 1.0230776e+2 1.0412595e+2 1.1081779e+2
1.3522011e+2 2.1384219e+2 3.5314432e+2 3.6665005e+2 2.7873660e+2
1.558e-4 9.905e-1
1 1 1 1 1 1 2 1 3 3
400
1.0254485e+2 1.0242599e+2 1.0263553e+2 1.0437333e+2 1.1110025e+2
1.3691251e+2 2.1636301e+2 3.0087964e+2 2.1754163e+2 1.0243690e+2
1.213e-4 9.911e-1
1 1 1 1 1 1 1 2 3 1

400
1.0247128e+2 1.0234389e+2 1.0255995e+2 1.0407126e+2 1.1103828e+2
1.3722862e+2 2.1642690e+2 2.9497501e+2 2.1627440e+2 7.5800209e+1
1.213e-4 9.911e-1
1 1 1 1 1 3 3 4 1 5
425
1.0260268e+2 1.0250873e+2 1.0271098e+2 1.0427142e+2 1.1059281e+2
1.3660004e+2 2.1148648e+2 2.5603134e+2 1.4721648e+2 2.1686939e+1
1.080e-4 9.913e-1
1 1 1 1 1 3 2 3 1 1
450
1.0284614e+2 1.0267622e+2 1.0301979e+2 1.0467707e+2 1.1042390e+2
1.3463538e+2 1.9648579e+2 1.9059250e+2 6.1560932e+1 -5.1820179e+1
9.662e-5 9.917e-1
1 1 1 1 2 2 1 4 5 4
475
1.0300354e+2 1.0300655e+2 1.0343454e+2 1.0474388e+2 1.0933031e+2
1.3265140e+2 1.9464574e+2 1.8444788e+2 6.3894760e+1 -3.4365402e+1
8.678e-5 9.920e-1
1 3 1 2 1 3 3 3 5 2
500
1.0319577e+2 1.0328745e+2 1.0368348e+2 1.0475310e+2 1.0843387e+2
1.3068700e+2 1.9041113e+2 1.7332492e+2 6.0381989e+1 -2.7426756e+1
7.829e-5 9.917e-1
1 1 1 1 3 3 1 4 2 4
525
1.0360860e+2 1.0366975e+2 1.0388072e+2 1.0489974e+2 1.0818713e+2
1.2945079e+2 1.8399193e+2 1.5667368e+2 4.9364590e+1 -3.5174309e+1
7.087e-5 9.923e-1
1 1 1 1 1 3 1 4 5 2
550
1.0342017e+2 1.0339202e+2 1.0363517e+2 1.0488049e+2 1.0918906e+2
1.3109874e+2 1.8215231e+2 1.4084412e+2 3.4347786e+1 -4.3313499e+1
6.451e-5 9.917e-1
1 1 1 1 1 3 3 3 4 4
600
1.0368165e+2 1.0366319e+2 1.0394949e+2 1.0522383e+2 1.0957896e+2
1.3153139e+2 1.6941464e+2 1.1102373e+2 1.3770229e+1 -5.3793957e+1
5.381e-5 9.923e-1
1 1 1 1 3 1 1 3 6 5
650
1.0347385e+2 1.0352535e+2 1.0368215e+2 1.0486781e+2 1.0827052e+2
1.2542948e+2 1.4355032e+2 6.9797188e+1 -1.7260538e+1 -7.0225708e+1
4.539e-5 9.930e-1
1 1 2 2 1 3 4 6 4 4

L1sL1C3 Loop 1stripped Line 1W Component 3 - Hz (cont)

700
1.0402407e+2 1.0404038e+2 1.0429787e+2 1.0519189e+2 1.0717939e+2
1.2066548e+2 1.2631109e+2 4.9843376e+1 -2.3756308e+1 -7.1128181e+1
3.863e-5 9.938e-1
1 1 1 1 1 3 3 4 3 6
750
1.0400334e+2 1.0398125e+2 1.0416241e+2 1.0391198e+2 1.0278640e+2
1.0385538e+2 8.5832840e+1 5.2957220e+0 -5.1133270e+1 -8.0122269e+1
3.317e-5 9.928e-1
1 1 1 1 3 3 3 3 4 6
800
1.0413649e+2 1.0415948e+2 1.0423859e+2 1.0363414e+2 9.9603302e+1
9.4336082e+1 6.0783638e+1 -1.5907012e+1 -5.8433838e+1 -8.3329269e+1
2.871e-5 9.939e-1
1 3 1 1 1 1 4 4 4 6

L1sL2C3 Loop 1stripped Line 2W Component 3 - Hz

50
1.0497372e+2 1.0497943e+2 1.0502095e+2 1.0507442e+2 1.0533156e+2
1.0614481e+2 1.0884823e+2 1.1452431e+2 1.2344983e+2 1.2838797e+2
2.684e-3 9.926e-1
1 1 1 1 1 1 1 1 1 1
100
1.0482770e+2 1.0481751e+2 1.0487592e+2 1.0499979e+2 1.0567506e+2
1.0771796e+2 1.1426527e+2 1.2811017e+2 1.4866350e+2 1.6007320e+2
1.141e-3 9.928e-1
1 1 1 1 1 1 1 1 1 1
150
1.0792019e+2 1.0787598e+2 1.0797035e+2 1.0822460e+2 1.0951247e+2
1.1344264e+2 1.2550919e+2 1.5138348e+2 1.8809064e+2 2.0606514e+2
6.539e-4 9.928e-1
1 1 1 1 1 1 1 1 2 3
200
1.0602228e+2 1.0597794e+2 1.0610683e+2 1.0649326e+2 1.0842431e+2
1.1444299e+2 1.3317824e+2 1.7276465e+2 2.2888300e+2 2.5389935e+2
4.271e-4 9.976e-1
1 1 1 1 1 1 2 3 2 2
250
1.0447443e+2 1.0444042e+2 1.0461798e+2 1.0516343e+2 1.0793928e+2
1.1665912e+2 1.4499318e+2 2.0641881e+2 2.9359991e+2 3.3369568e+2
3.014e-4 9.967e-1
1 1 1 1 1 1 1 1 1 1
300
1.0181940e+2 1.0173129e+2 1.0191012e+2 1.0279061e+2 1.0642303e+2
1.1930240e+2 1.6023320e+2 2.5779181e+2 4.0242548e+2 4.7738412e+2
2.216e-4 9.910e-1
1 1 1 1 1 1 1 1 1 1
300
1.0224883e+2 1.0225977e+2 1.0247055e+2 1.0323666e+2 1.0691351e+2
1.1982542e+2 1.6035304e+2 2.5751129e+2 3.8906998e+2 4.6496509e+2
2.216e-4 9.910e-1
1 1 1 1 1 2 1 3 4 5
350
1.0107780e+2 1.0088306e+2 1.0112785e+2 1.0214797e+2 1.0730788e+2
1.2455238e+2 1.8465691e+2 3.3031223e+2 5.0283298e+2 5.7057013e+2
1.675e-4 9.905e-1
1 1 1 1 2 2 3 5 4 4
375
1.0122739e+2 1.0120222e+2 1.0138386e+2 1.0260600e+2 1.0799220e+2
1.2904851e+2 1.9980061e+2 3.5479666e+2 4.7728729e+2 4.8676913e+2
1.470e-4 9.900e-1
1 1 1 1 2 2 3 3 1 2

L1sL2C3 Loop 1stripped Line 2W Component 3 - Hz (cont)

400
1.0148751e+2 1.0137888e+2 1.0166572e+2 1.0278573e+2 1.0945911e+2
1.3290782e+2 2.1333882e+2 3.5965332e+2 3.9030362e+2 3.3398358e+2
1.298e-4 9.900e-1
1 1 1 1 2 1 1 3 3 3
425
1.0175304e+2 1.0173028e+2 1.0188978e+2 1.0338907e+2 1.1070740e+2
1.3781769e+2 2.2464169e+2 3.4547601e+2 3.0731595e+2 2.1130280e+2
1.153e-4 9.904e-1
1 1 1 1 2 1 3 1 1 3
450
1.0183210e+2 1.0180661e+2 1.0219489e+2 1.0349504e+2 1.0949538e+2
1.3356583e+2 2.1188208e+2 2.9613663e+2 2.1581827e+2 1.0602538e+2
1.029e-4 9.907e-1
1 1 1 1 1 1 1 4 4 4
475
1.0207455e+2 1.0204873e+2 1.0249975e+2 1.0378195e+2 1.0914144e+2
1.3102515e+2 2.0347971e+2 2.6064841e+2 1.5824252e+2 4.4932438e+1
9.222e-5 9.909e-1
1 1 2 1 2 1 1 4 4 4
500
1.0257046e+2 1.0254720e+2 1.0283168e+2 1.0438213e+2 1.1021269e+2
1.3153766e+2 2.0269801e+2 2.4801596e+2 1.5227725e+2 4.9315250e+1
8.303e-5 9.912e-1
1 1 1 1 1 3 2 1 3 2
525
1.0298676e+2 1.0301650e+2 1.0336854e+2 1.0518458e+2 1.1159147e+2
1.3443671e+2 2.0497194e+2 2.3263130e+2 1.3333583e+2 3.4713242e+1
7.502e-5 9.916e-1
1 1 1 1 1 1 1 1 2 3
550
1.0353521e+2 1.0356557e+2 1.0402398e+2 1.0583956e+2 1.1294621e+2
1.3712210e+2 2.0614842e+2 2.1511656e+2 1.1101338e+2 1.4568443e+1
6.802e-5 9.920e-1
1 1 1 1 2 3 3 5 1 5
600
1.0456589e+2 1.0465314e+2 1.0513946e+2 1.0730228e+2 1.1591765e+2
1.4433974e+2 2.1320009e+2 1.9611263e+2 9.0337196e+1 -4.2713237e-1
5.654e-5 9.925e-1
1 1 1 1 2 1 3 3 4 5
600
1.0455583e+2 1.0465897e+2 1.0508988e+2 1.0740015e+2 1.1557829e+2
1.4474101e+2 2.1412231e+2 1.9528680e+2 9.2990501e+1 4.7681341e+0
5.654e-5 9.925e-1
1 1 1 1 1 1 3 3 2 5

L1sL2C3 Loop 1stripped Line 2W Component 3 - Hz (cont)

650
1.0482080e+2 1.0489716e+2 1.0554819e+2 1.0813962e+2 1.1789791e+2
1.5115576e+2 2.1431151e+2 1.8005751e+2 7.3684677e+1 -1.2396076e+1
4.749e-5 9.931e-1
1 1 1 2 1 1 4 1 5 6
700
1.0454410e+2 1.0457336e+2 1.0525861e+2 1.0826436e+2 1.1831803e+2
1.5364566e+2 2.0843645e+2 1.5620955e+2 5.3565968e+1 -2.4062284e+1
4.032e-5 9.936e-1
1 1 1 1 1 3 4 5 4 5
750
1.0351074e+2 1.0370388e+2 1.0442307e+2 1.0696616e+2 1.1664140e+2
1.4911038e+2 1.8608267e+2 1.1505199e+2 2.3429955e+1 -4.0213028e+1
3.452e-5 9.940e-1
1 1 1 1 1 3 1 5 3 5
800
1.0338754e+2 1.0355562e+2 1.0434050e+2 1.0671336e+2 1.1574692e+2
1.4172980e+2 1.5652783e+2 7.5418289e+1 -5.1182494e+0 -5.7401558e+1
2.980e-5 9.943e-1
1 1 1 2 3 3 4 4 5 6

L1sL2C1 Loop 1stripped Line 2W Component 1 - Hx

300
1.8636871e+1 1.8655848e+1 1.8602905e+1 1.8518684e+1 1.8615871e+1
1.9464081e+1 2.5086441e+1 5.5833687e+1 1.1666255e+2 1.8171416e+2
2.216e-4 1.185e-1
1 1 1 1 3 1 3 3 2 3
350
1.7572790e+1 1.7592831e+1 1.7422047e+1 1.7266005e+1 1.7413233e+1
1.8629080e+1 2.8999643e+1 9.6262756e+1 2.4976923e+2 3.8326901e+2
1.675e-4 1.228e-1
1 1 1 2 2 2 4 5 4 5
375
1.7584116e+1 1.7601700e+1 1.7413673e+1 1.7110386e+1 1.7359283e+1
1.8693445e+1 3.7726891e+1 1.4767055e+2 3.8919223e+2 5.6594214e+2
1.470e-4 1.266e-1
1 1 1 1 2 1 3 5 6 5
400
1.7197464e+1 1.7174017e+1 1.7146704e+1 1.6695189e+1 1.6935249e+1
2.0166056e+1 4.9774830e+1 1.9364871e+2 4.5658475e+2 6.2205896e+2
1.298e-4 1.270e-1
1 2 1 1 1 2 4 5 4 5
425
1.6717796e+1 1.6727409e+1 1.6618923e+1 1.6067831e+1 1.5896572e+1
2.1588247e+1 6.4943756e+1 2.3576077e+2 4.7042719e+2 5.9935114e+2
1.153e-4 1.244e-1
1 1 1 1 1 2 4 5 5 6
450
1.5936491e+1 1.6005962e+1 1.5905692e+1 1.5251022e+1 1.7006176e+1
2.8751251e+1 8.9700394e+1 2.7545206e+2 4.6682663e+2 5.5367371e+2
1.029e-4 1.221e-1
1 1 1 1 2 3 3 4 4 5
475
1.6270164e+1 1.6321575e+1 1.5848577e+1 1.5569958e+1 1.8708685e+1
4.6985847e+1 1.5480070e+2 3.9109262e+2 5.3115564e+2 5.6771155e+2
9.222e-5 1.210e-1
1 1 1 1 1 3 3 5 4 5
500
1.5816703e+1 1.5929701e+1 1.5687375e+1 1.4635574e+1 1.4787464e+1
2.4946392e+1 9.3493134e+1 2.9120410e+2 4.3195975e+2 4.8252234e+2
8.303e-5 1.191e-1
1 1 1 1 1 3 3 6 5 6
525
1.5449620e+1 1.5497472e+1 1.5128486e+1 1.4741027e+1 1.3129763e+1
2.1513166e+1 9.1781342e+1 2.8347675e+2 4.0317303e+2 4.4367932e+2
7.502e-5 1.156e-1
1 1 2 1 1 4 2 4 6 6

550
1.4298145e+1 1.4364956e+1 1.4018207e+1 1.3301496e+1 1.2025188e+1
1.9012327e+1 8.7933380e+1 2.6490891e+2 3.6893503e+2 4.0132880e+2
6.802e-5 1.125e-1
1 1 1 1 1 3 1 4 4 3
600
1.5044662e+1 1.5126417e+1 1.4923139e+1 1.4281670e+1 1.5314550e+1
2.4893511e+1 1.0240156e+2 2.7290024e+2 3.6876382e+2 3.9088962e+2
5.654e-5 1.084e-1
1 1 1 1 4 4 4 6 4 5
600
1.4903769e+1 1.5085001e+1 1.4973834e+1 1.4396604e+1 1.5533943e+1
2.6420097e+1 1.0493670e+2 2.7751028e+2 3.6945010e+2 3.9003714e+2
5.654e-5 1.084e-1
1 1 1 1 1 1 1 1 1 1
650
1.5598051e+1 1.5726793e+1 1.5712840e+1 1.5817478e+1 1.7761574e+1
3.4059288e+1 1.2649538e+2 2.9108264e+2 3.6087549e+2 3.6840411e+2
4.749e-5 1.034e-1
1 1 1 3 3 4 2 7 4 6
700
1.4982514e+1 1.5055329e+1 1.4985101e+1 1.5442792e+1 1.8941376e+1
3.8766808e+1 1.3788873e+2 2.8570953e+2 3.3839972e+2 3.3966330e+2
4.032e-5 9.974e-2
1 1 1 3 4 4 3 5 6 6
750
1.4884683e+1 1.4908464e+1 1.5065708e+1 1.5705711e+1 2.0746889e+1
4.8718842e+1 1.5638147e+2 2.9082886e+2 3.3321323e+2 3.2726749e+2
3.452e-5 9.583e-2
1 1 1 2 1 3 5 5 1 2
800
1.4446580e+1 1.4624938e+1 1.4730160e+1 1.6087585e+1 2.6233999e+1
6.5094070e+1 1.8594405e+2 2.9622992e+2 3.3979926e+2 3.3250177e+2
2.980e-5 9.295e-2
1 1 2 3 4 3 4 6 6 6

L1sL3C3 Loop 1stripped Line 3W Component 3 - Hz

50
1.0088403e+2 1.0087949e+2 1.0089455e+2 1.0096455e+2 1.0120670e+2
1.0203505e+2 1.0447433e+2 1.0940394e+2 1.1708475e+2 1.1858380e+2
2.762e-3 9.947e-1
1 1 1 1 1 1 1 1 1 1
100
1.0310645e+2 1.0308858e+2 1.0311994e+2 1.0326487e+2 1.0387093e+2
1.0588173e+2 1.1166962e+2 1.2347655e+2 1.4118620e+2 1.4409430e+2
1.179e-3 9.960e-1
1 1 1 1 1 1 1 1 2 1
150
1.0403915e+2 1.0401211e+2 1.0407185e+2 1.0433096e+2 1.0540681e+2
1.0907865e+2 1.1946426e+2 1.3993024e+2 1.7112346e+2 1.7254970e+2
6.747e-4 9.954e-1
1 1 1 1 1 1 1 1 2 1
200
1.0706769e+2 1.0703862e+2 1.0715639e+2 1.0748622e+2 1.0933310e+2
1.1524850e+2 1.3218448e+2 1.6547601e+2 2.1684366e+2 2.1533160e+2
4.368e-4 9.964e-1
1 1 1 1 1 1 2 3 2 3
250
1.0433180e+2 1.0427734e+2 1.0441249e+2 1.0489306e+2 1.0738628e+2
1.1589630e+2 1.4008635e+2 1.8674547e+2 2.6079828e+2 2.5280519e+2
3.046e-4 9.990e-1
1 1 1 1 1 1 1 1 4 3
300
1.0173157e+2 1.0170683e+2 1.0188313e+2 1.0255700e+2 1.0574000e+2
1.1774875e+2 1.5301041e+2 2.2357985e+2 3.2665308e+2 3.2625491e+2
2.234e-4 9.981e-1
1 1 1 1 1 1 3 4 5 5
350
1.0003519e+2 9.9901268e+1 1.0012885e+2 1.0087234e+2 1.0501066e+2
1.2218101e+2 1.7580934e+2 2.9594055e+2 4.9304858e+2 5.6561597e+2
1.694e-4 9.901e-1
1 1 2 1 3 3 1 5 6 3
375
1.0051012e+2 1.0035162e+2 1.0050574e+2 1.0150493e+2 1.0681107e+2
1.3006892e+2 1.9946196e+2 3.1925931e+2 4.7004858e+2 3.6390875e+2
1.488e-4 9.891e-1
1 3 1 1 2 1 3 5 6 4
400
1.0066564e+2 1.0063934e+2 1.0079144e+2 1.0174429e+2 1.0860163e+2
1.4179425e+2 2.3783281e+2 3.8862375e+2 5.2240430e+2 3.8762686e+2
1.314e-4 9.896e-1
1 1 2 1 2 3 2 4 3 3

425
1.0116005e+2 1.0108698e+2 1.0115943e+2 1.0204797e+2 1.1132851e+2
1.6683398e+2 3.1972214e+2 5.0924634e+2 5.4617505e+2 3.4850894e+2
1.166e-4 9.895e-1
1 1 1 2 3 1 2 3 3 3
450
1.0171597e+2 1.0164823e+2 1.0182498e+2 1.0254409e+2 1.0734893e+2
1.3443678e+2 2.2479260e+2 3.7049350e+2 3.7828754e+2 2.1445309e+2
1.040e-4 9.899e-1
1 3 3 3 3 4 4 4 3 4
475
1.0227348e+2 1.0228627e+2 1.0283897e+2 1.0330391e+2 9.3985497e+1
2.0331522e+1 -1.2254787e+2 -1.3829797e+2 -5.8907875e+1 -5.0267998e+1
9.291e-5 9.901e-1
1 1 1 1 1 2 2 3 3 3
500
1.0285352e+2 1.0286377e+2 1.0307387e+2 1.0446059e+2 1.0458041e+2
8.5376534e+1 6.7740074e+1 1.2470827e+2 1.1985102e+2 3.9813820e+1
8.360e-5 9.903e-1
1 1 1 1 2 2 3 3 3 3
525
1.0292488e+2 1.0287558e+2 1.0313529e+2 1.0490766e+2 1.0814799e+2
1.0538039e+2 1.2238683e+2 1.8109004e+2 1.3488974e+2 3.3781872e+1
7.552e-5 9.905e-1
1 1 1 1 2 3 3 1 4 1
550
1.0296708e+2 1.0288940e+2 1.0322019e+2 1.0534298e+2 1.1051432e+2
1.1686066e+2 1.4932445e+2 1.9345653e+2 1.2189095e+2 1.7110733e+1
6.845e-5 9.908e-1
1 1 1 1 1 1 1 4 4 4
600
1.0343599e+2 1.0342693e+2 1.0383292e+2 1.0669165e+2 1.1469791e+2
1.3271156e+2 1.8000572e+2 1.9181937e+2 9.1812172e+1 -8.1595898e+0
5.681e-5 9.915e-1
1 1 1 1 2 4 4 3 4 3
650
1.0371485e+2 1.0373508e+2 1.0425428e+2 1.0747917e+2 1.1742072e+2
1.4445953e+2 1.9223967e+2 1.7062979e+2 6.4828087e+1 -2.7713474e+1
4.769e-5 9.920e-1
1 1 1 2 3 3 4 3 4 5
700
1.0368952e+2 1.0374837e+2 1.0430534e+2 1.0792204e+2 1.1928220e+2
1.5051859e+2 1.9460500e+2 1.4298193e+2 3.3045769e+1 -4.5187569e+1
4.046e-5 9.917e-1
1 1 1 1 1 3 1 1 4 3

750
1.0388150e+2 1.0389768e+2 1.0479220e+2 1.0862064e+2 1.2057243e+2
1.5623744e+2 1.9056987e+2 1.1766576e+2 1.6436193e+1 -5.6750645e+1
3.453e-5 9.918e-1
1 1 1 1 2 1 4 5 3 7
800
1.0366309e+2 1.0378558e+2 1.0461283e+2 1.0865340e+2 1.2222921e+2
1.5777780e+2 1.8378177e+2 1.0410989e+2 1.6240347e+1 -4.2549450e+1
2.978e-5 9.931e-1
1 1 2 2 3 4 4 4 3 2

L1sL4C3 Loop 1stripped Line 4W Component 3 - Hz

50
1.0302175e+2 1.0302252e+2 1.0304187e+2 1.0311691e+2 1.0334850e+2
1.0415902e+2 1.0633336e+2 1.1049224e+2 1.1883507e+2 1.2155312e+2
2.686e-3 9.914e-1
1 1 1 1 1 1 1 1 1 1
100
1.0375506e+2 1.0372070e+2 1.0373354e+2 1.0388570e+2 1.0445806e+2
1.0641076e+2 1.1152593e+2 1.2174008e+2 1.3799402e+2 1.4380569e+2
1.144e-3 9.894e-1
1 1 1 1 1 1 1 1 1 1
150
1.0463594e+2 1.0460851e+2 1.0466212e+2 1.0489959e+2 1.0597500e+2
1.0946400e+2 1.1878770e+2 1.3702107e+2 1.6370491e+2 1.7242166e+2
6.492e-4 9.891e-1
1 1 1 1 1 1 1 3 3 3
200
1.0903029e+2 1.0898912e+2 1.0906709e+2 1.0943933e+2 1.1125541e+2
1.1701718e+2 1.3262602e+2 1.6150854e+2 2.0339233e+2 2.1516092e+2
4.180e-4 9.883e-1
1 1 1 1 1 2 2 1 2 1
250
1.0689520e+2 1.0682574e+2 1.0691490e+2 1.0746506e+2 1.1003099e+2
1.1865275e+2 1.4169807e+2 1.8332843e+2 2.4246480e+2 2.5851514e+2
2.906e-4 9.923e-1
1 1 1 1 1 1 1 2 3 3
300
1.0335265e+2 1.0331373e+2 1.0346168e+2 1.0413192e+2 1.0727230e+2
1.1967773e+2 1.5252759e+2 2.1284073e+2 3.0315292e+2 3.3868787e+2
2.134e-4 9.982e-1
1 1 1 1 1 1 2 3 1 3
350
1.0468729e+2 1.0454871e+2 1.0478809e+2 1.0575598e+2 1.1088465e+2
1.3069618e+2 1.8106364e+2 2.6071402e+2 3.2644885e+2 3.0452081e+2
1.628e-4 9.995e-1
1 1 1 1 1 1 3 4 3 4
400
1.0105902e+2 1.0088187e+2 1.0119118e+2 1.0217157e+2 1.0966992e+2
1.4591583e+2 2.3704141e+2 3.7231155e+2 5.1105042e+2 5.2662213e+2
1.279e-4 9.923e-1
1 1 1 1 2 2 4 6 5 6
425
1.0123985e+2 1.0121053e+2 1.0150179e+2 1.0213778e+2 1.1225471e+2
1.7914098e+2 3.4456592e+2 5.4314801e+2 6.9305823e+2 6.8227551e+2
1.136e-4 9.916e-1
1 2 1 2 1 1 4 6 4 1

L1sL4C3 Loop 1stripped Line 4W Component 3 - Hz (cont)

450
1.0156703e+2 1.0158035e+2 1.0195876e+2 1.0242615e+2 1.0756614e+2
1.4002422e+2 2.3072412e+2 3.9351669e+2 5.5543805e+2 5.6607495e+2
1.014e-4 9.922e-1
1 2 1 1 3 2 1 5 4 5
475
1.0188684e+2 1.0179366e+2 1.0240643e+2 1.0300777e+2 9.3162735e+1
3.8111680e+0 -1.8074408e+2 -1.8735822e+2 -1.2128079e+1 8.4585060e+1
9.105e-5 9.925e-1
1 1 1 2 1 1 3 3 2 4
500
1.0228891e+2 1.0220223e+2 1.0257814e+2 1.0409039e+2 1.0418792e+2
7.1970711e+1 1.6915964e+1 8.7683693e+1 1.6374904e+2 1.5671188e+2
8.202e-5 9.928e-1
1 1 1 1 1 2 3 2 3 4
550
1.0291109e+2 1.0292154e+2 1.0320467e+2 1.0556002e+2 1.1092146e+2
1.0851791e+2 1.1939171e+2 1.9938910e+2 1.7811630e+2 1.0593237e+2
6.728e-5 9.928e-1
1 1 1 2 1 3 4 2 1 3
600
1.0369762e+2 1.0364524e+2 1.0401324e+2 1.0706969e+2 1.1505529e+2
1.2618661e+2 1.6048911e+2 2.0996590e+2 1.4152957e+2 5.5513821e+1
5.588e-5 9.934e-1
1 1 1 1 2 3 1 4 3 4
650
1.0376752e+2 1.0368127e+2 1.0421749e+2 1.0780341e+2 1.1879507e+2
1.4283827e+2 1.8446828e+2 1.8479146e+2 9.5164406e+1 1.0179487e+1
4.694e-5 9.936e-1
1 1 2 2 1 3 4 5 4 5
700
1.0363915e+2 1.0367503e+2 1.0430248e+2 1.0906985e+2 1.2333712e+2
1.5798938e+2 2.1142076e+2 1.9256143e+2 9.7497658e+1 1.1054131e+1
3.985e-5 9.939e-1
1 1 1 1 3 4 4 4 3 6
750
1.0324717e+2 1.0326620e+2 1.0407484e+2 1.0920856e+2 1.2724179e+2
1.7082933e+2 2.1594295e+2 1.6715756e+2 6.3664616e+1 -1.5602184e+1
3.412e-5 9.942e-1
1 1 1 2 2 3 3 2 5 5
800
1.0332431e+2 1.0335526e+2 1.0452876e+2 1.0998310e+2 1.2830338e+2
1.7564383e+2 2.1281287e+2 1.3531128e+2 3.5691292e+1 -2.4773333e+1
2.948e-5 9.943e-1
1 2 1 2 2 3 3 5 5 6

L2sL2C3 Loop 2stripped Line 2W Component 3 - Hz

0
9.9089172e+1 9.9140877e+1 1.0001100e+2 1.0399621e+2 1.2103009e+2
1.5364284e+2 1.4521820e+2 5.1136791e+1 -1.0793667e+1 -4.8713467e+1
1.231e-5 9.954e-1
1 1 1 2 5 1 6 8 8 6
50
1.0140441e+2 1.0157001e+2 1.0213290e+2 1.0637399e+2 1.2144123e+2
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1.438e-5 9.932e-1
1 1 1 2 3 5 3 5 6 6
100
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1.4516895e+2 1.2782588e+2 3.4008175e+1 -2.6744616e+1 -7.0558182e+1
1.697e-5 9.909e-1
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1.4302739e+2 1.2098621e+2 3.1297655e+1 -3.5785057e+1 -6.8563942e+1
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6.532e-5 9.994e-1
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L2sL3C3 Loop 2stripped Line 3W Component 3 - Hz

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1.019e-4 9.994e-1
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1.203e-4 9.995e-1
1 1 1 1 1 3 2 4 2 3
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1.732e-4 9.995e-1
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L2sL3C3 Loop 2stripped Line 3W Component 3 - Hz (cont)

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1.0333495e+2 1.1012004e+2 1.2060365e+2 1.2823813e+2 8.3818588e+1
2.279e-3 9.963e-1
1 1 1 1 1 1 1 1 1 1

Appendix D

Stripping of Cultural Responses

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Stripping Cultural Conductor Responses from EM Data

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SUMMARY

A simple but very effective technique can be formulated to remove much of the secondary response of cultural conductors. The method relies on estimation of the secondary current flowing within a conductor at each smalpe time by indirect measurement of its local vertical magnetic field, and it does not require an a-priori knowledge of the subsurface conductivity structure. Since the induced current flowing within a cultural conductor can be estimated at any point by a short traverse across it, the method can account reasonably for variations in induced current along the cultural feature's length caused by multiple grounding and variation in the primary electric field. This technique has been very successfully applied to data collected in areas cut by numerous cultural features of complex geometry.

INTRODUCTION

Long, cultural conductors such as fences, pipelines and powerlines are known to strongly affect controlled source transient EM measurements made in their vicinity (Fitterman, 1989). Cultural features cause two independent problems in EM exploration that we will call *noise* and *response*. *Noise* occurs because there are EM fields associated with cultural features that contain currents, these currents are uncorrelated with the geophysical system and may be channeled regional current systems in long conductors, or controlled powerline or communication current systems. *Response* refers to the anomalous response from currents induced in the cultural conductor by the geophysical EM system itself.. Methods for the minimization of noise have been discussed in Macnae et al, 1984, this paper will focus on the effects of cultural response.

Because of the need to perform transient EM exploration in populated areas it is essential that the response of culture be either minimized or removed from measured data. The response of a single cultural conductor can be minimized by a symmetric placement of an ungrounded transmitter loop such that it is null coupled to the conductor. However, such restrictions on loop placement often compromise the original aim of the survey and are not practical for multiple cultural features. As an alternative, this paper describes a simple technique which permits the quantitative estimation of the anomalous current induced in cultural conductors and the subsequent removal of the undesired response from the data.

The technique relies on detailed measurement of the anomaly caused by each cultural conductor along short traverses across it. This data is used to estimate the actual induced anomalous current flowing in the conductor at each delay time. The known geometry of the conductor is then used to compute and remove the anomalous response at each measurement station along the main traverse line. The method has been successfully applied to UTEM transient EM data collected in different applications, and will be illustrated by a sounding survey in Kyushu, Japan and a mineral prospecting survey in Australia. The survey areas in each case are cut by numerous powerlines and/or fences.

THEORY

The UTEM system uses a large loop ungrounded transmitter and a roving receiver to measure any component of the transient magnetic and electric field. After each transition in the waveform, the response is measured at twenty delay times ranging from 16 microseconds to 12 milliseconds. The digital UTEM receiver is generally operated at a base frequency of 31 Hz near 60 Hz powerlines and 26 Hz near 50Hz powerlines. This provides very good rejection at the fundamental powerline frequency and its odd harmonics while attenuating the powerline signal at sub-harmonics and sidebands caused by variations in the powerline load. A general description of the UTEM system is given by (West et al, 1984).

A full description of the anomalous UTEM response caused by the presence of a grounded cultural conductor is quite a complex 3D problem involving detailed information on the grounding resistance at each ground point as well as a full knowledge of the subsurface conductivity structure. However, we do not have to model the response of a grounded conductor to remove most of its effect from the data. This is because most of the vertical magnetic field response arises only from the induced currents flowing within the conductor itself which may be estimated by measurement. The response may be considered to be primarily one of current channeling. At each delay time the *primary* electric field driving the current channeling may be considered to be the electric field that would exist in the absence of the conductor. A schematic description of this process is shown in Figure 1. Figure 1a shows a uniform electic field parallel to a portion of a filamentary conductor grounded at two points. The resulting (total) *current* field is shown in Figure 1b. The introduction of a long conductor grounded at two points has resulted in charge accumulations at the grounding points which create an anomalous electric field. The resulting anomalous current distribution is shown amplified in Figure 1c. The anomalous current distribution associated with the current channeling can thus be thought of being composed of two parts; a discrete filamentary current along the cultural conductor (C1) located on the surface, and return currents within the ground (C2). An interesting result of the symmetry of the two current systems is that on the surface of an arbitrary *layered* earth, the cultural current element C1 produces only a vertical magnetic field while the current system C2 produces only a horizontal field. Due to this fact, the local vertical magnetic field measurements are primarily affected by the current within the cultural conductor itself rather than by the return currents within the earth. Due to spheric noise considerations, it is in fact the vertical magnetic field component that is most commonly measured in UTEM surveys. The current path C1 associated with a real cultural conductor may of course be located at a small depth within the earth (pipelines) or at a height above the earth (powerlines), but this does not greatly alter the conclusion that the vertical magnetic field is most responsive to currents in the cultural conductor.

The current flowing within the cultural conductor (C1) can be estimated at each delay time if vertical magnetic field data has been collected on a short traverse across the feature. Along such a short traverse the response of the conductor is very large and anti-symmetric about the conductor location while the response of the subsurface will likely be smooth and uncorrelated with the cultural conductor location. The current within the cultural conductor is then estimated by a simple least-squares fitting technique. The input to the process is a set of data D_{ij} measured at N stations (x_i,y_i,z_i), $i=1,N$ and M delay times t_j $j=1,M$. At each delay time the data is assumed to be composed of the magnetic field of the cultural conductor P_i carrying an unknown current a_{1j} plus a smooth background response S_{ij} which represents the desired stripped data. The cultural conductor field at each station, $Pi=P(R,x_i,y_i,z_i)$, is computed by the integration of a unit ampere current element along the known, digitized path of the cultural feature. Here, R is a generalized vector describing the 3D path of the cultural conductor. In the present realization of the technique the smooth response is taken to be a quadratic $S_{ij}=a_{2j}x'^2_i+a_{3j}x'_i+a_{4j}$ with unknown coefficients a_{2j},a_{3j},a_{4j}. The coordinates x' are obtained by rotating the field coordinates onto a least-squares best fit to the actual set of traverse stations. In this way traverses which are not straight can be accommodated without biasing the fitting. The solution for each delay time t_j, thus consists of the least-squares solution to the set of N equations:

$$D_{ij}=a_{1j}P_i+a_{2j}x'^{2}_i+a_{3j}x'_i+a_{4j} \quad i=1,N \qquad (1)$$

The solution of the above equations for a1 may be then used to strip the response of the current flowing within the cultural conductor from any data collected at any location (x,y,z) from the same transmitter loop:

$$D(x,y,z,t_j)_{stripped}=D(x,y,z,t_j)-a_{1j}P(S,x,y,z) \qquad (2)$$

Figure 2a shows an example of a 6 station traverse across a cultural conductor. The field coordinates are defined by the X-Y axes. The dashed line is the x' axis, the least-squares best fit to the traverse line. Figure 2b shows the four basis functions used to fit the observed data.

The application of this technique requires a detailed knowledge of the 3D path of each conductor. Although most cultural conductors other than buried pipelines can be easily surveyed, there may result slight error in the assumed location of the conductor which compromise the fitting of the response. This is particularly true of powerlines which carry a grounded skywire for lightning protection. In these cases it is impossible to precisely survey the location and height of the skywire, particularly as its height must follow a catenary curve between suspension points. To account for this problem, one or more of the vertices defining the conductor are allowed to vary their assumed location so as to minimize the residual error of fit resulting from the solution of equations (1). A simple steepest descent non-linear minimization is performed to minimize this error with respect to the x,y and z offsets of the varying vertices.

Most often cultural conductors are grounded at many points along their length. Skywires associated with powerlines are often grounded at each pole or tower while conductors such as pipelines, guardrails and fences may be considered to be almost continuously grounded along their length. In these cases the induced current flowing within the conductor will not be constant along its length, particularly if the component of the primary electric field in the direction of the conductor varies strongly. To properly estimate the induced current flowing in a cultural conductor may require that several traverses be made across it along its length.
In these cases the conductor may be assumed to be composed of a number of non-overlapping pieces, each with its own traverse profile. The induced current in each piece is then estimated independently to account approximately for its variation along the conductor.

THE SOUNDING SURVEY

The aim of the UTEM survey carried in Kyushu was to obtain a detailed conductivity sections beneath two profiles for the purpose of locating conductive targets. To obtain good lateral resolution in the conductivity sections, a technique called Depth Image Processing was applied to the data. The layout of the transmitter loops and the survey line required by the processing method is shown in Figure 3. The line runs through the centre of a sequence of loops which share common sides. At each station on the survey line three measurements of the vertical magnetic field are obtained, one from each of the two loops either side of the station and one from the loop surrounding the station. The use of the three-fold data redundancy improves both the vertical and horizontal resolution within the processed section (Macnae and Lamontagne, 1987). Figure 4 shows one of the two lines along with powerlines which affect the data. The data most affected was collected from loop 4 which has two local powerlines running near its north and east edge. The secondary vertical magnetic field data collected along the central profile from this loop is shown in Figure 5. Figure 5a shows the data expressed as a percent of the primary magnetic field magnitude at each station. This normalization continuously amplifies the secondary response as a function of distance from the loop so that the response both very near and very far from the loop can be easily seen on the same plot. Figure 5b shows the same data expressed as a percentage of the primary field magnitude at a single station, denoted by the arrow on the profile. This shows the true shape of the transient magnetic field. For comparison, Figures 5c and 5d show a continuous and point normalized synthetic layered earth response. This response was computed for the same loop/line geometry using a layered earth model roughly compatible with the known geology. The response is symmetric about the loop with a positive amplitude envelope outside the loop of about 40%. This envelope amplitude is relatively insensitive to changes in the layered earth model. It may vary from about 30% for a thin sheet at surface to 49% for a homogeneous half-space. The response of the powerline PL1 can be clearly seen in both profiles as a cross-over anomaly around 25N. This anomaly severely depresses the secondary field observed at station north of the powerline. Less obvious is the response of powerline PL2 which is roughly parallel and about 150 metres away from the survey line. However, the positive secondary field envelope in the continuously normalized response (5a) observed near the south end of the line is about 70%. This suggests that a substantial positive response from powerline PL2 is contributing to the response observed near the south end of the line.

Data was collected from the three short traverses TL1-TL3 shown in Figure 4 to estimate the induced current flowing within the powerlines. Because the powerlines are grounded at every pole, which are about 50 metres apart, we do not expect that the current flowing in each powerline is exactly constant along its length. The variation in induced current was expected to be worse along the portion of PL2 extending south of the loop since the primary electric field of the loop varies quite strongly along its length. For this reason, PL2 has been split into two parts PL2N and PL2S for the purposes of anomaly stripping. Figure 6 shows the results of the fitting of the powerline response along each traverse. The left hand column in this figure shows the raw data (D_{ij}) collected on each traverse. The right hand column shows the response on these profiles after stripping of the fitted powerline response at each delay time ($D_{ij}-a_{1j}P_i$). Clearly the process has done a very good job of estimating the induced current flowing locally in each powerline.

The three sets of induced current estimates were then used to strip the powerline response from the data collected on the main profile. Figure 7 compares the stripped and the unstripped point and continuously normalized data form loop 4. The response of the powerline PL1 at 25 N has been very well removed from the data. The stripped response is also much more symmetric about the loop. The positive amplitude envelope near the south end of the line is now about 45% which is consistent with a layered earth response. The late time response at the opposite ends of the line are now of comparable amplitude. Remaining in the data is the response of a shallow conductor at about 125N. This response is also clearly seen in the raw data.

PROSPECTING DATA

Figures 8 and 9 compare some data collected in Australia before and after stripping of fence responses, whose location, and the location of the transmitter loop are shown in Figure 10. A dramatic improvement in the smoothness of the data is evident, and some local anomalous features of small amplitude are evident. However, it is still necessary to be suspicious of measured responses close to cultural conductors, particularly if the geometry of the culture is not well known, or if only a few traverses have been used to estimate the current in the culture as a function of location.

Classification and interpretation of local anomalous features after stripping is done conventionally (West et al, 1984); in cases where there is doubt as to whether a stripped anomalous response is that of a conductor within the earth or the result of poor stripping, characteristics such as anomaly shape and decay rate (Silic, 1989) usually resolve the issue. For ease of comparison, it is useful to compare the decays of local anomalies and that of the nearest powerline

CONCLUSIONS

A simple but very effective technique has been described which removes much of the secondary response of cultural conductors. The method relies on estimation of the secondary current flowing within a conductor by direct measurement, and it does not require an a-priori detailed knowledge of the subsurface conductivity structure. Since the induced current flowing within a conductor can be estimated at any point by a short traverse across it, the method can account reasonably for variations in induced current along its length caused by multiple grounding and variation in the primary electric field. This technique has been very successfully applied to data collected in areas cut by numerous cultural features of complex geometry.

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West, G.F., Macnae, J.C., and Lamontagne Y., 1984, A time-domain EM system measuring the step response of the ground, Geophysics 49, 1010-1026.

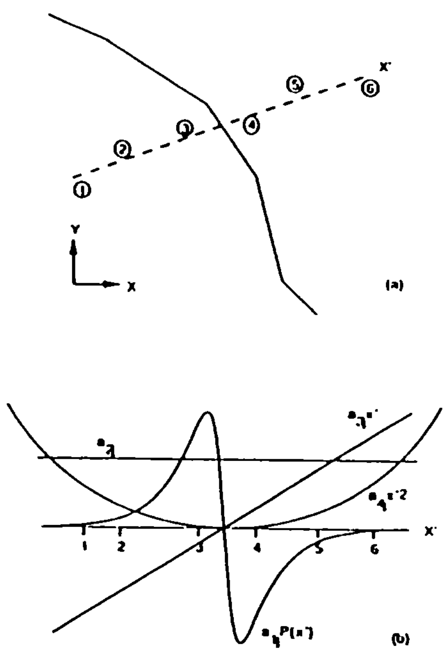
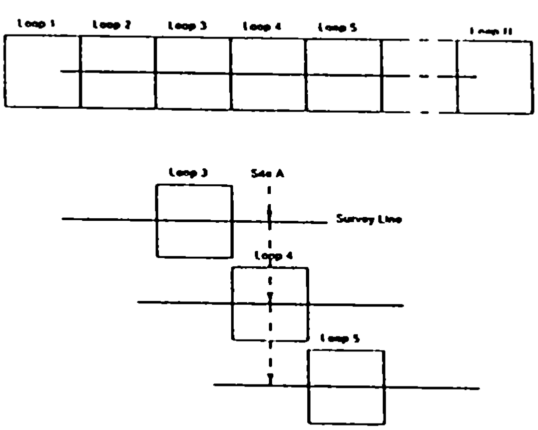


Figure 2: a) Survey stations 1-6 over powerline
b) Basis functions for fitting response.

Figure 3: Geometrical Survey Layout for 3-fold coverage



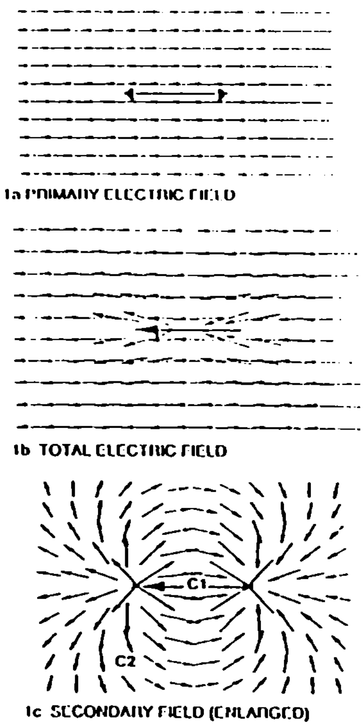
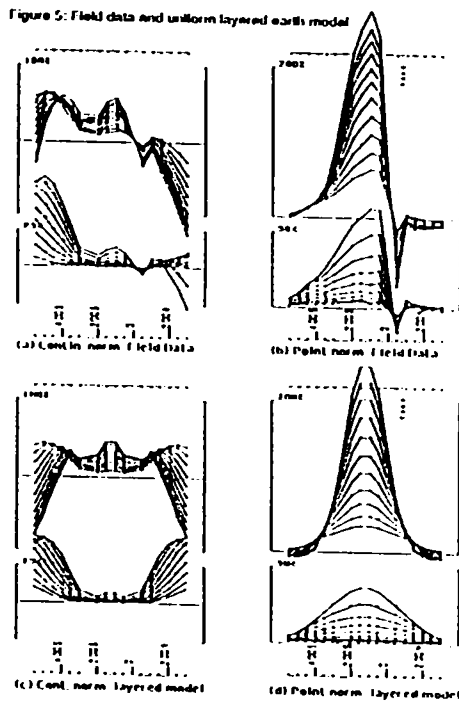


Figure 1: Current Gathering in Cultural Conductors

Figure 5: Field data and uniform layered earth model



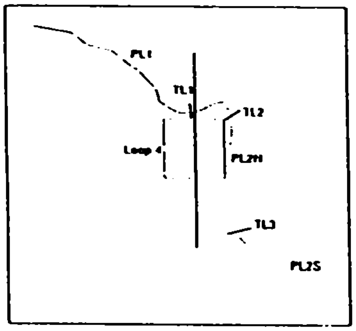


Figure 4: Powerlines, test lines, loop 4 and survey line location

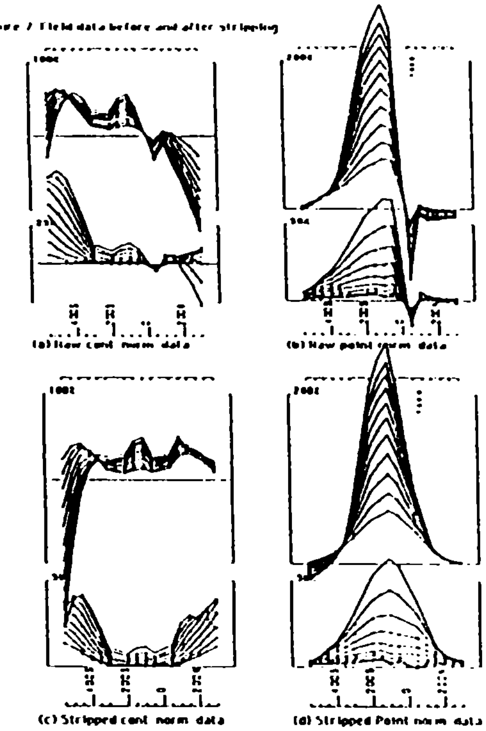
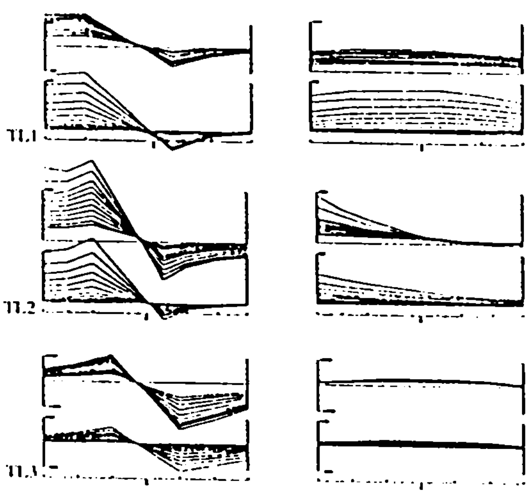


Figure 6: (left) Test line data; (right) Residual after stripping



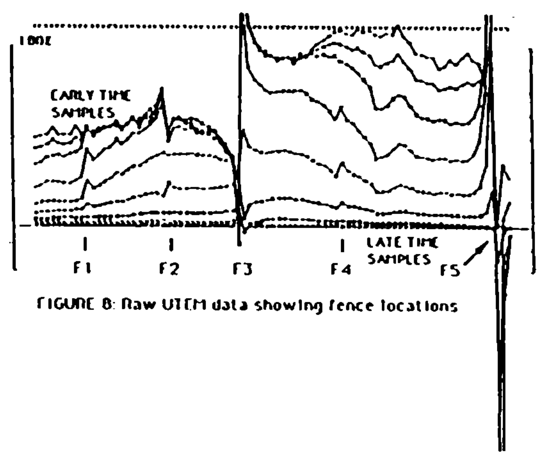


FIGURE 8: Raw UTEM data showing fence locations

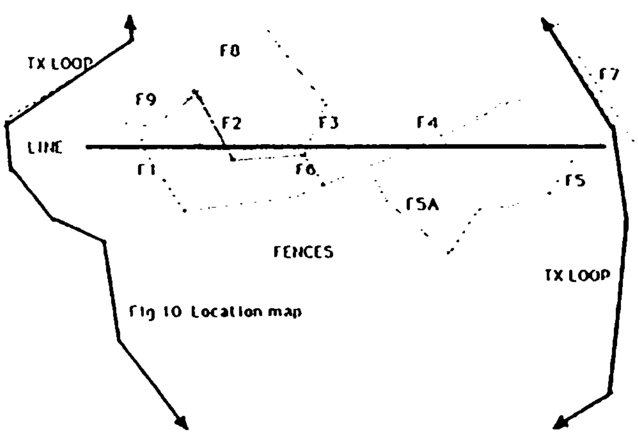


Fig 10 Location map

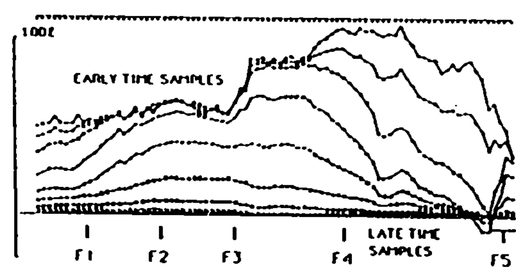


Figure 9: UTEM data after stripping of fence responses

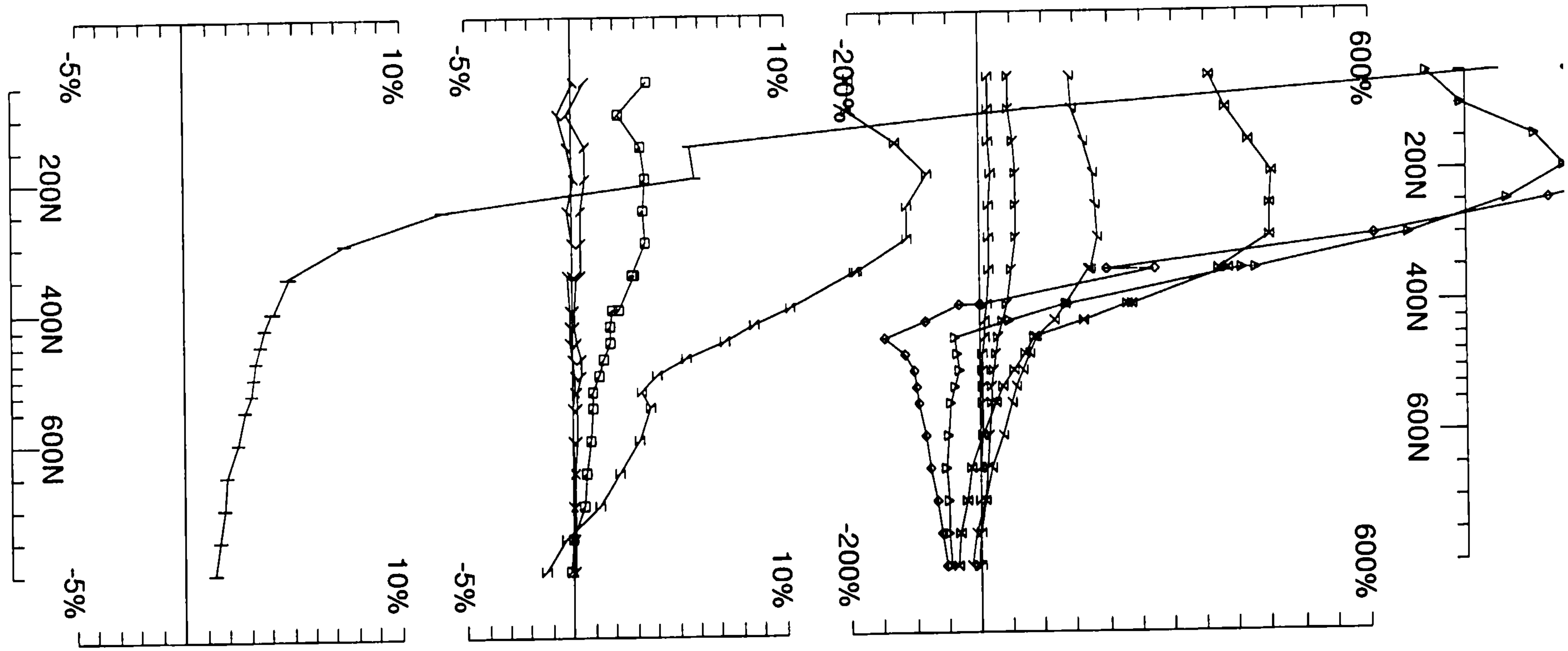
Appendix E

Final UTEM 3 Profiles

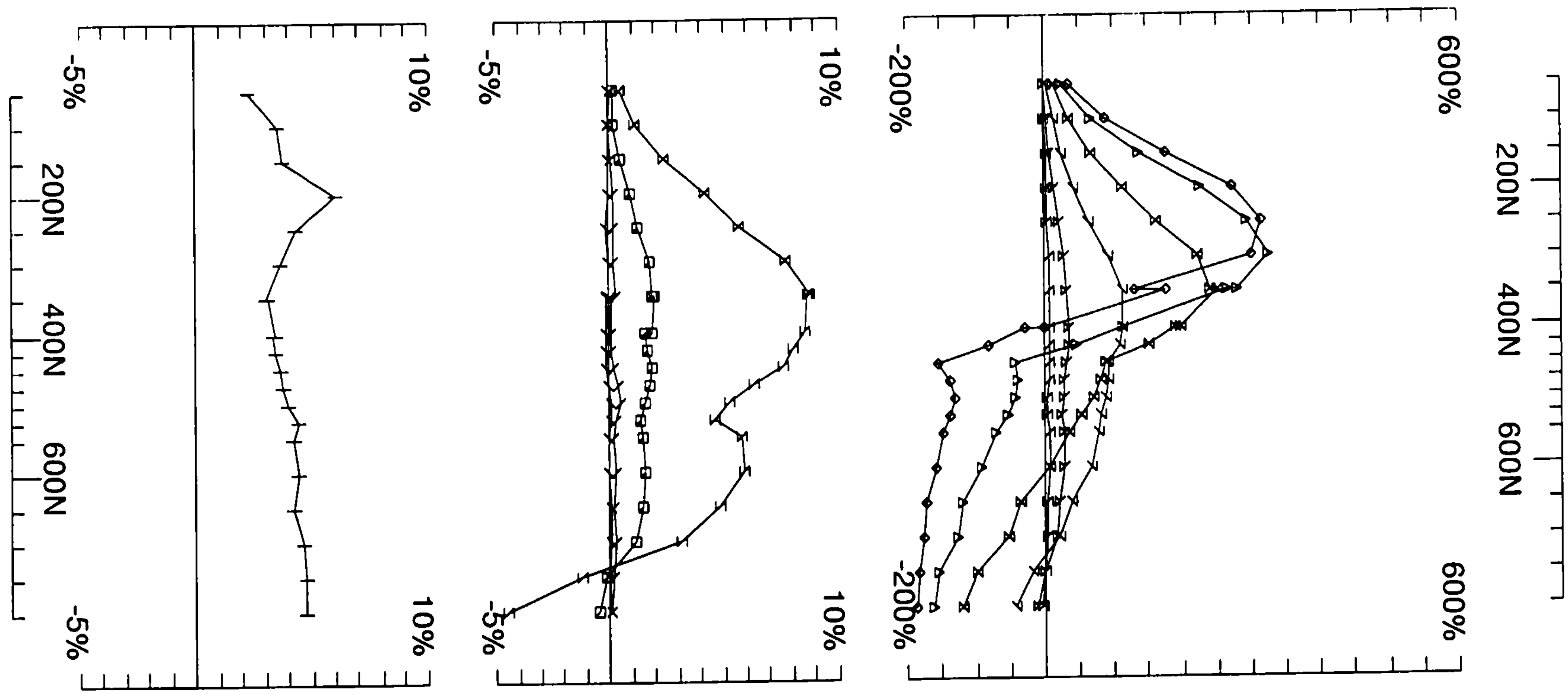
Final UTEM 3 Profiles

The following is a list of the UTEM 3 profiles as they appear in this Appendix.
Notes: All point normalized plots are normalized at (450N,250W,0).
The "s" after the Loop number indictaes that the data has been stripped.

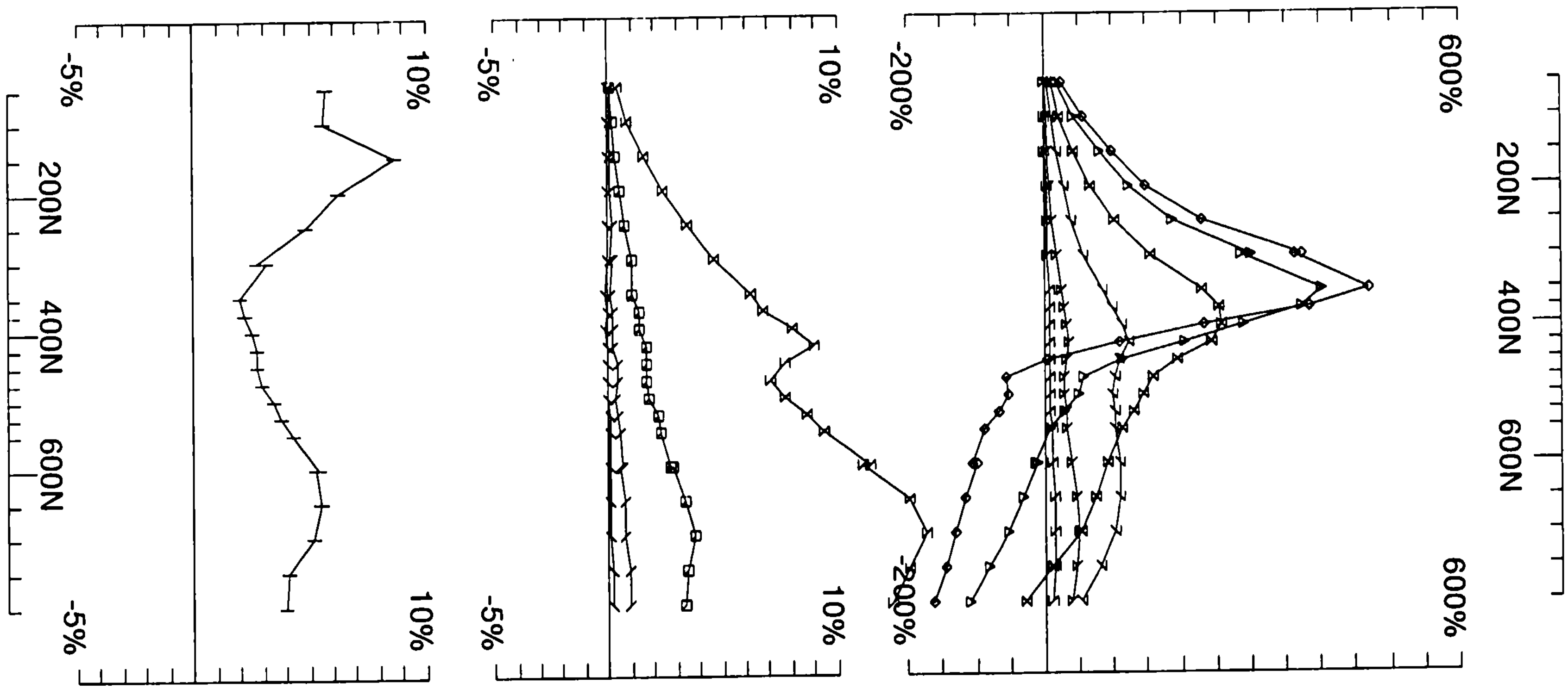
Loop	Line	component	normalization
Loop 1s	L1+00W	Hz	continuous
			point
	L2+00W	Hz	continuous
			point
	L2+00W	Hx	point
	L3+00W	Hz	continuous
			point
	L4+00W	Hz	continuous
			point
Loop 2s	L2+00W	Hz	continuous
			point
	L3+00W	Hz	continuous



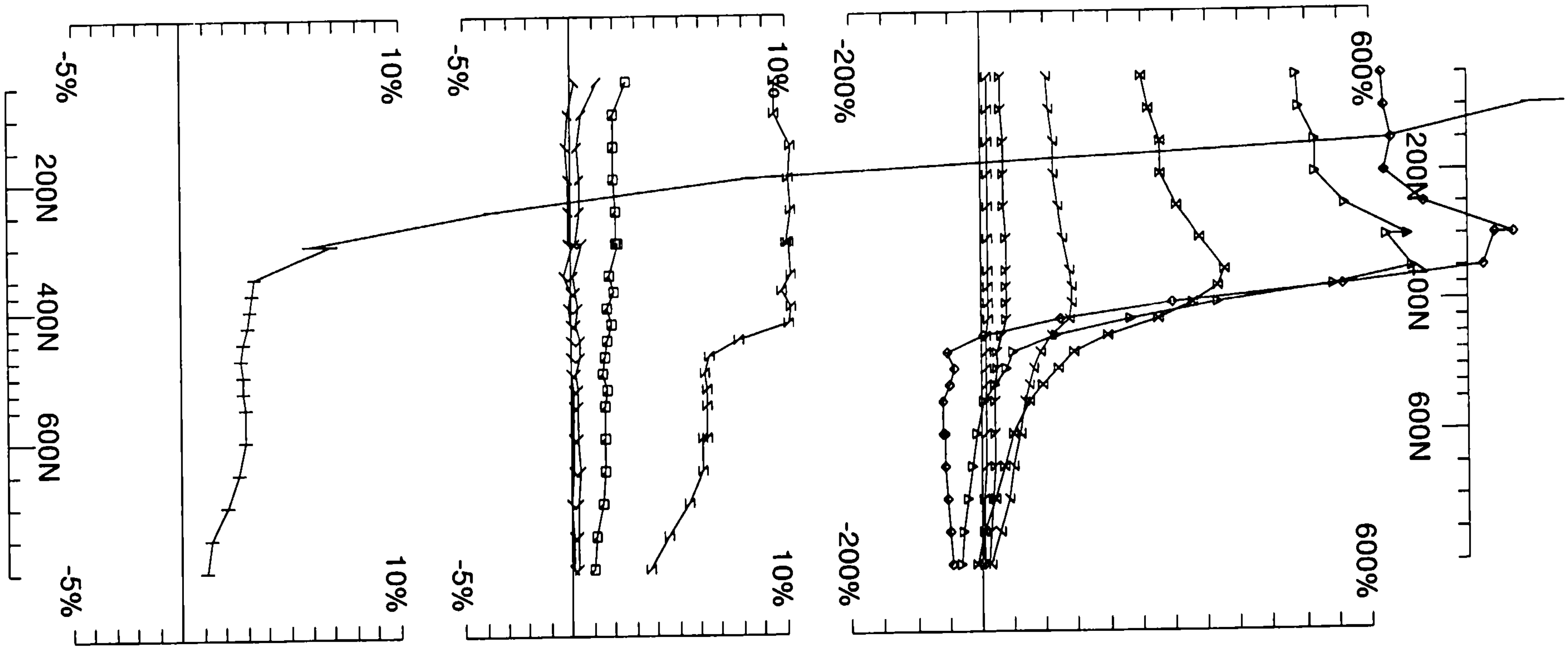
Loop: 1s Line: 1 Compt: Hz	Secondary, (Chn - Ch1)/IHpl Point Norm.at x,y,z (450,250,0) Base Freq. 30.974 Hz	UTEM Survey at: TROLLEY LINE PROPERTY For: DAVE MEUNIER LAMONTAGNE GEOPHYSICS LTD GEOPHYSIQUE LTEE Job 9417 Plotted : 2/11/94



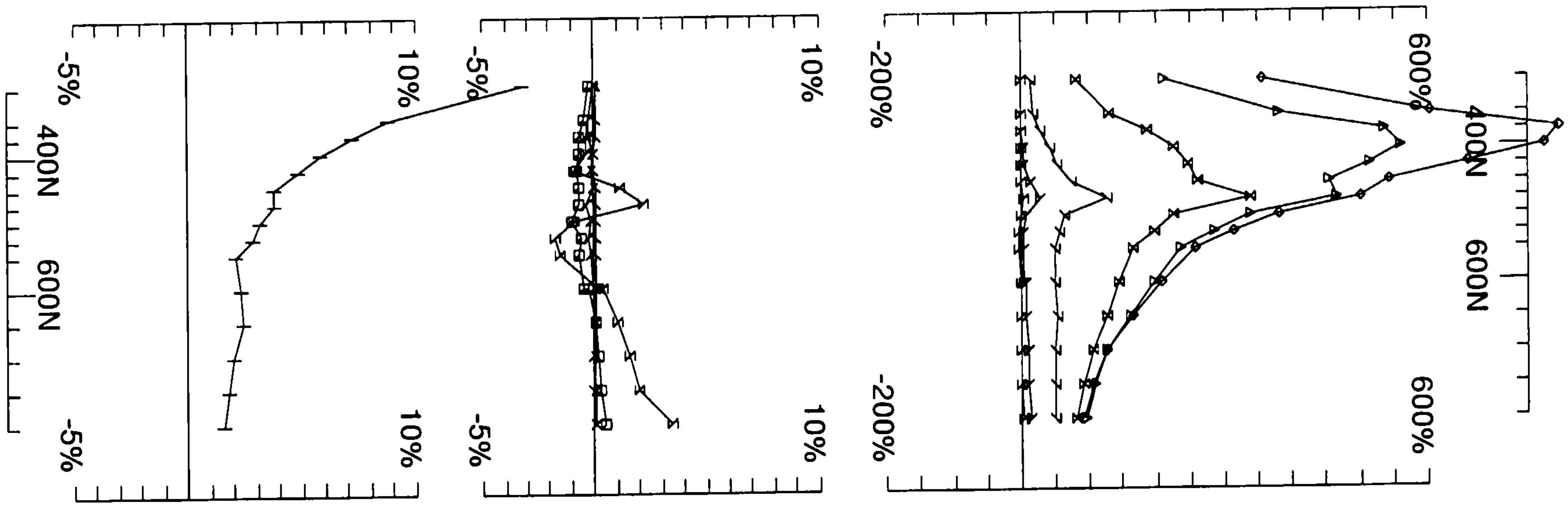
Loop: 1s Line: 1 Compt: Hz	Secondary, (Chn - Ch1)/IHpl Contin. Norm at depth of 0 m Base Freq. 30.974 Hz	UTEM Survey at: TROLLEY LINE PROPERTY For: DAVE MEUNIER LAMONTAGNE GEOPHYSICS LTD GEOPHYSIQUE LTEE Job 9417 Plotted : 2/11/94



Loop: 1s Line: 2 Compt: Hz	Secondary, (Chn - Ch1)/IHpl Contin. Norm at depth of 0 m Base Freq. 30.974 Hz	UTEM Survey at: TROLLEY LINE PROPERTY For: DAVE MEUNIER LAMONTAGNE GEOPHYSICS LTD GEOPHYSIQUE LTEE Job 9417 Plotted : 2/11/94



Loop: 1s Line: 2 Compt: Hz	Secondary, (Chn - Ch1)/IHpl Point Norm.at x,y,z (450,250,0) Base Freq. 30.974 Hz	UTEM Survey at: TROLLEY LINE PROPERTY For: DAVE MEUNIER LAMONTAGNE GEOPHYSICS LTD GEOPHYSIQUE LTEE Job 9417 Plotted : 2/11/94



Loop: 1s
Line: 2
Compt: Hx

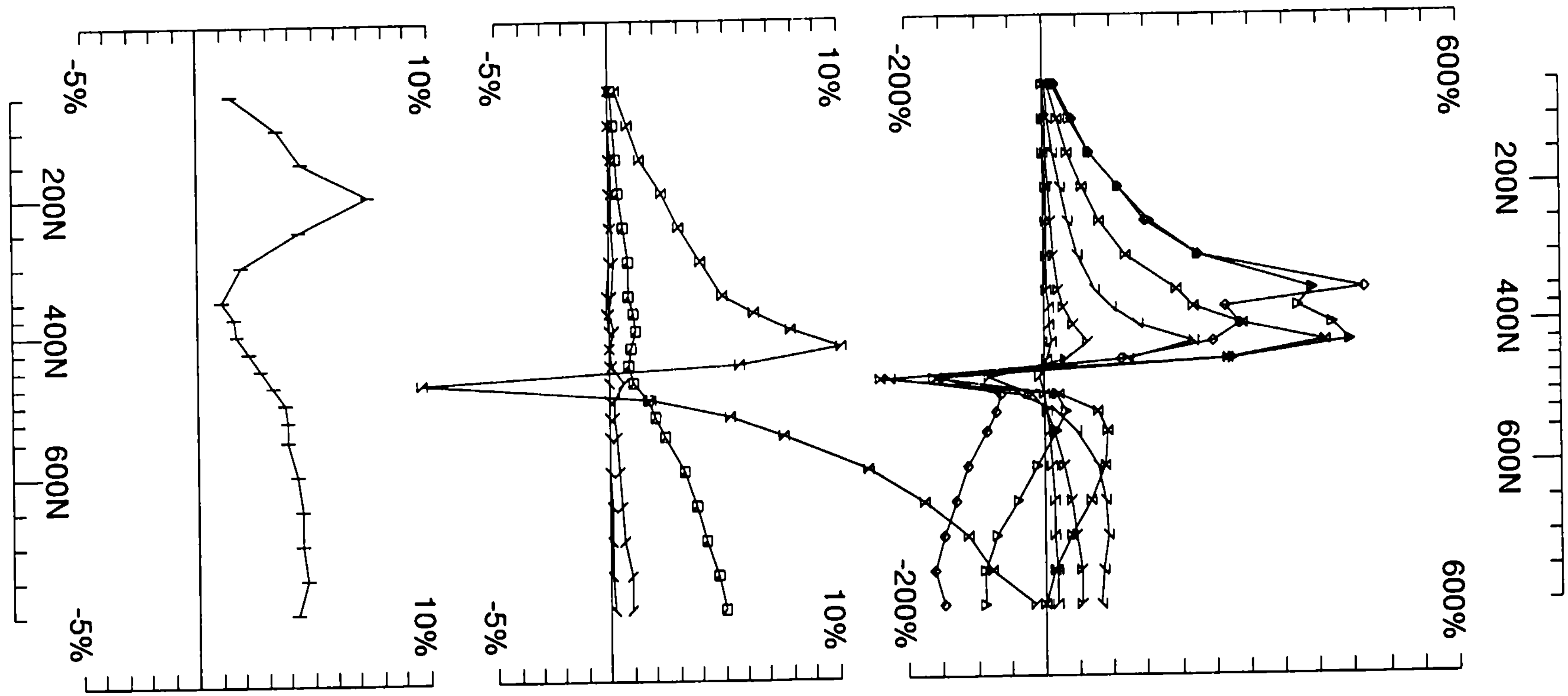
Secondary, (Chn - Ch1)/lHpl
Point Norm.at x,y,z
(450,250,0)
Base Freq. 30.974 Hz

UTEM Survey at: TROLLEY LINE PROPERTY
For: DAVE MEUNIER

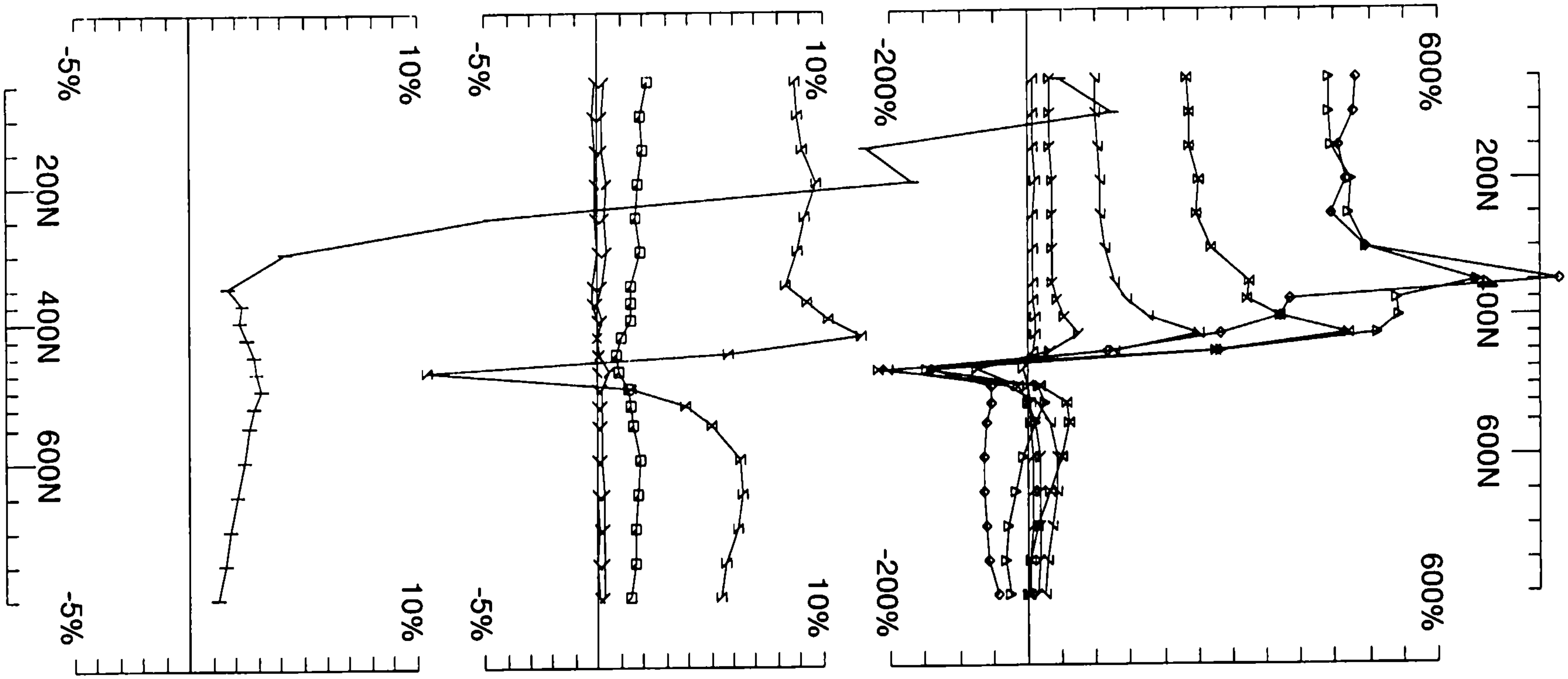
LAMONTAGNE GEOPHYSICS LTD
GEOPHYSIQUE LTEE

Job
9417

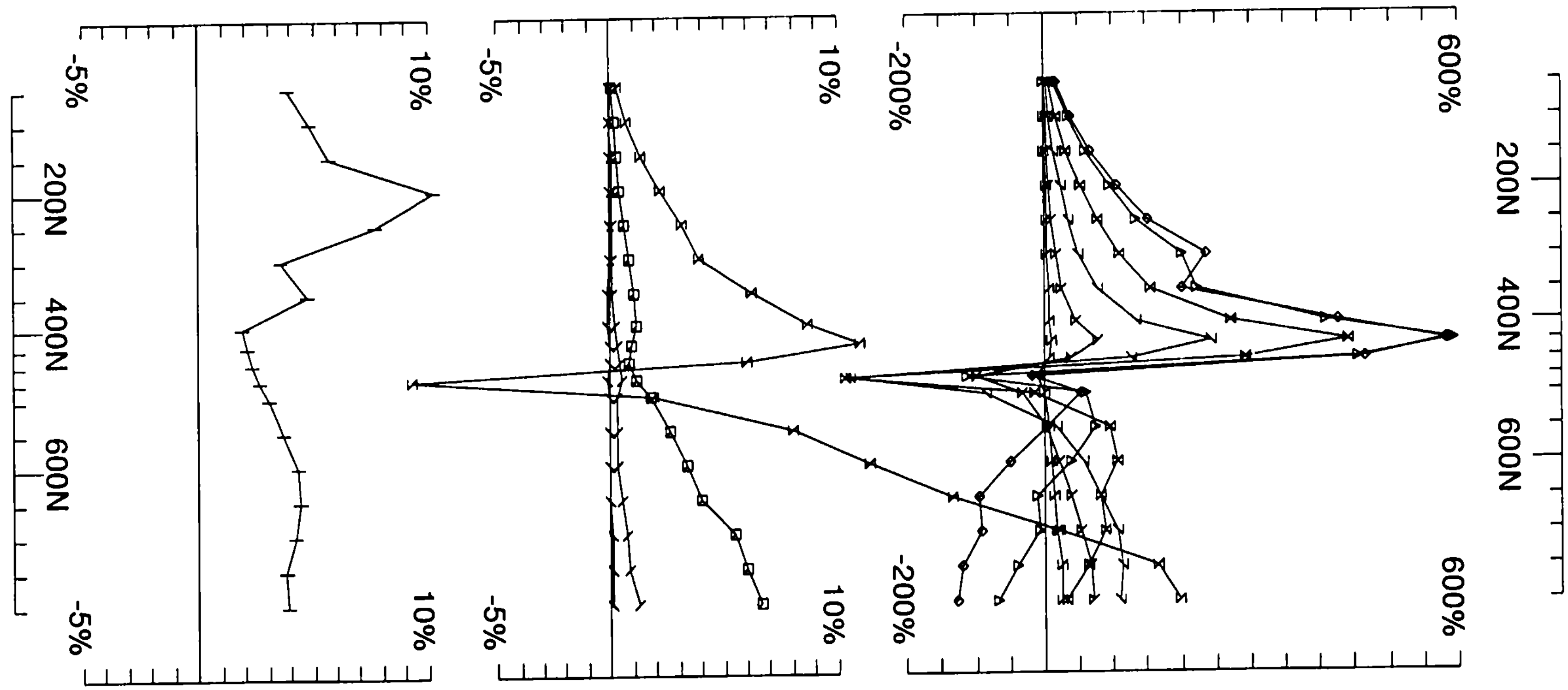
Plotted : 2/11/94



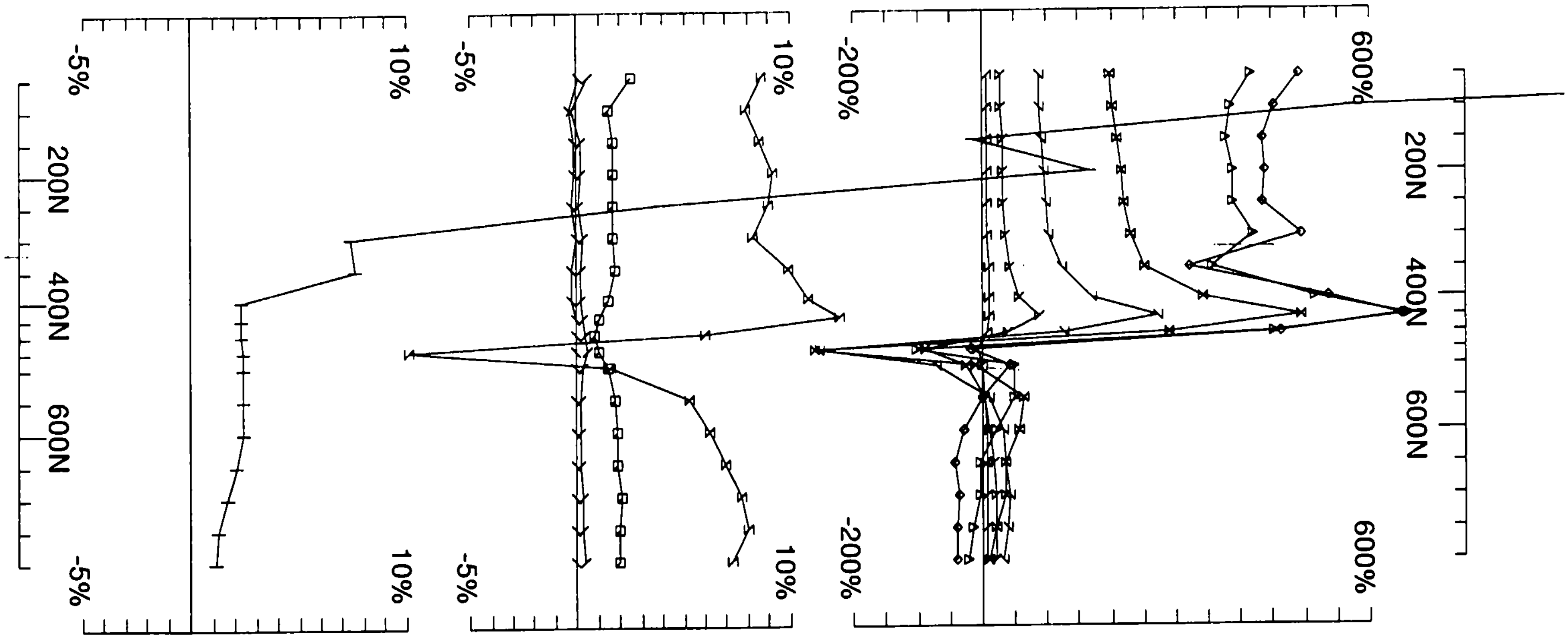
Loop: 1s	Secondary, (Chn - Ch1)/IHpl	UTEM Survey at: TROLLEY LINE PROPERTY
Line: 3	Contin. Norm at depth of 0 m	For: DAVE MEUNIER
Compt: Hz	Base Freq. 30.974 Hz	LAMONTAGNE GEOPHYSICS LTD GEOPHYSIQUE LTEE Job 9417 Plotted : 2/11/94



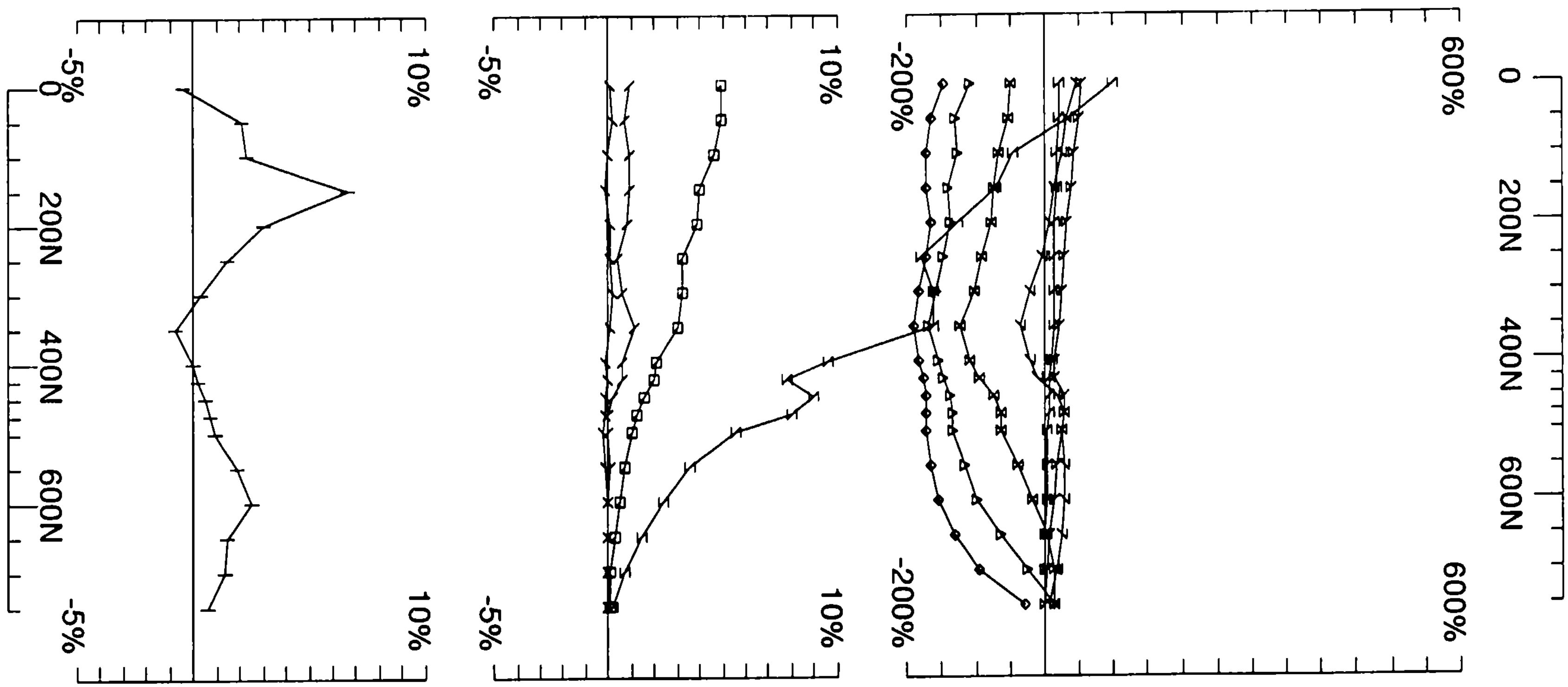
Loop: 1s Line: 3 Compt: Hz	Secondary, (Chn - Ch1)/IHpI Point Norm.at x,y,z (450,250,0) Base Freq. 30.974 Hz	UTEM Survey at: TROLLEY LINE PROPERTY For: DAVE MEUNIER LAMONTAGNE GEOPHYSICS LTD GEOPHYSIQUE LTEE Job 9417 Plotted : 2/11/94



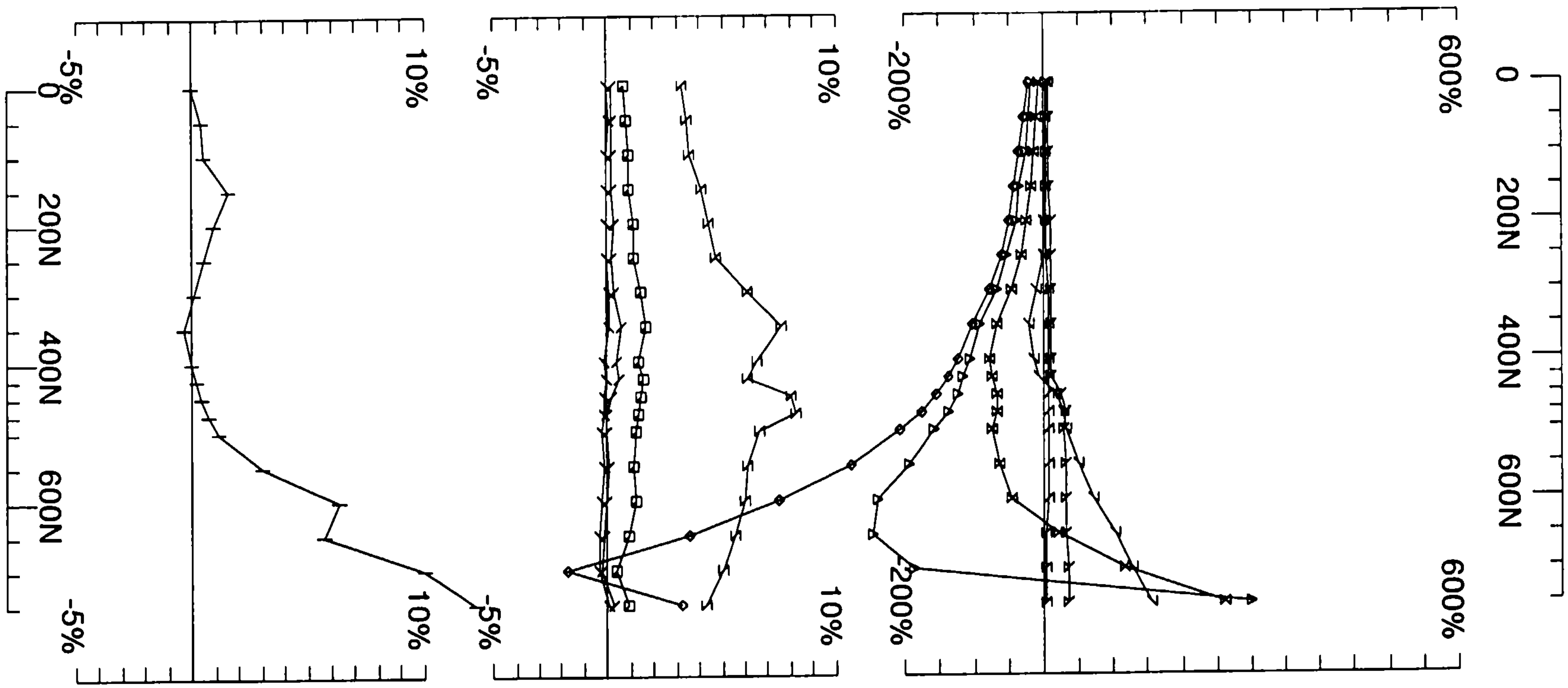
Loop: 1s	Secondary, (Chn - Ch1)/IHpl	UTEM Survey at: TROLLEY LINE PROPERTY
Line: 4	Contin. Norm at depth of 0 m	For: DAVE MEUNIER
Compt: Hz	Base Freq. 30.974 Hz	LAMONTAGNE GEOPHYSICS LTD GEOPHYSIQUE LTEE Job 9417 Plotted : 2/11/94



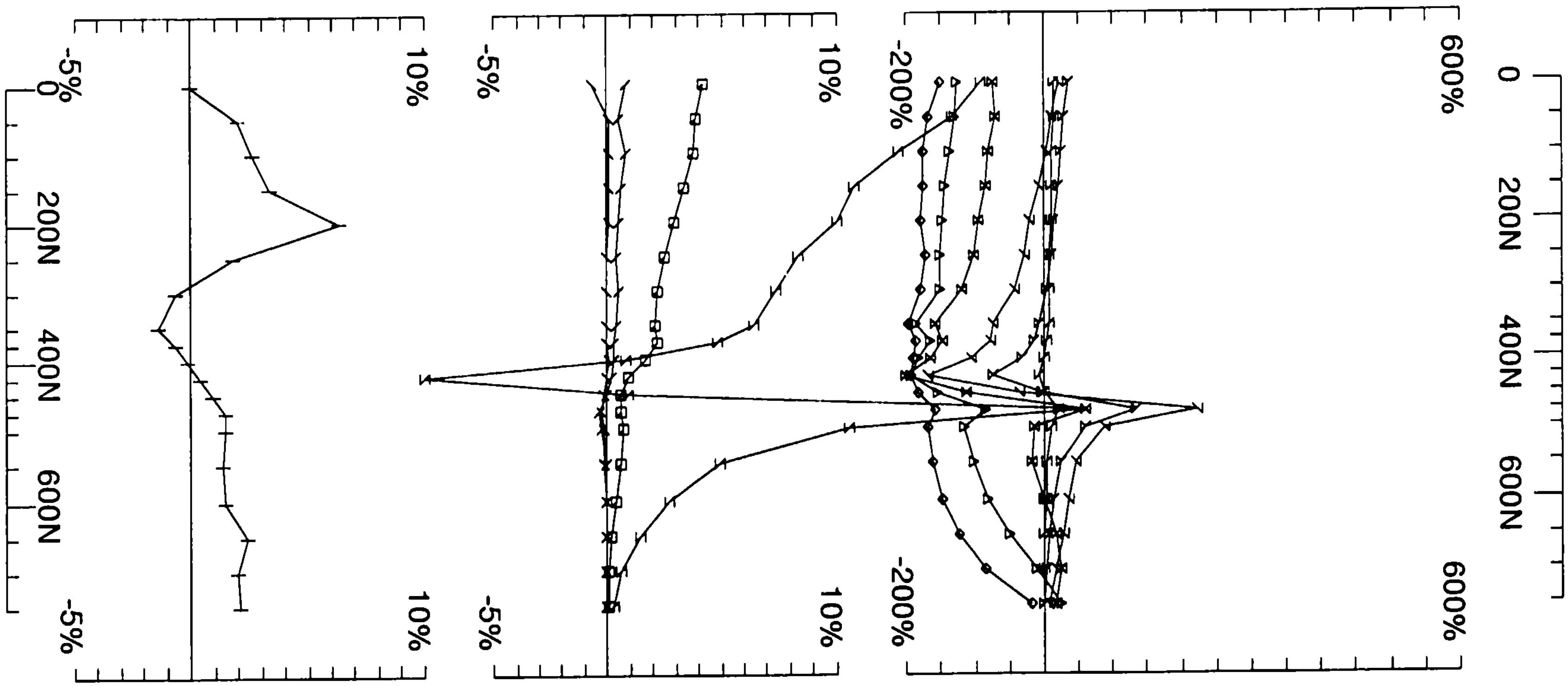
Loop: 1s Line: 4 Compt: Hz	Secondary, (Chn - Ch1)/IHpl Point Norm.at x,y,z (450,250,0) Base Freq. 30.974 Hz	UTEM Survey at: TROLLEY LINE PROPERTY For: DAVE MEUNIER LAMONTAGNE GEOPHYSICS LTD GEOPHYSIQUE LTEE Job 9417 Plotted : 2/11/94



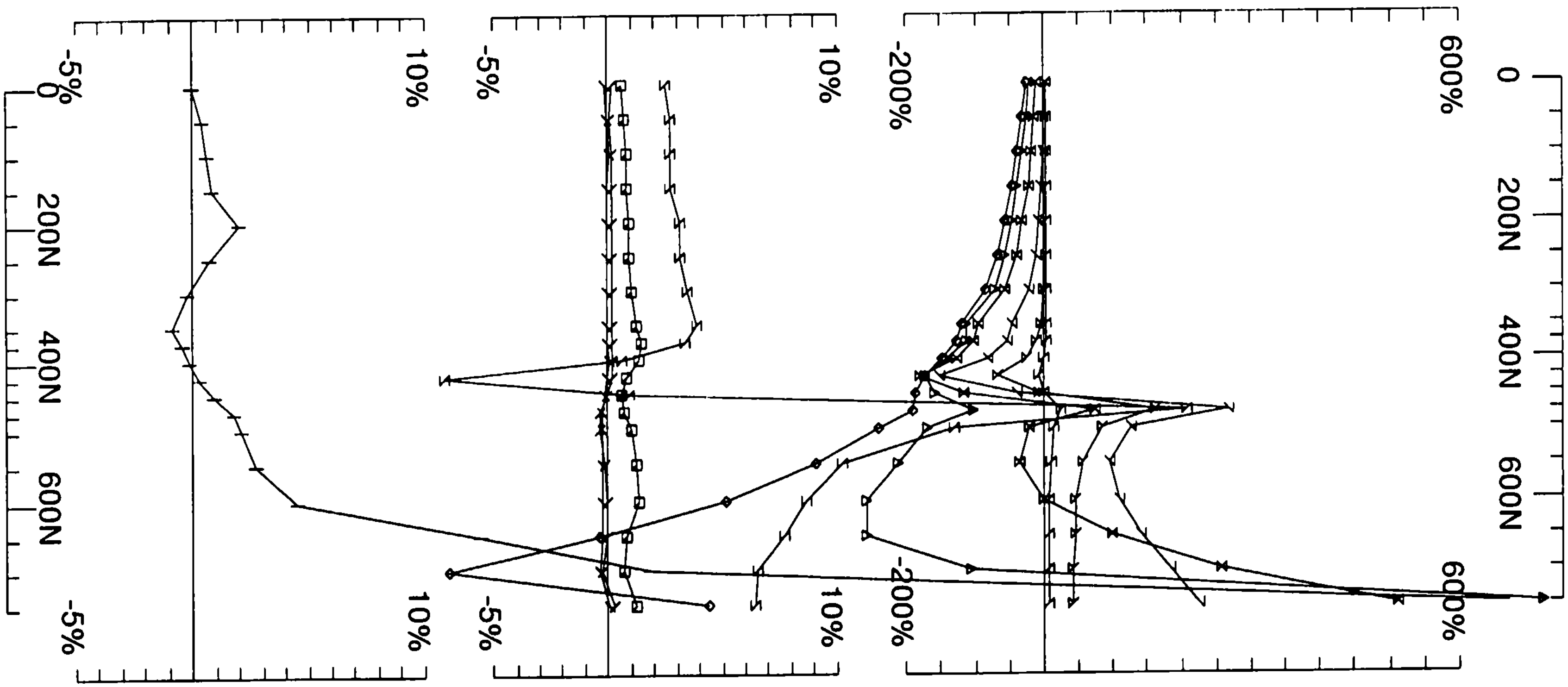
Loop: 2s Line: 2 Compt: Hz	Secondary, (Chn - Ch1)/IHpl Contin. Norm at depth of 0 m Base Freq. 30.974 Hz	UTEM Survey at: TROLLEY LINE PROPERTY For: DAVE MEUNIER LAMONTAGNE GEOPHYSICS LTD GEOPHYSIQUE LTEE Job 9417 Plotted : 2/11/94



Loop: 2s Line: 2 Compt: Hz	Secondary, (Chn - Ch1)/IHpI Point Norm.at x,y,z (450,250,0) Base Freq. 30.974 Hz	UTEM Survey at: TROLLEY LINE PROPERTY For: DAVE MEUNIER LAMONTAGNE GEOPHYSICS LTD GEOPHYSIQUE LTEE Job 9417 Plotted : 2/11/94



Loop: 2s Line: 3 Compt: Hz	Secondary, (Chn - Ch1)/IHpI Contin. Norm at depth of 0 m Base Freq. 30.974 Hz	UTEM Survey at: TROLLEY LINE PROPERTY For: DAVE MEUNIER LAMONTAGNE GEOPHYSICS LTD GEOPHYSIQUE LTEE Job 9417 Plotted : 2/11/94



Loop: 2s Line: 3 Compt: Hz	Secondary, (Chn - Ch1)/lHpl Point Norm.at x,y,z (450,250,0) Base Freq. 30.974 Hz	UTEM Survey at: TROLLEY LINE PROPERTY For: DAVE MEUNIER LAMONTAGNE GEOPHYSICS LTD GEOPHYSIQUE LTEE Job 9417 Plotted : 2/11/94

Appendix F

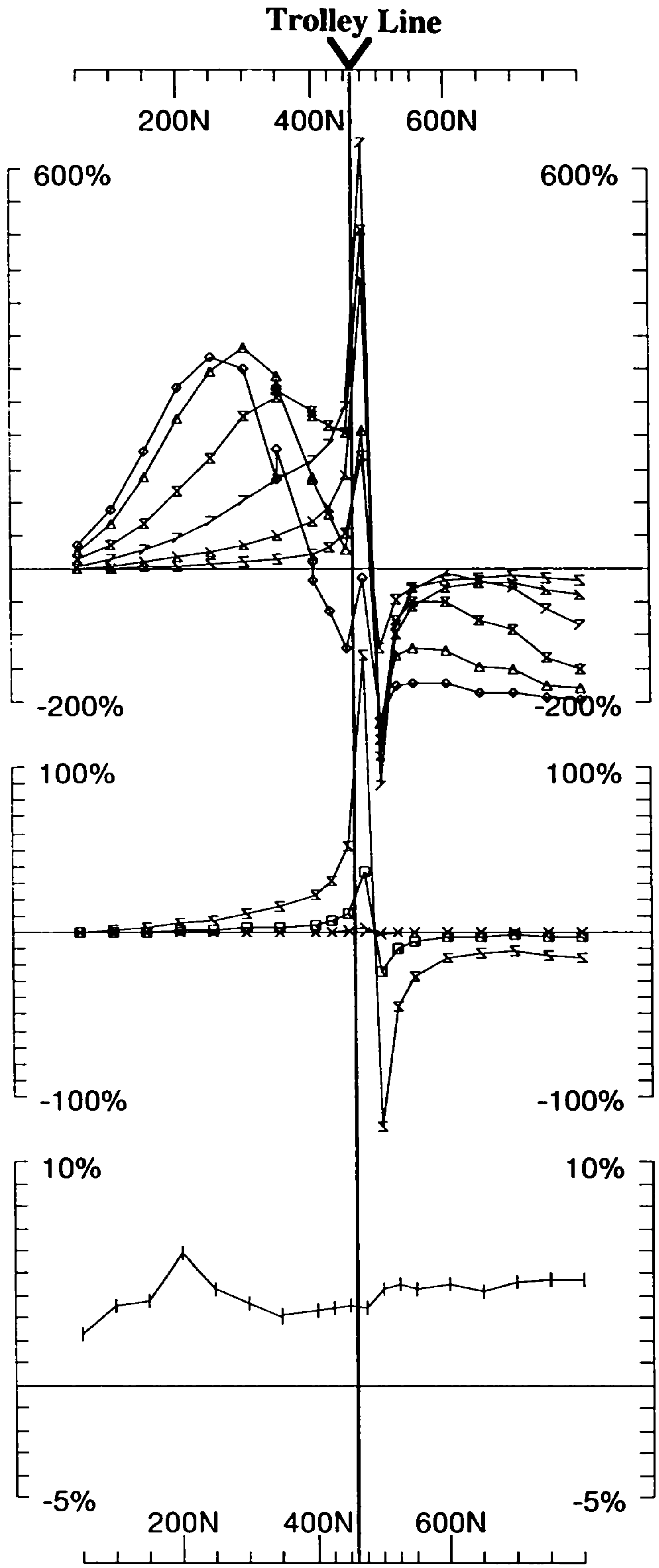
Raw (UnStripped) UTEM 3 Profiles

Raw (unstripped) UTEM 3 Profiles

The following is a list of the UTEM 3 profiles as they appear in this Appendix.
Notes: All point normalized plots are normalized at (450N,250W,0).

The location of the trolley line has been marked on the continuously normalized Hz plots.

Loop	Line	component	normalization
Loop 1	L1+00W	Hz	continuous
	L2+00W	Hz	continuous
	L2+00W	Hx	point
	L3+00W	Hz	continuous
	L4+00W	Hz	continuous
Loop 2	L2+00W	Hz	continuous
	L3+00W	Hz	continuous



UTEM Survey at: TROLLEY LINE PROPERTY

For: DAVE MEUNIER

LAMONTAGNE GEOPHYSICS LTD GEOPHYSIQUE LTEE

Job 9417

Plotted : 2/11/94

Secondary, (Chn - Ch1)/IHpI

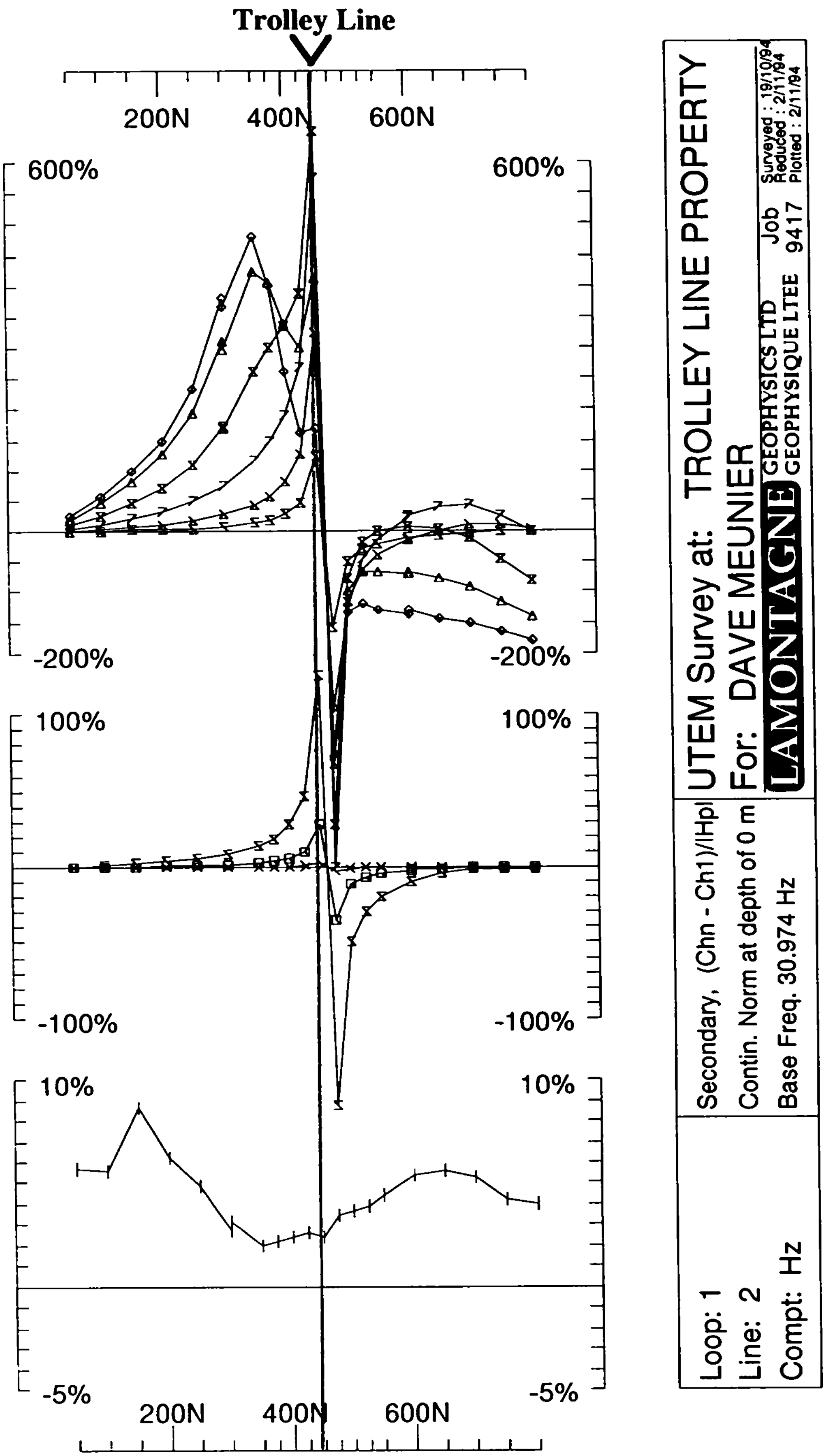
Contin. Norm at depth of 0 m

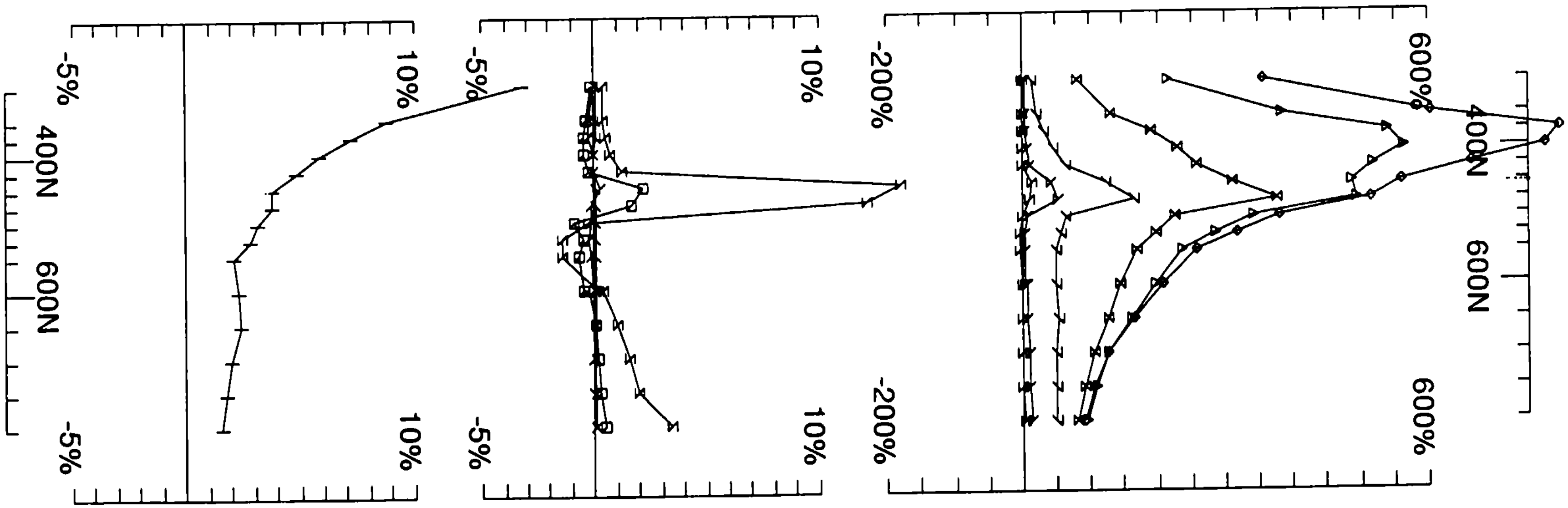
Base Freq. 30.974 Hz

Loop: 1

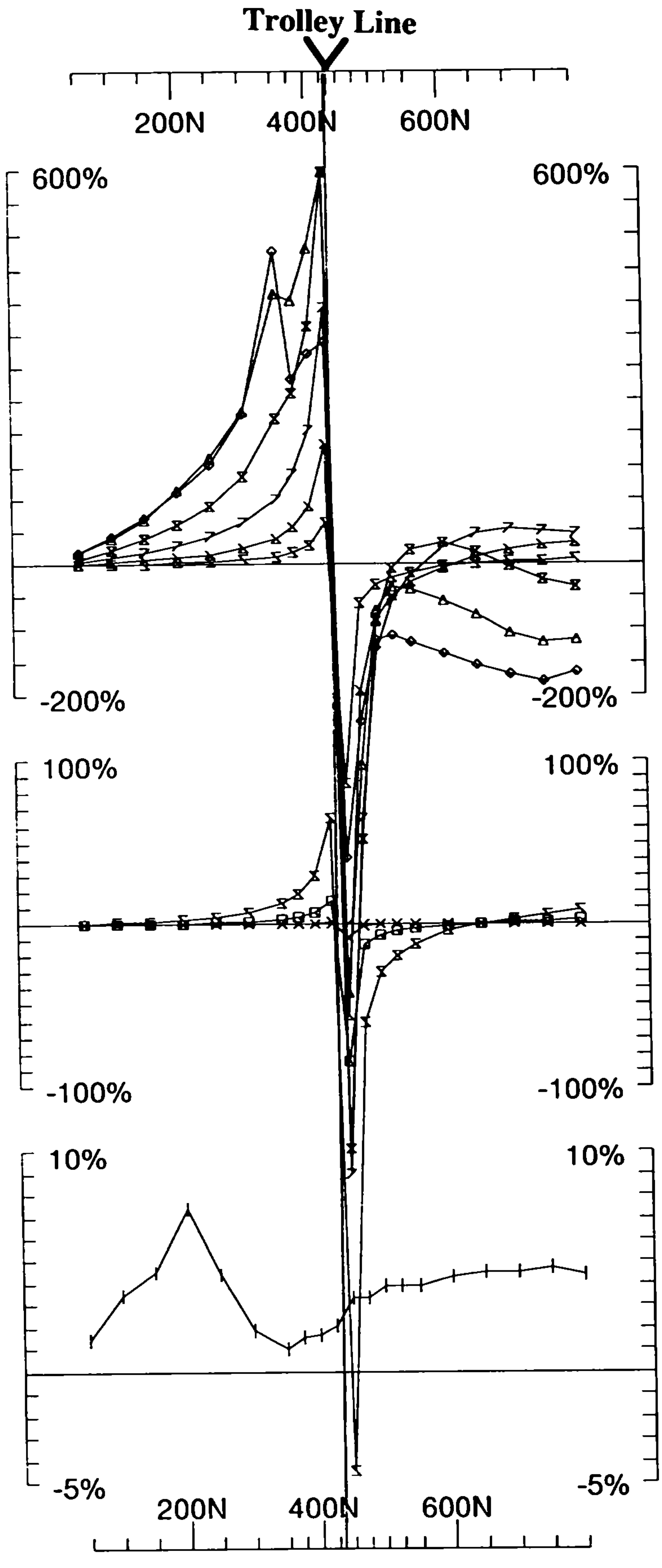
Line: 1

Compt: Hz


Trolley Line
200N
400N
600N
600%
600%
-200%
-200%
100%
100%
-100%
-100%
10%
10%
-5%
-5%
200N
400N
600N
UTEM Survey at: TROLLEY LINE PROPERTY
For: DAVE MEUNIER
LAMONTAGNE GEOPHYSICS LTD GEOPHYSIQUE LTEE
Job 9417
Surveyed : 19/10/94
Reduced : 2/11/94
Plotted : 2/11/94
Secondary, (Chn - Ch1)/IHpI
Contin. Norm at depth of 0 m
Base Freq. 30.974 Hz
Loop: 1
Line: 2
Compt: Hz



Loop: 1 Line: 2 Compt: Hx	Secondary, (Chn - Ch1)/lHpl Point Norm.at x,y,z (450,250,0) Base Freq. 30.974 Hz	UTEM Survey at: TROLLEY LINE PROPERTY For: DAVE MEUNIER LAMONTAGNE GEOPHYSICS LTD GEOPHYSIQUE LTEE Job 9417 Surveyed : 19/10/94 Reduced : 2/11/94 Plotted : 4/11/94



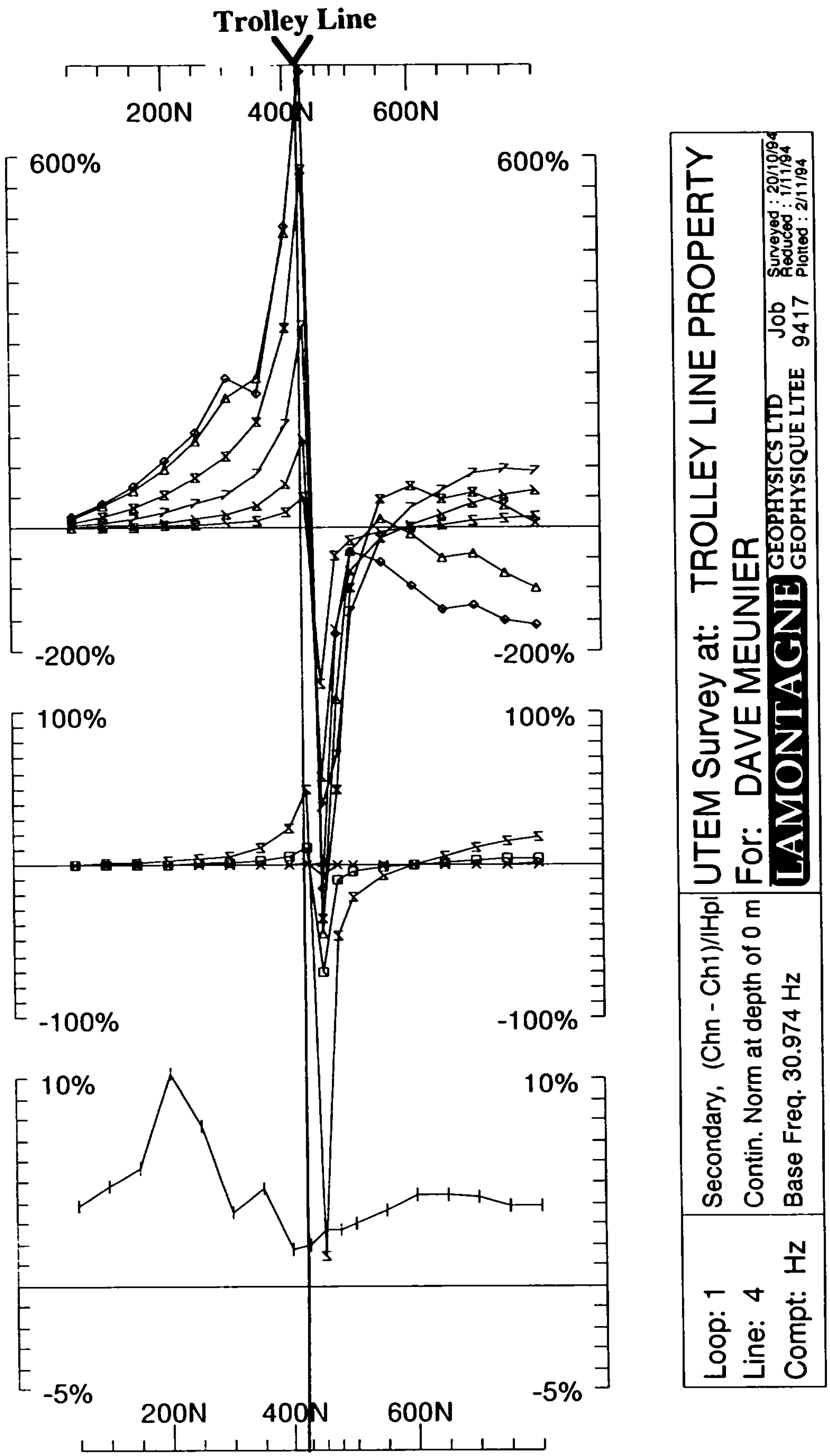
UTEM Survey at: TROLLEY LINE PROPERTY
For: DAVE MEUNIER
LAMONTAGNE GEOPHYSICS LTD GEOPHYSIQUE LTEE

Job 9417

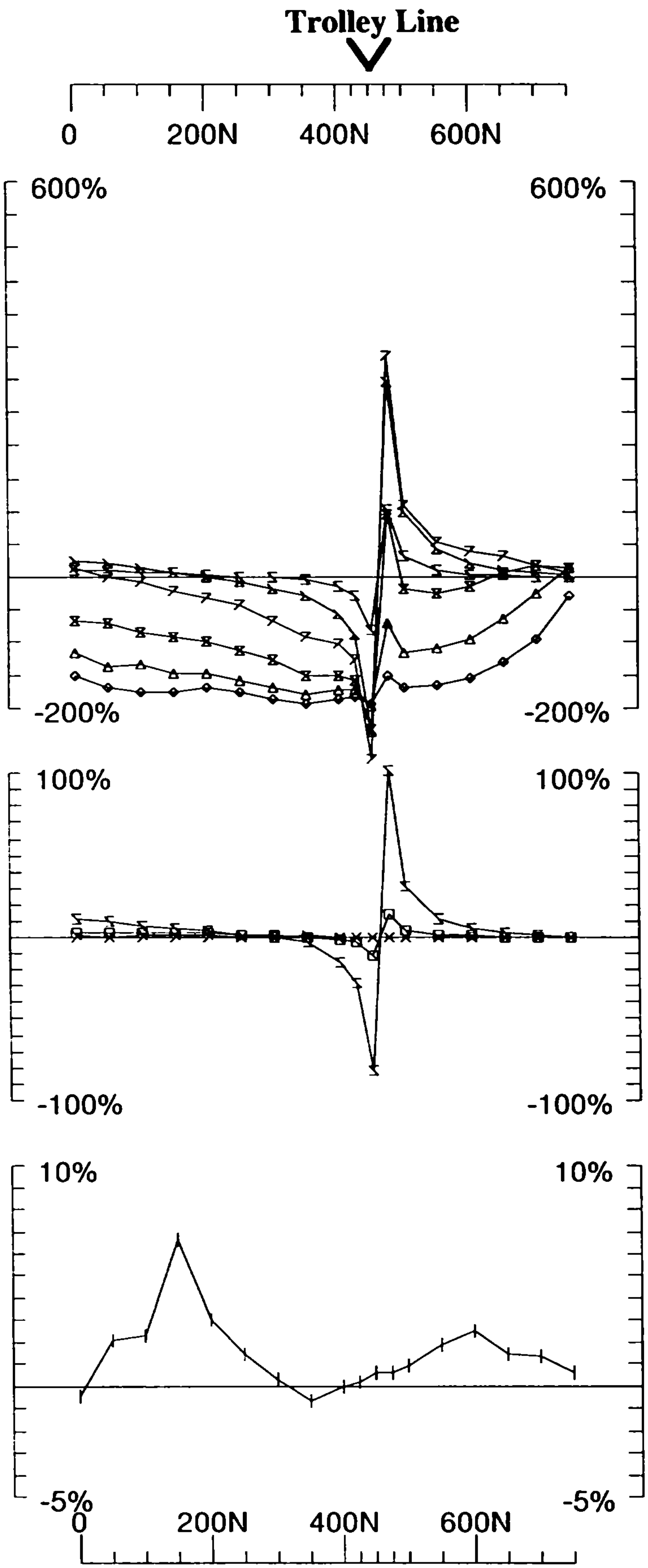
Surveyed : 19/10/94
Reduced : 1/11/94
Plotted : 2/11/94

Secondary, (Chn - Ch1)/IHpI
Contin. Norm at depth of 0 m
Base Freq. 30.974 Hz

Loop: 1
Line: 3
Compt: Hz



Trolley Line
200N
400N
600N
600%
600%
-200%
-200%
100%
100%
-100%
-100%
10%
10%
-5%
-5%
200N
400N
600N
UTEM Survey at: TROLLEY LINE PROPERTY
For: DAVE MEUNIER
LAMONTAGNE
GEOPHYSICS LTD
GEOPHYSIQUE LTEE
Job
9417
Surveyed : 20/10/94
Reduced : 1/11/94
Plotted : 2/11/94
Secondary, (Chn - Ch1)/|Hp|
Contin. Norm at depth of 0 m
Base Freq. 30.974 Hz
Loop: 1
Line: 4
Compt: Hz



UTEM Survey at: TROLLEY LINE PROPERTY

For: DAVE MEUNIER

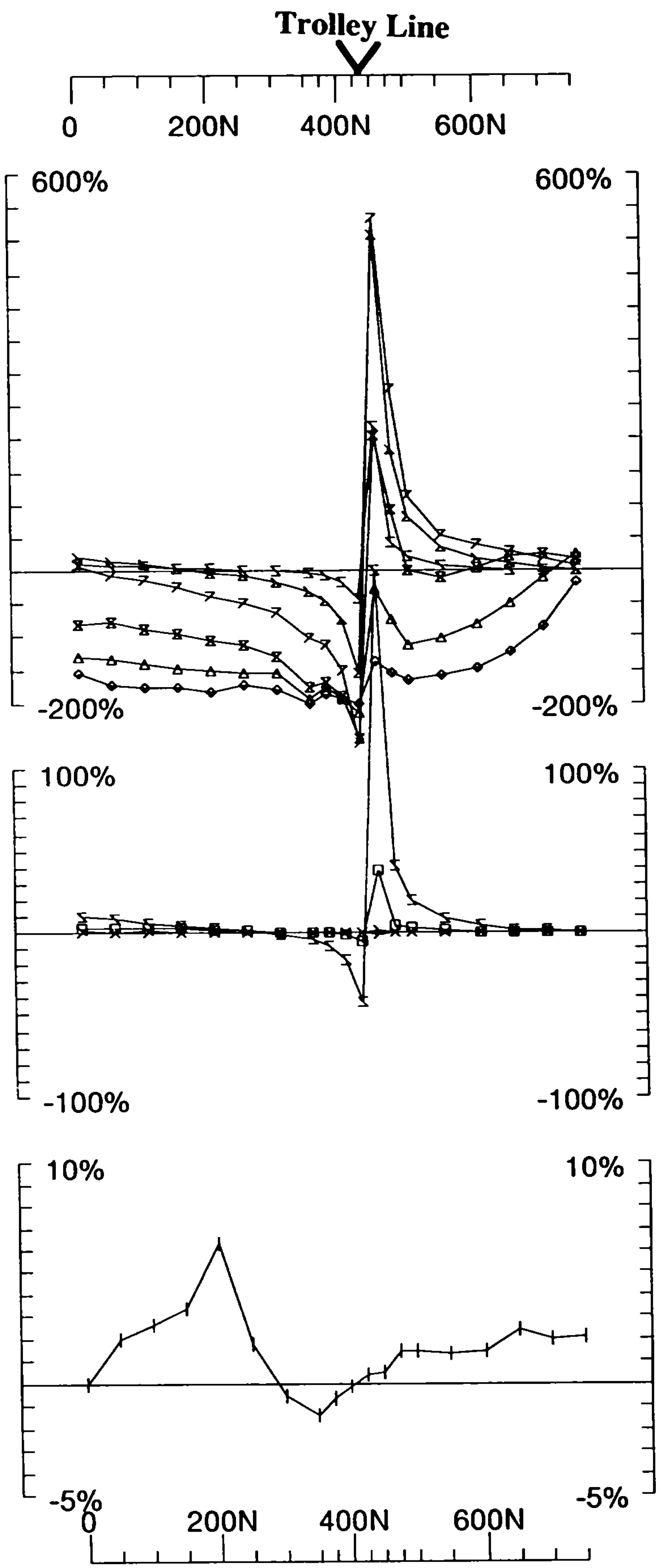
LAMONTAGNE GEOPHYSICS LTD GEOPHYSIQUE LTEE

Job 9417

Surveyed : 20/10/94
Reduced : 2/11/94
Plotted : 2/11/94

Secondary, (Chn - Ch1)/IHpl
Contin. Norm at depth of 0 m
Base Freq. 30.974 Hz

Loop: 2
Line: 2
Compt: Hz



UTEM Survey at: TROLLEY LINE PROPERTY

For: DAVE MEUNIER

LAMONTAGNE GEOPHYSICS LTD GEOPHYSIQUE LTEE

Job 9417

Surveyed : 20/10/94
Reduced : 2/11/94
Plotted : 2/11/94

Secondary, (Chn - Ch1)/lHpl
Contin. Norm at depth of 0 m
Base Freq. 30.974 Hz

Loop: 2
Line: 3
Compt: Hz

Appendix G

Qualifications Statement

Qualifications Statement

The following is a list of the UTEM 3 profiles as they appear in this Appendix.

I, **Robert John Langridge** of 1-162 King Street East, Kingston, Ontario certify that:

1) I am a graduate of Queen's University
   Degree: B.Sc.(Hons) Geology and Physics received 1978.

2) I am a graduate of the University if Toronto
   Degree: M.Sc. Physics received 1982.

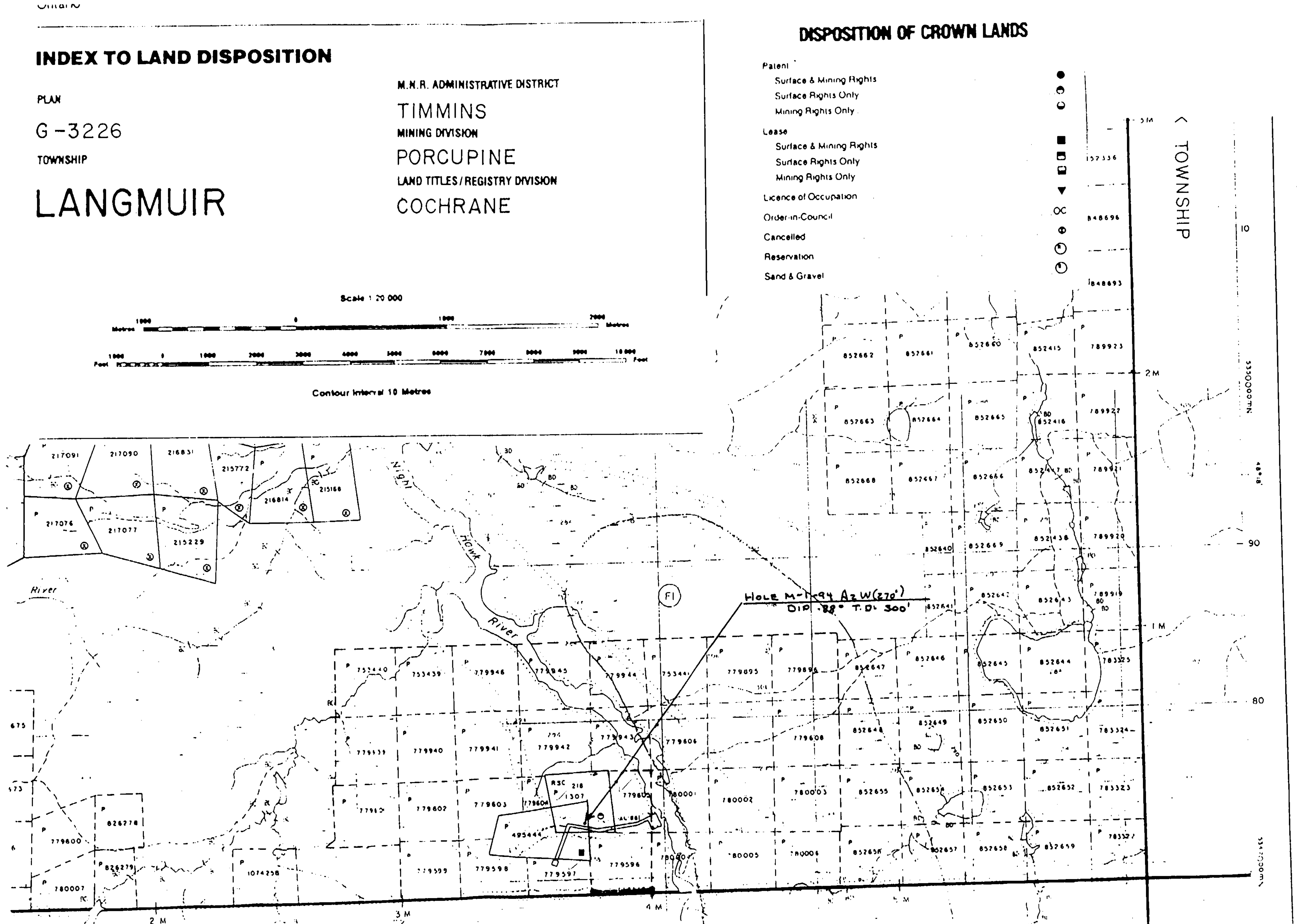
3) I have been practicing as a geophysicist since 1976.

4) I have no direct interest in the companies, leases or securities of Dave Meunier.

5)This report was prepared by me and is based on field work done by:
   Lamontagne Geophysics Ltd.
   115 Grant Timmins Drive, Kingston, Ontario

Robert Langridge

94.11.04
Date



CLAIM GROUP

CLAIMS ON WHICH SURVEY WAS PERFORMED

Ministry of Northern Development and Mines
Ontario

Report of Work Conducted After Recording Claim

Mining Act

Transaction Number: W9560.00354

2.16223

Personal information collected on this form is obtained under the authority of the Mining Act. This information will be used for correspondence. Questions about this collection should be directed to the Provincial Manager, Mining Lands, Ministry of Northern Development and Mines, Sudbury, Ontario, P3E 6A5, telephone (705) 670-7264.

Instructions:
- Please type or print and submit in duplicate.
- Refer to the Mining Act and Regulations for requirements of filing assessment work or consult the Mining Recorder.
- A separate copy of this form must be completed for each Work Group.
- Technical reports and maps must accompany this form in duplicate.
- A sketch, showing the claims the work is assigned to, must accompany this form.

42A07SW0001 2 16223 LANGMUIR

900

Recorded Holder(s): DAVID J. MEUNIER		Client No.: 169976
Address: 403 DOME ST. P.O. BOX 1624 S. PORCUPINE ONT. P0N-1H0		Telephone No.: 705-235-5426
Mining Division: PORCUPINE	Township/Area: LANGMUIR TWP	M or G Plan No.: 3226
Dates Work Performed From: JUNE 15.94	To: NOV. 1.94	

Work Performed (Check One Work Group Only)

	Work Group	Type
✓	Geotechnical Survey	LINECUTTING + U.T.EM SURVEY (DEEP EM)
	Physical Work, Including Drilling	
	Rehabilitation	
	Other Authorized Work	
	Assays	
	Assignment from Reserve	

RECEIVED
OCT 6 1995
Mining Lands Branch

Total Assessment Work Claimed on the Attached Statement of Costs $ 9700.00

Note: The Minister may reject for assessment work credit all or part of the assessment work submitted if the recorded holder cannot verify expenditures claimed in the statement of costs within 30 days of a request for verification.

Persons and Survey Company Who Performed the Work (Give Name and Address of Author of Report)

Name	Address
LAMONTAGNE GEOPHYSICS LTD	115 GRANT TIMMINS DR. KINGSTON ONT
GERRY LAFORTUNE	115 GRANT TIMMINS DR. KINGSTON ONT
MIKE MILLS ASSISTANT	BRUCE AVE. S. PORCUPINE ONT. P0N-1H0
DAVID MEUNIER	403 DOME ST. P.O. BOX 1624. S. PORC. ONT. P0N-1H0

(Attach a schedule if necessary)

Certification of Beneficial Interest * See Note No. 1 on reverse side

	Date	Recorded Holder or Agent (Signature)
I certify that at the time the work was performed, the claims covered in this work report were recorded in the current holder's name or held under a beneficial interest by the current recorded holder.	AUG 15.95	[signature]

Certification of Work Report

I certify that I have a personal knowledge of the facts set forth in this Work report, having performed the work or witnessed same during and/or after its completion and annexed report is true.

Name and Address of Person Certifying: 403 DOME ST. P.O. BOX 1624 S. PORCUPINE ONT. P0N-1H0

Telephone No.	Date	Certified By (Signature)
705 235-5426	AUG 15.95	[signature]

For Office Use Only

Total Value Cr. Recorded	Date Recorded	Mining Recorder	Received Stamp
9700.		unaided Gary White	RECEIVED (c) AUG 16 1995 TB 2:30 PORCUPINE MINING DIVISION
	Deemed Approval Date: Nov 14/95	Date Approved	
	Date Notice for Amendments Sent		

(03/91)

Work Report Number for Applying Reserve	Claim Number (see Note 2)	Number of Claim Units	Value of Assessment Work Done on this Claim	Value Applied to this Claim	Value Assigned from this Claim	Reserve: Work to be Claimed at a Future Date
	P.779605	1	$4850.00	$400.00	$4450.00	
	P.779596	1	$4850.00	$400.00	$1550.00	$2900.00
	P.779604	1		$400.00		
	P-779597	1		$400.00		
	P.779606	1		$400.00		
	P.780004	1		$400.00		
	P-780005	1		$400.00		
	P-780006	1		$400.00		
	P.779944	1		$400.00		
	P-779945	1		$400.00		
	P-779946	1		$400.00		
	P-753440	1		$400.00		
	P-779939	1		$400.00		
	P-779940	1		$400.00		
	P-779602	1		$400.00		
	P-779601	1		$400.00		
	P-779599	1		$400.00		
	Total Number of Claims		Total Value Work Done $9700.00	Total Value Work Applied 6800.00	Total Assigned From 6000.00	Total Reserve $2900.00

Credits you are claiming in this report may be cut back. In order to minimize the adverse effects of such deletions, please indicate from which claims you wish to priorize the deletion of credits. Please mark (✓) one of the following:

1. ☐ Credits are to be cut back starting with the claim listed last, working backwards.
2. ☐ Credits are to be cut back equally over all claims contained in this report of work.
3. ☐ Credits are to be cut back as priorized on the attached appendix.

In the event that you have not specified your choice of priority, option one will be implemented.

Note 1: Examples of beneficial interest are unrecorded transfers, option agreements, memorandum of agreements, etc., with respect to the mining claims.

Note 2: If work has been performed on patented or leased land, please complete the following:

I certify that the recorded holder had a beneficial interest in the patented or leased land at the time the work was performed.	Signature [signature]	Date Aug 16 95

Northern Development and Mines
Ontario

Ministère du Développement du Nord et des mines

Statement of Costs for Assessment Credit

État des coûts aux fins du crédit d'évaluation

Mining Act/Loi sur les mines

Transaction No./N° de transaction W9560.00354

2.16228

Personal information collected on this form is obtained under the authority of the **Mining Act**. This information will be used to maintain a record and ongoing status of the mining claim(s). Questions about this collection should be directed to the Provincial Manager, Minings Lands, Ministry of Northern Development and Mines, 4th Floor, 159 Cedar Street, Sudbury, Ontario P3E 6A5, telephone (705) 670-7264.

Les renseignements personnels contenus dans la présente formule sont recueillis en vertu de la **Loi sur les mines** et serviront à tenir à jour un registre des concessions minières. Adresser toute quesiton sur la collece de ces renseignements au chef provincial des terrains miniers, ministère du Développement du Nord et des Mines, 159, rue Cedar, 4e étage, Sudbury (Ontario) P3E 6A5, téléphone (705) 670-7264.

1. Direct Costs/Coûts directs

Type	Description	Amount Montant	Totals Total global
Wages Salaires	Labour Main-d'oeuvre	$1900.00	
	Field Supervision Supervision sur le terrain	800.00	$2700.00
Contractor's and Consultant's Fees Droits de l'entrepreneur et de l'expert-conseil	Type GEOPHYSICAL	$6000.00	
			$6000.00
Supplies Used Fournitures utilisées	Type		
Equipment Rental Location de matériel	Type		
		Total Direct Costs Total des coûts directs	$8700.00

2. Indirect Costs/Coûts indirects

** **Note:** When claiming Rehabilitation work Indirect costs are not allowable as assessment work.
Pour le remboursement des travaux de réhabilitation, les coûts indirects ne sont pas admissibles en tant que travaux d'évaluation.

Type	Description	Amount Montant	Totals Total global
Transportation Transport	Type		
Food and Lodging Nourriture et hébergement			
Mobilization and Demobilization Mobilisation et démobilisation	COST OF MOVING GEOPHYSICAL CREW FROM KINGSTON TO TIMMINS TO KIRKLAND [illegible]		1000.00
		Sub Total of Indirect Costs Total partiel des coûts indirects	1000.00
		Amount Allowable (not greater than 20% of Direct Costs) Montant admissible (n'excédant pas 20 % des coûts directs)	$1000.00
		Total Value of Assessment Credit (Total of Direct and Allowable Indirect costs) Valeur totale du crédit d'évaluation (Total des coûts directs et indirects admissibles)	$9700.00

Note: The recorded holder will be required to verify expenditures claimed in this statement of costs within 30 days of a request for verification. If verification is not made, the Minister may reject for assessment work all or part of the assessment work submitted.

Note : Le titulaire enregistré sera tenu de vérifier les dépenses demandées dans le présent état des coûts dans les 30 jours suivant une demande à cet effet. Si la vérification n'est pas effectuée, le ministre peut rejeter tout ou une partie des travaux d'évaluation présentés.

Filing Discounts

1. Work filed within two years of completion is claimed at 100% of the above Total Value of Assessment Credit.
2. Work filed three, four or five years after completion is claimed at 50% of the above Total Value of Assessment Credit. See calculations below:

Total Value of Assessment Credit		Total Assessment Claimed
	× 0.50 =	

Remises pour dépôt

1. Les travaux déposés dans les deux ans suivant leur achèvement sont remboursés à 100 % de la valeur totale susmentionnée du crédit d'évaluation.
2. Les travaux déposés trois, quatre ou cinq ans après leur achèvement sont remboursés à 50 % de la valeur totale du crédit d'évaluation susmentionné. Voir les calculs ci-dessous.

Valeur totale du crédit d'évaluation		Évaluation totale demandée
	× 0,50 =	

RECEIVED (c) AUG 16 1995 TB 2:30 ...S DIVISION

Certification Verifying Statement of Costs

I hereby certify:
that the amounts shown are as accurate as possible and these costs were incurred while conducting assessment work on the lands shown on the accompanying Report of Work form.

that as RECORDED HOLDER (Recorded Holder, Agent, Position in Company) I am authorized

to make this certification

Attestation de l'état des coûts

J'atteste par la présente :
que les montants indiqués sont le plus exact possible et que ces dépenses ont été engagées pour effectuer les travaux d'évaluation sur les terrains indiqués dans la formule de rapport de travail ci-joint.

Et qu'à titre de ______ (titulaire enregistré, représentant, poste occupé dans la compagnie) je suis autorisé

à faire cette attestation.

Signature	Date
[signature]	Aug 15-95

0212 (04/91)

Nota : Dans cette formule, lorsqu'il désigne des personnes, le masculin est utilisé au sens neutre.

Ontario

Ministry of
Northern Development
and Mines

Ministère du
Développement du Nord
et des Mines

Geoscience Approvals Section
933 Ramsey Lake Road
6th Floor
Sudbury, Ontario
P3E 6B5

Telephone: (705) 670-5853
Fax: (705) 670-5863

October 12, 1995

Our File: 2.16223
Transaction #: W9560.00354

Mining Recorder
Ministry of Northern Development & Mines
60 Wilson Avenue, 1st floor
Timmins, Ontario
P4N 2S7

Dear Mr. White:

Subject: APPROVAL OF ASSESSMENT WORK CREDITS ON MINING CLAIMS 779605 & 779596 IN LANGMUIR TOWNSHIP

Assessment credits have been approved as outlined on the report of work form. The credits have been approved under Section 14 (Geophysical) of the Mining Act Regulations.

The approval date is October 12, 1995.

If you have any questions regarding this correspondence, please contact Steven Beneteau at (705) 670-5855.

Yours sincerely,

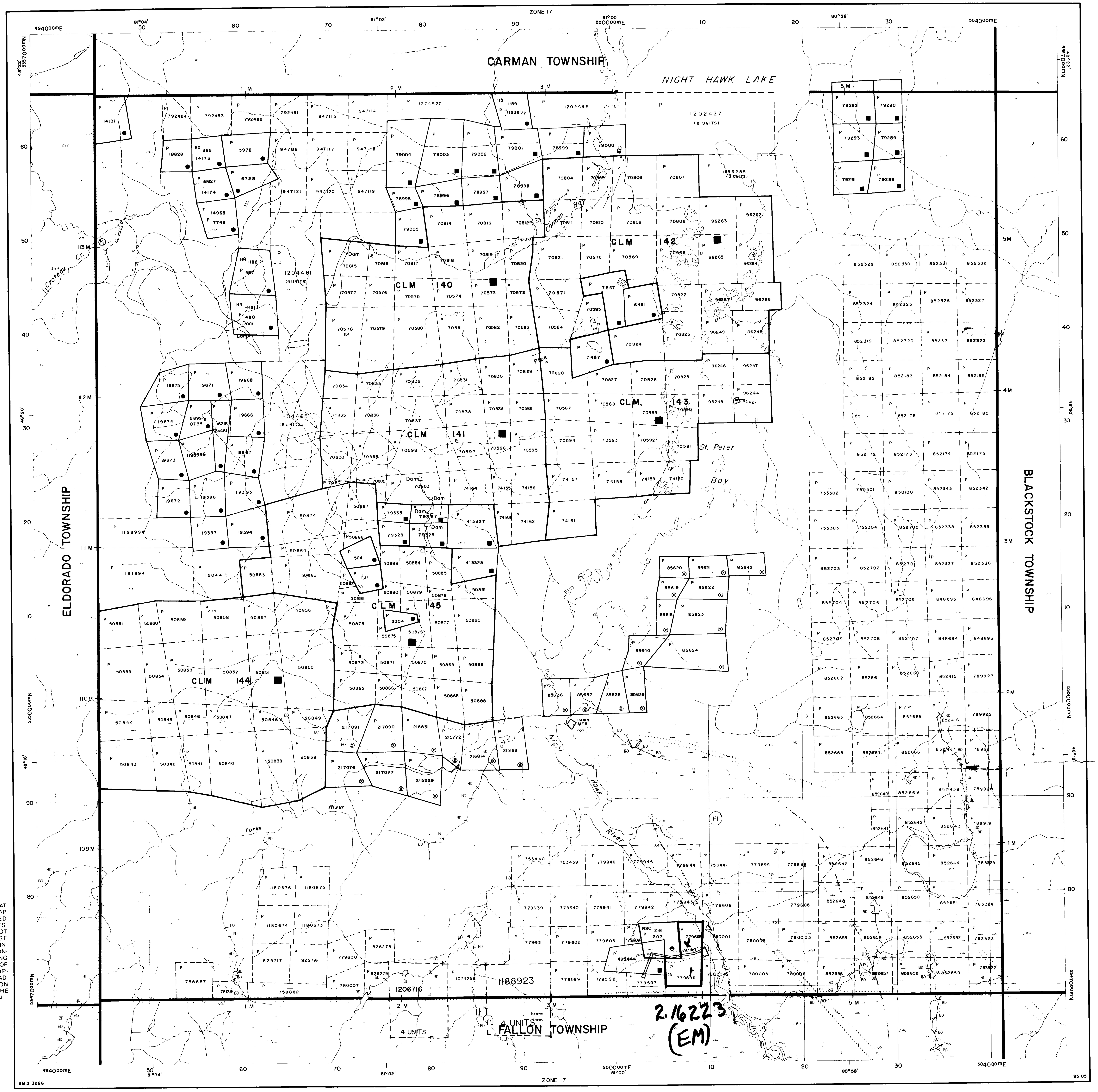
Ron C. Gashinski
Senior Manager, Mining Lands Section
Mining and Land Management Branch
Mines and Minerals Division

SBB SBB/sb

cc: Resident Geologist
Timmins, Ontario

Assessment Files Library
Sudbury, Ontario

G-3226



THE INFORMATION THAT APPEARS ON THIS MAP HAS BEEN COMPILED FROM VARIOUS SOURCES, AND ACCURACY IS NOT GUARANTEED. THOSE WISHING TO STAKE MINING CLAIMS SHOULD CONSULT WITH THE MINING RECORDER, MINISTRY OF NORTHERN DEVELOPMENT AND MINES, FOR ADDITIONAL INFORMATION ON THE STATUS OF THE LANDS SHOWN HEREON.

Ministry of Natural Resources
Ministry of Northern Development and Mines
Ontario

INDEX TO LAND DISPOSITION

PLAN
G-3226
TOWNSHIP
LANGMUIR

M.N.R. ADMINISTRATIVE DISTRICT
TIMMINS
MINING DIVISION
PORCUPINE
LAND TITLES/REGISTRY DIVISION
COCHRANE

Scale 1:20 000

Contour Interval 10 Metres

OCT 05 1995
PORCUPINE MINING DIV.

SYMBOLS

Boundary
Township, Meridian, Baseline
Road allowance; surveyed
shoreline
Lot/Concession; surveyed
unsurveyed
Parcel; surveyed
unsurveyed
Right-of-way; road
railway
utility
Reservation
Cliff, Pit, Pile
Contour
Interpolated
Approximate
Depression
Control point (horizontal)
Flooded land
Mine head frame
Pipeline (above ground)
Railway; single track
double track
abandoned
Road; highway, county, township
access
trail, bush
Shoreline (original)
Transmission line
Wooded area

AREAS WITHDRAWN FROM DISPOSITION

MRO - Mining Rights Only
SRO - Surface Rights Only
M + S - Mining and Surface Rights

Description	Order No.	Date	Disposition	File
(R) APPLICATION PENDING UNDER P L A.—SURFACE RIGHT WITHDRAWN				

(FI) THIS TWP IS SUBJECT TO FOREST ACTIVITY IN 1995-96. FURTHER INFORMATION AVAILABLE ON FILE.

NOTES

THIS TOWNSHIP LIES WITHIN THE MUNICIPALITY OF THE CITY OF TIMMINS

FLOODING RIGHTS ON NIGHT HAWK LAKE TO THE CONTOUR ELEVATION 903 5 RESERVED TO ONT HYDRO.

DISPOSITION OF CROWN LANDS

Patent
Surface & Mining Rights
Surface Rights Only
Mining Rights Only
Lease
Surface & Mining Rights
Surface Rights Only
Mining Rights Only
Licence of Occupation
Order-in-Council OC
Cancelled
Reservation
Sand & Gravel

ACTIVATED JULY 18, 1995 BY:

Map base and land disposition drafting by Surveys and Mapping Branch, Ministry of Natural Resources.

The disposition of land, location of lot fabric and parcel boundaries on this index was compiled for administrative purposes only.

95 05

LANGMUIR TWP.

42A07SW0001 2.16223 LANGMUIR

200