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ApendixB Reports on GPS survey Vakkerlien
ApendixC Logistic Report 2005 UTEM survey Vakkerlien
ApendixD In House UTEM Maxwell Modelling Vakkerlien

2 stk CDer ligger vedlagt: Vakkerlien GPS 2005 og 2005 UTEM Survey 0531 Data and Logistic Report

2005 Fall Ground Geophysical Program
Vakkerlien Project

Hedemark County, Norway

P. Tirschmann
Falconbridge Limited

On behalf of
Sulfidmalm A/S

February 27, 2006

SUMMARY AND CONCLUSIONS

This report gives the details and results of a ground geophysical program carried out on the Vakkerlien project in the fall of 2005. The project is located approximately 300km north of Oslo and 90km south of Trondheim in central Norway and is an option and joint venture between Sulfidmalm A/S (Norway), a wholly-owned subsidiary of Falconbridge Limited, and Blackstone Ventures Inc. (Canada). Exploration programs are carried out by Falconbridge Limited on behalf of Sulfidmalm.

The Vakkerlien project area is underlain by Gula group supracrustal and intrusive rocks within the central Norwegian Caledonides. This region host the Vakkerlien nickel deposit (400,000 tonnes grading 1.0% Ni & 0.4% Cu) as well as the Olkar and Kaltberget nickel occurrences.

In order to evaluate nickel sulphide potential in the Vakkerlien area, a 3,750 line km helicopter-borne magnetic and frequency domain electromagnetic survey was contracted out to the NGU and flown in June of 2004. A ground follow-up and prospecting program was carried out during June and July of the same year. The airborne survey and ground follow-up identified areas of interest east and south of the Vakkerlien deposit and a ground geophysical program was subsequently planned.

The 2005 fall ground geophysical program was carried out during the period October 3rd to November 26th, 2005 and consisted of 50.45 line km of gridding and UTEM surveying. A bamboo picket grid was established by McKeown Exploration Services (Canada) using a differential global positioning system (DGPS), base station and repeater. Grids lines were spaced 100-200m apart. The UTEM surveying was carried out by Lamontagne Geophysics Limited (Canada). Measurements were taken at station intervals of either 25m or 50m depending on survey logistics and noise levels.

The UTEM survey identified a two-line UTEM response flanking the west side of the hook-shaped magnetic feature which is situated immediately east of the Vakkerlien deposit. In-house modeling by A. Watts outlined a UTEM plate with a conductance of 2000 siemens, a strike extent of 300m, a dip extent of 400m and a 53° east dip. This anomaly represents a viable drill target and drill testing is planned for 2006.

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Appendix D: In-house UTEM Maxwell Modeling, Vakkerlien Project, Norway. **Anthony Watts**, Falconbridge Ltd for Sulfidmalm A/S.

1.0 Location, Topography and General Access

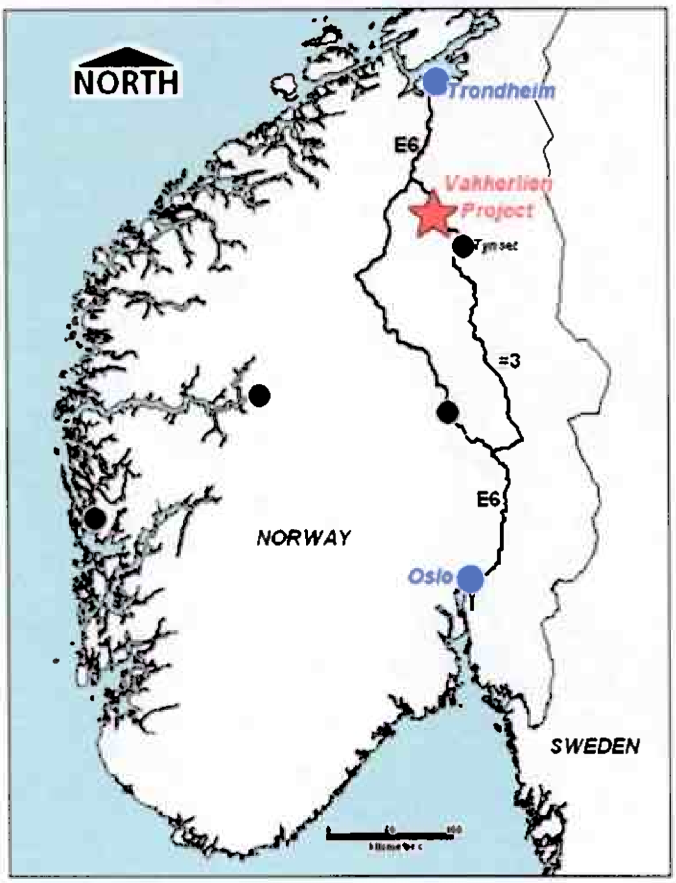
The Vakkerlien project area is located 300 km north of Oslo and 90km south of Trondheim in central Norway. The project is situated within Tynset kommune, Hedemark fylke and is easily accessible by car via the E6 and #3 highways north from Oslo or south from Trondheim (Figure 1).

The Orkla River transects the center of the project area and represents a prominent topographic low (440-700m) in the region. The ground rises steeply to the east and west of the Orkla River with local mountain peaks up to 1400m in elevation. Much of the project area has either open deciduous forest cover or is above the tree line. The Vakkerlien deposit is situated on a broad, relatively flat plateau just at the tree line with an average elevation of 900m. Elevation in the work area ranges from 750-1,000m.

Access to the field area is good via highway #3 and a well-developed system of secondary gravel roads and hiking trails. Tolls must be paid for access along many of the local gravel roads. The following two secondary roads were used to access the work area:

- road located approx. 6.5 km south of Kvikne extending west off of highway #3 past the Vakkerlien deposit (toll required)
- road located approx. 13.5km south of Kvikne extending west off of highway #3 and running along the north side of the Orkla river.

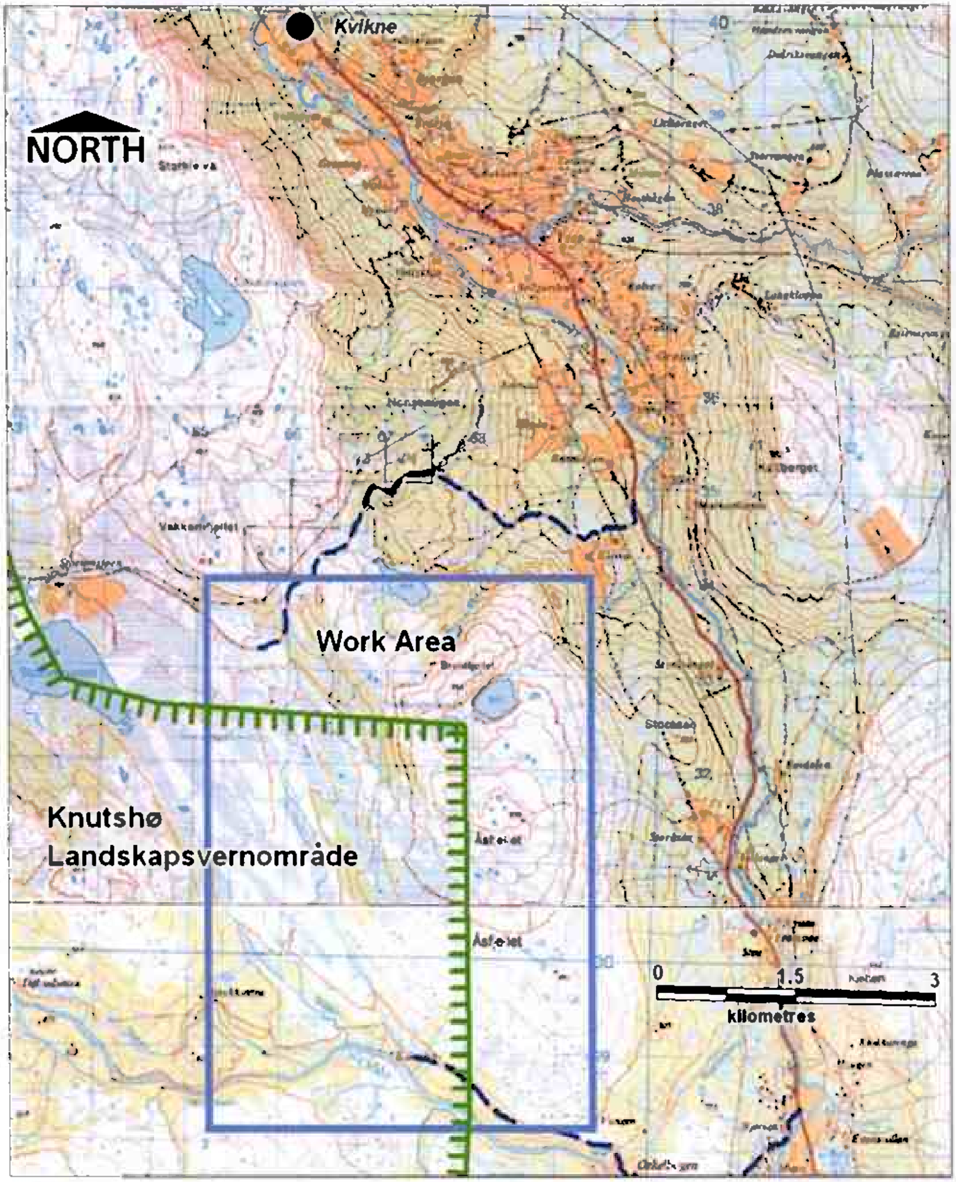
Figure 1
Vakkerlien Project – Location



2.0 Land Access Issues

Land in the work area is held by private landowners as well as collective groups ("sameie"). Permission for the off-road use of snowmobiles was required from both the local kommune and the landowners. In addition, approximately half of the planned geophysical grid was situated within the Knutshø Landskapsvernområde or "landscape protected area" as shown in Figure 2. Although permission for the use of snowmobiles was received from Tynset kommune, use was restricted to pre-authorized access routes *external* to the Knutshø Landskapsvernområde. This significantly complicated the logistics of the ground work and added to the time and cost of surveying. In extreme cases, the survey equipment had to be moved manually by wheelbarrow or sled.

Figure 2
Location of Knutshø Landskapsvernområde in Relation to Work Area



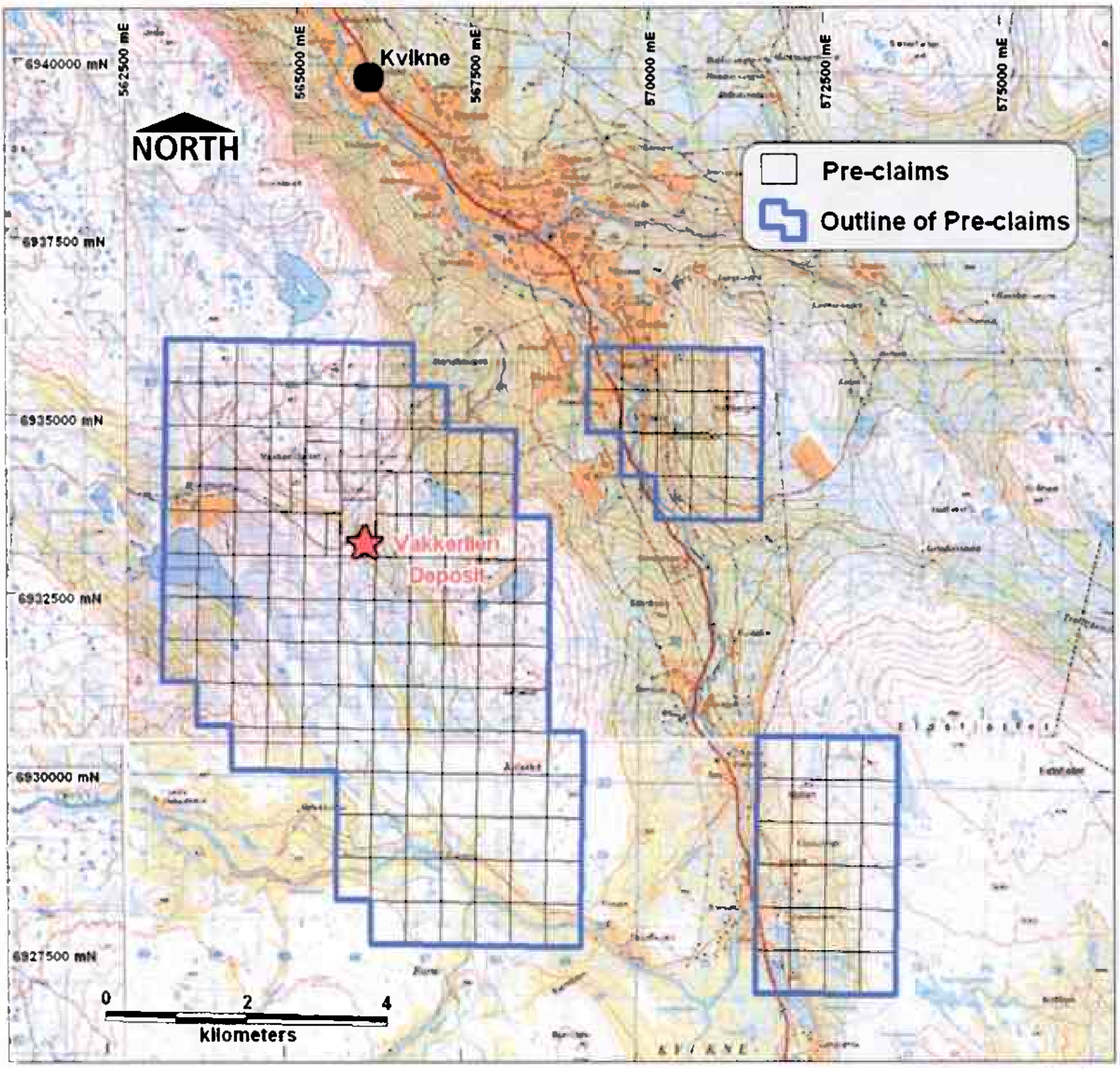
UTM WGS84 Zone 32N

3.0 Property and Ownership

The Vakkerlien property, at the time the work reported herein was performed, consisted of 173 pre-claims or "mutinger" in three separate blocks collectively covering a total area of 50.1 sq km (Figure 3). (The claim block has since been reduced to 126 pre-claims totalling 36 sq km). The pre-claims are registered to Sulfidmalm A/S (Norway), a wholly owned subsidiary of Falconbridge Nikkleverk (Norway) which is owned by Falconbridge Limited (Canada). Exploration on the project is carried out under an option and joint venture agreement between Sulfidmalm A/S and Blackstone Ventures Inc. (Canada). Work programs are carried out by Falconbridge Limited on behalf of Sulfidmalm.

NOTE: Pre-claims owned by a third party over part of the Vakkerlien deposit were allowed to lapse in 2005 and, therefore, pre-claims registered to Sulfidmalm A/S now take precedence.

Figure 3
Vakkerlien Project – Pre-claims



UTM WGS84 Zone 32N

4.0 Geological Setting

The Vakkerlien project is underlain by Gula group lithologies of the central Norwegian Caledonides. The Gula group forms the oldest part of the Trondheim nappe and is thought to be Proterozoic in age. Main lithologies include metasediments in the form of psammitic, pelitic, calcareous and graphitic schists as well as iron formations, metavolcanics (amphibolites), trondjemitic intrusions and occasional gabbroic to ultramafic intrusions. The metamorphic grade is middle to upper amphibolite facies.

A number of deposits are hosted in the Gula group including the Vakkerlien nickel sulphide deposit (400,000 tonnes grading 1.0% Ni & 0.4% Cu) discovered by Sulfidmalm A/S in 1974. The deposit is hosted in the core of a differentiated gabbroic to ultramafic intrusion and forms a plunging rod-shaped (10m x 40m) zone which can be traced laterally for 1,250m.

Other nickel occurrences in the area include the Kaltberget showing and the Olkar mine.

5.0 Previous Work

Past copper-zinc focused mining and exploration activity in the Kvikne-Tynset area is voluminous and a detailed summary is beyond the scope of this report. Abundance evidence of surface prospecting can be seen in the form of old pits and trenches.

Several older vintage airborne geophysical surveys flown at 200m line spacing covered portions of the current exploration area and include the following:
- 1974 helicopter-borne Sander EM-3 and mag survey
- 1979 helicopter-borne Sander EM-3, mag, radiometric and VLF survey
- 1981 helicopter-borne EM, mag and VLF survey

Sulfidmalm A/S initiated exploration in the area for Besshi-type VMS deposits in the early 1970's. This program included regional stream sediment sampling as well as prospecting and lithogeochemical sampling, the latter of which led to the discovery of the Vakkerlien deposit in 1974. During the course of sampling pits at the historical Vakkerlien showing for copper and zinc mineralization, Sulfidmalm obtained grab samples assaying up to 3.02% Ni. Subsequent work by Sulfidmalm concentrated on delineation of the Vakkerlien deposit and on exploration in the immediate vicinity as summarized in Table 1.A small amount of nickel-related exploration was also carried out concurrently at several other sites in the Kvikne area as summarized in Table 2.

Table 1
Summary of Work Completed over the Vakkerlien Deposit and Immediate Area

Period	Company	Description of Work
1975-1977	Sulfidmalm A/S	• 109 holes drilled and a **resource of 400,000 tonnes grading 1.0% Ni & 0.4% Cu** delineated using a 0.4% Ni cut-off • Metallurgical testing yielding a **concentrate grading 15.5% Ni @ 80% recovery and 7.0% Cu @ 92% recovery**
1975	Sulfidmalm A/S	• Surface geophysical surveys including magnetics, VLF, Slingram, Mise-la-Masse, resistivity sounding and Turam to try and trace deposit along strike and down plunge to SE
1979	Sulfidmalm A/S	• Max-Min and Crone PEM test surveys
1991-1992	Folldall Verk A/S & Outokumpu (Norsulfid A/S) Joint Venture	• 100 holes drilled on deposit on sections between Sulfidmalm holes to confirm resource • **Resource estimated to be 104,516 tonnes grading 1.73% Ni, &0.55% Cu using a 0.5% Ni cut-off *or* 52,132 tonnes grading 2.55% Ni & 0.80% Cu using a 1.0% Ni cut-off**

Table 2
Summary of Work Completed by Sulfidmalm A/S at Selected Locations in the Kvikne Area Prior to 2002

Period	Area	Description of Work/Results
1975-1976	Olkar	• Grab samples from dump pile taken; best sample assayed 1.5% Ni, 1.6% Cu & 23.6% S • VLF and magnetic survey • Geological mapping and prospecting • 6 drillholes totaling 269.9m; best result of **1.78% Ni, 1.18% Cu and 22.5% S over 1.5m in DDH2**
1976-1977	Kaltberget	• Geological mapping, ground mag & VLF survey • Discovered Grötberget showing with grab samples up to 2.1% Ni & 1.12% Cu • 1976: 13 drillholes totaling 609.95m; best result of **1.60% Ni, 0.30% Cu & 7.5% S over 5.5m in DDH12** • Surface and downhole charge potential surveys • 1977: 4 drillholes totaling 324.1m; best result of **1.55% Ni, 0.48% Cu & 11.2% S over 0.5m in DDH 17**
1977	Kletten	• chip sampling (no significant values) and VLF survey
1979	Regional	• helicopter survey; magnetic and single frequency (1000Hz) Sander EM data collected on 200m spaced lines

6.0 Recent Work by Sulfidmalm A/S

Falconbridge geologists made a reconnaissance visit to the Vakkerlien area in late 2002. In early 2003, Sulfidmalm acquired new pre-claims in the area and initiated nickel sulphide exploration, signing an option and joint venture arrangement with Blackstone Ventures Inc. in August 2003.

In June 2004, Sulfidmalm commissioned the Geological Survey of Norway (NGU) to fly a 3,750 line km regional helicopter-borne magnetics and electromagnetic (EM) survey. Data was acquired on east-west oriented flight lines spaced 150m apart with a nominal flying height of 60m above ground level. The EM system used was the 5-frequency Geotech Ltd. Hummingbird system. A ground EM follow-up and prospecting program was carried out during June and July 2004. The preceding work is described in Tirschmann (2005).

The airborne survey identified a number of strong, laterally continuous EM conductors typically associated with strong magnetic highs and occurring in the central and eastern portions of the survey block. Field checking of a number of these anomalies found them to be associated with sulphidic and/or graphitic metasediments.

The northwestern portion of the airborne survey block was characterized by subtle EM conductors and more discrete NW-SE and N-S striking magnetic highs superimposed on a rather featureless low to moderately magnetic background. All of the well-known nickel occurrences (Vakkerlien, Olkar & Kaltberget) were observed to be situated within this geophysical domain. Ground follow-up and prospecting on one 300m long EM anomaly in the immediate area of the old Olkar mine found the anomaly to correlate with apparent sulphidic sediments assaying **0.62% Ni, 0.53% Cu, 0.13% Co, 0.02 g/t Pt, 0.08 g/t Pd & 19.1% S.** The new airborne data also showed the presence of weak EM conductors correlated with a subtle 1km long magnetic trend in the Kalberget area.

In the vicinity of the Vakkerlien deposit, the new airborne survey detected only weak EM anomalies. However, several interesting magnetic anomalies were identified including the following:

- a NW trending hook-shaped magnetic anomaly situated immediately east of the Vakkerlien deposit, possibly representing a folded extension of the host intrusion
- a large (1.5km x 2km) magnetic high located 1km south of Vakkerlien
- 2nd large (0.7km x 1km) magnetic high with a coincident subtle EM response located 3km SE of Vakkerlien

Field-checking of these magnetic features was hampered by thick overburden. However, boulders and float of altered ultramafic rocks were found at the anomaly situated 1km south of Vakkerlien. The two large magnetic features were postulated to represent ultramafic intrusions, potentially related to the same magmatic system which formed the Vakkerlien deposit. A ground UTEM (University of Toronto Electromagnetic System) survey was subsequently planned to test all three magnetic features.

Ground follow-up in the Olkar and Kalberget areas, though merited, was deferred due to complicated logistics, challenging topography and limited in-house resources.

7.0 2005 Fall Ground Geophysics Program

During the period October 3rd to November 26th 2005, a fall work program consisting of 50.45km line km of gridding and UTEM geophysical surveying was carried out (Figure 4). A list of field personnel involved in the program can be found in Appendix A.

Grid Preparation

The grid was established by McKeown Exploration Services, with the help of Falconbridge and Sulfidmalm personnel, between October 3rd and October 16th. The gridding team consisted of one operator and two helpers. Gridding was accomplished using a real-time differential global positioning system (DGPS) and local base station ± repeater. DGPS control was used on both the grid and the geophysical loops in order to provide the location and elevation (x, y & z) accuracy required for detailed geophysical modelling.

The grid variably consisted of N-S and E-W oriented lines spaced 100-200m apart with stations set at 25m intervals along each line and marked by thin bamboo pickets (Figure 5). The grid reference system used was UTM WGS84 (zone 32N). For ease of labelling both in the field and with respect to data handling, the first two and three digits, respectively, were dropped from the eastings and northings of grid locations (e.g. 566750E & 6931700N would be referred to as "6750E & 1700N").

All gridding was carried out on foot due to a lack of snow. Bamboo pickets were collected in November upon completion of the UTEM surveying in order to return the survey area to its original state.

Appendix B consists of a detailed report by McKeown Exploration Services on the fall 2005 DGPS surveying and grid work. Documentation and data are also given in digital form on an accompanying CD.

UTEM Geophysical Surveying

Lamontagne Geophysics Limited carried out 50.45 line km of UTEM survey between November 3rd and November 26th (Figure 6). The UTEM crew consisted of two Lamontagne operators, one Lamontagne helper and two Falconbridge/Sulfidmalm helpers. Surveying was carried out on foot but snowmobiles were selectively used to help move people and equipment as needed. The inability to use snowmobiles within the Knutshø Landskapsvernområde resulted in more time-consuming "manual" forms of haulage (Figure 7).

Surveying was conducted using five large transmitter loops consisting of narrow gauge copper wire. Data was collected in both "off-loop" and in-loop configurations on 100-200m spaced lines at station intervals of either 25m or 50m depending on survey logistics and noise levels. Loop 2a was only used to survey the northern extensions of L670E and 671E where additional data was required.

Appendix C contains a detailed logistical report by Lamontagne Geophysics on the fall 2005 UTEM surveying. Included are a description of the survey logistics and methodology and a full listing of the UTEM profiles. Documentation and data are also given in digital form on an accompanying CD.

8.0 Results of 2005 UTEM Survey

UTEM responses were obtained at several locations throughout the grid, one of which merited more detailed modeling. Results are summarized as follows:

Loop #1:

- UTEM responses on L336N and L337N @ approximately 5950-5975E, flanking the west side of hook-shaped magnetic feature east of Vakkerlien deposit. Data from L336N was modeled in-house by A. Watts and outlined a **UTEM plate with a conductance of 2000 siemens, a strike extent of 300m, a dip extent of 400m and a 53° east dip (see Figure 8 & Appendix D).** The ability to extend UTEM coverage to the north is limited by the presence of a NE-SW trending power line.
- UTEM responses on L334N (@ ~5730E), L335N (@ ~5635E) and L336N (@ ~5540E) which can be correlated with the Vakkerlien deposit. Coupling was probably not optimum for "seeing" the deposit as the position of Loop #1 was optimized for surveying over the hook-shaped magnetic feature to the east rather than for the well explored deposit area. It should also be noted that the data was relatively noisy on the west end of the loop #1 lines due to the power line which transects the extreme NW corner of the grid.

Loop #2:

- Early channel, low conductance response on L669E and L670E @ approximately 2600N.

Loop #3:

- No UTEM responses

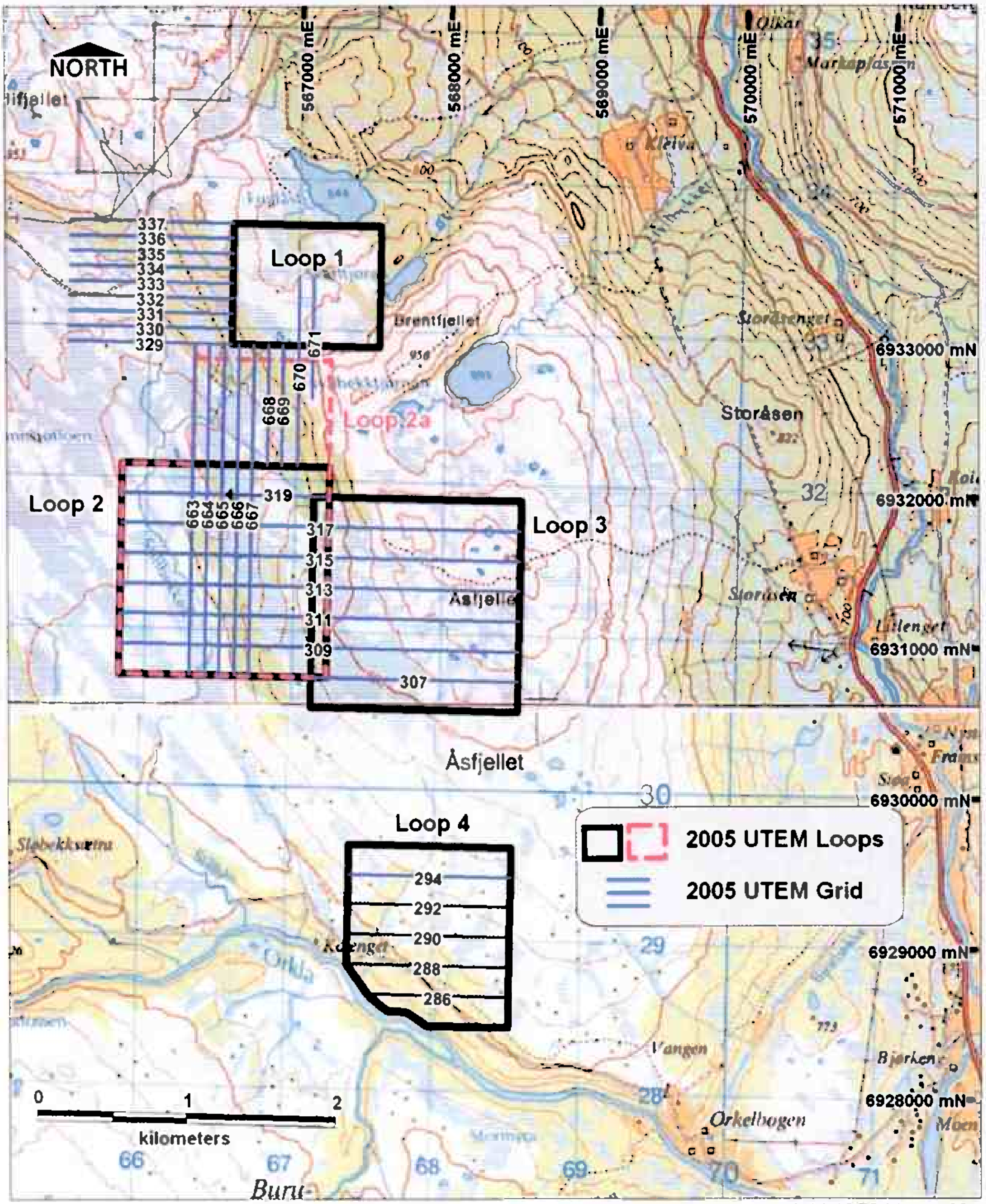
Loop #4:

- Early channel, low conductance response on L292N @ approximately 7950E.

The UTEM anomaly modeled on L336N represents a viable drill target and should be drill-tested. No further work is recommended elsewhere on the grid at this time.

P. Jarst

Figure 4
Vakkerlien Project – 2005 UTEM Grids and Loops



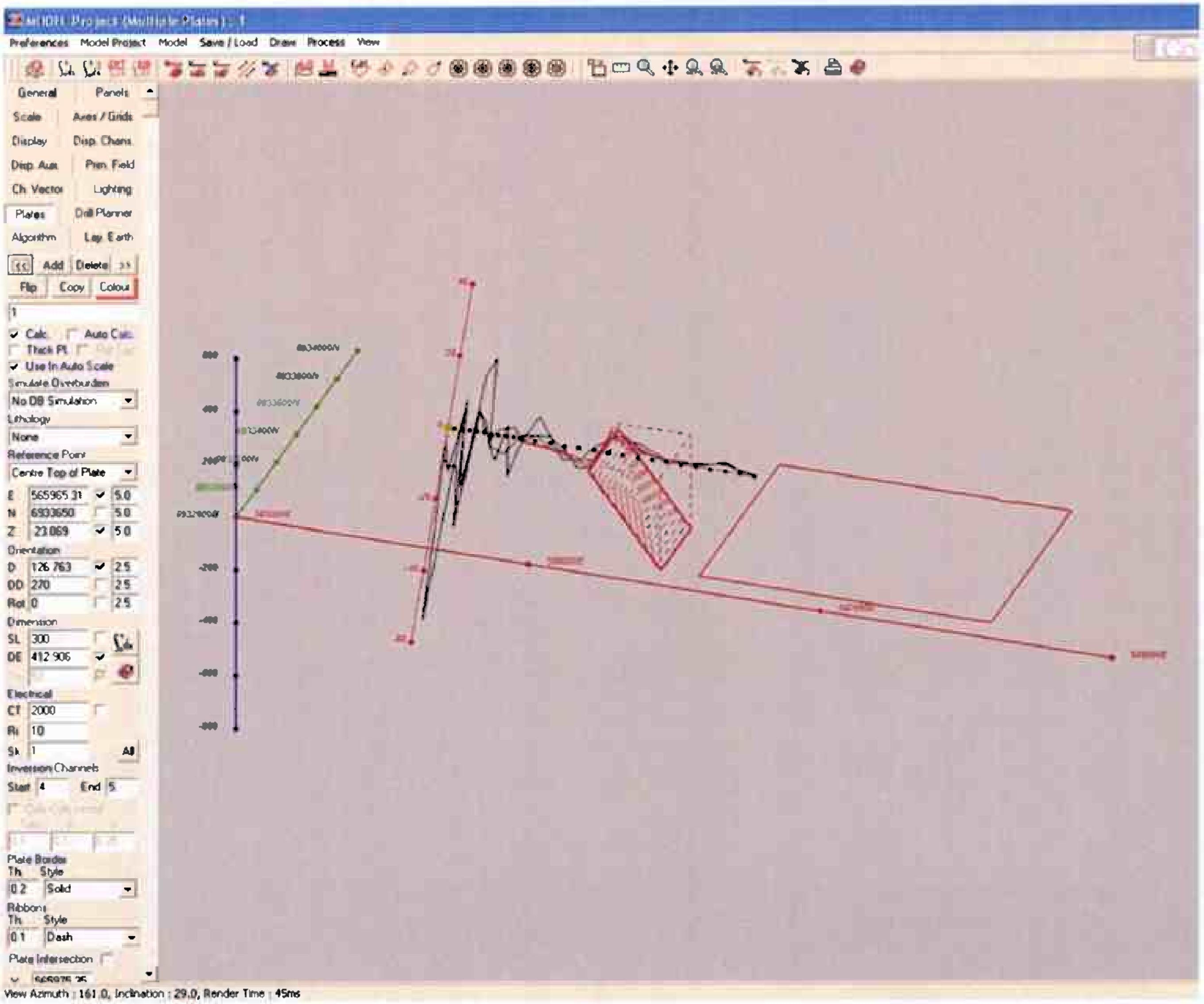
UTM WGS84 Zone 32N

Figure 5: Establishment of DGPS-controlled Grid

Figure 6: UTEM Surveying

Figure 7
Manual Transport of UTEM Survey Equipment

Figure 8
Maxwell Model for Loop 1, Line 336N UTEM Plate



9.0 References

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Vakkerlien Project Report on 2004 Work Program: Airborne Geophysics & Ground Follow-up, Hedemark County, Norway, Falconbridge Limited for Sulfidmalm A/S, April 10, 2005.

APPENDIX A

APPENDIX A
LIST OF FIELD PERSONNEL

Falconbridge Limited:	Patti Tirschmann	Senior Geologist (Project Supervision)
	Robert Jones	Senior Field Geologist
	Doris Fox	Senior Field Geologist
	207 Queen's Quay West, Suite 800 Toronto, ON, Canada M5J 1A7	
Sulfidmalm A/S:	Lars Weierhaeuser	Field Geologist
	Finn Hansen	Field Manager, Logistics
	Serviceboks 604 4606 Kristiansand, Norway	
Lamontagne Geophysics:	Robert Langridge	Senior Geophysicist/UTEM Operator
	John Frost	UTEM Operator
	Tim Pinkerton	UTEM helper
	115 Grant Timmins Dr. Kingston, ON, Canada K7M 8N3	
McKeown Exploration Services:	Rob McKeown	DGPS Operator
	55-1330 Trowbridge Dr. Oshawa, ON, Canada L1G 7L1	

APPENDIX B

REPORT ON GPS SURVEY

FOR FALCONBRIDGE LTD.

VAKKERLIEN PROECT

TYNSET KOMMUNE, NORWAY

OCTOBER 2005

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robmckeown@compuserve.com

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1 Introduction

On 04 October, 2005, a crew was mobilised from Oshawa, Ontario to Falconbridge's Vakkerlien Project in the Tynset province of Norway, 175km south of Trondheim, to fix the position of an exploration grid in three dimensions using Global Positioning System (GPS) satellite receivers. The work was carried out by McKeown Exploration Services of Oshawa, Ontario.

2 Background

2.1 GPS General Theory

The Global Positioning System (GPS) is a network of twenty four earth orbiting NAVSTAR satellites (SVs) operated by the United States Department of Defense. The satellites orbit the earth every twelve hours at an altitude of approximately 20,200km. Four SVs orbit in each of six different planes inclined at 55deg to the equator, they provide constant positioning and time information by means of radio signals broadcast from each satellite.

Each GPS satellite broadcasts two radio signals known as L1 and L2 (1575.42 MHz, 1227.6 MHz). The L1 signal is modulated with two pseudorandom noise (PRN) ranging codes; P-code, and C/A code. The precision or P-code can be encrypted for military use, while the C/A code is not encrypted. The L2 signal is modulated with the P-code only. Most GPS receivers make use of the L1 signal only, while some survey grade GPS receivers take advantage of both

The US Department of Defense tracks each of the satellites continuously, constantly monitoring and calculating the exact path of the satellite. The exact path of the satellite, as well as atomic clock correction coefficients (each satellite contains several very precise atomic clocks) are broadcast to the satellite daily, this information (called the Broadcast Ephemeris and Almanac) is rebroadcast by each SV and used by the GPS receiver on the ground.

The GPS receiver is capable of receiving signals from several different satellites at once. The incoming code from the satellite contains information regarding the identity of each SV. The receiver calculates the distance that it is from the satellite by looking at the incoming code from the satellite, and then looks at how long ago it (the receiver) generated the same code. The difference in time is multiplied by the speed of light to give the distance, and through the use of triangulation, an exact position of the receiver antenna can be calculated.

2.2 Errors in the GPS Position

The calculated GPS position assumes that light travels at a constant speed, unfortunately this is only true of light travelling in a vacuum. When the GPS signal enters the Earth's atmosphere, the signal is slowed down by both the ionosphere and the troposphere, which may result in incorrect distance calculations. This effect is minimized by calculated correction factors that are broadcast with the Broadcast Ephemeris.

Multipath can be another significant source of error in the calculated GPS position. If the satellite signal is reflected off of objects in close proximity to the GPS receiver, it can interfere with the straight-line signal coming from the satellite, slowing the signal down and "confusing" the GPS receiver. This type of error is more common in areas with man-made cultural influence, such as large buildings, and generally is not a factor in the wilderness setting.

Until recently, the largest single source of error was known as "Selective Availability", or the intentional degradation of the GPS signal by the US Department of Defense, it may cause an error in the horizontal positions of the receiver of more than 100m. In the Spring of 2000 the US government removed Selective Availability, as a result, a standard off-the-shelf single frequency GPS may now yield a horizontal position with a +/- 5m precision.

2.3 Real Time Differential Correction and WAAS

The technique of Real Time Differential Correction (RTC) greatly increases the accuracy of the GPS position and helps minimize the effects of atmosphere, multipath, and selective availability. It employs two GPS receivers, one placed at a known location (the base) and one at an unknown position (the rover). The data collected at the base are used to determine the error in the GPS position, this error is in turn broadcast, through the use of an FM/UHF band radio-modem, to the rover unit and used to remove the errors in the position at the unknown location in real-time.

Using a single frequency GPS receiver (L1 only), with a base-rover separation (base-line length) of less than 10km can yield real-time sub-meter accuracy in both horizontal and vertical position, while use of a survey grade dual frequency L1/L2 GPS receiver can yield real-time 2cm-5cm accuracy in both horizontal and vertical positions.

WAAS, or Wide Area Augmentation System, is a real-time differential correction system implemented and operated by the American FAA (Federal Aviation Authority) for use in GPS aided navigational approaches for aircraft. The system employs a broad network of GPS base stations over the continental United States , the data from which is broadcast by satellite. This differential correction is broadcast on the same frequency as the Navstar signal. Specially equipped GPS receivers are able to apply this correction in real-time to yield a real time position with <2 metre accuracy.

EGNOS is the European equivalent to WAAS.

2.4 Postprocessed Differential Corrections

Similar to the RTC method described above, data can be corrected after-the-fact by collecting data at a base station, and simultaneously collecting data at the rover unit. The data can then be downloaded from the GPS receiver to a computer and "post-processed" to give a differentially corrected position. This is useful in "fixing" base station positions from known geodetic control points where base-rover separation is in excess of 10km (the range of the FM radio modem). The amount of data collected (i.e. the time spent "occupying" a station) to produce a precise position is proportional to the base-rover separation. A general rule of thumb for rover occupation time is fifteen minutes plus one minute for every kilometer over ten kilometers base-rover separation, i.e. a base-rover separation of 100km should be occupied for 15min + (100km- 10km) * 1min / km = 15min + 90 min = 105 minutes.

Post-processed single frequency data can yield 10-15cm precision, while survey grade dual frequency receivers can yield up to part-per-million precision.

2.5 Dilution of Precision (DOP) and Elevation Mask

The DOP is a measure of the geometry of the satellites relative to each other. The best possible position fix, or most accurate, will be possible when the geometry of the satellites is such that the satellites are within range, but as far apart from each other as possible. A low PDOP (position DOP) indicates that the geometry of the satellites, relative to each other, is good for a triangulation fix. If the SVs are close to each other, or are lined up, then the geometry will be poor for triangulation, and the PDOP will be higher. A PDOP less than 4 gives the best position fix, 5-8 is marginally acceptable, and 9 or over is poor. Generally a PDOP mask (or filter) is applied so that if the PDOP is over a certain level (6 is the maximum for this particular survey), then a reading is not possible.

A minimum of four satellites are generally required to give an accurate position fix. The GPS system used for this particular survey uses a proprietary algorithm called "Over-Determined 3D" , which requires at least five common base/rover SVs to compute a position fix.

The elevation mask is a user entered angle filter which will tell the GPS to ignore all SVs within the zero degree above horizon to elevation mask range. When satellites are low on the horizon, the signal is forced to travel farther through the atmosphere, and the low angle of incidence means signals reflect off of objects more readily and the multipath error is increased. The elevation mask for this survey is 13°.

3 Mobilization and Equipment

3.1 Mobilization

On 04 October, 2005, a crew was mobilised from Oshawa, Ontario to Falconbridge's Vakkerlien Project in the Tynset province of Norway, 175km south of Trondheim

The crew, which included the author, and two representatives from Falconbridge Ltd stayed in the Hogstad Campground ten kilometers north of the survey areas just off of highway 3. Access to the Vakkerlien project was by pick-up truck via two farm access roads just south of Vikne. The grid was accessed on foot

Figure 3.1.1 – Location Map

Figure 3.1.2 – Location Map

3.2 Equipment

All GPS equipment was rented by the author on behalf of Falconbridge. Two Trimble dual frequency geodetic grade GPS receivers were employed, one Trimble model 5700 and one model 5800 receiver, along with a Trimble 25 watt base station radio modem, and a similar 25 watt Trimble radio acting as a modem repeater (see Appendix D for specifications).

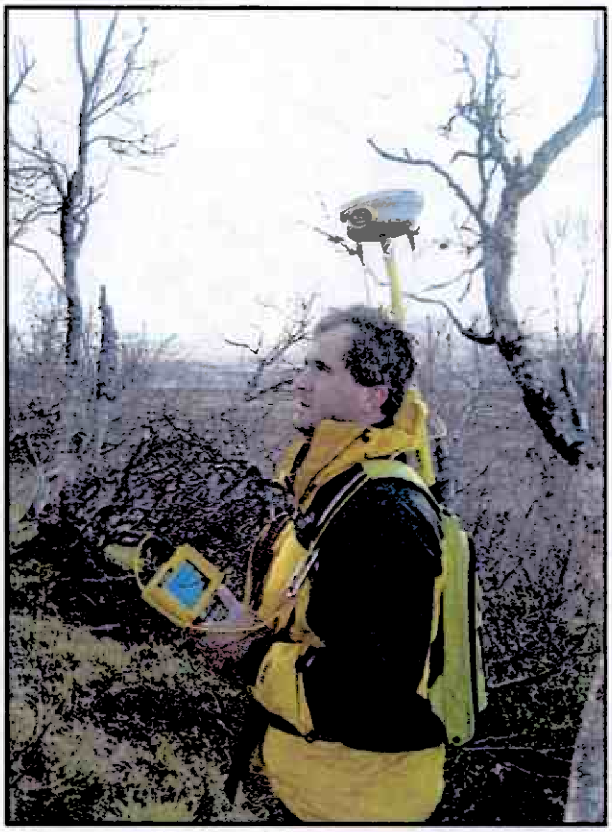


Figure 3.2.1 – Author with Trimble 5800 GPS system

4 Survey Procedure

4.1 The Local Grid

The local grid was originally designed and oriented to produce lines perpendicular to the geological trend or strike. Grids followed universal transverse mercator (UTM) projection gridlines, lines were running either north-south, or east west. Magnetic declination in the survey area is zero, so magnetic north and grid north are essentially the same.

The World Geodetic System 1984 (WGS84) UTM reference system was chosen by Falconbridge as the default coordinate system. The Survey area was located in UTM zone 32V.

Lines were placed at either 100 metre or 200 metre intervals, with a station spacing of 25 metres.

4.2 GPS Base Station and Repeater

On 06 October 2005, the real-time GPS base station was erected at government geodetic control point known as G27T0222 "Storinnsjoen" which was chosen due to it's central location to the grid and easy walk-in access.

GPS occupations were observed at two other government control points, "Vakkerlifjell" and "Slobekksetera" for comparison, readings were within +/- 2 cm of the published coordinates.

Point V999 was established relative to G27T0222 by static occupation of site for 15 minutes. Over the course of the survey, G27T0222, V999, and G27T0023 were used as GPS base stations.

Figure 4.2.1 – GPS Basestation SLOBEKKSETERA

ID	Name	UTM_N	UTM_E	Elev.
G27T0065	Asfjell	6931463.775	568571.041	970.249
G27T0136	Vakkerlifjell	6935786.254	565601.417	989.559
G27T0222	Storinnsjoen	6933997.854	564379.512	879.776
G27T0023	Slobekksetera	6929262.312	565619.475	809.177

Figure 4.1.1 – Coordinates of published government control points, ETRS89.

ID	UTM_N	UTM_E	Elev.
V999	6933842.725	566311.650	900.489

Figure 4.1.2 – GPS Base derived from static occupation of G27T0222

The published geodetic control point coordinates are in the ETRF89 (or EUREF89) coordinate system, or European Terrestrial Reference Frame. The Norweigan government agency "Statenskart" which is responsible for geodetic control points in Norway responded to an inquiry on the definition with the following: "...EUREF89 is apparently very close to WGS84, the difference is in the order of 20-30cm".

This statement, combined with the evidence from the comparison of the coordinates obtained from the test, provided enough support for keeping WGS84 without any detrimental effects.

WGS84 elevations and coordinates were used for the duration of the survey.

A GPS repeater was used on various days when signal propagation was RTK signal was obstructed

4.3 The Survey

The Trimble 5800 RTK GPS was used to navigate from one ideal station to the next, Falconbridge personnel then placed a labeled bamboo pickêt at the station. Periodically it was not possible to place the real station at the ideal station location due to trees or topographic obstruction, in such instances the station was moved away from the ideal by up to 5 metres. The station was then staked out, i.e. the real location and elevation observed and recorded in the GPS data controller.

Figure 4.3.1 GPS Repeater set up next to road

The GPS antenna was placed on the GPS backpack, which was 2.04m above ground level (see figure 4.3.1).

The GPS fix, depending on the Dilution of Precision (DOP) value was usually obtained with 3 readings (one per second) taken over the course of at least 5 seconds. If DOPs were low, (<6.0) then a shorter reading was possible, if high (>6.0), then generally a longer observation was necessary to obtain the desired precision, normally less than one minute.

Initially, the desired precision was set to 5cm. This was later changed to 20cm metre L1/L2 fine initialisations due to time limitations and the fact that tree cover was causing lengthy L2 or " Fine initialization". The initialization type is displayed in the attached data file in column 9, a "F" indicates fine or L1/L2 high precision observation (+/- 5cm), and a "C" indicates course or L1 only float observation (+/- 1m).

All observations were "F" or fine high-precision initializations on this survey

Readings were stored in the hand-held GPS computer and downloaded nightly to a laptop computer. Trimble Geomatics Office Version 1.6 (TGO) software was used to transfer and decode binary data. Data were exported from TGO into ASCII format, which was then imported in Excel. An master Excel spreadsheet was created and contained all merged data (see Appendix A).

The production GPS survey was started 07 October 2005, and completed 17 Oct 2005 (see Appendix C for details on daily progress).

The GPS was also used to fix the positions of all UTEM Loop wires to be used by Lamontagne Geophysics. Four loops were surveyed (1-4) with position fixes taken every 100m, or at any line or elevation break (see Map 7.1).

5.0 Quality Control

To maintain a quality data set, and to test the manufacturer's claim of error/precision, as many random repeats were taken as time would allow. The results of the repeats are outlined below (see Chart 5.0.1).

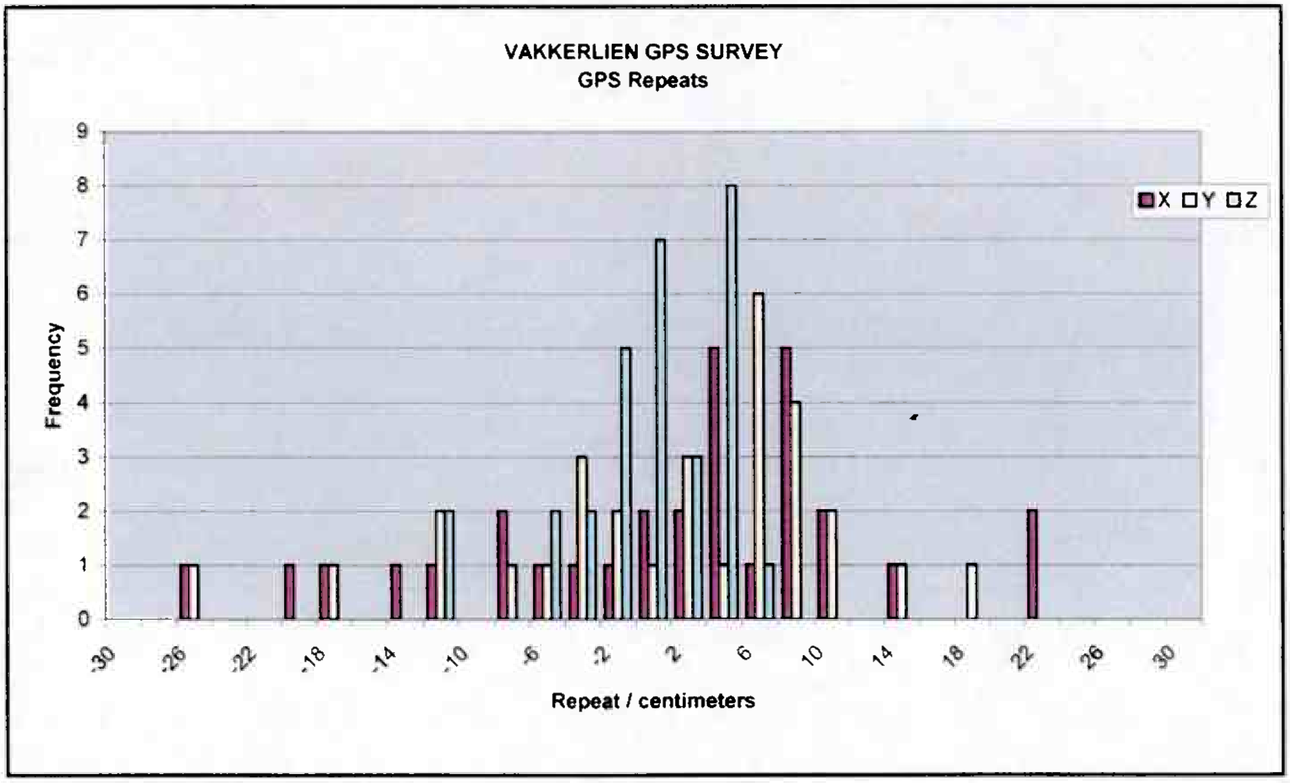


Chart 5.0.1 – GPS Repeats

Chart 5.0.1 illustrates that the precision is as expected (sub-metre). The average of the absolute Z repeat value is 3.4cm, with the standard deviation (single population) of 3cm. This implies that if the number of repeats is statistically significant, and approximates a normal distribution, 68% of the readings should have an error in elevation of 3cm or less (one standard deviation), and 95% should have an error less than 6cm (two standard deviations)

As the error is random as far as being positive or negative in value, the absolute value is considered when calculating averages.

Only 30 repeats were considered for approximately 1825 stations, or 1.6%. Ideally 5-10% should be randomly repeated for a survey of this size.

6 Comments

6.1 Comments on Satellite Geometry

During the course of a survey day, three significant time periods were observed where satellite geometry was less than ideal; around 8:00-8:45, 10:30 to 11:30, 13:15-14:00. During these times it became apparent early in the survey that readings taken in the trees would be difficult to obtain as satellites were either very low on the horizon, or all available satellites were grouped directly overhead and geometry was not favorable for triangulation. With proper planning, usually a survey crew can plan to be working in the clear open areas during these times.

Appendix E contains plots of sample satellite geometry for 05 October 2005 and again for 17 October 2005. Bad times can be seen to shift back in time approximately 30 minutes over this period.

The charts in Appendix E shows number of satellites and PDOP plotted against time. Periods of 5 satellites or less, or a PDOP greater than 4 can be difficult times to survey. Obstructions such as mountains or trees can significantly block satellites from the view of the antenna.

6.2 WAAS/EGNOS versus Dual Frequency RTK

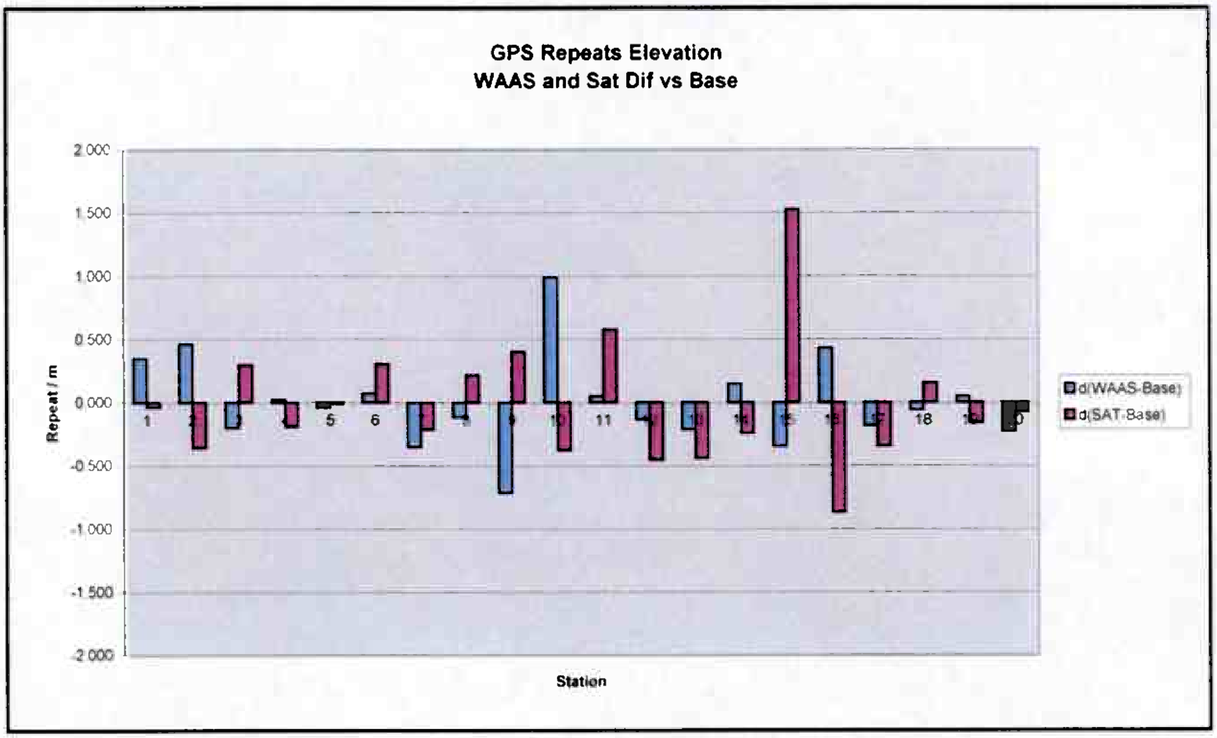


Chart 6.2 – WAAS and Sat Dif vs Base

On the final day of surveying, a test was done to compare observations made using two different types of differential correction.

A section of line was chosen that was previously read using the high-precision geodetic grade GPS system using a base station, these values for the sake of the test were assumed to be the "most correct" coordinates for each station. The stations were re-read using both Falconbridge's Trimble Pathfinder PRO XRS which uses the Fugro Omnistar satellite differential correction system (paid subscription service), and the Trimble 5800 system configured in WAAS/EGNOS mode (free aviation-approach service).

The relative change from one station to the next was compared to the change observed with the geodetic system and plotted above. The chart above indicates that both systems are providing typically submeter precision. The Omnistar system appears to have one repeat in excess of 1m.

The WAAS/EGNOS system was significantly slower in the trees owing to the fact that the differential correction satellite was low on the horizon during the test and lost easily while walking in the trees.

It is doubtful that enabling the WAAS/EGNOS option on Falconbridge's GPS would offer a significant advantage, and could possibly slow down production while working in the trees.

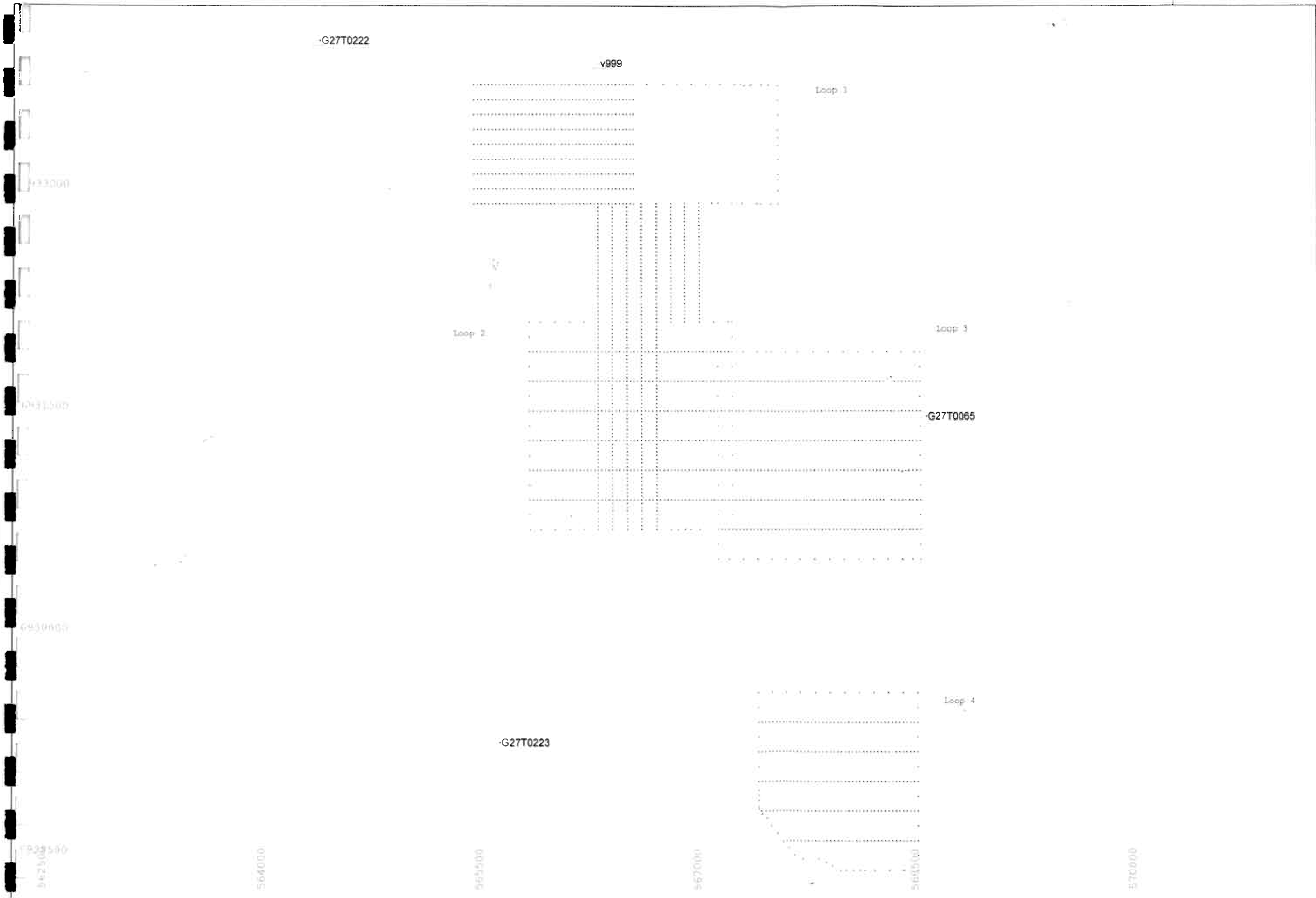
The most robust method of improving Falconbridge's Pathfinder system would be to use it in conjunction with a local RTK GPS base station

6.3 Elevation

It was noted that the Falconbridge GPS was collecting data with elevations significantly different than those indicated on the topo maps and geodetic control points, this is probably owing to the difference in ellipsoid vs geoid height. The data presented in this report is in agreement with the local topo maps and geodetic control. Over such a small survey area the lateral variation is quite small (~20cm) and heights could be adjusted by a simple addition/subtraction of 42.320m, this is the average separation as indicated in the datasheet supplied by the government of Norway (see Appendix)

Respectfully Submitted,

Robert L. McKeown, B.Sc.
2005-10-28



Field surveyor:
RLM
Computer operator:
RLM
Reference:
WGS 84 Zone 32V

Scale 1:25000
0 1200 m
Meters

N
000 DEG

Plot Scale: 1:25000

Printed from Trimble Geomatics Office

Site: VAKKERLIEN, System: WGS84 UTM
Zone: 32N, Datum: WGS84

Project: VAKKERLIEN
GPS Survey for Falconbridge Ltd

Appendix A Data CD Information

The attached data CD contains all raw and processed data collected. Raw Trimble binary files are located in the directory :

\GPS\RAWDATA

and are only readable with Trimble Geomatics Office. All binary files were decoded and exported as ASCII text files, then imported into the excel spreadsheet vakkerlien.xls Geosoft space delimited xyz data was exported from excel and saved in the folder:

\GPS\XYZ

UTEM loops' GPS data are located in the directories:

\GPS\LOOPS

The figure below is a sample of the final data format (Geosoft XYZ) located in the master spreadsheet :

\GPS\XYZ\vakkerlien.xls

/GPS Survey for Falconbirdge Ltd											
/Vakkerlien Project, Norway											
/UTM_E UTM_N ID Elev Lat Long Precision Date GMT_Time Line Station											
/WGS84 Zone 32V											
/											
Line	286.000										
567599.975	6928600.021	286567600	759.205	62.48232784	10.31147977	F	051016	1409	286	567600
567624.234	6928600.455	286567625	764.034	62.48232731	10.31195043	F	051016	1407	286	567625
567650.022	6928600.050	286567650	764.991	62.48231898	10.31245042	F	051016	1402	286	567650
567674.961	6928600.019	286567675	771.257	62.48231416	10.31293409	F	051016	1400	286	567675
567699.951	6928599.961	286567700	772.645	62.48230908	10.31341873	F	051016	1359	286	567700
567724.983	6928599.987	286567725	775.069	62.48230474	10.31390423	F	051016	1357	286	567725
567749.534	6928599.988	286567750	776.886	62.48230027	10.31438038	F	051016	1356	286	567750
567774.927	6928600.009	286567775	779.730	62.48229581	10.31487287	F	051016	1354	286	567775
567799.431	6928600.032	286567800	780.979	62.48229155	10.31534813	F	051016	1353	286	567800
567824.148	6928599.458	286567825	775.109	62.48228188	10.31582728	F	051016	1349	286	567825
567850.019	6928600.047	286567850	781.172	62.48228243	10.31632926	F	051016	1345	286	567850
567875.007	6928600.021	286567875	786.176	62.48227763	10.31681388	F	051016	1344	286	567875
567899.866	6928600.010	286567900	787.469	62.48227298	10.31729601	F	051016	1342	286	567900
567924.854	6928600.065	286567925	785.412	62.48226891	10.31778065	F	051016	1341	286	567925
567950.134	6928600.011	286567950	790.578	62.48226379	10.31827093	F	051016	1340	286	567950
567975.050	6928599.931	286567975	792.451	62.48225851	10.31875413	F	051016	1339	286	567975
567999.908	6928600.091	286568000	793.272	62.48225539	10.3192363	F	051016	1336	286	568000
568024.935	6928600.016	286568025	795.606	62.48225013	10.31972164	F	051016	1334	286	568025
568050.014	6928600.111	286568050	795.772	62.48224638	10.32020807	F	051016	1333	286	568050
568075.625	6928600.127	286568075	797.436	62.48224182	10.32070481	F	051016	1331	286	568075
568100.048	6928599.931	286568100	799.618	62.48223559	10.3211784	F	051016	1327	286	568100
568124.963	6928599.994	286568125	801.052	62.48223158	10.32166163	F	051016	1327	286	568125
568149.974	6928599.967	286568150	802.079	62.48222674	10.32214669	F	051016	1326	286	568150
568175.051	6928599.964	286568175	803.915	62.48222211	10.32263304	F	051016	1325	286	568175
568200.113	6928600.027	286568200	805.575	62.48221806	10.32311913	F	051016	1324	286	568200
568225.024	6928599.980	286568225	806.417	62.48221307	10.32360223	F	051016	1323	286	568225
568249.921	6928599.970	286568250	808.130	62.4822084	10.3240851	F	051016	1322	286	568250

Figure A.1 – Sample Data

APPENDIX B REPEATS

GPS Survey for Falconbridge Ltd.
Vakkerlien Project - GPS Repeats

Appendix B

Reading 1				Reading 2				Repeat					
X1	Y1	STAT1	Z1	X2	Y2	STAT2	Z2	dX	dY	dZ	+dX	+dY	+dZ
566300.065	6930899.949	663930900	802.834	566300.087	6930900.141	309566300	802.813	-2.2	-19.2	2.1	2.2	19.2	2.1
566300.025	6931099.949	663931100	803.011	566299.952	6931099.898	311566300	802.972	7.3	5.1	3.9	7.3	5.1	3.9
566300.024	6931300.024	663931300	802.526	566300.065	6931299.983	313566300	802.519	-4.1	4.1	0.7	4.1	4.1	0.7
566599.862	6931299.549	666931300	829.679	566599.822	6931299.558	313566600	829.668	4	-0.9	1.1	4	0.9	1.1
566700.116	6931300.056	667931300	828.332	566700.079	6931300.113	313566700	828.309	3.7	-5.7	2.3	3.7	5.7	2.3
566300.098	6931499.937	663931500	812.567	566300.116	6931499.868	315566300	812.543	-1.8	6.9	2.4	1.8	6.9	2.4
566600.033	6931500.091	666931500	820.519	566600.021	6931500.068	315566600	820.486	1.2	2.3	3.3	1.2	2.3	3.3
566700.025	6931499.988	667931500	828.582	566699.969	6931499.986	315566700	828.556	5.6	0.2	2.6	5.6	0.2	2.6
566299.976	6931700.022	663931700	817.247	566300.102	6931700.060	317566300	817.245	-12.6	-3.8	0.2	12.6	3.8	0.2
566399.994	6931700.054	664931700	815.725	566399.966	6931699.988	317566400	815.671	2.8	6.6	5.4	2.8	6.6	5.4
566600.014	6931699.962	666931700	820.751	566599.936	6931699.830	317566600	820.719	7.8	13.2	3.2	7.8	13.2	3.2
566599.969	6931902.068	666931900	827.192	566600.066	6931902.059	319566600	827.153	-9.7	0.9	3.9	9.7	0.9	3.9
566300.038	6931900.006	663931900	812.882	566300.102	6931900.137	319566300	812.916	-6.4	-13.1	-3.4	6.4	13.1	3.4
566399.973	6930900.002	664930900	802.193	566399.948	6930900.098	309566400	802.197	2.5	-9.6	-0.4	2.5	9.6	0.4
566400.070	6931100.038	664931100	802.011	566399.858	6931099.981	311566400	802.072	21.2	5.7	-6.1	21.2	5.7	6.1
566399.956	6931300.032	664931300	816.086	566399.895	6931300.077	313566400	816.096	6.1	-4.5	-1	6.1	4.5	1
566400.044	6931500.340	664931500	824.785	566399.827	6931500.268	315566400	824.823	21.7	7.2	-3.8	21.7	7.2	3.8
566400.040	6931897.578	664931900	814.282	566400.057	6931897.522	319566400	814.402	-1.7	5.6	-12	1.7	5.6	12
566500.102	6930899.659	665930900	804.218	566500.367	6930899.616	309566500	804.286	-26.5	4.3	-6.8	26.5	4.3	6.8
566500.054	6931100.089	665931100	811.992	566500.243	6931100.048	311566500	812.004	-18.9	4.1	-1.2	18.9	4.1	1.2
566500.045	6931299.933	665931300	824.691	566500.039	6931300.072	313566500	824.722	0.6	-13.9	-3.1	0.6	13.9	3.1
566500.005	6931499.930	665931500	823.116	566500.220	6931499.972	315566500	823.118	-21.5	-4.2	0	21.5	4.2	0
566500.012	6931699.999	665931700	815.524	566499.942	6931699.985	317566500	815.539	7	1.4	-1.5	7	1.4	1.5
566499.979	6931899.850	665931900	826.155	566500.078	6931899.925	319566500	826.166	-9.9	-7.5	-1.1	9.9	7.5	1.1
566600.078	6930900.017	666930900	820.170	566600.046	6930899.936	309566600	820.298	3.2	8.1	-12.8	3.2	8.1	12.8
566600.001	6931100.038	666931100	828.084	566599.925	6931099.869	311566600	828.106	7.6	16.9	-2.2	7.6	16.9	2.2
566699.954	6930899.816	667930900	840.363	566700.107	6930900.079	309566700	840.407	-15.3	-26.3	-4.4	15.3	26.3	4.4
566699.933	6931099.928	667931100	839.471	566699.797	6931099.866	311566700	839.512	13.6	6.2	-4.1	13.6	6.2	4.1
566700.094	6931700.120	667931700	830.126	566700.003	6931700.028	317566700	830.144	9.1	9.2	-1.8	9.1	9.2	1.8
566699.997	6931899.926	667931900	830.072	566699.911	6931899.954	319566700	830.110	8.6	-2.8	-3.8	8.6	2.8	3.8

count	30					
min	-26.5	-26.3	-12.8	0.6	0.2	0.0
max	21.7	16.9	5.4	26.5	26.3	12.8
mean	0.1	-0.1	-1.3	8.8	7.3	3.4
stdev	11.4	9.5	4.3	7.1	5.9	3.0

Frequency Distribution

Interval cm	x	y	z
-30	0	0	0
-28	0	0	0
-26	1	1	0
-24	0	0	0
-22	0	0	0
-20	1	0	0
-18	1	1	0
-16	0	0	0
-14	1	0	0
-12	1	2	2
-10	0	0	0
-8	2	1	0
-6	1	1	2
-4	1	3	2
-2	1	2	5
0	2	1	7
2	2	3	3
4	5	1	6
6	1	6	1
8	5	4	0
10	2	2	0
12	0	0	0
14	1	1	0
16	0	0	0
18	0	1	0
20	0	0	0
22	2	0	0
24	0	0	0
26	0	0	0
28	0	0	0
30	0	0	0

APPENDIX C PRODUCTION SUMMARY

GPS Survey for Falconbridge Ltd.

Vakkerlien, Norway
October 2005
Production Summary

Date	Prod	S/B	M/D	Line	Station From	Station To	Length	Notes
05/10/04			1					-p.m. RLM Departs Toronto for Norway
05/10/05			1					-p.m. RLM Arrives Trondheim
								-p.m. RLM arrives in Vakkerlien
05/10/06		1						-a.m. setup base station at geodetic point G27T0222
								-checked against G27T0136 and G27T0223, aggrees with publised coordinates +/- 2cm x,y,z
								-base V999 established realative to G27T0222 at north end of survey area
								-base G27T0223 to be used for southern grid
05/10/07	1			66933700	565450	566550	1100	-surveyed in norther grid
				66933600	565450	566550	1100	-switched base battery at 3pm
				66933500	565450	566000	550	-bad PDOP/RMS for half hour at 11:00-11:30am
				66933400	565450	566000	550	
				66933300	565450	565975	525	
				66933200	565450	566000	550	
				66933100	565450	566000	550	
				66933000	565450	566000	550	
				66932900	565450	566000	550	
TOTAL							6025	
05/10/08	0.5	0.5		6933500	566025	566550	525	-worked a.m.
				6933400	566025	566550	525	-p.m. Rob Jones to Trondheim, not possible to work in field while driving him to airport
				6933300	566000	566550	550	
				6933200	566025	566550	525	
				6933100	566025	566550	525	
				6933000	566025	566550	525	
TOTAL							3175	
05/10/09	1			6933000	566025	566550	525	-rain and sleet all day
				566300	6930700	6932900	2200	-survey controller locked up in afternoon at 4pm
				566400	6930700	6932700	2000	-radio link lost at south end of lines on south side of ridge, will move base station tomorrow
TOTAL							4725	-slow day!
05/10/10	1			566400	6932725	6932900	175	-moved base station to point G27T0222, to northwest to try to get better radio coverage to south
				566500	6930700	6932900	2200	-problem with radio coverage at north end of grid after moving base
				566000	6930700	6932900	2200	-returned to cabin to get repeater, installed on road near north grid centre
TOTAL							4575	-no more problems with radio link for entire length of north south lines
								-slow going in trees, satellites low on horizon
05/10/11	1			567000	6932900	6932100	800	- sunny day, no problems
				6931900	565825	567225	1400	
				6931700	565825	568525	2700	
				6931500	565825	568525	2700	
TOTAL							7600	
05/10/12	1			566900	6932900	6932100	800	-slow day today, all lines in trees
				566800	6932900	6932100	800	-GPSed in south, west, north loop edge of Loop 2005-02
				566700	6932900	6930700	2200	
TOTAL							3800	
05/10/13	1			566900	6932900	6932100	800	
				566800	6932900	6932100	800	
				566700	6932900	6930900	2000	
TOTAL							3600	
05/10/14	1			6930900	566850	568525	1675	-GPSed in part of loop 2005-02
				6931100	568375	568525	150	
				6930700	567125	568525	1400	
TOTAL							3225	
05/10/15	1							-GPSed Loop 2005-03, 2005-04
05/10/16	1			6929400	568500	567400	1100	-all grids and loops complete today
				6929200	568500	567400	1100	
				6929000	568500	567400	1100	
				6928800	568500	567450	1050	
				6928600	568500	567600	900	
TOTAL							5250	
05/10/17	1							-carried out test/repeats using Pathfinder PRO XRS GPS with satellite differential correction and Trimble 5800 using WAAS
								-p.m. demobed, travel Vakkerlien to Espadelen
05/10/18								-RM and LW to Oslo
TOTAL	10.5						41975	

TOTAL TO DATE:	41975
PRODUCTION DAYS TO DATE:	10.5

APPENDIX D GPS EQUIPMENT SPECIFICATIONS

TSCe Controller

The flexible data collector of choice

The TSCe™ controller is a rugged and adaptable handheld data collector. Running powerful Trimble field software on a Microsoft® Windows® operating system, TSCe provides exceptional control of Trimble GPS and optical sensors, whatever your surveying or construction application.

Exceptional in the field even in extreme temperatures

The TSCe controller is the rugged data-collection solution that fits comfortably in your hand and in your field processes. And because it's designed to take the knocks and drops of the surveying and construction environment, the TSCe controller's ruggedness makes it a reliable and dependable member of your field crew. When you're out working long days, TSCe will keep on working right there with you.

In extremely cold temperatures, TSCe is more robust than ever before. With its new color touch screen, TSCe will easily operate in temperatures as low as -25 °C without the addition of an internal heater.

Full keyboard and touch screen

On the TSCe controller you can choose to drive your data collection software using the full alphanumeric keyboard, or via the easy-to-use color touch screen–TSCe enables you to use the method or method combination that provides you with the most efficient data control.

The instant results of the touch screen offer complete control over data and make light work of navigation, data selection, positioning, and stakeout.

Color graphic display

The color graphic display of the TSCe controller is clearly readable in a wide range of field conditions. The display's reflective LCD technology makes it easy to read in bright sunlight, and it is front lit for when light levels are low, such as on dark winter days.

The color display makes not only simple text easier to read, but also complex maps and technical drawings. Having these graphics in colour right at your fingertips makes navigating and positioning much easier, and speeds up stakeout and data selection. Data management and quality assurance are also greatly improved. Because you can thoroughly check your data in the field, errors and omissions are minimized.

TSCe Applications

- Exceptional in the field even in extreme temperatures
- Full keyboard and touch screen
- Color graphic display
- Large memory capacity
- Adaptable

Large memory capacity

The TSCe controller comes with 512 MB of CompactFlash memory as standard. This large storage capacity means that you can work with larger data files and background maps, and that you can work for longer in the field without backup storage.

Adaptable

The TSCe controller is designed to operate with all your Trimble sensors, including the Trimble® R7 and R8 GPS receivers with R-track technology, the 5700 and 5800 GPS receivers, and the 3600 and 5600 total stations. It also supports many major third-party total stations. In addition, when the Trimble BlueCap module is used, Bluetooth® wireless technology provides cable-free communication with the Trimble R8 and 5800 GPS systems.

Trimble.

TSCe Controller

The flexible data collector of choice

Specifications

Power	Internal 3800 mAh NiMH rechargeable battery pack Battery life of 30 hours under normal operating conditions Complete recharge in under three hours
Size	25.8 cm (10.2 in) × 13 cm (5.1 in) × 5.2 cm (2.1 in) 7.4 cm (2.9 in) at handgrip
Weight	990 gm (2.2 lb) including battery
Certification	FCC class B, CE Mark, CSA, and C-tick approval
Serial Port I/O	9-pin serial port–RS232 (115 kB/s), COM1 with 5 V (250 mA) on pin 9
MultiPort I/O	26-pin MultiPort–RS232, COM2, Ethernet 10BaseT, USB client, power in/out and audio in/out 0-Shell Lemo RS-232 (115 kB/s)
Processor	Intel StrongARM SA-1110 @ 206 MHz
Memory	512 MB non-volatile flash disk; 64 MB SDRAM
Display	320 × 240 pixels (¼ VGA) reflective color TFT, frontlight illuminated display
Touch Screen	Passive touch screen, works with stylus or finger
Keyboard	57-key tactile action with separate navigation, alpha and numeric keypads
Audio	Integrated speaker and microphone

Environmental

Temperature:	
Operating	-25 °C to 60 °C (-13 °F to 140 °F)
Storage	-30 °C to 60 °C (-22 °F to 140 °F)
Water	ICE 529, IP 67, sealed against temporary immersion
Drop	1.22 m (4 ft) to concrete on all faces, edges and corners
Sand and Dust	ICE 529, IP 6X and MIL-STD-810E, Method 510.3
Vibration	MIL-STD-810E, I-3.4.9 category 10, Fig 16 and 17
Altitude	MIL-STD-810E, Method 500.3

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Trimble

Trimble 5700 GPS System

One receiver, many configurations, for greater flexibility and choice

The Trimble® 5700 GPS receiver is an advanced, but easy-to-use, surveying instrument that is rugged and versatile enough for any job.

Combine your 5700 with the antenna and radio that best suit your needs, and then add the Trimble controller and software of your choice for a total surveying solution. The powerful 5700 GPS system will provide all the advanced technological power and unparalleled flexibility you need to increase your efficiency and productivity in any surveying environment.

Advanced GPS receiver technology

The 5700 is a 24-channel dual-frequency RTK GPS receiver featuring the advanced Trimble Maxwell™ technology for superior tracking of GPS satellites, increased measuring speed, longer battery life through less power use, and optimal precision in tough environments. WAAS and EGNOS capability lets you perform real-time differential surveys to GIS grade without a base station.

Modular design for versatility

For topographic, boundary, or engineering surveying, clip the receiver to your belt, carry it in a comfortable backpack, or configure it with all components on a lightweight range pole. With the receiver attached to your site vehicle, you can survey a surface as fast as you can drive! For control applications, attach the receiver to a tripod...it's designed to work the way your job requires.

Full metal jacket...and lightweight

The 5700 GPS receiver boasts the toughest mechanical and waterproofing specs in the business. Its magnesium alloy case is stronger than aluminum, but also 30% lighter–the 5700 weighs just 1.4 kg (3 lb) with batteries. Whether you're collecting control points on a tripod, or scrambling down a scree slope collecting real-time kinematic data, the receiver is light enough and tough enough to carry on performing.

Fast and efficient data storage and communications

Use the receiver's CompactFlash memory to store more than 3,400 hours of continuous L1/L2 data collection at an average of 15-second intervals. Transfer data to a PC at speeds of more than 1 megabit per second through the super-fast USB port. Your choice of UHF radio modem is built in to the receiver to provide RTK communications receiving without the need for cables or extra power!

Your choice of Trimble antenna

Choose the high-accuracy Trimble GPS antenna that best suits your needs: the lightweight and portable Zephyr™ antenna for RTK roving, or the Zephyr Geodetic™ antenna for geodetic surveying.

The Zephyr Geodetic antenna offers submillimeter phase center repeatability and excellent low-elevation tracking, while the innovative design of its

Key Benefits

- Industry-leading technology provides superior performance
- Flexible configurations put you in total control
- Rugged, high-performance hardware is built to last
- With the Trimble controller and software of your choice, enjoy seamless integrated surveying

Trimble Stealth™ ground plane literally burns up multipath energy using technology similar to that used by stealth aircraft to hide from radar. The Zephyr Geodetic antenna thus provides unsurpassed accuracy from a portable antenna.

Trimble.

Trimble 5700 GPS System

General

- Front panel for on/off, one-button-push data logging, CompactFlash card formatting, ephemeris and application file deletion, and restoring default controls
- LED indicators for satellite tracking, radio-link, data logging, and power monitoring
- Tripod clip or integrated base case

Performance specifications

Measurements

- Advanced Trimble Maxwell technology
- High-precision multiple correlator L1 and L2 pseudorange measurements
- Unfiltered, unsmoothed pseudorange measurement data for low noise, low multipath error, low time domain correlation, and high dynamic response
- Very low noise L1 and L2 carrier phase measurements with <1 mm precision in a 1 Hz bandwidth
- L1 and L2 Signal-to-Noise ratios reported in dB-Hz
- Proven Trimble low-elevation tracking technology
- 24 Channels L1 C/A Code, L1/L2 Full Cycle Carrier, WAAS/EGNOS

Code differential GPS positioning[1]

Horizontal .... ±(0.25 m + 1 ppm) RMS
Vertical .... ±(0.5 m + 1 ppm) RMS
WAAS differential positioning accuracy typically <5 m 3DRMS[2]

Static and FastStatic GPS surveying[1]

Horizontal .... ±5 mm + 0.5 ppm RMS
Vertical .... ±5 mm + 1 ppm (× baseline length) RMS

Kinematic surveying[1]

Real-time and postprocessed kinematic surveys
Horizontal .... ±(10 mm + 1 ppm) (× baseline length) RMS
Vertical .... ±(20 mm + 1 ppm) RMS
Initialization time .... Single/Multi-base minimum 10 sec + 0.5 times baseline length in km, up to 30 km
Scalable GPS infrastructure initialization time .... <30 seconds typical anywhere within coverage area
Initialization reliability[3] .... Typically >99.9%

Hardware

5700 GPS receiver

Physical:
Casing .... Tough, lightweight, fully sealed magnesium alloy
Waterproof .... Tested to IPX7 standards
Shock and vibration .... Tested and meets the following environmental standards:
  Shock .... MIL-STD-810F to survive a 1 m (3.28 ft) drop onto concrete
  Vibration .... MIL-STD-810-F on each axis
Weight .... With internal batteries, internal radio, internal battery charger, standard UHF antenna: 1.4 kg (3 lb)
  As entire RTK rover with batteries for greater than 7 hours, less than 4 kg (8.8 lb)
Dimensions (W×H×L) .... 13.5 cm × 8.5 cm × 24 cm (5.3 in × 3.4 in × 9.5 in)

Electrical:
Power .... DC input 11 to 28 V DC with over voltage protection
Power consumption .... 2.5 W receiver only, 3.75 W including internal radio
Battery .... Greater than 10 hours data logging, or greater than 7 hours of RTK operation on two internal 2.0 Ah lithium-ion batteries
Battery weight .... 0.1 kg (3.5 oz)
Battery charger .... Internal with external AC power adapter; no requirement for external charger
Power output .... 11.5 to 20 V DC (Port 1), 11.5 to 27.5 V DC (Port 3) on external power input
Certification .... Class B Part 15 FCC certification, CE Mark approved, C-Tick approved, Canadian FCC

Environmental:
Operating temperature[4] .... -40 °C to 65 °C (-40 °F to 149 °F)
Storage temperature .... -40 °C to 80 °C (-40 °F to 176 °F)
Humidity .... 100%, condensing

Communications and data storage:
- 2 external power ports, 2 internal battery ports, 3 RS232 serial ports
- Integrated USB for data download speeds in excess of 1 Mb per second
- External GPS antenna connector
- CompactFlash advanced lightweight and compact removable data storage. Options of 64 MB or 128 MB from Trimble
- More than 3,400 hours continuous L1+L2 logging at 15 seconds with 6 satellites typical with 128 MB card
- Fully integrated, fully sealed internal UHF radio modem option
- GSM, cellphone, and CDPD modem support
- Dual event marker input capability
- 1 Hz, 2 Hz, 5 Hz, and 10 Hz positioning and data logging
- 1 pulse per second output capability
- CMRII, CMR+, RTCM 2.*x* and 3.*x* input and output standard
- 14 NMEA outputs

Zephyr antenna

Dimensions .... 16.2 cm (6.38 in) diameter × 6.2 cm (2.44 in) height
Weight .... 0.55 kg (1.20 lb)
Operating temperature .... -40 °C to 70 °C (-40 °F to 158 °F)
Humidity .... 100% humidity proof, fully sealed
Shock and vibration .... Tested and meets the following environmental standards:
  Shock .... MIL-STD-810-F to survive a 2 m (6.56 ft) drop onto concrete
  Vibration .... MIL-STD-810-F on each axis

- 4-point antenna feed for submillimeter phase center repeatability
- Integral low noise amplifier
- 50 dB antenna gain

Zephyr Geodetic antenna

Dimensions .... 34.3 cm (13.5 in) diameter × 7.6 cm (3 in) height
Weight .... 1.31 kg (2.88 lb)
Operating temperature .... -40 °C to 70 °C (-40 °F to 158 °F)
Humidity .... 100% humidity proof, fully sealed
Shock and vibration .... Tested and meets the following environmental standards:
  Shock .... MIL-STD-810-F to survive a 2 m (6.56 ft) drop onto concrete
  Vibration .... MIL-STD-810-F on each axis

- 4-point antenna feed for submillimeter phase center repeatability
- Integral low noise amplifier
- 50 dB antenna gain
- Trimble Stealth ground plane for reduced multipath

1 Accuracy may be subject to conditions such as multipath, obstructions, satellite geometry, and atmospheric parameters. Always follow recommended survey practices.
2 Depends on WAAS/EGNOS system performance.
3 May be affected by atmospheric conditions, signal multipath, and satellite geometry. Initialization reliability is continuously monitored to ensure highest quality.
4 Receiver operates normally to –40 °C (–40 °F) but some office-based functions such as USB download or internal battery charging are not recommended at temperatures below freezing.
Specifications subject to change without notice.

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DATA SHEET

TRIMMARK 3 RADIO MODEM

KEY FEATURES

Versatile: Use as base, repeater or rover

Flexible: 2 W, 10 W, or 25 W power output

Channel spacing programmable at 12.5 kHz or 25 kHz

Easy to use and configure

Built-in channel selector and monitor

Rugged and weatherproof

RUGGED AND VERSATILE MULTICHANNEL RADIO MODEM

The TRIMMARK™ 3 radio modem provides a convenient, versatile means of establishing a robust wireless data broadcast network for real-time, high-precision GPS survey and telemetry applications.

The rugged, compact TRIMMARK 3 radio modem is designed for use in tough environments and in a variety of situations. The single unit is usable as a base station, repeater station, or rover receiver for maximum versatility. However you use it, you'll appreciate its simplicity and famous Trimble reliability and quality.

SELECT THE POWER YOU NEED

The TRIMMARK 3 radio modem provides selectable power outputs of 2 W, 10 W, or 25 W to support both short and long-range operations, conserve battery life and minimize risk of interference with other systems.

A 25 W base unit broadcasts up to 15 km (8 miles) line-of-sight, under optimal conditions. Path obstructions and terrain can reduce the typical effective range to 10 km to 12 km (6 miles to 7 miles). One or two additional units can be networked as repeater stations to extend range, minimize base station moves, and provide seamless coverage around local obstacles such as large buildings or hills. The typical range of a 2 W repeater is 5 km to 8 km (3 miles to 5 miles).

A TRIMMARK 3 radio modem broadcasts or repeats data to Trimble survey-grade GPS receivers, such as the Trimble R8, 5800, Trimble R7, and 5700, that either contain an internal radio modem or are being used with an external rover radio. The TRIMMARK 3 is fully backward compatible with the TRIMMARK IIe radio modem, so it can be used in both new and existing systems.

CONFIGURE IT TO YOUR NEEDS

The TRIMMARK 3 radio modem can be configured completely and easily in the office by using the supplied WinFLASH utility on your computer. Many functions also can be configured in the field from the front panel or from the Trimble Survey Controller™ software used with your GPS survey receivers. The serial port communication settings are easily set to match the default settings on the GPS receiver.

You can configure each broadcast network to operate on one of up to 20 programmed channels via a built-in channel selector. Channel spacing of either 12.5 kHz or 25 kHz is programmable at the factory or by a service provider.

To reduce the risk of interference in a congested RF environment, you can use the built-in audio speaker to monitor activity on the selected channel. The unit also can automatically monitor the channel using its software selectable carrier detect function to detect other users on the channel before transmitting.

The TRIMMARK 3 radio modem is available as a stand-alone product as well as in convenient base and repeater equipment sets. Available in three frequency bands, the TRIMMARK 3 radio modem is designed to meet the licensing requirements of many countries around the world.

Trimble

TRIMMARK 3 RADIO MODEM

STANDARD FEATURES

- Selectable 20-channel capacity
- Rugged weatherproof construction
- Configurable from front panel, survey controller, or from supplied WinFLASH utility on your computer
- Up to 15 km line-of-sight range
- Same unit can function as base station, repeater station, or rover receiver
- Selectable power outputs of 2 W, 10 W, or 25 W
- Programmable channel spacing of 12.5 kHz or 25 kHz
- Built-in channel selector
- Supports up to two repeaters in a network
- 4800, 9600 and 19200 baud rate over the air
- Retrievable/storable radio diagnostic information

TRIMMARK 3 BASE/REPEATER

Physical

Size .... 12.5 cm W x 22.9 cm D x 7.9 cm H (4.9" W x 9.0" D x 3.1" H)

Weight .... 1.59 kg (3.5 lb)

Electrical

Power:

Input................................ 12 V DC to 16 V DC, nominal

Connectors:

Power................................... 2-pin LEMO (+VDC, GND)

Data .... 7-pin female LEMO (supports RXD, TXD and SGND)

Antenna.. TNC female

Environmental

Temperature:

Operating .... –40 °C to +65 °C (–40 °F to +149 °F)

Storage........................ –55 °C to +75 °C (–67 °F to +167 °F)

Humidity........................ 100%, fully sealed, weatherproof

TECHNICAL SPECIFICATIONS

Transmit Power[1] .... 2 W, 10 W, 25 W

Wireless Data Rate.................. 4800 bps, 9600 bps, 19200 bps

Frequency Bands .... 410–420 MHz, 430–450 MHz, or 450–470 MHz (Only one band per radio modem)

Channel Spacing............................... 12.5 kHz or 25 kHz (Only one spacing per radio modem)

Number of Channels[2]...... Can be ordered with up to 20 programmed frequencies, internally stored

RF Modulation Format........ Gaussian Minimum Shift Keying (GMSK)

Range (typical)[3]

25 W Base...................... 10 km to 12 km (6 miles to 7 miles)

2 W Repeater .... 5 km to 8 km (3 miles to 5 miles)

Power Consumption[4]	Voltage	Current	Nominal Load
2 W mode	12.6 V	0.8 A	~10 W
10 W mode	12.6 V	3.6 A	~45 W
25 W mode	12.6 V	8.0 A	~75 W

Serial Port...................... One set of RS-232 signals available. Data is 8 bits with selectable parity and 1 stop bit. Supported data rates are 9600 bps, 19200 bps, and 38400 bps[5]

ANTENNA PHYSICAL SPECIFICATIONS	LENGTH (TYPICAL)	WEIGHT
Standard antenna		
0 dB UHF omni whip	47 cm (18.5 in)	0.5 kg (1.1 lb)
5 dB UHF omni whip	99 cm (39 in)	0.5 kg (1.1 lb)

1. Radios are configured as 25-W units at the factory
2. Use the same frequency for all radio modems in the same wireless data network.
3. Varies with terrain and operational conditions. Up to 2 repeaters can be used to extend range.
4. Power consumption and battery life depend on the broadcast information content and wireless data rate (e.g., CMR versus RTCM SC-104 Ver 2.x packets at 1-Hz epoch rates).
5. Communications rate between the radio and GPS receiver; not wireless rate.

Specifications subject to change without notice.

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DATA SHEET

TRIMBLE 5800 GPS SYSTEM

KEY FEATURES

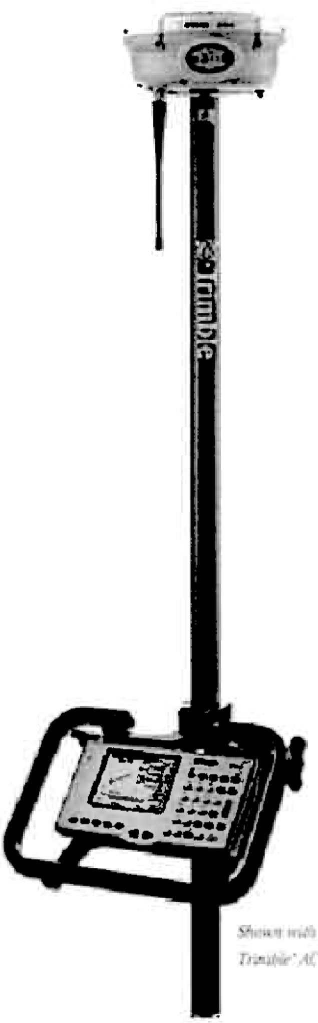
Purpose-built integrated GPS receiver for improved productivity

Can be used as a rover or base for unrivaled versatility

Extremely lightweight—to reduce fatigue on all-day operations

Cable-free rover for more flexibility and ease-of-use in the field

Accurate and reliable for confidence in your results



Shown with the Trimble® ACU Controller

FULLY INTEGRATED, EXTREMELY LIGHTWEIGHT, CABLE-FREE GPS SYSTEM

The Trimble® 5800 GPS system makes cables a thing of the past. The receiver itself combines a dual-frequency GPS receiver, Trimble GPS antenna, UHF (receive only) radio and batteries in one compact unit.

INTEGRATED SYSTEM

Because the Trimble 5800 GPS system's components are completely integrated, as a rover the system is lightweight and ergonomic—and completely cable-free. 2 MB of internal memory makes collecting data for postprocessing extremely easy and efficient, whether for static or kinematic (stop-and-go) surveying.

The Trimble 5800 can also be used as a base station, so it is versatile to meet the changing needs of your business.

ADVANCED TECHNOLOGY

The Trimble 5800 GPS system offers advanced Trimble GPS technology. It is a 24-channel dual-frequency GPS/WAAS/EGNOS receiver, containing Trimble's proven Maxwell™ technology for robust tracking in difficult GPS environments.

Its WAAS and EGNOS capability provides real-time differential positioning without a base station.

The dual-frequency Trimble antenna enhances the tracking capabilities of the Trimble 5800—the patented four-point antenna feed provides submillimeter phase center stability for precise results. The position of the UHF radio antenna mounting further increases accuracy by being out of the GPS line-of-sight, reducing multipath and avoiding interference with the GPS antenna.

For rover communications use the built-in 450 or 900 MHz radio, or use an external radio, cell phone or wireless packet data modem.

For base communications, select a radio from Trimble's range of powerful communication products. Just the kind of flexibility you need!

For extended coverage and comprehensive error checking when roving, the Trimble 5800 works with signals from multiple base stations transmitting on the same radio channel. For even larger area coverage, at highest accuracies, the Trimble 5800 works with Trimble VRS™ networks.

Integrated Bluetooth wireless technology enables cable-free communication between the receiver and your Trimble controller.

BUILT FOR THE FIELD

The Trimble 5800 as a rover is not only lightweight and cable-free; it also consumes minimal power. Two miniature batteries will power the receiver for up to 11 hours – at least enough for a full working day.

Environmentally rated to IPX7, and submersible to a depth of 1 m, the Trimble 5800 is rugged enough for any job. It can withstand a drop of up to 2 m on to a hard surface.

WIDE RANGE OF APPLICATIONS

The 5800 GPS system is ideal for a wide range of positioning applications, including:

- Survey
- Construction
- Asset management

It offers you the accuracy, flexibility, and ease of use you need for all your survey-grade GPS applications.

• *Bluetooth type approvals are country specific. Contact your Trimble representative for more information.*

Trimble

PERFORMANCE SPECIFICATIONS

Measurements

- Advanced Trimble Maxwell Custom Survey GPS Chip
- High precision multiple correlator for L1 and L2 pseudorange measurements
- Unfiltered, unsmoothed pseudorange measurements data for low noise, low multipath error, low time domain correlation and high dynamic response
- Very low noise L1 and L2 carrier phase measurements with <1 mm precision in a 1 Hz bandwidth
- L1 and L2 Signal-to-Noise ratios reported in dB-Hz
- Proven Trimble low elevation tracking technology
- 24 Channels L1 C/A Code, L1/L2 Full Cycle Carrier, WAAS/EGNOS support

Code differential GPS positioning[1]

Horizontal .... ±0.25 m +1 ppm RMS
Vertical .... ±0.50 m +1 ppm RMS
WAAS differential positioning accuracy[2] .... Typically <5 m 3DRMS

Static and FastStatic GPS surveying[1]

Horizontal .... ±5 mm +0.5 ppm RMS
Vertical .... ±5 mm +1 ppm RMS

Kinematic surveying[1]

Horizontal .... ±10 mm +1 ppm RMS
Vertical .... ±20 mm +1 ppm RMS
Initialization time .... Single/Multi-base minimum 10 sec +0.5 times baseline length in km, up to 30 km
Initialization reliability[3] .... Typically >99.9%

HARDWARE

Physical

Dimensions (WxH) . 19 cm (7.5 in) × 10 cm (3.9 in), including connectors
Weight .... 1.31 kg (2.89 lb) with internal battery, internal radio, standard UHF antenna. 3.67 kg (8.09 lb) entire RTK rover including batteries, range pole, ACU controller and bracket
Temperature[4]
Operating ....–40 °C to +65 °C (–40 °F to +149 °F)
Storage ....–40 °C to +75 °C (–40 °F to +167 °F)
Humidity .... 100%, condensing
Waterproof .... IPX7 for submersion to depth of 1 m (3.28 ft)
Shock and vibration .... Tested and meets the following environmental standards:
Shock ..... Non-operating: Designed to survive a 2 m (6.6 ft) pole drop onto concrete. Operating: to 40 G, 10 msec, sawtooth
Vibration MIL-STD-810F, FIG.514.5C-1

Electrical

- Power 11 to 28 V DC external power input with over-voltage protection on Port 1 (7-pin Lemo)
- Rechargeable, removable 7.4 V, 2.0 Ah Lithium-Ion battery in internal battery compartment. Power consumption is <2.5 W, in RTK mode with internal radio.
- Operating times on internal battery: 450 MHz or 900 MHz receive only 5.5 hours, varies with temperature
- Certification Class B Part 15, 22, 24 FCC certification, Canadian FCC, CE Mark approval, and C-tick approval

Communications and Data Storage

- 3-wire serial (7-pin Lemo) on Port 1. Full RS-232 serial on Port 2 (Dsub 9 pin)
- Fully Integrated, fully sealed internal 450 MHz receiver
- Fully Integrated, fully sealed internal 900 MHz receiver
- Fully integrated, fully sealed 2.4 GHz communications port (Bluetooth)[5]
- External GSM, Cellphone and CDPD modem support for RTK and VRS operations
- Data storage on 2 MB internal memory: 55 hours of raw observables based on recording data from 6 satellites at 15 second intervals
- Data storage on controller with 128 MB memory: Over 3400 hours of raw observables based on recording data from 6 satellites at 15 second intervals
- 1 Hz, 2 Hz, 5 Hz, and 10 Hz positioning
- CMRII, CMR+, RTCM 2.1, RTCM 2.3, RTCM 3.0 Input and Output
- 14 NMEA outputs, GSOF and RT17 outputs
- Supports BINEX and smoothed carrier

1 Accuracy and reliability may be subject to anomalies such as multipath, obstructions, satellite geometry, and atmospheric conditions. Always follow recommended survey practices.
2 Depends on WAAS/EGNOS system performance.
3 May be affected by atmospheric conditions, signal multipath, and satellite geometry. Initialization reliability is continuously monitored to ensure highest quality.
4 Receiver will operate normally to –40 °C, Bluetooth module and internal batteries are rated to –20 °C.
5 Bluetooth type approvals are country specific. Contact your local Trimble office or representative for more information.

Specifications subject to change without notice.

Bluetooth

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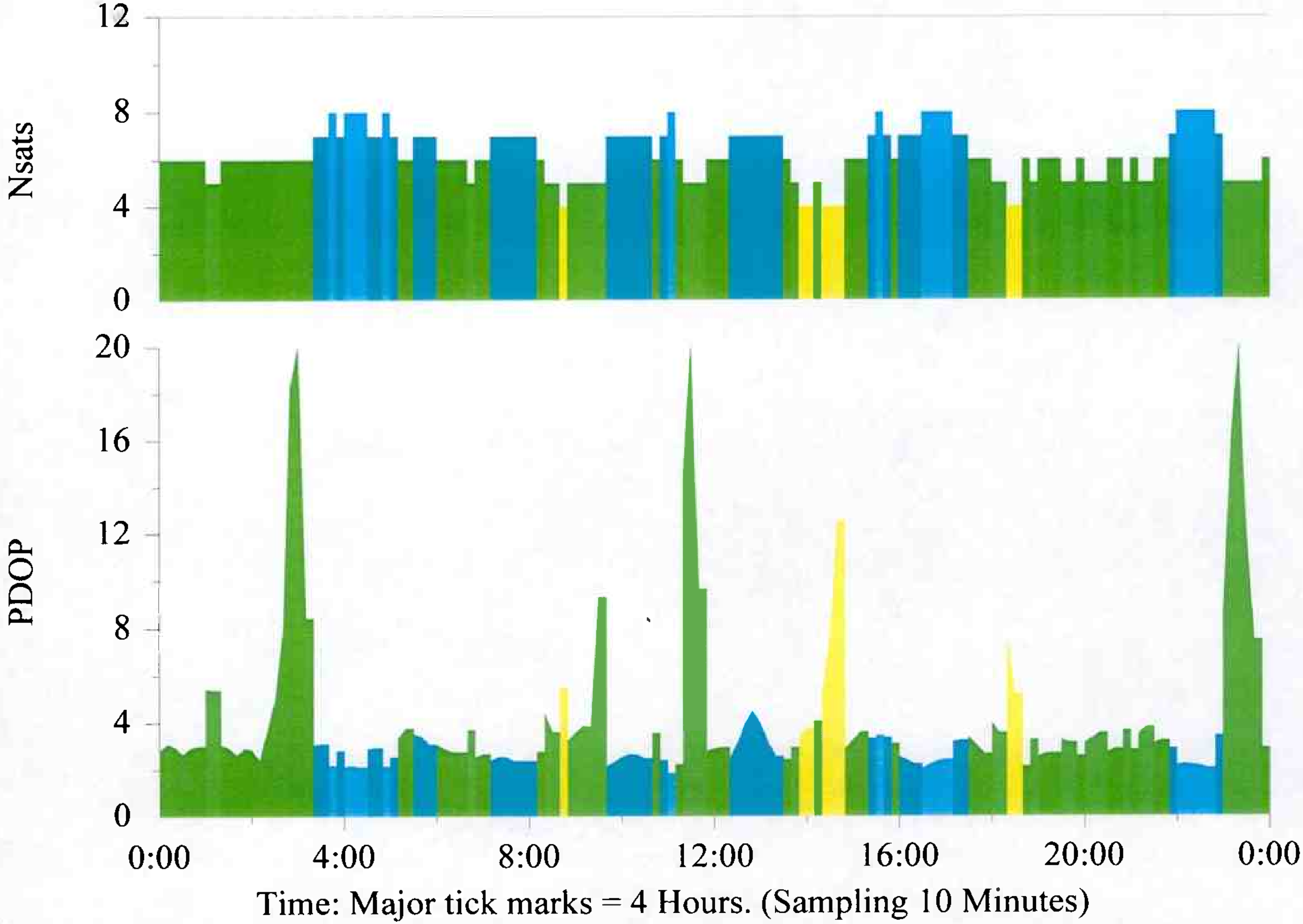
APPENDIX E SATELLITE GEOMETRY PLOTS

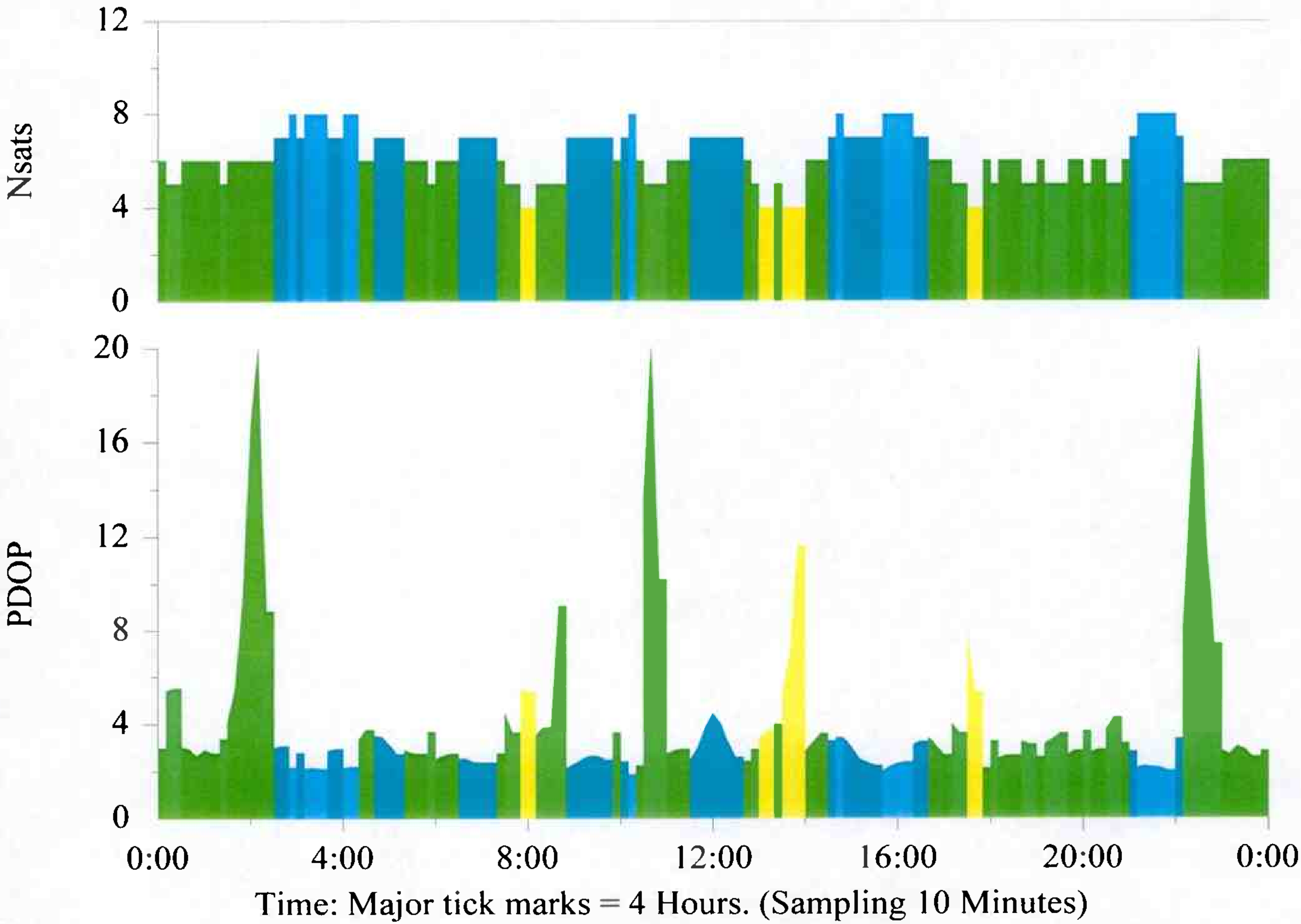
Number SVs and PDOP

Point: Vakkerlien | Lat 62:32:0 N Lon 10:17:0 E | Almanac: ALMANAC.EPH 05/10/06
Date: 2005/October/05 | Threshold Elevation 20 (deg) | Time Zone 'Central European Day' 2:00
28 Satellites considered : 1 2 3 4 5 6 7 8 9 10 11 13 14 15 16 18 19 20 21 22 23 24 25 26 27 28 29 30



Number SVs and PDOP

Point: Vakkerlien | Lat 62:32:0 N Lon 10:17:0 E | Almanac: ALMANAC.EPH 05/10/06
Date: 2005/October/17 | Threshold Elevation 20 (deg) | Time Zone 'Central European Day' 2:00
28 Satellites considered : 1 2 3 4 5 6 7 8 9 10 11 13 14 15 16 18 19 20 21 22 23 24 25 26 27 28 29 30



APPENDIX F LINE STATISTICS REPORT

APPENDIX F – LINE STATISTICS REPORT

XYZSTAT version 1.50.02 Copyright GEOSOFT Inc. 1994

Statistics report for file: VAKK.XYZ
Z column number: 2

type	line#	#pts	X-min	X-max	Y-min	Y-max	Z-min	Z-max
line	286	37	567600	568500	6928600	6928601	759.205	815.422
line	288	43	567452.1	568500.1	6928799	6928801	765.184	827.209
line	290	45	567400.1	568500	6929000	6929000	783.443	835.697
line	292	45	567400	568500	6929200	6929200	796.88	847.407
line	294	45	567399.9	568500.1	6929400	6929400	811.317	857.527
line	307	57	567125.1	568525	6930700	6930700	872.161	934.362
line	309	109	565825	568525	6930900	6930900	801.653	945.488
line	311	110	565825	568525.1	6931093	6931100	802.072	951.317
line	313	109	565825	568525.5	6931299	6931301	802.519	962.49
line	315	109	565825	568525.1	6931500	6931501	803.055	969.197
line	317	109	565825	568524.9	6931699	6931730	803.08	961.781
line	319	57	565825	567225.1	6931898	6931902	804.794	877.292
line	329	46	565450	566550.3	6932899	6932900	823.568	848.081
line	330	45	565450	566550	6933000	6933001	830.665	855.017
line	331	46	565450.1	566550	6933100	6933100	835.083	858.869
line	332	45	565449.8	566550.1	6933195	6933203	840.146	864.598
line	333	45	565449.9	566550	6933300	6933301	846.675	875.823
line	334	46	565449.9	566549.7	6933400	6933400	853.333	882.359
line	335	45	565450	566549.9	6933499	6933500	860.853	887.847
line	336	45	565449.9	566550	6933598	6933601	866.741	893.797
line	337	45	565449.9	566550.1	6933700	6933702	875.204	903.316
line	663	88	566299.8	566300.5	6930700	6932875	802.128	838.43
line	664	89	566399.9	566400.3	6930700	6932875	801.433	844.807
line	665	88	566499.9	566500.1	6930700	6932875	802.416	846.91
line	666	89	566599.8	566601.9	6930700	6932900	813.705	850.332
line	667	89	566699.9	566701.2	6930700	6932900	824.446	862.219
line	668	33	566799.8	566800.1	6932100	6932900	830.748	867.056
line	669	33	566899.9	566901.4	6932100	6932903	838.835	870.994
line	670	33	566999.9	567000.2	6932100	6932901	844.551	878.568

Statistics report for file: ALL.XYZ
Z column number: 2

Number of points: 1825
Number of lines: 29
Base lines: 0
Tie lines: 0
Trend lines: 0
Test lines: 0

SUMMARY				
	X-min:	565449.8	X-max:	568525.5
	Y-min:	6928600	Y-max:	6933702
	Z-min:	759.205	Z-max:	969.197
	Z-mean:	851.8904	Z-dev:	44.18187

APPENDIX G STARTKART CONTROL POINT DESCRIPTIONS

FOUR (4) GEODETIC POINT's at KVIKNE NORWAY

This info / table is made / based on info from www.startkart.no -> norgesglasset (old version).

FIXED MARK	G27T0065	G27T0136	G27T0222	G27T0223
NAME	ÅSFJELL	VAKKERLIFJELL	STORINNSJØEN	SLØBEKKSETERA
NORTH	6931463,775	6935786,254	6933997,854	6929262,312
EAST	568571,041	565601,417	564379,512	565619,475
ZONE	32	32	32	32
HIGHT (orto)	970,249	989,559	879,776	809,177
POINT / TYPE	T *)	T *)	L **)	L **)
SURFACE			BEDROCK	BEDROCK
QUALITY XYm	0,03	0,05	0,03	0,03
QUALITY Horto	0,030	0,050	0,030	0,030
HIGHT (ell)	1012,440	1031,880	922,180	851,542
STATUS				
REF. YEAR				
KOMMUNE	437	437	437	437
OTHER ID				
DESCRIPTION	About 10 Km. S of the church in Kvikne. From Kvikne along the main road towards SE to STORÅSEN. From here a foot-path to the top.	70 – 80 m. S of the highest point and 4 m. S of the road to the seter.	In the S end of a small hill, 40 m. NE of road and 20 (?) m. ENE of highvoltage mast.	About 4 m. S of road ditch, 10 m. SSE of the highest point of road.
Height Diff (orto-ell)	42.191	42.321	42.404	42.365

"Fixed point" , fastmerke :
*) = "Triangel point" , Trig. Pt. / trekant punkt
**)= "Country grid" , Lands-nett

Enclosed are four (4) maps showing location of the points as described under description in the table concerning the grids in "The North Area" - Vakkerlien and "The South Area" - Orkla.

Rgds. finn h

Rev.: B 2005.10.13

APPENDIX H WAAS/EGNOS/OMINSTAR TEST DATA

GPS Survey for Falconbridge Ltd.

Vakkerlien Project - WAAS/EGNOS and Omnistar Differential Correction versus Geodetic Grade RTK with Basestation

Statiom	WAAS					SAT DIF					BASE			
	x	y	z	running diff	base diff	x	y	z	running diff	base diff	x	y	z	running diff
335565950	565949.885	6933500.795	908.381			565949.751	6933499.969	908.697			565949.833	6933499.823	865.572	
335565925	565925.341	6933501.140	905.862	-2.519	0.348	565925.077	6933500.240	906.563	-2.134	-0.037	565924.938	6933499.935	863.401	-2.171
335565900	565899.870	6933501.416	906.362	0.500	0.462	565900.308	6933500.591	907.883	1.320	-0.358	565900.019	6933500.036	864.363	0.962
335565875	565875.022	6933501.269	906.698	0.336	-0.201	565875.179	6933500.267	907.721	-0.162	0.297	565874.997	6933499.988	864.498	0.135
335565850	565850.269	6933501.143	907.328	0.630	0.021	565850.315	6933500.261	908.561	0.840	-0.189	565850.093	6933500.047	865.149	0.651
335565825	565825.253	6933501.201	907.108	-0.220	-0.040	565825.256	6933500.122	908.310	-0.251	-0.009	565825.078	6933500.063	864.889	-0.260
335565800	565800.168	6933501.153	907.889	0.781	0.070	565800.307	6933499.901	908.858	0.548	0.303	565800.111	6933499.966	865.740	0.851
335565775	565774.815	6933500.998	909.210	1.321	-0.353	565775.095	6933500.217	910.038	1.180	-0.212	565774.929	6933499.923	866.708	0.968
335565750	565749.615	6933500.849	910.708	1.498	-0.114	565750.144	6933500.217	911.207	1.169	0.215	565749.862	6933499.902	868.092	1.384
335565725	565724.988	6933501.523	909.135	-1.573	-0.715	565725.564	6933500.486	908.519	-2.688	0.400	565725.011	6933500.116	865.804	-2.288
335565700	565700.224	6933500.646	907.273	-1.862	0.989	565700.375	6933500.001	908.023	-0.496	-0.377	565700.017	6933499.679	864.931	-0.873
335565675	565675.374	6933501.508	905.159	-2.114	0.048	565675.441	6933500.777	905.382	-2.641	0.575	565675.054	6933500.212	862.865	-2.066
335565650	565650.295	6933501.098	903.428	-1.731	-0.134	565650.209	6933500.661	903.970	-1.412	-0.453	565649.996	6933500.040	861.000	-1.865
335565625	565625.201	6933500.980	903.495	0.067	-0.214	565625.169	6933500.305	904.265	0.295	-0.442	565624.937	6933500.097	860.853	-0.147
335565600	565600.112	6933500.903	906.657	3.162	0.148	565600.097	6933500.127	907.818	3.553	-0.243	565599.959	6933500.082	864.163	3.310
335565575	565575.332	6933500.619	911.040	4.383	-0.347	565575.259	6933500.078	910.331	2.513	1.523	565575.079	6933499.868	868.199	4.036
335565550	565550.244	6933500.938	910.170	-0.870	0.428	565550.089	6933500.429	910.756	0.425	-0.867	565549.870	6933499.965	867.757	-0.442
335565525	565525.149	6933500.902	905.954	-4.216	-0.182	565525.146	6933500.534	906.706	-4.050	-0.348	565524.896	6933500.014	863.359	-4.398
335565500	565500.288	6933500.905	907.167	1.213	-0.062	565500.337	6933500.334	907.703	0.997	0.154	565500.028	6933500.052	864.510	1.151
335565475	565475.225	6933500.967	909.429	2.262	0.046	565475.215	6933500.397	910.172	2.469	-0.161	565475.095	6933499.985	866.818	2.308
335565450	565450.313	6933500.686	909.441	0.012	-0.230	565450.307	6933500.444	910.030	-0.142	-0.076	565450.008	6933499.993	866.600	-0.218

APPENDIX I REFERENCES

Trimble Navigation,2000. *Mapping Systems Manual*

Telford, W.M., Geldhart, L.P., and Sheriff, R.E. 1990. *Applied Geophysics, 2nd Edition*, NY: Cambridge University Press

APPENDIX C

-Logistics Report-
2005 UTEM Survey
Vakkerlien
Norway
for
A/S Sulfidmalm

LAMONTAGNE GEOPHYSICS LTD
GEOPHYSIQUE LTEE

December, 2005

Rob Langridge, M.Sc.

CONTENTS

Figures

Appendices

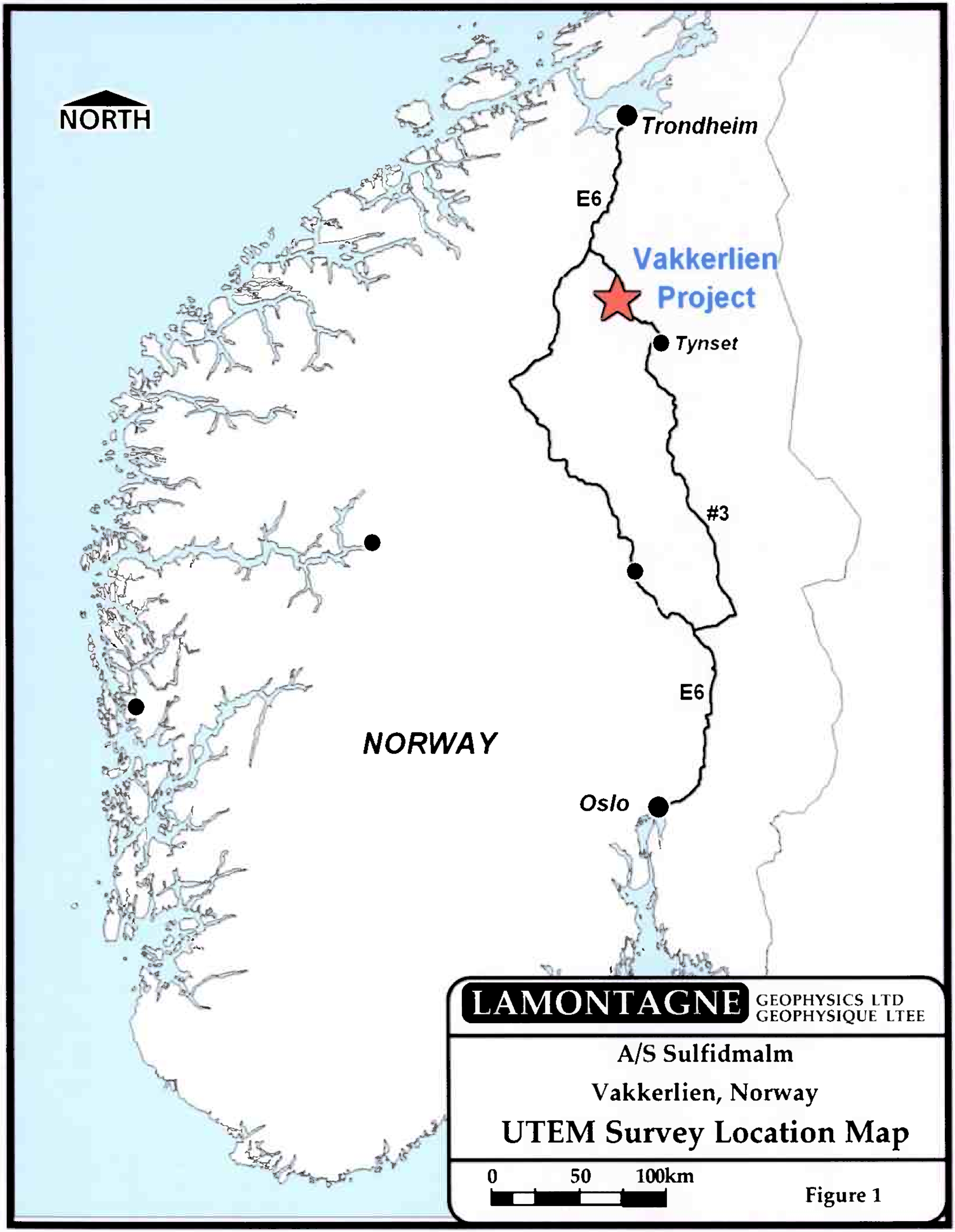
INTRODUCTION

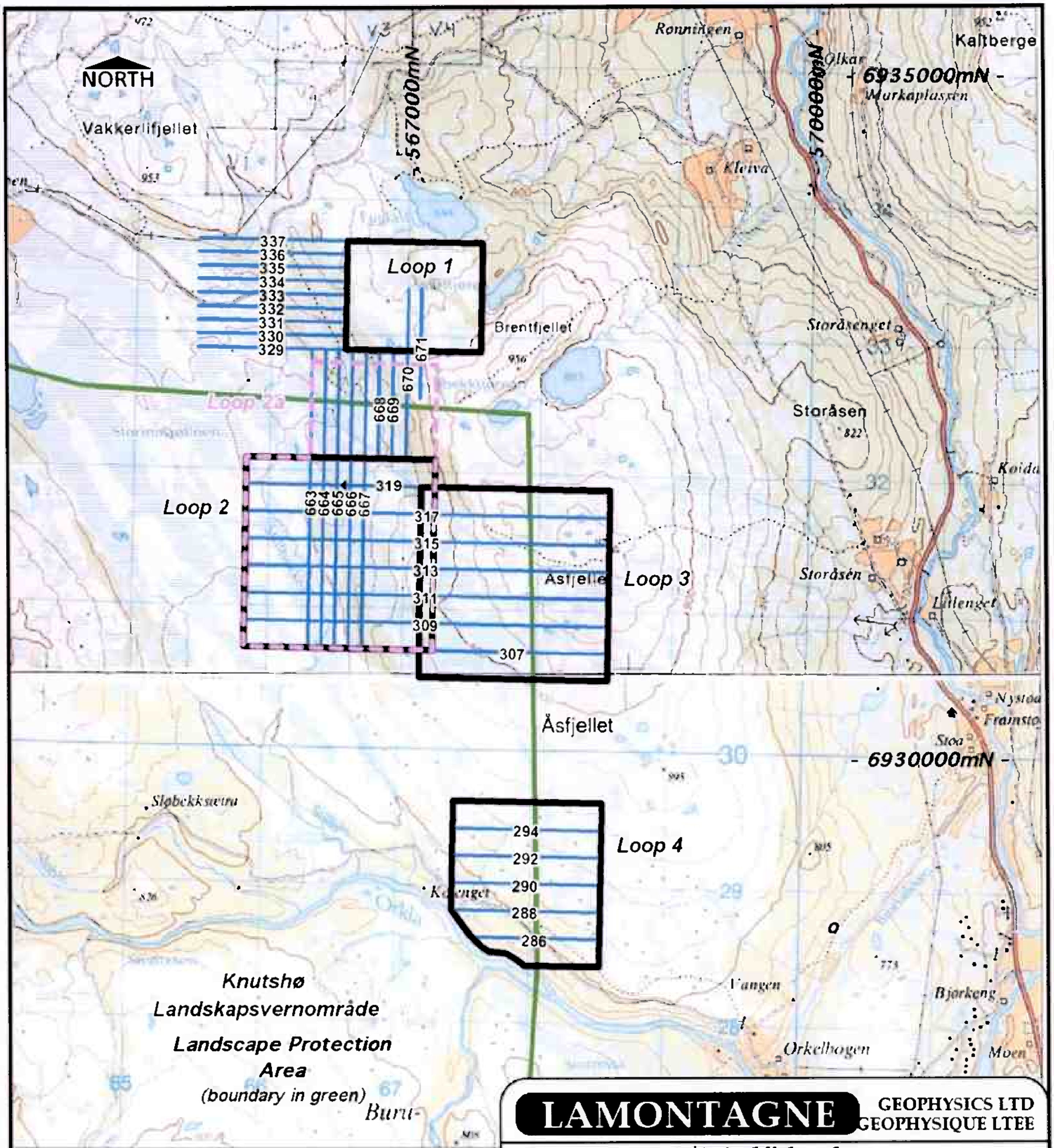
During the period of November 3rd 2005 through November 26th 2005 a UTEM survey was carried out by Lamontagne Geophysics Limited personnel for A/S Sulfidmalm in the area of Vakkerlien, Norway (Figure 1). The location of the property is shown in Figures 1 and 2. Areas of interest were identified from the results of an airborne survey and the results of previous work in the area. The survey was carried out to locate conductors in the immediate grid areas with the intention of outlining targets for future work.

A total of 50.450km of surface UTEM data was collected using 5 transmitter loops (Loops 1, 2, 2a, 3, and 4). All lines were surveyed measuring the vertical component, Hz. A station spacing of 25m or 50m and a line spacing of 200m or 100m was employed. For all loops the receiver operated in 10-channel mode at a transmitter frequency of 3.251Hz.

This report documents the UTEM survey in terms of logistics, survey parameters and field personnel. Appendix A contains the data presented in profile form. Other appendices contain:

- List of Personnel/Production Diary (Appendix B)
- an outline of the UTEM System (Appendix C)
- Note on sources of anomalous Ch1 (Appendix D)
- Note on 4Hz UTEM Data (Appendix E)


NORTH
Trondheim
E6
Vakkerlien Project
Tynset
#3
E6
NORWAY
Oslo
LAMONTAGNE GEOPHYSICS LTD GEOPHYSIQUE LTEE
A/S Sulfidmalm
Vakkerlien, Norway
UTEM Survey Location Map
0
50
100km
Figure 1



Notes:
- Local grid coordinates are: (grideast, gridnorth)=(UTM$_{easting}$-560000, UTM$_{northing}$-6900000)
- Loop 2a (in pink) was a modified Loop 2 designed to test a noisy area on Lines 670E and 671E.
- snoscooter access to the Landscape Protection area was not granted.

LAMONTAGNE GEOPHYSICS LTD GEOPHYSIQUE LTEE

A/S Sulfidmalm

Vakkerlien, Norway
Idealized Grid Map

0 1000m

Figure 2

SURVEY DESIGN

This UTEM survey is part of a nickel exploration program in the Vakkerlien area. Historically mining of Ni-bearing massive sulfide deposits has been carried out in the area. The UTEM survey was planned and carried out to outline and allow better definition of known conductors, to detect/outline new conductors and to detect/outline deeper features and depth continuations of known features.

The grid and loop layout was designed by A/S Sulfidmalm/Falconbridge Ltd. personnel to allow efficient coverage of the area. Loop size and locations were selected to provide good coupling with the expected targets and to allow efficient coverage of the grid area. The base frequency was lowered from the international standard ~26Hz to 3.251Hz to eliminate the response of many "moderate" conductors - these responses will have decayed away by Ch1 time. Any remaining Ch1 responses are then considered to be representative of conductors of an appreciably higher conductivity.

The survey parameters employed:

- both in-loop and outside-the-loop coverage with 2 receivers
- variable transmitter loop size - to fit the area to be covered and the relief
- 1.18mm (~1mm^2 ~17-gauge copper wire) doubled in places for increased current - more signal requires shorter stacking times and/or better quality data
- line spacing of 200m or 100m intervals as required
- station interval of 25m or 50m.
- Hz (vertical component measurements)
- 10-channel data at a frequency of 3.251Hz
- minimum 256 stacking (512 half-cycles) increased where noise levels dictate

In nickel exploration non-decaying Channel 1 (Ch1) conductors are indicative of highly conductive mineralization. Any non-decaying anomalous Ch1 features are therefore of interest. Non-decaying channel UTEM anomalies can reflect:

i) the presence of conductive mineralization
ii) the presence of a magnetic anomaly
iii) poor geometric control - either station location or loop location

These are outlined in more detail in Appendix D. From an interpretation standpoint magnetic anomalies and geometric control should be considered and evaluated as a mandatory part of any interpretation. From a field standpoint precise geometric control should be part of any UTEM survey where the target is non-decaying. Poor geometric control has the potential to both mask and invent Ch1 conductors.

For this survey GPS data was collected by the client and made available for use in reducing the UTEM data. GPS data was collected for all survey points and at intervals around all transmitter loops. GPS data collection for UTEM reduction should be most detailed along loop fronts - the most important portion of the loop from a UTEM reduction perspective. The goal along the loop front - and loop sides/back - is to recover the topographic shape of the loop as well as the loop/line intersection points.

SURVEY LOGISTICS

A Lamontagne Geophysics crew mobilized from Kingston/Calgary to Oslo/Trondheim in early November. The crew consisted of Rob Langridge (crew chief) , John Frost (operator) and Tim Pinkerton (looper). John Frost arrived in Oslo on October 31st along with Falconbridge personnel. They and the UTEM equipment were met by client representative Finn Hansen and together they drove to Espedalen. The following morning they continued on to the base of operations for the Vakkerlien survey - at the Hogstad Campground roughly ten kilometers north of the survey areas. Equipment was unpacked and loop laying began. Rob Langridge and Tim Pinkerton were collected from Trondheim on the evening of November 3rd and surveying began the following day - November 4th.

Five transmitter loops were used during the surface UTEM survey for a total survey coverage of 50.450km. Figure 2 shows the loop locations and grid layout. Access to the Vakkerlien project was by pick-up truck via farm access roads. The grid/loop positions had been established by GPS and were demarcated by bamboo wands and flagging. Access to the grid was on foot and later, with the snowfall, in part by snoscooter. Part of the survey area lies in a Landscape Protection Area (outlined on Figure 2) and the snoscooter permit did not allow us access to this area. The only access to the Landscape Protection Area - including all of Loop 2 - was on foot.

There was no snow on the ground for the first part of the survey and as a result surveying began with Loop 4 - the loop most easily accessible by road. The wire for this loop was laid in advance by the client. Loop 1 - the second-most accessible by road - was surveyed next. The generator (Honda 7500W) was moved out to the loop along with the UTEM equipment. The generator is larger than would typically be required (~2500W) and moving it about proved to be difficult under the field conditions. A wheel-barrow was used to transport it to the transmitter sites of Loop 1 and Loop 2/3. It was removed from the survey area by sled - hand towed to the edge of the Landscape Protection Area and then pulled by snoscooter.

Electrical connection to the generator was made through an LGL isolation-transformer/Variac combination rewired to conform with the sockets (standard 2-pin/side-clip ground european) on the generator. For all but a few nights the transmitter was connected to a battery, switched to remote, packed up against the weather and left in the field. This worked well for the duration of the survey. The small-volume gas tank on the generator was the only drawback - it required filling at least 2 times a survey day (every 4.5-5 hours).

In general surface surveying for all loops went well although more slowly than planned. Noise levels proved to be high and in places, along certain geologic structures, extremely high. Higher noise levels in the vertical component are typical of very resistive areas. Locally noisy areas indicate some channeling of telluric currents along features in the very-resistive country rock. For the final two loops - Loop 3 and then Loop 2 - the highest possible pre-whitening level was used and all sides of the loop were doubled as much as possible. Doubling the wire reduces the resistance of the loop and this allows a higher transmitter current to be used. Higher current equals more signal and an improved signal-to-noise ratio - less stacking is required and surveying proceeds more quickly. In practice it requires a considerable additional effort to lay/retrieve double strands of wire. Because access to these loops was limited to foot access the doubled wire proved a useful resource when repairing loop breaks. Use of a heavier gauge wire could be considered on future surveys.

The northern section of the area surveyed from Loop 1 is cut by a powerline. The powerline crosses the northernmost line surveyed - Line 337N. The powerline meets Line 336N at the westernmost station surveyed. In general surveying in the area of powerlines required additional stacking and the profiles from Loop 1(Appendix A) are noisy in the vicinity of the cultural features. The noise is particularly evident on the earlier channels - Ch10-5 - as the channel width is too narrow to allow the 50Hz powerline transmission to be adequately stacked out (Appendix E). Note that the powerline is not the source of all the noise present on the Loop 1 profiles in Appendix A. The very resistive geological setting is also a contributor as discussed above.

For logistical reasons Tim Pinkerton was demobilized as scheduled on November 24th. The final surface UTEM data was collected November 24th and the survey was declared completed. All remaining wire and pickets were picked up on November 25th and 26th and the equipment was packed for shipping. The crew and equipment, along with the Falconbridge crew and equipment, demobilized. The crew demobilized to Canada on November 28th and the equipment was transported to Gardemoen Airport the same day by Falconbridge personnel. . Details of the daily production and personnel are included in the Production Diary (Appendix B) along with a summary of production.

The survey equipment consisted of two UTEM 3 receivers and one UTEM 3 transmitter as well as all necessary accessories, support equipment and backup equipment. Data was reduced on a field computer (Macintosh) and UTEM profiles and digital data were made available/emailed to the client's personnel on a daily basis. Boots and then snowshoes were used during the survey.

Care was taken during the survey not to leave anything on the site. One site which should be checked over after the snow melts is the the Loop 2/3 transmitter site (Line 319N @ 7225E where the loops intersect) which was occupied for over two weeks - from November 11th to the 26th. The site lies in the Landscape Protection Area and although care was taken with the amount of snow that fell it is possible something was left at the site.

In practice the UTEM operators worked with coilers. Where survey conditions allowed - towards the ends of survey lines where long stacking times were required - the coiler could be freed up to facilitate looping and picket retrieval. The coilers also trekked back to the generator to fill up the gas tank as required. The weather conditions were generally fair-to-good for surveying. Prior to the arrival of snow the days were cool but windy. The snow conditions were generally good although a considerable amount of snow disappeared over the course of a few warmer days.

SURVEY RESULTS

The results of the survey are summarized and presented as UTEM profiles in Appendix A. The final grid and Loop Locations are presented in Figures 2. Overall the data quality is good - though in places it is noisy. Little evidence of conductors and/or conductive features are evident. Although every effort was taken to shelter the receiver coil minor wind noise may be evident in some profiles.

Surface profiles are listed by Loop number and presented as 3-axis profiles in the following order:

Hz	**continuous norm**	***Ch1 reduced***	**(blue separator)**
Hz	**point normalized**	***Ch1 reduced***	**(pink separator)**

A description of the standard plotting formats used and of the UTEM System is presented in Appendix C.

Outline of surface profile types

Hz continuous norm ***Ch1 reduced*** **(blue separator)**

Continuous normalization is useful for detection of the presence of anomalies at any position on a profile. The anomaly shape is distorted by the normalization to the local field. As the field gets very big near the wire the continuously normalized Ch1 tends towards zero.

top axis - Ch5-10
middle axis - Ch2-5
bottom axis - Ch1
bottom axis - topography - no vertical exaggeration

Hz point normalized ***Ch1 reduced*** **(pink separator)**

normalization point: all data~300m out from the loop-front centre

Point normalized data is useful for interpretation purposes. Anomaly shape is preserved as is the amplitude if the normalization point is local to the anomaly.

All data has been point normalized to a the field at a point ~300m out from the centre of the loop front. Note that this field value is intermediate and it was chosen because the survey was roughly half inside-the-loop and half off-loop. Normalizing to an intermediate point allows the interpretation of responses along the entire line. The amplitude of responses close to (**further from**) the loop front will be blown up (**muted**).
Note: Typically the normalization point for off-loop profiles is 4-500m out from the centre of the loop front and for inside-the-loop profiles it is the loop centre.

The disadvantage of point normalization is that small errors in location near the wire and in current tend to appear as large errors in Ch1. If the loop/station locations and the current are accurately known then point normalized Ch1 (in the absence of a local conductor) will tend to be continuous approaching the wire - unlike the continuously normalized Ch1 which, as described above, will dip to zero.

top axis - Ch5-10
middle axis - Ch2-5
bottom axis - Ch1
bottom axis - topography - no vertical exaggeration

Discussion of Results

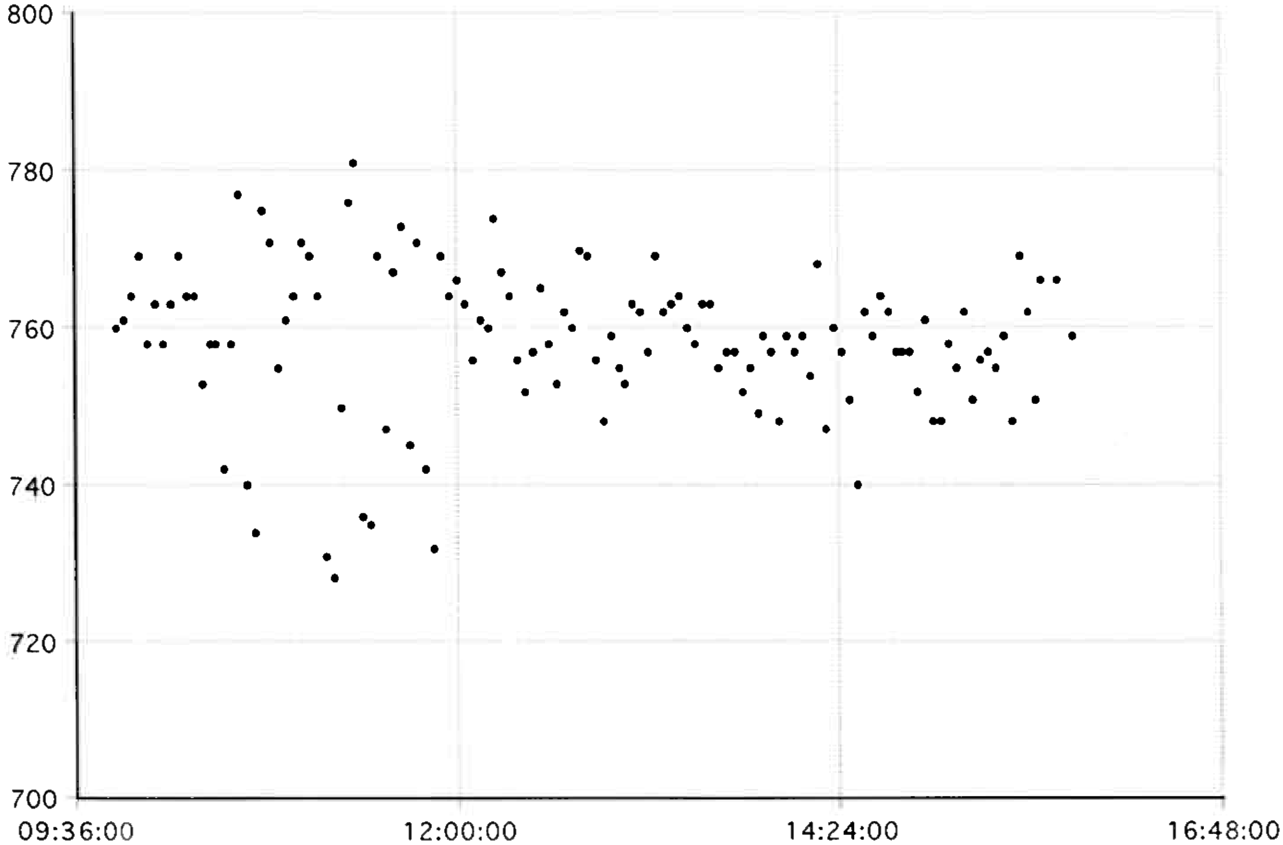
The area surveyed is very resistive - little response is seen at even the earliest time-channels. The off-loop data - Loop 1 and the lines surveyed to the north of Loop 2 - is noisy-to-very-noisy in places once the distance to the loop front exceeds 500-600m.

Noise levels proved to be high and in places, along certain geologic structures, extremely high. Higher noise levels in the vertical component are typical of very resistive areas. Locally noisy areas can indicate some channeling of telluric currents along features in the very-resistive country rock.

As a test of whether the powerline that just comes onto the area surveyed from Loop 1 (NE corner of Figure 2) was responsible for some of the noise seen in the survey data the spare receiver was set up and recorded data during a survey day (November 10). The site selected was reasonably close to the powerline and well-sheltered to reduce wind noise. Staking was deliberately set a little low for the site - 512 full-cycles (1024 half-cycles). A 512 reading takes ~3 minutes to complete and record (2:54) and 124 readings were taken in a 6-hour period.

The results are plotted in Figure 3 and show that noise conditions at the site on the day in question were better after noon than prior to noon. This indicates that the powerline may be having some variable influence on the noise conditions. We were actually testing for ~the opposite influence. As we begin surveying at the loop and as noise levels increased sharply at a given distance - ~a given time in the survey day - from the loop we were testing whether the afternoons were noisier. Had this been the case we would have changed procedure and started surveying at the ends of lines.

Using the higher pre-whitening level and doubling the loop wire made a difference when surveying the final two loops - Loop 3 and then Loop 2. Even then we needed to "move the loop closer to the area of interest" - extend Loop 2 northward to form Loop 2a - in order to resolve a noise-or-response issue on Lines 670 and 671E. Surveying from Loop 2a brought the area of interest/dispute within 4-600m of the loop front. Reasonably clean data could be efficiently collected and no response was detected. Of note, however, is that stacking times had to be sharply increased (4-8x) over one section of the lines surveyed. Past that section stacking could be reduced again despite the greater distance from the loop.



These are 124 Ch1 readings were taken at Line 137N 5910E 2005.11.10. The site selected was reasonably close (within ~100m) to the powerline and well-sheltered to reduce wind noise. Staking was deliberately set a little low for the site - 512 full-cycles (1024 half-cycles). A 512 reading takes ~3 minutes to complete and record (2:54) and 124 readings were taken in a 6-hour period.

The results are plotted in Figure 3 and show that noise conditions at the site on the day in question were better after noon than prior to noon. This indicates that:

- the powerline may be responsible for some variation in noise levels
- surveying from the loop outwards - ie. surveying at lower signal-to-noise ratios in the afternoon may, in this instance, improve data quality.

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A/S Sulfidmalm

Vakkerlien, Norway

Noise test - Stacking figure

0 50 100km

Figure 3

Conclusions and Recommendations

The results of the survey are summarized and presented as UTEM profiles in Appendix A. Overall the data quality is good - though in places it is noisy. The final Grid and Loop Locations are presented in Figure 2. The area surveyed is very resistive - little response is seen at even the earliest time-channels.

The profiles presented in Appendix A have been reduced with a grid corrected as well as possible using available information. The location of all survey points and loop locations were collected using a GPS system. For reference GPS collection for UTEM reduction should be more detailed along loop fronts. The goal along the loop front - and loop sides/back - is to recover the topographic shape of the loop as well as the loop/line intersection points.

In terms of logistics the survey ran very smoothly and the crew supplied by Falconbridge was excellent and is thanked for their efforts. Several small points should be noted for future surveys:

- If the same generator is to be used on future surveys it should be rigged with a larger gas tank. The small-volume gas tank currently on the generator required filling 2-3 times a survey day.

- Use of a heavier gauge wire (1.70mm diameter DAMID PE GR 2) on future surveys should be considered.
  As noted above: during this survey a Loops 2 and 3 were doubled. In practice it requires an additional effort to lay/retrieve double strands of wire. The total loop resistance is lowered, however, allowing a higher transmitter current. Signal-to-noise is improved, less stacking is required and surveying proceeds more quickly.

Appendix A

0531 UTEM Profiles

UTEM 3 Survey

Vakkerlien
Norway

for

A/S Sulfidmalm

Presentation

The results of the survey are summarized and presented as UTEM profiles in Appendix A. The final grid and Loop Locations are presented in Figures 2. Overall the data quality is good - though in places it is noisy. Few conductive features are evident. A description of the standard plotting formats used and of the UTEM System is presented in Appendix C.

The profiles are listed by Loop number and presented as 3-axis profiles in the order:

Hz continuous norm *Ch1 reduced* **(blue separator)**
Hz point normalized *Ch1 reduced* **(pink separator)**

Outline of surface profile types

Hz continuous norm *Ch1 reduced* **(blue separator)**

Continuous normalization is useful for detection of the presence anomalies at any position on a profile. The anomaly shape is distorted by the normalization to the local field. As the field gets very big near the wire the continuously normalized Ch1 tends towards zero.

top axis - Ch5-10
middle axis - Ch2-5
bottom axis - Ch1
bottom axis - topography - no vertical exaggeration

Hz point normalized *Ch1 reduced* **(pink separator)**

normalization point: all data ~300m out from the loop-front centre

Point normalized data is useful for interpretation of responses. Anomaly shape is preserved as is the amplitude if the normalization point is local to the anomaly.

All data has been point normalized to a the field at a point ~300m out from the centre of the loop front. Note that this field value is intermediate and it was chosen because the survey was roughly half inside-the-loop and half off-loop. Normalizing to an intermediate point allows the interpretation of responses along the entire line. The amplitude of responses close to (**further from**) the loop front will be blown up (**muted**). Note: Typically the normalization point for off-loop profiles is 4-500m out from the centre of the loop front and for inside-the-loop profiles it is the loop centre.

The disadvantage of point normalization is that small errors in location near the wire and in current tend to appear as large errors in Ch1. If the loop/station locations and the current are accurately known then point normalized Ch1 (in the absence of a local conductor) will tend to be continuous approaching the wire - unlike the continuously normalized Ch1 which, as described above, will dip to zero.

top axis - Ch5-10
middle axis - Ch2-5
bottom axis - Ch1
bottom axis - topography - no vertical exaggeration

List of Data Collected and Plotted

Vakkerlien 2005 Grid

Surface coverage - @ 3.251 Hertz

	Line	coverage	
Loop 01	Line 329N	5500N - 6550N	1050m
	Line 330N	5450N - 6550N	1100m
	Line 331N	5450N - 6550N	1100m
	Line 332N	5450N - 6550N	1100m
	Line 333N	5450N - 6550N	1100m
	Line 334N	5450N - 6550N	1100m
	Line 335N	5450N - 6550N	1100m
	Line 336N	5450N - 6550N	1100m
	Line 337N	5450N - 6550N	1100m
		Vakkerlien Loop 01 Total	9850m
Loop 02	Line 309N	5825N - 7225N	1400m
(E-W)	Line 311N	5825N - 7225N	1400m
	Line 313N	5825N - 8200N	2175m
	Line 315N	5825N - 7225N	1400m
	Line 317N	5825N - 7225N	1400m
	Line 319N	5825N - 7225N	1400m
(N-S))	Line 663E	700N - 2900N	2200m
	Line 664E	700N - 2900N	2200m
	Line 665E	700N - 2900N	2200m
	Line 666E	700N - 2900N	2200m
	Line 667E	700N - 2900N	2200m
	Line 668E	2100N - 2900N	800m
	Line 669E	2100N - 2900N	800m
	Line 670E	2100N - 3150N	1050m
	Line 671E	2500N - 3150N	650m
		Vakkerlien Loop 02 Total	23675m
Loop 02a	Line 670E	2800N - 3400N	600m
	Line 671E	2800N - 3400N	600m
		Vakkerlien Loop 02a Total	1200m
Loop 03	Line 307N	7125N - 8525N	1400m
	Line 309N	7125N - 8525N	1400m
	Line 311N	6125N - 8525N	2400m
	Line 313N	7125N - 8525N	1400m
	Line 315N	7125N - 8525N	1400m
	Line 317N	6100N - 8525N	2425m
		Vakkerlien Loop 03 Total	10425m

List of Data Collected and Plotted

Vakkerlien 2005 Grid

Surface coverage - @ 3.251 Hertz

	Line	coverage	
Loop 04	Line 286N	7600N - 8500N	900m
	Line 288N	7400N - 8500N	1100m
	Line 290N	7400N - 8500N	1100m
	Line 292N	7400N - 8500N	1100m
	Line 294N	7400N - 8500N	1100m
		Vakkerlien Loop 04 Total	5300m
		Vakkerlien **2005 Total**	**50.450km**

Note: The total of 51.750km listed in Appendix B - the Production Diary includes some sections of Loop 1 reread at increased stacking to improve data quality.

Vakkerlien

Loop 1

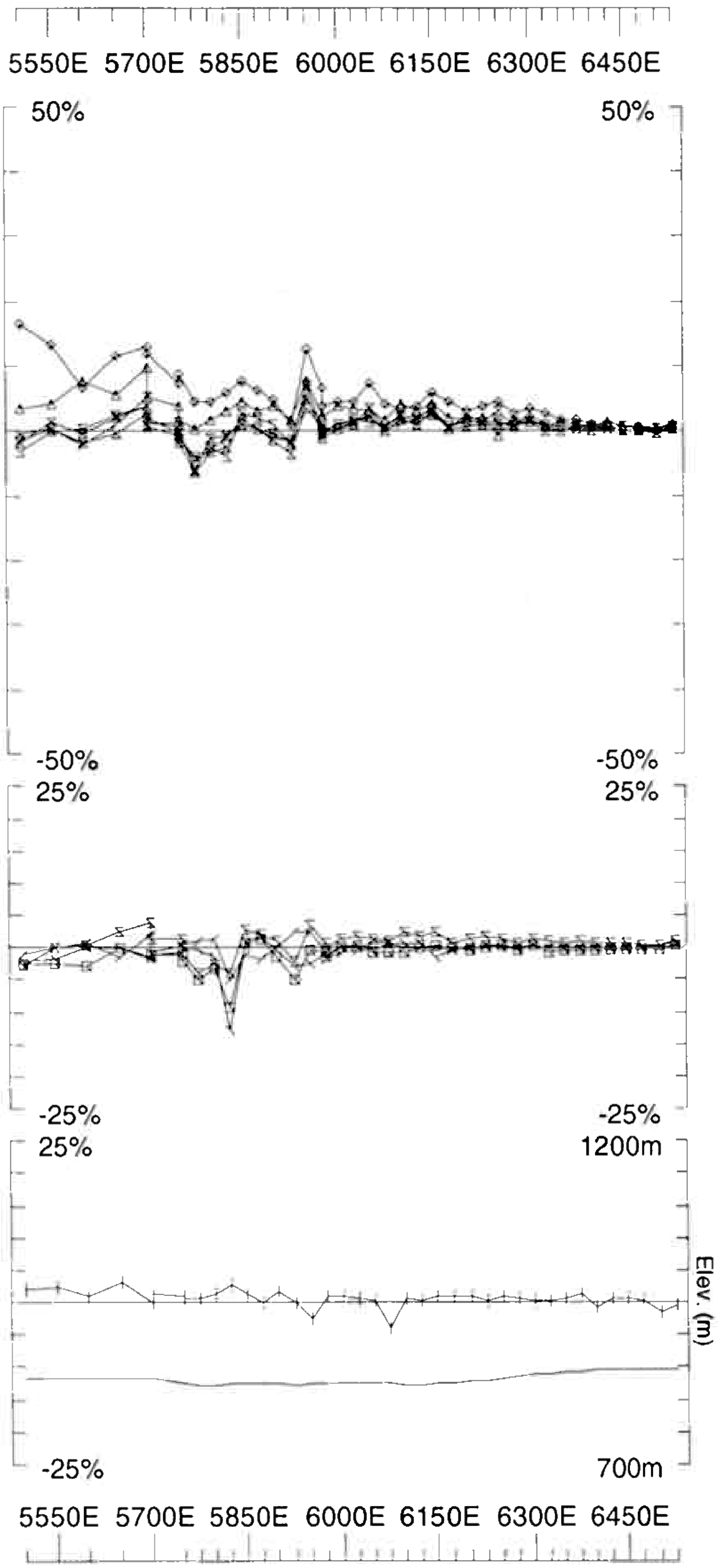
Hz
@3.251 Hz frequency

continuous norm

Ch1 reduced

Loop 01	Line 329N	5500N - 6550N	1050m
	Line 330N	5450N - 6550N	1100m
	Line 331N	5450N - 6550N	1100m
	Line 332N	5450N - 6550N	1100m
	Line 333N	5450N - 6550N	1100m
	Line 334N	5450N - 6550N	1100m
	Line 335N	5450N - 6550N	1100m
	Line 336N	5450N - 6550N	1100m
	Line 337N	5450N - 6550N	1100m
		Vakkerlien Loop 01 Total	9850m

Loop 1 - continuous norm



UTEM Survey at: Vakkerlien
For: A/S Sulfidmalm

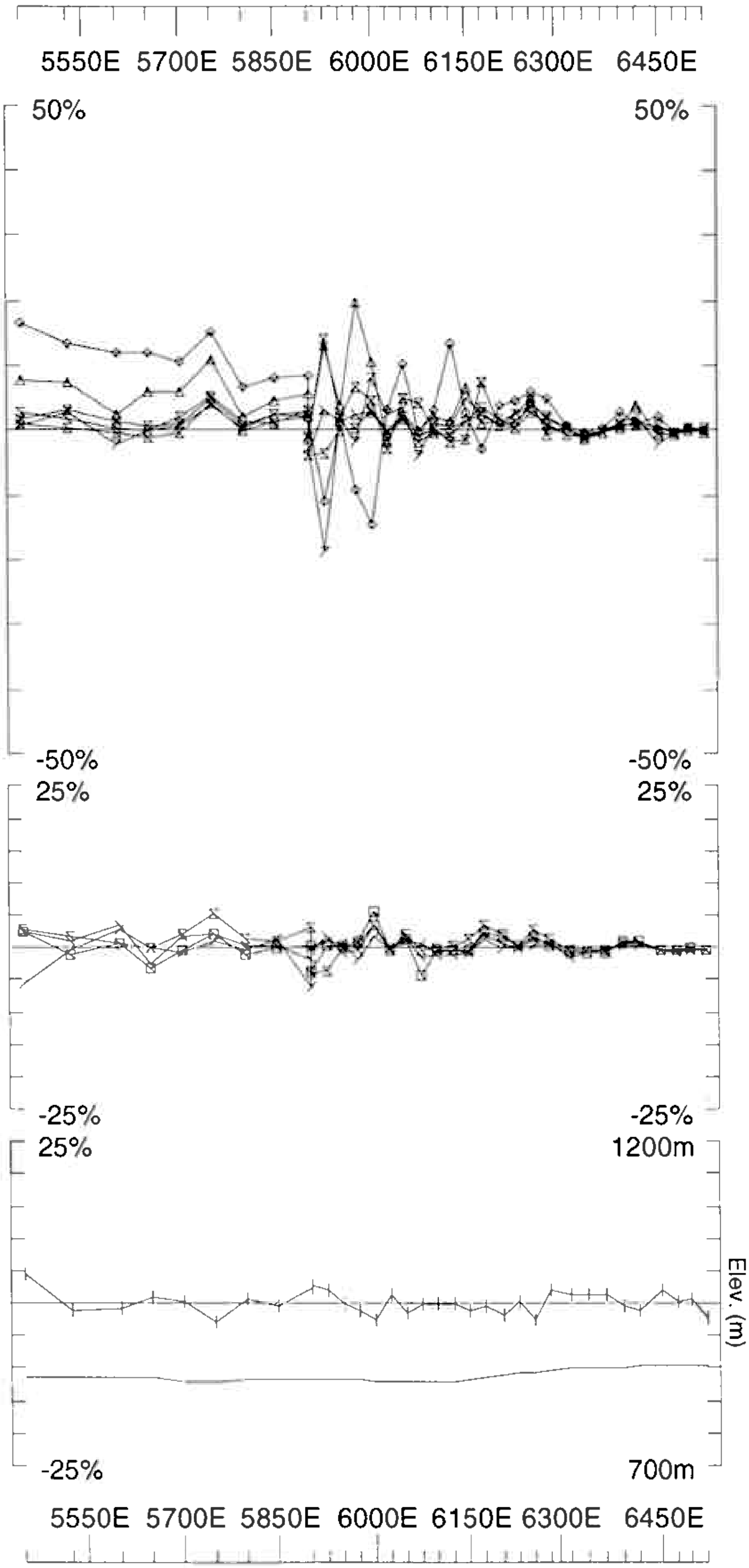
LAMONTAGNE GEOPHYSICS LTD GEOPHYSIQUE LTEE

Job 0531

Plotted : 24/12/5

Secondary, (Chn - Ch1)/|Hp|
Contin. Norm at depth of 0 m
Base Freq. 3.251 Hz

Loop: 01
Line: 329N
Compt: Hz



UTEM Survey at: Vakkerlien
For: A/S Sulfidmalm

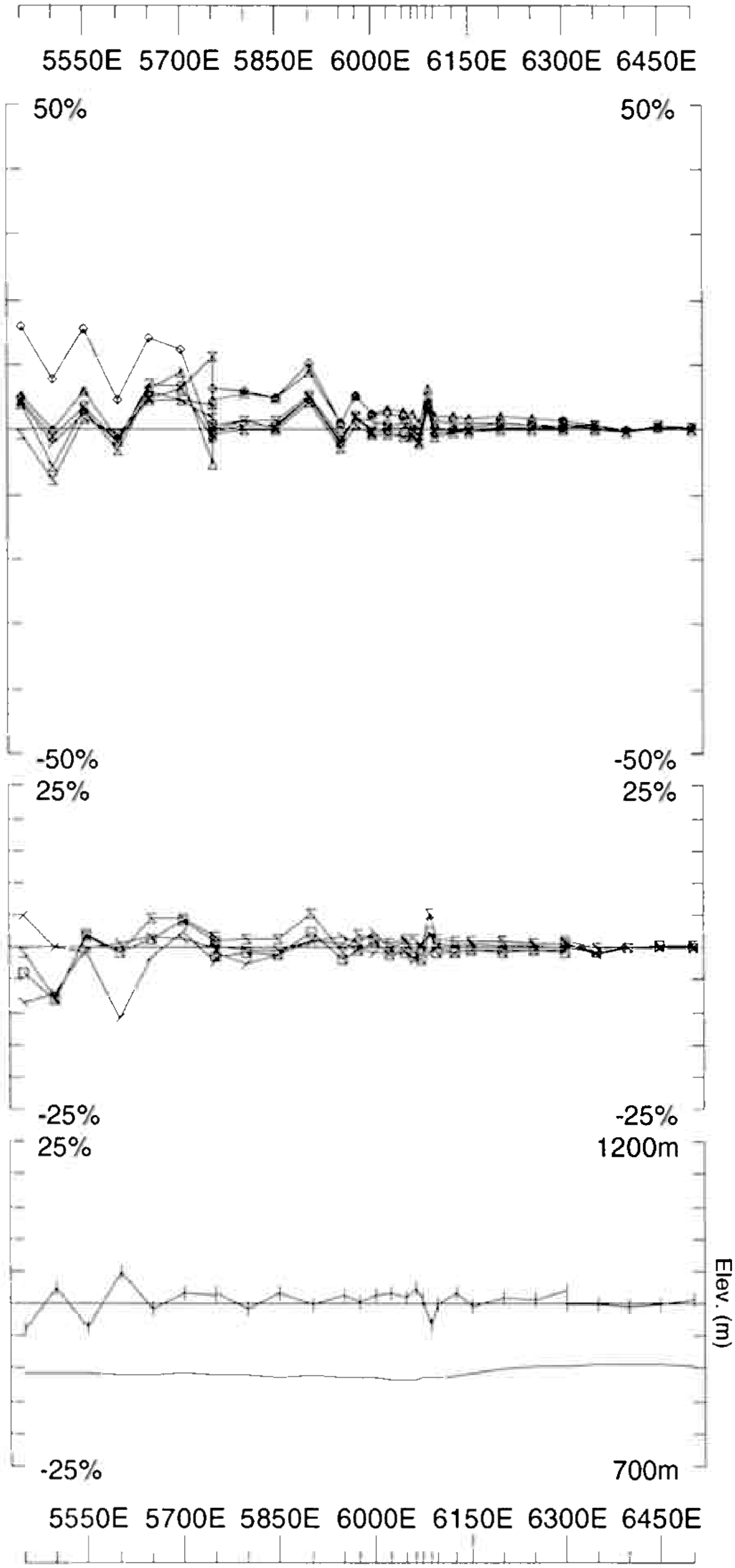
LAMONTAGNE GEOPHYSICS LTD
GEOPHYSIQUE LTEE

Job
0531

Surveyed : 6/11/5
Reduced : 8/11/5
Plotted : 24/12/5

Loop: 01
Line: 330N
Compt: Hz

Secondary, (Chn - Ch1)/IHpI
Contin. Norm at depth of 0 m
Base Freq. 3.251 Hz



UTEM Survey at: Vakkerlien

For: A/S Sulfidmalm

LAMONTAGNE GEOPHYSICS LTD
GEOPHYSIQUE LTEE

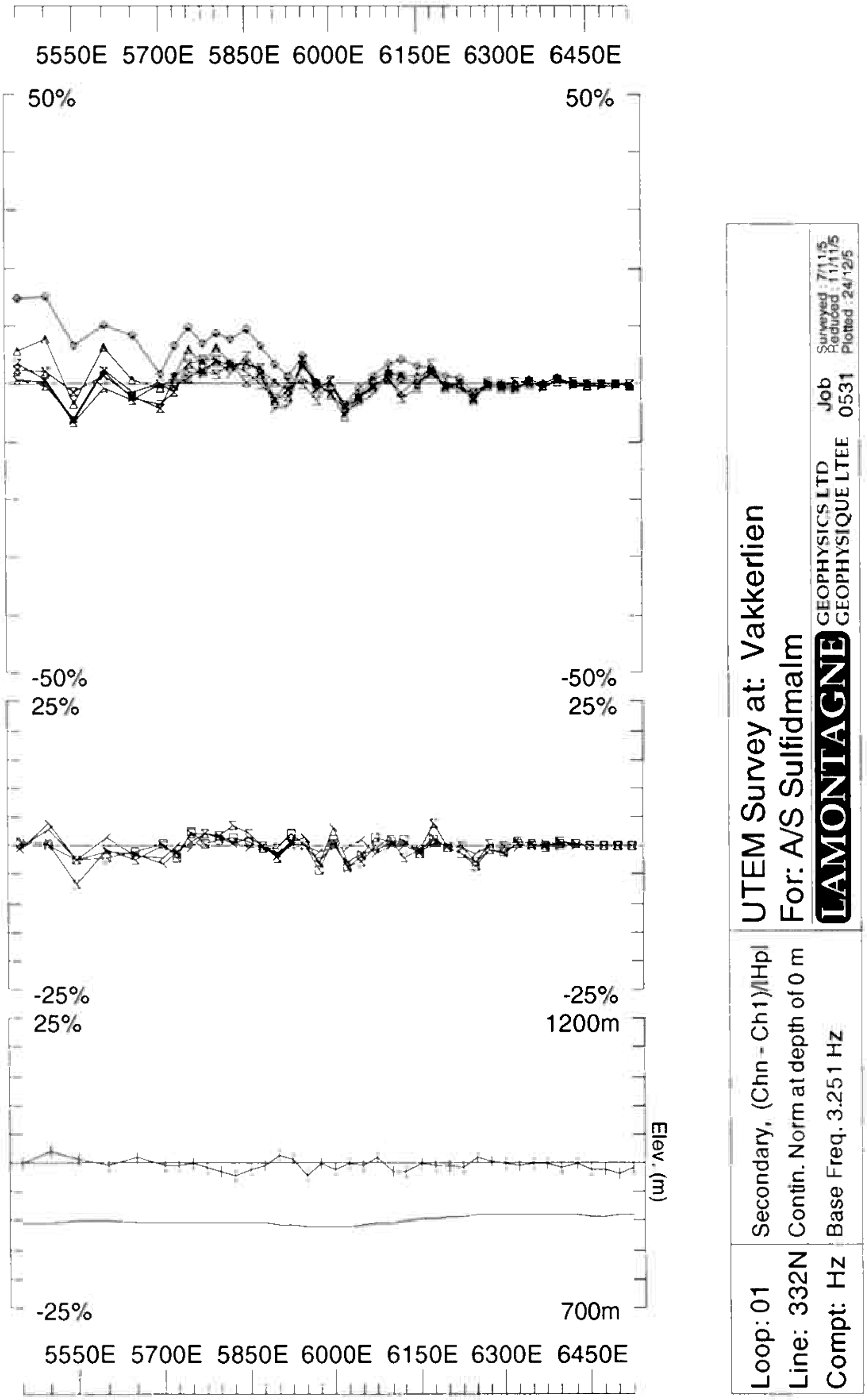
Job 0531

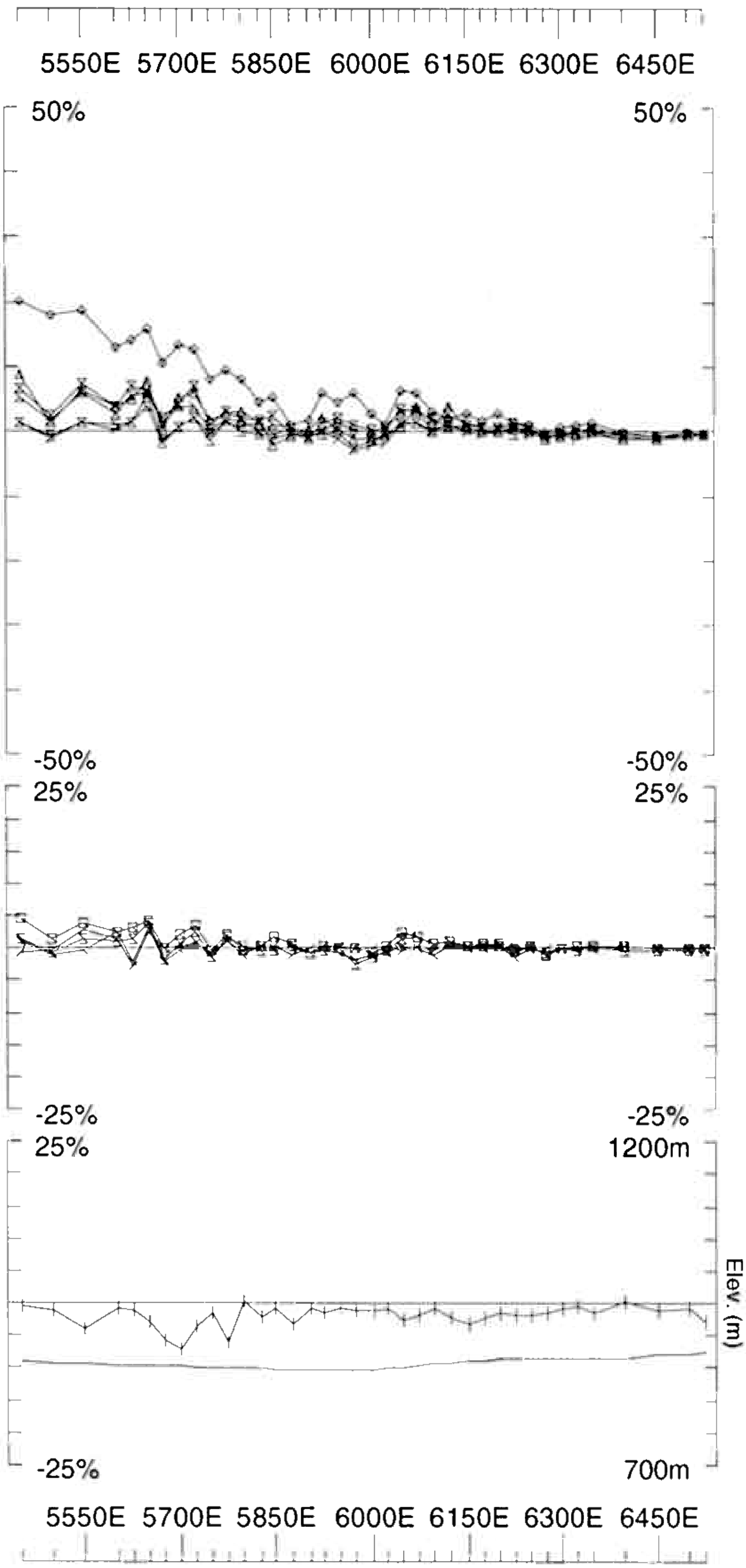
Surveyed: 10/11/5
Reduced: 11/11/5
Plotted: 24/12/5

Loop: 01 | Secondary, (Chn - Ch1)/|Hp|

Line: 331N | Contin. Norm at depth of 0 m

Compt: Hz | Base Freq. 3.251 Hz


5550E 5700E 5850E 6000E 6150E 6300E 6450E
50%
50%
-50%
-50%
25%
25%
-25%
-25%
25%
1200m
Elev. (m)
-25%
700m
5550E 5700E 5850E 6000E 6150E 6300E 6450E
UTEM Survey at: Vakkerlien
For: A/S Sulfidmalm
LAMONTAGNE GEOPHYSICS LTD GEOPHYSIQUE LTEE
Job 0531
Surveyed: 7/11/5
Reduced: 11/11/5
Plotted: 24/12/5
Loop: 01
Line: 332N
Compt: Hz
Secondary, (Chn - Ch1)/IHpI
Contin. Norm at depth of 0 m
Base Freq. 3.251 Hz



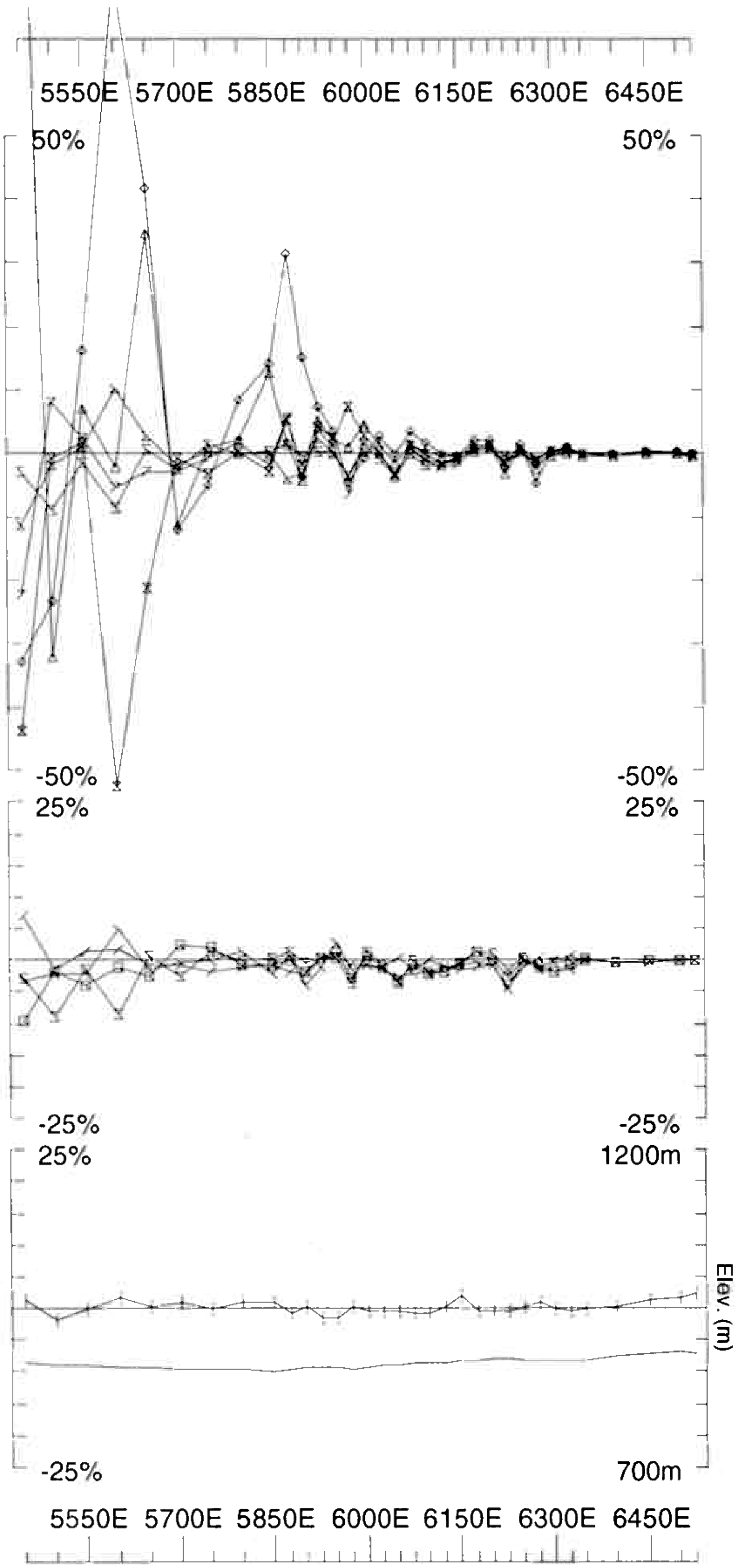
UTEM Survey at: Vakkerlien
For: A/S Sulfidmalm

LAMONTAGNE GEOPHYSICS LTD GEOPHYSIQUE LTEE

Job 0531

Surveyed : 7/11/5
Reduced : 11/11/5
Plotted : 24/12/5

Loop: 01 | Secondary, (Chn - Ch1)/lHpl
Line: 333N | Contin. Norm at depth of 0 m
Compt: Hz | Base Freq. 3.251 Hz



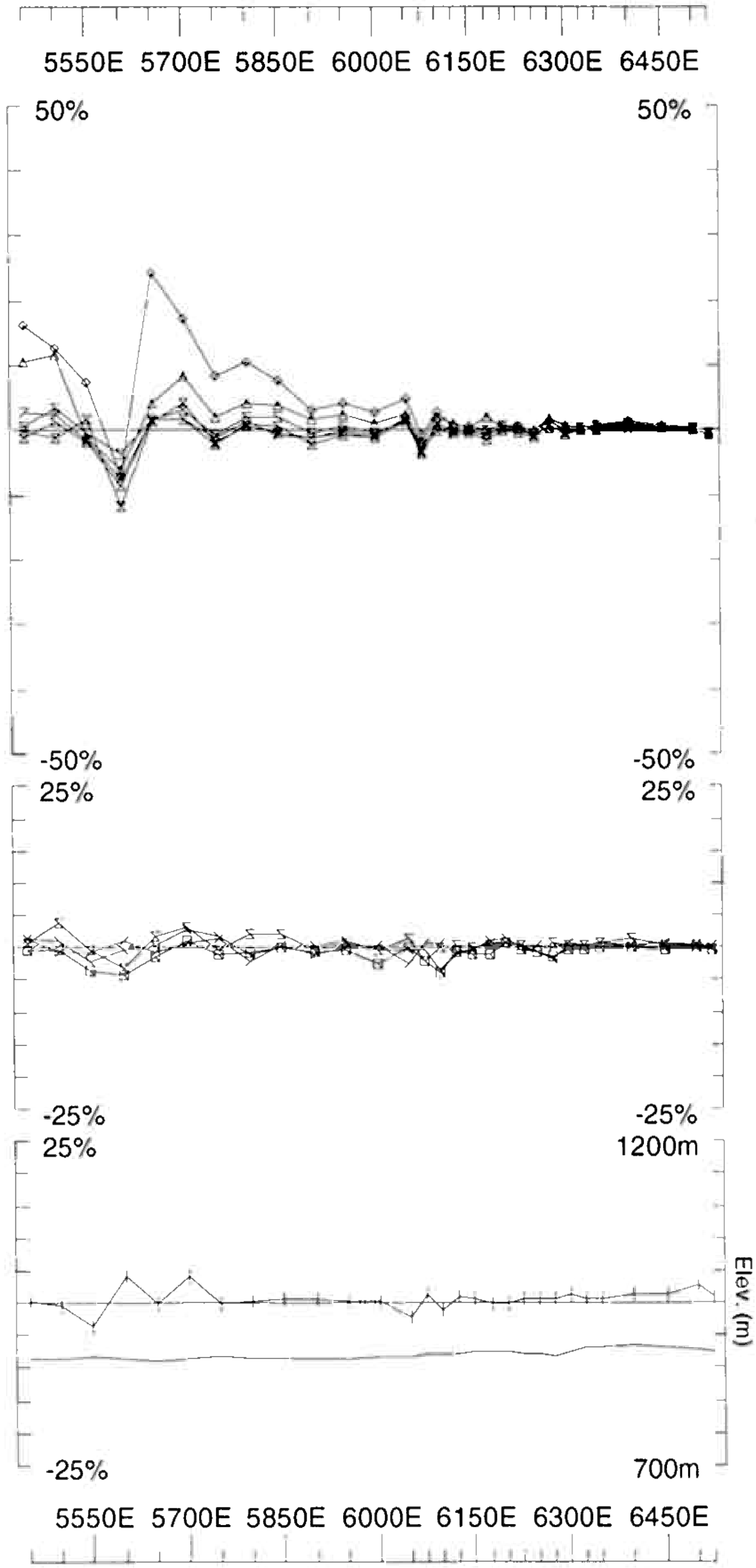
UTEM Survey at: Vakkerlien
For: A/S Sulfidmalm

LAMONTAGNE GEOPHYSICS LTD GEOPHYSIQUE LTEE

Job 0531

Surveyed: 8/11/5
Reduced: 11/11/5
Plotted: 24/12/5

Loop: 01 Secondary, (Chn - Ch1)/lHpl
Line: 334N Contin. Norm at depth of 0 m
Compt: Hz Base Freq. 3.251 Hz



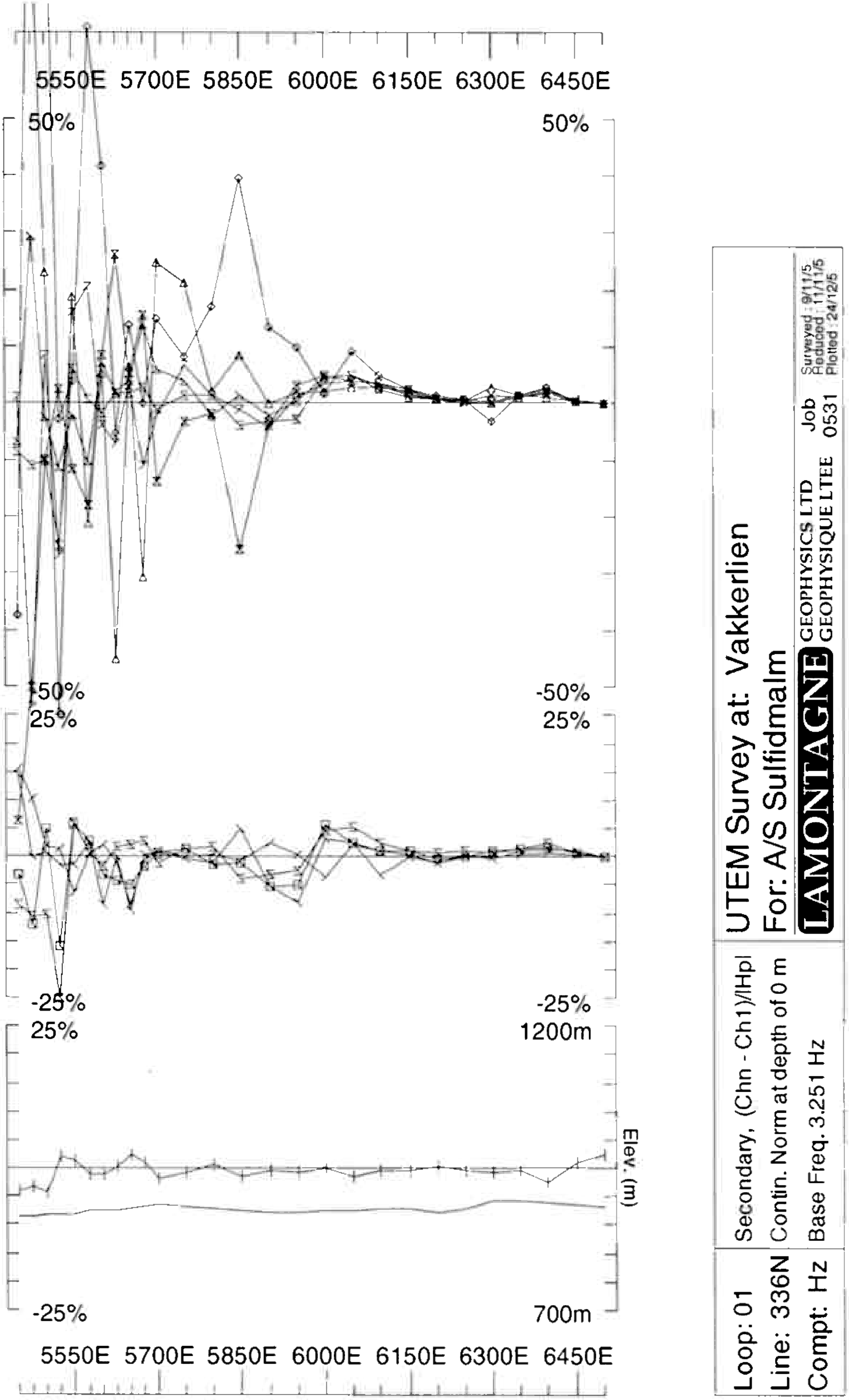
UTEM Survey at: Vakkerlien
For: A/S Sulfidmalm

LAMONTAGNE GEOPHYSICS LTD GEOPHYSIQUE LTEE

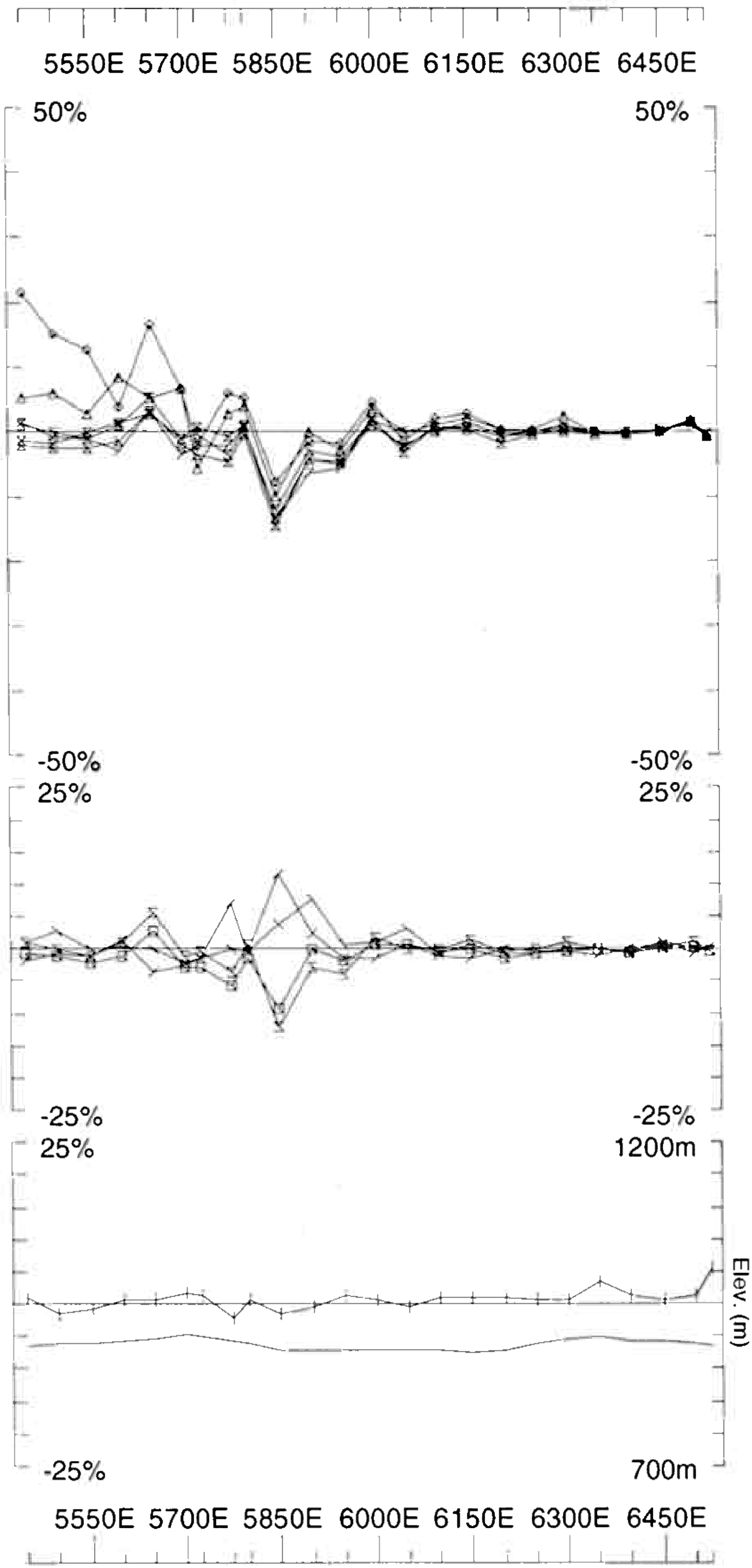
Job 0531

Surveyed: 8/11/5
Reduced: 11/11/5
Plotted: 24/12/5

Loop: 01 | Secondary, (Chn - Ch1)/|Hp|
Line: 335N | Contin. Norm at depth of 0 m
Compt: Hz | Base Freq. 3.251 Hz



5550E 5700E 5850E 6000E 6150E 6300E 6450E
50%
50%
-50%
-50%
25%
25%
-25%
-25%
25%
1200m
Elev. (m)
-25%
700m
5550E 5700E 5850E 6000E 6150E 6300E 6450E
UTEM Survey at: Vakkerlien
For: A/S Sulfidmalm
LAMONTAGNE
GEOPHYSICS LTD
GEOPHYSIQUE LTEE
Job 0531
Surveyed : 9/11/5
Reduced : 11/11/5
Plotted : 24/12/5
Loop: 01
Line: 336N
Compt: Hz
Secondary, (Chn - Ch1)/lHpl
Contin. Norm at depth of 0 m
Base Freq. 3.251 Hz



UTEM Survey at: Vakkerlien

For: A/S Sulfidmalm

LAMONTAGNE GEOPHYSICS LTD / GEOPHYSIQUE LTEE

Job 0531

Surveyed : 9/11/5
Reduced : 11/11/5
Plotted : 24/12/5

Secondary, (Chn - Ch1)/|Hp|
Contin. Norm at depth of 0 m
Base Freq. 3.251 Hz

Loop: 01
Line: 337N
Compt: Hz

Vakkerlien

Loop 1

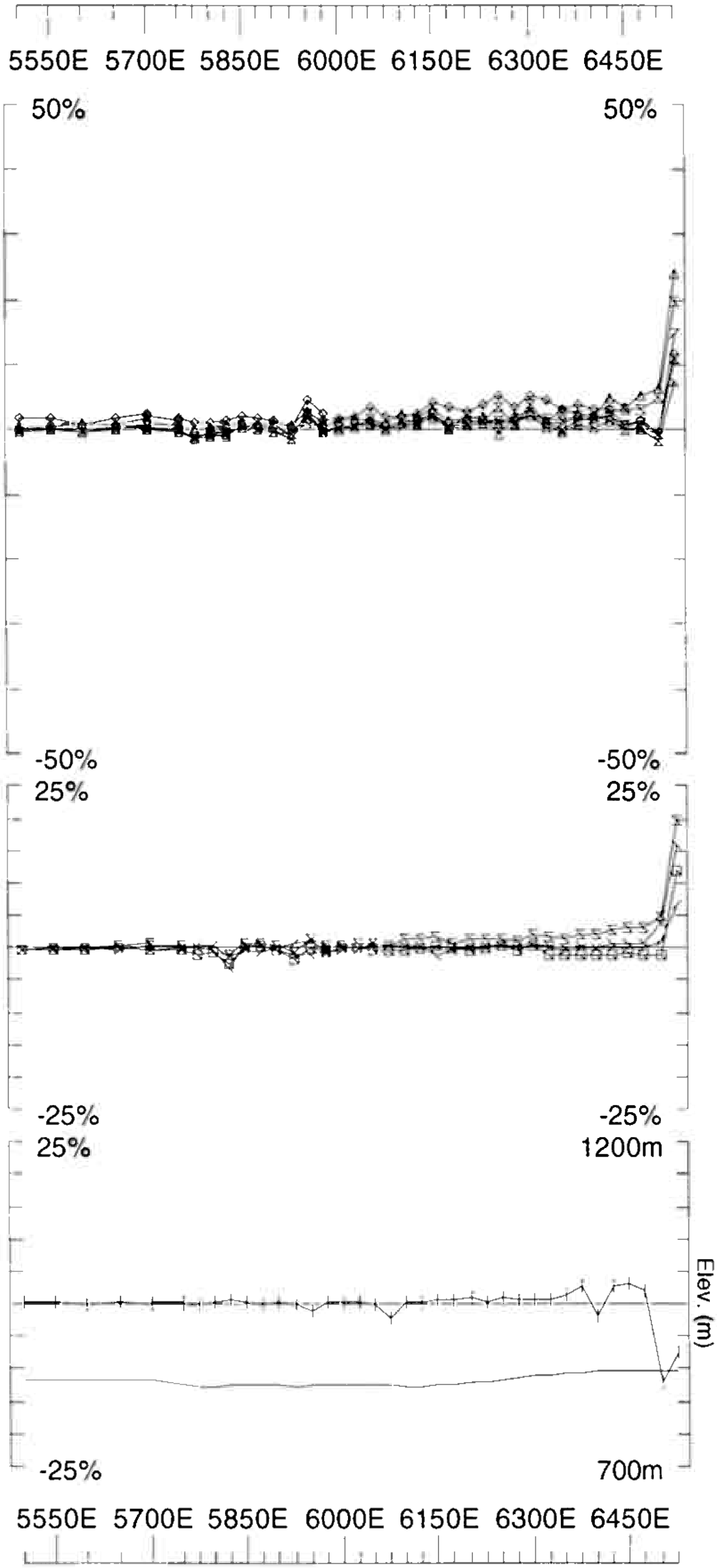
Hz
@3.251 Hz frequency

point norm
@
(x,y,z) = (6150E,33300N, 860 m.a.s.l.)

Ch1 reduced

Loop 01	Line 329N	5500N - 6550N	1050m
	Line 330N	5450N - 6550N	1100m
	Line 331N	5450N - 6550N	1100m
	Line 332N	5450N - 6550N	1100m
	Line 333N	5450N - 6550N	1100m
	Line 334N	5450N - 6550N	1100m
	Line 335N	5450N - 6550N	1100m
	Line 336N	5450N - 6550N	1100m
	Line 337N	5450N - 6550N	1100m
		Vakkerlien Loop 01 Total	9850m

Loop 1 - point norm



Loop: 01
Line: 329N
Compt: Hz

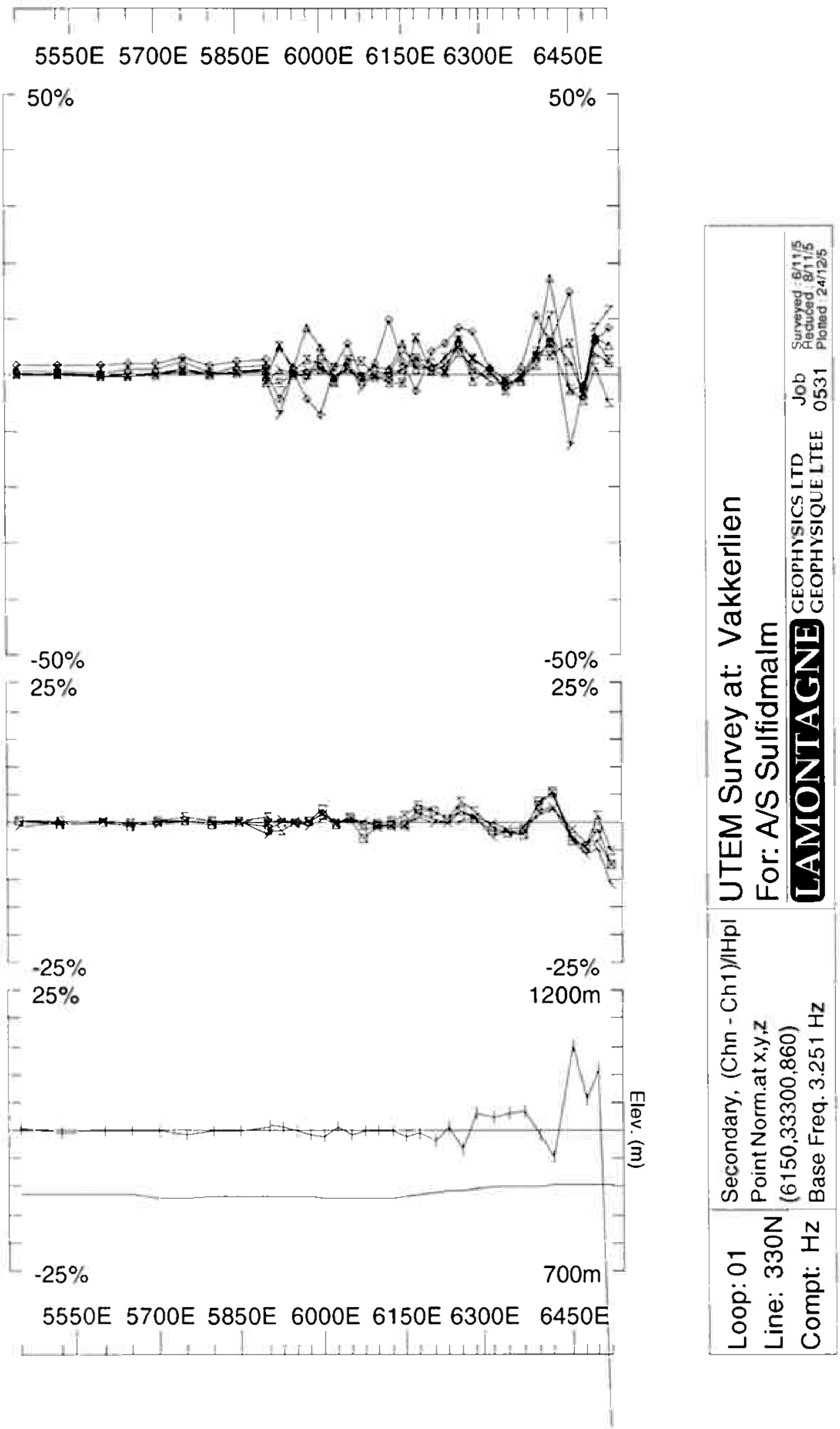
Secondary, (Chn - Ch1)/lHpl
Point Norm.at x,y,z
(6150,33300,860)
Base Freq. 3.251 Hz

UTEM Survey at: Vakkerlien
For: A/S Sulfidmalm

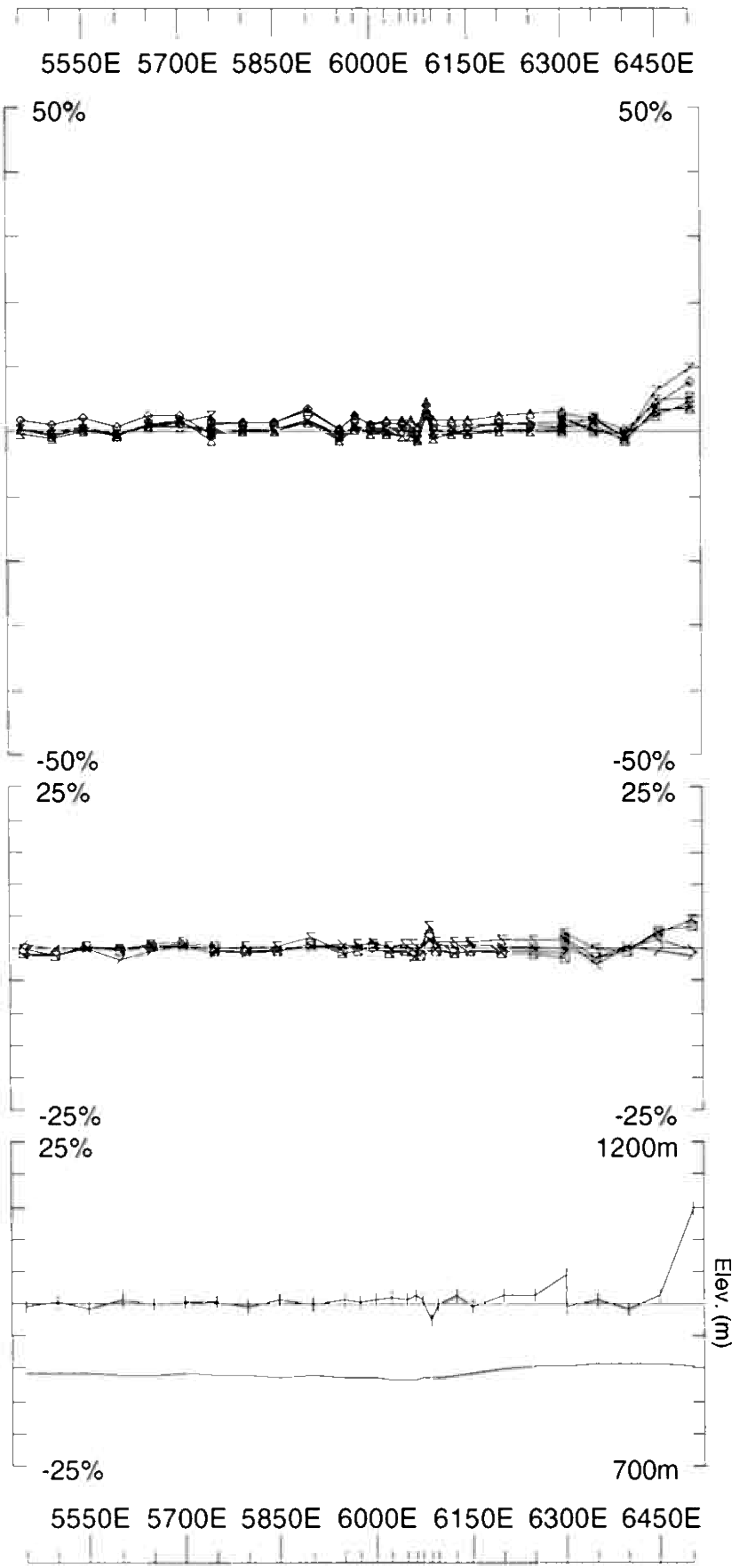
LAMONTAGNE GEOPHYSICS LTD GEOPHYSIQUE LTEE

Job 0531

Plotted : 24/12/5



5550E 5700E 5850E 6000E 6150E 6300E 6450E
50%
50%
-50%
-50%
25%
25%
-25%
-25%
25%
1200m
Elev. (m)
-25%
700m
5550E 5700E 5850E 6000E 6150E 6300E 6450E
UTEM Survey at: Vakkerlien
For: A/S Sulfidmalm
LAMONTAGNE GEOPHYSICS LTD GEOPHYSIQUE LTEE
Job 0531
Surveyed: 6/11/5
Reduced: 8/11/5
Plotted: 24/12/5
Loop: 01
Line: 330N
Compt: Hz
Secondary, (Chn - Ch1)/IHpI
Point Norm.at x,y,z
(6150,33300,860)
Base Freq. 3.251 Hz



Loop: 01
Line: 331N
Compt: Hz

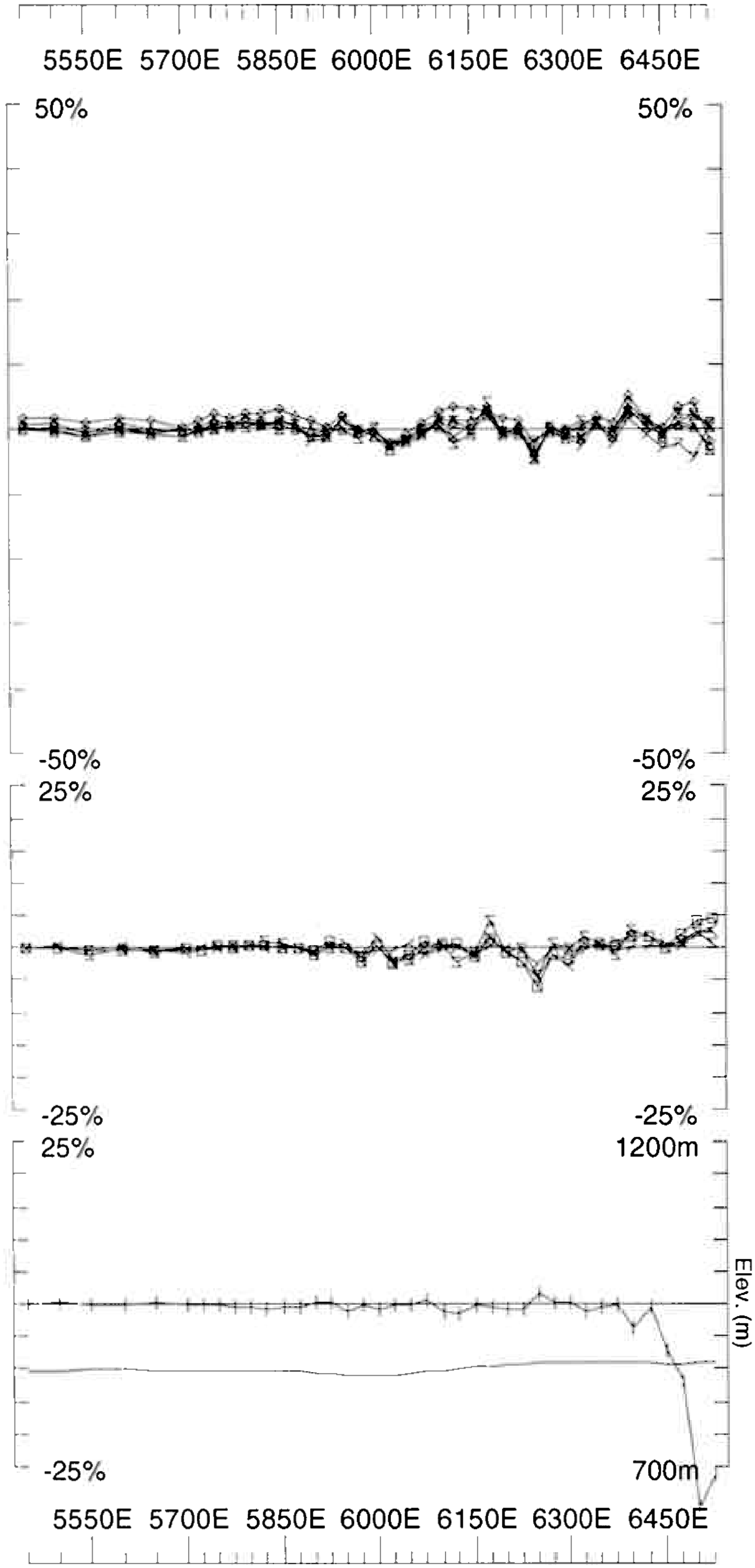
Secondary, (Chn - Ch1)/|Hp|
Point Norm.at x,y,z
(6150,33300,860)
Base Freq. 3.251 Hz

UTEM Survey at: Vakkerlien
For: A/S Sulfidmalm

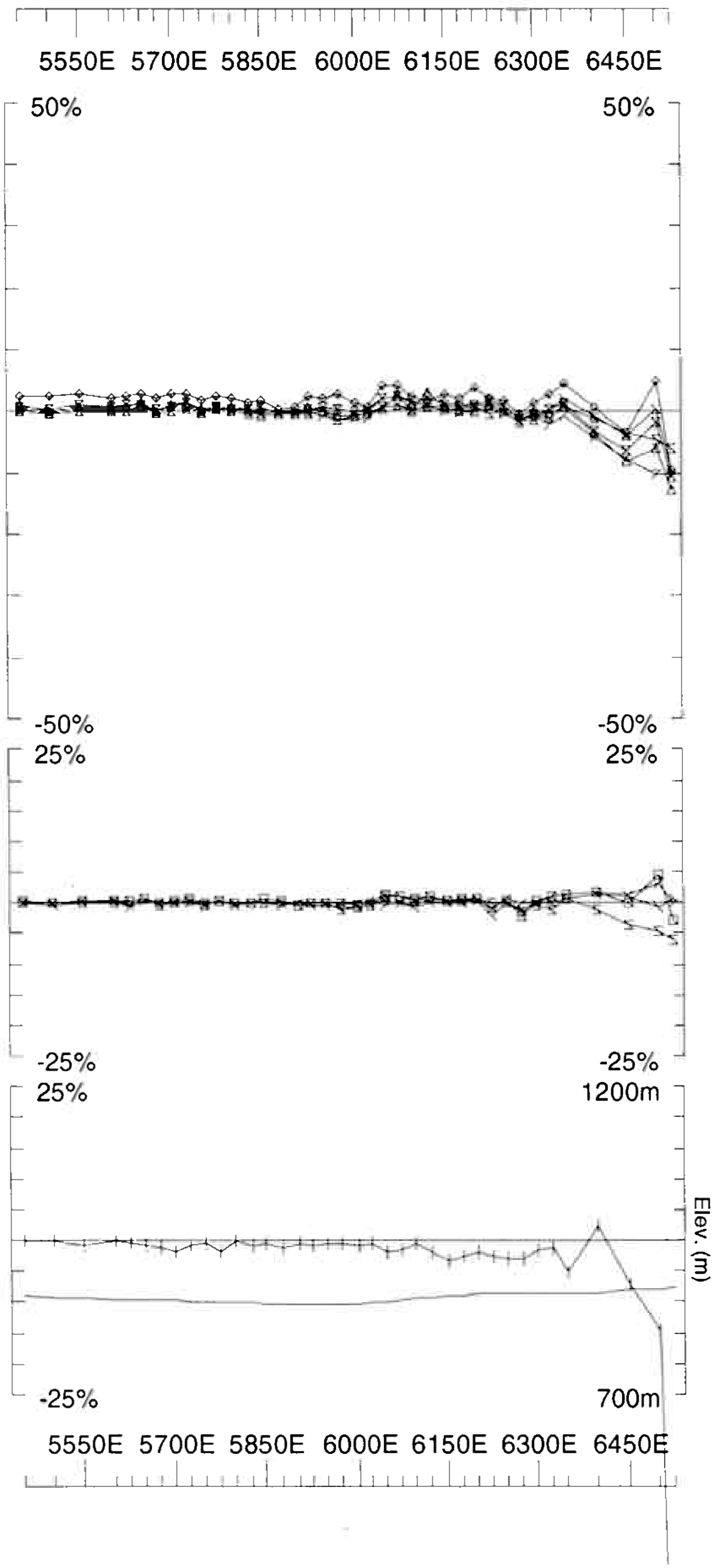
LAMONTAGNE GEOPHYSICS LTD GEOPHYSIQUE LTEE

Job 0531

Surveyed : 10/11/5
Reduced : 11/11/5
Plotted : 24/12/5



Loop: 01 Line: 332N Compt: Hz	Secondary, (Chn - Ch1)/|Hp| Point Norm.at x,y,z (6150,33300,860) Base Freq. 3.251 Hz	UTEM Survey at: Vakkerlien For: A/S Sulfidmalm LAMONTAGNE GEOPHYSICS LTD GEOPHYSIQUE LTEE Job 0531 Surveyed : 7/11/5 Reduced : 11/11/5 Plotted : 24/12/5



UTEM Survey at: Vakkerlien
For: A/S Sulfidmalm

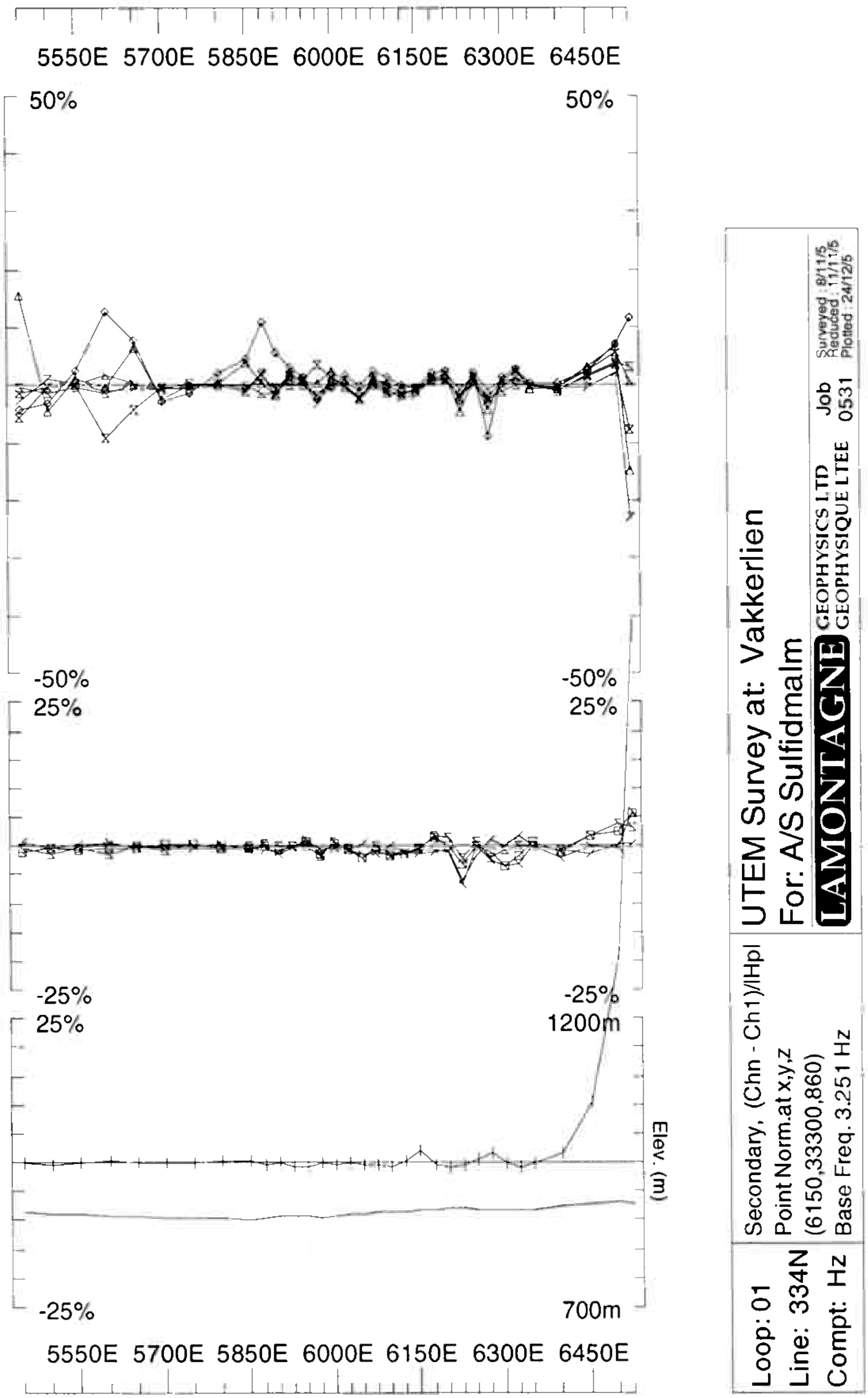
LAMONTAGNE GEOPHYSICS LTD
GEOPHYSIQUE LTEE

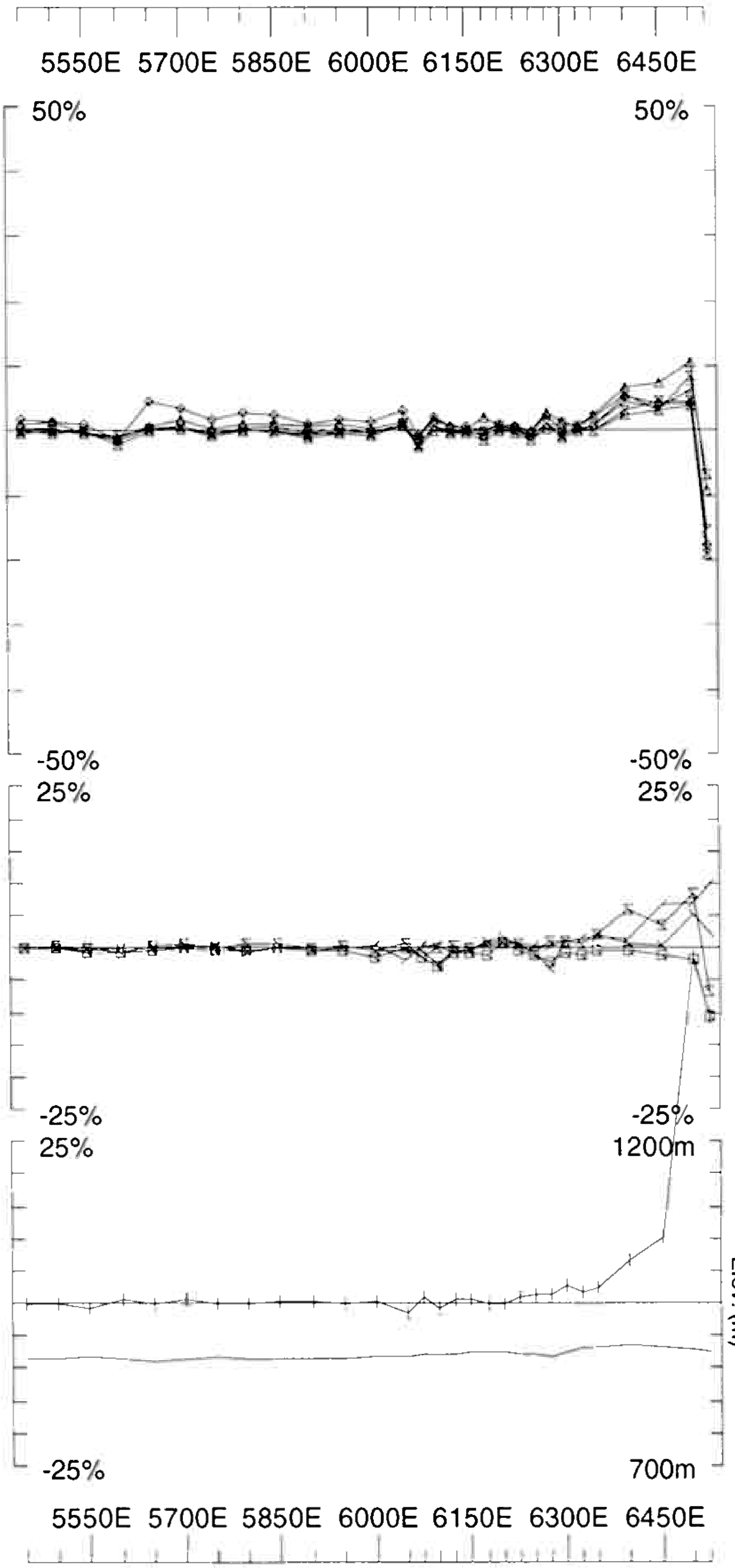
Job 0531

Surveyed: 7/11/5
Reduced: 11/11/5
Plotted: 24/12/5

Secondary, (Chn - Ch1)/lHpl
Point Norm.at x,y,z
(6150,33300,860)
Base Freq. 3.251 Hz

Loop: 01
Line: 333N
Compt: Hz


5550E 5700E 5850E 6000E 6150E 6300E 6450E
50%
50%
-50%
-50%
25%
25%
-25%
-25%
25%
1200m
Elev. (m)
-25%
700m
5550E 5700E 5850E 6000E 6150E 6300E 6450E
UTEM Survey at: Vakkerlien
For: A/S Sulfidmalm
LAMONTAGNE GEOPHYSICS LTD GEOPHYSIQUE LTEE
Job 0531
Surveyed : 8/11/5
Reduced : 11/11/5
Plotted : 24/12/5
Secondary, (Chn - Ch1)/IHpI
Point Norm.at x,y,z
(6150,33300,860)
Base Freq. 3.251 Hz
Loop: 01
Line: 334N
Compt: Hz



UTEM Survey at: Vakkerlien
For: A/S Sulfidmalm

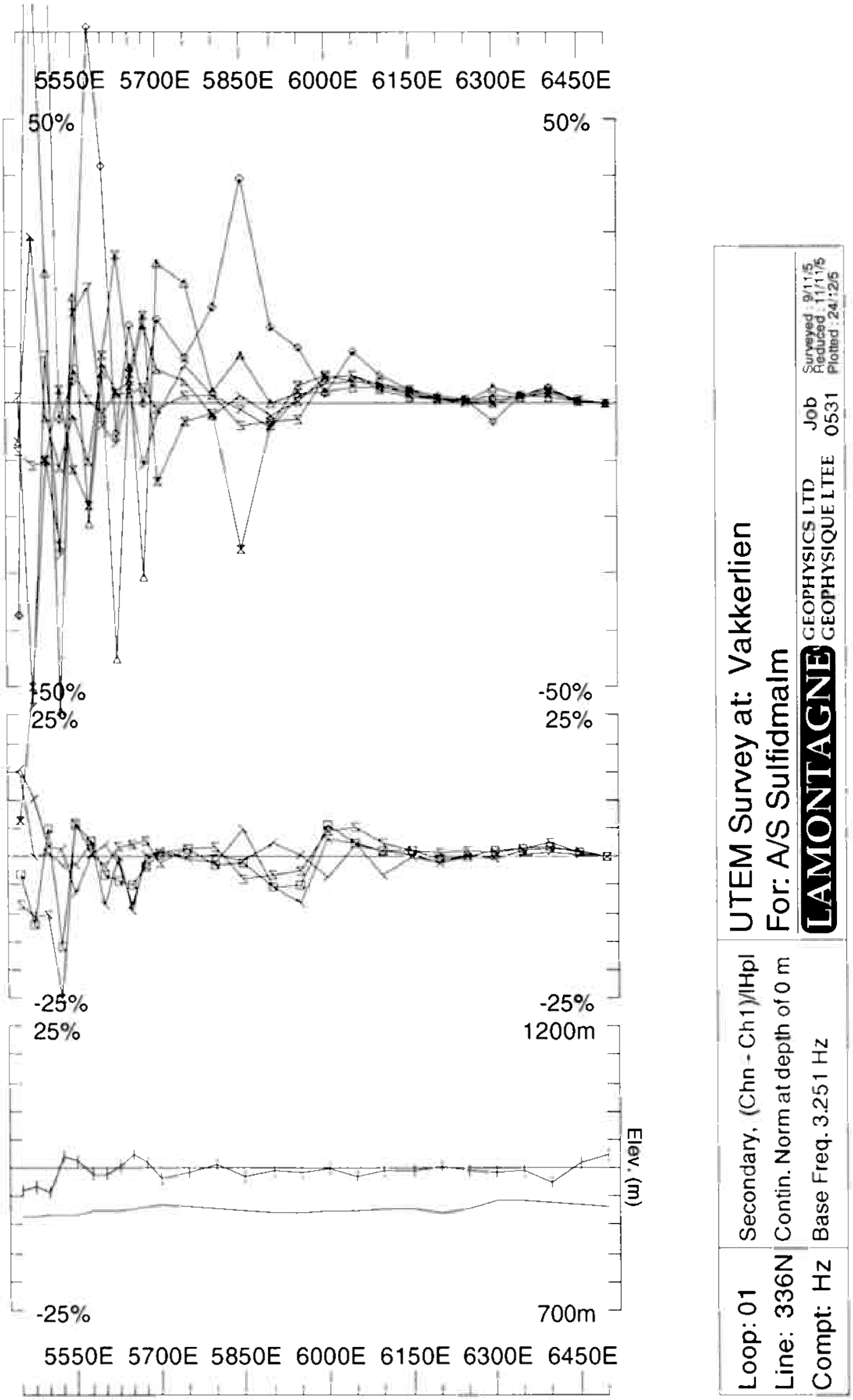
LAMONTAGNE GEOPHYSICS LTD GEOPHYSIQUE LTEE

Job 0531

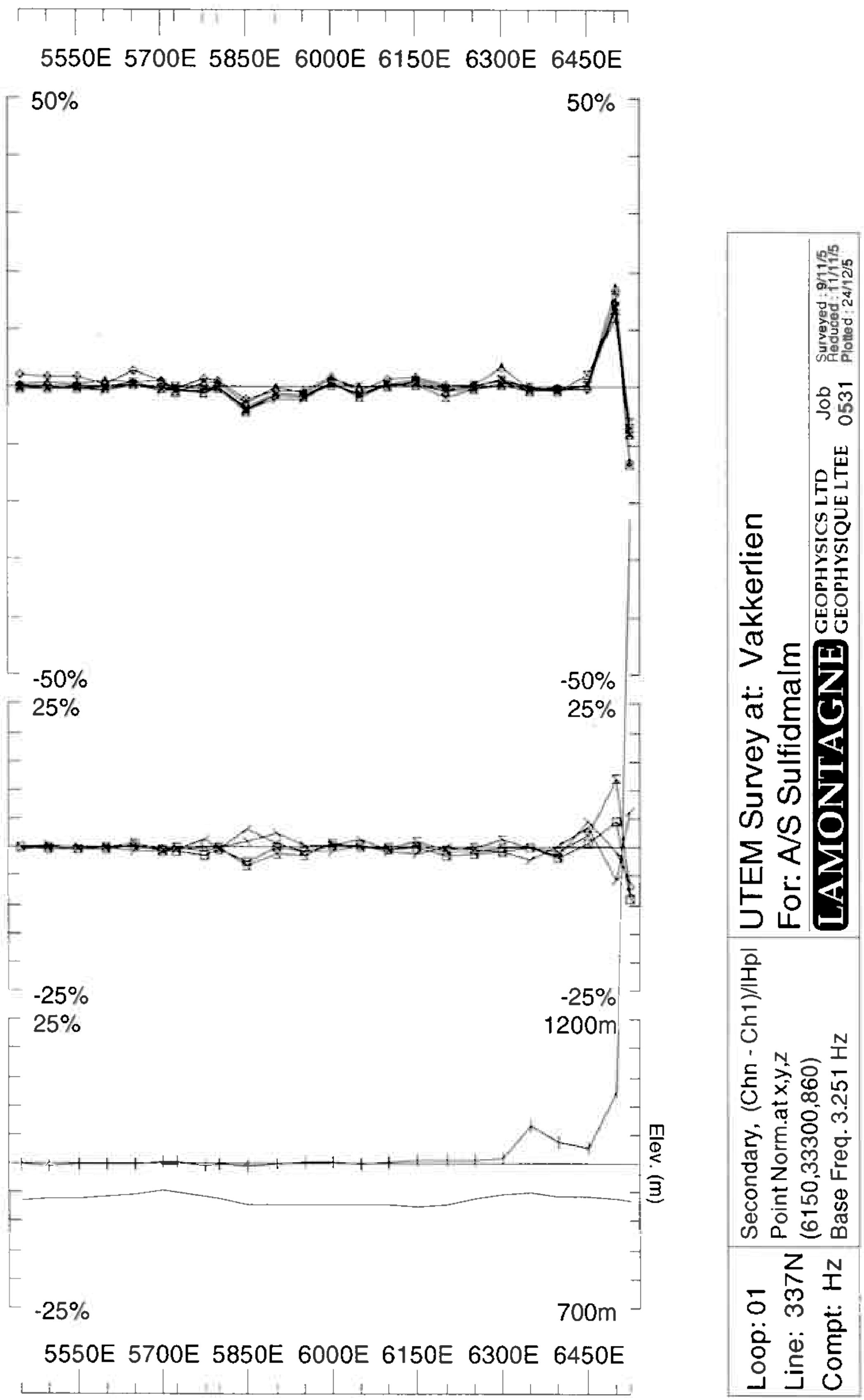
Surveyed : 8/11/5
Reduced : 11/11/5
Plotted : 24/12/5

Loop: 01
Line: 335N
Compt: Hz

Secondary, (Chn - Ch1)/|Hp|
Point Norm.at x,y,z
(6150,33300,860)
Base Freq. 3.251 Hz



5550E 5700E 5850E 6000E 6150E 6300E 6450E
50%
50%
-50%
-50%
25%
25%
-25%
-25%
25%
1200m
-25%
700m
Elev. (m)
5550E 5700E 5850E 6000E 6150E 6300E 6450E
UTEM Survey at: Vakkerlien
For: A/S Sulfidmalm
LAMONTAGNE GEOPHYSICS LTD GEOPHYSIQUE LTEE
Job 0531
Surveyed: 9/11/5
Reduced: 11/11/5
Plotted: 24/12/5
Loop: 01
Line: 336N
Compt: Hz
Secondary, (Chn - Ch1)/IHpl
Contin. Norm at depth of 0 m
Base Freq. 3.251 Hz


5550E 5700E 5850E 6000E 6150E 6300E 6450E
50%
50%
-50%
-50%
25%
25%
-25%
-25%
25%
1200m
Elev. (m)
-25%
700m
5550E 5700E 5850E 6000E 6150E 6300E 6450E
UTEM Survey at: Vakkerlien
For: A/S Sulfidmalm
LAMONTAGNE GEOPHYSICS LTD GEOPHYSIQUE LTEE
Job 0531
Surveyed : 9/11/5
Reduced : 11/11/5
Plotted : 24/12/5
Secondary, (Chn - Ch1)/|Hp|
Point Norm.at x,y,z
(6150,33300,860)
Base Freq. 3.251 Hz
Loop: 01
Line: 337N
Compt: Hz

Vakkerlien

Loop 2

Hz

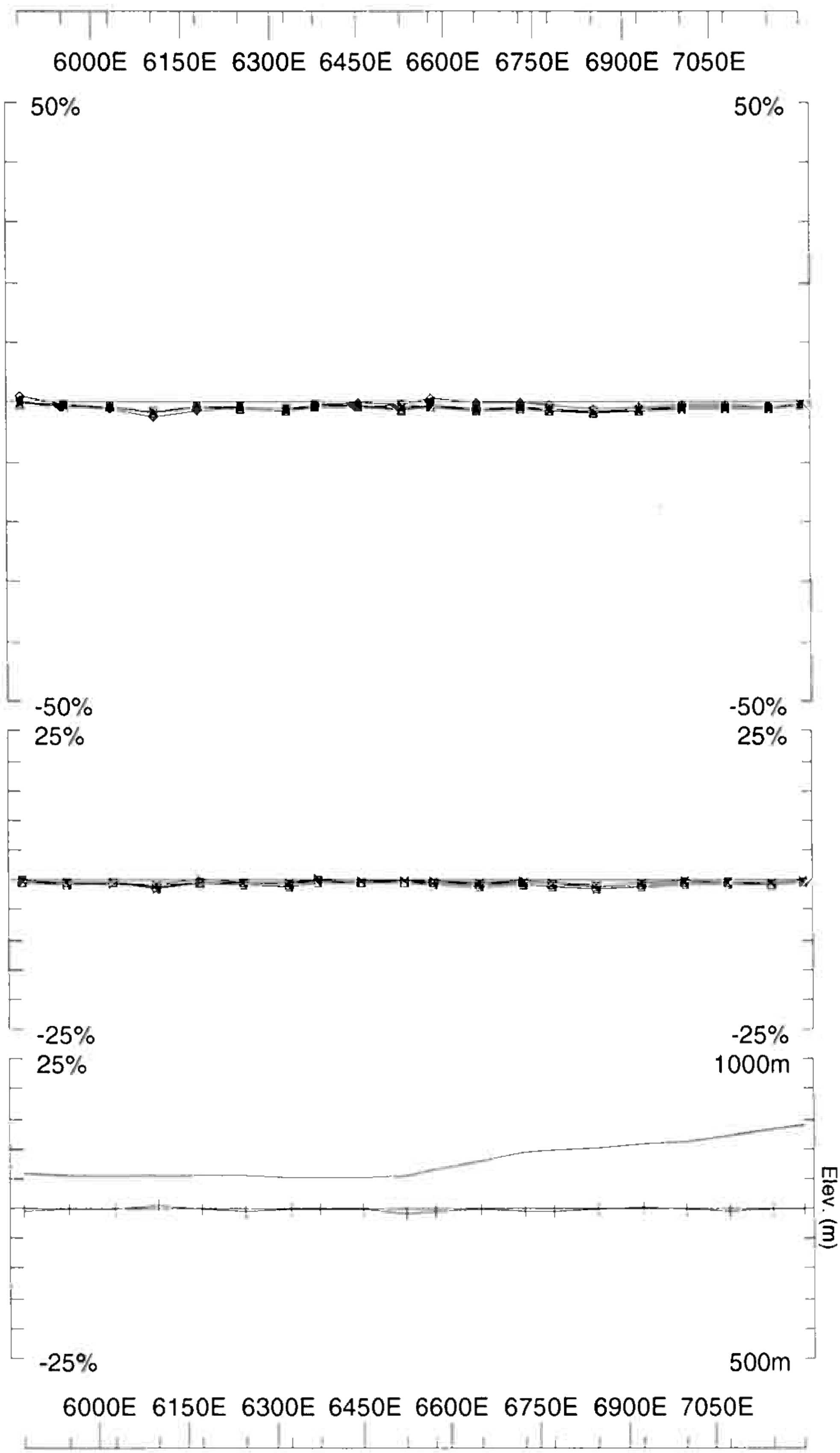
@3.251 Hz frequency

continuous norm

Ch1 reduced

Loop 02 (E-W)	Line 309N	5825N - 7225N	1400m
	Line 311N	5825N - 7225N	1400m
	Line 313N	5825N - 7225N	
	off-loop	7225N - 8000N	2175m
	Line 315N	5825N - 7225N	1400m
	Line 317N	5825N - 7225N	1400m
	Line 319N	5825N - 7225N	1400m
(N-S))	Line 663E	700N - 2900N	2200m
	Line 664E	700N - 2900N	2200m
	Line 665E	700N - 2900N	2200m
	Line 666E	700N - 2900N	2200m
	Line 667E	700N - 2900N	2200m
	Line 668E	2100N - 2900N	800m
	Line 669E	2100N - 2900N	800m
	Line 670E	2100N - 3150N	1050m
	Line 671E	2500N - 3150N	650m
	Vakkerlien Loop 02 Total		23475m

Loop 2 - continuous norm



UTEM Survey at: Vakkerlien
For: A/S Sulfidmalm

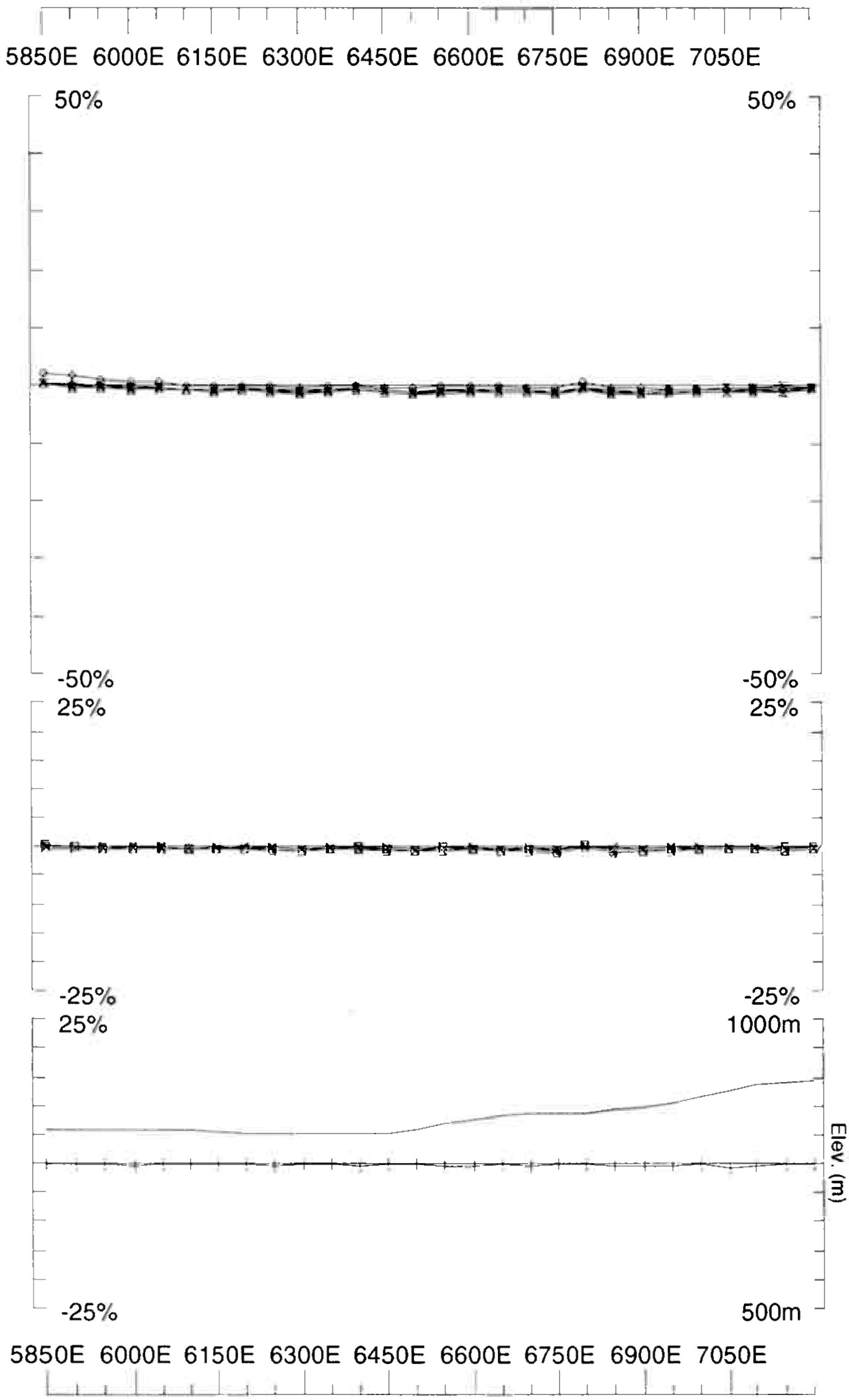
LAMONTAGNE GEOPHYSICS LTD
GEOPHYSIQUE LTEE

Job 0531

Surveyed: 23/11/5
Reduced: 24/12/5
Plotted: 24/12/5

Loop: 02
Line: 309N
Compt: Hz

Secondary, (Chn - Ch1)/|Hp|
Contin. Norm at depth of 0 m
Base Freq. 3.251 Hz



UTEM Survey at: Vakkerlien

For: A/S Sulfidmalm

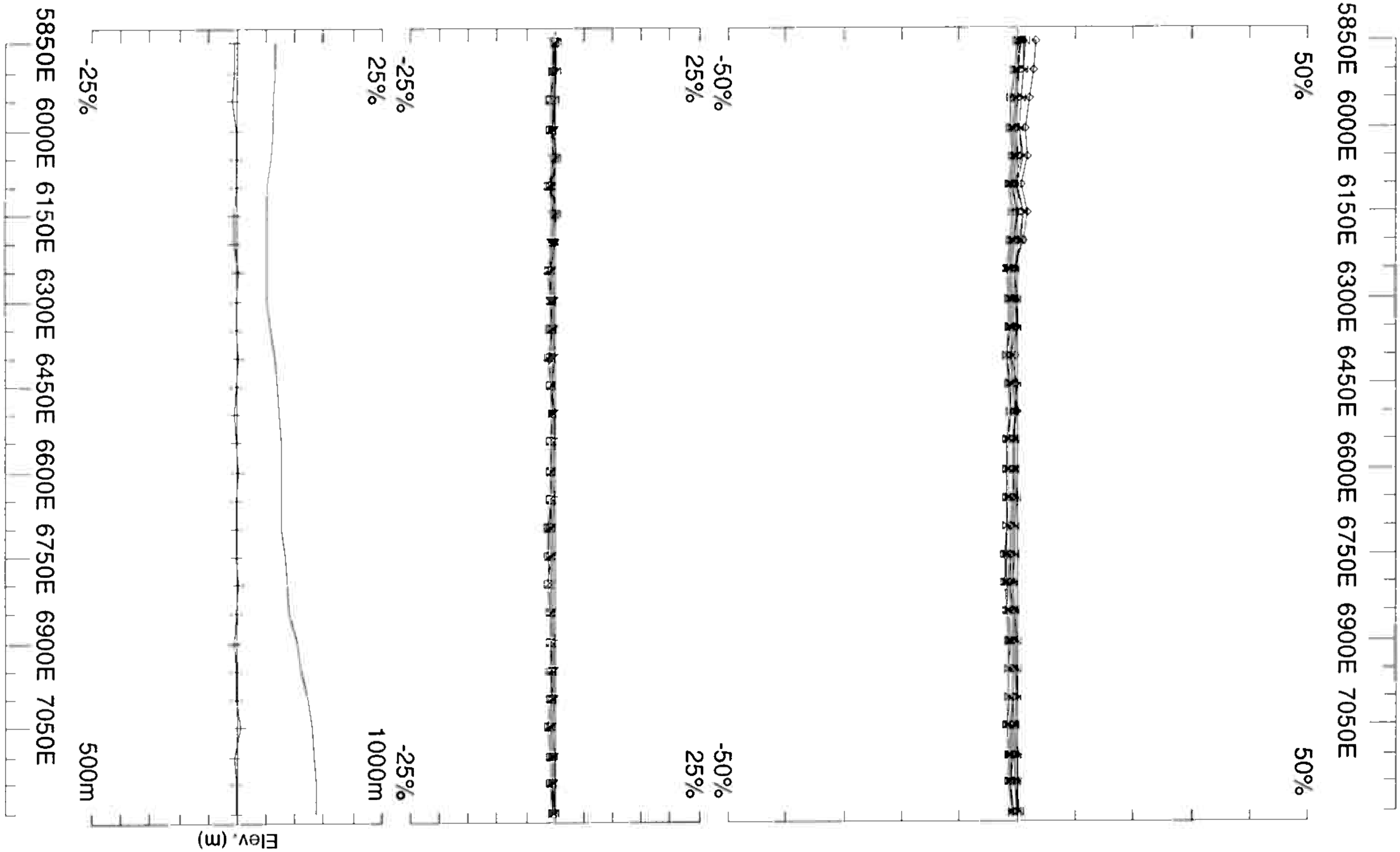
LAMONTAGNE GEOPHYSICS LTD GEOPHYSIQUE LTEE

Job 0531

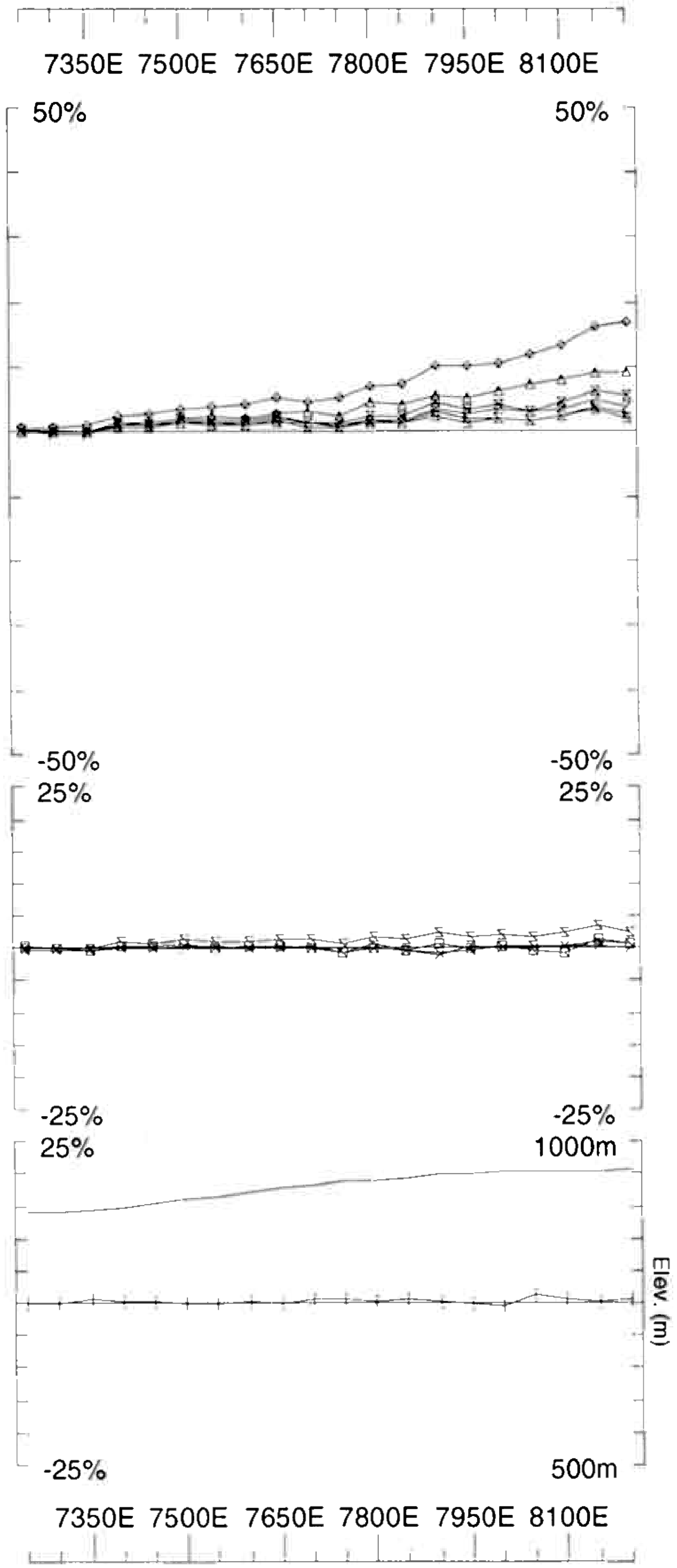
Surveyed : 22/11/5
Reduced : 24/12/5
Plotted : 24/12/5

Loop: 02
Line: 311N
Compt: Hz

Secondary, (Chn - Ch1)/|Hp|
Contin. Norm at depth of 0 m
Base Freq. 3.251 Hz



Loop: 02 Line: 313N Compt: Hz	Secondary, (Chn - Ch1)/IHpl Contin. Norm at depth of 0 m Base Freq. 3.251 Hz	UTEM Survey at: Vakkerlien For: A/S Sulfidmalm LAMONTAGNE GEOPHYSICS LTD GEOPHYSIQUE LTEE Job 0531 Surveyed : 22/11/5 Reduced : 24/12/5 Plotted : 24/12/5



UTEM Survey at: Vakkerlien
For: A/S Sulfidmalm

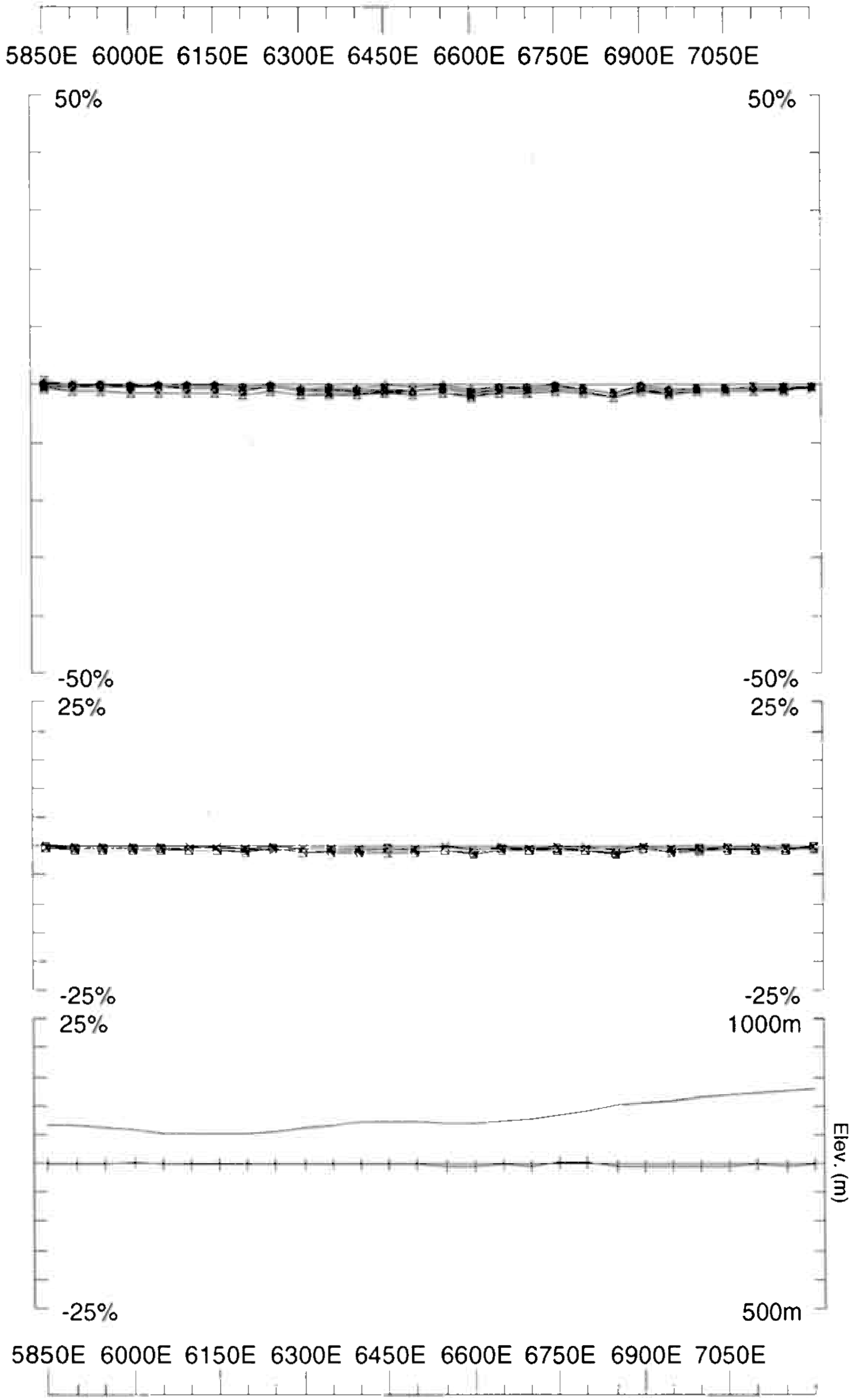
LAMONTAGNE GEOPHYSICS LTD / GEOPHYSIQUE LTEE

Job 0531

Surveyed: 23/11/5
Reduced: 24/12/5
Plotted: 24/12/5

Loop: 02
Line: 313N off-loop
Compt: Hz

Secondary, (Chn - Ch1)/lHpl
Contin. Norm at depth of 0 m
Base Freq. 3.251 Hz



UTEM Survey at: Vakkerlien
For: A/S Sulfidmalm

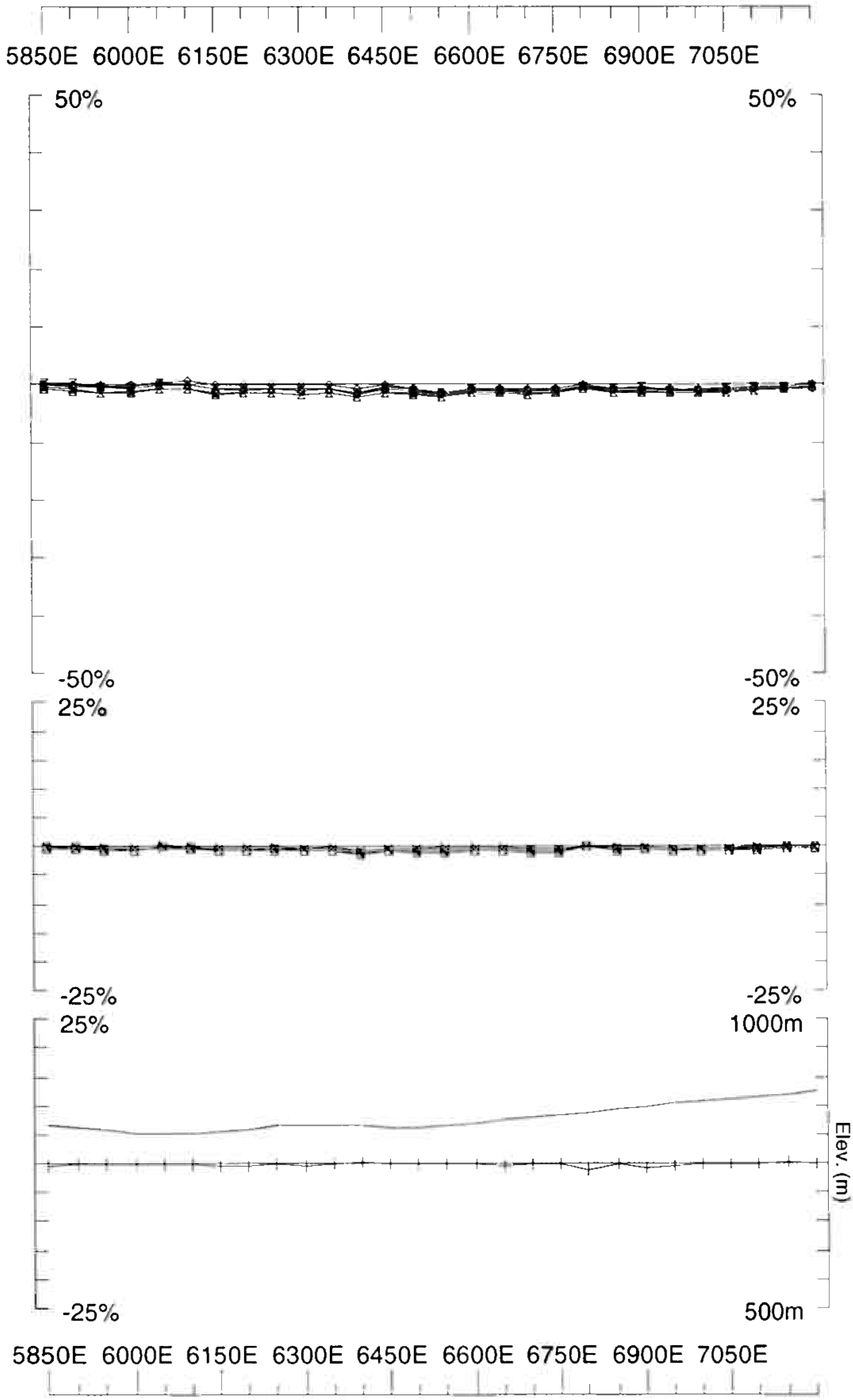
LAMONTAGNE GEOPHYSICS LTD GEOPHYSIQUE LTEE

Job 0531

Surveyed : 17/11/5
Reduced : 24/12/5
Plotted : 24/12/5

Secondary, (Chn - Ch1)/|Hp|
Contin. Norm at depth of 0 m
Base Freq. 3.251 Hz

Loop: 02
Line: 315N
Compt: Hz



UTEM Survey at: Vakkerlien
For: A/S Sulfidmalm

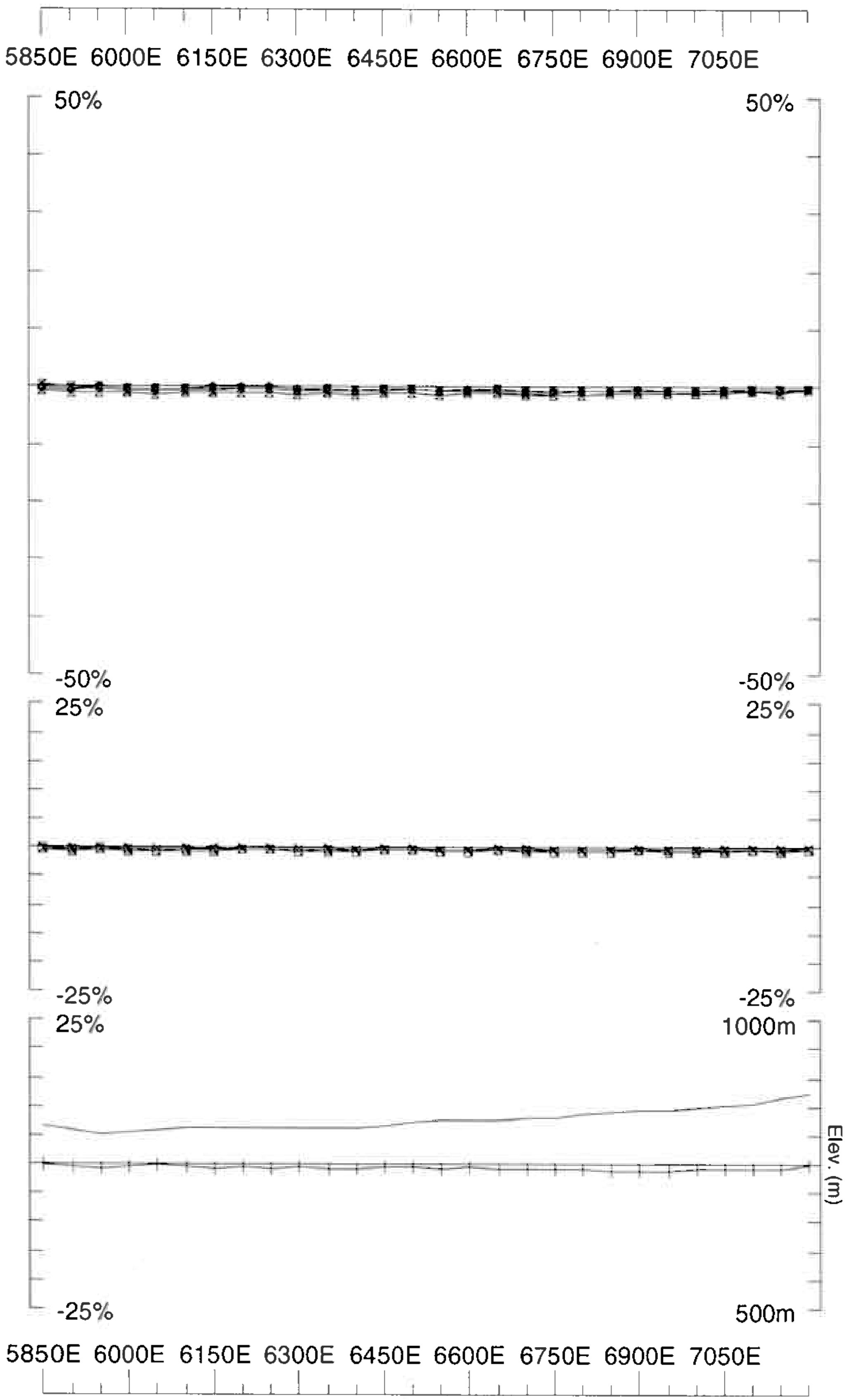
LAMONTAGNE GEOPHYSICS LTD
GEOPHYSIQUE LTEE

Job 0531

Surveyed : 17/11/5
Reduced : 24/12/5
Plotted : 24/12/5

Secondary, (Chn - Ch1)/|Hp|
Contin. Norm at depth of 0 m
Base Freq. 3.251 Hz

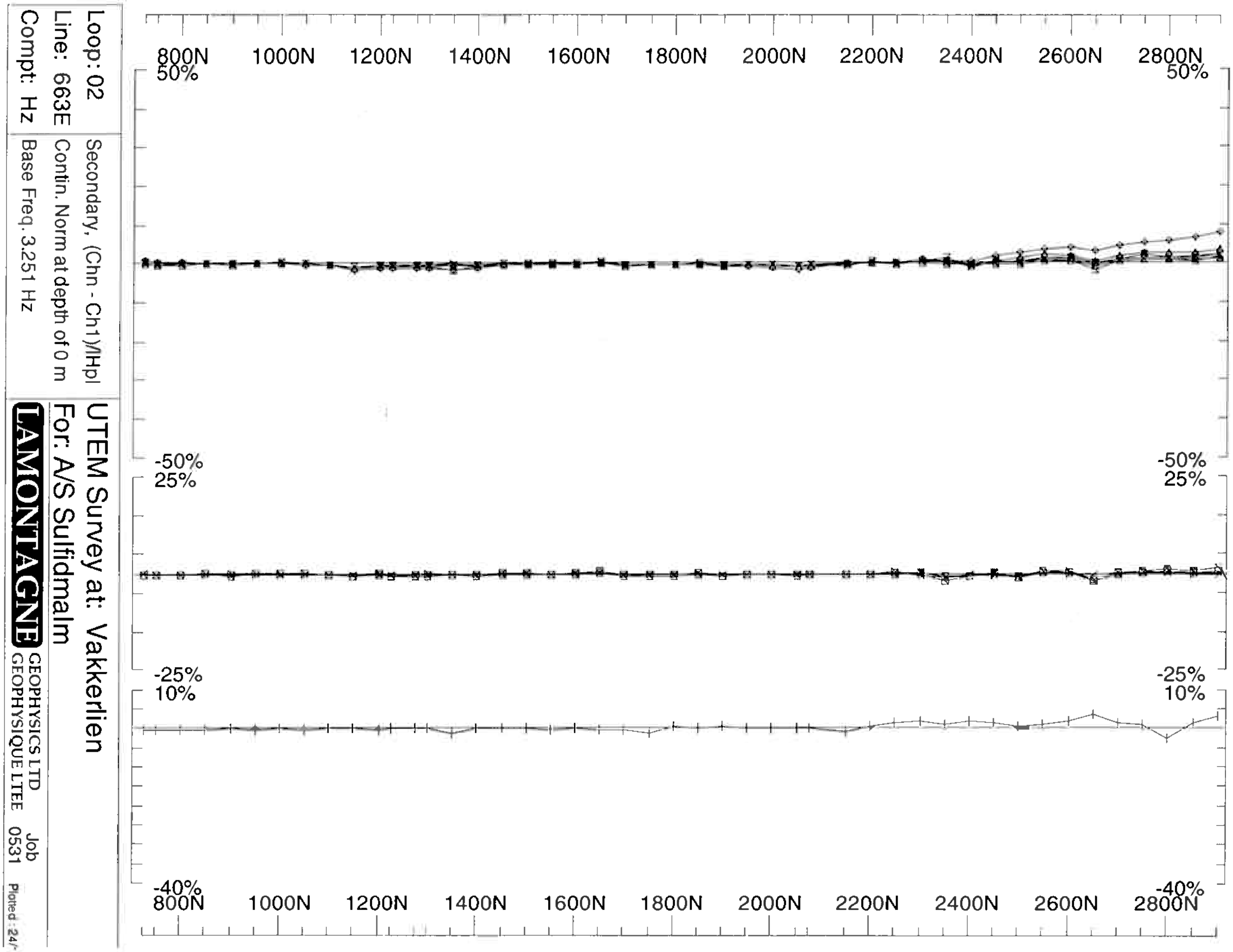
Loop: 02
Line: 317N
Compt: Hz

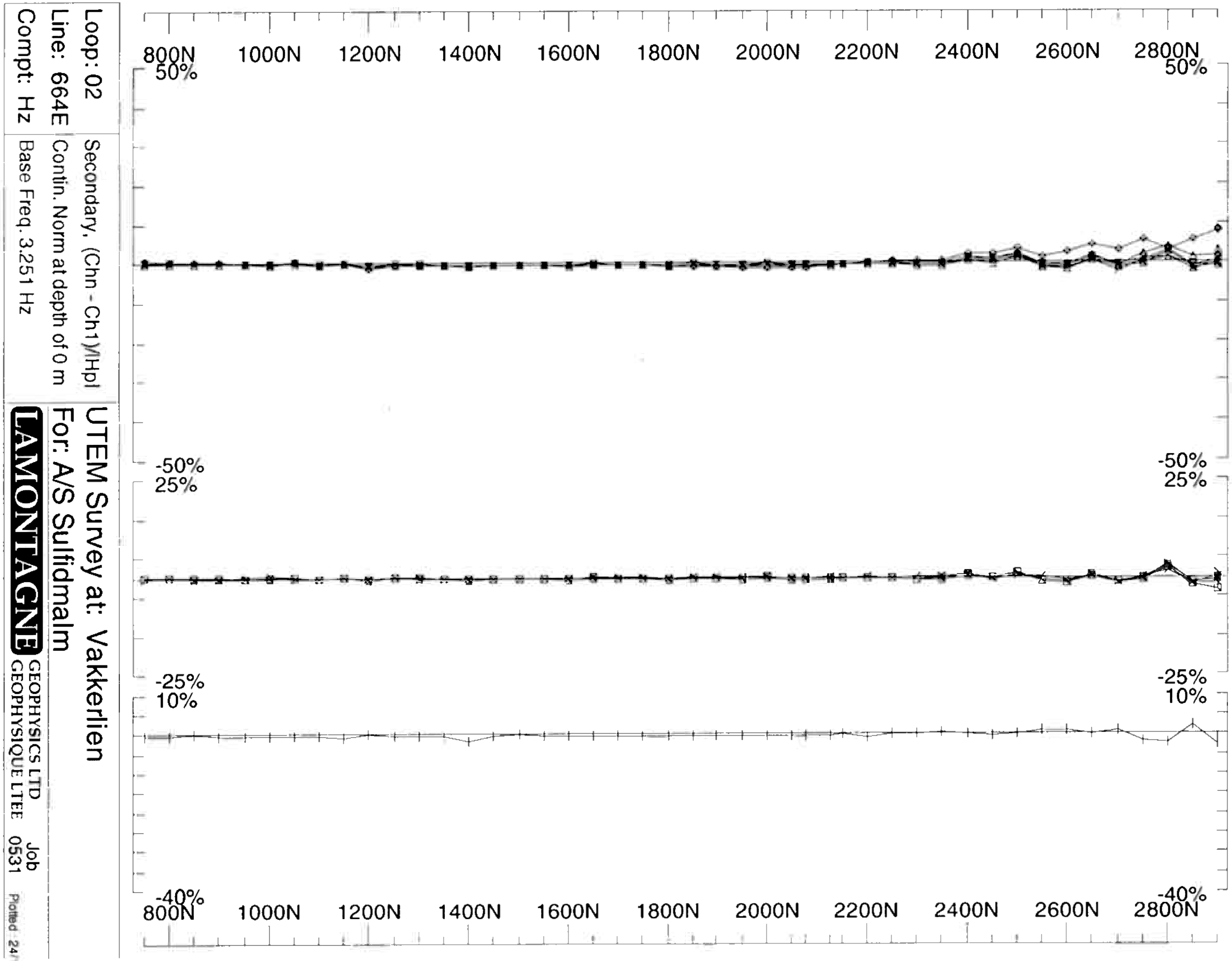


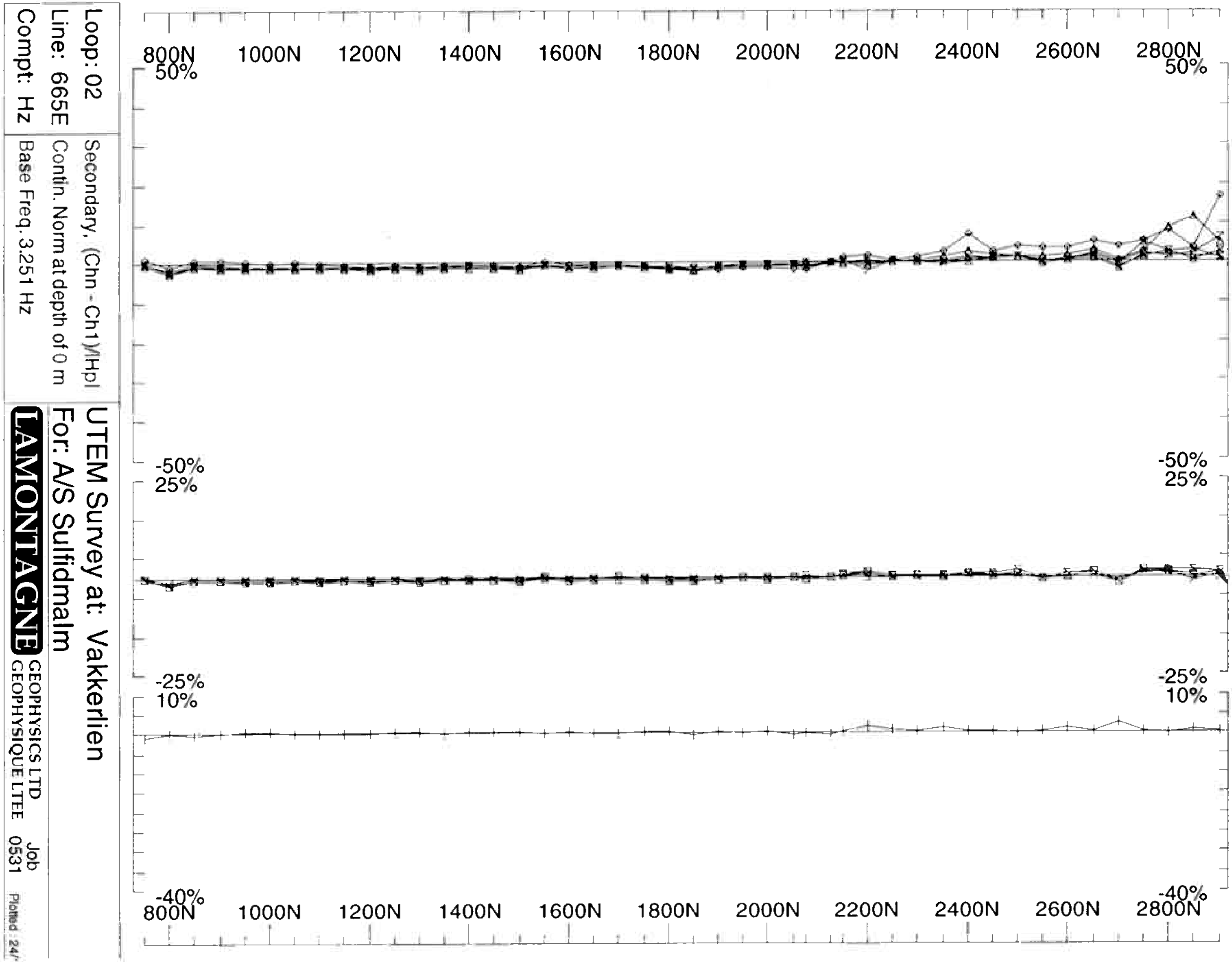
UTEM Survey at: Vakkerlien
For: A/S Sulfidmalm
LAMONTAGNE GEOPHYSICS LTD GEOPHYSIQUE LTEE
Job 0531
Surveyed: 16/11/5
Reduced: 24/12/5
Plotted: 24/12/5

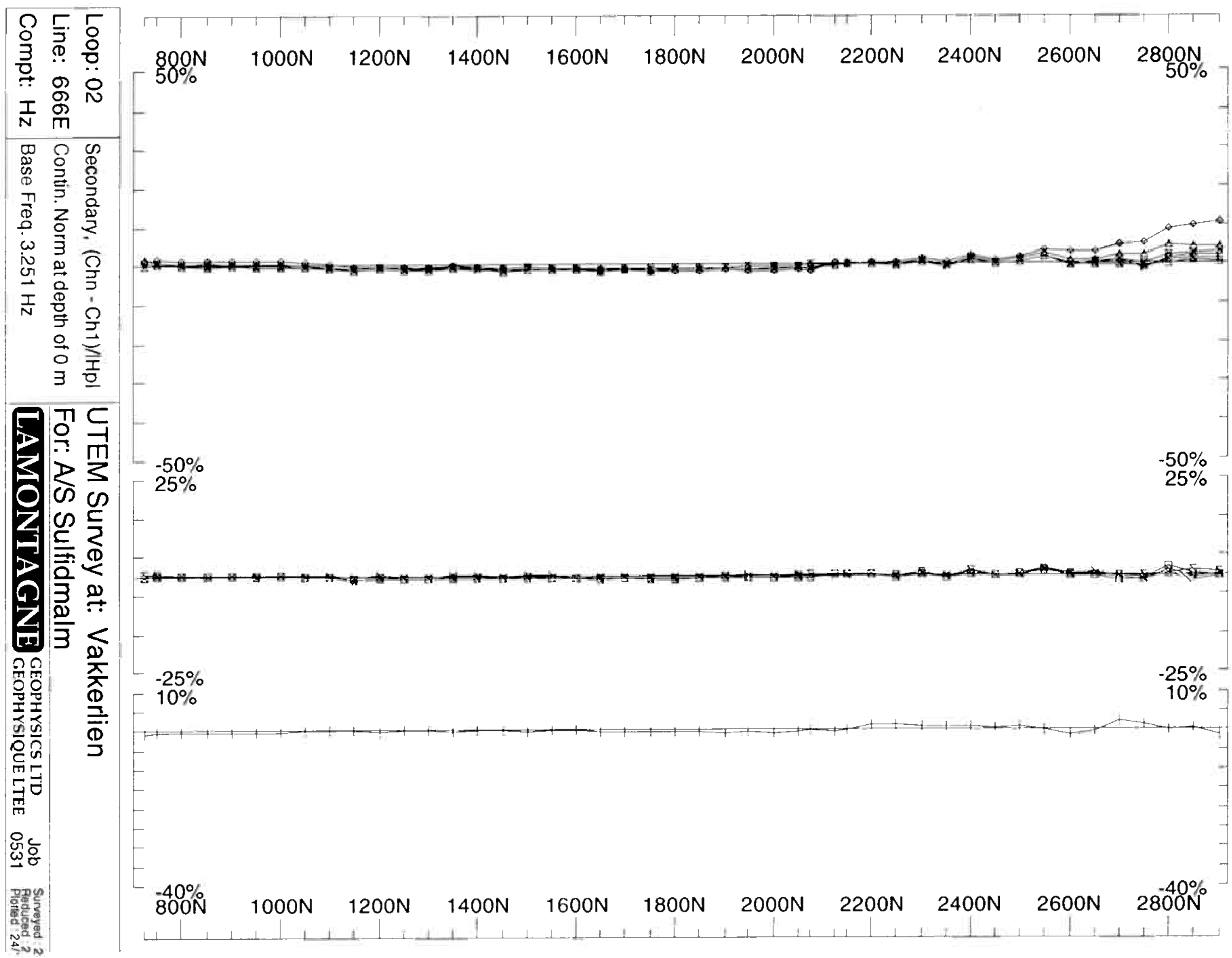
Loop: 02
Line: 319N
Compt: Hz

Secondary, (Chn - Ch1)/|Hp|
Contin. Norm at depth of 0 m
Base Freq. 3.251 Hz

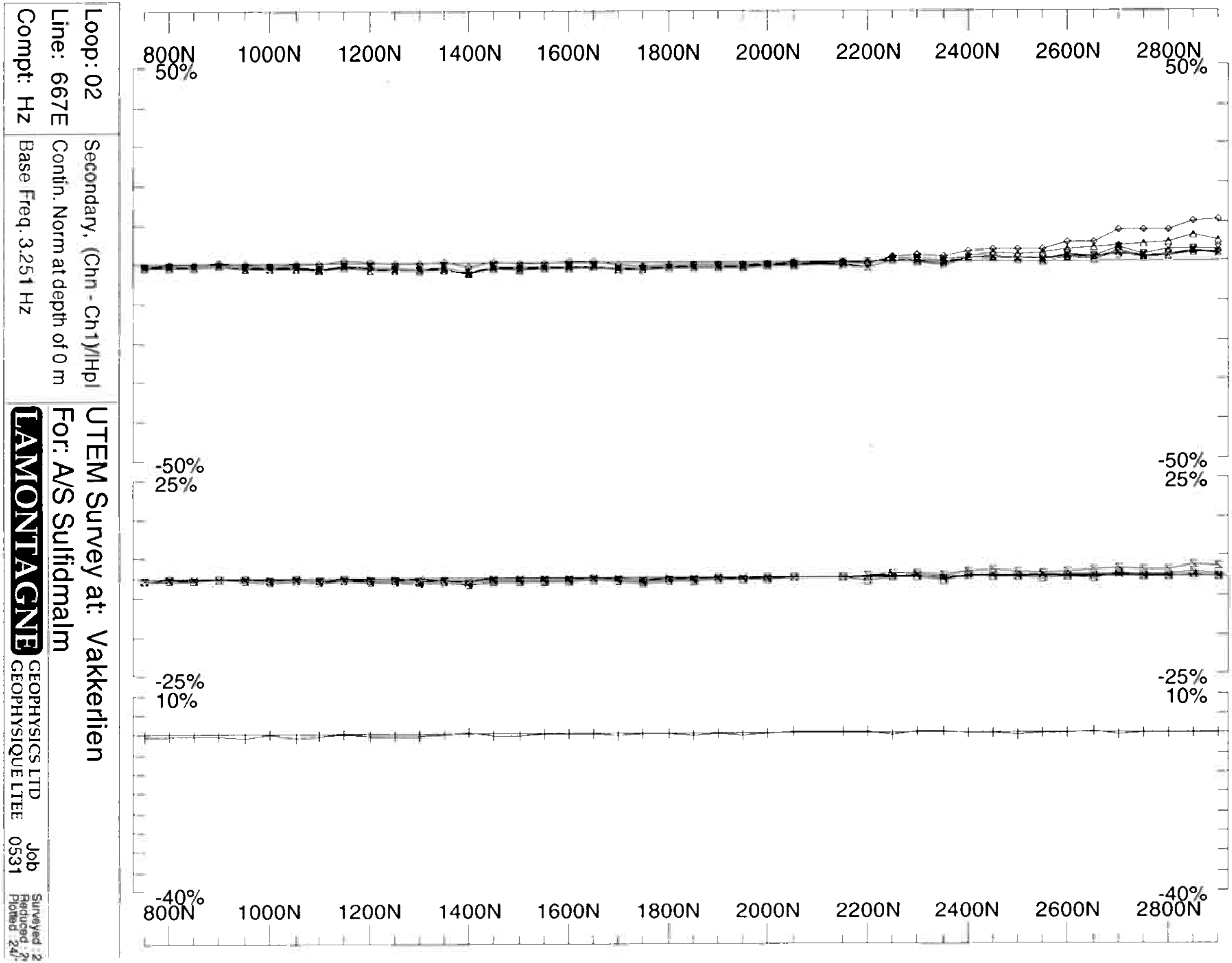

Loop: 02
Line: 663E
Compt: Hz
Secondary, (Chn - Ch1)/Hpl
Contin. Norm at depth of 0 m
Base Freq. 3.251 Hz
UTEM Survey at: Vakkerlien
For: A/S Sulfidmalm
LAMONTAGNE
GEOPHYSICS LTD
GEOPHYSIQUE LTEE
Job
0531
800N
1000N
1200N
1400N
1600N
1800N
2000N
2200N
2400N
2600N
2800N
50%
-50%
25%
-25%
10%
-40%


Loop: 02
Line: 664E
Compt: Hz
Secondary, (Chn - Ch1)/Hpl
Contin. Norm at depth of 0 m
Base Freq. 3.251 Hz
UTEM Survey at: Vakkerlien
For: A/S Sulfidmalm
LAMONTAGNE GEOPHYSICS LTD
GEOPHYSIQUE LTEE
Job 0531
800N
1000N
1200N
1400N
1600N
1800N
2000N
2200N
2400N
2600N
2800N
50%
-50%
25%
-25%
10%
-40%

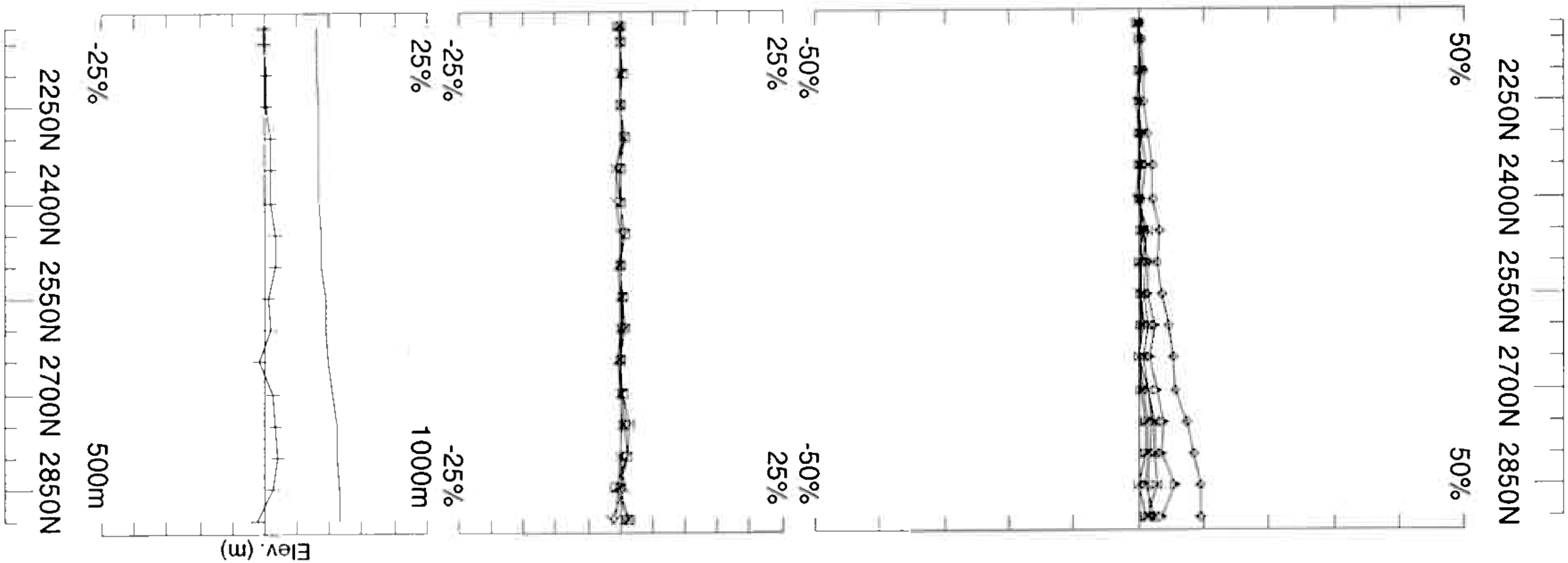

Loop: 02
Line: 665E
Compt: Hz
Secondary, (Chn - Ch1)/Hpl
Contin. Norm at depth of 0 m
Base Freq. 3.251 Hz
UTEM Survey at: Vakkerlien
For: A/S Sulfidmalm
LAMONTAGNE
GEOPHYSICS LTD
GEOPHYSIQUE LTEE
Job
0531
Plotted : 24/
800N 1000N 1200N 1400N 1600N 1800N 2000N 2200N 2400N 2600N 2800N
50%
-50%
25%
-25%
10%
-40%



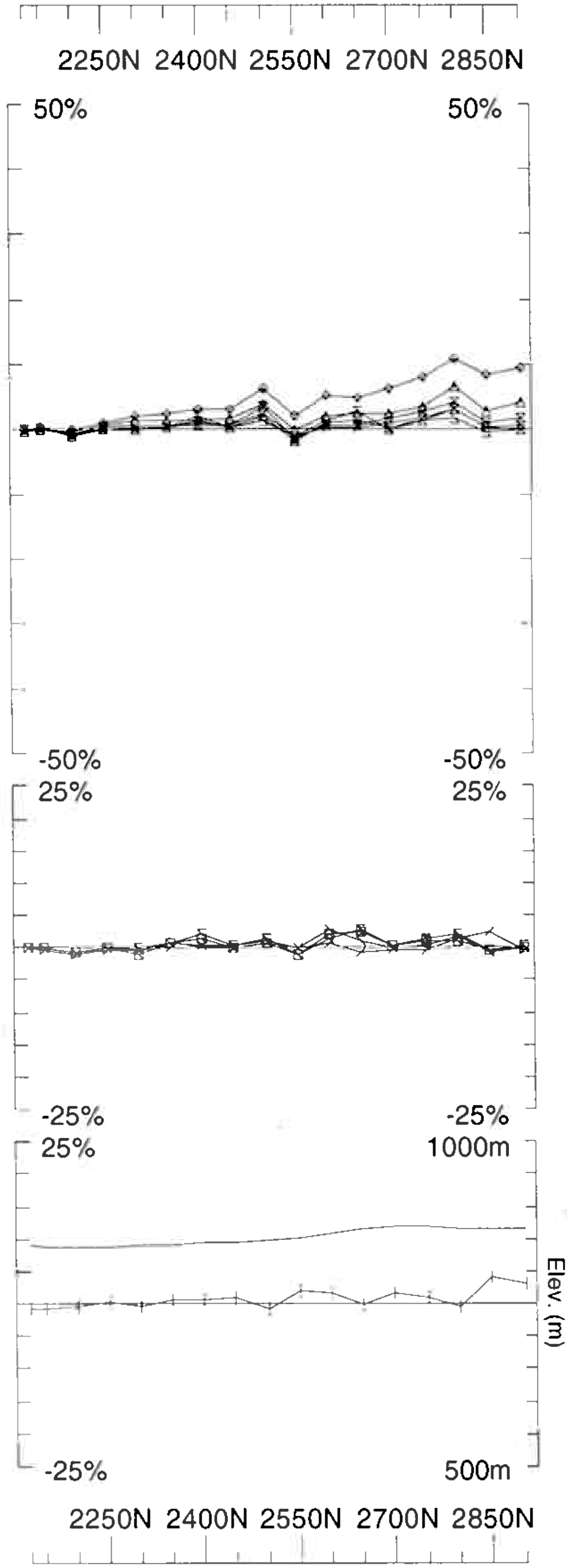
Loop: 02
Line: 666E
Compt: Hz
Secondary, (Chn - Ch1)/Hpl
Contin. Norm at depth of 0 m
Base Freq. 3.251 Hz
UTEM Survey at: Vakkerlien
For: A/S Sulfidmalm
LAMONTAGNE GEOPHYSICS LTD GEOPHYSIQUE LTEE
Job 0531
800N
1000N
1200N
1400N
1600N
1800N
2000N
2200N
2400N
2600N
2800N
50%
-50%
25%
-25%
10%
-40%



Loop: 02
Line: 667E
Compt: Hz
Secondary, (Chn - Ch1)/Hpl
Contin. Norm at depth of 0 m
Base Freq. 3.251 Hz
UTEM Survey at: Vakkerlien
For: A/S Sulfidmalm
LAMONTAGNE GEOPHYSICS LTD
GEOPHYSIQUE LTEE
Job 0531
Surveyed : 2
Reduced : 2
Plotted : 24
800N
1000N
1200N
1400N
1600N
1800N
2000N
2200N
2400N
2600N
2800N
50%
-50%
25%
-25%
10%
-40%



Loop: 02	Secondary, (Chn - Ch1)/IHpI	UTEM Survey at: Vakkerlien
Line: 668E	Contin. Norm at depth of 0 m	For: A/S Sulfidmalm
Compt: Hz	Base Freq. 3.251 Hz	LAMONTAGNE GEOPHYSICS LTD GEOPHYSIQUE LTEE Job 0531 Surveyed : 18/11/5 Reduced : 24/12/5 Plotted : 24/12/5



UTEM Survey at: Vakkerlien
For: A/S Sulfidmalm

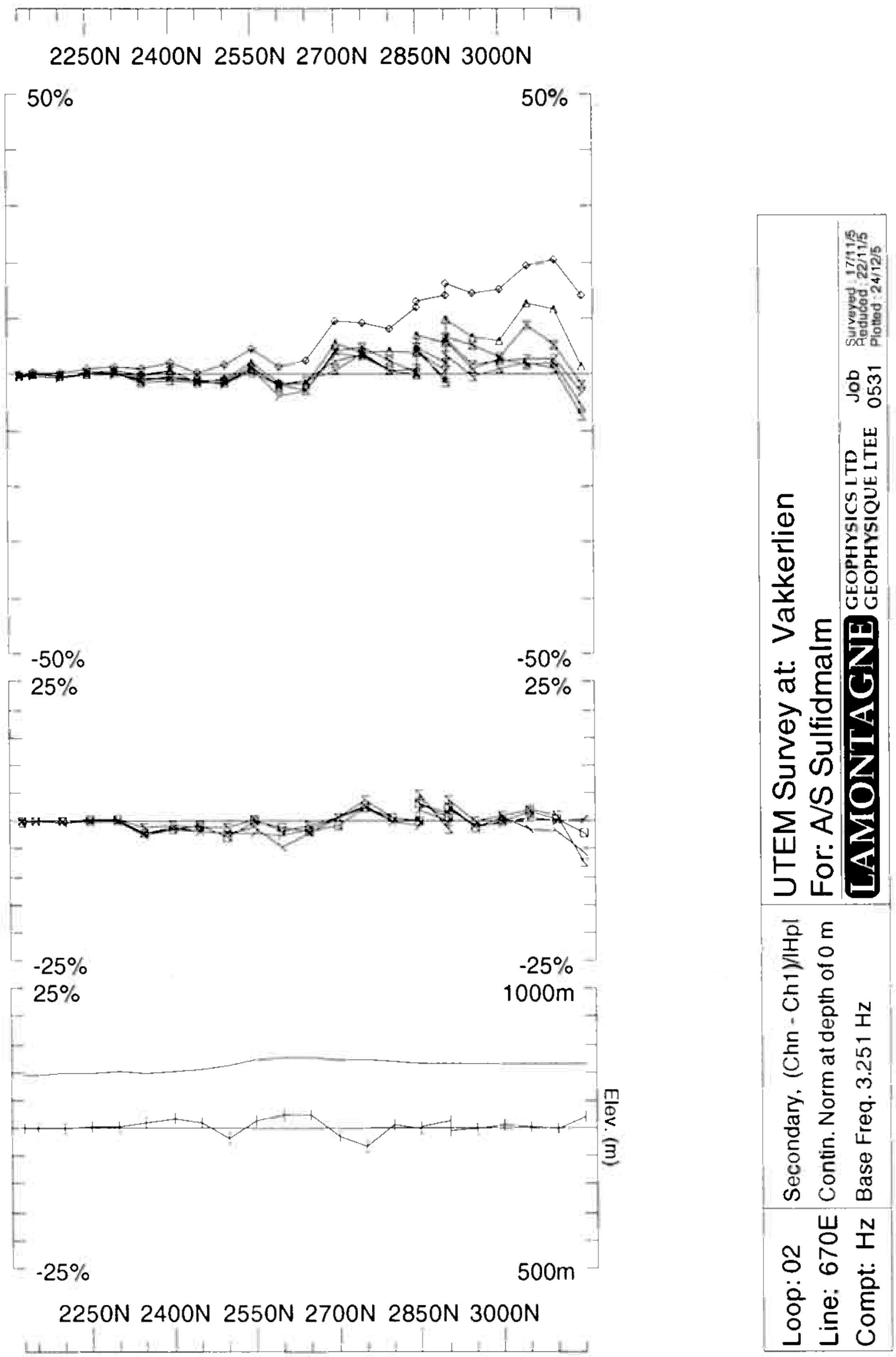
LAMONTAGNE GEOPHYSICS LTD GEOPHYSIQUE LTEE

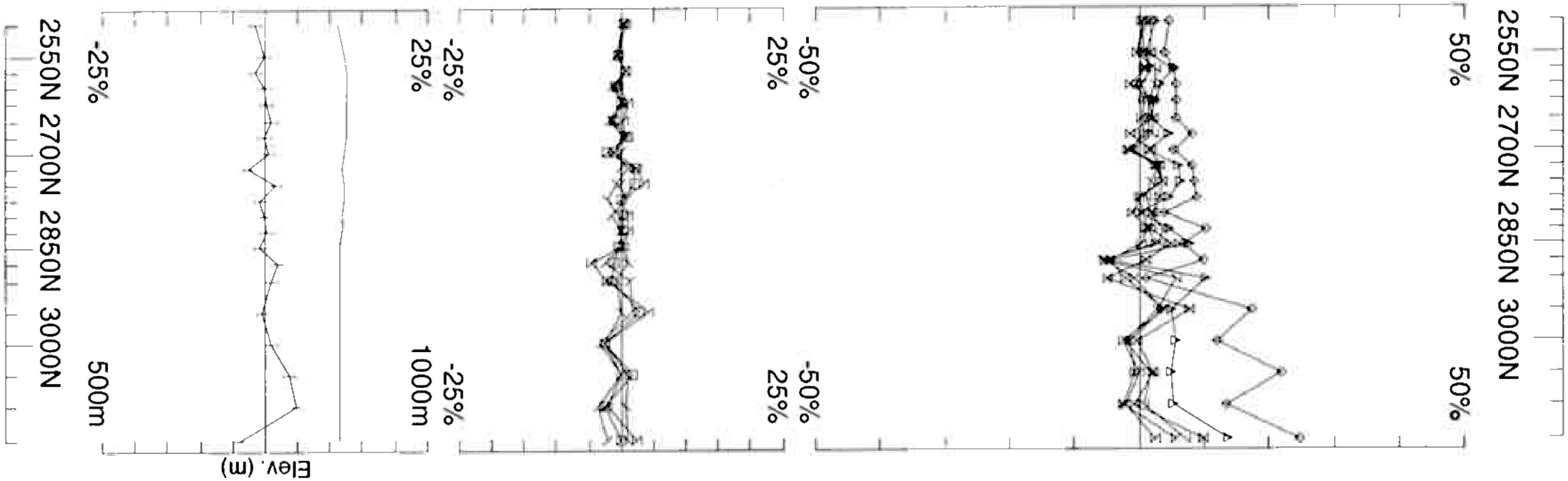
Job 0531

Surveyed: 17/11/5
Reduced: 24/12/5
Plotted: 24/12/5

Secondary, (Chn - Ch1)/IHpl
Contin. Norm at depth of 0 m
Base Freq. 3.251 Hz

Loop: 02
Line: 669E
Compt: Hz


2250N 2400N 2550N 2700N 2850N 3000N
50%
50%
-50%
-50%
25%
25%
-25%
-25%
25%
1000m
Elev. (m)
-25%
500m
2250N 2400N 2550N 2700N 2850N 3000N
UTEM Survey at: Vakkerlien
For: A/S Sulfidmalm
LAMONTAGNE
GEOPHYSICS LTD
GEOPHYSIQUE LTEE
Job
0531
Surveyed : 17/11/5
Reduced : 22/11/5
Plotted : 24/12/5
Loop: 02
Line: 670E
Compt: Hz
Secondary, (Chn - Ch1)/IHpI
Contin. Norm at depth of 0 m
Base Freq. 3.251 Hz



Loop: 02	Secondary, (Chn - Ch1)/lHpl	UTEM Survey at: Vakkerlien
Line: 671E	Contin. Norm at depth of 0 m	For: A/S Sulfidmalm
Compt: Hz	Base Freq. 3.251 Hz	LAMONTAGNE GEOPHYSICS LTD GEOPHYSIQUE LTEE Job 0531 Surveyed : 23/11/5 Reduced : 24/12/5 Plotted : 24/12/5

Vakkerlien

Loop 2

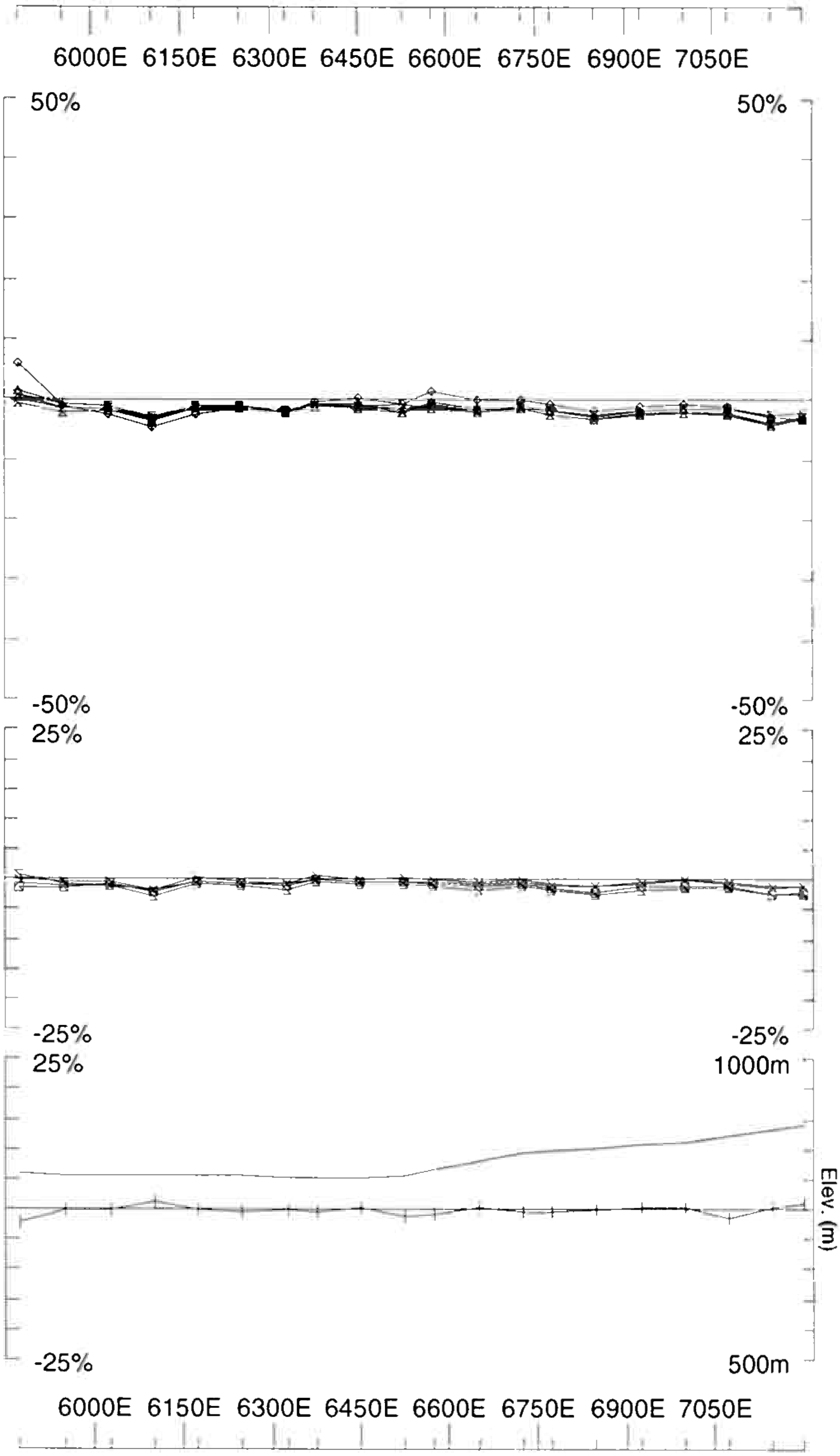
Hz
@3.251 Hz frequency

point norm
@
(x,y,z) = (6525E,31400N, 850 m.a.s.l.)

Ch1 reduced

Loop 02 (E-W)	Line 309N	5825N - 7225N	1400m
	Line 311N	5825N - 7225N	1400m
	Line 313N	5825N - 8000N	2175m
	Line 315N	5825N - 7225N	1400m
	Line 317N	5825N - 7225N	1400m
	Line 319N	5825N - 7225N	1400m
(N-S))	Line 663E	700N - 2900N	2200m
	Line 664E	700N - 2900N	2200m
	Line 665E	700N - 2900N	2200m
	Line 666E	700N - 2900N	2200m
	Line 667E	700N - 2900N	2200m
	Line 668E	2100N - 2900N	800m
	Line 669E	2100N - 2900N	800m
	Line 670E	2100N - 3150N	1050m
	Line 671E	2500N - 3150N	650m
		Vakkerlien Loop 02 Total	23475m

Loop 2 - point norm



Loop: 02
Line: 309N
Compt: Hz

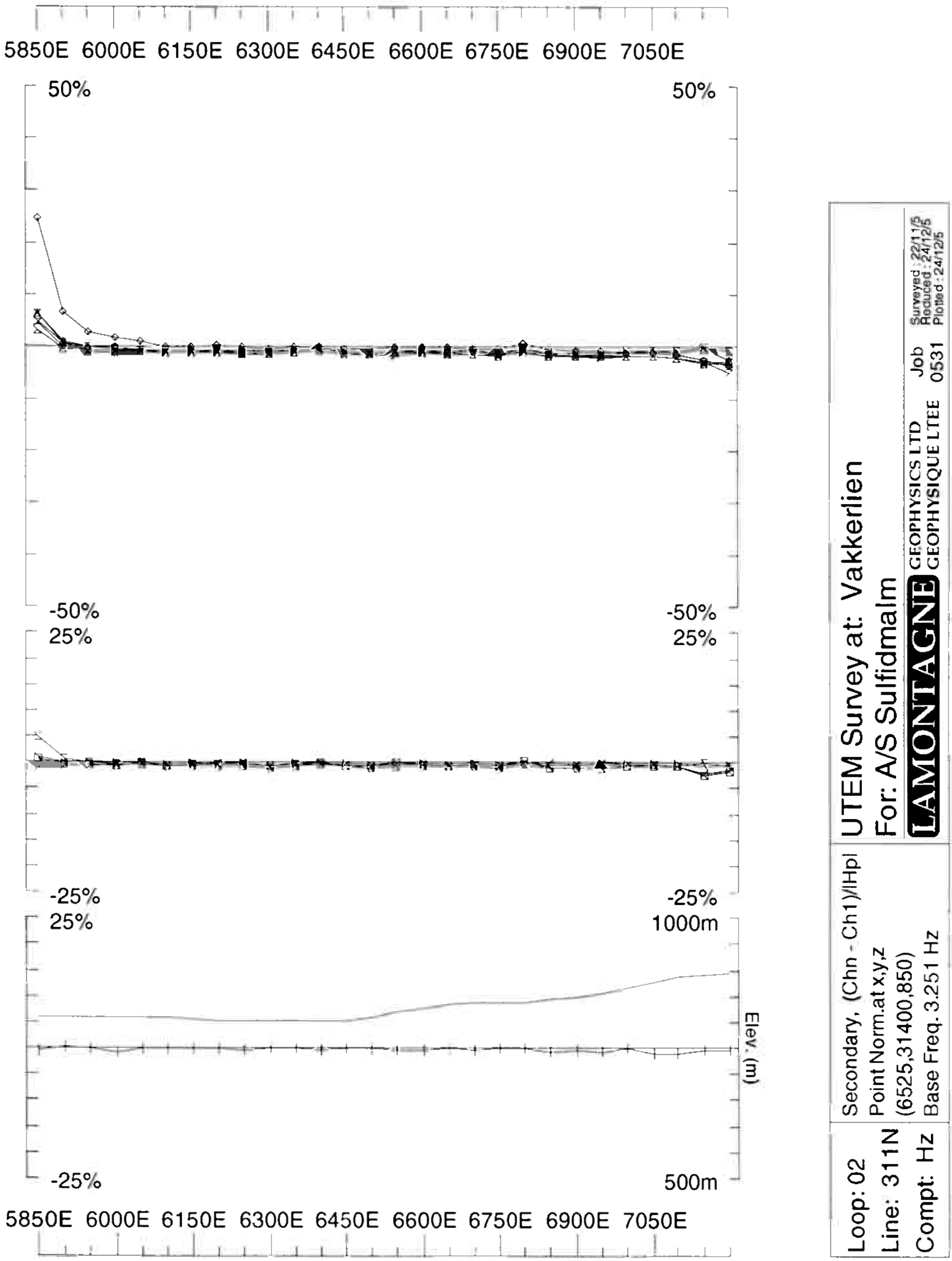
Secondary, (Chn - Ch1)/|Hp|
Point Norm.at x,y,z
(6525,31400,850)
Base Freq. 3.251 Hz

UTEM Survey at: Vakkerlien
For: A/S Sulfidmalm

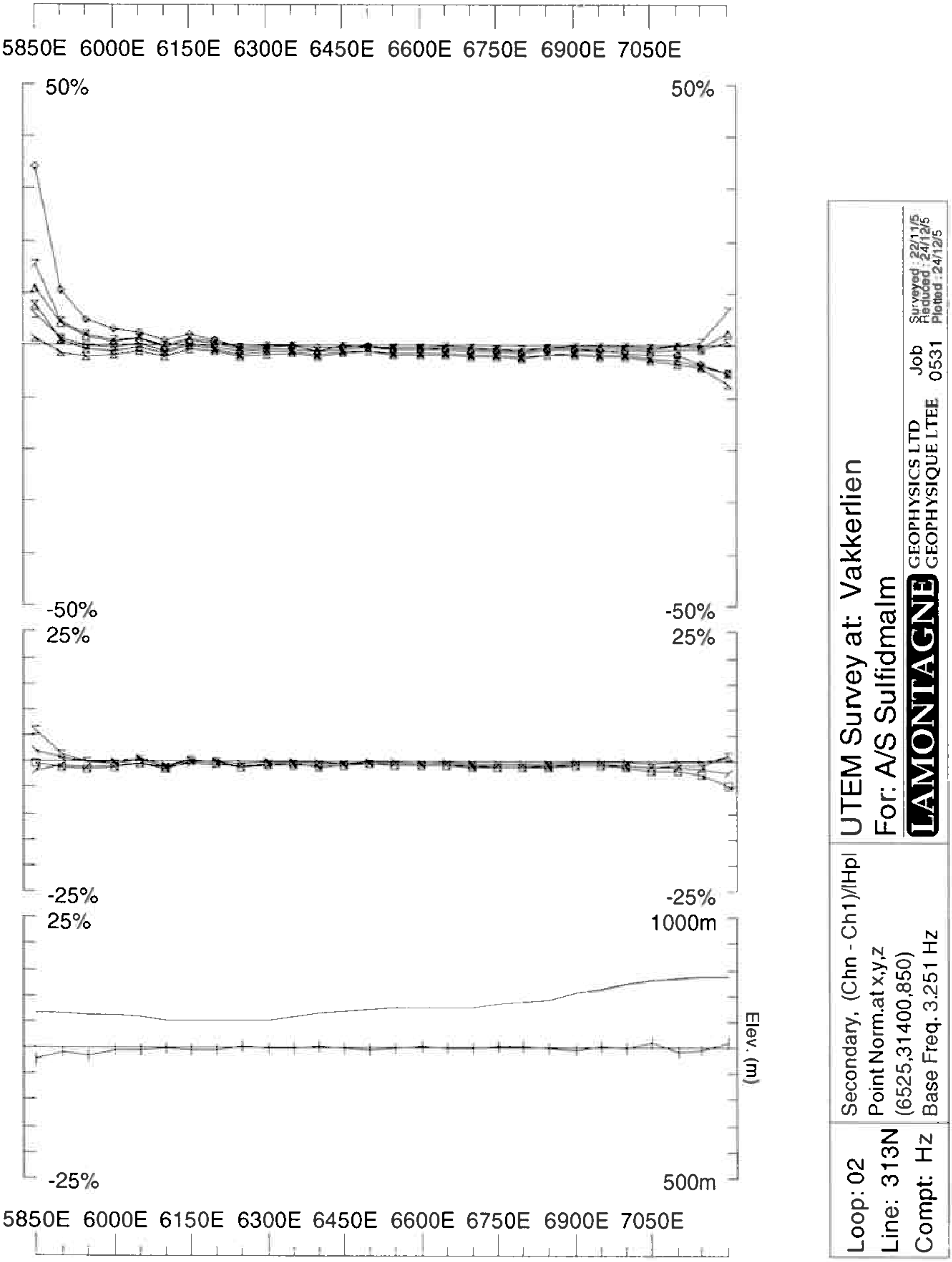
LAMONTAGNE GEOPHYSICS LTD
GEOPHYSIQUE LTEE

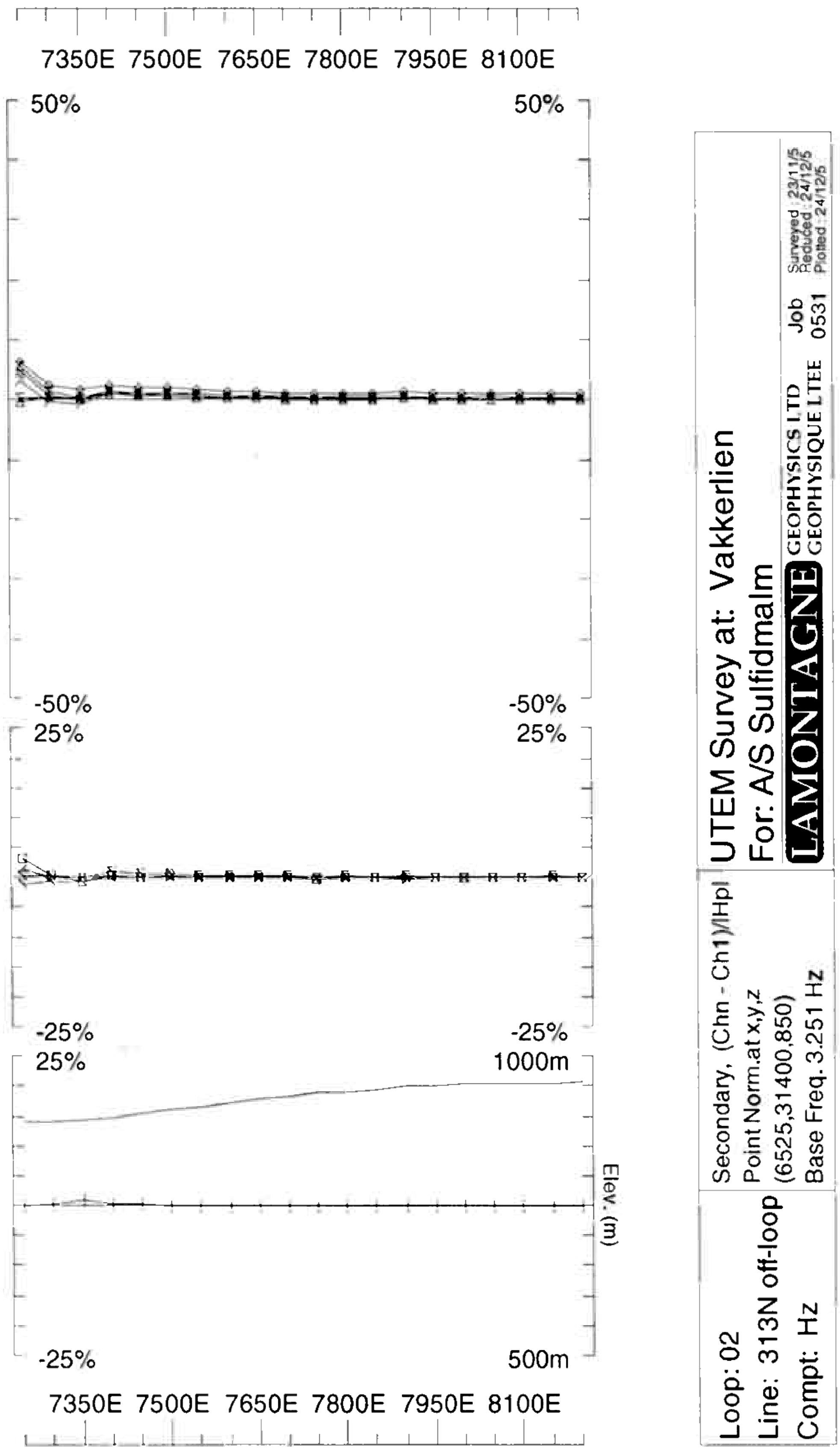
Job
0531

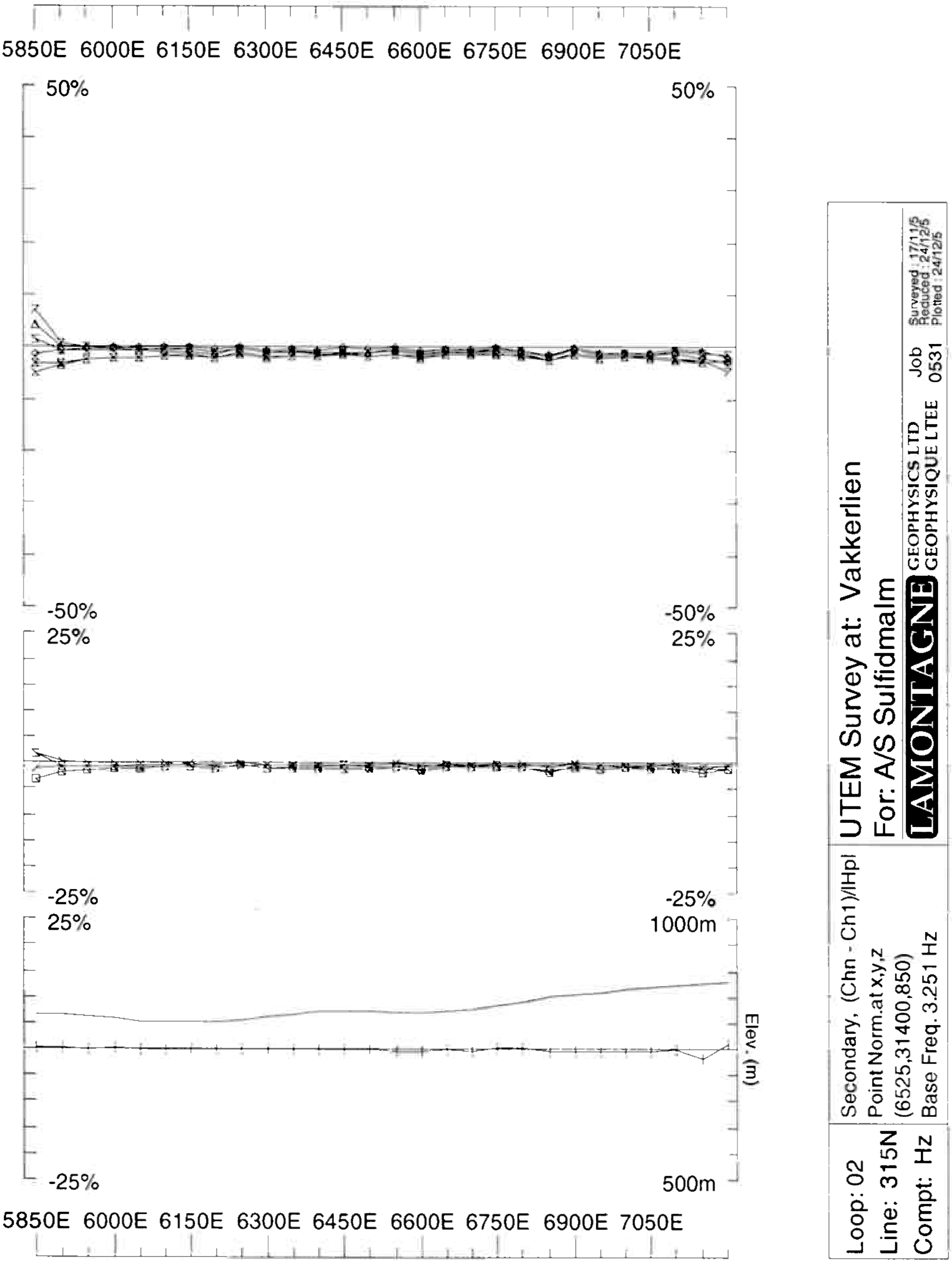
Surveyed : 23/11/5
Reduced : 24/12/5
Plotted : 24/12/5

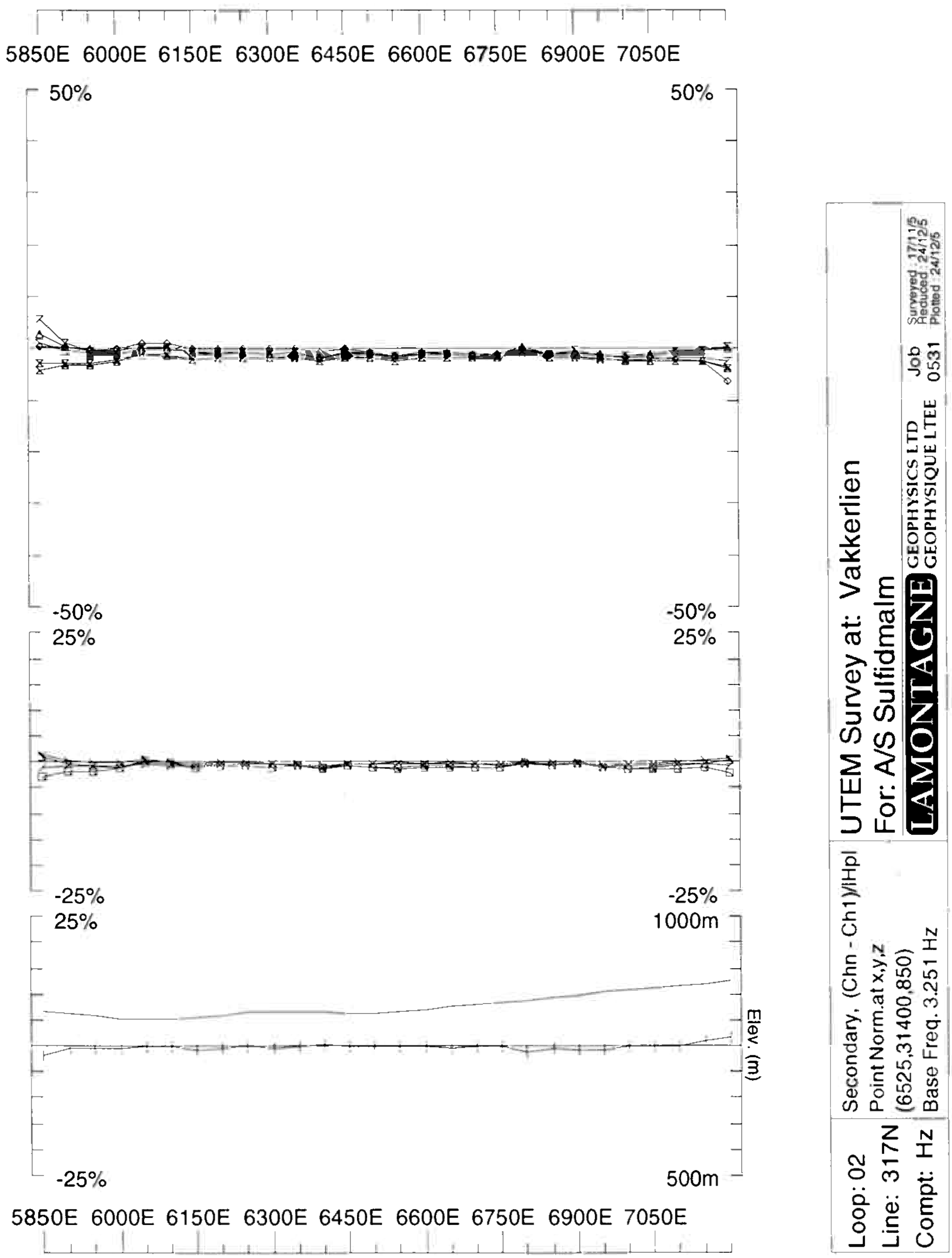


5850E 6000E 6150E 6300E 6450E 6600E 6750E 6900E 7050E
50%
50%
-50%
-50%
25%
25%
-25%
-25%
25%
1000m
Elev. (m)
-25%
500m
5850E 6000E 6150E 6300E 6450E 6600E 6750E 6900E 7050E
UTEM Survey at: Vakkerlien
For: A/S Sulfidmalm
LAMONTAGNE GEOPHYSICS LTD GEOPHYSIQUE LTEE
Job 0531
Surveyed: 22/11/5
Reduced: 24/12/5
Plotted: 24/12/5
Loop: 02
Line: 311N
Compt: Hz
Secondary, (Chn - Ch1)/IHpI
Point Norm.at x,y,z
(6525,31400,850)
Base Freq. 3.251 Hz

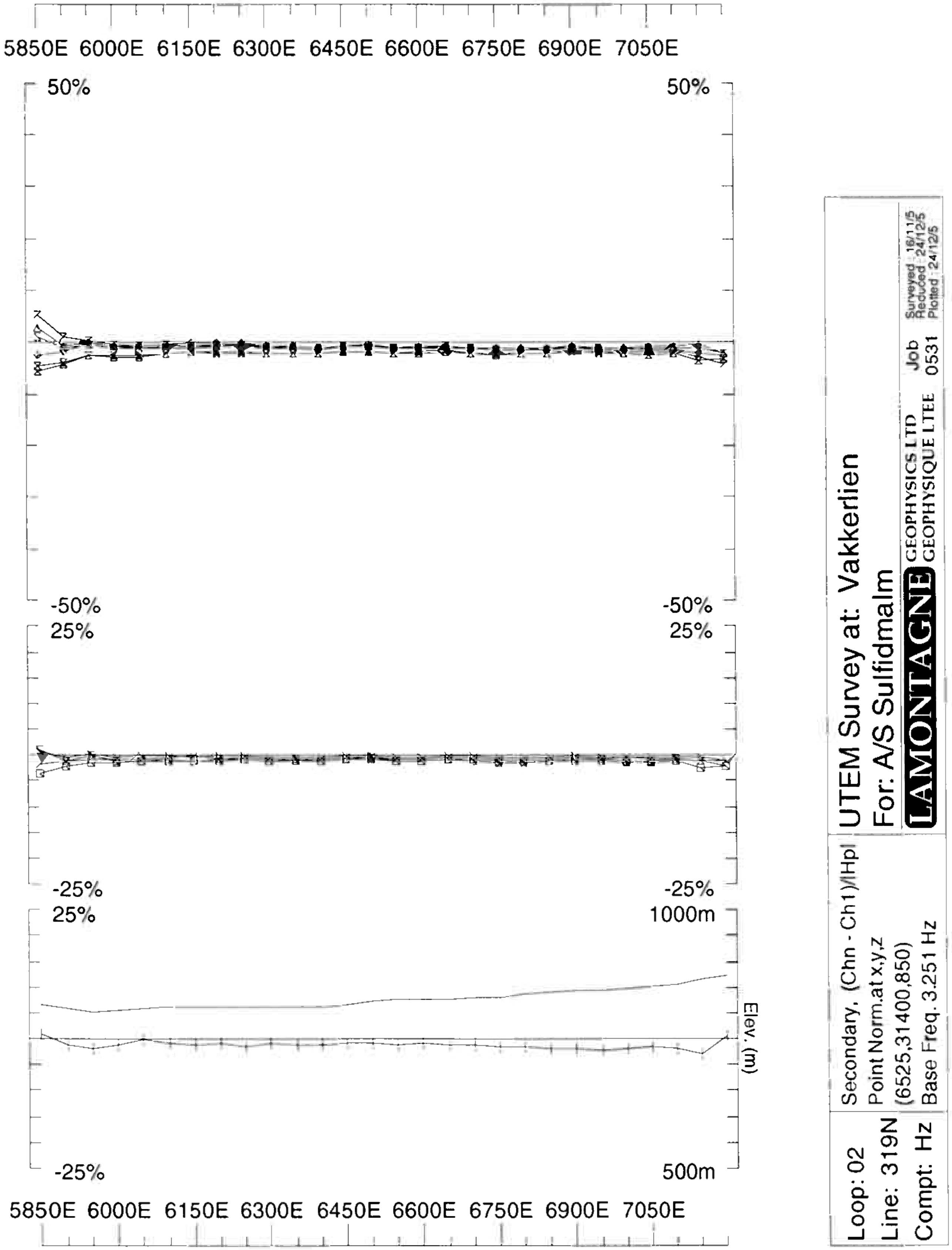

5850E 6000E 6150E 6300E 6450E 6600E 6750E 6900E 7050E
50%
50%
-50%
-50%
25%
25%
-25%
-25%
25%
1000m
Elev. (m)
-25%
500m
5850E 6000E 6150E 6300E 6450E 6600E 6750E 6900E 7050E
UTEM Survey at: Vakkerlien
For: A/S Sulfidmalm
LAMONTAGNE GEOPHYSICS LTD GEOPHYSIQUE LTEE
Job 0531
Surveyed : 22/11/5
Reduced : 24/12/5
Plotted : 24/12/5
Loop: 02
Line: 313N
Compt: Hz
Secondary, (Chn - Ch1)/IHpl
Point Norm.at x,y,z
(6525,31400,850)
Base Freq. 3.251 Hz

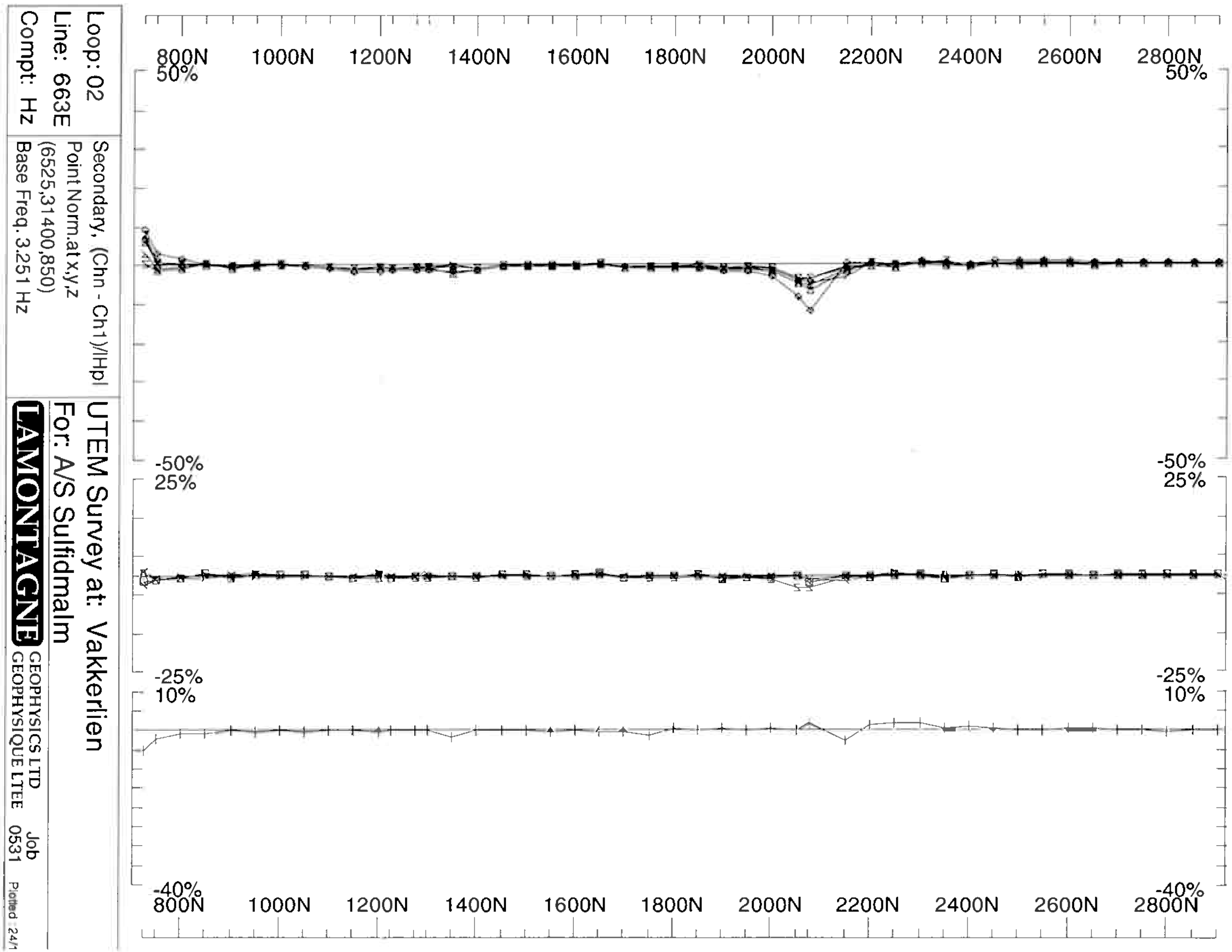

7350E 7500E 7650E 7800E 7950E 8100E
50%
50%
-50%
-50%
25%
25%
-25%
-25%
25%
1000m
Elev. (m)
-25%
500m
7350E 7500E 7650E 7800E 7950E 8100E
UTEM Survey at: Vakkerlien
For: A/S Sulfidmalm
LAMONTAGNE GEOPHYSICS LTD GEOPHYSIQUE LTEE
Job 0531
Surveyed: 23/11/5
Reduced: 24/12/5
Plotted: 24/12/5
Secondary, (Chn - Ch1)/MHpl
Point Norm.at x,y,z
(6525,31400,850)
Base Freq. 3.251 Hz
Loop: 02
Line: 313N off-loop
Compt: Hz


5850E 6000E 6150E 6300E 6450E 6600E 6750E 6900E 7050E
50%
50%
-50%
-50%
25%
25%
-25%
-25%
25%
1000m
Elev. (m)
-25%
500m
UTEM Survey at: Vakkerlien
For: A/S Sulfidmalm
LAMONTAGNE GEOPHYSICS LTD GEOPHYSIQUE LTEE
Job 0531
Surveyed : 17/11/5
Reduced : 24/12/5
Plotted : 24/12/5
Secondary, (Chn - Ch1)/lHpl
Point Norm.at x,y,z
(6525,31400,850)
Base Freq. 3.251 Hz
Loop: 02
Line: 315N
Compt: Hz



5850E 6000E 6150E 6300E 6450E 6600E 6750E 6900E 7050E
50%
50%
-50%
-50%
25%
25%
-25%
-25%
25%
1000m
Elev. (m)
-25%
500m
5850E 6000E 6150E 6300E 6450E 6600E 6750E 6900E 7050E
UTEM Survey at: Vakkerlien
For: A/S Sulfidmalm
LAMONTAGNE GEOPHYSICS LTD GEOPHYSIQUE LTEE
Job 0531
Surveyed : 17/11/5
Reduced : 24/12/5
Plotted : 24/12/5
Loop: 02
Line: 317N
Compt: Hz
Secondary, (Chn - Ch1)/|Hp|
Point Norm.at x,y,z
(6525,31400,850)
Base Freq. 3.251 Hz


5850E 6000E 6150E 6300E 6450E 6600E 6750E 6900E 7050E
50%
50%
-50%
-50%
25%
25%
-25%
-25%
25%
1000m
Elev. (m)
-25%
500m
5850E 6000E 6150E 6300E 6450E 6600E 6750E 6900E 7050E
UTEM Survey at: Vakkerlien
For: A/S Sulfidmalm
LAMONTAGNE GEOPHYSICS LTD GEOPHYSIQUE LTEE
Job 0531
Surveyed: 16/11/5
Reduced: 24/12/5
Plotted: 24/12/5
Loop: 02
Line: 319N
Compt: Hz
Secondary, (Chn - Ch1)/|Hp|
Point Norm.at x,y,z
(6525,31400,850)
Base Freq. 3.251 Hz


Loop: 02
Line: 663E
Compt: Hz
Secondary, (Chn - Ch1)/IHpI
Point Norm.at x,y,z
(6525,31400,850)
Base Freq. 3.251 Hz
UTEM Survey at: Vakkerlien
For: A/S Sulfidmalm
LAMONTAGNE
GEOPHYSICS LTD
GEOPHYSIQUE LTEE
Job
0531
800N
1000N
1200N
1400N
1600N
1800N
2000N
2200N
2400N
2600N
2800N
50%
-50%
25%
-25%
10%
-40%

Loop: 02
Line: 664E
Compt: Hz

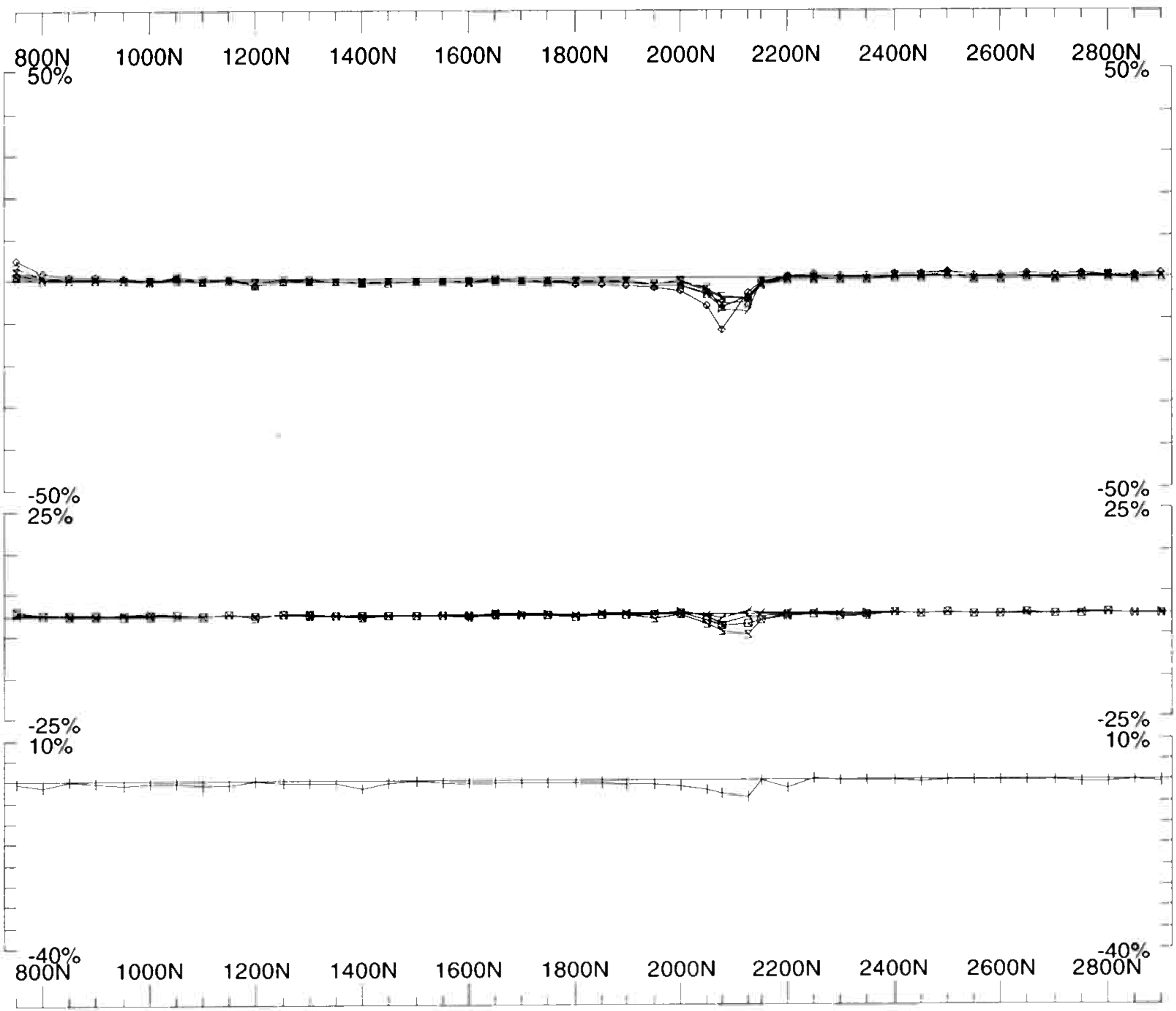
Secondary, (Chn - Ch1)/Hpl
PointNorm.at x,y,z
(6525,31400,850)
Base Freq. 3.251 Hz

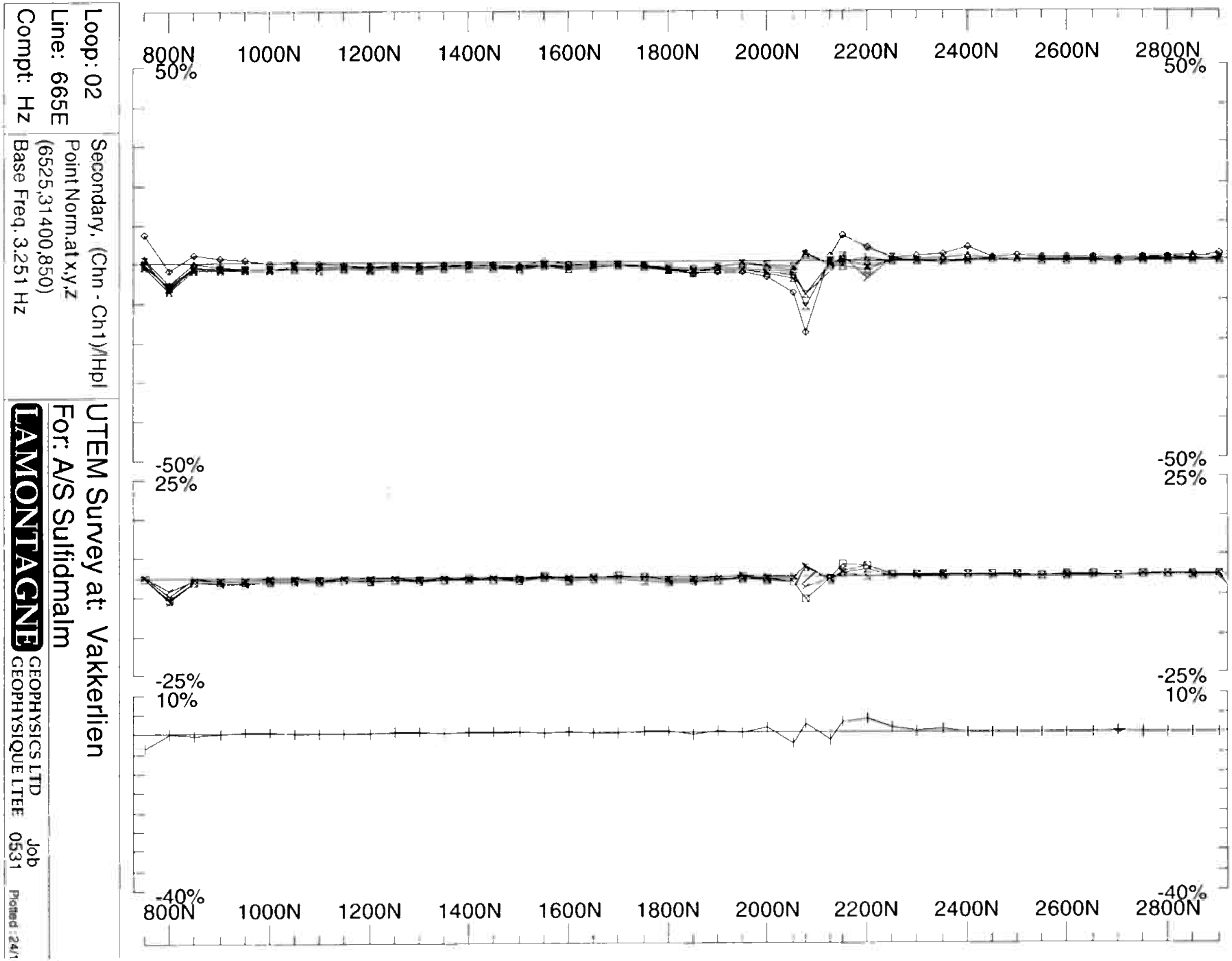
UTEM Survey at: Vakkerlien
For: A/S Sulfidmalm

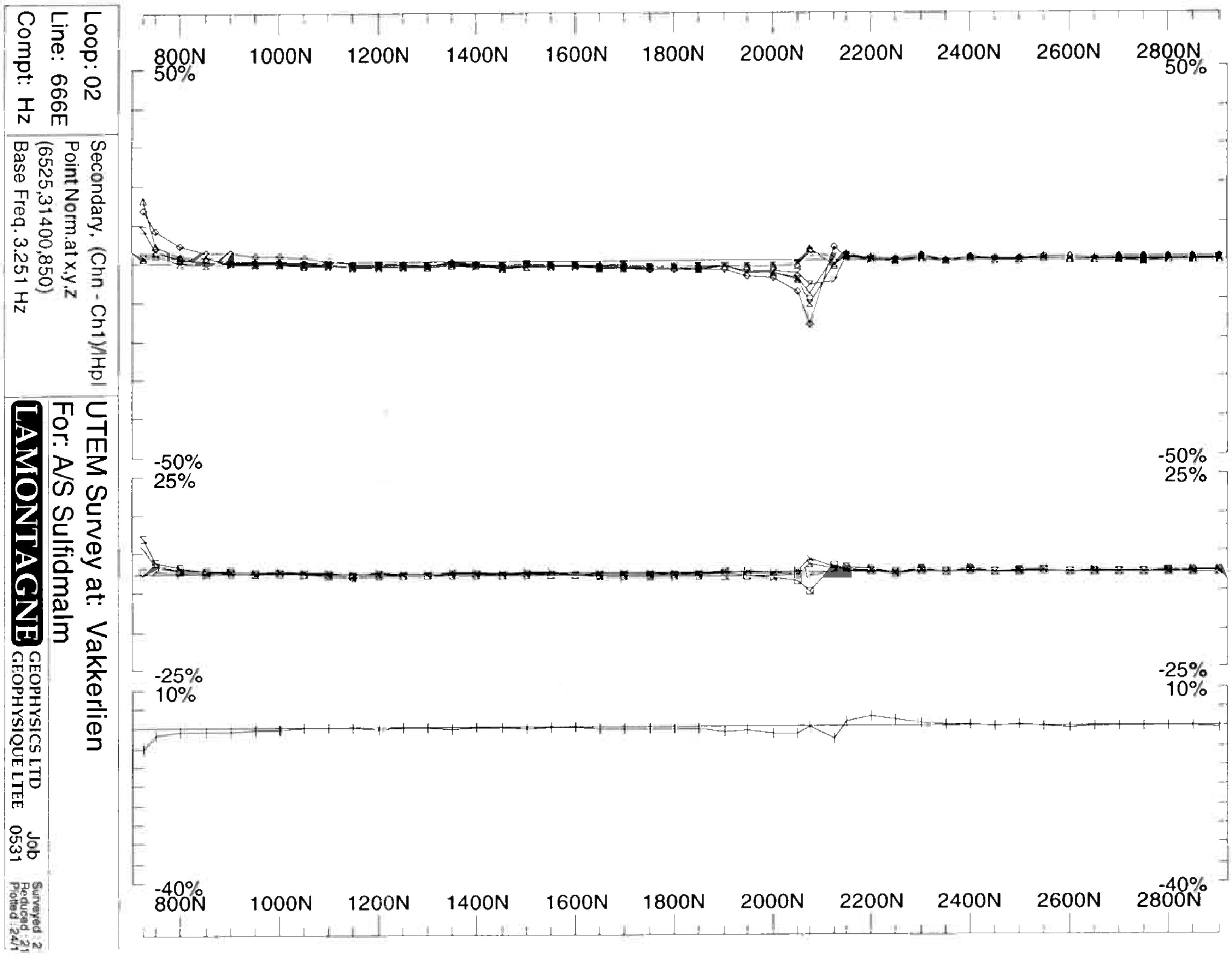
LAMONTAGNE GEOPHYSICS LTD
GEOPHYSIQUE LTEE

Job 0531

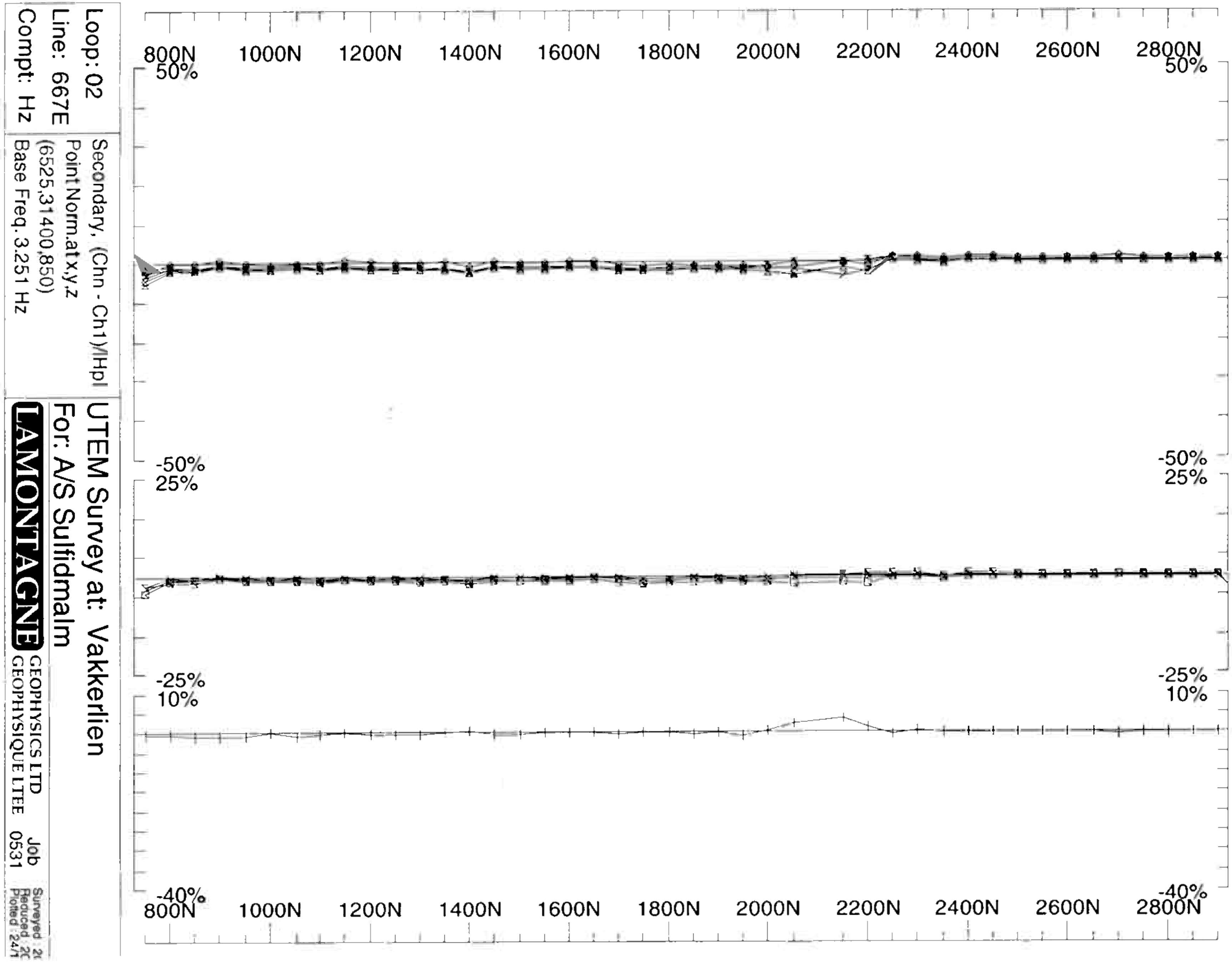
Plotted: 24/1

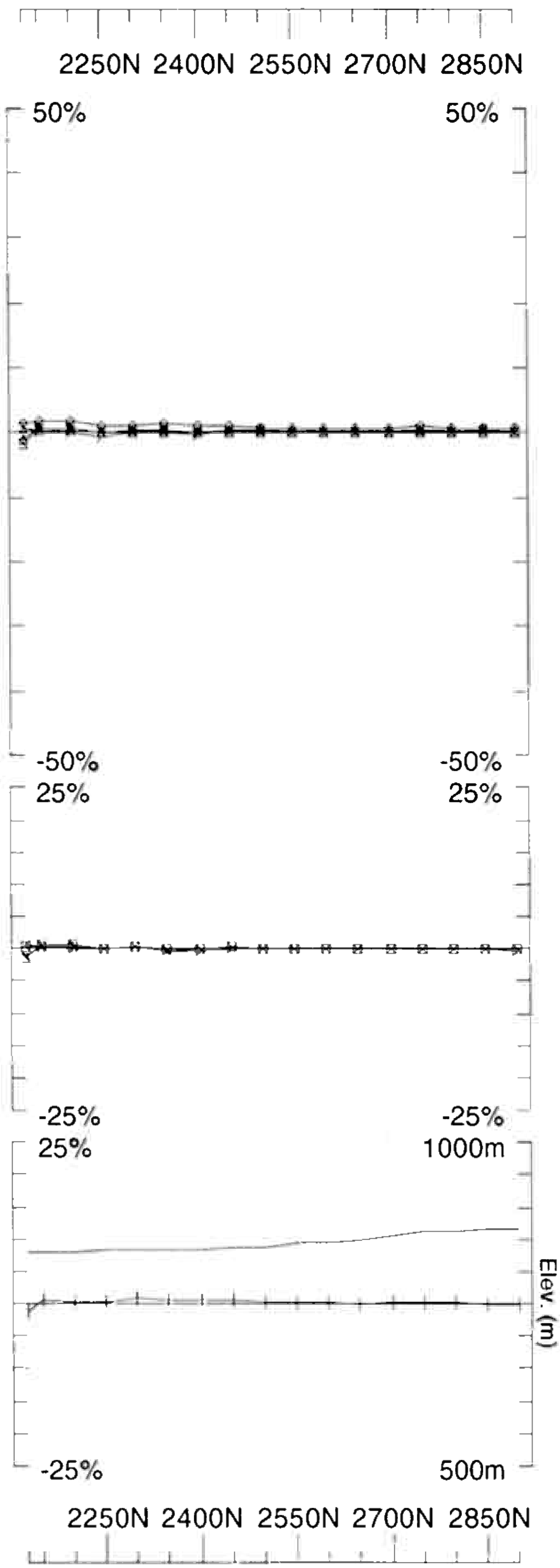



Loop: 02
Line: 665E
Compt: Hz
Secondary, (Chn - Ch1)/Hpl
Point Norm.at x,y,z
(6525,31400,850)
Base Freq. 3.251 Hz
UTEM Survey at: Vakkerlien
For: A/S Sulfidmalm
LAMONTAGNE
GEOPHYSICS LTD
GEOPHYSIQUE LTEE
Job
0531
Plotted : 24/
800N
1000N
1200N
1400N
1600N
1800N
2000N
2200N
2400N
2600N
2800N
50%
-50%
25%
-25%
10%
-40%



Loop: 02
Line: 666E
Compt: Hz
Secondary, (Chn - Ch1)/Hpl
Point Norm.at x,y,z
(6525,31400,850)
Base Freq. 3.251 Hz
UTEM Survey at: Vakkerlien
For: A/S Sulfidmalm
LAMONTAGNE
GEOPHYSICS LTD
GEOPHYSIQUE LTEE
Job
0531
800N
1000N
1200N
1400N
1600N
1800N
2000N
2200N
2400N
2600N
2800N
50%
-50%
25%
-25%
10%
-40%


Loop: 02
Line: 667E
Compt: Hz
Secondary, (Chn - Ch1)/Hpl
PointNorm.atx,y,z
(6525,31400,850)
Base Freq. 3.251 Hz
UTEM Survey at: Vakkerlien
For: A/S Sulfidmalm
LAMONTAGNE
GEOPHYSICS LTD
GEOPHYSIQUE LTEE
Job
0531
800N
1000N
1200N
1400N
1600N
1800N
2000N
2200N
2400N
2600N
2800N
50%
-50%
25%
-25%
10%
-40%



Loop: 02
Line: 668E
Compt: Hz

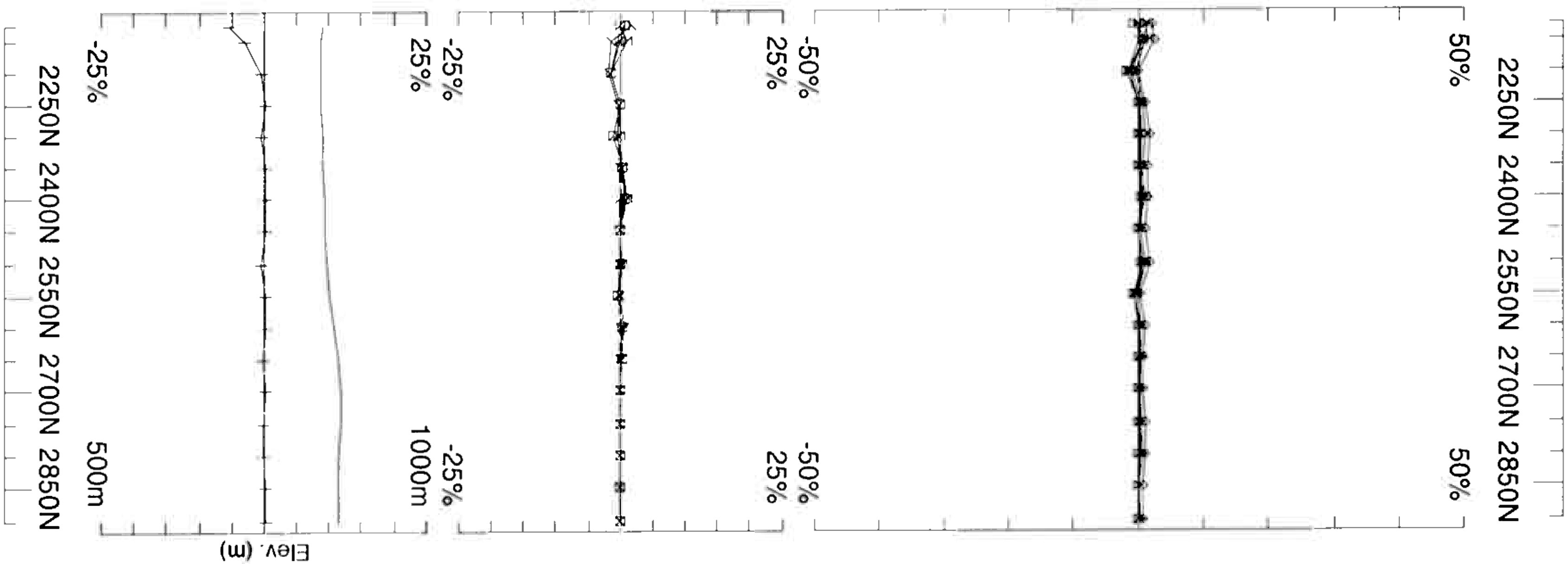
Secondary, (Chn - Ch1)/IHpl
Point Norm.at x,y,z
(6525,31400,850)
Base Freq. 3.251 Hz

UTEM Survey at: Vakkerlien
For: A/S Sulfidmalm

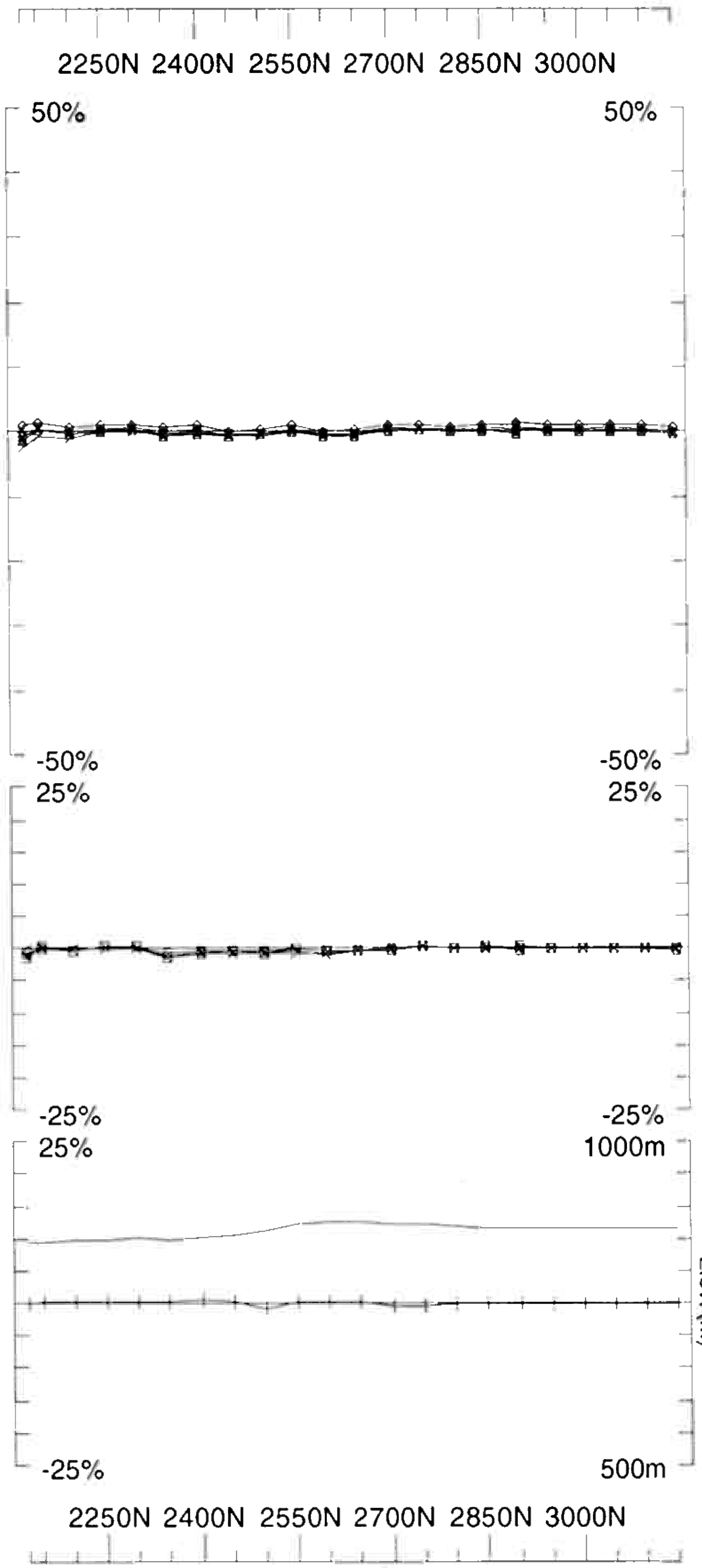
LAMONTAGNE GEOPHYSICS LTD
GEOPHYSIQUE LTEE

Job
0531

Surveyed 18/11/5
Reduced 24/12/5
Plotted 24/12/5



Loop: 02 Line: 669E Compt: Hz	Secondary, (Chn - Ch1)/IHpl Point Norm.at x,y,z (6525,31400,850) Base Freq. 3.251 Hz	UTEM Survey at: Vakkerlien For: A/S Sulfidmalm LAMONTAGNE GEOPHYSICS LTD GEOPHYSIQUE LTEE Job 0531 Surveyed : 17/11/5 Reduced : 24/12/5 Plotted : 24/12/5



UTEM Survey at: Vakkerlien
For: A/S Sulfidmalm

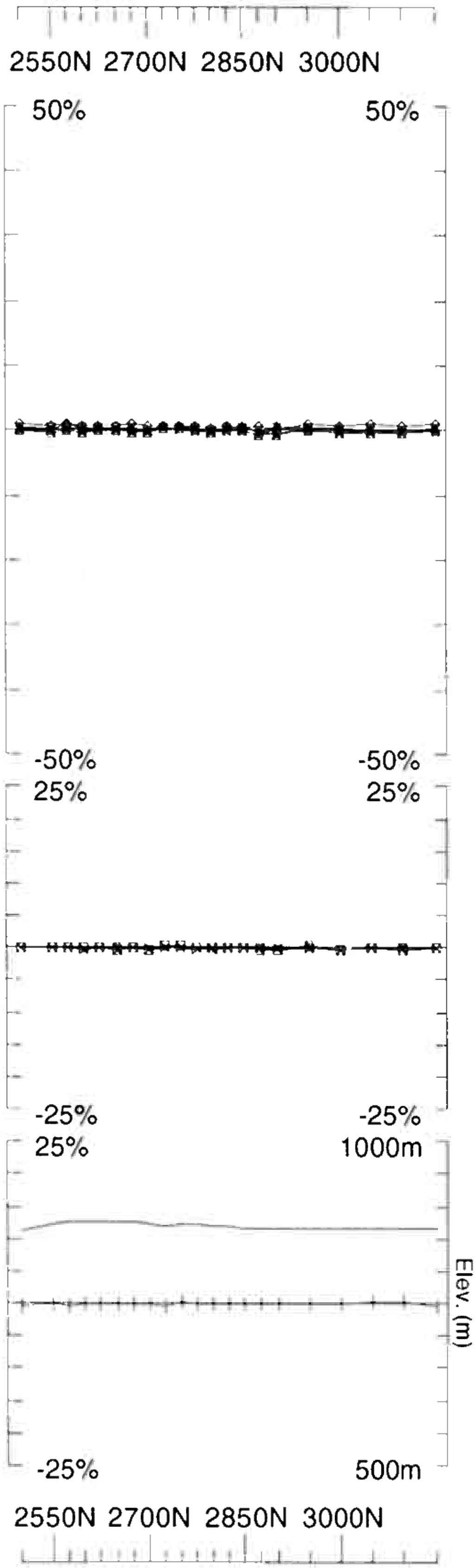
LAMONTAGNE GEOPHYSICS LTD
GEOPHYSIQUE LTEE

Job 0531

Surveyed: 17/11/5
Reduced: 22/11/5
Plotted: 24/12/5

Loop: 02
Line: 670E
Compt: Hz

Secondary, (Chn - Ch1)/IHpI
Point Norm.at x,y,z
(6525,31400,850)
Base Freq. 3.251 Hz



UTEM Survey at: Vakkerlien
For: A/S Sulfidmalm

LAMONTAGNE GEOPHYSICS LTD GEOPHYSIQUE LTEE

Job 0531

Surveyed : 23/11/5
Reduced : 24/12/5
Plotted : 24/12/5

Secondary, (Chn - Ch1)/IHpl
Point Norm.at x,y,z
(6525,31400,850)
Base Freq. 3.251 Hz

Loop: 02
Line: 671E
Compt: Hz

Vakkerlien

Loop 2a

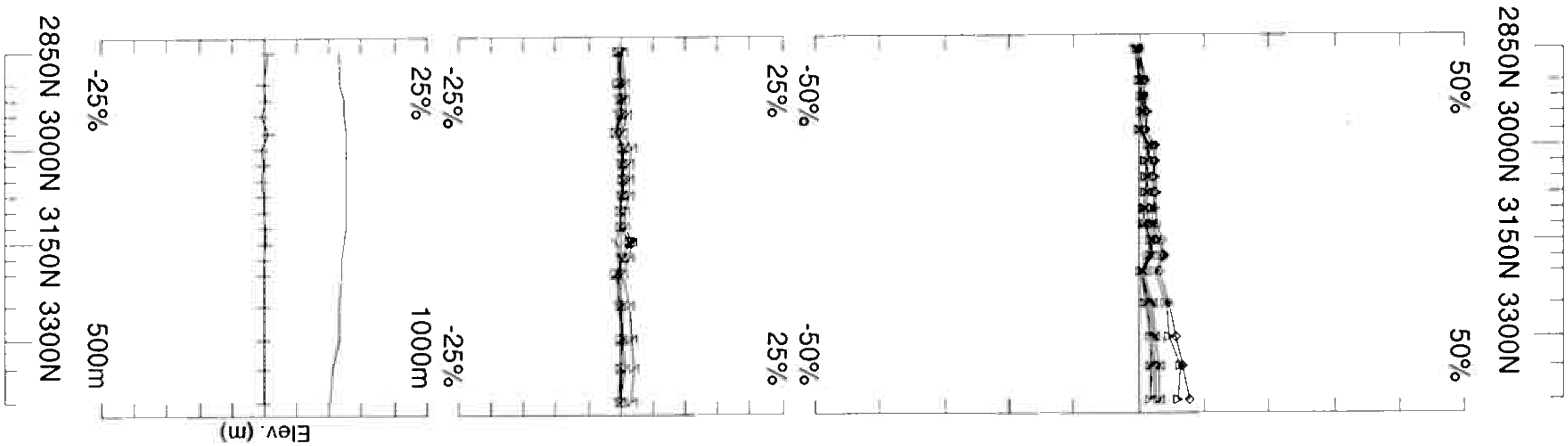
Hz
@3.251 Hz frequency

continuous norm

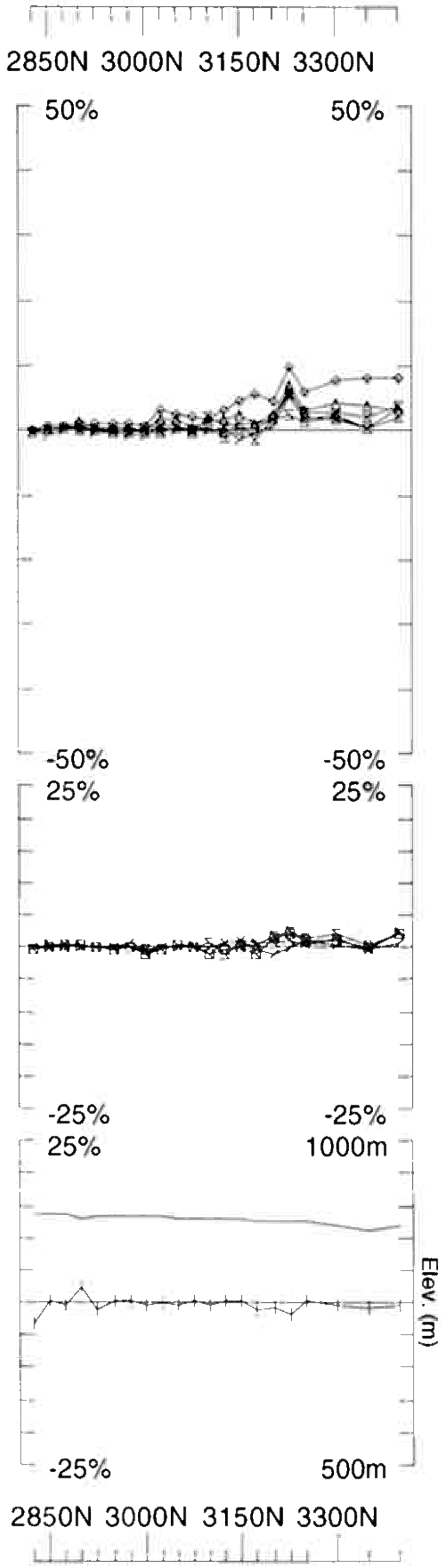
Ch1 reduced

Loop 02a	Line 670E	2800N - 3400N	600m
	Line 671E	2800N - 3400N	600m
		Vakkerlien Loop 02a Total	1200m

Loop 2a - continuous norm



Loop: 02a	Secondary, (Chn - Ch1)/lHpl	UTEM Survey at: Vakkerlien
Line: 670E	Contin. Norm at depth of 0 m	For: A/S Sulfidmalm
Compt: Hz	Base Freq. 3.251 Hz	LAMONTAGNE GEOPHYSICS LTD GEOPHYSIQUE LTEE — Job 0531 — Surveyed : 24/11/5 Reduced : 24/11/5 Plotted : 24/12/5



Loop: 02a
Line: 671E
Compt: Hz

Secondary, (Chn - Ch1)/IHpI
Contin. Norm at depth of 0 m
Base Freq. 3.251 Hz

UTEM Survey at: Vakkerlien
For: A/S Sulfidmalm

LAMONTAGNE GEOPHYSICS LTD
GEOPHYSIQUE LTEE

Job 0531

Surveyed : 24/11/5
Reduced : 24/11/6
Plotted : 24/12/5

Vakkerlien

Loop 2a

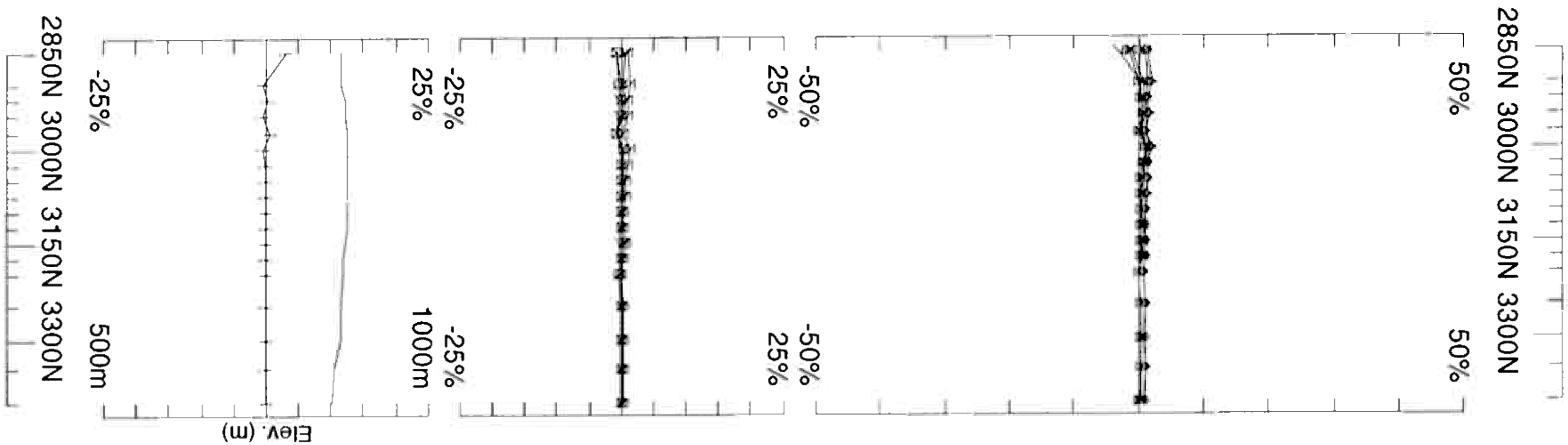
Hz
@3.251 Hz frequency

point norm
@
(x,y,z) = (6600E,31650N, 850 m.a.s.l.)

Ch1 reduced

Loop 02a	Line 670E	2800N - 3400N	600m
	Line 671E	2800N - 3400N	600m
		Vakkerlien Loop 02a Total	1200m

Loop 2a - point norm



Loop: 02a
Line: 670E
Compt: Hz

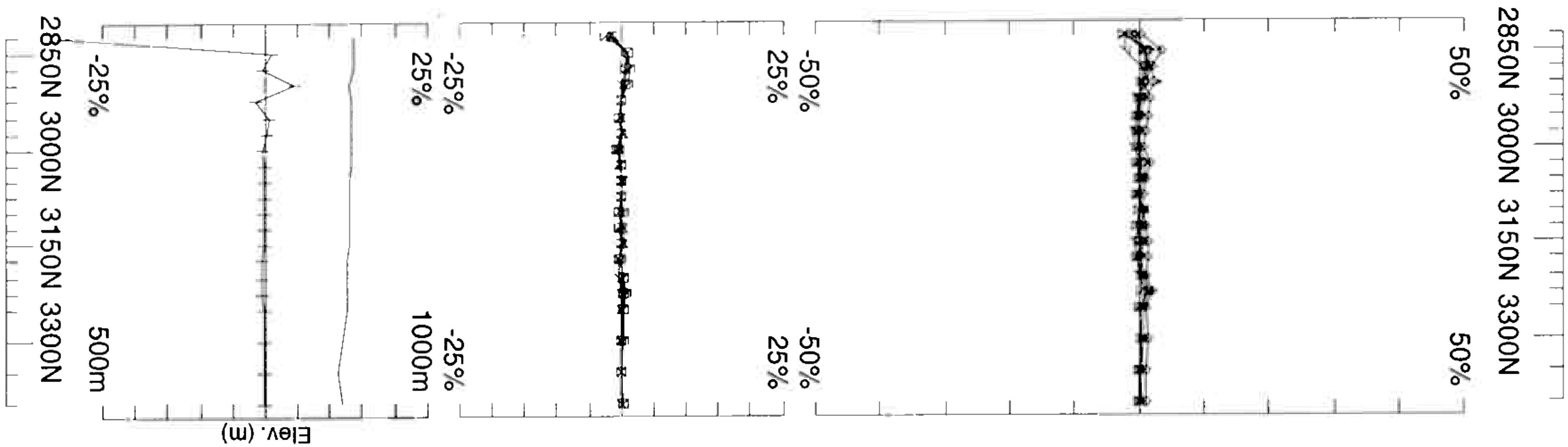
Secondary, (Chn - Ch1)/IHpI
Point Norm.at x,y,z
(6600,31650,850)
Base Freq. 3.251 Hz

UTEM Survey at: Vakkerlien
For: A/S Sulfidmalm

LAMONTAGNE GEOPHYSICS LTD GEOPHYSIQUE LTEE

Job 0531

Surveyed : 24/11/5
Reduced : 24/11/5
Plotted : 24/12/5



Loop: 02a Line: 671E Compt: Hz	Secondary, (Chn - Ch1)/lHpl Point Norm.at x,y,z (6600,31650,850) Base Freq. 3.251 Hz	UTEM Survey at: Vakkerlien For: A/S Sulfidmalm LAMONTAGNE GEOPHYSICS LTD GEOPHYSIQUE LTEE Job 0531 Surveyed 24/11/5 Reduced 24/11/5 Plotted 24/12/5

Vakkerlien

Loop 3

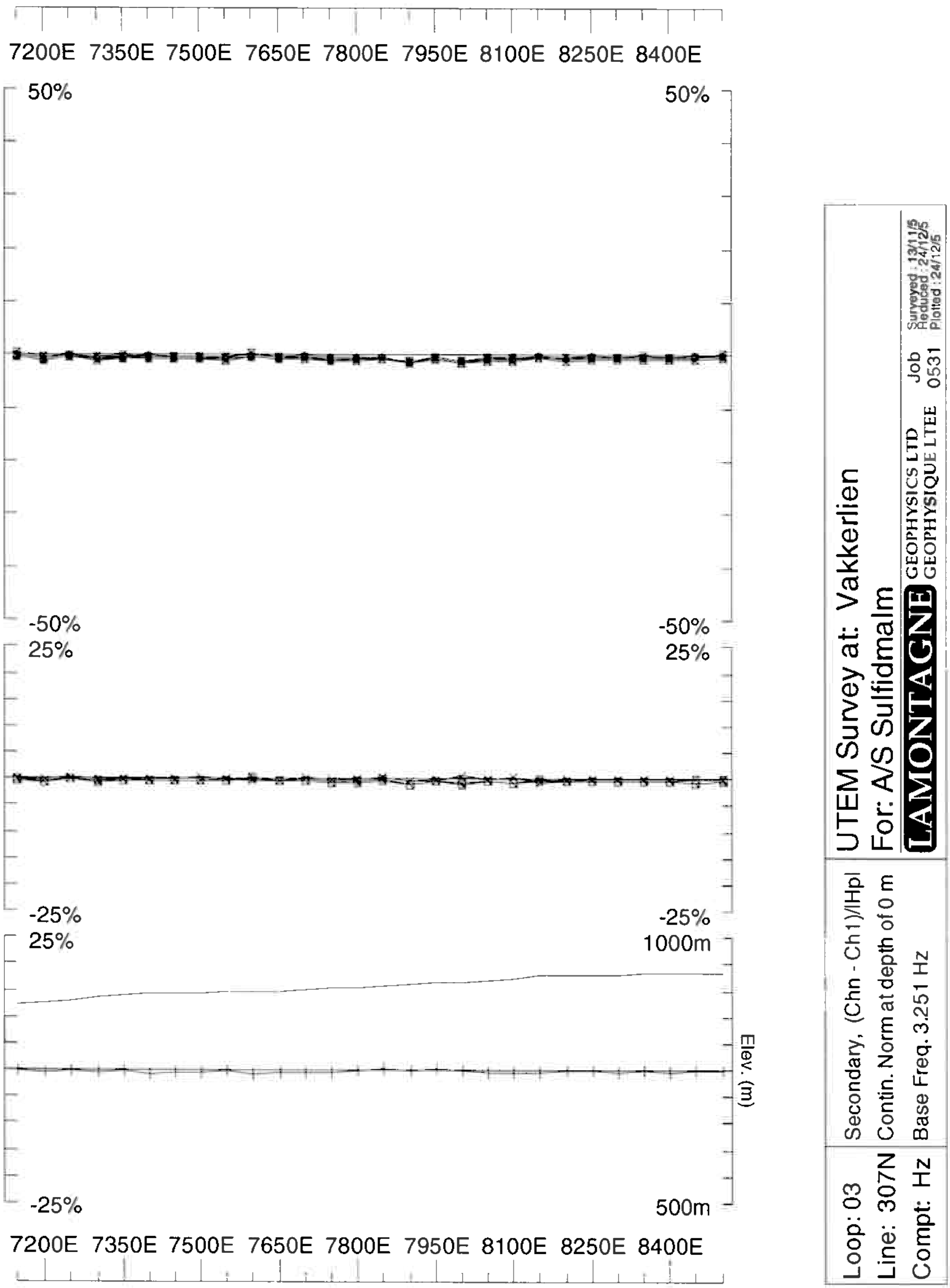
Hz
@3.251 Hz frequency

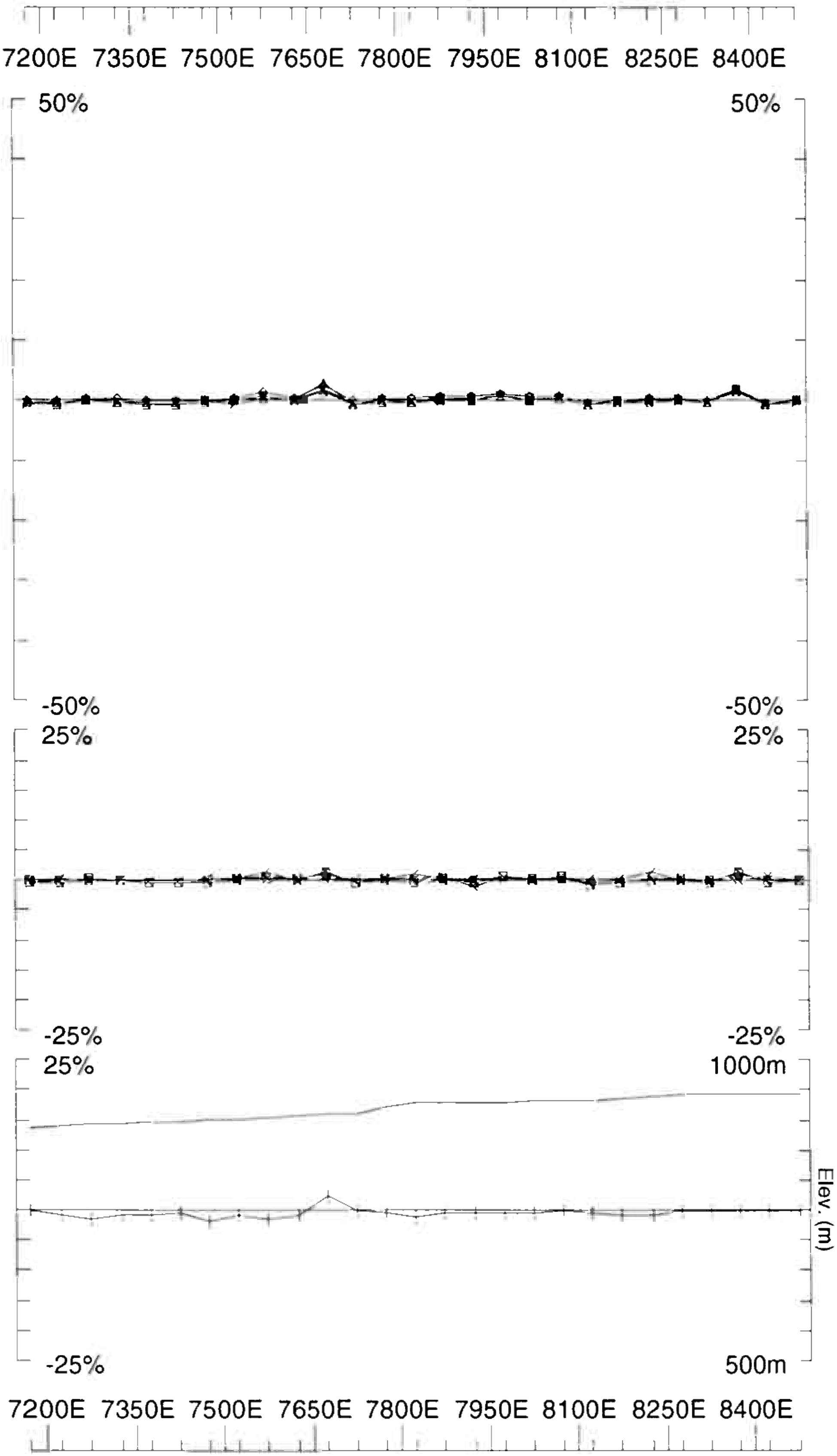
continuous norm

Ch1 reduced

Loop 03	Line 307N		7125N - 8525N	1400m
	Line 309N		7125N - 8525N	1400m
	Line 311N		7125N - 8525N	
		off-loop	6125N - 7125N	2400m
	Line 313N		7125N - 8525N	1400m
	Line 315N		7125N - 8525N	1400m
	Line 317N		7125N - 8525N	
		off-loop	6100N - 7125N	2425m
		Vakkerlien Loop 03 Total		10425m

Loop 03 - continuous norm


7200E 7350E 7500E 7650E 7800E 7950E 8100E 8250E 8400E
50%
50%
-50%
-50%
25%
25%
-25%
-25%
25%
1000m
Elev. (m)
-25%
500m
7200E 7350E 7500E 7650E 7800E 7950E 8100E 8250E 8400E
UTEM Survey at: Vakkerlien
For: A/S Sulfidmalm
LAMONTAGNE GEOPHYSICS LTD GEOPHYSIQUE LTEE
Job 0531
Surveyed : 13/11/5
Reduced : 24/12/5
Plotted : 24/12/5
Loop: 03
Line: 307N
Compt: Hz
Secondary, (Chn - Ch1)/IHpI
Contin. Norm at depth of 0 m
Base Freq. 3.251 Hz



UTEM Survey at: Vakkerlien
For: A/S Sulfidmalm

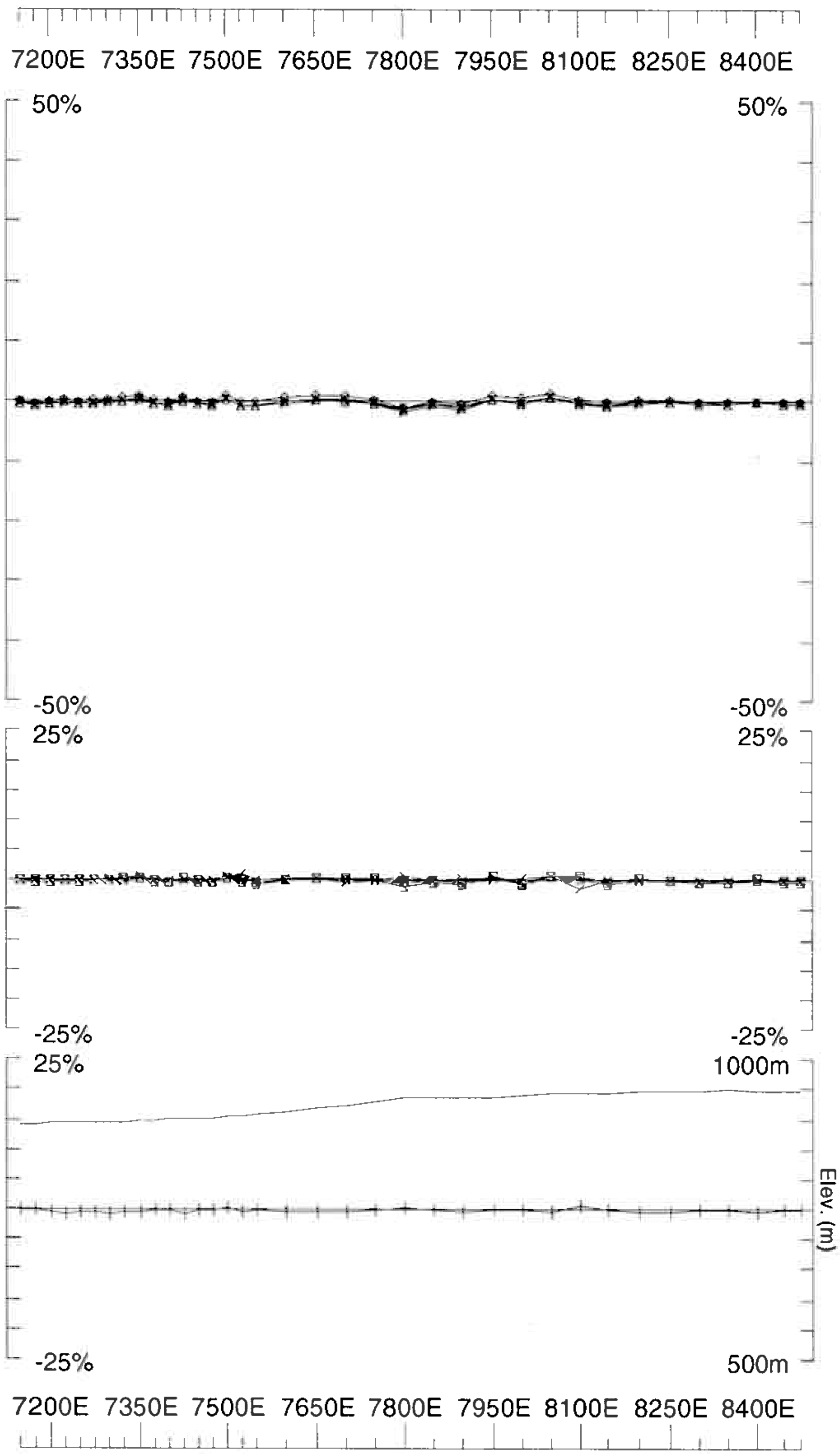
LAMONTAGNE GEOPHYSICS LTD GEOPHYSIQUE LTEE

Job 0531

Surveyed : 13/11/5
Reduced : 24/12/5
Plotted : 24/12/5

Loop: 03
Line: 309N
Compt: Hz

Secondary, (Chn - Ch1)/IHpl
Contin. Norm at depth of 0 m
Base Freq. 3.251 Hz



UTEM Survey at: Vakkerlien
For: A/S Sulfidmalm

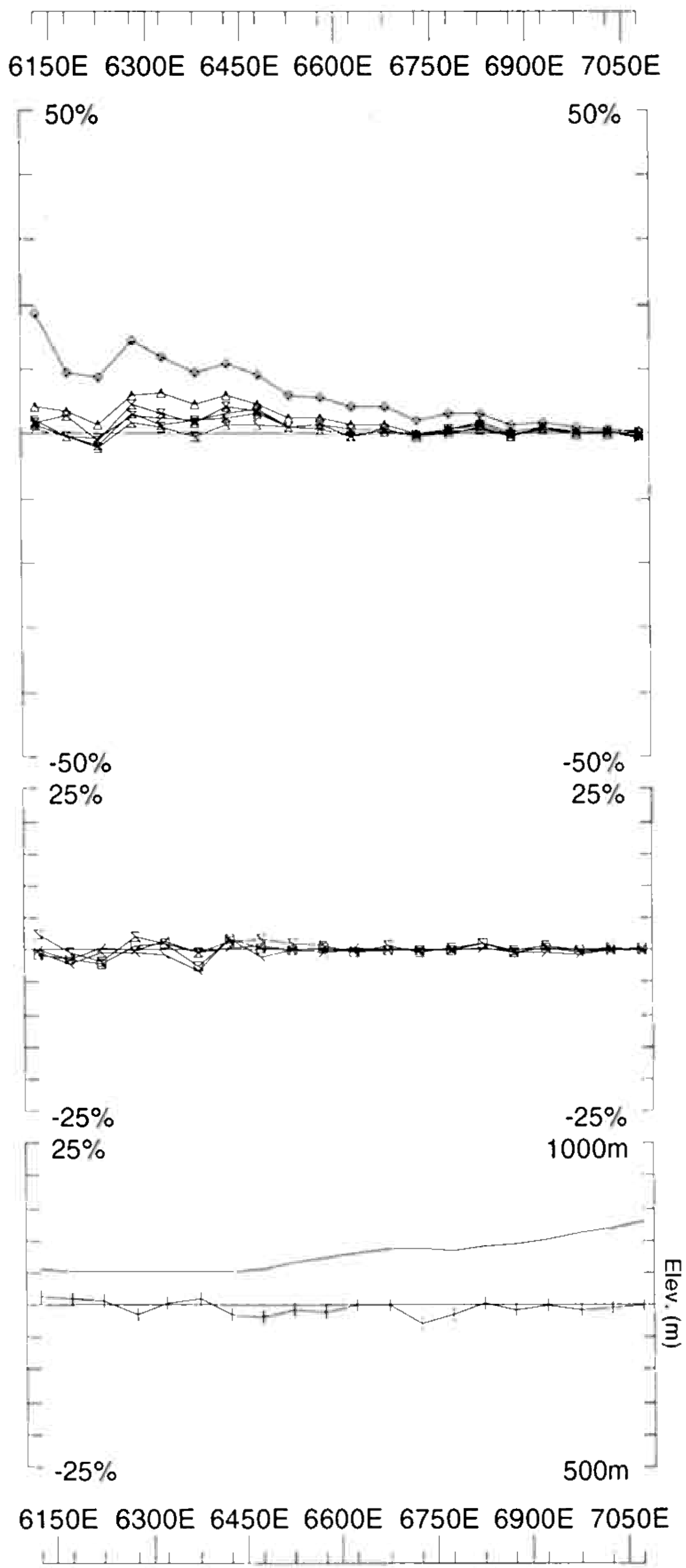
LAMONTAGNE GEOPHYSICS LTD GEOPHYSIQUE LTEE

Job 0531

Surveyed : 13/11/5
Reduced : 24/12/5
Plotted : 24/12/5

Secondary, (Chn - Ch1)/|Hp|
Contin. Norm at depth of 0 m
Base Freq. 3.251 Hz

Loop: 03
Line: 311N
Compt: Hz



Loop: 03
Line: 311N off-loop
Compt: Hz

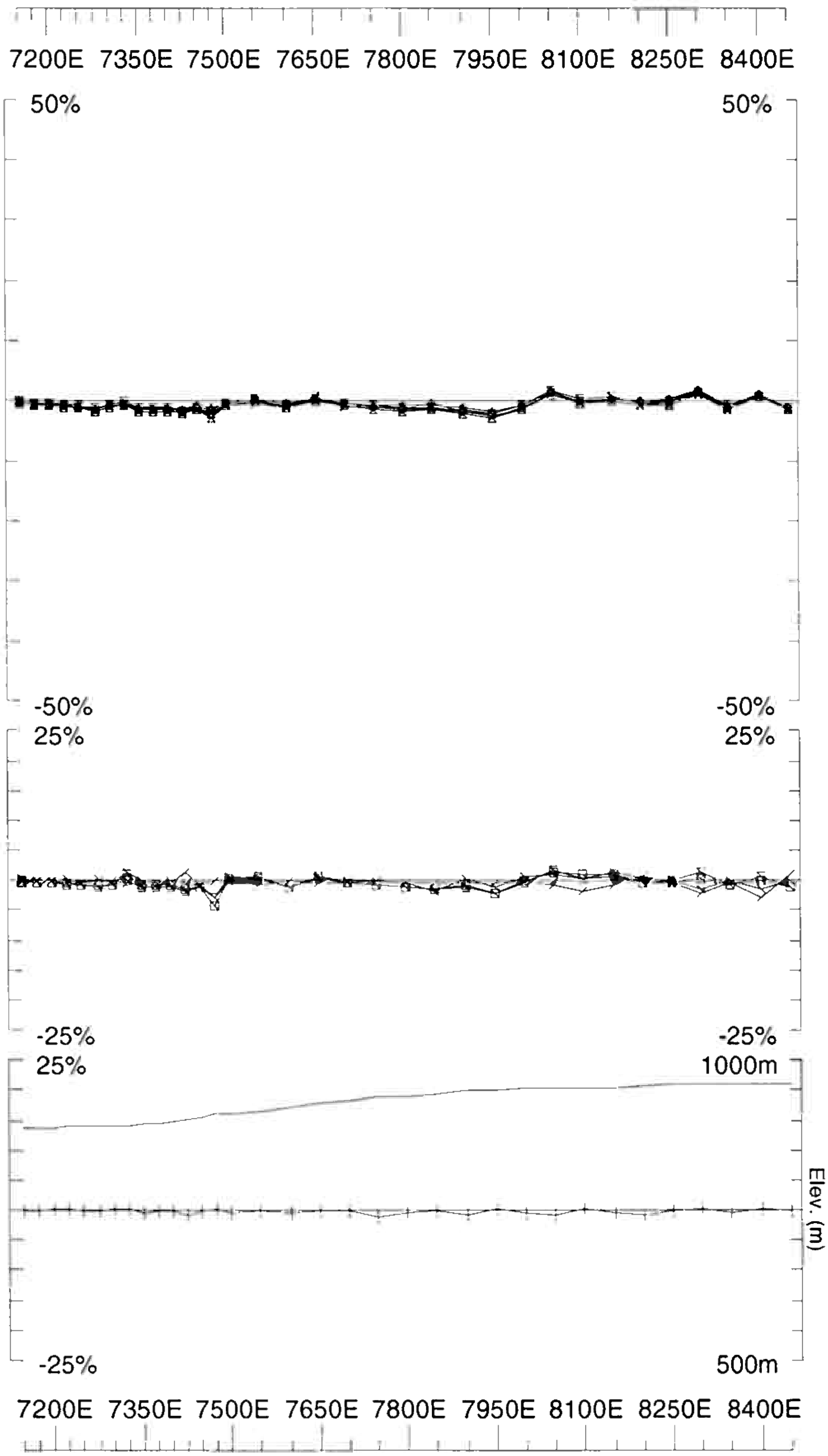
Secondary, (Chn - Ch1)/IHpl
Contin. Norm at depth of 0 m
Base Freq. 3.251 Hz

UTEM Survey at: Vakkerlien
For: A/S Sulfidmalm

LAMONTAGNE GEOPHYSICS LTD GEOPHYSIQUE LTEE

Job 0531

Surveyed : 14/11/5
Reduced : 24/12/5
Plotted : 24/12/5



UTEM Survey at: Vakkerlien
For: A/S Sulfidmalm

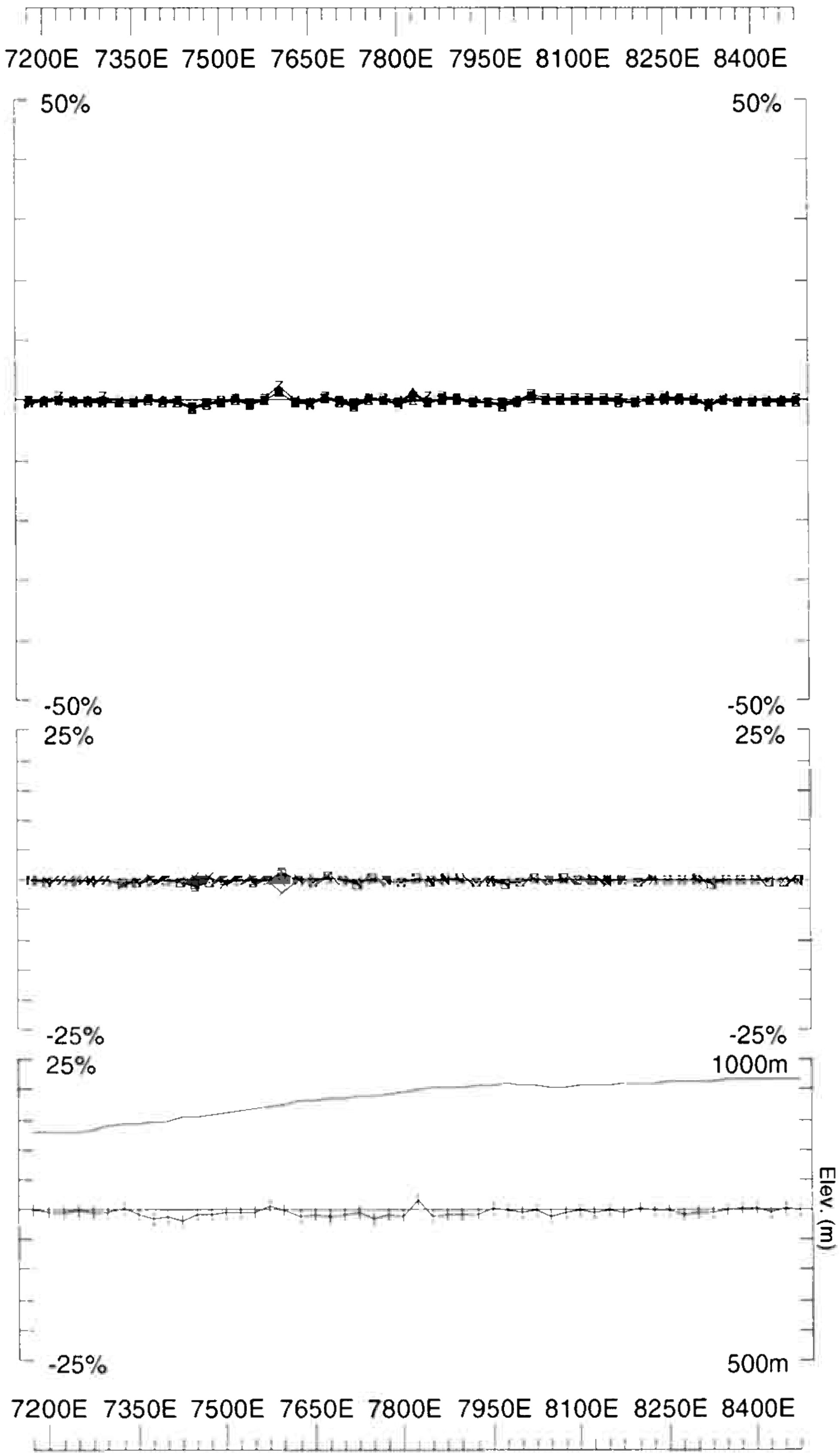
LAMONTAGNE GEOPHYSICS LTD
GEOPHYSIQUE LTEE

Job 0531

Surveyed: 13/11/5
Reduced: 24/12/5
Plotted: 24/12/5

Loop: 03
Line: 313N
Compt: Hz

Secondary, (Chn - Ch1)/IHpI
Contin. Norm at depth of 0 m
Base Freq. 3.251 Hz



UTEM Survey at: Vakkerlien
For: A/S Sulfidmalm

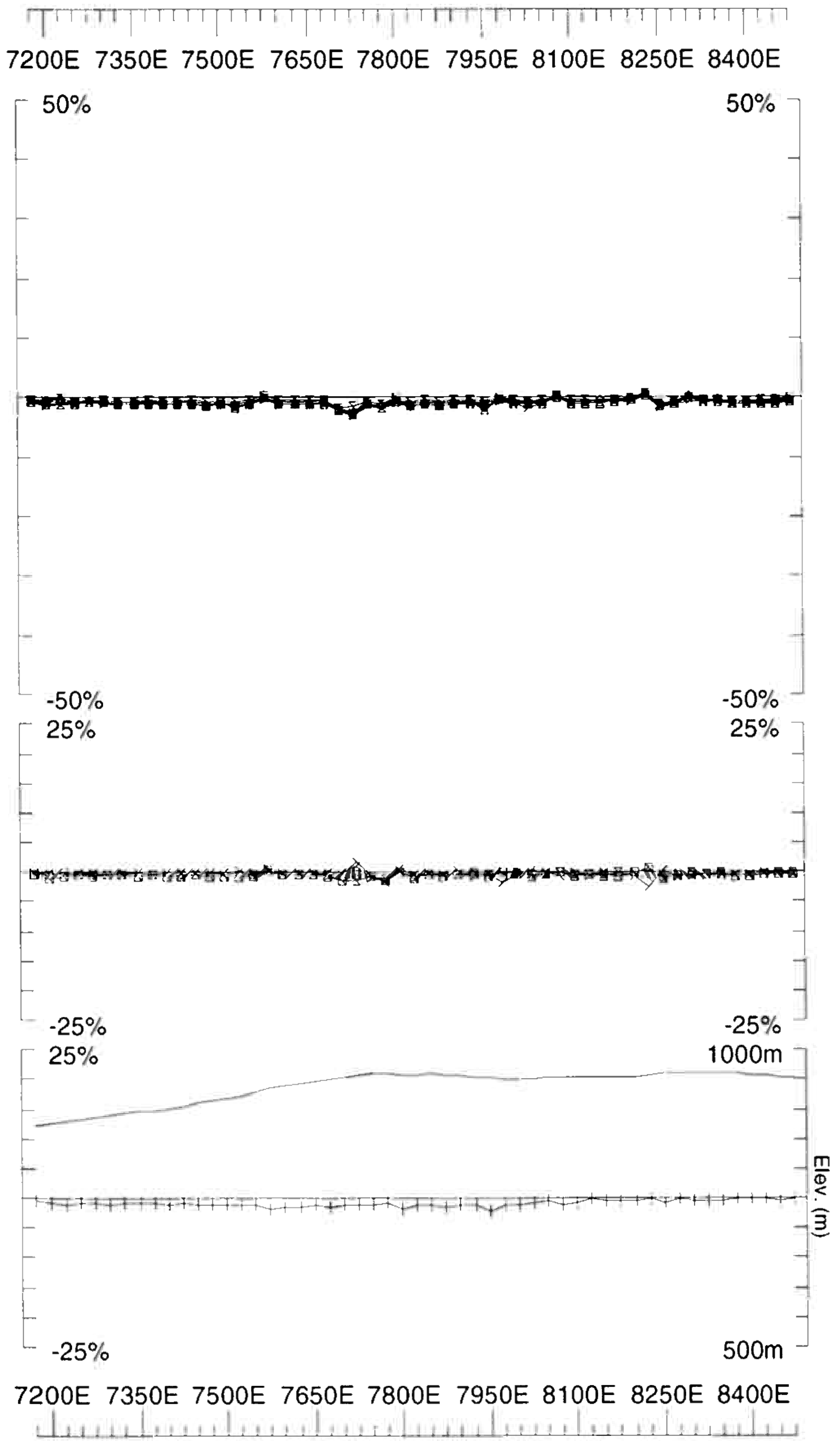
LAMONTAGNE GEOPHYSICS LTD GEOPHYSIQUE LTEE

Job 0531

Surveyed: 12/11/5
Reduced: 24/12/5
Plotted: 24/12/5

Loop: 03
Line: 315N
Compt: Hz

Secondary, (Chn - Ch1)/IHpI
Contin. Norm at depth of 0 m
Base Freq. 3.251 Hz



UTEM Survey at: Vakkerlien
For: A/S Sulfidmalm

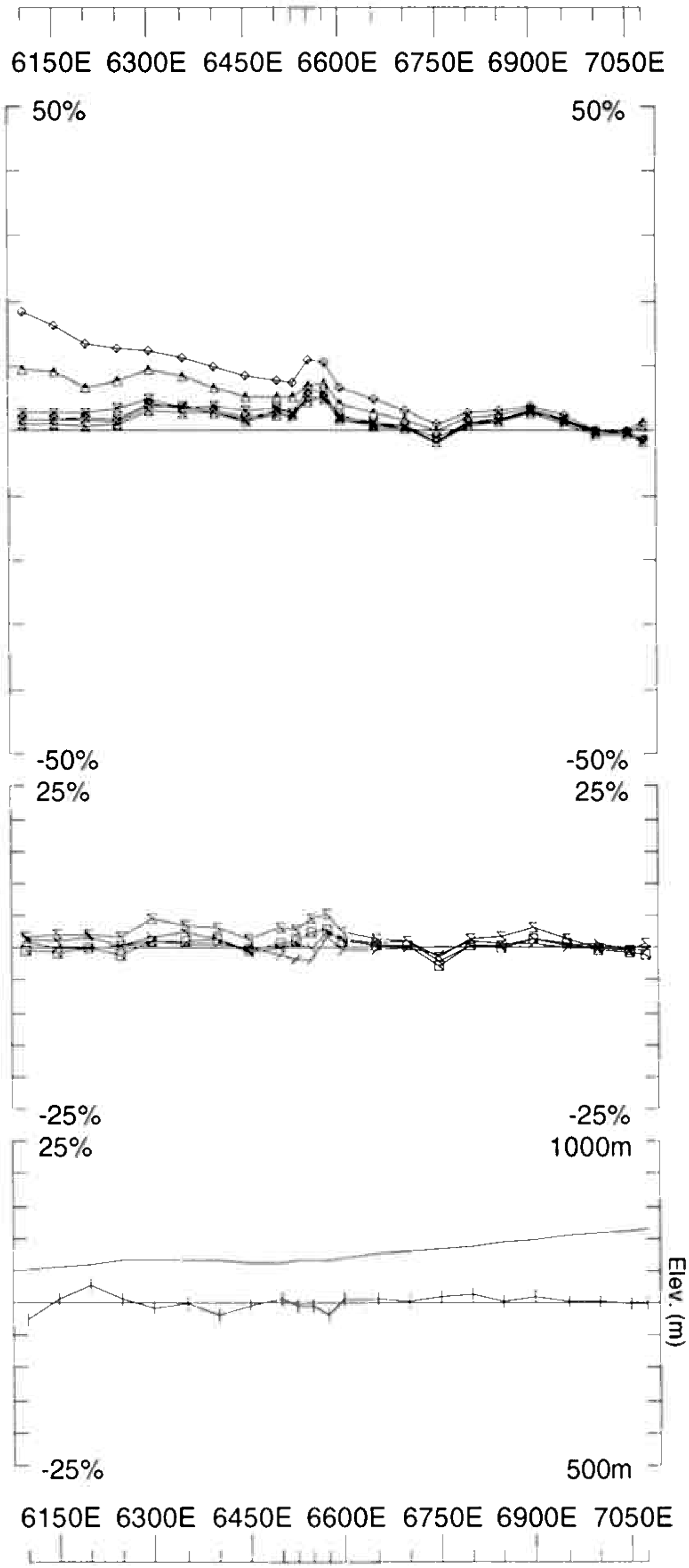
LAMONTAGNE GEOPHYSICS LTD
GEOPHYSIQUE LTEE

Job 0531

Surveyed: 12/11/5
Reduced: 24/12/5
Plotted: 24/12/5

Loop: 03
Line: 317N
Compt: Hz

Secondary, (Chn - Ch1)/|Hp|
Contin. Norm at depth of 0 m
Base Freq. 3.251 Hz



UTEM Survey at: Vakkerlien
For: A/S Sulfidmalm

LAMONTAGNE GEOPHYSICS LTD
GEOPHYSIQUE LTEE

Job 0531

Surveyed : 14/11/5
Reduced : 24/12/5
Plotted : 24/12/5

Secondary, (Chn - Ch1)/IHpl
Contin. Norm at depth of 0 m
Base Freq. 3.251 Hz

Loop: 03
Line: 317N off-loop
Compt: Hz

Vakkerlien

Loop 3

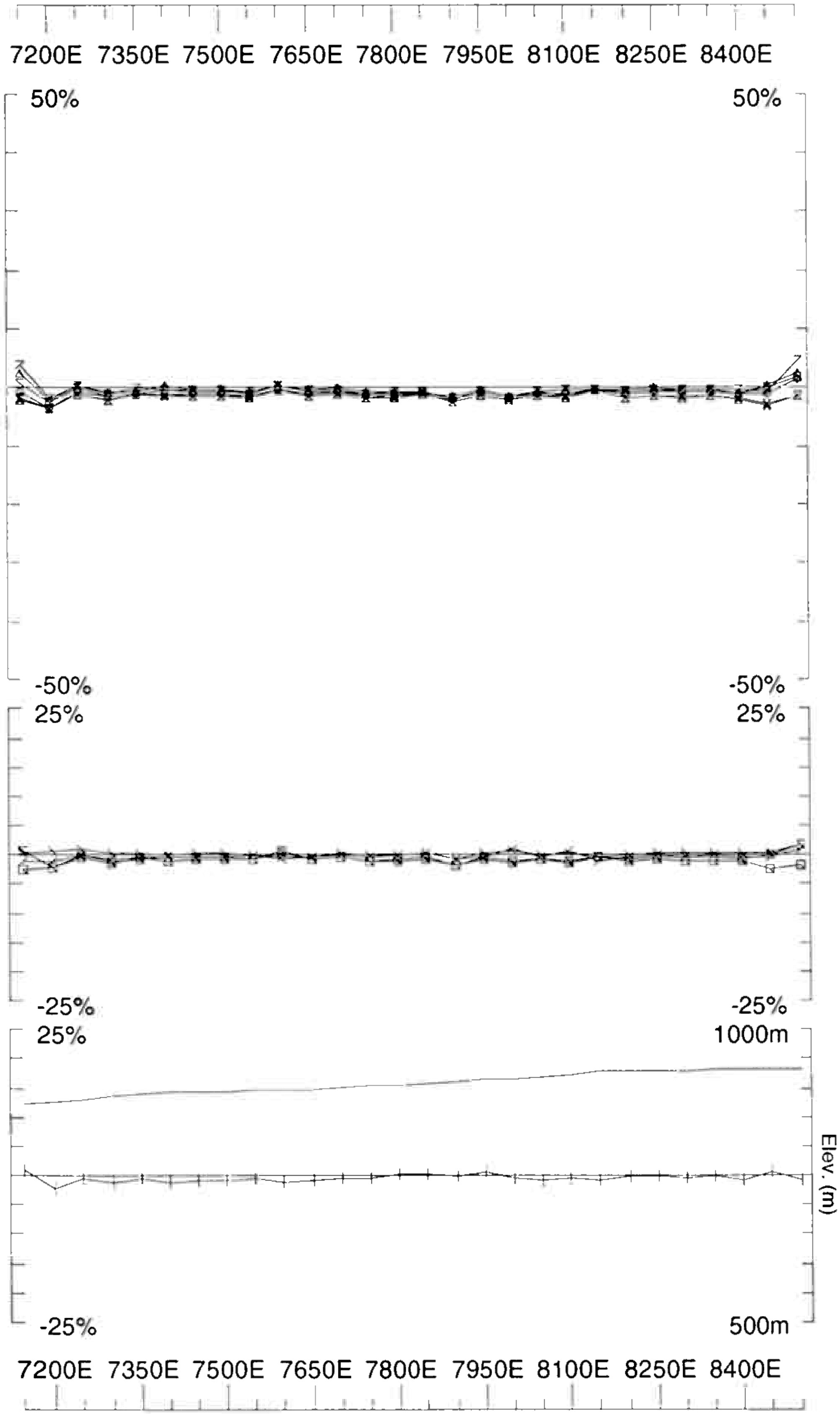
Hz
@3.251 Hz frequency

point norm
@
(x,y,z) = (7825E,31200N, 910 m.a.s.l.)

Ch1 reduced

Loop 03	Line 307N	7125N - 8525N	1400m
	Line 309N	7125N - 8525N	1400m
	Line 311N	6125N - 8525N	2400m
	Line 313N	7125N - 8525N	1400m
	Line 315N	7125N - 8525N	1400m
	Line 317N	6100N - 8525N	2425m
		Vakkerlien Loop 03 Total	10425m

Loop 3 - point norm



UTEM Survey at: Vakkerlien
For: A/S Sulfidmalm

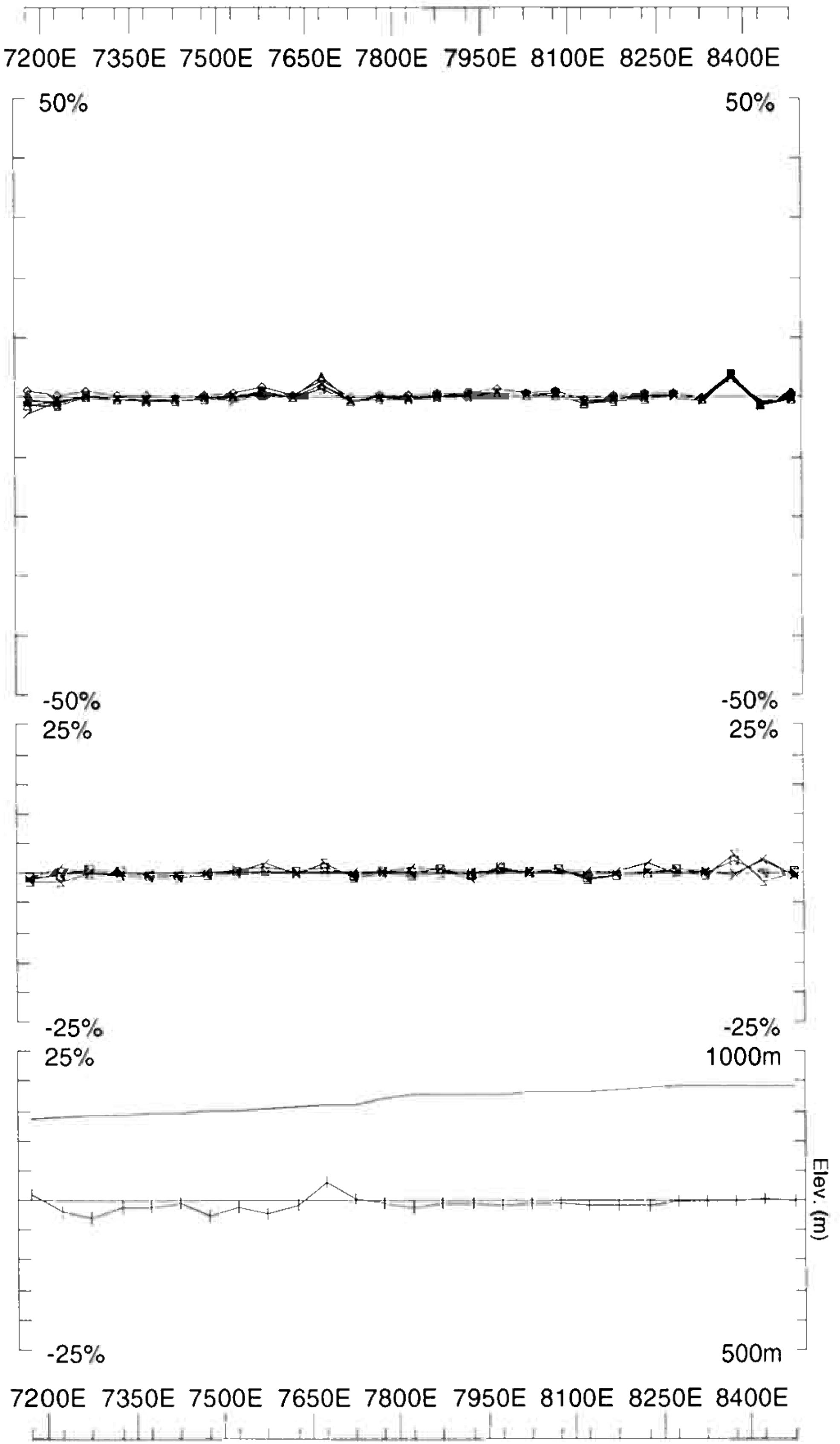
LAMONTAGNE GEOPHYSICS LTD GEOPHYSIQUE LTEE

Job 0531

Surveyed : 13/11/5
Reduced : 24/12/5
Plotted : 24/12/5

Secondary, (Chn - Ch1)/|Hp|
Point Norm.at x,y,z
(7825,31200,850)
Base Freq. 3.251 Hz

Loop: 03
Line: 307N
Compt: Hz



UTEM Survey at: Vakkerlien
For: A/S Sulfidmalm

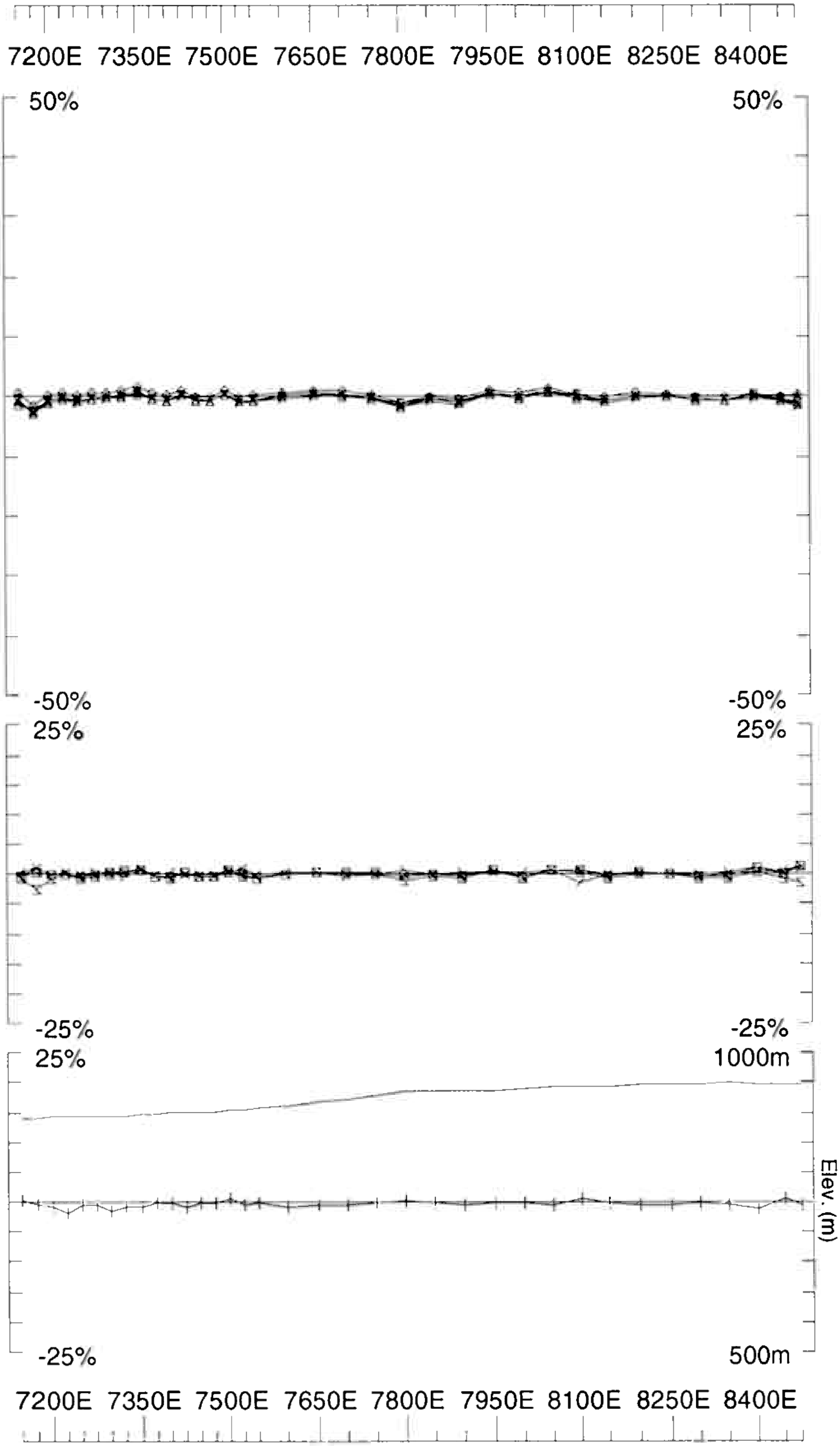
LAMONTAGNE GEOPHYSICS LTD
GEOPHYSIQUE LTEE

Job 0531

Surveyed: 13/11/5
Reduced: 24/12/5
Plotted: 24/12/5

Secondary, (Chn - Ch1)/lHpl
Point Norm.at x,y,z
(7825,31200,850)
Base Freq. 3.251 Hz

Loop: 03
Line: 309N
Compt: Hz



UTEM Survey at: Vakkerlien
For: A/S Sulfidmalm

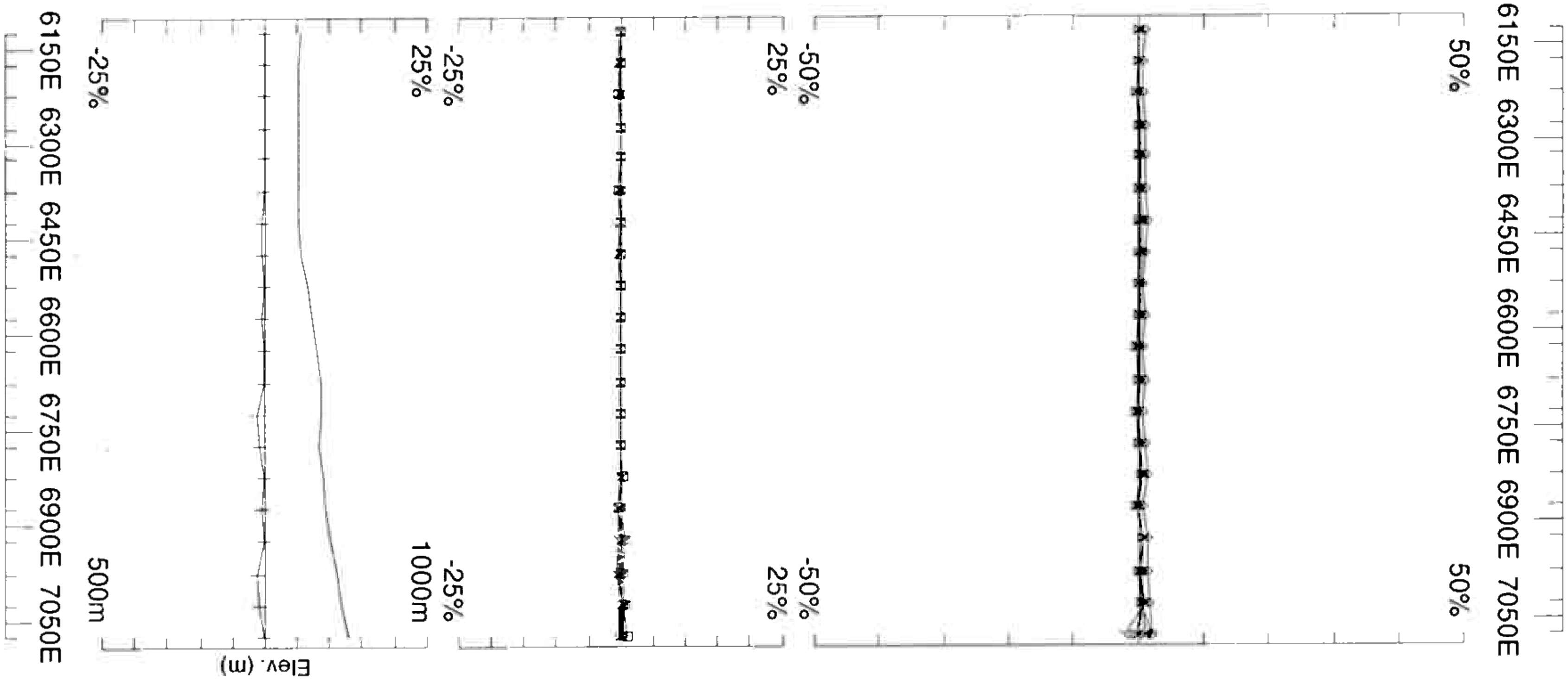
LAMONTAGNE GEOPHYSICS LTD
GEOPHYSIQUE LTEE

Job 0531

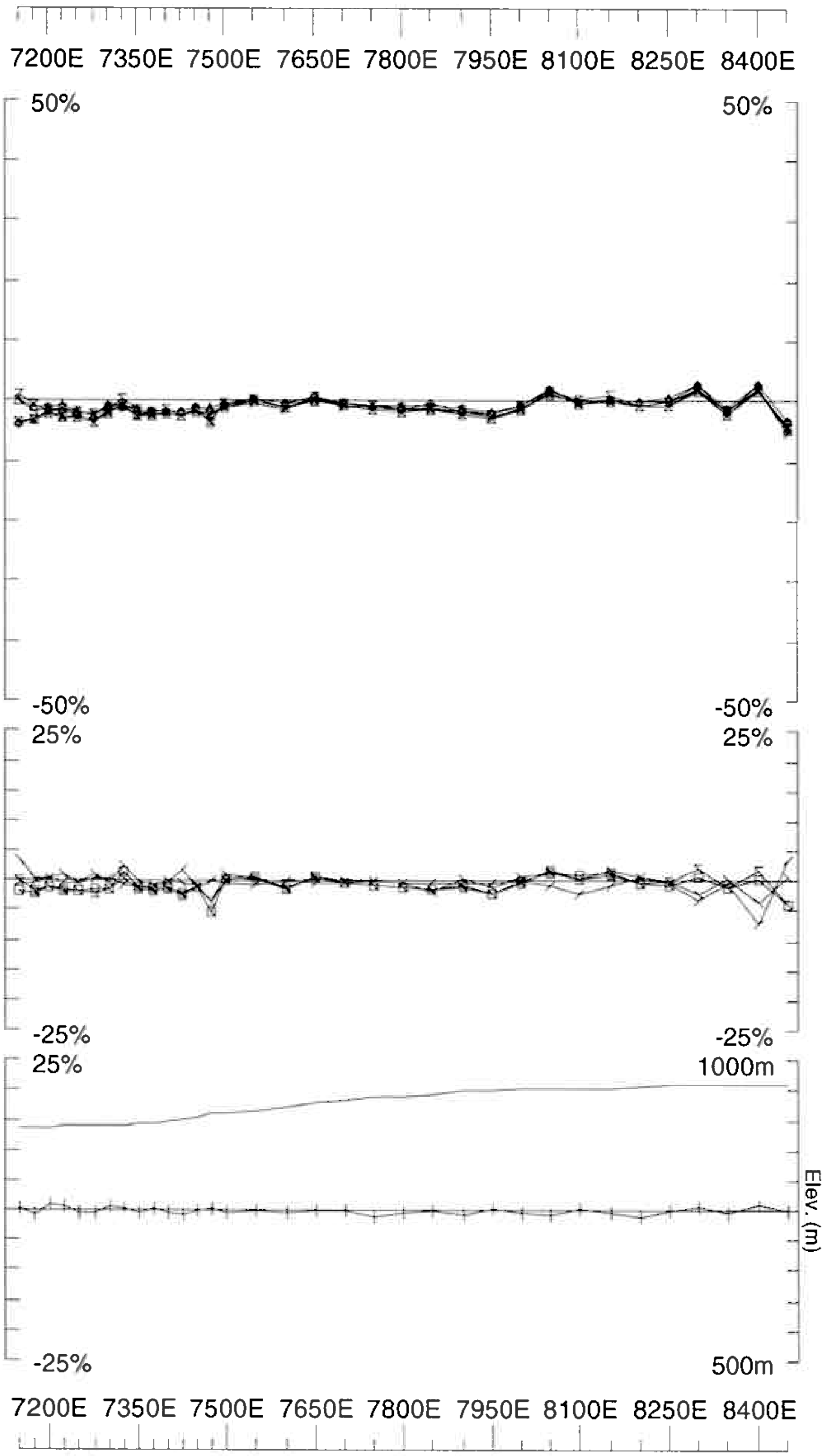
Surveyed : 13/11/5
Reduced : 24/12/5
Plotted : 24/12/5

Loop: 03
Line: 311N
Compt: Hz

Secondary, (Chn - Ch1)/|Hp|
Point Norm.at x,y,z
(7825,31200,850)
Base Freq. 3.251 Hz



Loop: 03 Line: 311N off-loop Compt: Hz	Secondary, (Chn - Ch1)/IHpl Point Norm.at x,y,z (7825,31200,850) Base Freq. 3.251 Hz	UTEM Survey at: Vakkerlien For: A/S Sulfidmalm LAMONTAGNE GEOPHYSICS LTD GEOPHYSIQUE LTEE Job 0531 Surveyed : 14/11/5 Reduced : 24/12/5 Plotted : 24/12/5



UTEM Survey at: Vakkerlien
For: A/S Sulfidmalm

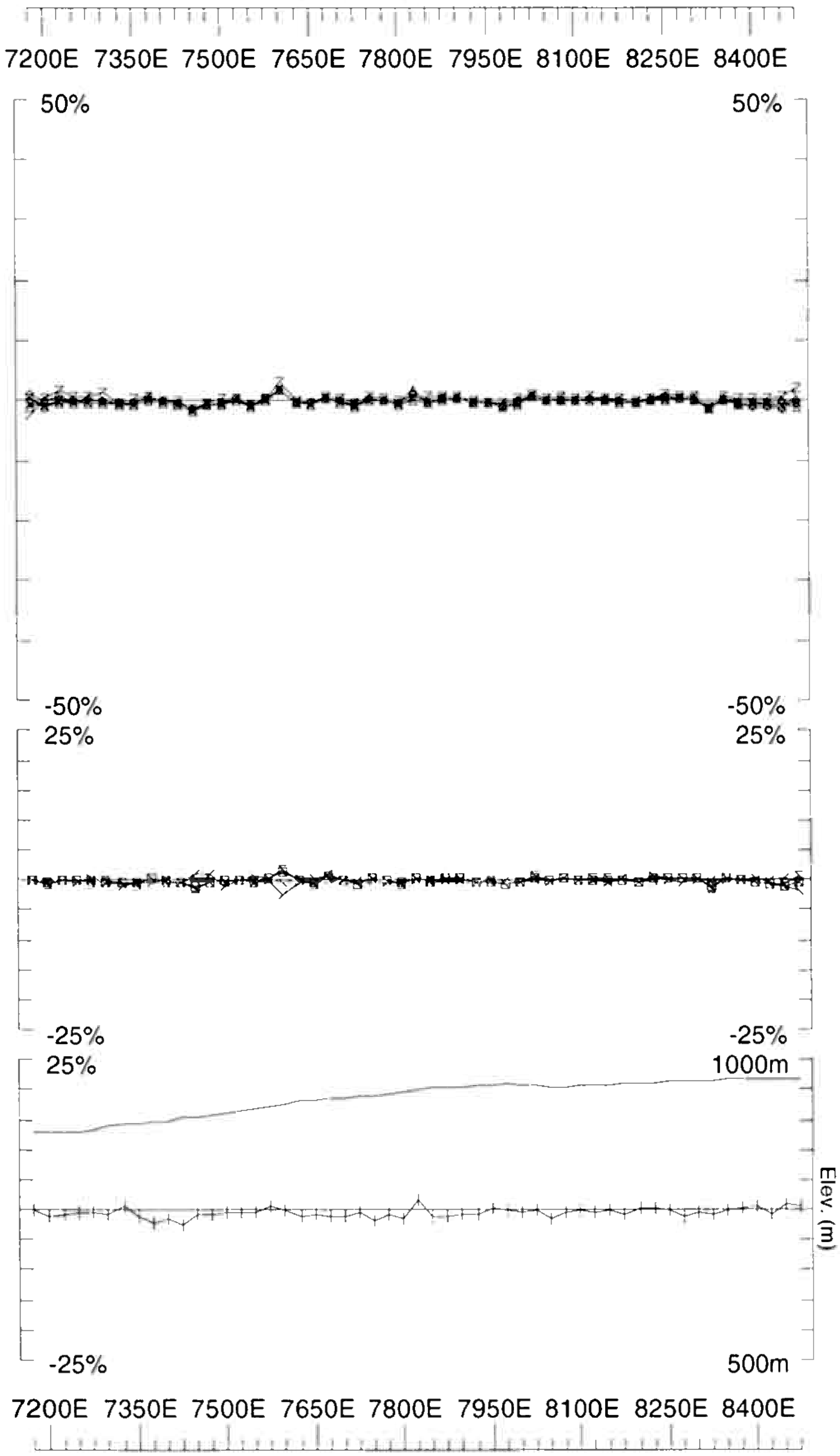
LAMONTAGNE GEOPHYSICS LTD
GEOPHYSIQUE LTEE

Job 0531

Surveyed : 13/11/5
Reduced : 24/12/5
Plotted : 24/12/5

Loop: 03
Line: 313N
Compt: Hz

Secondary, (Chn - Ch1)/|Hp|
Point Norm.at x,y,z
(7825,31200,850)
Base Freq. 3.251 Hz



Loop: 03
Line: 315N
Compt: Hz

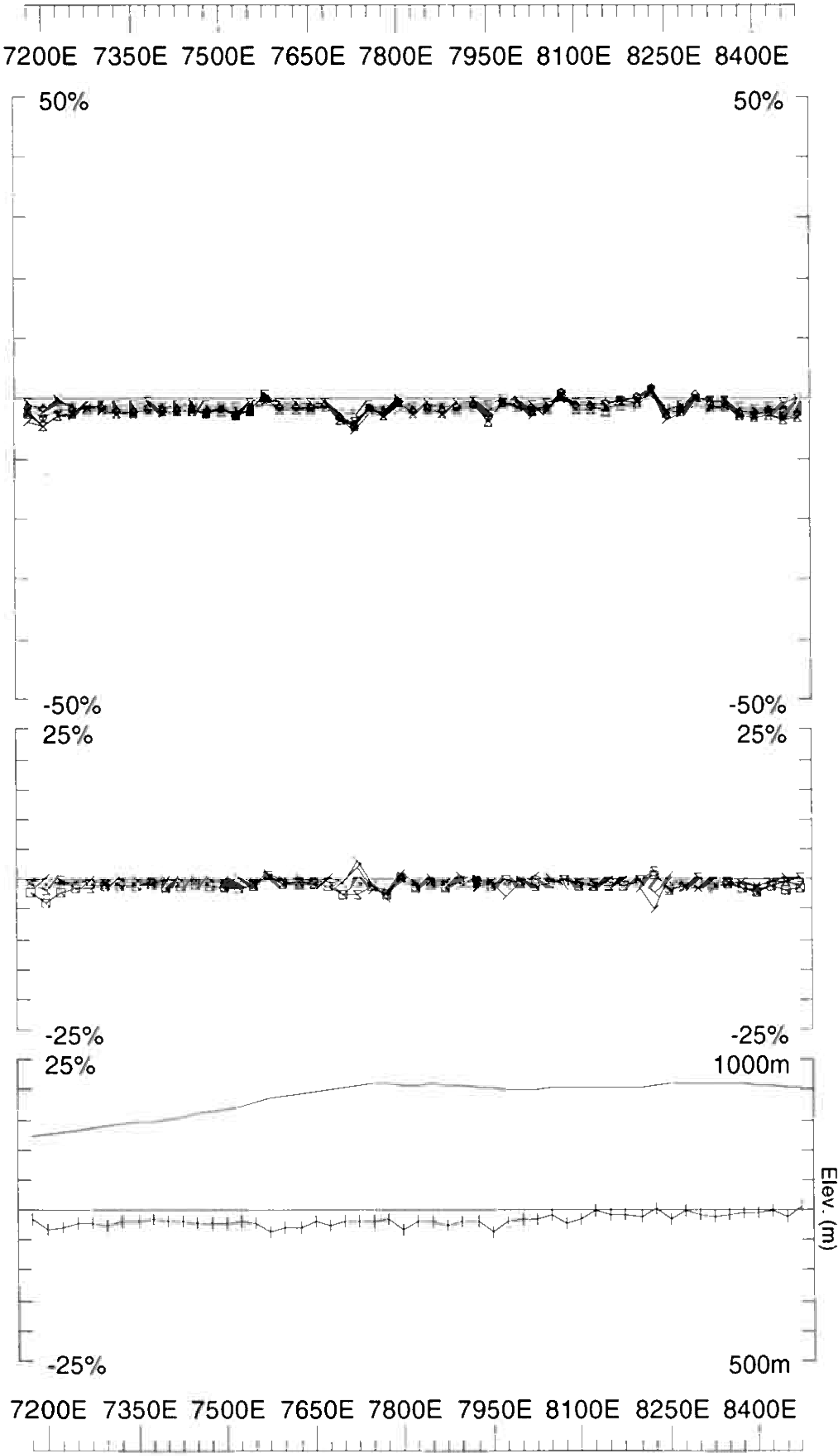
Secondary, (Chn - Ch1)/|Hp|
Point Norm.at x,y,z
(7825,31200,850)
Base Freq. 3.251 Hz

UTEM Survey at: Vakkerlien
For: A/S Sulfidmalm

LAMONTAGNE GEOPHYSICS LTD
GEOPHYSIQUE LTEE

Job 0531

Surveyed: 12/11/5
Reduced: 24/12/5
Plotted: 24/12/5



UTEM Survey at: Vakkerlien

For: A/S Sulfidmalm

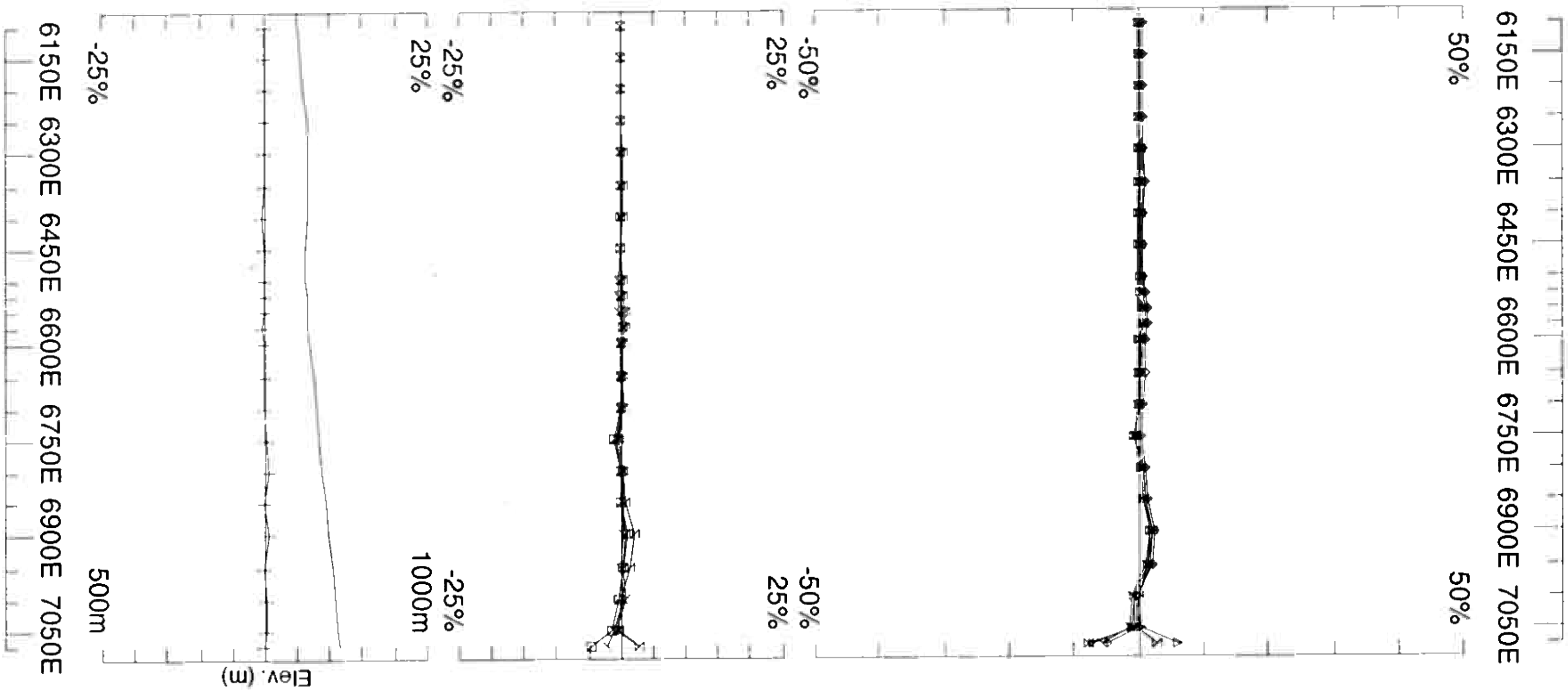
LAMONTAGNE GEOPHYSICS LTD
GEOPHYSIQUE LTEE

Job 0531

Surveyed: 12/11/5
Reduced: 24/12/5
Plotted: 24/12/5

Loop: 03
Line: 317N
Compt: Hz

Secondary, (Chn - Ch1)/|Hp|
Point Norm.at x,y,z
(7825,31200,850)
Base Freq. 3.251 Hz



Loop: 03 Line: 317N off-loop Compt: Hz	Secondary, (Chn - Ch1)/IHpl Point Norm.at x,y,z (7825,31200,850) Base Freq. 3.251 Hz	UTEM Survey at: Vakkerlien For: A/S Sulfidmalm LAMONTAGNE GEOPHYSICS LTD GEOPHYSIQUE LTEE Job 0531 Surveyed : 14/11/5 Reduced : 24/12/5 Plotted : 24/12/5

Vakkerlien

Loop 4

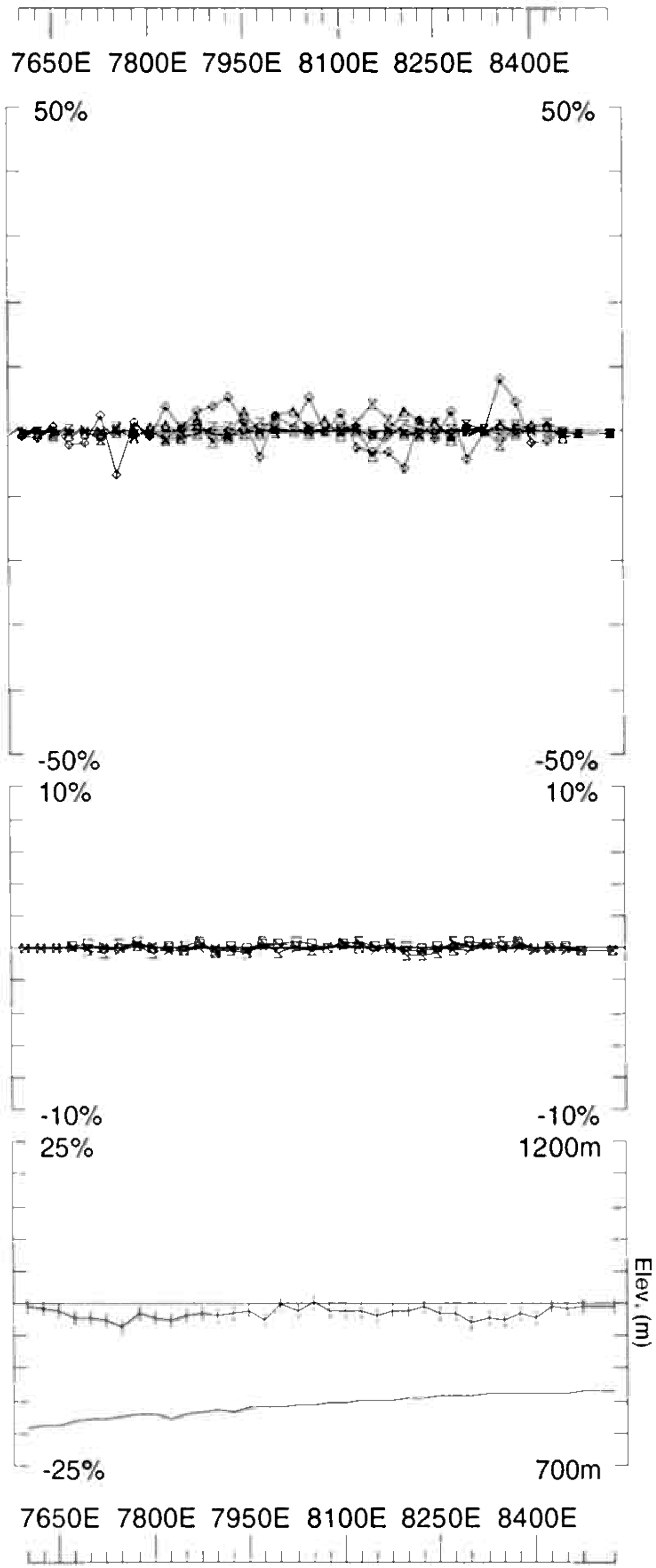
Hz
@3.251 Hz frequency

continuous norm

Ch1 reduced

Loop 04	Line 286N	7600N - 8500N	900m
	Line 288N	7400N - 8500N	1100m
	Line 290N	7400N - 8500N	1100m
	Line 292N	7400N - 8500N	1100m
	Line 294N	7400N - 8500N	1100m
		Vakkerlien Loop 04 Total	5300m

Loop 4 - continuous norm



UTEM Survey at: Vakkerlien
For: A/S Sulfidmalm

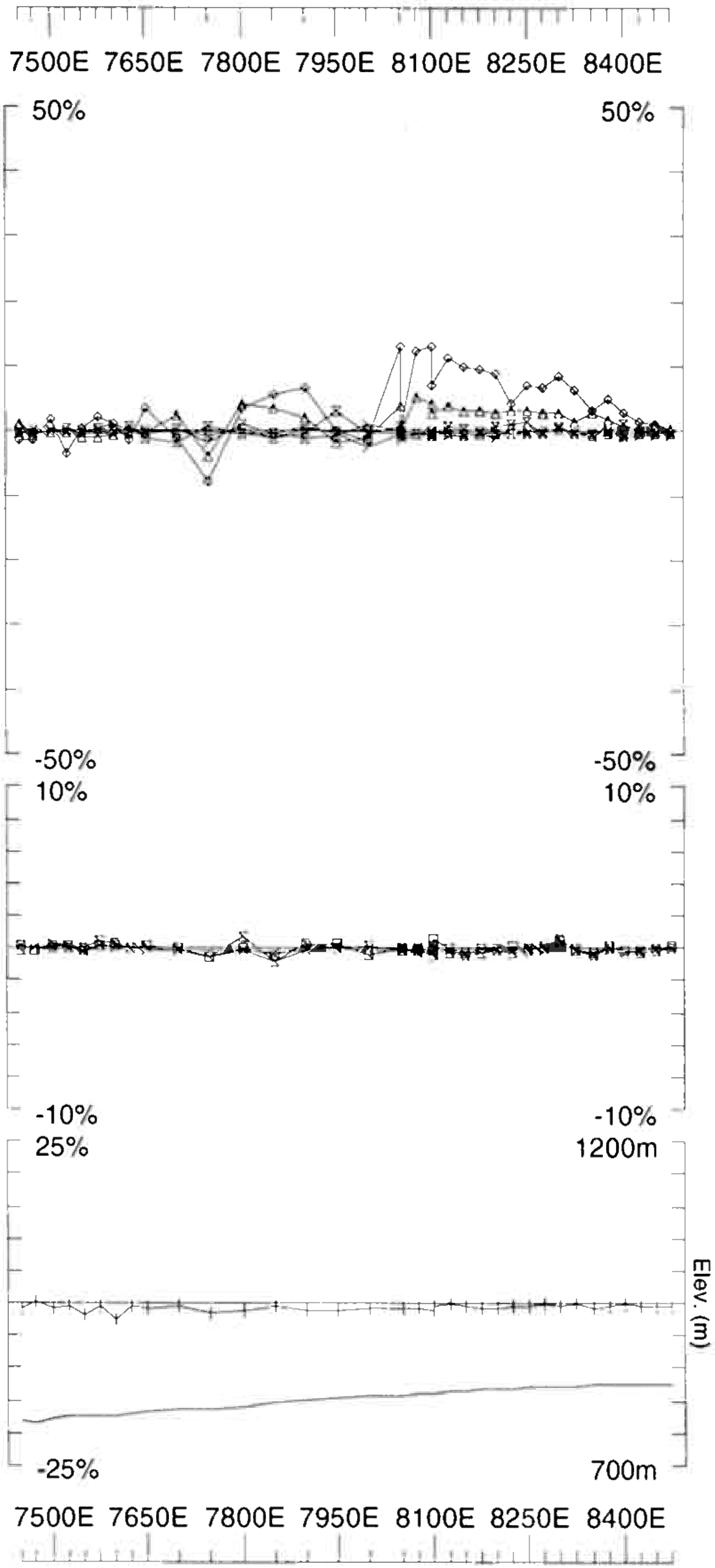
LAMONTAGNE GEOPHYSICS LTD GEOPHYSIQUE LTEE

Job 0531

Surveyed : 4/11/5
Reduced : 24/12/5
Plotted : 24/12/5

Loop: 04
Line: 286N
Compt: Hz

Secondary, (Chn - Ch1)/IHpl
Contin. Norm at depth of 0 m
Base Freq. 3.251 Hz



UTEM Survey at: Vakkerlien
For: A/S Sulfidmalm

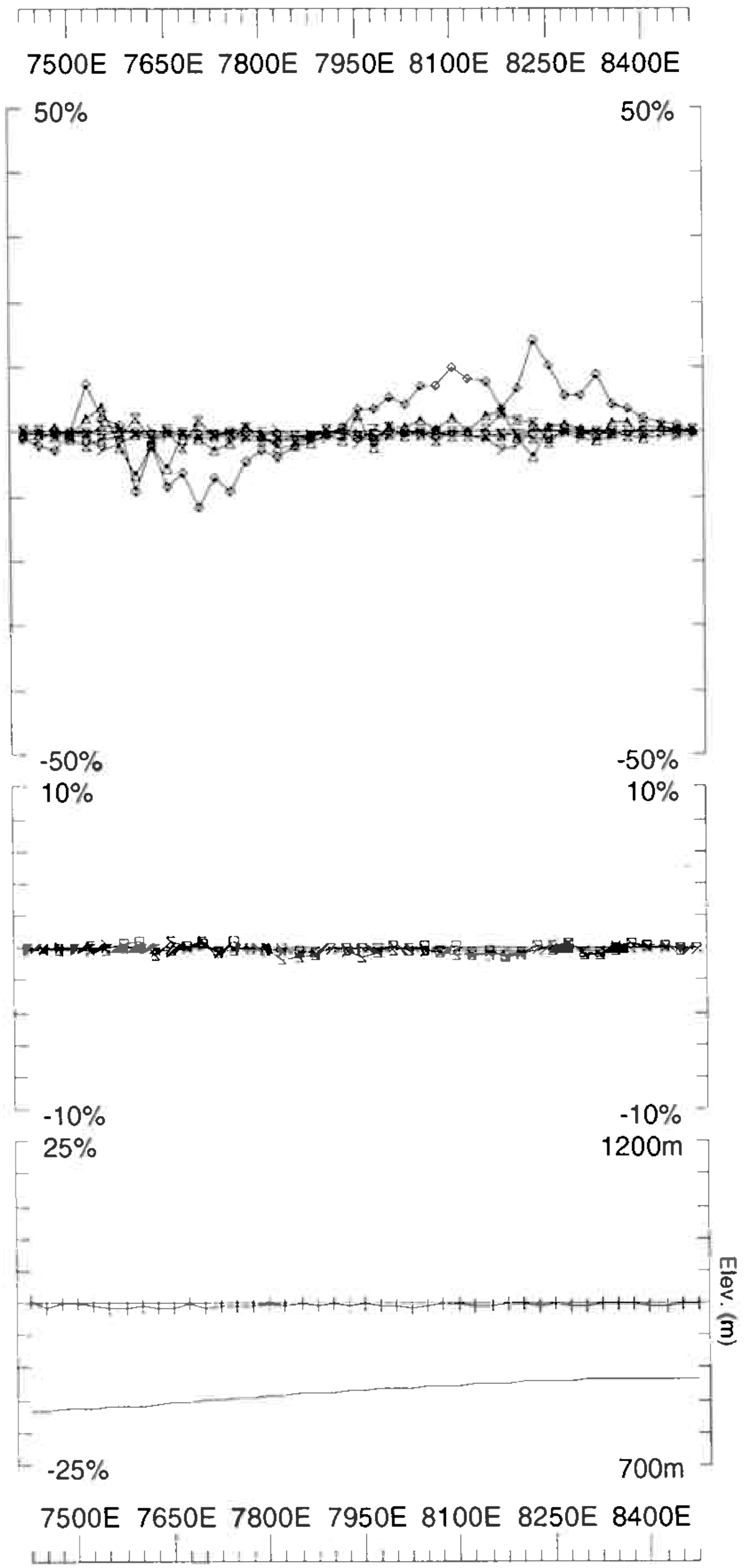
LAMONTAGNE GEOPHYSICS LTD
GEOPHYSIQUE LTEE

Job 0531

Plotted : 24/12/5

Loop: 04
Line: 288N
Compt: Hz

Secondary, (Chn - Ch1)/|Hp|
Contin. Norm at depth of 0 m
Base Freq. 3.251 Hz



UTEM Survey at: Vakkerlien
For: A/S Sulfidmalm

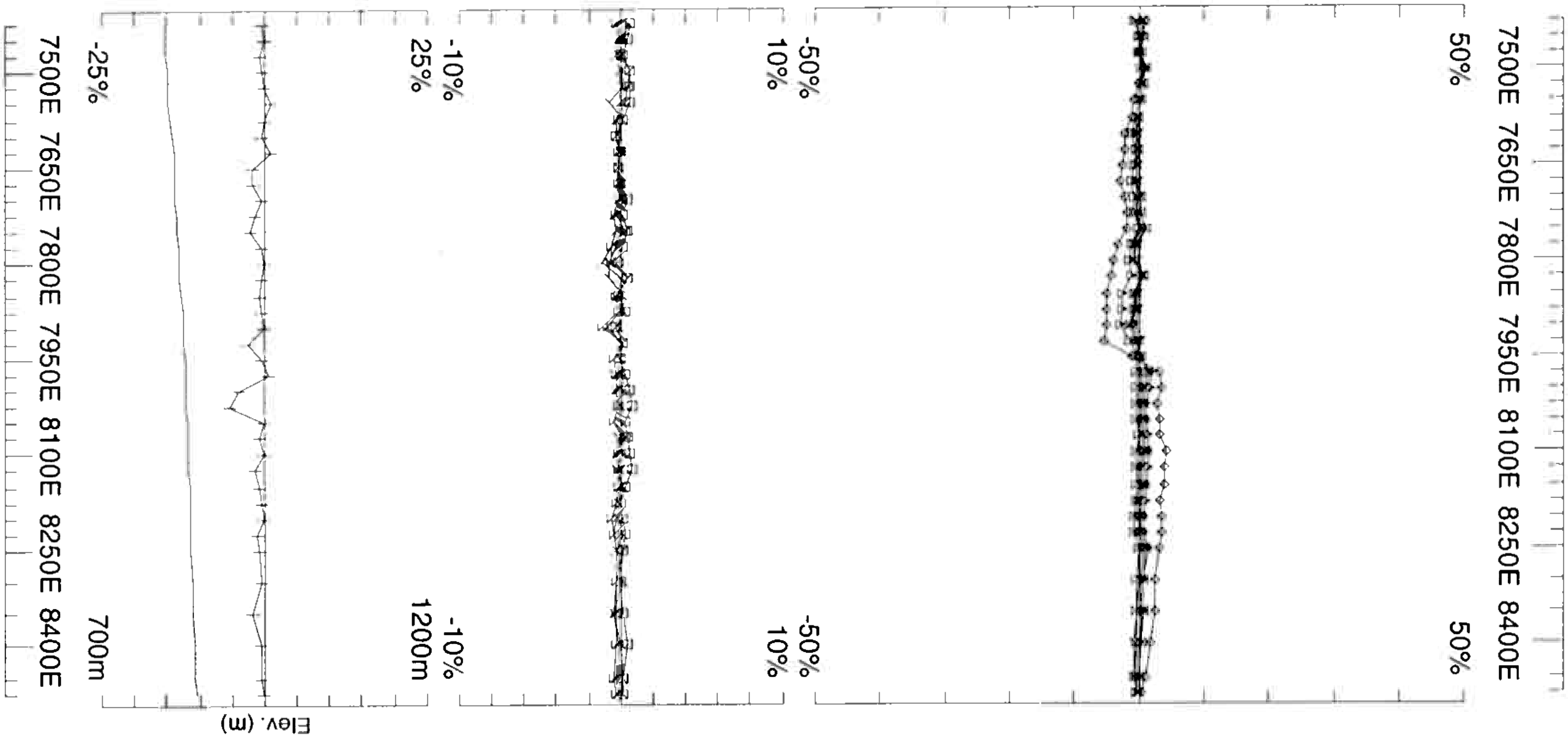
LAMONTAGNE GEOPHYSICS LTD GEOPHYSIQUE LTEE

Job 0531

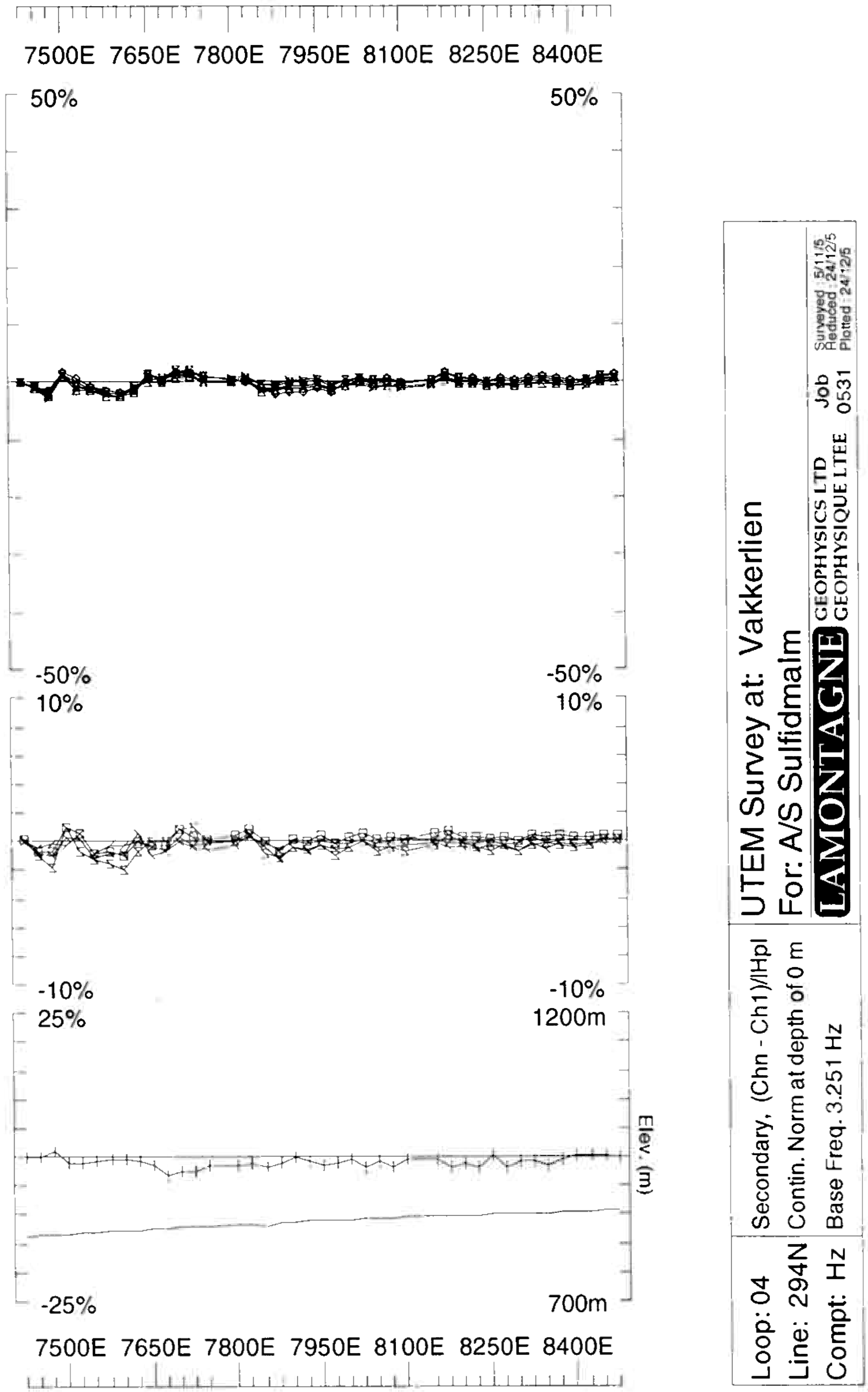
Surveyed: 5/11/5
Reduced: 24/12/5
Plotted: 24/12/5

Loop: 04
Line: 290N
Compt: Hz

Secondary, (Chn - Ch1)/|Hp|
Contin. Norm at depth of 0 m
Base Freq. 3.251 Hz



Loop: 04	Secondary, (Chn - Ch1)/IHpl	UTEM Survey at: Vakkerlien
Line: 292N	Contin. Norm at depth of 0 m	For: A/S Sulfidmalm
Compt: Hz	Base Freq. 3.251 Hz	LAMONTAGNE GEOPHYSICS LTD GEOPHYSIQUE LTEE — Job 0531 — Surveyed: 5/11/5 Reduced: 24/12/5 Plotted: 24/12/5


7500E 7650E 7800E 7950E 8100E 8250E 8400E
50%
50%
-50%
-50%
10%
10%
-10%
-10%
25%
1200m
Elev. (m)
-25%
700m
7500E 7650E 7800E 7950E 8100E 8250E 8400E
UTEM Survey at: Vakkerlien
For: A/S Sulfidmalm
LAMONTAGNE GEOPHYSICS LTD GEOPHYSIQUE LTEE
Job 0531
Surveyed: 5/11/5
Reduced: 24/12/5
Plotted: 24/12/5
Secondary, (Chn - Ch1)/IHpl
Contin. Norm at depth of 0 m
Base Freq. 3.251 Hz
Loop: 04
Line: 294N
Compt: Hz

Vakkerlien

Loop 4

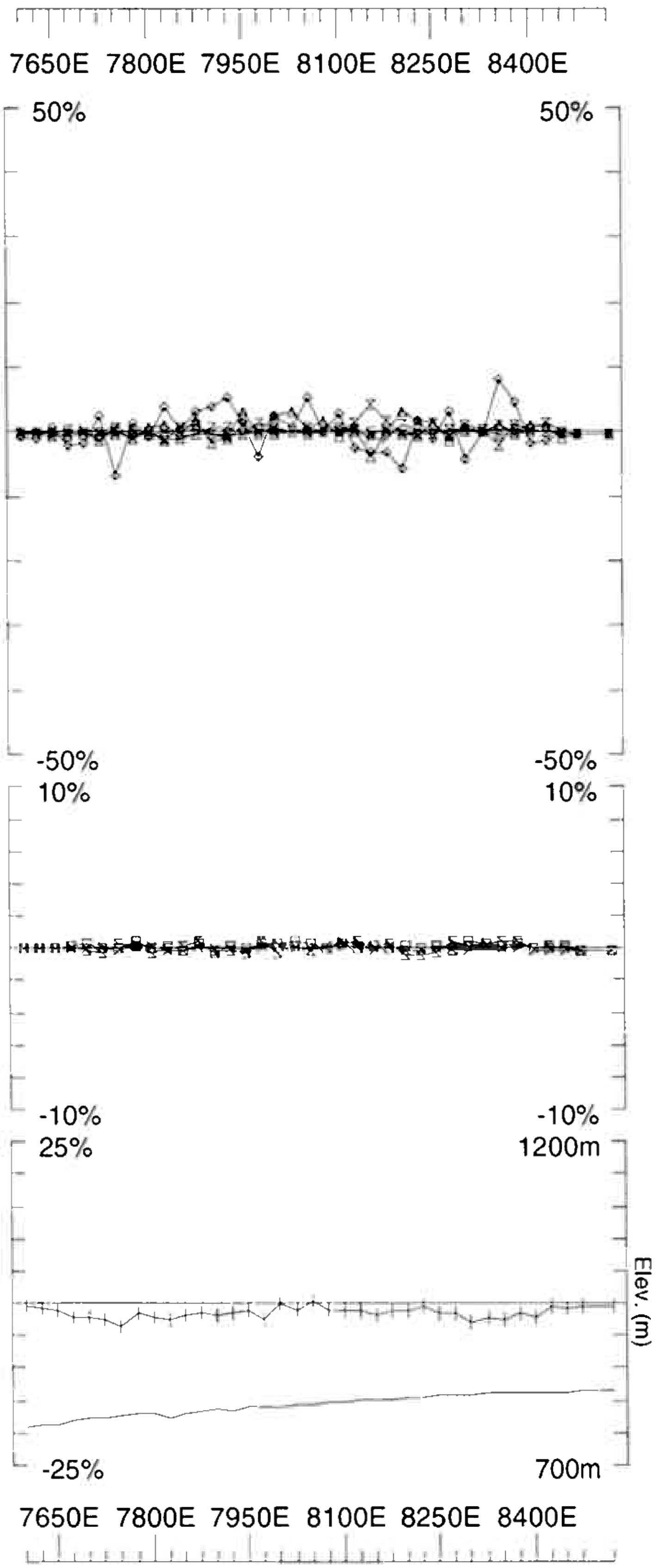
Hz
@3.251 Hz frequency

point norm
@
(x,y,z) = (8500E,29000N, 800 m.a.s.l.)

Ch1 reduced

Loop 04	Line 286N	7600N - 8500N	900m
	Line 288N	7400N - 8500N	1100m
	Line 290N	7400N - 8500N	1100m
	Line 292N	7400N - 8500N	1100m
	Line 294N	7400N - 8500N	1100m
		Vakkerlien Loop 04 Total	5300m

Loop 4 - point norm



UTEM Survey at: Vakkerlien
For: A/S Sulfidmalm

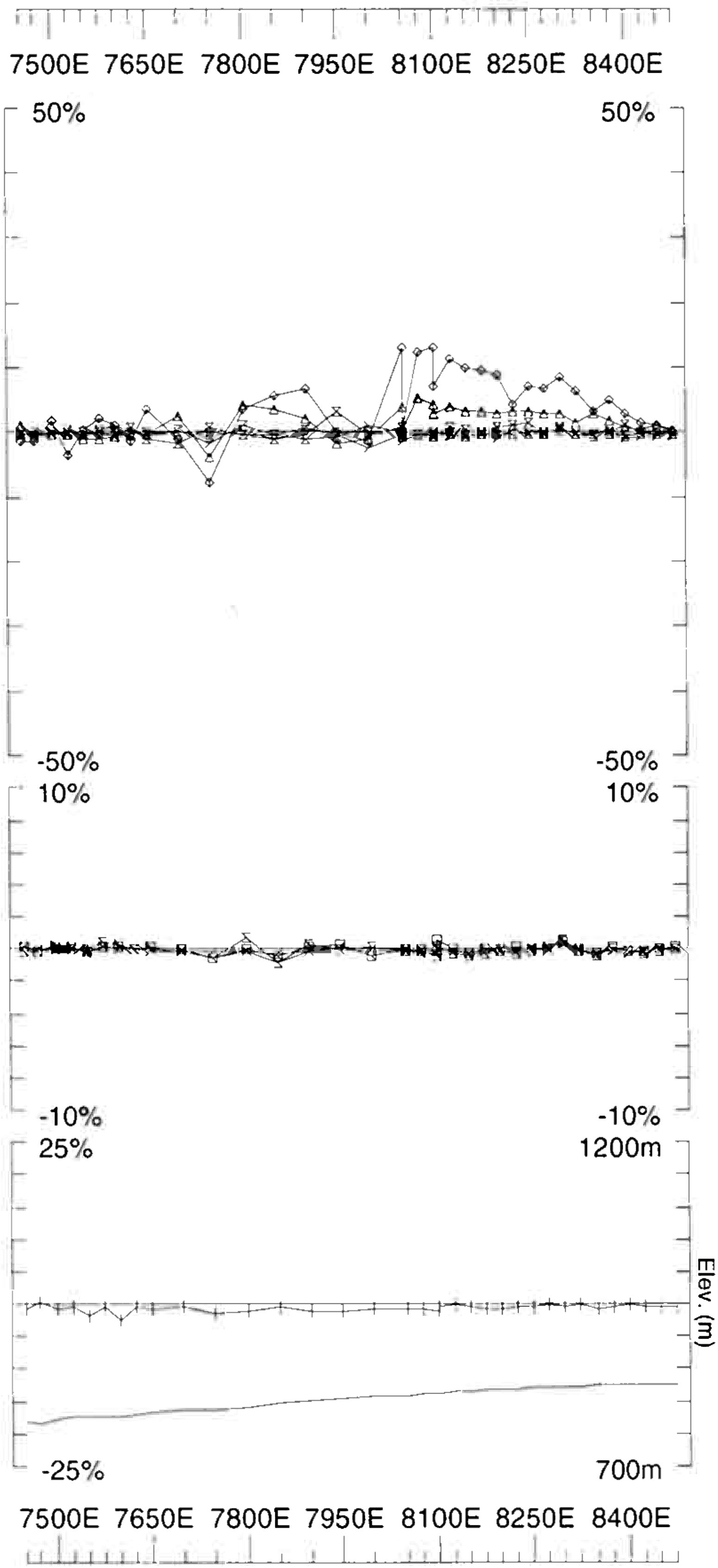
LAMONTAGNE GEOPHYSICS LTD GEOPHYSIQUE LTEE

Job 0531

Surveyed : 4/11/5
Reduced : 24/12/5
Plotted : 24/12/5

Secondary, (Chn - Ch1)/|Hp|
Contin. Norm at depth of 0 m
Base Freq. 3.251 Hz

Loop: 04
Line: 286N
Compt: Hz



UTEM Survey at: Vakkerlien
For: A/S Sulfidmalm

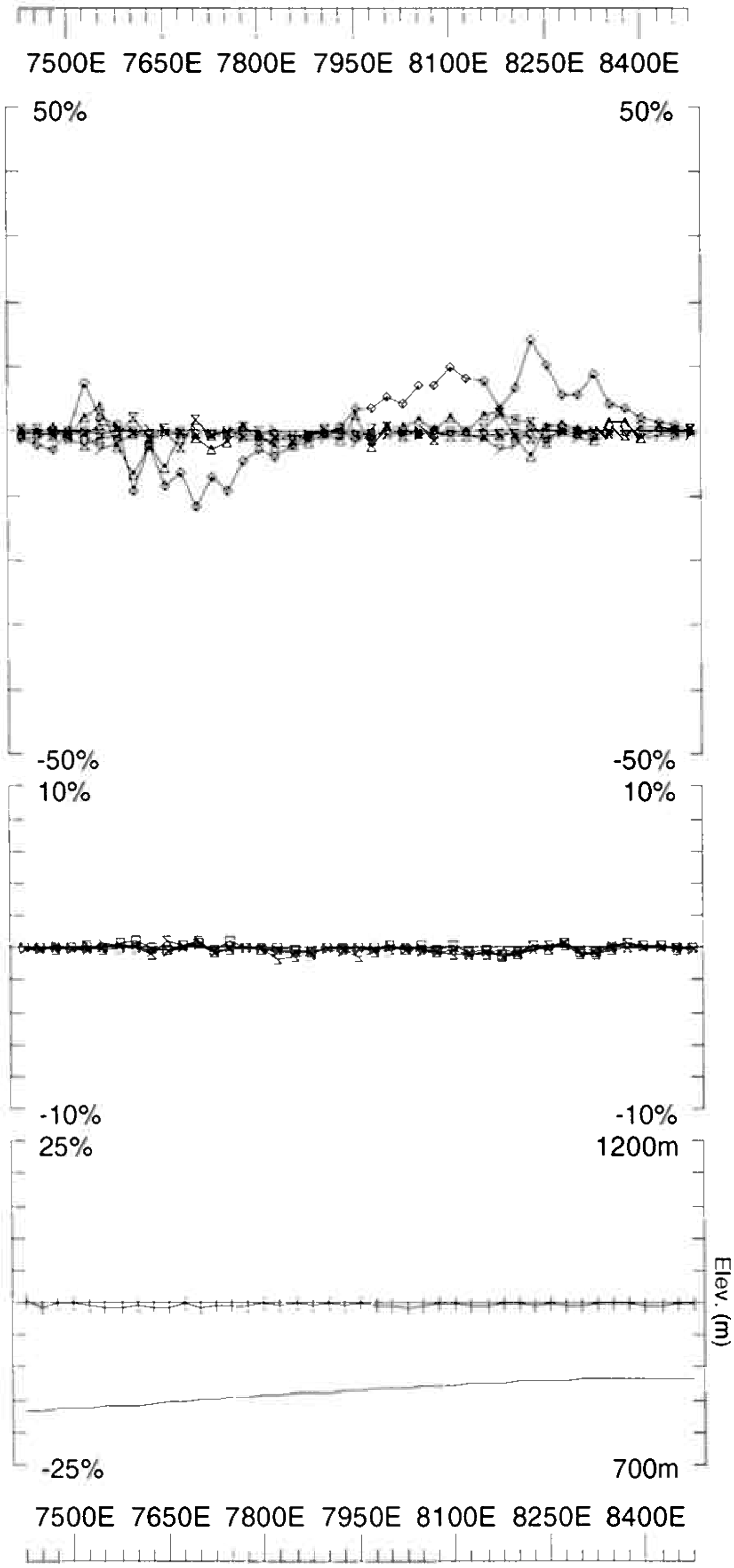
LAMONTAGNE GEOPHYSICS LTD GEOPHYSIQUE LTEE

Job 0531

Plotted : 24/12/5

Loop: 04
Line: 288N
Compt: Hz

Secondary, (Chn - Ch1)/IHpI
Contin. Norm at depth of 0 m
Base Freq. 3.251 Hz



UTEM Survey at: Vakkerlien
For: A/S Sulfidmalm

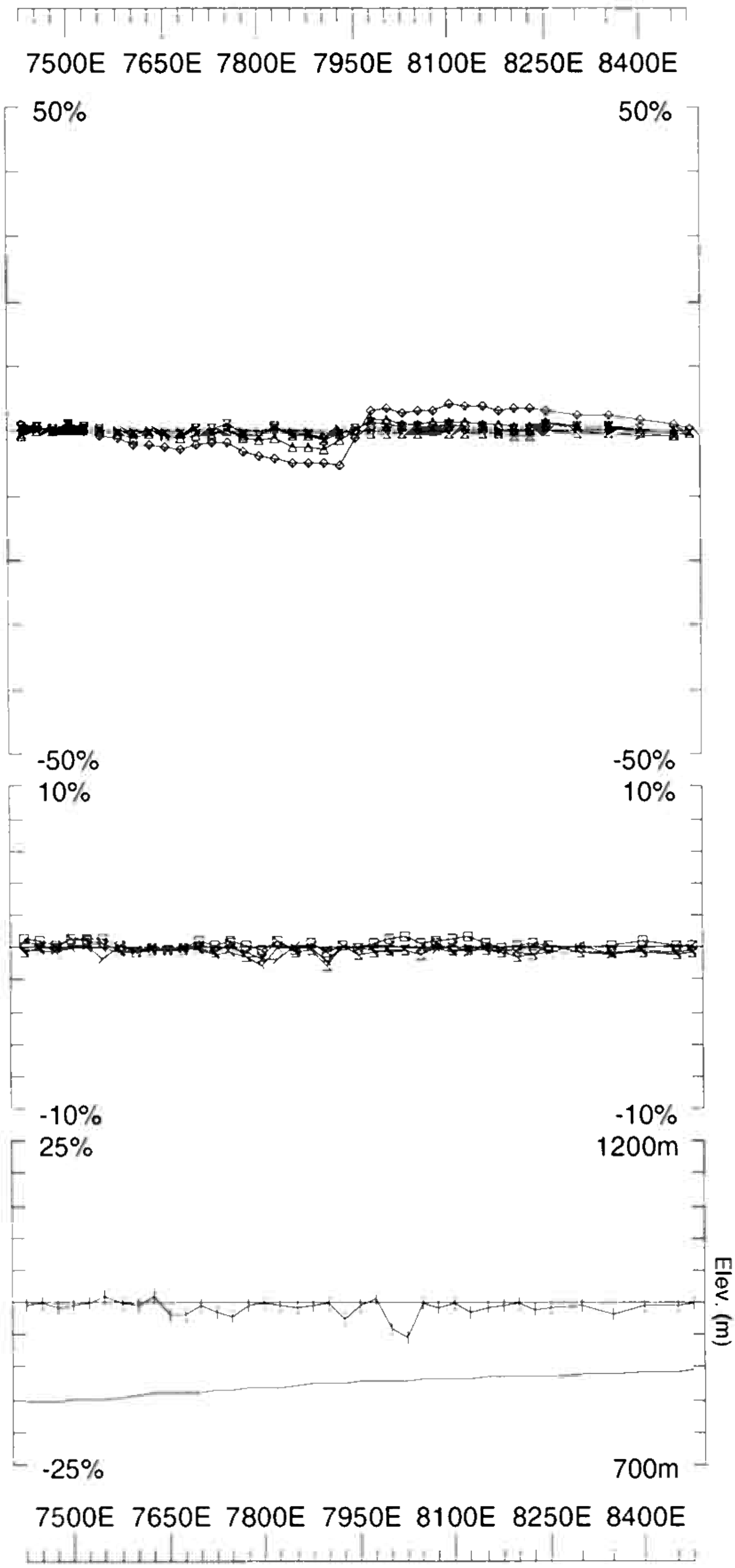
LAMONTAGNE GEOPHYSICS LTD GEOPHYSIQUE LTEE

Job 0531

Surveyed : 5/11/5
Reduced : 24/12/5
Plotted : 24/12/5

Secondary, (Chn - Ch1)/|Hp|
Contin. Norm at depth of 0 m
Base Freq. 3.251 Hz

Loop: 04
Line: 290N
Compt: Hz



UTEM Survey at: Vakkerlien
For: A/S Sulfidmalm

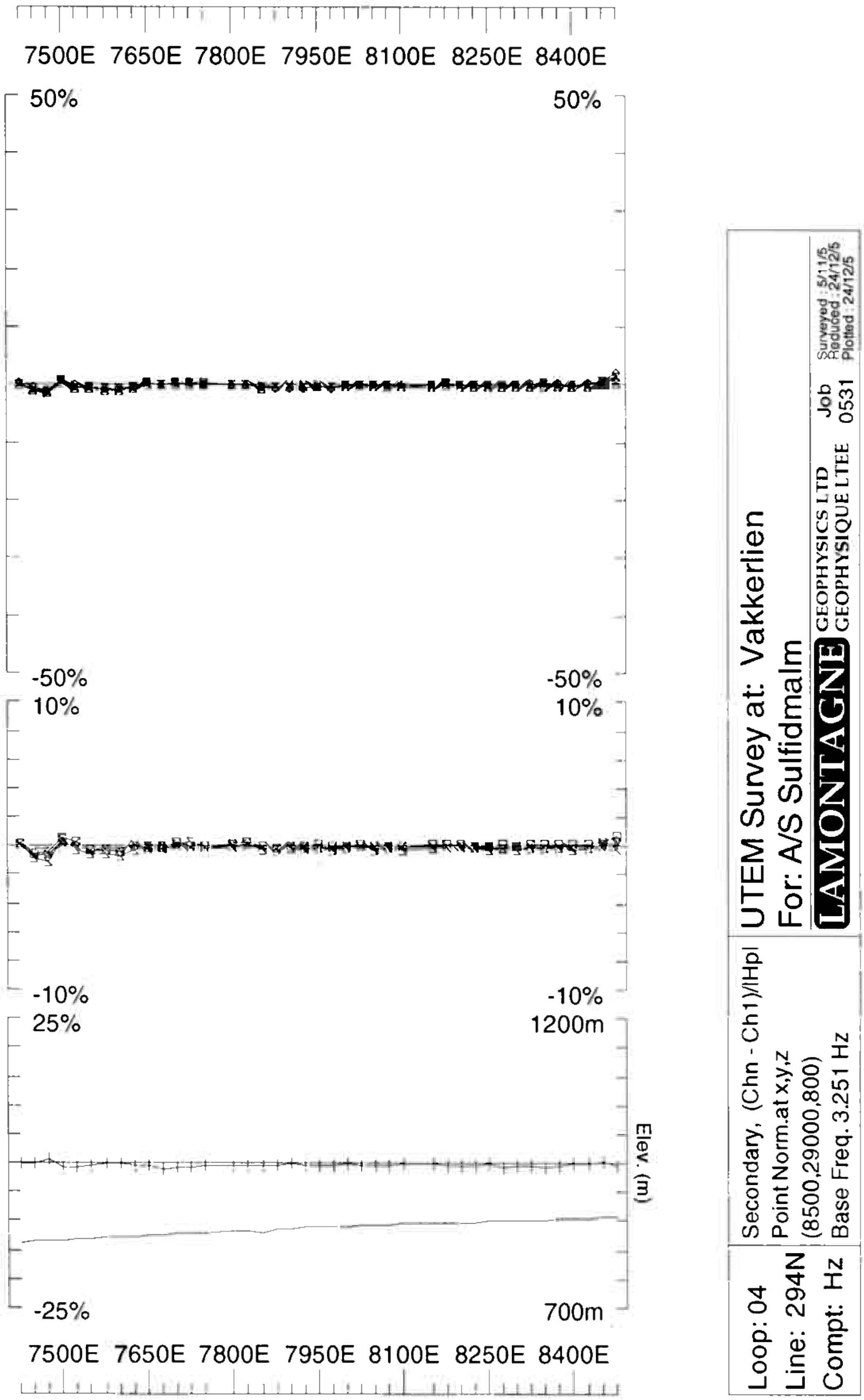
LAMONTAGNE GEOPHYSICS LTD GEOPHYSIQUE LTEE

Job 0531

Surveyed: 5/11/5
Reduced: 24/12/5
Plotted: 24/12/5

Loop: 04
Line: 292N
Compt: Hz

Secondary, (Chn - Ch1)/|Hp|
Contin. Norm at depth of 0 m
Base Freq. 3.251 Hz


7500E 7650E 7800E 7950E 8100E 8250E 8400E
50%
50%
-50%
-50%
10%
10%
-10%
-10%
25%
1200m
Elev. (m)
-25%
700m
7500E 7650E 7800E 7950E 8100E 8250E 8400E
UTEM Survey at: Vakkerlien
For: A/S Sulfidmalm
LAMONTAGNE GEOPHYSICS LTD GEOPHYSIQUE LTEE
Job 0531
Surveyed : 5/11/5
Reduced : 24/12/5
Plotted : 24/12/5
Secondary, (Chn - Ch1)/|Hp|
Point Norm.at x,y,z
(8500,29000,800)
Base Freq. 3.251 Hz
Loop: 04
Line: 294N
Compt: Hz

Appendix B

0531 Production Diary

UTEM 3 Surface Survey

Vakkerlien Grid
Norway

for

A/S Sulfidmalm

Production Log (0531)
UTEM Survey - Vakkerlien
Norway
A/S Sulfidmalm

Date	Rate	Production	Comments
up to October 24		-	Discussions, signing of the contract, assembly of crew and equipment.
October 24	Mob	(equip)	Equipment packed up and labelled. Picked up from Kingston.
October 30	Mob	-	John Frost of the LGL crew travels from Kingston (YGK)->Toronto (YYZ)->Frankfurt(FRA)->Oslo (OSL). Crew: J.Frost
October 31	Mob	-	John Frost completes journey ->Oslo (OSL). Meets up with Falconbridge personnel and travels with equipment to Espedalen. Crew: J.Frost
November 01	Mob	-	John Frost and Falconbridge personnel complete journey to Vakkerlien and unpack. Crew: J.Frost
November 02	Mob+?	-	The LGL crew -Rob Langridge and Tim Pinkerton start travel from Canada->Frankfurt(FRA)->Oslo (OSL)->Trondheim (TRD). John unpacks gear while the Falconbridge personnel lay out wire. Crew: R.Langridge, T.Pinkerton, **J.Frost**
November 03	Mob+?	-	Rob Langridge and Tim Pinkerton continue traveling and arrive ->Trondheim (TRD). They are met by Lars Weiershaeuser of Falconbridge and drive out to the jobsite arriving ~22:00. Set up for the morning. John Frost and Falconbridge personnel (Doris Fox) lay out wire. Crew: R.Langridge, T.Pinkerton, **J.Frost**

Date	Rate	Production	Comments
November 04	1/2**L(2)-3** 1/2**P(1)-2**	1600m	Get equipment ready. Drive out to site picking up fuel for the generator enroute. Complete loop, setup and start surveying ~12:00. Survey till dark - just past 16:00. Pack up, dinner in town and then head home. Data from Rx06 will be repeated.

Loop 04

Line 286N	**7600E**	**- 8500E**	**Hz**	**Rx05**
Line 288N	**7400E**	**- 8100E**	**Hz**	**Rx05**
Line 288N	7400E	- 8500E	Hz	Rx06
Line 290N	7400E	- 8500E	Hz	Rx06

Crew: R.Langridge,T.Pinkerton,J.Frost Total to date: 1.600k

November 05	**P(2)-3**	3700m	Get equipment ready. Setup, connect loop and start surveying. Survey till 16:00. Pack up and head home.

Loop 04

Line 288N	**8100E**	**- 8500E**	**Hz**	**Rx06**
Line 290N	**7400E**	**- 8500E**	**Hz**	**Rx06**
Line 292N	**7400E**	**- 8500E**	**Hz**	**Rx04**
Line 294N	**7400E**	**- 8500E**	**Hz**	**Rx04**

Crew: R.Langridge,T.Pinkerton,J.Frost Total to date: 5.300k

November 06	1/2**L(2)-3** 1/2**P(2)-3**	1825m	Get equipment ready. Drive out to Loop 01 site via the back route. Wheelbarrow in the generator and some gear, carry in some gear and setup while the loop is completed. Some of the pickets near the access path have been moved or removed. Loop is completed ~11:00 and surveying starts ~12:00. Missing pickets slow surveying and the area seems quite noisy - production will go slowly. Late in the afternoon (15:00) Rx05 develops a problem. Survey with one Rx till 16:00 - pack up and head home. Overhaul Rx05 and 06 in the evening.

Loop 01

Line 329N	**5500E**	**- 6550E**	**Hz**	**Rx06**
Line 330N	**5775E**	**- 6550E**	**Hz**	**Rx05**

Crew: R.Langridge,T.Pinkerton,J.Frost Total to date: 7.125k

November 07	**P(2)-3**	2200m	Out to Loop 01 - use Tx06 to test if the Tx is related to the noisy data. Survey till 16:15 and head home.

Loop 01

Line 332N	**5450E**	**- 6550E**	**Hz**	**Rx05**
Line 333N	**5450E**	**- 6550E**	**Hz**	**Rx04**

Crew: R.Langridge,T.Pinkerton,J.Frost Total to date: 9.325k

Date	Rate	Production	Comments

November 08 **P(2)-3** 2200m

Out to Loop 01. Survey till 16:15. Pack up/head home.
Sunrise/sunset: 08:12-15:52

Loop 01

Line 334N	**5450E**	**- 6550E**	**Hz**	**Rx05**
Line 335N	**5450E**	**- 6550E**	**Hz**	**Rx04**

Crew: R.Langridge,T.Pinkerton,J.Frost Total to date: 11.525k

November 09 **P(2)-3** 2200m

Out to Loop 01. Survey till 16:10. Pack/head home.
Sunrise/sunset: 08:15-15:49

Loop 01

Line 336N	**5450E**	**- 6550E**	**Hz**	**Rx05**
Line 337N	**5450E**	**- 6550E**	**Hz**	**Rx06**

Crew: R.Langridge,T.Pinkerton,J.Frost Total to date: 13.725k

November 10 **P(2)-3** 1775m

Out to Loop 01. Survey till 15:50. Pack/head home.
Sunrise/sunset: 08:18-15:47

Loop 01

Line 329N	**5700E**	**- 5975E**	**Hz**	**Rx06**
Line 330N	**5450E**	**- 5900E**	**Hz**	**Rx06**
Line 331N	**5450E**	**- 6550E**	**Hz**	**Rx05**

Crew: R.Langridge,T.Pinkerton,J.Frost Total to date: 15.500k

November 11 **P(2)-3** 950m

Out to Loop 01 to re-read in detail a section of Line 331N. Survey till 13:15. Pack and shift the generator by wheelbarrow across the swamp.- this takes ~90 minutes. Move the tx, transformer and battery as far as we can before dark. Walk out and head home very tired.
Sunrise/sunset: 08:21-15:44

Loop 01

Line 331N	**5450E**	**- 6300E**	**Hz**	**Rx5/6**

Crew: R.Langridge,T.Pinkerton,J.Frost Total to date: 16.450k

November 12 **P(2)-3** 2800m

Out to Loop 03. Finish moving the Tx in the last few hundred metres and set up. Read till ~13:45 when a moose is spotted. Loop is broken soon after and the search for the break completes the day. Walk out - back at the truck @15:40.
Sunrise/sunset: 08:24-15:41

Loop 03

Line 317N	**7125E**	**- 8525E**	**Hz**	**Rx06**
Line 315N	**7125E**	**- 8525E**	**Hz**	**Rx05**

Crew: R.Langridge,T.Pinkerton,J.Frost Total to date: 19.250k

Date	Rate	Production	Comments
November 13	**P(2)-3**	5600m	Out to Loop 03. Set up and go to work in light snow. Evidence of the moose... and the Tx shut down. It turned out to be an old friend - the Tx had simply shut down as it has occasionally on all the jobs in Norway. Turned It back on and surveyed all day. Sunrise/sunset: 08:27-15:39

Loop 03

Line 307N	**7125E**	**- 8525E**	**Hz**	**Rx06**
Line 309N	**7125E**	**- 8525E**	**Hz**	**Rx05**
Line 311N	**7125E**	**- 8525E**	**Hz**	**Rx05**
Line 313N	**7125E**	**- 8525E**	**Hz**	**Rx06**

Crew: R.Langridge,T.Pinkerton,J.Frost   Total to date: 24.850k

Date	Rate	Production	Comments
November 14	**P(2)-3**	2025m	Out to Loop 03. Set up and go to work in light rain. Stationed Tim at the transmitter and it shut down a number of times during the day. Finished reading ~14:30 and picked up/pulled wire on the north and west sides. Out to the trucks by 16:20. Sunrise/sunset: 08:29-15:36

Loop 03

Line 311N	**6125E**	**- 7125E**	**Hz**	**Rx05**
Line 317N	**6100E**	**- 7125E**	**Hz**	**Rx06**

Crew: R.Langridge,T.Pinkerton,J.Frost   Total to date: 26.875k

Date	Rate	Production	Comments
November 15	**L(2)-3**		Up to a world covered with snow. Tried the lower access road but it appeared to be stengt - closed. Took a look at the road we have been using and decided to back off for a few hours to check on the lower road status and the snow-scooter permit. Shopped - looked for some hardware to modify the snow shoes for muskeg but there was none locally. Headed out ~11:00. Walked out and laid out wire in windy, snowy conditions - snowier than expected. Managed to complete three sides (double wire) in poor conditions. The walk out extended into the early evening but we were all back at the trucks by 16:45. Sunrise/sunset: 08:32-15:33

Crew: R.Langridge,T.Pinkerton,J.Frost   Total to date: 26.875k

Date	Rate	Production	Comments
November 16	**P(2)-3**	2200m	Out to Loop 02. Complete loop and work on the generator. Set up and go to work in light snow. Out to the trucks by 16:30. The gate was locked when we arrived - Finn to the rescue Sunrise/sunset: 08:35-15:31

Loop 02

Line 319N	**5825E**	**- 7225E**	**Hz**	**Rx06**
Line 663E	**2100N**	**- 2900N**	**Hz**	**Rx05**

Crew: R.Langridge,T.Pinkerton,J.Frost   Total to date: 29.075k

Date	Rate	Production	Comments
November 17	**P(2)-3**	4400m	Out to Loop 02. Set up and go to work in light snow. Out to the trucks by 16:40. Find out in the evening that we can use the snoscooters outside the environmentally protected area. Sunrise/sunset: 08:38-15:28

Loop 02

Line 315N	**5825E**	**- 7225E**	**Hz**	**Rx06**
Line 317N	**5825E**	**- 7225E**	**Hz**	**Rx06**
Line 669E	**2100N**	**- 2900N**	**Hz**	**Rx05**
Line 670E	**2100N**	**- 2900N**	**Hz**	**Rx05**

Crew: R.Langridge,T.Pinkerton,J.Frost Total to date: 33.475k

November 18	**P(2)-3**	2200m	Out to Loop 02. Trailered snoscooters out and set up. Loop was broken - in a number of places but mainly where it crosses a river - the steady snowfall of the past few days (a metre or so) backed up the river and took out a section - roughly as far from the Tx as possible. With the double loop there is wire available so it was patched. started reading ~12:45 and read one line each. Getting the snoscooter trailer out proved a little difficult. Sunrise/sunset: 08:41-15:25

Loop 02

Line 667E	**700N**	**- 2100N**	**Hz**	**Rx06**
Line 668E	**2100N**	**- 2900N**	**Hz**	**Rx05**

Crew: R.Langridge,T.Pinkerton,J.Frost Total to date: 35.675k

November 19	**n/c**		Day off. Picked up tow rope and supplies in Tynset. Sunrise/sunset: 08:44-15:23
November 20	**P(2)-3**	1600m	Out to Loop 02. The loop was good but the negative lead had broken off the back up battery and the Tx was off. Decided to get the other Tx. Back to Hogstad to pick-up the Tx and gas etc. On the way back the truck went into the ditch. Pulled it out with the tow rope. Out to the transmitter site again. The backup Tx would not put out as much current @ pre-whitening level 4 - and blew a fuse. Used the same Tx again. Read one line each. Sunrise/sunset: 08:47-15:21

Loop 02

Line 666E	**2100N**	**- 2900N**	**Hz**	**Rx05**
Line 667E	**2100N**	**- 2900N**	**Hz**	**Rx06**

Crew: R.Langridge,T.Pinkerton,J.Frost Total to date: 37.275k

Date	Rate	Production	Comments
November 21	**P(2)-3**	4400m	Out to Loop 02. The loop was good. Read two lines each. Sunrise/sunset: 08:49-15:19 **Loop 02** **Line 664E 2100N - 2900N Hz Rx05** **Line 665E 2100N - 2900N Hz Rx05** **Line 665E 700N - 2100N Hz Rx06** **Line 666E 700N - 2100N Hz Rx06**
			Crew: R.Langridge,T.Pinkerton,J.Frost — Total to date: 41.675k
November 22	**P(2)-3**	5600m	Out to Loop 02. The loop was good. Read two in-loop lines each. Everybody was a little wet after multiple creek crossings. Sunrise/sunset: 08:52-15:16 **Loop 02** **Line 311N 5825E - 7225E Hz Rx06** **Line 313N 5825E - 7225E Hz Rx06** **Line 663E 700N - 2100N Hz Rx05** **Line 664E 700N - 2100N Hz Rx05**
			Crew: R.Langridge,T.Pinkerton,J.Frost — Total to date: 47.275k
November 23	**P(2)-3**	3275m	Out to Loop 02. The loop was good. Read all remaining lines including extended sections of Lines 670E and 671E. Tim Pinkerton to Trondheim in the evening. Sunrise/sunset: 08:52-15:16 **Loop 02** **Line 309N 5825E - 7225E Hz Rx06** **Line 313N 7225E - 8200E Hz Rx06** **Line 670E 2900N - 3150N Hz Rx05** **Line 671E 2500N - 3150N Hz Rx05**
			Crew: R.Langridge,T.Pinkerton,J.Frost — Total to date: 50.550k
November 24	**P(2)-2** **demob (Tim)**	1200m	Out to Loop 02. The loop was good. Modified the loop to read sections of Lines 670 and 671E. Finished @ dark. Back to the trucks @ 16:50. Tim Pinkerton flies home. Sunrise/sunset: 08:55-15:14 **Loop 02a** **Line 670E 2800N - 3400N Hz Rx05** **Line 671E 2800N - 3400N Hz Rx06**
			Crew: **R.Langridge, J.Frost,** T.Pinkerton — Total to date: 51.750k
November 25	**L(2)-2**		Out to pick up Loop 02. and pickets Worked till after dark. Back to the trucks @ 16:50. Sunrise/sunset: 09:00-15:10
			Crew: R.Langridge, J.Frost

Date	Rate	Production	Comments
November 26	**L(2)-2**		Out to pick up the remainder of Loop 02. and pickets Worked till ~noon. Drove snoscooters down to the road. One truck went in the ditch on the way down. Pulled it out with the snoscooter. Brought trailers back and loaded the snoscooters. Packed gear for transport to Espedalen/Gardemoen. Sunrise/sunset: 09:02-15:08
	Crew: R.Langridge, J.Frost		
November 27	**demob**		Loaded gear for transport to Gardemoen in the morning. Drove south to Vinstra. Left the gear with Falconbridge personnel and continued on to Gardemoen. Arrived ~18:30. Went to sort out our tickets and had some trouble with John Frost's ticket. This was finally resolved to some satisfaction at 23:00.
	Crew: R.Langridge, J.Frost		
November 28	**demob**		Gear and crew to Gardemoen. Gear taken to shipper by Falconbridge personnel. Crew to Canada.
November 29 ->December 10	**equipment-**		Equipment in transit.
December 11			Equipment arrives in Kingston.

LEGEND

P(n)-x	Surface Production (# of receivers) - # of personnel
L(n)-x	Looping (# of receivers) - # of personnel
S(n)-x	Standby (# of receivers) - # of personnel
D(n)-x	Down (# of receivers) - # of personnel

Appendix C

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 syncronized 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 synchronisation.

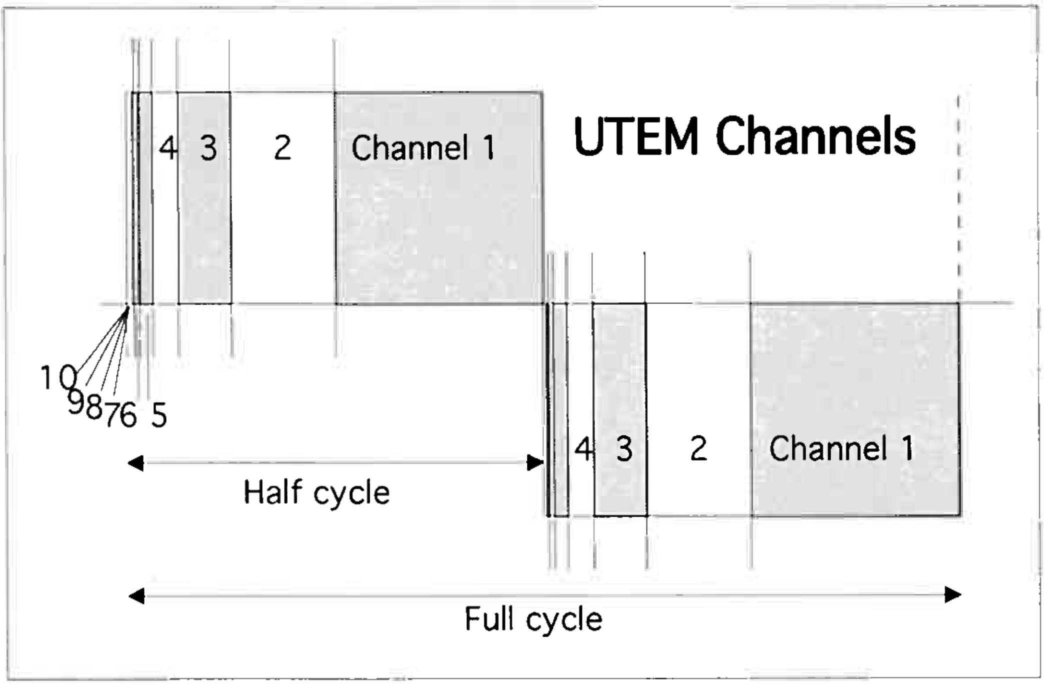
Measurements are routinely taken to a distance of 1.5 to twice the loop dimensions, depending on the local noise levels, and can be continued further. Lines are typically surveyed out from the edge of the loop but may also be read across the loop wire and through the centre of the loop, a configuration used mainly to detect horizontal conductors. BHUTEM - the borehole version of UTEM -surveys have been carried out to depths up to 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, however, it is usually set at 31 Hz to minimise power line (60 Hz in North America) 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. UTEM is the only time domain system which measures the step response of the ground. All other T.D.E.M. systems to date 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 an equivalent to the 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 10 delay times (channels). UTEM channels are spaced in a binary, geometric progression across each half-cycle of the received waveform. Channel **10** is the earliest channel and it is $1/2^{10}$ of the half-cycle wide. Channel **1**, the latest channel, is $1/2^{1}$ of the half-cycle wide (see Figure below). The measurements obtained for each of 10 channels are accumulated over many half-cycles. Each final channel value, as stored, is the average of the measurements for that time channel. The number of half-cycles averaged generally ranges between 2048 (1024 full-cycles - 1K in UTEM jargon) to 32768 (16K) depending on the level of ambient noise and the signal strength.



System Configurations

For surface work the receiver coil is mounted on a portable tripod and oriented. 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 the electric field components. This is generally used for outlining resistive features to which the magnetic field is not very sensitive.

BHUTEM surveys employ a receiver coil that is smaller in diameter than the surface coil. The borehole receiver coil forms part of a down-hole receiver package used to measure the axial (along-borehole) component of the magnetic field of the transmitter loop. Due to the distance between coil and receiver in borehole surveys the signal must be transmitted up to the receiver. In BHUTEM the signal 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 3000+m. The cable is also very light - the specific gravity is nearly 1.0 - making the cable handling hardware quite portable.

The EM Induction Process

Any time-varying transmitted ("primary") field 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 for the transmitted current flow to be redirected (reversed) and reestablished to full amplitude after the rate-of-change of the primary field reverses direction. This measurable reversal time is characteristic for a given conductor. In general, for a good conductor this time is greater than that of a poor conductor. This is because in a good conductor the terminal current level is greater, whereas its rate of change is limited by the inductance of the current path. The time-varying current causes an Emf in the sensor proportional to the time derivative of the current. This Emf decays with time - it vanishes when the reversal is complete - and the characteristic time of the Emf decay as measured by the sensor is referred to as the **decay time** of the 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 slight-to-large response due to any conductors present.

The result is that in the presence of conductors the primary field waveform is substantially (and anomalously) distorted.

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 the depth is the estimated target depth is used.

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:

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

$R1_j$ is the result plotted for the latest-time UTEM channel, channel 1,

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

$Ch1_j$ is the raw component sensor value for channel 1 at station j,

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

$|H^P|$ 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, $\mathbf{H^P}$ 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, $\mathbf{H^P{}_j}$) 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	Σ
6	0.378	4
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 D

Note on sources of anomalous Ch1

Note on sources of anomalous Ch1

This section outlines the possible sources of anomalous channel 1 which is not correlated to the Ch2-10 data plotted on the upper axes of a *channel 1 normalized* plot.

1) **Mislocation of the transmitter loop and/or survey stations**

Mislocating the transmitter loop and/or the survey stations results in an error in the calculated primary field at the station and appears as an anomalous Ch1 value not correlated to *channel 1 normalized* Ch2-10. The effect is amplified near the loop front. This can be seen in the profiles - the error in Ch1 generally increases approaching the loop. As a rule a 1% error in measurement of the distance from the loop will result in, for outside the loop surveys, an error in Ch1 of:

- 1% near the loop front (long-wire field varies as 1/r)
- 3% at a distance from the loop front (dipolar field varies as $1/r^3$)
- 2% at intermediate distances (intermediate field varies as $\sim 1/r^2$)

Errors in elevation result in smaller errors but as they often affect the chainage they accumulate along the line.

The in-loop survey configuration generally diminishes geometric error since the field gradients are very low. At the centre of the loop the gradient in the vertical field is essentially zero so it is difficult to introduce geometric anomalies near the loop centre. Near the loop sides and at the closest approach of the lines to the wire mislocation of the loop and the station becomes more critical. Typically loop sides are designed to be >200m from any survey stations.

2) **Magnetostatic UTEM responses**

Magnetostatic UTEM responses arise over rocks which generate magnetic anomalies. Such magnetic materials will amplify the total (primary + secondary) field of the UTEM transmitter which is sensed by the receiver coil. The secondary field is generated by subtracting a computed primary which does not include magnetic effects. This can give rise to strong and abrupt channel 1 anomalies when the source of the magnetics is at surface. This is the case in a number of places on these grids. UTEM magnetostatic anomalies differ from DC magnetic anomalies in the following three major ways:

1) In the case of DC magnetics the field is dipping N and is very uniform over the scale of the survey area while the UTEM field inside the loop is vertical and it is stronger near the loop edges.
2) Most aeromagnetics are collected as total field while with UTEM we measure a given (in this case generally z,x) component.
3) DC magnetic instruments observe the total magnetization of the causative body which is due to its susceptibility as well as any remnant magnetization. An AC method such as UTEM will not respond to the remnant portion of the magnetization.

The larger amplitude of the UTEM Ch1 response is explained by the fact that the UTEM primary field is often more favourably coupled (magnetostatically speaking) to

magnetic mineralization as compared to the earths field. Another factor could be the presence of a reverse remnant component to the magnetization.
Note that positive magnetic anomalies will cause:

- positive Ch1 anomalies in data collected outside the loop
- negative Ch1 anomalies in data collected inside the loop

3) **Extremely good conductors**

An extremely good conductor will be characterized by a time constant much longer than the half-period (@ 30Hz >>16ms). This will give rise to an anomalous Ch1 which is not correlated to the Ch2-10 data plotted on the upper axes of a *channel 1 normalized* plot.

Appendix E

Note on 4 Hz UTEM data:
The effect of the presence of a 60-cycle powerline.

Note
While this Appendix uses data collected in the presence of a 60Hz powerline the issue dealt with applies equally to UTEM data collected in the presence of a 50Hz powerline.

Note: The standard presentation in Appendix A has Ch2-5 plotted on the middle axis. An alternative presentation - with Ch2 and Ch3 on the middle axis - is sometimes chosen when a powerline cuts through the surveyed area. This Appendix is a brief discussion of why the alternative presentation is chosen.

Note on 4 Hz UTEM data:The effect of the presence of a 60-cycle powerline.

This appendix outlines and discusses the effect of the presence of a 60-cycle powerline on ~4Hz (3.872Hz) UTEM data. The example data is from Loop 12 Line 280S. This line is from a series of loops with a powerline cutting across the survey area. The Loop 12 Line 280S UTEM data is affected by the presence of the powerline.

example data:

Figure E1(a) is the example data as presented in Appendix A - an alternative presentation with Ch2 and Ch3 on the middle axis. The standard presentation is shown in Figure E1(b) - with Ch2-5 plotted on the middle axis. The alternative presentation was chosen for a series of loops (including this loop) with a powerline cutting through the surveyed area. Figure E1(c) shows why - Ch4 and Ch5 show a pattern where when one is up the other is down and vice versa. The amplitude of the pattern decreases with distance away from the powerline. It was felt that this pattern obscured the information in Ch2 and 3 and the alternative presentation was chosen.

explanation:

Figure E2a) shows the UTEM waveform at ~4Hz with a 60Hz waveform superimposed on it. Roughly 16 cycles of the 60-cycle waveform fit into the full UTEM waveform. On a channel-by-channel basis:

~4 cycles fit into Ch1
~2 cycles fit into Ch2
~1 cycle fits into Ch3.

The multiple cycles tend to cancel out. Earlier channels are narrower - only part of a cycle wide. In particular Ch4 is ~half a cycle wide and Ch5 falls in the opposite halfcycle. The result is the pattern shown in Figure 1(c): Ch4 and Ch5 tending to diverge from one another - more strongly near the powerline.

other presentations:

Figures E3(a) and (b) show the example data in two other presentations where several channels are combined to give fewer, cleaner channels:

Figure E3(a): In this presentation Ch4 and 5 are combined to give a combined Ch"4" that is ~1.5 times as wide as the original Ch4. The Ch"4" is cleaner than the original. The original Ch5-10 are shown on the upper axis.

Figure E3(b): In this presentation Ch4-10 are combined to give a combined Ch"4" that is 2x as wide as the original Ch4 (equal in width to the original Ch3). The Ch"4" is as clean as the original Ch3. Note that Ch10 is added in twice to make the 2x factor exact. The original Ch5-10 are shown on the upper axis.

Discussion:

Several elements of UTEM survey design and procedure will have an affect on the number of useful channels in the final data set. These would include:

- careful positioning of the transmitter loops relative to the powerline(s)
- increasing the transmitter current (and the signal-to-noise ratio)
- care in the selection of gains during surveying. Near a source of coherent noise (eg powerline) the signal gain should be selected to minimize data rejections.

Consideration should also be given to increasing the station spacing in the vicinity of the powerline. This allows additional stacking to be done (at fewer stations) without much of an increase in surveying time.

Several other ways to increase the number of channels free of the powerline affects are:

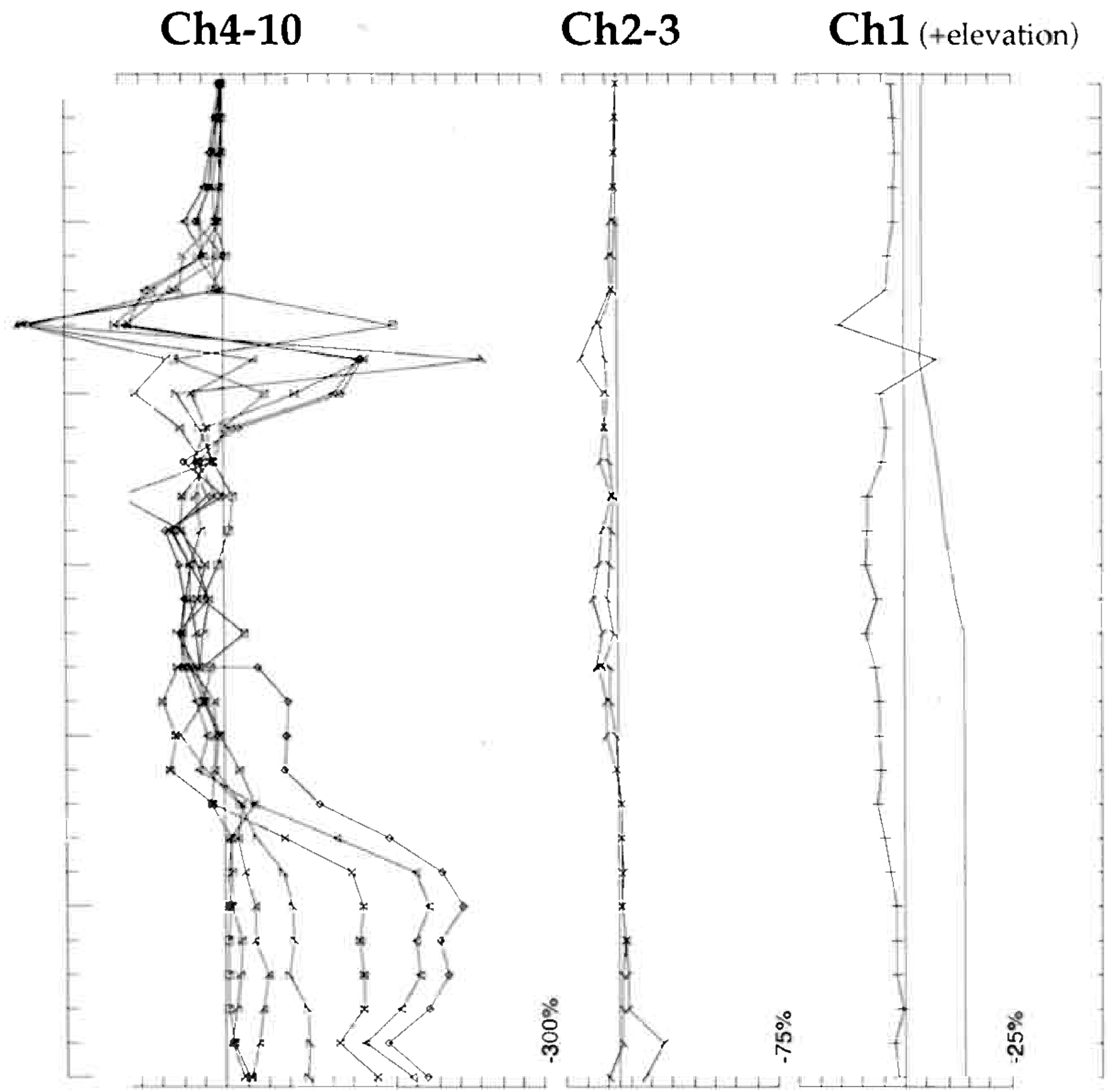
- <u>lowering the frequency</u>: each factor of two lower in frequency would add a channel relatively free of the affects of the powerline. The cost would be increased stacking time at each station.

- <u>taking multiple readings</u>: each reading starts at a different (random) point on the 60-cycle waveform. The sum of several readings will tend to better average out any affect.

- <u>alternative channel sampling</u>: Figure E2b) shows the standard UTEM 3 Boxcar channel sampling. An alternative - tapered channel sampling - is available (and often used) with UTEM 4. In this case if tapered sampling had been available it would likely have been used. The result would have been:

  - a slightly noisier Ch3
  - a considerably improved Ch4
  - an improved Ch5

  The choice of which sampling to use on a UTEM 4 survey depends on the frequency of the survey, the proximity and the frequency of any local powerline and the type of decay seen.



Loop	Secondary, (Chn-Ch1 / Hp)	
Line	Contin. Norm at a depth of 0m	
Compt: Hz	Base Freq. 3.872Hz	LAMONTAGNE GEOPHYSICS LTD GEOPHYSIQUE LTEE

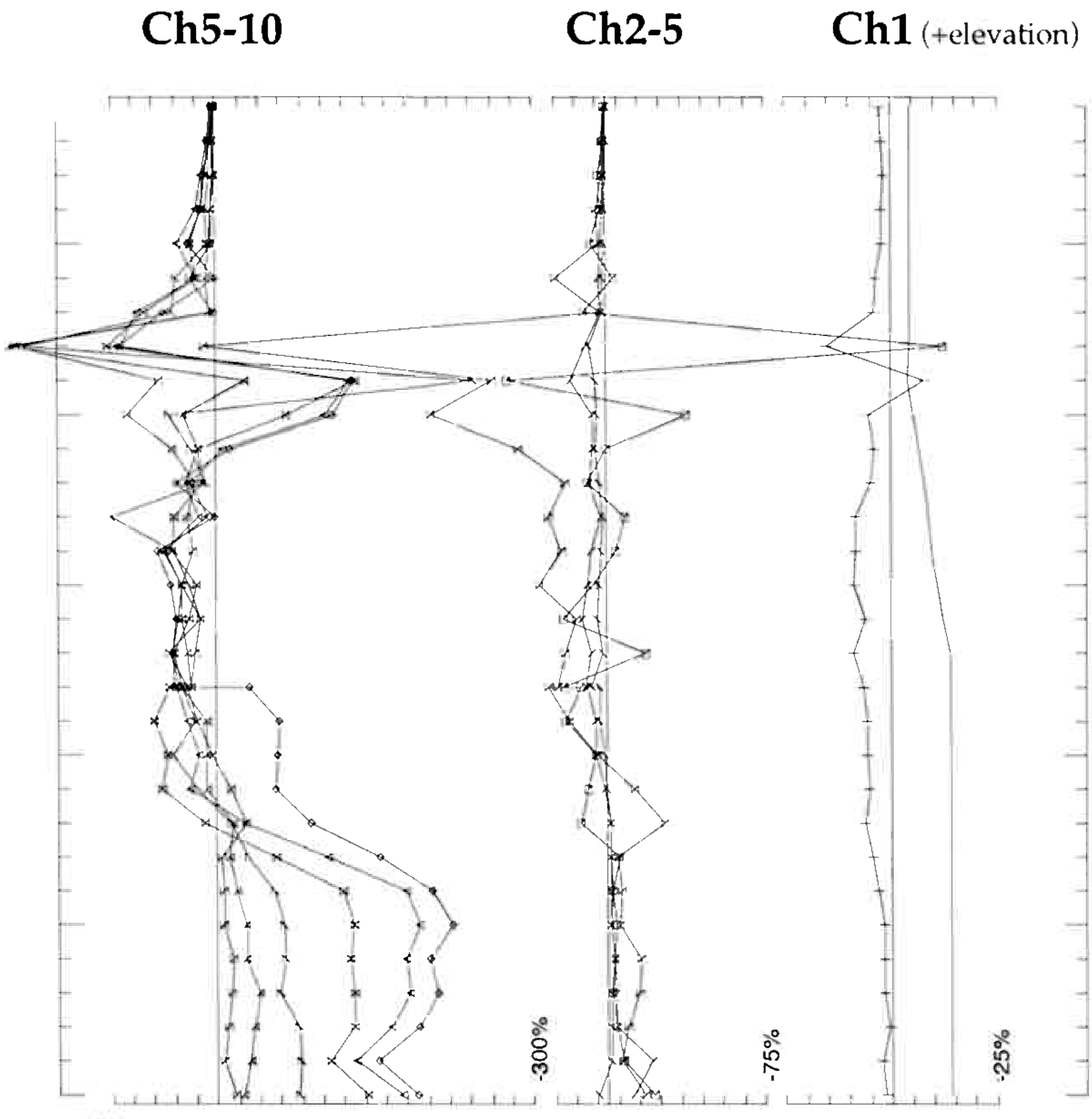
LAMONTAGNE GEOPHYSICS LTD GEOPHYSIQUE LTEE

Appendix E

Figure E1(a)

Original 4Hz data: alternative format

Figure E1a



Loop.	Secondary, (Chn-Ch1/Hpl	
Line	Contin. Norm at a depth of 0m	LAMONTAGNE GEOPHYSICS LTD GEOPHYSIQUE LTEE
Compt: Hz	Base Freq. 3.872Hz	

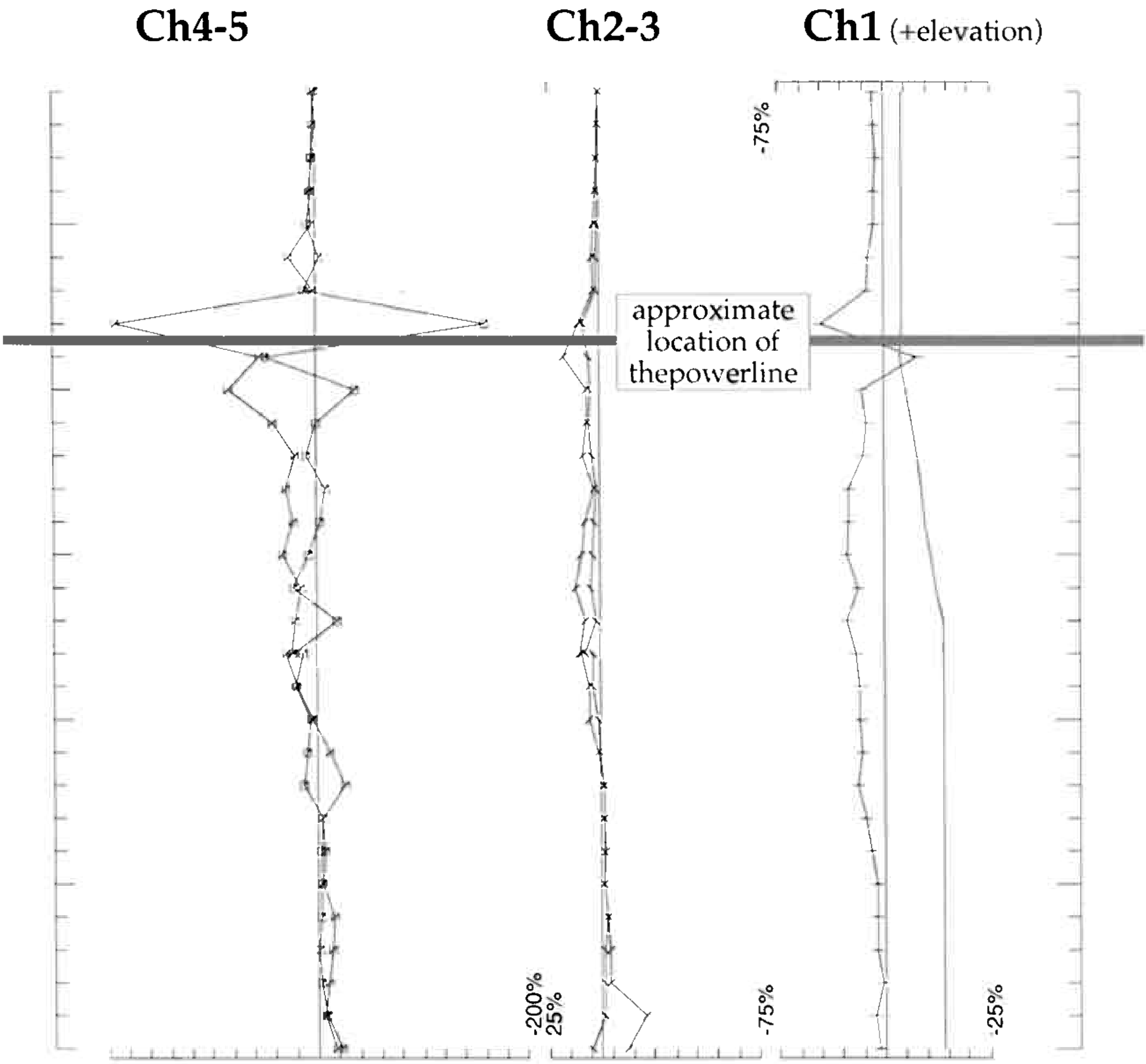
LAMONTAGNE GEOPHYSICS LTD GEOPHYSIQUE LTEE

Appendix E

Figure E1(b)

Original 4Hz data: standard format

Figure E1b



Loop:	Secondary, (Chn-Ch1 / Hpl	
Line	Contin. Norm at a depth of 0m	
Compt: Hz	Base Freq. 3.872Hz	LAMONTAGNE GEOPHYSICS LTD GEOPHYSIQUE LTEE

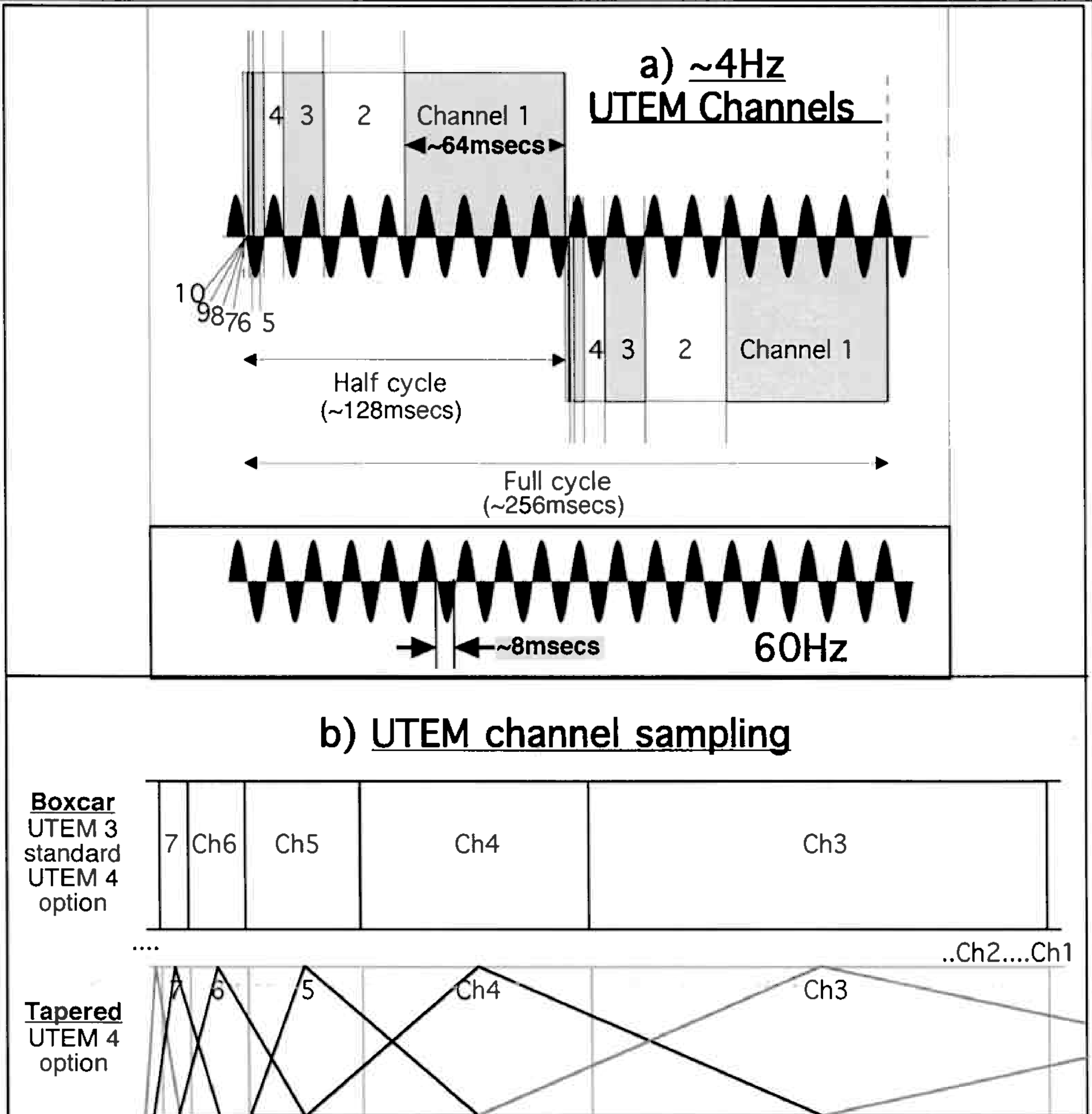
LAMONTAGNE GEOPHYSICS LTD
GEOPHYSIQUE LTEE

Appendix E

Figure E1(c)

Original 4Hz data: Ch4/5 detail

Figure E1c



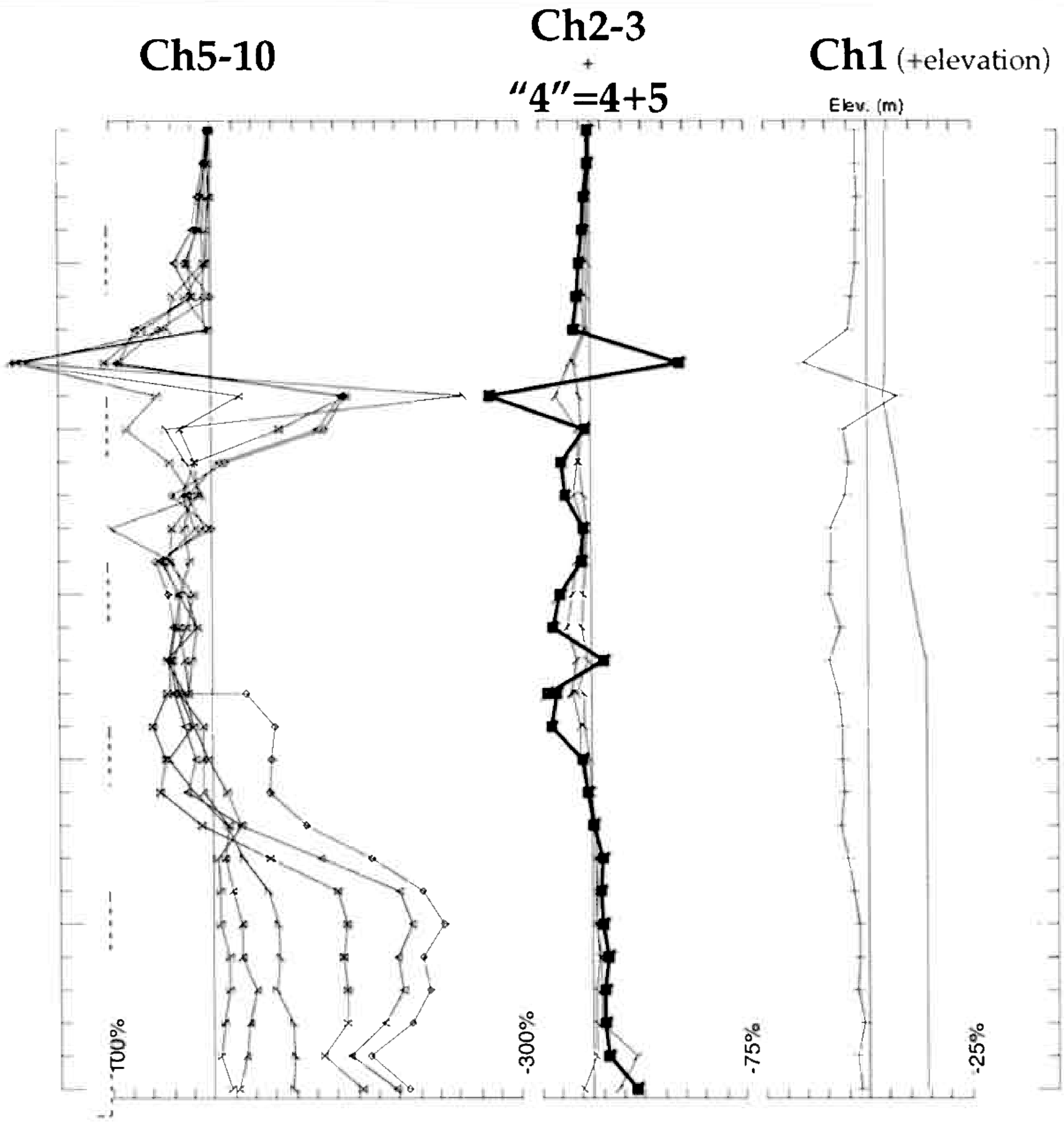
LAMONTAGNE GEOPHYSICS LTD GEOPHYSIQUE LTEE

Appendix E

Figure E2

a) ~4Hz UTEM Channels with 60Hz signal
b) UTEM Channel sampling options

Figure E2



Loop:	Secondary, (Chn-Ch1/Hpl	
Line	Contin. Norm at a depth of 0m	
Compt: Hz	Base Freq. 3.872Hz	LAMONTAGNE GEOPHYSICS LTD GEOPHYSIQUE LTEE

"modified" Ch4
=
2/3(Ch4+1/2Ch5)

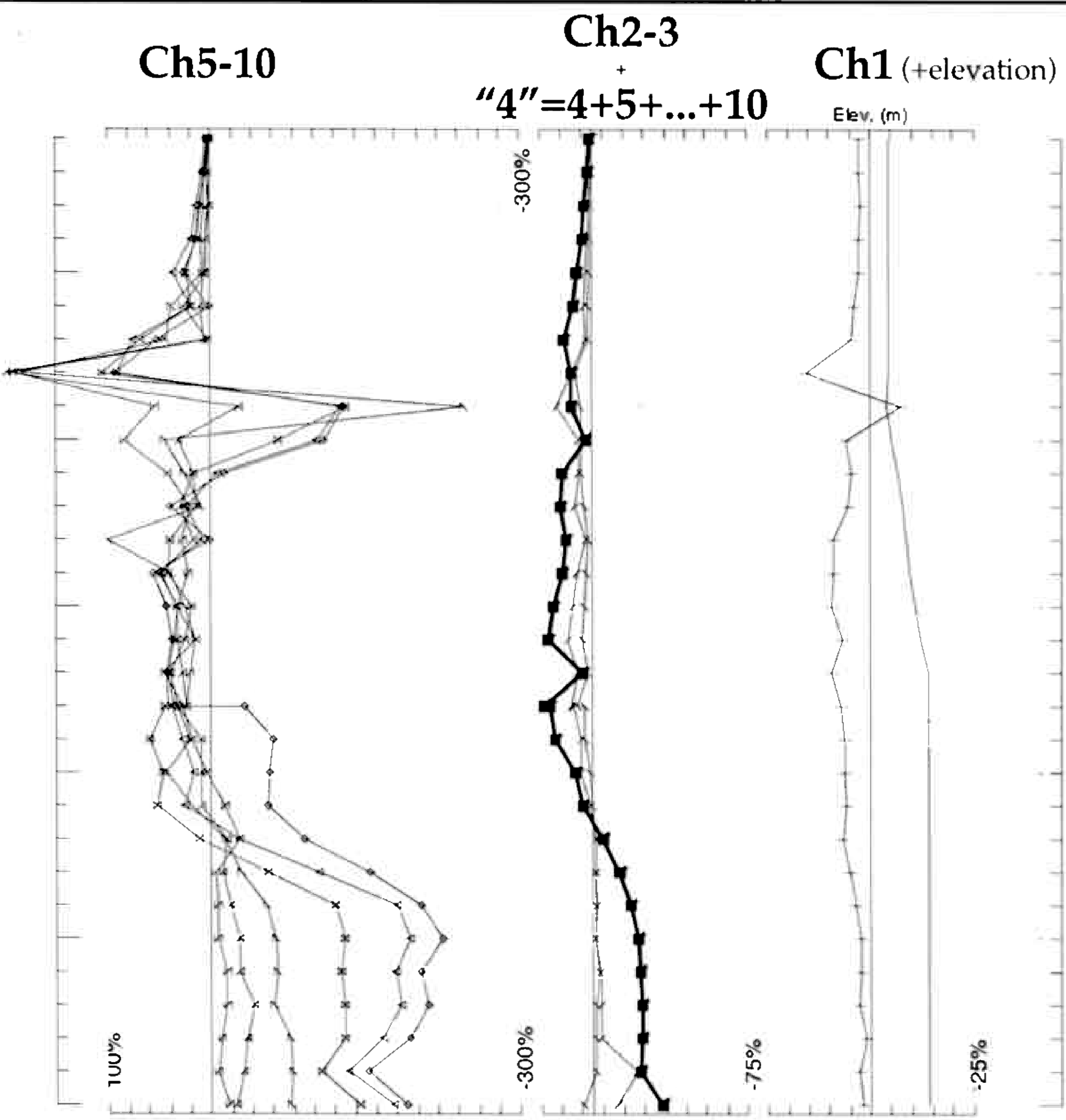
LAMONTAGNE GEOPHYSICS LTD GEOPHYSIQUE LTEE

Appendix E

Figure E3(a)

Modified 4Hz data: Ch4/5 combined

Figure E3a



Loop:	Secondary, (Chn-Ch1 / Hpl	
Line	Contin. Norm at a depth of 0m	
Compt: Hz	Base Freq. 3.872Hz	LAMONTAGNE GEOPHYSICS LTD GEOPHYSIQUE LTEE

"modified" Ch4
=
1/2Ch4+1/4Ch5+1/8Ch6+1/16Ch7)+
1/32Ch8+1/64Ch9+1/128Ch10+
1/128Ch10
Note: extra 1/128Ch10 to ~complete
"modified" Ch4

LAMONTAGNE GEOPHYSICS LTD GEOPHYSIQUE LTEE

Appendix E

Figure E3(b)

Modified 4Hz data: Ch4-10 combined

Figure E3b

APPENDIX D

APPENDIX D

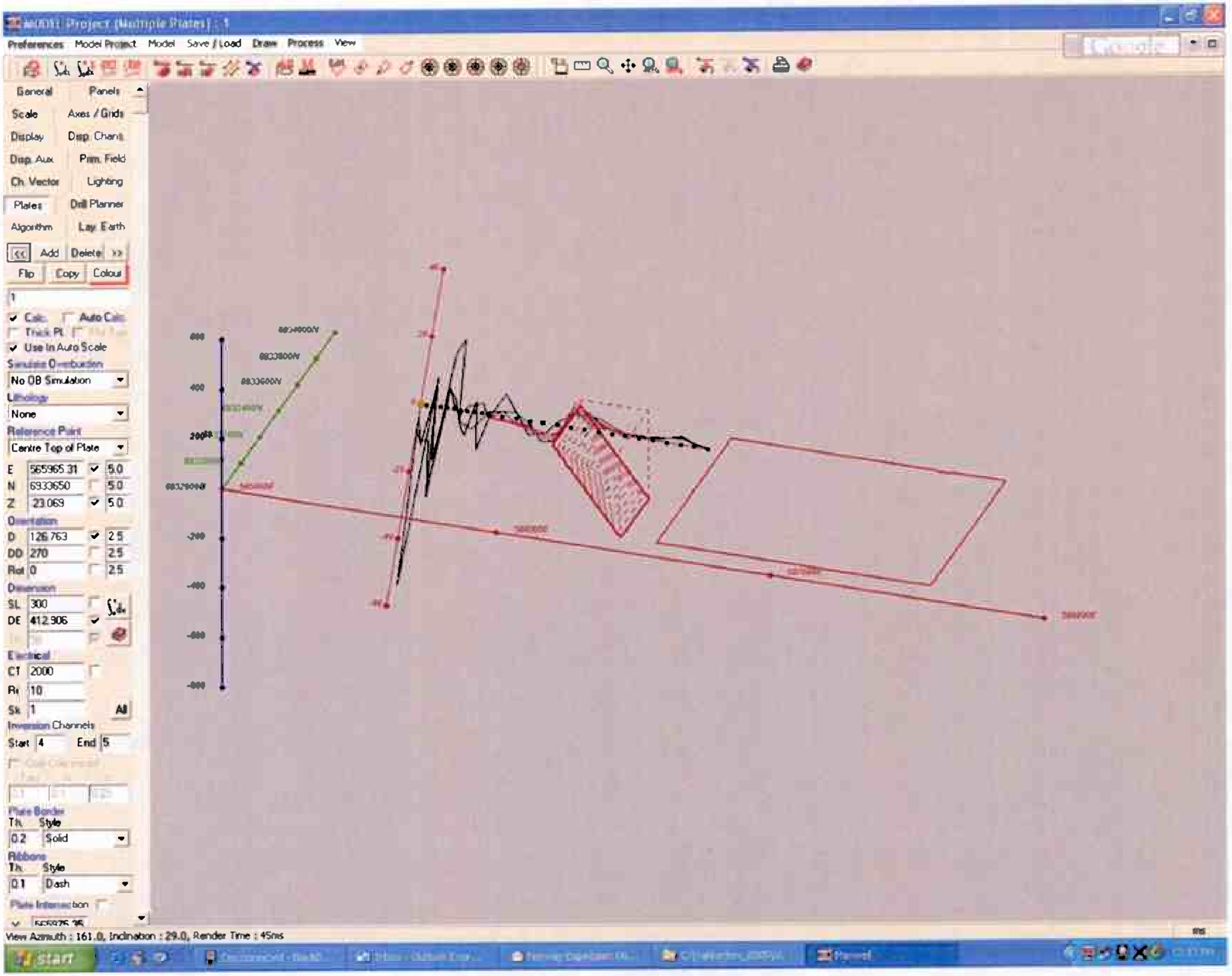
In-house UTEM Maxwell Modeling

Vakkerlien Project, Hedemark Province, Norway

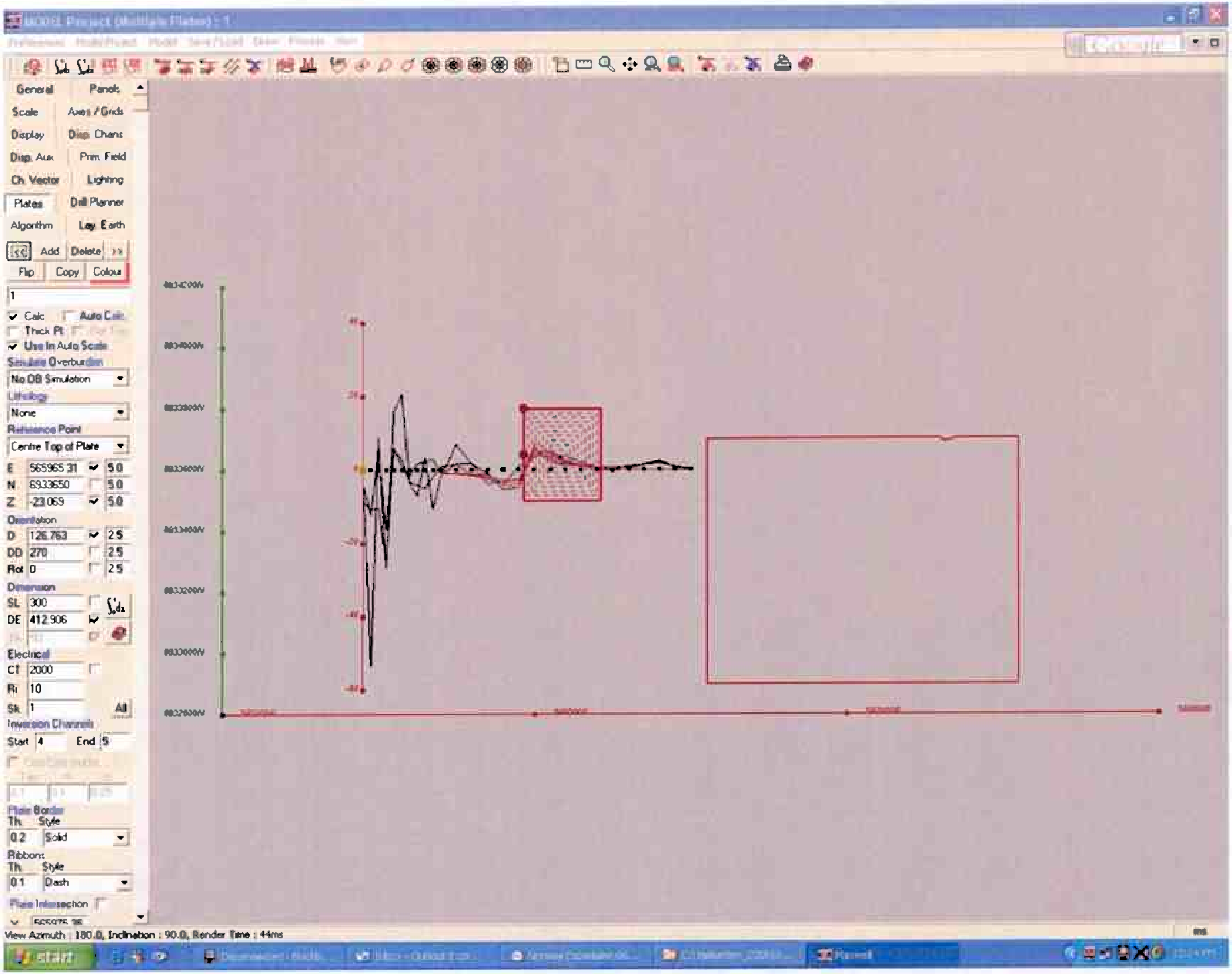
Anthony Watts, Falconbridge Ltd for Sulfidmalm A/S

Model 1: Loop 1, L336N – Isometric View
Model 2: Loop 1, L336N – Plan View
Model 3: Loop 1, L336N – Sectional View Looking North
Model 4: Loop 1, L336N – Longitudinal View

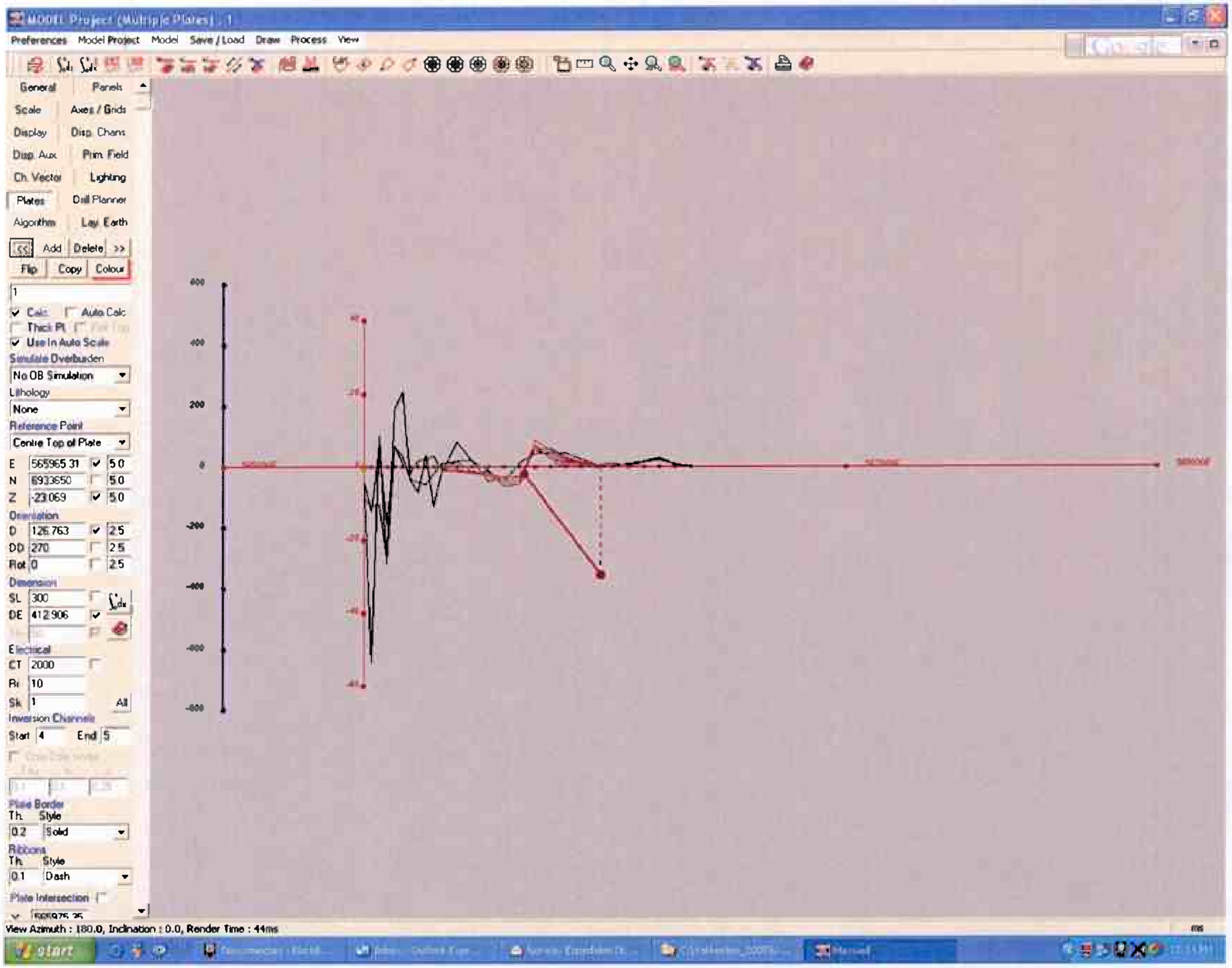
Model 1: Loop 1, L336N – Isometric View



Model 2: Loop 1, L336N – Plan View



Model 3: Loop 1, L336N – Sectional View Looking North



Model 4: Loop 1, L336N – Longitudinal View