GM 60694

AUDIO-MAGNETOTELLURIC SURVEY, DANIEL JOINT VENTURE

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AUDIO-MAGNETOTELLURIC SURVEY

DANIEL JOINT VENTURE
MATAGAMI, QUEBEC

for

Noranda Inc.

by

GEOSYSTEM CANADA INC.
Ottawa, Ontario

April 2003

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1 INTRODUCTION

This report describes acquisition and interpretation of audio-frequency magnetotelluric (AMT) data, collected on the Daniel Joint Venture property of Noranda Inc..The AMT survey grid was located approximately 13 km west of Matagami and consisted of 594 AMT soundings (Figure 1).

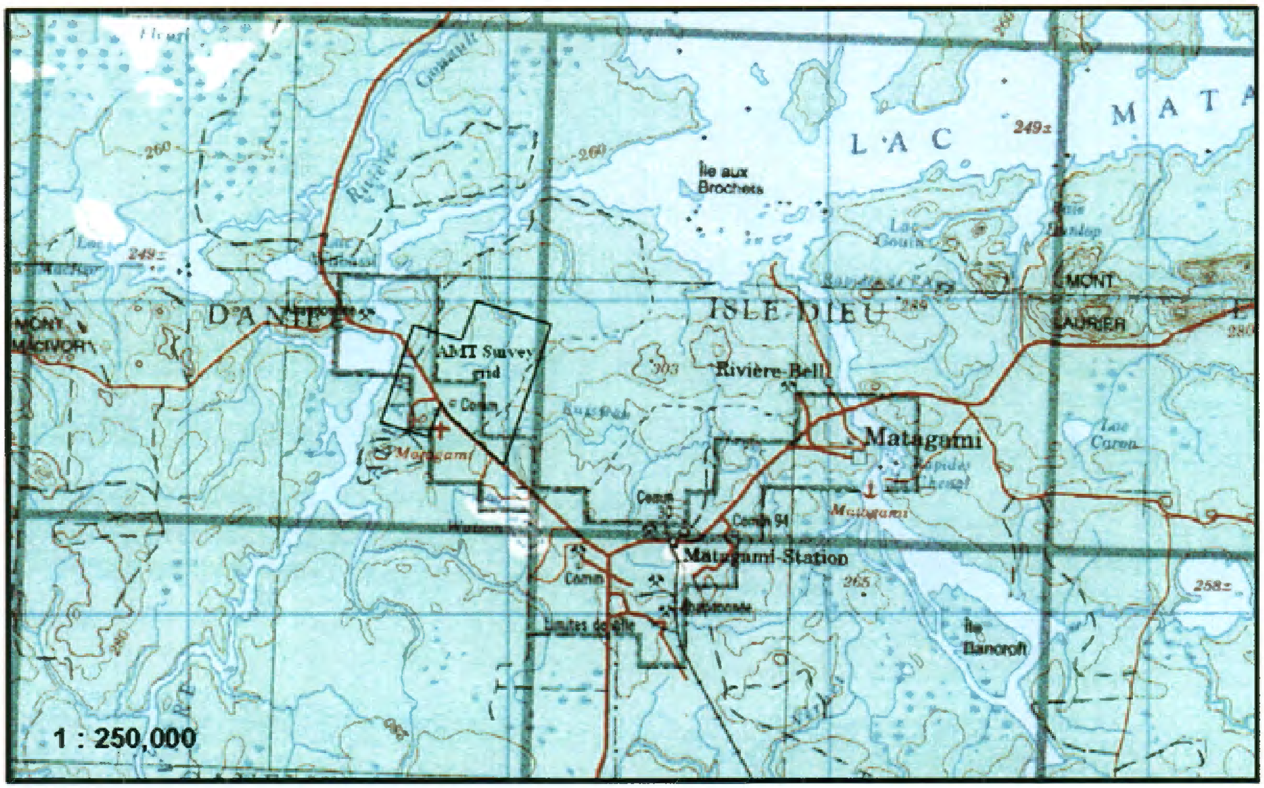

Figure 1: Topographic map showing the location of the survey grid.

2 SURVEY DESCRIPTION

2.1 SURVEY ORGANIZATION

The project manager and the party chief arrived in Matagami on November 27th, 2002 organize logistics (Appendix 2). The remaining members of the field crew mobilized on November 29th. Following equipment verification tests on the 29th, data acquisition commenced on November 30th and was completed on January 10th, 2003. A total of 594 AMT soundings were acquired at an average of about 8 AMT soundings per crew per day.

A motel rooms, located in Matagami, served as the base for the crews and data processing. A temporary field office was set up there for processing, instrument maintenance and battery charging. Contact with field crews was maintained through two-way radio.

2.2 SURVEY DESIGN

Data were collected at a nominal 100m-station spacing along 16 profiles orientated approximately 10 degrees from north-south (Figure 2 and Plate1).

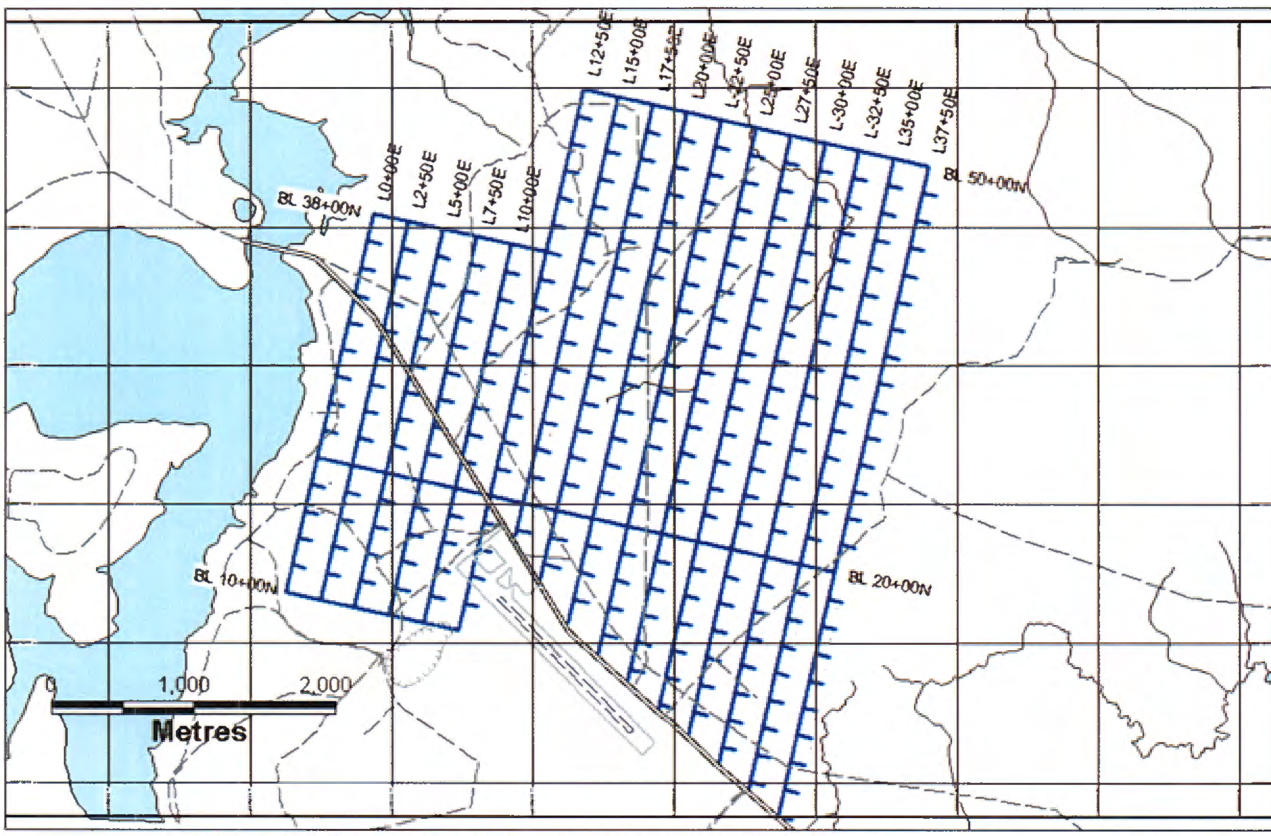

Figure 2: Map showing the location of the 16 AMT profiles. The blue tick marks occur a every second AMT station.

2.3 Coordinate System

All maps are plotted using a metric UTM (Zone 18R) coordinate system, as follows:

Spheroid:	Hayford International 1924
Central Meridian:	-75°
Datum:	North America 1983 Canada.

2.4 Weather and Access

Despite some occasional snow and rain storms, the survey was conducted in typical winter weather conditions. Access to the sites was by 4WD vehicles as far as possible and on foot, snowshoe and snowmobile in more remote areas.

2.5 HSE

The field survey was terminated with a total of 276 man-days worked and two lost time accidents. On December 5th, one helper, unable to work due to a sore knee, left the project to recuperate. This individual recovered approximately one week later with no long-term effects. On December 10th a second helper could not work due to a sore knee. A local replacement was found and the injured worker returned to work two days later.

2.5.1 HSE Program

At project start-up the following documents, adapted specifically for this project, were adopted as the core of the HSE procedures:

- Logistics and Safety Agreement (specifying the standards, equipment and reporting)
- Emergency procedures (1-page instruction list to follow in case of accident)
- Accident Reporting forms.

2.5.2 Safety Meetings

At project start-up instructions were given to all crews in order to ensure that all the people involved in geophysical operations knew and followed safety program and emergency procedures.

Geosystem has established and maintains documented procedures in order to verify the application of the safety policy, define responsibilities and ensure the correct use of safety forms and records.

3 DATA ACQUISITION

The survey was carried out using five 24-bit ADU-06 systems manufactured by Metronix GmbH of Braunschweig, Germany. Magnetic sensors were the Metronix MFS06 and Geosystem AMT induction coils produced by Geosystem Canada, Inc. Appendix 3 contains a detailed description of the personnel, the equipment used for the survey, and a description of the data formats.

3.1 PARALLEL SENSOR TEST

Prior to mobilizing to the field area, the electrodes were placed in a plastic container filled with salt water and pairs of electrodes were systematically examined for DC offset and/or spiking behavior with the use of a portable (Fluke) oscilloscope. All electric wires were checked for correct length (25m) and obvious external damage to the protective insulation. Coil cables were similarly tested for correct pin-to-pin continuity and the absence of cross-channel interference (partial grounding between pins).

Prior to starting the survey, all receivers and induction coils were checked on November 29th in a series of parallel sensor tests at an accessible, quiet and flat site.

The magnetic sensors were buried to depths of about 20 cm, and each was located parallel to and about 2m from its neighbor. The electric channels E_x and E_y on each ADU-06 were connected to the same single pair of electrodes, laid out at right angles to the coils.

Given identical sensor and acquisition systems, one would expect to see very similar outputs both in time and frequency domain: resulting coherencies should be greater than 0.9 between pairs of like sensors over the range 0.1 – 10,000 Hz, and amplitude and phase transfer functions close to the theoretical values of 1.0 and 0.0° respectively. In this way both the magnetic coils and the individual ADU channel boards could be verified.

Suspect sensors and components were re-tested and ultimately excluded from the production pool if still noisy or otherwise defective.

3.2 SITE PREPARATION AND LAY-OUT

The AMT crews located the sites at pre-survey and picketed locations. Hand-held GPS receivers were used to record the position of each of the AMT stations. Arriving at a new site, the first course of action was to extend the dipoles (4x25m wires), and install the electrodes to allow sufficient time for stabilization.

Trenches 10-15 cm deep were dug to bury the horizontal coils, as well as a hole for the vertical coil, to minimize wind vibration and to provide thermal stability. Where frost had significantly penetrated the ground, the vertical coil was buried as far as possible and protected from wind noise by a mound of snow.

The operators measured SP (Self Potential) and contact resistance across the dipoles and recorded them in the field books, together with the magnetic sensor serial numbers and the dipole lengths. In case of high contact resistance, salt water was used to lower the contact resistance.

The magnetic sensors were buried at a distance of 5-7 m from the acquisition unit; the dipole length was 50m; x and y directions were 10° and 100° respectively; the GPS antenna could be placed up to 10m from the ADU-06 unit to improve satellite coverage. A computer was connected to set up the acquisition run and to download data (in extreme cold, the receiver was programmed for the day at the first sounding)(Figure 3).

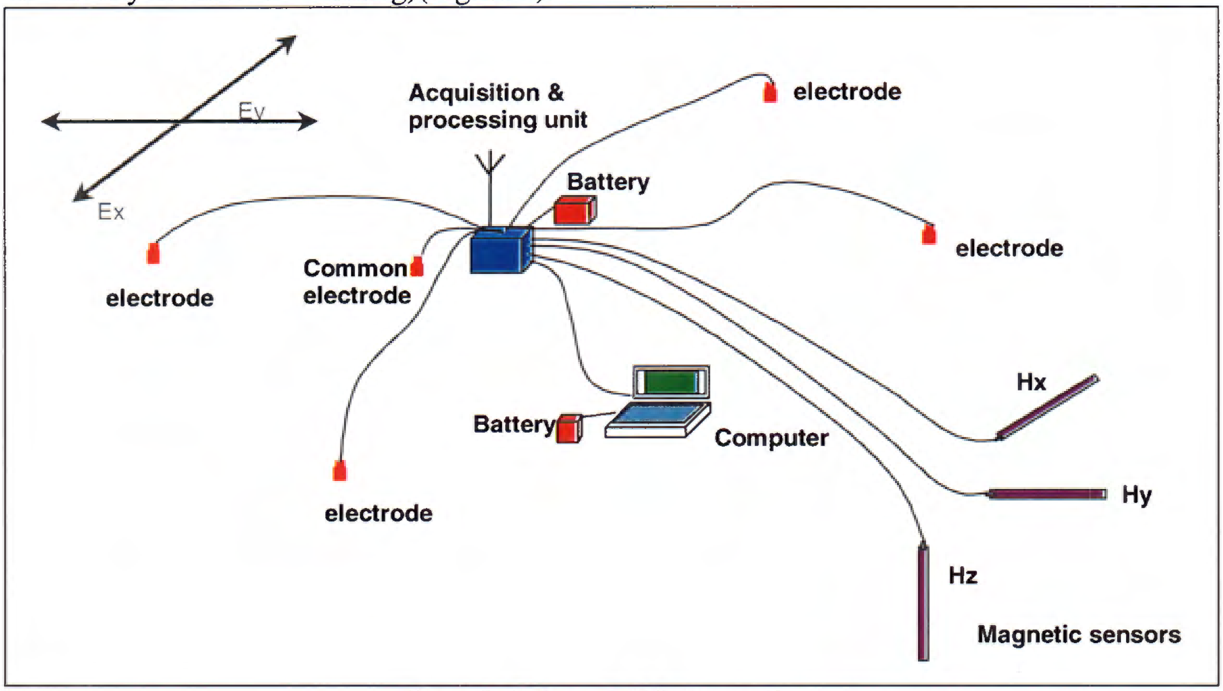

Figure 3: 5-channel AMT layout diagram.

Prior to the main recording, test time series were recorded. The visual inspection of these allowed the operator to check the status of the instruments and the data quality. The correct orientation of the sensors was specifically checked, by verifying relationships between the recorded time-series curves.

Once the operator was satisfied that the equipment was operating correctly, a predefined recording schedule was initiated and the crew moved onto the next site.

3.3 RECORDING PARAMETERS

Soundings were recorded during the daytime using the following schedules (Table 1):

Table 1: Daytime recording schedule

Band	*Sampling frequency (Hz)*	*Duration, seconds*	*Data quantity, MB*
HF	40960	7	5
HF	40960	7	5
LF	4096	120	9
Free	512	1200	12
HF	40960	7	5

In order to achieve synchronization with the local and distant remote stations, this schedule was repeated every 45 minutes. At the end of each field day the receiver was programmed to record an over night sounding. At these stations both daytime and night-time soundings were carried out using the following schedule (Table 2):

Table 2: Night time recording schedule

Time	*Band*	*Sampling frequency (Hz)*	*Duration, seconds*	*Data quantity, MB*
1800	HF	40960	7	5
	HF	40960	7	5
	LF	4096	120	9
	Free	512	1200	12
	HF	40960	7	5
2300	HF	40960	7	5
	HF	40960	7	5
	LF	4096	120	9
	Free	512	1200	12
	HF	40960	7	5
0100	HF	40960	7	5
	HF	40960	7	5
	LF	4096	120	9
	Free	512	1200	12
	HF	40960	7	5
	LF2	64	9600	12.5

3.4 REMOTE REFERENCE SITE

Remote reference processing techniques, as described by Gamble et al. (1979), were utilized. Remote-referencing was carried out using two separate sites within the survey area, identified as RR01 to RR03 in Table 3.

Table 3: Remote reference sites coordinates.

Site	Easting (m) NAD 83	Northing (m) NAD 83	Latitude (DMS) NAD 83	Longitude (DMS) NAD 83	Elev (m)
Local remote	295849	5519019	49:47:20.00	-77:50:11.00	228
Distant remote	286990	5467906	49:19:36.00	-77:55:54.00	271

Robust remote reference data processing resulted in good quality data.

3.5 QUALITY CONTROL

Quality control procedures were taken at each stage of data acquisition. The AMT crews assessed the status of the equipment on a daily basis, as described above. Field records were kept, to track possible equipment problems, with the following information:

- AMT site description, project identification, operator names;
- date and weather condition;
- coordinates;
- telluric lines lengths and azimuths;
- contact resistance;
- magnetic sensor and ADU-06 serial numbers.

Further quality control measures were completed in the field office. Time series data from the overnight recordings were brought together on the processing computer and inter-channel correlation was checked. Any discrepancies noted were relayed to the operators, so that suspect equipment could be set aside until further testing was undertaken.

4 DATA PROCESSING AND EDITING

4.1 PROCESSING OVERVIEW

Data were processed at field office within 48 hours of recording, using robust, remote reference techniques. The basic steps required to transform field time-series to usable data are as follows:

1. Automatic selection of coherent data segments (low noise) by comparison of the electric and magnetic fields;
2. Robust processing of the 150 most coherent data segments in each sample band;
3. Merging of individual bands to form a complete sounding curve;
4. Checking of calculated curves for geophysical plausibility;
5. Robust processing (Larsen code);
6. Data analysis and interpretation (WinGLink software).

Data were archived on CD ROM on a daily basis after the time series was transferred from the field computers to the processing computer.

4.2 ROBUST PROCESSING

Robust processing techniques were employed to improve data quality and reduce the effects of noise bias. The method of Larsen and others (1996) was used to estimate smooth magnetotelluric transfer functions (i.e. impedances) relating the electric and magnetic field data.

Data segments were automatically selected on the basis of electric and magnetic field coherency, and used as input to the robust processing algorithm. The magnetic and electric fields are used in an iterative re-weighted method to determine the impedance tensor. During the iterations, the electric fields are corrected in both the frequency and time domains, utilizing a smooth MT transfer function to estimate the electric field data from the magnetic fields. The total time required to robust process a single sounding was approximately 20 minutes.

The program outputs data at 5 equi-spaced frequencies per decade (e.g. 12, 19, 30, 49, and 78 Hz). All of the soundings were processed using the robust algorithm.

4.3 SIGNAL AND NOISE

MT signal was relatively low (A index < 8) for approximately half of the survey, however some days of excellent signal are evident (Figure 4). Given the relatively low signal strength, the data quality on this survey is generally fair to good.

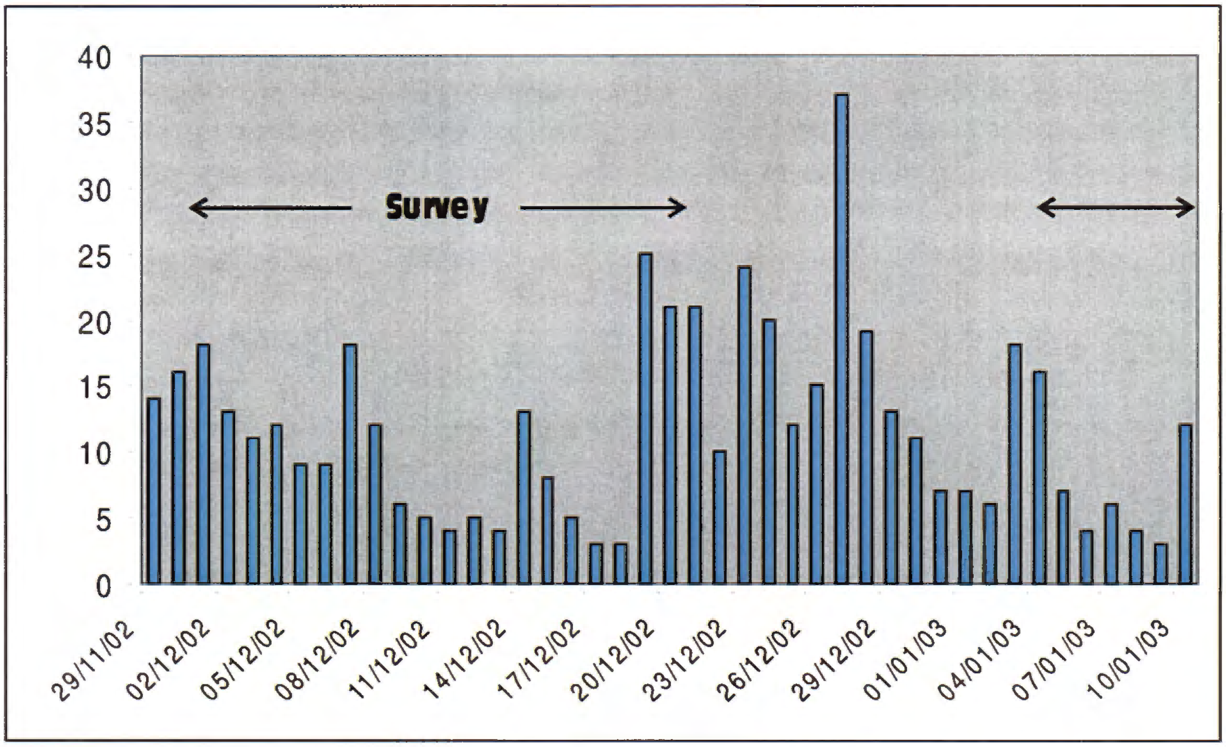

Figure 4: The geomagnetic planetary A index for the survey period.

The A index is really only indicative of the signal strength for the lower frequencies of the measurement band. At frequencies greater than 1000 Hz the signal strength is related to global lightning storms, which during the Canadian winter are located at significant distances (e.g. Gulf of Mexico). The seasonal change in the location of thunderstorms results in a seasonal variation in AMT signal strength. In addition to this seasonal change there is a diurnal variation produced by changes in the atmospheres ionic charge composition. The atmospheres ionic charge composition changes diurnal, seasonally and as a function of the 11 year sun spot cycle. The diurnal change results in reduced signal attenuation during the local night-time. In our experience this diurnal variation appears to be more significant during the summer months. This observation however may be related to level of the instrument noise floor. If the signal during the day and night are both below the noise floor, no day versus night variation will be observed.

In order to take advantage of this diurnal variation in signal strength, we recorded the last sounding of each day over night. As a result approximately 1/8th of the soundings were recorded during both the day and the night. Figure 5 shows an example of daytime and night-time recording at station 175240. In general, we did not observe significant improvement at high frequencies and noted more improvement at frequencies below 10 Hz. The improvement in low frequency data is undoubtedly related to the increased observation time but may also be the result of diurnal variation in low frequency MT signals.

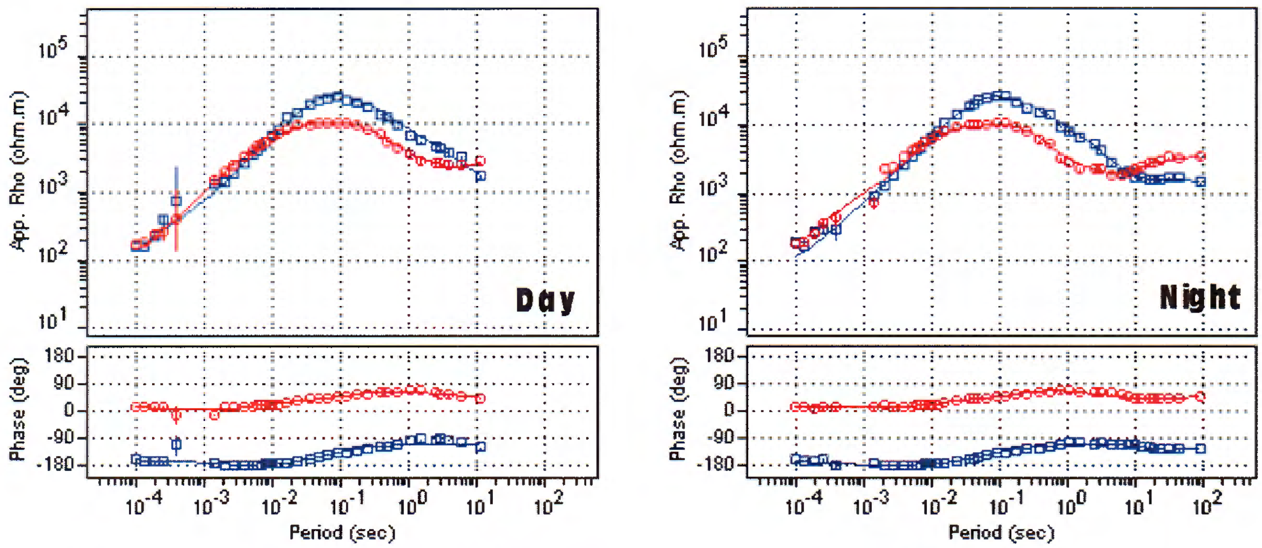

Figure 5: Comparison of a daytime and night-time sounding made at station 175240.

The recorded AMT data was affected by cultural noise sources located at the southern edge of the survey grid. The AMT survey grid was located immediately north of the Matagami airport. AMT profiles 150 to 375 terminate at their southern ends at a power line which parallels the edge of the survey grid. While we were able to collect data within 100 m of this power line the data quality was adversely affected.

4.4 WIND NOISE

Wind noise adversely affected low frequency magnetic measurements on some of the windiest days. Most of the survey region is covered with dense spruce forests, growing on relatively swampy ground. On windy days the trees move producing ground motions that in turn move the magnetic sensor in the earth's magnetic field. These ground motions typically occur in the frequency range from 1 to 5 Hz.

To reduce the affect of wind noise, low frequency (5 Hz and below) data showing wind noise was reprocessed using the local remote magnetic fields. The local remote was installed in a clearing and was not affected significantly by wind noise. Figure 6 shows and example of reprocessing using the local magnetic fields.

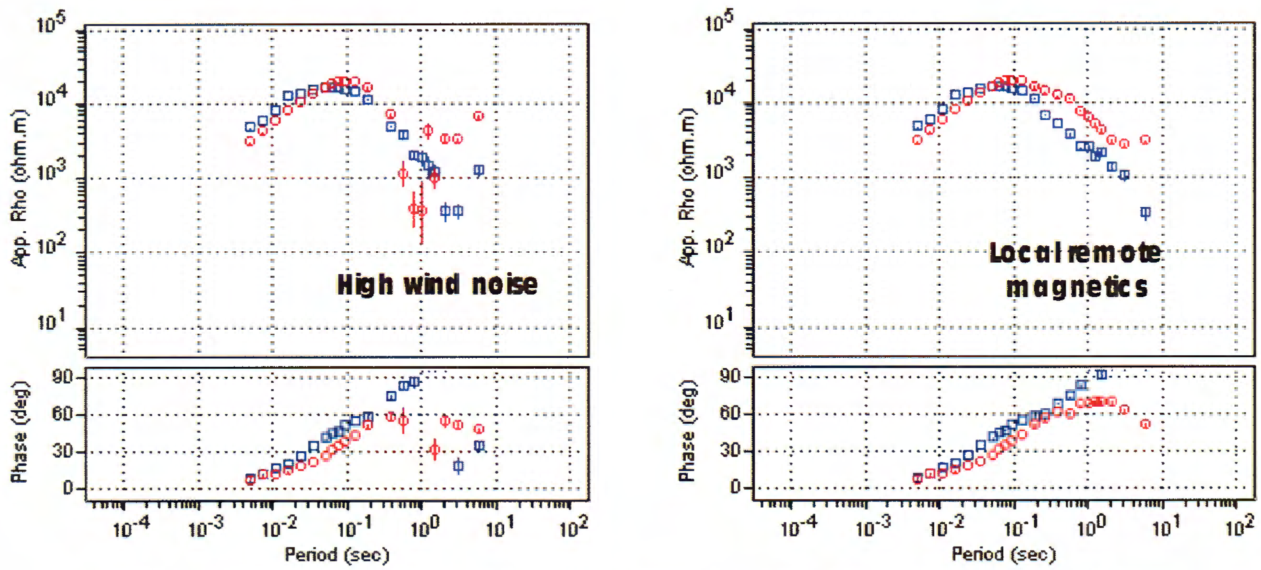

Figure 6: Comparison of processing station 250300 with the site and local remote magnetic fields.

Note: All of the recorded soundings were re-processed with the local magnetic fields. The majority of the soundings showed some improvement at low frequencies, however only approximately half of the resulting curves could be utilized. Variation in the observed magnetic fields produces an apparent resistivity and phase offset. This offset, where observed is frequency dependent becoming smaller at lower frequencies. This offset is most likely the result of secondary magnetic fields that decay as a function of frequency.

4.5 DATA PRESENTATION

The processed AMT data, in the form of impedances, are contained in EDI format in the attached CD. Derived AMT parameters include the following interpretation parameters, and can be viewed or manipulated in the WinGlink data base on the same CD:

- apparent resistivities, ρ_{xy} and ρ_{yx};
- phases, ϕ_{xy} and ϕ_{yx};
- impedance rotation and strike; tipper strike;
- impedance skew and ellipticity;
- tipper magnitude;
- impedance polarization ellipses, induction arrow, and tipper strike;

Rotation is normally to –70°. A smooth curve, computed from the D+ function (Beamish and Travassos, 1992), is fitted to each component. Data which are geophysically-plausible should lie close to this curve.

5 DATA INTERPRETATION

5.1 QUALITATIVE ANALYSIS

One of the first steps of magnetotelluric data interpretation is the determination of the data's dimensionality and electrical strike. This step is important as it determines the reference frame for subsequent interpretation and is also the justification for proceeding with one, two or three dimensional interpretation techniques. In practice this can be a difficult task as one wishes to determine characteristics of the data that vary on a survey wide scale. However, in many cases these regional variations are obscured by small scale near surface variations.

Impedance tensor decomposition techniques (McNeice and Jones, 2001) have been developed to solve for regional variations in the presence of smaller scale near surface distorting structures. This technique attempts to explain the observed impedances with a 3D over 2D-impedance model. This procedure provides an estimate of the regional strike and the fit of the decomposition model provides insight into the dimensionality of the survey area.

5.1.1 Strike direction

Decomposition of the impedances gives an estimate of strike direction, subject to an ambiguity of ±90°. Figure 7 shows the decomposition strike for a frequency range of 100 to 400 Hz, with ambiguity reduced by geological information. The fit of the decomposition model and the relatively consistent east-west strike estimate obtained, suggest the data set is reasonably two dimensional. Strike estimates in the southwest corner of the survey area differ somewhat from the rest of the grid. This may be related to faults that cut through this corner of the grid.

The recovered decomposition parameters suggest distortion produced by near surface features does not significantly affect the data set. Galvanic distortion is typically not significant in regions covered by conductive overburden.

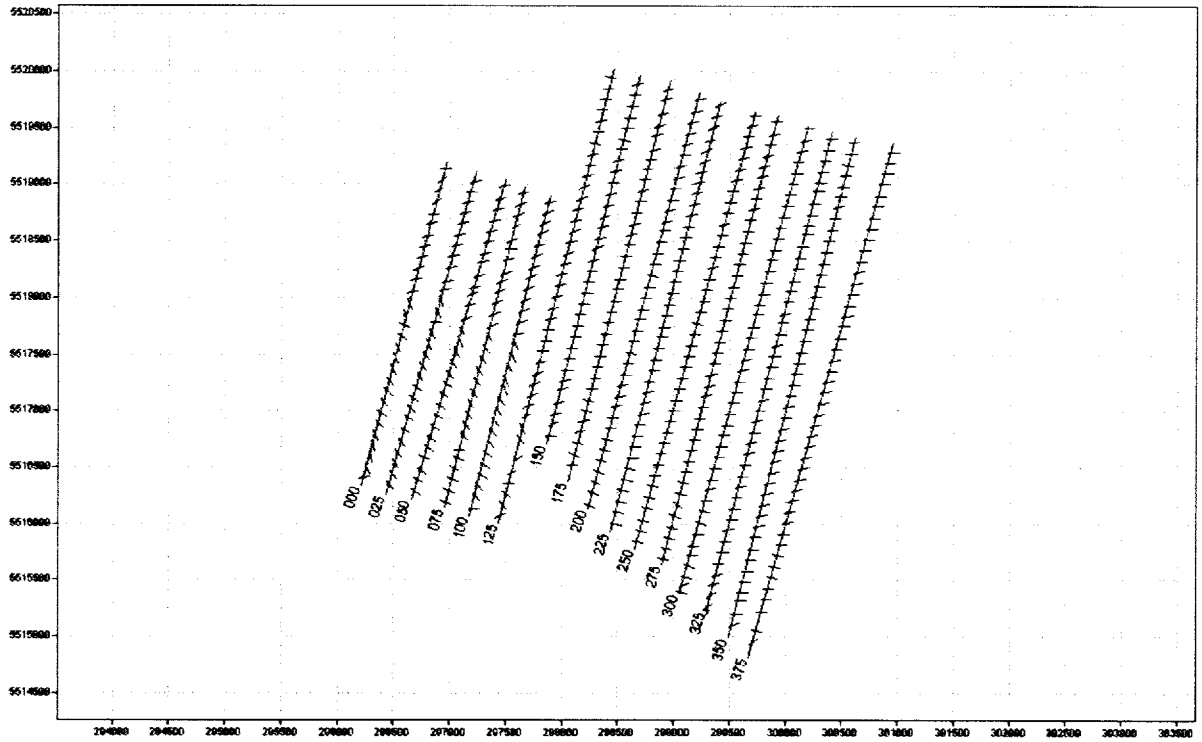

Figure 7: Strike direction found through decomposition of data in the frequency band 100 to 400 Hz.

5.1.2 Static Shift

The small scale near surface structures that are responsible for galvanic distortion of the observed electric fields result is what is termed static shift. Static shift is a frequency independent shift of the observed apparent resistivity. Unfortunately, there is no way of removing static shift without independent information. While this often presents a challenge in magnetotelluric interpretation the impedance phase is not affected by static shift and can be used to both recognize and reduce the effects of static shift.

In order to asses the importance of static shift in the Matagami data set the structure observed in impedance phase was compared that observed in the apparent resistivity. Structure observed in apparent resistivity data without corresponding phase structure may be the result of static shift. The AMT apparent resistiviy was additionally compared to apparent resistivities calculated from MEGATEM data and free of static shifts. Figure 8 shows a colour contour plot of the apparent resistivity calculated from MEGATEM data overlaid with contours from the AMT apparent resistivity at 600 Hz. The similarity in the two data sets and similarity of structure observed in the AMT impedance phase and apparent resistivity suggests static shift is not a significant problem. The absence of significant static shift is in agreement with the observation that galvanic distortion is not a significant factor.

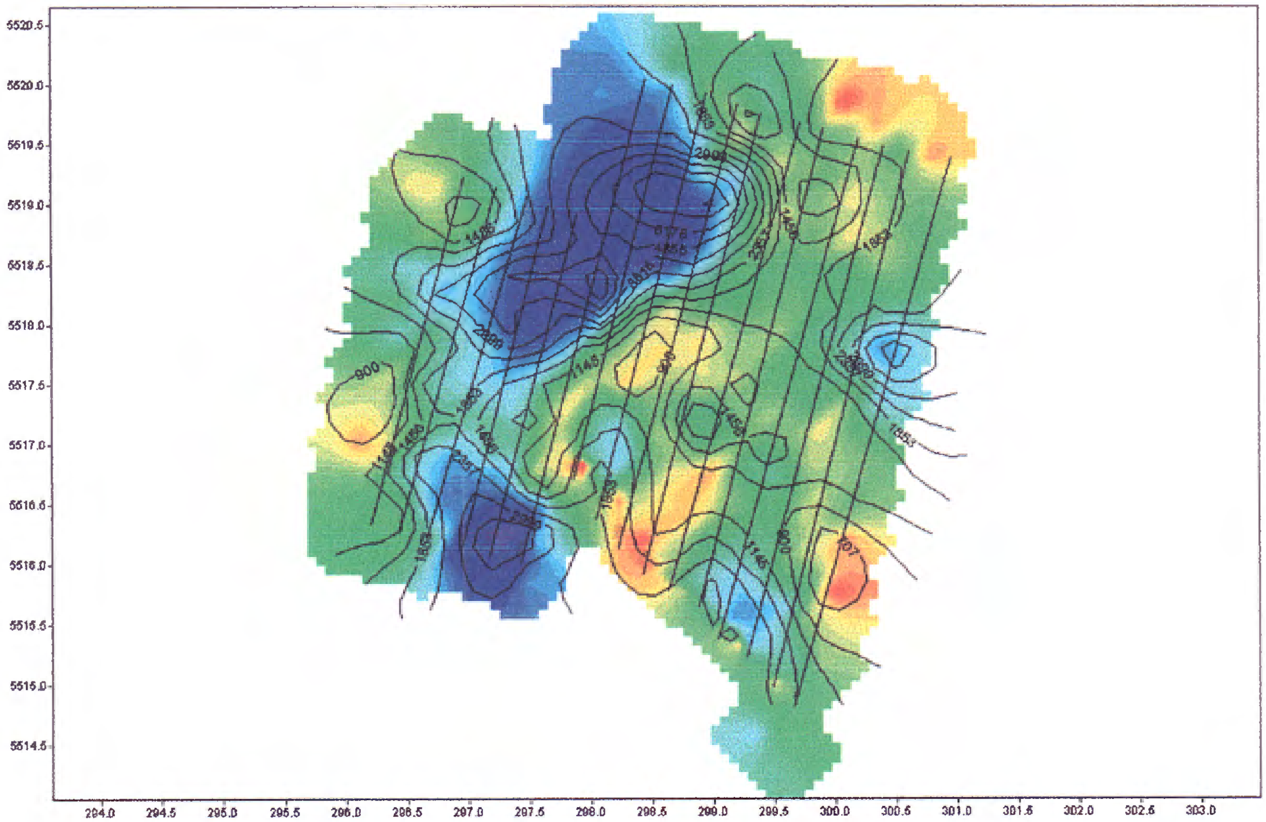

Figure 8: Comparison of MEGATEM apparent resistivity (colour contours) and AMT apparent resistivity at 600 Hz (Contours).

5.2 SOUNDING TYPES

For the purpose of visualization, it is useful to decompose the complex impedance tensor into orthogonal pairs of apparent resistivity and phase. Examples are shown in Figure 9, and indicate the main sounding types in the survey area. The first type has similar TE and TM mode curves and is consistent with essentially a three layer Earth (conductive overburden, resistive basement becoming more conductive at great depth). In second curve type the TE mode is lower than the TM curve suggesting the sounding is on the resistive side of a contact.

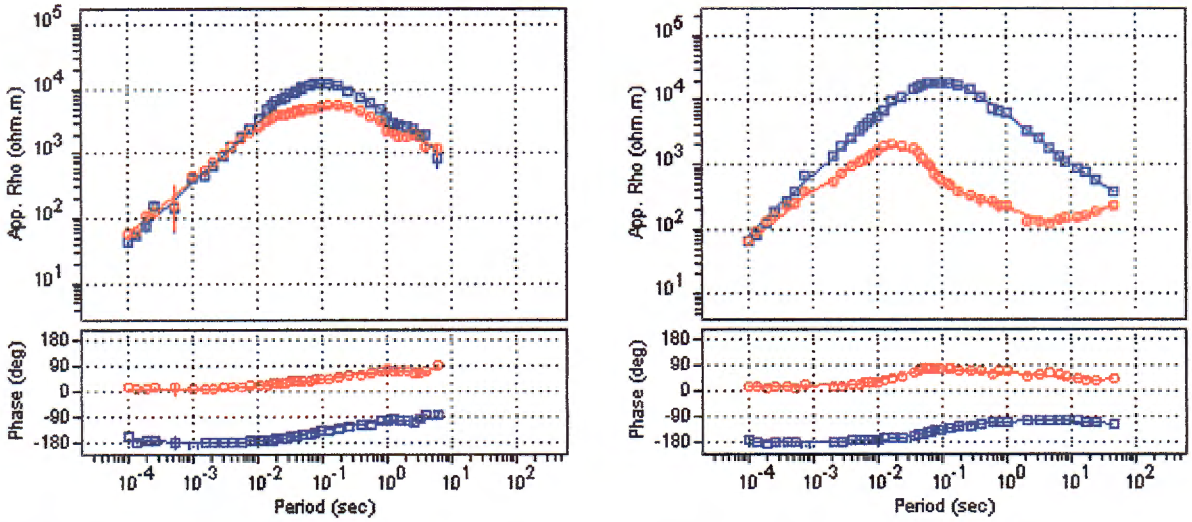

Figure 9: Soundings 025370 and 250130.

All rotated to strike direction (-90° and –70°), so red curve corresponds to TE (strike direction).

5.3 MAPPED FIELD PARAMETERS

In that phase can be approximated by

$$\phi=45°-\partial\rho/\partial t,$$

where $\partial\rho/\partial t$ is the gradient of the apparent resistivity curve, it follows that

1. on a homogenous earth, phase should be close to 45°;
2. where resistivity increases with depth, phase should be less than 45°;
3. where resistivity decreases with depth, phase should be greater than 45°.

Although this is greatly complicated by multi-dimensional effects, phase maps are still a useful qualitative guide to the resistivity structure, particularly as they are not subject to static shift effects. The two figures below present impedance phase in two orthogonal directions at a frequency of 200Hz (Figure 10 and Figure 11). The TE mode shows two anomalous trends, one at the southern edge of the grid that is possibly in part due to known minieralization and a second that crosses the profiles in the northern portion of the grid. The TM mode, perpendicular to strike, shows a clear correlation with variations in overburden thickness.

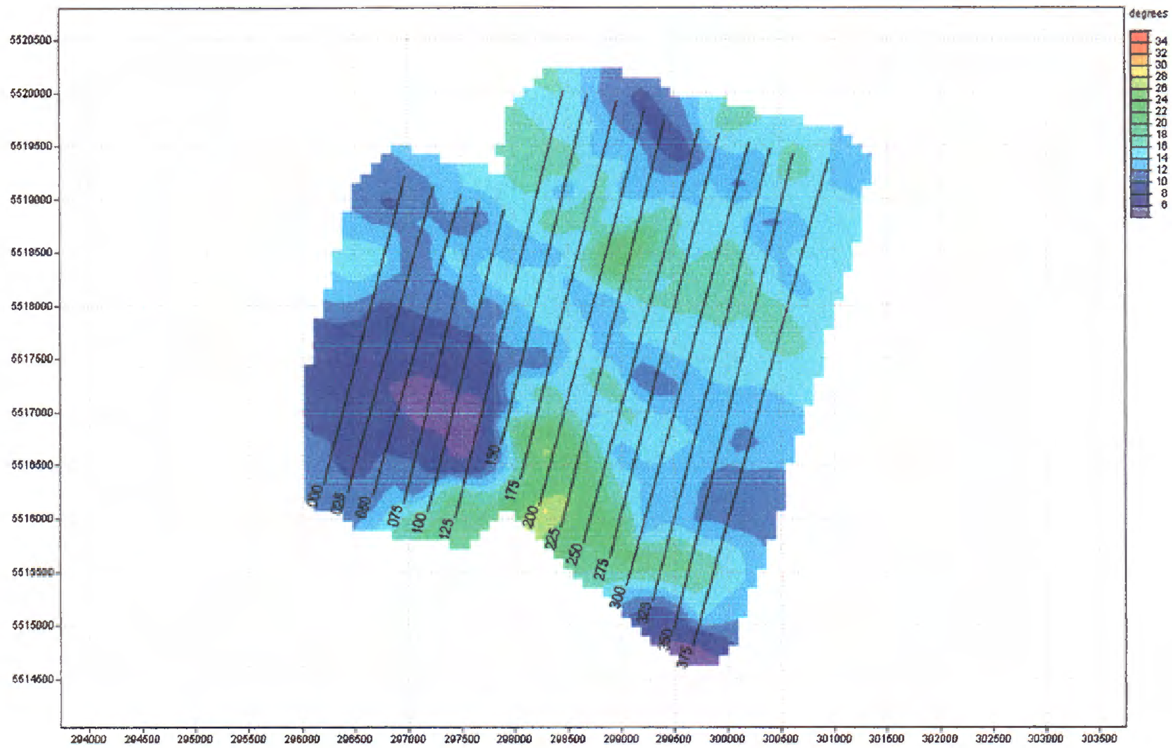

Figure 10: TE Phase (parallel to strike) at 100Hz.

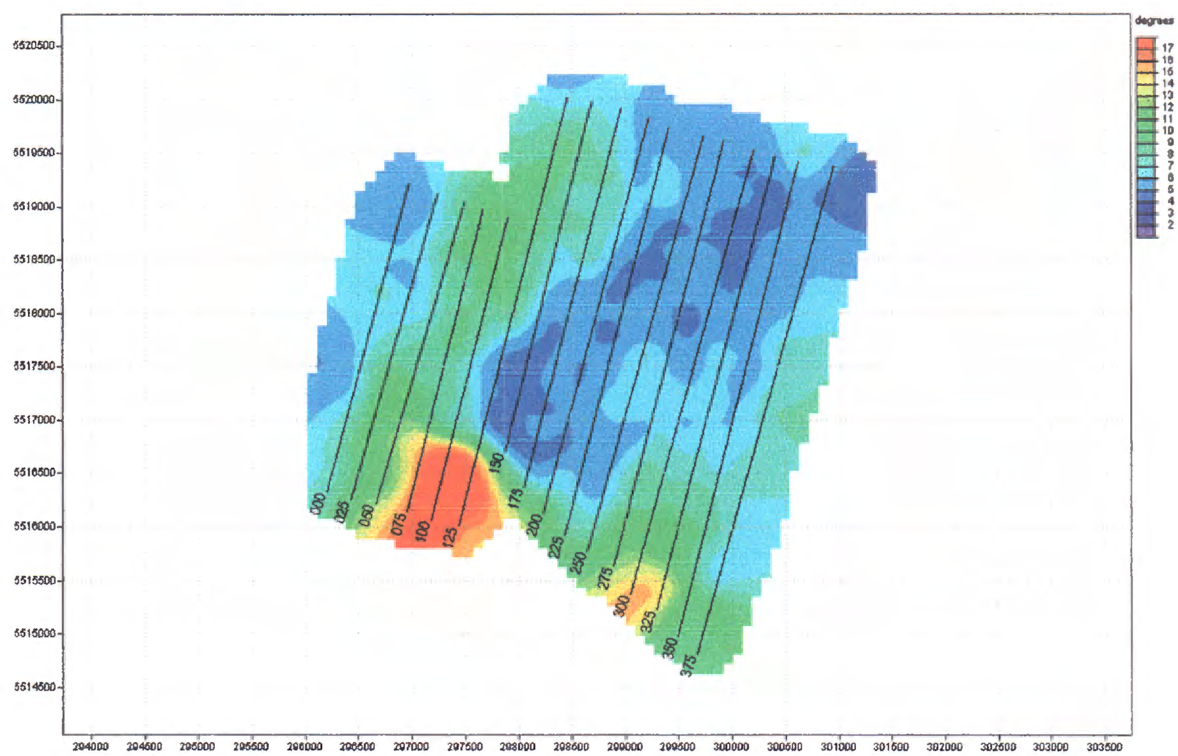

Figure 11: TM Phase (perpendicular to strike) at 200Hz.

5.4 2D INVERSION OF FIELD DATA

2D inversion was used to solve for resistivity–depth models of the Matagami data set. 2-D inversions of the TE and TM modes were performed using the 2-D finite-difference code of Randy Mackie (Rodi and Mackie, 2001). In the Mackie inversions, static shift was incorporated as a variable in the inversion routine. The starting model was a four layer model representing the 1st order regional structure of the area:

Layer	Depth	Resistivity
1	40 m	100 Ωm
2	800m	8500 Ωm
3	16000m	25000 Ωm
5		1000 Ωm

Data errors floors were set to 5%, and 2% for apparent resistivity and phase noise floors respectively. The inversions ran until the rms error could not be further reduced, typically after about 100 iterations and an RMS of approximately 5. The fit to the TM mode was usually very good, whilst that of the TE mode was slightly poorer.

One difficulty experienced during 2D inversion of the Matagami data set was finding the correct balance between data fit and model smoothness. In regions with conductive overburden such as Matagami, observed anomalies are often relatively subtle, however the basement conductivity variations required to produce these anomalies can be significant. The conductive overburden reduces resolution. This presents somewhat of a problem to inversion, as you want to recover a minimum structure model but at the same time you do not want to smooth away a potential target.

In order to devise a set of parameters to invert the Matagami data set a simulation was undertaken. In this simulation the synthetic response of structures similar to those observed in the Matagami data was calculated and used to find a set of appropriate smoothing parameters. The goal of this simulation was to find a set of parameters that would produce the smoothest models while still recovering the synthetic targets. Figure 12 shows a number of inverse models run to try and optimize the depth dependence of regularization. The parameter optimized in figure 12 controls shallow model roughness. A number of simulation steps were undertaken to determine the importance and optimize each of the parameters.

2D inversion models for each of the profiles are plotted at 1: 25000 scale (vertical exaggeration = 1) in the back of the report.

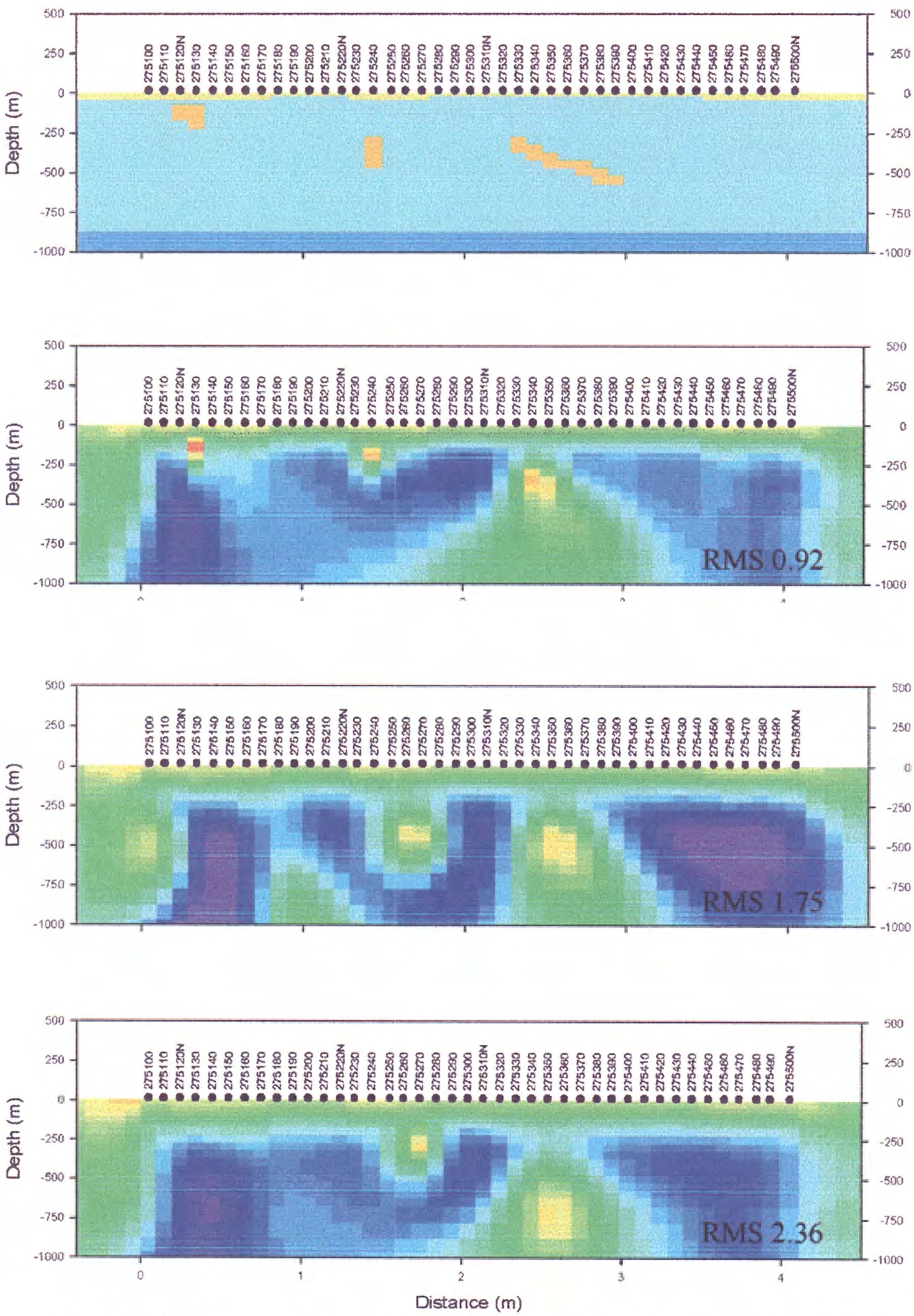

Figure 12: 2D inversion simulation, optimizing the transition from depth independent to depth dependent regularization.

5.5 3D INVERSION OF FIELD DATA

The next step in the interpretation of the field data is numerical inversion, with the objective of determining the 3D resistivity distribution. For this, the recently-developed code of Randy Mackie (see Appendix 6) was used. The input data were the complex tensor impedances of the 594 AMT soundings. These were located on a 3D model grid consisting of 59 blocks in the E-W direction, 64 blocks in the N-S direction, and 32 blocks vertically (plus 10 additional air layers needed for the computations). The block sizes at stations locations were 100 meters horizontally increasing smoothly away from the volume of interest, and from 10m increasing with depth. The starting resistivity value for the inversion was a three layer model representing the approximate regional structure. The full impedance tensor at twelve frequencies in the range 1 to 800Hz was used as input data at each station. A 5% error floor was used for the inversion, and the final RMS misfit between observed and predicted data was 1.8 after 30 iterations.

It should be noted that a regularization operator, in this case an isotropic Laplacian smoothing function, was used to ensure stability of the 3D mesh. Without this, the results can be become unstable, resembling a checker-board. The negative aspect of this operator is that it imposes smoothness on the resulting resistivity distribution.

5.6 COMPARISON WITH FIELD DATA

The individual soundings are generally fit well over the entire frequency range. This is demonstrated by the two maps below, which show the computed phase responses for the modes and frequency used in Figure 10 and Figure 11.

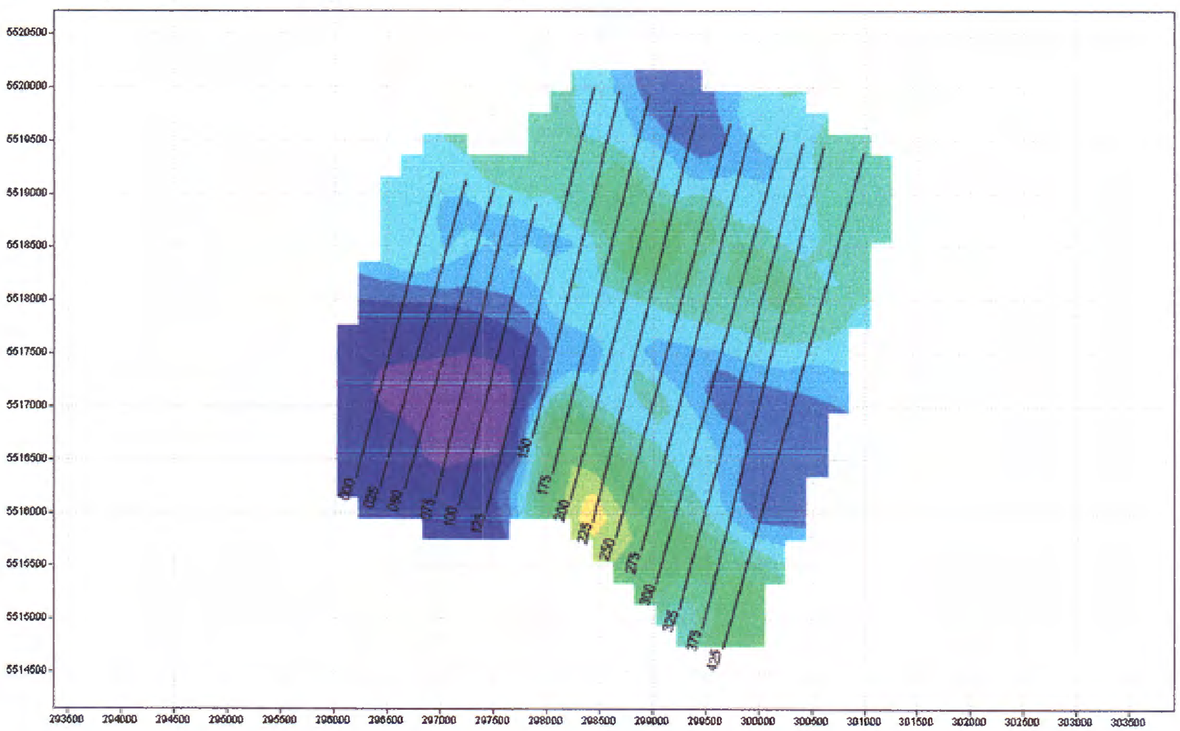

Figure 13: Computed phase response, TE mode, 200Hz.

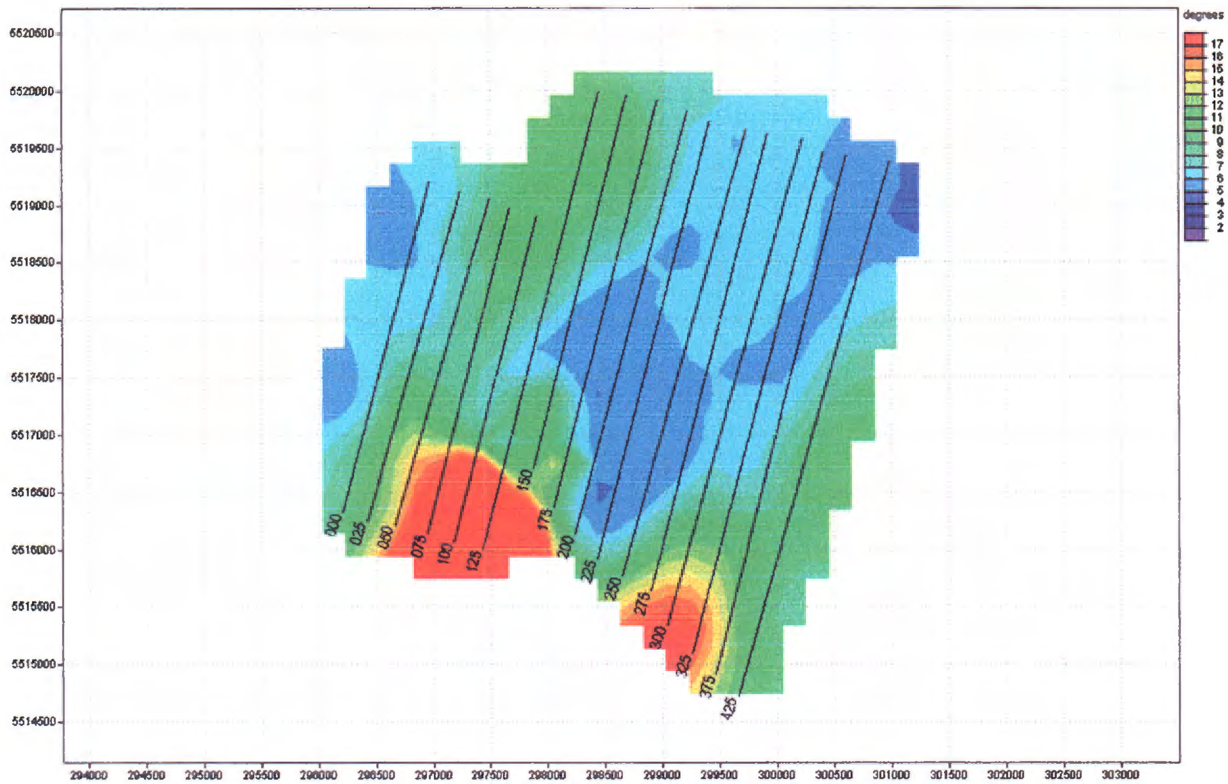

Figure 14: Computed TM phase response, 200Hz.

5.7 DESCRIPTION OF 2D AND 3D RESISTIVITY MODELS

The 2D model and plan view slices through the 3D model are plotted in the appendices to this report. The color scheme adopted uses red to indicate more conductive zones and blue for more resistive ones.

The AMT survey did not detect the presence of any large conductive system or large conductive targets. The anomalies detected by the AMT survey appear to be relatively small in scale. This observation is in agreement with the style of known mineralization in the area. The known mineralized zones are small in size and are not surrounded by large disseminated halos. The AMT survey did detect the presence of a number of anomalous zones. Figure 15 a plot of the TE phase at a frequency of 400 Hz, summarizes the observed anomalies.

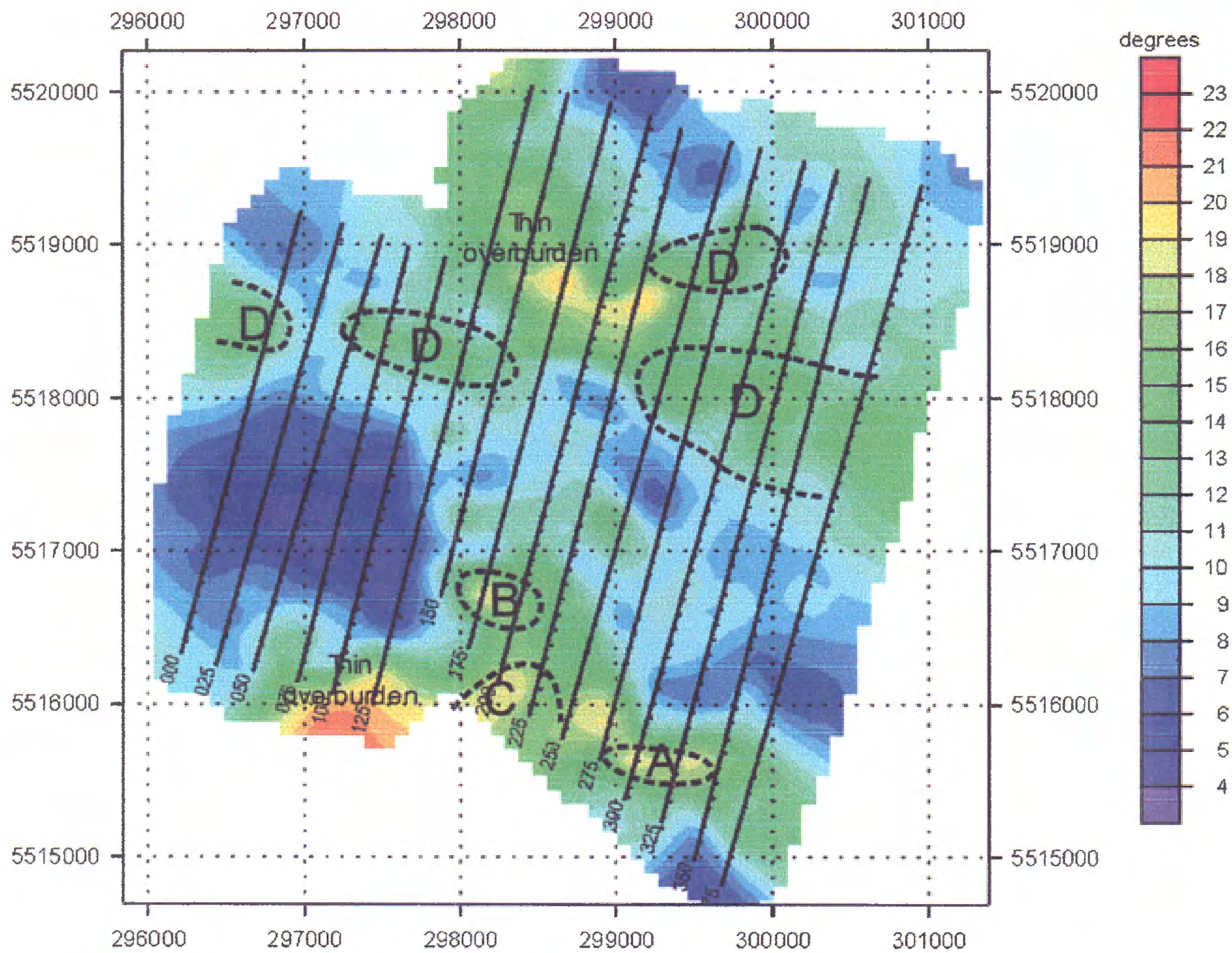

Figure 15: 400 Hz TE phase map showing anoumalous zones.

Zone A is a region of known mineralization, two shallow ore bodies named Perserverence and Perserverence West are located in this zone. Figure 16 shows a close-up of zone A , the position of known mineralization is indicted by the drill hole pattern. The known minralization appears to have a weak high frequency response in both the TE and TM mode phase.

Zones B and C are similar to A although they only occur in the TE mode and persist to low frequencies. Unfortunately, these anomalies, along with that of zone A, are very close to a power line and man made infrastructure. It appears they are not solely related to man made factors however this is difficult determine. In this respect Zone B has a higher confidence than zone C as it appears to be isolated. Figure 17 shows a 2D inversion model crossing zone B, this model suggests enhanced conductivity at a depth of approximately 300m. Modeling suggests that zone C if not related to grounded conductors at the airport may be a deeper target and possibly continues to the south (see 3D model in appendix). The maximum response appears to occur at approximately 10 Hz which would be consistent with depths on the order of 1 km.

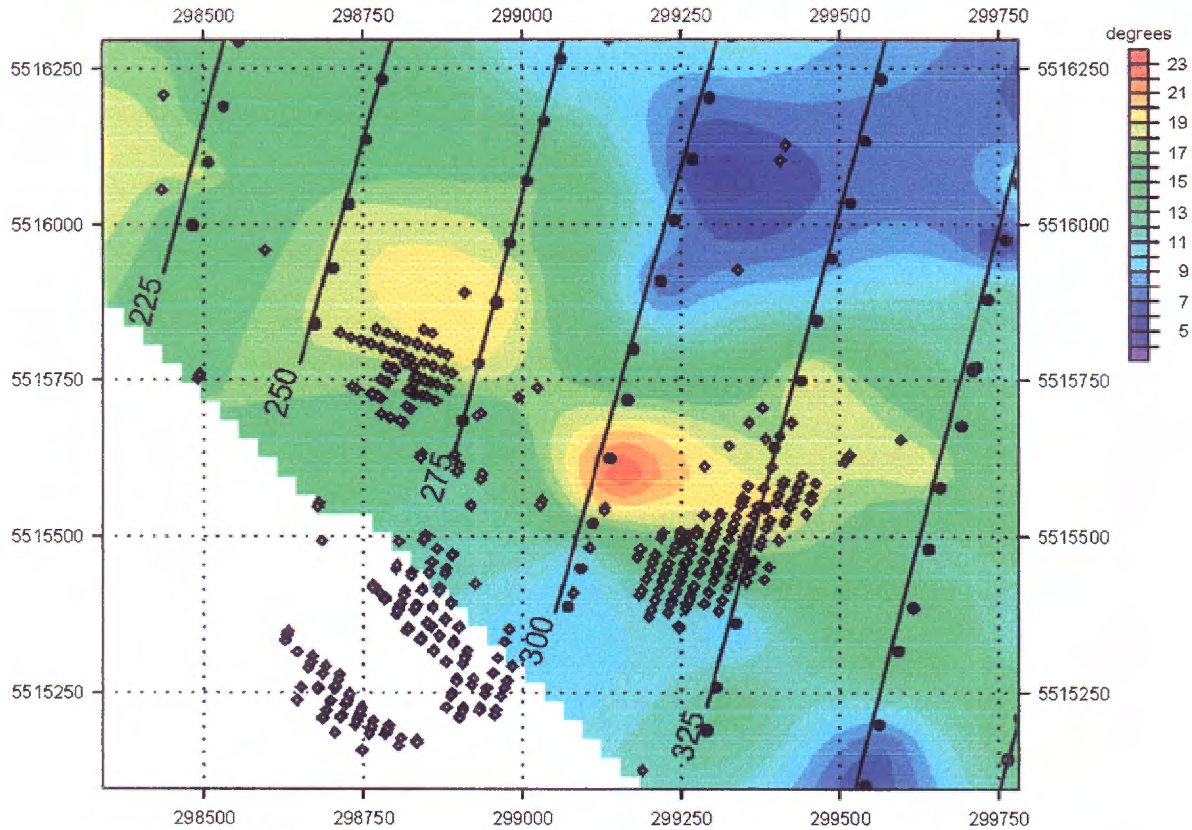

Figure 16: 400 Hz TE Phase map of the Perseverance region.

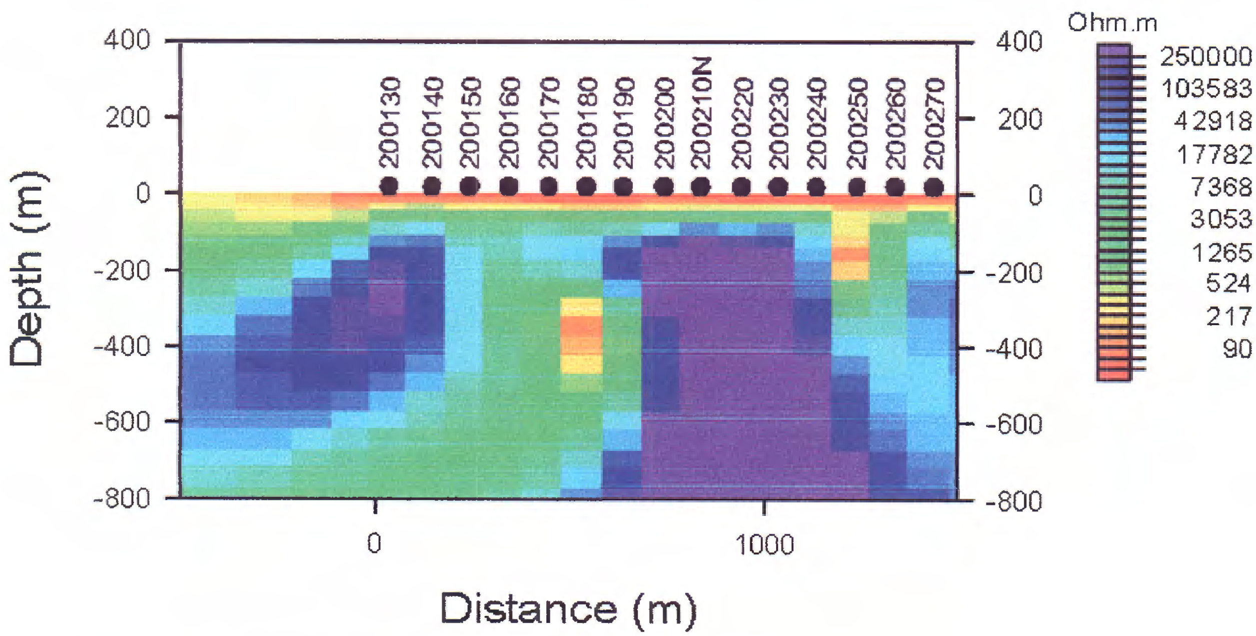

Figure 17: 2D inversion model of a portion of profile 200.

Zone D consists of a number of east-west orientated TE phase anomalies. These zones may be related to basement geology, however a number of small relatively shallow conductors occur in the 2D inversion models with in these zones (profiles 000, 050, 250 and 275). The 3D model additionally suggests a shallow conductive target situated near station 275360.

In addition to the zones discussed above the AMT data suggests the presence of a conductive zone at a depth of 500 m or greater in the east central portion of the grid. Figure 18 shows a 2D inversion model of this feature. The 3D model does not appear to contain this feature.

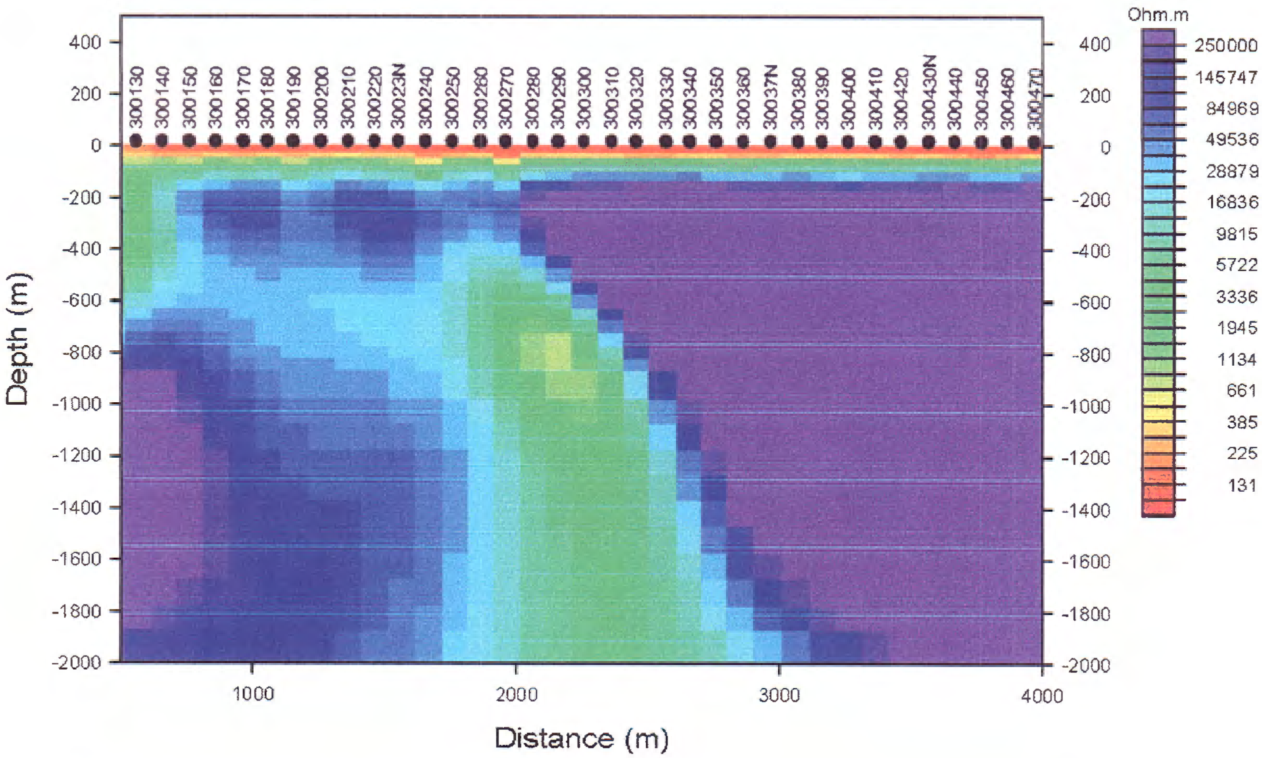

Figure 18: 2D inversion model of a portion of profile 300.

6 CONCLUSIONS

The AMT survey resulted in good quality data which have been inverted using 2D and 3D techniques to provide the resistivity distribution down to a depth in excess of 1500m. In the absence of geological information, it has not been possible to correlate resistivity with lithology. However, the inversion shows a number of anomalous weakly conductive zones. Care was taken to derive the best possible 2D inversion models, in order to recover small conductive feature. As a result the derived 2D models in some cases may contain poorly resolved structures. Smoother 2D models could be derived at the expense of possibly missing smaller structures.

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APPENDIX 1 STATION LOCATIONS

Note: Geographic coordinates are in degree, minutes and seconds. Coordinates in EDI files use the WGS84 system. Report, maps and WinGLink database coordinates are on UTM grid (zone 18R).

Spheroid: International Hayford 1924
Datum: North America 1983 (Canada)
Central Meridian: -75° E of Greenwich
Latitude origin: 0° N
Coordinates at origin: 500000 m E, 0 m N.
Elevation listed are mean at sea level from single site GPS.

AMT Site	Easting (m) NAD 83	Northing (m) NAD 83	Latitude (DMS)	Longitude (DMS)	Elev (m)
000100	296238	5516402	49:45:55.82	-77:49:46.65	233
000110	296266	5516493	49:45:58.81	-77:49:45.42	232
000120	296292	5516594	49:46:02.11	-77:49:44.31	230
000130	296319	5516697	49:46:05.46	-77:49:43.16	223
000140	296343	5516790	49:46:08.50	-77:49:42.14	229
000150	296368	5516888	49:46:11.71	-77:49:41.07	229
000160	296391	5516981	49:46:14.74	-77:49:40.10	224
000170	296417	5517084	49:46:18.10	-77:49:39.00	228
000180	296443	5517173	49:46:21.01	-77:49:37.86	227
000190	296468	5517273	49:46:24.27	-77:49:36.80	225
000200	296496	5517371	49:46:27.48	-77:49:35.59	228
000210	296516	5517470	49:46:30.71	-77:49:34.78	219
000220	296541	5517566	49:46:33.84	-77:49:33.71	220
000230	296566	5517664	49:46:37.04	-77:49:32.65	221
000240	296585	5517766	49:46:40.37	-77:49:31.89	223
000250	296601	5517856	49:46:43.29	-77:49:31.26	227
000260	296642	5517951	49:46:46.42	-77:49:29.39	227
000270	296666	5518053	49:46:49.75	-77:49:28.39	228
000280	296693	5518161	49:46:53.27	-77:49:27.24	227
000290	296720	5518256	49:46:56.37	-77:49:26.07	217
000300	296744	5518356	49:46:59.64	-77:49:25.06	223
000310	296773	5518450	49:47:02.72	-77:49:23.79	224
000320	296795	5518544	49:47:05.78	-77:49:22.86	224
000330	296828	5518654	49:47:09.37	-77:49:21.42	223
000340	296854	5518736	49:47:12.06	-77:49:20.28	223
000350	296870	5518841	49:47:15.47	-77:49:19.68	222
000360	296897	5518942	49:47:18.77	-77:49:18.52	221
000370	296923	5519039	49:47:21.95	-77:49:17.40	226
000380	296953	5519136	49:47:25.12	-77:49:16.09	227
025100	296460	5516345	49:45:54.26	-77:49:35.46	244
025110	296491	5516441	49:45:57.39	-77:49:34.09	238
025120	296516	5516539	49:46:00.60	-77:49:33.03	234
025130	296541	5516628	49:46:03.50	-77:49:31.95	237
025140	296569	5516723	49:46:06.62	-77:49:30.73	239

025150	296600	5516830	49:46:10.11	-77:49:29.38	250
025160	296627	5516941	49:46:13.73	-77:49:28.24	234
025170	296653	5517019	49:46:16.29	-77:49:27.09	239
025180	296677	5517111	49:46:19.29	-77:49:26.06	235
025190	296705	5517209	49:46:22.49	-77:49:24.85	233
025200	296733	5517306	49:46:25.67	-77:49:23.63	234
025210	296760	5517401	49:46:28.77	-77:49:22.46	239
025220	296786	5517495	49:46:31.85	-77:49:21.34	239
025230	296815	5517593	49:46:35.04	-77:49:20.08	236
025240	296843	5517689	49:46:38.19	-77:49:18.86	231
025250	296872	5517784	49:46:41.29	-77:49:17.59	236
025260	296899	5517880	49:46:44.43	-77:49:16.42	237
025270	296925	5517974	49:46:47.51	-77:49:15.30	240
025280	296954	5518070	49:46:50.64	-77:49:14.03	241
025290	296975	5518147	49:46:53.16	-77:49:13.13	238
025300	297009	5518266	49:46:57.05	-77:49:11.65	239
025310	297029	5518366	49:47:00.31	-77:49:10.84	241
025320	297057	5518456	49:47:03.25	-77:49:09.61	234
025330	297083	5518557	49:47:06.55	-77:49:08.50	227
025340	297114	5518653	49:47:09.69	-77:49:07.13	228
025350	297138	5518747	49:47:12.76	-77:49:06.11	228
025360	297158	5518845	49:47:15.96	-77:49:05.30	229
025370	297190	5518928	49:47:18.69	-77:49:03.86	237
025380	297231	5519028	49:47:21.96	-77:49:02.00	228
050100	296691	5516278	49:45:52.36	-77:49:23.80	237
050110	296720	5516384	49:45:55.83	-77:49:22.55	236
050120	296748	5516472	49:45:58.72	-77:49:21.32	239
050130	296768	5516587	49:46:02.45	-77:49:20.53	241
050140	296806	5516669	49:46:05.15	-77:49:18.79	243
050150	296828	5516758	49:46:08.06	-77:49:17.86	247
050160	296860	5516855	49:46:11.23	-77:49:16.44	246
050170	296890	5516952	49:46:14.41	-77:49:15.13	248
050180	296916	5517046	49:46:17.48	-77:49:14.01	248
050190	296949	5517147	49:46:20.79	-77:49:12.55	245
050200	296973	5517242	49:46:23.90	-77:49:11.53	245
050210	297002	5517334	49:46:26.90	-77:49:10.25	249
050220	297032	5517428	49:46:29.98	-77:49:08.93	249
050230	297062	5517521	49:46:33.02	-77:49:07.61	248
050240	297090	5517617	49:46:36.16	-77:49:06.39	243
050250	297116	5517714	49:46:39.32	-77:49:05.27	236
050260	297144	5517815	49:46:42.63	-77:49:04.06	238
050270	297181	5517934	49:46:46.52	-77:49:02.44	241
050280	297201	5518028	49:46:49.58	-77:49:01.62	241
050290	297223	5518095	49:46:51.79	-77:49:00.64	236
050300	297256	5518197	49:46:55.11	-77:48:59.19	239
050310	297296	5518312	49:46:58.89	-77:48:57.41	241
050320	297317	5518390	49:47:01.44	-77:48:56.50	241
050330	297342	5518487	49:47:04.60	-77:48:55.43	221
050340	297369	5518581	49:47:07.66	-77:48:54.24	232
050350	297394	5518677	49:47:10.80	-77:48:53.19	229
050360	297424	5518775	49:47:14.01	-77:48:51.88	224

050370	297448	5518870	49:47:17.12	-77:48:50.86	228
050380	297480	5518985	49:47:20.87	-77:48:49.48	233
075100	296961	5516190	49:45:49.85	-77:49:10.15	256
075110	296991	5516297	49:45:53.34	-77:49:08.85	254
075120	297019	5516394	49:45:56.52	-77:49:07.64	250
075130	297041	5516488	49:45:59.58	-77:49:06.72	246
075140	297067	5516584	49:46:02.72	-77:49:05.60	248
075150	297087	5516656	49:46:05.07	-77:49:04.73	246
075160	297121	5516782	49:46:09.20	-77:49:03.27	248
075170	297145	5516875	49:46:12.23	-77:49:02.25	250
075180	297170	5516972	49:46:15.40	-77:49:01.18	247
075190	297188	5517073	49:46:18.69	-77:49:00.48	243
075200	297212	5517169	49:46:21.82	-77:48:59.46	236
075210	297240	5517266	49:46:24.99	-77:48:58.24	238
075220	297265	5517361	49:46:28.09	-77:48:57.17	247
075230	297293	5517461	49:46:31.36	-77:48:55.96	246
075240	297318	5517558	49:46:34.53	-77:48:54.89	241
075250	297350	5517658	49:46:37.80	-77:48:53.48	246
075260	297371	5517748	49:46:40.74	-77:48:52.60	246
075270	297397	5517852	49:46:44.13	-77:48:51.50	245
075280	297419	5517955	49:46:47.49	-77:48:50.59	236
075290	297451	5518065	49:46:51.08	-77:48:49.20	253
075300	297464	5518142	49:46:53.59	-77:48:48.70	252
075310	297504	5518218	49:46:56.09	-77:48:46.84	249
075320	297518	5518339	49:47:00.02	-77:48:46.37	249
075330	297540	5518437	49:47:03.22	-77:48:45.46	252
075340	297555	5518506	49:47:05.47	-77:48:44.83	248
075350	297587	5518626	49:47:09.39	-77:48:43.46	243
075360	297611	5518726	49:47:12.66	-77:48:42.45	242
075370	297631	5518816	49:47:15.59	-77:48:41.62	238
075380	297652	5518921	49:47:19.01	-77:48:40.76	232
100100	297214	5516134	49:45:48.35	-77:48:57.42	270
100110	297240	5516237	49:45:51.71	-77:48:56.31	283
100120	297265	5516336	49:45:54.94	-77:48:55.25	278
100130	297288	5516430	49:45:58.02	-77:48:54.28	271
100140	297314	5516517	49:46:00.86	-77:48:53.14	265
100150	297338	5516619	49:46:04.19	-77:48:52.13	256
100160	297364	5516715	49:46:07.32	-77:48:51.01	253
100170	297391	5516815	49:46:10.59	-77:48:49.85	250
100180	297412	5516909	49:46:13.66	-77:48:48.98	248
100190	297439	5517011	49:46:16.98	-77:48:47.82	246
100200	297462	5517099	49:46:19.86	-77:48:46.84	244
100210	297486	5517200	49:46:23.16	-77:48:45.83	244
100220	297504	5517273	49:46:25.53	-77:48:45.07	240
100230	297537	5517394	49:46:29.49	-77:48:43.65	232
100240	297561	5517487	49:46:32.52	-77:48:42.62	231
100250	297580	5517596	49:46:36.08	-77:48:41.88	250
100260	297611	5517679	49:46:38.80	-77:48:40.49	247
100270	297636	5517782	49:46:42.17	-77:48:39.43	244
100280	297656	5517886	49:46:45.55	-77:48:38.62	239
100290	297679	5517979	49:46:48.58	-77:48:37.65	243

100300	297704	5518077	49:46:51.79	-77:48:36.59	251
100310	297722	5518179	49:46:55.11	-77:48:35.88	249
100320	297752	5518264	49:46:57.89	-77:48:34.54	251
100330	297771	5518368	49:47:01.28	-77:48:33.79	256
100340	297795	5518460	49:47:04.28	-77:48:32.76	264
100350	297823	5518573	49:47:07.97	-77:48:31.57	264
100360	297844	5518654	49:47:10.61	-77:48:30.67	263
100370	297867	5518753	49:47:13.84	-77:48:29.71	266
100380	297891	5518849	49:47:16.97	-77:48:28.69	264
125100	297453	5516069	49:45:46.53	-77:48:45.36	241
125110	297472	5516171	49:45:49.85	-77:48:44.60	249
125120	297501	5516264	49:45:52.91	-77:48:43.33	251
125130	297527	5516359	49:45:56.00	-77:48:42.21	251
125140	297551	5516443	49:45:58.75	-77:48:41.17	249
125150	297609	5516572	49:46:02.99	-77:48:38.51	243
125170	297628	5516751	49:46:08.80	-77:48:37.90	246
125180	297653	5516851	49:46:12.07	-77:48:36.84	245
125190	297678	5516946	49:46:15.17	-77:48:35.77	242
125200	297703	5517042	49:46:18.31	-77:48:34.70	245
125210	297728	5517140	49:46:21.51	-77:48:33.63	242
125220	297756	5517234	49:46:24.58	-77:48:32.41	240
125230	297779	5517328	49:46:27.65	-77:48:31.44	239
125240	297812	5517432	49:46:31.06	-77:48:29.99	239
125250	297831	5517537	49:46:34.47	-77:48:29.23	239
125260	297855	5517621	49:46:37.22	-77:48:28.19	240
125270	297883	5517720	49:46:40.46	-77:48:26.98	240
125280	297903	5517809	49:46:43.36	-77:48:26.15	238
125290	297924	5517905	49:46:46.48	-77:48:25.28	242
125300	297948	5518005	49:46:49.74	-77:48:24.27	246
125310	297980	5518115	49:46:53.35	-77:48:22.87	248
125320	297998	5518204	49:46:56.25	-77:48:22.14	245
125330	298023	5518296	49:46:59.25	-77:48:21.06	240
125340	298058	5518390	49:47:02.34	-77:48:19.49	254
125350	298079	5518489	49:47:05.55	-77:48:18.63	270
125360	298106	5518586	49:47:08.73	-77:48:17.46	261
125370	298122	5518676	49:47:11.65	-77:48:16.83	279
125380	298144	5518779	49:47:15.01	-77:48:15.92	283
125390	298176	5518874	49:47:18.13	-77:48:14.50	291
125400	298188	5518970	49:47:21.25	-77:48:14.08	301
125410	298219	5519073	49:47:24.62	-77:48:12.73	300
125420	298244	5519169	49:47:27.75	-77:48:11.66	285
125430	298268	5519266	49:47:30.92	-77:48:10.64	270
125440	298289	5519363	49:47:34.07	-77:48:09.77	259
125450	298314	5519465	49:47:37.40	-77:48:08.71	259
125460	298335	5519559	49:47:40.47	-77:48:07.84	258
125470	298351	5519661	49:47:43.80	-77:48:07.23	247
125480	298382	5519754	49:47:46.83	-77:48:05.85	244
125490	298403	5519849	49:47:49.94	-77:48:04.98	239
125500	298425	5519947	49:47:53.12	-77:48:04.07	245
150180	297898	5516781	49:46:10.10	-77:48:24.47	246
150190	297922	5516875	49:46:13.17	-77:48:23.45	246

150200	297943	5516970	49:46:16.28	-77:48:22.58	245
150210	297974	5517070	49:46:19.53	-77:48:21.22	244
150222	298003	5517192	49:46:23.52	-77:48:20.00	244
150230	298029	5517264	49:46:25.89	-77:48:18.84	244
150240	298044	5517363	49:46:29.09	-77:48:18.27	244
150250	298068	5517460	49:46:32.27	-77:48:17.25	244
150260	298090	5517560	49:46:35.53	-77:48:16.34	244
150270	298115	5517655	49:46:38.62	-77:48:15.27	241
150280	298140	5517751	49:46:41.77	-77:48:14.20	239
150290	298165	5517848	49:46:44.93	-77:48:13.13	237
150300	298191	5517943	49:46:48.03	-77:48:12.01	240
150310	298219	5518041	49:46:51.24	-77:48:10.80	243
150320	298235	5518144	49:46:54.59	-77:48:10.19	242
150330	298261	5518236	49:46:57.59	-77:48:09.06	235
150340	298278	5518330	49:47:00.66	-77:48:08.39	244
150350	298315	5518435	49:47:04.10	-77:48:06.74	248
150360	298336	5518526	49:47:07.06	-77:48:05.86	248
150370	298361	5518622	49:47:10.20	-77:48:04.79	254
150380	298361	5518623	49:47:10.24	-77:48:04.79	258
150390	298407	5518814	49:47:16.47	-77:48:02.85	262
150400	298430	5518910	49:47:19.60	-77:48:01.88	261
150410	298458	5519014	49:47:23.00	-77:48:00.68	265
150420	298478	5519113	49:47:26.22	-77:47:59.86	267
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275390	299638	5518482	49:47:07.21	-77:47:00.74	240
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275420	299709	5518776	49:47:16.80	-77:46:57.74	232
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300310	299694	5517651	49:46:40.40	-77:46:56.40	252
300320	299714	5517740	49:46:43.31	-77:46:55.57	240
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325090	299358	5515456	49:45:29.01	-77:47:09.11	246
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325110	299397	5515643	49:45:35.11	-77:47:07.51	237
325120	299439	5515749	49:45:38.58	-77:47:05.61	240
325130	299464	5515845	49:45:41.73	-77:47:04.54	236
325140	299489	5515944	49:45:44.95	-77:47:03.48	240
325150	299517	5516033	49:45:47.87	-77:47:02.24	239
325160	299541	5516133	49:45:51.12	-77:47:01.23	240
325170	299566	5516232	49:45:54.36	-77:47:00.17	242
325180	299592	5516325	49:45:57.40	-77:46:59.04	240
325190	299616	5516420	49:46:00.50	-77:46:58.02	242
325200	299640	5516516	49:46:03.63	-77:46:57.00	239
325210	299668	5516618	49:46:06.97	-77:46:55.79	250
325220	299694	5516714	49:46:10.10	-77:46:54.67	250
325230	299716	5516807	49:46:13.14	-77:46:53.74	250
325240	299743	5516906	49:46:16.36	-77:46:52.58	257
325250	299769	5517005	49:46:19.60	-77:46:51.46	246
325260	299797	5517095	49:46:22.55	-77:46:50.23	245
325270	299824	5517197	49:46:25.87	-77:46:49.07	243
325280	299847	5517286	49:46:28.79	-77:46:48.09	231
325290	299874	5517390	49:46:32.18	-77:46:46.93	236
325300	299894	5517481	49:46:35.15	-77:46:46.10	236
325310	299918	5517576	49:46:38.25	-77:46:45.08	238
325320	299949	5517676	49:46:41.51	-77:46:43.71	238
325330	299969	5517782	49:46:44.98	-77:46:42.91	236
325340	299997	5517857	49:46:47.43	-77:46:41.65	235
325350	300027	5517968	49:46:51.05	-77:46:40.36	246
325360	300050	5518057	49:46:53.97	-77:46:39.38	246
325370	300080	5518146	49:46:56.88	-77:46:38.04	243
325380	300105	5518257	49:47:00.49	-77:46:37.00	241
325390	300123	5518350	49:47:03.51	-77:46:36.26	235
325400	300150	5518446	49:47:06.66	-77:46:35.10	240
325410	300187	5518564	49:47:10.52	-77:46:33.47	241
325420	300202	5518633	49:47:12.77	-77:46:32.85	238

325430	300229	5518728	49:47:15.88	-77:46:31.68	236
325440	300253	5518830	49:47:19.21	-77:46:30.67	246
325450	300289	5518940	49:47:22.80	-77:46:29.07	243
325460	300309	5519018	49:47:25.35	-77:46:28.22	238
325470	300333	5519110	49:47:28.35	-77:46:27.19	235
325480	300351	5519211	49:47:31.64	-77:46:26.47	232
325490	300379	5519305	49:47:34.72	-77:46:25.25	228
325500	300405	5519402	49:47:37.88	-77:46:24.13	232
350050	299518	5515003	49:45:14.55	-77:47:00.29	241
350060	299540	5515101	49:45:17.75	-77:46:59.37	241
350070	299562	5515199	49:45:20.95	-77:46:58.45	239
350080	299592	5515317	49:45:24.79	-77:46:57.17	241
350090	299616	5515386	49:45:27.06	-77:46:56.10	241
350100	299640	5515480	49:45:30.12	-77:46:55.08	238
350110	299658	5515577	49:45:33.29	-77:46:54.36	236
350120	299692	5515677	49:45:36.55	-77:46:52.85	235
350130	299717	5515771	49:45:39.63	-77:46:51.77	233
350140	299734	5515879	49:45:43.14	-77:46:51.12	242
350150	299762	5515974	49:45:46.25	-77:46:49.90	239
350160	299784	5516066	49:45:49.25	-77:46:48.97	234
350170	299809	5516163	49:45:52.42	-77:46:47.91	233
350180	299835	5516259	49:45:55.55	-77:46:46.78	234
350190	299862	5516357	49:45:58.75	-77:46:45.62	228
350200	299887	5516447	49:46:01.69	-77:46:44.54	227
350210	299913	5516546	49:46:04.93	-77:46:43.42	233
350220	299934	5516647	49:46:08.22	-77:46:42.56	232
350230	299954	5516738	49:46:11.18	-77:46:41.73	236
350240	299979	5516835	49:46:14.35	-77:46:40.66	233
350250	300004	5516938	49:46:17.72	-77:46:39.60	239
350260	300026	5517037	49:46:20.94	-77:46:38.69	242
350270	300050	5517131	49:46:24.01	-77:46:37.66	244
350280	300075	5517230	49:46:27.24	-77:46:36.60	243
350290	300100	5517333	49:46:30.61	-77:46:35.54	242
350300	300124	5517418	49:46:33.38	-77:46:34.50	238
350310	300139	5517517	49:46:36.60	-77:46:33.93	240
350320	300168	5517616	49:46:39.85	-77:46:32.67	230
350330	300193	5517718	49:46:43.16	-77:46:31.61	235
350340	300218	5517810	49:46:46.18	-77:46:30.53	237
350350	300241	5517908	49:46:49.38	-77:46:29.56	239
350360	300265	5518006	49:46:52.56	-77:46:28.54	240
350370	300293	5518099	49:46:55.61	-77:46:27.32	236
350380	300315	5518199	49:46:58.88	-77:46:26.40	239
350390	300338	5518297	49:47:02.06	-77:46:25.43	238
350400	300363	5518399	49:47:05.39	-77:46:24.37	235
350410	300384	5518497	49:47:08.59	-77:46:23.51	240
350420	300410	5518594	49:47:11.77	-77:46:22.39	236
350430	300435	5518693	49:47:14.99	-77:46:21.32	242
350440	300464	5518804	49:47:18.62	-77:46:20.08	241
350450	300486	5518894	49:47:21.54	-77:46:19.14	240
350460	300509	5518978	49:47:24.30	-77:46:18.15	239
350470	300528	5519079	49:47:27.59	-77:46:17.39	243

350480	300553	5519168	49:47:30.49	-77:46:16.30	244
350490	300577	5519271	49:47:33.86	-77:46:15.29	248
350500	300598	5519372	49:47:37.15	-77:46:14.43	239
375040	299679	5514841	49:45:09.51	-77:46:51.95	242
375050	299712	5514950	49:45:13.08	-77:46:50.50	240
375060	299741	5515048	49:45:16.27	-77:46:49.24	240
375070	299764	5515144	49:45:19.41	-77:46:48.27	241
375080	299784	5515210	49:45:21.56	-77:46:47.39	235
375090	299821	5515329	49:45:25.46	-77:46:45.76	232
375100	299847	5515418	49:45:28.37	-77:46:44.63	235
375110	299878	5515525	49:45:31.87	-77:46:43.28	231
375120	299902	5515616	49:45:34.84	-77:46:42.25	223
375130	299934	5515715	49:45:38.07	-77:46:40.84	231
375140	299958	5515809	49:45:41.15	-77:46:39.81	231
375150	299985	5515903	49:45:44.21	-77:46:38.64	232
375160	300016	5516005	49:45:47.55	-77:46:37.28	229
375170	300040	5516098	49:45:50.60	-77:46:36.25	229
375180	300071	5516197	49:45:53.82	-77:46:34.89	231
375190	300101	5516294	49:45:57.00	-77:46:33.57	231
375200	300127	5516388	49:46:00.08	-77:46:32.44	224
375210	300156	5516485	49:46:03.24	-77:46:31.17	231
375220	300183	5516579	49:46:06.32	-77:46:30.00	232
375230	300212	5516683	49:46:09.72	-77:46:28.74	241
375240	300237	5516775	49:46:12.72	-77:46:27.67	234
375250	300265	5516870	49:46:15.83	-77:46:26.44	234
375260	300297	5516958	49:46:18.71	-77:46:25.01	236
375270	300325	5517066	49:46:22.24	-77:46:23.81	251
375280	300356	5517163	49:46:25.42	-77:46:22.44	243
375290	300380	5517257	49:46:28.48	-77:46:21.41	239
375300	300410	5517349	49:46:31.50	-77:46:20.09	242
375310	300429	5517444	49:46:34.59	-77:46:19.31	247
375320	300459	5517546	49:46:37.92	-77:46:18.00	237
375330	300487	5517643	49:46:41.10	-77:46:16.78	241
375340	300513	5517750	49:46:44.59	-77:46:15.68	245
375350	300543	5517838	49:46:47.46	-77:46:14.35	247
375360	300568	5517930	49:46:50.48	-77:46:13.27	234
375370	300597	5518033	49:46:53.85	-77:46:12.01	235
375380	300627	5518120	49:46:56.69	-77:46:10.67	245
375390	300656	5518224	49:47:00.09	-77:46:09.41	240
375400	300678	5518318	49:47:03.15	-77:46:08.49	233
375410	300707	5518423	49:47:06.58	-77:46:07.23	236
375420	300738	5518513	49:47:09.54	-77:46:05.85	234
375430	300767	5518609	49:47:12.67	-77:46:04.58	229
375440	300790	5518701	49:47:15.68	-77:46:03.60	230
375450	300821	5518805	49:47:19.08	-77:46:02.24	241
375460	300845	5518893	49:47:21.95	-77:46:01.21	234
375470	300873	5519000	49:47:25.44	-77:46:00.01	236
375480	300902	5519096	49:47:28.59	-77:45:58.73	232
375490	300920	5519187	49:47:31.55	-77:45:58.00	229
375500	300956	5519286	49:47:34.80	-77:45:56.39	233

APPENDIX 2 SURVEY HISTORY

Day	Activity	Sites
Nov 27	Portion of the crew drives to Matagami	
28	Scout field area and organize equipment	
29	Prepare equipment, perform parallel sensor test and install local and distant remote (remaining members of crew drive to Matagami).	
30	Crew 1:(Andrew) 000330, 000340, 000350, 000360, 000370, 000380, 025380, Crew 2: (Gary) 000320, 000310, 000300, 000290, , 000270, 000260, 000250 Crew 3: (Ross) 150220, 150230, 150240, 150250, 150260, 150270, 150280, 150290	7 7 8
Dec 1	Crew 1:(Andrew) 025360, 025350, 025340, 025330, 025320, 025310, 025300, 025290, 025280 Crew 2: (Gary) 000240, 000230, 000220, 000210, 000200, 000190, 000180 Crew 3: (Ross) 150300, 150310, 150320, 150330, 150340, 150350, 150360, 150370, 150380	9 7 9
2	Crew 1:(Andrew) 025280, , 025260, 025250 Crew 2: (Ross) 150390, 150400, 150410, 150420, 150430, 150440, 150450, 150460, 150470, 150480	3 10
3	Crew 1:(Andrew)025240, 025230, 025220, 025210, 025200, 025190, 025180, 025170, 025160, 050150 Crew 2: (Gary) 000170, 000160, 000150, 000140, 000130, 000120, 000110, 000100, 025100 Crew 3: (Ross) , 125450, 125440	10 9 2
4	Crew 1:(Andrew) 050160, 050170, 050180, 050190, 050200, 050210, 050220, 050230, 050240 Crew 2: (Gary) 025110, 025120, 025130, 025140, 025150, 250130 Crew 3: (Ross) 125430, 125420, 125410, 125400, 125390, 125380, 125370, 125360, 125350, 125340	9 6 10
5	Crew 1:(Andrew) 050250, 050260, 050270, 050280, 050290, 050300, 050310, 050320, 050320, 050330, 050340 Crew 2: (Mauricio) 250140, 250150, 250160, 250170, 250180, 250190, 250200, 250210, 250220, 250230 Crew 3: (Ross) 125330, 125320, 125310, 125300, 125290, 125280, 125270, 125260, 125250	11 10 9
6	Crew 1:(Andrew) 050350, 050360, 050370, 050380, 075380, 075 370, 075360, 075350, 075340, 075330 Crew 2: (Mauricio) 250240, 250250, 250260, 250270, 250280, 250290, 250300, 250310 Crew 3: (Ross) 125240, 125230, 125220, 125210, 125200, 125190, 150180, 150190, 150200, 150210	10 8 10
7	Crew 1:(Andrew) 075320, 075310, 075300, 075290, 075280, 075270, 075260, 075250 Crew 2: (Mauricio) 250320, 250330, 250340, 250350, 250360, 250370, 250380, 250390, 250400 Crew 3: (Ross) 175150, 175160, 175170, 175180, 175190, 175200, 175210, 175220, 175230, 175240	8 9 10

8	Crew 1:(Andrew) 075240, 075230, 075220, 075210, 075200, 075190, 075180, 075170, 075160, 075150 Crew 2: (Mauricio) 250410, 250420, 250430, 250440, 250450, 250460, 250470, 250480 Crew 3: (Ross) 175250, 175260, 175270, 125280, 125290, 125300, 125310, 125320	10 8 8
9	Crew 1:(Andrew) 050140, 050130, 050120, 050110, 050100, 075100, 075110, 075120, 075130, 075140 Crew 2: (Mauricio) 250490, 250500, 225500, 225490, 225480, 225470, 250460, 225450 Crew 3: (Ross) 175330, 175340, 175350, 175360, 175370, 175380, 175390, 175400, 175410, 175420	10 8 10
10	Crew 1:(Andrew) 125170, 125150, 125140, 125130, 125120, 125110, 125100, 100100 Crew 2: (Mauricio) 225440, 224430, 225420, 225410, 225400, 225390, , 225370, 225360, 225350 Crew 3: (Ross) 175430, 175440, 175450, 175460, 175470, 175480, 175590, 175500, 200500	8 9 9
11	Crew 1:(Andrew) 100110, 100120, 100130, 100140, 100150, 100160, 100170, 100180, 100190 Crew 2: (Mauricio) 225340, 225330, 225320, 225310, 225300, 225290, 225280, 225270, 225260, 225250 Crew 3: (Ross) 200490, 200480, 200470, 200460, 200450, 200440, 200430, 200420, 200410	9 10 9
12	Crew 1:(Andrew) 100200, 100210, 100220, 100230, 110240, 110250, 110260, 100270, 100280 Crew 2: (Mauricio) 224240, 225230, 225220, 225210, 225200, 225,190, 225180, 225170, 225160, 225150 Crew 3: (Ross) 200400, 200390, 200380, 200370, 200360, 200350, 200340, 200330, 200320, 200310	9 10 10
13	Crew 1:(Andrew) 100290, 100300, 100310, 100320, 100330, 100340, 100350, 100360, 100370, 100,380 Crew 2: (Mauricio) 225140, 225130, 225120, 250110, 250120, 275100, 275110, 275120 Crew 3: (Ross) 200300, 200290, 200280, 200270, 200260, 200250, 200240, 200230, 200220, 200210	10 8 10
14	Crew 1:(Andrew) 375040, 375050, 375060, 375070, 375080, 375090, 375100, 375110 Crew 2: (Mauricio) 275130, 275140, 275150, 275160, 275170, 275180, 275190, 275200, 275210, 275220 Crew 3: (Ross) 200200, 200190, 200180, 200170, 200160, 200150, 200140, 200130, 200120, 325090	8 10 10
15	Crew 1:(Andrew) 375120, 375130, 375140, 375150, 375160, 375170, 375180, 375190, 375200, 375210, 375220 Crew 2: (Mauricio) 275230, 275240, 275250, 275260, 275270, 275280, 275290, 275300, 275310 Crew 3: (Ross) 325100, 325110, 325120, 325130, 325140, 325150, 325160, 325170, 325180, 325190, 325200	11 9 11

16	Crew 1:(Andrew) 375230, 375240, 375250, 375260, 375270, 375280, 375290, 375300 Crew 2: (Mauricio) 275320, 275330, 275340, 275350, 275360, 275370, 275380, 275390, 275400 Crew 3: (Ross) 325210, 325220, 325230, 325240, 325250, 325260, 325270, 325280, 325290, 325300	8 9 10
17	Crew 1:(Andrew) 350050, 350060, 350070, 350080, 350090, 350100, 350110, 350120, 350130 Crew 2: (Mauricio) 275410, 275420, 275430, 275440, 275450, 275460, 275470, 275480, 275490, 275500 Crew 3: (Ross) 325310, 325320, 325330, 325340, 325350, 325360, 325370, 325380, 325390	9 10 9
18	Crew 1:(Andrew) 350140, 350150, 350160, 350170, 350180, 350190, 350200, 350210, 350220 Crew 2: (Mauricio) 300500, 300490, 300480, 300470, 300460, 300450, 300440, 300430 Crew 3: (Ross) 325400, 325410, 325430, 225440, 325450, 325460, 325470, 325480	9 8 8
19	Crew 1:(Andrew) 350230, 350240, 350250, 350260, 350270, 350280, 350290, 350300 Crew 2: (Mauricio) 300420, 300410, 300400, 300390, 300380, 300370, 300360, 300350, 300340 Crew 3: (Gary) 325490, 325500, 350500, 350490, 350480, 350470, 350460, 350450	8 0 0
20	Crew 1:(Andrew) 350310, 375370, 375360, 375350 Crew 2: (Mauricio) 300330, 300320, 300310, 300300, 300290 Crew 3: (Ross) 350440, 325430, 325420	4 5 3
21	Crew leaves for Christmas	
Jan 3	Crew returns to Matagami	
4	Crew 1:(Andrew) 375500, 375490, 375480, 375470, 375460, 375450 Crew 2: (Ross) 325080, 325070, 325060, 300070, 300080, 300090, 300100, 300110	6 8
5	Crew 1:(Andrew) 375440, 375430, 375420, 375410, 375400, 375390, 375380, 375310 Crew 2: (Ross) 300120, 300130, 300140, 300150, 300160, 300170,	8 6
6	Crew 1:(Andrew) 350320, 350330, 350340, 350350, 350360, 350370, 350380, 350390, 350400, 350410 Crew 2: (Ross)	10 0
7	Crew 1:(Andrew) 375320, 375330, 375340, 350300, 350290, 350280, 350270, 350260 Crew 2: (Ross) 025170, , 150450, 150460, 150470	8 4
8	Crew 1:(Andrew) 350250, 250240, 350230, 350220, 300280, 300270, 300260, 300250, 300240, 300230 Crew 2: (Ross) 150480, 150490, 150500, 125500, 125490, 125480, 125470, 125460	10 8
9	Crew 1:(Andrew) 300220, 300210, 300200, 300190, 300180, Crew 2: (Ross) 125450, 125440, 025370, 000280, 125180	5 5
10	Crew 1:(Andrew) , 225380 Crew 2: (Ross)	1 0
11	Crew leaves Matagami	
	Total number of stations sounded	594

APPENDIX 3 PERSONNEL AND EQUIPMENT

3.1. PERSONNEL

Party Chief..Gary McNeice
Data processor ....Mark Kitchen
Operators ....Ross Gordon, Andrew Libey-Lahaie, Mauricio Berrios
Field Helpers....................................Lucien Patry, Luc Laurin, Luc Watier, Andre Lacroix, Andrew Becket, Alain Patry and Marc Eithier.

3.2. EQUIPMENT

At any one time, three AMT systems were used in the field area. Each 5-channel MT site used the following equipment:

- 5 channel Metronix ADU-06 acquisition systems, with GPS antenna for synchronization;
- 2 Metronix MFS06 magnetic sensors (H_x, H_y):
- 1 GSY AMT magnetic sensor (H_z);
- 5 Pb-PbCl_2 non-polarizing electrodes;
- 100m IP wire (4x25m dipoles);
- 1 Pentium Notebook Computer;
- 1 sealed lead-acid battery, 12V/34Ah;
- Connecting cables.

3.2.1 Technical specifications

ADU-06 (data acquisition unit):
32 bit internal computer, two 24 bit A/D converter, 4096 sample/sec and 49Ksample/sec data rate, standard LAN connection for transfer to system computer.

GPS system:
Motorola internal GPS receiver; clock precision ± 130ns to satellite reference; 8 parallel channels; L1 1575.42MHz; C/A code.

Magnetic Sensors, AMT:
Hx, Hy, Hz Geosystem AMT (2Hz to 20000 Hz). Sensitivity 0.04 V/nT

Electric Sensors:
4x25m dipoles, AWG #12 wire with stainless steel rods

System computer:
Ruggedized Pentium notebook PC Computer, with 32Mb RAM and 3.2 Gb hard disk.

Power Supply:

ADU-06	12V 34 Ah sealed lead acid battery

Environmental:

Temperature:

ADU-06	-40°C to +75°C
GSY-AMT Sensor	-30°C to +50°C
MFS06 Sensor	-30°C to +75°C

Weights:

ADU-06	5.0 kg
GSY–AMT Sensor	2.5 kg
MFS06 Sensor	8.5 kg

3.2.2 Equipment deployed at each site

AMT site	Date	ADU #	Azimuth	Ex	Ey	Rx	Ry	Hx	Hy	Hz
Loc. remote			10	50	50	2.0	1.5	0110	0112	-
Far remote			10	50	50	5.0	4.5	6101	6117	-
000330	30-11-2002	037	10	48	50	11	2.0	6107	6109	0211
000340	30-11-2002	037	10	50	47	4.0	1.5	6107	6109	0211
000350	30-11-2002	037	10	50	50	1.7	1.5	6107	6109	0211
000360	30-11-2002	037	10	50	50	2.0	2.5	6107	6109	0211
000370	30-11-2002	037	10	50	49	1.7	1.7	6107	6109	0211
000380	30-11-2002	037	10	50	50	2.1	2.5	6107	6109	0211
025380	30-11-2002	037	10	50	50	3.0	1.1	6107	6109	0211
025370	30-11-2002	037	10	50	50	2.5	2.5	6107	6109	0211
000320	30-11-2002	038	10	50	50	1.0	3.0	6108	6111	0206
000310	30-11-2002	038	10	50	50	5.0	4.0	6108	6111	0206
000300	30-11-2002	038	10	49	50	3.0	1.0	6108	6111	0206
000290	30-11-2002	038	10	49	49	2.0	2.0	6108	6111	0206
000280	30-11-2002	038	10	50	50	2.0	2.5	6108	6111	0206
000270	30-11-2002	038	10	50	50	1.5	2.5	6108	6111	0206
000260	30-11-2002	038	10	50	50	2.0	2.0	6108	6111	0206
000250	30-11-2002	038	10	50	50	1.0	1.0	6108	6111	0206
150220	30-11-2002	011	10	50	50	0.7	1.0	6116	6106	0205
150230	30-11-2002	011	10	50	50	2.0	2.0	6116	6106	0205
150240	30-11-2002	011	10	50	50	3.0	2.0	6116	6106	0205
150250	30-11-2002	011	10	50	47	2.0	2.0	6116	6106	0205
150260	30-11-2002	011	10	50	50	2.0	2.0	6116	6106	0205
150270	30-11-2002	011	10	50	46	2.0	2.0	6116	6106	0205
150280	30-11-2002	011	10	50	48	2.0	2.0	6116	6106	0205
150290	30-11-2002	011	10	50	47	2.0	2.0	6116	6106	0205
025360	01-12-2002	037	10	50	50	2.0	1.1	6107	6109	0211
025350	01-12-2002	037	10	50	50	1.5	3.0	6107	6109	0211
025340	01-12-2002	037	10	50	50	2.5	2.0	6107	6109	0211
025330	01-12-2002	037	10	50	50	2.5	2.0	6107	6109	0211
025320	01-12-2002	037	10	50	50	3.0	3.0	6107	6109	0211
025310	01-12-2002	037	10	50	50	9.0	5.5	6107	6109	0211
025300	01-12-2002	037	10	50	50	6.0	5.5	6107	6109	0211
025290	01-12-2002	037	10	50	50	5.0	2.0	6107	6109	0211
025280	01-12-2002	037	10	50	50	10	4.0	6107	6109	0211
000240	01-12-2002	038	10	50	50	1.0	5.0	6108	6111	0206
000230	01-12-2002	038	10	50	50	1.5	2.5	6108	6111	0206
000220	01-12-2002	038	10	50	50	2.0	2.0	6108	6111	0206
000210	01-12-2002	038	10	50	50	1.0	1.0	6108	6111	0206
000200	01-12-2002	038	10	48	50	1.5	1.5	6108	6111	0206
000190	01-12-2002	038	10	50	50	2.0	1.5	6108	6111	0206
000180	01-12-2002	038	10	50	50	3.0	4.0	6108	6111	0206
150300	01-12-2002	011	10	47	48	4.5	6.0	6116	6106	0205
150310	01-12-2002	011	10	50	50	2.0	2.0	6116	6106	0205
150320	01-12-2002	011	10	50	50	3.0	3.0	6116	6106	0205
150330	01-12-2002	011	10	50	45	3.0	4.0	6116	6106	0205
150340	01-12-2002	011	10	50	50	3.0	3.0	6116	6106	0205
150350	01-12-2002	011	10	50	50	3.0	3.0	6116	6106	0205

150360	01-12-2002	011	10	50	50	6.0	12	6116	6106	0205
150370	01-12-2002	011	10	50	50	2.5	2.5	6116	6106	0205
150380	01-12-2002	011	10	50	50	3.0	8.0	6116	6106	0205
025280	02-12-2002	037	10	50	50	0.5	0.5	6107	6109	0211
025270	02-12-2002	037	10	50	50	1.5	2.5	6107	6109	0211
025260	02-12-2002	037	10	50	50	3.0	3.0	6107	6109	0211
025025	02-12-2002	037	10	50	50	1.5	5.0	6107	6109	0211
150390	01-12-2002	011	10	50	50	4.0	4.0	6116	6106	0205
150400	01-12-2002	011	10	50	50	5.0	5.0	6116	6106	0205
150410	01-12-2002	011	10	50	50	4.0	4.0	6116	6106	0205
150420	01-12-2002	011	10	50	47	3.0	3.0	6116	6106	0205
150430	01-12-2002	011	10	50	50	3.0	4.0	6116	6106	0205
150440	01-12-2002	011	10	50	50	3.0	3.0	6116	6106	0205
150450	01-12-2002	011	10	50	50	4.0	5.0	6116	6106	0205
150460	01-12-2002	011	10	50	50	3.0	3.0	6116	6106	0205
150470	01-12-2002	011	10	50	48	3.0	3.0	6116	6106	0205
150480	01-12-2002	011	10	50	50	4.0	4.0	6116	6106	0205
025240	03-12-2002	037	10	50	50	1.2	1.3	6107	6109	0211
025230	03-12-2002	037	10	50	50	2.0	3.0	6107	6109	0211
025220	03-12-2002	037	10	50	50	1.5	10	6107	6109	0211
025210	03-12-2002	037	10	50	50	10	14	6107	6109	0211
025200	03-12-2002	037	10	50	50	2.5	2.0	6107	6109	0211
025190	03-12-2002	037	10	50	50	2.0	3.0	6107	6109	0211
025180	03-12-2002	037	10	50	50	2.5	2.5	6107	6109	0211
025170	03-12-2002	037	10	50	50	2.5	3.5	6107	6109	0211
025160	03-12-2002	037	10	50	50	4.0	0.5	6107	6109	0211
025150	03-12-2002	037	10	50	50	4.0	5.5	6107	6109	0211
000170	03-12-2002	038	10	50	50	2.0	2.5	6108	6111	0206
000160	03-12-2002	038	10	50	50	2.5	1.0	6108	6111	0206
000150	03-12-2002	038	10	50	50	2.0	1.5	6108	6111	0206
000140	03-12-2002	038	10	50	50	2.5	1.5	6108	6111	0206
000130	03-12-2002	038	10	50	50	3.5	5.0	6108	6111	0206
000120	03-12-2002	038	10	50	50	2.5	2.0	6108	6111	0206
000110	03-12-2002	038	10	50	50	1.0	3.0	6108	6111	0206
000100	03-12-2002	038	10	50	50	3.0	1.5	6108	6111	0206
025100	03-12-2002	038	10	50	50	3.0	1.5	6108	6111	0206
150490	03-12-2002	011	10	50	50	5.0	5.0	6116	6106	0205
150500	03-12-2002	011	10	50	50	5.0	5.0	6116	6106	0205
125500	03-12-2002	011	10	50	50	4.0	5.0	6116	6106	0205
125490	03-12-2002	011	10	50	50	6.0	6.0	6116	6106	0205
125480	03-12-2002	011	10	50	50	6.0	7.0	6116	6106	0205
125470	03-12-2002	011	10	50	50	2.0	2.0	6116	6106	0205
125460	03-12-2002	011	10	50	50	8.0	20	6116	6106	0205
125450	03-12-2002	011	10	50	50	6.0	6.0	6116	6106	0205
125440	03-12-2002	011	10	50	50	6.0	6.0	6116	6106	0205
050016	04-12-2002	037	10	50	50	4.5	2.5	6107	6109	0211
050170	04-12-2002	037	10	50	50	2.5	4.5	6107	6109	0211
050180	04-12-2002	037	10	50	50	4.5	6.0	6107	6109	0211
050190	04-12-2002	037	10	50	50	2.5	3.0	6107	6109	0211
050200	04-12-2002	037	10	50	50	3.0	3.0	6107	6109	0211
050210	04-12-2002	037	10	50	50	3.0	4.0	6107	6109	0211

050220	04-12-2002	037	10	50	50	5.5	4.0	6107	6109	0211
050230	04-12-2002	037	10	50	50	4.5	7.0	6107	6109	0211
050240	04-12-2002	037	10	50	50	4.0	4.5	6107	6109	0211
025110	04-12-2002	038	10	50	50	2.5	2.5	6108	6111	0206
025120	04-12-2002	038	10	50	50	2.5	2.0	6108	6111	0206
025130	04-12-2002	038	10	50	50	1.5	1.0	6108	6111	0206
025140	04-12-2002	038	10	50	48	3.0	1.5	6108	6111	0206
025150	04-12-2002	038	10	50	50	1.5	2.5	6108	6111	0206
250130	04-12-2002	038	10	50	50	1.5	1.5	6108	6111	0206
125430	04-12-2002	011	10	50	50	3.0	3.0	6116	6106	0205
125420	04-12-2002	011	10	50	50	3.0	3.0	6116	6106	0205
125410	04-12-2002	011	10	50	50	3.0	3.0	6116	6106	0205
125400	04-12-2002	011	10	50	50	3.0	3.0	6116	6106	0205
125390	04-12-2002	011	10	50	50	3.0	3.0	6116	6106	0205
125380	04-12-2002	011	10	50	50	3.0	3.0	6116	6106	0205
125370	04-12-2002	011	10	50	50	10	10	6116	6106	0205
125360	04-12-2002	011	10	50	50	6.0	6.0	6116	6106	0205
125350	04-12-2002	011	10	50	50	8.0	6.0	6116	6106	0205
125340	04-12-2002	011	10	50	50	6.0	6.0	6116	6106	0205
050250	05-12-2002	037	10	50	50	2.0	3.5	6107	6109	0211
050260	05-12-2002	037	10	50	50	3.0	3.0	6107	6109	0211
025270	05-12-2002	037	10	50	50	12	7.5	6107	6109	0211
050280	05-12-2002	037	10	50	49	2.5	3.0	6107	6109	0211
050290	05-12-2002	037	10	50	50	3.0	2.5	6107	6109	0211
050300	05-12-2002	037	10	50	50	5.0	3.0	6107	6109	0211
050310	05-12-2002	037	10	50	50	4.0	5.0	6107	6109	0211
050320	05-12-2002	037	10	50	50	4.0	3.5	6107	6109	0211
050330	05-12-2002	037	10	50	50	1.5	4.0	6107	6109	0211
050340	05-12-2002	037	10	48	50	1.0	1.5	6107	6109	0211
250140	05-12-2002	038	10	50	50	2.0	4.0	6108	6111	0206
250150	05-12-2002	038	10	50	50	2.2	4.8	6108	6111	0206
250160	05-12-2002	038	10	50	50	2.5	2.5	6108	6111	0206
250170	05-12-2002	038	10	50	50	4.5	2.7	6108	6111	0206
250180	05-12-2002	038	10	50	50	1.5	3.0	6108	6111	0206
250190	05-12-2002	038	10	50	50	2.7	2.0	6108	6111	0206
250200	05-12-2002	038	10	50	50	2.0	2.6	6108	6111	0206
250210	05-12-2002	038	10	50	50	2.0	1.5	6108	6111	0206
250220	05-12-2002	038	10	50	50	4.0	2.0	6108	6111	0206
250230	05-12-2002	038	10	50	50	3.0	2.2	6108	6111	0206
125330	05-12-2002	011	10	50	50	6.0	8.0	6116	6106	0205
125320	05-12-2002	011	10	50	47	8.0	8.0	6116	6106	0205
125310	05-12-2002	011	10	50	50	6.0	6.0	6116	6106	0205
125300	05-12-2002	011	10	50	50	3.0	3.0	6116	6106	0205
125290	05-12-2002	011	10	50	50	2.0	2.0	6116	6106	0205
125280	05-12-2002	011	10	50	50	2.0	2.0	6116	6106	0205
125270	05-12-2002	011	10	50	50	3.0	3.0	6116	6106	0205
125260	05-12-2002	011	10	50	50	4.0	6.0	6116	6106	0205
125250	05-12-2002	011	10	50	50	2.0	2.0	6116	6106	0205
050350	06-12-2002	037	10	50	50	2.5	2.5	6107	6109	0211
050360	06-12-2002	037	10	50	50	2.5	4.0	6107	6109	0211
050370	06-12-2002	037	10	50	50	2.0	2.0	6107	6109	0211

050380	06-12-2002	037	10	50	50	2.0	2.0	6107	6109	0211
075380	06-12-2002	037	10	49	50	3.0	3.0	6107	6109	0211
075370	06-12-2002	037	10	50	50	5.0	7.0	6107	6109	0211
075360	06-12-2002	037	10	50	50	4.0	4.5	6107	6109	0211
075350	06-12-2002	037	10	50	50	6.0	3.0	6107	6109	0211
075340	06-12-2002	037	10	50	50	2.7	8.0	6107	6109	0211
075330	06-12-2002	037	10	50	50	15	17	6107	6109	0211
250240	06-12-2002	038	10	50	50	4.0	2.0	6108	6111	0206
250250	06-12-2002	038	10	50	50	3.0	6.0	6108	6111	0206
250260	06-12-2002	038	10	50	50	4.0	2.2	6108	6111	0206
250270	06-12-2002	038	10	50	50	3.0	4.5	6108	6111	0206
250280	06-12-2002	038	10	50	50	2.0	2.5	6108	6111	0206
250290	06-12-2002	038	10	50	50	2.5	9.0	6108	6111	0206
250300	06-12-2002	038	10	50	50	2.2	2.1	6108	6111	0206
250310	06-12-2002	038	10	50	50	1.5	2.0	6108	6111	0206
125240	06-12-2002	011	10	50	50	1.0	1.0	6116	6106	0205
125230	06-12-2002	011	10	50	47	3.0	3.0	6116	6106	0205
125220	06-12-2002	011	10	50	50	2.0	2.0	6116	6106	0205
125210	06-12-2002	011	10	50	47	2.0	2.0	6116	6106	0205
125200	06-12-2002	011	10	47	50	1.0	1.0	6116	6106	0205
125190	06-12-2002	011	10	50	47	2.0	2.0	6116	6106	0205
150180	06-12-2002	011	10	50	50	15	3.0	6116	6106	0205
150190	06-12-2002	011	10	50	50	4.0	4.0	6116	6106	0205
150200	06-12-2002	011	10	50	50	4.0	4.0	6116	6106	0205
150210	06-12-2002	011	10	50	50	1.0	1.0	6116	6106	0205
075320	07-12-2002	037	10	50	50	9.0	10	6107	6109	0211
075310	07-12-2002	037	10	50	50	2.0	12	6107	6109	0211
075300	07-12-2002	037	10	50	49	2.0	1.0	6107	6109	0211
075290	07-12-2002	037	10	50	50	2.0	3.0	6107	6109	0211
075280	07-12-2002	037	10	50	50	14	6.0	6107	6109	0211
075270	07-12-2002	037	10	50	50	2.0	2.0	6107	6109	0211
075260	07-12-2002	037	10	50	50	2.0	2.0	6107	6109	0211
075250	07-12-2002	037	10	50	50	1.0	2.0	6107	6109	0211
250320	07-12-2002	038	10	50	50	2.6	1.5	6108	6111	0206
250330	07-12-2002	038	10	50	50	6.0	2.5	6108	6111	0206
250340	07-12-2002	038	10	50	50	2.0	1.0	6108	6111	0206
250350	07-12-2002	038	10	50	50	2.2	3.0	6108	6111	0206
250360	07-12-2002	038	10	50	50	6.0	5.0	6108	6111	0206
250370	07-12-2002	038	10	50	50	3.8	5.0	6108	6111	0206
250380	07-12-2002	038	10	50	50	1.5	2.5	6108	6111	0206
250390	07-12-2002	038	10	50	50	3.0	8.0	6108	6111	0206
250400	07-12-2002	038	10	50	50	3.0	2.8	6108	6111	0206
175150	07-12-2002	011	10	50	50	1.0	1.0	6116	6106	0205
175160	07-12-2002	011	10	50	50	1.0	1.0	6116	6106	0205
175170	07-12-2002	011	10	50	52	1.0	1.0	6116	6106	0205
175180	07-12-2002	011	10	50	50	1.0	1.0	6116	6106	0205
175190	07-12-2002	011	10	50	50	2.0	1.0	6116	6106	0205
175200	07-12-2002	011	10	50	50	2.0	2.0	6116	6106	0205
175210	07-12-2002	011	10	50	50	2.0	2.0	6116	6106	0205
175220	07-12-2002	011	10	50	50	3.0	3.0	6116	6106	0205
175230	07-12-2002	011	10	50	50	3.0	3.0	6116	6106	0205

175240	07-12-2002	011	10	50	50	3.0	3.0	6116	6106	0205
075240	08-12-2002	037	10	50	50	2.0	2.0	6107	6109	0211
075230	08-12-2002	037	10	50	50	5.0	2.5	6107	6109	0211
075220	08-12-2002	037	10	50	50	2.0	1.5	6107	6109	0211
075210	08-12-2002	037	10	50	50	2.0	2.0	6107	6109	0211
075200	08-12-2002	037	10	50	50	2.0	2.0	6107	6109	0211
075190	08-12-2002	037	10	50	50	2.0	2.0	6107	6109	0211
075180	08-12-2002	037	10	50	50	2.0	2.0	6107	6109	0211
075170	08-12-2002	037	10	50	50	2.5	2.5	6107	6109	0211
075160	08-12-2002	037	10	50	50	6.0	2.5	6107	6109	0211
075150	08-12-2002	037	10	50	50	9.5	6.5	6107	6109	0211
250410	08-12-2002	038	10	50	50	3.5	5.0	6108	6111	0206
250420	08-12-2002	038	10	50	50	3.0	3.8	6108	6111	0206
250430	08-12-2002	038	10	50	50	6.0	3.0	6108	6111	0206
250440	08-12-2002	038	10	50	50	2.0	3.5	6108	6111	0206
250450	08-12-2002	038	10	50	50	2.8	6.0	6108	6111	0206
250460	08-12-2002	038	10	50	50	4.5	3.0	6108	6111	0206
250470	08-12-2002	038	10	50	50	4.5	8.0	6108	6111	0206
250480	08-12-2002	038	10	50	50	3.0	5.5	6108	6111	0206
175250	08-12-2002	011	10	50	50	2.0	2.0	6116	6106	0205
175260	08-12-2002	011	10	50	50	2.0	3.0	6116	6106	0205
175270	08-12-2002	011	10	48	50	2.0	3.0	6116	6106	0205
175280	08-12-2002	011	10	50	50	3.0	3.0	6116	6106	0205
175290	08-12-2002	011	10	50	50	2.0	2.0	6116	6106	0205
175300	08-12-2002	011	10	48	50	2.0	2.0	6116	6106	0205
175310	08-12-2002	011	10	50	48	2.0	2.0	6116	6106	0205
175320	08-12-2002	011	10	50	50	3.0	3.0	6116	6106	0205
050140	09-12-2002	037	10	50	47	10	2.0	6107	6109	0211
050130	09-12-2002	037	10	50	50	2.0	2.0	6107	6109	0211
050120	09-12-2002	037	10	50	50	3.0	2.0	6107	6109	0211
050110	09-12-2002	037	10	50	50	4.0	1.0	6107	6109	0211
050100	09-12-2002	037	10	50	50	2.5	2.0	6107	6109	0211
075100	09-12-2002	037	10	50	50	3.0	2.5	6107	6109	0211
075110	09-12-2002	037	10	50	50	3.5	3.5	6107	6109	0211
075120	09-12-2002	037	10	50	50	10	2.0	6107	6109	0211
075130	09-12-2002	037	10	50	50	2.5	5.0	6107	6109	0211
075140	09-12-2002	037	10	50	50	0.2	1.0	6107	6109	0211
250490	09-12-2002	038	10	50	50	3.0	3.0	6108	6111	0206
250500	09-12-2002	038	10	50	50	3.0	3.0	6108	6111	0206
225500	09-12-2002	038	10	50	50	2.0	2.0	6108	6111	0206
225490	09-12-2002	038	10	49	49	10	2.5	6108	6111	0206
225480	09-12-2002	038	10	50	50	3.5	8.0	6108	6111	0206
225470	09-12-2002	038	10	50	50	2.0	2.0	6108	6111	0206
225460	09-12-2002	038	10	50	50	3.5	10	6108	6111	0206
225450	09-12-2002	038	10	50	50	15	9.0	6108	6111	0206
175330	09-12-2002	011	10	50	48	2.0	2.0	6116	6106	0205
175340	09-12-2002	011	10	50	50	2.0	2.0	6116	6106	0205
175350	09-12-2002	011	10	50	50	2.0	2.0	6116	6106	0205
175360	09-12-2002	011	10	50	50	2.0	2.0	6116	6106	0205
175370	09-12-2002	011	10	50	50	9.0	12	6116	6106	0205
175380	09-12-2002	011	10	50	50	8.0	10	6116	6106	0205

175390	09-12-2002	011	10	50	50	10	12	6116	6106	0205
175400	09-12-2002	011	10	50	48	20	15	6116	6106	0205
175410	09-12-2002	011	10	50	50	10	10	6116	6106	0205
175420	09-12-2002	011	10	50	50	8.0	10	6116	6106	0205
125170	10-12-2002	037	10	50	50	3.0	2.0	6107	6109	0211
125150	10-12-2002	037	10	50	50	1.5	3.5	6107	6109	0211
125140	10-12-2002	037	10	50	50	1.0	1.0	6107	6109	0211
125130	10-12-2002	037	10	50	50	2.0	3.0	6107	6109	0211
125120	10-12-2002	037	10	50	50	4.0	9.0	6107	6109	0211
125110	10-12-2002	037	10	50	50	2.0	10	6107	6109	0211
125100	10-12-2002	037	10	49	50	4.0	15	6107	6109	0211
100100	10-12-2002	037	10	50	50	12	12	6107	6109	0211
225440	10-12-2002	038	10	50	50	2.5	3.0	6108	6111	0206
224430	10-12-2002	038	10	50	50	8.0	3.0	6108	6111	0206
225420	10-12-2002	038	10	50	50	2.5	13	6108	6111	0206
225410	10-12-2002	038	10	50	50	3.5	2.5	6108	6111	0206
225400	10-12-2002	038	10	50	50	4.0	7.0	6108	6111	0206
225390	10-12-2002	038	10	50	50	15	2.0	6108	6111	0206
225380	10-12-2002	038	10	50	50	3.0	1.5	6108	6111	0206
225370	10-12-2002	038	10	50	50	1.5	7.0	6108	6111	0206
225360	10-12-2002	038	10	50	50	12	6.5	6108	6111	0206
225350	10-12-2002	038	10	50	50	10	3.0	6108	6111	0206
175430	10-12-2002	011	10	50	50	11	7.0	6116	6106	0205
175440	10-12-2002	011	10	50	50	15	15	6116	6106	0205
175450	10-12-2002	011	10	50	50	3.0	4.0	6116	6106	0205
175460	10-12-2002	011	10	50	50	3.0	3.0	6116	6106	0205
175470	10-12-2002	011	10	50	50	3.0	3.0	6116	6106	0205
175480	10-12-2002	011	10	50	50	3.0	3.0	6116	6106	0205
175490	10-12-2002	011	10	50	50	3.0	4.0	6116	6106	0205
175500	10-12-2002	011	10	50	50	3.0	3.0	6116	6106	0205
200500	10-12-2002	011	10	50	50	3.0	3.0	6116	6106	0205
100110	11-12-2002	037	10	50	50	11	9.0	6107	6109	0211
100120	11-12-2002	037	10	50	50	13	9.0	6107	6109	0211
100130	11-12-2002	037	10	50	50	15	2.0	6107	6109	0211
100140	11-12-2002	037	10	50	50	2.0	4.5	6107	6109	0211
100150	11-12-2002	037	10	50	50	2.0	7.0	6107	6109	0211
100160	11-12-2002	037	10	50	50	1.5	1.5	6107	6109	0211
100170	11-12-2002	037	10	50	50	1.5	1.5	6107	6109	0211
100180	11-12-2002	037	10	50	50	3.5	3.5	6107	6109	0211
100190	11-12-2002	037	10	50	50	2.0	2.0	6107	6109	0211
225340	11-12-2002	038	10	50	50	6.0	6.0	6108	6111	0206
225330	11-12-2002	038	10	50	50	2.5	10	6108	6111	0206
225320	11-12-2002	038	10	50	50	2.2	4.5	6108	6111	0206
225310	11-12-2002	038	10	50	50	1.5	2.5	6108	6111	0206
225300	11-12-2002	038	10	50	50	7.0	3.5	6108	6111	0206
225290	11-12-2002	038	10	50	50	7.0	3.0	6108	6111	0206
225280	11-12-2002	038	10	50	50	1.5	2.5	6108	6111	0206
225270	11-12-2002	038	10	50	50	10	3.0	6108	6111	0206
225260	11-12-2002	038	10	50	50	2.5	0.5	6108	6111	0206
225250	11-12-2002	038	10	50	50	1.5	2.0	6108	6111	0206
200490	11-12-2002	011	10	50	50	2.0	2.0	6116	6106	0205

200480	11-12-2002	011	10	50	50	2.0	2.0	6116	6106	0205
200470	11-12-2002	011	10	50	50	2.0	2.0	6116	6106	0205
200460	11-12-2002	011	10	50	50	4.0	2.0	6116	6106	0205
200450	11-12-2002	011	10	50	48	2.0	2.0	6116	6106	0205
200440	11-12-2002	011	10	50	50	2.0	2.0	6116	6106	0205
200430	11-12-2002	011	10	50	50	2.0	2.0	6116	6106	0205
200420	11-12-2002	011	10	50	50	3.0	3.0	6116	6106	0205
200410	11-12-2002	011	10	50	50	2.0	2.0	6116	6106	0205
100200	12-12-2002	037	10	50	50	5.0	2.0	6107	6109	0211
100210	12-12-2002	037	10	50	50	8.0	7.0	6107	6109	0211
100220	12-12-2002	037	10	50	50	2.0	2.0	6107	6109	0211
100230	12-12-2002	037	10	50	50	2.0	3.0	6107	6109	0211
100240	12-12-2002	037	10	50	50	2.0	11	6107	6109	0211
100250	12-12-2002	037	10	50	50	2.0	1.5	6107	6109	0211
100260	12-12-2002	037	10	50	50	2.0	2.0	6107	6109	0211
100270	12-12-2002	037	10	50	50	2.0	2.0	6107	6109	0211
100280	12-12-2002	037	10	50	50	2.0	8.0	6107	6109	0211
225240	12-12-2002	038	10	50	50	3.5	2.0	6108	6111	0206
225230	12-12-2002	038	10	50	50	2.0	0.7	6108	6111	0206
225220	12-12-2002	038	10	50	50	3.0	4.5	6108	6111	0206
225210	12-12-2002	038	10	50	50	10	1.0	6108	6111	0206
225200	12-12-2002	038	10	50	50	2.5	0.8	6108	6111	0206
225190	12-12-2002	038	10	50	50	5.0	3.0	6108	6111	0206
225180	12-12-2002	038	10	50	50	9.0	1.5	6108	6111	0206
225170	12-12-2002	038	10	50	50	2.0	7.0	6108	6111	0206
225160	12-12-2002	038	10	50	50	9.0	9.0	6108	6111	0206
225150	12-12-2002	038	10	50	50	1.5	15	6108	6111	0206
200400	12-12-2002	011	10	50	49	2.0	2.0	6116	6106	0205
200390	12-12-2002	011	10	50	50	2.0	2.0	6116	6106	0205
200380	12-12-2002	011	10	50	50	2.0	2.0	6116	6106	0205
200370	12-12-2002	011	10	50	50	2.0	2.0	6116	6106	0205
200360	12-12-2002	011	10	50	50	2.0	2.0	6116	6106	0205
200350	12-12-2002	011	10	50	50	3.0	5.0	6116	6106	0205
200340	12-12-2002	011	10	50	50	2.0	2.0	6116	6106	0205
200330	12-12-2002	011	10	50	45	2.0	3.0	6116	6106	0205
200320	12-12-2002	011	10	50	46	3.0	2.0	6116	6106	0205
200310	12-12-2002	011	10	50	50	8.0	6.0	6116	6106	0205
100290	13-12-2002	037	10	50	49	11	7.0	6107	6109	0211
100300	13-12-2002	037	10	50	50	3.0	21	6107	6109	0211
100310	13-12-2002	037	10	50	50	4.0	5.0	6107	6109	0211
100320	13-12-2002	037	10	50	50	1.5	2.0	6107	6109	0211
100330	13-12-2002	037	10	50	50	5.0	5.0	6107	6109	0211
100340	13-12-2002	037	10	50	49	6.0	9.0	6107	6109	0211
100350	13-12-2002	037	10	50	50	4.0	2.0	6107	6109	0211
100360	13-12-2002	037	10	50	50	8.0	2.5	6107	6109	0211
100370	13-12-2002	037	10	50	50	7.0	4.0	6107	6109	0211
100380	13-12-2002	037	10	50	50	2.0	2.0	6107	6109	0211
225140	13-12-2002	038	10	50	50	8.0	1.0	6108	6111	0206
225130	13-12-2002	038	10	50	50	5.0	5.0	6108	6111	0206
225120	13-12-2002	038	10	50	50	1.5	2.5	6108	6111	0206
250110	13-12-2002	038	10	50	50	3.0	4.0	6108	6111	0206

250120	13-12-2002	038	10	50	50	2.5	1.5	6108	6111	0206
275100	13-12-2002	038	10	50	50	1.5	3.5	6108	6111	0206
275110	13-12-2002	038	10	50	50	5.0	3.0	6108	6111	0206
275120	13-12-2002	038	10	50	50	2.0	4.0	6108	6111	0206
200300	13-12-2002	011	10	50	45	3.0	2.0	6116	6106	0205
200290	13-12-2002	011	10	44	50	2.0	2.0	6116	6106	0205
200280	13-12-2002	011	10	50	48	2.0	2.0	6116	6106	0205
200270	13-12-2002	011	10	50	49	2.0	2.0	6116	6106	0205
200260	13-12-2002	011	10	50	50	0.5	0.5	6116	6106	0205
200250	13-12-2002	011	10	49	50	1.5	1.5	6116	6106	0205
200240	13-12-2002	011	10	50	45	1.0	1.0	6116	6106	0205
200230	13-12-2002	011	10	50	50	2.0	2.0	6116	6106	0205
200220	13-12-2002	011	10	50	50	2.0	2.0	6116	6106	0205
200210	13-12-2002	011	10	50	50	2.0	2.0	6116	6106	0205
375040	14-12-2002	037	10	50	50	1.5	2.5	6107	6109	0211
375050	14-12-2002	037	10	50	50	1.0	1.0	6107	6109	0211
375060	14-12-2002	037	10	50	49	1.0	1.0	6107	6109	0211
375070	14-12-2002	037	10	50	50	1.0	1.0	6107	6109	0211
375080	14-12-2002	037	10	50	50	1.0	2.0	6107	6109	0211
375090	14-12-2002	037	10	49	49	1.0	1.0	6107	6109	0211
375100	14-12-2002	037	10	50	50	2.0	2.0	6107	6109	0211
375110	14-12-2002	037	10	50	50	2.0	0.3	6107	6109	0211
275130	14-12-2002	038	10	50	50	3.0	2.5	6108	6111	0206
275140	14-12-2002	038	10	50	50	11	2.0	6108	6111	0206
275150	14-12-2002	038	10	50	50	3.0	3.0	6108	6111	0206
275160	14-12-2002	038	10	50	50	7.0	3.0	6108	6111	0206
275170	14-12-2002	038	10	50	50	10	3.0	6108	6111	0206
275180	14-12-2002	038	10	50	50	4.0	3.5	6108	6111	0206
275190	14-12-2002	038	10	50	50	7.0	1.5	6108	6111	0206
275200	14-12-2002	038	10	50	50	2.0	1.5	6108	6111	0206
275210	14-12-2002	038	10	50	50	3.0	2.0	6108	6111	0206
275220	14-12-2002	038	10	50	50	2.0	3.0	6108	6111	0206
200200	14-12-2002	011	10	50	49	1.0	1.0	6116	6106	0205
200190	14-12-2002	011	10	50	50	1.0	2.0	6116	6106	0205
200180	14-12-2002	011	10	46	48	2.0	1.0	6116	6106	0205
200170	14-12-2002	011	10	40	40	2.0	2.0	6116	6106	0205
200160	14-12-2002	011	10	50	50	2.0	2.0	6116	6106	0205
200150	14-12-2002	011	10	50	50	2.0	2.0	6116	6106	0205
200140	14-12-2002	011	10	49	50	1.0	1.0	6116	6106	0205
200130	14-12-2002	011	10	50	50	1.0	1.0	6116	6106	0205
200120	14-12-2002	011	10	50	50	2.0	2.0	6116	6106	0205
200090	14-12-2002	011	10	45	47	2.0	2.0	6116	6106	0205
375120	15-12-2002	037	10	50	48	1.0	2.0	6107	6109	0211
375130	15-12-2002	037	10	50	50	1.0	2.0	6107	6109	0211
375140	15-12-2002	037	10	50	50	2.0	2.0	6107	6109	0211
375150	15-12-2002	037	10	50	50	4.0	1.0	6107	6109	0211
375160	15-12-2002	037	10	50	50	1.5	1.0	6107	6109	0211
375170	15-12-2002	037	10	50	50	2.0	0.5	6107	6109	0211
375180	15-12-2002	037	10	50	50	1.5	1.5	6107	6109	0211
375190	15-12-2002	037	10	50	50	1.0	1.0	6107	6109	0211
375200	15-12-2002	037	10	50	50	2.5	1.0	6107	6109	0211

375210	15-12-2002	037	10	50	50	2.5	1.5	6107	6109	0211
375220	15-12-2002	037	10	50	49	1.0	1.0	6107	6109	0211
275230	15-12-2002	038	10	50	50	2.5	3.0	6108	6111	0206
275240	15-12-2002	038	10	50	50	2.5	3.0	6108	6111	0206
275250	15-12-2002	038	10	50	50	4.0	3.5	6108	6111	0206
275260	15-12-2002	038	10	50	50	2.5	5.0	6108	6111	0206
275270	15-12-2002	038	10	50	50	6.0	8.0	6108	6111	0206
275280	15-12-2002	038	10	50	50	9.0	10	6108	6111	0206
275290	15-12-2002	038	10	50	50	7.0	1.0	6108	6111	0206
275300	15-12-2002	038	10	50	50	2.0	4.0	6108	6111	0206
275310	15-12-2002	038	10	50	50	7.0	9.0	6108	6111	0206
325100	15-12-2002	011	10	50	50	1.0	1.0	6116	6106	0205
325110	15-12-2002	011	10	50	50	2.0	2.0	6116	6106	0205
325120	15-12-2002	011	10	50	50	2.0	2.0	6116	6106	0205
325130	15-12-2002	011	10	50	49	1.0	1.0	6116	6106	0205
325140	15-12-2002	011	10	50	50	1.0	1.0	6116	6106	0205
325150	15-12-2002	011	10	50	50	2.0	2.0	6116	6106	0205
325160	15-12-2002	011	10	50	50	2.0	2.0	6116	6106	0205
325170	15-12-2002	011	10	50	50	2.0	2.0	6116	6106	0205
325180	15-12-2002	011	10	50	50	2.0	2.0	6116	6106	0205
325190	15-12-2002	011	10	50	50	3.0	3.0	6116	6106	0205
325200	15-12-2002	011	10	50	50	2.0	2.0	6116	6106	0205
375230	16-12-2002	037	10	50	50	2.0	2.0	6107	6109	0211
375240	16-12-2002	037	10	50	50	1.5	2.4	6107	6109	0211
375250	16-12-2002	037	10	50	50	3.0	2.0	6107	6109	0211
375260	16-12-2002	037	10	50	50	1.0	1.0	6107	6109	0211
375270	16-12-2002	037	10	50	50	2.0	4.0	6107	6109	0211
375280	16-12-2002	037	10	50	50	2.0	1.0	6107	6109	0211
375290	16-12-2002	037	10	50	50	1.5	1.5	6107	6109	0211
375300	16-12-2002	037	10	50	50	2.0	2.0	6107	6109	0211
275320	16-12-2002	038	10	50	50	2.0	4.0	6108	6111	0206
275330	16-12-2002	038	10	50	50	10	9.0	6108	6111	0206
275340	16-12-2002	038	10	50	50	8.0	4.0	6108	6111	0206
275350	16-12-2002	038	10	50	50	6.0	5.0	6108	6111	0206
275360	16-12-2002	038	10	50	50	3.5	5.0	6108	6111	0206
275370	16-12-2002	038	10	50	50	3.0	4.0	6108	6111	0206
275380	16-12-2002	038	10	50	50	1.5	2.5	6108	6111	0206
275390	16-12-2002	038	10	50	50	4.0	4.0	6108	6111	0206
275400	16-12-2002	038	10	50	50	1.5	2.5	6108	6111	0206
325210	16-12-2002	011	10	50	50	2.0	2.0	6116	6106	0205
325220	16-12-2002	011	10	50	50	1.0	1.0	6116	6106	0205
325230	16-12-2002	011	10	50	50	2.0	2.0	6116	6106	0205
325240	16-12-2002	011	10	50	50	2.0	2.0	6116	6106	0205
325250	16-12-2002	011	10	50	50	3.0	3.0	6116	6106	0205
325260	16-12-2002	011	10	50	50	3.0	3.0	6116	6106	0205
325270	16-12-2002	011	10	50	49	3.0	3.0	6116	6106	0205
325280	16-12-2002	011	10	50	50	3.0	3.0	6116	6106	0205
325290	16-12-2002	011	10	50	50	3.0	3.0	6116	6106	0205
325300	16-12-2002	011	10	50	50	3.0	3.0	6116	6106	0205
350050	17-12-2002	037	10	50	50	2.0	2.0	6107	6109	0211
350060	17-12-2002	037	10	50	50	1.0	1.5	6107	6109	0211

350070	17-12-2002	037	10	49	49	1.0	2.0	6107	6109	0211
350080	17-12-2002	037	10	50	50	1.0	1.0	6107	6109	0211
350090	17-12-2002	037	10	50	50	1.0	1.0	6107	6109	0211
350100	17-12-2002	037	10	50	50	1.0	1.0	6107	6109	0211
350110	17-12-2002	037	10	50	50	1.0	1.0	6107	6109	0211
350120	17-12-2002	037	10	50	50	1.0	1.0	6107	6109	0211
350130	17-12-2002	037	10	50	50	1.0	1.0	6107	6109	0211
275410	17-12-2002	038	10	50	50	2.5	2.0	6108	6111	0206
275420	17-12-2002	038	10	50	50	2.0	5.0	6108	6111	0206
275430	17-12-2002	038	10	50	50	4.5	3.5	6108	6111	0206
275440	17-12-2002	038	10	50	50	2.0	3.0	6108	6111	0206
275450	17-12-2002	038	10	50	50	2.5	2.5	6108	6111	0206
275460	17-12-2002	038	10	50	50	2.0	2.5	6108	6111	0206
275470	17-12-2002	038	10	50	50	4.0	4.0	6108	6111	0206
275480	17-12-2002	038	10	50	50	2.5	8.0	6108	6111	0206
275490	17-12-2002	038	10	50	50	11	3.0	6108	6111	0206
275500	17-12-2002	038	10	50	50	1.0	1.5	6108	6111	0206
325310	17-12-2002	011	10	50	50	6.0	6.0	6116	6106	0205
325320	17-12-2002	011	10	50	50	2.0	2.0	6116	6106	0205
325330	17-12-2002	011	10	50	44	2.0	5.0	6116	6106	0205
325340	17-12-2002	011	10	50	50	2.0	1.0	6116	6106	0205
325350	17-12-2002	011	10	46	50	2.0	2.0	6116	6106	0205
325360	17-12-2002	011	10	46	50	2.0	3.0	6116	6106	0205
325370	17-12-2002	011	10	50	48	2.0	2.0	6116	6106	0205
325380	17-12-2002	011	10	50	50	2.0	2.0	6116	6106	0205
325390	17-12-2002	011	10	50	40	1.0	1.0	6116	6106	0205
350140	18-12-2002	037	10	50	50	4.0	7.5	6107	6109	0211
350150	18-12-2002	037	10	50	50	3.0	2.0	6107	6109	0211
350160	18-12-2002	037	10	50	50	8.0	5.0	6107	6109	0211
350170	18-12-2002	037	10	49	44	7.0	2.5	6107	6109	0211
350180	18-12-2002	037	10	50	50	2.0	2.0	6107	6109	0211
350190	18-12-2002	037	10	50	50	2.0	2.0	6107	6109	0211
350200	18-12-2002	037	10	48	49	8.0	2.0	6107	6109	0211
350210	18-12-2002	037	10	50	50	1.0	3.0	6107	6109	0211
350220	18-12-2002	037	10	50	50	2.0	1.0	6107	6109	0211
300500	18-12-2002	038	10	50	50	1.5	2.0	6108	6111	0206
300490	18-12-2002	038	10	50	50	7.0	2.0	6108	6111	0206
300480	18-12-2002	038	10	50	50	8.0	2.0	6108	6111	0206
300470	18-12-2002	038	10	50	50	1.5	2.5	6108	6111	0206
300460	18-12-2002	038	10	50	50	3.5	9.0	6108	6111	0206
300450	18-12-2002	038	10	50	50	2.0	6.0	6108	6111	0206
300440	18-12-2002	038	10	50	50	7.0	6.0	6108	6111	0206
300430	18-12-2002	038	10	50	50	2.0	1.5	6108	6111	0206
325400	18-12-2002	011	10	50	50	4.0	6.0	6116	6106	0205
325410	18-12-2002	011	10	50	50	3.0	3.0	6116	6106	0205
325420	18-12-2002	011	10	50	50	4.0	4.0	6116	6106	0205
325430	18-12-2002	011	10	50	50	2.0	2.0	6116	6106	0205
325440	18-12-2002	011	10	50	50	3.0	3.0	6116	6106	0205
325450	18-12-2002	011	10	50	50	3.0	3.0	6116	6106	0205
325460	18-12-2002	011	10	50	50	4.0	7.0	6116	6106	0205
325470	18-12-2002	011	10	50	50	4.0	4.0	6116	6106	0205

325480	18-12-2002	011	10	50	50	4.0	4.0	6116	6106	0205
350230	19-12-2002	037	10	50	50	3.0	7.0	6107	6109	0211
350240	19-12-2002	037	10	50	50	1.0	1.0	6107	6109	0211
350250	19-12-2002	037	10	50	50	2.0	2.0	6107	6109	0211
350260	19-12-2002	037	10	50	50	3.0	3.0	6107	6109	0211
350270	19-12-2002	037	10	50	50	3.0	2.0	6107	6109	0211
350280	19-12-2002	037	10	50	50	2.0	2.0	6107	6109	0211
350290	19-12-2002	037	10	50	50	1.0	2.0	6107	6109	0211
350300	19-12-2002	037	10	50	49	1.0	1.0	6107	6109	0211
350310	19-12-2002	037	10	50	50	1.0	1.0	6107	6109	0211
300420	19-12-2002	038	10	50	50	2.0	3.5	6108	6111	0206
300410	19-12-2002	038	10	50	50	8.0	5.5	6108	6111	0206
300400	19-12-2002	038	10	50	50	6.0	9.0	6108	6111	0206
300390	19-12-2002	038	10	50	50	12	5.0	6108	6111	0206
300380	19-12-2002	038	10	50	50	3.5	20	6108	6111	0206
300370	19-12-2002	038	10	50	50	7.0	4.0	6108	6111	0206
300360	19-12-2002	038	10	50	50	4.5	3.0	6108	6111	0206
300350	19-12-2002	038	10	50	50	4.5	3.5	6108	6111	0206
300340	19-12-2002	038	10	50	50	2.0	4.5	6108	6111	0206
325490	19-12-2002	011	10	47	50	3.0	1.5	6116	6106	0205
325500	19-12-2002	011	10	50	50	3.0	2.0	6116	6106	0205
350500	19-12-2002	011	10	50	50	1.5	1.0	6116	6106	0205
350490	19-12-2002	011	10	50	50	1.0	1.0	6116	6106	0205
350480	19-12-2002	011	10	50	50	1.5	1.5	6116	6106	0205
350470	19-12-2002	011	10	50	47	2.5	1.0	6116	6106	0205
350460	19-12-2002	011	10	50	47	1.0	1.0	6116	6106	0205
350450	19-12-2002	011	10	50	50	1.0	1.5	6116	6106	0205
350310	20-12-2002	037	10	50	50	1.0	1.0	6107	6109	0211
375370	20-12-2002	037	10	50	50	1.0	1.0	6107	6109	0211
375360	20-12-2002	037	10	50	50	1.0	1.0	6107	6109	0211
375350	20-12-2002	037	10	50	50	2.0	2.0	6107	6109	0211
300330	20-12-2002	038	10	50	50	8.0	3.0	6108	6111	0206
300320	20-12-2002	038	10	50	50	9.0	2.0	6108	6111	0206
300310	20-12-2002	038	10	50	50	6.0	7.0	6108	6111	0206
300300	20-12-2002	038	10	50	50	2.5	2.5	6108	6111	0206
300290	20-12-2002	038	10	50	50	10	1.5	6108	6111	0206
350440	20-12-2002	011	10	50	50	2.0	2.0	6116	6106	0205
350430	20-12-2002	011	10	50	50	1.0	2.0	6116	6106	0205
350450	20-12-2002	011	10	50	50	2.0	2.0	6116	6106	0205
350420	20-12-2002	011	10	50	50	2.0	2.0	6116	6106	0205
375490	04-01-2003	037	10	50	50	2.0	3.0	6108	6111	0206
375480	04-01-2003	037	10	50	50	1.0	1.0	6108	6111	0206
375470	04-01-2003	037	10	50	50	1.0	1.0	6108	6111	0206
375460	04-01-2003	037	10	50	50	2.0	1.0	6108	6111	0206
375450	04-01-2003	037	10	50	45	1.0	1.0	6108	6111	0206
325080	04-01-2003	038	10	50	50	3.0	3.0	6116	6106	0205
325070	04-01-2003	038	10	50	50	1.0	2.0	6116	6106	0205
325060	04-01-2003	038	10	46	50	0.5	0.5	6116	6106	0205
300070	04-01-2003	038	10	50	50	1.0	1.0	6116	6106	0205
300080	04-01-2003	038	10	50	50	1.0	2.0	6116	6106	0205
300090	04-01-2003	038	10	50	46	1.0	1.0	6116	6106	0205

300100	04-01-2003	038	10	50	48	2.0	2.0	6116	6106	0205
300110	04-01-2003	038	10	50	48	2.0	2.0	6116	6106	0205
375440	05-01-2003	037	10	50	50	1.0	2.0	6108	6111	0206
375430	05-01-2003	037	10	50	50	2.0	2.0	6108	6111	0206
375420	05-01-2003	037	10	50	50	2.0	2.0	6108	6111	0206
375410	05-01-2003	037	10	50	50	2.0	1.0	6108	6111	0206
375400	05-01-2003	037	10	50	50	2.0	3.5	6108	6111	0206
375390	05-01-2003	037	10	50	50	2.5	3.5	6108	6111	0206
375380	05-01-2003	037	10	50	50	1.0	1.0	6108	6111	0206
375370	05-01-2003	037	10	50	50	2.0	1.0	6108	6111	0206
300120	05-01-2003	038	10	50	49	1.0	1.0	6116	6106	0205
300130	05-01-2003	038	10	50	50	1.0	1.0	6116	6106	0205
300140	05-01-2003	038	10	50	50	1.0	1.0	6116	6106	0205
300150	05-01-2003	038	10	50	50	2.0	2.0	6116	6106	0205
300160	05-01-2003	038	10	50	50	2.0	2.0	6116	6106	0205
300170	05-01-2003	038	10	50	50	2.0	2.0	6116	6106	0205
300180	05-01-2003	038	10	50	50	1.0	1.0	6116	6106	0205
300190	05-01-2003	038	10	50	50	1.0	1.0	6116	6106	0205
300200	05-01-2003	038	10	50	50	2.0	2.0	6116	6106	0205
300210	05-01-2003	038	10	50	50	2.0	2.0	6116	6106	0205
350320	06-01-2003	037	10	50	46	2.5	3.5	6108	6111	0206
350330	06-01-2003	037	10	50	50	2.5	1.0	6108	6111	0206
350340	06-01-2003	037	10	50	50	2.0	2.0	6108	6111	0206
350350	06-01-2003	037	10	50	50	2.0	2.0	6108	6111	0206
350360	06-01-2003	037	10	50	50	3.0	1.0	6108	6111	0206
350370	06-01-2003	037	10	50	48	1.5	1.5	6108	6111	0206
350380	06-01-2003	037	10	50	50	1.0	1.0	6108	6111	0206
350390	06-01-2003	037	10	50	50	1.0	2.0	6108	6111	0206
350400	06-01-2003	037	10	50	50	1.0	1.0	6108	6111	0206
350410	06-01-2003	037	10	50	50	0.5	0.5	6108	6111	0206
300220	06-01-2003	038	10	50	50	1.0	1.0	6116	6106	0205
300230	06-01-2003	038	10	50	50	1.0	1.0	6116	6106	0205
300240	06-01-2003	038	10	46	49	1.0	1.0	6116	6106	0205
300250	06-01-2003	038	10	50	50	1.0	1.0	6116	6106	0205
300260	06-01-2003	038	10	50	49	1.0	2.0	6116	6106	0205
300270	06-01-2003	038	10	50	48	1.0	1.0	6116	6106	0205
300280	06-01-2003	038	10	50	50	1.0	1.0	6116	6106	0205
125180	06-01-2003	038	10	48	50	1.0	1.0	6116	6106	0205
375320	07-01-2003	037	10	50	50	3.0	4.0	6108	6111	0206
375330	07-01-2003	037	10	50	50	4.0	5.0	6108	6111	0206
375340	07-01-2003	037	10	50	50	3.0	3.0	6108	6111	0206
350300	07-01-2003	037	10	50	49	1.0	1.5	6108	6111	0206
350290	07-01-2003	037	10	50	50	0.5	2.0	6108	6111	0206
350280	07-01-2003	037	10	50	50	2.0	2.0	6108	6111	0206
350270	07-01-2003	037	10	50	50	1.5	2.5	6108	6111	0206
350260	07-01-2003	037	10	50	50	3.0	3.0	6108	6111	0206
025170	07-01-2003	038	10	50	50	1.0	1.0	6116	6106	0205
225380	07-01-2003	038	10	50	50	1.0	1.0	6116	6106	0205
150450	07-01-2003	038	10	50	50	2.0	2.0	6116	6106	0205
150460	07-01-2003	038	10	50	50	2.0	2.0	6116	6106	0205
150470	07-01-2003	038	10	50	50	2.0	2.0	6116	6106	0205

350250	08-01-2003	037	10	50	50	1.0	1.0	6108	6111	0206
350240	08-01-2003	037	10	50	50	3.0	1.0	6108	6111	0206
350230	08-01-2003	037	10	50	50	2.0	2.0	6108	6111	0206
300280	08-01-2003	037	10	50	50	1.0	1.0	6108	6111	0206
300270	08-01-2003	037	10	50	50	1.0	1.0	6108	6111	0206
300260	08-01-2003	037	10	50	50	1.0	1.0	6108	6111	0206
300250	08-01-2003	037	10	49	50	1.0	1.0	6108	6111	0206
300240	08-01-2003	037	10	50	50	1.0	1.0	6108	6111	0206
300230	08-01-2003	037	10	50	50	1.0	1.0	6108	6111	0206
150480	08-01-2003	038	10	50	50	2.0	2.0	6116	6106	0205
150490	08-01-2003	038	10	50	50	3.0	3.0	6116	6106	0205
150500	08-01-2003	038	10	50	50	3.0	3.0	6116	6106	0205
125500	08-01-2003	038	10	50	47	3.0	3.0	6116	6106	0205
125490	08-01-2003	038	10	50	47	4.0	4.0	6116	6106	0205
125480	08-01-2003	038	10	50	50	4.0	5.0	6116	6106	0205
125470	08-01-2003	038	10	50	50	3.0	3.0	6116	6106	0205
125460	08-01-2003	038	10	47	50	9.0	9.0	6116	6106	0205
300220	09-01-2003	037	10	50	50	1.0	1.0	6108	6111	0206
300210	09-01-2003	037	10	50	50	1.0	1.0	6108	6111	0206
300200	09-01-2003	037	10	50	50	1.0	2.0	6108	6111	0206
300190	09-01-2003	037	10	50	50	1.0	1.0	6108	6111	0206
300180	09-01-2003	037	10	50	50	1.0	2.5	6108	6111	0206
300340	09-01-2003	037	10	50	50	1.0	3.0	6108	6111	0206
300350	09-01-2003	037	10	50	50	2.0	2.0	6108	6111	0206
300360	09-01-2003	037	10	50	50	2.0	1.0	6108	6111	0206
300370	09-01-2003	037	10	50	50	2.0	1.0	6108	6111	0206
125450	09-01-2003	038	10	50	50	6.0	7.0	6116	6106	0205
125440	09-01-2003	038	10	50	50	2.0	2.0	6116	6106	0205
025370	09-01-2003	038	10	50	50	2.0	2.0	6116	6106	0205
000280	09-01-2003	038	10	50	50	1.0	1.0	6116	6106	0205
125180	09-01-2003	038	10	49	50	1.0	1.0	6116	6106	0205
300380	10-01-2003	037	10	50	50	1.0	3.0	6108	6111	0206
300390	10-01-2003	037	10	50	50	9.0	3.0	6108	6111	0206
300400	10-01-2003	037	10	50	50	3.0	3.0	6108	6111	0206
300410	10-01-2003	037	10	50	50	2.0	1.0	6108	6111	0206
300420	10-01-2003	037	10	50	50	2.0	4.0	6108	6111	0206
224380	10-01-2003	037	10	50	50	2.0	1.0	6108	6111	0206
325490	09-01-2003	038	10	47	44	1.0	1.0	6116	6106	0205
325500	09-01-2003	038	10	50	50	1.0	1.0	6116	6106	0205
350500	09-01-2003	038	10	50	50	1.0	1.0	6116	6106	0205
350490	09-01-2003	038	10	50	50	1.0	1.0	6116	6106	0205
350480	09-01-2003	038	10	50	50	1.0	1.0	6116	6106	0205
350470	09-01-2003	038	10	50	46	1.0	1.0	6116	6106	0205
350460	09-01-2003	038	10	50	47	1.0	1.0	6116	6106	0205

3.3. DATA FORMATS

Original field data were archived in time-series files in a mixed binary format as written by the Metronix acquisition program GMS183b. All times series data are stored in a directory corresponding to the site name within a directory designated by the date of acquisition. Individual files within the directory follow the convention.

ssscrrtb.ATS
where:

sss = ADU06 serial number
c = ADU06 channel number (a=1..h=8)
rr = Run number
t = channel type (a=Ex, b=Ey, x=Hx, y=Hy, z=Hz)
b = Sample rate (a=40960, b=4096, c=64, f=2048 or 512 Hz)

3.4. EDI FILES:

XXXYYY.EDI, defines an EDI file obtained by robust processing.
Where XXX = grid easting in units of 10m
and YY = grid northing in units of 10m

The 250m x 100m survey grid was rotated aproximately 10° east.

Data were normally archived in the following formats:
SEG-Electromagnetic Data Interchange (EDI) format containing all MT parameters;
Binary files in Metronix GMS183b format containing acquisition information and time-series.
The SEG MT/EMAP Data Interchange Standard is described in Wight, 1988. Since this is an extremely lengthy standard (91 pages), the reader is referred to that document for details.

METRONIX TIME SERIES: ATS FORMAT

Byte off-set	ADR	Byte	Type	Name	Info
1	000H	2	INTEGER	Header Length	Length of Header in Byte
3	002H	2	INTEGER	Header Version	Version Number of Header (*100)[4]
5	004H	4	LONGINT	Samples	Number of Samples
9	008H	4	SINGLE	Sample Freq.	Sample Frequency
13	00CH	4	LONGINT		Start Time of Measurement (in seconds since 1.1.70)
17	010H	8	DOUBLE	LSBV	LSB Unit in mV[2]
25	018H	8	BYTE	Reserved	Reserved
33	020H	2	INTEGER		Serial number of ADU06
35	022H	2	INTEGER		Serial number of ADB06 (ADC Board)
37	024H	1	BYTE		Channel number (0...7)
38	025h	1	BYTE	Reserved	Reserved
39	026h	2	CHAR		Channel Type (Ex,Ey,Hx,Hy,Hz)
41	028H	6	CHAR		Sensor Type (MFS05, BF4...)
47	02EH	2	INTEGER		Serial number of sensor
49	030H	4	SINGLE		x1 coordinates of Dipole(m)
53	034H	4	SINGLE		y1
57	038H	4	SINGLE		z2
61	03CH	4	SINGLE		x2 coordinates of Dipole (m)
65	040H	4	SINGLE		y2
69	044H	4	SINGLE		z2
73	048H	4	SINGLE		e-field dipole length (m)
77	04CH	4	SINGLE		Angle (0°=north) (degrees °)
81	050H	4	SINGLE		Probe resistivity (ohm)
85	054H	4	SINGLE		DC offset voltage[3] (mV)
89	058H	4	SINGLE		Internal gain amplification (1 or 30)[4]
93	05CH	4	BYTE		Reserved
97	060H	4	LONG		Latitude (msec)
101	064H	4	LONG		Longitude (msec)

105	068H	4	LONG		Elevation (cm)
109	06CH	1	CHAR		Lat/Long Type: 'U' user defined, 'G' internal GPS clock
110	06DH	1	CHAR		Type of additional coordinates: 'U' UTM 'G' Gauss-Kruger
111	06EH	2	INTEGER		Reference median
113	070H	8	DOUBLE		X coordinate
121	078H	8	DOUBLE		Y coordinate
129	080H	1	CHAR		GPS/CLK status: 'G' GPS locked, 'C' CLK synchronized, 'N' CLK not synchronized
130	089H	1	BYTE		Approximate accuracy of GPS/CLK: 9 means accuracy of 10^9
131	082H	14	BYTE		Reserved
145	090H	12	CHAR		Survey header file name
157	09CH	4	CHAR		Type of measurement: MT or CSAMT
161	0A0H	12	CHAR		Log file of system self test
173	0ACH	2	CHAR		Result of self test 'OK' or 'NO'
175	0AEH	2	BYTE		Reserved
177	0B0H	2	INTEGER		Number of calibration frequencies in file
179	0B2H	2	INTEGER		Length of frequency entry (32 byte)
181	0B4H	2	INTEGER		Version of calibration format (*100)
183	0B6H	2	INTEGER		Start address of calibration information in header (400H)
185	0B8H	8	BYTE		Reserved
193	0C0H	12	CHAR		File name of ADU06 cal file
205	0CCH	4	LONG		Date/time of calibration
209	0D0H	12	CHAR		File name of sensor calibration
221	0DCH	4	LONG		Date/time of calibration
225	0E0H	4	SINGLE		Power-line freq. 1
229	0E4H	4	SINGLE		Power-line freq.2
233	0E8H	8	BYTE		Reserved
241	0F0H	4	SINGLE		CSAMT transmitter frequency
245	0F4H	2	INTEGER		CSAMT time series block
247	0F6H	2	INTEGER		CSAMT stacks/block
249	0F8H	4	LONG		CSAMT block length
253	0FCH	4	BYTE		Reserved
257	100H	16	CHAR		Client
273	110H	16	CHAR		Contractor
289	120H	16	CHAR		Area
305	130H	16	CHAR		Survey ID
321	140H	16	CHAR		Operator
337	150h	112	CHAR		Reserved
449	1C0H	64	CHAR		Weather
513	200H	512	CHAR		Comments
1025	400H	32			Calibration frequency 1
1025	400H	4	SINGLE		Frequency
1029	404H	4	SINGLE		Amplitude: e-field (V) - h-field (nT/V)
1033	408H	4	SINGLE		Phase (degrees)
1037	40ch	4	SINGLE		Accuracy of amplitude (%)
1041	410H	4	SINGLE		Accuracy of phase (+/- degrees)
1045	414H	12	BYTE		Reserved
1057	420H	32			Calibration frequency 2
	400H+(n.1)*20H	32			Calibration frequency n
	400H+n*20H	4 Samples	LONGINT		Time series data

APPENDIX 4 MT PARAMETERS

4.1. OVERVIEW

The magnetotelluric method is a means of determining the resistivity distribution of the earth through the measurement of time varying electric and magnetic fields at the surface. At each MT site, data from five channels are recorded as a function of time, which is referred to as time series. These channels are indicated in the following figure, and correspond to three orthogonal magnetic field components (designated H_x, H_y, and H_z), and two horizontal electric field components (designated E_x and E_y). Note that a right-hand coordinate system is used and z is positive downwards.

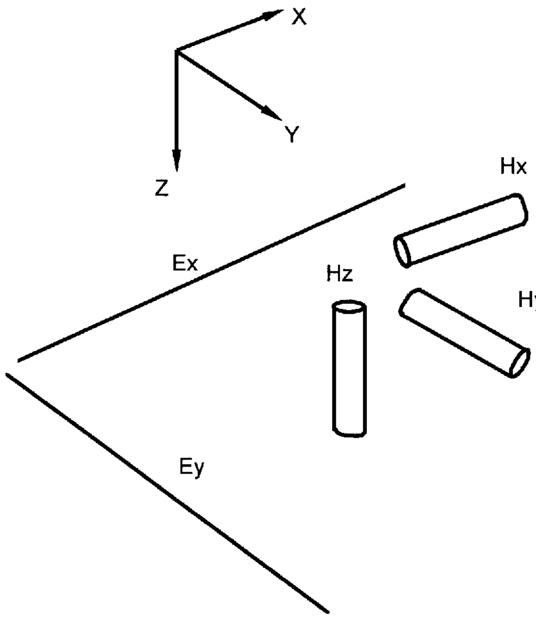
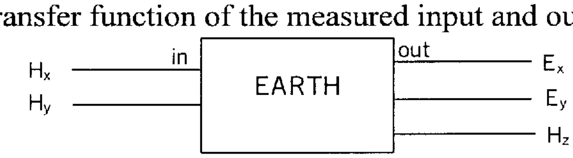


Figure 4.1: Coordinate axes and component identifications for 5-component MT site.

As an electromagnetic method, magnetotelluric depends on Maxwell's law stating that a time-varying magnetic field induces an electric field in a conductor. The source fields are the time-varying horizontal magnetic fields (H_x and H_y), which are generated by two distinct phenomena. The high frequency source fields, greater than 1 Hz, are generated by lightning discharges of distant electrical storms. The low frequency source fields are generated by the interaction of charged particles, solar wind, with the earth's ionosphere. The output of the source fields convolved with the earth consists of the horizontal electric field (E_x, and E_y) and the vertical magnetic field (H_z). Thus, ideally, the electrical nature of the earth (i.e. the impedance) can be determined through the transfer function of the measured input and output signals.



4.2. MEASURED QUANTITIES

The actual parameters measured in the field are the time-varying voltage outputs of the electric and magnetic field sensors: E_x, E_y, H_x, H_y, and H_z. Data were recorded in 2 bands, 40960 and 2048 Hz sample rates.

4.3. COMPUTED FUNCTIONS

The measured parameters, the electric and magnetic field values, are transformed into the frequency domain using FFT procedures, and convolved with the sensor responses to give the complex values of electric and magnetic fields at specific frequencies.

The resulting Fourier-transformed spectral estimates are combined into a spectral crosspower matrix relating all of the measured electromagnetic fields at discrete frequency values. If the spectral values of two channels at frequency f_j in the channel bounded by frequencies between f_{j-m} and f_{j+m} are A and B (complex numbers), then

$$\langle A(f_j), A(f_j)\rangle = \frac{1}{2m+1}\sum_{k=j-m}^{j+m} A_k A_k^* = \langle A_k A_k^*\rangle$$

define the autopower $A_j A_j^*$; and

$$\langle A(f_j), B(f_j)\rangle = \frac{1}{2m+1}\sum_{k=j-m}^{j+m} A_k B_k^* = \langle A_k B_k^*\rangle$$

define the crosspower $A_k B_k^*$,where the * indicates the complex conjugate.

The impedance tensor is calculated directly from the crosspower matrix, via relationships of the form

$$Z_{xy} = \frac{\begin{vmatrix} \langle E_x H_x^*\rangle & \langle E_y H_x^*\rangle \\ \langle E_x H_y^*\rangle & \langle E_y H_y^*\rangle \end{vmatrix}}{\begin{vmatrix} \langle H_x H_x^*\rangle & \langle H_y H_x^*\rangle \\ \langle H_x H_y^*\rangle & \langle H_y H_y^*\rangle \end{vmatrix}}$$

The relationships between the five measured components at each site are contained in the impedance tensor (Z_{ij}) and the tipper transfer function (T_i), expressed by:

$$\begin{aligned} E_x &= Z_{xy}H_y + Z_{xx}H_x \\ E_y &= Z_{yx}H_x + Z_{yy}H_y \\ H_z &= T_xH_x + T_yH_y \end{aligned}$$

The impedance tensor and the crosspower matrix are used to derive more practical parameters for interpretation and data quality assessment.

4.4. DATA INTERPRETATION PARAMETERS

The interpretation parameters are calculated using the standard definitions of Vozoff (1991), and are described here in simplified form:

Apparent Resistivity - scaled magnitude of the ratio of each orthogonal E and H pair, with associated variances, i.e.

$$\rho_{ij} = \frac{1}{5f}|Z_{ij}|^2$$

Impedance Phase - impedance phase of each orthogonal E and H pair, with associated variances.
Impedance Rotation - presents rotation direction of Z_{xy} (i.e. it can be a fixed, user-specified rotation angle, or that defined as impedance strike).
Impedance Strike (θ) - angle which minimizes $|Z_{xx}(\theta)|^2 + |Z_{yy}(\theta)|^2$. In an ideal 2-D environment, one component will be parallel to strike (transverse electric, or TE mode), and the other will be perpendicular to strike (transverse magnetic, or TM mode).
Tipper Strike - direction which maximizes the cross power of horizontal and vertical magnetic field components + 90 degrees.
Tipper Magnitude – magnitude of the vertical magnetic field with respect to the total horizontal magnetic field.

$$\text{Tipper} = \text{SQRT}(|T_x|^2 + |T_y|^2)$$

Impedance Skew - impedance tensor ratio, 3-D indicator, invariant with rotation.

$$|Z_{xx}+Z_{yy}|/|Z_{xy}-Z_{yx}|$$

Impedance Ellipticity - impedance tensor ratio, 3-D indicator, dependent upon rotation.

$$|Z_{xx}(\theta)-Z_{yy}(\theta)|/|Z_{xy}(\theta)+Z_{yx}(\theta)|$$

APPENDIX 5 DIGITAL DATA

The accompanying CD contains:

1) unedited EDI impedances
2) WinGLink database
3) this report
4) pdf copies of maps and sections
5) 2D model xyz files

APPENDIX 6 THREE-DIMENSIONAL INVERSION

6.1. AN INTRODUCTION TO 3D MT INVERSION

The general approach to the inversion of geophysical data consists of three steps: the computation of a forward response, the comparison of this with observed data, and the modification of the starting model in light of the differences between observed and computed data. To be reasonably practical, this requires a fast forward code and an efficient approach to inversion.

6.1.1 3-D Forward Modeling

3-D MT data are derived from measurements at Earth's surface of naturally occurring electric and magnetic fields. A standard 3-D MT dataset usually comprises four complex quantities (impedances) as a function of receiver position and frequency. The four impedances observed in 3-D MT, then, are the components of a 2 x 2 impedance tensor. Modeling of the impedance tensor entails solving Maxwell's equations in the solid earth and atmosphere using a horizontal current source in the atmosphere to represent ionospheric and magnetospheric sources. In our modeling algorithm we divide the earth and atmosphere into rectangular blocks with the magnetic fields defined along the block edges and the electric fields defined along the normals to the block faces (Mackie et al., 1994). Finite difference equations can be easily derived using this formulation. If one eliminates the electric fields from the difference equations, one obtains a second-order set of equations in H. This system of equations is sparse, symmetric, and complex (all elements are real except for the diagonal elements). The solution to this system is obtained by use of the stabilized biconjugate gradient algorithm. Convergence is speeded up by use of a preconditioner that is the incomplete Cholesky decomposition of the diagonal sub-blocks with fill-in plus a correction for the divergence of the magnetic field (Mackie et al., 1994). Once the E and H fields have been determined for two linearly-independent source polarizations, the impedance tensor can be computed.

6.1.2 3-D Inversion

The general magnetotelluric inverse problem in posed is canonical form and solved using the framework of Tikhonov regularization (Tikhonov and Arsenin, 1977). Following many previous workers in MT inversion, a smooth, or `minimum-structure', resistivity model that give acceptable fits to the observed data is sought. Thus, using a simple second-order operator, solutions are models with minimum spatial variability, or roughness. The method of nonlinear conjugate gradients (NLCG) is used to minimize the misfit; nonlinear conjugate gradients are a well-known optimization method (Fletcher and Reeves, 1959) which has been applied in a variety of nonlinear geophysical inverse problems, e.g., Ellis and Oldenburg (1994). While NLCG is a general method for optimization, it is not necessarily efficient in a computationally intensive problem like 2-D and 3-D MT inversion. The efficiency of NLCG for computing solutions of the inverse problem depends strongly on the preconditioner and the line minimization algorithm. The purpose of these is to steer the gradient into a direction in model space which parallels the final solution as much as possible. A restriction on this goal is that applying the preconditioner can require an excessive amount of computation if it is too complicated. It is applied to a parameter vector by solving the linear system, and which can therefore be applied efficiently, acting in some sense acts like the inverse Hessian matrix. The amount of computation needed to solve the system is less than one forward function evaluation and thus adds little overhead to the algorithm. Line minimization is only a one-dimensional problem, requiring the computation of at least one forward problem, which in 3-D MT is computationally demanding. It is thus very important to use an algorithm that does a reasonable job in the current search direction with as few trials as possible. Algorithms such as that in Press et al. (1992) do not achieve this goal. In our 3-D MT algorithm, we use a line minimization algorithm that is basically a univariate version of the Gauss-Newton method. While details of this algorithm are given in Rodi and Mackie (2001), the important result of this algorithm is that each step of the line minimization iteration requires the equivalent work of only three MT forward calculations (the real one and two pseudo ones). An additional efficiency is our choice of stopping criterion. It ensures that, when the forward problem is well-approximated by its linear approximation, each line minimization converges in a single step.

The net result is that the observed 3D data (each element of the impedance tensor, at each frequency used) can be inverted to give a smooth 3D model. The method is efficient and fairly fast: an inversion of 20 iterations took approximately 10 hours of CPU time on a 400 MHz computer running the Linux operating system.

6.2. Output data formats

The files associated with the 3D inversions consist of the following:

1. model file, which contains the mesh specifications and the final resistivity values;
2. site file, relating model cells to real station ids;
3. predicted data, in EDI format, that is, the computed impedance responses at each site.
4. interpolated model data.

6.3. Model file

This is an ASCII fixed-format file, which begins in the following form:

```
66 55 24
20000.0000 10000.0000 5000.00000 2000.00000
20000.0000 10000.0000 5000.00000 2000.00000
50.0000000 50.0000000 100.000000
1
1000.01361 1000.08789 1000.08502 1000.07678
1000.09277 1001.36438 994.871033 988.765442
1000.08075 1014.51385 1023.62531 1055.44202
```

In this, the first three figures indicate the number of cells in the x, y, and z directions, and the following three rows list the cell dimensions in meters. The number 1 (fourth row) is a flag indicating that the resistivity values follow, and these are listed in the order of row (x), horizontal column (y), and depth (z) respectively.

6.4. Site file

This is again an ASCII file, in which each station is identified in terms of its cell location (i,j) on the grid which forms the first part of the model file. Thus, station S092E040 is at the center of cell (25,12). This, in turn, is then related to real-world coordinates through the UTM coordinates from the field surveys.

```
S092E040.edi  25  12
S092E048.edi  26  12
S092E056.edi  27  12
S092E064.edi  28  12
S092E072.edi  29  12
S092E080.edi  30  12
```

6.5. Predicted data

The computed responses are output in separate EDI files (Wight, 1988), one per site. These contain the frequencies and computed impedances corresponding to the final 3D inversion model.

6.6. Interpolated data

The 3D model is interpolated onto a regular grid, using one of two different techniques: averaging over a moving volume of radius equal to the inter-station distance, and a non-averaged method in which the value of the 3D model is assigned directly to each interpolated depth point. This latter method results in a rougher grid, and maps of resistivity as a function of depth are presented for the both interpolation techniques in the Plates.

Each (x,y) grid node has a column of z values associated with it. These are combined with the site file and the real-world coordinates to produce a geographically-located file in which all of the

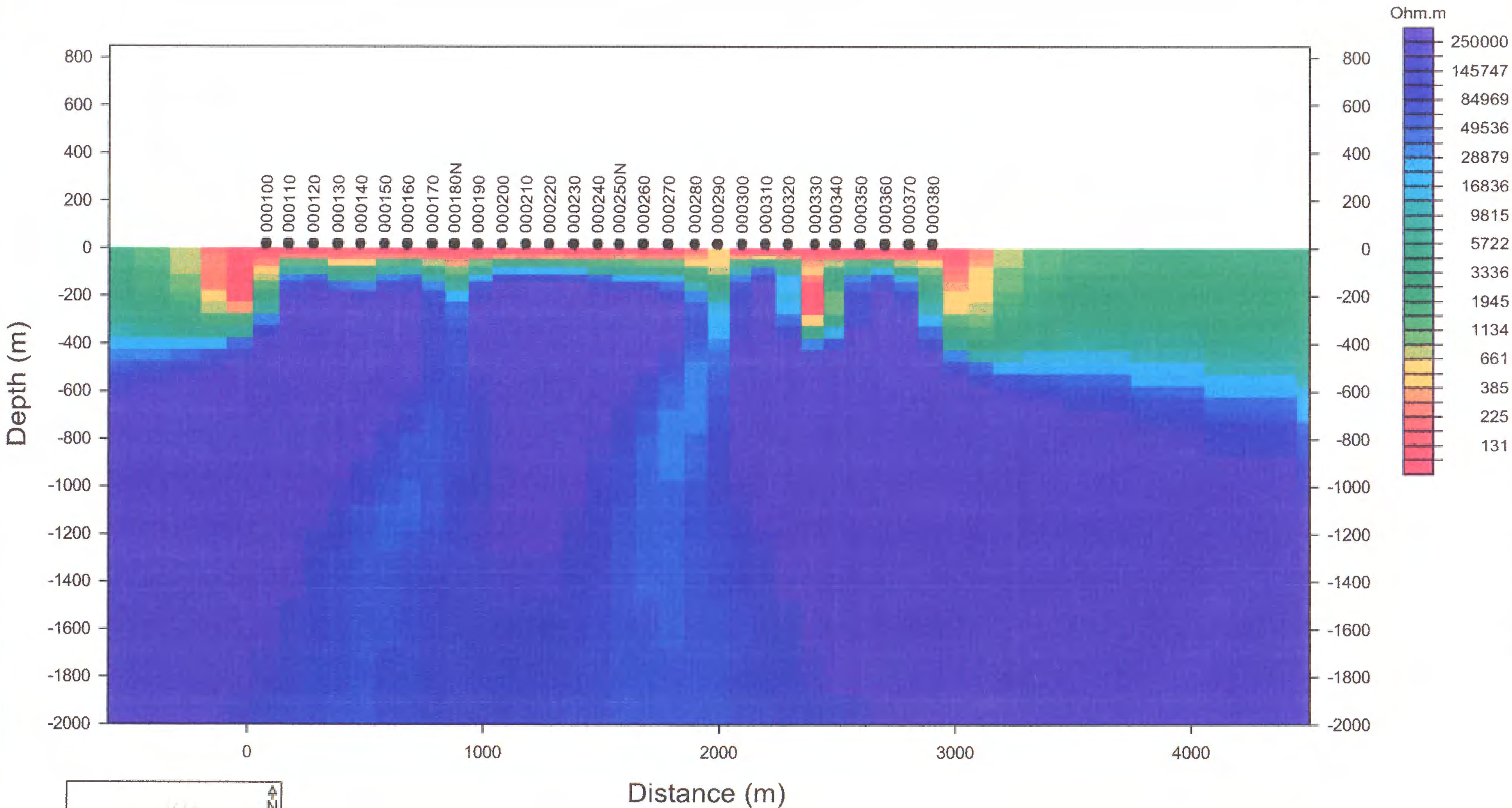
interpolated data are present. This, in turn, can then be used to extract sections or maps.
The interpolated data file, OUT.tgf, is divided into two sections, The first (below) lists interpolated "stations" and their x,y,z coordinates.

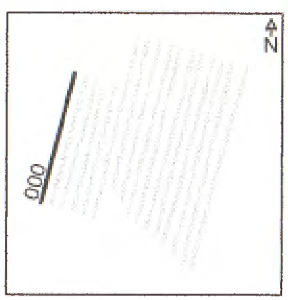
```
<DATA=STAT_COORDS> ; Station Coordinates
; Stat Name, X [Km], Y [Km], Elev. [m]
"ST-    1"          -3460.832          -36995.227          0.00
"ST-    2"          -3214.416          -36995.227          0.00
"ST-    3"          -2968.000          -36995.227          0.00
"ST-    4"          -2721.584          -36995.227          0.00
```

Following this, the data for each "station" are listed in the form shown below, where the two columns are respectively depth in meters and resistivity in Ohm.m.

```
STATION="ST-    1"
 STYPE="APP.res"
 0.00000000E+00 379.3555
 -51.9799995 380.966125
 -103.959999 382.344757
 -155.940002 392.685333
 -207.919998 400.552856
 -259.899994 416.812378
 -311.880005 440.258240
 -363.859985 457.282654
 -415.839996 500.895020
 -467.820007 517.525024
```

These data are finally imported into a WinGLink database as Vertically Distributed Data, which can then be used to extract maps at different depths or sections at any orientation.





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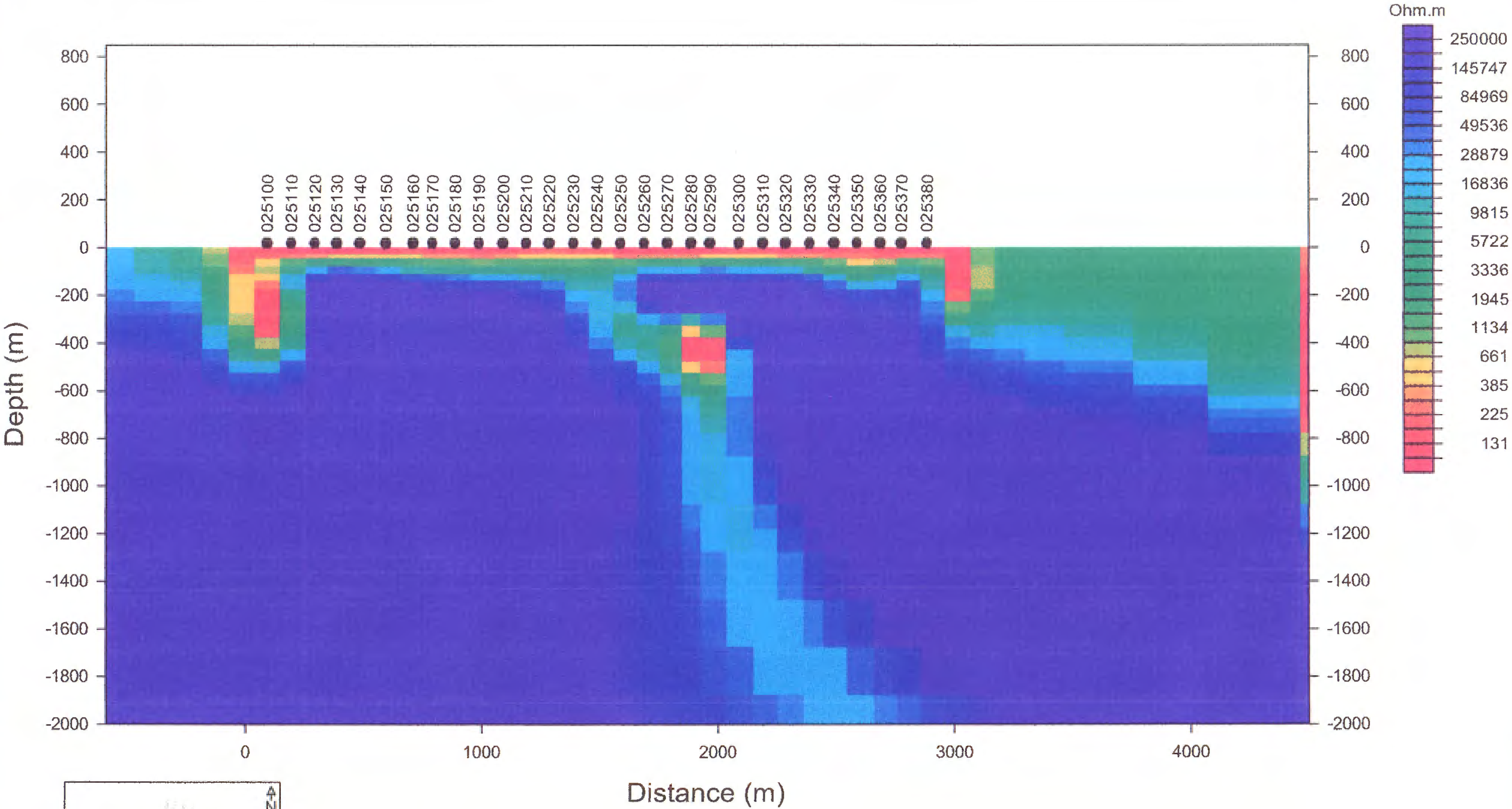
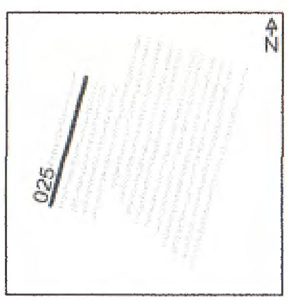
Vertical Scale 1 : 25000

Vertical Exaggeration = 1

Noranda Inc.
Danial J.V., Matagami, Quebec
2D Inversion model profile 000
Geosystem Canada Inc.





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Danial J.V., Matagami, Quebec
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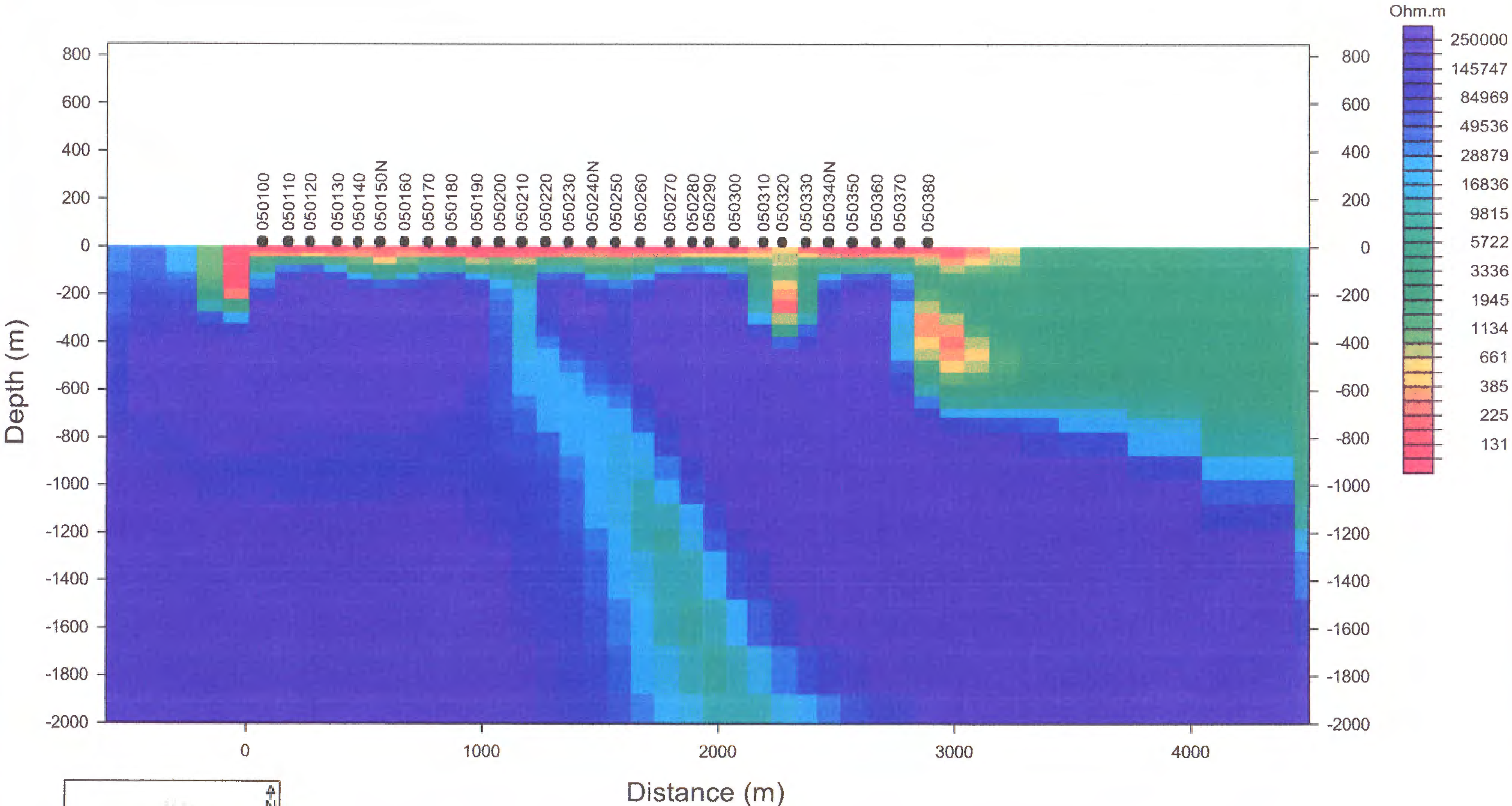

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Noranda Inc.
Danial J.V., Matagami, Quebec
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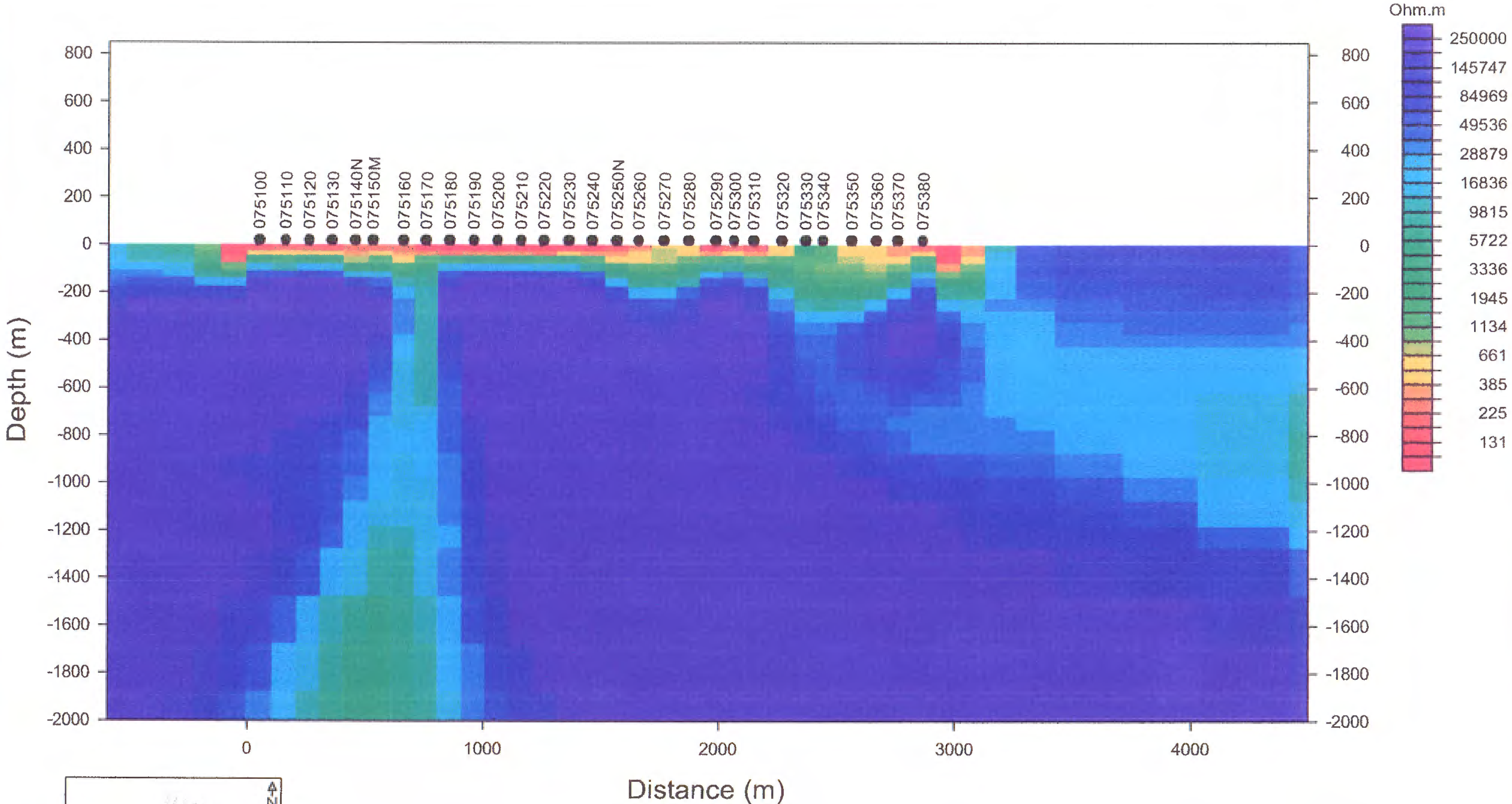

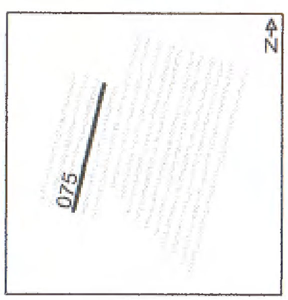

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Vertical Exaggeration = 1

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Danial J.V., Matagami, Quebec
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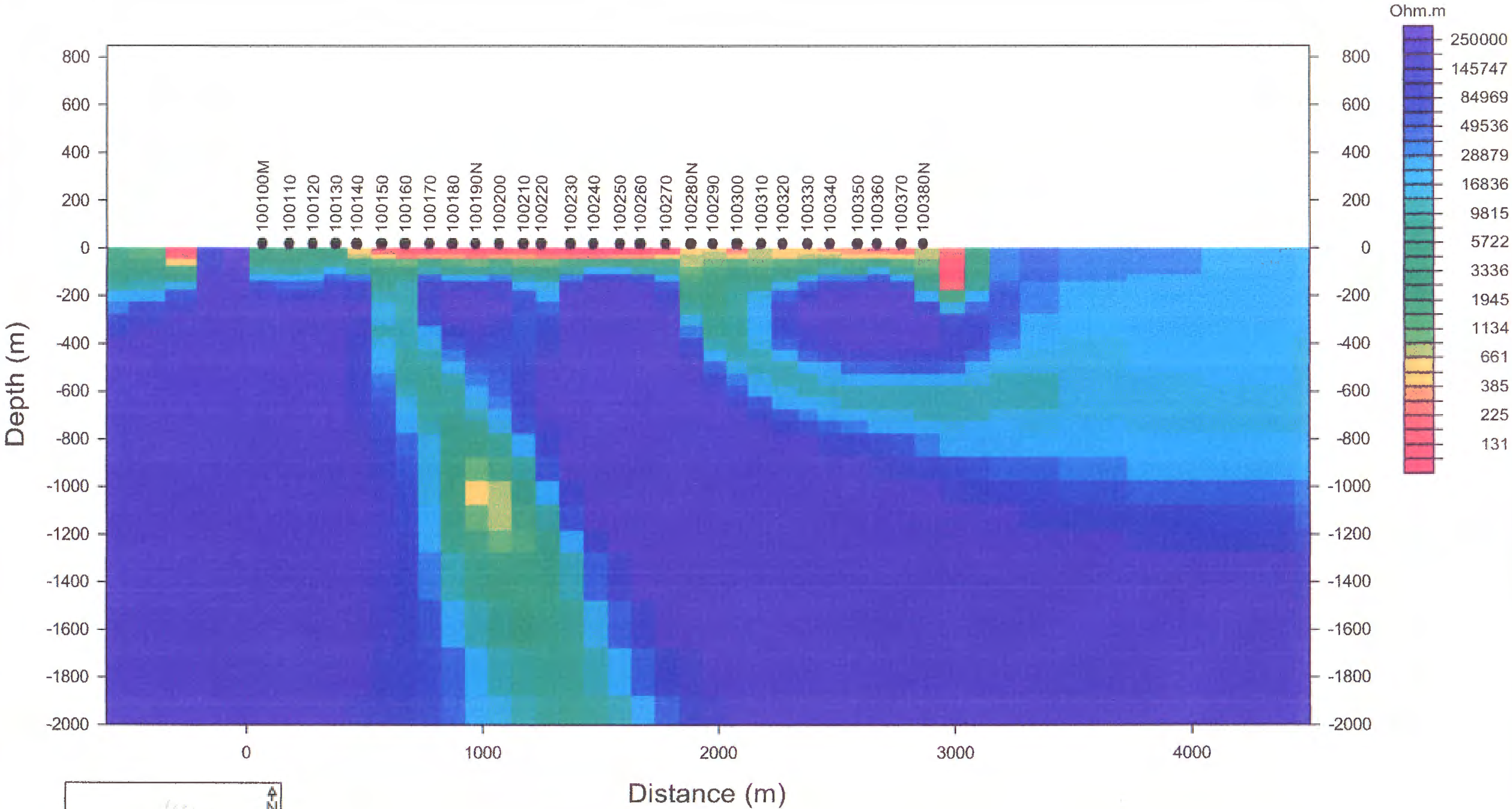
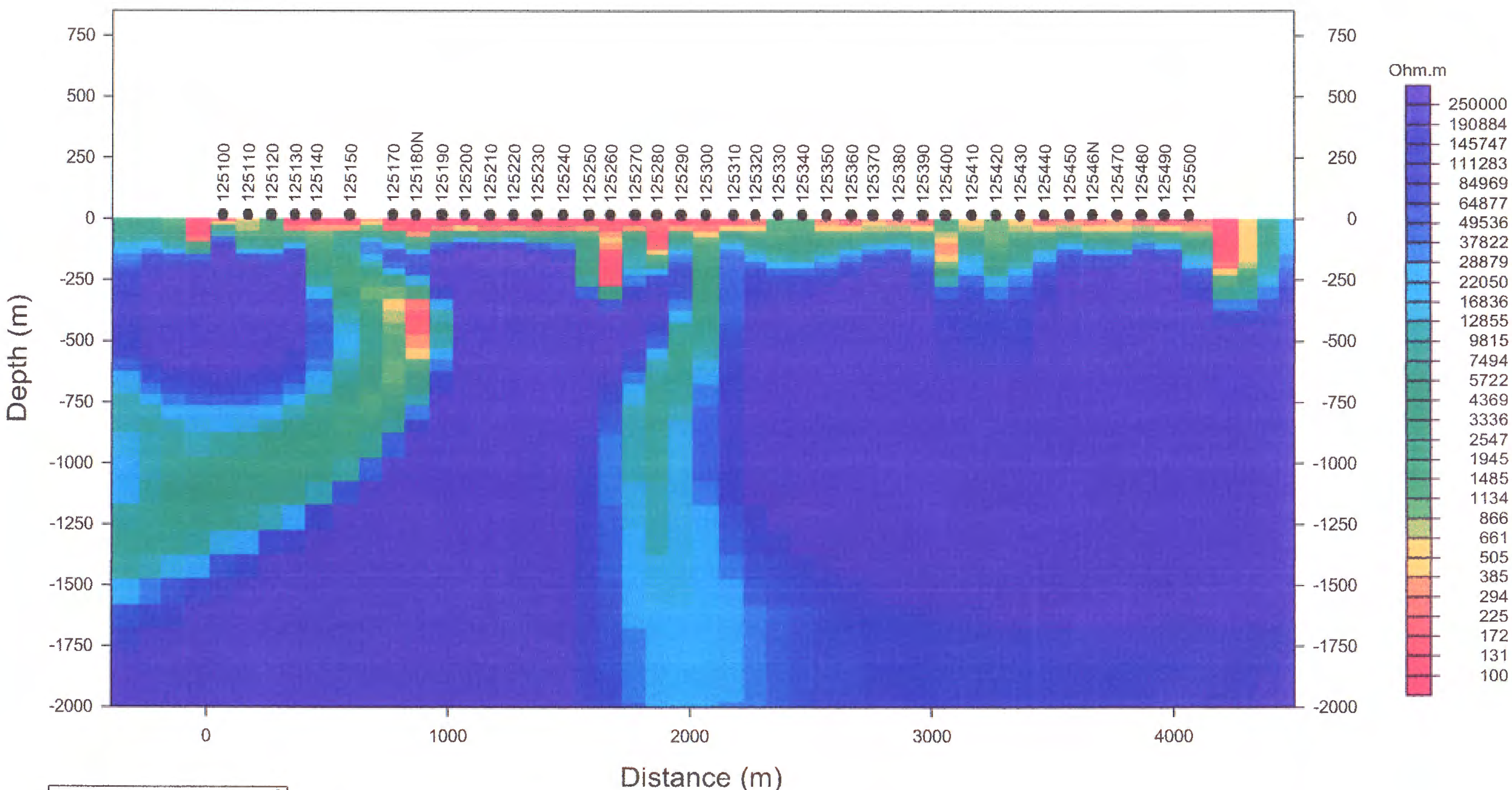


Horizontal Scale 1 : 25000
Vertical Scale 1 : 25000

Vertical Exaggeration = 1

Noranda Inc.
Danial J.V., Matagami, Quebec
2D Inversion model profile 100
Geosystem Canada Inc.



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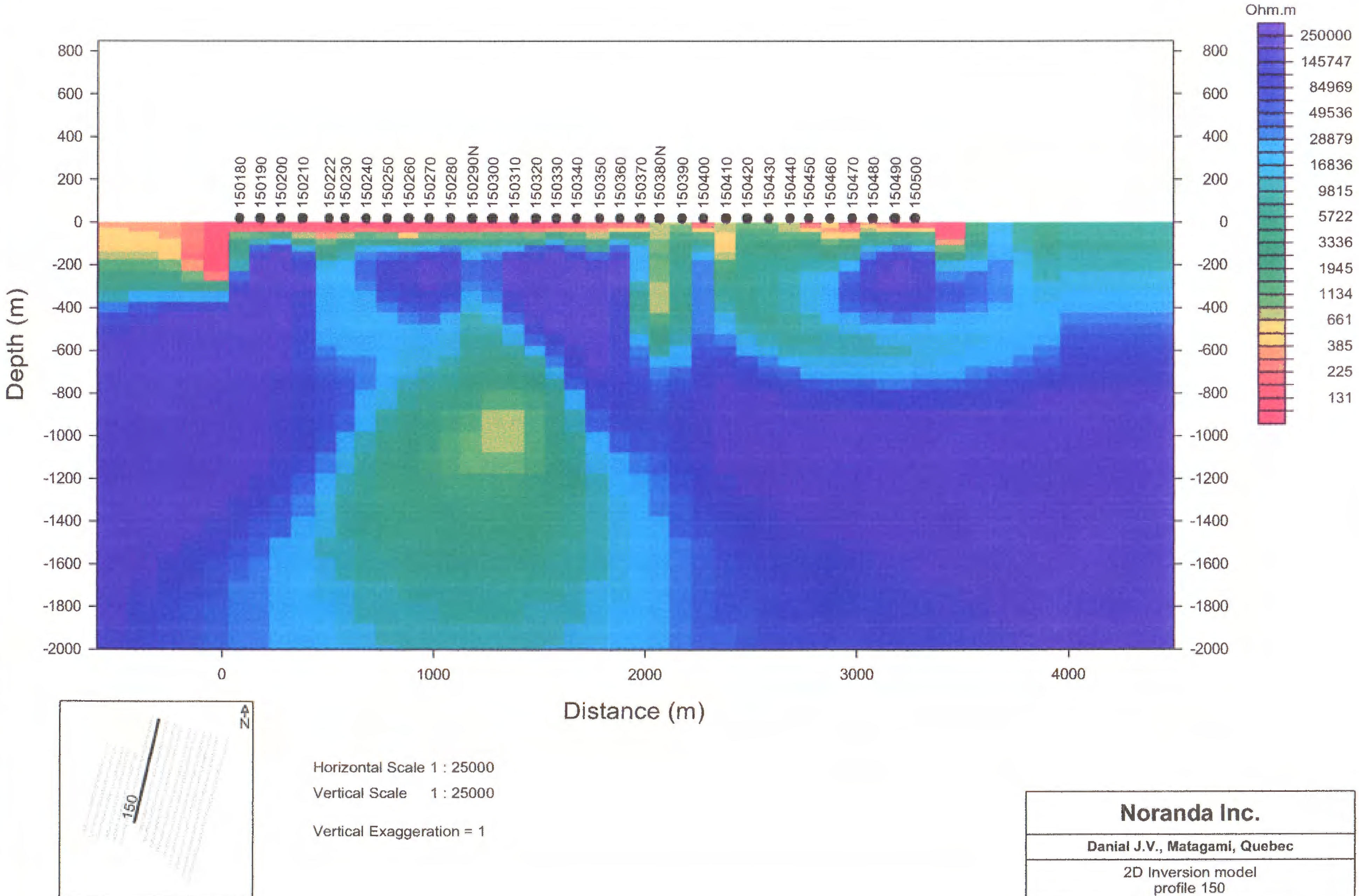
Matagami
Noranda Inc.
Geosystem Canada Inc.
125



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Danial J.V., Matagami, Quebec
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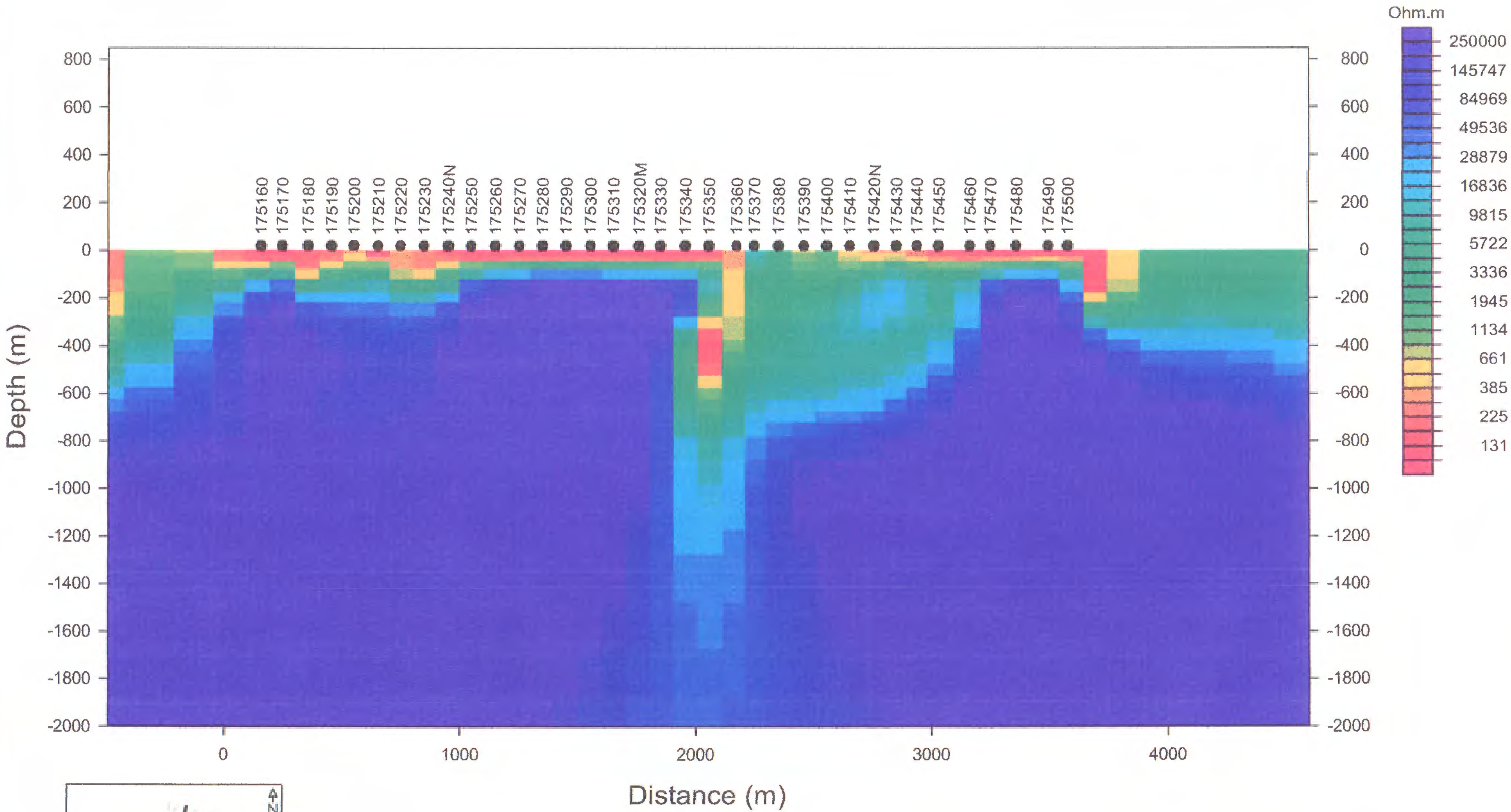

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2D Inversion model
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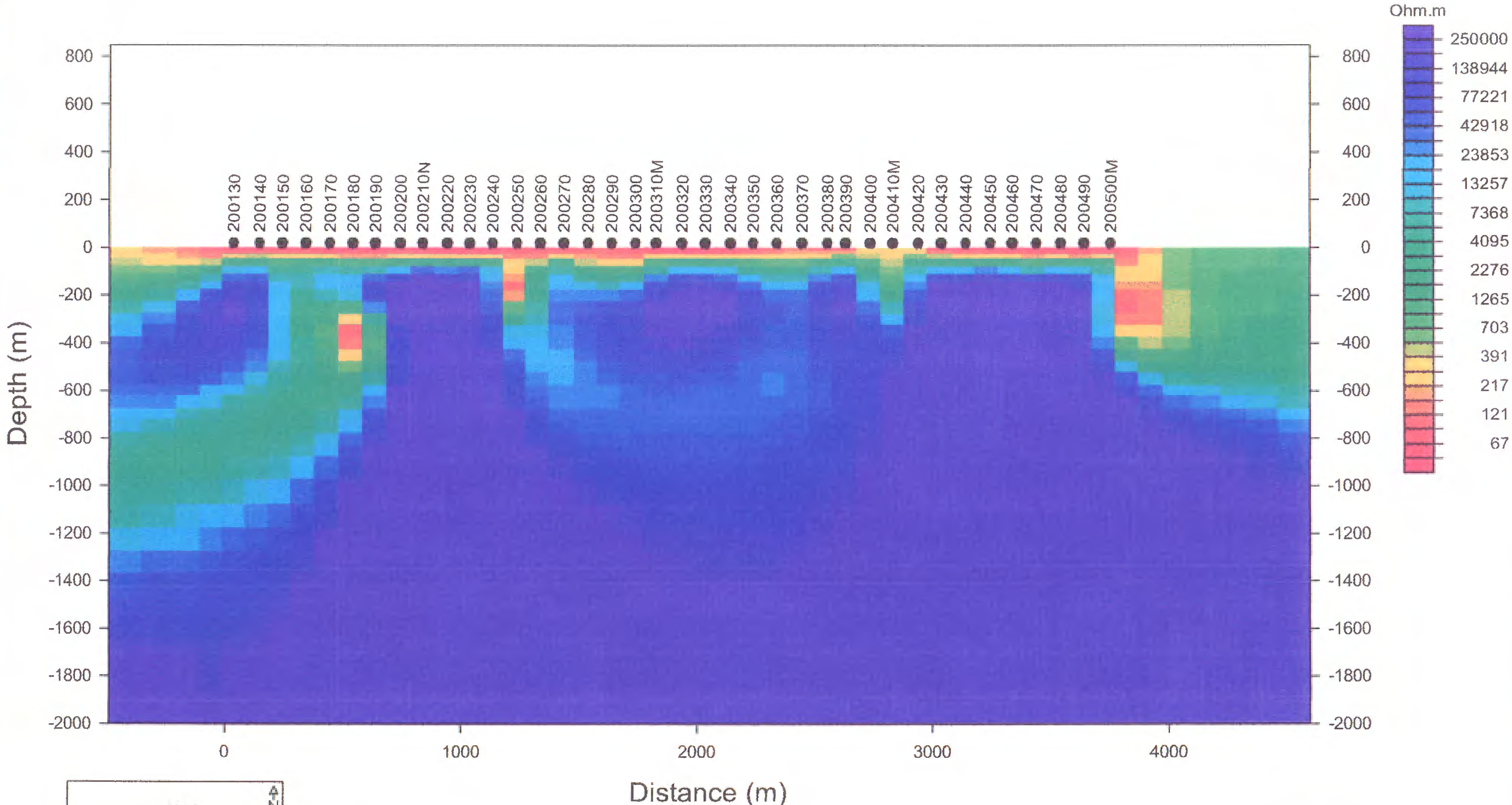

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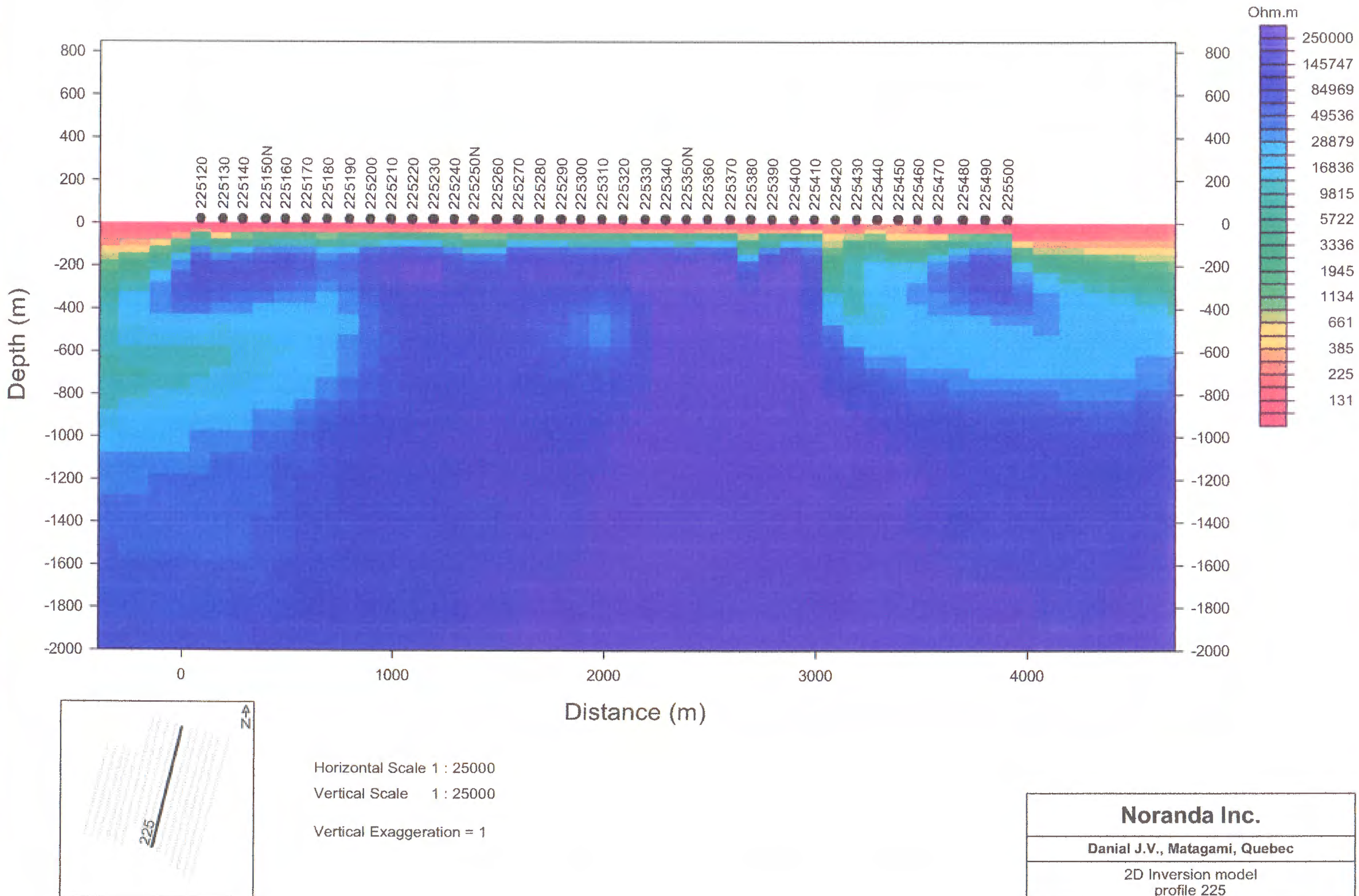

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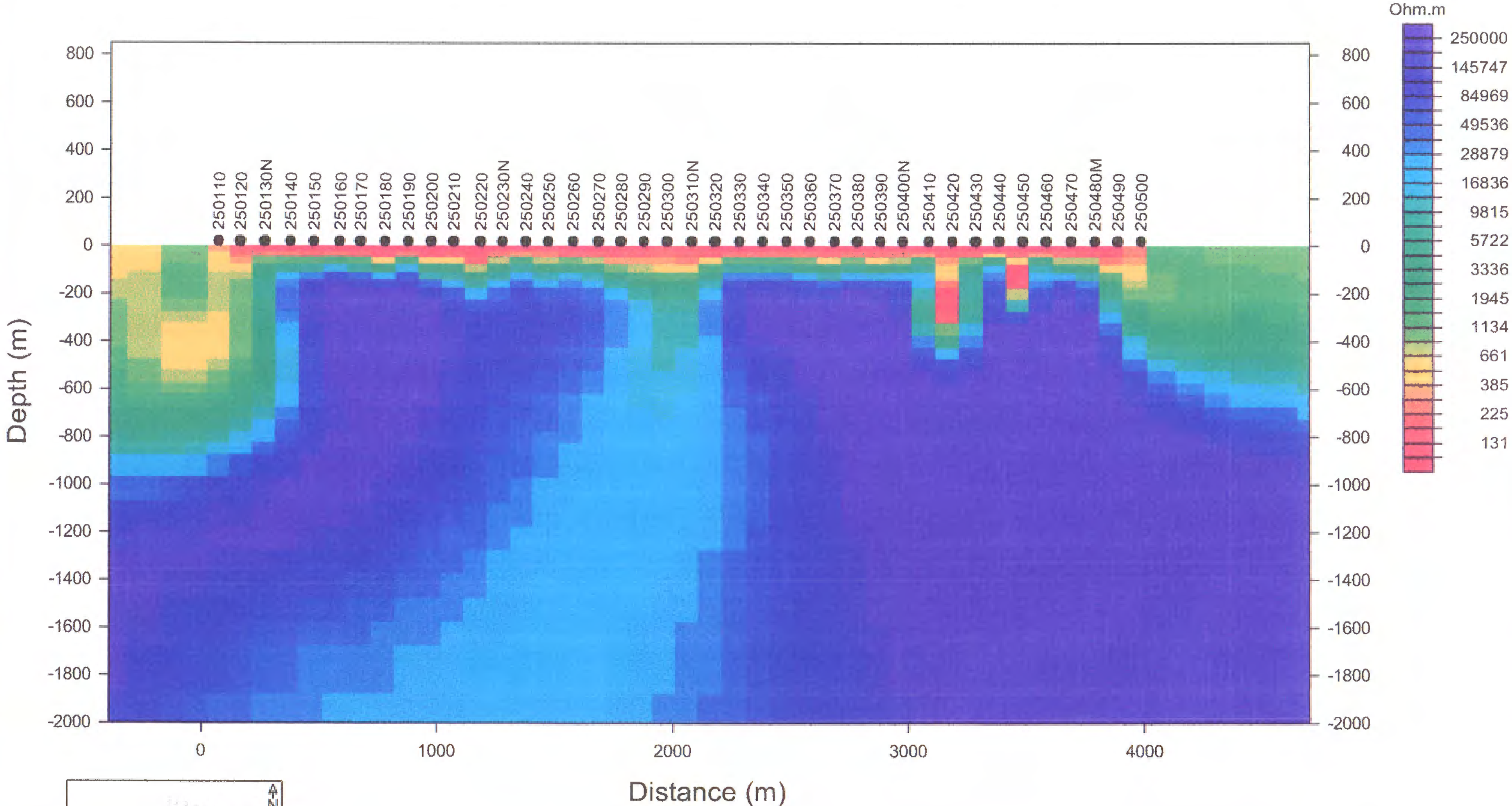

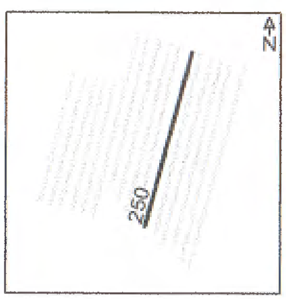

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Danial J.V., Matagami, Quebec
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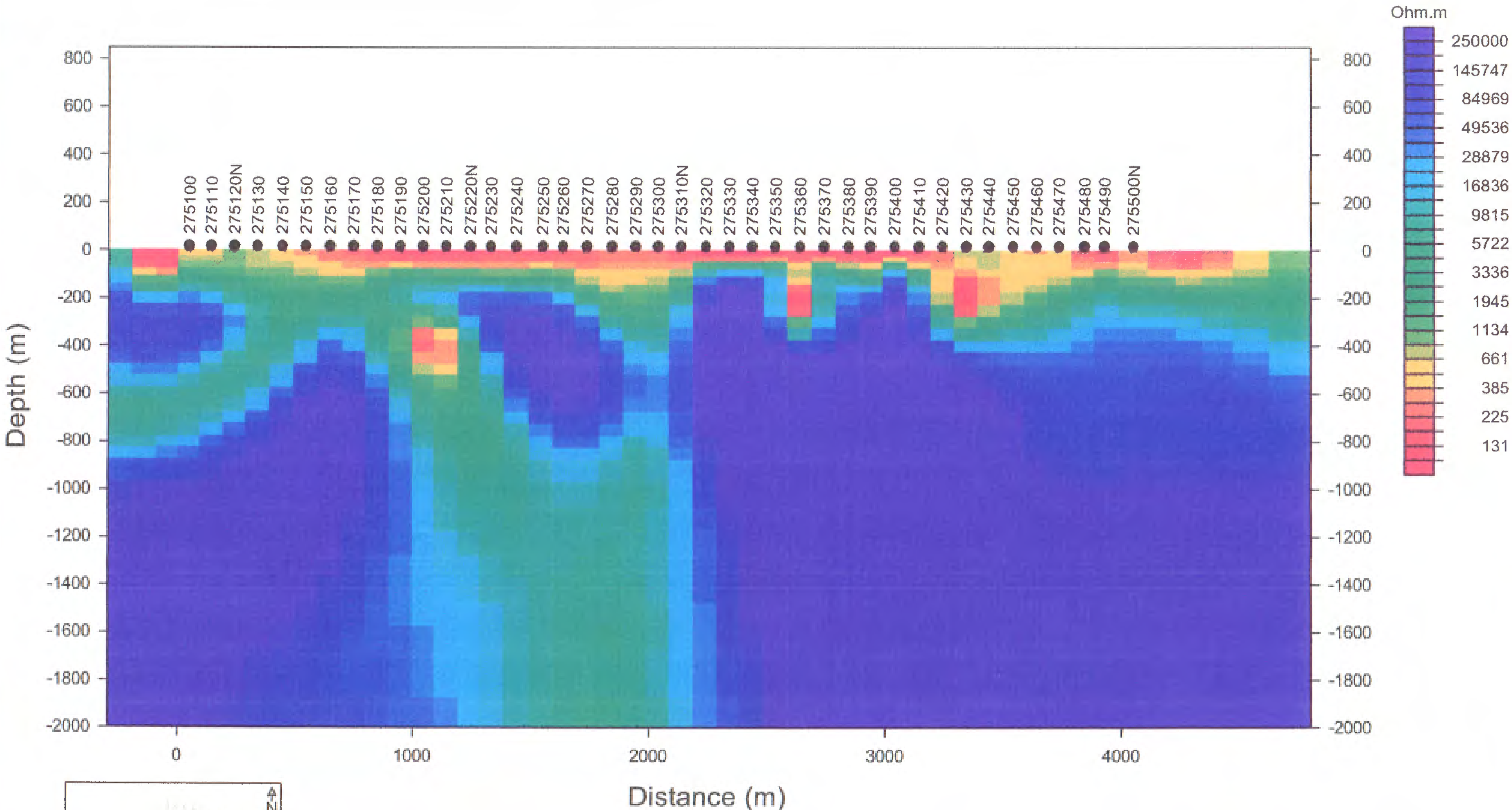

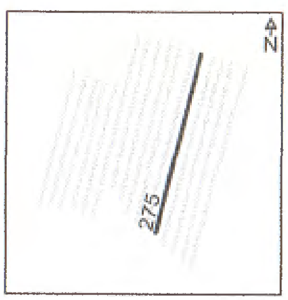

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Danial J.V., Matagami, Quebec
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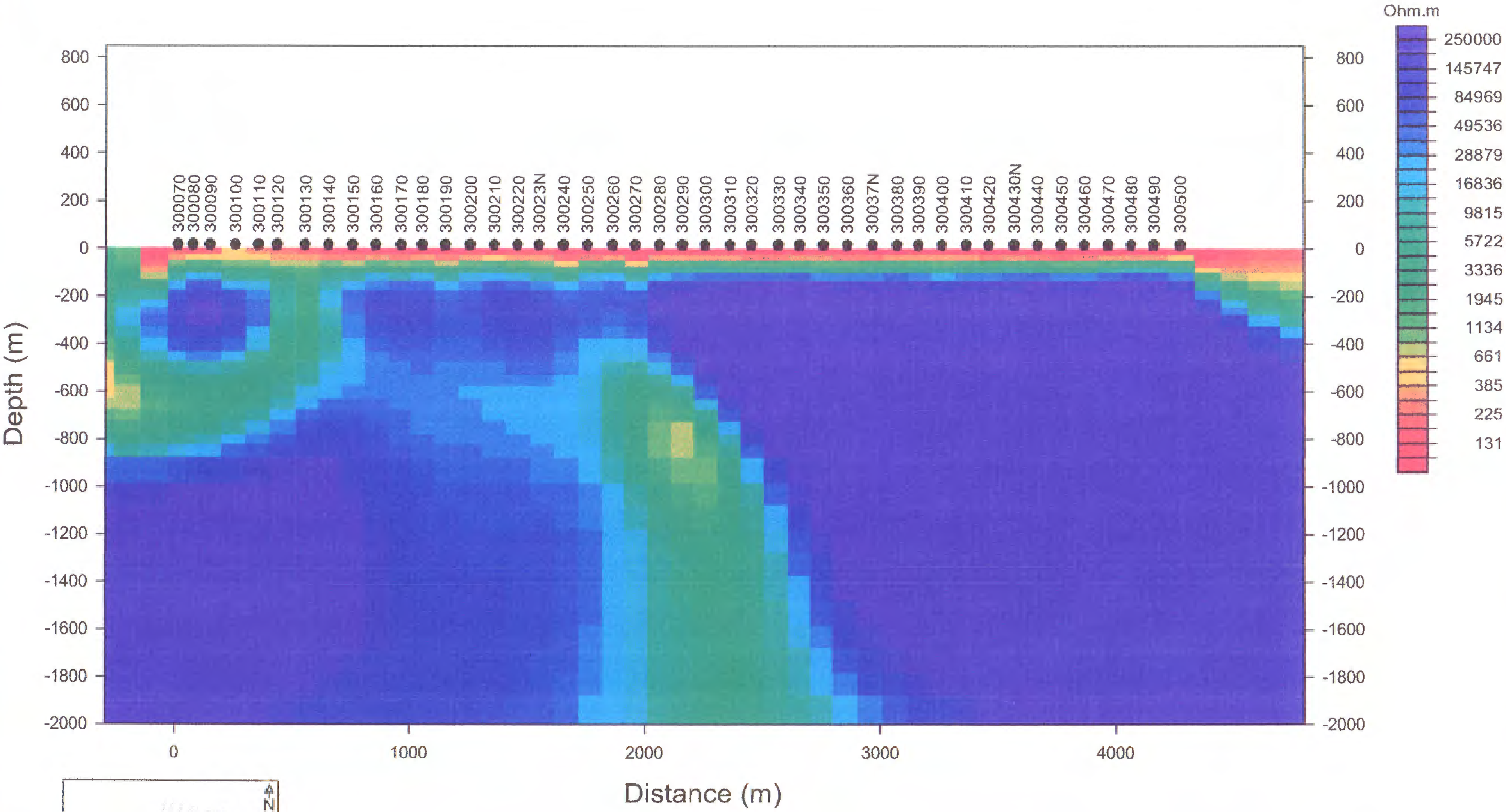

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Danial J.V., Matagami, Quebec

2D Inversion model
profile 300

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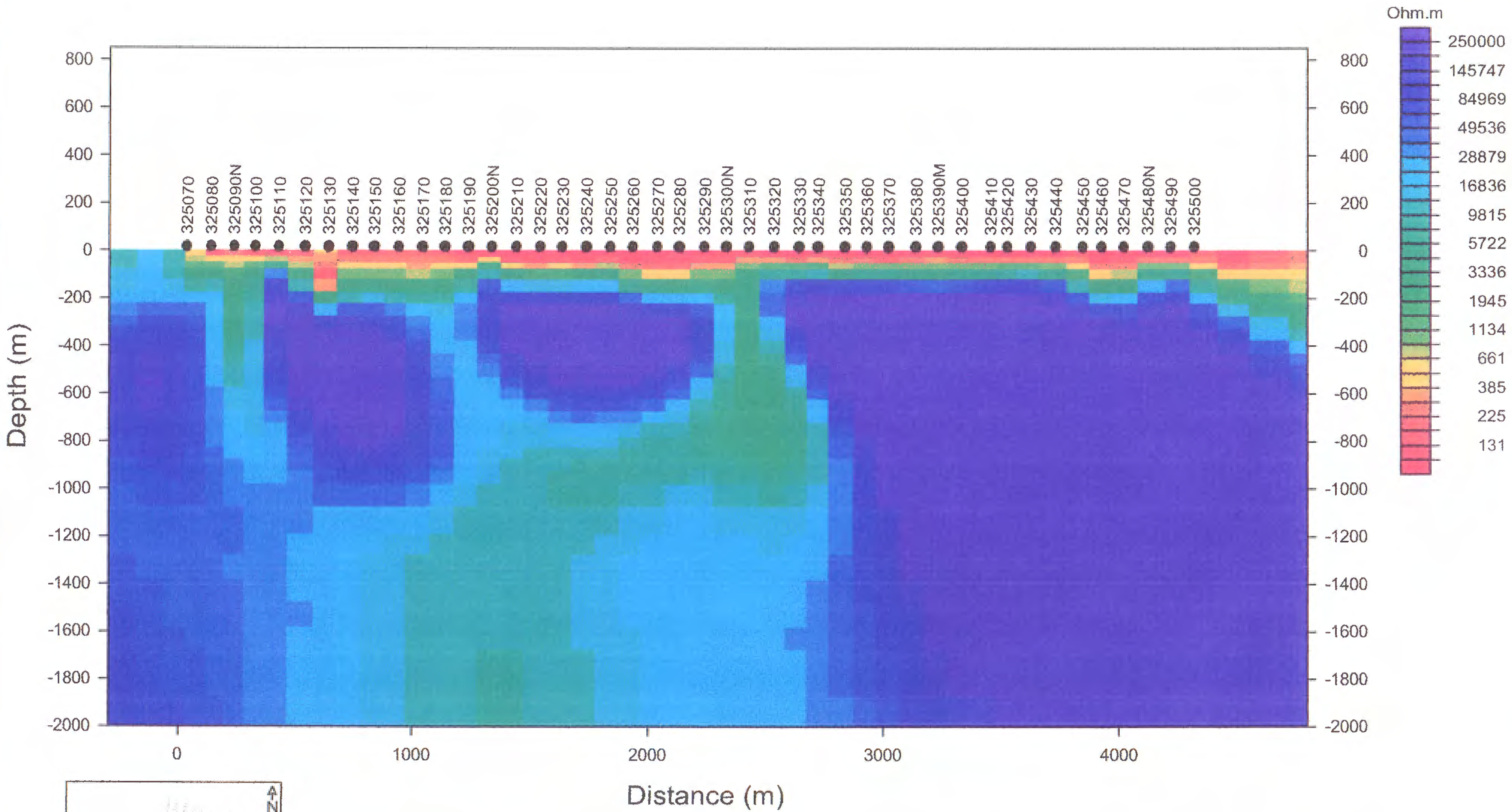

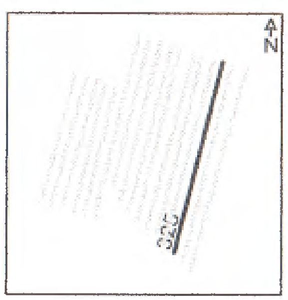

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Danial J.V., Matagami, Quebec

2D Inversion model
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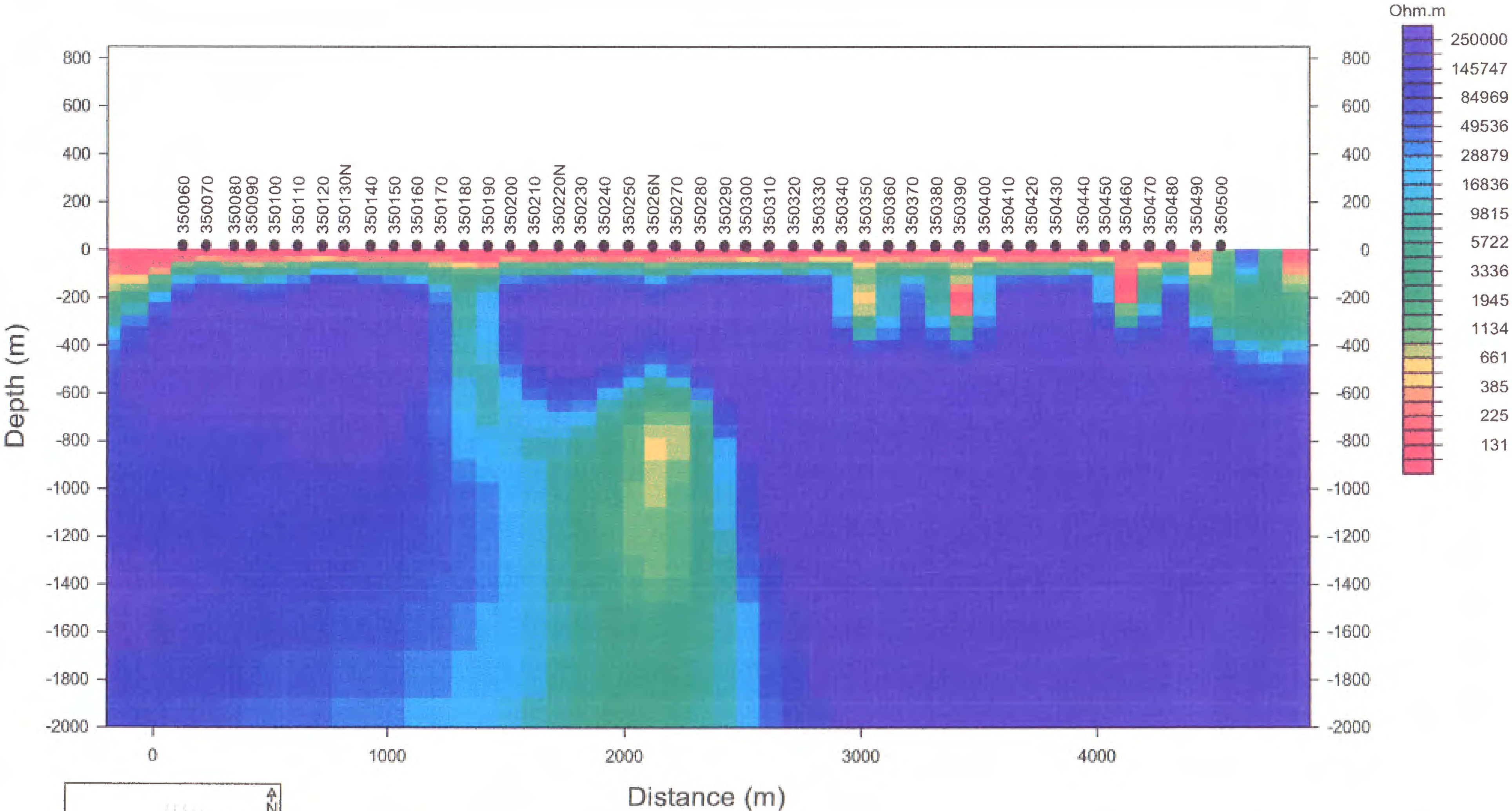

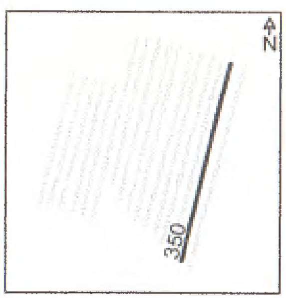

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Noranda Inc.

Danial J.V., Matagami, Quebec

2D Inversion model
profile 350

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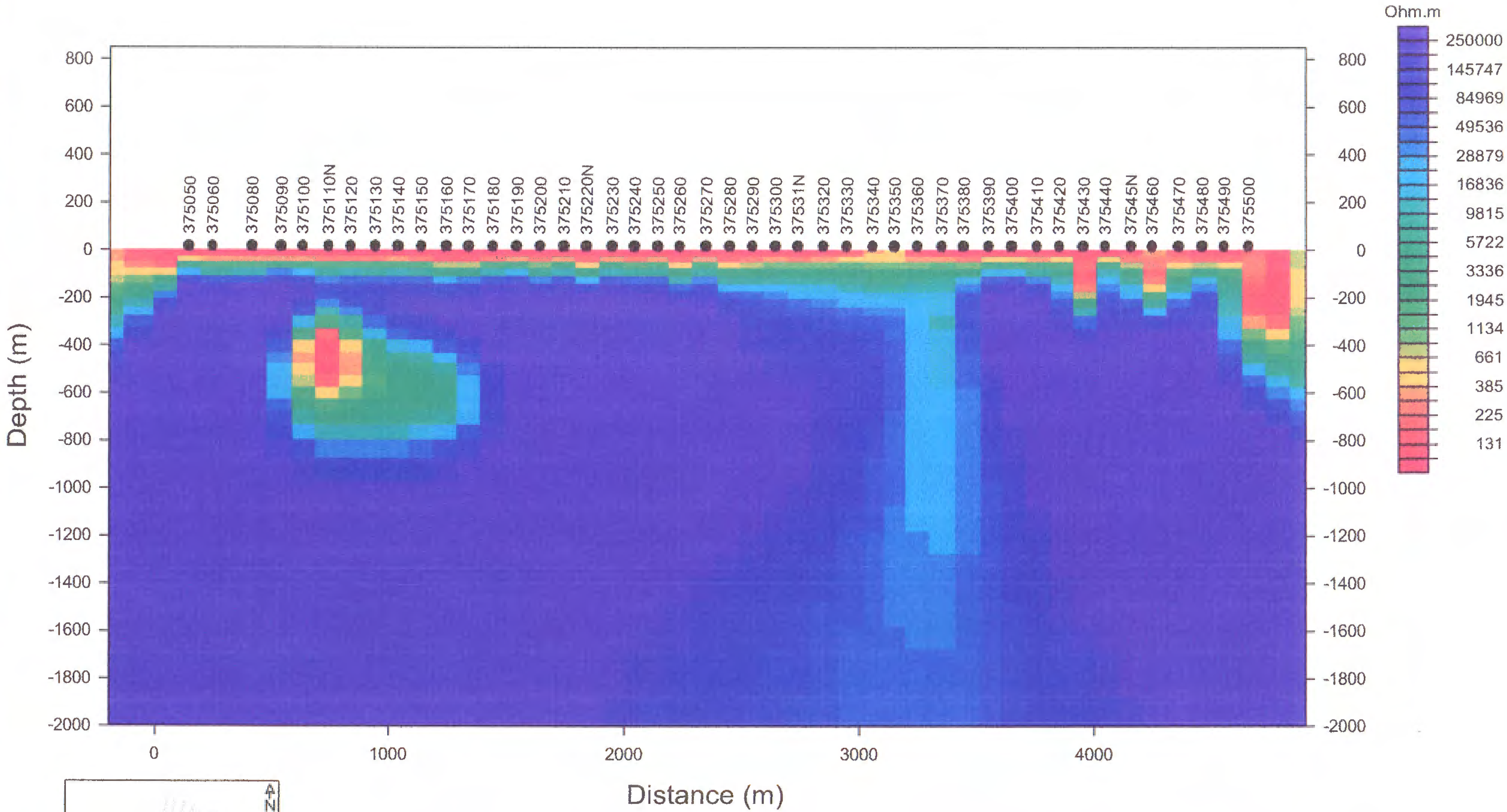

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Danial J.V., Matagami, Quebec
2D Inversion model profile 375
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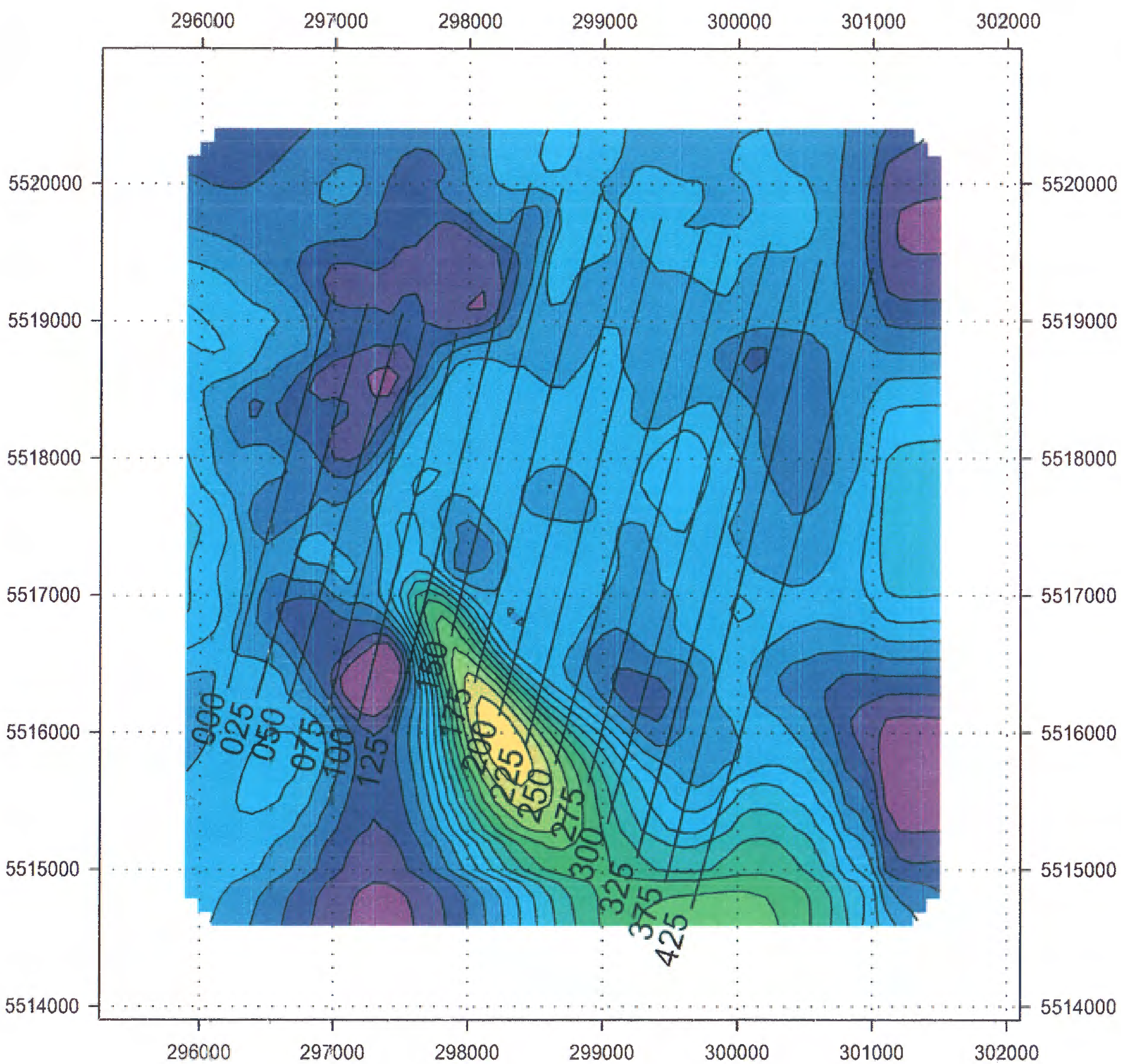
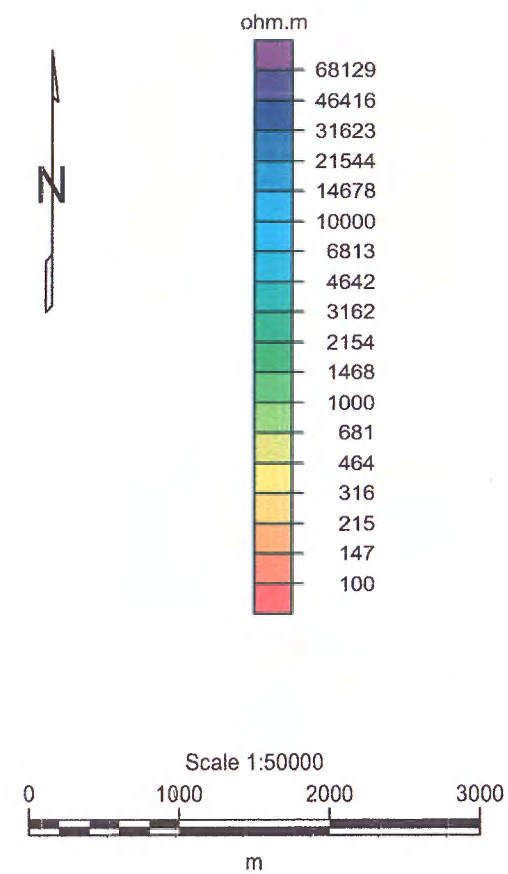


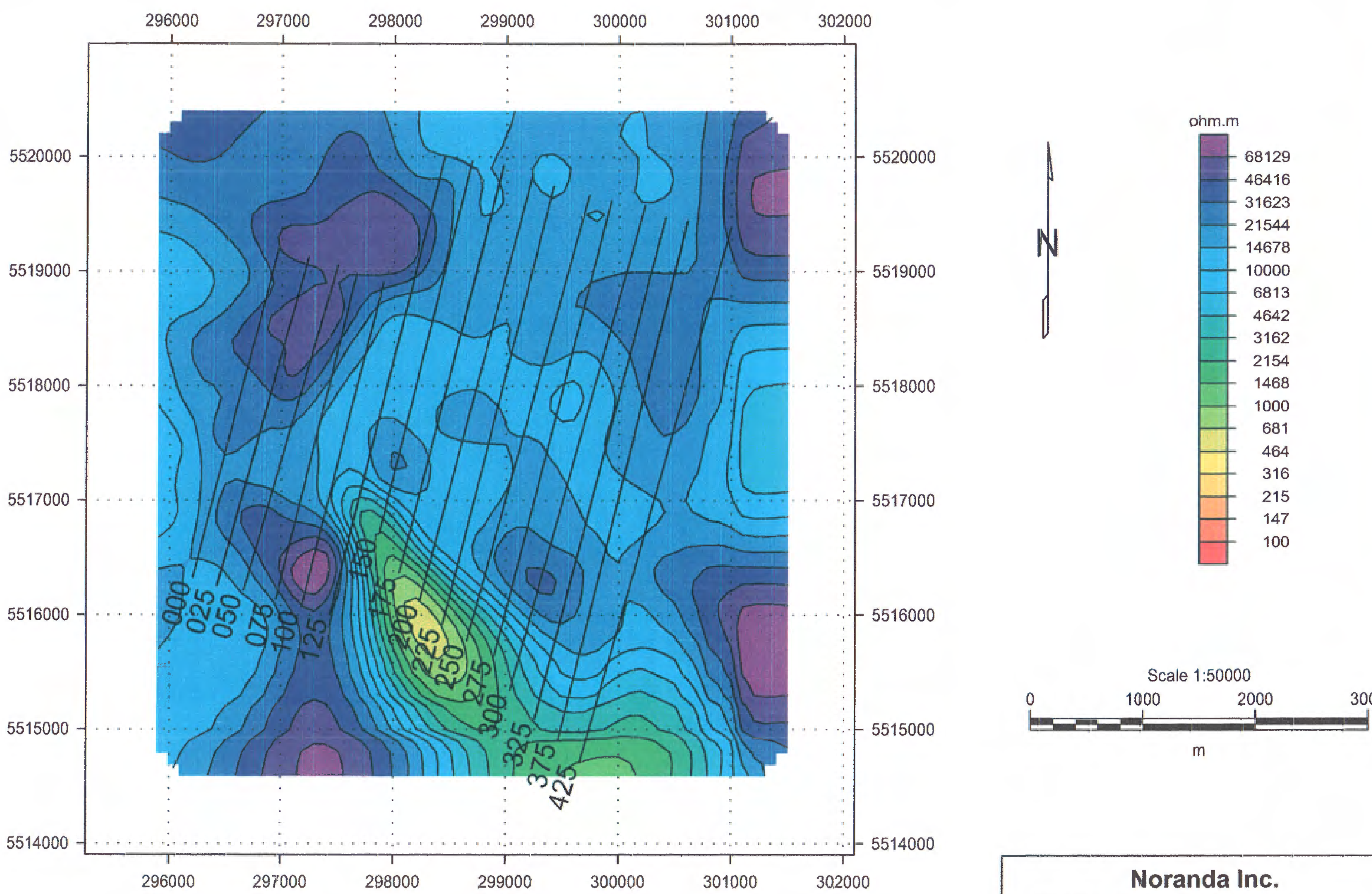


Noranda Inc.

Daniel J.V., Matagami, Quebec
App. Res. at 100 m Depth

from 3D inversion
Plate 2

Geosystem Canada Inc..

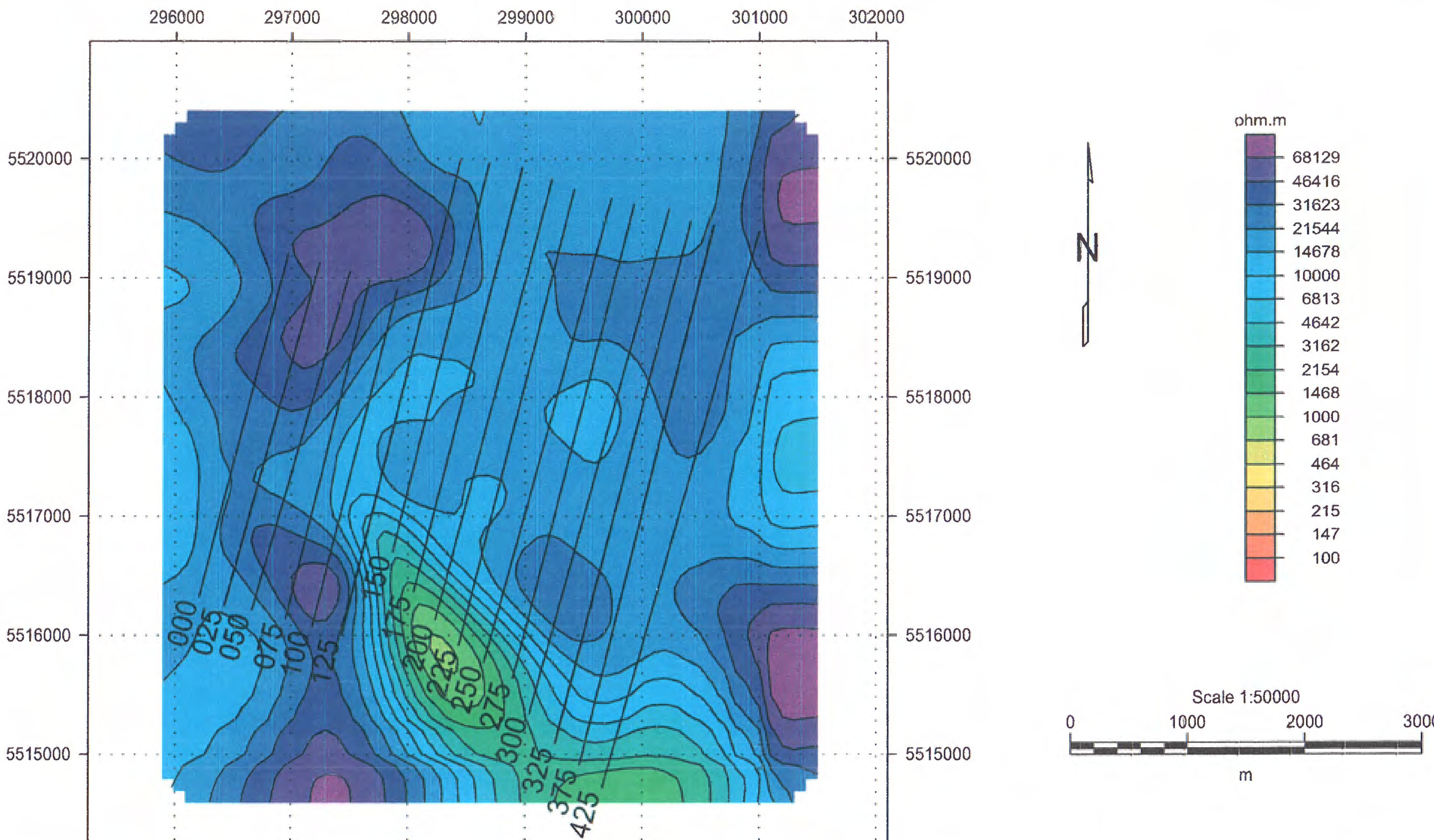


Noranda Inc.

Daniel J.V., Matagami, Quebec
App. Res. at 200 m Depth

from 3D inversion
Plate 3

Geosystem Canada Inc..

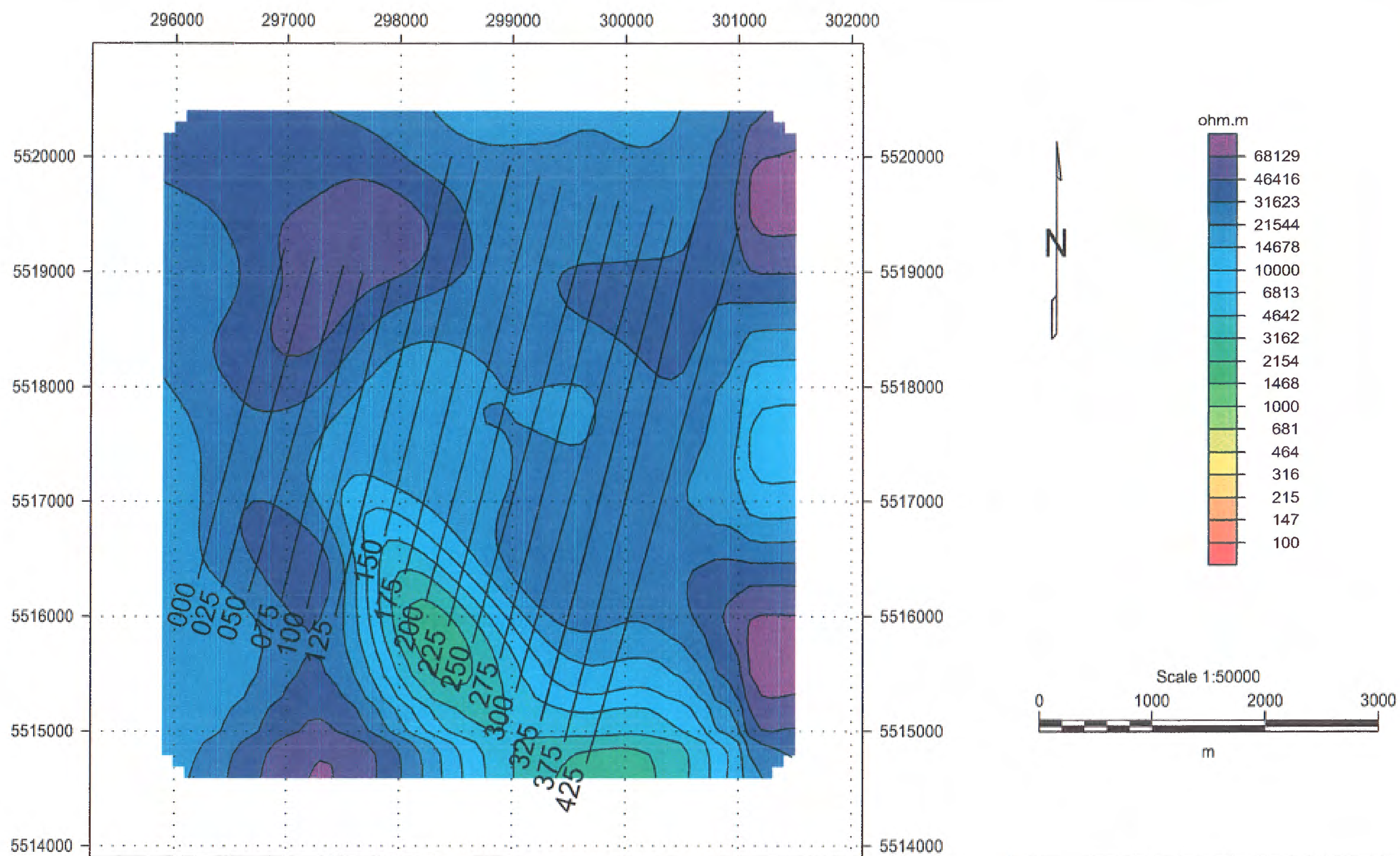


Noranda Inc.

Daniel J.V., Matagami, Quebec
App. Res. at 300 m Depth

from 3D inversion
Plate 4

Geosystem Canada Inc..

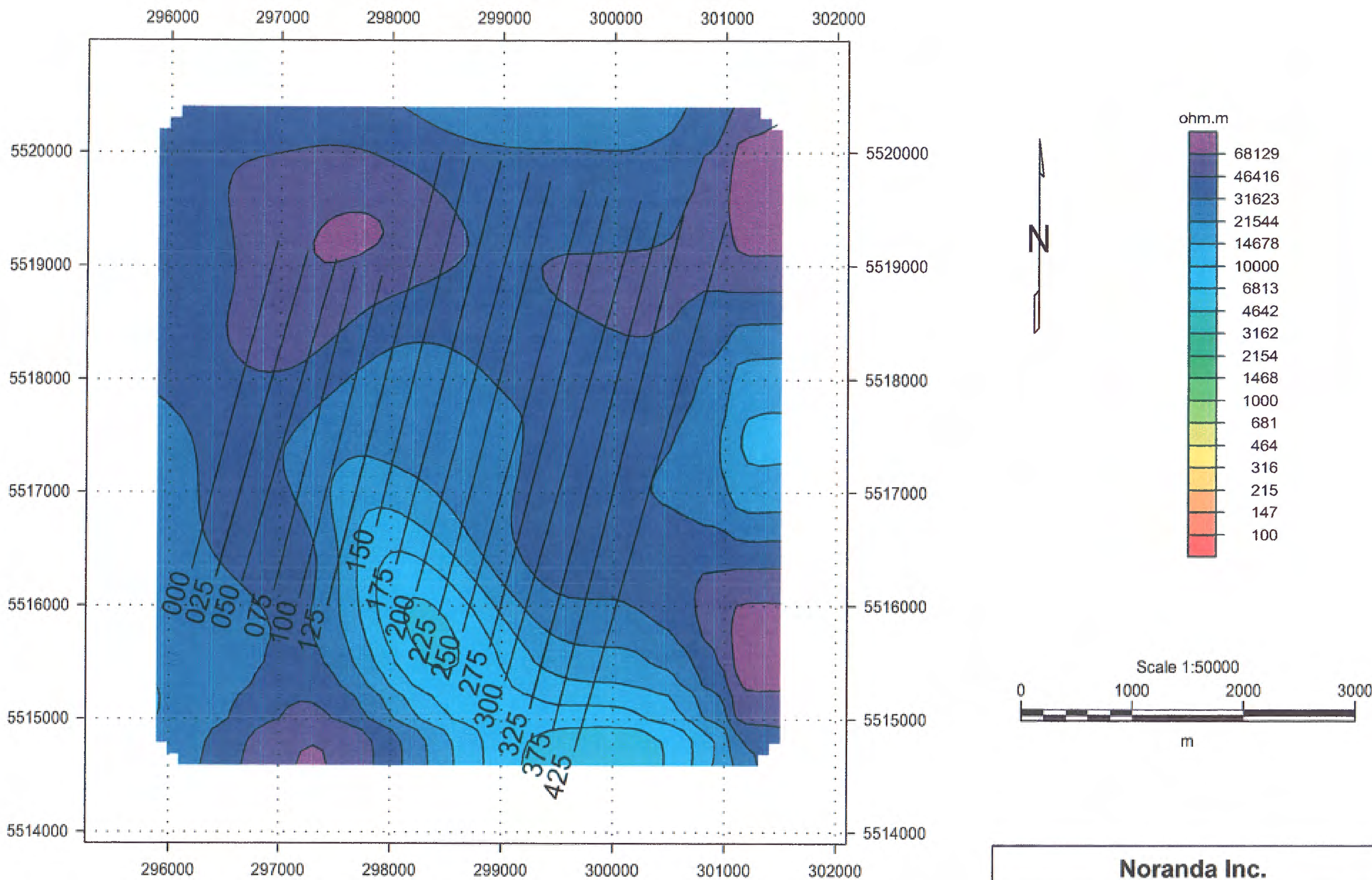


Noranda Inc.

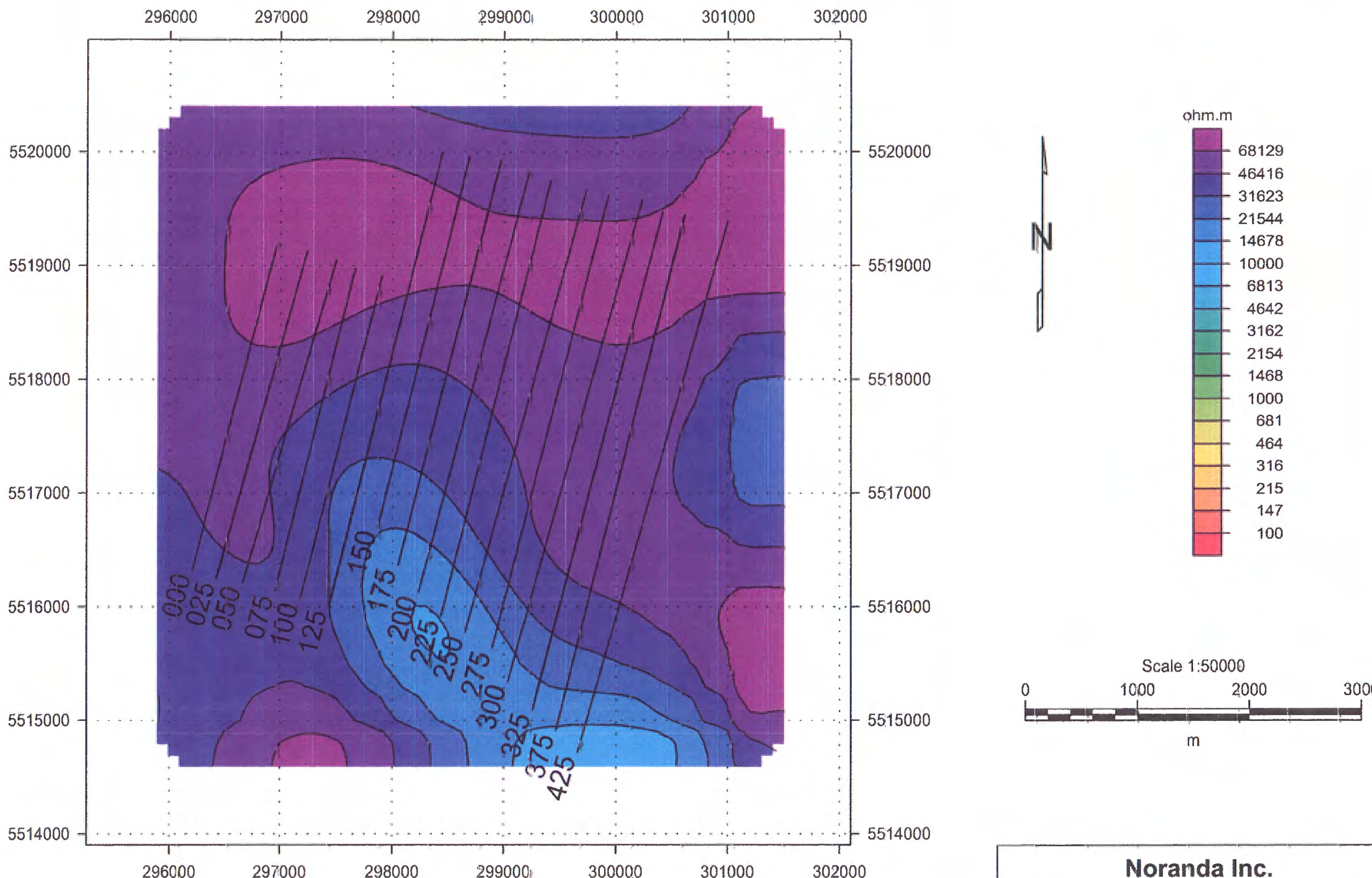
Daniel J.V., Matagami, Quebec
App. Res. at 500 m Depth

from 3D inversion
Plate 5

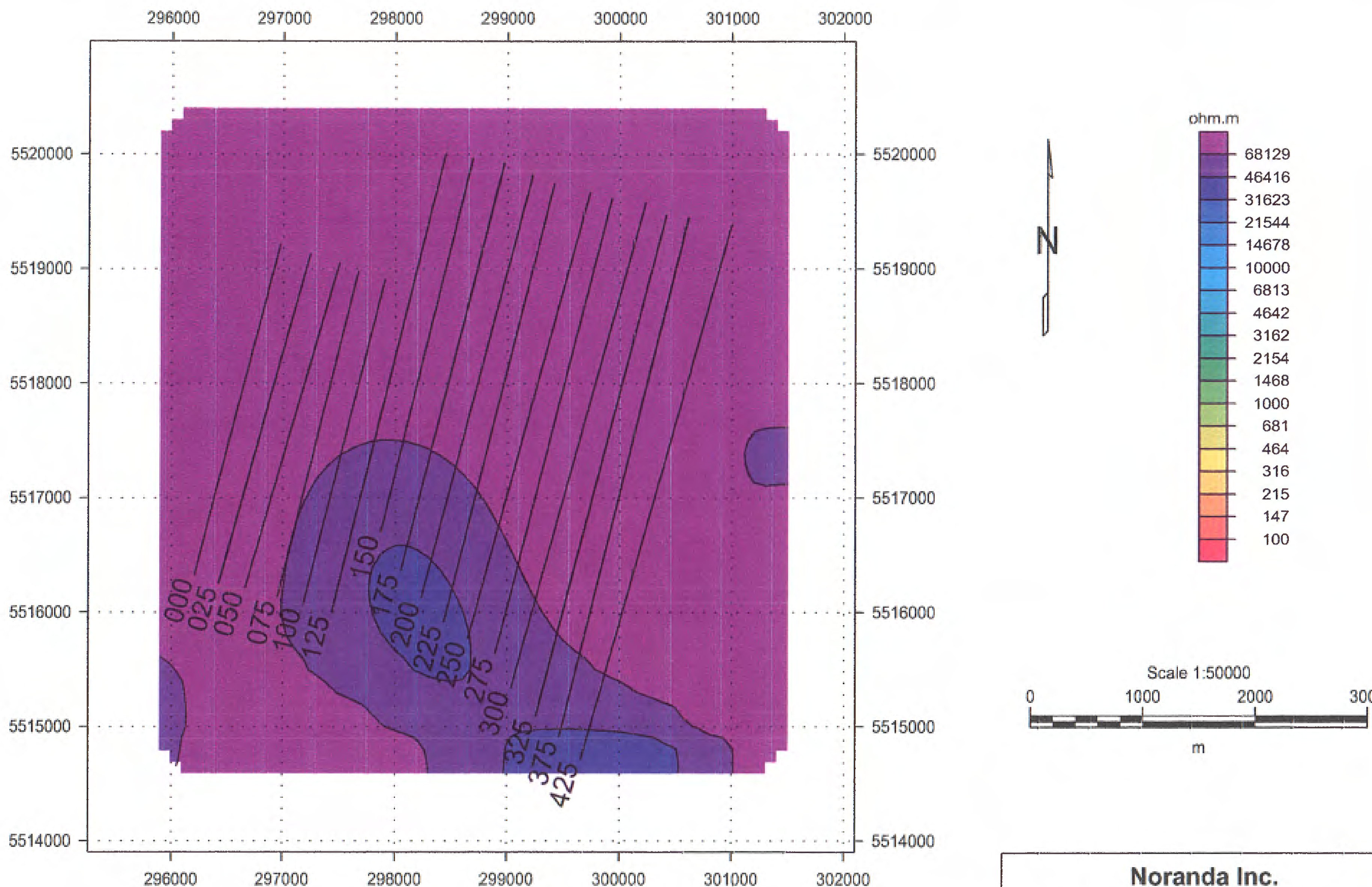
Geosystem Canada Inc..



Noranda Inc.
Daniel J.V., Matagami, Quebec **App. Res. at 750 m Depth**
from 3D inversion **Plate 6**
Geosystem Canada Inc..



Noranda Inc.
Daniel J.V., Matagami, Quebec **App. Res. at 1000 m Depth**
from 3D inversion **Plate 7**
Geosystem Canada Inc..



Noranda Inc.

Daniel J.V., Matagami, Quebec
App. Res. at 1500 m Depth

from 3D inversion
Plate 8

Geosystem Canada Inc..