ELECTRICAL RESISTIVITY SURVEY OF THE MARTISON SITE, HEARST, ONTARIO

Lease # - G6060124

Claim #'s -420104, 4202106, 4202108,4202111, 4202105

Presented to:

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TABLE OF CONTENTS

TABLE OF FIGURES

APPENDICES

1. Introduction

Geophysics GPR International Inc. was requested by PhosCan Chemical Corp. to perform a resistivity survey at the Martison Phosphate Site (**Lease #** - G6060124 **Claim #'s** -420104, 4202106, 4202108,4202111, 4202105) located approximately 90 km north of Hearst, Ontario (Figure 1, Figure 2). The purpose of the survey was to provide information to regarding overburden/bedrock contacts and possible structures within the bedrock.

The resistivity surveys were carried out from December 2008 to February 2009. Figure 3 indicates the locations of the resistivity profiles.

Figure 1: Martison Site Location Map – 90 km north of Hearst, Ontario

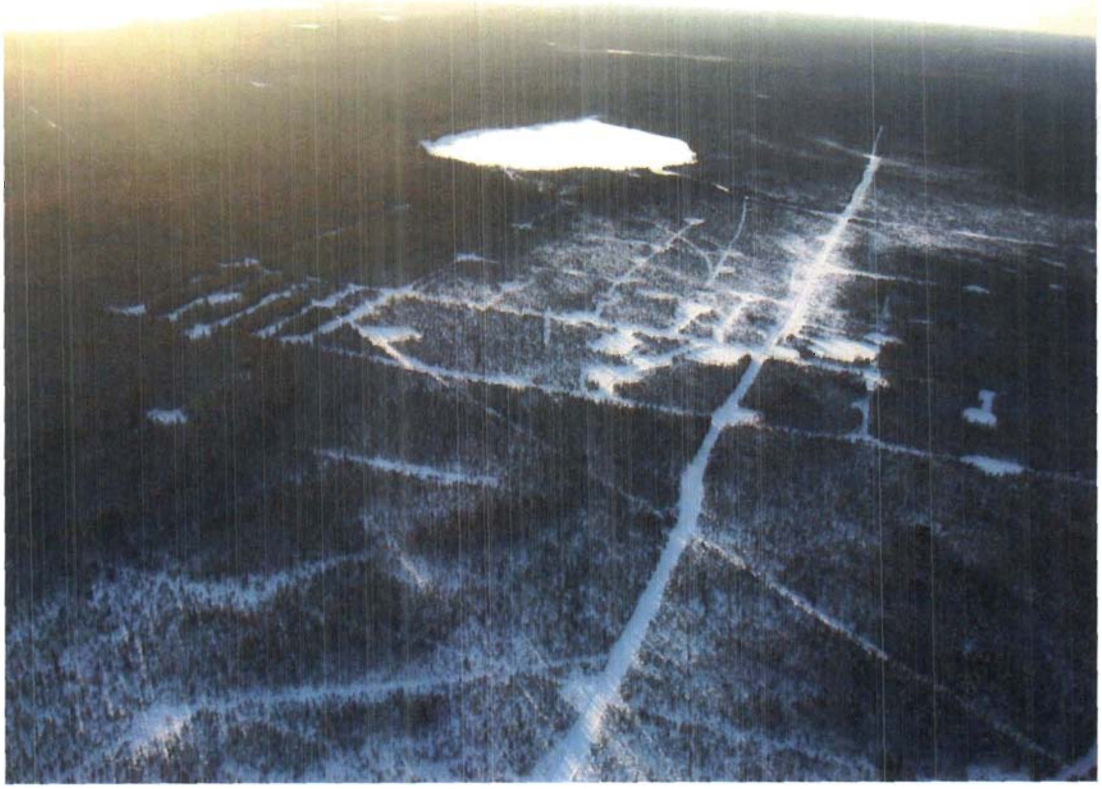


Figure 2: Survey Area, looking to the south-west

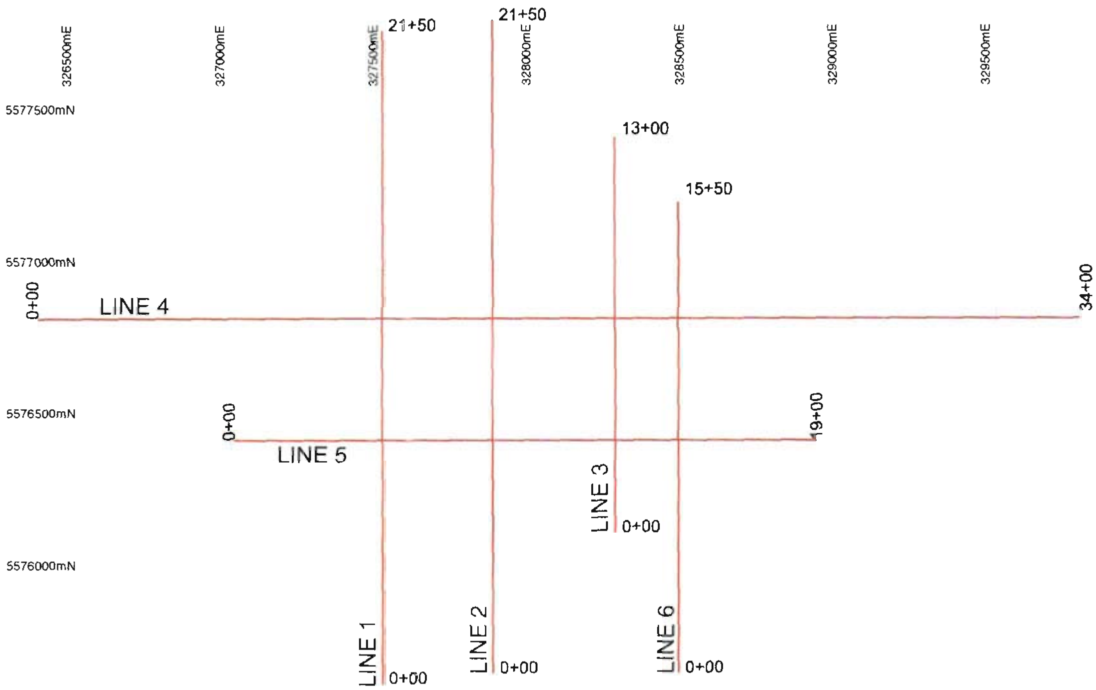


Figure 3: Profile Line Location Map

2. Methodology

Basic Theory - Resistivity

The electrical resistivity method involves measuring the variation in potential (ΔV) at the surface due to the current flow through the subsurface. Individual readings involve injecting current (I) into two outer probes and measuring the potential (ΔV) across two inner probes. Different combinations of outer and inner electrodes are used along the array to sample from varying depths and positions (Figure 6). The Reciprocal Schlumberger configuration was applied for this project, whereby the current is injected into the inner probes and potential difference measured in the outer probes. The resistance is given by:

$$R = \Delta V / I$$

The measured resistance is then converted into an apparent resistivity. This apparent resistivity (ρ_a) is an average of the different true resistivities crossed by the current over the investigated volume. It provides a good indication of the variation of resistivity with depth as the electrode spacing increases. The apparent resistivity for a Schlumberger array at each station is given by

$$\rho_a = \pi\left(\frac{MN^2}{4AB} - \frac{AB}{4}\right)R$$

where AB is the current electrode spacing, and MN the potential electrode spacing.

A series of 16 cables are laid out with a total of 96 electrodes. Software and a control unit, Iris Instruments' Syscal Pro Switch 96 (refer to Appendix A for equipment details), selected combinations of electrodes to produce readings at various locations and various electrode separations, thus at varying depths of investigation. For this project a probe separation of 10 metres was used, making each fully accessible profile length 950m. Profile lengths are then extended by "rolling over." This involves moving the first four cables to the end of the sixteenth cable and repeating the measurement cycle. This procedure can extend profiles for straight lengths typically limited only by physical space. Each rollover extends the data set by 240m.

Basic Theory – Induced Polarization

Induced polarization (IP) methods can be employed alongside resistivity methods to better identify conductive targets. IP works by stimulating a rock mass with a current and measuring the decay curve of the voltage in any given channel over time. When the current is switched off, the voltages in the subsurface do not cease instantaneously, but rather decay over time due to electrode and membrane polarizations (Figure 4). IP is often measured as chargeability, the ability of a mass to retain charge. Simply, the more gradual the decay curve, the more chargeable the subsurface material.

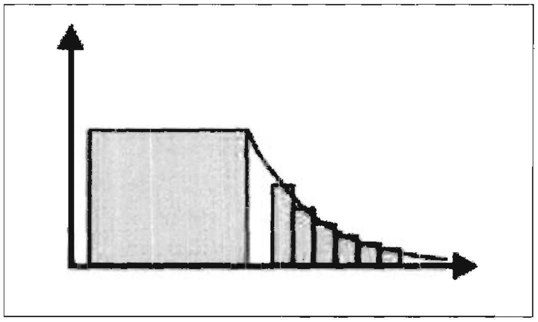


Figure 4: Induced Polarization Decay Curve

IP surveys can be performed simultaneously with resistivity surveys, and thus their survey layouts are identical.

Survey Design

A reciprocal Schlumberger array was employed. This type of array injects current through current electrode pair near the centre of the array and measures the potential difference in the potential electrode pairs spaced outward from the centre (Figure 5). The reciprocal Schlumberger array was used because it is more efficient in that it maximizes the number of potential channels the instrument can measure at once.

Figure 5: Simplified, Single-channel Reciprocal Schlumberger Array

Initially it was proposed to collected both IP and resistivity data; however, after the first two profiles (#4 and part of #2) it was decided to no longer collect IP data due to the limited additional insight provided by the results and the additional time required to collect the data.

Approximately 12.5 km of profile were collected in total. Profile statistics are summarized in Table 1, below.

Table 1:Profile Statistics

Profile #	Start Point	End Point	Profile Length	RMS Error (%)	# Data Points
1	5575635mN, 327495mE	5577786mN, 327495mE	2150	87	3983
2	5575670mN, 327856mE	5577820mN, 327856mE	2150	15	9396
3	5576136mN, 328256mE	5577436mN, 328256mE	1300	15	4696
4	5576840mN, 326373mE	5576840mN, 329772mE	3400	115(west) 8 (east)	9623
5	5576438mN, 3270112mE	5576438mN, 328912mE	1900	19	6013
6	5575671mN, 328462mE	5577221mN, 328462mE	1550	24	5366
Total			**12,450m**		**39,077**

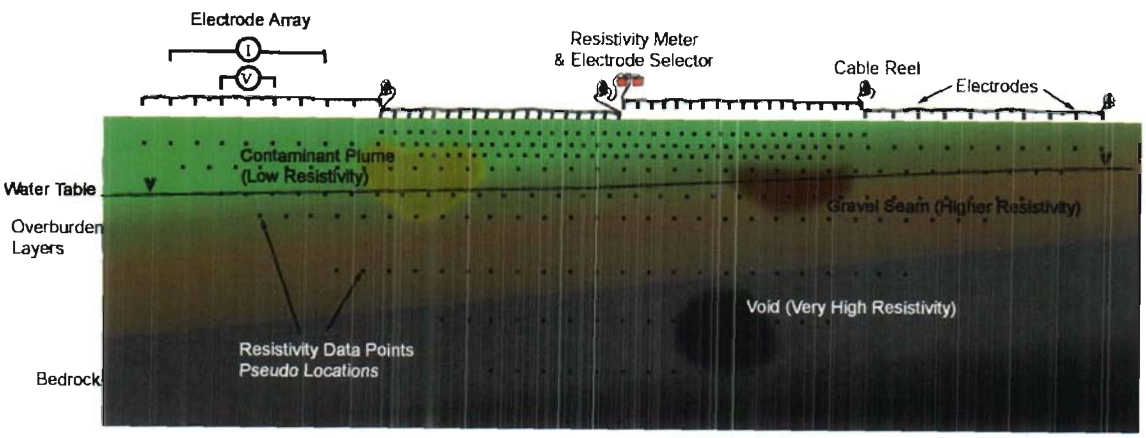


Figure 6: Resistivity Profiling Operating Principle and Applications

Resistivity Quality Control

Electrodes (steel rods) are usually planted to a minimum depth of 200 mm into unfrozen soil. The electrodes are attached to the cables and a connectivity test is run to check for contact resistance. If the contacts are adequate then the system initiates data collection. If there is a poor contact then a warning is given to improve the contacts by various means including adding the following:

- Add Water
- Sink the rods deeper into the ground
- Use two or more electrodes
- Add water, salt and dish soap

Consecutive readings are taken automatically and the resistivity meter averages the measured results continuously. Measurement cycles are taken until the standard deviation falls below a preset threshold (typically 2%) or until a maximum number of readings are taken.

Contact resistance was not a major problem at this site; however, on the survey days with extremely cold weather the electrodes would freeze into the ground at depth increasing the contact resistance.

Processing, Interpretation and Accuracy of Results

Processing of the resistivity data involves running a 2D inversion routine to generate an inversion model with resistivity values and depths. The most critical processing element is the removal of data that is considered too low in good signal. Data that is removed fall into these categories:

- Negative resistivity values
- Near zero or very high injection currents
- High or low voltage that usually exceeds 2 standard deviations

The main processing sequence was completed using the Res2Dinv© software package. The 2D resistivity profiles are presented in Appendix C. The top pseudo-section on each figure is a plot of the measured resistivity values, the raw data. Through an inversion process a physical model with depths and resistivity values is generated. This model is presented as the third pseudo-section of each figure. The middle pseudo-section represents the calculated resistivity values based on the inversion model. How well the calculated apparent resistivity data compares with the measured apparent resistivity data is calculated as the root mean square (RMS) error. Lower RMS errors indicate a better fitting model.

The RMS error for the profiles ranged from 8% to 115%. Values below 20% are considered very good for profile lines longer than 300m. As mentioned above, the higher RMS errors imply that the resistivity values based on the inversion model do not match the raw data as well. This typically occurs where there is noise in the data that cannot be fit by the inversion, or fine detailing which the software cannot accurately model. The higher RMS does not necessarily imply that the final interpretation is any less accurate.

The calculated inversion model is a resistivity model and must be interpreted in terms of geologic units or subsurface features. Geological materials will have different resistivities based primarily on variations in water content and the dissolved ions in the water (a table of typical values is enclosed in Appendix A). The interpretation will not extend the entire length of the profile because of the geometry. The depth of the readings decreases towards the ends of the profiles such that there are no readings directly beneath the end electrodes. The interpreted models are presented in Drawings T08110_A1 and T08110_A2.

In regards to the accuracy of the results, it is difficult to assign a true error estimate. The following factors must be considered when interpreting 2D inversion models:

- 3D geology – The process is assuming a 2D subsurface model. Larger electrode separations are influenced not only by deeper features but also by features offset horizontally from the profile line. Variations in the subsurface perpendicular to the survey line can distort the results.

- Non-uniqueness – The inversion process is inherently non-unique; that is, different models can be generated from similar data sets. In general however, the main features of the models will be similar. Constraints can be placed on the inversion process given knowledge of the geology.

- The resolving power of the resistivity method decreases exponentially with depth.

- A contrast in resistivity is required to distinguish geologic layers.

3. Results

A total of six resistivity profiles were collected at the Martison Site (**Lease #** - G6060124, **Claim #'s** -420104, 4202106, 4202108,4202111, 4202105). IP data were collected along segments of Profile 2 and Profile 4.

Table 1 lists the chainages and UTM coordinates of the profiles. Ground surface elevation was relatively level over the survey area with an estimated variation of less than 2m. Accordingly, the survey area topography was assumed flat with a surface elevation of 190m.

Figure 3 indicates the location of the resistivity survey lines. The position of the profile lines were predetermined by GPS coordinates. The coordinate system in the plan drawing is in UTM NAD 83 system. The coordinates along the profiles were recorded with a hand-held WAAS enabled GPS unit and should be accurate to within -/+ 10m.

The interpreted 2D resistivity profiles are presented as Drawings T08110_A1 and T08110_A2 in Appendix D. The results were also provided in 3D CAD format. All the profiles have been plotted at the same distance/depth scale and with the same colour palette.

As discussed above, interpretation of resistivity data involves assigning resistivity contour values to geological contacts. Typically the contact between the overburden and bedrock is well defined, as bedrock tends to be more resistive. The bedrock contact has less to do with a specific resistivity value than an increase in the resistivity gradient. With that in mind however, the 250 Ohm·m contact has been found to be a fairly common boundary for the overburden bedrock contact at a majority of previous sites.

At this particular site the resistivity model has been interpreted in terms of three geologic contacts. The three contacts are discussed below:

1) **Base of Overburden**: The overburden material was expected to comprise of 2m peat/muskeg with varying degrees of water saturation, underlain by 35 to 50m of silt to sand till. Frost at the time of the data collection was apparent in some of the survey areas. Based on borehole data, the overburden layer was expected to be approximately 30 to 50m thick over most of the survey area. Isolated pockets of high resistivity near surface are attributed to varying degrees of frost/frozen soil but could also be attributed to shallow sand and gravel patches.
2) **Clay**: Isolated pockets of cretaceous clay are known to exist in some areas. The areas of low resistivity have been identified as potential clay deposits.

3) **Top of Carbonatite (Bedrock)**: The contact between overburden and bedrock material is typically a relatively well-defined increase in resistivity. At this particular site a sand residuum material overlying the bedrock in some areas is expected to 'blur' this contact. As the residuum material is expected to have varying degrees of competence and composition, thus varying degrees of moisture content and resulting varying degrees of resistivity. The result is a contact that will appear as more gradual increase in resistivity. The top of carbonatite contact in shallow areas appeared as a relatively high gradient in the resistivity data. In these areas the 250 Ohm·m resistivity contour was in good agreement with the borehole data. Areas with a lower resistivity gradient appear where the borehole data indicates deeper bedrock. In areas of deeper bedrock a higher resistivity contour value has been chosen to better agree with the borehole data. The residuum material can be interpreted as the material occurring between the base of the overburden and the top of the bedrock.

The following is a brief description of the interpreted models:

Profile 1 (North to South) – Profile 1 oriented south to north along the easting line 327495mE. This profile had noise levels higher than typical. This was the last profile collected and the affects of the persistent cold weather were taking affect. The frost was penetrating deeper than the 3 foot long probes. The result is an increase in contact resistance.

The interpreted bedrock contact along this profile ranged in depth from 38m greater than 155m. In general there was good agreement between the boreholes and resistivity data.

Profile 2 (North to South) – Profile 2 was oriented south to north along the easting line 327856mE. This profile had low noise levels.

The interpreted bedrock contact along this profile ranged in depth from 52m to 120m. The 250-Ohm·m contour line is in very good agreement with the top of carbonatite contact identified in the borehole data with the exception of boreholes 83-51, M99-5 and M83-5, which have the bedrock contact as being deeper. The discrepancy could be related to steep variations in the bedrock elevation offset from the profile to the east.

Induced polarization data were collected along the eastern section of this profile. The results of which are presented in Appendix C. It was decided that the limited additional insight into the subsurface provided by the IP data at this particular site did not justify the extra field time (approximately double) required to collect the IP data.

Profile 3 (North to South) – Profile 3 was oriented south to north along the easting line 328256mE. This profile had low noise levels.

As with Profile 2, the 250- Ohm·m contour line has been interpreted as the top of carbonatite. The interpreted depth to bedrock along this profile ranged from approximately 47m to 100m.

Many of the boreholes along this alignment did not extend down to the carbonatite contact. Borehole 83-64 is deeper than the interpreted resistivity contact. Borehole 83-63 is in good agreement with the interpreted resistivity contact.

Profile 4 (West to East) – Profile 4 was oriented west to east along the northing line 5576840mN. This profile had low noise levels towards the east and west ends and higher noise near the intersection with Profiles 1 and 2. The middle portion of the profile was data collected in December with shorter probes and the frost levels were only just taking affect.

The 250- Ohm·m contour line has been interpreted as the top of carbonatite along the majority of this profile. The interpreted depth to bedrock along this profile ranged from approximately 47m to 155m. There was good agreement between this profile and the intersection lines with the exception of the intersection with Profile 2. The lower noise levels along Profile 2 and borehole data suggest the contact should be deeper at this point then suggested by the Profile 4 model.

Induced polarization data were collected along the western portion of this survey line. The results of the IP data are presented Appendix C.

Profile 5 (West to East) – Profile 5 was oriented west to east along the easting line 5576438mE. This profile had low noise levels.

The 250- Ohm·m contour line has been interpreted as the top of carbonatite in areas of higher resistivity gradient. In areas of deeper bedrock, and lower gradient, a higher resistivity contact has been chosen as it was in better agreement with the boreholes and at the intersection points of the south-north lines. The interpreted depth to bedrock along this profile ranged from approximately 37m to 120m.

In general the interpreted resistivity profile was in good agreement with the borehole results.

Profile 6 (North to South) – Profile 6 was collected south to north along the easting line 328462mE. This profile had low noise levels.

As with Profile 2 and 3, the 250- Ohm·m contour line has been interpreted as the top of carbonatite. The interpreted depth to bedrock along this profile ranged from approximately 30m to 140m.

Many of the boreholes along this alignment did not extend down to the carbonatite contact. Borehole 82-20 is in good agreement with the interpreted resistivity contact. Borehole 83-66 is shallower than the interpreted resistivity contact.

4. Conclusions and Recommendations

Six resistivity profiles were collected for a total length of approximately 12.45 km and over 39,000 data points. Profile 1 and the western half of Profile 4 had higher than typical noise levels. The higher noise levels coincided with extremely cold weather days, which resulted in an increase in electrode contact resistance. Profiles 2, 3 and 6 had the lowest noise levels.

Induced polarization data (IP) were collected along portions of Profiles 4 and 2. The data did not contribute to the geologic model and the quality was considered low so it was decided that the additional field time required to continue collecting IP data was not justified.

The interpreted 2D resistivity profiles are presented as Drawings T08110_A1 and T08110_A2. The results were also provided in 3D CAD format.

The 250-Ohm·m contour line was found to be in very good agreement with the top of carbonatite in areas of shallow bedrock (<60m depth). In areas of deeper bedrock, and suspected residuum material, a higher resistivity contour value was found to be in better agreement. Also apparent in the areas of deeper bedrock was a lower gradient in the resistivity values.

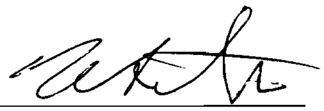
A sharper contrast (higher gradient) generally allows for a more accurate interpretation. Where there is diminished contrast between the two units there will also be diminished accuracy in the interpreted contact. The contrast between the residuum and the overburden and the residuum and the bedrock both appear to have lower contrasts making this contact less well defined. The lower contrasts are attributed to the gradated nature of the residuum material. Use of the borehole data in these areas was helpful in assigning a resistivity value for the bedrock surface.

The profiles were interpreted in conjunction with each other and the borehole data. In general there was excellent agreement between the profiles and good agreement with the boreholes. The four main reasons for differences between the borehole data and the interpreted resistivity models are:

1) 3D geology –Variations in the subsurface perpendicular to the survey line can influence the results, which can differ from a single borehole point.
2) Steep variations in contact elevations – steep changes in bedrock elevation will typically be smoothed.
3) Non-uniqueness - The inversion process is inherently non-unique; that is, different models can be generated from similar data sets
4) The gradual change between the residuum and competent bedrock – this factor can have an influence both on the interpreted resistivity contact and the physical contact as observed in the borehole data.

The modelling depth limit for the applied configuration was about 150 meters. If more data is required at a greater depth the following is recommended. In future, these data sets could be augmented with a different hardware system that uses only 16 to 32 probes but the configuration will be a pole – dipole array. This is more labour intensive and time consuming per data point but some data points could be obtained at much greater depths. It would then be possible to obtain a depth to the deepest residuum valley and possibly the base of the carbonitite.

Data collection was performed by Guillaume Perron. This report has been written by Milan Situm, P.Geo.



Milan Situm, P.Geo.
Manager

Appendix A – Resistivity Information Sheets

Iris Instruments Syscal Pro – INFORMATION SHEET

IRIS INSTRUMENTS

RESISTIVITY SOUNDING AND IMAGING SYSTEM

SYSCAL Pro

resistivity & IP equipment

for SOUNDING, IMAGING and MONITORING

SYSCAL Pro Switch MAIN FEATURES

- **The SYSCAL Pro Switch** is a versatile electrical resistivitymeter which combines a transmitter, a receiver and a switching unit in one single casing. It is supplied by a 12V battery.
- **The measurements** are carried out automatically (output voltage, stacking number, quality factor) after selection of limit values by the operator, and are stored in the internal memory.
- **The output specifications** are 800V (switch mode), 1 000V (manual mode) for the voltage, 2.5A for the current and 250W for the power using the internal DC/DC converter and the battery.
- **The SYSCAL Pro Switch** uses multi-core cables for controlling a set of electrodes connected in a line or in several lines. The standard number of electrodes: 24, 48, 72, 96, 120, can be increased through Switch Pro units for 2D or 3D ground images.
- **The ten channels** of the system permit to carry out up to 10 readings at the same time for a high efficiency.
- **The Induced Polarisation chargeability (IP)** is also measured through 20 windows for a detailed analysis of the decaying curves displayed on the graphic LCD screen.
- **The SYSCAL Pro Switch unit** can be operated with cables in boreholes, or cables pulled on the ground by a vehicle or on the surface of the water by a boat for continuous acquisition surveys.
- **The SYSCAL** can be used for time lapse readings (monitoring)

1D, 2D, 3D, 4D

RESISTIVITY INVESTIGATIONS

for characterizing underground structures:

- *ENVIRONMENT*
- *CIVIL ENGINEERING*
- *GROUNDWATER*
- *ARCHAEOLOGY*
- *MINING EXPLORATION*

TEN SIMULTANEOUS CHANNELS:
for high speed data acquisition, up to 1 000 rdgs/mn

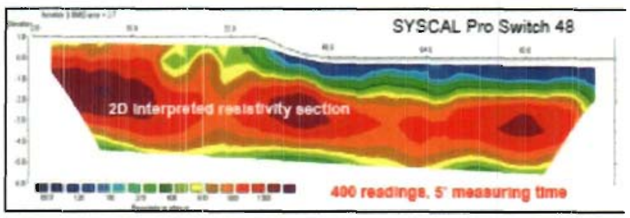
UP TO 800 - 1 000V, 2.5A OUTPUTS:
for penetration & data quality

AUTOMATIC SWITCHING CAPABILITY:
for 24, 48, 72, 96, 120, up to 1 300 electrodes

RESISTIVITY & INDUCED POLARIZATION:
twenty IP chargeability windows

PC SOFTWARE:

- **ELECTRE Pro:** sequence management
- **PROSYS II:** data transfer, process, display
- **COMSYSPro:** control of SYSCAL by PC
- **SYSMAR:** continuous acquisition
- **PROCESSING:** x2ipi (w/seq manag.)
- **INTERPRETE:** ERTLab (w/seq manag.) Res2/3Dinv, IX1D, Winsev



SYSCAL Pro SPECIFICATIONS

TRANSMITTER
- Max voltage: 800V in switch mode
- Max voltage: 1 000V in manual mode
- Max current: 2.5A, typ. accuracy 0.2%
- Max power : 250W with internal DC/DC converter and 12V external battery; 1200W with external AC/DC and Motor Gene.
- Option 25mA max for readings on samples
- Pulse duration: 0.2s, 0.5s, 1s, 2s, 4s, 8s
- Internal 12V, 7Ah battery, plug for ext. batt.

RECEIVER
- Automatic ranging, 10 input channels
- Input impedance: 100 Mohm
- Max voltage channel 1: 15V
- Max voltage sum of channel 2 to 10: 15V
- Protection up to 1 000V
- Typ accuracy: 0.2%, resolution: 1 microV
- 50 to 60Hz power line frequency rejection
- Stacking process, SP linear drift correction
- Reading of current, voltage, standard dev., 20 IP windows (preset or selectable).
- Internal 12V, 7Ah battery

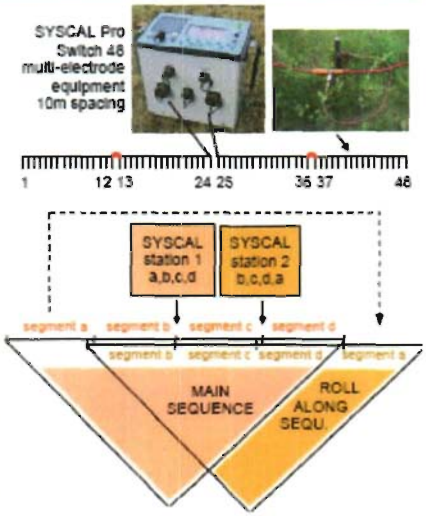
GENERAL
- Memory: 21 000 readings USB & SD card link
- GPS input for coordinates
- Fiber glass casing, weather proof
- Temperature range: -20 to +70°C
- SYSCAL Pro Switch 48: 31x23x36cm,
- Weight: 13kg, Cable w/ 24 take-out: 23kg

SYSCAL Pro Switch for resistivity imaging

The **SYSCAL Pro Switch** units use segments (seg) of multi-core cable which are reversible and interchangeable.

For instance, the **SYSCAL Pro Switch 48** with 10m spacing has 4 segments of cable a, b, c, d, with 12 electrodes each, for a total line length of 480m. The SYSCAL is placed in the middle of the line, between segments b and c.

If the profile to measure is longer than the line length, a **ROLL ALONG** technique can be applied where, after a first set of readings with (a, b, c, d), segment a is placed after segment d to form a new (b, c, d, a) combination etc.

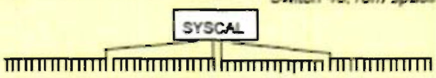


SYSCAL Pro Switch	48	72	96	120
5m spacing total line length	2 seg x 24 elect 240m	4 seg x 18 elect 360m	6 seg x 16 elect 480m	12 seg x 10 elect 600m
10m spacing total line length	4 seg x 12 elect 480m	8 seg x 9 elect 720m	12 seg x 8 elect 960m	24 seg x 5 elect 1 200m

All the SYSCAL Pro Switch units (48, 72, 96, 120) can also be delivered with segments of cables of:

- **24 electrodes** for the 5m spacing
- **12 electrodes** for the 10m spacing

In this case, **extension cables** directly connect the external cable segments to the meter. Example: SYSCAL Pro Switch 48, 10m spacing:



RESISTIVITY IMAGING IN 4 STEPS			
1 Choose & load a sequence	2 Take readings in the field	3 Transfer & process the data	4 Interpret the data
ELECTRE Pro software	**SYSCAL Pro Switch**	**PROSYS software**	**INVERSION software**

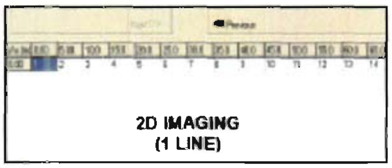
ELECTRE Pro software for sequence management

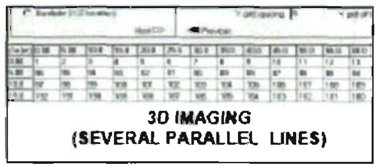
Introduction of parameters:
- type of electrode array (Wenner Schlumberger, dipole-dipole, pole-dipole
- number of electrodes 'n'
- value of spacing 'a'
- depth to reach
- number of stacks to use &/or quality factor to reach

Creation of the sequence of readings with various multi-spacing levels, such as 'a', '2a', '3'a, '5a', to increase the signal strength at a given depth. Visualization of the points

Transfer of the sequence file from the PC to the SYSCAL Pro Switch internal memory

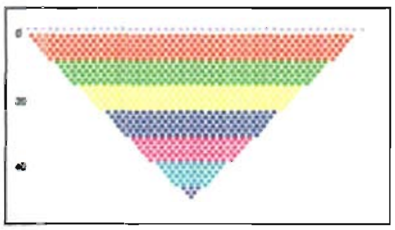
Automatic (or manual) numbering of electrodes

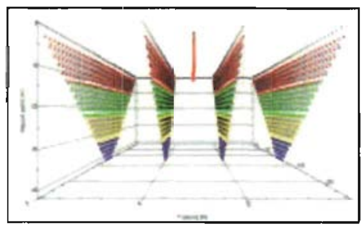




Automatic (or manual) generation of the sequence of readings

Visualization of the investigation points

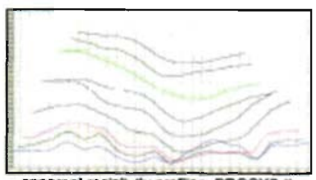




ELECTRODE ARRAYS	depth / line length	signal strength	lateral resolution	field set up
Wenner Sclumb	20%	regular	regular	regular
Dipole Dipole	20%	weak	best	regular
Pole Dipole	35%	medium	good	medium
Pole Pole	90%	best	weak	weak

PROSYS II software for data processing

- data transfer from SYSCAL to PC
- data plotting in profile & section
- elimination of noisy data
- introduction of topography
- export to interpretation software

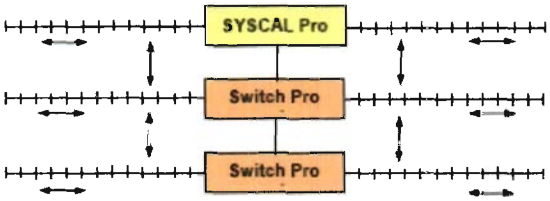


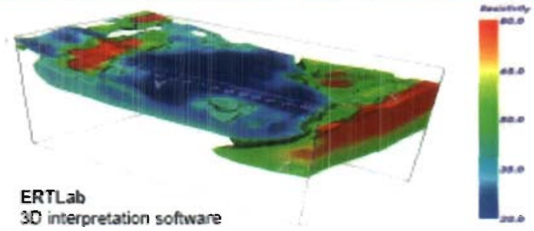
apparent resistivity profiles, PROSYS II

SWITCH Pro modules

SWITCH Pro (48, 72; 96, ...) units can be used to increase the number of electrodes controlled by the SYSCAL Pro Switch in a 3D survey for instance

ACQUISITION TIME for 1 000 READINGS	High speed mode 1 stack, 0.2s, ON time	Resistivity 5 stacks 0.5s ON time	Resistivity & IP 10 stacks, 2s ON/OFF time
ONE channel SYSCAL R1 Plus Sw	n/a	1 hour	8 hours
TEN channel SYSCAL Pro Switch	1 minute	8 minutes	1 hour





ERTLab
3D interpretation software

SYSCAL Pro options and accessories

'RECEIVER only' OPTION

with this option, the SYSCAL Pro can be used as a separate receiver, the current being generated by external powerful transmitters such as VIPs (3000V, up to 10kW)

VENTILATION OPTION

For high temperature surveys, the ventilated casing maintains the full power of the SYSCAL Pro Switch during the whole acquisition.

RESISTOR TEST BOX

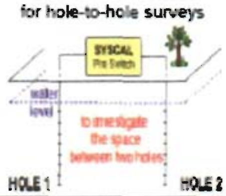
The resistor test box permits to run a sequence of readings on a set of resistors and check the good operation of the SYSCAL Pro Switch

INSULATION TEST BOX

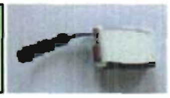
The insulation test box detects short circuit and open line at 800V test voltage for multi-core cables and for testing internal relays of SYSCAL Pro Switch

BOREHOLE CABLES

for hole-to-hole surveys



SD card writer for memory transfer



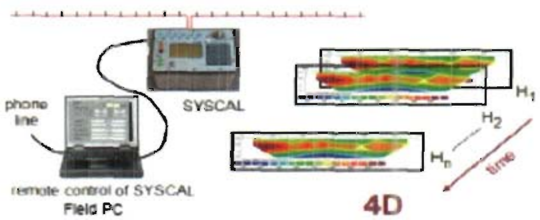
STRIP unit

Individual wires coming from the electrodes can be screwed on the front panel of a STRIP unit, itself connected to a Switch Pro module

12V BATTERY TESTER

The battery tester gives the remaining time of acquisition available for 50, 100, 250W output power

SYSCAL Pro Switch for resistivity monitoring

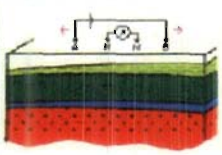


Remote control of the resistivity meter: COMSYS Pro software

With **COMSYS Pro software**, the SYSCAL Pro Switch can be fully controlled by the PC during the measurements. In particular, the PC can repeat sequences at preset dates and hours (H_1, H_2, ...H_n) through the 'script' function of the software, for resistivity monitoring applications. Data can be sent after each new set of readings to an office PC by e-mail or consulted on a dedicated website.

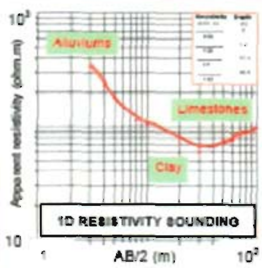
SYSCAL Pro for resistivity sounding

SYSCAL Pro (transmitter & receiver) and **SYSCAL Pro Switch** (transmitter, receiver & switcher) can be used for traditional vertical electrical sounding (VES), such as **Schlumberger Sounding**, to determine the depths and the resistivities of horizontal layers at the vertical of the centre of the array.
- **individual wires** for A, B (current) and M, N (potential) electrodes are connected to the front panel of the unit.
- in this manual mode, the maximum output voltage Vab is 1 000V.



Rho = K x Vmn / Iab

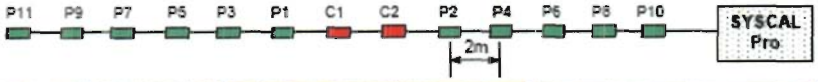
- **Rho**, apparent resistivity in ohm.m,
- **K**, geometrical coefficient in m
- **Vmn**, received potential in mV
- **Iab**, transmitted current in mA

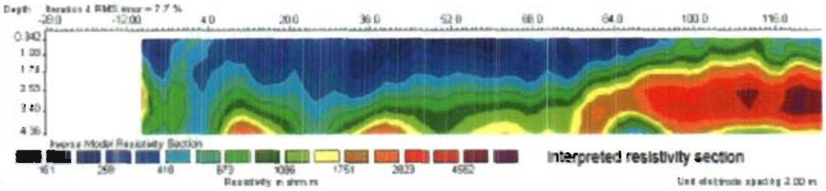


SYSCAL Pro for continuous land survey

DYNAMIC ACQUISITION for LAND SURVEYS

- **The SYSCAL Pro** can be used with a specific cable pulled on the ground by a light vehicle, for a continuous acquisition of resistivity readings.
- **The cable features** 13 cylindrical stainless steel electrodes (8cm diameter, 25cm length, 4.2kg) at *2m spacing*:
  - 2 for transmitting the current,
  - 11 for simultaneously measuring ten potential channels.
- **A PC** continuously records the 10 resistivity values and the GPS data, displays profiles in real time
- **Recommended electrode array:** reciprocal Wenner Schlumberger
- **Penetration depth:** about 5m
- **Best conditions:** wet grounds
- **Acquisition speed:** typ. 3km/h

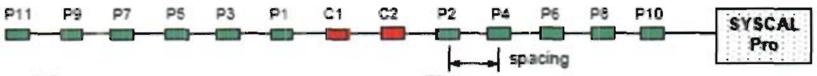


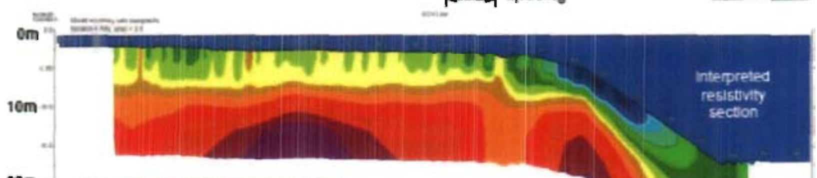


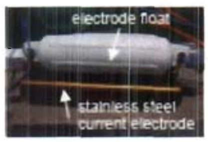
SYSCAL Pro for river and sea survey

DYNAMIC ACQUISITION for RIVER & SEA SURVEYS

- **The SYSCAL Pro** can be used with a specific cable pulled on the surface of water (lake, river or sea) by a light boat, for a continuous acquisition of resistivity readings.
- **The cable features** 13 cylindrical graphite electrodes (4cm diameter, 10cm length) at *5m spacing*:
  - 2 for transmitting the current,
  - 11 for simultaneously measuring ten potential channels.
- **A PC** continuously records the 10 resistivity / IP values and the GPS data, displays profiles in real time
- **GPS** *track* vizualisation on Google Earth
- **Recommended electrode array:** reciprocal Wenner Schlumberger
- **Penetration depth:** about 15m with a 100m total length cable
- **Acquisition speed:** typ. 3km/h







Current electrode of SYSCAL Pro Deep Marine

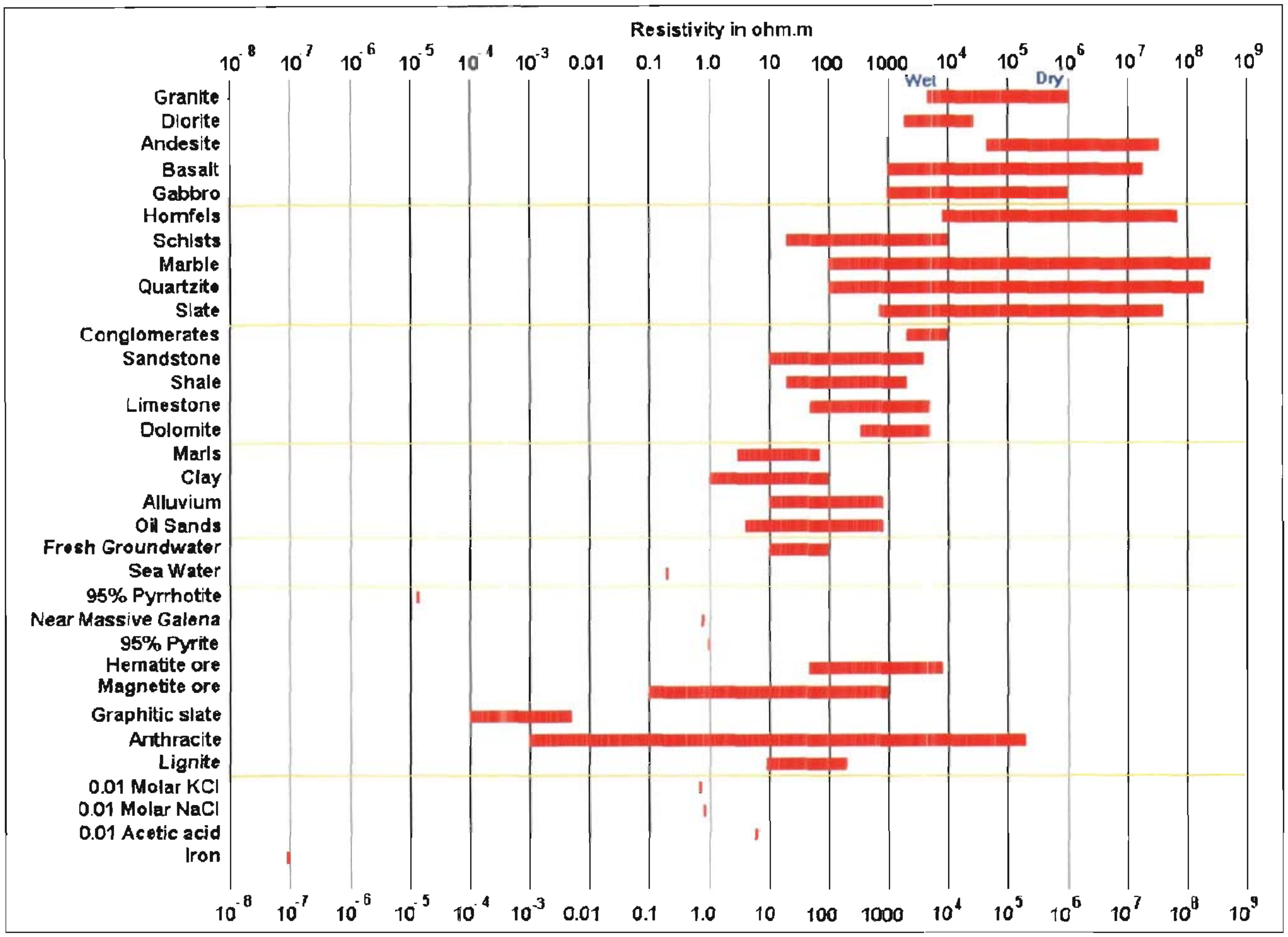
SYSCAL Pro Deep Marine is a SYSCAL Pro dedicated to measurement in sea water:

- **with outputs of 50V, 50A, 2500W**
- **for higher penetration**
- **for higher speed (up to 10km/h)**
- **with reciprocal Wenner-Schlumb & dip-dip**

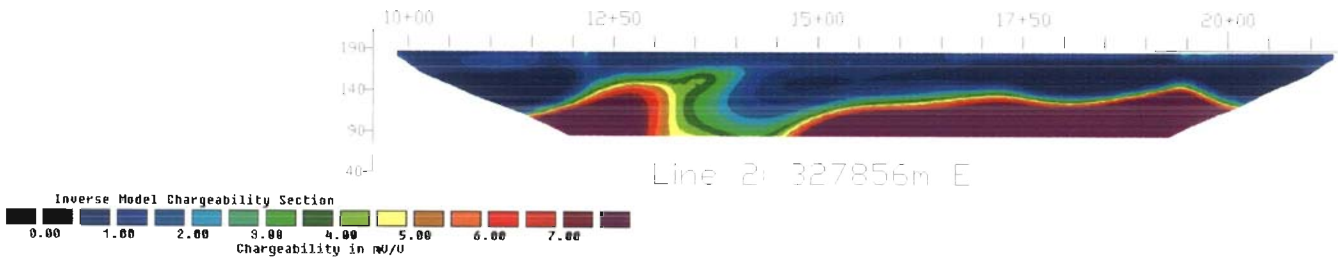
It uses the same graphite electrode cable as the SYSCAL Pro for the measurement of the potential, but stainless steel electrodes for the current (5cm diameter, 30cm length)

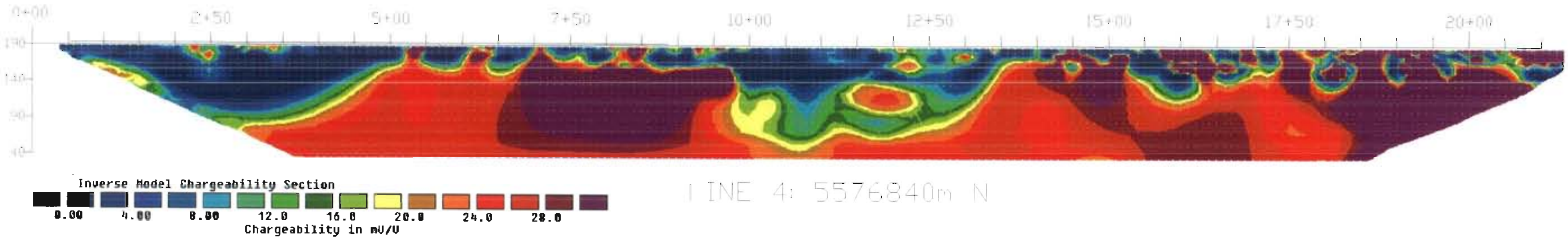
It can be used with a cable of 25m spacing between electrodes (total cable length 350m), for a depth of penetration of about 60m

IRIS Instruments, 1 avenue Buffon, BP 6007, 45060 ORLEANS Cedex 2, FRANCE
Tel: + 33 2 38 63 81 00 Fax: + 33 2 38 63 81 82 E-mail: info@iris-instruments.com Web: iris-instruments.com

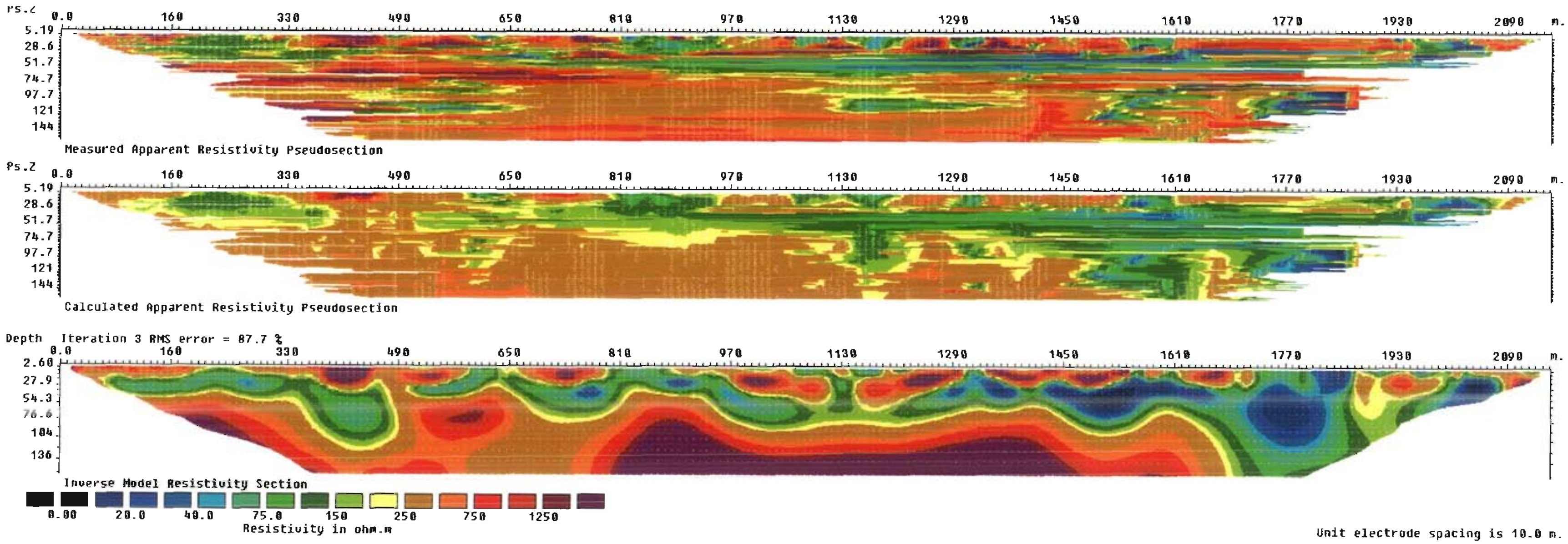

Resistivity in ohm.m
10-8 10-7 10-6 10-5 10-4 10-3 0.01 0.1 1.0 10 100 1000 10^4 10^5 10^6 10^7 10^8 10^9
Wet
Dry
Granite
Diorite
Andesite
Basalt
Gabbro
Hornfels
Schists
Marble
Quartzite
Slate
Conglomerates
Sandstone
Shale
Limestone
Dolomite
Marls
Clay
Alluvium
Oil Sands
Fresh Groundwater
Sea Water
95% Pyrrhotite
Near Massive Galena
95% Pyrite
Hematite ore
Magnetite ore
Graphitic slate
Anthracite
Lignite
0.01 Molar KCl
0.01 Molar NaCl
0.01 Acetic acid
Iron

Appendix B – IP Data –Profiles 2 and 4

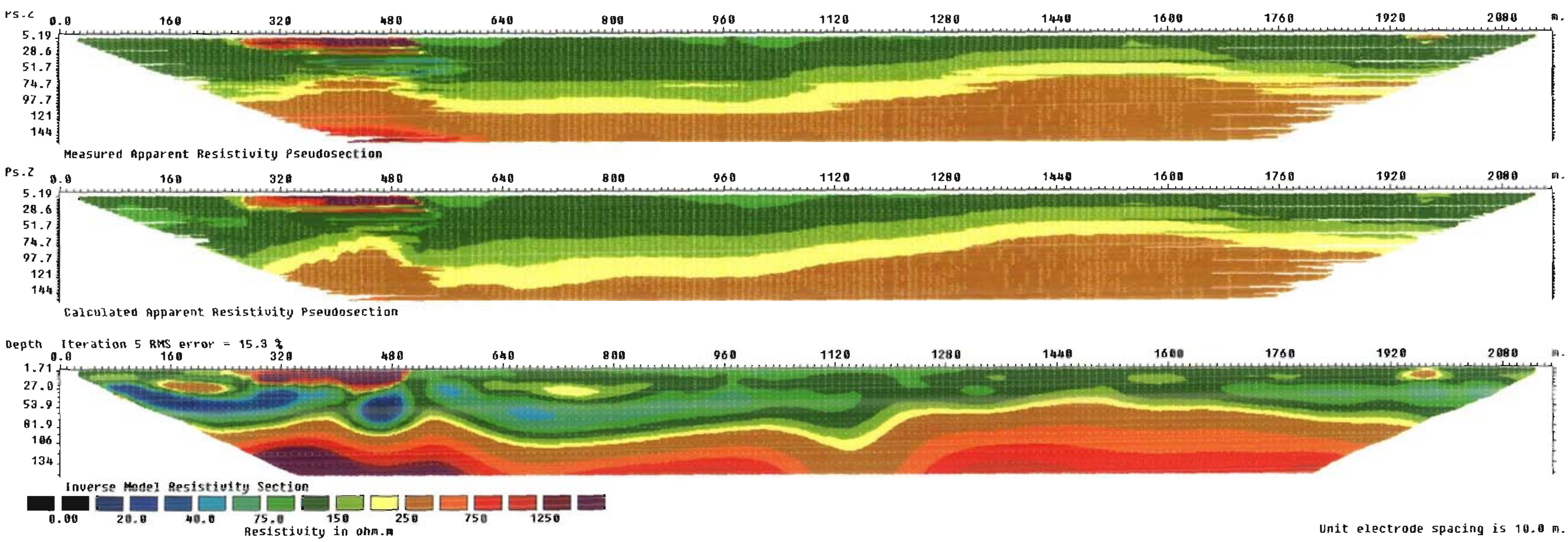

10+00
12+50
15+00
17+50
20+00
190
140
90
40
Line 2: 327856m E
Inverse Model Chargeability Section
0.00
1.00
2.00
3.00
4.00
5.00
6.00
7.00
Chargeability in mV/V


0+00
2+50
5+00
7+50
10+00
12+50
15+00
17+50
20+00
190
140
90
40
LINE 4: 5576840m N
Inverse Model Chargeability Section
0.00
4.00
8.00
12.0
16.0
20.0
24.0
28.0
Chargeability in mV/V

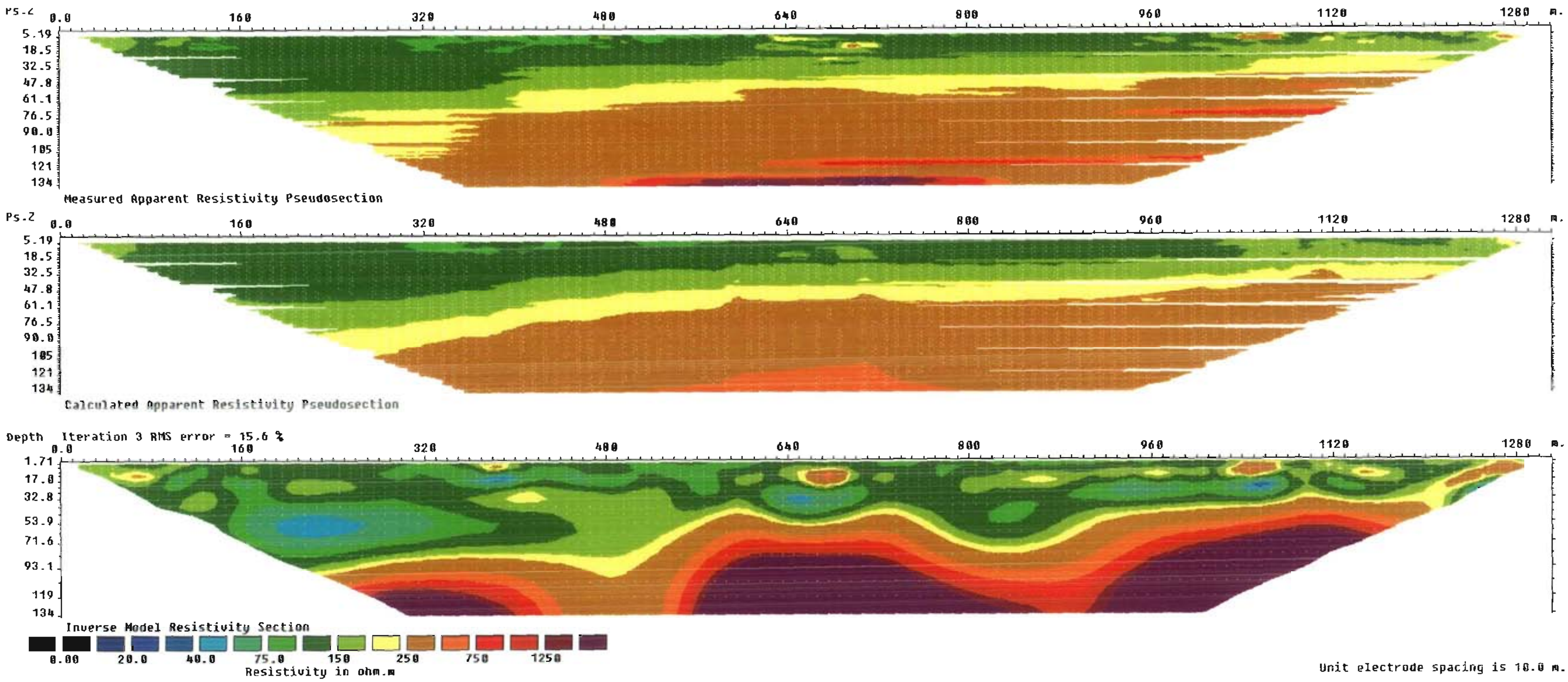
Appendix C – Inversion Models


Measured Apparent Resistivity Pseudosection
Calculated Apparent Resistivity Pseudosection
Depth Iteration 3 RMS error = 87.7 %
Inverse Model Resistivity Section
Resistivity in ohm.m
Unit electrode spacing is 10.0 m.

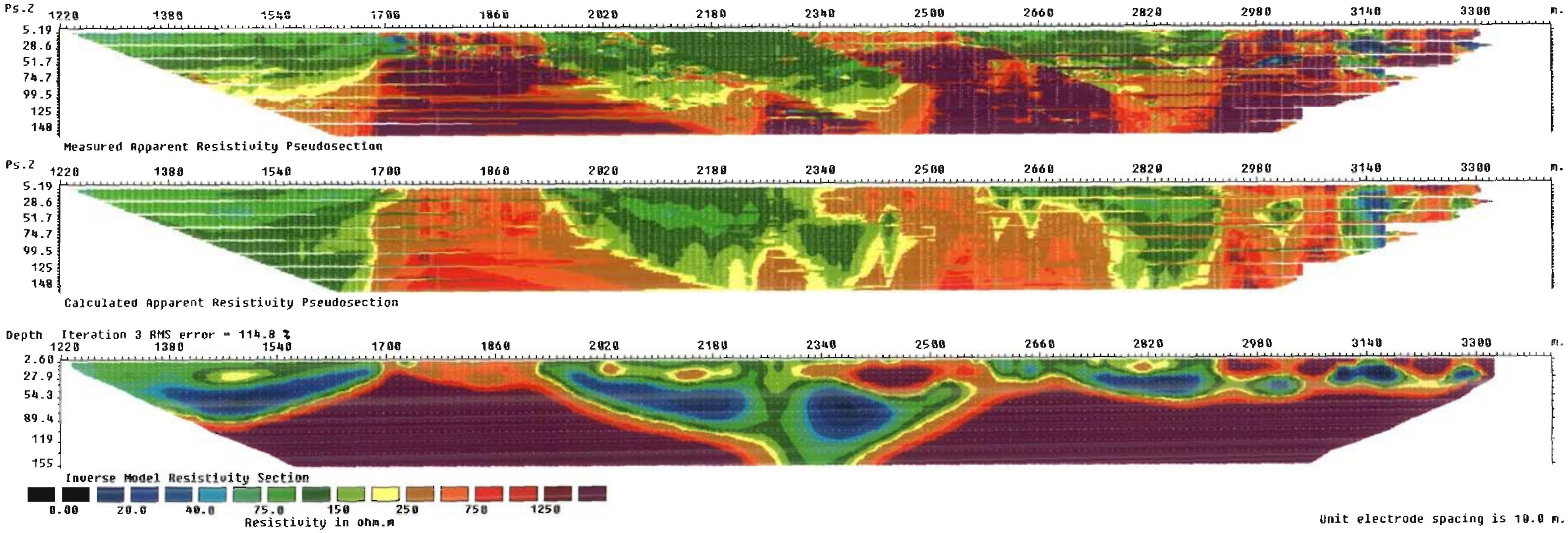
Profile 1

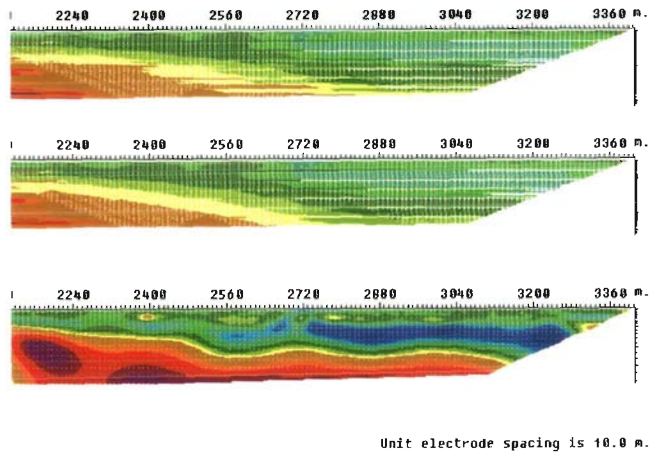

Ps.Z
0.0
160
320
480
640
800
960
1120
1280
1440
1600
1760
1920
2080
m.
5.19
28.6
51.7
74.7
97.7
121
144
Measured Apparent Resistivity Pseudosection
Calculated Apparent Resistivity Pseudosection
Depth Iteration 5 RMS error = 15.3 %
1.71
27.0
53.9
81.9
106
134
Inverse Model Resistivity Section
0.00
20.0
40.0
75.0
150
250
750
1250
Resistivity in ohm.m
Unit electrode spacing is 10.0 m.

Profile 2

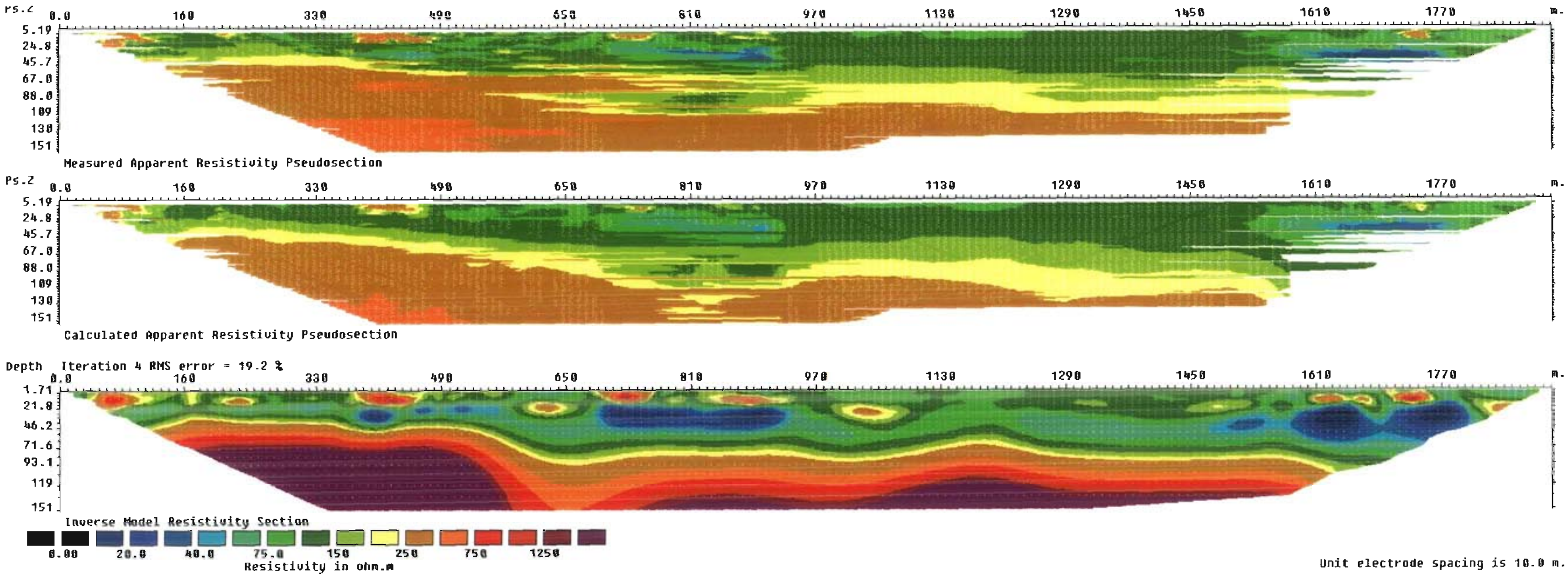

Ps.Z
0.0 160 320 480 640 800 960 1120 1280 m.
5.19 18.5 32.5 47.8 61.1 76.5 90.0 105 121 134
Measured Apparent Resistivity Pseudosection
Ps.Z
0.0 160 320 480 640 800 960 1120 1280 m.
5.19 18.5 32.5 47.8 61.1 76.5 90.0 105 121 134
Calculated Apparent Resistivity Pseudosection
Depth Iteration 3 RMS error = 15.6 %
0.0 160 320 480 640 800 960 1120 1280 m.
1.71 17.0 32.8 53.9 71.6 93.1 119 134
Inverse Model Resistivity Section
0.00 20.0 40.0 75.0 150 250 750 1250
Resistivity in ohm.m
Unit electrode spacing is 10.0 m.

Profile 3

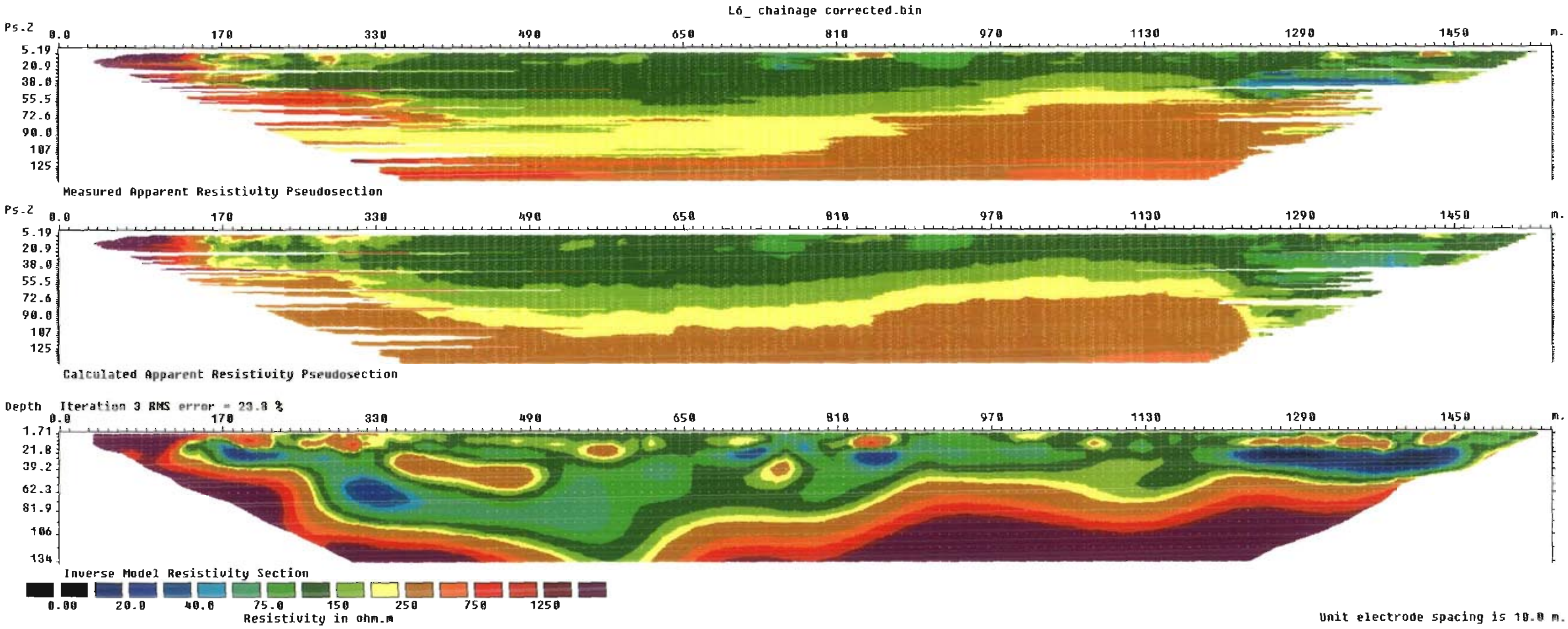




Profile 4: (Note Top Profile Chainage numbering offset by 1220m)


Measured Apparent Resistivity Pseudosection
Calculated Apparent Resistivity Pseudosection
Depth Iteration 4 RMS error = 19.2 %
0.0 160 330 490 650 810 970 1130 1290 1450 1610 1770 m.
5.19 24.8 45.7 67.0 88.0 109 130 151
1.71 21.8 46.2 71.6 93.1 119 151
Inverse Model Resistivity Section
0.00 20.0 40.0 75.0 150 250 750 1250
Resistivity in ohm.m
Unit electrode spacing is 10.0 m.

Profile 5


L6_ chainage corrected.bin
Ps.Z
0.0 170 330 490 650 810 970 1130 1290 1450 m.
5.19 20.9 38.0 55.5 72.6 90.0 107 125
Measured Apparent Resistivity Pseudosection
Calculated Apparent Resistivity Pseudosection
Depth Iteration 3 RMS error = 23.9 %
1.71 21.8 39.2 62.3 81.9 106 134
Inverse Model Resistivity Section
0.00 20.0 40.0 75.0 150 250 750 1250
Resistivity in ohm.m
Unit electrode spacing is 10.0 m.

Profile 6

Appendix D: Drawings – Interpreted Resistivity Profiles

T08110_A1
T08110_A2