Hayasa Resources Corp LLC

Urasar (Hanqakutak) Prospect

Lori Province, Armenia,

Ground Geophysical Survey
High Resolution Resistivity / Time Domain IP

Project-N°: S24-248

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Date: April 23, 2025

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1.1 Introduction

This is a report on a ground geophysical survey carried out at Urasar (Hanqakutak) prospect, Lori province, Armenia, in the Lesser Caucasus Mountains.

Client:	**Hayasa Resources Corp LLC,** Totovents street /bld./ 11 / 3 Nor Nork 0062, Yerevan, Armenia
Managing director:	Hovhannes Karapetyan
Company /address:	
Contractor:	**terratec geophysical services GmbH & Co KG** Schillerstraße 3 D-79423 Heitersheim / Germany Phone: +49 (0) 7634 50319-0 e-mail : info@terratec-geoservices.com
Project Number:	S24-240

1.2 Objective

The objective of the survey was to investigate potentially mineralized zones in the prospect area and to support the geological interpretation. The method to be applied as well as the positions of the lines to be surveyed have been fixed in accordance with the client representative based on existing information. To meet the objectives a HIRIP array (High Resolution Resistivity and IP) was selected.

1.3 Survey design and specification

Following an example for the data distribution on a 1900 m line length is illustrated in Figure 1 below.

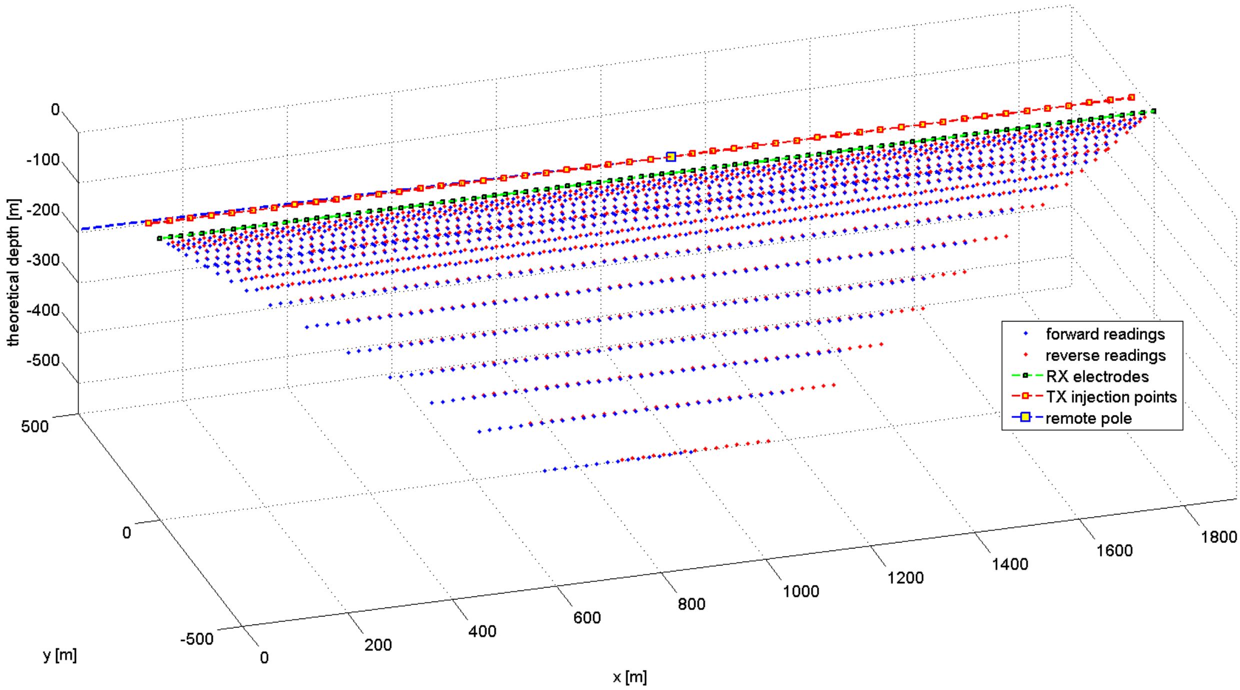

Figure 1*:* ***HIRIP Pole-Dipole array, Data distribution and layout of RX and TX***

Standard transmitter injection points have a spacing of 50 m and offset 50 m parallel to the receiver lines.

Parameters of HIRIP array (for 1900 m long profile):

RX spacing	a	=	20 m
Current injection spacing	TX_Spacing	=	50 m
Section length		=	1540 m

Settings:

Time domain cycle	T	=	2 sec
IP Delay time	M_D	=	240 ms
Width of partial IP window	T_M1-T_M20	=	80 ms

1.3.1 Equipment used

- HIRIP - time domain induced polarization multi-electrode receiver (Iris)
- Instruments Elrec Pro (10 Channel) connected via a Switch Pro to a 1540 m long cable with electrode take outs every 20 m
- stainless steel electrodes
- Transmitter – Iris VIP4000 4 kVA
- Field computers and Garmin GPSmap64s handheld GPS
- 1 x motor generator 6.5 kVA

1.3.2 Deliverables

- Daily working report (Annex 2)
- Raw data and processed data digitally delivered via e-mail
- HIRIP – model resistivity and model chargeability sections digitally delivered via e-mail
- Geosoft project including all data sections and maps

1.4 HIRIP Field Work

From September 7th to September 9th a total of 3 HIRIP (**Hi**gh Resolution **R**esistivity and **IP**) lines with 1540m each were measured. Figure 2 shows the sitemap of the measured lines and the positions of the remote poles P1, P2 and P3.

The team consisted of 3 experienced people from terratec responsible for the transmitter, the receiver and the line logistics, supported by a big team of technicians provided by the client.

The coordinate system used is UTM WGS 84 Zone 38.
A detailed field progress report is given in Annex 2.

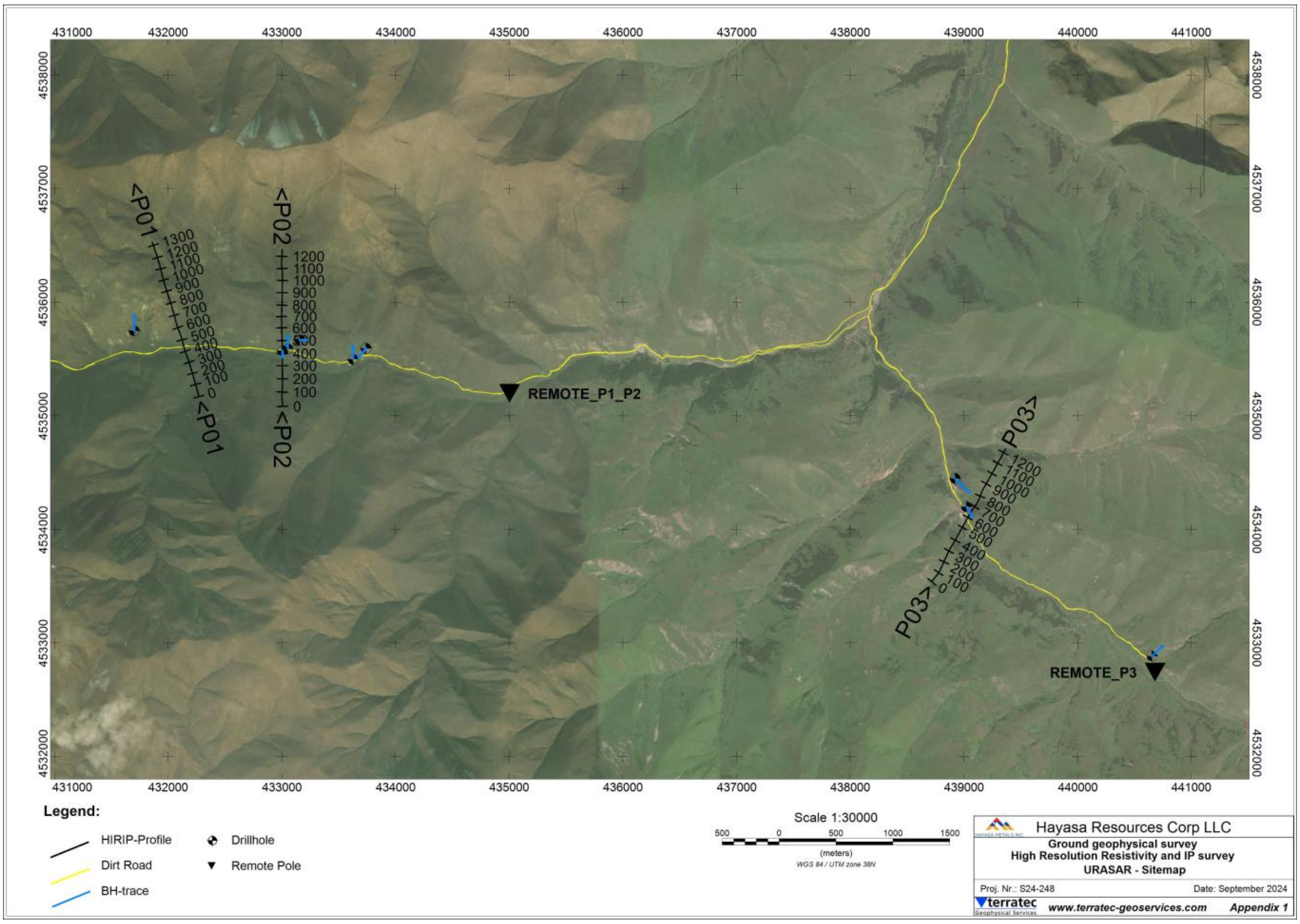

Figure 2: Area of investigation sitemap
HIRIP lines are shown as black lines the triangles are showing the remote poles

An impression of the field conditions can be seen in Figure 3 below.

Figure 3: General Field Aspect

Figure 4: Transmitter setup with operator and generator

Figure 5: Receiver site, view perpendicular to the line

The lines were measured from South to North. All positions in meters and the according UTM positions are given in the ascii database which was delivered to the client.

2 Data processing

2.1 GPS processing

Due to the open survey area and the good satellite coverage, accuracy of about 3m can be achieved with the GARMIN GPS units. It was decided to measure the start point, the connection boxes of the measurement cables (every 120m), significant points (e.g. change of direction, cliffs) along the profiles and the end point of the measurement profile using GARMIN handheld GPS. In addition, all injection points were measured with the GARMIN GPS. All positions were taken in UTM WGS 84 Zone 38 coordinates. The elevations were sampled from a DEM grid provided by the client. All positions can be found in the database delivered to the client.

2.2 Steps in analysing data quality and preparing data prior to inversion

A first quality control was done in the field by the operator. The data processing, modelling and plotting were done in the terratec head office in Germany by Diplom Geophysiker Michael Tauchnitz. The injected current varied between 800mA and 1.7A. The data is of a good quality.

The following data preparation steps have been done:

- Removal of “visible outliers (of the apparent resistivity and chargeability)”

- Normalization of the voltage error (standard deviation); removal of resistivity and IP data points having standard deviation higher than 4 %
- Assessment of the quality IP decay curves. Each of the recorded IP decay curve was assessed in quality and evaluated statistically on the basis of the fit to a Debye model. All decay curves that were insufficiently fit by the Debye model (coefficient < 0.3 %) were masked and not considered in the IP inversion. The corresponding resistivity data remained in the data set.

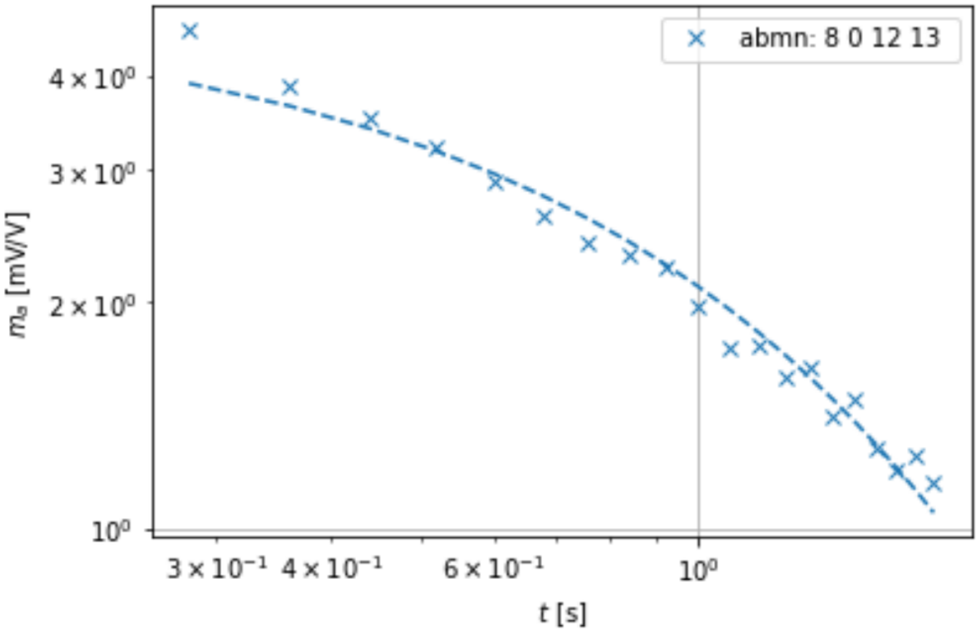

Figure 6: ***the measured IP decay curve (crosses) and the fitted Debye curve (blue dashed).***

2.3 Data Plotting

For the visualization of the data in Geosoft the resistivity and chargeability model derived by the 2D inversion in the Zond2D software were used.

These 2D HIRIP sections and the GPS data (given in UTM WGS84 Zone 38U coordinates) were imported into Geosoft Oasis Montaj. For the gridding of the resistivity and chargeability sections the minimum-curvature gridding method with a cell size of 10 m was used. The limits of the resistivity and chargeability colour scale were statistically determined.

General remarks:

The resistivity is mainly used to distinguish between different lithologies. The resistivity of a rock is particularly sensitive to changes in pore fluid resistivity and saturation as the principal current flow in the subsurface is mainly through electrolytic conduction in the pore fluid.

As a result, statements can be made about the weathering or the degree of weathering of a rock.

Secondly clay minerals exert a particularly strong influence on resistivity due to electric conduction on the clay mineral surface. Therefore, increasing water saturation / electrolytic conduction in the pore fluid (e.g. weathered rock, fractures and/or fault zones), and increasing proportion of clay in a soil or rock (e.g. in sandstone) is generally linked to a reduction in resistivity.

The chargeability is used to detect minerals showing polarisation effects. Strongest effects can be observed on sulphides, magnetite and graphite. To a lesser extent, clay minerals can also show a polarization effect.

In the HIRIP model resistivity and chargeability sections the same colour scale was used for the project. The colour scales were determined statistically, representing 95 % of the model data.

The chargeability anomalies are statistically classified and outlined as shown in the following table. ***The terms weak and strong are only referring to the statistics in the described chargeability sections and are a relative classification for this project. This is not a general classification for the quality of the chargeability anomalies to be used to compare with other areas or projects.***

Chargeability (mV/V)	**Symbol**	**Geophysical interpretation**
3.3 – 4.9		Weak chargeability anomaly *(lower limit: median of modelled IP line data)*
5.0 – 6.7		Intermediate chargeability anomaly *(lower limit: median + simple standard deviation of all modelled IP line data)*
> 6.7		Strong chargeability anomaly *(median + 2 x simple standard deviation of all modelled IP line data)*

These anomaly zones are marked on the following resistivity and chargeability plots of Figure 7,8,9 of the next chapters.

2.3.1 HIRIP Model Section – P1

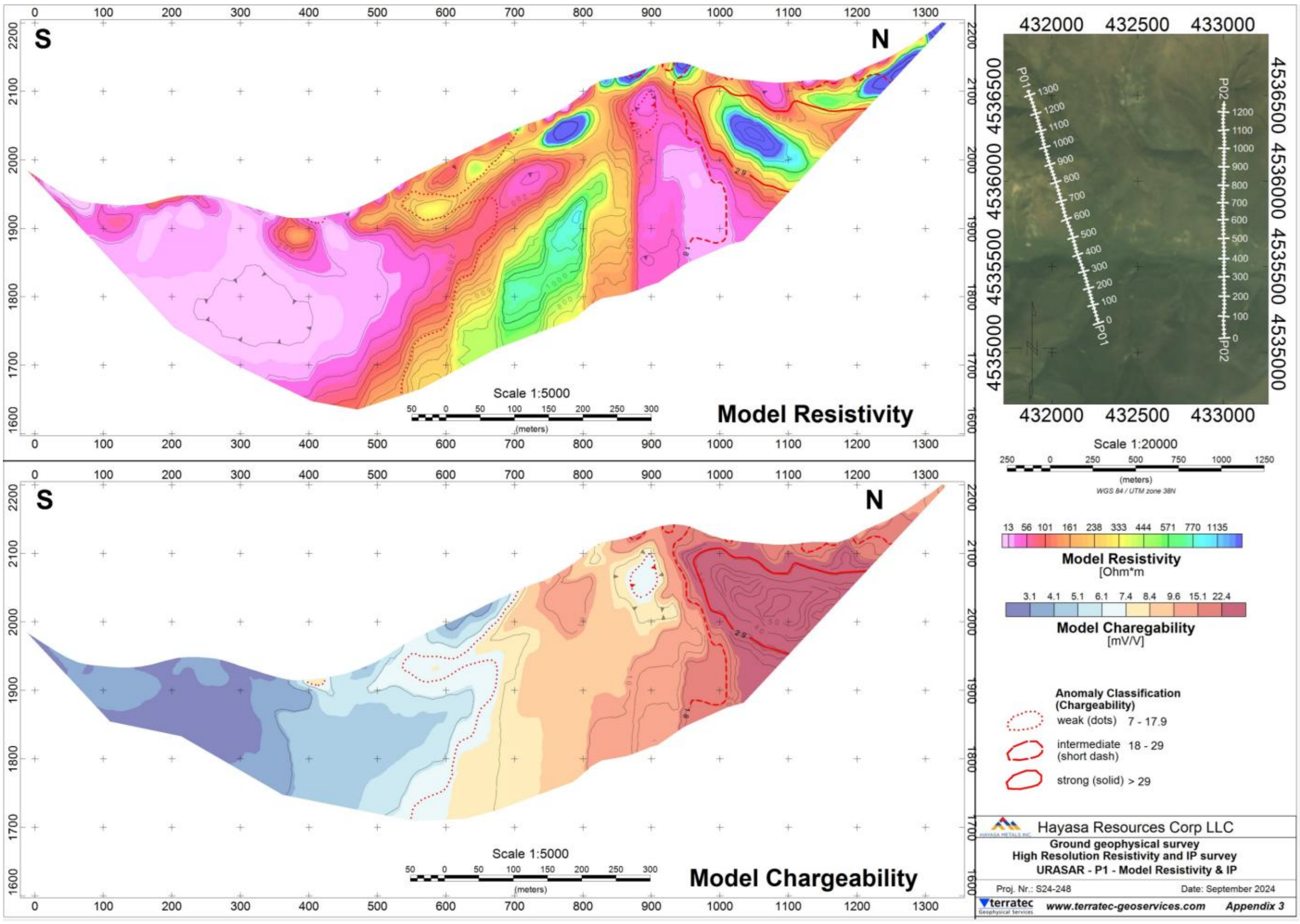

Figure 7: HRIP Section P1

HIRIP-Section P1 shows a low resistivity (high conductivity) zone in the southern part from position 0 m to approximately 500 m on the profile. This resistivity low correlates to the adjacent HIRIP-Section P2 and to low chargeabilities in the South of both sections.

At approximately Position 900 m at surface, a pronounced sub vertical conductor (= low resistivity) with an apparent dip to North is visible. The apparently south-dipping southern flank of this conductive feature correlates with the southern flank of the zone with higher chargeabilites. A second high conductive feature with an apparent dip of approximately 30 degrees to South also starts from Position 900 m at surface. Hints of slightly elevated chargeabilities can be seen in the same area.

2.3.2 HIRIP Model Section – P2

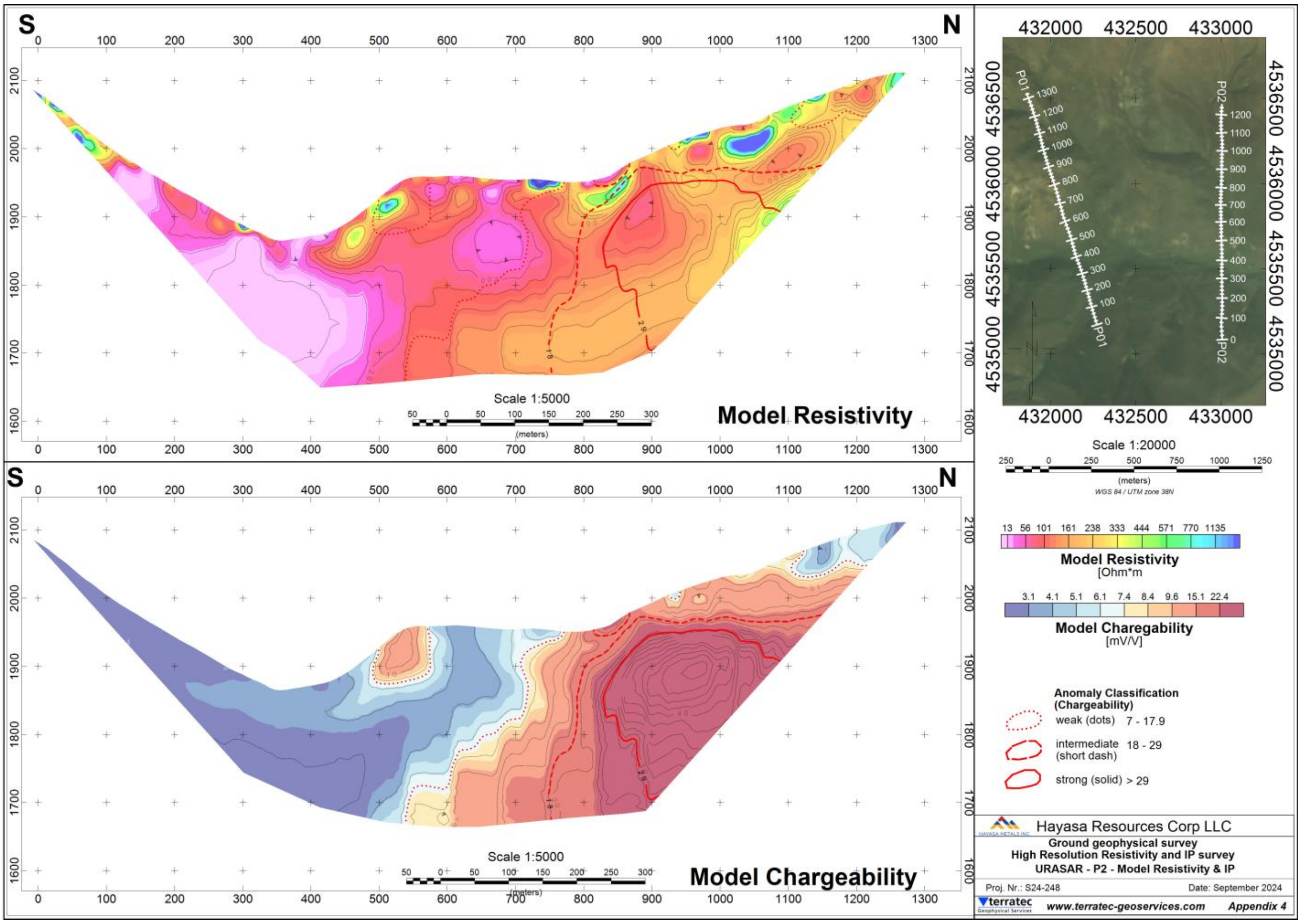

Figure 8: HIRIP Section P2

As P1, P2 shows a distinctive low resistivity zone in south. No distinct pronounced features like on P1 can be seen on the North part of the resistivity model of P2. Apparently the geologic setting is complex, no 'simple' 2D geologic situation, along the profiles as well as between P1 and P2.

A chargeability anomaly is present in the North part of P2, with a bigger central core and some weaker border zones. The contact between IP high and low has also dip to south as on P1. In the zone with higher resistivities in the North part of the section the resistivity features are less pronounced, not showing distinct dip or strike

P1: The apparently sub-vertical dipping low resistive feature associated with high chargeabilities presents a geophysical target for follow up investigation. This target is represented on P2 mainly by a zone with high chargeabilities. To resolve the complex geological situation, infill Profiles would be needed.

2.3.3 HIRIP Model Section – P3

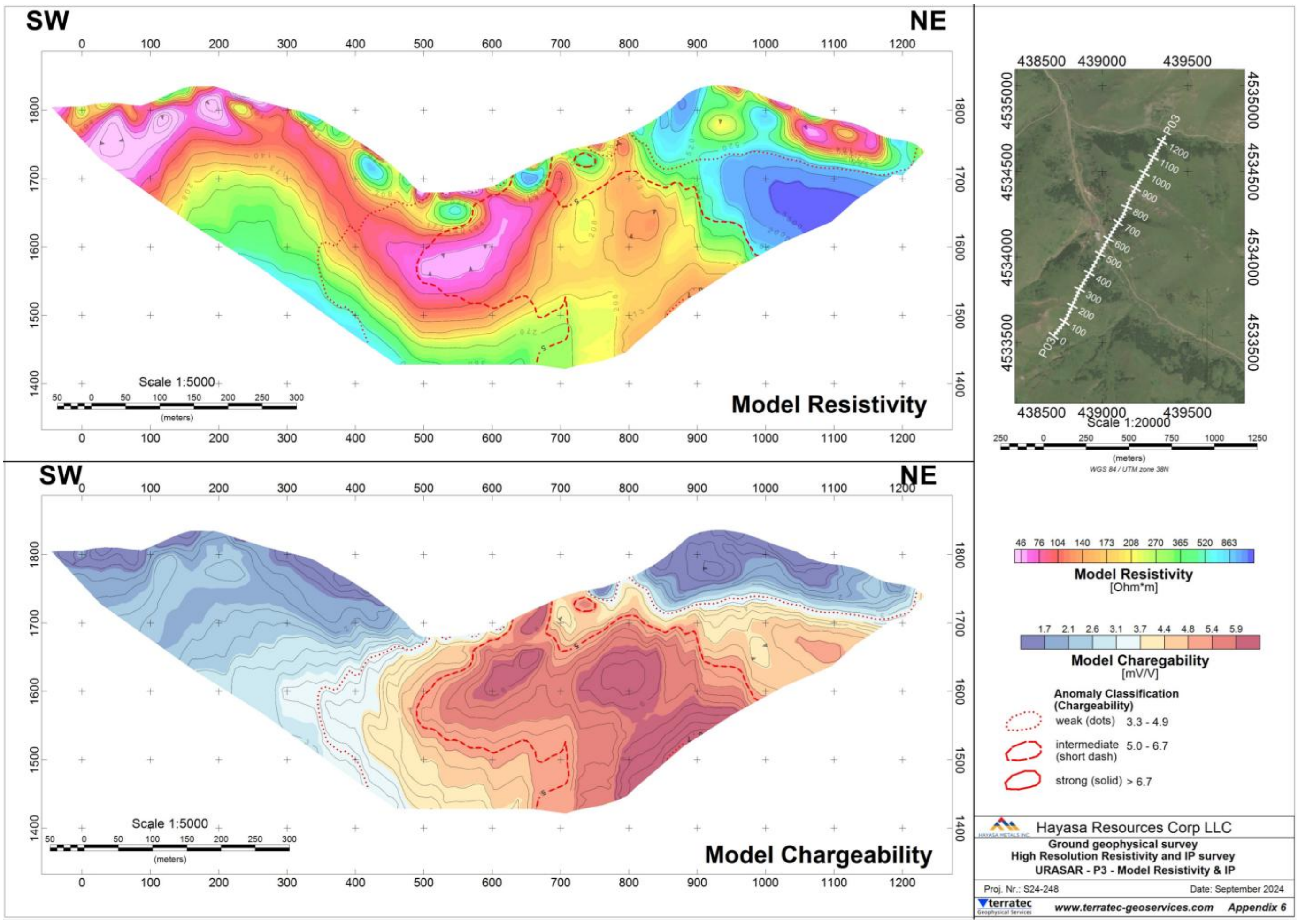

Figure 9: HIRIP Section P3

Please note that for better contrast the color zones for resistivity and IP of P3 are different than the one of P1 and P2!

The resistivity section shows until position 700 m a high resistive unit with an approximately max. 100 m thickness, underlain by a low resistive unit. The form of these two bodies could be showing a fold. At position 700 a low resistive feature in the depth seems to stop at a vertical feature. This vertical feature can be seen in the deeper parts of the IP anomaly approx. at Position 700m.

These structures are followed to the North by a high resistive wedge broadening towards depth, with a low resistive unit on its NE flank. The highest chargeability values are localized in the sub-vertical high resistive zone between position 700 m and 900 m. According to this single profile this chargeability zone is broadening toward depth with an apparent dip towards Northeast.

The high chargeabilities on P3 are located in the high resistive zones, unlike on P1 and P2. This zone between 500 m and 800 m at surface, continuing and broadening to depth towards NE represents a potential geophysical target for follow up investigation.

3 Digital Deliverables

Additionally, to this report the complete Geosoft project including all data bases and the plotted sections was delivered digitally to the client. Additionally, all sections have been delivered to the client as PDF and as spreadsheet with all model data points (resistivity and chargeability) and their X_UTM/Y_UTM/Z_DEM positions.

T. Eckardt

Thomas Eckhardt
(Senior geophysicist)

Klaus Brauch
(managing director)

Heitersheim, 23.04.2025

Respectfully submitted,
per terratec geophysical services

Annex 1: HIRIP survey – field progress report

<table>
<tr><th colspan="8">Daily report</th></tr>
<tr><td rowspan="3"># Day</td><td rowspan="3">Date</td><td>Client:</td><td colspan="6">Hayasa resources</td></tr>
<tr><td>Project:</td><td colspan="3">Urasar HIRIP</td><td>Coordinate system:</td><td>UTM 38</td></tr>
<tr><td colspan="6"></td></tr>
<tr><td rowspan="7">Saturday</td><td rowspan="7">07.09.</td><td colspan="6">Profil 01</td></tr>
<tr><td>first TX</td><td>last Tx</td><td>first electr.</td><td>last electr.</td><td>array</td><td>line direction</td></tr>
<tr><td>0m</td><td>1550m</td><td>0m</td><td>1540m</td><td>P-DP</td><td>N-S</td></tr>
<tr><td colspan="6">* REM240906
* Rs of RX electrodes: In the west 0.5kOhm to 5kOhm</td></tr>
<tr><td>RX - Spacing:</td><td>TX - Spacing:</td><td>TX side</td><td colspan="2">distance (TX to Profile):</td><td>Current used (range):</td></tr>
<tr><td>20</td><td>50</td><td>east</td><td colspan="2">~50m</td><td>0.7A to 1.8A</td></tr>
<tr><td colspan="6"></td></tr>
<tr><td rowspan="6">Sunday</td><td rowspan="6">08.09.</td><td colspan="6">Profil 01</td></tr>
<tr><td>first TX</td><td>last Tx</td><td>first electr.</td><td>last electr.</td><td>array</td><td>line direction</td></tr>
<tr><td>0m</td><td>1550m</td><td>0m</td><td>1540m</td><td>P-DP</td><td>N-S</td></tr>
<tr><td colspan="6">* REM240906
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<tr><td>RX - Spacing:</td><td>TX - Spacing:</td><td>TX side</td><td colspan="2">distance (TX to Profile):</td><td>Current used (range):</td></tr>
<tr><td>20</td><td>50</td><td>east</td><td colspan="2">~50m</td><td>0.7A to 1.8A</td></tr>
<tr><td rowspan="6">Monday</td><td rowspan="6">09.09.</td><td colspan="6">Profil 01</td></tr>
<tr><td>first TX</td><td>last Tx</td><td>first electr.</td><td>last electr.</td><td>array</td><td>line direction</td></tr>
<tr><td>0m</td><td>1550m</td><td>0m</td><td>1540m</td><td>P-DP</td><td>N-S</td></tr>
<tr><td colspan="6">* REM240909
*Rs of RX electrodes: In the north between 0.8kOhm to 11kOhm and one 16kOhm, In the south between 0.4kOhm to 3kOhm
*water pipe starting from the water tank (100m from RX line), but not crossing the line</td></tr>
<tr><td>RX - Spacing:</td><td>TX - Spacing:</td><td>TX side</td><td colspan="2">distance (TX to Profile):</td><td>Current used (range):</td></tr>
<tr><td>20</td><td>50</td><td>east</td><td colspan="2">~50m</td><td>0.5A to 1.8A</td></tr>
</table>

Annex 2: Method Description – HIRIP

This paper describes the design and function of our in-house developed HIRIP system and provides background knowledge on the measured parameter. HIRIP is an imaging system for measuring high resolution IP and Resistivity sections of up to 500 m depth.

A) Measured Parameters

The HIRIP-method measures the ground resistivity and chargeability (IP effect). The system employed for the time-domain induced polarisation/resistivity survey consists of a current transmitting device and a receiver system. A transmitter generates a bipolar on-off (50% duty cycle) square wave, typically with current injection times of T = 2 s. Copper meshes, aluminium paper, stainless steel electrodes and salt water are used to transmit current through the ground.

During current injection, the apparent **bulk resistivity** of the ground is calculated from the input current and the measured primary voltage (vp). After the pulse has been transmitted, the **IP** effect is measured as a time diminishing voltage at the receiver electrodes. Therefore, the **IP** data is simultaneously taken when measuring resistivity with the same equipment and staking.

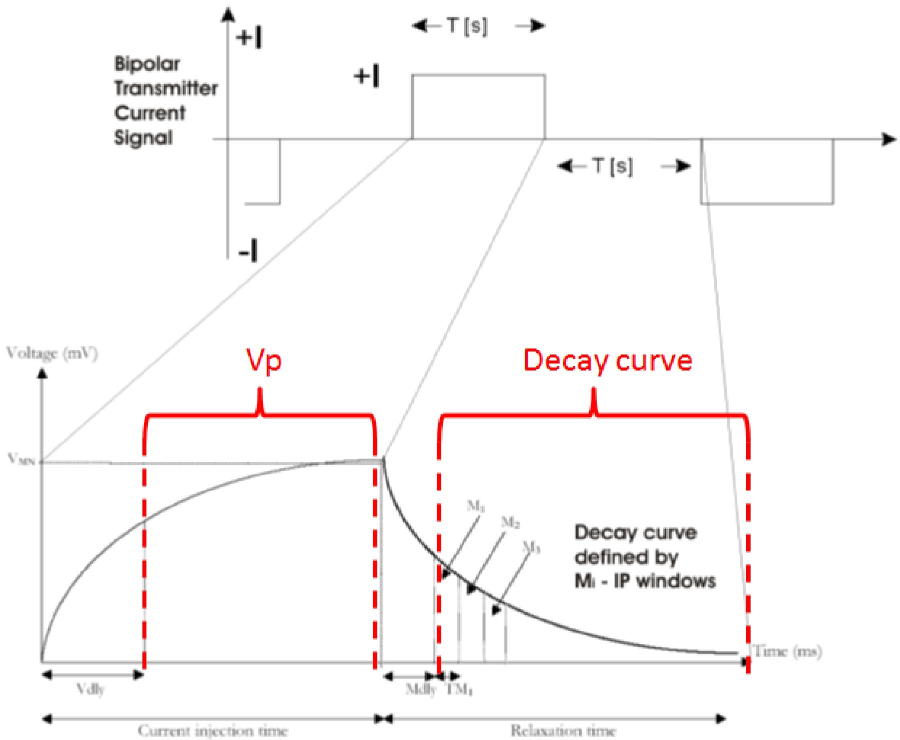

Figure 10: Transmitted current signal and the signal integration.

B) DC Resistivity – Fundamentals

DC electrical resistivity methods measure earth resistivity by injecting a direct current (DC) signal into the ground and measuring the resulting potentials (voltages) created in the earth. From this data the resistivity of the earth can be derived and the geologic properties of the earth can be inferred.

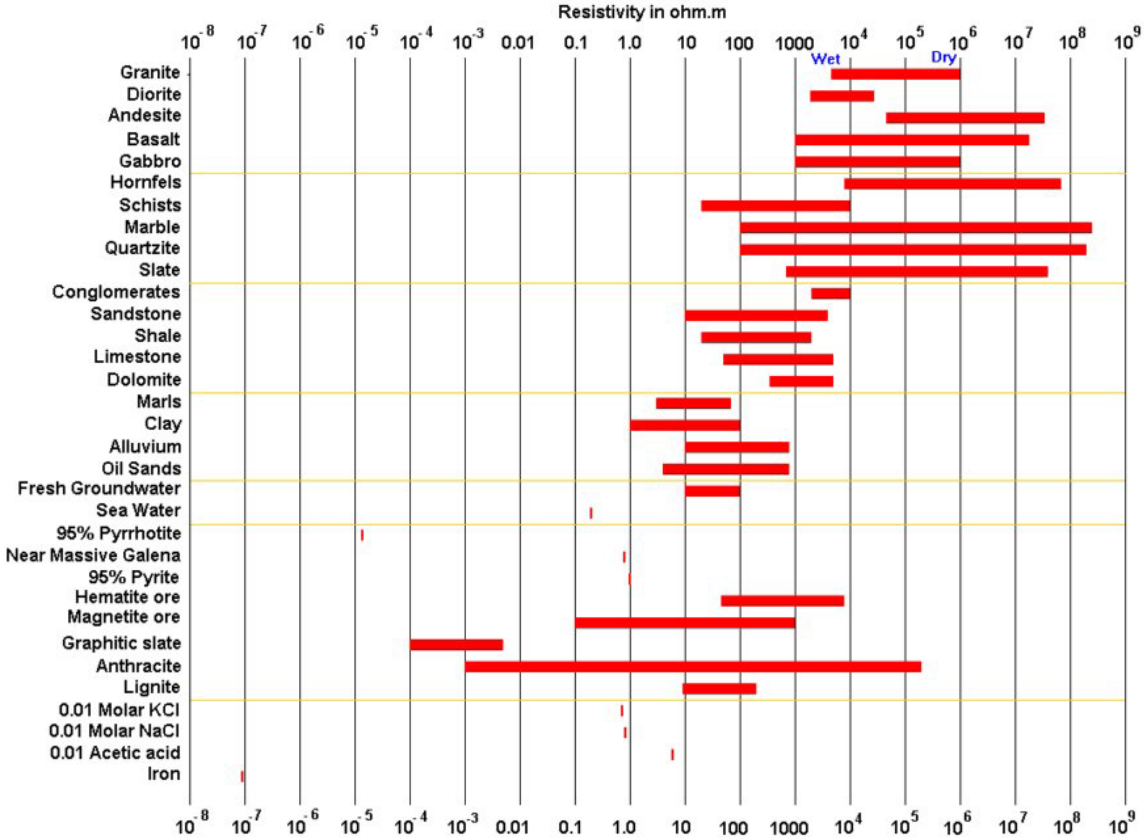

Figure 11: The resistivity of rocks, soils and minerals *(M.H.Loke (1996-2001)*.

C) Induced Polarization (IP) – Fundamentals

Induced Polarizations (IP) is perhaps the most popular of all geophysical techniques in mineral exploration because it is the only technique responsive to low-grade disseminated sulfides. There are two main mechanisms of rock polarization that can be measured, the Membrane Polarization and the Electrode Polarization.

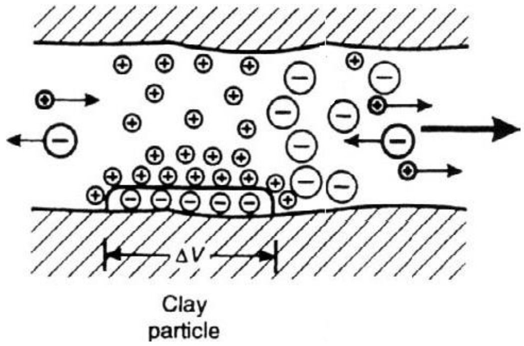

Figure 12: Membrane polarization associated with negatively charged clay particles (Reynolds, 1997).

The Membrane Polarization effect is largely caused by clay minerals present in the rock or sediment. This is particularly relevant in engineering and environmental surveys.

The Electrode Polarization effect is caused by conductive minerals in rocks such that the current flow is partly electrolytic (through groundwater) and partly electronic (through the conductive mineral).

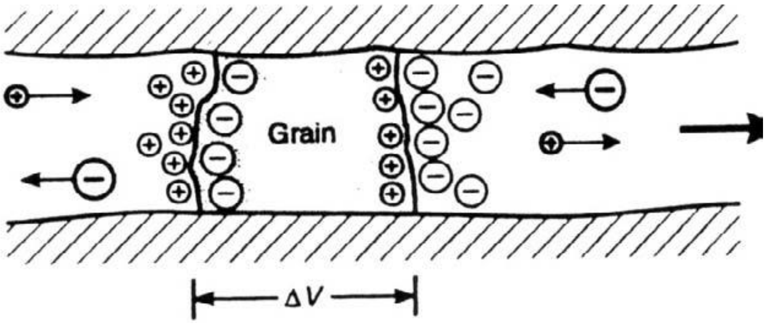

Figure 13: Grain electrode polarization (Reynolds, 1997).

This effect is of particular interest in surveys for metallic minerals, such as disseminated sulfides. IP measurements are made in the time-domain or frequency domain. In the HIRIP system the time-domain is used. In the time-domain, the IP effect is measured by the residual decay voltage after the current is switched off (Figure 1 and 5).

The time domain IP unit, the chargeability, is usually given in millivolt per volt (mV/V). The figure above shows the IP values (in terms of mV/V) for several mineralized rocks and common rocks. It should be noted that the IP effect due to sulfide mineralization (the electrode polarization effect) is much larger than that due to clay minerals (membrane polarization) present in sandstone and siltstones *[Tutorial : [2-D and 3-D electrical imaging surveys, M.H.Loke (1996-2001)].*

Processing and representation of the observed data

The electrical properties of earth materials in the subsurface give rise to anomalies in the surveyed data. After a quality control in the field during the data collection, the observed 2D apparent resistivity and IP data were analysed in the post-processing in the terratec Geophysical Services head office in Germany. The recorded data is visualised and bad data points are filtered out. Each of the recorded IP decay curves were assessed according to quality and were evaluated statitically. The global chargeability *Mg* is the weighted average of the *n* partial apparent chargeability windows (*Mi*) and can be described as:

$$M_g = \frac{\sum_{i=1}^{n} M_i \cdot T_{Mi}}{\sum_{i=1}^{n} T_{Mi}} \qquad [mV/V]$$

All measurements are performed in the arithmetic mode. The number of IP windows available depends on the receiver system and the window wide *TMi* on the current injecttion times (*T*).

HIRIP

The HIRIP technique is a modification of a classic wide spaced Pole-Dipole and advanced Multi-Electrode Pole-Dipole measurement.

The HIRIP technique separates the current transmission system from the potential voltage measurement system, allowing more current to be injected into the ground at the dedicated transmission electrodes. The pole-dipole array has relatively good horizontal coverage, but it has a significantly higher signal strength compared with the dipole-dipole array and it is not as sensitive to telluric noise as the pole-pole array. Unlike the other common arrays as Schlumberger or Wenner, the Pole-Dipole array is an asymmetrical array. Across symmetrical structures, the apparent resistivity anomalies in the pseudosection are asymmetrical. In some situations, the asymmetry in the measured apparent resistivity values could influence the model obtained after inversion. One method to eliminate the effect of this asymmetry is to repeat the measurements with the electrodes arranged in reverse.

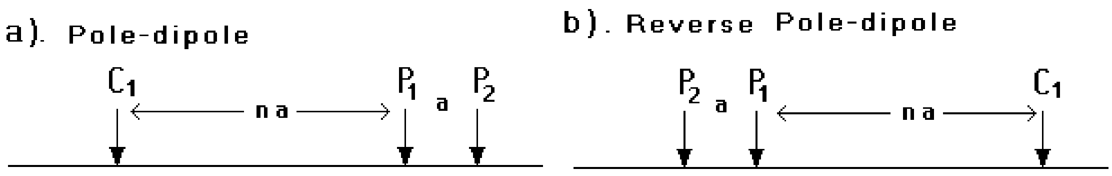

Figure 14: Pole-Dipole array measured forward (left) and reverse (right) *[2-D and 3-D electrical imaging surveys, Dr. M.H.Loke (1996-2004)].*

By combining the measurements with the “forward” and “reverse” pole-dipole arrays, any bias in the model due to the asymmetrical nature of this array would be removed *[2-D and 3-D electrical imaging surveys, Dr. M.H.Loke (1996-2004)].*

The data distribution of the HIRIP survey is presented below.

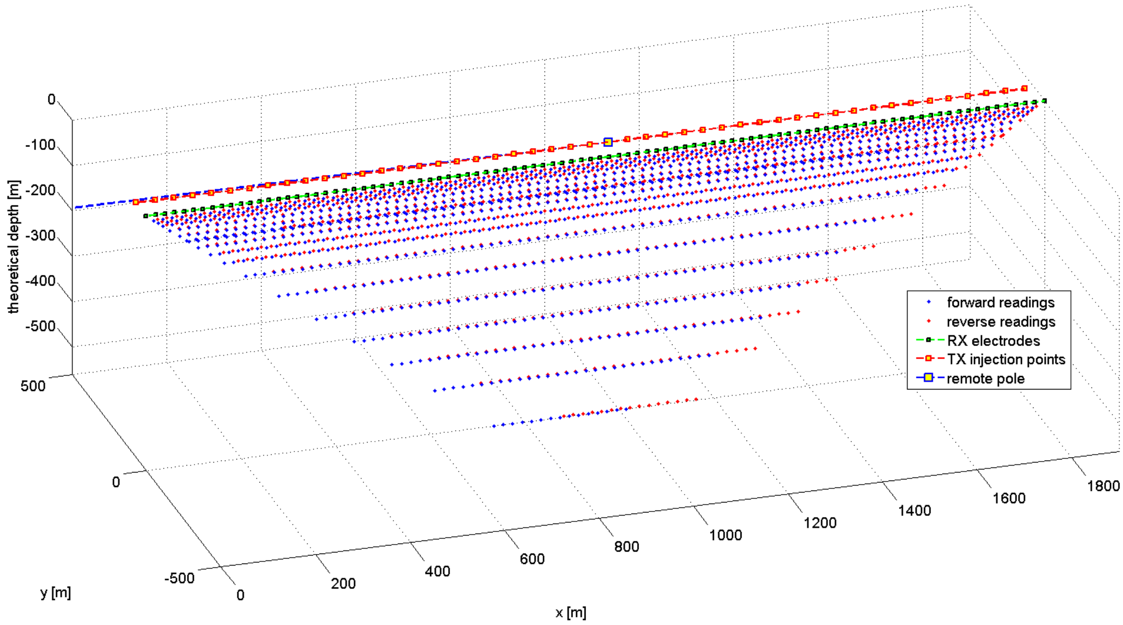

Figure 15: HIRIP array - Distribution of the data points (TX spacing = 50 m).

The pole-dipole array requires a remote electrode, which is placed at a great distance to the receiver line. A special induced polarization receiver is used for the data acquisition together with brass electrodes. The primary voltage, *Vp = VMN* and the signal integration of the transient voltages after current shut-off are used to determine the apparent resistivity and the chargeability.

The apparent resistivity *pa* is defined by:

$$\rho_a = \frac{V_{MN}}{I} \cdot K \qquad [\Omega\, m]$$

where *I [A]* is the injected current and *K* is the geometric factor which depends on the geometric array of the electrodes in the field.

For the pole-dipole array the geometric factor is calculated with the following expression:

$$\rho_a = \frac{V_{MN}}{I} \cdot K \quad with \quad K = \frac{2 \cdot \pi}{\left(\frac{1}{AM} - \frac{1}{AN} \right)}$$

The global chargeability *Mg* is the weighted average of the *n* partial apparent chargeability windows (*Mi*) and can be described as:

$$M_g = \frac{\sum_{i=1}^{n} M_i \cdot T_{Mi}}{\sum_{i=1}^{n} T_{Mi}} \qquad [mV/V]$$

All measurements are performed in the arithmetic mode. The number of IP windows available depends on the receiver system and the window wide *TMi* on the current injections times (*T*).