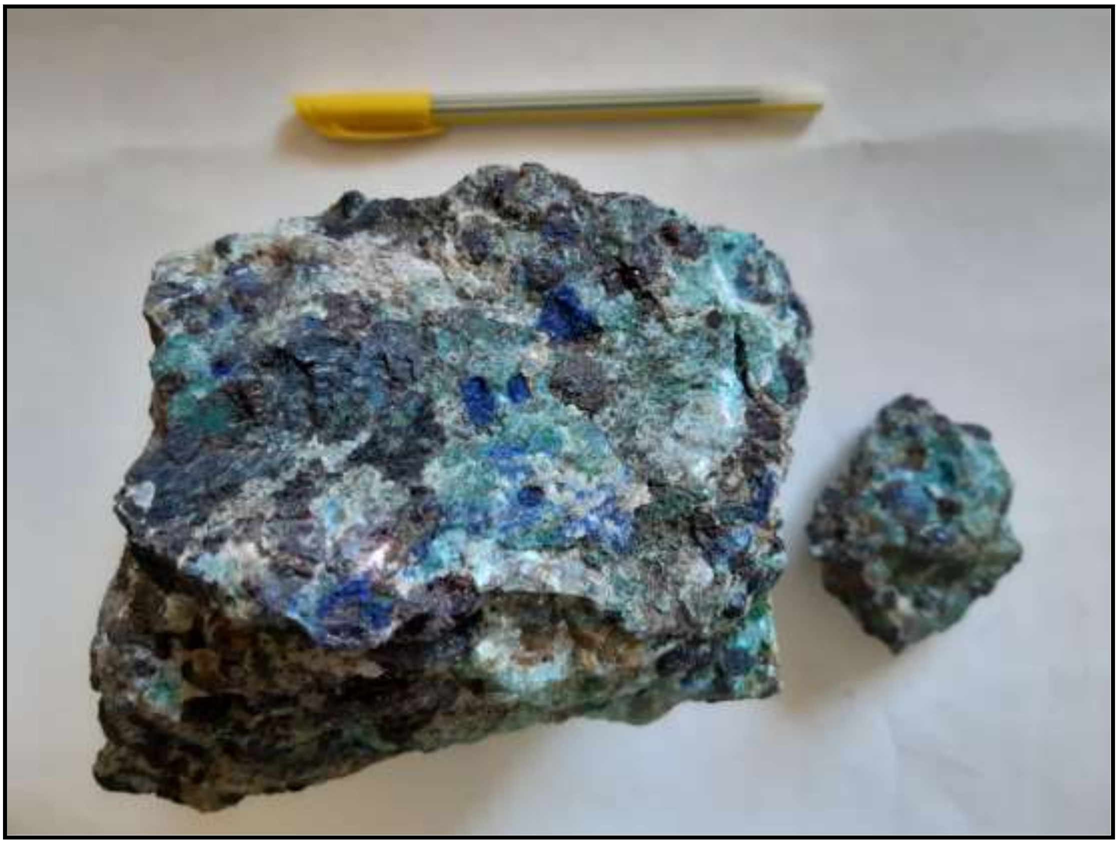
THE UNITED REPUBLIC OF TANZANIA

MINISTRY OF MINERALS

GEOLOGICAL SURVEY OF TANZANIA

(GST)

REPORT ON GEOPHYSICAL INVESTIGATION FOR LICENCE PML0895TNG, PML0896TNG, PML0897TNG, PML0898TNG AND PML91299/EZ LOCATED IN HANDENI DISTRICT TANGA REGION



JUNE, 2021 **DODOMA**

REPORT ON GEOPHYSICAL INVESTIGATION FOR LICENCE PML0895TNG, PML0896TNG, PML0897TNG, PML0898TNG AND PML91299/EZ LOCATED IN HANDENI DISTRICT TANGA REGION

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SUMMARY

Geological Survey of Tanzania was contracted by Dharti Minerals Company Limited to undertake geophysical survey using Induced polarization (IP) and resistivity method at PML0895TNG, PML0896TNG, PML0897TNG, PML0898TNG AND PML91299/EZ located in Msangazi village, Handeni District in Tanga region. The general purpose of this work was to conduct IP survey in order to depict any subsurface structures that might be controlling copper mineralization. The work involved gathering and review of different published geoscientific reports of concession area. The information obtained were used to plan a fieldwork which involved conducting geophysical survey by using Induced polarization method. Thirty four (34) profile lines were planned to be surveyed by deploying dipole – dipole configuration at an electrode interval of 10 m. The geophysical work went together with geological mapping of lithological units and structures and establish their relationship with copper mineralization within the area.

The concessions area is mainly dominated by garnetiferous hornblende gneiss particularly in the southern part of the area. The northern part especially near Msangazi River is covered by superficial soil. Besides, the results from ground geophysical survey under IP method conducted in the concession area has shown variation of resistivity and chargeability along the surveyed profile lines. The areas with high resistivity were demarcated as the anomalous zones which are occupied by outcrops of garnetiferous hornblende gneiss. The lithological units is well exposed on the surface and widely dispersed and cross-cut by quartz veins trending east - west. The copper mineralization is associated with a mineral garnet and probably hosted and controlled in quartz veins filled structures within garnetferous hornblende gneiss.

Moreover, further exploration work (geological mapping, pitting, trenching, geochemical sampling and drilling) on the demarcated zone is recommended in order to reveal potential quartz veins filled structures hosting copper mineralization.

1. INTRODUCTION

Geological Survey of Tanzania and Dharti Minerals Limited signed a contract on 24th May, 2021 to carry out geophysical survey using induced polarization (IP) and resistivity method on PML0895TNG, PML0896TNG, PML0897TNG, PML0898TNG and PML91299/EZ (**Table 1**) located in Handeni District, Tanga Region. The primary mining licenses mentioned above are fully owned by Mr. Paschal Musira Rugembe of P.O. Box 4458, Dar es Salaam according to *https://portal.madini.go.tz/map/*. The owner is in joint venture (JV) with Dharti Minerals Company Limited to exploit and mine copper ores in the area.

A team of one (1) geophysicist and one (1) geotechnician from GST was assigned to conduct an IP and resistivity survey on the said concessions in order to identify structure(s) related to copper mineralization. The whole work was divided into two (2) phases; the first phase involved desk and fieldwork which took two weeks (25th May, to 08th June, 2021 while second phase comprised of data processing, interpretation and report writing which took three (3) weeks to accomplish.

Table 1: *Coordinates for the concessions area (PML0895TNG, PML0896TNG, PML0897TNG, PML0898TNG and PML91299/EZ)*

Licence No.	Corner	Latitude	Longitude	Area (Ha)
PML91299/EZ	A	S05°30'07.00"	E038°13'26.00"	9.45
	B	S05°30'07.00"	E038°13'36.00"	
	C	S05°30'17.00"	E038°13'36.00"	
	D	S05°30'17.00"	E038°13'26.00"	
PML0895TNG	A	S05°30'14.50"	E038°13'15.00"	4.27
	B	S05°30'14.50"	E038°13'10.00"	
	C	S05°30'08.70"	E038°13'10.00"	
	D	S05°30'08.70"	E038°13'09.60"	
	E	S05°30'05.70"	E038°13'09.60"	
	F	S05°30'05.70"	E038°13'15.00"	
PML0896TNG	A	S05°30'08.70"	E038°13'10.00"	9.76
	B	S05°30'14.00"	E038°13'10.00"	
	C	S05°30'14.00"	E038°12'50.50"	
	D	S05°30'08.70"	E038°12'50.50"	

PML0897TNG	A	S05°30'08.70"	E038°12'40.30"	9.83
	B	S05°30'19.00"	E038°12'40.30"	
	C	S05°30'19.00"	E038°12'30.20"	
	D	S05°30'08.70"	E038°12'30.20"	
PML0898TNG	A	S05°30'14.50"	E038°13'26.00"	9.89
	B	S05°30'17.00"	E038°13'26.00"	
	C	S05°30'17.90"	E038°12'50.50"	
	D	S05°30'14.50"	E038°12'50.50"	

2. LOCATION OF THE STUDY AREA

The area of investigation covers an area of 43.20 hectares and is located in Kwamsangazi village in Handeni District, Tanga Region (**Figure 1**). Kwamsangazi Village is situated approximately 40 km south-east (SE) of Handeni town centre via Magamba Village. The village is accessible via Handeni – Mkata main road. The concessions are located northern part of QDS 148 and south of Msangazi River. The area is limited in accessibility and is easily accessible by motorable roads during dry seasons. The topography of the area ranges between 438 m to 530 m above mean sea level which is characterized by gently to steeping slopes.

Figure 1*: Location of the study area modified from topographical map of Tanzania and satellite imagery*

3. OBJECTIVE OF THE STUDY

The main objective of this study is to delineate and locate geological structures, define their orientation and extension potential for copper mineralization within the area of investigation (PML0895TNG, PML0896TNG, PML0897TNG, PML0898TNG and PML91299/EZ).

4. METHODOLOGY

The following methodologies were used to accomplish the work:-

4.1. Desk Work

Desk work involved collecting and review geoscientific information from previous work done (secondary data) in and/or around the concession area and these are:-

i. Published Geological map of Quarter Degree Sheet (QDS) 148,
ii. High resolution airborne magnetic images of QDS 148 and
iii. Published geological reports and papers.

4.2. Geological Observation

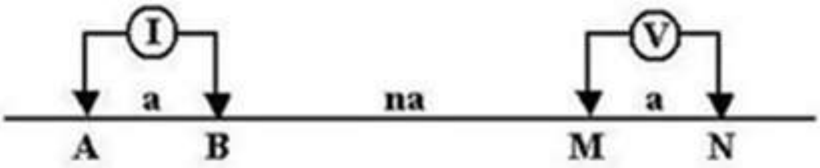
Geological observation was made in order to understand the spatial distribution of different lithologies found in the area. This involved documentation and measuring important geological features including rock units and structures.

4.3. Geophysical Survey

IP geophysical technique was employed to measure chargeability and resistivity of the ground concurrently. Chargeability of the ground indicates how well materials retain electrical charges while resistivity indicates how well materials is resistive in conducting an electric current.

4.3.1. Survey Parameters

The dipole – dipole array (**Figure 2**) was used to measure electrical conductivity of the ground whereby two (2) polarized electrodes were used to inject current in the ground and two (2) non polarized (porous) electrodes were used to measure decay voltage. Potential electrodes used in the survey were plastic and ceramic porous pots filled with copper sulphate solution were used in order to reduce the noise caused by ground resistance. Electrodes spacing was 10 m and survey direction was north – south (**Figure 3**) cross-cutting the general strike of geological structures of the area.



$$\rho_A = \frac{V}{I} \pi a n(n+1)(n+2).$$

***Figure 2**: Dipole-dipole configuration; AB are current electrodes, MN are potential electrodes and 'a' is electrode spacing (https://openei.org/wiki/DC_Resistivity_Survey (Dipole-Dipole_Array))*

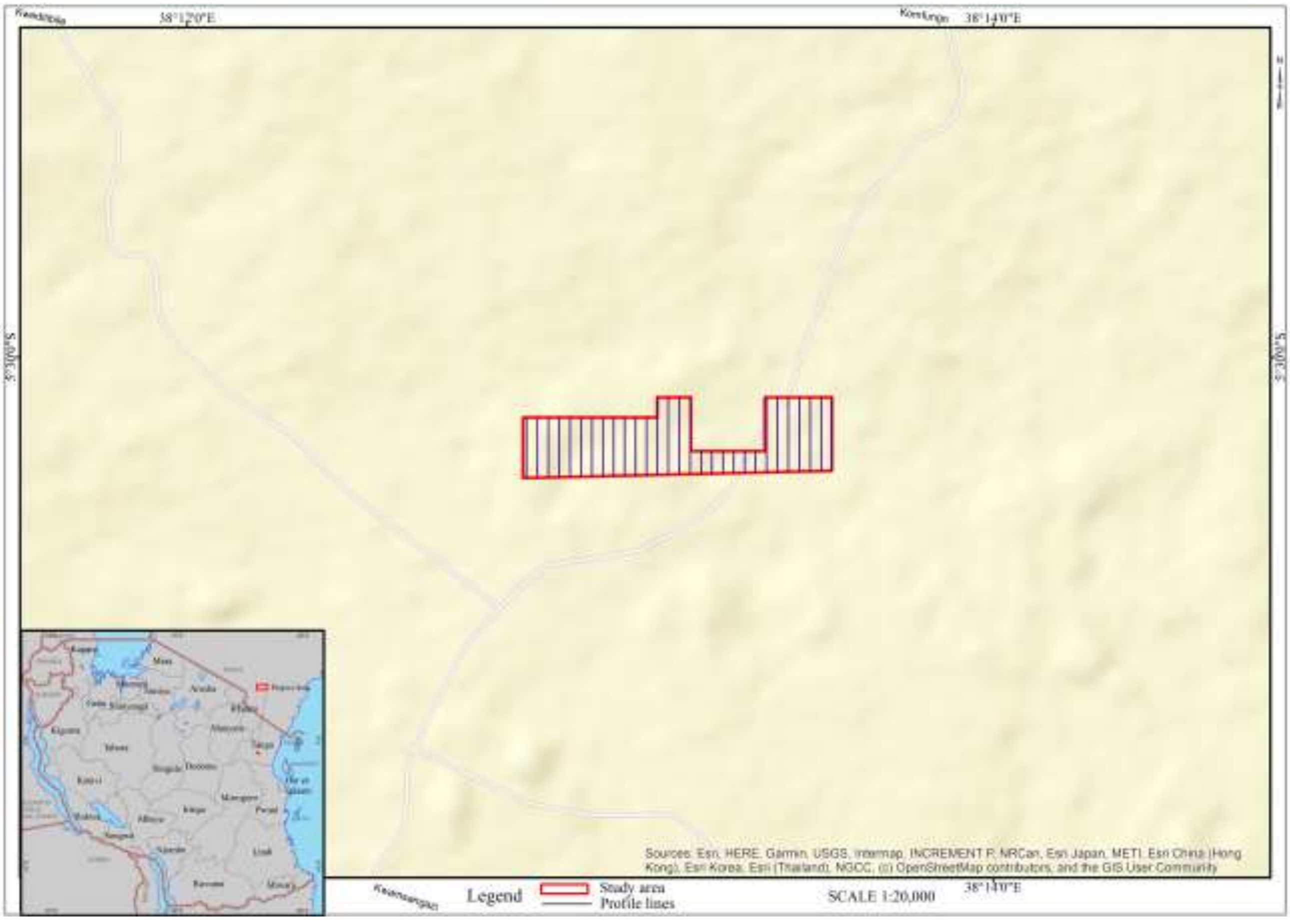


***Figure 3:** Induced Polarization (IP) profile lines; Red polygon is the area of investigation*

4.3.2. Equipment Used

GDD Transmitter (Tx4) and Receiver (GRx8-32) designed for resistivity and time-domain induced polarization (IP) surveys in a wide range of applications according to *www.gddinstrumentation.com*, Allegro PDA (hand held PC), Honda Generator (5 KV), Stainless steel electrodes, glass and plastic porous pots, 100m tape measure, 3 kg hammer, two way radio calls, GPS, tool box, salt, copper sulphate crystals and varying electrical wires (15 m, 25 m, 35 m, 55 m, 105 m, 155 m, 205 m, 255 m, 305 m, 355 m, 405 m, 455 m, 505 m, and 1500 m). Furthermore, the processing of IP and resistivity data was done using Res2Dinv software.

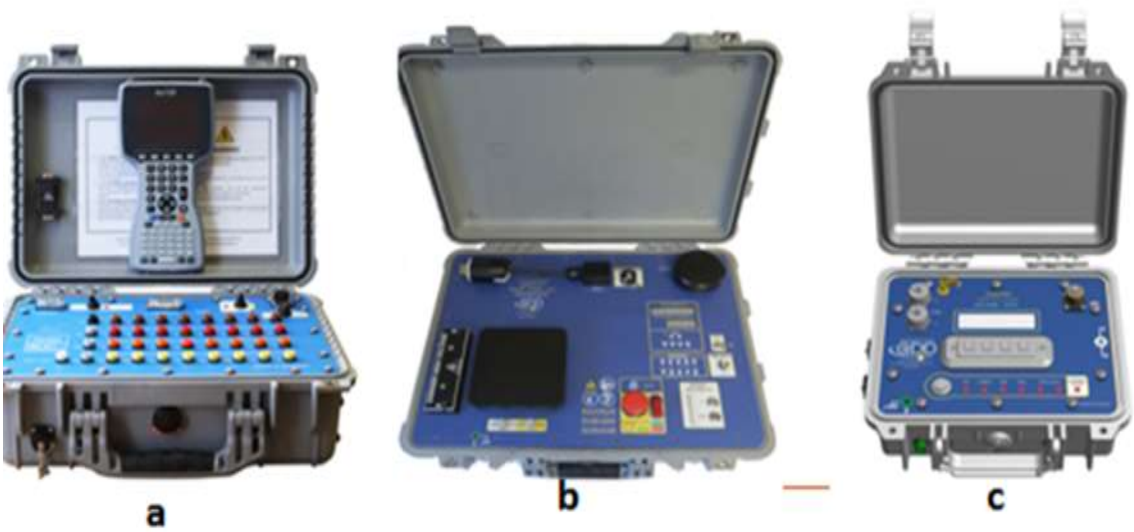


Figure 3: *(a) IP Receiver GRx 8 – 32 (b) IP Transmitter TX4 5000W (c) EM - IP Tx Controller*

5. RESULTS AND INTERPRETATION

This section presents the results and interpretation of data obtained from acquired and published geoscientific reports, geological observation and IP and resistivity survey.

5.1. Geology and mineralization

Regionally, the area is found in the Neoproterozoic Mozambique belt (***Figure 4***) characterized by high grade regional granulite terranes, limited juvenile materials and predominated by reworking of older crustal components (Muhongo et. al., 1994). The area of investigation is part of the eastern granulites (Hepworth, 1972) which comprises of high pressure granulite – facies rocks outcropping in the Pare – Usambara and Uluguru Mountains. Other rock types found in the region are marbles, quartzites, schists, kyanite- and graphite – bearing gneisses which are known for gemstones mineralization.

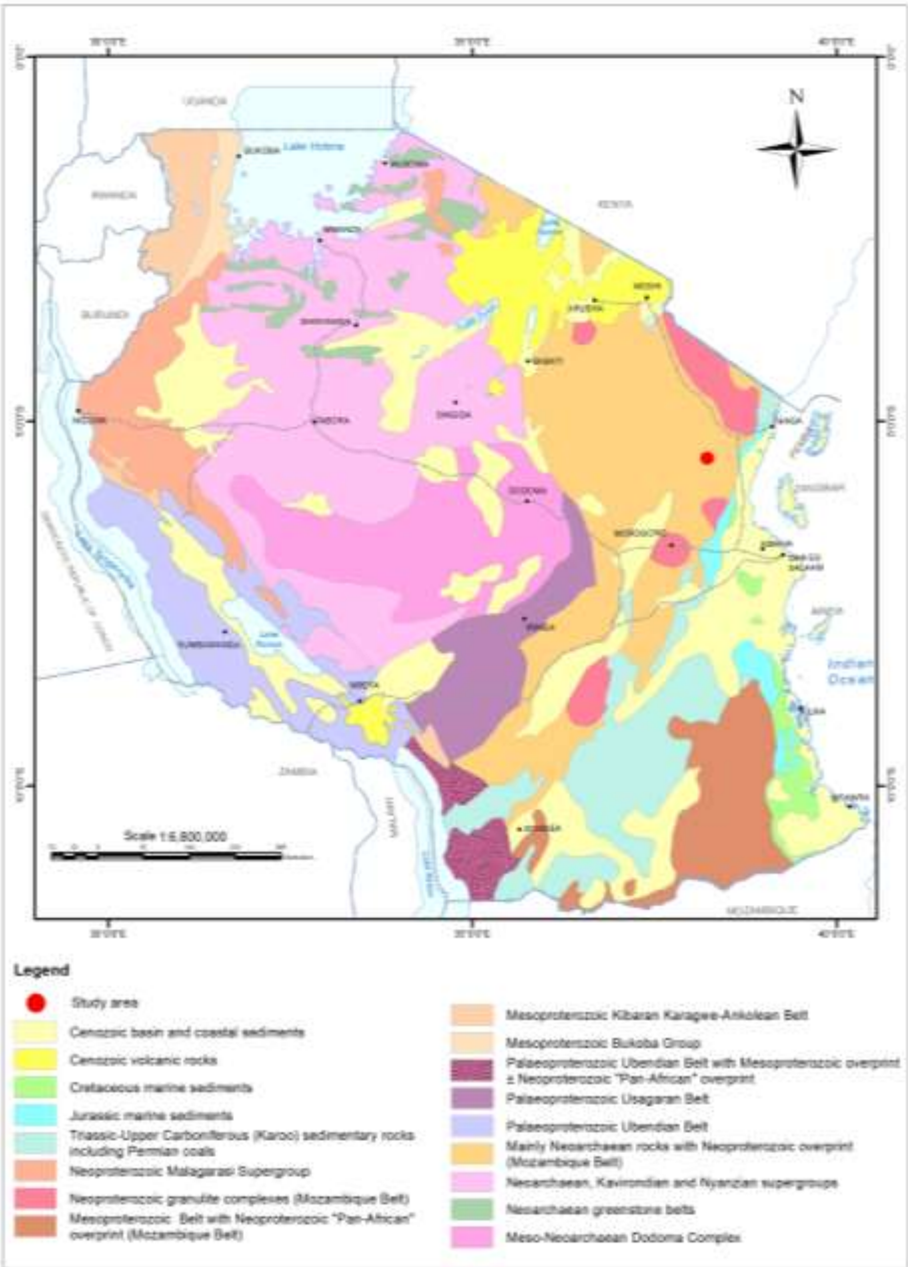


Figure 4: *Regional geology of Tanzania adopted from regional geological map by Leger et al. (2015)*

Locally, the concession area is dominated by high grade metamorphic rocks mainly granulites with garnet and hornblende as indicated in ***Figure 5*** and

Figure 6. These rocks are characterized by foliations trending east – west direction, course grained texture with visible mineral crystals, gneissic bands of felsic (quartz) and mafic (biotite and hornblende) minerals. The quartz veins observed within the area cross-cut the garnet hornblende gneiss rocks with different orientation but mainly east – west. The quartz vein

extends from few mm to few metres as revealed in one of the excavated exploration pits width of up to 30 m.

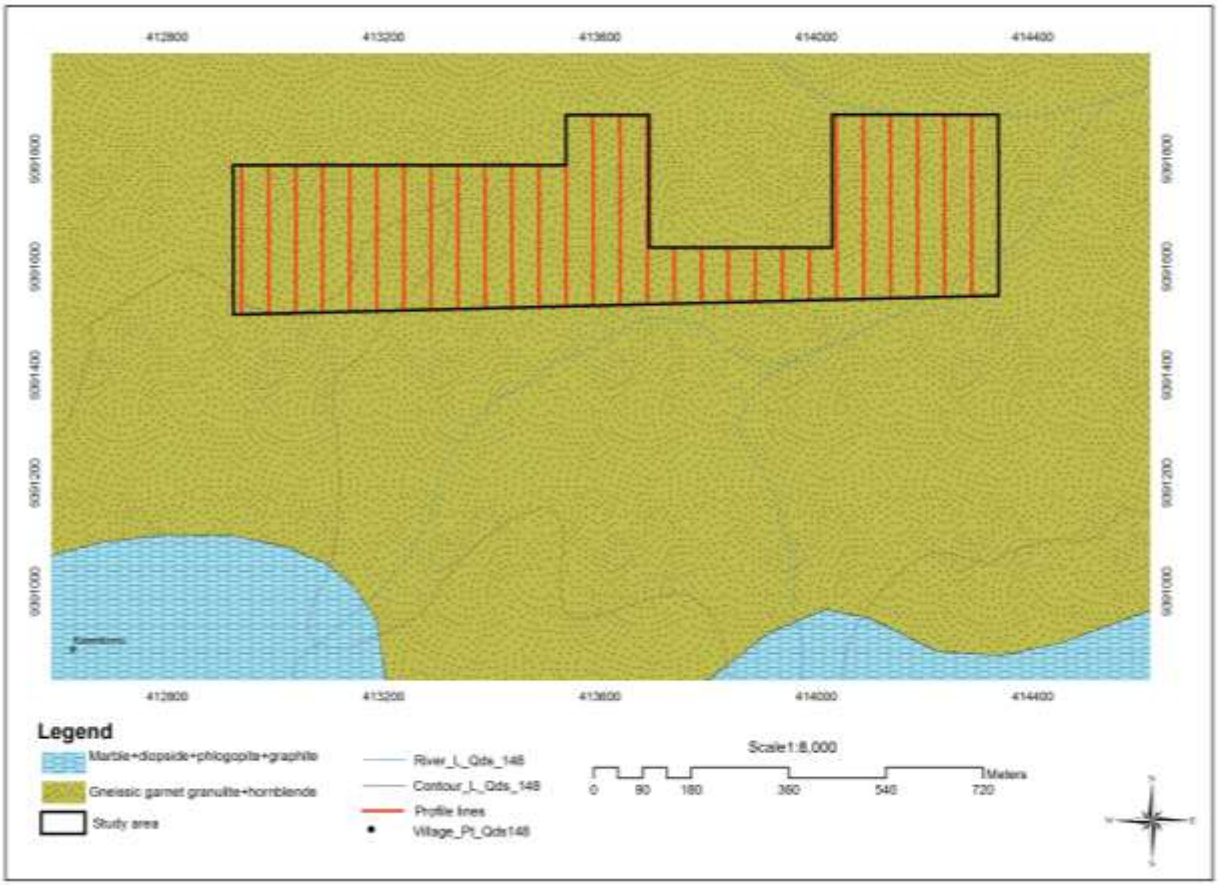


Figure 5: *Generalized geology of the area adopted from geological map QDS 148, geological survey of Tanzania, 2014*

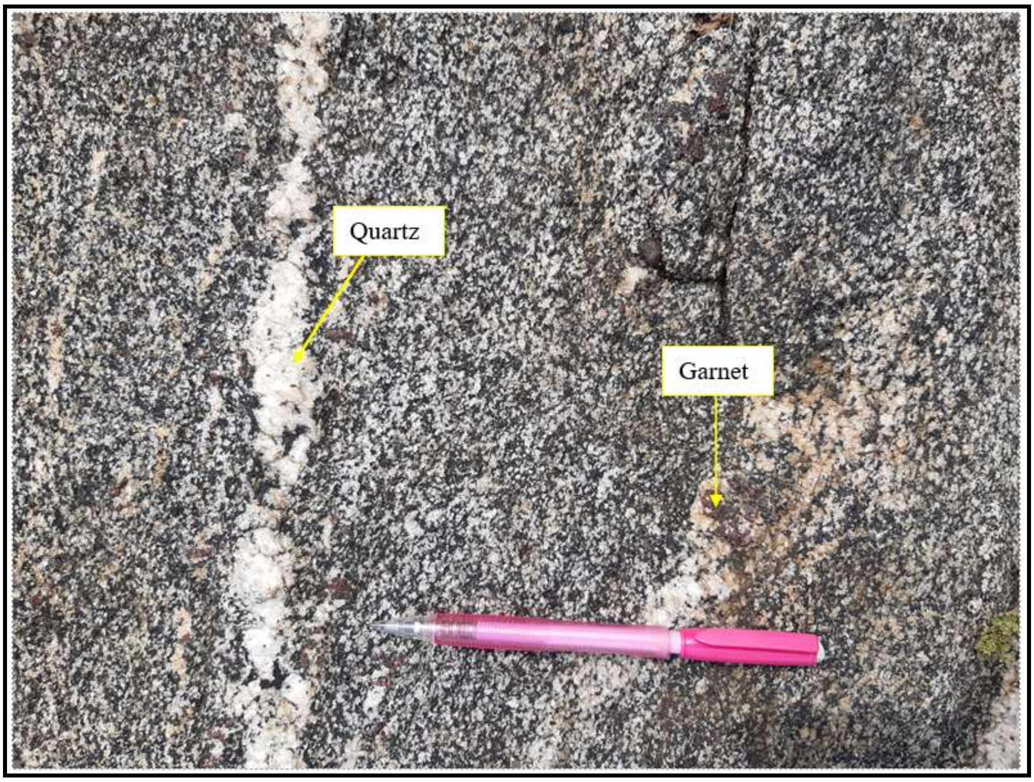


Figure 6: *Garnetiferous hornblende Gneiss outcrop found on the study area*

Copper ores dominating the area are azurite ($Cu_3(CO_3)_2(OH)_2$) and malachite ($Cu_2CO_3(OH)_2$) which occur concurrently with quartz garnet and hornblende (**Figure 7**). Copper mineralization in the area of study is predominantly hosted in quartz veins of up to 30 cm width with an orientation of east – west.

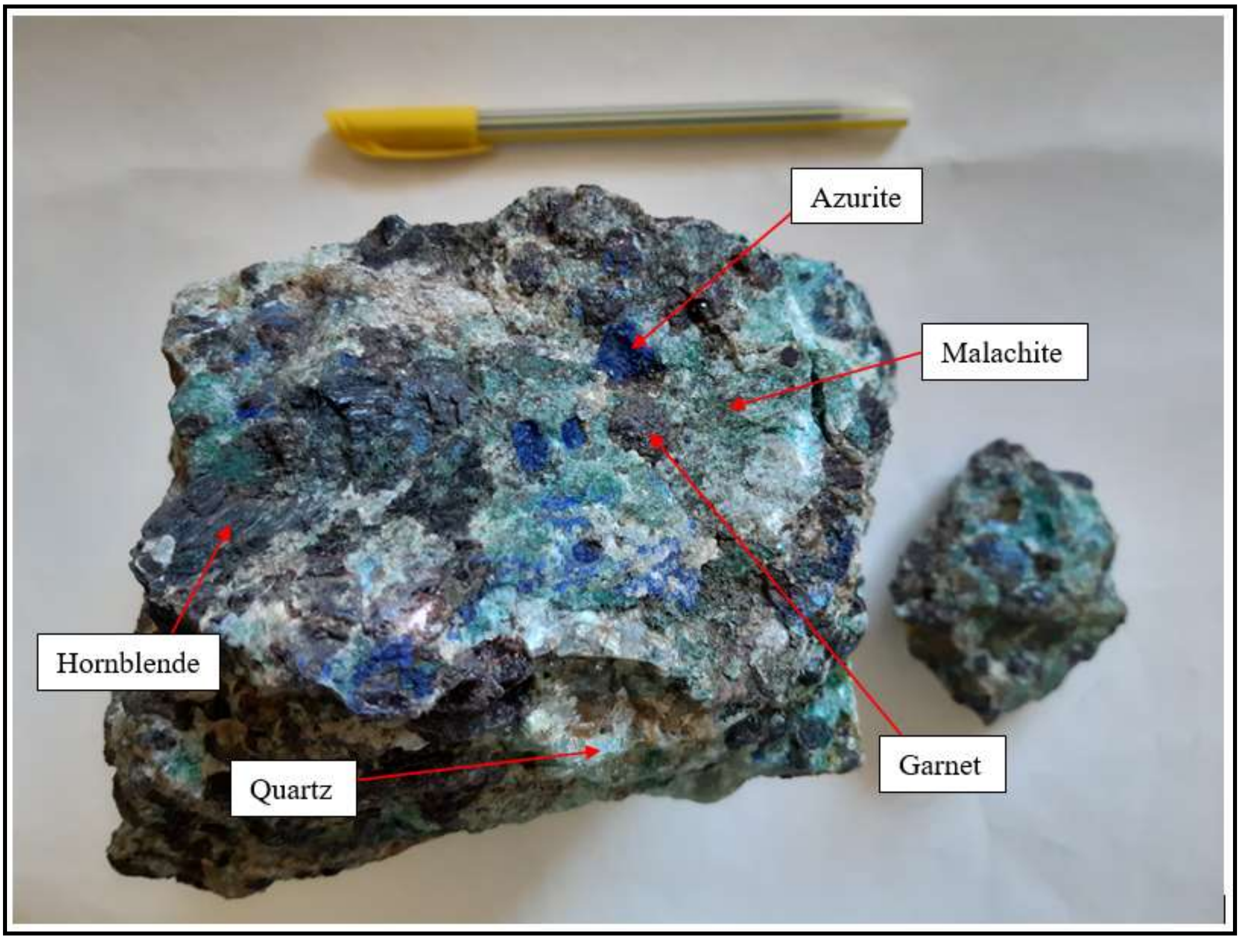


Figure 7: *Copper ores in the study area; Malachite (light green) and Azurite (deep blue) found in quartz vein*

5.2. Magnetic Anomaly

Mostly magnetism of rocks is attributed to the presence of iron-bearing minerals such as magnetite and pyrrhotite. The northern part of the area of investigation is characterized by low magnetic intensity probably due to the distribution of lithological units with relatively low content of iron-bearing minerals. Nevertheless, the southern part is dominated by medium to high magnetic intensity possibly due to high content of iron-bearing minerals in garnetiferous hornblende gneiss rocks.

5.3. Induced Polarization Data Analysis

Induced Polarization survey was conducted in thirty four (34) profile lines from north to south with a total length of approximately 7.6 line kilometres. Electrical resisitivity variations in profile lines are clearly visualized in 2D images (**Figure 8 - 41**) as inverse model resistivity and chargeability sections. Equal values of resistivity are ploted as contoured images to describe the variations. High resistive body *(purple to red colour)* indicates stable environment and low resistive body *(blue colour)* is a weak environment. The weak zones may indicate lithological contact, fault plane or variation in porosity, textures, water and mineral contents. The geological features infilled with saline water or any other conducting materials are good conductors therefore can be easily marked by electrical resistivity. Generally, the images can be interpreted as presence of garnetiferous hornblende gneiss which are very competent and does not allow electric current to pass through easily while the near surface soil is somewhat saturated or consists of much fractured rocks thus allow water to percolate easily.

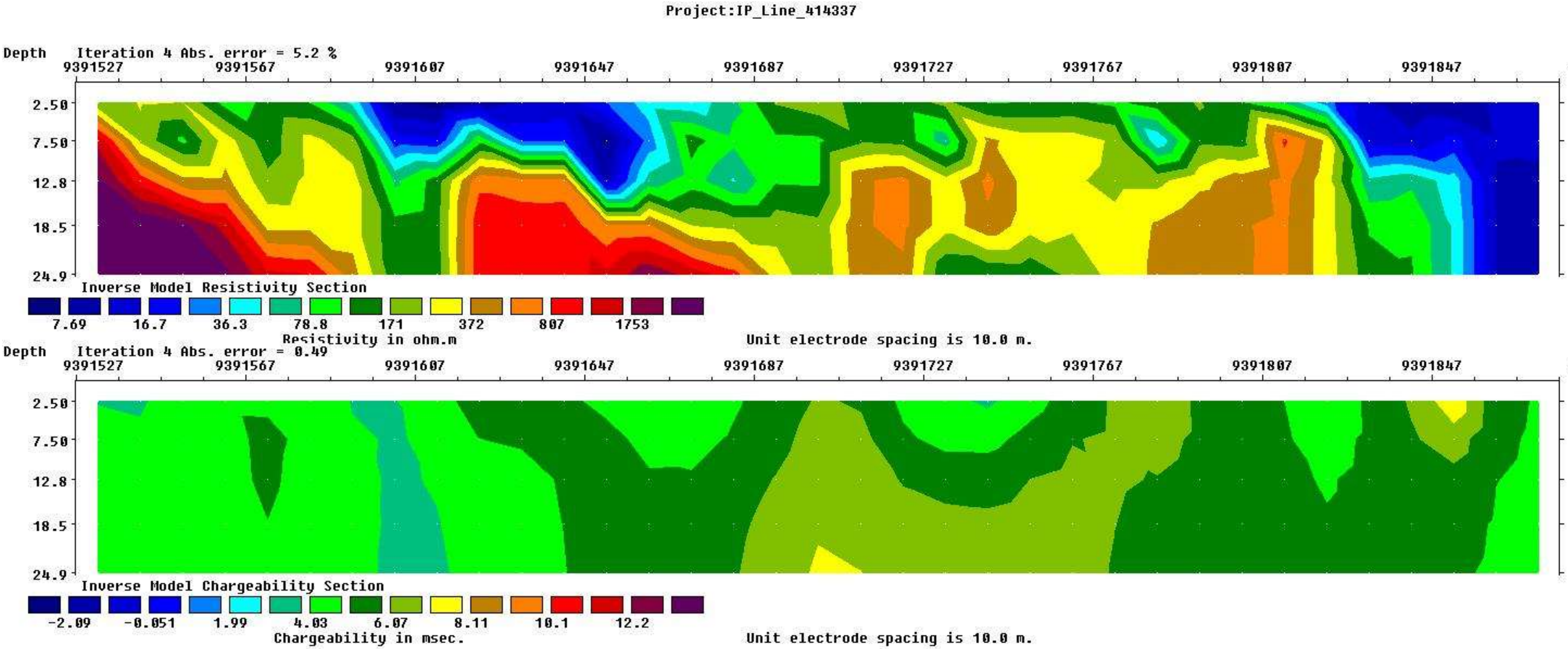


Figure 8: Inverse model resistivity and chargeability sections of line 414337

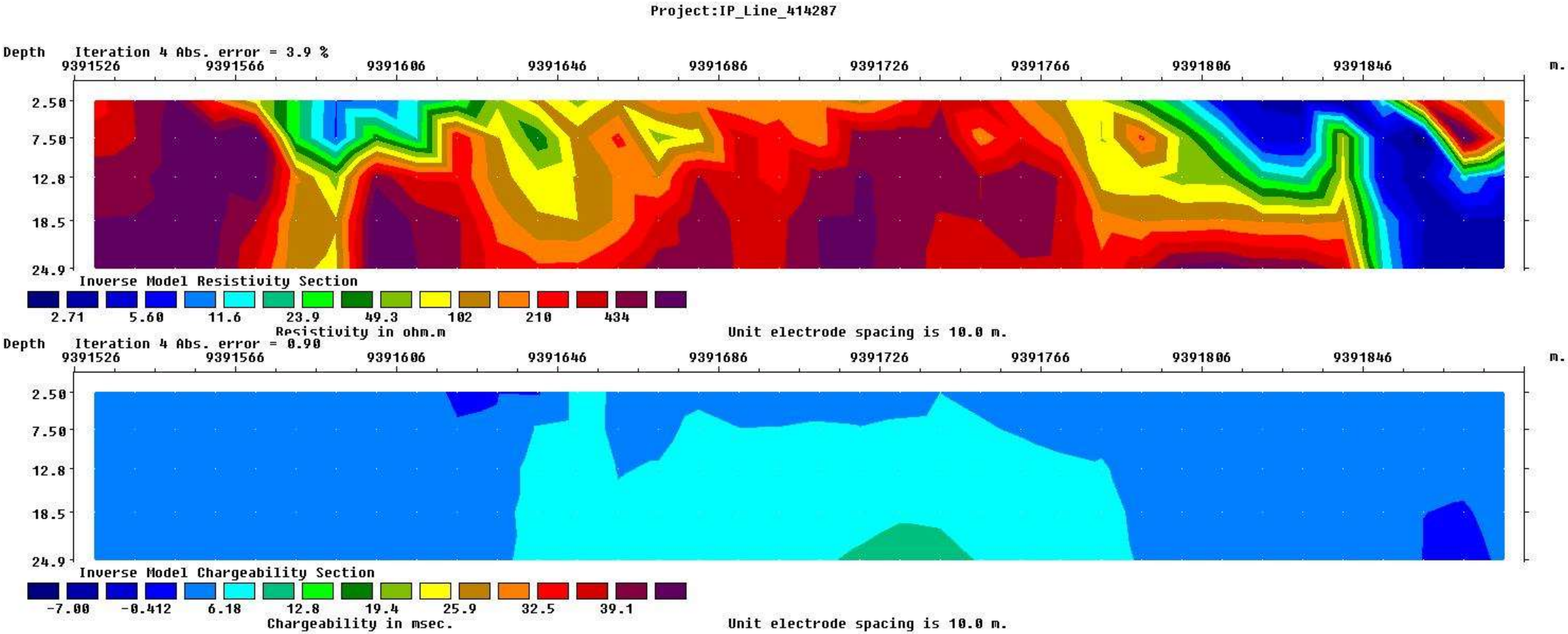


Figure 9: Inverse model resistivity and chargeability sections of line 414287

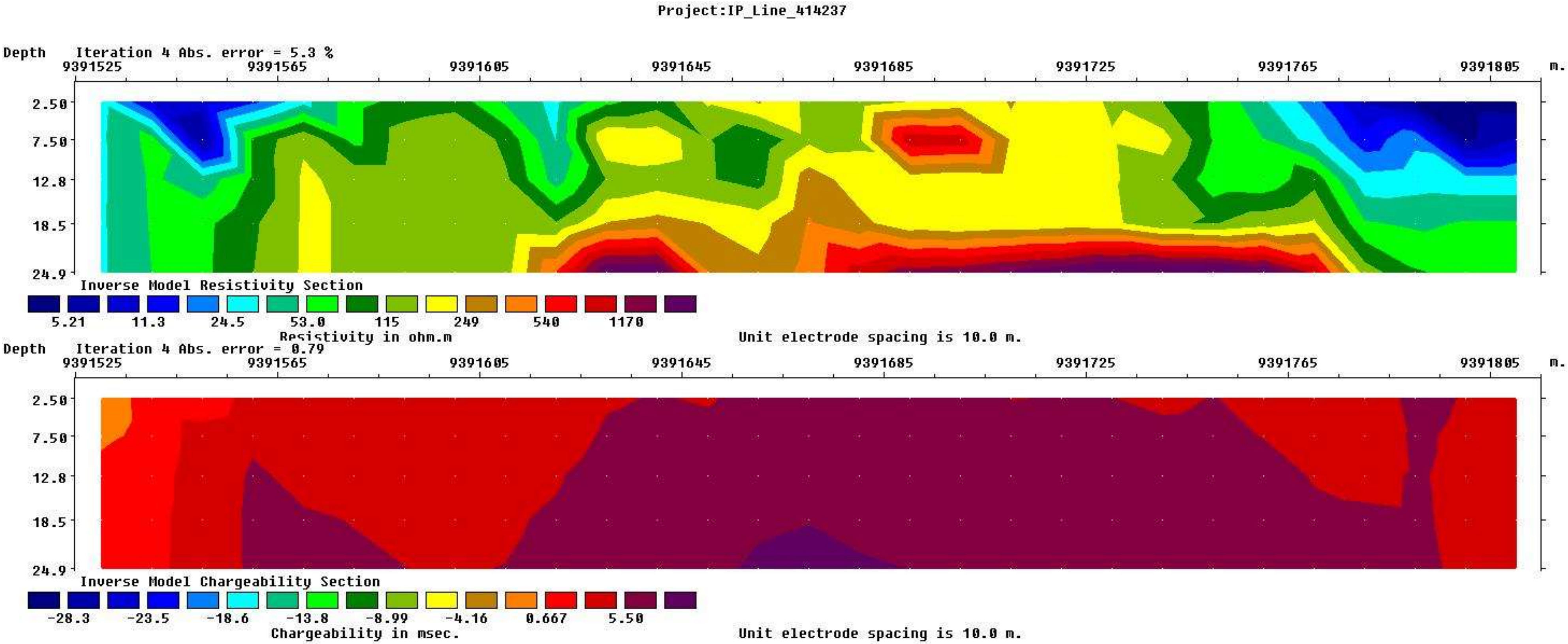


Figure 10: Inverse model resistivity and chargeability sections of line 414237

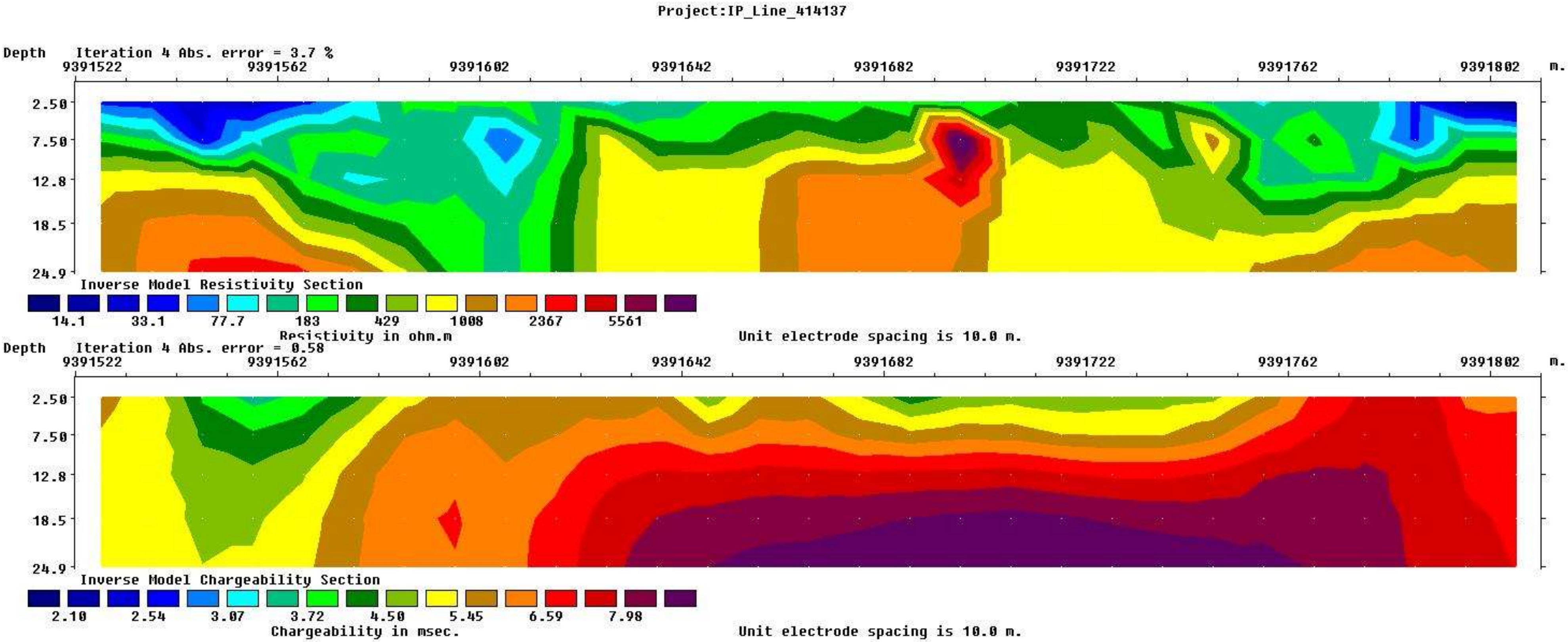


Figure 11: Inverse model resistivity and chargeability sections of line 414137

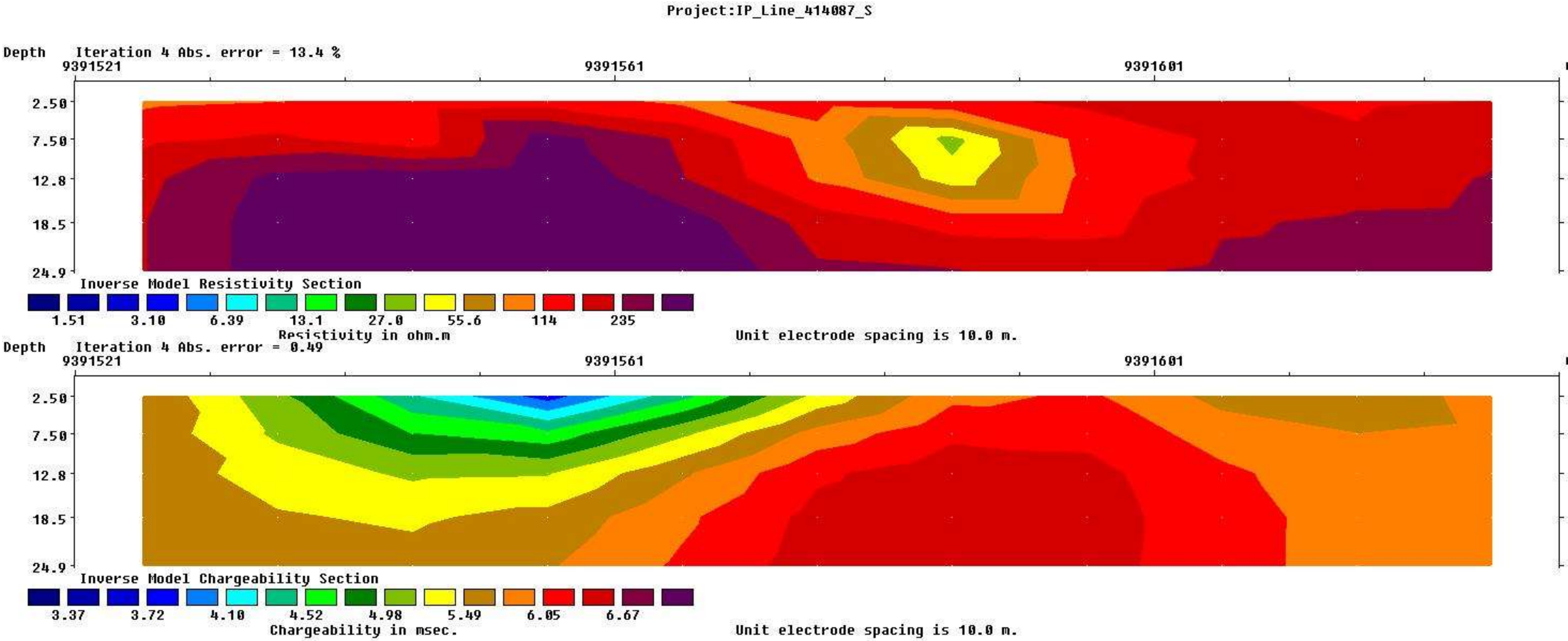


Figure 12: Inverse model resistivity and chargeability sections of line 414087 South

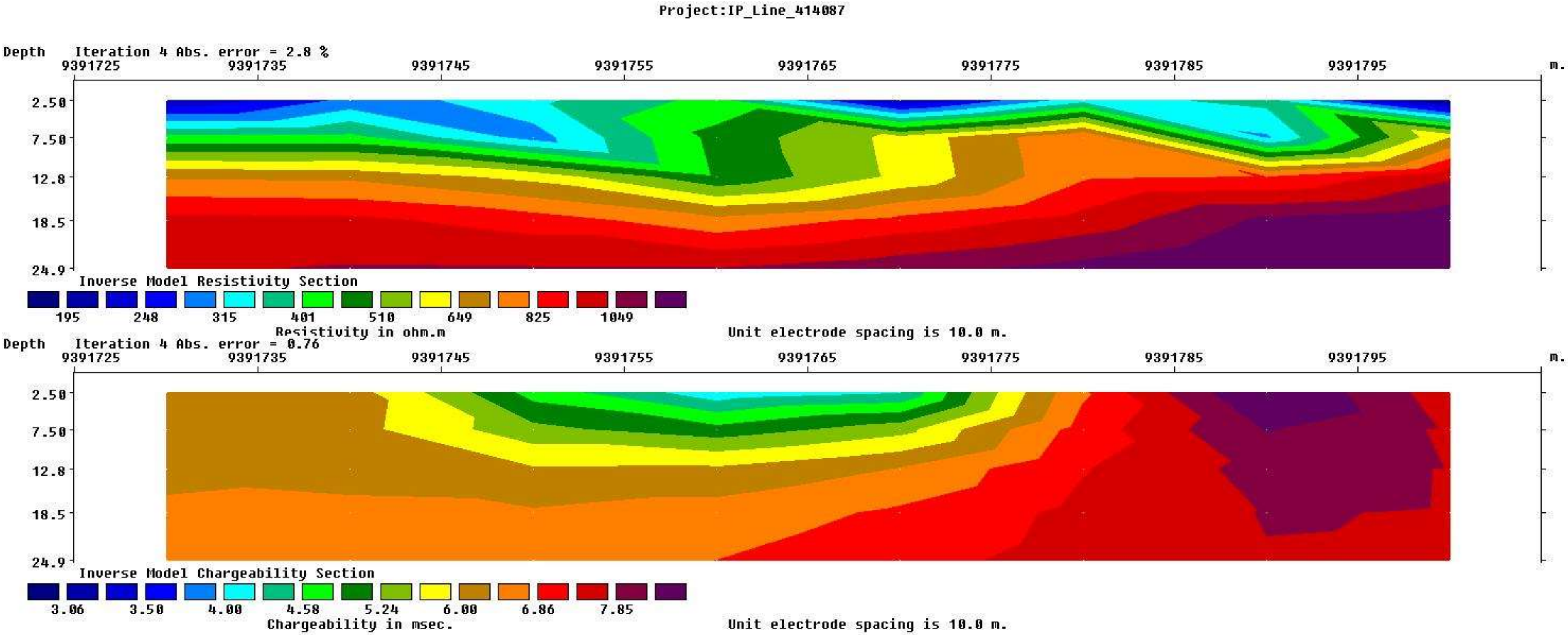


Figure 13: Inverse model resistivity and chargeability sections of line 414087

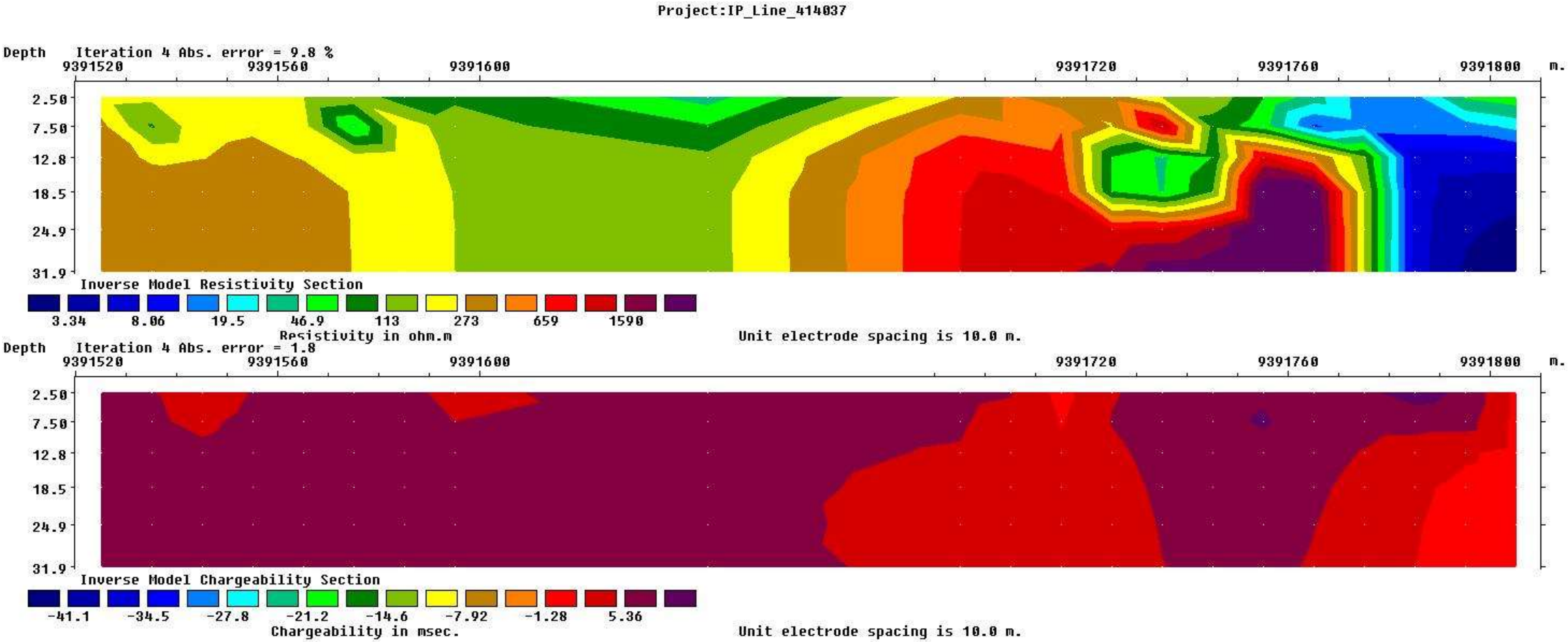


Figure 14: Inverse model resistivity and chargeability sections of line 414037

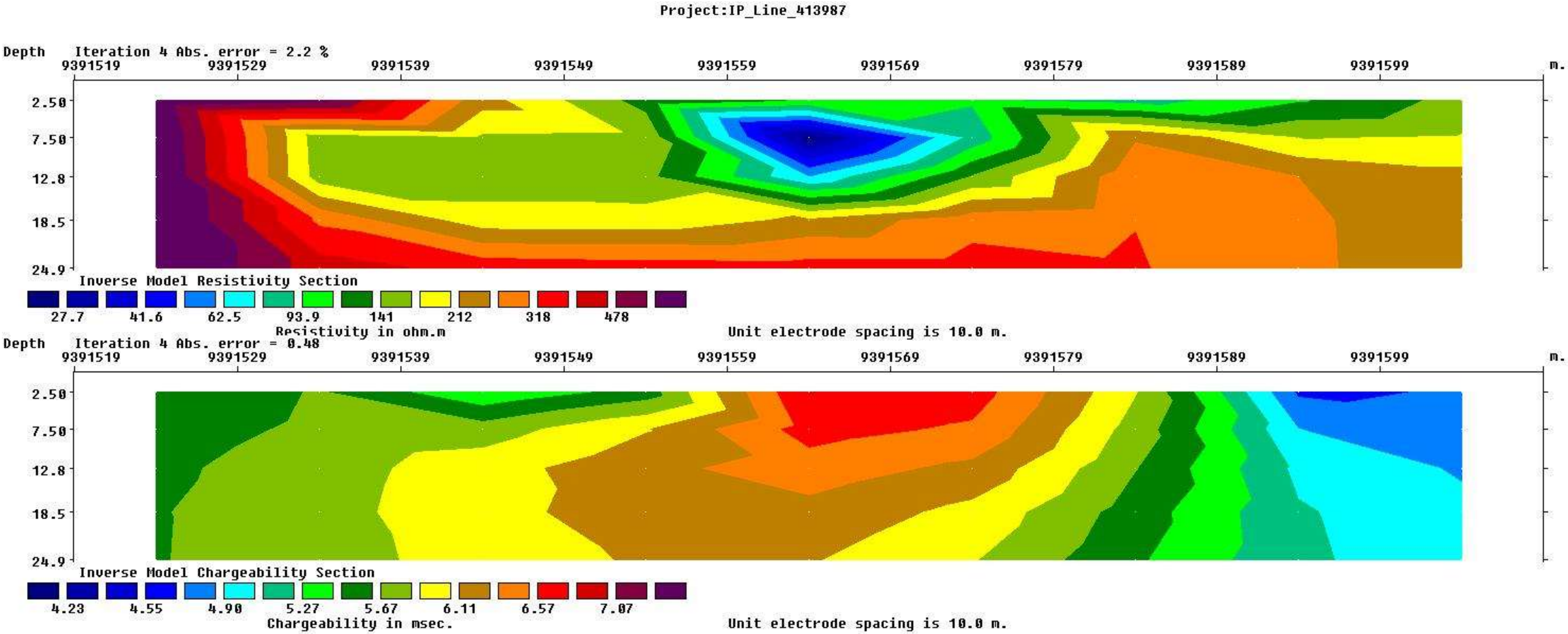


Figure 15: Inverse model resistivity and chargeability sections of line 413987

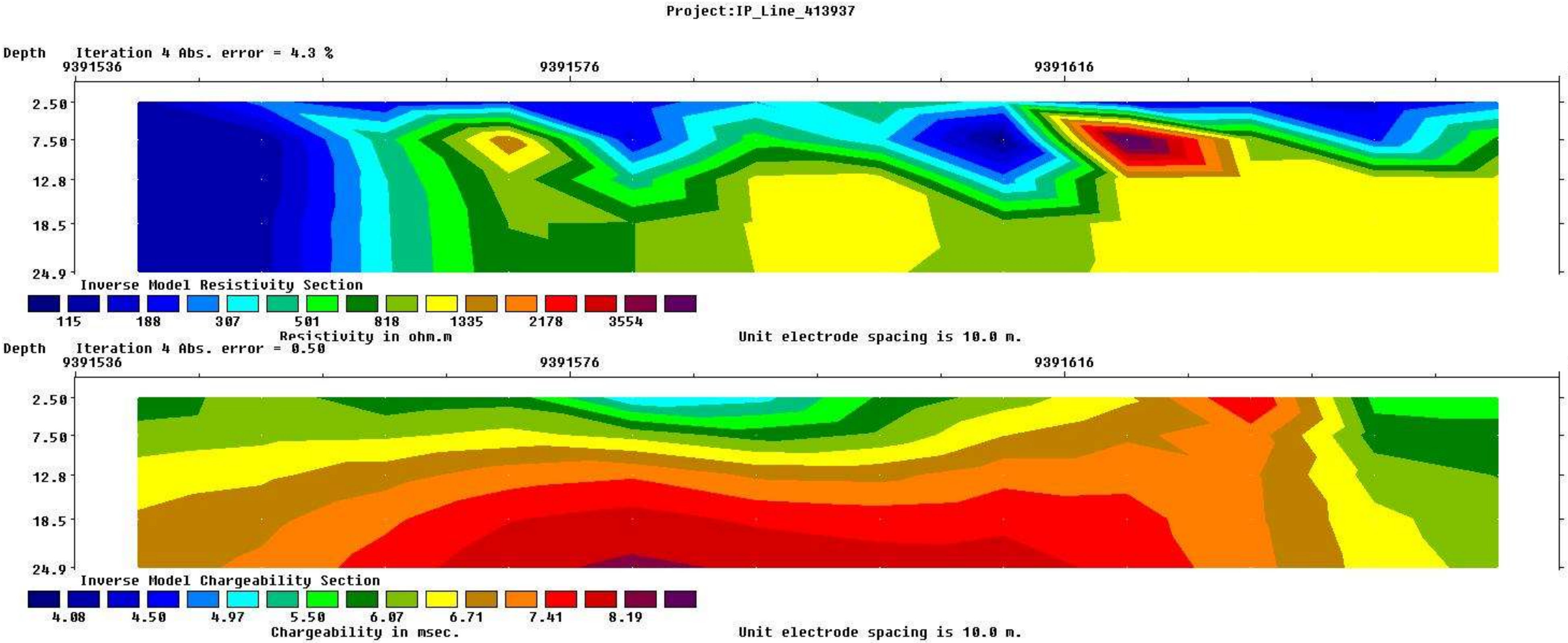


Figure 16: Inverse model resistivity and chargeability sections of line 413937

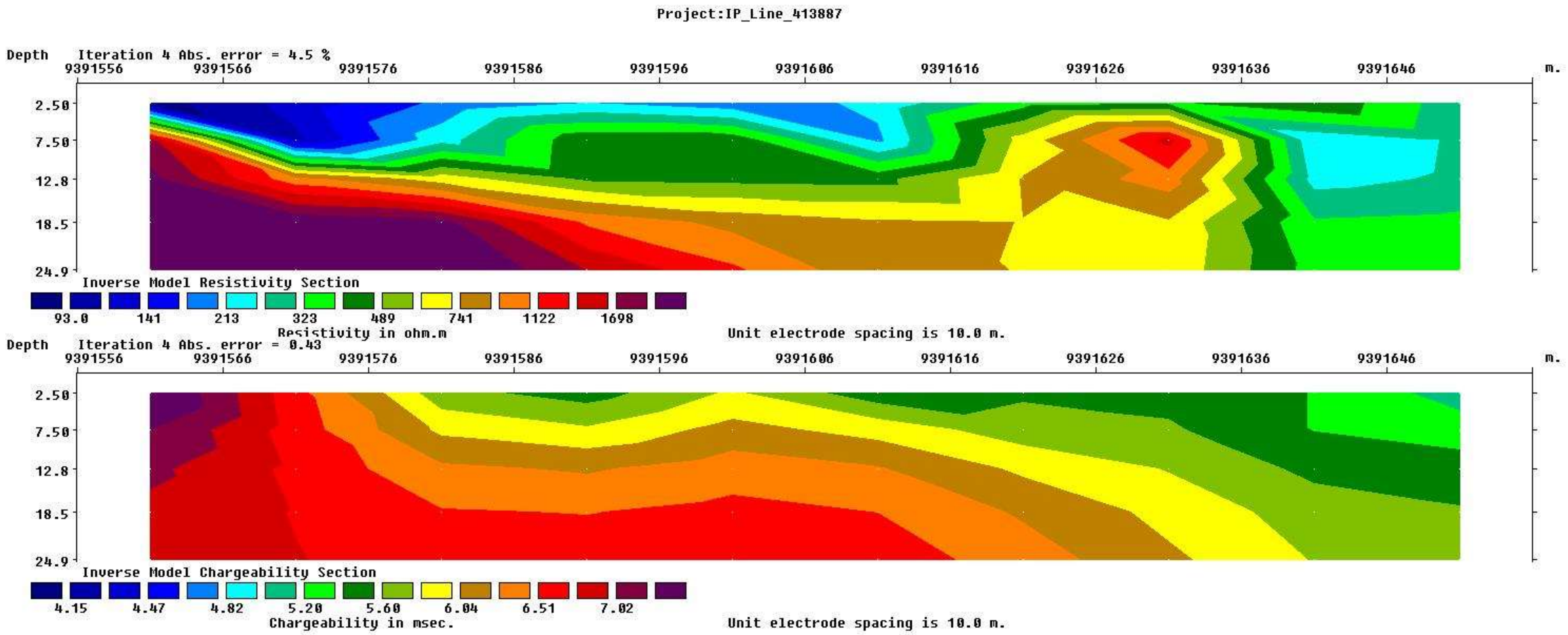


Figure 17: Inverse model resistivity and chargeability sections of line 413887

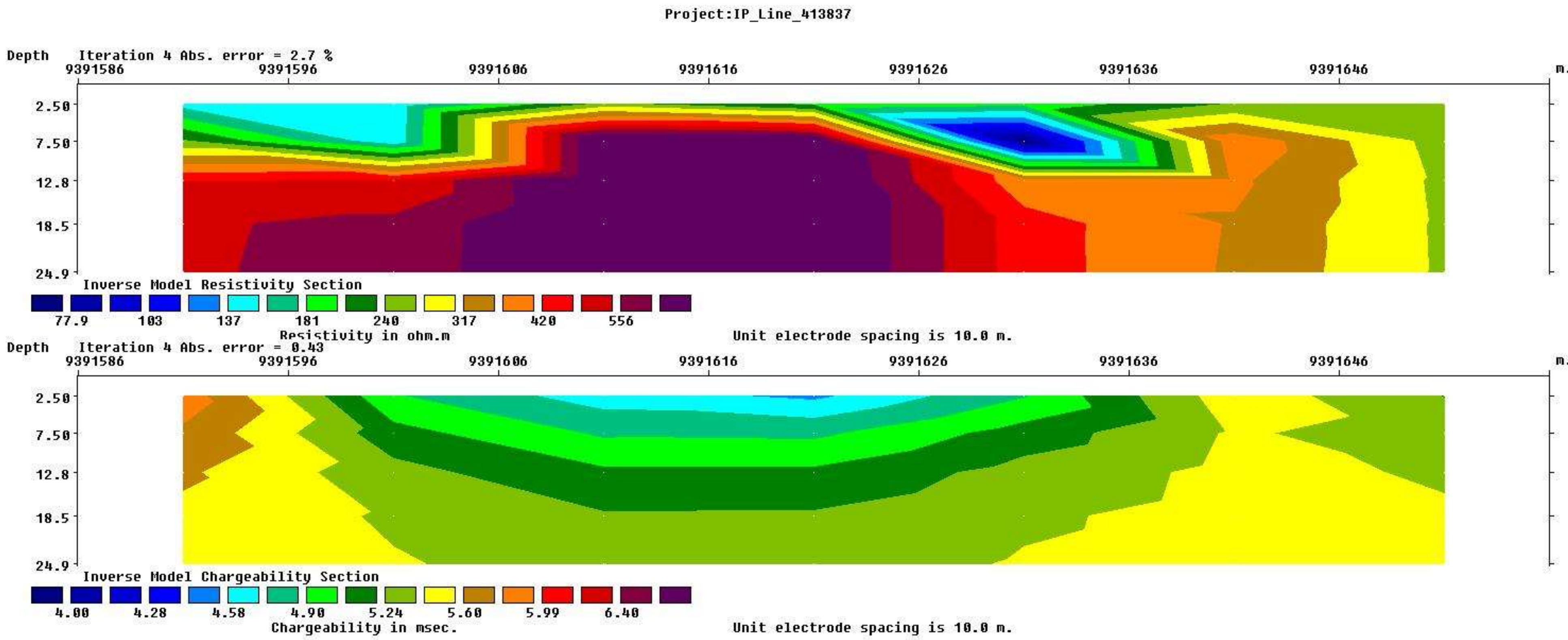


Figure 18: Inverse model resistivity and chargeability sections of line 413837

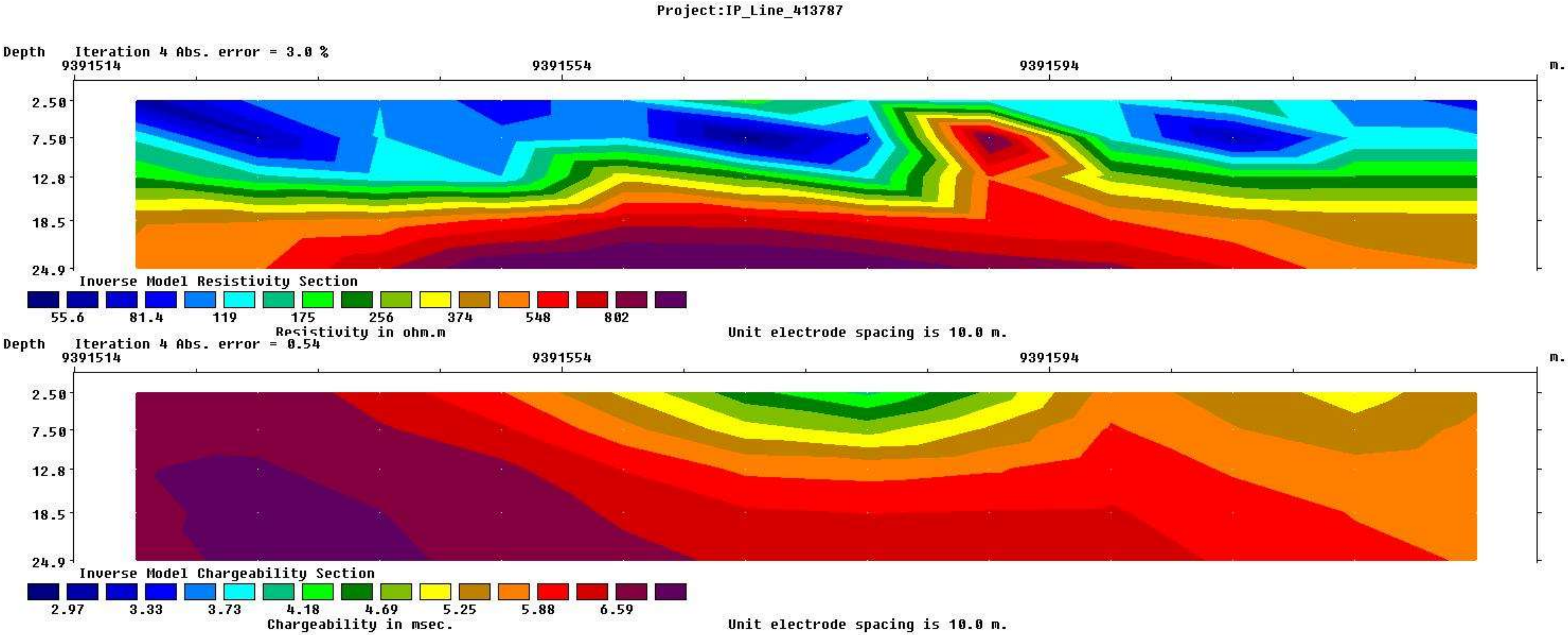


Figure 19: Inverse model resistivity and chargeability sections of line 413787

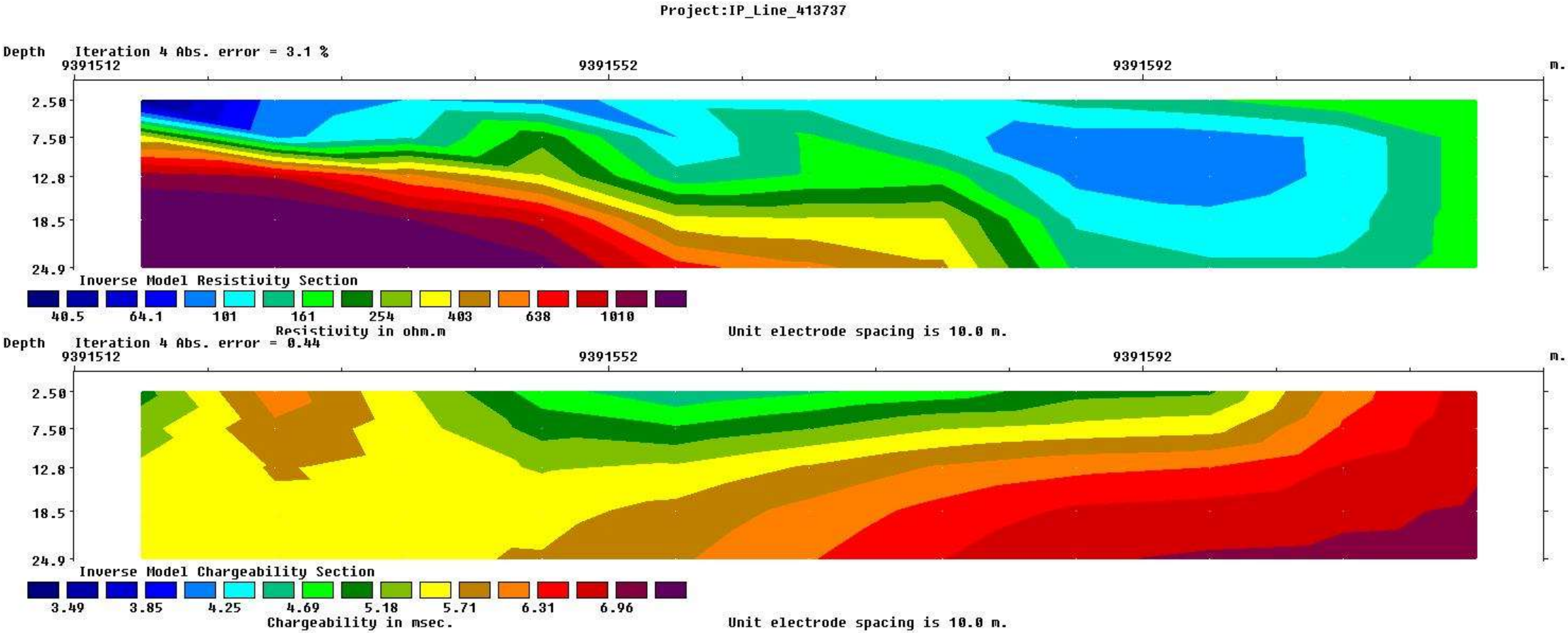


Figure 20: Inverse model resistivity and chargeability sections of line 413737

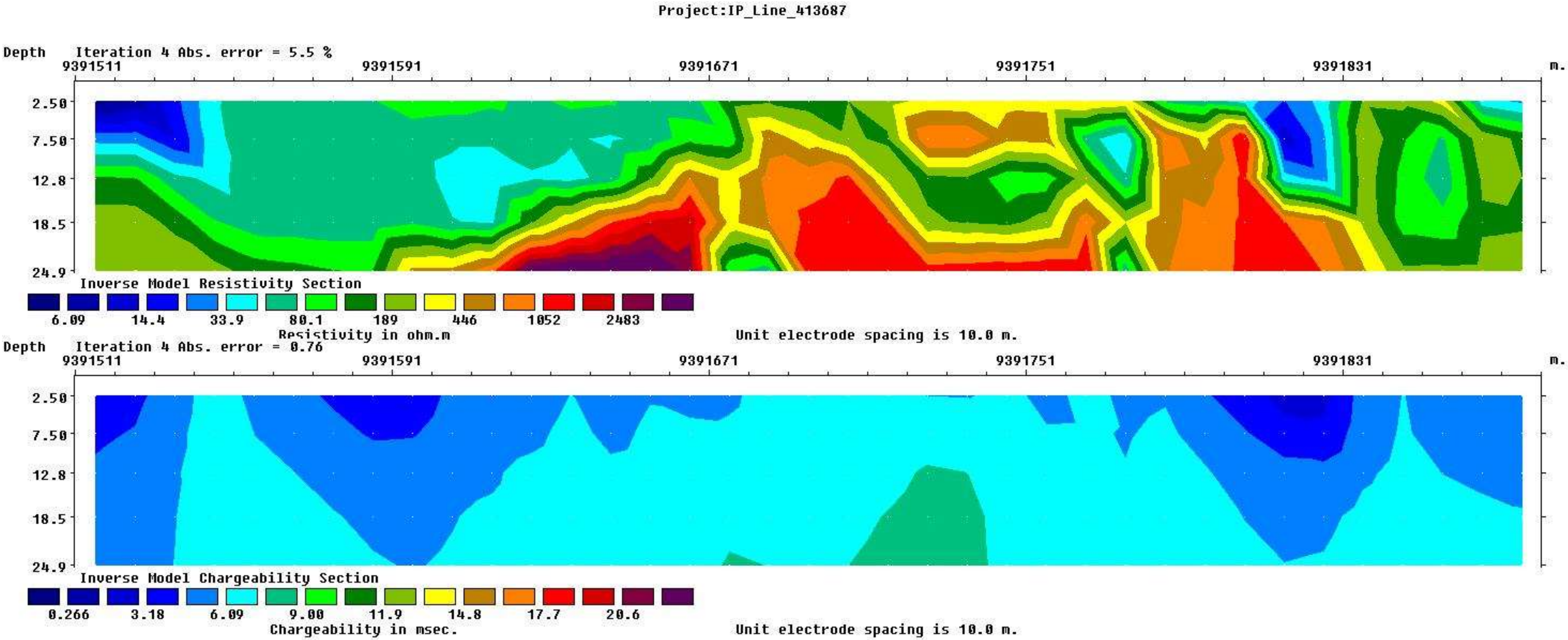


Figure 21: Inverse model resistivity and chargeability sections of line 413687

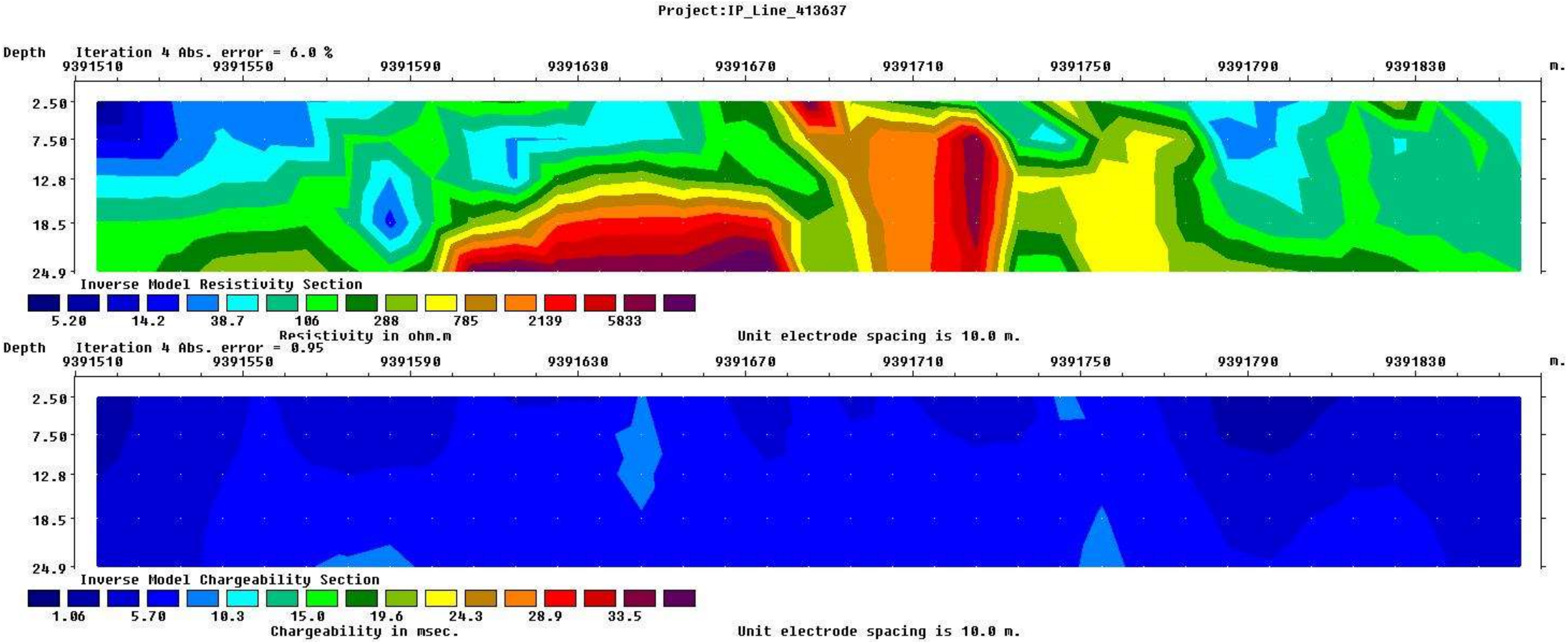


Figure 22: Inverse model resistivity and chargeability sections of line 413637

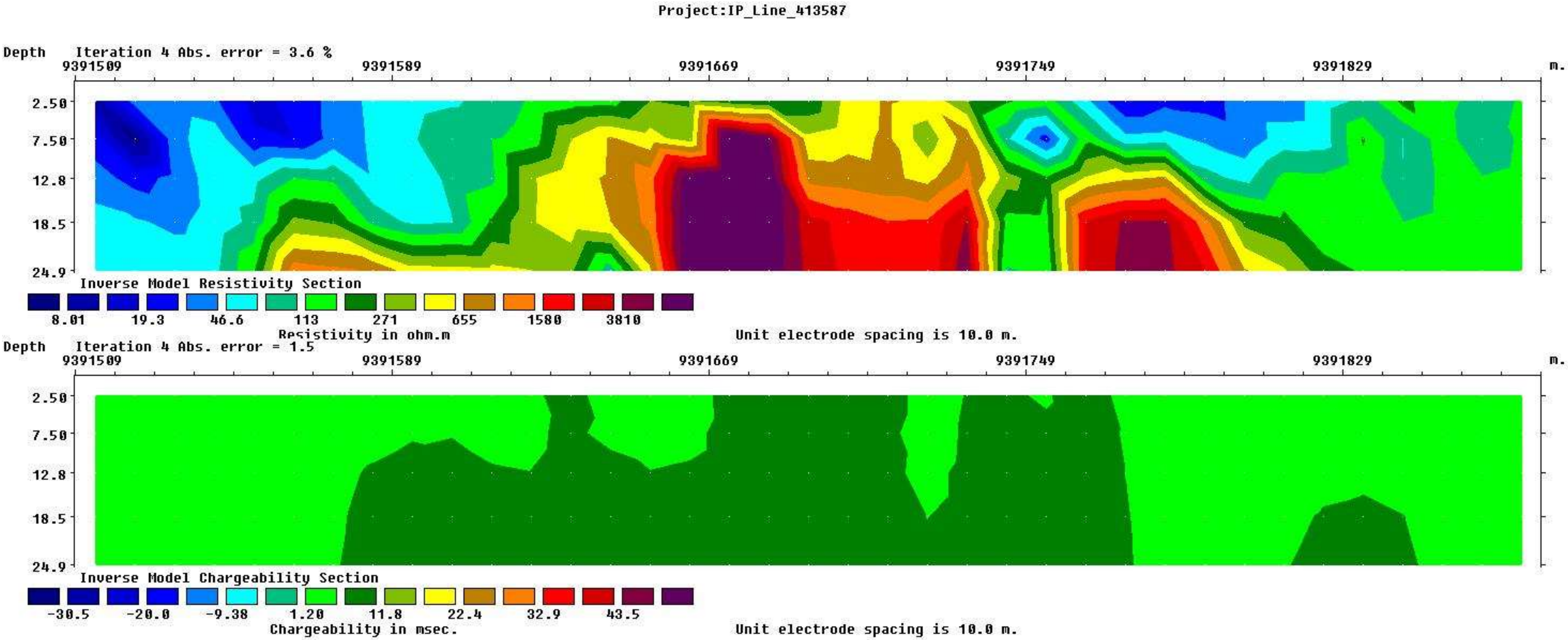


Figure 23: Inverse model resistivity and chargeability sections of line 413587

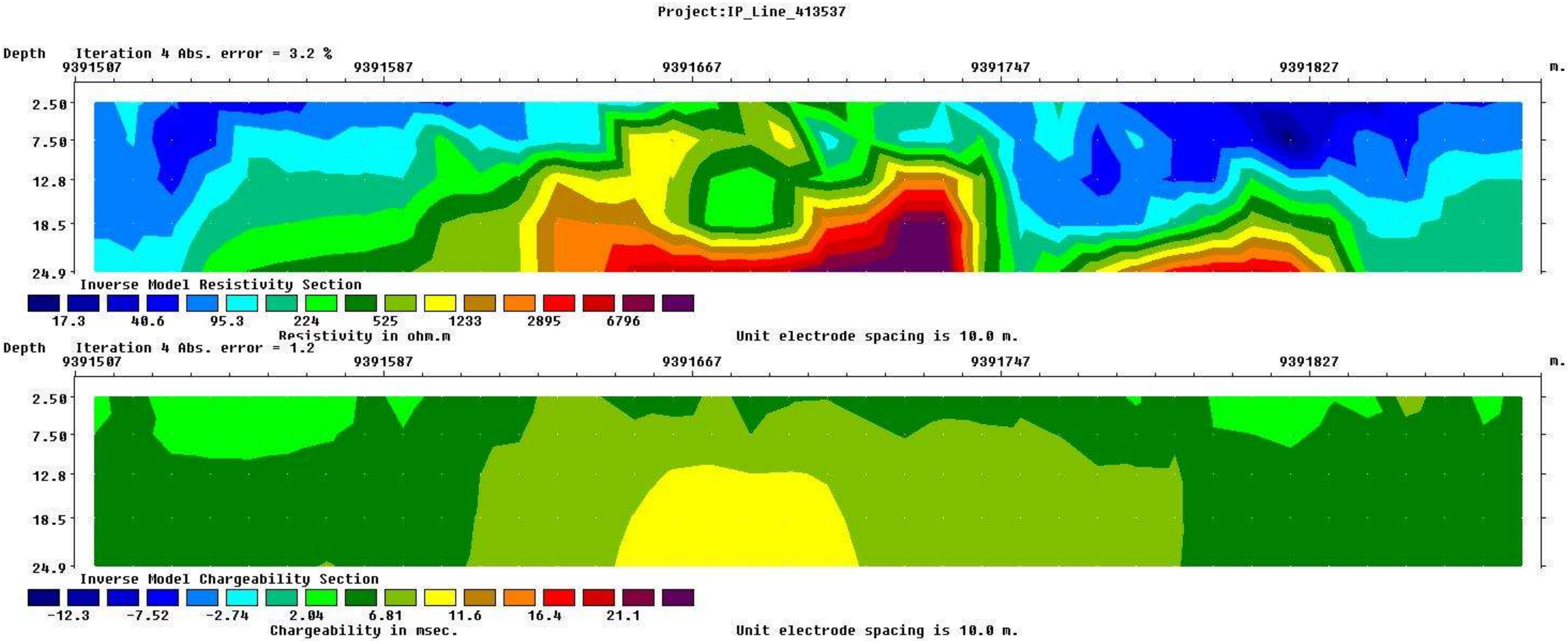


Figure 24: Inverse model resistivity and chargeability sections of line 413587

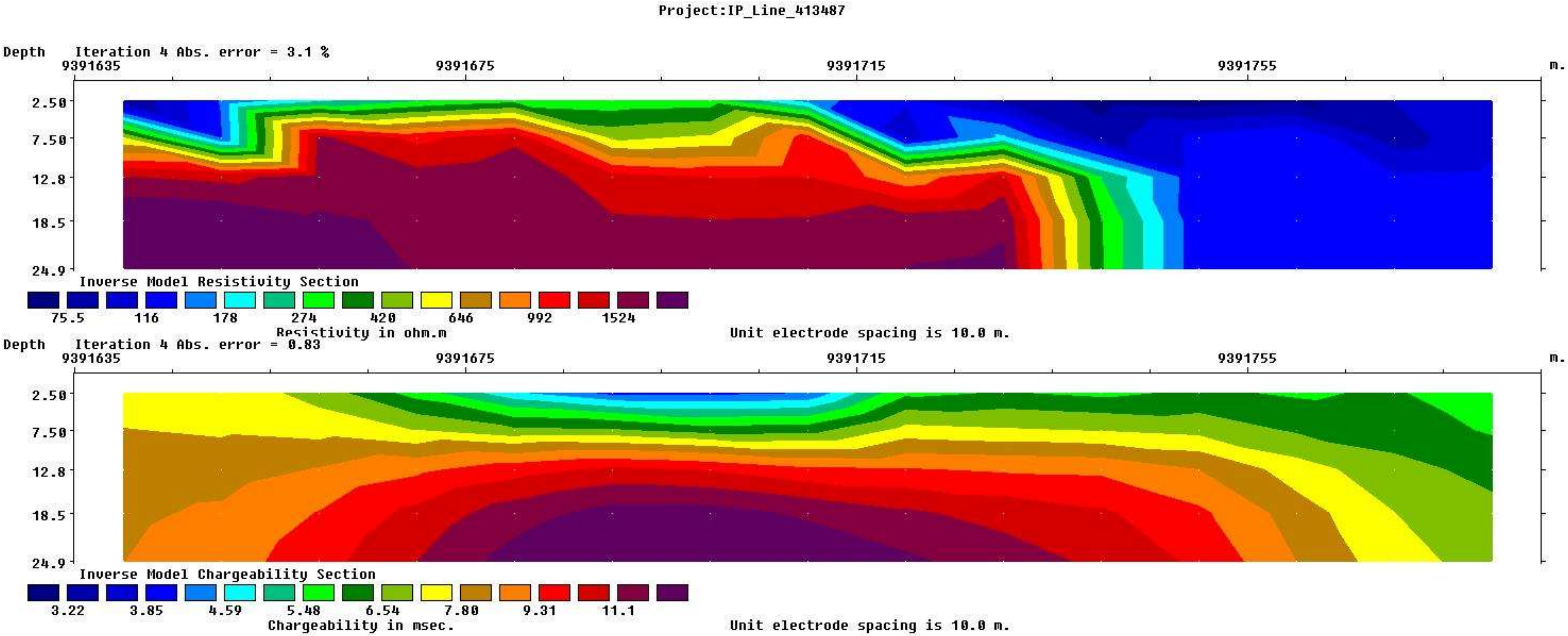


Figure 25: Inverse model resistivity and chargeability sections of line 413487

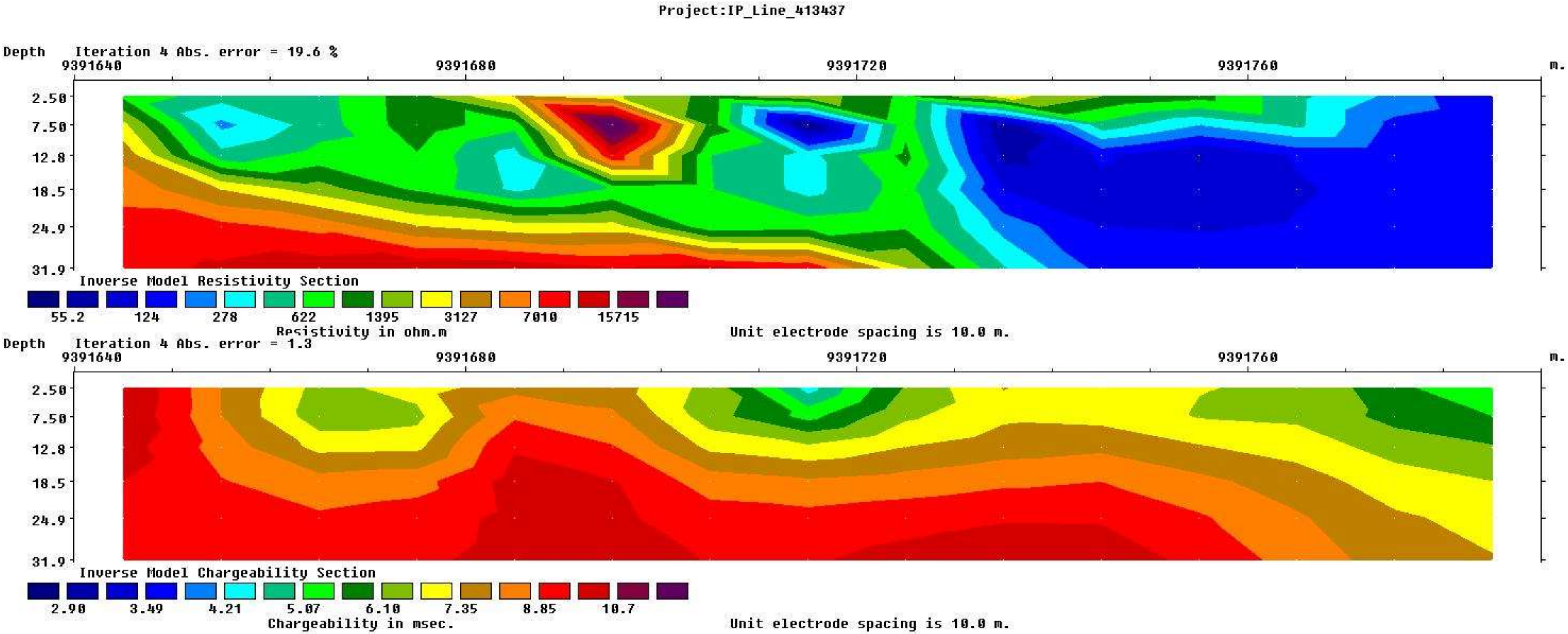


Figure 26: Inverse model resistivity and chargeability sections of line 413437

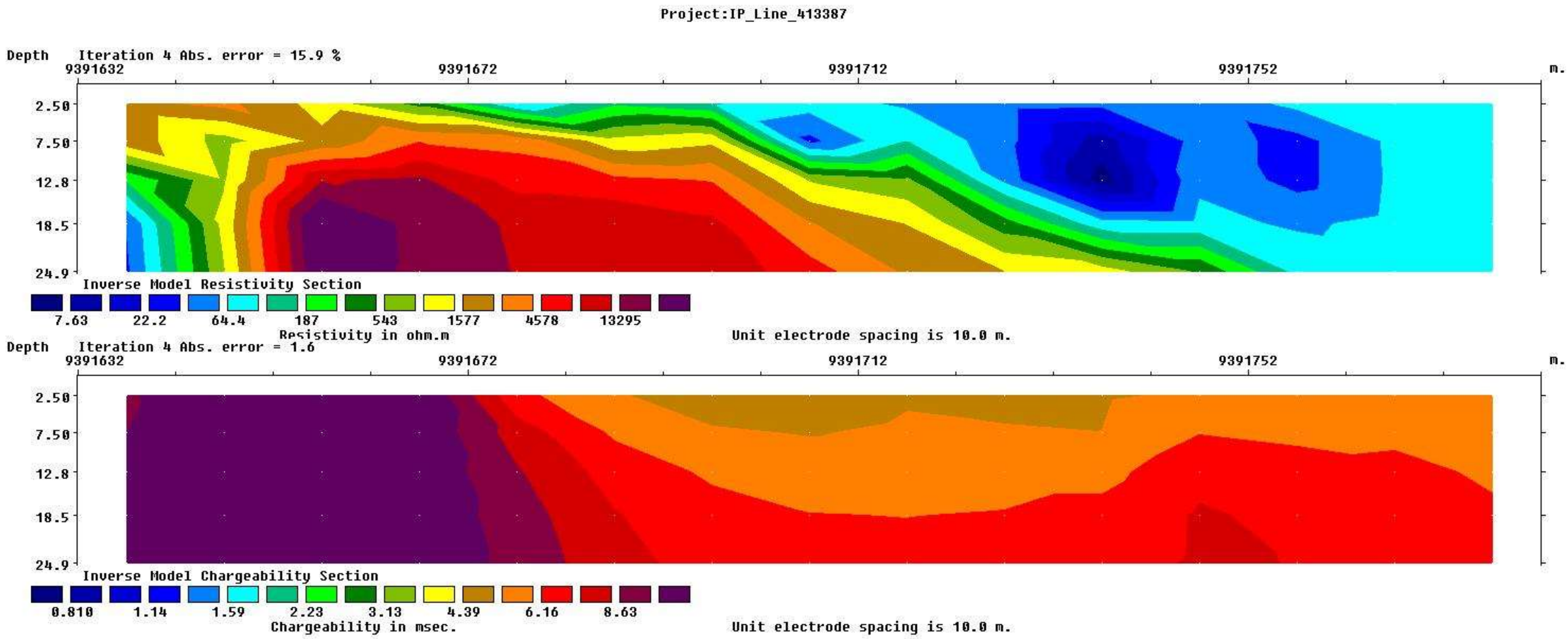


Figure 27: Inverse model resistivity and chargeability sections of line 413387

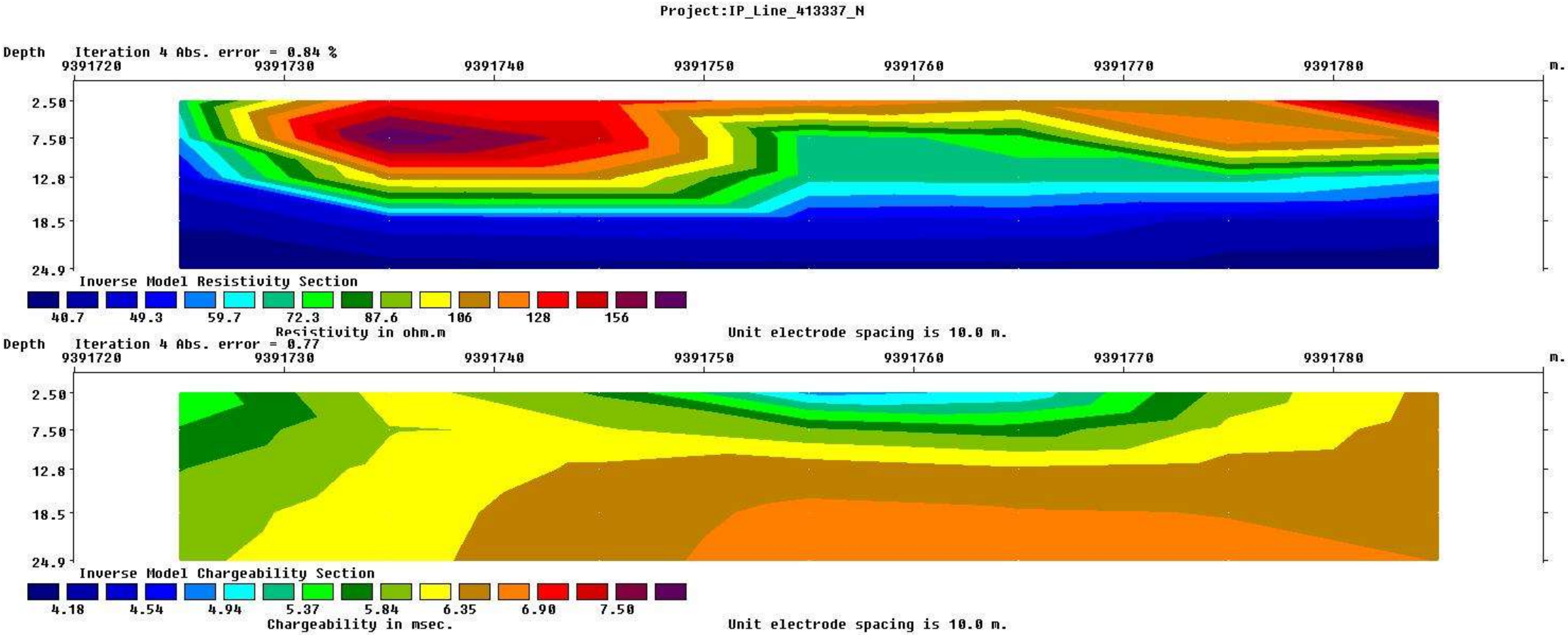


Figure 28: Inverse model resistivity and chargeability sections of line 413337 North

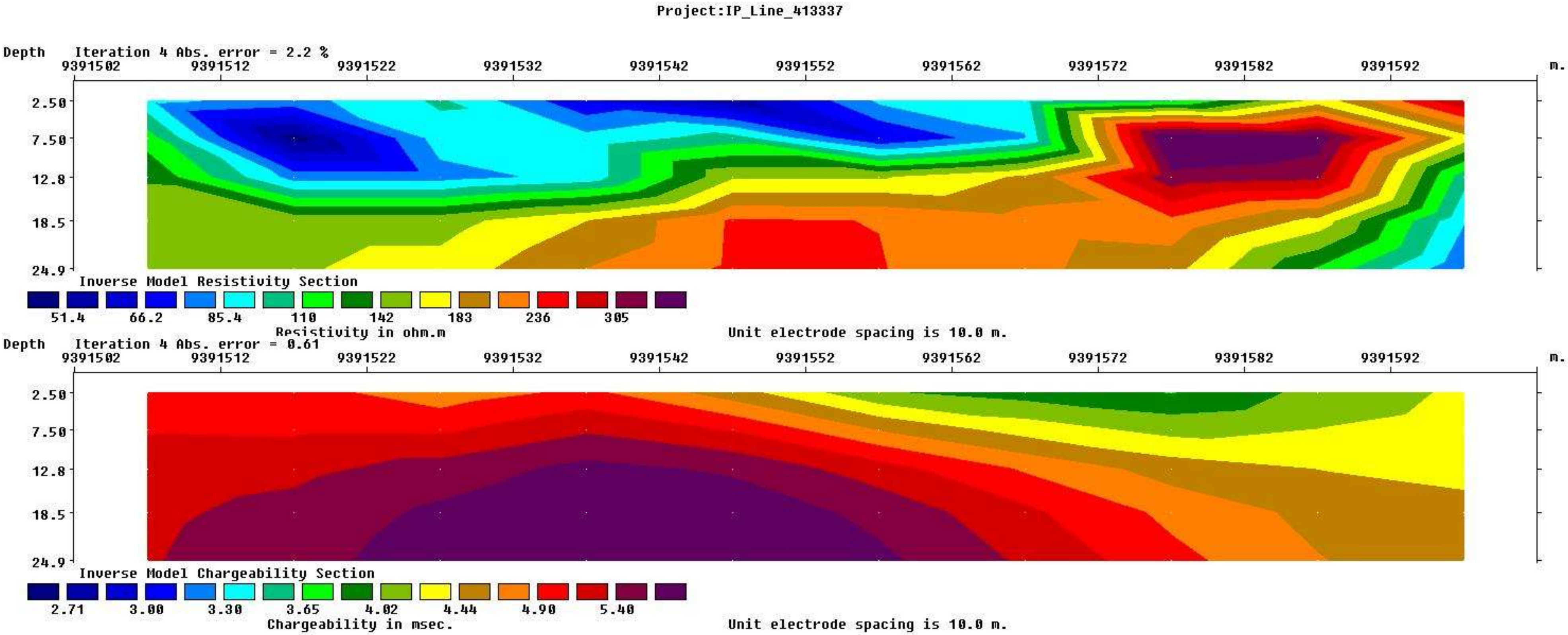


Figure 29: Inverse model resistivity and chargeability sections of line 413337

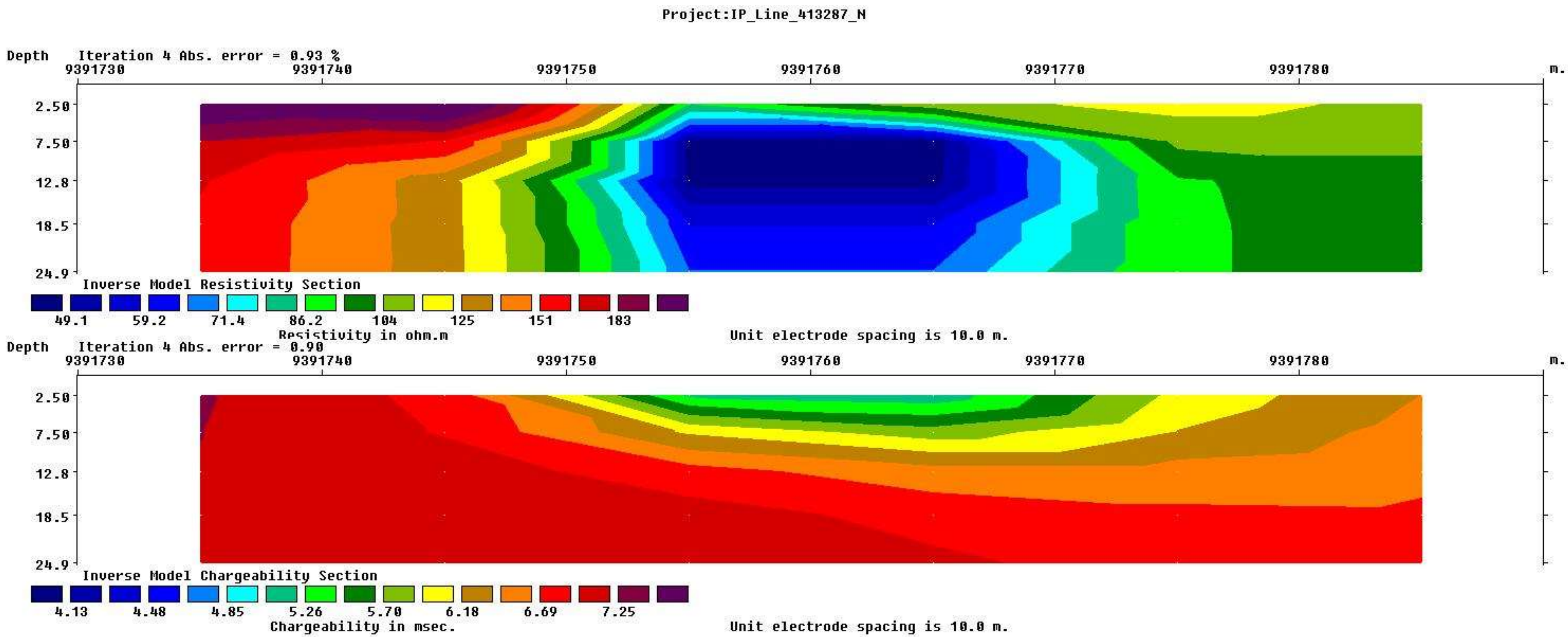


Figure 30: Inverse model resistivity and chargeability sections of line 413287 North

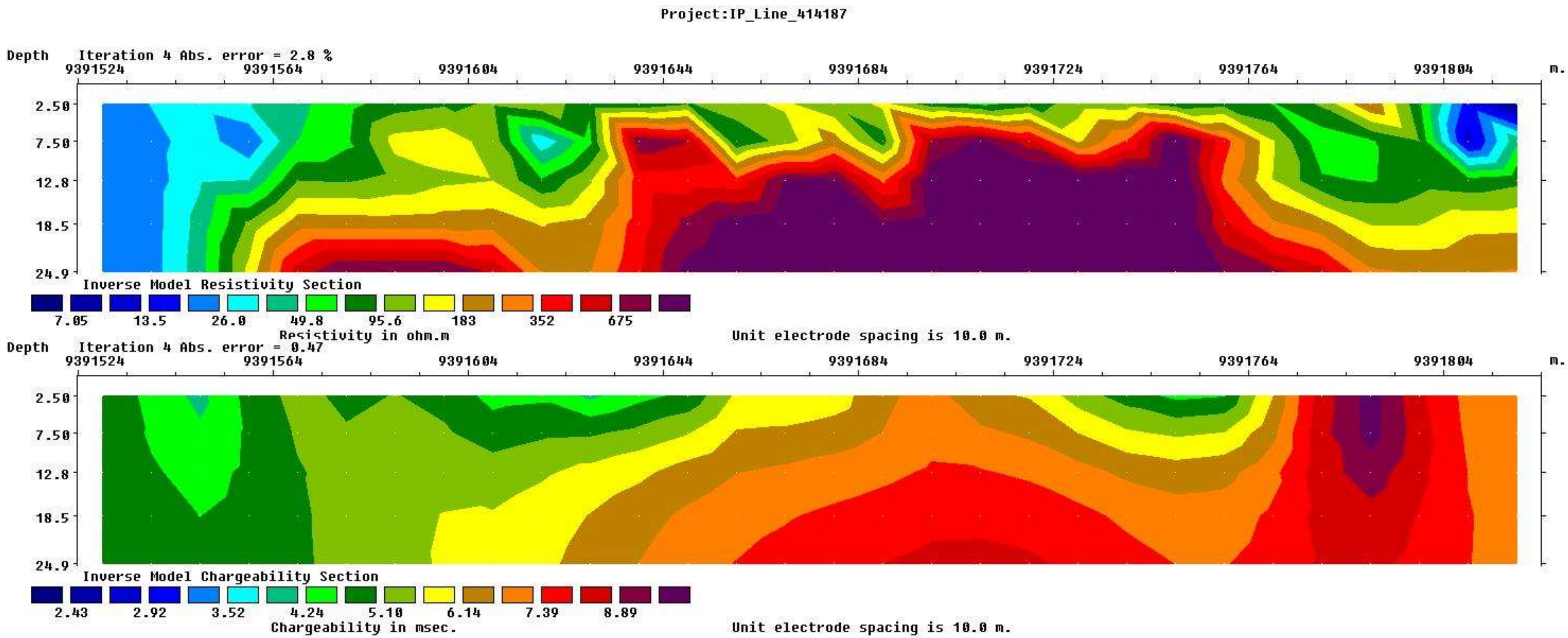


Figure 31: Inverse model resistivity and chargeability sections of line 414187

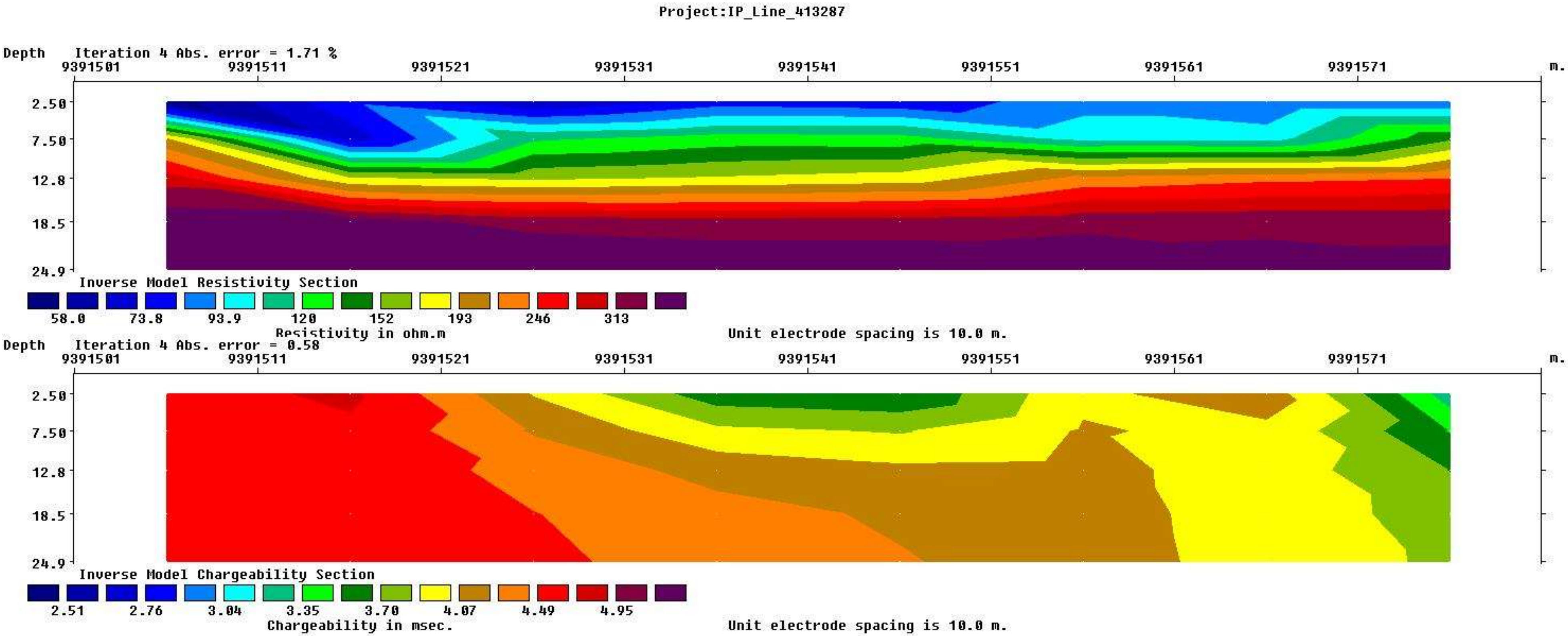


Figure 32: Inverse model resistivity and chargeability sections of line 413287

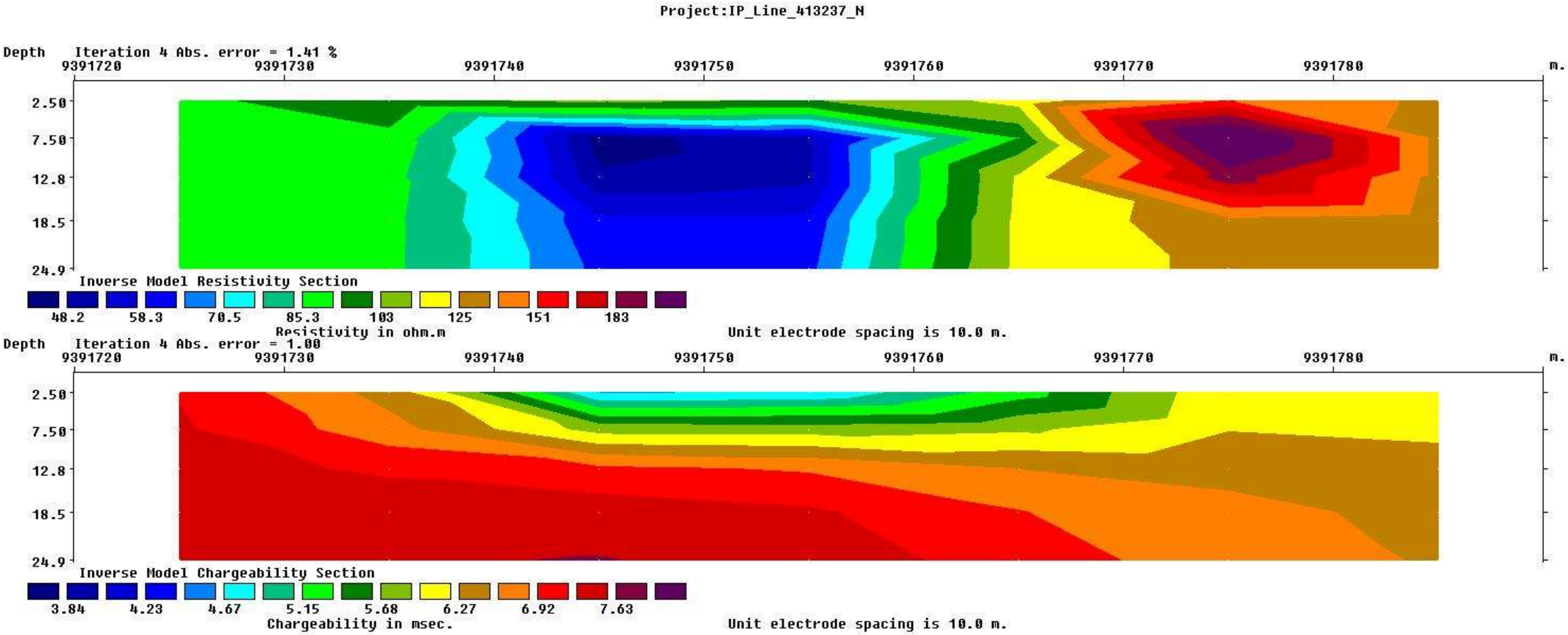


Figure 33: Inverse model resistivity and chargeability sections of line 413237 North

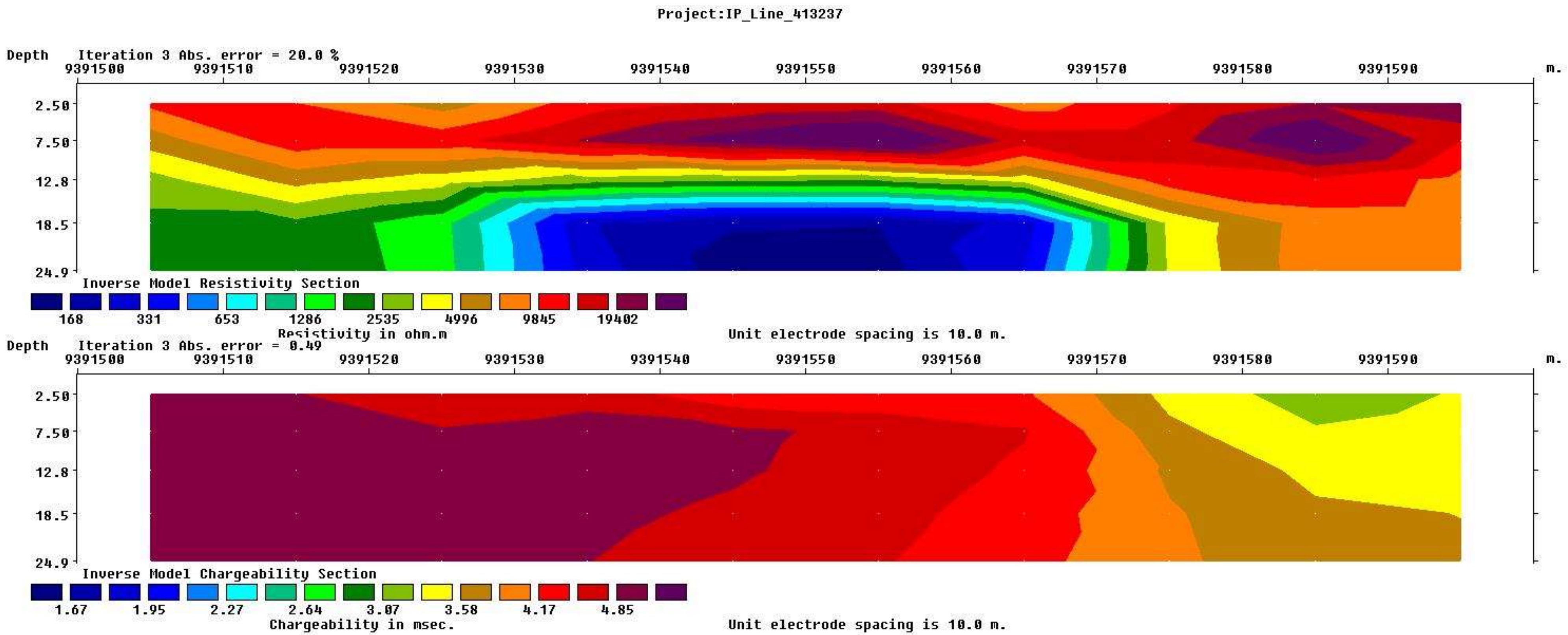


Figure 34: Inverse model resistivity and chargeability sections of line 413237

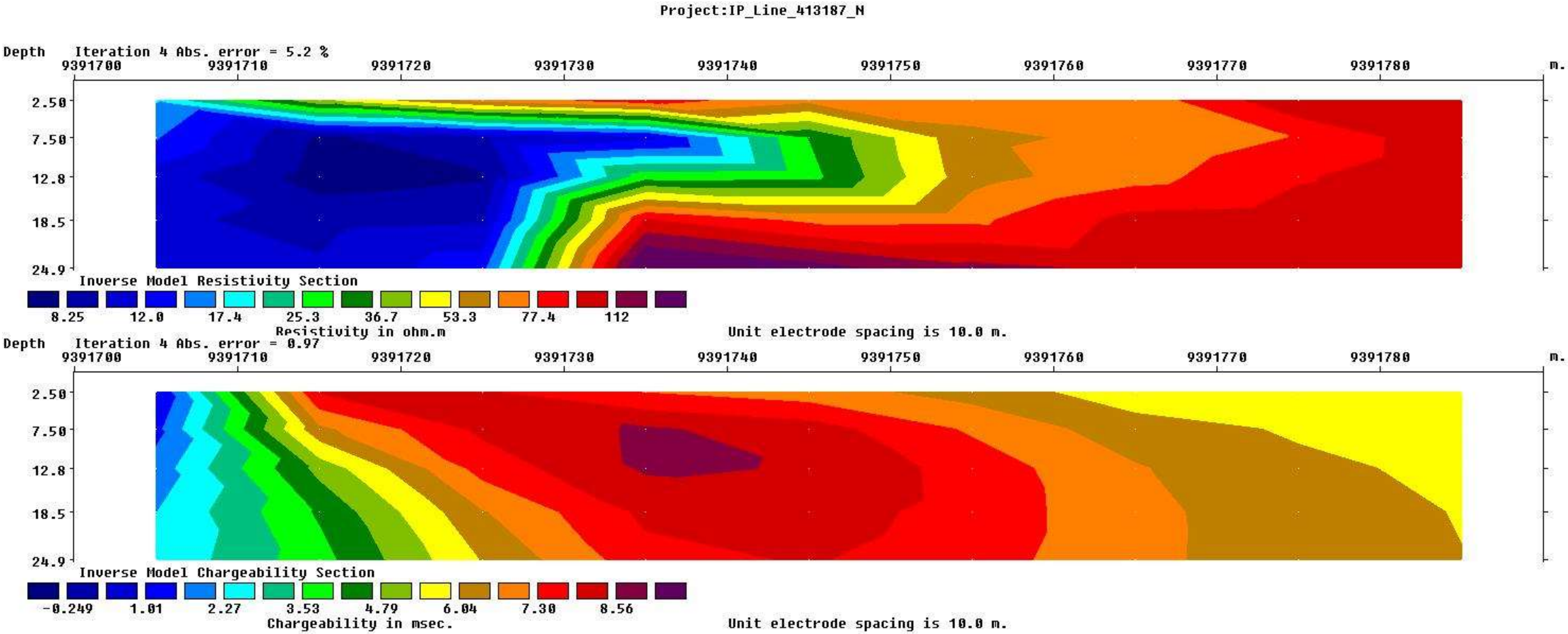


Figure 35: Inverse model resistivity and chargeability sections of line 413187 North

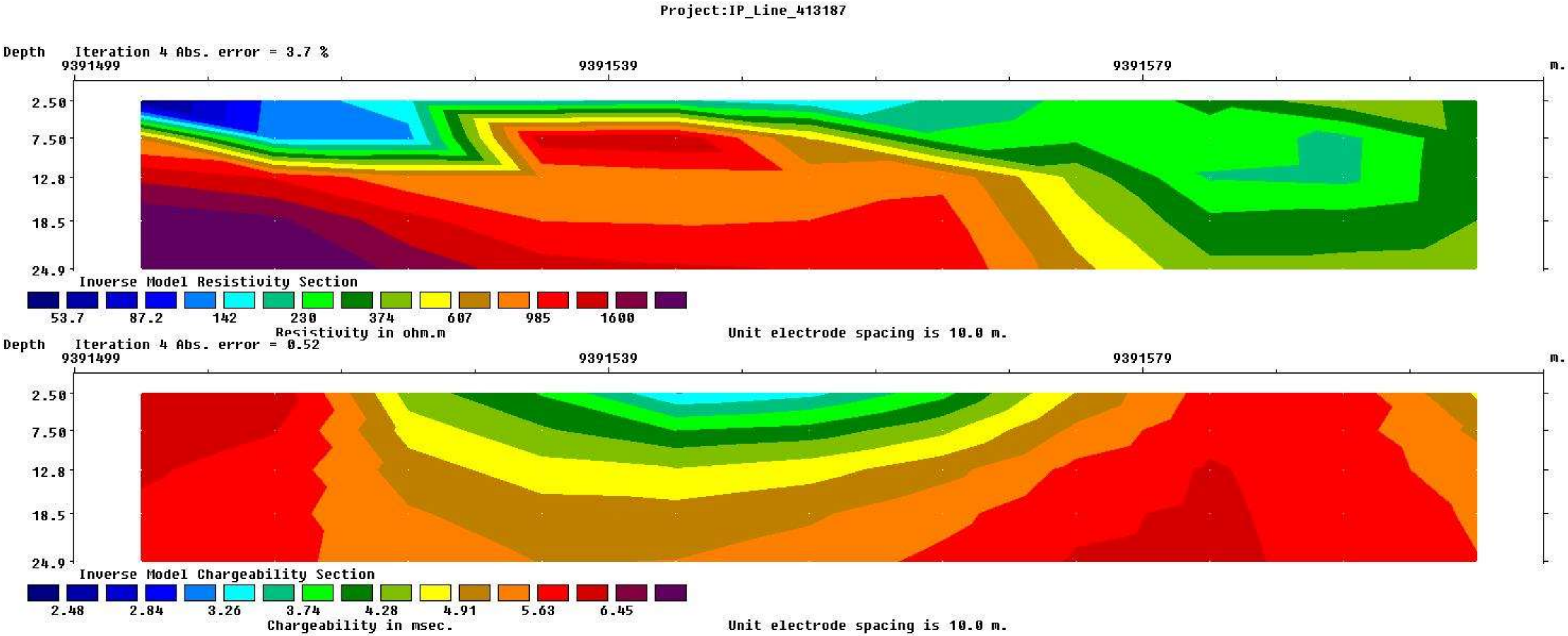


Figure 36: Inverse model resistivity and chargeability sections of line 413187

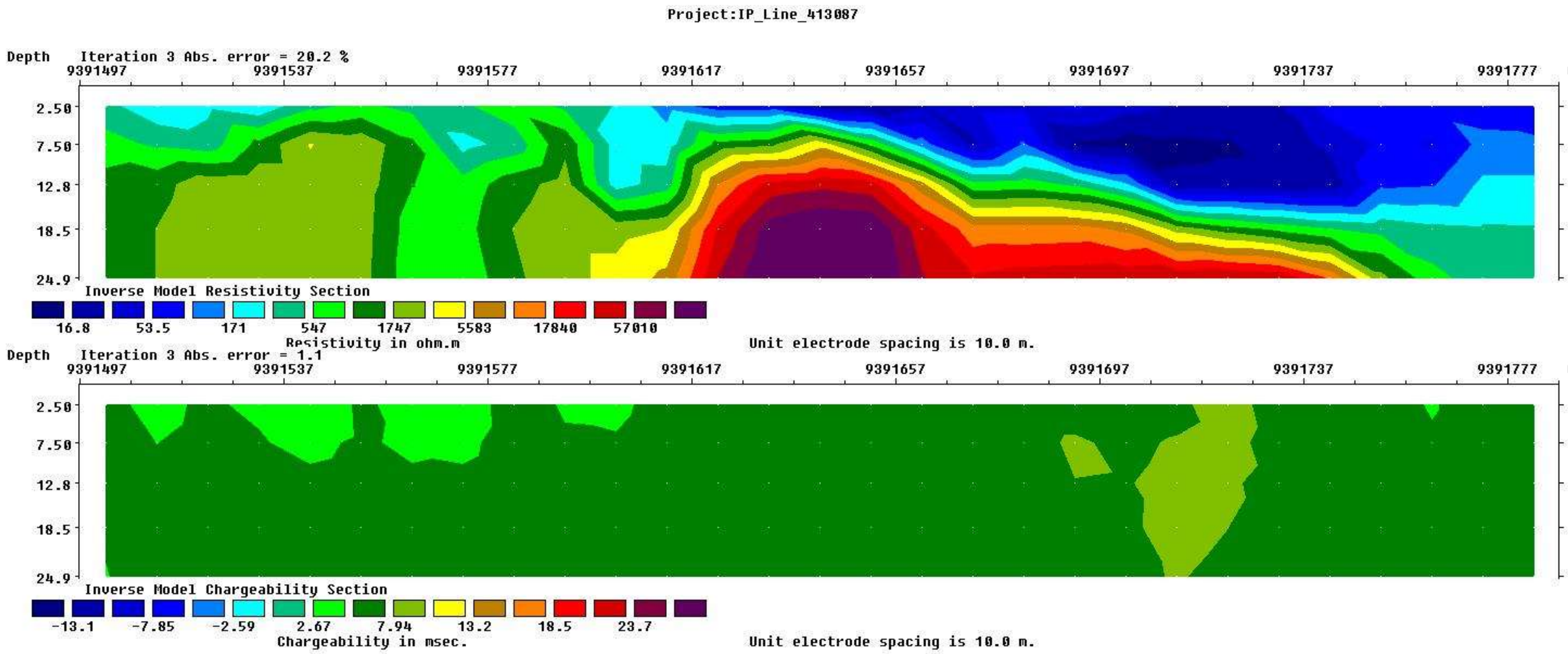


Figure 37: Inverse model resistivity and chargeability sections of line 413087

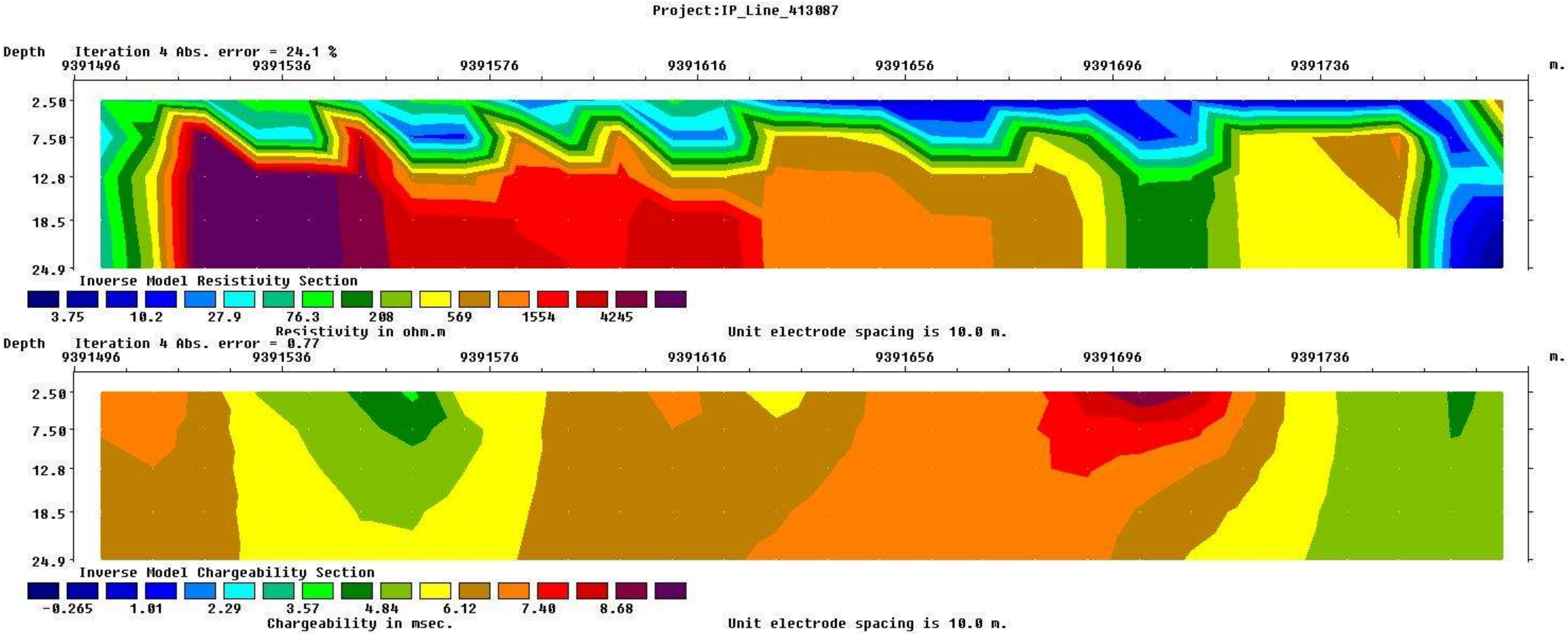


Figure 38: Inverse model resistivity and chargeability sections of line 413087 North

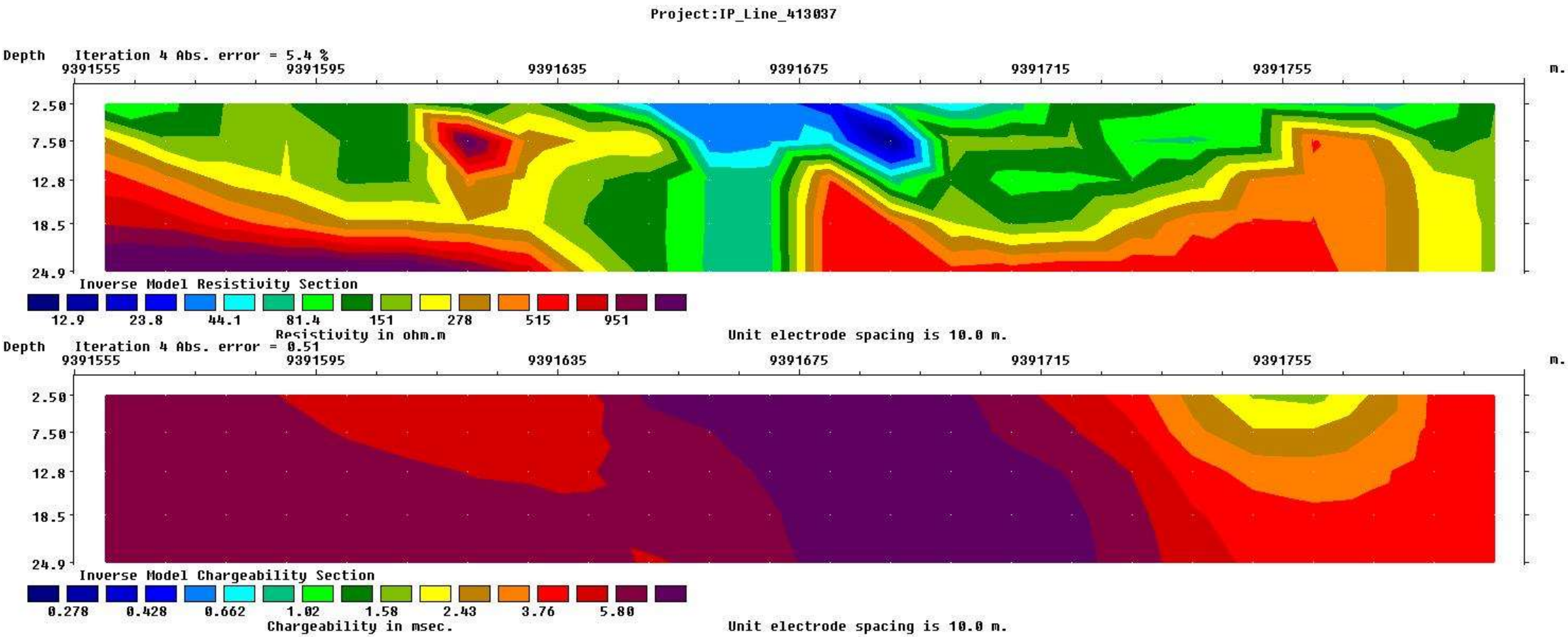


Figure 39: Inverse model resistivity and chargeability sections of line 413037

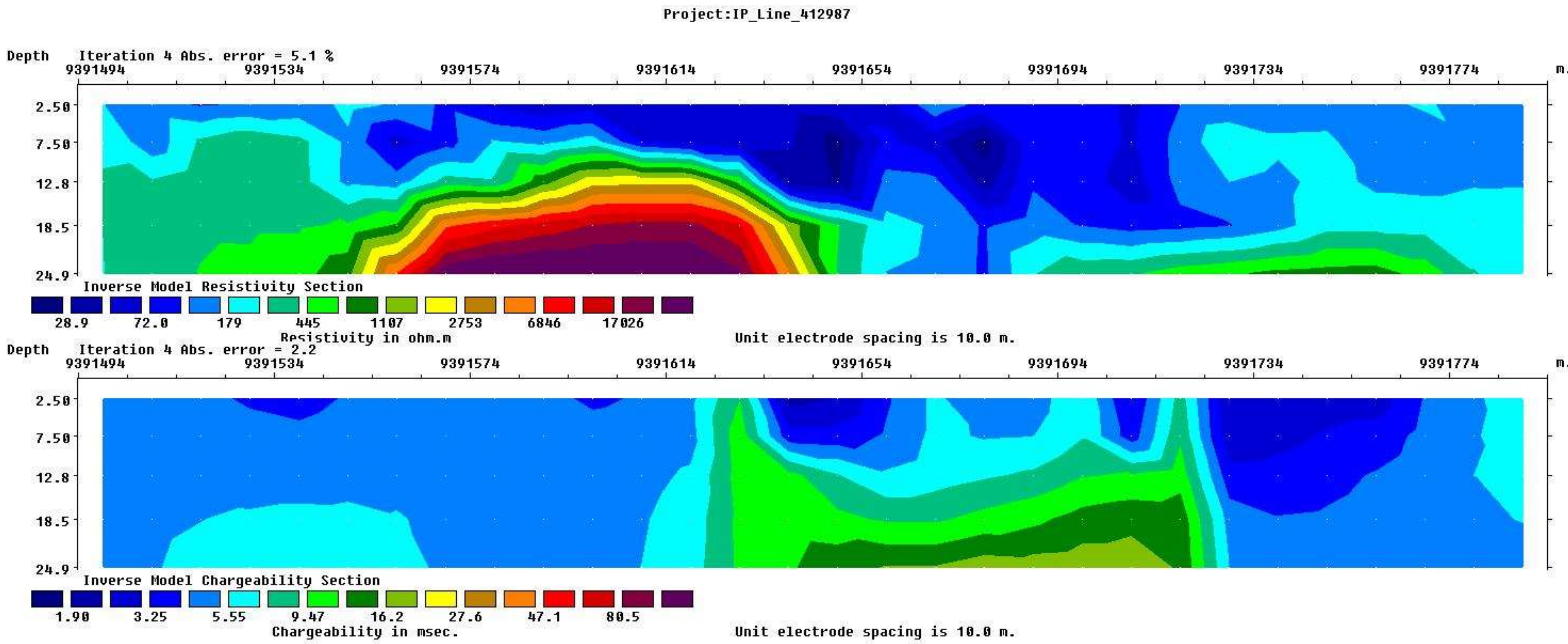


Figure 40: Inverse model resistivity and chargeability sections of line 412987

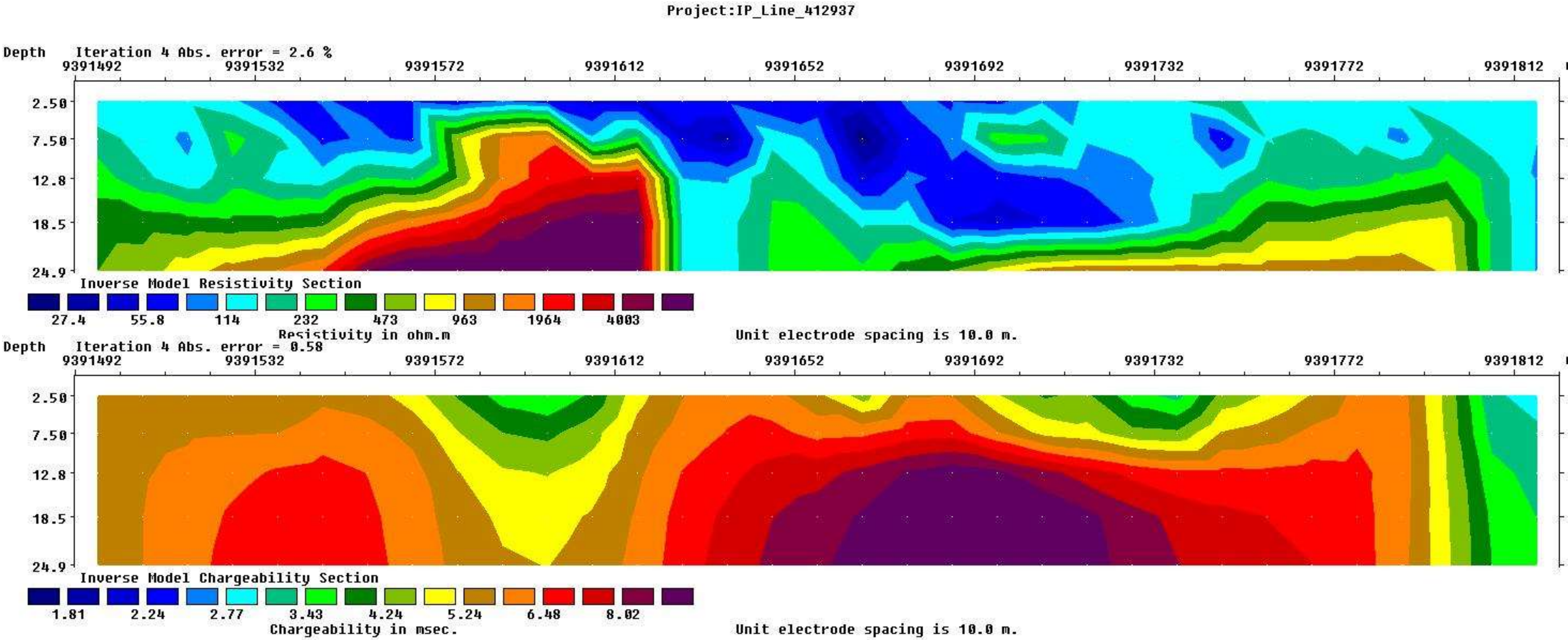


Figure 41: Inverse model resistivity and chargeability sections of line 412937

Generally, the interpretation based on IP and resistivity results has demarcated a zone of interest illustrated by **Figure 42** beolow. The demarcated zone of interest is located to the south of the study area and strikes parallel to the general trend of foliations direction.

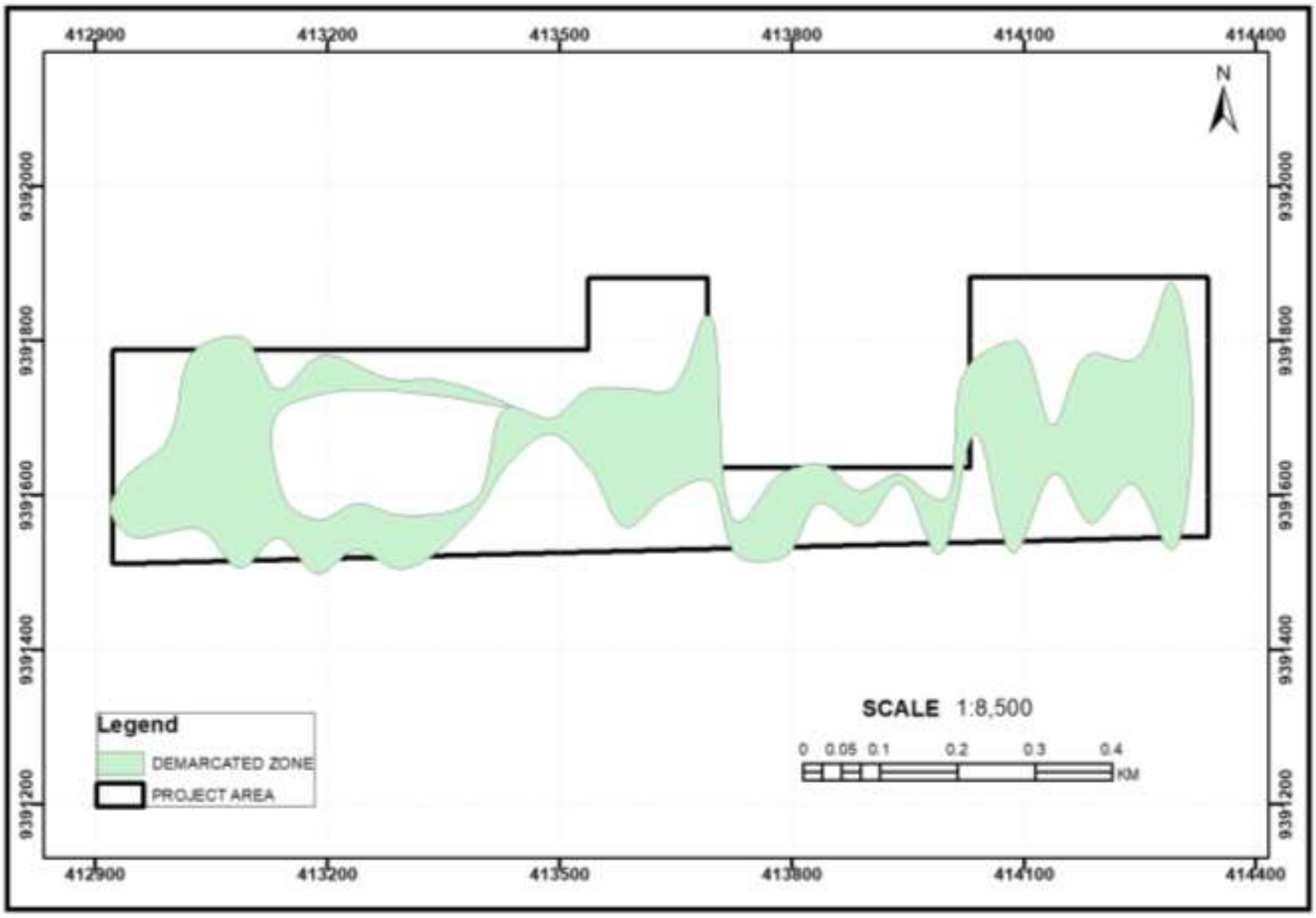


Figure 42: *Demarcated zone based on IP and resistivity results*

6. CONCLUSION AND RECOMMENDATION

The geophysical survey using IP and resistivity methods has demarcated a geological feature signifying the garnetiferous hornblende gneiss rocks which extend east – west direction. These garnetiferous hornblende gneiss bodies have a varying width from 10 to 200 m and some are cross-cutted by mineralized quartz veins. Copper deposit in the area of investigation is predominantly hosted in quartz veins. Major copper ores hosted in quartz veins are malachite and azurite which occur concurrently with fractured garnet crystals of up to 3 cm.

Conversely, more detailed exploration work including geological mapping, geochemichal survey, trenches, pitting and drilling on demarcated zone is recommended in order to study well the spatial distribution and characteristics of rocks, to determine the concentration of copper minerals, to expose copper mineralized quartz veins, and to obtain a preliminary resources of copper deposit respectively.

7. DISCLAIMER

This report aimed at verifying the geophysical signatures and locate amomalous areas possible for copper deposits in PML0895TNG, PML0896TNG, PML0897TNG, PML0898TNG and PML91299/EZ situated Kwamsangazi village, in Handeni District, Tanga Region. The licences are owned by Mr. Paschal Musira Rugembe of P.O. Box 4458, Dar es Salaam.

The contractor (GST) however will not be responsible for any, misinterpretation or any other financial losses which may be incurred based on this report. Geophysical survey techniques is a paramount tool for identifying geophysical anomalies, surface and subsurface structures. Moreover, the interpreted geophysical structures tends to be associated with the mineralization, however, not all structures are necessarilymineralized. The final decision of mining operation on the property area must be independently made by the company management and should, however, be based on integration of currently acquired geophysical data and multidisciplinary geoscientific data/information.

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