RESISTIVITY AND INDUCED POLARISATION (I.P) REPORT FOR NARAWA LIMITED IN EASTERN REGION

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EXECUTIVE SUMMARY

Nine (9) Electrical Resistivity and Induced Polarisation (I.P) surveys have been carried out to map underlying rocks and delineate potential mineralization zones for Narawa Limited. The survey involved the measurements of ground resistivity and chargeability to generate 2-D tomography for underlying rock detection and mineral prospects delineation. The work involved geological studies, geophysical data acquisition, processing, interpretation, and report documentation. Recommended areas of interest have been presented in Tables 2 and 3 in Appendix I on page 27 to aid Narawa set drill targets and do geological and geochemical studies. Consequently, recommendations based on the findings from the geophysical report have been made on page 26.

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CHAPTER ONE

1.0 Introduction

As part of the exploratory activities of Narawa Mines to increase its resources, resistivity, and Induced Polarisation (IP) geophysical surveys were conducted on some parts of the concession. Nine (9) geophysical surveys were conducted between 9^{TH} and 16^{TH} September 2022. The goal was to measure ground resistivity and chargeability and use them to predict the possible subsurface rock and to help predict potential areas of sulphide accumulation. Resistivity and chargeability are two geophysical indicators that may serve as a tool for mineral prospecting. At the end of the survey, a total of 10.2-kilometer resistivity and Induced Polarization (IP) surveys were conducted in Bunsu and its environs, and the results, interpretation, and recommendations are contained in this report. The underlying rock, potential points of mineralisation, and their corresponding depth have been indicated.

1.1 Objectives

1. To map the underlying rock body below the subsurface
2. To delineate potential areas of mineralisation that could be targeted for gold exploration

CHAPTER TWO

2.0 BACKGROUND

2.1 Electrical Resistivity

The purpose of an electrical survey is to determine the subsurface resistivity distribution, by making measurements on the subsurface and from which the true resistivity of the subsurface can be estimated (Loke, 1999). Measurements are processed and interpreted to relate to subsurface bodies like rocks, ore bodies, water resources, and buried utilities. The method has been used in diverse ways and thus has been used for a wide range of applications ranging from archaeological, hydrological, geotechnical, environmental, and mineral exploration problems (Auken et al., 2006; Loke et al., 2013)

2.2 Induced Polarization (I.P)

Induced Polarization (IP) measures ground chargeability which is closely related to mineralization. I.P is critical for mineral exploration, which involves locating economically valuable minerals such as gold, manganese copper, and silver. Hydrothermal fluids deposited pyrite and large sulfide minerals and these minerals have a large IP signal, particularly when dispersed as smaller grains in a rock matrix. IP is one of the most widely used techniques in the mineral exploration and mining industry and it has other applications in hydrogeophysical surveys, environmental investigations, and geotechnical engineering projects.

2.3 Site

Figure 2.1 below shows the site and the geophysical survey lines. Surveys were made in six localities: Bunsu, Etukrom, Asiakwa, and around the Birim river. The topography of the survey area differs from location to location ranging from steep to gentle. Elevation as high as 450 meters was encountered at Etukrom and Bunsu whiles other areas were generally flat lands. The soil was mainly loamy and clayey for most of the area.

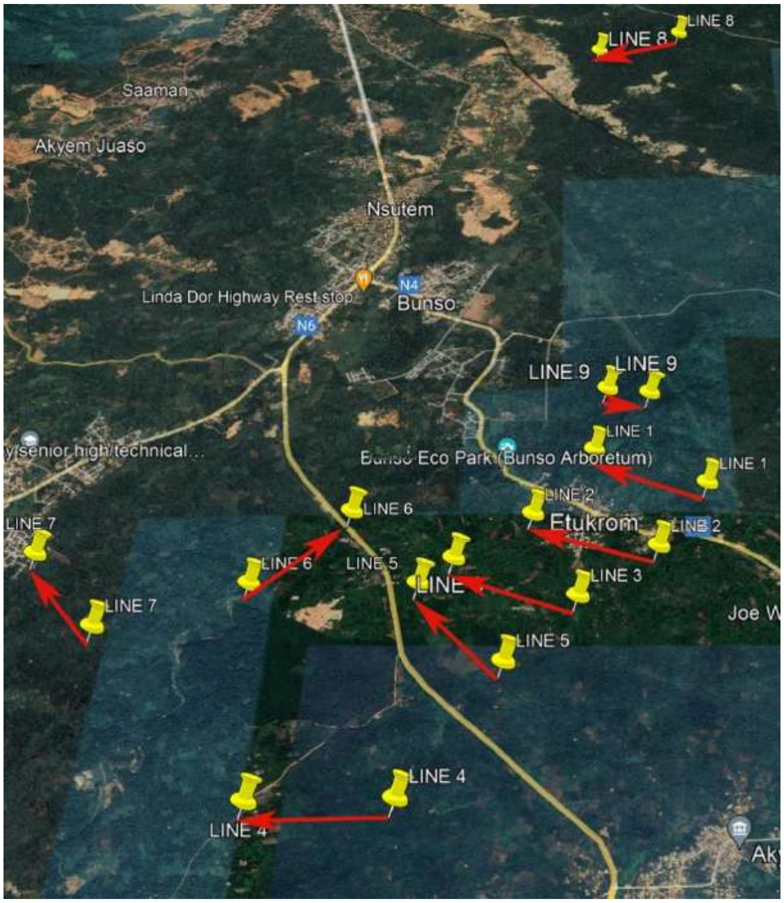


Figure 2. 1: Google Map showing Geophysical Lines

2.4 Geology

Regionally, the Narawa concession lies on the Birimian system of Ghana, a place that sprouted out from the Eburnean orogeny. The Eburnean orogeny happened in the

Paleoproterozoic era and affected most of the rocks on the West African Craton (WAC). The Birimian terrain is noted for Metasediment and Metavolcanic rocks, and it's intruded by a series of granitoids (Perrouty, 2002). Locally, the geologic map of the area indicates the presence of Dacites or Rhyolites, Volcaniclastic sediments, detrital sediments, sandstones, basaltic lava, and Mica Schists. Different rock formations were intercepted per each geophysical survey that was made. Line 1 falls on two rock types namely, Mica Schist and Dacites or Rhyolite. Similarly, Line 2 also lies on Dacitic or Rhyolitic rock at the Northwest and Mica Schist on the Southeast. Lines 4, 5, 6 and 9 fell on the felsic Dacites or Rhyolites. Line 8 which was surveyed at the Northmost part of the area lie on Dacites and Conglomeratic rocks and Line 7 surveyed at Asiakwa was on Sandstone/Conglomerates and basalts.

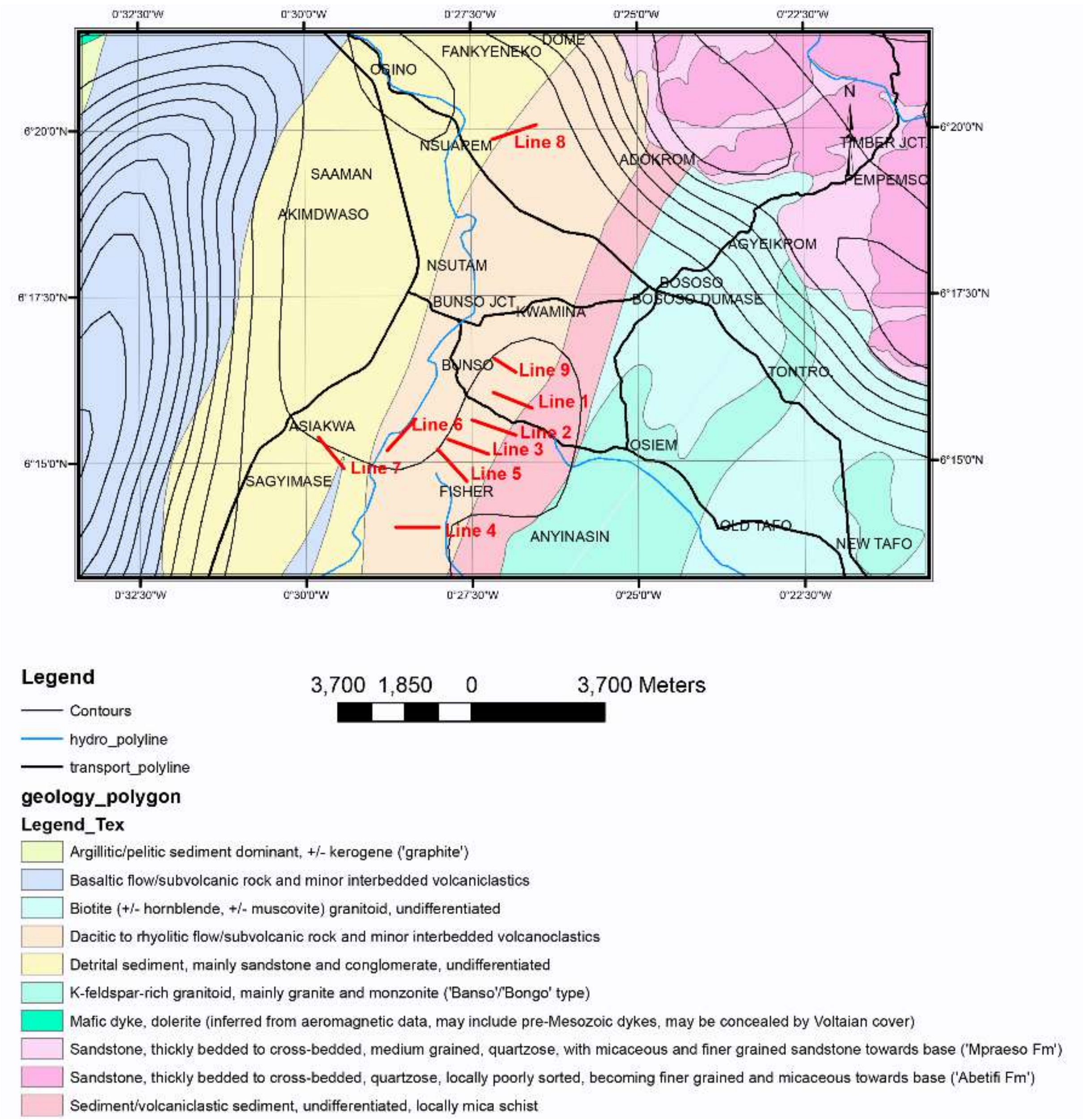


Figure 2. 2: Geological map of the area

CHAPTER THREE

3.0 METHODOLOGY

3.1 Geophysical Survey

3.1.3 Data Acquisition

Data were acquired with the maiden ABEM Terrameter LS 2 resistivity meter shown in Fig 3.1, a multichannel resistivity and I.P instrument for electrical imaging. The instrument comes with both the transmitter and receiver altogether in one package for faster data collection. The ABEM Terrameter L2 was attached to a double 2 x 21 cable system consisting of 21 electrode takeouts each. 41 non-polarizable electrodes were connected to each takeout on the two 2 x 21 cables and measurements were taken for 9 survey lines. Table 1 shows the survey lines, geographic coordinates, and their corresponding lengths.

For a typical field survey as shown in Fig 3.2, the Terrameter LS2 is placed at the central part of the spread (ABEM, 2010). **Error! Reference source not found.** shows a typical f ield arrangement for resistivity measurements on a 200/400 m profile. Measurements are automatically taken by the equipment and stored in the Terrameter LS2 and data can later be transferred to a computer to be processed.

Figure 3. 1 : ABEM Terrameter LS 2

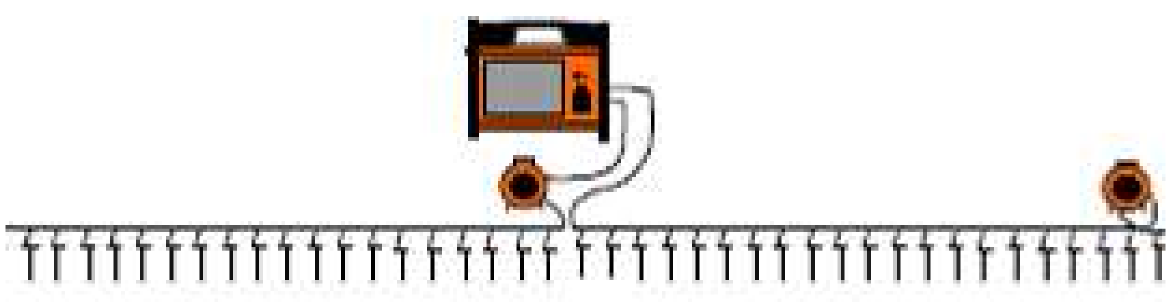


Figure 3. 2 Field arrangement of 2 x 21 cable electrode system

Table 1 : Geophysical Survey Lines

LINE NAME	SURVEY	EASTERNS	NORTHERNS	LENGTH(M)
LINE 1	START	782854	693031	1200
	END	781837	693438	
LINE 2	START	782389	692287	1200
	END	781287	692667	
LINE 3	START	781687	691731	1200
	END	780612	692141	
LINE 4	START	780302	689743	1200
	END	779155	689705	
LINE 5	START	781078	691032	1200
	END	780325	691860	
LINE 6	START	778876	691866	1200
	END	779670	692707	
LINE 7	START	777647	691379	1200
	END	776985	692162	
LINE 8	START	782927	700852	1200
	END	781933	700458	
LINE 9	START	781967	694283	600
	END	782359	694085	

The depth of the electrical method depends on the total survey length and for the dipole-dipole array a depth between 18 % to 25 % of the survey length can be reached depending on ground conditions. For the entire survey, the dipole array was used because of the excellent resolution of the protocol. To reach the maximum depth of interest, a survey length of 1200m was run with an interelectrode spacing of 30m electrode. A depth of 200 meters was reached for most of the survey lines.

3.2 Data Quality

Best data collection practices were ensured throughout the survey. The process of ensuring data quality started from data acquisition to data processing. Highly resistive and contact electrode problems are normally associated with the electrical method and can compromise data collection and render data less quality. Contact electrode checks were always initiated at the start of each survey to ensure free current injection into the ground. In the case of high contact electrode that is greater than 1.0K Ohm, a salt solution was used around the electrodes to increase conductivity and reduce contact resistance. Before data processing and inversion, Negative apparent resistivity and chargeability values which are less typical of an electric survey were removed to reduce the errors associated with the inversion process.

3.3 Data Processing

Field data was inverted with Res2Dinv Software from Arhus Geotomo. The software uses the smoothness constraint algorithm to give suitable models of data. The RES2DINV modeling software is based on the smoothness constraint (de Groot-Hedlin & Constable S, 1990; Sasaki Y, 1992) and provided a very fast quasi-Newton method (Loke MH & Barker RD, 1996). The program calculates the apparent resistivity values of the model blocks using a finite difference or finite element method and compares them with the field-measured data.

CHAPTER FOUR

4.0 RESULT AND DISCUSSION (RESISTIVITY & INDUCED POLARISATION)

4.1 Resistivity Tomography

4.1.1 Resistivity Model Of Line 1(Etukrom)

A highly resistivity anomalous body is mapped on line 1 in Fig. 4.1 below. This anomalous body occurs at a depth of about 120m and is estimated to be about 900m in length. It has a resistivity of about 40,000 Ohm.m. The high resistivity anomaly may represent the hard geologic material buried below the subsurface. The discontinuity at 240 m has been interpreted as a possible fault and may serve as a spot for mineral accumulation. The thin conductive layer at the surface may represent clay materials that are present on line 1.

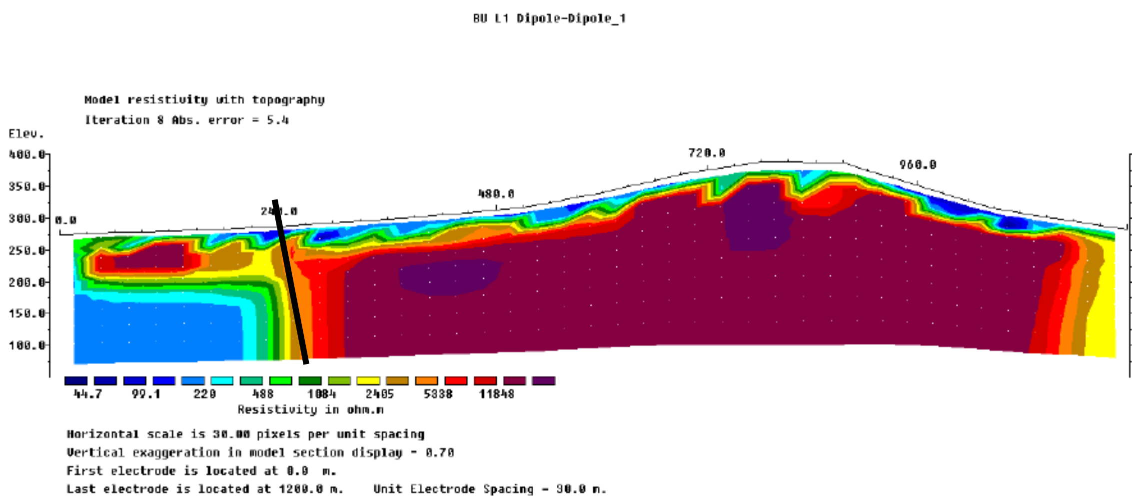


Figure 4. 1: Resistivity Model For Line 1(Etukrom)

4.1.2 Resistivity Model Of Line 2

The 1200-meter Line 2 as shown in Fig 4.2 was imaged to a depth of about 200m. High resistivity anomalous body was detected on this line at an average depth between 120 to 140m. A possible normal fault seems to occur at 480m and can serve as a conduit for mineral accumulation.

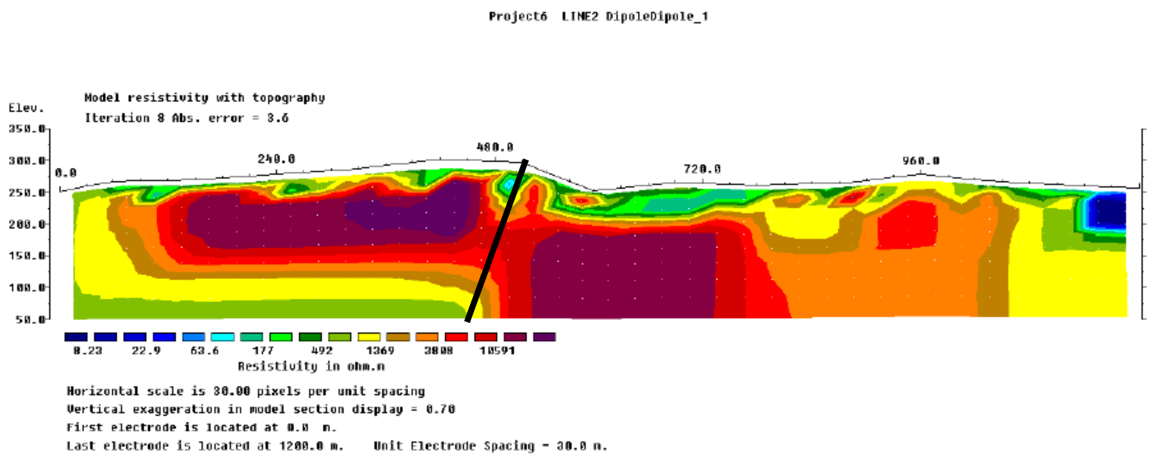


Figure 4. 2: Resistivity model for Line 2(Etukrom)

4.1.3 Resistivity Model Of Line 3

High resistivity anomalies were detected on line 3. Discontinuities may also suggest the presence of a possible fault at 480m and 780m of the survey line. A very low resistive anomaly also reveals itself and may represent saturated material. The resistivity inversion model of line 3 is shown in Fig. 4.3.

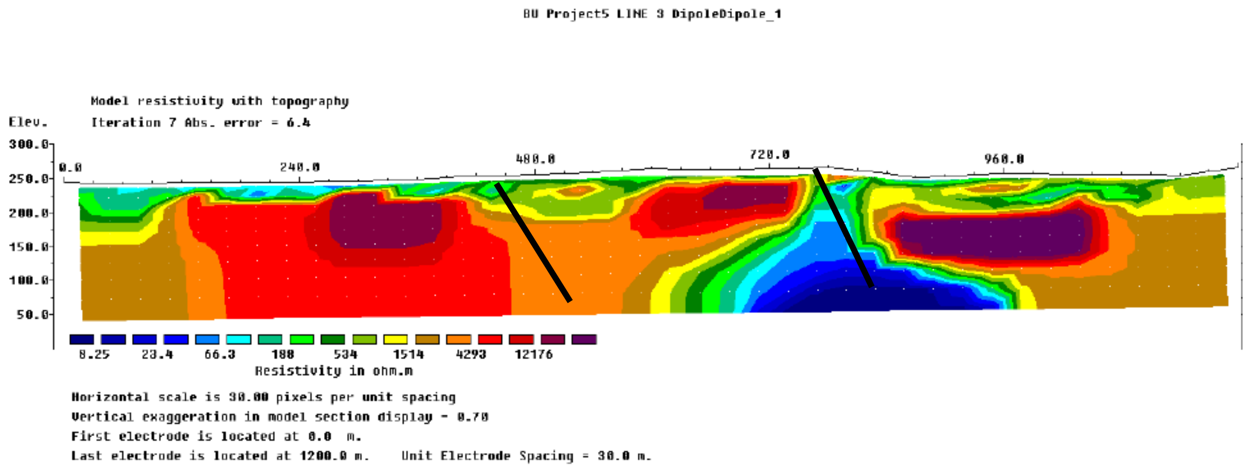


Figure 4. 3 : Resistivity Model of Line 3(Etukrom)

4.1.4 Resistivity Model Of Line 4

Fig 4.4 also reveals a resistive anomaly from the resistivity distribution on line 4. This anomaly is within an average depth of about 75 to 120m. Thin conductive clay material is also represented with a resistivity of about 150 Ohm.m.

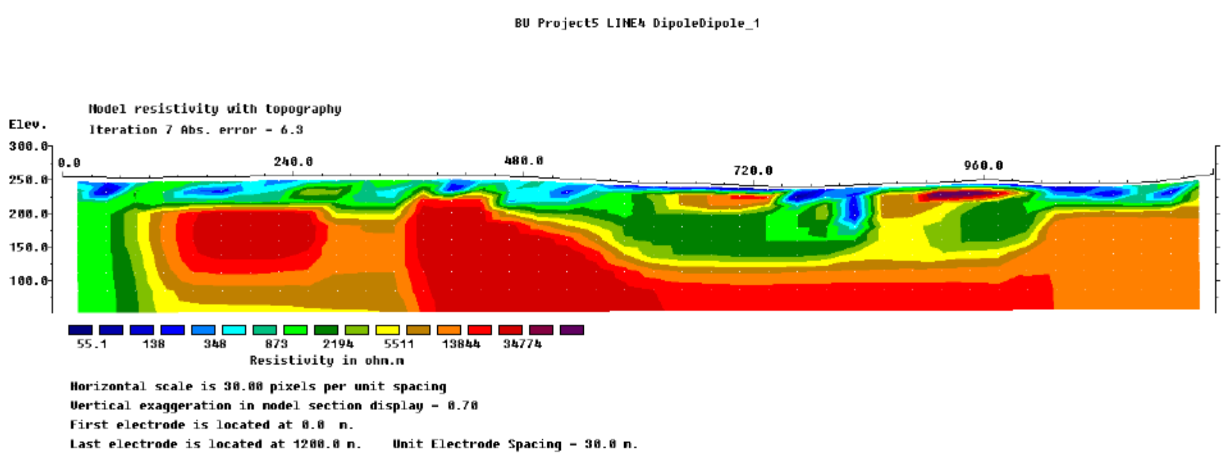


Figure 4. 4: Resistivity model of Line 4(Kibi)

4.1.5 Resistivity Model Of Line 5

A low resistivity anomaly at 480m is sandwiched between high resistivity anomalies. This may represent a fracture filled with saturated geologic material, possibly clay or water. Fig. 4.5 is the inversion model of line 5

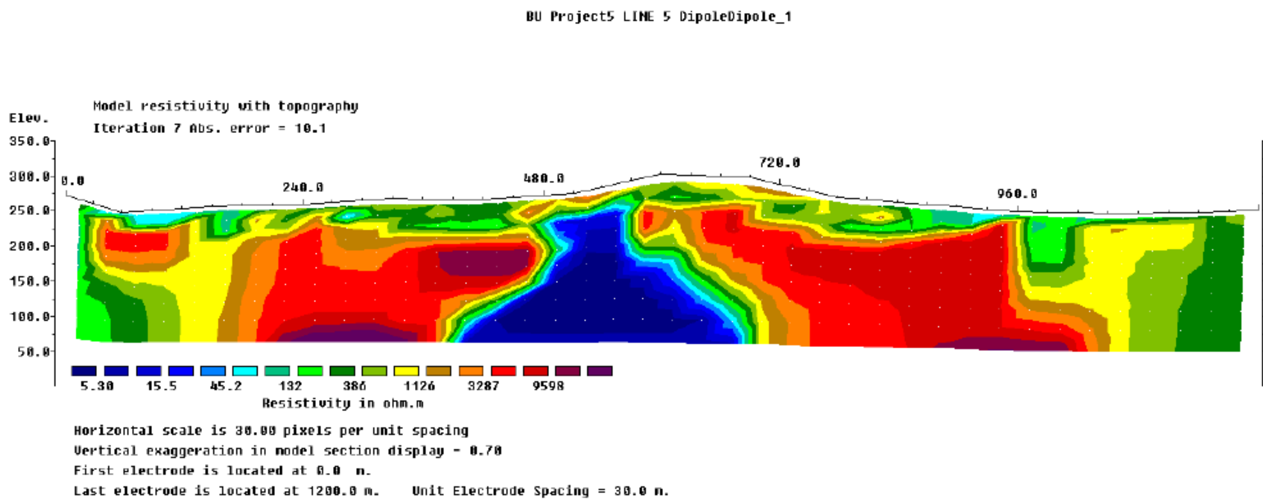


Figure 4. 5 : Resistivity Model of Line 5(Birim)

4.1.6 Resistivity Model Of Line 6

Fig 4.6 shows the inversion model from resistivity distribution on line 6. A very large resistivity anomalous body occurs from about 180m to 870m. This is consistent with the high geologic bodies that are buried on the other survey lines according to inversion models.

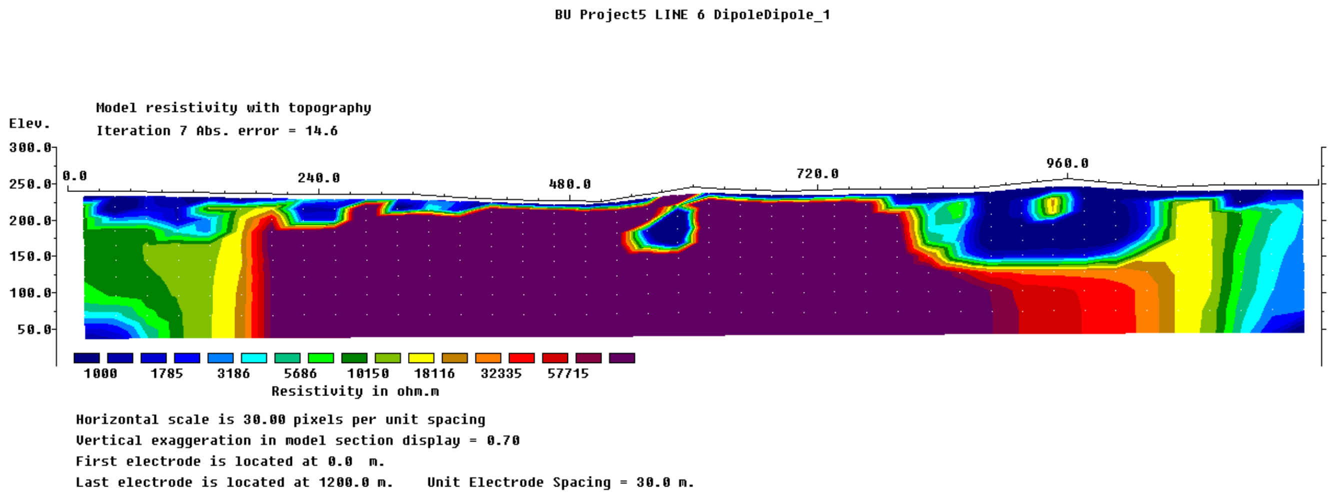


Figure 4. 6 : Resistivity model of Line 6(Birim)

4.1.7 Resistivity Model of Line 7

Large resistivity anomalies occur between 240m and 480m and truncate between 570m and reappear around 840m. This discontinuity may represent a fault or a weathered-away geologic material. The top layers have a low resistivity value which represents the clay material that is predominant at the surface. Fig. 4.7 represents the inversion model of survey line 7.

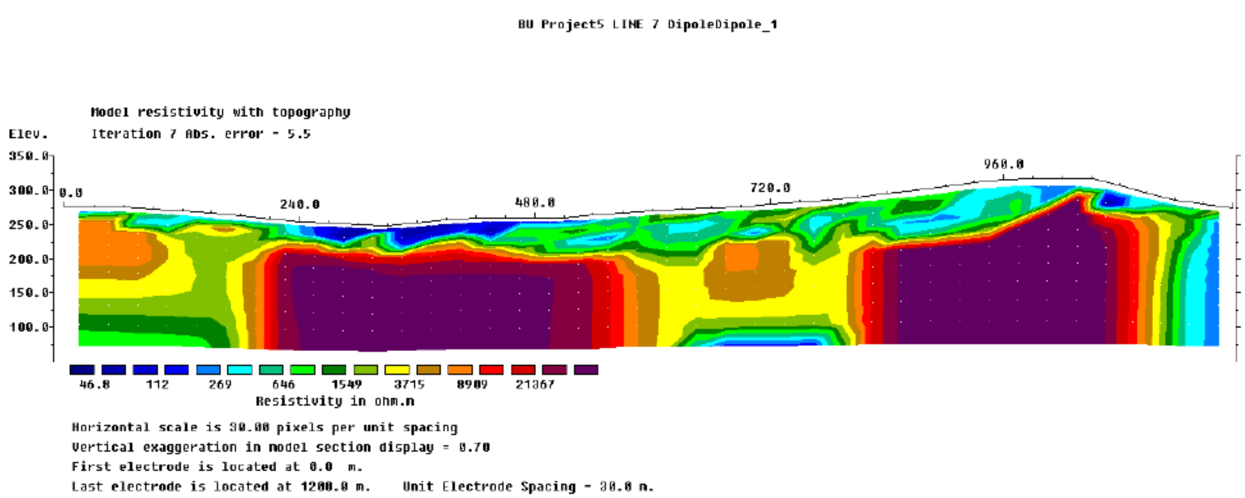


Figure 4. 7 : Resistivity model of Line 7(Asiakwa)

4.1.8 Resistivity Model Of Line 8

Fig. 4.8 is the inversion model for the resistivity distribution of line 8. A high resistivity anomaly is between 120m and 450m. Beyond 450m a less resistive anomaly is present which may indicate a different geologic body.

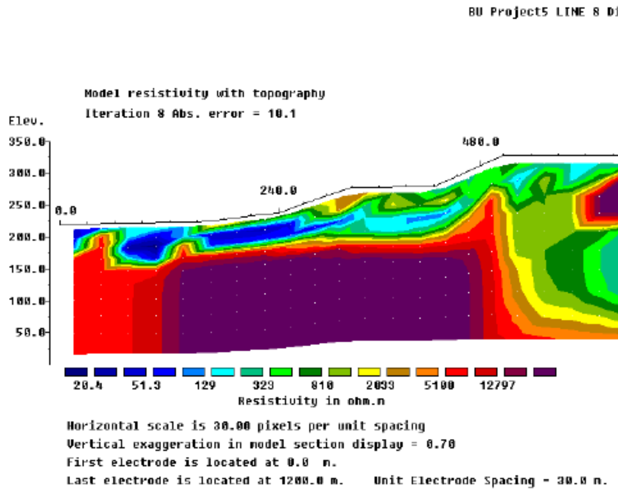
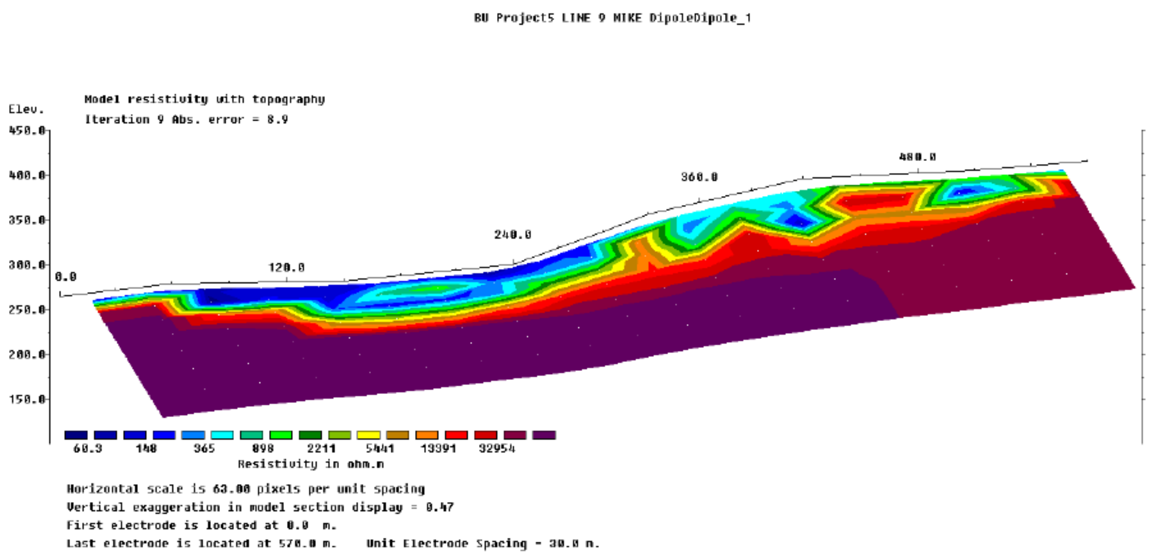


Figure 4. 8 : Resistivity model of Line 8(Hemang)

4.1.9 Resistivity Model Of Line 9



4.2 Chargeability Tomography

4.2.1 Chargeability of Line 1(Etukrom)

There is a high chargeability anomaly that extends from about 330m to 1020m. A chargeability value as high as 260 msec could be further investigated. High chargeability is closely related to sulphide accumulation which can usually hold gold. The depth of this anomalous body according to the inversion model may be about 100m to 170m. The geophysical line 1 that was surveyed at Etukrom may hold a prospect and could be investigated and possibly drilled at point A (960m) in Fig 4.9.

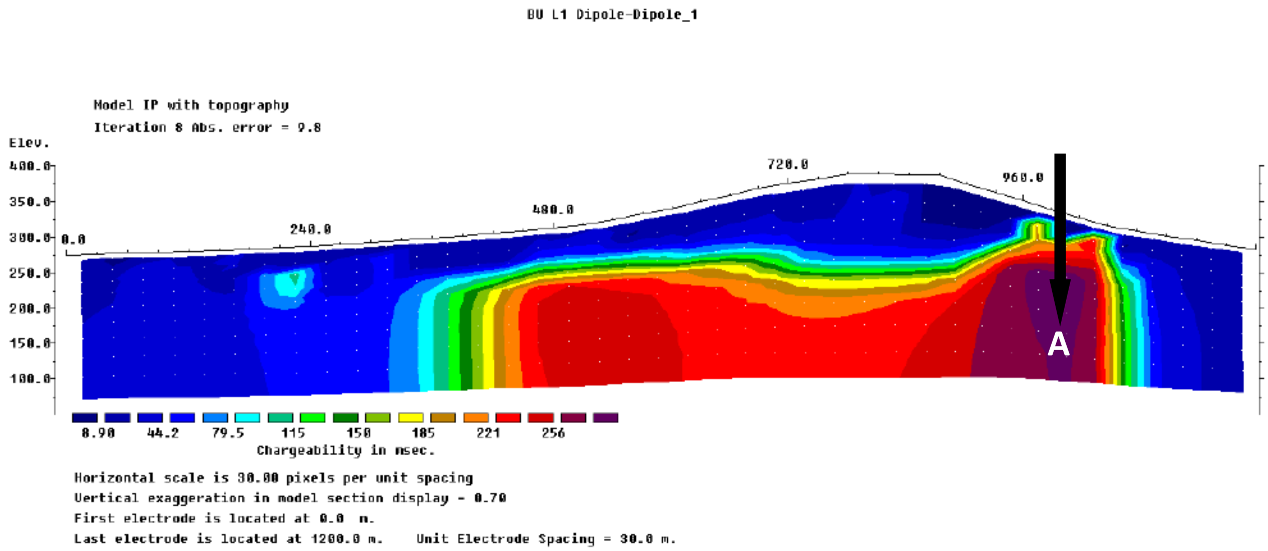


Figure 4. 9: IP Model For Line 9(Etukrom)

4.2.2 Chargeability Model of Line 2(Etukrom)

Line 2 is at the Southern part of line 1 and a high chargeability anomalous body was mapped here as well. The chargeability values indicate a possible sulphide body that suggests possible mineralisation. A high chargeability anomalous body extends from 0m and peaks at about 720m. Such a high chargeability anomaly at point A (680m) in Fig 4.10 needs further investigation and possibly drilled samples for lab analysis. The estimated depth of this anomaly is about 120m to 170m.

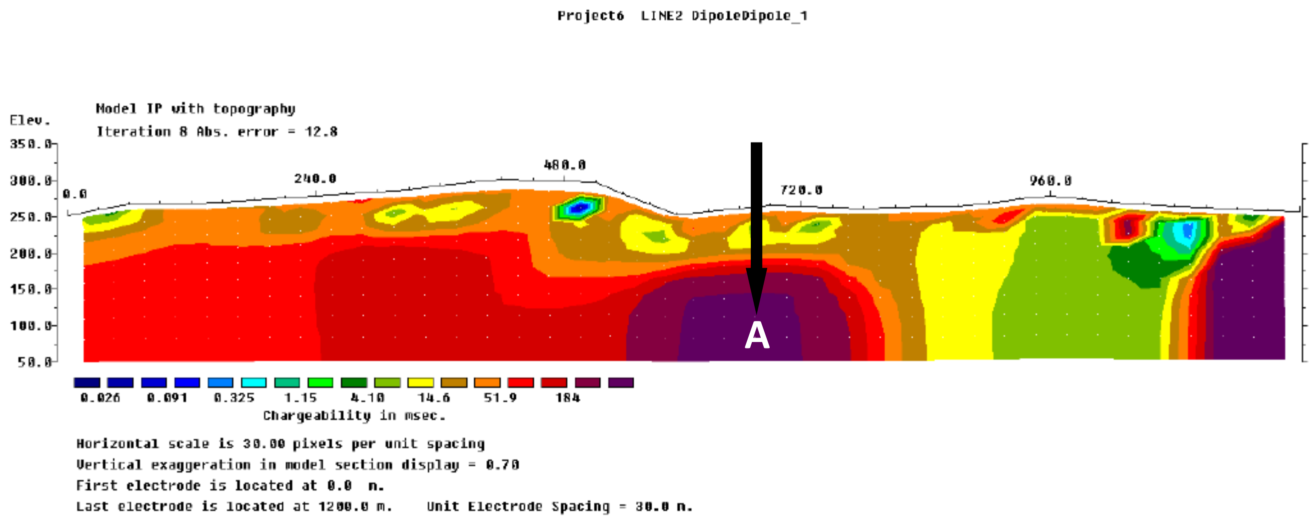


Figure 4. 10 : I.P Model For Line 2(Etukrom)

4.2.3 Chargeability Model of Line 3(Etukrom)

A relatively high chargeability anomalous body was also mapped at a depth of about 120 to 170m on this survey line. The chargeability of line 3 was not as high as the previous line (Lines 1 and 2). Further investigation could be started at 720m at point A in Fig. 4.11.

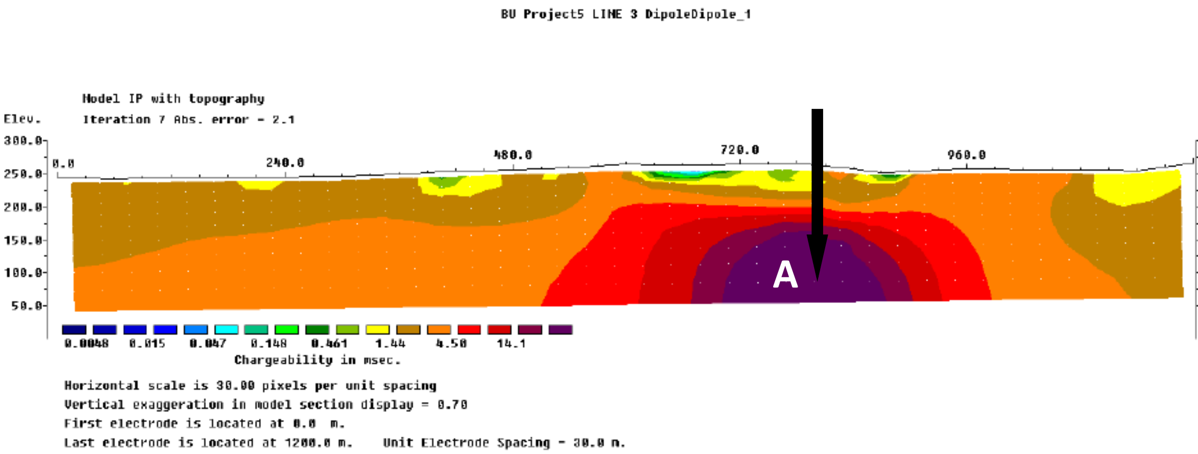


Figure 4. 11 : IP Model For Line 3(Etukrom)

4.2.4 Chargeability Model of Line 4(Kibi)

High chargeability anomalies are concentrated between 540m and 1200m on Line 4 in Fig. 4.12. This location can be investigated, and geochemical samples could be taken for Lab analysis. Chargeability values here are relatively low compared to previous lines northwards. Further geochemical and geological investigations should be made around this line to map the higher chargeability zones.

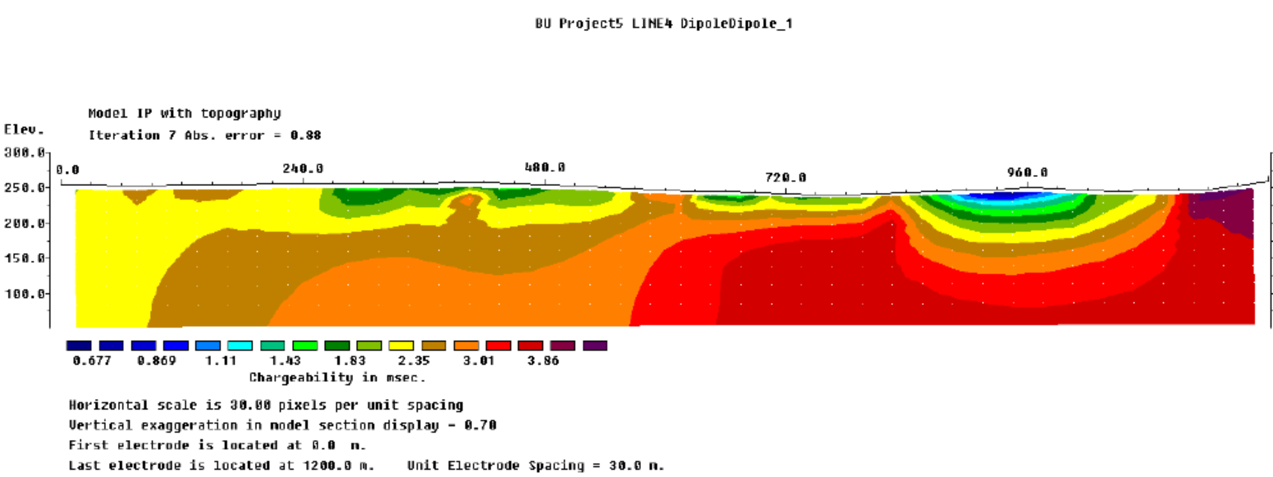


Figure 4. 12: IP Model For Line 4(Kibi)

4.2.5 Chargeability Model of Line 5(Birim)

The average chargeability values of IP anomalies in the Line 5 area are relatively high. A high chargeability anomalous body is present at 480m at a depth of about 40m. Beyond 0m, a high chargeability anomaly reveals itself and this location should be further investigated to ascertain the merging anomalous body. Further investigation or drilling may be done at 480m on Fig. 4.13.

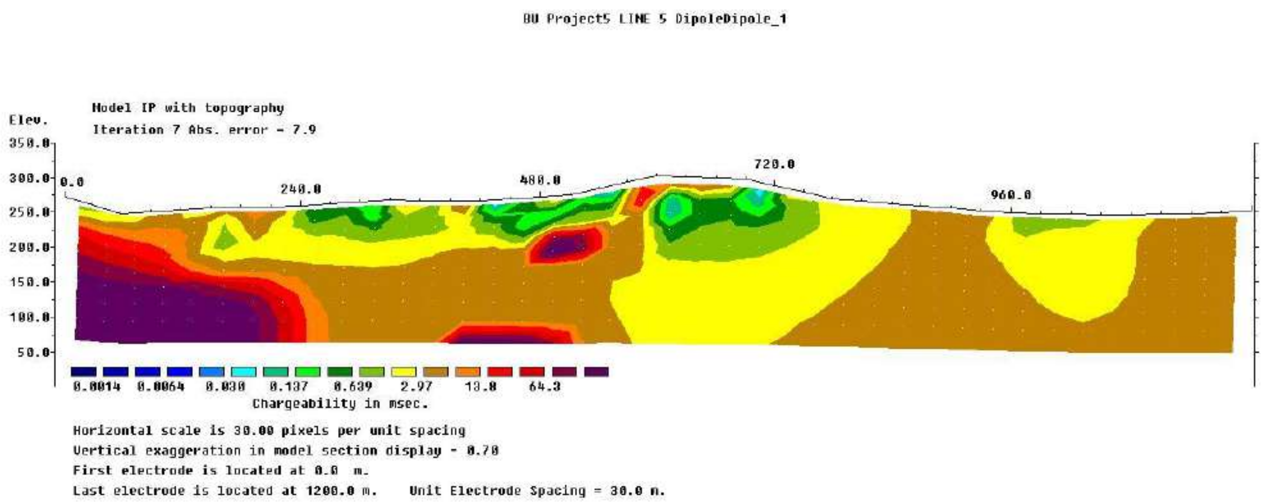


Figure 4. 13 : IP Model For Line 5(Birim)

4.2.6 Chargeability Model of Line 6(Birim)

The chargeability anomalies on Line 6(Fig. 4.14) were low and possibly might be a result of the orientation of the survey line which trends northwards along the strike of the rhyolite rock. However, a few areas of relatively high chargeability may be investigated. A second geophysical survey can be run in an east-west direction to compare current tomography.

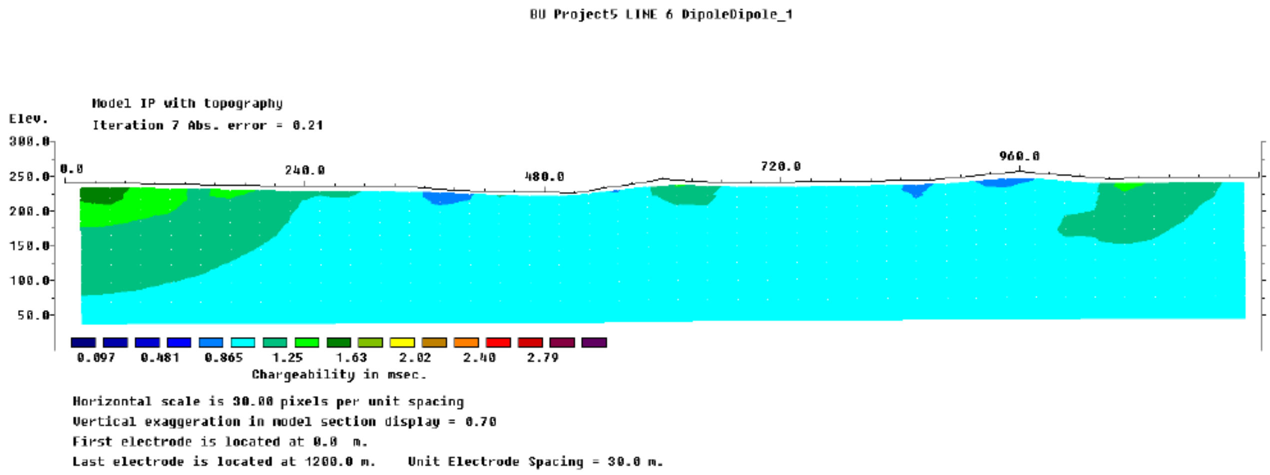


Figure 4. 14 : IP Model For Line 6(Birim)

4.2.7 Chargeability Model of Line 7(Asiakwa)

Fig. 4.15 represents the chargeability tomography of Line 7 surveyed at Asiakwa. Relatively high chargeability anomalous bodies are between 480m – 930m. The area could be geologically and geochemically investigated.

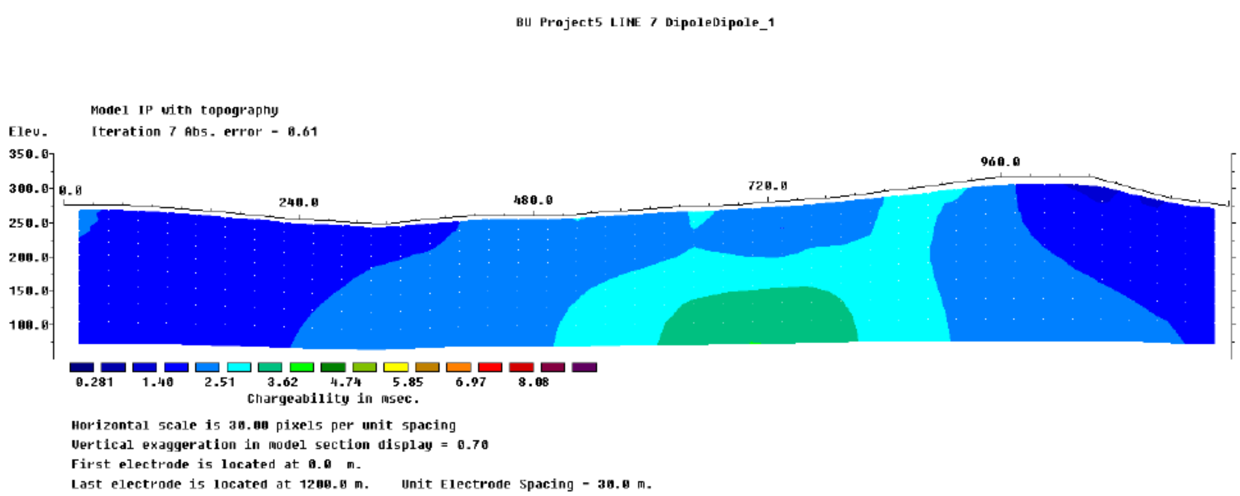


Figure 4. 15 : IP Model For Line 7(Asiakwa)

4.2.8 Chargeability Model of Line 8 (Hemang)

Line 8 was surveyed at Hemang in the northmost part of the survey area. High chargeability anomalous bodies were delineated at around 240m and 930m. At a depth of about 175m, a relatively high chargeability anomaly is also present. Geological and geochemical investigations could be made along this line. Fig 4.16 represents the chargeability tomography of Line 8.

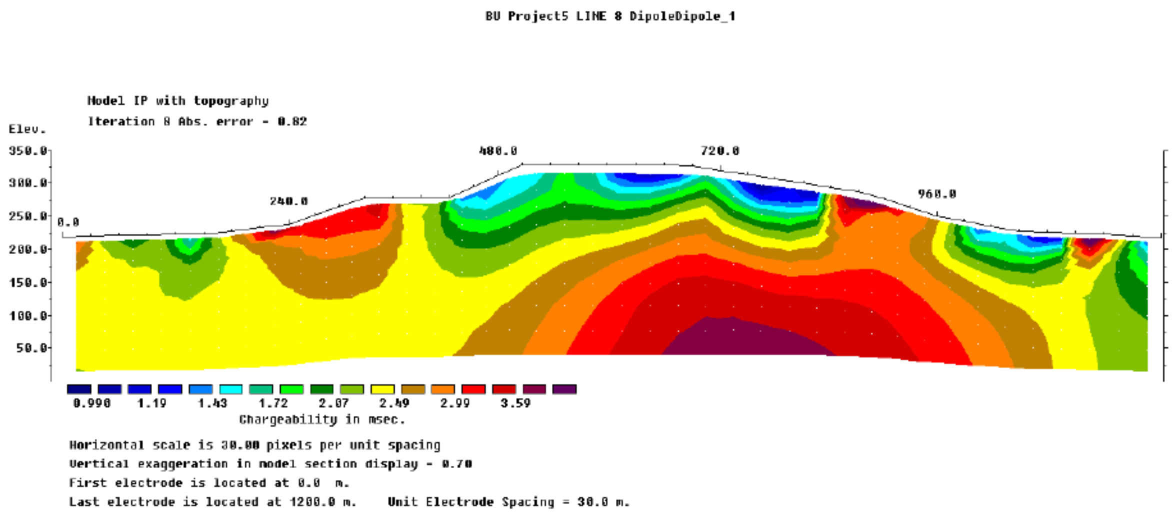


Figure 4. 16: IP Model For Line 8 (Hemang)

4.2.9 Chargeability Model of Line 9 (Bunsu)

Fig. 4.17 represents the chargeability tomography of line 9 which is about 400m north of line 1. The length of Line 9 is 600m and the chargeability values are quite low. However, chargeability seems to increase from 380m along the line. Extrapolating from Line 9, a possible high chargeability anomaly may be encountered when the survey line is extended and made to run parallel to Line 1

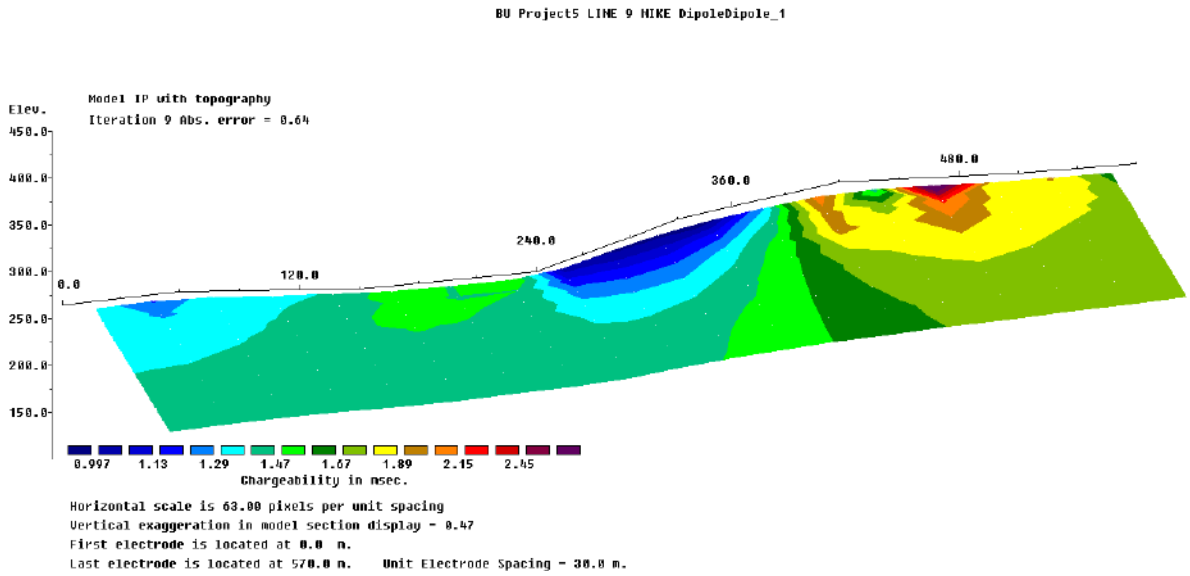


Figure 4. 17: IP Model For Line 9(Bunsu)

CHAPTER FIVE

5.0 Conclusion

The Nine (9) geophysical lines surveyed for Narawa Limited in connection with their exploratory activities were successful and yielded some good mineral exploration information. This geophysical information would aid Narawa Limited to make an informed decision on the development of the mine and its resources. A total of 10.2 km Induced Polarisation (IP) and a total of 10.2km Resistivity survey lines were run. The hard resistive geologic body is buried at a depth between 80m and 150m. The result from induced polarization indicated a good prospect that could be drilled for truthing. Results for Four (4) IP Lines suggest possible sulfide accumulation which may hold some minerals. The Five (5) remaining lines would also need geological and geochemical studies to help understand the anomalies detected.

CHAPTER SIX

6.0 Recommendation

1. Based on the results from geophysical studies, further ground studies must be conducted, and these points have been summarised in Table 2 and Table 3 in Appendix I.
2. Drilling test should be conducted on Line 1(Etukrom), Line 2 (Etukrom), Line 3(Etukrom), and Line 5 (Birim).
3. Geological and Geochemical studies should be done on Line 4 (Kibi), Line 7(Asiakwa), Line 8 (Hemang), and Line 5 (Birim)
4. Geological and geochemical studies can be done on Line 6 and another geophysical line could be conducted in the East-West Direction.

6.1 Future Geophysical Investigation

It is expected that drilling starts on geophysical lines that recorded high chargeability values. Depending on drilling results, a detailed geophysical survey would be carried out to give detailed information and delineate the full extent of the anomalous body.

APPENDIX I

Table 2 : Suggested Drilling Points

Line	Anomalous Point (m)	Estimated Depth (m)
Line 1 (Etukrom)	960	100 – 170
Line 2 (Etukrom)	720	120 – 170
Line 3 (Etukrom)	480	120 – 170
Line 5 (Birim)	480 and 60	100 - 150

Table 3 : Table: Areas For Further Investigation

Line	Point Of Interest(m)	Recommendations
Line 1 (Etukrom)	330 - 1020	Geochem/Geological Investigation or Drill
Line 2 (Etukrom)	0 - 720	Geochem/Geological Investigation or Drill
Line 3 (Etukrom)	480 -930	Geochem/Geological Investigation or Drill
Line 4 (Kibi)	540 - 1200	Geochem/Geological Investigation
Line 5 (Birim)	450 - 550 and 0 - 210	Geochem/Geological Investigation or Drill
Line 6 (Birim)	No discernible anomaly	Geophysical Survey in West-East Direction
Line 7 (Asiakwa)	480 – 930	Geochem/Geological Investigation
Line 8 (Hemang)	480 – 1140 and 180 - 390	Geochem/Geological Investigation
Line 9 (Bunsu)	360 - 600	Geochem/Geological Investigation

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