Available online at:
Al-Fiziya: Journal of Materials Science, Geophysics, Instrumentation and Theoretical Physics
Website: http://journal.uinjkt.ac.id/index.php/al-fiziya
Vol.2 No.II Tahun 2019, 102-111

IDENTIFICATION OF MINERAL POTENTIAL IN GALANG DISTRICT TOLITOLI REGENCY USING THE METHOD OF RESISTANCE AND INDUCED POLARIZATION

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Diterima: April 2019; Diperbaiki: April 2019; Disetujui: Mei 2019; Tersedia Daring: Desember 2019

Abstrak

Secara geologi, provinsi Sulawesi Tengah tersusun dari jenis batuan yang bervariasi, baik berupa batuan beku, sedimen maupun metamorf. Sehingga Provinsi Sulawesi Tengah memiliki potensi sumber daya mineral baik metal maupun non-metal yang cukup bervariasi. Meningkatnya kebutuhan dan permintaan terhadap mineral, baik metal maupun non-metal. Sehingga dilakukan penelitian yang bertujuan untuk mengetahui potensi mineral di salah satu Kabupaten yang ada di Provinsi Sulawesi Tengah. Penelitian ini dilakukan di Kecamatan Galang Kabupaten Tolitoli Provinsi Sulawesi Tengah dengan menggunakan metode resistivitas dan metode *Induced Polarization* (IP) dengan konfigurasi *Wenner- Schlumberger* yang terdiri dari 8 lintasan. Metode IP sangat akurat untuk mengidentifikasi potensi mineral yang ada di bawah permukaan. Pengolahan data dilakukan dengan proses inversi agar didapatkan bentuk pemodelan nilai resistivitas dan *chargeability* yang sebenarnya. Berdasarkan pemodelan, potensi mineral yang ada di Kecamatan Galang Kabupaten Tolitoli Provinsi Sulawesi Tengah hampir ditemukan di seluruh lintasan yaitu lintasan 01;02;04;05;06;07. yang ditandai dengan nilai *chargeability* yang sangat tinggi berkisar antara 300 msec – 500 msec. Daerah penelitian juga didominasi oleh batuan granit dan andesit yang memiliki nilai resistivitas yang tinggi yaitu berkisar antara 2000 Ωm – 400000 Ωm.

Kata Kunci*: Chargeability, Induced Polarization, Metode Resistivitas, Mineral, Wenner-Schlumberger.*

Abstract

Geologically, the province of Central Sulawesi is composed of various types of rocks, both in the form of igneous, sedimentary and metamorphic rocks. Regarding Central Sulawesi Province, mineral resources both metal and non-metal are quite varied. Increasing demand and demand for minerals, both metals, and non-metals. Research conducted to study the mineral potential in one of the regencies in Central Sulawesi Province. This research was conducted in Galang Sub-district, Tolitoli Regency, and Central Sulawesi Province by using the resistivity method and the Induced Polarization (IP) method with the Wenner-Schlumberger arrangement consisting of eight lines. The IP method is very accurate to discuss the potential of minerals that are below the surface. The inversion process does data processing in order to obtain the actual form of resistivity and chargeability modeling. Based on the modeling, the mineral potential in Galang Sub-district, Tolitoli Regency, Central Sulawesi Province is mostly found in all trajectories namely lane 01; 02; 04; 05; 05; 06; 07. Which is marked by a very high chargeability value between 300 msec - 500 msec. The research area also discusses granite and andesite, which have high resistivity values, between 2000 Ωm – 400000 Ωm.

P-ISSN: 2621-0215, E-ISSN: 2621-489X

***Keywords**: Chargeability, Induced Polarization, Mineral, Resistivity Method, Wenner-Schlumberger.*

INTRODUCTION

In Indonesia, the potential for mineral resources is very abundant, according to the Ministry of Energy, Mineral Resources in 2018 there are 2,100 locations of potential metal mineral resources, and there are 3,663 locations of potential non-metallic mineral resources[1]. Based on data on the regional potential of the mining and energy sector in the Central Sulawesi provincial government there are many mineral potentials owned, namely Nickel with estimated reserves of 8,000,000 tons, Galena of 100 million tons, Gold 16 million tons, Molybdenum 18 million tons, it also has a potential of Feldspar reserves of 71,211,000 m^3 and many more mineral potentials that are scattered in several regencies in Central Sulawesi Province.

At the research location, Tolitoli Regency has quite a lot of mineral potentials, such as Galena, Zinc, Molybdenum, Copper, Gold, Granite, and Feldspar Sand. The minerals found in Tolitoli Regency include metal minerals such as molybdenite, gold, and lead. While non-metallic minerals consist of granite [2].

Therefore, based on the mineral potential in Tolitoli Regency, a survey was conducted to determine the distribution of minerals found in the Tolitoli Regency, especially in Galang District. The method used is an active geophysical method where measurements are made using artificial sources so that the response arises as a parameter to be measured.

One active geophysical method used is the geoelectric method. The geoelectric method used in this study is the resistivity method and the Induced Polarization (IP) method with the Wenner-Schlumberger configuration.

This study aims to make 2-Dimensional modeling and interpretation of resistivity and IP cross-sections so that the potential distribution of minerals can be identified at the research location, namely in Galang District, Tolitoli Regency, Central Sulawesi Province.

Geology Research Area

Sulawesi is a complex area due to the meeting point of three large plates namely the Indo-Australian plate which moves northward, the Pacific plate which moves westward, and the Eurasian plate which moves south-southeast and the smaller ones, the Philippine plate [3].

Based on the geological map of Tolitoli sheet, stratigraphy and lithology of the rocks making up this region based on the youngest to the oldest age, it consists of Alluvium (Qal), Reef Limestone (Ql), Granite Frozen Rock (Qtv), Sea Sedimentary Rocks (Tms), Tinombo Formation (Tts), Volcanic Rocks (Ttv), and Metamorphic Rock Complex (km). In the study area, there are several rock units namely; volcanic rocks (Ttv) whose lithology is andesite or basalt and breakthrough rock formations (gr) in the form of granite intrusion rocks [4].

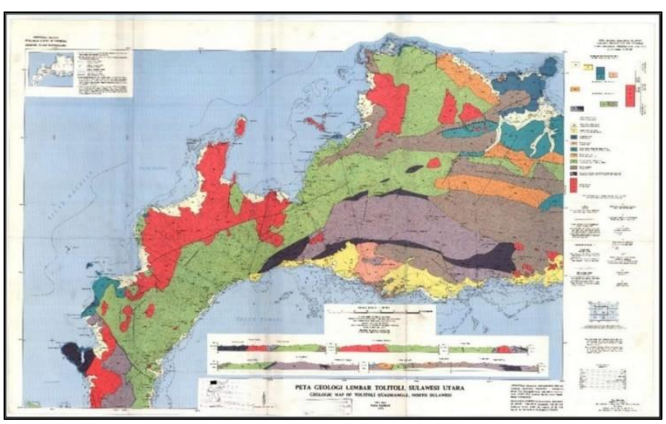

Figure 1. Geological Map of Tolitoli[4].

Resistivity Method

The resistivity method is used in the study of electrical properties of soils and in the detection of objects based on anomalies of electrical conductivity below the surface. In the geoelectric method, low-frequency direct current (DC) or alternating current (AC) is introduced into the ground by using two current electrodes (C1, C2) that are connected to the source terminal on the device. The distribution of the potential generated on the ground is mapped using two potential electrodes (P1, P2). So as to produce information about the distribution of electrical resistivity below the surface. The basic concept of this method is Ohm's law in which there is a

relationship between electric current (I) and potential difference (V), which can provide resistance values in a medium, formulated as follows[5].:

$$\rho = K\frac{\Delta V}{I} \tag{1}$$

Where K is a geometry factor whose magnitude depends on the electrode arrangement, the electrode arrangement or the configuration used in this study is the Wenner-Schlumberger configuration.

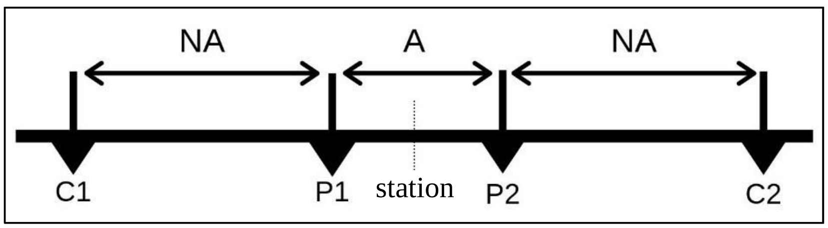

Figure 2. Wenner-Schlumberger Configuration Electrode Arrangement

The distance between the potential electrodes is A and the distance between the current electrode and the potential electrode is NA so that the distance between the electrodes is constant. Has a geometric factor value of:

$$K = \pi \times N(N+1) \times A \tag{2}$$

Induced Polarization Method

The Induced Polarization method is very sensitive to the conductive material. Induced Polarization geoelectric method utilizes capacitive subsurface values to find zones where conductive minerals are scattered in their host rocks [6].

The principle of measuring the Induced Polarization method is that when the current is injected and then turned off, the voltage between the potential electrodes does not immediately become zero, this is because the medium below the surface will temporarily store electrical energy and will be released again, or in other words the medium in subsurface will act as a capacitor. Therefore, even if the current is cut off, the voltage will gradually drop to zero with time. This effect is called Induced Polarization or impact polarization [7].

The parameter obtained is the value of chargeability (M) in units of milliseconds (msec).
Chargeability is defined as:

$$\mathrm{M} = \frac{\mathrm{A}}{\Delta Vc} = \frac{1}{\Delta Vc}\int_{t_1}^{t_2} V(t)dt \tag{3}$$

METHODS

This research was conducted in Galang Sub district, Tolitoli Regency, Central Sulawesi Province using the resistivity method and the Induced Polarization (IP) method with a Wenner-Schlumberger configuration. The measurement points in the survey consisted of 2 research blocks where each block contained 4 lines with a length of ± 235 m each and an electrode spacing of 5 m. In this study, several steps are carried out, as follows:

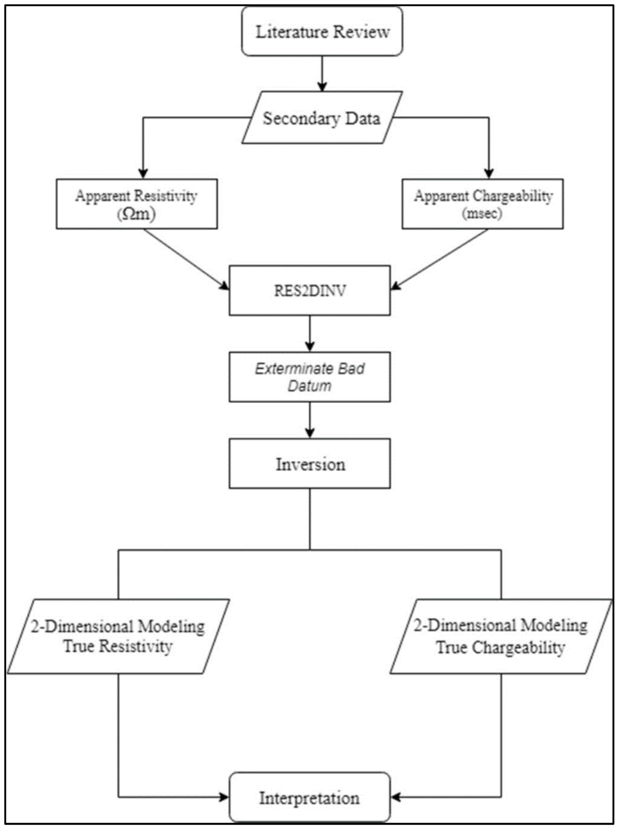

Figure 3. Research Stages

Data processing is performed using RES2DINV software to obtain a 2-Dimensional modeling of true resistivity data and true chargeability data so that it can be analyzed regarding the potential presence of minerals on each track. The 2-Dimensional modeling will be visualized in the form of 3-Dimensions to be able to analyze the pattern of the distribution of mineralized zones in each study block.

Interpretation of the existence of mineral potential in the study area is done by correlating the results of data processing with geological information in the form of resistivity and chargeability reference table and geological map of the study area. Indications of the potential for minerals in each track are indicated by high chargeability values and low resistivity values [8].

RESULTS AND DISCUSSIONS

The modeling results describe a cross-section with a track distance of ± 220 m and with depth reaching ± 46 m. This cross-section illustrates the distribution of resistivity value of subsurface rocks and illustrates the distribution of subsurface chargeability values. Chargeability indicates the ability of rocks below the surface to store electric current while resistivity indicates the ability of electrical conductivity contained in these rocks. The range of resistivity values of all trajectories ranges from 3.33 Ωm - 377971 Ωm while the chargeability values range from 16 msec - 464 msec.

The following are interpretations of each measuring track, starting from 01 - 08.

Interpretation of Line 01

In cross-section 01, the topographic shape on the track illustrates that the morphology is in the form of plain. From the IP section it can be seen that the value of the high chargeability distribution ranges from 60 msec to 90 msec, when correlated with the resistivity cross-section there is an indication of the presence of minerals with rocks of low resistivity value.

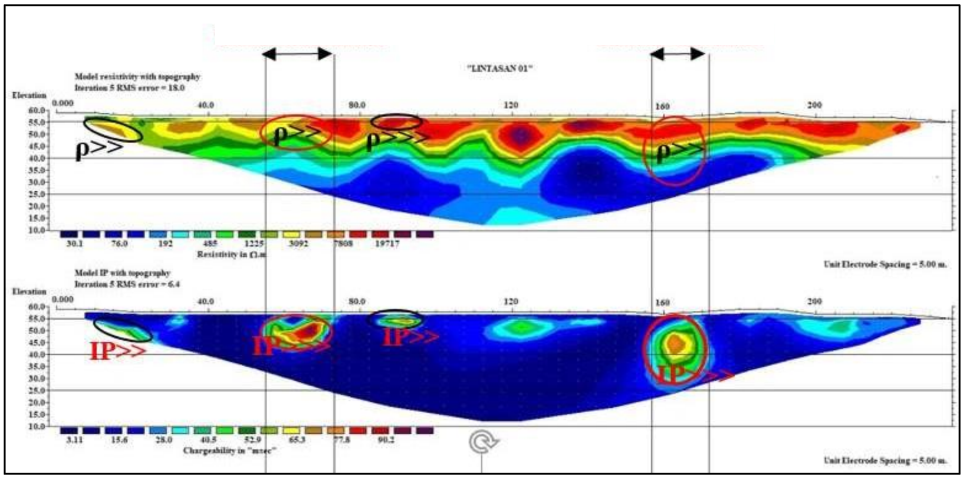

Figure 4. Interpretation of Line 01

Table 1. Potential Distribution of Mineral Line 01

Distance (m)	Depth (m)	Chargeability	Resistivity	Mineral Indication	Forming Rock	Mineral
10 – 25	5 – 12	Middle	High	Low	Andesite alliterated	Non-Metal
55 – 70	12 – 20	High	Middle	High	Sedimentary rocks	Metal
85 - 95	2 - 6	Middle	High	Low	Andesite	Non-Metal
160 - 170	12 – 20	High	Middle	High	Sedimentary rocks	Metal

Interpretation Line 02

This line is right at the foot of the hill, it can be seen from the shape of the higher topography in the west and the plains in the east. From the IP section it can be seen that the value of the high chargeability distribution ranges from 30 msec - 40 msec, when correlated with the resistivity cross-section there is an indication of the presence of minerals with rocks of low resistivity value.

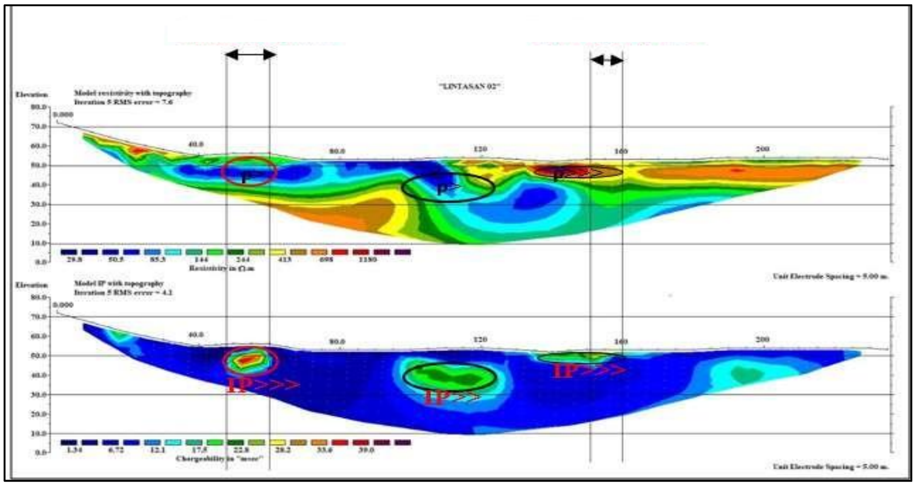

Figure 5. Interpretation of Line 02

The following is a table of mineral potentials in line 02:

Table 2. Potential Distribution of Mineral Line 01

Distance (m)	Depth (m)	Chargeability	Resistivity	Mineral Indication	Forming Rock	Mineral
50 – 60	6 – 15	High	Low	High	Clays	Metal
100 – 120	12 – 25	Middle	Low	Middle	Clays	Non-Metal
140 – 160	1 – 7	Middle	High	Middle	Granite	Non-Metal

Interpretation Line 03

Lane 03 is at the foot of the hill with its flat morphology, from the IP cross-section there is no visible mineral distribution, which is indicated by high chargeability values. Therefore, this track does not indicate the presence of minerals.

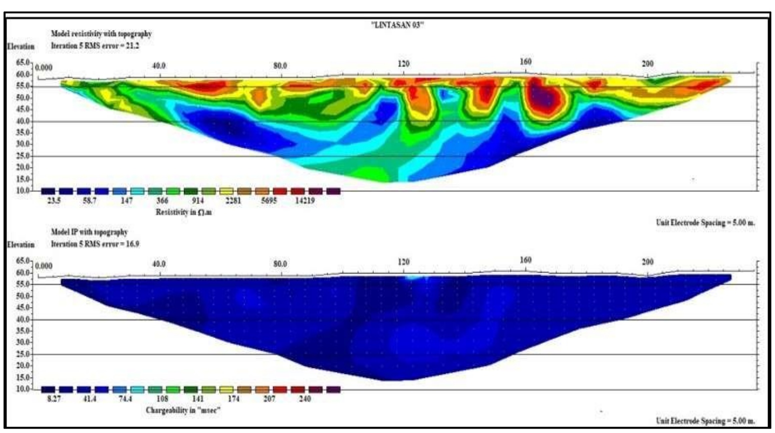

Figure 6. Interpretation of Line 03

Interpretation Line 04

Judging from the shape of the topography of this pathway has a morphology in the form of undulating hills. From a cross-section of IP chargeability, correlate high dispersion value looks that ranged from 26.8 msec – 37.1 msec, if the cross-section of the resistivity is obtained with indication of the existence of the mineral rock with low resistivity value.

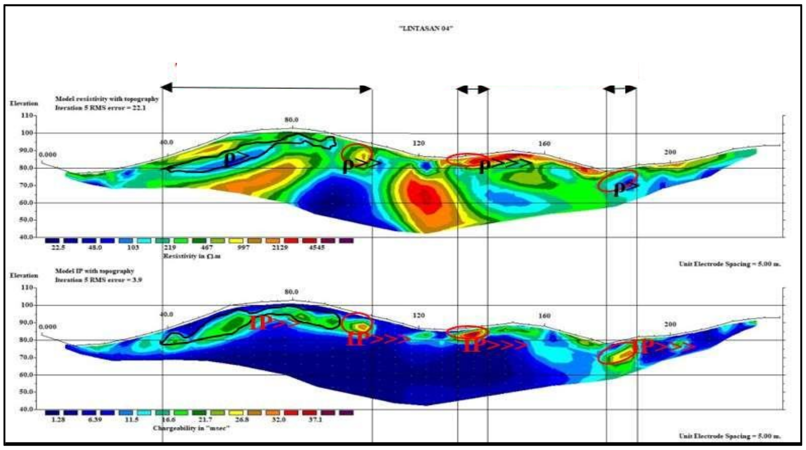

Figure 7. Interpretation Line 04

Table 1. Potential Distribution of Mineral Line 04

Distance (m)	Depth (m)	Chargeability	Resistivity	Mineral Indication	Forming Rock	Mineral
40 – 90	5 – 15	Middle	Low	Low	Clay	Non-metal
100 – 105	6 – 10	High	High	High	Andesite	Metal
125 – 135	5 – 10	High	High	High	Andesite	Metal
180 – 190	6 – 15	High	Low	High	Clay	Metal

Interpretation Line 05

Line 05 is an increasingly uphill in the hills, as seen from the cross-sectional indication IP mineral presence exists only in one location and at that location indication of vast grounds are very weak, characterized by having a value of chargeability are namely Ωm 208 – 336 Ωm and low resistivity value i.e. 6.44 Ωm – 26.5 Ωm. This mineral as they would non-metal minerals in wet rocks (clay) at a distance of 120 m – 90 m with a depth of approximately 45 m.

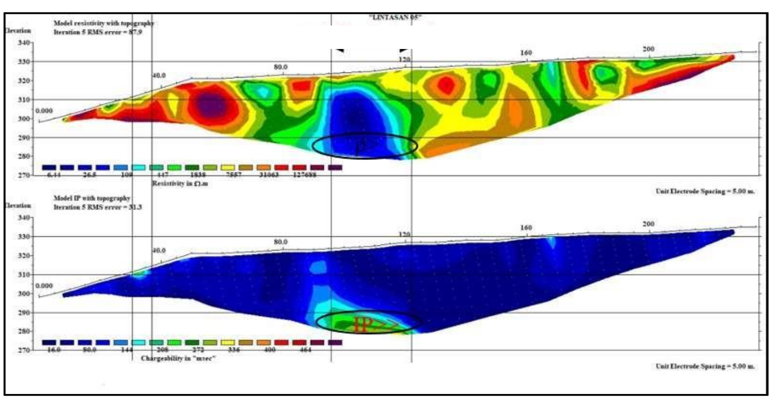

Figure 8. Interpretation of Line 05

Interpretation Line 06

Judging from the shape of the topography of this path has the morphology of the form level ground which has a basin in the middle of the path. From a cross-section of IP chargeability high dispersion value looks that ranged from 147 msec – 203 msec, if the cross-section of the resistivity is obtained be correlated with indication of the existence of the mineral rock with low resistivity value.

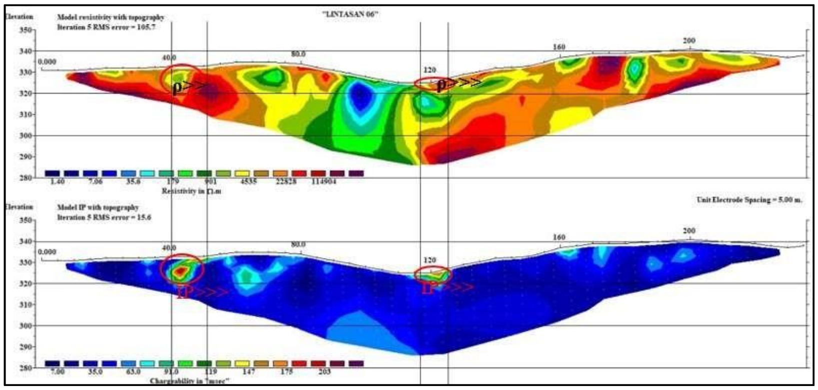

Figure 9. Interpretation of Line 06

Table 2. Potential Distribution of Mineral Line 06

Distance (m)	Depth (m)	Chargeability	Resistivity	Mineral Indication	Forming Rock	Mineral
40-50	6-12	High	Middle	High	Sedimentary	Metal rocks
120-125	1-5	High	High	High	Granite	Metal

Interpretation Line 07

Judging from the shape of the topography of this path at the foot of the Hill to the East. From a cross-section of IP chargeability, correlate high dispersion value looks that ranged from 204 msec – 236 msec, if the cross-section of the resistivity is obtained with indication of the existence of minerals with low resistivity value rocks.

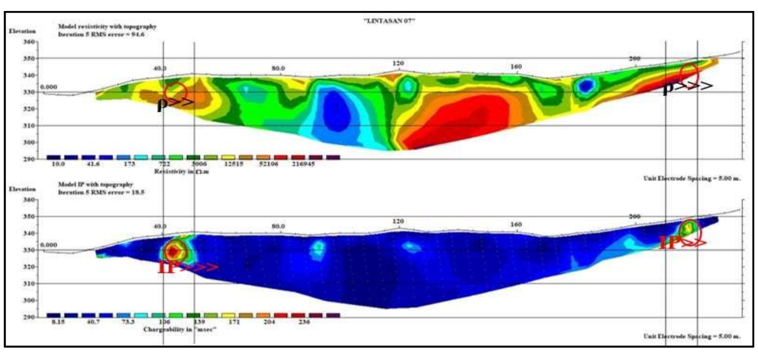

Figure 10. Interpretation of Line 07

Table 3. Potential Distribution of Mineral Line 07

Distance (m)	Depth (m)	Chargeability	Resistivity	Mineral Indication	Forming Rock	Mineral
40-50	6-12	High	Middle	High	Sedimentary	Metal rocks
215-220	6-15	High	High	High	Granite	Metal

Interpretation Line 08

Line 08 is located in the foothills with his flat morphology. From a cross-section of IP invisible existence of distribution of minerals, indicated by the value of the chargeability high. Therefore, on this path they would not the presence of minerals.

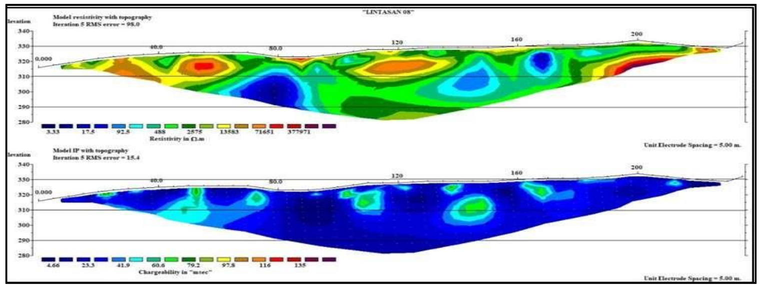

Figure 11. Interpretation of Line 08

Mineral Spread Patterns

In the analysis of mineral distribution patterns in the study area, several allegations of the distribution of mineralized zones can be seen at several points. Where there is a continuity of mineralized zones between tracks that are facing each other. Continuity is directed from north to south with the assumption that the distance of continuity is around ± 50 m. However, the estimated distribution of this mineralized zone can be optimized with closer geoelectric measurements on each trajectory, so that the mineralization zone will be clearly visible.

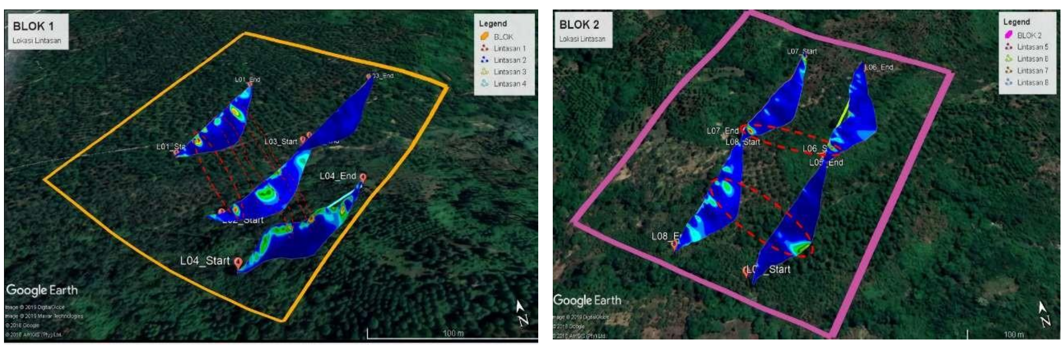

Figure 12. Spread Pattern of Mineralization Zones Block 1 (Left) Block 2 (Right)

CONCLUSION

Based on the results of the analysis and interpretation through 2-Dimensional modeling that has been correlated with the resistivity and chargeability values in the cross-section as well as with other geological information, it can be concluded as follows:

1. The identification of mineral potential is based on a low resistivity value of <300 μm and a high chargeability value of> 350 msec. The mineral potential was found in trajectories 01, 02, 04, 05, 06, 07. While in trajectory 03 and trajectory 08 there was no indication of mineral potential, because in this track there was no high chargeability value, so no mineral presence was identified.
2. Based on the fence diagram analysis pattern for estimating the mineral distribution, there is the continuity of the mineralized zone in block 1 and block 2 of the study area vertically from north to south on the crossing track, and horizontally from west to east on track 04.

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