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IDENTIFICATION OF SUBSURFACE SOIL LAYERS USING GEOELECTRIC METHOD IN ENVIRONMENT 2 OF RIANIATE VILLAGE TAPANULI SELATAN REGENCY

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ABSTRACT
A research on the identification of subsurface layers using the schlumberger configuration geoelectric method has been carried out on the coast of Lake Siais Environment 2, Rianiate Village, South Tapanuli Regency. With the aim of knowing the identification of subsurface layers, rock types, resistivity values, 2D contour cross section using Res2DinV software and the relationship of the resistivity value of the subsurface layer with climatology data. The results collected on 3 tracks with a length of 155m have a resistivity value of 133Ωm – 3389Ωm on the first track, the second track has 140Ωm - 2768Ωm and the third track 705Ωm - 4358Ωm. The results were processed by Res2DinV software to obtain a 2D cros section. As for the relationship of field data to BMKG data, rainfall has decreased from the last five years from 3744 mm – 3534 mm/year, humidity has decreased by 0,01762% each year, air temperature has increased by 0,09270 ^{0}C. From these results, resulting in changes in resistivity value in the subsurface.

Keywords: Schlumberger Geoelectrical Configuration, Resistivity Value, Res2DinV, Climatology

INTRODUCTION

Tapanuli Selatan Regency is one of the regencies in North Sumatra Province, Indonesia, with Sipirok as its capital. The regions that have separated from Tapanuli Selatan Regency are Mandailing Natal, Padang Sidempuan City, Padang Lawas Utara, and Padang Lawas Selatan. The area of Tapanuli Selatan Regency is 379,326 hectares, with an elevation ranging from 0 to 1,985 meters above sea level. This regency has tourist attractions, including Lake Marsabut, Lake Siais, and Simatutung Waterfall (Pokja, 2016).

The Tapanuli Selatan region has an average temperature ranging from 18.4^{o}C to 28.8^{o}C, with an average monthly humidity of 83% (Suheri, 2021). The rainfall in Tapanuli Selatan Regency tends to be irregular each year. In December, the highest rainfall occurs (189.57 mm), while the lowest is in April (47.29 mm) (Central Statistics Agency, 2020).

The Geoelectric Method (resistivity) is a geophysical technique used in mineral resources, geothermal energy, and water supply reserves. This configuration is designed to provide subsurface information with electrical conductivity anomalies (Kadri et al., 2019).

Geoelectric measurements using the Schlumberger configuration are conducted similarly to the Wenner configuration; however, the current electrode spacing can be different from the potential electrode spacing. The resistivity values from the Schlumberger configuration can range from 1/3 to 1/5. The Schlumberger configuration is used for sounding, which involves data collection focused vertically (Hidayat et al., 2013).

The weakness of the Schlumberger configuration is that the voltage reading at electrodes M and N is lower, especially when the distance AB is relatively far. Therefore, a multimeter with 'high impedance' characteristics and high accuracy is required, capable of displaying voltage with at least 4 digits or 2 digits after the decimal point. Alternatively, it is necessary to use a current transmitter that provides very high DC voltage.

The advantage of the Schlumberger configuration is its ability to detect the non-homogeneity of rock layers at the surface by comparing the apparent resistivity values when there is a change in the electrode spacing MN/2. The Schlumberger configuration can produce smoother graphical curves from the segments of each point combined, even when the distances between M and N are increased (Sedana et al., 2015).

The Schlumberger configuration uses a system of constant spacing rules, with the factor 'n' representing the ratio of the distance between electrodes C1-P1 and C2-P2 to the spacing between P1-P2. If the distance between the potential electrodes (P1 and P2) is 'a,' then the distance between the current electrodes (C1 and C2) is 2na + a. The process of determining resistivity uses four electrodes placed in a straight line (Nengga et al., 2018).

Therefore, the research site is located on the shores of Lake Siais in Environment 2 of Rianiate Village, Tapanuli Selatan Regency, to determine the conditions of the subsurface layers located along the shores of Lake Siais. The method used to identify the subsurface soil layers is the geoelectric method with the Schlumberger configuration, which aims to produce a contour map of the area along the shores of Lake Siais in Tapanuli Selatan Regency.

Research related to the analysis of subsurface soil layers using the geoelectric method was conducted by Rita Juliani et al. (2015) on the use of resistivity geoelectricity to identify the subsurface structure of rocks between Lau Ketuken and Lau Bekerah in Sulkam Village, Langkat Regency. Additionally, a study by Setia Ningsih and Motlan (2020) focused on the identification of subsurface layers at archaeological sites using the Schlumberger geoelectric configuration method in Lobu Tua Village, Tapanuli Tengah Regency.

RESEARCH METHOD

This research was conducted on the shores of Lake Siais in Environment 2 of Rianiate Village, Tapanuli Selatan Regency.

Figure 1. Research location map

In conducting the measurement to identify the subsurface soil layers, the method used was a set of geoelectric equipment ARES-G4 v4.7, SN: 06091435 (Automatic Resistivity System), 32 electrodes, and a GPS (Global Positioning System), which is a device used to determine position based on satellite monitoring results.

The data collection process was carried out using a resistivity meter. With the Schlumberger configuration, each current electrode (C1-C2) and potential electrode (P1-P2) is injected into stakes that have been adjusted according to the electrode configuration used. Then, the current electrodes (C1-C2) and potential electrodes (P1-P2) are connected to their respective terminals on the resistivity equipment.

Before data collection, the steps taken included determining 3 data collection lines and identifying the survey area position using GPS. Then, measurements were taken for the distance between the electrodes at (5 meters) and the length of the line at 155 meters.

The method of data collection in geoelectricity is as follows

a. Download the data from the ARES-G4 v4.7 geoelectric system, SN: 06091345.
b. The data obtained using Res2Dinv software.
c. Distinguish the resistivity values based on color and geological data to observe the resistivity values along the 2D cross-section of the line.
d. After obtaining the resistivity data from the subsurface layers, this data is then correlated with the climatological data obtained from the Meteorology, Climatology, and Geophysics Agency (BMKG). Based on the 2D cross-section results, changes in resistivity values influenced by climatological data can be observed.

Below is the flow diagram of the research using the geoelectric method with the Schlumberger configuration.

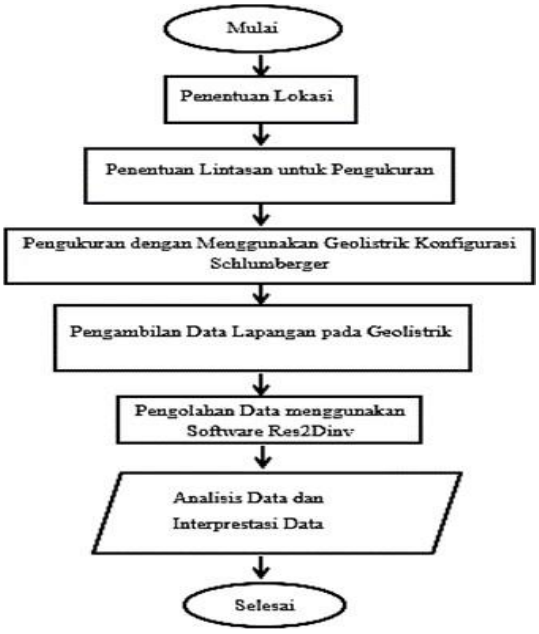

Figure 2. Flow Diagram of research using the Geoelectric Method with Schlumberger Configuration

RESULT AND DISCUSSION

1. Identification of subsurface layers

Based on the results of the resistivity values of the subsurface material obtained using the geoelectric method with the Schlumberger configuration along a line length of 155 meters, using 32 electrodes spaced 5 meters apart, and the coordinate position data along with the elevation values of the three lines obtained using GPS (Global Positioning System), the results are as follows

a. First line

The coordinate position of the first line is located at Lat: 1.303662 and Log: 99.014532 with an elevation of ± 24 meters above sea level (mdpl). Based on the 2D cross-section results of the first line, the resistivity values range from 133 Ωm to 3389 Ωm at depths of 1.25 meters to 31.3 meters. The first line consists of several types of materials, namely sand, alluvium, and sandstone.

The identification of the subsurface layers based on depth can be described as follows: at depths of 10 meters to 20 meters, there is sand material with resistivity values ranging from 133 Ωm to 532 Ωm. At depths of 0 meters to 12.5 meters, there is alluvium with a resistivity value of 846 Ωm, and at depths of 1.25 meters to 26.2 meters, there is sandstone material with resistivity values ranging from 1343 Ωm to 3389 Ωm.

b. Second line

The coordinates of the second trajectory are located at Lat: 1.303699 and Log: 99.014038, with an elevation of approximately 25 meters above sea level. Based on the results of the 2D cross-section of the second trajectory, the resistivity values range from 140 Ωm to 2768 Ωm. This second trajectory consists of materials including sand, alluvium, and sandstone.

The identification of the subsurface layers based on depth can be described as follows: at a depth of 0 meters to 12.5 meters, there is sandstone with a resistivity value of 1180 Ωm to 2768 Ωm. At a depth of 0 meters to 20 meters, there is alluvium with a resistivity value of 770 Ωm, and at a depth of

20 meters to 30 meters, there is sand with a resistivity value of 140 Ωm to 503 Ωm.

c. Third line

The coordinate position of the third line is at Lat: 1.303436 and Log: 99.013832 with an elevation of approximately 30 meters above sea level. Based on the results of the 2D cross-section of the third line, the resistivity values range from 705 Ωm to 4358 Ωm. This third line is composed of materials including alluvium and sandstone.

The identification of the subsurface layers based on depth can be described as follows: at a depth of 0 meters to 30 meters, there is sandstone with a resistivity value of 914 Ωm to 4538 Ωm, while at the same depth of 0 meters to 15 meters, there is alluvium with a resistivity value of 705 Ωm.

2. 2D cross-section results using Res2Dinv

To comprehensively understand the types of materials and the variations in resistivity values contained in the subsurface layers of the three profiles, the data can be processed using a color scale method with Res2DinV software in the form of a 2D cross-section. The initial step using Res2DinV involves inputting the ARES Resistivity Meter data from the .dat file into Res2DinV. Next, in the software, select the 'Read Data File' menu to read the data. The following step is to choose the 'Last Square Inversion' menu to obtain the 2D cross-section data inversion. The final step is to select the 'Bad Datum Point' menu to reduce error values. Below are the 2D cross-section results of the three profiles.

a. 2D Cross-section of the first line

The structure of the subsurface layers of the first profile underwent 3 iterations with an error value of 17.8%. The resulting 2D cross-section can be seen in Figure 3 below.

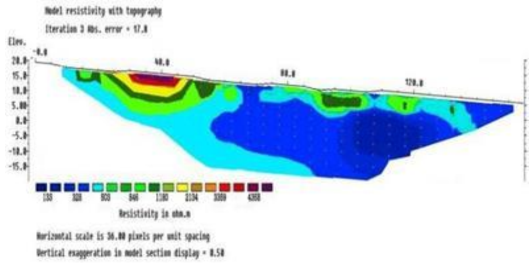

Figure 3. 2D cross-section of the first line

From the 2D cross-section results in Figure 3, the resistivity values range from 133 Ωm to 3389 Ωm. The blue color represents sand, with a resistivity value of 133 Ωm to 532 Ωm at depths of 0 m to 30 m. The green color indicates alluvium, with a resistivity value of 846 Ωm, found at depths of 0 m to 12.5 m. Additionally, the resistivity values of 1343 Ωm to 3389 Ωm, found at depths of 1.25 m to 26.2 m, correspond to sandstone, as shown in yellow, orange, red, and purple.

b. 2D cross-section of the second line

The structure of the subsurface layers in the second trajectory underwent 4 iterations with an error value of 5.3%. The resulting 2D cross-section can be observed in Figure 4 below.

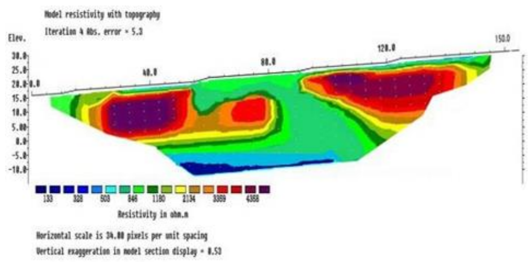

Figure 4. 2D cross-section of the second line

From Figure 4, it can be explained that the resistivity values ranging from 140 Ωm to 503 Ωm at a depth of 25 m to 30 m indicate the presence of sand, shown in blue. The green color, with a resistivity value of 770 Ωm at a depth of 0 m to 20 m, indicates alluvium. Additionally, at a depth of 0 m to 12.5 m, the yellow, orange, red, and purple colors represent sandstone.

c. 2D cross-section of the third line

The structure of the subsurface layers in the third path underwent 4 iterations with an error value of 14.7%. The results of the 2D cross-section can be seen in Figure 5 below.

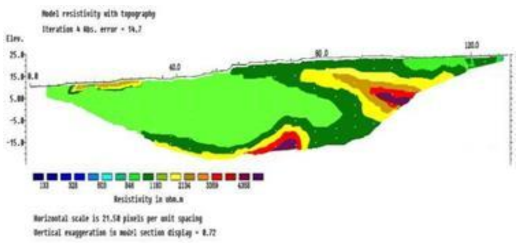

Figure 5. 2D cross-section of the third line

Dilihat dari gambar 5 pada nilai resistivitas 705 Ωm pada kedalaman 0 m – 15 m yang ditunjukkan dengan warna hijau tua dan hijau muda menghasilkan alluvium. Terdapat pada warna hijau, kuning, orange, merah dan ungu, dengan kedalaman 0 m – 2,5 m,5 m – 10 m dan 20 m – 30 m pada nilai resistivitas berkisar 914 Ωm – 4358 Ωm menghasilkan batu pasir.

CONCLUSION

Based on the results obtained using the geoelectric method with the Schlumberger configuration in the Tapanuli Selatan region, it can be concluded that the results of the identification of the subsurface layers reveal three lines with different resistivity values. In the first line, the resistivity ranges from 133 Ωm to 3389 Ωm. Several types of rocks in this first line are dominated by layers estimated to be sand, alluvium, and sandstone. The second line has resistivity values ranging from 140 Ωm to 2768 Ωm. The subsurface layers in this line are dominated by sand, sandstone, and alluvium. Finally, the third line has resistivity values ranging from 705 Ωm to 4358 Ωm. The layers in the third line are dominated by layers estimated to be sandstone and alluvium.

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