Indonesian Physical Review

Volume xx Issue xx, Month 20xx

P-ISSN: 2615-1278, E-ISSN: 2614-7904

# Detection and Identification of Sliding Planes Using Geoelectric Methods at Bengkaung Tourism Area

**Muhammad Andika Pratama[1], Suhayat Minardi[1*], Marzuki[1]**

[1] *Physics department, Faculty Mathematics and Natural Science University of Mataram, Indonesia*

*Corresponding Authors E-mail:* suhayat.minardi@unram.ac.id

**Article Info**

***Keywords:***

Geoelectric method, landslide, Res2dinv, Slip surface.

***How To Cite:***

*Pratama,M.A., Minardi,S., Marzuki.(2024). Detection and Identification of Sliding Planes Using Geoelectric Methods at Bengkaung Tourism Area*

***DOI:***

**Abstract**

Landslides are one of the most common problems that occur on natural and man-made slopes. Factors that cause landslides are the presence of a sliding plane, steep slope, and also the type of rock, while the triggers of landslides are vibration, human activity, and water infiltration into the slope. The sliding plane itself is an impermeable and slippery plane that is usually in the form of a clay layer, so that it becomes the foundation for the movement of soil masses. This study aims to determine the type of rock and the depth of the potential landslide slide plane in Bengkaung Village. The data used in this study is data obtained by taking direct measurements in the field, namely by injecting electric current into the earth using geoelectric method tools. Data processing, namely by using the Res2dinv application. The results of this study are the types of rocks in the study area in the form of sandstone, clay, silt, limestone, breccia, lava and the depth of the sliding plane is between (2.8 - 5) meters.



## Introduction

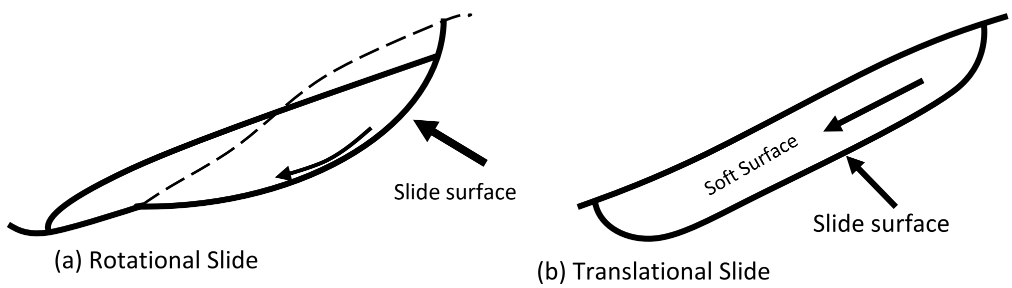
Bengkaung tourist destination located in Bengkaung Village, West Lombok Regency, is a tourist attraction that has the advantage of the natural charm of the city of Mataram in the afternoon and evening, because this place has an altitude of (205 - 309) meters above sea level and a slope with 3 classifications, namely rather steep, steep, and very steep. Places with a rather steep and steep classification have a slope of (15 - 40) % while the steepest has a slope of more than 40% [1] and the potential for natural disasters is quite high [2], so it is thought to have a sliding field that can cause landslides.

Landslides are a common problem in areas with steep slopes [3]. Landslide or often called earth/rock movement is a geological event that occurs due to the movement of rock or soil with various types such as falling rocks or large clumps of soil. Landslide prevention and mitigation needs to be done in areas with landslide potential to reduce the risk. One of the efforts to overcome this is by detecting the condition and structure of subsurface geology so that the slip surface of the slope can be predicted [4]. The slip surface itself is an impermeable and slippery area that is usually in the form of a clay layer, thus becoming the foundation for the movement of soil masses [5].

In this research, geoelectric method is used to determine the depth of the sliding plane as the cause of the landslide. Geoelectric method is also an appropriate method in identifying cracks as a source of landslides in the subsurface [6]. Resistivity method is one of the geophysical methods, where this method can be used to estimate subsurface hydrogeological conditions such as to detect the type of rock and rock water conditions based on the electrical properties of rocks in the form of their specific resistance values. The working principle of the geophysical resistivity (geoelectric) method is that an electric current is injected into the earth through two current electrodes. The potential difference that occurs is measured through two potential electrodes. From the measurement of current and potential difference for each specific electrode distance, the apparent density resistance value can be calculated [3].

## Theory

Slip planes come in two forms. First, the shape of the sliding plane that is parallel and almost straight with the ground is called Translational Slip. Second, the curved slip plane in the form of a circular arc is called Rotational Slip. Figure 1 shows the types of slip planes [7].




The use of this geoelectric method is used to determine the nature of electrical flow under the earth's surface [8]. By using the geoelectric method, an inversion image of the subsurface cross section can be obtained, the layers below the ground surface, and can determine the possibility of groundwater and minerals at a certain depth.

The working principle of this Geoelectric Method is with an electric current injected into the earth through two current electrodes. Through two potential electrodes, the potential difference that occurs can be measured and from the results of measuring the current and potential difference for each specific electrode distance, it can determine the variation in the price of the specific resistance of each layer under the measuring point [9].

The measured potential value is the influence of these layers because the earth is composed of layers with different resistivity. So that the measured resistivity price seems to be the resistivity price for one layer only. In this case the measured resistivity is actually the apparent resistivity ($\rho_a$

To determine the apparent resistivity value $\rho_a$, see the following equation:

$$\rho_{\text{a}} = \frac{2\pi}{\left[\left(\frac{1}{r_1} - \frac{1}{r_2}\right) - \left(\frac{1}{r_3} - \frac{1}{r_4}\right)\right]} \cdot \frac{\Delta V}{I} \quad (1)$$

Or

$$\rho_{\text{a}} = \text{K}\,\frac{\Delta V}{I} \quad (2)$$

We can know that $\rho_a$ is apparent resistivity (Ωm), $\Delta V$ is potential difference (volt), **I** is electric current (ampere), and **K** is geometry factor. The geometry factor is the amount of correction of the location of the two potential electrodes to the location of the current electrode [10]. The **K** value of the Wenner configuration is as follows:

$$\text{K} = 2\pi\left(\frac{1}{\left[\left(\frac{1}{r_1} - \frac{1}{r_2}\right) - \left(\frac{1}{r_3} - \frac{1}{r_4}\right)\right]}\right) \quad (3)$$

Apparent resistivity represents the weighted average of the true resistivity over a large volume of soil where the apparent resistivity of rocks and soils can cover a wide range, the value of which depends on the electrode spacing. If the spacing between electrodes is small, it will give apparent resistivity values that are close to the resistivity of rocks near the surface for a small layered medium. It can be concluded that if the distance is larger, the resistivity obtained will represent the price of deeper rock resistivity [11].

The Wenner configuration is a geoelectric configuration method whose electrodes are arranged at the same distance, 4 electrodes in the Wenner configuration (A, M, N, B). The principle of the Wenner Configuration is AM = MN = NB = a, then the distance between the adjacent electrodes M and N is also equal to the distance A to M and N to B. In the Wenner configuration the distance between the current electrode and the potential electrode is the same.

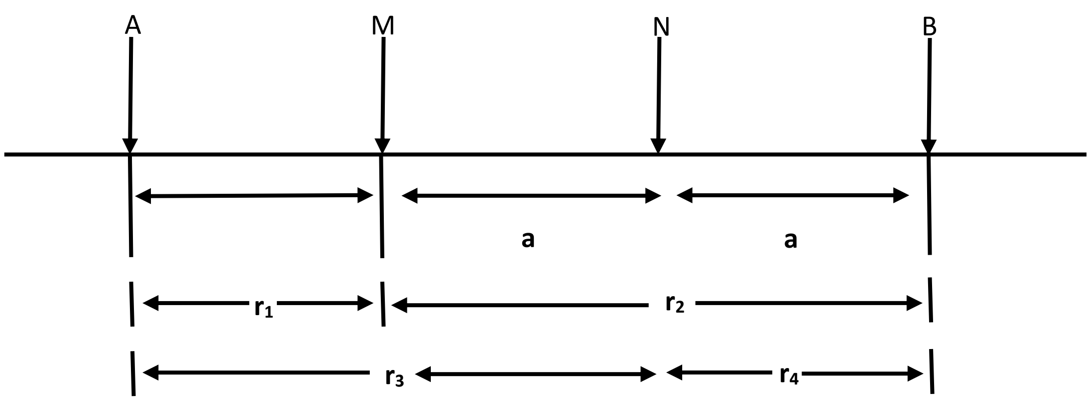



**Figure 1**. Wenner configuration electrode array

We can know that a is electrode spacing, A and B are current electrodes, M and N are potential electrodes, $r_1$ is distance A to M, $r_2$ is distance B to M, $r_3$ is distance A to N, $r_4$ is distance B to N.

## Methods

This research was conducted in Bengkaung Village, Batu Layar Sub-district. This research is quantitative descriptive research because it describes the geological conditions of the area under study. This research aims to determine the type of rock and the depth of the sliding plane in the Bengkaung Tourism area. The following is a Figure of the research location. Figure 2 is the location of the research site, which consist of 5 lines with the longest line length of 115 meters.

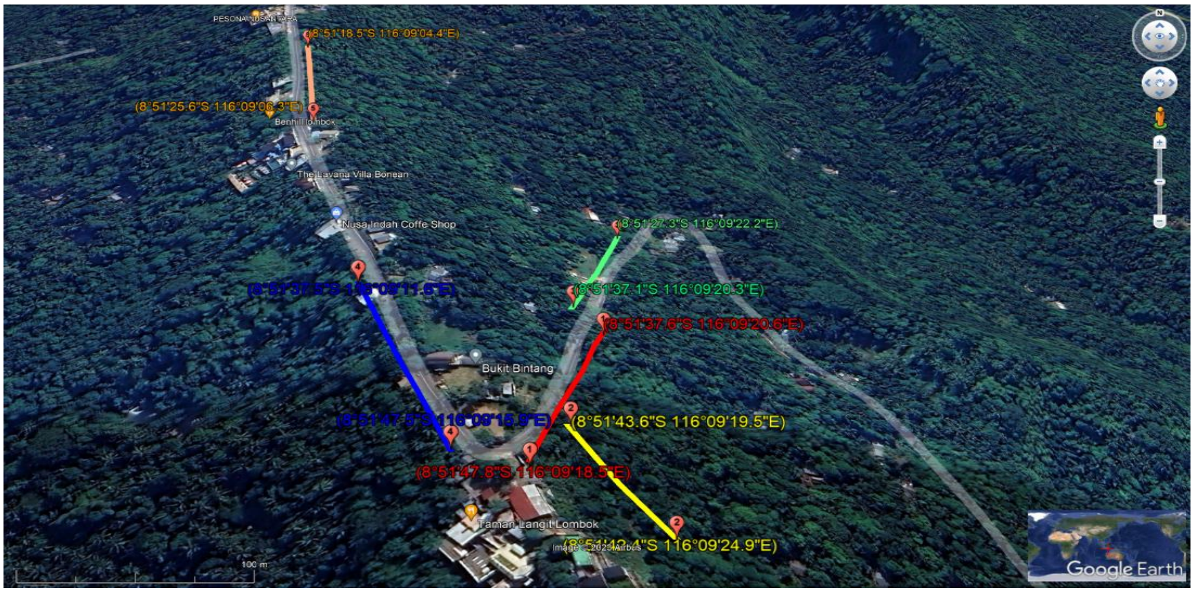



**Figure 2**. Research location in Bengkaung village

Figure 3 is a picture is the research location using the QGIS application, in order to map the village and also the research location.

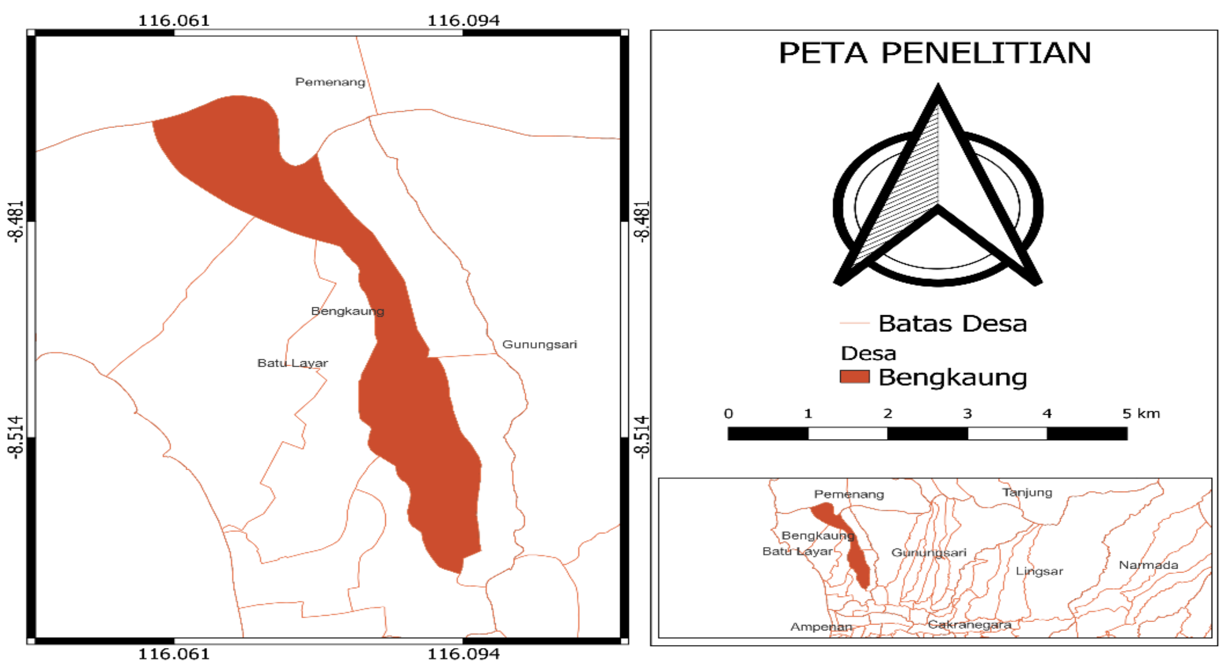



**Figure 3**. Research Location Map using QGIS.

Figure 4 is a geological map of the study area, in order to find out the geological conditions in the study area and also what types of rocks are the study area, so that it can facilitate researchers in identifying the type of rock in the area.

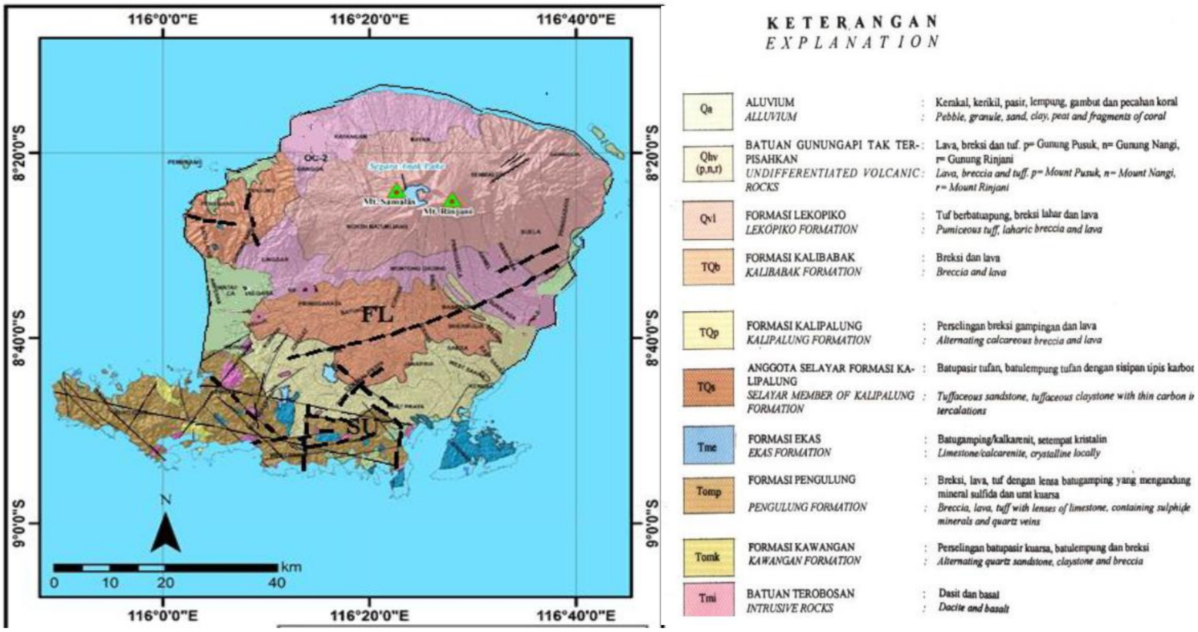



**Figure 4**. Geologic map [12].

The data used in this research is data obtained by making direct measurements in the field. The data acquisition stage in the field is carried out by arranging electrode equipment and resistivity tools connected to cables and then to electrodes. The following is the arrangement of the Wenner configuration electrodes.

## Results and discussion

Based on the Lombok geological map in Figure 4, it is known that the formation in the research area is the Kalibabak formation. Kalibabak formation is composed of breccia and lava rocks. Based on the rock resistivity value, the subsurface rocks in the research area are in accordance with the constituent rocks of the formation. The following are the results of the cross section of line 1 - line 5.

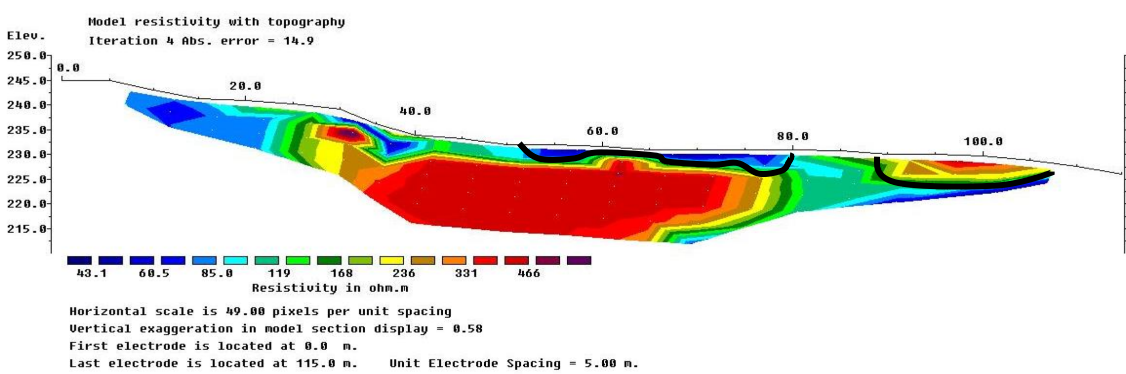



**Figure 5**. Resistivity cross section on line 1.

The location of line 1 is at coordinates (8◦51'47.8 "S 116◦09'18.5 "E - 8◦51'37.6 "S 116◦09'20.6 "E). The rock formation on this line is the Kalibabak Formation which consists of breccia and lava rocks. The length of this line is 115 meters with a spacing of 5 meters per electrode. Based on the picture, the constituent rocks of this track at positions (1 - 24) meters and (47 - 85) meters are (43.1 - 60.5) Ωm which is suspected to be sandstone on the surface. The rock resistivity at position (1 - 90) meters is (60.6 - 168) Ωm which is suspected to be clay and silt with a depth of 4.5 meters, this clay and silt rock is suspected to be the rock that can cause landslides. The rock resistivity of positions (26 - 80) meters and (88 - 115) meters, namely (169 - 466) Ωm, is suspected to be breccia and lava rocks on the surface.

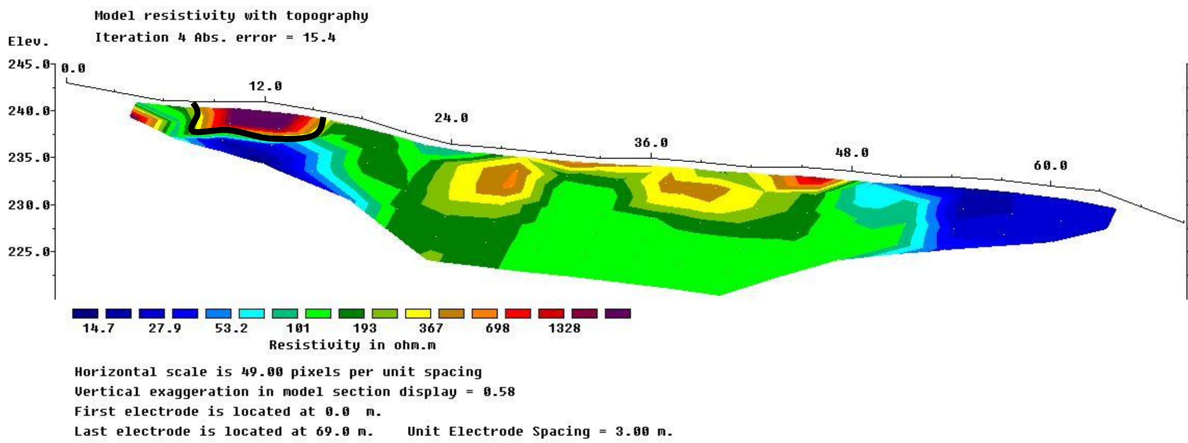



**Figure 7**. Resistivity cross section on line 2

The location of line 2 is at coordinates (8◦51'43.6 "S 116◦09'19.5 "E - 8◦51'42.4 "S 116◦09'24.9 "E). The rock formation on this line is the Kalibabak Formation which consists of breccia and lava rocks. The length of this line is 69 meters with a spacing of 3 meters per electrode. Based on the picture, the constituent rocks of this line at position (1 - 48) meters are (194 - 1328) Ωm which is suspected of lava rock on the surface in accordance with the rock formation in the area and place, namely the Kalibabak formation. The rock resistivity at position (7 - 21) meters is (14.7 - 53.2) Ωm which is suspected to be sandstone with a depth of 3.82 meters and the same as position (49 - 69) meters on the surface. The rock resistivity at position (1 - 51) meters is (53.3 -193) Ωm which is suspected to be clay and silt rock with a depth of 3 meters, this clay and silt rock can cause landslides.

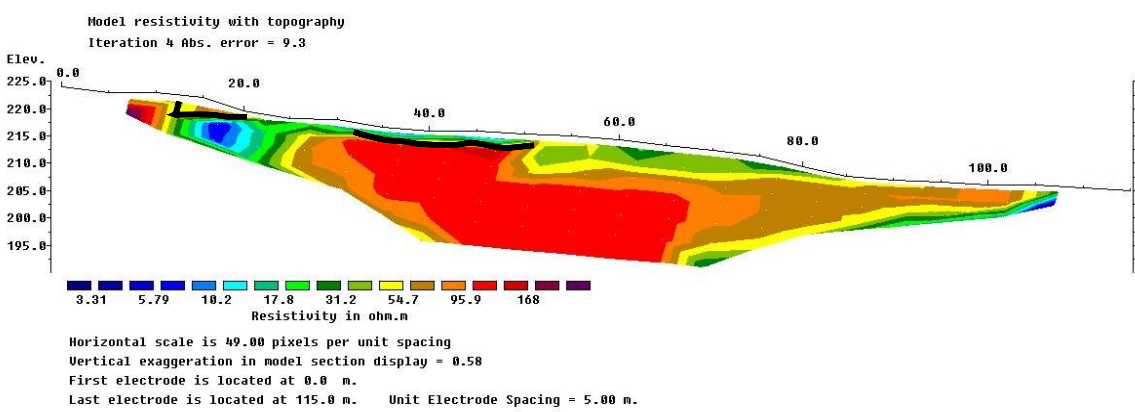



**Figure 8**. Resistivity cross section on line 3

The location of line 3 is at coordinates (8◦51'37.1 "S 116◦09'20.3 "E - 8◦51'27.3 "S 116◦09'22.2 "E). The rock formation on this line is the Kalibabak Formation which consists of breccia and lava rocks. The length of this line is 115 meters with a spacing of 5 meters per electrode. Based on the picture, the constituent rocks of this track in position (1 - 20) meters, namely (54.8 - 168) Ωm are rocks that are suspected of being breccia rocks on the surface as well as in position (26 - 105) meters on the surface and at a depth of 1.25 meters, according to the formation in the geological data of the area, namely the Kalibabak formation. The rock resistivity at positions (15 - 22) meters and (30 - 50) meters on the surface is (3.31 - 10.2) Ωm, which is a rock suspected of being sandstone at a depth of 2.57 meters. The rock resistivity at position (1 - 115) meters is (10.3 - 54.7) Ωm which is suspected to be clay rock with a depth of 3 meters, this clay rock can cause landslides.

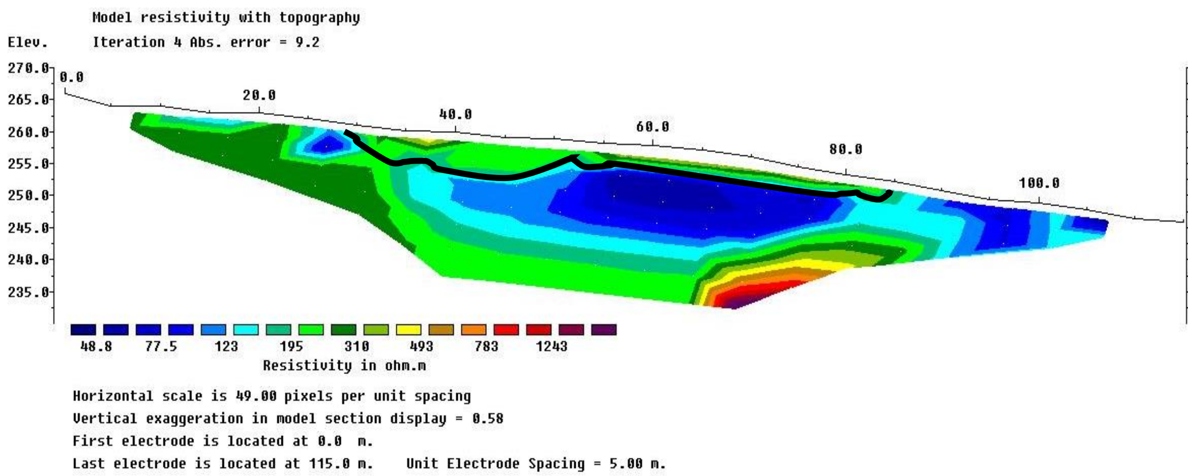



**Figure 9**. Resistivity cross section on line 4

The location of line 4 is at coordinates (8◦51'37.5 "S 116◦09'11.6 "E - 8◦51'47.5 "S 116◦09'15.9 "E). The rock formation on this line is the Kalibabak Formation which consists of breccia and lava rocks. The length of this line is 115 meters with a spacing of 5 meters per electrode. Based on the picture, the constituent rocks of this line at position (1 - 90) meters are (195 - 1243) Ωm which is suspected of breccia and lava rocks on the surface, according to the formation in this area, namely the Kalibabak formation. Rock resistivity at position (13 - 110) meters is (48.8 - 77.5) Ωm which is suspected to be sandstone with a depth of 4 meters. The rock resistivity of (77.6 - 194) Ωm is suspected to be clay and silt at position (8 - 110) meters with a depth of 5 meters and on the surface, this silt rock can cause landslides.

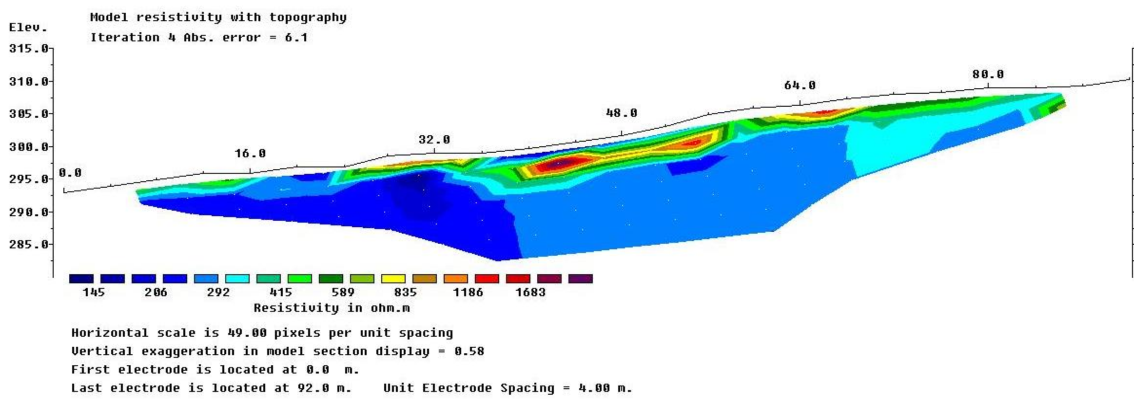



**Figure 10**. Resistivity cross section on line 5

The location of line 5 is at coordinates (8◦51'25.6 "S 116◦09'06.3 "E - 8◦51'18.1 "S 116◦09'04.4 "E). The rock formation in this line is Kalibabak Formation which consists of breccia and lava rocks. The length of this line is 92 meters long with a spacing of 4 meters per electrode. Based on the picture, the constituent rocks of this line at positions (23 - 56) meters on the surface and (59 - 69) meters on the surface are (590 - 1683) Ωm which is suspected to be limestone, just like the geological rock formation in this area, namely the Kalibabak formation which consists of breccia and lava. Rock resistivity at position (24 - 92) meters is (207 - 589) Ωm which is suspected to be lava rock with a depth of 5.42 meters and on the surface. Rock resistivity at position (1 - 92) meters is (145 - 206) Ωm which is suspected to be sandstone with a depth of 3.2 meters.

## Conclusion

The research that has been done to detect and identify the sliding field is by knowing the type of rock and the depth of the sliding field in the research area, based on the resistivity value of the rocks in the research area, namely sandstone, clay, silt, limestone, breccia and lava, while the depth of the sliding field is (2.8 - 5) meters.

## Acknowledgments

The author would like to thank, Physics class 19 friends who have helped with the data collection of this research.

## References

[1] Aditya, R. R., Humairoh S., dan Agus S. 2023. *Analisis Tingkat Bahaya Banjir Menggunakan Sistem Informasi Geografis Pada Kecamatan Batu Layar Kabupaten Lombok Barat*. Jurnal Teknik Unram, Hal 12-13.

[2] Wiwit, B.A., Sukuryadi., Agum, M., Fathul, R., dan Ahmad, K.R. 2022. *Analisis Kemampuan Lahan Desa Bengkaung Untuk Arahan Pengembangan Kawasan Destinasi Wisata*. Jurnal *Geo Image*. 11(2) : 14-15.

[3] Darsono, B. Nurlaksito & B. Legowo. 2012. *Identifikasi Bidang Gelincir Pemicu Bencana Tanah Longsor Dengan Metode Resistivitas 2 Dimensi Di Desa Pablengan Kecamatan Matesih Kabupaten Karanganyar*. Indonesian Journal of Applied Physics, 2 (1): 57-66. A

[4] Sulaksana, N., & Yasir, I. Z. (2013). *Survey Geofisika Metode Resistivitas 2-D untuk Mitigasi Bencana Longsor di Lintasan Kereta Api Purwakarta - Padalarang*. Bulletin of Scientific Contribution, 11(3), 153–167.

[5] Muslihudin., Susilo, Adi., dan M.A. Juwono. 2013. *Studi Bidang Gelincir Sebagai Langkah Awal Mitigasi Bencana Longsor Di Kampung Ledok Kecamatan Sumberpucung Kabupaten Malang Menggunakan Metode Geolistrik Konfigurasi Dipol-dipol*. Jurnal Fisika Brawijaya. Malang.

[6] Agustin, A. D., Utama W., dan Pandu G. N. R. 2017. *Identifikasi Letak Cracks pada Bidang Longsor menggunakan Metode Resistivitas 2D*. Jurnal Teknik ITS, 6: 103 – 105.

[7] Refa, Irepia Dona., Akmam dan Yendri, Novi Sudiar. *Identifikasi Bidang Gelincir Menggunakan Metode Geolistrik Tahanan Jenis Konfigurasi Schlumberger Di Lantiak Kecamatan Padang Selatan*. PILLAR OF PHYSICS, Vol. 3.

[8] Wijaya, A.S. (2015). *Aplikasi Metode Geolistrik Resistivitas Konfigurasi Wenner Untuk Menentukan Struktur Tanah di Halaman Belakang SCC ITS Surabaya*. Jurnal Fisika Indonesia. Volume XIX No 55. ISSN 1410-2994.

[9] Simpen, I Nengah, 2015. *Solusi Permasalahan Sumur Bor versus Sumur Gali dengan Metoda Geolistrik dan Uji Pemompaan Sumur (Suatu Studi Kasus di Bugbug Karangasem Bali)*. Prosiding SeminarNasional Fisika dan Pembelajarannya 2015, Jurusan Fisika Fakultas Matematika dan Ilmu Pengetahuan Alam Universitas Negeri Malang, Malang.

[10] Hakim., Rahma, H.M. 2016. Aplikasi Konfigurasi Wenner Dalam Menganalisis Jenis Material Bawah Permukaan. Jurnal Ilmiah Pendidikan Fisika, 5(1): 95 – 103.

[11] Yaqin, Farid Nurul. 2014. *Lapisan Tanah di Ruas Jalan Sampangan-Banaran Kecamatan Gunungpati Semarang Berdasarkan Data Geolistrik*. Skripsi. Semarang: Unnes.

[12] Hiden Hiden, Kirbani SB, Wiwit S, Danang SH. (2019). Analisis Dan Pemodelan Inversi Struktur Bawah Permukaan Berdasarkan Nilai Gravitasi Pulau Lombok. Indonesian Physical Review, vol 2 No. 1.