International Journal of Engineering and Science Applications
Vol 10 Issue 1 May 2023
ISSN 2406-9833

IJEScA

Identification of Andesite Rock Distribution Using Resistivity Geoelectric Method in Tapalang Area of Mamuju District West Sulawesi Province

Alvian Nawir[1], Alam Budiman Thamsi[1], and Muhammad Farid Wajdi MH[1]
[1]Faculty of Industrial Technology, Mining Engineering Study Programme, Universitas Muslim Indonesia
E-mail: alambudiman.thamsi@umi.ac.id

ABSTRACT

Volcanoes make Indonesia have andesite rock reserves in several areas, including this research area carried out in Labuang Rano Village, West Tapalang District, Mamuju Regency. The geological complex of ancient volcanoes of the Adang Formation includes the morphology of hills from the eruption. The research aims to identify the subsurface layers of the earth using geoelectricity. The geoelectric method used in this research is the resistivity method with Wenner schlumberger configuration. With a stretch of track area of 320 meters each. The data obtained as apparent resistivity values are then processed in Res2Dinv Demo, producing an inversion cross-section. The results of the XYZC variable interpretation in Voxler Demo display andesite rocks at different depths from each track ranging from depths between 15-45 meters with resistivity values of 100-200 Ωm. The first layer is sandstone and clay resistivity <100 Ωm, the second layer is andesite rock resistivity of 100-200 Ωm, and the base layer is tuff resistivity of 20-100. Based on the type of layer, it is identified that the rock layer in this area is andesite rock.

Keywords: Adang volcano, Resistivity, Wenner Schlumberger, Andesite rock

1. BACKGROUND

Andesite is an excavation commodity the community needs, such as building foundations, paving roads, making bridges, making river gabions, etc. Andesite is widely found near the location of development projects and will be of economic value to be mined. However, in its exploration, not all of them are visible on the surface, so it is necessary to conduct further investigations using geophysical methods to determine the presence of andesite and reduce the risk of failure in mining. It can estimate the potential of andesite resources in the study area. [1]

Rocks cannot be found therefore, research with geophysical methods aims to determine the condition of the earth's subsurface in shape and depth. One of the geophysical methods that can be used to model the earth's subsurface is the geoelectric method. [2]

The geoelectric method is a geophysical science that determines the distribution of electrical properties of the subsurface medium. These measurements can estimate the condition of rocks with their characteristics to electric current. The state of subsurface electrical properties can be mineral porosity and water content and the degree of water saturation in the rock. [3]

As seen from satellite images, the formation of hilly morphology with steep slope angles in the mamuju area and its surroundings is influenced by ancient volcanic activity and geological structures [4].

In the research area in the mamuju sheet, the adang volcanic rock complex is composed of lapillary tuff of volcanic breccia with lava inserts (basal leucite) and sandstone and claystone. The adang complex can still be identified morphologically well. The Adang volcanic rock complex has a thickness of about 400 m in the eastern area, juxtaposed with the Mamuju Formation (Tmm) and the Tapalang Member of the Mamuju Formation (Tmmt). This unit is estimated to be Middle to Late Miocene in age [5].

The use of the resistivity geoelectric method in the research area is more due to the geological conditions exposed above the surface, which have electrical properties. When electrified, the rock's characteristics can come from nature itself due to the imbalance or electric current that is deliberately inserted and topography that does not allow for the taking of drill data, and some are still in the surrounding residents' plantations [6].

This is the background for the author to conduct research that will discuss identifying the distribution of andesite rocks with the resistivity geoelectric method in the western tapalang area of mamuju district, west Sulawesi province.

2. RESEARCH METHOD

The resistivity value of a rock depends on the degree of compactness and the percentage of fluid content that fills the rock. However, the importance of several types of stones usually overlaps. This is because the resistivity of rocks is influenced by several factors, namely: clay content, the presence of groundwater, the type and physical characteristics of gravel, rock mineralogy, and so on. The following is the value of rock resistivity.

Table 1. Rock Resistivity Value (Sedana, 2015)

No.	Rock Type	Resistivity (Ω.m)
1	Clay	1 – 100
2	Silt	10 – 200
3	Mudstone	3 – 70
4	Quartz	$10 – 2 \times 10^8$
5	Sandstone	1 – 1.000
6	Limestone	100 – 500
7	Lava	$100 – 5 \times 10^4$
8	Groundwater	0.5 – 300
9	Breccia	75 – 200
10	Andesite	100 – 200
11	Tufa	20 – 100
12	Conglomerate	$10^3 – 10^4$

The research method is done by taking samples that are exposed above the earth's surface and looking at regional geological conditions, and then determining the geoelectric measurement trajectory by making a research track map that informs the topographic conditions of the research area such as coordinates and elevation points using GPS and then taking a geoelectric database, namely the value of current (I) and potential difference (ΔV) with the configuration used by Wenner Schlumberger then creating a data format including datum point, electrode spacing, n value and apparent resistivity (geoelectric database).

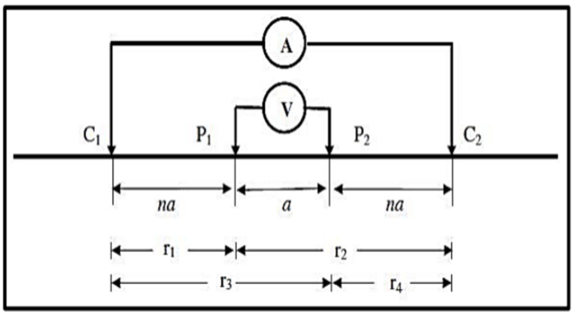

Figure 1. Illustration of Wenner Schlumberger measurement points (Syukri, 2020)

For interpretation, using res2dinv demo software with apparent resistivity data can determine the type of layering and identification of andesite rock layers exposed on the earth's surface. The distribution of rocks with a resistivity value of 100-200 Ωm of andesite rock from the XYZC format, namely coordinate points (X, Y), elevation-depth (Z), and apparent resistivity value (C) in all passes, is managed in voxel demo software. The data sources used in writing this research were obtained directly from geoelectric results and direct analysis in the survey area and literature books related to the research conducted.

3. RESULTS AND DISCUSSION

3.1 Tracks

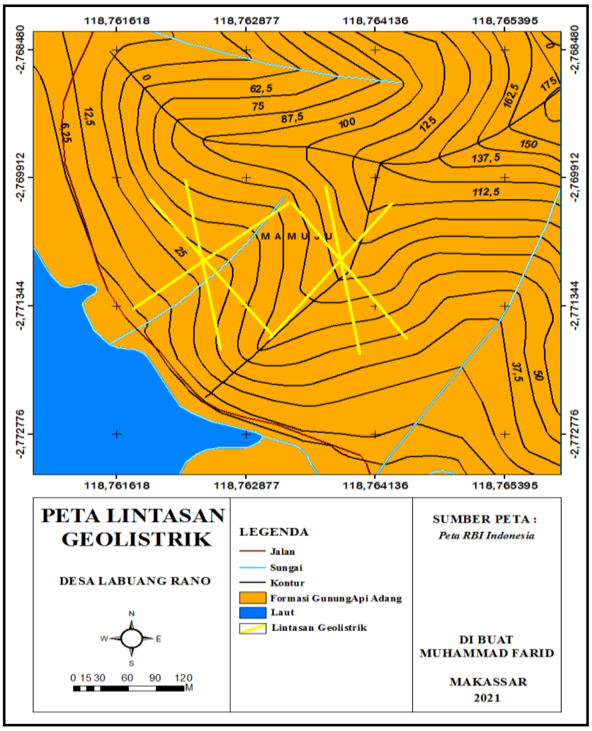

Figure 2. Map of Geoelectric Measurement Tracks

Determination of the geoelectric trajectory is an essential thing in the activities of the resistivity geoelectric method with several parameters that can be a reference, namely looking at regional geological maps that indicate the rocks to be mined and rock outcrops that are often seen on the surface such as slopes and rivers. From the results of field orientation, we can find out the type of rock that is exposed megaskopically in the research area. The things that are avoided when taking geoelectric data include rain, areas crossed by transmission cables, and slopes that reach more than 30°. The tool used on this occasion is a genres brand resistivity-meter unit with 32 electrodes using multi-channels with the help of a laptop during the injection. After that, the data obtained at the end of data collection is then used as input data to determine the cross-section of the distribution of the excavation material. This data processing is called the inversion process. The author used the res2dinv demo to process the data on this occasion. res2dinv demo is a computer program that can determine the 2D resistivity model of the subsurface from field data from electrical imaging surveys (Loke, 2001).

3.2 Inversion Result in Cross Section

a) *Track 1*

On track 1, the penetration depth reached ± 60 meters. From the resistivity cross-section model, there are at least 3 rock layers with low, medium, and high resistivity. The first layer with low resistivity (1-10 Ωm) at a depth of 0-5 m from the surface with a thickness of 85 m2. it is possible that this layer is clay. The second layer with medium resistivity (10-100 Ωm) at a depth of 10-60 m from the surface with a thickness of 114 m2. This layer is probably sandstone. The third layer with high resistivity (100-200 Ωm) at a depth of 20-60 m is about 45 m2 thick. This layer may be basalt-andesitic rocks that break through the surrounding rock layers and are unaffected by external atmospheric factors. The direction of the geoelectric track is from southeast to northwest.

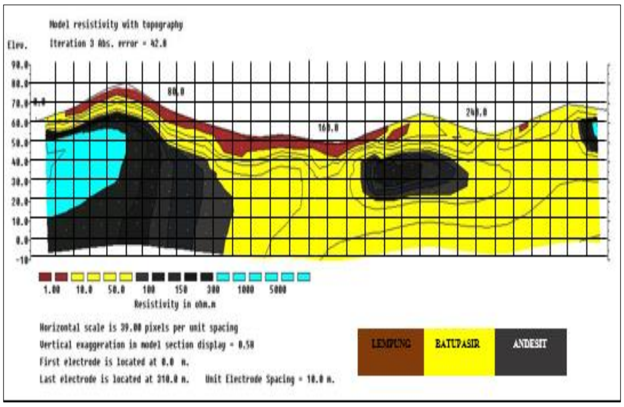

Figure 3. Track 1

b) *Track 2*

On track 2, the penetration depth reached ± 60 metres. From the resistivity cross-section model, there are at least 3 rock layers with low, medium and high resistivity. The first layer with low resistivity (1-10 Ωm) at a depth of 0-10 metres from the surface with a thickness of about 16 m2. It is possible that this layer is clay. The second layer with medium resistivity (10-100 Ωm) at a depth of 10-30 metres is approximately 96 m2 thick. This layer is probably sandstone. The third layer with high resistivity (100-200 Ωm) at a depth of 30-60 meters from the surface is about 174 m2 thick. This layer may be an andesitic basalt rock that breaks through the surrounding rock layers and is unaffected by external atmospheric factors. The direction of the geoelectric track is from south to north.

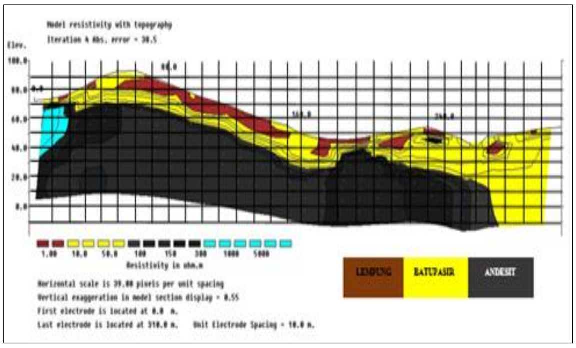

Figure 4. Track 2

c) *Track 3*

On Track 3, the penetration depth reached ± 60 meters. From the resistivity cross-section model, there are at least 3 rock layers with low, medium, and high resistivity. The first layer with low resistivity (1-10 Ωm) at a depth of 0-10 meters from the surface with a thickness of about 18 m2. It is possible that this layer is clay. The second layer with medium resistivity (10-100 Ωm) at a depth of 10-20 meters with a thickness of about 22 m2. This layer is probably sandstone. The third layer with high resistivity (100-200 Ωm) at a depth of 20-30 metres with a thickness of about 120 m2. This layer may be basalt-andesitic rocks that break through the surrounding rock layers and are not affected by external atmospheric factors. As well as a layer (300-5000 Ωm) that is not yet known. The direction of the geoelectric track is from southwest to northeast.

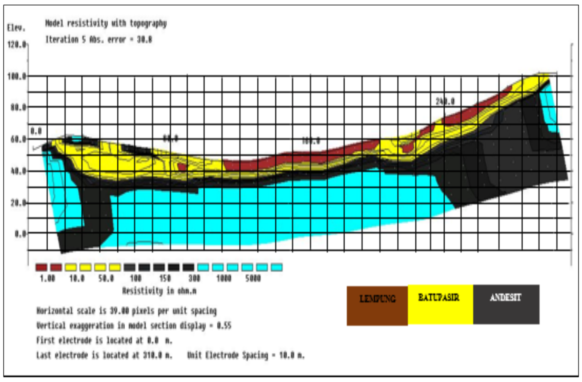

Figure 5. Track 3

d) *Track 4*

On Track 4, the depth penetration reached ± 60 meters. The resistivity cross-section model shows at least 3 rock layers with low, medium, and high resistivity. The first layer with low resistivity (1-10 Ωm) at a depth of 0-5 meters from the surface with a thickness of about 15 m2. It is possible that this layer is clay. The second layer with medium resistivity (10-100 Ωm) at a depth of 10-60 meters with a thickness of around 40 m2. This layer is probably sandstone. The third layer with high resistivity (100-200 Ωm) at a depth of 20-60 meters from the surface is about 95 m2 thick. This layer may be basalt-andesitic rocks that break through the surrounding rock layers and are unaffected by external atmospheric factors. The direction of the geoelectric trajectory is from northwest to southeast.

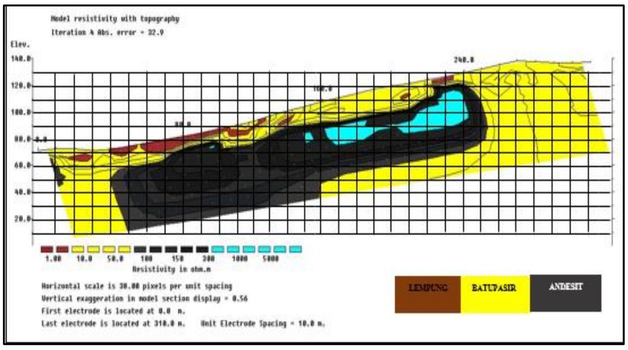

Figure 6. Track 4

e) *Track 5*

On Track 5, the penetration depth reached ± 60 metres. From the resistivity cross-section model, there are at least 3 rock layers with low, medium and high resistivity. The first layer with low resistivity (1-10 Ωm) at a depth of 0-10 meters from the surface with a thickness of about 90 m2. It is possible that this layer is clay. The second layer with medium resistivity (10-100 Ωm) at a depth of 10-40 metres with a thickness of 140 m2. This layer is probably sandstone. The third layer with high resistivity (100-200 Ωm) at a depth of 10-60 meters with a thickness of about 50 m2. This layer may be basalt-andesitic rocks that break through the surrounding rock layers and are unaffected by external atmospheric factors. Geoelectric trajectory direction from southwest to northeast.

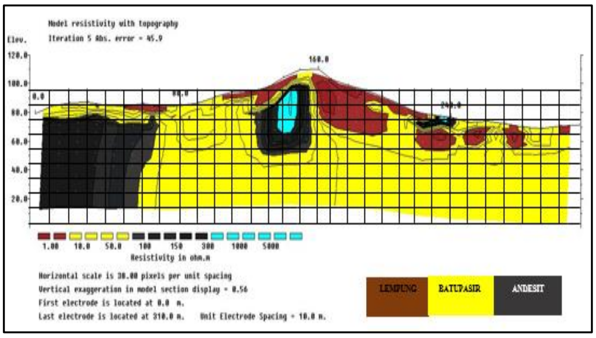

Figure 7. Track 5

f) *Track 6*

On Track 6, the penetration depth reached ± 60 meters. The resistivity model shows that there are at least 3 rock layers with low, medium and high resistivity. The first layer with low resistivity (1-10 Ωm) at a depth of 0-10 metres from the surface with a thickness of about 70 m2. It is possible that this layer is clay. The second layer with medium resistivity (100-200 Ωm) at a depth of 20-60 metres with a thickness of about 360 m2. This layer is probably sandstone. The third layer with high resistivity (100-200 Ωm) at a depth of 30-60 metres from the ground surface with a thickness of about 120 m2. This layer may be basalt-andesitic rocks that are intruded and not affected by external atmospheric factors.

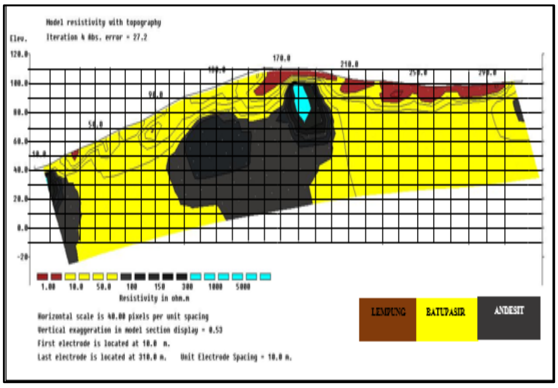

Figure 8. Track 6

Based on the description above, the results of the interpretation of each measurement track can be seen in the following table:

Table 2. Interpretation of each layer

Track	Resistivity Range (Ωm)	Depth (m)	Thickness (m^2)
Track 1	0 – 10	0-5	85
	10-100	10-60	114
	100-200	20-60	45
Track 2	0 – 10	0-10	16
	10-100	10-30	96
	100-200	30-60	174
Track 3	0 – 10	0-10	18
	10-100	10-20	22
	100-200	20-30	120
Track 4	0 – 10	0-5	15
	10-100	10-60	40
	100-200	20-60	95
Track 5	0 - 10	0-10	90
	10-100	10-40	140
	100-200	10-60	50
Track 6	0 - 10	0-10	70
	10-100	20-60	360
	100-200	30-60	120

3.3 Potential Andesite Rock Distribution

From the six inversion cross-sections, it is known that there are 3 rock layers interpreted from the rock resistivity value, namely the 1-10 Ωm clay layer and the 10-100 Ωm sandstone layer and the 100-200 Ωm basalt-andesite layer. Tracks 1,2,3 cross each other with tracks 4,5,6. The goal is to be able to correlate between cross sections with the help of voxler demo. Input data with topographic data (coordinates and elevation points) and resistivity values. In this view we can see from a wider perspective. Designed to display XYZC data, where C is a variable at each X, Y, and Z location. For example, if applied in the field of geophysics in creating geoelectric model data, X, Y and Z are coordinates (longitude, latitude and elevation/depth) and C is resistivity (Rho). With Voxler you can create stunning graphical output for your 3D models. Models can be sliced (slides) displayed at any angle and even animated with simple mouse movements. Standard or custom colouring can be applied to your model. (Golden Software, 2012).

At this stage, the database has been input to the voxler demo software and displays the shape of the space in the XYZC variable.

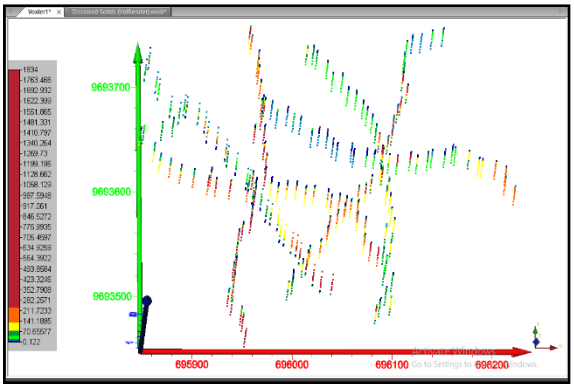

Figure 9. Variable XYZC

Further management is to use the HeightField function in the voxler demo software, which displays a field to help bring up the rock resistivity value described by colour.

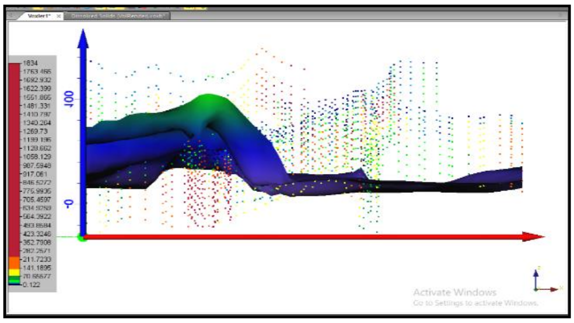

Figure 10. Rock Resistivity Field

3.4 Correlation of Resistivity Values of Each Track

Layers with high resistivity values equal to 100-200 Ωm form a spread in the form of magma intrusions that may have ancient volcanoes around the area and cut through sedimentary rock layers. These rocks are usually deep igneous rocks.

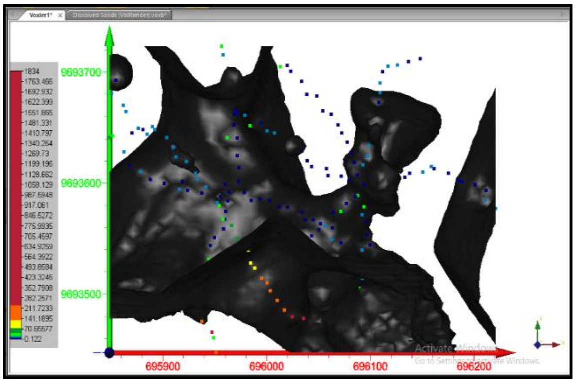

Figure 11. Rock Resistivity Field

4. CONCLUSION

Based on observations of lithological conditions during the field and data processing of geoelectric measurement results, it can be concluded that indicated outcrops on the surface and rock resistivity values (100-200 Ωm) are possible andesite rocks seen from the results of cross-section inversion and the shape of this rock distribution such as dike intrusion cutting the surrounding rock layers that form a flat (plate) in each geoelectric track.

1. Drilling is needed to find out more details in areas suspected of having potential. From the existing drill data, corrections can be made to

the calculation of geoelectric measurement data so that the geological confidence level of the potential in the PT Aneka Bara Lestari area can be upgraded to the reserve classification.

2. It is important to conduct petrographic tests on core sheet samples when drilling to confirm the rock type and mineral content.

REFERENCES

[1] Muhammad Irsyad, 2018, "Pemodelan 2D Batuan Bawah Permukaan Daerah Mamuju Sulawesi Barat dengan Menggunakan Metode Magnetik", Pusat Teknologi Bahan Galian Nuklir BATAN, Jakarta.

[2] Ilham, 2020, "Tipologi Sistem Akuifer Gunungapi Adang Desa Labuang Rano Kecamatan Tapalang Barat Kabupaten Mamuju", Universitas Hasanuddin, Makassar.

[3] Indrastomo F. D,. 2017 "Identifikasi Pola Struktur Geologi Sebagai Pengontrol Sebaran Mineral Radioaktif Berdasarkan Kelurusan pada Citra Landsat-8 Kabupaten Mamuju Provinsi Sulawesi Barat", Pusat Teknologi Bahan Galian Nuklir BATAN, Jakarta.

[4] I Gde Sukadana. 2015, "Tataan Tektonika Batuan Gunung Api Di Komplek Adang, Kabupaten Mamuju, Provinsi Sulawesi Barat", Pusat Teknologi Bahan Galian Nuklir BATAN, Jakarta.

[5] Hendrajaya L, dan Arief., I. 1988. "Geolistrik Tahanan Jenis". ITB, Bandung.

[6] Sedana, D., As'ari dan Tanauma, A. 2015. Pemetaan Akuifer Air tanah di Jalan Ringroad, Kelurahan Malendeng dengan Menggunakan Metode Geolistrik Tahanan Jenis. Jurnal Ilmiah Sains.15 (2): 33-37. Fisika Modern. Yogyakarta.

[7] Syukri M. 2020, "Dasar-Dasar Metode Geolistrik", Universitas Syiah Kuala Press, Provinsi Banda Aceh.

[8] Loke, M.H., 2001. Tutorial 2-D and 3-D Electrical Imaging Surveys.2013, 22–25.

[9] Golden Software, 2012. Voxler 3 Quick Star Guide.

[10] Eko Bayu Purwasatriya. 1973. "Studi Potensi Sumberdaya Andesit Menggunakan Metode Geolistrik Di Daerah Kokap Kabupaten Kulonprogo Daerah Istimewa Yogyakarta" Universitas Jenderal Soedirman, Yogyakarta.