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Identification of Subsurface Lithology Using the Vertical Electrical Sounding Geoelectric Method in The Kuta Area, Central Lombok, West Nusa Tenggara

Warni Multi[1*], Arif Wijaya[2]

[1] Teknik Geofisika, Fakultas Teknik, Universitas Pattimura, Ambon, Indonesia
[2]Teknik Pertambangan, Fakultas Teknik, Universitas Muhammadiyah Mataram, Mataram, Indonesia

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Correspondence:

Warni Multi

Phone: +62 812 4005 8103

Abstract: The Kuta region is one of the most developed tourism areas in the Central Lombok Regency. This development impacts the population that continues to increase in the area, thereby influencing the increasing need for groundwater. However, the study area tends to be dry, especially in the dry season and rainfall is very low. This is quite difficult for residents to find good aquifers for groundwater exploration. From this, subsurface lithology identification is carried out to determine the lithology of the subsurface layers to obtain potential aquifers. The method used is geoelectric vertical electrical sounding which is carried out at two location points with a track length of 500 meters and a spacing of 10 meters. From the analysis of the 1D resistivity curve produced in this survey, information on subsurface lithology at the measurement point, consisting of layers of clay, sandstone, and breccia, was obtained. At the MR-1 line there is sandstone lithology at a depth of 53-84.3 meters which is thought to have the potential to be an aquifer, while at the MR-2 line, the presence of sandstone lithology is at a depth of 67.5-110 meters. Therefore, this measurement location shows the prospect of the existence of an aquifer which is characterized by a layer of sandstone which is a rock with good porosity and permeability

Keywords: Geoelectric; Kuta; Lithology; Vertical Electrical Sounding.

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Introduction

State the Subsurface rock lithology is generally composed of very varied types of materials or rocks. The importance of knowing the kind of lithology that makes up subsurface rocks in an area will make it easier for residents to identify the potential for freshwater contained in rock pores. The Kuta area is an area located in Central Lombok Regency which has a population density of 939,409.0 people as of 2018, which does not rule out the possibility that it will continue to increase over time (BPS, 2018). With the increase in population and development of tourism in the area, this will of course have an impact on increasing the need for clean water sources. It is crucial for resident's survival and overall health (Agbasi dkk., 2019). However, based on the conditions of the research area which tend to be dry in the dry season with very low rainfall, identifying the presence of groundwater is quite a difficult challenge. Moreover, the local community does not yet understand the subsurface lithological conditions of the surrounding area. So conventional drilling activities that are often carried out are not effective in predicting the presence of groundwater at a certain depth.

It is not uncommon for conventional drilling to not only consume a lot of energy and time, but the cost factor is also a consideration. This is because conventional drilling also costs quite a lot of accommodation costs. Therefore, to meet water resource needs, especially in the Kuta area, Central Lombok Regency, it is necessary to carry out a Vertical Electrical

Email: wmtgflecturer16@gmail.com

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Sounding (VES) geoelectric survey (Musa dkk., 2023) to determine the lithology of subsurface rocks that are prospective as groundwater aquifers in that location. This method is a very good method and easy to use (Ibrahim dkk., 2024). Several previous researchers have also made extensive use of this application to search for aquifer layers, as was done by (Dewi dkk., 2023) The geoelectric method has been utilized in various studies, including research by (Zuhdi dkk., 2022) who estimated potential aquifer water discharge in the Mataram area. Similarly, (Wijaya, 2019) applied this method to analyze soil structure in the Surabaya campus area. These prior investigations have guided the author's decision to employ the geoelectric method, particularly for the identification of lithology in the research area.

The geoelectric method is one of the simplest and easiest methods to use in geophysics (Ojo, 2015). This method can detect subsurface lithology by utilizing the injection of electric current using two current electrodes into the earth's subsurface and the potential is measured with two potential electrodes. This geoelectric survey can generally be carried out in two ways, namely mapping and sounding which helps produce information on changes in resistivity value variations laterally and vertically (Golovko dkk., 2011). Therefore, the geoelectric sounding method in this research needs to be used to identify subsurface lithology in the Kuta area, Central Lombok Regency to obtain aquifer prospects to meet the freshwater needs of the local population.

Method

This research was conducted in the Kuta area, Central Lombok Regency, West Nusa Tenggara Province. This area is the focus of research in the region because there are still problems in the exploration of the clean water needs of residents living around the area. Data collection was carried out at two possible measurement lines in the area. The measurement coordinate lines can be seen more clearly in Table 1. Each measurement point in Table 1 in the research area can be depicted more clearly in Figure 1

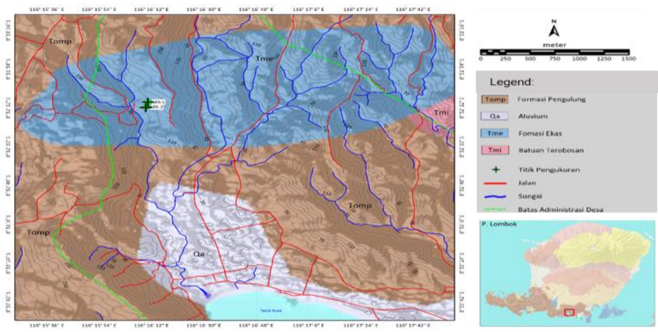


Figure 1. Research location in the Kuta area (Zuhdi dan Sukrisna, 2023).

Tabel 1. Coordinates of geoelectric measurement points in the research area.

Lines	Latitude (S)	Longitude (S)	Elevation
MR-1	08°52′9.21″	116°16′10.85″	89
MR-2	08°52′11.45″	116°16′10.85″	88

Data acquisition in the research area was carried out using the Schlumberger configuration, where the data acquisition stage begins with the installation of two potential electrodes (P1 and P2) with a spacing of *b* placed between two current electrodes (C1 and C2) with *a* spacing of *2a* (Telford dkk., 1990). The implementation of this geoelectric acquisition uses a Single Channel Geo Soil Resistivitymeter tool. This method can analyze the uniqueness of vertical electrical resistivity caused by current penetrating the subsurface which is injected through current and potential electrodes in measurements (Jimoh dkk., 2023). For more details, the arrangement of electrodes using the Schlumberger configuration geoelectric method can be seen in Figure 2.

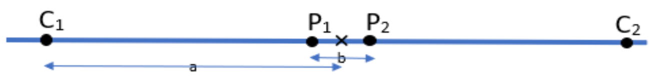


Figure 2. Electrode arrangement with Schlumberger configuration (Reynolds, 1997).

If data acquisition has been carried out, observation data will be produced in the form of apparent resistivity values (rho apparent). Then this data is processed further into the inversion stage to obtain an apparent resistivity curve. Through this inversion stage, the best model parameters will be obtained through a repeated iteration process to obtain a subsurface model that is considered to be closest to or similar to the actual state of the earth's subsurface. This is also validated by the relatively small root mean square value (Achmadin dkk., 2024). The results of this data processing are in the form of a 1D resistivity curve which describes information on the lithology of subsurface rocks. The stages of data processing are shown in Figure 3.

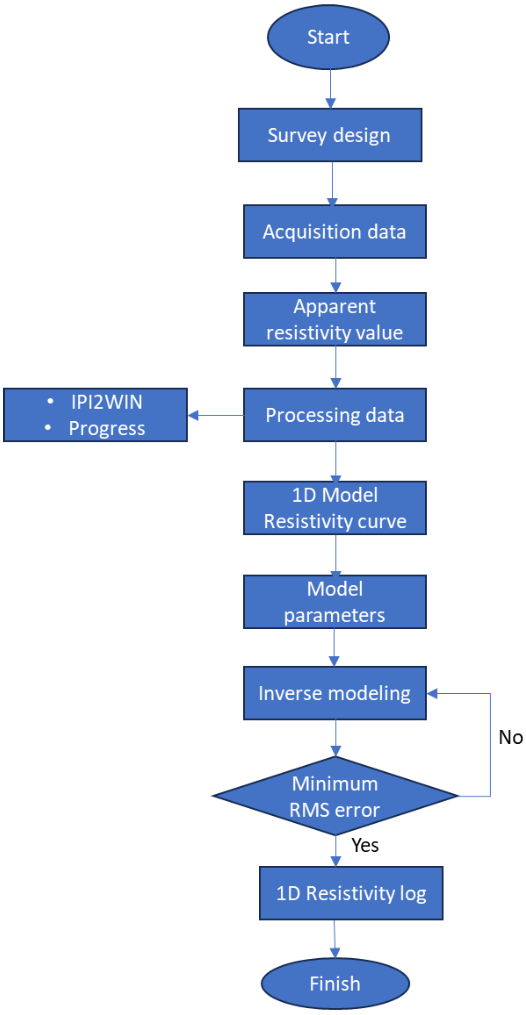


Figure 3. Research flowchart.

Result and Discussion

The results of data processing at the MR-1 line are in the form of an apparent resistivity curve (ρ_{app}) against stretch length (AB/2) and a 1D model-sounding resistivity log shown in Figure 4. The inversion results obtained at this measurement point show that the subsurface lithology can be identified as consisting of several layers with the resistivity, depth, and thickness values of each layer shown in Table 2. The advantage of this VES technique is that the subsurface image looks clearer (layered) in the study area, namely from one to eight different layers (Hervé dkk., 2021).

Tabel 2. Result of subsurface lithology measurement in the research area.

Lines	Layers	Depth (meters)	Thickness (meters)	Resistivity (Ωm)
MR-1	Layer 1	0.845	0.845	30.6
	Layer 2	1.49	0.64	3.89
	Layer 3	3.01	1.53	21.4
	Layer 4	8.22	5.2	2.34
	Layer 5	12.7	4.46	50.7
	Layer 6	30.7	18.1	3.32
	Layer 7	53	22.3	232
	Layer 8	84.3	31.3	182
MR-2	Layer 1	0.461	0.461	6.63
	Layer 2	1.29	0.829	70.6
	Layer 3	2.84	1.55	1.31
	Layer 4	8.27	5.42	1.82
	Layer 5	8.87	0.599	749
	Layer 6	20	11.2	338
	Layer 7	27.2	7.13	37.1
	Layer 8	67.5	40.3	4.33

The description of the subsurface lithology of each measurement line in the research area is shown through the resistivity curve and 1D resistivity log model shown in figure 4 and figure 5.

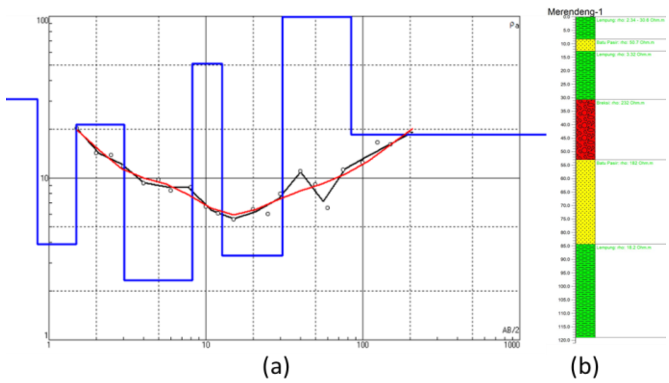
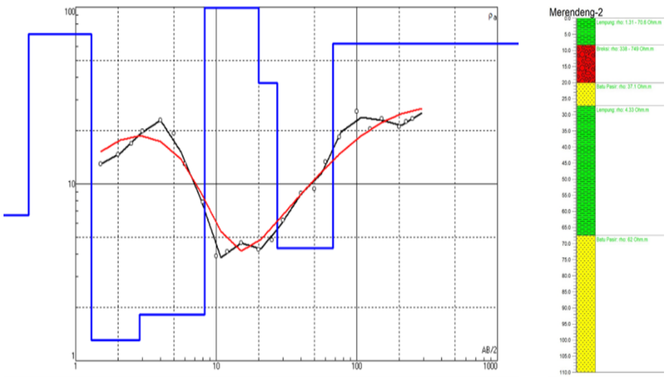


Figure 4. (a) Apparent resistivity curve for the length of AB/2 and (b) 1D resistivity log MR-1.

Based on the results of data processing, it can be identified that the MR-1 line consists of several rock layers, namely clay, sandstone, and breccia which is quite a potential lithology (Septianan dkk., 2024) In the study area. In particular, layers 7 and 8 (Table 2) are layers that are thought to be sandstone layers that have the potential to carry water (aquifer) at a depth of 53-84.3 meters (Figure 4). In general, sandstone is also a rock lithology that has good porosity and permeability (Mohamaden dkk., 2024) as an aquifer (Purnama dkk., 2023). Based on the interpretation results, this layer is also located under the breccia layer with a thickness of 22.3-31.3 meters with a resistivity value of 182 Ωm. This result is quite good and close to the actual subsurface conditions seen from the relatively low RMS error value of 2.3%. Meanwhile, for measurements at the MR-2 line, the apparent resistivity curve for the AB/2 electrode length and the 1D resistivity log from the sounding results can be seen in Figure 5. The results obtained at the MR-2 measurement line based on Figure 5 show that the subsurface lithology consists of several layers. This layer is thought to consist of clay, sandstone, and breccia. It is suspected that the potential layer as an aquifer is a sandstone layer located at a depth of 67.5-110 meters which generally has good porosity and permeability (Nababan dkk., 2020).



(a) (b)

Figure 5. (a) Apparent resistivity curve for the length of AB/2 and (b) 1D resistivity log MR-2.

If we refer to regional geological information (Figure 1), this research area is included in the Ekas formation which is composed of clay layers. Generally, it tends to act as a semi-impermeable (watertight) layer with a thickness of up to 40.3 meters with a resistivity of up to 62 Ωm. It is possible that groundwater can be extracted from this layer, but the amount is limited and will take a long time to be replenished (Xing dkk., 2018). The possibility of drilling for good groundwater exploitation can be carried out up to 90 meters below the surface to obtain a fairly stable water discharge. For interpretation results that are more detailed and have good continuity, you can also continue by adding measurement points near the sorrounding area.

Conclusion

Based on the results of research conducted in the Kuta area, it can be concluded that in this area the subsurface structural lithology is composed of layers of clay, sandstone, and breccia. At the MR-1 measurement line, there is rock lithology that has good potential as an aquifer, namely sandstone which is found at a depth of 53-84.3 meters. Meanwhile, at the MR-2 measurement line, the sandstone layer that is as good as an aquifer in the area is located at a depth of 67.5-110 meters.

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