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Using the Geoelectric Method to Identify Groundwater Schlumberger Configuration Resistivity in the Gambesi and Sasa Villages, South Ternate District, North Maluku Province

Hilda Alkatiri[1*] *Arbi* Haya[2] *Yusdi* Akin[3]

[1,2,3] Mining Engineering, Faculty of Engineering, Universitas Khairun, Ternate, Indonesia

Abstract. One of the geophysical techniques that may be used to define subsurface lithology is the geoelectric approach. The Schlumberger configuration's resistivity technique is used on the assumption that the distance between the potential electrodes is fixed. In contrast, the distance between the current electrodes progressively varies following the resistivity-to-depth curve and the resistivity table. This study aims to determine the lithology of the soil layer and the lithology of the soil layer that serves as an aquifer based on their respective resistivity values. The acquired data demonstrate the presence of multiple layers, including alluvium, sand, gravel, and andesite, in the subsurface lithology at two sites with a depth of 25 meters and a track length of 50 and 100 meters. Based on the resistivity curve to depth and the findings of data processing at the two data collecting sites, groundwater at location 1 (Gambesi Village) could not be identified in the resistivity table because of the location's hilly terrain and alluvial rock types. However, at location 2 (Sasa Village), groundwater was present at depths of 12.8 meters with thicknesses of 6.24 cm and 0.57 Ωm and at depths of 12.8 meters with thicknesses of 4.91 meters and 297 Ωm, respectively. This region slopes down from this position.

Keywords: Schlumberger Configuration, Groundwater, Surface Carry Layer Lithology

* Corresponding author: hildaenviroment@gmail.com

1 Introduction

Use One of the geophysical techniques for determining the underlying lithology is the geoelectric approach, particularly the resistivity geoelectric method (Reynolds, 2011). By measuring the electrical characteristics of the rock, this approach may provide a general idea of how the rock layers are arranged and how deep they are (Plummer. C. M, 2005; Sutasoma et al., 2018). Both mapping and sounding, which provide information on changes in resistivity price fluctuations in both the lateral and vertical directions, may be used to conduct a geoelectric survey using the resistivity technique (Anonim, 1992; Dobrin & Savit, 1988).

The purpose of this study was to establish the depth of the groundwater and the underlying lithology at the research site (Sheriff. R. E, 2002; Todd D. K, 1959). This technique allows for measuring aquifer layer depth, thickness, and distribution. The Gambesi Sub-District, Sasa Sub-District, and South Ternate City Sub-District were the places where this action took place. The goal of this research phase was to identify the lithology of the soil layer based on its resistivity value and the lithology of the soil layer that serves as an aquifer based on its resistivity value. Data collection was done at random around the study site.

2 Method

The Schlumberger setup is used in this work to locate aquifers and groundwater. The resistivity approach for the Schlumberger configuration is based on the notion that the distance between potential electrodes is constant while that of current electrodes progressively varies (Sheriff. R. E, 2002; Sutasoma et al., 2018). One of the resistivity geoelectrical techniques to ascertain changes in soil resistivity with depth is called Vertical Electrical Sounding (VES), which attempts to investigate the vertical variations in the resistivity of rocks under the ground's surface (Halik. G & Widodo. G, 2008; Hendrajaya L & Arif. I, 1990).

The potential difference is measured at the MN electrode while the current is injected via the AB electrode, where the current electrode distance is much bigger than the voltage electrode distance (Telford et al., 1990; Triahadin & Setyawan. A, 2014).

The Schlumberger configuration's geometry factor is as follows: The dipole apparent resistivity value changes depending on the setup utilized while collecting data in the field (Hakim. A.R & Hairunisa. H, 2017; Halik. G & Widodo. J, 2008). The reason is that each arrangement's geometry factor (K) value varies (Tama. S. K, 2015). Use the equation below to determine resistivity values in general:

The following are the Schlumberger configuration geometry factors:

$$\pi an = (n + 1) \quad (1)$$

The following relationship often expresses the value of apparent resistivity:

$$\rho_a = K \frac{V}{I} \quad (2)$$

While the resistivity in the Schlumberger configuration

$$\rho_a = R \, . K \quad (3)$$

$$R = \frac{V}{I} \quad (4)$$

$$K = \frac{\pi \, (AB^2 - MN^2)}{(2 \, .MN)} \quad (5)$$

$$\rho_a = \frac{\pi \, (AB^2 - MN^2)}{(2 \, .MN)} \times \frac{V}{I} \quad (6)$$

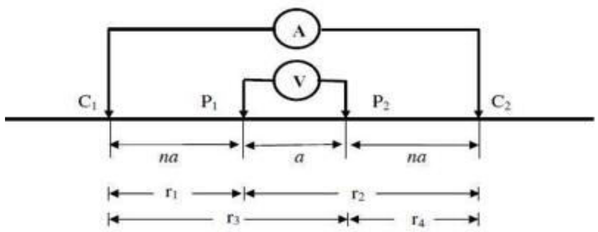

Fig. 1. Electrode rules with the Schlumberger method

The resistivity values for each earthly substance are shown in Table 1.

Table 1. Resistivity values of earth materials

Materials	Resistivities (Ohm-Mater)
Pyrite	0.01- 100
Quartz	500- 800.000
Calcite	1 x 10^{12} – 1 x 10^{13}
Rock Salt	30 – 1 x 10^{13}
Granite	200 – 100. 000
Andesite	1.7 x 10^{2} – 45 x 10^{4}
Basalt	200 – 100.000
Limestone	500 – 10.000
Sandstone	200 – 8.000
Shales	20 - 2000
Sand	1 - 1000
Clay	1 - 100
Ground Water	0.5 - 300
Sea Water	0.2
Magnetite	0.01 – 1.000
Dry Gravel	600 – 10. 000
Alluvium	10 - 800
Gravel	100 - 600

3 Results and Discussion

Equations Data processing is done using IP2WIN software based on the information gathered at the study site by measuring current and potential using a resistivity meter. Resistivity values (Ωm) to depth (m) are shown as the data processing results for each sounding site in 1D log graphs and tables.

3.1. Sounding Point 1, Gambesi Village

At sounding site 1 in Gambesi Village, in a west-to-east measurement direction with a hilly morphology, at 52 m above sea level, and over a measuring track length of 100 meters, geoelectrical measurements were

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made using the Schlumberger configuration technique (Singh. K. B et al., 2014).

Table 2. Geoelectric measurement data for sounding point 1, Gambesi Village

No	Depth (m)	Thickness (m)	Resistivity (Ωm)	Composing Rocks
1	0.169	0.169	11.6	Alluvium
2	0.888	0.716	10.3	Alluvium
3	3.4	2.51	12.2	Alluvium
4	6.61	3.31	1014	Gravel
5	25	18.4	1.07	Andesite

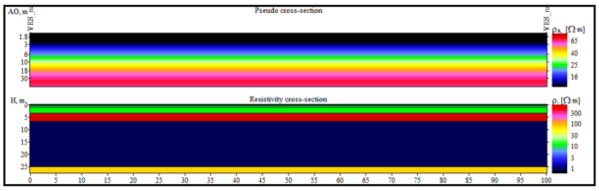

Fig. 2. Modelling of the sounding point cross-section 1, Gambesi Village

3.1.1. Lithology Analysis (Laying)

- Alluvium material (also known as alluvium) exists in the first to third zones, with depths ranging from 0.169 m to 3.4 m, thicknesses ranging from 0.169 to 2.51 m, and resistivities ranging from 10.3 Ωm to 12.2 Ωm.
- The fourth zone has a resistivity value of 1014 Ωm, a thickness of 3.21 m, and a depth of 6.61 m. Gravel is present in the fourth zone.
- The fifth zone has a resistivity value of 1.07 Ωm, a depth of 25 m, and a thickness of 18.4 m. Materials made of andesite are found in the fifth zone.

3.2. Location of sounding point 2, Gambesi Village

3.2.1. Observation Location

At sounding station 2 in the Gambesi Sub-District, north-south measurements were made using the Schlumberger configuration technique, with a measuring track length of 50 meters and a hilly, sloping morphology at 44 meters above sea level.

Table 3. Geoelectric measurement data for sounding point 2, Gambesi Village

No	Depth (m)	Thickness (m)	Resistivity (Ωm)	Composing Rocks
1	0.556	0.556	11.6	Alluvium
2	1.25	0.965	10.3	Alluvium
3	2.58	1.05	12.2	Alluvium
4	6.09	3.52	473	Gravel
5	12.2	6.13	1.01	Andesite

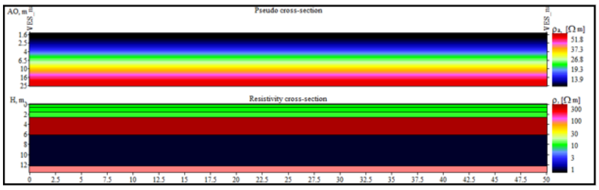

Fig. 3. Modelling of the sounding point cross-section 2 of Gambesi Village

3.2.2. Lithology Analysis (Laying)

- Alluvium material may be found in the first zone to the third zone, which has a depth of 0.556 m-2.58 m and a thickness of 0.556-1.05 m with a resistivity value of 10.3 Ωm-12.2 Ωm.
- The fourth zone has a resistivity value of 473 Ωm, a thickness of 3.52 m, and a depth of 6.09 m. Gravel makes up the last area.
- The fifth zone measures 12.2 m in depth, 6.13 m in thickness, and 1.01 Ωm in resistivity. Material made of andesite S is found in zone five.

3.3.Sounding Point 1, Sasa Village

3.3.1. Observation Location

Results of measurements made at sounding site 1 in Sasa Village in a west-to-east direction on a 100-meter-long measuring track with a sloping morphology, 24 meters above sea level.

Table 4. Processing Results sounding point 1

No	Depth (m)	Thickness (m)	Resistivity (Ωm)	Composing Rocks
1	1.31	1.31	10.3	Alluvium
2	3.24	2.09	1.51	Sand
3	6.61	3.21	1.13	Sand
4	12.8	6.24	0.57	Groundwater
5	25.5	12.7	100	Sandstone

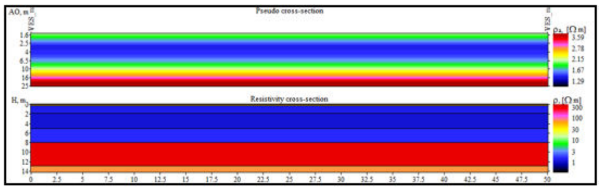

Fig. 4. Modelling of the sounding point 1 cross-section of Sasa Village

3.3.2. Lithology Analysis (Laying)

- The first zone, also known as the surface zone, has a resistivity value of 10.3 Ωm, a depth of 1.31 m, and a thickness of 1.31 m. Materials from the first zone are alluvium.
- The second and third zones' depth, thickness, and resistivity are 3.24 m–6.61 m, 2.09 m–3.21 m, and 1.151 Ωm–1.13 Ωm, respectively. The area contains the substance sand.

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• The fourth zone is 12.8 cm deep, 6.24 cm thick, and has a resistivity of 0.57 Ωm. Groundwater is utilised in the fourth zone.

• The fifth zone measures 25.5 cm in depth and 12.7 cm in thickness and has a resistivity of 100 Ωm. Sandstone is found in the fifth zone.

3.4. Sounding Point 2 of Sasa Village

3.4.1. Observation Location

At sounding station 2 in Sasa Village, in the North-South measurement direction, with a slightly sloping morphology, at an altitude of 24 m asl, and with a measuring route length of 50 meters, geoelectrical measurements were made

Table 5. Sounding point processing results 2

No	Depth (m)	Thickness (m)	Resistivity (Ωm)	Composing Rocks
1	0.271	1.271	10.4	Alluvium
2	1.87	1.6	1.51	Sand
3	5.08	3.21	1.24	Sand
4	7.93	2.85	1.94	Sand
5	12.8	4.91	297	Groundwater

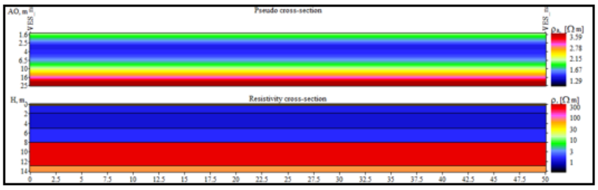

Fig. 5. Modelling the cross-section of point 2 of Sasa Village

3.4.2. Lithology Analysis (Laying)

• The first zone, the surface zone, measures 0.271 cm in depth, 0.271 m in thickness, and 50.4 Ωm in resistivity. Alluvium material and alternating material are both present in the first zone.

• The second to fourth zones' depth, thickness, and resistivity is 1.87 m–7.93 m, 1.6 m–2.85 m, and 1.51 Ωm–1.94 m, respectively. Sand is present.

• The fifth zone has a resistivity value of 297 Ωm, a thickness of 4.91 m, and a depth of 12.8 m. The fifth zone is the subsurface.

4 Conclusion

There are multiple strata of subsurface lithology at two places, including alluvium, sand, gravel, and andesite, at depths of 25 meters and track lengths of 50 and 100 meters, respectively. The outcomes of data processing at the two sites where data were collected are shown. The resistivity curve to depth and the resistivity table reveals groundwater is not present at position 1, Gambesi Village. Alluvial is difficult to store and release water; however, in position 2, Sasa Sub-District, there is likely groundwater. This is because the location is in a hilly region, and the material tends to be alluvial and andesite. Sand and gravel, as well as some groundwater, make up the majority of the subsurface composition. Sounding point 1 is located at a depth of 12.8 m, has a thickness of 6.24 cm, and a resistivity value of 0.57 Ωm, while sounding point 2 is located at a depth of 12.8 m, has a thickness of 4.91 m, and a resistivity value of 297 Ωm. Sand has good porosity to store and pass water. This region slopes down from this position.

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