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Study of Potential Groundwater Aquifers with Schlumberger Configuration Geo-electric Method in Palanggai Village East Sumba Regency

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Groundwater is one source of water needed for the life of creatures on earth. The presence of groundwater is not evenly distributed for every place and is strongly related to its geological and geohydrological conditions. The research location is in Palanggai Village, East Sumba Regency, East Nusa Tenggara Province. Monthly rainfall according to BMKG climatology data in 2005 - 2013 was highest in December, which was 176.78 mm and the lowest was in August at 0.44 mm. This research was conducted to find out about the subsurface layer. Existing groundwater or aquifer carriers are using the geo-electric approach of the Schlumberger method. From the results of the study it can be concluded that (1) geo-electric estimation has been able to provide an overview of the state of the rock layers both vertically and laterally, (2) hydrogeological conditions in the investigation area, including aquifer systems with small to moderate productivity and is widespread, (3) rocks which are expected to be able to act as a limestone and limestone sand aquifer, (4) From the results of a geo-electric estimation investigation, it can be seen that the aquifer layer is found in depths ranging from 10-110m.

Key words: *Groundwater, aquifer, hydrogeology, geo-electric, Schlumberger.*

Introduction

Groundwater is one source of water that is needed for the life of creatures on earth. The presence of groundwater is not evenly distributed for every place and is strongly related to its geological and geohydrological conditions. Therefore, the provision of clean water by utilizing ground water must be done through a study of the potential of groundwater in the area concerned.

Although groundwater cannot be directly observed through the surface of the earth, ground surface investigations are an important start of investigation, and can give a picture of the location and the presence of the groundwater. Although groundwater can't be directly observed on the earth layer, the soil layer investigation is the important beginning; it is just used for described the groundwater location.

The research location is in Palanggai Village, East Sumba Regency, East Nusa Tenggara Province. Monthly rainfall according to BMKG climatology data in 2005 - 2013 was highest in December at 176.78 mm and the lowest was in August at 0.44 mm. The number of monthly rainy days ranges from 1-19 days, monthly air humidity ranges from 70-81%, monthly air temperatures range from 25-28˚C, monthly wind speeds range from 131-181mile / day and monthly solar radiation ranges from 49-94%.

It appears that unsaturated air humidity always occurs in the area of Waingapu and its surroundings. If combined with solar radiation, where solar radiation is high (above 80%) in May to November, it can be estimated that water evaporation will be high in these months. Also if you see a relatively high wind speed throughout the year, evaporation will certainly be high. Therefore, it is necessary to look for water sources other than rainwater and surface water, namely the potential of groundwater sources.

Several methods for investigating groundwater potential can be carried out, including: geological methods, gravity methods, magnetic methods, seismic methods, and geo-electric methods. From these methods, the geo-electric method is a method that is very widely used and the results are quite good (Bisri, 1991). This study was conducted to determine the subsurface layer of the soil, so that it can be seen that there are layers of groundwater or aquifer present using a geo-electric approach.

This geo-electric estimation is intended to obtain an overview of the subsurface soil layer and the possibility of groundwater and minerals at a certain depth. This geo-electric estimation is based on the fact that different materials will have different types of resistance when electric current is flowed. Groundwater has a lower resistance than mineral rocks. Some studies related to this geo-electric estimation include: investigations to find out the distribution of

coal minerals (Azhar, et al., 2003) and investigations of underground water exploration (Ali M.N, et al., 2003).

Figure 1. Location of groundwater observation points by geo-electric method

Literature Review

In principle, geo-electric estimation utilizes the electrical properties of rocks against the physical properties of the rock itself by injecting a direct current into the earth through current electrodes, which are plugged in on the earth's surface, and then measuring the potential difference generated through potential electrodes plugged into the earth's surface based on certain electrode configuration. Geo-electric measurements are carried out with 2 electrodes as the sender of electric current into the earth and 2 electrodes to measure the potential difference on the surface due to electric current injection / transmission. The electrode distance determines the depth range of the measured layer.

The potential difference between the two electrodes is measured by volt meters and, from the measurement price, can be calculated the resistance of all types of rocks using the following formula (Anonym, 1992 and Todd, 1980):

$$\rho = 2.\pi.a.\frac{V}{I}$$

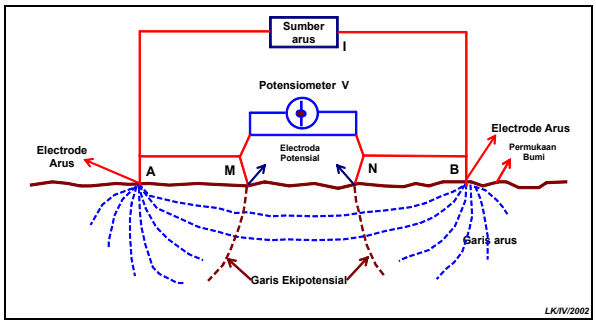
Where ρ is type resistance, 2π is a constant, V is the potential difference and 'a' is the electrode distance.

The measurement procedure for each configuration depends on the variation of resistivity to depth which is in the direction of vertical (sounding) or lateral direction (mapping) (Derana, 1981). The resistivity method with Schlumberger configuration is done by conditioning the spacing between potential electrodes while the spacing between the electrodes flows gradually (Sheriff, 2002). Vertical Electrical Sounding (VES) is one of the geo-electric resistivity methods to determine changes in soil resistivity to depth which aims to study rock resistivity variations below the earth's surface vertically (Telford, et al., 1990).

Method

In this study, the configuration of Schlumberger electrodes was used because the target was made as an object in the form of water-bearing rock layers (aquifer). Schlumberger electrode configuration places the electrode arrangement, where 2 (two) potential electrodes (MN) are placed between 2 (two) current electrodes (AB). At the time of measurement, the current electrode (AB) and the potential electrode (MN) are moved according to a predetermined distance, provided the potential electrode distance (MN) is ≤ 1/5 current electrode (AB).

Figure 2. Electrode arrangement of Schlumberger method



The resistivity survey will give an idea of the subsurface resistivity distribution. The price of a certain resistivity will be associated with certain geological conditions. To convert resistivity prices into geological forms, knowledge of the typical resistivity price for each material type and structure of the survey area is needed. The resistivity prices of rocks, minerals, soil and chemical elements in general have been obtained through various measurements and can be used as a reference for the conversion process (Telford, et al., 1990).

Figure 3. Geoelectric observation equipment

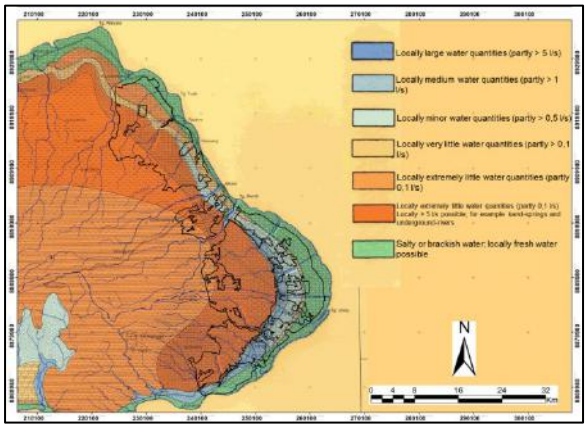
Figure 4. Electrode planting Schlumberger method

Figure 5. Recording of voltage

Result and Analysis

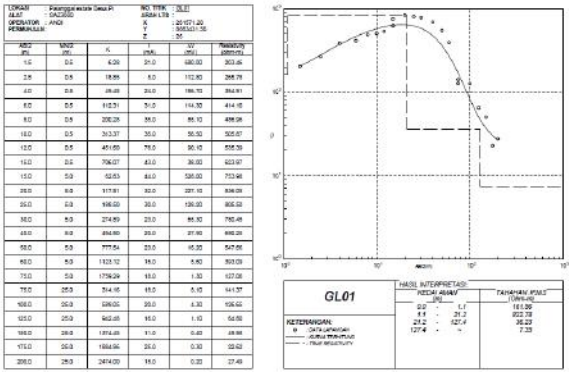
Based on the analysis of the hydrogeological map for East Sumba locations in general the potential for underground water is small between 0.1-0.5 litres / second with several possible underground rivers (local not one region) with a flow of 5 litres / second in some areas marked with a red shading box. Whereas in the geological area of East Sumba the base layer of the soil is formed from the limestone structure of the reef (Saudi et al., 2019).

Figure 6. Hydrogeological map of East Sumba Region



Measurements of the type of detainees at the study site were measurements of apparent type resistance. The quasi-type prisoner data is processed or inversed with mathematical equations to obtain the actual type of resistivity value (Jabarullah, Aziz, & Shah, 2019).

Figure 7. The geoelectric observation measurement data curve



The interpretation of the curve obtained is done in two stages, namely:

- **The first stage**

  Curve matching is done by matching the field curve with the auxiliary curve and calculated theoretically so as to produce the price of the resistance of the actual type (ρs) and the thickness of each layer.

- **Second stage**

To improve accuracy and interpretation, so that misinterpretations can be minimized then using the Resoma Interpretation Program computer program used in the interpretation of data compiled by Yeah.

From the results of the interpretation and analysis of the field curve which is then correlated with the geological data of the local area, it can be concluded that the price of the type of

prisoners at the location of the investigation ranged from 6 - 3000 Ohm – meters (Sinaga et al., 2019).

Table 1: Resistivity Interpretation

Resistivity	Interpretation	Hydrogeology
< 10	Clay	
10 – 20	Sandy Clay Limestone	Aquitar
20 – 100	sand	Aquifer/Surface Water
100 – 500	Lime	
500 >	Limestone	

The result of data processing is obtained in the form of resistivity cross sections which describe the value of the subsurface layer distribution at each point of the sounding. In the resistivity cross section, changes in resistivity values are expressed in the form of different colour images - different from the depth or thickness of a particular layer according to the resistivity value.

Figure 8. Several vertical cross-section of data interpretation results

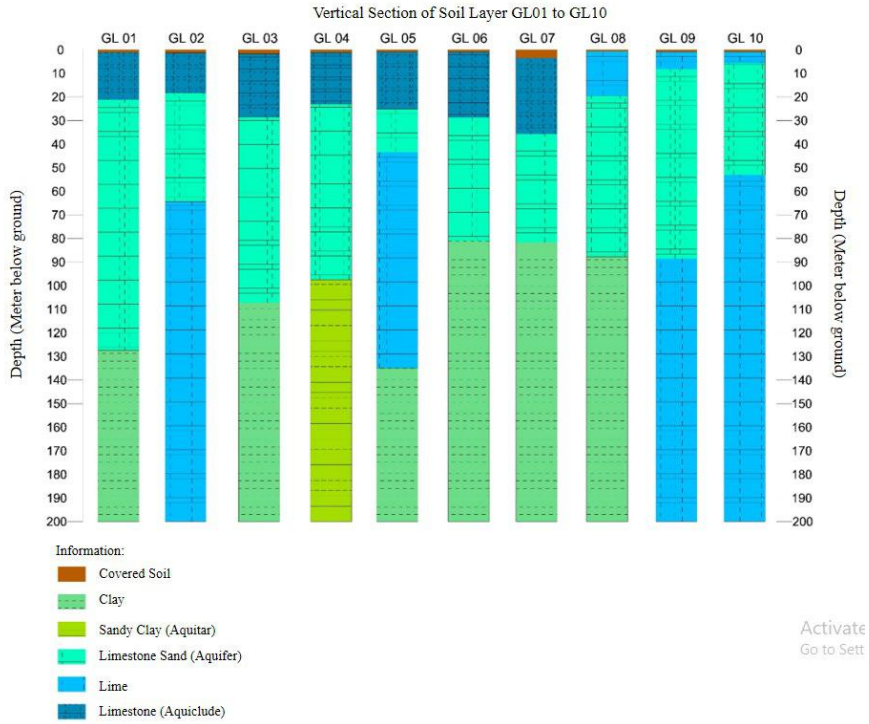


Figure 9. One 2D cross section of data interpretation results

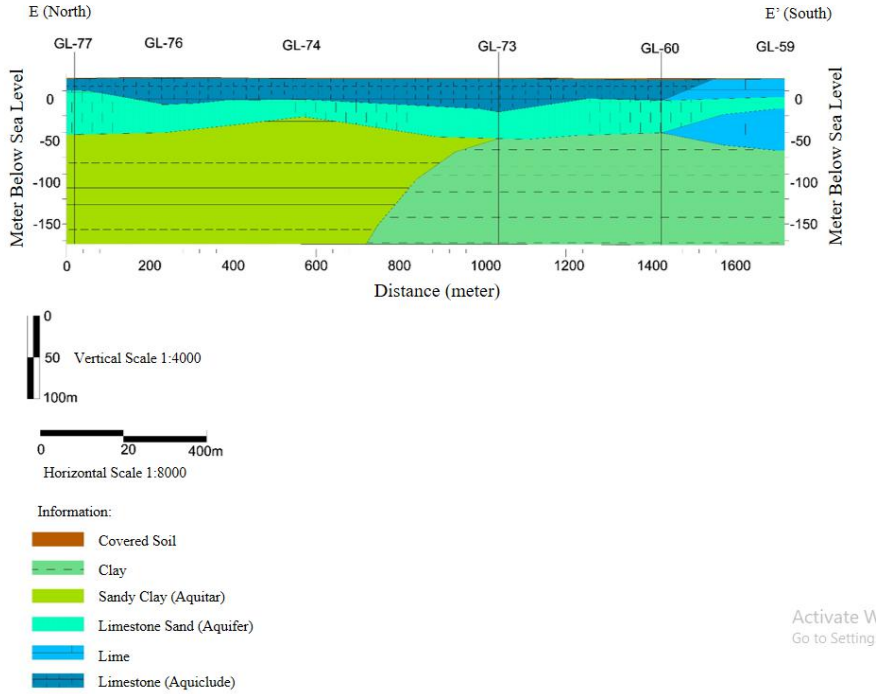


Table 2. Some Results of Data Interpretation

Poin	Layer	Interpretation				Litology
		Depth			Resistivity	
GL.1	1	0.00	-	1.10	161.56	Covered Soil
	2	1.10	-	21.20	822.78	Limestone
	3	21.20	-	127.40	36.23	Limestone sand
	4	127.40	-	~	7.35	Clay
GL.2	1	0.00	-	1.40	171.58	Covered Soil
	2	1.40	-	18.40	1784.91	Limestone
	3	18.40	-	64.40	36.01	Limestone sand
	4	64.40	-	~	301.82	Lime
GL.3	1	0.00	-	1.80	274.90	Covered Soil
	2	1.80	-	28.50	864.81	Limestone
	3	28.50	-	107.20	26.43	Limestone sand
	4	107.20	-	~	7.48	Clay
GL.4	1	0.00	-	1.10	151.10	Covered Soil
	2	1.10	-	23.00	1049.00	Limestone
	3	23.00	-	97.50	76.03	Limestone sand
	4	97.50	-	~	14.68	Limestone sand
GL.5	1	0.00	-	1.00	74.01	Covered Soil
	2	1.00	-	25.00	720.40	Limestone

Poin	Layer	Interpretation				Litology
		Depth			Resistivity	
	3	25.00	-	43.40	40.03	Limestone sand
	4	43.40	-	134.90	167.02	Lime
	5	134.90	-	~	9.59	Clay

Conclusion

From the results of the interpretation and discussion above, the following can be concluded:

1. Geo-electric estimation can provide an overview of the state of the rock layers both vertically and laterally.
2. Hydrogeological conditions in the investigation area, including in the Aquifer system with small to moderate productivity and is wide spread.
3. Rocks that are expected to act as aquifers. Sand and limestone sand.
4. From the results of the geo-electric estimation investigation, it can be seen that the aquifer layer is in the depth of 10-110m

Suggestion

1. From the results of geo-electric measurements at the location and those that have been analyzed in the field and adapted to the local hydrogeological map, the location of geo-electric measurements can be done by drilling deep wells around all points of estimation (priority scale) with drilling depths of ± 60-120 meters.
2. After drilling is completed in the selected location, it is recommended to conduct a well investigation, to determine the position of the screen / filter in the layer of the aquifer to be tapped.

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