DETECTION OF GROUNDWATER POTENTIAL USING GEOELECTRICITY IN KRACAK VILLAGE, AJIBARANG DISTRICT, BANYUMAS REGENCY

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Abstract. This study aims to understand the type and arrangement of rock layers below the earth's surface and the aquifer, along with their thickness, which has groundwater potential. This study is located in the Kracak Village, Ajibarang District, Banyumas Regency. Three specific point locations (namely, Kracak-1, Kracak-2, and Kracak-3) have been selected to investigate the groundwater potential using a Geoelectricity method with a Schlumberger electrode configuration consisting of 4 sounding points. Based on the analysis and interpretation of the geoelectric survey, all geoelectric points have the potential for groundwater but vary in thickness. In addition, the best location point for drilling a well is at the Kracak-2, considering the thickest aquifer ranging from around 21 to 58 meters. The Kracak-2 well was drilled to a depth of 70 meters. The casing design for the drilled well at the Kracak-2 point can be made at a depth of 20-60 (10 casing screen pipes).

Keywords: groundwater, water resources, geoelectricity

1. Introduction

Water resources are a vital human need for household, industrial and village community needs. Meanwhile, the availability of surface water as a source of demand is decreasing or limited. To overcome water shortages, one way is by utilizing groundwater sources through investigations, including by estimating subsurface geology through geophysical methods with geoelectric measurements.

A geoelectrical investigation is a geophysical method commonly used to estimate subsurface geological conditions based on the physical properties of rocks in response to electric current flowing into them. The physical properties of rocks in response to electric currents depend on their compactness (hardness), the size of the rock grains and the content of dissolved substances in water or electrolyte solutions. From the data on rocks' physical and electrical properties in resistivity values, each is grouped and interpreted by considering local geological conditions.

This activity aims to conduct a geoelectrical survey to search for profound groundwater potential for the needs of the village population. The objectives to be achieved in this activity are 1) knowing the type and arrangement of rock layers below the surface and 2) knowing the water-bearing layers (aquifer or aquitard) along with their thickness, which has the potential to act as a groundwater-carrying layer.

With the completion of this geoelectric survey activity, the expected output, as a result, is as follows: 1) Availability of subsurface geological data and information at the location of the measurement point, 2) Availability of subsurface interpretation results through estimating resistivity values to obtain zones. -zones that have the potential to become groundwater aquifers.

2. Methods

2.1 Study location

The geoelectric survey activity was held on Saturday, July 29 2023, in Kracak Village, Ajibarang District, Banyumas Regency, with 3 (three) geoelectric points as follows.

Table 1. Study locations

No	Name	Latitude	Longitude	Information
1	Kracak-1	-7406632	109.058274	Next to the durian garden
2	Kracak-2	-7407748	109.0555146	Near the public bathing spring
3	Kracak-3	-7403281	109.060568	On the side of the road leading to the Islamic boarding school

2.2 Regional Geological Condition

Based on the Purwokerto-Tegal Geological Sheet map scale 1:100,000, Kracak Village, Ajibarang District, Banyumas Regency is included in 4 rock formations, namely the Halang Formation in the North, the Tapak Formation in the Middle, the Limestone Formation Member Tread in the South and Volcanic Rocks of Mount Slamet in the East (Figure 1). The Halang Formation comprises interbedded sandstone-mudstone lithologies and intercalations of marl and limestone. The sandstone and mudstone generally contain tuff. The Tapak Formation comprises calcareous marl with intercalations of calcareous sandstone containing mollusc fragments. The Limestone Member of the Tapak Formation includes lenses of yellowish-grey unlayered limestone, and the Mount Slamet Volcanic Rock consists of volcanic breccia, lava and tuff.

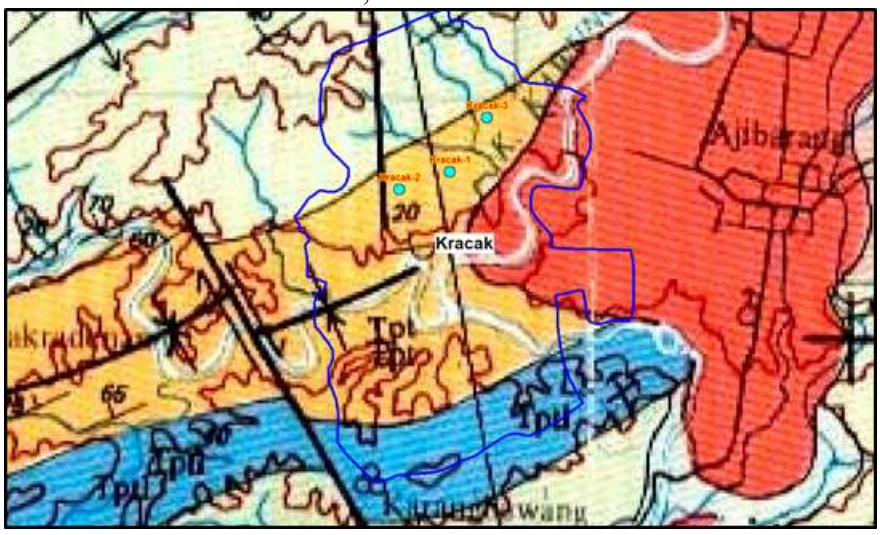

Figure 1. Research location (*blue curve*) on the Geological Map Sheet of Purwokerto-Tegal

The geological conditions of the research area determine the groundwater potential of a site. Geoelectric surveys function to estimate the geological conditions below the surface so that we can find out whether, below the surface, some aquifers have the potential to produce groundwater. However, this geoelectric survey cannot change the natural condition of the rock, so if there are areas where there is no profound groundwater potential, then other strategies are needed to meet water needs in that area.

2.3 Method

The method used in Geoelectrical Survey work to investigate profound groundwater potential is the Survey Method, which collects primary data in the field and is supported by existing secondary data. One of the survey methods used is the geoelectric method with the Schlumberger/Vertical Electrical

Sounding Method configuration to estimate subsurface geological conditions based on the resistance properties of rocks and fluids.

Preparation

At this stage, the activities include a Literature study, a Review of base maps/previous reports, Personnel preparation, Tools preparation, and Licensing preparation.

Field orientation work

Preparatory activities for field survey work and ground-check primary map data with field conditions include Secondary data collection, Field orientation and observation of general geological and hydrogeological conditions, Planning geoelectric measurement locations, planning geoelectric measurement routes, and determining geoelectric measurement points.

Fieldwork (surveys and geolectric measurements)

1. Observation of geological and hydrogeological conditions
   Observations and collection of geological and hydrogeological data are carried out by making direct observations in the field. Data collected from geological and hydrogeological observations are morphological conditions and lithological conditions. These data are to support data analysis of geoelectric measurement results.
2. Geoelectrical surveys and measurements
   Geoelectric survey is a geophysical method for estimating subsurface geological conditions based on the electrical properties of rocks and fluids. From the data on the electrical properties of rocks in the form of resistivity, each is grouped and interpreted by considering existing data on local geological conditions. Measuring the resistivity of rocks below the ground surface using the Schlumberger / Vertical Electrical Sounding (VES) method aims to determine variations in the vertical arrangement of underground rock layers by providing an electric current into the ground and recording the measured potential differences.

Geoelectric survey is a geophysical method for estimating subsurface geological conditions, especially the type and nature of rocks, based on the electrical properties of rocks. From the data on the electrical properties of rocks in the form of resistivity, each is grouped and interpreted by considering existing data on local geological conditions. Measuring the magnitude of the resistivity of rocks below the ground surface using the Schlumberger Vertical Electrical Sounding (VES) method aims to determine variations in the vertical arrangement of underground rock layers by providing an electric current into the ground and recording the measured potential differences.

The Schlumberger configuration is a configuration with current electrodes A and B kept at the same distance at opposite positions from the centre of measurement and is denoted as AB. Meanwhile, the potential electrodes M and N are located between the current electrodes A and B at the same distance in opposite positions to the central point of measurement, denoted as MN. The description of the current and potential electrode configuration in geoelectric sizes using the Schlumberger method is shown in Figure 2.

The rock resistivity value measured directly in the field is the apparent resistivity value. Therefore, the resistivity value in the area must be calculated and analyzed to obtain the actual resistivity value. The method used is the Schlumberger method, using the calculation formula.

$$\rho a = K \frac{\Delta V}{I}$$

$$K = \frac{\Pi}{MN}\left[(AB/2)^2 - (MN/2)^2\right]$$

Where ρa: the value of apparent resistivity (ohm meter), ΔV: potential difference (milli Volts) I: current (milliAmpere), K: Schlumberger Geometric Factor, AB: current electrode distance (meters), MN: potential electrode distance (meters).

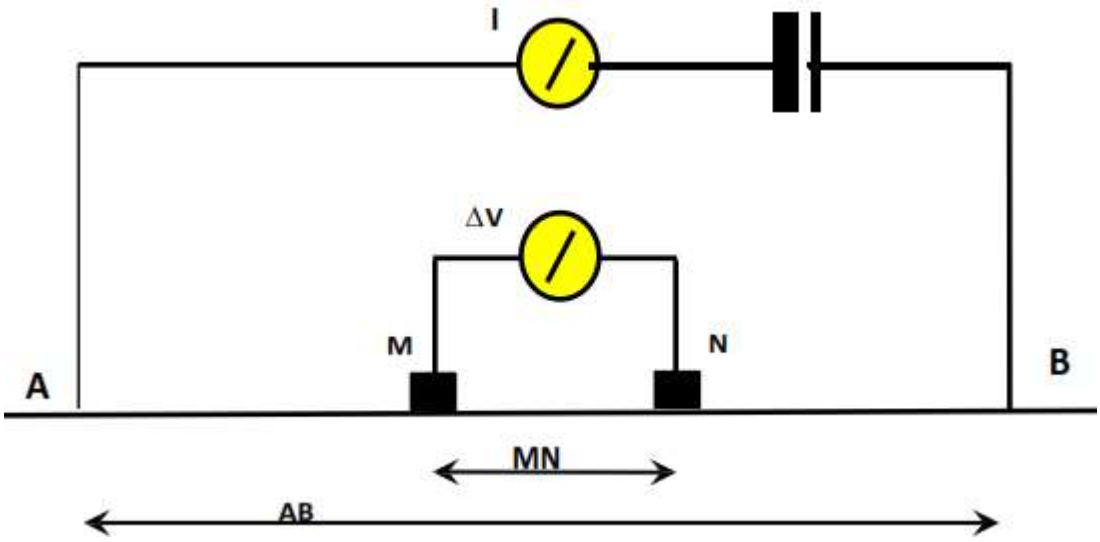

Figure 2. Geoelectric survey scheme using the Schlumberger method

Data Analysis and Processing

1. Analysis based on geological, hydrogeological and geoelectrical data processing results.
2. Presentation of analysis results in images/graphs and interpretation of lithology logs, which contain the results of measurements and evaluation of primary and secondary data in the field. This analysis includes an analysis of geoelectric measurement data so that a qualitative picture of the groundwater potential at the geoelectric measurement location can be obtained.

3. Result and Discussion

Geoelectric measurements were carried out in Kracak Village, Ajibarang District, Banyumas Regency, at 3 (three) points. The geoelectric issues in Kracak Village are coded Kracak-1 to 3 according to the sequence of implementation in the field.

3.1. Analysis and Interpretation of Geoelectric Data at Point Kracak-1

Kracak-1 point is located next to the durian garden in Hamlet 1, Kracak Village, Ajibarang. Around this point, there is already a former gold mining well that was dug to a total depth of 15 meters and is already producing groundwater.

Figure 3. Kracak-1

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Field data for the Kracak-1 point is given in Table below as follows:

Table 2. Field data from Geoelectric measurements at Point Kracak-1

DATA PENGUKURAN TAHANAN JENIS (OBSERVER'S LOG)
Metode Schlumberger / Vertical Electrical Sounding (VES)

KEGIATAN : Penyelidikan Airtanah Dalam dengan Metode Geolistrik
Operator :
LOKASI : Desa Kracak, Kecamatan Ajibarang, Kabupaten BANYUMAS
TANGGAL : 29 July 2023
NO. TITIK : Kracak-1
KOORDINAT : 109.058274, -7.406632
ELEVASI : 164
ALAT : Resistivity Meter

$$\rho a = G\frac{\Delta V}{I} \qquad G = \frac{\Pi}{MV}\left[(AB/2)^2 - (MN/2)^2\right]$$

No	AB/2 (m)	MN/2 (m) 0.5	2.5	5	10	25	50	I (mA) 1	2	3	ΔV (mV) 1	2	3	Rho app Ohm-M 1	2	3	rata rata
		Faktor Geometri (G)															
1	1.5	6.29						144	144		685.5	685.5		29.92	29.92		29.92
2	2.5	18.86						142.7	142.6		141.6	137.3		18.71	18.16		18.43
3	5		11.79					144.1	144.3		137	137.3		11.21	11.21		11.21
4	7.5		31.43					114.1	113.6		38.3	35.2		10.55	9.74		10.14
5	10		58.93					143.4	144.4		23.7	23.6		9.67	9.63		9.65
6	12.5		94.29					144.1	144.1		13.8	13.9		9.03	9.09		9.06
7	15			62.86				144	144.2		18.3	19		7.99	8.28		8.14
8	20			117.86				145.8	145.9		10.4	10.4		8.41	8.40		8.40
9	25			188.57				145.1	145.2		6.8	6.8		8.84	8.83		8.83
10	30				125.72			145.1	145.2		9.8	9.8		8.49	8.48		8.49
11	40				235.71			138.9	138.9		5.6	5.6		9.50	9.50		9.50
12	50				377.14			143.4	253.1		3.6	6.5		9.47	9.69		9.58
13	75					314.29		159.7	159.5		5.4	5.3		10.63	10.44		10.54
14	100					589.29		283.4	283.2		5.2	5.3		10.81	11.03		10.92
15	125					942.86		276	275.9		3.5	3.2		11.96	10.94		11.45
16	150						628.57	85.3	86		1.6	1.7		11.79	12.43		12.11
17	200						1178.57	134.4	134.7		1.1	1.2		9.65	10.50		10.07

Then, it is processed using Progress software to get a resistivity value that is close to the actual one.

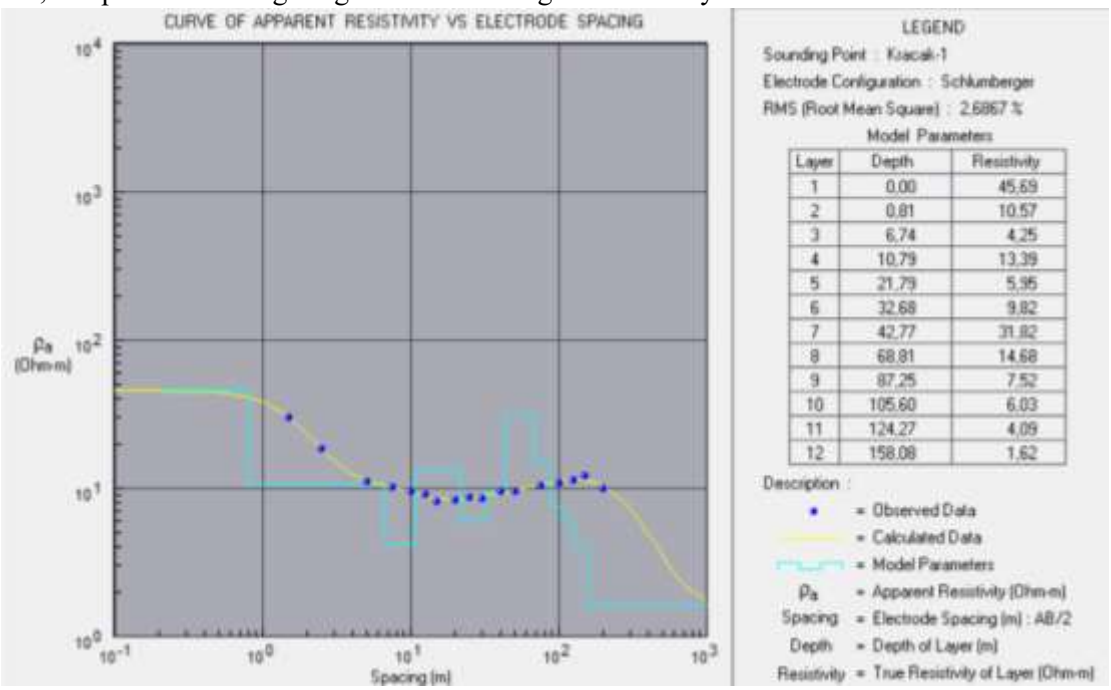

Figure 4. Inversion results of resistivity values at Point Kracak-1

Then a lithology log is made from the results of the interpretation of the resistivity values as follows.

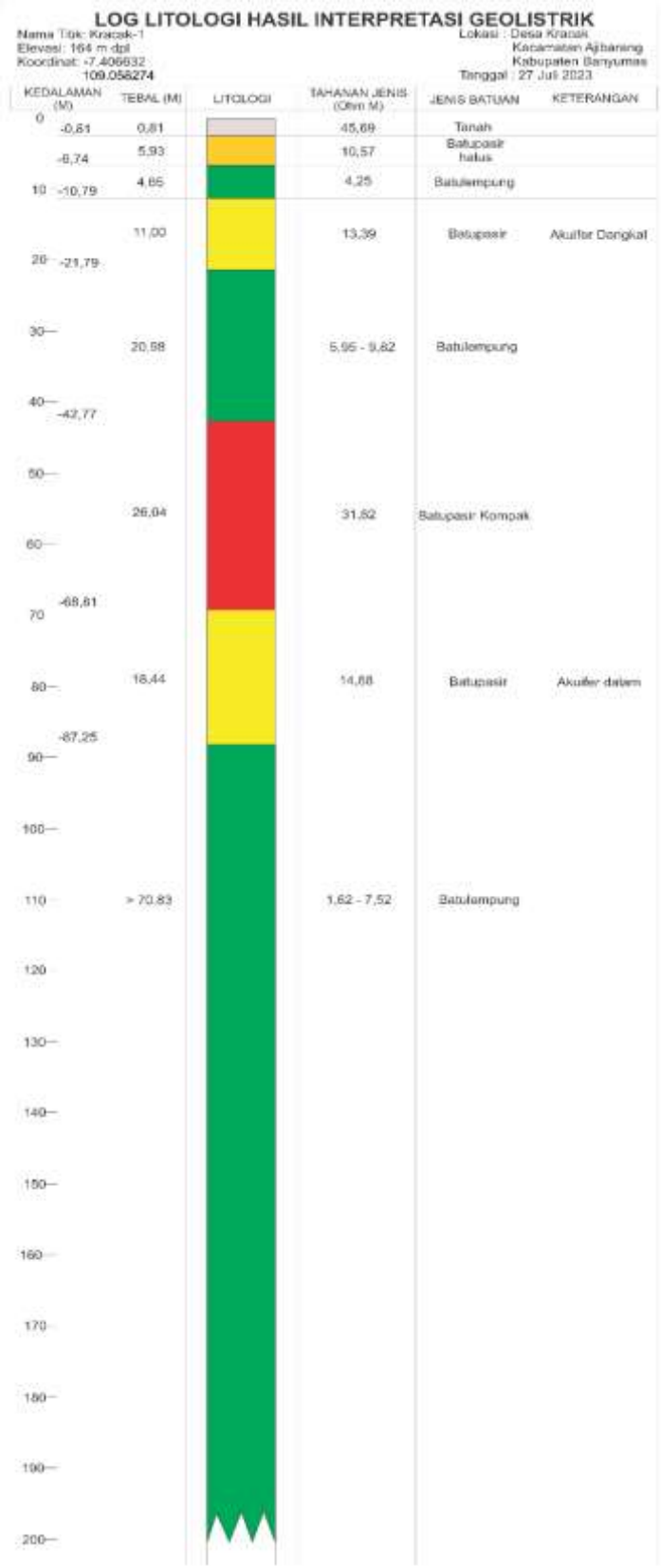

Figure 5. Lithology column resulting from the interpretation of geoelectric data at Kracak-1 point

3.2. Analysis and Interpretation of Geoelectric Data at Point Kracak-2

Point Kracak-2 is located near a spring near the public baths in Hamlet 1, Kracak Village, Ajibarang. The situation photo is as follows.

Figure 6. Photo of the situation around the Kracak-2 point

Around the Kracak-2 point, there are several springs, and residents use the largest one for bathing and washing clothes. This spring arises due to the slope being cut by a fault so that shallow groundwater emerges as a spring.

Several things that must be considered if you are going to drill around this point are that the location of the drill point must be at the bottom of the slope from the spring point so that the spring water supply is not disturbed. Then, it would be better to close the upper casing so that the drill point only takes groundwater from deep layers that are not connected to the shallow groundwater from the spring.

For the Kracak-2 point, the field data is as follows.

Table 2. Field data from geoelectric measurements at Point Kracak-2

DATA PENGUKURAN TAHANAN JENIS (OBSERVER'S LOG)
Metode Schlumberger / Vertical Electrical Sounding (VES)

KEGIATAN	: Penyelidikan Airtanah Dalam dengan Metode Geolistrik							NO. TITIK			Kracak-2									
Operator	:							KOORDINAT			109.055146									
											-7.407748									
LOKASI	: Desa Kracak																			
	Kecamatan Ajibarang							ELEVASI			148									
	Kabupaten BANYUMAS																			
								ALAT			: Resistivity Meter									
TANGGAL	: 29 July 2023																			

No	AB/2 (m)	MN/2 (m)						I (mA)			ΔV (mV)			Rho app Ohm-M			rata rata
		0.5	2.5	5	10	25	50										
		Faktor Geometri (G)						1	2	3	1	2	3	1	2	3	
1	1.5	6.29						146.9	146.9		190.2	190.1		8.14	8.13		8.14
2	2.5	18.86						146.8	146.8		56.4	56.3		7.24	7.23		7.24
3	5		11.79					147	147		84.1	79.5		6.74	6.37		6.56
4	7.5		31.43					146.6	146.7		28.7	28.6		6.15	6.13		6.14
5	10		58.93					146.5	146.5		15.1	15.1		6.07	6.07		6.07
6	12.5		94.29					146.6	146.7		8.9	8.8		5.72	5.66		5.69
7	15			62.86				145	145		14.2	14.8		6.16	6.42		6.29
8	20			117.86				144.4	144.5		8.8	8.9		7.18	7.26		7.22
9	25			188.57				146.1	146.2		6	6.2		7.74	8.00		7.87
10	30				225.71			146	146		9.2	8.4		7.92	7.23		7.58
11	40				235.71			145.8	145.8		5.2	5		8.42	8.09		8.26
12	50				377.14			145.9	146		4.1	4		10.60	10.33		10.47
13	75					314.29		145.6	145.7		5.6	5.5		12.09	11.86		11.98
14	100					589.29		121.9	122.2		2.3	2.4		11.12	11.57		11.35
15	125					942.86		257.7	257.7		3.4	3.6		12.44	13.17		12.81
16	150						628.57	253.4	252.9		4	4		9.92	9.94		9.93
17	200						1178.57	165.5	165		1.3	1.4		9.26	10.00		9.63

Then it is processed using Progress software to get a resistivity value that is close to the actual one using the following inversion method.

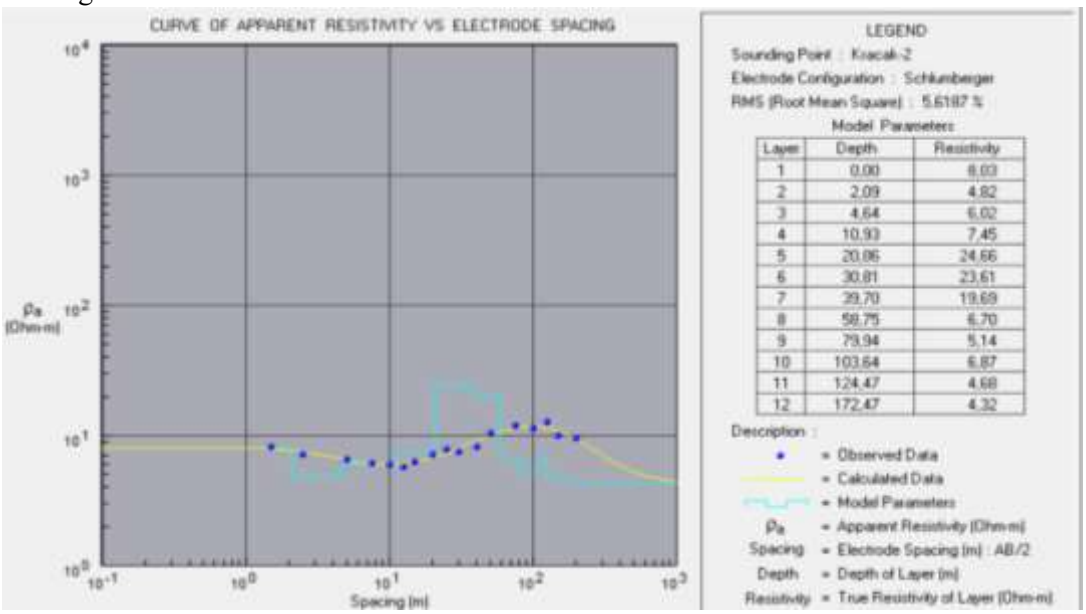

Figure 7. Inversion results of resistivity values at Point Kracak-2

Then the rocks are interpreted and a lithology column is created as follows.

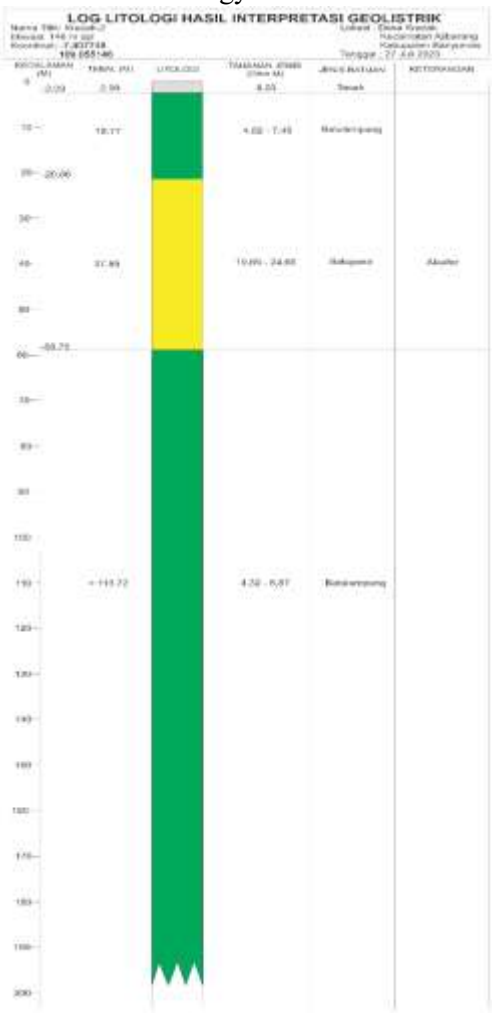

Figure 8. Lithology column resulting from interpretation of geoelectric data at Kracak-2 point

3.3. Analysis and Interpretation of Geoelectric Data at Point Kracak-3

Point Kracak-3 is on the side of the road north of Kracak Village, which leads to the Kracak Village Islamic Boarding School. The photo of the situation is as follows. This location is close to the "Bengkok" rice fields of Kracak Village which are located in Hamlet 3, Kracak Village, Ajibarang. If drilling is carried out around this location, road and electricity access tends to be very easy because it is close to road access and electricity access. Permitting is also relatively easy because the land belongs to the village, so the bureaucratic process is more accessible. Kracak-3 point field data is as follows.

Figure 9. Photo of the situation around the Kracak-3 point

Tabel 3. Field data from Geoelectric measurements at Point Kracak-3

DATA PENGUKURAN TAHANAN JENIS (OBSERVER'S LOG)
Metode Schlumberger / Vertical Electrical Sounding (VES)

KEGIATAN : Penyelidikan Airtanah Dalam dengan Metode Geolistrik
Operator :
LOKASI : Desa Kracak, Kecamatan Ajibarang, Kabupaten BANYUMAS
TANGGAL : 29 July 2022
NO. TITIK : Kracak-3
KOORDINAT : 109.060568, -7.408281
ELEVASI : 138
ALAT : Resistivity Meter

$\rho a = G\frac{\Delta V}{I}$

$G = \frac{\Pi}{MN}\left[(AB/2)^2 - (MN/2)^2\right]$

No	AB/2 (m)	MN/2 (m)						I (mA)			ΔV (mV)			Rho app Ohm-M			rata rata
		0.5	2.5	5	10	25	50	1	2	3	1	2	3	1	2	3	
		Faktor Geometri (G)															
1	1.5	6.29						143.3	143.5		478.2	482.2		20.98	21.12		21.05
2	2.5	18.86						143.7	143.8		74.8	74.9		9.82	9.82		9.82
3	5		11.79					128.3	128.1		51.8	51.9		4.76	4.78		4.77
4	7.5		31.43					141.7	141.8		16.3	16.3		3.62	3.61		3.61
5	10		58.93					144.7	144.7		9.3	9.2		3.79	3.75		3.77
6	12.5		94.29					143.5	143.5		6.2	6.3		4.07	4.14		4.11
7	15			62.86				144.8	144.8		8.9	8.5		3.86	3.69		3.78
8	20			117.86				132.7	132.3		5	4.9		4.44	4.37		4.40
9	25			188.57				145.7	145.7		3.2	3.3		4.14	4.27		4.21
10	30				125.71			145.7	145.7		5.7	5.7		4.92	4.92		4.92
11	40				235.71			189.7	190.5		3.7	3.7		4.60	4.58		4.59
12	50				377.14			204.5	204.1		2.5	2.4		4.61	4.43		4.52
13	75					314.29		253	252.4		2.3	2.3		2.86	2.86		2.86
14	100					589.29		153.8	154.3		0.5	0.6		1.92	2.29		2.10
15	125					942.86		290.6	290.7		0.7	0.6		2.27	1.95		2.11
16	150						628.57	275.7	275.7		1.4	1.3		3.19	2.96		3.08
17	200						1178.57	289	289		0.8	1		3.26	4.08		3.67

Then it is processed into near-actual resistivity data with the Progress software as follows.

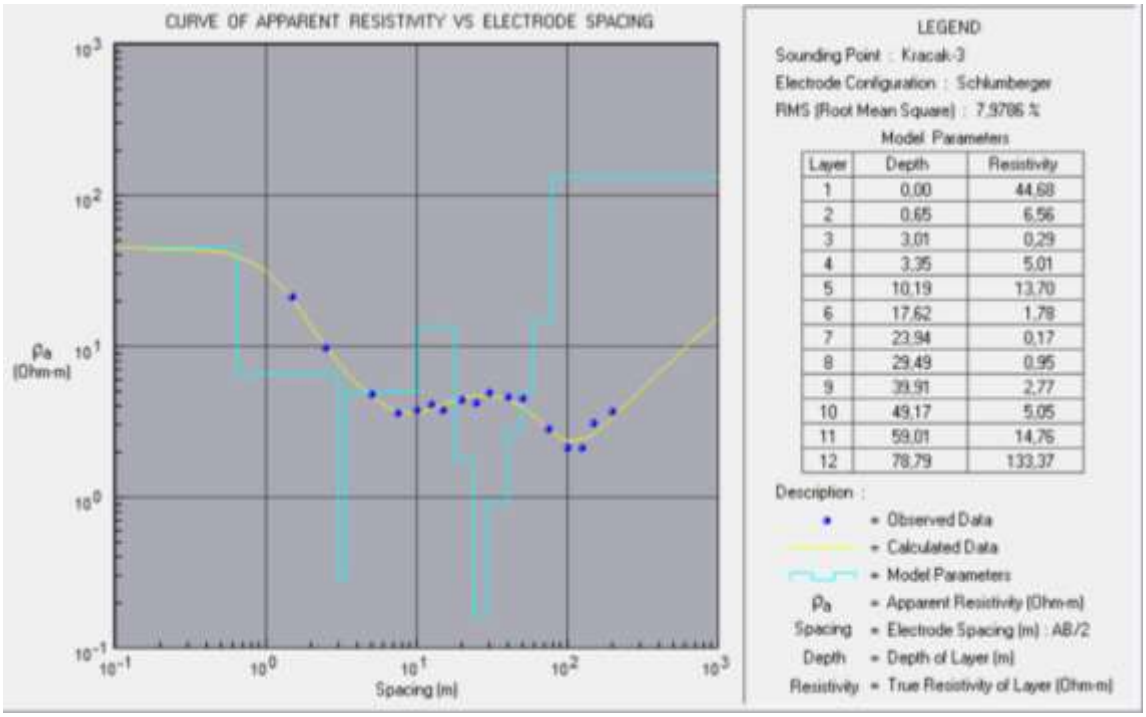

Figure 10. Inversion results of resistivity values at Point Kracak-3

Then the rocks are interpreted and a lithology column is created as follows.

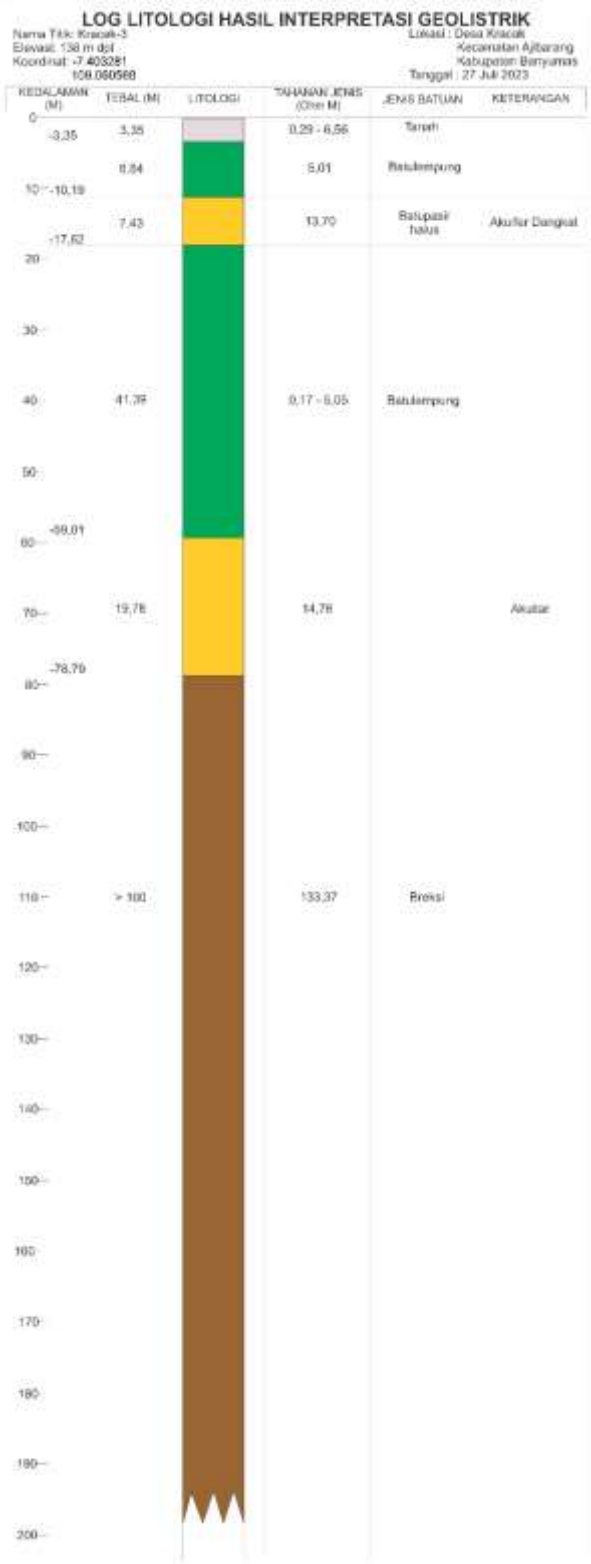

Figure 11. Lithology column resulting from interpretation of geoelectric data at Kracak-3 point

The locations of geoelectric points on the earth's map are as follows.

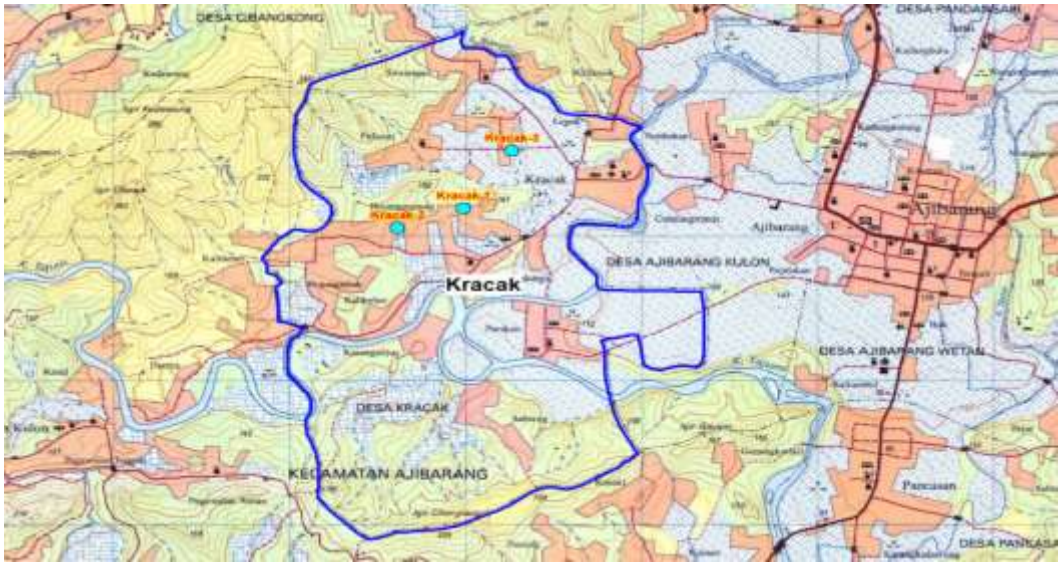

Figure 12. Earth Map showing current geoelectric points (light blue)

Based on the lithology log from geoelectric points Kracak-1 to 3, the best is point Kracak-2, which is near the spring and public baths in Hamlet 1, Kracak Village, Ajibarang. This is because the Kracak-2 point has the thickest and relatively shallow aquifer. The estimated depth is the aquifer at a depth of around 21 m – 58 m with an aquifer thickness of approximately 40 meters. In terms of elevation, it is also sufficient for the gravity system to reach the destination hamlet, which is to the south.
The design plan for the Kracak-2 point well is planned to be 70 meters deep with a design drawing as follows:

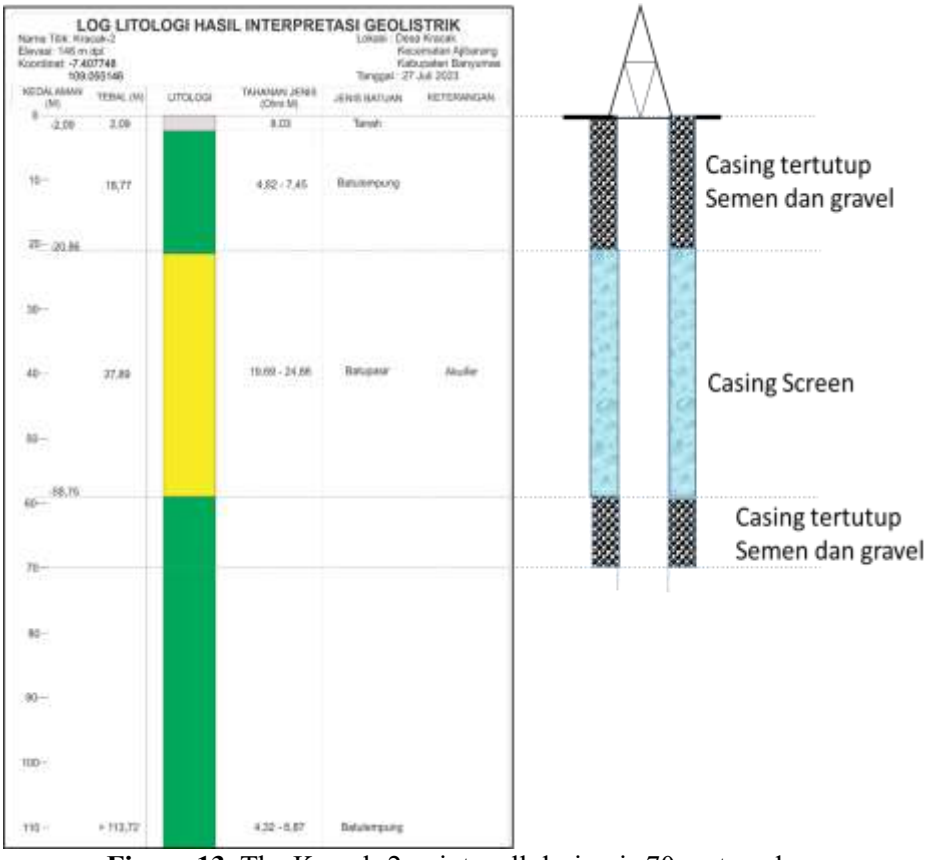

Figure 13. The Kracak-2 point well design is 70 meters deep

4. Conclusion

Based on the results of the analysis and interpretation of the geoelectric survey in Kracak Village, Ajibarang District, Banyumas Regency, several conclusions can be drawn as follows:

1. All geoelectric points have the potential for groundwater but vary in thickness
2. The best point for drilling a well is at the Kracak-2 point, considering the thickest aquifer ranging from around 21 meters to 58 meters
3. The Kracak-2 well was drilled to a depth of 70 meters
4. The casing design for the drilled well at the Kracak-2 point can be made at a depth of 20-60 (10 casing screen pipes)

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