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Identification of the Aquifer Type to Determine the Location of Groundwater Drilling in Karangsari Village, Kulonprogo Regency, Special Region of Yogyakarta

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Abstract

Kulonprogo Regency is area that have an existing problem with clean water resource. This water resource distribution influed by the rock formation of this area and can be overcome with developing groundwater source. This research was conducted with the aim of determining the location of groundwater drilling that can meet the availability of clean water for the area. The method used is geoelectrical measurement using the Schlumberger method, by Vertical Electrical Sounding (VES) method. The best drilling point is at KP 05.3 with aquifer resistance value is 20.20 ohm-m at a dept of 53-70 m and 41.9 ohm-m at a dept of 90-115 m. The aquifer is composed of volcanic sandstone lithology. Each drilling point is measured by three geoelectric points, obtained an error rate of 10% and an accuracy of 90%.

***Keywords*:** Kulonprogo Regency, groundwater source, Schlumberger method, Vertical Electrical Sounding (VES) method, aquifer

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INTRODUCTION

Groundwater as one of the potential raw water resources has received a lot of attention in relation to meeting the needs of raw water domestic needs. Groundwater resources are naturally renewable, because groundwater is an important part of the hydrological cycle on earth. Groundwater is found in several types of geology and geological structures also stratigraphy. The most important are aquifers, which is namely rock formation that can store and drain water in sufficient quantities (Todd, 1980). One of the method that can be applied to determine the groundwater drilling location is the geoelectrical estimation method which can be correlated with the result of the analysis of existing drill data. The results obtained are in form of information about type, composition and thickness of the constituent materials, so that the groundwater drilling location can be de5ermined properly. This research will conduct geoelectrical measurement using the Vertical Electrical Sounding (VES) method at three different locations.

LITERATURE REVIEW

Kulonprogo is part of the southern part of the Central Java zone, so the Kulonprogo area is one of the most extensive plateaus known as the Jonggrangan Plato (Van Bemmelen, 1949). This area is an uplift area that forms a large dome. The dome is relatively rectangular with a length of about 32 km across from the north-south direction, while the width is about 20 km in the west-east direction. By Van Bemmelen, the dome was named Oblong Dome.

The stratigraphic order of the Kulonprogo Mountains area can be divided into sedimentary rock groups and volcanic rock groups. According to Sujanto, Roskamil (1975) the Kulonprogo area is an elevation bounded by the highs and lows of Kebumen in the west and Yogyakarta in the east, which is based on the tectophysiographical division of the southern part of Central Java. The height of Kulonprogo is characterized by the number of ancient volcanoes that appear above paleogene rocks and are covered by carbonate and neogene marl rock.

The stratigraphy of the Kulonprogo Mountains was reviewed based on the literature and research results that had been used as parameters according to Van Bemmelen (1949, p.598), Pringgoprawito et al. (1988), Suroso, et al. (1986) and according to several experts. The lithology that composes the research area is Tertiary deposits that make up the Kulonprogo Mountains. The naming of the lithological unit in the study area refers to its physiographic position, which refers to the Stratigraphy of the Kulonprogo

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Mountains. Lithology in Kamal Hamlet, Karangsari Village, Pengasih District, Kulonprogo Regency is in the form of tuff, volcanic sandstone, and breccia which are include in the OAF Formation (Old Andesite Formation) with a geological age of Late Oligocene to Early Miocene.

Based on the results of identification by the Geology Agency, Departement of Energy and Mineral Resources, in 2007, Kulonprogo Regency has two groundwater basins, namely the Wates Groundwater Basin which is the Wates CAT and the Menoreh CAT. Based on the concept of hydrostratigraphic units, the configuration of the aquifer system in CAT Wates is include in the Coastal Aquifer System and has two subsystems, namely:

- Alluvial - Coastal Subsystem (Aquifer Group 1);
- Sand Dune Subsystem (Aquifer Group 2);
- Basic Aquifer / Non Aquifer Group.

Geomorphologically, the series of Kulonprogo Hills and Sentolo Hills composed of Tertiary Rocks also limit the Wates CAT in the northwest and northeast, respectively. Meanwhile, geologically CAT Wates is limited by the Kebo Butak Formation and part of the Yogyakarta Formation and the Merapi Muda deposits in the eastern part (Kusumayudha, 2010).

RESEARCH METHODOLOGY

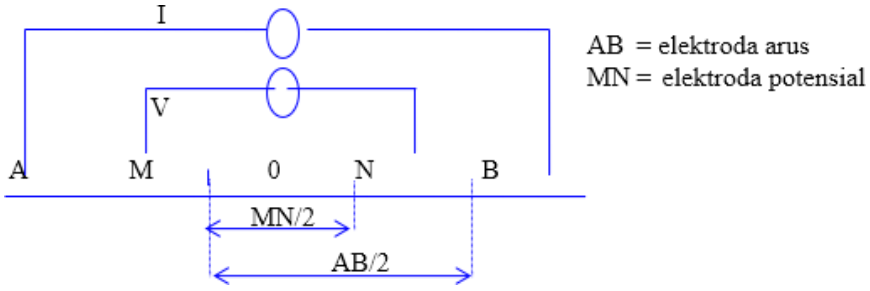
i) Geoelectrical Measurement Location

Geoelectrical measurement were carried out at three points, at Kamal Hamlet, Karangsari Village, Pengasih District, Kulonprogo Regency with the coordinates of the location points as follows:

a) The point KP 05.1 is carried out at the coordinates of 07°499.9 latitude and 110°816.3 east longitude with an elevation of 128 m.
b) The point KP 05.2 is carried out at the coordinates of latitude 07°49'8,8 latitude and 110°8'19,1 east longitude with an elevation of 119 m.
c) The point KP 05.3 is carried out at the coordinates of latitude 07°49'18,1 latitude and 110°8'14,5 east longitude with an elevation of 106 m.

ii) Measurement Method

Geoelectric measurements in the field using the Schlumberger method, by means of Vertical Elektikal Sounding (VES). Working Principle: The two potential electrodes are fixed while the two current electrodes are spaced arbitrarily.



Description :

a	= Current electrode distance	V	= Potential difference (Volt)
b	= Potential electrode distance	I	= Strong currents
ρa	= Pseudo-type resistance (ohm-m)		

Current electrodes (A and B) are placed on the outside and potential electrodes (M and N) are placed on the inside. Each measuring point of the spacing (distance) of the electrode array is gradually enlarged, with a maximum distance of 300 m.

The price measured in the field is the apparent resistivity value, which needs to be analyzed using the curve equation method using a standard curve. In this investigation the data recorded and measured in the field are No Location, Azimuth, and Geographical Location. Then the current electrode range, potential electrode range, current flowing, and apparent resistivity (ohm-m) were measured. The tool used in this measurement is digitally read, which can determine the course of the injected current, so that it can be seen when the current is disturbed.

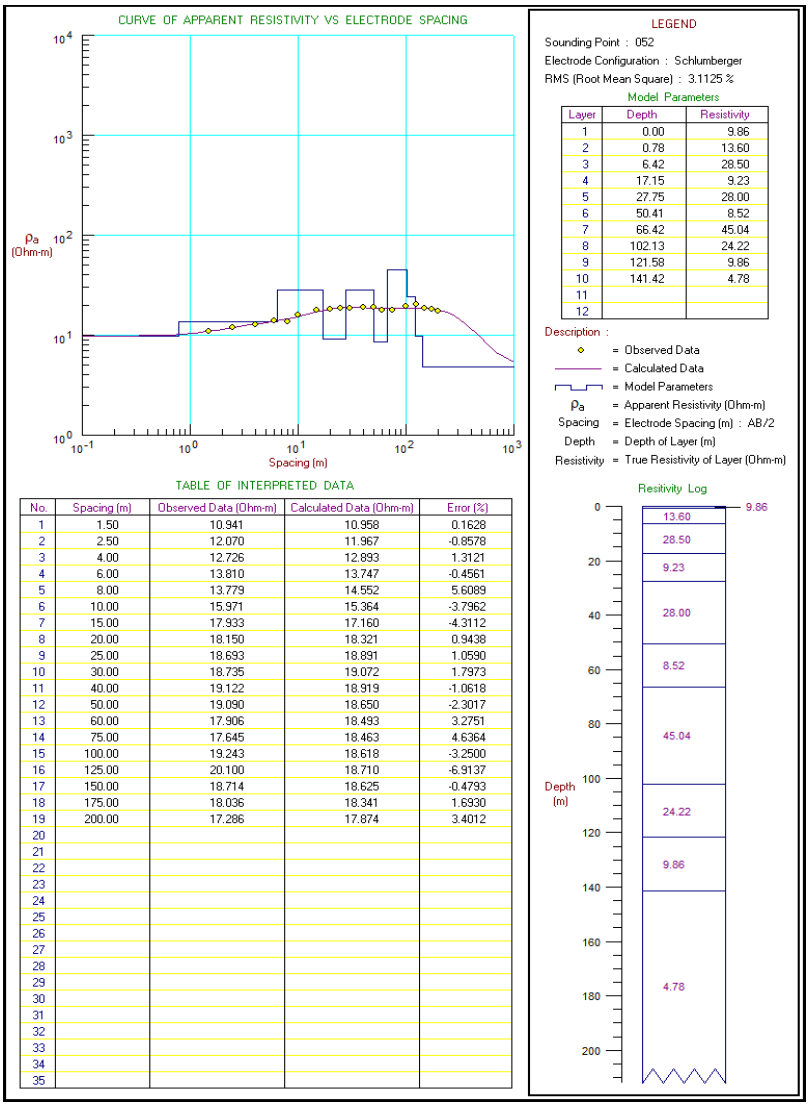
FINDING AND DISCUSSION

Based on the results of the final sounding analysis (Schlumberger method) which was carried out with a computer program, and also with curve matching and supported by local and regional geological data in the study area, the final result of depth that correlated with the true resistivity of the rock was divided into some rock units as follows:

a) Cover Layer (Soil)
   The resistivity values range from 50 to more than 1000 ohm-meters, consisting of loose sand, clay, silt, pebble and gravel.
b) Tuf Unit
   The resistivity value is less than 10 ohm-meters, consisting of tuff. Generally very impermeable.
c) Volcanic Sandstone Unit
   The resistivity value is 20 - 50 ohm-meters, consisting of sandstone. It is a good aquifer, highly permeable and contains water with sufficient discharge.
d) Breccia Unit
   The resistivity value is 50 – 200 ohm-meter, consisting of a compact breccia, so it has poor porosity and permeability.
e) Andesite Lava Unit
   The resistivity value is >200 ohm-meter, consisting of andesite lava which is very compact, so it has very poor porosity and permeability.

Interpretation is carried out based on manual comparisons and the results of three computer programs, then the final results that best represent each area will be analyzed geologically (qualitatively) and quantitatively, the final results are as follows:

1. KP 05.1: The constituent rocks are interspersed with tuff and volcanic sandstone. The depth of the groundwater aquifer is at a depth of 30 - 50 m, with a thickness of 20 m and a resistivity of 28.00 ohm-m, and at a depth of 67 - 120 m, with a thickness of 53 m and a resistivity of 45.04 and 24.22 ohm-m.



No.	Spacing (m)	Observed Data (Ohm-m)	Calculated Data (Ohm-m)	Error (%)
1	1.50	10.941	10.958	0.1628
2	2.50	12.070	11.967	-0.8578
3	4.00	12.726	12.893	1.3121
4	6.00	13.810	13.747	-0.4561
5	8.00	13.779	14.552	5.6089
6	10.00	15.971	15.364	-3.7962
7	15.00	17.933	17.160	-4.3112
8	20.00	18.150	18.321	0.9438
9	25.00	18.693	18.891	1.0590
10	30.00	18.735	19.072	1.7973
11	40.00	19.122	18.919	-1.0618
12	50.00	19.090	18.650	-2.3017
13	60.00	17.906	18.493	3.2751
14	75.00	17.645	18.463	4.6364
15	100.00	19.243	18.618	-3.2500
16	125.00	20.100	18.710	-6.9137
17	150.00	18.714	18.625	-0.4793
18	175.00	18.036	18.341	1.6930
19	200.00	17.286	17.874	3.4012
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Layer	Depth	Resistivity
1	0.00	9.86
2	0.78	13.60
3	6.42	28.50
4	17.15	9.23
5	27.75	28.00
6	50.41	8.52
7	66.42	45.04
8	102.13	24.22
9	121.58	9.86
10	141.42	4.78
11		
12		

Figure 2. Geoelectric Data Processing KP 05.1

2. KP 05.2: The constituent rocks are intercalated tuff, volcanic sandstone, and breccia. The depth of the groundwater aquifer is at a depth of 18 – 45 m, with a thickness of 45 m and resistivity of 32.61 and 20.96 ohm-m, and at a depth of 84 – 115 m, with a thickness of 31 m and a resistivity of 26.90 ohm-m.

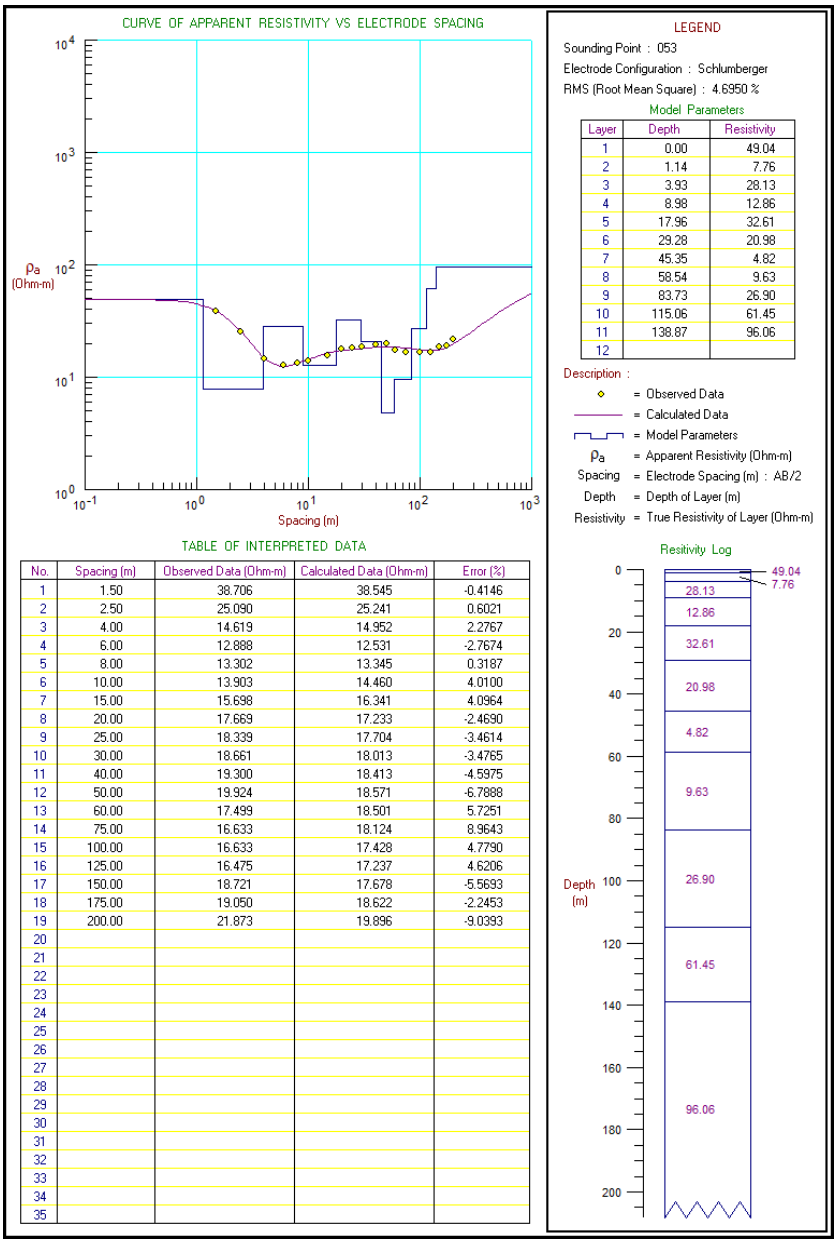
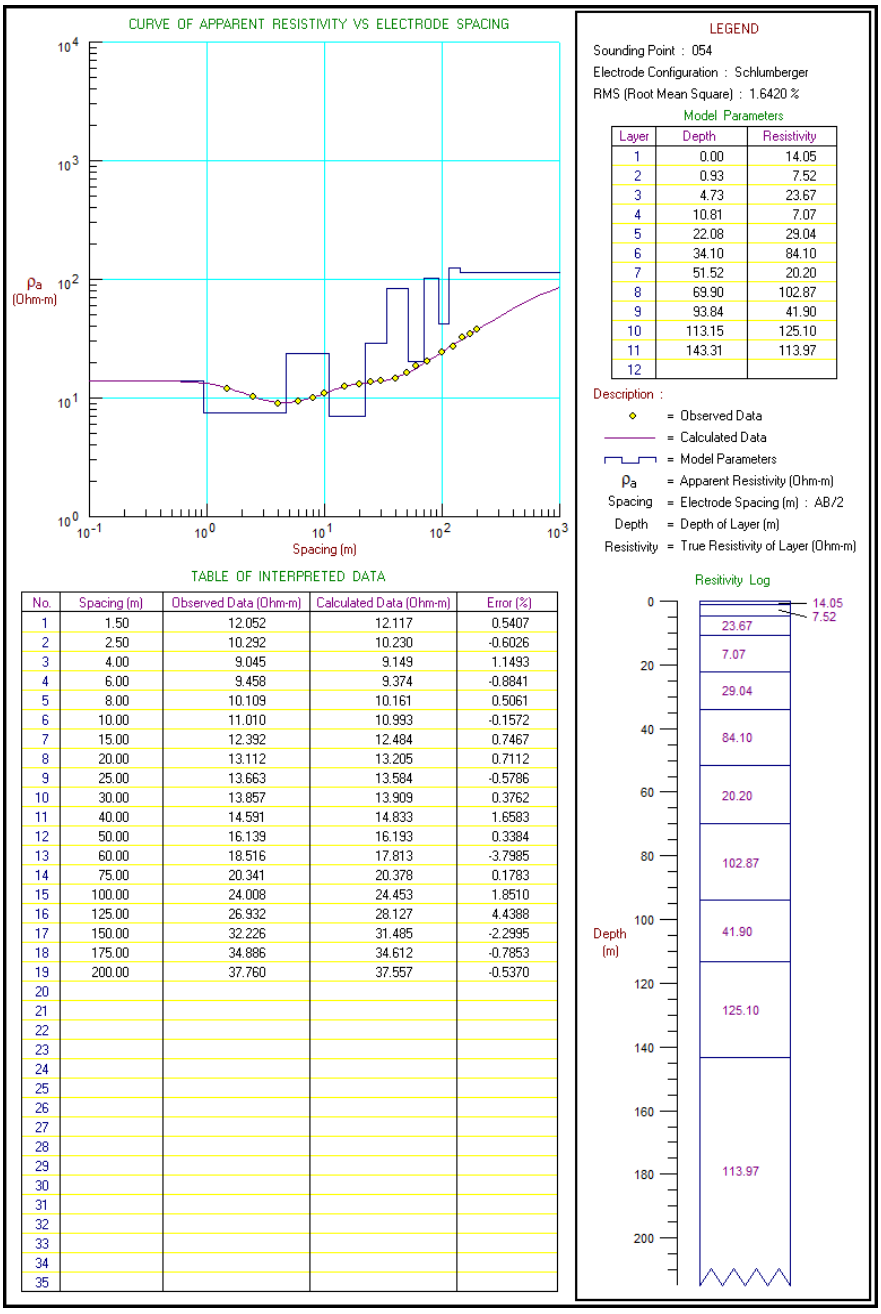


Figure 3. Geoelectric Data Processing KP 05.2

3. KP 05.3: The constituent rocks are interspersed with tuff, volcanic sandstone, and breccia. The depth of the groundwater aquifer is at a depth of 53 70 m, with a thickness of 17 m and a resistivity of 20.20 ohm-m, and at a depth of 90 115 m, with a thickness of 25 m and a resistivity of 41.90 ohm-m.



Layer	Depth	Resistivity
1	0.00	14.05
2	0.93	7.52
3	4.73	23.67
4	10.81	7.07
5	22.08	29.04
6	34.10	84.10
7	51.52	20.20
8	69.90	102.87
9	93.84	41.90
10	113.15	125.10
11	143.31	113.97
12		

TABLE OF INTERPRETED DATA

No.	Spacing (m)	Observed Data (Ohm-m)	Calculated Data (Ohm-m)	Error (%)
1	1.50	12.052	12.117	0.5407
2	2.50	10.292	10.230	-0.6026
3	4.00	9.045	9.149	1.1493
4	6.00	9.458	9.374	-0.8841
5	8.00	10.109	10.161	0.5061
6	10.00	11.010	10.993	-0.1572
7	15.00	12.392	12.484	0.7467
8	20.00	13.112	13.205	0.7112
9	25.00	13.663	13.584	-0.5786
10	30.00	13.857	13.909	0.3762
11	40.00	14.591	14.833	1.6583
12	50.00	16.139	16.193	0.3384
13	60.00	18.516	17.813	-3.7985
14	75.00	20.341	20.378	0.1783
15	100.00	24.008	24.453	1.8510
16	125.00	26.932	28.127	4.4388
17	150.00	32.226	31.485	-2.2995
18	175.00	34.886	34.612	-0.7853
19	200.00	37.760	37.557	-0.5370
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Figure 4. Geoelectric Data Processing KP 05.3

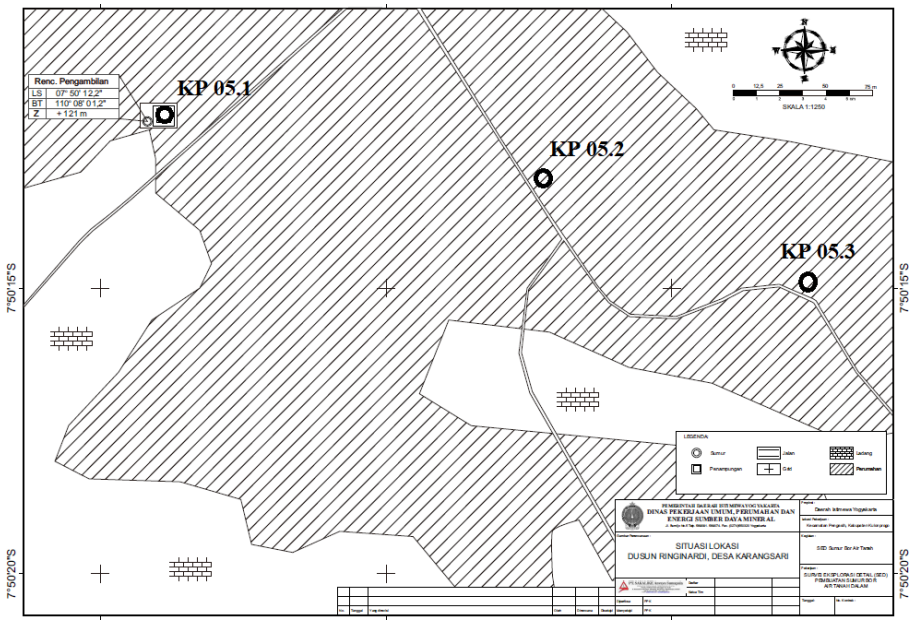

Figure 5. Geoelectrical Measurement Point of Kamal Hamlet, Karangsari Village, Pengasih District

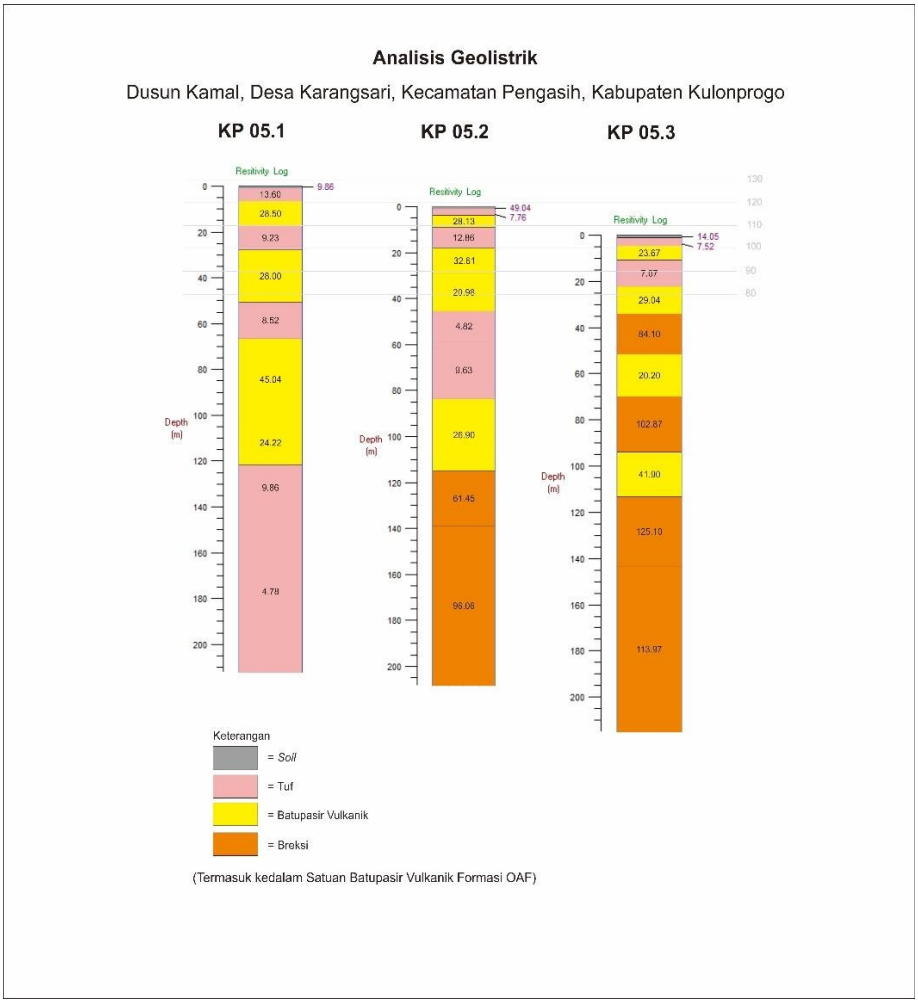

Figure 6. Correlation of Geoelectrical Analysis in Kamal Hamlet, Karangsari Village, Pengasih District (Without Scale)

Based on 3 geoelectrical measurement points, it was found that the result with the most potential for groundwater drilling is KP 05.3 with an aquifer resistivity value of 20.20 ohm-m at a depth of 53 to 70

meters and 41.9 ohm-m at a depth of 90 to 115 meters. The aquifer is composed of volcanic sandstone lithology.

No	Location	Village	District	Shallow Aquifer (m)	Deep Aquifer (m)	Water Flow Forecast (lt/s)
1	Kamal	Karangsari	Pengasih		53 - 70 m dan 90 - 115 m	2 - 3

Table 1. Depth Position of Shallow Groundwater Aquifers and Deep Groundwater Aquifers

Geoelectrical measurement accuracy rate:

a) For one drill point with >5 geoelectric points, 95% accuracy (error = 5%)
b) For one drill point with 3 - 5 geoelectric points, 90% accuracy (error = 10%)
c) For one drill point with 2 geoelectric points, 80% accuracy (error = 20%)
d) For one drill point with 1 geoelectric point, 70% accuracy (error = 30%)

In this study, one drill point is measured by 3 (three) geoelectric points, so the error rate is 10% and the accuracy is 90%.

CONCLUSION AND FURTHER RESEARCH

Detailed Exploration Survey for Groundwater Production Drilling Wells in Kamal Hamlet, Karangsari Village, Pengasih District, and Kulonprogo Regency was carried out using the Schlumberger method, using the Vertical Electical Sounding (VES) method. From the three survey points, it was found that the results with the most potential for groundwater drilling are KP 05.3 with an aquifer resistivity value of 20.20 ohm-m at a depth of 53 70 m with an aquifer thickness of 17 m and 41.9 ohm-m at a depth of 90 115. Meters with an aquifer thickness of 25m. The estimated average discharge of this area is 2-3 liters per second. And the type of aquifer at the location point is composed of volcanic sandstone lithology. It is hoped that further research will be able to take more location points in order to obtain accurate groundwater source locations with large water discharges.

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