



Groundwater Potential of the East and North Sides of Gunungmasigit Village: A Case Study

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Abstract

The purpose of this research is to conduct a groundwater survey by analyzing the availability of groundwater on the east and north sides of Gunungmasigit Village, Kec. cipatat, kab. west bandung (case study: PPSDM Geominerba field campus KESDM). The aim of this study was to determine the potential for groundwater in the northern area of the PPSDM Geominerba Field Campus and to find information regarding the absence of groundwater after drilling was carried out in 2019 in the area on the east side of the PPSDM Geominerba Field Campus. The research administrative area is located in Gunungmasigit Village, Kec. Cipatat, Kab. West Bandung (PPSDM Geominerba field campus KESDM). The author will focus more on the end of Cipatat-1 (north side) on the map, where it is located in the gate area of the Geominerba PPSDM Field Campus. This study uses the geoelectrical measurement method. One of the geoelectrical methods is the resistivity or resistivity method. This method studies the subsurface structure based on the different resistivity values in the rock with depth. Data analysis used IPI2WIN Software with track 1 having a length of 200 meters and track 3 having a length of 400 meters. In the results of Cipatat-1 it is suspected that there is a water-carrying layer at a depth of 11.9 – 45.9 m. Meanwhile, the results of Cipatat-3 suggest that there is a water-carrying layer at a depth of 26.3 m.

Introduction

One of the sources of life on earth is water. Every living creature needs water to survive. As the population increases in an area, the need for water will also increase. Water is a source of life and the most important need in the process of human life. The increasing need for clean water is triggered by the increase in population, residential areas, irrigation, industry and offices. As community activities develop, plans are needed to determine catchment areas that can meet community needs (Mitamura & Kumai, 2005). One of the existing water sources is groundwater. Groundwater is water that is in cavities in geological layers in the saturated zone (Bisri, 2012). The need for clean water in a place is accompanied by an activity at that location.

The field campus of the Geological, Mineral and Coal Human Resources Development Center, Ministry of Energy and Mineral Resources (PPSDM Geominerba) is located in Gunung Masigit Village, Cipatat District, West Bandung Regency, which is the location used by the agency for field practice activities in its education and training activities. Until 2023, the provision of clean water at the Field Campus has not been optimally met. Currently, the source of clean water supply is provided by purchasing clean water from the local water company. In fact, having its own water source makes it possible to save on existing budget expenditures on

PPSDM Geominerba. Action to search for clean water sources needs to be carried out as an anticipatory step to reduce the burden on the Geominerba PPSDM budget in the long term.

There needs to be a groundwater study at the Field Campus to inform whether there are possible sources of clean water. The groundwater assessment at the PPSDM Geominerba Field Campus was carried out in the fourth quarter of 2019 using the Schlumberger configuration geoelectric method, at that time there were 4 predicted locations for searching for groundwater sources. Geoelectric estimates were obtained at that time with a resistivity between 6-311 Ωm , a reference for tuff sand with a resistivity of 40-50 Ωm . Based on these references, the condition of the PPSDM Geominerba Field Campus area has the potential for clean water sources and there is no difficulty in getting clean water if you want to utilize the potential of groundwater sources. However, in 2019, after drilling was carried out on the eastern side of the area, there were no water sources because when drilling is carried out on soil with permeable or water-tight characteristics, it will be difficult to find free groundwater, namely groundwater that can be found by digging ordinary wells.

This drilling method is less effective because groundwater cannot be found in such soil conditions. Therefore, so that groundwater can be easily found without needing to dig deeper, it is best to first know the groundwater zoning. In theory, groundwater can easily be found in the discharge area. The discharge area is the area where water is collected, and the water remains relatively constant in that place. In this area, there are usually springs, but in the water catchment area no groundwater was found. Not all areas have good natural groundwater potential. Water zones often seem to disappear due to human activity. In some areas, such as densely populated areas and industrial areas, groundwater experiences excessive exploitation. Every day, from day to night, people draw groundwater using electric pumps. As a result, the area loses a lot of water and becomes dry. Apart from drought, excessive exploitation of groundwater can cause land subsidence.

The groundwater study itself needs to look at various conditions in the PPSDM Geominerba Field Campus area, such as geological and hydrogeological conditions. From his own research, he analyzed the possibility of an aquifer (a layer in the soil that is capable of holding and releasing water) at that location. To determine the condition of the aquifer in the research area, one method can be used, namely the geoelectric resistivity method. The existence of groundwater aquifers is something that needs to be considered when determining groundwater well points (Eugene et al., 2020). This is useful for determining well drilling points more effectively and efficiently, both in terms of cost and energy. To be able to map the subsurface cross-section in 2D, the Vertical Electrical Sounding (VES) geoelectric method can be measured which produces 1D data in the form of variations in rock resistivity values. The electrical resistivity method is an application of the geophysical method which is a method commonly used in groundwater potential research. Vertical Electrical Sounding (VES) is a general geoelectric method for measuring vertical changes in subsurface electrical resistivity (Alabi et al., 2010).

The resistivity geoelectric method utilizes electric current by injecting it into the ground and then measuring the electrode potential using a geoelectric measuring instrument. This aims to obtain information regarding the resistivity value of rock formations in the ground. By knowing the resistivity, you will know the type of rock, the groundwater resistivity value ranges from $\pm 30 \Omega\text{m}$ -100 Ωm .

In 2022, there needs to be a review and update of the geoelectric data, one of which is adding measurement points. The addition of measurement points allows for more accurate data. With the updated data, PPSDM Geominerba can consider drilling for groundwater so that there is a

clean water source available to support education and training activities at the Field Campus in the long term.

As a result of industrial growth accompanied by very rapid population growth, the need for water is also increasing so that the use of groundwater now and in the future can no longer be avoided. Land use for various uses in industrial areas, housing, liquid/solid waste disposal, mining, agriculture, transportation, provision of water infrastructure, etc., will affect the quantity and quality of groundwater. Therefore, the author is interested in researching more deeply regarding "Groundwater Potential on the East and North Sides of Gunungmasigit Village, Kec. Cipatat, Kab. West Bandung (Case Study: PPSDM Geominerba KESDM Field Campus)". The aim and objective of this research is to determine the groundwater potential in the area on the north side of the PPSDM Geominerba Field Campus. The scope of the problem is predicting groundwater sources in the PPSDM Field Campus Area. The limitation in the research is collecting geoelectric data on the east and north sides of the PPSDM Geominerba Field Campus by looking at existing research through published journals using the Supersting R8 geoelectric method and/or other types of tools and then making a 2D cross-section. After collecting the latest geoelectrical data, data reading analysis was carried out to predict the possibility of groundwater potential on the north and east sides of the PPSDM Geominerba Field Campus. The benefit of the research is to provide knowledge about the groundwater potential in the PPSDM Geominerba Field Campus area.

Methods

The research activities used are collecting data in the field with the help of geoelectric tools to be used as primary data and processing field data with software and computers. The type of research used is a combined quantitative and qualitative method. Carrying out research activities with literature studies, namely collecting data and information related to the research topic. The references used are from published books, published journals, and other research reports. This activity is to obtain secondary data that supports discussions related to the research topic.

Results and Discussion

Looking at the Cianjur Geological Map reference (figure 5), it is found that the composition of aid from the PPSDM Geominerba Field Campus Area and its surroundings is Qob, Oml, Omc, and Mts. Qob in the Geological Map of Cianjur, means the result of old volcanoes (0-150 m), Oml is a member of limestone (0-650 m) - solid limestone and layered limestone, Omc is the Rajamandala Formation, a member of clay, marl, rock quartz sand (1150 m), and Mts is a member of breccia and sandstone (1200 m) - perfectly layered sandstone interbedded with slate, mudstone, grauwacke and breccia. Referring to Figure 7, namely the regional stratigraphic column of the West Java Bogor basin (Martodjojo, 1984) and the stratigraphic structure of the Rajamandala area (Siregar, 2005), the PPSDM Geominerba Field Campus is included in the Rajamandala Formation, formed after the Batuasih formation, at the age of the early Miocene (N4-N5), 22.5 ma (Tertiary Age), with the lithological characteristics or rock deposited being limestone. The depositional environment is shallow sea.

Limestone is a sedimentary rock formed from calcium carbonate deposits originating from the remains of marine biota such as coral and mollusks. Limestone has a hard, dense texture and is usually white or gray in color. Limestone is a type of sedimentary rock (soil layer) that functions as a water-carrying layer (Bisri, 2012). Sedimentary rock is the best water-bearing layer because it has good porosity and permeability. Porosity is the ability of a rock to hold water in the pore spaces it contains, while permeability is the ability to allow water to flow

through the rock's pore spaces. Because limestone has good porosity and permeability, rainwater that seeps into the soil can be collected in the pore spaces of the limestone and become a source of groundwater that can be extracted through drill holes or river flows. However, not all types of limestone have the ability to store sufficient water, depending on their porosity and permeability. Apart from limestone, other sedimentary rocks such as sand and gravel can also be a source of ground water if they have good porosity and permeability. It depends on the size and shape of the particles in the rock.

When viewed from the age of the rocks on the geological map of the PPSDM Geominerba Field Campus area, the limestone of the Rajamandala formation is included in the tertiary rock age. Rocks older than Quaternary are poor to very poor water-bearing layers (Bisri, 2012). So this is one of the considerations for investigating groundwater in the research area and re-examining existing data for re-analysis.

If you look at the groundwater potential of CAT, where CAT can be described as a natural underground reservoir, so that extracting water using wells in one area will affect the amount of water supply in other places in the same basin, the Field Campus is close to CAT Batujajar. Regulation of the Minister of Energy and Mineral Resources (Permen ESDM) RI No. 2 of 2017 concerning Groundwater Basins in Indonesia states that the Batujajar CAT has an area of 89 km². This value is considered broad enough to be said to be a source of groundwater. However, it should be noted that the PPSDM Geominerba Field Campus is a dominant area of tertiary limestone (Rajamandala formation) and the landscape forms hills so it is suspected that groundwater flow will go to a lower point and pass through the PPSDM Geominerba Field Campus area.

The research area is also in Gunung Masigit Village, District. Cipatat, Kab. West Bandung and based on hydrogeological map data of the research area (figure 9), shows that the PPSDM Geominerba Field Campus research area is aquiferless, which means the groundwater area is rare or insignificant. Hydrogeological data released by the Geological Agency of the Ministry of Energy and Mineral Resources in the Indonesian Hydrogeological Map Cianjur Sheet 1209-2 Scale 1:100,000 in 1998 is one of the data considerations for groundwater geoelectrical investigations.

Based on geoelectrical investigation report data to support groundwater investigations, the data collected is made in the form of a thematic map. Thematic maps are created in raster format with the Universal Transverse Mercator (UTM) zone 48S projection system. Geoelectrical investigations are carried out on the basis of the physical properties of rock to electric current, where each different type of rock will have a different resistivity value. This depends on several factors, including the age of the rock, electrolyte content, density of the rock, the amount of minerals it contains, porosity, permeability and so on. Based on the above, if direct current is applied to the ground through 2 (two) current electrodes A and B, a potential difference will arise between the two current electrodes. This potential difference is then measured by the receiver via the M and N potential electrodes in millivolt units. In this geoelectric investigation, an electrode arrangement using Schlumberger's rules has been used where the two MN potential electrodes are always placed between 2 current electrodes.

During the geoelectric survey activities carried out, 2 sounding points were obtained which could represent the situation and conditions at the location. The sounding data obtained is then processed into an earth model. In Figure 1 there is a distribution of geoelectric points in Gunung Masigit Village, Kec. Cipatat, west Bandung (Cipatat-1 and Cipatat-3).



Figure 1. Location of Goelectrical Measurements in the PPSDM Geominerba Field Campus

Based on figure 1, the provision of clean water at the investigation location which is expected to be taken from deep groundwater using the drilling method can be carried out and is recommended around the estimation point, namely the Cipatat-1 and Cipatat-3 locations with a water-bearing layer depth of \square 11-47 m, based on the results of previous research Budiyo & Harmoko (2019). Cipatat-1 is located on the north side in the PPSDM Geominerba Field Campus area, while Cipatat-3 is located on the east side in the PPSDM Geominerba Field Campus area.

Groundwater geoelectric data is also related to Fault and Fracture Density (FFD) in an area. By analyzing resistivity patterns detected beneath the surface, it is possible to identify and map areas with high levels of faults and cracks. This information can be used to understand the likelihood of seismic events in an area, as well as to plan and reduce disaster risk. Therefore, the FFD method complements each other in geological and geophysical studies. The groundwater geoelectric method is used to identify and map geological structures which include faults and fractures, while fault density provides information about the distribution of faults and fractures in an area.

The FFD map itself is a map that shows the distribution of faults or cracks in rocks in an area. This map is used in oil and gas exploration to predict hydrocarbon potential in an area. To create an FFD map, it is necessary to carry out geological and geophysical surveys in the field, including measurement and analysis of data from various types of geophysical data, such as seismic data, magnetic data or gravity data. The results of this survey and analysis are then used to create geological models and the distribution of faults or cracks in the rock.

This model can then be used as a basis for creating FFD maps using an appropriate scale, such as a regional or local scale. FFD maps can help geologists and geophysicists evaluate the hydrocarbon potential in an area and estimate the possibility of a reservoir containing hydrocarbons. However, keep in mind that FFD maps are not completely accurate because it is difficult to detect very small or hidden faults or cracks in the rock. Therefore, it is necessary to carry out field verification to ensure the accuracy of the FFD map and the prediction results of hydrocarbon potential in an area. The following are the results of processing the FFD map of the PPSDM Geominerba Field Campus, Gunung Masigit Village, District. Cipatat, Kab. West Bandung uses ArcGIS and Geomatica software.

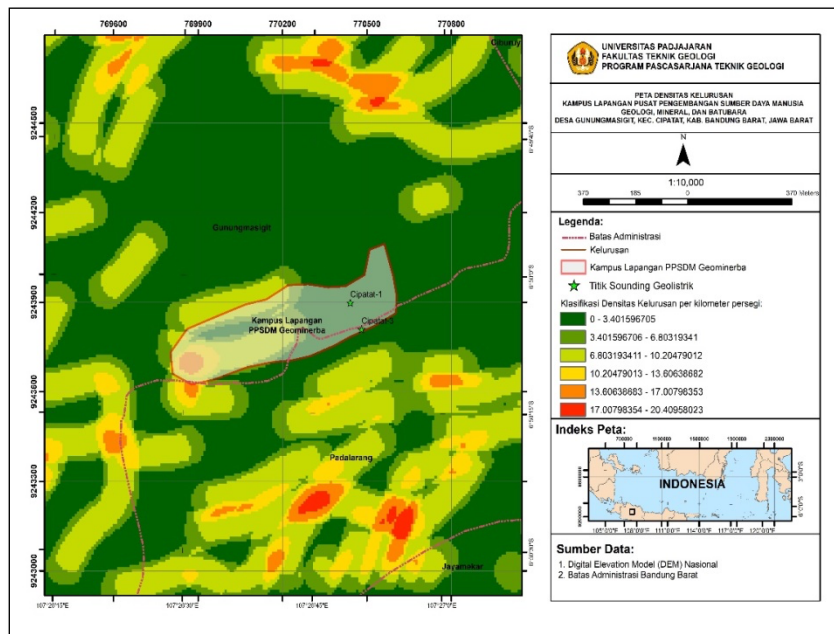


Figure 2. Fault Fracture Density (FFD) Map of the PPSDM Geominerba Field Campus

If the survey location for sounding point measurements is interpolated using Figure 2, it can be seen that the lineament density on the north to east side shows a green image, which means that this area has a relatively low lineament density. The low density of lineaments in these places can be associated with the level of permeability. Areas with low permeability can also be interpreted as meaning that these areas are areas that lack the ability to absorb water better than the surrounding areas.

Goelectric Resistivity Analysis

Goelectric resistivity analysis divides an area into several measurement points whose resistivity values are then measured using electrodes placed on the ground surface. From the results of this measurement, a picture of the resistivity distribution below the surface can be produced. The results of goelectric resistivity analysis can be used for various purposes such as mineral exploration, geothermal studies, identification of groundwater zones, and structural geology studies. However, the results of this analysis need to be interpreted carefully and compared with other data such as geological and geochemical measurements to get a more complete picture of the subsurface structure.

The results of goelectric analysis can provide information about rock types and soil characteristics below the surface, as well as determine the possibility of groundwater and the depth of groundwater at that location. This data can be used as a basis for developing plans for well drilling and water resource management in the area. However, please remember that the results of goelectric analysis are only additional information and cannot be used as the sole basis for decision making. Therefore, it is necessary to carry out additional research and measurements to obtain a complete and more accurate picture of the geological and hydrogeological conditions at the PPSDM Geominerba Field Campus.

Data collection activities in the field are the result of training activities carried out by the Geominerba PPSDM agency. This training activity is entitled Goelectric Training for Groundwater Exploration which will take place from 29 August – 2 September 2022. The activity begins with providing material on hydrogeology, an introduction to goelectric tools,

discussion of cases that have been experienced by participants or teachers. The provision of material regarding geoelectricity lasted for 2 days, followed by 2 days of field practice, and 1 day of data discussion and preparation of training reports.

For training and learning that takes place in class, it is carried out in the PPSDM Geominerba training building located at Jl. Gen. Sudirman No. 623 Bandung. For practical education and training learning, it is carried out at the PPSDM Geominerba Field Campus which is located in the Gunungmasigit Village area, Cipatat District, West Bandung Regency, West Java. The committee has divided the training participants into 3 groups. Group 1 is tasked with carrying out practicals in the northern area (Cipatat-1), group 2 is tasked with carrying out practicals in the southern area (outside the PPSDM Geominerba Field Campus area), and group 3 is tasked with carrying out practicals in the eastern area (Cipatat-3).

Each group consists of 10 people and has their own role as directed by the instructor and committee. All participants are equipped with head protection in the form of a hat. There are at least 2 people tasked with installing electrode pegs on the left and right sides or along the track. Participants tasked with installing the electrode pegs are equipped with measuring instruments, a hammer and a handy talky communication device. 2 people are tasked with recording the numbers printed on the device in the form of voltage and amperage values. 1 person is tasked with documentation and ensuring equipment is always ready for use, 2 people take turns operating geoelectric equipment, and 1 person is tasked with checking data directly via laptop using Microsoft Excel to illustrate geoelectric data calculations with graphs between current distances (a (m) = AB) with resistivity or specific resistance (ρ app). Checking directly in Microsoft Excel anticipates data errors.

In accordance with the instructions of the instructor, measurements for each current distance (a = AB) should be carried out 2 times to ensure that the values listed at the beginning and at the end are almost close. This measurement activity was carried out as a learning method for future participants to act more carefully in recording data or presenting data. If there is incorrect data after the training activities have been completed, it is suspected that the data processing results will not be optimal.

The activity takes place from 10.00 WIB to 12.00 WIB, then a break until 13.30 WIB. After that, it was continued with a discussion of geoelectric data per group. Participants carry out data processing together guided by the instructor using IPI2WIN software and Progress 3.0 software.

Data Processing and Interpretation

Data processing has been carried out on each track using progress ver3.0 software and combining tracks 1 and 3 using IPI2WIN software, track 1 has a length of 200 meters and track 3 has a length of 400 meters. Based on the geological data obtained, the research area is located in Gunung Masigit Village, Kec. Cipatat, Kab. West Bandung is dominated by alluvium units and alluvium fan units.

Based on the results of geoelectric data processing, the division of rock groups at the location is clay (very low resistivity with ρ 0-10 Ohm.m) represented by dark green; weathered limestone (low resistivity with ρ 10-40 Ohm.m) is represented by green; hollow limestone, tuffaceous sand, thought to be filled with water (medium resistivity with ρ 40-70 Ohm.m) represented by yellow; and hollow, dry limestone (high resistivity ρ >70 Ohm.m) is represented in red. Referring to table 2.8, groundwater rock resistivity has a resistivity of 30-100 Ohm.m (Sosrodarsono & Takeda, 1977).

Cipatat-1 location

From the results of measurements in the field in 2022, the results were obtained in the form of the following table. Table 1 is a table of measurements using geoelectric tools carried out by the PPSDM Geominerba team.

Table 1. Measurement Table with Geoelectric Tools Cipatat-1 PPSDM Geominerba Field Campus

Point Name: Cipatat-1					Day: Thursday		
Dusun:					Date: September 1, 2022		
Village: Gunungmasigit					Jam: 10.15 WIB		
District: Cipatat					Weather: Sunny		
Regency: West Bandung					Operator: group 1		
Coordinates: X= 770441 Y=9243898					Elevasi: 757		
No.	a(m) =AB/2	b(m) = MN	ΔV (mV)	I (mA)	R (Ω m)	towards	ρ app = k. ΔV /I
1	1.5	0.5	602	69	8.725	6.286	54.841
2	2.5	0.5	428	175	2.446	18.857	46.119
3	4	0.5	131	161	0.814	49.500	40.276
4	6	0.5	53.6	159	0.337	112.357	37.876
5	8	0.5	52.4	247	0.212	200.357	42.505
6	10	0.5	32.5	297	0.109	313.500	34.306
7	12	0.5	16.8	263	0.064	451.786	28.859
8	15	0.5	6.8	228	0.030	706.357	21.067
9	15	5	117.1	228	0.514	62.857	32.283
10	20	5	115.3	271	0.425	117.857	50.144
11	25	5	133.9	608	0.220	188.571	41.529
12	30	5	53.5	600	0.089	275.000	24.521
13	30	10	118	465	0.254	125.714	31.902
14	40	10	70.4	407	0.173	235.714	40.772
15	50	10	92.4	630	0.147	377.143	55.314
16	60	10	36.4	385	0.095	550.000	52.000
17	75	10	26.4	745	0.035	868.214	30.766
18	75	25	91	746	0.122	314.286	38.338
19	100	25	47.3	785	0.060	589.286	35.507

Measurements were carried out on September 1 2022, starting at 10.15 WIB with sunny weather conditions. If you look at table 1, the measurements were carried out 19 times, with b (m)/MN being the potential or voltage post distance for 0.5 m 8 times with a current post displacement (a (m) = AB) of 1.5- 15 m on both left and right sides of the track. The potential or voltage stake distance for 5 m is 4 times with the displacement of the current stake (a (m) = AB) from 15-30 m on both the left and right sides of the track. The potential or voltage stake distance for 10 m is 5 times with the displacement of the current stake (a (m) = AB) from 30-75 m on both the left and right sides of the track. The distance between the potential or voltage posts is 25 m twice with the displacement of the current posts (a (m) = AB) from 75-100 m on both the left and right sides of the track. Then the data from the table is processed with Microsoft Excel on the computer to see a graph between the current distance (a (m) = AB) and the resistivity or resistivity (ρ app). This graph shows that each measurement point does not overlap. The graph is shown in figure 3. If during measurements in the field there are

anomalies, for example there are points that are very far from each other and there are points that overlap, then it is necessary to re-measure at that point.

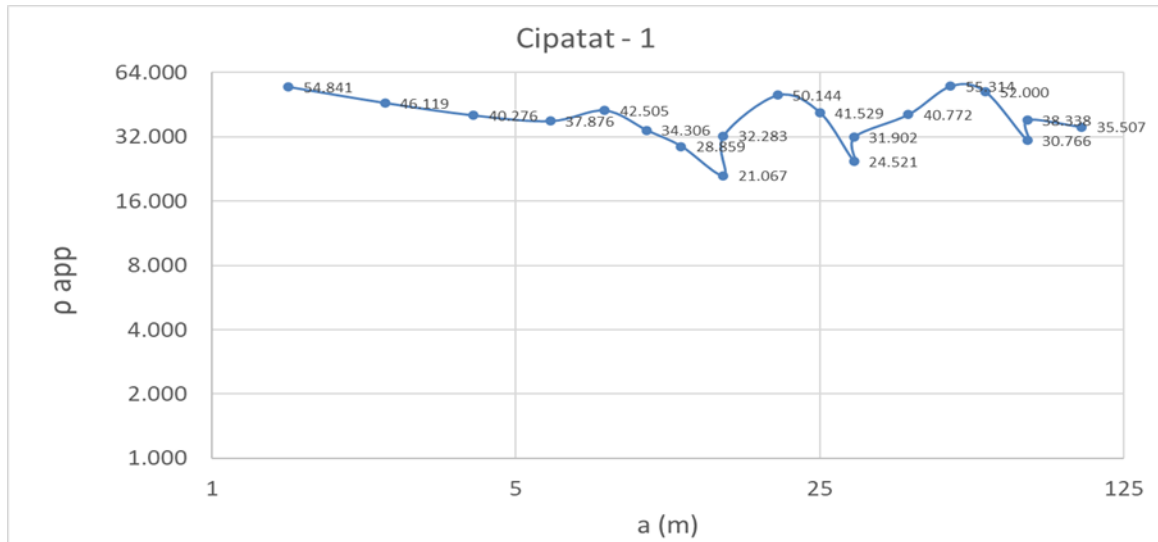


Figure 3. Comparison Graph of Current Distance with Resistivity in Cipatat-1 Measurement

After seeing the results of field data processing in Microsoft Excel, then proceed with data processing with Progress 3.0 software. So the results can be seen as in Figure 4.

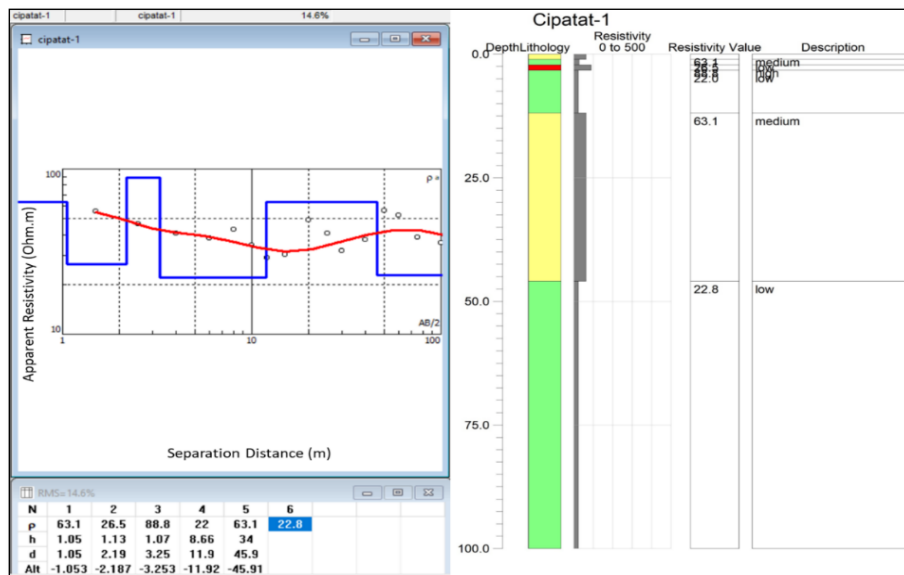


Figure 4. Geoelectric Data Processing Results from the Cipatat-1 Location in Progress 3.0 Software

Table 2. Table of Cipatat-1 Processing Results with Progress 3.0 Software

Guess Point		Analysis Results with IP12WIN program				
		N	R	h	d	Old
Cipatat-1	Lap. 1	1	63,1	1,05	1,05	-1,053
	Lap. 2	2	26,5	1,13	2,19	-2,187
	Lap. 3	3	88,8	1,03	3,25	-3,253
	Lap. 4	4	22	8,66	11,9	-11,92
	Lap. 5	5	63,1	34	45,9	-45,91

Table 2 shows the data processing results from the Progress 3.0 software. for Cipatat-1. N is the layer number, ρ is the actual resistivity value, h is the layer thickness, d is the layer depth, and Alt is the layer height. From the results of geoelectric data processing at the Cipatat-1 point, it was found that there were 5 rock layers.

From the results of data processing in the Progress 3.0 software shown in the image above, it was found that Cipatat-1 was suspected to have a water-bearing layer at a depth of 11.9-45.9 m (table 2 with green shaded columns). Correlation of investigations in 2019 with investigations in 2022 at locations that are almost close to each other, but still in the northern area of the PPSDM Geominerba Field Campus, shows that Budiyono & Harmoko (2019) (table 2) describes the suspected presence of groundwater in the 3rd layer with resistivity 31.1 Ohm.m., at a depth of 9.46-84.9 meters above sea level, and has a thickness of up to 75 m. Meanwhile, if you look at the investigation in 2022, the hollow limestone, suspected to be filled with water (medium resistivity with rho 40-70 Ohm.m) is represented by the color yellow, resistivity 63.1 Ohm.m., at a depth of 11.9-45.9 above sea level, and a thickness of 34 m. (Figure 4). Looking at the water flow coefficient table, the water flow coefficient in various rocks according to Bisri (2012) in table 2 states that limestone has a water flow rate of 0.9400 mm/day, a relatively small water flow rate. Meanwhile, limestone porosity based on Todd & Mays (1980) has a value of 1-10 ϕ , a very low value for the ability to accommodate the large amount of water contained in the rock (table 2).

Cipatat-3 location

From the results of measurements in the field in 2022, the results were obtained in tabular form. Table 3 is a table of measurements using geoelectric tools carried out by the PPSDM Geominerba team.

Table 3. Measurement Table with Cipatat-3 Geoelectric Equipment PPSDM Geominerba Field Campus

No.	a(m) =AB/2	b(m) = MN	ΔV (mV)	I (mA)	R (Ω m)	towards	$\rho_{app} = k. \Delta V / I$
1	1.5	0.5	20.4	10.8	1.889	6.286	11.873
2	2.5	0.5	2.2	2.5	0.880	18.857	16.594
3	4	0.5	18.6	74.5	0.250	49.500	12.358
4	6	0.5	7.1	74.5	0.095	112.357	10.708
5	8	0.5	4.8	74.6	0.064	200.357	12.892
6	10	0.5	3.6	74.6	0.048	313.500	15.129
7	12	0.5	2.9	74.7	0.039	451.786	17.539
8	15	0.5	2.2	74.8	0.029	706.357	20.775
9	15	5	22.2	74.7	0.297	62.857	18.680
10	20	5	16.4	74.8	0.219	117.857	25.840
11	25	5	13.6	75	0.181	188.571	34.194
12	30	5	11.7	75.1	0.156	275.000	42.843
13	40	5	8.6	75	0.115	495.000	56.760
14	50	5	6.4	75.2	0.085	777.857	66.201
15	60	5	4.5	75.2	0.060	1123.571	67.235
16	75	25	19.8	75.3	0.263	314.286	82.641

17	100	25	8.2	75.3	0.109	589.286	64.172
18	125	25	4.3	75.3	0.057	942.857	53.842
19	150	25	4.6	108.8	0.042	1375.000	58.134
20	175	25	3.3	108.9	0.030	1885.714	57.143
21	200	25	3.6	183.3	0.020	2475.000	48.609

Measurements were carried out on September 1 2022, starting at 10.15 WIB with sunny weather conditions. If you look at table 3, the measurements were carried out 21 times, with b (m)/MN being the potential or voltage post distance for 0.5 m 8 times with a current post displacement (a (m) = AB) of 1.5-15 m on both the left and right sides of the track. The potential or voltage stake distance for 5 m is 7 times with the displacement of the current stake (a (m) = AB) from 15-60 m on both the left and right sides of the track. The potential or voltage stake distance for 25 m is 6 times with the displacement of the current stake (a (m) = AB) from 75-100 m on both the left and right sides of the track.

Then the data from the table is processed with Microsoft Excel on the computer to see a graph between the current distance (a (m) = AB) and the resistivity or resistivity (ρ app). This graph shows that each measurement point does not overlap. The graph is shown in figure 5 following. If during measurements in the field there are anomalies, for example there are points that are very far from each other and there are points that overlap, then it is necessary to re-measure at that point.

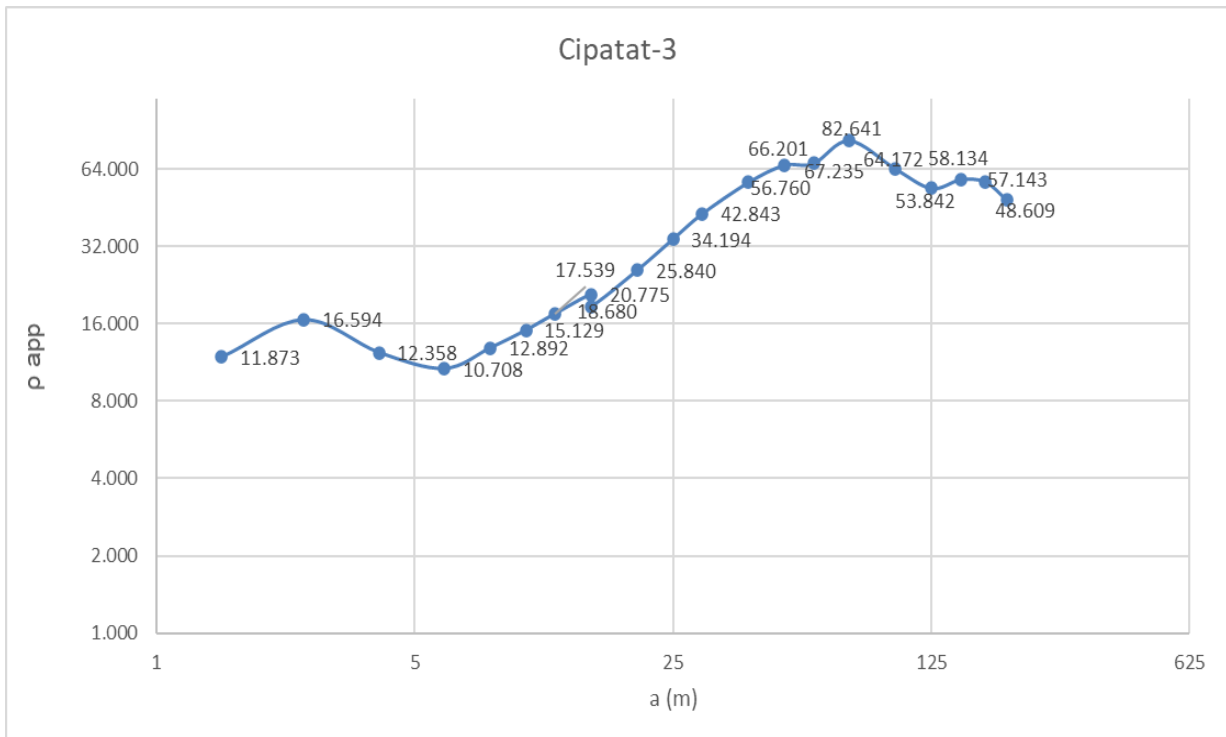


Figure 5. Comparison Graph of Current Distance with Resistivity in Cipatat-3 Measurement

After seeing the results of field data processing in Microsoft Excel, then proceed with data processing with Progress 3.0 software. So the results can be seen as in Figure 6.

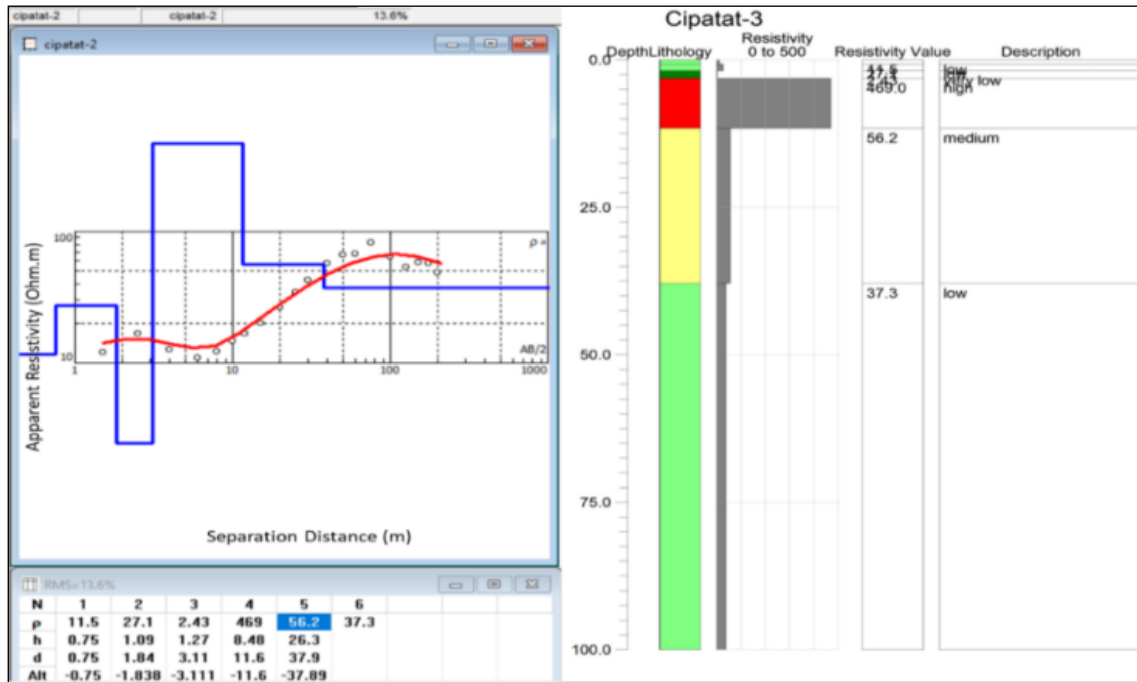


Figure 6. Geoelectric Data Processing Results from Cipatat-3 Location in Software Progress 3.0

Table 4. Table of Cipatat-3 Processing Results with Software Progress 3.0

Guess Point		Analysis Results with IP12WIN program				
		N	R	h	d	Old
Cipatat-3	Lap. 1	1	11,5	0,75	0,75	-0,75
	Lap. 2	2	27,1	1,09	1,84	-1,838
	Lap. 3	3	2,43	1,27	3,11	-3,111
	Lap. 4	4	469	8,48	11,6	-11,6
	Lap. 5	5	56,2	26,3	37,9	-37,89

Table 4 shows the data processing results from the Progress 3.0 software. for Cipatat-3. N is the layer number, ρ is the actual resistivity value, h is the layer thickness, d is the layer depth, and Alt is the layer height. From the results of geoelectric data processing at the Cipatat-3 point, it was found that there were 5 rock layers.

From the results of data processing in the Progress 3.0 software shown in the image above, it was found that in Cipatat-3 it is suspected that there is a water-bearing layer in the 5th layer that has a depth of 26.3 m with a thickness of 37.9 m. Correlation of investigations in 2019 with investigations in 2022 at locations that are almost close to each other, but still within the eastern area of the Geominerba PPSDM Field Campus, shows that the Geominerba team (table 3) describes that the Cipatat-3 point is almost close to point P.4., alleged presence of groundwater in the 5th layer and 7th layer with a resistivity of 47.30 Ohm.m. and 45.20 Ohm.m., at depths of 58.31 m-89.72 m and 125.18-145.25 m. These two geoelectric data show quite significant differences. The latest data in 2022 suggests groundwater at a depth of 26.3 m, but data from 2019 shows it at a depth of 58.31 m. The significant differences in results are thought to be caused by the use of inappropriate tools, incorrect reading of analysis data, and tools that have not been calibrated.

Drilling failure and the absence of groundwater in the east side area in 2019 due to alleged inaccurate data analysis and referring to the Fault Fracture Density (FFD) map made in 2022 as well as re-investigation with different geoelectric tools showed low lineament density in that place, which can be associated with the level of permeability. Areas with low permeability can also be interpreted as meaning that these areas are areas that lack the ability to absorb water better than the surrounding areas (Iqbal & Juliarka, 2019).

Looking at investigations in 2019 and 2022, the geoelectric data results are similar in that the suspected groundwater in the area north of the PPSDM Geominerba Field Campus (Cipatat-1) is at a depth of 9-11 meters above sea level. PPSDM Geominerba needs to reconsider drilling in the northern area, because looking at the FFD map, the northern area is included in the low lineament density zone, meaning that with a low level of permeability it can also be interpreted that the area is an area that lacks the ability to absorb more water. good compared to the surrounding area. Table 4.5 is a table summary of the results of geoelectric data processing for Cipatat-1 and Cipatat-3.

Table 5. Summary of Cipatat-1 and Cipatat-3 Geoelectric Data Processing Results

Name	Across	Longitude	Elevasi - mdpl	Information	Note
Cipatat-1	-6.834147° or 770441	107.446933° or 9243898	757 M	Geoelectric Point	Water carrier layer at a depth of 11.9 – 45.9 m
Cipatat-3	-6.834950° or 770481	107.447299° or 9243809	797 M	Geoelectric Point	Water-carrying layer at a depth of 26.3 m

Surface Water Flow

Apart from looking at the results of the geoelectric data that has been carried out at the PPSDM Geominerba Field Campus, it is also necessary to look at references from surface water flows in the area. Figure 7 depicts the direction of water flow in the research area and its surroundings. If you look closely around the geoelectric sounding points (Cipatat-1 and Cipatat-3), you can see the direction of the water flow towards the south.

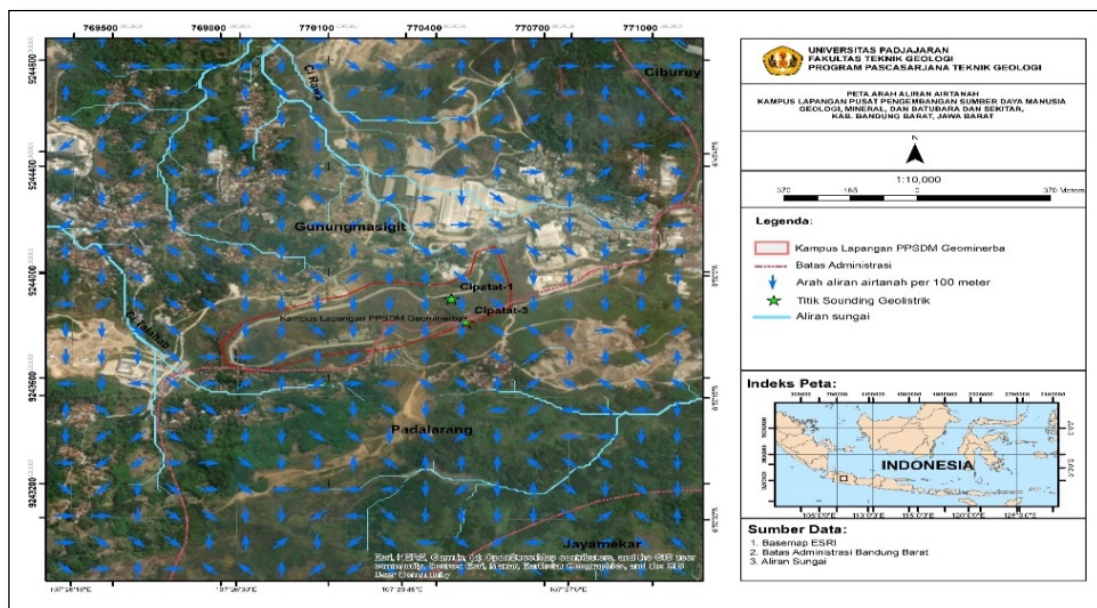


Figure 7. Groundwater flow of the Study Area and Surroundings

This water flow is described with the help of Arcgis software with the data needed being map data of the research area, administrative boundaries and river flow data around the area. The depiction of water flow is made on an area scale per 100 meters to ensure more detail about the direction of water flow. The water flow is thought to come from the north, namely the Cirawa River. The water flow crossed the Cipatat-1 and Cipatat-3 geoelectric sounding points in the PPSDM Geominerba Field Campus area until it crossed the boundary of the research area, collecting at a point in the residential area outside the PPSDM Geominerba Field Campus.

Estimates from data processing at Cipatat-1 and Cipatat-3 points show the potential for groundwater at certain depths, namely 11.9 meters and 26.3 meters. It can be seen that the PPSDM Geominerba Field Campus area is just a water flow that passes, not a discharge area or a place where the water comes out. This is an additional consideration for agencies to obtain groundwater by drilling.

Groundwater Potential

The results of previous interpretations stated that the types of layers found at the research location were in accordance with the geological data obtained. The geological data explains that the Gunung Masigit Village area, Kec. Cipatat, Kab. West Bandung is dominated by limestone. From the geological map of the research area (figure 5), the rock layers in the research area consist of omc-rajamandala formation, namely clay, marl and quartz sandstone with a depth of 1150 m, oml-rajamandala formation, namely limestone with a depth of 0-650 m, and qob-products of old volcanoes, namely breccia, lava, volcanic lava-breccia with a depth of 0-150 m. Meanwhile, the aquifer layer is interpreted to be found in the limestone layer which is found in the OMC formation-Rajamandala formation.

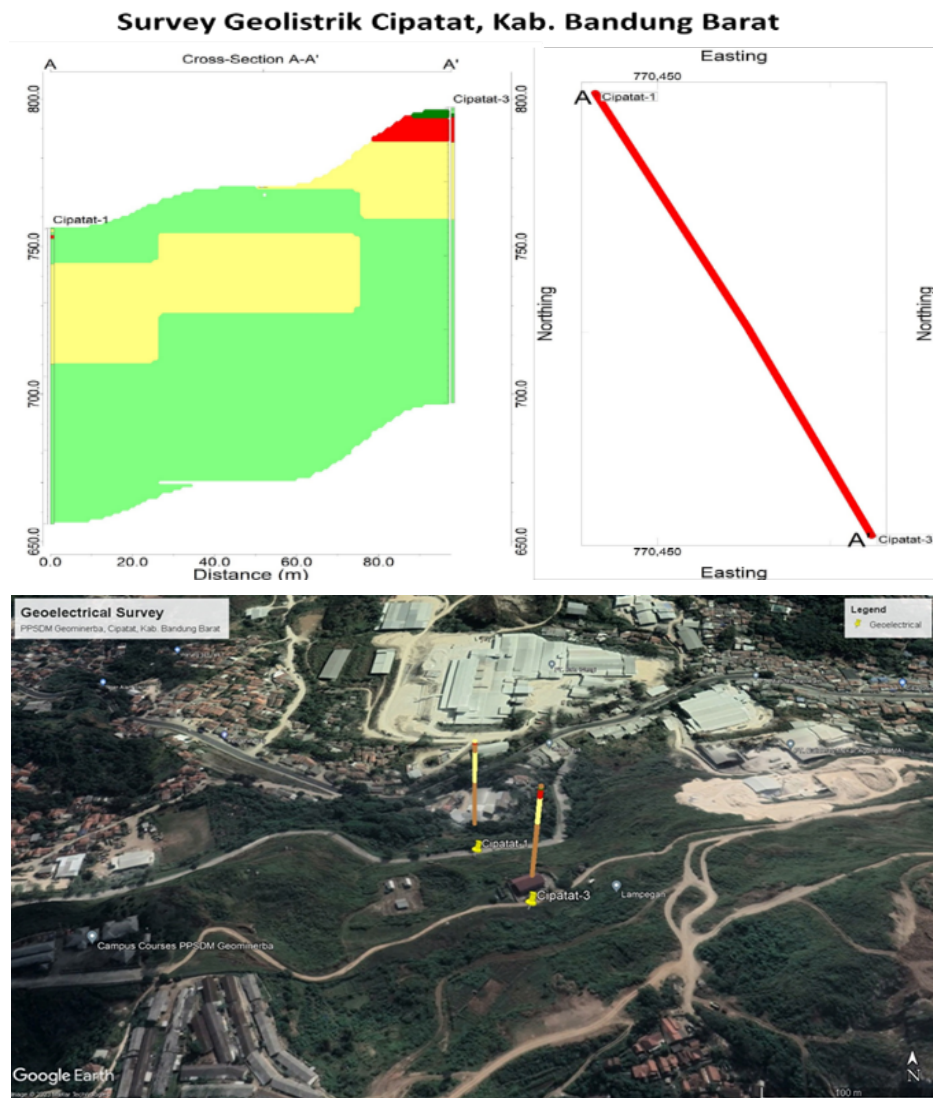
The research location area is estimated to have quite large and good groundwater reserves, seen from the discovery of surface aquifers on each track and aquifers on tracks 1 and 3 and has a fairly good layer thickness (figure 8). Figure 8 is a cross-sectional view of the research area and interpolation of the results of geoelectric data processing at Cipatat-1 and Cipatat-3. The division of rock groups is based on the results of geoelectrical data processing at the location, namely clay is represented by dark green, weathered limestone is represented by green, hollow limestone is thought to be filled and is represented by yellow, which refers to the resistance of the type of rock or material (Sosrodarsono & Takeda, 1977) that groundwater has resistivity. of 30-100 Ohm.m., and dry hollow limestone is represented by red.

Figure 4.8 depicts the results of cross section A-A' which crosses the Cipatat-1 and Cipatat-3 geoelectric sounding points and cross section B-B' which passes from west to east in the PPSDM Geominerba Field Campus area. From the cross section it can be seen that the western area is a high area. The height is around 820 meters above sea level and if you look at the naked eye, the west side of the PPSDM Geominerba Field Campus is a limestone hill. This area is deemed unsuitable for groundwater drilling, apart from the thick limestone, high area, this area is the access road to the top of the PPSDM Geominerba Field Campus. The areas that are more suitable for groundwater investigations are the northern and eastern regions because the northern region has a surface height of 740 meters above sea level and the eastern region has a surface height of 760 meters above sea level.

From the results of geoelectrical and morphological investigations, the research area has good groundwater source potential because at this location there are still many trees that function as groundwater catchment. Meanwhile, the deep aquifer layer can be used as a water reserve in dry seasons and the depth of the layer makes it less easily contaminated by polluted substances.

However, its existence must still be utilized as efficiently as possible so as not to damage and reduce water resources.

This research was carried out using 2 software aimed at making the interpretation of the results clearer. The principle of both software tends to be the same, namely viewing the subsurface layer through 2D images. However, the advantage of the IPI2WIN software is that images can be interpreted in color images which makes it easier to identify the structures of the rock layers. Another advantage of the IPI2WIN software is that it can combine more than two paths whose positions are still parallel. Analysis from the IPI2WIN software is then correlated with geological data that has been published by the relevant agency. By reading geological data, it can be predicted what type of rock layers are present at a certain point.



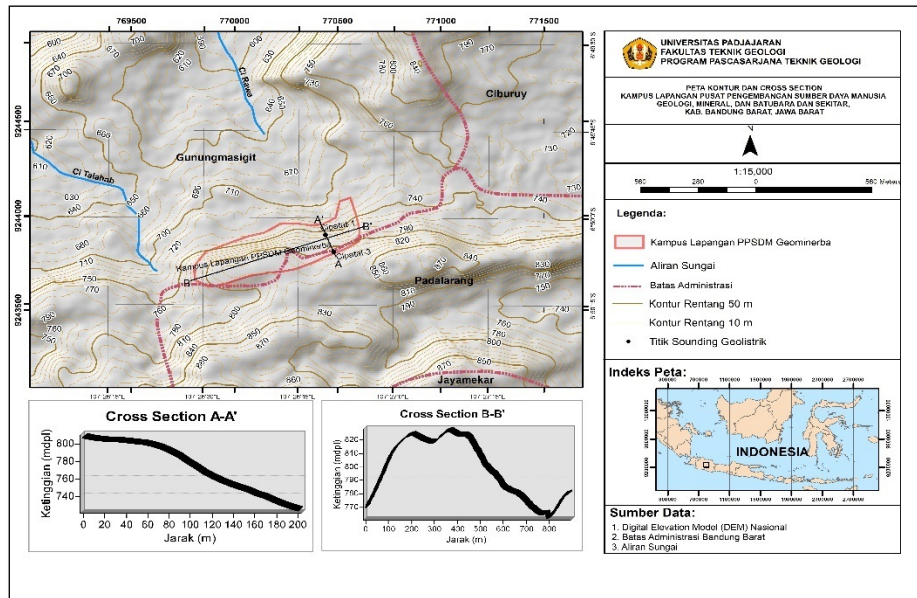


Figure 8. Fence Diagram, Distribution Log, and Cross Section of Research Area

Groundwater can be used as a source of clean water for consumption, irrigation, industry, and so on. Groundwater potential can be determined by conducting hydrogeological studies, which is the science that studies underground water. Several factors note the groundwater potential at the PPSDM Geominerba Field Campus, Gunung Masigit Village, District. Cipatat, Kab. West Bandung include: (1) Rainfall, high rainfall can cause water to enter the ground quickly, thereby increasing groundwater potential; (2) Soil type, the type of soil that has high water holding capacity, such as clay, has large groundwater potential; (3) Topography, flat or concave topography can increase groundwater potential, because water can easily seep into the ground; (4) Depth of groundwater, the closer the groundwater is to the ground surface, the greater the groundwater potential; (5) Water quality, good groundwater quality, namely free from dangerous chemicals and pathogens, increases the potential of groundwater as a source of drinking water.

From the results of data analysis in this research, it is hoped that groundwater findings will be large enough to support the PPSDM Geominerba Field Campus. Agencies need to pay more attention to studies other than research, so that agencies are confident in carrying out groundwater drilling. If you look at the final results of the research, drilling can be carried out at the suspected Cipatat-1 point. It is hoped that the drilling action at Cipatat-1, apart from getting groundwater, will involve getting wellbore data. Wellbore data can be used as additional data for future analysis to carry out a review of the discovery of other suspected points to find groundwater sources at the PPSDM Geominerba Field Campus and its surroundings.

Cipatat-1 was chosen because the depth of the potential groundwater is quite shallow, namely at a depth of 11.9 meters. The value obtained is the result of geoelectric data analysis carried out in 2022. If you look at the data from 2019 (Budiyono & Harmoko, 2019) you also suspect that there is groundwater potential at a depth of around 10 meters. From the results of these two data, agencies can take action to carry out drilling. The risk faced by agencies if groundwater is not found is quite small. The costs incurred by the agency are relatively small if drilling at Cipatat-1 compared to drilling at Cipatat-3.

Cipatat-3 and 2019 data in this area show significantly different results. There is a high risk that drilling in this area (eastern area) will fail. Considering what the agency has done in 2019, namely drilling and the absence of groundwater.

The availability of clean water at the PPSDM Geominerba Field Campus is very important. This is related to the ongoing activities carried out by the agency at that location. The Geominerba PPSDM Field Campus is one of the locations used for education and training (training) activities. So far, the PPSDM Geominerba Field Campus provides clean water by storing rainwater in reservoirs or water tanks and purchasing clean water from local clean water companies. Apart from training activities, it is hoped that the discovery of groundwater can support the clean water needs of residential areas around the PPSDM Geominerba Field Campus area.

Conclusion

Based on the results of the research and discussion previously described, it can be concluded that in 2022, from the results of geoelectric investigations there is potential for groundwater at a depth of 11.9 meters on the north side below the ground surface with the aquifer being a layer of hollow limestone. There was a drilling failure and there was no groundwater in the east side area in 2019 because it was suspected that the results of data analysis were not careful and referred to the Fault Fracture Density (FFD) map made in 2022 and re-investigation with different geoelectric tools showed low lineament density in that place. which can be associated with the level of permeability. Areas with low permeability can also be interpreted as meaning that these areas are areas that lack the ability to absorb water better than the surrounding areas. The results of re-investigation in the eastern area (Cipatat-3) also show significant differences in groundwater potential, namely at a depth of 26.3 m (in 2022).

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