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Identifying of ground water level by using geoelectric method in Karanganyar, Central Java, Indonesia

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Abstract. This study aims to determine ground water level in Karanganyar regency, Central Java Province, Indonesia. Karanganyar regency is located in west flank of Lawu volcano, the third highest volcano in Central Java Province. Karanganyar lays from the top submit of Lawu volcano to down town of city with altitude 3265 m to 88 m. Same as other mountain area, Karanganyar has a lot of ground water potential. We use geoelectric method to finds out how deep of ground water level. The survey locations are distributed surround Karanganyar regency which contain 22 sites, in period survey of 2013 – 2015. Schlumberger configuration is used for acqusition data with lenght of current electrode distance varies from 1 m to 700 m. The result shows that ground water level are located in depth from 50 meter to 150 meter with lithology of tuff and sand. In Munggur and Kedung Jeruk sites, we found two potential aquifers, which are shallow and deep aquifers.

1. Introduction

Karanganyar regency is located in coordinates between 110°40′E to 110°70′E and 7°28′S to 7°46′S, with average height is 511 meters above sea level. This regency is located in eastern part of Central Java province, Indonesia. Most of Karanganyar regency area is mountains with its summit is Lawu volcano, which its height around 3265 meter. The geology of Lawu volcano was first presented in Van Bemmelen [1], further in Sampurno and Samodro [2] has made a geological map named Ponorogo sheet with 1 : 100.000 scale. The Lawu volcano complex can be distinguished as having older and younger parts. The older products are deeply carved by erosion, while the younger parts are characterized by a smoother surface [3]

Similar to other mountains area in southern part of Java island, Karanganyar regency where located with altitude from 88 meter to 3265 meter, has a lot of potential of ground water. Many water companies has explore the ground water in Lawu volcano and then sell it to other city near Karanganyar regency. Some industries also takes ground water for their production process, most of them located in Palur, near Surakarta. And most widely used of ground water are distributed by Government Water Company which is in 2015 has delivered 82.502 m^3 to residents in Karanganyar regency [4]. This research's purpose to determine the ground water level in 22 sites of Karanganyar regency by using geoelectric method.

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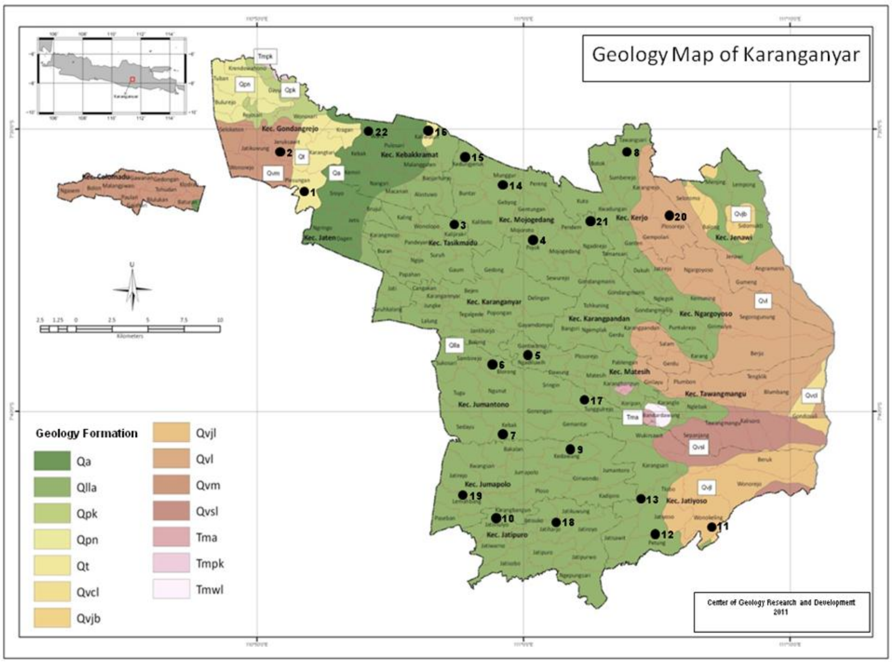

Figure 1. Geology map of Karanganyar regency. Solid circle is location of survey. Inserted map is Java island.

2. Method

The principle of geoelectric method is by injecting an electric current into the earth through two current electrodes, which causing a potential difference. The potential difference that occurs is measured by two potential electrodes. The injected current and potential difference is used to calculate resistivity value for each particular electrode configuration beneath the measuring point. This geoelectric method is more effective and suitable for exploration near surface survey for instance in determining the depth of the basement [5], water aquifer [6], seawater intrusion [7] and exploration of geothermal [8], [9].

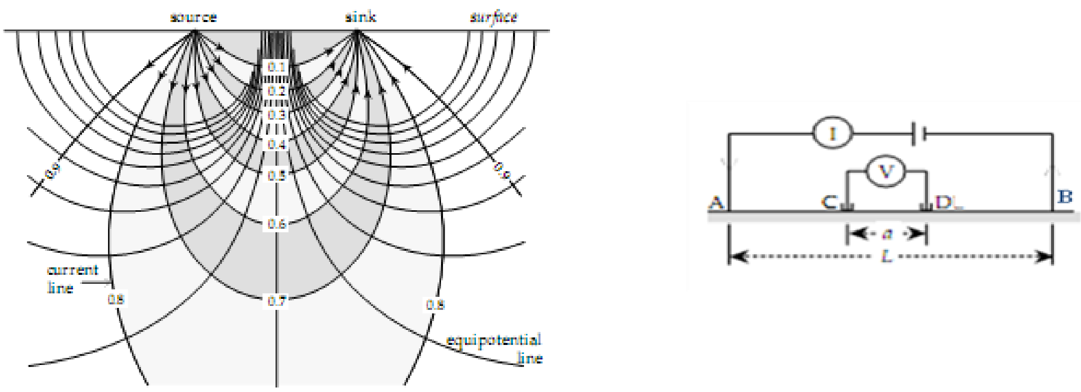

Figure 2. Distribution of current and equipotential line in geoelectric method (left). Schlumberger electrode configuration (right).

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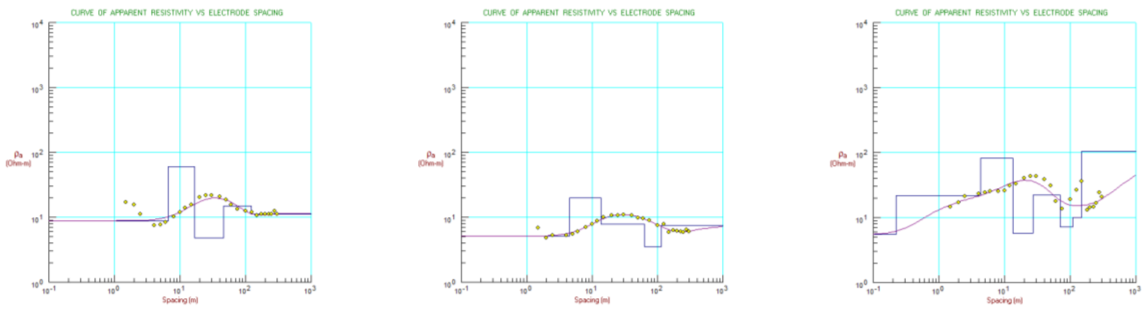
$$\rho_a = \frac{\pi}{4}\frac{V}{I}\frac{\left(L^2 - a^2\right)}{a} \quad (1)$$

The Schlumberger array configuration consists of four electrodes. The outer two electrodes are current electrodes as source, and the inner two electrodes are the potential electrodes as receiver. The potential electrodes are installed on the center of the electrode array with a certain separation, typically less than one fourth or one fifth of the spacing between the current electrodes. The current electrodes distances are increased to a greater separation during the survey while the potential electrodes remain in the same position until observed potential becomes too small to measure. In this research, we used Schlumberger electrode configuration with interval current electrodes maximum is 700 meter. Figure 2 shows current–potential distribution in Schlumberger configuration and equation 1 is formula to calculate the resistivity value [10].

3. Result and Discussions

The data processing method uses curve matching method. Principally, this method compare or match between field measurement data and master curve data in order to obtain an errata between field data and model data as small as possible. By using this method, it will be known resistivity values and the depth of each layered rocks.

The following is shown the results of processing data which have been plotted in double log graph. Y axis is resistivity and X axis is distance of current electrodes.



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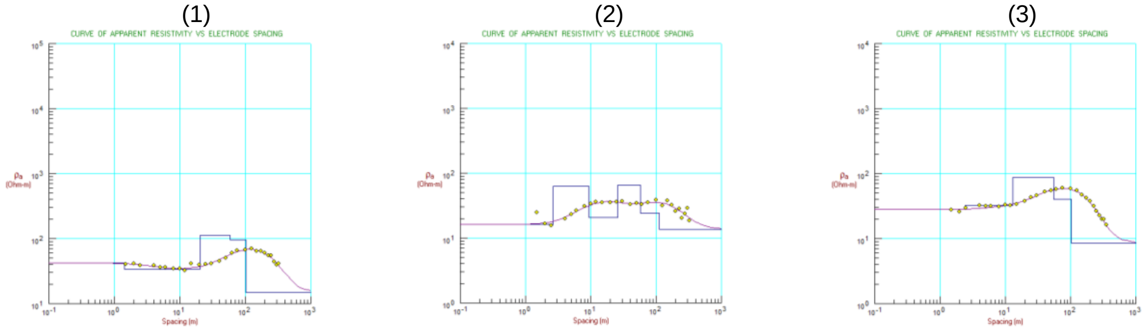

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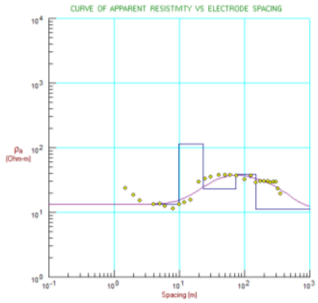

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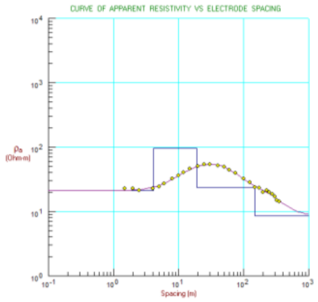

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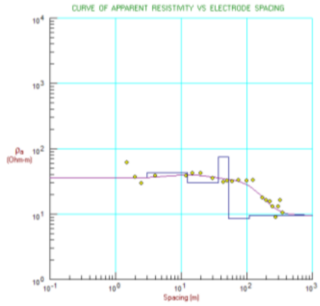

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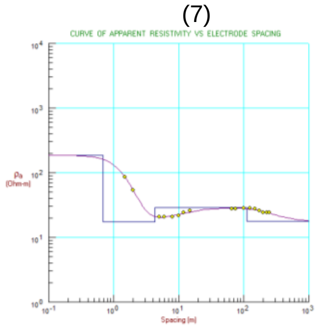

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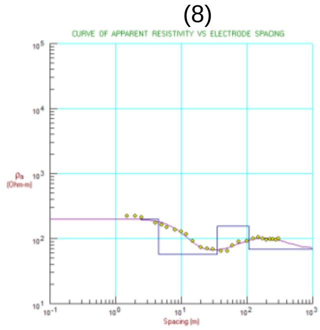

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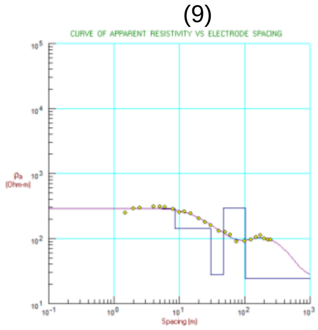

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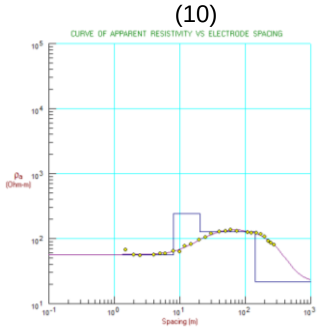

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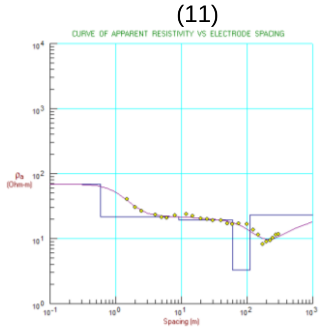

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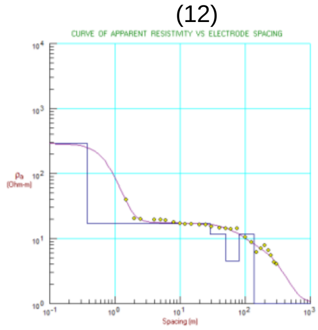

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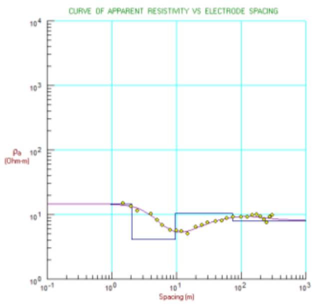

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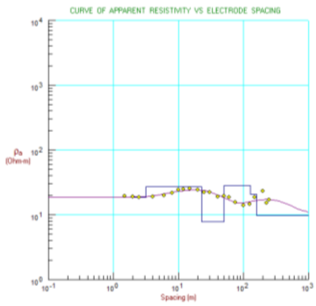

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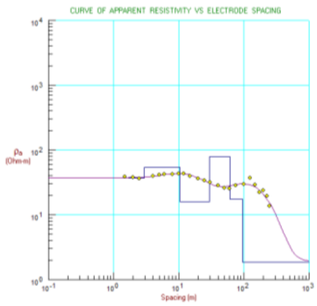

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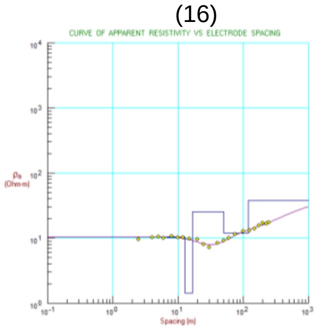

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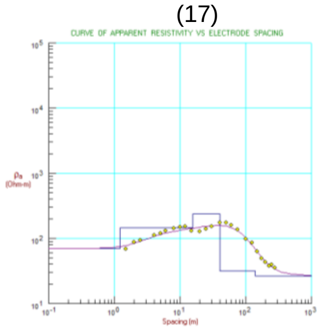

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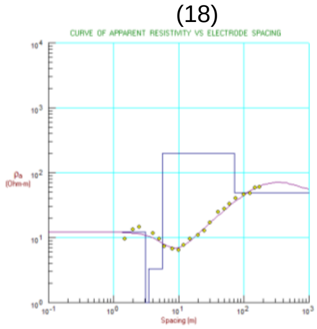

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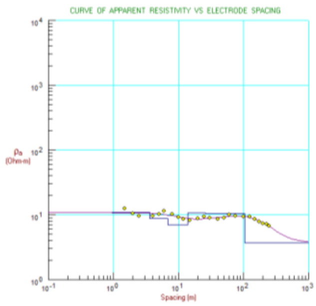

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Figure 3. Plotting the measurement data on a double logarithmic graph. The yellow circle is the measurement data, the red curve is the result of interpolation and the blue line is a layered model and resistivity value

The processing data obtained that variations in the depth of the groundwater (aquifers) were measured at 22 survey sites are varying from 50 meters to 150 meters. This result shows that the groundwater table is not the same in Karanganyar regency. It may also infleunce by water resources and topography. So it can be said that ground water table follows contour of the existing topography. The model of underground layer and the determination of the depth of the aquifer is based on the value of low resistivity in a unit cross section of the model. Aquifer usually contains a lot of water so it has a low resistivity values. Moreover, it can be also analogized with some lithology, for instance clay, sand, or tuff or other kind of rock or mineral [10].

We found two potential aquifers in Munggur and Kedung Jeruk sites, shallow and deep aquifer. In Munggur the potential aquifer found in 60 meter and 111 meter for shallow and deep aquifers respectively. In Kedung Jeruk sites the deep of the aquifer are 50 meter and 135 meter for shallow and deep aquifer. This two sites are in adjacent area with distance around 5 kilometer, where could be from the same water source (see figure 1). The all results of the aquifer depth of 22 locations including its lithology are summarized in table 1 below.

Table 1. Survey location and depth of aquifers

No	**Location**	**Coordinates**		**Elevation (m)**	**Depth Aquifer (m)**	**Lithology**
		S	**E**			
1	Plesungan Gondangrejo	7 º 31,725’	110 º 51,131’	139	121	Sand clay
2	Jeruksawit Gondangrejo	7 º 31,173’	110 º 51,526’	114	63	Tuff
3	Kalijirak Mojogedang	7 º 33,431’	110 º 57,199’	149	70	Sand clay
4	Pojok Mojogedang	7 º 33,780’	111 º 00,695’	312	103	Tuff
5	Ngadiluwih Matesih	7 º 37,994’	110 º 59,950’	276	58	Grainy tuff
6	Blorong Jumantono	7º 38,786’	110 º 59,602’	274	101	Tuff
7	Kebak Jumantono	7 º 40,847’	111 º 00,169’	323	150	Sand clay
8	Tawangsari Kerjo	7 º 30,316’	111 º 04,559’	245	149	Middle tuff
9	Kedawung Jumapolo	7 º 41,600’	111 º 02,386’	496	108	Middle tuff
10	Jatimulyo Jatipuro	7 º 43,927’	110 º 59,220’	299	112	Sand
11	Wonokeling Jatiyoso	7 º 43,248’	111 º 06,936’	963	106	Sand
12	Jatiyoso Jatiyoso	7 º 44,263’	110 º 51,526’	645	103	Sand
13	Tlobo Jatiyoso	7 º 42,995’	111 º 04,616’	631	143	Sand
14	Munggur Mojogedang	7 º 31,790’	110 º 59,473’	236	60 (111)	Sand

15	Kedung Jeruk Mojogedang	7 º 31,060’	110 º 58,380’	174	50 (135)	Sand clay
16	Kaliwuluh Kebakkramat	7 º 30,258’	110 º 55,976’	96	72	Sand clay
17	Tunggulrejo Jumantono	7 º 39,450’	111 º 02,150’	414	128	Sand
18	Jatiharjo Jatipuro	7 º 43,995’	111 º 01,333’	393	61	Sand
19	Lemahbang Jumapolo	7 º 43,090’	110 º 58,526’	282	50	Sand clay
20	Plosorejo Kerjo	7 º 33,206’	111 º 05,315’	510	139	Sand
21	Pendem Mojogedang	7 º 33,273’	111 º 01,783’	355	72	Sand
22	Waru Kebakkramat	7 º 30,758’	110 º 54,091’	88	140	Tuff

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