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Research Paper

Investigation Of Aquifer Using The Resitivity And Poisson's Ratio Method, In Sangubanyu Sub-village, Banyuwangi Village, Bandongan District, Magelang Regency

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ABSTRACT: *Sangubanyu Sub-village, Banyuwangi Village, Bandongan District, Magelang Regency, was an area that had found difficulty in getting water because it was not located in the groundwater basin area. The the Resistivity anda Poisson's ratio method could be used to determine the estimation of the aquifer's presence. Based on the interpretation of the rock resistivity value and poisson'n ratio showed the presence of aquifers at a depth of between 64-105 meters below the earth's surface in the sandy-tuff layer, based on HVSR at a location that has a poison's ratio value (σ) 0,275-0,325 and in resistivity modeling had a value of 16-21,7 ohm-m.*
KEYWORDS: *Aquifer, Resistivity, Poison's Ratio, Sangubanyu.*

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I. INTRODUCTION

Sangubanyu Hamlet is administratively located in Banyuwangi Village, Bandongan District, Magelang Regency (Figure 1). During the dry season, people's wells are often found to be dry, so that people have difficulty getting fresh water. This condition is very ironic because in general Magelang Regency is an area with high rainfall, located in the watersheds of the Progo and Bogowonto rivers and surrounded by mountains which in theory are water catchment areas.

The resistivity survey technique is used to solve many problems related to groundwater assessment, investigation and exploration. Some uses of this method in groundwater are; determination of the thickness, boundary and depth of different layers of an aquifer [1][2][3]. To ensure that the rock layers contain water, measurements are made using the resistivity method where the aquifers layer can be determined based on the rock resistivity value. Vertical Electrical Sounding method with Schlumberger array assumes considerable importance in the field of ground water exploration because this method is regularly used to solve a wide variety of groundwater problems. Such as determination of depth, thickness and boundary of a aquifer.

The shear wave velocity (Vs) is one of the waves body whose direction of deviation is perpendicular to the direction of propagation. The value of shear wave velocity (Vs) and the ratio of Vp/Vs can be used to determine the lithology layer. Rock or soft material will have a relatively smaller Vs value compared to hard rock, because the value of the shear wave velocity is directly proportional to the density of the rock.

By using two-dimensional analysis and inversion of HVSR data, it is expected that the distribution of the P wave velocity (Vp) and S wave velocity (Vs) values to both the horizontal and vertical directions in the area around the measurement location. The characteristics of the soil and rock layers can be identified using Vp and Vs. According to [4] the comparison of the P wave and the S wave velocities that propagates on a medium depends on the medium characteristics.

By knowing the comparative value of Vp/Vs, it can be estimated whether the layer contains water or not [5]. A location below the surface which is estimated to contain water has a ratio of Vp and Vs greater than 1.4 [6].

The Poisson's Ratio is the ratio of transverse contraction to elongation when the stem is stretched. Poisson's ratio can be measured from the arrival of seismic waves. Ideally, Poisson's ratio is 0.25 or the ideal elastic body. If Vs is low, the Vp/Vs ratio becomes high and σ approaches 0.5. The relationship between Poisson's ratio (σ) and Vp/Vs ratio can be formulated as in the following equation :

$$\sigma = \frac{V_p{}^2 - 2V_s{}^2}{2\left(V_p{}^2 - V_s{}^2\right)} = \frac{\left(\frac{V_p}{V_s}\right)^2 - 2}{2\left[\left(\frac{V_p}{V_s}\right)^2 - 1\right]}$$

where σ is Poisson's ratio, Vp is the velocity of the P wave (m/s), and Vs is the velocity of the S wave (m/s).

.**Figure 1.:** Map of location Resistivity Measurement In Sangubanyu

II. METHODS

The methods to determine the condition and physical properties of soil using a geophysical approach is the resistivity and HVSR method.

The geoelectrical method is one of the geophysical methods to study the electrical properties inside the earth and how to detect it [7]. This method aims to determine the subsurface conditions based on the electrical conductivity of the rocks. In this method, the current injection into the ground is carried out through two electrodes which are also connected to the power supply. The response given by the earth is in the form of a potential difference value received through two potential electrodes so that the subsurface rock resistivity value is obtained. The free electrons contained in the rock play a role in conducting the electrical current flowing in the rock. Apart from the free electrons present in rocks, the rock's ability to conduct electricity or the resistivity of the rocks is also one of the factors that influence the flow of electricity in the rock. The greater the resistivity value of a rock, the more difficult it is for the rock to conduct electric current, and vice versa. The electrode configuration used in the measurement of this resistivity method uses the Schlumberger sounding configuration; this configuration can detect the non-homogeneity of rock layers and can penetrate the deep surface by widening the current injected into the earth so that the change in the resistivity value indicates the rock type. The measurement data obtained in the form of electrode position and pseudo resistivity values are processed using IPIwin2 software so that a subsurface model based on the depth and resistivity value of the rock is obtained.

The Horizontal to Vertical Spectral Ratio (HVSR) method is a method that calculates the comparison of seismic recording data from the horizontal component to its vertical component. The HVSR method was introduced by [5] to estimate the resonance frequency and amplification factor of rocks beds in an area of microseismic data. The HVSR method is typically used in three-component passive seismic (microtremor) seismic. The important parameters generated from the HVSR method are natural frequency and amplification. HVSR which is measured on the soil aims to characterize the seismic wave velocities both P wave and S wave at the depth direction of a place. Natural frequency and amplification are related to subsurface physical parameters[8]. The results of the data inversion are the profiles of the value of the S wave P wave velocities and rock layers density towards the depth [6] [9].

III. RESULT AND DISCUSSION

3.1. Resistivity results

The results of 1 D resistivity measurements on lines 1 and 2 as shown in Figure 1 produced the resistivity model shown in Figures 2 and 3

Based on the modeling results of Figure 2 and Table 1, at the measurement location point 1, 7 layers of soil were obtained with varying resistivity values, where the top layer was top soil fill soil with a resistivity value of 56.5 Ωm, a shallow aquifer layer with a value of 17.0 Ωm is tufan sand, layers with a resistivity value of 40.1 Ωm are andesite breccias, layers with a resistivity value of 181 Ωm are breccias, the presence of aquifers in rocks with a resistivity value of 21.7 Ωm at a depth of 70.6-103 m with sandy tuff rocks form a deep aquifer.

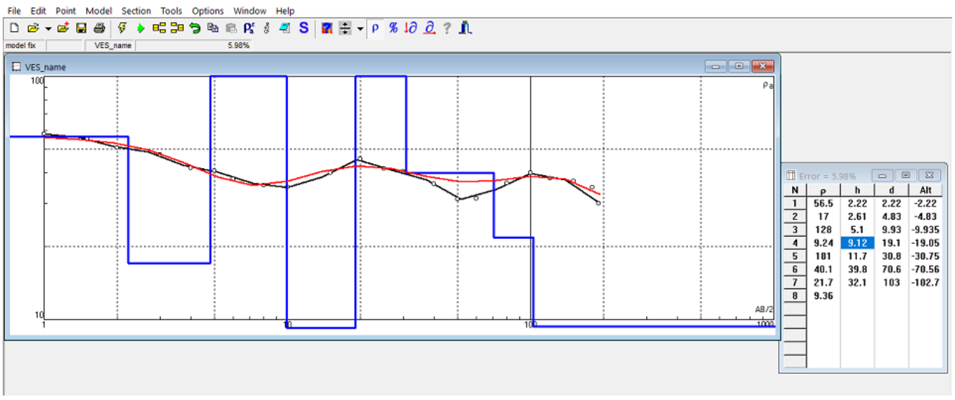

Figure 2 : 1-D resistivity model to depth in line-1

Table 1 : The results of the resistivity model for each layer on line-2

No	ρ(ohm/meter)	depth (meters)	Layer thickness (meters)	Descriptions
1	56,5	2,22	0-2,22	Top Soil
2	17,0	4,83	2,22-4,83	Sandy Tuff
3	128	9,93	4,83-9,93	Breccia
4	9,24	19,1	9,93-19,1	Tuff
5	181	30,8	19,1-30,8	Breccia
6	40,1	70,6	30,8-70,6	Andesitic Breccia
7	21,7	103	70,6-103	Sandy Tuff
8	9,36		>103	Sand

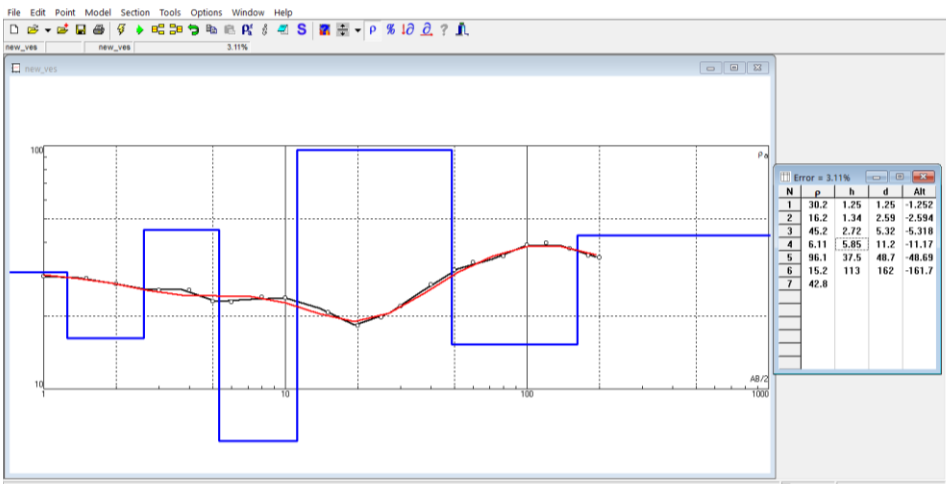

Figure 3 : 1-D resistivity model to depth in line-2

Table 2 : The results of the resistivity model for each layer in line-2

No	ρ(ohm/meter)	depth (meters)	Layer thickness (meters)	Descriptions
1	17,2	1,66	0-1,66	Top soil
2	6,84	5,74	1,66-12	Sandy Tuff
3	148,0	22,7	12,0-22,7	Breccia
4	68,4	64,1	22,7-64,1	Andesitic Breccia
5	16,4	105	64,1-105	Sandy Tuff
6	4,68		>105	Sand

Based on the modeling results of Figure 3 and Table 2, at the measurement location point 2, 6 soil layers with varying resistivity values were obtained, where the top layer was top soil fill soil with a resistivity value of 17.2 Ωm, a shallow aquifer layer with a value of 6.84 Ωm is a sandy tuff, layers with a resistivity value of 148 Ωm are breccias, layers with a value of 68.4 are andesitic breccias, the deep aquifer layer is at a depth of 64.1 – 205 m rocks with a resistivity of 16.4 Ωm

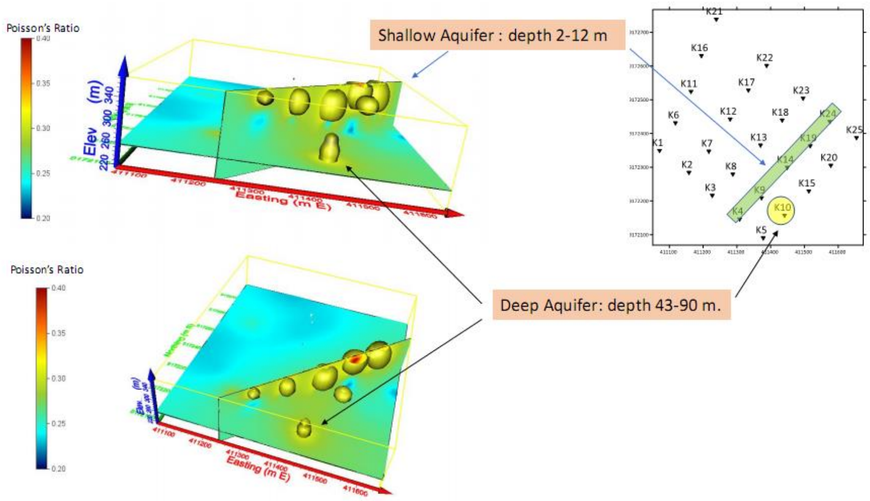

Figure 4 : Distribution of Poisson' ratio values and aquifer depth

3.2. Poisson's Ratio

To determine the presence of fluid in the subsurface layer usually have a poison's ratio value (σ) ranging from 0.25 to 0.4 [10].

Based on the comparison of the Vp/Vs values, the results of the Poisson's ratio value are obtained, this Poisson' ratio value can indicate the presence of rocks containing water, in this case an aquifer, which has a value of 0.275 to 0.325, according to research conducted [11] As the Vp/Vs ratio is above 1.73 or Poisson's ratio 0,235, it is a condition of high-water prospects and porosity. The higher the Vp/Vs ratio, the greater the rock porosity value, this is what causes water to accumulate in the rock. Figure 4 shows the presence of shallow aquifers at a depth of 2-12 meters, while deep aquifers are at a depth of 40-90 meters

IV. CONCLUSION

Based on the interpretation using the rock resistivity model and Poisson's ratio values, respectively indicate the presence of shallow and deep aquifers at a depth of 2-16 meters and 64-105 meters below the earth's surface in a sandy-tuff layer. Sand-tuff based on HVSR at a location that has a Poisson's ratio of about 0,275-0,325 and in resistivity modeling has a value of 16-21,7 Ωm.

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