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One-dimensional analysis of underground water using geoelectric methods

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ABSTRACT

The regional development issues in Tambang Kampar District that are most important to solve are environmental issues related to surface water potential and limited clean water. Environmental potential through good environmental management can become potential natural resources that can be utilized to support the regional economic sector. Groundwater potential needs to be studied and interpreted in the matrix of groundwater resource management through geophysical studies, namely by using the geoelectric method. This matrix will be able to provide solutions to environmental problems with the potential for fresh water in Tambang District, Kampar, thereby supporting economic growth in terms of meeting water needs. The material that is the object of research is underground water, and the aspects of research that will be studied include clean water exploration and environmentally friendly management patterns of potential underground water resources. The research location is Tambang District, Kampar, Riau Province. The targeted finding is an environmental management model of potential underground water resources in Tambang Kampar District using the Schlumberger rule geoelectrical method. Fundamental contributions to a field of science are geophysics and environmental science disciplines related to groundwater availability.

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1. INTRODUCTION

The presence of groundwater can be identified through rock formations from subsurface geological structures by determining variations in resistivity values using the geoelectric method [1-5]. The geoelectric method is a geophysical exploration method that uses the electrical properties of the earth to study subsurface conditions such as stratigraphy [6], geological structure [7], distribution of material properties [8], and so on [9-15]. Measurements using the geolistic method aim to obtain the resistivity of the earth's layers.

Kualu village, Mining sub-district, Kampar district, is one of the areas that has peat soil lithology. The condition of this peat soil is very vulnerable to underground water pollution, both due to waste from industrial waste and domestic waste [16-20]. Domestic waste is produced from residential areas [21-24]. In Kualu Village this triggers underground water pollution because limited green space will cause the distribution of underground water to be focused on one point of the water flow path which will speed up the pollution process itself. Based on the conditions in Kualu Village, it is necessary to research to analyze one dimension of underground water using the geoelectric method.

2. LITERATURE REVIEW

The Schlumberger configuration geoelectric method is a 1-dimensional model that can be used to determine the subsurface layering system vertically. The Schlumberger geoelectric method is composed of 4 electrodes as shown in Figure 1.

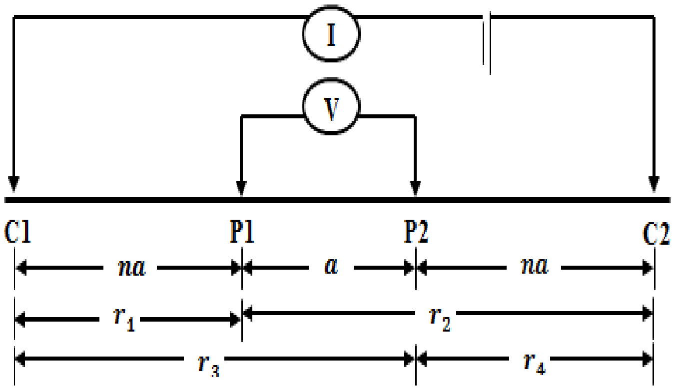

Figure 1. Shlumberger's rule [4].

The data obtained is the apparent resistivity which is formulated by [25]:

$$\rho_a = K\frac{\Delta V}{I} \tag{1}$$

where C, P, r, and a are the electrode positions and the distance between the electrodes as shown in Figure 1. K is the geometric factor (m), ΔV is the measured potential difference (volt), and I is the measured electric current (ampher). The Schlumberger rule geoelectric method will then be used to interpret groundwater geohydrology.

Groundwater geohydrology is closely related to the hydrological cycle. The hydrological cycle begins with the evaporation of water on the earth due to heat from the sun reaching the earth, causing the water to change form into gas or steam. Steam will move in the atmosphere (air) because in the atmosphere there is a change in temperature from hot to cold. In this process, water will be formed due to condensation of water vapor into liquid [26]. If the temperature is below freezing point, water will freeze, forming ice crystals. As a result of the condensation event, small water droplets will appear and collide with other water droplets which are then carried away by the turbulent movement of the air, thus forming very large water droplets [27]. Enough water droplets will fall to the earth due to their weight and due to the influence of gravitational force, this process is called rain or precipitation. If the air temperature drops below 0°C, the water droplets will turn into snow [28].

3. RESEARCH METHODS

This research uses a field experiment method, a measurement process in the field to obtain comprehensive location coordinates using the global position system (GPS). The data collected is processed to create an interpretation processing model for underground water exploration in the peat area in Kualu Village, Tambang District [26].

Tabel 1. Research tools and materials.

Tools and materials	Utility
Resistivity meters	To provide a value for the potential difference (V) and current strength (I)
Voltage electrode (potential)	To determine the magnitude of the voltage generated
Power cable	As a cable connecting the electrode and batter
12 Volt battery	As a current source
Meter	To measure track length
Hammer	To hit the current electrode and potential electrode into the ground
GPS	To find out the coordinates of the research location
Measuring table book	To record the magnitude of the current (I) and potential (V) values generated
Geological map	To find out about the geology in the research area
Progress Software	For mapping/contouring the subsurface layer
Digital camera	To document research

4. RESULTS AND DISCUSSIONS

The research track is at coordinates 0°45'20" N and 101°35'79" E. The results of calculations and data processing on track 1 with the Progress Software for the Schlumberger Configuration Geoelectric Method obtained an RSM-error value of 5.4368% with a maximum depth of 33.20 meters and a resistivity of 837.45 Ωm. Modeling the distribution of material resistance values below the surface along the path as in Figure 2.

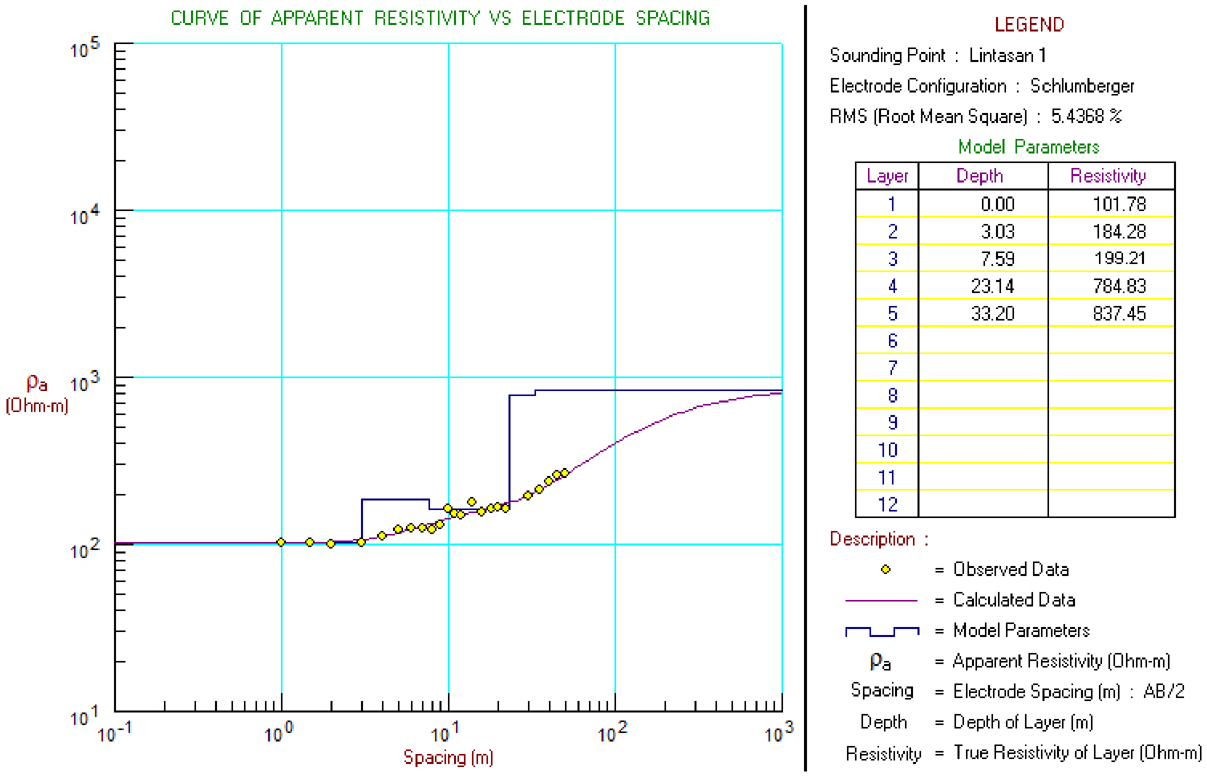

Figure 2. Dimensional progress model interface.

The resistivity value of the soil layer ranges from 101.78 – 837.45 Ωm. The first soil layer at the research location with a resistivity value of 101.78 Ωm at a depth of 0 – 3.03 meters is interpreted as a peat layer. Peat is a wetland formed from piles of organic material originating from the remains of trees, grass, and rotting animal bodies [29].

The second layer has a resistivity value of 184.28 Ωm at a depth of 3.03 – 7.59 meters, which is interpreted as a peat layer. The third layer has a resistivity value of 199.21 Ωm at a depth of 7.59 – 23.14 meters, interpreted as a clay layer. Clay or clay has a mineral particle size with a basic silicate framework that is less than 4 micrometers in diameter. Then the next resistivity value is 784.83 Ωm at a depth of 23.14 - 33.20 meters, which is interpreted as a layer of sand with potential fresh water. The last layer which read a resistivity value of 837.45 Ωm at a depth of 33.20 – 49 meters was interpreted as a gravel layer. Gravel is a small rock which is usually granite which is broken or weathered so that over time it becomes small [30].

Table 2. Table of data processing results.

Depth (m)	Resistivity (Ωm)	Rock type	Thickness (m)
0 – 3.03	101.78	Peat	3.03
3.03 – 7.59	184.28	Peat	4.56
7.59 – 23.14	199.21	Clay	15.55
23.14 – 33.20	784.83	Sand	10.06
33.20 – 49	837.45	Gravel	15.8

Based on Table 2, it can be recommended that the potential of the underground water environment that can be utilized through good environmental management will become a potential natural resource that can be utilized to support the regional economic sector. This underground water potential needs to be studied further in the underground water resources management matrix. This matrix will be able to provide solutions to the environmental problems of fresh water potential in Tambang District, Kampar, thereby supporting economic improvement in terms of meeting clean water needs. The material that is the object of research is underground water and can be explored to become clean water and environmentally sound management patterns for the potential of underground water resources in Kuala Kampar Village using the Schlumberger rule geoelectric method at the location of Tambang District, Kampar, Riau Province. The findings of an environmentally sound management model for potential underground water resources in Tambang Kampar District using the Schlumberger Rule Geoelectric Method have been found. The results of this research are expected to provide a fundamental contribution to a field of science: (a) Geophysics and environmental science disciplines related to the availability of underground water; and (b). About science and technology, namely the realization of conservation of underground water resources in synergy with government policy patterns and the three pillars of sustainable development, namely: social, economic, and environmental sustainability as well as contributing to the achievement of the higher education strategic plan.

5. CONCLUSION

The conclusion that can be drawn from the results of research using the Schlumberger electrode configuration geoelectric method in the peat area of Kualu Village, Tambang sub-district is that the results of geoelectric data processing obtained a resistivity value of 101.78 – 837.45 Ωm. The aquifer has a depth of 33.20 meters, so it can be concluded that the potential for a large aquifer has been successfully created as a model for environmentally sound management of potential underground water resources in the Tambang Kampar District using the Schlumberger Rule Geoelectric Method.

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