Application of Geoelectrical Resistivity Method for Groundwater Exploration Using Wenner-Schlumberger Configuration in Sampakang, Maros Regency, Indonesia

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Abstract. Indonesia is one of the tropical countries that only has two seasons, namely the dry season and the rainy season. The prolonged dry season caused the villagers in Sampakang, Indonesia to face difficulties in obtaining clean water sources. This research conducted in Sampakang, Maros, Indonesia aims to obtain groundwater that can be used as a spring for villagers. The research was conducted using the Geoelectrical Resistivity Method Wenner Schlumberger configuration with a total trajectory of 56 m. The results of the analysis showed that the soil structure consists of shallow groundwater and the RMS error is 2.2%. Where the thickness of the aquifer layer is 9 m and was found at a depth of 2.5 m-11.5 m. Aquifer layer in the form of alluvium deposits with a resistivity value of about <10.9 Ωm-100 Ωm. There is a permeable layer in the form of limestone in a depth of 9.6 m with resistivity value at >100 Ωm.

1. Introduction

One method of exploration geophysics is the geoelectric method. The principle of this method is to study the flow of electricity that is on earth and how to detect it on the surface of the earth. Consists of several basic measurements such as electric potential, electric current, and electromagnetic fields. All naturally or directly injected into the earth.

The principle of conducting resistivity surveys is to spread the electric current in the direction of the earth through two current electrodes which are plugged into two ground points and then measure the potential difference response that occurs between two other points on the earth's surface where two potential electrodes are placed together in a certain arrangement [1].

According to Telford, 1990 that electric currents in rocks or even minerals can be divided into three types, namely electronic conduction, electrolytic conduction and dielectric conduction. Also, the nature of rock's electricity is the characteristics of rocks that exist when an electric current flows into it. This electric current can come from nature itself due to an imbalance, or an electric current that is intentionally inserted into it [2].

Factors that influence resistivity are lithology composition, rock conditions, mineral composition contained, and liquid content [3]. The value of resistivity is inversely proportional to the value of conductivity. Conductivity is a quantity that shows the number of ions dissolved in water that can conduct an electric current of 1 μvolt in a 1 cm metal layer. This is influenced by the amount of content called free ions. The geoelectrical resistivity method is generally based on that an earth is homogeneous isotropic. But in reality, the earth is a layer of rock that has different resistivity values for each layer. This causes the measured potential to be ultimately affected by these layers and causes the values of the measured resistance to depend on the distance of the electrodes. The type of detainee that is measured is not the actual type of prisoner but the type of apparent resistance (ρa) [4].
Formulas are used in the geoelectric resistivity method. The basic concept of the geoelectrical method is Ohm Law, which applies namely:

$$ R = \frac{V}{I} \quad (1) $$

- $R$ = resistance (Ohm), $V$ = Electric Potential (Volts), and $I$ = Current (Ampere).

In geophysical exploration, one of the methods used in geoelectric search for ground water sources. In general, groundwater can be found in layers of soil near the surface to layers that are so far from the soil. Sometimes ground water looks clean. But, sometimes it also looks muddy to the point of being dirty. But, in general, can be clean and clear. It is known that ground water comes from rain water that falls to the earth and surface water, which infiltrates first time into the aeration zone or unsaturated zone. Then enter deeper into the water saturation zone and gather into ground water. Ground water comes from the hydrological cycle. Repeated events consisting of several stages through which water passes from the atmosphere to the earth and back to the atmosphere; evaporation on land and sea or become condensation which eventually forms clouds, outpourings, loosens groundwater bodies and then experiences evaporation which all occur periodically and repeatedly [5].

From this hydrological cycle it is known that groundwater generally interacts with surface water and many other components that help in the hydrological cycle. Like the topography, the type of cover rock, existing land use, plants and even humans on the surface of the earth. Groundwater and surface water are interrelated and interacting. Every pumping action, contamination of groundwater will react to surface water, and vice versa [5].

In Maros Regency, there are several types of rocks such as sandstone, coal, lava, breccia, limestone, sedimentary rock. Geological conditions generally describe the type, position, distribution, process and time of formation of the host rock, as well as the ability of soil morphology such as the caldera cliff fault and others. While the type of soil based on the results of identification that has been carried out in Maros Regency, there are five types of soil spread in several areas such as alluvial, lithosol, Mediterranean and podzolic soil types.

**Table 1. Soil distribution in Maros Regency**

| Soil Types   | Wide (Ha) | Percentage (%) |
|--------------|-----------|----------------|
| Alluvial     | 38.191    | 23.5           |
| Mediterranean| 51.498    | 32             |
| Lithosol     | 45.632    | 28.1           |
| Podzolic     | 8.729     | 5.4            |
| Latosol      | 17.862    | 11             |

This research was conducted in the Sampakang District, Maros Regency, Indonesia. This area is one of the areas in Maros Regency that is difficult to get clean groundwater sources when the dry season comes each year which disrupts the activities of the local's villagers. The importance of conducting this research is to find clean groundwater sources with Geophysical methods, namely the Geoelectric method with the Wenner-Schlumberger configuration with the aim of finding clean groundwater sources and determining the location of aquifers in this area when the dry season. So, its known that the formulation of the problem in this research is at what depth and the aquifer layer can be found in the Sampakang area, Maros Regency, Indonesia.

2. Data and Method
This research consists of three steps. The first one is an acquisition. The acquisition is collecting the data in the field using a geophysical method, in this case, we were using geoelectrical resistivity method Wenner-Schlumberger array to delineate how subsurface looks like.
The acquisition was conducted on the 4th of July 2018 and located in Sampakang, Maros, Indonesia. The measurement was using Geomatics Supreme GD 10 with 28 electrodes and the space of each electrode are 2 meters. The coordinates of each electrode were conducted using GPS.

After data sets were collected, the next was data sets processing. Processing of existing data sets, using the least inversion technique, RES2DINV. The least inversion technique was used to delineate the layers of subsurface with the smallest RMS (root mean square). The output of this process is cross-section.

The final step is to interpretation. The existence of a mathematical analysis of quantitative interpretations derived from the results of resistivity was developed for vertical sound techniques and can detect the presence of 3D anomalies. Generally, in geophysical methods, quantitative interpretations where possible, assessments in the results will have to develop from the initial estimates made in the field. Then in the method of interpretation is much better, seen in surveys that are complete [3]. Interpretation means translating the cross-section into geological terms and something that everyone could easily understand.

Figure 1. Location of the research

3. Result and Discussion
According to the result, the soil structure consists of shallow groundwater. The RMS error of the results is 2.2 %. Where the thickness of the aquifer layer is 9 meters with depth from 2.5 - 11.5 m. Aquifer layer in the form of alluvium deposits with a resistivity value of about <10.9 Ωm-100 Ωm. There is a permeable layer in the form of limestone in a depth of 9.6 m with resistivity value at >100 Ωm. Besides, there is a borehole at 35 m.
4. Conclusions
Geoelectrical resistivity method is one of geophysical method that can delineate subsurface. So that it can help in finding clean groundwater sources. The resistivity method generally uses an artificial current source. Do it directly to the ground through the electrode points or use long line contacts. The applicable procedure is to measure the potential of other electrodes around the current flow that arises. Because the current is measured too. So that later in determining whether subsurface resistivity can be effective and clear to be observed.

By using geoelectrical resistivity method explorations or subsurface delineation could possibly do in a simple way and affordable than another geophysical method.

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