

Geoelectric Methods to Determine the Location of Old Graves

Aco Wahyudi Efendi¹

¹ Department of Civil Engineering, Tridharma University, Indonesia

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ABSTRACT

Gunung Selendang site is known for being classified as a burial site containing human bones, based on excavation findings in the form of a jug tomb (tajau), including; Limbs, hip fragments, jaw fragments, teeth, skull fragments, and small bone fragments that are difficult to identify. In general, the Tajau shape at this point consists of two groups, namely the slender Tajau group with wavy lips with a diameter of 23.5 cm and the chubby Tajau group with simple, unadorned lips with a diameter of 22 cm. Geophysical methods widely used in exploration include seismic, magnetic, gravitational, electrical, and electromagnetic resistance methods. The geoelectric method is one of the geophysical exploration methods that can be used to study the properties of a geothermal system, determine the lithology of rock layers, deposit locations, flow patterns, and the distribution of geothermal fluids below the earth's surface. From this material it can be clearly seen in the color of the soil layer and shows a collection of urn-shaped material in this color at a depth of up to 2 meters and according to the knowledge that from the side of the soil to a depth of 2 meters a collection of Urns with ancient fragments found.

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Corresponding Author:

Aco Wahyudi Efendi,
Department of Civil Engineering, Tridharma University,
Jalan AW Syahrani No. 7 Balikpapan, Indonesia
Email: aw.efendi2018@gmail.com

1. INTRODUCTION

Gunung Selendang site is known for being classified as a burial site containing human bones, based on excavation findings in the form of a jug tomb (tajau), including; Limbs, hip fragments, jaw fragments, teeth, skull fragments, and small bone fragments that are difficult to identify. In general, the Tajau shape at this point consists of two groups, namely the slender Tajau group with wavy lips with a diameter of 23.5 cm and the chubby Tajau group with simple, unadorned lips with a diameter of 22 cm. Based on observations of the existing Tajau fragments, it can be seen that all types of Tajau that are used as grave containers are made of stoneware. Technically, these Bajau-Bajau are made using fairly advanced ceramic-making technology, albeit not as advanced as the process of making porcelain. The slim Tajau type at the Sanga-Sanga site is very similar to the Martavan type Tajau from the "Tempayan Martavan" book, which is about 80 cm high and has a dragon image with cloud and flower motifs. Marta van is one of the ports in Burma that is a place for shipping jar/jar type ceramic products, so jars sent through this port are known as Marta van. The Tagus like this one was in the 17th-18th centuries. Widespread manufacture in southern China in the 18th century AD. This type of tagua is common in East Kalimantan and is used as a burial container.

Geophysical methods widely used in exploration include seismic, magnetic, gravitational, electrical, and electromagnetic resistance methods. The geoelectric method is one of the geophysical exploration methods that can be used to study the properties of a geothermal system, determine the lithology of rock layers, deposit locations, flow patterns, and the distribution of geothermal fluids below the earth's surface. The use of geoelectricity was first carried out in 1912 by Conrad

Schlumberger. Geoelectricity is one of the geophysical methods of determining changes in resistivity of rock layers below the soil surface by the flow of direct current (direct current) with high voltage into the soil. This electric current injection uses 2 current electrodes A and B, which are inserted into the ground at a certain distance.

This geoelectrical method is used to determine the properties of underground rock strata to determine the possibility of an aquifer layer, namely a rock stratum that is an aquifer. The search is generally for a limited aquifer, which is an aquifer layer that is flanked at the top and bottom by a layer of impermeable rock (eg a layer of clay). This limited aquifer has a replenishment relatively distant so that the availability of groundwater below the well site is not affected by local weather changes. The basic principle of this method is to inject an electric current into the earth with two current electrodes and then to measure the potential difference via two further electrodes on the earth's surface. The injected electrical current flows through the rock layers below the surface, generating potential difference data, the value of which depends on the resistivity of the rock it traverses. This phenomenon is used to identify and determine the type of rock, including the fluids that are below the surface.

The use of the geoelectric resistance method is widespread for observing shallow geological layers. The performance of the geoelectric method is strongly supported by the subsurface conditions, which are composed of layers with different resistance. The change in the resistivity of the layers can be observed by injecting an electric current into the earth and recording the resistivity at observation points on the earth's surface. By varying the electrode spacing according to a particular configuration, vertical and horizontal changes in resistivity can be interpreted. This geoelectrical survey consists of two types of activities, namely resistivity mapping (mapping) and resistivity estimation (sounding). The results of the mapping measurements will be in the form of apparent resistivity maps for various lengths of current electrodes, while the probing measurements will be in the form of profiles of the actual resistivity values.

2. RESEARCH METHOD

The specific resistance is determined from an apparent specific resistance, which is calculated from the measurement of the potential difference between the electrodes placed in the ground. As a result, a potential difference between two electrodes is measured, as shown in Figure 2.1). The specific resistance is determined from an apparent specific resistance, which is calculated from the measurement of the potential difference between the electrodes placed in the ground. Measurement of a potential difference between two electrodes as in Figure 2.1) as a result of the other two electrodes at point C in Figure 2.1, namely the specific resistance below the ground surface under the electrode [1]–[4].

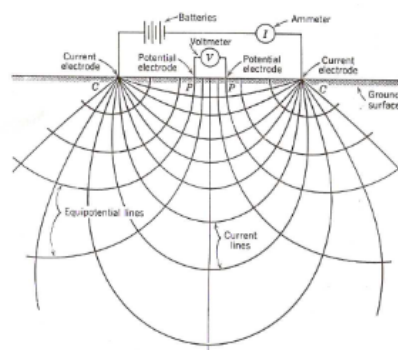


Figure 2.1. Determination of the electrical cycle of the specific resistance and the electrical field for a homogeneous layer below the surface

There are two types of resistivity studies, namely Horizontal Profiling (HP) and Vertical Electrical Sounding (VES) or depth studies, with anisotropic cross-sectional differences in the horizontal direction and anisotropic estimation differences in the vertical direction. Profiling and sounding results are often affected by both vertical variation and the type of electrical formation. The

vertical and horizontal distribution of resistivity in the volume of rock is called the geoelectric section, as shown in Figure 2.2.[2], [5]–[8]

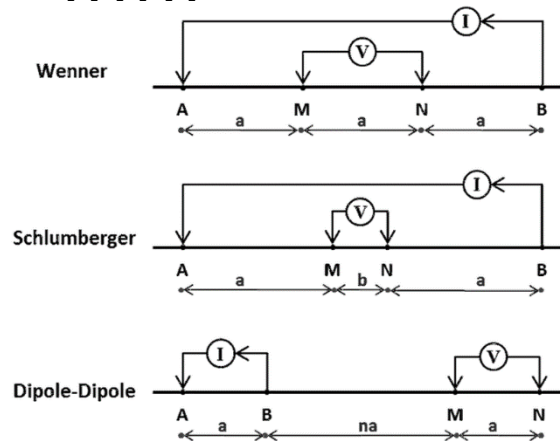


Figure 2.2 Electrode configuration in the Wenner-Schlumberger method for horizontal sections and vertical estimation

Geoelectricity is one of the geophysical methods to determine changes in the resistivity of rock layers below the surface of the ground by the flow of direct current ('direct current') with high voltage into the ground. This electric current injection uses 2 'current electrodes' A and B that are inserted into the ground at a certain distance. The longer the electrode spacing AB has the effect that the flow of electrical current penetrates deeper rock layers.

The flow of electrical current creates an electrical voltage in the ground. The electrical voltage occurring on the earth's surface is measured with a multimeter which is connected via 2 'voltage electrodes' M and N, which are shorter than the distance between the electrodes AB. As the position of the AB electrode gap becomes larger, the electrical voltage appearing on the MN electrode also changes according to the information on the type of rock that is injected with an electrical current at a greater depth.

Assuming that the depth of the rock layer that can be penetrated by this electric current is equal to half the distance AB, which is usually referred to as $AB / 2$ (when a pure direct electric current is used), it is estimated that the effect The injection of this electric current has the shape of a hemisphere with a radius of $AB / 2$.

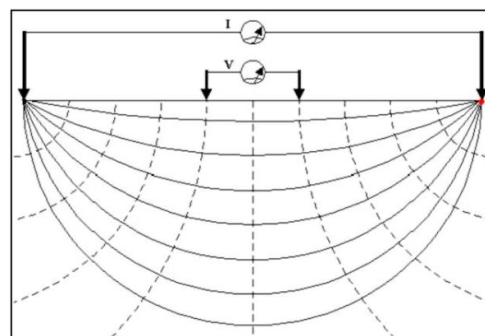


Figure 2.3 The geoelectric method works

The geoelectrical method generally used is that which uses 4 electrodes arranged in a straight line and symmetrically to the center point, namely 2 current electrodes (AB) on the outside and 2 voltage electrodes (MN) on the inside.

The combination of the distance $AB / 2$, the distance $MN / 2$, the amount of the flowing electric current, and the occurring voltage results in an apparent specific resistance value ('apparent specific resistance'). It is known as the apparent resistivity because the calculated resistivity is a combination of many layers of rock below the surface through which an electrical current flow.

If a series of apparent resistivity measurements from shortest distance AB to longest are plotted on a logarithmic chart with distance $AB / 2$ as the x-axis and the apparent resistivity as the y-

axis, a geoelectric data curve is obtained. The properties of the rock layers beneath the surface can be calculated and predicted from the data curve [1].

The geoelectric method consists of several configurations, for example, the 4 electrodes are in a straight line with the AB and MN electrode positions symmetrical to the midpoint on either side, namely the Wenner and Schlumberger configuration. Each configuration has its calculation method to determine the value of the thickness and resistivity of the underground rock. The Schlumberger Configuration geoelectrical method is a popular method that is widely used to determine the properties of underground rock strata with a relatively low cost of surveying.

Rock strata generally do not have the perfectly homogeneous properties required by geoelectrical measurements. For the location of rock strata close to the ground has a significant influence on the results of the voltage measurements and means that the geoelectric data deviate from the actual value. What can affect the homogeneity of rock layers are other rock fragments brought into the layer, the uneven weathering of the bedrock, the material contained in the road, local waterlogging, and piping made of electrically conductive metal materials, wire fences connected to the ground, and so on.

"Spontaneous potential" is a natural electrical voltage that generally occurs in rock layers, caused by the presence of a conductive solution that chemically creates voltage differences in minerals from different rock layers, which also cause rock layer inhomogeneities. This voltage difference is generally relatively small, but if a Schlumberger configuration with a long AB electrode spacing and a relatively short MN spacing is used, there is a possibility that the natural electrical voltage may contribute to the electrical voltage measurement results. MN electrode contributes so that the measurement data are less correct.

To overcome this natural electrical voltage, the multimeter is set to the natural voltage and the starting position of the multimeter to zero before electrical current flows through it. Thus, the multimeter measuring device shows the actual voltage caused by the current supply to the AB electrode. Multimeters with such facilities can only be found in multimeters with high accuracy [1][5], [9]–[11].

2.1. Wenner configuration

The advantage of this Wenner configuration is that the accuracy of the voltage measurement on the MN electrode is better for relatively large numbers since the MN electrode is relatively close to the AB electrode. Here you can use a multimeter measuring device with a relatively low impedance.

However, the weakness is that the homogeneity of rocks near the surface cannot be recognized, which can affect the calculation results. With the data from the Wenner configuration method, it is very difficult to eliminate the inhomogeneity factor of rocks, so that the calculation results become inaccurate.

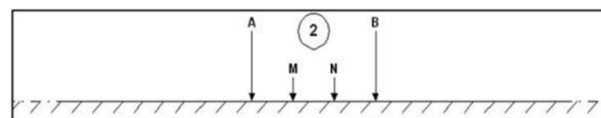


Figure 2.3 Wenner configuration

2.2. Schlumberger configuration

In the Schlumberger configuration, the MN distance is ideally made as small as possible so that the theoretical MN distance does not change. Due to the limited sensitivity of the measuring device, however, the MN distance should be changed if the AB distance is relatively large. The change in the MN distance should not be greater than 1/5 of the AB distance.

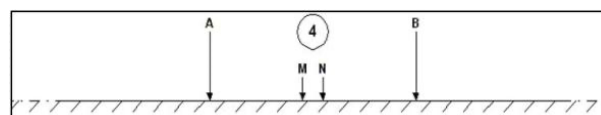


Figure 2.4 Schlumberger configuration

The weakness of this Schlumberger configuration is that the voltage reading at the MN electrode is smaller, especially if the distance AB is relatively large, indicating a voltage of at least 4 digits or 2 digits behind. Or devices that send electricity in another way and have a very high DC voltage.

Meanwhile, the advantage of this Schlumberger configuration is the ability to detect the presence of inhomogeneities of rock strata on the surface by comparing the apparent resistance values as the MN / 2 electrode spacing changes.

So that the voltage measurement at the MN electrode is reliable, the MN electrode distance should also be increased if the distance AB is relatively large. Consider the change in distance between the MN electrode and the distance between the AB electrode, namely when the electrical voltage display on the multimeter is already so small, e.g., 1.0 millivolt.

In general, changes to the MN distance can be made when a ratio of MN distance to AB distance = 1:20 is reached. Minor comparisons, such as a very large DC voltage output, say 1000 volts or more so that the measured voltage difference across the MN electrode is no less than 1.0 millivolts.

There are various methods of exploring subsurface conditions, one of which is the geoelectric method. Using the geoelectric method, we can study the nature of the flow of electricity in the earth and then measure the response in terms of potential difference, electric current, and electromagnetic fields (both natural and injected). The resistance method uses a source of electrical power. An electric current is injected into the soil through the current electrode. The potential difference is measured with a potential electrode that is plugged into the earth in the area of the power feed [12]–[17].

The concept of apparent specific resistance by knowing the injected current and measuring the potential difference at the point where the current is injected, the soil resistance value can be obtained. The specific resistance value obtained from the measurement results is called an apparent specific resistance or an apparent specific resistance. This method assumes that the earth has an isotropic homogeneous nature. In actual conditions, the soil is not homogeneous because the earth is made up of layers of different ρ , so the resistance value we get is a resistance value that is the resistance value of all the layers crossed by the equipotential line. This resistance method is widely used in the exploration world for various purposes, including finding geothermal deposits and groundwater exploration.

There are several types of electrode arrangements/configurations for resistivity data acquisition. In general, the electrode configuration is for data acquisition.

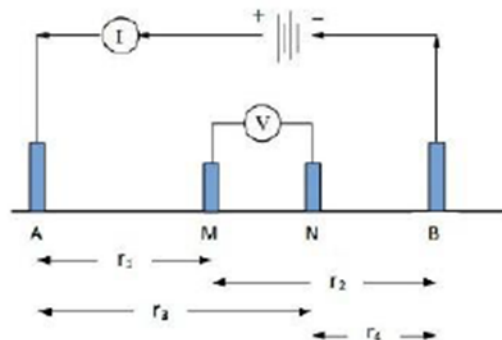


Figure 2.5 Electrode configuration for data acquisition

The value (apparent resistivity) can be obtained using the relationship:

$$\rho_a = Ks \frac{\Delta V_{MN}}{I} \quad (1)$$

Where is the potential difference between points M and N, I is the current and K is the configuration factor which is important:

$$Ks = 2\pi \left(\frac{1}{r_1} - \frac{1}{r_2} - \frac{1}{r_3} + \frac{1}{r_4} - \frac{1}{r_5} \right)^{-1} \quad (2)$$

Several types of configurations that already exist include the Wenner configuration, Schlumberger, Pol-Dipole, Dipole-Dipole, and so on. There are advantages and disadvantages to using these configurations, each depending on the needs of the user. For example, the Wenner

configuration is best used for lateral mapping purposes, while the Schlumberger configuration is typically used for vertical exploration purposes. This is where I attach the Schlumberger configuration and the Wenner electrode configuration.

The resistivity measurement method commonly used in field data acquisition has different functions. As already announced, lateral mapping and vertical sounding will be discussed here. Lateral mapping uses this method to determine the trend in resistivity prices in a given area. Each target point is followed by several measuring points. The figure is shown in Figure 2.6.

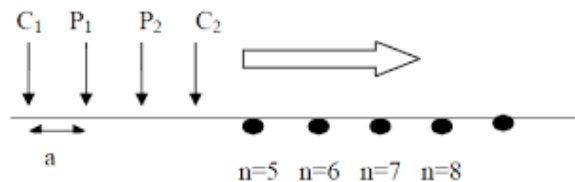


Figure 2.6 Acquisition technique with lateral mapping

The above picture shows a schematic representation of the data acquisition by mapping with the Wenner configuration. For the first measurement ($n = 1$), the distance between the electrodes was made equal to a . After the first measurement, the electrode is shifted to the right by a distance a ($C1$ shifts to $P1$, $P1$ shifts to $P2$, $P2$ shifts $C1$) up to the desired maximum distance.

Used tool is Geolistic Single Channel Twin Probe (G-Sound), G-Sound was developed to meet the need for inexpensive and reliable (geoelectric) measuring devices for resistivity. This geoelectrical instrument is designed for portable measurements with a current penetration depth of 100 m to 150 m. With G-Sound there is no complicated SP setting; the SP value is automatically corrected using the setting button. This is very helpful for inexperienced device operators and, with a weight of approx. 1 kg, makes the work of resistance profiling or probing data acquisition easier. G-Sound's power source technology makes it a reliable, safe anti-short circuit system, where short circuit conditions often occur when the AB (current) distance is too close or in a layer with low impedance. With a multimeter impedance on the instrument of 10 MOhm and a resolution of 12 bits, the measurement of voltage and current values is very precise and accurate.

The power source and anti-short circuit technology applied to any geoelectric instrument can be used to perform laboratory-scale measurements such as the resistance of soil media (soil box), rock (core samples), and mud. G-Sound thus supports all measurement requirements both in the field and in the laboratory.

This lithological interpretation will get closer to the truth when we have underground data, such as data from boreholes. If there are no wells, we should know the regional geology of the study area or obtain data from geological observations of the area (to determine lithological variations) [18], [19].

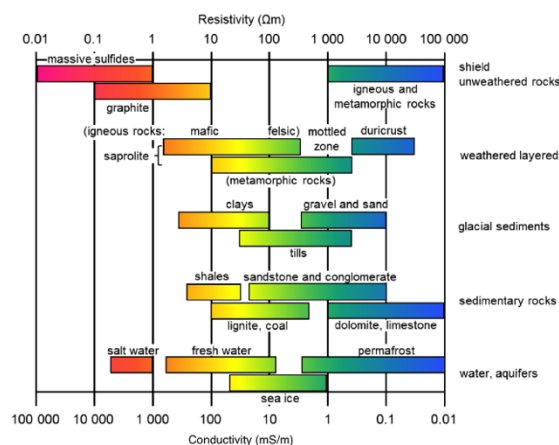


Figure 2.7 Resistances of ordinary rocks and ore minerals (Ohm-Meter)

RESULTS AND DISCUSSION

The determination of the zoning / segmentation on geoelectrics is necessary in order to obtain the behavior and the segmentation of the soil type per examined layer. For this work the zoning is as follows.

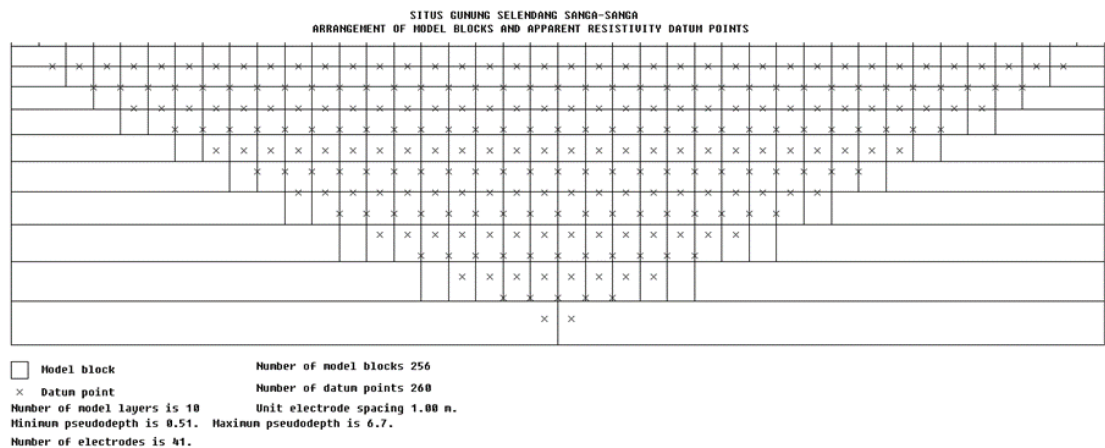


Figure 2.8 Resistivity Datum Point

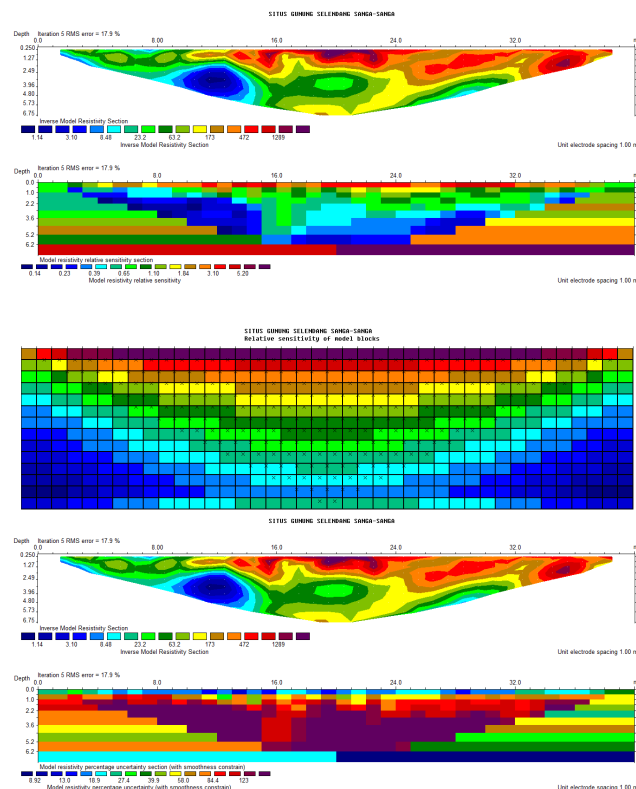


Figure 2.9 Resistivity Block Model

At the time of processing the data from the geoelectrical survey, it was found that the color contour display hue which shows color differences according to the electrical resistance that occurs in each layer, in Figure 2.9 shows the shape or color hue that looks significantly different at a depth of 1-2 meters where from the type of layer The soil appears to have very high electrical resistance and is indicated to be similar to oil and calcium material, this indicates that the layer is the result of deliberate changes, because it has a very significant hue and does not mix with the surrounding soil material.

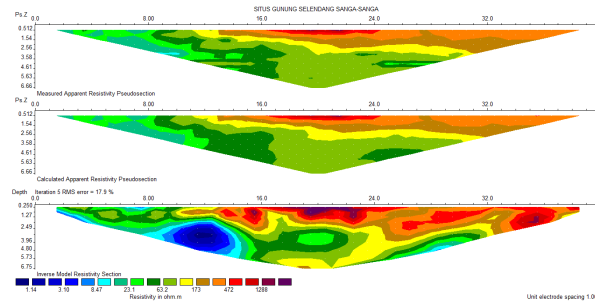


Figure 2.10 2D representation of geoelectric test results for mapping soil patterns.

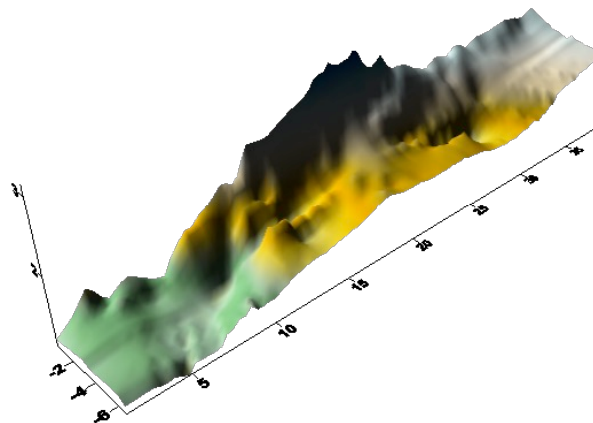


Figure 2.11 3D representation of geoelectric test results for mapping soil patterns.

From the investigation results, it was found that the soil layer at a depth of 0.00 meters to 2.49 m at a reference distance of 15 to 24 meters has a sheet resistance with a value of 1,099.5 ohms to 1,636.62 ohms (with purple Color). which was categorized as a layer with hard / rock material and at a depth of 2.49 m to 5.73 m with a date of 8 to 15 m a water zone or waterway (blue) and a clay layer with a resistance value of 63.2 ohms up to 100 ohms (in yellow). The location of the makam is at a distance of 15-16 meters at a depth of 1.00 to 1.27 meters from the surface and for a date of 36-37 meters at a depth of 2.00 to 2.49 meters [20-24].

3. CONCLUSION

From the results of examining the soil layer to obtain the hue of the soil layer under examination, the results of field data processing are obtained as shown in the figure 2.13.



Figure 2.12 Documentation of geoelectric field data collection on selendang site zoning

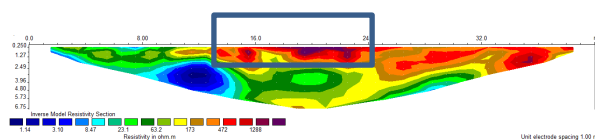


Figure 2.13 The results of identification of soil layers from geoelectric field report



Figure 2.14 Field findings after digging in the geoelectric survey area

This is linear with geoelectric findings at a reference distance of 15 to 24 meters at a depth of 0.00 meters to 2.49 m, the type of soil found with a resistance value of 1,099.5 ohms to 1,636.62 ohms; this gives the color nuance of the Clay layer. That surrounds solid objects such as rocks with resistance values such as sandstone, limestone, green stone, gabbro, granite, and basalt, specifying the type of soil layer. In this way, the object can be identified as a strong and solid object, such as stone-like stoneware filled with fragments; the results of the layer shade also indicate that the zoning is a different material than clay-like topsoil. This is also confirmed by the shape of the shade of the soil layer, which forms a jar-like shape, which can be seen in Figure 2.13 in the area marked with a blue box [6]; when excavated in the zone, we marked with a square, we discovered that the material consisted of Tajau fragments, namely tableware material such as solidified clay, predominantly only partially glazed. It can be glassy or semi-vitreous. It is usually gray or brownish in color due to impurities in the clay it was made from and is usually glazed. From this material, it can be clearly seen in the color of the soil layer, and it can be seen that this accumulation of colored urn-shaped material is located at a depth of up to 2 meters and, as far as we know, from the bottom side to a depth of 2 meters Collection of Guci with ancient fragments found as shown in Figure 2.13.

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