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Identification of the Potential Quartz Sandstone in the Sambong Area By the Dipole-Dipole Configuration of Resistivity Method

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Abstract

The presence of quartz sandstone outcrops in the southeast of the study site suggests the presence of quartz sandstones in the northwest, according to the strike direction. This geoelectrical measurement aims to determine the distribution of these sandstones below the surface. The method used is geoelectric with a dipole dipole configuration.

Measurements were made on four track lines. Tracks A and B indicate the existence of a layer of sandstone below the surface. Tracks C and D do not show any layers of quartz sandstone. This is caused by the presence of faults or folds that cause the layer to shift from the previously predicted path.

Keywords: sandstone, ngrayong, resistivity

1. Introduction

1.1 Background

In the last few decades, the development of technology has been very rapid. This causes an increase in the need for raw materials. Development requires quartz sand to be one of its raw materials. Quartz sand is needed as a basic ingredient for making lightweight bricks (Haryanti and Wardhana, 2019; Sujatmiko et al., 2018). For technological needs, quartz sand also has an important role as a raw material for making glass fiber (Li, 2014).

Central Java and East Java are two of the locations that have rock formations bearing silica sand with a fairly high silica content. The formation that carries silica sand is the Ngrayong Formation (Khaing et al., 2017; Winarno et al., 2021). The Sambong area in Central Java is one of the exposed locations of the Ngrayong Formation.

1.2 Research Objectives

The research location is in Sedan Area, Rembang Regency. Precisely in the north of the abandoned sand mining opening (Fig. 1). The rest of the mining shows the presence of quartz sand outcrops. The direction of the straightness of the outcrop is towards the north, or the research location. The problem that arises is that, at the research location, the sandstone outcrops are not visible because of the cover in the form of andesite breccias.This study aims to identify the presence and depth of quartz sandstones in the Ngrayong Formation using the geoelectric method.

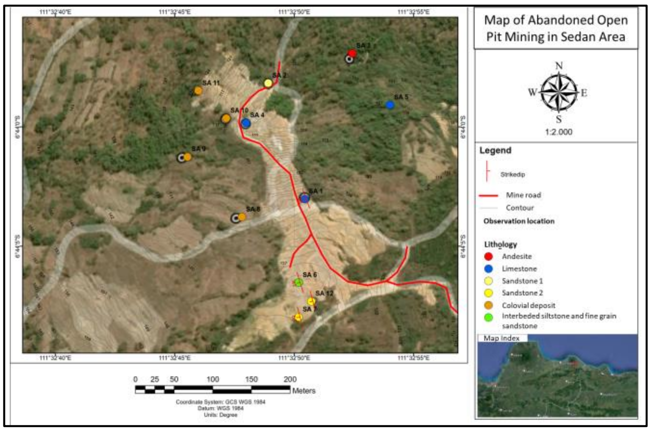

Fig 1. Map of the location of the silica sand mine in the southeast of the study location

1.3 Literature Review

Referring to the physiographic division of the East Java Basin according to Bemelen, 1949 and Satyana, 2005 in (Abdillah, 2013) the research location is included in the Rembang Zone (Fig. 2). This basin was formed in the late Oligocene geological time span.The Rembang zone is composed of rock formations that have an abundance of silica sand. This is why the Rembang Zone is one of the oil-producing basins in Indonesia (Choiriah et al., 2021; Ran et al., 2020; Telaumbanua et al., 2019). The Ngrayong Formation is one of the formations that is a reservoir in the petroleum system in the Rembang Zone. The Ngrayong Formation in the Rembang Zone shows an indication of a shallow marine depositional environment or not far from the coast (Rabbani, 2021). This is also supported by the presence of carbonate rocks or limestone in the rock formations of the Ngrayong Formation.

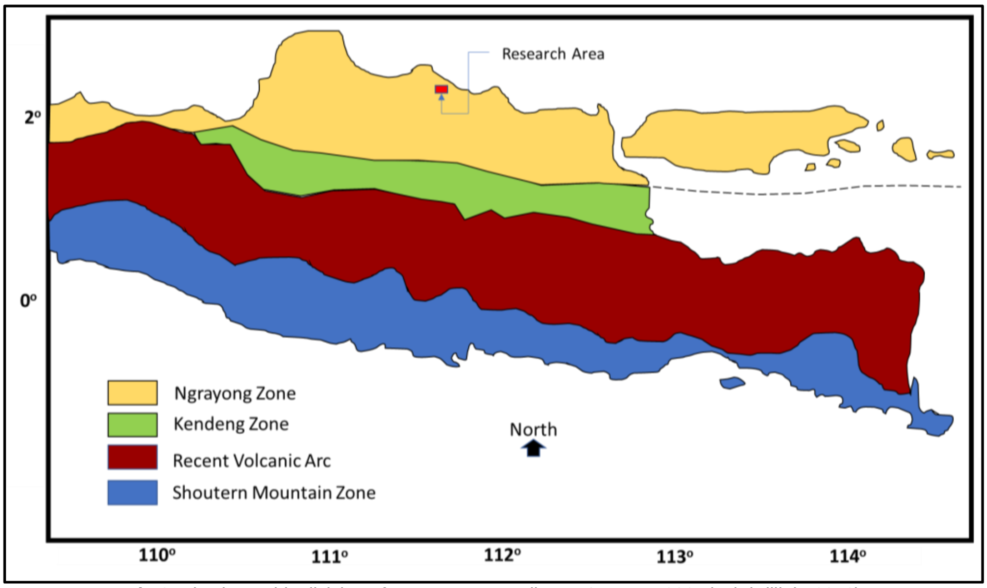

Fig 2. Physiographic division of East Java according to Satyana, 2005 in (Abdillah, 2013)

2. Methodology

Estimation of subsurface geological conditions can be done using several methods, one of which is geoelectric. The geoelectric method can be used to identify the presence of groundwater, as has been done by (Dzakiya et al., 2022) in the Nglanggran area with the Wenner configuration. This study uses a different geoelectrical method, namely the dipole-dipole configuration. This aims to be able to read the depth and distribution direction of the sandstone, which is the target of research. Data obtained by measuring dipole-dipole configurations was analyzed and presented in two dimensions using the RES2DINV software.

The resistivity measurement is carried out on the earth's surface, which is considered an isotropically homogeneous medium. In fact, the earth is composed of rocks that are heterogeneous both vertically and horizontally. As a result, rock objects that are not homogeneous and diverse will also provide various resistivity values. So that the measured resistivity is the apparent resistivity. The measurement of the geoelectrical method is carried out using a dipole-dipole configuration, in which the current electrode and the potential electrode move together so that the apparent resistivity values are obtained laterally (horizontally). The spacing of the electrodes used is 10 to 20 meters.

The measured resistivity data is plotted at points corresponding to the apparent depth level, so that pseudodepth section contours can be made for resistivity variations laterally and towards apparent depth (Yatini and Suyanto, 2018). Measurement results using a wider spacing between current electrodes and potential electrodes will provide deeper subsurface structure information.

Pseudo-depth sections are vertical cross-sectional images of a slice where there are plotting points drawn at different depths based on the position of the current electrode and potential electrode (Apparao et al., 1997; Apparao and Sarma, 1983). The point forms an angle of 45°, which is located between the middle position of the current source and the position of the receiver, which varies with a certain density. The results of data processing can be displayed in the form of a pseudo-depth section, where the magnitude of the apparent resistivity depends on the spacing of the electrodes used (Raiche and Gallagher, 1985).

The first stage is to calculate the geometric factor using the dipole-dipole configuration so as to obtain the apparent resistivity value of the rock in the study area. The height of the measurement point is calculated using the trigonometry rule of the sine function by multiplying the distance between the measurement points with the sine value of the angle difference between the two measurement points. The diagram of data processing can be seen in (Fig. 3).

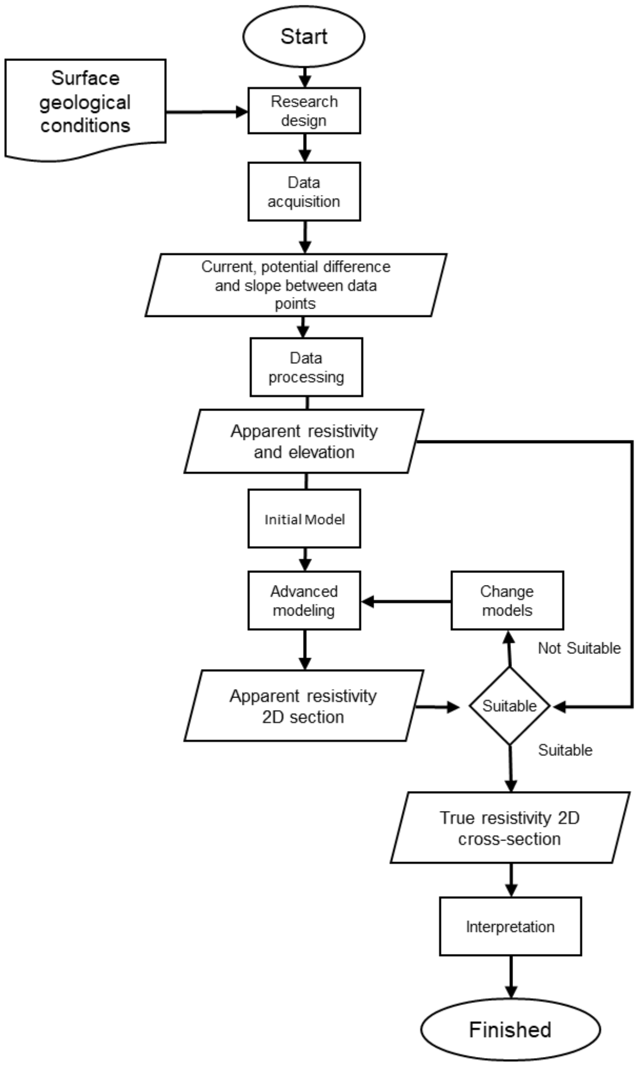

Fig 3. Data processing diagram

3. Results and Discussion

Geoelectrical measurements were carried out in the Sedan area, Rembang Regency, Central Java. The tools used in this research are ARES and its equipment; GPS is used to determine the trajectory points and elevation of each point. There are four geoelectric measurement lines. The electrode distance used is 20 meters, with a target depth of 50 meters. Track length is 250 m to 300 m (Fig. 4).

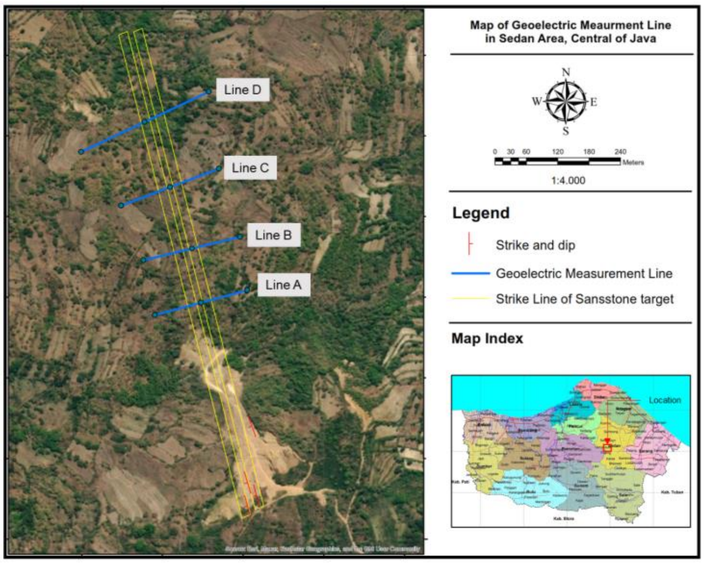

Fig 4. Map of the geoelectrical measurement line

The resistivity value of sandstones in the outcrop is measured as a reference for assessing the resistivity of quartz sandstones at the study site. The measurement results show that quartz sandstone has a resistivity value of 25 – 50 Ohm.m. A resistivity value of more than 50 Ohm.m is the value for andesite. Measurements on the four lines show varying values as shown in Table 1.

Table 1. Variation of resistivity

No	Line	Variasi nilai resistivity (Ohm.m)
1	A	0 – 40,9
2	B	0 – 43,9
3	C	0 – 19,6
4	D	0 – 84,2

Line A is the southernmost track. The length of the measurement path is 250 meters. The elevation of this track is 109 to 132.3 meters above sea level, with a slope toward the east (Fig 5). The variation of the resistivity value on this path ranges from 0-49 ohm.m. There are two different resistivity patterns on this path. A depth of 0 to -30m has a resistivity value that tends to be low.

Only the eastern part of the track with a depth of -10m shows a resistivity value of 20 – 50 ohm m. This indicates the presence of sandstones among the groundwater, which is quite abundant in the measurement path. The presence of andesite breccias covering the surface is biased due to the presence of groundwater, which causes a small potential difference value to be read with a large current injection value. Quartz sandstones on this track are clearly defined at depths of 35 to 50 meters.

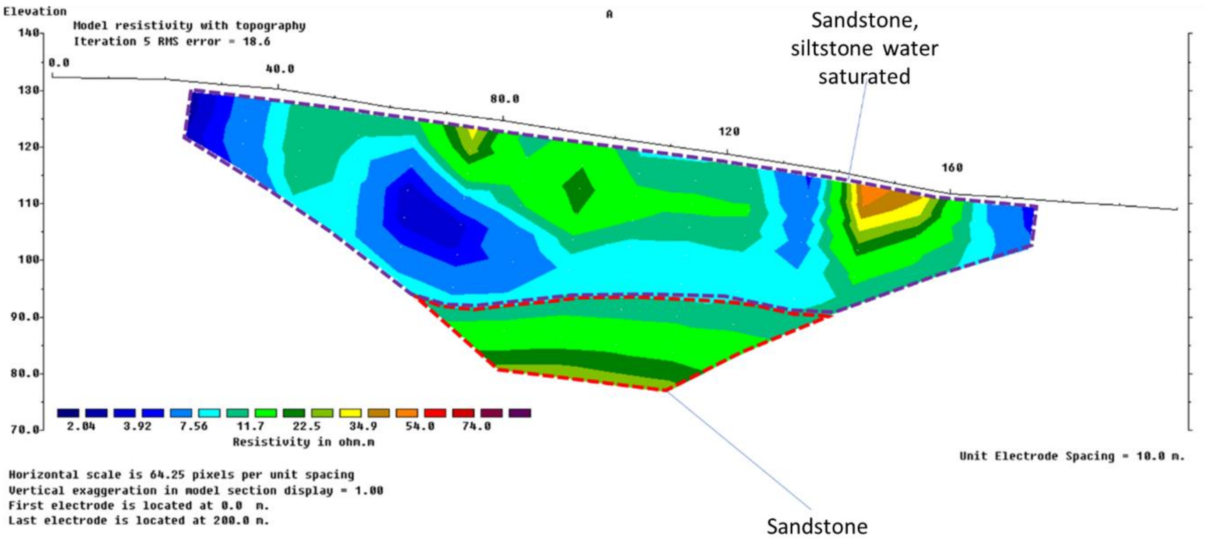

Fig 5. Line A, located at an altitude 109–132.3 meters above sea level

Line B, this track is north of Line A. Located at an altitude of 115 – 134.4 meters above sea level (Fig 6). The first electrode is placed at the westernmost point, and the last electrode is placed 200 m to the east. On this track, the resistivity value ranges from 0 to 43.9 Ohm.m.The resistivity pattern on this line has a character similar to the previous line. This path has two general resistivity values. Characters close to the surface indicate a resistivity value of 0 to 54 Ohm.m.

This provides information that there are sandstones that are saturated with groundwater, causing a small potential difference value to be read with a large current injection value. The presence of sandstone is clearly observed with a resistivity value of 20–50 Ohm.m at a depth of 30 m.

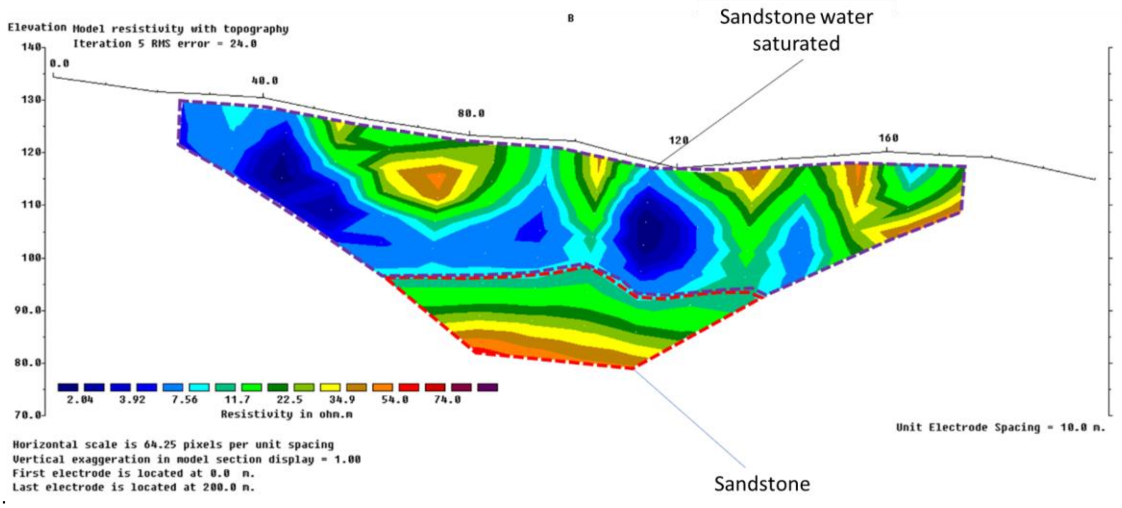

Fig 6. Line B, located at an altitude 115 – 134.4 meters above sea level

Line C, this track is located at an altitude of 106 – 134.4 meters above sea level (Fig 7). The total length of this path is 200 meters in an east-west direction. Variations in resistivity values range from 0 to 20 Ohm.m. This shows that there is no quartz sand on this route. The resistivity value only indicates the presence of water-saturated siltstone.

The loss of sandstone layers in this path indicates a deviation from the alleged straightness of the sandstones based on strike and dip data. There are two possibilities that occur at this location. The first possibility is that there is a down fault, which causes the rock to be at a deeper depth than the previous measurement path. The second possibility is that there are folds that cause the sandstone layers to shift or curve more towards the west.

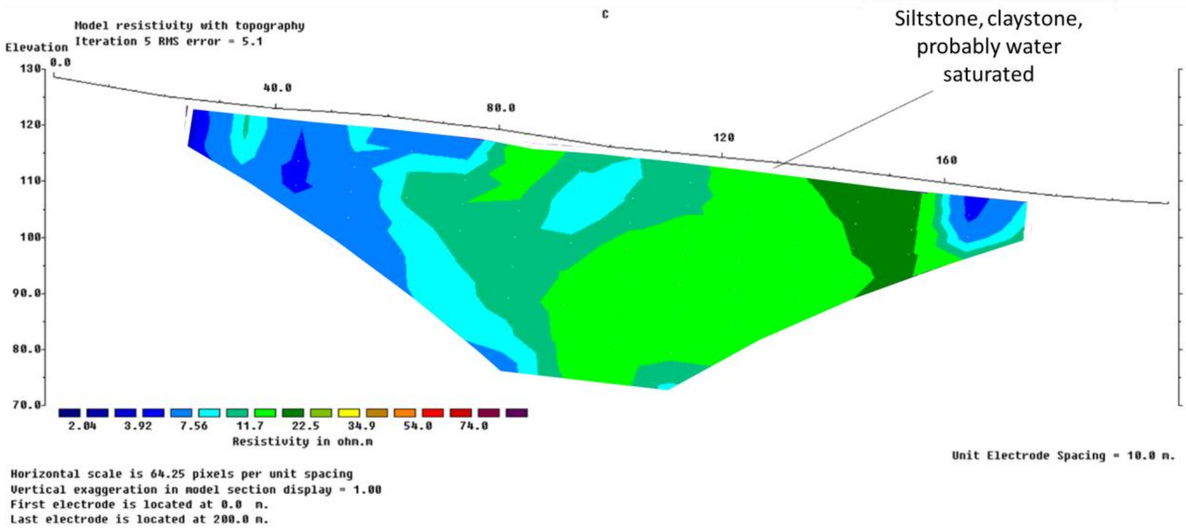

Fig 7. Line C, located at an altitude of 106 - 134.4 meters above sea level

Line D, this line is at an altitude of 101 – 128 meters above sea level (Fig 8). The variation in the resistivity value of this path is wider than that of the other three routes. The resistivity value starts from 0 to 84.2 Ohm.m. This indicates the emergence of andesite, which has a resistivity value of more than 50 Ohm.m.

The presence of andesite is indicated on the west side of the measurement path, where it is read at the surface. Then at the bottom, it shows the resistivity value of quartz sandstones. The existence of both led to an interpretation of andesitic breccia rock with fragments of andesitic igneous rock and sand in a silt-sized matrix. This character is also visible on the surface. The andesite fragments measure up to two meters in diameter.

The east side of the measurement path shows a resistivity value of 0 – 30 Ohm.m. This value provides an interpretation of water-saturated subsurface conditions as in the previous three trajectories. This water-saturated zone is composed of silt-sized rocks, which can be referred to as siltstones. There is no visible appearance of sandstone layers in this section.

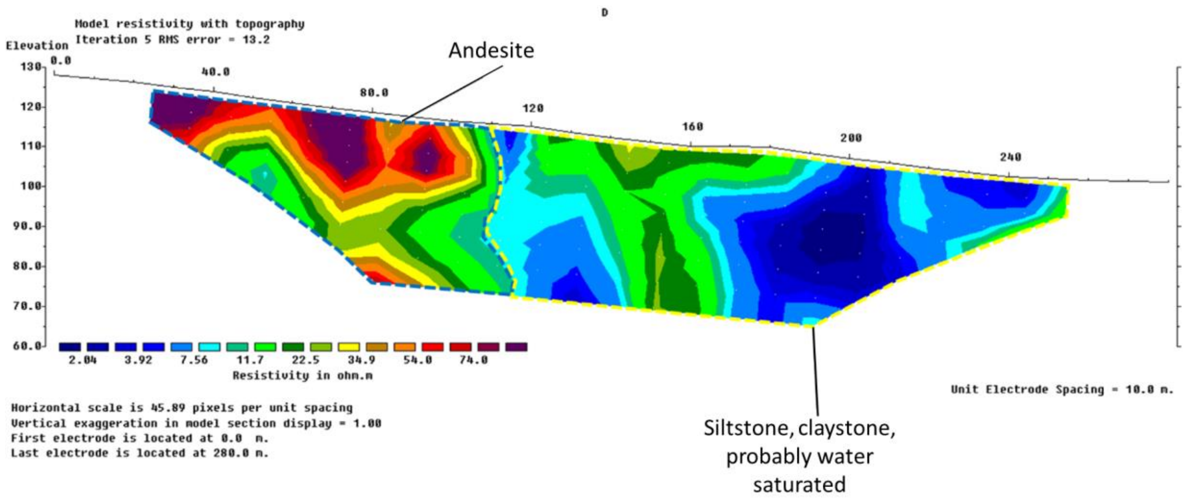

Fig 8. Line D, located at an altitude of 101 – 128 meters above sea level

4. Conclusion

Based on the results of the interpretation of geolastic data, quartz sand is found on lines A and B. On lines A and B, the condition of the quartz sand close to the surface does not give a strong indication. This is indicated by the presence of a resistivity value of 0 Ohm.m. This indicates the presence of fresh water or surface conditions that are saturated with water. This condition affects the reading of the resistivity value because it shows a relatively small potential difference value with a large current injection value. The new quartz sandstone shows clear value at depths of 30 to 35 m.

Tracks C and D do not show the existence of a sandstone layer below the surface, indicated by a low resistivity value. This gives an indication of the presence of faults or folds that deflect the direction of the sandstone layer so that it does not match the predicted presence based on strike and dip data in the outcrop.

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