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To cite this article: Nazaruddin Nasution et al 2018 J. Phys.: Conf. Ser. 1120 012064

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Identification of surface rock types in Durin mbelang kutambaru area Langkat, North Sumatera, using 2D resistivity imaging

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Abstract. The research has been carried out to identify subsurface rock types in the Durin Mbelang area of Langkat Regency. In order to determine the variations of rock resistivity values and subsurface structures 2D resistivity imaging technique was utilized. The 2-D resistivity imaging technique utilized Schlumberger electrode array configuration because this array is moderately sensitive to both horizontal and vertical structures. Six lines were surveyed for subsurface rock identification. The length for each survey lines is 155 m. The survey site shows the resistivity value varies about 5 - 2500 Ohm-m. The maximum depth of investigation survey is 29 meters. In general the results show that the subsurface is made up of clay and alluvium and the high resistivity values of more than 1000 ohm-m near the surface is due laterite and the end of the depth can be interpreted as mixture of weathered material or bedrock and at the depth of 28 meters is dominated by limestone.

Keyword: resistivity imaging, limestone, clay and alluvium.

1. Introduction

Rocks is formed from magma that freeze beneath the earth and it become to various rock types. Rocks have very important benefits for human life as a basic material for buildings and industry to support the facilities and infrastructure of the life. Rocks are build by some minerals. Based on the sources, textures and minerals, rocks can be divided into three rocks, they are igneous rocks, sedimentary rocks, metamorphic rocks. The availability of natural resources of rock in various regions of North Sumatra is important information for regional development efforts through mining business. Since the potential of natural resources is limited, and cannot be renewed., the development activities of rocks cannot be separated from the need for various natural resources.

Langkat is one of the protected forest areas and it has a lot of potential natural rock resources. So, it is needed to explore the rocks in this area. One area that has never been surveyed is in Durin Melang district.
Geoelectric method is used to determine the rock structures. Geoelectric methods are simply analogous to electrical circuits. If the current from a source is channeled to an electric load, the magnitude of the resistance (R) can be estimated based on the magnitude of the source potential and the amount of current flowing. To find out the types of rocks that exist at each point adjusted to the size of the type of resistivity owned and geological data in the study area. Based on the study, it can be determined the rocks resistivity and mineral areas. So, it can be found the resistance of rock types below the earth's surface.

2. Research Methodology

The research is done at Durin Mbelang at Langkat District. Electrical Imaging system is now mainly carried out with a multi-electrode resistivity meter system. Each survey uses a line of 41 electrodes laid out in a straight line with a constant spacing. A computer-controlled system is then used to automatically select the active electrodes for each measure. Throughout the survey conducted in the proposed site, the Schlumberger array have been used with the ABEM SAS 4000 system. In this survey the 2D resistivity array is Schlumberger array, we need to move the two potential electrodes to obtain readings. This can significantly reduce the time required to acquire a sound. Because the electrode potential remains at a fixed location, the effects of near-surface lateral variations in custody deducted (Loke, 2004).

![Schlumberger array](image)

3. Data and Method

Electrical Imaging System is now mainly carried out with a multi-electrode resistivity meter system (Figure 3). Such surveys use a number (usually 25 to 100) of electrodes laid out in a straight line with a constant spacing. A computer-controlled system is then used to automatically select the active electrodes for each measure (Griffith & Barker, 1993). Throughout the survey conducted in the proposed site, the Wenner array has been used with the ABEM SAS 4000 system. The data collected in the survey can be interpreted using an inexpensive microcomputer.

The resistivity method basically measures the resistivity distribution of the subsurface materials. Appendix A shows the resistivity and conductivity values of some of the typical rocks and soil materials (Keller & Frischknecht, 1996). Igneous and metamorphic rocks typically have high resistivity values. The resistivity of these rocks is mainly dependent on the degree of fracturing. Since the water table in Malaysia is generally shallow, the fractures are commonly filled with ground water. The greater the fracturing, the lower is the resistivity value of the rock. As an example, the resistivity of granite varies from 5000 ohm-m in wet condition to 10,000 ohm-m when it is dry. When these rocks are saturated with ground water, the resistivity values are low to moderate, from a few ohm-m to a less than a hundred ohm-m. Soils above the water table is drier and has a higher resistivity value of several hundred to several thousand ohm-m, while soils below
the water table generally have resistivity values of less than 100 ohm-m. Also clay has a significantly lower resistivity than sand.

4. Result and Discussion

The location of the survey lines is shown in Figure 1 and Figure 2. A spacing of 5 meters using the pole dipole array was used on the survey. The maximum depth of investigations for the surveys is 70 meters. The total length of the survey lines is 200 meters. Generally, the subsurface is made up of sand and clay resistivity value of less than 100 ohm-m) and sandstone with resistivity of more than 2000 ohm-m (Fig 4 and Fig 5).

**Line 1**

The length of Line 1 is 155 meters. A unit electrode spacing of 5 meters was used which give a maximum depth of investigation of about 30 meters. The low resistivity value can be interpreted as clay and the high resistivity as sandstone (Figure 2). The depth of clay varies from near the surface to more than 20 meters. The depth of alluvium varies from the surface to 10 meters. Note that there are also subsurface boulders in the sections.

![Figure 2. line 1](image)

**Line 2**

The length of Line 2 is 155 meters. A unit electrode spacing of 5 meters was used which give a maximum depth of investigation of about 30 meters. The low resistivity value can be interpreted as clay and the high resistivity as sandstone. The depth of clay varies from near the surface to more than 20 meters. The depth of alluvium varies from the surface to 10 meters.

![Figure 3. line 2](image)
Line 3
The length of Line 3 is 155 meters. A unit electrode spacing of 5 meters was used which give a maximum depth of investigation of about 30 meters. The low resistivity value can be interpreted as clay and the high resistivity as sandstone. The depth of clay varies from near the surface to more than 15 meters. The depth of alluvium varies from the surface to 10 meters. The depth of limestones varies from the surface to 9 meters.

Figure 4. line 3

Line 4
The length of Line 4 is 155 meters. A unit electrode spacing of 5 meters was used which give a maximum depth of investigation of about 30 meters. The low resistivity value can be interpreted as clay and the high resistivity as sandstone. The depth of clay varies from near the surface to more than 25 meters. The depth of alluvium varies from the surface to 10 meters. The depth of limestones varies from the surface to 6 meters.

Figure 5. line 4

Line 5
The length of Line 5 is 155 meters. A unit electrode spacing of 5 meters was used which give a maximum depth of investigation of about 30 meters. The low resistivity value can be interpreted as clay and the high resistivity as sandstone. The depth of clay varies from near the surface to more than 20 meters. The depth of alluvium varies from the surface to 10 meters. The depth of limestones varies from the surface to 30 meters.
The length of Line 6 is 155 meters. A unit electrode spacing of 5 meters was used which give a maximum depth of investigation of about 30 meters. The low resistivity value can be interpreted as clay and the high resistivity as sandstone. The depth of clay varies from near the surface to more than 24 meters. The depth of alluvium varies from the surface to 10 meters. The depth of limestones varies from the surface to 7 meters.

5. Data Analysis

The results of data collection and processing from the first to the sixth line can be obtained from the constituent rock layers. Estimation of limestone in the measurement area is supported by the results of the resistivity values obtained and the geological conditions of the area which have many limestone outcrops.

The data obtained will be analyzed using surfer 8 and will be taken per depth for the overall measurement path. Twelve measurement points that can describe the type of rock in the area and describe the spread of rocks per depth. The depth to be displayed is a depth of 5 meters, 10 meters, 15 meters, 20 meters, 25 meters and 28 meters of the result of resistivity (Ωm) which will be discussed in Figure 4.14 below.
Figure 8. The results of data rock layers
Analysis of rock types found at depths of five to twenty-eight meters throughout the measurement path is shown in Figure 4.15 which shows that most of the rock types found on the subsurface are limestone scattered on a track and have a resistivity value above 1000 Ωm (Telford 1982 and Mori 1993), where this presence can be shown on the surface to a depth of 28 m. Besides that the other layers are also dominated by alluvium which can be shown at a depth of 28 m with a resistivity value below 700 Ωm represented by Green. The next layer is also obtained from clay, silt, mud and sand rocks with resistivity
values below 100 Ωm and only found on a few trajectories where the rock type has a minimum resistivity value.

6. Conclusion
From the results of processing, analysis and interpretation of data in the study can be concluded as follows:

1. Following resistivity data Layer of subsurface rock types in Durin Mbelang area:
   - Line 1, the resistivity value between 31.2 Ωm to 3879 Ωm.
   - Line 2, the resistivity value between 15.1 Ωm to 12004 Ωm.
   - Line 3, the resistivity value between 5.02 Ωm to 10885 Ωm.
   - Line 4, the resistivity value between 84.0 Ωm to 11822 Ωm.
   - Line 5, the resistivity value between 30.2 Ωm to 1863 Ωm.
   - Line 6, the resistivity value between 38.8 Ωm to 25075 Ωm.

2. The distribution of subsurface rocks based on the resistivity value in the Durin Mbelang area is dominated by limestone and alluvium is almost all scattered in each track at 1.25 m and 28.7 m depth.

3. Rock types based on the resistivity values obtained are clay, silt, mud, sand, alluvium, and limestone.

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