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Identification of Basalt Rock Distribution Using Resistivity Geoelectric Method in The National Capital City (IKN), Paser, East Kalimantan

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ABSTRACT

The construction of the National Capital City (IKN) is currently being carried out in East Kalimantan, resulting in increased demand for construction materials. Basalt is among the rocks that can be used as construction material in IKN. This rock has a high economic value due to its high demand but limited quantity. Basalt exploration around IKN is carried out to acquire rock resources and reduce construction costs due to its proximity to the site. This study aims to determine the distribution of basalt in the Kuaro area, East Kalimantan. The geology of the research area is composed of the Ultramafic Complex Formation, which comprises gabbro, basalt, serpentinite, and harzburgite. This research uses the Wenner-Alpha configuration geoelectric method to identify the distribution of basalt in the subsurface. Geoelectric measurements were carried out on six measurement lines, each line length of 470 m and electrode spacing of 10 m. The results of geoelectric data analysis show that the basalt has a specific resistivity value ranging from 200–4022 Ωm. Basalts were identified at depths of 10–75 m with 145 m, 325 m, 165 m and 183 m thicknesses in lines 1, 2, 5 and 6, respectively. The presence of basalt in lines 3 and 4 is at a depth of 10–75 m with an average thickness of 153 m and 125 m, respectively. Economically, basalt rocks in this area are classified as medium to highly recommendable for exploitation.

Keywords: IKN, geoelectric method, resistivity, Wenner-Alpha, basaltic rock.

INTRODUCTION

Geophysics is a branch of earth science that uses the rules or principles of physics to study the earth and determine conditions in the subsurface, which are measured using physical parameters of rocks in the earth. From these measurements, conclusions can be drawn about subsurface conditions both vertically and horizontally. Geophysical exploration is an applied field of geophysics that uses physical methods (seismic, geoelectric, magnetic, gravity, electromagnetic, etc.) on the earth's surface to measure physical properties in the subsurface. The main objective of geophysical exploration is to model the earth's subsurface based on field data at a certain height and depth, identify the distribution of rocks, and detect fold structures and intrusive rocks. Periodic surveys or measurement activities are carried out to be sustainable using various geophysical methods to achieve these goals [1].

The geoelectric method is one of the geophysical methods in natural resource exploration that is generally used to study subsurface conditions using the resistivity properties of rocks. The principle of the geoelectric method is carried out by flowing a

DC electric current with a high voltage into the ground to determine the nature of the electric current under the earth's surface [2]. Several geoelectrical configurations, like Schlumberger, Wenner, and Dipole-dipole, are commonly used for mineral surveys. The Wenner-Alpha Configuration could be selected because it is sensitive to lateral changes. This configuration creates greater penetration power applied to deep resistivity exploration. This configuration is widely used to investigate the distribution of minerals and rocks (mining) [3].

The National Capital City (IKN) is a crucial component that reflects the nation's identity and political center. One of the important stages in the initial development of the IKN is the construction of road/bridge infrastructure, water resources, and building structures. Basalt is a material that is suitable for supporting the IKN construction. This rock has high density, extraordinary strength, and weather resistance, making it a popular choice in modern construction. Basalt is used in various applications, including manufacturing aggregates, blocks, and boards for building construction. Basalt is often used as a raw material in the polishing industry, as building materials foundations (buildings, roads, bridges, etc.) and as aggregates [4].

Basalt primarily comprises pyroxene and plagioclase minerals, contributing to its high density and strength. Compared to other volcanic rocks like andesite, basalt has a finer grain structure and higher hardness, making it more resistant to abrasion and mechanical stress [5]. Andesite presence is more limited and has not been widely reported in geological studies of this region; the exploration of andesite in Paser, such as that conducted in Petangis Village [6], is still in its early stages and requires further verification to determine the extent of the deposits. Additionally, basalt is far more abundant and suitable for the IKN project in Paser than andesite, as it is locally available, highly durable, and ideal for large-scale construction. In contrast, andesite remains limited in quantity and requires further exploration.

East Kalimantan is rich in mineral resources, including basalt rock, coal, and silica sand. The region's abundant basalt deposits provide a locally available and cost-effective source of construction material, reducing the need for imports and supporting the local economy [7]. The proximity of basalt sources to the IKN construction site further enhances its feasibility as a primary construction material.

Basalt rocks in East Kalimantan are abundant and of high quality, making them economically valuable for construction and industrial applications. Beyond its use in traditional construction, basalt can be processed into advanced materials such as basalt fiber and glass wool, which are used as insulators and reinforcement materials in modern infrastructure [8]. This versatility further underscores basalt's suitability for the IKN project, where innovative and sustainable building solutions are prioritized.

The use of geoelectric methods has previously been used in analyzing the subsurface of the Port Plan area in East Kalimantan, where the results of measurement and processing can be known fresh groundwater, alluvium, clay, dolomite, limestone, and slate layers [9]. In this study, the geoelectric measurements were carried out using the Wenner-alpha configuration to analyze the distribution of basalt in the Kuaro area, Paser, East Kalimantan.

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METHODOLOGY

Literature data collection was conducted regarding the basic concepts of the resistivity geoelectric method, the relationship between the geoelectric method and rocks and minerals, as well as the process of processing and interpreting resistivity geoelectric data to identify the distribution of basalt rocks. The data sources were obtained from acquisition results by PT Geoscan Eksplorasindo Utama and other supporting data, such as geological maps of the research area and its topography. The secondary data consists of resistivity geoelectric data from the Kuaro area, Paser, East Kalimantan.

The resistivity geoelectric method measurement uses the Wenner-Alpha configuration with the ARES (Automatic Resistivity System) tool. The tool flows the current, and the potential difference variation is recorded. This current and potential difference data will later be processed to obtain subsurface rock layers. The survey design used is shown in Figure 1.

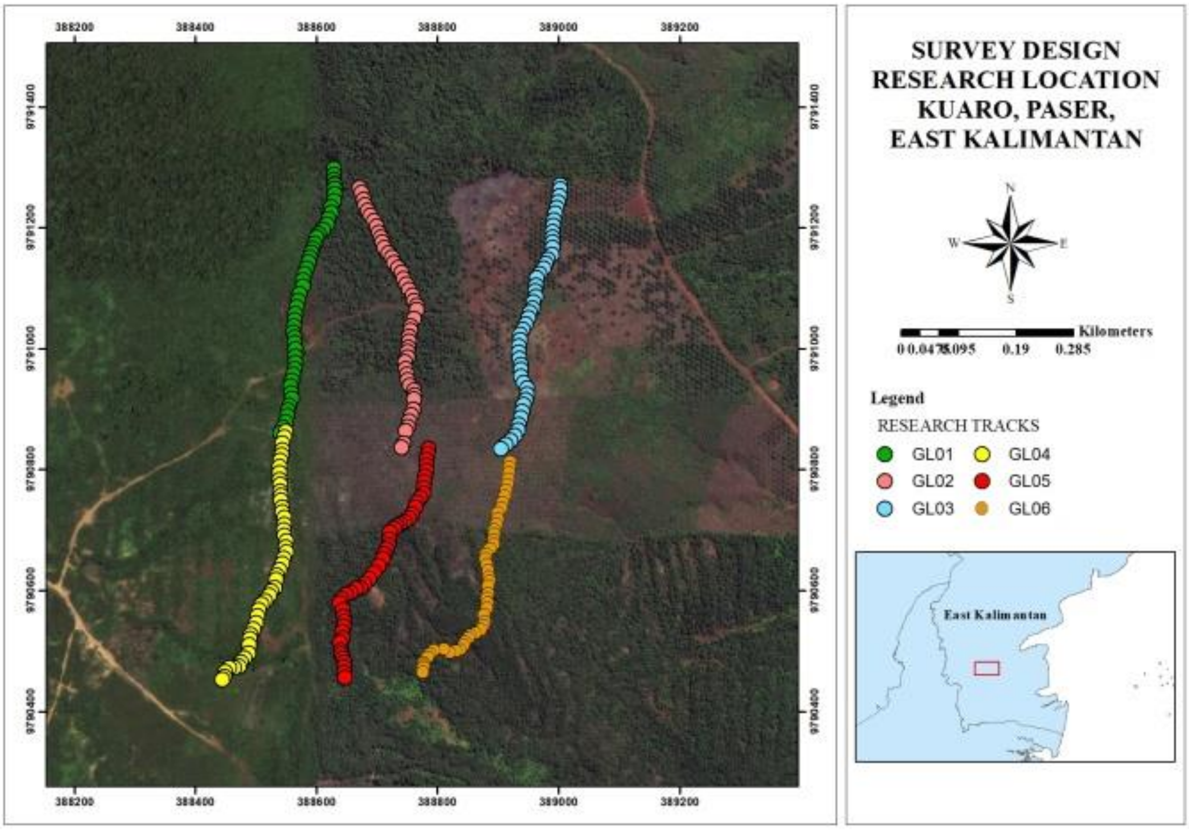

Figure 1. Research site survey design.

The processing and interpretation of resistivity geoelectric data include field data in apparent resistivity in ".2dm" and ".dat" format. The next step is to QC the data and adjust it to the format of Res2Dinv Software. The data is then inversed using Res2Dinv Software. The results are 2D cross-sections that are then analyzed and interpreted using a reference for resistivity values to estimate the presence of basalt rock [10]. The basaltic rock is interpreted with resistivity values 200–100000 Ωm. The resistivity values should be correlated with the presence of basalt on the surface.

RESULTS AND DISCUSSION

Geology

The geology of the research area and its surroundings, located in Paser Regency, East Kalimantan Province, is composed of four rock formations, namely Ultramafic Complex (Ju), Pintap Formation (Ksp), Haruyan Formation (Kvh) and Tanjung Formation (Tet). Geoelectric measurements were carried out on the Ultramafic Complex Formation (Ju) rocks. The Ultramafic Complex Formation (Ju) age ranges from 201.3 to 145 million years (Jurassic) [11]. This formation comprises gabbro, basalt, serpentinite and harzburgite. Ultramafic rocks contain high magnesian olivine (Mg_2SiO_4) and low SiO2 (<45 wt.%). These rocks can be found as plutonic igneous rocks that have been uplifted and at the edge of the oceanic crust [12].

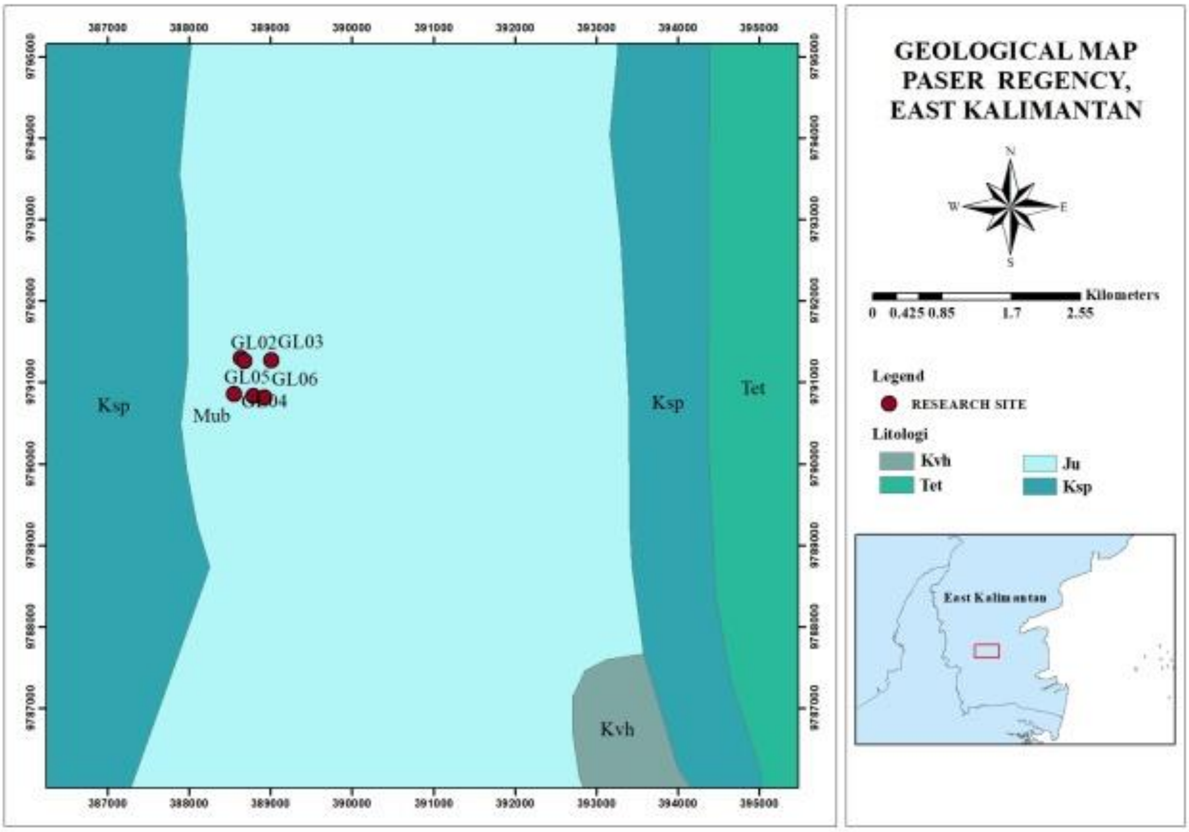

Figure 2. Geological map of Paser Regency, East Kalimantan [11]

2D Modelling

2D modeling is performed using the resistivity geoelectric method, which aims to analyze rock lithology and identify the distribution of basalt rocks in the subsurface. The constituent rocks can be seen based on the range of resistivity values in the 1990 Telford table [10]. The research was carried out in six lines, with the length of each line of 470 m and an electrode spacing of 10 m. The target of this research is basalt rock with a resistivity value > 200 Ωm.

The 2D resistivity cross-sections were made using iterations five times, resulting in RMS errors of 2.3% to 5.1% and depth interpretation of 80 m to 100 m (Figure 3–8). Based on the 2D cross-section model and then correlated with geological information, the

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high resistivity values, figured by light yellow to dark purple, are identified as basalt. Basalt resistivity values range from 200 Ωm to 4022 Ωm. This rock originates from the Ultramafic Complex Formation.

The 2D resistivity cross-section in Line 1 shows two large boulders and several small boulders along the line (Figure 3). The first boulder, at a distance of 70–410 m with a depth of about 20–60 m and a rock thickness of about 200 m, is in the form of a large boulder. The second boulder is at a distance of 330–420 m on the measurement line with a depth of 30–40 m and a rock thickness of about 90 m in the form of small boulders. Line 1 is a good and feasible area (highly recommended) for basalt rock exploitation.

Basalt in Line 2 is located at a distance of 75–400 m (Figure 4). The depth is interpreted as about 40–70 m and a rock thickness of about 325 m in the form of large boulders and intrusions. Line 2 is considered a good and feasible area (highly recommended) for exploitation.

Two large bodies in Line 3 are identified as basalt (Figure 5). The first body, at a distance of 75–250 m with a depth of 50 m and a rock thickness of about 175 m, is interpreted as a large basaltic boulder and an intrusion rock. The second body is a large basaltic boulder at a distance of 270–400 m with a depth of > 70 m and a rock thickness of about 130 m. Line 3 is considered a good and feasible area (highly recommended) for the next exploitation process.

Along with Line 3, the basaltic rock in Line 4 is identified as two bodies (Figure 6). The first body, at a distance of 75–140 m, is a small boulder located at a depth of 50 m and has a rock thickness of about 65 m. The second one is in the form of large boulders at a distance of 275–460 m with a depth of > 50 m and a rock thickness of about 185 m. The rocks in Line 4 are classified as fairly good and feasible areas (medium recommended) for exploitation.

The cross-section in Line 5, located in the eastern part of Line 3, shows two bodies (Figure 7). The first body is a large basaltic boulder situated at a distance of 80–320 m with a depth of 30–75 m and about 240 m thick. The second body is a wide cone located at a distance of 370–460 m with a depth of 30–35 m and approximately 90 m thick. The wide cone is interpreted as an intrusion rock. The deposits in this line are considered a good and feasible area (highly recommended) for exploitation.

Line 6 is located in the southern part of Line 5. The resistivity cross-section at this line discovered that this area contains two bodies. The first body is a large basaltic boulder, measuring 30 to 345 meters in distance, with a depth of 10–75 m and 315 m thick (Figure 8). The second boulder, at a distance of 405 m – 455 m, has a depth of 25 m and a rock thickness of about 50 m. It is in the form of a small boulder. Economically, the boulders in Line 6 are classified as a good and feasible area (highly recommended) for exploitation.

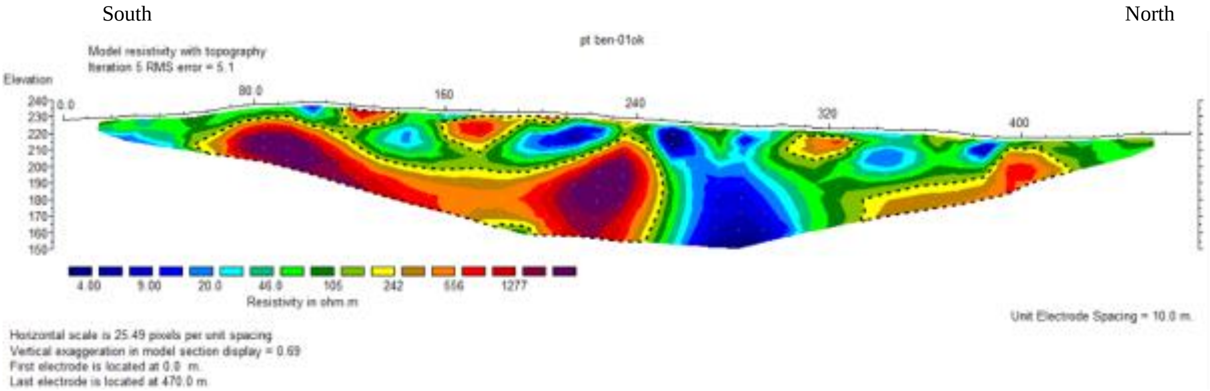

Figure 3. 2D rock resistivity cross-section of Line 1

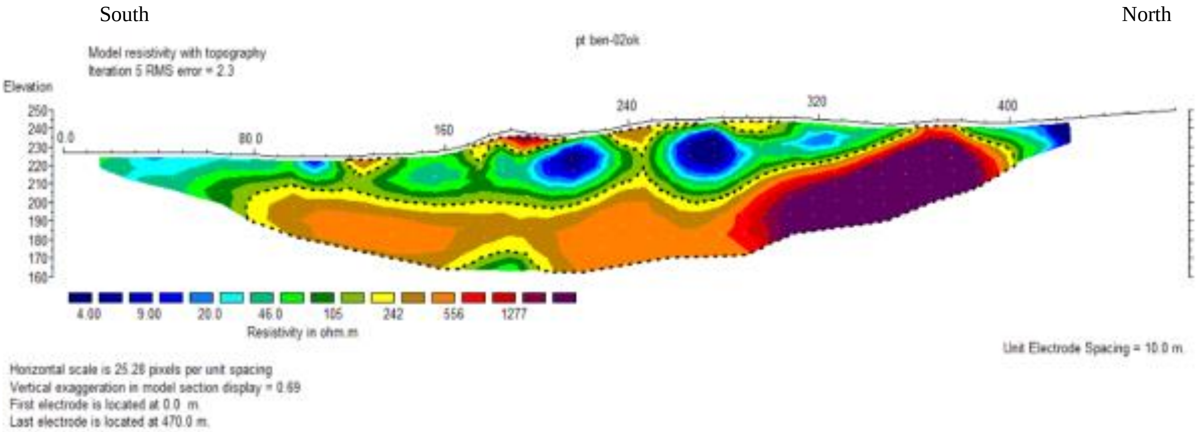

Figure 4. 2D rock resistivity cross-section of Line 2

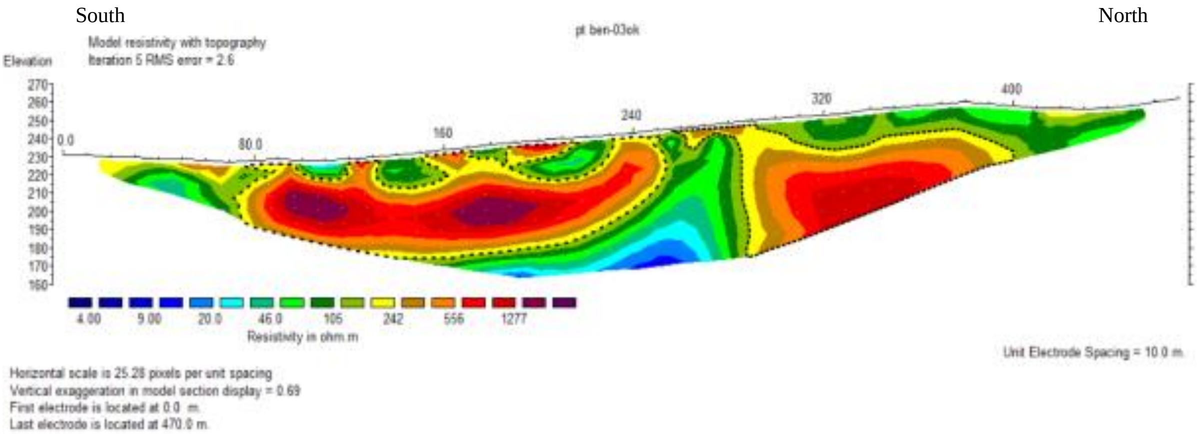

Figure 5. 2D rock resistivity cross-section of Line 3

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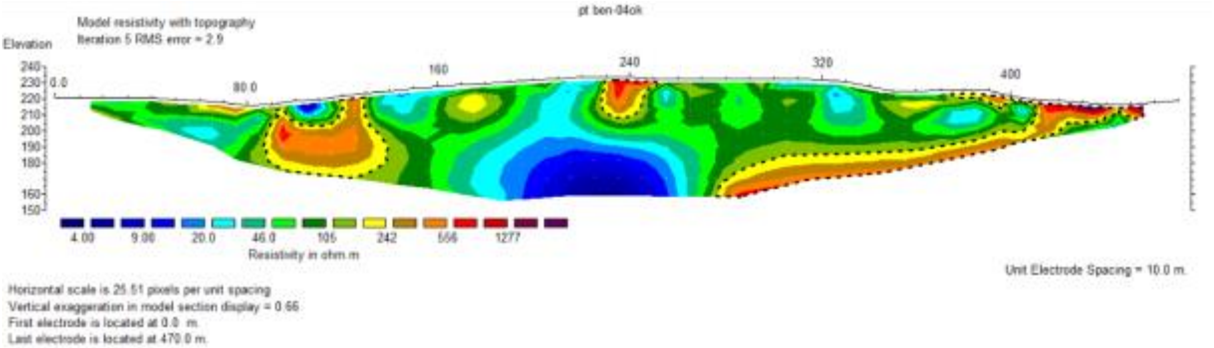

Figure 6. 2D rock resistivity cross-section of Line 4.

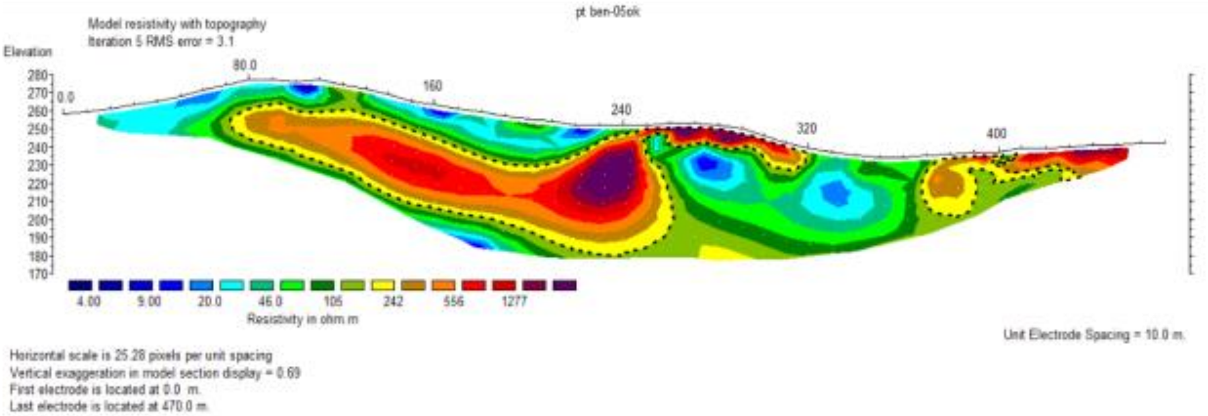

Figure 7. 2D rock resistivity cross-section of Line 5

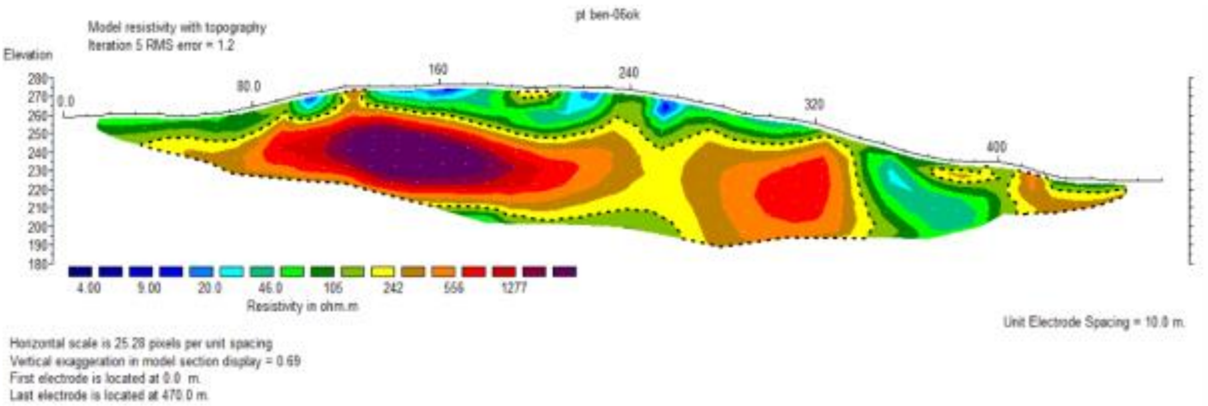

Figure 8. 2D rock resistivity cross-section of Line 6

CONCLUSION

Basalts were identified at depths of 10–75 m in Lines 1, 2, 5 and 6 with 145 m, 325 m, 165 m and 183 m thicknesses, respectively. The presence of basalt in lines 3 and 4 is known to be at a depth of 10–75 m with an average thickness of 153 m and 125 m, respectively. Economically, basaltic rocks in this area are classified as medium to highly recommendable for mining.

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