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IDENTIFYING AND CLASSIFYING ANDESITE ROCKS BASED ON RESISTIVITY IN TANAH BUMBU COUNTY, SOUTH KALIMANTAN

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Keywords: *Tanah Bumbu county, andesite rock, Bukit Baru Village, Wenner configuration, resistivity method*

Summary. Tanah Bumbu County has the potential for natural resources in the form of andesite rocks. Andesite rock utilization is widely used in the construction sector, so an exploration method is needed to determine the presence of fresh andesite rock below the surface. The aim of this research is finding andesite rock potential in Tanah Bumbu County, South Kalimantan, Indonesia. To this purpose, measurement is conducted based on the Wenner configuration geoelectric resistivity method and obtaining the 2D cross-section model, analyzing the type of lithology and also the depth and thickness of andesite rocks in Bukit Baru Village, Tanah Bumbu County. Measurements are conducted on four tracks with a length of 270 m each and an electrode spacing of 10 m. Data processing is carried out using AGI EarthImager 2D and Surfer software. The results of identification of the 2D cross-section: three types of lithology layers, namely clay with a resistivity value of 10-45 Ωm, sandstone with 45-333 Ωm and andesite with 333-550 Ωm are found. The results of the 2D interpretation show that andesite which is at a depth of 1-67 m is characterized by a thickness of 4-42 m has a resistivity value of 333-550 Ωm.

Introduction

The rock cycle can describe the main material that composes the Earth as the formation process starts from hot molten rock called magma or lava. Igneous rock comes from lava erupted onto the Earth's surface which cools and freezes through a process of crystallization (Johnson et al., 2017) and may contain glass, gas bubbles, or exhibit a flow structure (Price, Walsh, 2005). Andesite is an igneous rock that lies between light-colored rhyolite and dark basalt. These rocks are classified as the most common intermediate volcanic rocks (Carlson et al., 2008). Johnson et al. (2017) also stated that andesite is an intermediate extrusive rock with fine gray crystals and is porphyritic.

Andesites are usually found in stratovolcano lava flows above subduction zones. Lava is made up of tiny crystals that cool quickly on the surface. Some of the specimens that cooled quickly were mostly glassy in texture, while others formed from gas-laden lava had a vesicular texture (King, 2018). Andesite rocks which are included in igneous rocks have a hardness level that is classified from medium to very strong. The compressive strength values range from 40-320 MPa or 408-3.265 kg/cm^2 (Lenggono et al., 2018). Tanah Bumbu County has various potential natural resources, one of which is andesite. In its utilization, andesite rock is widely used in the construction sector, especially in the construction of roads, bridges, airports, ports to house foundations.

Electrical resistivity can identify andesite rocks in the subsurface without drilling the area since each rock resistivity value is unique. Previously, the lab scale research found out the characteristics of BANDIT (andesite rock) in Laksanamekar Village, Bandung, showed that its resistivity is 351.7±5.3 Ωm (Saputro, Winingsih, 2018). Meanwhile, Jayadi et al. (2019) determined the resource of andesite rocks using the Wenner-Schlumberger geoelectric resistivity method in Loli Village, Donggala Regency, Central Sulawesi, and obtained andesite rock resource content with high resistivity value ranging from 300-600 Ωm and low cover ranging from 14-45 Ωm. Kusmita, Iwalzi (2021) show that the range of andesite resistivity was 170- >1095 Ωm. Furthermore, using 2D and 3D ERT modeling, in (Antosia et al., 2021) the estimated resistivity value of sandy tuff is 65-212 Ωm, of tuff is 212-655 Ωm and of andesite is more than 655 Ωm. Another findings by (Prastowo et al., 2021) show that the andesite resistivity is more than 668 Ωm, while the value of weathered andesite resistivity ranges from 256 to 536 Ωm. These previous studies are summarized in Table 1.

The objective of this research is finding andesite rocks potential in Tanah Bumbu County South Kalimantan, Indonesia. To this purpose, a measurement based on Wenner configuration geoelectric method and obtaining the 2D cross-section model, analyzing the type of lithology and also the depth and thickness of andesite rocks in Bukit Baru Village, Tanah Bumbu County is conducted. The outcome of the study is providing the andesite rocks characteristics in Bukit Baru Village, Tanah Bumbu County and its potential for further development.

Table 1

List of resistivity value of andesite rocks from various studies

No.	Resistivity Value (Ωm)	Publication
1	351.7	(Saputro, Winingsih, 2018)
2	- 300-600 (high resistivity value) - 14-45 (low cover)	(Jayadi et al., 2020)
3	170 - >1095	(Kusmita, Iwalzi, 2021)
4	> 655	(Antosia et al., 2021)
5	> 668	(Prastowo et al., 2021)
6	320-1000	(Simamora et al., 2021)
7	≥ 324	(Wahyono et al., 2020)

Methods

This research was conducted in June – December 2021 in Bukit Baru Village, Tanah Bumbu County, South Kalimantan, Indonesia (as seen in Fig. 1). The geoelectric and andesite rock outcrop data in this study are secondary data obtained from the Regional Technical Implementation Unit (UPTD) of the ESDM Laboratory of South Kalimantan. The geoelectric data acquisition was carried out on four measuring tracks each with a length of 270 m. The used electrode spacing is 10 m and the electrode arrangement follows the Wenner configuration. In this research, andesite rocks resistivity value ranges from 333 to 550 Ωm based on previous studies (Saputro, Winingsih, 2018; Wahyono et al., 2020).

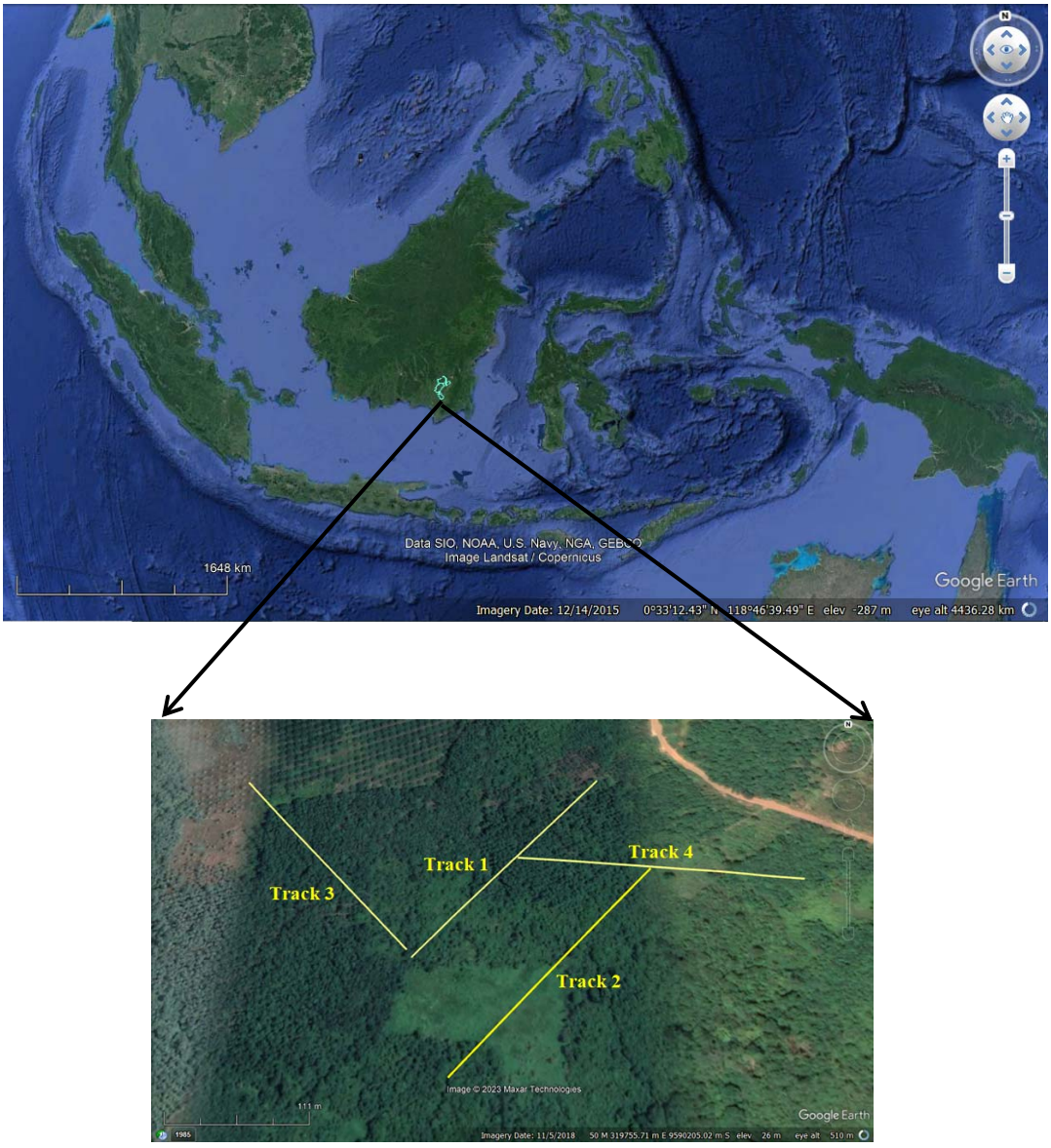

Fig. 1. Map of measurement locations in South Kalimantan, Indonesia (above) and the research location of Bukit Baru Village, Tanah Bumbu County (below)

The collected data is processed using AGI EarthImager 2D software to produce a 2D cross-section containing resistivity values. The results of data processing were interpreted by correlating the 2D cross-section containing the resistivity value with the geological conditions of the research area, andesite rock outcrops and previous studies. The results of data interpretation and analysis are displayed in a lithological section using Surfer software. This lithological cross-section depicts rock layers to determine the depth and thickness of the rock which provides information on the presence of andesite rocks in Bukit Baru Village, Tanah Bumbu County.

Results

Track 1 shown in Fig. 2 is in the direction of the relative north-east–south-west section with steep slope terrain conditions. Resistivity with a value range of 333-550 Ωm which is represented by orange to red indicates an andesite. The first andesite indications are known to be at a distance of 4-40 m with a depth of 1-37 m and a thickness of 36 m. The second indication is at a depth of 17-26 m and at a distance of 48-69 m with andesite thickness of about 9 m. In addition to andesite, on track 1 there are also other indications that are suspected to be layers of clay and sandstone. The clay layer, which has a resistivity value range of 10-45 Ωm, is symbolized by dark blue to light blue. This layer dominates from a distance of 40-260 m and is distributed not only on the surface but also occurs under igneous rocks. The sandstone layer has resistivity values ranging from 45-333 Ωm. The first indication is at a distance of 21-146 m, the second one is at a distance of 180-252 m. Sandstone in the form of small chunks spreads at a distance of 78-93 m, 121-144 m and 203-215 m at a depth of 11-41 m. In Fig. 3 it is seen that the lithology on track 1 is divided into three layers, namely clay, sandstone and andesite.

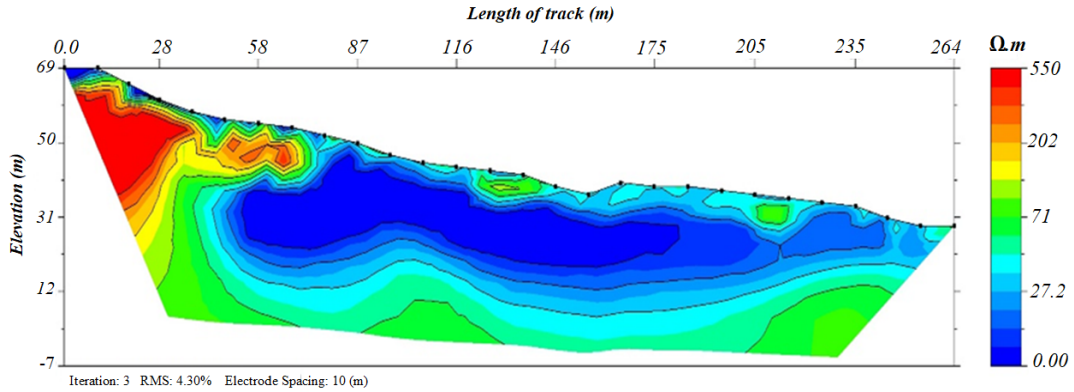

Fig. 2. 2D cross-section of Geoelectric Value on track 1

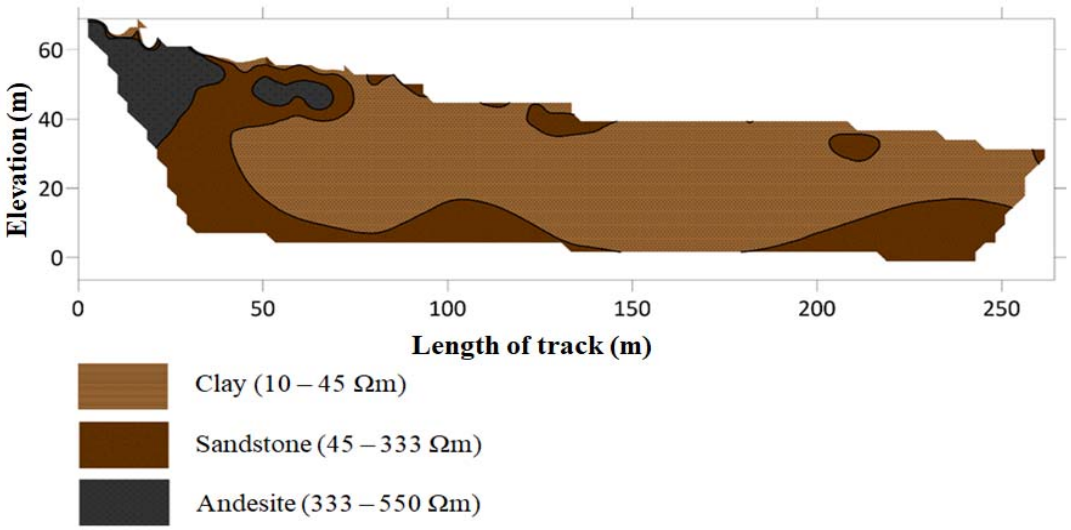

Fig. 3. 2D cross-section of lithology on track 1

Track 2 is relatively parallel to track 1, namely north-east–south-west and is in the form of hillsides in the terrain condition. This layer has a resistivity value of 333-550 Ωm symbolized by orange to red in Fig. 4. The first indication is at a distance of 2-24 m at a depth of 3-23 m with a thickness of 20 m. The resistivity value of 333-550 Ωm is symbolized by orange to red. The second indication is at a depth of 13-17 m with a thickness of 4 m and only spreads at a distance of 26-28 m. The third indication has a resistivity value of 333-428 Ωm and is symbolized by an orange to light orange. Andesite at this point spreads at a distance of 42-50 m and at a depth of 16-22 m with a thickness of about 6 m. In addition to andesite, on track 2 there are also other indications that are suspected to be layers of clay and sandstone. The clay layer has a resistivity value range of 10-45 Ωm while the resistivity value of 45-333 Ωm indicates a sandstone layer. Indications of the clay layer were found at a distance of 19-261 m and the sandstone layer was found at a distance of 13-55 m, 141-180 m and in the form of small boulders scattered at a distance of 189-230 m. A 2D cross-section showing three lithologies is given in Fig. 5.

Track 3 is in the direction of a relatively north-west–south-east stretch almost with flat terrain conditions. The andesite resistivity values range from 333 to 428 Ωm in this path (Fig. 6). In Fig. 7 it is seen that the first indication which is at a depth of 22-57 m has a thickness of 35 m and is at a distance of 40-130 m. The second indication is at a depth of 25-35 m with an andesite thickness of about 10 m. The third indication is not far from the second indication which is considered at a depth of 12-21 m with a thickness of about 9 m. These two indications are at a distance of 192-222 m and both in the form of chunks. The fourth indication which is at a distance of 230-240 m is considered at a depth of 12-28 m with a thickness of about 16 m. Andesite outcrops are found at this point, namely at electrodes 24 and 25. Other layers that are also indicated to be in track 3 are clay and sandstone. The sandstone layer that dominates this path has a resistivity value of 45-333 Ωm. This layer spreads thoroughly at a distance of 3-265 m from the surface to a depth of 61 m. The clay layer which has a resistivity value of 10-45 Ωm was found in the form of small lumps at a distance of 120-141 m and 241-250 m.

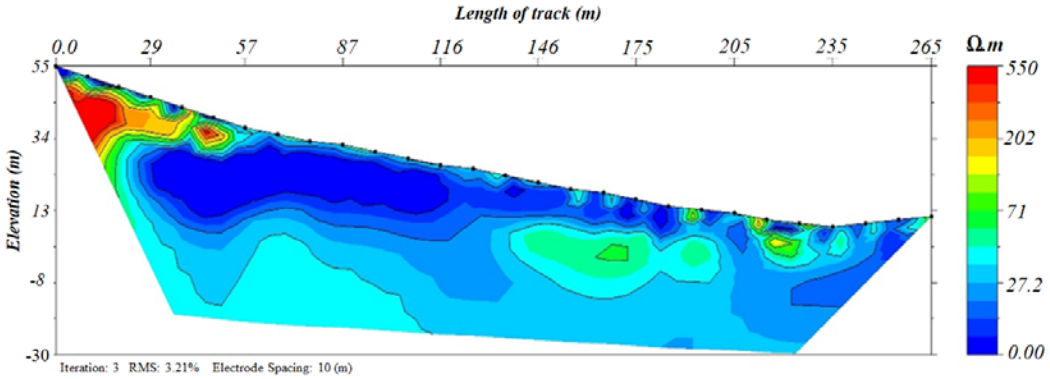

Fig. 4. 2D section of Geoelectric Value on track 2

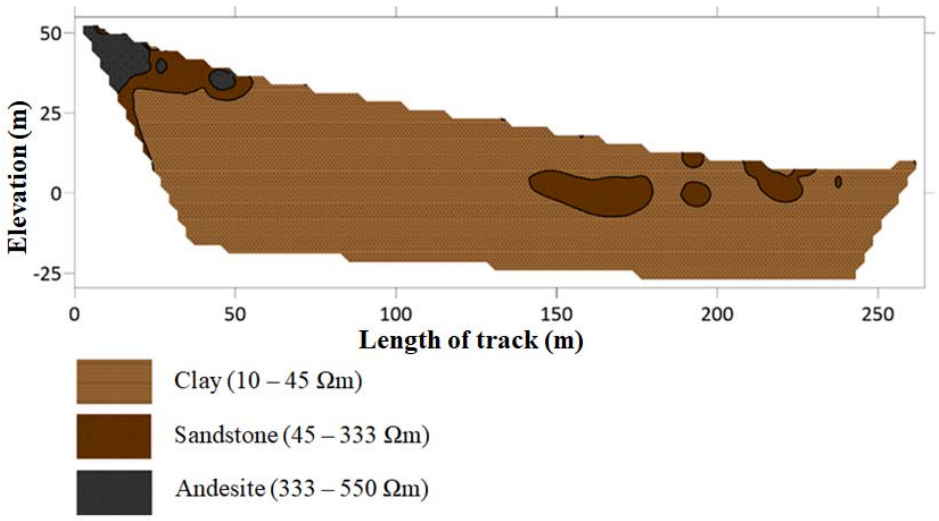

Fig. 5. 2D lithology section on track 2

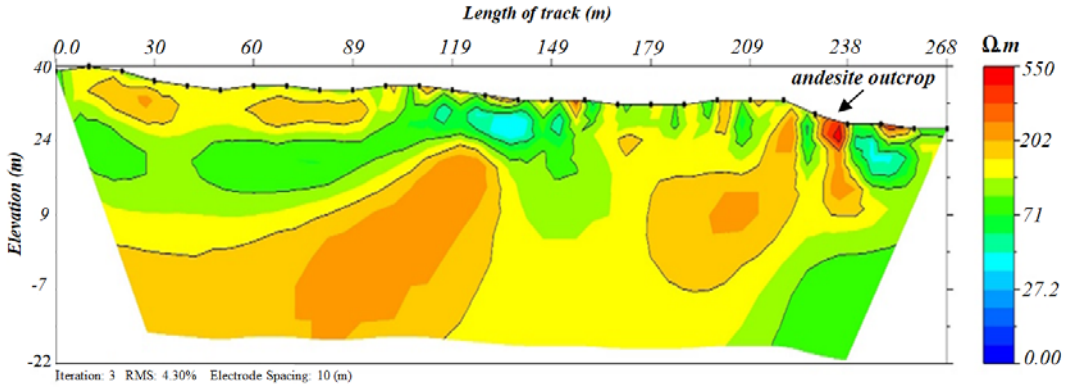

Fig. 6. 2D cross-section of Geoelectric Value on track 3

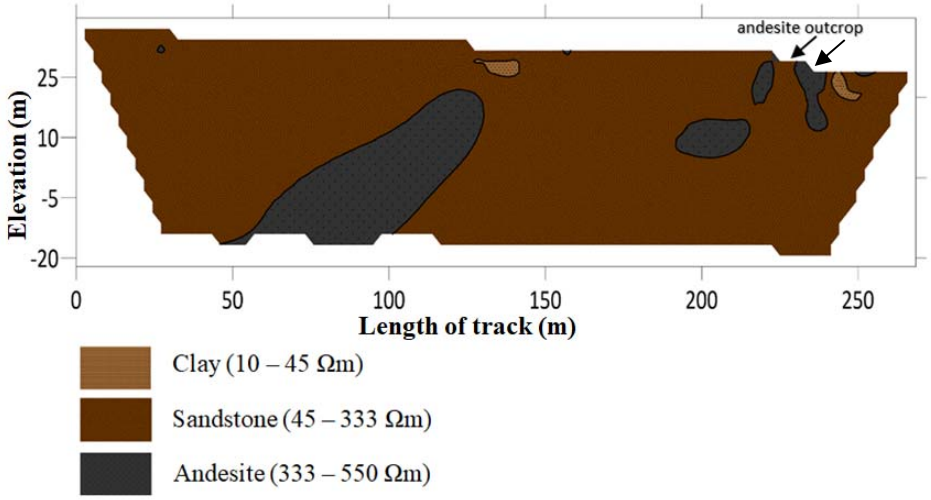

Fig. 7. 2D cross-section of lithology on track 3

Track 4 is in the direction of a relatively east-west stretch with the terrain condition being the top of a hill. Overall, the andesite on track 4 has a resistivity value of 333-550 Ωm which is symbolized by orange to red. This layer has a high resistivity value compared to the surrounding layers. The first indication has a larger size and is at a distance of 2-120 m. Andesite is thought to be at a depth of 23-65 m with a thickness of about 42 m. The second indication is at a distance of 200-239 m at a depth of 53-67 m. The thickness of andesite is about 14 m at the second point. The clay layer which has a resistivity value range of 10-45 m is found at a distance of 129-256 m. The determination of this value is in accordance with Jayadi's research (2019) which obtained a clay layer value of 14-45 m. The clay layer is symbolized by dark blue to light blue in Fig. 8. The sandstone layer has a resistivity value ranging from 45-333 Ωm, is located at a distance of 40-245 m and is found in the form of small boulders at a distance of 27-34 m and 41-45 m. Fig. 9 is a 2D cross-section showing the lithology on track 4.

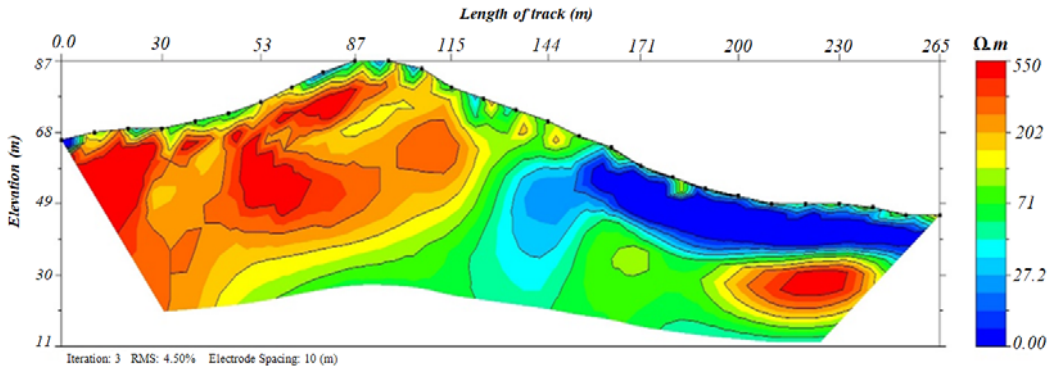

Fig. 8. 2D cross-section of Geoelectric Value on track 4

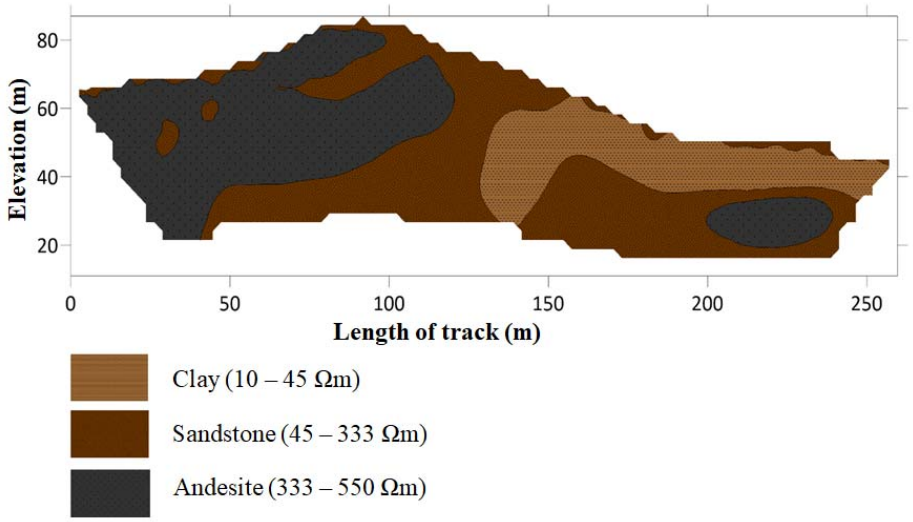

Fig. 9. 2D cross-section of lithology on track 4

Overall, the subsurface layer is composed of three layers, namely clay, sandstone and andesite at the study site. Andesite resistivity for each path is > 333 Ωm. This value refers to the results of Wahyono's research (2020) which obtained an andesite resistivity value of 324 Ωm. The results of the research by Saputro, Winingsih (2018) categorize the resistivity value of 300-600 Ωm as andesite and the research (Ilmi et al., 2018) states that the potential of andesite is estimated to have a resistivity value of > 100 Ωm. In this research, compared to other tracks, the andesite indication in the middle of track 3 has a fairly low resistivity value which is thought to indicate the physical condition of the andesite rock experiencing mild weathering. Andesite rocks that have undergone mild weathering have fracture lines that appear clearer and appear less fresh in color than secondary minerals (Simamora et al., 2020). The andesite resistivity value increased towards the end of the measurement path which also found andesite outcrops at a distance of 230-240 Ωm. Two andesite indications were found at a depth of 23-67 m with a thickness of 14-42 m on track 4. Andesite at a distance of 2-120 m is thought to be a laccolith with a dome-shaped rock body and a boulder at a distance of 200-239 m. The andesite distribution on track 4 appears to be thicker towards the base of the track and is slightly detected at the end of the measurement track. It can be seen clearly in Fig. 10 and Fig. 11 as the result of combining each 2D cross-section which is vertically displayed andesite distribution information.

Conclusions

In conclusion, there are indications of andesite in Bukit Baru Village, Tanah Bumbu County, Indonesia. Processing of 2D lithology shows that the resistivity value is 10-550 Ωm and there are three types of lithology at the research site, namely clay with a resistivity value of 10-45 Ωm, sandstone with a resistivity value of 45-333 Ωm and andesite with a resistivity value of 333-550 Ωm. Andesite indications were found on all tracks. On track 1 andesite is at a depth of 1-37 m with a thickness of 9-36 m. Track 2 andesite is at a depth of 3-23 m with a thickness of 4-20 m. On track 3 it is at a depth of 12-57 m with a thickness of 9-35 m and on track 4 it is at a depth of 23-67 m with a thickness of 14-42 m.

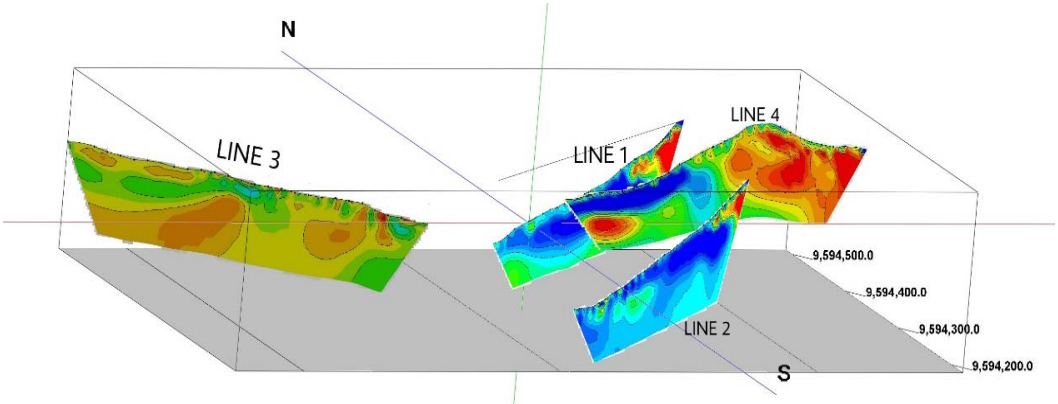

Fig. 10. Combined of 2D geoelectrical section

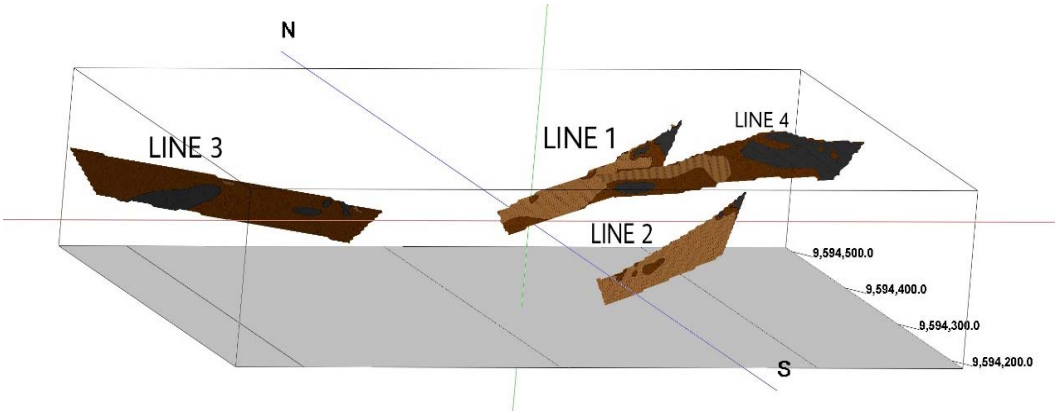

Fig. 11. Combined of 2D Lithology section

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ИДЕНТИФИКАЦИЯ И КЛАССИФИКАЦИЯ АНДЕЗИТОВЫХ ПОРОД ОКРУГА ТАНАХ БУМБУ, ЮЖНЫЙ КАЛИМАНТАН НА ОСНОВЕ УДЕЛЬНОГО СОПРОТИВЛЕНИЯ

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Резюме. В округе Танах-Бумбу имеются значительные запасы андезитовых пород, которые широко используются в строительном секторе. Целью этого исследования является поиск новых месторождений андезита в округе Танах-Бумбу, Южный Калимантан, Индонезия. Для этого проводят измерения на основе геоэлектрического метода, конфигураций Веннера и получения 2D-модели, анализируют литологический тип, а также глубину расположения и толщину андезитовых пород в деревне Букит-Бару, графство Танах-Бумбу. Измерения проводятся на четырех дорожках длиной 270 м каждая и расстоянием между электродами 10 м. Расположение электродов соответствует конфигурации Веннера. Обработка данных осуществляется с помощью программного обеспечения AGI EarthImager 2D и Surfer. Результаты обработки данных были интерпретированы путем корреляции 2D поперечных сечений, содержащих значения удельного сопротивления, с геологическими условиями района исследований, выходами андезитовых пород и предыдущими исследованиями. Результаты интерпретации и анализа данных отображаются в литологическом разрезе с помощью программного обеспечения Surfer. Этот литологическое разрез изображает слои породы для определения ее глубины и толщины, что дает информацию о наличии андезитовых пород в деревне Букит-Бару, округ Танах-Бумбу. В результате идентификации 2D поперечных сечений делается заключение о том, что обнаружено три типа литологических слоев, а именно: глина со значением удельного сопротивления 10-45 Ωm, песчаник – с 45-333 Ωm, андезит – с 333-550. Результаты двумерной интерпретации показывают, что андезит, который находится на глубине 1-67 м и характеризуется толщиной 4-42 м, имеет значение удельного сопротивления 333-550 Ωm.

Ключевые слова: *округ Танах Бумбу, андезитовая порода, деревня Букит-Бару, конфигурация Веннера, метод удельного сопротивления*

XÜSUSİ MÜQAVİMƏT ƏSASINDA CƏNUBİ KALİMANTANIN TANAX BUMBU DAİRƏSİNİN ANDEZİT SÜXURLARININ İDENTİFİKASİYASI VƏ TƏSNİFATI

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Xülasə. Tanax Bumbu dairəsində tikinti sektorunda geniş istifadə edilən andezit süxurlarının böyük ehtiyatları mövcuddur. Bu tədqiqatın məqsədi İndoneziya, Cənubi Kalimantanın Tanax Bumbu dairəsində andezitlərin yeni yataqlarının axtarışından ibarətdir. Buna nail olmaq üçün geoelektrik metod əsasında Venner konfiqurasiyaları ölçülmələri və 2D modelləri almaq üçün litoloji tipləri, həmçinin Tanax Bumbu qraflığının Bukit-Baru kəndində andezit süxurlarının qalınlığını təhlil edirlər. Ölçülmələr hərəsinin uzunluğu 270 m və elektrodlar arası məsafə 10 m olan dörd zolaqda aparılır. Elektrodların yerləşməsi Venner konfiqurasiyasına müvafiqdir. Məlumatların emalı AGI EarthImager 2D və Surfer proqram təminatı vasitəsilə həyata keçirilir. Məlumatların emal nəticələri andezit süxurları çıxışları olan tədqiqat rayonunun geoloji şəraitlində xüsusi müqavimətə malik 2D köndələn kəsimlərin korrelyasiyası və əvvəlki tədqiqatlarla interpretasiya olunmuşdur. Məlumatların təhlili və interpretasiya nəticələri Surfer proqram təminatı vasitəsilə litoloji kəsilişdə əks olunur. Bu litoloji kəsiliş süxur qatlarının dərinlik və qalınlığını əks etdirərək, Tanax Bumbu qraflığının Bukit-Baru kəndində andezit süxurlarının varlığı haqqında məlumat verir. 2D köndələn kəsimlərin identifikasiyası əsasında belə nəticə çıxarmaq olur ki, üç tip litoloji qat: gil – 10-45 Ωm, qumdaşı – 45-333 Ωm və andezit – 333-550 Ωm xüsusi müqavimətli aşkar olunmuşdur. İkiölçülü interpretasiya nəticələri göstərir ki, andezit 1-67 m dərinlikdə yerləşir və 4-42 m qalınlıqla səciyyələnir, 333-550 Ωm xüsusi müqavimətə malikdir.

Açar sözlər: *Tanax Bumbu, andezit süxurları, Bukit-Baru kəndi, Venner konfiqurasiyası, xüsusi müqavimət metodu*