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Estimation of Geothermal Potential Area in Kabawetan Sub-District, Using 2D Magnetotelluric Inversion Method

Usman Gumanty[1], Muchammad Farid[1*], Refrizon[1], Gusti Ayu Zahwa Azzahra[1], Ratna Dewi Nurhayati[1], Andre Rahmat Al-Ansory[1], Hana Raihana[1]

[1]Geophysics Program Study, Faculty of Mathematics and Sciences, University of Bengkulu
*Corresponding author: mfarid@unib.ac.id

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Abstract – Kabawetan is located in the subduction zone of the magmatic arc in the Indonesian tectonic system. The geothermal energy potential in this region is closely tied to volcanic activity, which is prevalent along the Ring of Fire on the island of Sumatra. This study aims to identify the distribution of subsurface resistivity values related to geothermal potential in the Kabawetan Region. To achieve this, the magnetotelluric (MT) method is used, utilizing electrical and magnetic sensors. Data were collected using two horizontal electrical sensors (Ex, Ey) and three magnetic sensors, including two horizontal sensors (Hx, Hy) and one vertical sensor (Hz). Measurements using the magnetotelluric method can be used to determine the subsurface rock layers based on resistivity values. The results of data processing yield a 2D cross-section of the resistivity value, which characterizes the potential for geothermal energy. This study used four measurement points to analyze resistivity variations and determine geothermal potential. Field measurement data were processed using MAPROS software, and a 2D cross-section model was created using ZONDMT2D. The results showed that resistivity values of 20-60 Ωm, thought to be impermeable overburden, were at depths of 0-1.5 km and 2.5-4 km, resistivity values of 0.54-1 Ωm indicated permeable reservoirs at depths of 1.5-2.5 km, and resistivity values of 290-550 Ωm indicated geothermal rocks at depths of 4-10 km. The findings of this research are expected to enhance the understanding of geothermal energy as a renewable resource, thereby supporting the Sustainable Development program.

Keywords: Kabawetan; Geothermal; Magnetotelluric; Resistivity.

Introduction

Indonesia is one of the regions with abundant natural resources, including geothermal energy sources. The existence of geothermal reserves in Indonesia is due to the territory's location at the confluence of three active tectonic plates in the world, namely the Eurasian Plate, the Indo-Australian Plate, and the Pacific Plate. (Syafitri et al., 2020). The area is characterized by the presence of many active volcanoes, also known as the Ring of Fire region (Ratai, 2021). Kepahiang Regency is a regency in Bengkulu Province, which is located in the Sumatra fault zone. The Kabawetan area is one of the areas in Sumatra that is crossed by this fault zone (Mukazairo et al., 2020). Over time, industrial and population growth have led to an annual increase in energy consumption, including electricity. One of the renewable energy sources that can be promoted is geothermal energy (Andini et al., 2020).

Geothermal energy can be generally defined as the amount of heat content stored in the Earth, forming a geothermal system that has existed since the Earth's formation. The geothermal system comprises a hydrothermal system, which is a water-based system, a heating process, and specific conditions where heated water is collected. Consequently, the geothermal system has specific requirements, including the availability of water, heated rocks, nesting rocks, and cover rocks. In hydrothermal systems, heat can move by conduction and convection (Handayani et al., 2020). Geothermal energy is one of the potential alternative energies to be developed. Geothermal energy is a clean, sustainable, and environmentally friendly energy source both in production and use (Andini et al., 2020).

Geothermal systems involve the transfer of heat from a heat source to its surroundings. Heat transfer occurs by conduction (through rocks) and convection. In convection heat transfer, there is contact between the heat source and water. Water tends to move downward due to the Influence of gravity. If the water comes into contact with the heat source, its temperature will rise, and the water will become lighter. The hot water will move upwards, and the cooler water will move downwards, resulting in convection currents. The hot water does not become vapor because it is not in direct contact with the air (Singarimbun and Nurlela, 2020). Geothermal heat at the surface can manifest in various forms, including warm ground, steaming ground, hot mud pools, hot water pools, fumaroles, hot springs, seeps, geysers, and hydrothermal alteration areas, all of which are linked to geological processes and geothermal systems (Fadli et al., 2023). Warm ground is characterized by high thermal conductivity and a temperature gradient. Steaming ground is ground that emits steam from the evaporation of hot water. Hot mud pools or mud volcanoes are areas of mud that contain little steam and low-temperature CO2 gas. Hot mud pools can be found in ancient hydrothermal vents and also in hot lakes. Fumaroles are fissures that emit hot gases and vapors at temperatures below 100°C (Basid et al., 2014).

The source of geothermal energy originates from magma within the Earth. Magma conducts heat to the surrounding rocks. Geothermal is related to the manifestation of hot fluids on the Earth's surface. Heat in geothermal systems comes from volcanic and non-volcanic sources. Geothermal potential can serve as a primary reference for geothermal exploration, which can be utilized both economically and non-economically.

Furthermore, geothermal potential can be estimated by conducting geological, geochemical, and geophysical measurements (Widyaningrum et al., 2023). The existence of a geothermal system can be estimated by examining the resistivity value of the rocks that form the geothermal system. The formation of geothermal systems on the surface includes warm ground, steaming ground, hot mud pools, hot water pools, fumaroles, hot springs, seeps, geysers, and hydrothermal altruistic areas related to geological processes and geothermal system models that raise the temperature of water below the ground surface so that it becomes geothermal steam is magma (Al Ansory et al., 2023).

Based on research conducted by Nanang Sugianto et al. (2022). This study found that the 2D geothermal distribution is located at depths of 1,500 to 5,000 m below the ground surface, with the length of the geothermal distribution reaching 3,000 m from the Taba Tebelet area to Pagar Gunung. After that, Anggini et al. (2019) conducted geothermal distribution research in the Babakan Bogor, Taba Tebelet, and Kuto Rejo areas, and suspected that the bottom of the geothermal distribution was located in the Taba Tebelet and Babakan Bogor areas, at depths of 200-2000 m. According to the research, the distribution of geothermal energy in the Babakan Bogor area is located at depths ranging from 200 to 2000 m (Farid et al., 2023). Geothermal energy reserves in Kepahiang Regency have up-and-coming prospects. This survey needs to be expanded to provide confidence to all parties that there are large geothermal energy reserves in Bengkulu.

Geothermal energy is a form of heat energy generated and stored within the Earth. Heat energy alone determines the temperature of an object. Some of the sources for this energy are the result of planetary formation, accounting for approximately 20%, and the result of radioactive decay of minerals, which accounts for approximately 80%. The geothermal gradient, which is the temperature difference between the Earth's core and its surface, controls the continuous conduction of heat energy, primarily from the core to the Earth's surface (Adistia et al., 2020). In Indonesia, there are two islands with great potential for producing geothermal energy: Java Island and Sumatra Island. According to data reported by Pertamina Geothermal Energy, Indonesia has geothermal potential reserves capable of producing 27,000 megawatts of electricity. Of the total energy that can be generated, only about 1,179 megawatts have been utilized (Hakim et al., 2017).

The Magnetotelluric (MT) method is a geophysical technique used in geothermal surveys, yielding resistivity values as its results. Based on research conducted by Pratama et al. (2021). Magnetotelluric (MT) surveys are sensitive to the Earth's resistivity structure, potentially extending to depths exceeding 100 km. MT data analysis is performed to determine the dimensionality of data from the study area. The analysis process uses a phase tensor plot to visualize the distribution of data types within each period range. This research utilizes four measurement points located on one track to examine the variation in resistivity values and determine the geothermal potential in Kabawetan District, Kepahiang Regency. The measurement results in the field were processed using MAPROS software, which then generated a 2D model with ZONDMT2D. The results of this research are expected to provide the community and government with information regarding the geothermal potential for utilizing renewable energy in the construction of PLTPs (Geothermal Power Plants).

Various obstacles and challenges are faced in geothermal development, both in terms of policies and regulations, institutional arrangements, cross-sector coordination issues, regional autonomy, human resources, good governance issues, and technical matters, such as data accuracy, auction process, community involvement in the development process, price negotiations, licensing, and others. The development of geothermal energy as a renewable energy source is significant to discuss, particularly in light of the limited fossil energy reserves, fluctuating energy prices influenced by global political and economic situations, and increasing greenhouse gas emissions resulting from the burning of fossil fuels (Fandari, Arief Daryanto, 2014).

Geological setting of the study area

The geological background of the study area is the Kabawetan Sub-district, Kepahiang Regency, which is geologically located in the Bukit Barisan Mountains. This lineage is part of an active tectonic system formed by the collision between the Indo-Australian Plate and the Eurasian Plate. This tectonic process has given the Kabawetan sub-district a complex geological history and high geodynamic potential. Physiographically, the Kabawetan area is part of a volcanic mountain zone characterized by an undulating to steeply hilly morphology. This indicates that the area is located near active volcanic zones, specifically the Bukit Daun volcanic complex and Mount Kaba, which are part of the Quaternary volcanic sequence in Sumatra (Sihombing et al., 2024). The main rocks in the region are volcanic rocks of Quaternary age, including andesite, basalt, tuff, and volcanic breccia. In addition, there are scattered sediments in the low parts of the region, which are the result of weathering and erosion in the form of alluvium and colluvium. The geological structures developed include active horizontal and oblique faults, including the possible Influence of the Semangko fault, which runs along the island of Sumatra. The area of alteration in the vicinity of the Air Sempiang manifestation consists of impermeable rocks containing clay minerals such as kaolinite and montmorillonite. Argillaceous to advanced argillaceous alteration is found in the pyroclastic flows and lavas of Mount Kaba (Raharjo et al., 2022).

The Sempiang fault zone, which runs north-south, is the central location of the host rock. Young lavas of the Kaba product serve as overlying rocks, while Tertiary sedimentary and volcanic materials cover Quaternary deposits. The history of Mount Kaba is characterised by explosive eruptions that produced Old Kaba I-III lavas and pyroclastic flows and falls (Triyoso et al., 2020). Various types of rocks in Kepahiang Regency have changed due to hydrothermal activity. The geological formations in this area include the Quaternary Volcanic Formation, diorite, Gumai Formation, Hulusimpang Formation, Sebelat Formation, and Kaba Volcanic Formation. Other rock types, including scoria, andesite, tuff breccia, and basalt, are also found here. Vein rocks with high concentrations of the clay minerals montmorillonite and kaolinite are found in alteration areas where pyroclastic and lava flows of Mount Kaba erupted (Firdasari, 2018).

Materials and Methods

This research uses the ADU-07e Magnetotelluric tool in the Kabawetan sub-district, Kepahiang district. This research was conducted on one track with a total of 4 measurement points around the geothermal manifestation. The measurement track stretches along the Babakan Bogor fault to the Sempiang fault. The. The research was conducted to determine the geothermal potential through subsurface resistivity values, resistivity anomalies, fault information, as well as the depth of investigation and geological conditions around hot springs.

The magnetotelluric (MT) method is a geophysical exploration technique that utilizes natural electromagnetic fields. The electrical conductivity structure of the Earth can be investigated using natural electromagnetic fields. The frequency range used by the MT method spans from 10^-5 Hz to 10^3 Hz. MT can reach depths of up to 10 Km. MT can be used to determine the electrical properties of materials (rocks) that exist below the Earth's surface at relatively large depths (including the mantle) (Al Ansory et al., 2023). Magnetotellurics utilizes electromagnetic fields generated by various complex physical processes. As a result, the simultaneous spectrum of variations in the electric field (E) and magnetic field (H) is observed as a function of time (Hakim et al., 2011). States that electromagnetic waves in nature, originating from the ionospheric layer, military radio communication waves, and electromagnetic waves controlled by human sources, are believed to propagate to the subsurface of the Earth and induce conductive materials to produce secondary electromagnetic waves. This is the basic principle of the electromagnetic method. The value of this secondary electromagnetic wave is highly dependent on the condition of the conductive material under the Earth's surface.

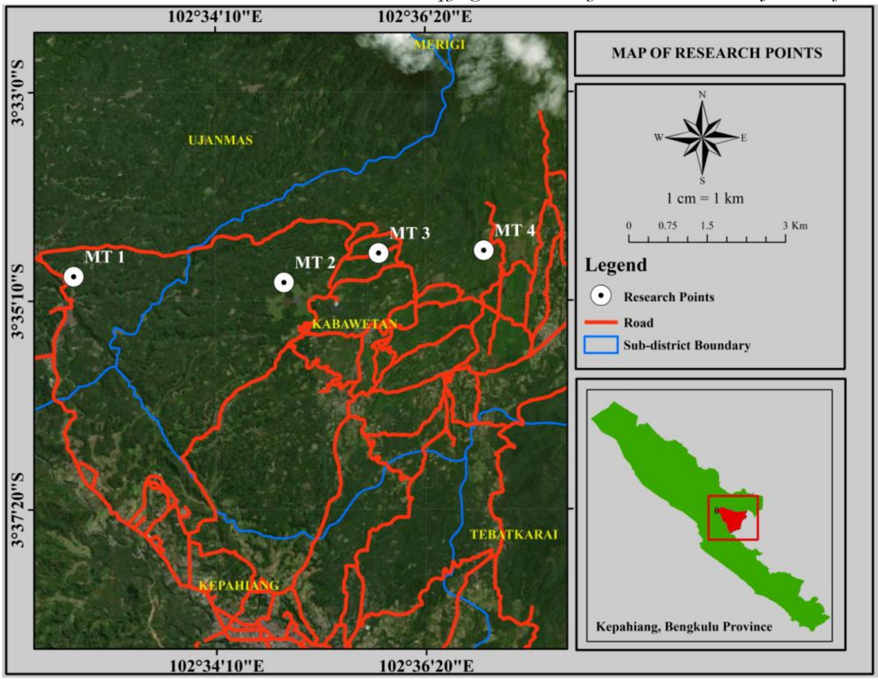

Figure 1. Research location map

Magnetotellurics belongs to a large class of geophysical methods whose phenomena are described by Maxwell's equations. It is a passive technique, and its sources are EM fields of external origin over a broad frequency spectrum. (10^{-4}–10^{4} Hz) occurs naturally around the Earth (Zukir, 2019). Maxwell's equations are a synthesis of experimental (empirical) results on electrical and magnetic phenomena obtained by Faraday, Ampere, Gauss, and Coulomb, in addition to those carried out by Maxwell himself in differential form. Maxwell's equation in the frequency domain can be written as follows:

$$\nabla x E = -\partial B/\partial t \quad (1)$$

$$\nabla x H = j + \partial D/\partial t \quad (2)$$

$$\nabla . D = q \quad (3)$$

$$\nabla . B = 0 \quad (4)$$

By E (Volt/m) is the electric field, H (Ampere/m) is the magnetic field, B (Weber/m^2) or T is the magnetic flux or induction, D (Coulomb/m^2) is the electrical displacement, and q (Coulomb/m^3) is the electric charge density, j is the current density (Andini et al., 2020).

The electromagnetic field response of rocks beneath the Earth's surface can be obtained by increasing the period of electromagnetic sounding.. This principle is consistent with the electromagnetic skin depth equation, which describes the penetration depth of electromagnetic waves as they diffuse into a medium (Nurwahyudin and Harmoko, 2020). Skin depth is defined as the depth in a homogeneous medium where the EM wave amplitude has been reduced to ${}^{1}/_{e}$ from its amplitude at the earth's surface ($e = 1$ or $e = 2{,}718\ \ldots$). The magnitude is formulated as the frequency is very dense (10^{-5} Hz -10^{4} Hz). This is done by measuring:

$$\delta = \sqrt{\frac{2\rho}{\omega\mu\sigma}} \quad (5)$$

Where ϱ is the specific gravity of a homogeneous medium or its equivalent, $\omega = 2\pi f$, the skin depth quantity is used to estimate the penetration depth or investigation depth of EM waves. For practical purposes, a smaller definition of adequate depth than skin depth is used, that is, $\delta/(\sqrt{2})$.

Data Acquisition

First, the layout of the components is determined by (Figure 2) and the arrangement of the internal coordinate system (Figure 3). In the figure, the configuration of the induction coil and porous pot installation is presented. The coil is planted in three different quadrants, and a porous pot is installed in four cardinal directions: north, east, south, and west. One porous pot is used as a ground. For the induction coil, which serves as a magnetic field sensor, Hx is installed in the north-south direction with the coil connector cable pointing south.

In contrast, the Hy coil is installed in the east-west direction with the connector cable pointing east. Both coils are installed horizontally on the ground surface and differ from the Hz coil, which is installed vertically towards the center of the Earth. For the installation of a porous pot, bentonite needs to be placed at the bottom of the porous pot, and salt water should be added to the excavation hole for planting the porous pot (Perdana, 2011). This is necessary to establish good contact with the Earth's natural electrical flow for accurate measurement. If the equipment has been installed to the standards, the data recording process can be carried out. Where in this process must it be done first by checking the contact between the porous pot and the ground? If the contact has a relatively small resistivity value, then the contact is declared good. After the contact is deemed satisfactory and the GPS is connected to the MTU, parameters can be set during the measurement process using a laptop.

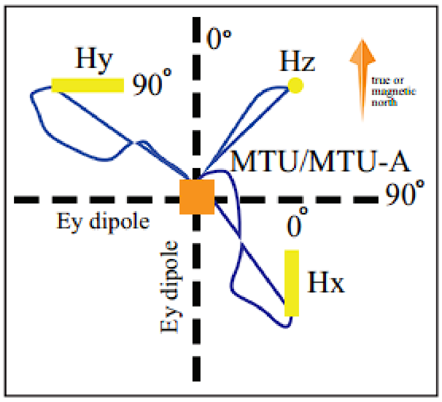

Figure 2. Field layout for the MT acquisition system.

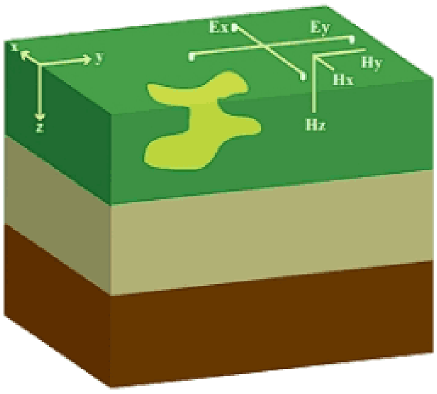

Figure 3. MT arrangement in the internal coordinate system.

Data Processing

Data processing was done using Mapros and ZondMT2D software. ZondMT2D to convert, visualise, and analyse subsurface resistivity parameters. Mapros was used to transform the survey data into EDI format, starting with file management, survey and traverse creation, and data import using Easy ATS Import Files. After data editing and filtering, the resulting EDI files were processed in ZondMT1D for resistivity (ρ) and depth (Z) modelling, which were then visualised in Interpretation Mode with specific inversion parameters. Next, processing in ZondMT2D involved dongle installation, file opening, and Mesh Constructor activation to improve interpretation resolution. The final stage involves applying various processing options, such as Apply, Pseudosection, and Inversion, before saving and exporting the final results in Save Mod2D format, resulting in a more accurate and structured geophysical model. Inversion methods are indispensable for producing models that can reconstruct the Earth's subsurface data.

Geology Overview

Kabawetan District, Kepahiang Regency is a geothermal prospect area located 101°55'19"-103°01'29" (BT) and 02°43'07"-03°46'48" (LS). This area is situated on the subduction line within the magmatic arc of western Sumatra, in the tectonic setting of western Indonesia. The existence of geothermal systems in the area is linked to the volcanic activity that occurs in the Ring of Fire of Sumatra Island, particularly the volcanic activity of Mount Kaba (Fahmi et al., 2015). Based on the journal published by the Proceedings of the Indonesia International Geothermal Convention & Exhibition (2015), the geological conditions of Kepahiang Regency are primarily characterized by deposits resulting from volcanic activity during the Quaternary period, including volcanic breccias and andesite-basaltic lava flows. Not only that, tertiary sedimentary and volcanic materials are also found in this area, which stratigraphically underlie the overlying Quaternary deposits.

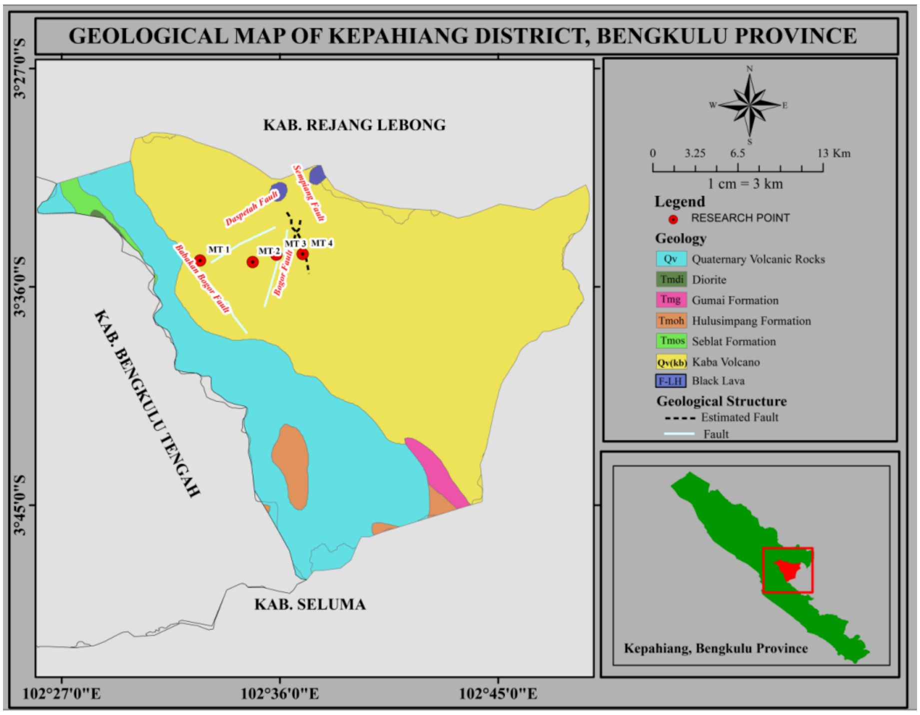

Figure 4. Geological map of the study area.

Mount Kaba experienced a major eruption that formed the rim of the caldera, as shown on the map, in the western and eastern parts of the Kaba Complex. This eruption created the caldera rim pattern, which caused severe opening and fracturing. The subsequent magmatic eruption of Bukit Hitam, Bukit 1960, Biring, Salojuang, and Mount Kaba products was assisted by faults moving in a northwest-southeast direction, such as the Kaba fault and Sempiang fault. The Itam fault moves in a west-east direction. Each of these products is located on the caldera rim of the Kaba complex. On the other hand, the New Bandung fault develops in the southern Kaba body, which promotes the appearance of cinder cones such as the one in Kepahiang Indah (Sihombing et al., 2024).

Geomorphology research results (Firdasari, 2018) indicate that the study area is divided into four landform units: strong undulating hills, denudational hills, and plateaus. The stratigraphy is composed of the Hulusimpang Formation and the Volcanic Quaternary, which is divided into four rock units: Hulusimpang andesite, Hulusimpang lapilliferous, and Quaternary lava. A left-ascending shear fault characterizes the geological structure of the study area. Based on the results of petrographic analysis, the characteristics of volcanic rocks have been altered, estimated to be in the propylitic and subpropylitic zones. The geological history was influenced by magmatic activity in the late Oligocene to early Miocene and early Quaternary periods. In the late Miocene to recent periods, a left-ascending shear fault was formed due to tectonic activity. The study area is situated around the Babakan Bogor fault, Daspetah fault, Bogor fault, and Sempiang water fault, resulting in a diverse range of rock formations.

Results

The research was conducted in Kabawetan District, Kepahiang Regency, which is astronomically located between 101°55'19" and 103°01'29" east longitude (BT) and 02°43'07" and 03°46'48" south latitude (LS).

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Bukit Kaba and Bukit Hitam are manifestations of geothermal resources that can be seen directly as characteristics of heat sources that can be utilized as geothermal power plants. It is estimated that geothermal heat in Kepahiang is 74 MW (speculative) and 180 MW (suspected).

Research in the same area by (Farid et al., 2021), based on the results of measurements using the magnetotelluric method, obtained a resistivity and depth graph showing resistivity values from 10^{-4} Ωm to 10^{4} Ωm and a depth of 1 Km to 5 Km at each sonar measurement, shown by the red line ?. This layer is thought to be composed of cover rock, which in geothermal settings is referred to as cap rock. Cap rock is impermeable and is usually composed of sandstone and clay. The cap rock layer is typically located at a depth of 500 meters below the Earth's surface. At a depth of 1 km-5 km, where a geothermal reservoir is expected, the resistivity is medium (20-200 Ωm), while at a depth of 1.5 km-5km, where a heat source is expected, the resistivity is high (800 Ωm). The 2D resistivity contour model was obtained from field data acquisition at each different sonar point. This 2D resistivity model shows the distribution of geothermal energy in Babakan Bogor Village, Kepahiang Regency.

Geothermal investigation using the magnetotelluric (MT) method on one track with a total of four measurement points covering the Kabawetan area with a track that runs along the Babakan Bogor fault to the Sempiang fault to see the distribution of geothermal resistivity values in the Kabawetan sub-district area, Kepahiang district. As a result of the measurements, a 1D resistivity graph and a 2D resistivity cross-section model were obtained through processing using ZONDMT1D and ZONDMT2D software. The results of the resistivity graph, extending to 1D depth, are used to determine the thickness and resistivity value of each layer. The 2D resistivity cross-section results are used to describe the distribution of subsurface resistivity values in the geothermal area.

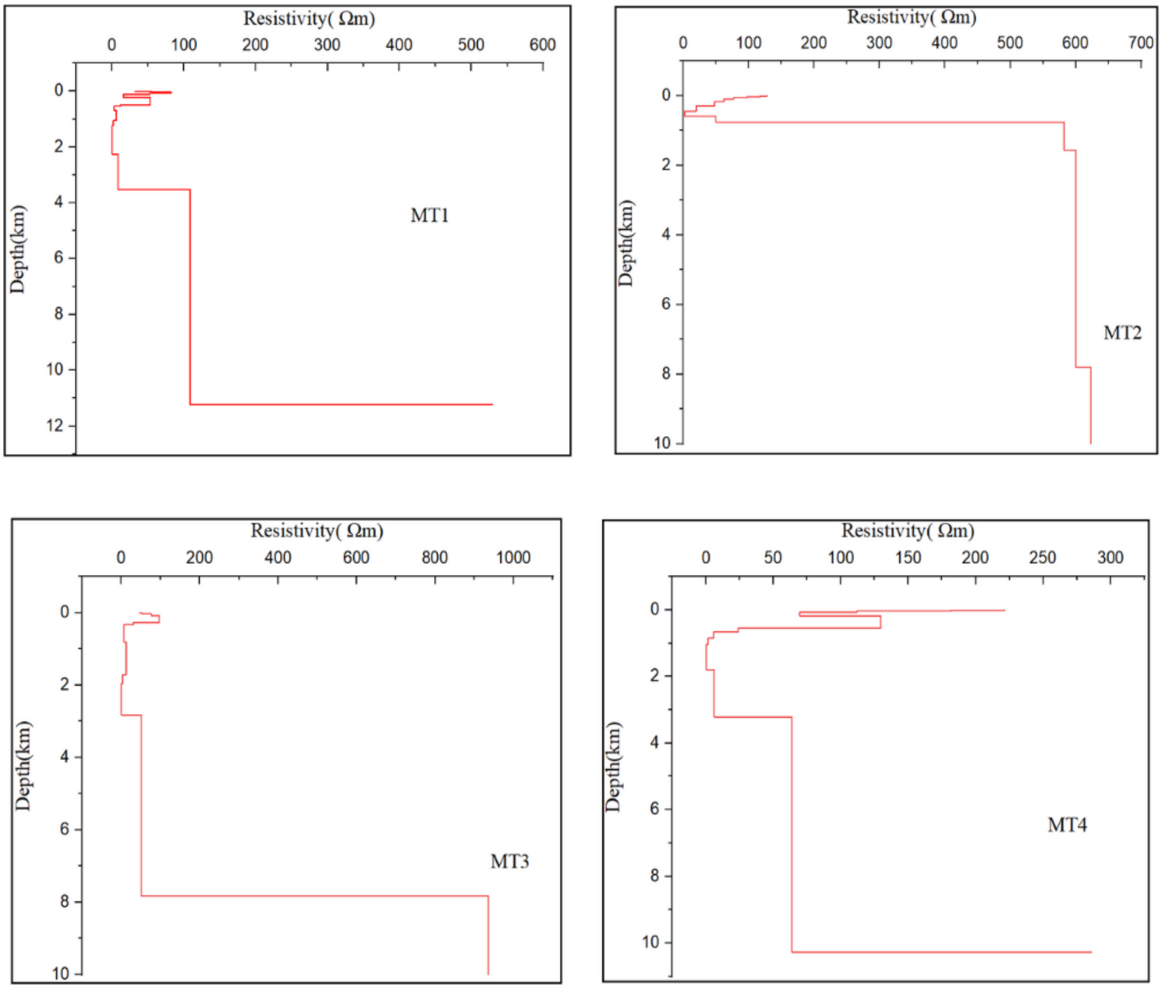

Figure 5. Graph of resistivity against depth in 1D at points MT1, MT2, MT3, and MT4

The graph of the relationship between resistivity value and depth is used to show the resistivity value at each depth. 1D modeling at each sounding point can be utilized in 2D modeling to determine the distribution of resistivity values in geothermal areas during the inversion stage. 1D processing results illustrate varying resistivity values. Based on the graph of the relationship between resistivity value and depth (Figure 5), it can be seen that at point MT1 the resistivity value starts from 90 (Ωm) then the resistivity value increases to 120 (Ωm) at a depth of 3.8 km, this is due to the research point adjacent to the Babakan Bogor fault, besides that at a depth of 0-2 km it is thought to be a layer composed of impermeable chlorite and clay, at a depth of 2-3 km it is thought to be a layer composed of sandstone, limestone, and dolomite. At a depth of 4-7 km, it is thought to be a layer composed of chlorite and clay. At a depth of 7-10 km, it is composed of granite and basaltic material. The 1D results of point MT2 show a high increase in resistivity value, at a depth of 0-1 km it is identified as a layer composed of chlorite and clay, at a depth of 1-3 km it is identified as a layer composed of sandstone, limestone, and dolomite which is permeable, a depth of 3-10 km is identified as a layer composed of chlorite and clay. At point MT3 0-1 km is thought to be a cap rock layer composed of impermeable chlorite and clay materials, 1-3 km depth is thought to be a reservoir layer composed of sandstone, limestone, and dolomite, at a depth of 3-10 km is thought to be a cap rock layer composed of chlorite and dolomite materials. Based on (Figure 5), the graph showing the relationship between resistivity values and depth, point MT4 is located around the black hill, where there is a manifestation of geothermal heat on the surface in the form of a crater with higher topography in the research area at point MT4. It is estimated that the subsurface layer at the research point has a high slope, indicating that the magma flow likely spreads from point MT4 towards point MT1. At a depth of 0-1 km, it is identified as a layer composed of chlorite and clay, at a depth of 1-3 km, it is identified as sandstone, limestone, and dolomite, and at a depth of 3-10 km, it is identified as a layer composed of granite and batholith.

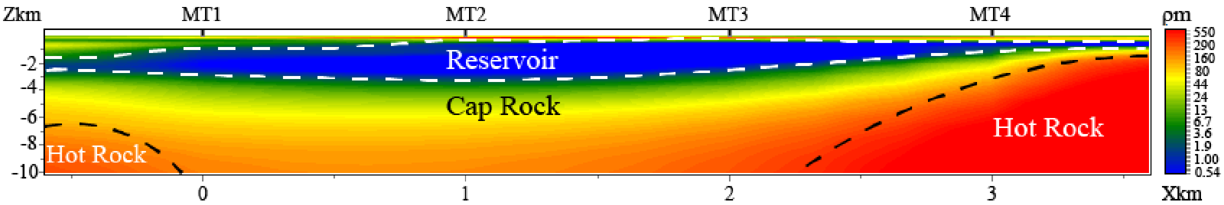

Figure 6. 2D resistivity cross-section model.

The 2D resistivity cross-section model shows that the resistivity value is related to the rock type. Low resistivity is thought to come from reservoir rocks composed of permeable rocks such as sandstone, limestone, and dolomite with a depth of 1.5-2.5 km, medium resistivity comes from a layer suspected of being a geothermal cap rock composed of impermeable chlorite and clay with a depth of 0-1.5 km and 2.5-4 km (do you have references about it?), and high resistivity comes from heat sources with a depth of 4-10 km which is identified as hot rock composed of igneous rocks in the form of granite and batolite. Based on the inversion results in Figure 6, point MT4 is considered a prospective point, with a manifestation in the form of hot water near the research point.

Discussion

Based on the 2D resistivity cross-section model (Figure 6), the resistivity values are categorized into three groups: low, medium, and high resistivity, as shown in Table 1. The resistivity value (0.54-1 Ωm), shown in blue, is thought to be the reservoir layer in the geothermal system. The reservoir layer is a subsurface layer containing hot water and steam derived from heat emitted from the Earth's core. In this zone, it is estimated that andesitic rock types have experienced fractures, which are thought to be a location where geothermal fluids are stored, with depths ranging from 1.5 to 2.5 km. The reservoir layer is composed of several types of rocks, including sandstone, limestone, and dolomite. Sandstone is the most critical reservoir, comprising approximately 60% of all reservoir rocks. In sandstone, porosity and permeability are determined by grain size and its distribution, sorting, grain shape, grain roundness, grain arrangement, compaction, and cementation (Uthami et al., 2023). The resistivity value (20-60 Ωm), shown in green to yellow, is thought to be cap rock. The cap rock layer is a type of rock that covers the reservoir rock layer, serving as a cap to prevent the escape of geothermal fluids. Geothermal systems with depths ranging from 0-1.5 km to 2.5-4 km. In this zone, an andesitic lava rock type is identified, which has undergone alteration. Some of the alterations are in the form of chlorite and clay so that they can withstand the release of geothermal fluids to the surface because these rocks are impermeable (Al Ansory et al., 2023) and resistivity values (290-550 Ωm) displayed in orange to red colors are thought to be hot rock with depths ranging from (4-10 km). Hot rock in geothermal systems is composed of metamorphic and igneous rock. The hot rock is located below the

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reservoir rock layer. Hot rock in geothermal systems can take the form of granite or basalt, which are types of rock characterized by high temperatures and very low permeability, resulting in little stored fluid.

According to Noviantari Manyoe (2018), this geothermal system utilizes heat stored in low-porosity, impermeable rocks. Based on the results of the study, the measurement point suspected as a geothermal prospect area by referring to the resistivity value of the processing results of the 2D inversion magnetotelluric method is point MT4, from these results it is expected to provide information to the community and government regarding geothermal potential for the utilization of renewable energy in the construction of PLTP (Geothermal Power Plant) to meet the country's electrical energy supply, especially areas near PLTP.

Table 1. Estimated Grouping of Resistivity Values (Ωm)

No	Resistivity(Ωm)	Depth(km)	Description
1	0.54-1 Ωm	1.5-2.5 km	*Reservoir*
2	20-60 Ωm	0-1.5 km & 2.5-4 km	*Cap Rock*
3	290-550 Ωm	4-10 km	*Hot Rock*

Overall, the model depicts three main features. The first feature is a rock with a high resistivity value, which is interpreted as the heat source rock. The second feature is a low-resistivity layer, interpreted as a cap rock. The third feature is an intermediate resistivity layer interpreted as a reservoir layer; the surface part is interpreted as an overburden that does not undergo alteration processes. However, the resulting 2D inversion model cannot distinguish between reservoirs characterized by vapor dominance and those characterized by water dominance.

Conclusion

Based on the research results described above, it can be concluded that the 2D model in the geothermal area of Kabawetan sub-district, Kepahiang Regency, shows that the geothermal area can be grouped into three categories of variations in resistivity values: low, medium, and high resistivity. The results of the research in Kabawetan District concluded that the resistivity value is identified into three layers, namely the reservoir layer with a resistivity value between 0.54-1 Ωm, the cap rock layer with a resistivity value between 20-60 Ωm and the hot rock layer which is suspected to be a heat source rock with a resistivity value between 290-550 Ωm with a depth of 4-10 km. Based on the results of four research points scattered in the Kabawetan sub-district area, point MT4 is suspected to be a geothermal prospect area, as indicated by the resistivity value obtained through the 2D inversion magnetotelluric method.

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