American Journal of Engineering Research (AJER)
e-ISSN: 2320-0847 p-ISSN : 2320-0936
Volume-7, Issue-4, pp-116-120
www.ajer.org
Research Paper Open Access

Identification Of Subsurface Area In Tinggi Raja Simalungun District By Using Geomagnetic Method

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ABSTRAK :*This research was done entitiled* ***identification of subsurface area in Tinggi Raja Simalungun district by using geomagnetic method.*** *It was aimed to identify geothermal fluid dispersion pattern of geothermal areain TinggiRaja.Geographically, the study area is located at coordinates 03º09'01,39 "North Latitude and 98º47'10.08" East Longitude. The measurements of Total magnetic field use a tool called Proton Precission Magnetometer (PPM), positioning using the Global Position System (GPS) and determining the orientation of the north using a geological compass. Data collection was done randomly with the number of points obtained as much as 40 measuring point. Data analysis was started with IGRF correction to obtain the total magnetic field anomaly. Then,data analysis of total magnetic anomaly data was done by using Surfer program 12. To get a magnetic anomaly section used Mag2dc For Windows program. The anomaly cross section with geomagnet method has the lowest value of -3.01 nT at the coordinates of 0476241 N 0348117 E to 69.28 nT at the coordinates of 0476241 N 0348120 E where the model of the subsurface layer is composed of salt rock.*
KEYWORDS: *Magnetic Methods, Susceptibility, GPS, Tinggi Raja*

Date of Submission: 31-03-2018 Date of acceptance: 16-04-2018

I INTRODUCTION

Environment is a combination of physical conditions that include of natural resources condition such as land, water, solar energy, geothermal, minerals and flora and fauna. Geothermal is an example of the environment. It is one of the natural resources on earth where its appearance in the form of hot water (hydrothermal). The existence of the environment is very important for human life. One of the needs of human life is energy resources [1]. Energy is the absolute necessity that is needed in human life, and its availability provides a major influence on the progress of development. Theincreasing of human activity and the magnitude of the demand for practice and convenience human life, resulting in increasing of energy consumption [2].Based on data from the Directorate General of Renewable Energy and Energy Conservation of the Ministry of Energy and Mineral Resources (ESDM) in recent years, Indonesia's energy consumption growth reaches 7% per year. It is above the world energy consumption growth of 2.6% each year. Indonesia's high energy consumption is almost 95% filled from fossil fuels. From the total number, 50% of it, is Fuel Oil (BBM). Currently, Indonesia only has oil fuel reserves of 3.7 billion barrels or 0.3% of the world's reserves. This makes the government save on energy fuels and continue to seek alternative energy sources to fulfill human needs [3]. One of energysource that is expected as an alternative energy is geothermal energy [4]. North Sumatra Province is one of the areas in Indonesia that holds a lot of geothermal potential because the islands of Sumatran are located at the meeting of two tectonic plates, the Eurasian Plate and the Indo-Australian plate, causing thepotential frequent of Sumatran earthquake and earth geothermal. Geothermal potential in Sumatra reaches 9562 MW [5].

According to the geological map, Simalungun district has potential geothermal located in Silau kahean sub-district, Dolok Morawa village. Several studies have been conducted in high geothermal of TinggiRaja, such as investigations by Geothermal Research Program Group (2006), stating that fluid in Geothermal Region of Dolok Marawa is neutral, hot water-dominated, geothermometer fluid 180 ° C, in the medium enthalpy

category and potential reserves of 49-50 Mwe. Then, the surface water temperature at geothermal of Dolok Morawa is 60 0C - 66,5 0C with neutral pH equal to 6,48 - 7,63 with average concentration of the most element is calcium reach 135,81 Ppm, then second element is Sodium (108.97 Ppm) and Silica (82.28 Ppm) and the least element is Potassium at 30.44 Ppm [6]. Magnetic methods are one of the most common geophysical methods used in a preliminary survey in geothermal or geothermal exploration [7]. The accuracy of measurement of magnetic methods is relatively high and the operation in the field is relatively simple, easy and fast [8].This method is based on the difference of rocks magnetization rates which is induced by the Earth's magnetic field. This occurs as a result of the difference in the characteristics of material magnetism. [9] The material capability for being magnetization depends on the magnetic susceptibility of the rock. [10] The geomagnetic method was done based on anomalous geomagnetic measurements which is caused from the contrast difference in sunseptibility or the magnetic permeability of the trapped body from the surrounding area. The difference in relative permeability is due to differences in the distribution of ferromagnetic, paramagnetic and diamagnetic minerals [11]. The price of susceptibility is very important in the identification of anomalous objects because of the characteristic properties of each mineral or metal type. The price will be greater if the amount of magnetic mineral content in the rock more and more [12]. Previous research has been done by several people, such as Survei panas terpadu(hendro, 2006) and Geothermal fluid determination and geothermal stones mineral (Kadri, 2017), but they are different with my researchbefore, the researchers conducted a geomagnetic study with a distance of one meter from a source geothermal.The result of the susceptibility calculation will be compared with the price of the susceptibility table (telford 1991)[13].

The purpose of this study was to identify the environment of subsurface structures based on the total and regional magnetic anomaly data and to detect lithologic boundaries between intrusive rocks and other rocks.

II RESEARCH METHODOLOGY

A. Location and Time

Dolok Tinggi Raja is a nature reserve area of 167 Ha located in Silau Kahen Subdistrict, Simalungun District, North Sumatera Province. Inside the area of nature reserve Dolok Tinggi Raja , there is a white crater tourist attraction, which is more commonly known by kawah putih tinggi raja. Geographically, the location of Simalungun is located between 03º09'01,39 "North Latitude and 98º47'10.08" East Longitude with an area of 4,386.60 km2. The research was conducted in May 2017.The location of research can be seen in the picture

below. **Figure 3.1 Figure 3.1 Research location**

B. Tool and Material

1. Research Tool

PPM (*Proton protezion magneto meters)*, Casio Stopwatch, Compass, Meter, Battery, DNS GARMIN, Stationary, Transmitter.

2.Research Material

The research material is the location of the sampling point.

C. Research Procedure

1. Review the location and picture shooting that will become research area.
2. Determine the reference point coordinates in the research area using GPS (Global position system).
3. Determine the base points on the area to be surveyed based on the anomaly determination
4. Make measurements using the PPMgeomagnet*Type elsec 770*.
5. Process the data that was obtained by Geomagnet PPM *Type elsec 770*.
6. Process the data with mag2DC softwere.
7. Differentiate types of resistance values based on anomalies and colors to see susceptibility.

III RESULT AND DISCUSSION

Field data obtained during field measurement using geomagnet method in the form of magnetic value from each point. Magnetic data collection aims to observe the magnetic field Total (H) on earth at a certain point. The obtained data will be obtained by an induced magnetic object where the magnetic field value (H) must be reduced by the value of the induced magnetic field resulting in a magnetic field value called the magnetic anomaly (ΔH) .The earth magnetic field data is at the base station. Field measurement data in the form of total earth magnetic field is still mixed with the earth's main magnetic *International Geomagnetic Reference Field* (IGRF) and daily magnetic.

To obtain the value of the total magnetic anomaly (ΔH), the following correction is made: daily correction (ΔH_{vh},) IGRF correction price (HIGRF), and topographic correction (H_T), Magnet price measured (H_{obs}) and to obtain strong field magnet (H), Anomaly with the equation:

$$\Delta H = \Delta H_{obs} \pm \Delta H_{vh} \pm H_T - H_{IGRF} \quad (1)$$

And susceptibility (K) is determined by the following equation

$$k = \frac{\Delta H}{H} \quad (2)$$

A. Result

a. Distribution Pattern of Earth Magnetic Anomaly

Result of earth magnetic anomaly can be figured in the form of anomaly map contour by using *software surfer* 11. It can be seen in this figure 1:

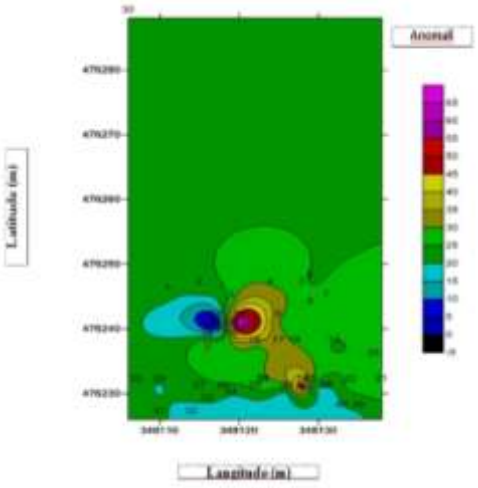

Figure 4.1. Distribution Pattern of Earth Magnetic Anomaly in Survey Area

Figure 4.1. shows the survey area with low anomaly at the 12th point of -3.01 nT and low anomaly is at the 11th point of 69.28 nT. The low magnetic anomaly price obtained in the survey area is interpreted as an area closely related to the formation of geothermal manifestations in the area.

a. Rock Susceptibility of Tinggi Raja Geothermal Area

The susceptibility of rock magnetization is the parameter of fundamental physical in magnetic probe, because susceptibility is a measure of the ability of a rock to receive magnetization from the earth's magnetic field. To obtain a clear picture of the magnetism properties encountered in the study area, magnetic susceptibility measurements were taken at each measurement point.

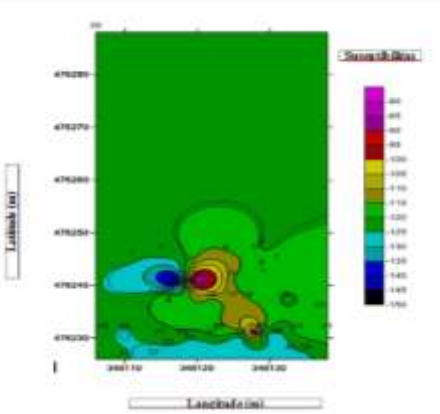

Figure 4.2. Susceptibility of Map Contour at Kawah Putih Tinggi Raja

From the calculation of susceptibility value obtained that the geothermal of Tinggi Raja has the lowest susceptibility value until the greatest susceptibility value is: -188.24 x 103 sd -75.92 x 103. The susceptibility value obtained will be used to know the type of rock beneath the subsurface geothermal area of Tinggi Raja.

B. Discussion

1. Geomagnetic Interpretation Data

Based on the magnetic anomaly (Figure 4.1) and the rock susceptibility (figure 4.2) which was obtained, a magnetic anomaly model was developed to interpret the subsurface rock structure. The initial step of modeling in the form of line section (path AA ') from the low anomaly to the high suspected as a source of magnetic anomalies above the contour anomaly map as seen in Figure 4.3 below

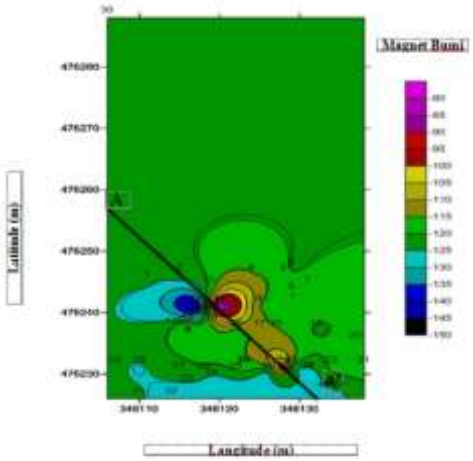

Figure 4.3. Earth Magnetic Contour Map with A-A'

2. Magnetic Anomaly Model

Quantitative interpretation is needed to describe the subsurface structure of data measurement. Quantitative interpretation aims to determine the lithology of the research area. Interpretation is done to create geomagnetic sectional model using Mag2DC software by input data in table 4.1, so that figure 4.4 will be obtained which has translation in the form of picture by showing the susceptibility value and color based on rock layer. In numerical modeling, some geometric magnetic field parameters of the study area are needed, including IGRF value (41856.7 nT), declination angle (17 °), inclination angle (13 °), and some modeling parameters are required.

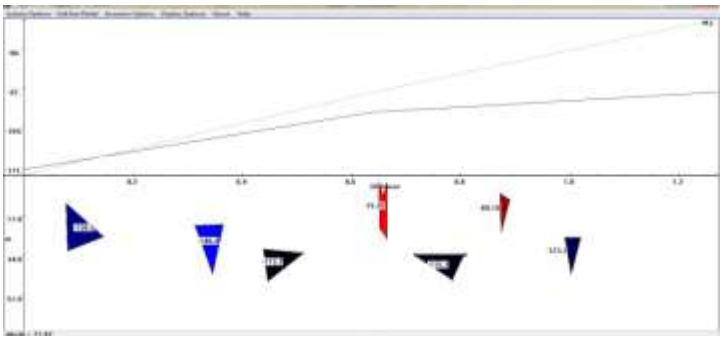

Figure 4.4. Using Geomagnetic Section Modeling *softwareMag2DC*

Figure 4.4 shows a cross-sectional model AA ' which in the figure contains the x-axis and the y-axis. The x-axis shows the length of the incision, the positive y-axis indicates the magnetic intensity variation value and the negative y-axis indicates the depth. From the modeling results can be determined rocks lithology based on the susceptibility value. The modeling results of the obtained susceptibility value show the type of salt rock with the suseptibility value (-130.52, -148,22, -113.7, -113.7, -75.92, -115.39, -89.10, -123.77.) Contrast the negative susceptibility value (-) and positive (+) in the alleged region A are interpreted as Horst Graben structures, ie fractures which are used as the out flow of geothermal vapor. the above calculation and compared with telford suseptibility table, the result of the value of the negative value susceptibility is allegedly classified into diamagnetic rock, but with a low negative price and very different from telford table price, this research still needs to be continued to get more accurate result.

IV CONCLUSION

Based onresearch results, it can be concluded that the surface environment has a value, such as: Magnetic anomaly values in the survey area ranged between: -3.01 nT at coordinates 0476241 N 0348117 E to 69.28 nT at coordinates 0476241 N 0348120 E, the existence of anomalous magnetic field is caused by the contact between several types of rocks in the study area. Based on the value of susceptibility obtained, the rock types found in this study area were salt rocks altered with the value of suseptibility are classified as diamgnetic rocks.

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Togi Tampubolon. " Identification Of Subsurface Area In Tinggi Raja Simalungun District By Using Geomagnetic Method"American Journal of Engineering Research (AJER), vol. 7, no. 4, 2018, pp.116-120.