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INTEGRATING OF GEOMAGNETIC DATA AND VERTICAL ELECTRICAL SOUNDING FOR IDENTIFICATION OF RESERVOIR AND GEOTHERMAL FLUIDS IN GEOTHERMAL PROSPECTS RAJABASA MOUNTAIN ABSTRACT This study has been done to determine the spread of reservoir rocks and geothermal fluids that are beneath the surface of the geothermal prospect of Mount Rajabasa, South Lampung Regency, Lampung Province. The stages of study carried out in the form of (i) measurement of geomagnetic data and vertical electrical sounding AB/2 150, 300, 450 and 600 meters; (ii) magnetic anomaly data processing consisting of diurnal and IGRF correction, reduction of the surface, upward continuation, separation of regional-residual anomalies, reduction to the pole, and 3D residual anomalies modeling from reduction to the pole; (iii) determining the value of resistivity every depth.

The range of geomagnetic anomalies obtained is -419.404 nT to 1429.022 nT. Based on the results of 3D residual anomalies from reduction to the pole process can be estimated that the geothermal reservoir has a susceptibility value of 0.0022 cgs (103 SI) to 0.289 cgs (103 SI) estimated as intermediate (andesitic-basaltic) rocks. The position of the reservoir is located southwest of the peak of Mount Rajabasa at a depth of 1300 meters below the mean sea level. The results of resistivity analysis showed that the capillary rock was characterized by a low resistivity value (10 - 60 O geothermal reservoir characterized by a high resistivity value (> 210 ? m). Based on the profile of resistivity anomaly there is a distribution of geothermal fluid from the Northwest and extends with increasing depth.

The cross section of the geomagnetic anomaly shows that the geological structure that traverses Northeast - Southwest and North-South is a fluid control factor in the area of the prospect of the Gunung Rajabasa geothermal, South Lampung Regency, Lampung Province. Keywords: Geothermal, magnetic, Villamasin. INTRODUCTION Rajabasa Mountain is located in the south of Sumatra Island, precisely in Kalianda, South Lampung Regency. The presence of several geothermal manifestations on Mount Rajabasa is an indication of the potential for geothermal energy. Based on the interpretation of satellite imagery there are several lithological units produced from three volcanic cones that are interpreted as the old Mount Rajabasa, Mount Balerang, and the young Mount Rajabasa.

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This result is confirmed by the petrographic results in the field data in the form of fresh rock samples. Some alterations are also found in geothermal manifestations located in the north and south of Mount Rajabasa. Therefore it is necessary to do research on geological conditions in the geothermal prospect area of Mount Rajabasa (Darmawan et al., 2013). In this study several geophysical methods were used, namely the magnetic method and the vertical electrical sounding (VES) method. In geothermal exploration, magnetic methods are useful for knowing magnetic field variations in the study area. The variation of magnetism is caused by nonhomogeneous magnetic properties of the earth's crust. Where rocks in geothermal systems generally have low magnetization compared to surrounding rocks.

This is due to the demagnetization process by hydrothermal alteration processes, the process of converting existing minerals into paramagnetic or even diamagnetic minerals. The low magnetic value can interpret potential zones as reservoirs and heat sources (Sumintadirejo, 2005). Whereas, the VES method itself is one of the more effective types of resistance methods when used for shallow exploration, rarely providing layer information at depths greater than 1000 or 1500 feet. Therefore this method is rarely used for oil exploration but is more widely used in the field of geological engineering such as determination of bedrock depth, search for water reservoirs, also used in geothermal exploration.

Excellence in general is the price of equipment is relatively cheap, survey costs are relatively cheap, the time needed is relatively very fast, can reach 4 measurement points or more per day, workload; small and light equipment so easy to mobilize, the personal needs of around 5 people, especially for Schlumberger configuration and data analysis globally can be directly predicted when on the ground METHODS The study using the geomagnetic method and Vertical Electrical Sounding was carried out in the Rajabasa Mountain, South Lampung Regency, Lampung Province. Figure 1, is a topographical modeling image of the research area accompanied by measurement points carried out in the area. The highest topography of Mount Rajabasa is at a value of 1200 meters above sea level. The point of magnetic measurement is spread from the northwest to the Northeast and around the foot of the mountain.

Then for the vertical electrical sounding point of measurement there is an altitude of 200 to 300 meters above the surface of the earth which lies on the Northwest of the mountain area of Rajabasa. Figure 1: Topography map. The principle of the magnetic method is to utilize magnetic susceptibility variations found in subsurface rocks. Magnetic method surveys have the benefit of knowing geological structures, such as faults, folds, igneous intrusions, geothermal reservoirs, groundwater aquifers, metal mineral deposits, and others (Lukhvich et al, 2003). Basically the data from the measurement of magnetic fields is the contribution of three basic components, namely the main magnetic field of the earth, the outer magnetic field and the anomalous field. The main magnetic field value is the IGRF value.

If the value of this main magnetic field is eliminated by diurnal correction, then the contribution of the main magnetic field is eliminated by IGRF correction. IGRF correction can be done by subtracting the IGRF value from the diurnal corrected total magnetic field at each measurement point in the appropriate geographical position. The correction equation (after diurnal correction) can be written as follows: (1) Basically the data from the measurement of magnetic fields is the contribution of three basic components, namely the main magnetic field of the earth, the outer magnetic field and the anomalous field. The main magnetic field value is the IGRF value. If the value of this main magnetic field is eliminated by diurnal correction, then the contribution of the main magnetic field is eliminated by IGRF correction.

IGRF correction can be done by subtracting the IGRF value from the diurnal corrected total magnetic field at each measurement point in the appropriate geographical position. The correction equation (after diurnal correction) can be written as follows: (2) Where is IGRF To simplify the processing and interpretation of magnetic data, the anomalous data of the total magnetic field that is still scattered in the topography must be reduced to a flat surface. This transformation must be done, because the data processing process further requires that the magnetic field input be distributed to the flat surface. This reduction uses Taylor series revisions written in equations (Blakely, 1995): ? (3) Then, an upward continuation process is carried out.

upward continuation is performed to reveal anomalies caused by deeper sources or eliminate anomalies caused by superficial sources (Blakely, 1995). upward continuation is carried out on the total magnetic field anomaly map. Determination of regional anomalies is carried out by an upward continuation process on total magnetic field anomalies. The use of upward continuation is expected to help to separate regional anomalies from local anomalies. Continuation process with trial and error test is done by looking at the tendency of contour patterns of the results of continuation at a certain height (Indratmoko et al., 2009). The higher the data continuity, the more local information is lost and the regional information becomes clearer. After the upward continuation process, a reduction to the pole is carried out.

At low geomagnetic latitude magnetic data interpretation is more difficult than at high geomagnetic latitudes since anomaly maxima are not located directly over the causative bodies. This interpretation technique reduce dipole field to monopole field, the anomaly is directly above the causative body as like gravity anomaly, since it assume the perfect induction for simplicity. Reduction to the pole is done by making the object's inclination angle to 90� and its declination 0�. With the reduction to the poles, it is expected to produce a magnetic anomaly pattern that is monopolistic in nature, thus facilitating qualitative interpretation (Yaoguo and Oldenburg, 2001).

After the reduction to pole stage is completed, 3D inversion modeling of residual rock geomagnetic anomalies below the surface. Model parameters from inversion modeling are obtained directly from the data. 3D inversion modeling provides an overview of susceptibility distribution. If a 3-D subsurface model is built from a set of upright prisms with the intensity of magnetization or homogeneous susceptibility then the vector of magnetic data d (di, i = 1,2, ..., N) is a linear transformation between the intensity of magnetization of each prism (mi, i = 1,2, ...,

M) with the kernel matrix (Grandis and Yudistira, 2001) sized (N X M) as follows : d = G m (4) where, G = matrix kernel m = model parameter d = data The kernel matrix is an expression or elaboration of the geometry of an anomalous model built from a collection of prisms. Data (d) is magnetic anomaly data, while the model (m) parameter is the susceptibility of each prism and is the parameter sought. Combined data on the surface (z = 0) and the results of upward continuation (z > 0) produce data with a number greater than the number of model parameters (N> m so that the inversion solution is over-determined (Kusnida et al., 2009) m = [GT G ]-1 GT d (5) Besides using the magnetic method, the VES (Vertical Electrical Sounding) method is also used.

According to Loke (2000), in this technique the measurement is the arrangement of the electrodes with the distance of the electrode spacing graduated arbitrarily for the observed point, while the potential electrodes (M and N) are fixed. In this case, the greater the distance of the electrode, the more injected current will be until the measurement location is covered. Where the type of resistance is given by Equations: (6) where, = apparent resistivity = geometric factors = potential difference = electric current Based on geoelectric measurement techniques, there are two measurement techniques, namely the geoelectric method of resistivity mapping and sounding. Resistivity mapping geoelectric method is a resistivity method which aims to study the subsurface resistivity variations horizontally.

Therefore, in this method the electrode spacing is fixed for all sounding points on the earth's surface. The resistivity sounding geoelectric method aims to study the resistivity variations of rock beneath the earth's surface vertically. In this method, measurements at a sounding point are carried out by changing the distance of the electrode. Changing the distance of the electrode is done from the distance of the small electrode then enlarges gradually. This electrode distance is proportional to the depth of the rock layers detected. The greater the electrode distance, the deeper the rock layers are detected (Menke, 1984) The resistivity geoelectric method is one of the common geophysical methods used in geoelectric exploration.

Geoelectric resistivity methods can be used to provide subsurface information by utilizing the electrical resistivity properties found in rock layers, where the earth is composed of rocks that have different electrical conductivity. The principle of the resistivity geoelectric method is the electric current is flowed into the earth layer by using two potential electrodes so that the potential current price can be known and the subsurface resistivity value can be determined. The data obtained in the field is the subsurface resistivity value data so that inversion calculations can be performed and resistivity variations obtained from a soil layer system associated with subsurface geological structures (Looke, 1995). Based on the electrode configuration, a type of configuration is known, namely Schlumberger Configuration. In the Schlumberger configuration current electrodes and potential electrodes are placed as shown in Figure 2.

This configuration is used to probe changes in subsurface resistivity vertically. At a fixed measuring point, the distance of the current and voltage electrodes is changed. Commonly used methods include Vertical Electrical Sounding (VES). According to Loke (2000), in this technique the measurement is the arrangement of the electrodes with the distance of the electrode spacing graduated arbitrarily for the observed point, while the potential electrodes (M and N) are fixed. In this case, the greater the distance of the electrode, the more injected current will be until the measurement location is covered. Where the type of resistance is given by Equations: (7) Figure 2: Schlumberger Configuration. RESULTS AND DISCUSSIONS Vertical Electrical Sounding Figure 3: Reduce to level surface anomaly.

The results of vertical electrical sounding analysis (Figure 3) showed that the capillary rock was characterized by a low resistivity value (10 - 60 � geomal esero characterized by a higrstiy ue > 1�.B n profile of resistivity anomaly there is a distribution of geothermal fluid from the Northwest and extends with increasing depth. The cross section of the geomagnetic anomaly shows that the geological structure of the Northeast and North-South is a fluid control factor in the area of the prospect of the Gunung Rajabasa geothermal, South Lampung Regency, Lampung Province. Magnetic Method Based on Figure 4, positive and negative anomalies that show a response to the surface anomaly magnetic surface. The value of the magnetic area is in the range of -419.404 nT to 1429.022 nT.

When viewed from the total magnetic field anomaly data, there are considerations with the magnetic anomaly response caused by rocks below the surface. The response was indicated by the closure pair in the south, southeast, northwest, north and central parts of the study area. Figure 4: Total magnetic field anomaly. On the contour map the results of the reduction to level sufrace do not have a significant difference in the anomalous value when compared with the anomalous value on the total anomaly contour map (Figure 5). Figure 5: Reduce to level surface anomaly. Qualitative interpretations of the regional anomaly maps obtained are obtained from the upward continuation process (Figure 6). Contour maps of regional geomagnetic anomalies determine the high value distribution in the range 622-903.822 nT which extends from the Southwest to the North. Figure 6: Regional anomaly. After obtaining regional anomalies, the reduction process is then carried out to obtain residual anomaly values.

After obtaining residual anomalies, then interpretations are carried out. Based on Figure 7, a residual anomaly map can be interpreted which shows a high anomaly value with a range of values of 751 to 1429 nT which is in the middle of the research area that stretches west and northwest of the study area. Based on these interpretations, that pattern of anomalies can indicate the existence of a geothermal reservoir. Figure 7: Residual anomaly. After obtaining the remaining anomalies, then the remainder of the anomaly is used for the process of reduction to the poles to eliminate ambiguity in interpretation because of the magnetic nature of the two poles (Yaoguo and Oldenburg, 2001).

The results of the reduction to pole process are shown in Figure 8. Based on the results of the process of reduction to the poles found in positive and negative patterns of magnetic anomalies. The reduced contours to the poles indicate areas that have high magnetic values produced by subsurface rock responses. The high values on the contours of the reduction to the poles are in the range 2020- 6480. Where the high value stretches from North to South, then in the Northeast. Positive and negative anomalous patterns show manifestations. This anomaly shows the demagnetization process occurs below the surface. Figure 8: Reduction to pole anomaly. Then the modeling process is carried out, in this study a 3D modeling process is carried out. Modeling is done to get the distribution and move the rock based on the required surface into a geothermal reservoir.

3D modeling uses anomalous data from the results of reduction to the poles. The results of 3D reduction to polar modeling can be seen in Figure 9. Based on the modeling results explain what is meant by the rock released into a geothermal reservoir that has a geometry consisting of a batholite with a type of stone made of igneous rock. Figure 9: The susceptibility model from the inversion of the reduction to pole residual anomaly in the Rajabasa Mountain region. The 3D model (Figure 10), the high suseptibility value is found in the part that has a high magnetic anomaly which is indicated by the polar reduction anomaly contour map that is contained in the 3D model.

If viewed from the topographic contour map in the 3D model, the high anomaly is found at an altitude of 800 to 1000 meters which is located on the back of Mount Rajabasa. Based on the suseptibility model in the 3D model, the anomaly has a geometry that extends from Northeast to Southwest in the study area. The rock geometry has batholite characteristics, wherein the batholite is an igneous rock that tries to rise to the surface and undergoes hardening and freezing so as to form a large and wide geometry. The suseptibility model has a high value with a range of values of 0.0022 cgs (103 SI) to 0.289 cgs (103 SI) with rock lithology, which is basaltic andesite located at a depth of 1300 meters below mean sea level.

Based on this interpretation that the rock is a rock that has the potential to become a geothermal reservoir because it is seen from its very large geometry. Figure 10: The Susceptibility model from the inversion of the reduction to pole residual anomaly with the highest susceptibility value in the Rajabasa Mountain region. Figure 11: The Susceptibility sections model from the inversion of the reduction to pole residual anomaly in the Rajabasa Mountain region. Based on the 3D section model (Figure 11), it can be seen that the high susceptibility value is formed from rocks produced by the intrusion process because it has a geometry that extends from beneath the surface of the earth and then widens when rising to the surface of the earth. The appearance of the manifestation or crater on Mount Rajabasa is caused by a fairly large fault, so the hydrothermal fluid can come out to the surface through the formed fault field (Rasimeng, 2008).

This can be seen with the emergence of manifestations with the northwest-southeast relative direction, namely the manifestation of the Way Sulfur-dry sulfur field-the crater of the peak of Rajabasa-manifestation Simpur. Based on the geological map of the Rajabasa Mountain region consisting of volcanic rocks in the form of lava and breccia, pleistocene volcanic rock in the form of andesite lava and breccia and andesite in the form of andesite lava rock (Mango, et al, 1993). So if it is correlated with the magnetic field anomaly that is reduced to the pole, there is a correlation with the magnetic anomaly response caused by the rock below the surface. CONCLUSION Based on the results of vertical electrical sounding and magnetic method data processing, the results of vertical electrical sounding analysis indicate that capillary rocks are characterized by low resistivity values (10 - 6 m)a tmalrvo s that are characterized by high resistivity values (> 210 �.B

n ualitatianal fmag field data from the reduction to pole process at Mount Rajabasa, we can estimate the existence of geothermal reservoirs in the Northeast to Southwest modeling area and also in the study area. Based on 3D modeling, where the susceptibility value generated by the rock response below the surface is in the value range of 0.0022 cgs (103 SI) to 0.289 cgs (103 SI). The subsurface rock geometry is formed by intrusive rocks with basal andesitic lithology and rocks with a combination of tuff and breccia which are used as reservoirs in geothermal systems