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IDENTIFICATION OF VARIATIONS IN GRAVITY ANOMALY VALUES IN THE GEOTHERMAL DISTRIBUTION AREA OF THE RANTAU DEDAP REGION, SOUTH SUMATRA

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Abstract. This study identifies gravity anomaly values using the gravity method in the Geothermal distribution area of the Rantau Dedap area, anomaly data obtained from the TOPEX satellite. This study is located at coordinates 103.275º- 103.6917º East Longitude and 3.9052º-4.2876º South Latitude. Free air and topographic anomaly data obtained were 625 data points along with topographic data. This study aims to support previous study with different methods and aims to support study data, especially in the field of geophysical exploration in looking at the subsurface geological structure of this region based on variations in gravity anomaly values. The Simple Bouguer Anomaly (SBA) obtained was in the range -37.2827 mGal to 34.4800 mGal. The Complete Bouguer Anomaly (CBA) value is -37.0843 mGal to 34.6802 mGal. The estimated value obtained is not too different from the Simple Bouguer Anomaly value so it produces the same contour pattern. Meanwhile, the Regional Anomaly obtained has a value of -36.8 mGal to 39.7 mGal and the Residual Anomaly value range is -16.1 mGal to 9.2 mGal. In the residual anomaly map, it can be seen that the anomaly values are positive and negative, this affects several things such as rock density, position and size of the rocks that produce the anomaly. Based on the results of variations in the magnitude of the gravity anomaly obtained, the results obtained are in very good agreement with the geological conditions of the study area.

Keywords: gravity method, geothermal, rantau dedap

Abstrak. Penelitian ini mengindentifikasi nilai anomali gayaberat menggunakan metode gravitasi pada wilayah sebaran Geotermal daerah Rantau Dedap, data anomali diperoleh dari satelit TOPEX. Objek penelitian ini berada pada koordinat 103.275º- 103.6917º BT dan 3.9052º-4.2876º LS. Data anomali udara bebas dan topografi yang diperoleh sebanyak 625 titik data beserta data topografi. Penelitian ini bertujuan sebagai pendukung penelitian terdahulu dengan metode yang berbeda dan bertujuan sebagai pendukung data penelitian yang terutama dalam bidang eksplorasi geofisika dalam melihat struktur geologi bawah permukaan wilayah ini berdasarkan variasi nilai anomali gravitasi. Simple Bouguer Anomaly (SBA) yang diperoleh berada pada rentang -37.2827 mGal hingga 34.4800 mGal. Untuk nilai Complete Bouguer Anomaly (CBA) yaitu -37.0843 mGal hingga 34.6802 mGal. Nilai estimasi yang diperoleh ini tidak terlalu berbeda jauh dengan nilai Simple Bouguer Anomaly sehingga menghasilkan pola kontur yang sama. Sedangkan Anomaly Regional yang diperoleh bernilai -36.8 mGal hingga 39.7 mGal dan rentang nilai Anomaly Residual yaitu -16.1 mGal hingga 9.2 mGal. Pada peta anomali residual terlihat bahwa nilai anomali positif dan negatif, hal ini dipengaruhi beberapa hal seperti kerapatan batuan, posisi dan ukuran batuan yang menghasilkan anomali tersebut. Data variasi anomali gravitasi yang diperoleh sangat sesuai dengan kondisi geologi wilayah penelitian.

Kata kunci: metode gravitasi, geothermal, rantau dedap

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1. Introduction

One of the geophysical exploration methods used to measure variations in the Earth's gravitational field due to differences in mass density between rocks beneath the surface and differences in topography on the Earth's surface and produce variations in gravitational anomaly values is the gravity method [1]. The study area is in the Rantau Dedap Geothermal Field, which is one of the geothermal prospect areas on the island of Sumatra. The Rantau Dedap Geothermal Field is located in South Sumatra Province, about 225 km southwest of Palembang City. According to study conducted by [2] This area contains active faults which cause active deformation related to the movement of the fault, causing the formation of fractures and disruption of local stress. Previous study conducted by Artyanto showed that in this area there are many fractures composed of layers of rock that channel fluid to every well in the Rantau Dedap Geothermal Field [2].

This makes this area have very unique rock lithology and subsurface structures, such as the geothermal fields in this area. In general, the study location is in a volcanic area which is composed of the Hulusimpang Formation, Posumah Formation and Volcanic Breccia Rocks [3]. So this area is very interesting to study variations in gravity anomaly values as a reference for researchers in the field of geophysics for geophysical exploration and mitigation purposes.

In this study, the author identifies subsurface geological structures and variations in gravity anomaly values using the gravity anomaly method. Variations in the value of the gravitational field are caused by the location of extreme points on the earth's surface which is caused by the shape of the earth not being perfectly round and the relief of the earth being different. By applying the gravity method, gravitational anomaly values can be determined which can provide an overview of the geometric structure beneath the earth's surface [4]. The gravity method is used because this method is able to describe subsurface geological conditions based on variations in gravity values caused by differences in rock density and is able to describe 3D modeling of deeper subsurface geological structures compared to other methods [5]. Gravity and topography anomaly data in this study were obtained from TOPEX data [6]. This study will be carried out to obtain variations in Regional Anomalies and Residual Anomalies which will be separated using the Gaussian method. Separation of regional and residual anomalies is carried out using methods such as Gaussian in his study, the Gaussian method is carried out using the Gaussian kernel matrix distribution at Oasis Montaj [7].

Regional anomalies are gravitational anomalies that are related to and caused by anomalous sources that are at great depths and have large sizes [8], while residual anomalies are associated anomaly sources and are caused by anomaly sources at shallow depths which are usually small in size [9]. This study aims to support existing study data, especially in the field of geophysical exploration, in looking at the subsurface geological structure of this region based on variations in gravity anomaly values.

2. Research Methods

This study uses TOPEX satellite gravity anomaly data. In this study, the area that is the object of research is the Rantau Dedap Geothermal distribution area, South Sumatra, which is at coordinates 103.275º- 103.6917º East Longitude and 3.9052º- 4.2876º South Latitude. Free air and topographic anomaly data obtained were 625 data points along with topographic data. To obtain the Bouger Correction (BC) value, it is necessary to estimate the average density value which can be obtained from the Parasnis method, which can be calculated using equation 1 where BC is the Bouguer Correction (mGal), ρ is the rock density (gram /cm^3), and h is the height (m) [10].

$$BC = 0{,}04193\rho h \quad (1)$$

Simple Bouguer Anomaly (SBA) is obtained from processing Free Air Anomalies (FAA) with Bouguer Correction

$$(BC).SBA=FAA-BC \quad (2)$$

Figure 1. Study area map

2.1 Terrain Correction

Before making corrections, the first thing to do is convert the coordinates from the satellite image gravity anomaly data. The coordinates obtained from satellite images are latitude and longitude in degrees which need to be converted to UTM (Easting X, Northing Y) format. This coordinate conversion uses Surfer software. Terrain correction calculations were carried out using Global Mapper and Oasis Montaj software. Global Mapper software plays a role in processing DEM (Digital Elevation Modeling) maps into grids for regional and residual anomalous areas. After the grid is obtained, terrain correction calculations are then carried out using Oasis Montaj software [11].

2.2 Complete Bouguer Anomaly (CBA)

Complete Bouguer Anomaly (CBA) is obtained after the Bouguer Correction (BC) is searched first, as for the mathematical equation to find the CBA value, namely [12]:

$$ABL= SBA-TC \quad (3)$$

2.3 Separation of Regional Anomaly and Residual Anomaly

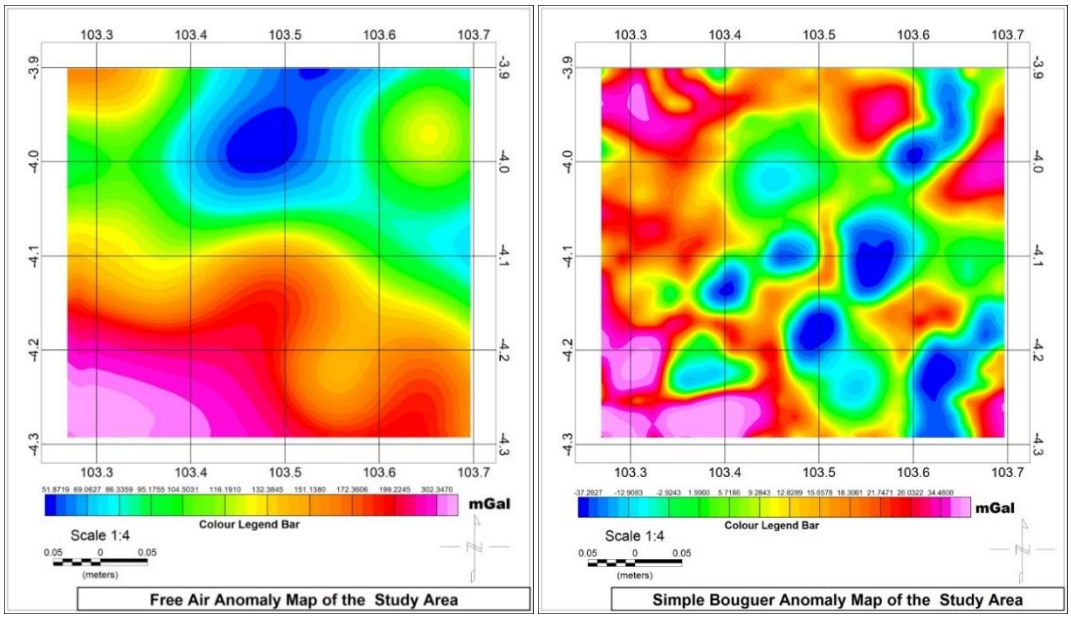
All anomalies in this study will be observed from both shallow and deep areas, therefore it is necessary to separate regional anomalies and residual anomalies using Gesoft Oasis Montaj software, this separation uses the Gaussian method. Separation of regional and residual anomalies is carried out using the Gaussian method. The Gaussian method is carried out using the Gaussian kernel matrix distribution in Oasis Montaj. Gaussian Elimination converts linear equations into matrix form, then converts them into Row Echelon form via Basic Row Operations. After that, the matrix form is solved by back

substitution. Gaussian elimination comes from mathematical operations on matrix rows that are continued until one variable remains [13].

3. Results and Discussion

3.1 Free Air Anomaly (FAA)

This free air anomaly is a free air anomaly in which the measured gravity anomaly is used to calculate the height of the research area. Based on research results based on TOPEX data, the FAA estimated value was 51.8719 mGal to 302.3470 mGal.



(a) (b)

Figure 2. (a) Free air anomaly of the study area, (b) *Simple bouguer anomaly* (SBA) map of the study area

3.2 Simple Bouguer Anomaly (SBA)

In this study the simple Bouguer anomaly (SBA) was obtained from the results of Free Air Anomaly (FAA) and Bouguer Correction (BC) data processing.

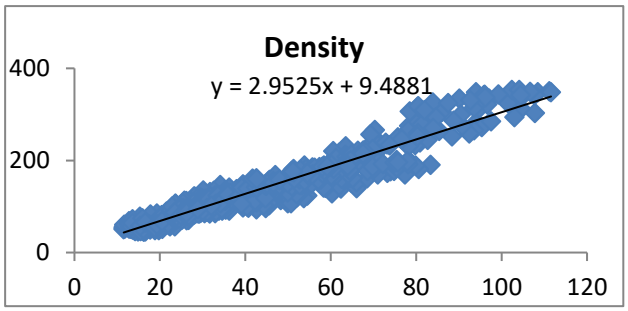


Figure 3. Parasnis method graph

To obtain the Bouguer Correction (BC) value, an average density estimation value is needed which can be obtained from the Parasnis method. Based on the results of

processing using the parasnis method, an estimated average value of rock density in the study area was 2.9525 g/cm3. The average density obtained is very high so that based on the geological map and the estimated average density value obtained, this area is dominated by sedimentary rocks with a high density, namely breccia.

This estimated density value is adjusted to the rock density table available (10) and (14). The average density estimation value obtained is used to calculate the Bouguer Correction (BC) which will be used to calculate the Simple Bouguer Anomaly (SBA) value. The distribution of Simple Bouguer Anomaly (SBA) values obtained in the Kepahiang Regency area is shown in Figure 2b.

Based on modeling and the results obtained, the range of Simple Bouguer Anomaly (SBA) values in this area ranges from -37.2827 mGal to 34.4800 mGal. High Simple Bouguer Anomaly (SBA) values are marked with orange to whitish pink, while low Bouguer anomaly values are marked with light blue to dark blue. If the value of the Simple Bouguer Anomaly (SBA) is higher, it indicates that the rock below the surface is dense which is influenced by variations in the density of the rock below the surface.

3.3 Complete Bouguer Anomaly (CBA)

After getting the Simple Bouguer Anomaly value and getting the Terrain Correction value from the processing results in Global Mapper and Oasis Montaj, then you can get a variation of the Complete Bouguer Anomaly (CBA) value. The Complete Bouguer Anomaly Value obtained is shown in Figure 5. Based on CBA, the variation in values obtained was -37.0843 mGal to 34.6802 mGal. The estimated value obtained is not much different from the Simple Bouguer Anomaly value, resulting in the same contour pattern. High Complete Bouguer Anomaly (CBA) values are marked with orange to whitish pink, while low CBA values are marked with light blue to dark blue.

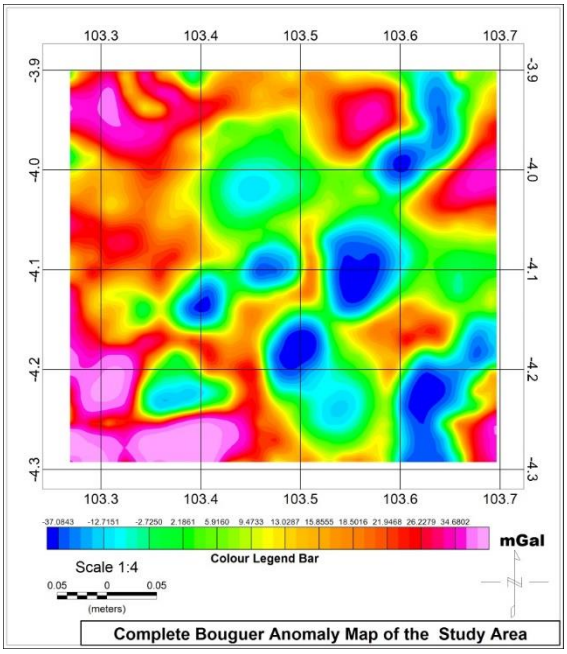
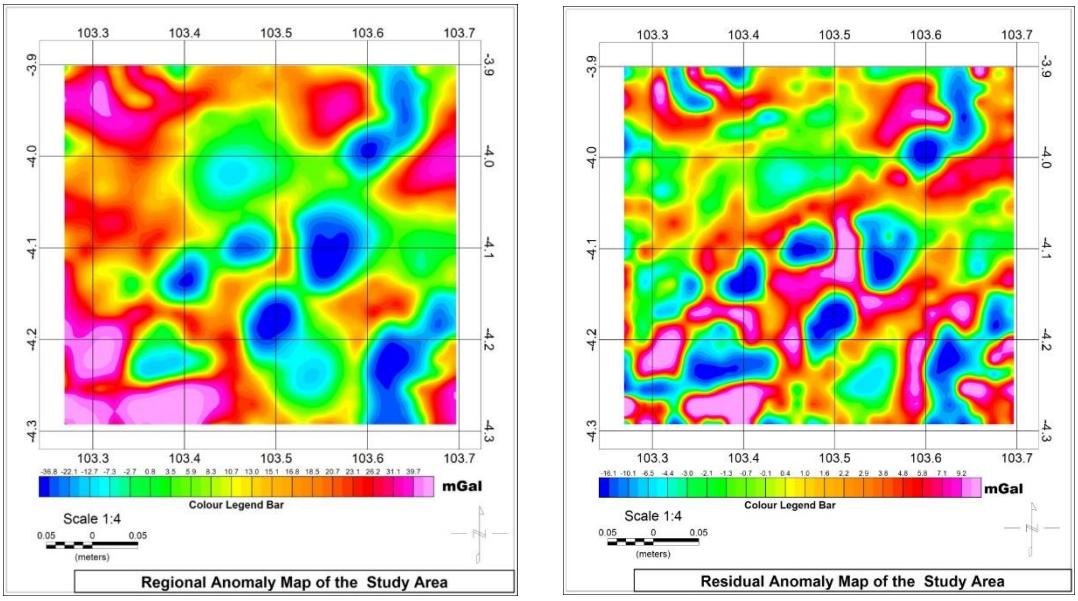


Figure 4. *Complete bouguer anomaly* (SBA) map of the study area

3.4 Separation of Regional and Residual Anomalies

3.4.1 Regional Anomaly

Regional anomaly are anomalies that originate very deep in the surface such as the earth's crust and the earth's gravitational field. In obtaining the distribution of regional anomalies, it is necessary to carry out a filtering process to separate regional anomalies and residual anomalies. The filter used in the separation of this study is the Gaussian method carried out on Oasis Montaj. Based on the regional anomaly values obtained, the estimated regional anomaly values obtained are in the range -36.8 mGal to 39.7 mGal. High regional anomalies are marked with orange to whitish pink, while low CBA values are marked with light blue to dark blue.



(a) (b)

Figure 5. (a) *Regional anomaly* map of the study area, (b) *Residuals anomaly* map of the study area

3.4.2 Residuals Anomaly

Residual anomaly are anomalies that are local and originate shallower than regional anomalies. Residual anomalies describe shallow subsurface structural conditions such as faults, depressions and rock outcrops. The residual anomaly is obtained from the reduction of the simple Bouguer anomaly with regional anomalies. The residual anomalies obtained were in the range of -16.1 mGal to 9.2 mGal. On the residual anomaly map, positive and negative anomaly values can be seen. This is influenced by several things such as rock density, position and size of the rocks that produce the anomaly.

4. Conclusions

Based on the study results, it can be concluded that the Simple Bouguer Anomaly (SBA) value in the Rantau Dedap Geothermal distribution area, South Sumatra Province is in the range of -37.2827 mGal to 34.4800 mGal. The Complete Bouguer Anomaly (CBA) value is -37.0843 mGal to 34.6802 mGal. The estimated value obtained is not much different from the Simple Bouguer Anomaly value, resulting in the same contour pattern. Meanwhile, the Regional Anomaly obtained has a value of -36.8 mGal to 39.7 mGal and

a range of Residual Anomaly values of -16.1 mGal to 9.2 mGal. On the remaining anomaly map, positive and negative anomaly values can be seen. This is influenced by several things such as rock density, position and size of the rocks that produce the anomaly. Based on the results of variations in the magnitude of the gravity anomaly obtained, results were obtained which were in very good agreement with the geological conditions of the study area.

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