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Submission date: 07-Mar-2023 02:30PM (UTC+0700)

Submission ID: 2031042297

File name: of_magnetic_data_to_enhance_fault_interpretation_of_Jabungan.pdf (888.35K)

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Character count: 10232

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To cite this article: A S Hidayah *et al* 2020 *J. Phys.: Conf. Ser.* **1524** 012143



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The use of magnetic data to enhance fault interpretation of Jabungan area, South Semarang

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Abstract. Geophysical survey at the Jabungan area (South Semarang) has been done by using magnetic method. The aim of the research is looking for the existence of fault structure at the study area and apply the moving average analysis to separate of regional-residual anomaly based on the RTP magnetic total anomaly algorithm. The results shows of the residual anomaly map. According to 3D model, it's can be obtained the existence of fault. It has 0.0222 cgs to 0.0293 cgs of magnetic anomaly, and could be interpreted as Northwest-Southeast lineament of faults. The model also shows the existence of clay, volcanic braccia, gravel, stone, tuff, sand, and sandstone in the study area.

1. Introduction

The magnetic method can influence a better characteristics result of subsurface structure[1]. We interested to conduct a fault characterization in Jabungan Area, Central java, Indonesia. There is a preliminary study of the study area that has been conducted using gravity data[2]. It was stated that in the Jabungan area there are zones prone to landslides. Based on the geological map of the Semarang sheet, there were two faults [3]. The method used in this study is magnetic methods. Data processing in the separation of regional-residual anomalies in magnetic methods generally uses the upward continuation method. In the upward continuation method, the determination of the value used in the separation uses the trial end error value by looking at the trend of the contour pattern of the continuation where the value used in the separation cannot be too high, if the value used is too high the observed anomaly will disappear in the process of separation. Implementation of multi-altitude influence some advantages and limitation[4]. The upward method used of the moving average could not applied for high anomaly value, it would implicate for the unnecessary result of the anomaly[5]. The separation of regional anomalies with a residual anomaly, in determining the moving average filtering value using collateral the results of spectrum analysis, the excess of moving average is compared with upward in determining the filtering value[6]. The data while moving averages use spectrum analysis data, the results of the moving average are more precise than upward. The study area used as the basis for research on its geological condition.

The general geological picture of the study area has several rock formations as well as the presence of faults at the study site. The research area formation is divided into four formations, namely Alluvium (Qa) formation, hoist formation (Tmk), Kaligetas formation (Qphg), and Kalibeng (Tmptk) formation. Alluvium Formation (Qa) is a coastal plain, river, and lake. The coastal plain generally consists of clay and sand reaching a depth of 50 meters or more. Sand deposits generally form delta deposits as 80 meters thick water carriers. Sungai deposits and lakes consist of gravel, sand, sand, and silt 1 to 3 meters thick. The layer is composed of andesite, limestone and a little sandstone. The Kerek (Tmk) formation is



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claystone, Nepal, tuff sandstone, claystone, old light gray, mollusk, and coral colonies. The conglomerate thin layer is found in clay stones at Kripik river and in sandstone, limestone is generally layered, crystalline and has a total thickness of more than 400 meters. The age of this unit is the middle Miocene. Kaligetas formation (Qphg) is volcanic breccia rock, lava flow, tuff, tuffaceous sandstone and clay rock, flow bract and lava with lava inserts and fine to coarse tuffs. A place in the bottom is found with clay stones containing mollusks and tuffaceous sandstones. Volcanic rocks that decay are reddish-brown and often form large chunks. Thickness ranges from 50 meters to 200 meters. The Kalibeng Formation (TmPk) is a formation consisting of Nepal solid at the top of a carbonized area, Nepal with tuff sandstones and 3 to 200 centimeters of middle striped limestone nodules. According to the fossils which were observed at the field showed that the ancient Pliocene (zones 16-21). The geological map of the Magelang-Semarang sheet in central Java, there are two faults will be the object of research, this reinforces the basis of research to be able to examine the existence of information on the geological map. Fault that looks close to one another. The field survey process of one fault is visible, but the fault below is not visible from the surface. The fault located at the top is seen bordering the Kalibeng Formation (TmPk) with the Kerek (Tmk) Formation while the second fault is seen below the first fault, there is a formation that is passed through the Kerek (Tmk) Formation. Fig. 1 shows the geological map of the research area, which is separated to be four types of formation.

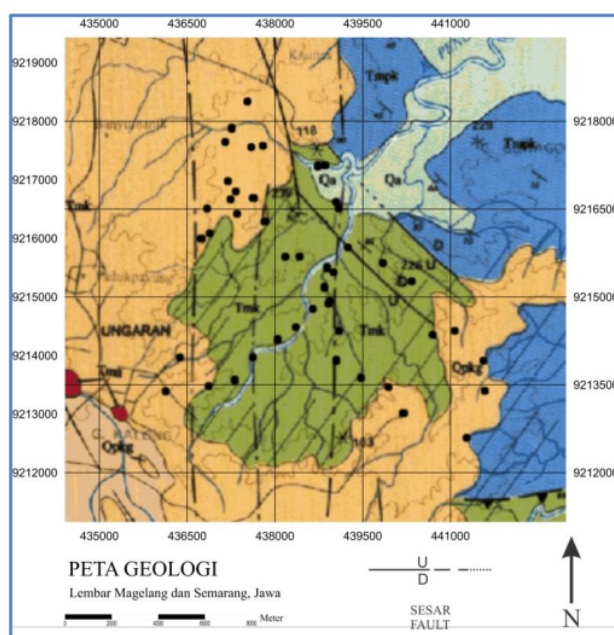


Figure 1. Geological map of the study area[3]

2. Methods

We collected magnetic data at Jabungan area, South Semarang, Central Java. The selected area covered of about 6 km x 6.5 km which is separated to be 59 stations and 1 selected area as a base. The magnetometer type GSM-19T as a main equipment and supported by portable GPS as a mapping tools. The diurnal correction was applied as a standard procedure for the data observation data by IGRF[7]. Another correction also used to eliminate the influence of solar radiation and changes in magnetic field anomalies over a 24-hours. The IGRF correction of the earth's main total magnetic field obtained from measurements in the research area with predetermined references updated every 5 years. The results of daily correction and IGRF was a total anomaly map. Reduction to the cover of surface has been done to

eliminate the nature of the dipole (two-pole) into monopole (one cap) after the reduction to the next level is taken spectrum analysis. Moving average method is a functions that can be used in the separation of regional and residual anomalies. In moving average process need a window size for calculate regional anomaly. The residual anomaly was a result of magnetik total subtracted with regional anomaly. To determine the window size can be use spectrum analysis method. The spectral analysis should be carried out by Fourier transformations.

3. Results and discussion

The magnetic field anomalies is the result of measuring anomalies of the earth's magnetic field that corrected by several corrections. The corrections consist of daily variation and IGRF (International Geomagnetic Reference Field) corrections. The diurnal correction was be done to eliminate the influence of the external magnetic field within 24 hours and the effect of solar radiation, while IGRF correction functions to eliminate the value of the total earth magnetic field in the study area. The results of magnetic field anomalies that are still dipole can be seen in fig. 2. The response of the value of the high field anomaly has a value of 247.4468 nT to 484.5979 nT, while the response value for the low anomaly ranges from -57.2363 nT to -236.9390 nT.

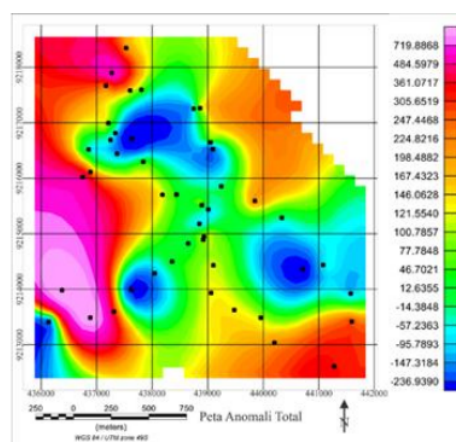


Figure 2 The magnetic total anomaly

Reduction to pole is used for filtration of total magnetic field anomalies that still have dipole properties. Polar reduction filtering will make the total anomalous map monopole (as shown fig 3), so it will make anomalous objects above the source of the anomaly.

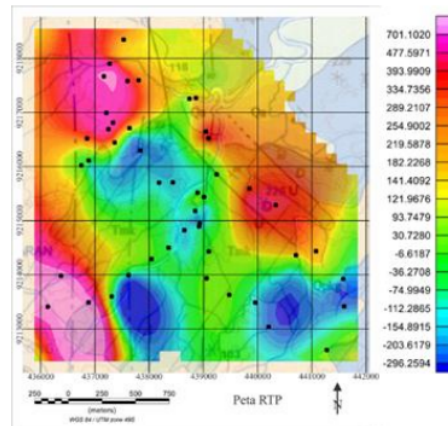


Figure 3. A total anomaly map that has been reduced to the pole.

The RTP result is high anomalies range from 309.4052 nT to 567.8634 nT. The further process is regional-residual separation.

Spectrum analysis is used to determine the depth estimation of shallow anomalies (residuals) and in (regional) anomalies and to find out the width of the window. Through the spectrum analysis equation, a cutoff value and window value will be obtained in the separation of regional maps with residual maps. The spectrum analysis result is a number window ($n \times m$), that was used in a moving average process. A number on n is 7 and m is 7, so the matrix used is 7×7 . The smaller the value from the window, the modeling data that will be obtained will be finer. The more chirping the window will be directly proportional to the error value. The process of separating magnetic field anomalies using Moving Average with a window width of 7 where the matrix used 7×7 as a low pass filtering moving average. The results of the separation can be seen in fig. 4

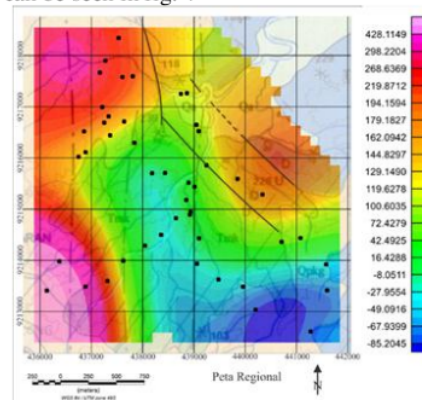


Figure 4 Regional map overlay with stations

Separation using a moving average produces a residual map with a high anomaly value of 268,6369 cgs marked with a color response in the form of pink while for low anomalies -85,2045 cgs the intended color response is dark blue. The results of the separation of the moving average look smooth on the regional map. If the window results obtained from the spectrum analysis are smaller, the results will be even more optimal. The smaller the noise will be directly proportional to the value of the window.

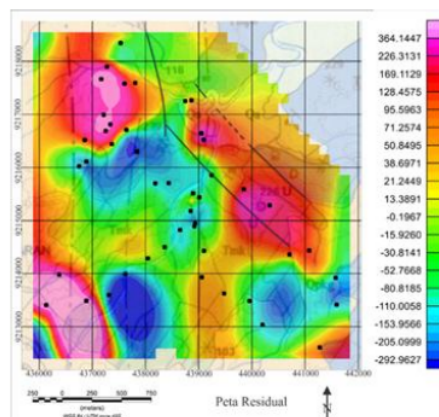


Figure 5 Residual map overlay with stations

Figure 5 shows the residual anomaly map with the moving average calculation results obtained from the residual anomaly having a high value of 565.7525 cgs with a pink color response. High-value anomalies are dominantly dominant in the periphery area of the study area. Anomaly with a low value of -292.9627 cgs, the response color is dark blue. The dominant low-value spread is in the middle area of the study. The results shown by line b are faults located above or north.

4. Conclusions

The residual map shows that the fault structure coincide well to the geological map, those are on the paralel orientation of Northwest to Southeast. We can interperate some of litologys such as sandstone, with a low susceptibility value of -0.0293 cgs whereas for structures with high anomalies there are structures of tufan sandstones, there are volcanic breccia and limestone with a susceptibility value of 0.0222 cgs at the northern part of the study area. The anomalies of local magnetic fields show volcanic tufan and breccia which are characterized by high susceptibility values of 0.0120 to 0.0222 cgs.

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