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The Comparison for Separation of Regional-Residual Anomaly Using Moving Average and Upward Continuation Method; Case Study of Merapi Vulcanos's Gravity Data 1998

Sandy IndraPurwagandhi, Indah Islamiaty, Imam Suyanto

Geophysics Study Program, Physics Department, Universitas Gadjah Mada

sandy.indra.p@mail.ugm.ac.id

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ABSTRACT

A research has been conducted to separate regional-residual anomaly in Gravity method. This research is done to process Merapi Volcano data in 1998 using Moving Average and Upward Continuation method. The processing of data utilize computer program such as Matlab, Magpick and Surfer 11. The result from both methods are compared each other to identify the suitability of regional-residual anomaly shape. Regional anomaly map as the result of Moving Average method is in conformity with the result of regional anomaly map from Upward Continuation method on 5000 meters high. The separation of regional-residual anomaly using Moving Average method generates range of regional anomaly between 21,72 mGal to 105,33 mGal and range of residual anomaly between -96,7 mGal to 15,6 mGal. In the other side, the separation of regional-residual anomaly by using Upward Continuation method on 5000 meters high generates range of regional anomaly between 30,48 mGal to 94 mGal and range of residual anomaly between -101,9 mGal to 23,3 mGal.

INTRODUCTION

Geophysics is knowledge about earth with using the physical parameters. In this case, Geophysics target is subsurface of the earth. Gravity method has been an advantage for the beginning of the survey because it gives sufficient information about geology structure and rocks density contrast.

The aim of processing of gravity data is to find the anomalies that appeared in research field. Anomalies are target in this gravity method research and then the geology structure in subsurface will be interpreted. Anomaly is the result of density difference in subsurface of the earth between one with another rocks. A very well-known anomaly in the final result from the processing of gravity method is Bouguer anomaly. Bouguer anomaly is difference of acceleration of gravity value with the gravity normal value. Observation gravity is gravity value that read in gravitymeter followed by many corrections such as drift correction, tide correction and height of the tool. Gravity normal is combination from many corrections in gravity processing such as latitude correction, free air correction topography correction and terrain correction.

Bouguer anomaly is combination between regional anomaly and residual anomaly. Both of anomalies are overlapped each other so the anomalies must be separated. The regional-residual anomaly value can be used in interpreting the subsurface geological model. The methods to separate regional-residual anomalies are using moving average and upward continuation

BASIC THEORY

Moving average

One of the methods to separate regional-residual anomaly is moving average. The character of the process from this method is similar with process of low-pas-filter. Low frequency needs to be passed from anomaly bouguer so that regional anomaly can be seen. Whereas to obtain residual anomaly by subtracting total of bouguer anomaly with regional anomaly.

Moving average equation to obtain the width of window can be written as:

$$\Delta g_{reg}\left(\frac{N+1}{2}\right).\left(\frac{M+1}{2}\right)=\sum_{i=1}^{N}\sum_{j=1}^{M}\frac{\Delta g(i,j)}{\left(\frac{N+M}{2}\right)^2} \quad (1)$$

Then, residual anomaly can be obtained from this equation:

$$\Delta g_{res}(i,j)=\Delta g(i,j)-\Delta g_{reg}(i,j) \quad (2)$$

Upward continuation

Upward continuation is a process measuring at a lower elevation and then extrapolating upward, assuming continuity. This method is used because it can transform potential field at a lower elevation and how it will become in other elevation (above lower elevation). It tends to accentuating anomaly caused by deep source (regional effect) whilst eliminating or ignoring anomaly caused by shallow source (residual effect). The result from this method is regional anomaly. Residual anomaly is obtained by calculating difference from total of bouguer anomaly and regional anomaly [2]. Calculation of the value of potential field in every observation point on continuation field result (z) can be done by using the equation [3]:

$$z(x,y,z)=\frac{|z|}{2\pi}\int_{-\infty}^{\infty}\int_{-\infty}^{\infty}\frac{z(x',y',z')}{(|x-x'|^2+|y-y'|^2+|z-z'|^2)^3}dx'dy' \quad (3)$$

RESEARCH METHOD

Research in this paper is based on various studies on the data to produce a new relevant assessment. The research objective is comparing both methods' ability to separate regional-residual anomaly on gravity method. Data used in this paper is gravity survey in 1998 which has 394 measurement points scattered around the Mt. Merapi.

Separation regional-residual anomaly with moving average method is using equation [1]. In the equation, the value of regional anomaly will be calculated by averaging result from the total of bouguer anomaly. Regional anomaly in a particular research point is result from averaging bouguer anomaly around that point. After obtaining the regional anomaly, the value of residual anomaly can be calculated by

subtracting total of bouguer anomaly with regional anomaly in the same research point. Matlab is utilized to analyze spectrum which result of slicing bouguer anomaly map that have been transformed to obtain the width of window. The width of window is obtained from value of cut-off between regional gradient zone with residual gradient zone on the graphic k vs ln A (see fig.1). Regional and residual anomaly map is made by software Surfer 11.

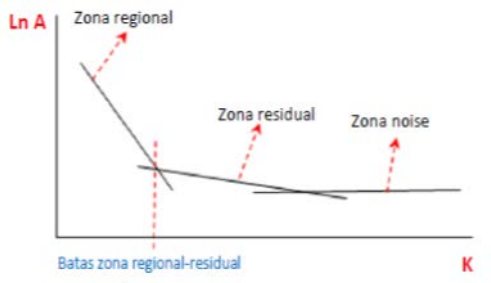

Figure (1). Graphic k vs ln A

Then result from all of this will be compared with result of regional-residual anomaly with comparison method. The comparison method used is Upward continuation by utilizing Magpick software.

DISCUSSION

In this research, the obtained total bouguer anomaly result which has been transformed with interval parameter between points is 125 m, depth of field equivalent is 3500 m, error tolerance is about 10-10, and iteration as much as 1000 times.

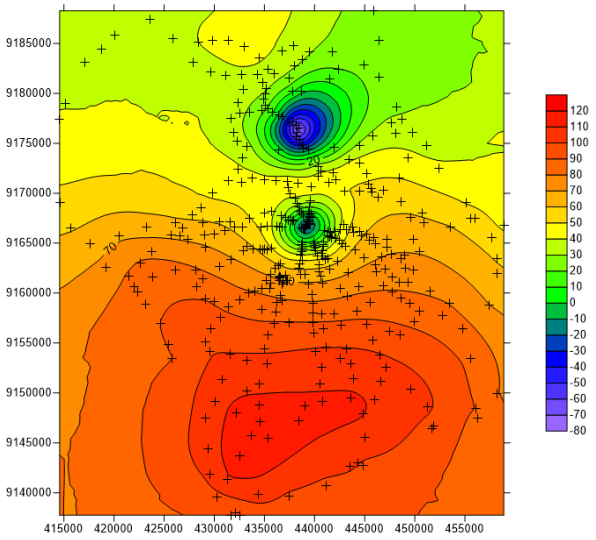

Fig (2).Transformed total of Bouguer anomaly map

Figure (2) shows the bouguer anomaly map of merapi volcano in 1998, has value ranging from -72.39 mGal (lowest) to 116.46 mGal (highest). Southern region tends to have positive anomaly value, whereas the value more negative focused on two closures in the northern region, which both are peak of Merapi volcano (bottom part of the map) and peak of Merbabu volcano (top part of the map).

The next step of processing is the separations of regional and residual anomaly. This research has compared two methods for the separation both of anomaly, which are upward continuation and moving average method. In the moving average method where spectrum analysis is used, gravity anomaly becomes frequency value, its real and imaginary number. Then, they are processed to get the wave number (k), and Ln A (Amplitude). The result of the spectrum analysis is used to obtain window length and the depth of anomaly boundaries by separating the trend of its regional and residual data (see Fig. 3).

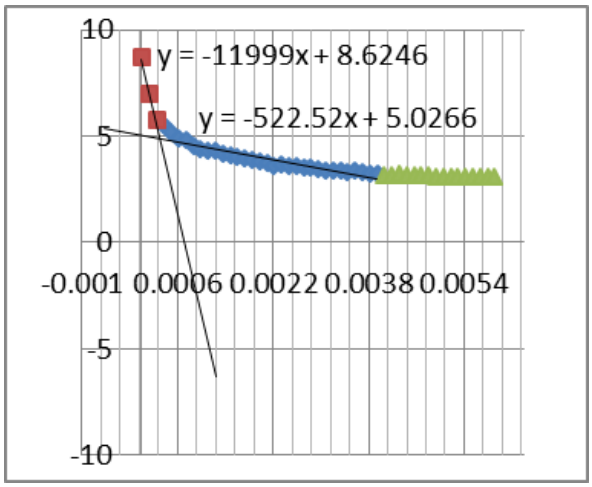

Fig (3). k vs ln A slice data of bouguer anomaly maps that have been transformed to separate the regional anomaly (orange), residual anomaly (blue) and noise (green)

Window length is used, both of vertical (N) and horizontal (M) trajectory, in this case is 35x33, where the window length is computed based on cut-off of the wave number value (k) from intersection of trend the regional and residual anomaly. The averages of upper boundaries limit for both regional and residual anomaly are 10665 m and 885 m.

Upward continuation is obtained by adding parameter of height until it reaches an altitude where regional anomaly is similar with the result from separation using moving average method. In this case, it varies from 4000 m, 5000 m to 6000 m.

Fig (4) shows the comparison of regional anomaly using moving average (fig 3.a) and upward continuations method (fig 3.b, 3.c, and 3.d). They show the similarity on the result of regional anomaly between moving average and upward continuation at height of 5000 m. The range of value of regional anomaly using moving average is from 21,72 mGal (lowest) to 105,33 mGal (highest). Whereas for upward continuation on height of 5000 m is from 30,48 mGal (lowest) to 94 mGal (highest).

Fig (5) shows the comparison of residual anomaly using moving average (Fig 5.a) and upward continuation (Fig 5.b, 5.c, and 5.d). They show that there is similarity on the result of residual anomaly between moving average and upward continuation at height of 5000 m. The range value of regional anomaly using moving average is from -96.7 mGal (lowest) to 15,6 mGal (highest). Whereas for upward continuation on height of 5000 m is from -101,9 mGal (lowest) to 23,3 mGal (highest).

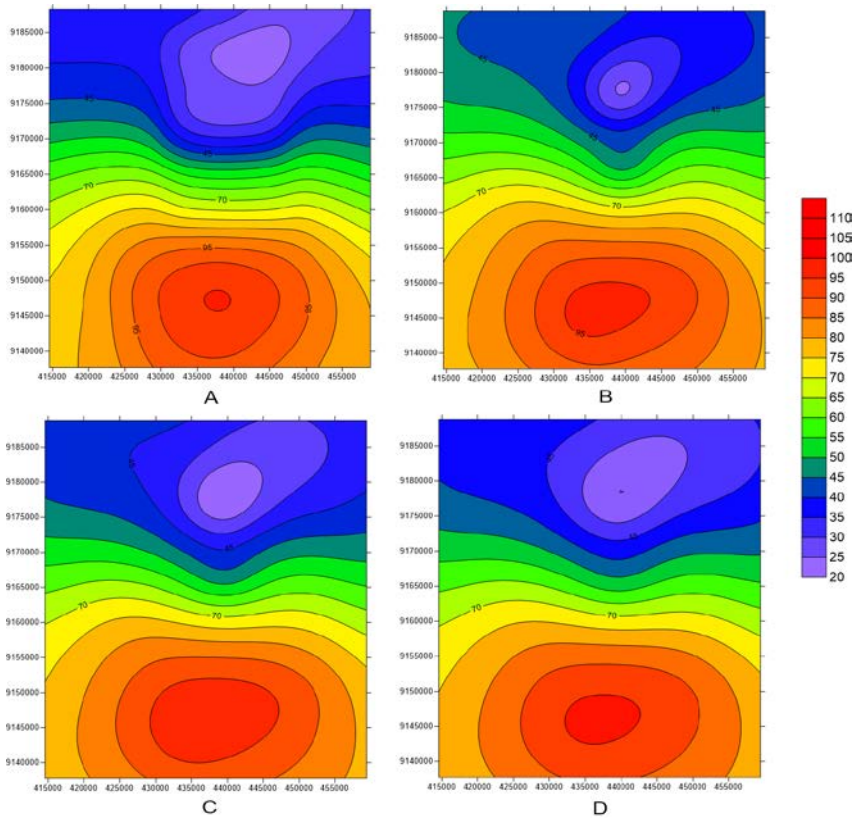

Fig (4). Anomaly regional maps : a) using moving average method, b) using upward continuation of 4000 m height, c) height 5000 m, and d) height 600 0m.

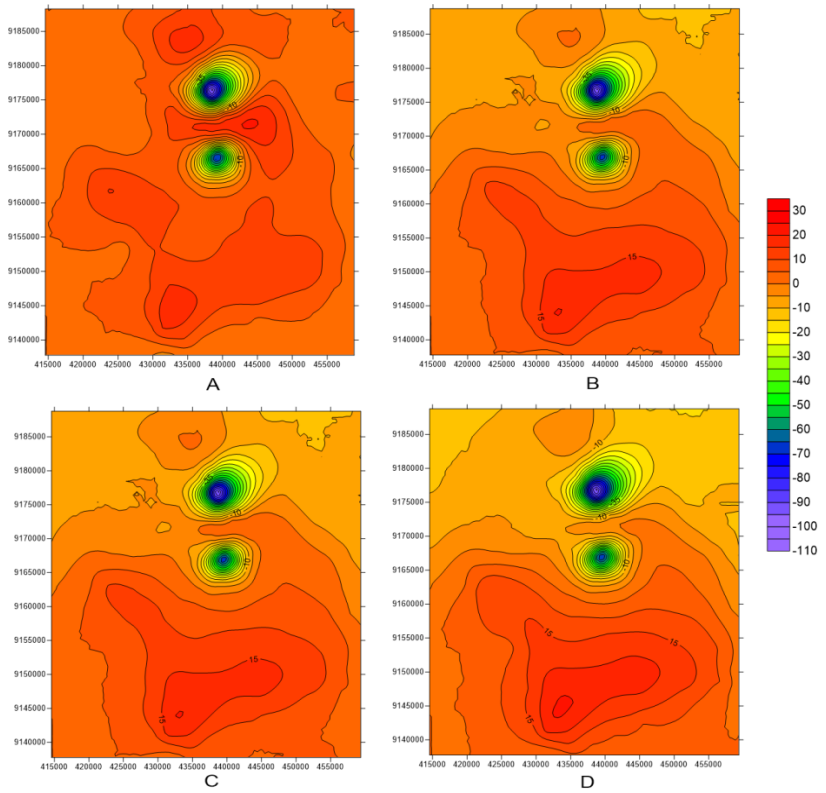

Fig (5). Anomaly residual maps : a) using moving average method, b) using upward continuation of 4000 m height, c) height 5000 m, and d) height 600 0m.

CONCLUSIONS

From the result of research that has been conducted on gravity data of Merapi volcano 1998 can be concluded as follows:

1. Range of bouguer anomaly that is transformed into flat surface has values from -72,39 mGal to 116,46 mGal.

2. The similarity between moving average and upward continuations at height of 5000 m can be showed by the maps.

3. The separation of regional and residual anomaly using moving average with 33 x 35 window length and the depth boundaries for regional anomaly is10.665 m and residual anomaly is 885 m, resulting the range regional anomaly value from 21,72 mGal to 105,33 mGal, whereas the range residual anomaly value is from -96,7 mGal to 15,6 mGal.

4. The separations of regional and residual anomaly using upward continuations at the height of 5000 m resulting range value from 30,48 mGal to 94 mGal for regional anomaly, and -101,9 mGal to 23,3 mGal for residual anomaly.

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