Comparison of Percentage Error in Depth Estimation of Magnetic Anomalies Due Dyke-like Bodies

Fitian R. Al-Rawi [1], and Sabbah J. D. Shejiri [2]

[1] Previously, Department of Geology, College of Science, University of Baghdad
[2] Al-Farabi University College

Abstract: The Percentage errors in depth estimation from magnetic anomalies due to dyke-like bodies, having various depths and inclination angles, are calculated. Two methods have been used to estimate the depth of these bodies and then their percentage errors in depth estimation are compared. These methods are the well-known slope-half slope method and the method adopting procedure through using Fraser filter. The two methods have accompanied various percent errors in depth estimation for models having various magnetic parameters. The comparison between the calculated error values obtained from the two methods show that the differences between the maximum and minimum percent error with various inclination angles and depths are smaller for depths estimated by using Fraser filter procedure. Such results highlight the lesser mistakes that can be achieved if the procedure of depth estimation using Fraser filter is considered and in addition, the ease of the application of this procedure compared with slope method.
Keywords: Depth Estimation, Magnetic Anomalies.

1. Introduction

The depth to magnetic source is a piece of important information in geological/ geophysical interpretation of subsurface structures. Much was written on the variety and relative merits of methods for estimating the depth to the source of magnetic anomaly [1]. Several empirical and analytical methods have been developed to estimate magnetic source depth in most cases, depth may be estimated by visual inspection, several rules of thumb, measured gradient techniques and various computer-oriented procedures [2].

A given magnetic anomaly could have an infinite number of possible sources and source depths. The subject of depth estimation for magnetic sources has been discussed by Li and with a discussion to the output of these methods was giving [3]. The depth estimates derived from any of the Techniques described in the literatures are seldom accurate less than 10% of the actual Depths and sometimes as poor as 50% [4]. By theory, most of the estimates are maximum estimate, so that the real source will actually be at a shallow depth [5]. Showed that the percentage errors for dyke-like bodies are low at inclination angle around 45 degrees and increased towards the equator and the pole up to 30% by using slope-half slope method.

The accuracy of depth estimation by the various published procedures is always calculated by comparing the actual depth to the estimated one for models of known parameters. The subject of percent error and how to reduce its values and the range of errors in depth estimation is so important that allow the interpreter to be more confidence about his results. Although the published procedures are so many and everyone tries to highlight the advantages of their method, the subject of percent error in depth estimation is still engage the mind of worker in this field.

The well-known and still used in geophysical books is the slope-half slope method [2], depends on the horizontal distance between two parallel lines that pass through the maximum and minimum of an anomaly and they have a slope equal to one half the maximum horizontal gradient of the anomaly. When this distance multiplied by a factor gives the depth to the top of the magnetic source. Percent error values are reduced by adopting a new scheme to estimate the depth of the same sources of magnetic anomalies through using Fraser filter [6]. The amplitude at two-third of maximum anomaly of the residual filtered data ensue from applying Fraser filter defined the depth to the top of the magnetic source, or a straight line obtained by plotting filtered data at various levels of amplitude against distances between these levels will define at two third maximum amplitude the depth to magnetic source. This procedure was developed via derivation of an equation from the relation between the various levels of amplitude of the filtered profile against distances that can be used to determine the depth of magnetic sources which make the estimation easier and quicker [7].

The present paper exhibits the comparison between the percent errors ensue from applying the two methods above. This will highlight the important of the new procedure and presented a way to reduce and improve the percentage errors in depth estimation of magnetic sources.

2. Percent Errors Calculation

The procedure followed to calculate the percentage error is through using models of thick dykes having various depths and different inclination angles. Calculation of magnetic anomalies due to these models is based on a ready computer program issued by Geophysical Software Solution Pty Ltd-P dyke. Magnetic profiles due to these dykes are shown in Fig. (1). Then, depth estimation is carried out by using the well-known slope-half slope method and the procedure adopted Fraser filter to magnetic profiles [7]. Then, the estimated depths are compared with the actual depth values of the dyke-like sources. The percentage errors in depth values for the various models are calculated from the results of the two methods for the purposes of comparison.

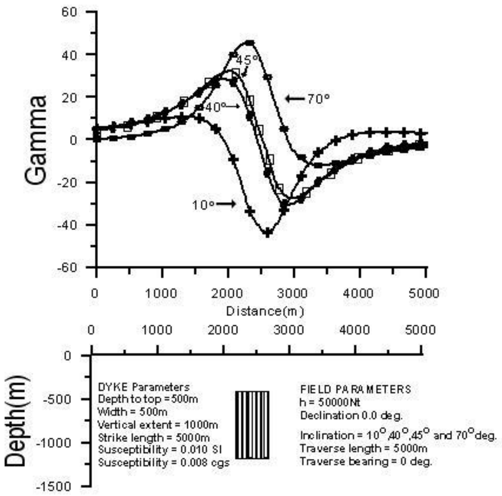

Fig. (1): Example of total magnetic intensity profile dyke-like

In order to exhibit the various percent error values and highlight the differences, ensue by applying the two methods mentioned above on models of various parameters, the calculated values are plotted as (a) Percent errors against various inclination angles of the magnetic field for models having the same depths Fig. (2). (b) Percent errors against various depths for models having the same inclination angle Fig. (3).

For case (a), the percent error values in depth estimation calculated from the two methods show the increasing values towards the equator and the pole. Although the two methods have positive and negative percentage errors, the ranges between the maximum and minimum values are smaller and very accepted when Fraser filter is used in depth estimation. The small range has an Advantage upon Peter's method because it will be reducing the errors on predicted depth values of magnetic sources. In the second case (b), the characters of the percent error histograms illustrate the differences between the two methods with the likelihood of Fraser. The variation of percent values for dykes having the same inclination angle with various depths exhibited good results in depth estimate-ion by applying Fraser filter compared to slope-half slope method.

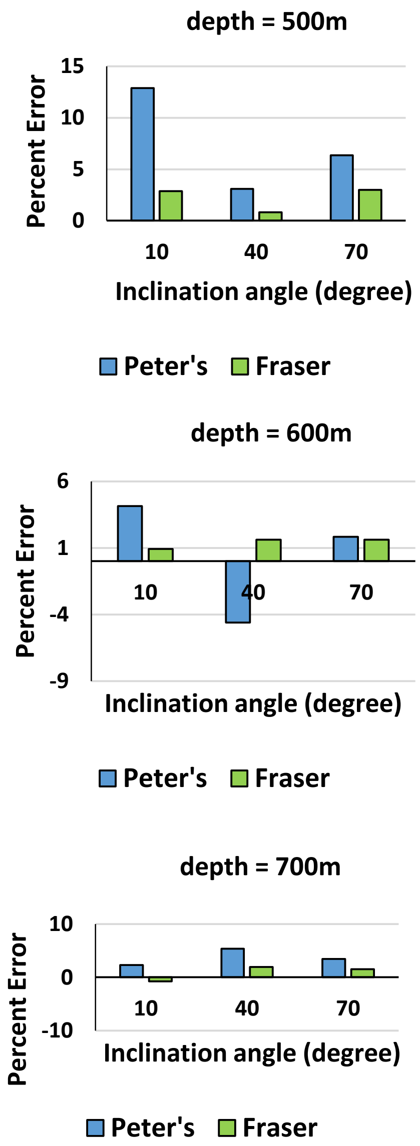

Fig. (2): Comparison of the calculated percent error values by applying slope half slope method (Peter's method) and Fraser filter method against various inclination angles for dyke-like body with the same depth.

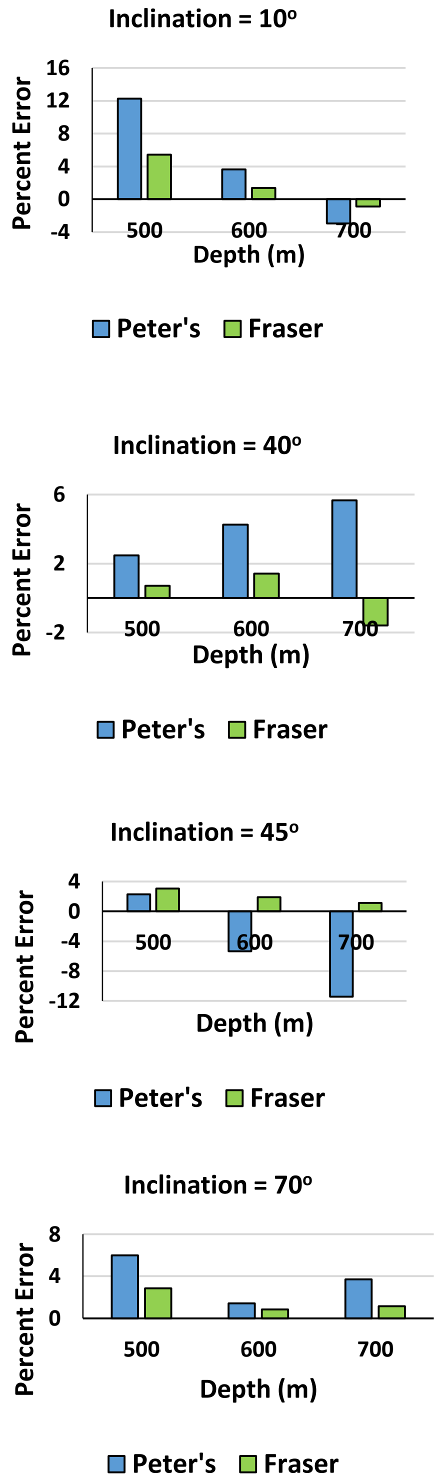

Fig. (3): Comparison of the calculated percent error values by applying slope half slope method (Peter's method) and Fraser filter method against various depths for dyke-like body with the same inclination.

4. Conclusion

The low ranges between the maximum and minimum values in percent errors for various models, and the error histogram obtained by adopting Fraser filter highlight the advantage of the new scheme in depth estimation. Such reduction in percentage errors in depth estimation give the interpreter a confidence on his results and can be used for further steps of interpretation. However, Fraser filter procedure depends mostly in calculations of the residual magnetic profiles and therefore can be considered as half analytical and have empirical method. Such method does not accompany bias results as given by slope-half slope method where the selection of the best slope and tangential points at half-slope lines by the interpreter sometimes are not accurate and any slight deviation may create large error.

5. References

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