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Improvement of the accuracy of calculations in determination of the spatial location of buried geological structures by restricting the Euler-3D deconvolution depth estimation method using combination of Tilt angle derivatives

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Extended Abstract

Summary

Local phase filters such as vertical tilt derivative (TDR) and horizontal tilt derivative (TDX) are extensively used to interpret magnetic data. We use two combinations of these filters, namely TDR - TDX and TDR + TDX, to design a constraining mask that guides the Euler deconvolution moving data window. The TDR - TDX filter produces sharp peaks over the centers of the sources, while the TDR + TDX filter generates plateaus over them. Motivated by previous approaches that make use of Laplacian filter or analytic signal to constrain the Euler deconvolution window, we compute the solutions for windows centered at points that (1) have positive values of TDR - TDX and (2) are contained in the plateaus of TDR+ TDX. The use of both criteria improves the selection of source-related points while reducing the number of spurious ones. Our method is tested on synthetic anomalies due to dike-like sources, and also, on field data from an area in southeast of Iran. The experiments show that the use of a constraining mask based on combined tilt filters produces Euler solutions that are more contiguous and less sensitive to noise than the traditional methods.

Introduction

In this research work, we focus on estimating the depth of magnetic anomalies due to dikes. The dike model is useful for the analysis of magnetic data because, despite being a very specific application (Blakely,1996), it can be generalized to a range of significant two-dimensional geological structures (McGrath and Hood, 1970). For instance, the thin sheet and the contact models can be seen as limiting cases of the dike model, as demonstrated by Nelson (1988). In addition, quantitative methods based on dike models are important interpretation tools in mineral and hydrocarbon prospecting (McGrath and Hood, 1970) besides being essential in studies ahead of coal mining (Dentith and Mudge 2014).

Methodology and Approaches

In this study, an approach termed Tilt Euler deconvolution has been proposed. This method combines vertical (TDR) and horizontal (TDX) tilt derivatives (Miller and Singh 1994; Cooper and Cowan 2006) to design a mask that restricts the regions where the Euler deconvolution is computed. These regions are located around the peaks of TDR – TDX combined filter. Because it is not easy to distinguish source-related peaks from noise, we select only TDR - TDX points that fall within plateaus defined by another combination of filters, namely TDR + TDX. Using synthetic and field data, we demonstrate that our method is capable of selecting solutions that are clearly related to causative sources as well as capable of significantly decreasing the number of spurious solutions. The synthetic model has been used to assess the robustness of the Euler deconvolution algorithm against interference between sources as well as noise.

Results and Conclusions

Interpreting magnetic anomalies using Euler deconvolution demands handling a huge number of spurious solutions. Although post-processing procedure are traditionally used, our method is found to be capable of removing spurious solutions while preserving a significant number of physical solutions that makes the sources location easily recognized. We have improved the previously proposed techniques for Euler deconvolution using a combination of vertical (TDR)

and horizontal (TDX) tilt derivatives. Our method can better distinguish noise from true anomalies. The effectiveness of tilt Euler deconvolution is due to constraining solutions to the plateaus of TDR + TDX, and avoiding the need of data smoothing tools, such as the Henning convolution filter. Such an strategy to distinguish true maximal values of TDR - TDX from noise might be useful to other semi quantitative techniques.