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A derivative-based interpretation approach to estimating source parameters of simple 2D magnetic sources from Euler deconvolution, the analytic-signal method and analytical expressions of the anomalies

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ABSTRACT

The major advantage of using either the analytic-signal or the Euler-deconvolution technique is that we can determine magnetic-source locations and depths independently of the ambient earth magnetic parameters. In this study, we propose adopting a joint analysis of the analytic signal and Euler deconvolution to estimate the parameters of 2D magnetic sources. The results can avoid solution bias from an inappropriate magnetic datum level and can determine the horizontal locations, depths, structural types (indices), magnetization contrasts and/or structural dips. We have demonstrated the feasibility of the proposed method on 2D synthetic models, such as magnetic contacts (faults), thin dikes and cylinders. However, the method fails to solve the parameters of magnetic sources if there is severe interference between the anomalies of two adjacent magnetic sources.

INTRODUCTION

The analytic-signal and the Euler-deconvolution techniques have been widely used for estimating subsurface magnetic or gravity source parameters (e.g. Nabighian 1972, 1974, 1984; Thompson 1982; Reid *et al*. 1990; Roest *et al*. 1992; Hsu *et al*. 1996; Thurston and Smith 1997; Hsu *et al*. 1998; Smith *et al*. 1998; Fedi and Florio 2001; Salem and Ravat 2003; Williams *et al*. 2005; Smith and Salem 2005). The main advantage of using these two techniques is that we can delineate geological boundaries and determine depths to sources without considering the ambient earth magnetic parameters. However, in the traditional Euler-deconvolution method, an a *priori* selected structural index is usually used to estimate the causative source position (Thompson 1982). The relationship between the structural index and the geometry of the causative body is shown in Table 1. Unfortunately, the geometric type of a subsurface magnetic source is also a parameter that a geologist or geophysicist would wish to determine. Moreover, the datum level of a magnetic anomaly usually involved in the traditional Euler-deconvolution method is difficult to determine unambiguously, which results in the dependence of the structural index on the datum level. An incorrect structural index causes spatially diffuse Euler solutions (Thompson 1982; Reid *et al*. 1990; Ravat 1996; Hsu 2002). Salem and Ravat (2003) proposed a combined method (AN-EUL), based on the Euler equation and the analytic signal. Their method is independent of datum level but it can only determine locations and geometry of the causative magnetic sources. Mushayandebvu *et al*. (2001) also proposed using both Euler-deconvolution and analytic-signal techniques to solve the magnetic parameters of 2D models, such as contact and thin-sheet sources. However, the results from their method are still affected by an uncertain datum level and they have to determine the structural type prior to the application of the technique. Hsu (2002) proposed a combined inversion for the structural index and the source locations from Euler's equation by using only the derivatives of the magnetic anomalies. On the basis of Hsu's (2002) method, we propose a joint analysis of the analytic-signal and Euler-deconvolution

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