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Imaging magnetic sources using Euler's equation

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ABSTRACT

The conventional Euler deconvolution method has the advantage of being independent of magnetization parameters in locating magnetic sources and estimating their corresponding depths. However, this method has the disadvantage that a suitable structural index must be chosen, which may cause spatial diffusion of the Euler solutions and bias in the estimation of depths to the magnetic sources. This problem becomes more serious when interfering anomalies exist. The interpretation of the Euler depth solutions is effectively related to the model adopted, and different models may have different structural indices. Therefore, I suggest a combined inversion for the structural index and the source location from the Euler deconvolution, by using only the derivatives of the magnetic anomalies. This approach considerably reduces the diffusion problem of the location and depth solutions. Consequently, by averaging the clustered solutions satisfying a given criterion for the solutions, we can image the depths and attributes (or types) of the causative magnetic sources. Magnetic anomalies acquired offshore northern Taiwan are used to test the applicability of the proposed method.

INTRODUCTION

Techniques using potential field derivatives to image subsurface magnetic or gravity source geometry, such as locations and depths, draw more and more attention. Among these, the analytic signal and Euler deconvolution techniques are widely used (e.g. Nabighian 1972, 1974, 1984; Atchuta Rao, Ram Babu and Sanker Narayan 1981; Thompson 1982; Sundararajan *et al.* 1985; Hansen, Pawlowski and Wang 1987; Reid *et al.* 1990; Roest, Verhoef and Pilkington 1992; MacLeod, Jones and Dai 1993; Marson and Klingele 1993; Hsu, Sibuet and Shyu 1996; Ravat 1996; Debeglia and Corpel 1997; Thurston and Smith 1997; Hsu, Coppens and Shyu 1998; Keating 1998; Smith *et al.* 1998; Barbosa, Silva and Medeiros 1999). The main advantage of using the two techniques is that identified locations and depths to the causative sources are independent of magnetization directions. To the author's knowledge, the analytic signal method has attained, to some extent, the ability of recognizing the source attributes of simple forms, such as thin sheet (or thin dike), contact and cylinder structures (e.g. Hsu *et al.* 1998; Smith *et al.* 1998). Barbosa *et al.* (1999) provided a means of estimating a structural index but this requires (probably manual) isolation of individual anomalies. Fully automatic Euler deconvolution still suffers from the critical problem of choosing an appropriate structural index to estimate the source parameters. Unfortunately, a poor choice of structural index can cause diffused solutions of source locations and serious bias in depth estimation. This problem becomes serious when the magnetic anomalies from two or more sources interfere; for example, when two structures having different structural indices are close to each other. In fact, interfering anomalies are more or less inevitable in real data.

The structural index is a measure of the rate of change with distance of a field (Reid *et al.* 1990). In other words, this parameter provides information on the geometry of a causative body (Table 1). Thus, we should estimate the structural indices when we estimate the locations and depths of the causative sources from a field anomaly, rather than giving a structural index prior to applying the Euler deconvolution.

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