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Simple Micro-Levelling for Aeromagnetic Data

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Abstract

A simple technique is described for removing residual levelling errors from aeromagnetic data. These residual errors have a distinct spectral signature and are easily removed from a grid of the data using existing directional grid-filtering methods. The filtered grid is then used to correct the located data. The method can not distinguish between levelling errors and real elongate anomalies parallel to the flight-line direction. It should therefore be used selectively.

Key words: airborne magnetic surveying, aeromagnetic surveys, aeromagnetic levelling, data processing, filtering, directional filtering.

Introduction

The conventional levelling of aeromagnetic data using cross-over ties is subject to errors due to magnetometer noise, poor flight path recovery, and inadequate diurnal and altitude corrections. Whilst these residual levelling errors are usually small, the application of image processing and display enhancements amplify their presence.

Several strategies could be employed to improve the levelling of tie-line levelled data.

— Pseudo-ties can be used to give additional tie-line control in magnetically quiet areas. These additional ties are generated by sampling the lines at each pseudo-tie intersection. The pseudo-ties are then low-pass filtered to remove levelling-related high frequency effects prior to their use as additional ties in the normal way.

— Statistically based methods can be used to improve the levelling by matching histograms, medians, or means between short sections of adjacent lines.

— Curve-matching methods can be applied to either short sections of adjacent lines, or to the differences between adjacent lines.

Each of these methods suggests possible solutions in particular circumstances. However, their implementation may be complex, and require a significant programming effort. This paper describes a simple and inexpensive technique for removing residual levelling errors from located aeromagnetic data. The method is not rigorous, but when selectively applied, can dramatically improve the quality of the data processing.

Levelling technique

The strategy is first to grid the data, then use existing directional grid-filtering methods to remove the levelling-related effects from the grid. Fuller (1967) describes the design of two-dimensional directional filters. These can be designed to pass or reject linear features of varying strikes. Urquhart (1988) describes a simple directional filtering method for grids where the elongate anomalies lie along one of the grid axes. What appears to have been overlooked, however, is that the filtered grids are then easily used to correct the located data.

I use a simple grid filtering technique similar to that proposed by Urquhart (1988). The spurious, elongate anomalies introduced by inadequate levelling have a distinct spectral signature. They are characterised by a wavelength in the flight-line direction greater than the tie-line spacing, and a wavelength perpendicular to the flight-line direction of precisely twice the flight-line spacing.

If one of the grid axes is parallel to the flight-line direction, then the spurious elongate anomalies can be removed from the grid by applying one-dimensional filters to the rows and columns of the grid as follows.

(a) Low pass filter the grid (grid A, say) in the flight-line direction and store the result in grid B.

(b) High pass filter grid B in the direction perpendicular to the flight-line direction and store the result in grid C. Grid C should now contain only the elongate anomalies we wish to remove.

(c) Subtract grid C from grid A to obtain the final grid with all elongate anomalies removed.

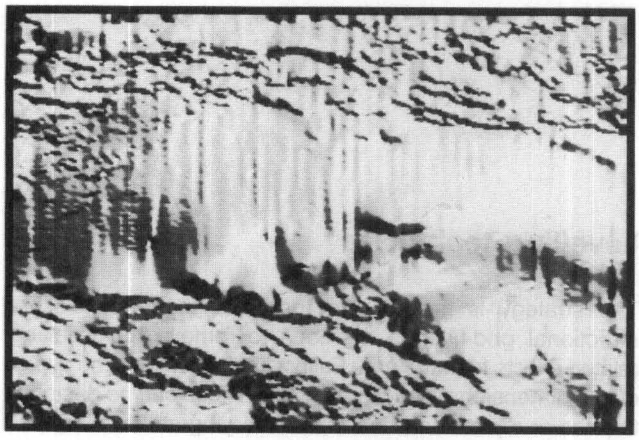
Alternatively, the following sequence of filtering operations would produce exactly the same result.

(a) High pass filter grid A in the direction perpendicular to the flight-line direction and store the result in grid B.

(b) Low pass filter grid B in the flight-line direction and store the result in grid C.

(c) Subtract grid C from grid A to obtain the final grid.

The filtered grid can then be used to correct the located data. For each value along a line, the grid is sampled at the nearest grid point and the difference between the two values is used to compile a correction string for each line. The correction strings are low-pass filtered to further restrict their frequency content prior to subtracting them from the located data.



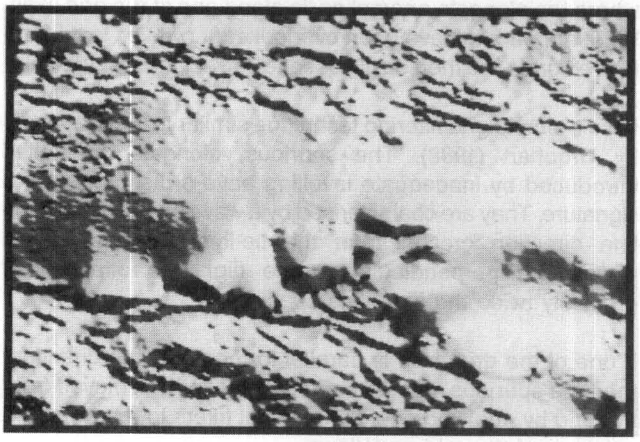


FIGURE 1a (top)
Hill-shade image (45° azimuth, 30° elevation) of the tie-lined levelled aeromagnetic data for the Mount Doreen 1:250,000 sheet area, Northern Territory.

FIGURE 1b (bot)
Hill-shade image (45° azimuth, 30° elevation) of the micro-levelled version of the data shown in Figure 1(a).

The application of the method to aeromagnetic data from the Mount Doreen 1:250,000 sheet area, Northern Territory, is shown in Figure 1. These data were acquired by the Bureau of Mineral Resources along N-S flight lines 1.5 km apart. Tie-lines were flown E-W at approximately 27 km spacing. Navigation and flight-path recovery was via aerial photography and tracking film over fairly featureless terraine. A combination of poor flight-path recovery and the large tie-line spacing has resulted in levelling errors of up to 5 nT in the data (Figure 1a). The levelling technique has substantially improved the quality of the data processing (Figure 1b).

Concluding remarks

The method can not be used to replace conventional tie-line levelling. The grid filtering technique requires that the residual errors have their wavelength restricted in the direction perpendicular to the flight-line direction. The data should thus be reasonably level prior to the application of the method. Tie-lines also introduce independant information into a levelling process based on observations. By contrast, this method is non-rigorous, and can not distinguish between levelling errors and real elongate anomalies parallel to the flight-line direction. It should therefore be used selectively. In my implementation, rectangular windows can be used to restrict the filtering and thus preserve real anomalies that would otherwise have been removed.

Acknowledgements

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