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Why Is High Resolution Aeromagnetic (HRAM) Data Better For Exploration Purposes Than The Magnetic Data Available From The GSC?

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ABSTRACT

Summary

The Western Canada Sedimentary Basin (WCSB) and the Williston Basin are both covered by many aeromagnetic surveys of many different resolutions. Almost the entire WCSB and the Canadian portion of the Williston Basin are covered by regional aeromagnetic surveys flown by the Geological Survey of Canada (the GSC data) and compiled into a regional grid, which is available free over the Internet. Much of the same prospective area is also covered by High Resolution AeroMagnetic (HRAM) data which are licensed on a multi-client basis by service companies or as trade data by oil and mining companies.

What is the difference between these two sources of data when it comes to solving exploration problems? The difference is resolution. The GSC data, in gridded form, does not have adequate frequency content to solve structural problems except on a very regional scale. HRAM data, on the other hand, can resolve faults in both the basement and the sedimentary section and allow one to map the depth to magnetic basement.

Introduction

For many explorationists the total magnetic field image from the GSC data and from the HRAM data appear to be nearly identical and therefore they believe that the end results of interpreting their prospects using either kind of data will be the same. However, those who have worked in detail with both the HRAM and the GSC data find a somewhat enormous difference between the two datasets, especially in term of their power to resolve subtle geological features in the sedimentary section.

This poster compares in detail the HRAM data with the GSC gridded aeromagnetic data, using data from North Eastern British Columbia (NEBC). The GCS data is a synthesis of many vintages of aeromagnetic surveys which have been merged together at the grid level. In general, these surveys are flown at relatively high altitudes (e.g. 300 m barometric above the highest topography in the area) without GPS navigation on relatively wide line spacings (typically 1 x 3 miles). The merged data have been gridded using a 2 km cell size. The newer GSC surveys, flown since 1992, have used GPS navigation and tighter line spacings, and often they have been flown at lower elevations. For the most part these newer surveys are in southern Alberta, southwest Saskatchewan, and in the Mackenzie Valley and Mackenzie Delta. The comparisons in this poster are not valid for these newer surveys, which are, in fact, HRAM surveys flown by the GSC, and available in line format at very low cost.

HRAM data refers to data flown at 800 m line spacing or closer, navigated with GPS, and generally flown close to the ground in drape mode (e.g., 100-150 m above topography, within aircraft safety limitations). Some HRAM data available for licensing has been edited to remove manmade cultural effects such as pipe lines and well heads.

NEBC Comparisons

For this comparison, an area in NEBC covered by both HRAM and GSC data was selected and analyzed in detail. The radial power spectra of the two data sets demonstrate that the GSC data is unable to resolve geological features located at shallow depths (i.e., depth < 3.0 km) whereas the HRAM data is able to resolve geological features located as shallow as 400 m (*Fig. 1*).

In order to illustrate this point further we have decomposed the total magnetic field grids into four band pass filters of varying wavelengths manifesting different geological depths. These are: 1.2 - 4.8 km (shallow depth), 3.0 - 6.0 km (medium depth), 4.8 - 9.6 km (deep) and 8.0 - 24 km (very deep, within the crust) (*Fig. 2*). Note that these filters are described by wavelengths in kilometres. For a very crude translation from wavelength to depth, divide by two. So a band pass of 3 – 6 km wavelength has most resolution in the range of 1.5 – 3 km depth, but signal from other depths will also be present.

Note that the GSC data becomes noisier and has less resolving power as we move towards the high-frequency low wavelength end of the spectrum (i.e., 1.2 - 4.8 km band pass filter). In contrast, the HRAM data maintains a coherent image quality and has resolving power along the entire spectrum. Statistical correlation coefficients between the HRAM and the GSC data calculated on the band pass filters show low correlation coefficients (r = 0.37-0.51) for the shallow-depth band pass (1.2 - 4.8 km) and high correlation coefficients (r = 0.95 -0.96) for the very deep band pass (8.0 - 24.0 km). These results indicate that the GSC data is good enough to map deep, regional geological structures associated with crystalline basement rocks (e.g., geological terranes) but, they are not good enough to map shallow subtle geological structures in the sedimentary basin. In contrast, the HRAM data has the frequency content to make mapping of subtle geological features in the sedimentary basin possible, as well the in the basement.

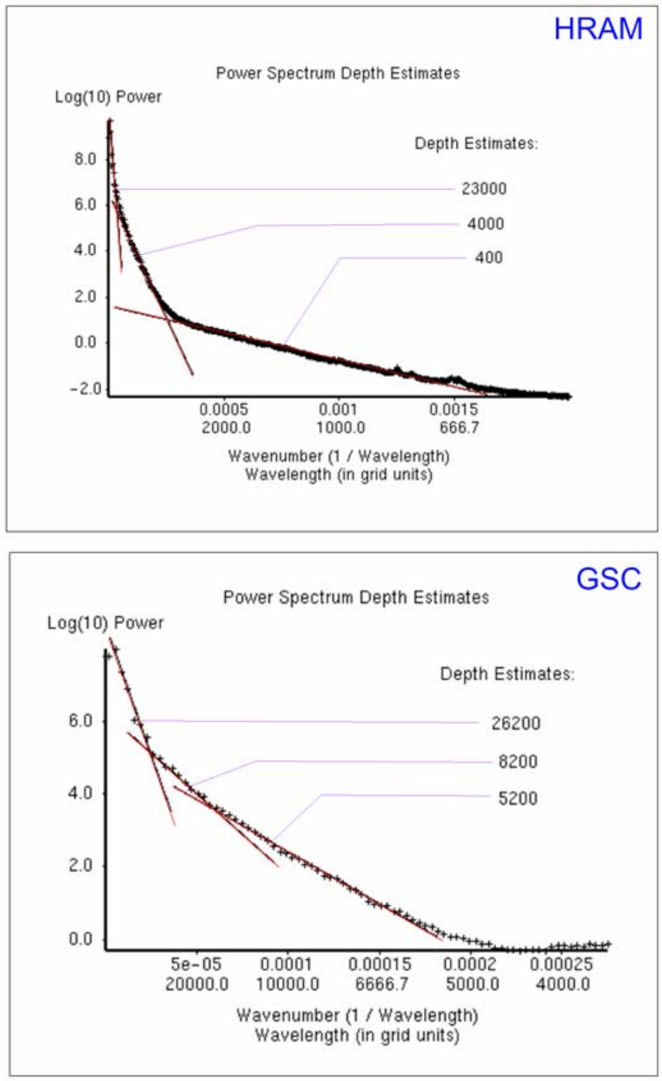

Figure 1. Radially averaged power spectra of the HRAM (top) and the GSC (bottom) data. Higher frequencies (shorter wavelengths) are to the right. The red segmented lines show the various assemblages of power in the data. The depth of each assemblage was calculated from the slope of each red line segment.

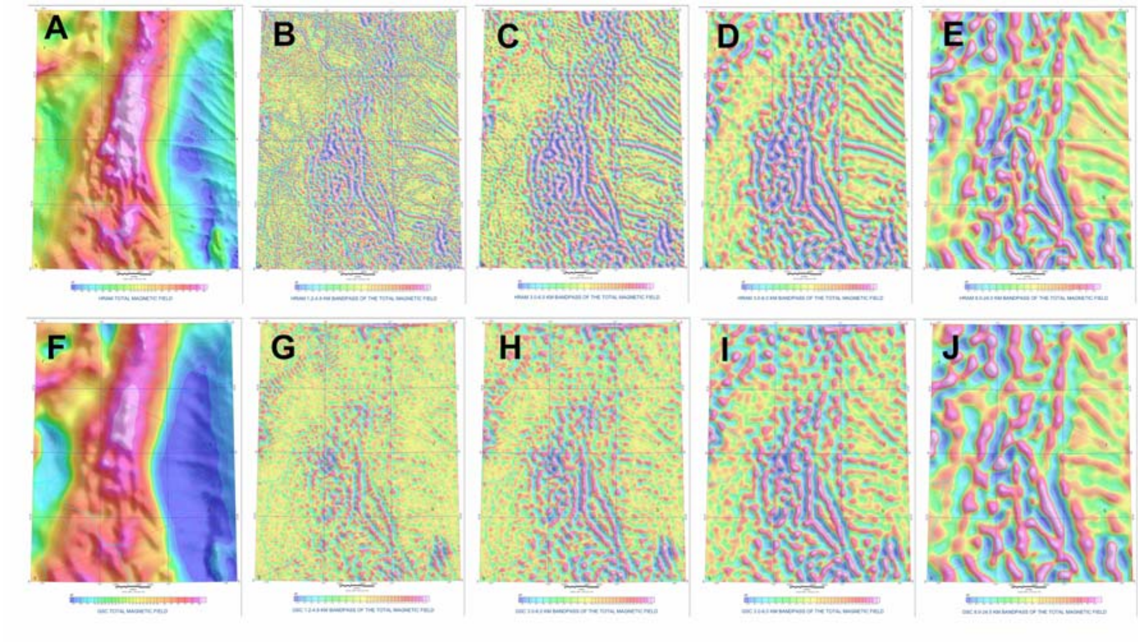

Figure 2. Comparison between HRAM data (top row) and the GSC data (bottom row) for northeastern British Columbia. A and F (total magnetic field), B and G (1.2 - 4.8 km band pass), C and H (3.0 - 6.0 km band pass), D and I (4.8 - 9.6 km band pass), E and J (8.0-24.0 km band pass).