MINERAL RESOURCES BRANCH

Processing and Enhancement of East Kemptville Airborne Magnetometer Survey

Open File Report ME 2006-1

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NOVA SCOTIA
Natural Resources

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Halifax, Nova Scotia
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Processing and Enhancement of East Kemptville Airborne Magnetometer Survey[1]

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[1]Contractor's report submitted to Geological Services Division, Nova Scotia Department of Natural Resources, PO Box 698, 1701 Hollis St., Halifax, NS B3J 2T9

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Introduction

Geological mapping and mineral exploration in the project area have relied on detailed geological knowledge and complete, map-scale information of a consistent resolution. This project was designed to improve the spatial consistency and increase the quality of the geoscience dataset in the Davis Lake - East Kemptville area.

The objective of re-processing data is to provide geoscientists with detailed (e.g. 1:10 000 scale) map products to assist in unravelling geological problems related to mapping and exploration. Existing data are re-processed to remove line and/or other errors common to airborne geophysical surveys, and are enhanced using advanced digital processing techniques to better define local structural and stratigraphic trends. The resulting images are produced in a high-resolution geo-referenced format for inclusion in the provincial digital GIS database where they can be easily distributed and/or compared to complementary data sets.

Background

The project area includes parts of five National Topographic Series (NTS) map sheets in southern Nova Scotia (Fig. 1) covered by the Davis Lake – East Kemptville Survey (Geological Survey of Canada, 1987).

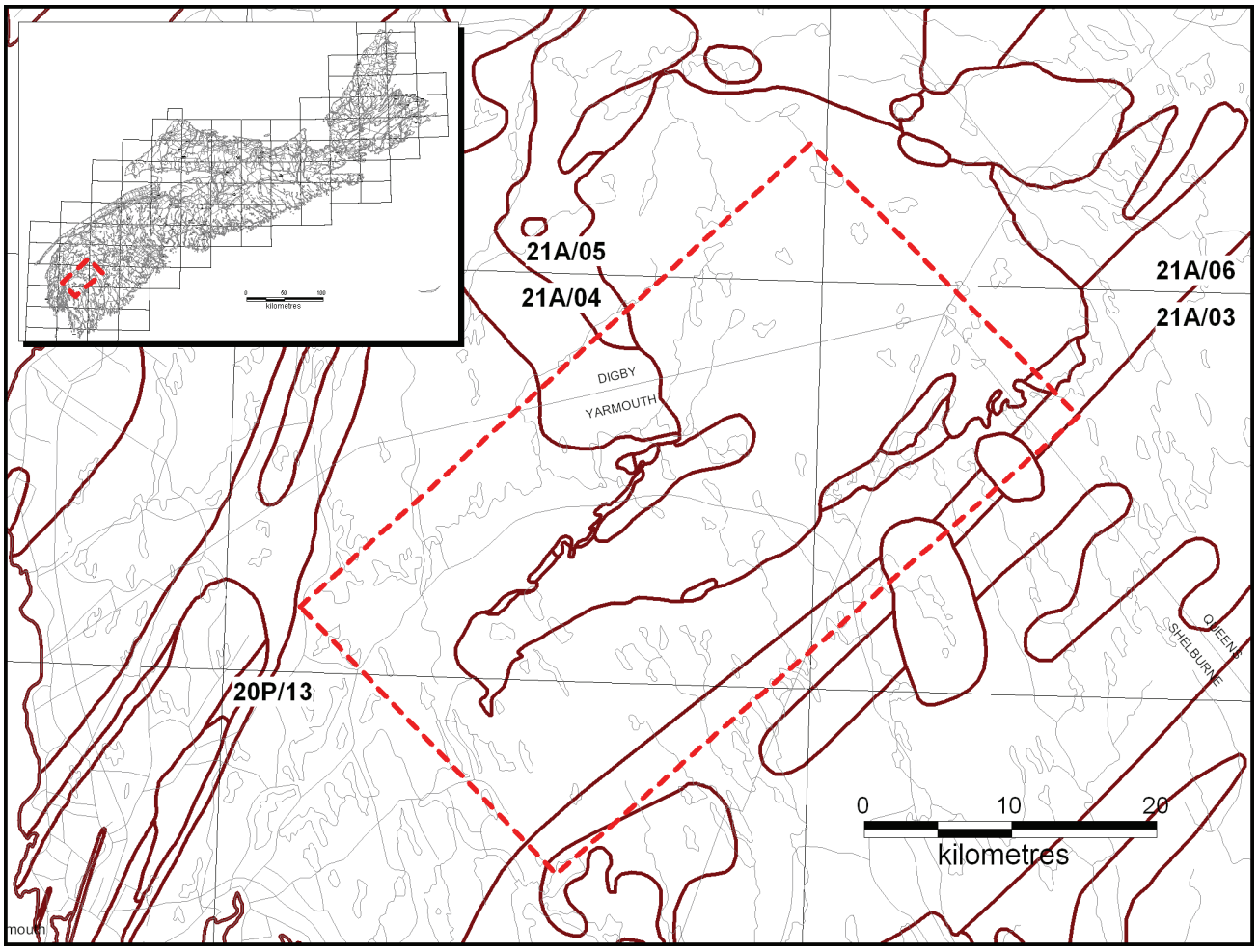

Figure 1. Davis Lake - East Kemptville Survey (red dashed line) location map including 1:50 000 NTS map boundaries and 1:250 000 planimetric base information. Provincial geology (brown lines) modified after Keppie (2000).

Magnetic map pattern data can provide detailed information regarding the location of igneous intrusions and the structure and stratigraphy in the Meguma Group, where well-developed linear magnetic anomalies can be used to decipher complex relationships (e.g. Horne and King, 2001; Horne *et al.,* 2001).

Data Description

High-resolution airborne geophysical survey data exist for the project area; the Radiation Geophysics Section of the Geological Survey of Canada, however, have also flown a more detailed radiometric survey, which included acquisition of magnetic data. The Davis Lake - East Kemptville survey data were acquired at a nominal altitude of 100 m on survey lines spaced 250 m apart (Geological Survey of Canada, 1987). Raw ASCII data were made available by the Radiation Geophysics Section - Geological Survey of Canada in the UTM NAD 27 coordinate system.

Data Processing

Pre-Processing (Grid Analysis)

Levelled magnetic total field data were initially gridded using a minimum curvature algorithm with limited internal tension to reduce overshoot (Fig. 2). Grid cell size was one-quarter of the nominal line spacing, resulting in a cell size of 65 m for the digitally acquired high-resolution Davis Lake – East Kemptville survey.

Processing (Error Analyses)

The Davis Lake – East Kemptville Survey raw total field data (Fig. 2) contain fairly significant levelling errors (linear line-parallel patterns) that data enhancement techniques will amplify to unacceptable levels. Therefore, a standard de-corrugation filter was applied to the data. This procedure (Table 1) necessitates quantifying the frequency and amplitude of the errors in order to design the appropriate filter. This filter is then used to generate a data subset (i.e. grid) consisting of error signals only, which is then removed from the raw data grid prior to enhancement.

Several steps shown in Table 1 are repeated to determine the optimum filter characteristics (e.g. frequency, orientation and width). In some cases filters are too strong or remove too much of the geological signal, resulting in overly smoothed data or similar artifacts with opposite polarity.

Post-Processing (Enhancement)

Enhanced map products derived from the de-corrugated total field grid include filtered first and second derivative maps. Enhancements were completed according to the procedures outlined in Table 1. First and second derivative data provide more spatial discrimination of causative bodies but may also amplify the relative effects of subtle noise and artifacts in the original data. These high-frequency features can be reduced in the enhanced derivative data in the same step as the derivative calculation itself by upward continuation. This process is completed in several steps to preserve as much of the original signal amplitude as possible. Data are first upward continued ¼ of a cell size (in metres) and the noise level is reviewed. This is revised incrementally in steps to ½ and ¾ cells up to 1 full cell (i.e. 65 m) if required. Filtered data are also monitored to ensure that they are not over-smoothed.

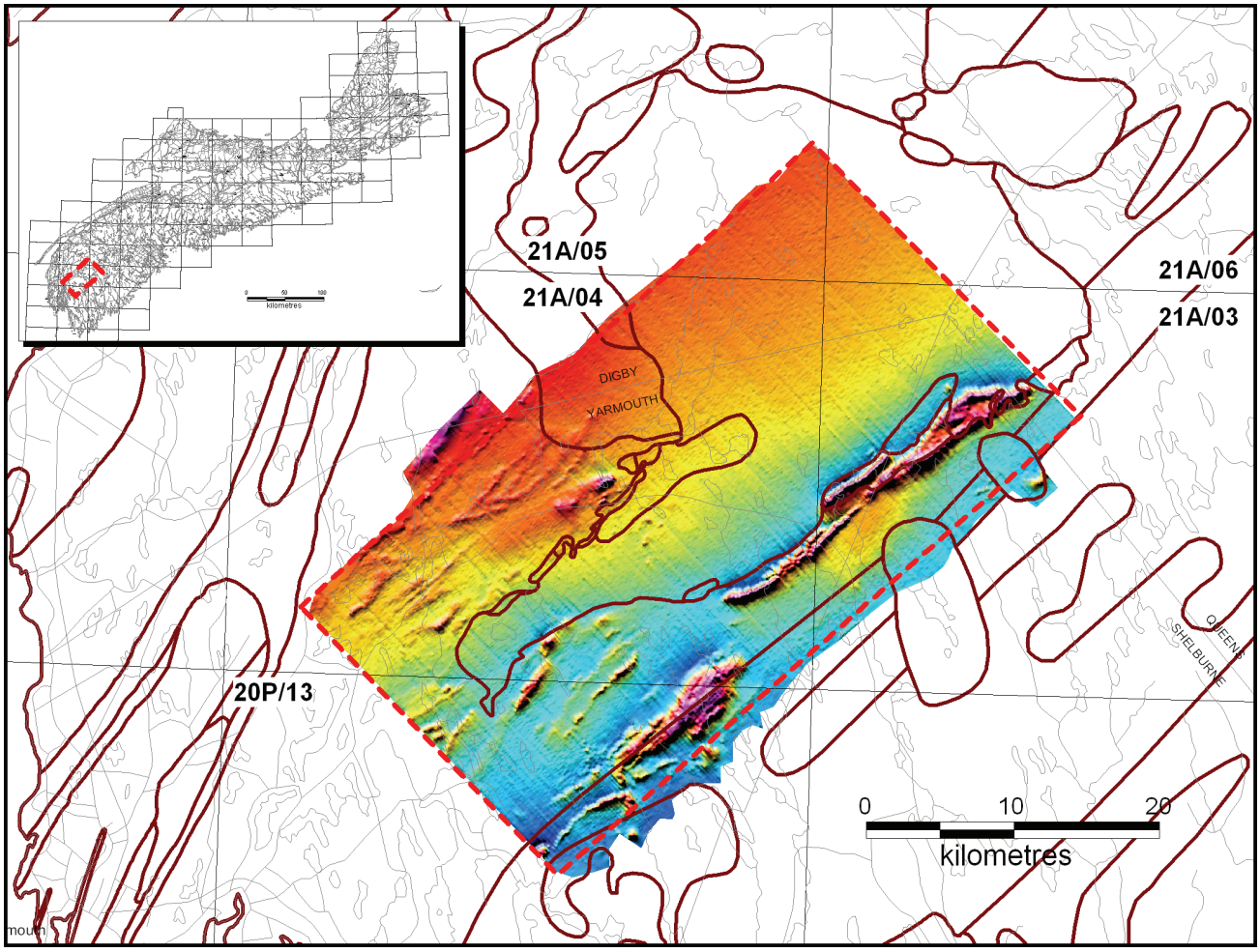

Figure 2. Raw, gridded, colour contoured/shaded relief magnetic total field data for the East Kemptville survey. Note linear pattern related to errors in flight line levelling.

Map Products

Colour contoured/shaded relief, geo-registered map images were produced for the de-corrugated total field, calculated first vertical derivative, and the second vertical derivative. Table 2 provides a list of the digital produces produced and submitted with this report.

Discussion

The enhanced magnetic data for the Davis Lake – East Kemptville survey provides increased spatial resolution and signal-to-noise ratio (SNR) over existing published geophysical data. Linear magnetic anomalies related to Meguma Group sedimentary rocks form systematic patterns related to kilometre-scale folding in the area. The granitic intrusions in the area show very little magnetic response; however, there are several locations where linear magnetic anomalies occur where granite bodies are mapped (e.g. Keppie, 2000). These areas may represent occurrences of rafts or pendants of Meguma Group rocks, or they may reflect *in situ* Meguma Group rocks not previously mapped.

Table 1. Template for processing (EA) and post-processing (EN) airborne magnetic data from the Davis Lake – East Kemptville survey.

Step	Procedure	Description
EA1	**Assess error character and amplitude**	Calculate second vertical derivative to enhance and isolate grid noise
EA2	**Generate 1st error grid (Line levelling artifacts)**	Apply combination directional and high pass filters
EA3	**De-corrugate grid Remove line error**	Subtract 1st error grid (EA2) from total field grid
EA4	**Determine error character and amplitude** **Adjust width and frequency**	Calculate second vertical derivative to assess de-corrugation efficacy Repeat (EA2 and EA3) process as necessary
EN1	**Assess error character and amplitude**	Calculate second vertical derivative to enhance and isolate other noise / culture
EN2	**Remove high frequency noise**	Upward continuation filter: Up 1 to X metres; where X is grid cell size
EN3	**Assess remaining signal**	Calculate second vertical derivative to assess smoothing effect Adjust upward continuation filter and repeat process as necessary

Numerous magnetic anomalies are truncated or appear to be locally interrupted along strike. Truncation of linear magnetic anomalies in the Meguma Group generally takes three forms:

(1) Sharp terminations adjacent to areas of low magnetic responses. These occur adjacent to plutons and may also indicate the presence of shallow unexposed intrusions.
(2) Local terminations conformable with regional folding patterns. These may reflect plunging non-cylindrical folds.
(3) Abrupt terminations and/or change in orientation. These are interpreted to represent oblique structures, which offset stratigraphy and occur in the northwest corner of the survey area (e.g. Kemptville Shear Zone, White *et al.,* 2001)

Careful interpretation of these new enhanced magnetic map images, in addition to radiometric data available for the same survey, should provide a valuable exploration and mapping tool for geoscientists and explorationists. Radiometric data provide enhanced spatial resolution and discrimination of granitic bodies, whereas magnetic data provide the most information in areas underlain by the Meguma Group.

References

Geological Survey of Canada, 1987: Davis Lake Complex, East Kemptville Area, Nova Scotia; Leve Geophysique Aerien, Complexe de Davis Lake, Region de East Kemptville, Nouvelle Ecosse; Geological Survey of Canada, Open File Report 1784, 16 maps.

Horne, R. J. and King, M. S. 2001: Geological map of Central Musquodoboit, Nova Scotia; presented at Mining Matters for Nova Scotia 2001, Opportunities for Economic Development, Halifax Nova Scotia, November 8-9, 2001. *(Poster)*

Horne, R. J., MacDonald, L. A. and King, M. S. 2001: Geological map of the Meguma Group in the

Table 2. List of digital map products associated with this report.

File Description	File Name	Grid Cell (m)	Image Cell (m)	Illumination	
				Az.	Incl.
Total Field	EK-DCM.tif	65	10	135	35
Registration File	EK-DCM.reg	n/a	n/a	n/a	35
De-corrugated	TFM-Cbar.jpg	n/a	n/a	n/a	35
First Vertical Mag	EK-1DM.tif	65	10	135	35
Registration File	EK-1DM.reg	n/a	N/a	n/a	35
1DM Colour Bar	1DM-Cbar.reg	n/a	N/a	n/a	35
Second Vertical	EK-2DM.tif	65	10	135	35
Registration File	EK-2DM.reg	n/a	n/a	n/a	35
2DM Colour Bar	2DM-Cbar.jpg	n/a	n/a	n/a	35
Report Text	EK-report.pdf	n/a	n/a	n/a	n/a
Raw Data	All_Data.xyz	n/a	n/a	n/a	n/a

Horne, R. J., MacDonald, L. A. and King, M. S. 2001: Geological map of the Meguma Group in the Rawdon area [part of 11E/04], Hants County, Nova Scotia; Nova Scotia Department of Natural Resources, Open File Map ME 2001-1, scale 1:50 000,.

Keppie, J. D. (compiler) 2000: Geological map of the Province of Nova Scotia; Nova Scotia Department of Natural Resources, Minerals and Energy Branch, Map ME 2000-1, scale 1:500 000.

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White, C. E., Horne, R. J., Tèniére, P. J., Jodrey, M. J. and King, M. S. 2001: Geology of the Meteghan River-Yarmouth area: a progress report on the southwest Nova Scotia Mapping Project; *in* Nova Scotia Department of Natural Resources, Mines and Energy Branch, Annual Report of Activities 2000, Report ME 2001-1, p. 95-111.

Statement of Qualifications

I, Mark Stephen King, residing at 6214 Regina Terrace, Halifax, Nova Scotia, do hereby certify that:

1. I am a registered professional Geoscientist, licensed to practice by the Association of Professional Engineers and Geoscientists of Newfoundland, Member # 3047.

2. In 1991 I received a Bachelor of Science degree (Geophysics) from Memorial University of Newfoundland in St. John's, Newfoundland.

3. In 2002 I received a Master of Science degree (Geology) from Acadia University in Wolfville, Nova Scotia.

4. I am an independent geoscientist and I have continuously provided professional consulting services for government and industry clients since 1992.

5. The conclusions drawn in this report are based on previously collected data from a variety of sources. These data are presumed to be accurate and correct; however, no liability can be assumed for any misrepresentations contained therein.

6. I am actively consulting on other projects with similar scope and purposes.

7. I have no interest, in matter or promise, in the foregoing projects as a result of the conclusions drawn or recommendations contained herein.

December 14, 2005

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