# A comparison between VTEM and HeliGEOTEM II with examples from data collected in early 2008

## Introduction

A comparison of survey data from the VTEM and HeliGEOTEM II systems over the McFaud's Lake area of the Superior Province in Canada is presented. Both VTEM and HeliGEOTEM II flew the same area, 220 line-km with the same line spacing 100 m, and the same north – south line direction.

## System configuration

**Table 1** shows the system configuration used for the survey.

| | VTEM | HeliGEOTEM II |
|---|---|---|
| Transmitter loop diameter | 26 m | 14 m |
| Peak dipole moment | 425,000 NIA | 550,000 NIA |
| Transmitter base frequency | 30 Hz | 90 Hz |
| Transmitter Pulse | Rectangular, 7.5 ms | Half-sine, 2 ms |
| Geometry | Symmetrical in-loop | Asymmetrical out-of-loop |
| EM transmitter loop terrain clearance | 30 m | 35 m |
| EM receiver terrain clearance | 30 m | 65 m |
| Receiver coils | Z-Axis | X,Y and Z-Axis |
| Windowed EM data sampling rate | 10 Hz | 4 Hz |
| Magnetometer terrain clearance | 60 m | 68 m |

**Table 1** – System configuration

The main advantages of VTEM are:

- ***Transmitter Current Pulse Shape and Length.*** VTEM uses a long rectangular waveform pulse as opposed to a short half-sine waveform pulse that HeliGEOTEM II uses. The VTEM waveform is more efficient for good conductors.
- ***Low Transmitter Base Frequency.*** VTEM uses 30 Hz base frequency while HeliGEOTEM II uses 90 Hz base frequency. The lower base frequency provides more late time gates, and, as a result, better depth of investigation and better conductor discrimination.
- ***Symmetrical In-Loop Geometry.*** The VTEM receiver is in the middle of the transmitter loop, while the HeliGEOTEM II receiver is located about 15 m in front and 30 m above the centre of the transmitter. The VTEM response over the same point does not depend on the flight direction, while the HeliGEOTEM II response varies with the line direction. Having a symmetric response allows for rapid and accurate conductor location and direct drilling from VTEM data without the use of ground geophysics to confirm the targets.
- ***Lower Terrain Clearance.*** The VTEM receiver and transmitter terrain clearance of 30 m has a definite advantage over the higher HeliGEOTEM II transmitter (35 m) and receiver (65 m) clearances. As a result, the secondary field from the conductors is stronger for VTEM then for HeliGEOTEM II, even with the slightly higher HeliGEOTEM II peak dipole moment.
- ***EM Sampling Rate.*** VTEM samples the EM data at 10 Hz or approximately every 2.5 m, while HeliGEOTEM II samples at 4 Hz or approximately every 6.3 m. The higher VTEM data sampling rate (EM data) together with the lower terrain clearance provides better special resolution of the conductors

The following comparison of actual data from VTEM and HeliGEOTEM II shows, that the VTEM system is superior both in finding anomalies which cannot be seen on the HeliGEOTEM II data and in defining the anomalies which can be seen on both data sets.

### *Data Comparison – Grids*

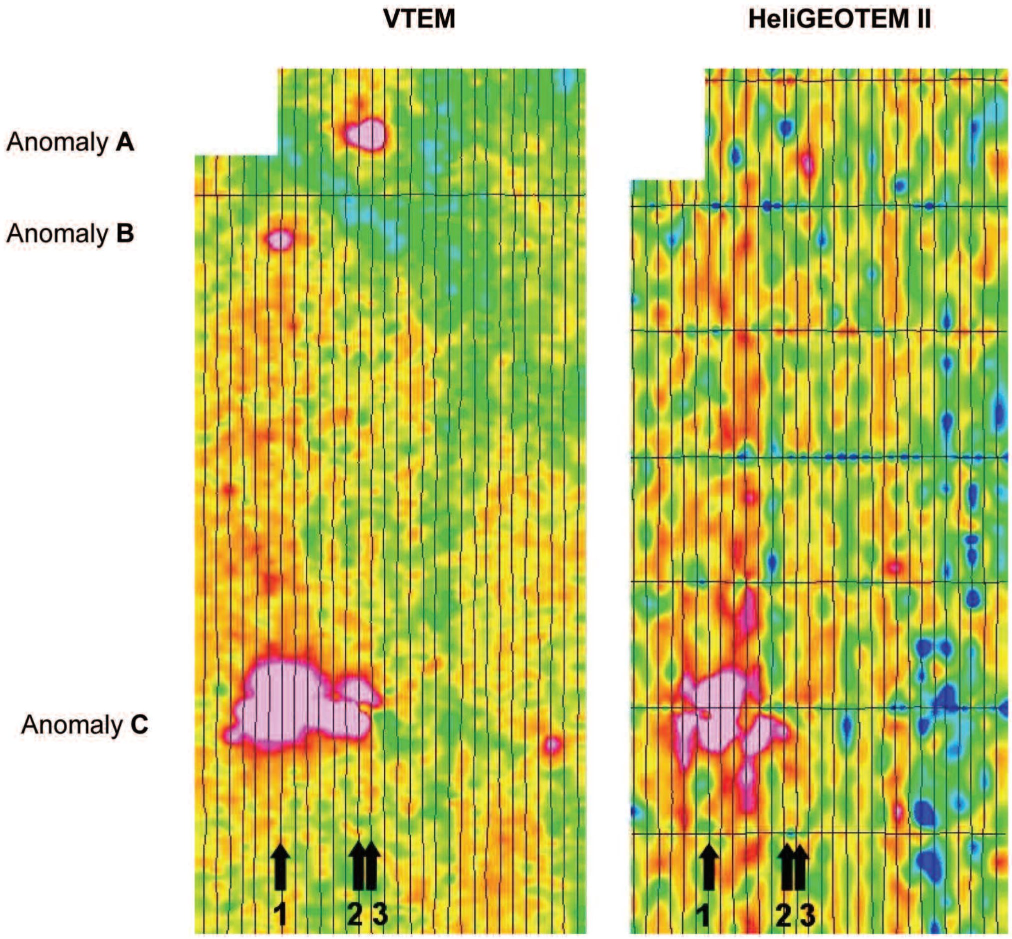


**Figure 2** – EM time gate grids, left - VTEM B-field channel 20 (0.682 milliseconds), right - HeliGEOTEM II Z component B-field channel 10 (0.652 milliseconds)

Figure 2 shows the gridded EM data of the two systems. The VTEM noise level is visibly lower resulting in the detection of two anomalies marked A and B, which are obscured by the HeliGEOTEM II noise on this channel. The anomaly A was detected on 4 lines and the anomaly B on 2 lines with VTEM. The anomaly C is detected with both systems, but it is much better defined by VTEM. This is illustrated in Figure 3 which shows the same grids as Figure 2, but zoomed in around Anomaly C and with colour-scaling adjusted to the viewed areas. On closer inspection of the VTEM grid, it becomes clear that there are in fact two conductors in close proximity. The interpreted conductor axes and dip directions are indicated on the grid in Figure 3. The dip angles can be inferred as near-vertical for the western conductor and shallow dipping for the eastern conductor. Although an anomaly in the same area is detected by HeliGEOTEM II, it is not nearly defined well enough to allow a similar interpretation as from the VTEM data.

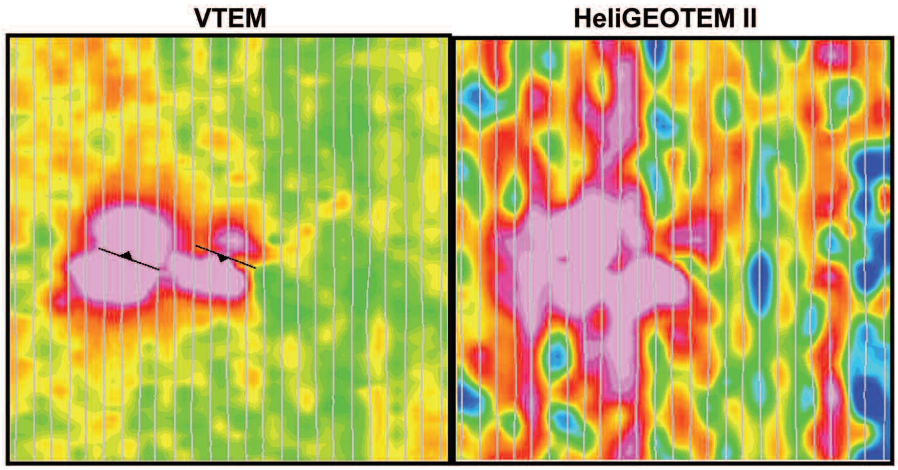


**Figure 3** - Comparison of VTEM 0.682ms (left) and HeliGEOTEM 0.652ms (right) grids over Anomaly C. Black symbols indicate conductor axes locations and dip directions inferred from the VTEM data.

## Data Comparison – Profiles

Three profile comparisons are shown in Figures 3, 4 and 5 (The positions of these lines are indicated on Figure 2).

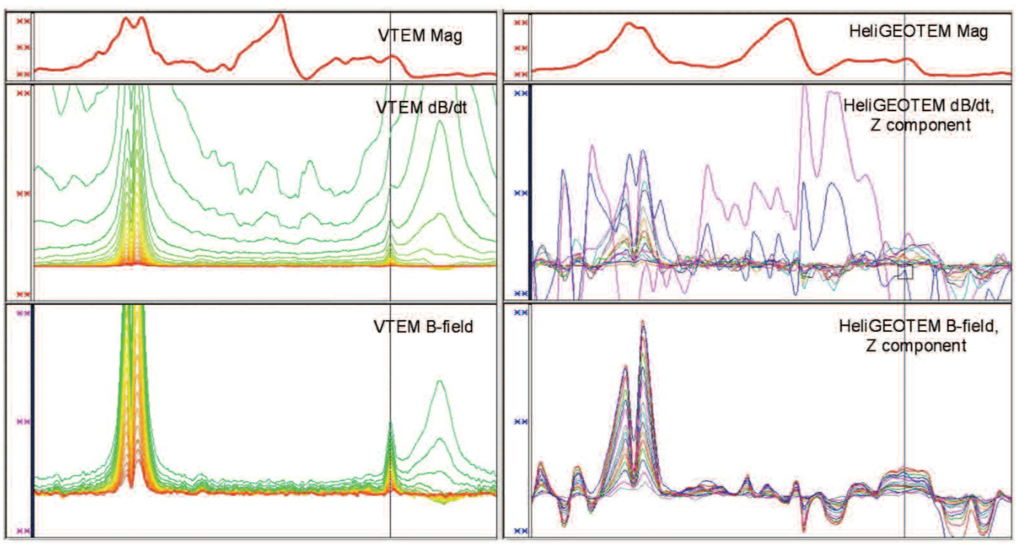


**Figure 4** – EM profiles, Line 1. Anomalies C (left) and B (right) are intersected.

The profile comparisons in Figure 4 confirm the much lower noise levels of VTEM data, and show how this enables the detection of anomaly B (right) on both dBdt and B-field profiles. There is no clear anomaly visible on HeliGEOTEM II data at this position. Anomaly C (left) is visible on all profiles, but the high noise in the HeliGEOTEM II dBdt profiles causes channel cross-overs, which will lead to inaccurate modeling or inversion results.

Also important to note is the frequency content of the respective signals. HeliGEOTEM II has lower frequency content (visible as longer wavelengths in the noise). This is partially due to the lower sampling rate (4Hz compared to VTEM 10Hz) which results in larger station spacing. It can also be ascribed to more severe filtering of data during the processing phase to reduce system noise. A severe consequence of this is that even well-defined anomalies (as Anomaly C on HeliGEOTEM II B-field profiles) are distorted (i.e. peak to peak distance are increased and peak amplitudes decreased). Worse, it approaches the wavelength of valid bedrock conductors. This will introduce errors in any modeling or inversion results.

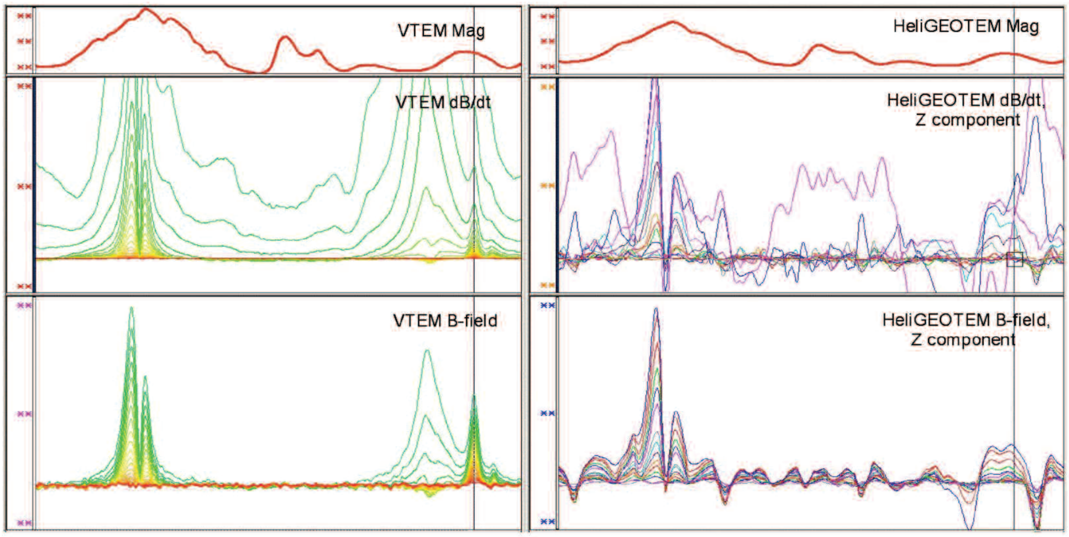


**Figure 5** – EM profiles, Line 2. Anomalies C (left) and A (right) are intersected.

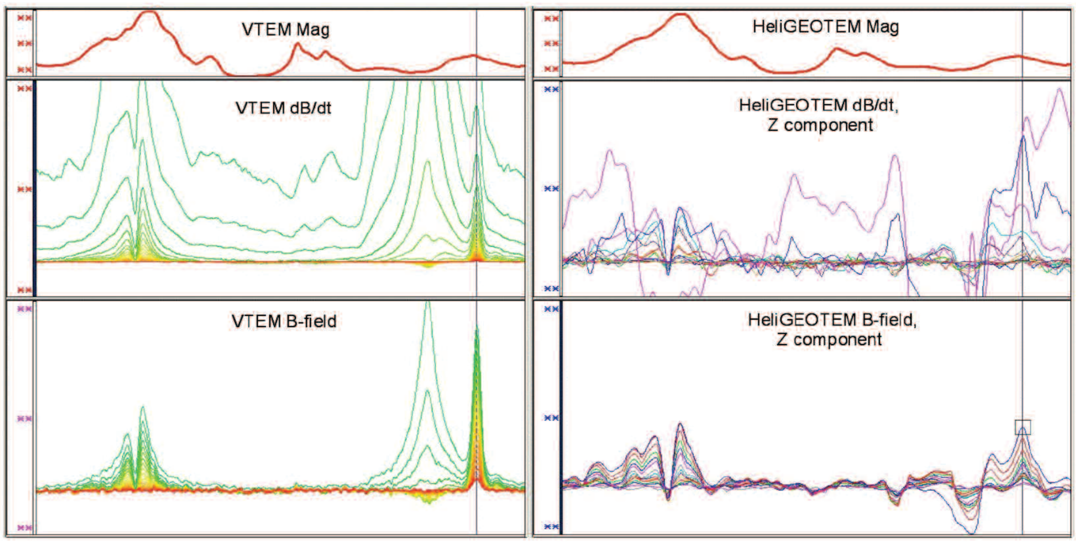


**Figure 6** – EM profiles, Line 3. Anomalies C (left) and A (right) are intersected.

Figures 5 and 6 compare data over lines 2 and 3. Both lines 2 and 3 intersect the eastern edge of anomaly C and anomaly A. As with line 1, the better resolution and lower noise levels of VTEM is clearly visible. Also note that the VTEM's magnetometer is closer to the ground than the HeliGeoTEM's magnetometer. The added spatial resolution of the VTEM's magnetometer data is evident by inspection of the magnetometer trace (top panel) in Figures 4, 5 and 6.

## *Conclusions*

The comparison of the two systems using actual survey data collected over the same area shows that VTEM outperforms HeliGeoTEM II in terms of signal-to-noise, special resolution, conductor location and conductor definition.