MobileMTm – focusing on details

Overview

Expert Geophysics Limited (EGL) continues to provide airborne electromagnetic (EM) surveys with innovative and scalable technologies to achieve project-specific exploration goals. EGL's proprietary **MobileMT** (Mobile MagnetoTellurics) technology utilizes the earth's natural (or passive) EM fields, primarily generated from global thunderstorm activity, which induce secondary fields and currents in the subsurface, to develop an understanding of the subsurface conductivity structure. The use of naturally occurring EM fields as a source of 'transmitted energy' overcomes many limitations inherent to other airborne EM systems and principles. The newly developed **MobileMTm** technology is a modification of the original **MobileMT** technology that is aimed toward identification and imaging of discrete targets and complex structures in the depth range from near surface up to several hundred meters.

Technical description

MobileMTm is a compact version of **MobileMT** that is outfitted with two magnetic sensors, configured to measure the horizontal gradient of the magnetic field (Figure 1). The airborne EM system utilizes naturally occurring EM fields in the frequency range of 90 – 27,000 Hz, which are mainly associated with lightning discharges around the world. The EM sensor, comprised of three orthogonal induction coils, is located inside the shell. The two magnetic sensors, separated by 4 m horizontally, are positioned on the same frame as the EM sensor, 4 meters aft. The position of the sensors is accurately retrieved through use of a GPS receiver and gyro inclinometer, both located on the frame. The **MobileMTm** bird is towed by a helicopter using a 55 m long cable. The nominal clearance for the **MobileMTm** bird is 30 m. A synchronized ground EM base station simultaneously measures variations of the electric field in two orthogonal directions with four pairs of electrodes.

Figure 1 – MobileMTm

Exploration capabilities

The **MobileMTm** system was developed specifically for identification of discrete targets and structural features, with the focus on the relatively near surface depth range. The nominal depth of investigation of the system is on the order of several hundred meters, however, under certain conditions, it can extend to up to 1 km.

Tel: (+1) 647-657-4774
e-mail: info@expertgeophysics.com
www.expertgeophysics.com

High-resolution aeromagnetic data is essential for geological and structural mapping, and an important complementary dataset to EM data. The magnetic data of the **MobileMTm** system, free of noise from any artificially driven transmitting field, is collected from the horizontal (cross-line) gradiometer. The data acquired from the two magnetic sensors during flight are used to calculate the cross-line and in-line gradients, which can then be used for calculation of the total horizontal gradient of the magnetic field.

MobileMTm field data example over kimberlite pipes

A **MobileMTm** survey was conducted in July 2021 over two known kimberlite pipes located in northeastern Ontario (KL-01 and KL-22), approximately 120 km NNE of Sudbury. Both kimberlite pipes are close to the surface. The KL-01 kimberlite is covered by 1 to 4 m of till and is deeply weathered. The KL-22 kimberlite is covered by more than 10 m of glacial sediments and is fresh at its subcropping surface. The kimberlites "follow an azimuth that is parallel to the "Kerry Lake" fault, which trends at ~325°. Both the KL-01 (~150 m x 300 m) and KL-22 (~140 m x 420 m) kimberlites have an elongated morphology following this northwest-southeast trend" (McClenaghan et. Al., 2008).
Test blocks were flown over the two kimberlites, in both cases the line spacing was 100 m. The following 18 **MobileMTm** frequencies were utilized: 84Hz, 102Hz, 140Hz, 164Hz, 209Hz, 267Hz, 340Hz, 419Hz, 533Hz, 677Hz, 842Hz, 1067Hz, 5381Hz, 6785Hz, 8550Hz, 10765Hz, 13571Hz, 17099 Hz.
Some examples of **MobileMTm** apparent conductivity grids, resistivity sections and magnetic field grids for both test survey blocks are provided below.

KL-01 kimberlite

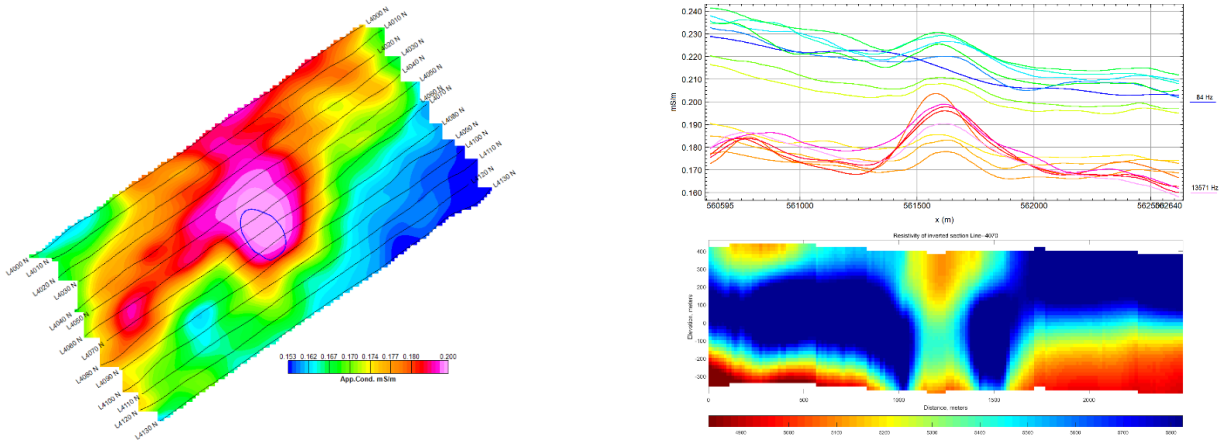

Figure 2 – A - Apparent Conductivity at 8550 Hz with the main magnetic anomaly contour, B - Apparent Conductivity data profiles and the resistivity section for L4070 (the section is presented in the 750 m depth range from surface).

KL-22 kimberlite

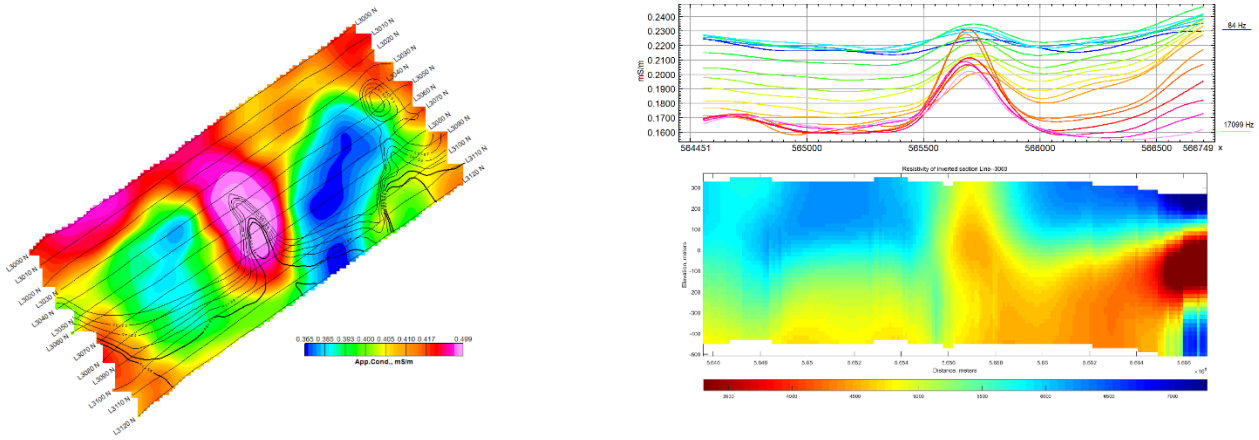

Figure 3 - A - Apparent Conductivity at 13571 Hz with magnetic anomaly contours overlain, B - Apparent Conductivity data profiles and the resistivity section for L3060 (the section is presented in the 750 m depth range from surface).

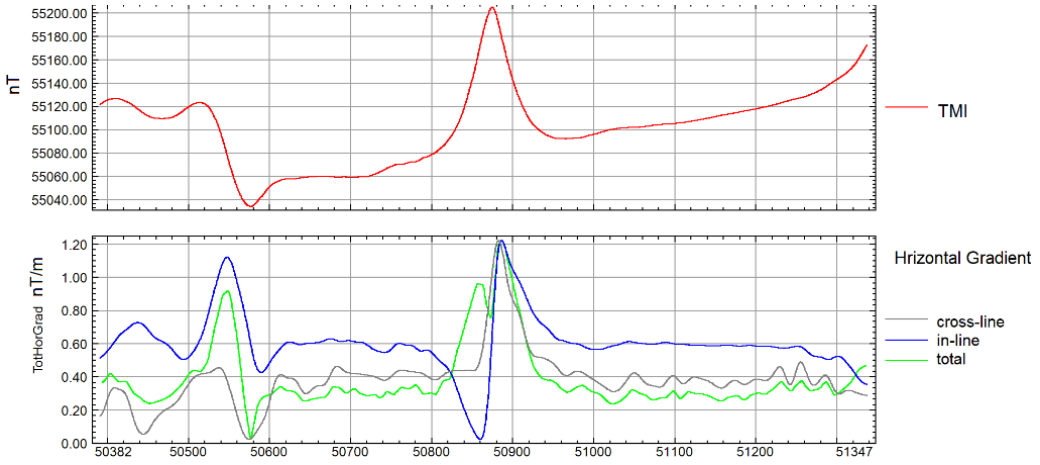

Figure 4 – Magnetic field and its measured horizontal gradients along a line

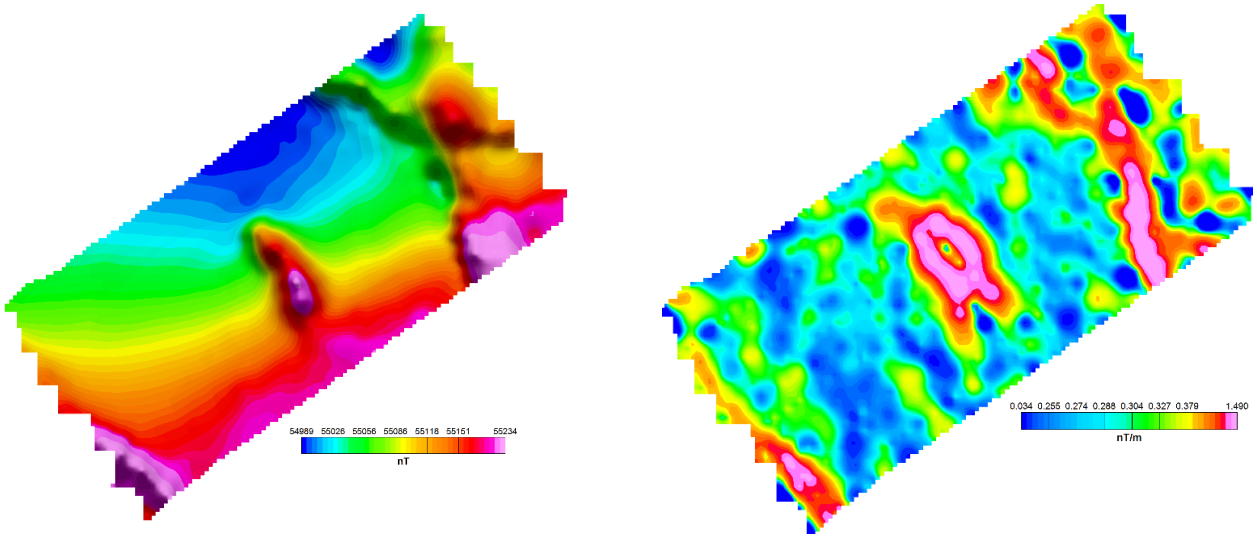

Figure 5 – Magnetic field (TMI) – left, and Total Horizontal Gradient of magnetic field - right

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Conclusions

This case study demonstrates the capabilities of the modified airborne **MobileMT** technology, **MobileMTm**, for identification of near surface and discrete geological targets, specifically its applicability for kimberlite exploration. The **MobileMTm** system detected the relatively small (~150 m x 300 m and ~140 m x 420 m), near surface kimberlite pipes, in both EM and magnetic data. With a wide frequency range, the MobileMTm system is capable of exploring both near surface and relatively deep geological structures with high resolution.

In comparison to time-domain technologies, both the original and the modified **MobileMT** systems are sensitive to resistivity differentiation over a wider range, including thousands of ohm-m, and are not susceptible to parasitic distortions caused by IP or SPM effects. The depth of investigation of the **MobileMT** technology always exceeds the depth of investigation of systems with controlled primary field sources, frequency- or time-domain.

References

1. Bagrianski, A., Kuzmin, P., Prikhodko, A. (2019) AFMAG Evolution - Expanding Limits. 16th SAGA Biennial Conference & Exhibition.

2. Moul, F., Witherly, K., (2020) A comparison of MobileMT with ZTEM and HELITEM over isolated conductors in the Athabasca Basin, Saskatchewan, Canada. SEG International Exposition and 90th Annual Meeting.

3. Prikhodko, A. (2020), Capabilities of the airborne MobileMT for the expansion of active and historical mines. Fast Times (EEGS), Volume 25, Number 4, p.p 107-113.

4. McClenaghan, M.B., Kjarsgaard, I.M., and Kjarsgaard, B.A. (2008), Indicator mineralogy of the KL-01 and KL-22 kimberlites, Lake Timiskaming kimberlite field, Ontario. Geological Survey of Canada, Open File 5800.

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