MobileMT: The next level of Airborne Electromagnetic Exploration in the Athabasca Basin

Athabasca Basin is best known as the world's leading source of high-grade uranium and currently supplies about 20% of the world's uranium. There are three types of uranium deposits in the frame of the basin and around it – basement-hosted, unconformity and sandstone-hosted.

To find the mineralization, geophysical exploration methods should be able to solve a diversity of exploration tasks.

The Basin, historically, became a challenging polygon for testing geophysical technologies including airborne EM principles and systems. The range of depth of investigation, resistivity resolution including in the band of high resistivities, sensitivity to different directions of boundaries, capability to recover complex structures and contacts with low differentiations, are some of practically verifiable parameters in the quite unique geological region.

MobileMT is the first airborne electromagnetic system with ability of resistivity mapping in the full range of resistivities and depths of the Athabasca basin rocks, mineralization and alteration zones from the surface to 1.5-2 km depth. In comparison with other existing and historical airborne EM technologies, MobileMT is able to explore not only deep and highly conductive graphitic horizons but recover resistivity variations in the sandstone cover reflecting alteration zones which attribute sandstone-hosted uranium deposits. Due to very wide frequency broadband and total field measurement, MobileMT is applicable for the next main exploration tasks in the Athabasca basin:

- Identification mineralization potential trends;
- Targeting graphitic fault-conductor axis, markers and assemblages;
- Mapping possible alteration zones, sandstone breaches, desilicification and argillization of the sandstone and/or basement and lithostructural favor ore depositions in 3D in the full shallow-to-deep range.

The airborne EM MobileMT technology having many of technical advantages is one of the geophysical tools which is able to solve of the required exploration tasks in the region what is demonstrated in the field examples.

MobileMT airborne EM technology brief description

MobileMT (Mobile MagnetoTelluric) is a passive airborne electromagnetic technique that records magnetic (in the air) and electric (on the ground) fields generated by natural sources in the frequency range from 25 Hz to 20 kHz. The exploration system includes two pairs of grounded electric wire lines, one of them is for reference signal, and moving three-component inductive coil system softly suspended and with low-noise signal amplifiers for magnetic field measurements (dB/dt) in three orthogonal directions (Figure 1).

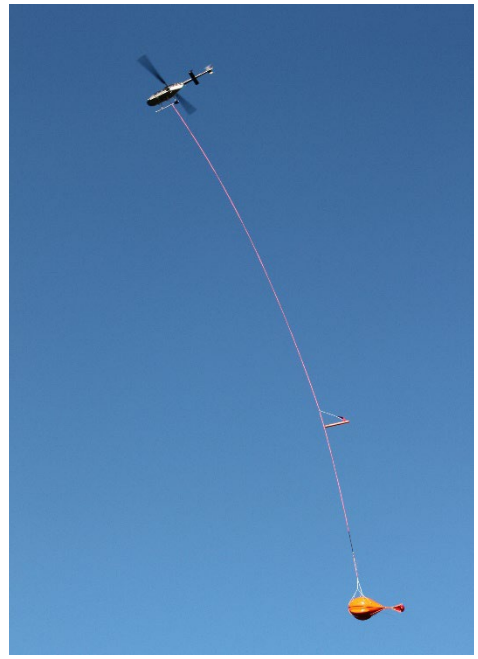


Figure 1 - MobileMT three component magnetic sensor in the air (Wawa, Ontario)

The MobileMT system features are:

- Frequency range 25 Hz – 20,000 Hz
- Advanced noise processing on both electronic and signal levels ensures high data quality
- Lightweight, aerodynamic bird is ideal for surveys with small helicopters in terrain conditions
- Resistivity contrast in geologic structures of any shape due to total field measurements
- Broad frequency range provides excellent resistivity discrimination for both deep and shallow geology
- High data quality even at low natural field signals
- Second pair of ground electrodes provide an electrical reference signal for removing noise bias
- High signal to noise ratio; all three orthogonal components of the magnetic field are measured at the receiver in the air, as opposed to a single vertical component measurement
- High spatial data resolution due to high digitizing rate (in-line resolution) and optimal splitting time series data into frequency windows (in-depth resolution)

Shea Creek Test

Expert Geophysics Limited flew a MobileMT test line over the Shea Creek uranium deposits area in the western Athabasca basin, just south of the former Cluff Lake mine site (Figure 2).

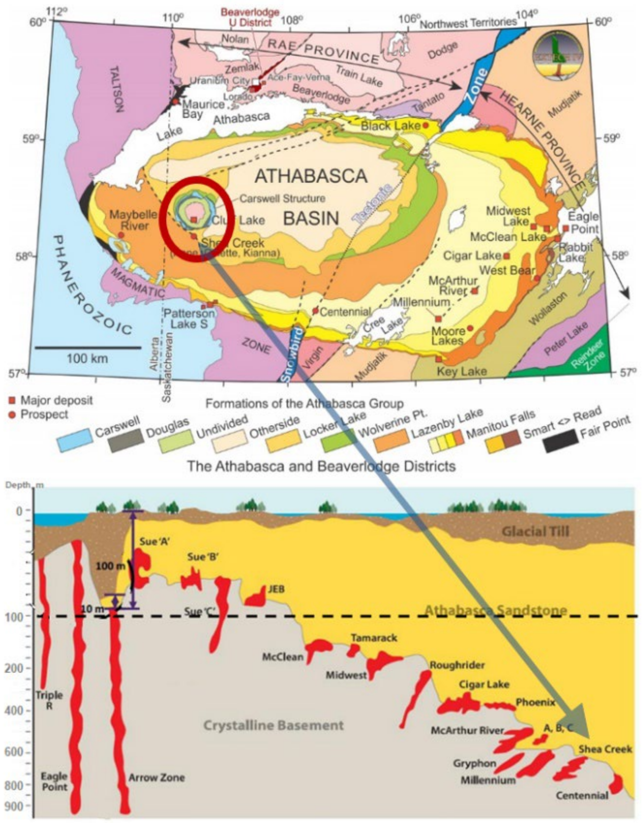


Figure 2 - Position of the Shea Creek deposit over geology (top) and in the regional geological section (bottom) (after Rhys et.al., 2010)

The area is underlain by 400 to 800 m of Athabasca sandstone cover.

Shea Creek deposits display full range of mineralization styles in the Athabasca basin (Rhys D., Sierd E., Luke van der Meer, Geology of the Shea Creek uranium deposits: an expanding uranium district in the Western Athabasca Basin. Saskatchewan Geological Survey Open House, Nov. 29, 2010.):

- unconformity mineralization along the Saskatoon Lake conductor (UC);
- basement mineralization (UB) localized mainly in footwall of conductor;
- alteration plume developed above and surrounded by clay-chlorite alteration in sandstone (UP).

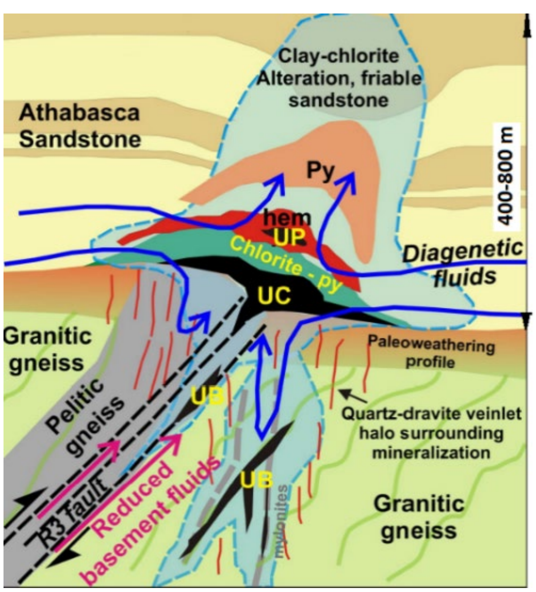


Figure 3 - Typical schematic Shea Creek geological cross-section (after Rhys et.al., 2010)

The schematic cross-section (Figure 3) shows the mineralization styles and their relative position in the Shea Creek area.

MobileMT Shear Creek test results

The range of frequencies less than 1000 Hz used for the case study, with 11 extracted frequency windows. MobileMT apparent conductivity profiles over the test line, for each frequency window, are presented in Figure 4.

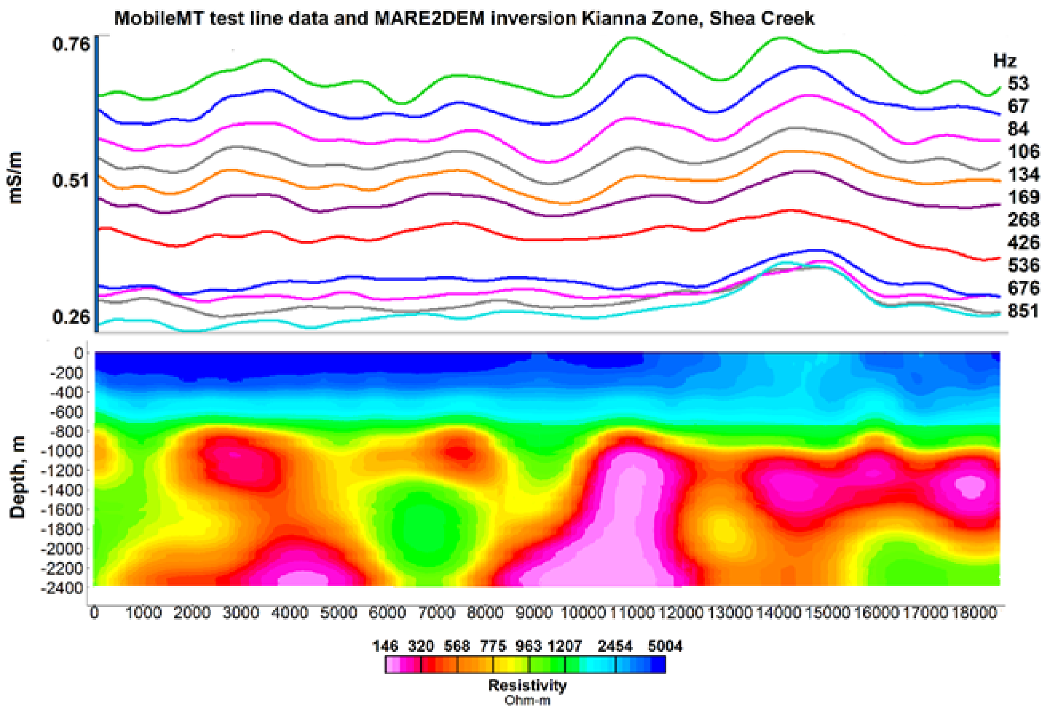


Figure 4 - The line over Kianna Zone, Shear Creek. From top to bottom:

- **MobileMT apparent conductivity profiles in 53-851 Hz frequency range;**
- **resistivity section derived by MARE2DEM inversion for selected 11 frequencies;**

The test line is crossing the Kianna unconformity style mineralized zone. Position of the zone at the unconformity between the sandstone underlying crystalline basement (~11000 m mark along the line). MobileMT data 1) clearly shows the horizontal contact (unconformity) between Athabasca sandstones and the crystalline basement throughout the line (on the depth ~700 m); 2) capable to differentiate resistivity inhomogeneity in the highly resistive sandstones strata; 3) demonstrates comparatively high resolution in the geoelectric picture overall.

The resistivity distribution shows that MobileMT data is sensitive not only to highly conductive targets but to resistivity variations in the highly resistive sandstone unit. The shape of the anomaly at the 13000-15000m in the Figure 5 marks similar to clay-chlorite alteration (Figure 3).

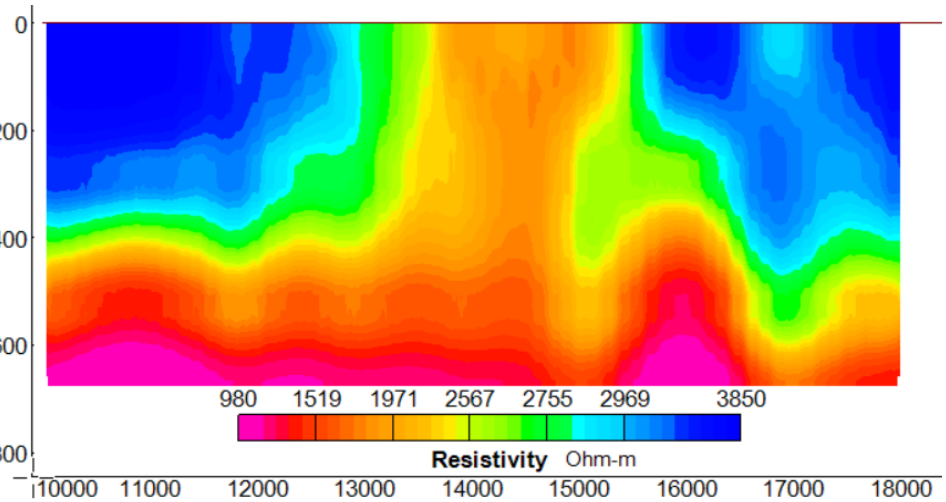


Figure 5 - Zoomed-in resistivity section of possible clay-chlorite alteration in the sandstone cover. 10000-18000 m part of the full section in the 0-700 m depth range.

Basement-hosted, fracture controlled or vein mineralization

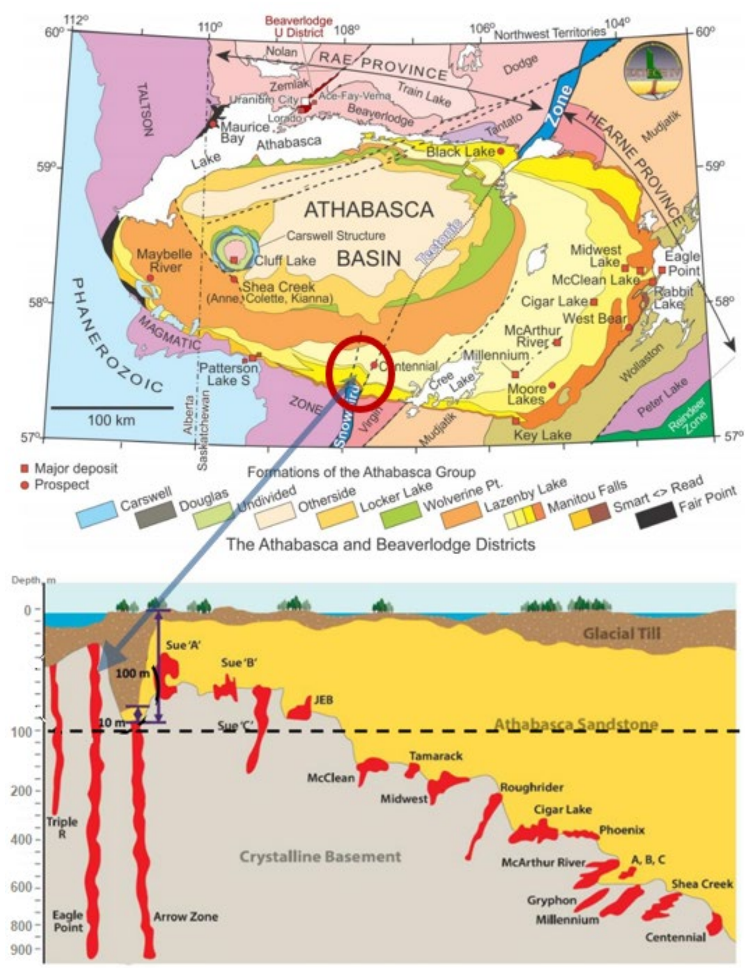


Figure 6 - Position of the mineralization controlling structure over geology (top) and in the regional geological section (bottom) (after Rhys et.al., 2010)

Uranium deposits can form at the unconformity, above, and below. Also, the same mineralization processes that are present within the sedimentary basin, are also acting around the basin. This means that instead of deep, underground mines to access mineralization at depth (under sandstone), open pit mines can be used to extract ore that is around the basin, where the thickness of sandstone is negligible. Usually, these deposits are structurally controlled by a regional, northeasterly trending fault rooted in graphitic basement rocks.

One of the examples of MobileMT mapping of a deeply rooted structure in the crystalline basement is presented in Figure 7.

MobileMT section

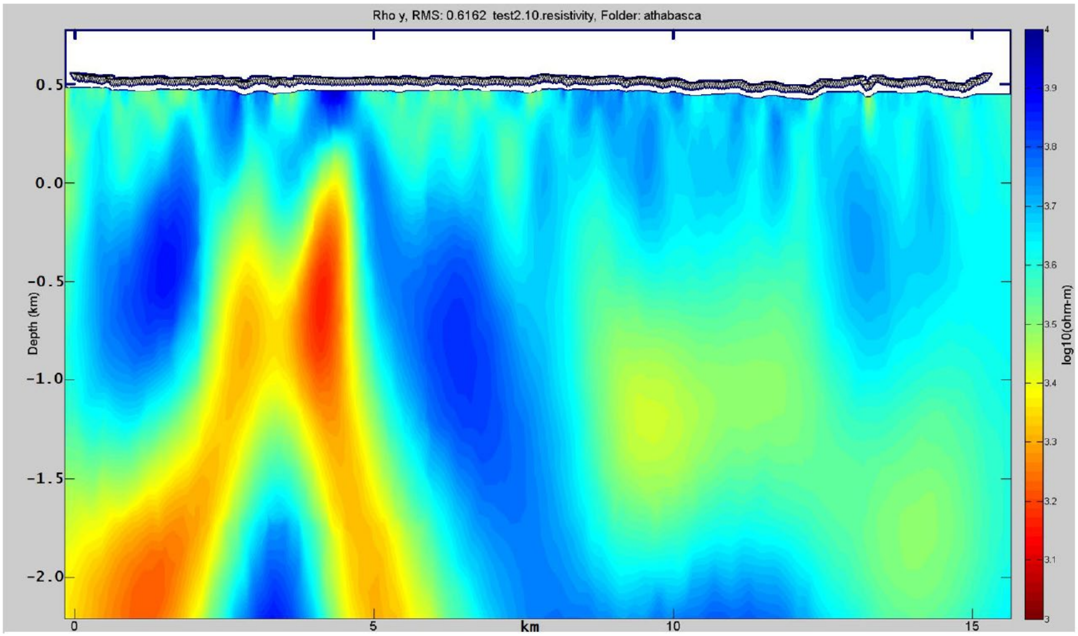


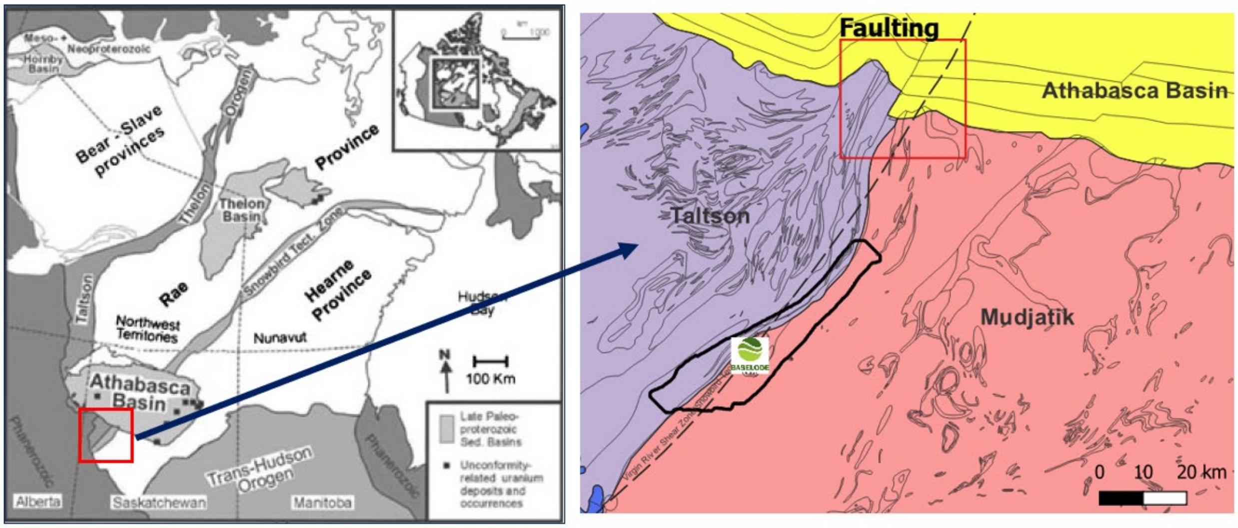
Figure 7 - MobileMT resistivity section over a deep structure in the crystalline basement on the edge of Athabasca basin

Shadow Project

Baselode Energy Corp.'s Shadow project is located ~30 km south of the Athabasca Basin margin along on one of the largest structural trends observed in northern Saskatchewan, the Virgin River Shear Zone, which hosts other uranium deposits (Figure 8). Detection and exploring for deep-rooted structural systems with specific mechanical and chemical traps is important for targeting basement-hosted uranium deposits, which could prove to be more economic with easy mineability alternatives to "traditional" unconformity deposits with substantial overlying problematic sandstone cover.

MobileMT 3D resistivity mapping from the surface up to 1.5 km depth over the Virgin river Shear Zone is demonstrated in Figure 9 and Figure 10.

In-depth interpretation of the geophysical results, in particular, resistivity distribution patterns, outlined a large-scale tectonic shear zone which included areas with noticeably low resistivities, the interpretation of fault architectures, and tectonic lozenges with expected high level of porosity (i.e., hypothetical fluid migration zones). The recognized 3D structural patterns produced by MobileMT at Shadow show similar geological characteristics with the Key Lake, Eagle Point/SUE and Arrow high-grade uranium deposits of the Athabasca Basin, providing exceptional exploration targets requiring validation with diamond drilling.



From Cloutier et al. (2011).

Figure 8 - Shadow Athabasca-2.0 project block (black contour) on the schematic geological map

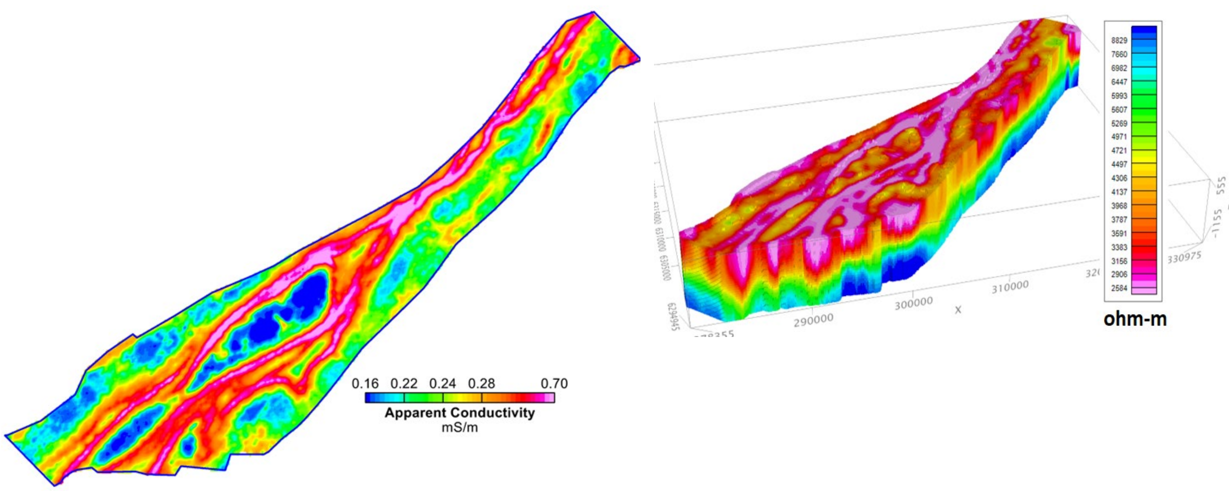


Figure 9 - MobileMT apparent conductivity (268 Hz) grid (left) and resistivity-depth 3D voxel (right) over the Shadow project

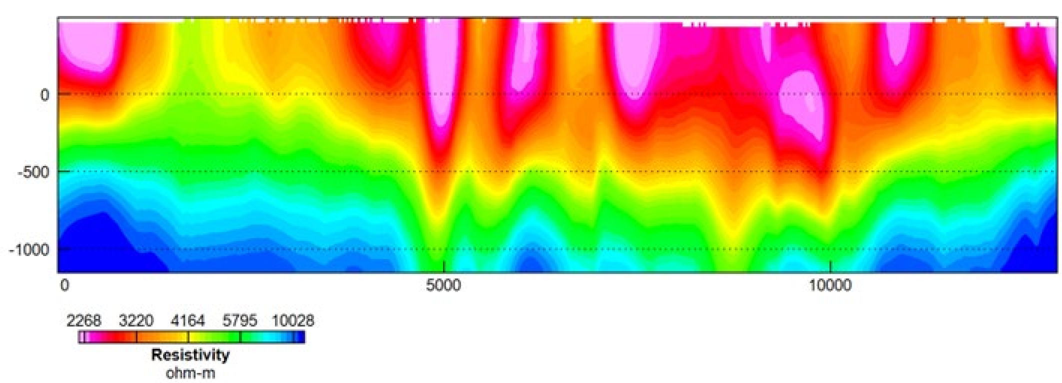


Figure 10 - MobileMT resistivity section over a survey line crossing the Virgin River Shear Zone

EXPERT GEOPHYSICS

from innovations to discoveries

AIRBORNE GEOPHYSICAL SURVEYS WORLDWIDE

with advanced electromagnetic systems

MobileMT is the most advanced generation of airborne AFMAG technology for the fast and effective solution for 3D geoelectrical mapping applied to any kind of geological prospecting projects.

MobileMTm is a lightweight version of MobileMT plus two total field magnetic sensors in the horizontal gradient configuration.

TargetEM is a new generation of a high-power time-domain system with a 3-component receiver.

mTEM is a time-domain system designed for high resolution near surface electromagnetic investigations.

Contacts

Expert Geophysics Limited (Head Office, Canada) **Phone: (+1) 647-657-4774**
Expert Geophysics Pty Ltd (Australian Office) **Phone: (+61) 0499934611**
Expert Geophysics Limited (South Africa) **Phone: (+27) 83 659 3082**

www.expertgeophysics.com