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# TECHNICAL NOTE

**Subject: TargetTEM™**

Modern airborne time domain electromagnetic (TDEM) systems such as GEOTEM, TEMPEST, MULTIPULSE, HELITEM, SPECTREM, VTEM, XTEM, RepTEM, SkyTEM, AeroTEM, XCITE etc, are characterised by very large volumes of complex, multichannel data that are difficult and enormously time-consuming to analyse in terms of mineral targets.

Conventional data processing techniques, such as apparent conductivity, layered-earth inversion (LEI) and conductivity-depth imaging (CDI) algorithms, transform multichannel TDEM data into conductivity-versus-depth images showing the absolute conductivity of the sub-surface at particular depths. These algorithms assume that the electrical structure of the ground is either homogeneous at particular decay times, or horizontally layered. However, this is usually not the case in mineral provinces so they produce 'mathematical' artefacts or false responses in the resultant images, in addition to the normal 'non-uniqueness' phenomena (different models can produce the same response) inherent of all modelling systems. They also fail to resolve small and subtle, conductive and resistive features which are often important exploration targets. CDIs and LEIs provide only limited resolution of the underlying geology. Note that for the case of the helicopter TDEM systems, where the receiver is located in the transmitter loop, CDI and LEI techniques can only be applied to the vertical (Z) component of the measurement as there is no horizontal (X and Y) component responses over a layered earth structure.

TargetTEM™ is a combined anomaly detection, data compression and anomaly ranking algorithm specifically for resolving detail in multichannel airborne TDEM data. It is based on the premise that variations in the measured response and variations in the transient decay are more important as indicators of exploration targets than the absolute response of the underlying geology.

TargetTEM™ does not compute conductivity or depth and makes no assumptions about the underlying geology. Instead, it resolves conductive and resistive features with respect to the background response of the host rocks and any conductive overburden present. It accurately maps the variation in thickness of conductive layers, such as an overburden layer, and resolves structural discontinuities in these large features. It also removes the response of unconfined conductive background and conductive layers, such as an overburden layer, to resolve the weaker early-time responses of confined conductors. It provides the highest resolution of subtle features in complex geological environments. TargetTEM™ can be applied to the vertical (Z) and horizontal (X and Y) components of all types of multichannel B-field (magnetic sensor) and dB/dt (coil sensor) TDEM data complementing CDI and LEI results. When both step (B-field) and impulse (dB/dt) response data are available, TargetTEM™ merges their processed responses into a single COMPOSITE response parameter to provide a convenient means of analysing the multi-parameter data.

TargetTEM™ operates on survey line data in preference to gridded data in order to preserve survey resolution. From the multichannel data, it resolves the TEMPORAL response, related to the conductivity and size of the subsurface conductors. This can be displayed as pseudo-sections for each survey line, or selected channels can be displayed as 2-dimensional images. The overburden response is removed and the multi-channel response is further reduced, or compressed, into three time-category responses, referred to as the **EARLY**, **MID** and **LATE (EML)** time responses, which are a convenient and accurate way of displaying and interpreting large volumes of multichannel TDEM data. The EML channels resolve the electrical structure of the sub-surface at shallow and deeper depths, but the actual conductivities and depths remain undetermined.

TargetTEM™ also resolves the induced polarisation (IP) response and displays this with the EM responses.

Anomalous features in the EML channels are automatically **ranked** according to their decay characteristics and displayed as multi-coloured plans, that can be easily integrated with other geological information, allowing the responses to be quickly and accurately identified and targeted for further investigation

TargetTEM™ is an accurate and convenient way to process and display large volumes of multichannel airborne TDEM data. The various responses can be easily integrated with geological information using standard GIS systems allowing geologists to make their own interpretations of complex multichannel TDEM data. TargetTEM™ reduces the time and cost of interpreting TDEM data and improves drill targeting.

Some applications include: mapping overburden thickness variations, delineation of subtle conductive and resistive features in the sub-surface geology, detection of conductive zones and resistive zones in conductive environments, detection of "spot" or "bullseye" anomalies, delineation of linear and curvilinear features related to structures, bedding and stratigraphy, and mapping the electrical texture of the underlying geology.

TargetTEM™ is the basis for detecting and discriminating exploration targets in multichannel TDEM data. It has been applied to airborne TDEM data for base-metals, nickel sulphides, laterite nickel, gold, manganese, diamonds, uranium, coal, geological mapping, ground water and salinity studies, and environmental studies.

The TargetTEM™ standard processing package for each measured component (i.e. X and Z components of both dB/dt and B-field data) includes:

1. ASCII located data files containing the TEMPORAL responses for all decay channels;
2. ASCII located data file containing the anomaly rankings of the compressed EML channel data;
3. For each survey line, pseudosection bipole images (*.dxf) of all decay channels with plotted profiles of DTM and magnetics, and IP-effect, included within the plots;
4. Bipole plan plots for each compressed EML data channel, and a plot of IP-effect (*.dxf);
5. The multi-coloured anomaly ranking plan images (*.dxf);
6. The survey line plan image (*.dxf);
7. The TargetTEM™ data processing report (not a data interpretation report).
5. Optionally, for each survey line, 3-dimensional pseudosection bipole images (*.dxf) of all decay channels suitable for displaying in a 3D GIS environment.

The **bipole image** is a two-polarity (bipole), dual coloured vector graphic 'dxf' formatted image of the response values. It is prepared from the survey line data and does not involve gridding the data. The resolution of the survey is preserved because every measurement is represented in the image, and at its true location. Bipole images are more accurate than grid based contour maps and images.

**TargetTEM™**, a new standard in the processing of all modern fixed-wing and helicopter airborne TEM data:

- makes no assumptions about the electrical structure of the subsurface;
- increases resolution of conductive and resistive features;
- maps variations in the thickness of conductive layers, such as an overburden layer;
- discriminates conductive and resistive features from overburden and background responses;
- displays both the impulse and step responses in a single image;
- identifies anomalous features based on their decay characteristics;
- resolves and displays IP effects;
- reduces the uncertainty in the interpretation of survey data;
- helps geologists to quickly analyse large volumes of complex multichannel TDEM data;
- reduces interpretation costs; and
- is applicable in all geological terrains.

**TargetTEM™ is the fastest and cheapest way of accurately analysing multichannel airborne TDEM data. It is being used by an increasing number of mineral explorers to identify drill targets.**

*TargetTEM™ is a trade mark of Vector Geoscience Pty Ltd. Another innovation from the research laboratory of Vector Geoscience.*

For a non-mathematical description of time domain EM (TDEM), with example datasets, see Section 5.7 of the following text book:

Dentith, M. and Mudge, S. T., 2014. *Geophysics for the Mineral Exploration Geoscientist*, Cambridge University Press, ISBN 978-0-521-80951-1.
For further details and online resources see: www.cambridge.org/9780521809511