HELI-GT Magnetics

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The most advanced 3-axis magnetic gradiometer and mapping system.

Providing the ultimate in resolution and accuracy.

In 2002 **Scott Hogg & Associates Ltd**. introduced the **GT-GRID** process for magnetic gradient mapping and set a new industry standard for resolution and quality that has not been surpassed. The **GT-GRID** system has played a role in the discovery of kimberlites, gold and base metal deposits.

The **GT-GRID** process requires accurate 3-axis magnetic gradient information for optimal performance. For helicopter surveys no system was available to collect all the information necessary, so we built our own. The **HELI-GT** system is not simply an array of magnetometers but a full measurement platform with GPS navigation, radar altimeter and full pitch, roll and yaw instrumentation on the bird. It is a **magnetic gradient measurement system** that provides for the realities of cross winds, pitch and roll motion when contour flying, elevation changes from line to line and even magnetic compensation. The entire system is custom designed and purpose built.

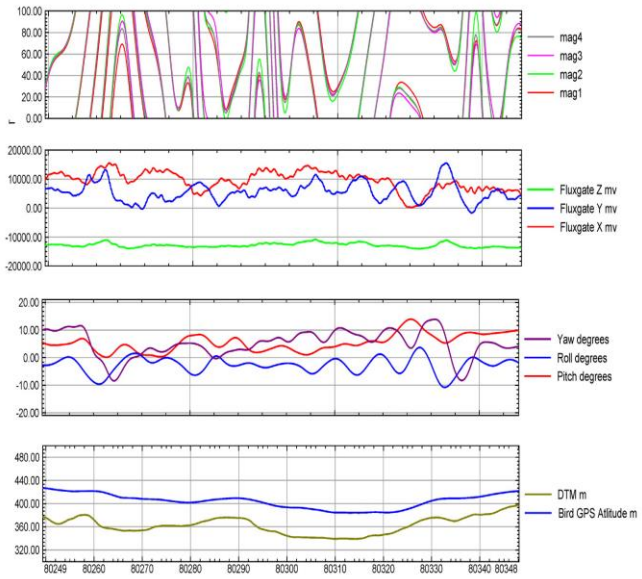
Since 2008.**Scott Hogg & Associates** has been actively surveying with the **HELI- GT** system across Canada, from the Canadian Shield to the Rocky Mountains. Heli-GT surveys can be complimented by Gamma Spectrometer and VLF-EM instrumentation.

The following presents an overview of the **HELI-GT** design and operation and illustrates the significance of the unique hardware and software elements in creating the most accurate and highest resolution maps.

The Heli-GT Airborne System

The Heli-GT bird is towed 25 m. below the helicopter. It is of modular design for ease of transportation and is fabricated from non-magnetic fiber reinforced plastic. All sensors are mounted on the bird so that all measurements are fully independent of the helicopter and tow cable configuration.

On the bird measurements.



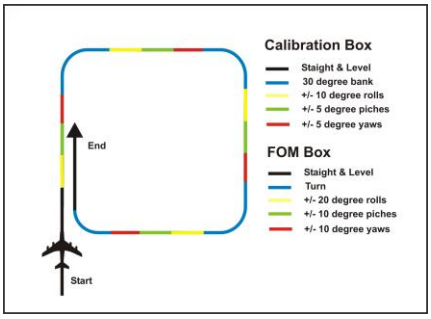
4 Scintrex CS-3 cesium magnetometers provide the basic measurements of total magnetic field and magnetic gradients along 3 orthogonal axes.

A 3-axis fluxgate magnetometer measures the direction cosines of the earth's magnetic field relative to the bird axes.

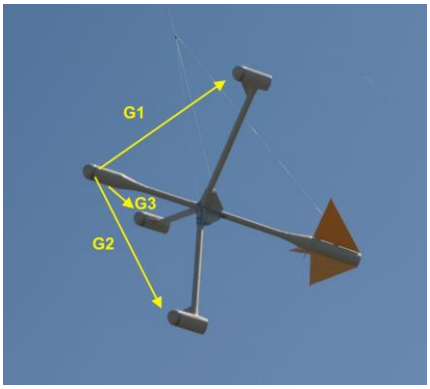
An AHRS measures the pitch, roll and yaw of the bird and attached sensors.

A GPS receiver on the bird tracks its position.
A radar altimeter on the bird directly measures its terrain clearance without assumptions of helicopter-bird position.

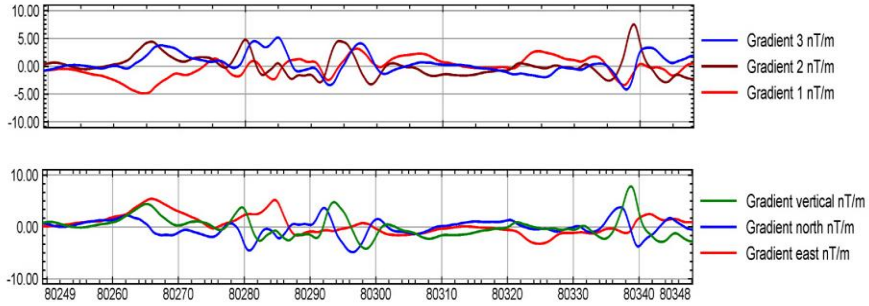
Magnetic Processing



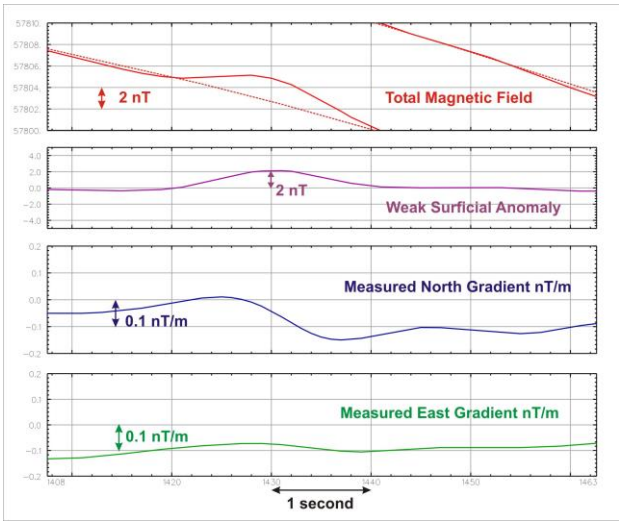
The 4 magnetic profiles are compensated for magnetic interference and inherent sensor orientation error. The process uses the 18 term Leliak model for each sensor and the full calibration box illustrated to provide a unique robust solution that covers all possible bird orientations. The uncompensated FOM is t less than 1 nT, even with motions of 30 degrees. The compensated FOM is less than 0.5 nT and generally too small to accurately measure. There is clearly an advantage to not placing a helicopter in the middle of the sensor array.



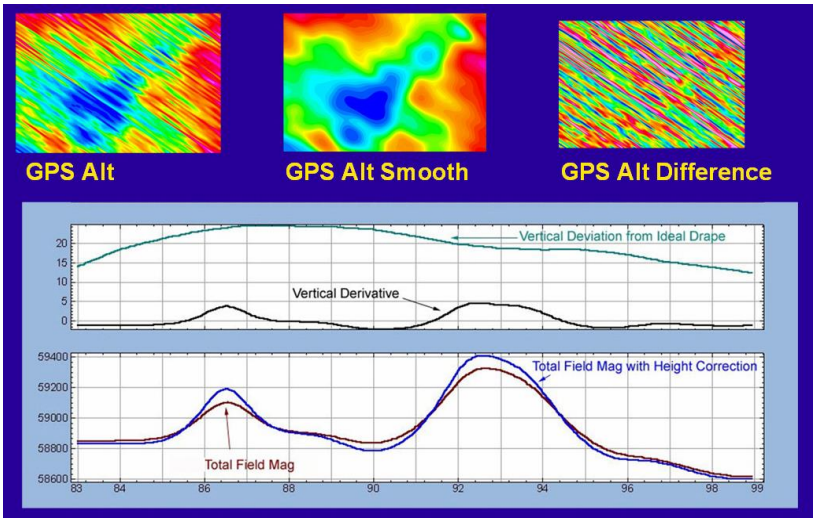
The compensated magnetic data from the 4 sensors is used to calculate the 3 orthogonal gradients G1, G2 and G3, on 3 metre baselines, as illustrated. The accuracy and resolution of these gradients is far better than needed to map anomalies of less than 1 nT amplitude.



The pitch, roll and yaw measurements are then used to rotate G1, G2 and G3 in 3 dimensions to provide G-east, G-north and G-vertical. This transformation is only possible with a 3 axis gradient measurement. These geo-referenced gradients are fully independent of line direction and bird orientation.

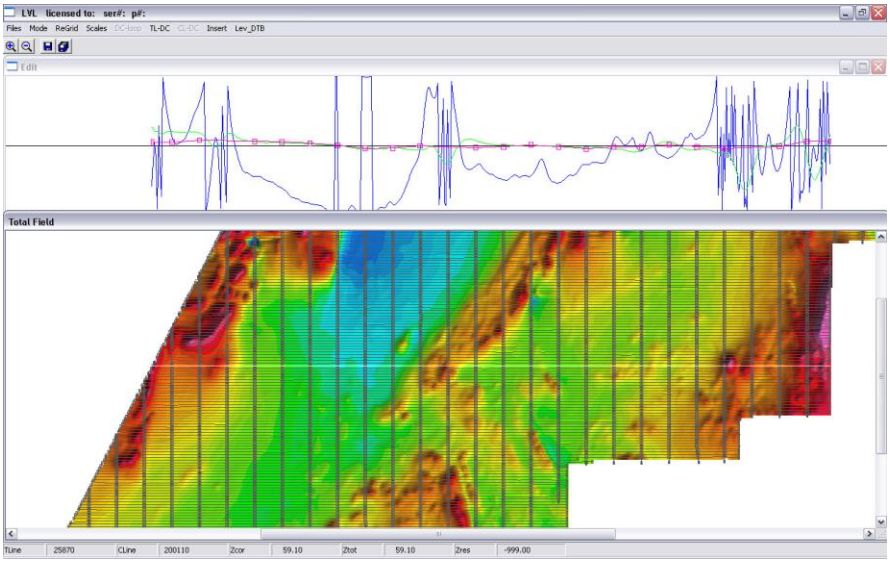


The resolution and accuracy of the measured gradients is exceptional. The measured gradient east and north profiles associated with a 2 nT total field magnetic anomaly at 30 m terrain clearance are clearly and accurately measured. The resolution and noise levels of the gradient measurements are much better than needed to map total field anomalies of less than 1 nT amplitude. The effectiveness of these precise gradient measurements will be illustrated in map examples of glacial till anomalies.



The measured vertical gradient is used to correct for small variations in survey altitude. This minimizes small profile amplitude and shape differences, line to line, that are not of geologic origin.

The correction is typically small but can become hundreds of nT in the vicinity of strong anomalies such as iron formations and greatly improve map resolution.

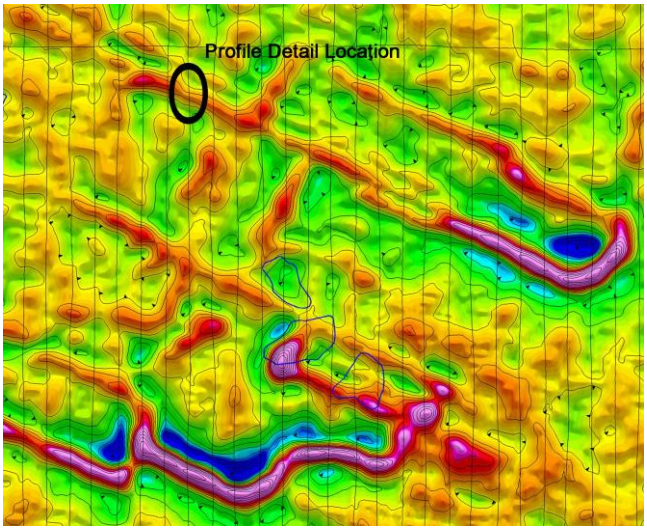


The magnetic variation measured at the base station is applied as a first order diurnal correction. Next the control line intersections are analyzed. The altitude corrections noted above reduce spurious differences from control and traverse lines at different altitudes. The control line levelled output is an input to the GT-GRID process.

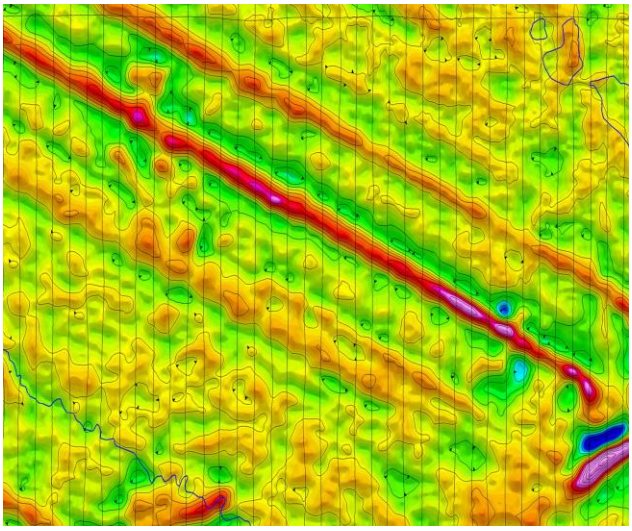
The GT-GRID Map

The levelled, altitude corrected total field profile together with the measured gradients is used by the GT-GRID software to produce the total field grid. The process is able to identify small magnetic sources between flight lines, an important consideration for kimberlite exploration. Of broader significance is the ability to clearly resolve magnetic and structural axes over a wide range of strike directions, even those approaching the flight line direction.

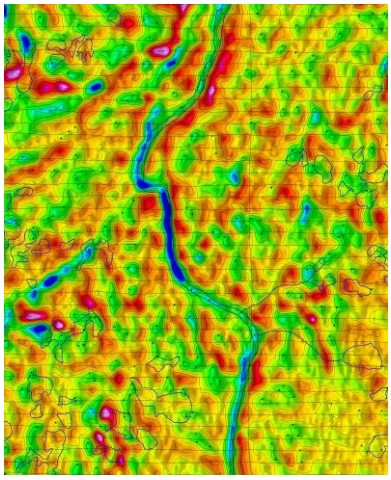
To illustrate, the maps below reflect anomalies from glacial till that are only a few nT in amplitude. The narrow sinuous trends are clearly rendered around complex bends that at points follow the flight line direction. The linear features are sharply rendered and can reveal minor structural off-sets. The contour interval in these samples is 1 nT, the line spacing 75 m. and the terrain clearance 30 m. The location of the profile illustration above, of the measured gradient detail associated with a weak 2 nT total field magnetic anomaly, is indicated.



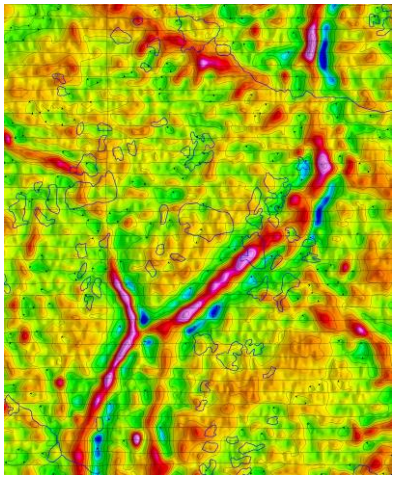
Sinuous magnetic anomalies are accurately mapped, regardless of local strike angle and flight line direction.



These linear anomalies may represent till collected along scarps which in turn could reflect geologic structure.



A magnetic low is produced by a modern river, eroding the surface till.



A sinuous magnetic high is the result of a pre-glacial river that has etched a channel that has since been filled with till.

The Unique Benefits of the Heli-GT System

- Direct and accurate magnetic gradient measurements in the north, east and vertical direction.
- Direct and accurate measurement of sensor locations and height above ground.
- Full magnetic compensation for any interference or sensor orientation error to an FOM better than 0.5 nT
- Totally independent of crab angle and pitch, roll and yaw of bird or helicopter.
- Isolated from magnetic and electrical noise of helicopter and rotors.
- Proven gradient accuracy and resolution for anomalies of less than 1 nT in amplitude.

The Unique Benefits of the GT-Grid System

- Proprietary software system designed to take full advantage of the precise Heli-GT measurements.
- Proven ability to correctly resolve magnetic contacts and axes in almost every strike direction.
- Proven ability to create maps and grids of the highest resolution and accuracy

Heli-GT + GT-Grid = Unmatched Magnetic Resolution & Accuracy