Selecting Your Next Magnetometer

Today's explorationists face unique challenges in mapping geology, defining structure and identifying drill targets. These challenges helped make magnetics a cornerstone of many projects – projects that depend on data quality, cost control, and robustness.

Data quality is best measured by results, namely the gold, base metal, diamond and other deposits being discovered with the GSM-19 Overhauser magnetometer. This system, with its high sensitivity (0.015 nT @ 1 sample per second), minimal system noise, and insensitivity to sensor orientation (i.e. almost no heading error) is recognized as a global standard for finding diverse deposit types in even the most demanding of environments.

The GSM-19 system also helps reduce costs. Integrated GPS enables surveying without cut grids and acquisition of accurately positioned surveys for integration with other data. 3D elevation data is now available for easy import into 3D geophysical modeling software, an increasing requirement in today's landscape.

Other cost-reduction innovations include recent Version 7 upgrade with programmable data export for rapid output, enhanced memory for virtually unlimited data acquisition, 5 times per second sampling for nearly continuous surveys, and ergonomic design for improved operator performance.

Regarded as a robust system, the Overhauser magnetometer is valued by majors, juniors and contractors globally. Its reputation reflects proven operation in hostile settings -- spanning arctic to equatorial to desert environments. All cables and physical components are designed for maximum wear-and-tear, and the warranty is the longest in industry.

As an explorationist considering the effective use of magnetics for your next project, the choice is clear … Overhauser magnetometers position you for success. To see how systems are being used around the world, clich here. You will be taken to a list of case histories showing the various applications of magnetometers in mineral exploration.

”The difference is in the data, the cost and the ruggedness.”

Latest Advances in Magnetics

Today's explorationists face unique challenges in mapping geology, defining structure and identifying drill targets. These challenges helped make magnetics a cornerstone of many projects – projects that depend on data quality, cost control, and robustness.

New technologies offer data quality and high sampling for effective decision-making in mineral exploration. Some of the leading technology-movers are the magnetometer and gradiometer - both ground and airborne - which continue to evolve through persistent, progressive and productive research and development (R&D). Terraplus is at the forefront of these developments - re-inforcing the company's reputation as the sector's most dynamic magnetic technology provider.

For those of you who work with magnetic technologies regularly, you will recognize that changes in magnetometer and gradiometer systems are occurring both on the ground and in the air - with changes reflecting industry needs in our modern exploration era. Read on to learn more about magnetometer, gradiometer and magnetic sensor evolutions in ground and airborne magnetics.

The Ground Magnetometer and Gradiometer - Evolving for Quality and Efficiency

Data volumes have exploded in the last five years. But more than simply quantity, explorationists require data quality. Geologic maps, numerical geophysical models and ultimately, drilling decisions, all require "clean" magnetic results. The drive for highest resolution (i.e. quality) results is a main driving force behind magnetometer and gradiometer evolution.

Other factors include the efficiency and cost reduction - recognizing that bottom-line profitability is tied to these factors. From a ground instrumentation perspective, this means that instrumentation must be "smarter", easier-to-operate, and reliable so that each day of surveying returns the maximum quantity of high-quality data.

The drive for efficiency is also encouraging individuals to look at the role of ground magnetometer and gradiometer surveys on the whole. A review of industry press releases re-inforces the role of ground magnetics as a key tool in exploration. As one experienced explorationist notes, "There is no replacement for spotting drill holes from known picket positions."

Ground Magnetometers and Gradiometers – Developments

Meaningful developments are occurring in a number of areas, including:

- Instrumentation
- Multi-Sensor
- Platforms
- GPS
- Navigation Systems
- Integration of Instruments

Read on to learn more about these systems.

Instrumentation

Industry is now geared to acquisition of the highest resolution results possible. “Clean” data is required for powerful 2-Dimensional (2D) and 3D modeling software which is playing an increased role in exploration today. Higher sampling is also essential for productivity and automation. Other needs include higher gradient tolerance (for iron formations) and lower power (i.e. ease-of-operation and efficiency).

How are these needs being addressed? Firstly, customer-oriented groups recognize these needs and are establishing their R&D priorities accordingly. Some of the technologies developed recently include:

- Higher sampling. The optically pumped Potassium magnetometer / gradiometer can sample to very high rates (100 samples / sec) with 20 samples / sec established as the standard limit for ground surveys. Typical applications include adding Potassium magnetic sensors to mobile ground platforms as described later. Overhauser sensors are also an option with sampling up to 5 samples / sec.

- Increase in memory by 8 times to more than 2.3 million readings in walking (i.e. nearly continuous) mode. This development is a good example of the power of the ability to handle today’s huge datasets. More memory also translates into the ability to spend more time in the field; hence increased daily productivity.

- Gradient tolerance. For surveys over iron formations, for example, increased gradient tolerance is essential. The optically pumped Potassium magnetometer / gradiometer is an excellent example of this capability with 35,000 nT/m tolerance available.

- Low power. The Overhauser magnetometer remains the industry's lowest power choice. This means easier operation and increased productivity since heavy external battery packs are not required and the system is operated in a "hands-free" mode. This is an important distinction between Overhauser and both Proton and Optically Pumped magnetics technology (which need external batteries).

Multi-Sensor Magnetometer and Gradiometer Arrays

The gradiometer is the standard example of a multi-sensor array. Interest in multi-sensor arrays is at a peak because of the many potential benefits of these types of surveys. These include:

- Increased resolution of complicated responses
- Removal of diurnal effects
- Increased resolution of sub-vertical geologic contacts
- Optimal positioning of "off-line" anomalies
- More orientation information than total magnetic intensity values alone

Interest in multi-sensor arrays is also being extended to 3- and 4-sensor arrays in a man-portable unit. This necessitates lighter sensors which have recently been put into use. The most common type of deposit for which multi-sensor arrays are envisioned are diamond plays; however, there are bound to be other types of deposits (typically complex) where multi-sensor arrays will start to play a role.

Platforms

Interest in platforms (i.e. mobile arrays) stems from several sources, including the drive for additional surveying efficiencies, the added geologic information, and the feasibility of integrating multiple types of sensors (ex. electromagnetics and magnetics) for simultaneous measurement.

Some examples of platforms include carts (man-operated and automated as in an All Terrain Vehicle installation), marine (on a Zodiac or other towed platform), snowmobile, bicycle, etc.

GPS / DGPS

GPS / DGPS has made a significant impact in many industries but perhaps not as much as in the exploration profession. Since the loosening of Selective Availability (SA) by the U.S. military, GPS systems have sprung up all over … in many different roles. From a ground exploration perspective, GPS provides the ability to survey rapidly while acquiring fully located data for integration with other available results.

A magnetometer or gradiometer fitted with GPS can now also recover GPS elevation data … a newly released capability … which is invaluable for 2D and 3D modeling where an accurate understanding of the local topography is essential to acquiring "good" model results. Or, in the absence of a Digital Terrain Model, one can be constructed using GPS data from magnetometer and gradiometer sources.

GPS gives the option of surveying without grids; however, there is a caveat. As stated previously, drill holes are generally spotted using a valid position on the ground (i.e. a picket from a previously established grid). This said, GPS can be used on a standalone basis for controlling a survey … depending on the explorationist's confidence in the GPS resolution, operators, etc.

With the interest in GPS, it is not surprising that new capabilities have been added. For instance, explorationists can pre-program up to 1000 way points either from the office or field … allowing pre-planning of surveys, operational efficiency and reduction of positioning errors. Automatic end-of-line and guidance to next line provide effective control during the survey. Real-time coordinate transformation to UTM offers flexibility in terms of the positioning system used. And local X-Y coordinate rotation allows explorationists to survey according to their existing coordinate systems for easy integration of magnetometer and gradiometer data with prior results.

Integration of a Magnetometer or Gradiometer with EM

In the past decade, integrated exploration has become the norm rather than the exception. Many ground surveys are typically run with two or more methods (ex. IP and magnetics for gold or IP, magnetics and EM for copper, etc.). These methods are typically applied sequentially resulting in increased surveying costs.

An alternate approach is to integrate magnetics and EM, for instance, on a suitable platform such as a towed cart, and make measurements simultaneously.

The Airborne Magnetometer and Gradiometer – Introducing New Technologies

While recognizing that ground magnetometer and gradiometer surveys are here to stay, it is also important to recognize that airborne methods offer a viable alternative where ground methods are uneconomic. This can include large surveys, remote-access surveys or surveys with challenging terrain. Other considerations for airborne surveys are acquisition of data that is free from near surface geologic noise and the cost of land permissions to perform ground surveys.

As we look further, we'll also find that there are new methods filling a void between traditional fixed-wing / helicopter and ground surveys.

Airborne Magnetometers and Gradiometers – Developments

Developments in airborne magnetics are occurring in a number of areas, including:

- Instrumentation
- Acquisition Systems
- Gradiometers
- Platforms

Read on to learn more about these systems or access GEM's PowerPoint presentation on "Latest Advances in Magnetics" by clicking here (XXX).

Instrumentation

As with ground magnetics, industry is seeking as high resolution data as possible. The rationale is similar to ground methods and you may want to refer to the ground instrumentation section for details.

Industry needs can now be met more easily with the development of an airborne optically pumped Potassium magnetometer (K-Mag). This system comprises a magnetic sensor

head of variable dimensions (according to survey specifications or need), and pre-amplifier / heating console with connecting cable to the sensor.

In use in Mexico, Israel and other countries, the K-Mag offers an order-of-magnitude higher sensitivity than other units, and delivers excellent results, for example, in mapping alteration halos around suspected resource locations. The higher sensitivity coupled with high sampling (up to 100 samples / sec is feasible) deliver a new level of quality in airborne magnetic measurements.

As described in the Exploration Trends and Developments article for 2004 published by the Geological Survey of Canada, " Terraplus now offers the GSMP-30A helicopter magnetic system for acquiring high-quality airborne data at minimal cost based on the company's optically pumped Potassium technology. The benefits include:

- Relatively inexpensive installation
- Easy operation and elimination of costly data acquisition systems with GEM's GSMP-30A console
- Reliable acquisition of data via the most sensitive commercial airborne magnetometer / gradiometer on the market
- Accurate positioning of survey measurement locations with the system's integrated radar altimeter and GPS data
- Quick downloading of results

The unit also comes with a precision-designed bird for housing the magnetic sensors, sensor electronics, and GPS antenna and radar altimeter. State-of-the-art instrumentation includes the TRA3500 Terra Radar Altimeter and NovAtel GPS receivers with antenna. Cabling includes high-strength Kevlar-reinforced tow cable and a data communications cable. With all the mechanisms provided, installation involves simply connecting the tow / communication cable, bird and helicopter-based acquisition / GPS console and start. Systems are also available for fixed-wing installation."

Magnetometer / Gradiometer Acquisition Systems

Various commercial systems are now available for controlling data sampling, recording and data formats. These systems provide an alternative that can be quite powerful - depending on the system, it is possible to handle up to 4 magnetometers with sampling rates to 100 samples / second, for example. These systems can typically provide a simultaneous graphic display - data, navigation & pilot guidance, survey path – for facilitation of high efficiency surveys.

Inputs are available for analog data from sources such as radar altimeters or from compensation systems. Advanced compensation routines for fixed-wing aircraft are currently available from a number of suppliers.

Gradiometers

There is significant interest in gradiometers for resolving anomalies, removing diurnal effects and other applications as described in our discussion of ground-based methods.

The company continues to develop its technology and evolved from Overhauser to optically pumped Potassium magnetometer for airborne work. These systems are now available in either single or multi-sensor configurations according to the requirements of the work to be performed. Additional research is currently underway to develop more advanced configurations of sensors for gradiometer work.

Platforms

Airborne magnetometry and gradiometry has typically been performed using either fixed-wing or helicopter-based installations. However, a new hybrid technology is now being introduced. This class of vehicles, called Unmanned Airborne Vehicles or UAVs, appears to have interesting potential for remote regions in which the topography is not overly challenging (climb rates of most UAVs is still low at this stage of the technology's development).

Summary

As we have seen in this short overview, new magnetic technologies offer data quality and high sampling for effective decision-making in mineral exploration. Ground technologies continue to advance in many areas including instrumentation, multi-sensor arrays, platforms, GPS, navigation systems and integration of instruments. Some of these are also affecting airborne technologies, notably including instrumentation, magnetometer / gradiometer acquisition systems, gradiometers and platforms.

These evolutions all are positive signs of change for a method that continues to be one of the mainstays of exploration. The bottom line is increased efficiency in the field, higher quality data and hence, better use of resources and better decision-making in the placement of high-return exploration drill holes.

As an explorationist considering the effective use of magnetics for your next project, the choice is clear … Overhauser magnetometers position you for success. To see how systems are being used around the world, clich here. You will be taken to a list of case histories showing the various applications of magnetometers in mineral exploration.

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