RECENT ADVANCES IN MAGNETIC TECHNOLOGIES

Near-Ground Sensor Arrays for Near Surface Geophysics

Near surface geophysical applications, such as UXO / EOD and archeology, call for high-sensitivity surveys – a result often obtained by altering the sensor geometry to move the sensor close to the target source (i.e. near surface anomaly).

As shown below, GEM's Overhauser system provides several options for positioning sensors in this type of orientation. Sensors can be operated in either hand-held or hands-free modes, depending on operator preference.

New GEM Overhauser sensor designs are focused on decreasing sensor weight and to further enable operator productivity, comfort and convenience in the field.

Hands-free gradiometer as required in UXO / EOD and other near surface applications. System includes built-in GPS and configurable gradiometer to eliminate diurnal effects without base station corrections.

Hand-held Overhauser magnetometer applied in archeological survey application.

Multi-Sensor Ground Systems

As the application of magnetics continues to mature in disciplines such as UXO / EOD detection and characterization, there is increasing demand for multi-sensor systems. As with airborne systems, ground multi-sensor systems enable more precise resolution of geologic boundaries and orientation / characteristics of buried magnetic sources.

GEM is currently deploying the first commercial generation of multi-sensor ground sensors as part of its ongoing R&D initiatives.

Future applications may extend not only to traditional fields such as resource exploration but also to environmental, engineering and other mapping applications, where the availability of high-resolution Overhauser and Potassium systems combined with multi-sensor arrays will provide new means of characterizing near-surface geologic and man-made targets.

Upgraded Web Site for Latest Technical Information and Case Histories

GEM has recently upgraded its website (www.gemsys.ca) for easier navigation and access to the latest information on magnetic technologies and case histories. You can also subscribe to our quarterly e-newsletter, Quantum, and view the latest product details.

RECENT ADVANCES IN MAGNETIC TECHNOLOGIES

Lower-Noise, Higher-Productivity Magnetometers

In the past year, many innovations have been made in sensor technology; signal counting; firmware and software; and hardware and console design. GEM's recent v6.0 release is implemented in its Overhauser, Potassium and Proton Precession systems and delivers:

Enhanced data quality

- 25% improvement in sensitivity (new frequency counting algorithm)
- New intelligent spike-free algorithms (in comparison with other manufacturers, GEM ***does not apply smoothing or filtering*** to achieve high data quality)

Improved operational efficiency

- Enhanced positioning (GPS engine with optional integrated / external GPS and real-time navigation)
- 16 times increase in memory to 32 Mbytes (optional). 4 Mbytes standard
- 1000 times improvement in processing and display speed (RISC microprocessor with 32-bit data bus)
- 2 times faster digital data link (115 kBaud through RS-232)

Innovative technologies

- Battery conservation and survey flexibility (base station scheduling option with 3 modes - daily, flexible and immediate start)
- Survey pre-planning (up to 1000 programmable waypoints that can be entered directly or downloaded from PC for greater efficiency)
- Efficient GPS synchronization of field and base units to Universal Time (UTC)
- Cost saving with firmware upgrades that deliver new capabilities via Internet (enhanced GEMLinkW software)

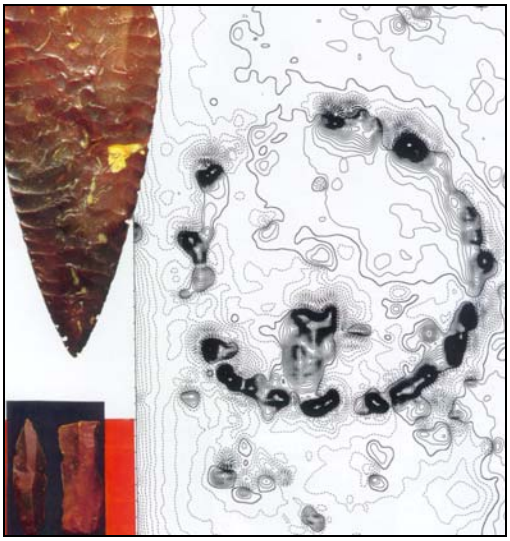
High Sensitivity Results with Overhauser Magnetometers

Since their introduction by GEM Systems, Inc., Overhauser magnetometers have become a standard for sensitivity and accuracy in many applications, including mineral exploration, archeology, observatories, volcanology, etc.

Unlike the proton precession systems to which they are often compared, Overhauser magnetometers employ an electron-enhanced mix of protons and electrons, and a Radio Frequency field for polarization. This approach generates a very high amplitude signal with minimal consumption.

Overhauser magnetometers also occupy a unique position in terms of quantum magnetometers. Specifically, they are ***more than an order of magnitude more sensitive than proton precession systems and nearly match the sensitivity of cesium systems.*** In comparison with cesium, there are also major benefits in terms of cost, heading errors and power savings.

Overhauser systems are evolving rapidly with many new developments, such as the v6.0 enhancements described previously. As well, applications continue to increase as shown in the archeological example below.



Case history example from Danish archeological survey. High-sensitivity Overhauser data show outline of magnetic megaliths within Stone Age barrow.

RECENT ADVANCES IN MAGNETIC TECHNOLOGIES

Built-In GPS / DGPS

As the only commercial magnetometer manufacturer to offer built-in GPS / DGPS, GEM's built-in approach gives a seamless and integrated positioning solution that minimizes weight and removes additional components that are inconvenient in the field.

Built-in GPS also provides significant cost advantages … talk to GEM about their new ***lower GPS / DGPS system prices***.

Our customers can choose from a range of GPS and DGPS options to fit different application needs and budgets. For mineral exploration, a positioning accuracy of <3m may be sufficient whereas an archeological or UXO survey may require an accuracy of <1m.

A. v5.0 and v6.0 Options

- Time only, built-in GPS.

B. Stand-alone GPS (v6.0)

- <5m resolution, built-in GPS.

C. Stand-alone DGPS (v6.0)

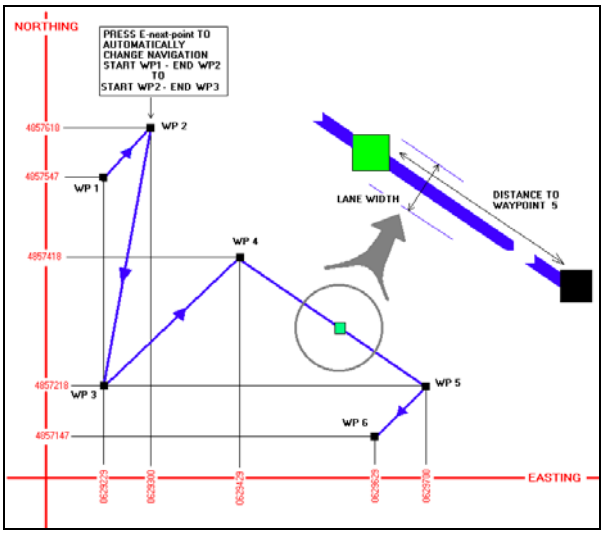
- <3m resolution, built-in DGPS with WAAS / EGNOS.
- <1m resolution, external DGPS with WAAS / EGNOS or international subscriber services - OmniSTAR or Thales).

D. DGPS Systems (v6.0)

- 0.1 to 1m resolution, internal DGPS system with post-processing. Requires base and rover GPS / Mag.
- 1 cm resolution, external high-end DGPS system. Requires radio modems.

Waypoint Programming

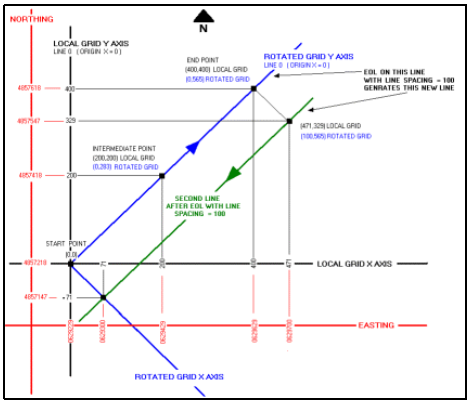
Waypoint navigation enables operators to pre-program their surveys prior to reaching the field – a process that reduces set-up and surveying times. It also facilitates irregular "search-type" survey acquisition patterns.



Waypoint navigation example showing path and inset with lane width. Operators navigate precisely within a pre-defined "corridor" or lane to meet exacting survey specifications.

Coordinate Rotation

Another recently implemented system is coordinate rotation.



Lane rotation example showing re-orientation of paths to survey obliquely oriented targets.

Note: Categories B, C and D above include time, lat / long, and navigation option (UTM conversion, coordinate rotation, waypoint programming and lane guidance).

RECENT ADVANCES IN MAGNETIC TECHNOLOGIES

Small-Diameter Sensor Potassium Magnetometers

Optically pumped potassium magnetometers are often compared with cesium devices. However, there are significant technical differences as described in the technical paper, "A Brief Overview of Quantum Magnetometers," available at www.gemsys.ca.

In a recent development, GEM is implementing new, smaller diameter sensors that maintain many of the advantages of potassium over cesium systems, while enhancing gradient tolerance significantly.

Ultimately, these developments will provide significant benefits for users performing archeological and other similar high-end surveys. These include very high sensitivity and absolute accuracy.

Airborne Potassium Instrumentation

GEM recently introduced "SuperSenser" -- the highest resolution airborne system available. The GSMP-30A is based on a unique optically pumped Potassium sensor - a technology that offers an order-of magnitude increase in resolution over other systems as well as:

- Reduced "heading" errors
- Highest absolute accuracy
- Decreased maintenance costs

These advantages make the GSMP-30A a key solution to consider for your next airborne installation. The sensor deploys as a single unit or in combination with other sensors for magnetic gradient measurements.

SuperSenser (previous column) deployed in a multi-sensor configuration for gradient and total field measurements. SuperSenser (above) deployed in a "stinger" configuration.

Implementation of a New, Ultra-Sensitive Gradiometer

Over the past decade the Soreq Nuclear Research Center, the Geological Survey of Israel and the Survey of Israel have accumulated substantial experience in applying modern and advanced technologies in earth sciences.

Recently, Isorad (the commercial branch of Soreq) in cooperation with R&D institutes - Soreq NRC, the Geological Survey of Israel and the Survey of Israel – and GEM Systems, Inc. implemented a new advanced gradiometer system. The gradiometer is specially designed for acquiring precise geomagnetic field observations worldwide and long-term monitoring. For details, visit www.gemsys.ca.

Summary

Magnetics is a dynamic and constantly evolving field with many new developments contributed by GEM Systems, Inc. These include:

- Advanced GPS positioning strategies
- Lower-noise, higher productivity magnetometers / gradiometers
- Overhauser enhancements
- Multi-sensor ground systems
- Small-sensor potassium magnetometers
- Airborne potassium systems
- Ultra-sensitive gradiometers

And with the advance in technologies, applications are also evolving … providing new means of addressing geophysical problems in a variety of earth science disciplines.