In 2012, EON Geosciences flew surveys in Quebec for the Ministère des Ressources Naturelles et de la Faune (MRNF), Iamgold and Belmont Resources; in California, for the United States Geological Survey (USGS); and in southeastern Greenland, for the Geological Survey of Denmark and Greenland. The Greenland survey marked EON’s first international survey, with a second planned for 2013. The company began flying its new ET-HEM time-domain electromagnetic system, which is now available for surveys worldwide. The system has a 50-sq.-metre octagonal transmitter loop with a dipole moment of 235,000 NIA, and a programmable base frequency of 30, 45, 75, or 90 Hz. Additionally, EON put its recently acquired Piper Cheyenne II twin-turbine aircraft into operation, increasing the company’s survey capacity.

Sister company EON Airborne is in the process of obtaining its air operator certification from Transport Canada, which will allow it to control and manage the operation and maintenance of the aircraft fleet.

Fugro deployed additional TEMPEST EM systems on Cessna Caravans in Africa, for a total of three systems. In 2012, the company introduced the 75 Hz TEMPEST with improved spatial resolution and lower noise levels in shallow or resistive terrain. R&D into the TEMPEST transmitter and receiver design led to significant transmitter power and signal-to-noise improvements which will be introduced into the Australian market in early 2013. The TEMPEST system, using a 225 Hz base frequency, branded as GENESIS, successfully completed a paleochannel mapping program in Africa, launching a new near-surface, high-resolution mapping capability. The Cessna Caravan-mounted TEMPEST system will receive a dipole moment upgrade in early 2013 with a doubling of transmitter power. HELITEM developments in 2012 pushed the envelope for difficult deposit detection with the detection of the Lalor Lake massive sulphides (600 metres wide and 550 metres deep) in the Snow Lake area of Manitoba. According to Fugro, Lalor Lake deposit, owned by HudBay Minerals, had not been detected previously by any active airborne EM system.

The company’s aeromagnetic fleet conducted a variety of surveys in 2012, ranging from large-scale mapping programs to high-resolution mineral and petroleum exploration programs across the globe. Fugro’s Canadian-based magnetic and gamma-ray spectrometric aircraft were busy flying surveys primarily in Eastern Canada. In addition to a number of surveys conducted for publicly traded companies, several government mapping surveys were started or completed including: a survey in northern Quebec for the MRNF; a survey near Pelly Lake, Nunavut, for Natural Resources Canada (NRCan); and a survey in northern Ontario for the Ministry of Northern Development and Mines (MNNDM). Surveys were also carried out in the United States in Kansas and Colorado.

Fugro conducted numerous HELITEM surveys in Canada, West and East Africa, the Middle East, Brazil and Australia. Fugro’s broadband GEOTEM and TEMPEST time-domain electromagnetic systems were active in the Northwest Territories and
Aeromagnetic Surveying

GEM Systems of Markham, Ont., has developed a Potassium optically pumped magnetometer sensor specifically for making ultra-high sensitivity magnetic measurements with Unmanned Airborne Vehicles. GEM’s UAV sensor is the most sensitive airborne system available globally and is easily installed in UAV platforms. Data can be stored onboard in an electronics box or transmitted during flight. Data from multiple days may be stored in the large-format memory. The sensitivity of the Potassium vapour sensor is 0.0005 nT @ 1 Hz, and can be configured as a single unit or multiple units for gradiometers.

Geotechnologies developed a second generation of its Rein-Mag magnetic compensation software in 2012. The concept that temporal and spatial variations of the earth’s magnetic field during calibration will affect calibration results was implemented in the ReinMag algorithm to improve compensation quality. Rein-Mag is used as a part of Geotechnologies’ GT-MAG aeromagnetic system. Initial surveys with the new ReinMag version were conducted last summer in Kazakhstan by Geoken Co., using AN-2 and L-410 fixed-wing aircraft.

Goldak’s Triaxial magnetic gradient system coupled with attitude determination and correction was a popular choice for airborne magnetic surveys. Attitude determination allows the measured gradients to be “rotated” to the line direction, removing the effects of crab, roll and pitch that cannot otherwise be corrected. In 2012, the company also began to employ a Novatel SPAN-CPT GPS receiver to provide accurate pitch, roll and yaw information in its Caravan.

Mississauga, Ont.-based RMS Instruments has expertise in magnetics, compensation, aircraft magnetic signature analysis and modification, radiometrics, gravity, navigation, ancillary equipment, field operations and complete system integration. The company has delivered technically advanced turnkey systems, including training, to clients globally. RMS reported that the second-generation of AARC500 and DAARC500 systems for real-time aeromagnetic compensation and data acquisition saw high demand in its first full year on the market. The new technology offers improvements in performance, functionality and reliability, and full compatibility with first-generation instruments. New updates are added periodically through firmware updates, such as the upcoming support for dynamic compensation of onboard electronic systems. The AARC510 Adaptive Aeromagnetic Real-Time Compensator which saw its first year in full production in 2011, now includes new built-in features tailored to UAV applications. The system is compact and cost-effective, yet powerful and comprehensive and is ideally suited to strap-down installations in small, fixed-wing aircraft and helicopters.
In an interesting ongoing R&D project, Carleton University in Ottawa, and Sander Geophysics are collaborating to design, build, and test an Unmanned Air System (UAS) for aeromagnetic surveying, the GeoSurv II. The latest GeoSurv II prototype weighs 90 kg, has a wingspan of 4.9 metres and is powered by a 30 HP 2-stroke engine. While its first flight is planned for spring 2013, a simulated version of the UAS was built to execute preliminary tests of its future performance. The simulated UAS was slung 33 metres below a helicopter as a T-shaped structure configured with a horizontal gradiometer with two magnetometers spaced 4.67 metres apart, to replicate the wingspan and sensor geometry of the UAS. A test survey was conducted using the simulated UAS in the Plevna area of Ontario, in the Grenville Province. The total magnetic intensity data recorded by the simulated UAS could then be compared to data from a conventional regional fixed-wing survey and a ground magnetic survey.

During 2012, Scott Hogg & Associates (SHA) carried out Heli-GT surveys in Ontario, British Columbia and Nunavut. The company developed the Heli-GT system to measure total magnetic field plus three geo-referenced magnetic gradients. Unlike most gradiometers, the system measures the pitch, roll and yaw of the bird in order to automatically resolve accurate gradients in the north, east and vertical directions, no matter the heading or attitude of the helicopter or magnetometer array. These geo-referenced gradients are then used by SHA’s GT-Grid software to produce high-resolution maps of the magnetic field in even the most complex geological settings. In 2012, a second Heli-GT was built and VLF-EM and gamma-ray spectrometer systems have been optionally included. SHA continued to work with Tundra Airborne Surveys, which brings years of field experience to the operations.

**Airborne Electromagnetic Surveying**

Fugro developed and tested an advanced broadband helicopter time-domain EM system that uses a novel dual-pulse waveform. The new system design provides HELITEM-like power for deep detection while offering a second unique pulse that effectively characterizes near-surface geology with high resolution.

**Geophysics GPR** continued to improve the helicopter GPR-TEM system (600,000 NIA) first introduced in 2011. The company has updated the receiver coils and electronics, increasing the signal-to-noise ratio and improved the data processing to optimize accuracy of the extracted data.

**Geotech** continued to survey across the globe with its fleet of over 30 VTEM helicopter-borne time-domain electromagnetic (EM) systems in 2012. A new full-waveform VTEM system with improved early-time data was developed and is currently being flown for surveys requiring very shallow mapping capability, i.e. for near-surface, hydrogeologic and kimberlite exploration, without any loss to its deep penetration characteristics. The system features both an improved system frequency bandwidth that allows for earlier time-decay measurements and a newly implemented system response calibration design. The new VTEM design uses the streamed half-cycle recording of transmitter and receiver waveforms to obtain a complete system response correction throughout the entire survey flight that helps to precisely eliminate the effect of the data acquisition system response on the recorded signals. The full-waveform technology can be added to the standard VTEM system without diminishing its patented low noise and deep penetration characteristics. In addition to improving the system bandwidth and the complete system response calibration, new digital signal processing techniques have been applied to reduce the effect of the input transmitter waveform and time-varying injected current using both a parasitic loop capacitance correction and a transmitter drift correction, as well as ideal waveform deconvolution. A new VTEM max system has been engineered to offer excellent shallow and deep mapping capabilities. It has an extremely large loop 35 metres in diameter, over 1.3 million NIA, and an improvement in the signal-to-noise ratio by a factor of 190 compared to the 2009 version of VTEM. The continuous improvement in the VTEM’s signal-to-noise levels and increase in dipole moment al-