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HALL OF FAME

Peter Annan, Mike Carson, David Fountain, John Gingerich
George Nader, Bruce Magnes, Tom Payne, Al Proulx
Brenda Sharp, Richard Smith & Ken Witherly,
the MEGATEM development team

/EXPLORATION

Ken Witherly (BHP) and John Gingrich (Noranda) were users of the equipment that recognised the potential of the system and drove its development from the demand perspective. This demand was not just in their organisations, but also from governments and public organisations.

Mike Carson led the interaction with BHP, while George Nader and David Fountain interacted with Noranda. All were champions within the Geoterrex corporate structure and collectively convinced senior management and employees to get behind the development project.

Richard Smith and Peter Annan were involved with the geophysical justifications for the system and design and development of the system and the prior successful developments that were incorporated into the MEGATEM development. They provided strong technical support and gave confidence that the system would be a successful exploration project.

Tom Payne, Bruce Magnes and Al Proulx designed and tested the electronic and software systems for the MEGATEM developments and upgrades. Proulx operated the system in the early period when the bugs were being worked out of the system.

Brenda Sharp processed the data from the MEGATEM and identified an anomaly that led to the discovery of the $4 billion Perseverance deposit near Matagami, Quebec. This discovery was critical at an early stage, when the system was just starting and needed success to gather momentum.

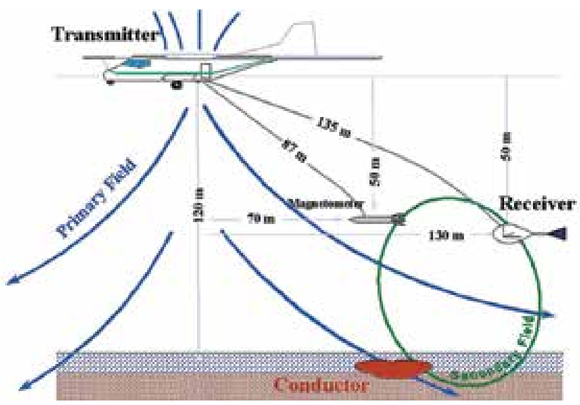
The strengths of the system were explained to potential users by Smith and Fountain, who were critical in the technical marketing of the system to the exploration community.

MEGATEM was an extremely successful system, being able to fly at very high latitudes in Chile and Peru. The system identified an anomaly of the Spence deposit prior to its discovery, but it was not drilled at that time for geological reasons.

The MEGATEM system refuelling while on a government survey.

In Canada, the system was used by the Ontario Geological Survey and Discover Abitibi to refly areas in Ontario and virtually all the greenstone belts in the Abitibi subprovince of Quebec were reflown by Noranda with support from the Quebec ministry. During the uranium boom in the first decade of the new millennium, it was extensively flown in the Athabasca basin for its ability to detect the prospective graphite horizons at more than 700 m depth. The use of the MEGATEM technology became a critical part of junior companies' exploration strategy and was mentioned in press releases in order to raise funds on the stock exchanges.

In the mid-1980s, Geoterrex (later Fugro Airborne Surveys) introduced the GEOTEM system, a fully digital airborne electromagnetic (AEM) receiver, using the same transmitter that had previously been used, very successfully, on the INPUT system. The GEOTEM system was mounted on a twin engine CASA 212 aircraft, and the transmitter loop was wound around the nose, wing tips and the tail of the aircraft. A transmitter excites eddy currents in the subsurface with periodic pulses of the 'primary' magnetic field. The decay of these currents is measured with a receiver that is towed behind the aircraft in a 'bird'. When the eddy currents decay slowly, this is generally indicative of material in the subsurface that is conductive.



A schematic diagram of the GEOTEM airborne electromagnetic system. The receiver sensor is towed in a 'bird' 130 m below and 50 m behind the transmitter. There is also a magnetometer bird for measuring the intensity of the Earth's geomagnetic field

Airborne electromagnetic systems typically also measure the intensity of the Earth's geomagnetic field. For the GEOTEM system the magnetometer is in a second bird that is also towed behind and below the aircraft. Having magnetic data is useful for mineral exploration, as it can help to distinguish between conductive suphides (which are often associated with magnetic sulphides – for example pyrrhotite) and other conductive features like clay, graphites and shear zones (which are not magnetic). The magnetometer towed-bird location puts the magnetometer sensor close to the ground and provides high-resolution data.

In the mid 1990s, the GEOTEM system on a CASA had been deployed by BHP for exploration at relatively high altitudes (less than 2,400 m) in the Altiplano regions of the Andes Mountains of South America. By 1996, BHP was interested in exploring in areas above 2,400 m altitude.

The CASA fixed-wing aircraft carrying a GEOTEM system is limited to flying in areas when the altitude is less than 2,400 m. In order for a twin engine aircraft to fly surveys safely, the aircraft must be able to maintain altitude (or climb) after it has lost the use of one engine. When the aircraft is surveying at high altitudes (and temperatures) the ability of the aircraft's wing to provide lift is reduced.

Effectively this means that the aircraft cannot fly safely at high altitudes, particularly when the temperature is high either at the airport or in the survey area. The additional weight and drag of the transmitter loop mounted on the aircraft means that the performance of the CASA with a GEOTEM system is not equivalent to a standard CASA.

BHP wanted to extend the capability of the existing GEOTEM system without compromising safety. In order to satisfy BHP's requirement for airborne electromagnetic surveys at the higher altitudes, it was felt a new type of aircraft was needed.

As a consequence of this need, BHP was supportive of installing the GEOTEM system on another aircraft. The aircraft selected was the Dash-7, primarily because this aircraft had four engines, and losing a single engine would not be as critical – there would still be three engines remaining in operation to maintain the altitude of the aircraft.

A major project was then begun in 1997 to install a transmitter loop and the associated EM equipment on the Dash-7 aircraft. The primary task was to design a transmitter loop and the attachments to the nose, wing tips and tail of the aircraft. The engineering design of a safe transmitter loop is a major task, so basing the loop and installation as much as possible on the existing six-conductor CASA installation minimized the technical complexity. An attempt was made to construct an eight-conductor loop, but this loop was unstable in flight, so the design reverted to a six-conductor loop.

At the time, a deliberate business decision was made to minimise the technical and financial risk by simply installing the existing EM transmitter current pulser and the receiver system onto the aircraft. However, it was acknowledged that because the aircraft was capable of supplying more electrical power and carrying heavier EM equipment, the Dash-7 could be upgraded at a later time to carry a higher power transmitter pulser.

The Dash-7 mounted system was flight tested in late 1998 and was found to be able to operate safely up to altitudes of more than 4,400 m when operating on three engines. Being able to operate at these altitudes opened up a large percentage of the High Andes for exploration with fixed-wing AEM equipment. The larger size of the aircraft meant that the area of the transmitter loop was 406 m^2 compared with 232 m^2 for the CASA installation (an increase of 75%). Thus, although the EM transmitter was not upgraded, the peak transmitter dipole moment of the system also increased by 75% to about 1.1 million Am^2. Because of this larger dipole moment and the physical size of the Dash-7 aircraft, the system earned the name MEGATEM.

The MEGATEM system was deployed for almost a year in South America and returned to Canada in late 1999. At that time, Noranda explorationists were carrying out a re-evaluation of the Matagami camp. An historical analysis of the depth to the top of discovered deposits and ore bodies raised the question as to whether historical fixed-wing AEM systems had been as effective as had previously been thought. As a consequence, Noranda undertook an evaluation of all existing AEM systems over a test area near Matagami that included the Caber deposit. This deposit is a difficult target for AEM systems, being shaped like a cigar standing on its end and having its top buried more than 125 m deep. The MEGATEM system flew this test area in December 1999.

The Dash-7 aircraft is capable of supplying more electrical power and carrying heavier EM equipment than the CASA aircraft. With Noranda's encouragement and support, the MEGATEM system underwent a further upgrade in early 2001. This upgrade took advantage of the power available from the AC generators on each engine. The total power available is about 40 kW, this power was converted to DC and used to drive an upgraded transmitter pulser. The four-fold increase in power resulted in a two-fold increase in peak transmitter dipole moment to 2.2 million Am^2. This upgrade to the MEGATEM system was designated MEGATEM II.

In 2005, Fugro introduced the HeliGEOTEM. This system brings together the proven GEOTEM/MEGATEM technology with the greater operational flexibility and improved lateral resolution of helicopter-mounted AEM systems. This HeliGEOTEM system has undergone significant improvements since its introduction and is now marketed as HELITEM by CGG (to whom Fugro Airborne Surveys was sold).