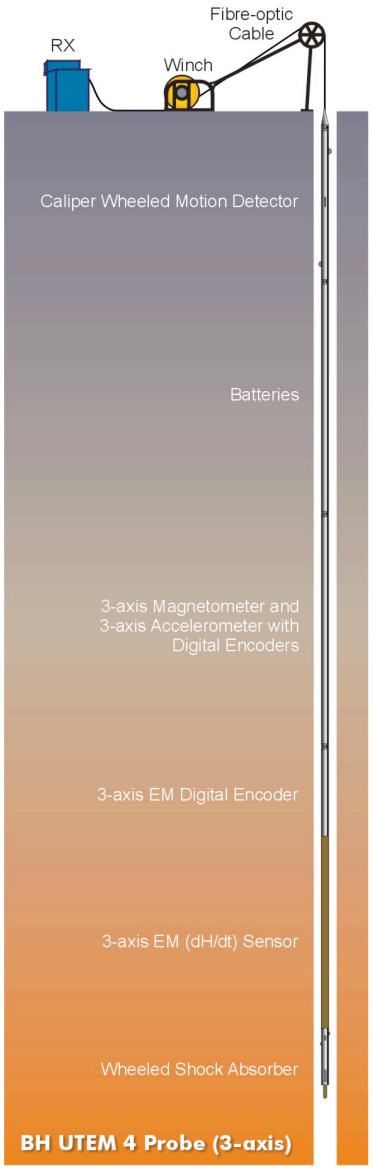

BH UTEM 4 - Down-Hole Probe

The BH UTEM 4 system includes a down-hole probe made up of five modules that are assembled at the hole collar by means of quick locking couplings with double 'o' rings. All listed modules are needed to obtain oriented three component measurements. Additional battery modules can be added to the probe to extend the survey time available. The BH UTEM 4 output is a serial data stream compatible with the BH UTEM 3 fibre optic data link. The BH UTEM 4 probe incorporates down the hole analog to digital conversion and much of the data processing and control functions that are normally found in a digital EM receiver.

The BH UTEM 4 probe is designed to be assembled at the hole collar by means of single turn twist lock mating threads. Special collar clamps are used to hold the suspended assembly.

BH UTEM 4 SYSTEM COMPONENTS: (38 mm diameter modules)

3-axis EM (dH/dt) Sensor and Digital Encoder module:
- -coincident measurement point
- -simultaneous measurements of all 3 axes
- -proprietary 3-component sigma-delta digital encoder
- -field nulling feedback design
- -sensor length: 112 cm
- -overall module length: 164 cm
- -effective area axial: 165 m2
- -effective area transverse components: 45 m2

3-axis magnetometer and 3-axis accelerometer (with digital encoder) module:
- -3-axis ring core flux gate magnetometer
- -3-axis micro-machined accelerometers
- -temperature sensor (+0.02C with deconvolution)
- -multiplexed multi-channel digital encoder
- -data decimation and preprocessing
- -data compression
- -serial multiplexing and packed formatting
- -gain/power supply/motion sensing/options controller
- -2 hour battery warning
- -fibre optic data stream encoding
- -power supplies
- -length: 131 cm

Battery module:
- -4.4 Amp-hours/ from two 12 Volt rechargeable battery packs
- -battery life: >15 hrs continuous operation
- -additional modules can be stacked to increase survey time
- -length: 130 cm
- -2 hour battery life warning

Caliper Wheeled Motion Detector module
- -sends motion signals to controller
- -triggers power supply turn off in default mode
- -remote setting of down-hole controller options
- -prevents severe probe rolling
- -length: 85 cm

Wheeled Shock Absorber module:
- -reduced friction for shallow dip holes
- -shock absorbing plunger
- -length: 45 cm

Complete BH UTEM 4 Probe assembly:
- -length: 5.7 m (single battery module configuration)
- -weight: 14.2 kg (8.6 kg with buoyancy)

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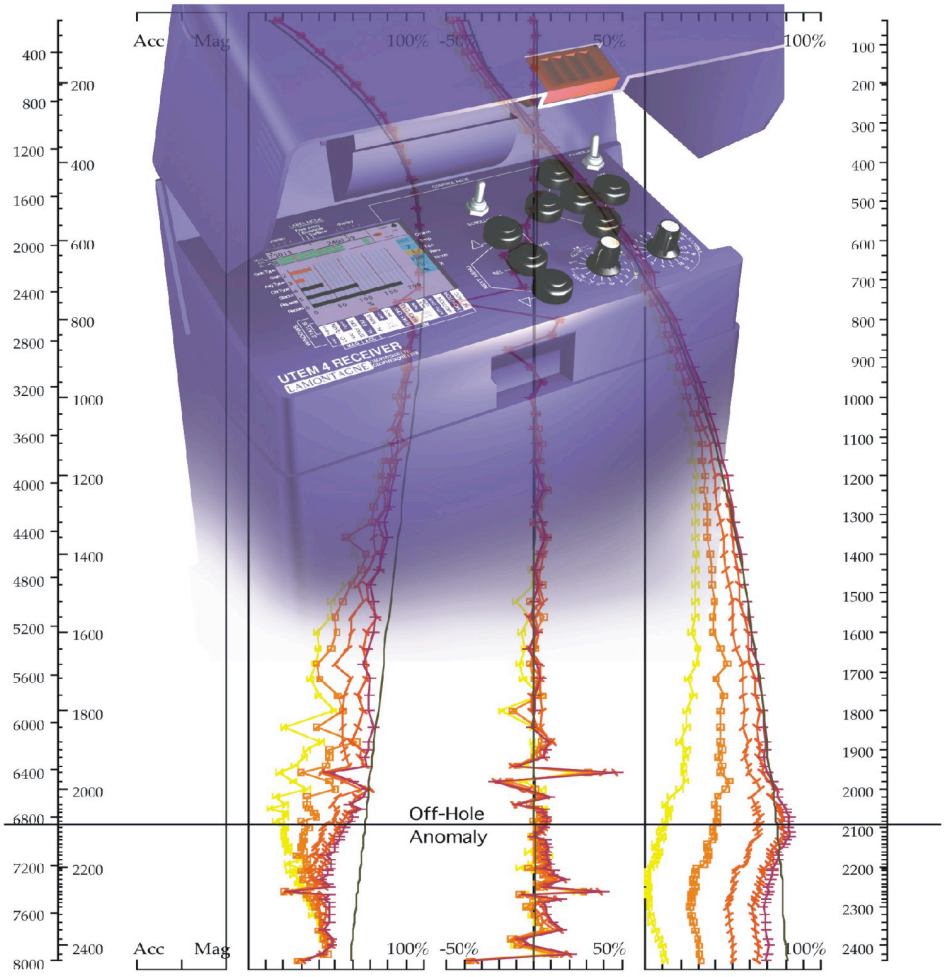
LAMONTAGNE GEOPHYSICS LTD
GEOPHYSIQUE LTEE

BH UTEM 4

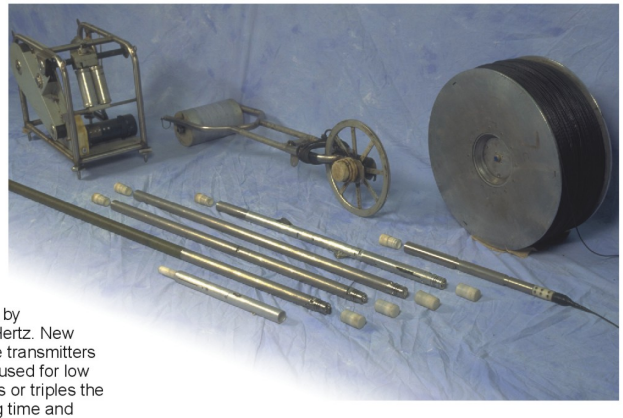
3-Axis Downhole System



1997 BH UTEM 4 data from Falconbridge Ltd. Hole NRD-008 near Sudbury, Ontario.
The original 1993 BH UTEM 3 (single axis) survey gave an early indication
that led to the Craig Depth discovery

BH UTEM 4 SYSTEM

The Borehole UTEM 4 (BH UTEM 4) system is the new generation borehole EM system from Lamontagne Geophysics Ltd. This system has been designed to do simultaneous three-axis (axial and two transverse) oriented down-hole UTEM measurements. The BH UTEM 4 system is able to survey diamond drill holes of up to 3400 metre (11,000 feet) in depth. As the UTEM system is a step response system (measures only in the "on time" while the primary field is ramping) it can detect conductors that are extremely conductive. As well, nuisance conductors can be overcome by using base frequencies as low as 1.0 Hertz. New transmitter advances allow two or three transmitters to be run simultaneously. This feature, used for low frequency operation, effectively doubles or triples the output current thus decreasing stacking time and saving valuable drill standby time. With both 3-axis magnetometers and 3-axis tilt meters (accelerometers), orienting the probe in the hole is highly reliable and accurate, even in near vertical drill holes. The BH UTEM 4 technique is the tool you need to detect conductive deposits of economic tonnage at up to hundreds of metres away from drill holes.



BH UTEM 4 - SYSTEM DESCRIPTION

The main new feature of BH UTEM 4 is its ability to do simultaneous and coincident three axis oriented down-hole UTEM measurements. Orientation of the EM sensor is recovered by the combined use of three-axis magnetometer and temperature compensated three-axis accelerometer. The digital data are preprocessed down the hole, compressed, and transmitted to the surface by means of a single fibre optical link at a rate of 100k samples simultaneously for each component. Magnetometer data, accelerometer based tilt sensor data, temperature, and system monitoring data are multiplexed with the three component EM data. The key performance numbers of the system are:

- 3400 m depth capability
- Very low deep hole system noise levels
  < 40 pT/s transverse component repeatability
  < 8 pT/s axial component repeatability
- Very high system gain fidelity for 'on' time measurement use
  < 0.05% late channel probe/receiver gain variation

The BH UTEM 4 system comprises the BH UTEM 4 down-hole probe and the BH UTEM 4 receiver. A field ready system would also include a BH UTEM winch, a winch motor controller, one or more fibre optic cable spools, inter-connecting cables, and wire laying accessories which are unchanged from those used in the BH UTEM 3 system. The BH UTEM 4 down-hole probe has a maximum diameter of 38mm for use in holes of AQ and greater diameter. The BH UTEM 4 data reduction and display software includes 3-axis data reduction oriented relative to a user specified section. Magnetometer, inclinometer and temperature data profiles can be plotted in addition to the EM data.

BH UTEM 4 - RECEIVER

The BH UTEM 4 receiver is a multi-component EM receiver for use with the BH UTEM 4 down-hole probe. It incorporates an improved pre-emphasis deconvolution (PED) and other new noise processing techniques, yielding significantly improved noise performance. In addition to EM data processing, the BH UTEM 4 receiver automatically acquires magnetometer, tilt sensor, and monitoring parameters from the down-hole probe. All data are acquired in digital form via the fibre optic link.

The input signal is a high speed compressed serial code. The BH UTEM 4 receiver performs decompression, decoding, secondary sigma-delta decimation, PED noise processing, gate sampling, stacking, probe orientation, primary field reduction, data logging and user interfacing. Magnetometer, tilt sensor, temperature data, battery voltage, and other status information are automatically acquired as they occur in the data stream and used in recovering the probe orientation.

The BH UTEM 4 receiver also has a integrated depth counter for automatic down hole data labelling. It can be connected to other compatible instruments for clock synchronisation and parameter data transfer. There is an integrated data logger with non-volatile memory and a SCSI interface with both upload and download capability. Data dumping and uploading of geometrical data are done by connecting the BH UTEM 4 receiver to a SCSI compatible drive with removable media (such as a Zip drive.) The geometrical data are stored in the receiver and used in the probe orientation and primary field calculations. A minimum curvature 3D hole trajectory is calculated from the raw dip and azimuth using a proprietary algorithm.

The BH UTEM 4 receiver has extensive real time monitoring capabilities. Raw signal levels, down-hole settings, and live stacked channel data can be monitored. For quality control the EM channel data can be monitored during stacking through multiple bar graphs that mimic analogue meters. The monitoring functions are controlled by rotary switches for easy scanning between channels, components and display modes.

BH UTEM 4 - RECEIVER CHARACTERISTICS:

- Simultaneous 3-component data acquisition
- Programmable Pre-Emphasis Deconvolution noise filtering
- 10 µs per component input code rate
- Ultra high A/D linearity (combined receiver and probe characteristic)
- Single Extended Precision (SEP) floating point decimation/filtering (44 bit), IEEE 754 floating point output format
- 524 Kb flash memory data logger
- SCSI upload/download interface
- Integrated depth counter with 0.4 cm resolution
- High resolution 4" colour LCD TFT display with ambient/internal lighting
- Weather proof thermally controlled case
- High precision crystal clock

BH UTEM 4 - USER INTERFACE:

- Interactive display and controls (controls always live)
- Monitoring choice raw / oriented / absolute / primary field reduced
- Auxiliary monitoring: magnetometer, tilt data, raw input signal levels
- EM display formats: analogue bar graphs, profiles, vector view, map view
- Automatic overload monitoring and detection
- Monitoring of BH UTEM 4 probe battery level, probe leakage, gains, settings, operating mode
- Remote DBH UTEM 4 probe programming capability
- Virtual keypad parameter data entry
- Mode-less rotary switch scanning control
- Tripod legged backpack

BH UTEM 4 - ADVANCED SPECIFICATIONS:

- Physical: dimensions H 61 cm, W 30 cm, D 15 cm weight 12kg (without backpack)
- Environmental: temperature powered: -40C-45C temperature storage: -10C-50C (limited by LCD display)
- Batteries: NiMH 18 A-Hr @14V
  Minimum life: 12 hours operating internal LCD lighting
  18 hours operating external light source
  30 hours 'clock on' standby

LAMONTAGNE