

HORIZONTAL LOOP EM SURVEY

Objective: To explore the electromagnetic induction response characteristics of sheet-like conductors by making model measurements with a horizontal loop EM system

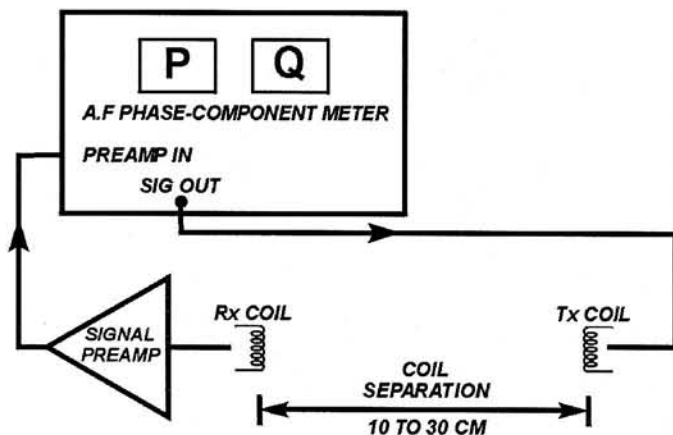
Introduction:

The Horizontal Loop EM method is widely used to explore for base metal sulphide ores in resistive host rocks (e.g., in crystalline igneous/metamorphic formations like the Precambrian shield of northern Canada). In this assignment, the HLEM method's main characteristics are studied in a laboratory scale model. There are two parts:- **a)** a laboratory study of the HLEM response of a known sheet-like conductor, and **b)** a scale model survey of a region that contains some unknown conductors.

The basic concepts of EM methods are described in the Laboratory Manual section "EM Exploration Methods". The HLEM ground survey method is outlined in section 5 "A Model of the Horizontal Loop, In phase and Quadrature method". Please read these.

Apparatus: A typical field HLEM uses operates its Tx and Rx about 30 - 100 m apart and works at one or more frequencies in the range 100 to 20,000 Hz. Your experiments will be done with a laboratory scale model about 300 times smaller, but using the same frequency range. Conductive targets will be made of aluminum sheet or foil.

OPERATING STEPS



- 1 Select coil separation.
- 2 Select frequency.
- 3 Meter Sense to 10 V, (P & Q) (No Bucking).
- 4 Turn on.
- 5a Adjust Sig. Gain & Output Level for +10 V on P, and Phase Adj for 0 V on Q. Coils must be remote from conductors.
- 5b Make fine adjustment of Output Level and Phase Adj using 2 V ranges, and Bucking On for P. Both meters should be nulled, i.e., 0 V.
- 6 Approach coil system to conductors. Read P and Q meters, adjusting meter sensitivity as required and noting ranges. Convert all readings to % (10 V = 100%).

Figure 1: Apparatus for HLEM model measurements.

The apparatus is somewhat complicated, and is more fully described on a display sheet beside it. It consists of an electronic instrument unit connected to a model coil system. The electronic unit provides an alternating audio frequency current of selectable frequency for driving the EM transmitter coil (loop), and a voltmeter system for measuring the alternating voltage induced in

the receiver coil. The meter is complicated by the need to measure both phase components of the received alternating voltage (not just its total amplitude), and to measure quite small changes in the total voltage. In HLEM, we are interested in the *relative* amplitude and the *relative* phase of the secondary and primary signals induced in the receiver coil. Thus, we must adjust the apparatus so the signal received when no conductors are present (the primary signal) has a specified amplitude and phase. The adjustment must be repeated whenever the coil spacing, the Tx current, or the Tx frequency is changed.

Controls on the apparatus: See the display sheet for this.

Exercise a: Response of a vertical sheet-like conductor There are two aspects to this:- i) determining the response profile for a vertical conductor and ii) determining how the peak response (which occurs when the coils are symmetrically placed over the edge of the conductor) varies with conductor thickness and with the frequency used by the EM system (i.e., with the induction number or response parameter of the system).

i) Response profile Use a thick aluminum sheet as the conductor and traverse that coil system perpendicularly over its edge (near the middle of that edge). Note carefully the depth of the conductor's edge beneath the profile line along which the centres of the HLEM coils are traverse. Consider the midpoint between the Rx and Tx coils to be the reference point of the coil system.

The response from a thick aluminum plate should be largely in-phase at any possible frequency. An EM system frequency at 1 kHz, and a coil separation in the range 15 - 30 cm are suggested. Obtain profiles at two coil different separations and for two different dimensionless depths. Dimensionless depth means the ratio - (depth of the top of the sheet below the profile) / (coil separation). Suitable values are in the range 0.05 to 0.3. Plot graphs of the profiles as in-phase (P) and quadrature (Q) secondary response versus position of the HLEM system on the profile. Express secondary voltages as a percentage of the primary (in phase) voltage. (The primary voltage usually is set to a level of 10 volts, so 1 volt of secondary signal is 10%).

ii) Effect of induction number Measure the variation in response amplitude of the EM system to two different conductors, as a function of frequency over the range 0.1 to 20 KHz. (Only the peak anomaly needs to be determined). Sheets of several different thickness are available. (Thicknesses are marked in mils. The conductivity of aluminum is about 2.5×10^7 S/m. A sheet of 15 mils (15/1000 inch) thickness displays both high and low induction number characteristics in the 0.1 to 10 kHz range. Plot graphs of P and Q response (linear) versus induction number (on a logarithmic scale); also a phasor diagram of the responses.

Exercise b: Explore for conductors hidden in one of the two cream and brown-coloured table boxes in the laboratory. Set up a survey grid on the surface, taking note of the fact that the long axis of the box is the regional strike direction. The target bodies are sheet-like, but none comes closer than to within 3 cm to the measurement plane (10 mm above the top of the table; i.e., the area has a moderately thick overburden), so keep this in mind in choosing survey parameters. Conductors may lie anywhere in the box. To be assured of "seeing" any conductors near the sides, you will need to continue your surveys as far out on the edges of the box as possible. Surveying on about 5 lines with survey stations spaced no more than 0.5 coil spacings along the lines should give a good first look. If more detail is required, additional lines or additional points on the lines can be surveyed. Record profiles at more than one frequency over some of the anomalous features. Plot your survey data in a clear and logical manner, and interpret your results in the light of Exercise a.