Paper 104

An InfiniTEM® Survey Leads to a New Discovery on the Coulon Property

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ABSTRACT

A new time-domain electromagnetic (TDEM) configuration for fixed loop surveys that improves investigation depth is presented. Most TDEM surveys use a rectangular transmitting loop. The loop can be positioned to optimize EM coupling with the conductive target. To detect deeply buried and steeply dipping conductors, the loop has to be placed far from the target to maximize EM coupling, resulting in a relatively weak intensity of the primary field. The new TDEM configuration (InfiniTEM®) consists of two lobes connected in series with a variable offset. The width and spacing of the lobes, or half-loops, can be varied depending on the depth of the target conductor. The measurements are taken inside the transmitting array along survey lines. The InfiniTEM® loop generates a strong horizontal primary field under the region between the two lobes. In this region the magnetic field is oriented parallel to the overburden cover which minimizes EM coupling with the overburden and is perpendicular to steeply dipping conductive bodies which maximizes the induction of eddy currents within the target. This configuration is the result of a research project (initiated by Abitibi Geophysics Inc. and SOQUEM INC.) involving extensive field-testing of loop configurations and geometry. Over 3,000 line-km of commercial InfiniTEM® surveys have been carried out to date and have led to new discoveries in areas where conventional rectangular loop TDEM surveys did not detect any conductors. The example presented here is the discovery of a new polymetallic sulphide lens (lens 43) on the Coulon property. It shows the case where a moderately buried conductor was identified following an InfiniTEM® survey and where a previous heliborne TDEM survey had detected nothing.

INTRODUCTION

Time-Domain Electromagnetic (TDEM) surveys are widely used for base metal exploration. This geophysical method is based on electromagnetic induction within conductive media. TDEM survey equipment and interpretation tools have greatly improved over the past several decades. An important aspect of these surveys is the geometrical relationship between the primary field (Hp) generated by the transmitter, the target and host and the secondary field (Hs) measured at the receiver. The shape and location of the transmitter and receiver define the configuration of the survey and have a crucial influence on the intensity and response from the target.

This paper presents results from a TDEM ground survey using an innovative fixed loop configuration called the InfiniTEM®. The new configuration generates a strong horizontal primary field that is ideal for investigating steeply dipping and deeply buried base metal targets. It is vaguely similar to Macnae (1978) figure 8 loop and Spies (1975) dual-loop moving configuration.

THE INFINITEM® CONFIGURATION

The InfiniTEM® configuration consists of a distorted figure 8 loop. The loop is thus composed of two lobes or half-loops of width x separated by distance d (Figure 1). Note that the primary field is horizontal under the region between the two lobes. Measurements are taken using a roving receiver along survey lines inside the configuration.

InfiniTEM® surveys are ideal for investigating deep steeply dipping buried conductors. The primary field generated from the configuration is mostly horizontal between the centers of the two half-loops. To detect a deeply buried and steeply dipping conductor using a conventional rectangular transmitting loop, the loop has to be placed far from the target to maximize EM coupling, resulting in a weak intensity of the primary field. When using the InfiniTEM® configuration, the area of investigation for this type of target is beneath the transmitter, resulting in a much greater primary field intensity (Figure 2). In addition, a horizontal primary field makes exploration underneath conductive overburden more effective. Indeed, the primary magnetic field is parallel to the subsurface conductive

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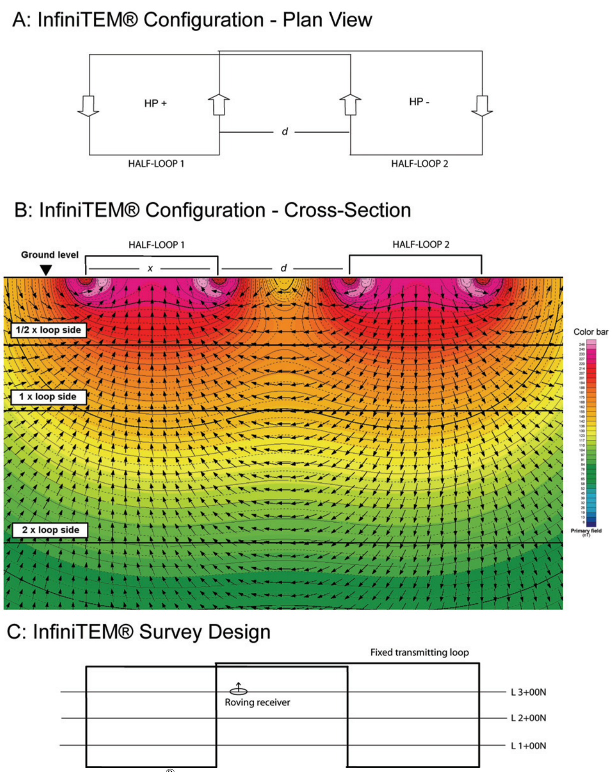

Figure 1: InfiniTEM® configuration setup. A: plan view, B: associated primary field cross-section showing field orientation (arrows) and intensity (color) computed with Biot-Savard equation, C: plan view of a typical survey design.

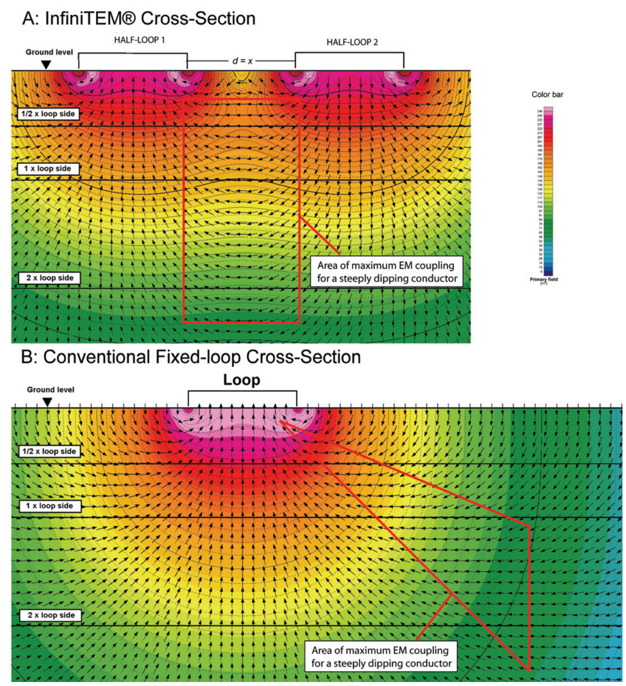

Figure 2: Comparison of primary field cross-section for both InfiniTEM® and conventional rectangular loop configurations in the case of steeply dipping conductor exploration. For a vertical conductor buried at a depth equivalent to 2x, the InfiniTEM® survey provides a more intense horizontal primary field (cyan zone) than the conventional loop design (light blue zone).

layer; coupling with the overburden is thus poor in the area between the loops. The offset between the two lobes makes it possible to investigate a larger area with a horizontal primary field. However, field testing suggested that lobe spacing has to remain reasonable ($d < 2x$) to maintain an adequate primary field intensity.

In order to be consistent with traditional rectangular loop surveys, the polarity of the primary field within the southern- or westernmost lobe (depending on the orientation of the survey grid) has to be positive. Dipping conductors, whether thin or thick, that are located between the centers of the two lobes will thus generate a response similar to the conventional fixed-loop surveys, characterized by a positive-to-negative cross-over on the Z component and a positive peak on the X component, both centered over the conductive source.

The InfiniTEM® configuration is the result of a research project initiated in 2003 in partnership with SOQUEM INC. with the goal of improving ground TDEM survey performance. The National Research Council of Canada (Industrial Research Assistance Program) and Canada Economic Development provided funding for the project. The development of this survey configuration involved a large field test program of various loop configurations over the Caber and Caber North Cu-Zn deposits in the Matagami Mining Camp in Quebec. According to Metco Resources Inc., Caber Deposit resources are estimated at 515,000 t of inferred resources @ 11.0% Zn, 0.56% Cu, 11.1 g/t Ag and 0.14 g/t Au. The Caber North Deposit is evaluated at 2,610,000 t of inferred resources @ 4.26% Zn, 1.59% Cu and 21.06 g/t Ag. These two sub-vertical deposits are buried 125 meters and approximately 350 meters, respectively, under a dozen meters of conductive overburden mainly composed of organic soil and clay minerals. Moving loop and fixed loop surveys using variable loop sizes were first carried out. The results of the surveys confirmed that the intensity of the perpendicular primary field crossing the conductive geological target was the key to getting a clear anomalous response and that it should be possible to improve on currently available fixed-loop arrays.

In an attempt to improve the field intensity and EM coupling with steeply dipping targets, a few fixed-loop surveys were tested using a primary field transmitter with two adjoining loops connected in parallel. The results were not encouraging. Strong mutual inductance between the two loops occurred and the Caber deposit response was not clearly detected. On the other hand, encouraging results were obtained when the two loops were connected in series. Numerous field investigations were then carried out to evaluate the effect of width and offset of the half-loops on the responses of the deposit and the overburden. The new survey configuration yielded impressive results using both optimal and minimal coupling configurations, including those obtained at the Caber North deposit, (Figure 3). InfiniTEM® is the first EM system, whether ground or airborne, to unequivocally detect the Caber North deposit.

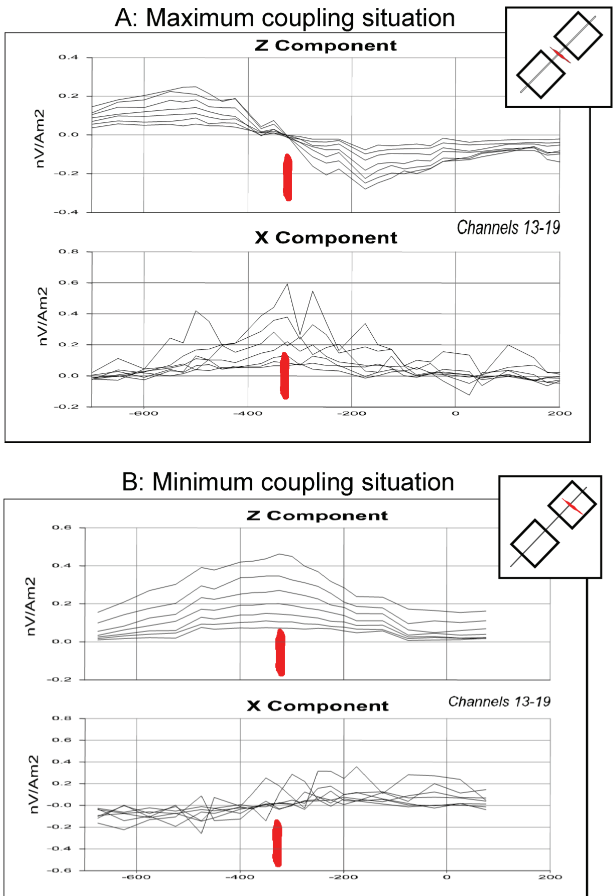

Figure 3: InfiniTEM® survey results over Caber-North deposit (in red) using a loop design of 400 x 400 m half-loops 200 m apart. A: The deposit is located in the area of horizontal primary field yielding in a maximum coupling situation. B: The deposit is located in the area of vertical primary field yielding in a minimal coupling situation. For both cases, the 350 m deep conductor is detected. A Protem 67D and a TEM57 and TEM67 transmitting combo were used to energize the ground with 8 amps.

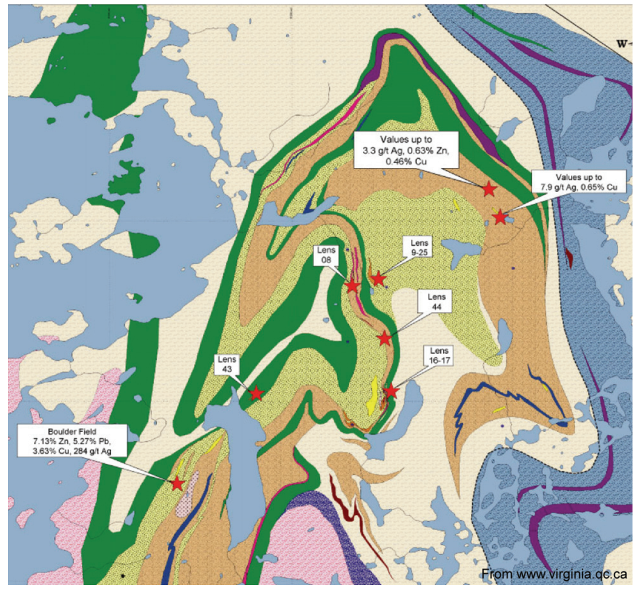

Figure 4: Geological plan map of the Coulon Property, Quebec James Bay low lands (Virginia Mines Inc.). Lens 43 is located within the green volcanic belt.

COULON PROPERTY NEW DISCOVERY

To date, more than 3,000 line-km of commercial InfiniTEM® surveys have been carried out. In the case of the Coulon Property, the survey led to the discovery of a new massive polymetallic sulphide lens: lens 43.

The Coulon project is located within Quebec James Bay Low lands in an unexplored Archean volcanic belt with the typical geological characteristics of belts that commonly host volcanogenic massive sulphide deposits (Figure 4). Three massive polymetallic sulphide lenses discovered in 2004 reported up to 15.39% Zn, 3.12% Pb, 117 g/t Ag and 0.46% Cu over 10.5 m (lens 16-17); 2.91% Zn, 1.12% Cu, 34.25 g/t Ag, and 0.3 g/t Au over 21.8 m (lens 9-25); and 12.65% Zn, 1.36% Cu, 1.54% Pb,125 g/t Ag, and 0.3 g/t Au over 4.70 m (lens 08). According to Virginia Mines Inc. press release (December, 2006), lens 43 was discovered by hole CN-06-43, which was drilled to investigate a new EM anomaly (EM-01) detected in summer 2006 by an InfiniTEM® survey in an area of thick overburden (20-25 m). Previous geophysical surveys (heliborne TDEM) had not detected any conductor, most likely because of the thick conductive cover.

Figure 5 shows the profile of the InfiniTEM® survey over line 7+00N stacked over the geological section of lens 43. The later consists of a steeply dipping mineralized zone approximately 10 metres wide, consistent with the observed symmetric signature. A dip to the west can be interpreted from the smoothness of the western shoulder of the Z component profile. The massive sulphide lens is mainly composed of pyrite, chalcopyrite, and pentlandite. Of course no rock composition can be inferred with TDEM data but it is interesting to compare this result with the calculated time constant (Tau) of anomaly EM-01. On line 7+00N, the Tau value is 1.0 ms, which can be associated to a moderately conductive source. The drilling intersected mineralization at a vertical depth of 120 metres, giving a maximum depth to top. The anomaly wavelength (approx. 350 m) suggests a depth-to-top of 75 meters.

CONCLUSION

The InfiniTEM® loop configuration generates a strong horizontal primary field in the area between the two transmitter lobes and this is ideal for investigating steeply dipping and deeply buried conductive targets. The significantly lower EM coupling with the overburden makes it possible to investigate at much greater depth than conventional rectangular shaped transmitting loops. In challenging environments with thick conductive overburden, this aspect is crucial. Lens 43 discovery on the Coulon property is a good example of a situation where the conductive cover prevented standard TDEM surveys from investigating at depth.

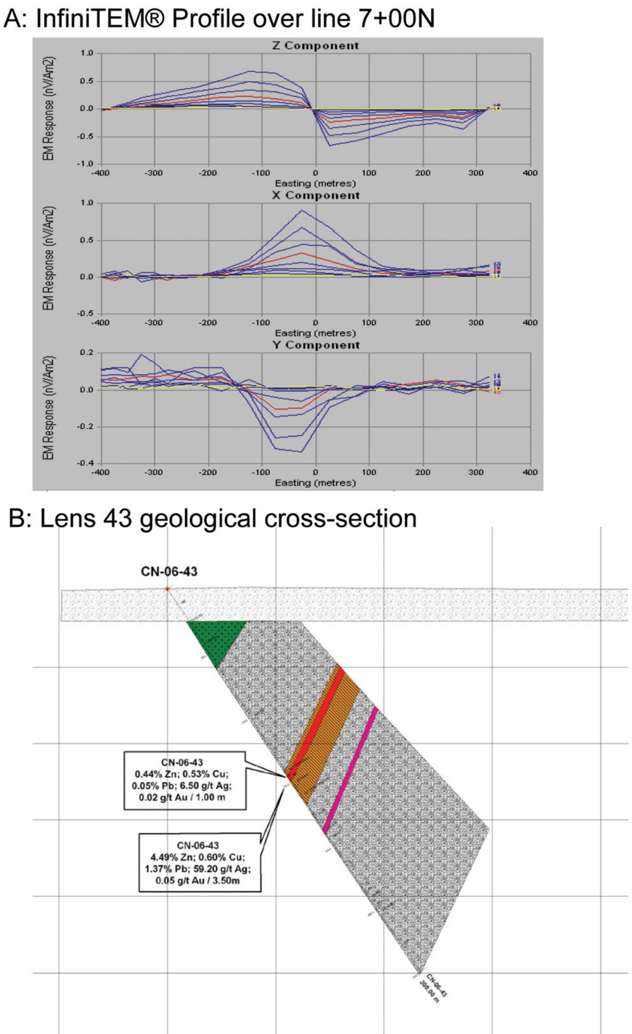

Figure 5: InfiniTEM® survey profile (A) and associated geological cross-section (B) within Coulon Property over survey line 7+00N. Anomaly "EM-01" centered on 0+25W shows the signature of a conductor steeply dipping to the west and buried at a depth of approximately 75 meters. Inferred cross-section from DDH CN-06-43 agrees with qualitative interpretation.

The configuration is continuously being fine-tuned and ongoing field testing improves survey results and understanding of the phenomena associated with the loop shape (Malo Lalande, et al., unpublished).

AKNOWLEDGMENTS

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