AN *INFINITEM* ® SURVEY LEADS TO A NEW DISCOVERY ON THE COULON PROPERTY

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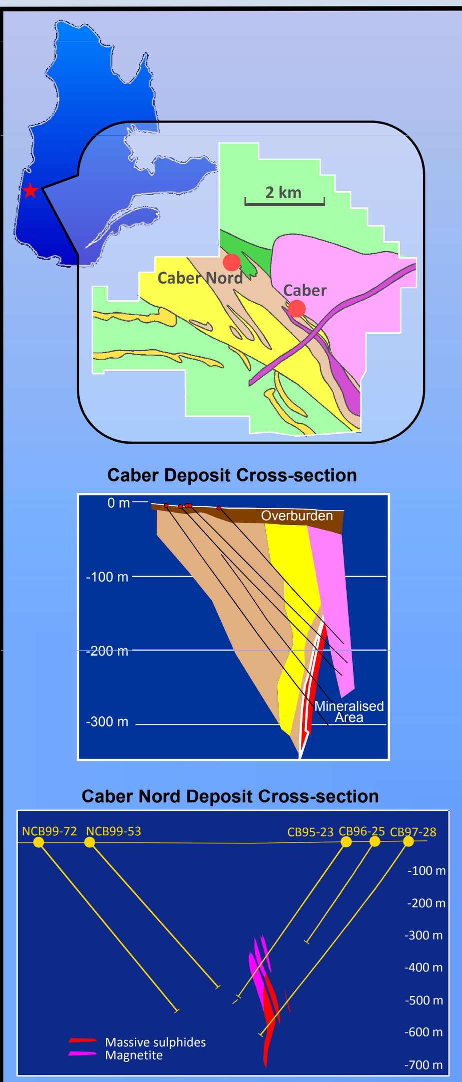
ABSTRACT

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 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 vary 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 particularly under the offset between the two lobes. Under this area, the field is oriented parallel to the overburden cover to minimize EM coupling with the overburden and perpendicular to steeply dipping conductive bodies to maximize the induction of eddy currents. 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 3,500 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 yielded negative results. One example is the Coulon Property where a new massive polymetallic sulphide lens (Lens 43) was detected during an InfiniTEM® survey.

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) transmitter and the secondary field (Hs) 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 conductor's signature.

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.



InfiniTEM® Development History

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 InfiniTEM® 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.

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. 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.

To improve the field intensity and EM coupling of steeply dipping targets, few fixed-loop surveys were carried out using as a primary field transmitter two adjoining loops connected in parallel. The results were not encouraging. Strong mutual inductance between the two loops occurred and prevented the Caber deposit response to be clearly detected. On the other hand, astonishing 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 air-based, to have unequivocally confirmed the Caber North deposit.

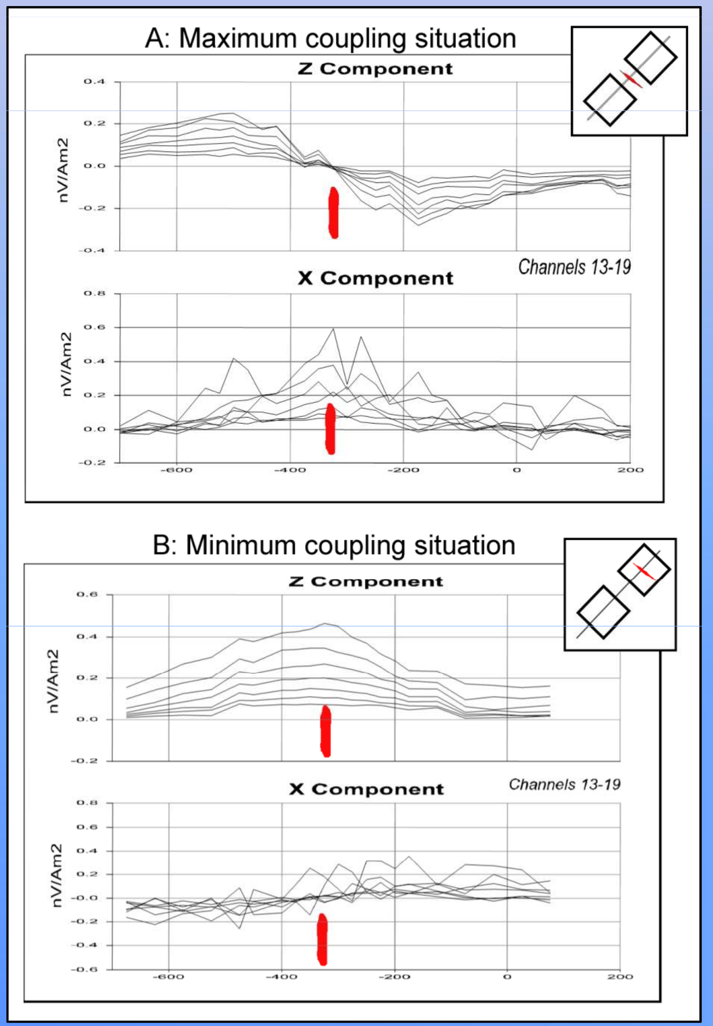


Figure 3: InfiniTEM® survey results over Caber-North deposit (in red) using a loop design of 400 x 400 m half-loops 200 m apart. A: The deposit is located in the area of horizontal primary field yielding in a maximum coupling situation. B: The deposit is located in the area of vertical primary field yielding in a minimal coupling situation. For both case, 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.

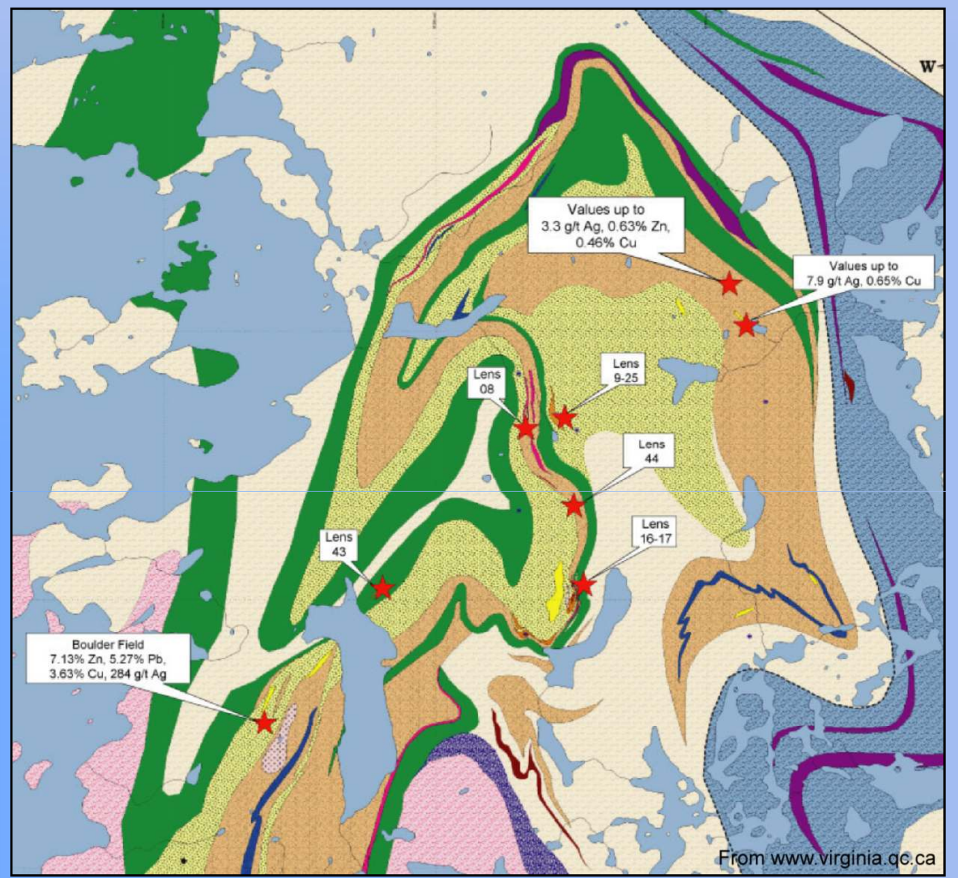


Figure 4: Geological plan map of the Coulon Property, Quebec James Bay low lands (Virginia Mines Inc.). Lens 43 is located within the green volcanic belt.

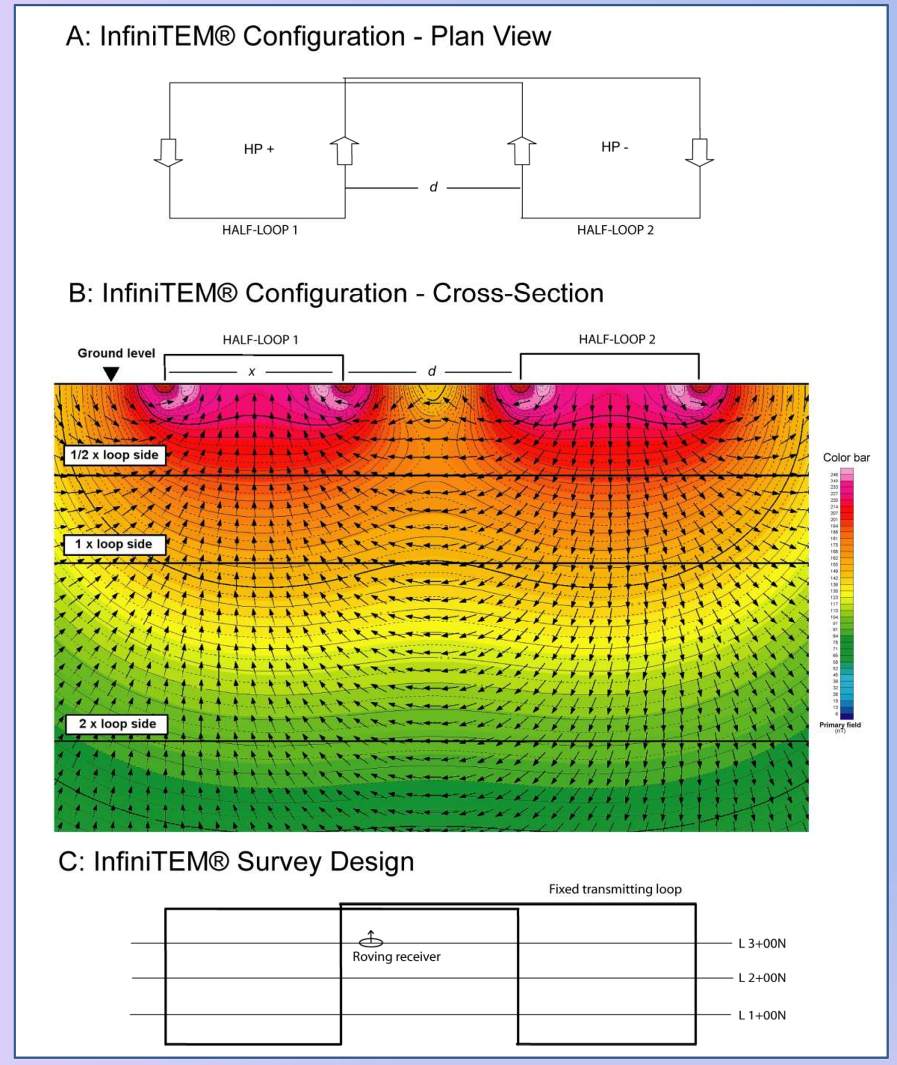


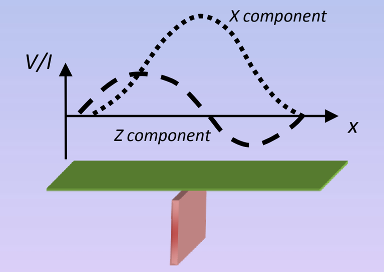
Figure 1: InfiniTEM® configuration setup. A: plan view, B: associated primary field cross-section showing field orientation (arrows) and intensity (color) computed with Biot-Savard equation, C: plan view of a typical survey design.

THE INFINITEM® CONFIGURATION

The InfiniTEM® configuration consists of a distorted 8 shaped loop. The loop is thus composed of two lobes or half-loops of width *x* separated by distance *d* (figure 1). Since the configuration consists of two loops connected in series, these are called lobes or half-loops in order to prevent confusion when the configuration is referred as the transmitting loop. The InfiniTEM® configuration generates a horizontal primary field under the offset between the two lobes. Measurements are taken using a roving receiver along survey lines inside the configuration. The innovative InfiniTEM® configuration has been inspired by Macnae and Spies studies but it is not a moving loop configuration and its half-loops are spaced apart.

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 just beneath the transmitter, resulting in a much greater primary field intensity (figure 2). In addition, a horizontal primary field makes exploration underneath conductive overburden much easier. Since the eddy currents are parallel to the subsurface conductive layer, they diffuse downward more efficiently. 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.

Regarding data interpretation, in order to be comparable 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.



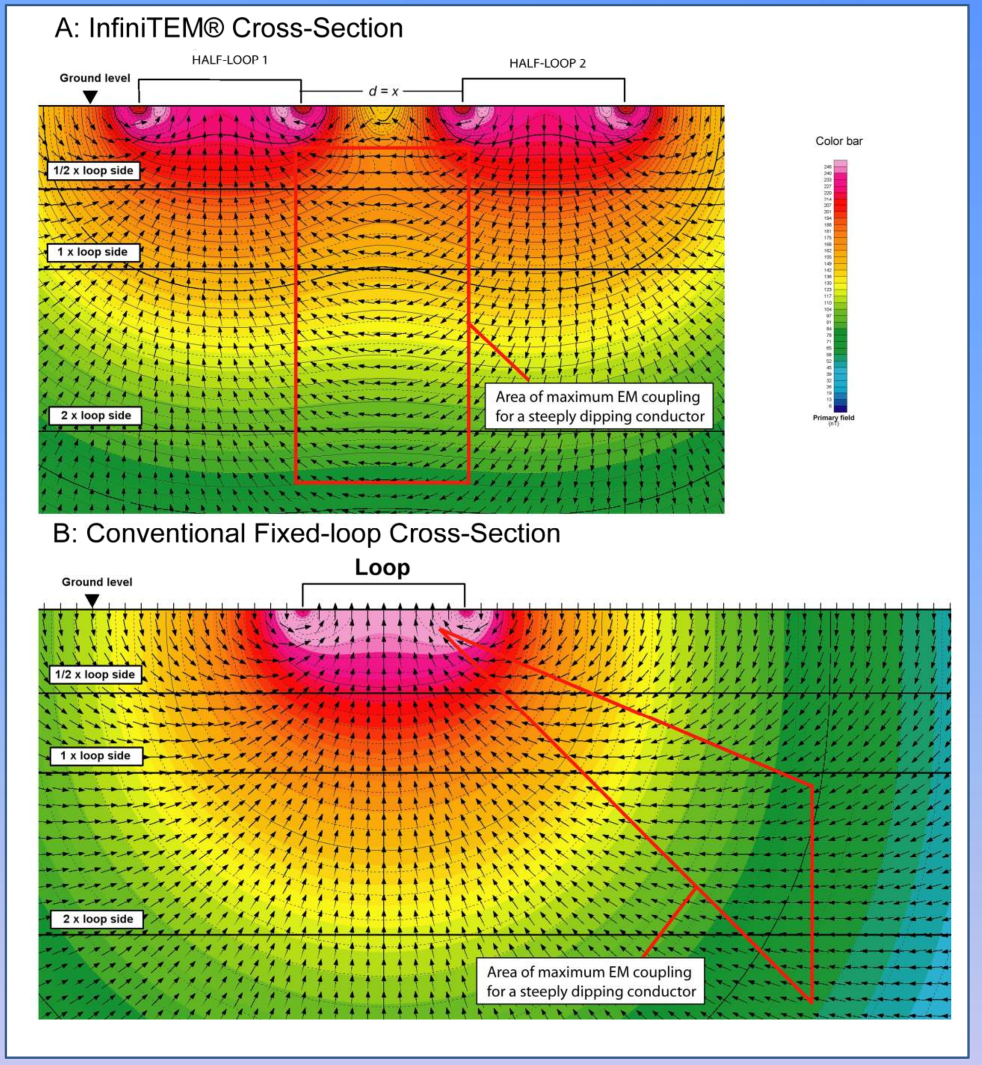


Figure 2: Comparison of primary field cross-section for both InfiniTEM® and conventional rectangular loop configurations in the case of steeply dipping conductor exploration. For a vertical conductor buried at a depth equivalent to 2x, the InfiniTEM® survey provide with a more intense horizontal primary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

COULON PROPERTY NEW DISCOVERY

To date, more than 3,500 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 are fertile in 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) where previous geophysical surveys (heliborne TDEM) had not detected any conductor.

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, agreeing with InfiniTEM® symmetric signature. A dip towards west can be interpreted from the Z component smoothest western shoulder. The massive sulphide lens is composed mainly 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 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 results indicated that the mineralized intersection vertical depth is 120 metres. The InfiniTEM® anomaly wavelength (approx. 350 m) suggests a depth-to-top of 75 meters. The lack of geological information above DDH CN-06-43 prevents us to confirm the actual burial depth of lens 43. Even though the conductor is not deeply buried, a heliborne TDEM survey has missed it, most likely because of the thick conductive cover. However, the strong and horizontal InfiniTEM® primary field made it possible to detect the massive sulphide lens.

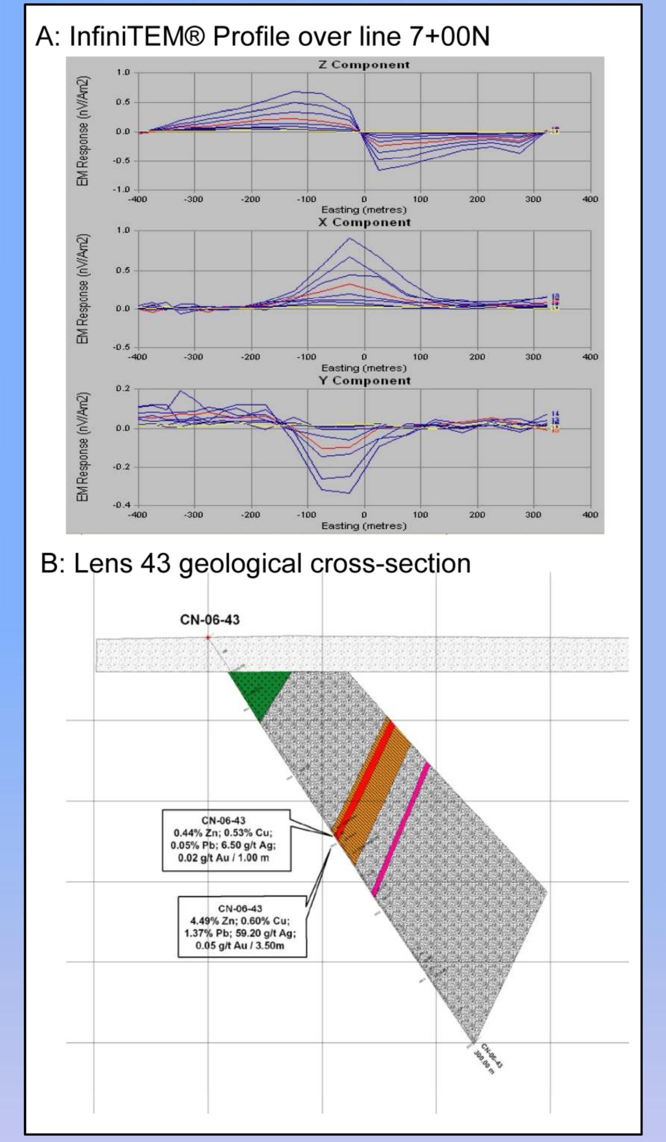


Figure 5: InfiniTEM® survey profile (A) and associated geological cross-section (B) within Coulon Property over survey line 7+00N. Anomaly "EM-01" centered on 0+25W shows the signature of a steeply dipping towards west conductor buried at a depth of approximately 75 meters. Inferred cross-section from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

CONCLUSION

The InfiniTEM® loop configuration generates a strong horizontal primary field that 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. The strong InfiniTEM® horizontal primary field made it possible to detect a lens that had been missed by a heliborne TDEM survey.

The configuration is being constantly fine-tuned and field testing is ongoing to improve survey results and to better understand the phenomena associated with the loop shape (Malo Lalande, et al., unpublished). Over 100 surveys have been carried out throughout the Canadian Shield. New challenging environments will also be surveyed using the InfiniTEM® to discover more deeply buried and steeply dipping conductors.

AKNOWLEDGMENTS

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Canada Economic Development for Quebec Regions

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