

Advances in Geophysical Exploration for Uranium Deposits in the Athabasca Basin

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ABSTRACT

Some recent Greenfield discoveries made by Cameco in the last 10 years include the Millennium Zone on the Cree Extension project, and La Rocque Lake and Collins Creek on the Dawn Lake project (eastern Athabasca), and the Centennial Zone on the Virgin River project (central Athabasca). These illustrate some of Cameco's advances in geophysical exploration methods over this period of time. The Millennium zone (2000) is a basement-hosted discovery that demonstrates the value of drilling away from the historic conductor axis. Considerable difficulty had been experienced drill intersecting the hanging wall B1 conductor, as defined by Fixed Loop Time Domain Electro-Magnetic (TDEM) coverage in the general area of the Millennium zone. Significant alteration was noted in drill core from deep within the basement of a single drill hole step-out (CX-38) to the west of the Fixed Loop B1 conductor tested by CX-35. A second step-out, CX-40, led to the discovery of the Millennium zone. Subsequently, Stepwise Moving Loop TDEM profiles were completed to map a previously unidentified footwall conductor closely associated with the ore zone and therefore important for furthering the delineation drilling. TDEM Soundings, Pole-pole DC Resistivity and TAMT surveys mapped significant alteration anomalies in the sandstone above the mineralization, which are inferred to be related to the mineralizing process. The La Rocque Lake (1998) and Collins Creek (1999) discoveries are classical unconformity uranium zones that demonstrate the use of combined Fixed Loop and Stepwise Moving Loop TDEM surveys for definition of complex multi-conductor systems. Critical in these examples were 1) good correlation between the drill-defined graphite and geophysically defined conductors, 2) good definition of conductor pattern complexities, 3) good knowledge of alternative conductor targets with respect to alteration and geochemistry. TDEM Soundings, TAMT and Pole-pole resistivity were successfully used to map alteration at La Rocque Lake. The Centennial zone (2004) has both sandstone-hosted and unconformity components. This discovery exemplifies a more focused approach on a 50 km long, 10 km wide, and up to one km deep multi-conductor corridor (the Virgin River trend) by selectively looking for evidence of enhanced structure and alteration within the sandstone. Numerous conductors had been defined with Fixed and Tandem Moving Loop surveys, but the large depths to basement, poor drilling conditions, high drilling costs, poor ground access to the area, and poor conductor resolution precluded the traditional approach of systemically drilling conductors. This problem was resolved by the innovative application of a longitudinal Pole-pole Resistivity survey along one of the more favourable conductors.

INTRODUCTION

The Athabasca Basin is a large Paleo to Mesoproterozoic quartz arenite sandstone basin that occupies much of the northernmost one-quarter of the province of Saskatchewan and a smaller portion of northeastern Alberta. The locations of the basin and the discoveries discussed in this paper are shown in Figure 1. The majority of the unconformity uranium deposits of the eastern Athabasca Basin are associated with post-Hudsonian reactivated graphitic faults within Aphebian metasedimentary gneisses of the Wollaston Domain (e.g. Collins Creek zone). Some are associated with the Wollaston-Mudjatik transition (e.g. Millennium zone) while a few others (e.g. La Rocque Lake zone) are in the Mudjatik Domain. The Centennial zone overlies

the Virgin River Domain in the south central part of the Athabasca Basin.

Exploration for uranium in the Athabasca Basin began in the mid-1960's, with companies looking for sandstone-hosted and/or paleochannel-type uranium deposits. Airborne and ground radiometric prospecting followed by systematic drilling led to the early discoveries at Rabbit Lake (1968) and Cluff Lake (1970). This led eventually to the establishment of a significant uranium resource in the basin and the recognition of the unconformity deposit model. The discoveries at Key Lake (1975-76) and Cigar Lake (1981) prompted a growing emphasis on Electromagnetic (EM) conductors as a key factor in exploration for these deposits, which became a standard for the next quarter century (Gandhi, 1995). Historically EM surveys played a key role in the discoveries and delineations of about 80% of the known deposits in the Athabasca Basin. Consequently it is easier to name the deposits where EM

methods did not play a key role: the original Rabbit Lake deposit and the Cluff Lake deposits.

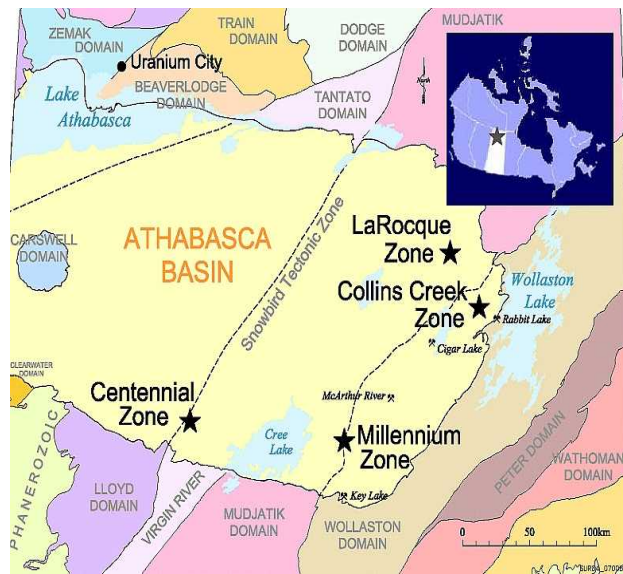


Figure 1: Locations of the Athabasca Basin and the mineralized zones discussed in this paper.

Table 1 summarizes some more recent Cameco Athabasca uranium discoveries discussed in this paper and the geophysical methods applied. These span the three types of deposits now recognized in the Athabasca: basement-hosted, unconformity and sandstone-hosted. The geophysical survey methods applied to each are listed, and have been divided into three exploration categories in order to clarify their roles in: 1) discovery, 2) delineation, and 3) orientation or further exploration. It is clear from this table that EM methods still play an important role.

At present, the preference is for a fluid ingress / egress (into / from basement) deposit model producing basement-hosted / unconformity uranium as described by Fayek and Kyser (1997). Basement-hosted uranium deposits are spatially associated with, and closely related to, unconformity uranium occurrences. The former apparently arose from uranium-bearing sandstone fluid ingress into the basement along permeable structures, mixing with egressing hydrothermal fluid, and precipitation of uranium at 1) some distance (up to 225+ m) horizontally from the graphitic fault-conductor axis, 2) comparable distances vertically below the unconformity, and 3) near the down-dip projection of the fault-conductor. Unconformity uranium deposits are believed to involve fluid mixing and uranium precipitation at points of hydrothermal fluid egress from the basement into the sandstone, very close to the graphitic fault-conductor axis (<35 m). Thermohaline convection of an oxidizing, hypersaline sandstone fluid (Derome et al., 2005) could have transported uranium in solution into the deposit site.

Table 1: Geophysics Applied to Some Recent Cameco Uranium Discoveries, Athabasca, 1997 – 2007.

Mineralized zone	Geophysical Role in Discovery	Ore Delineation Surveys	Other Geophysical Surveys
Millennium , Cree Extension project, 2000, basement-hosted U at 650 m depth.	1. Reconnaissance and systematic Fixed Loop TDEM defined the targeted B1 conductor trend, 1986 - 2000.	1. EScan, 2001. 2. TAMT, 2002. 3. Step Loop TDEM, 2003. 4. Gravity, 2003.	1. 3D Resistivity test, 2004. 2. Aeromag. gradient, 2001. 3. MEGATEM test, 2004. 4. TEMPEST test, 2006. 5. Surface seismic, VSP and downhole, 2007.
La Roque Lake , Dawn Lake project, 1998, unconformity U at 275 to 300 m.	1. INPUT, 1978, identified the trend. 2. Fixed Loop, 1987 – 2000. 3. Step Loop test line 0+00 in 1997 located the targeted A1 conductor for drill testing.	1. Systematic Fixed and Step Loop, 2000. 2. Ground mag., 2000	1. Pole-pole Resistivity and TAMT tests, L 4N, 2002 2. VTEM, 2004, 2005. 3. TDEM soundings, 2006.
Collins Creek , Dawn Lake, 1999, unconformity U, 180 m depth.	1. INPUT, 1980, identified the trend. 2. Fixed Loop, 1995-97. 3. Step Loop test line 14+00E located the conductor for drill testing, 1999.	1. Systematic Fixed & Step Loop surveys, 2001.	1. TEM soundings, 2004. 2. AEROTEM test, 2002. 3. VTEM, 2005.
Centennial , Virgin River / MacFarlane projects, 2004, sandstone U at 710/760m, unconformity U at 790 m depth.	1. GEOTEM, 1998, identified trend. 2. Tandem Moving Loop along the Virgin R. trend defined the C1 conductor, 1999-2002. 3. Longitudinal Pole-pole resistivity survey defined sandstone breach, 2003.	1. Tandem Moving Loop, 2006 - 2007.	1. Aeromag. gradient, 2001. 2. TAMT profiles, 2003. 3. Airborne gravity, 2005.
O2 Next, Eagle Point Mine , Rabbit Lake project, 2003, basement-hosted U, 75 to 500+ m depth. (Powell et al, 2005; O'Dowd et al, 2007)	1. INPUT, 1980, identified trend. 2. Orientation surveys defined in-loop bright spot at zone O2, 1997. 3. Fixed & Step Loop surveys, along Collins Bay fault, defined in-loop bright spot, 2001-2. 4. Grid format TDEM Soundings to better define bright spot, 2003.		1. EScan 3D resistivity survey, 2002. 2. TDEM Soundings, 2004. 3. Aeromag. gradient, 2005. 4. VTEM test, 2004 5. VTEM survey, 2005. 6. Airborne gravity, 2007.

Some deposits are transitional between basement-hosted and unconformity deposit styles (e.g. zone 2 at McArthur River and the Deilman deposit at Key Lake). A few other deposits exhibit associated sandstone-hosted uranium occurring 10's to 100's of metres above the unconformity (e.g. Centennial zone, Virgin River and the Shea Creek zones).

The eastern Athabasca Basin has seen most of the historic exploration work, and is considered a mature uranium play. There is a limited amount of high-priority conductor length remaining to be tested for conventional unconformity-type deposits. While discoveries of less than 50 Mlb U3O8 continue, it has been nineteen years since the discovery of the world class McArthur River P2 North deposit in 1988. This has led to a realization that a greater emphasis should be placed on employing geophysical techniques to map the ore deposit setting at all scales, notably the geological conditions that favour uranium deposition and preservation, and the subtler manifestations of the presence of a uranium deposit. This means greater attention to the lithostructural setting of the deposit, the fluid pathways, and the ore-fluid processes involved.

Prior to the discovery of the Cigar Lake unconformity uranium deposit, basement-hosted deposits accounted for approximately 50 percent of the known resources of the Athabasca Basin. With the subsequent increased emphasis on exploration for unconformity uranium, the basement-hosted share of total uranium resources fell to less than 17% by 2005. Greater attention is now paid to basement-hosted uranium deposits because they are recognized as cheaper and easier to mine at large depths, a function of the relatively impermeable basement host-rock compared to the overlying sandstone (Powell et al., 2005). This necessitates some changes to traditional exploration methodology, notably a willingness to step off the conductor axis.

The costs and diminishing returns associated with the established method of systematically drilling EM conductors have led to changes in exploration strategy to improve the rate of discovery. At Cameco a more integrated approach involving geology, geochemistry, EM and other geophysical methods is used to define exploration corridors. (Matthews et al, 1997). Geophysical targets are then defined within these corridors.

These can be loosely grouped into two categories: 1) indicators of uranium traps and 2) indicators of hydrothermal alteration. They are summarized in Table 2.

GEOPHYSICAL ADVANCEMENTS IN URANIUM EXPLORATION

Improvements in airborne EM survey methods, such as MEGATEM and VTEM, have facilitated exploration in deeper parts of the Athabasca Basin. Airborne EM techniques have successfully imaged conductive packages to depths of as much as 800 m, in significantly reduced time frames and at costs much less than traditional ground EM survey methods. These systems have the potential to map interpreted fault offsets and potential zones of alteration along conductive trends. This has led to a better understanding of the large to intermediate scale geological setting. However drillhole targeting still relies heavily on the resolution and confidence of ground EM methods.

The three large loop EM configurations currently used in the Athabasca basin are summarized in Figure 2. The Fixed Loop TDEM method remains a commonly used first pass exploration tool along new and/or under-explored conductor corridors. It employs a large rectangular transmitter loop placed well back from a suspected conductor trend while a roving receiver maps the conductive response(s). It is a common technique for initially mapping conductor systems, but will not necessarily map, or even identify, all discrete conductors accurately in a complex conductive environment. The interpreted location of a conductor can be skewed or entirely masked by the presence of 1) a strong half-space or layered-earth response, 2) a conductive host lithology, 3) conductive regolith and/or conductive brine pooling at the unconformity, 4) conductive brine in permeable fault ones, 5) the bounding conductors in a multi-conductor package, 6) unresolved conductors adjacent to the target conductor, and 7) hanging wall conductors at a reverse faulted offset of the unconformity. Consequently Fixed Loop surveys alone can easily miss the conductor that hosts a significant uranium deposit.

Table 2: Summary of Geophysical Indicators for Athabasca Uranium Deposits.

Indicators	Comments
A. Potential uranium traps:	Graphite, redox boundaries
1. The locations and orientations of plate-like, single or multiple graphitic fault-conductors, complexity, bends, offsets, etc. associated with the unconformity.	From Fixed & Moving Loop surveys.
2. Graphitic lithologies, fold repeated or facies concentrations of graphite, and positions with respect to EM conductors.	EM bright spots or Tau anomalies, inversions of TDEM or DC Resistivity data.
3. Deep, conductive, clay-altered graphitic lithology in the basement associated with basement-hosted uranium.	Smaller, off-conductor EM bright spots, like zones O2 and O2 Next, Eagle Point mine.
B. Potential hydrothermal alteration:	Fluid transport of uranium
4. Conductive features indicating de-silicification and argillization of the sandstone and/or basement.	Indicators of hydrothermal fluid flow and removal of silica.
5. Resistive features indicating silicification of the sandstone and/or basement.	Indicators of fluid transport and dumping of silica.
6. Combinations of 4 and 5, and position relative to plate-like conductors.	e.g. silica cap with a breach.
7. Locations and orientations of weakly conductive second order or crosscutting faults.	Sources of structural complexity and fluid egress/ingress.

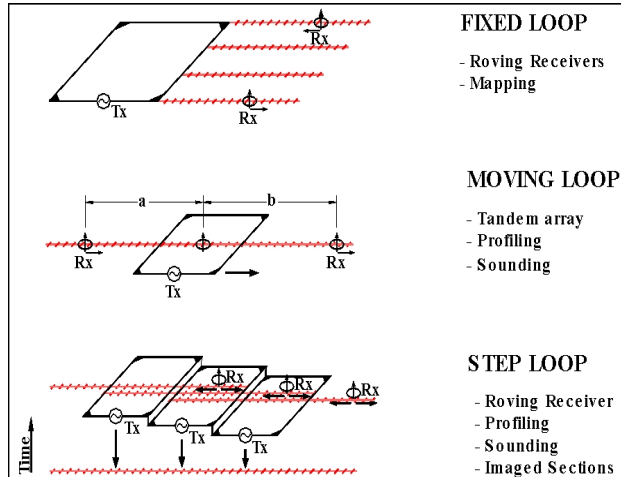


Figure 2: The three types of large loop EM configurations commonly used in the Athabasca Basin.

In areas with complex or multiple conductor systems Moving Loop surveys are used to supplement or replace Fixed Loop delineation of conductors (after airborne EM surveys). Conductor mapping is improved with Tandem Moving Loop by presenting a constant EM array, thus diminishing the influence of the layered earth response that can be problematic in interpreting Fixed Loop data. But because the fixed transmitter – receiver separation can limit conductor resolution, it is advantageous to employ multiple separations and/or include some Fixed Loop coverage to help ensure that all conductors are mapped.

The Stepwise Moving Loop or Step Loop method (Powell, 1990; Matthews et al., 1997) is a hybrid of Fixed Loop and Tandem Moving Loop methods, and thus has some qualities of both. The survey is conducted in a fashion similar to a seismic reflection survey with the transmitter loop located at the center of each group of readings associated with that loop. The loop is moved along the survey line at relatively large intervals, typically equal to one-half or one loop dimension. Multiple transmitter-receiver separations provide a wider range of responses and resolutions than can be achieved with Tandem Moving Loop, so conductor picks tend to be less skewed by nearby conductive features. As described below, the Step Loop method has been used to map the location of: 1) embedded conductors in multiple conductor systems where bounding conductors can otherwise mask them, and 2) footwall conductors at significant unconformity offsets related to reverse faults where a hanging wall conductor can otherwise mask them.

Fixed and Step Loop surveys have relatively low acquisition costs per reading because the number of readings taken per transmitter loop setup are maximized and survey logistics are relatively simple. On the other hand Step Loop and Tandem Moving Loop have the highest acquisition costs per kilometer of total coverage because of the greater total amount of labor involved per kilometer with these more elaborate surveys. However depending on the survey parameters, Step Loop may have a smaller total survey cost than Tandem Moving Loop because only the zone of interest needs to be covered, as with Fixed Loop.

Fixed Loop and Tandem Moving Loop allow the simplest processing, presentation, forward modeling and interpretation of the data. Step Loop requires more time for these activities because of the greater amount of data acquired per kilometer (about an order of magnitude more). There are also more ways to view and thus interpret Step Loop data for interpretation, notably component plots by loop, composite in-loop profiles and pseudosections by time channel, as is demonstrated below.

Layered earth inversions are now commonly done on in-loop and / or near-loop TDEM data, from either Step Loop or Tandem Moving Loop surveys, where appropriate data have been collected. This aids considerably in understanding the geological setting in the basement and identifying hydrothermal alteration in the overlying sandstone.

Pole-pole Resistivity surveys involve single electrodes for current source and potential field measurement within the survey area, with return electrodes far enough away to be considered at infinity. Pole-dipole surveys involve a similar current electrode configuration, but with two potential field electrodes at a fixed separation. DC Resistivity surveys are commonly carried out and inverted in 2D or 3D (Loke and Barker, 1996; Loke, 2005). The objective of these surveys is typically to identify structure and alteration features within the otherwise uniformly resistive Athabasca Group Manitou Falls formation. These may be silicification features that appear as resistivity highs peripheral to an unconformity uranium occurrence. Or they may be desilicification features, usually with clay, that appear as resistivity lows more closely associated with occurrences than are the silicification features. If these alteration features appear in the mid to upper sandstone, then there is greater confidence that they are caused by alteration, and not by nearby basement graphitic conductors or brine lying on the unconformity.

Pole-dipole DC Resistivity surveys have been used in shallower areas of the basin where penetration is less of an issue and good resolution is a priority. Pole-pole surveys have been more commonly implemented at larger unconformity depths (>300 m) for better imaging of deeper alteration features. Also smaller arrays can be used to achieve the same degree of penetration as with a Pole-dipole survey. However, greater care must be taken with Pole-pole surveys to avoid the risk of abnormal return currents from the infinite electrodes, which can cause spurious results.

Audio Magneto-Telluric (AMT) and Transient AMT or TAMT (Goldak and Goldak, 2001) surveys have occasionally been carried out in deeper parts (>300 m) of the Athabasca Basin as a first pass, reconnaissance tool for mapping graphitic fault zones, unconformity depth, basement graphitic conductors, and sandstone alteration. The major advantages of this technique are the ability to 1) operate autonomously from a camp, plane, helicopter, truck, boat, etc. in fairly remote locations with little or no grid preparation and a minimum of planning, 2) record a broader range of frequencies from which to base a conductor interpretation, and 3) invert the data into 2D or 3D resistivity models allowing one to assess the geological setting, conductors and sandstone alteration. In this paper inversions were done in 2D using Occam's inversion (deGroot-Hedlin and Constable, 1990).

In the ELF/VLF audio bandwidth, the largest naturally occurring signals are of a transient nature due to electromagnetic radiation from individual lightning discharges. These signals are

measured at the surface of the earth as two horizontal components of the electric field using electrodes (5 m dipoles) and three components of the magnetic field using coils. A transient AMT or TAMT receiver captures individual transient events in a time-localized fashion in the 5 Hz to 32 kHz band. The transient approach is especially important in times of low source field activity (winter at high latitudes) and in general ensures that the highest possible Signal-to-Noise ratio (SNR) data is obtained.

Adaptive Polarization Stacking or APS (Goldak and Goldak, 2001) was developed to properly reflect the polarization properties of the source field, sample size and the SNR in the final earth response curve estimates and errors. Given typical polarization characteristics of transient data, the APS algorithm displays a higher order bias convergence than conventional AMT methods. However, since transient events are linearly polarized, good polarization diversity is necessary for the proper estimation of the earth response curves.

The Transverse Electric field or TE mode, in 2D modeling, occurs when the electric field lies parallel to geological strike (and typically perpendicular to the survey profile) while the magnetic field lies perpendicular. The Transverse Magnetic field or TM mode occurs when the magnetic field is parallel to strike and the electric field lies perpendicular (and typically parallel to the survey profile). The TE mode is well coupled with any discrete, strike-parallel basement conductors whereas TM mode is poorly coupled to these. However the TM mode has a higher resolution with respect to defining strike-parallel geological contacts, and is more robust to 3D effects associated with conductive structure (Wannamaker, 1995; Berdichevsky et al., 2002).

See O'Dowd et al (2007) for further comments on geophysical advancements in the Athabasca Basin.

MILLENNIUM ZONE, CREE EXTENSION PROJECT

The Cree Extension project is a Cameco operated joint venture among Cameco Corporation (30.17%), JCU (Canada) Exploration Company Ltd. (30.10%), UEM Inc.1 (23.59%) and AREVA (16.14%). The north to northeast oriented B1 conductor trend (Figure 3) was discovered on the west side of the Cree Extension project in the mid-eighties. It was initially mapped by reconnaissance Fixed Loop UTEM (University of Toronto EM) surveys targeting magnetic lows in the deeper sandstone portions of the project area, where historic airborne EM coverage had been unsuccessful in locating basement conductors. By the time of discovery, exploration work had identified significant sandstone geochemistry and alteration in drill holes along the B1 trend, notably along the north-south portion of the trend at the south end of the project area. This provided encouragement to continue exploration along this conductor to the present.

The basement-hosted Millennium zone uranium discovery (Roy et al., 2005; Powell et al., 2005) illustrates the importance of stepping away from the established conductor axis for basement-hosted targets, and the use of Step Loop TDEM for a more complete conductor picture than could be achieved with Fixed Loop alone. The zone is located midway between the McArthur River and Key Lake mine sites at the boundary between the Wollaston and Mudjatik domains. Depth to basement is between 500 m (east side) and 600 m (west side).

The Millennium zone, as currently defined, has a minimum strike length of 230 m, a maximum width of 30 m and a down-dip extent of 70 m. It was discovered in 2000, at a depth of 650 m on the west flank of a major structural trend mapped historically as the B1 conductor (Figure 3). The zone was discovered as a result of drill step-outs westward from the B1 conductor axis as it was defined by Fixed Loop TDEM surveys dating back to 1986-87.

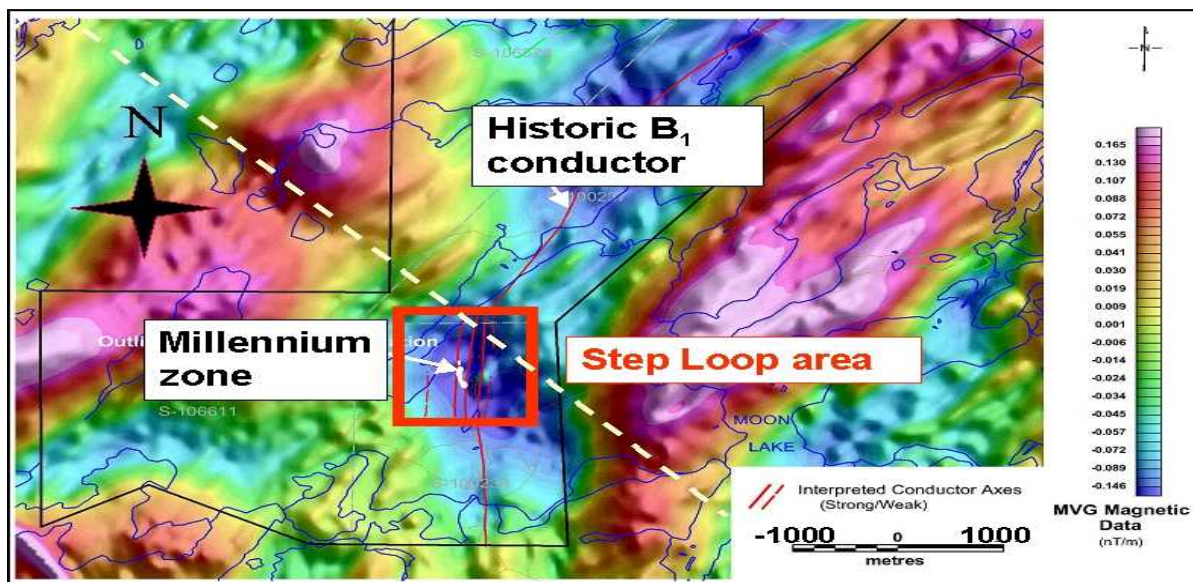


Figure 3: Magnetic vertical gradient setting of the Millennium zone (white) with conductors (red lines).

Considerable difficulty was experienced intersecting the historic B1 conductor in the Millennium zone area, with most holes ending in granite. This was believed to be due to the complexity of the conductor setting, notably 1) 75 m of unconformity relief associated with and west of the B1 conductor, 2) an overlying granitic gneiss on the graphitic metasediments hosting the conductor system, and 3) the presence of multiple unresolved conductors immediately west of the B1 conductor.

Drill step outs were executed westward from the B1 conductor because the granite intersected in the drill holes was thought to be related to a significant aeromagnetic high to the east of the B1 conductor (Figure 3). On the discovery fence, line 0+00, drill hole CX-35 had targeted the historic B1 conductor and intersected granitic gneiss. A graphitic conductor was then intersected in 1998 by drill hole CX-38, a 100 m step out to the west from CX-35. This then became the drill-defined B1 conductor location.

Significant alteration and elevated uranium were noted in the basement core near the bottom of CX-38. This led to a second 45 m step out to the west in 2000 and the first mineralized intersection, in drill hole CX-40. The sandstone-basement unconformity was intersected in this hole at 569.4m and the uranium mineralization below (0.35% U₃O₈ over 17 m). The best interval of continuous mineralization to date is 1.02% U₃O₈ over 28.7 m, approximately 100 m below the unconformity. Pervasive hydrothermal alteration is widespread in the basement of drill hole CX-40. The lower sandstone from 441.4 m to the unconformity is also quite altered with moderate to strong bleaching and moderate matrix clay development. The deposit is hosted in a predominantly semipelitic metasedimentary assemblage locally intruded by pegmatites (Figure 4).

Regionally, the B1 conductive package is hosted in a north-south segment of a northeast trending magnetic low related to folded Wollaston Group metasediments. A significant northwest trending magnetic break crosses the area and may have been a factor in the location of the zone. There is also evidence of a significant north-south structural fabric in the vicinity of the zone and to the northeast in Figure 3.

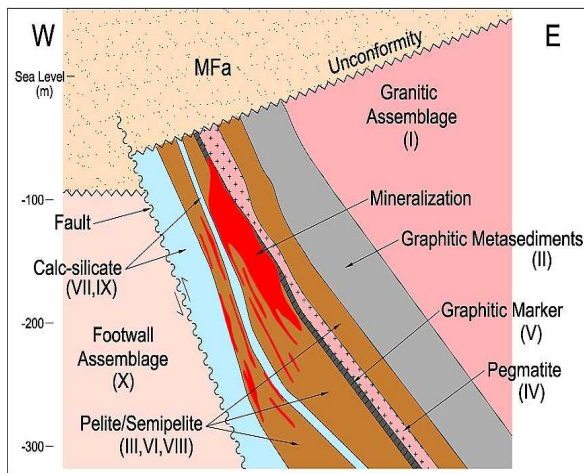


Figure 4: Millennium basement lithologies and location of mineralization below the graphitic marker (V).

TDEM Conductors

Step Loop TDEM profiles, using 400 x 800 m loops, an EM37 transmitter and the Protem 20 channel receiver configuration, were carried out in support of drilling. This work identified new conductors to the west of the historic B1, including the important “Graphitic Marker” which is closely associated with the Millennium zone. Note the increase in the number of conductors in the general vicinity of the zone where Step Loop surveys were carried out in support of delineation drilling (Figure 3).

The “Graphitic Marker” is the westernmost, thinnest and deepest graphitic unit within the B1 conductor system. Stratigraphically, the Graphitic Marker and the mineralization just beneath it are located roughly 150 to 200 metres grid west of and footwall to the historic Fixed Loop B1 conductor.

A Step Loop pseudosection of channel 14 (Figure 5) demonstrates the advantage of being able to look at the TDEM data in two dimensions, rather than the usual one. The vertical component data are plotted at the midpoint between transmitter and receiver at a pseudo-depth equal to half the Transmitter-Receiver separation. If the loop size is less than or equal to the conductor depth, the principle of transmitter-receiver reciprocity allows plotting of the vertical component data from both sides of the loop on the same pseudosection with minimal error. The cool colours define the conductor anomalies as triangular to half-moon shaped lows. A horizontal slice anywhere through the image would represent a single Slingram transmitter-receiver separation.

The Graphitic Marker is easily discernible in early to mid channel pseudosections. In Figure 5 it is identified as a shoulder anomaly in the blue-green portion of the pseudosection. The migration of this shoulder through the green is believed to be an artifact of the contouring and the sampling. The Graphitic Marker location is picked in the blue-green portion of the anomaly where the sampling is best, as depicted by the plot points in the pseudosection. The shoulder associated with the Eastern conductor (at the location of the historic Fixed Loop B1 conductor) displays better stacking from red through green. The darker blue portion of the pseudosection is centered on the “drill-defined” B1 conductor. For models of some of the Step Loop data from the Millennium zone the reader is referred to Walker and Lamontagne (2007).

Also included in Figure 5 are profiles of ground Bouguer gravity (Bouguer density of 1.9 gm/cc) and measured aeromagnetic vertical gradient across the zone. The gravity profile shows a very slight gravity high centered at 9+50 E, possibly related to basement metapelite and/or an unconformity high. A more significant gravity low (-0.8 mgal) to the west may be partly the surface expression of the B1 fault, and partly low-density sediments at the bottom of Slush Lake, immediately to the north and west of Millennium zone (See Figures 3 and 7). The broad aeromagnetic low (0.2 nT/m) is believed to be due to the folded meta-sedimentary sequence associated with the Millennium zone. The sharp aeromagnetic high centered at 7+50 E is at the location of the parked drill rig and rod sloop at the time of the aeromagnetic survey.

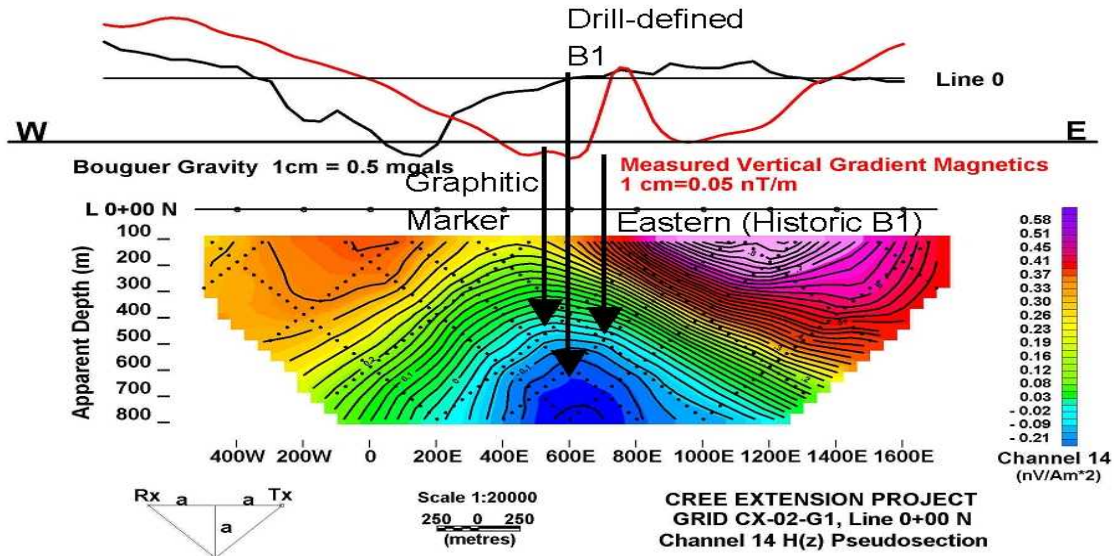


Figure 5: Millennium zone, Step Loop line 0+00, channel 14, vertical component data plotted and contoured in pseudo-section.

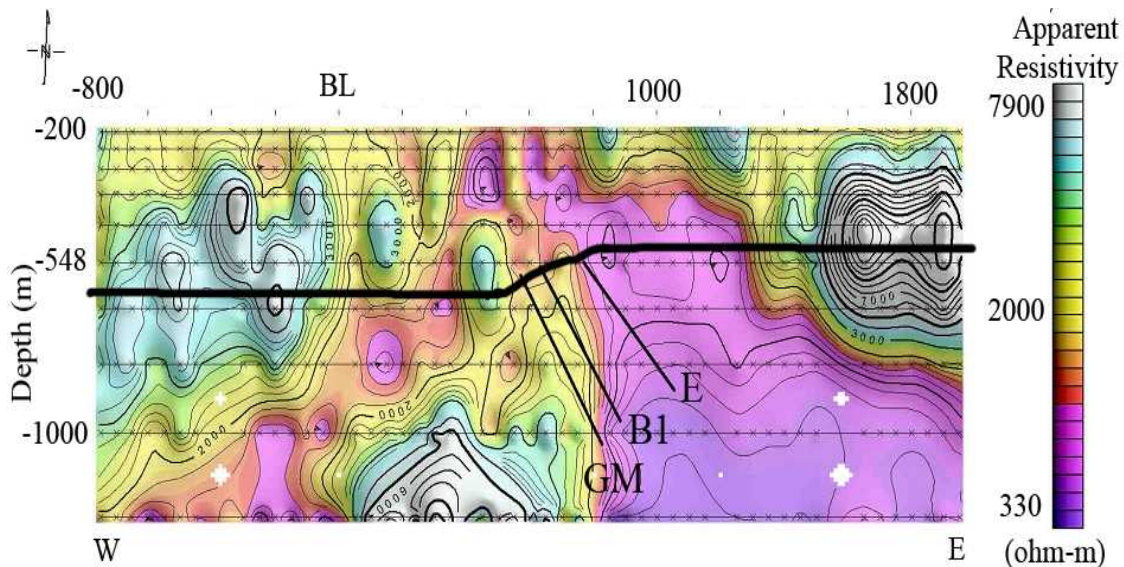


Figure 6: Millennium zone, 1D smooth model inversion of in-loop data from Step Loop line 2+00S.

A smooth model 1D layered earth inversion of the in-loop data from Step Loop line 2+00 S shown in Figure 6 indicates that the bulk of the graphitic metapelite is actually located to the east of the discrete conductors, labeled GM (Graphitic Marker in Figure 4), (drill-defined) B1 and E (Eastern conductor, at the historic Fixed Loop B1 conductor location). This large package of conductive basement could have played a role in skewing the position of the historic B1 conductor, which was difficult to drill intersect. The Eastern conductor, which is at the approximate location of the historic Fixed Loop B1, was drill intersected in 2007 for the first time in drill hole CX-62. The final naming of the conductors arose from the sequence in which they were intersected with the drill.

Other Surveys

An EScan survey (Shore, 2002) test was performed with some success (not shown). However poor electrode contacts related to thick seasonal frost at the time of the survey (March, 2001) limited the effective survey coverage. Subsequently Pole-pole DC Resistivity and TAMT test surveys were completed with the objective of determining the merit of these methods for mapping the structure and alteration in the sandstone.

The resistivity data were collected using a basic electrode spacing of a = 150 m with multipliers of n= 1, 1.5, 2, 2.5, ...,6. The data were inverted in 3D (Loke, 2005), from which a 310 m depth slice through the model is shown in Figure 7. The TAMT

data were inverted in two dimensions using Occam's inversion (Figure 8; deGroot-Hedlin and Constable, 1990). The three surveys produced fairly similar results showing a marked north-northeast trending resistivity low in the mid to lower sandstone above the mineralized zone. Based on limited downhole normal resistivity logs, physical property determinations made on drill core and the geological logs, this low is interpreted to be largely due to hydrothermal alteration of the sandstone overlying the Millennium zone.

In 2003 a MEGATEM test survey was carried out along the historic B1 conductor. This comprised four flight lines at 300 m

intervals flown sub-parallel to the conductor. The objective was to test the B1 trend for areas of locally enhanced conductive response, which might be indicative of enhanced graphite +/- alteration in the basement. The computed decay time (channels 6 to 20) or Tau map (Figure 9) shows that the Millennium zone is situated at the north end of a 100+ microsecond Tau anomaly. The anomaly extends north-south, roughly following the conductor package and may be related to host graphite content, +/- alteration, +/- brine. However the precise cause of the Tau anomaly is not yet fully determined.

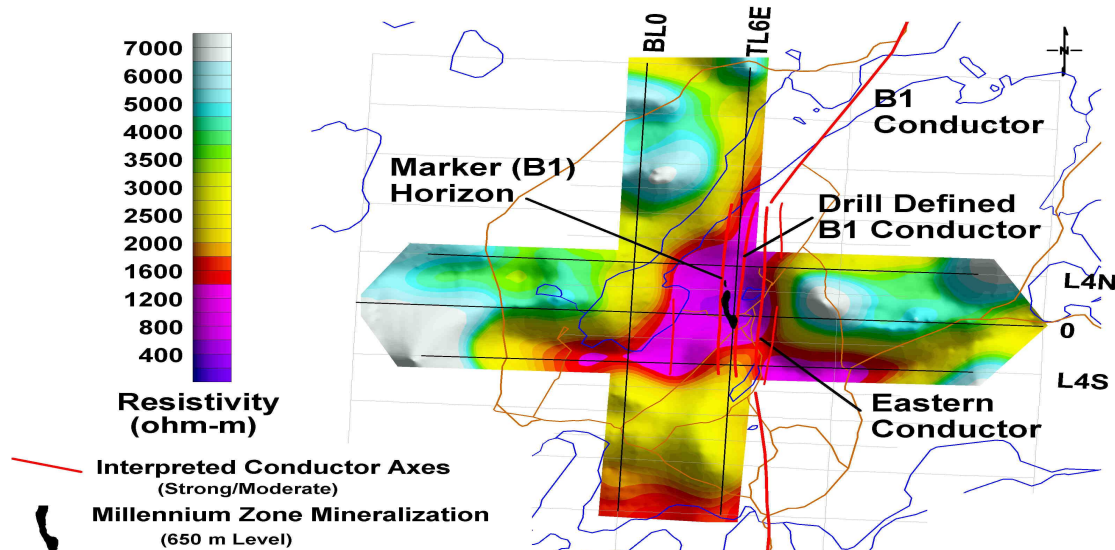


Figure 7: Millennium zone, 310 m depth slice from a 3D inversion of five test lines of Pole-pole resistivity data.

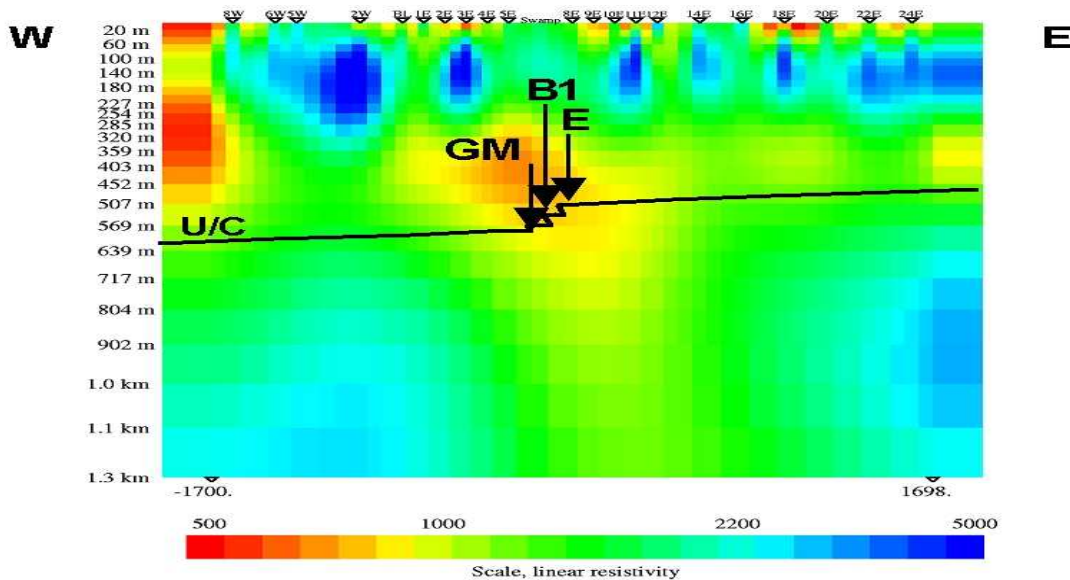


Figure 8: Millennium zone, TM mode Occam's inversion of TAMT data from line 4+00S.

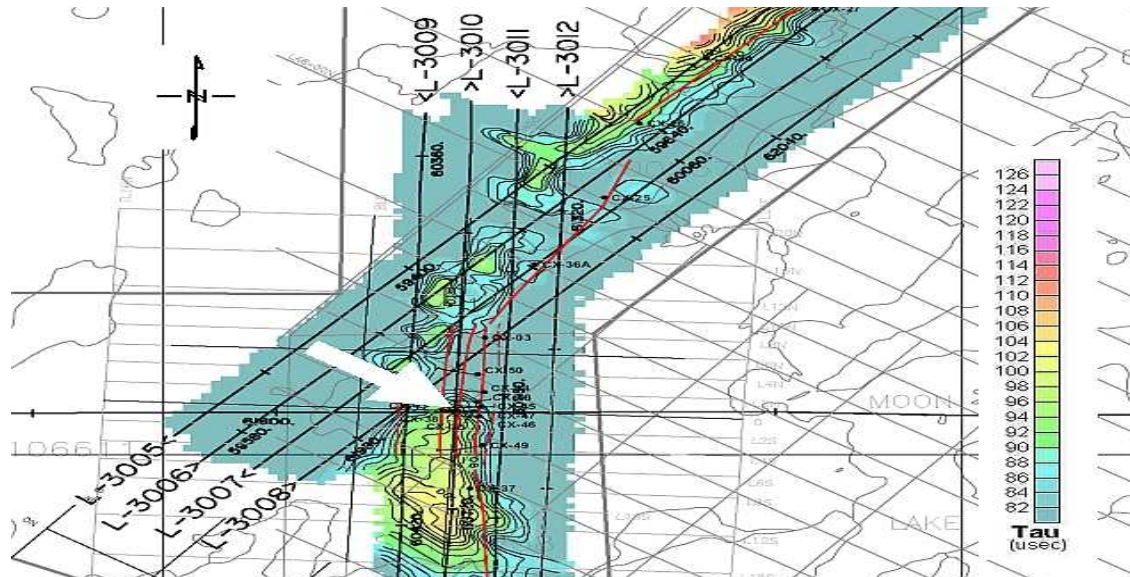


Figure 9: Tau map of MEGATEM test survey along the the historic B1 conductor, with Millennium zone indicated by the arrow.

Exploration Model Changes

The significance of the Millennium zone relates to the presence of the relatively under-tested basement-hosted uranium deposit type, in the Athabasca Basin. The large depth below the unconformity and distances off the dominant conductor bear similarities to other deposits of this type, notably the original Rabbit Lake deposit (Heine, 1986; Ruzicka, 1986), Zones O2 (Andrade, 1987), and O2 Next (Powell et al., 2005) at the Eagle Point Mine.

Based upon the various EM techniques applied to date at Millennium, the Stepwise Moving Loop method produced significantly better conductor resolution than the historic Fixed Loop coverage along the B1 trend. Definition of the Graphitic Marker likely would have played a role in discovery if it had been identified and defined before the fact. Nevertheless it was important after discovery as a primary ore control for delineation drilling.

Both the DC Resistivity and the TAMT tests demonstrated their potential value as tools for pre-screening the B1 trend for additional mineralized zones.

The MEGATEM test demonstrated that there is an EM bright spot associated with this deposit, expressed in this instance as a decay time Tau anomaly. It also identified a second such anomaly about 5 km to the north on the same trend.

LA ROCQUE LAKE AND COLLINS CREEK ZONES, DAWN LAKE PROJECT

The Dawn Lake project is a Cameco operated exploration joint venture among Cameco Corporation (57.466%), AREVA (23.086%), and JCU (Canada) Exploration Co. Ltd. (19.448%).

4.1 La Rocque Lake Zone

The La Rocque Lake zone is located near the extreme northwestern extent of the Dawn Lake Project. It is within the Mudjatik Domain of the Hearne Province, in the northeastern part of the Athabasca Basin, about 50 km northwest of the MacLean Lake mine complex. Depth to basement is between 250 and 300 m in this area. Historic exploration work included airborne INPUT, mag/radiometrics, lake sediment geochemistry, surficial geology/prospecting, ground magnetics, VLF, HLEM, Fixed Loop DEEPEM / EM37 / Protom, 1969-present. Significant structure, geochemistry and alteration in some drill holes provided encouragement to continue exploration in the area.

The La Rocque Lake conductor system is unusual in so far as it correlates well with a weak linear aeromagnetic vertical gradient high (Figure 10). Most Athabasca deposits correlate with magnetic lows. This was confirmed in a ground magnetic survey conducted over the La Rocque Lake zone in 2000. Three-dimensional inversion of the ground magnetic data (not shown) suggested that the magnetic source extends from the unconformity to a significant depth (600+ m) into the basement along the La Rocque Lake conductor system, suggesting a weakly magnetic unit is closely associated with it. There could be a contribution from a known magnetic upper till sequence found in this region as many magnetic highs in the general area are associated with topographic highs. However much of the conductor system and the magnetic high are under the topographic low of La Rocque Lake. There are numerous north-south, east-west and northwest-southeast oriented magnetic breaks identifiable in the ground magnetic data, some of which pass through the La Rocque Lake zone. It is thought that one of these, a north-south oriented shear zone, was principally responsible for a 400 m left-lateral offset of the conductor system across the zone (Figure 10) and the complex structures observed in the drill core from this locale.

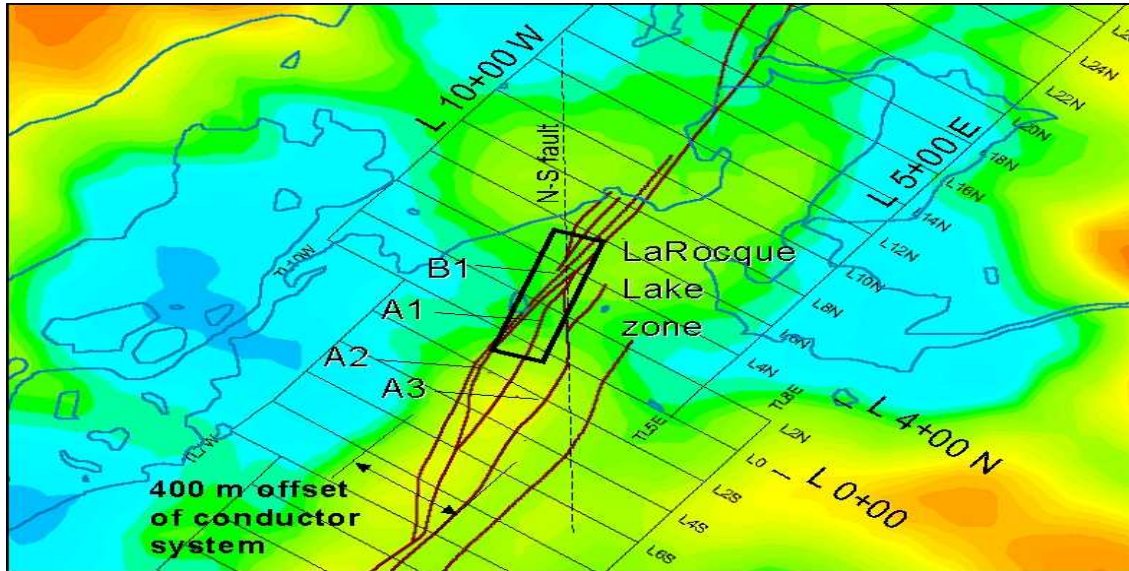


Figure 10: La Rocque Lake zone (black box) and aeromagnetic vertical gradient setting, with the conductors shown as red lines.

The history of the defined conductor pattern in this area is one of increasing complexity. A relatively simple interpretation was obtained from the original sparse Fixed Loop coverage obtained in 1987, while a relatively complex interpretation was obtained from fairly dense Fixed Loop plus Step Loop coverage by 2000.

The first Step Loop profile, using 200 x 200 m loops, an EM37 transmitter and Protem receiver was performed in 1997, along line 0+00 (Figure 10). This was done because the limited historic Fixed Loop coverage and drilling results in that locale indicated more conductor complexity than could be easily resolved with Fixed Loop alone. Some anomalous drill holes gave encouragement to continue testing in this area. The first drill hole intersection of significant uranium mineralization occurred on this line in 1998, on the A1 conductor. More Step Loop profiles were subsequently completed and played a key role in defining the complex imbricate fault-conductor system shown in Figure 10.

Figure 11 shows the late channel data from the first Step Loop profile, along line 0+00 near the south end of the La Rocque Lake zone. The locations of the conductors are shown as X's on the loop profiles, as black dots on the line and as inverted triangles on the pseudosection. The locations were selected by correlating horizontal component profile peaks and shoulders with vertical component inflections and pseudosection anomalies in which conductors are manifested as triangular to half-moon shaped response lows (colder colors). Conductor A1 is the second conductor from the left at 1+15 W in Figure 11.

For an embedded conductor, like the A1, one or more loops will be optimally coupled with it and thus will detect and define its position better, notably loops 6 and 7 in this instance. Thus better conductor resolution can be achieved than would be the

case with just one or two Fixed Loops. EM forward models (not shown) of the line 0+00 interpretation were computed in the 3D modeling program Emigma (Groom and Alvarez, 2002) to verify the interpretation. This demonstrated that the Step Loop survey in this case could readily resolve a response from the A1 conductor.

Additional forward modeling using a Tandem Moving Loop survey configuration indicated that it would have been difficult to resolve conductor A1 with transmitter-receiver separations in the range from 0 to 600 m. This result is born out by the pseudosection image in Figure 11. Any horizontal pseudo-depth slice represents a corresponding Tandem Moving Loop profile with transmitter-receiver separation equal to twice the pseudo-depth. It is clear from the image that the bounding conductors are resolvable but not so the interior conductors A1 (1+25 W) and A3 (0+50 E). However they were easily picked out from the individual loop – component profiles, shown above the pseudosection image in Figure 11.

In the geological section shown in Figure 12, along line 0+00, the discovery drill hole Q22-17 targeted the conductor A1 late time Step Loop response and intersected uranium mineralization at the unconformity, with graphitic metapelite in the basement immediately below. A 20 m step-out to the east (Q22-19) based on the early to mid channel A1 location also intersected structure and graphite but only minor amounts of uranium. A step-out hole was then completed to the west (Q22-30), defining a more significant uranium resource. A further 20 m step out to the west (Q22-33) then closed off the zone. Exploration of the mineralized zone proceeded in this fashion along the A1 conductor and then northward onto the adjacent B1 conductor (Figure 10).

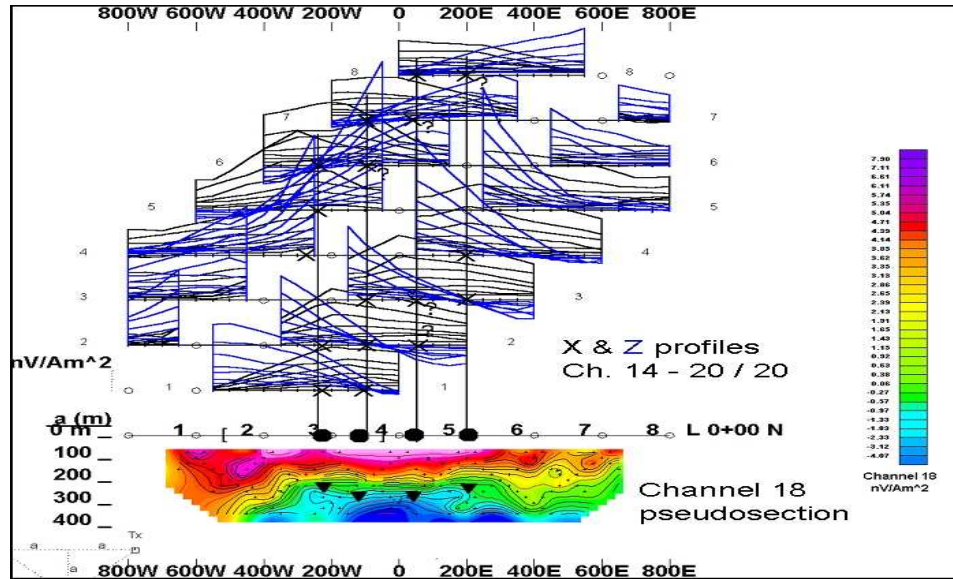


Figure 11: La Rocque Lake zone original Step Loop line 0+00 showing late channel (14-20) in-line X component profiles in black, Z in blue. A channel 18 pseudosection has conductor picks indicated by black circles and triangles.

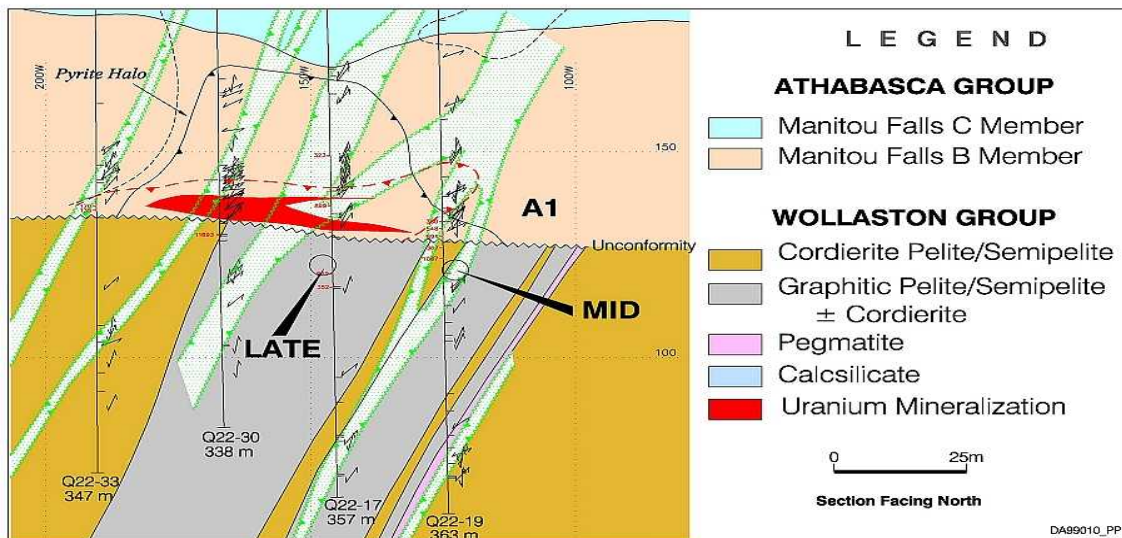


Figure 12: La Rocque Lake geological section for line 0+00, showing discovery hole Q22-17, and the mid and late channel A1 conductor picks.

La Rocque Lake Zone - Other Surveys

In addition to the key role of the TDEM surveys in defining the conductor system associated with the La Rocque Lake mineralization, it was important to define areas of enhanced sandstone alteration along the trend. The best mineralization to date is located along line 4+00N. Therefore, this line was chosen to test the effectiveness in defining alteration chimneys within the Athabasca Group sediments using three techniques: DC Resistivity, TAMT, and small loop TDEM soundings.

In 2002, a 2.5 km long profile of Pole-pole resistivity data was collected along the test line using an “a” spacing of 100 m,

with n=1 to 8. A 2D inversion of the resistivity data is shown in Figure 13. The resistivity data have defined a broad central zone of low resistivity basement between 7+00 W and 1+00 E. However, more importantly the survey outlined a zone of low resistivity values extending into the sandstone, centred at 2+50 W.

A 2D Occam’s inversion of a 2002 TAMT test profile is presented in Figure 14. Naturally occurring transient electromagnetic spectra were recorded over the frequency band from 5 Hz to 32 kHz for the estimation of the surface impedance tensor and the magnetic field tipper.

There is a difference in the location of the strongest sandstone anomaly between the Pole-pole Resistivity and the

TAMT inversions, which may be due to a lower resolution of the Pole-pole resistivity survey and some influence from a much broader zone of low-resistivities in the basement. In the resistivity survey, the strongest part of the anomaly is centered at approximately 2+50 W, whereas the TAMT resistivity low is centered at 1+00 W to 1+50 W, which correlates with the location of the A3 conductor on the test line. There is also evidence of extension of the low to 3+50 W in the lower sandstone where drill hole Q22-40 intersected mineralization associated with the western B1 conductor (Figure 15) on this line (29.87% U3O8 over 7 m just above the unconformity).

Significant structure and alteration were intersected in both the sandstone and the basement of this hole.

In 2006, as part of an ongoing program of TDEM soundings at La Rocque Lake, line 4+00 N was surveyed utilizing 100 m x 100 m loops with near-loop receiver readings. A smooth model 1D layered earth inversion of the sounding data (Figure 15) shows an upper sandstone zone of low resistivity values interpreted as a breach that was verified by drilling, as structure and alteration. This compares well with the 2D inversions of the Pole-pole Resistivity and TAMT surveys (Figures 13 and 14), which indicate a similar breach.

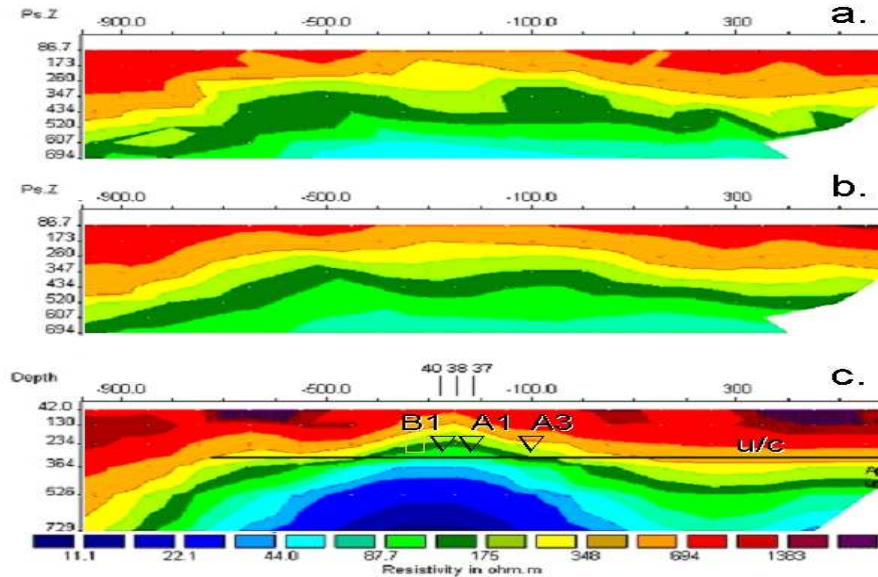


Figure 13: La Rocque Lake zone, line 4+00 N, 2002 Pole-pole DC Resistivity profile: a) measured, and b) model apparent resistivity, and c) 2D inversion model.

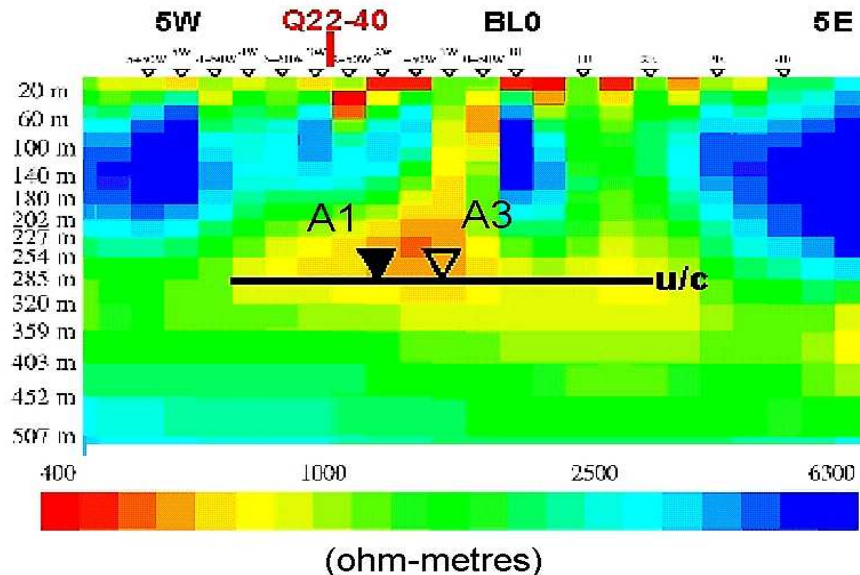


Figure 14: La Rocque Lake, 2D TM mode Occam's inversion of TAMT profile L 4+00 N.

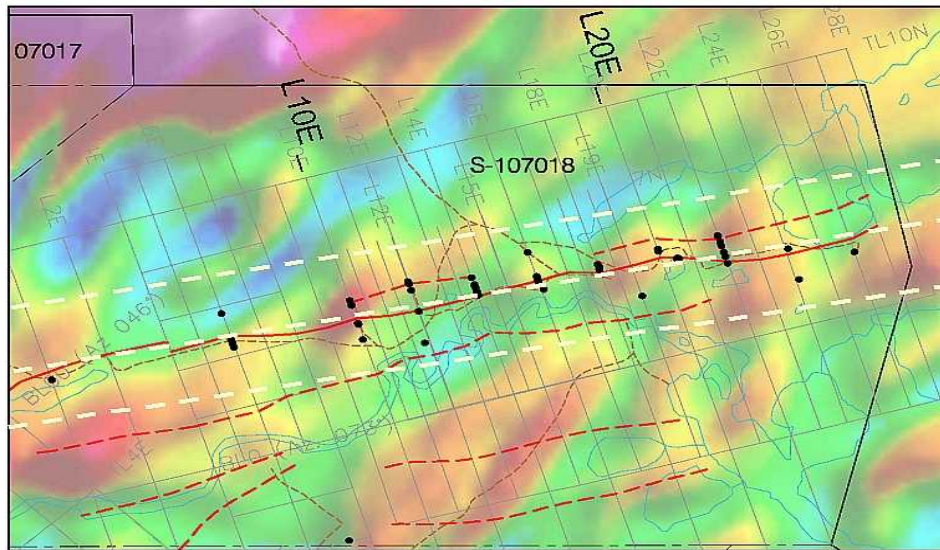


Figure 17: Collins Creek zone, aeromagnetic vertical gradient. Inferred breaks in the image related to the Tent-Seal fault are indicated in white dashed lines. Historic Fixed Loop conductors are shown as red lines.

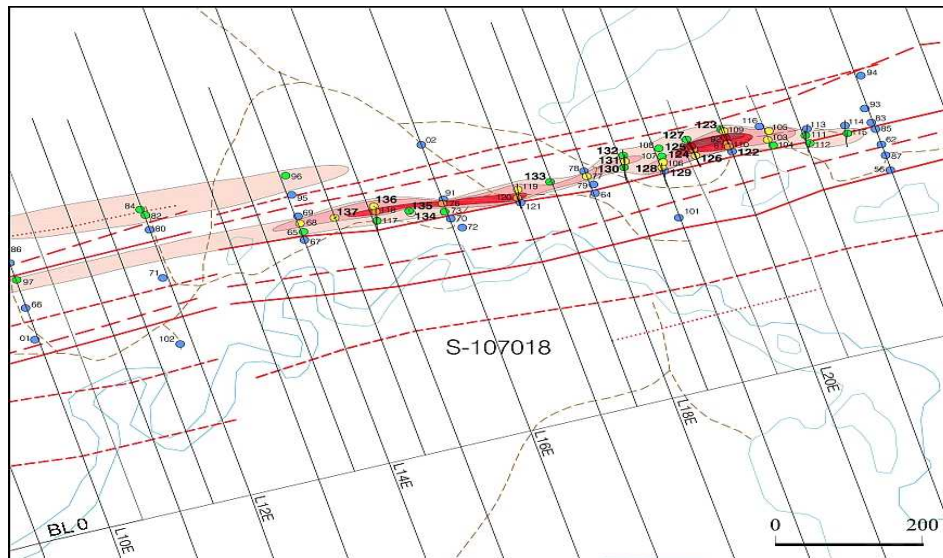


Figure 18: Collins Creek zone (high grade in red) showing drill hole locations and conductor locations (red lines). The new conductors are shown in red.

The history of discovery was similar to that of the La Rocque Lake zone. Significant mineralization was first intersected in 1999 by drill hole Q8-65 (0.22% U3O8 / 3.3m), which was drilled to test a moderate strength conductor defined on a single Step Loop test profile on line 14+00 E, completed the same year. However some problems were experienced reconciling the follow up drilling results with the Fixed Loop interpretation as it existed in 1997. At issue were the number, locations and orientations of conductors, notably on the eastern half of the grid.

In 2001, a systematic program of combined Step Loop and Fixed Loop coverage produced a more complete picture of the conductor system (Figure 18). This led to better consistency with the drilling, which increased the strike extent of the

mineralized zone by about 400 m. The zone is thought to be more or less closed to the east but still remains open to the west. The conductor system here is noticeably different from the La Rocque Lake zone, in so far as the conductors run largely sub-parallel to each other.

A geological section along line 19+50E is shown in Figure 19, crossing one of the better ore intersections to date - about 10 metres of high grade in the sandstone immediately above the unconformity. The multiple conductor package is explained as multiple tight folds of the same graphitic pelitic gneiss.

Late channel data for the nearest Step Loop profile, line 20+00E, is shown in Figure 20. The southern loops 4 to 7 produce a strong response reflecting better coupling with the conductors compared to the northern loops 1 to 3. Loop 3

produces the smallest response, which is a reflection of the moderate southerly dip of the conductors. The conductor pick at 2+60 N has the least confidence associated with it and may be a contact response related to the southern edge of the graphitic package. The pick at 3+75 N comes closest to matching graphitic structure 50 m away on line 19+50 E, shown in Figure 19.

A smooth model 1D inversion (Stoyer, 1988) of the in-loop data from Step Loop line 20+00 E is shown in Figure 21. The sandstone-basement unconformity is reasonably well resolved at about 175+ m depth, with a possible unconformity offset

suggested near 4+50 N. A large low resistivity body (<200 ohm-m), representing the graphitic lower Wollaston Group, which hosts the graphitic conductors, is defined in the basement over most of the southern half of the profile, with hints of a significant, steeply dipping fault following its north edge. It intersects the unconformity at about 4+25 N, near the mineralized zone. There is a possible hint of slightly lower resistivity sandstone east of the fault but this anomaly is too subtle and the sandstone too thin here to resolve with the 20 channel Step Loop data alone.

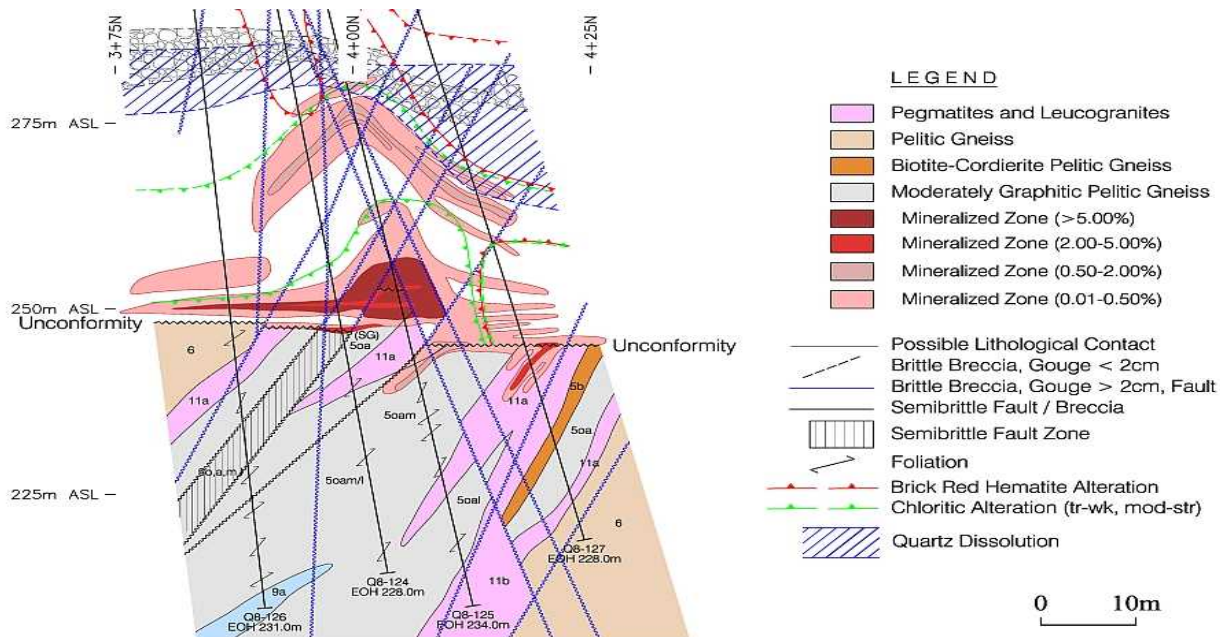


Figure 19: Collins Creek zone geological section along line 19+50 E. High grade mineralization is indicated in red, graphitic metapelite in grey.

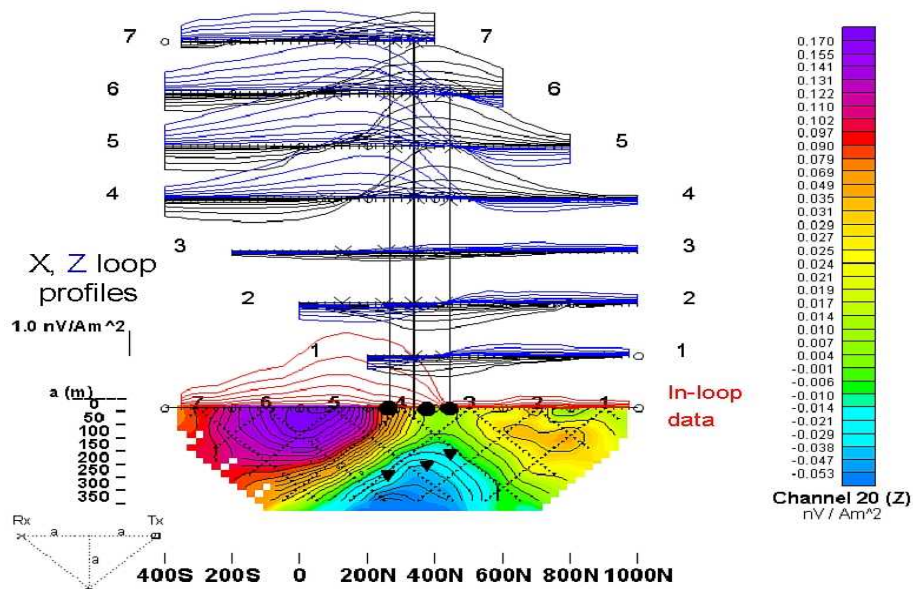


Figure 20: Collins Creek zone, Step Loop line 20+00 E. Late channel (14-20) in-line X, Z component profiles are in black and blue respectively. Conductor picks are shown on the pseudosection as black circles and triangles

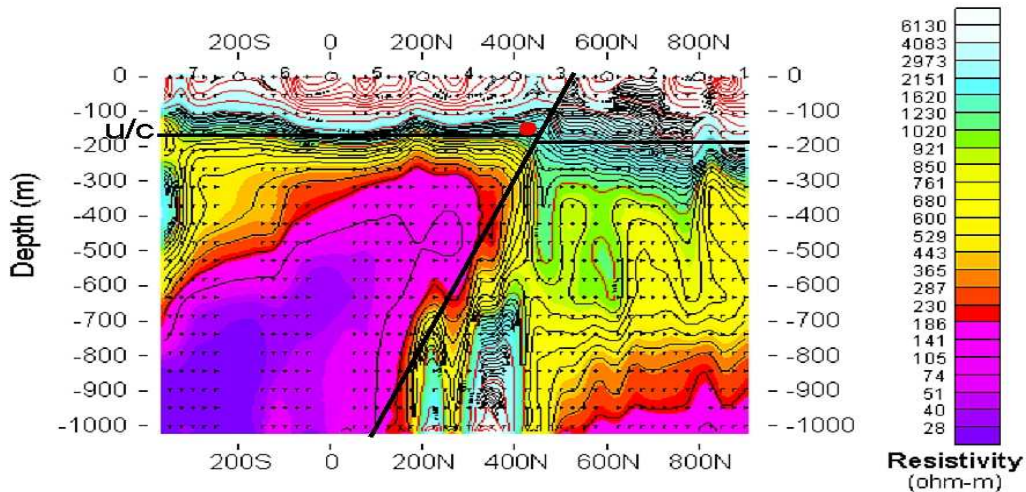


Figure 21: Collins Creek zone, stitched smooth model 1D resistivity inversion of in-loop data from Step Loop line 20+00E. The location of the mineralized zone is indicated in red.

Collins Creek Zone - Other Surveys

Other ground surveys at Collins Creek zone were minimal due to poor ground access related to Collins Creek which meanders across the survey grid. A winter small loop TDEM Sounding test was completed on a few selected lines in 2004 to determine if this method could be used to map the sandstone alteration associated with mineralization. The loops were 100 m square, and 30 channel Protom receiver readings were taken with an air cored coil 50 m grid-east of the loop to minimize coupling with the east-northeast trending conductors.

A wideband 1D inversion computed in Emigma from the Sounding data collected along line 19+00 E is shown in Figure 22. This was unsuccessful in imaging a sandstone resistivity anomaly in the vicinity of the mineralized zone, whereas noticeably lower sandstone resistivities appear 100+ m south of the mineralized zone. The reason for this is unclear at the moment.

A downhole normal resistivity log of drill hole Q8-101, located on line 19+00E approximately 100 m south of the Collins Creek zone, is shown Figure 23. The resistivity distribution matches the inversion result in the sandstone reasonably well, which suggests that the Sounding inversion is reasonably correct. The collection of more downhole resistivity logs, particularly in the vicinity of the mineralization, will hopefully clarify this in the future. Saline water appears to be resting on or just below the unconformity, as evidenced by low fluid resistivities below 195 m depth.

Exploration Model Changes

The La Rocque Lake and Collins Creek discoveries emphasized the importance of good conductor resolution for 1) more accurate drill targeting, and 2) better discernment of conductor system complexity. This is important because structural complexity favors open fracture systems that enhance fluid flow and uranium deposition.

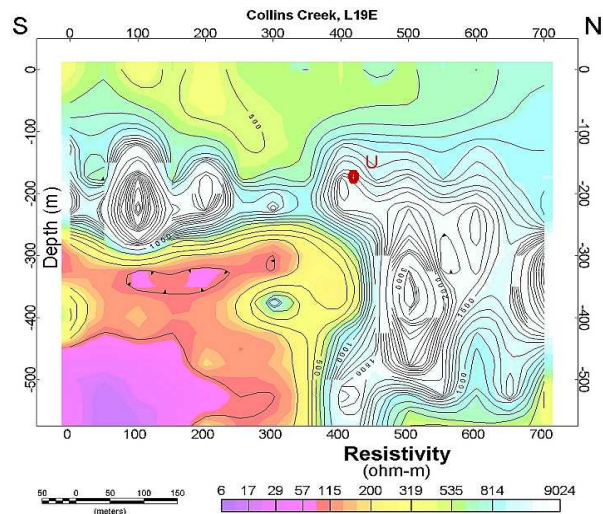


Figure 22: Collins Creek zone, line 19+00E, 1D inversion of a TDEM Sounding test line.

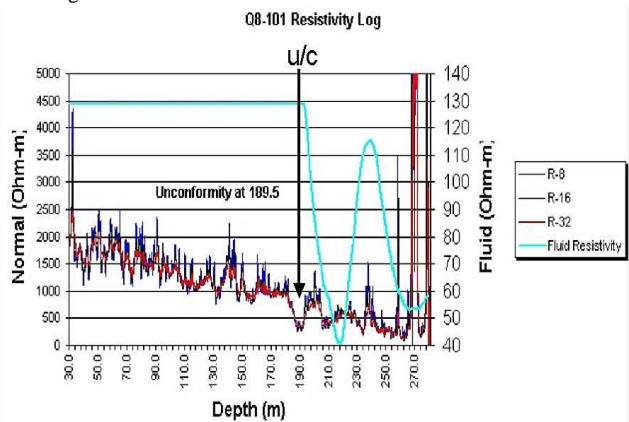


Figure 23: Collins Creek zone, downhole resistivity log of DDH Q8-101, on line 19+00E, 100 m south of the mineralization.

The structure and alteration in the sandstone, associated with the La Rocque Lake zone, were successfully mapped with all three of the sounding methods tested there. Of these, the small loop TDEM sounding method was selected for systematic mapping of the sandstone alteration in this area.

At Collins Creek, results of the TDEM sounding test were less clear. A unique low resistivity zone was not identified in the sandstone above the deposit, though one is identified further south. At the moment there is insufficient information about the sandstone resistivities in the vicinity of the mineralized zone. A DC Resistivity test would be a worthwhile comparison in the future.

CENTENNIAL ZONE, VIRGIN RIVER PROJECT

The Virgin River project area is a Cameco operated joint venture controlled by UEM Inc. (98%) and Formation Capital (2%). UEM Inc. is jointly owned by Cameco Corp. and AREVA. The project area is located near the southern edge of the central portion of the Athabasca Basin within the Virgin River Domain (Figure 1), which consists of dominantly high grade felsic gneisses with a sliver of mid-amphibolite supracrustals known as the Virgin Schist Group (Card, 2002). It is bounded on the west side by the Lloyd Domain with the contact marked by the Virgin River Shear zone, which is considered part of the Snowbird Tectonic Zone (Hoffman, 1990), a major continental scale structural feature. A local reactivation of the Virgin River shear zone is manifested as the Dufferin Lake fault (Figure 24), which has a 200+ m unconformity offset with the northwest side up-thrown relative to the southeast side.

Historic exploration in the area included airborne magnetics and radiometrics, surficial geology and prospecting, soil and lake sediment geochemistry, soil gas radon, drilling, reconnaissance boulder and outcrop sampling, GEOTEM, Fixed and Moving Loop TDEM and gravity, 1978–present. Significant structure and anomalous sandstone geochemistry associated with the Dufferin Lake fault and Virgin River

conductor trend provided encouragement to continue exploration in the area.

The Centennial zone unconformity uranium occurrence was discovered in 2004 in the footwall of the Dufferin Lake fault near Wide Lake. It demonstrates the innovative use of a longitudinal DC Resistivity survey toward a more focused approach on a 50 km long, 10 km wide, deep conductor corridor.

Shown in Figure 24 is an image of the historic vertical magnetic gradient data for the Wide Lake area. Significant uranium enrichment occurs along the Virgin River trend at the interpreted intersections of a north-northeast trending antiform with west-northwest trending synforms, forming “saddles” every 6 to 10 kilometres along the antiform. These “saddles” are recognizable in the detailed vertical gradient magnetic and Bouguer gravity data (not shown) for the area.

The unconformity-hosted uranium mineralization occurs on the northeast trending C1 fault-conductor that flanks the west side of the antiformal fold axis, at or near zones of upper-sandstone de-silicification (of previously silicified sandstone). Paragenetic studies indicate that the de-silicification was a premineralization event that may have controlled synmineralization fluid flow patterns (Sopuck, 2004).

TDEM CONDUCTORS

Fixed Loop surveys were conducted early in the history of this project (mid-1990's) but were deemed to be yielding inadequate information. A switch was therefore made to widely spaced Tandem Moving Loop profiles in 1999 for defining the conductors on this project and has continued to the present.

The C1 conductor was outlined in the saddle area shown in Figure 24 by Tandem Moving Loop profiles using large transmitter loops (1000 x 1000 m), with transmitter-receiver separations of 1000 and 1800 m. The late channel data (17-20) for line 10+00 N, obtained with the 1800 m transmitter-receiver separation, are shown in Figure 25 along with the interpreted location of the C1 conductor.

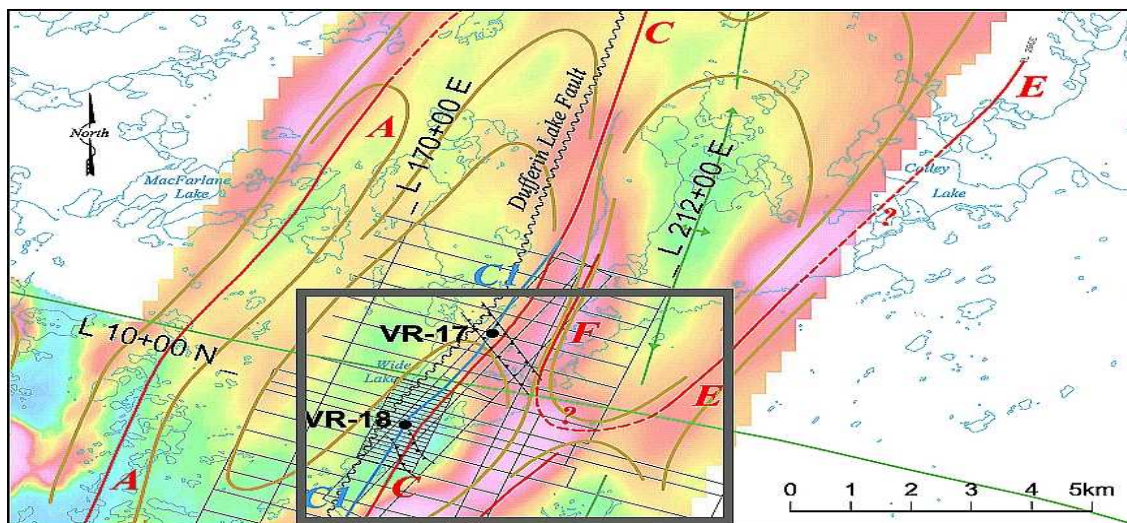


Figure 24: Centennial zone aeromagnetic vertical gradient with interpreted basement fold saddle (box), sandstone breaches (fiducials), Moving Loop line 10+00N and discovery hole VR-18.

While no significant graphite has been drill intersected yet along, or within, the Centennial zone, the Tandem Moving Loop coverage is regarded as having been useful for focusing exploration activity in this locale. A down hole TDEM survey in 2006 (not shown) using two surface loops (before the hole was lost) failed to identify a discrete conductor at the zone, which is unusual for a significant Athabasca unconformity uranium occurrence.

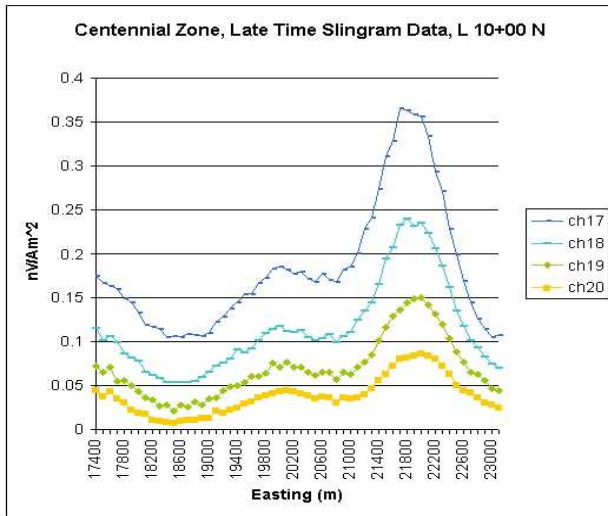


Figure 25: Centennial zone, Tandem Moving Loop data for line 10+00N with an 1800 m transmitter-receiver separation.

Other Surveys

A three-line, Pole-pole Resistivity survey (a=200, n=1 to 10) was carried out along, and parallel to, the C1 conductor. The

interval between lines was 500 m. A 3D inversion of the data was then completed. Figure 26 shows a section through the model along the middle line of the survey, along conductor C1. This shows evidence of two zones of lower resistivities interpreted as sandstone breaches (structure plus alteration) in an otherwise very resistive, silicified upper sandstone (>10,000 ohm-m). The intersection of the TDEM-defined basement fault-conductor and the unconformity proximal to the breaches was then considered a valid drill target. Two such targets were drill tested in 2004.

The discovery hole VR-18 is located on the north edge of the southern breach (Figure 26). This hole intersected perched uranium in the sandstone from 710.5 to 711.7 and 752.0 to 762.8 m, and unconformity-hosted uranium from 789.1 to 795.5 m, with average grades of 0.27%, 1.0% and 5.83% U3O8 respectively. Diamond drill hole VR-17, which was sited within the northern breach, encountered anomalous radioactivity (6,433 cps) and alteration in the lower sandstone.

Petrophysical logs are rare from the Virgin River project due to the instability of the drill holes in this area. Figure 27 displays resistivity log data recorded in discovery hole VR-18. These are roughly consistent with the DC Resistivity inversion results. It displays higher sandstone resistivities (>2,000 ohm-m) near the surface and in several bands between 230 and 570 m depth, with moderate sandstone resistivities (1,500 ohm-m) in the rest of the hole and lower resistivities (<1000 ohm-m) in the lower sandstone.

The fluid resistivity in drill hole VR-18 (Figure 27) remains high indicating freshwater to a depth of 680 m, then drops sharply to near zero values below indicating saltwater resting on the sandstone-basement unconformity. This suggests that the brine layer and/or brine saturation of the underlying fault zone associated with the Centennial zone is a possible explanation for the C1 conductor.

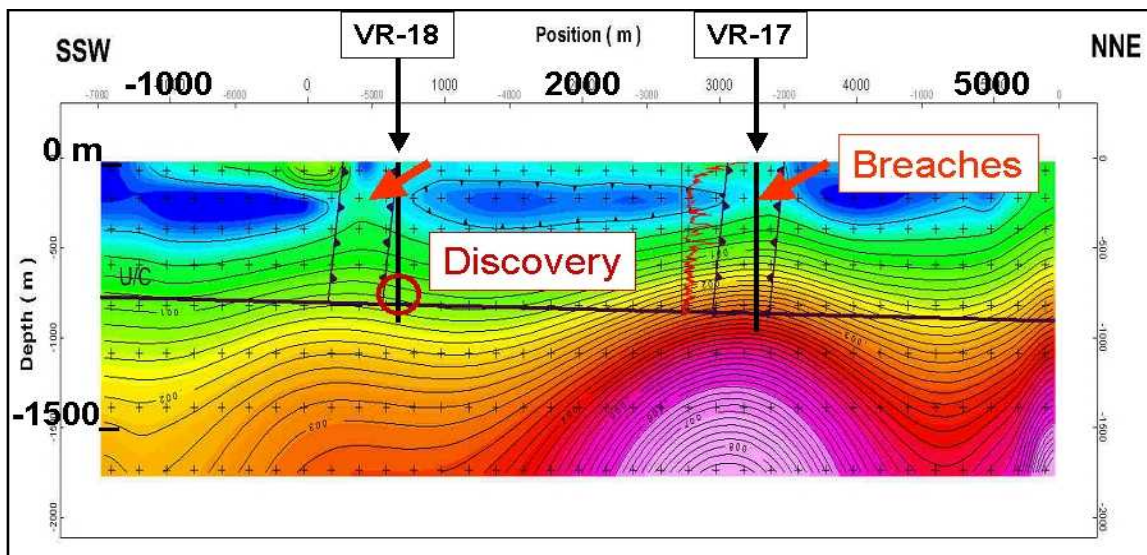


Figure 26: Centennial zone, longitudinal conductivity section along conductor C1. The resistivity range in the image is 10,000 (blue) to 100 ohm-m (pink).

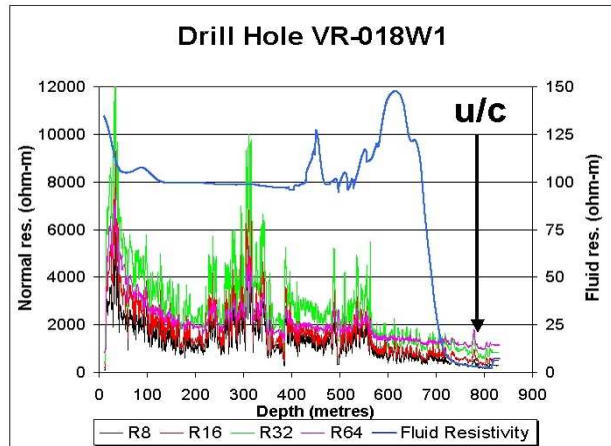


Figure 27: Downhole normal and fluid resistivity logs of discovery hole VR-18

EXPLORATION MODEL CHANGES

The Centennial zone discovery demonstrates that considerable efficiencies are achievable by taking a more selective approach to systematic drilling of conductors, particularly under deep sandstone cover. The longitudinal Pole-pole Resistivity survey along the interpreted C1 conductor was a unique first test of this methodology and was cost-effective for focusing expensive exploration drilling within a large multi-conductor corridor in an area of deep sandstone cover, leading directly to a significant uranium discovery. DC Resistivity profiling perpendicular to the conductor system has been and continues to be the historical norm for mapping sandstone alteration, to optimize across-strike resolution. It remains to be seen whether Athabasca explorationists will take up the longitudinal resistivity innovation as a more efficient means of accomplishing the same goal.

The downhole normal and fluid resistivity logs in this case, verify the resistivity inversion results. The presence of highly conductive brine at the unconformity is often missed or ignored but can have a major impact on EM and DC Resistivity survey results and interpretation.

CONCLUSIONS

An innovative and integrated approach to exploration has aided in discovery of significant new uranium mineralization in the Athabasca Basin. The significance of the Millennium zone discovery, relates to the presence of the relatively under-tested basement-hosted deposit variant of the unconformity uranium deposit model. Their large depths below the unconformity and distances off the dominant conductor make them more difficult, but not impossible to find.

The Millennium, La Rocque Lake, and Collins Creek discoveries benefited from the Stepwise Moving Loop EM method and the better conductor resolution achievable, notably for embedded and footwall conductors. TAMT and Pole-pole resistivity surveys were both employed at the Millennium and La Rocque Lake zones for mapping sandstone alteration above

the mineralized zones with positive results. Small loop TDEM Sounding at La Rocque Lake also provided good accuracy in mapping sandstone alteration and was the preferred choice there. TDEM Sounding results at Collins Creek were less clear in mapping sandstone alteration at the mineralized zone, possibly due to poor contrast between altered and unaltered sandstone.

EM bright spots, defined here either as amplitude or decay time (Tau) anomalies are useful indicators of uranium occurrences in the Athabasca Basin, as exemplified by the MEGATEM Tau anomaly at Millennium, the VTEM mid channel anomaly at La Rocque Lake and the off-conductor, mid-channel, in-loop anomalies at zones O2 and O2 Next, Eagle Point mine (O'Dowd et al, 2007).

The Centennial zone discovery demonstrated that considerable efficiencies are achievable by taking an innovative and more selective approach to systematic drilling of large conductor corridors. This may be the first DC Resistivity survey, with 3D inversion, to play a key role in discovery of a significant, deep uranium zone in the Athabasca Basin. The innovative use of DC Resistivity lines parallel to the conductor axis has the potential to efficiently test long conductor corridors for evidence of sandstone alteration.

ACKNOWLEDGEMENTS

We thank the following people for their cooperation and assistance: 1) the Cameco geologists who directly worked on or oversaw these discoveries; 2) joint venture partners JCU (Canada) Exploration Co., Ltd., UEX Corp. and Formation Capital Corp; 3) contractors / consultants Discovery International Inc., EMpulse Geophysics Ltd., Goldak Airborne Surveys, Lamontagne Geophysics Ltd., Patterson Geophysics Inc., and Quantec Geoscience Ltd.; and 4) hardware / software suppliers Advanced Geosciences Inc., Geonics Ltd., Interpex Ltd., Iris Instruments, Mount Sopris Co., Inc., and PetRos Eikon Inc.

IN MEMORIAM

This paper is dedicated to the memory of Dr. Michael Leppin, who was a life-long uranium explorationist in the Athabasca Basin and elsewhere throughout the world. His geophysical work on the Virgin River project was crucial to the discovery of the Centennial zone in 2004. He was also a generous guiding light to many who worked in the business.

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