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Report on an Insight IP Gradient & Insight IP Section
Ground Geophysical Survey

As completed by Insight Geophysics Inc., and

Report on a Surface UTEM-5
Ground Geophysical Survey

As completed by Lamontagne Geophysics Ltd. for:

NORONT

# Area 5 Property

Ring of Fire, James Bay Lowlands
BMA 527861
Porcupine Mining District, Ontario

May 10, 2017

# Area 5 Property
# 2016 Exploration Report
# Insight IP Gradient & Section Survey and
# Surface UTEM-5 Survey

Report prepared for:

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May 10, 2017
*133 Pages*

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## 1. Introduction

From June 28, 2016 to August 2, 2016, Noront Resources Ltd. (“Noront”) contracted Insight Geophysics Inc. (“Insight”) and Lamontagne Geophysics Ltd. (“Lamontagne”) to perform an Insight IP Gradient and Section Array Survey and a Surface UTEM-5 Survey, respectively, on their Area 5 Property. The Area 5 Property, which contains the Big Daddy Chromite Deposit, lies on claim 3012253 in the township of BMA 527 861 (NTS 043D16) in the Porcupine Mining District (Figures 1 and 2).

The Insight IP Gradient survey commenced on June 28, 2016 and was completed on July 17, 2016. It covered an area of approximately 1.36 $km^2$ (or 136 hectares), with 14.2 line km of gradient array surveying being completed and two Insight Sections, each of 750m length, totaling 1500m, being completed (Figures 3, 4, and 5).

The Surface UTEM-5 survey commenced on July 18, 2016 and was completed on August 2, 2016. It covered an area of approximately 1.87 $km^2$ (or 187 hectares), with 13.275 line km of surveying being completed (Figures 3, 4, and 5).

Noront’s 2016 Exploration focus was on Ni-Cu-PGE sulphide mineralization in the footwall zone of the Ring of Fire ultramafic intrusive suite, which hosts the majority of the magmatic sulphide mineralization in the Ring of Fire (Eagle’s Nest, Blue Jay/AT12, AT12 extension, F2 Zone, Contact Zone, NW Breccia). Noront holds nearly the entire Ring of Fire ultramafic footwall contact zone and thus holds a significant package of land on which to explore for further Ni-Cu-PGE mineralization (Figure 4).

The ground that Noront holds in the ultramafic intrusive and footwall contact zones has been divvied into Areas 1 through 10, with Areas 1 and 2 covering a large area just north, northwest, and northeast of the Eagle’s Nest and Blackbird deposits (this area also covers the AT5 and AT6 anomalies). Area 3 covers the Blue Jay Ni-Cu-PGE prospect and surrounds (formerly known as AT12). Area 5 covers the footwall contact zone in the area of the Big Daddy chromite deposit (a Joint Venture with KWG Resources), and Area 6 covers the footwall contact zone in the area of the Black Thor and Black Label chromite deposits. Area 6 is also host to Ni-Cu-PGE footwall sulphide mineralization that was discovered by Cliffs Natural Resources in the AT12 Extension, F2 Zone, Contact Zone, and NW Breccia Zone (Figure 4).

The overall plan for the 2016 Exploration program involved initial ground geophysical surveying of focus areas (namely, Areas 1, 2, 3, 5, and 6) by Insight IP, which would then provide target areas for follow-up surveying by Lamontagne Geophysics’ UTEM-5 system. The UTEM-5 survey was carried out to test anomalies outlined by earlier exploration, to detect/outline new conductors, and to detect/outline deeper features and potential depth continuations of shallow features. The UTEM surveying would then, ideally, delineate drill targets.

The fourth phase of the 2016 exploration program, as detailed within this report, involved Insight IP surveying of project Area 5 (Figure 5a) followed by Surface UTEM-5 surveying of a slightly larger area (Figure 5b).


**Figure 1: General location map in Ontario.**

## 2. Exploration History

Between 1959 and 1988, there was sporadic exploration for diamonds by companies such as Consolidated African Selection Trust, De Beers South Africa (1962), and Monopros Limited (the Canadian subsidiary of De Beers), until the discovery of the Attawapiskat diamondiferous kimberlite field by Monopros Limited in 1988. In the early to mid-1990s, joint ventures partners Spider Resources Inc. ('Spider') and KWG Resources Inc. ('KWG') conducted an airborne magnetic survey throughout the northern part of the James Bay Lowlands focusing on diamond exploration. They discovered the Good Friday and MacFadyen kimberlites in the Attawapiskat cluster, as well as the five Kyle series kimberlites, that lie to the east of the property being reported herein.

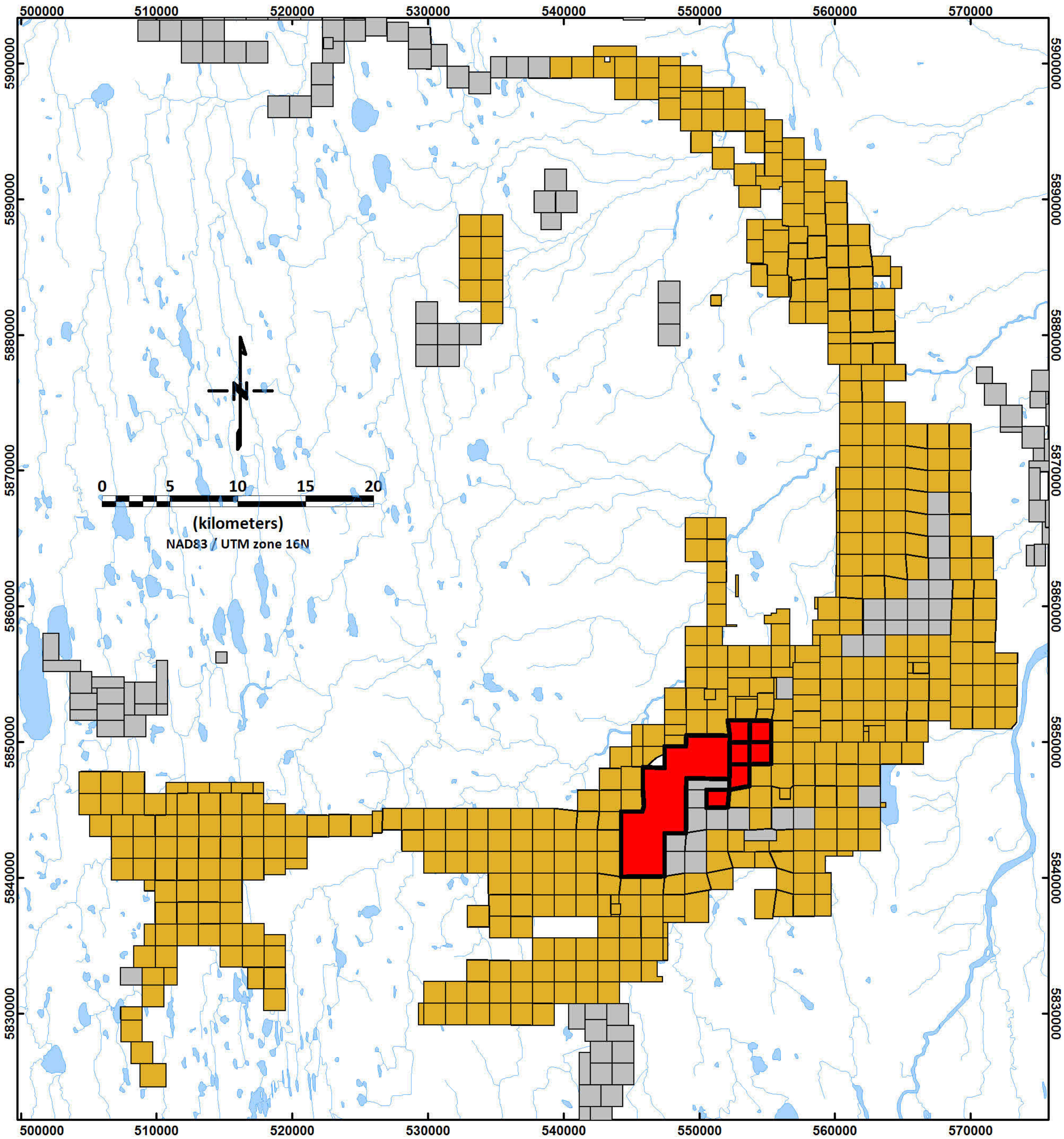


**Figure 2: Ring of Fire claim map, with mining leases shown. Claims in yellow are of Noront Resources; claims in grey are of other companies. Claims in red are those of Noront's (including Noront's mining lease) on which exploration was completed in 2016.**

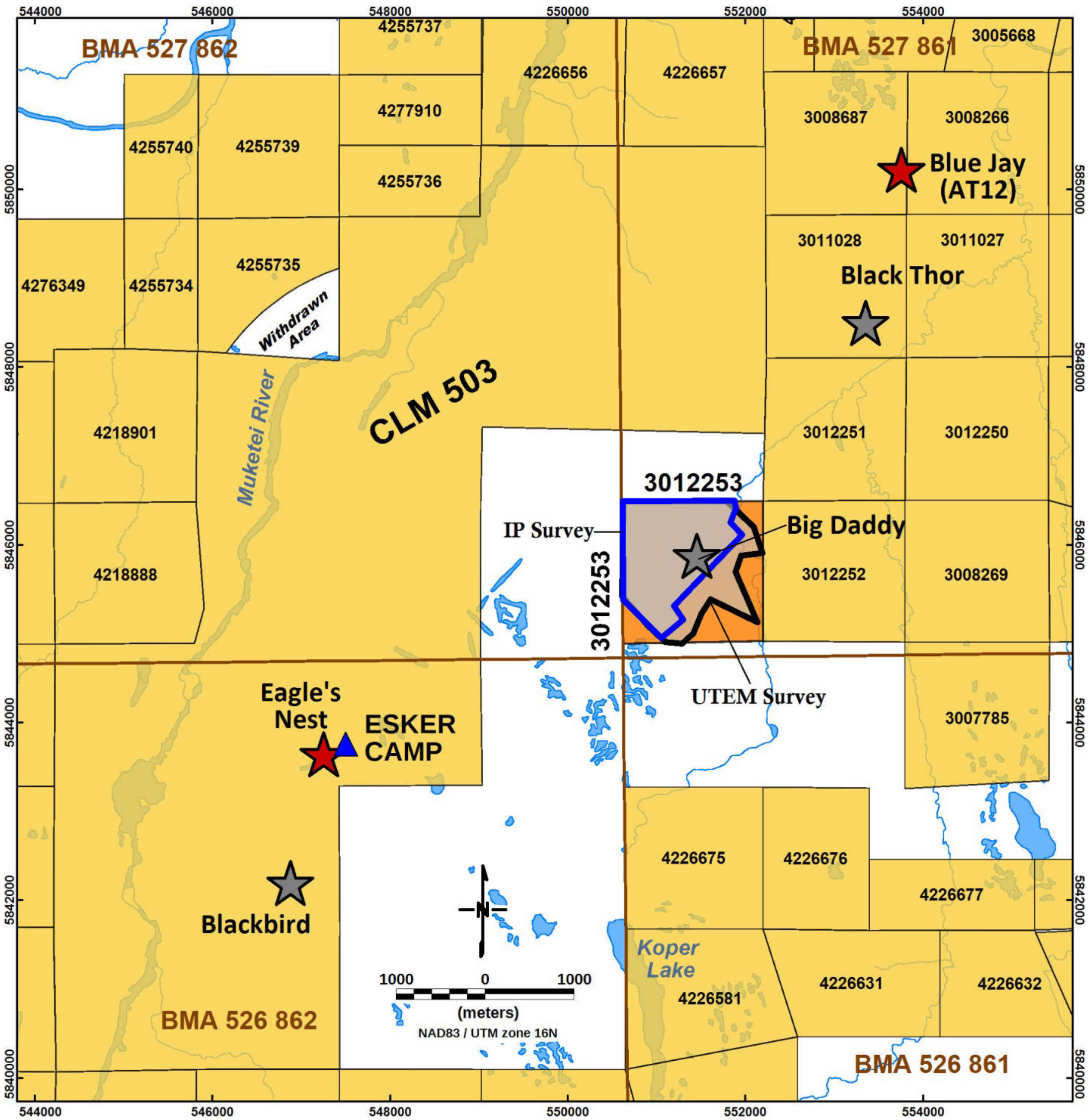


**Figure 3: Property claim map. All claims shown (in yellow) belong 100% to Noront Resources, with the exception of claims 3012253, 3012252, and 3008269, which are 72% Noront – 28% KWG. Orange claims are those being filed for work herein. CLM503 is Noront's Mining Lease. Black polygon represents the Area 5 UTEM-5 survey outline whereas the overlapping blue polygon represents the Area 5 IP survey.**

In 2002, De Beers Canada Inc. entered into a joint venture with Spider and KWG after discovering the McFaulds No. 1 volcanogenic massive sulphide (VMS) deposit while searching for kimberlites in 2001. Subsequent work by Spider and KWG, following another Spider/KWG airborne magnetometer survey, led to the discovery of the McFaulds No. 3 deposit and other related VMS occurrences nearby.

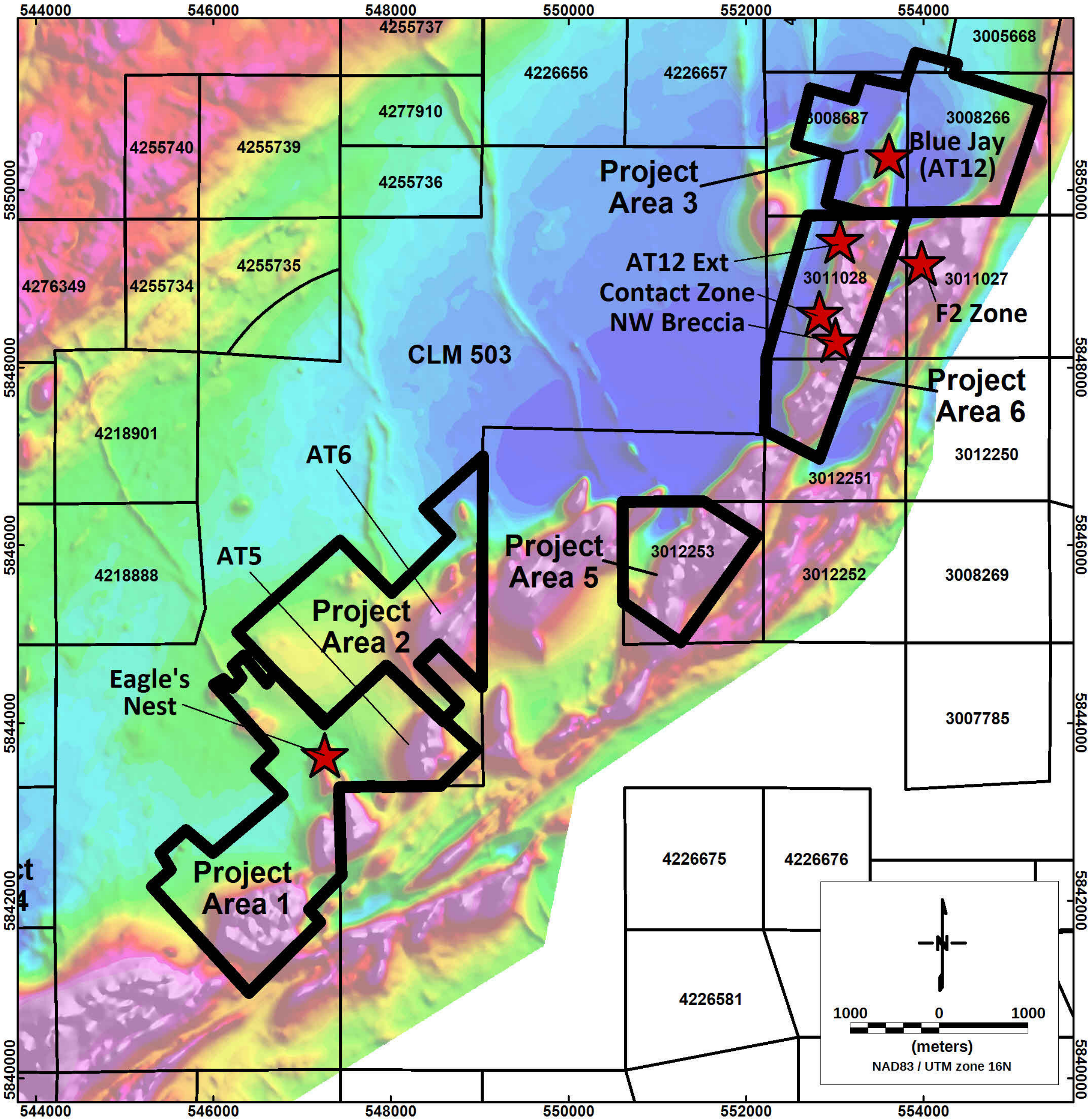


**Figure 4: 2016 Exploration Focus Areas. Total magnetic intensity in background. Claims shown are of Noront Resources.**

The discovery of these deposits, and the recognition of the region as a greenstone belt with great potential for further discoveries of base metal deposits, led to a staking rush by junior mining companies (including Noront) that began in December 2002 and continued well into 2003. The staking rush and subsequent exploration led to the discovery of six additional VMS deposits in 2003 by other junior exploration companies in the region.

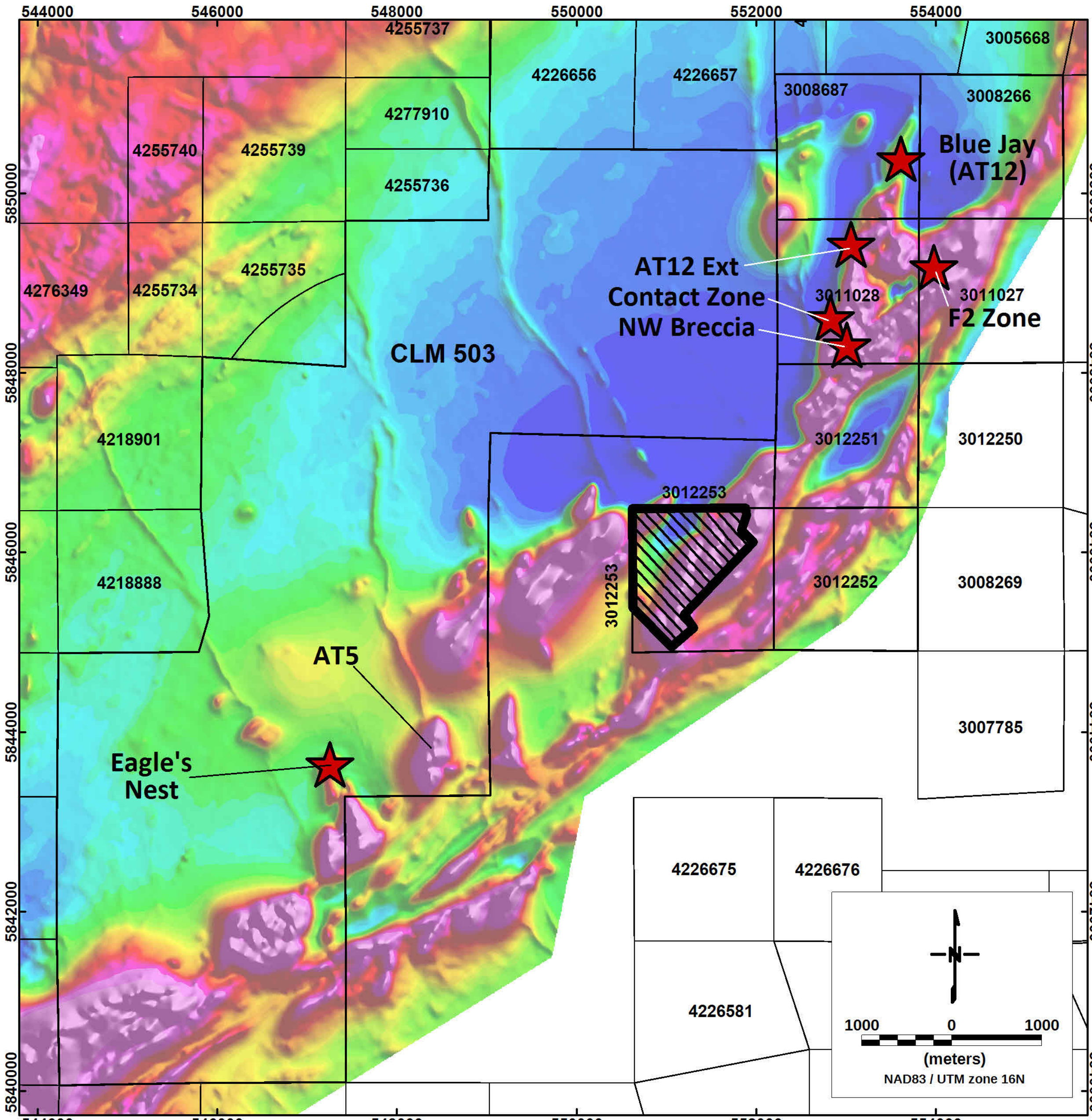


Figure 5a: Location map of the Insight IP survey over the Area 5 project. The thick polygon represents the complete survey outline; thinner lines represent surveyed lines. Total magnetic intensity in the background.

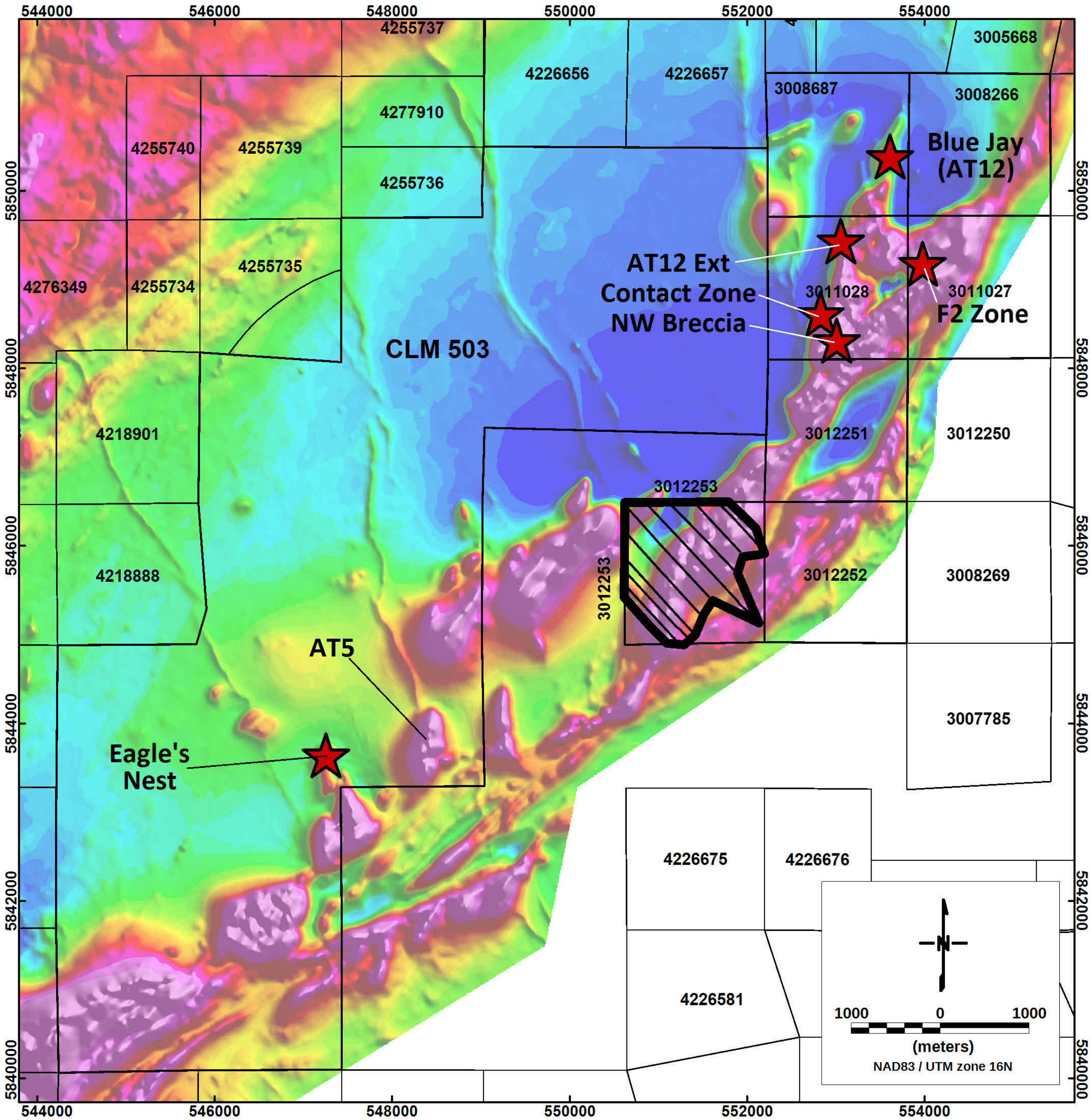


**Figure 5b: Location map of the Lamontagne Surface UTEM-5 survey over the Area 5 project. The thick polygon represents the complete survey outline; thinner lines represent surveyed lines. Total magnetic intensity in the background.**

Noront has been exploring the general area since early 2003, shortly after the VMS mineralization was discovered near McFaulds Lake by De Beers Canada. Noront acquired their initial claims by staking in August 2003 and followed that up with additional claim staking in January 2006, in the fall of 2007, and in the spring of 2008. Geophysical surveys (VTEM and ground magnetometer) conducted between 2004 and 2006 identified magnetic targets that were drilled in 2006 by Probe Mines Ltd. on Noront-held claims. It was this drilling that led to the identification of ultramafic rock, which thus highlighted the potential for Ni-Cu-PGE-Cr mineralization in the area.

Noront discovered the Eagle One (now termed Eagle's Nest) magmatic massive sulphide (MMS) deposit while searching for VMS mineralization in 2007. Following this discovery, Noront commissioned airborne and ground geophysical surveys to aid in the search for other similar deposits nearby. Noront completed a large-scale airborne geophysical survey in the fall of 2007 using Aeroquest Ltd. and their AeroTEM system. This was then followed by ground geophysical surveying (magnetics and gravity) by JVX Ltd., which was completed in the early part of 2008 on the Grid 1 property, as well as in late 2008 and early 2009 on the Grid 2 property. In 2008, Noront completed another large-scale airborne geophysical survey (Geotech VTEM) over nearly all of Noront's claims in the Ring of Fire region.

Following these surveys, a total of twelve anomalous conductive and magnetic targets were chosen for further exploration, in the hopes of finding another MMS deposit in the host ultramafic rocks. These targets were given a project designator, 'AT', and a number (1 through 12), and most were investigated through diamond drilling. This led to the 2008 discovery of the Eagle Two shear hosted sulphide deposit nearby, as well as the AT12 (now called Blue Jay) MMS deposit to the northeast of Eagle's Nest. It was the drilling of the Eagle Two deposit that led to the later discovery of the Blackbird chromite deposits in 2008 and the Blackstone/AT1 chromite occurrence in 2010, which are both hosted by the same ultramafic complex as Eagle's Nest. In 2009, the Thunderbird vanadium occurrence was discovered further to the east of Blackbird – Eagle Two – Eagle's Nest in a large mafic body (thought to the be the compliment to the Eagle's Nest – Blackbird ultramafic body), and in late 2009, the Triple J gold occurrence was discovered in the area of Eagle Two and Blackbird, in a contact zone between the granodiorite and Blackbird-hosting peridotite. In January 2010, a resource model and National Instrument 43-101 report was released on the Blackbird Chromite deposits, entitled "Technical Report on the Mineral Resource Estimate for the Blackbird Chrome Deposits, James Bay Lowlands, Northern Ontario, Canada". The resource model and report were created by Micon International Ltd. In April 2011, an updated resource model and National Instrument 43-101 report was released for the Eagle's Nest Sulphide deposit, entitled "Technical Report on the Updated Mineral Resource Estimate for the Eagle's Nest Property, McFaulds Lake Project, James Bay Lowlands, Ontario, Canada". The resource model and report were created by Micon International Ltd. And in May 2012, an updated resource model and National Instrument 43-101 report was released for the Blackbird Chromite deposits, entitled "Technical Report on the Updated Mineral Resource Estimate for the Blackbird Chrome Deposits, McFaulds Lake Property, James Bay Lowlands, Ontario, Canada". The resource model and report were again created by Micon International Ltd. In 2010, Noront completed yet another large-scale airborne geophysical survey (Terraquest High Resolution Magnetic and VLF-EM Airborne Survey) over nearly all of Noront's claims in the Ring of Fire region.

Noront completed a preliminary feasibility study in October 2011 (Burgess et al. 2011) to evaluate the development of the Eagle's Nest deposit, a high-grade Ni-Cu-Pt-Pd mineralized pipe-like body that is approximately 60 by 200 metres wide, and extends to depths beyond

1600 metres. This study indicated that the proposed mine infrastructure would be constructed underground. A contained, buried pipeline would then pump and transport a slurry of nickel-copper concentrate from the mill at the Eagle's Nest mine site to Webequie Junction, 90 kilometres west of the proposed mine site. From there, the concentrate would be dewatered and loaded for bulk transportation along a proposed 210 kilometre-long all-season road to Highway 808 north of Pickle Lake, Ontario. Transportation would then continue along the existing highway through Pickle Lake to the proposed Savant Lake concentrate handling facility. Development of a 105 kilometre-long winter road would provide a road connection from Webequie Junction to the Eagle's Nest mine site. This proposed infrastructure plan is termed the "East-West Corridor Alternative". In May, 2012, the Ontario Government announced their support for a north-south access route (the "North-South Corridor Alternative"), which provides access to the Ring of Fire via an access road from Nakina, Ontario. Noront adopted this proposed infrastructure corridor as the base case for the Eagle's Nest project in their 2012 feasibility study (Burgess et al. 2012). However, Noront has retained the originally designed East-West Corridor as an alternative, and in order to support construction activities, Noront plans to upgrade the existing winter road along the existing East-West Corridor from Pickle Lake to Webequie, in conjunction with the First Nations that currently use this route. This will include increasing funding to develop the main winter road towards Webequie and development of a new winter road leading east to the project site from south of Webequie, at Webequie Junction.

Insight IP was conducted over the Eagle's Nest – Blackbird property area in 2011-2012, and was followed by limited drilling of IP targets in 2012. IP was also conducted over the AT12/Blue Jay property, and drilling took place there as well. Valuable information on the geology of these areas was gained, but no deposits were uncovered.

In 2015, Noront purchased Cliffs Chromite Far North (formerly Spider Resources) and Cliffs Chromite Ontario (formerly Freewest Resources), thereby purchasing all property formerly owned by Cliffs Natural Resources in the Ring of Fire. In doing so, Noront purchased a 100% ownership in the Black Thor & Black Label chromite deposits, a 70% and controlling interest in the Big Daddy chromite deposit, an 85% and controlling interest in the McFaulds Lake VMS deposits and occurrences, and a 50% interest in the Kyle kimberlite occurrences. As a result, Noront now owns the majority of property in the Ring of Fire, and with it, all major deposits and much of the prospective ground.

In August 2016, Noront purchased a 75% interest in the Butler Lake and Sanderson properties from MacDonald, both located in the Ring of Fire area of Northern Ontario. MacDonald will carry a 25% interest in the two properties until the issuance of a NI 43-101 compliant resource on either property, at which time MacDonald will have the option to convert the interest into a 1% NSR. If MacDonald does not elect to convert, Noront can elect to purchase the remaining 25% from MacDonald. If neither company chooses their respective options, then a joint venture arrangement will be formed in order to develop the properties.

Noront’s exploration plan for the Ring of Fire for 2017 involves Ni-Cu-PGE exploration in and around its flagship property of Eagle’s Nest, as well as in the Sanderson area, and VMS exploration on the McFaulds and Butler properties.

## 3. Property Description and Location

The Area 5 Property is located in the James Bay Lowlands of Northern Ontario in the Porcupine Mining District. Using NAD83 / UTM Zone 16N, the project is located at approximately 551220mE, 5845830mN. It is located approximately 75 kilometres east of the community of Webequie, 125 kilometres northeast of the community of Neskantaga, 125 kilometres northwest of the community of Marten Falls, 285 kilometres north of the town of Nakina, and is immediately north of the Eagle’s Nest deposit (Figure 1).

Noront’s land package in the Ring of Fire contains 495 unpatented mineral claims and one mining lease totaling 115,556 hectares of ground and mineral exploration rights. In 2016, Noront’s multifaceted exploration program focused on a total of six claims, as well as Noront’s mining lease (Table 1).

Exploration personnel were accommodated at the Esker Camp (547500mE, 5843730mN). Access to the field survey area was by snowmobile, and the crews mobilized to site every day from Esker Camp. Access to the Esker Camp is by snowmobile, helicopter, ATV, or Argo from the Koper Lake base camp (~4 km southeast of the camp), which is serviced by fixed wing (ice or float planes) from Nakina, Ontario, or from the First Nation community of Webequie.

The Lamontagne Geophysics crew (with survey equipment) mobilized from Kingston, Ontario via truck. They overnighted in Sudbury and Geraldton, and arrived at the Esker Camp via a Nakina–Webequie–Esker Camp flight.

### *3.1 Claims Being Filed for Assessment*

The IP and UTEM-5 surveys covered portions of one claim, P 3012253, which is owned 72% by Noront Muketei Minerals (a 100% owned subsidiary of Noront Resources) and 28% by Canada Chrome, a subsidiary of KWG Resources. This claim is a part of the Noront-KWG Big Daddy Chromite Joint Venture Project. It is a 16-unit claim located in the township area of BMA 527 861 (NTS 043D16) in the Porcupine Mining District (Figure 3). It was recorded on April 22, 2003, and has a due date of April 22, 2020. Please refer to Table 1 for a claim-by-claim detail of township/area, recording date, due date, ownership, and number of units/hectares.

| Claim Number | Units | Township/ Area | Recording Date | Claim Due Date | Ownership |
|---|---|---|---|---|---|
| 3008266 | 16 | BMA 527 861 | 2003-Jul-31 | 2019-Feb-28 | Noront Resources 100% |
| 3008687 | 16 | BMA 527 861 | 2003-Oct-08 | 2019-May-08 | Noront Resources 100% |

| Claim Number | Units | Township/ Area | Recording Date | Claim Due Date | Ownership |
|---|---|---|---|---|---|
| 3011028 | 16 | BMA 527 861 | 2003-Apr-22 | 2019-Apr-22 | Noront Muketei Minerals 100% |
| 3012251 | 16 | BMA 527 861 | 2003-Apr-22 | 2019-Apr-22 | Noront Muketei Minerals 100% |
| **3012253** | **16** | **BMA 527 861** | **2003-Apr-22** | **2020-Apr-22** | **Noront Muketei 72% - Canada Chrome 28%** |
| CLM503 (G 60100775) | 4100 ha | BMA 526 862<br>BMA 527 861<br>BMA 527 862 | 2013-Aug-01 | 2034-Jul-31 | Noront Resources 100% |

**Table 1: Listing of claims & lease on which exploration was done during Noront's 2016 exploration program. Those highlighted in bold red text are those being filed for assessment herein.**

### *3.2 Personnel*

Noront's 2016 exploration team consisted of Ryan Weston (VP Exploration), Matt Downey (Manager, Lands & Data), Matt Deller & Roland Landry (Project Geologists), and Jeremy Brett (Consulting Geophysicist with MPH Consulting). They were all involved in the planning, targeting, and execution of the exploration program. Rob Lyght and Cory Exell, Noront geotechs, were involved in line cutting and geo-referencing.

Noront contracted the IP geophysical survey to Insight Geophysics Inc., of Oakville, Ontario. Craig Pawluk oversaw the project, while Perry Nielsen was the project field geophysicist.

Noront contracted the UTEM-5 geophysical survey to Lamontagne Geophysics Ltd., of Kingston, Ontario. Rob Langridge oversaw the project and wrote the report, while the Lamontagne field crew consisted of Phil Guimond (crew chief/operator), Gerry Lafortune (Rx/Tx operator), Richard Lahaye (Rx/Tx operator), Bill Dingwall (Tx operator/electronics), and Joey Plouffe (field assistant). Yves Lamontagne provided insight.

Numerous personnel from the communities of Webequie and Marten Falls were also employed by Noront as line cutters and geophysical assistants.

## 4. Geology

### *4.1 Regional Geology*

The project area is situated in the Ring of Fire ('ROF') in Northern Ontario (also known as the McFaulds Lake area). This area is underlain by rocks of the northwestern part of the Archean Superior Province, which is the world's largest continuously-exposed Archean craton. The northwestern Superior Province is composed of a series of major Mesoarchean volcanic and plutonic belts trending from west to east that each formed as separate microcontinents <3.0 Ga, and are separated by younger Neoarchean metasedimentary belts and crustal-scale faults. These continental fragments underwent rifting and lateral transport through processes considered to be a mixture of modern horizontal plate tectonics (such as those presently operative in largely oceanic domains such as the western Pacific Ocean) and vertical plate tectonics (those that would have occurred during the Archean when the continents were thinner, hotter, and less dense). Later subduction of the oceanic crust between these microcontinents eventually led to their collision and amalgamation to form the current geometry of the Superior Province (Figure 6).

The property areas lie within the McFaulds Lake greenstone belt, which lies within the North Caribou terrane of the western Superior Province (Stott et al. 2010; Stott 2011), formerly known as the Sachigo Subprovince, the Sachigo Superterrane, and the North Caribou Superterrane (Rayner and Stott 2005; Percival et al. 2006; Stott 2007). The North Caribou terrane is comprised of a centrally-located core flanked by the Island Lake domain in the north and west, the Uchi domain in the south, and the Oxford-Stull domain in the north and east (Stott et al. 2010; Stott 2011). The terrane is dominated by two major periods of plutonic and metamorphic activity at 2.895-2.89 Ga and 2.86-2.85 Ga, but the subdomains within it (Island Lake, Uchi, and Oxford-Stull) contain evidence of Neoarchean magmatism and sedimentation (Stott et al. 2010). Along the margins of the North Caribou core there are remnants of a platformal sedimentary succession of quartzite, arkose, and iron formation (evidence of an older continental margin). This is overlain by mafic to komatiitic lavas which are believed to be the product of rifting of the protocontinental landmass circa 2.99-2.98 Ga (Percival et al. 2006; Stott 2008). Following rifting, the area underwent periodic episodes of plutonism, arc volcanism, sedimentation, accretion of fragments of intra-oceanic island arcs, and related obduction of oceanic crust as a result of the subduction of oceanic crust underneath it on both its northern and southern margins. The crust accreted onto the margins of the North Caribou core during this period is recognized as the Island Lake domain on the northern and western margins, the Oxford-Stull domain on the northern and eastern margins, and the Uchi domain on the southern margin (Stott 2008; Stott et al. 2010; Stott 2011). It is thusly interpreted that the North Caribou terrane forms a Mesoarchean core upon which subsequent Neoarchean crust was added (Percival et al. 2006; Stott 2008; Stott et al. 2010). As well, several older greenstone belts, from 3.0 to 2.9 Ga, are preserved in the terrane, as are ca. 3.0 to 2.9 Ga rift sequences (Stott et al. 2010). This terrane also experienced repeated episodes of deformation and medium- to high-grade metamorphism between 3.0 and 2.7 Ga (Percival et al. 2006; Stott 2007, 2008).

The Oxford-Stull domain (Thurston et al. 1991; Oxford-Stull Subprovince of Rayner and Stott 2005), which contains the McFaulds Lake greenstone belt at its eastern limit of exposure, runs east-southeast and forms the northern-eastern portions of the North Caribou terrane. It stretches from northwestern Manitoba to north-central Ontario where it extends under the Paleozoic cover rocks of the James Bay Lowlands (Figure 6). Across the breadth of the Oxford-Still domain, there is a preponderance of Neoarchean U/Pb zircon ages in volcanic and plutonic rocks (Stott et al. 2010). As well, this domain is distinguished from other domains of the North

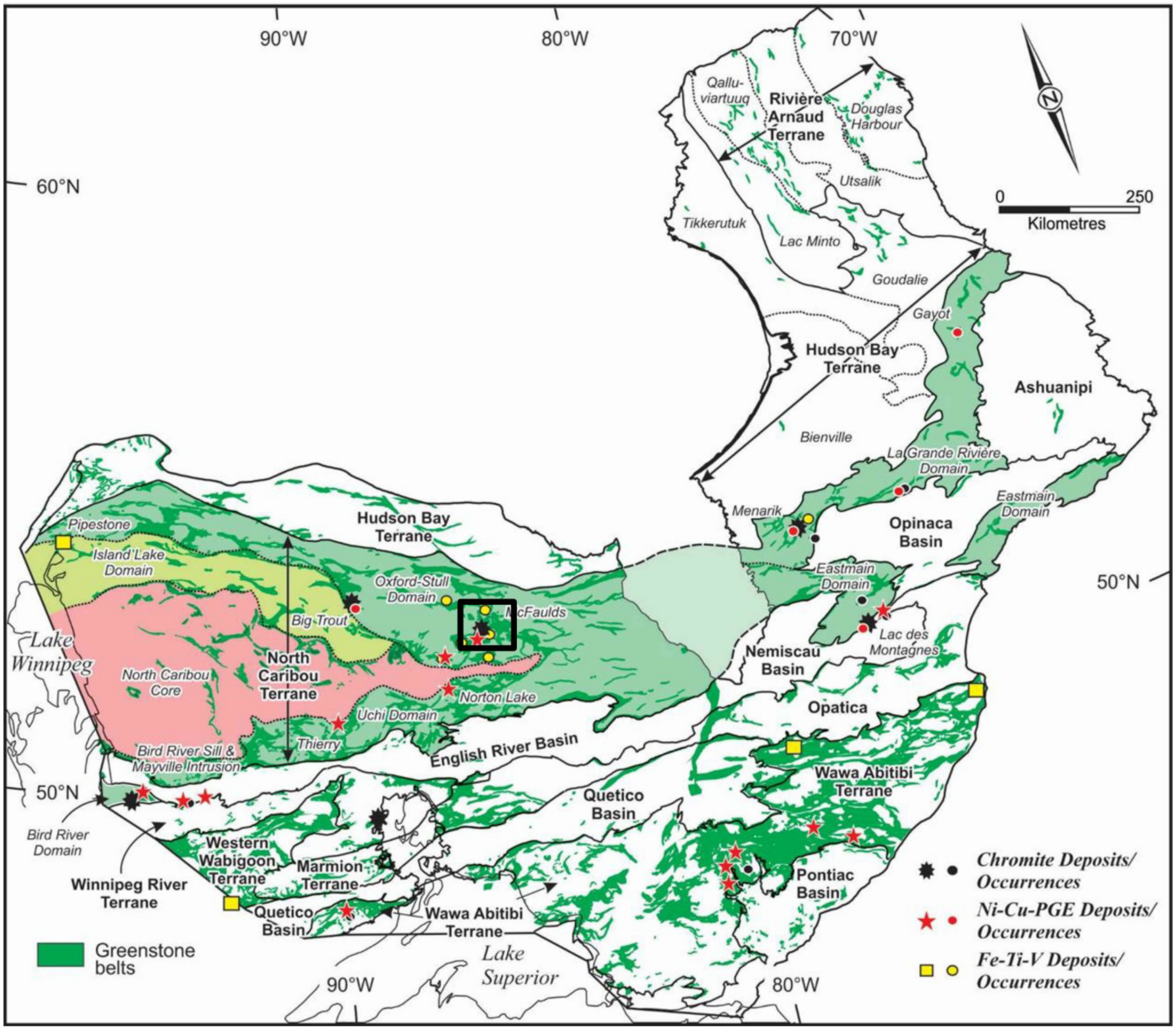


**Figure 6: Geology of the Superior Province in Canada (from Houlé et al. 2015). The McFaulds Lake Greenstone Belt is in the centre of the figure.**

Caribou terrane by its lack of pre-3.0 Ga crustal ages as determined by U-Pb dating and Sm-Nd isotope systematics (Stott et al. 2010). It includes several assemblages ranging in age from Mesoarchean (2.87 to 2.83 Ga) to Neoarchean volcanism at 2.72 to 2.71 Ga (Stott 2008). U/Pb zircon analyses of volcanic and plutonic rocks near the James Bay Lowlands region give ages from 2.737 Ga to as young as 2.683 Ga, and Nd model ages suggest relatively juvenile crustal growth (Rayner and Stott 2005; Stott 2008; Stott et al. 2010). Mesoarchean crystallization ages are somewhat scarce, and are generally restricted close to the northern and southern boundaries of the domain (Stott et al. 2010).

At the southern boundary of this domain lies a series of major ductile shear zones that separate it from the Island Lake domain and the rest of the North Caribou terrane. In the McFaulds Lake area this boundary is called the Stull-Wunnummin fault. The southern contact of the Oxford-Stull domain with the Island Lake domain shows a prevalence of Mesoarchean zircon ages and isotopic evidence suggests that the two domains share a constructive history prior to the development of the Stull-Wunnummin fault (Stott 2008). The northern boundary of the Oxford-Stull domain is the North Kenyon fault, a major ductile strike-slip deformation corridor that separates the entire North Caribou terrane from the Hudson Bay terrane to the north, which is recognized as another older (> 3.0 Ga) continental fragment (Stott et al. 2010).

### *4.2 Ring of Fire Geology and the McFaulds Lake Greenstone Belt*

A key feature of the McFaulds Lake area is a prominent linear magnetic high (associated with laterally extensive formational conductors) that is continuous for up to tens of kilometers, and forms a semi-circle, ~60 kilometres in diameter from north to south, as seen on the regional airborne magnetic anomaly maps. This prominent linear magnetic high is known as the Ring of Fire (ROF). The ROF has been interpreted as a regionally extensive iron formation, or more probably a series of ferrogabbroic intrusions, that was deposited/intruded along the margins of a regional scale granodiorite pluton, one that had been intruded into and caused doming of supracrustal rocks of the Oxford-Stull domain. Along the length of the ROF magnetic high, it is generally intercalated with mafic to intermediate lavas and tuffs and intruded by a variety of mafic to intermediate sills and dykes. Although original theories included iron formation as the sulphur source, there is little evidence for the existence of large volumes of iron formation in the ROF area. There are, however, extensive ferrogabbroic intrusions, which would not account for the Sulphur, but may be accountable for the extensive magnetic highs in the ROF.

Due to the near-total absence of outcrops, no such greenstone belt was recognized in the McFaulds Lake area until 1999 (Percival et al. 1999). Since then, however, much work has been done, sparked by the discoveries from 2003-2007. The McFaulds Lake Greenstone Belt (MLGB), as it is now termed (Metsaranta and Houlé 2011, 2012, and 2013), is comprised of six lithotectonic assemblages, which have all been age-dated and are listed here from youngest to oldest: the Tappan Assemblage (< ca. 2702 Ma); the Muketei Assemblage (ca. 2735 Ma); the Winiskisis Assemblage (ca 2757 Ma, < ca. 2714 Ma); the Victory Assemblage (2797-2781 Ma); the Attawapiskat Assemblage (2820-2811 Ma); and the Butler Assemblage (ca. 2828 Ma; Mungall et al. 2010; Metsaranta and Houlé 2011, 2012, and 2013). See Figure 7 for a summary map of the MLGB geology. This data suggests that the MLGB has had a complex history of volcanism, sedimentation, and deformation spanning from at least ca. 2828 Ma to 2702 Ma (Metsaranta and Houlé 2013). The Muketei Assemblage is the most fertile of the assemblages and is host to roughly half of all known occurrences in the Ring of Fire, including the major ultramafic Ni-Cu-PGE and chromite deposits (Eagle’s Nest, Black Thor, Blackbird, Big Daddy), as well as the McFaulds Lake VMS deposits and occurrences.

The Muketei Assemblage displays a complex history of volcanism, sedimentation, and plutonism, with two ages of volcanic deposition, two ages of felsic plutonism, one mafic-ultramafic intrusive event, and one ferrogabbroic event. A period of mafic to felsic volcanism was the first to occur (with synvolcanic granitic intrusion), and has been dated at 2782.2 +/- 5.2 Ma (Mungall et al. 2010). This volcanism was proceeded shortly after by the intrusion of large tonalitic bodies at 2773.4 +/- 0.9 Ma (Mungall et al. 2010 and R. Metsaranta, pers. comm.). This

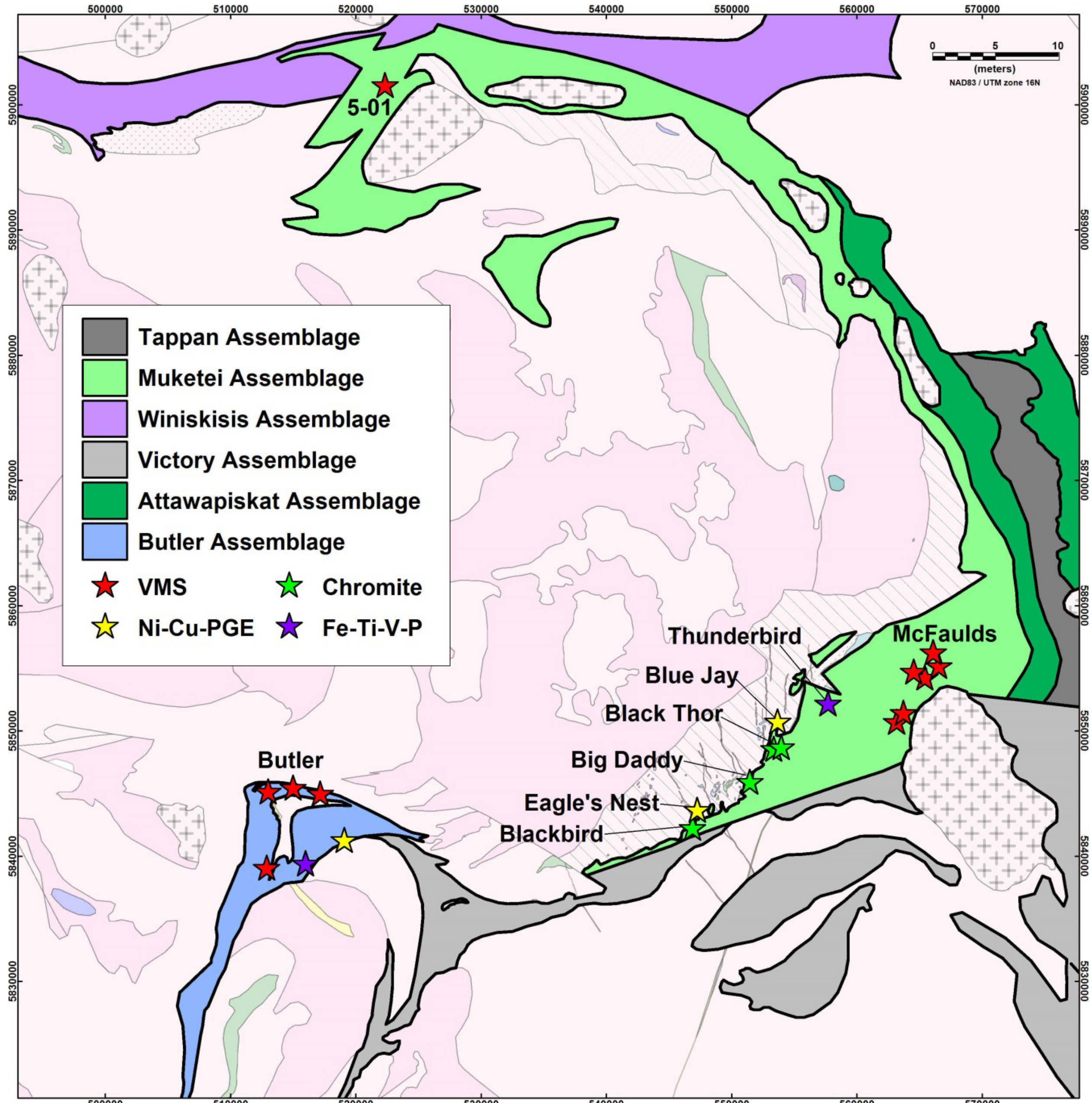


**Figure 7: Geological Assemblages of the McFaulds Lake Greenstone Belt (modified from Metsaranta and Houlé 2013).**

event in turn was proceeded by a very significant and short period of intermediate to felsic volcanism and mafic to ultramafic intrusion at 2734 Ma, which marks the main deposition of the Muketei Assemblage (Mungall et al. 2010, Metsaranta and Houlé 2011, 2012, and 2013, and R. Metsaranta, pers. comm.). Many drill core samples from a variety of rock types in the Muketei Assemblage have been age-dated and all have been found to lie, within error, very close to this date. Ultramafic sills and dykes, which host the Ni-Cu-PGE and Cr deposits, and which also cut the 2773.4 Ma footwall tonalite, have been dated at 2734 Ma. Intermediate volcanics, which lie stratigraphically beneath and above the felsic volcanics which host the

McFaulds Lake VMS deposits and occurrences, have been dated at 2734 Ma as well. Finally, the ferrogabbroic intrusions, which host the Fe-Ti-V-P mineralization in the ROF, have an age of 2733 Ma. Late granitic intrusions cap the activity in the area, and have been dated at ca. 2728 to 2698 Ma (R. Metsaranta, pers. comm.).

### *4.3 Property Geology*

Several magmatic Ni-Cu-PGE sulphide occurrences, such as the Eagle's Nest and Blue Jay/AT12 deposits, are hosted in ultramafic dykes that lie structurally beneath the ROF magnetic high. Extensive layered ultramafic sills (which are considered to form the main intrusion) consisting of dunite, harzburgite, orthopyroxenite, and chromite lie structurally on top of the aforementioned ultramafic dykes. These sills were preferentially developed at the horizon formerly occupied by the ferrogabbros. This most likely occurred via magmatic assimilation (Figure 8).

The current theory for the formation of the Eagle's Nest magmatic sulphide deposit, as well as other nearby sulphide and chromite deposits, is that a mantle plume appeared beneath the margin of the North Caribou microcontinent around 2735 Ma. Passing up through extensional faults, the ultramafic komatiitic parental magma interacted with sulphide-bearing metasediments (including iron formation), causing saturation with sulphide liquid and the collection of massive to net-textured magmatic sulphides in short-lived orthocumulate-textured mush zones at the bases of dykes (Eagle's Nest, Eagle Two, AT12 deposits). In places, these feeders formed into substantial sills, and in these sills, in higher, longer-lasting sill-like feeders, chromite and olivine were segregated mechanically into layers and lenses from the highly contaminated komatiite magma (Blackbird, Black Creek, Big Daddy, Black Thor, Black Label deposits). The magma residual to the deposition of the sulphide, dunite, chromitite, peridotite and pyroxenite crystallized as a layered intrusion, leading to the deposition of norite, anorthosite, ferrogabbro, and V-rich titanomagnetite layers (Thunderbird deposit). Heat-driven circulation of hydrothermal fluids through the older, pre-existing and overlying sedimentary and volcanic rocks caused the deposition of massive Cu-Zn sulphide mineralization (VMS) where these fluids vented at the sea floor during volcanism. Subsequent metamorphic fluid flow through shear zones caused the formation of mesothermal Au mineralization in the Triple J Gold occurrence directly adjacent to the Blackbird and Eagle Two deposits (Figure 8). The AT5 anomaly was discovered by early drilling to contain ultramafic intrusive rocks of the Eagle's Nest – Blackbird igneous complex. However, until 2016, the area had been under-explored.

The Black Thor – Black Label Igneous Complex is a mantle derived, layered ultramafic intrusion, and was emplaced along the contact of the uplifted gneissic dome and the McFaulds Lake Greenstone Belt. Sulphide droplets separated from the melt as an immiscible liquid and settled towards the base of the intrusion because of their greater densities, accumulating as massive sulphides in embayments and producing the basal contact zone sulphide mineralization (i.e. at the AT12 Extension, Contact Zone, F2 Zone, and NW Breccia Zone). Base and precious metals (Ni-Cu-PGEs) were scavenged from the melt into sulphide droplets due to their chalcophile affinity. The ultramafic magma became oversaturated in chromite via magma mixing,

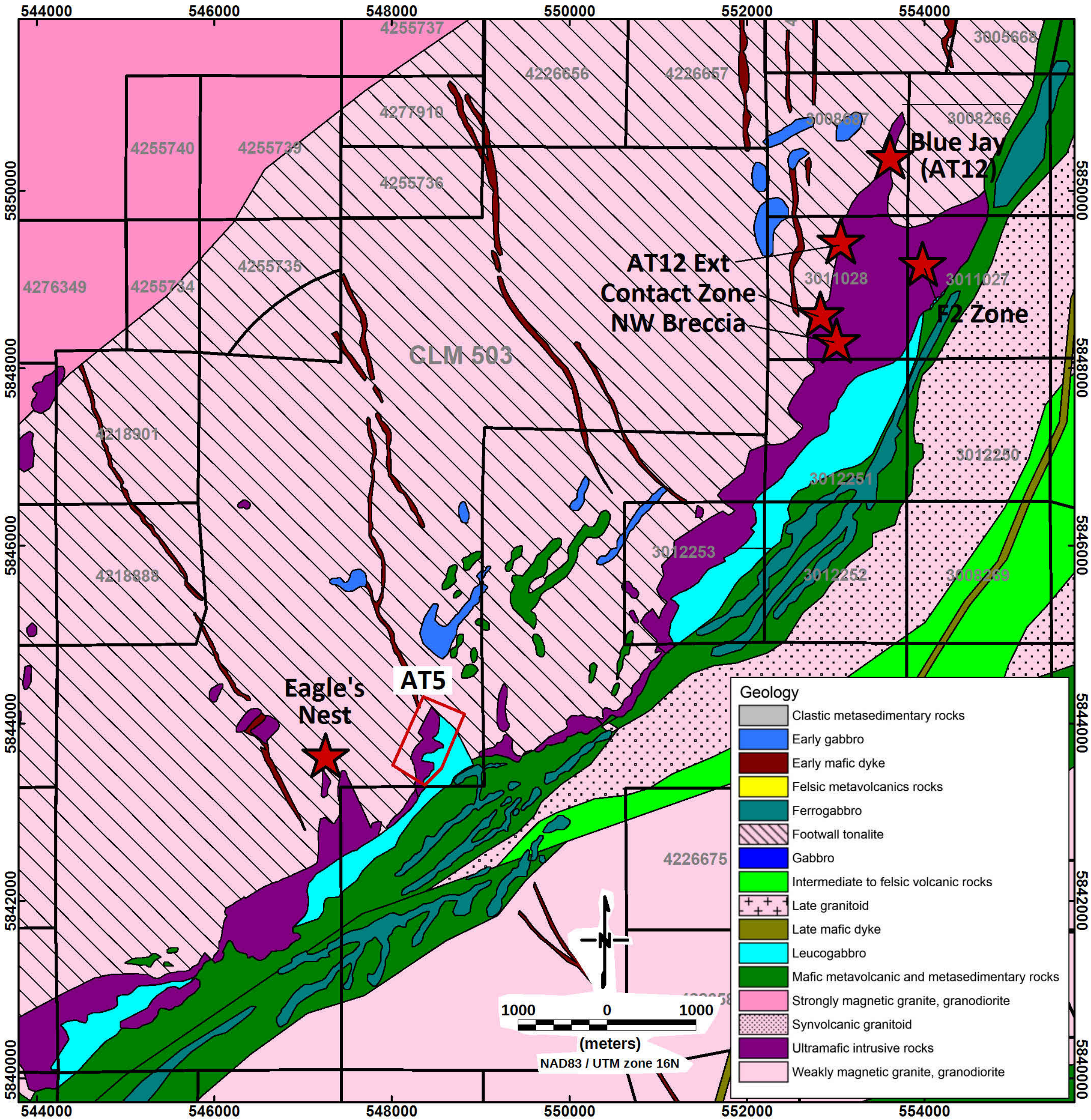


**Figure 8: Property Geology**

contamination, a decrease in oxygen fugacity, and/or an increase in pressure, which led to the chromite mineralization seen in the Black Thor and Black Label areas. Continual pulses of magma led to further chromite mineralization. The Igneous Complex was subsequently intruded by a late websterite intrusion that crosscut and brecciated older rocks in the area. Sulphides were subsequently precipitated and possibly remobilized within magmatic breccias formed along the margins of the websterite intrusion (e.g. F2 Zone and NW Breccia Zone). The Igneous Complex was then intruded by a late biotite gabbro intrusion (Figure 8).

The Eagle's Nest deposit is a subvertically dipping body of massive and net-textured magmatic sulphide minerals (pyrrhotite, pentlandite, and chalcopyrite) and magnetite in the form of a sheet about 200 metres long, as much as several tens of metres thick, and at least >1000 metres deep. It strikes northeast-southwest and occupies the northwestern margin of a vertically inclined serpentinized peridotite dyke. Near the surface, the massive sulphides are confined to the northwestern tip edge of this intrusive body, and are bordered to the south and southeast by thicker zones of net-textured sulphides, which are hosted by serpentinized peridotite. At depth, there are occurrences of massive sulphides further to the east within the dyke, although they tend to be concentrated near the western and northern extremities. The dyke is closed off both at its northern and southern ends and plunges vertically or very steeply to the south (Figure 8).

## 5. Geophysical Program

### *5.1 Insight IP*

The Insight IP Gradient survey covered an area of approximately 1.36 $km^2$ (or 136 hectares), with 14.2 line km of gradient array surveying being completed and two Insight Sections, each of 750m length, being completed along lines L9000E and L9700E. The IP survey area covers Noront cut-line grid 5.

For this project, Noront contracted the geophysics to Insight Geophysics Inc., of Oakville, Ontario. Craig Pawluk oversaw the project, while Perry Nielsen was the project field geophysicist.

The Insight IP report, with maps, is provided as Appendix 1. The data is also provided as maps in this report, as Figures 9 through 11.

### *5.2 Lamontagne Surface UTEM*

Lamontagne Geophysics Ltd., of Kingston, Ontario, carried out and completed the Surface UTEM-5 survey over the Area 5 Property. Rob Langridge oversaw the project and wrote the report, while the Lamontagne field crew consisted of Phil Guimond (crew chief/operator), Gerry Lafortune (Rx/Tx operator), Richard Lahaye (Rx/Tx operator), Bill Dingwall (Tx operator/electronics), and Joey Plouffe (field assistant). Yves Lamontagne provided insight.

The survey covered an area of approximately 1.87 $km^2$ (or 187 hectares), with 13.275 line km of surveying being completed.

The Lamontagne report is provided as Appendix 2. It contains loop layouts, maps, and all EM profiles collected from the survey. A map of the UTEM coverage is provided in this report as Figure 12.

## 6. Conclusions and Recommendations

From June 28, 2016 to July 17, 2016, Insight Geophysics was contracted by Noront to perform an Insight IP Gradient and Section Array Survey on portions of their Area 5 Property, which lies on claim 3012253, which is part of the Big Daddy Chromite Joint Venture Project between Noront and KWG Resources. Approximately 14.2km of gradient line surveying was completed on grid 5, and two Insight Sections, totaling 1500m, were completed. The purpose of the survey was to test anomalous chargeability along the hangingwall/footwall contact of the ROF ultramafic intrusion with the basement tonalite. This contact represents the stratigraphic bottom of the ultramafic intrusive body and contains embayments favourable for sulphide emplacement, and in which there exists the majority of Ni-Cu-PGE sulphide mineralization in the Ring of Fire.

Following the IP survey, from July 18, 2016 to August 2, 2016, Lamontagne Geophysics was contracted to perform a Surface UTEM-5 survey over the Grid 5 area. The UTEM-5 system is a more sensitive system and is used to detect new conductors as well as deep conductors.

No new targets were uncovered during the Area 5 IP and UTEM surveys and thus no new drilling was planned.

Respectfully submitted:

Matt Downey, M.Sc., P.Geo., May 10, 2017

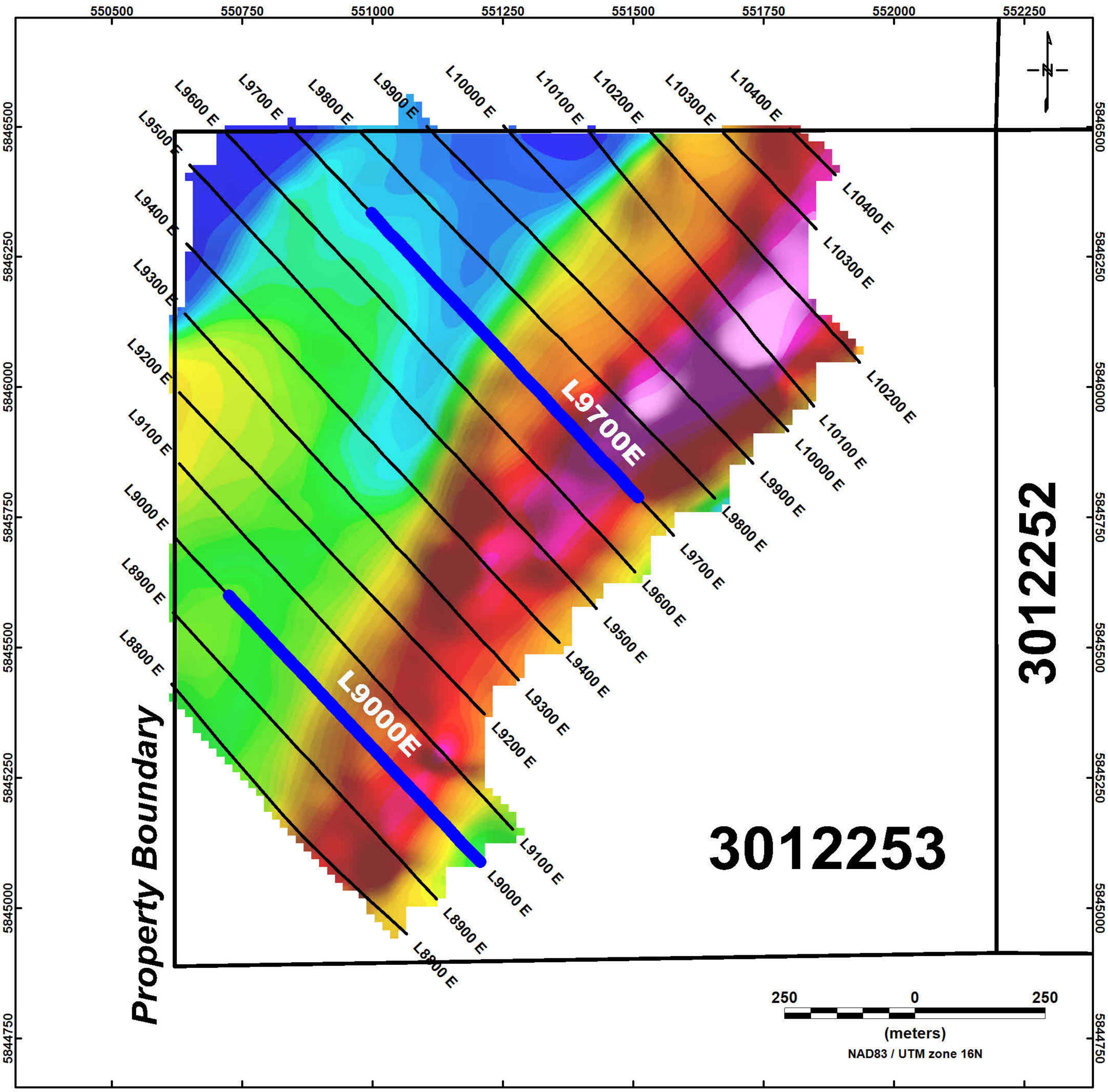


Figure 9a. Insight IP Gradient map showing total chargeability. Thick blue lines are Insight Section lines.

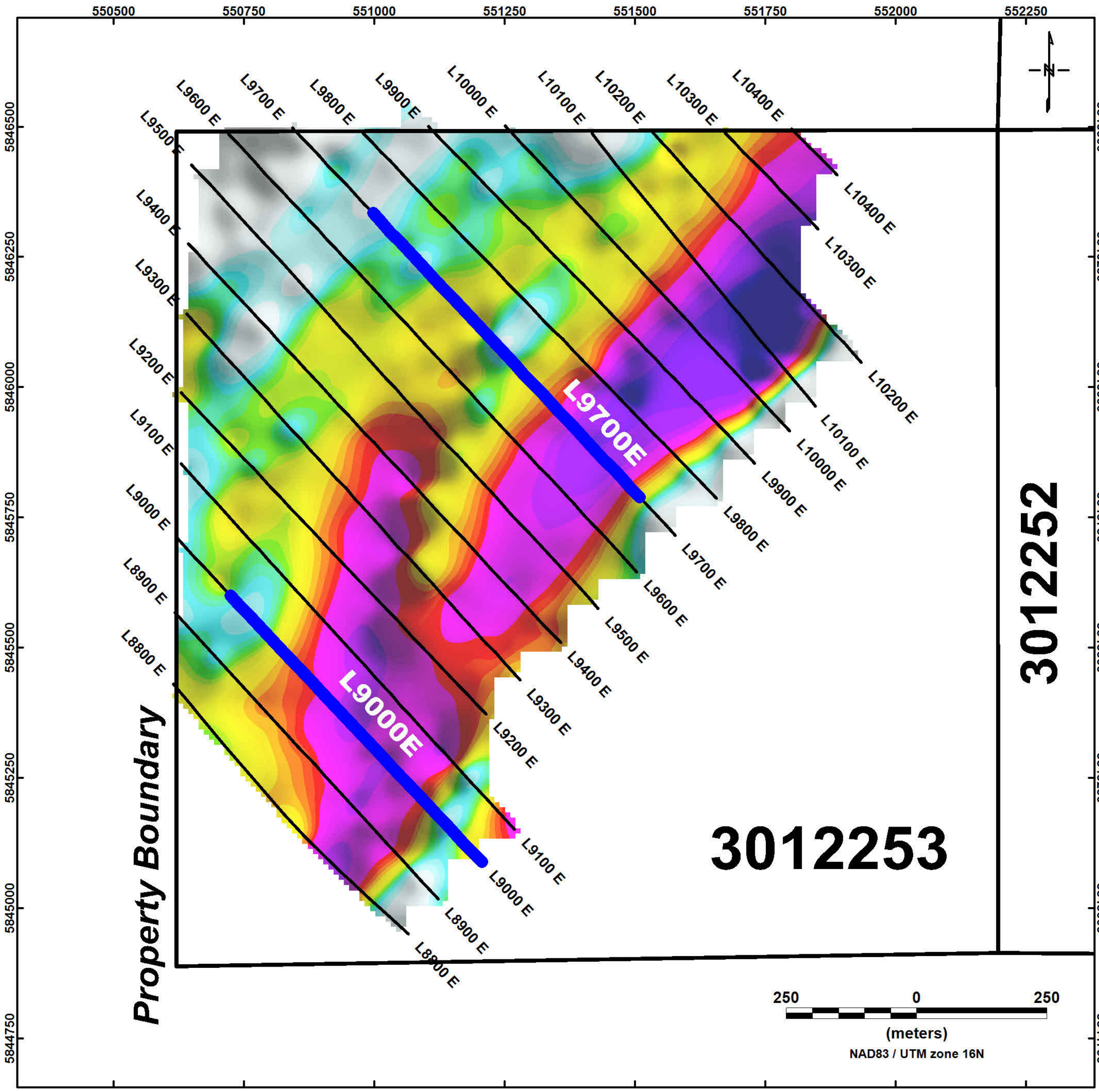


**Figure 9b. Insight IP Gradient map showing apparent resistivity. Thick blue lines are Insight Section lines.**

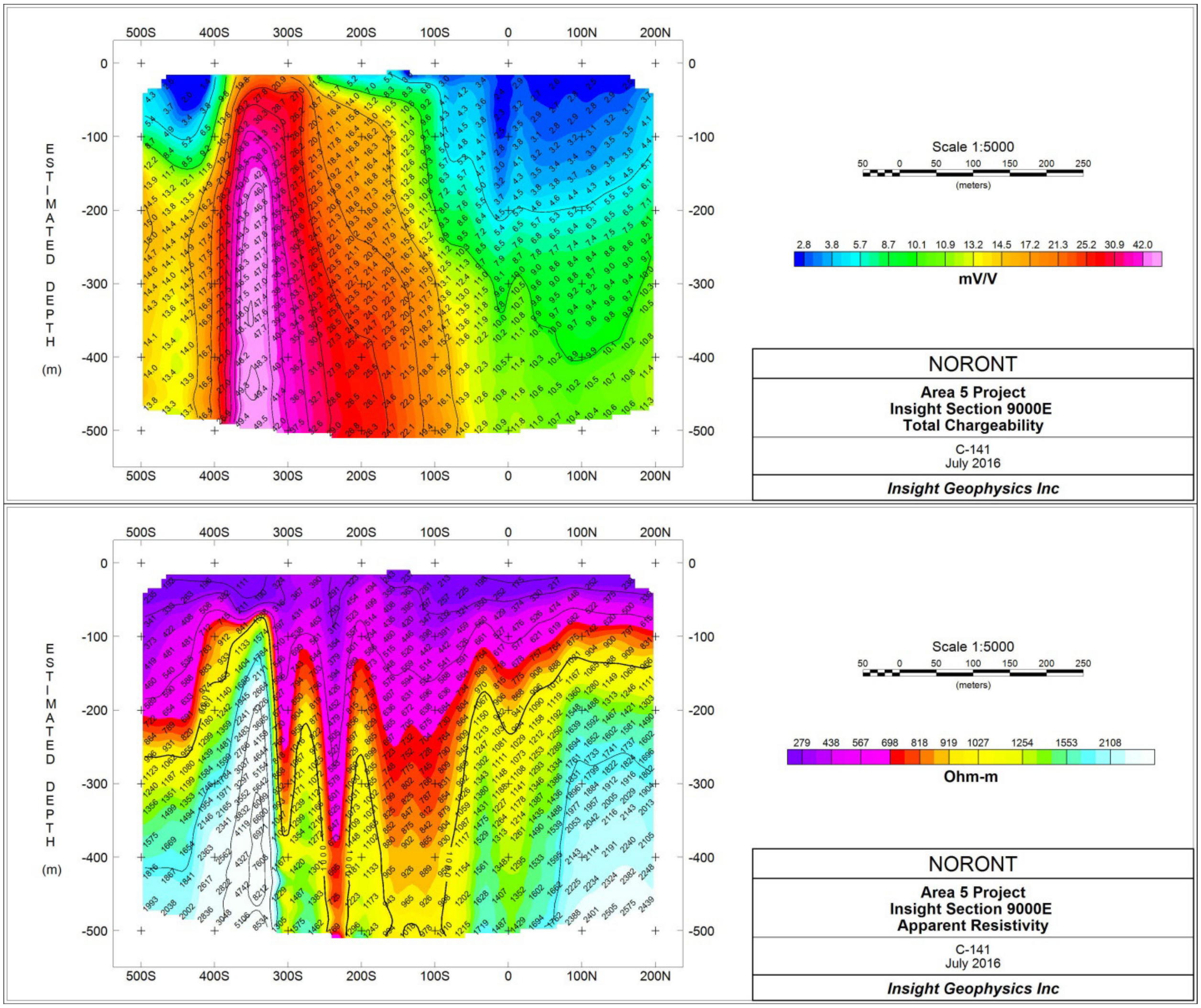


**Figure 10. A (top): Insight Section along L9000E showing total chargeability. B (bottom): Insight Section along L9000E showing apparent resistivity.**

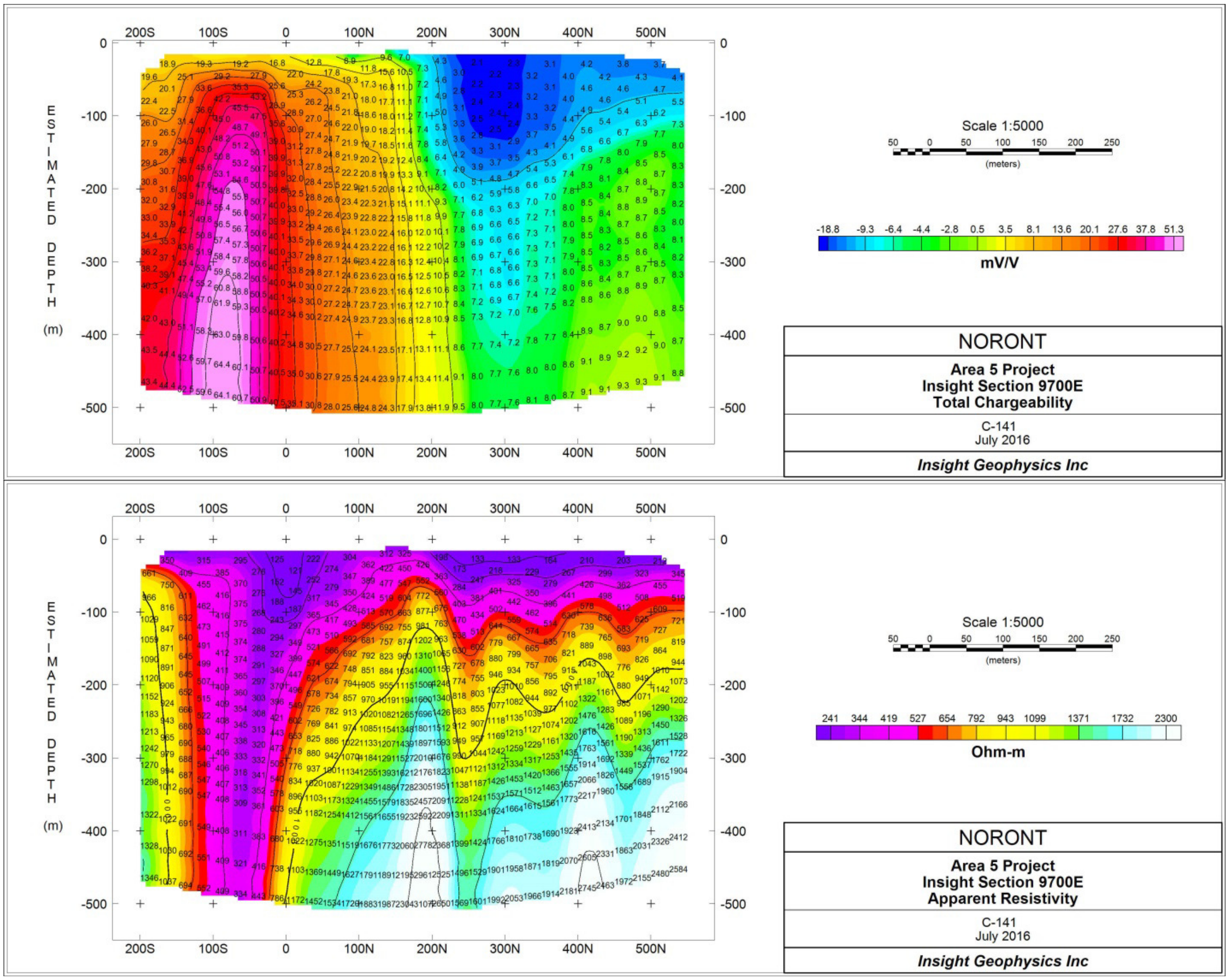


**Figure 11. A (top): Insight Section along L9700E showing total chargeability. B (bottom): Insight Section along L9700E showing apparent resistivity.**

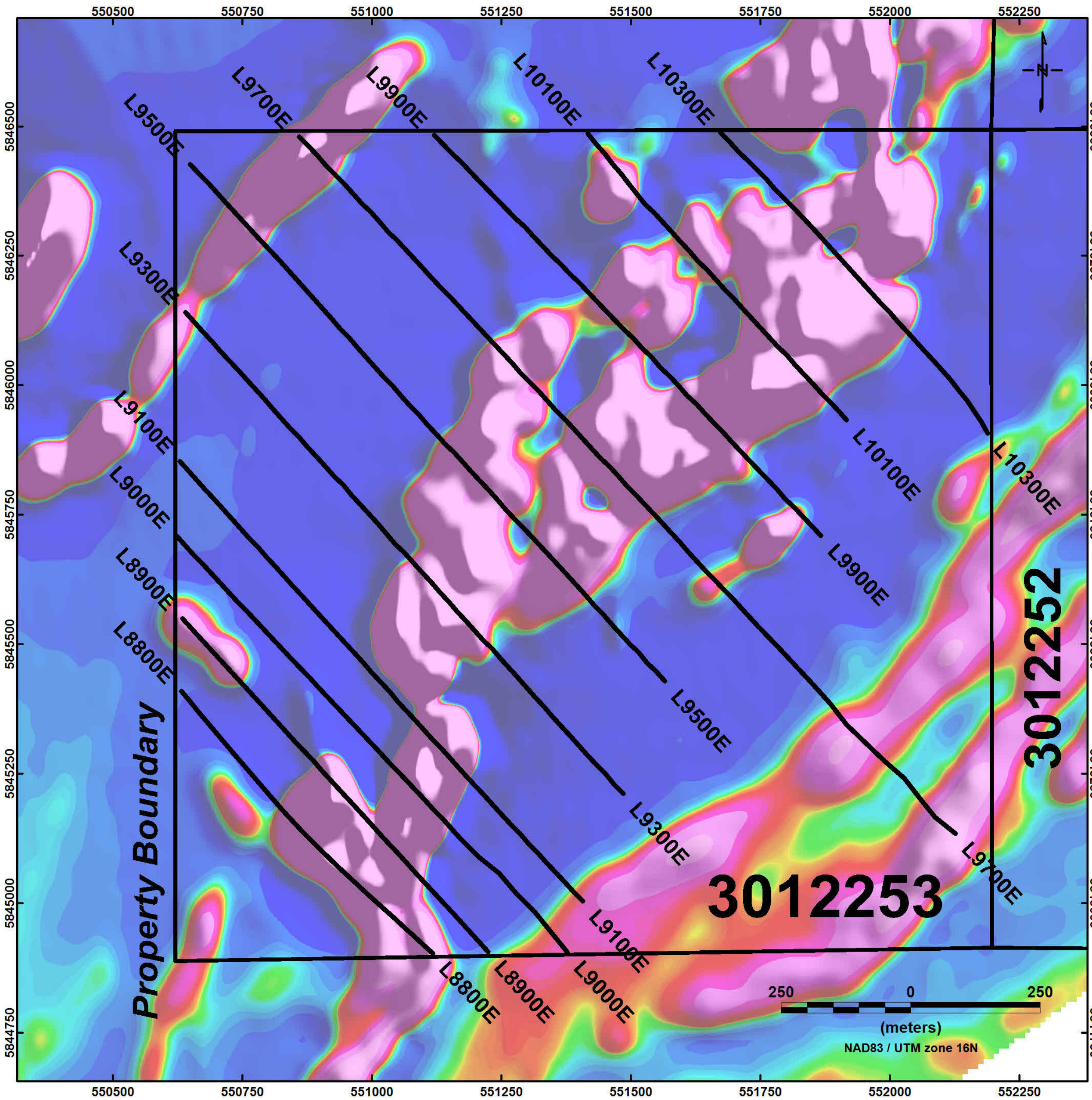


**Figure 12. Map of Area 5 UTEM-5 survey area. Survey lines shown in black. Heli-GT first vertical derivative is in the background.**

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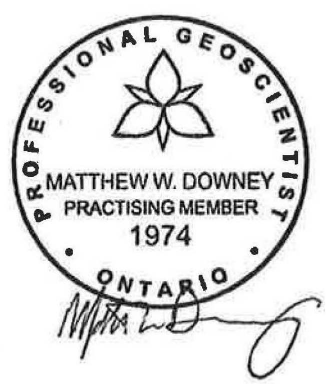
## CERTIFICATE

I, Matt Downey, M.Sc., P. Geo., of 34 Glen Dhu Drive, Whitby, Ontario, do hereby certify that:

1. I am a geologist in the Province of Ontario with twelve years of experience in the mineral exploration industry. I have an Hon. B.Sc. from the University of Toronto, Toronto, Ontario (2002) and an M.Sc. from the University of Waterloo, Waterloo, Ontario (2005).
2. I have worked in the Ring of Fire as a geologist and data manager since September 2008.
3. I have studied the project area thoroughly, and have visited the project area a number of times since 2009.
4. I obtained my P. Geo status within the Province of Ontario (APGO) in March, 2011.
5. I am responsible for the preparation of this report, except as provided for or disclaimed in the report, based on the sources and documents described in the report.
6. As of the date of this report, I am not aware of any material fact or material change with respect to the subject matter of this report, which is not reflected in this report, the omission to disclose which makes this report misleading.
7. I am the Manager, Lands & Data for Noront Resources Ltd. and handle land and data management, map and geological report preparation, and aid in Noront's exploration projects.
8. I hereby give my consent to Noront Resources to use this report in support of their application for assessment credit on the subject property.




Matt Downey, M.Sc., P. Geo., May 2017
Toronto, Ontario

## Appendix 1

## Noront 2016 Exploration Program

Insight IP on the Area 5 Property

Insight IP Report

# INSIGHT GEOPHYSICS INC.

95 WALBY DR., OAKVILLE, ONTARIO, CANADA, L6L-4C8
905 465 2996


# Geophysical Survey Logistics Report

## Gradient and Insight Section Array Resistivity Survey

## Area 5 Project

James Bay Lowlands, Ontario, Canada
Noront Resources Inc.

July 2016

C-141


Craig Pawluk
Insight Geophysics Inc.

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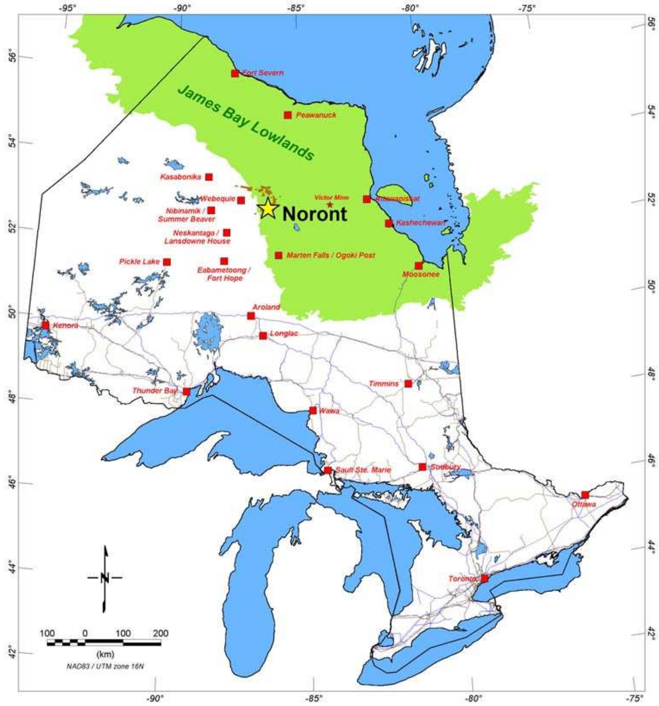
## INTRODUCTION

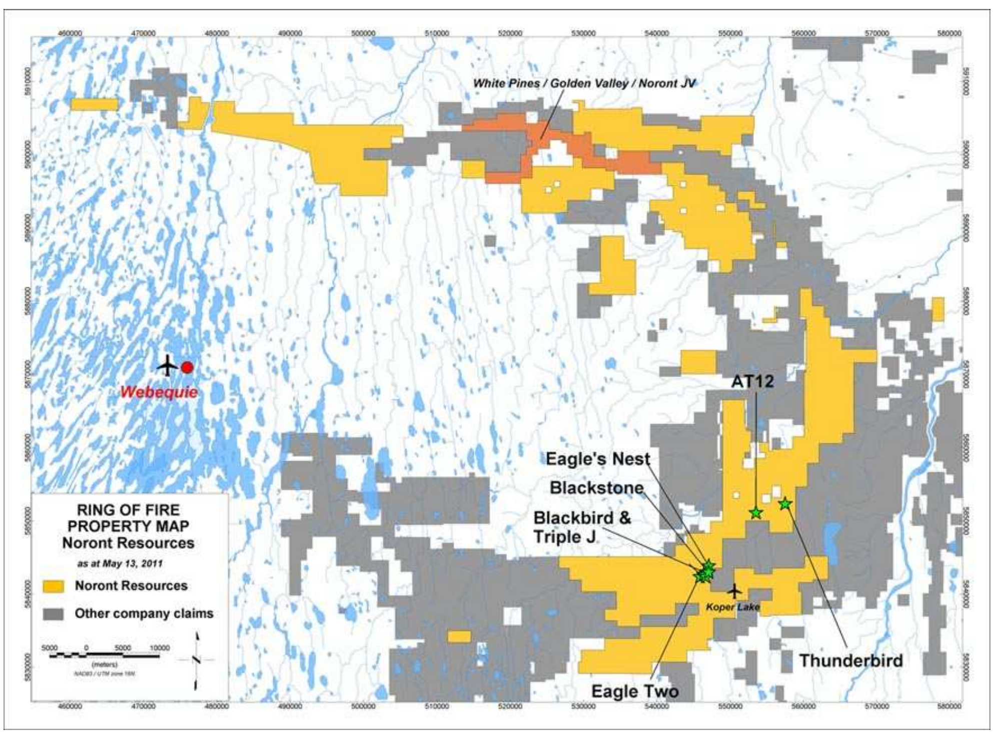
From June 28 through July 17, Insight Geophysics Inc. was contracted by Noront to perform Gradient and Insight Section IP/Resistivity surveys on the Area 5 Project located Ring of Fire multi-metals district in James Bay Lowlands, Ontario.

### General Information

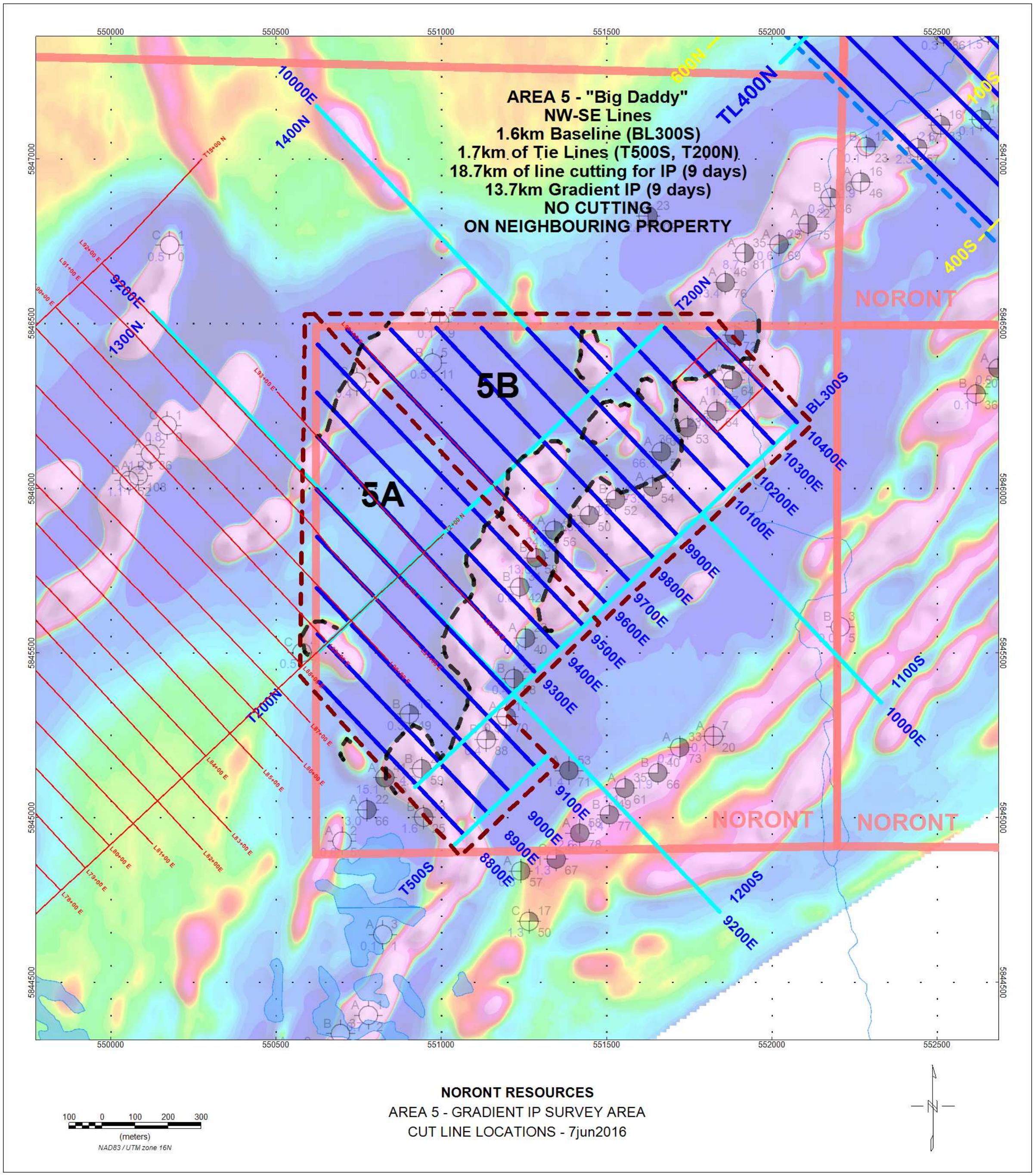
| | |
|---|---|
| Project Name: | Area 5 Project |
| Survey Type: | Gradient and Insight Section Time Domain Induced Polarization / Resistivity |
| Client: | Noront Resources Inc |
| Representatives: | Mr. Jeremy Brett (MPH Consulting) |

## SURVEY GRID




PROJECT LOCATION MAPS

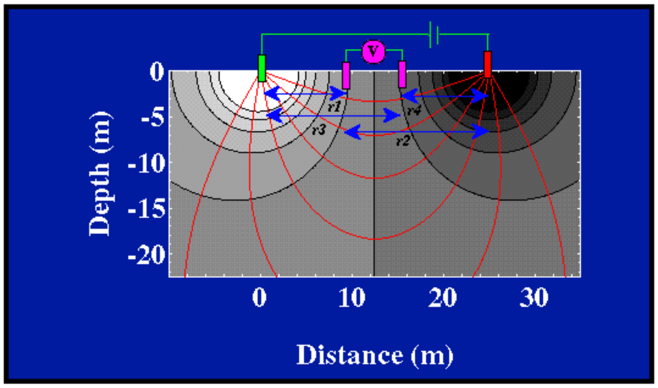



AREA 5 Survey Area per J Brett, MPH Consulting

## SURVEY PARAMETERS

### Apparent Resistivity

Let the distances between the four electrodes be given by *r1, r2, r3,* and *r4* as shown in the figure.




Knowing the locations of the four electrodes, and by measuring the amount of current input into the ground, *i*, and the voltage difference between the two potential electrodes, *ÆV*, we can compute the resistivity of the medium, *rho-a*, using the following equation

$$\rho_a = \frac{2\pi\Delta V}{i}\left[\frac{1}{\left(\frac{1}{r_1}-\frac{1}{r_2}-\frac{1}{r_3}+\frac{1}{r_4}\right)}\right]$$

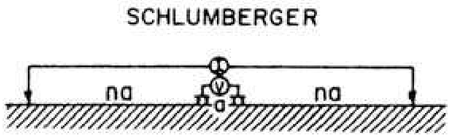
The resistivity computed using the equation given above is referred to as the *apparent resistivity*. We call it the apparent resistivity for the following reason. We can always compute *rho-a*, we only need to know the locations of the electrodes and measure the current and voltage. If, however, the Earth does not have a constant resistivity (that is if the resistivity varies with depth or horizontally), the resistivity computed by the above equation will not represent the true resistivity of the Earth. Thus, we refer to it as an apparent resistivity.

### Chargeability (M)

True chargeability is the ratio of the over- or secondary voltage, $V_s$, to the observed voltage, $V_o$, applied by way of an electrode array so that $M = V_s/V_o$, expressed as a percentage or as millivolts per volt. In reality, what is measured is the apparent chargeability ($M_a$) which is the area (A) beneath the voltage-time decay curve over a defined time interval ($t_1$ to $t_2$) and normalized by the assumed steady-state primary voltage, $V_p$, such that $\mathbf{M_a = A/V_p = (1/V_p) \times \int^{t2}_{t1}}$ of V(t)dt, in units of mVs/V.

# Data Acquisition

Data acquisition of the gradient and the Insight Section arrays are based on the principles of the Schlumberger array. In the Schlumberger array, a vertical geo-electric sounding is produced by expanding the current electrodes out from a centrally located pair of potential electrodes. As the Distance between the current electrodes (L) is increased, the effective depth of penetration is also increased, thus creating a geo-electric sounding curve.




$$\rho = \pi \frac{V}{I} n(n+1)a$$

The Gradient Array is a modified Schlumberger array which is best utilized for economically covering large areas. As with the Schlumberger array, the potential electrodes are always located within the boundaries of the two current electrodes. However, unlike the Schlumberger array, the current electrodes are placed at a fixed location (up to 100 times the potential dipole separation) and the potential electrodes are moved in a profile manner up and down lines between the current electrodes. Typically several lines can be read from a single transmitter placement.

The effective depth of penetration can be approximated from Edwards(1977) where he defines the effective depth (Ze) between current electrodes separated by (L) as:

$$\mathbf{Z_E/L = 0.190}$$

The results from the Gradient array are used to define the lateral boundaries of geo-electric anomalies. These anomalies can then be further detailed in a vertical dimension by surveying them with Insight Sections.

The Insight Section is composed of a fixed array of potential electrodes (typically 40 with a potential dipole separation (MN) of 25 meters). The dimensions of the array are completely flexible pending the target depth and dimensions. Starting at the center location of the Insight Section, multiple current injections at various AB lengths are used to create vertical geo-electric soundings beneath each of the receiver potential dipoles. AB lengths used to create an Insight Section typically range from 5MN to 100MN.

Data points are plotted directly below the center point of each potential electrode in the array. The estimated depth calculation for each plot point uses Edwards Ze estimation that has been further modified to reflect the reduction in effective penetration encountered as the position of any given potential electrode deviates from the center of L towards one or the other current electrode positions.

## Instrumentation

# ELREC PRO Ten channel IP receiver

### TECHNICAL SPECIFICATIONS

• Input voltage:
Max. input voltage: 15 V
Protection: up to 800V
• Voltage measurement:
Accuracy: 0.2 % typical
Resolution: 1 µV
Minimum value: 1 µV
• Chargeability measurement:
Accuracy: 0.6 % typical
• Induced Polarization (chargeability) measured over to 20 automatic or user defined windows
• Input impedance: 100 MΩ
• Signal waveform: Time domain (ON+,OFF,ON-,OFF) with a pulse duration of 500 ms - 1 s - 2 s - 4 s - 8 s
• Automatic synchronization and re-synchronization process on primary voltage signals
• Computation of apparent resistivity, average chargeability and standard deviation
• Noise reduction: automatic stacking number in relation with a given standard deviation value
• SP compensation through automatic linear drift correction
• 50 to 60Hz power line rejection
• Battery test

### GENERAL SPECIFICATIONS.

• Data flash memory: more than 21 000 readings
• Serial link RS-232 for data download
• Power supply: internal rechargeable 12V, 7.2 Ah battery ; optional external 12V standard car battery can be also used
• Weather proof
• Shock resistant fiber-glass case
• Operating temperature: -20 °C to +70 °C
• Dimensions: 31 x 21 x 21 cm
• Weight: 6 kg

# Walcer Model TX KW10

**Voltage Input**
125V line to neutral
400 Hz / 3 phase
Powered by MG12, MG6 and MG12A

**Output**
100 - 3200V in 10 steps
0.05 - 20 Amps
Tested to 10.5 kVA

**Switching**
1 sec., 2 sec., 4 sec., 8 sec.

**Metering**
LED for line voltage
and output current

**Size**
63cm. x 54cm. x 25cm.

**Weight**
44 kg.

## IP Parameters

Transmitted Waveform: Square wave @ 0.0625 Hz (***4 second Square Wave***)
50% duty cycle

Receiver Sampling: Semi-Logarithmic windows (20 windows)

| Window | Width (ms) | Window | Width (ms) |
|---|---|---|---|
| M Delay | 160 | | |
| 1 | 80 | 11 | 160 |
| 2 | 80 | 12 | 160 |
| 3 | 80 | 13 | 160 |
| 4 | 80 | 14 | 160 |
| 5 | 80 | 15 | 320 |
| 6 | 80 | 16 | 320 |
| 7 | 80 | 17 | 320 |
| 8 | 80 | 18 | 320 |
| 9 | 160 | 19 | 320 |
| 10 | 160 | 20 | 320 |
| | | **TOTAL** | 3680ms |

## Recorded Parameters

IP measured parameter: Chargeability in mV/V

Resistivity measured Parameters: Primary Voltage in mV and Transmitted Current in mA.

## Specifications

**IP Survey**

Survey Type: Time Domain Induced Polarization / Resistivity

Array Types: Gradient and Insight Section Array

AB (Tx dipole spacing): Multiple AB injections (200m to 3000m)

MN (Rx dipole spacing): 50 meters gradient, 25 meters Sections

Sampling Interval: 25 meters gradient, 25 meters Sections

## SURVEY EXECUTION

### Generalities

**Survey Dates**: June 28-July 17, 2016

### IGI PERSONNEL:

Perry Nielsen

### Survey Coverage:

#### Gradient

A total of approximately 14.2 km of gradient array surveying was completed on Area 5Project

#### Insight Section Survey

| Line | Coverage | | Length |
|---|---|---|---|
| L9000E | 550S | 200N | 750m |
| L9700E | 200S | 550N | 750m |
| | | | |
| | | | |

# DATA PRESENTATION

## Quality Control and Processing

The Insight Section Array utilizes a distributed array of 40 channels. Special attention is taken to ensure best possible contact resistance (k-Ohm) prior to acquisition. Approximately 10-15% of the data is repeated and saved in the field for quality control purposes.

Particular attention is given to the time decay curves of the chargeability. The curves are monitored by the operator in real time while taking measurements in the field and every effort is made to ensure the maximum quality of decay curve is achieved. Decay curves are further analyzed by the processing department prior to producing final plots of the data using the Halverson-Wait model as a reference..

Apparent resistivity and total chargeability are calculated by the Elrec-Pro receiver. All receiver data is stored in the final data.csv file including all geometry points, primary voltages and voltage decays for further quality control and data reduction as required.

Once the data has been quality reviewed and low quality readings rejected, a depth estimate calculation is made for the remaining data. The depth estimate is based on a uniform half space and does not account for resistivity changes actually encountered at surface or at depth. Changes in half space penetration resulting from the geometry of the receiver dipoles positions relative to transmitter dipoles positions are estimated.

Depending on the surface conditions encountered on the property, the data will also be corrected for topographic and surface effects.

The final reduced field data can then be inverted using the UBD-2D inversion program. Final inversions are an optional product to the client.

## Maps

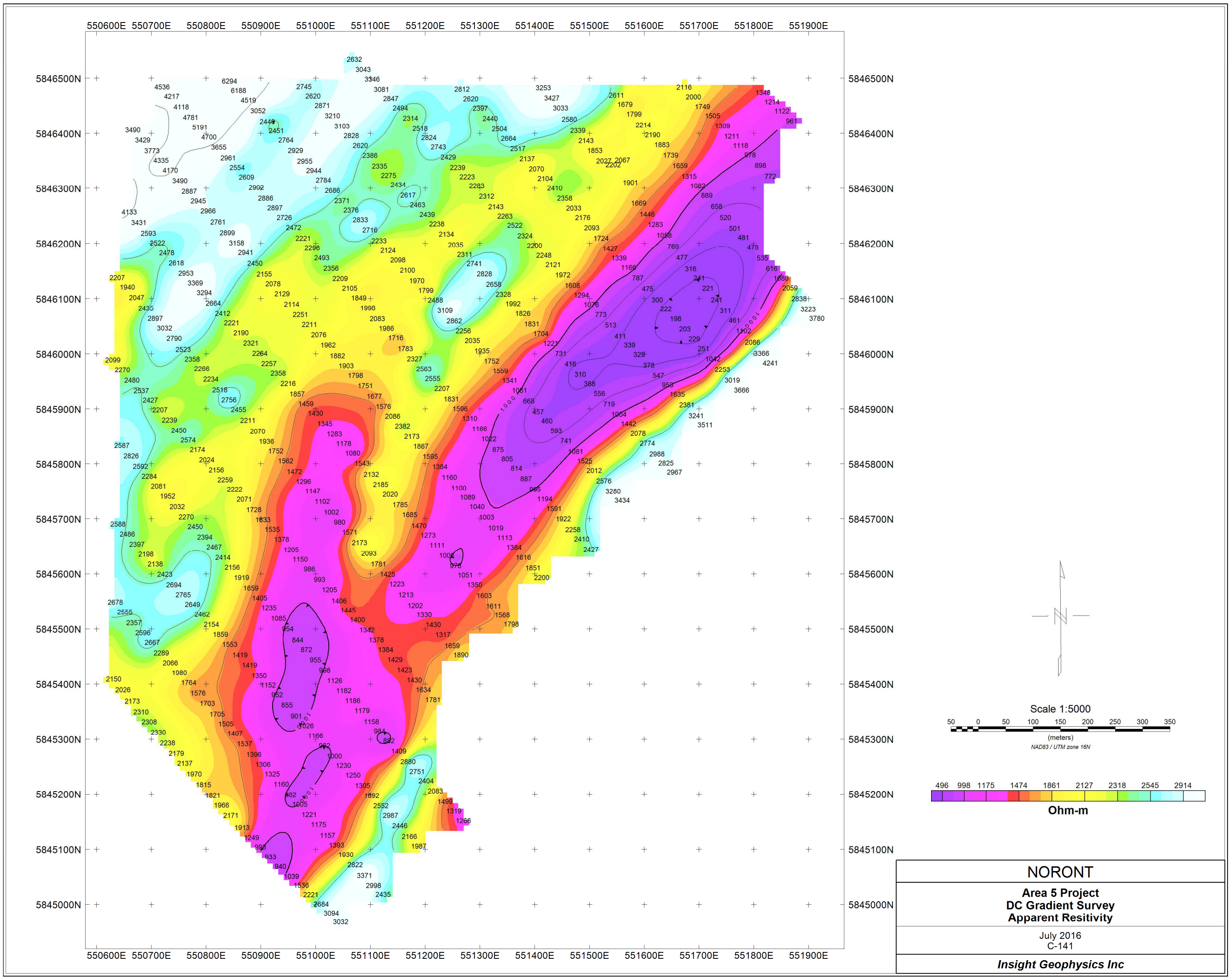
Gradient maps of the Total Chargeability and Apparent Resistivity are presented at a scale of 1:10,000 and are in grid co-ordinates .

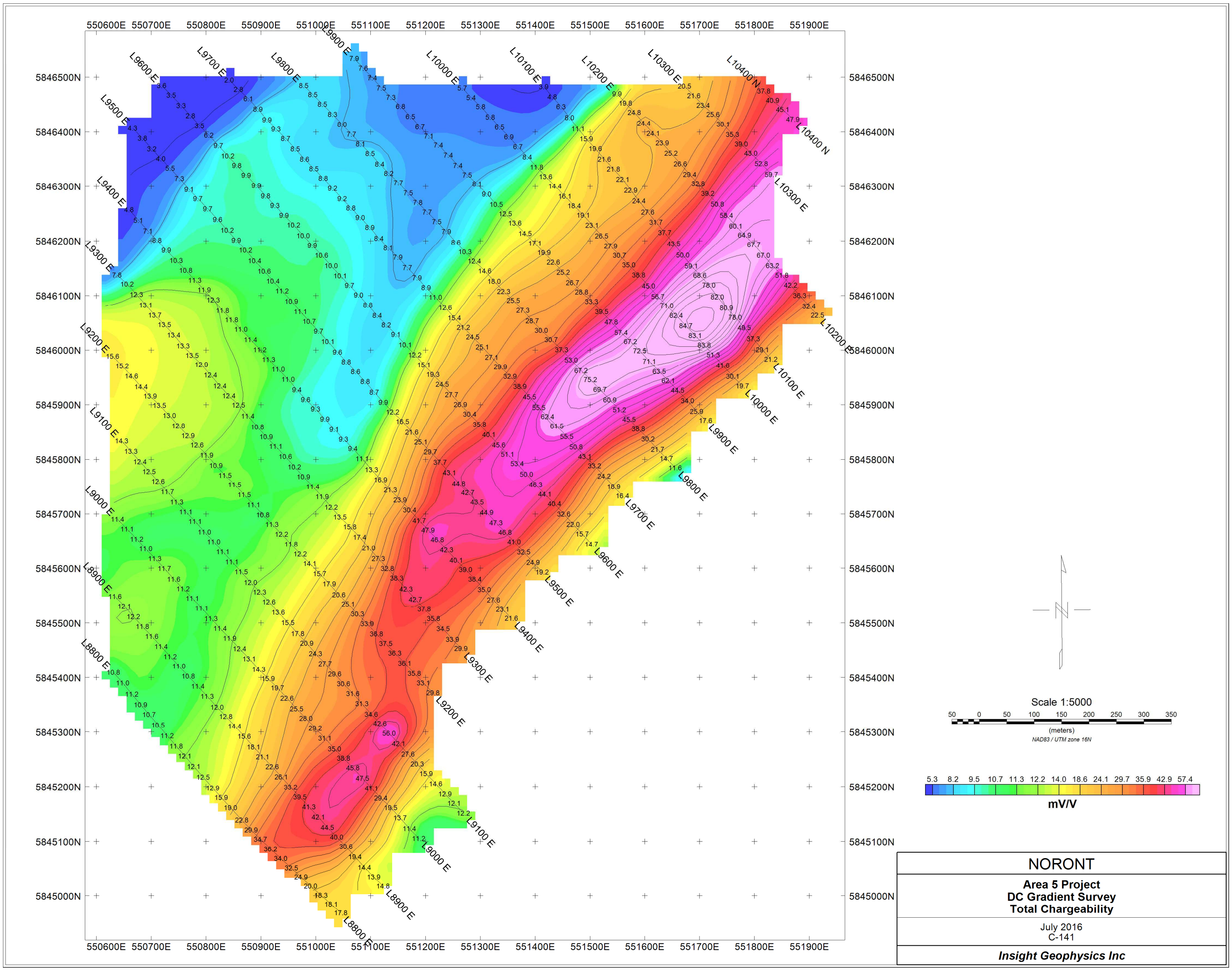
Section maps of the Apparent Resistivity and Total Chargeability are presented at a scale of 1:5000 and are in grid co-ordinates.

Respectfully Submitted

Craig Pawluk
Geophysicist
Insight Geophysics Inc

# APPENDIX A: MAPS




550600E 550700E 550800E 550900E 551000E 551100E 551200E 551300E 551400E 551500E 551600E 551700E 551800E 551900E
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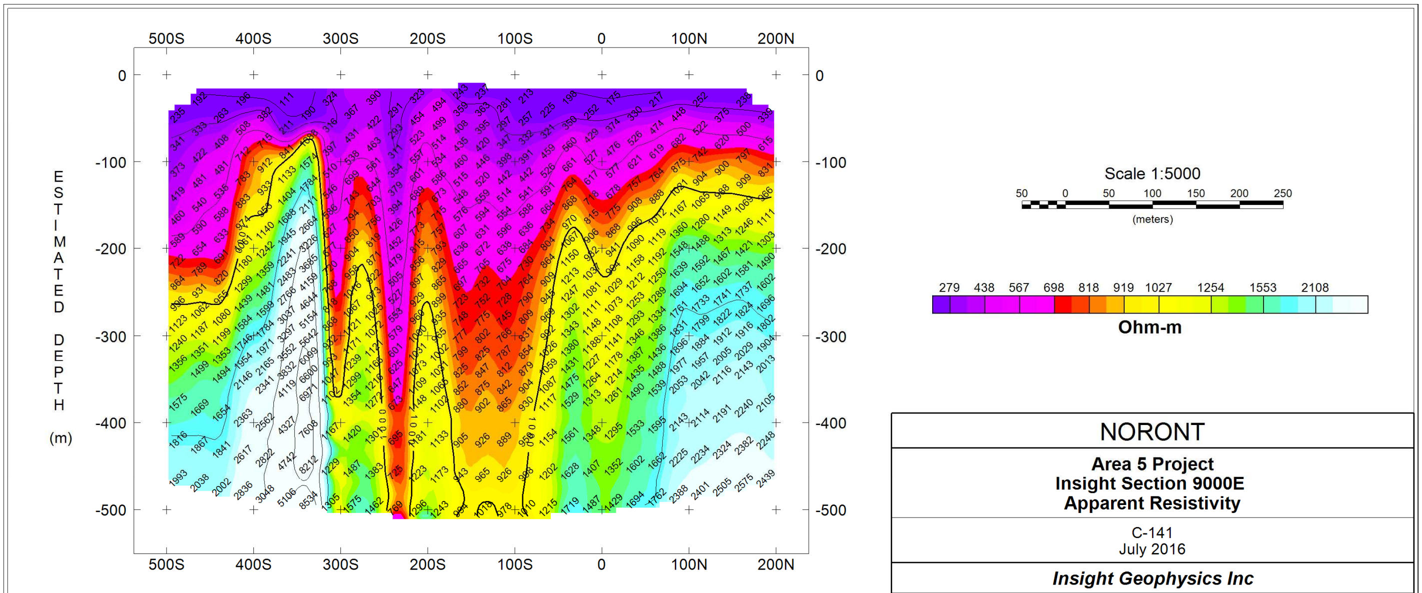
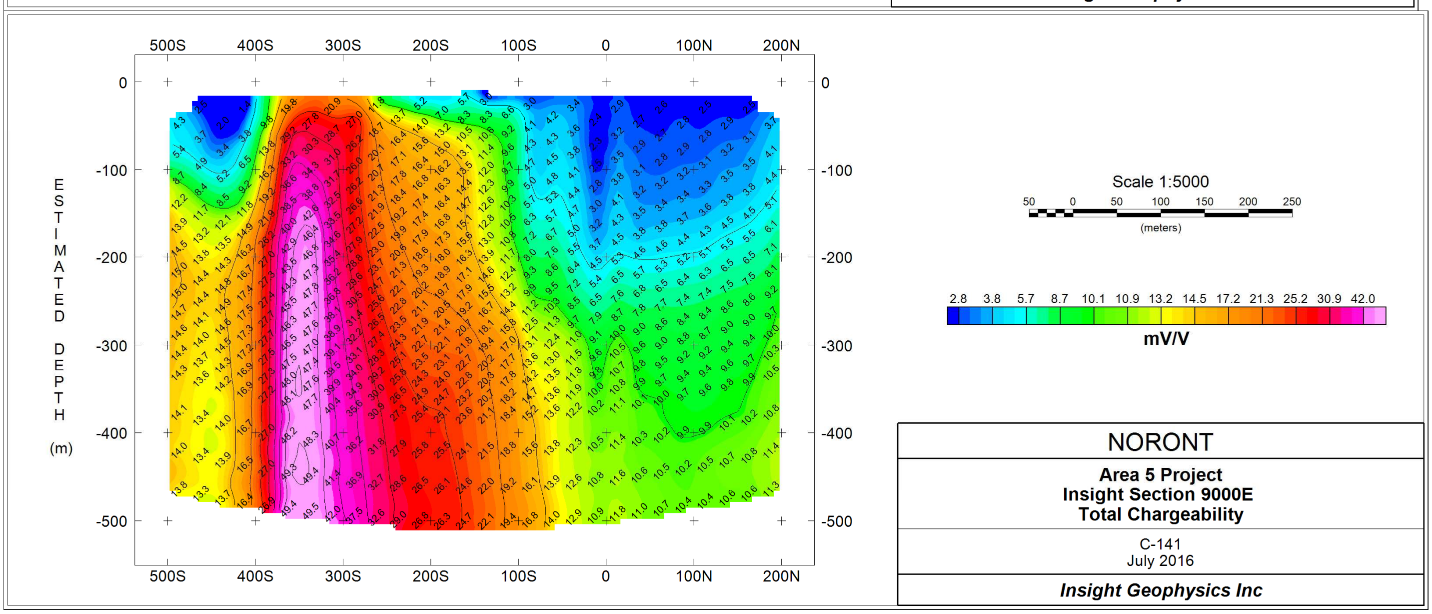
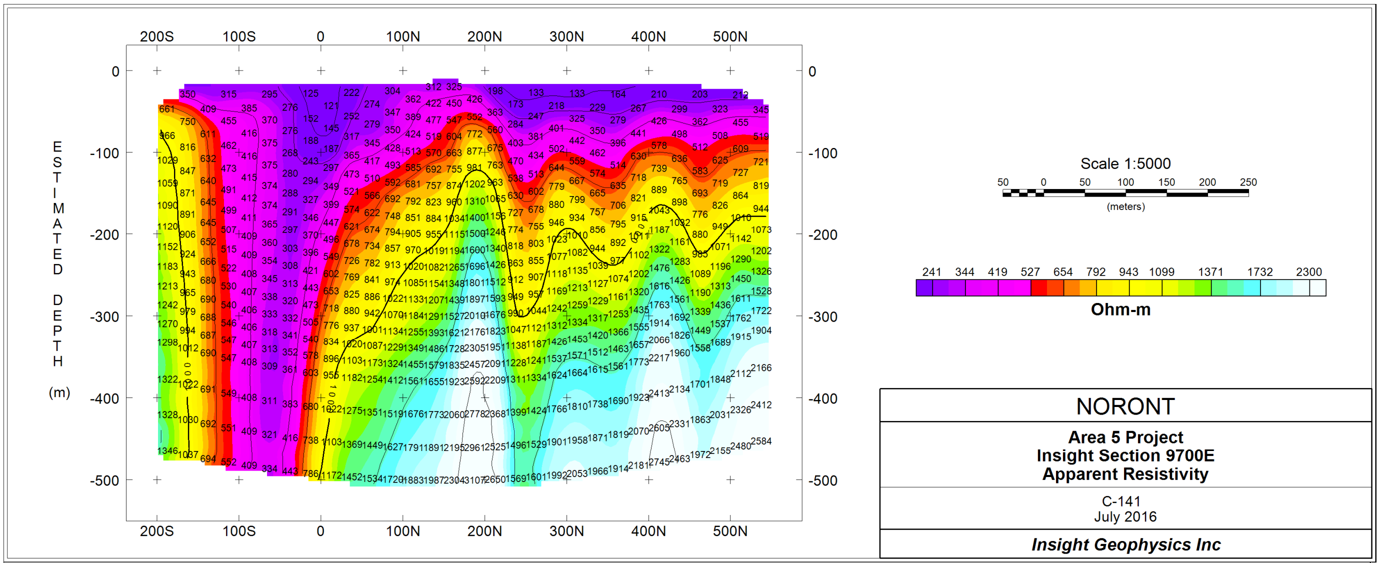
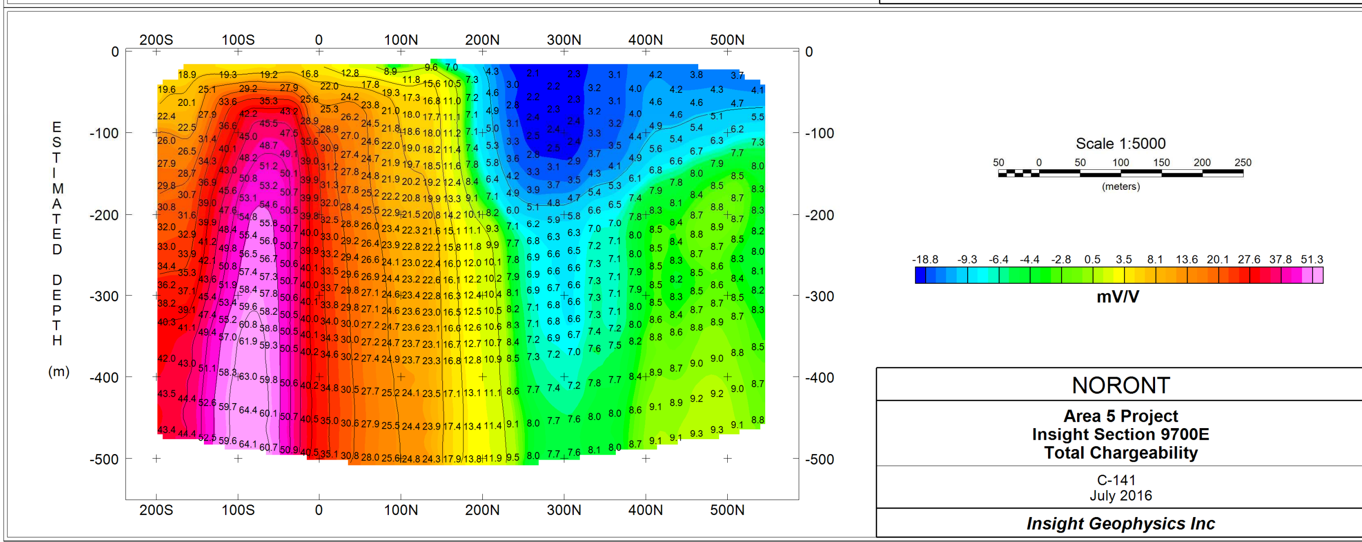
5846400N
5846300N
5846200N
5846100N
5846000N
5845900N
5845800N
5845700N
5845600N
5845500N
5845400N
5845300N
5845200N
5845100N
5845000N
N
Scale 1:5000
50 0 50 100 150 200 250 300 350
(meters)
NAD83 / UTM zone 16N
5.3 8.2 9.5 10.7 11.3 12.2 14.0 18.6 24.1 29.7 35.9 42.9 57.4
mV/V
NORONT
Area 5 Project
DC Gradient Survey
Total Chargeability
July 2016
C-141
Insight Geophysics Inc


500S 400S 300S 200S 100S 0 100N 200N
ESTIMATED DEPTH (m)
0
-100
-200
-300
-400
-500
Scale 1:5000
50 0 50 100 150 200 250
(meters)
279 438 567 698 818 919 1027 1254 1553 2108
Ohm-m
NORONT
Area 5 Project
Insight Section 9000E
Apparent Resistivity
C-141
July 2016
Insight Geophysics Inc


500S 400S 300S 200S 100S 0 100N 200N
ESTIMATED DEPTH (m)
0
-100
-200
-300
-400
-500
Scale 1:5000
50 0 50 100 150 200 250
(meters)
2.8 3.8 5.7 8.7 10.1 10.9 13.2 14.5 17.2 21.3 25.2 30.9 42.0
mV/V
NORONT
Area 5 Project
Insight Section 9000E
Total Chargeability
C-141
July 2016
Insight Geophysics Inc


200S 100S 0 100N 200N 300N 400N 500N
0 -100 -200 -300 -400 -500
ESTIMATED DEPTH (m)
Scale 1:5000
50 0 50 100 150 200 250
(meters)
241 344 419 527 654 792 943 1099 1371 1732 2300
Ohm-m
NORONT
Area 5 Project
Insight Section 9700E
Apparent Resistivity
C-141
July 2016
Insight Geophysics Inc


200S 100S 0 100N 200N 300N 400N 500N
0 -100 -200 -300 -400 -500
ESTIMATED DEPTH (m)
Scale 1:5000
50 0 50 100 150 200 250
(meters)
-18.8 -9.3 -6.4 -4.4 -2.8 0.5 3.5 8.1 13.6 20.1 27.6 37.8 51.3
mV/V
NORONT
Area 5 Project
Insight Section 9700E
Total Chargeability
C-141
July 2016
Insight Geophysics Inc

# Appendix 2

# Noront 2016 Exploration Program

Surface UTEM-5 on the Area 5 Property

Lamontagne Geophysics Report

**-2016 UTEM5 Survey Report-**
**Area 5 Grid**
**Ring of Fire**
**for**
**Noront Resources Ltd.**

LAMONTAGNE GEOPHYSICS LTD GEOPHYSIQUE LTEE

November, 2016

Rob Langridge, M.Sc.

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## INTRODUCTION

During the period of July $20^{th}$ 2016 through July $31^{st}$ 2016 a UTEM5 survey (surveying days: July $23^{rd}$ - July $29^{th}$) was carried out by Lamontagne Geophysics Limited personnel for Noront Resources Ltd. on their property in the Ring of Fire area located in the James Bay Lowlands of Northern Ontario. The survey covered the Area 5 Grid - location/layout of the Area 5 Grid is shown in Figures 1 and 2. The UTEM5 survey was carried out to test anomalies outlined by earlier exploration, to detect/ outline new conductors and to detect/outline deeper features and potential depth continuations of shallow features.

A total of 13.275 line km of BL/BT/Bz UTEM5 data was collected with the UTEM5 receiver using four transmitter loops(Figure 2). The basic coverage (11.650km) consisted of three-component data collected from two loops simultaneously. Detailing work - 1.625km of three-component data collected from one loop - was then carried out The survey frequencies and coverage for the survey are summarized below

**Area 5 Grid** **13.275km total** (11.650km 2 loop + 1.625km 1 loop coverage)

SE-NW Lines covering Lines 8800E to 9100E: 4.800km total

- S1: 1.7857Hz (off-loop - loop to the gridNorthW) - Loop 2016-19
- S2: 0.7143Hz (in-loop) - Loop 2016-17

SE-NW Lines covering Lines 9300E to 10300E: 6.850km total

- S1: 1.7857Hz (off-loop - loop to the gridNorthW) - Loop 2016-18
- S2 0.7143Hz (in-loop) - Loop 2016-17

SE-NW Lines covering Lines 9500E + 9700E: 1.625km total

- S2: 0.7143Hz (off-loop - loop to the gridSouth) - Loop 2016-20

This report documents the UTEM5 survey in terms of logistics, survey parameters and field personnel, outlines the data processing and discusses the results. Appendix A contains the data presented as BL/BT/Bz profiles.

Other appendices contain:

- List of Personnel/Production Diary (Appendix B)
- an outline of the UTEM5 System (Appendix C)
- Note on sources of anomalous Ch0 (Appendix D)


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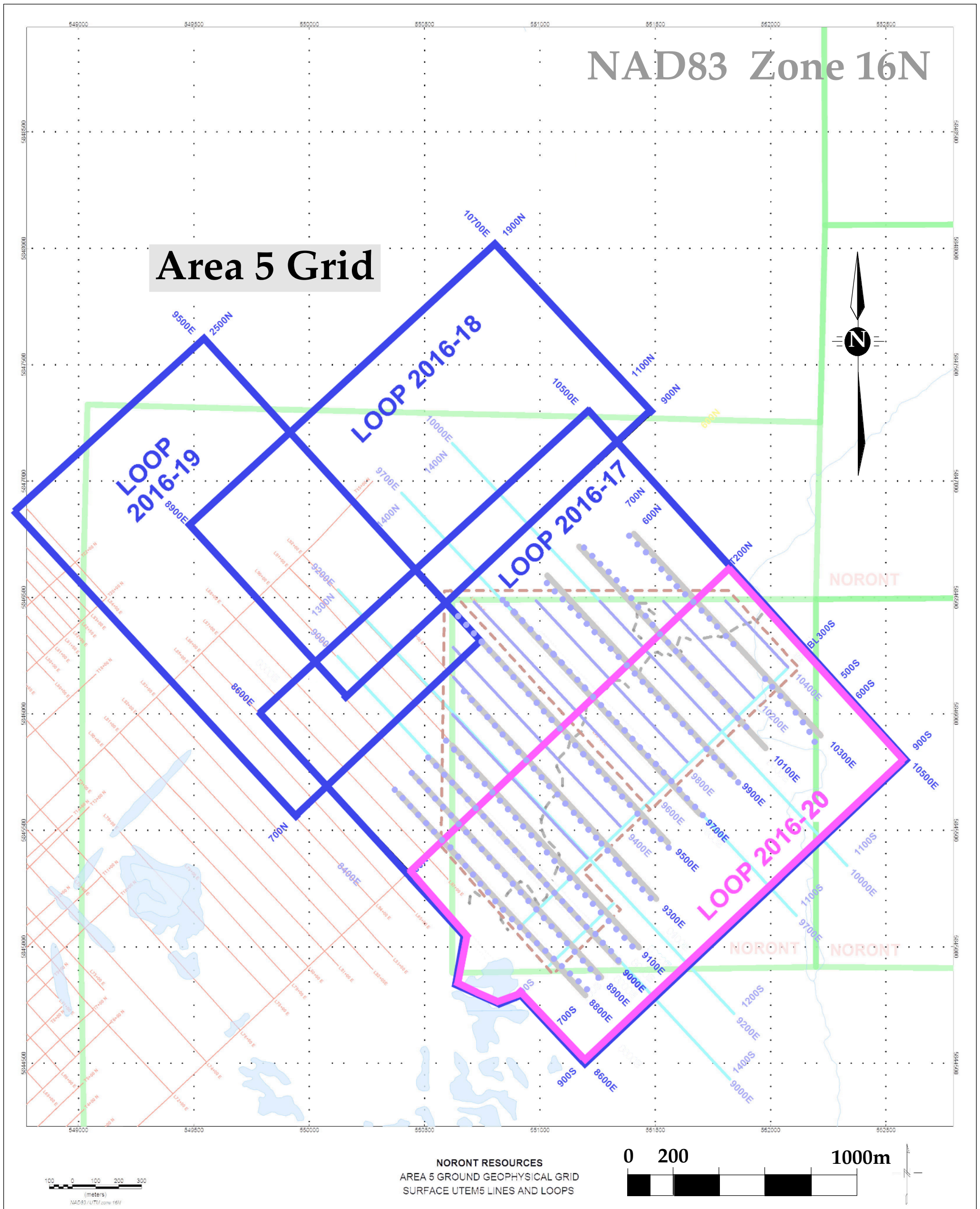
Noront Resources Ltd.
Area 5 Grid UTEM5 Survey
Location Map

Figure 1




**SE-NW Lines 8800-9100E**
surveyed simultaneously from:
**Loop 2015-19** S1 @ 1.7857Hz
**Loop 2015-13** S2 @ 0.7143Hz

**SE-NW Lines 9300-10300E**
surveyed simultaneously from:
**Loop 2015-18** S1 @ 1.7857Hz
**Loop 2015-13** S2 @ 0.7143Hz

**SE-NW Lines 9500E/9700E**
surveyed from:
**Loop 2015-20** S2 @ 0.7143Hz

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Noront Resources Ltd.
Area 5 Grid - UTEM5 Survey
Grid Map

Figure 2

SURVEY DESIGN

The UTEM5 survey was planned and carried out to test anomalies outlined by earlier exploration, to detect/outline new conductors and to detect/outline deeper features and potential depth continuations of shallow features.

The grid and loop layout was designed by Noront Resources personnel in consultation with Lamontagne Geophysics. Loop size and location were selected to provide good coupling with the expected targets and to allow efficient coverage of the area of interest.

The survey parameters employed are as follows:

- line spacing of: 100m for SE-NW Lines 8800- 9100E
  200m for SE-NW Lines 9300-10300E
- station interval of 50m reduced to 25m if required.
- 3-component measurements from a pair of Transmitter loops simultaneously:

Grid Area 5:

| | | | |
|---|---|---|---|
| Loop 2016-19 | 1.7857Hz | - loop to the gridNorthW | ~1100x1800m loop |
| Loop 2016-18 | 1.7857Hz | - loop to the gridNorthE | ~1800x1000m loop |
| + Loop 2016-17 | 0.7143Hz | - in-loop | ~1900x2000m loop |

- detailing 3-component measurements from a single Transmitter loop:
- Loop 2016-20 1.7857Hz - loop to the gridSouth ~1900x1100m loop
- 12Ch single (minimum 120s) stacking (duplicates as required) as follows:
  frequencies for coverage (in the ratio 5:2) (Figure 3):
  - 1.7857Hz S1 - Area 5 Loops 2016-19/8
    average stacking 2x151sec stacking = 1080 full-cycles/2160 half-cycles
  - 0.7143Hz S2 Area 5 Loop 2016-17 and Loops 2016-20
    average stacking 2x151sec stacking = 432 full-cycles/ 864 half-cycles

Note: further details of frequencies/sampling/stacking are listed in Figure 3.

Noront Resources provided GPS (NAD83) locations for all survey stations and the transmitter loops. The LGL crews routinely collect handheld-GPS (Garmin eTrex) data for all transmitter loops for the purpose of control.

Note: Geometric control should be considered a mandatory part of the interpretation of any UTEM survey where the target is potentially non-decaying. Poor geometric control has the potential to both mask and invent Ch0 (latest time) conductors (Appendix D).

## Sampling 1
## 1.7857Hz

| off loop | frequency | 1.785714 | Hz | Sampling 1 | |
|---|---|---|---|---|---|
| | period | 0.560000 | s | | |
| (5MHz clock) | half period | 1400000 | 0.2µs cycles | **Loop 2016-19** | |
| (narrowest Ch=1unit) | XNP | **4444** | /halfperiod | **and** | |
| | width of unit channel | 6.30063E-05 | s | **Loop 2016-18** | |
| | width of unit channel | 63.0063 | µs | | |

| (symbol) channel | | peak of tapered Ch (µs) | tapered Ch begins - unit - | tapered Ch ends - unit - | Maxwell equivalent boxcar Ch mid point (ms) | Maxwell equivalent boxcar Ch width (ms) |
|---|---|---|---|---|---|---|
| timing Ch13 | ⱪ | 31.50 | -0.5 | 1.5 | 0.0315 | 0.0630 |
| 12 | ✗ | 94.51 | 0.5 | 3 | 0.1027 | 0.0788 |
| 11 | + | 189.02 | 1.5 | 6 | 0.2143 | 0.1418 |
| 10 | Φ | 378.04 | 3 | 12 | 0.4287 | 0.2835 |
| 9 | ⊽ | 756.08 | 6 | 24 | 0.8574 | 0.5671 |
| 8 | ⧖ | 1512.15 | 12 | 48 | 1.7147 | 1.1341 |
| 7 | ⁊ | 3024.30 | 24 | 96 | 3.4295 | 2.2682 |
| 6 | ∡ | 6048.61 | 48 | 192 | 6.8590 | 4.5365 |
| 5 | Σ | 12097.21 | 96 | 384 | 13.7179 | 9.0729 |
| 4 | □ | 24194.42 | 192 | 768 | 27.4359 | 18.1458 |
| 3 | ╲ | 48388.85 | 384 | 1536 | 54.8717 | 36.2916 |
| 2 | ╱ | 96777.69 | 768 | 3072 | 109.7434 | 72.5833 |
| 1 | \| | 193555.39 | 1536 | 4269 | 188.0596 | 86.0981 |
| 0 | ○ | 268973.94 | 3072 | 4442.5 | 250.6185 | 43.1751 |
| timing Ch15 | ≅ | 279905.54 | 4269 | 4443.5 | -3.2741 | 5.4973 |
| timing Ch14 | ⊟ | 279968.54 | 4442.5 | 4444+0.5 | -0.0315 | 0.0630 |

| | | |
|---|---|---|
| TSS: sub-stack time = | **2.800000** | s |
| StackN: number of substacks = | **43** | substacks |
| stacking time = | 120.40 | s |
| cycles stacked = | 215.00 | cycles |
| half-cycles stacked = | 430.00 | half-cycles |

## Sampling 2
## 0.7143Hz

| off loop | frequency | 0.714286 | Hz | Sampling 2 | |
|---|---|---|---|---|---|
| | period | 1.400000 | s | | |
| (5MHz clock) | half period | 3500000 | 0.2µs cycles | **Loop 2016-17** | |
| (narrowest Ch=1unit) | XNP | **4444** | /halfperiod | **and** | |
| | width of unit channel | 1.57516E-04 | s | **Loop 2016-20** | |
| | width of unit channel | 157.5158 | µs | | |

| (symbol) channel | | peak of tapered Ch (µs) | tapered Ch begins - unit - | tapered Ch - unit - | Maxwell equivalent boxcar Ch mid point (ms) | Maxwell equivalent boxcar Ch width (ms) |
|---|---|---|---|---|---|---|
| timing Ch13 | ⱪ | 78.76 | -0.5 | 1.5 | 0.0788 | 0.1575 |
| 12 | ✗ | 236.27 | 0.5 | 3 | 0.2569 | 0.1969 |
| 11 | + | 472.55 | 1.5 | 6 | 0.5359 | 0.3544 |
| 10 | Φ | 945.09 | 3 | 12 | 1.0717 | 0.7088 |
| 9 | ⊽ | 1890.19 | 6 | 24 | 2.1434 | 1.4176 |
| 8 | ⧖ | 3780.38 | 12 | 48 | 4.2869 | 2.8353 |
| 7 | ⁊ | 7560.76 | 24 | 96 | 8.5737 | 5.6706 |
| 6 | ∡ | 15121.51 | 48 | 192 | 17.1474 | 11.3411 |
| 5 | Σ | 30243.02 | 96 | 384 | 34.2948 | 22.6823 |
| 4 | □ | 60486.05 | 192 | 768 | 68.5896 | 45.3645 |
| 3 | ╲ | 120972.10 | 384 | 1536 | 137.1793 | 90.7291 |
| 2 | ╱ | 241944.20 | 768 | 3072 | 274.3586 | 181.4582 |
| 1 | \| | 483888.40 | 1536 | 4269 | 470.1489 | 215.2453 |
| 0 | ○ | 672434.76 | 3072 | 4442.5 | 626.5463 | 107.9377 |
| timing Ch15 | ≅ | 699763.74 | 4269 | 4443.5 | -8.1851 | 13.7433 |
| timing Ch14 | ⊟ | 699921.26 | 4442.5 | 4444+0.5 | -0.0788 | 0.1575 |

| | | |
|---|---|---|
| TSS: sub-stack time = | **2.800000** | s |
| StackN: number of substacks = | **43** | substacks |
| stacking time = | 120.40 | s |
| cycles stacked = | 86.00 | cycles |
| half-cycles stacked = | 172.00 | half-cycles |

### UTEM5 Frequency Selection

A target frequency is entered for each UTEM transmitter and the local powerline frequency are entered in the UTEM receiver. The actual frequencies used are selected by the receiver software to be as close to the entered target frequencies as possible while optimizing rejection of the other transmitters and powerline noise.
The minimum substack time is set by the receiver software to the shortest time that will include an integer number of cycles of each frequency used and 30Hz (the first harmonic of the 60 Hz powerline frequency).

Allowable stacking times are required to be a multiple of the minimum substack time.

Where responses extend to the latest time-channel measured (Ch0) the survey frequency can be lowered. Reducing the number of channels from 12 to 10 allows for a wider anti-aliasing filter bandwidth.
This can help improve S/N (signal-to-noise ratio) when dealing with high-frequency noise - eg. wind “whistling”.

**The equivalent boxcar channels are centred on the median (by area) of the tapered Chs (Figure 4).**

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Noront Resources Ltd.
UTEM5 Survey
Frequency / Chs details

Figure 3

## SURVEY LOGISTICS

A Lamontagne Geophysics crew and survey equipment mobilized from Kingston, Ontario, on July 18th, overnighting in Sudbury and Geraldton, arriving at Noront's Esker Camp on July 20th via the Nakina-Webequie-Esker Camp flight. Camp orientation was completed upon arrival and the rest of the day was spent unpacking and readying the equipment. The Lamontagne crew consisted of Phil Guimond (crew chief/operator), Gerry Lafortune (Rx/Tx operator), Richard Lahaye (Rx/Tx operator), Bill Dingwall (Tx operator/electronics), and Joey Plouffe (field assistant). The location of the project is shown in Figure 1 and the Area 5 Grid location is shown in Figure 2.

Loop deployment began on July 21st with Loops 2016-19 and 2016-17. This transmitter loop pair was used to survey the four western-most SE-NW trending lines (L88+00E to L91+00E). The LGL crew was assisted by local helpers supplied by Noront as noted in the job diary (Appendix B). The initial loop pair was completed the following day. Surveying began on July 23rd.and was completed July 24th. Loop 2016-18 was then deployed. Surveying with Loops 2016-18 and 2016-17 covered Lines 9300E-10300E and took from July 26th to July 28th. This completed the planned surveying.

It was decided to test a detected response with a loop to the southeast - Loop 2016-20 (modified from Loop 2016-17). Loop 2016-20 was connected on July 29th and two lines - L9500E and L9700E - were surveyed to the northwest. This completed the UTEM5 survey and all wire was picked up/equipment packed up on July 30th. The crew and equipment demobilized over July 31st through August 2nd. A detailed description of the Area 5 Grid UTEM5 survey is in Appendix B - the Production Diary.

Surveying proceeded fairly smoothly for the duration of the project. Weather conditions were typical for this time of year.. Transportation to/on the grid was by helicopter, argo and on foot. The survey equipment consisted of two UTEM5 receiver/coils, 2 UTEM4 Transmitters as well as all necessary accessories, support equipment and backup equipment. Data was reduced on a field computer (MacBook) and UTEM profiles and digital data were made available/emailed to the client daily.

## SURVEY RESULTS

The results of the survey are summarized and presented as UTEM5 profiles in Appendix A. The final Area 5 Grid and loop locations are presented in Figure 2 and 3. The data presented in Appendix A are reduced with a UTM grid (NAD83). Overall the UTEM data quality is considered good. Note that Ch0 (latest time channel) profiles should be considered in conjunction with other available information (App. D).

For each line surveyed the continuously normalized profiles have been plotted for the three components collected covering the Area 5 Grid. Note that in order to show the range of responses there are two sets of profiles plotted for the data:

- • all Chs:from Ch12-Ch1 and Ch0
  • the 8 late Chs: Chs8-Ch1 and Ch0

For each pair of Transmitter loops the S1 profiles are presented followed by the S2 profiles. Four-axis profiles are presented in order of line number from west-to-east or south-to-north. The order is as follows:

**Area 5 Grid**

| | | | |
|---|---|---|---|
| Loop 2016-19 S1: | 1.7857Hz | | |
| + Loop 2016-17 S2: | 0.7143Hz | Lines | 8800E to 9100E |
| Loop 2016-18 S1: | 1.7857Hz | | |
| + Loop 2016-17 S2: | 0.7143Hz | Lines | 9300E to 10300E |
| Loop 2016-20 S2: | 0.7143Hz | Lines | 9500E and 9700E |

Note: all UTEM5 reports present data as:

- BL - in-line horizontal component (c1) - UTEM3 ~equivalent - Hx
  the L-azimuth direction is selectable
- BT - the transverse horizontal component (c2) - UTEM3 ~equivalent - Hy
  the T-azimuth direction is 90° counterclockwise from L-azimuth
- BZ -vertical component (c3) - UTEM3 equivalent - Hz

**Outline of profile types**:

BL BT Bz continuous norm Ch0 reduced

Continuous normalization is useful for detection of the presence of anomalies at any position on a profile. The anomaly shape is distorted by normalization to the local field. Near the wire (large field) continuously normalized Ch0 tends towards zero.

Note: Ch0 is later in time and narrower than Ch1 (Appendix C).

The BL/BT/Bz continuously normalized data are presented as 4-axis profiles:

| | | |
|---|---|---|
| top axis: Ch1-12/7 | Bz | Ch0 Reduced |
| upper middle axis: Ch1-12/7 | BT | Ch0 Reduced |
| lower middle axis: Ch1-12/7 | BL | Ch0 Reduced |
| bottom axis: Ch0 | BL BT Bz | Primary Field Reduced |

A description of the standard plotting formats used and of the UTEM System is presented in Appendix C.

Note on digital data:

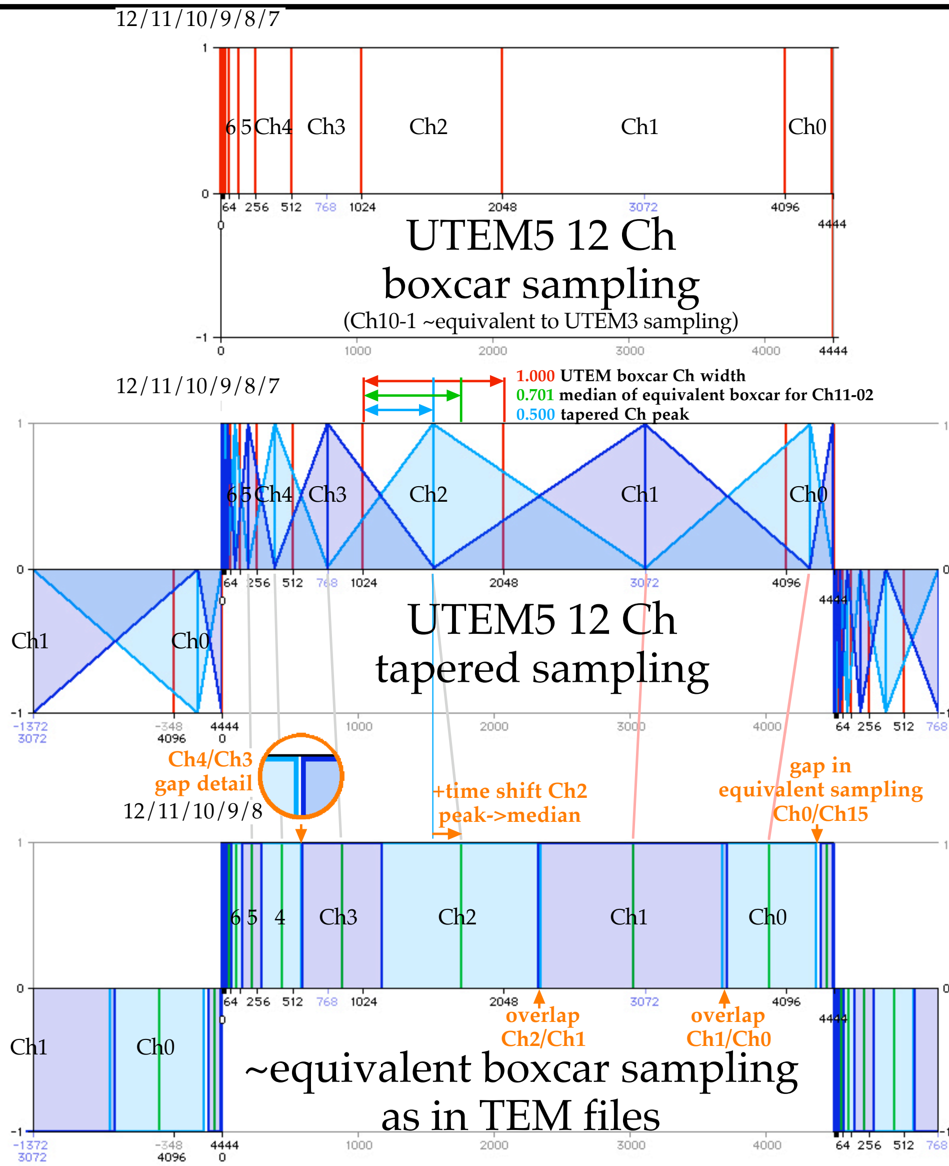
The standard formats of the UTEM5 data - raw, edited, reduced (3CH5) - are all included in the digital record of the Area 5 Grid UTEM5 Survey accompanying this report. The 3cH5 files can be plotted using the 3C Plotter:

https://www.lamontagnegeophysics.com/plotter/

The 3C Plotter is a geophysical data plotter that runs in any modern web browser running locally on your machine or online. The 3C Plotter is designed to aid in visualization and interpretation of electromagnetic data. The output is in Scalable Vector Format (SVG), which means it can be presented in large format without loss in quality and is suitable for printing and exporting to pdf. The features of the plotter are outlined in the 3C Plotter Manual:

https://lamontagnegeophysics.com/plotter/manual.pdf

TEM files - compatible with Maxwell - are also included. For the TEM files the UTEM5 12 Ch tapered sampling has been approximated with an (~)equivalent boxcar sampling. The details of the equivalent boxcar channels are listed along with the standard sampling/Ch information in Figure 3 . In Figure 4 the UTEM5 boxcar and UTEM5 tapered samplings are shown and compared to the equivalent boxcar sampling.




Notes:
- **upper**: boxcar sampling equivalent to UTEM3 sampling
- **centre**: UTEM5 tapered sampling (Appendix C)
- **lower**: ~equivalent boxcar sampling in TEM files
    - Chs centred on the median (by area) of the tapered Ch
    - Ch area is the same as in UTEM5 tapered sampling
    - a Ch followed by a wider (or an equal-width) Ch :
        - the median time shifts to later than the tapered peak
        - Chs abut or gap between Chs (**gap detail Ch4/Ch3**)
    - for a Ch followed by a narrower Ch (Ch1 or Ch0):
        - the median time shifts to earlier than the tapered peak
        - ~overlap with previous Ch (**Ch2/Ch1** or **Ch1/Ch0**)

Note: The time shifts that result from the choice of centring the ~equivalent boxcar Chs on the median (by area) of the tapered Chs yield modeling results that will better match the actual conductivity values at early times (of a given decay). Applying a factor (~0.95/0.9) to reduce these time shifts somewhat will yield modeling results that better match actual conductivity values at later/late times (of a given decay).

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GEOPHYSIQUE LTEE

UTEM5 12Ch Sampling
boxcar/tapered channel options
~equivalent boxcar sampling

Figure 4

# Appendix A

## 2016-3 UTEM5 Profiles

**UTEM5 Survey**

**Area 5 Grid**
**Ring of Fire**

**for**

**Noront Resources Ltd.**

Presentation

The results of the survey are summarized and presented as UTEM5 profiles in Appendix A. The final Area 5 Grid and loop locations are presented in Figure 2 and 3. The data presented in Appendix A are reduced with a UTM grid (NAD83). Overall the UTEM data quality is considered good. Note that Ch0 (latest time channel) profiles should be considered in conjunction with other available information (App. D).

For each line surveyed the continuously normalized profiles have been plotted for the three components collected covering the Area 5 Grid. Note that in order to show the range of responses there are two sets of profiles plotted for the data:

- • all Chs:from Ch12-Ch1 and Ch0
  • the 8 late Chs: Chs8-Ch1 and Ch0

For each pair of Transmitter loops the S1 profiles are presented followed by the S2 profiles. Four-axis profiles are presented in order of line number from west-to-east or south-to-north. The order is as follows:

**Area 5 Grid**

| | | | |
|---|---|---|---|
| Loop 2016-19 S1: | 1.7857Hz | | |
| + Loop 2016-17 S2: | 0.7143Hz | Lines | 8800E to 9100E |
| Loop 2016-18 S1: | 1.7857Hz | | |
| + Loop 2016-17 S2: | 0.7143Hz | Lines | 9300E to 10300E |
| Loop 2016-20 S2: | 0.7143Hz | Lines | 9500E and 9700E |

Note: all UTEM5 reports present data as:

- BL - in-line horizontal component (c1) - UTEM3 ~equivalent - Hx
  the L-azimuth direction is selectable
- BT - the transverse horizontal component (c2) - UTEM3 ~equivalent - Hy
  the T-azimuth direction is 90° counterclockwise from L-azimuth
- BZ -vertical component (c3) - UTEM3 equivalent - Hz

**Outline of profile types**:

BL BT Bz continuous norm Ch0 reduced

Continuous normalization is useful for detection of the presence of anomalies at any position on a profile. The anomaly shape is distorted by normalization to the local field. Near the wire (large field) continuously normalized Ch0 tends towards zero.

Note: Ch0 is later in time and narrower than Ch1 (Appendix C).

The BL/BT/Bz continuously normalized data are presented as 4-axis profiles:

| | | |
|---|---|---|
| top axis: Ch1-12/7 | Bz | Ch0 Reduced |
| upper middle axis: Ch1-12/7 | BT | Ch0 Reduced |
| lower middle axis: Ch1-12/7 | BL | Ch0 Reduced |
| bottom axis: Ch0 | BL BT Bz | Primary Field Reduced |

A description of the standard plotting formats used and of the UTEM System is presented in Appendix C.

Note on digital data:

The standard formats of the UTEM5 data - raw, edited, reduced (3CH5) - are all included in the digital record of the Area 5 Grid UTEM5 Survey accompanying this report. The 3cH5 files can be plotted using the 3C Plotter:

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The 3C Plotter is a geophysical data plotter that runs in any modern web browser running locally on your machine or online. The 3C Plotter is designed to aid in visualization and interpretation of electromagnetic data. The output is in Scalable Vector Format (SVG), which means it can be presented in large format without loss in quality and is suitable for printing and exporting to pdf. The features of the plotter are outlined in the 3C Plotter Manual:

https://lamontagnegeophysics.com/plotter/manual.pdf

TEM files - compatible with Maxwell - are also included. For the TEM files the UTEM5 12 Ch tapered sampling has been approximated with an (~)equivalent boxcar sampling. The details of the equivalent boxcar channels are listed along with the standard sampling/Ch information in Figure 3 . In Figure 4 the UTEM5 boxcar and UTEM5 tapered samplings are shown and compared to the equivalent boxcar sampling.

# List of Data Collected and Plotted

## Noront Resources Ltd. (2016-3)
## Area 5 Grid - UTEM5 Surface coverage

| Loop | Line | Coverage | m | components |
|---|---|---|---|---|
| Loop 2016-19 (@ **1.785714Hz**) | | off-loop - loop to the gridNorth | | |
| Loop 2016-17 (@ **0.7142857Hz**) | | in-loop | | |
| 2 Loop coverage | Line 8800E | 700S - 500N | 1200m | BL/BT/Bz |
| | Line 8900E | 700S - 500N | 1200m | BL/BT/Bz |
| | Line 9000E | 700S - 500N | 1200m | BL/BT/Bz |
| | Line 9100E | 700S - 500N | 1200m | BL/BT/Bz |
| U5 BL/BT/Bz coverage | | Loop 19/17 | 4800m | BL/BT/Bz |
| Loop 2016-18 (@ **1.785714Hz**) | | off-loop - loop to the gridNorth | | |
| Loop 2016-17 (@ **0.7142857Hz**) | | in-loop | | |
| 2 Loop coverage | Line 9300E | 600S - 600N | 1200m | BL/BT/Bz |
| | Line 9500E | 500S - 700N | 1200m | BL/BT/Bz |
| | Line 9700E | 500S - 700N | 1200m | BL/BT/Bz |
| | Line 9900E | 500S - 700N | 1200m | BL/BT/Bz |
| | Line 10100E | 350S - 700N | 1050m | BL/BT/Bz |
| | Line 10300E | 600S - 250S | | |
| | | 50S - 600N | 1000m | BL/BT/Bz |
| U5 BL/BT/Bz coverage | | Loop 18/17 | 6850m | BL/BT/Bz |
| **Area 5 Grid Total U5** | | **2 loop coverage** | **11650m** | **BL/BT/Bz** |
| Loop 2016-20 (@ **0.7142857Hz**) | | in-loop/off-loop - loop to the gridSouth | | |
| | Line 9500E | 0 - 850N | 850m | BL/BT/Bz |
| | Line 9700E | 0 - 775N | 775m | BL/BT/Bz |
| U5 BL/BT/Bz coverage | | Loop 20 | 1625m | BL/BT/Bz |
| **Area 5 Grid Total U5** | | **1 loop coverage** | **1625m** | **BL/BT/Bz** |

**Area 5 Survey Total:**

- 11650m UTEM5 2 Transmitter BL/BT/Bz line coverage
  plus
- 1625m UTEM5 1 Transmitter BL/BT/Bz line coverage

equalling:

- 74775m UTEM5 single component/single Tx coverage
- 24925m UTEM5 1 loop coverage
- 11650m UTEM5 **1.785Hz** BL/BT/Bz coverage
- 13275m UTEM5 **0.714Hz** BL/BT/Bz coverage

# Area 5 Grid

| | | | | |
|---|---|---|---|---|
| Loop 2016-19 (@ **1.785714Hz**) | | off-loop - loop to the gridNorth | | |
| Loop 2016-17 (@ **0.7142857Hz**) | | in-loop | | |
| 2 Loop coverage | Line 8800E | 700S - 500N | 1200m | BL/BT/Bz |
| | Line 8900E | 700S - 500N | 1200m | BL/BT/Bz |
| | Line 9000E | 700S - 500N | 1200m | BL/BT/Bz |
| | Line 9100E | 700S - 500N | 1200m | BL/BT/Bz |
| Loop 2016-18 (@ **1.785714Hz**) | | off-loop - loop to the gridNorth | | |
| Loop 2016-17 (@ **0.7142857Hz**) | | in-loop | | |
| 2 Loop coverage | Line 9300E | 600S - 600N | 1200m | BL/BT/Bz |
| | Line 9500E | 500S - 700N | 1200m | BL/BT/Bz |
| | Line 9700E | 500S - 700N | 1200m | BL/BT/Bz |
| | Line 9900E | 500S - 700N | 1200m | BL/BT/Bz |
| | Line 10100E | 350S - 700N | 1050m | BL/BT/Bz |
| | Line 10300E | 600S - 250S<br>50S - 600N | 1000m | BL/BT/Bz |
| Loop 2016-20 (@ **0.7142857Hz**) | | in-loop/off-loop - loop to the gridSouth | | |
| | Line 9500E | 0 - 850N | 850m | BL/BT/Bz |
| | Line 9700E | 0 - 775N | 775m | BL/BT/Bz |

# Area 5 Grid

# Loop 2016-19/18

## BL/BT/Bz

~1.785Hz frequency

continuous norm

12Ch - Ch0 reduced

## all Chs plotted

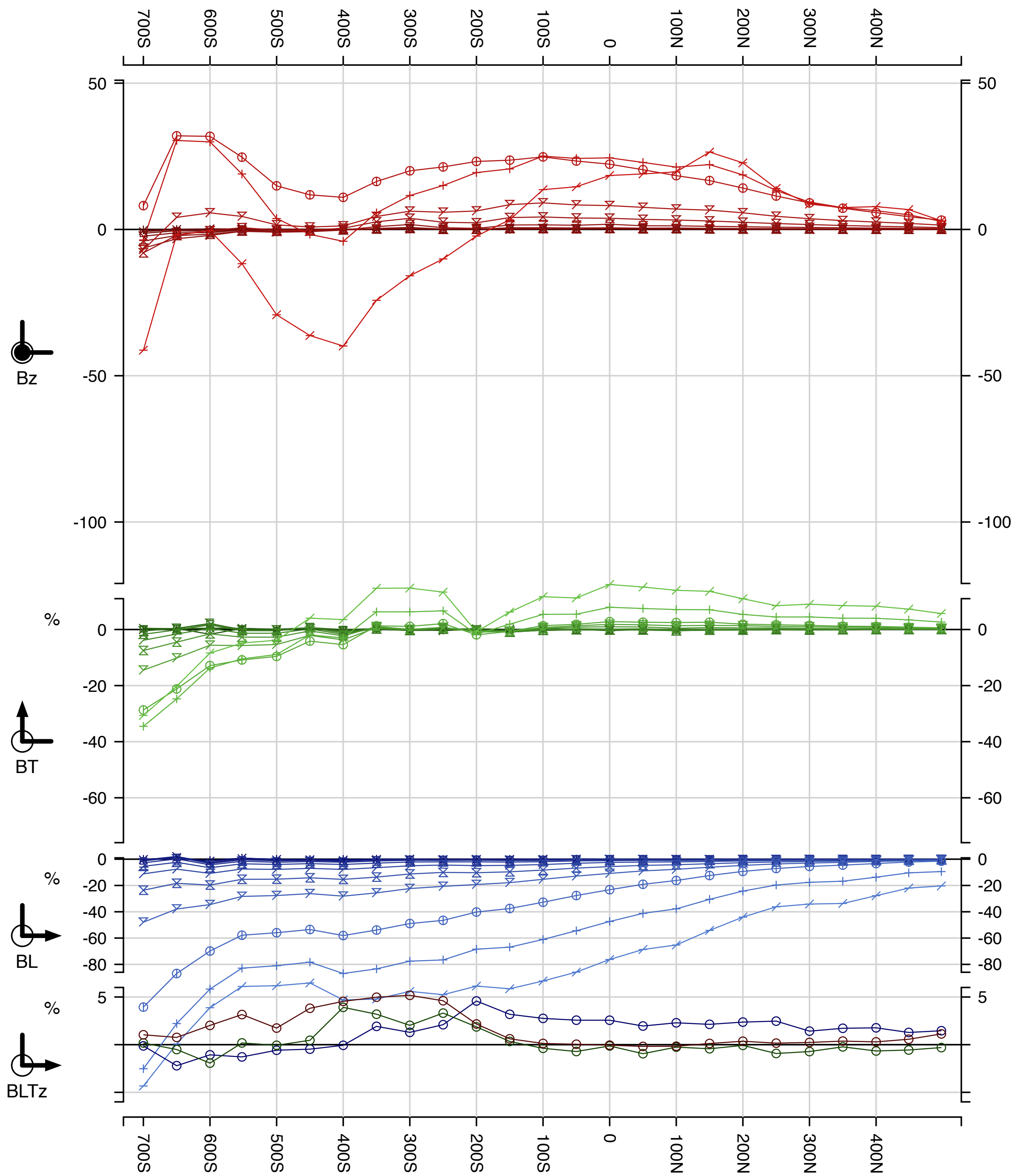
Loop 2016-19 (@ **1.785714Hz**) off-loop - loop to the gridNorthW

| | | | |
|---|---|---|---|
| Line 8800E | 700S - 500N | 1200m | BL/BT/Bz |
| Line 8900E | 700S - 500N | 1200m | BL/BT/Bz |
| Line 9000E | 700S - 500N | 1200m | BL/BT/Bz |
| Line 9100E | 700S - 500N | 1200m | BL/BT/Bz |

Loop 2016-18 (@ **1.785714Hz**) off-loop - loop to the gridNorthE

| | | | |
|---|---|---|---|
| Line 9300E | 600S - 600N | 1200m | BL/BT/Bz |
| Line 9500E | 500S - 700N | 1200m | BL/BT/Bz |
| Line 9700E | 500S - 700N | 1200m | BL/BT/Bz |
| Line 9900E | 500S - 700N | 1200m | BL/BT/Bz |
| Line 10100E | 350S - 700N | 1050m | BL/BT/Bz |
| Line 10300E | 600S - 250S | | |
| | 50S - 600N | 1000m | BL/BT/Bz |

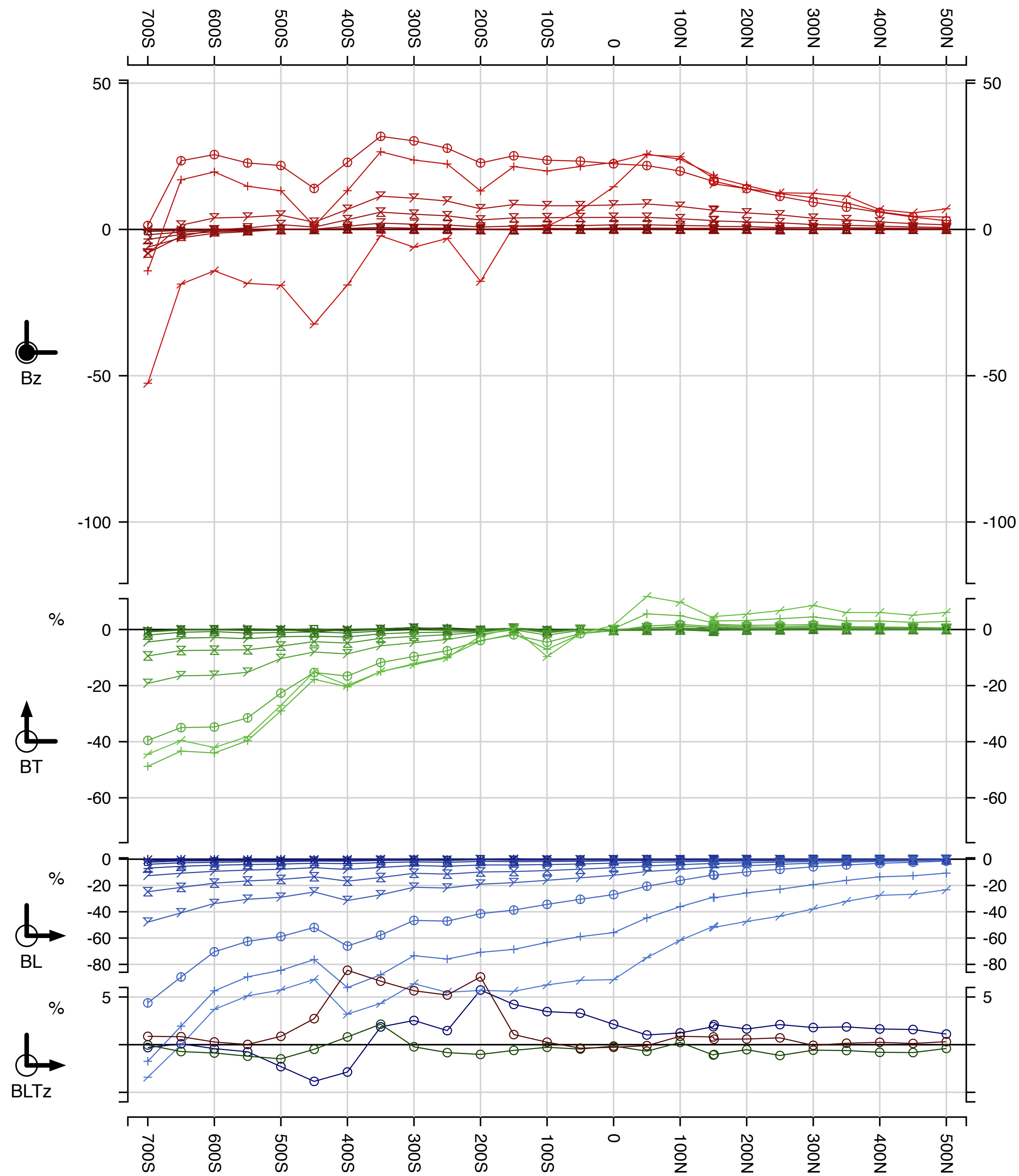
## Loop 2016-19/18 - all Chs - $B_{LTZ}$ pg 16




| | | |
|---|---|---|
| Line: L8800EA<br>Loop: 2016-19S1<br>Cpt: BL, BT, Bz<br>L 317.0° | (Chn - Ch0) / \|Bp\| (%)<br>Cont norm @ Δz: 0m<br>Base Freq: 1.78571Hz<br>aLp2016-19S1_L8800EA.3cH5 / AREA5 3-Axis S1* | UTEM-5 Survey at: AREA 5<br>For: NORONT<br>LAMONTAGNE GEOPHYSICS LTD GEOPHYSIQUE LTÉE<br>Job 1613<br>Surv: 24/7/16 Red: 6/11/16 Plot: 7/11/16 |

# Loop 2016-19 - all Chs - $B_{LTZ}$

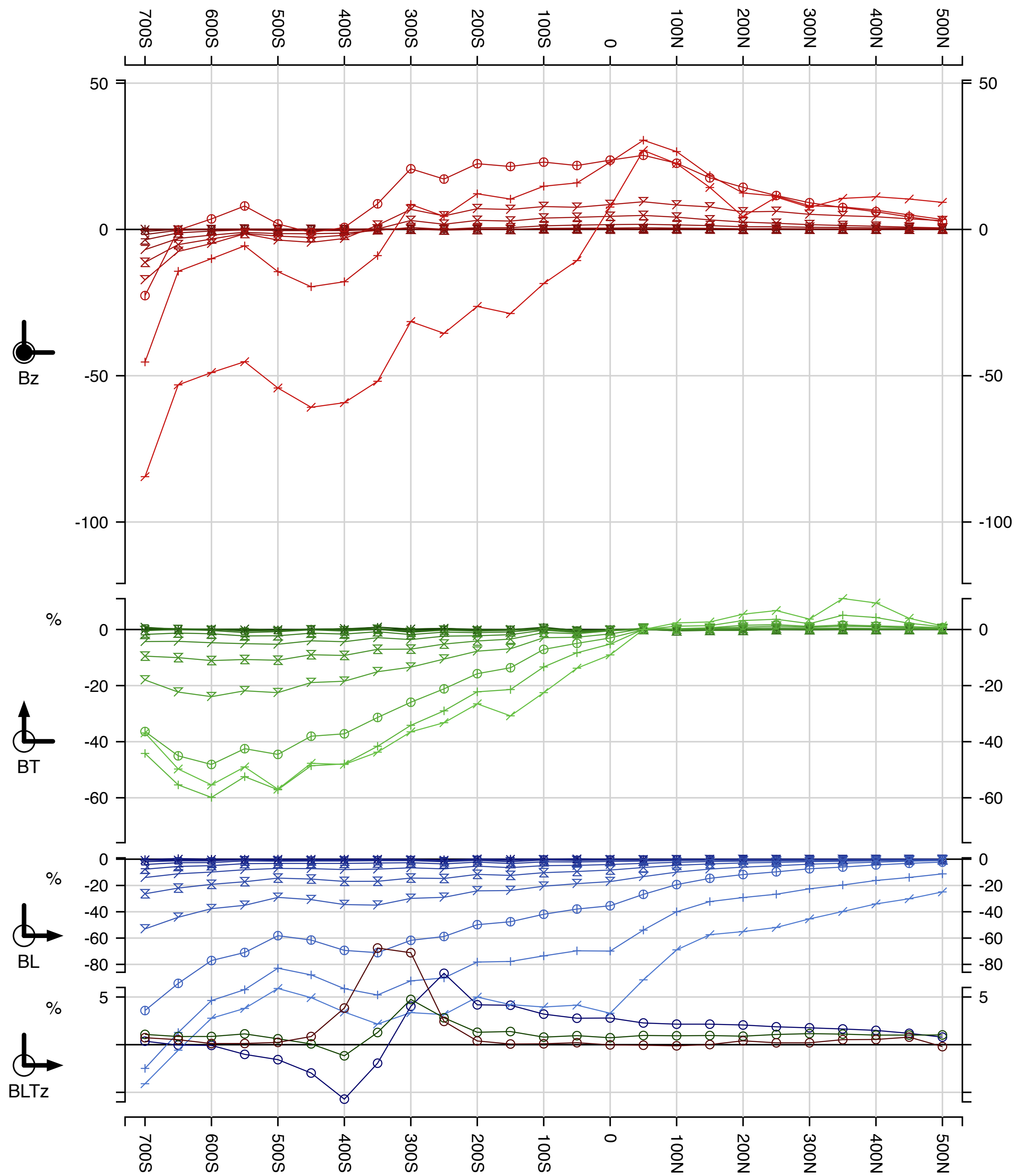
pg 17




| | | |
|---|---|---|
| Line: L8900EA<br>Loop: 2016-19S1<br>Cpt: BL, BT, Bz<br>L 317.0° | (Chn - Ch0) / \|Bp\| (%)<br>Cont norm @ Δz: 0m<br>Base Freq: 1.78571Hz<br>aLp2016-19S1_L8900EA.3cH5 / AREA5 3-Axis S1* | UTEM-5 Survey at: AREA 5<br>For: NORONT<br>LAMONTAGNE GEOPHYSICS LTD GEOPHYSIQUE LTÉE<br>Job 1613<br>Surv: 24/7/16<br>Red: 6/11/16<br>Plot: 7/11/16 |

# Loop 2016-19 - all Chs - $B_{LTZ}$

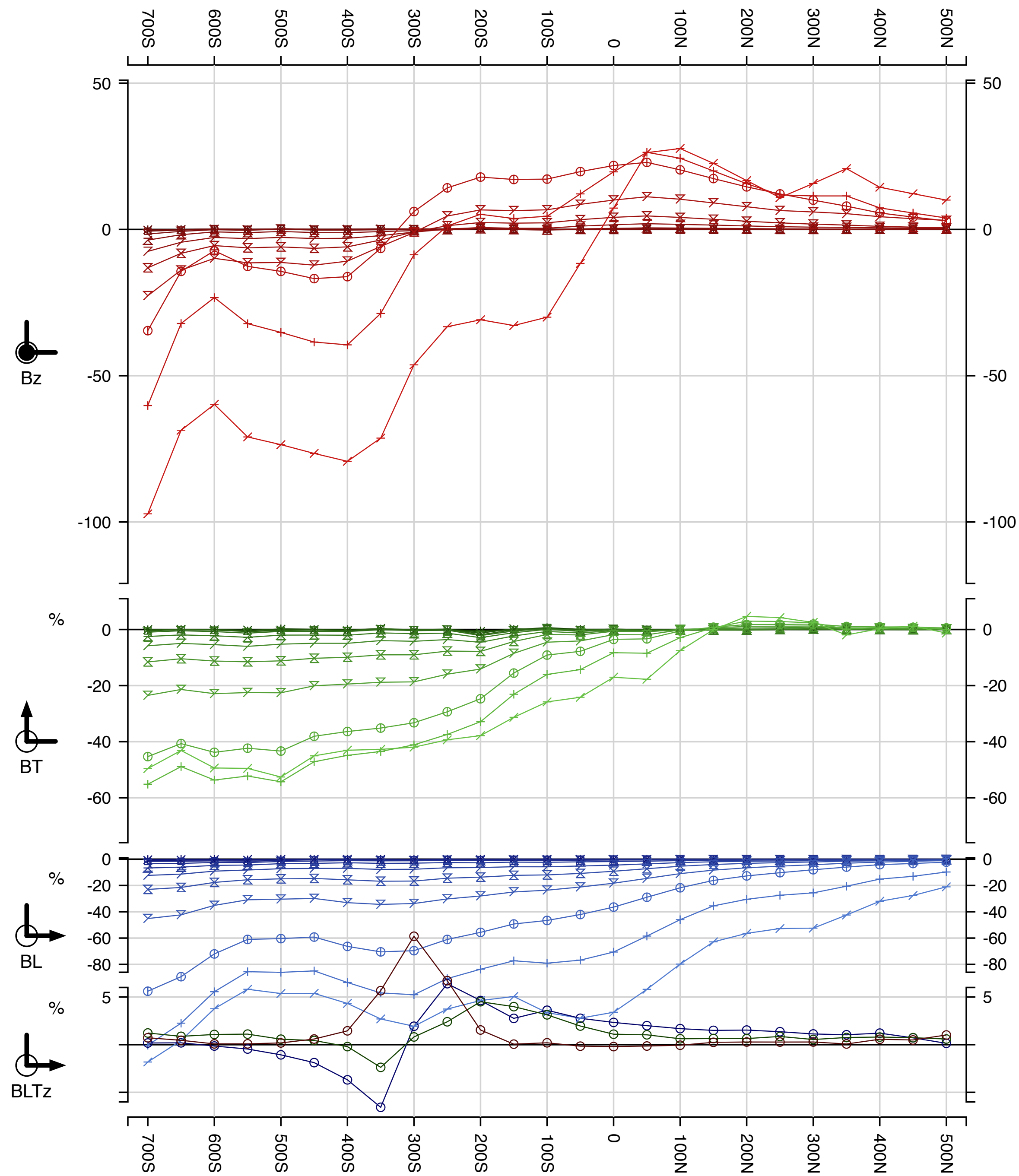
pg 18




| Line: L9000EA<br>Loop: 2016-19S1<br>Cpt: BL, BT, Bz<br>L 317.0° | (Chn - Ch0) / \|Bp\| (%)<br>Cont norm @ Δz: 0m<br>Base Freq: 1.78571Hz<br>aLp2016-19S1_L9000EA.3cH5 / AREA5 3-Axis S1* | UTEM-5 Survey at: AREA 5<br>For: NORONT<br>LAMONTAGNE GEOPHYSICS LTD GEOPHYSIQUE LTÉE<br>Job 1613<br>Surv: 24/7/16<br>Red: 6/11/16<br>Plot: 7/11/16 |
|---|---|---|

# Loop 2016-19 - all Chs - $B_{LTZ}$

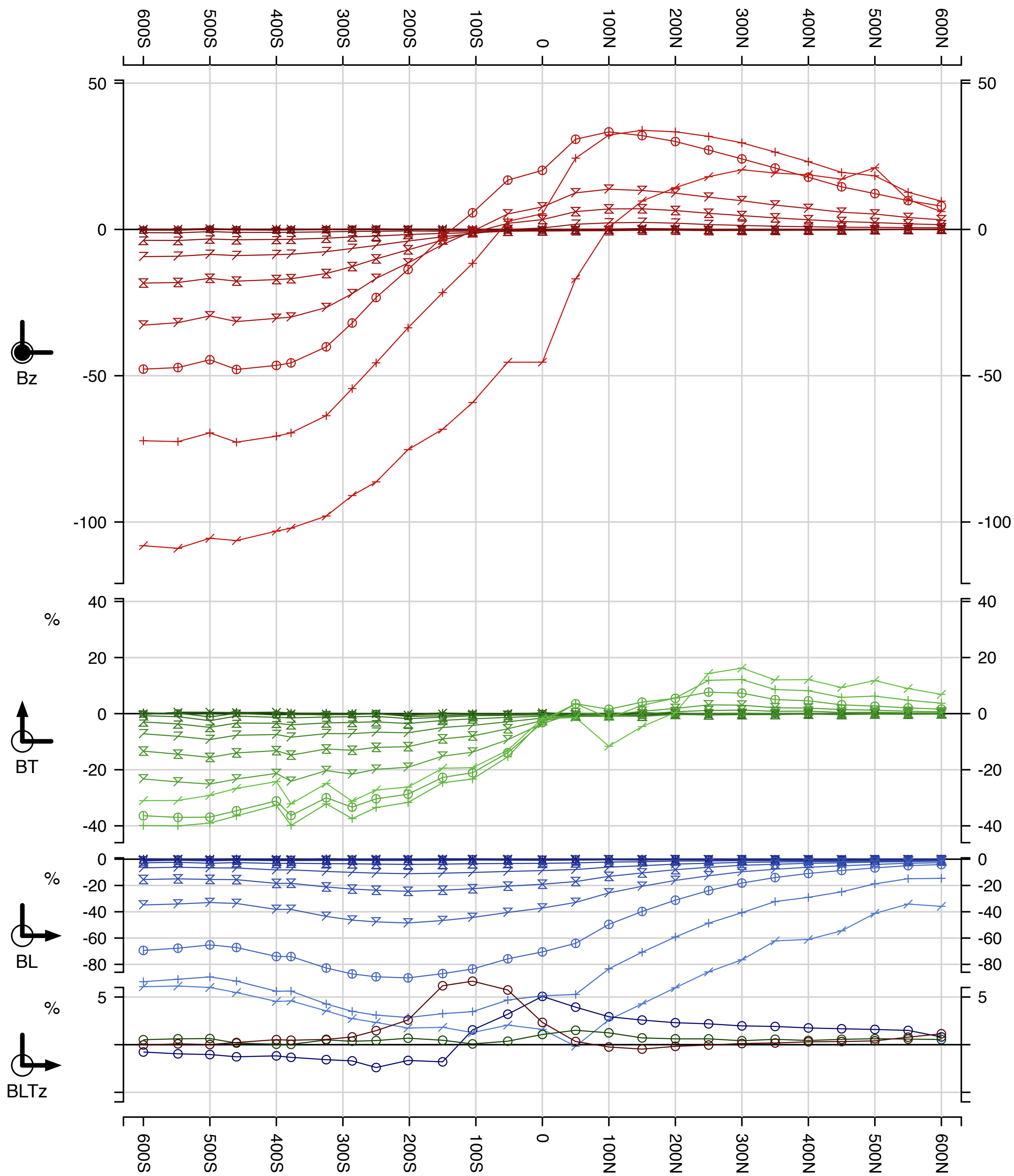
pg 19




| | | |
|---|---|---|
| Line: L9100EA<br>Loop: 2016-19S1<br>Cpt: BL, BT, Bz<br>L 317.0° | (Chn - Ch0) / \|Bp\| (%)<br>Cont norm @ Δz: 0m<br>Base Freq: 1.78571Hz<br>aLp2016-19S1_L9100EA.3cH5 / AREA5 3-Axis S1* | UTEM-5 Survey at: AREA 5<br>For: NORONT<br>LAMONTAGNE GEOPHYSICS LTD GEOPHYSIQUE LTÉE Job 1613 Surv: 24/7/16 Red: 6/11/16 Plot: 7/11/16 |

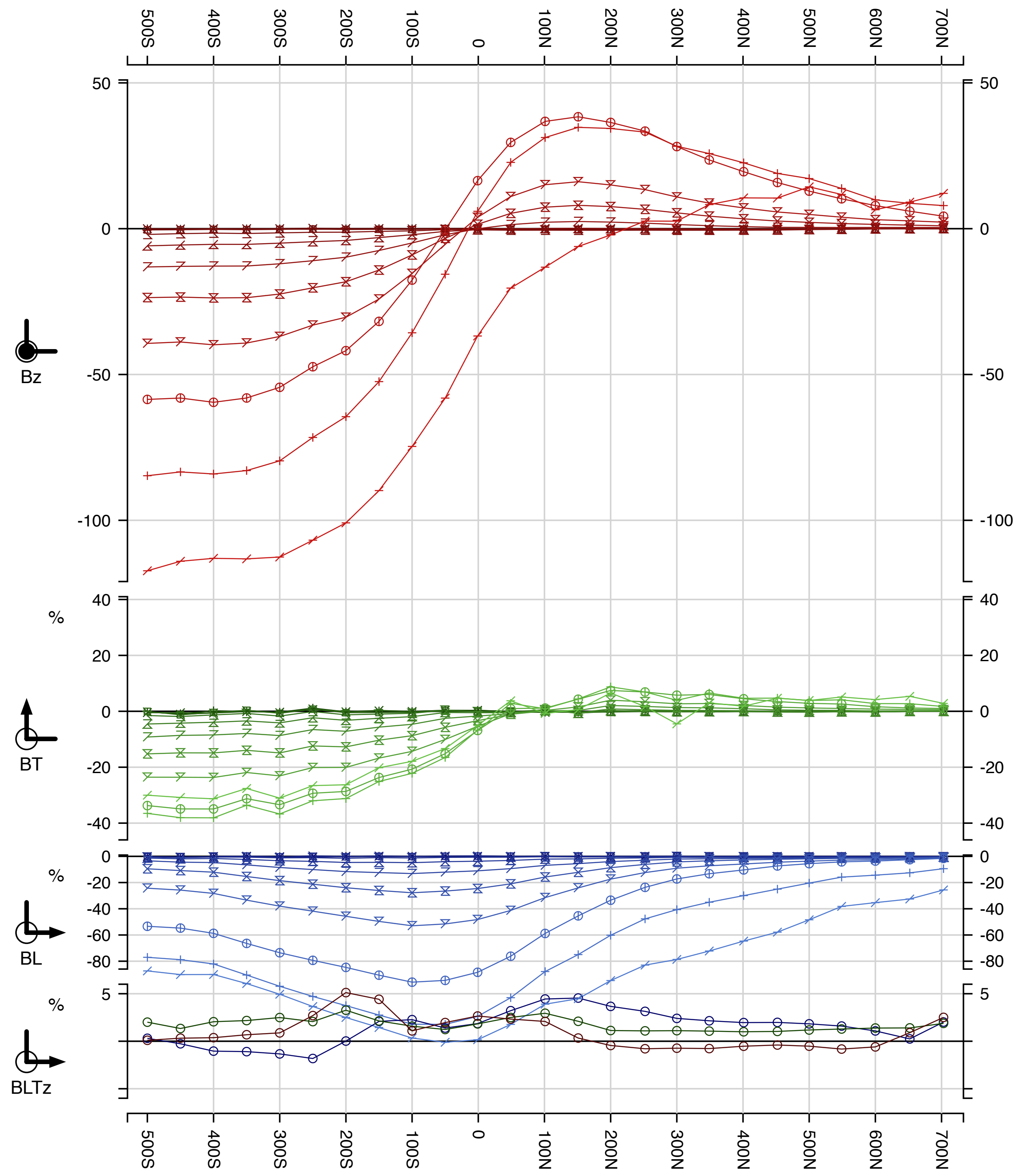
# Loop 2016-19 - all Chs - $B_{LTZ}$

pg 20




| | | | |
|---|---|---|---|
| Line: L9300EA<br>Loop: 2016-18S1<br>Cpt: BL, BT, Bz<br>L 317.0° | (Chn - Ch0) / \|Bp\| (%)<br>Cont norm @ Δz: 0m<br>Base Freq: 1.78571Hz<br>aLp2016-18S1_L9300EA.3cH5 / AREA5 3-Axis S1* | UTEM-5 Survey at: AREA 5<br>For: NORONT<br>LAMONTAGNE GEOPHYSICS LTD GEOPHYSIQUE LTÉE | Job 1613<br>Surv: 21/7/16<br>Red: 6/11/16<br>Plot: 7/11/16 |

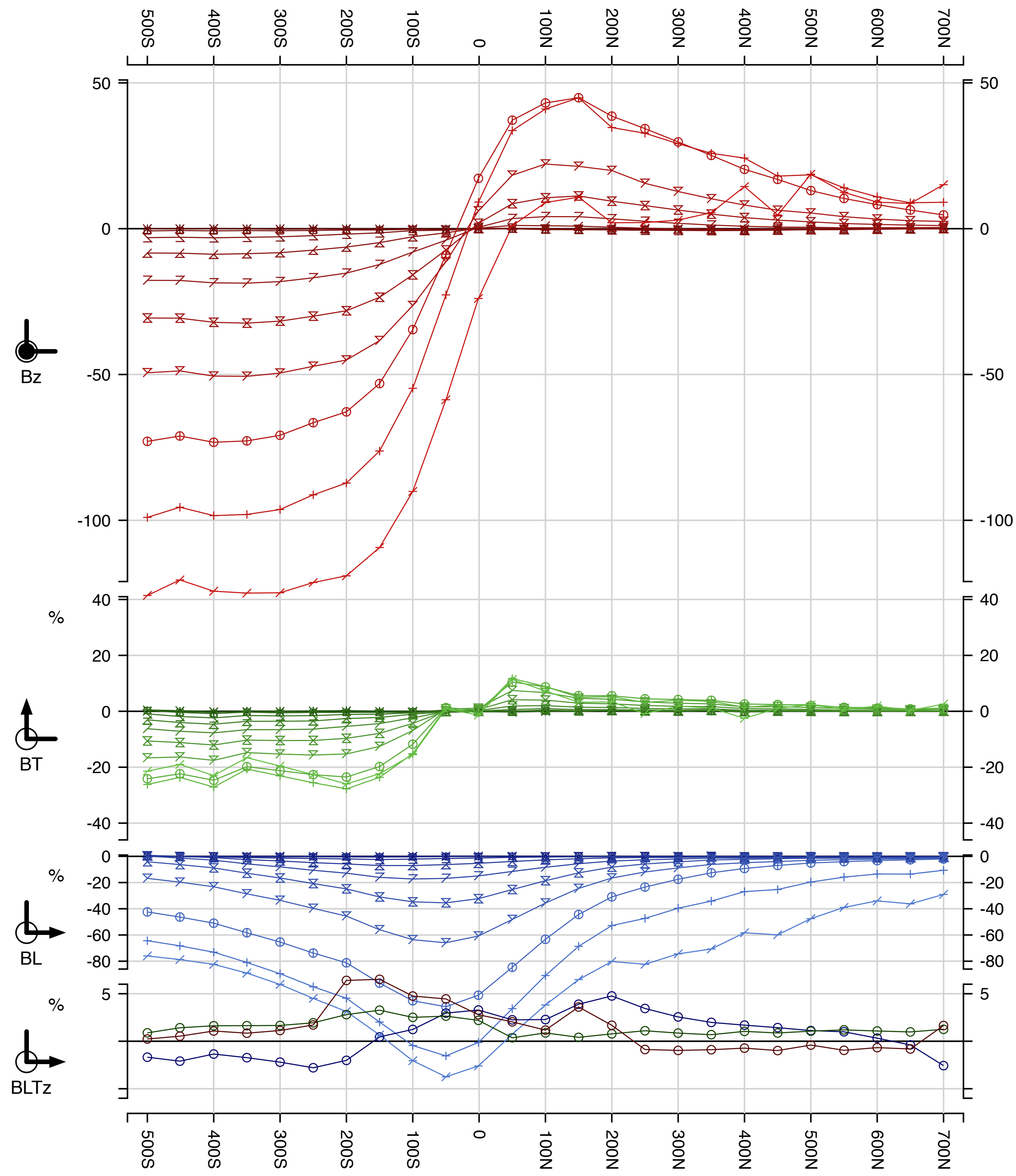
# Loop 2016-18 - all Chs - $B_{LTZ}$




| | | |
|---|---|---|
| Line: L9500EA<br>Loop: 2016-18S1<br>Cpt: BL, BT, Bz<br>L 317.0° | (Chn - Ch0) / \|Bp\| (%)<br>Cont norm @ Δz: 0m<br>Base Freq: 1.78571Hz<br>aLp2016-18S1_L9500EA.3cH5 / AREA5 3-Axis S1* | UTEM-5 Survey at: AREA 5<br>For: NORONT<br>LAMONTAGNE GEOPHYSICS LTD GEOPHYSIQUE LTÉE<br>Job 1613<br>Surv: 22/7/16<br>Red: 6/11/16<br>Plot: 7/11/16 |

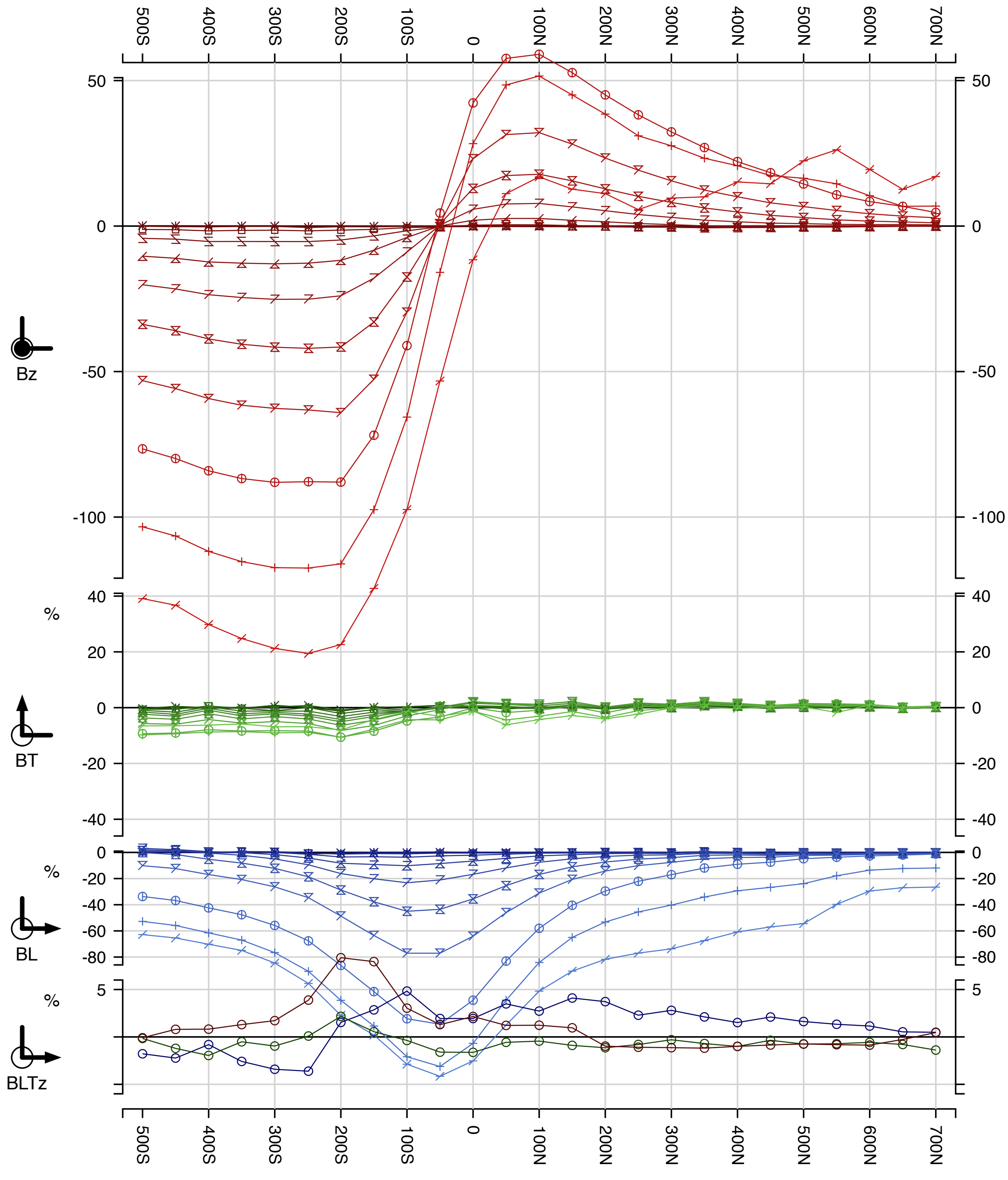
# Loop 2016-18 - all Chs - $B_{LTZ}$

pg 22



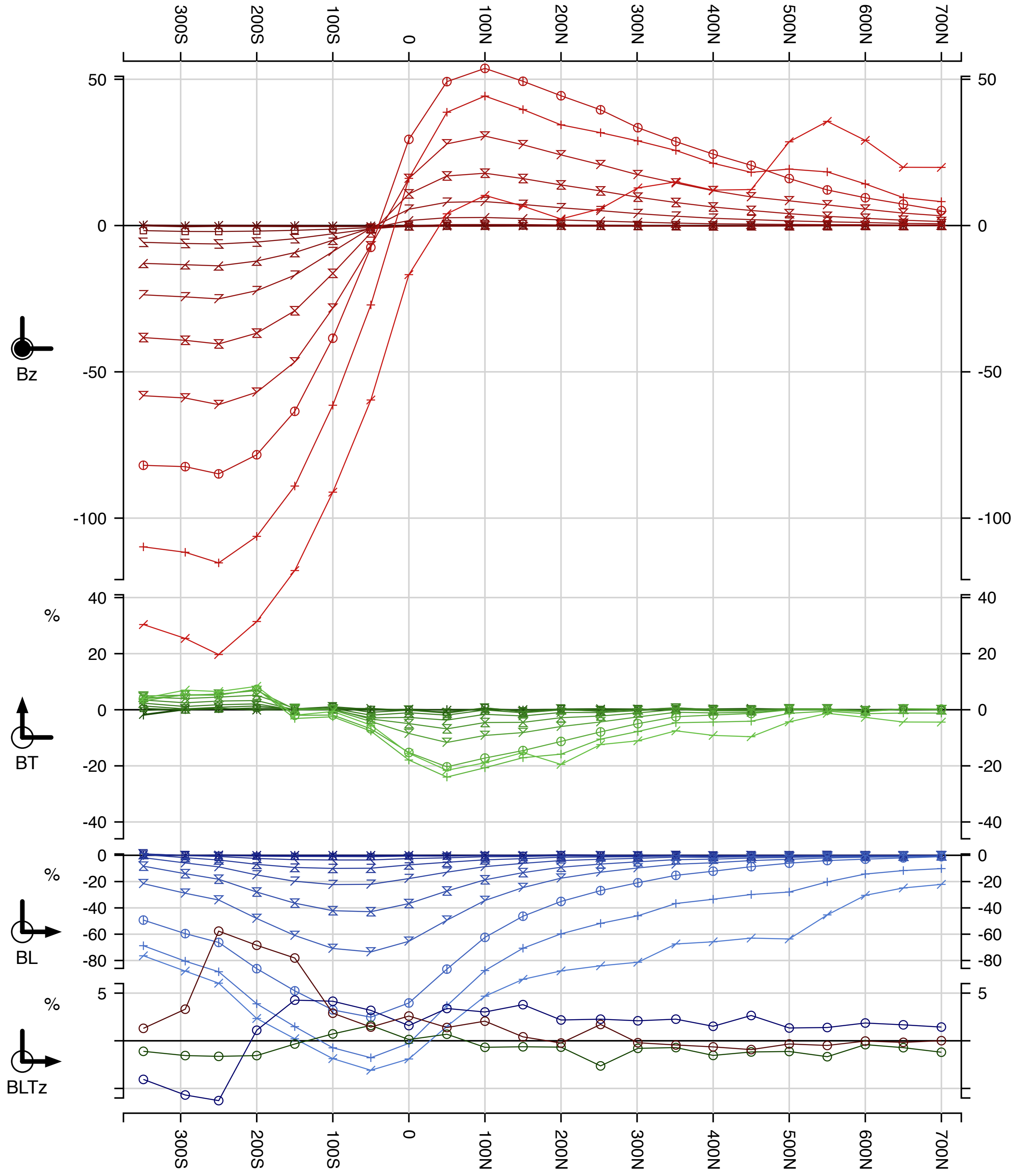

| Line: L9700EA<br>Loop: 2016-18S1<br>Cpt: BL, BT, Bz<br>L 317.0° | (Chn - Ch0) / \|Bp\| (%)<br>Cont norm @ Δz: 0m<br>Base Freq: 1.78571Hz<br>aLp2016-18S1_L9700EA.3cH5 / AREA5 3-Axis S1* | UTEM-5 Survey at: AREA 5<br>For: NORONT<br>LAMONTAGNE GEOPHYSICS LTD GEOPHYSIQUE LTÉE<br>Job 1613<br>Surv: 23/7/16<br>Red: 6/11/16<br>Plot: 7/11/16 |
|---|---|---|

# Loop 2016-18 - all Chs - $B_{LTZ}$



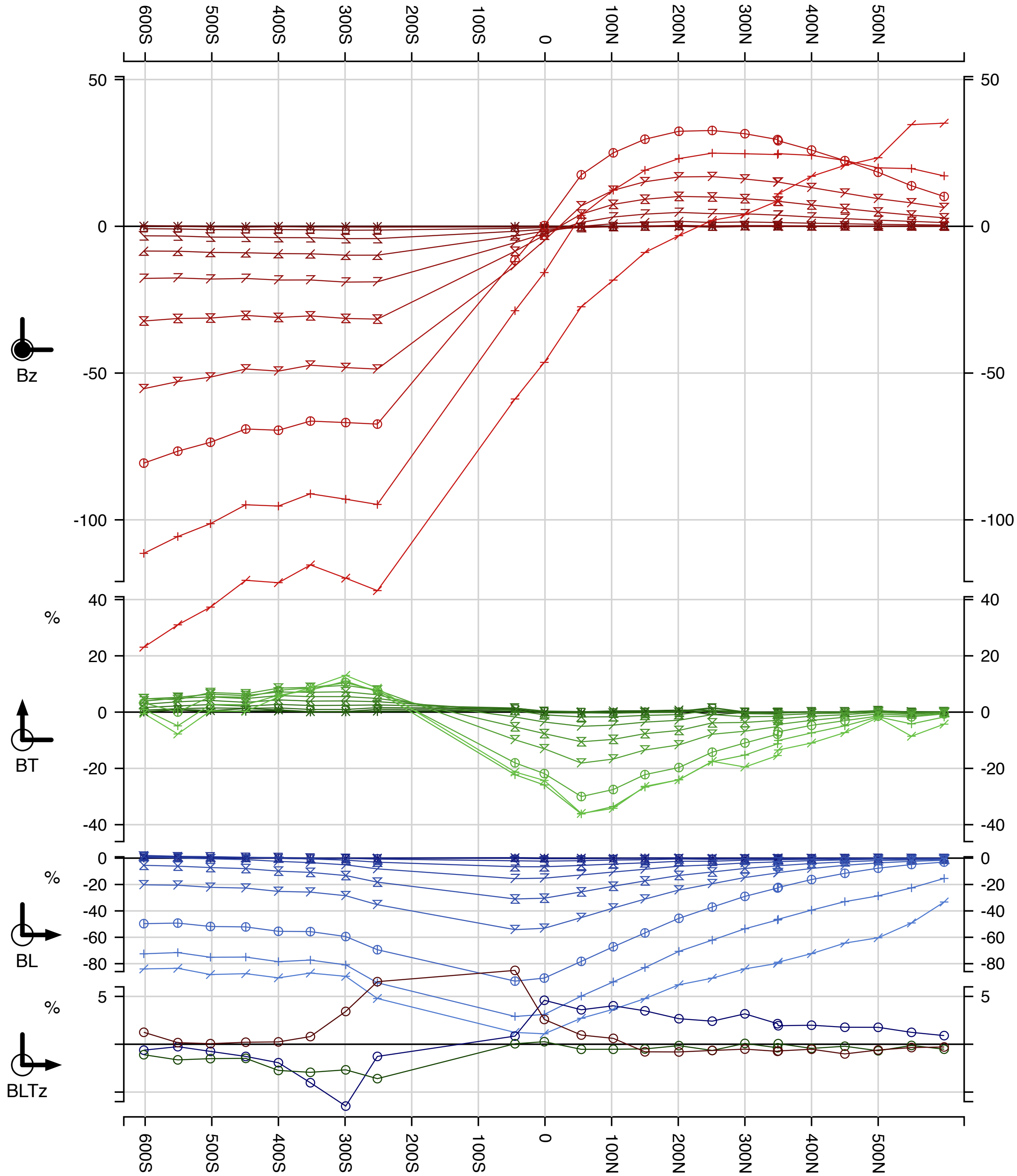

| Line: L9900EA<br>Loop: 2016-18S1<br>Cpt: BL, BT, Bz<br>L 317.0° | (Chn - Ch0) / \|Bp\| (%)<br>Cont norm @ Δz: 0m<br>Base Freq: 1.78571Hz<br>aLp2016-18S1_L9900EA.3cH5 / AREA5 3-Axis S1* | UTEM-5 Survey at: AREA 5<br>For: NORONT<br>LAMONTAGNE GEOPHYSICS LTD GEOPHYSIQUE LTÉE<br>Job 1613<br>Surv: 21/7/16<br>Red: 7/11/16<br>Plot: 7/11/16 |
|---|---|---|

# Loop 2016-18 - all Chs - $B_{LTZ}$




| | | |
|---|---|---|
| Line: L10100EA<br>Loop: 2016-18S1<br>Cpt: BL, BT, Bz<br>L 317.0° | (Chn - Ch0) / \|Bp\| (%)<br>Cont norm @ Δz: 0m<br>Base Freq: 1.78571Hz<br>aLp2016-18S1_L10100EA.3cH5 / AREA5 3-Axis S1* | UTEM-5 Survey at: AREA 5<br>For: NORONT<br>LAMONTAGNE GEOPHYSICS LTD GEOPHYSIQUE LTÉE<br>Job 1613<br>Surv: 22/7/16<br>Red: 7/11/16<br>Plot: 7/11/16 |

# Loop 2016-18 - all Chs - $B_{LTZ}$




| | | |
|---|---|---|
| Line: L10300EA<br>Loop: 2016-18S1<br>Cpt: BL, BT, Bz<br>L 317.0° | (Chn - Ch0) / \|Bp\| (%)<br>Cont norm @ Δz: 0m<br>Base Freq: 1.78571Hz<br>aLp2016-18S1_L10300EA.3cH5 / AREA5 3-Axis S1* | UTEM-5 Survey at: AREA 5<br>For: NORONT<br>LAMONTAGNE GEOPHYSICS LTD GEOPHYSIQUE LTÉE<br>Job 1613<br>Surv: 23/7/16<br>Red: 7/11/16<br>Plot: 7/11/16 |

# Loop 2016-18 - all Chs - $B_{LTZ}$

pg 26

# Area 5 Grid

# Loop 2016-19/18

## BL/BT/Bz

~1.785Hz frequency

continuous norm

12Ch - Ch0 reduced

## late Chs8-Ch0 plotted

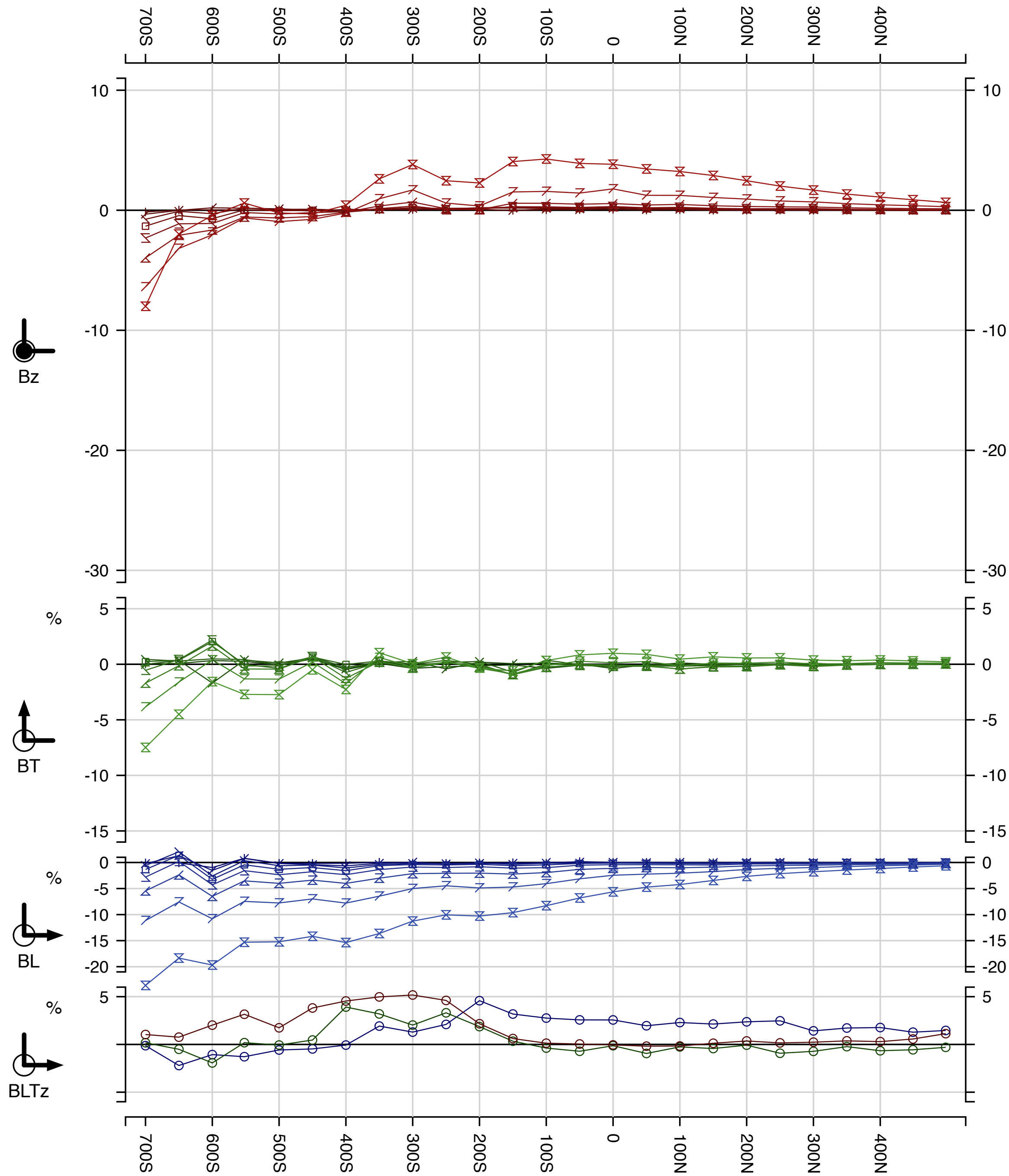
Loop 2016-19 (@ **1.785714Hz**) off-loop - loop to the gridNorthW

| | | | | |
|---|---|---|---|---|
| Line | 8800E | 700S - 500N | 1200m | BL/BT/Bz |
| Line | 8900E | 700S - 500N | 1200m | BL/BT/Bz |
| Line | 9000E | 700S - 500N | 1200m | BL/BT/Bz |
| Line | 9100E | 700S - 500N | 1200m | BL/BT/Bz |

Loop 2016-18 (@ **1.785714Hz**) off-loop - loop to the gridNorthE

| | | | | |
|---|---|---|---|---|
| Line | 9300E | 600S - 600N | 1200m | BL/BT/Bz |
| Line | 9500E | 500S - 700N | 1200m | BL/BT/Bz |
| Line | 9700E | 500S - 700N | 1200m | BL/BT/Bz |
| Line | 9900E | 500S - 700N | 1200m | BL/BT/Bz |
| Line | 10100E | 350S - 700N | 1050m | BL/BT/Bz |
| Line | 10300E | 600S - 250S | | |
| | | 50S - 600N | 1000m | BL/BT/Bz |

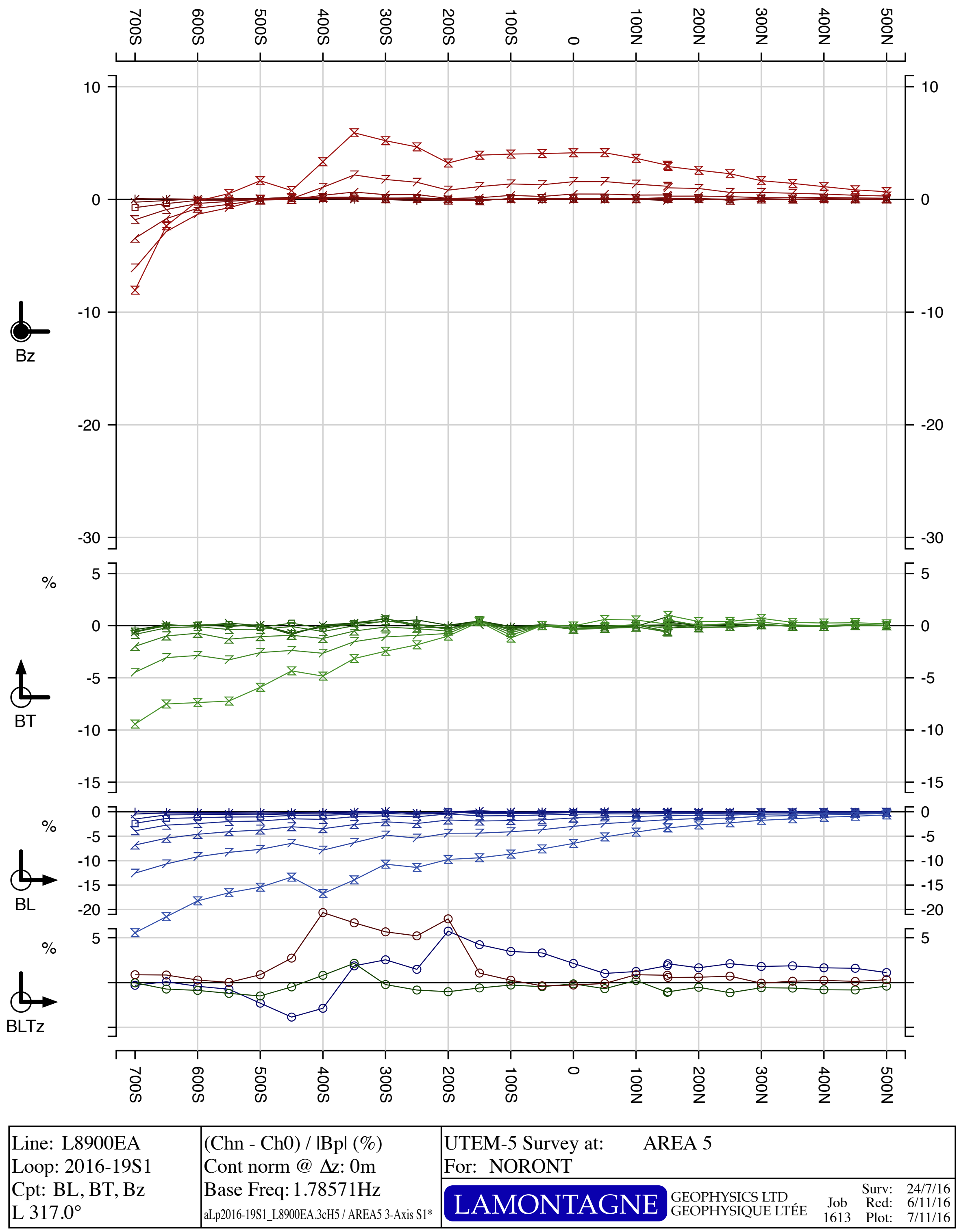
## Loop 2016-19/18 - late Chs8-Ch0 - $B_{LTZ}$



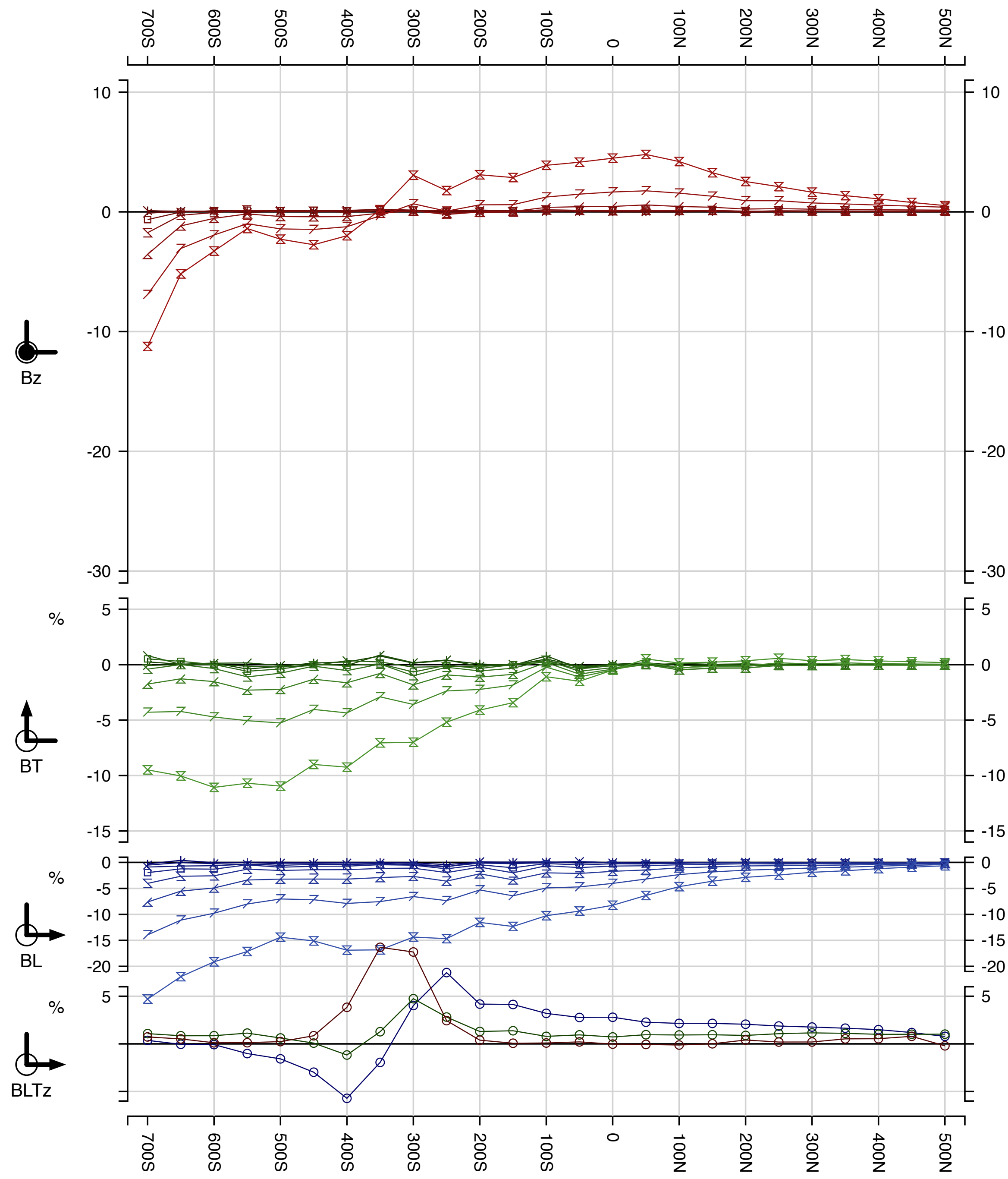

| | | |
|---|---|---|
| Line: L8800EA<br>Loop: 2016-19S1<br>Cpt: BL, BT, Bz<br>L 317.0° | (Chn - Ch0) / \|Bp\| (%)<br>Cont norm @ Δz: 0m<br>Base Freq: 1.78571Hz<br>aLp2016-19S1_L8800EA.3cH5 / AREA5 3-Axis S1* | UTEM-5 Survey at: AREA 5<br>For: NORONT<br>LAMONTAGNE GEOPHYSICS LTD GEOPHYSIQUE LTÉE Job 1613 Surv: 24/7/16 Red: 6/11/16 Plot: 7/11/16 |

# Loop 2016-19 - late Chs8-Ch0 - $B_{LTZ}$

pg 28



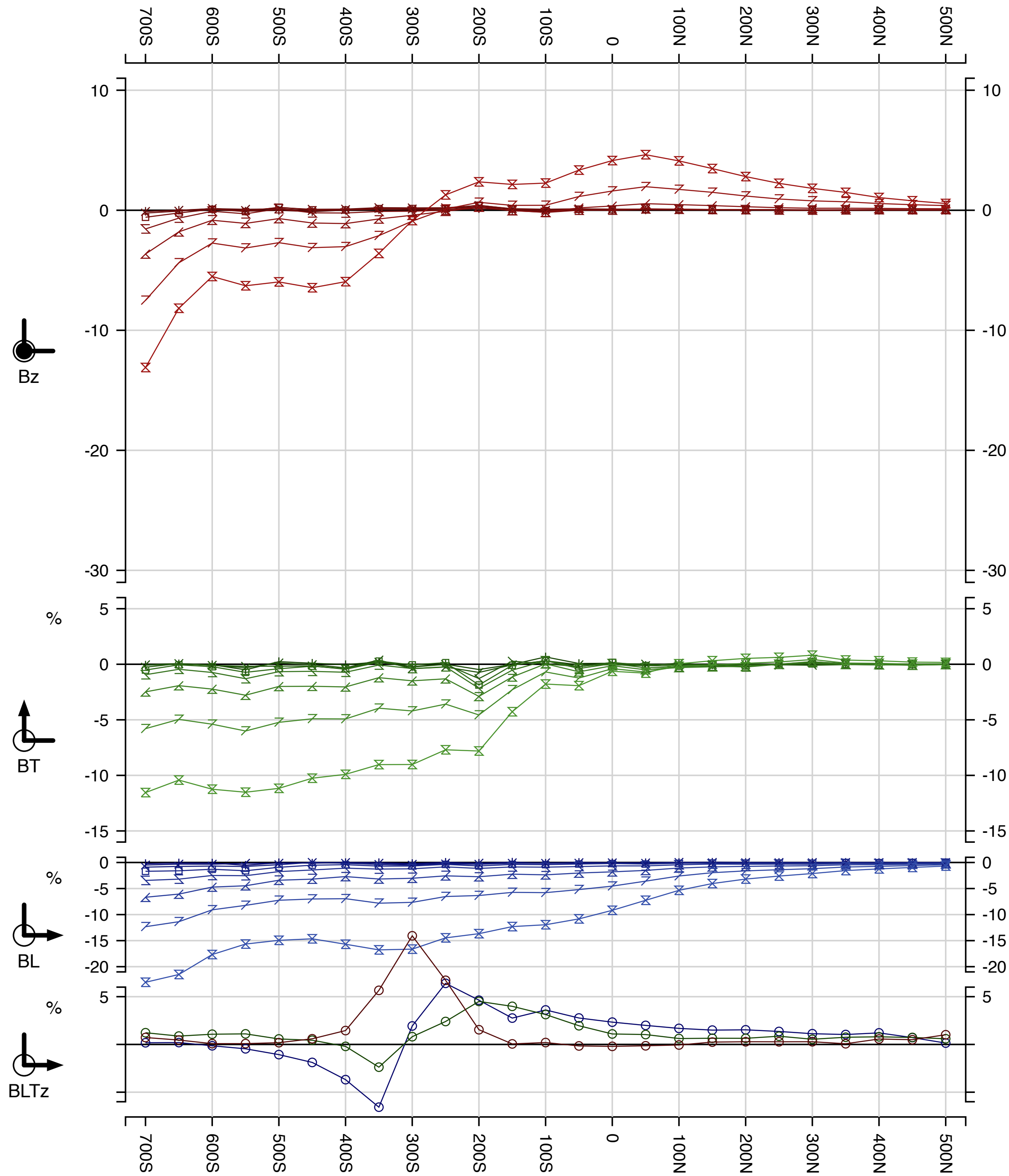

# Loop 2016-19 - late Chs8-Ch0 - $B_{LTZ}$




| | | |
|---|---|---|
| Line: L9000EA<br>Loop: 2016-19S1<br>Cpt: BL, BT, Bz<br>L 317.0° | (Chn - Ch0) / \|Bp\| (%)<br>Cont norm @ Δz: 0m<br>Base Freq: 1.78571Hz<br>aLp2016-19S1_L9000EA.3cH5 / AREA5 3-Axis S1* | UTEM-5 Survey at: AREA 5<br>For: NORONT<br>LAMONTAGNE GEOPHYSICS LTD GEOPHYSIQUE LTÉE Job 1613 Surv: 24/7/16 Red: 6/11/16 Plot: 7/11/16 |

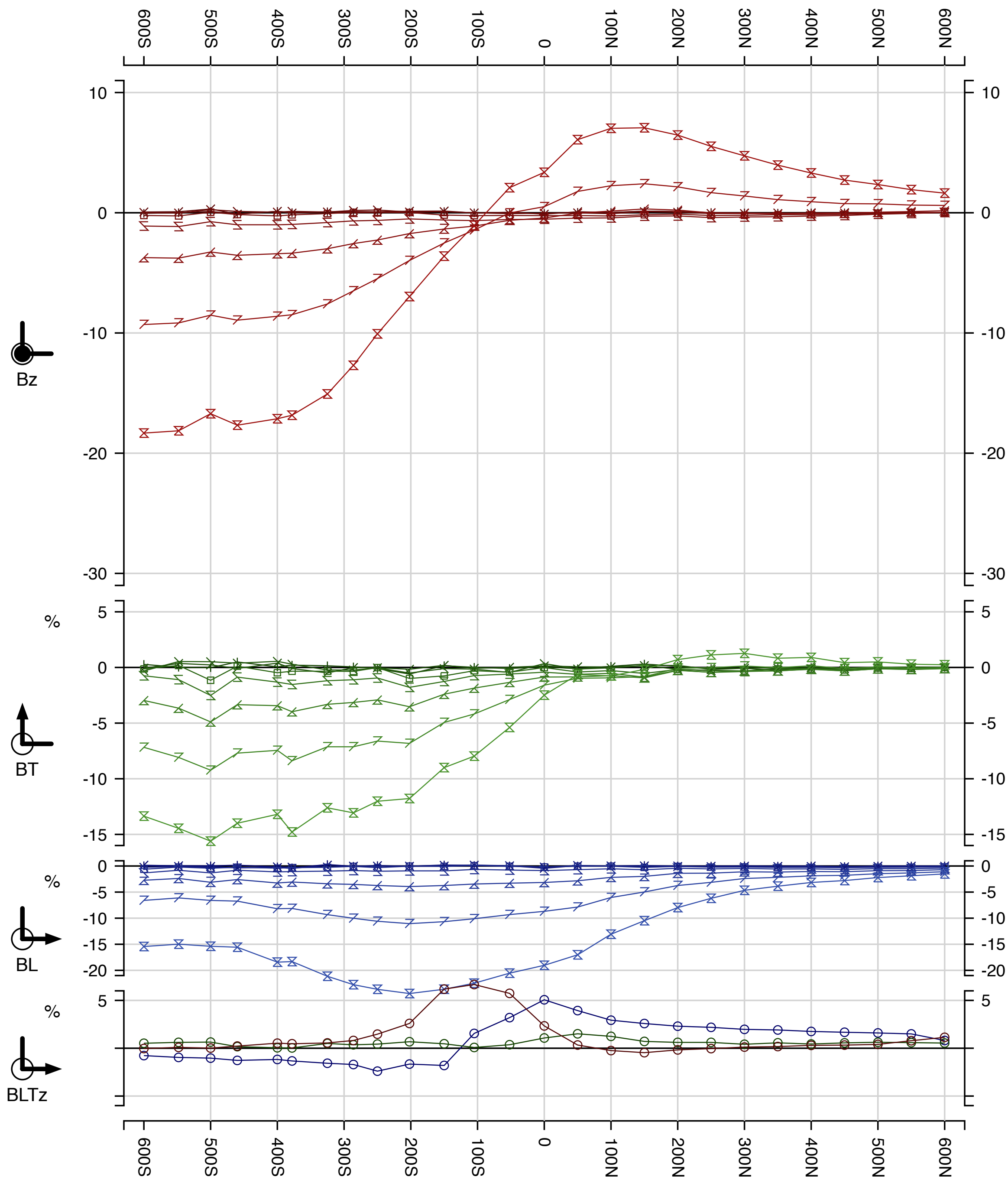
# Loop 2016-19 - late Chs8-Ch0 - $B_{LTZ}$

pg 30




| Line: L9100EA<br>Loop: 2016-19S1<br>Cpt: BL, BT, Bz<br>L 317.0° | (Chn - Ch0) / \|Bp\| (%)<br>Cont norm @ Δz: 0m<br>Base Freq: 1.78571Hz<br>aLp2016-19S1_L9100EA.3cH5 / AREA5 3-Axis S1* | UTEM-5 Survey at: AREA 5<br>For: NORONT<br>LAMONTAGNE GEOPHYSICS LTD GEOPHYSIQUE LTÉE<br>Job 1613 Surv: 24/7/16 Red: 6/11/16 Plot: 7/11/16 |
|---|---|---|

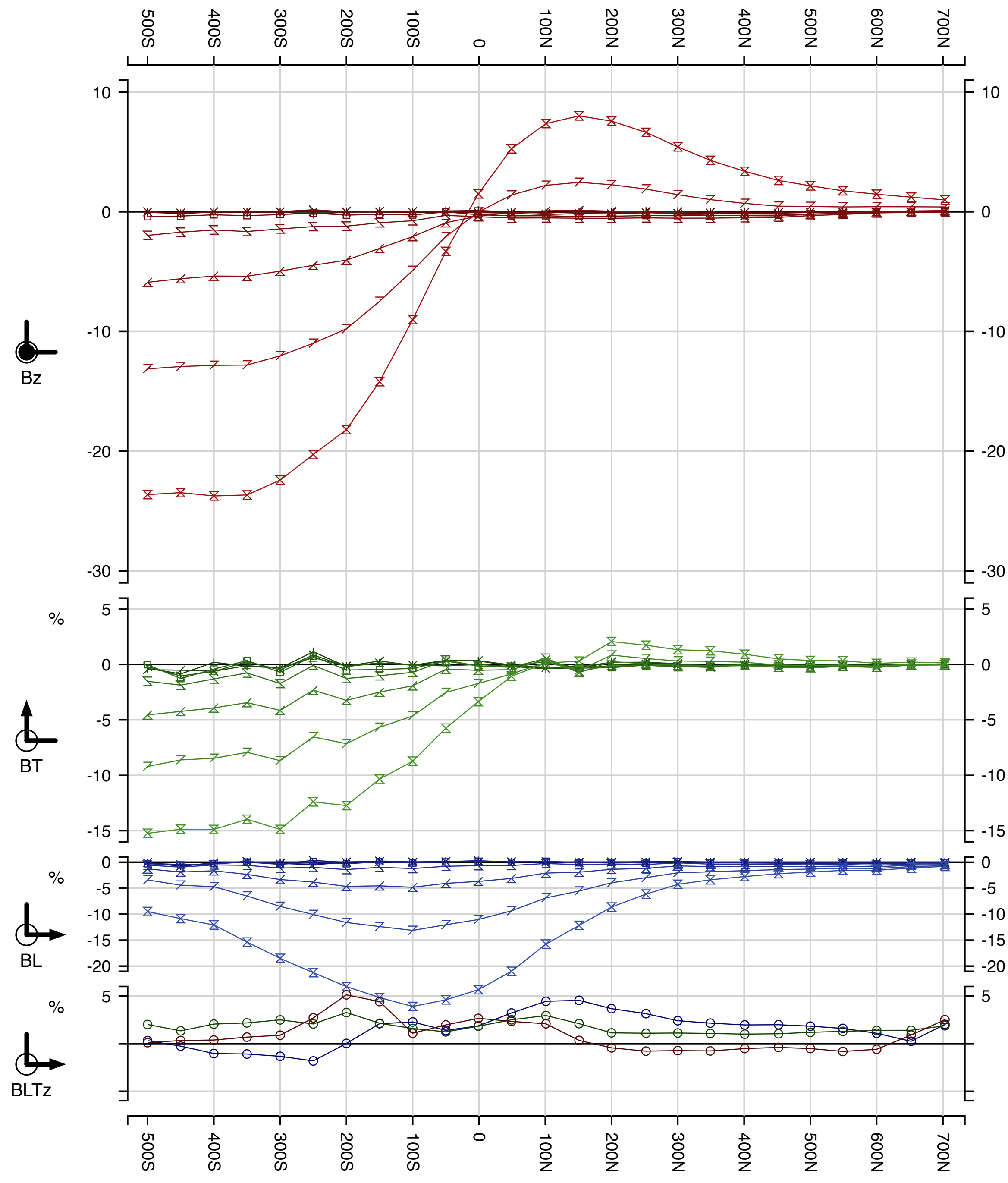
# Loop 2016-19 - late Chs8-Ch0 - $B_{LTZ}$




| | | |
|---|---|---|
| Line: L9300EA<br>Loop: 2016-18S1<br>Cpt: BL, BT, Bz<br>L 317.0° | (Chn - Ch0) / \|Bp\| (%)<br>Cont norm @ Δz: 0m<br>Base Freq: 1.78571Hz<br>aLp2016-18S1_L9300EA.3cH5 / AREA5 3-Axis S1* | UTEM-5 Survey at: AREA 5<br>For: NORONT<br>LAMONTAGNE GEOPHYSICS LTD GEOPHYSIQUE LTÉE<br>Job 1613 Surv: 21/7/16 Red: 6/11/16 Plot: 7/11/16 |

# Loop 2016-18 - late Chs8-Ch0 - $B_{LTZ}$

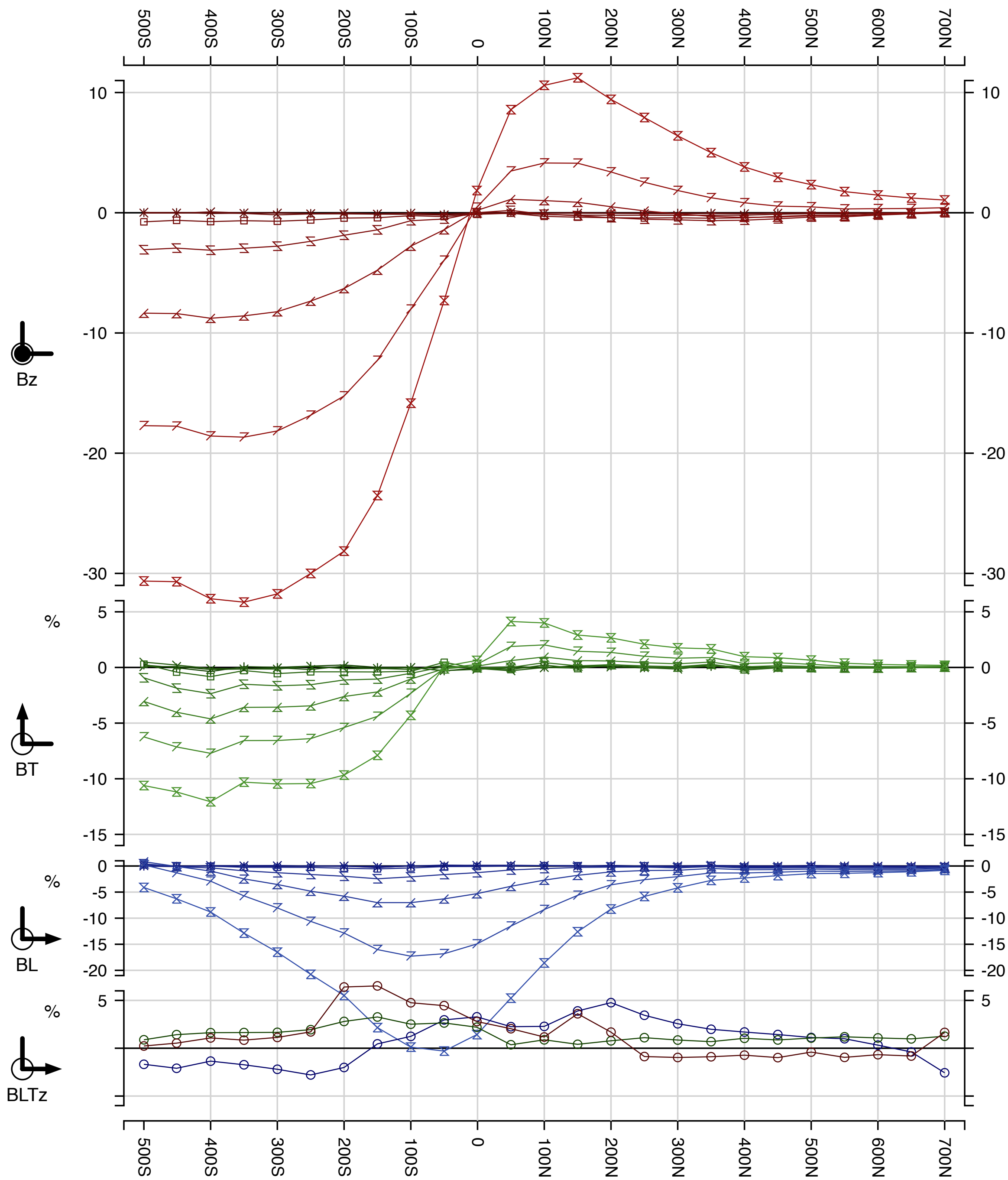
pg 32




| | | |
|---|---|---|
| Line: L9500EA<br>Loop: 2016-18S1<br>Cpt: BL, BT, Bz<br>L 317.0° | (Chn - Ch0) / \|Bp\| (%)<br>Cont norm @ Δz: 0m<br>Base Freq: 1.78571Hz<br>aLp2016-18S1_L9500EA.3cH5 / AREA5 3-Axis S1* | UTEM-5 Survey at: AREA 5<br>For: NORONT<br>LAMONTAGNE GEOPHYSICS LTD GEOPHYSIQUE LTÉE<br>Job 1613 Surv: 22/7/16 Red: 6/11/16 Plot: 7/11/16 |

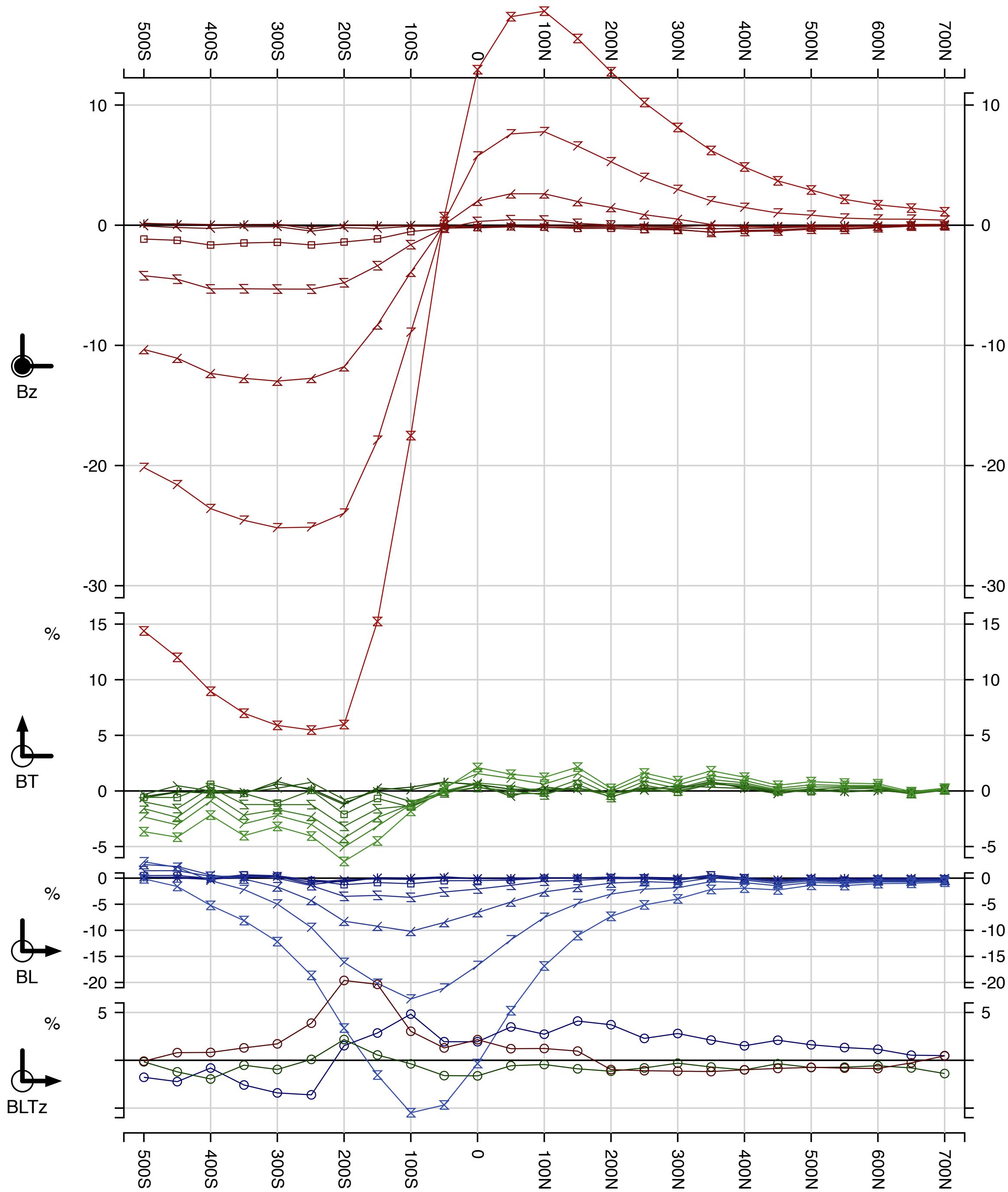
# Loop 2016-18 - late Chs8-Ch0 - $B_{LTZ}$

pg 33




| Line: L9700EA<br>Loop: 2016-18S1<br>Cpt: BL, BT, Bz<br>L 317.0° | (Chn - Ch0) / \|Bp\| (%)<br>Cont norm @ Δz: 0m<br>Base Freq: 1.78571Hz<br>aLp2016-18S1_L9700EA.3cH5 / AREA5 3-Axis S1* | UTEM-5 Survey at: AREA 5<br>For: NORONT<br>LAMONTAGNE GEOPHYSICS LTD GEOPHYSIQUE LTÉE<br>Job 1613 Surv: 23/7/16 Red: 6/11/16 Plot: 7/11/16 |
|---|---|---|

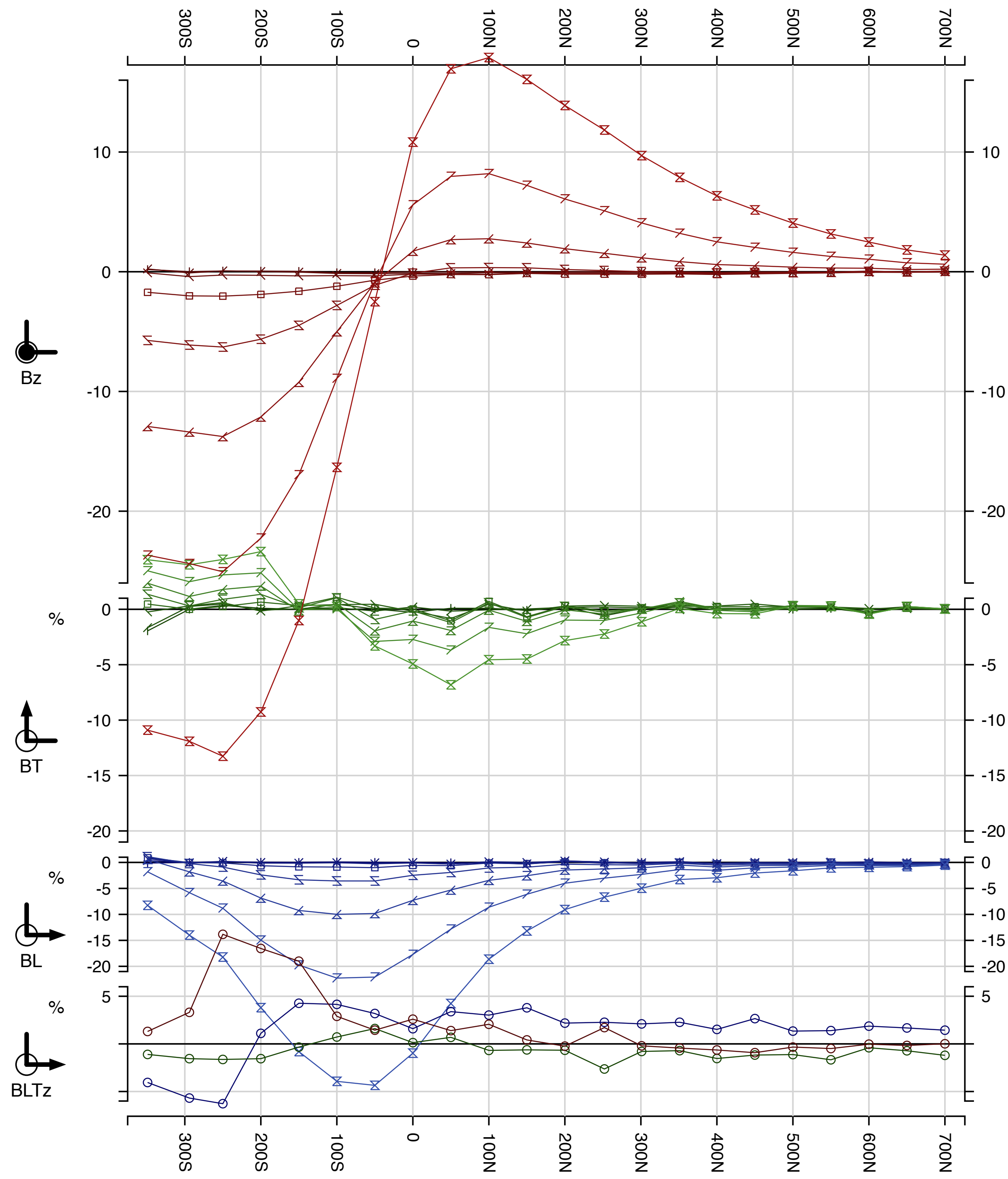
# Loop 2016-18 - late Chs8-Ch0 - $B_{LTZ}$




| | | |
|---|---|---|
| Line: L9900EA<br>Loop: 2016-18S1<br>Cpt: BL, BT, Bz<br>L 317.0° | (Chn - Ch0) / \|Bp\| (%)<br>Cont norm @ Δz: 0m<br>Base Freq: 1.78571Hz<br>aLp2016-18S1_L9900EA.3cH5 / AREA5 3-Axis S1* | UTEM-5 Survey at: AREA 5<br>For: NORONT<br>LAMONTAGNE GEOPHYSICS LTD GEOPHYSIQUE LTÉE Job 1613 Surv: 21/7/16 Red: 7/11/16 Plot: 7/11/16 |

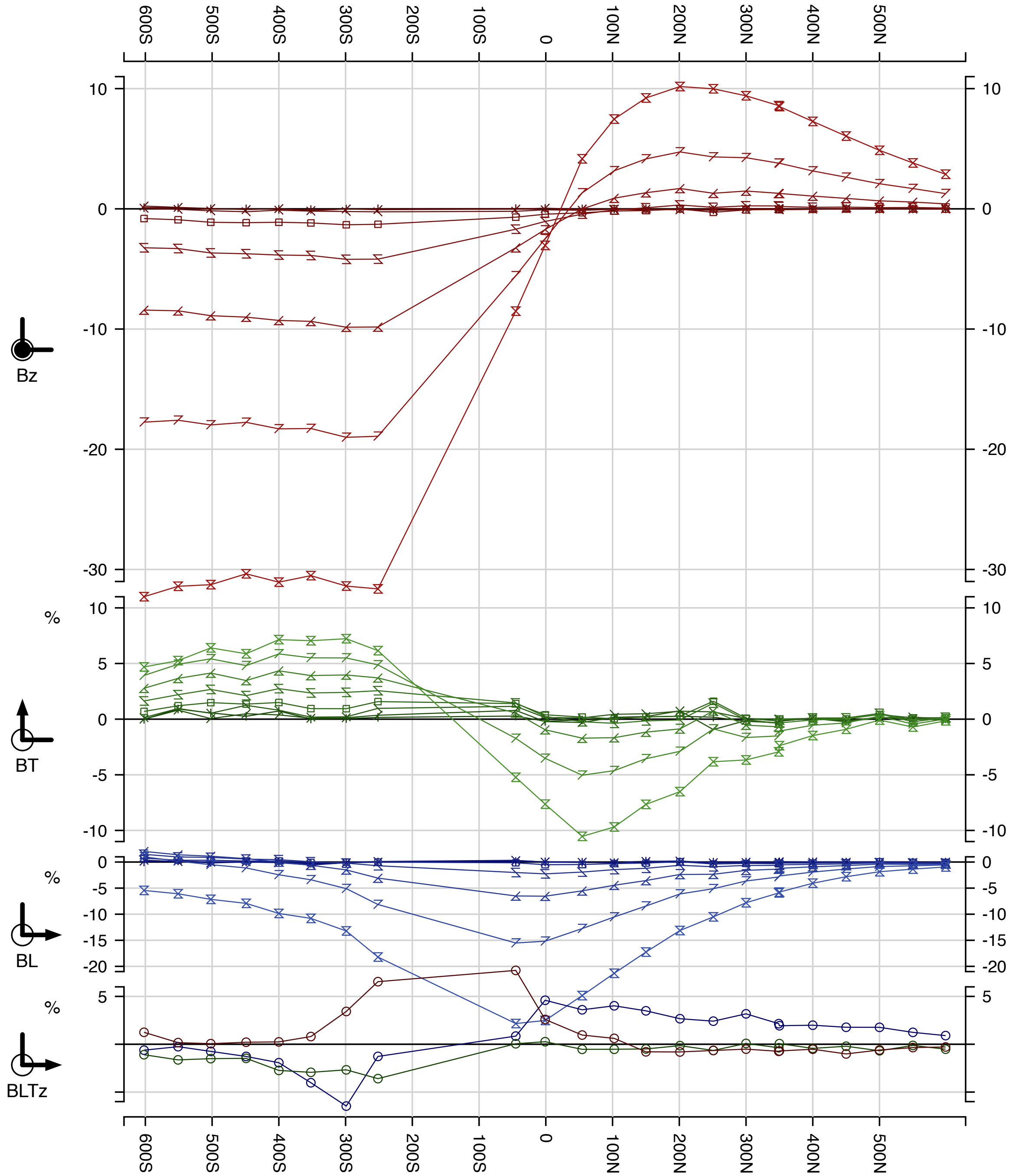
# Loop 2016-18 - late Chs8-Ch0 - $B_{LTZ}$

pg 35




| | | |
|---|---|---|
| Line: L10100EA<br>Loop: 2016-18S1<br>Cpt: BL, BT, Bz<br>L 317.0° | (Chn - Ch0) / \|Bp\| (%)<br>Cont norm @ Δz: 0m<br>Base Freq: 1.78571Hz<br>aLp2016-18S1_L10100EA.3cH5 / AREA5 3-Axis S1* | UTEM-5 Survey at: AREA 5<br>For: NORONT<br>LAMONTAGNE GEOPHYSICS LTD GEOPHYSIQUE LTÉE<br>Job 1613<br>Surv: 22/7/16<br>Red: 7/11/16<br>Plot: 7/11/16 |

# Loop 2016-18 - late Chs8-Ch0 - $B_{LTZ}$




| | | |
|---|---|---|
| Line: L10300EA<br>Loop: 2016-18S1<br>Cpt: BL, BT, Bz<br>L 317.0° | (Chn - Ch0) / \|Bp\| (%)<br>Cont norm @ Δz: 0m<br>Base Freq: 1.78571Hz<br>aLp2016-18S1_L10300EA.3cH5 / AREA5 3-Axis S1* | UTEM-5 Survey at: AREA 5<br>For: NORONT<br>LAMONTAGNE GEOPHYSICS LTD GEOPHYSIQUE LTÉE Job 1613 Surv: 23/7/16 Red: 7/11/16 Plot: 7/11/16 |

# Loop 2016-18 - late Chs8-Ch0 - $B_{LTZ}$

pg 37

# Area 5 Grid

# Loop 2016-17

## BL/BT/Bz

~0.7143Hz frequency

continuous norm

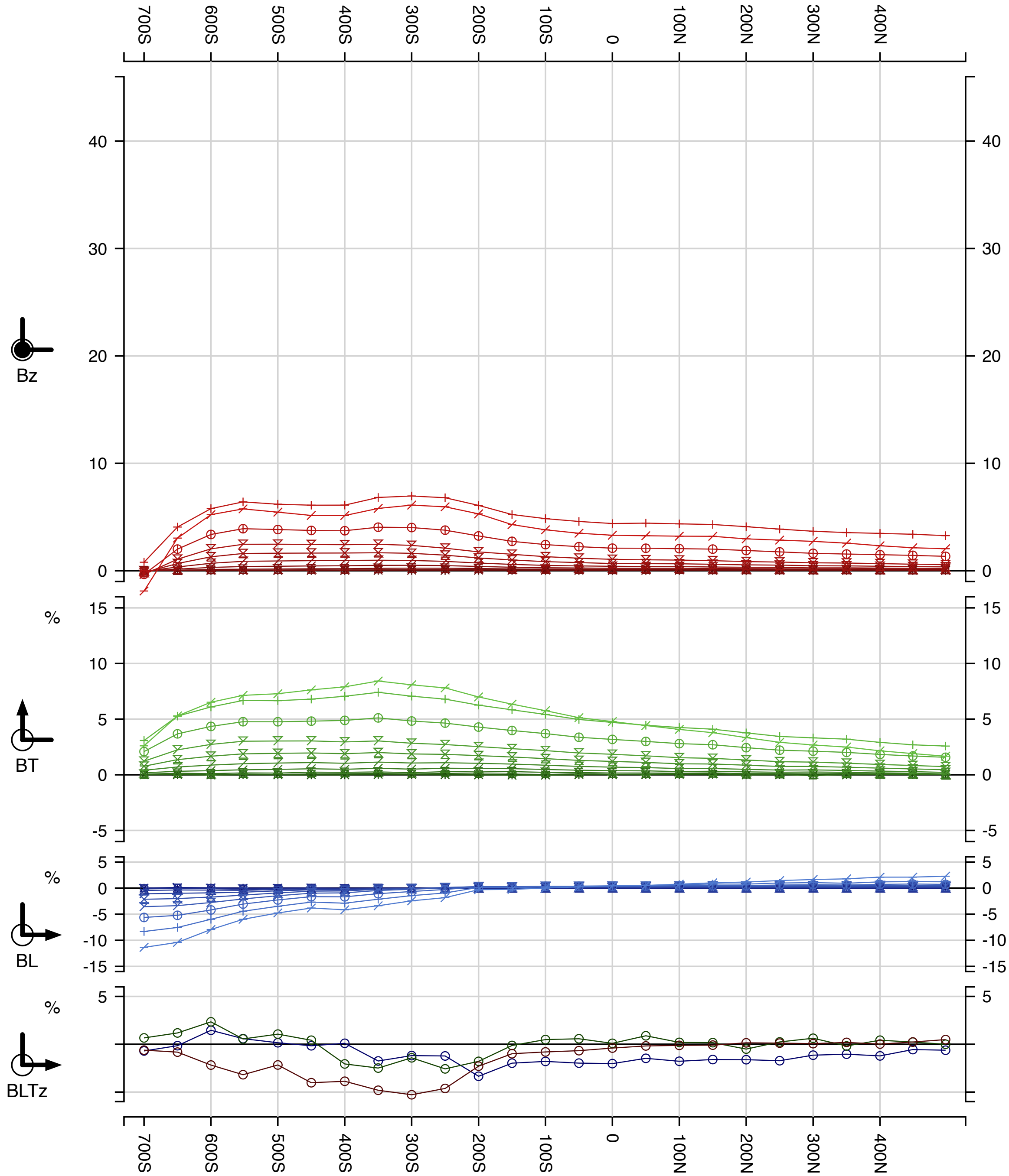
12Ch - Ch0 reduced

## all Chs plotted

Loop 2016-17 (@ **0.7142857Hz**) in-loop

| | | | |
|---|---|---|---|
| Line 8800E | 700S - 500N | 1200m | BL/BT/Bz |
| Line 8900E | 700S - 500N | 1200m | BL/BT/Bz |
| Line 9000E | 700S - 500N | 1200m | BL/BT/Bz |
| Line 9100E | 700S - 500N | 1200m | BL/BT/Bz |
| Line 9300E | 600S - 600N | 1200m | BL/BT/Bz |
| Line 9500E | 500S - 700N | 1200m | BL/BT/Bz |
| Line 9700E | 500S - 700N | 1200m | BL/BT/Bz |
| Line 9900E | 500S - 700N | 1200m | BL/BT/Bz |
| Line 10100E | 350S - 700N | 1050m | BL/BT/Bz |
| Line 10300E | 600S - 250S | | |
| | 50S - 600N | 1000m | BL/BT/Bz |

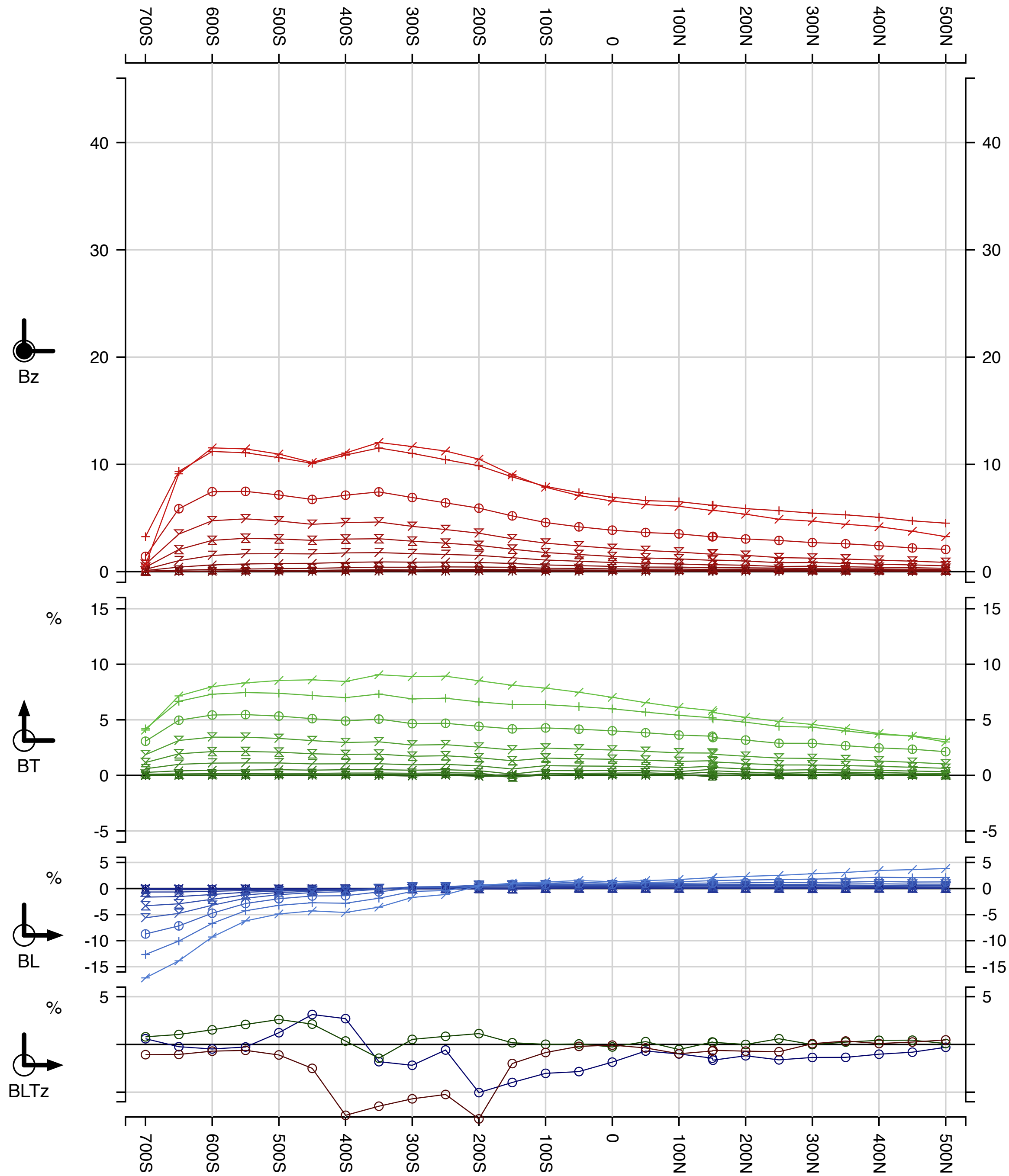
**Loop 2016-17 - all Chs - $B_{LTZ}$** pg 38




| | | |
|---|---|---|
| Line: L8800EB<br>Loop: 2016-17S2<br>Cpt: BL, BT, Bz<br>L 317.0° | (Chn - Ch0) / \|Bp\| (%)<br>Cont norm @ Δz: 0m<br>Base Freq: 0.71429Hz<br>aLp2016-17S2_L8800EB.3cH5 / AREA5 3-Axis S2* | UTEM-5 Survey at: AREA 5<br>For: NORONT<br>LAMONTAGNE GEOPHYSICS LTD GEOPHYSIQUE LTÉE<br>Job 1613 Surv: 24/7/16 Red: 6/11/16 Plot: 6/11/16 |

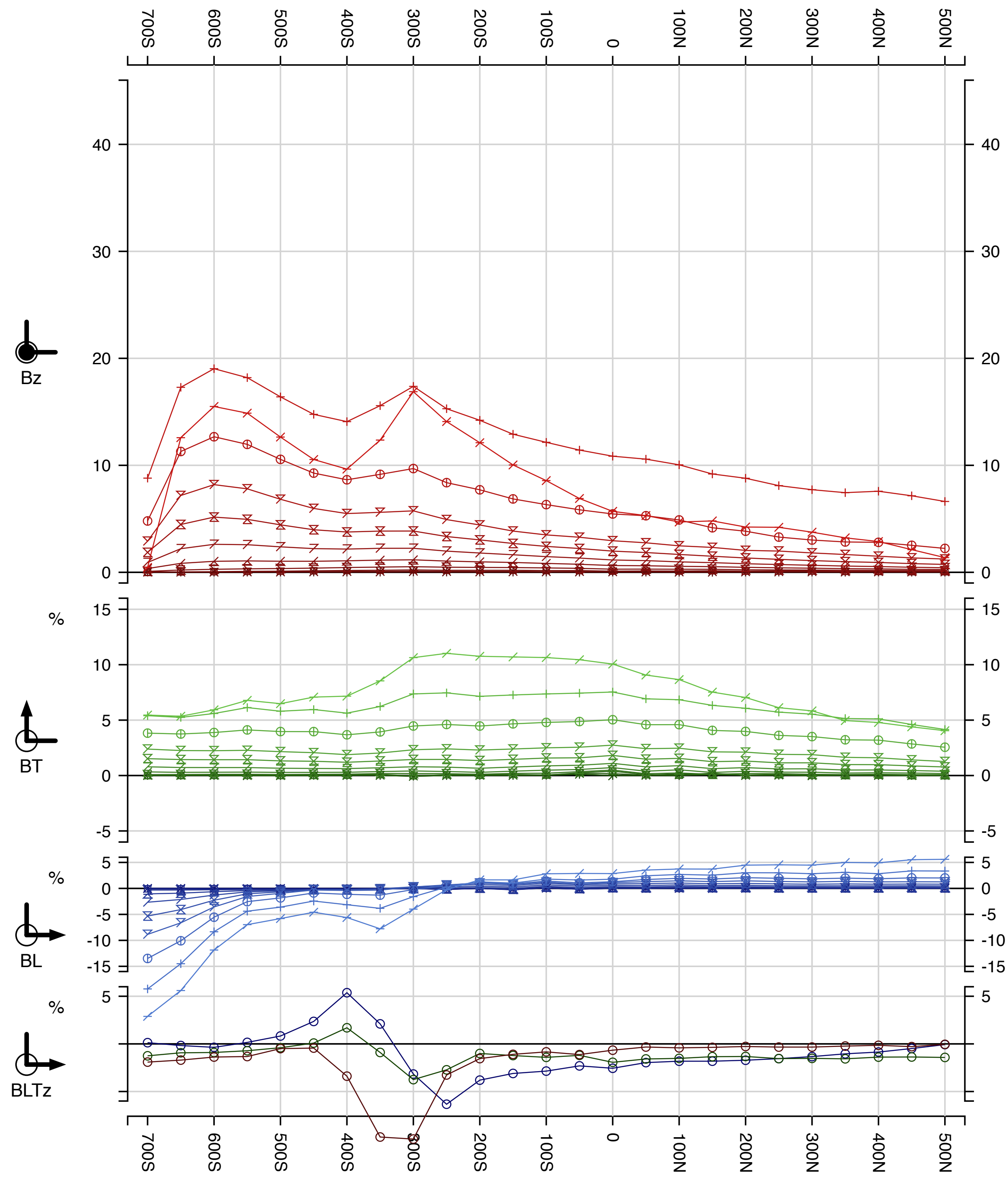
# Loop 2016-17 - all Chs - $B_{LTZ}$

pg 39



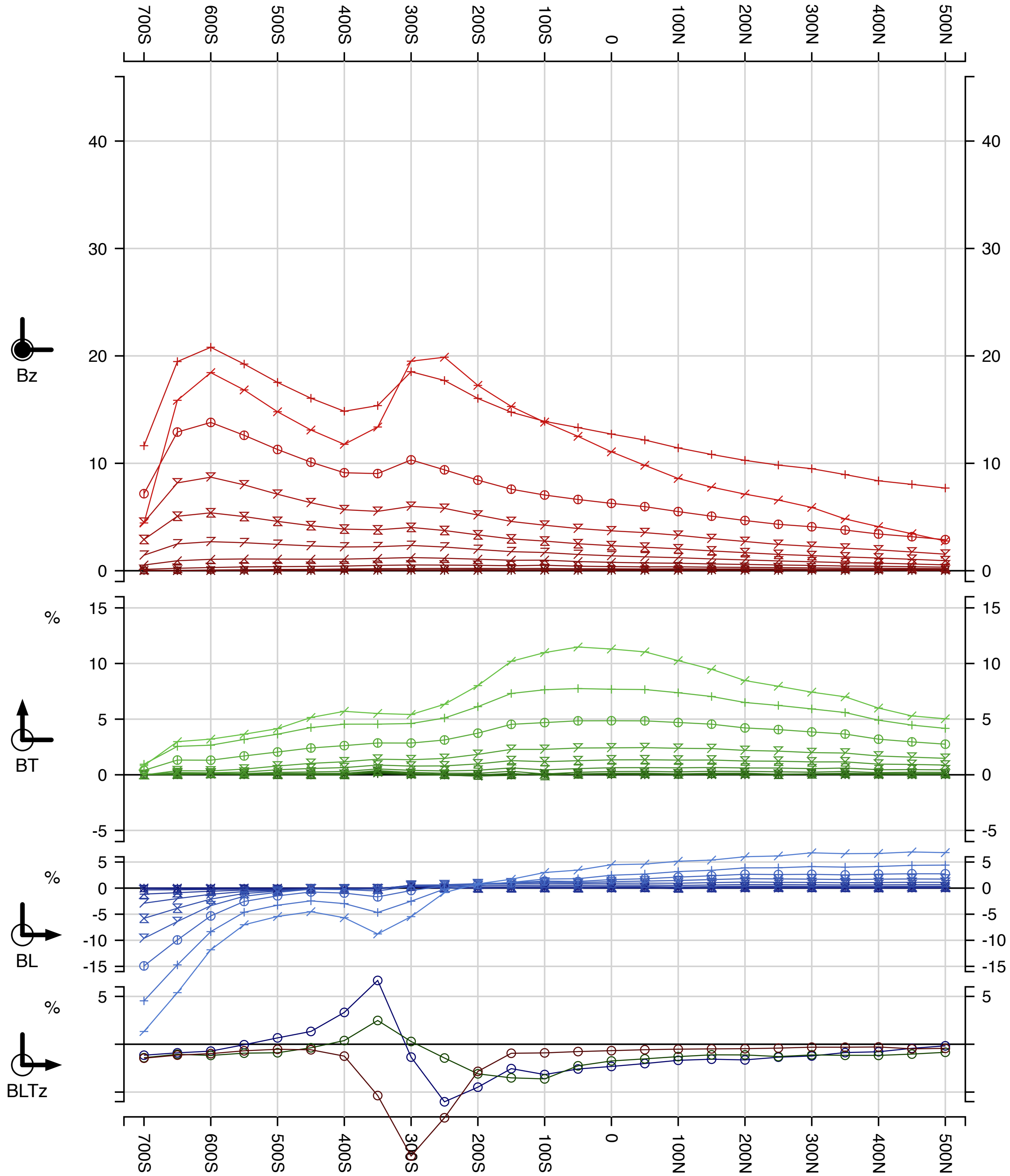

| | | |
|---|---|---|
| Line: L8900EB<br>Loop: 2016-17S2<br>Cpt: BL, BT, Bz<br>L 317.0° | (Chn - Ch0) / \|Bp\| (%)<br>Cont norm @ Δz: 0m<br>Base Freq: 0.71429Hz<br>aLp2016-17S2_L8900EB.3cH5 / AREA5 3-Axis S2* | UTEM-5 Survey at: AREA 5<br>For: NORONT<br>LAMONTAGNE GEOPHYSICS LTD GEOPHYSIQUE LTÉE<br>Job 1613<br>Surv: 24/7/16<br>Red: 6/11/16<br>Plot: 6/11/16 |

# Loop 2016-17 - all Chs - $B_{LTZ}$




| | | |
|---|---|---|
| Line: L9000EB<br>Loop: 2016-17S2<br>Cpt: BL, BT, Bz<br>L 317.0° | (Chn - Ch0) / \|Bp\| (%)<br>Cont norm @ Δz: 0m<br>Base Freq: 0.71429Hz<br>aLp2016-17S2_L9000EB.3cH5 / AREA5 3-Axis S2* | UTEM-5 Survey at: AREA 5<br>For: NORONT<br>LAMONTAGNE GEOPHYSICS LTD GEOPHYSIQUE LTÉE Job 1613 Surv: 24/7/16 Red: 6/11/16 Plot: 6/11/16 |

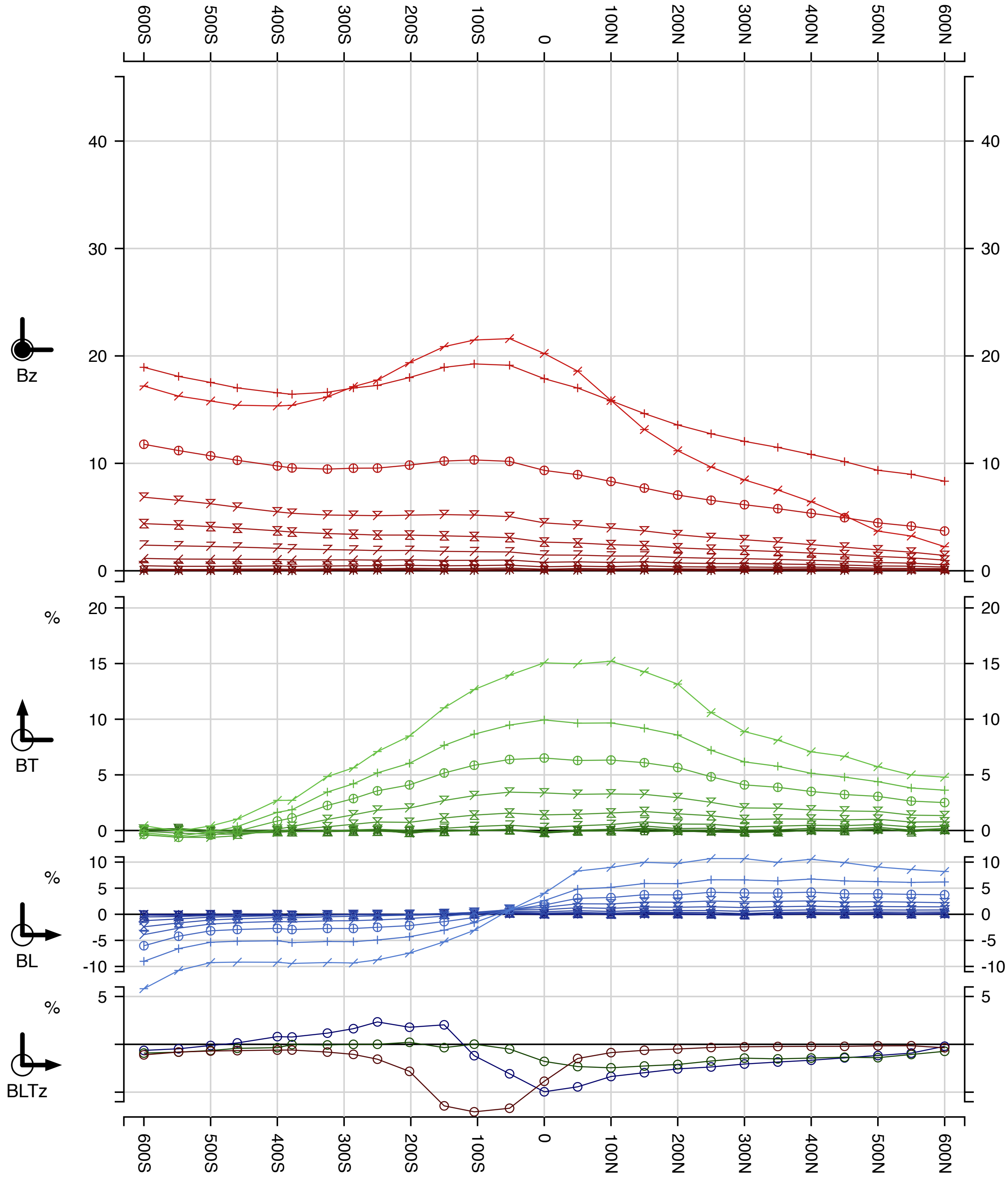
# Loop 2016-17 - all Chs - $B_{LTZ}$




| Line: L9100EB<br>Loop: 2016-17S2<br>Cpt: BL, BT, Bz<br>L 317.0° | (Chn - Ch0) / \|Bp\| (%)<br>Cont norm @ Δz: 0m<br>Base Freq: 0.71429Hz<br>aLp2016-17S2_L9100EB.3cH5 / AREA5 3-Axis S2* | UTEM-5 Survey at: AREA 5<br>For: NORONT<br>LAMONTAGNE GEOPHYSICS LTD GEOPHYSIQUE LTÉE<br>Job 1613<br>Surv: 24/7/16<br>Red: 6/11/16<br>Plot: 6/11/16 |
|---|---|---|

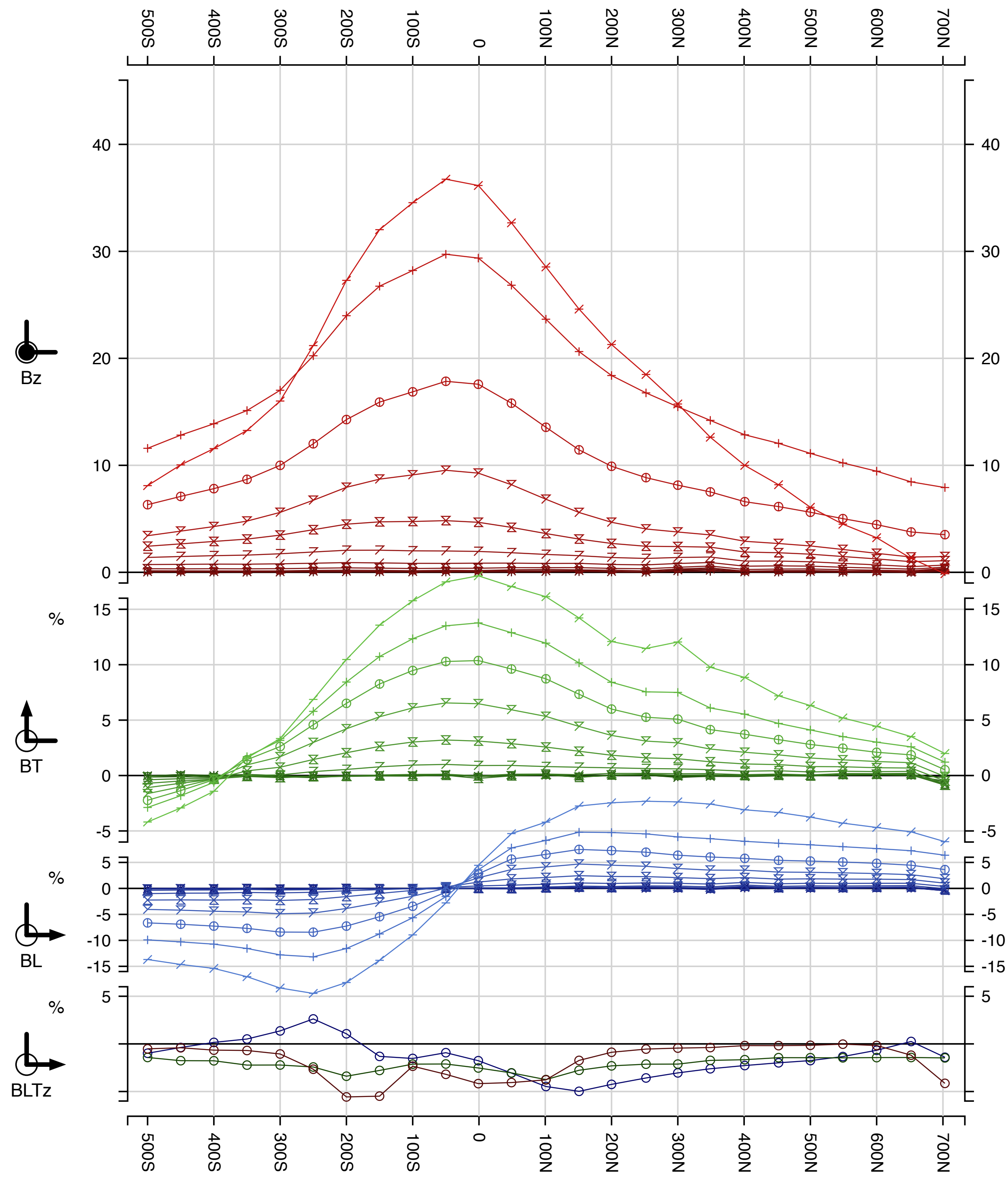
# Loop 2016-17 - all Chs - $B_{LTZ}$

pg 42




| | | |
|---|---|---|
| Line: L9300EB<br>Loop: 2016-17S2<br>Cpt: BL, BT, Bz<br>L 317.0° | (Chn - Ch0) / \|Bp\| (%)<br>Cont norm @ Δz: 0m<br>Base Freq: 0.71429Hz<br>aLp2016-17S2_L9300EB.3cH5 / AREA5 3-Axis S2* | UTEM-5 Survey at: AREA 5<br>For: NORONT<br>LAMONTAGNE GEOPHYSICS LTD GEOPHYSIQUE LTÉE<br>Job 1613<br>Surv: 21/7/16 Red: 6/11/16 Plot: 6/11/16 |

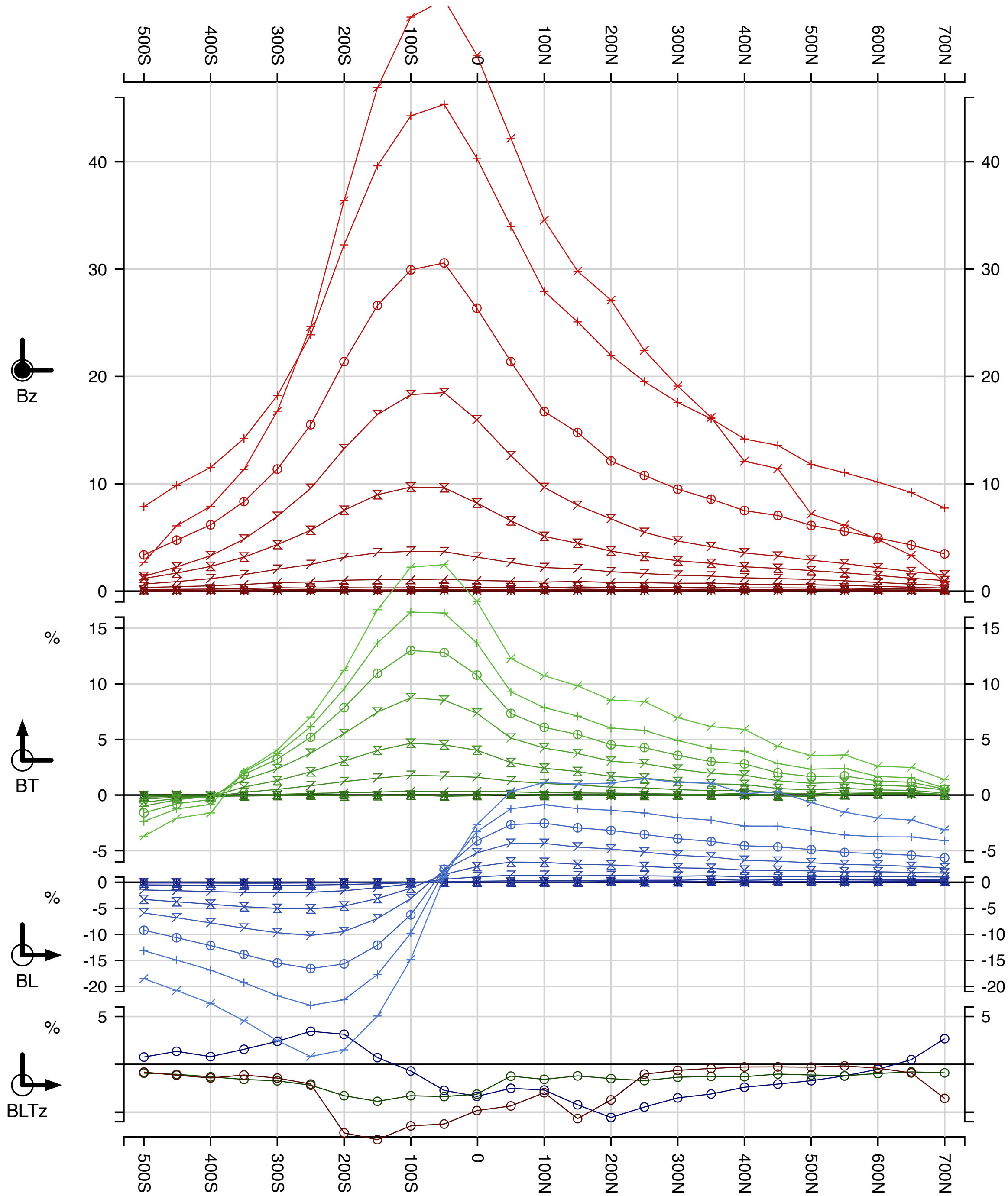
# Loop 2016-17 - all Chs - $B_{LTZ}$




| | | |
|---|---|---|
| Line: L9500EB<br>Loop: 2016-17S2<br>Cpt: BL, BT, Bz<br>L 317.0° | (Chn - Ch0) / \|Bp\| (%)<br>Cont norm @ Δz: 0m<br>Base Freq: 0.71429Hz<br>aLp2016-17S2_L9500EB.3cH5 / AREA5 3-Axis S2* | UTEM-5 Survey at: AREA 5<br>For: NORONT<br>LAMONTAGNE GEOPHYSICS LTD GEOPHYSIQUE LTÉE<br>Job 1613<br>Surv: 22/7/16<br>Red: 6/11/16<br>Plot: 6/11/16 |

# Loop 2016-17 - all Chs - $B_{LTZ}$

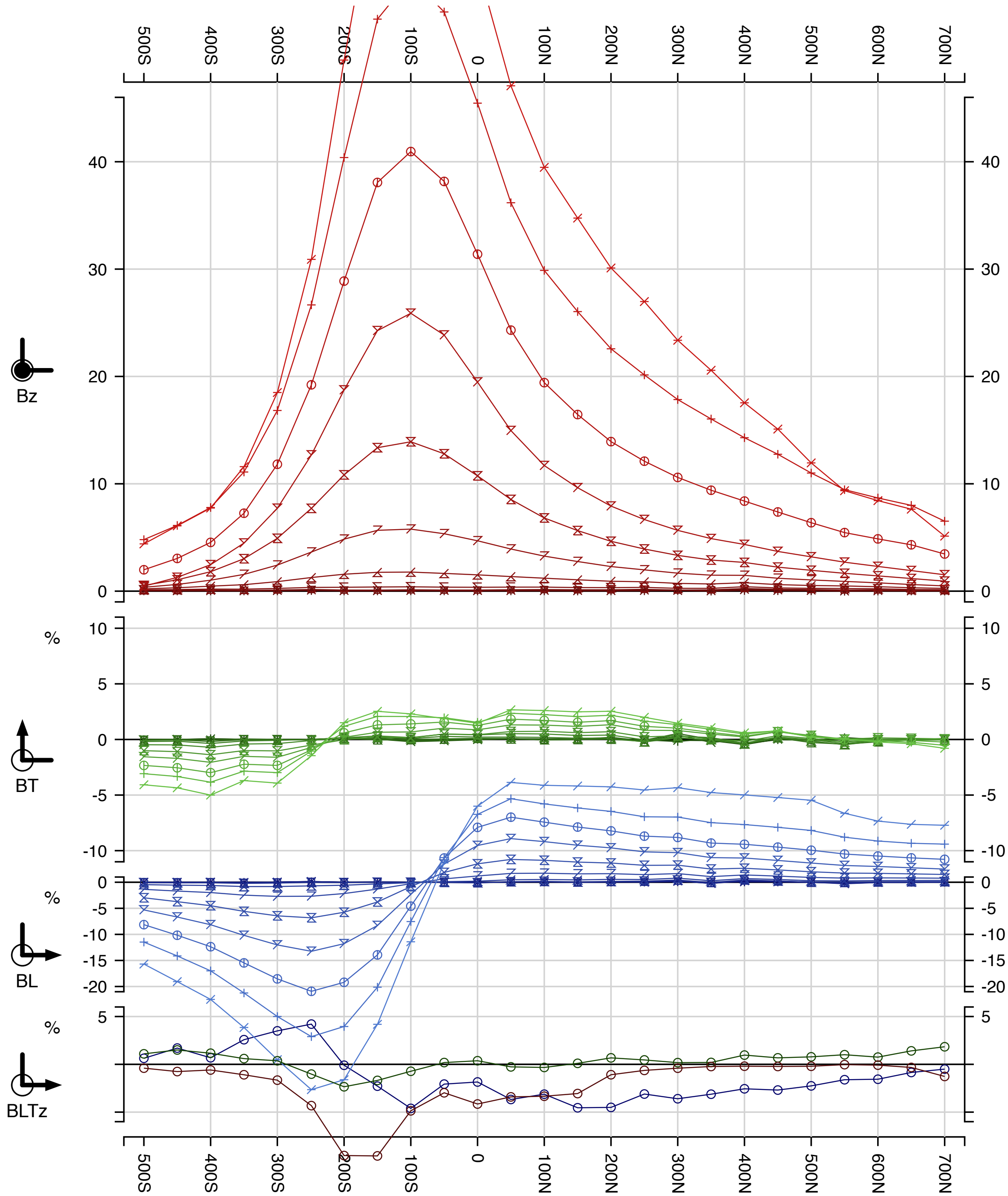
pg 44




| Line: L9700EB<br>Loop: 2016-17S2<br>Cpt: BL, BT, Bz<br>L 317.0° | (Chn - Ch0) / lBpl (%)<br>Cont norm @ Δz: 0m<br>Base Freq: 0.71429Hz<br>aLp2016-17S2_L9700EB.3cH5 / AREA5 3-Axis S2* | UTEM-5 Survey at: AREA 5<br>For: NORONT<br>LAMONTAGNE GEOPHYSICS LTD GEOPHYSIQUE LTÉE<br>Job 1613<br>Surv: 23/7/16<br>Red: 6/11/16<br>Plot: 6/11/16 |
|---|---|---|

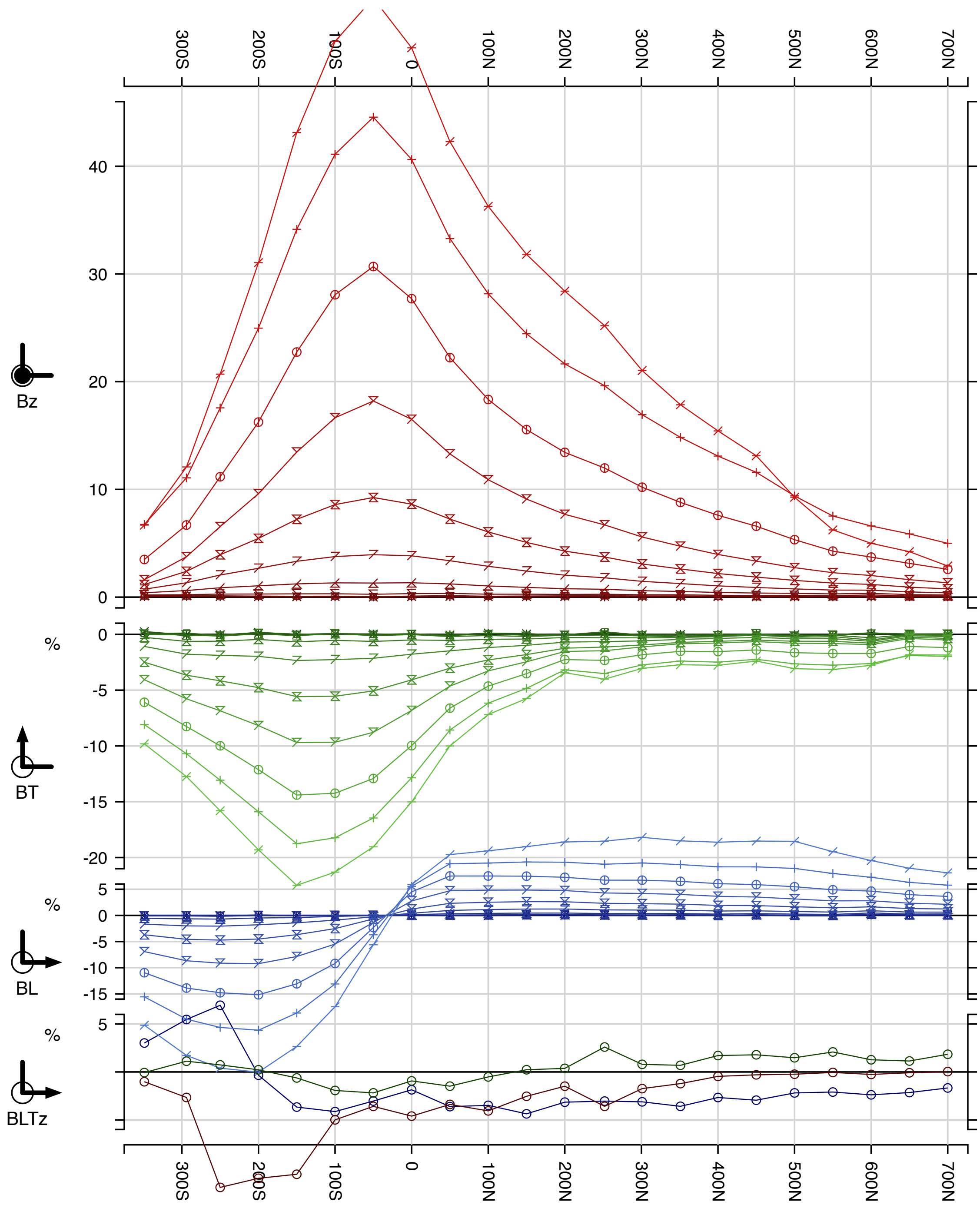
# Loop 2016-17 - all Chs - $B_{LTZ}$

pg 45



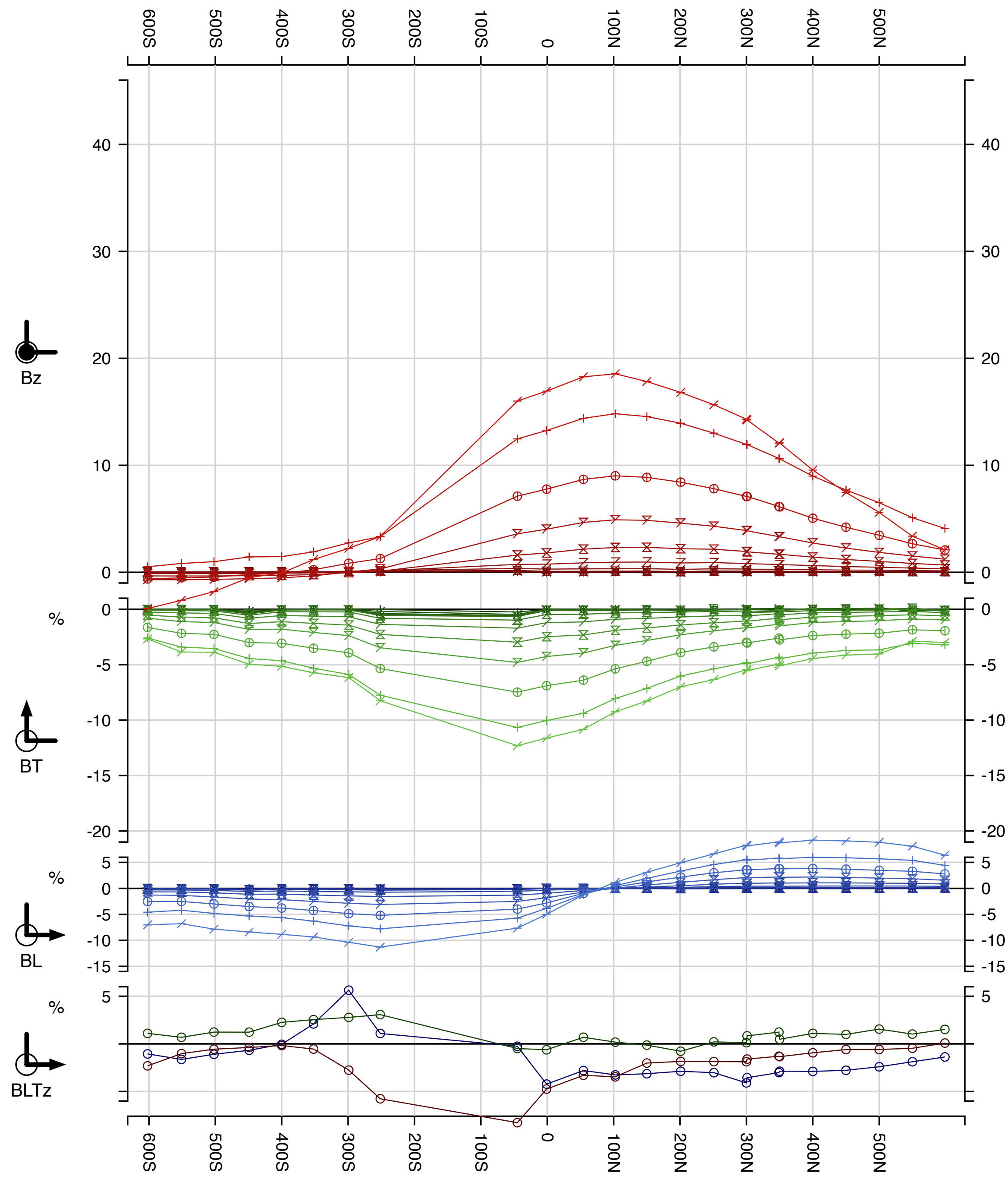

| | | |
|---|---|---|
| Line: L9900EB<br>Loop: 2016-17S2<br>Cpt: BL, BT, Bz<br>L 317.0° | (Chn - Ch0) / \|Bp\| (%)<br>Cont norm @ Δz: 0m<br>Base Freq: 0.71429Hz<br>aLp2016-17S2_L9900EB.3cH5 / AREA5 3-Axis S2* | UTEM-5 Survey at: AREA 5<br>For: NORONT<br>LAMONTAGNE GEOPHYSICS LTD GEOPHYSIQUE LTÉE<br>Job 1613 Surv: 21/7/16 Red: 6/11/16 Plot: 6/11/16 |

# Loop 2016-17 - all Chs - $B_{LTZ}$




| | | |
|---|---|---|
| Line: L10100EB<br>Loop: 2016-17S2<br>Cpt: BL, BT, Bz<br>L 317.0° | (Chn - Ch0) / \|Bp\| (%)<br>Cont norm @ Δz: 0m<br>Base Freq: 0.71429Hz<br>aLp2016-17S2_L10100EB.3cH5 / AREA5 3-Axis S2* | UTEM-5 Survey at: AREA 5<br>For: NORONT<br>LAMONTAGNE GEOPHYSICS LTD GEOPHYSIQUE LTÉE Job 1613 Surv: 22/7/16 Red: 6/11/16 Plot: 6/11/16 |

# Loop 2016-17 - all Chs - B$_{LTZ}$




| | | |
|---|---|---|
| Line: L10300EB<br>Loop: 2016-17S2<br>Cpt: BL, BT, Bz<br>L 317.0° | (Chn - Ch0) / \|Bp\| (%)<br>Cont norm @ Δz: 0m<br>Base Freq: 0.71429Hz<br>aLp2016-17S2_L10300EB.3cH5 / AREA5 3-Axis S2* | UTEM-5 Survey at: AREA 5<br>For: NORONT<br>LAMONTAGNE GEOPHYSICS LTD GEOPHYSIQUE LTÉE<br>Job 1613<br>Surv: 23/7/16<br>Red: 6/11/16<br>Plot: 6/11/16 |

# Loop 2016-17 - all Chs - $B_{LTZ}$

pg 48

# Area 5 Grid

# Loop 2016-17

## BL/BT/Bz

~0.7143Hz frequency

continuous norm

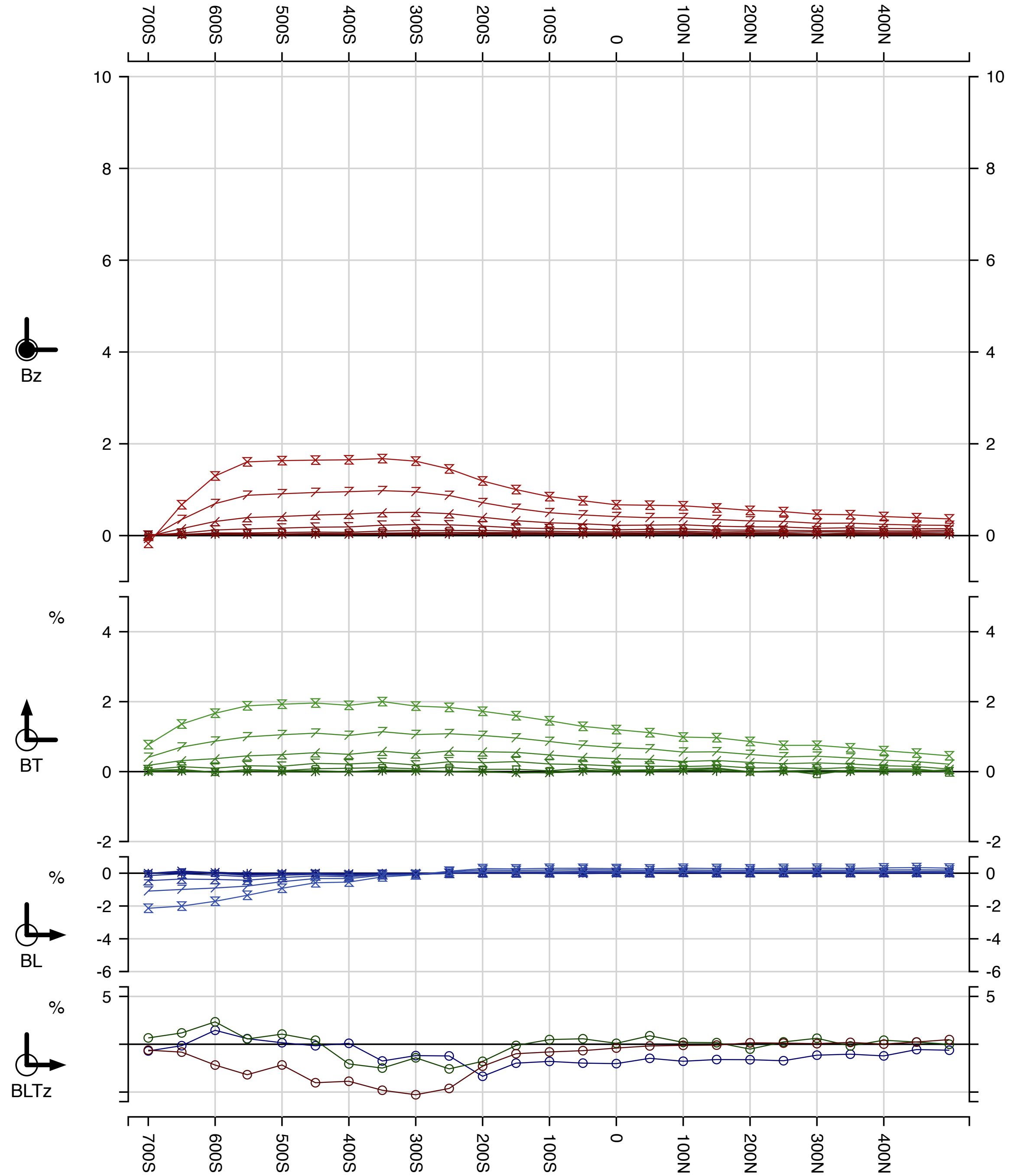
12Ch - Ch0 reduced

## late Chs8-Ch0 plotted

Loop 2016-17 (@ **0.7142857Hz**) in-loop

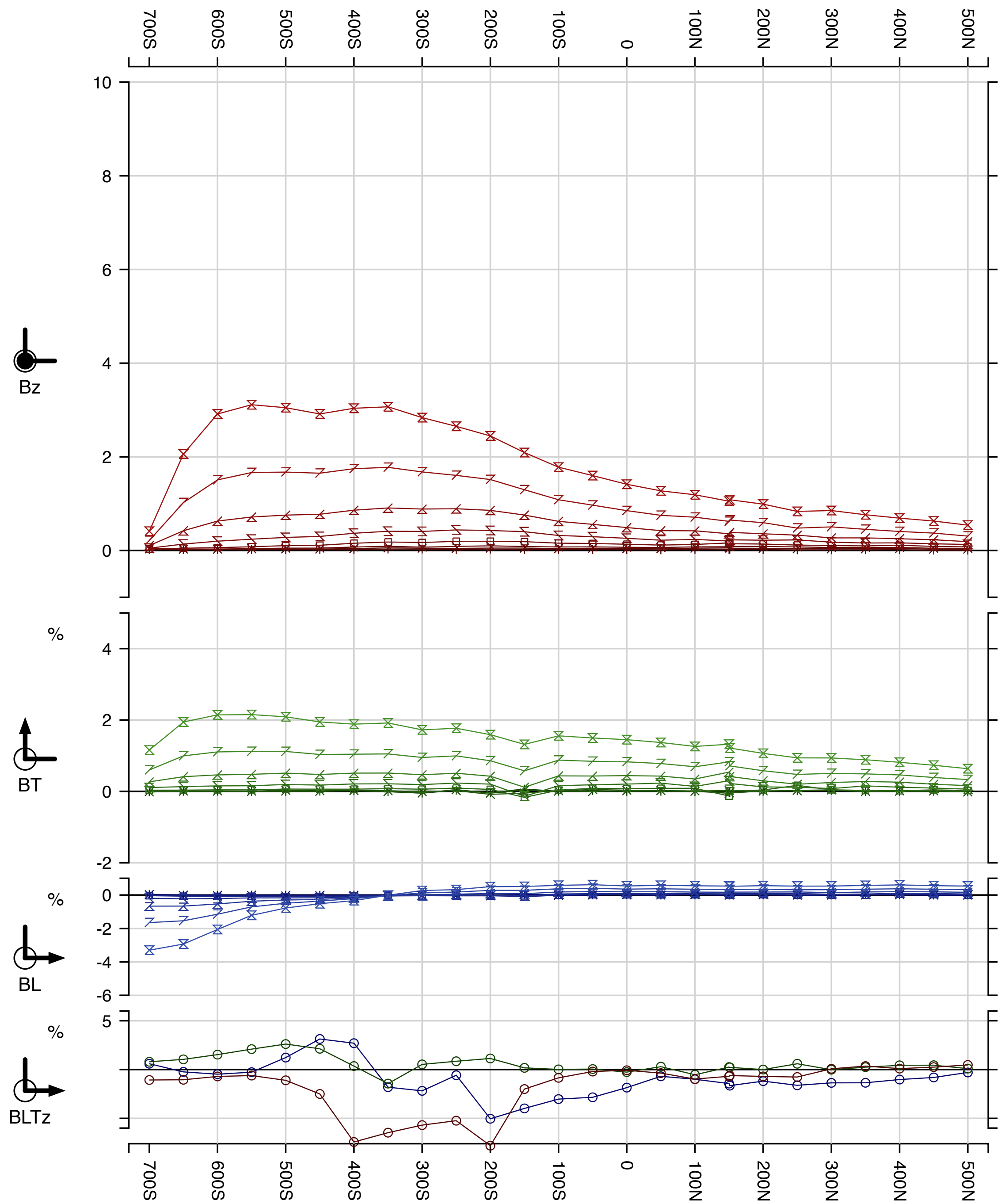
| | | | |
|---|---|---|---|
| Line 8800E | 700S - 500N | 1200m | BL/BT/Bz |
| Line 8900E | 700S - 500N | 1200m | BL/BT/Bz |
| Line 9000E | 700S - 500N | 1200m | BL/BT/Bz |
| Line 9100E | 700S - 500N | 1200m | BL/BT/Bz |
| Line 9300E | 600S - 600N | 1200m | BL/BT/Bz |
| Line 9500E | 500S - 700N | 1200m | BL/BT/Bz |
| Line 9700E | 500S - 700N | 1200m | BL/BT/Bz |
| Line 9900E | 500S - 700N | 1200m | BL/BT/Bz |
| Line 10100E | 350S - 700N | 1050m | BL/BT/Bz |
| Line 10300E | 600S - 250S | | |
| | 50S - 600N | 1000m | BL/BT/Bz |

## Loop 2016-17 - late Chs8-Ch0 - $B_{LTZ}$ pg 49



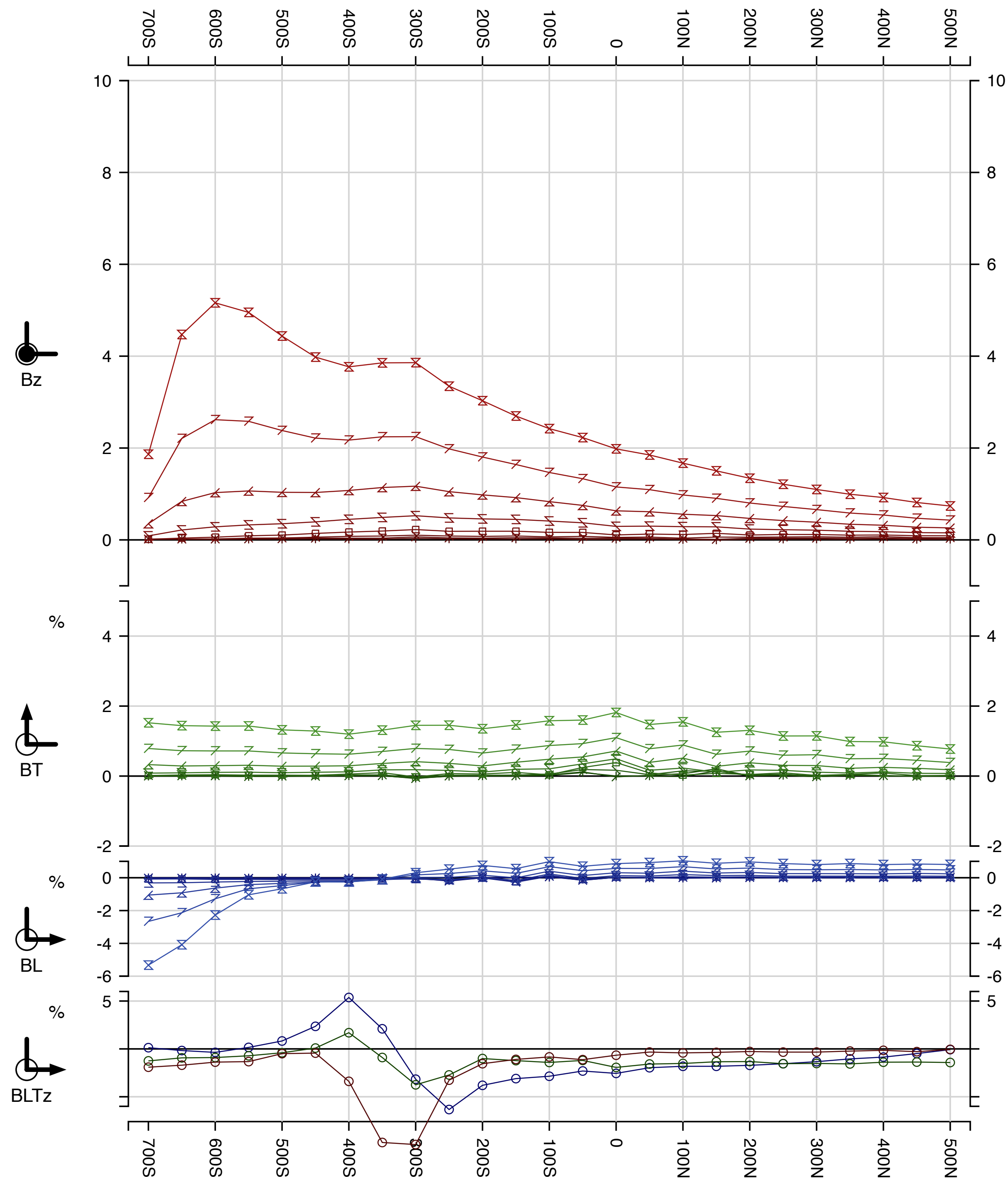

| Line: L8800EB<br>Loop: 2016-17S2<br>Cpt: BL, BT, Bz<br>L 317.0° | (Chn - Ch0) / \|Bp\| (%)<br>Cont norm @ Δz: 0m<br>Base Freq: 0.71429Hz<br>aLp2016-17S2_L8800EB.3cH5 / AREA5 3-Axis S2* | UTEM-5 Survey at: AREA 5<br>For: NORONT<br>LAMONTAGNE GEOPHYSICS LTD GEOPHYSIQUE LTÉE<br>Job 1613<br>Surv: 24/7/16<br>Red: 6/11/16<br>Plot: 6/11/16 |
|---|---|---|

# Loop 2016-17 - late Chs8-Ch0 - $B_{LTZ}$



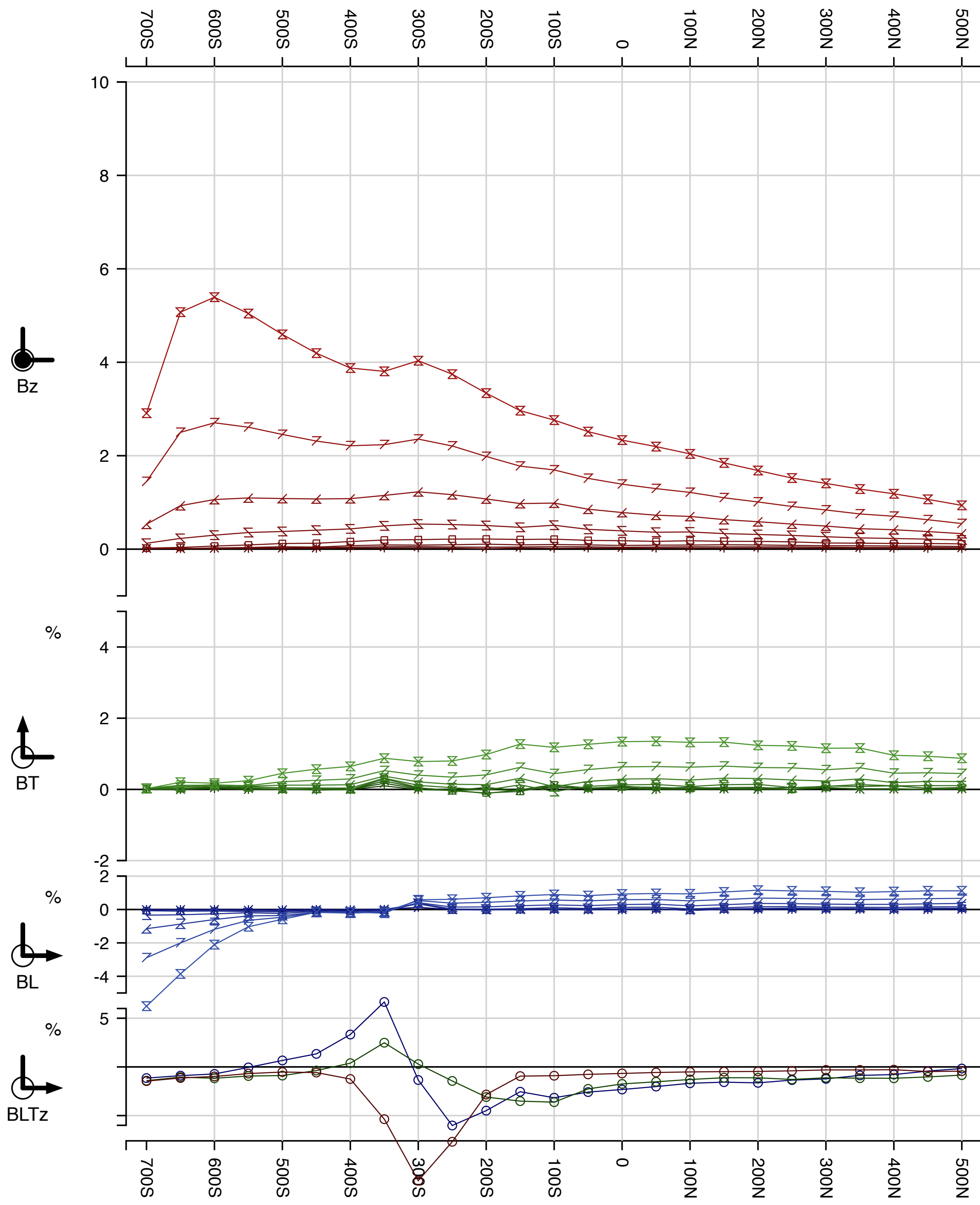

| | | |
|---|---|---|
| Line: L8900EB<br>Loop: 2016-17S2<br>Cpt: BL, BT, Bz<br>L 317.0° | (Chn - Ch0) / \|Bp\| (%)<br>Cont norm @ Δz: 0m<br>Base Freq: 0.71429Hz<br>aLp2016-17S2_L8900EB.3cH5 / AREA5 3-Axis S2* | UTEM-5 Survey at: AREA 5<br>For: NORONT<br>LAMONTAGNE GEOPHYSICS LTD GEOPHYSIQUE LTÉE<br>Job 1613<br>Surv: 24/7/16<br>Red: 6/11/16<br>Plot: 6/11/16 |

# Loop 2016-17 - late Chs8-Ch0 - $B_{LTZ}$



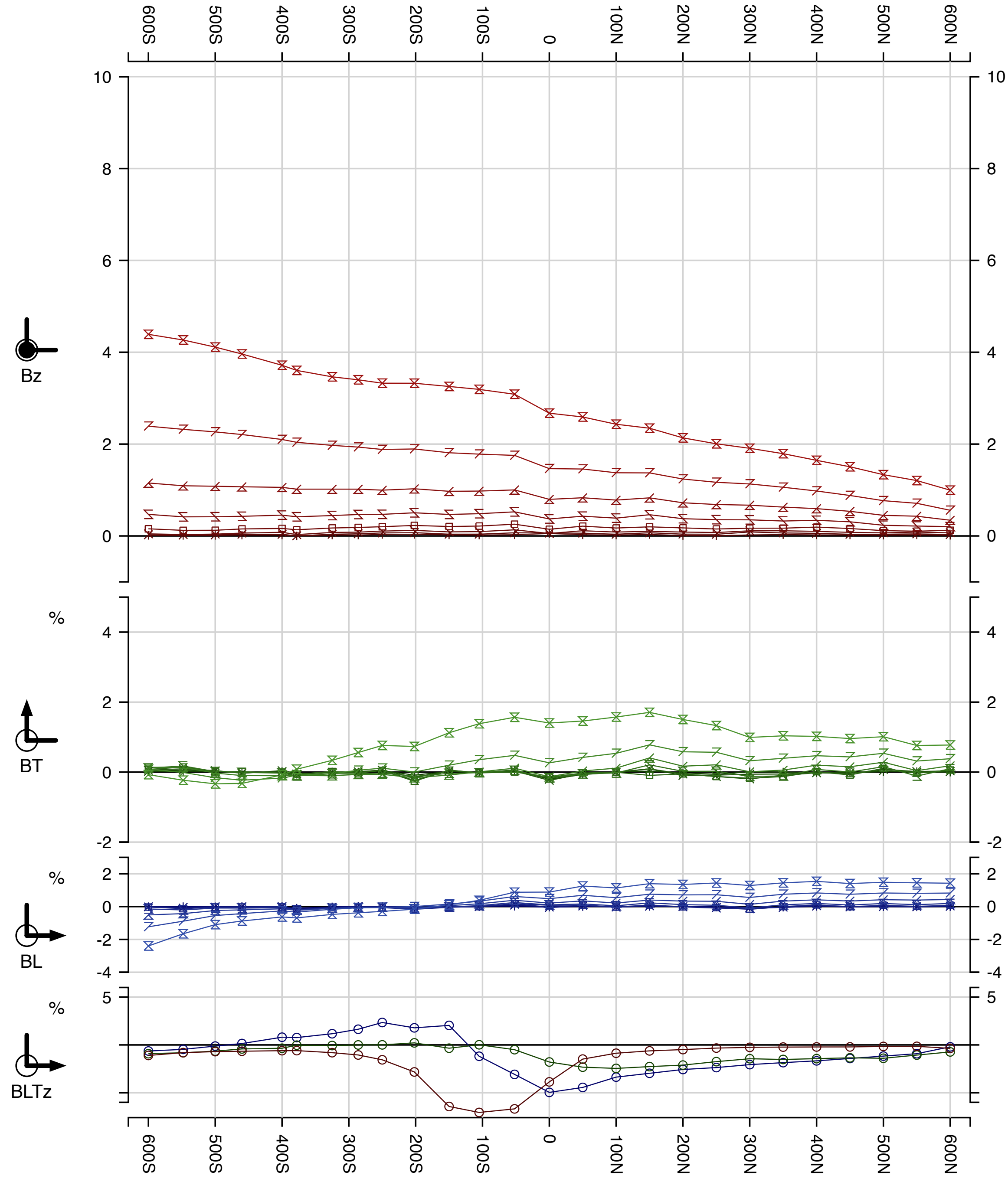

| | | |
|---|---|---|
| Line: L9000EB<br>Loop: 2016-17S2<br>Cpt: BL, BT, Bz<br>L 317.0° | (Chn - Ch0) / \|Bp\| (%)<br>Cont norm @ Δz: 0m<br>Base Freq: 0.71429Hz<br>aLp2016-17S2_L9000EB.3cH5 / AREA5 3-Axis S2* | UTEM-5 Survey at: AREA 5<br>For: NORONT<br>LAMONTAGNE GEOPHYSICS LTD GEOPHYSIQUE LTÉE<br>Job 1613 Surv: 24/7/16 Red: 6/11/16 Plot: 6/11/16 |

# Loop 2016-17 - late Chs8-Ch0 - $B_{LTZ}$




| | | |
|---|---|---|
| Line: L9100EB<br>Loop: 2016-17S2<br>Cpt: BL, BT, Bz<br>L 317.0° | (Chn - Ch0) / \|Bp\| (%)<br>Cont norm @ Δz: 0m<br>Base Freq: 0.71429Hz<br>aLp2016-17S2_L9100EB.3cH5 / AREA5 3-Axis S2* | UTEM-5 Survey at: AREA 5<br>For: NORONT<br>LAMONTAGNE GEOPHYSICS LTD GEOPHYSIQUE LTÉE Job 1613 Surv: 24/7/16 Red: 6/11/16 Plot: 6/11/16 |

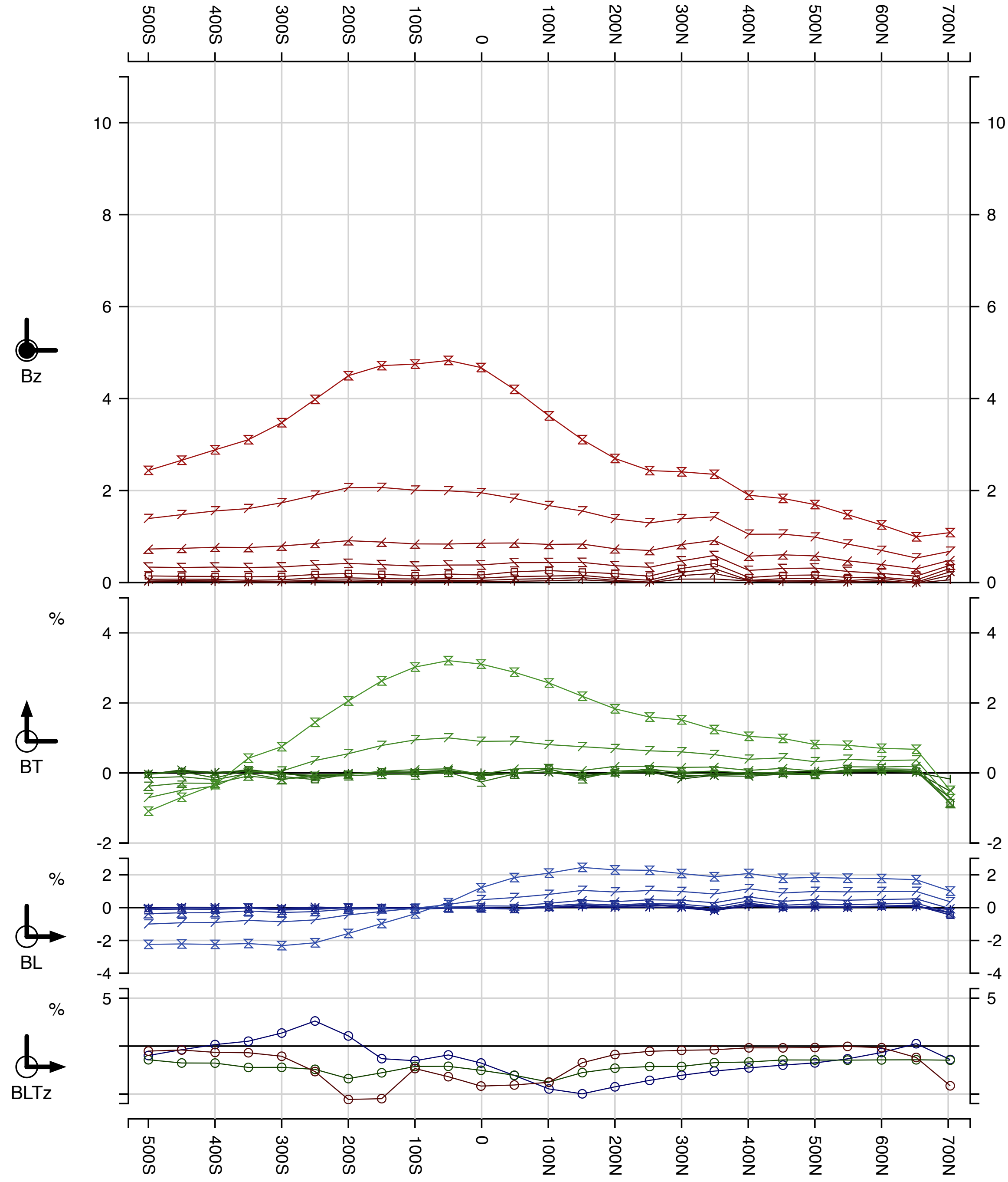
# Loop 2016-17 - late Chs8-Ch0 - $B_{LTZ}$




| Line: L9300EB<br>Loop: 2016-17S2<br>Cpt: BL, BT, Bz<br>L 317.0° | (Chn - Ch0) / \|Bp\| (%)<br>Cont norm @ Δz: 0m<br>Base Freq: 0.71429Hz<br>aLp2016-17S2_L9300EB.3cH5 / AREA5 3-Axis S2* | UTEM-5 Survey at: AREA 5<br>For: NORONT<br>LAMONTAGNE GEOPHYSICS LTD GEOPHYSIQUE LTÉE Job 1613 Surv: 21/7/16 Red: 6/11/16 Plot: 6/11/16 |
|---|---|---|

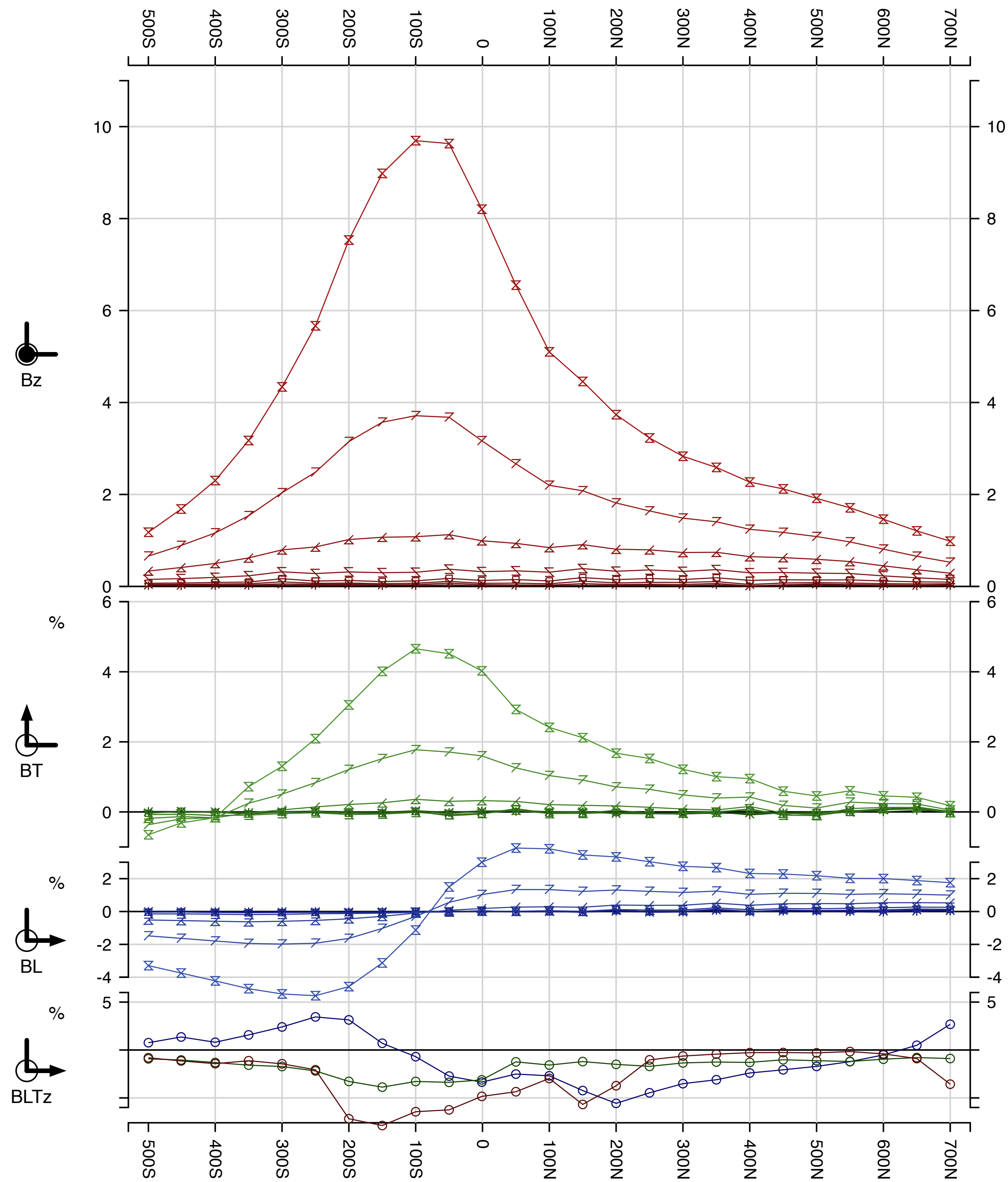
# Loop 2016-17 - late Chs8-Ch0 - $B_{LTZ}$

pg 54




| Line: L9500EB<br>Loop: 2016-17S2<br>Cpt: BL, BT, Bz<br>L 317.0° | (Chn - Ch0) / \|Bp\| (%)<br>Cont norm @ Δz: 0m<br>Base Freq: 0.71429Hz<br>aLp2016-17S2_L9500EB.3cH5 / AREA5 3-Axis S2* | UTEM-5 Survey at: AREA 5<br>For: NORONT<br>LAMONTAGNE GEOPHYSICS LTD GEOPHYSIQUE LTÉE<br>Job 1613<br>Surv: 22/7/16<br>Red: 6/11/16<br>Plot: 6/11/16 |
|---|---|---|

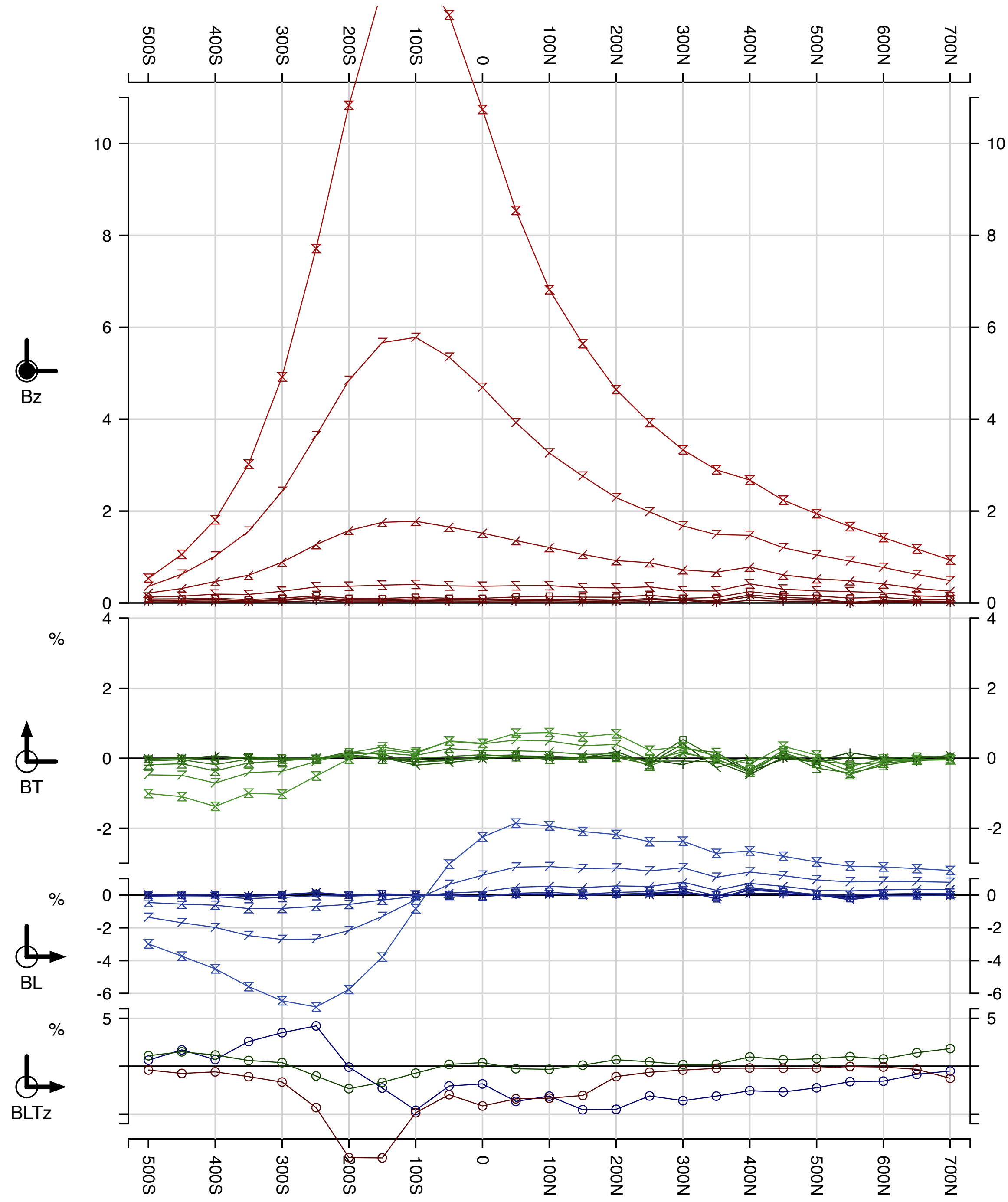
# Loop 2016-17 - late Chs8-Ch0 - $B_{LTZ}$




| | | |
|---|---|---|
| Line: L9700EB<br>Loop: 2016-17S2<br>Cpt: BL, BT, Bz<br>L 317.0° | (Chn - Ch0) / \|Bp\| (%)<br>Cont norm @ Δz: 0m<br>Base Freq: 0.71429Hz<br>aLp2016-17S2_L9700EB.3cH5 / AREA5 3-Axis S2* | UTEM-5 Survey at: AREA 5<br>For: NORONT<br>LAMONTAGNE GEOPHYSICS LTD GEOPHYSIQUE LTÉE<br>Job 1613<br>Surv: 23/7/16<br>Red: 6/11/16<br>Plot: 6/11/16 |

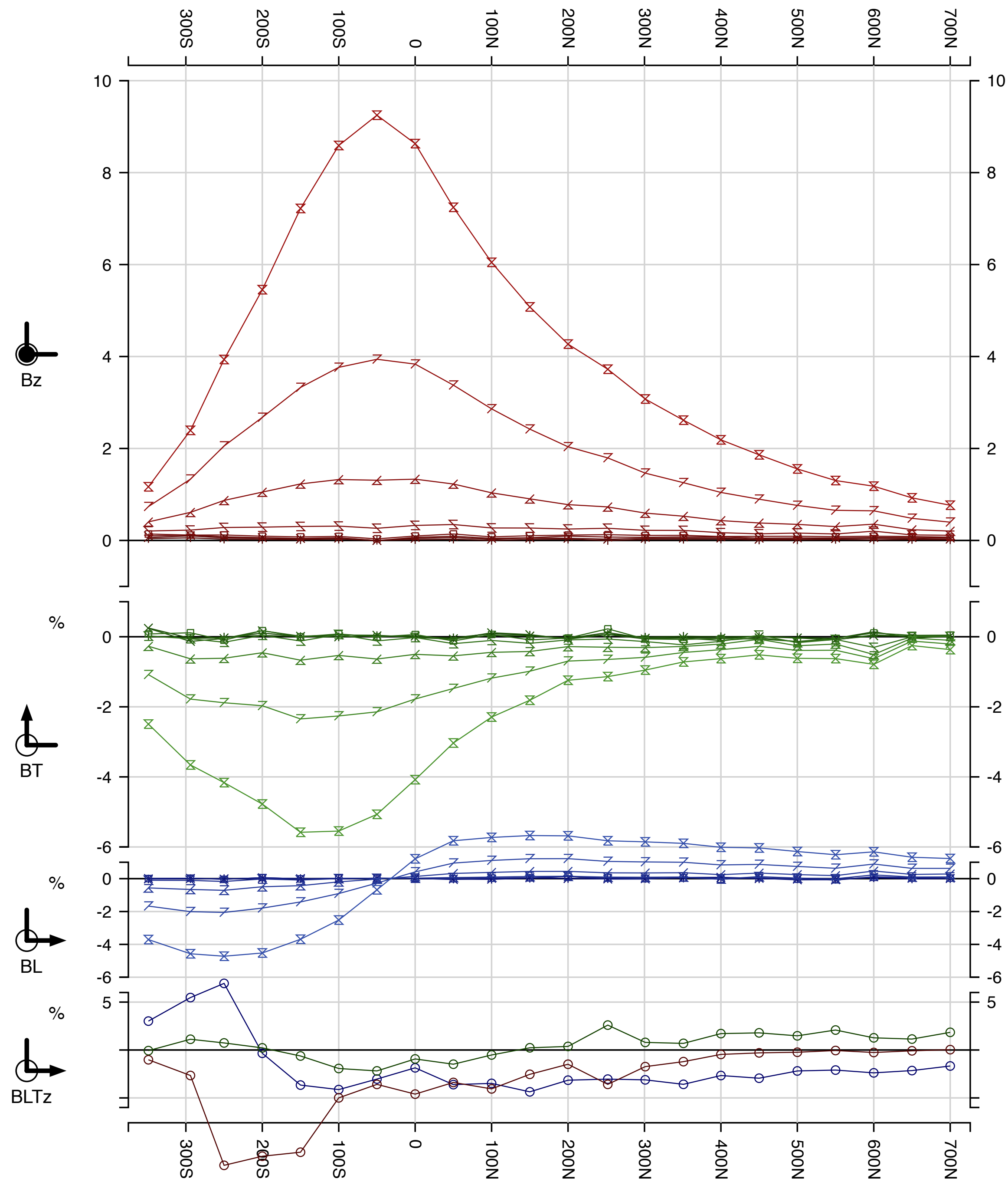
# Loop 2016-17 - late Chs8-Ch0 - $B_{LTZ}$

pg 56




| | | |
|---|---|---|
| Line: L9900EB<br>Loop: 2016-17S2<br>Cpt: BL, BT, Bz<br>L 317.0° | (Chn - Ch0) / \|Bp\| (%)<br>Cont norm @ Δz: 0m<br>Base Freq: 0.71429Hz<br>aLp2016-17S2_L9900EB.3cH5 / AREA5 3-Axis S2* | UTEM-5 Survey at: AREA 5<br>For: NORONT<br>LAMONTAGNE GEOPHYSICS LTD GEOPHYSIQUE LTÉE Job 1613 Surv: 21/7/16 Red: 6/11/16 Plot: 6/11/16 |

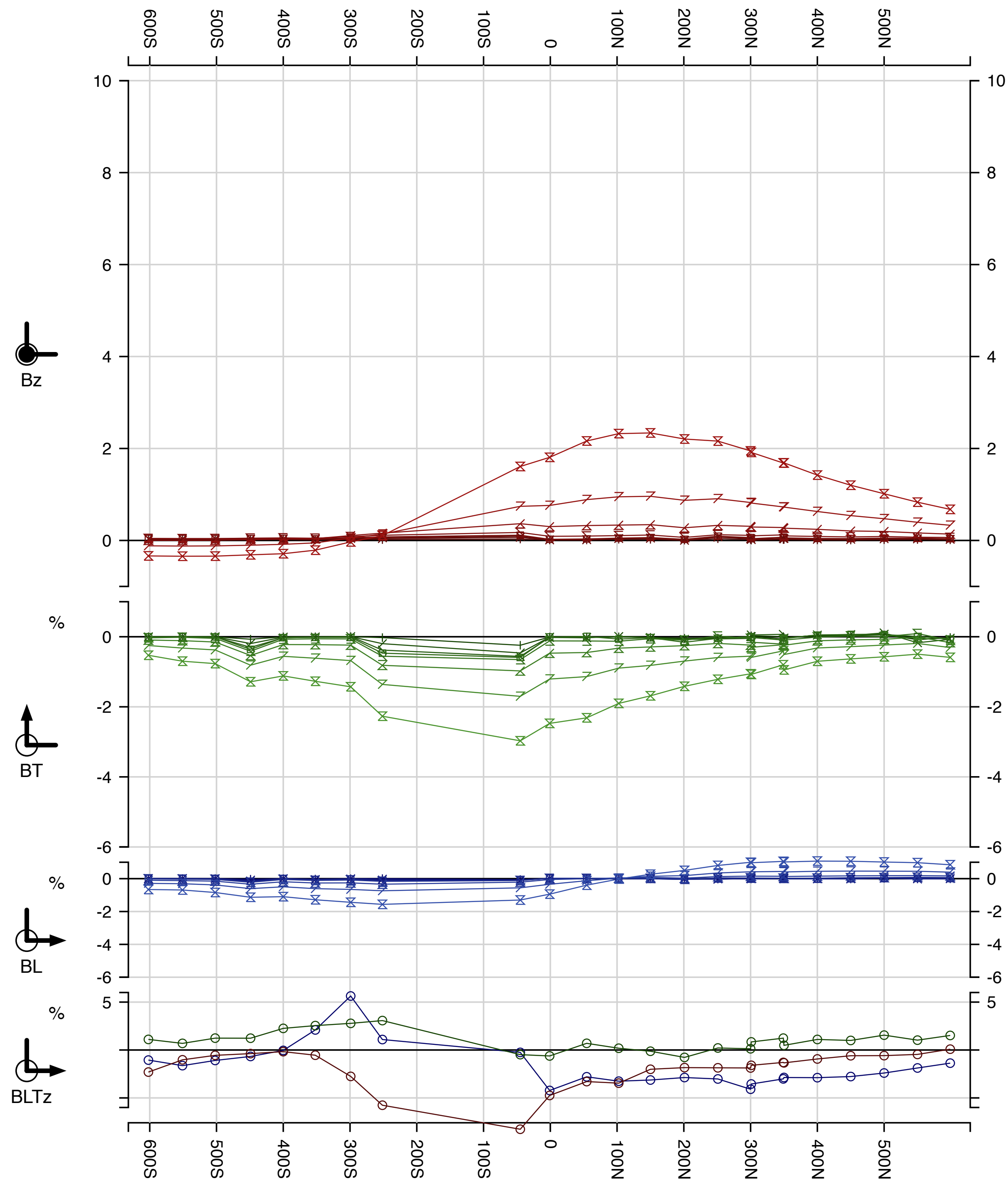
# Loop 2016-17 - late Chs8-Ch0 - $B_{LTZ}$




| | | |
|---|---|---|
| Line: L10100EB<br>Loop: 2016-17S2<br>Cpt: BL, BT, Bz<br>L 317.0° | (Chn - Ch0) / \|Bp\| (%)<br>Cont norm @ Δz: 0m<br>Base Freq: 0.71429Hz<br>aLp2016-17S2_L10100EB.3cH5 / AREA5 3-Axis S2* | UTEM-5 Survey at: AREA 5<br>For: NORONT<br>LAMONTAGNE GEOPHYSICS LTD GEOPHYSIQUE LTÉE<br>Job 1613<br>Surv: 22/7/16<br>Red: 6/11/16<br>Plot: 6/11/16 |

# Loop 2016-17 - late Chs8-Ch0 - $B_{LTZ}$

pg 58




| | | |
|---|---|---|
| Line: L10300EB<br>Loop: 2016-17S2<br>Cpt: BL, BT, Bz<br>L 317.0° | (Chn - Ch0) / \|Bp\| (%)<br>Cont norm @ Δz: 0m<br>Base Freq: 0.71429Hz<br>aLp2016-17S2_L10300EB.3cH5 / AREA5 3-Axis S2* | UTEM-5 Survey at: AREA 5<br>For: NORONT<br>LAMONTAGNE GEOPHYSICS LTD GEOPHYSIQUE LTÉE Job 1613 Surv: 23/7/16 Red: 6/11/16 Plot: 6/11/16 |

# Loop 2016-17 - late Chs8-Ch0 - $B_{LTZ}$

# Area 5 Grid

# Loop 2016-20

## BL/BT/Bz

~0.7143Hz frequency

continuous norm

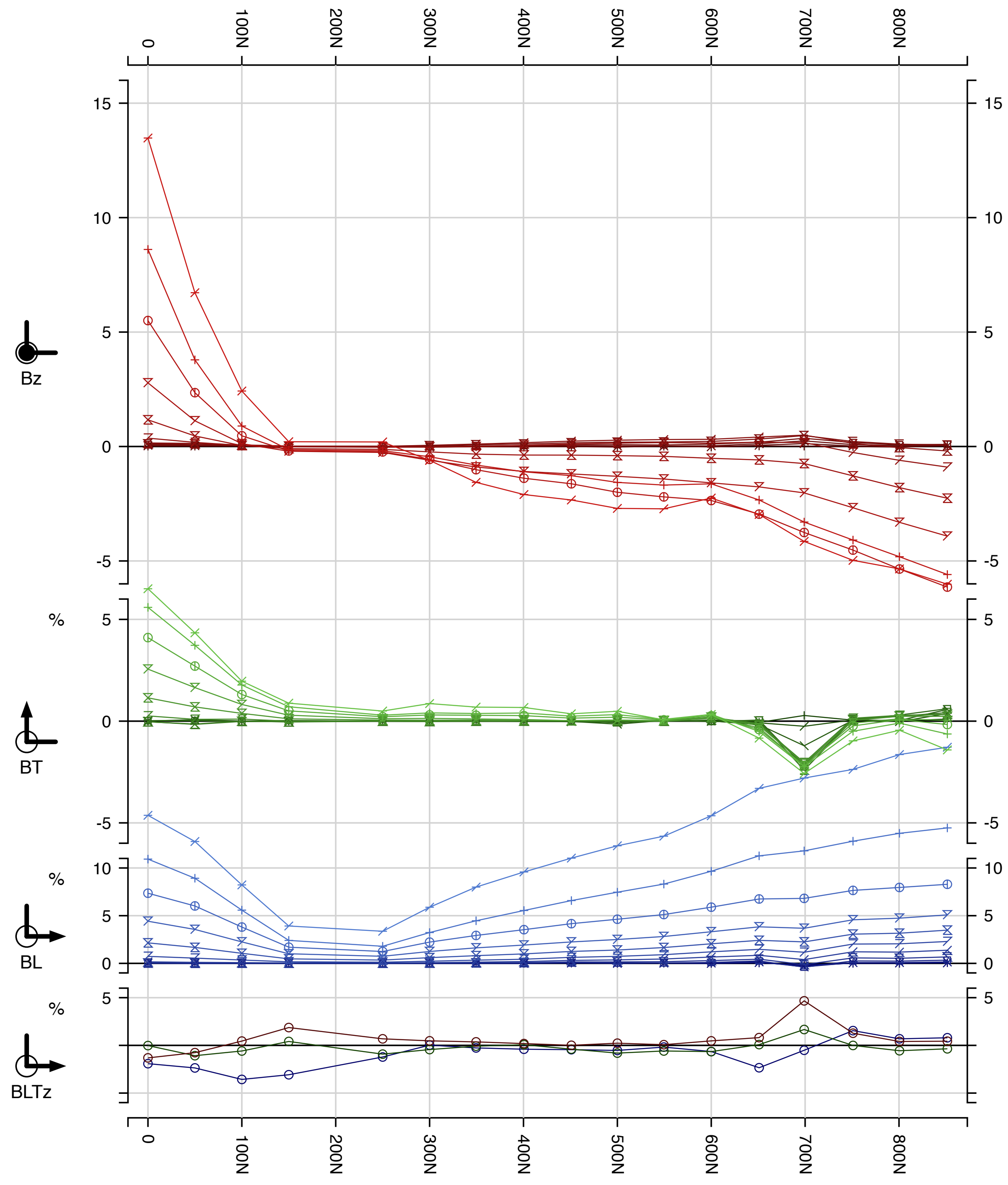
12Ch - Ch0 reduced

## all Chs plotted

Loop 2016-20 (@ **0.7142857Hz**) in-loop/off-loop - loop to the gridSouth

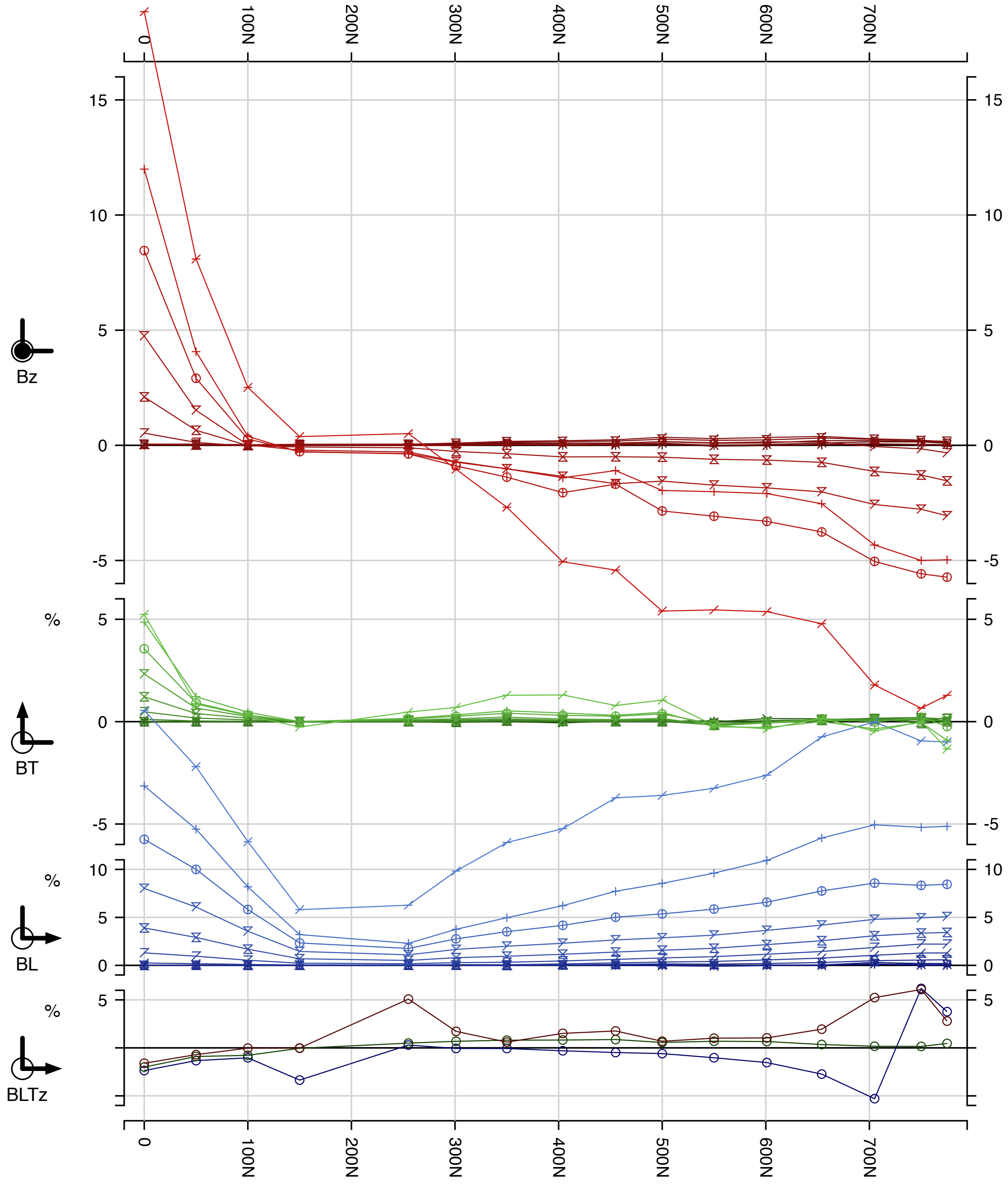
| | | | | |
|---|---|---|---|---|
| Line | 9500E | 0 - 850N | 850m | BL/BT/Bz |
| Line | 9700E | 0 - 775N | 775m | BL/BT/Bz |

**Loop 2016-20 - all Chs - $B_{LTZ}$** pg 60




| Line: L9500EA<br>Loop: 2016-20S2<br>Cpt: BL, BT, Bz<br>L 317.0° | (Chn - Ch0) / \|Bp\| (%)<br>Cont norm @ Δz: 0m<br>Base Freq: 0.71429Hz<br>aLp2016-20S2_L9500EA.3cH5 / AREA5 Lp20 3-Axis S2 | UTEM-5 Survey at: AREA 5<br>For: NORONT<br>LAMONTAGNE GEOPHYSICS LTD GEOPHYSIQUE LTÉE Job 1613 Surv: 24/7/16 Red: 6/11/16 Plot: 6/11/16 |
|---|---|---|

# Loop 2016-20 - all Chs - $B_{LTZ}$




| | | |
|---|---|---|
| Line: L9700EA<br>Loop: 2016-20S2<br>Cpt: BL, BT, Bz<br>L 317.0° | (Chn - Ch0) / \|Bp\| (%)<br>Cont norm @ Δz: 0m<br>Base Freq: 0.71429Hz<br>aLp2016-20S2_L9700EA.3cH5 / AREA5 Lp20 3-Axis S2 | UTEM-5 Survey at: AREA 5<br>For: NORONT<br>LAMONTAGNE GEOPHYSICS LTD GEOPHYSIQUE LTÉE<br>Job 1613<br>Surv: 24/7/16<br>Red: 6/11/16<br>Plot: 6/11/16 |

# Loop 2016-20 - all Chs - $B_{LTZ}$

# Area 5 Grid

# Loop 2016-20

## BL/BT/Bz

~0.7143Hz frequency

continuous norm

12Ch - Ch0 reduced

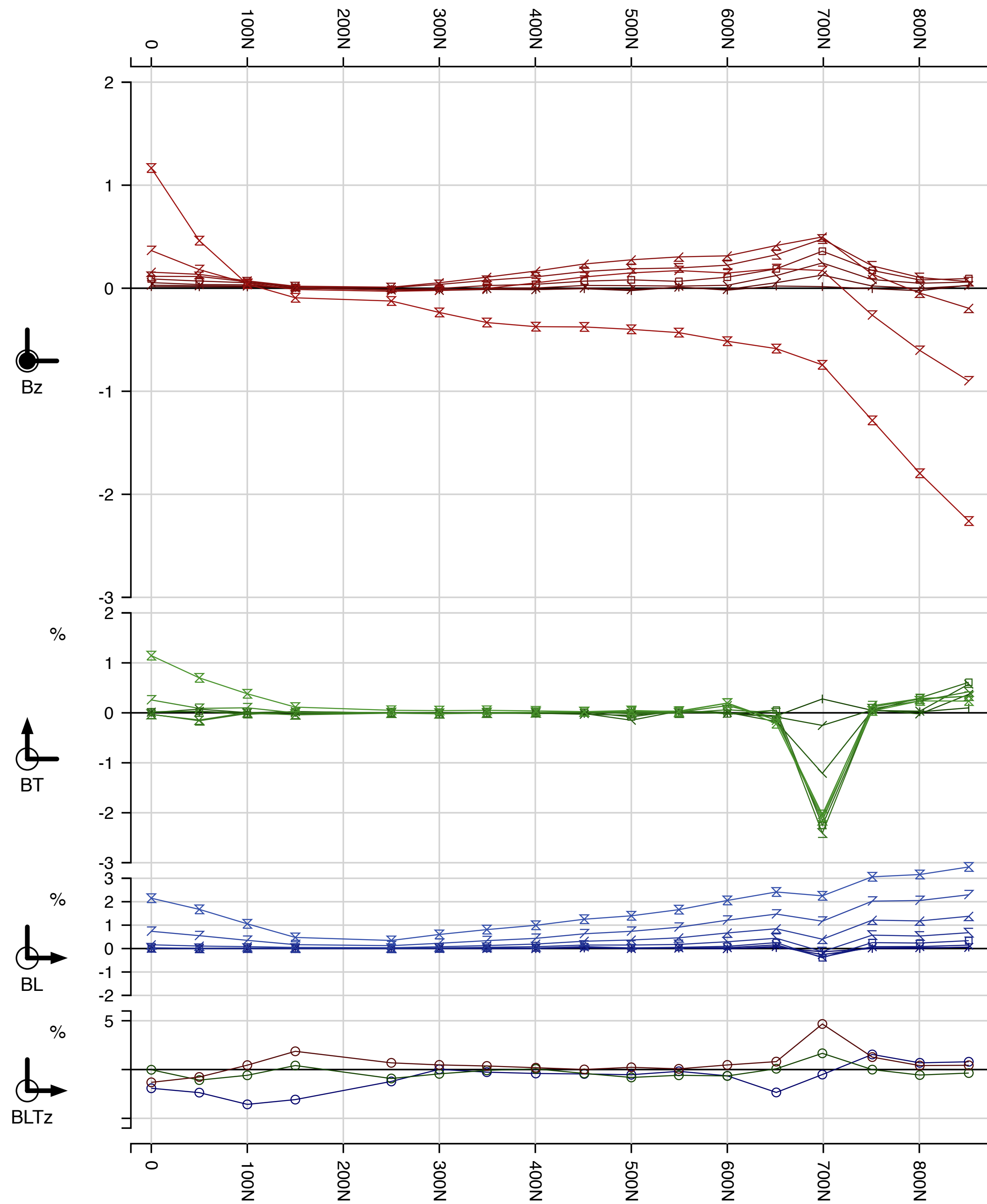
## late Chs8-Ch0 plotted

Loop 2016-20 (@ **0.7142857Hz**) in-loop/off-loop - loop to the gridSouth

| | | | | |
|---|---|---|---|---|
| Line | 9500E | 0 - 850N | 850m | BL/BT/Bz |
| Line | 9700E | 0 - 775N | 775m | BL/BT/Bz |

## Loop 2016-20 - late Chs8-Ch0 - $B_{LTZ}$

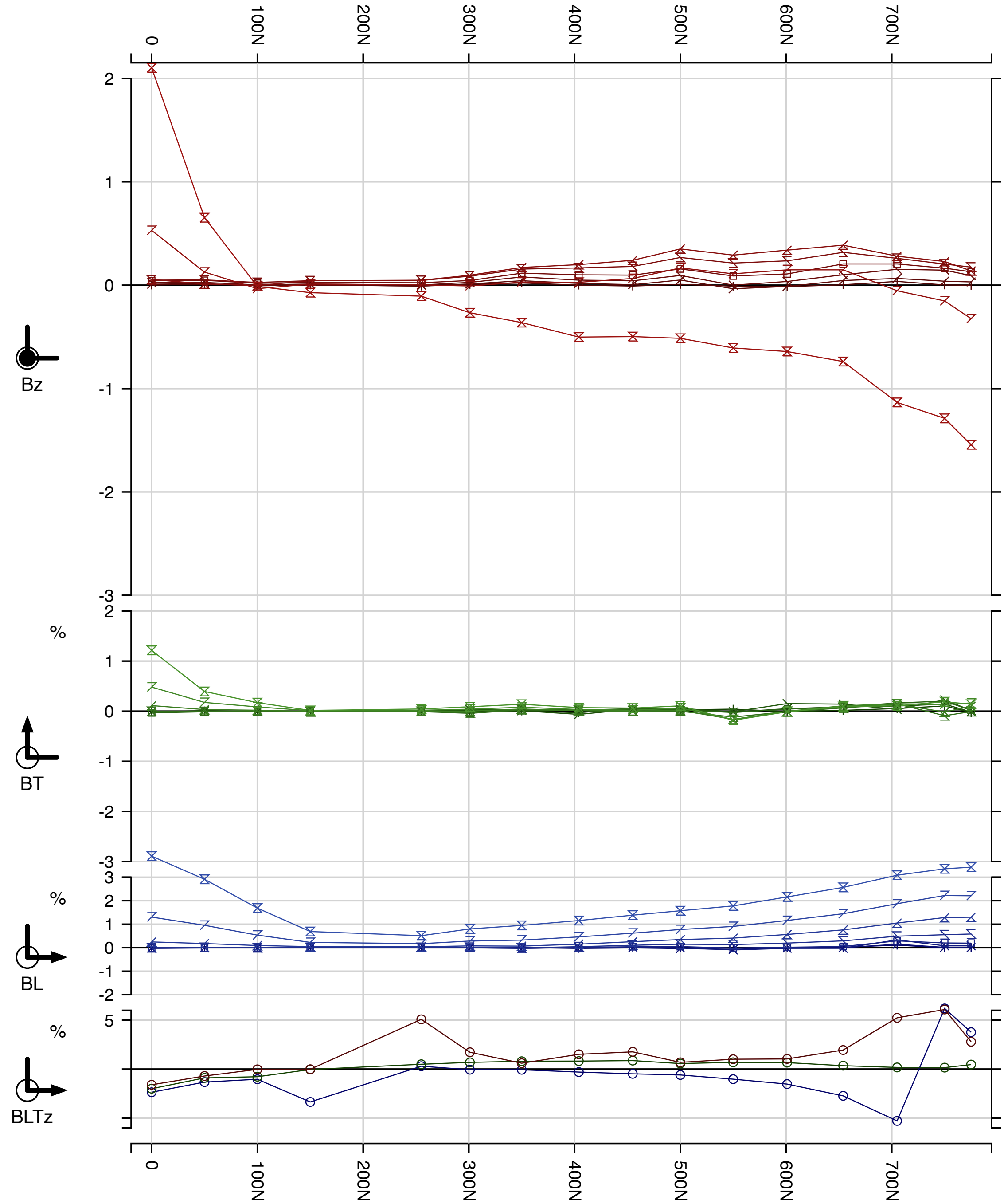
pg 63




| Line: L9500EA<br>Loop: 2016-20S2<br>Cpt: BL, BT, Bz<br>L 317.0° | (Chn - Ch0) / \|Bp\| (%)<br>Cont norm @ Δz: 0m<br>Base Freq: 0.71429Hz<br>aLp2016-20S2_L9500EA.3cH5 / AREA5 Lp20 3-Axis S2* | UTEM-5 Survey at: AREA 5<br>For: NORONT<br>LAMONTAGNE GEOPHYSICS LTD GEOPHYSIQUE LTÉE<br>Job 1613 Surv: 24/7/16 Red: 6/11/16 Plot: 6/11/16 |
|---|---|---|

# Loop 2016-20 - late Chs8-Ch0 - $B_{LTZ}$

pg 64




| | | |
|---|---|---|
| Line: L9700EA<br>Loop: 2016-20S2<br>Cpt: BL, BT, Bz<br>L 317.0° | (Chn - Ch0) / \|Bp\| (%)<br>Cont norm @ Δz: 0m<br>Base Freq: 0.71429Hz<br>aLp2016-20S2_L9700EA.3cH5 / AREA5 Lp20 3-Axis S2* | UTEM-5 Survey at: AREA 5<br>For: NORONT<br>LAMONTAGNE GEOPHYSICS LTD GEOPHYSIQUE LTÉE Job 1613 Surv: 24/7/16 Red: 6/11/16 Plot: 6/11/16 |

# Loop 2016-20 - late Chs8-Ch0 - $B_{LTZ}$

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# Appendix B

## 2016-3 Production Diary

## UTEM5 Survey

## Area 5 Grid
## Ring of Fire

## for

## Noront Resources Ltd.

# Production Log (2016-3 UTEM5)

## UTEM5 Survey - Area 5 Grid

## Noront Resources Ltd.

| Date | Rate - Production | | Comments |
|---|---|---|---|
| July 18 | Mob | - | B.Dingwall and R.Lahaye load the trucks up in Kingston and drive to Sudbury. P.Guimond departs Toronto and proceeds to Sudbury. |
| | Crew: P.Guimond,B.Dingwall,R.Lahaye | | |
| July 19 | Mob | - | Pick up two more crew (G.Lafortune,J.Ploufe) in Sudbury and drive to Geraldton to overnight. |
| | Crew: P.Guimond,B.Dingwall,G.Lafortune,R.Lahaye,J.Ploufe | | |
| July 20 | Mob | - | Drive to the Nakina seaplane base for 08h00. Unload the gear and depart for Koper Lake at 09h30, arriving at 11h00. A second plane with the remaining equipment arrives at 14h00. Safety orientation in the afternoon. |
| | Crew: P.Guimond,B.Dingwall,G.Lafortune,R.Lahaye,J.Ploufe | | |
| July 21 | L-5 | - | Pack up a basket of wire for slinging first thing in the morning. Nine men fly out to Area 5 to begin laying wire. The tenth man drives an Argo from camp to the grid. The wire is slung out and some spools are cached along the loop. Two river crossings and ~800m of wire are in place but an approaching thunderstorm necessitates a call for a chopper pickup to return to camp, arriving at 1200. The forecast calls for more thunderstorms in the afternoon so the crew remains in camp for the rest of the day. Bill remains in camp for the day to test the Tx gear. |
| | Crew: P.Guimond,B.Dingwall,G.Lafortune,R.Lahaye,J.Ploufe | | |
| July 22 | L-5 | - | A low ceiling/poor visibility/rain delays helicopter departure in the morning. When conditions improve, ten men fly out to Area 5 to continue laying wire on Loops 17 and 19. A transmitter site is prepared and the generators are slung out and set up. By the end of the day both loops are complete and tested for continuity. Back in camp by 16h30. |
| | Crew: P.Guimond,B.Dingwall,G.Lafortune,R.Lahaye,J.Ploufe | | |

| Date | Rate - Production | | Comments |
|---|---|---|---|
| July 23 | P(2/2)-5 | 2200m | Out to Area 5 to begin surveying. Three men fly to the Tx site to receive 2 sling loads of gear, set up the site, and retrieve an Argo. Two Noront mechanics also fly out to repair loose drive chains on one of the Argos and boost a second Argo. The rest of the crew remain in camp until the preparations at the transmitter site are nearly complete. Seven men fly out the the SW part of the grid to begin surveying on Lines 8800E to 9100E. They are later joined by two more crew members plus the Argo. The coils are started and surveying is underway by 11h00. Back in camp by 16h45. |

**Area 5** **Loop 2016-19 S1 1.7857 Hz Tx9**
**Loop 2016-17 S2 0.7143 Hz Tx5**

| | | | |
|---|---|---|---|
| **Line** | **88+00E** | **1+50N - 5+00N** | **R1RD1** |
| **Line** | **89+00E** | **3+50S - 5+00N** | **R1RD1** |
| **Line** | **90+00E** | **1+50N - 5+00N** | **R2RD2** |
| **Line** | **91+00E** | **1+50S - 5+00N** | **R2RD2** |

Crew: P.Guimond,B.Dingwall,G.Lafortune,R.Lahaye,J.Ploufe

| | | | |
|---|---|---|---|
| July 24 | P(2/2)-5 | 2600m | Ten men fly to Area 5 to continue surveying the 4 lines from yesterday. The coils are started and surveying is underway by 8h45. A loop break at noon (DGPS crew) causes a 45min delay. The four lines are completed and back in camp by 17h15. Periods of rain today with winds picking up in the late afternoon plus thunder off in the distance. |

**Area 5** **Loop 2016-19 S1 1.7857 Hz Tx9**
**Loop 2016-17 S2 0.7143 Hz Tx5**

| | | | |
|---|---|---|---|
| **Line** | **88+00E** | **7+00S - 1+50N** | **R1RD1** |
| **Line** | **89+00E** | **7+00S - 3+50S** | **R1RD1** |
| **Line** | **90+00E** | **7+00S - 1+50N** | **R6RD2** |
| **Line** | **91+00E** | **7+00S - 1+50S** | **R6RD2** |

Crew: P.Guimond,B.Dingwall,G.Lafortune,R.Lahaye,J.Ploufe

| | | | |
|---|---|---|---|
| July 25 | L-5 | - | A low ceiling/poor visibility delays helicopter departure until 10h00. Ten men fly out to Area 5 to pick up wire on Loop 19 and lay Loop 18. Upon arrival in the field the transmitters are started and calibration readings are collected for Loop 19. When complete all but 1100m of Loop 19 is picked up and all of Loop 18 is deployed. Before leaving the field Loop 18 is tested for continuity. Back in camp by 16h15. |

Crew: P.Guimond,B.Dingwall,G.Lafortune,R.Lahaye,J.Ploufe

| Date | Rate - Production | Comments |
|---|---|---|

July 26 P(2/2)-5 2400m — Ten men fly to Area 5 to start surveying lines using the Loop 18/19 combination. The coils are started at the Helipad and the survey gear is moved into position. Surveying is underway by 9h00. Two lines are completed and back in camp by 16h45. Another Argo is driven out to the grid by the DGPS crew and left at the tx site. Quite windy today with a few showers.

**Area 5** **Loop 2016-18 S1 1.7857 Hz Tx9**
**Loop 2016-17 S2 0.7143 Hz Tx5**

| | | | | |
|---|---|---|---|---|
| **Line** | **93+00E** | **6+00S** | **- 6+00N** | **R6RD2** |
| **Line** | **99+00E** | **5+00S** | **- 7+00N** | **R1RD1** |

Crew: P.Guimond,B.Dingwall,G.Lafortune,R.Lahaye,J.Ploufe

July 27P(2/2)-5 2650m — Eleven men fly to Area 5 to continue surveying lines using the Loop 18/19 combination. The two survey crews are dropped off at the beginning of their respective lines, the coils are started and surveying is underway by 8h45. Two lines plus one partial line are completed. At the end of the day Rx6 does a calibration on Loop 18. Everyone back in camp by 17h00.

**Area 5** **Loop 2016-18 S1 1.7857 Hz Tx9**
**Loop 2016-17 S2 0.7143 Hz Tx5**

| | | | | |
|---|---|---|---|---|
| **Line** | **95+00E** | **5+00S** | **- 7+00N** | **R6RD2** |
| **Line** | **101+00E** | **3+50S** | **- 7+00N** | **R1RD1** |
| **Line** | **103+00E** | **0+50S** | **- 3+50N** | **R1RD1** |

Crew: P.Guimond,B.Dingwall,G.Lafortune,R.Lahaye,J.Ploufe

July 28P(2/2)-5 1800m — Eleven men fly to Area 5 to continue surveying lines using the Loop 18/19 combination. One survey crew is dropped off south of the creek to finish L10300E and to do a calibration for Loop 17. At 11h30 a chopper is called for a pickup to bring the crew back across the creek. A spare Rx is also brought out on the flight to replace Rx2 which was having low battery problems. The north part of L10300E is completed, calibration data is collected for Loop 18, and for the remainder of the day, the remaining 1100m of wire on Loop 19 is picked up. The other survey crew completes L9700E. Everyone back in camp by 17h00.

**Area 5** **Loop 2016-18 S1 1.7857 Hz Tx9**
**Loop 2016-17 S2 0.7143 Hz Tx5**

| | | | | |
|---|---|---|---|---|
| **Line** | **97+00E** | **2+50N** | **- 7+00N** | **R2RD2** |
| **Line** | **97+00E** | **5+00S** | **- 2+50N** | **R6RD2** |
| **Line** | **103+00E** | **6+00S** | **- 2+50S** | **R1RD1** |
| **Line** | **103+00E** | **3+50N** | **- 6+00N** | **R1RD1** |

Crew: P.Guimond,B.Dingwall,G.Lafortune,R.Lahaye,J.Ploufe

Date Rate - Production Comments

July 29 P(2/2)-5 1625m Ten men fly to Area 5 to pick up the north side of Loop 17 and lay it on BL200N to create a new Loop 20. The Tx site for Loops 17/18 is packed up and a basket of gear is slung to the new Tx site on BL200N. At 11h30 P.Guimond flies out to the grid with the survey equipment. The new Tx site is set up, the coils are started and surveying is underway by 13h15. Two off-loop lines are surveyed to the NW. Back in camp by 16h30.

**Area 5** **Loop 2016-17 S2 0.7143 Hz Tx5**

**Line 95+00E 0+00 - 8+50N R1RD1**

**Line 97+00E 0+00 - 7+75N R6RD2**

Crew: P.Guimond,B.Dingwall,G.Lafortune,R.Lahaye,J.Ploufe

July 30 L-5 - Ten men fly out to Area 5 to pick up wire on Loop 18 and Loop 20. B.Dingwall stays in camp to pack up the electronic gear for transport. All wire for both loops is retrieved, the two Tx sites are packed up and four baskets of gear are slung back to camp. Four Noront crew fly out to Area 6B to successfully retrieve augers missing from June.

Crew: P.Guimond,B.Dingwall,G.Lafortune,R.Lahaye,J.Ploufe

July 31 Demob - Crew and equipment flown out. The gear is sorted ,loaded into two trucks and demobilized.

Crew: P.Guimond,B.Dingwall,G.Lafortune,R.Lahaye,J.Ploufe

August 01 Demob- The crew proceeds to Sudbury, dropping off G.Lafortune and J.Ploufe.

Crew: P.Guimond,B.Dingwall,G.Lafortune,R.Lahaye,J.Ploufe

August 02 Demob- B.Dingwall travels from Sudbury to Kingston, P.Guimond from Sudbury-Toronto and R.Lahaye Sudbury-Kingston-Montreal.

Crew: P.Guimond,B.Dingwall,R.Lahaye.

---

LEGEND

| | | |
|---|---|---|
| P(n/n)-x | Surface Production | (# of Rx/Tx) - # of personnel |
| L(n/n)-x | Looping | (# of Rx/Tx) - # of personnel |
| AL(n/n)-x | Advance Looping | (# of Rx/Tx) - # of personnel |
| S(n/n)-x | Standby | (# of Rx/Tx) - # of personnel |
| D(n/n)-x | Down | (# of Rx/Tx) - # of personnel |
| n/c(n/n)-x | no charge | (# of Rx/Tx) - # of personnel |

| | | | |
|---|---|---|---|
| Area 5 Grid data collected: | 2 loop coverage | 11650m | BL/BT/Bz |
| Area 5 Grid data collected: | 1 loop coverage | 1625m | BL/BT/Bz |
| Total UTEM5 data collected: | 1 loop coverage | 24925m | BL/BT/Bz |

# Appendix C

# The UTEM SYSTEM
# - UTEM 5 -

**- Introduction to UTEM5 -**

**The UTEM System**

**UTEM Data Reduction and Plotting Conventions**

**Data Presentation**

# UTEM5

The UTEM5 system collects 3-component data from up to 3 transmitter loops - three coupling angles - simultaneously - translating to superior target definition and improved detection of all targets. In addition:
\

• UTEM5 precision is at least an order of magnitude better than the UTEM3 system. Our current estimate is that the UTEM5 surface coil precision will prove to be better by a factor of 10-40 times. Improved sensitivity equals better depth penetration. It also translates to significantly shorter stacking times or alternatively, better precision for the same stacking time. The improvement in precision is greater at lower frequencies (<4Hz).

• UTEM5 surface equipment has a greater advantage at low frequency - <4Hz. The UTEM5 technical advantage is greatest in the search for targets that are deeper and more highly-conductive when (very) large-loops (geometry of the applied field is simpler). UTEM5, however, will be found to be extremely useful in numerous other applications.

• Figure C1 shows the UTEM5 channels when 12Ch sampling is selected. Channels are spaced in a binary, geometric progression across each half-cycle of the received waveform - giving just over 3 channels per decade. Ch**12**, the earliest channel, is (~)1/2**12** of the half-cycle wide. Ch**1**, the latest channel, is (~)1/2**1** of the half-cycle wide. The use of UTEM4/5 Transmitters and UTEM5 Receivers allows for the implementation of:
- Ch0 - a narrow Ch later than Ch1. Making Ch0 normalization an option.
- 3 timing channels - Ch13/14/15 (Figure C1) for 12Ch UTEM5 The timing Chs improve the operator's ability to monitor Rx/Tx(s) synchronisation and allow for more precise phase correction/improved deconvolution.

• the UTEM5 rejection of non-survey frequencies including powerline noise is far superior to previous UTEM systems. One of the many features of the UTEM5 system that add up to the improved rejection is the option of tapered channel sampling (Figure C1).

The ability to simultaneously collect higher-precision, 3-component data from multiple transmitters (coupling angles) at low frequency is really what the UTEM5 system is designed for - to be efficient and precise. To date UTEM5 surveys using multiple transmitters operating at base frequencies as low as 0.25Hz have confirmed that both the sensitivity of the system and the rejection of non-survey frequencies (powerline noise etc.) is far superior to previous UTEM systems.

In terms of BH operations, UTEM5 Rx coupled with our existing BHUTEM system allows for the collection of 3-component data from multiple transmitters simultaneously. The precision improvement may not be that noticeable near surface - in high field strengths. But at depth - low field strength - we estimate up to a factor of 5 improvement in precision. That improvement, and the multiple transmitter option, will add up to a considerable increase in the ability to resolve deep, highly-conductive targets - allowing for the detection of smaller targets and targets more distant from the hole.

# The UTEM SYSTEM

UTEM uses a large, fixed, horizontal transmitter loop as its source. Loops range in size from 300x300m to 4000x4000m and larger. Smaller loops are generally used over conductive terrain or for shallow sounding work. Larger loops are used over resistive terrain or where the ability of the system to resolve a response can be aided by the simpler geometry of the applied field. The UTEM receiver(s)/ transmitter(s) are typically synchronised at the beginning of a survey day and the Rx(s) operates remotely after that point. The Rx/Tx clocks are sufficiently accurate to maintain synchronisation.

Measurements are routinely taken to a distance of twice the loop dimensions and can be continued further depending on the local noise levels. Lines are typically surveyed:

- off-loop: out from an edge of the loop when the target is steeply dipping.
- inside-the-loop: when the target is ~flat-lying

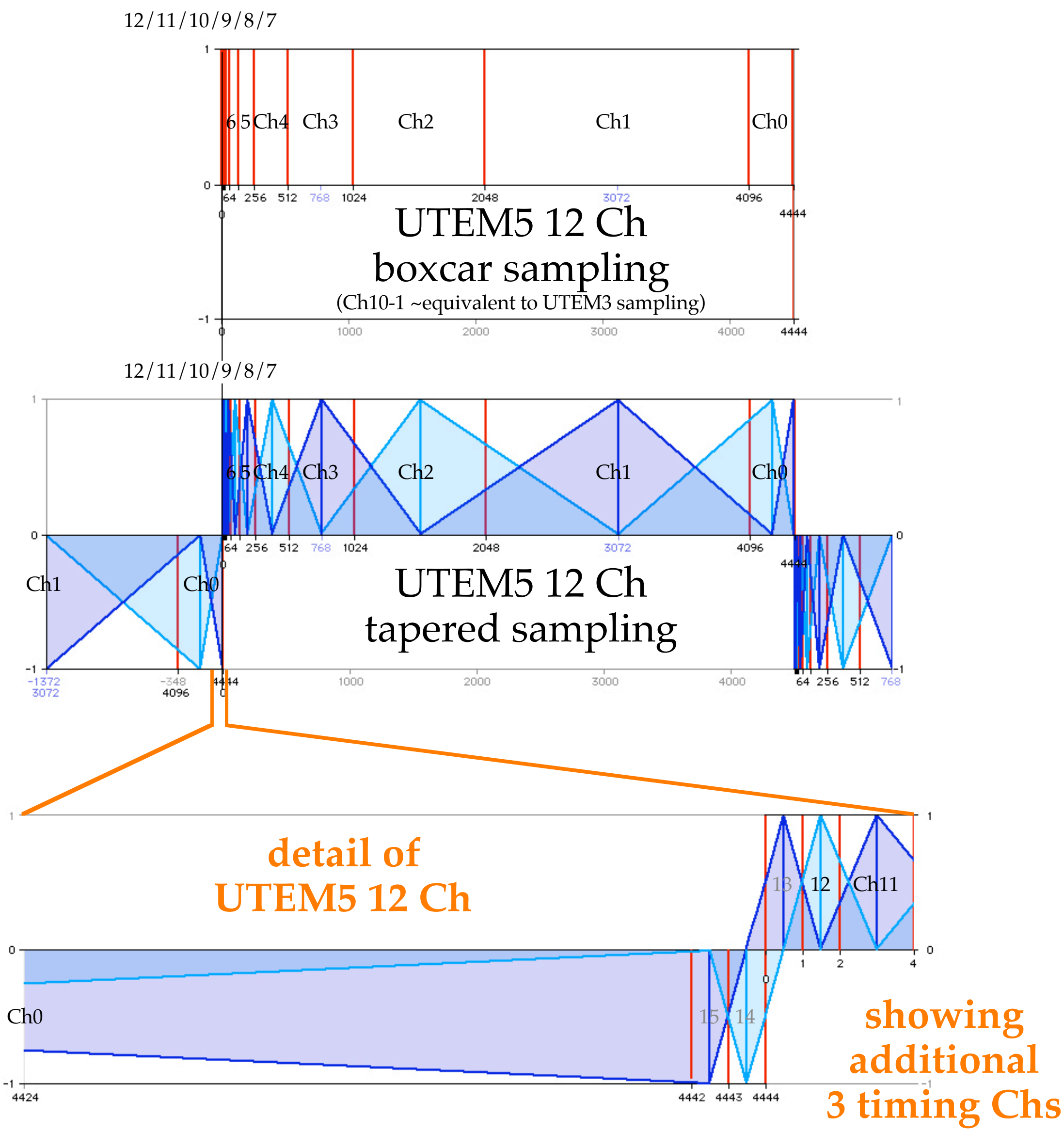
BHUTEM - the borehole version of UTEM - surveys have been carried out to depths up to 3000+ metres.

<u>System Waveform</u>

A UTEM transmitter passes a low-frequency current of a precisely regulated triangular waveform through the transmitter loop. The frequency can be set to any value within the operating range of the transmitter. A target frequency for each UTEM transmitter and the local powerline frequency are entered. The actual frequencies used are selected to be as close to the target frequencies as possible while optimising rejection of the other transmitters and powerline noise (60 Hz in North America/generally 50Hz elsewhere). Since the receiver coils responds to the time derivative of the magnetic field, the UTEM system really "sees" the step response of the ground. UTEM is the only time domain system which measures the step response of the ground. All other TDEM systems to date transmit a modified step current and "see" the (im)pulse response of the ground at the receiver. In practice, the UTEM waveform is filtered - pre-whitened - to optimize signal-to-noise. Deconvolution techniques produce the equivalent to the conceptual “step response” at the receiver.

<u>System Sampling</u>

The UTEM receiver measures the time variation of the magnetic field in the direction of the receiver coil at (typically) channels or delay times. UTEM channels are spaced in a binary, geometric progression across each half-cycle of the received waveform. Channel **12 (or Ch10)** is the earliest channel and it is $1/2^{12}$ of the half-cycle wide. Channel **1**, the latest channel, is $1/2^{1}$ of the half-cycle wide (see UTEM3 10Ch figure below and Figure C1). The measurements obtained for each of channels are accumulated over many half-cycles. The final channel value stored is the average of the measurements. The number of half-cycles averaged depends on the signal strength and the ambient noise.



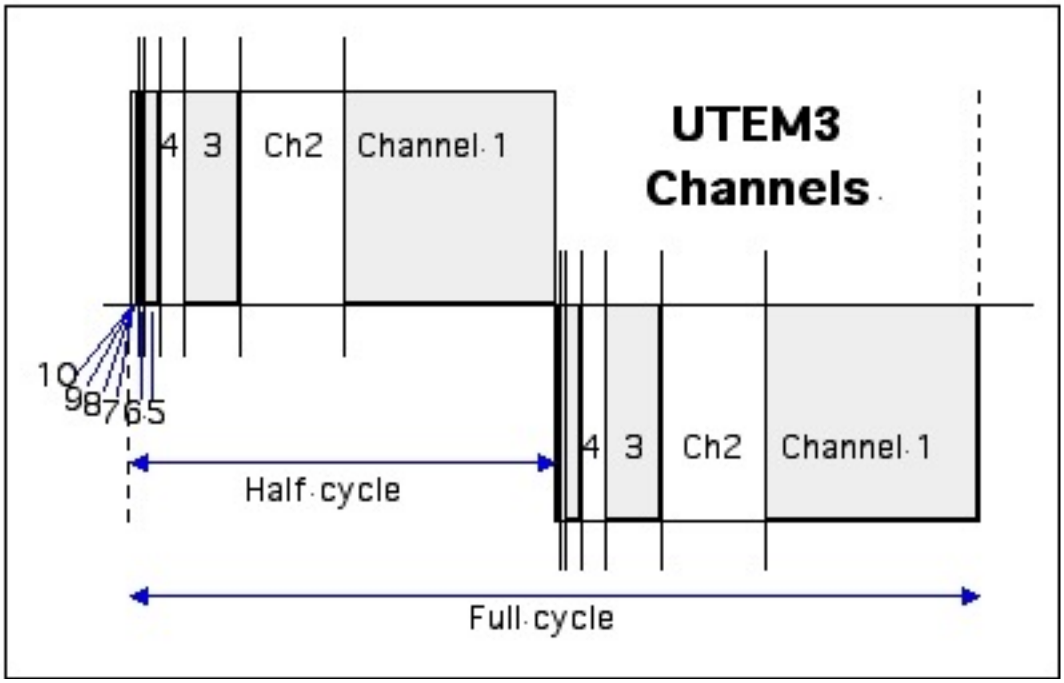

Notes:
- boxcar sampling equivalent to UTEM3 sampling
- tapered sampling: improved powerline rejection
- the use of UTEM4/5 Transmitters and UTEM5 Receivers improves syncing/timing and allows for the implementation of:
  - Ch0 - a narrow Ch after (later than) Ch1.
    - Ch0 normalization is an option
  - 3 timing channels - Ch13/14/15 shown for 12Ch UTEM5
    - improved ability to monitor Rx/Tx(s) synchronisation.
    - improved deconvolution/phase correction.

LAMONTAGNE GEOPHYSICS LTD GEOPHYSIQUE LTEE

**UTEM5 12Ch Sampling**

**boxcar/tapered options**

**Figure C1**




System Configurations

During a surface UTEM5 survey the 3-component receiver coil is oriented along the survey line and the coil orientation is determined from the data from a set of three orthogonal accelerometers in the coil in combination with the GPS coordinates of the line. The 3 measured (raw) components of the magnetic field - uvw - are oriented and resolved into:

- u the horizontal transverse component BT(ransverse) ~UTEM3 Hy
- v the vertical component Bz ~UTEM3 Hz
- w the horizontal in-line component BL(ine) ~UTEM3 Hx

Note: the UTEM System is also capable of measuring the electric field. The two horizontal components,Ex and Ey can be measured using a dipole sensor comprised of two electrodes. E-field measurements are useful for outlining resistive features to which the magnetic field is not very sensitive.

BHUTEM4 surveys employ a 3-component receiver coil - longer and smaller in diameter than the surface coil. The borehole receiver coil forms part of a down-hole receiver package used to measure the axial (along-borehole) and the two transverse components of the magnetic field. Due to the distance between coil and receiver in borehole surveys the signal must be transmitted up to the receiver. In BHUTEM the signal is transmitted to surface digitally using a kevlar-reinforced fibre-optic cable as a data link. Using a fibre-optic link avoids signal degradation problems and allows surveying of boreholes to 3000+m. The cable is also very light - the specific gravity is ~1.0 - making the cable handling hardware quite portable.

## The EM Induction Process

Any time-varying transmitted ("primary") field induces current flow in conductive regions of the ground below and around the transmitter loop (i.e. in the earth or "half-space"). This current flow produces a measurable EM field, the secondary field, which has an inherent "inertia" that resists the change in primary field direction. This "inertial" effect is called self-inductance; it limits the rate at which current can change and is only dependent on the shape and size of a conductive path.

It takes a certain amount of time for the transmitted current flow to be redirected (reversed) and re-established to full amplitude after the rate-of-change of the primary field reverses direction. This measurable reversal time is characteristic for a given conductor. In general, for a good conductor this time is greater than that of a poor conductor. This is because in a good conductor the terminal current level is greater, whereas its rate of change is limited by the inductance of the current path. The time-varying current causes an EMF in the sensor proportional to the time derivative of the current. This EMF decays with time - it vanishes when the reversal is complete - and the characteristic time of the EMF decay as measured by the sensor is referred to as the **decay time** of the conductor.

The large-scale current which is induced in the half-space by the primary field produces the half-space response as seen in typical UTEM profiles. This background response is influenced by the finite conductivity of the surrounding rock. Other currents may be induced in locally more conductive zones (conductors) that have longer decay times than the half-space response. The responses of these conductors are superimposed upon the background response. The result is that the UTEM receiver detects:

- the primary field waveform, a square-wave
- the half-space (background) response of the surrounding rock
- a slight-to-large response due to any conductors present.

The result is that in the presence of conductors the primary field waveform is substantially (and anomalously) distorted.

## UTEM DATA REDUCTION and PLOTTING CONVENTIONS

The UTEM data as it appears in the data files is in total field form in nanoTesla (nT). These are total field values - the UTEM system measures during the "on-time" and as such samples both the primary and secondary fields.

For plotting purposes, the magnetic field data are transformed to other formats as required. The following is provided as a description of the various plotting formats used for the display of UTEM data. A plot format is defined by choices of choice of the *normalization* and *field type* parameters selected for display.

**PLOT FORMATS**

UTEM results can be expressed as a % of a normalizing field at some point in space. In **continuously normalized** form the normalizing factor (the denominator) is the magnitude of the computed local primary field vector. As the primary exciting field magnitude diminishes with increasing distance from the transmitter loop the response is continuously amplified as a function of offset from the loop. Although this type of normalization considerably distorts the response shape, it permits anomalies to be easily identified at a wide range of distances from the loop.

Note: An optional form of continuous normalization permits the interpreter to normalize the response to the magnitude of the primary field vector at a fixed depth below each station. This is useful for surface profiles which come very close to the loop. Without this adjustment option, the normalizing field is so strong near the loop that the secondary effects become too small in the presence of such a large primary component. In such circumstances interpretation is difficult, however; by "normalizing at some depth" the size of the normalizing field, near the loop in particular, is reduced and the resulting profile can be more effectively interpreted to a very close distance from the transmitter wire. The usual choice for the depth is the estimated target depth.

In **Absolute** profiles the data is presented in picoTesla (pT). Data presented in this format show the non-distorted shape of the field profiles. Unfortunately, the very large range in magnitude of anomalies both near and far from the loop means that small anomalies, particularly those far from the loop, may be overlooked on this type of plot in favour of presenting larger amplitude anomalies.
Note: Selecting the correct plot scales is critical to the recognition of conductors over the entire length of a Absolute profile. This presentation is often used for interpretation where an analysis of the shape of a specific anomaly is required. Absolute profiles are therefore plotted selectively as required during interpretation. An exception to this procedure occurs where surface data has been collected entirely inside a transmitter loop. The primary field does not vary greatly inside the loop, therefore, the benefits of continuous normalization are not required in the display of such results.

## FIELD TYPE

The type of field may be either the **Total field** or the **Secondary field.** In general, it is the secondary field that is most useful for the recognition and interpretation of discrete conductors.

### UTEM Results as Secondary Fields

Because the UTEM system measures during the transmitter on-time the determination of the secondary field requires that an estimate of the primary signal be subtracted from the observations. Two estimates of the primary signal are available:

1) UTEM Channel 0

One estimate of the primary signal is the value of the latest time channel observed by the UTEM System, Channel 0. When Channel 0 is subtracted from the UTEM data the resulting data display is termed ***Channel 0 Reduced***. This reduction formula is used in situations where it can be assumed that all responses from any target bodies have decayed away by the latest time channel sampled. The Channel 0 value is then a reasonable estimate of the primary signal present during Channels 1....10/12.

In practice the ***Channel 0 Reduced*** form is most useful when the secondary response is very small at the latest delay time. In these cases Channel 0 is indeed a good estimate of the primary field and using it avoids problems due to geometric errors or transmitter loop current/system sensitivity errors.

2) Calculated primary field

An alternate estimate of the primary field is obtained by computing the primary field from the known locations of the transmitter loop and the receiver stations. When the computed primary field is subtracted from the UTEM data the resulting data display is termed ***Primary Field Reduced***.

The calculated primary field will be in error if the geometry is in error - mislocation of the survey stations or the loop vertices - or if the transmitter loop current/system sensitivity is in error. Mislocation errors from loop/station geometry may give rise to very large secondary field errors depending on the accuracy of the loop and station location method used. Transmitter loop current/ system sensitivity error is rarely greater than 2%. ***Primary Field Reduced*** is plotted in situations where a large Channel 0 response is observed. In this case the assumption that the Channel 0 value is a reasonable estimate of the primary field effect is not valid.

Note: for UTEM data profiles plotted in ***Channel 0 Reduced*** form the secondary field data for Ch0 itself are always presented in ***Primary Field Reduced*** form and are plotted on a separate axis. This plotting format serves to show any long time-constant responses, magnetostatic anomalies and/or geometric errors present in the data.

Mathematical Formulations

In the following expressions:

**Rnj** is the result plotted for the nth UTEM channel,
**R1j** is the result plotted for the latest-time UTEM channel, Channel 0,
**Chnj** is the raw component sensor value for the nth channel at station j,
**Ch1j** is the raw component sensor value for Channel 0 at station j,
**BPj** is the computed primary field component in the sensor direction
**|BP|** is the magnitude of the computed primary field at:

- a fixed station for the entire line (point normalized data)
- the local station of observation (continuously normalized data)
- a fixed depth below the station (continuously normalized at a depth).

***Channel 0 Reduced Secondary Fields*** : Here, the latest time channel, Ch0 is used as an "estimate" of the primary signal and other channels are expressed as:

**Rnj = (Chnj- Ch1j) / |BP| x 100%**

Ch0 itself is reduced by subtracting a calculation of the primary field observed in the direction of the coil, **HP** as follows:

**R1j = (Ch1j - HPj) / |BP| x 100%**

***Primary Field Reduced Secondary Fields*** **:** In this form all channels are reduced according to the equation used for Ch0 above:

**Rnj = (Chnj- BPj) / |BP| x 100%**

This type of reduction is most often used in cases where very good geometric control is available (leading to low error in the calculated primary field, **BPj**) and where very slowly decaying responses result in significant secondary field effects remaining in Ch0 observations.

## UTEM Results as a Total Field

In certain cases results are presented as a % of the **Total Field**. This display is particularly useful, in borehole surveys where the probe may actually pass through a very good conductor. In these cases the shielding effect of the conductor will cause the observed (total) field to become very small below the intersection point. This nullification due to shielding effects on the total field is much easier to see on a separate ***Total Field*** plot. In cases where the amplitude of the anomalies relative to the primary field is small, suggesting the presence of poorly conductive bodies, the ***Total Field*** plot is less useful.

The data contained in the UTEM reduced data files is in ***Total Field***, continuously normalized form if:

**Rnj = Chnj / |BP| x 100%**

## DATA PRESENTATION

All UTEM5 survey results are presented as profiles in an appendix of this report. For BHUTEM surveys the requisite Vectorplots, presented as plan and section views showing the direction and magnitude of the calculated primary field vectors for each transmitter loop, are presented in a separate appendix.

The symbols used to identify the channels on all plots (Appendix A) as well as the mean delay time for each channel (3.750Hz/12Ch) is shown in the following table (for details of frequencies used in this survey see figures in the report):

| off loop | | frequency | **3.750000** | Hz |
|---|---|---|---|---|
| | | period | 0.266667 | s |
| (5MHz clock) | | half period | 666666 | 0.2μs cycles |
| (narrowest Ch=1unit) | | XNP | **4444** | /halfperiod |
| | | width of unit channel | 3.00030E-05 | s |
| | | width of unit channel | 30.0030 | μs |
| (symbol) channel | | peak of tapered Ch (μs) | tapered Ch begins - unit - | tapered Ch ends - unit - |
| timing Ch13 | K | 15.00 | -0.5 | 1.5 |
| 12 | X | 45.00 | 0.5 | 3 |
| 11 | + | 90.01 | 1.5 | 6 |
| 10 | Φ | 180.02 | 3 | 12 |
| 9 | Y | 360.04 | 6 | 24 |
| 8 | ⧗ | 720.07 | 12 | 48 |
| 7 | Z | 1440.14 | 24 | 96 |
| 6 | ∡ | 2880.29 | 48 | 192 |
| 5 | Σ | 5760.58 | 96 | 384 |
| 4 | □ | 11521.15 | 192 | 768 |
| 3 | \ | 23042.30 | 384 | 1536 |
| 2 | / | 46084.61 | 768 | 3072 |
| 1 | \| | 92169.22 | 1536 | 4269 |
| 0 | ○ | 128082.81 | 3072 | 4442.5 |
| timing Ch15 | ≡ | 133288.33 | 4269 | 4443.5 |
| timing Ch14 | ⊟ | 133318.33 | 4442.5 | 4444+0.5 |

Note: With UTEM5 the number of Channels is routinely expanded to 12Chs (+Ch0) - from the standard UTM 10Ch sampling. There are tradeoffs involved in measuring additional earlier-time Chs - stacking time can be greatly increased by adding too many narrow(er) Chs. That said, when operating at a frequency of ~4Hz or lower, 2 Chs can be added without incurring significant penalty. 12Ch (+Ch0) sampling @4Hz brings the earliest delay time (Ch12 ) to 45.00$\mu$s - the equivalent of the earliest delay time when operating @15Hz with 10Ch sampling.

**Notes on Standard plotting formats**:

***Channel 0 Reduced*** form - The data are typically displayed on three separate axes. This permits scale expansion and allows for the accurate determination of signal decay rates. The standard configuration is:

Top axis - early time channels and a repeat of the latest channel from the centre axis for comparison are plotted at a reduced scale.

Centre axis - intermediate-to-late-time channels are plotted on the centre axis using a suitable scale.

Bottom axis -the latest time channel (Ch0) is plotted alone in ***Primary Field Reduced*** form using the same scale as the centre axis.

UTEM data in ***Primary Field Reduced*** form:

All channels are displayed on a single axis. Typically they are plotted using peak-to-peak scale values of up to -200% - 200%.

BHUTEM4 data plotted as total field profiles:

The 3 components are expressed directly as a percentage of the ***Total Field***. Each three-axis data plot shows peak values of up to 100%.
Note: the measured total field value is plotted as a polarity-reference tool.

BHUTEM data plotted as secondary field profiles:

Check the title block of the plot to determine if the data is in:
***Channel 0 Reduced*** form or in ***Primary Field Reduced*** form.
Note: the measured total field value is plotted as a polarity-reference tool.

# Appendix D

## Note on sources of anomalous Ch0

Note: The data presented in this report are channel 0 normalized - the latest time channel plotted is Ch0. Traditionally in UTEM data the latest time channel plotted has been Ch1.

## Note on sources of anomalous Ch0

This section outlines the possible sources of anomalous channel 0 which is not correlated to the Ch1-10/12 profiles on the upper axes of a channel 0 normalized plot.

1) **Mislocation of the transmitter loop and/or survey stations**

Mislocating the transmitter loop and/or the survey stations results in an error in the calculated primary field at the station and appears as an anomalous Ch0 value not correlated to channel 0 normalized Ch1-10/12. The effect is amplified near the loop front. This can be seen in the profiles - the error in Ch0 generally increases approaching the loop. As a rule a 1% error in measurement of the distance from the loop will result in, for off-loop surveys, an error in the Hz (vertical component) Ch0 of:

- 1% near the loop front (long-wire field varies as 1/r)
- 3% at a distance from the loop front (dipolar field varies as 1/r3)
- 2% at intermediate distances (intermediate field varies as ~1/r2)

The in-loop survey configuration generally diminishes geometric error since the field gradients are considerably lower. At the centre of the loop the gradient in the vertical field is essentially zero so it is difficult to introduce geometric anomalies near the loop centre. Near the loop sides and at the closest approach of the lines to the wire mislocation of the loop and the station becomes more critical. Typically loop sides are designed to be >200m from any survey stations.

Errors in elevation result in smaller errors in Hz but they can affect the chainage and accumulate along the line. Errors in elevation have a stronger affect on the two horizontal components, Hx and Hy.

2) **Magnetostatic UTEM responses**

Magnetostatic UTEM responses arise over rocks which generate magnetic anomalies. Such magnetic materials will amplify the total (primary + secondary) field of the UTEM transmitter which is sensed by the receiver coil. The secondary field is generated by subtracting a computed primary which does not include magnetic effects. This can give rise to strong and abrupt channel 0 anomalies when the source of the magnetics is at or near surface. This is the case in a number of places on these grids. UTEM magnetostatic anomalies differ from DC magnetic anomalies in the following three major ways:

1) In the case of DC magnetics the field is dipping N and is very uniform over the scale of the survey area while the UTEM field in-loop is vertical and it is stronger near the loop edges.
2) Most aeromagnetics are collected as total field while with UTEM we measure components - Bz, BL and BT..
3) DC magnetic instruments observe the total magnetization of the causative body which is due to its susceptibility as well as any remnant magnetization. An AC method such as UTEM will not respond to the remnant portion of the magnetization.

The larger amplitude of the UTEM Ch0 response is explained by the fact that the UTEM primary field is often more favourably coupled (magnetostatically speaking) to magnetic mineralization as compared to the earths field. Another factor could be the presence of a reverse remnant component to the magnetization.

Note: positive (negative) magnetic anomalies will cause:

- positive (negative) Ch0 anomalies in data collected outside the loop
- negative (positive) Ch0 anomalies in data collected inside the loop

3) **Extremely good conductors**

An extremely good conductor will be characterized by a time constant much longer than the half-period (@ 30Hz giving a time constant>>16ms). This will give rise to an anomalous Ch0 which is not correlated to the Ch1-10/12 data plotted on the upper axes of a channel 0 normalized plot.