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Ontario

-2017 UTEM5 Survey Report-
Teledyne Project UTEM Grid
Cobalt, ON
for
LiCo Energy Metals Inc.

LAMONTAGNE GEOPHYSICS LTD
GEOPHYSIQUE LTEE

February, 2017

Rob Langridge, M.Sc.

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INTRODUCTION

During the period of January 20th 2017 through January 18th 2017 a UTEM5 survey (surveying days: January 14 - 17th) was carried out by Lamontagne Geophysics Limited personnel for LiCo Energy Metals Inc. on their Teledyne Project property in the Cobalt, ON area. The survey covered the Teledyne Project UTEM Grid - location/layout of the Teledyne Project UTEM 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 3.000 line km of 3-component - BL/BT/Bz - 2 transmitter-loop UTEM5 data was collected using a total of four transmitter loops two sets of paired loops(Figure 2). The basic coverage consisted of three-component data collected from two loops simultaneously. The survey frequencies and coverage for the survey are summarized below

Teledyne Project UTEM Grid **3.000km total** (3.000km 2 loop coverage)

E-W Lines covering Lines 1450N to 1750N: 1.500km total

S1:	5.2273Hz (off-loop - loop to the gridWest)	Loop 1B
S2:	4.0909Hz (side-loop - loop to the gridSouth)	Loop 2B

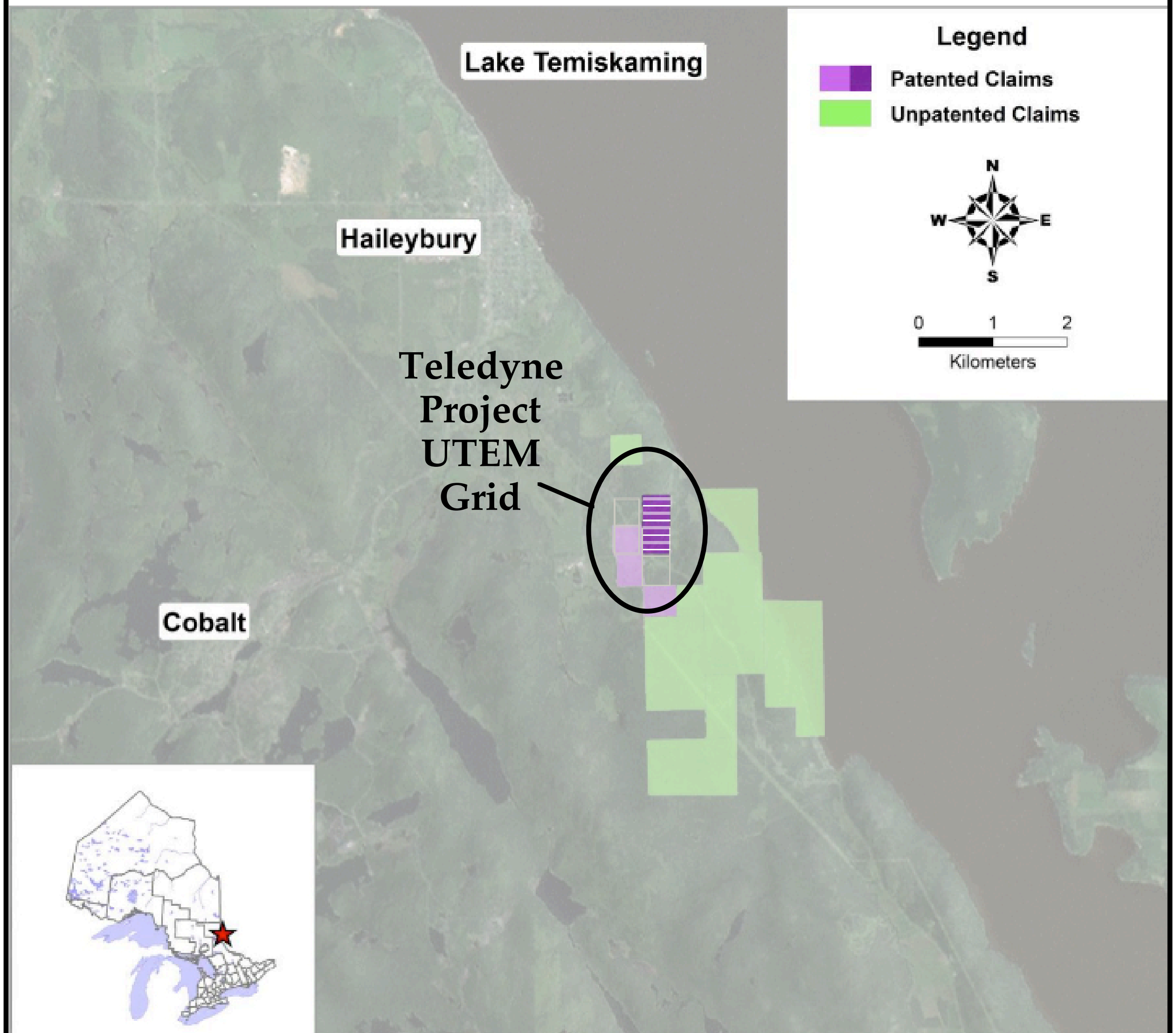
E-W Lines covering Lines 1850N to 2150N: 1.500km total

S1:	5.2273Hz (off-loop - loop to the gridWest)	Loop 1A
S2:	4.0909Hz (side-loop - loop to the gridSouth)	Loop 2A

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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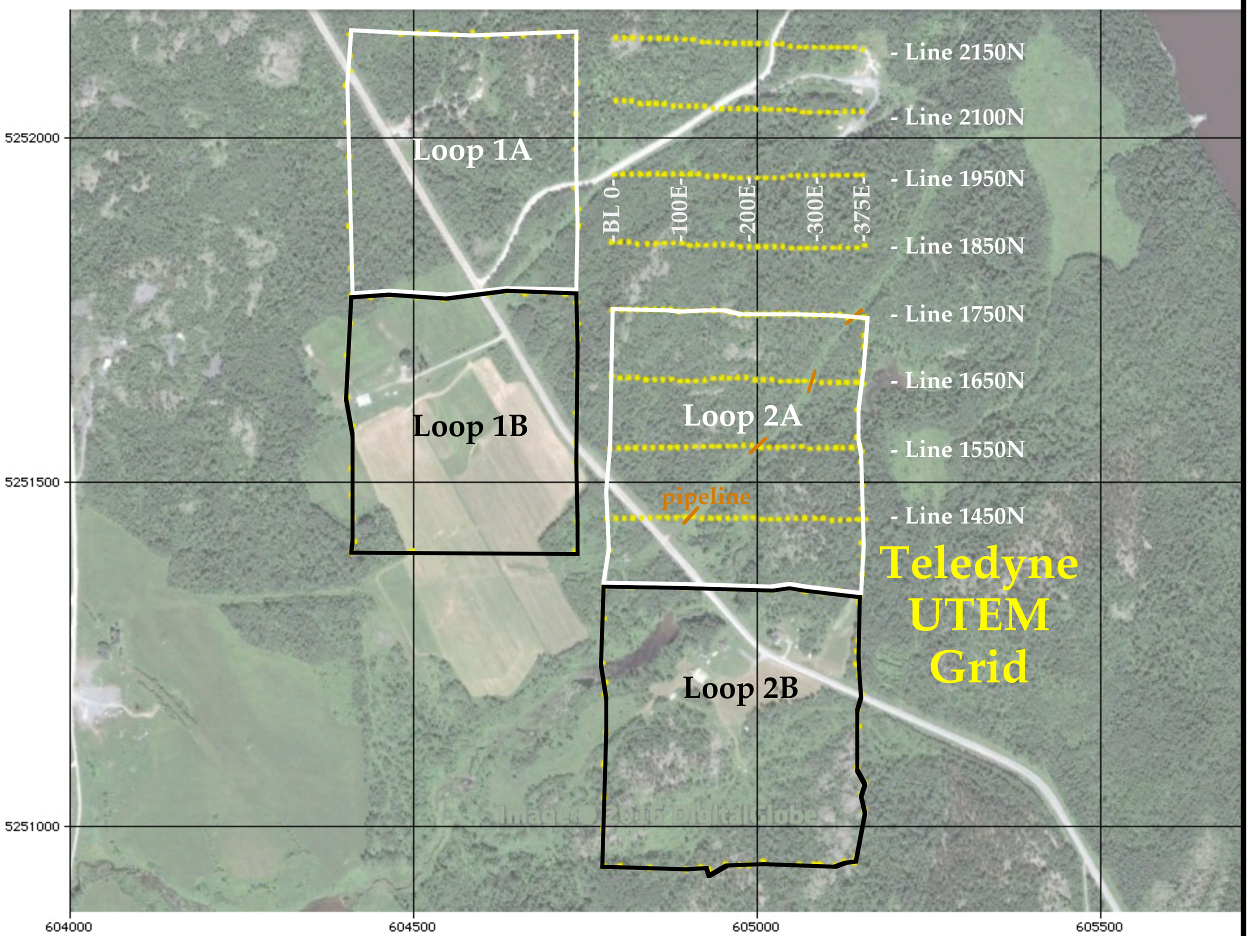
LiCo Energy Metals Inc.
Teledyne Project UTEM Grid UTEM5 Survey

Figure 1



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LiCo Energy Metals Inc.
Teledyne Project UTEM Grid - UTEM5 Survey

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 LiCo Energy Metals personnel in consultation with Lamontagne Geophysics. Loop size and location were selected to provide good general coupling - from two perpendicular directions - and to allow efficient coverage of the area of interest.

The survey parameters employed are as follows:

- survey line azimuth: LAZ=090
  Note: in the 3C Plotter (see below: Note on digital data and 3C Plotter) LAZ is adjustable to maximize/minimize the coupling of a response.
- line spacing of: 100m for E-W Lines 1450- 2150N
  Note: if required, intermediate lines available for surveying to bring the line spacing down to 50m.
- station interval of 12.5m to be reduced if required for detailing responses.
- 3-component measurements from a pair of Transmitter loops simultaneously with one loop to the gridWest and the other to the gridSouth:

Teledyne Project UTEM Grid:

pair:	Loop 1B	5.2273Hz - loop to the gridWest	~340x400m loop
	+ Loop 2B	4.0909Hz - side-loop to the gridSouth	~380x410m loop
pair:	Loop 1A	5.2273Hz - loop to the gridWest	~340x400m loop
	+ Loop 2A	4.0909Hz - side-loop to the gridSouth	~380x410m loop

- 12Ch double (minimum 167s) stacking (additional as required) as follows: frequencies for coverage (in the ratio 23:18) (Figure 3):
  - 5.2273Hz S1 - Area 5 Loops 2017-19/8
    average stacking 2x167sec stacking = 1748 full-cycles/3496 half-cycles
  - 4.0909Hz S2 Area 5 Loop E-1 and Loops 2017-20
    average stacking 2x167sec stacking = 1368 full-cycles/2736 half-cycles

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

The LGL crews routinely collect handheld-GPS (Garmin eTrex) data for all transmitter loops for the purpose of control. These data were used to generate UTM (NAD83) locations for all survey stations and the transmitter loops.

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). As a result we recommend that all transmitter loops and all stations surveyed be DGPSed for both accuracy and consistency.

Sampling 1
5.227Hz

off loop	frequency	**5.227282** Hz	**Sampling 1**
	period	0.191304 s	**Loop 1A/1B**
(5MHz clock)	half period	478260 0.2µs cycles	
(narrowest Ch=1unit)	XNP	**4444** /halfperiod	
	width of unit channel	2.15239E-05 s	
	width of unit channel	21.5239 µs	

(symbol) channel		peak of tapered Ch (µs)	tapered Ch begins - unit -	tapered Ch ends - unit -	Maxwell equivalent boxcar Ch mid point (ms)	width (ms)
timing Ch13	⅄	10.76	-0.5	1.5	0.0108	0.0215
12	✗	32.29	0.5	3	0.0351	0.0269
11	+	64.57	1.5	6	0.0732	0.0484
10	Φ	129.14	3	12	0.1464	0.0969
9	⊽	258.29	6	24	0.2929	0.1937
8	⧖	516.57	12	48	0.5858	0.3874
7	⁊	1033.14	24	96	1.1716	0.7749
6	∡	2066.29	48	192	2.3431	1.5497
5	Σ	4132.58	96	384	4.6862	3.0994
4	□	8265.16	192	768	9.3725	6.1989
3	＼	16530.32	384	1536	18.745	12.3977
2	／	33060.64	768	3072	37.4899	24.7955
1	|	66121.28	1536	4269	64.2438	29.4124
0	○	91885.33	3072	4442.5	85.6149	14.7492
timing Ch15	☰	95619.72	4269	4443.5	-1.1185	1.878
timing Ch14	⊟	95641.24	4442.5	4444+0.5	-0.0108	0.0215

TSS: sub-stack time =	**4.399992**	s
StackN: number of substacks =	**38**	substacks
stacking time =	167.20	s
cycles stacked =	874	cycles
half-cycles stacked =	1748	half-cycles

Sampling 2
4.091Hz

off loop	frequency	**4.090916** Hz	**Sampling 2**
	period	0.244444 s	**Loop 2A/2B**
(5MHz clock)	half period	611110 0.2µs cycles	
(narrowest Ch=1unit)	XNP	**4444** /halfperiod	
	width of unit channel	2.75027E-05 s	
	width of unit channel	27.5027 µs	

(symbol) channel		peak of tapered Ch (µs)	tapered Ch begins - unit -	tapered Ch - unit -	Maxwell equivalent boxcar Ch mid point (ms)	width (ms)
timing Ch13	⅄	13.75	-0.5	1.5	0.0138	0.0275
12	✗	41.25	0.5	3	0.0448	0.0344
11	+	82.51	1.5	6	0.0936	0.0619
10	Φ	165.02	3	12	0.1871	0.1238
9	⊽	330.03	6	24	0.3742	0.2475
8	⧖	660.06	12	48	0.7485	0.495
7	⁊	1320.13	24	96	1.497	0.9901
6	∡	2640.26	48	192	2.994	1.9802
5	Σ	5280.52	96	384	5.988	3.9604
4	□	10561.04	192	768	11.9759	7.9208
3	＼	21122.08	384	1536	23.9519	15.8415
2	／	42244.15	768	3072	47.9037	31.6831
1	|	84488.31	1536	4269	82.0893	37.5824
0	○	117409.04	3072	4442.5	109.3967	18.8462
timing Ch15	☰	122180.76	4269	4443.5	-1.4291	2.3996
timing Ch14	⊟	122208.26	4442.5	4444+0.5	-0.0138	0.0275

TSS: sub-stack time =	**4.399992**	s
StackN: number of substacks =	**38**	substacks
stacking time =	167.20	s
cycles stacked =	684	cycles
half-cycles stacked =	1368	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 will 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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LiCo Energy Metals Inc.
UTEM5 Survey
Frequency / Chs details

Figure 3

SURVEY LOGISTICS

A Lamontagne Geophysics crew and survey equipment mobilized from another jobsite to Haileybury, Ontario on January 12th. 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 Mathieu Savage (field assistant). The location of the project is shown in Figure 1 and the Teledyne Project UTEM Grid location is shown in Figure 2.

Loop deployment began on January 13th with Loops 1A and 2A. This transmitter loop pair was used to survey the four northern-most E-W lines (L18+50N to L21+50N). Road crossing were marked and connected daily for surveying and left open over night.The initial loop pair was surveyed over two days: January 14th and January 15th.

On January 16th the second loop pair - Loops 1B and 2B were deployed and wire was removed from Line 1750N to allow the surveying of the remaining 4 E-W lines (L14+50N to L17+50N). Surveying from Loops 1B and 2B was competed over two days: January 16th and January 18th. This completed the planned surveying.

After completion of coverage @100m line spacing the decision was made not to survey the intermediate survey lines (@50m). This completed the UTEM5 survey and all the equipment was packed up. The loop wire was picked up the morning of January 18th and the crew and equipment demobilized over January 18th and 19th. A detailed description of the Teledyne Project UTEM 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 4x4 truck and on foot/snowshoe. 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 to the client.

SURVEY RESULTS

The results of the survey are summarized and presented as UTEM5 profiles in Appendix A. The final Teledyne Project UTEM 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. There are several large powerline responses present in the profiles. In addition, the early-time response of a pipeline cuts across the Loop 1B/2B profiles at:

Line 1750N: between 350/362.5E
Line 1650N: between 287.5/300E
Line 1550N: between 212.5/225E
Line 1450N: between 112.5/125E

Note: The Ch0 (latest time channel) profiles should be considered in conjunction with other available information (Appendix D). The UTM grid used and the loop locations have been generated from handheldGPS data - much of the character in the Ch0 profiles reflects this. Poor geometric control has the potential to both mask and invent Ch0 (latest time) conductors (Appendix D). As a result we recommend that all transmitter loops and all stations surveyed be DGPSed for both accuracy and consistency.

For each line surveyed the continuously normalized profiles have been plotted for the three components collected covering the Teledyne Project UTEM 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 7 late Chs: Chs6-Ch1 and Ch0

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

Teledyne Project UTEM Grid

Loop 1B	S1:	5.2273Hz	Lines	1450N	to	1750N
+ Loop 1A	S1:	5.2273Hz	Lines	1850N	to	2150N
Loop 2B	S2:	4.0909Hz	Lines	1450N	to	1750N
+ Loop 2A	S2:	4.0909Hz	Lines	1850N	to	2150N

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 and 3C Plotter:

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

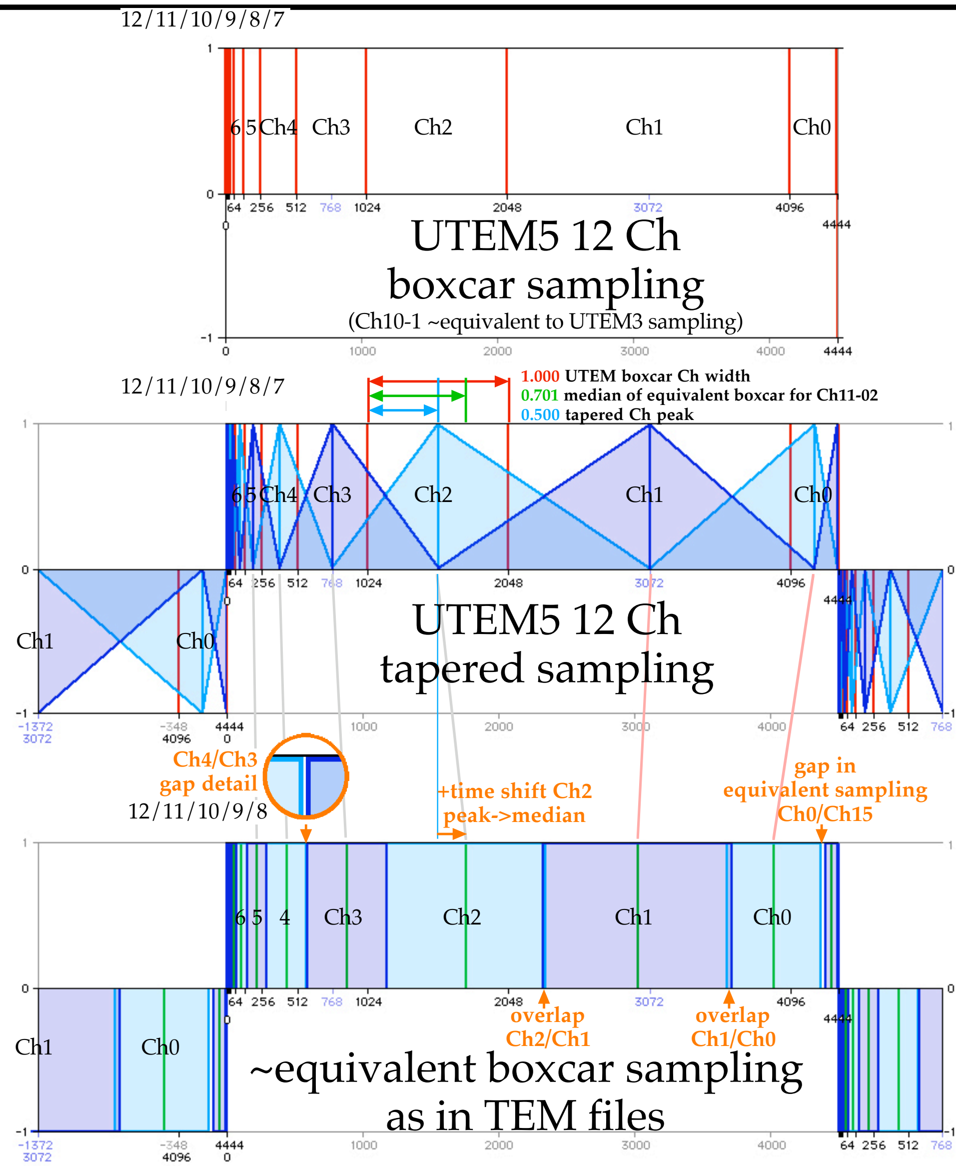
https://www.lamontagnegeophysics.com/plotter/

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

One of the useful features of the 3C Plotter is the ability to rotate 3-component data. Surface data can be rotated abo
t a vertical axis, effectively changing the LAZ (Line AZimuth). Rotating the LAZ allows maximization/minimization of the coupling of the two horizontal components - aiding in the determination of the local strike direction or the direction pointing to a feature. For Borehole data the Section azimuth is selectable/can be rotated. Again this allows a response to be rotated for maximization/minimization of the coupling - aiding greatly in determining distance/direction to an off-hole feature or to the edge of an in-hole feature.

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

Figure 4

Appendix A

1714 UTEM5 Profiles

UTEM5 Survey

Teledyne Project UTEM Grid
Cobalt, ON

for

LiCo Energy Metals Inc.

Presentation

The results of the survey are summarized and presented as UTEM5 profiles in Appendix A. The final Teledyne Project UTEM 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. There are several large powerline responses present in the profiles. In addition, the early-time response of a pipeline cuts across the Loop 1B/2B profiles at:

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- • all Chs: from Ch12-Ch1 and Ch0
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Teledyne Project UTEM Grid

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+ Loop 1A	S1:	5.2273Hz	Lines	1850N	to	2150N
Loop 2B	S2:	4.0909Hz	Lines	1450N	to	1750N
+ Loop 2A	S2:	4.0909Hz	Lines	1850N	to	2150N

Note: all UTEM5 reports present data as:

- BL - in-line horizontal component (c1) - UTEM3 ~equivalent - Hx
  the L-azimuth direction is selectable
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  the T-azimuth direction is 90° counterclockwise from L-azimuth
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Outline of profile types:

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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

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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

LiCo Energy Metals Inc. (1714)
Teledyne Project UTEM Grid - UTEM5 Surface coverage

Loop	Line	Coverage	m	components
Loop 1B	(@ **5.227282Hz**)	off-loop - loop to the gridWest		
Loop 2B	(@ **4.090916Hz**)	side-loop - loop to the gridSouth		
2 Loop	Line 1450N	000 - 375E	375m	BL/BT/Bz
coverage	Line 1550N	000 - 375E	375m	BL/BT/Bz
	Line 1650N	000 - 375E	375m	BL/BT/Bz
	Line 1750N	000 - 375E	375m	BL/BT/Bz
Loop 1A	(@ **5.227282Hz**)	off-loop - loop to the gridWest		
Loop 2A	(@ **4.090916Hz**)	side-loop - loop to the gridSouth		
2 Loop	Line 1850N	000 - 375E	375m	BL/BT/Bz
coverage	Line 1950N	000 - 375E	375m	BL/BT/Bz
	Line 2050N	000 - 375E	375m	BL/BT/Bz
	Line 2150N	000 - 375E	375m	BL/BT/Bz

Teledyne UTEM **Grid Total:** **2 loop coverage 3000m**

Teledyne Project UTEM5 Survey Total:

- 3000m UTEM5 2 Transmitter BL/BT/Bz line coverage

equalling:

- 18000m UTEM5 single component/single Tx coverage
- 6000m UTEM5 1 loop coverage
- 3000m UTEM5 **5.2273Hz** BL/BT/Bz coverage
- 3000m UTEM5 **4.0909Hz** BL/BT/Bz coverage

Teledyne Project UTEM Grid

Loop 1B/1A

BL/BT/Bz

~5.227Hz frequency

continuous norm

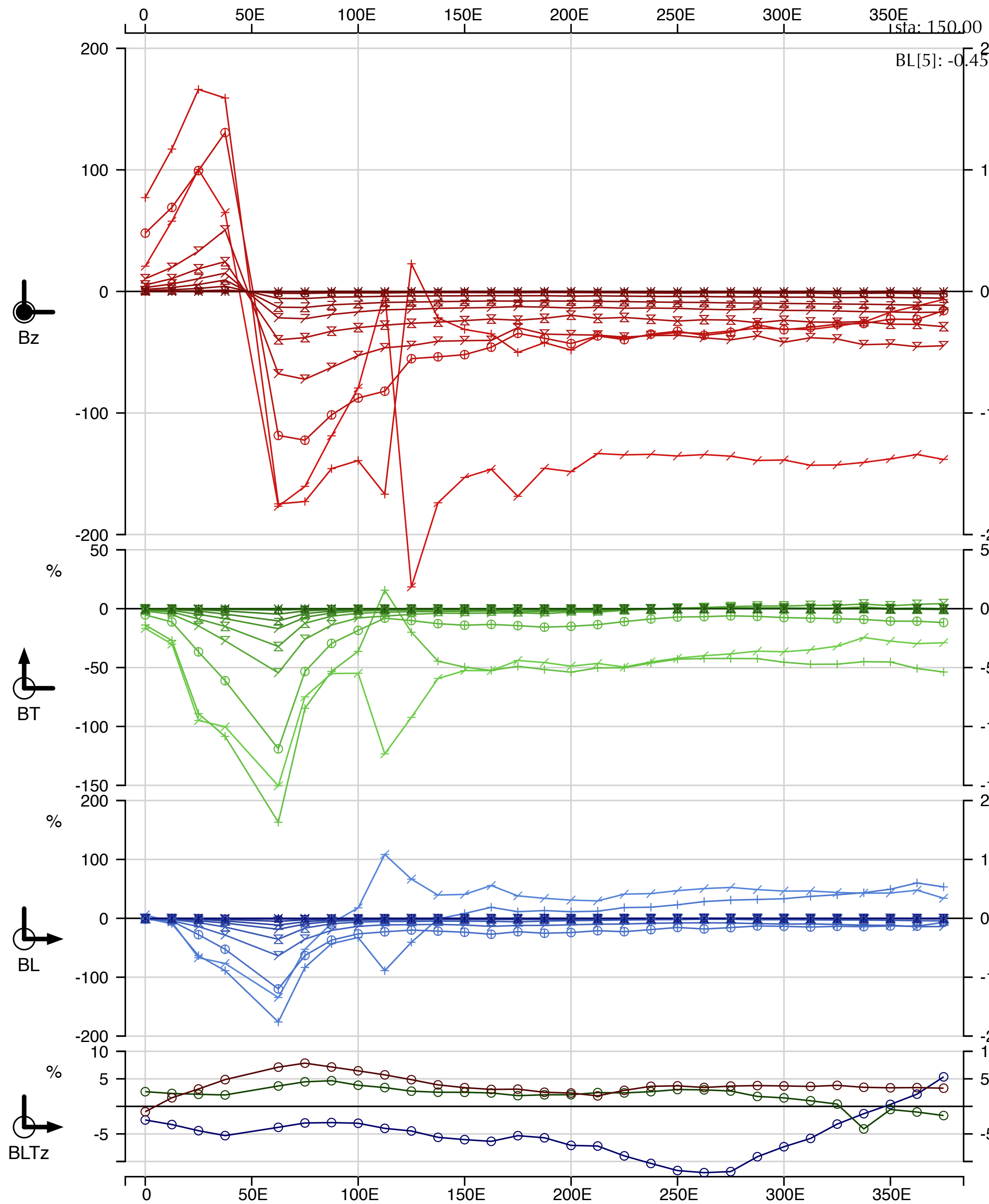
12Ch - Ch0 reduced

all Chs plotted

Loop 1B	(@ **5.227282Hz**)	off-loop - loop to the gridWest		
2 Loop	Line 1450N	000 - 375E	375m	BL/BT/Bz
coverage	Line 1550N	000 - 375E	375m	BL/BT/Bz
	Line 1650N	000 - 375E	375m	BL/BT/Bz
	Line 1750N	000 - 375E	375m	BL/BT/Bz

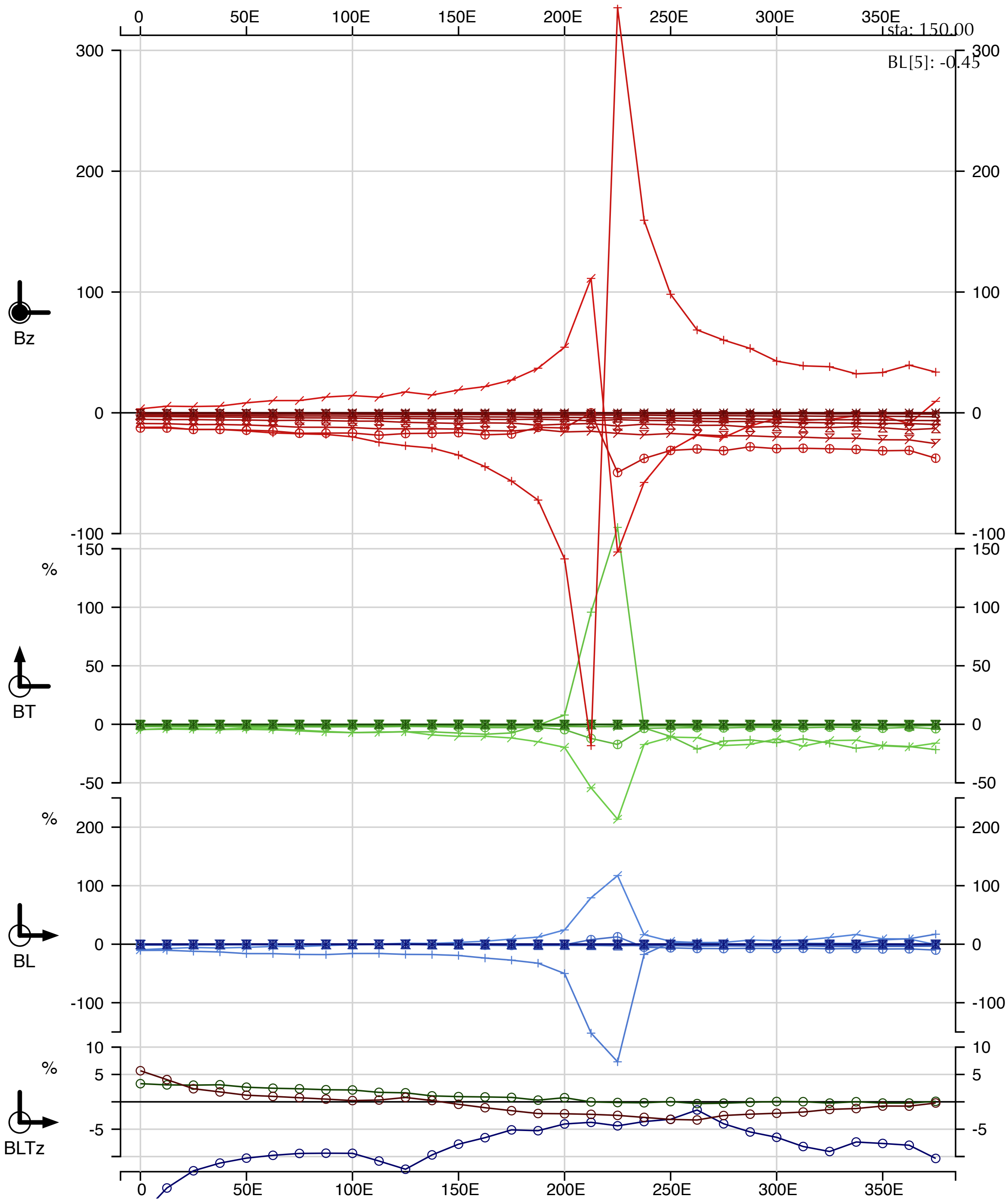
Loop 1A	(@ **5.227282Hz**)	off-loop - loop to the gridWest		
2 Loop	Line 1850N	000 - 375E	375m	BL/BT/Bz
coverage	Line 1950N	000 - 375E	375m	BL/BT/Bz
	Line 2050N	000 - 375E	375m	BL/BT/Bz
	Line 2150N	000 - 375E	375m	BL/BT/Bz

Loop 1B/1A - all Chs - B_{LTZ}



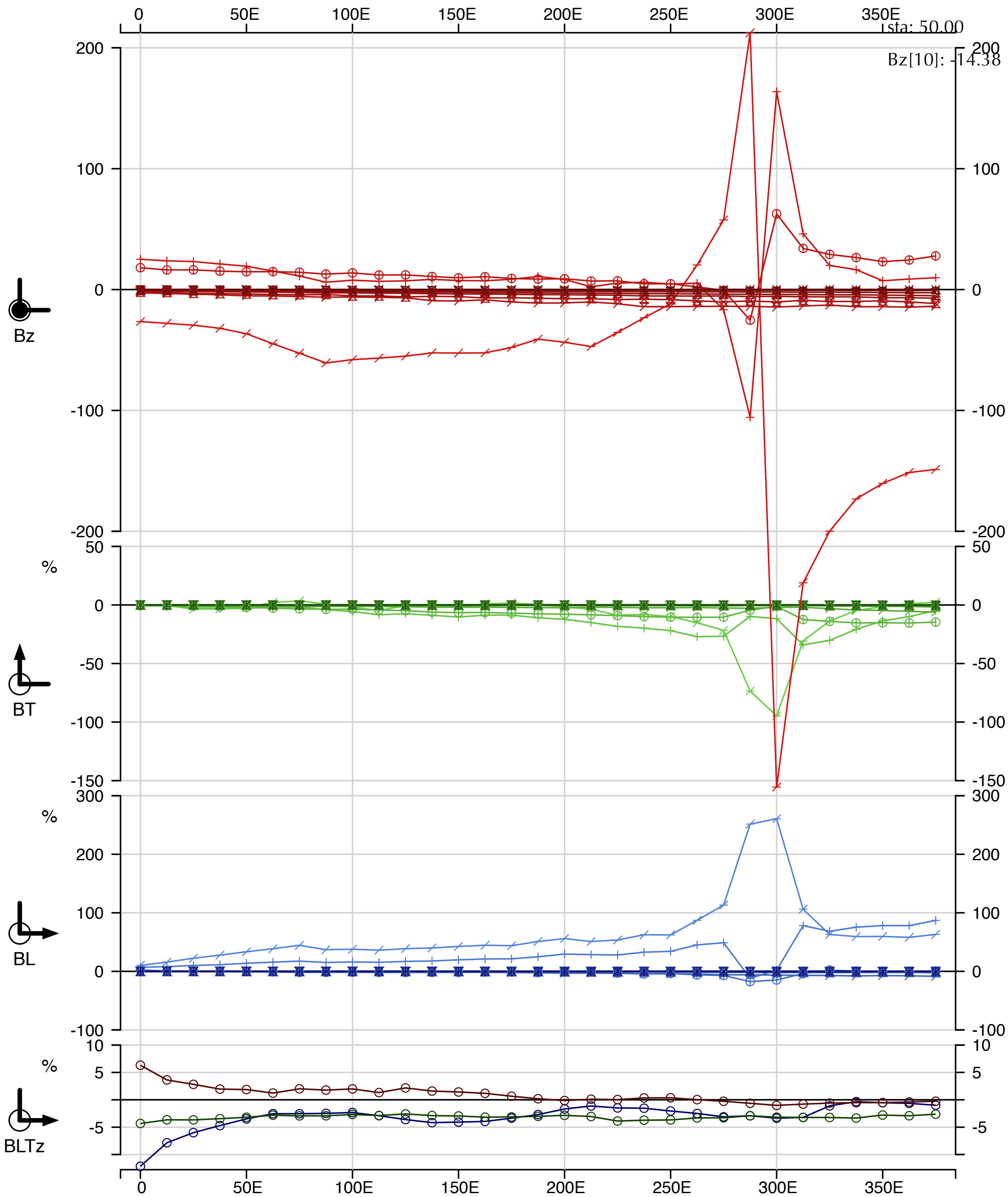
Line: L1450NA Loop: 1BS1 Cpt: BL, BT, Bz L 90.0°	(Chn - Ch0) / |Bp| (%) Cont norm @ Δz: 0m Base Freq: 5.22728Hz aLp1BS1_L1450NA.3cH5 / 3-Axis S1 LiCo	UTEM-5 Survey at: LiCo For: LiCo LAMONTAGNE GEOPHYSICS LTD GEOPHYSIQUE LTÉE Job 1701 Surv: 16/1/17 Red: 21/1/17 Plot: 26/1/17

Loop 1B - all Chs - B_{LTZ}



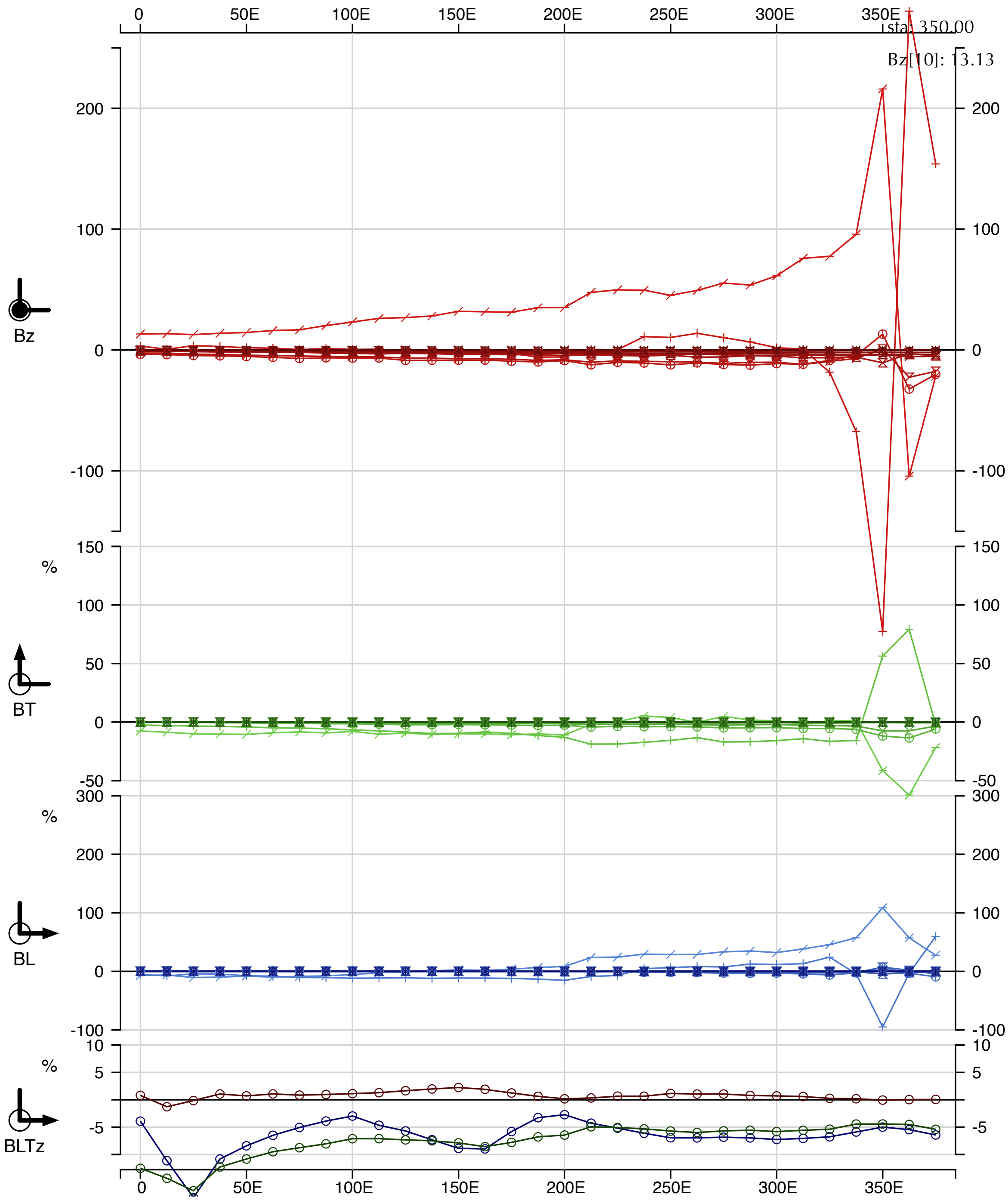
Line: L1550NA Loop: 1BS1 Cpt: BL, BT, Bz L 90.0°	(Chn - Ch0) / |Bp| (%) Cont norm @ Δz: 0m Base Freq: 5.22728Hz aLp1BS1_L1550NA.3cH5 / 3-Axis S1 LiCo*	UTEM-5 Survey at: LiCo For: LiCo LAMONTAGNE GEOPHYSICS LTD GEOPHYSIQUE LTÉE Job 1701 Surv: 16/1/17 Red: 21/1/17 Plot: 26/1/17

Loop 1B - all Chs - B_{LTZ}



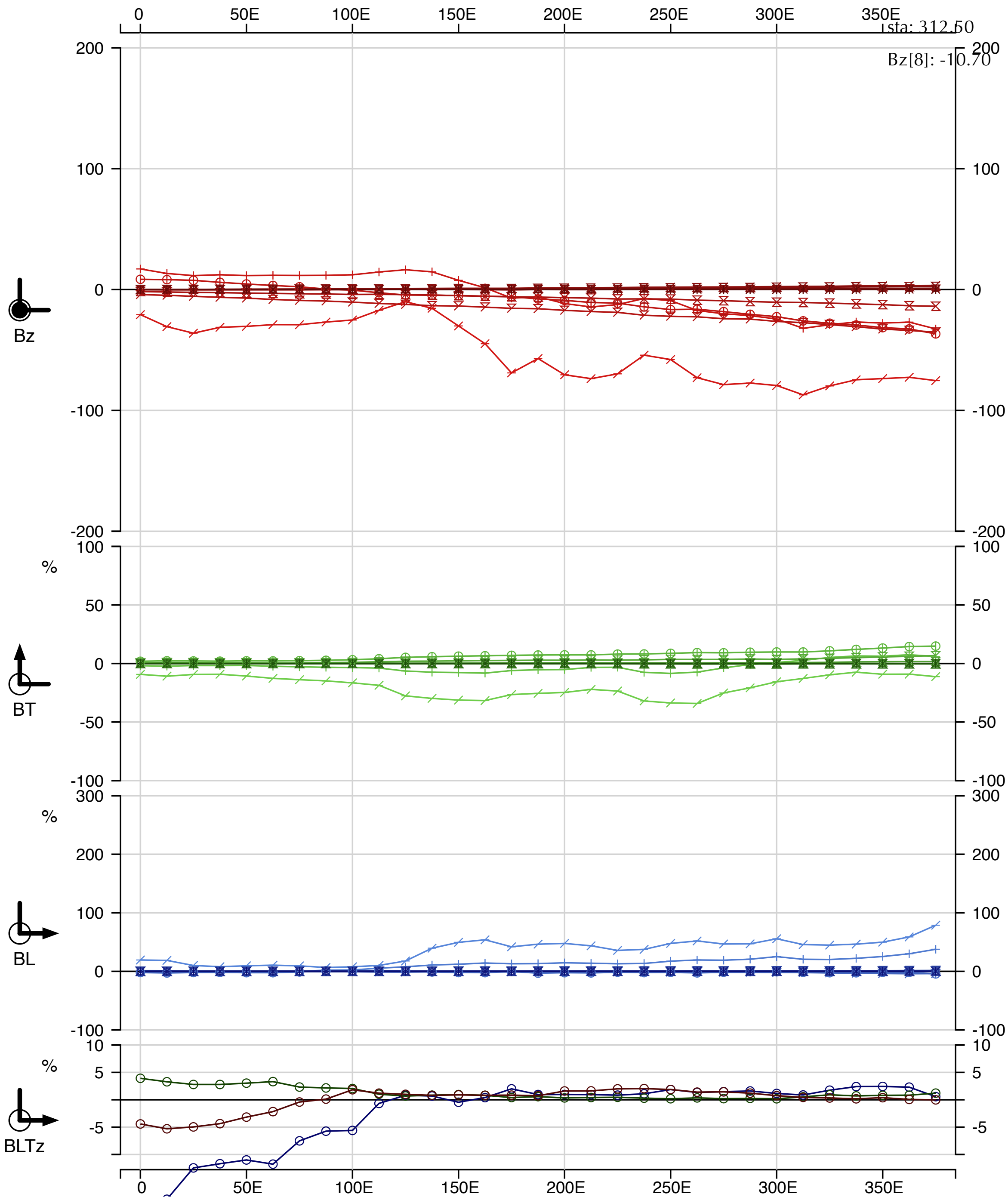
Line: L1650NA Loop: 1BS1 Cpt: BL, BT, Bz L 90.0°	(Chn - Ch0) / |Bp| (%) Cont norm @ Δz: 0m Base Freq: 5.22728Hz aLp1BS1_L1650NA.3cH5 / 3-Axis S1 LiCo*	UTEM-5 Survey at: LiCo For: LiCo LAMONTAGNE GEOPHYSICS LTD GEOPHYSIQUE LTÉE Job 1701 Surv: 17/1/17 Red: 21/1/17 Plot: 26/1/17

Loop 1B - all Chs - B_{LTZ}



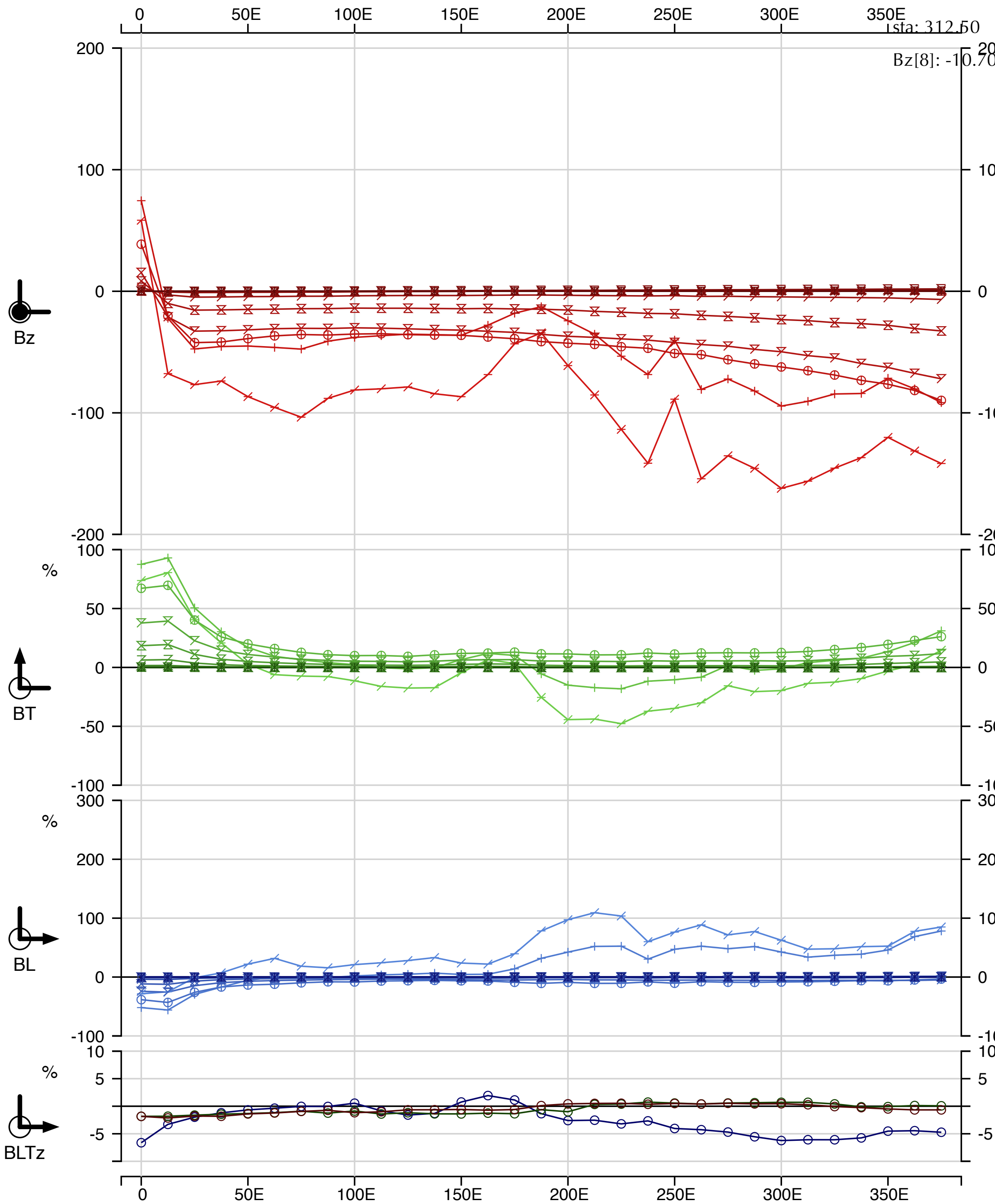
Line: L1750NA Loop: 1BS1 Cpt: BL, BT, Bz L 90.0°	(Chn - Ch0) / |Bp| (%) Cont norm @ Δz: 0m Base Freq: 5.22728Hz aLp1BS1_L1750NA.3cH5 / 3-Axis S1 LiCo*	UTEM-5 Survey at: LiCo For: LiCo LAMONTAGNE GEOPHYSICS LTD GEOPHYSIQUE LTÉE Job 1701 Surv: 17/1/17 Red: 21/1/17 Plot: 26/1/17

Loop 1B - all Chs - B_{LTZ}



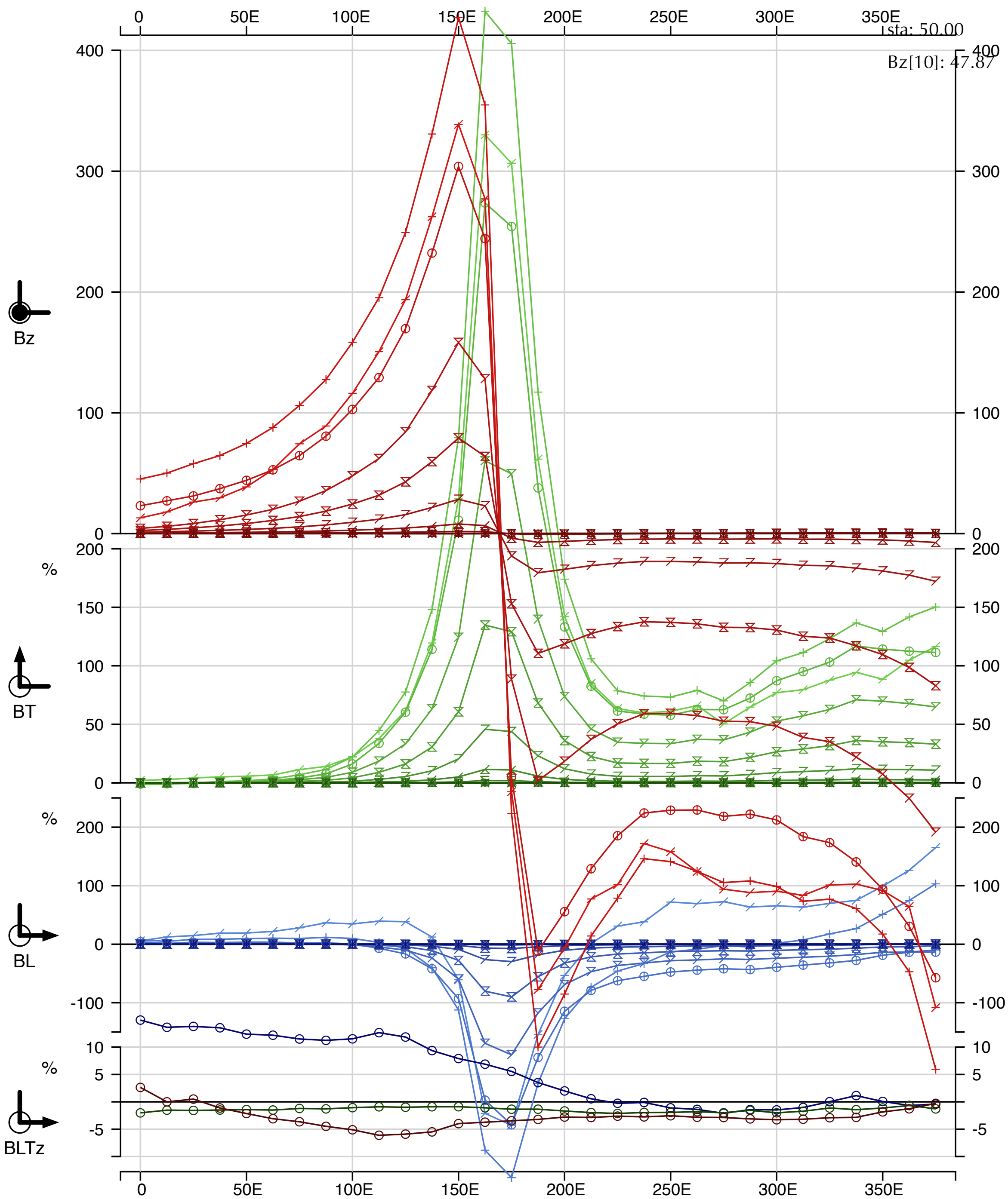
Line: L1850NA Loop: 1AS1 Cpt: BL, BT, Bz L 90.0°	(Chn - Ch0) / |Bp| (%) Cont norm @ Δz: 0m Base Freq: 5.22728Hz aLp1AS1_L1850NA.3cH5 / 3-Axis S1 LiCo*	UTEM-5 Survey at: LiCo For: LiCo LAMONTAGNE GEOPHYSICS LTD GEOPHYSIQUE LTÉE Job 1701 Surv: 15/1/17 Red: 21/1/17 Plot: 26/1/17

Loop 1A - all Chs - B_{LTZ}



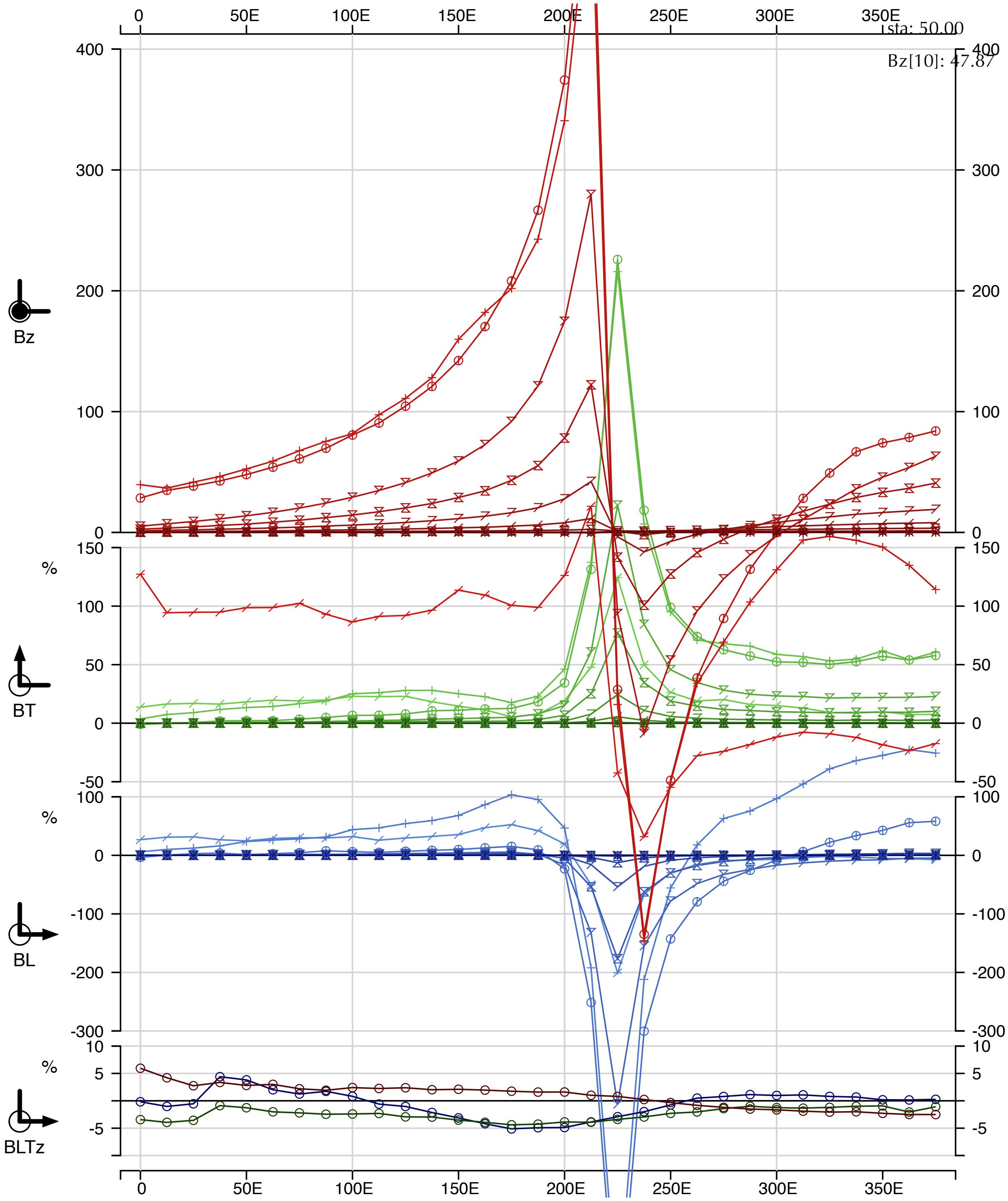
Line: L1950NA Loop: 1AS1 Cpt: BL, BT, Bz L 90.0°	(Chn - Ch0) / |Bp| (%) Cont norm @ Δz: 0m Base Freq: 5.22728Hz aLp1AS1_L1950NA.3cH5 / 3-Axis S1 LiCo*	UTEM-5 Survey at: LiCo For: LiCo LAMONTAGNE GEOPHYSICS LTD GEOPHYSIQUE LTÉE Job 1701 Surv: 15/1/17 Red: 21/1/17 Plot: 26/1/17

Loop 1A - all Chs - B_{LTZ}



Line: L2050NA Loop: 1AS1 Cpt: BL, BT, Bz L 90.0°	(Chn - Ch0) / |Bp| (%) Cont norm @ Δz: 0m Base Freq: 5.22728Hz aLp1AS1_L2050NA.3cH5 / 3-Axis S1 LiCo*	UTEM-5 Survey at: LiCo For: LiCo LAMONTAGNE GEOPHYSICS LTD GEOPHYSIQUE LTÉE Job 1701 Surv: 14/1/17 Red: 21/1/17 Plot: 26/1/17

Loop 1A - all Chs - B_{LTZ}



Line: L2150NA Loop: 1AS1 Cpt: BL, BT, Bz L 90.0°	(Chn - Ch0) / |Bp| (%) Cont norm @ Δz: 0m Base Freq: 5.22728Hz aLp1AS1_L2150NA.3cH5 / 3-Axis S1 LiCo*	UTEM-5 Survey at: LiCo For: LiCo LAMONTAGNE GEOPHYSICS LTD GEOPHYSIQUE LTÉE Job 1701 Surv: 14/1/17 Red: 21/1/17 Plot: 26/1/17

Loop 1A - all Chs - B_{LTZ}

Teledyne Project UTEM Grid

Loop 1B/1A

BL/BT/Bz

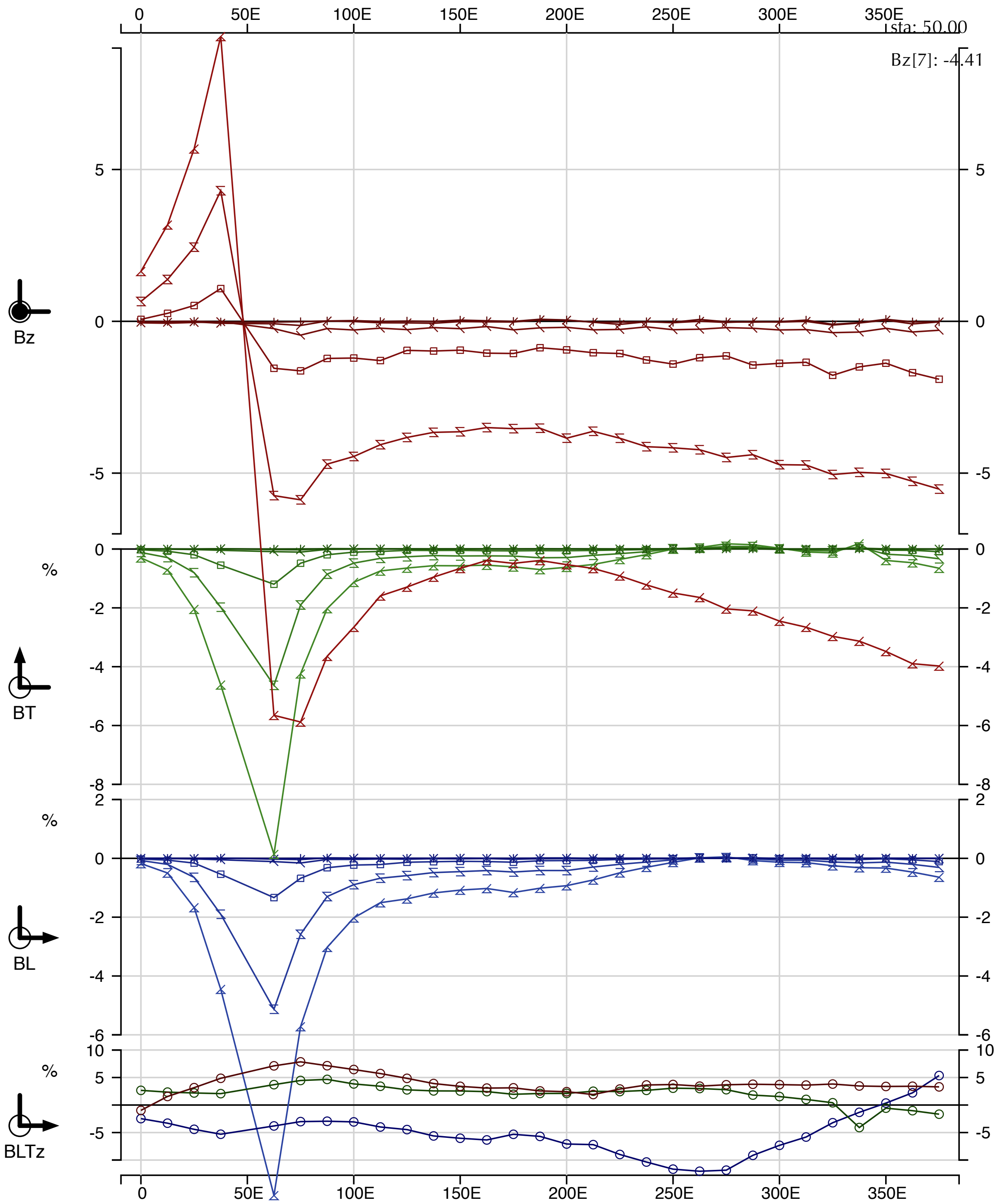
~5.227Hz frequency

continuous norm

12Ch - Ch0 reduced

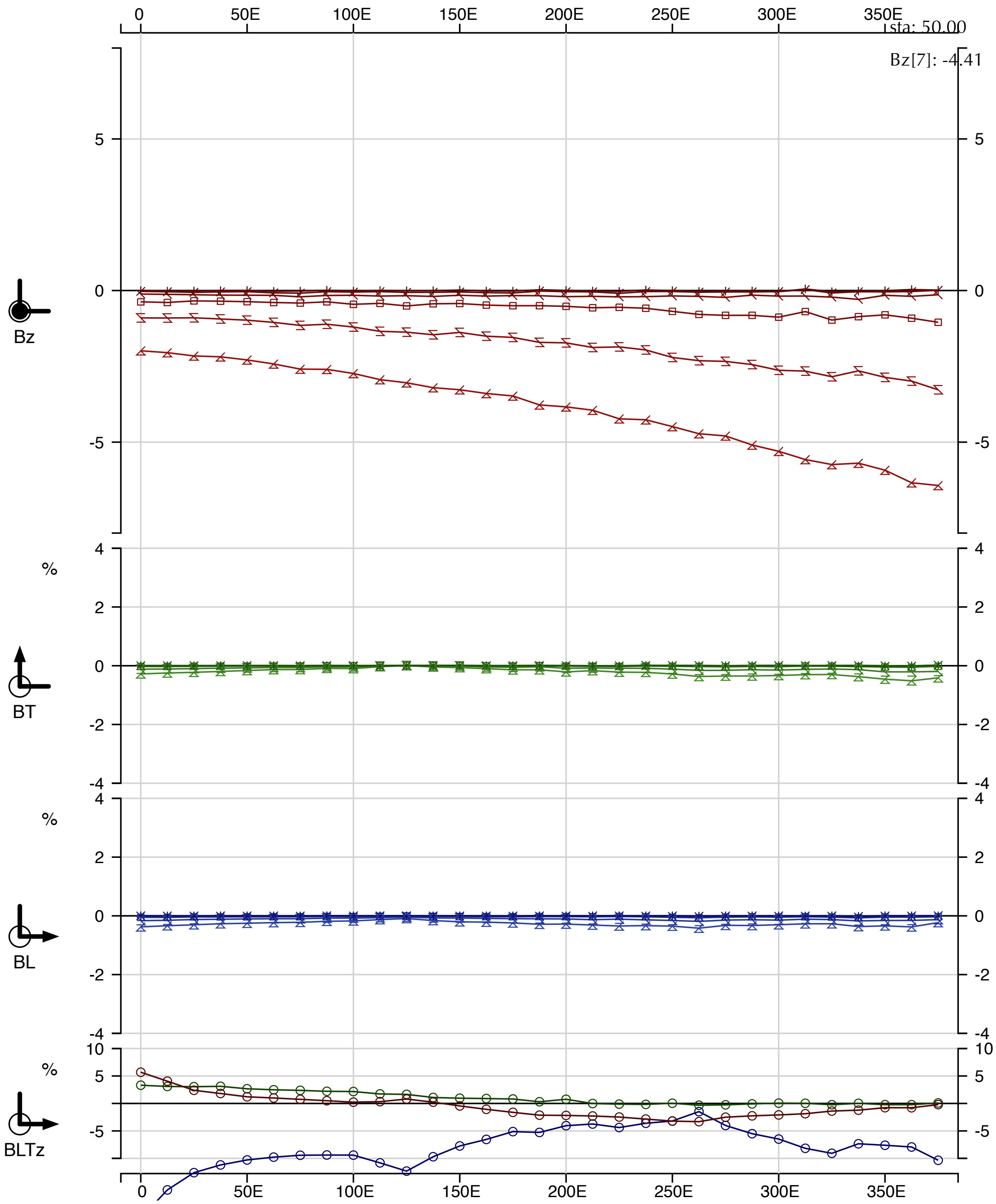
late Chs6-Ch0 plotted

Loop 1B	(@ **5.227282Hz**)	off-loop - loop to the gridWest			
2 Loop	Line 1450N	000 - 375E	375m	BL/BT/Bz	
coverage	Line 1550N	000 - 375E	375m	BL/BT/Bz	
	Line 1650N	000 - 375E	375m	BL/BT/Bz	
	Line 1750N	000 - 375E	375m	BL/BT/Bz	
Loop 1A	(@ **5.227282Hz**)	off-loop - loop to the gridWest			
2 Loop	Line 1850N	000 - 375E	375m	BL/BT/Bz	
coverage	Line 1950N	000 - 375E	375m	BL/BT/Bz	
	Line 2050N	000 - 375E	375m	BL/BT/Bz	
	Line 2150N	000 - 375E	375m	BL/BT/Bz	



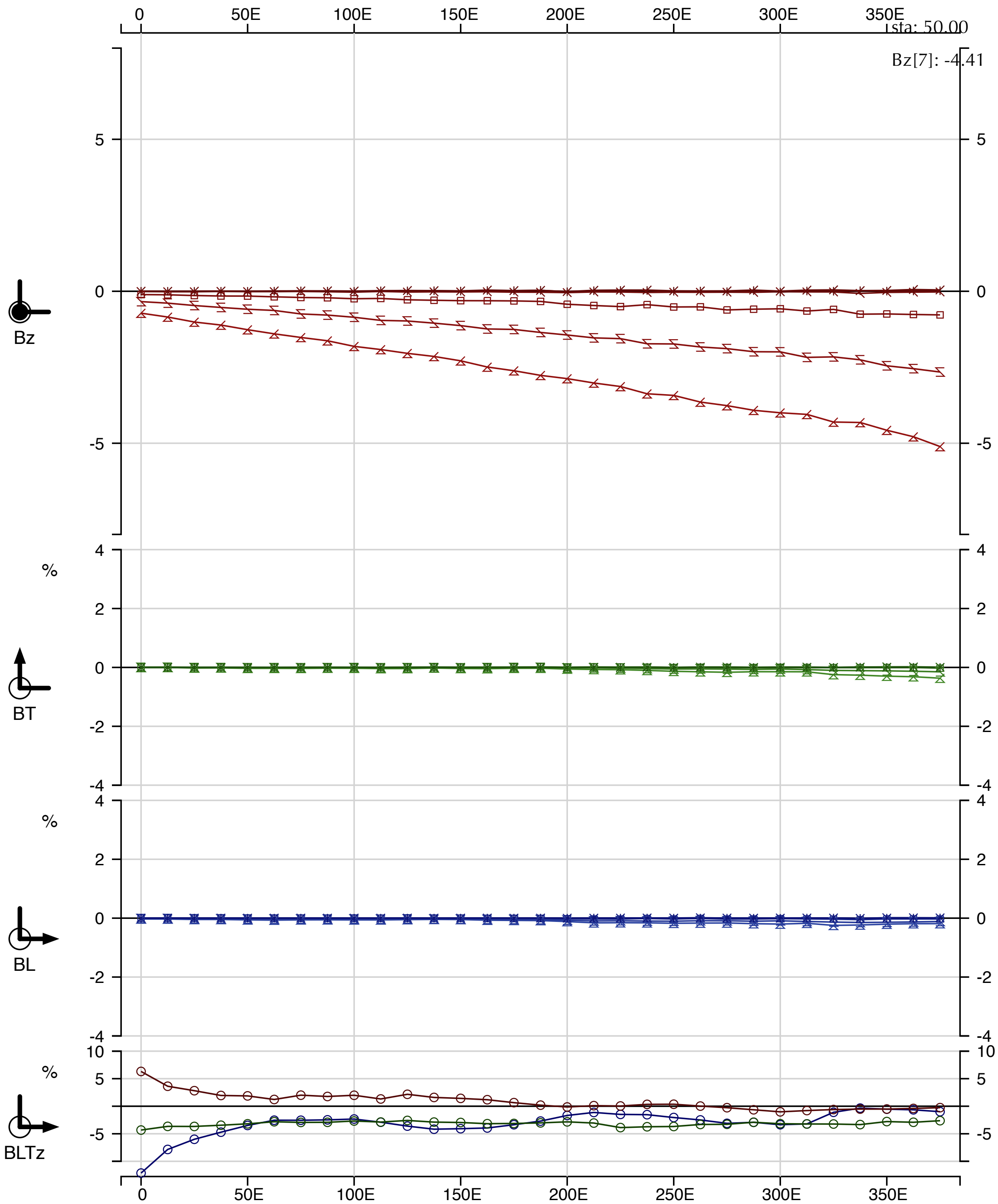
Line: L1450NA Loop: 1BS1 Cpt: BL, BT, Bz L 90.0°	(Chn - Ch0) / |Bp| (%) Cont norm @ Δz: 0m Base Freq: 5.22728Hz aLp1BS1_L1450NA.3cH5 / 3-Axis S1 LiCo latest 6Ch*	UTEM-5 Survey at: LiCo For: LiCo LAMONTAGNE GEOPHYSICS LTD GEOPHYSIQUE LTÉE Job 1701 Surv: 16/1/17 Red: 21/1/17 Plot: 26/1/17

Loop 1B - late Chs6-Ch0 - B_{LTZ}



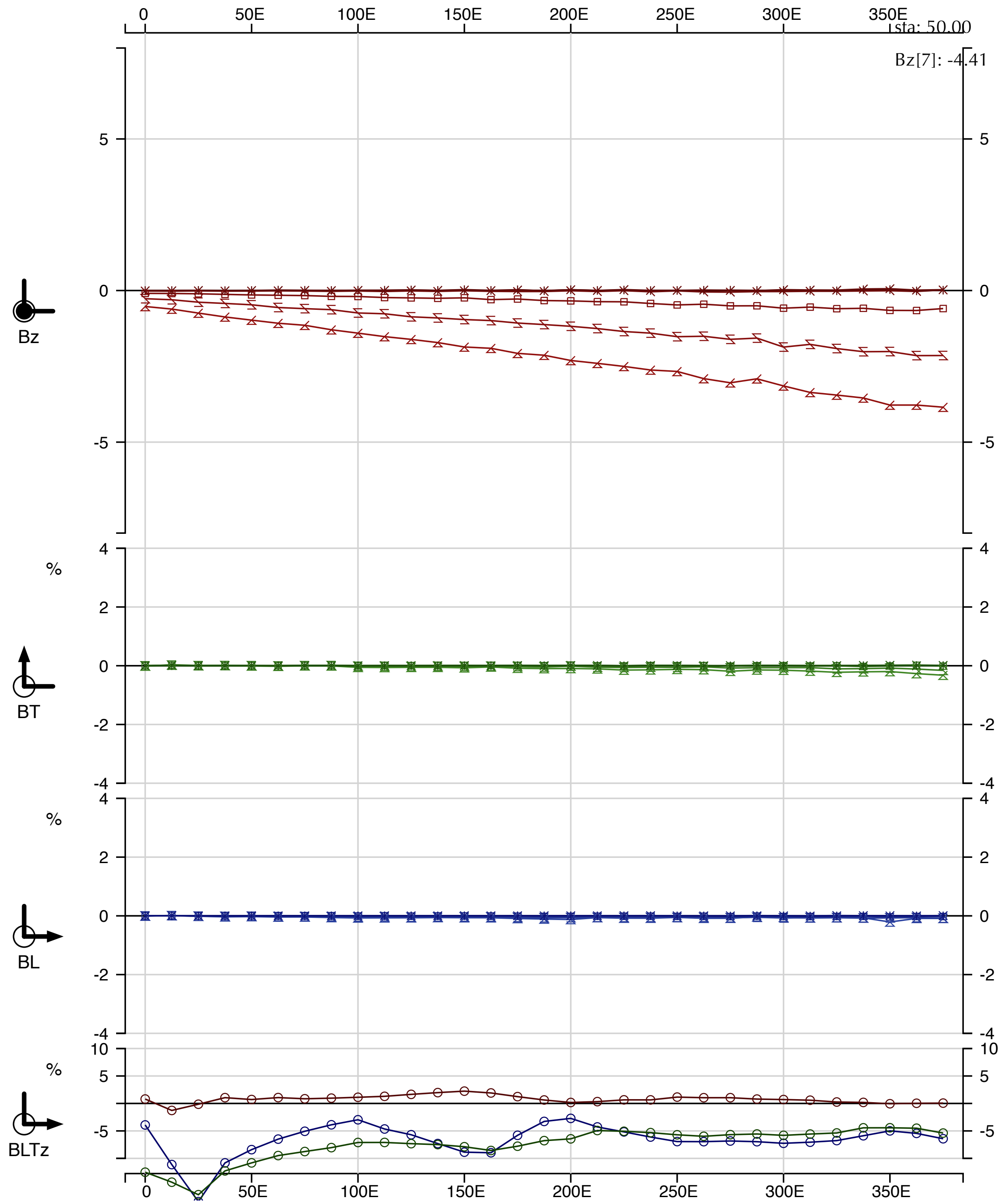
Line: L1550NA	(Chn - Ch0) / |Bp| (%)	UTEM-5 Survey at: LiCo
Loop: 1BS1	Cont norm @ Δz: 0m	For: LiCo
Cpt: BL, BT, Bz	Base Freq: 5.22728Hz	LAMONTAGNE GEOPHYSICS LTD GEOPHYSIQUE LTÉE Job 1701 Surv: 16/1/17 Red: 21/1/17 Plot: 26/1/17
L 90.0°	aLp1BS1_L1550NA.3cH5 / 3-Axis S1 LiCo latest 6Ch*	

Loop 1B - late Chs6-Ch0 - B_{LTZ}



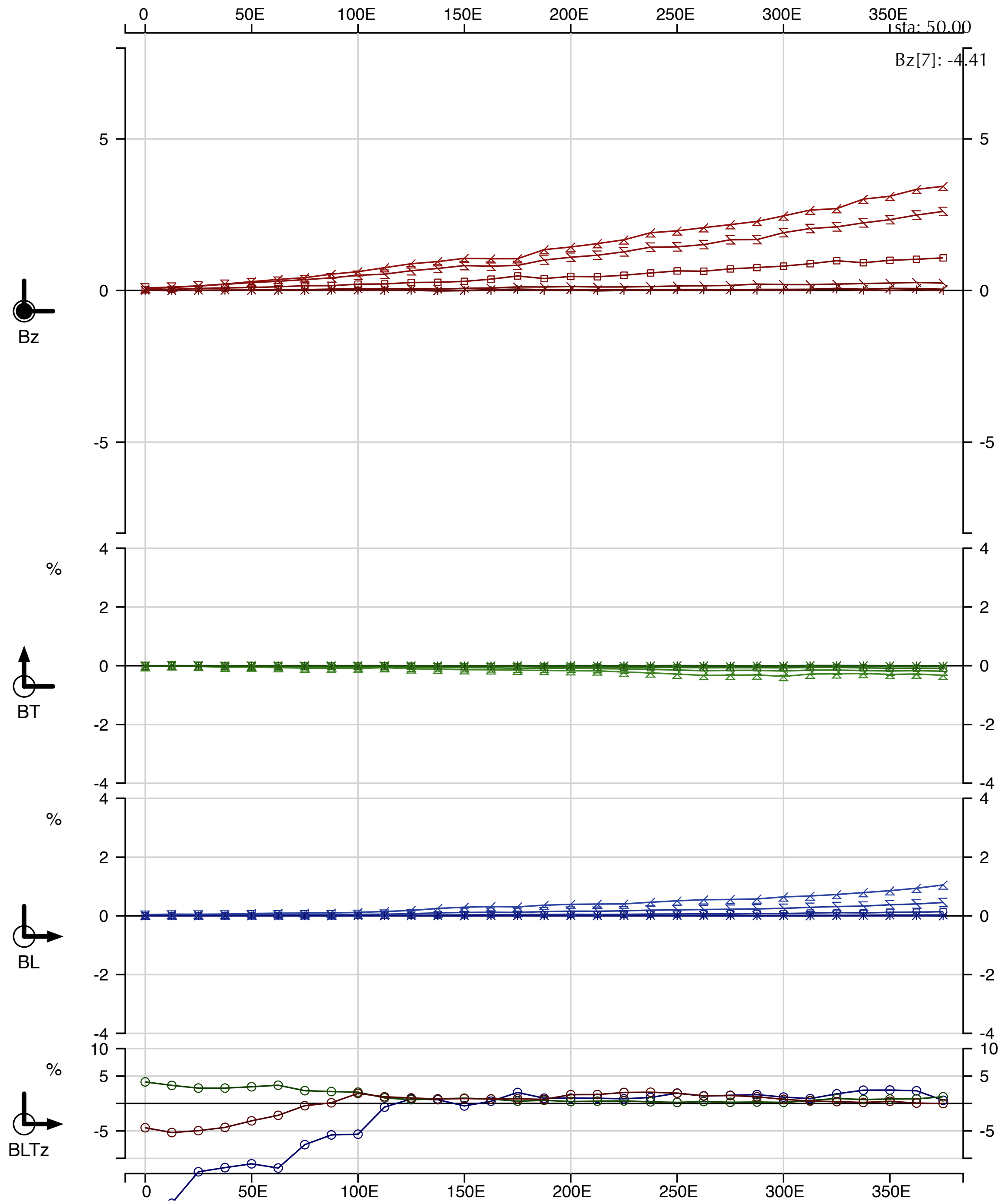
Line: L1650NA Loop: 1BS1 Cpt: BL, BT, Bz L 90.0°	(Chn - Ch0) / |Bp| (%) Cont norm @ Δz: 0m Base Freq: 5.22728Hz aLp1BS1_L1650NA.3cH5 / 3-Axis S1 LiCo latest 6Ch*	UTEM-5 Survey at: LiCo For: LiCo LAMONTAGNE GEOPHYSICS LTD GEOPHYSIQUE LTÉE Job 1701 Surv: 17/1/17 Red: 21/1/17 Plot: 26/1/17

Loop 1B - late Chs6-Ch0 - B_{LTZ}



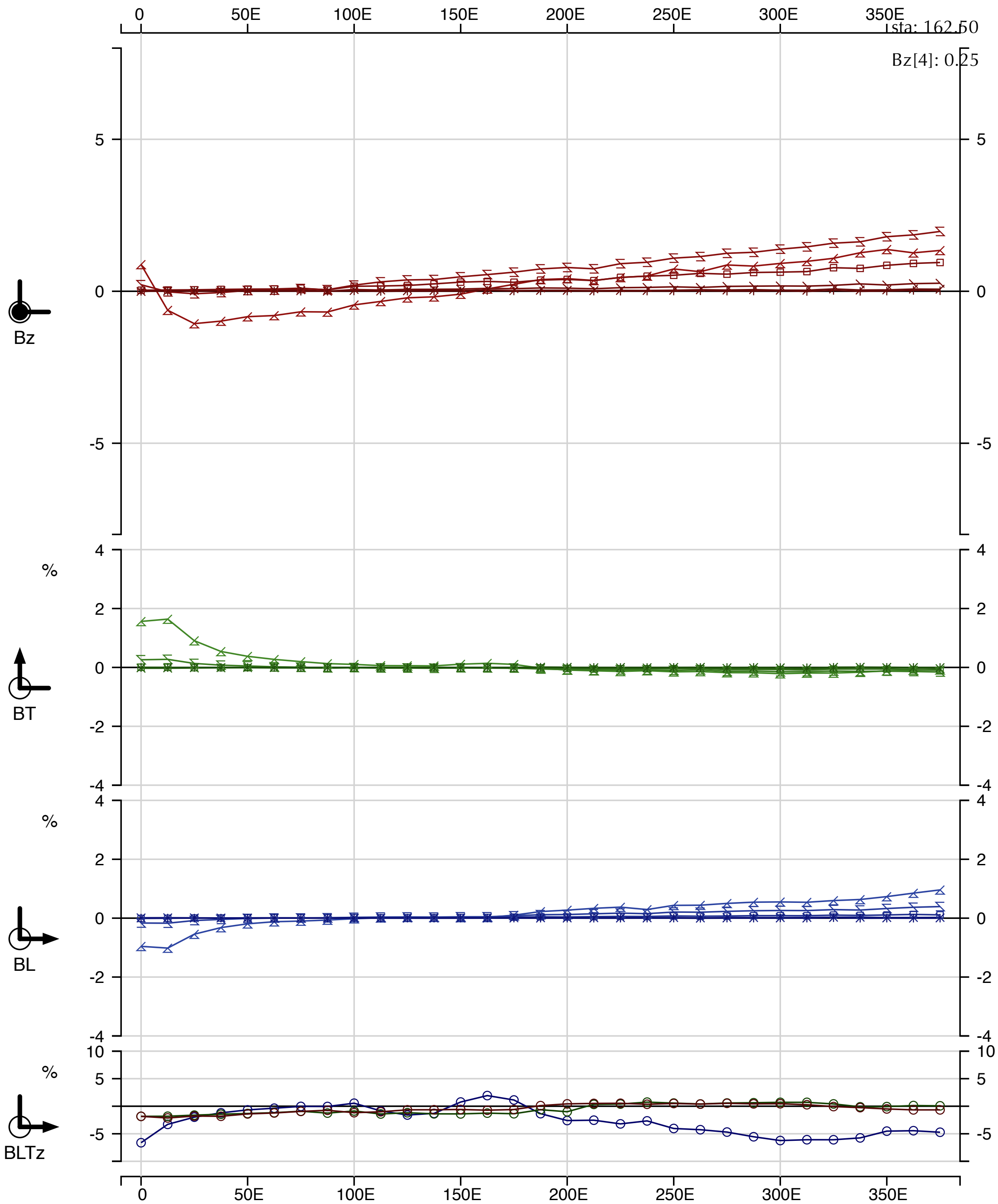
Line: L1750NA Loop: 1BS1 Cpt: BL, BT, Bz L 90.0°	(Chn - Ch0) / |Bp| (%) Cont norm @ Δz: 0m Base Freq: 5.22728Hz aLp1BS1_L1750NA.3cH5 / 3-Axis S1 LiCo latest 6Ch*	UTEM-5 Survey at: LiCo For: LiCo LAMONTAGNE GEOPHYSICS LTD GEOPHYSIQUE LTÉE Job 1701 Surv: 17/1/17 Red: 21/1/17 Plot: 26/1/17

Loop 1B - late Chs6-Ch0 - B_{LTZ}



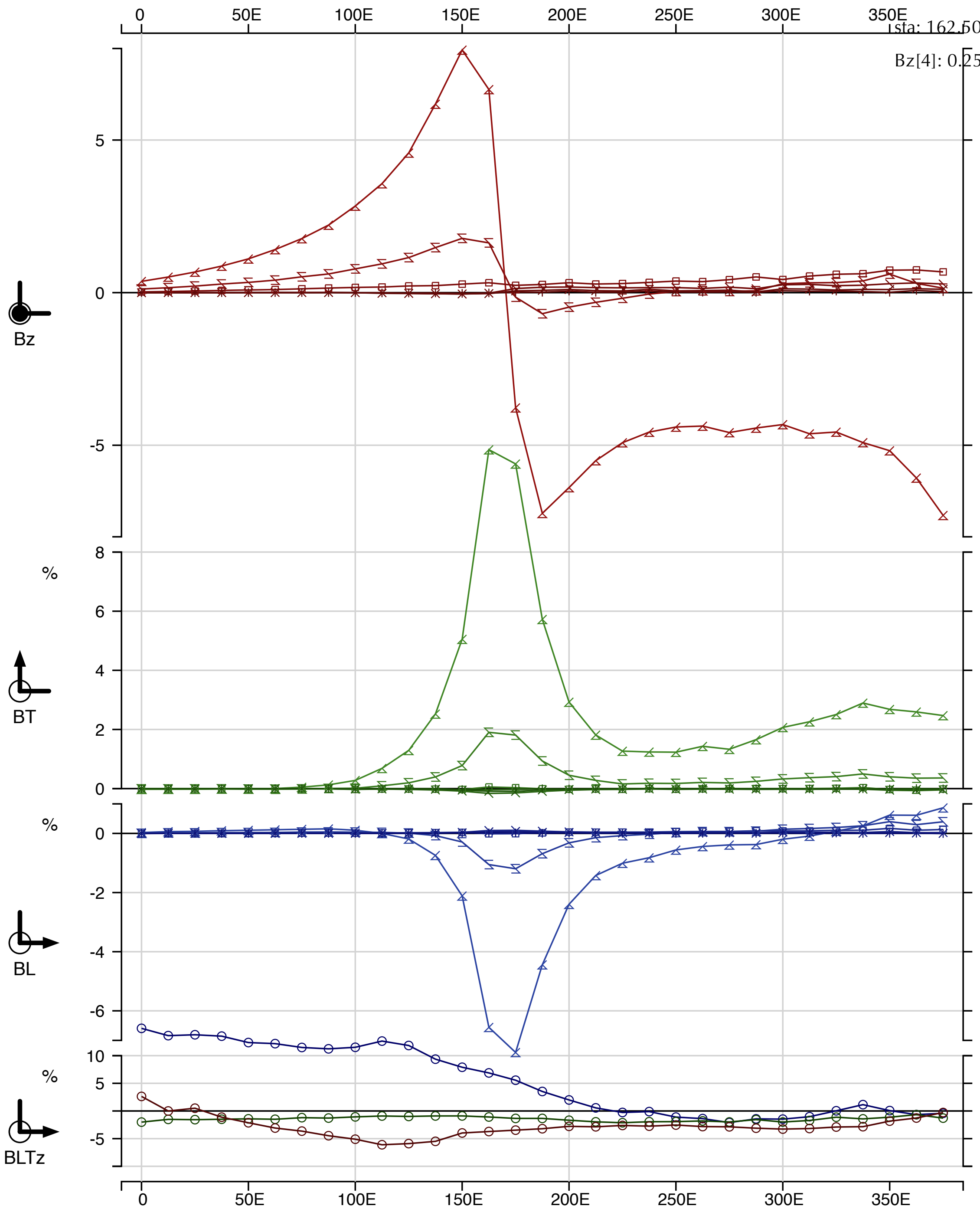
Line: L1850NA Loop: 1AS1 Cpt: BL, BT, Bz L 90.0°	(Chn - Ch0) / |Bp| (%) Cont norm @ Δz: 0m Base Freq: 5.22728Hz aLp1AS1_L1850NA.3cH5 / 3-Axis S1 LiCo latest 6Ch*	UTEM-5 Survey at: LiCo For: LiCo LAMONTAGNE GEOPHYSICS LTD GEOPHYSIQUE LTÉE Job 1701 Surv: 15/1/17 Red: 21/1/17 Plot: 26/1/17

Loop 1A - late Chs6-Ch0 - B_{LTZ}



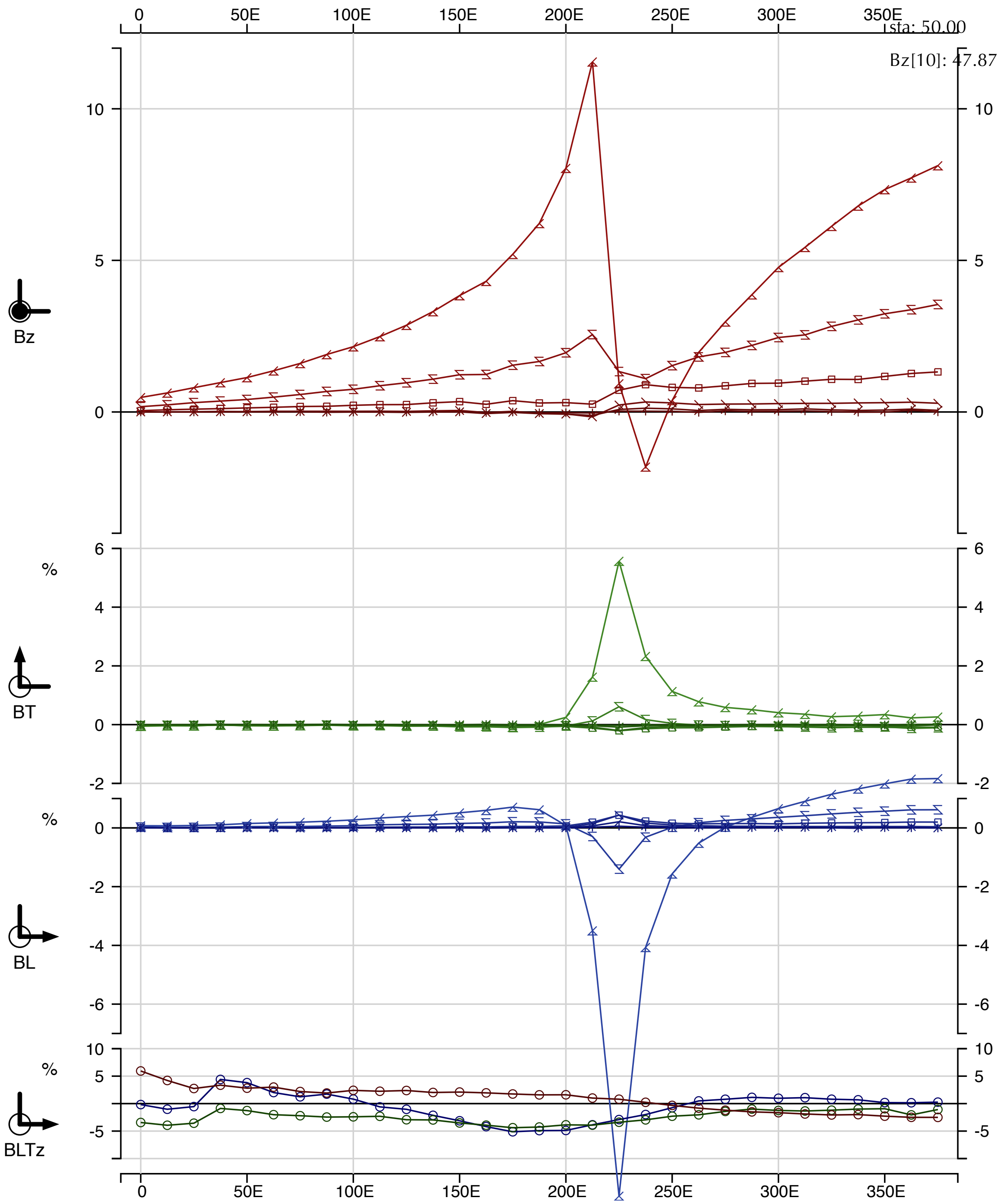
Line: L1950NA Loop: 1AS1 Cpt: BL, BT, Bz L 90.0°	(Chn - Ch0) / |Bp| (%) Cont norm @ Δz: 0m Base Freq: 5.22728Hz aLp1AS1_L1950NA.3cH5 / 3-Axis S1 LiCo latest 6Ch*	UTEM-5 Survey at: LiCo For: LiCo LAMONTAGNE GEOPHYSICS LTD GEOPHYSIQUE LTÉE Job 1701 Surv: 15/1/17 Red: 21/1/17 Plot: 26/1/17

Loop 1A - late Chs6-Ch0 - B_{LTZ}



Line: L2050NA Loop: 1AS1 Cpt: BL, BT, Bz L 90.0°	(Chn - Ch0) / |Bp| (%) Cont norm @ Δz: 0m Base Freq: 5.22728Hz aLp1AS1_L2050NA.3cH5 / 3-Axis S1 LiCo latest 6Ch	UTEM-5 Survey at: LiCo For: LiCo LAMONTAGNE GEOPHYSICS LTD GEOPHYSIQUE LTÉE Job 1701 Surv: 14/1/17 Red: 21/1/17 Plot: 26/1/17

Loop 1A - late Chs6-Ch0 - B_{LTZ}



Line: L2150NA Loop: 1AS1 Cpt: BL, BT, Bz L 90.0°	(Chn - Ch0) / |Bp| (%) Cont norm @ Δz: 0m Base Freq: 5.22728Hz aLp1AS1_L2150NA.3cH5 / 3-Axis S1 LiCo latest 6Ch*	UTEM-5 Survey at: LiCo For: LiCo LAMONTAGNE GEOPHYSICS LTD GEOPHYSIQUE LTÉE Job 1701 Surv: 14/1/17 Red: 21/1/17 Plot: 26/1/17

Loop 1A - late Chs6-Ch0 - B_{LTZ}

Teledyne Project UTEM Grid

Loop 2B/2A

BL/BT/Bz

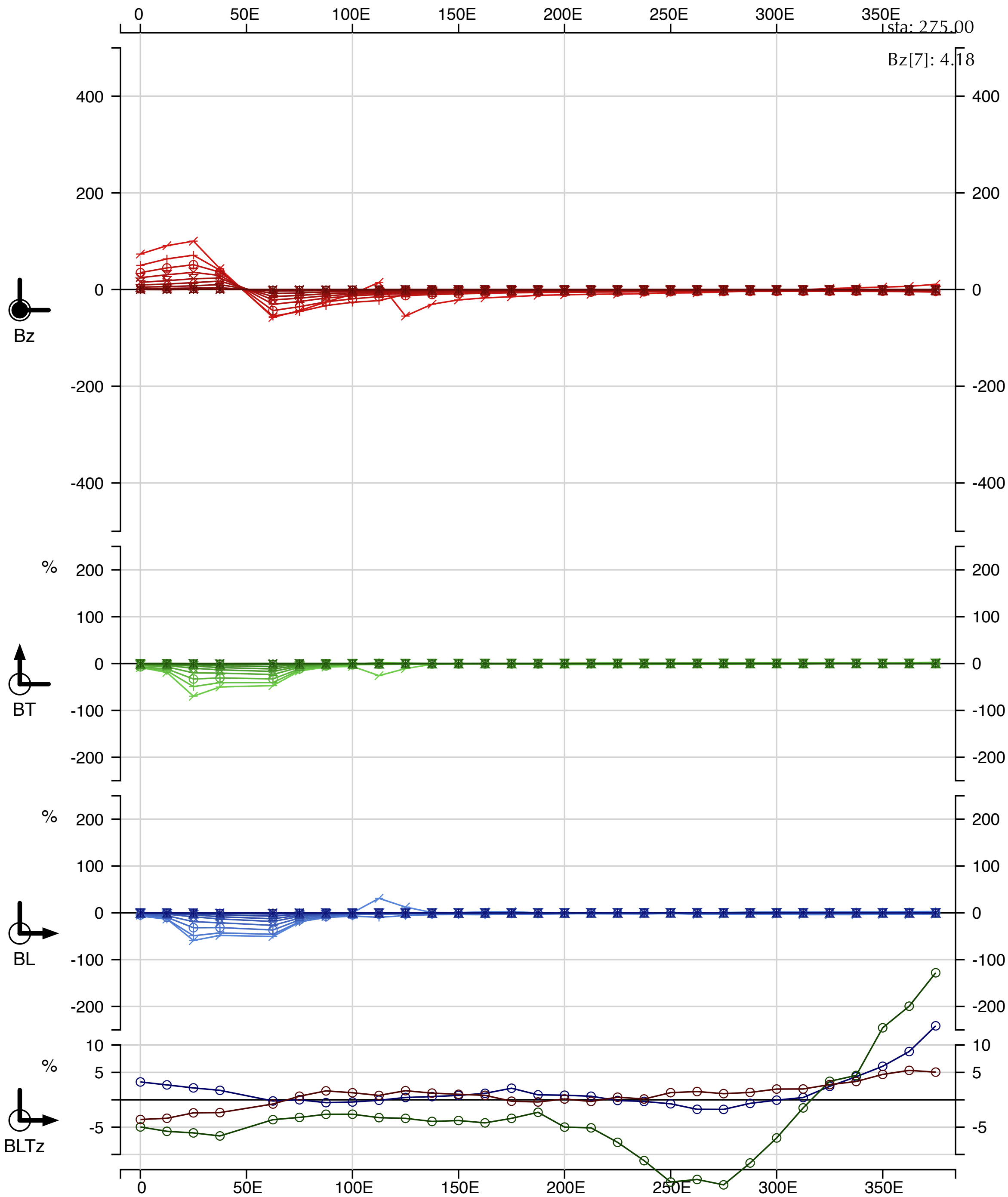
~4.0909Hz frequency

continuous norm

12Ch - Ch0 reduced

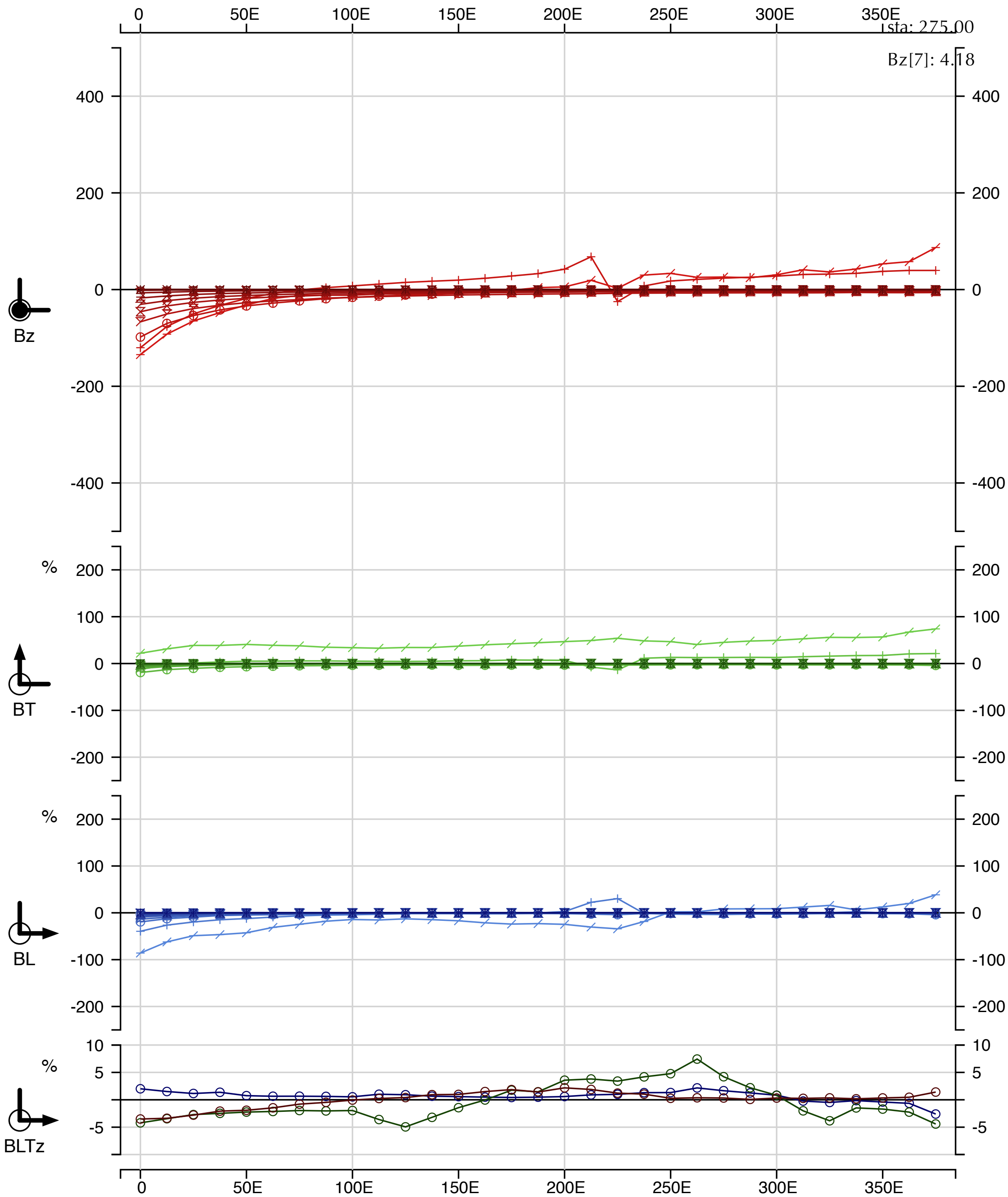
all Chs plotted

Loop 2B	(@ **4.090916Hz**)	side-loop - loop to the gridSouth		
2 Loop	Line 1450N	000 - 375E	375m	BL/BT/Bz
coverage	Line 1550N	000 - 375E	375m	BL/BT/Bz
	Line 1650N	000 - 375E	375m	BL/BT/Bz
	Line 1750N	000 - 375E	375m	BL/BT/Bz
Loop 2A	(@ **4.090916Hz**)	side-loop - loop to the gridSouth		
2 Loop	Line 1850N	000 - 375E	375m	BL/BT/Bz
coverage	Line 1950N	000 - 375E	375m	BL/BT/Bz
	Line 2050N	000 - 375E	375m	BL/BT/Bz
	Line 2150N	000 - 375E	375m	BL/BT/Bz



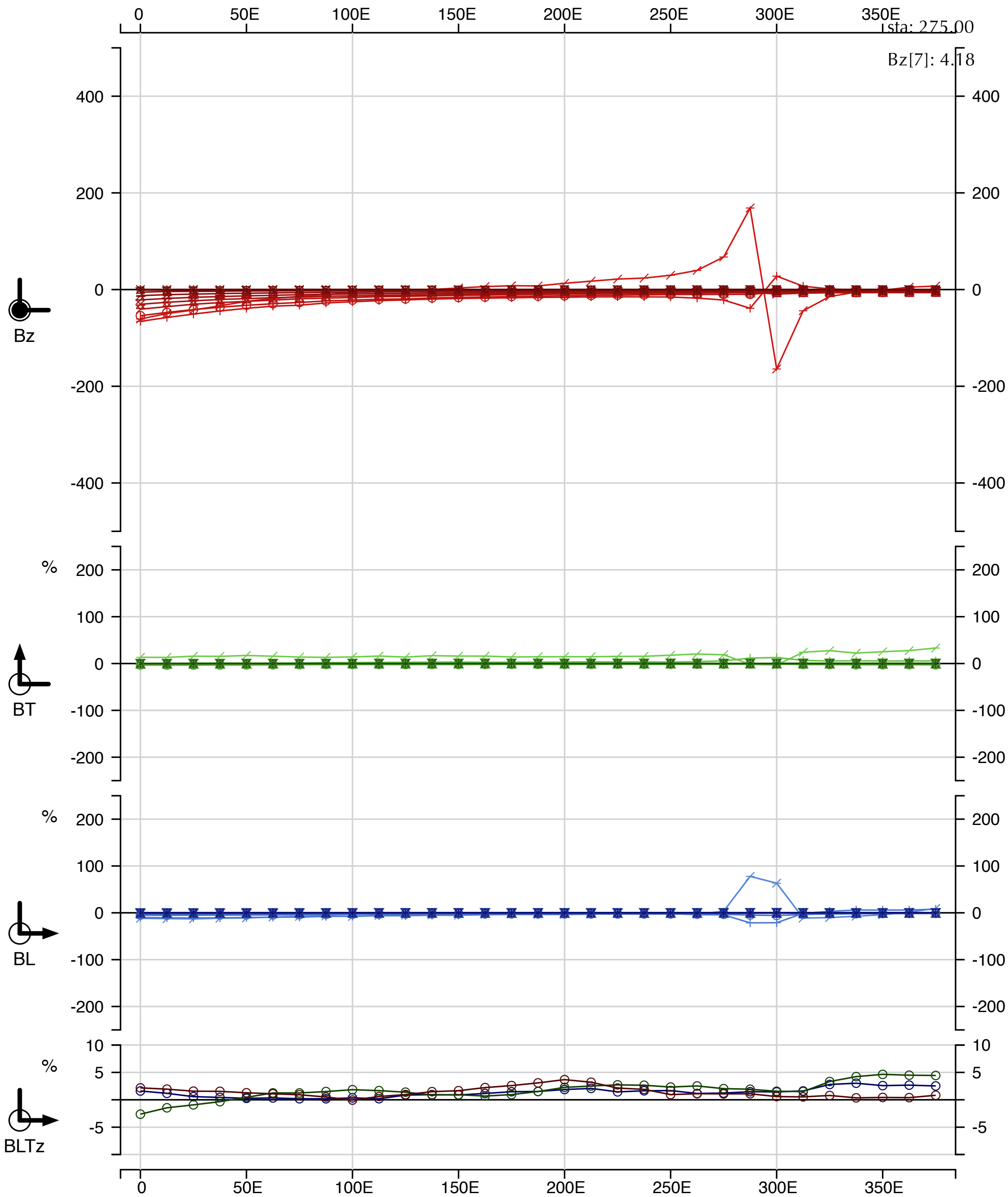
Line: L1450NB Loop: 2BS2 Cpt: BL, BT, Bz L 90.0°	(Chn - Ch0) / |Bp| (%) Cont norm @ Δz: 0m Base Freq: 4.09092Hz aLp2BS2_L1450NB.3cH5 / 3-Axis S2 LiCo*	UTEM-5 Survey at: LiCo For: LiCo LAMONTAGNE GEOPHYSICS LTD GEOPHYSIQUE LTÉE Job 1701 Surv: 16/1/17 Red: 21/1/17 Plot: 26/1/17

Loop 2B - all Chs - B_{LTZ}



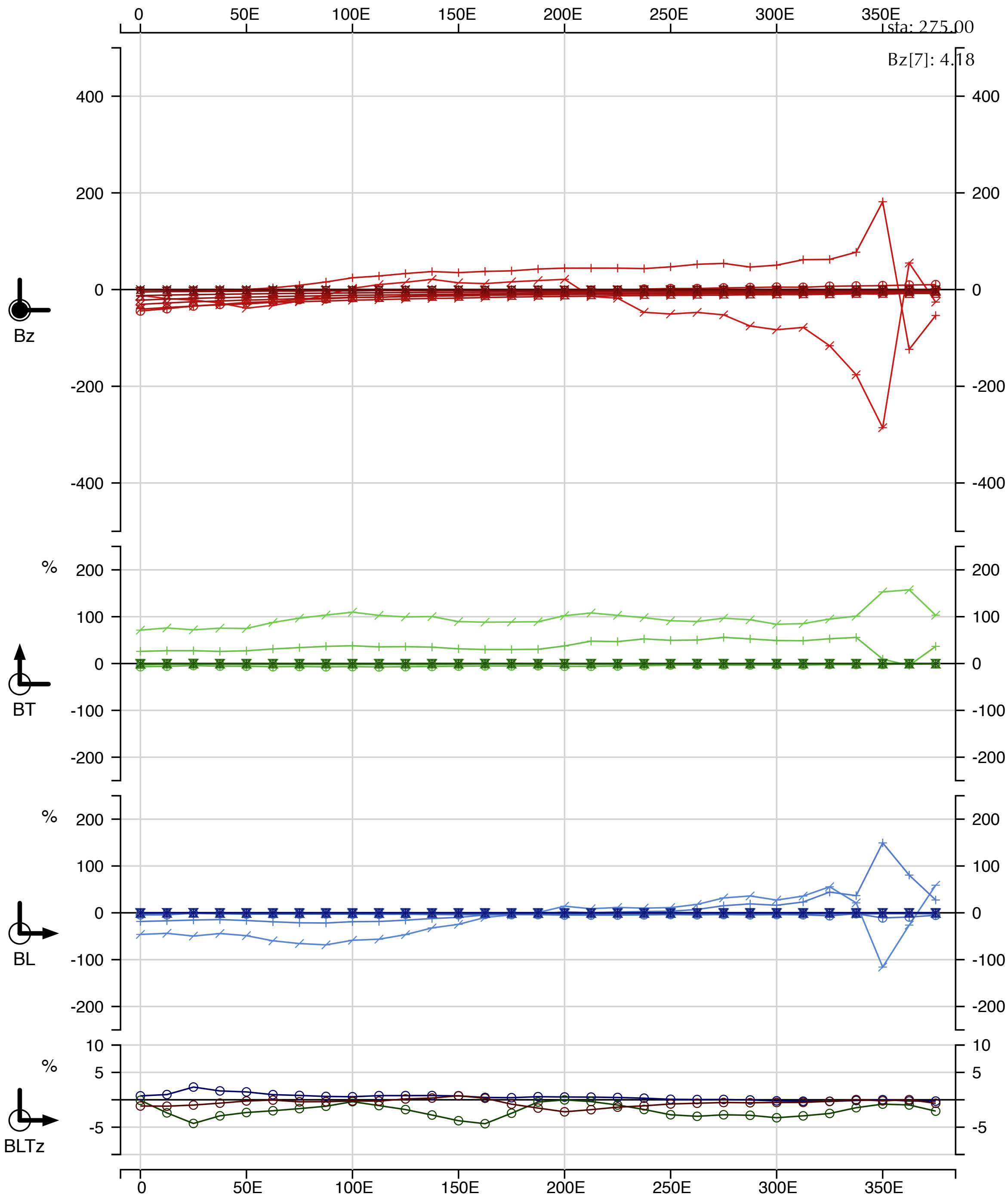
Line: L1550NB Loop: 2BS2 Cpt: BL, BT, Bz L 90.0°	(Chn - Ch0) / |Bp| (%) Cont norm @ Δz: 0m Base Freq: 4.09092Hz aLp2BS2_L1550NB.3cH5 / 3-Axis S2 LiCo*	UTEM-5 Survey at: LiCo For: LiCo LAMONTAGNE GEOPHYSICS LTD GEOPHYSIQUE LTÉE Job 1701 Surv: 16/1/17 Red: 21/1/17 Plot: 26/1/17

Loop 2B - all Chs - B_{LTZ}



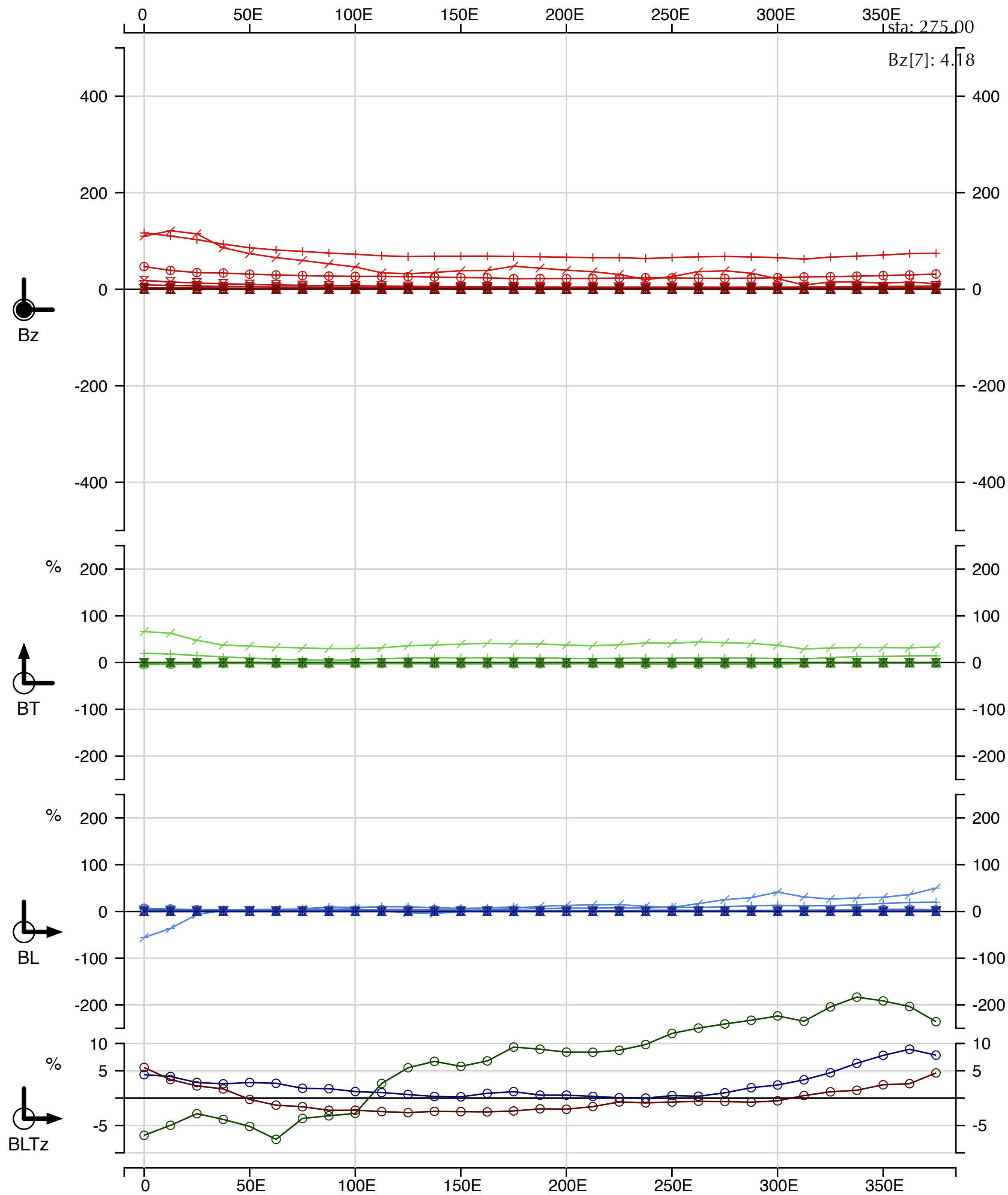
Line: L1650NB Loop: 2BS2 Cpt: BL, BT, Bz L 90.0°	(Chn - Ch0) / |Bp| (%) Cont norm @ Δz: 0m Base Freq: 4.09092Hz aLp2BS2_L1650NB.3cH5 / 3-Axis S2 LiCo*	UTEM-5 Survey at: LiCo For: LiCo LAMONTAGNE GEOPHYSICS LTD GEOPHYSIQUE LTÉE Job 1701 Surv: 17/1/17 Red: 21/1/17 Plot: 26/1/17

Loop 2B - all Chs - B_{LTZ}



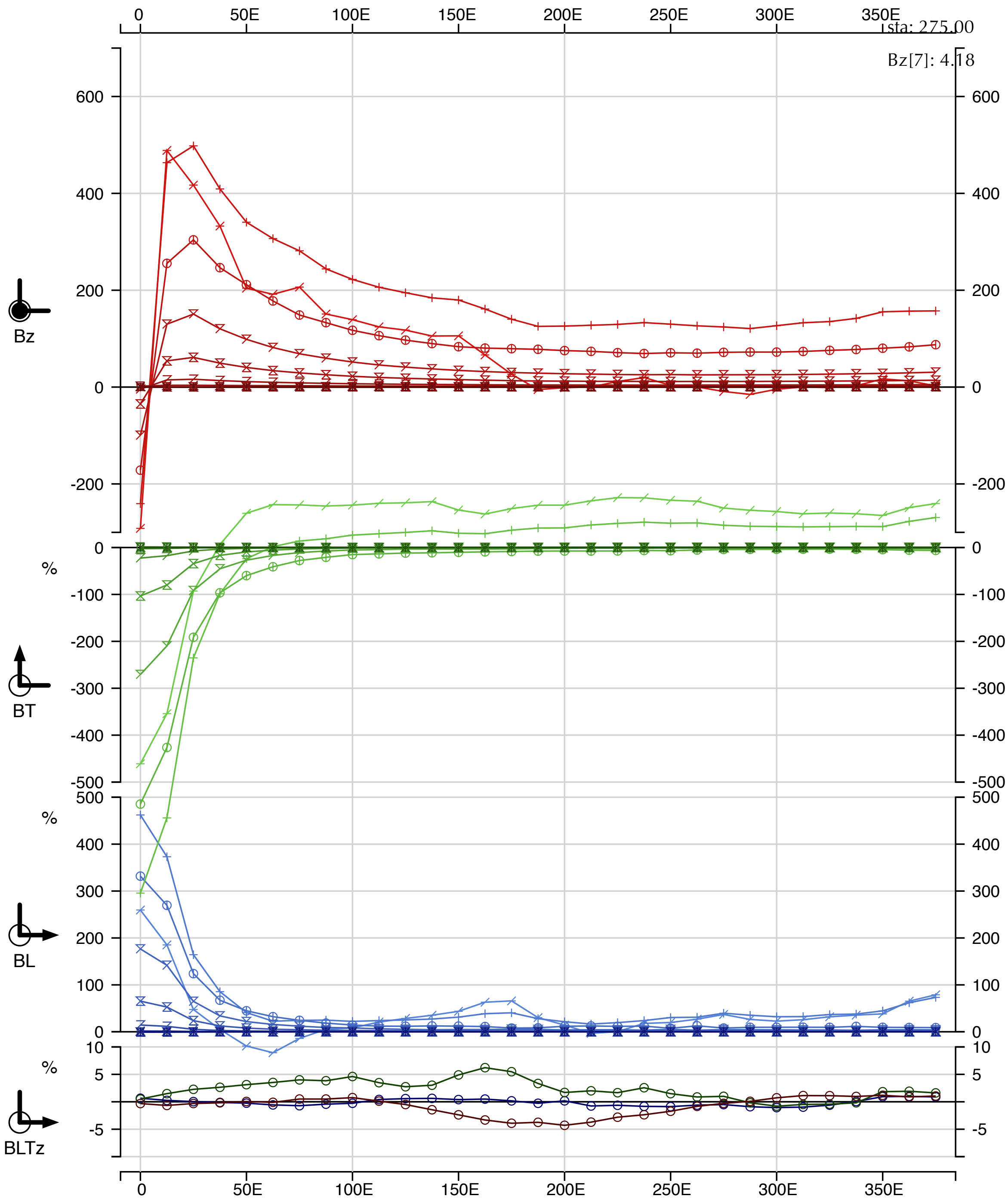
Line: L1750NB Loop: 2BS2 Cpt: BL, BT, Bz L 90.0°	(Chn - Ch0) / |Bp| (%) Cont norm @ Δz: 0m Base Freq: 4.09092Hz aLp2BS2_L1750NB.3cH5 / 3-Axis S2 LiCo*	UTEM-5 Survey at: LiCo For: LiCo LAMONTAGNE GEOPHYSICS LTD GEOPHYSIQUE LTÉE Job 1701 Surv: 17/1/17 Red: 21/1/17 Plot: 26/1/17

Loop 2B - all Chs - B_{LTZ}



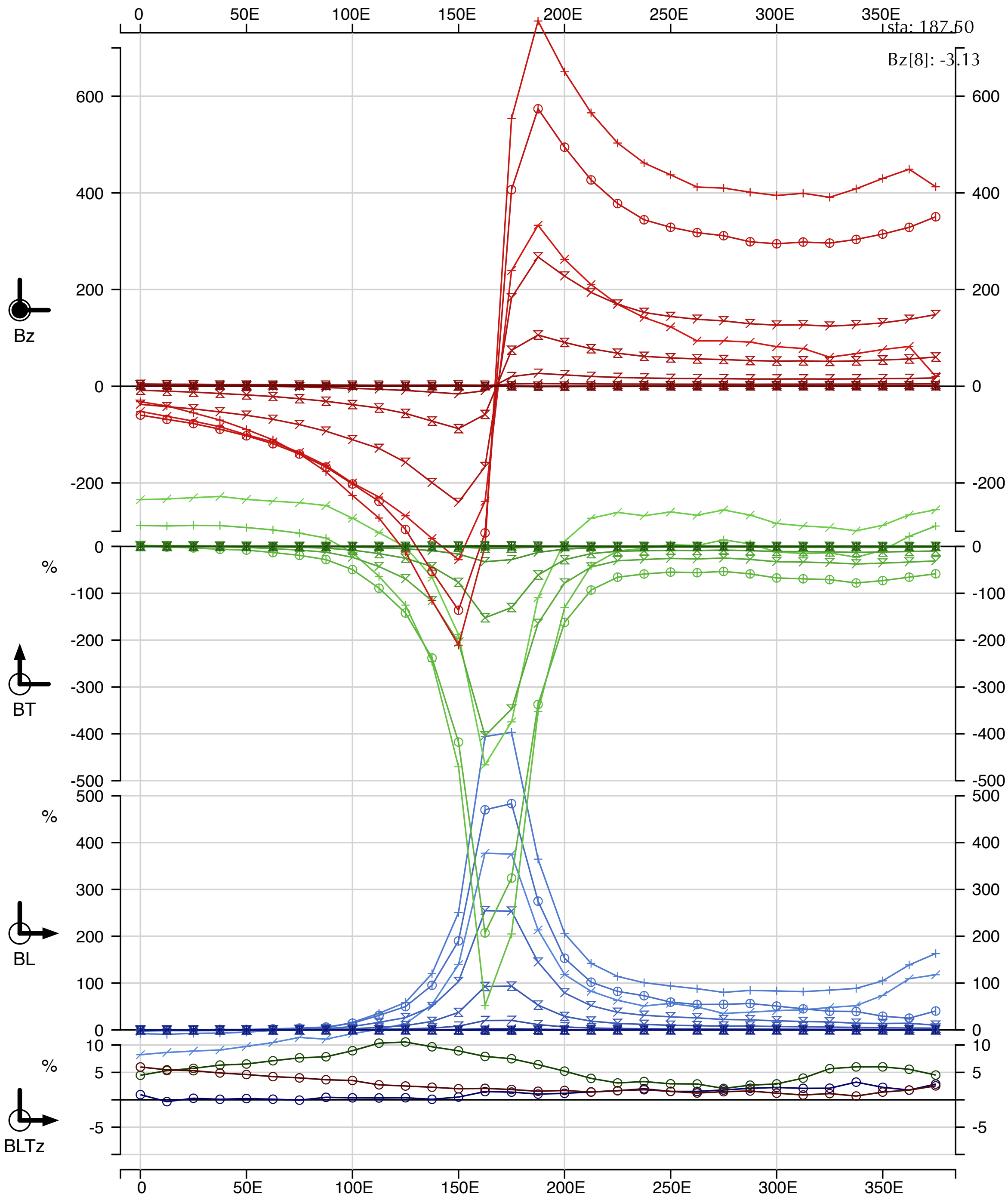
Line: L1850NB Loop: 2AS2 Cpt: BL, BT, Bz L 90.0°	(Chn - Ch0) / |Bp| (%) Cont norm @ Δz: 0m Base Freq: 4.09092Hz aLp2AS2_L1850NB.3cH5 / 3-Axis S2 LiCo*	UTEM-5 Survey at: LiCo For: LiCo LAMONTAGNE GEOPHYSICS LTD GEOPHYSIQUE LTÉE Job 1701 Surv: 15/1/17 Red: 21/1/17 Plot: 26/1/17

Loop 2A - all Chs - B_{LTZ}



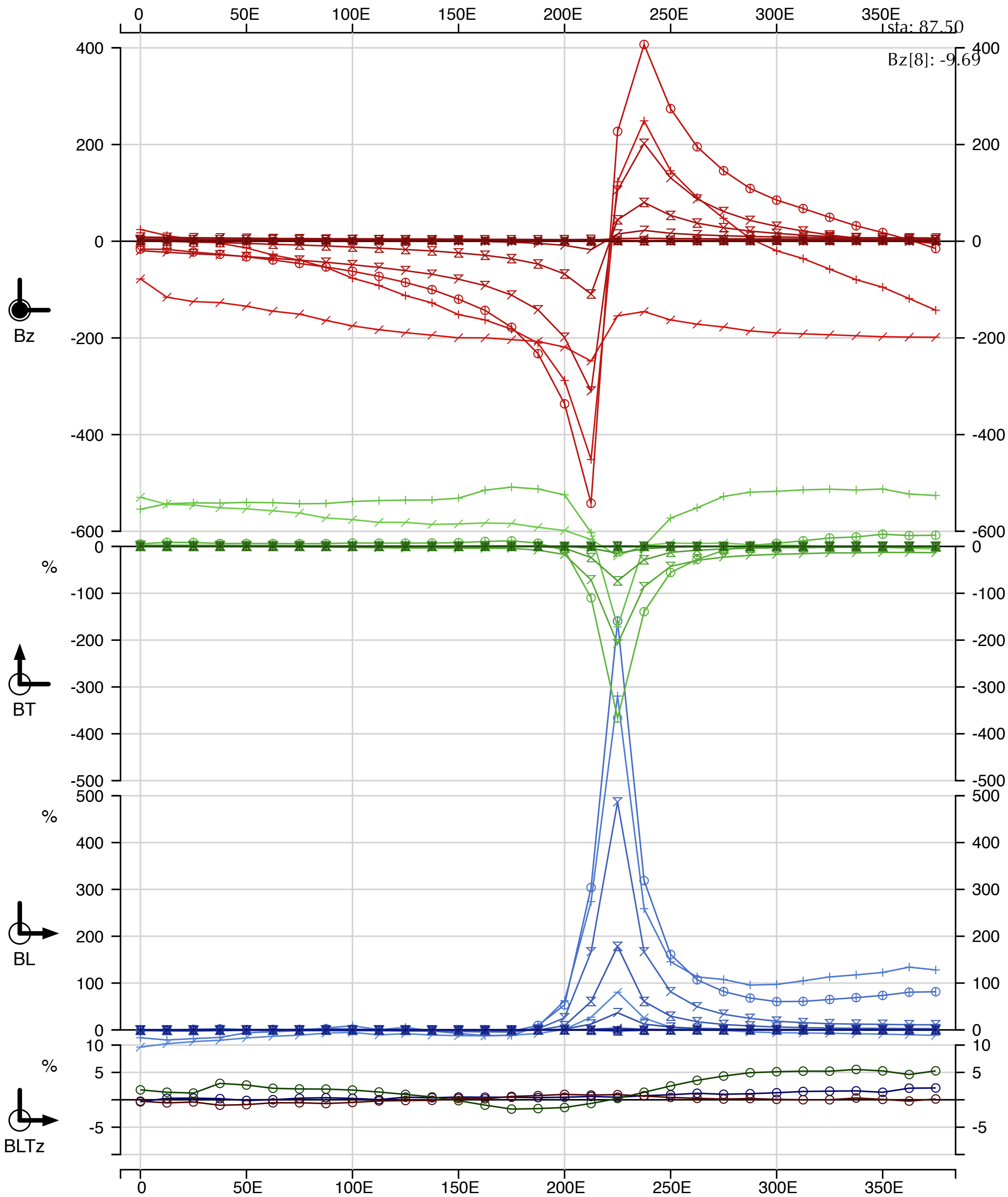
Line: L1950NB Loop: 2AS2 Cpt: BL, BT, Bz L 90.0°	(Chn - Ch0) / |Bp| (%) Cont norm @ Δz: 0m Base Freq: 4.09092Hz aLp2AS2_L1950NB.3cH5 / 3-Axis S2 LiCo*	UTEM-5 Survey at: LiCo For: LiCo LAMONTAGNE GEOPHYSICS LTD GEOPHYSIQUE LTÉE Job 1701 Surv: 15/1/17 Red: 21/1/17 Plot: 26/1/17

Loop 2A - all Chs - B_{LTZ}



Line: L2050NB Loop: 2AS2 Cpt: BL, BT, Bz L 90.0°	(Chn - Ch0) / |Bp| (%) Cont norm @ Δz: 0m Base Freq: 4.09092Hz aLp2AS2_L2050NB.3cH5 / 3-Axis S2 LiCo*	UTEM-5 Survey at: LiCo For: LiCo LAMONTAGNE GEOPHYSICS LTD GEOPHYSIQUE LTÉE Job 1701 Surv: 14/1/17 Red: 21/1/17 Plot: 26/1/17

Loop 2A - all Chs - B_{LTZ}



Line: L2150NB Loop: 2AS2 Cpt: BL, BT, Bz L 90.0°	(Chn - Ch0) / |Bp| (%) Cont norm @ Δz: 0m Base Freq: 4.09092Hz aLp2AS2_L2150NB.3cH5 / 3-Axis S2 LiCo*	UTEM-5 Survey at: LiCo For: LiCo LAMONTAGNE GEOPHYSICS LTD GEOPHYSIQUE LTÉE Job 1701 Surv: 14/1/17 Red: 21/1/17 Plot: 26/1/17

Loop 2A - all Chs - B_{LTZ}

Teledyne Project UTEM Grid

Loop 2B/2A

BL/BT/Bz

~4.0909Hz frequency

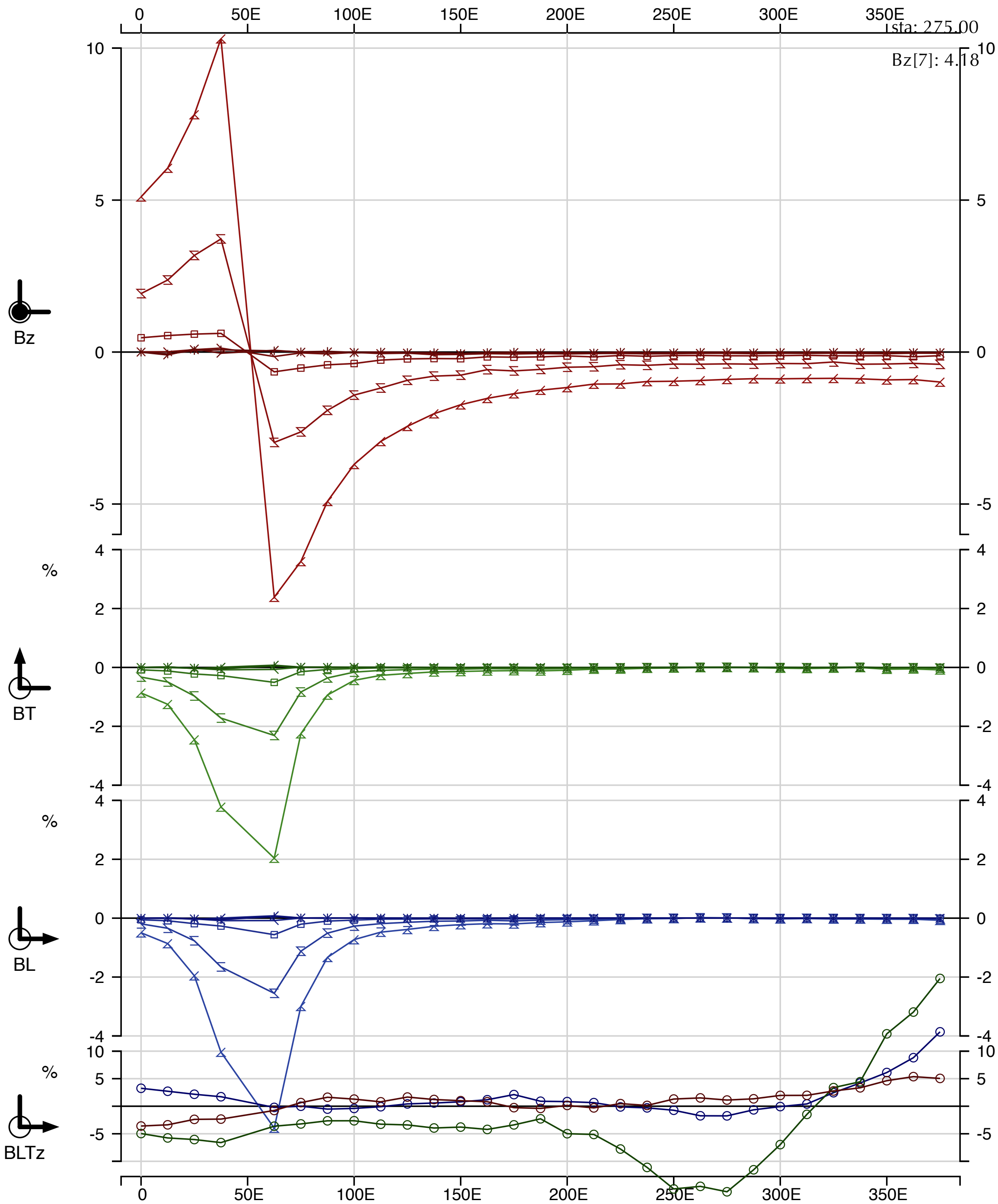
continuous norm

12Ch - Ch0 reduced

late Chs6-Ch0 plotted

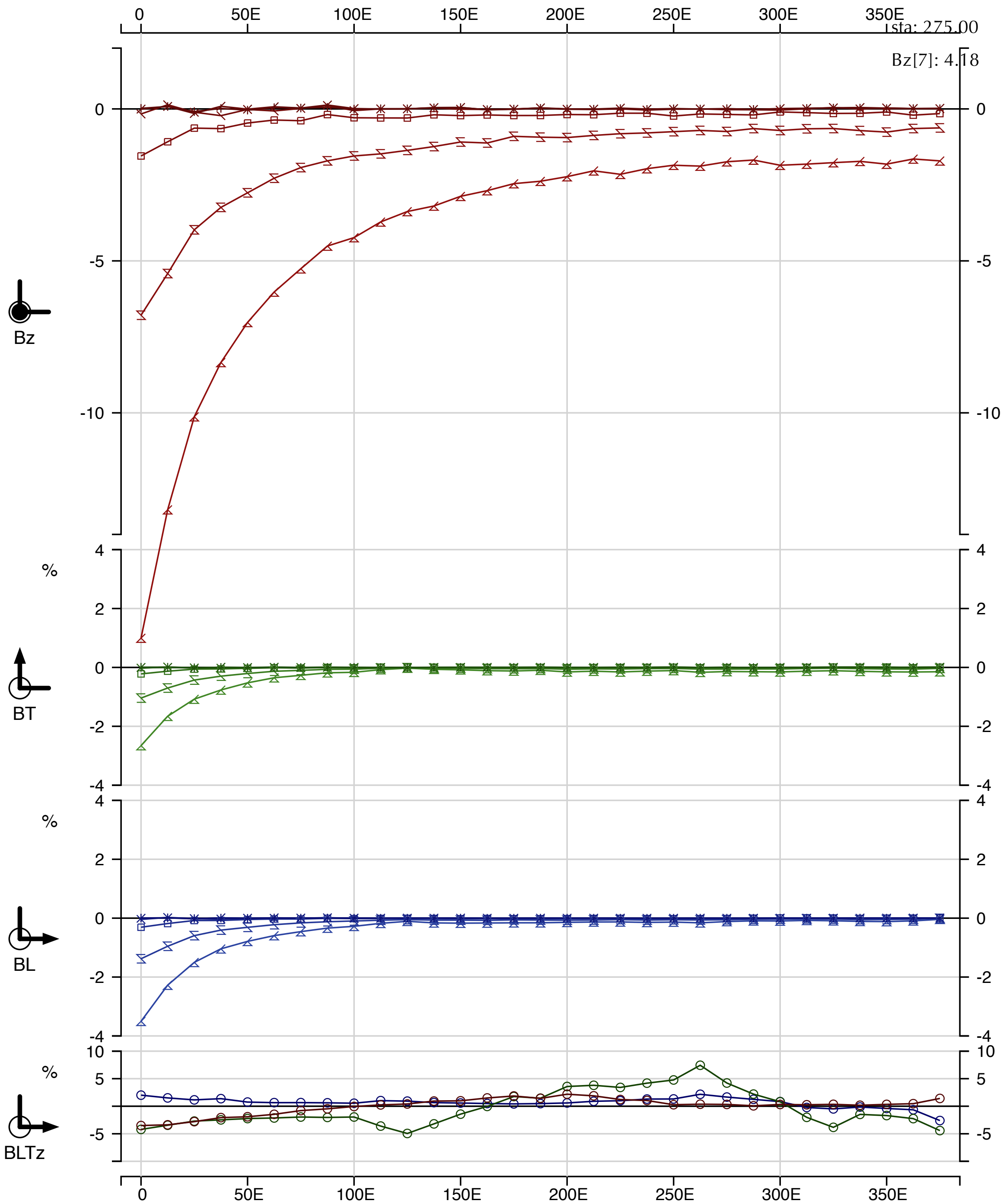
Loop 2B	(@ **4.090916Hz**)	side-loop - loop to the gridSouth			
2 Loop	Line 1450N		000 - 375E	375m	BL/BT/Bz
coverage	Line 1550N		000 - 375E	375m	BL/BT/Bz
	Line 1650N		000 - 375E	375m	BL/BT/Bz
	Line 1750N		000 - 375E	375m	BL/BT/Bz
Loop 2A	(@ **4.090916Hz**)	side-loop - loop to the gridSouth			
2 Loop	Line 1850N		000 - 375E	375m	BL/BT/Bz
coverage	Line 1950N		000 - 375E	375m	BL/BT/Bz
	Line 2050N		000 - 375E	375m	BL/BT/Bz
	Line 2150N		000 - 375E	375m	BL/BT/Bz

Loop 2B/2A - Chs6-Ch0 - B_{LTZ}



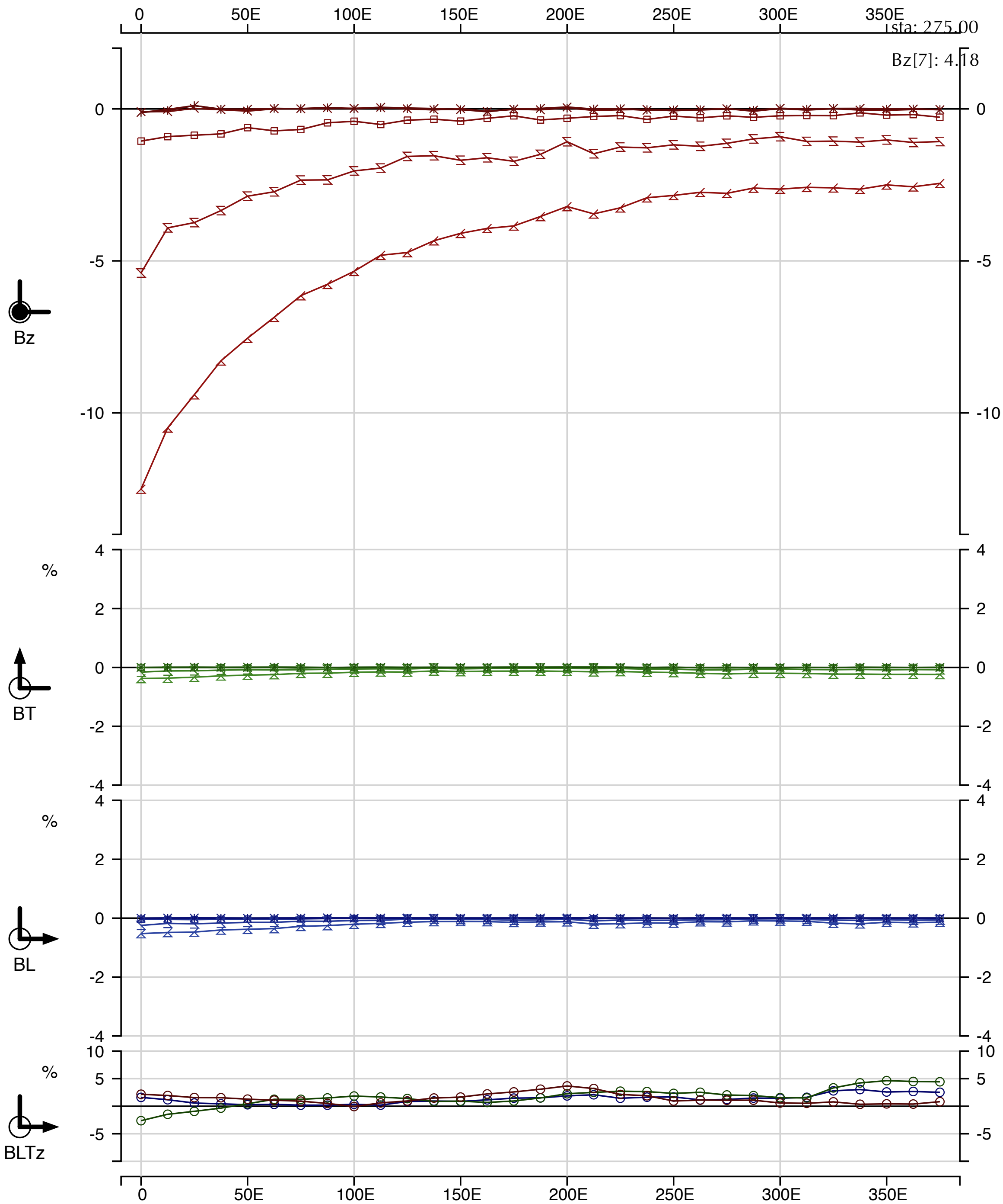
Line: L1450NB Loop: 2BS2 Cpt: BL, BT, Bz L 90.0°	(Chn - Ch0) / |Bp| (%) Cont norm @ Δz: 0m Base Freq: 4.09092Hz aLp2BS2_L1450NB.3cH5 / 3-Axis S2 LiCo latest 6Ch*	UTEM-5 Survey at: LiCo For: LiCo LAMONTAGNE GEOPHYSICS LTD GEOPHYSIQUE LTÉE Job 1701 Surv: 16/1/17 Red: 21/1/17 Plot: 26/1/17

Loop 2B - Chs6-Ch0 - B_{LTZ}



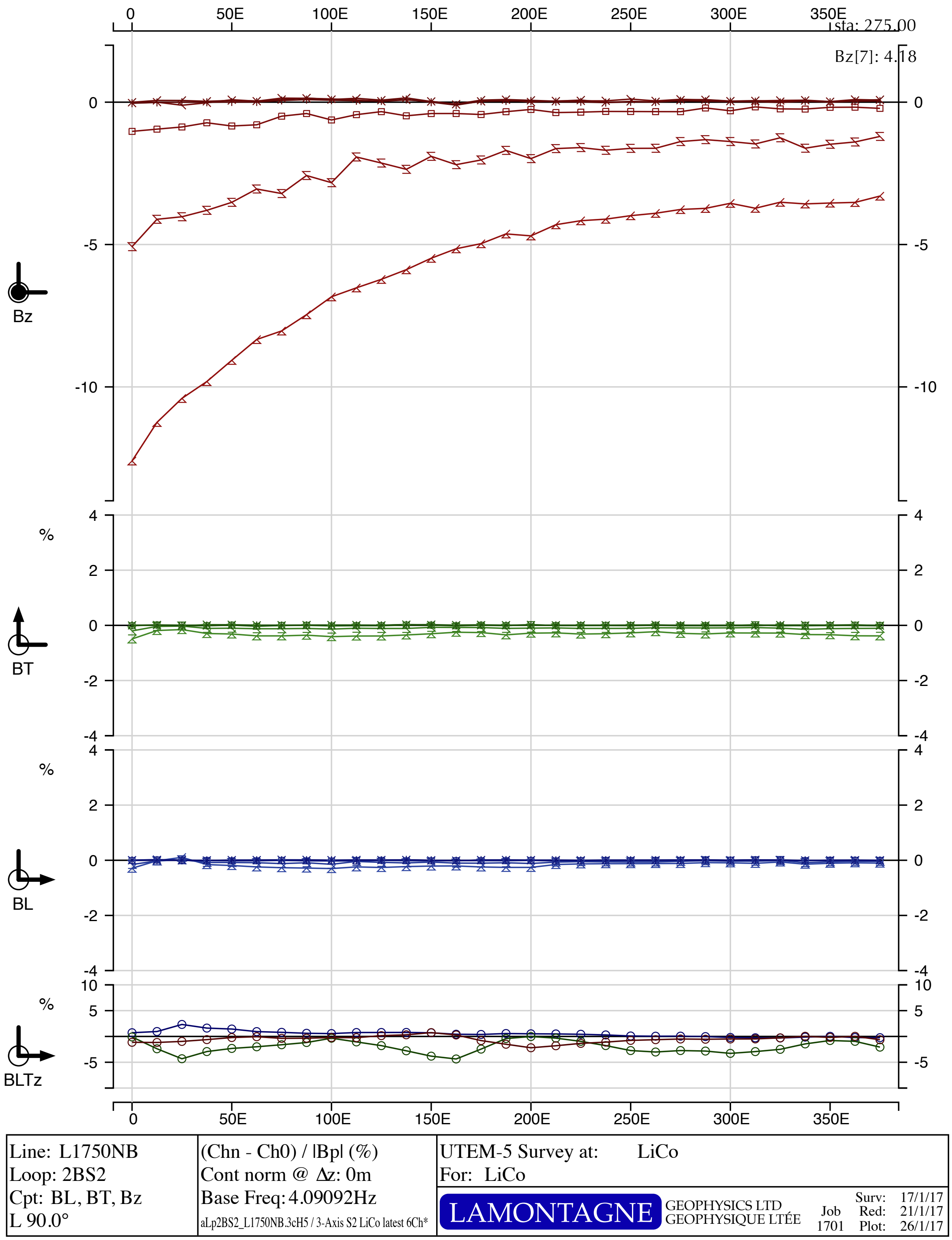
Line: L1550NB Loop: 2BS2 Cpt: BL, BT, Bz L 90.0°	(Chn - Ch0) / |Bp| (%) Cont norm @ Δz: 0m Base Freq: 4.09092Hz aLp2BS2_L1550NB.3cH5 / 3-Axis S2 LiCo latest 6Ch*	UTEM-5 Survey at: LiCo For: LiCo LAMONTAGNE GEOPHYSICS LTD GEOPHYSIQUE LTÉE Job 1701 Surv: 16/1/17 Red: 21/1/17 Plot: 26/1/17

Loop 2B - Chs6-Ch0 - B_{LTZ}

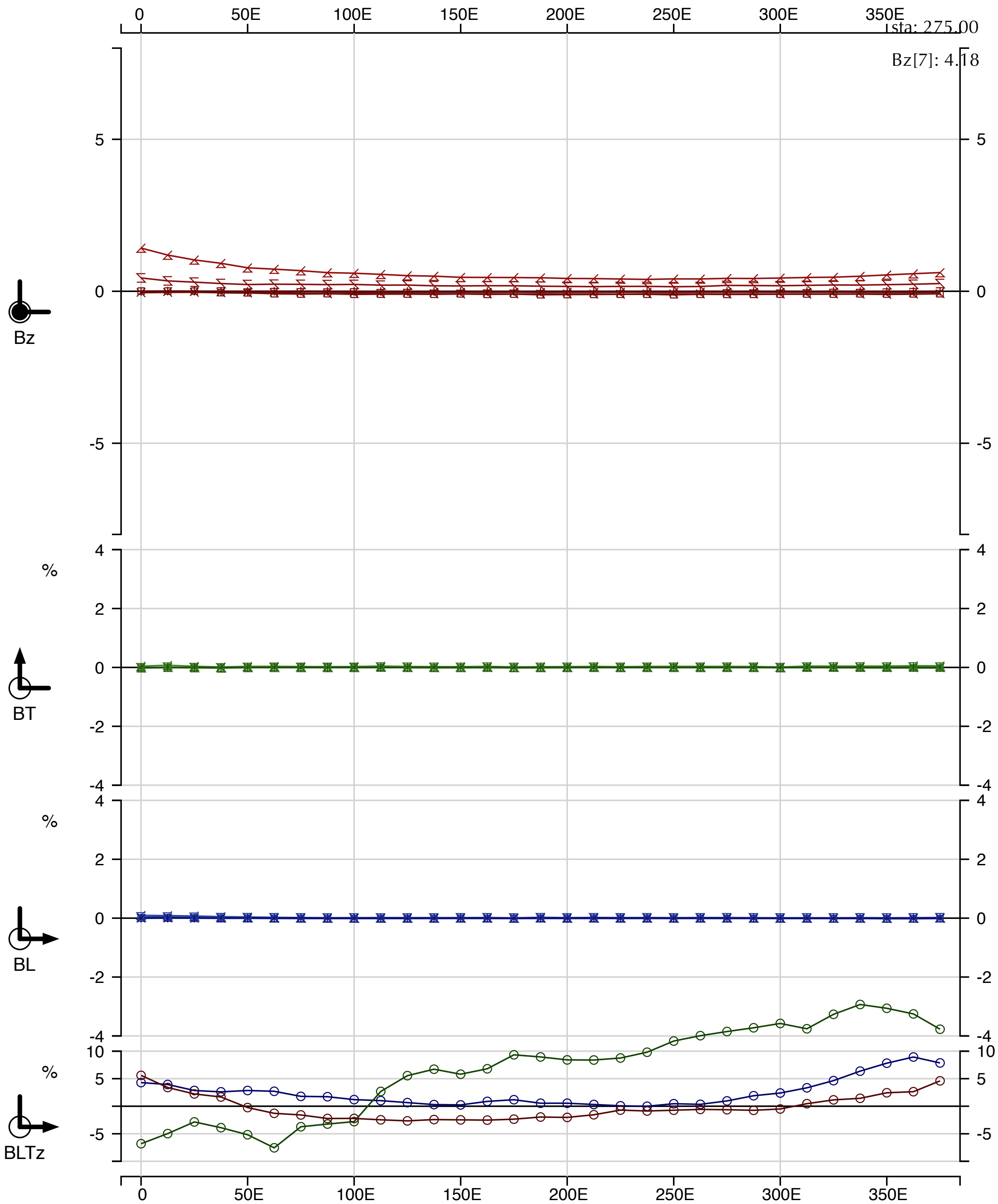


Line: L1650NB Loop: 2BS2 Cpt: BL, BT, Bz L 90.0°	(Chn - Ch0) / |Bp| (%) Cont norm @ Δz: 0m Base Freq: 4.09092Hz aLp2BS2_L1650NB.3cH5 / 3-Axis S2 LiCo latest 6Ch*	UTEM-5 Survey at: LiCo For: LiCo LAMONTAGNE GEOPHYSICS LTD GEOPHYSIQUE LTÉE Job 1701 Surv: 17/1/17 Red: 21/1/17 Plot: 26/1/17

Loop 2B - Chs6-Ch0 - B_{LTZ}

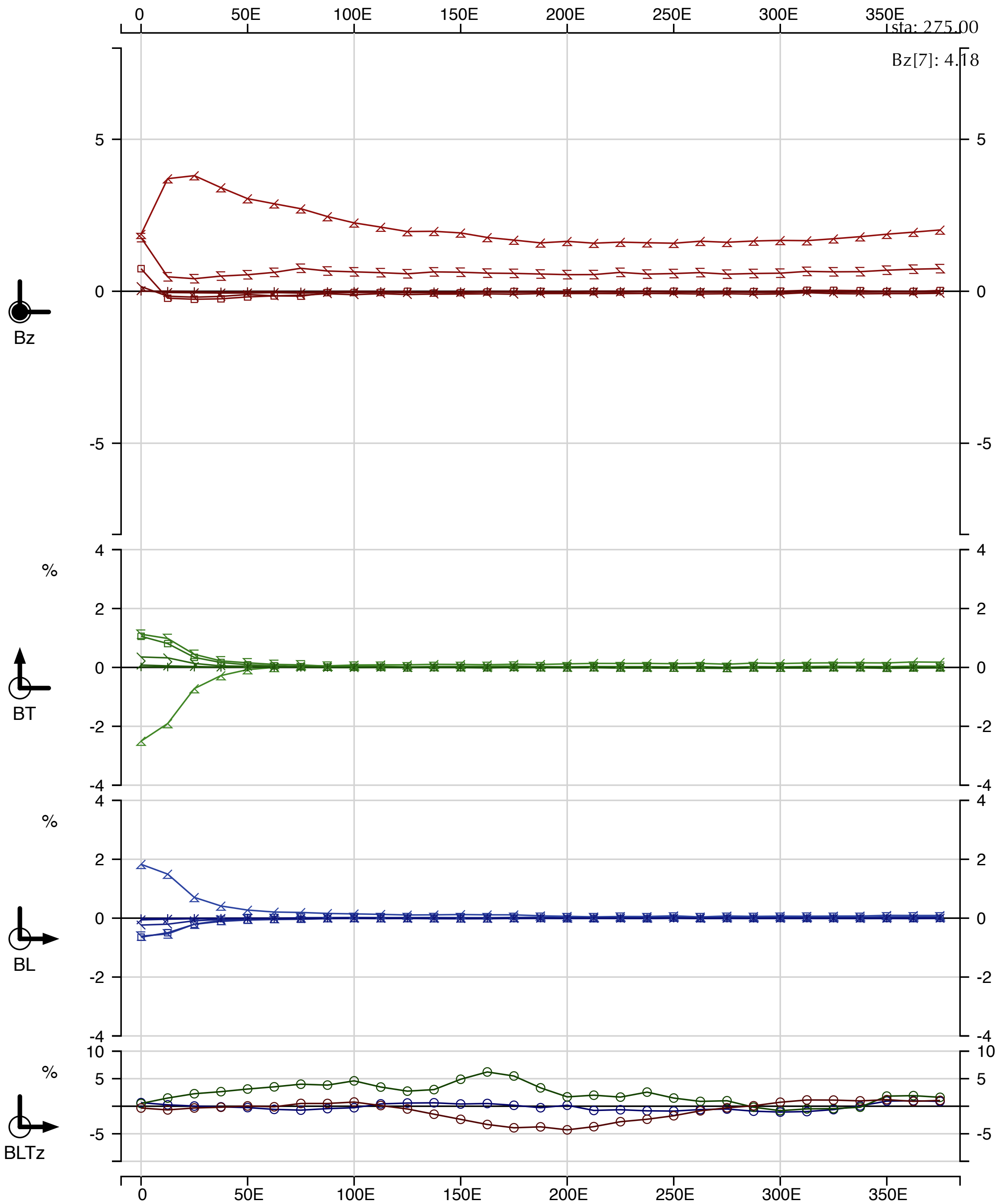


Loop 2B - Chs6-Ch0 - B_{LTZ}



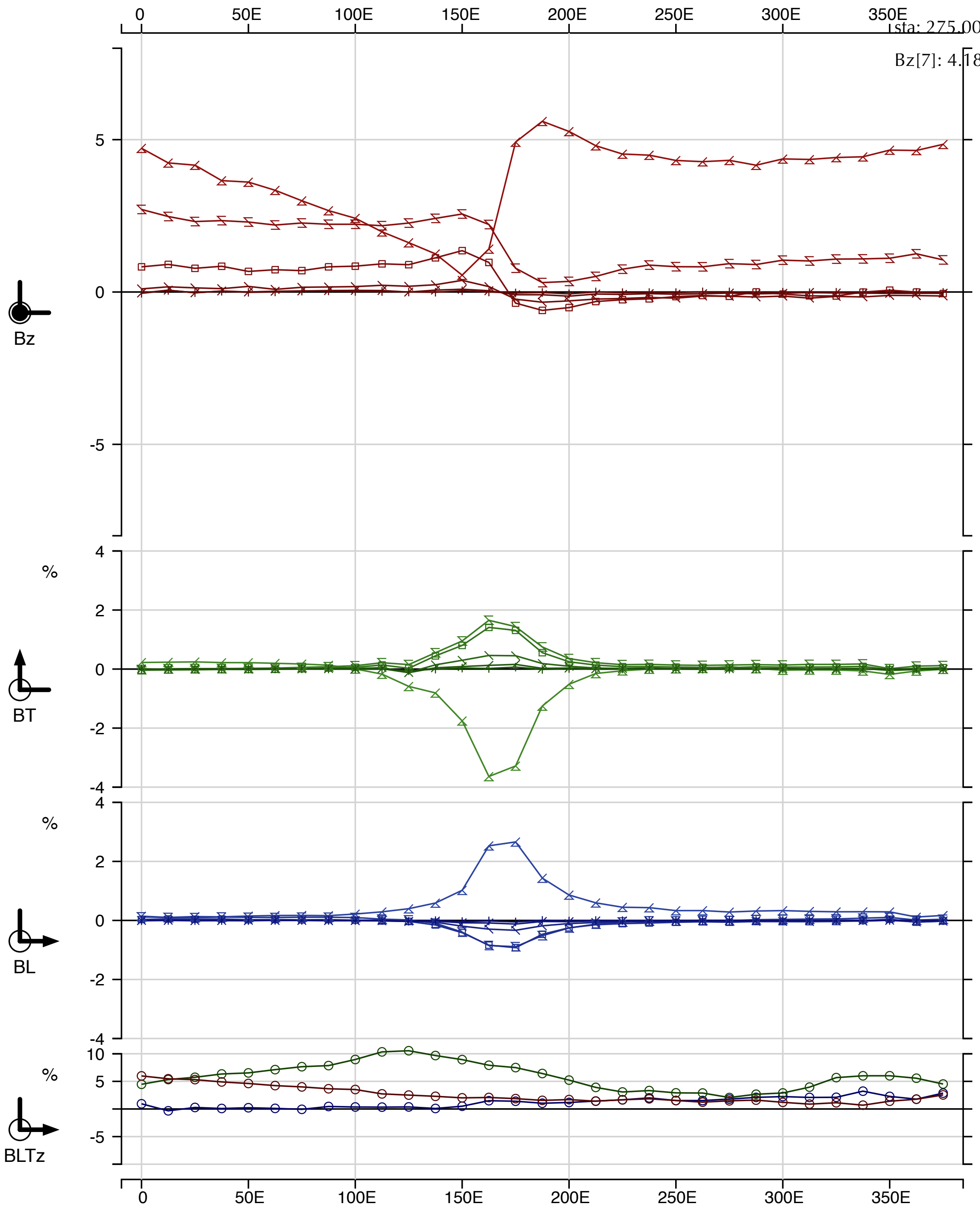
Line: L1850NB Loop: 2AS2 Cpt: BL, BT, Bz L 90.0°	(Chn - Ch0) / |Bp| (%) Cont norm @ Δz: 0m Base Freq: 4.09092Hz aLp2AS2_L1850NB.3cH5 / 3-Axis S2 LiCo latest 6Ch	UTEM-5 Survey at: LiCo For: LiCo LAMONTAGNE GEOPHYSICS LTD GEOPHYSIQUE LTÉE Job 1701 Surv: 15/1/17 Red: 21/1/17 Plot: 26/1/17

Loop 2A - Chs6-Ch0 - B_{LTZ}



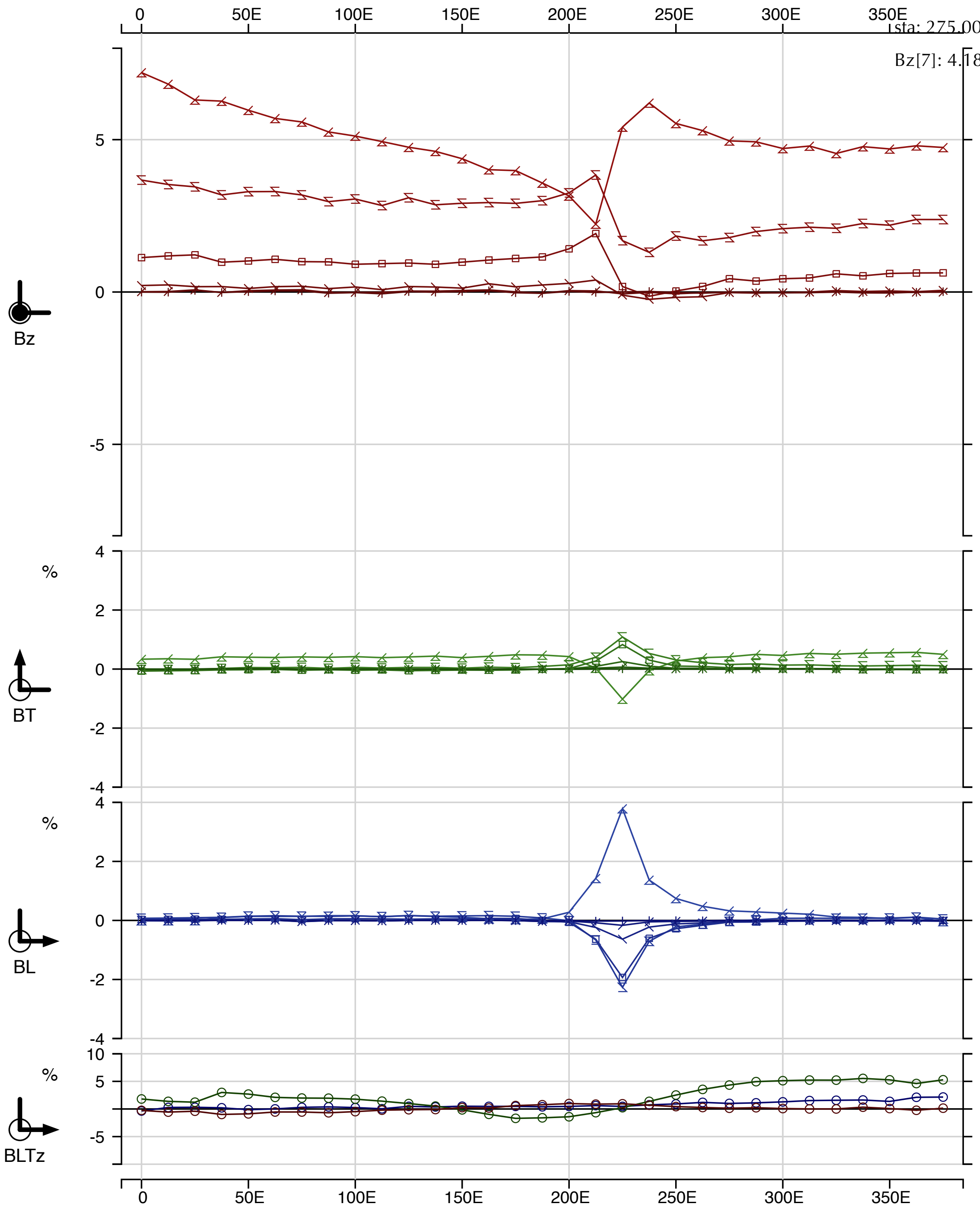
Line: L1950NB Loop: 2AS2 Cpt: BL, BT, Bz L 90.0°	(Chn - Ch0) / |Bp| (%) Cont norm @ Δz: 0m Base Freq: 4.09092Hz aLp2AS2_L1950NB.3cH5 / 3-Axis S2 LiCo latest 6Ch	UTEM-5 Survey at: LiCo For: LiCo LAMONTAGNE GEOPHYSICS LTD GEOPHYSIQUE LTÉE Job 1701 Surv: 15/1/17 Red: 21/1/17 Plot: 26/1/17

Loop 2A - Chs6-Ch0 - B_{LTZ}



Line: L2050NB Loop: 2AS2 Cpt: BL, BT, Bz L 90.0°	(Chn - Ch0) / |Bp| (%) Cont norm @ Δz: 0m Base Freq: 4.09092Hz aLp2AS2_L2050NB.3cH5 / 3-Axis S2 LiCo latest 6Ch	UTEM-5 Survey at: LiCo For: LiCo LAMONTAGNE GEOPHYSICS LTD GEOPHYSIQUE LTÉE Job 1701 Surv: 14/1/17 Red: 21/1/17 Plot: 26/1/17

Loop 2A - Chs6-Ch0 - B_{LTZ}



Line: L2150NB Loop: 2AS2 Cpt: BL, BT, Bz L 90.0°	(Chn - Ch0) / |Bp| (%) Cont norm @ Δz: 0m Base Freq: 4.09092Hz aLp2AS2_L2150NB.3cH5 / 3-Axis S2 LiCo latest 6Ch	UTEM-5 Survey at: LiCo For: LiCo LAMONTAGNE GEOPHYSICS LTD GEOPHYSIQUE LTÉE Job 1701 Surv: 14/1/17 Red: 21/1/17 Plot: 26/1/17

Loop 2A - Chs6-Ch0 - B$_{LTZ}$

Appendix B

1714 Production Diary

UTEM5 Survey

Teledyne Project UTEM Grid
Cobalt, ON

for

LiCo Energy Metals Inc.

Production Log 1714 UTEM5 Survey

UTEM5 Survey - Teledyne Project UTEM Grid

LiCo Energy Metals Inc.

Date	Rate - Production		Comments
January 12	mob	-	The crew departs at 08h30 from another Lamontagne project and drives to Haileybury, ON arriving at 13h30. The crew set up at the Leisure Inn in Haileybury.

Crew: P.Guimond,G.Lafortune,M.Savage,R.Lahaye,B.Dingwall

January 13	L-5	-	Four crew members drive out to the property and deploy wire on Loops 1 and 2. At the end of the day all loops are complete but the road crossings are intentionally left disconnected. They will be connected each morning and removed at the end of each survey day. B.Dingwall remains at the motel to prepare and test the survey gear.

Crew: P.Guimond,G.Lafortune,M.Savage,R.Lahaye,B.Dingwall

January 14	P(2/2)-5	750m	Drive out to the property to set up the transmitter site and put in the 5 road crossings and signage. After a bit of scouting around a spot is found to start the coils. Two complete lines are surveyed today at a 12.5m station interval. Finished surveying at 16h35. Back at the motel by 17h30.

Loop 1 S1 5.22 Hz Tx8
Loop 2 S2 4.09 Hz Tx10

Line 21+50N	**0+00**	**- 3+75E**	**R7P2**
Line 20+50N	**0+00**	**- 3+75E**	**R6P3**

Crew: P.Guimond,G.Lafortune,M.Savage,R.Lahaye,B.Dingwall

January 15	P(2/2)-5	750m	Drive out to the property to set up the transmitter site and put in the 5 road crossings and signage. Start up the coils and begin surveying by 9h15. Two more complete lines are surveyed today at a 12.5m station interval. Finished surveying at 15h00. Back at the motel by 16h30.

Loop 1 S1 5.22 Hz Tx8
Loop 2 S2 4.09 Hz Tx10

Line 19+50N	**0+00**	**- 3+75E**	**R7P2**
Line 18+50N	**0+00**	**- 3+75E**	**R6P3**

Crew: P.Guimond,G.Lafortune,M.Savage,R.Lahaye,B.Dingwall

Date	Rate - Production		Comments
January 16	P(2/2)-5	750m	Drive out to the property to begin laying wire for Loop 2A. Three sides are laid, loop corners are flipped, and 4 road crossings and signage are put in place. South wire of Loop 2 l(on L1750N) is picked up. B.Dingwall sets up the Tx site while the coils are being started. Surveying underway by 12h30. Two more complete lines are surveyed today at a 12.5m station interval. Finished surveying at 17h30. Back at the motel by 18h00.

Loop 1 S1 5.22 Hz Tx10
Loop 2 S2 4.09 Hz Tx8

Line 15+50N	**0+00**	**- 3+75E**	**R7P2**
Line 14+50N	**0+00**	**- 3+75E**	**R6P3**

Crew: P.Guimond,G.Lafortune,M.Savage,R.Lahaye,B.Dingwall

January 17	P(2/2)-5	750m	Drive out to the property, re-connect the 4 road crossings, set up the tx site and start up the coils. Survey the last two odd-numbered lines to complete the coverage. Spend several hours at the end of the day collecting calibration data for the two loops. Back at the motel by17h00.

Loop 1 S1 5.22 Hz Tx10
Loop 2 S2 4.09 Hz Tx5

Line 17+50N	**0+00**	**- 3+75E**	**R7P2**
Line 16+50N	**0+00**	**- 3+75E**	**R6P3**

Crew: P.Guimond,G.Lafortune,M.Savage,R.Lahaye,B.Dingwall

January 18	L5		Four crew members drive out to the property and pick up all the wire for the four loops. B.Dingwall remains at the hotel to pack up the gear. Back at the hotel by 10h30 to load the trucks. Depart the hotel at 11h30 for the demob back to Kingston, arriving at 18h30. M.Savage to Sudbury.

Crew: P.Guimond,G.Lafortune,M.Savage,R.Lahaye,B.Dingwall

January 19	Demob		P. Guimond to Toronto. R.Lahaye to Montreal. G.Lafortune to Sudbury.

Crew: P.Guimond,G.Lafortune,R.Lahaye

Teledyne Project UTEM Grid data collected: 2 loop coverage 3000m BL/BT/Bz

LEGEND

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

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

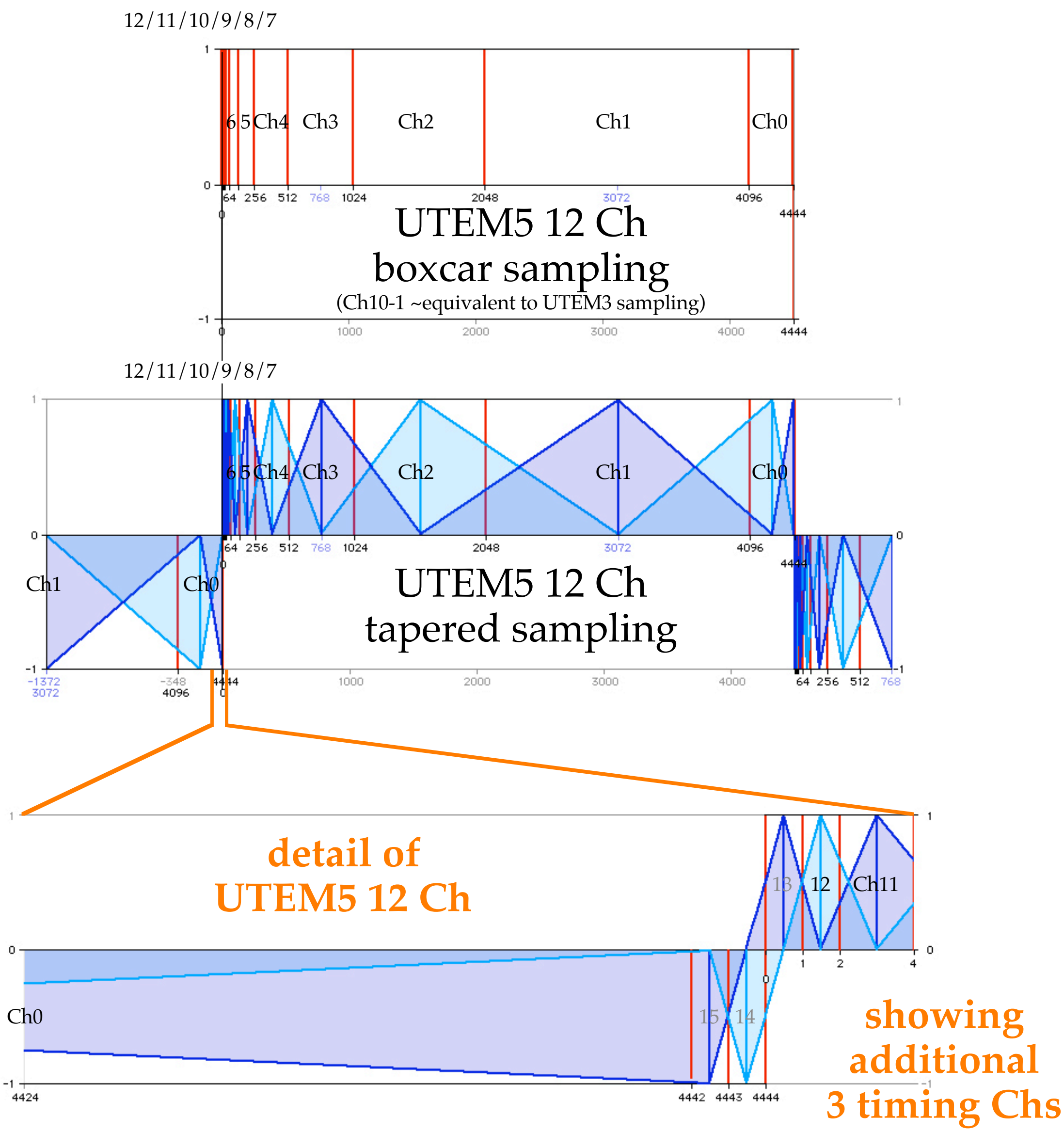
BHUTEM - the borehole version of UTEM - surveys have been carried out to depths up to 3000+ metres.

<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.

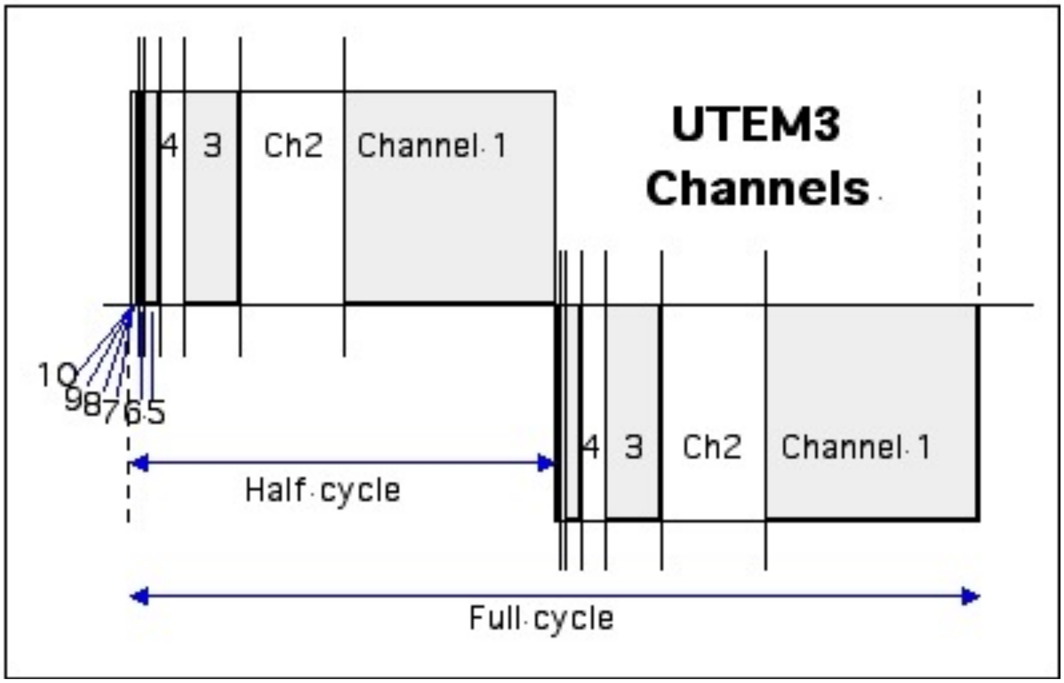


Notes:
- boxcar sampling equivalent to UTEM3 sampling
- tapered sampling: improved powerline rejection
- the use of UTEM4/5 Transmitters and UTEM5 Receivers improves syncing/timing and allows for the implementation of:
  - Ch0 - a narrow Ch after (later than) Ch1.
    - Ch0 normalization is an option
  - 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:

$$\mathbf{Rnj = (Chnj - Ch1j) / |BP| \times 100\%}$$

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

$$\mathbf{R1j = (Ch1j - HPj) / |BP| \times 100\%}$$

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

$$\mathbf{Rnj = (Chnj - BPj) / |BP| \times 100\%}$$

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:

$$\mathbf{Rnj = Chnj / |BP| \times 100\%}$$

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	⅄	15.00	-0.5	1.5
12	✗	45.00	0.5	3
11	+	90.01	1.5	6
10	Φ	180.02	3	12
9	⅀	360.04	6	24
8	⧗	720.07	12	48
7	⁊	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 45.00µs - 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.

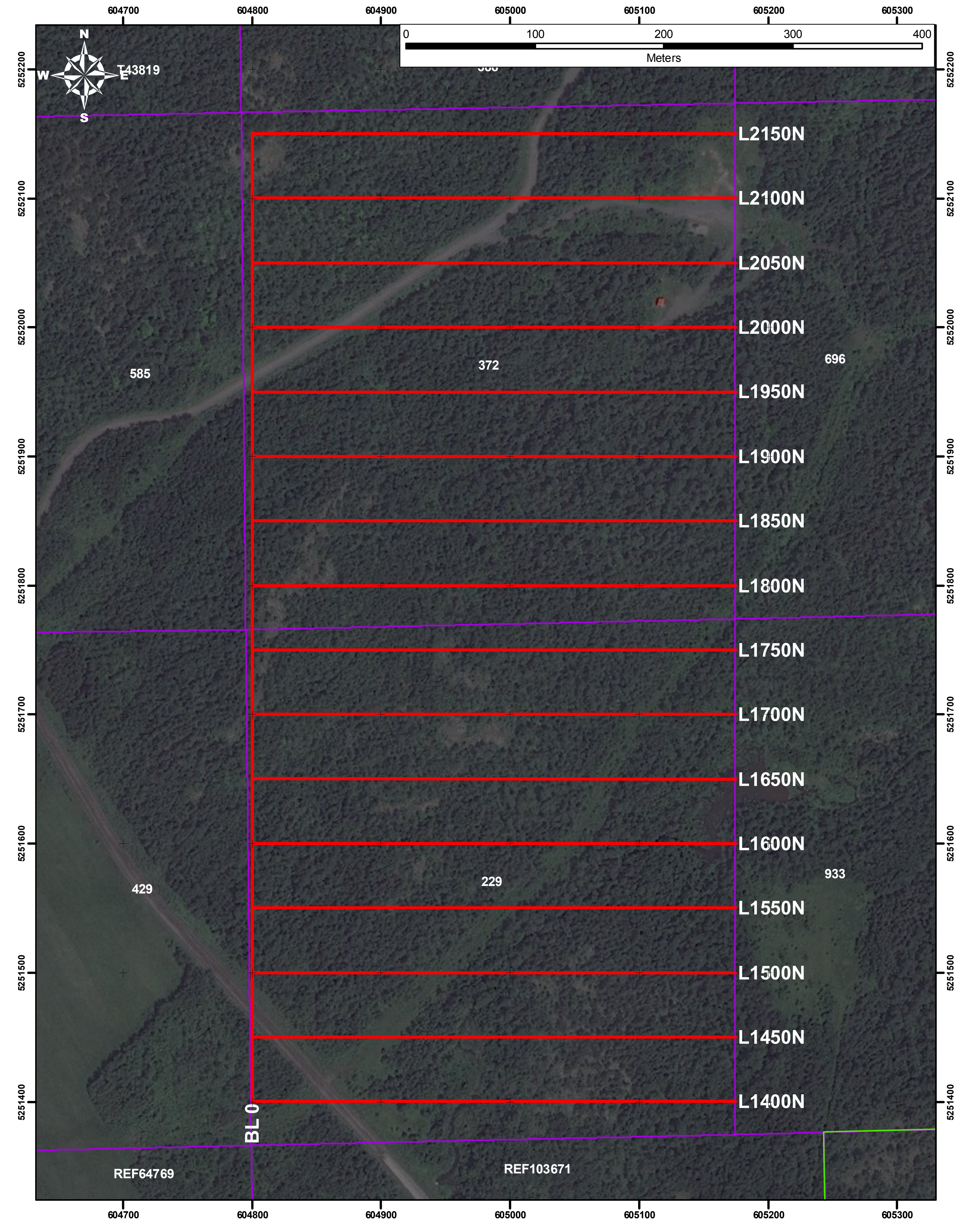
The larger amplitude of the UTEM Ch0 response is explained by the fact that the UTEM primary field is often more favourably coupled (magnetostatically speaking) to magnetic mineralization as compared to the earths field. Another factor could be the presence of a reverse remnant component to the magnetization.

Note: positive (negative) magnetic anomalies will cause:

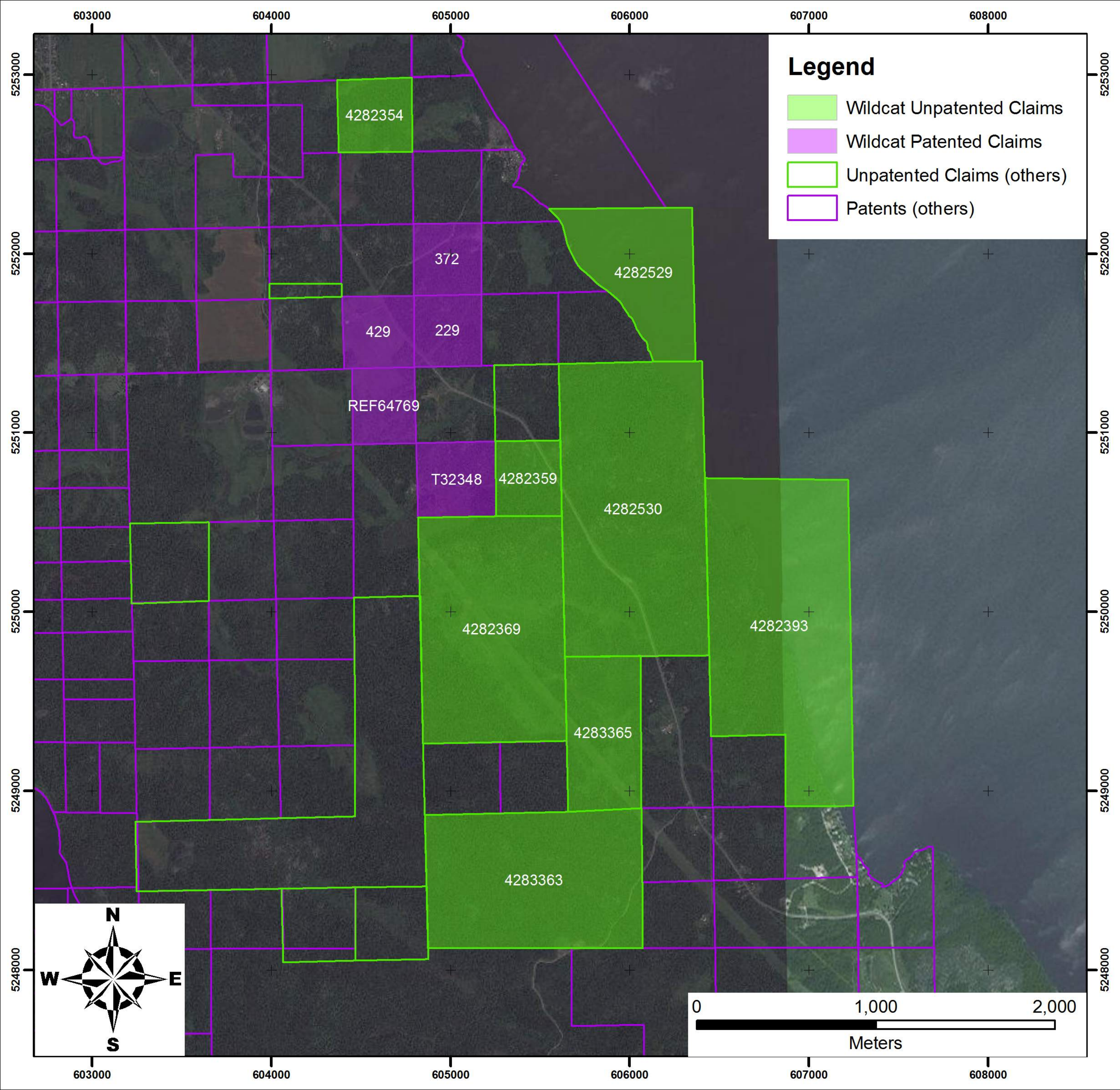
- positive (negative) Ch0 anomalies in data collected outside the loop
- negative (positive) Ch0 anomalies in data collected inside the loop

3) **Extremely good conductors**

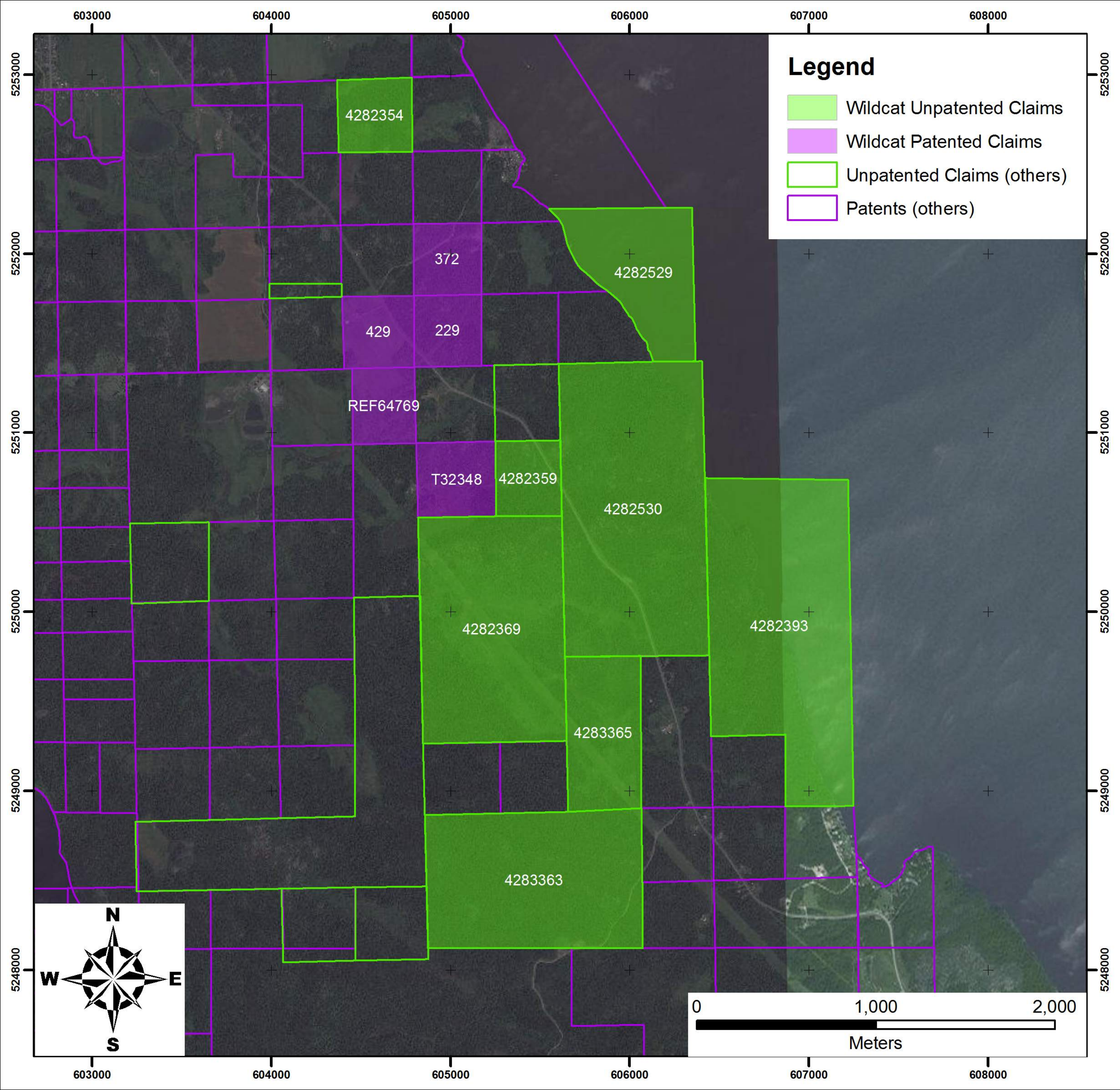
An extremely good conductor will be characterized by a time constant much longer than the half-period (@ 30Hz giving a time constant>>16ms). This will give rise to an anomalous Ch0 which is not correlated to the Ch1-10/12 data plotted on the upper axes of a channel 0 normalized plot.



604700
604800
604900
605000
605100
605200
605300
5252200
5252100
5252000
5251900
5251800
5251700
5251600
5251500
5251400
0
100
200
300
400
Meters
N
S
E
W
T43819
L2150N
L2100N
L2050N
L2000N
L1950N
L1900N
L1850N
L1800N
L1750N
L1700N
L1650N
L1600N
L1550N
L1500N
L1450N
L1400N
585
372
696
429
229
933
BL 0
REF64769
REF103671



603000
604000
605000
606000
607000
608000
5253000
5252000
5251000
5250000
5249000
5248000
Legend
Wildcat Unpatented Claims
Wildcat Patented Claims
Unpatented Claims (others)
Patents (others)
4282354
372
429
229
REF64769
T32348
4282359
4282529
4282530
4282369
4282393
4283365
4283363
N
W
E
S
0
1,000
2,000
Meters


603000
604000
605000
606000
607000
608000
5253000
5252000
5251000
5250000
5249000
5248000
Legend
Wildcat Unpatented Claims
Wildcat Patented Claims
Unpatented Claims (others)
Patents (others)
4282354
372
429
229
REF64769
T32348
4282359
4282529
4282530
4282369
4282393
4283365
4283363
N
S
W
E
0
1,000
2,000
Meters