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Mining Corporation

# Analyses of Airborne EM Anomalies

South and West of Alberts Lake

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# Introduction:

In late February 2010, several VTEM surveys were flown by Geotech Ltd, Aurora for Copper Reef Mining. To the west and south of Alberts Lake, one survey call Big Island Alberts was flown in east – west directions and another Alberts Lake Block was flown at an azimuth of approximately 30 degrees east of north. Geotech made a number of late time anomaly suggestions which were named "Z" picks.

Definition: ***Late Time EM Anomaly***

This term applies specifically to time domain electromagnetic data where the transmitter is a source of a time varying magnetic field and the receivers sense a time varying magnetic signal. The data is measured on a regular cycle rate and measured at specific times within that cycle. "Late Time" means that the measurement is made somewhere near the middle to the end of the cycle. A "late time" anomaly means that there is an unusual measurement over some of the late time channels and at a group of measuring stations. Normally, these unusual measurements are due to the presence of more conductive material.

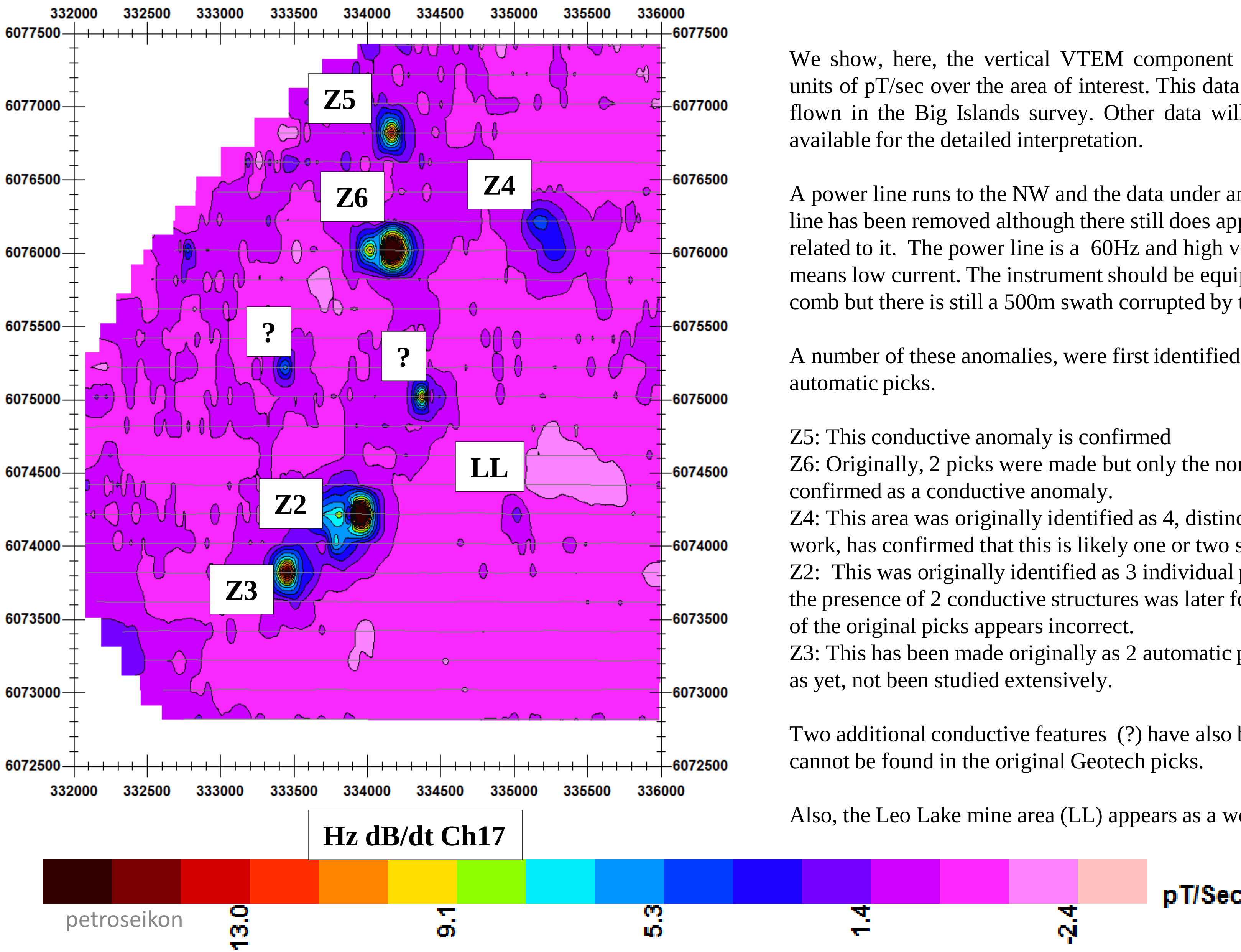
In this study, we study a group of picks in an area of about 4km x 4km to the south and west of Alberts lake. Our study includes a detailed analyses of several Geotech picks but also the identification of other interesting EM anomalies in the area and modifications to the Geotech picks.

In particular, we cover the Z2, Z4, Z5 and Z6 picks. The locations of these picks are not new to this area. There are suggestions of the detection of mineralization near these locations going back to the 1980's. These previous detections or suggestions were due to a variety of methods including three geophysical techniques: airborne frequency domain surveys (AEM), ground frequency domain surveys (HLEM) and very low frequency surveys due to remote transmitters (VLF). Unfortunately, the older data has not been found and only suggestions of the surveys are present on old maps from the period. Additionally, trenching has been found near some of the sites and mineralization found in those trenches. There has been drilling near these targets as well. However, logs of the core are also no longer available.

Our studies reveal that all these targets consist of more than one zone of mineralization. Interpretation of any EM target was difficult if not impossible in the 1980's as there was not simulation software available for such data to estimate a model until the 1990's. Thus, even if indications were found of conductive mineralization, in many cases drilling missed the target in virtually any mining camp.

The evolution of geophysical equipment and geophysical software and correct procedures has increased dramatically the likelihood of detection even in areas previously well explored.

# Analyses of AEM Anomalies




We show, here, the vertical VTEM component (Hz) contoured in units of pT/sec over the area of interest. This data is for those flights flown in the Big Islands survey. Other data will be utilized when available for the detailed interpretation.

A power line runs to the NW and the data under and near this power line has been removed although there still does appear some noise related to it. The power line is a 60Hz and high voltage line which means low current. The instrument should be equipped with a 60Hz comb but there is still a 500m swath corrupted by the power line.

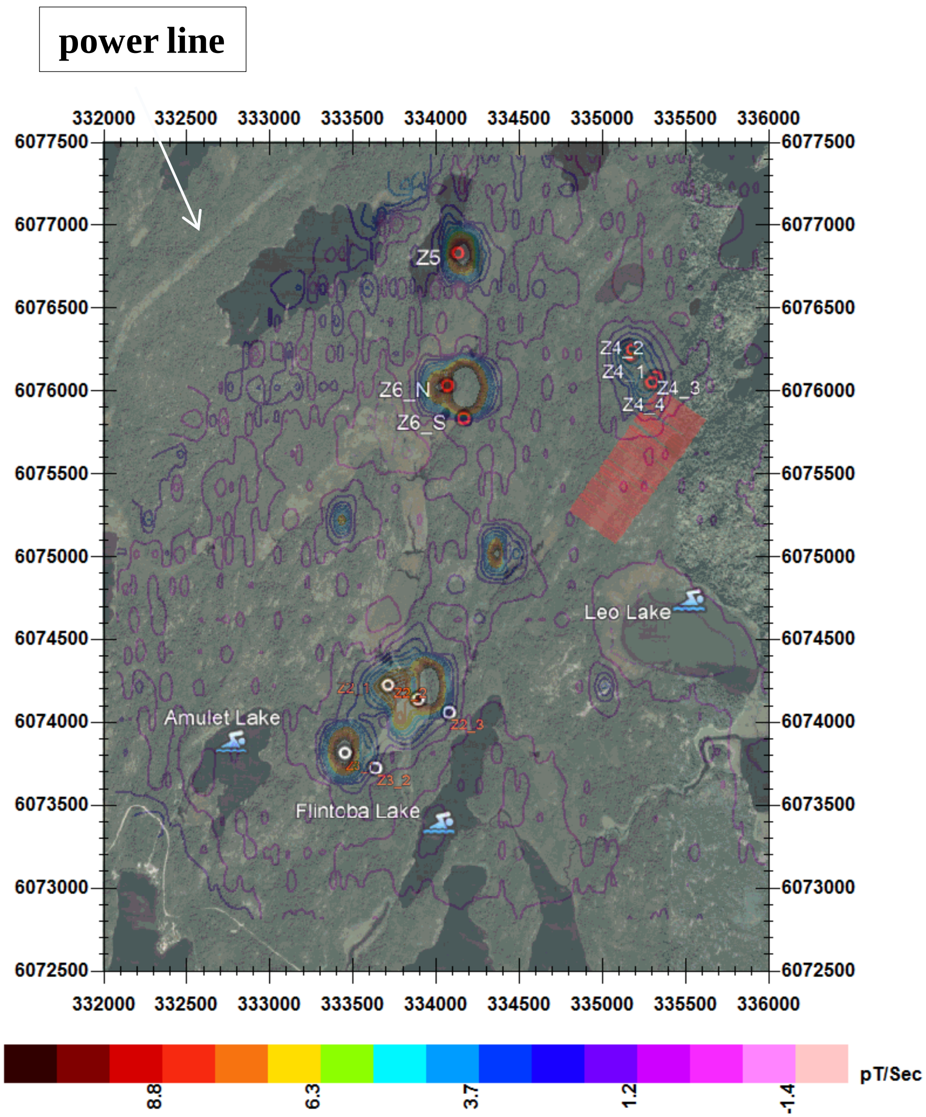
A number of these anomalies, were first identified by Geotech with automatic picks.

Z5: This conductive anomaly is confirmed
Z6: Originally, 2 picks were made but only the northern pick is confirmed as a conductive anomaly.
Z4: This area was originally identified as 4, distinct picks. Further work, has confirmed that this is likely one or two structures
Z2: This was originally identified as 3 individual picks. Although, the presence of 2 conductive structures was later found, the position of the original picks appears incorrect.
Z3: This has been made originally as 2 automatic picks. These have, as yet, not been studied extensively.

Two additional conductive features (?) have also been found which cannot be found in the original Geotech picks.

Also, the Leo Lake mine area (LL) appears as a weak conductor.

# Analyses of AEM Anomalies

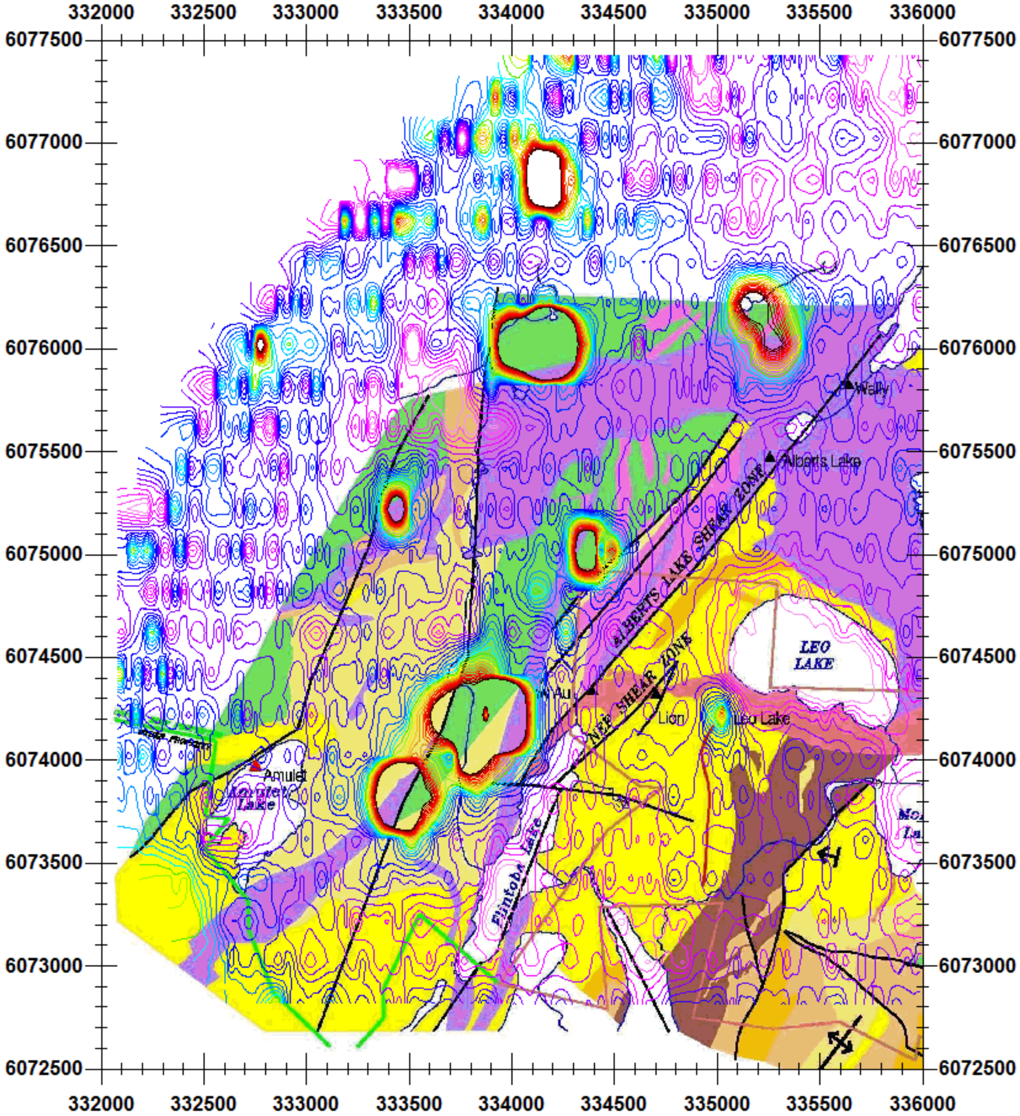



We show, here, the vertical VTEM component (Hz) Ch16 contoured in units of pT/sec over the area of interest.

A power line runs to the NW and the data under and near this power line has been removed although there still does appear some noise related to it.

A satellite image is underlain. White and red dots, indicate the locations of the original Geotech picks. The red lines are the location of the 2018 VLF and ground magnetics survey.

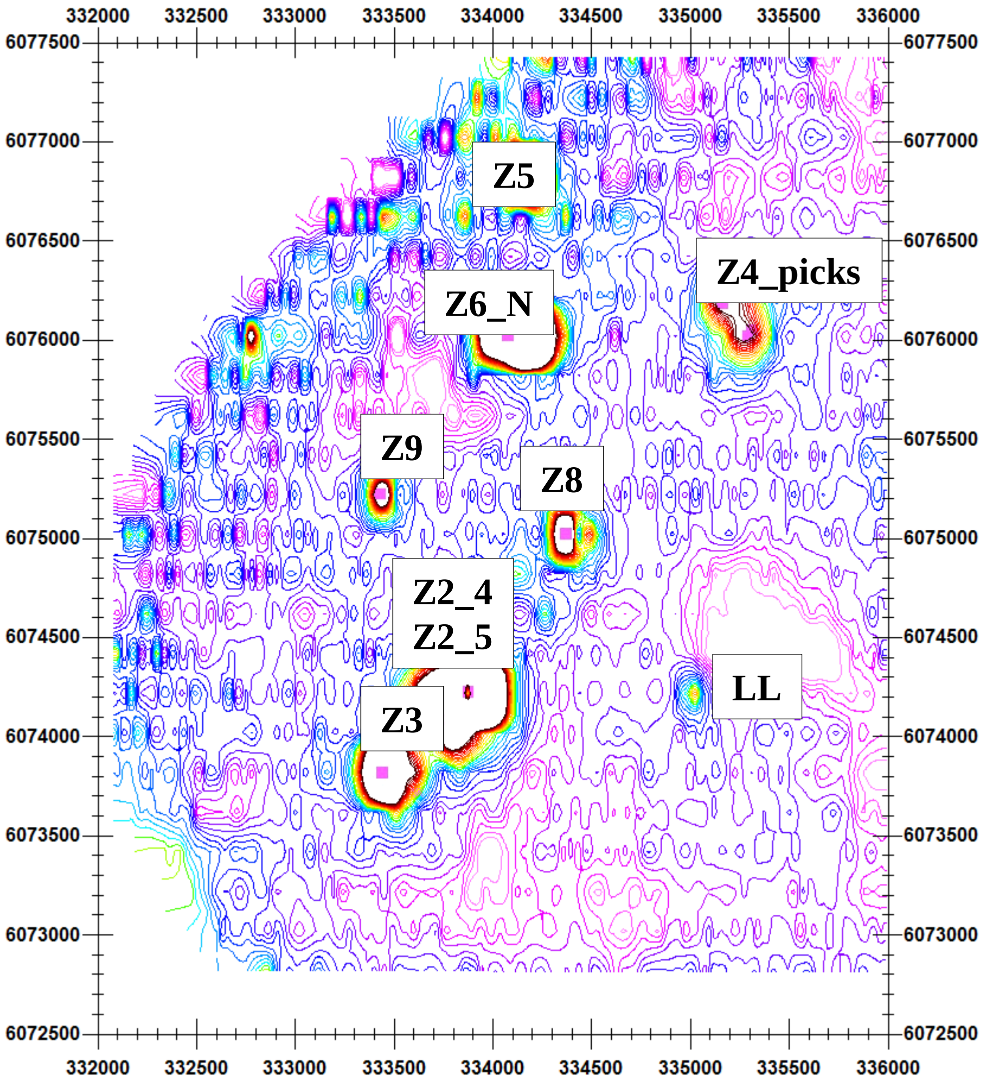
# Analvses of AEM Anomalies




Here, we contour Ch17 again but with a geological underlay courtesy of the Manitoba government.

4 of the anomalous areas lie between the Alberts Lake and Pine Bay shear zones.

# Analyses of VTEM EM Anomalies

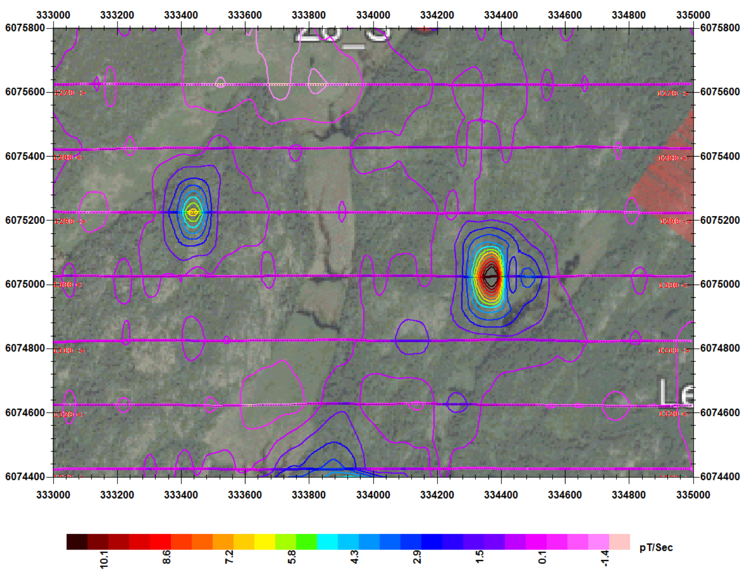



Here, we indicate the locations and names of the our updated EM conductive anomalies from this present analysis.

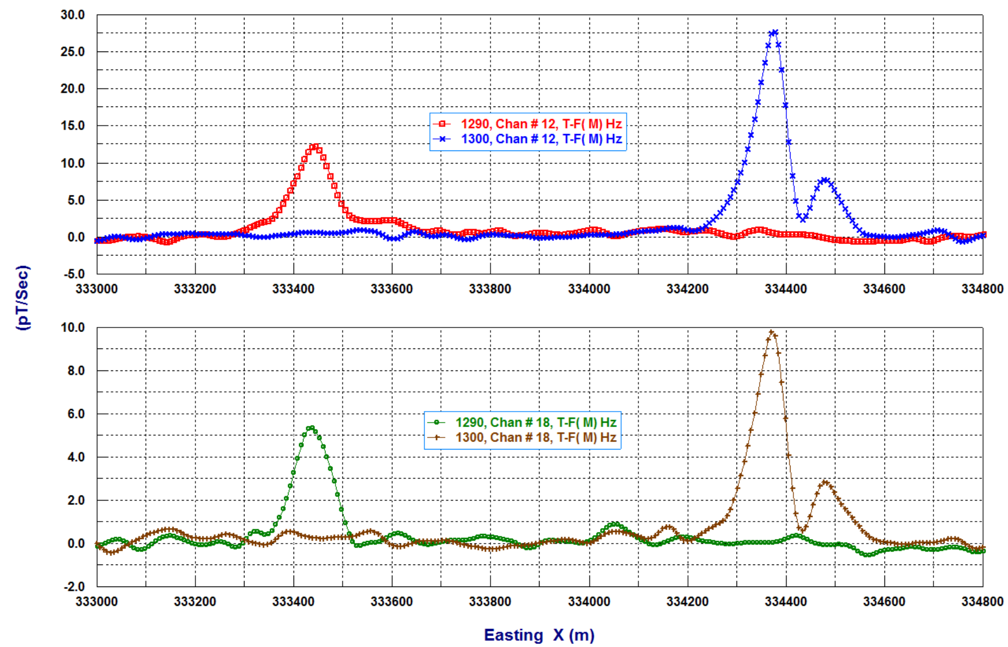
# Analyses of VTEM EM Anomalies

This study focuses primarily on the Z2, Z4, Z5 and Z6 anomalies for detailed modeling and interpretation. However, we will provide a brief look at Z8, Z9 and LL.

Z8 and Z9 appear to be isolated with a significant response on only one line for each. We present a contour of Ch16 on the left and two plots for Ch12 and Ch18 for both lines to the right. Both features do not appear in very early times, Z8 first appears at Ch5 and Z9 at Ch7. The satellite image does not show any obvious indication of surficial conductive material.



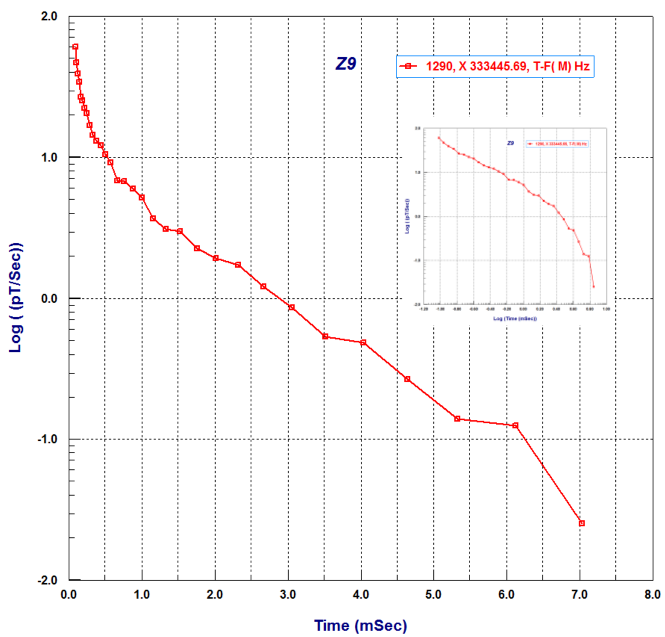

**Z8 to the right on L1300 and Z9 to the left on L1290. Ch16 is contoured.**

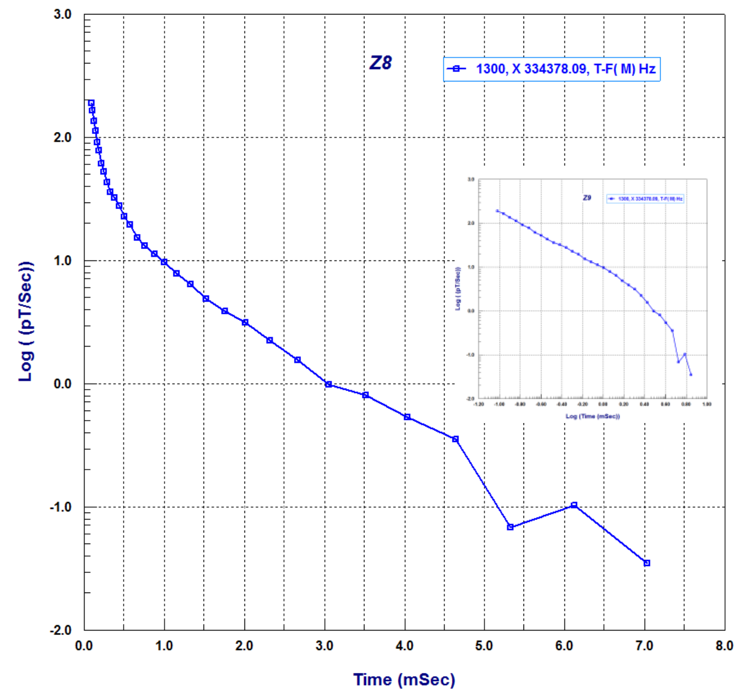



**Ch12 (top) for L1290, 1300**
**Ch18 (bottom) for L1290, 1300**

# Analyses of VTEM EM Anomalies

Below, we show decays at a central station over each anomaly. The main figure is the log of the amplitude by time channel while the insets are log (ampl) vs. log (time). The response at early time for Z8 is much stronger than Z9 and this appears to account for the cleaner, strong response into late time. By Ch23, the responses are very similar although Z8 remains cleaner. Both stations, show a very fast early time decay , which slows in later time.. Z8 would strongly indicate more conductive material at depth. This could also be true for Z9 but the data is too noisy to be confident.




**Z8 to the right on L1300 and Z9 to the left on L1290. Ch16 is contoured.**

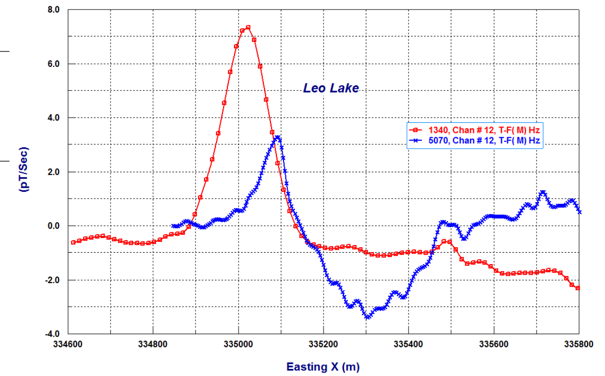
**Ch12 (top) L1290, 1300**
**Ch18 (bottom) L1290, 1300**

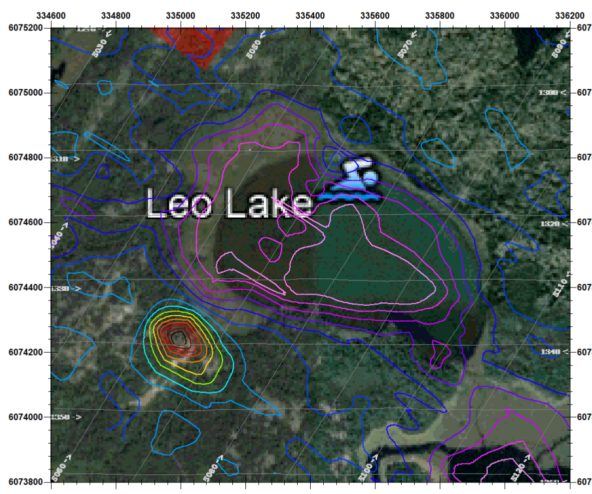
# Analyses of VTEM EM Anomalies

Leo Lake feature: For the Leo Lake anomaly, we have two surveys in order to study the response. The EW survey lines of Big Island and the NNE trending lines of the Alberts Lake survey. The feature appears on 2 lines (L1340 and L5070). The conductive feature identified as the Leo Lake mine is not strong and does not appear as an anomaly under late early time. The response locally is dominated by the response over Leo Lake. The reader will note that the response over the lake goes negative into mid-time and indicates a strong IP response by the lake sediments. A factor that should be considered when modeling anomalies over lakes in this area.

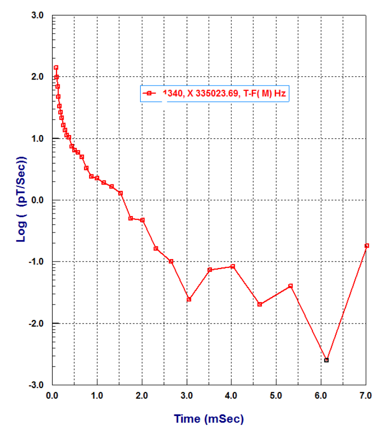
The response for Ch14 is shown contoured below while the profile responses on the 2 lines is shown for Ch12 on the right. The decays do not indicate anything exciting so far as conductive material at depth is concerned. However, the location has been mined but we do not have the information as to the mining depths.

**Ch12, L1340 (red) and L5070 (blue)**

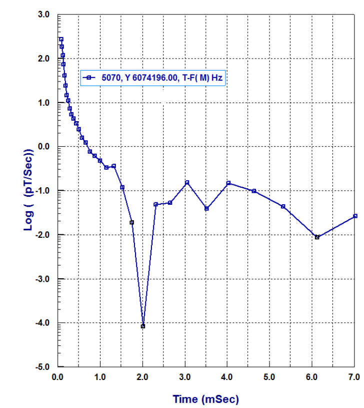



**Leo Lake anomaly at Ch14 with satellite image underlay.**




**Decay at peak L1340**



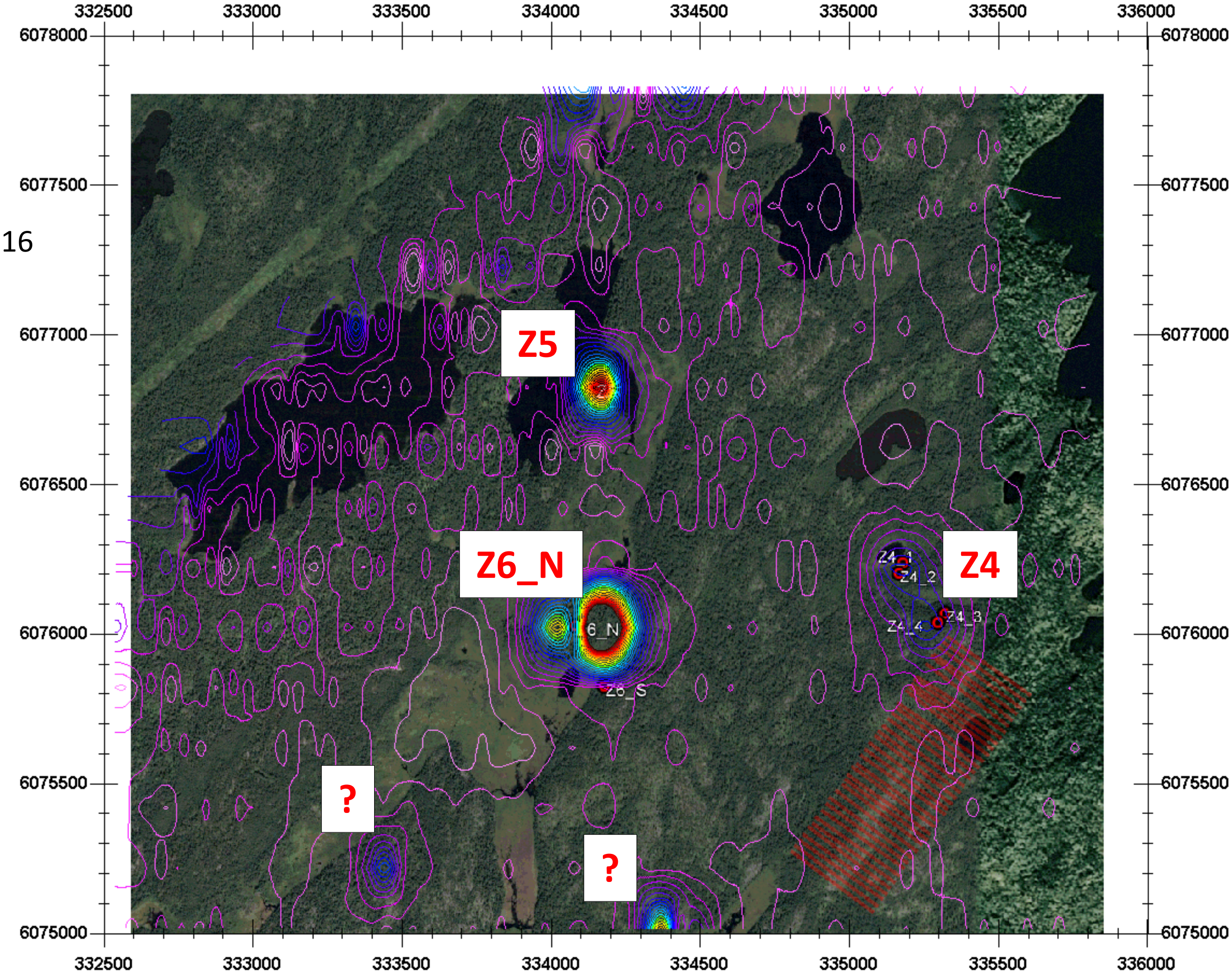

**Decay at peak 5070**

# Analyses of VTEM Z_5 Picks

Introduction:
In this study, only the Big Island Alberts survey is available. Lines were flown in east – west directions.  We study the area surrounding the pick named Z_5.

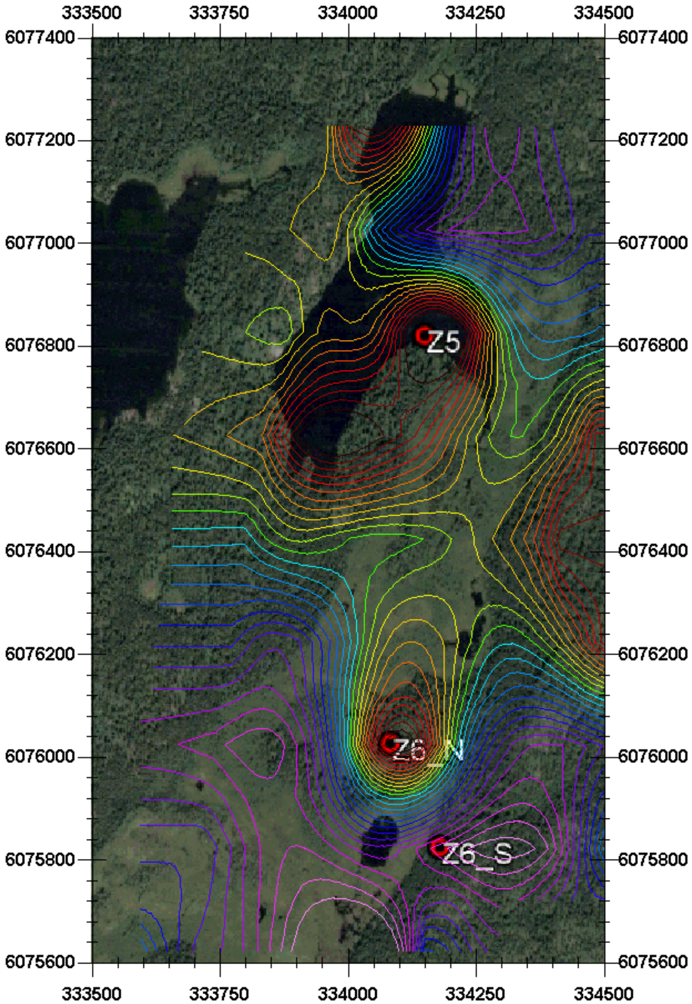
# Late Mid-time VTEM anomalies to the west of Alberts Lake

VTEM Ch16




In this area just west of Alberts Lake, there are 3 anomalies identified by Geotech picks (Z4,Z5 and Z6) plus two additional anomalies which were not as yet named. The anomalies are enclosed by area of about 2km x 2km.

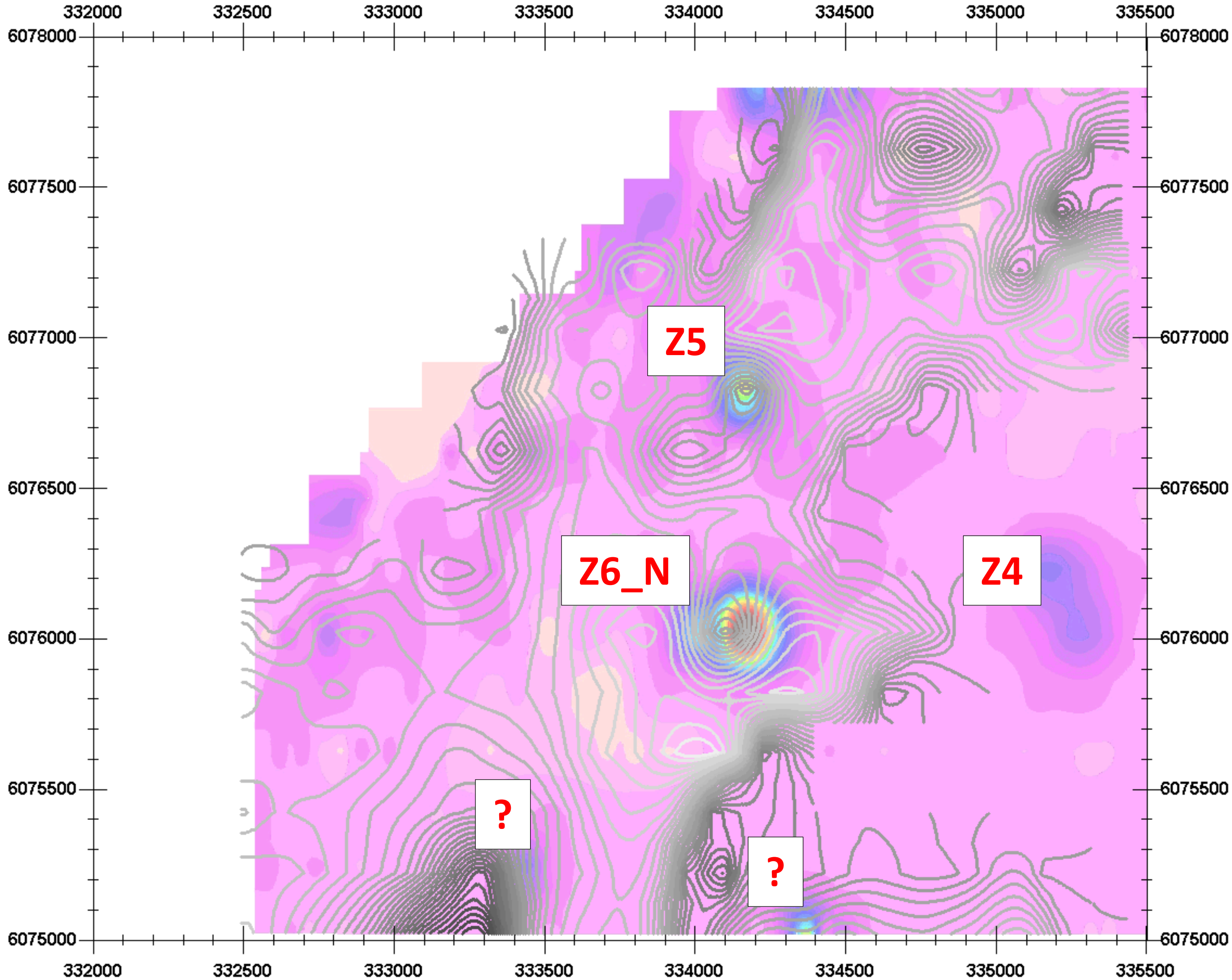
# Aeromagnetic – Local to Z5 and Z5




VTEM aeromagnetics in region of Z5 and Z6

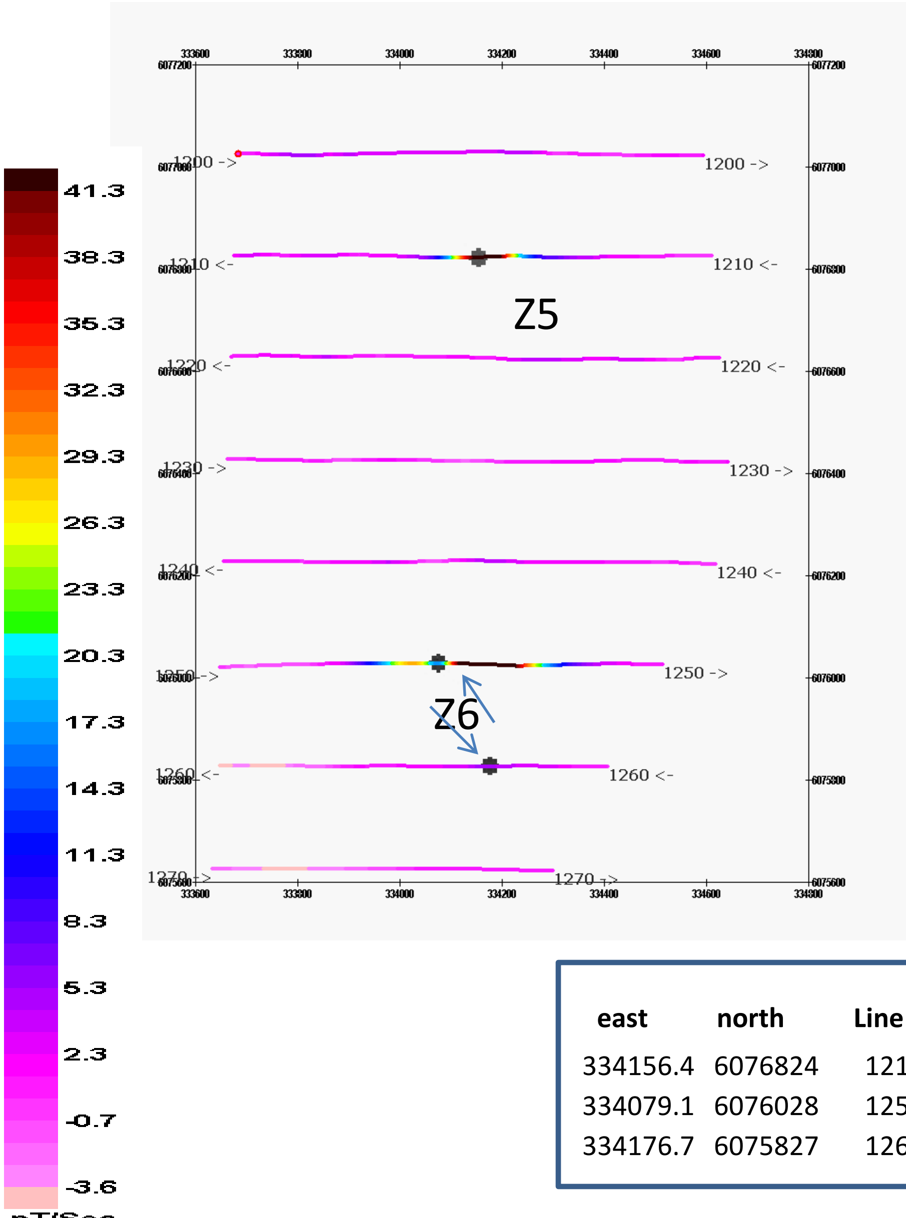
If we examine the aeromagnetics in the area, it is dominated by a large response to the east of Z5 and Z6. However, isolating the magnetics in the Z5 and Z6 region, local magnetic anomalies are identified around Z5 and Z6. The aeromagnetic anomaly surrounding Z5 extends in an approximate L-shape to the south and west.

# Aeromagnetic – Ch17 VTEM underlain




Z5 and Z6_N show local magnetic anomalies over a larger area contoured in black and white with the airborne EM at a later channel underlain.

# Z6 and Z5 Picks




Z5 was picked by Geotech on only 1 line – L1210 while Z6 was picked on 2 lines L1250 and L1260.

However, there is little indication of an anomaly in the VTEM EM data on L1260.

Here, we have displayed Ch12.

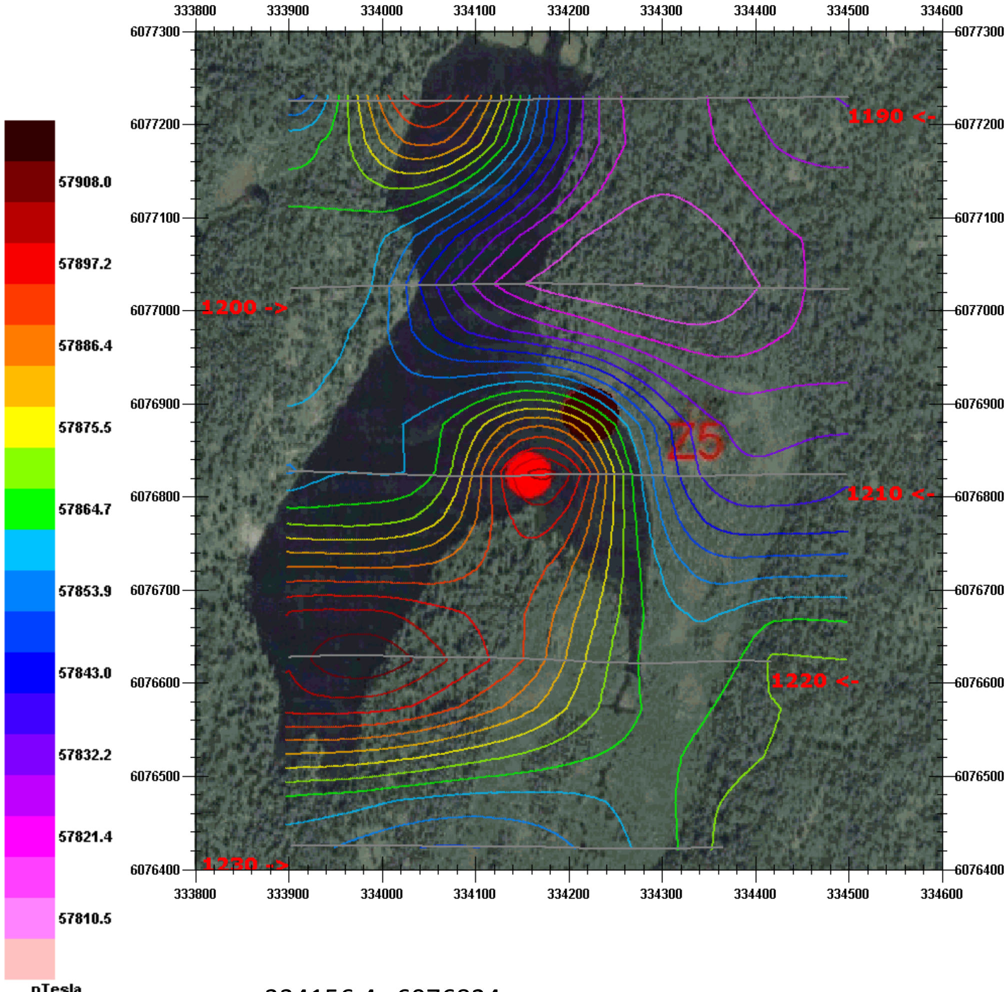
The coordinates of the Geotech picks are given below.

From here on, we name the anomaly on L1250 as Z6_N.

## Geotech picks

| east | north | Line | Longitude | Latitude | ID_numb | ID | Type | tauSF |
|---|---|---|---|---|---|---|---|---|
| 334156.4 | 6076824 | 1210 | -101.581 | 54.8111 | 5 | Z5 | ? | 3.6802 |
| 334079.1 | 6076028 | 1250 | -101.582 | 54.80393 | 6 | Z6 | PLATE | 4.4769 |
| 334176.7 | 6075827 | 1260 | -101.58 | 54.80215 | 6 | Z6 | ? | 1.2031 |

# Z5 Picks - aeromagnetics



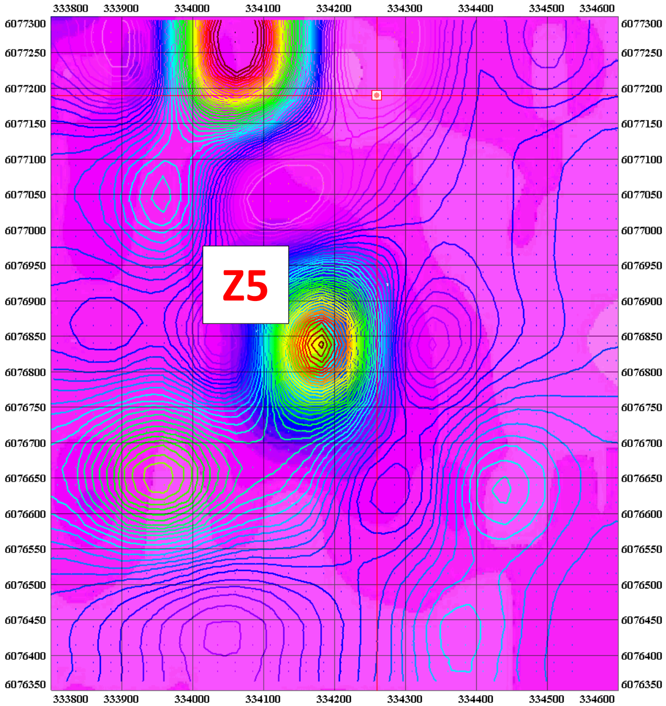

334156.4 6076824

The Z5 pick is on L1210 at 334156E, 6076824N near the centre of a small lake which is about 1.6km west of Alberts Lake.

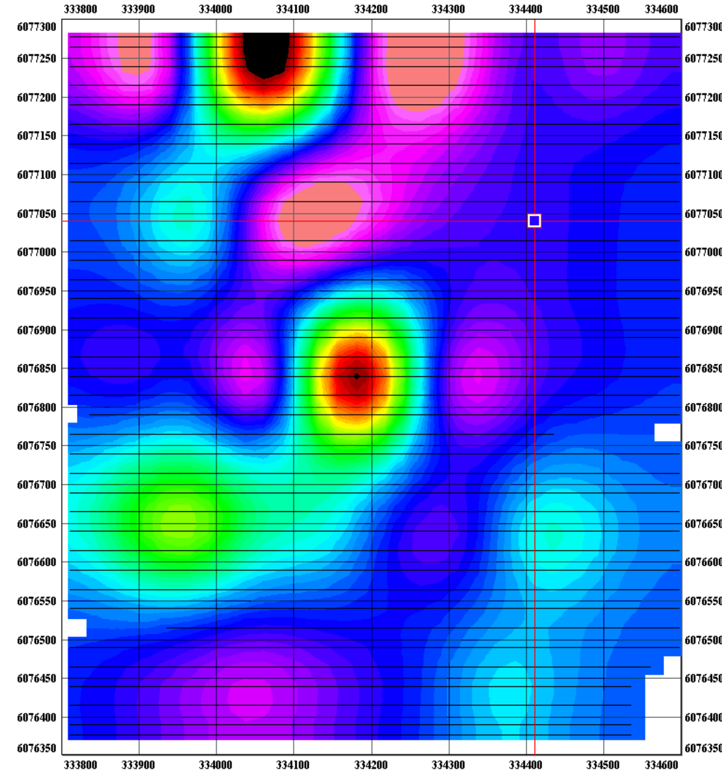
There are several small aeromagnetic anomalies in the area, one of which is clearly centered on the Z5 pick. These are small anomalies of only about 100 nT but the Z5 magnetic anomaly is quite circular and only about 150m in radius. But, there is an extension of this anomaly to the west and south.

Preliminary modeling places the top of the magnetic structure at about a depth of 150m. The other anomalies to the SW and to the north appear separate anomalies in structure while their magnetic responses merge.

# Aeromagnetic – 3D inversions Depth Sections



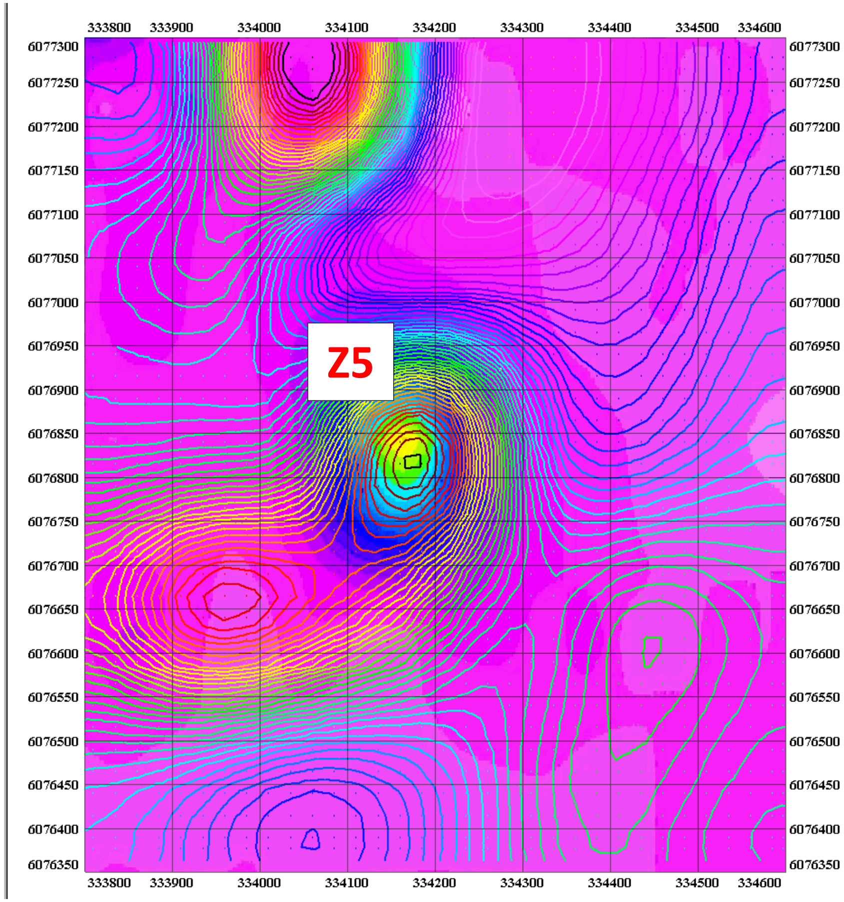

Inversion results contour line at Depth = 50m.
VTEM Ch17 response underlain

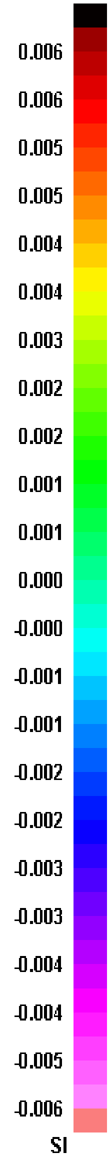

Inversion results filled contours at Depth = 50m.

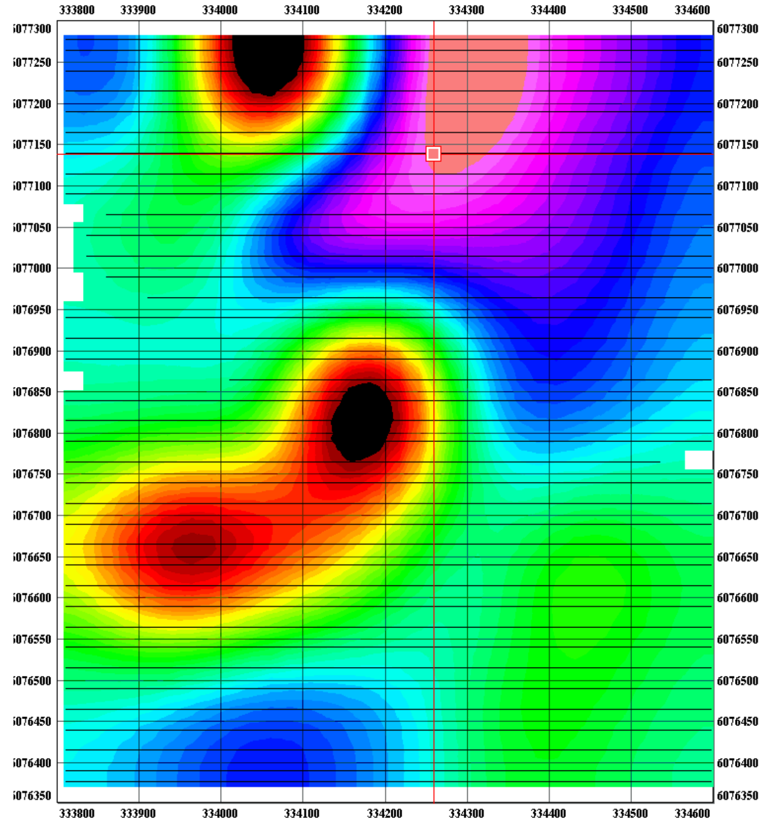
We point to the magnetic structure about the VTEM anomaly (Z5). This magnetic anomaly first appears significantly at a depth of about 50m. But, we also point on the weaker anomaly to the SW as this structure appears to be part of the Z5 magnetic anomaly.

# Aeromagnetic – 3D inversions Depth Sections




Inversion results contour line at Depth = 150m.
VTEM Ch17 response underlain

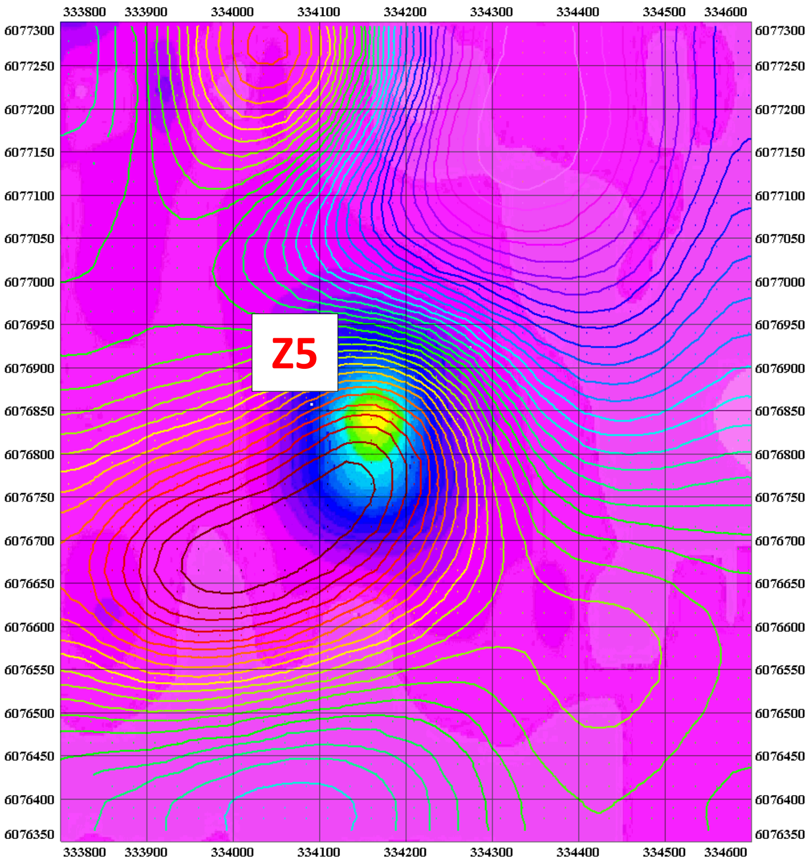


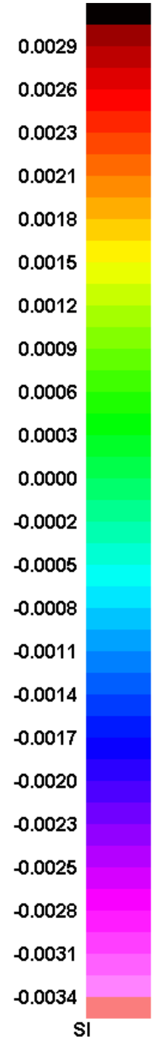



Inversion results filled contours at Depth = 150m.

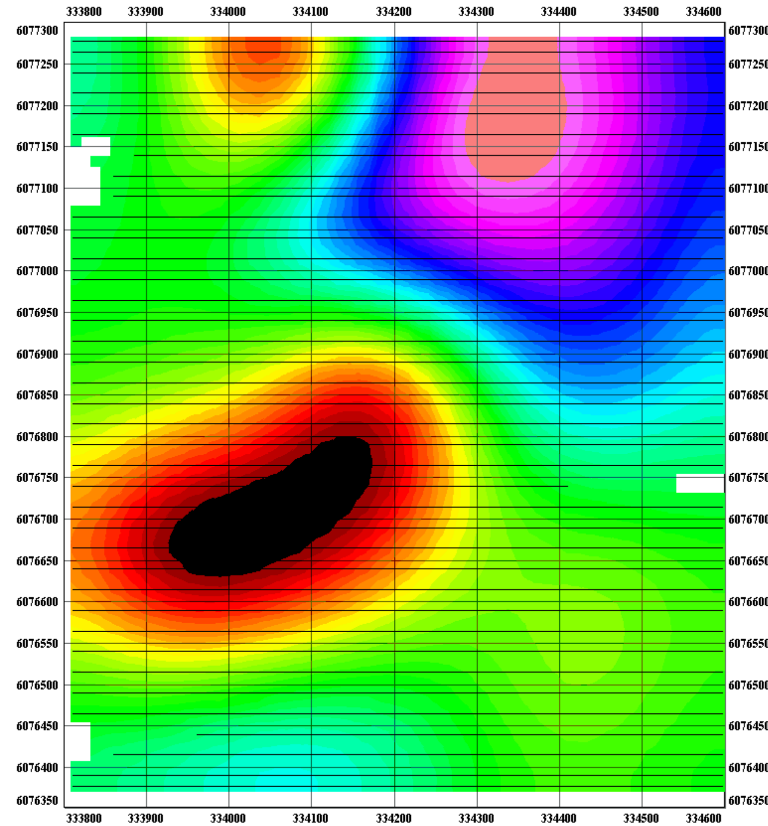
At a depth of 150m, the magnetic anomaly surrounding Z5 is still stronger than the SW extension. But, at this depth, we begin the see a stronger connection between the two parts.

# Aeromagnetic – 3D inversions Depth Sections



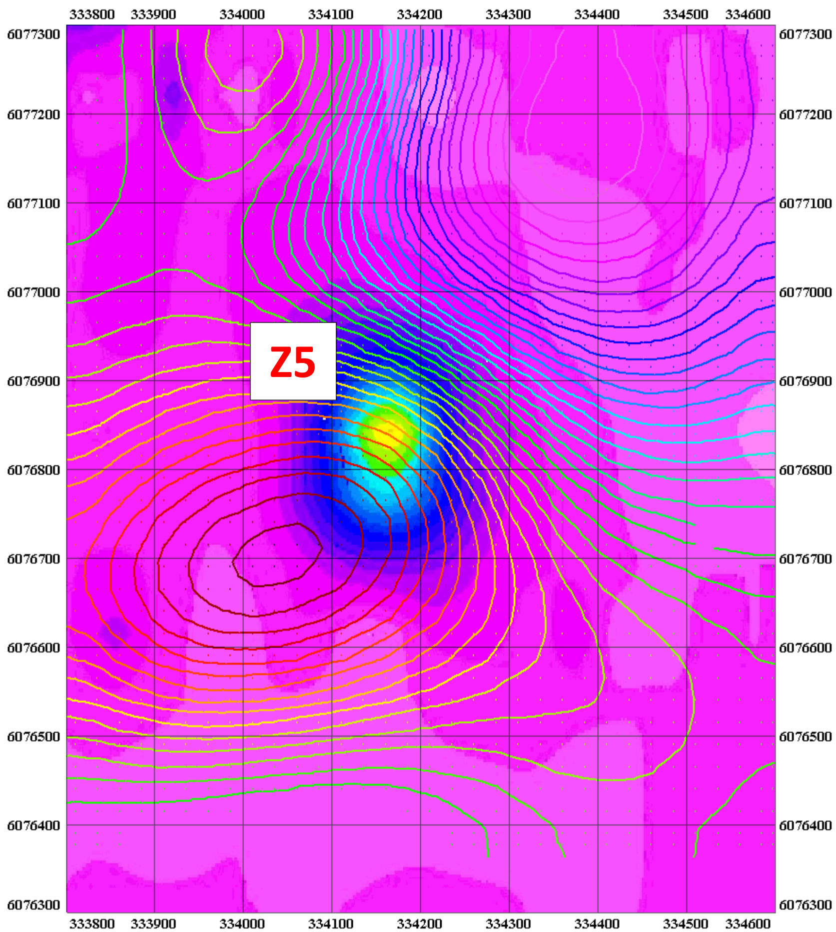

Inversion results contour lines at Depth = 250m.
VTEM Ch17 response underlain

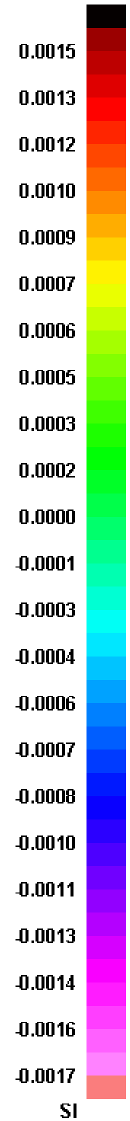


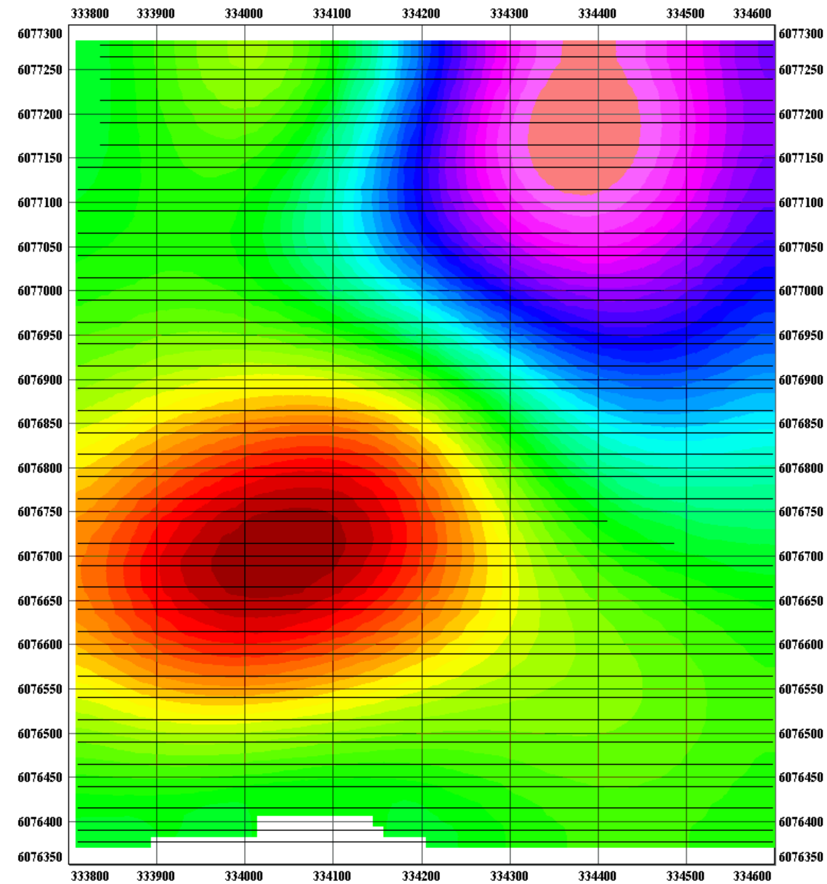

Inversion results filled contours at Depth = 250m.

By 250m, the structure now appears almost elliptical ending in the NE at Z5 and in the SW and the southwest extension.

# Aeromagnetic – 3D inversions Depth Sections



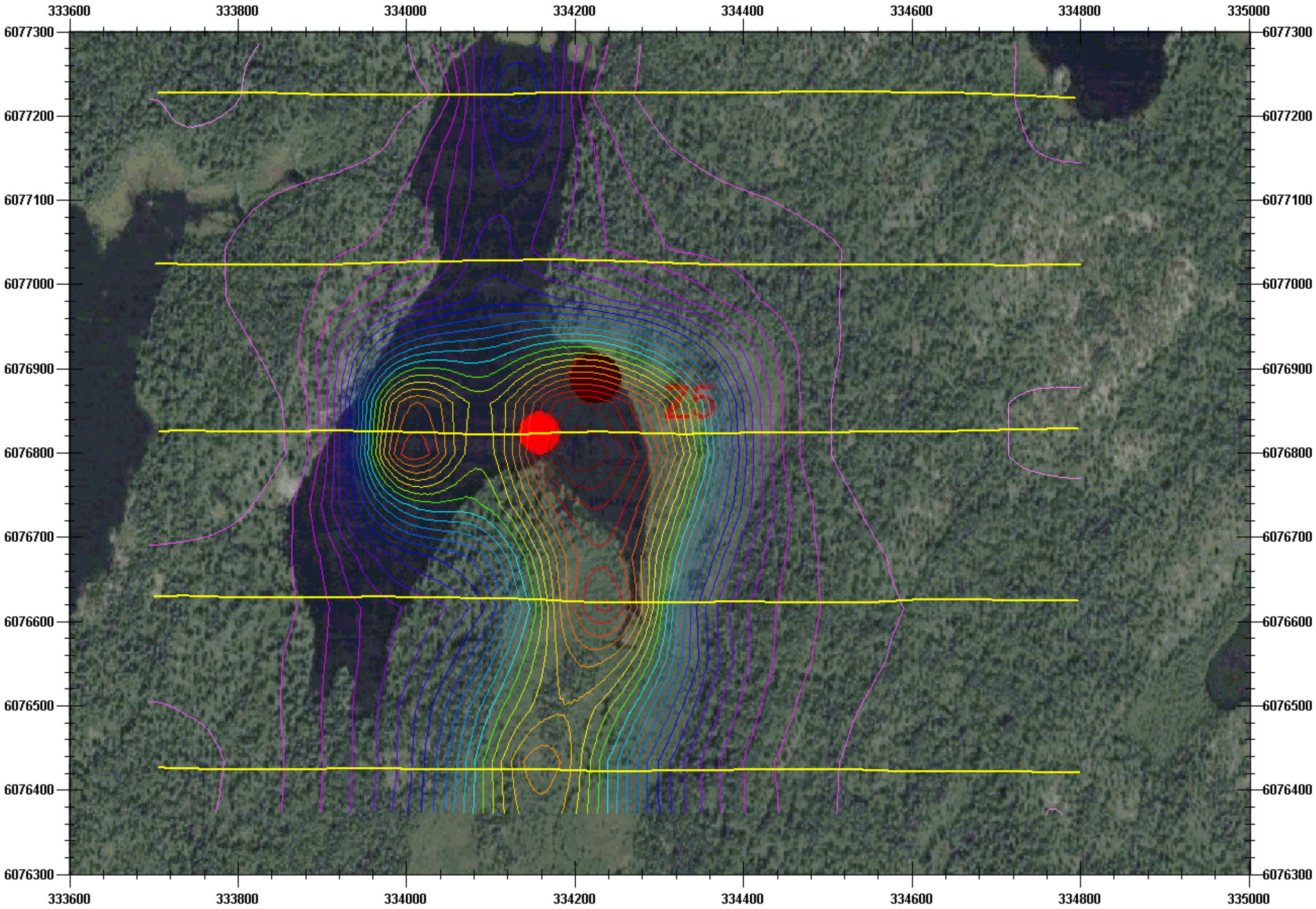




Inversion results contoured at Depth = 350m.
VTEM Ch17 response underlain

Inversion results filled contours at Depth = 350m.

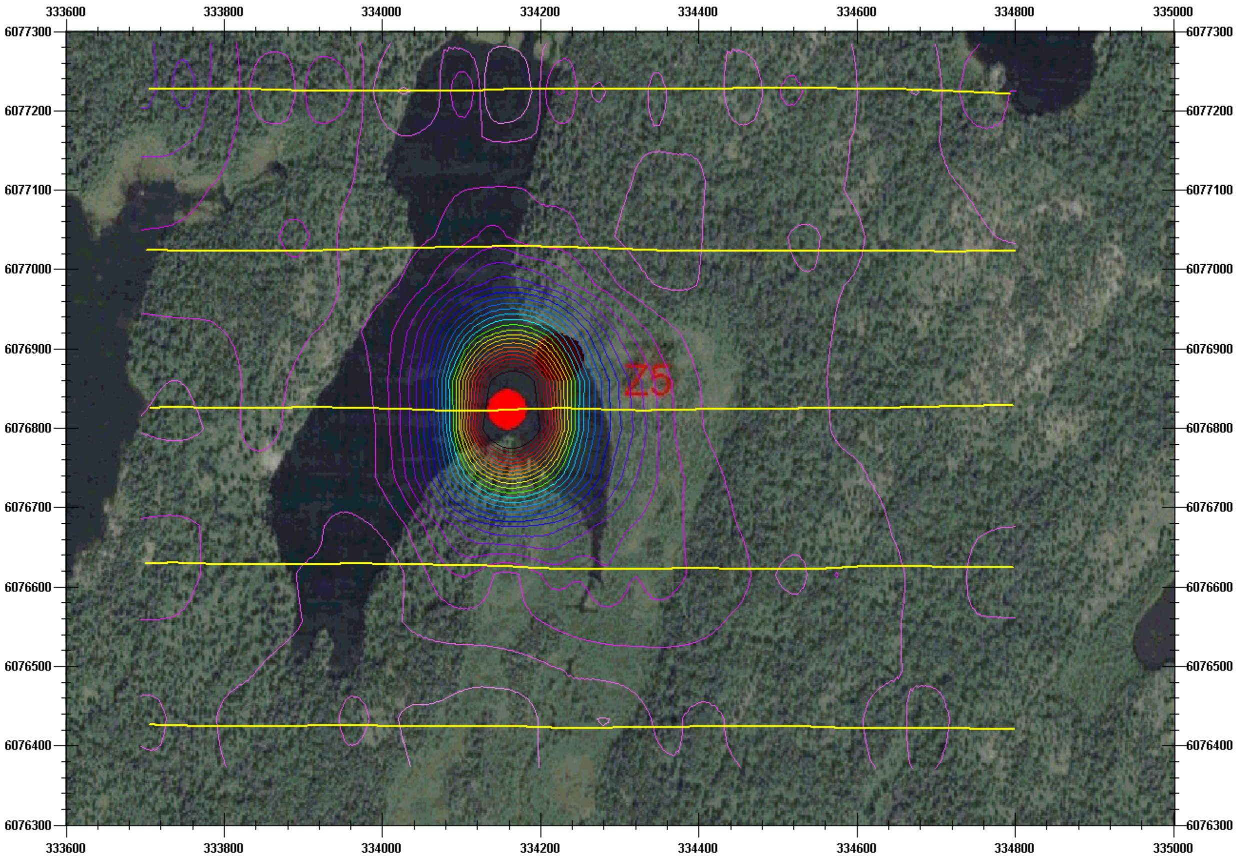
By the depth of 350m, the SW anomaly is stronger. The possibility is that the structure is extending deeper to the SW with the possibility that the TEM anomaly also extends SW and deeper. At these depths, if there is an extension of the TEM anomaly to the SW, the VTEM system with not detect it.

# Z5 Picks – VTEM early time



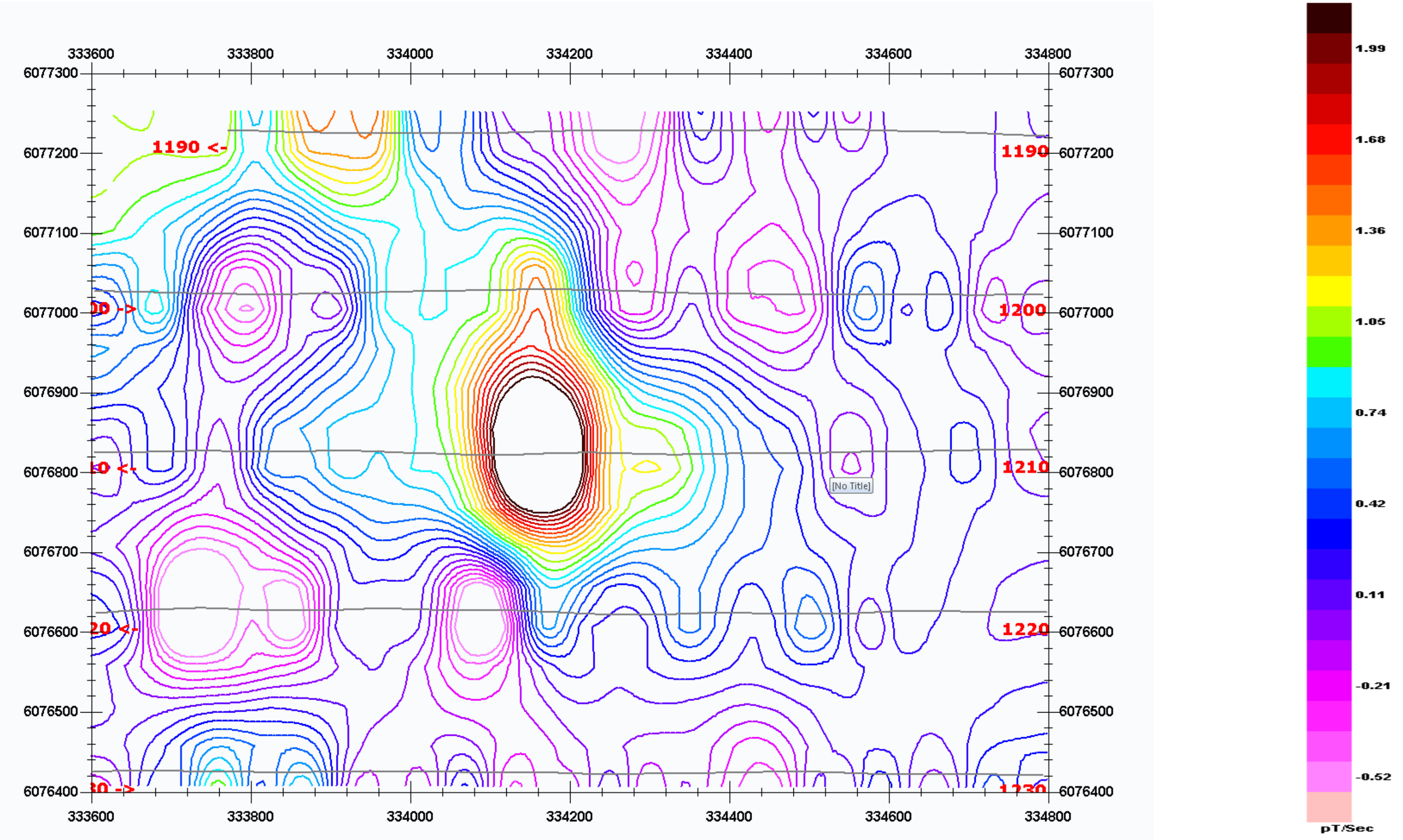

Channel 3 is contoured as Ch3 appears to be out of the system response and thus due only to the ground response. The early time response is centered of the main bodies of the lake but appears to follow south along a feature which has less foliage . This is a topographic low according to Google Earth and continues southwardly about 2.4km.  Possibly this feature is covered in water after winter thaw.

# Z5 Picks – VTEM mid- time



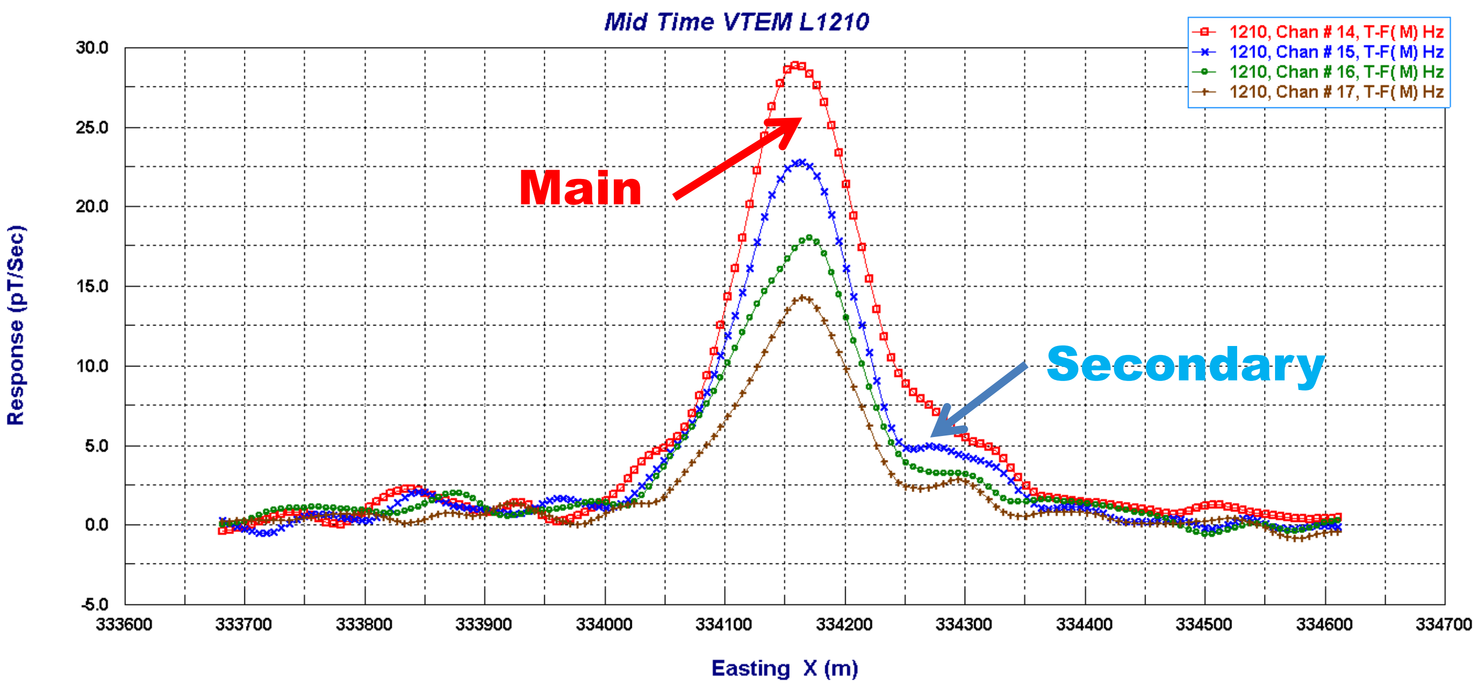

Channel 14 is contoured. By this time in the decay, the deeper anomaly is clearly visible and the mid-time TEM response and the aeromagnetic response are coincident. The response , however, is only seen clearly in L1210. But, the response is strong at about 25 pT/sec above the background response . For comparison, the pink contours are in the noise.

# Z5 Picks – VTEM Late Time




Channel 21 is contoured. At this time , late in the response, we appear to see an extension to the north line (L1200) and possibly to the south onto L1220. We will return to responses on the northern and southern line and examine the responses on these lines in a different manner to verify the detection of conductive material deep beneath these lines.

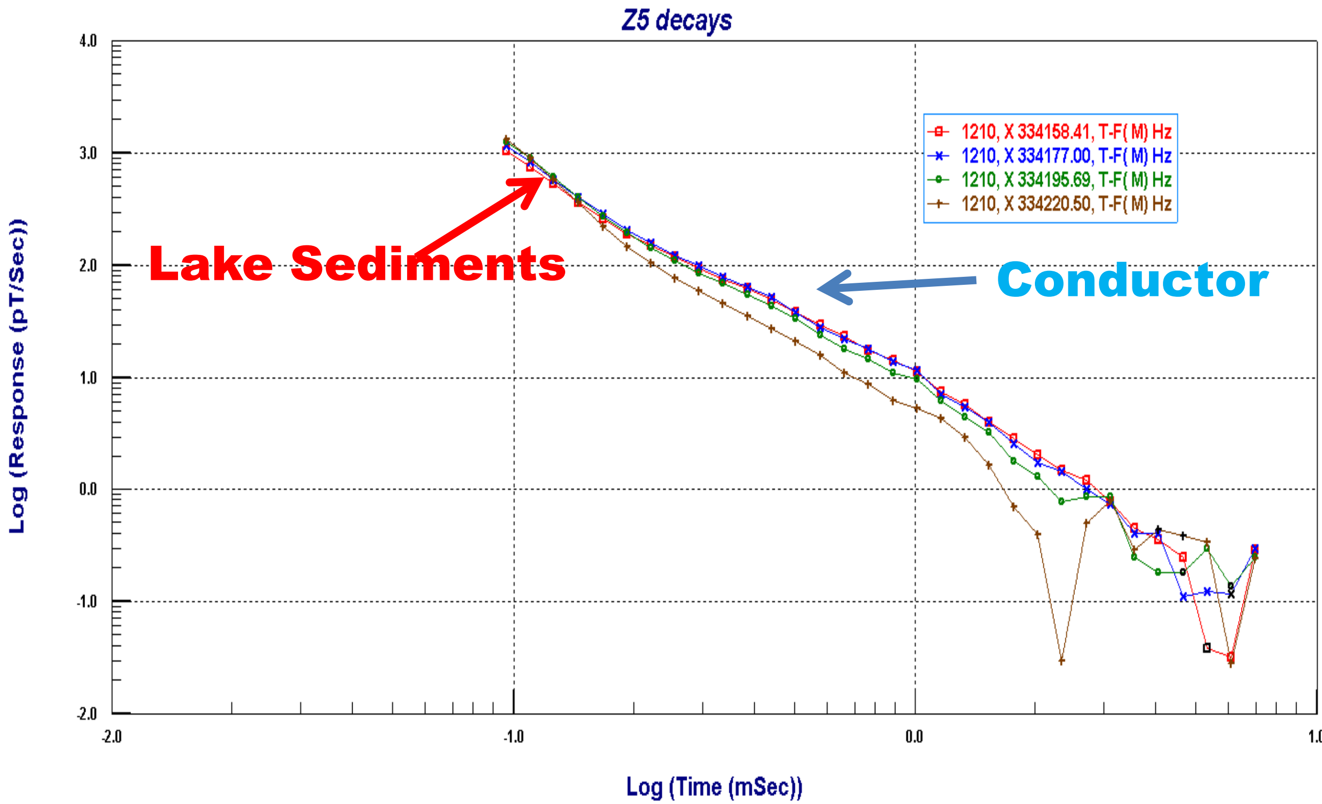
# Z5 Profile Response




We plot Ch14-17 in the mid-times for L1210 on which the TEM response appears. The main target is clearly dipping westerly while there does appear to be a secondary, deeper target slightly to the east of the main target. It is this deeper target which extends onto the line north (L1220) and possibly to the southern line (L1200).

We note here that the response of the secondary target responses about 5 pT/sec and out of the instrument noise.

<u>Z5 Decays</u>




We show the responses in time domain from the center of the anomaly (red) easterly at about 20m intervals over a width of 62m. The initial decay for the first 6 channels is mostly cover material which are likely the lake sediments. This determined by modeling which shows a weak surficial anomaly.

We see a clear slowdown in decay starting at Ch6 and continuing clearly until Ch18 and even into later time although somewhat noisy. The decay of the main feature is about 0.25msec which is indicative of a good conductor. The depth to the top is somewhat hard to determine as the response of the cover still continues into the response of the conductor. To deal with this issue , we have included a model for the sediments as well as the two conductors.

We note, again here, that responses in the 2 pT/sec and above the noise levels.

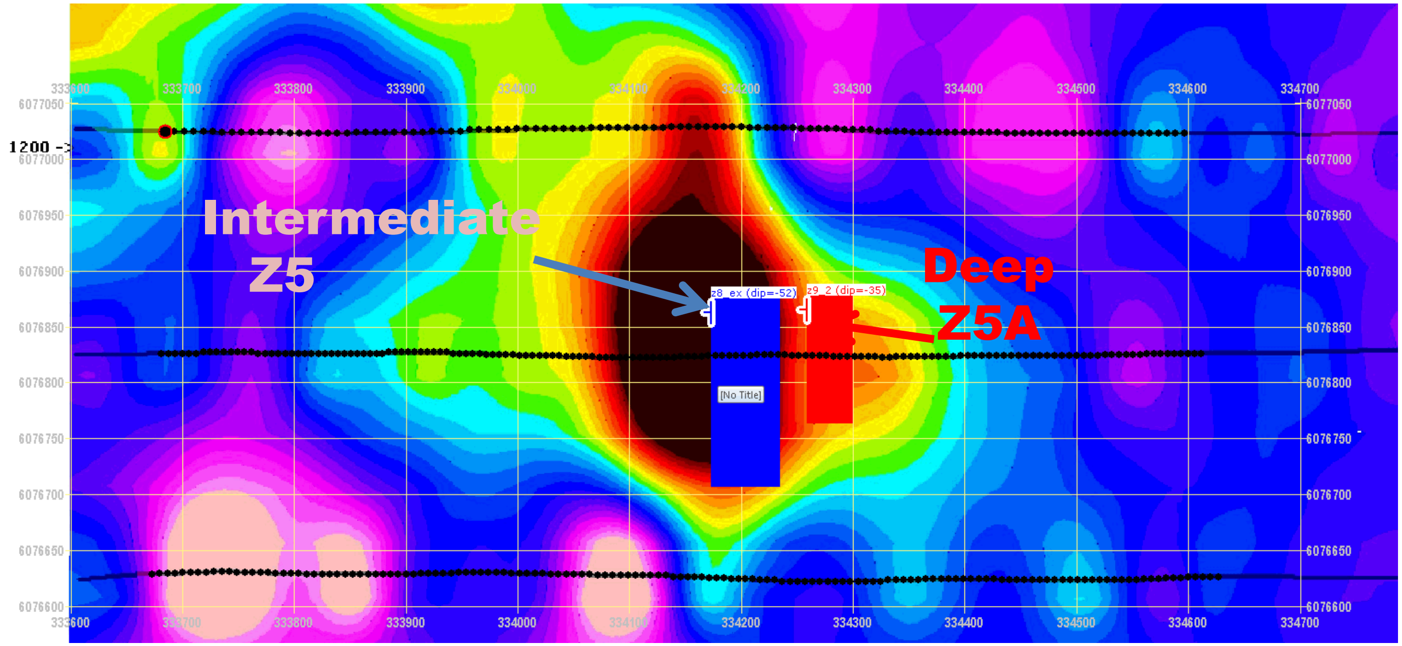
# Z5 Models

| | |
|---|---|
| Conductance | 30.000000 |
| Resistivity (O-m) | 0.00 |
| Susceptibility (k) | 0.0000 |
| Permittivity | 1.0000 |
| | |
| Order | 4 |
| | |
| Size (m) | |
| Strike Length | 180.000 |
| Dip Extent | 100.000 |
| Thickness | 0.010 |
| Position (m) | |
| Top (x, y, z) | 334235.00, 6076797.00, -85.00 |
| Center (x, y, z) | 334204.22, 6076797.00, -124.40 |
| Euler angles (degree) | |
| (1st, 2nd, 3rd) | 90.0000, -52.0000, 0.000 |
| Geological angles (de | |
| (Strike, Dip, Plunge) | 0.0000, -52.0000, 0.000 |

Intermediate Depth Target

| | |
|---|---|
| Conductance | 100.000000 |
| Resistivity (O-m) | 0.00 |
| Susceptibility (k) | 0.0000 |
| Permittivity | 1.0000 |
| | |
| Order | 4 |
| | |
| Size (m) | |
| Strike Length | 125.000 |
| Dip Extent | 50.000 |
| Thickness | 0.010 |
| Position (m) | |
| Top (x, y, z) | 334300.00, 6076827.00, -165.00 |
| Center (x, y, z) | 334279.52, 6076827.00, -179.34 |
| Euler angles (degree) | |
| (1st, 2nd, 3rd) | 90.0000, -35.0000, 0.000 |
| Geological angles (de | |
| (Strike, Dip, Plunge) | 0.0000, -35.0000, 0.000 |

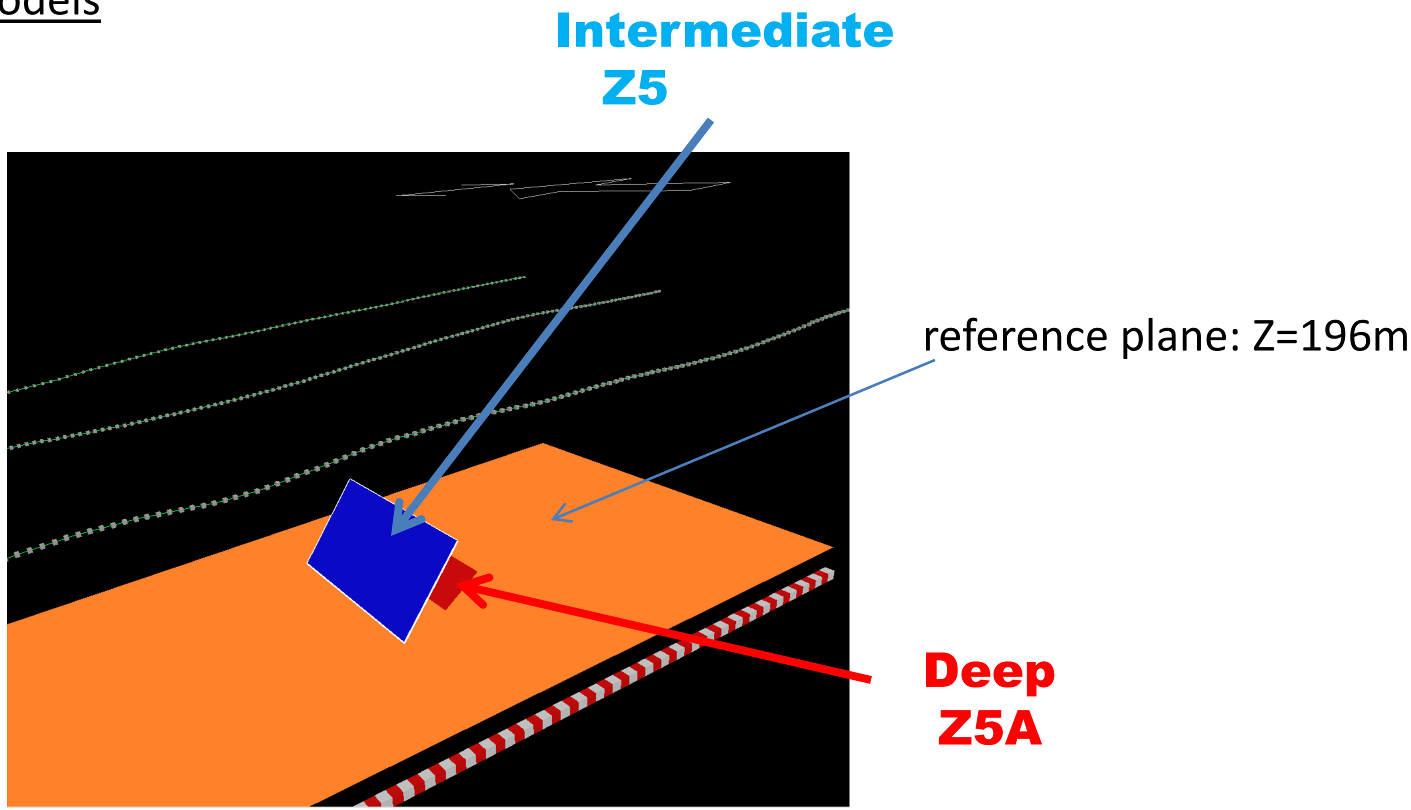
Deep Target




We are as yet not completely satisfied with our model. However, the above illustration covers the main aspects of the model. In this case, both plates are striking NS and the blue is dipping west at 52° while the red is dipping west at 35°. It is difficult, if not impossible, to determine the accurate strike length as we only see the response clearly on the one line.

However, we will discuss later the possible extension to the north and south and discuss the possible strike extent at that time.

# Z5 Models



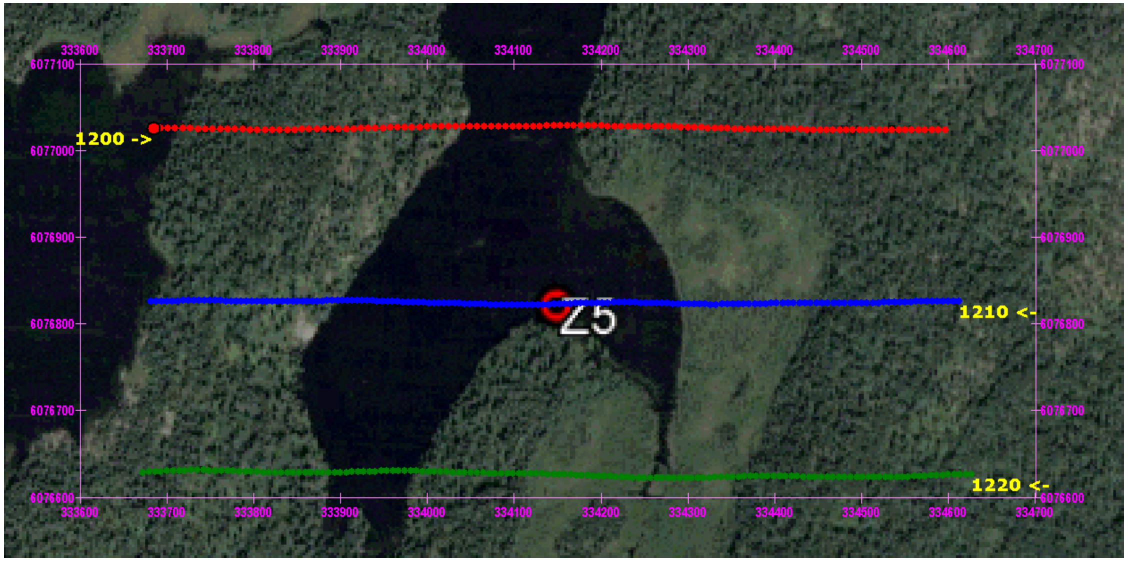

The VTEM data only perceives the top surface of the structure due to the small transmitter loop and the measurement of only the vertical response.  The shallow conductor has a top depth of approximately 85m as is about 30 Siemens.  Modelling the small, deeper conductor is difficult as we are now not too much above the noise level and the response of the small conductor is mixed with that of the bigger. But, at this point, our best estimate is depth to top of 165m and a  very strong conductance of 100 Siemens.

Preliminary inversion of the aeromagnetic s,  places the magnetic response at similar depths as indicated earlier.

The combination of a complex , multi-faced TEM target and a magnetic target would give good indication of a possible VMS target.

# Z5 Models - Possible Extensions North and South

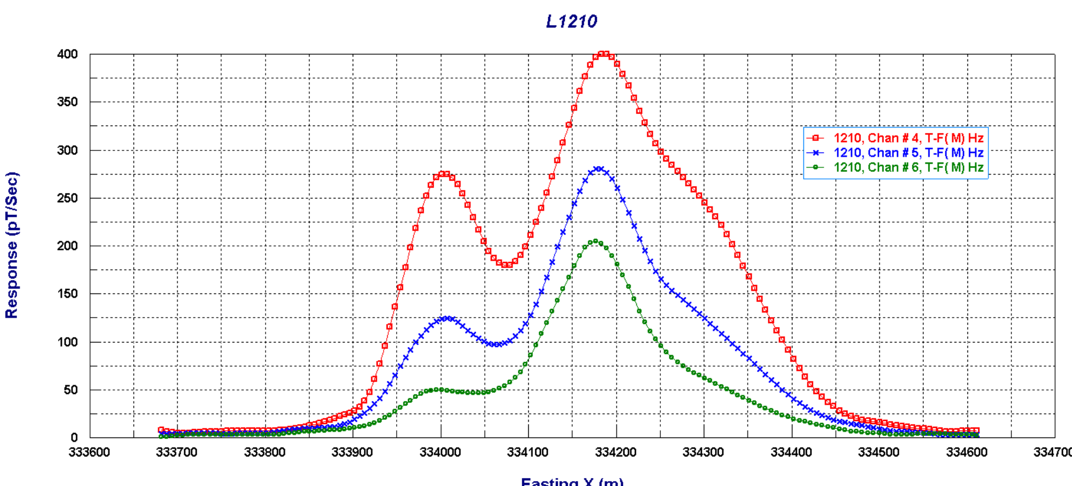
At this stage, we must move to a closer examination of the data. In particular, we will examine the data by channels in profile and as decays at individual locations.




To the left, we have shown the locations of the VTEM data along the 3 relevant lines. The location of the Z5 pick is given and a satellite image underlain where bodies of water appear as black in the satellite images.

The first 3 early channels of the VTEM seem to be highly affected by instrument noise. As well, these channels do not appear to indicate anything of interest from an exploration interest in this area of the survey.

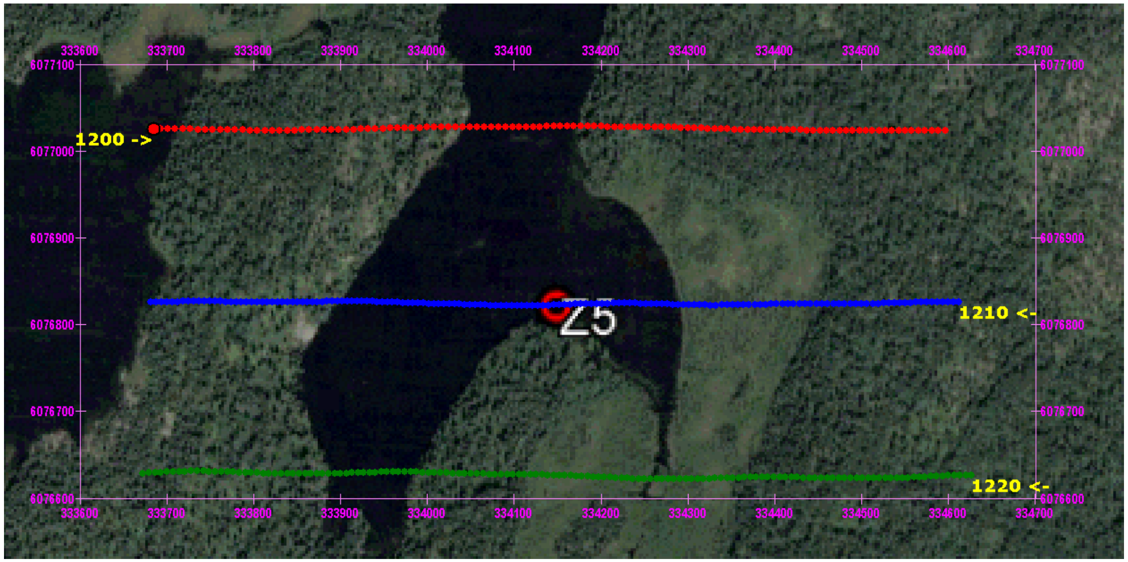
We first chose as profile plots, Ch4,5 &6. One can observe the correlation with the location of the lake but also that portion of the image displayed to the east of the lake as a light green which appears to be an area of less density of trees and possibly. This feature continues southwards and appears to contain structures related to drainage.

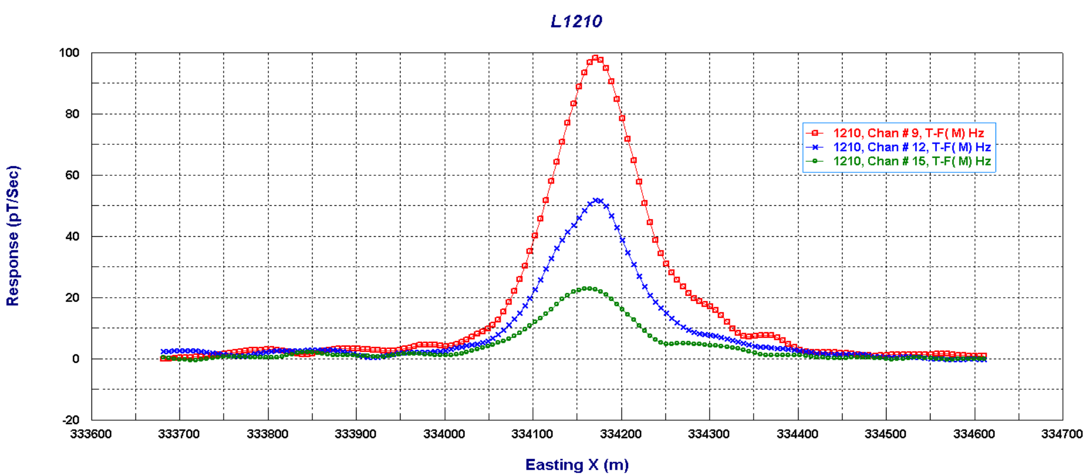



Three important issues are identified by the plot to the left. First, there are 2 peaks but the response over the west peak drops off quickly compared to the east peak. The west peak is centered over the west branch of the lake. Second, the response of the east peak is dropping off quite slowly and the location of the peak is altered only slightly to the west. Finally, there is a long tail to the east of the line but this tail is also dropping off in amplitude quickly.

# Z5 Models - Possible Extensions North and South

At this stage, we must move to a closer examination of the data. In particular, we will examine the data by channels in profile and as decays at individual locations.



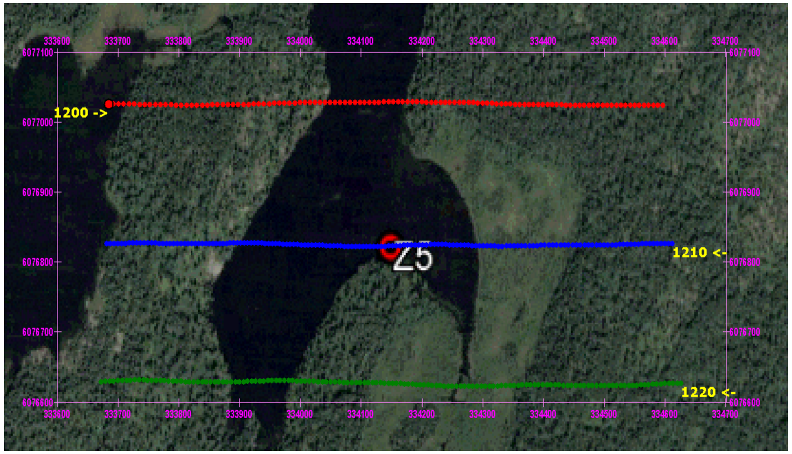



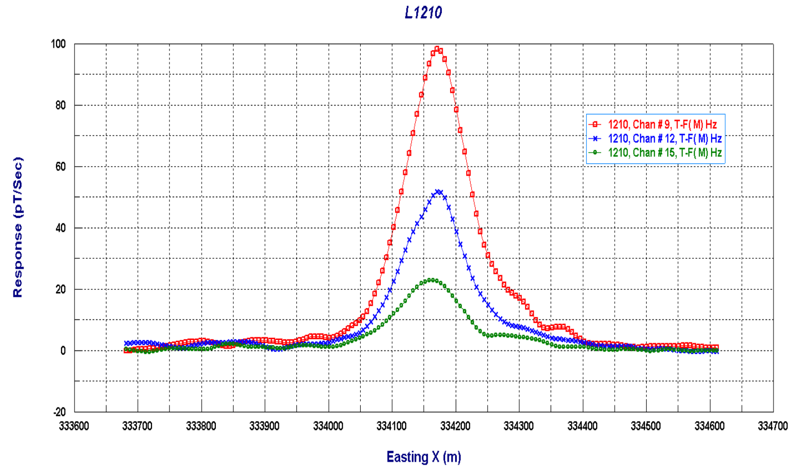

We next display, Chn 9 (late early time), and Chns 12 and 15 in the mid-time. We continue to see that the peak about Z5 is relatively stationary but the dip to the west becomes more obvious with later time.

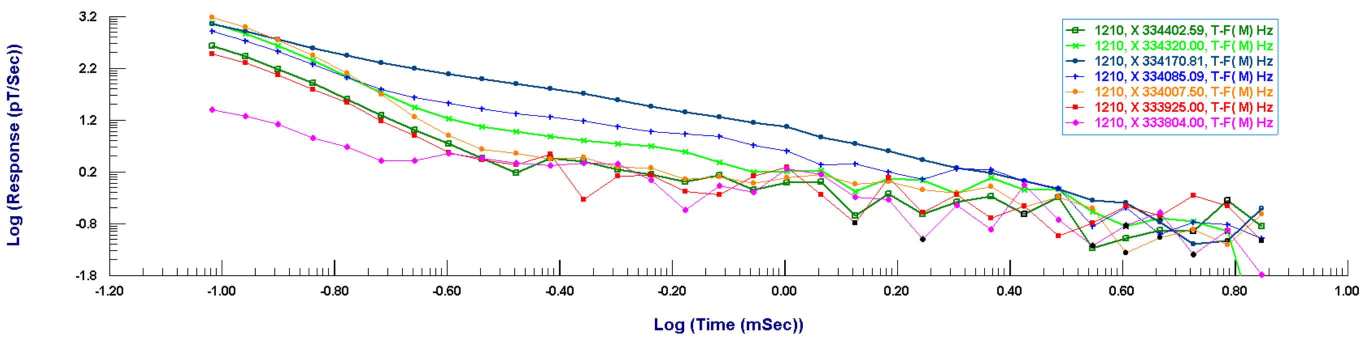
We can also, see with these later channels, the emergence of the response of the secondary target to the east of Z5.

# Z5 Models - Possible Extensions North and South

Now, we wish to examine the rate of fall-off with time (decays). As the decays, are the clearest indication of the presence of a conductor and provide us information as to the amount of conductive material presence not only from the conductivity of the target but also its spatial extent.



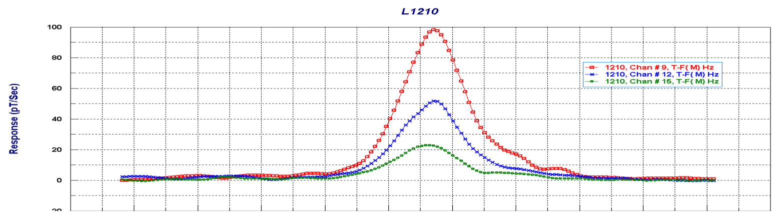



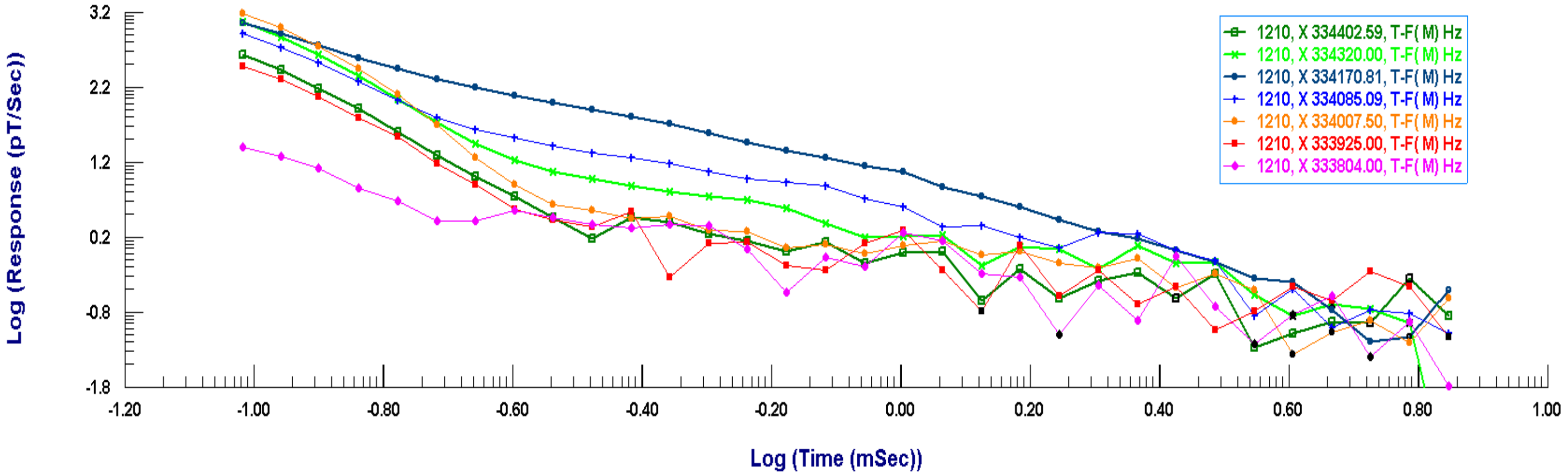




We display the responses at 6 locations along L1210. Beginning east of the lake and at the edge of the structure shown as light green in the satellite image. The most westerly is about 100m west of the lake. The most westerly station (333804E) display in pink, we believe to show only the system (instrument and processing) response. A great deal of the data away from lakes and anomalies looks like this station. On the other hand, all the other stations indicate a response due to some sort of cover material which is weakly conducting. We note, here, station 334403E (dark green) just on the eastern edge of the unknown surface structure and station 333925E (red) at the western edge of the lake. The 2 stations have very similar responses indicating a response to surficial material to Ch8 or Ch9 before becoming noise at about 2.3 pT/sec.

# Z5 Models - Possible Extensions North and South

We continue to examine, in detail, the responses around Z5.

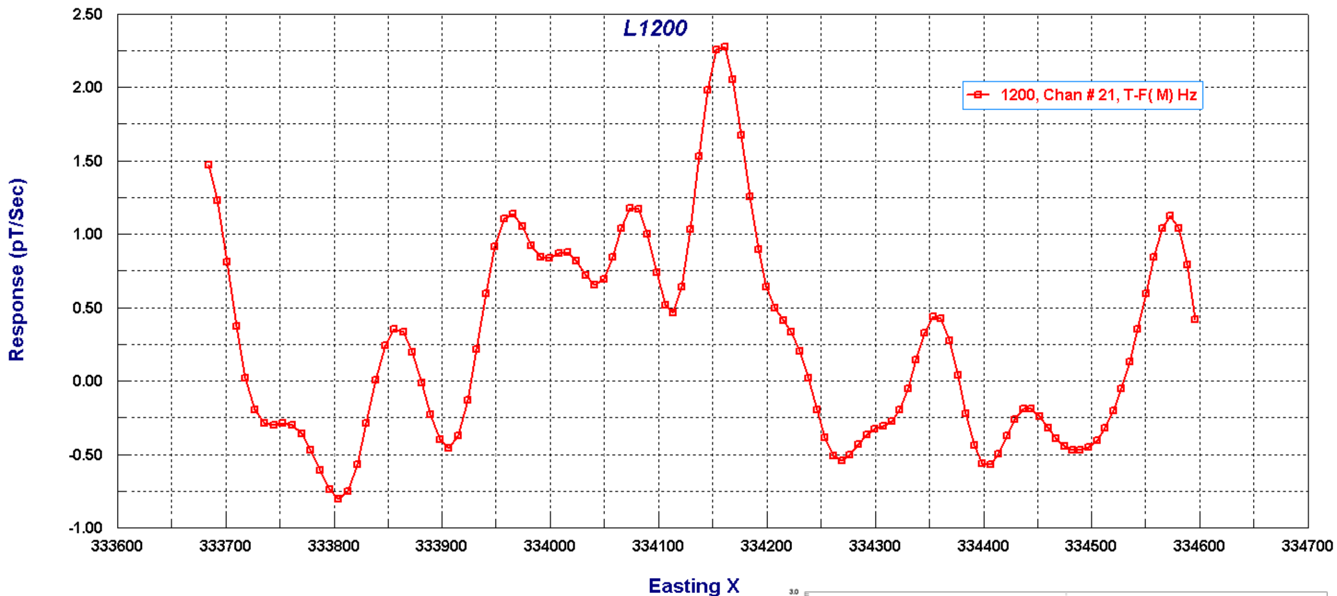


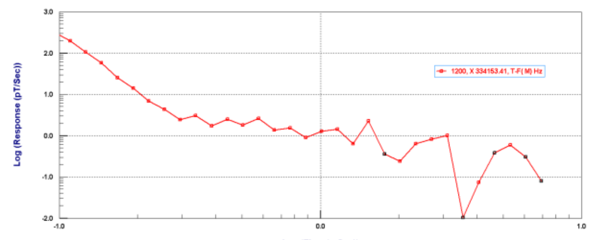




We next point out the response at 334008E (orange) which is over the lake but removed from the Z5 structure. The early time response is large but decays quickly in about 8 channels. There is, however, what appears to be a slight flattening for a few channels. At these response levels, it is difficult to determine if the response of the Z5 structure or some other structure is appearing at this station. We next point to the response at 334171E (dark blue) at the center of the Z5 response. We see that the early channels are the response of the surficial material under the lake but then a clear slowing down (higher conductivity) is observed beginning a Ch4 and this response stays clean well out to quite late time. Station 334085E (royal blue) takes longer before we see the conductor but the decays rate is parallel to the response of the peak but being less becomes noisier earlier. According to our modeling, 334085E is over a deeper part of Z5. Finally, to station 334320E (lime green) which is over the secondary structure. What is noted is that firstly, the conductor is seen even deeper (later) and the decay is slower (more conductive) than over the peak of Z5.

# Z5 Models - Possible Extensions North and South

L1200 to the north, when contoured, appears to show an extension of Z5 deeper in Ch21, We plot Ch21 below and show the decay at the peak at 334161E below.

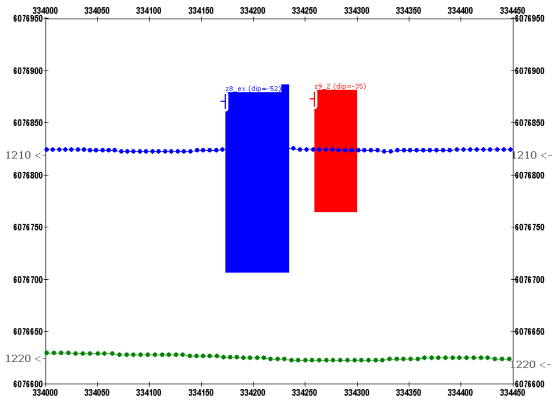



Nothing in the decays to indicate a conductor at depth.

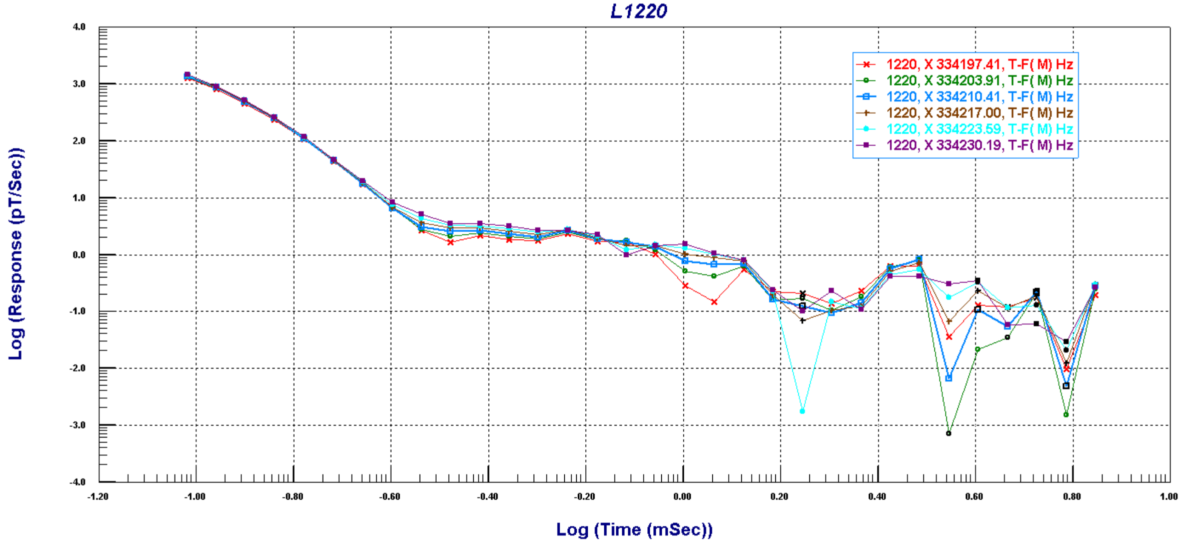
# Z5 Models - Possible Extensions North and South

Now, we examine L1220 to the south. Nothing appears obvious from the profile displays but there are indications in the decay of an extension southward of Z5 dipping south along the dip of the magnetic structure.



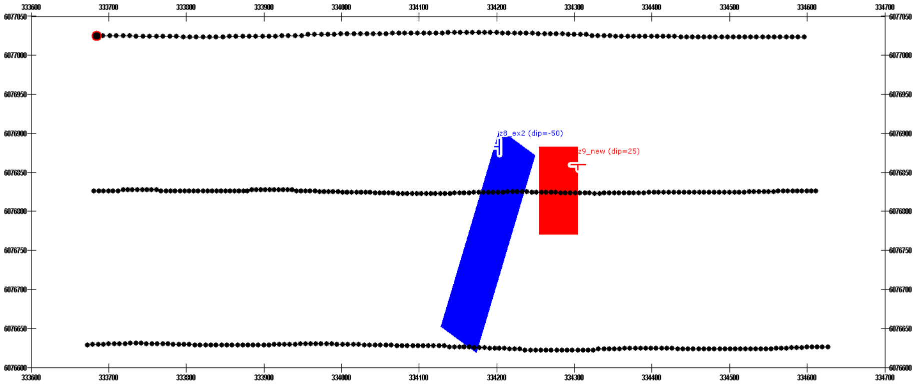

Projection of Z5 and Z5_Secondary.

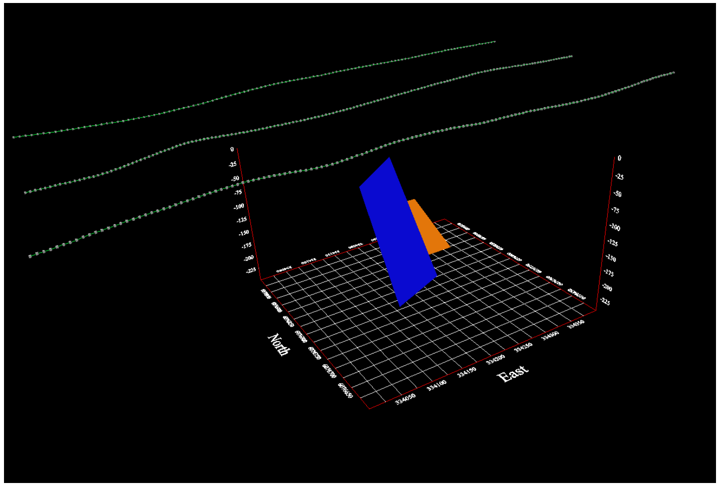
We show the decays on L1220 at increments of abut 7m from 334197E to 334230E. There seems to be a consistent indication of a deep conductor beginning at Ch8 and continuing for 8 channels until the response falls into the noise. This response is deeper than just north on L1210.



# Z5 Models – WARNING ! Multiple Different Model Types

Because, we see an EM data anomaly clearly on only one line (L1210) with an indication in the decays on another line (L1220), we cannot assert a unique model nor, in fact, a unique model type. As an example, given the depth a stronger, deeper conductor, if it were dipping or plunging steeply then it could be going anywhere and have any length. But, below we consider a different strategy. If we consider, that the EM anomaly is associated with the magnetic anomaly then the EM structure(s) would be striking NS but dipping westwards but plunging to the south..



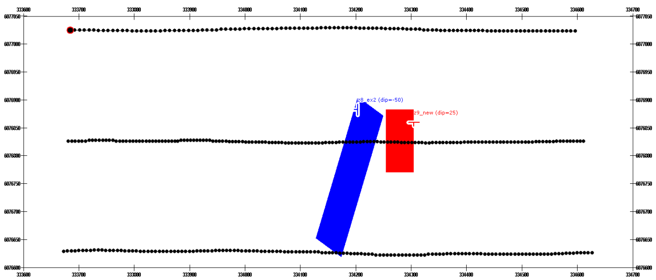



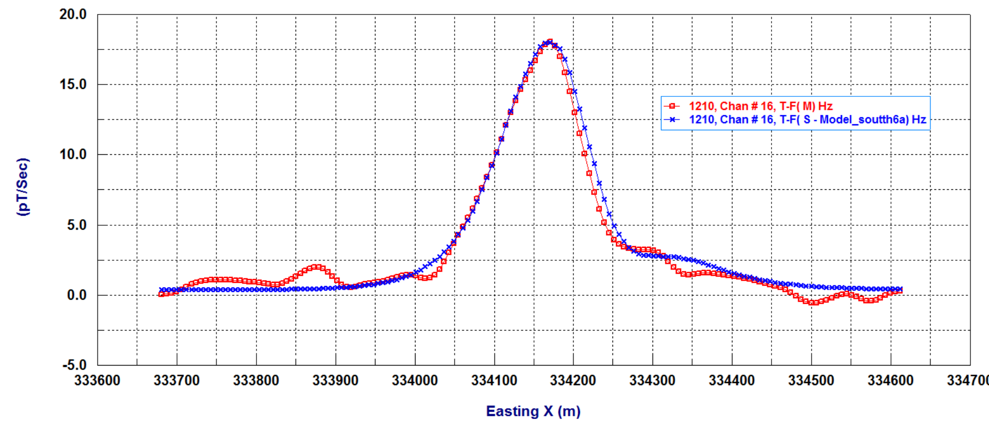

The model above also fits the data reasonably well on Line 1210. The blue anomaly is dipping 50 degrees to the west but now it is plunging 25 degrees to the south. In this case, we have shown the model with a strike length of 280m but with this plunge, we have no idea from the VTEM data, how long its strike may be. In this case, the depth to the top of the target is slightly shallower than in our previous model but the conductance is the same.

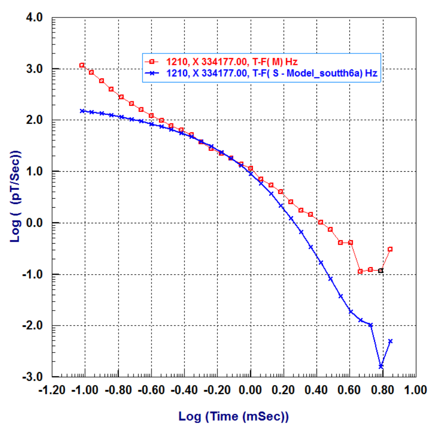
The smaller target is now striking EW and dipping to the south. At this depth, we can say little about the depth extent or in fact the dip angle to the south.

# Z5 Models – Model Type 2

Here, we compare the data to our new model response.  As example, the profile response is shown on L1210 and the decays at the peak.






Decays data to model, 334177E

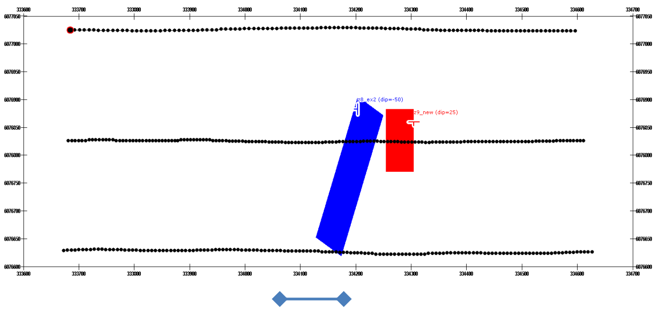
**Shallow target:**
Conductance: 30S
Strike length: 280m
Dip Extent: 80m
Strike Angle: $0^0$
Dip Angle: $50^o$ W
Plunge angle: $25^o$ S
Depth to Top: 65m

**Deep target:**
Conductance: 100S
Strike length: 50m
Dip Extent: 125m
Strike Angle: $90^0$
Dip Angle: $25^o$ S
Plunge angle: $0^o$ S
Depth to Top: 165m

In this case, we can see more definite evidence that there is more conducting material at depth. The data remains relatively clean until Ch23 but model response is too low (too quick ) in several late channels which appear well resolved in the data.

# Z5 Models – Model Type 2 – evidence of extension at depth to the south

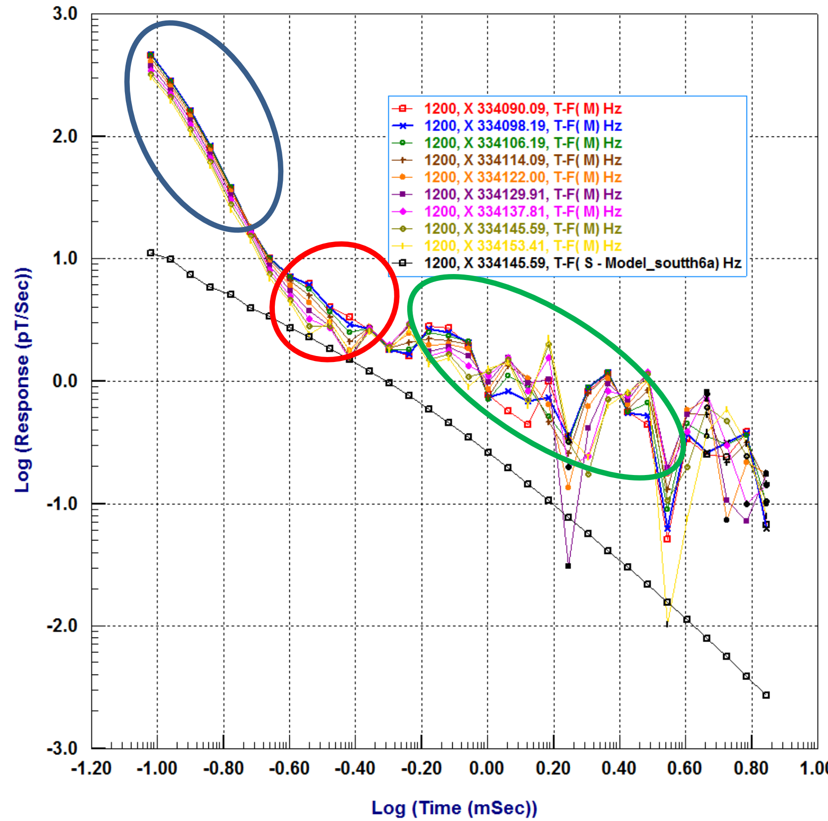
Here, we compare the data to our new model response.  As example, the profile response is shown on L1210 and the decays at the peak.



In the figure to the right, we show the decays across a 60m portion of the L1200 to the south of the main Z5 response. The model decay at a station in the  middle of this section is shown in black.

The blue oval is the response of the cover or overburden and is clean and consistent. There follows a section of about 6 channels marked by the red oval. It is this section that is hard to pass off as just noise. The data over this section of these 6 channels is all either above typical noise level or near noise levels. If this is not noise but signal with a noise superimposed then there is indication of a conductive response.  For comparison, we show the modeled data for the above model at a station in the middle of this 60m section. The overburden is not part of this model. However, we see that for at least chns 7-11, the response should be above the noise. However, the data is in fact higher and slower. Thus, there is some evidence for more conducting material to the south but deeper.

The green oval is the noise envelope.




Decays data to model, L1200: [ 334090E -  334153E]

# Comments and Recommendations

This data about the Z5 pick is a good illustration of potential dangers of misinterpreting these VTEM anomalies. The flight line has flown over a portion of two conductors. This portion does allow us to estimate the depth to the top of the structure and the conductance of the target in the vicinity of the line. But, having cut the target along a single line, we have little to guide us on its spatial size apart from a minimum size limitation to produce the EM signal.

It is important to understand the limitation of the VTEM system to "illuminate" the ground below the survey line. The transmitter or if you like our " lamp" is approximately 30m in radius and at the same time over 60m above the ground. This provides a limited volume both in depth and to the sides of the flight line that is illuminated. The large current in the VTEM system does not enhance this spatial window of illumination. If the structure is dipping or plunging even moderately steeply then we will not "see" it on more than one flight line. A corollary to this is that if there are multiple picks in an area, they may not be due to the same structure.

The TEM illumination of a conductor is not as simple as a light source as we do have the advantage that the induced currents in the target will migrate outwards with time so long as the conductor is not too strong. But, we still have limitations as to how large a structure we can detect from a single line. Also, there is the danger that this type of system cannot detect well a very strong conductor.

Given these comments and a range of other technical issues, it would be dangerous to drill on this data without corroborating and detailing ground EM. We would also suggest that the use of a ground magnetometer equipped with GPS capabilities would enable the rapid collection of high resolution ground data and thus allow enhanced detailing of the magnetic structures.

# Analyses of VTEM Z_6 Picks

15 June 2018

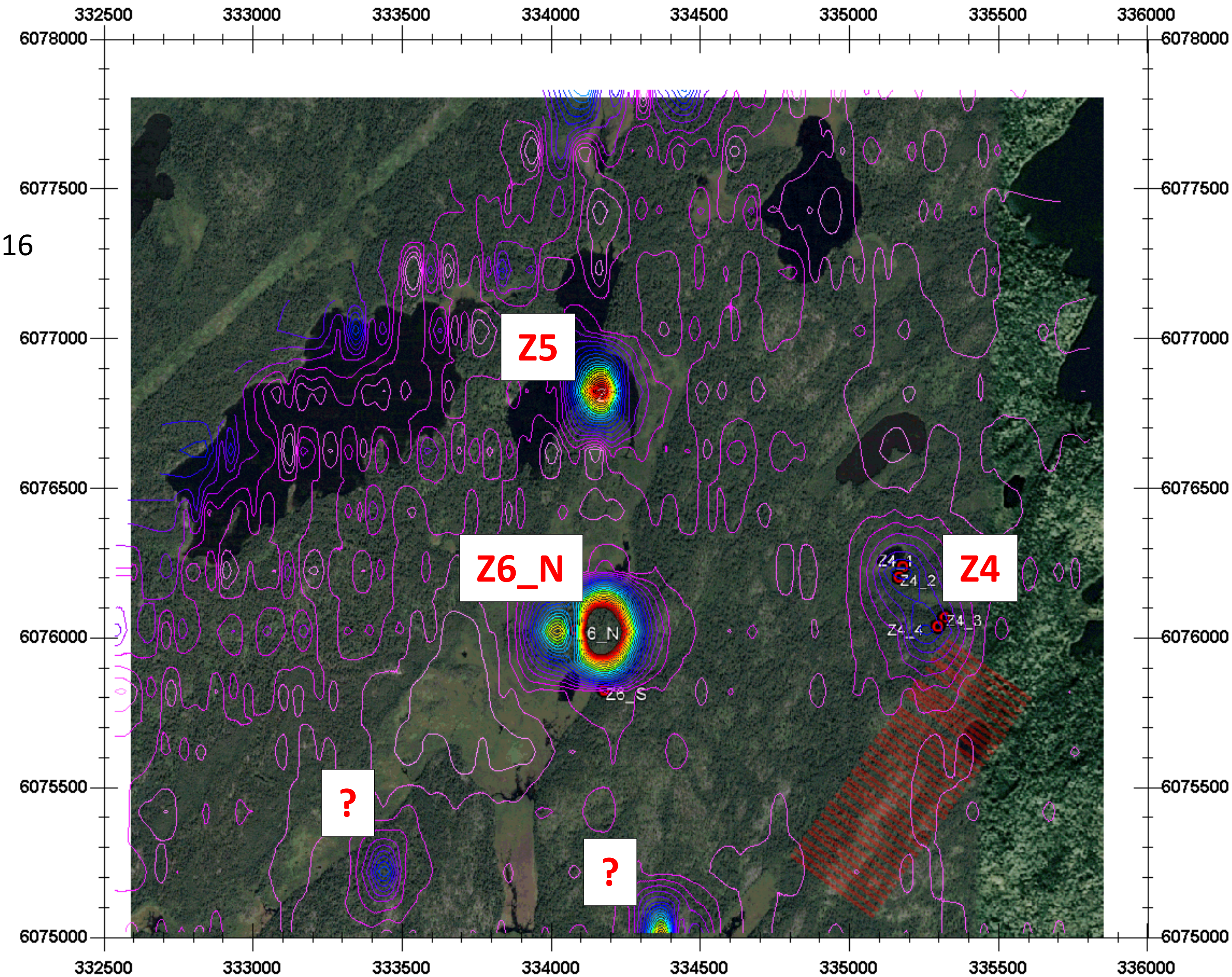
for Copper Reef Mining Corporation
Flin Flon, MB

R.W. Groom, PhD,BMath
Petros Eikon Incorporated

Introduction:
In 2010, several VTEM surveys were flown by Geotech Ltd, Aurora. To the west and south of Alberts Lake, one survey call Big Island was flown in east – west directions and another Alberts Lake was flown at azimuth of approximately 30 degrees east of north. Geotech made a number of late time anomaly picks which were named Z picks. In this study, we study the area surrounding 2 picks named Z_6.

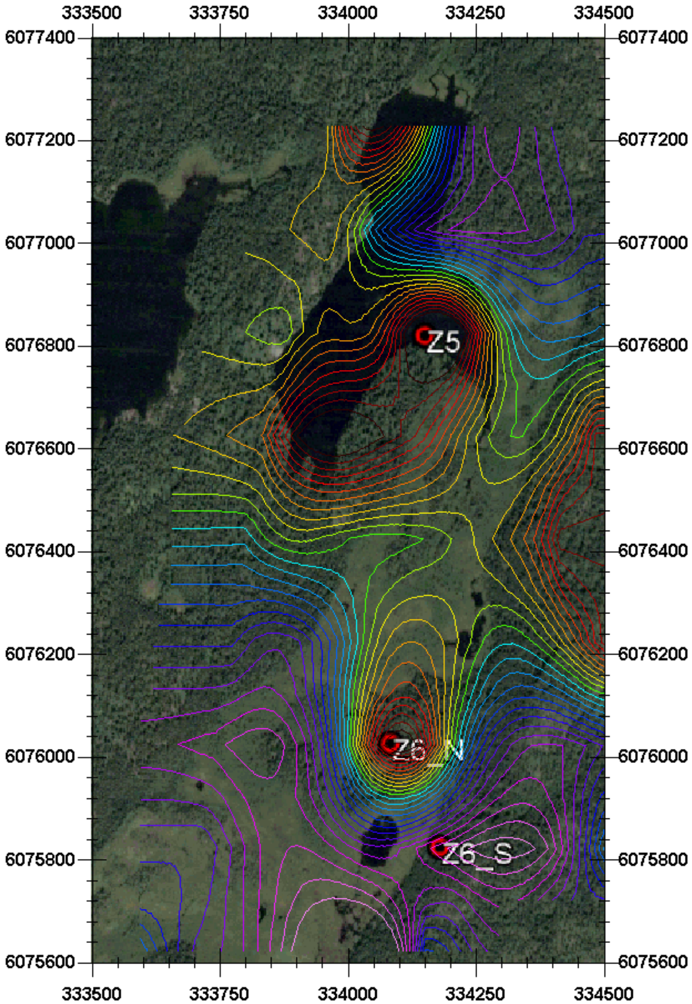
# Late Mid-time, VTEM anomalies to the west of Alberts Lake

VTEM Ch16




In this area just west of Alberts Lake, there are 3 anomalies identified by Geotech picks (Z4, Z5 and Z6) plus two additional anomalies which are not as yet named. The anomalies are enclosed by area of about 2km x 2km.

# Aeromagnetic – Local to Z5 and Z5

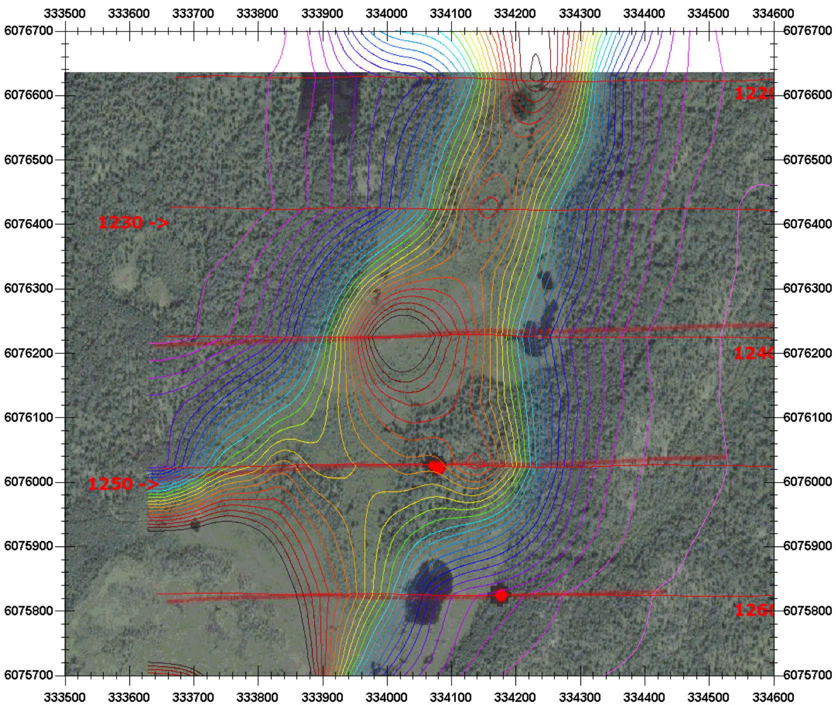



VTEM aeromagnetics in region of Z5 and Z6

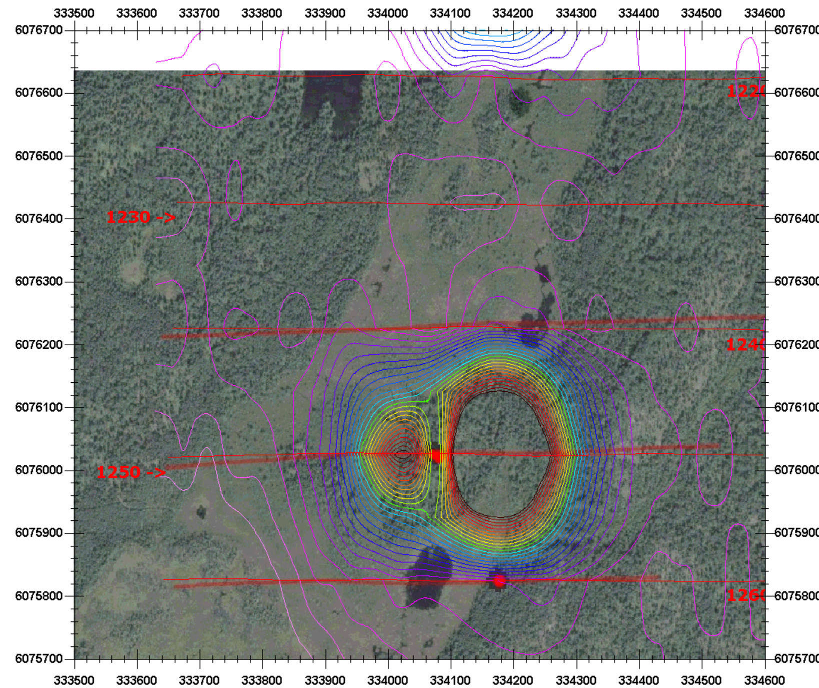
If we examine the aeromagnetics in the area, it is dominated by a large response to the east of Z5 and Z6. However, isolating the magnetics in the Z5 and Z6 region, local magnetic anomalies are identified around Z5 and Z6. The aeromagnetic anomaly surrounding Z5 extends in an approximate L-shape to the south and west.

# VTEM Contoured Z6 Region

In early time, the VTEM response is dominated by a grayish structure appearing in the satellite images. This area appears to be an area of only low level vegetation and seems possibly to be part of the local drainage system. By early mid-time, the response along the northern Z6 pick becomes evident but it is also shown to consist of 2 anomalies. We cannot find any significant response on L1260, being the 2$^{nd}$ of the Geotech Z6 picks.




Ch4 – Geotech Picks (red dots)

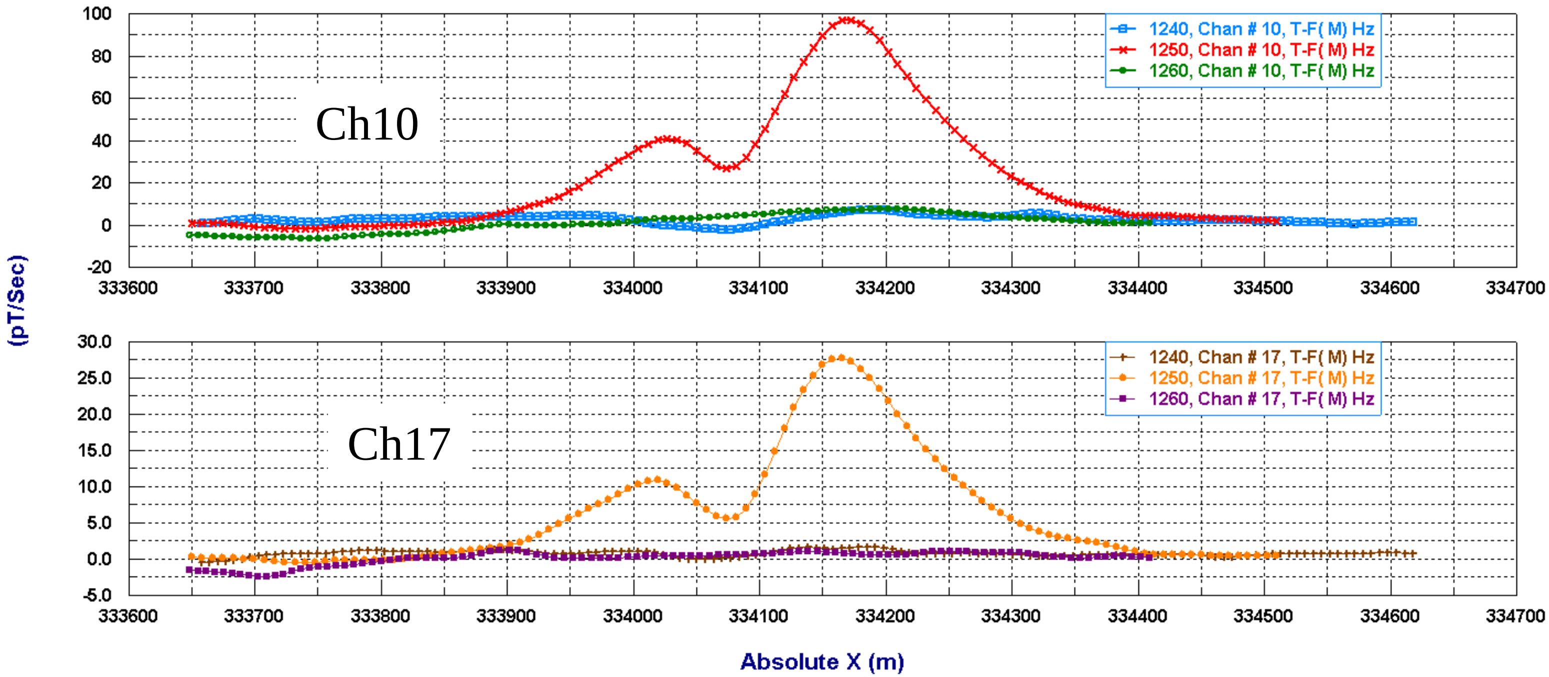



Ch14 – Geotech Picks (red dots)

| east | north | Line | Longitude | Latitude | ID_numb | ID | Type | tauSF |
|---|---|---|---|---|---|---|---|---|
| 334156.4 | 6076824 | 1210 | -101.581 | 54.8111 | 5 | Z5 | ? | 3.6802 |
| 334079.1 | 6076028 | 1250 | -101.582 | 54.80393 | 6 | Z6 | PLATE | 4.4769 |
| 334176.7 | 6075827 | 1260 | -101.58 | 54.80215 | 6 | Z6 | ? | 1.2031 |

# Z6 Picks – VTEM Profiles

We show the VTEM response on all 3 lines surrounding the significant Z6 pick (L1260, L1250 and L1240) at a late early time (Ch10) and an early late time (Ch17). The effects of the cover decay quite quickly and we can see that there is obvious picks on L1250 but the anomaly consists of 2 pieces.  One piece to the west of Geotech pick and one to the east.

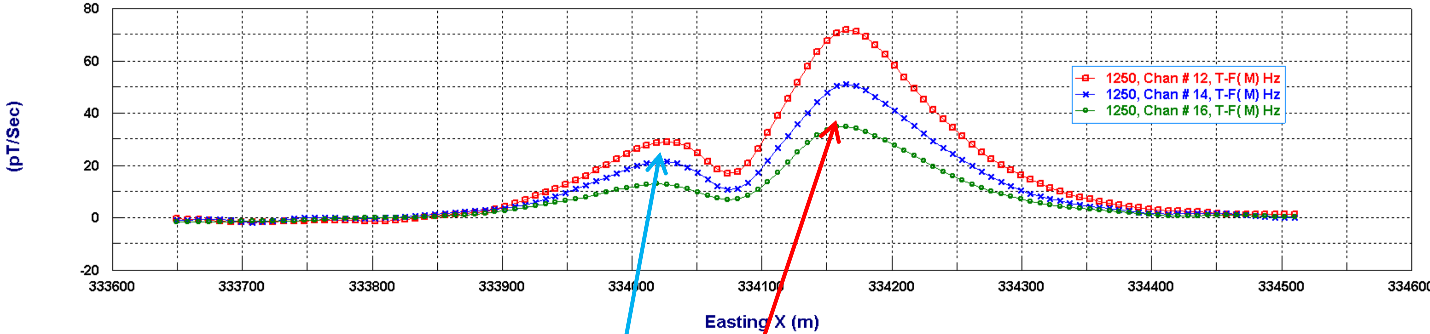



Geotech picks

| east | north | Line | Longitude | Latitude | ID_numb | ID | Type | tauSF |
|---|---|---|---|---|---|---|---|---|
| 334156.4 | 6076824 | 1210 | -101.581 | 54.8111 | 5 | Z5 | ? | 3.6802 |
| 334079.1 | 6076028 | 1250 | -101.582 | 54.80393 | 6 | Z6 | PLATE | 4.4769 |
| 334176.7 | 6075827 | 1260 | -101.58 | 54.80215 | 6 | Z6 | ? | 1.2031 |

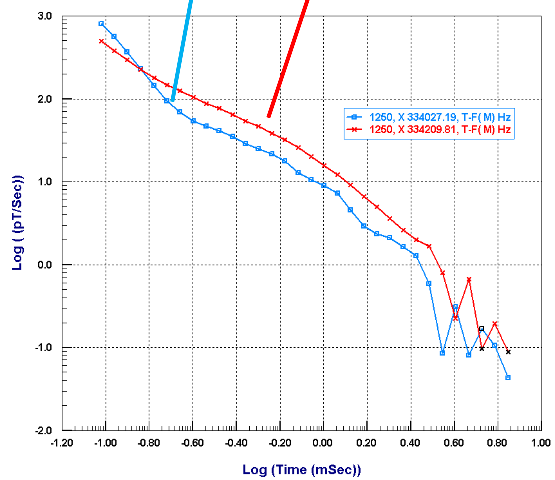
# Z6 Picks – VTEM Decays

We show the VTEM response on L1250 at 3 times,  ch12-14. First, the 2 anomalies are evident and it appears that  by the mid-time, the 2 anomalies are decaying similarly. Below, we show the decays at the center of the western peak and at the center of the eastern peak.  The response over the western peak has a clear surficial decay before slowing down at Ch8 when it becomes dominated by the deeper conductor.  The western peak has very little surficial response and it affected by the conductor early in time.  The eastern anomaly has clean data until very late in time and appears to have a deeper, less conductive part. The western conductor becomes noisy by Ch18.



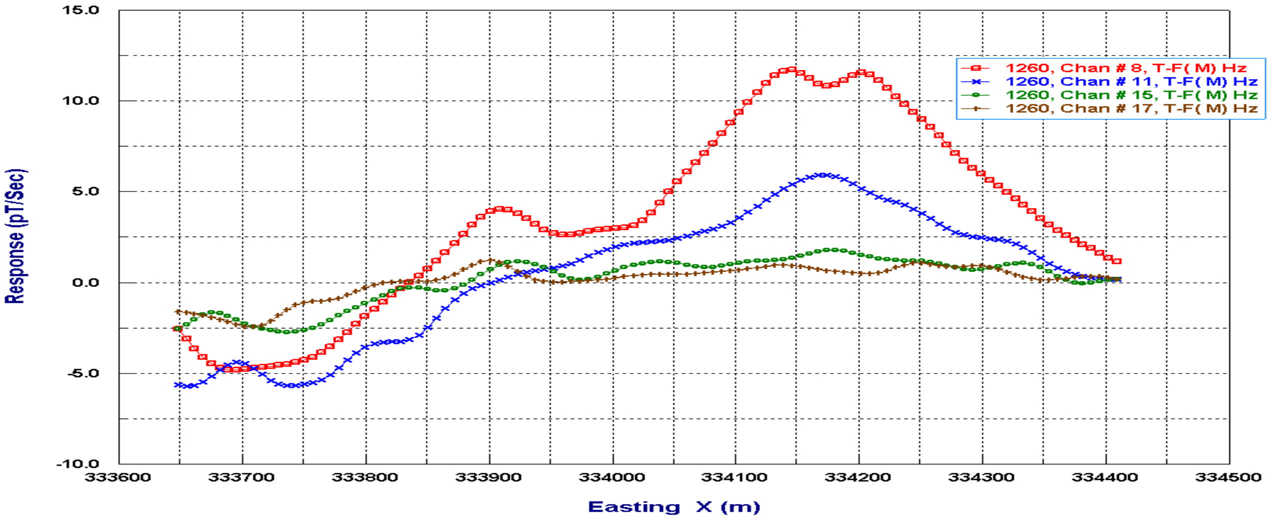

Ch12, 14 and 16 – Line 1250)

Decay Examples – Line 1250)



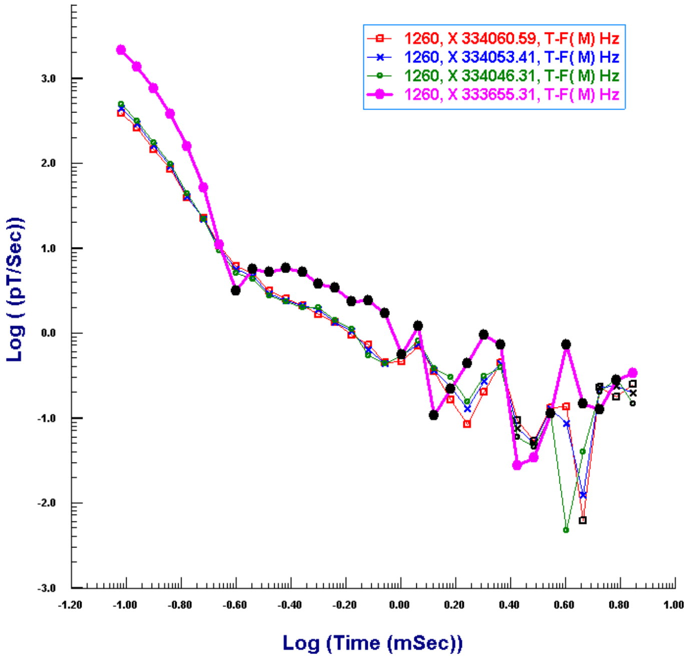
# Z6 Picks – VTEM Decays

While as a profile response, there is little evidence of a response from the conductors on the other lines, there does appear indications in the decays on L1260.




Ch12,

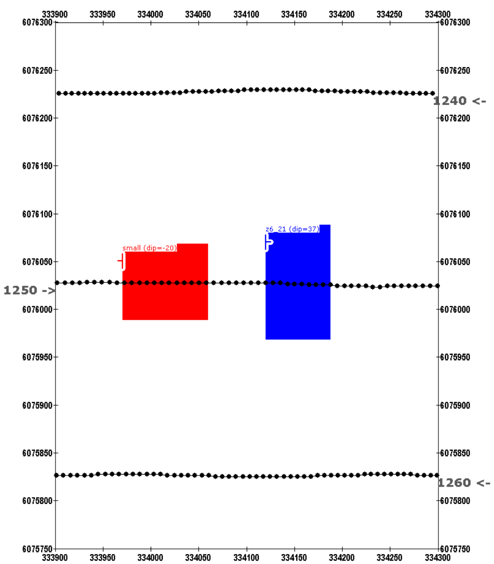
Decay Examples – Line 1250)



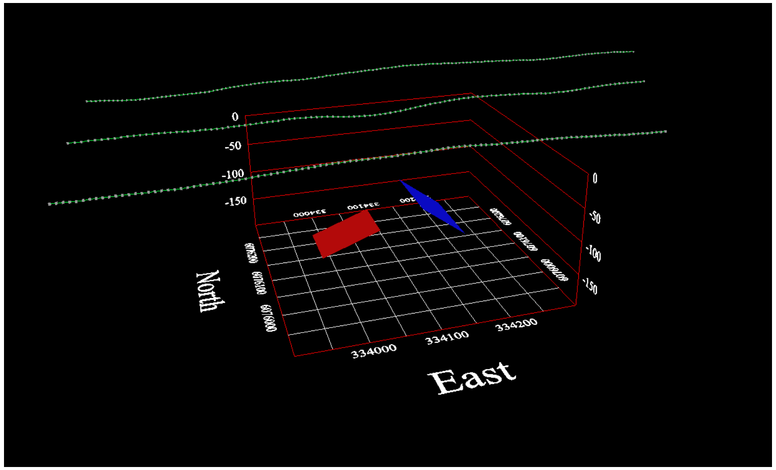

Note: When response becomes negative, the display shows black dots. Thus the pink curve is falls below the noise and becomes negative which is not a ground response in this case.

# Z6 Picks – VTEM Modeling Type 1

The most obvious direction to take for modeling is to place the conductor NS with appropriate depths, sizes and dips. It is difficult to find an exact model as there are too many parameters that are not constrained by having a response on only one line. However, the model below is a reasonable model given the limitations that we have in simulating conductive targets in resistive environments.  But, we utilize a cover model to represent the superficial materials in order to generate depths to the tops of the target which are constrained by the response of the ground cover.




Model Type Plan View

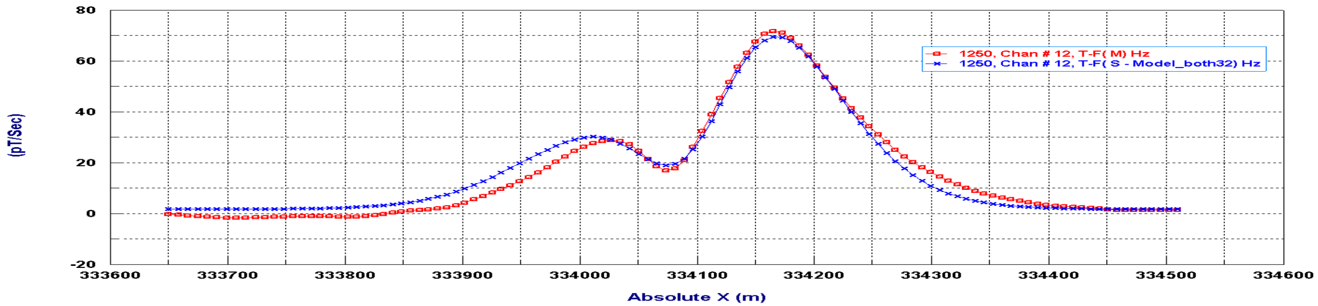



Anomaly 1
Strike Length: 80m
Dip Extent: 95m
Strike Angle: NS
Dip Angle: 20W
Conductance: 55 S
Depth to Top: 125m

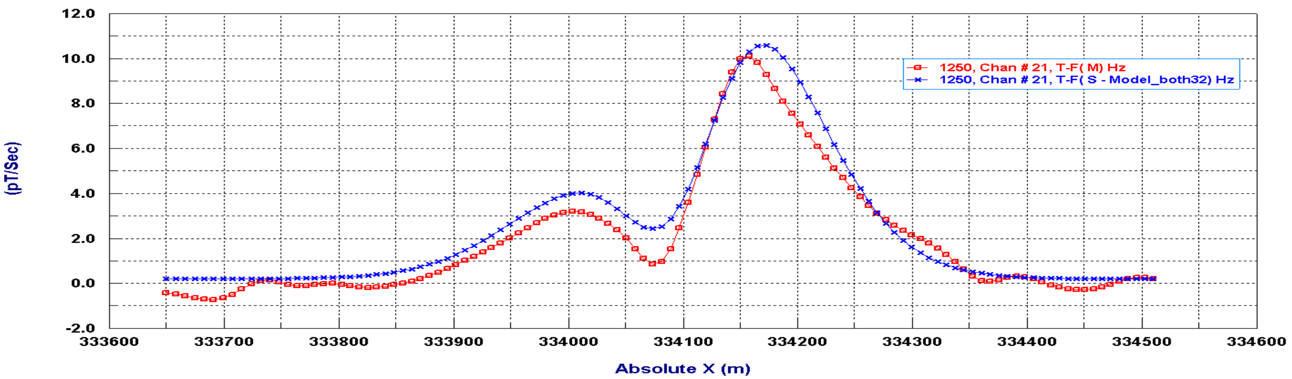
Anomaly 2
Strike Length: 120m
Dip Extent: 85m
Strike Angle: NS
Dip Angle: 37E
Conductance: 53 S
Depth to Top: 90m

# Z6 Picks – VTEM Modeling Type 1

We present the limitations of our model fit to the data.



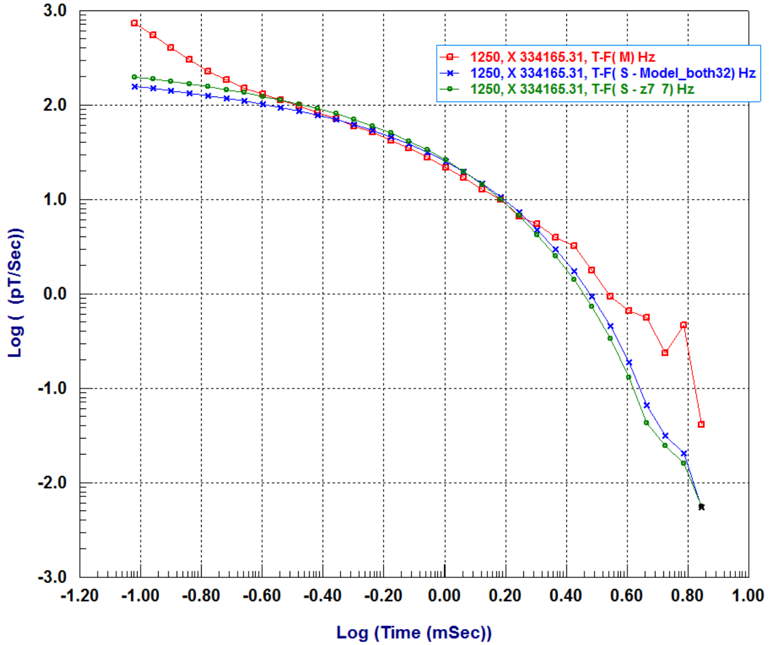

Data and Model response – Ch12 – mid-time – L1250



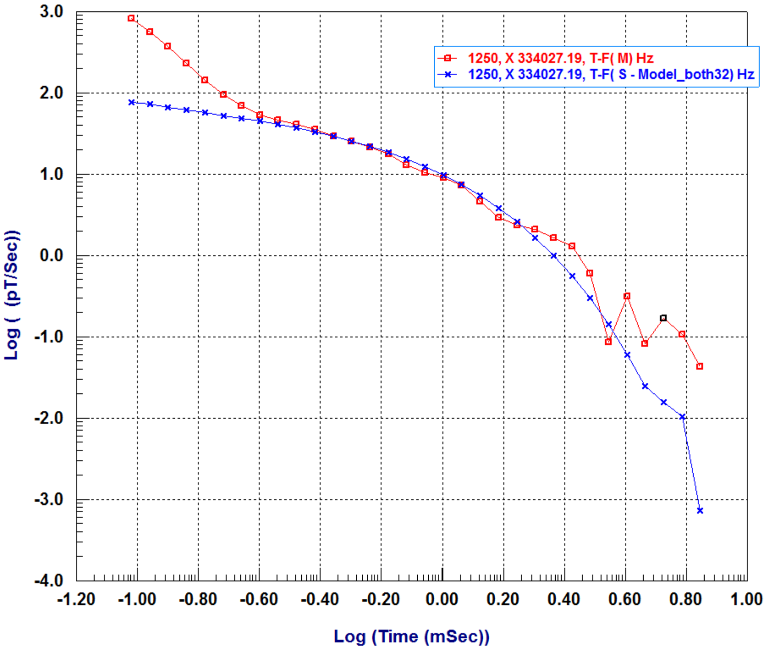

Data and Model response – Ch21 – late-time – L1250

# Z6 Picks – VTEM Modeling Type 1

We present the fit of the models as decays.




Data and Model response – near peak , 334165E

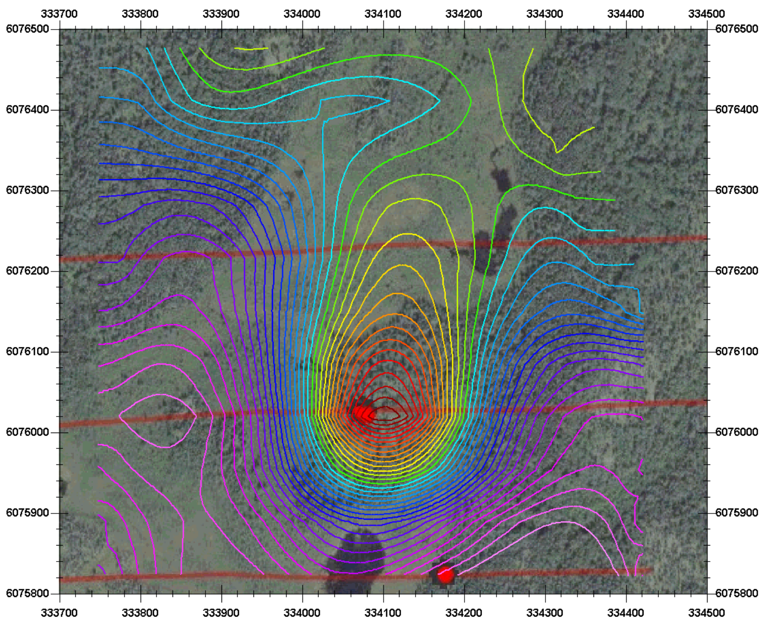



Data and Model response – near secondary peak , 334027E

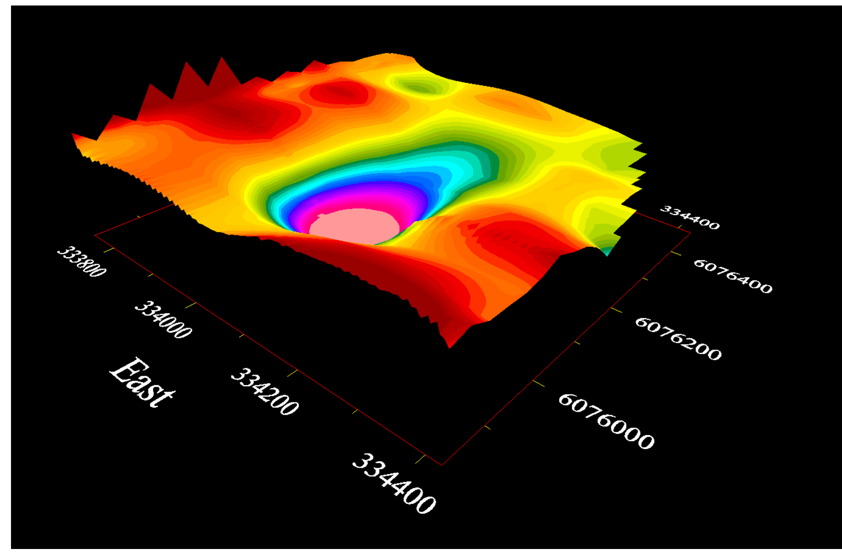
Note that here the early time does not fit as we have not attempted to model the overburden in this case. The last 8-9 channels also do not fit well. There are indications that the late time decays are slower indicating a deeper more conducting material. But, as the data is in these channels at or below the noise levels, we cannot determine with any precision if there is deeper more conducting material.

# Z6 Picks – VTEM Modeling Type 2

We now take another approach assuming the conductive response is related to the magnetic response around the conductive response. The contour of the TMI on the left shows the magnetic anomaly dipping a few degrees east of north and a strike approximately NS. On the right, we show the surface of the vertical derivative to emphasize the dip to the NNE.



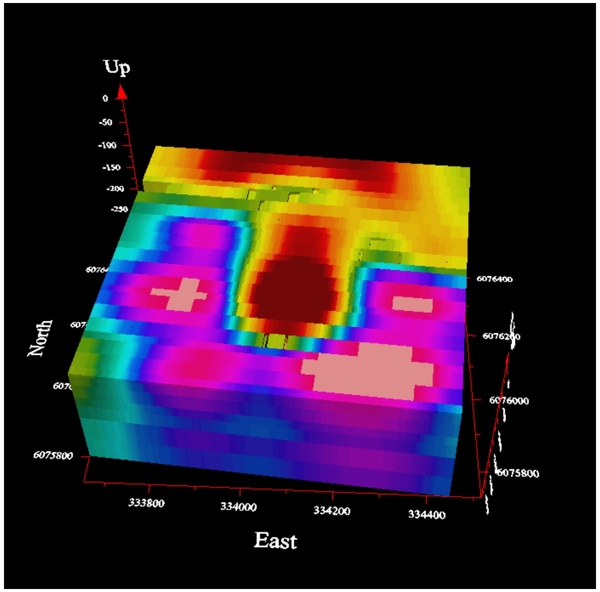

TMI contour



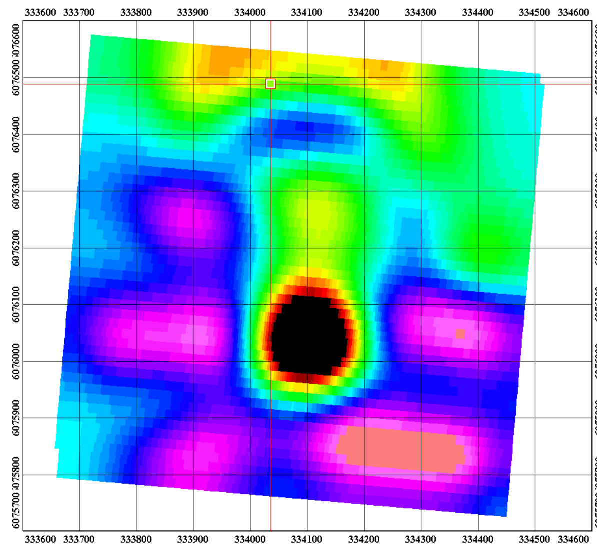

TMI vertical gradient as a surface

# Z6 Picks – VTEM Modeling Type 2 – Controlled by magnetic structure

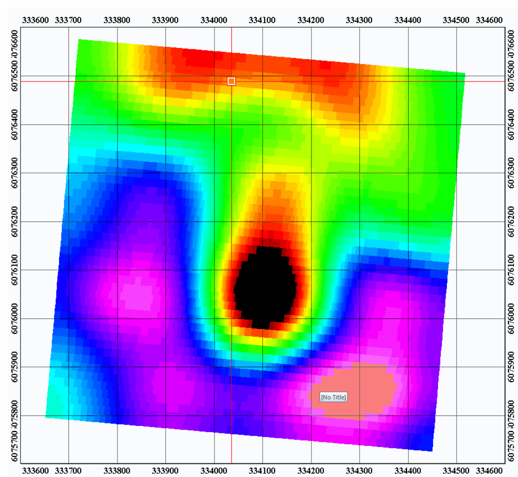
We take another approach assuming the conductive response is related to the magnetic response around the conductive response. The contour of the TMI on the left shows the magnetic anomaly dipping a few degrees east of north and a strike approximately NS. On the right, we show the surface of the vertical derivative to emphasize the dip to the NNE.




3D Inversion grid sliced at a depth of 104m




3D inversion grid sliced and gridded at 65m

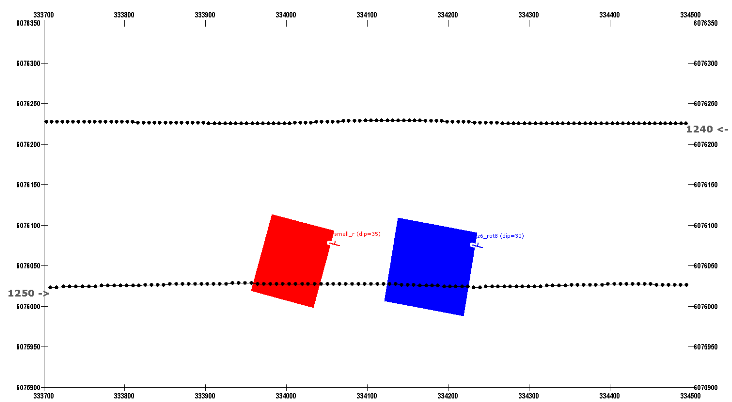



3D inversion grid sliced and gridded at 144m

# Z6 Picks – VTEM Modeling Type 2 – Controlled by magnetic structure

In modeling in the anomalies when striking approximately EW and dipping slightly east of north, we were guided first by the width of the responses along L1250 to provide initial estimates as to the strike length, the response in early time after the fall-off of the cover response to provide depth to top and then by the rate of decay into late time to provide us initial conductance estimates. The direction of the dip is provided by the magnetic response.

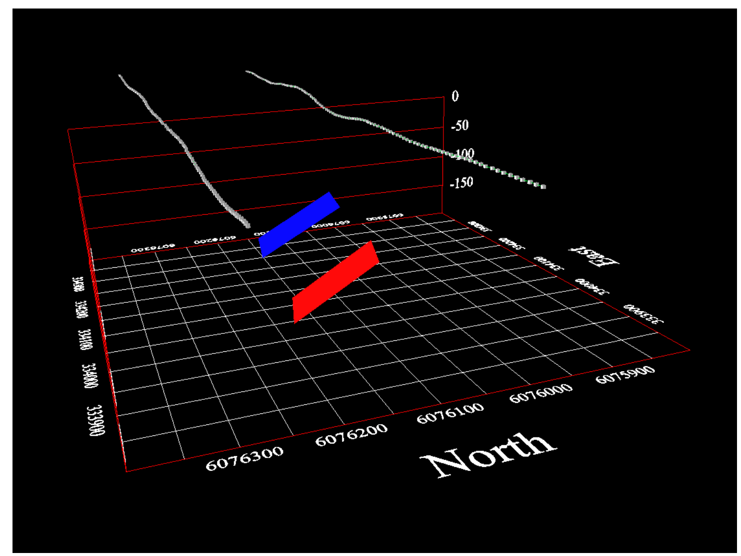
The algorithm limits us to have a strike slightly south of east in order to be able to dip the structure along the magnetic dip. The dip angle is controlled to some extent by the shape of the response, the dip of the magnetic structure. But, additionally, there is a late time response on Line 1240 immediately north. As such, the dip must be such that the response does not appear to early in time and is not too strong in the late time. However, what is most important is that we have used a dip extent of 120m, but the dip extent could be much greater at these dips and would have no effect on the response on L1240 or any further northern lines.




Model type 2 in plan

| Anomaly 1 |
|---|
| Strike Length: 75m |
| Dip Extent: 120m ? |
| Strike Angle: EW |
| Dip Angle: 35 NNE |
| Conductance: 60 S |
| Depth to Top: 105m |

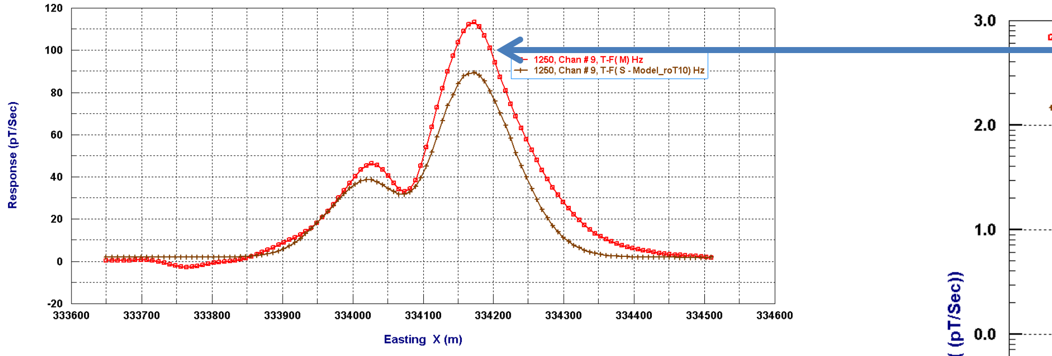
| Anomaly 2 |
|---|
| Strike Length: 90m |
| Dip Extent: 120m ? |
| Strike Angle: EW |
| Dip Angle: 30 NNE |
| Conductance: 50 S |
| Plunge: 14 deg East |
| Depth to Top: 81m |



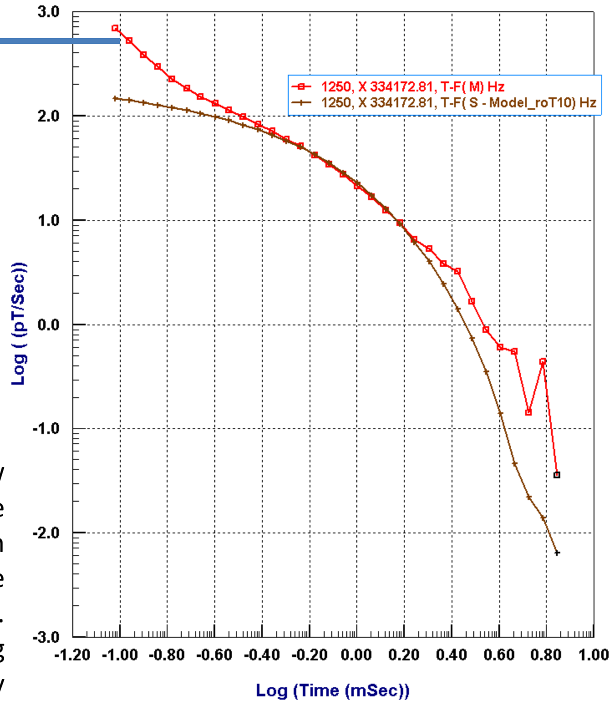

**Model type 2, 3D view**

# Z6 Picks – VTEM Modeling Type 2

We present the limitations of our model fit to the data and some more details on the VTEM response over the anomalies on Line 1250..




**Data and Model response – Ch9 – late early time**



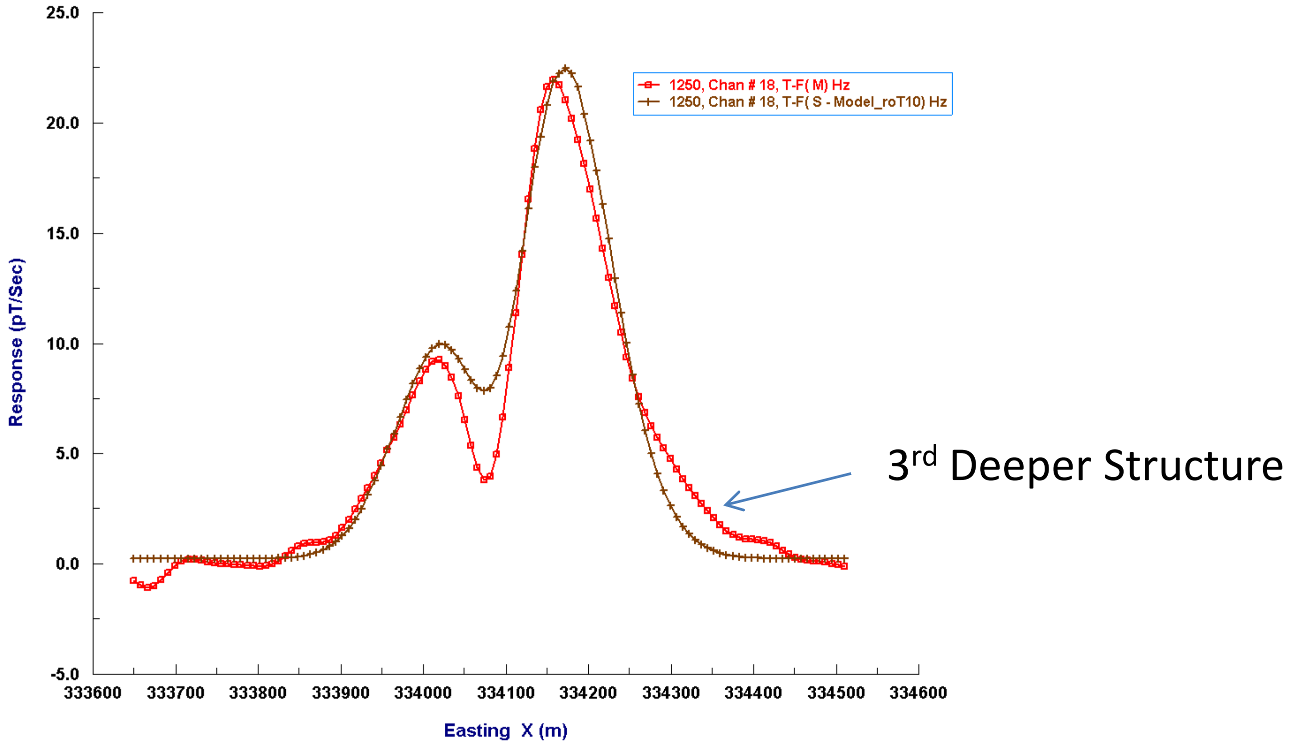

**Decay with time at peak**

Above, we show the VTEM response at Ch9 and the simulated response of the new model (brown). To the right, we give the response as a function of time at the peak of the VTEM response at this time (334172E). This figure to the right is interesting in comparison to the model as it tells us a few important aspects of the conductor. First, the fast decay in early times for the first 5 or 6 channels is the response of the cover. However, from this study , we can now see that there is a shallower, weaker conducting material beneath the cover and above the principle conductor. Thus, we should not try to fit to exactly the VTEM data channels until about Ch12. Also, now we can see that data beyond Ch22 is becoming noisy and may not be reliable.

We want to point out another aspect of the model and the actual response that can be observed in the upper plot. To the east, we can see that the response of the model falls off to the east more slowly than in the data. We have tried to encompass this aspect by extending the easterly anomaly (blue) further east and plunging it to the east . However, at this time, we are of the opinion that there is an additional structure deeper just east of the blue structure and from the data, this deeper structure may be slightly more conductive than the blue structure.

# Z6 Picks – VTEM Modeling Type 2

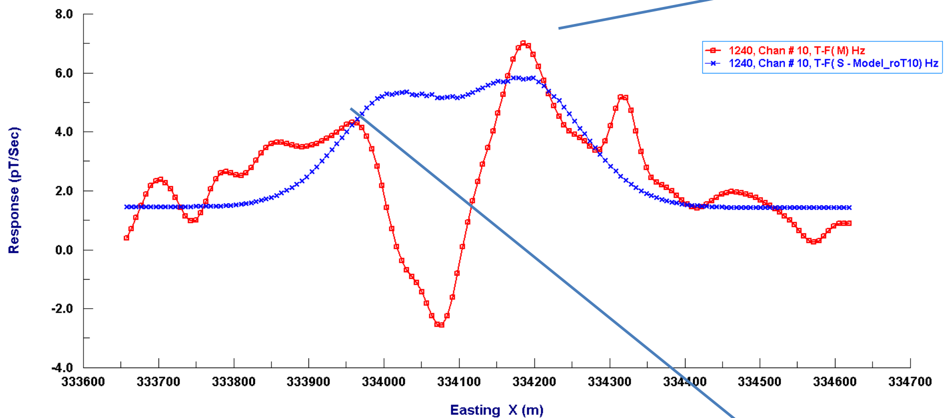
By Chn 18, we can see some limitations of the model. First, to the east, we can now see that there is more evidence that there is a third structure. Extending the model eastward and dipping eastward, causes the simulated response to move its peak due to the current migration.  Also, the response of the blue structure appears to large over the minimum between the 2 structures.

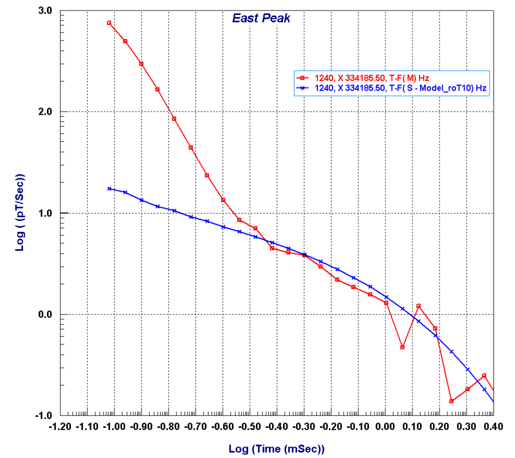



Data and Model response – Ch18 – late-time

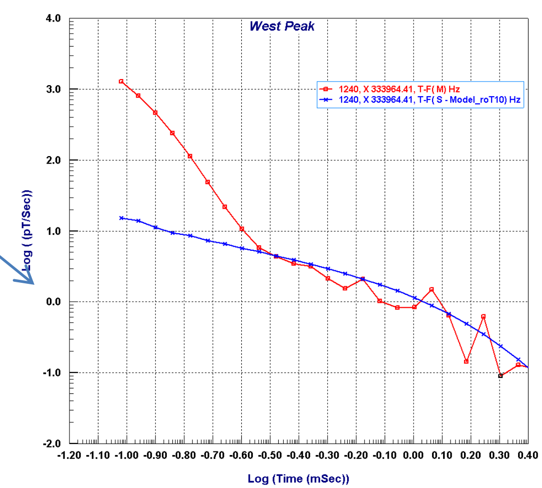
# Z6 Picks – VTEM Modeling Type 2 – extent to the north.

There are clear indications that the response of the conductors seen clearly on L1250 are also observed on L1240. However, clearly modeling the response is very difficult. Below, we show the data on L1240 for Ch10 and the model response (blue). Decays are shown to the right.




**Data and Model response – Ch10 – late-earl time**



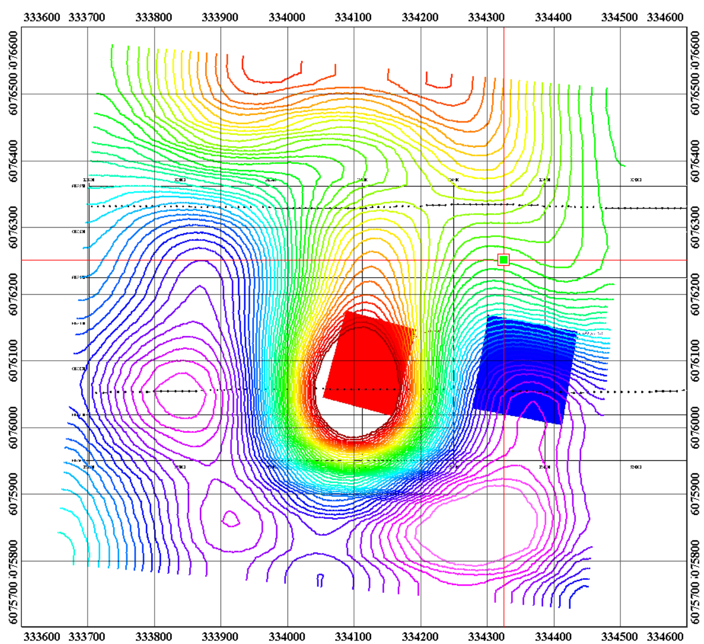

By plotting the decays, at the 2 locations, we can observe that probably the conductors are showing a weak response along the next line north beginning about Ch8 before the data falls into the noise a few channels later. If we extend the models, so that the depth extent is much greater it will have no effect upon the response on L1240 as the structure is too deep to have any effect.

One other factor is important. The response on L1240, appears to have some of the characteristics of a steeply dipping conductor. The response on this line can be very approximately modeled by a relatively deep conductor of about 200x200m. The conductance is very difficult to determine due to the quality of the data is the important channels to determine this aspect.

# Z6 Picks – VTEM Modeling Type 2

Finally, we show some aspects of the correspondence between the magnetic structure and our Type 2 EM model. Below, we contour a slice of the magnetic inversion at 145m and place a map of the projection of our latest model underneath.

There is a strong correction between the stronger, smaller conductor and the magnetic structure but apparently no correlation with a larger, somewhat weaker conductor.




Magnetic Inversion model at 145m depth
Underlay, TEM model Type 2.

# Z6 Picks

**Conclusions**:

Again, the data accompanied by modeling, indicates that the conducting structure is not simple. There are again in this area, indications of multiple structures at different depths. Also, again, it appears evident that the conductors that are "seen" on the widely spaced VTEM lines are quickly lost on neighbouring lines as they dip downwards. There is no definitive evidence that the conductors are small and of limited size.

What is interesting is that again, the conductors have similar conductances and depths as in the previous sites – Z4 and Z5. Here at Z6, there definitely at least 2 structures but good evidence of another two structures and weaker evidence of a further extension to the south as well.

The relationship between the EM and magnetic responses cannot be overlooked.

**Recommendations:**

It is again quite obvious that drilling on the VTEM data alone would be extremely risky and would likely not be successful. There are several methods to proceed:

1. high resolution, rapid ground magnetics: Given the number of EM anomalies in the vicinity is recommended that a comprehensive ground magnetic survey be done with the use of a GPS equipped magnetometer. As long as the bush is not too dense, rapid ground coverage can be done without need to cut grids. Reasonable daily coverage would be 12km with data collected at 1 or 2 second sampling (a few meters) with 50m line spacings. This means that an area of 1 sq. km can be covered in 2 days.

2. ground TEM surveys: A ground TEM survey should be taken with a 400x400m loop placed near the VTEM response on L1250 and 4, 800m lines collected either NS or EW at 25m intervals. Two lines would cross through the loop and two would be entirely outside t he loop. A 3-component Geonics coil should be utilized and a Geonics EM57 transmitter. A SmartTEM receiver would be recommended. The Geonics equipment with receiver could be rented from Geonics. Survey time for an experienced crew would be 2 days and for an inexperienced crew likely 4 days. A standard modest sized gasoline generator would be required. The loop wire can be purchased from the local hardware store and kept for further surveys. This survey size and procedures would be the very similar to those recommended at Z4 and Z5.

# Analyses of VTEM Z_2 Picks

25 June 2018

for Copper Reef Mining Corporation
Flin Flon, MB

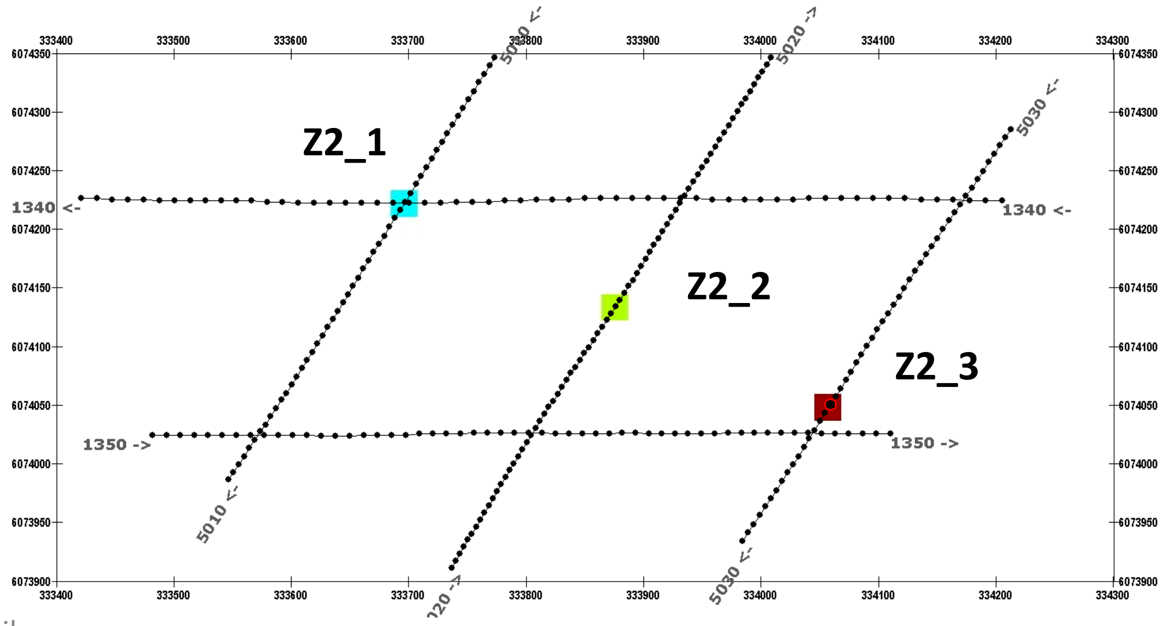
R.W. Groom, PhD,BMath
Petros Eikon Incorporated

Introduction:
In 2010, several VTEM surveys were flown by Geotech Ltd, Aurora. To the west and south of Alberts Lake, one survey call Big Island was flown in east – west directions and another Alberts Lake was flown at azimuth of approximately 30 degrees east of north.  Geotech made a number of late time anomaly picks which were named Z picks. In this study, we study the area surrounding 3 picks named Z_2.

# The Z2 Picks

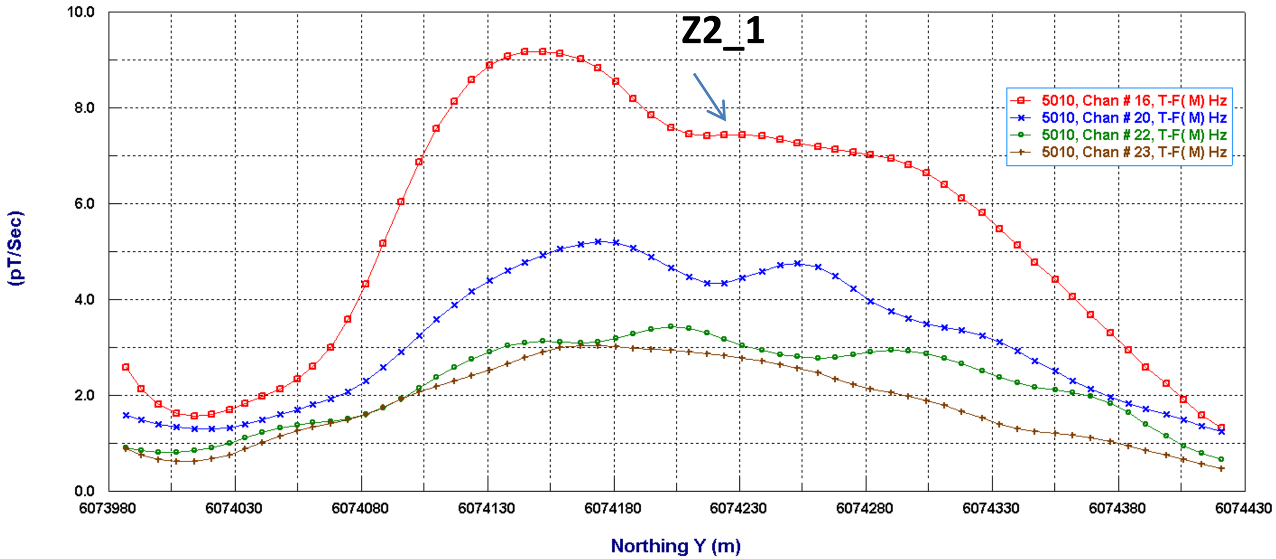
Geotech Late-Time Picks. In the immediate area Geotech made 3 picks all called Z_2 and immediately south 2 picks named Z_3.

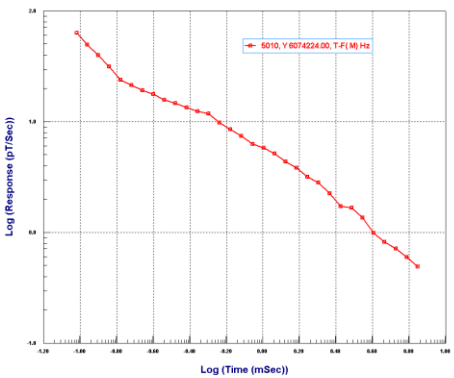
| east | north | Line | Longitude | Latitude | ID_numb | ID | Type | tauSF | pick | P Lines |
|---|---|---|---|---|---|---|---|---|---|---|
| 333695.7 | 6074221.8 | 5010 | -101.58643 | 54.787582 | 2 | Z2_1 | ? | 0.0875 | 99 | 1340, 5010 |
| 333876.1 | 6074134.6 | 5020 | -101.58358 | 54.786858 | 2 | Z2_2 | Plate | 0.119 | 99 | 5020 |
| 334057.4 | 6074048.6 | 5030 | -101.58071 | 54.786147 | 2 | Z2_3 | ? | 0.0023 | 99 | 5030 |
| 333443.0 | 6073821.8 | 5010 | -101.59013 | 54.783907 | 3 | Z3 | ? | 0.614 | 99 | 1360, 5010 |
| 333617.6 | 6073719.7 | 5020 | -101.58736 | 54.783048 | 3 | Z3 | ? | 0.0318 | 99 | 5020 |



# The Z2 Picks – L5010

We are not in exact agreement with the Geotech picks in this area. So, we will review the responses in this area and indicate our picks.



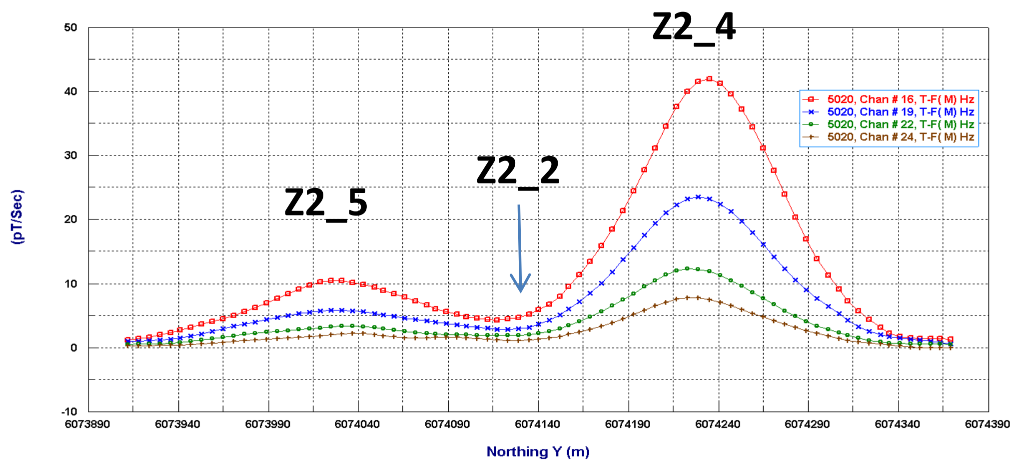

**Decays in the vicinity of the Z2_1 pick.**

**Profile response along L5010 from late mid-time into late time.**

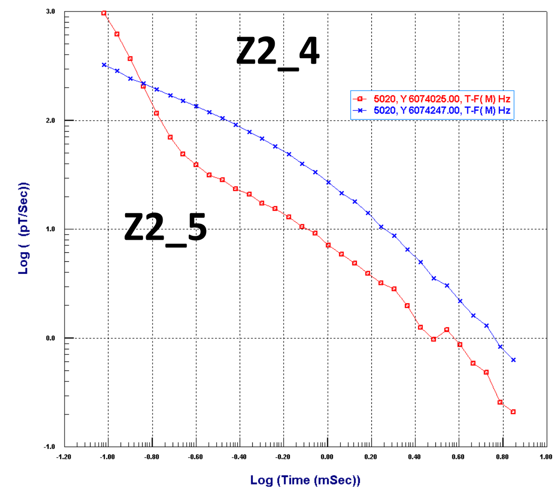
In profile mode, there appears no indication of strong anomalous response near the Z2_1 pick. In the decay to the left, we see a quick early time surficial response and slowing down at Ch6. However, the decay starting at Ch6 is not particularly slow and does not indicate a good conductor. But, we will return to this aspect later.

# The Z2 Picks – L5020

There appears no identifiable conductive anomaly near the Z2_2 pick. However, there are 2 identifiable anomalies along L5020, one to the north of the Z2_2 pick which we will call Z2_4 and one to the south which we will name Z2_5.




**Profile response along L5020 from late mid-time into late time.**

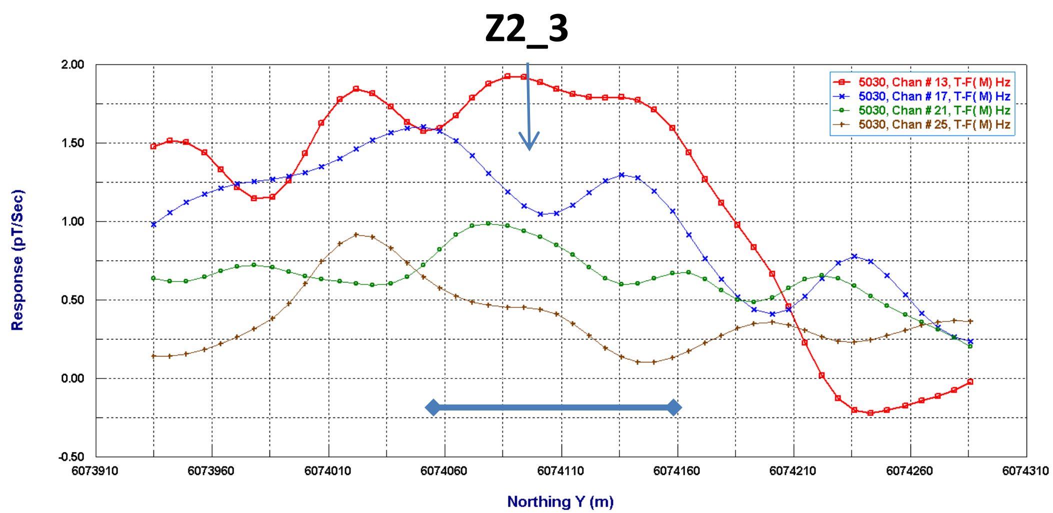



**Decays in the vicinity of the new Z2 picks.**

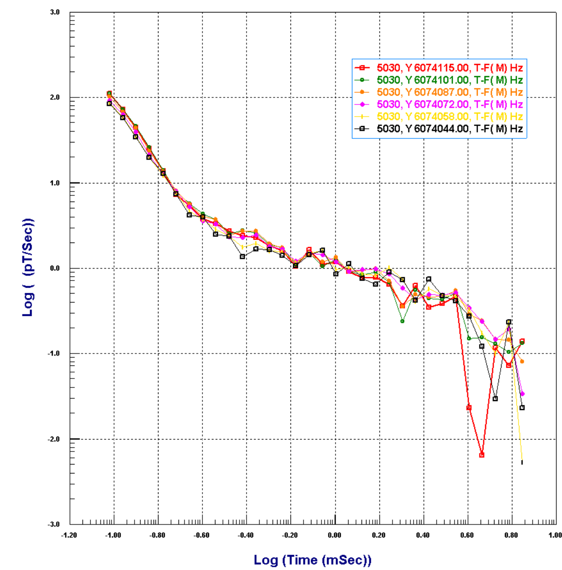
Z2_4 shows no surficial response and a conductive response appears early (shallow). Z2_5 shows a rapid early time (surficial response) followed by a deeper more conductive response.

# The Z2 Picks – L5030

There is also no obvious verifiable conductor on L5030, near Z2_3 or anywhere else within this area. However, there is some indication of a deep conductor which possibly a deeper extension of Z2_4.




**Profile response along L5030 from late mid-time into late time.**

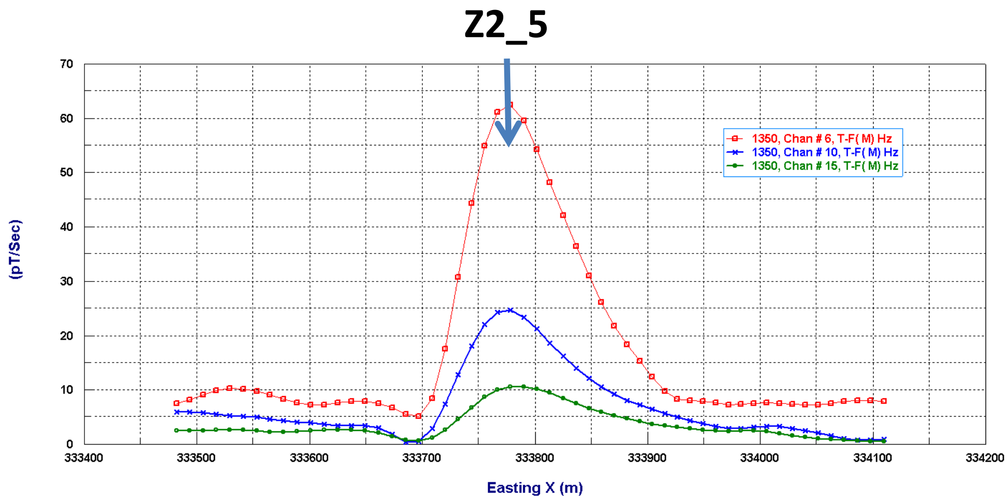



**6074044N to 6074115N**

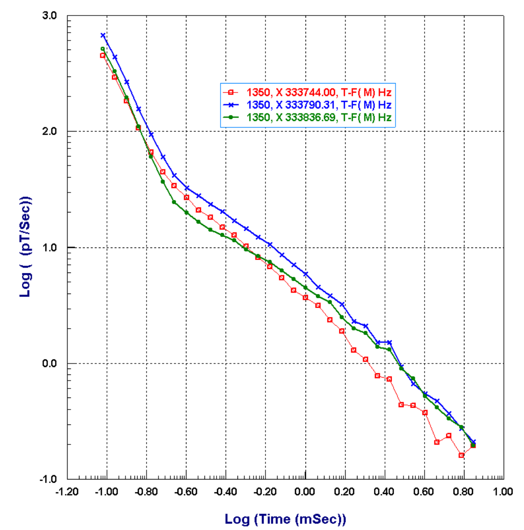
In the profile response above, there is little indication of any anomalies. However, when examining the decays, there does appear the possibility of a deeper conductor. The surficial response is easily identifiable in the first 7-8 channels, but then the response appears to slow down. The response is not large and thus noisy but it unusual for the response to be consistent over such a distance and simply be the effect of the instrumentation or noise. This is another indication that a large region of this area is underlain at depth with conductive material but not easily resolved in the VTEM data.

# The Z2 Picks – L1350

There is an obvious verifiable conductor on L1350, near the intersection with L5020. This anomaly was not identified by Geotech but we have named it Z2_5.




**Profile response along L1350 from mid-early time to mid-time.**

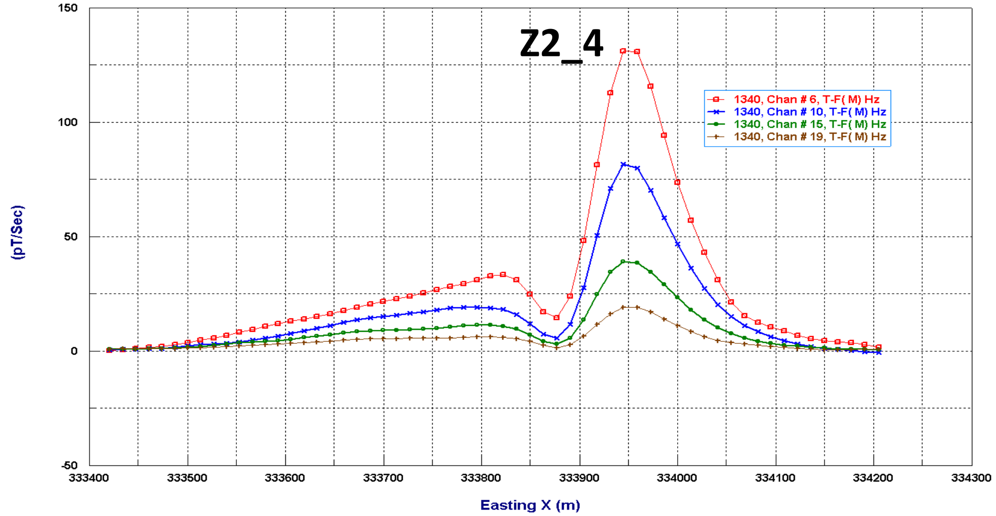



**333745E to 333837E**

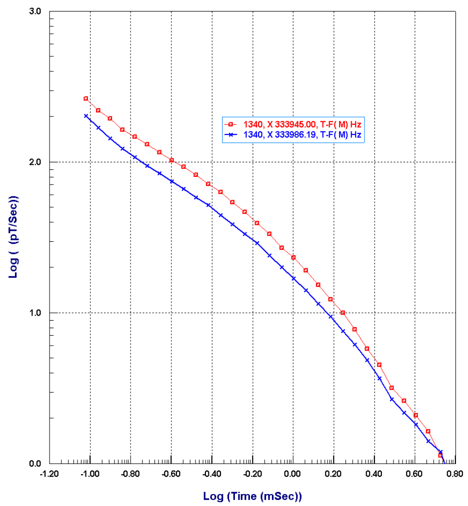
The profile response shows an anomaly likely striking approximately perpendicular to the line. We have shown some decays in the vicinity of the peak. There is an obvious fast decaying surficial response followed by a deeper conducting structure as seen on the figures for L5020 above.

# The Z2 Picks – L1340

There is an obvious verifiable conductor on L1340, near the intersection with L5020. This anomaly was not identified by Geotech but we have named it Z2_4. It is north along this line from the Geotech pick Z2_2.




Profile response along L1340 from mid-early time to early late time.

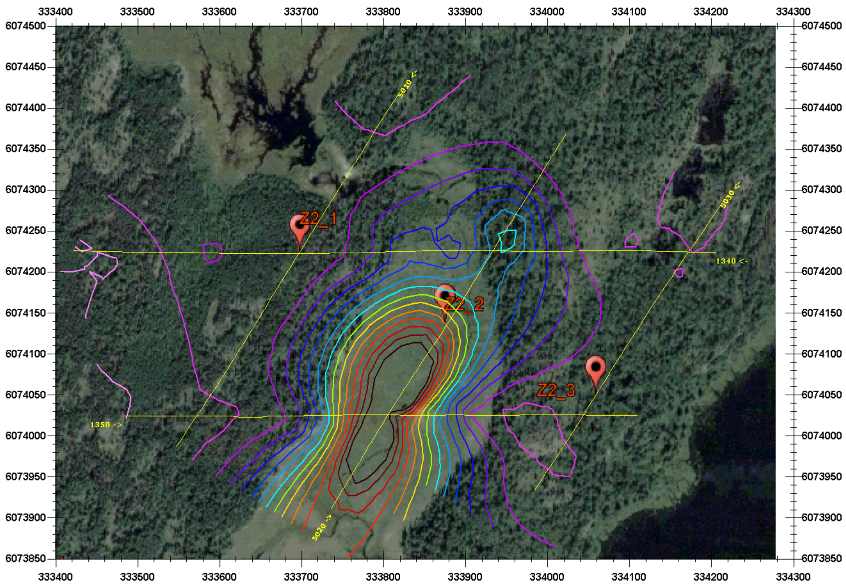



333945E to 333986E

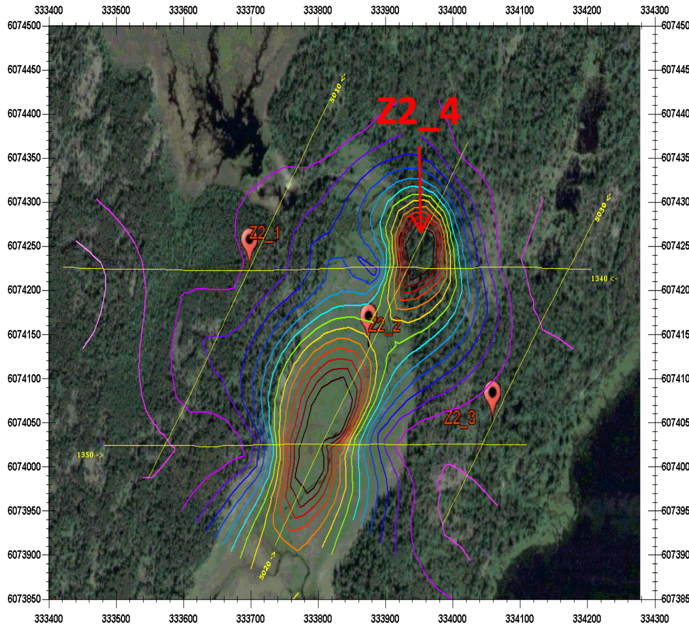
The profile response shows an anomaly likely striking approximately perpendicular to the line.
We have shown some decays in the vicinity of the peak. There is some indication of a surficial response and then the decay dramatically slows and there appears indication of a deeper more conducting structure.

# The Z2 Picks

We now examine contours of the VTEM data produced from data cut from 5 lines, L1340, L1350, L5010, L5020, and L5030.  Below, we contour Ch2 and Ch4 with a satellite map underlain with the location of the Geotech Z2 picks.




Ch2 VTEM

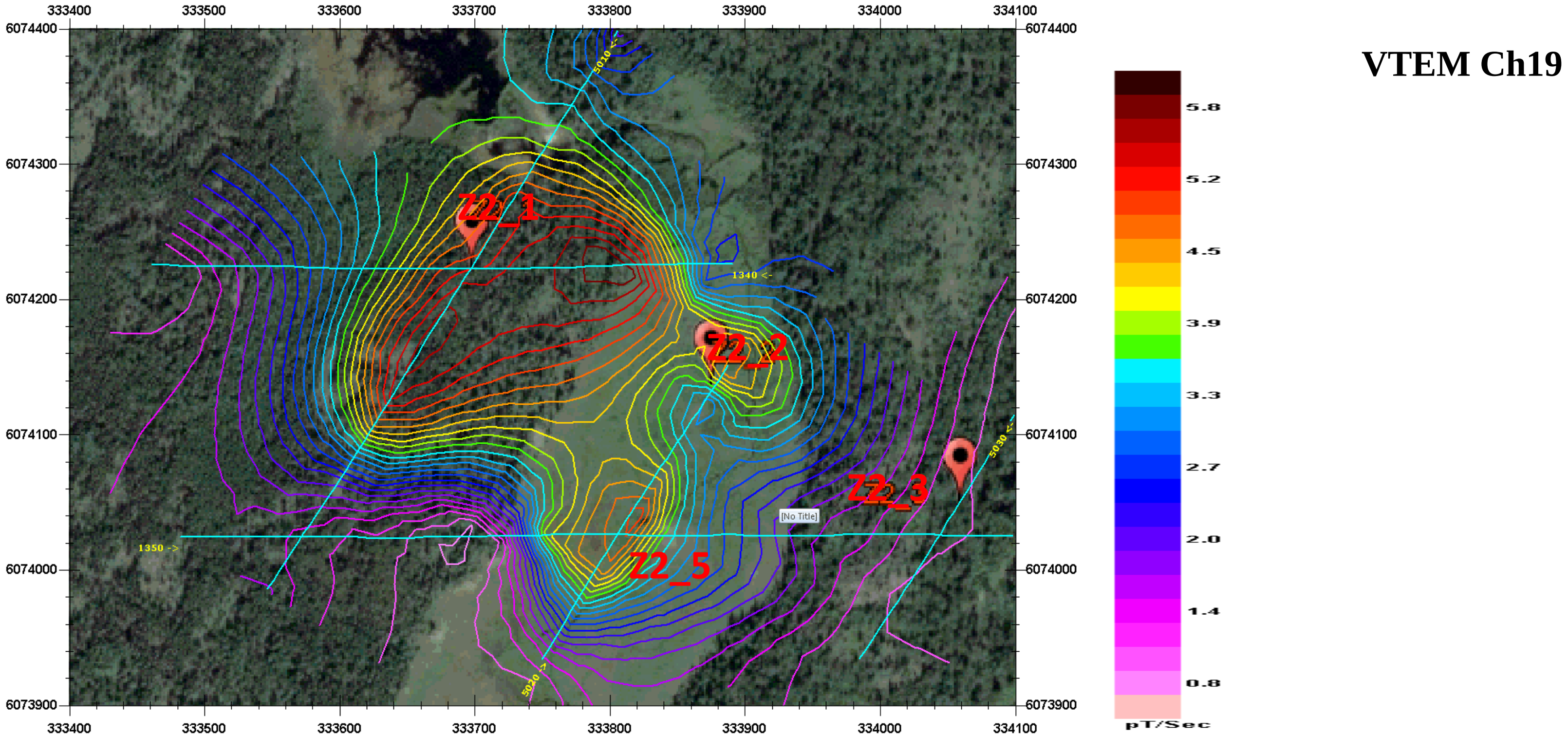



Ch4 VTEM

In very early time, the response is controlled by grey feature shown on the satellite map. This feature is an extension of the same type of feature to the north shown in relationship to the Z5 and Z6 picks.  This surficial structure must be included in the modeling in order to properly interpret the data. As early as Ch4, the Z2_4 feature appears.

# The Z2 Picks

Superficially, the VTEM responses are dominated by the target(s) at the intersection of L5020 and L1340. Some portion of this anomaly is shallow and thus the response in the area of the Z2_4 feature dominates the response at virtually all times. However, examination of the decays has as we have shown has identified other possible deeper conductors within this area.  One method, to examine the more carefully the remainder of the area is to cut out the portions of the lines with Z2_4 on them and examine again.

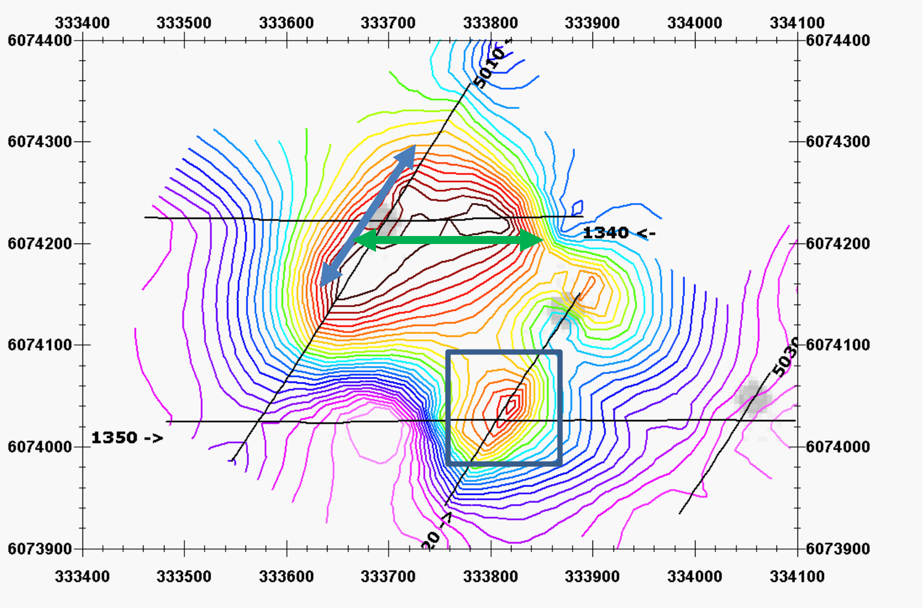



We contour the remaining data and here we display a quite late time channel. Everything blue and above is well above the nose. Thus, we see a large area of conductive to relatively conductive material. Now, it appears the original Z2_1  pick appears. The Z2_2 pick is highlighted but this could simply be a residue to the Z2_4 feature. What is clear is another  feature previously identified as Z2_5 at the intersection of L1340 and L5020. But, this display does indicate a large area of deep conducting material. Other analyses via decays confirms this indication.

# The Z2 Picks

We will discuss three other sections of the data here which appear as conductive at late time.

Section 1: This selection is a roughly 200m portion of L5010 which includes the original Z2_1 pick. Nothing is obvious is the data when displayed along the profile but this area does show conductive material at depth along this section. The degree of conductivity is not particularly striking but is consistent beginning at about Ch5. It is somewhat noisy but the data quality is adequate down to about ch21.




VTEM Ch20

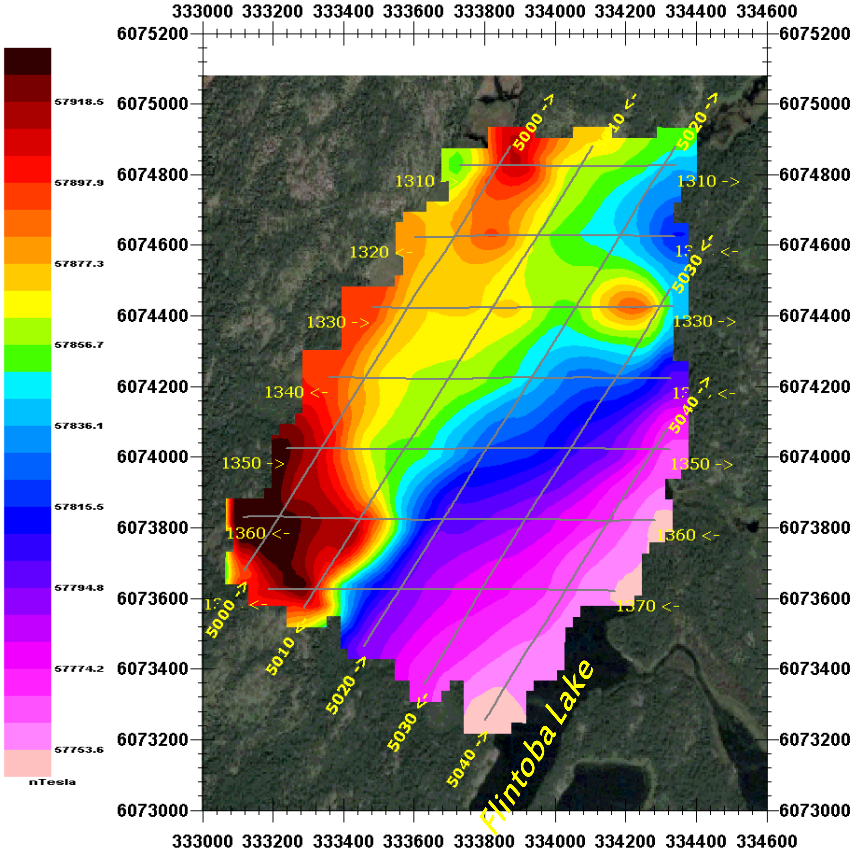
Section 2: This selection is a section of L1340 of about 150m intersecting the Section 1 data. This section of data has similar characteristics as Section 1 for the deeper material. However, the cover response varies across it and thus, the occurrence of the conductive material begins between Ch4 and Ch8 depending upon the immediate ground response.

Section 3: This selection is consists of 90m section along L5020 and a 90m intersecting section along L1350. On L1350, again the conductive response begins about Ch6 but near the intersection of the 2 lines, the conductivity increases somewhat. The response along L5020 is interesting. The entire section of line enclosed in the black square has an almost constant deep decay. However, this conductive response continues further south but the time that the conductive decay begins progresses later as we proceed south. Once we cross the centre of the response, the conductive feature again begins to appear later. The conductivity decreases out of the shown square but then begins to increase again as we move to Z2_4.

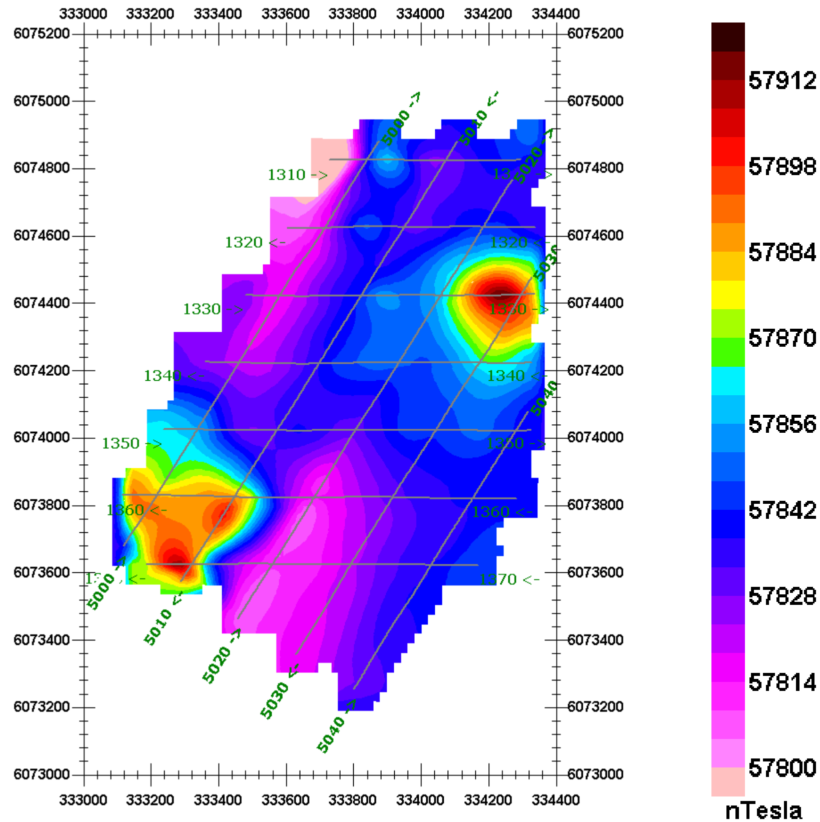
In summary, the entire area enclosed within L1350 to the south and L1340 to the north and L5010 to the west and L5020 to the east appears to be underlain with a reasonably good conductor. Within, this area there appears two additional , more conductive structures.

# The Z2 Z3 Aeromagnetic Data

There is a relatively strong NW to SE gradient in the TMI and thus difficult to see any details in its raw form. There is one significant elliptical anomaly north of the Z2 picks and another more complex high just west of the Z3 picks. If we remove the gradient then more can be observed in the data.




TMI

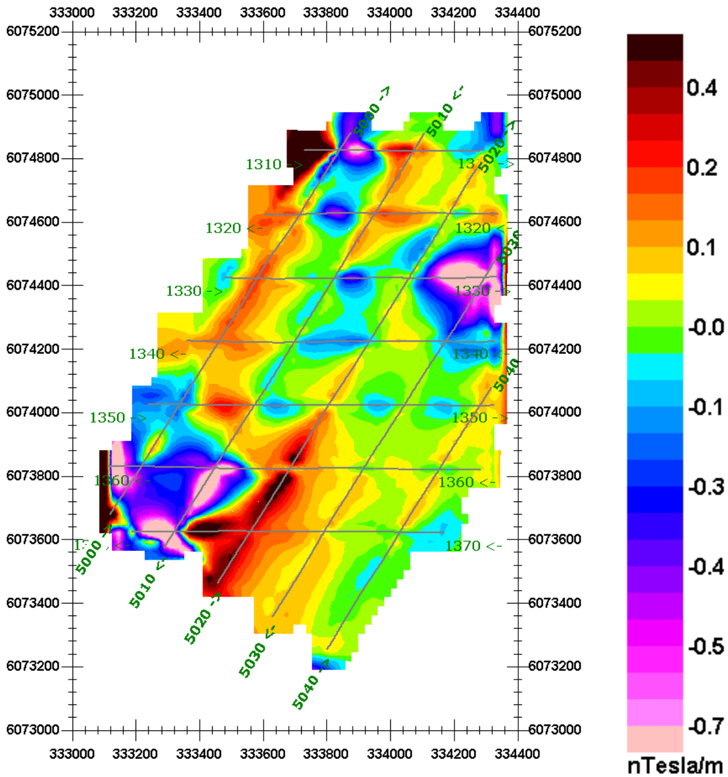



TMI gradient removed

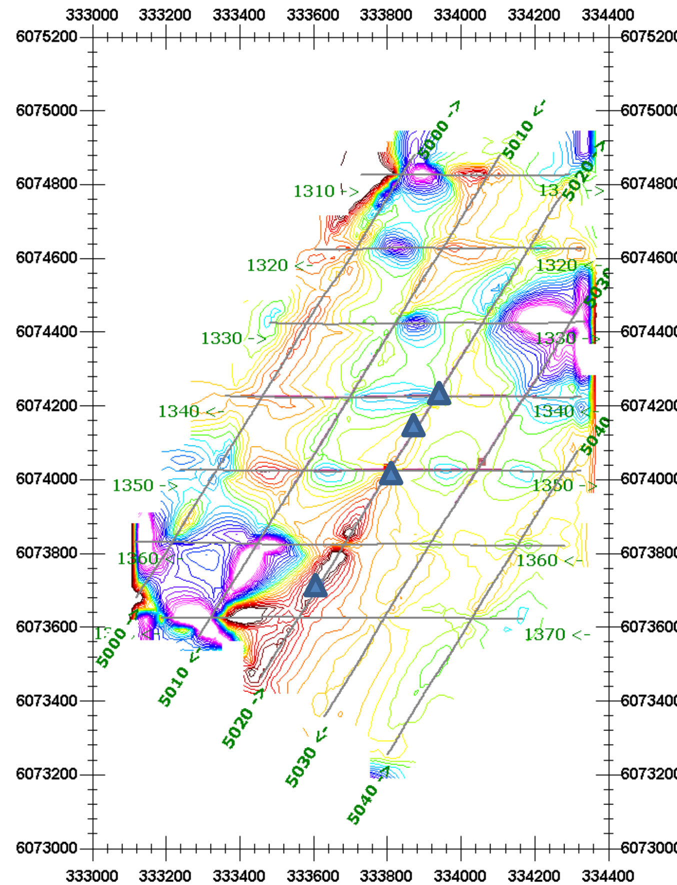
In particular, we would like to point out the magnetic low in the south which is striking to the north at about 30 degrees east of north.

# The Z2 Z3 Aeromagnetic Data

The vertical derivative of the TMI as shown on the left does appear to show an anomalous feature striking approximately along the SW-NE flight lines. As shown on the right, 4 picks appear along the feature Z3_2, Z2_5, Z2_2 and Z2_4. However, without reprocessing the aeromagnetic data from scratch, we could not be confident that this was not just artifacts from the Geotech processing.



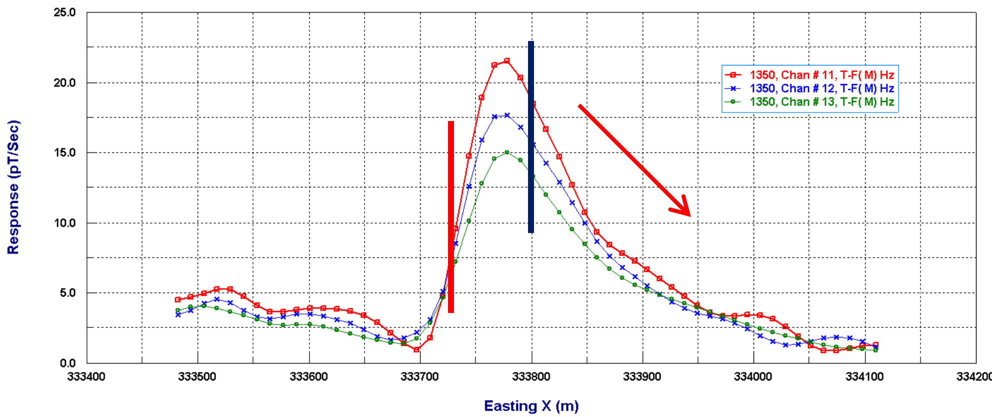

**Vertical derivative TMI**



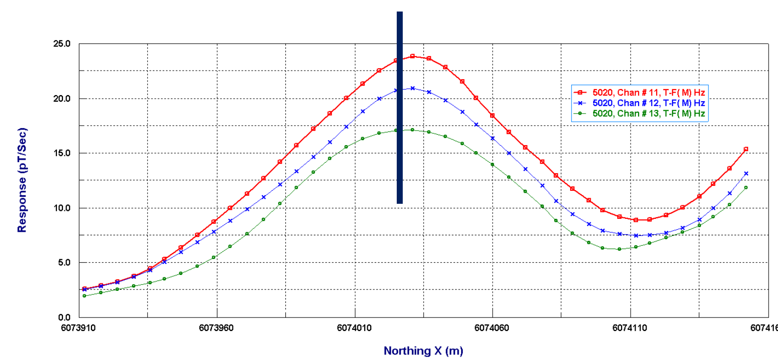

**Vertical derivative TMI with 4 Z picks along L5020**

# The Z2 Picks – Modeling – Z2-5

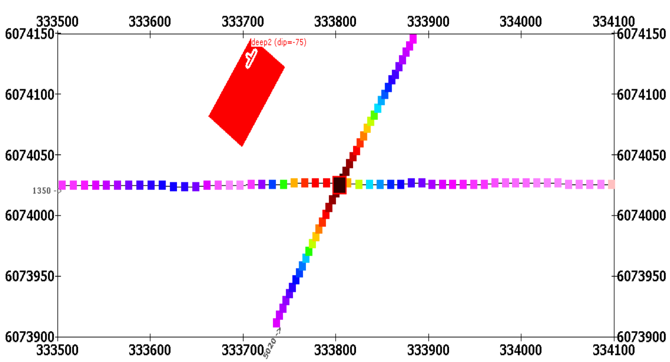
The Z2_5 feature occurs near the intersection of the EW line, L1350, and the NE line, L5020. The response in mid-time for Ch11, 12 and 13 are shown for L1350 to the left and for L5020 to the right. In both cases, the intersection is shown as a black vertical bar. A general examination of L1350 indicates a structure roughly perpendicular to the line and roughly vertical but dipping slightly to the east. Our model for the response of the 2 lines is shown below to the left.




Ch 11,12 and 13 – L1350



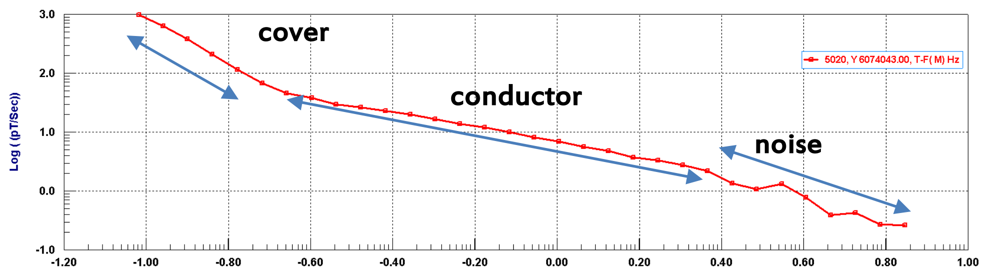

Ch 11,12 and 13 – L5020



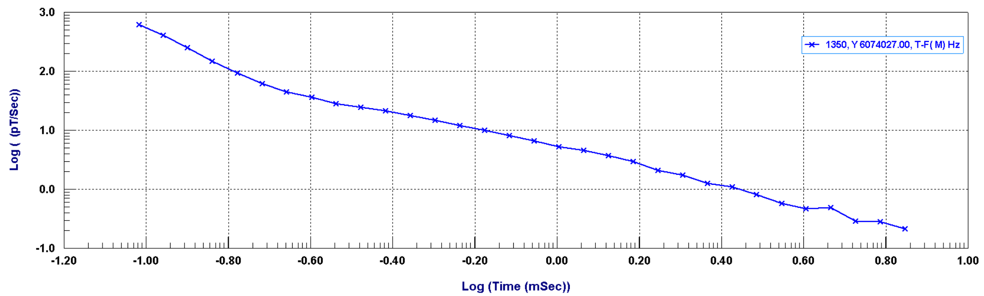
# The Z2 Picks – Modeling – Z2-5

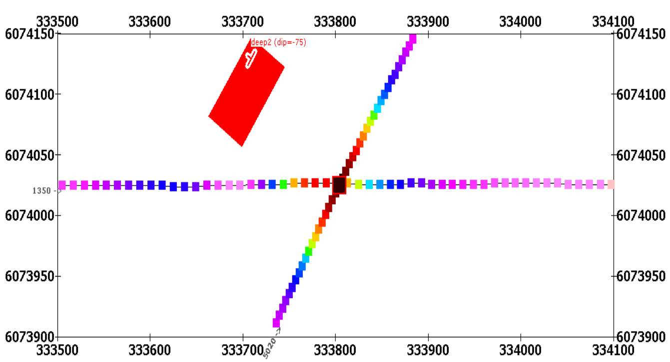
Below, we have shown the decay curve (log-log) at the peak position of the mid-time channels for both lines. It is clear that the decay rates in mid-times are quite close. In fact, for L5020, the decay rate is 0.598msec for channels 8-21 and for L1350 it is 0.545msec . This is indicative of a good conductor somewhat similar to Z5 and Z6.

**Decay near peak L5020**




**Decay near peak L1350**



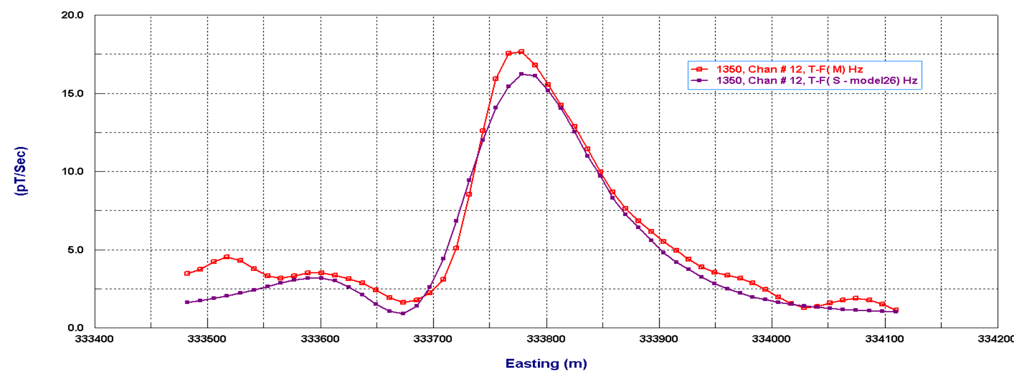




The early channels from Ch1 to Ch7 are quick and thus dominantly due to the cover material. We found it necessary to include this cover material in our modeling in order to properly determine, the depth to the conductors.

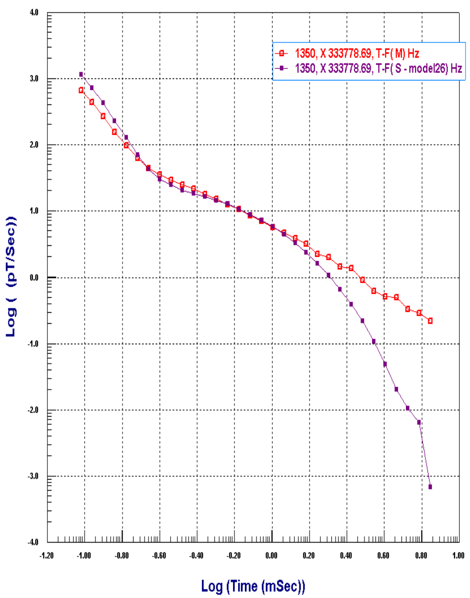
# The Z2 Picks – Modeling – Z2-5

Here, we have 2 lines responding to the anomaly and thus it is easier to constrain the model. Of course, we are still limited by the simplicity of the model. We show some characteristics of the model in respect to the data.

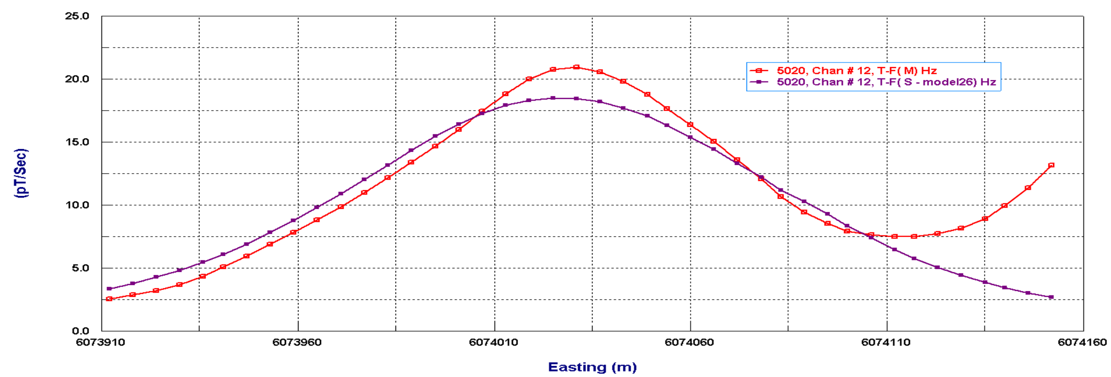
**Conductor Z2_5**
**Strike: 80m**
**Dip Extent: 170m**
**Strike Angle: 35°**
**Dip Angle: 85° E**
**Conductance: 55S**
**Depth to Top: 70m**




**Ch12 data (red) vs. model on L1350**




**Decay L1350 near peak response**




**Ch12 data (red) vs. model on L5020**

The model response follow approximately the shape of the data and decays in the early and mid- times quite accurately. Two aspects to point out, however. At the north of L5020, we see a diversion which is the effect of the northern anomaly Z2_4. The decay plot to the left indicates the possibility of deeper more conducting material. We will examine this further on.

# The Z2 Picks – Modeling – Z2-5

Here, we have 2 lines responding to the anomaly and thus it is easier to constrain the model. Of course, we are still limited by the simplicity of the model. We show some characteristics of the model in respect to the data.

**Conductor Z2_5**

**Strike: 80m**

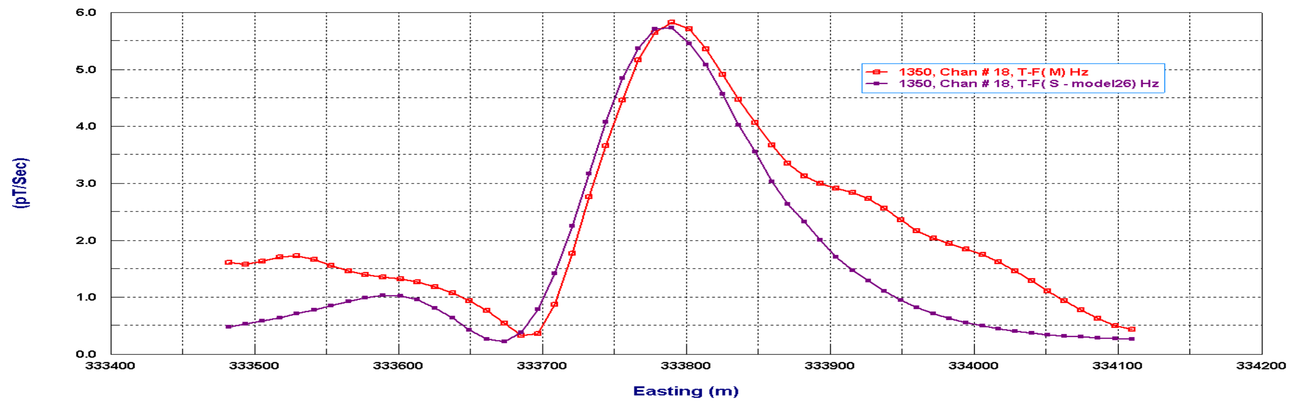
**Dip Extent: 170m**

**Strike Angle: 35°**

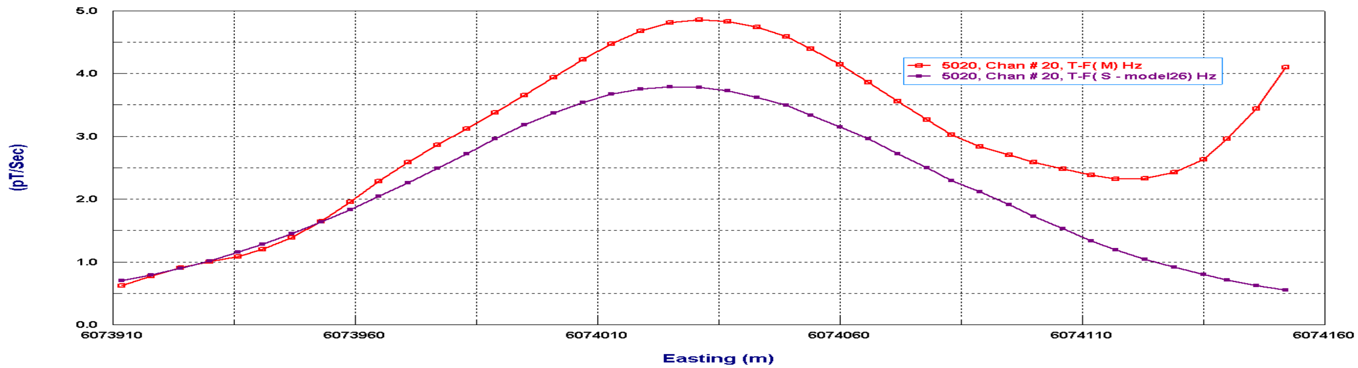
**Dip Angle: 85° E**

**Conductance: 55S**

**Depth to Top: 70m**




**Ch18 data (red) vs. model on L1350**



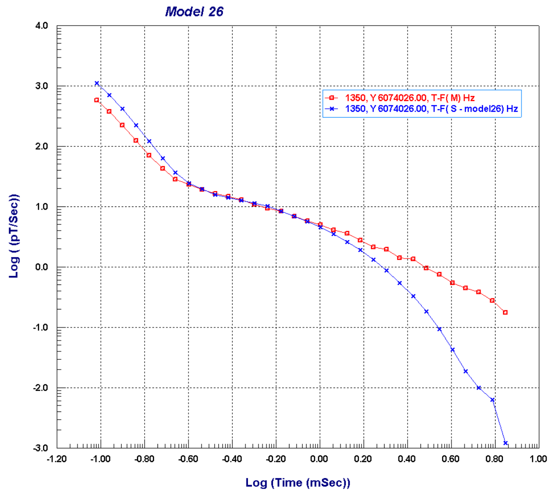

**Ch20 data (red) vs. model on L5020**

The model response follow approximately the shape of the data . But, on L1350 there appears to be more conductive material either deeper or to the east. L5020 appears to indicate that the central part of the target is more conductive in the deeper portion of the central zone of the target. Modeling does indicate there is much more conductive material at depth but likely also additional conductive material to the east.

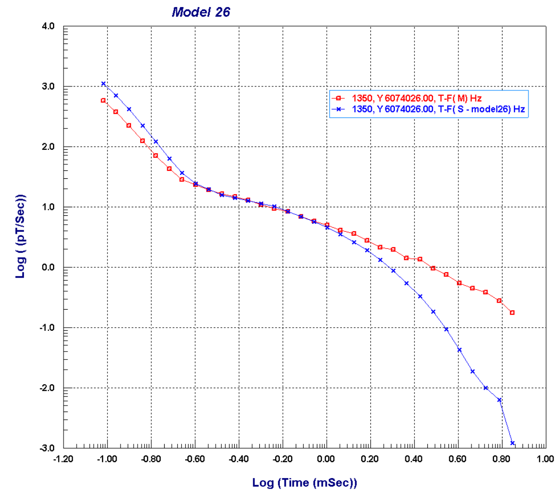
# The Z2 Picks – Modeling – Z2-5 – deeper more conducting target

Examining the decays on L1350 and L5020, we observe that the present model decays too quickly in the late time. Below, we compare the decays at the anomaly high on L1340 and L5020. The comparison is similar and all locations near these stations.

**Conductor Z2_5**
**Strike: 80m**
**Dip Extent: 170m**
**Strike Angle: 35°**
**Dip Angle: 85° E**
**Conductance: 55S**
**Depth to Top: 70m**




**Decays at peak L1350, data (red) , model (blue)**




**Decays at peak L5020, data (red) , model (blue)**

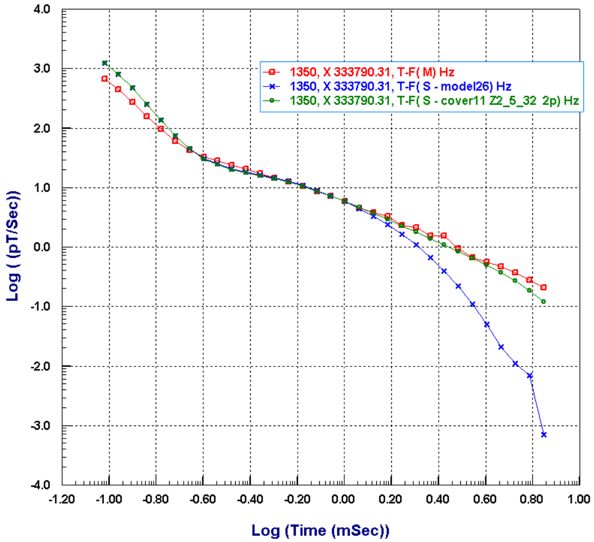
From this analyses, it is clear that there is more conducting material at depth.

# The Z2 Picks – Modeling – Z2-5 – deeper more conducting target

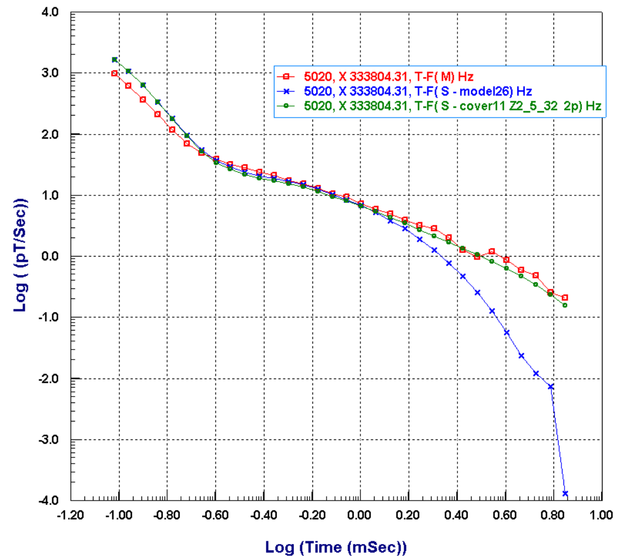
Examining the decays on L1350 and L5020, we observe that the present model decays too quickly in the late time. Below, we compare the decays at the anomaly high on L1340 and L5020. The comparison is similar and all locations near these stations.

**Conductor Z2_5_1**
**Strike: 80m**
**Dip Extent: 50m**
**Strike Angle: 35°**
**Dip Angle: 85° E**
**Conductance: 65S**
**Depth to Top: 55m**

**Conductor Z2_5_2**
**Strike: 80m**
**Dip Extent: 170m**
**Strike Angle: 35°**
**Dip Angle: 85° E**
**Conductance: 200S**
**Depth to Top: 120m**




**Decays at peak L1350, data (red) , model (blue), deeper conductive material model (green)**



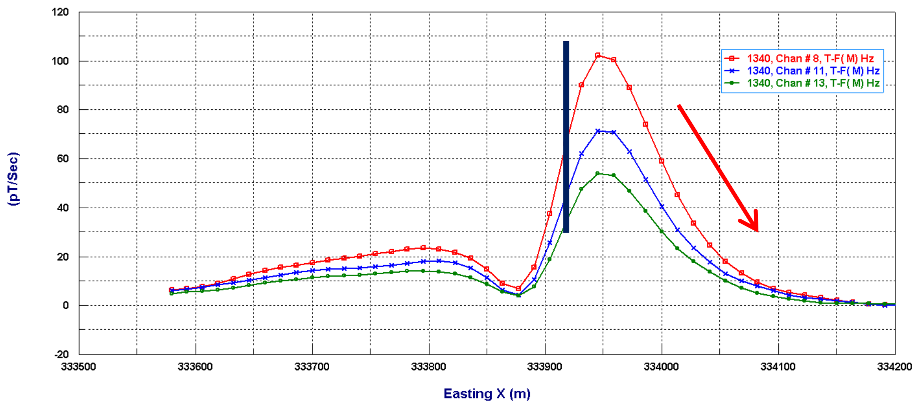

**Decays at peak L15020, data (red) , model (blue), deeper conductive material model (green)**

The most up-to-date model, splits the conductor into a shallow good conductor and a deeper, larger and much more conducting material. As you can view above, the late time fits are more representative of the data. The profile responses are also more representative but are not shown.

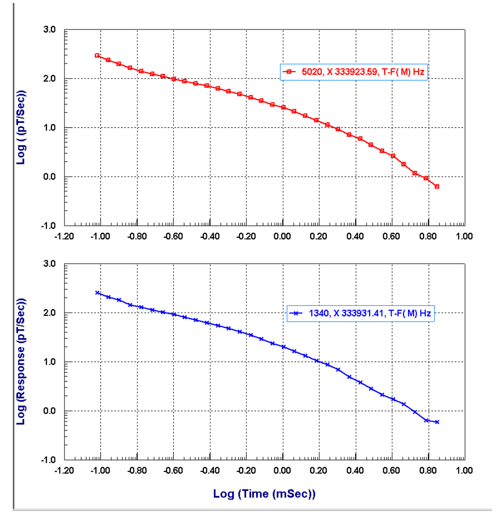
# The Z2 Picks – Modeling – Z2-4

The Z2_4 feature occurs near the intersection of the EW line, L1340, and the NE line, L5020. The response in late early-time to mid-time for Ch8,11 and 13 are shown for L1340 to the left and for L5020 to the right. In both cases, the intersection with the other line is shown as a black vertical bar. A general examination of L1340 indicates a structure roughly perpendicular to the line and roughly vertical but dipping slightly to the east. The reader will note that the responses on L5020 are slightly higher than on L1340. The peak responses on L5020 occur slightly north of L1340.

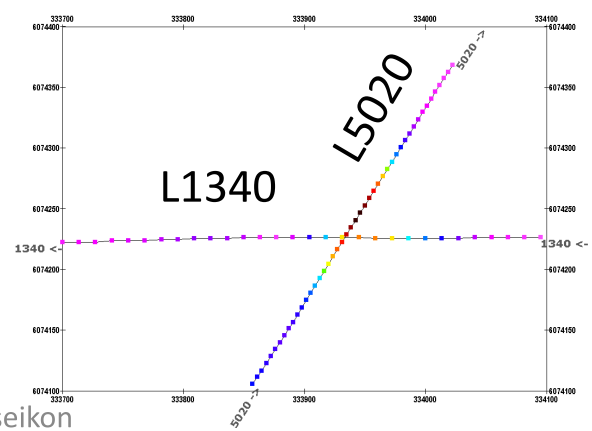
To the right, we show the decay examples near the intersection (L5020 red, L1340 blue). These show that the cover response is there but the conductor appears much earlier in time that for the southern anomaly.

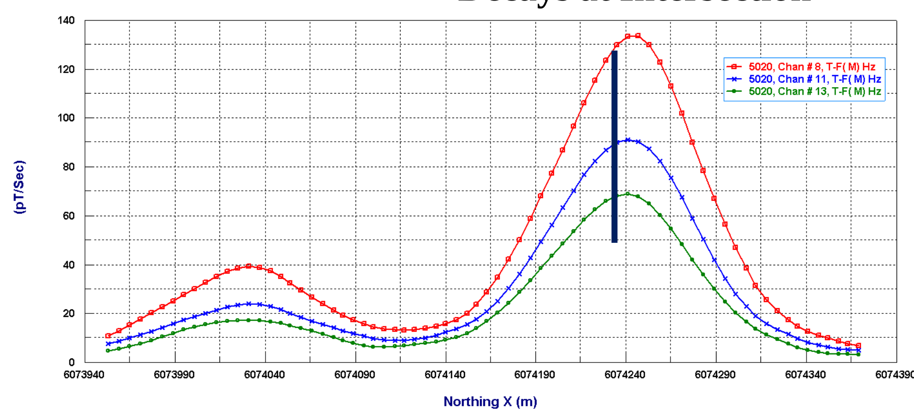



Ch 8,11 and 13 – L1340




Decays at Intersection

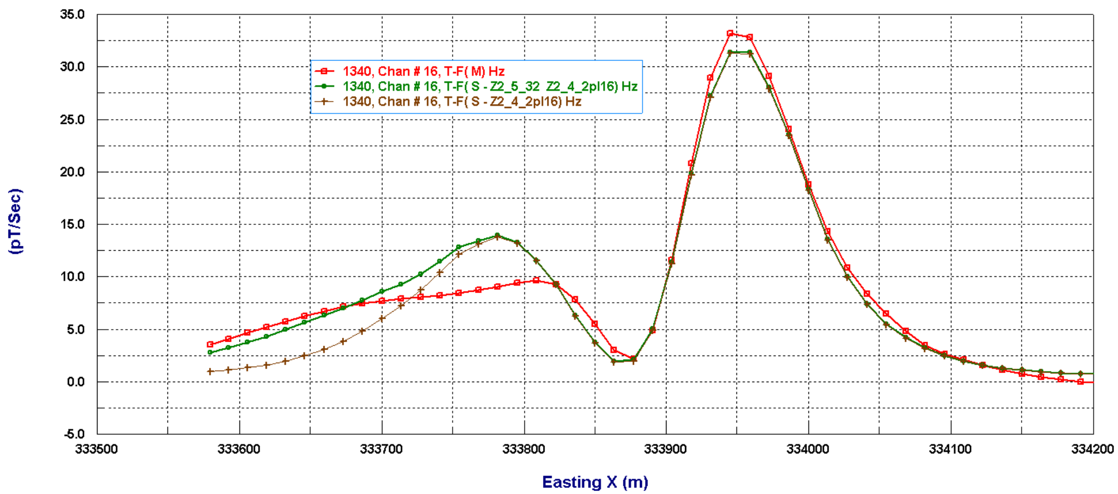


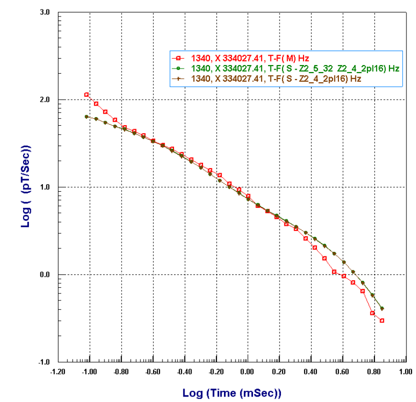

Ch 8,11 and 13 – L5020

# The Z2 Picks – Modeling – Z2-4

In this case, we needed to integrate a model for L1340 and L5020 at the Z2_4 anomaly with the southern models for Z2_5. Again, we found that the shallow conductivity for the Z2_4 anomaly was less conductive that the deeper anomaly.



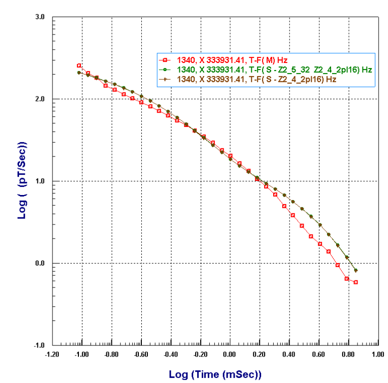

Ch 16 – L1340 with models



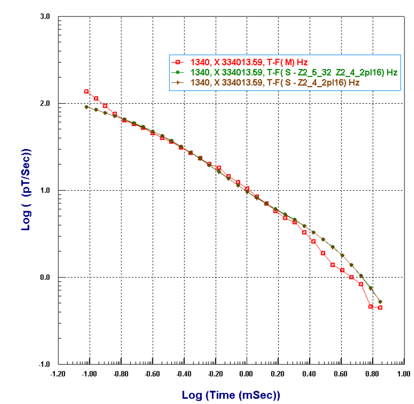

Decays 334027E

There are at least 4 conductors with different conductances that appear on this line. For example, in the plot immediately above, the brown plot is that of only the 2, Z2_4 anomalies while the green includes the 2, Z2_5 plates as well. The southern anomaly affects the west part of the line which provides the slow decays in the west as mentioned previously. We will return to this issue slightly later.

The decay on the top is in the middle of the downwards tail of the anomaly to the east. We see that there is a slight surficial response which we have not modeled. But, also the present of 3 distinct different decay rates. This is more obvious for the decay immediately to the right. To the far right, we see that although noisy, the influence of the deeper, more conducting material is visible.



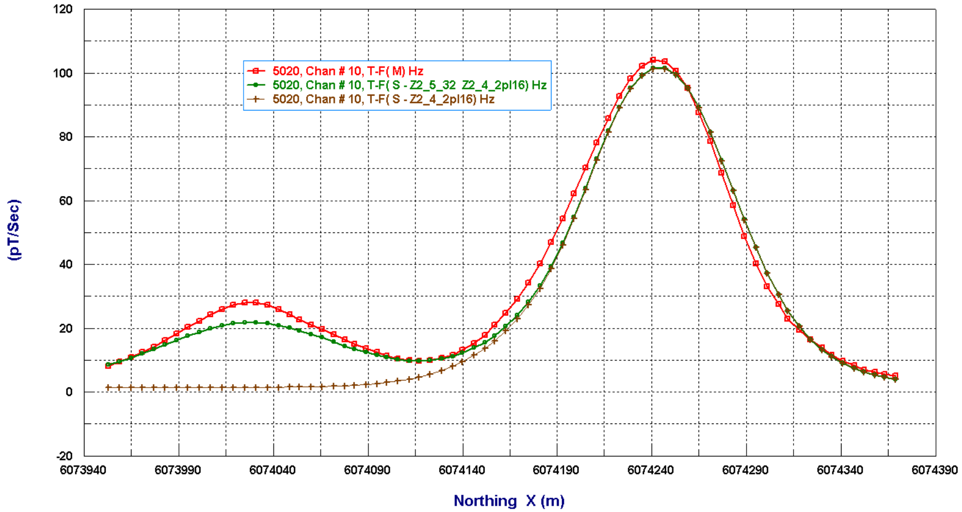

Decays at 333931E




Decays at 334013E

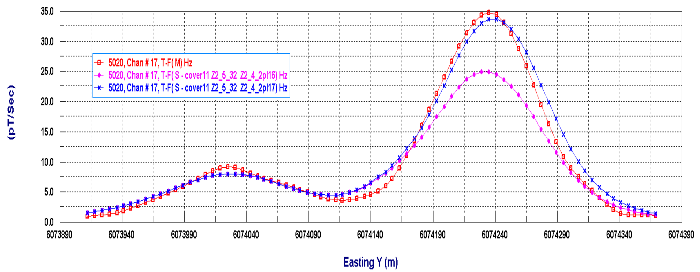
# The Z2 Picks – Modeling – Z2-4

In this case, we needed to integrate a model for L1340 and L5020 at the Z2_4 anomaly with the southern models for Z2_5. Again, we found that the shallow conductivity for the Z2_4 anomaly was less conductive that the deeper anomaly.



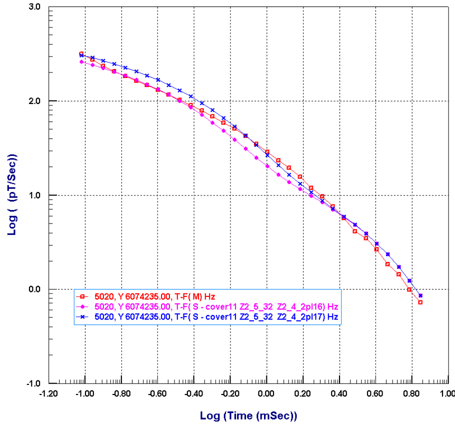

**Ch 10 – L5020 with models**

The brown plot shows the response only of the 2, Z2_4 targets while the green plot includes these 2 targets as well as the 2 targets to the south. Here, we have not included the overburden response in the model.




**Ch 17 – L5020 with models**

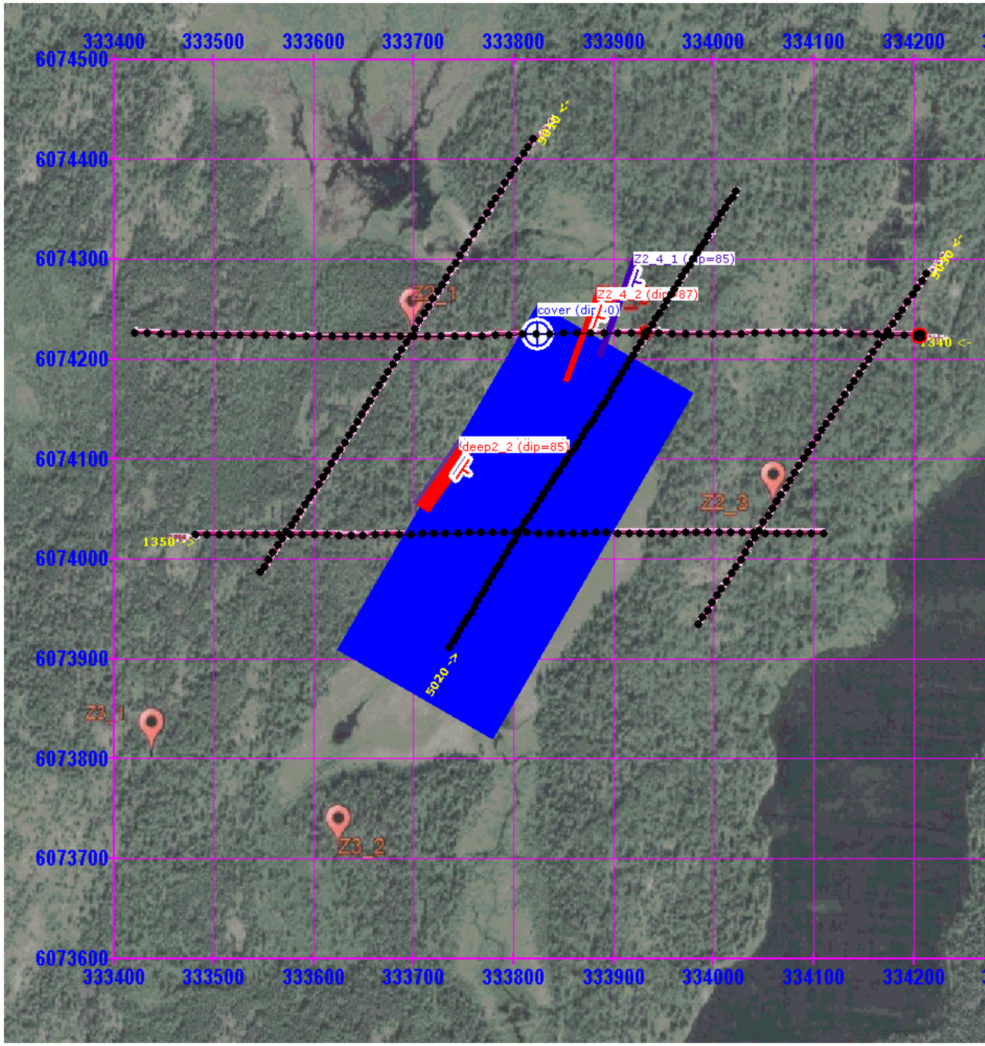
The plot to the upper right and the decay to the lower right, indicate complexity of the conductive structure at depth. The pink and the blue plots represent 2 slightly different models of the deeper, more conductive part of Z2_4. They indicate that there are likely at least 3 zones of different conductances. While, it is likely that a model could be found to identify the 3 zones, the amount of time required is probably not practical as far as modeling costs are concerned.



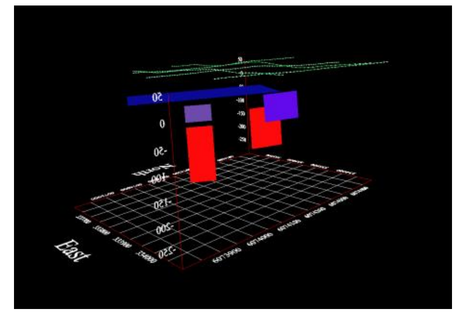

**Decays at 6074235N**

# The Z2 Picks – The model

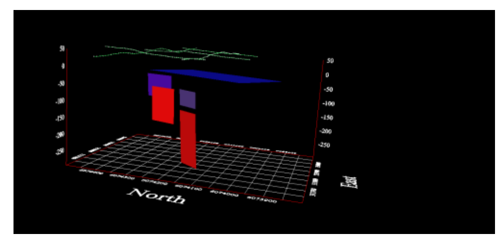
We will now attempt to describe and present our best model to date.




This figure shows a model comprising of 5 parts. The sections of 5 survey lines are shown. Our overburden model is shown in blue. The projection of the 2, Z2_4 models can be seen crossing L1340 but both parts of Z2_5 are difficult to see as a projection.



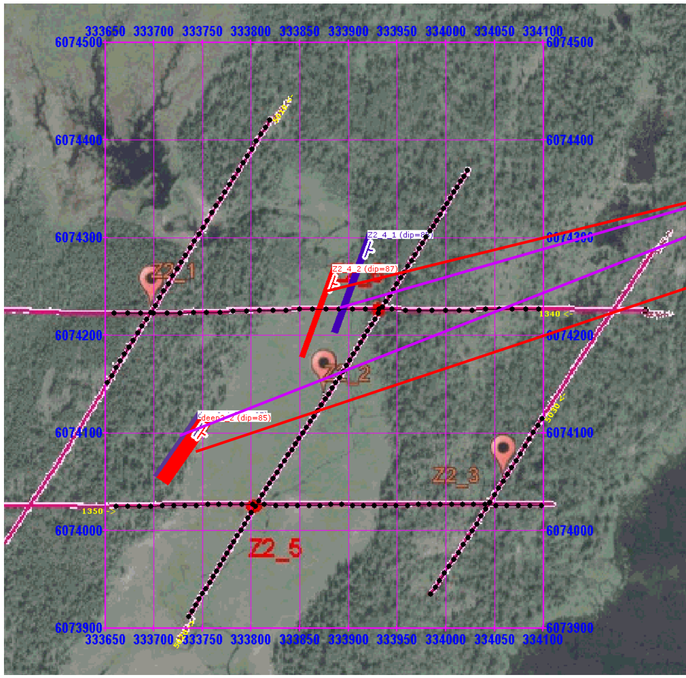
**View of model from East**

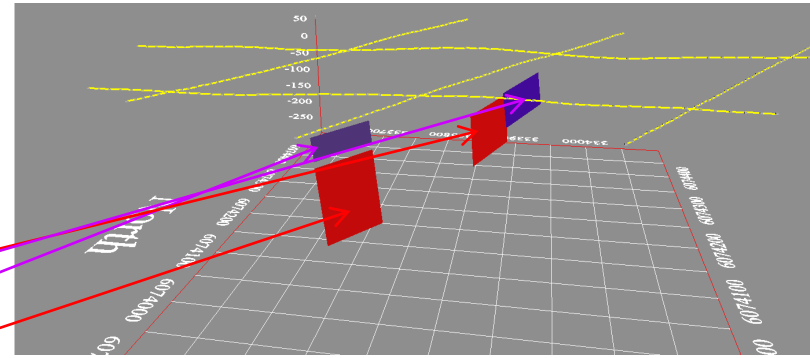


**View of model from West**

# The Z2 Picks – The model

We will now attempt to describe and present our best model to date.



View of model from South

**Conductor Z2_4_shallow**
**Strike: 110m**
**Dip Extent: 80m**
**Strike Angle: 20°**
**Dip Angle: 85° E**
**Conductance: 30S**
**Depth to Top: 30m**
**Position: (333900E, 6074256N)**

**Conductor Z2_4_deep**
**Strike: 100m**
**Dip Extent: 120m**
**Strike Angle: 20°**
**Dip Angle: 87° E**
**Conductance: 200S**
**Depth to Top: 120m**
**Position: (333866E, 607226N)**

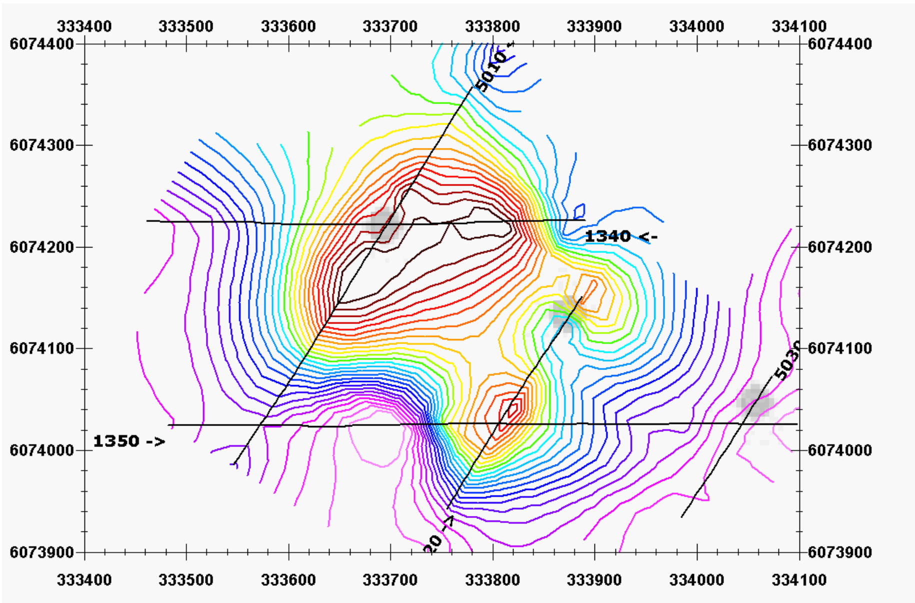
**Conductor Z2_5_shallow**
**Strike: 80m**
**Dip Extent: 50m**
**Strike Angle: 35°**
**Dip Angle: 85° E**
**Conductance: 65S**
**Depth to Top: 55m**
**Position: (333722E, 6074090N)**

**Conductor Z2_5_deep**
**Strike: 80m**
**Dip Extent: 170m**
**Strike Angle: 35°**
**Dip Angle: 85° E**
**Conductance: 200S**
**Depth to Top: 120m**
**Position: (333725E, 6074088N)**

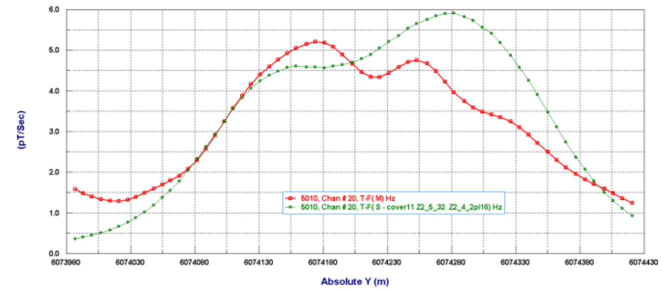
**The 4 parts of the model are shown. The two shallow, weaker conductors in purple and the 2 deeper, more conducting targets in red.**

# The Z2 Picks – Late Time slow decays remote to our model

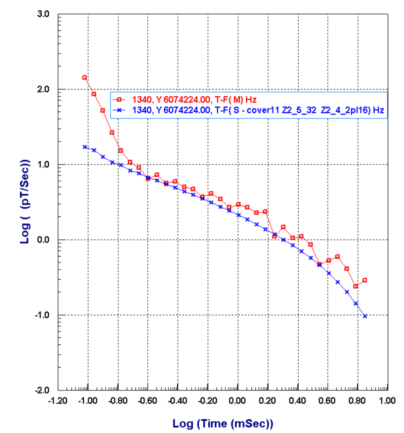
The figure below shows Ch20 contoured with the high response from the shallow Z2_4 omitted. It indicates the broad high, late response on L5010 and on L1340 at the intersection and towards the east. The late time response on L5030 does not show in the display.



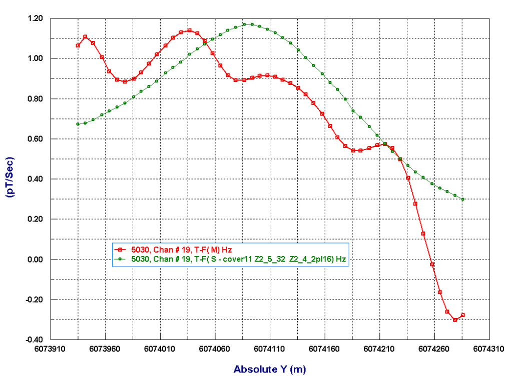

VTEM Ch20




Data vs. Model, L5010, Ch20




Data vs. Model, L1340 just east of intersection with L5010




Data vs. Model, L5030, Ch19

**The combined model to fit the Z2_5 and Z2_4 features does explain to a great extent the conductive features seen in the late time away from these targets but in the immediate vicinity.**

# The Z2 Picks – Comments

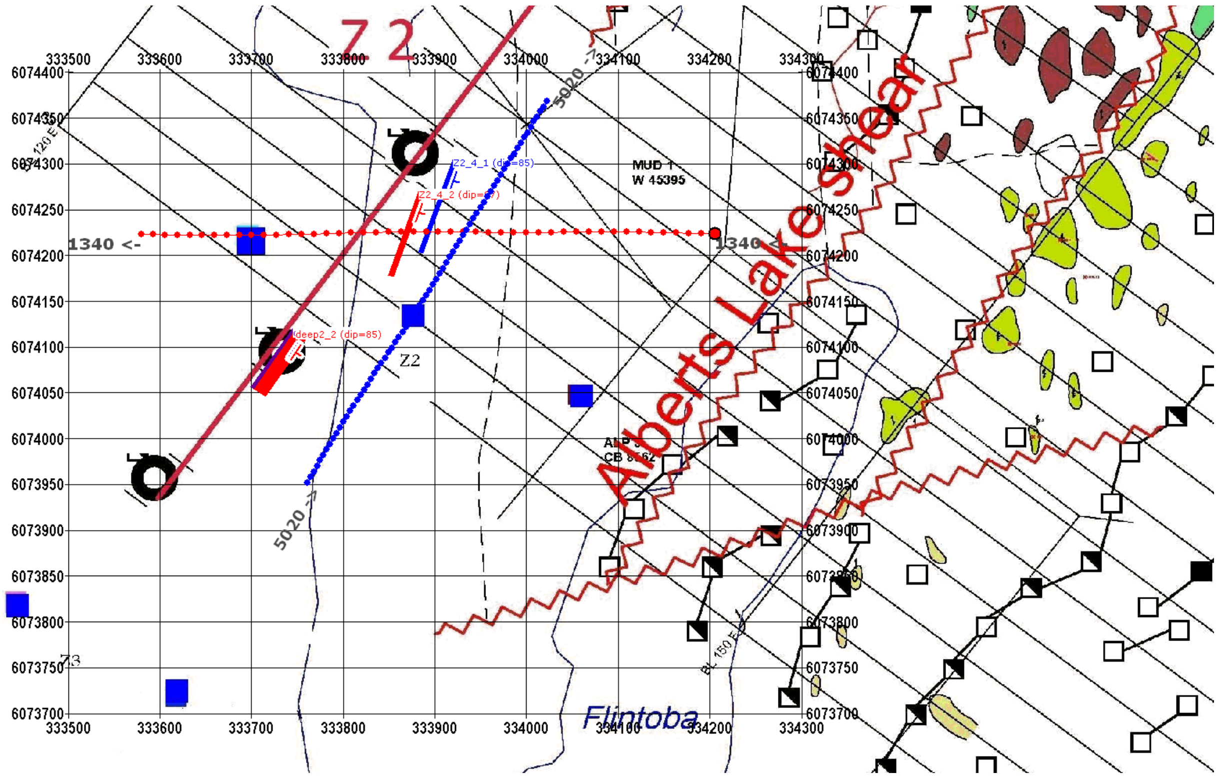
1. **Geotech picks: Generally, we do not understand the position by Geotech of their 3 Z_2 picks. These locations are definitely not the positions of the most interesting anomalies. From our analyses, our best conclusion concerning the Geotech picks is that the late time picks are based upon a fixed array of channels and if these locations also show anomalies in earlier times than the preset channels then these locations are not included in the late time picks. This conclusion would infer that all of the late time picks should be re-evaluated and other anomalies beginning in earlier channels should be determined.**

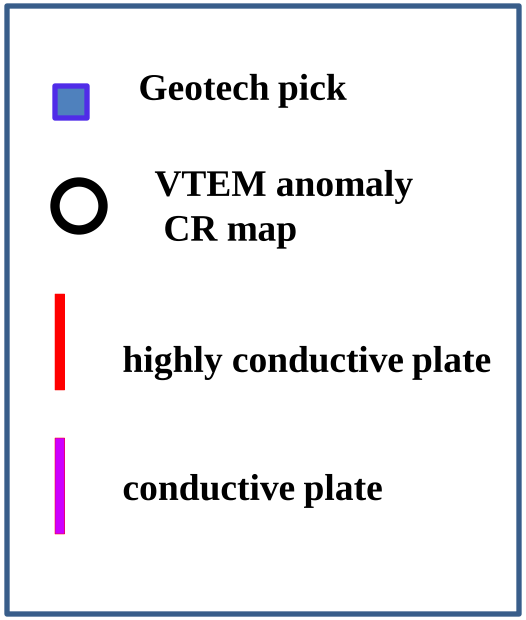
2. **Depth of Resolution: At the 2 Petros picks, Z2_4 and Z2_5, deep very conducting anomalies have been determined. However, the depth of these conductors is at the maximum resolution of the VTEM system. As such, we cannot determined if these conductors are more extensive at depth nor whether there are additional deeper conductors. But, certainly the occurrence of two relatively closely spaced good conductors would indicate a strong possibility of more conductive material at depth.**

3. **Target Resolution and possible Drill Holes: As we have two orientations for the flight lines in this area, we can be more confident of the anomaly positioning. Drill holes could be positioned but again there might be great risk without supporting ground TEM surveys.**

# The Z2 Picks – Relationship to Copper Reef Map

**The Z2 models combined with lines L1340 and L5020 are shown with the May, 2018 map provided by Copper Reef. Locations of the Z picks as found in the Geotech report are also positioned. Two of a line of three black circles from the Copper Reef map are very close to the modeled targets.**

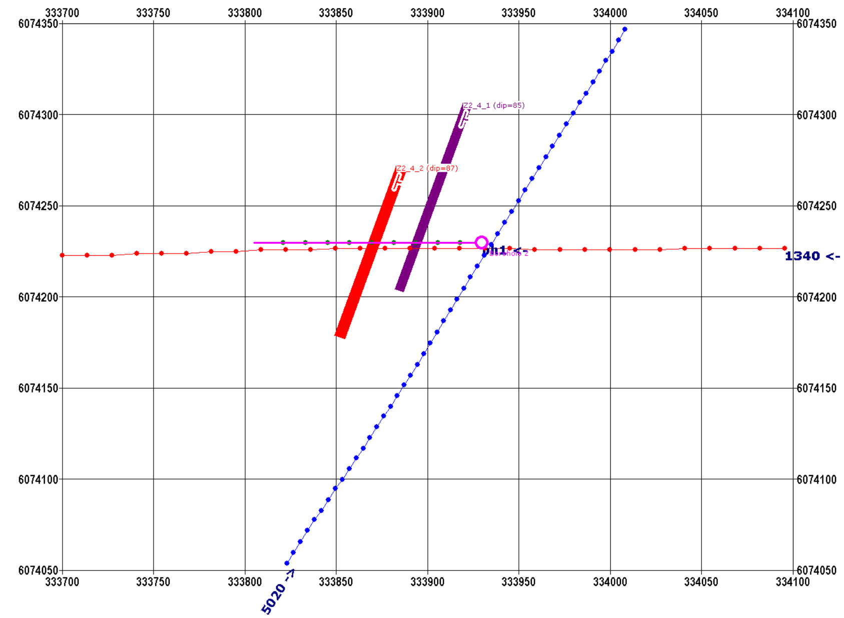


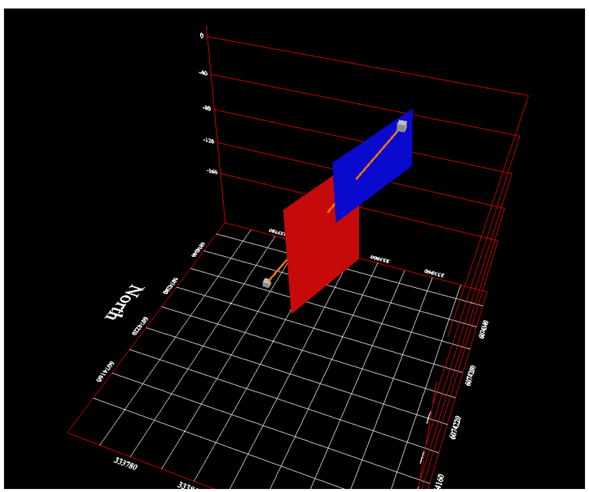



# The Z2 Picks – Possible Drill Holes

1. **Z2_4: We pick a borehole to try to intercept both the shallow and deep conductors.**

**Drillhole 1: Z2-4**
**Depth: 250m**
**Drill Azimuth Angle: -90° (west)**
**Dip Angle: 60° E**
**Collar: (333930E, 6074230N)**

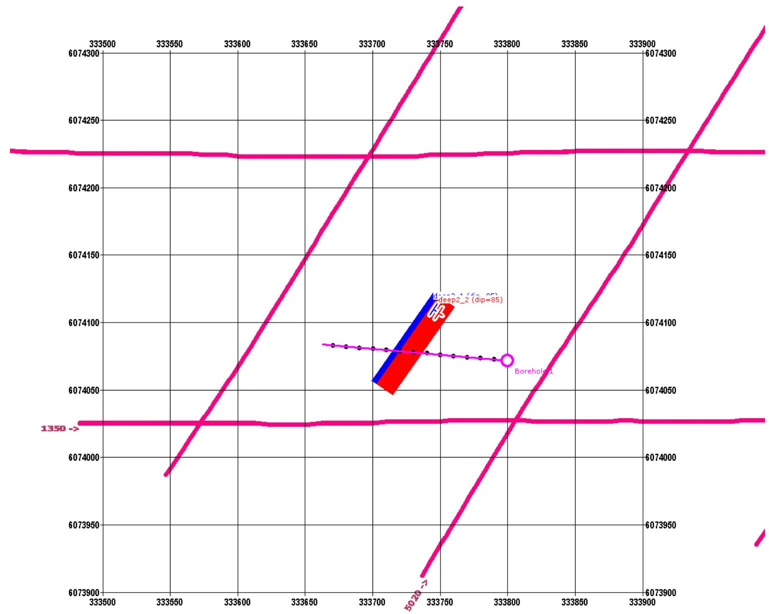


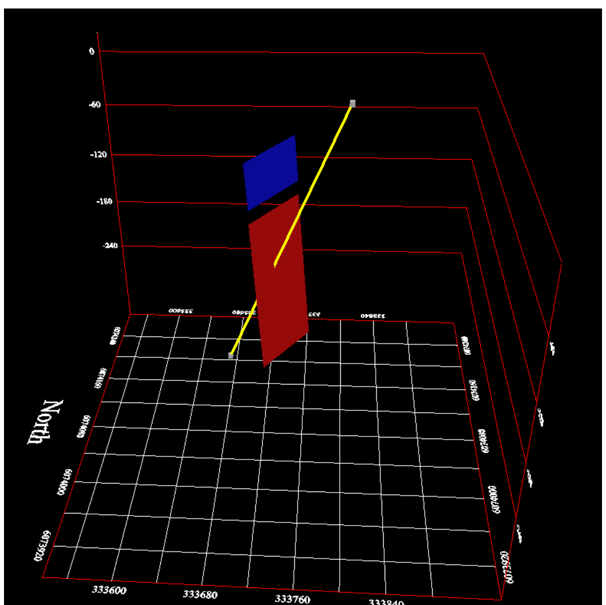



# The Z2 Picks – Possible Drill Holes

1. **Z2_5: In this case, a single borehole can not intersect both the shallow and deep models. Thus, the suggested borehole is only to intersect the deeper more conducting target.**

**<u>Drillhole 2: Z2-5</u>**
**Depth: 275m**
**Drill Azimuth Angle: -85° (west)**
**Dip Angle: 60° E**
**Collar: (333800E, 6074072N)**



# The Z2 Picks – Conclusions

**Clearly, the area of about 500m x 500m contains at least two very conducting zones. Both of the conducting zones are striking approximately 30 degrees east of north and both are topped by weaker conductors. From modeling, the sizes of the conducting zones are not large being slightly less than 100m in strike and at least 150m in depth extent. The two deeper conductors are less than 100m apart.**

**The area is sampled by 5 flight lines, 3 east-west and the other three at 30 degrees east of north. Both the EW lines and the NS lines are approximately 200m apart which leaves a large area of 40,000 square metres only indirectly investigated. Although from the modelling, we have verified that deeper, conductive targets can be seen at some distance along lines immediately proximate to the targets.**

**The magnetic structure of the entire area is such that there is a large gradient in the TMI from NW to SE which almost completely overshadows any local magnetic features. However, removal of the gradient and some Fourier filtering does show that there is a thin, weak magnetic low which comes near surface to which the conductors have some coincidence. If the host rocks are magnetic then shearing stresses can demagnetize the host rocks. Effects of such weathering are not evident in the airborne TEM.**

**The depth extent of the more conductive targets are at the very limit of the VTEM resolution. If there are other deep conductors within this area which do not have a shallow part, will be obscured by the responses of the already identified deep conductors.**

**A relatively small ground survey taking about 2 days would identify things much clearer to ensure the success of any drilling.**

**There are two other anomalies in the area which maybe should be examined, these are the two Z_3 anomalies to the south and one so far unidentified conductor . The other is a pair of closely spaced anomalies also along L5020 about 900m to the NE about 400m from the SW corner of the 2018 VLF grid. These two features are approximately located on the CR May, 2018 map. These features we, so far, cannot find identified in the hundreds of Geotech picks. It is interesting to note that there are now 6 anomalies found along L5020.**

# Analyses of VTEM Z_4 Picks

Revised 04 July 2018

for Copper Reef Mining Corporation
Flin Flon, MB

R.W. Groom, PhD,BMath
Petros Eikon Incorporated

Introduction:
In 2010, several VTEM surveys were flown by Geotech Ltd, Aurora. To the west and south of Alberts Lake, one survey call Big Island was flown in east – west directions and another Alberts Lake was flown at azimuth of approximately 30 degrees east of north. Geotech made a number of late time anomaly picks which were named Z picks.

In this study, we study the area surrounding 4 picks named Z_4.

# Z4 Picks

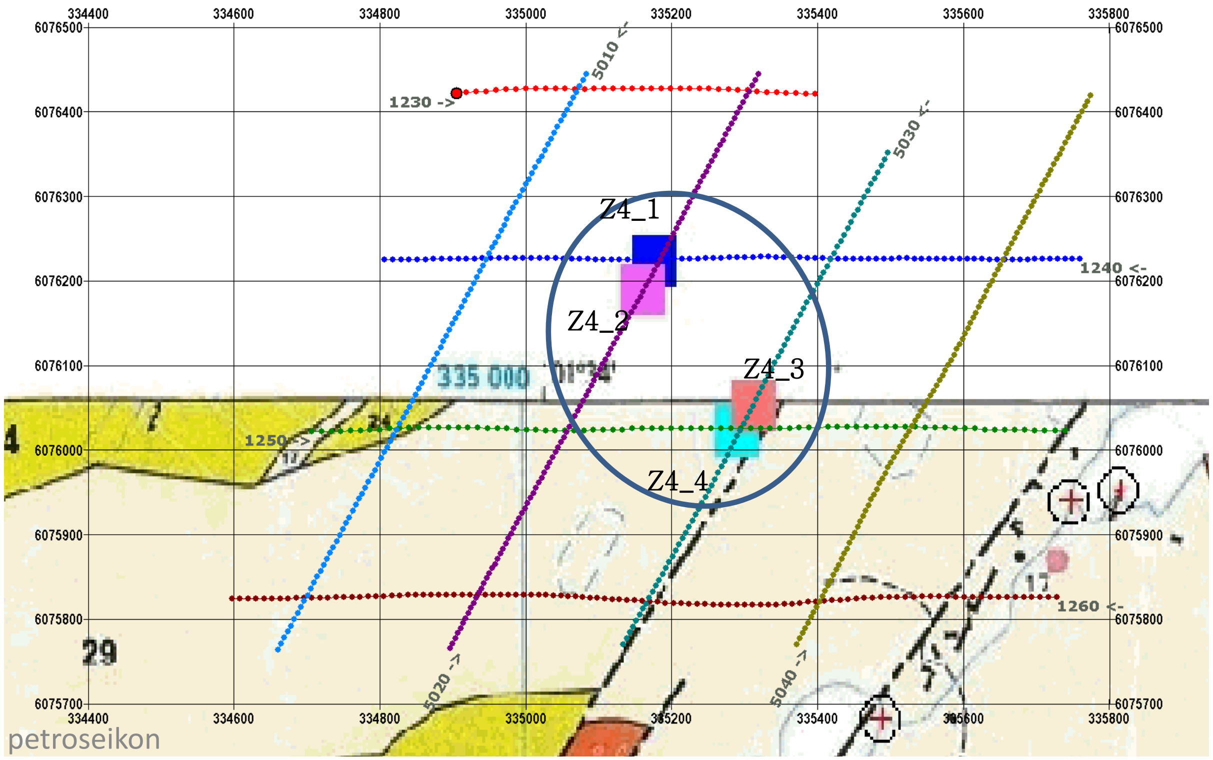
## All Geotech Z# Picks

| x | y | Line | Longitude | Latitude | ID_num | ID | Type | tauSF | pick |
|---|---|---|---|---|---|---|---|---|---|
| 334156.4 | 6076824.1 | 1210 | -101.580770 | 54.811097 | 5 | Z5 | ? | 3.6802 | 99 |
| 336547.4 | 6076227.8 | 1240 | -101.543260 | 54.806528 | 1 | Z1 | PLATE | 2.3770 | 99 |
| 335175.9 | 6076226.3 | 1240 | -101.564580 | 54.806066 | 4 | Z4 | ? | 1.3653 | 99 |
| 334079.1 | 6076028.1 | 1250 | -101.581510 | 54.803925 | 6 | Z6 | PLATE | 4.4769 | 99 |
| 335289.5 | 6076025.8 | 1250 | -101.562700 | 54.804303 | 4 | Z4 | ? | 2.1306 | 99 |
| 336484.9 | 6076029.3 | 1250 | -101.544120 | 54.804725 | 1 | Z1 | PLATE | 1.3384 | 99 |
| 336407.3 | 6075824.1 | 1260 | -101.545210 | 54.802858 | 1 | Z1 | ? | 1.8536 | 99 |
| 334176.7 | 6075826.6 | 1260 | -101.579880 | 54.802148 | 6 | Z6 | ? | 1.2031 | 99 |
| 335162.5 | 6076191.0 | 5020 | -101.564760 | 54.805741 | 4 | Z4 | ? | 0.2086 | 99 |
| 335313.1 | 6076055.8 | 5030 | -101.562350 | 54.804580 | 4 | Z4 | ? | 0.1830 | 99 |

There were 4, Z4, picks made by Geotech. One on each of lines L1240, L1250, L5020 and L5030.

L1240 and L1250 are EW lines and the other 2 lines are SW-NE flight lines (approx 32 degrees east of north)

The analyses question then is to first determine if the picks are valid and then just how many structures are present.




**Z4 picks with portions of VTEM lines and partial geology underlain**

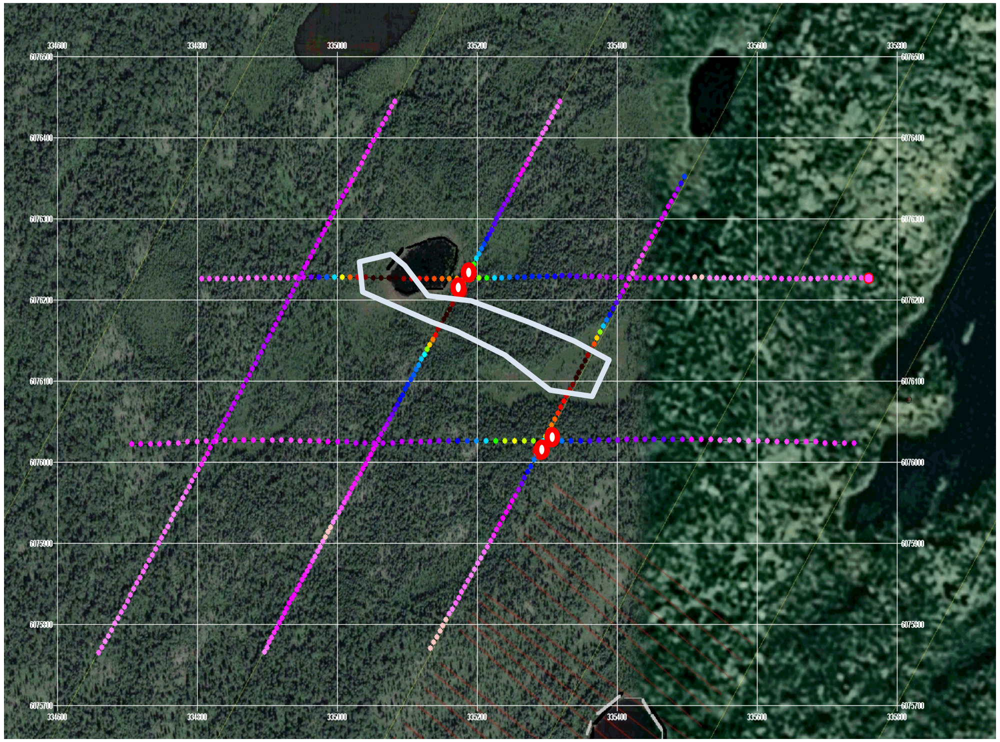
# Z4 Picks

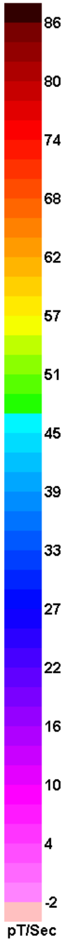
Introduction:

The data in this area pose some problem for interpretation. First, the data is unusually noisy and this is not just for the late time channels. Secondly, we have found it necessary to include into the modeling, the response of the cover as there is strong indication that here, again, we have more conducting material deeper below what would initially appear to be the main conductor.

The data for Ch3 (early time) is shown in its actual position, color coded for amplitude.
- pink can be considered noise
- red-brown largest strength
- strong responses seems associated with features appearing on the satellite map

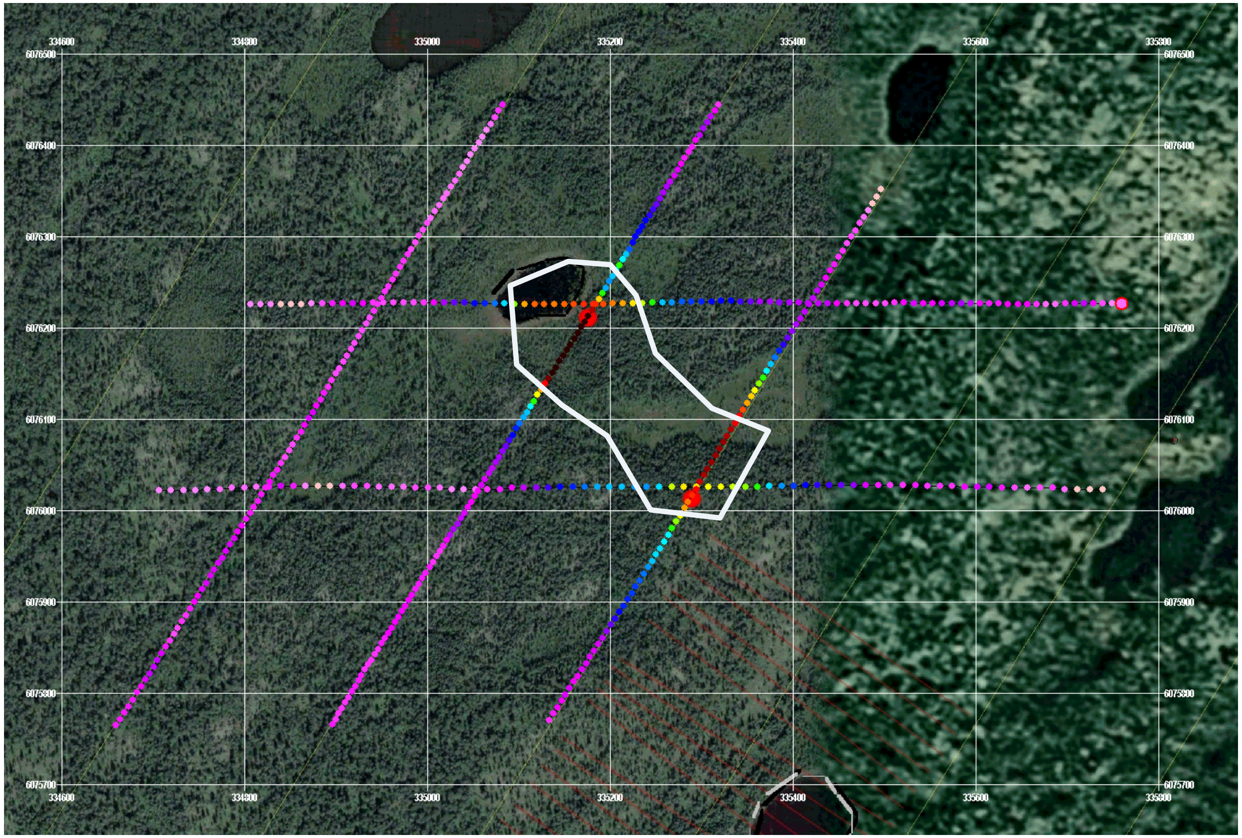
**Z4 picks with portions of VTEM lines at Ch3 and satellite map underlain**

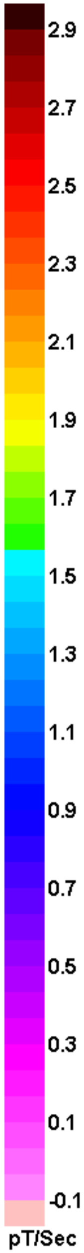




The data for Ch21 (early late time) is shown in its actual position, color coded for amplitude.
- pink can be considered noise
- red-brown is the largest strength
- the strong responses are now located differently than in early time and these late time strong responses only partially relate to VTEM picks
- this again points to the weaknesses in the methodology of Geotech's picks

**Z4 picks with portions of VTEM lines at Ch21 and satellite map underlain**

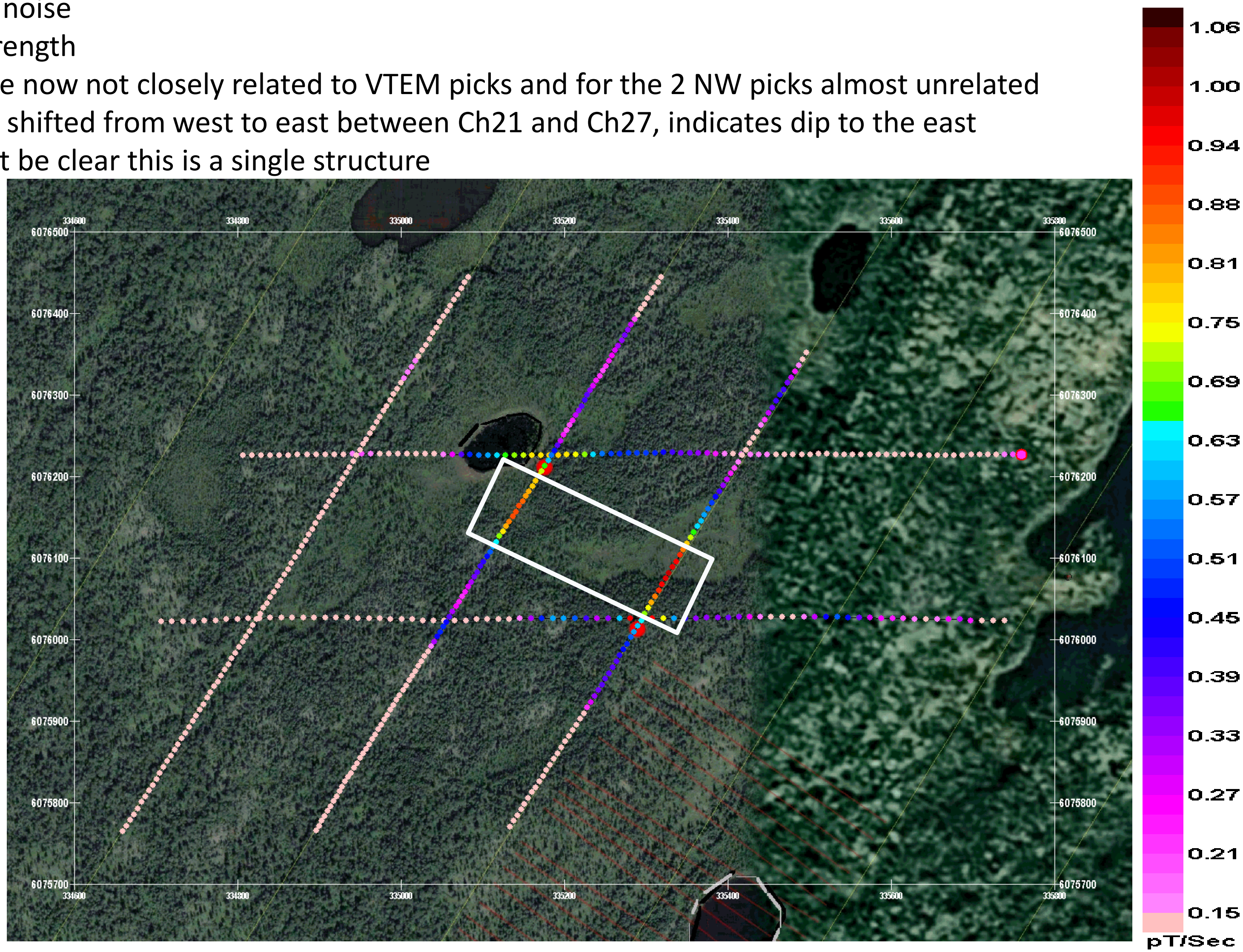




The data for Ch27 (mid- late time) is shown in its actual position, color coded for amplitude.

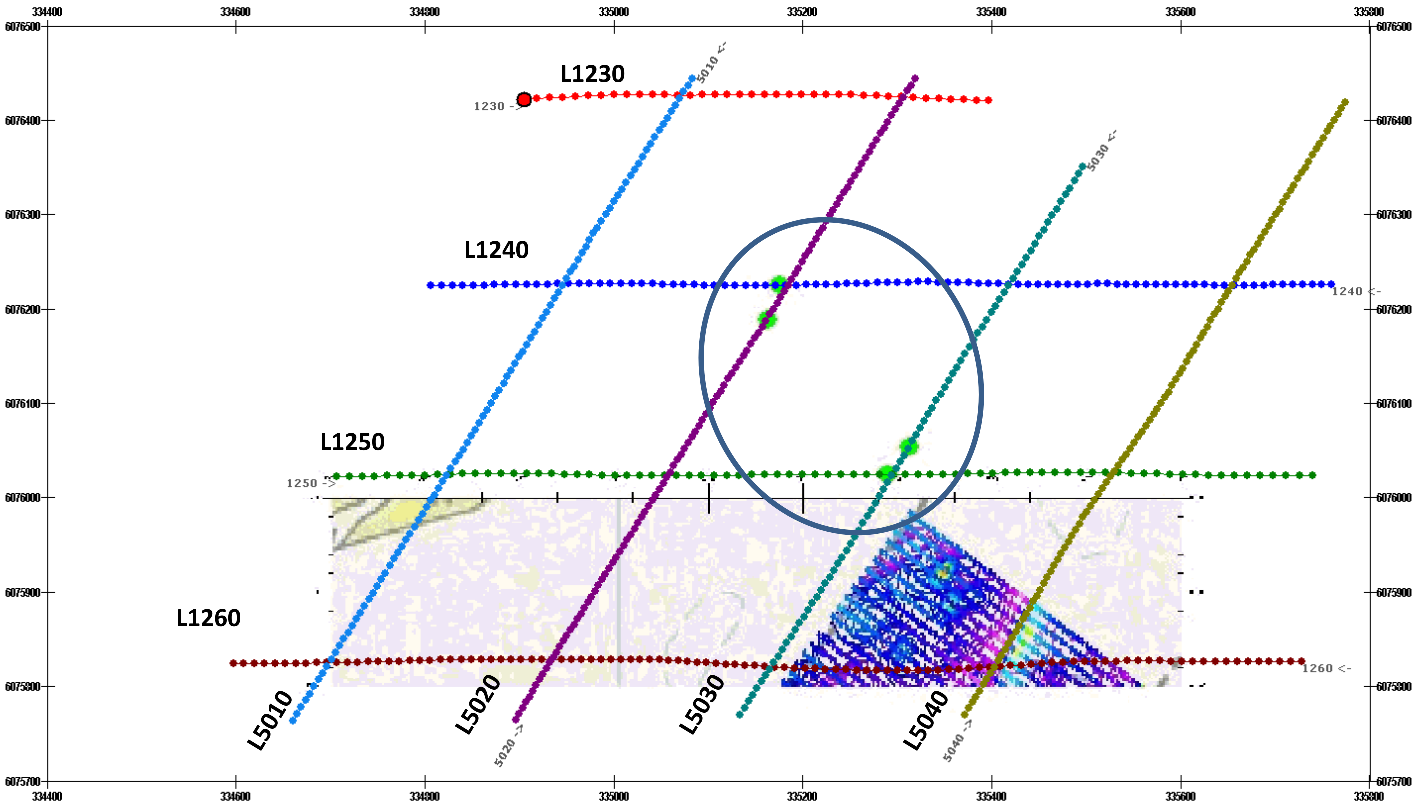
- this channel is almost the latest time with good data but the data in this area is generally more noisy than we have observed for these surveys when studying in detail
- coral pink – definite noise
- red is the largest strength
- strong responses are now not closely related to VTEM picks and for the 2 NW picks almost unrelated
- strongest amplitude shifted from west to east between Ch21 and Ch27, indicates dip to the east
- but again, we cannot be clear this is a single structure

**Z4 picks with portions of VTEM lines at Ch27 and satellite map underlain**



# Z4 Picks

Z4 picks shown as green dots. VTEM flight lines shown.
Northern portion of 2017 ground magnetic survey shown.

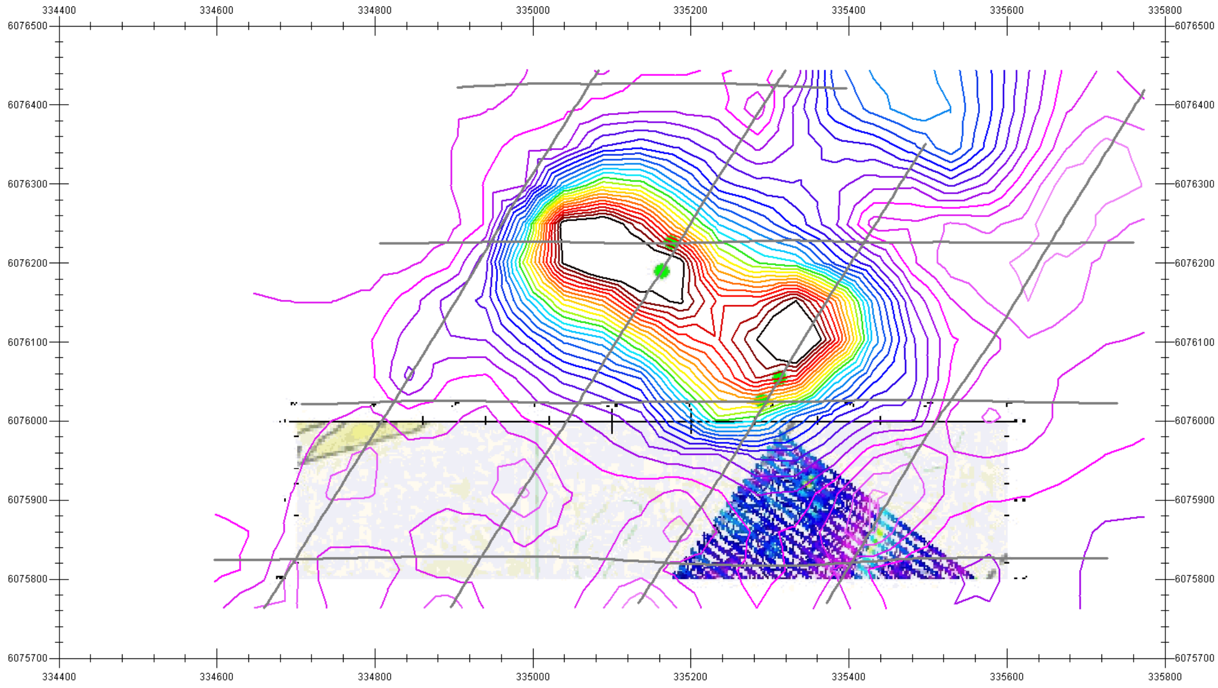


# NW Anomaly

Channel 3. Earliest reliable time channel contoured.

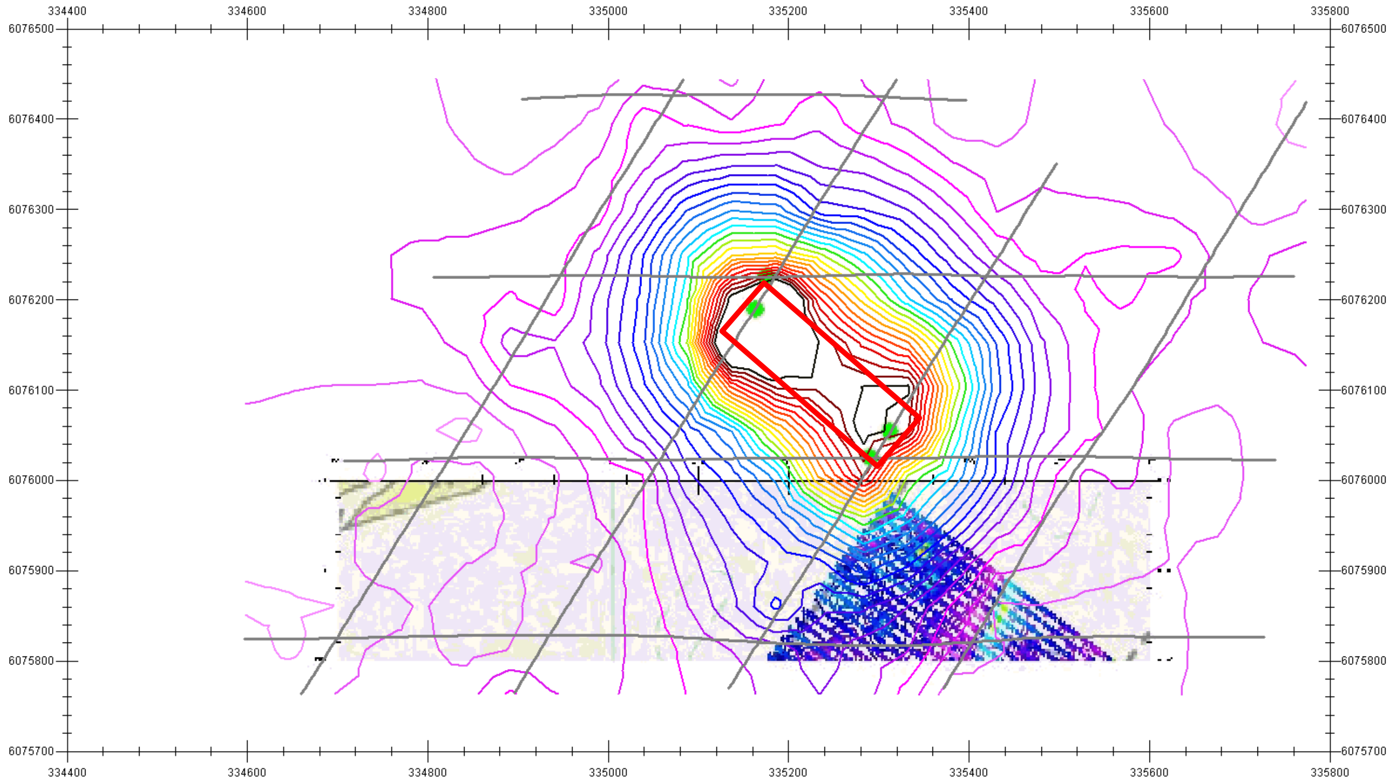
As this interpolation, requires a uniform grid of rectangular cells then the interpolation and subsequent contouring presupposes structure continues between flight lines. This aspect we must keep in context when interpreting grids or contours of the data.

Early time still influenced by surficial features.



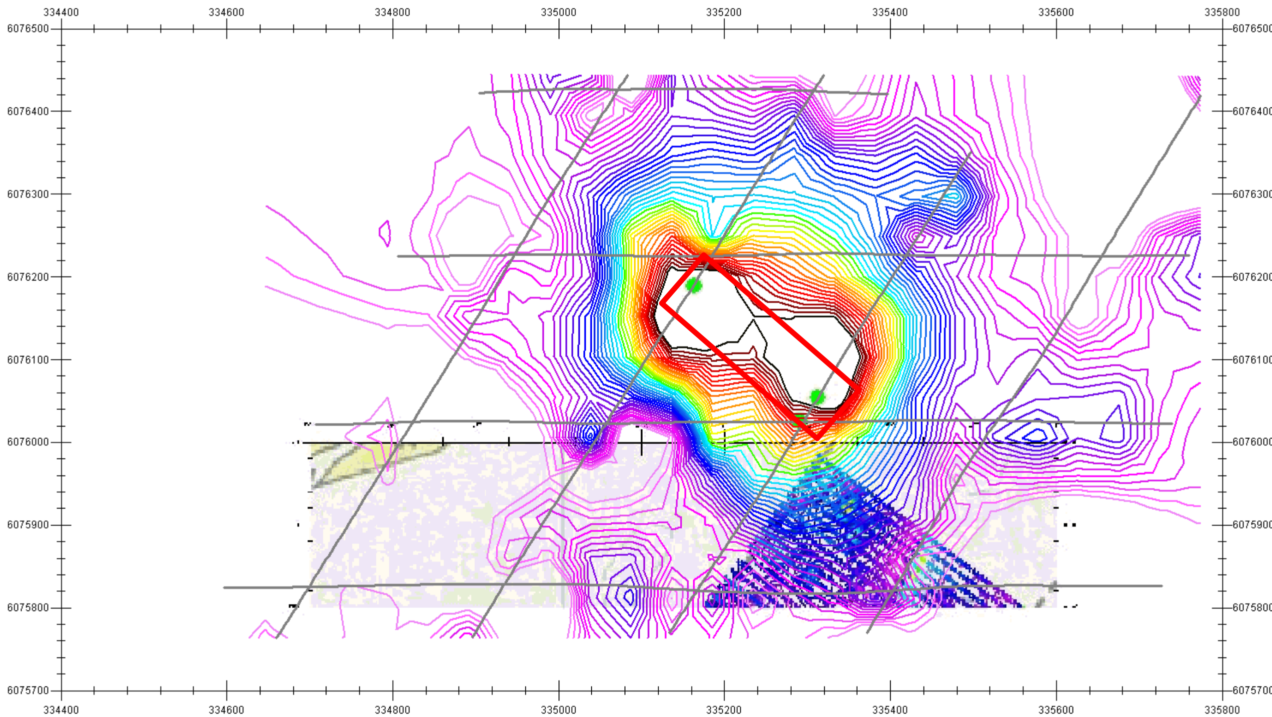
# Z4 Picks or NW Anomaly

Channel 18. Early late time. EM anomaly is decaying uniformly around the Z4 picks indicating the possibility of a single structure.  Initial modeling by a single structure does support a single structure at depth.



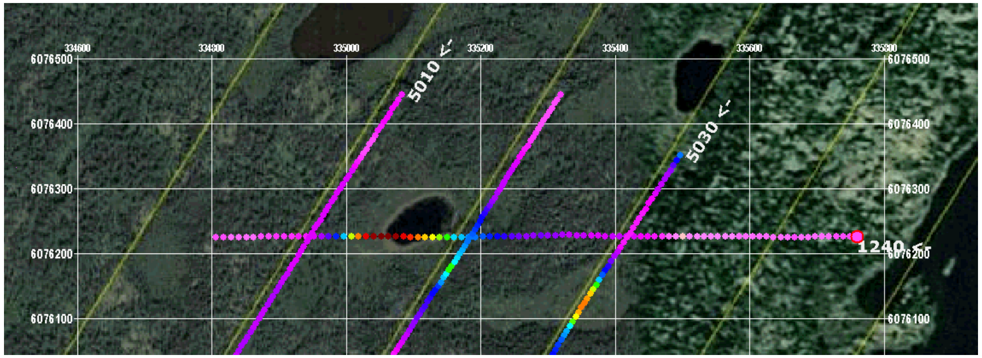
# NW Anomaly

Channel 27. Very late time. EM anomaly still is decaying uniformly around the Z4 picks but the EM anomaly is expanding slightly and no longer correlates well with VTEM picks.

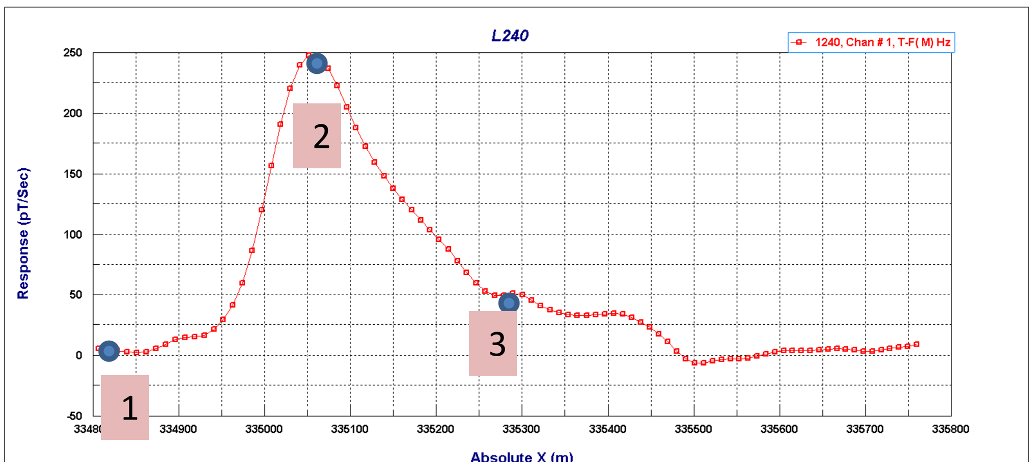


# NW Anomaly – WHY IS THIS ANOMALY SO INTERESTING ?

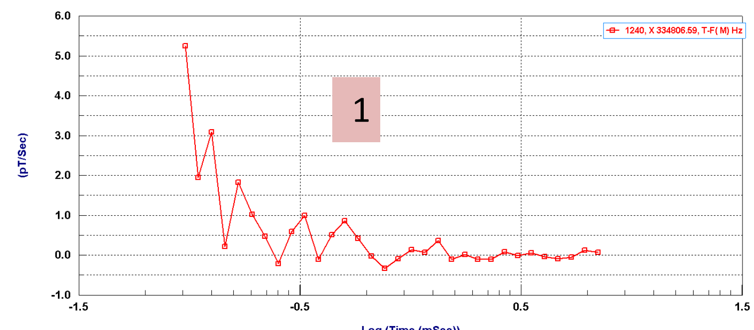
To see this, we have to look at the normal data in this area.




Line 1240 passes on the southern edge of a little pond or lake. The peak response for the first channel is about 30m west of the position of the lake in the satellite image although there appear to be sediments to the west of the imaged lake.




**Ch1, L1240**

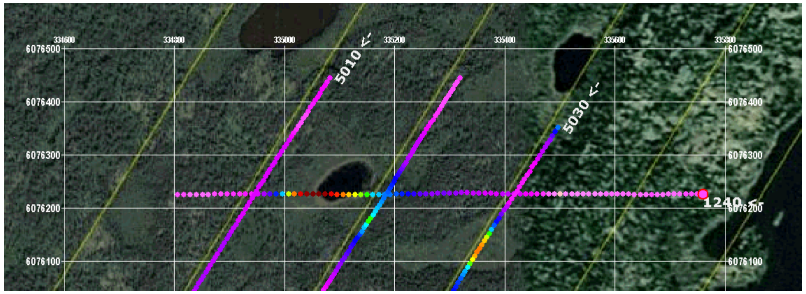



**Decay at location 1**

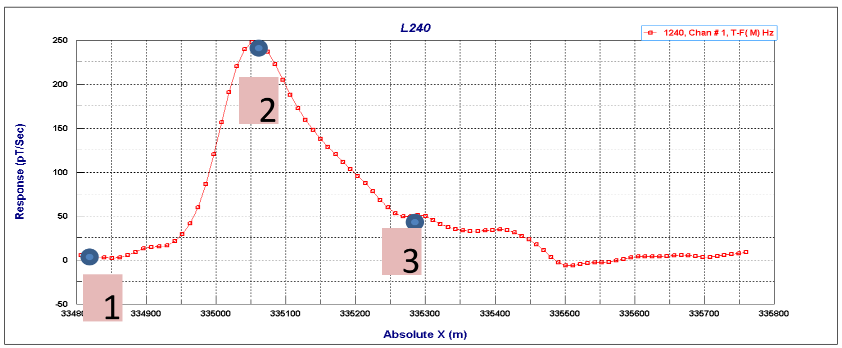
Station 1 on the west end of this line segment, is typical of much of the data over the entire region west and south of Albert's lake. It would be fair to say that there is "no" ground response but this is simply the response of the instrument. The early time data simply being what remains after attempting to turn off the current. VTEM does not provide any ontime data and thus it is not possible to better understand the early time data.

# NW Anomaly – WHY IS THIS ANOMALY SO INTERESTING ?

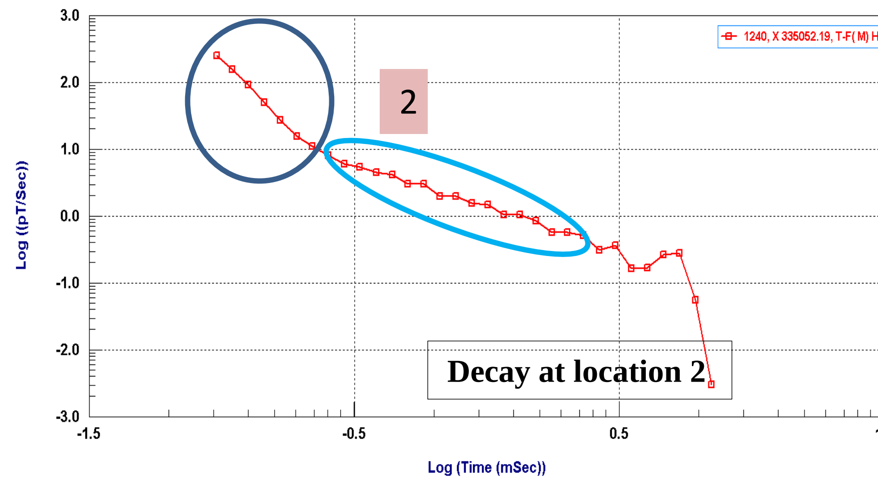
To see this, we have to look at the normal data in this area.




In the plot below, and to the left, is the response for Ch1. the peak is just west of the little lake and drops off slowly to the east.



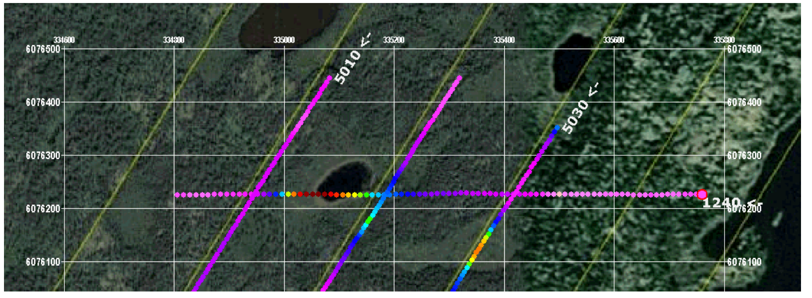

Ch1, L1240

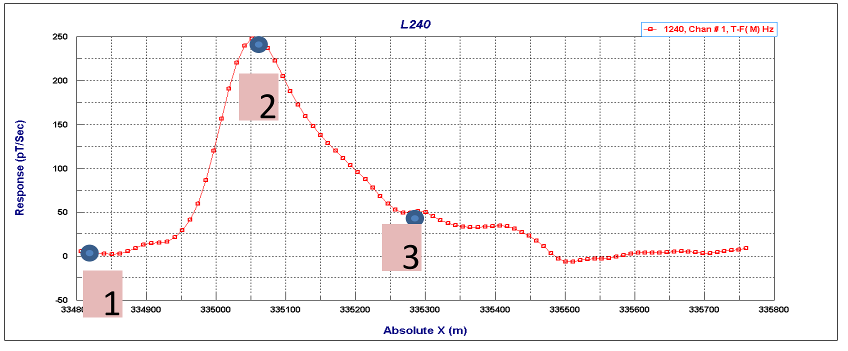



The early time response for Station 2 is typical of the response over ponds and lakes and likely swamps. The response is large enough to produce a clean signal indicating some conductivity but the response drops off (decays) very quickly indicating a weak conductor representative of conducting cover. However, the signal hits a second type of drop off (blue ellipse) and now the decay is quite slow indicating a conductor most likely at depth.

# NW Anomaly – WHY IS THIS ANOMALY SO INTERESTING ?

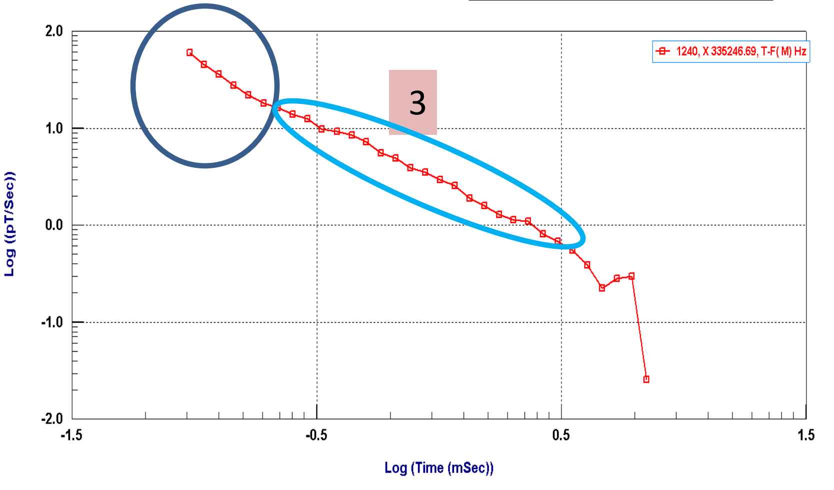
To see this, we have to look at the normal data in this area.



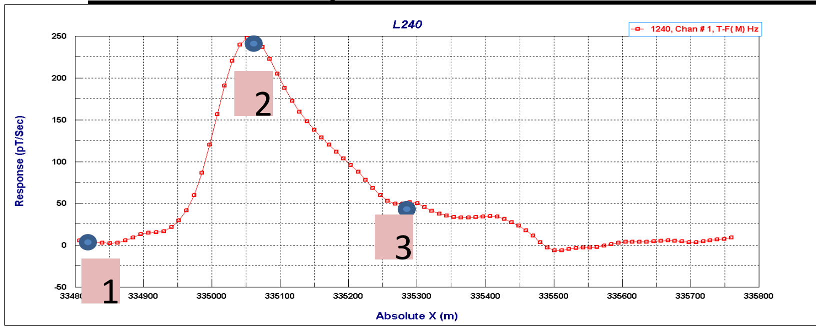

**Ch1, L1240**

**Decay at location 3**

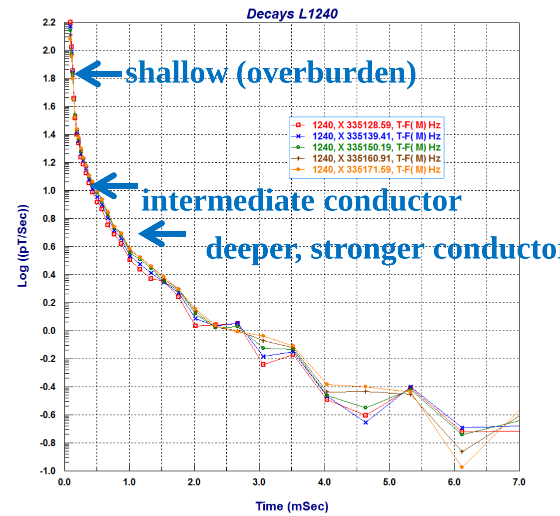


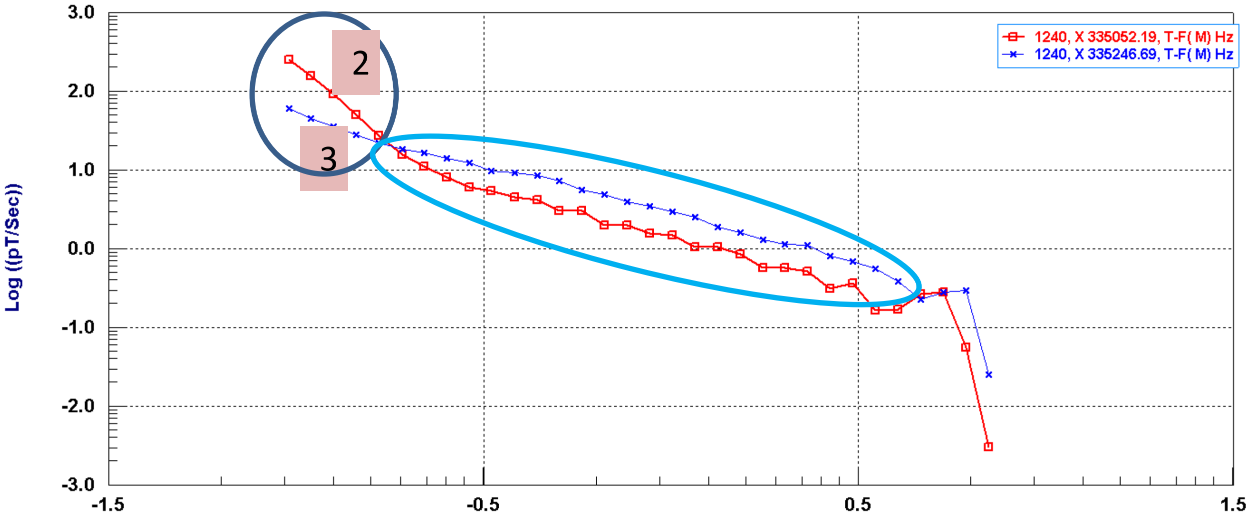

The early time response for Station 3 is not a prominent or long lasting as Station 2 which indicates a less conductive or thinner cover. By, Station 3 we are in area of a Z4 pick but the satellite image indicates still some sort of swamp or marsh. The later decay (blue) is also slow like station 2 but persists longer (next page)

# NW Anomaly – WHY IS THIS ANOMALY SO INTERESTING ?




**Ch1, L1240**



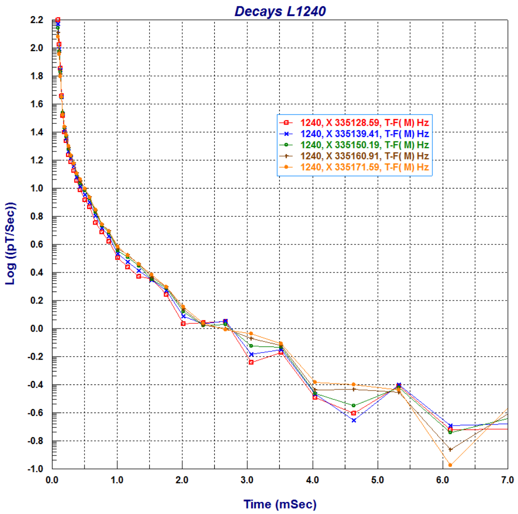

**Decay at location 3 – log(amplitude) vs. time**

**Decays at location 2,3 – log-log**

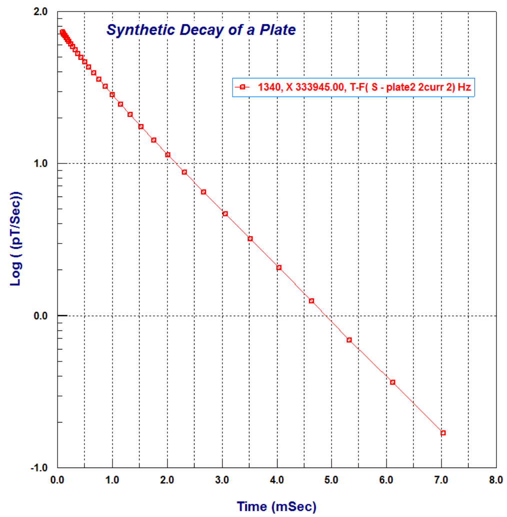
Plotting together, the response over the pond and the response at the Z4 pick, we observe 3 things. First, the cover response at position 3 is much weaker and quicker. Second, the slow decay response in mid- to late-time persists as a clean signal longer at Station 3 beyond that of Station 2. Secondly the amplitude of the slow response and clarity of the late time response is better at Station 3 indicting the structure is to the east of the pond.  But, also the decays at the 2 stations are very similar indicating the likelihood of a single structure.

However, looking at the data in another manner to the right. Here, the response is display as logarithmic vs. the time in linear. Now, we see indications of a deeper more conductive anomaly. Here, we show the decays along L1240 over 50m.

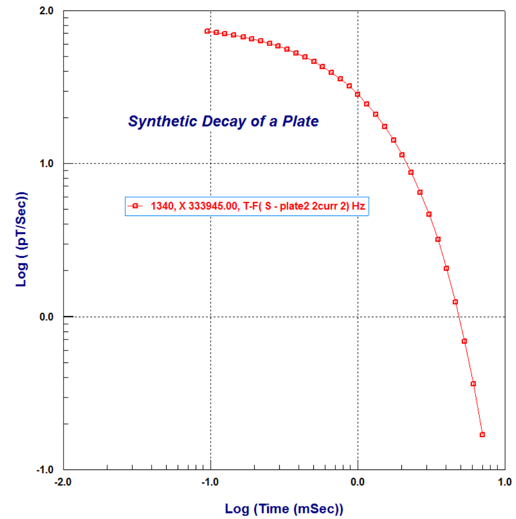
# NW Anomaly – Understanding TEM Decays




**Data decay at location 3 – log(amplitude) vs. time**




**Expected Decay of a single anomaly in log amplitude vs. time**

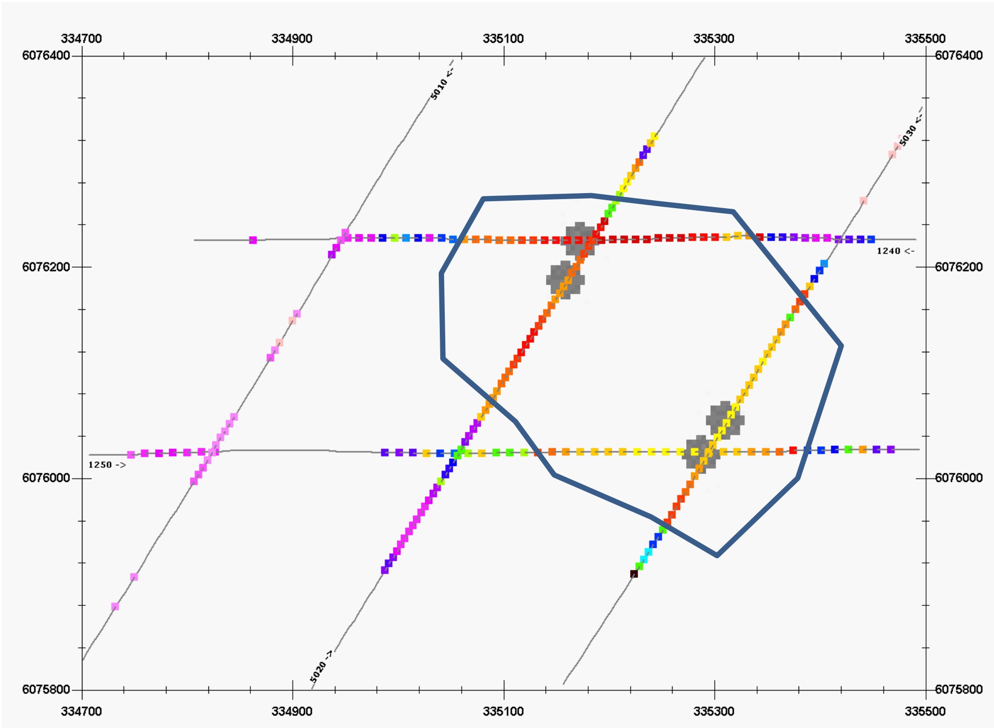


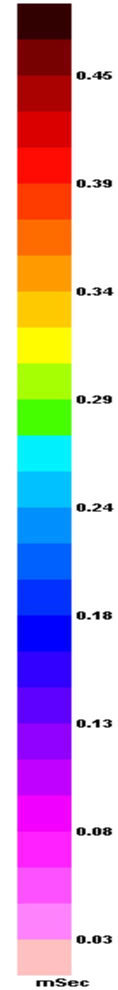

**Expected Decay of a single anomaly in log amplitude vs. log time**

When analyzing the data as decays (amplitude vs. time ), expect the response to be a linear function when displayed as logarithm of amplitude of the response vs. time. This is shown in the central figure above. In log amplitude vs. log time, the expected response has a shape as shown in the figure to the right. We show typical responses over the conductor on L1240 on the previous page for comparison. The log(Ampl) vs. time is shown to the left for immediate comparison.

From this analyzes, we can conclude that there is at least 3 different decays in the data which merge together.

# NW Anomaly – Initial Modeling

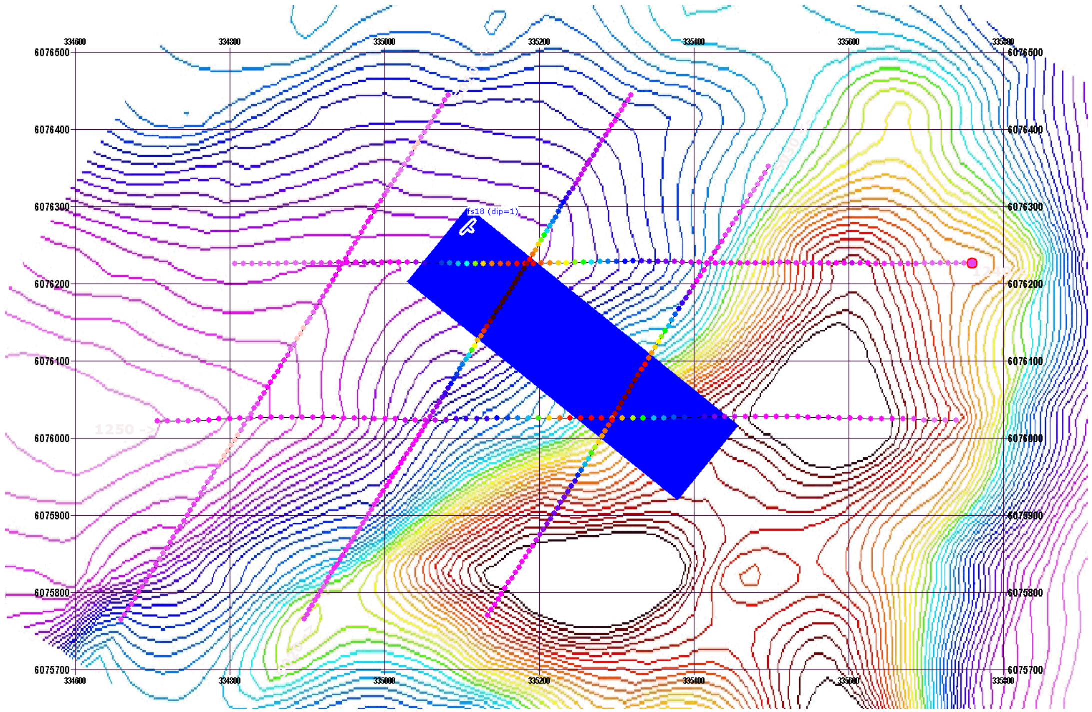



**Decay rates mapped per station. Z4 picks are indicated by grey symbols.**

Another way to indentify good conductors is to analyze the decay rates of the data. Here, we display the decay rate in msec for Chn 7-17 on the 5 lines where the decay rate is displayed as coloured dots according to value. Red is the slowest decay (most conductive) and pink the lowest (least conductive). Data points with no values means than no decay rate could be calculated from the data (i.e.. noise). This gives us reasonable indication of the location of the anomaly.  This a fairly sizeable anomaly if contiguous of about 300x300 m.

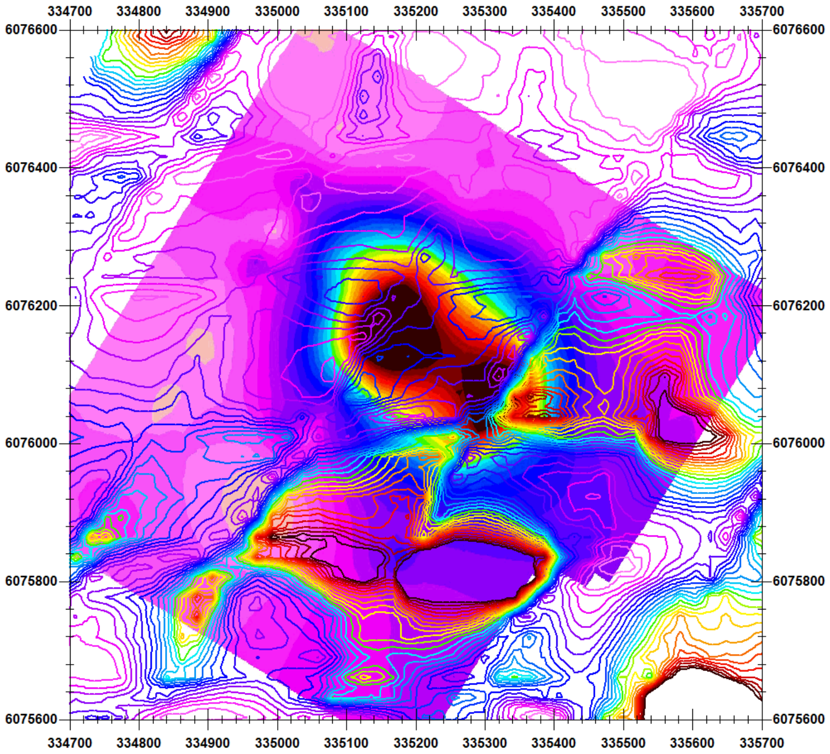
# NW Anomaly – Aeromagnetics




**Aeromagnetic total magnetic intensity (TMI) contoured with the prospective anomaly model displayed in blue.**

Here, we display the model with respect to the aeromagnetic data underlain as contours. It is common to see a VMS anomaly within a magnetic feature but here we see it arising out of a low and moving towards a high.

# NW Anomaly – Aeromagnetics



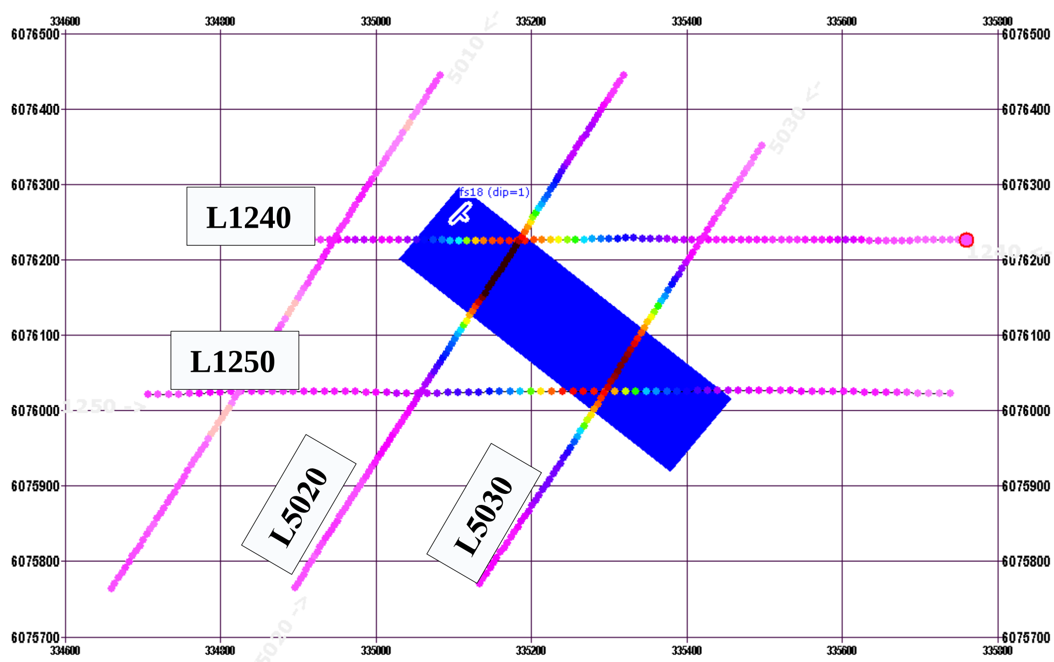

**Vertical derivative (dB/dz) of TMI contoured with the VTEM response at late time as filled contours underlain.**

Here, we display the vertical derivative of the aeromagnetic response with a late time EM channel underlain. Here, it appears that the EM response comes up against a strong signature in the vertical derivative. This is the strongest indication that we can find which relates the EM anomaly to the aeromagnetic response.

# NW Anomaly – Modeling

Two main issues revolve around the modeling:

1. Are the Z4 picks due to one target or two distinct targets
2. Is there more conducting material below the shallower conductor.




NW Anomaly:

Strike: 125m at 44 deg NE

Dip Extent: 400m at 1 deg SE

Depth to Top: 200m

Conductance: 15 Siemens

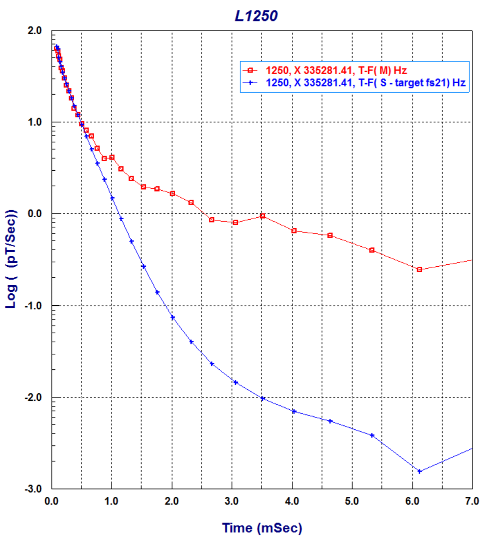
Host: 6000 Ω-m

We have displayed the data at Ch15 of one of our best single target models projected to surface as s single plate model (blue rectangle). However, this model indicates that the structure is not as simple as a single conductor or uniform conductance.

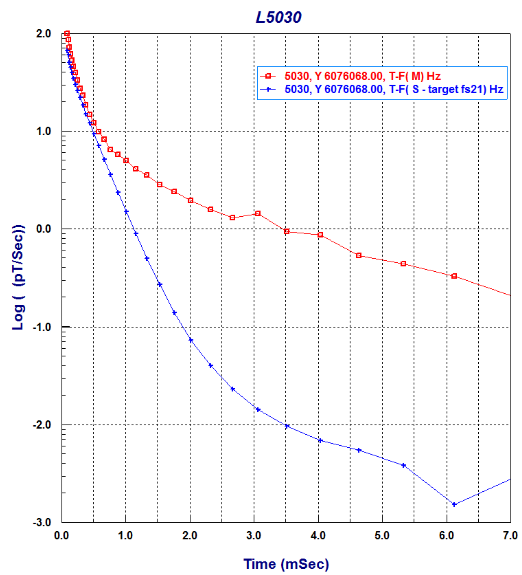
# NW Anomaly – Modeling

It appears that it is only possible to find an approximate single model to match the data over these 5 lines. Yet, the exercise does show us definitively that there is more conducting material at depth. And much less definitively, that there is more than one structure.

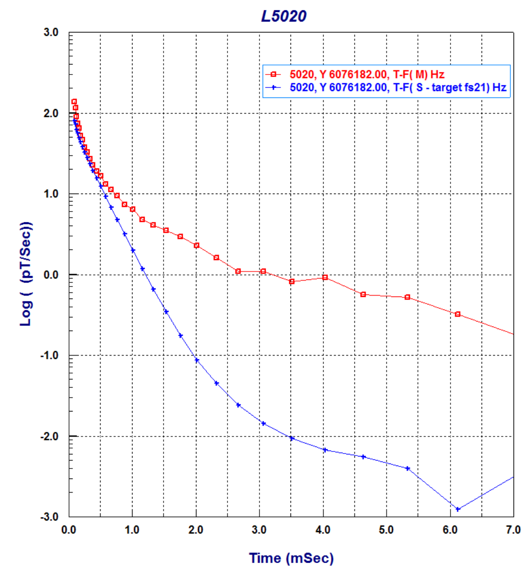
We will show, first, a comparison of the simulated data for this model at the peak responses on L1250, L5030 and L5020.




**Decay of Model at peak of L1250**
**red – data, blue - model**




**Decay of Model at peak of L5030**
**red – data, blue - model**

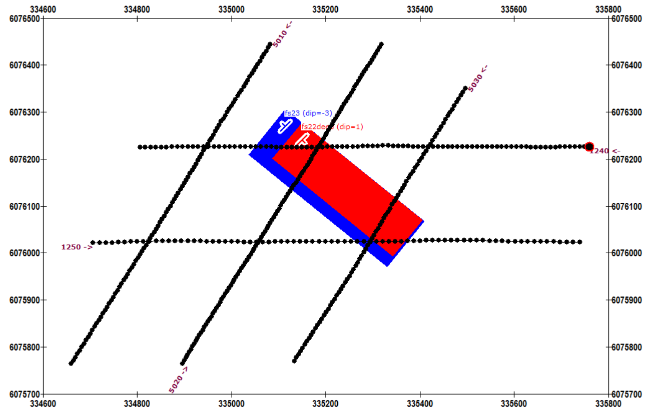



**Decay of Model at peak of L5020**
**red – data, blue - model**

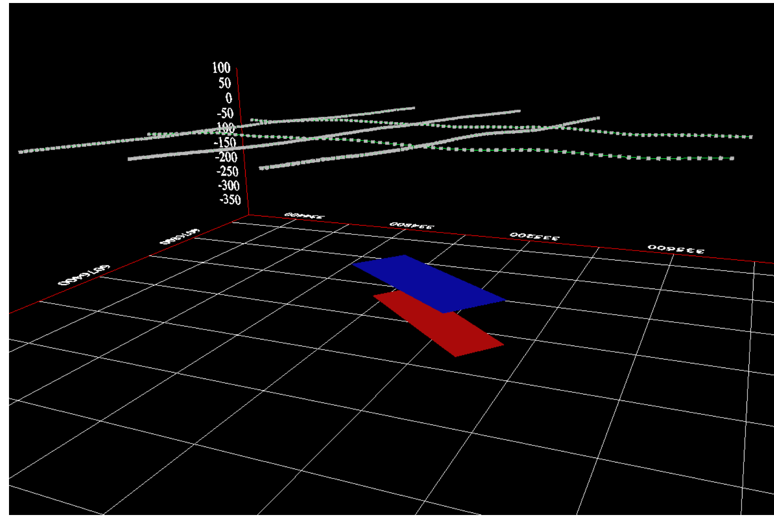
It is very obvious that the model fits the data very well to about Ch14. The early time data on L5030, is affected by some surficial material. However, after channel 14, the model response decays too quickly which indicates that the late time data is due to more conductive material. While, the response on L1250 is a little noisy after Ch14, the data on L5030 is clean until at least ch23. The comparison on L5020 is similar to L5030 except that the data quality is somewhere between that of L1250 and L5030.

# NW Anomaly – Modeling

It appears fairly clear that there is more conductive material below the rather weak conductor shown previously. Finding a 2 target model to exactly fit the response on 4 lines would be a very time consuming task. However, we have done some modeling to find a simple 2 target model that represents much of the response on these 4 lines.




Deep conducting target projected on top




View from south east

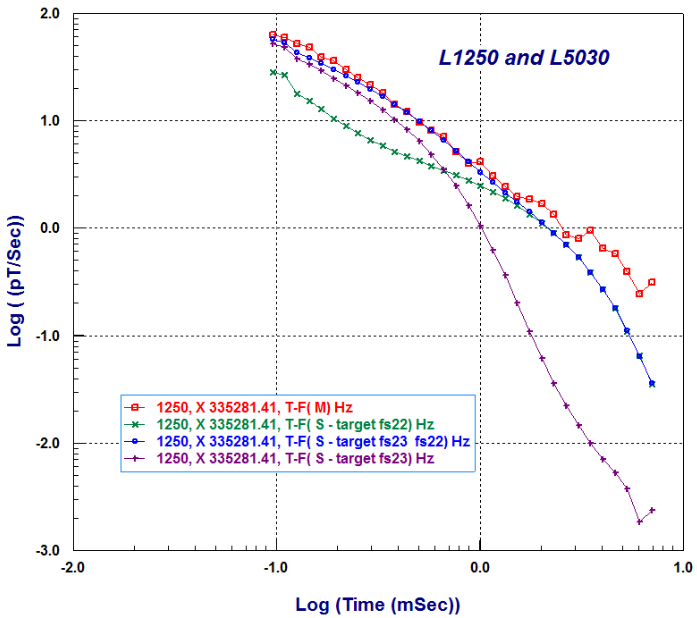
**Shallow Target**
strike Length: 125m
strike Angle: 44 deg east of north
dip Extent: 380m
dip Angle: 3 deg to NE
depth to top: 220m
conductance: 15 Siemens

**Deep Target**
strike Length: 100m
strike Angle: 44 deg east of north
dip Extent: 330m
dip Angle: 1 deg to SW
depth to top: 300m
depth to bottom: 400m
conductance: 100 Siemens

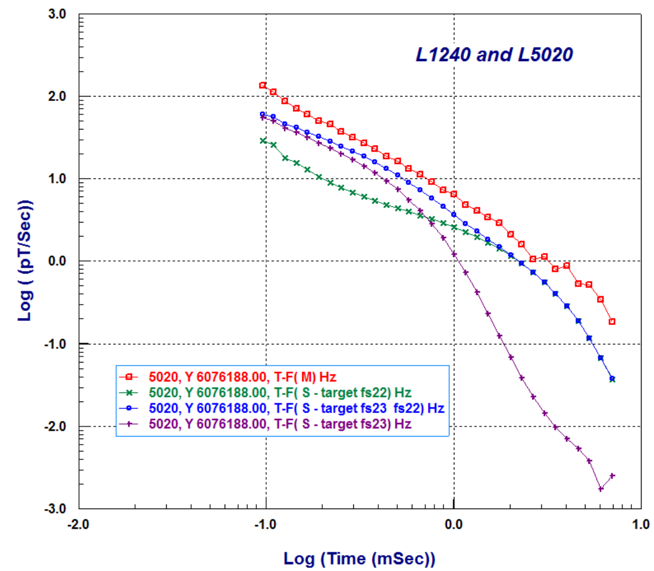
It is very obvious that the model fits the data very well to about Ch14. The early time data on L5030, is affected by some surficial material. However, after channel 14, the model response decays too quickly which

# NW Anomaly – Modeling

To show the influence on the simulated response of the parts of the combined target, we show the decays near the 4 original Z picks. In the figures below, the data is shown in red while the response of the shallow target only is given in purple, that of the deep, more conducting target in green and the combined response in blue. The model decays at the other significant line intersection near the placement of the 2 NW Z4 picks is not as satisfactory. This, we believe is primarily due to the model for the shallow material which points to either a simple 2 target model is not satisfactory in this case or the effects of the surficial cover.




**Intersection of L1250 and L5030**
data: red, shallow only: purple,
deep only: green, combined: blue

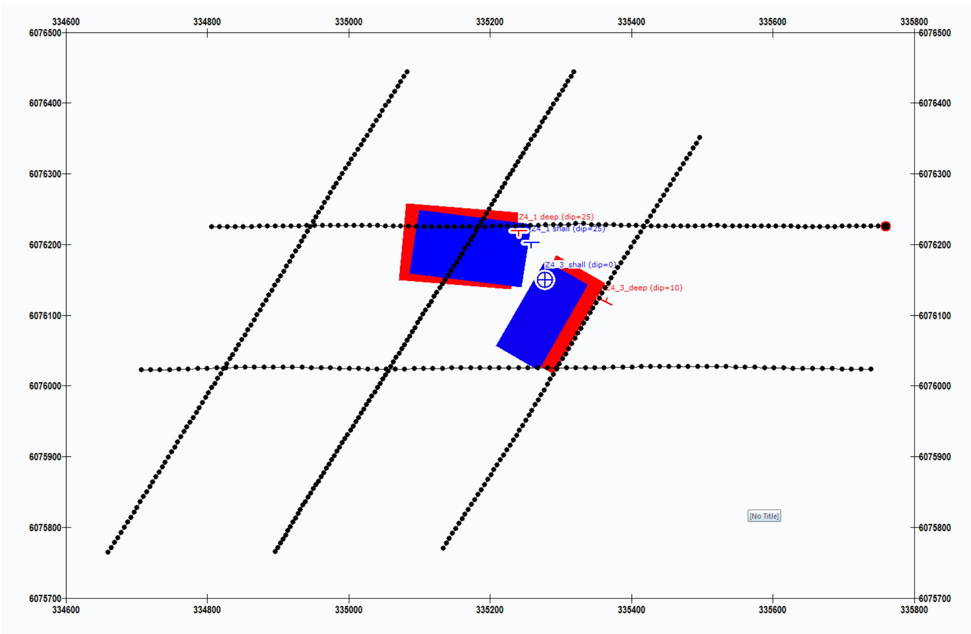



**Intersection of L1240 and L5020**
data: red, shallow only: purple,
deep only: green, combined: blue

The combined response and the deep response are possibly still a little troubling in late time. It is possible that there is an even deeper portion of the anomaly which provides data which is quite noisy but then again, the last 9 or 10 channels may just be noise. To determine the quality of the data in these late times requires some calibration work. A ground TEM survey would provide the necessary data to calibrate and thus possibly allow deeper analyses of the VTEM data over all survey areas.

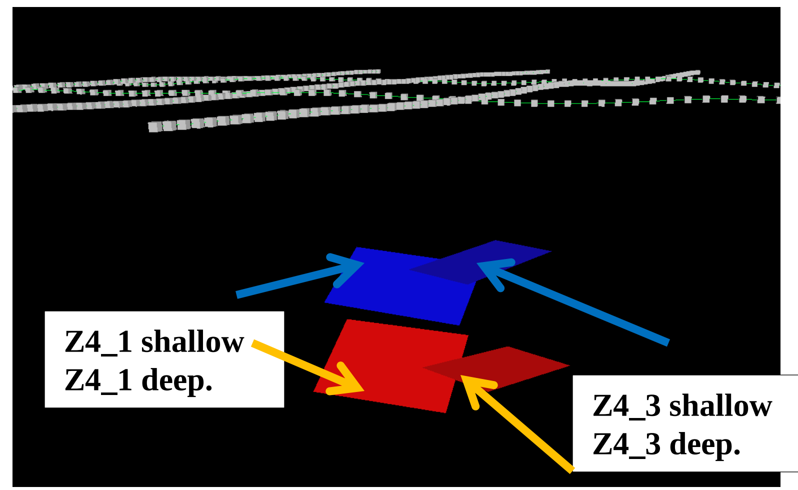
# NW Anomaly – Modeling

We have also attempted to model the NW picks separately from the SE picks to try to determine if these are two completely distinct targets. For this exercise, after getting a preliminary model of the surficial structure to understand its importance, we did not continue applying a superficial model in the further exercises. In this scenario, there are 4 plates. Two plates primarily are responsible for the NW anomaly in this area ( Z4_1, Z4_2) and the other two plates for the SE anomaly (Z4_3,Z4_4) although each individual plate also partially affects the response in the other area.



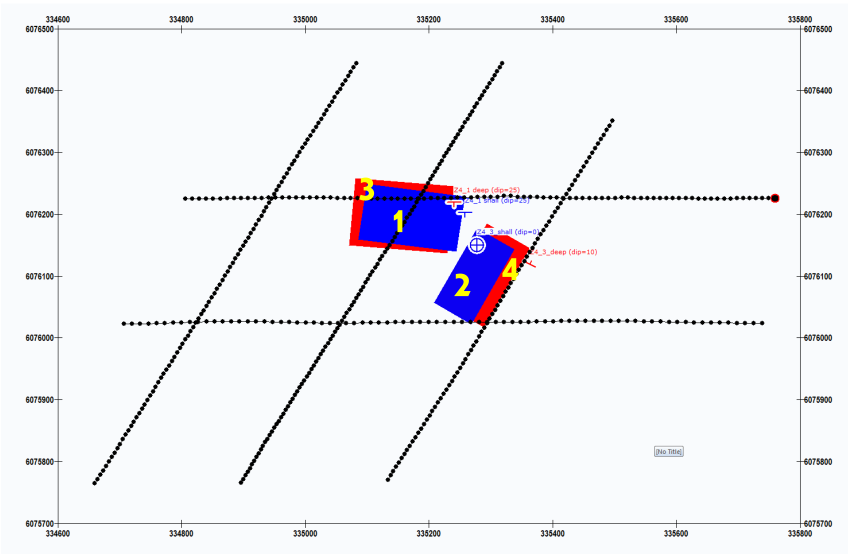

**Model Type 2: Z4_1 and Z4_3 shallow and Z4_1 and Z3_2 deep.**

In both cases, the blue plates are shallow and only moderately conductive while the red plates are much more conductive and deeper.



# NW Anomaly – Modeling

The details of each plate in the model are given below.




1
**Z4_1 shallow:**
strike Length: 160m
strike Angle: E-W
dip Extent: 100m
dip Angle: 25deg to south
plunge: 8 degrees to SE
depth to top: 150m
conductance: 15 Siemens

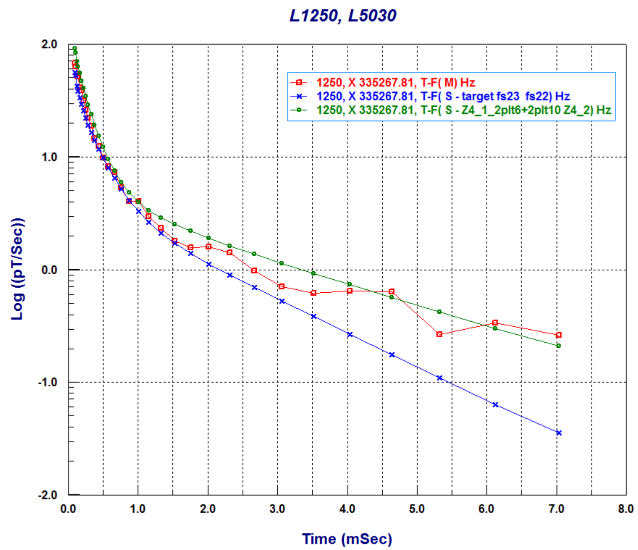
2
**Z4_3 shallow:**
strike Length: 140m
strike Angle: 30 deg east of north
width: 70m
depth to top: 115m
conductance: 20 Siemens

3
**Z4_1 deep:**
strike Length: 160m
strike Angle: E-W
dip Extent: 120m
dip Angle: 25deg to south
plunge: 5 degrees to SE
depth to top: 250m
conductance: 200 Siemens

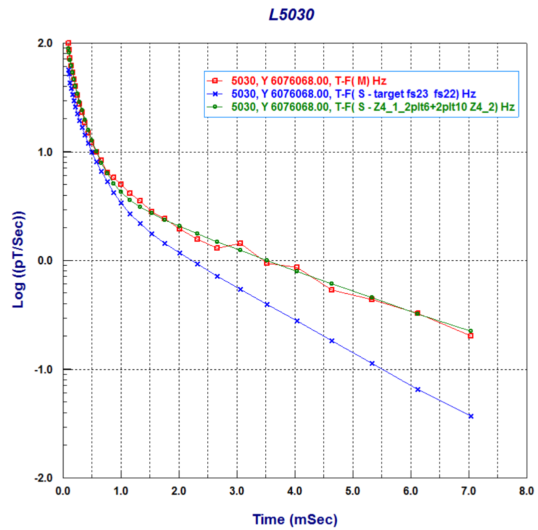
4
**Z4_3 deep:**
strike Length: 80m
strike Angle: 30 deg east of north
dip Extent: 150m
dip Angle: 10deg to south east
depth to top: 215m
conductance: 200 Siemens

# NW Anomaly – Modeling

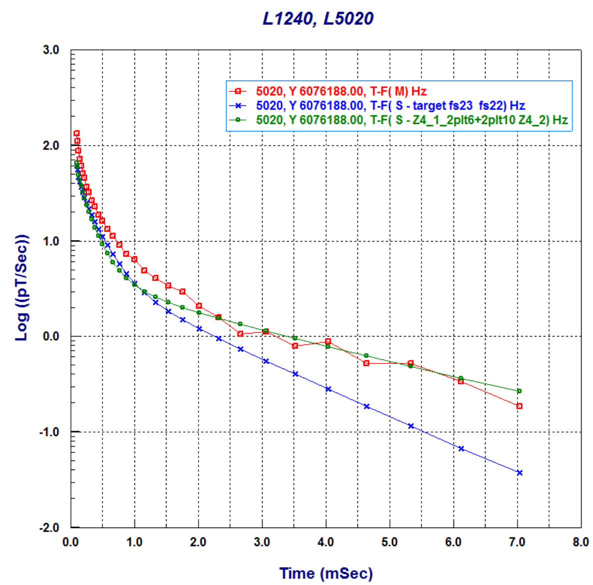
There are benefits to both model types ( 2 plates and 4 plates) but in general the 4 plate is easier to fit the data. We show examples below




**Intersection of L1250 and L5030**
data: red, blue: 2 plate model, green: 4 plate model

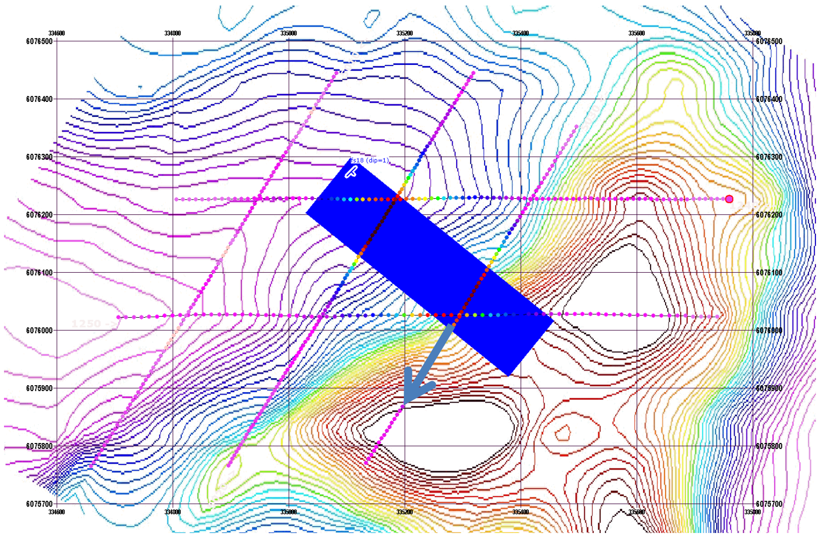


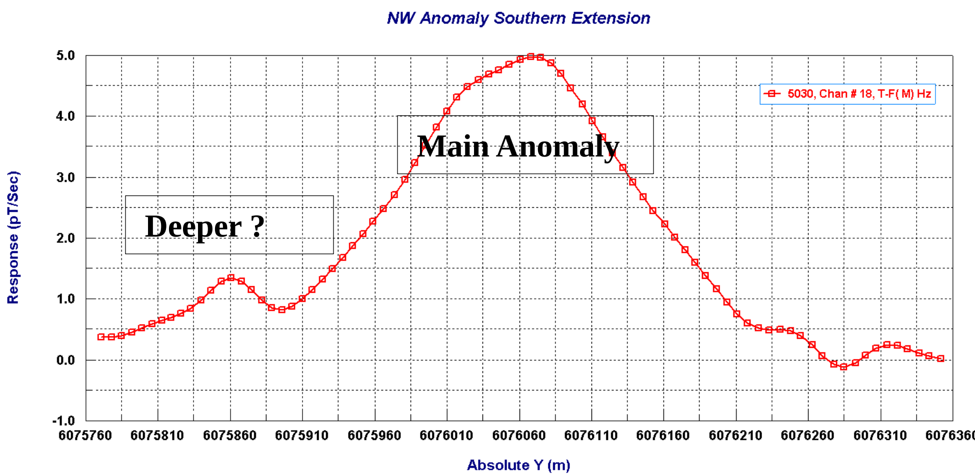

**L5030 peak**
data: red, blue: 2 plate model, green: 4 plate model




**Intersection of L1240 and L5020**
data: red, blue: 2 plate model, green: 4 plate model

# NW Anomaly – Evidence of Southern Extension






There is some evidence of a southern extension of this conductor down onto the NW portion of the LL VLF grid and also into the heart of the magnetic high.

This extension appears to be only visible on L5030 and shows up only very late in time (Ch18) and thus is considerably deep.

We plot, below, the vertical VTEM response at Ch18 and see the eruption of a small blip at 6075860 North.

This anomalous response migrates south with time before disappearing. This might indicate a conductor plunging south and deeper.

But, as this feature appears on only line with a suggestion on the southerly EW line (L1260), it is difficult to specify its characteristics with any certainty. Only ground TEM would verify its existent or not.

# Conclusions and Recommendations

There appears no question that there are two zones of conductive material within this small area bounding the initial Z4 picks. There is also no question that there is more conductive material at depth at the very limit of the ability of the VTEM system to resolve a conductor. Whether, the two zones are connected is still an outstanding question.

But, most importantly we have two models which both explain the data to a great extent. The models have many aspects in common but also differ in several important aspects. As such it is difficult, as was expected, to produce a single unified model for the two AEM data anomalies which are separated in their locations by a distance of 200m.

These issues combined with the possibility that there may be deeper conductive material out of reach of the VTEM system would strongly suggest that a ground 3-component time domain EM survey be carried out. As it will be difficult to separate the shallow surficial responses from the intermediate moderate conductor and the deeper stronger conductor, it is suggested that a TEM transmitter with a very controlled turn-off be utilized. It will be also important to utilize receiver coils with as high a bandwidth as possible.

# Priorities

| Anomaly Name | X | Y | Number Targets | shallow | | | | | deep | | | | | Priority |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | depth | strike(m) | dip(m) | volume | conductance(S) | depth | strike(m) | dip(m) | volume | conductance(S) | |
| Z2_4 | 333877 | 6074227 | 2 | 30 | 110 | 80 | 8800 | 30 | 120 | 100 | 120 | 12000 | 200 | 2 |
| Z2_5 | 333722 | 6074090 | 2 | 55 | 80 | 50 | 4000 | 65 | 120 | 80 | 170 | 13600 | 200 | 1 |
| Z4_1 | 335176 | 6076226 | 2 | 150 | 160 | 100 | 16000 | 15 | 250 | 160 | 120 | 19200 | 200 | 3 |
| Z4_3 | 335313 | 6076056 | 2 | 115 | 140 | 70 | 9800 | 20 | 215 | 80 | 150 | 12000 | 200 | 4 |
| Z5 | 334156 | 6076824 | 2 | 65 | 280 | 80 | 22400 | 30 | 165 | 50 | 125 | 6250 | 100 | 5 |
| Z6_N | 334079 | 6076028 | 2 | 90 | 120 | 85 | 10200 | 53 | 125 | 80 | 95 | 7600 | 55 | 6 |
| Z8 | 334368 | 6075025 | ? | ? | ? | ? | ? | ? | | | | | | |
| Z9 | 333430 | 6075227 | ? | ? | ? | ? | ? | ? | | | | | | |

We provide a short table summary. "Number Targets" refers to the number different zones in the anomaly. Depth, is the distance from the surface to the top of the target and strike an dip are the strike lengths and dip extent respectively. Volume assumes a 1m intersection. Conductance is in Siemens which is the conductivity-thickness product.

Our opinion at the present time of the order of priority or order ob best target is given in the last column. The Z2 anomalies are chosen in priority over Z4 because essentially they are shallower. While the two Z2 anomalies may be connected at depth, it is much more likely that the Z4 anomalies are in fact connected.