Hornby Bay Airborne and Ground Studies

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July 31, 2006

- HB-05-13
- S-16
- HB-05-12
- S-14
- S-17
- S-18
- Wolf Creek

Recommendations – *from March 2006 Report*

Conclusion:

- HB-05-13 is the only remaining site with suitable data for inversion which also has core information.
- HB-05-22 and HB-05-12 have BHTEM and have been inverted
- HB-05-17 and HB-05-19 have difficult in-loop data but we do have BHTEM
- CM-70 has multiple off-set data: central data as well as 2 outside loop MLTEM surveys.

Recommendations: 16 March 2006

1) *As HB-05-13 is the only remaining site with suitable data for inversion and has core data then it should be inverted as with the other 4 sites for comparison.*

2) *As HB-05-22, HB-05-12 have BHTEM data, the models should be analysed with the use of the BHTEM data for clarification and further understanding of the use of the sounding data.*

3) *HB-05-17, HB-05-19 have difficult in-loop data like HB-05-15. In these cases, however, we also have BHTEM data. The BHTEM data should be studied to see if an explanation for the unusual inloop responses can be found.*

4) *CM-70 has multiple moving loop data which is very useful for investigating depth to basement. There is the conventional sounding data as well as 2 outside offsets at 1200 and 1400m. This data can be used to further resolve basement and possibly to understand the nature of the inside loop data and whether in the final story it is useful. CM-70 has also FLTEM. With these combinations it may be possible to determine the best technique for deriving depth to basement.*

5) *The inversions should be checked against the MegaTem data. This would provide 2 possible avenues: a) corroboration of the inversions and b) a check as to whether the MegaTem can provide some depth to basement information or at least assist in the effort with the sounding data.*

June/July 2006 Work

Further interpretation work was performed based on the recommendations in the March report. Data was modeled at several locations in the region, and different types of data were compared.

• S-14, S-16, S-17, and S-18: Although these locations were not part of the recommendations in the previous report, the MegaTEM data and ground data were compared for these locations to see if they would provide information on the lack of consistency observed between the airborne and ground data for HB-05-12 and HB-05-13.

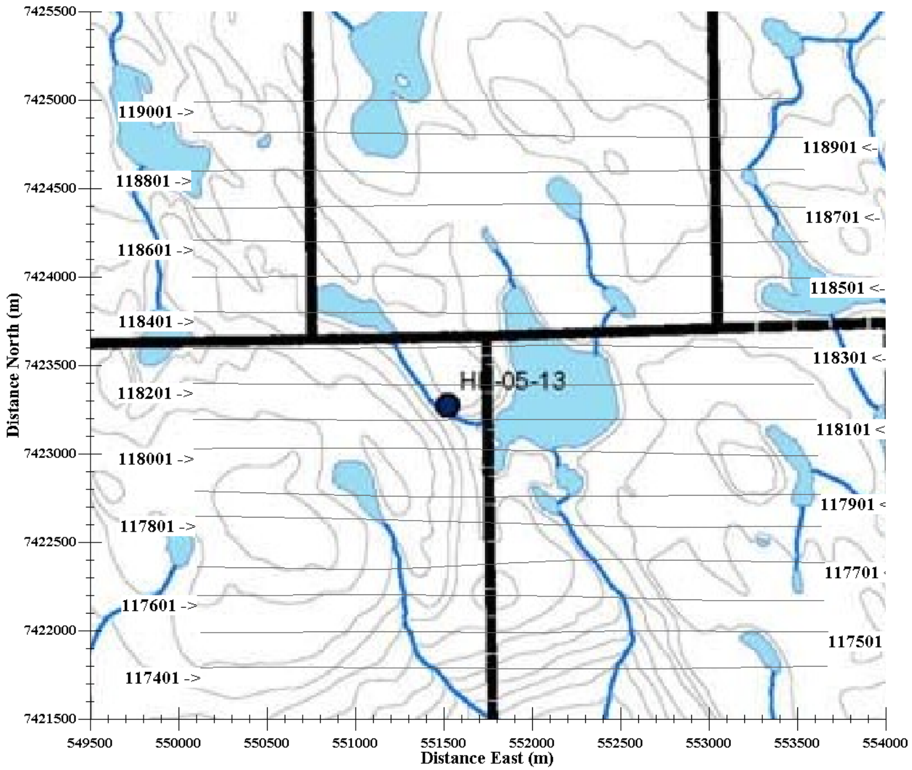
• HB-05-13: Modeling of the ground TEM data and comparison with the MegaTEM data and core results. Inversions on both data sets. S-16 is associated with HB-05-13. Hb-05-13 was initially discussed in the preliminary report (January 2006).

• HB-05-12: Modeling of the ground data, MegaTEM data, and borehole data, and comparison with the core data. Inversions on the MegaTEM data. Associated with S-14, S-17, S-18 (1, 2, and 3). HB-05-12 and S-18-n were discussed in the preliminary report. Further information on HB-05-12 can also be found in the March 2006 report.

• Wolf Creek (HB-05-18 and HB-05-19): Modeling of the aeromagnetic data. Interpretation of the MegaTEM data, ground data for HB-05-19, and borehole data for HB-05-18 and HB-05-19. Inversions on the MegaTEM data. Comparison of the magnetic and TEM data. HB-05-19 was discussed in th preliminary report.

Resistivity Information for HB-05-13

(551 500 m, 7 423 254 m)



Ground TEM and airborne TEM (MegaTEM) data collected near HB-05-13 were studied. The data were used to investigate the variation in resistivity with depth and to determine the depth to the basement. To develop a layered earth model, forward modeling was performed, with the user creating a model, comparing the synthetic data to the TEM data, and modifying the model as needed. Marquardt and Occam inversions were also used to assist with the interpretation of the data. Good models were compared with both sets of data, as an appropriate model should fit both the ground and airborne TEM data.

HB-05-13

***from preliminary report**

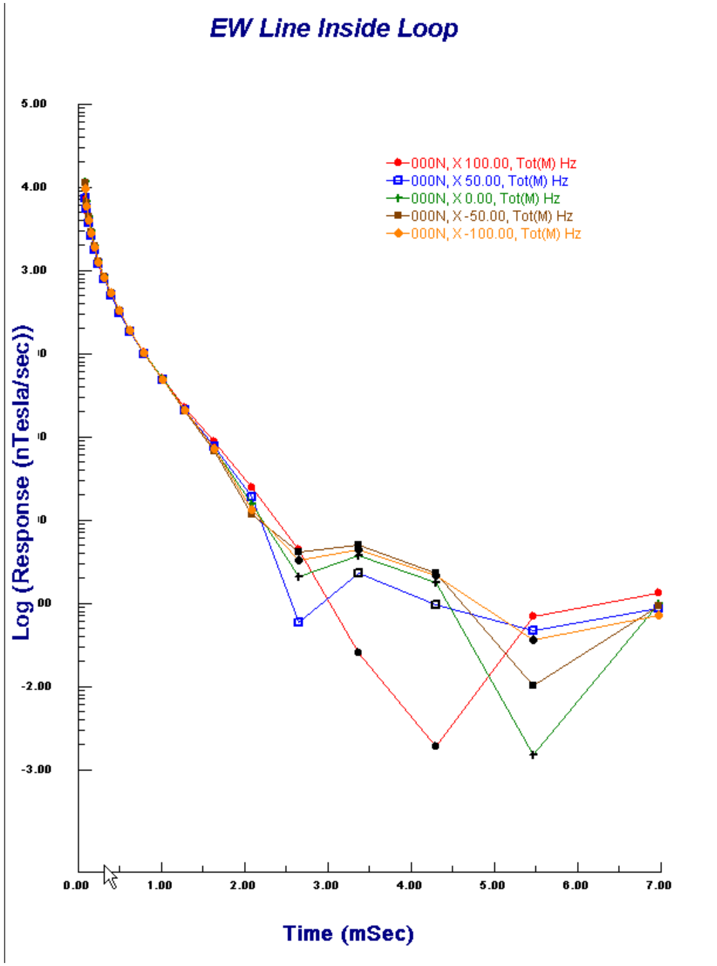
- Loop: 400x400
- Stations:
  - NS - 5 (Note 1)
  - EW –11
- Symmetric : Yes
- Central Meas. – 2
- On Channels: 0 (Note 1)
- Saturated: Note 1.
- Negative Early Off:
  - Inside: 0
  - Outside: 0

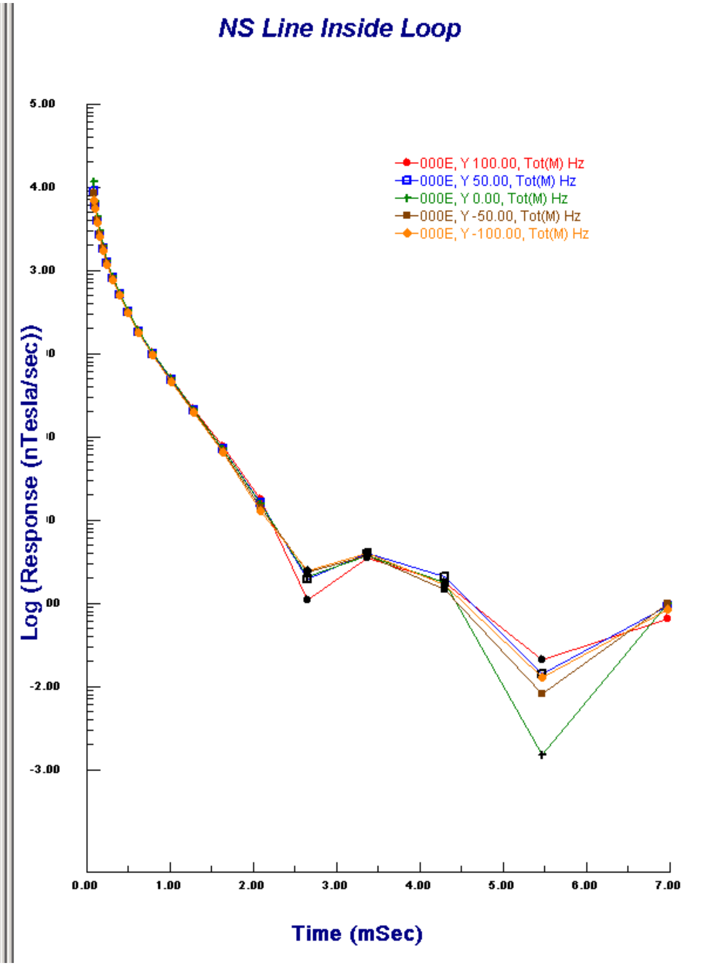
Note 1.
The NS line on HB-05-13 was initially read on May 31/05. The data was to be read with a conventional delay time and thus all off-time channels. However, clearly there is measurements during the on-time although the file indicates otherwise. It was indicated by the contractor that there was possible crystal clock problems with a drifting of the synchronization with the Rx and Tx crystals. This could account for this problem. The NS line was re-read only side the loop on June 1/05. This report will consider only that NS data.

Both the EW line and NS line have 5 symmetrical data points inside the loop. This gives us ample information to judge data quality. But, also it gives the ability to easily define the level of 3D effects in the data. The purpose of the survey is to do a “sounding”. By this, it is meant, that we hope to determine depths to various lithological structures. This would normally be accomplished by a 1D inversion technique. However, if the data is highly 3D then this approach may be spurious. Unfortunately, this capability is lost to some extent on many of the other soundings and the suggestions by this author to ensure that data was collected symmetrically with the centre repeated.

HB-05-13 ****from preliminary report***

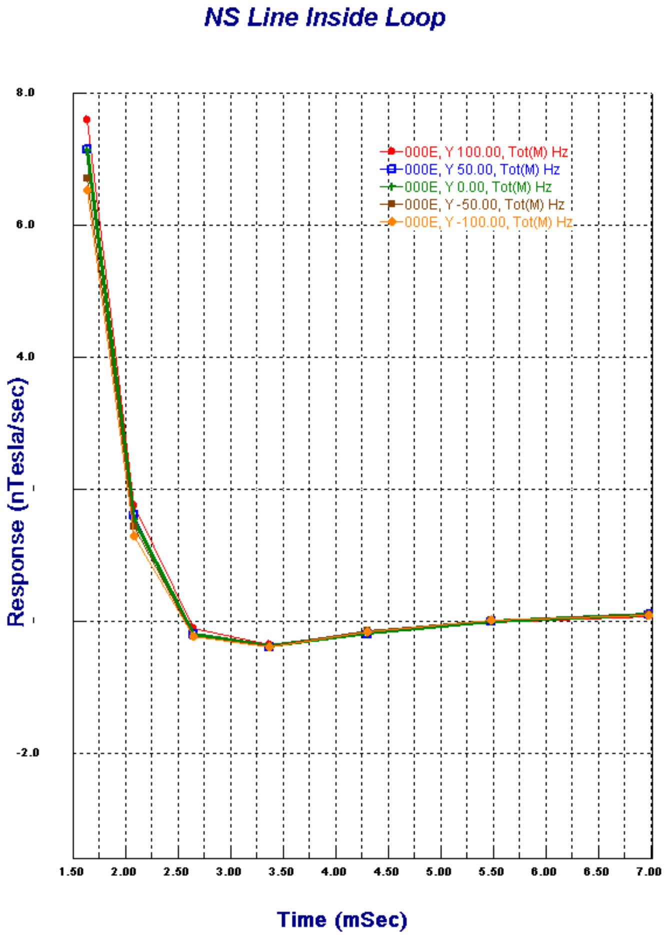
The image below shows in the inloop measurements (log amplitude vs linear time) for both the EW line (left) and the NS line (right). Notice that in both cases, the data breaks up in the last 5 data channels. If the resistivity structure is principally as function of depth then all data should be very similar particularly in late-time and the NS data should be very close to the EW data. The central point (0,0) should have the largest amplitude. You will note that all of the data is very similar for the first 14 channels. Ch15 has too much variation for the EW line while Ch15 may be acceptable for the NS line.

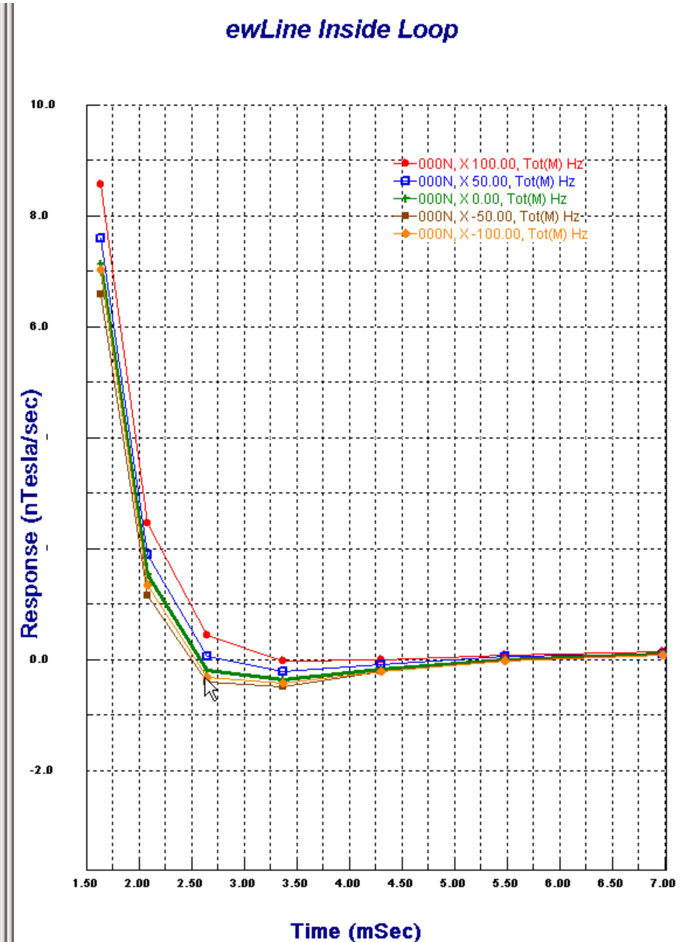




HB-05-13 ***from preliminary report***

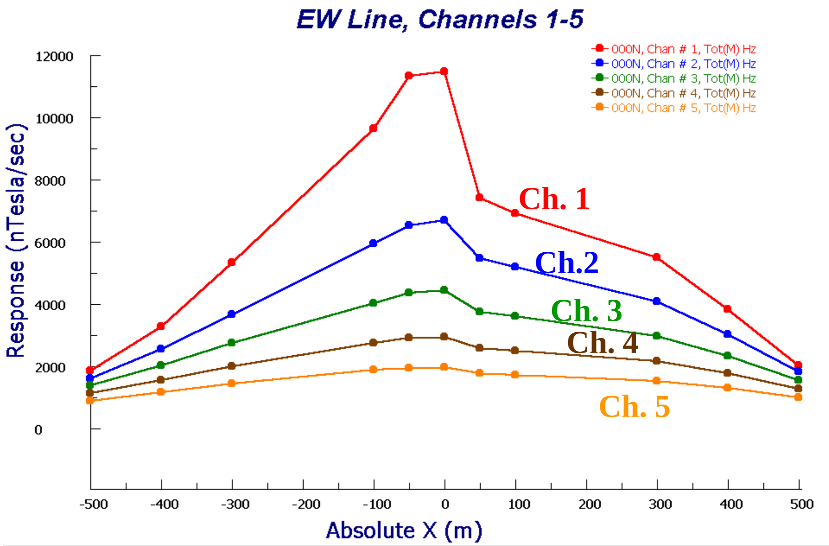
The image below shows in the in loop measurements (linear amplitude vs linear time) in late time for both the EW line (left) and the NS line (right). Notice in the NS line, the data drops below 0 and recovers in a characteristic response. The data values are very similar in late time arguing that it is either truly physical or a system response. It is important to note that this type of response is not characteristic of a simple layered earth model. The EW line shows the same character on the west side and at (0,0) while this response returns to a normal decay on the easy side. This implies the possibility of a response to the west which causes this late time response.

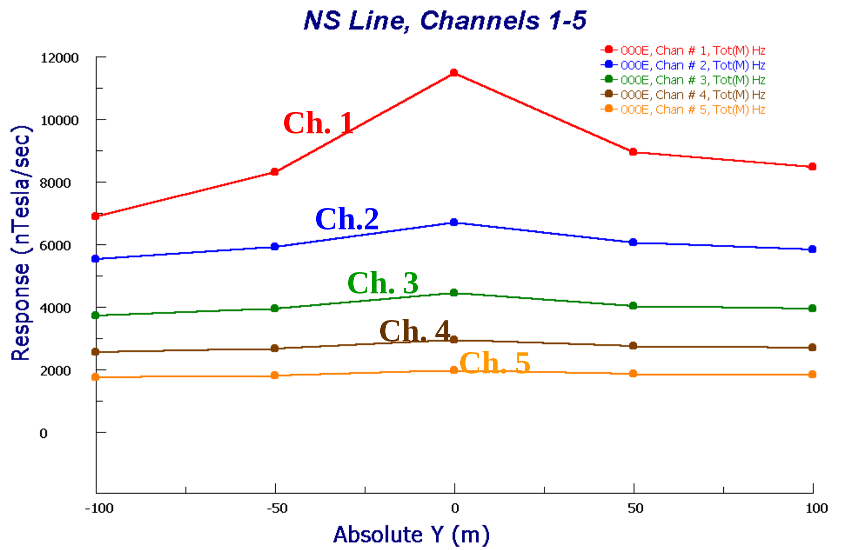




Note: The response at (0,0) is almost identical on the two lines. This strongly indicates that this is not noise but rather either:
a) a common system low pass system response b) a structure probably to the west

HB-05-13 Ground Data



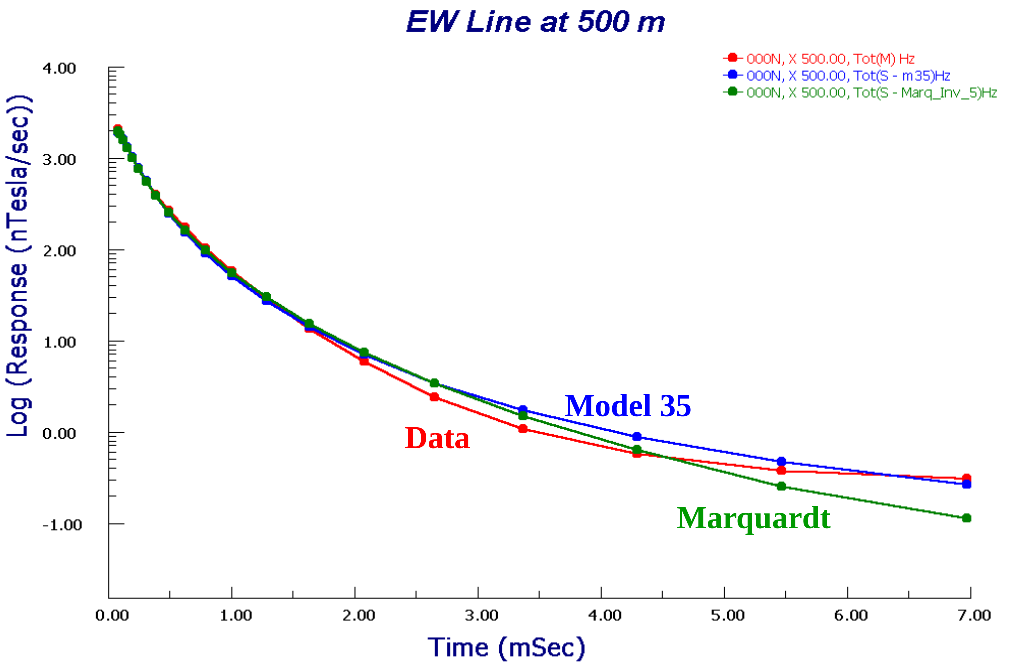


The ground TEM data used a fixed loop of about 400 m by 400 m, centered on the borehole. Measurements were taken along a north-south and an east-west line running through the center of the loop. The stations were symmetric about the center. There were 5 stations inside the loop along each line, and 6 stations outside the loop along the EW line. Along the EW line, the response inside the loop was smaller than the response outside the loop at late times, possibly due to a system response.

For sounding, the measurement at the receiver should depend only on the distance from the center, so the profiles should be symmetric if this is a valid assumption. The NS line is close to symmetric about the center of the loop, but the EW line is symmetric only at large distances from the center, with a pronounced asymmetry for the points inside the loop. This may be due to 3-D structure. For modeling, more importance was placed on modeling the points outside the loop, and inversions were performed on stacked data using only the points outside the loop.

HB-05-13 Ground Data

Model 5, from a Marquardt inversion, and Model 35, created by the user, fit the ground TEM data relatively well. In Model 35, a thin resistive layer is followed by several less resistive layers. The basement begins at -650 m, and a conductor is found below it, at a depth of nearly 2 km.The earlier channels are modeled well, but it was difficult to obtain a model that was suitable for the later channels. The Marquardt inversion, although producing a good fit at early channels, also did not fit the data well at later times.

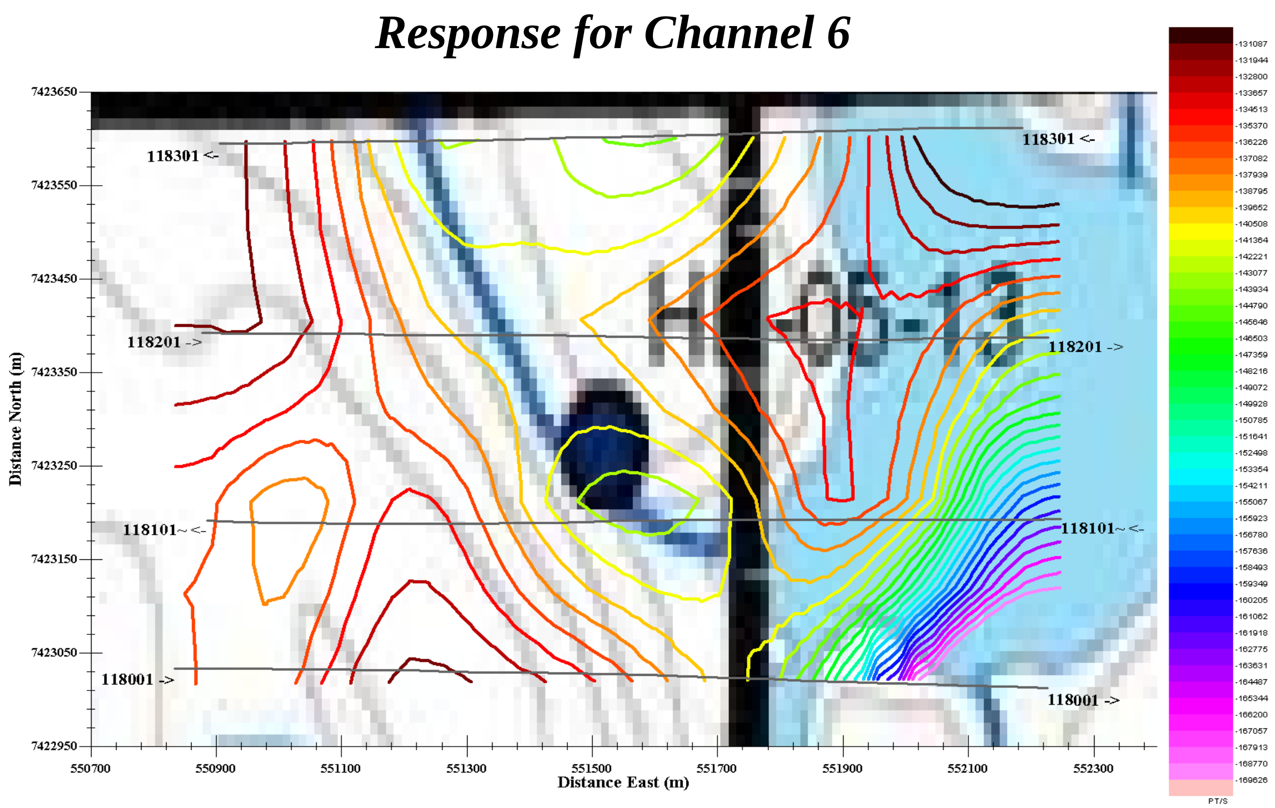


The core data indicate a thin overburden, underlain by Hornby Bay Sandstone. Interbeds of mudstone and siltstone in the sandstone began at around 70 m, and continued throughout the core sample. There were no basement rocks to a depth of 440 m.

Model 35

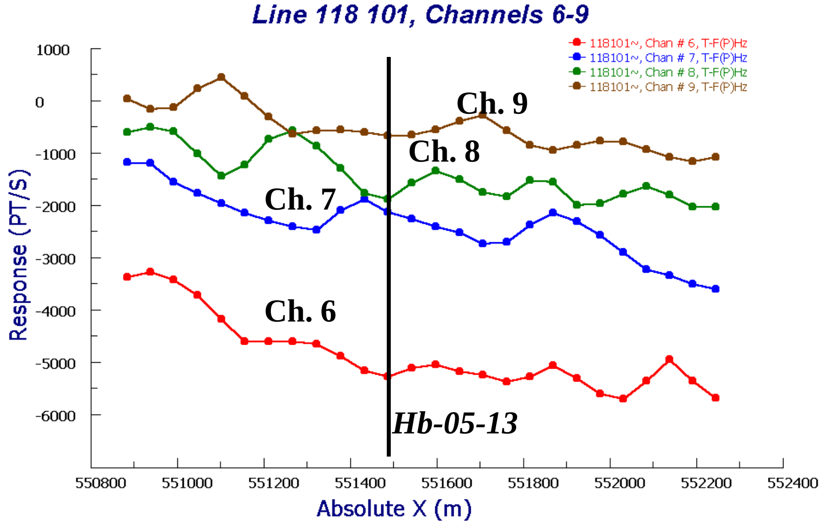
Resistivity (Ohm m)	Thickness (m)	Depth to Bottom (m)	Lithology
1200	25	-25	Overburden/Sandstone
600	275	-300	Sandstone/Mudstone
850	150	-450	Sandstone/Mudstone
550	200	-650	Sandstone/Mudstone
10000	1200	-1850	Basement
200			Conductor

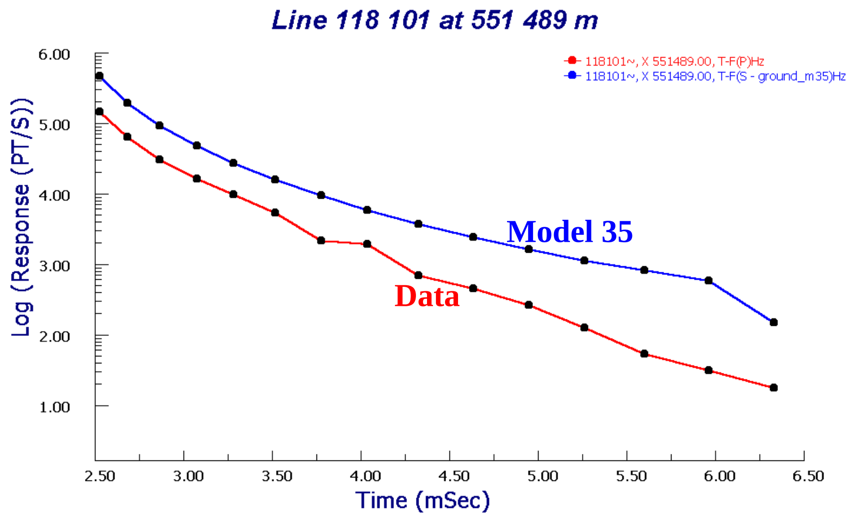
HB-05-13 Airborne Data



A MegaTEM survey was flown over the Coppermine River Region, and a focus area comprising part of the 4 lines around HB-05-13 was cut out for the purpose of comparing it with the ground data.

HB-05-13 Airborne Data



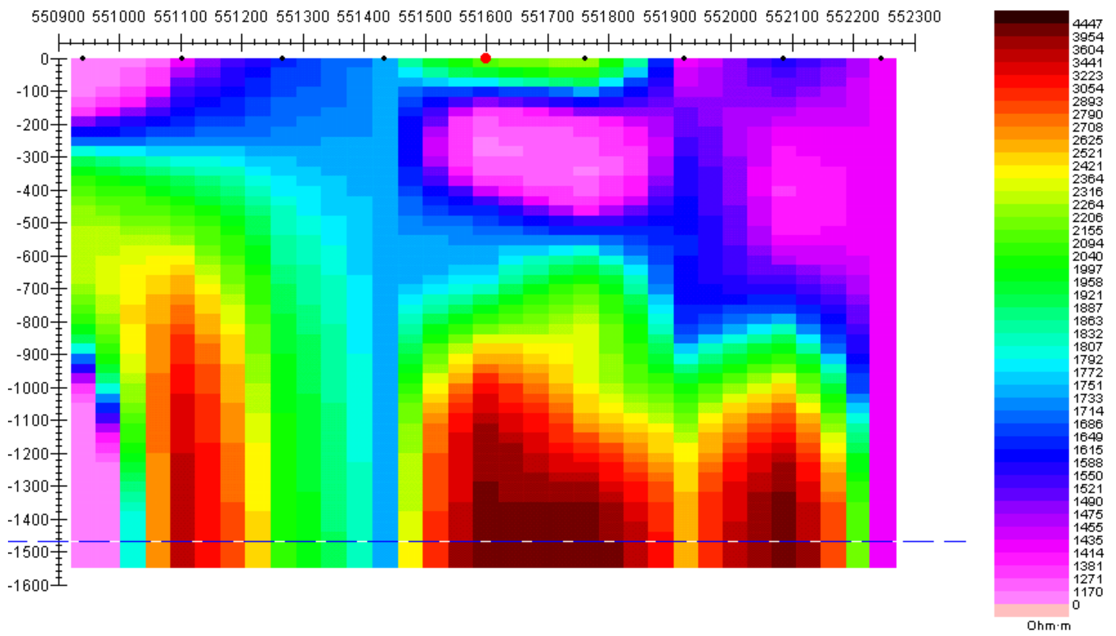


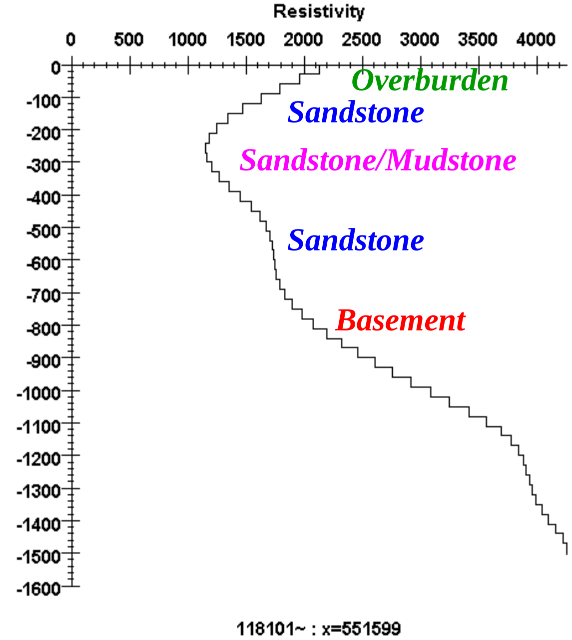
The first five measurements were taken in the on-time, and were not used for modeling. The sign of the airborne data was flipped to match the current direction of the model.

Model 35 did not fit the airborne data as well as the ground data. Although the shape of the response curve is fairly similar, the amplitude is too large across all the time channels.

HB-05-13 Airborne Data

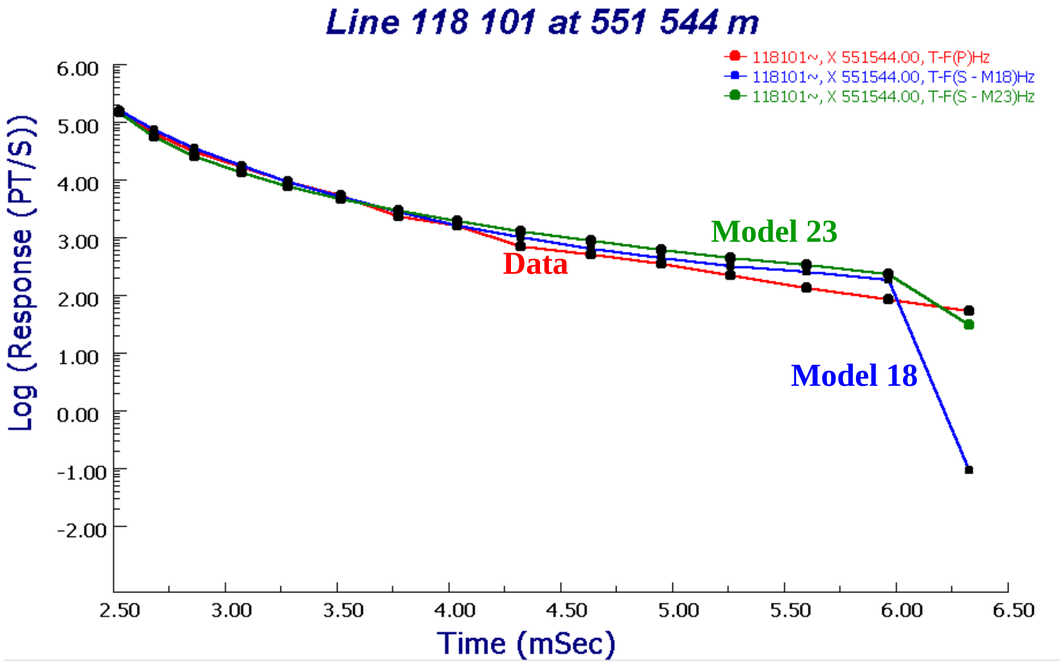
Occam Inversion





Modeling was conducted to find a better layered earth model for the airborne TEM data. Model 18 contains layers of fairly resistive rocks, with a more conducting layer at about 400 m and a good conductor at depth. It is more resistive at shallow depths than Model 35. An Occam inversion suggests a different model, with a lower resistivity near the surface and a more uniform resistivity throughout. Using the result of the Occam inversion, Model 23 was developed. Model 23 fits the data better in some locations than Model 18, but it is difficult to determine whether it is an improvement overall.

HB-05-13 Airborne Data



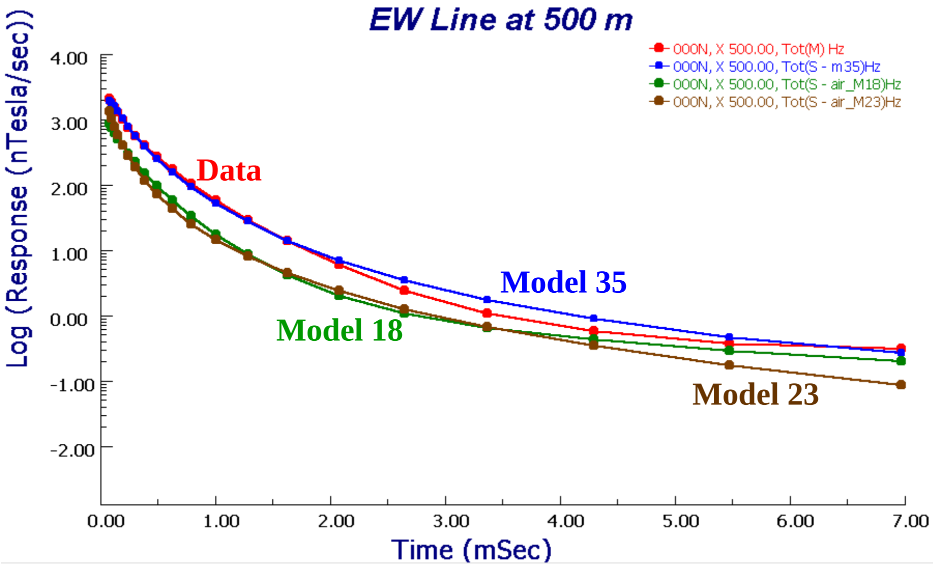
Model 18

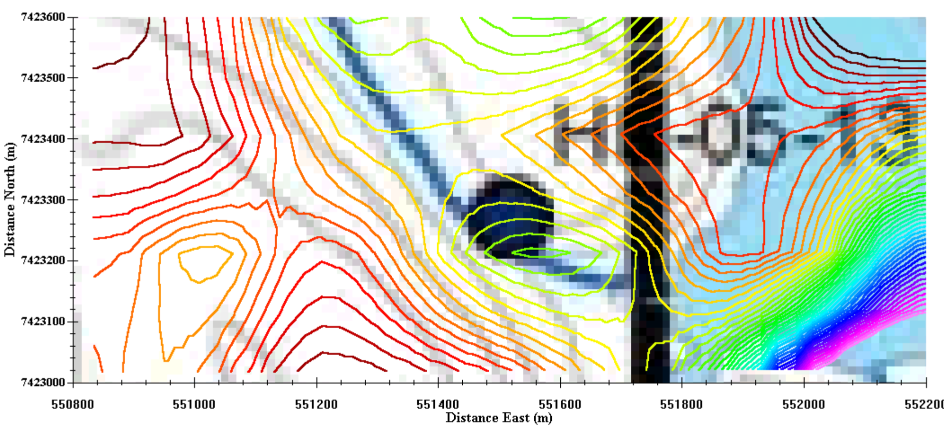
Resistivity (Ohm m)	Thickness (m)	Depth to Bottom (m)	Lithology
3500	225	-225	Sandstone
2000	150	-375	Sandstone
440	180	-555	Sandstone/Mudstone
1300	500	-1055	Basement
2000	350	-1405	Basement
7			Conductor

Model 23

Resistivity (Ohm m)	Thickness (m)	Depth to Bottom (m)	Lithology
1700	150	-150	Sandstone
1500	350	-500	Sandstone/Mudstone
2000	350	-850	Sandstone
3000			Basement

HB-05-13

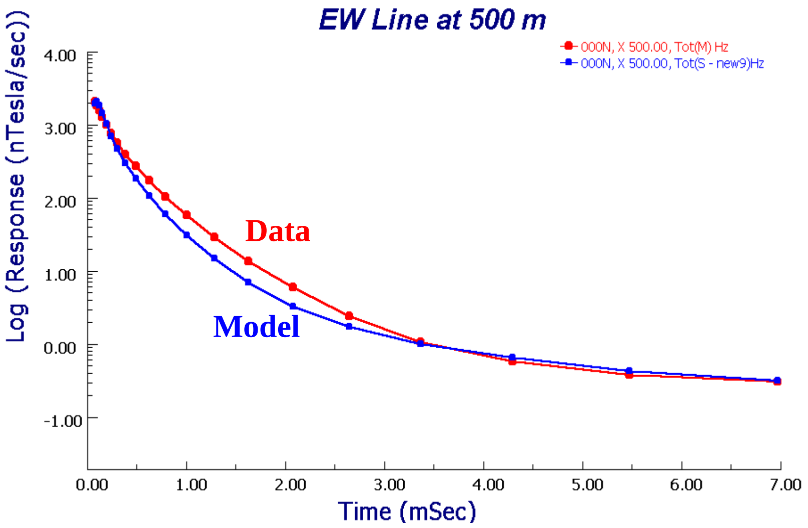


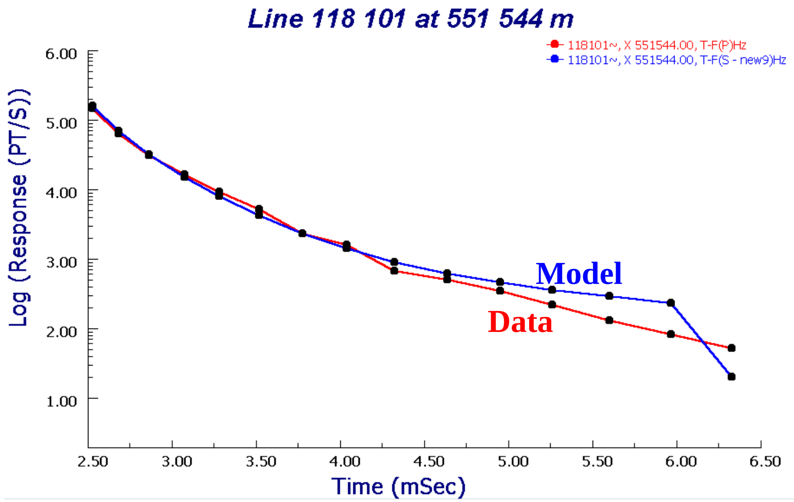


Models 18 and 23, developed for the airborne data, do not fit the ground data very well. For both models, the amplitude of the EM response curve is too small, particularly for the early time channels, and the decay is too fast at early times. The difficulty in matching the ground data to the airborne data may be due to lateral variation in resistivity. In the contour plot of the ground data for the first off-time channel, the area immediately around the borehole has a different response from the surrounding area, suggesting a lateral variation in material. Therefore, the response of the airborne TEM data collected near the borehole could be different from the ground data, as they do not capture a signal from exactly the same area.

HB-05-13

The ground and airborne TEM data were collected at different times of the year: the airborne data in late April/early May and the ground data in late May/early June. As noted on the map, the borehole is located near a river. Seasonal differences in the region might account for some or all of the difference in the ground and airborne data. When the airborne data was collected, the water would have been frozen, but it would have thawed by late May. To account for the water, a 1 m thick, high conductivity layer was added to models for the ground data. This raises the amplitude of the EM response for the model, improving the fit with the ground data. A new model was developed, similar to Model 18, but having better correlation with the core results. This new model fits both data sets relatively well. Further discrepancy between them is likely due to near surface effects from lateral variation in resistivity.



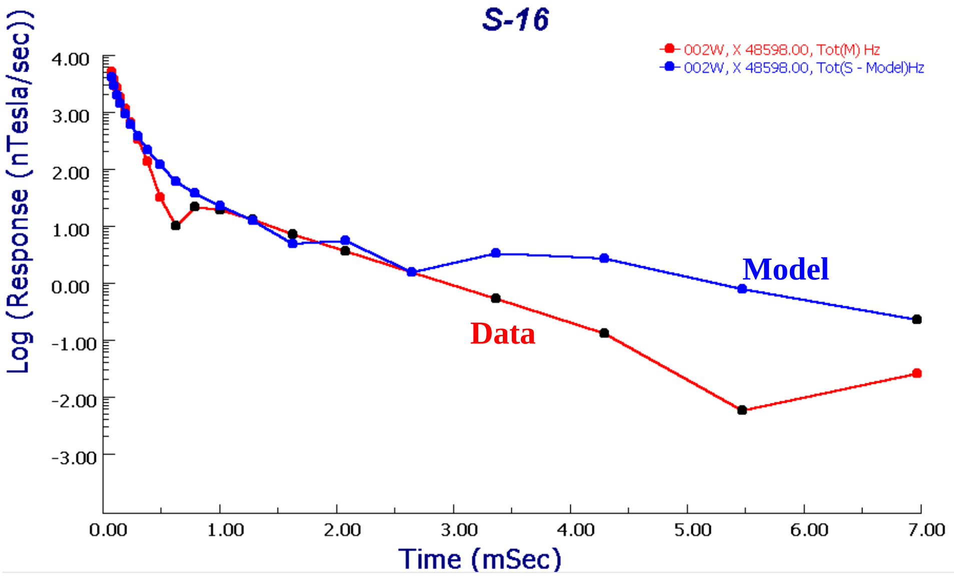


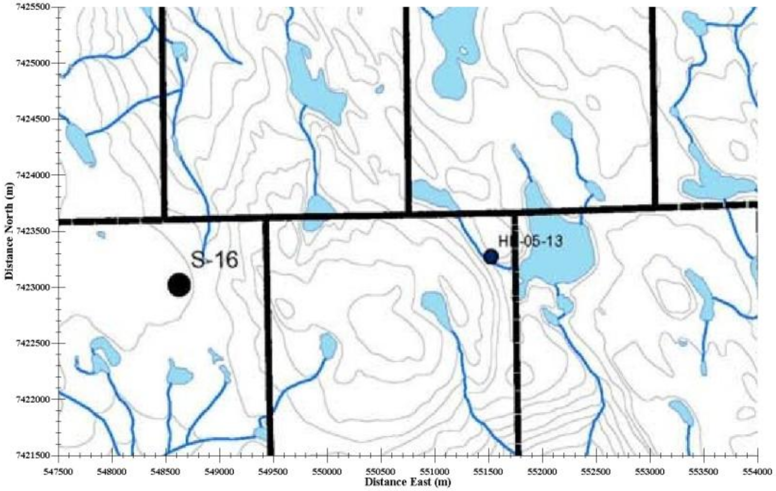
New Model (for the ground data)

Resistivity (Ohm m)	Thickness (m)	Depth to Bottom (m)	Lithology
5	1	-1	Water
3000	70	-71	Overburden/Sandstone
1500	430	-501	Sandstone with mudstone interbeds
400	200	-701	Sandstone with mudstone interbeds
2000	500	-1201	Basement
5			Conductor

S-16

S-16 is located near HB-05-13, slightly to the west. Modeling of S-16 is somewhat limited by the fact that there is only one data point. A simple model suggests that a thick, somewhat conductive layer is underlain by a resistive layer, but it is difficult to draw conclusions because of the limited data, and it is not of great use in improving the model for HB-05-13.





Model

Resistivity (Ohm m)	Thickness (m)	Depth to Bottom (m)	Lithology
1000	500	-500	Sandstone
3000			Basement

HB-05-13 Conclusions

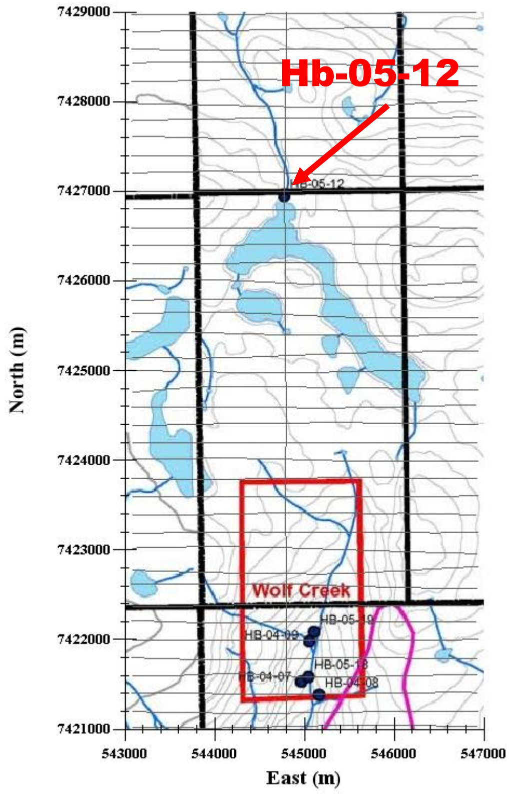
The TEM data and the core results suggest that there is a fairly resistive layer, Hornby Bay Sandstone, underlain by less resistive layers, in which the sandstone is interbedded with mudstone/siltstone. There seems to be a more conductive layer just below the basement, but resolution to this depth is not very good. A reasonably good model (Model 23) did not contain this conductor. The basement is not present at the bottom of the core, and based on the modeling, appears to be at a depth of 600-700 m. There seems to be a conductor at a depth of more than 1 km, but this is also somewhat unclear.

The difficulty in correlating the airborne and ground data was partially accounted for by water at the surface during the time of year when the ground survey as performed. By accounting for the times of the surveys, it was possible to develop a model that fit both the airborne and the ground TEM data reasonably well.

There also appears to be some lateral variation in resistivity across the region, which may explain some of the discrepancy between the response curves. The borehole seems to be in a river valley, where the EM response is different than in the nearby region, as noted in the airborne data.

Resistivity Information for HB-05-12

(544 756 m, 7 426 928 m)



Ground TEM , borehole TEM, and airborne TEM (MegaTEM) data collected near HB-05-12 were studied. The data were used to investigate the variation in resistivity with depth. To develop a layered earth model, forward modeling was performed, with the user creating a model, comparing the synthetic data to the TEM data, and modifying the model as needed. Good models were compared with all sets of data, as an appropriate model should fit the ground, borehole and airborne TEM data.

****from preliminary report***

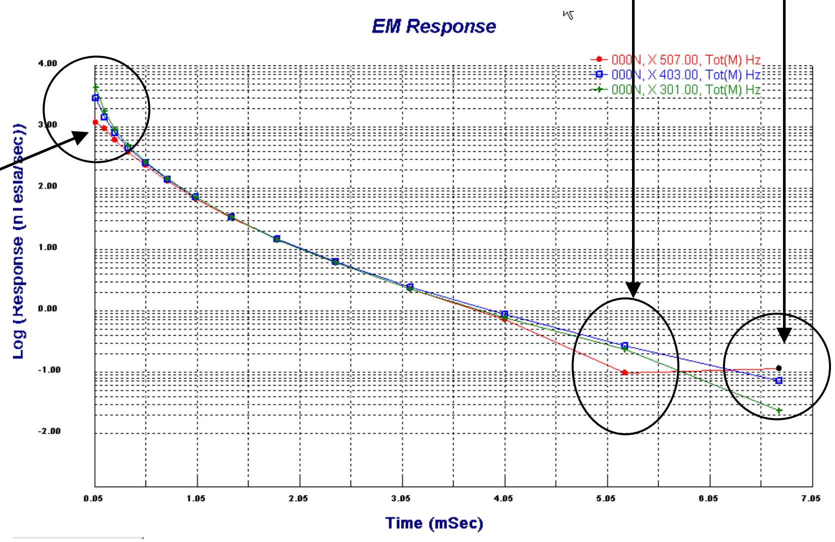
HB-05-12

- •Loop: 400x400
- •Stations:
- NS - 10
- EW – 9
- •Symmetric : No
- •On Channels: 6
- •Saturated: Yes
- •Negative Early Off:
- Inside: 0
- Outside: 0

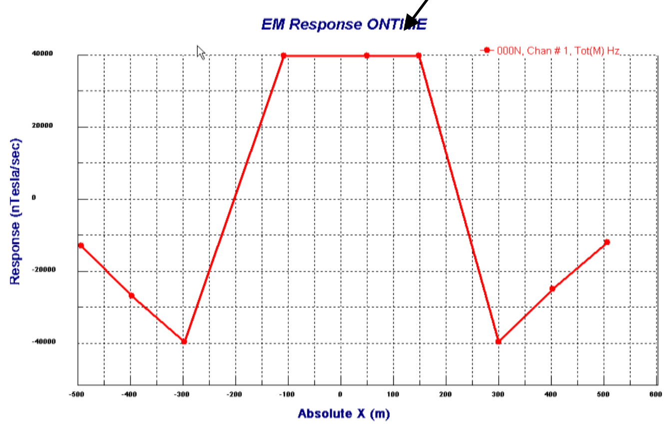
Line 000N 500E
inconsistent late times

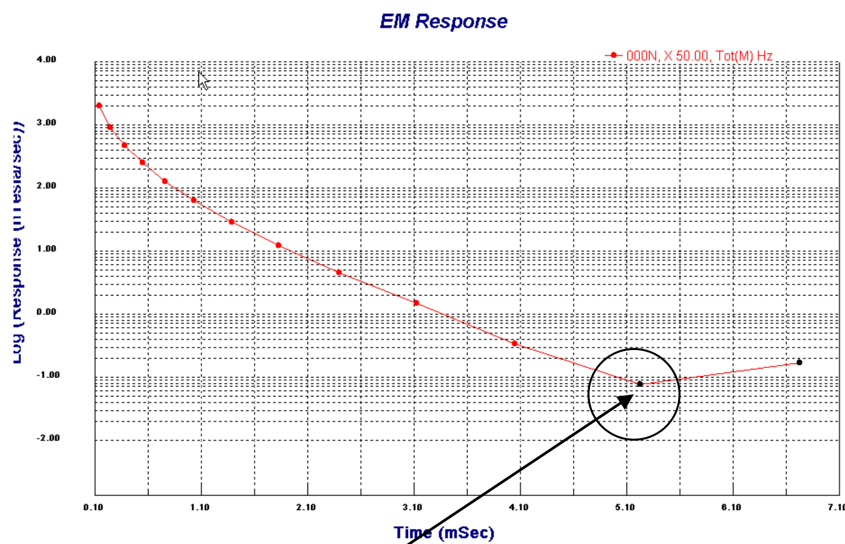
negatives

Strange early channels on line 000N 500E



saturated





Negatives

***from preliminary report**

HB-05-12

•Additional Comments:

•Saturated ON channels
•No centre loop measurements (ie. (0,0))

•Line 000N:
•All inloop stations have saturated ON-time measurements
•Station 500E Line 000N has early off-time data that requires further analysis
• later time channels negative and problematic decays and curvatures

•Line 000E:
•All inloop stations have saturated ON-time measurements
•Early off-time data have problematic decays and curvatures

Resistivity Depth Information

- <u>HB-05-12</u>

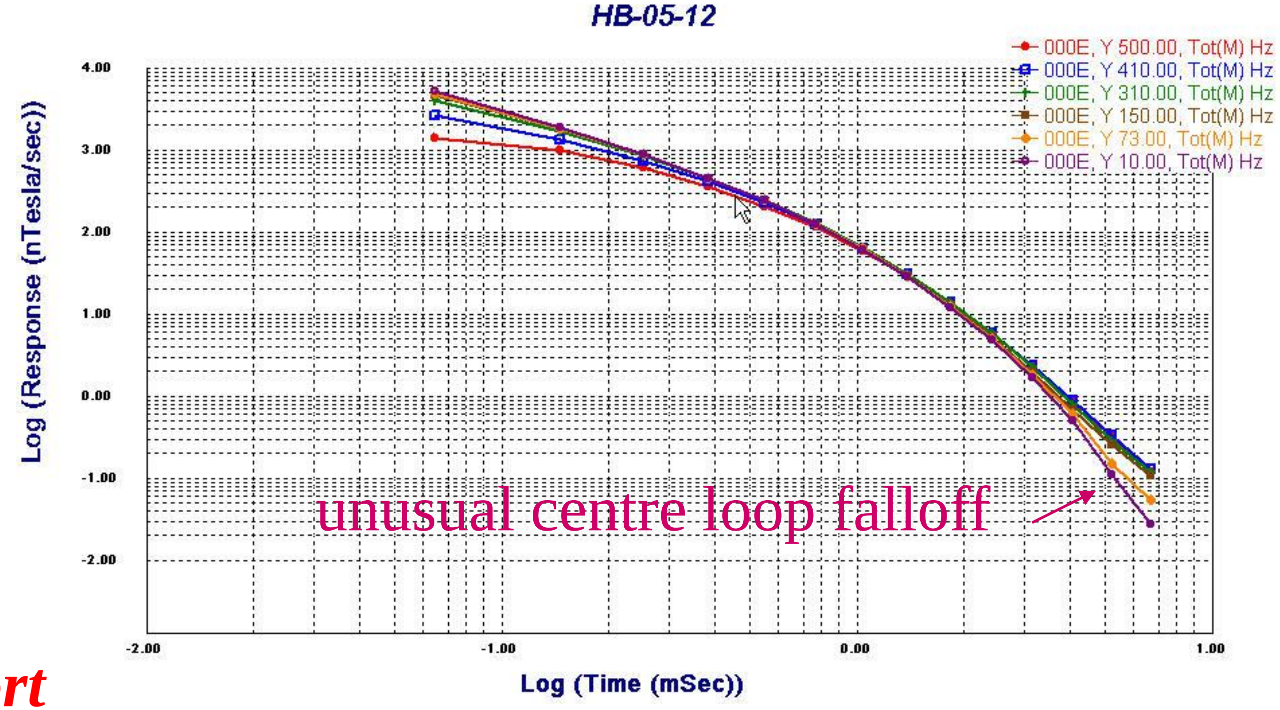
<u>Note: On-Time Data</u>. 6 channels lost

Lithology description	Lithology number	BP label	S. Earle label	vertical depth	Resistivity
Overburden	0	OB		-13.6	
HB sandstone	10	HB3-8	3	-104.0	
HB conglomerate	1	HB1	1	-116.1	
HB sandstone	10	HB3-8	3	-433.1	
HB conglomerate	1	HB1	1	-452.7	
HB sandstone and siltstone	10	HB3-8	3	-476.1	
Regolith	100			-480.7	
Basement rocks (feldspar porphyry)	120	MV		-536.5	

"Stacked" central measurements

If the geology is only a function of resistivity with depth then the early time measurements should decrease slightly in amplitude from the centre to the wire while the measurements should converge at late time.

This site had sufficient measurements inside the wire but the stations although were non symmetric so the stacking was modified slightly to assume one-dimensional result.



****from March report***

Resistivity Depth Information

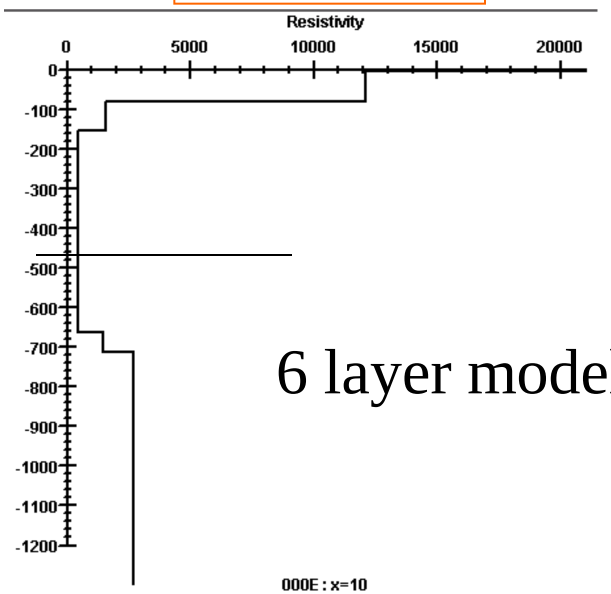
- HB-05-12

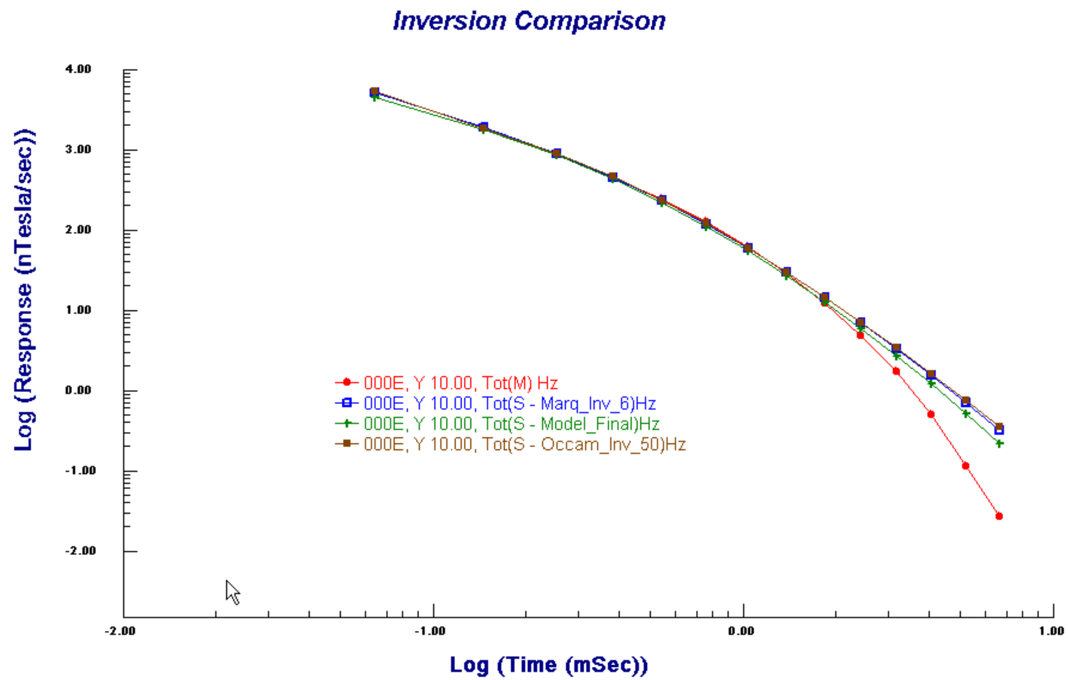
Lithology description	Lithology number	BP label	S. Earle label	vertical depth	Resistivity
Overburden	0	OB		-13.6	
HB sandstone	10	HB3-8	3	-104.0	
HB conglomerate	1	HB1	1	-116.1	
HB sandstone	10	HB3-8	3	-433.1	
HB conglomerate	1	HB1	1	-452.7	
HB sandstone and siltstone	10	HB3-8	3	-476.1	
Regolith	100			-480.7	
Basement rocks (feldspar porphyry)	120	MV		-536.5	

Resistive Models

The figure to the right contains the data at the central location with 3 techniques used to fit the data to a "1D" model. The red curve represents the actual data collected during survey. The Green is Occam or Smooth Inversion curve with results seen below in the resistivity vs depth. It is very similar to the Brown of the Marquardt or Course inversion The blue model was calculated with forward simulation model iteratively developed by the interpreter. The models all seen to follow the early and mid time channels quite well but in all the final 4 time channels sharply dip down and were not able to model correctly. The steeply dipping final channels are most likely due to system effects caused by bandwidth issues.
The models all followed the data very closely as can be seen at early to midtime channels but fall off in late times.

Resistivity vs Depth





****from March report***

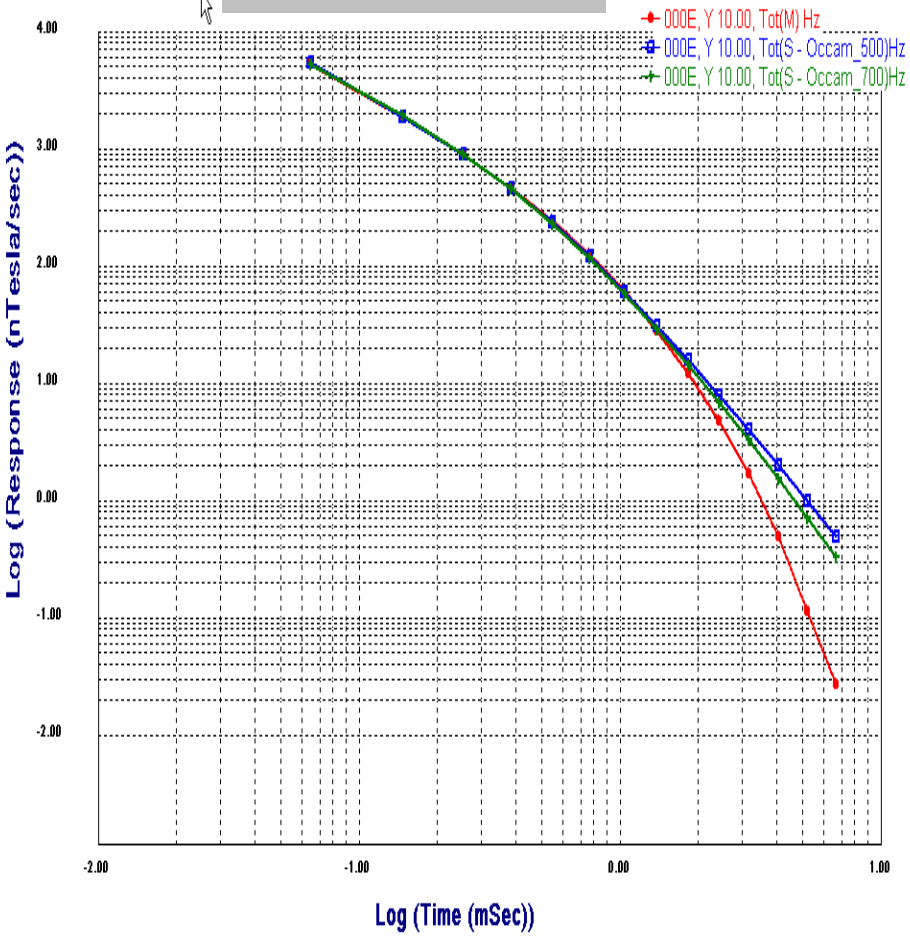
Resistivity Depth Information

- HB-05-12

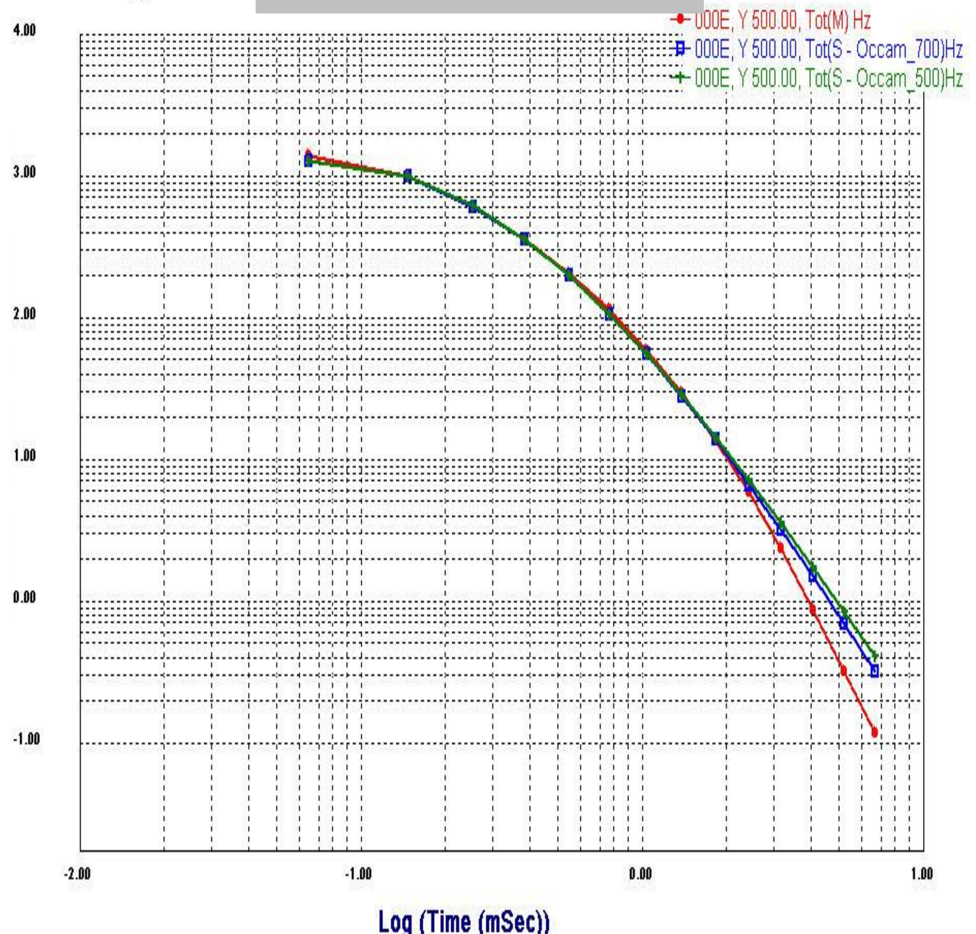
Below shows two inversions S_Occan_500 is modeled to 500meters depth where the other, S_Occam_700, fit is modeled deeper to 750 meters. The plots are to show the inversion fit at both ends of the stacked line. You will notice that sharp dip response cannot be fit properly and that the deflection occurs strongest inside the loop.

Lithology description	Lithology number	BP label	S. Earle label	vertical depth	Resistivity
Overburden	0	OB		-13.6	
HB sandstone	10	HB3-8	3	-104.0	
HB conglomerate	1	HB1	1	-116.1	
HB sandstone	10	HB3-8	3	-433.1	
HB conglomerate	1	HB1	1	-452.7	
HB sandstone and siltstone	10	HB3-8	3	-476.1	
Regolith	100			-480.7	
Basement rocks (feldspar porphyry)	120	MV		-536.5	

centre station



furthest station



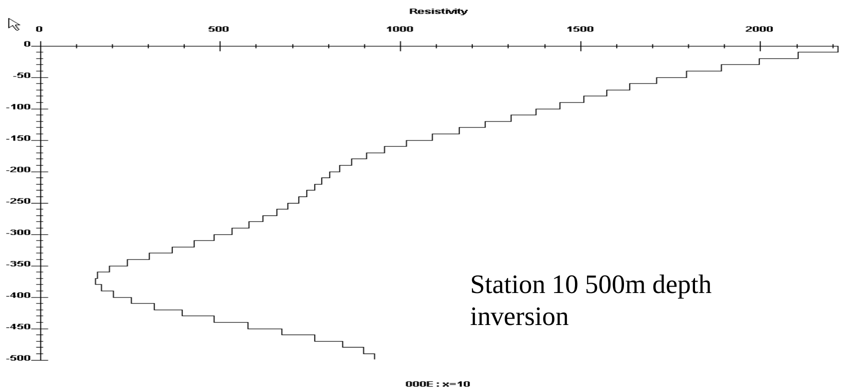
from March report

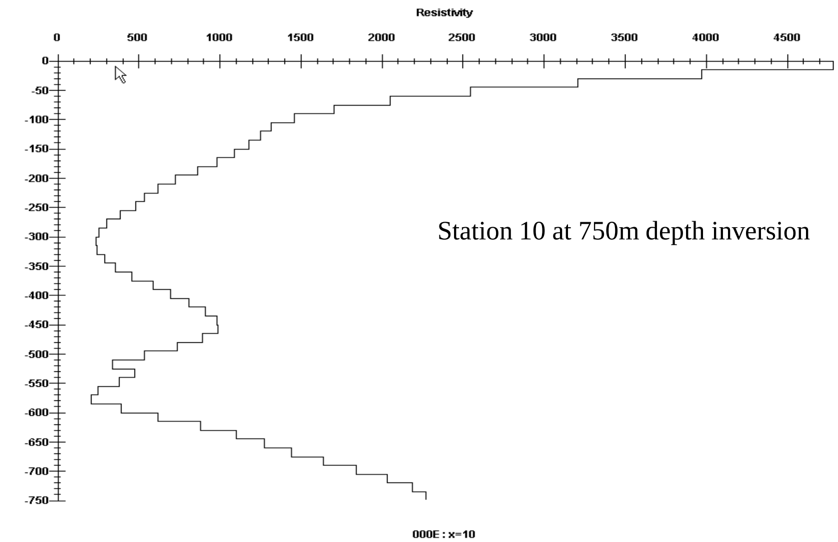
Resistivity Depth Information

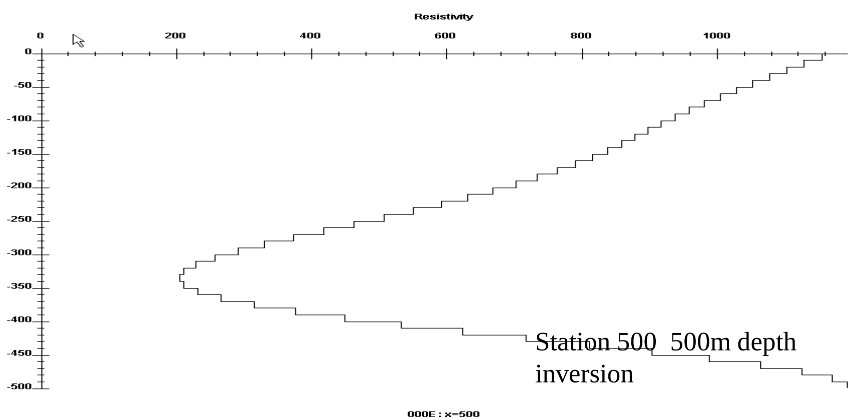
- HB-05-12

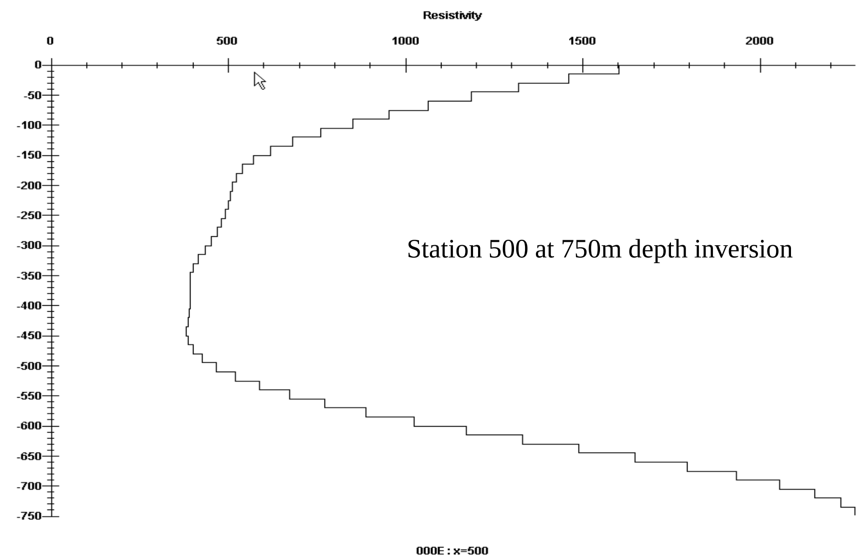
Lithology description	Lithology number	BP label	S. Earle label	vertical depth	Resistivity
Overburden	0	OB		-13.6	
HB sandstone	10	HB3-8	3	-104.0	
HB conglomerate	1	HB1	1	-116.1	
HB sandstone	10	HB3-8	3	-433.1	
HB conglomerate	1	HB1	1	-452.7	
HB sandstone and siltstone	10	HB3-8	3	-476.1	
Regolith	100			-480.7	
Basement rocks (feldspar porphyry)	120	MV		-536.5	

Below are the inversion depth profiles for both inversion depths to 500 and 750 at stations 10 and 500









****from March report***

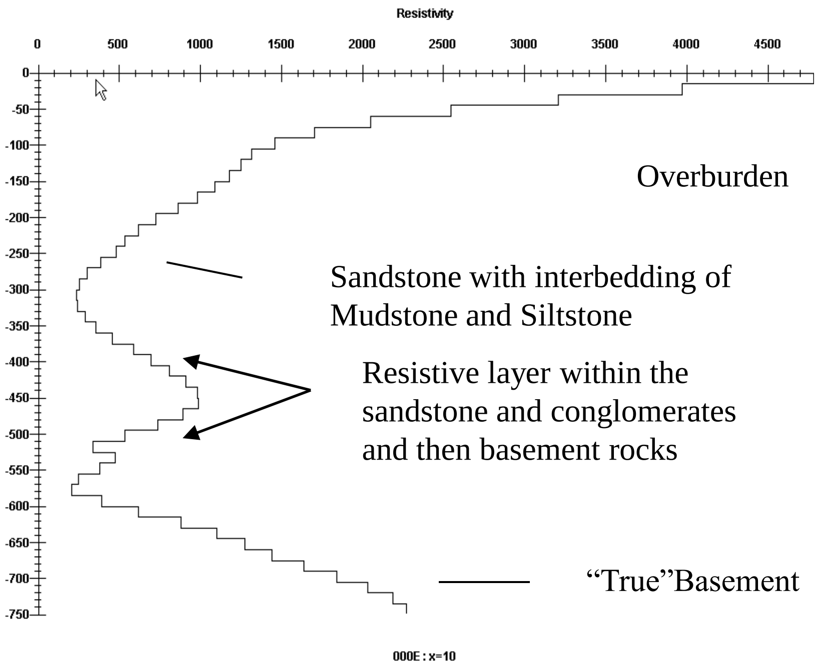
Resistivity Depth Information

- HB-05-12

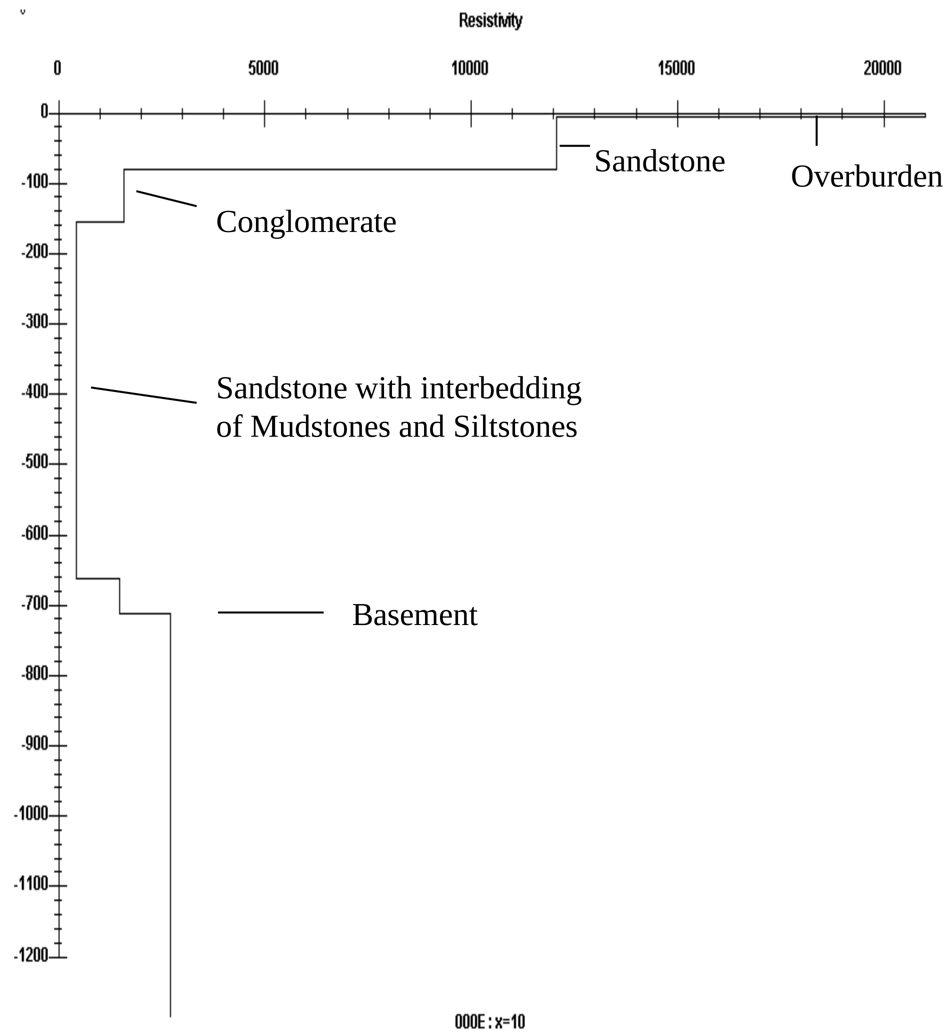
Lithology description	Lithology number	BP label	S. Earle label	vertical depth	Resistivity
Overburden	0	OB		-13.6	
HB sandstone	10	HB3-8	3	-104.0	
HB conglomerate	1	HB1	1	-116.1	
HB sandstone	10	HB3-8	3	-433.1	
HB conglomerate	1	HB1	1	-452.7	
HB sandstone and siltstone	10	HB3-8	3	-476.1	
Regolith	100			-480.7	
Basement rocks (feldspar porphyry)	120	MV		-536.5	

Both inversion techniques show that the basement at station 10 is much deeper then the 500m version inversion. Both models show basement at 750m .

Occam Inversion to 750m with layers



Marquardt Inversion to 1200m



from March report

Resistivity Depth Information

- <u>HB-05-12</u>

***from March report**

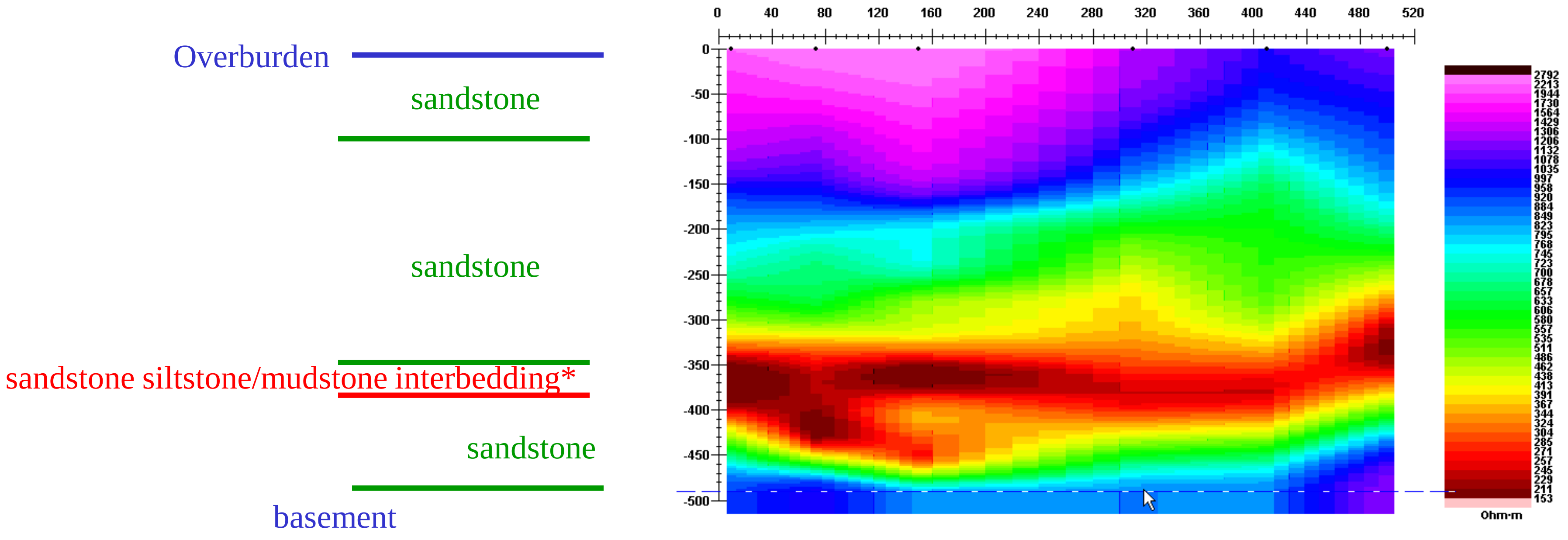
Resistivity Models

The grid blow shows the results of the gridded inversion data to a “1D” model. The black shows high resistivity where the red represents higher conductivity. This is to emphasize the presence of a conductive interbedding within the HB sandstone layers. The conglomerates demonstrate very similar resistivities with the sandstones and therefore due to the relatively thin layers are not as visible in this model. This model follows the drill sample lithology fairly well, but it is important to compare with other inversion models to verify.

Lithology description	Lithology number	BP label	S. Earle label	vertical depth	Average Resistivity
Overburden	0	OB		-13.6	2800
HB sandstone	10	HB3-8	3	-104.0	2000
HB conglomerate	1	HB1	1	-116.1	
HB sandstone	10	HB3-8	3	-433.1	700
HB conglomerate	1	HB1	1	-452.7	
HB sandstone and siltstone	10	HB3-8	3	-476.1	273
Regolith	100			-480.7	762
Basement rocks (feldspar porphyry)	120	MV		-536.5	1000

500m Occam Inversion

Distance from centre of loop



* please not description in HB-05-22.xls for the zone for depths 356-376

Resistivity Depth Information

- HB-05-12

Resistivity Models

The figure below shows the results of the contoured inversion data to a "1D" model for the 750 depth Occam Inversion. The pink shows high resistivity while the red represents low resistivity. The basement in this model shows at 625 meters and a new low-resistivity layer is also indicated t between two resistive layers just above "basement".

The new resistive structures begin to appear in this model within the conductive sandstone siltstone interbedding appear conductive interbedding within the HB sandstone layers. This could possibly be the results of some structural activity that may have folded or faulted the sandstone layers. The conglomerates demonstrate very similar resistivities with the sandstones and therefore due to the relatively thin layers are not as visible in this model

Lithology description	Lithology number	BP label	S. Earle label	vertical depth	Average Resistivity
Overburden	0	OB		-13.6	5000
HB sandstone	10	HB3-8	3	-104.0	1200
HB conglomerate	1	HB1	1	-116.1	
HB sandstone	10	HB3-8	3	-433.1	800
HB conglomerate	1	HB1	1	-452.7	
HB sandstone and siltstone	10	HB3-8	3	-476.1	350
Regolith	100			-480.7	1200
Basement rocks (feldspar porphyry)	120	MV		-536.5	4000

750m Occam Inversion

Distance from centre of loop

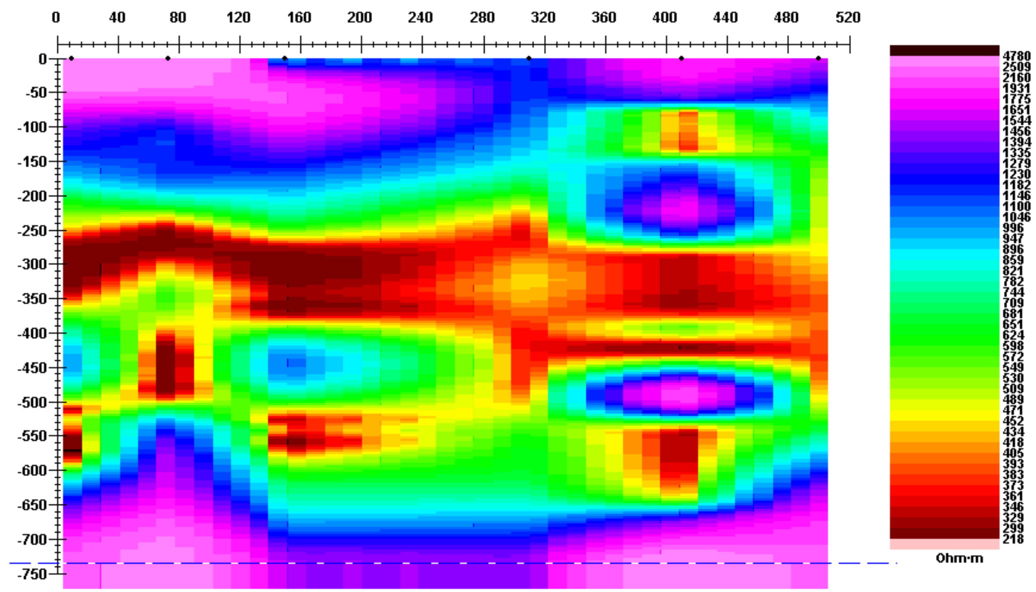
Overburden

sandstone

sandstone siltstone/mudstone interbedding

Resistive sandstone pockets
with basement rocks

Basement at 625m



from March report

Resistivity Depth Information

- HB-05-12

Resistivity Models

The contour below shows the results of the contoured inversion data to a "1D" model for the Marquardt Inversion. The black shows high resistivity where the red represents lower resistivity. The basement in this model shows at 650 meters.

This model shows well the highly resistive overburden and conductive layer within the sandstone layer. It does however extend the conductive layer for a wider depth then seen in the borehole core information and the resistive spot seen in the 750 Occam inversion model are not seen here due to the way Marquardt inversions are computed allowing only 7 layers so some definition will be lost from that. The basement however is still marked at about 700m as in the previous inversion .

Lithology description	Lithology number	BP label	S. Earle label	vertical depth	Average Resistivity
Overburden	0	OB		-13.6	50000
HB sandstone	10	HB3-8	3	-104.0	20000
HB conglomerate	1	HB1	1	-116.1	
HB sandstone	10	HB3-8	3	-433.1	1000
HB conglomerate	1	HB1	1	-452.7	
HB sandstone and siltstone	10	HB3-8	3	-476.1	450
Regolith	100			-480.7	1000
Basement rocks (feldspar porphyry)	120	MV		-536.5	8000

Marquardt Inversion

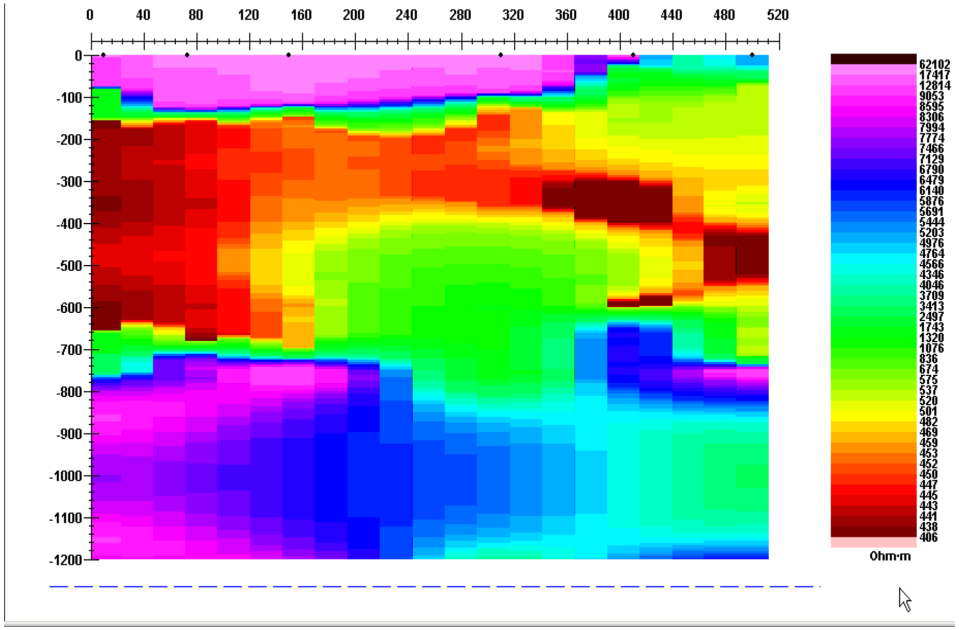
Overburden

sandstone

sandstone with siltstone/mudstone interbedding

Basement at 650m

Distance from centre of loop



***from March report**

Resistivity Depth Information

- <u>HB-05-12</u>

Summary:

The data for HB-05-12 consisted of 10 NS stations (non symmetric) and 9 EW stations (non symmetric). There were 3 stations inside the loop in the EW line and 6 outside and 4 inside the loop on the NS line and 6 outside. There was no zero-zero position on either line which would have allowed us verify data quality and repeatability of the data.

The data for HB-05-12 was relatively good on the NS line, there was although on the EW line some problems in late times, a possibility of some 3D structural effects, so after testing the effects of including the EW line in the stacked data models it was decided not to include the EW line since the problematic channels were effecting the data in late time stacks.

In both NS and EW lines, the log log decay curves showed a steeply dipping resistive response in late time channels within the loop. We interpreted this as a system response not a geological feature. As can be seen in EM models all attempts to model this feature in late times failed.

The core results indicated that there was an resistive overburden followed by sandstone/ conglomerate layers that decrease in resistivity with depth. Interbedding of mudstone/siltstone within the sandstone layers appear as a more conductive layer in our models. The core results show basment rocks at 480m depth. The inversion shows a resistive zone starting just above this depth and possibly peaking at about 460m but then the resistivity falls again before finding much more resistive material at about 650m.

Preliminary modelling/inversion without viewing the drillhole results resulted in model S_Model_Final fitting the inside loop data. S_Model_Final calibrated well with the drillhole results particularly with the early and mid time channels, but it was difficult to model the final four channels in all stacked stations due system response as mentioned previously. As seen two inversion models were plotted to further verify and discriminate.

All modelling and inversion results indicate the same main factors:

1. Moderately thick very resistive overburden covering
2. a resistive sandstone increasing in conductivity with depth
3. Interbedding of mudstones and siltstones within the thick sandstone layer showing as relatively conductive layer within the sandstones layer at 360m down to 420m.
4. The models fit the drillhole results reasonably well with the depth to the resistor at 460m. The data also shows a conductor from 360m to 420m where there is increased interbedding of siltstones and mudstones. But in both inversion techniques, the models strongly indicate that the "true" is in fact deeper at around 650-700 meters.

16 March 2006

from March report

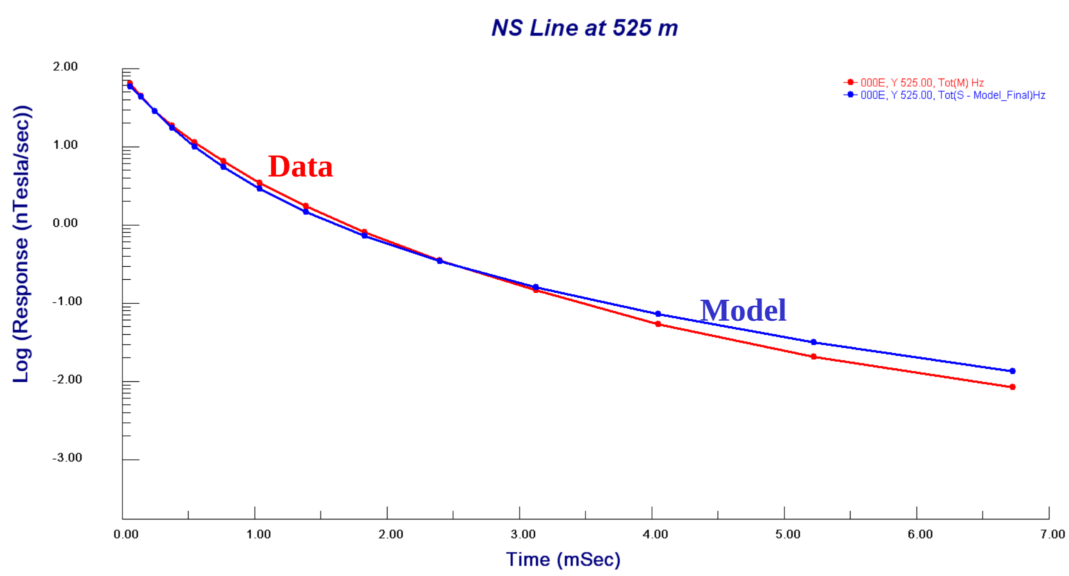
HB-05-12 Ground Data

Core Data

Lithology description	vertical depth
Overburden	-13.6
HB sandstone	-104.0
HB conglomerate	-116.1
HB sandstone	-433.1
HB conglomerate	-452.7
HB sandstone and siltstone	-476.1
Regolith	-480.7
Basement rocks (feldspar porphyry)	-536.5

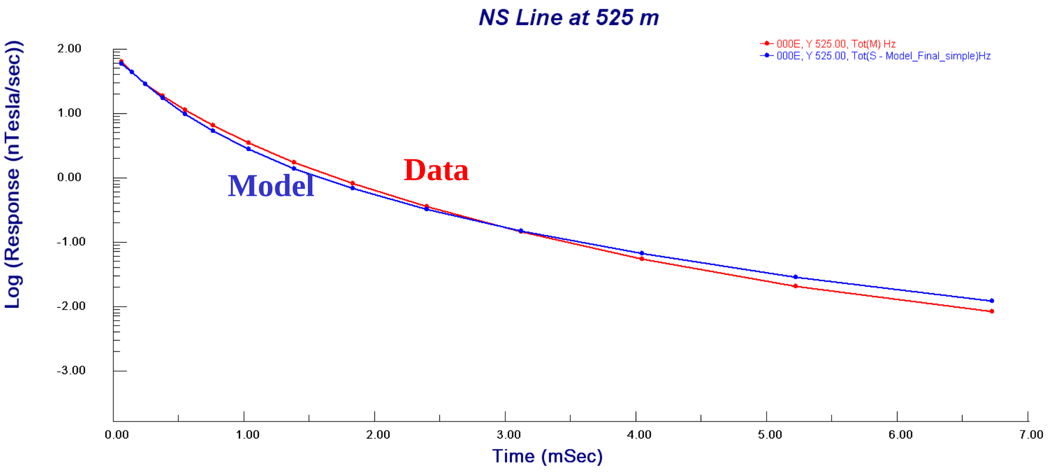
In previous modeling, a layered earth model for the ground data was developed. This model fits the ground data very well.

*The response inside the loop was smaller than the response outside the loop at late times, possibly due to a system response.

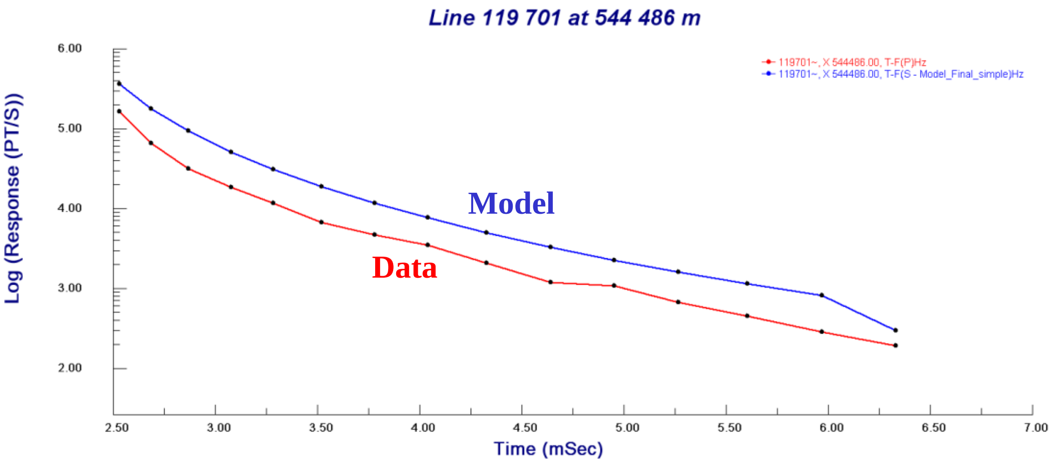


HB-05-12 Ground Model

Ground Data



Airborne Data



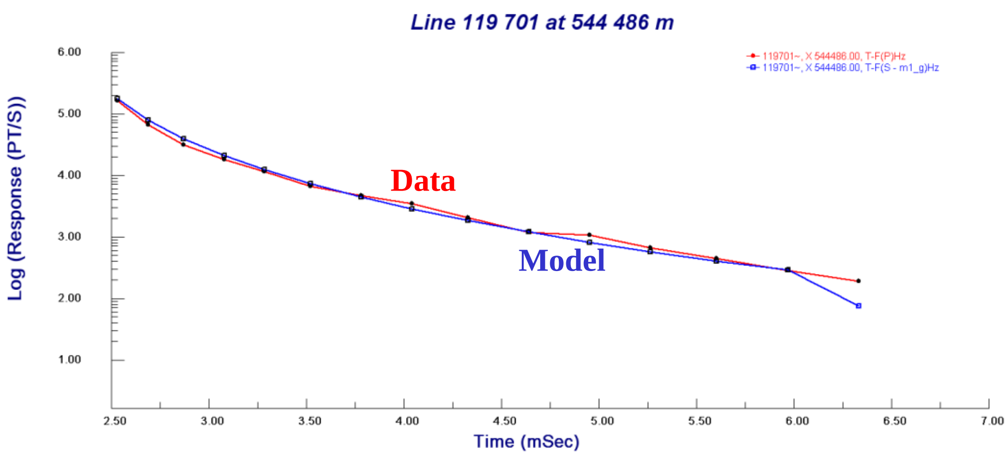
The previous model was simplified to develop a new model with a very similar response. However, the amplitude of the model is too large for the airborne data, although the shape is similar. Profile plots of the data, which are fairly symmetrical, do not suggest the presence of a significant target, and adding a small target makes the response much too large at early-mid times.

Ground Model

Resistivity (Ohm m)	Thickness (m)
100,000	50
10,000	100
500	110
350	200
1,000	370
5,000	500
50,000	

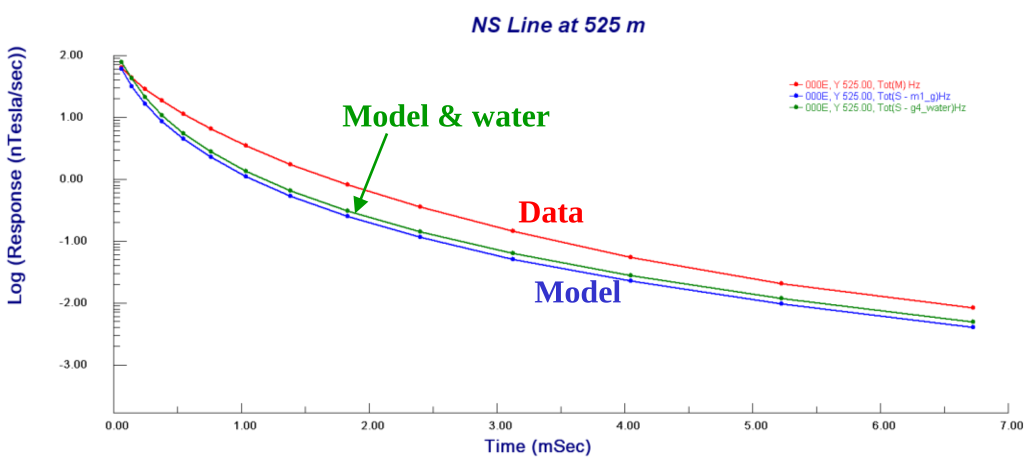
HB-05-12 Airborne Model

Airborne Data



A model was developed to fit the airborne data. Some of the resistivities at depth in the ground model were increased, and a good model was obtained. However, the amplitude of the response for the model is too low for the ground data, even with a conductive layer overtop to account for possible water at surface when the ground data was collected.

Ground Data

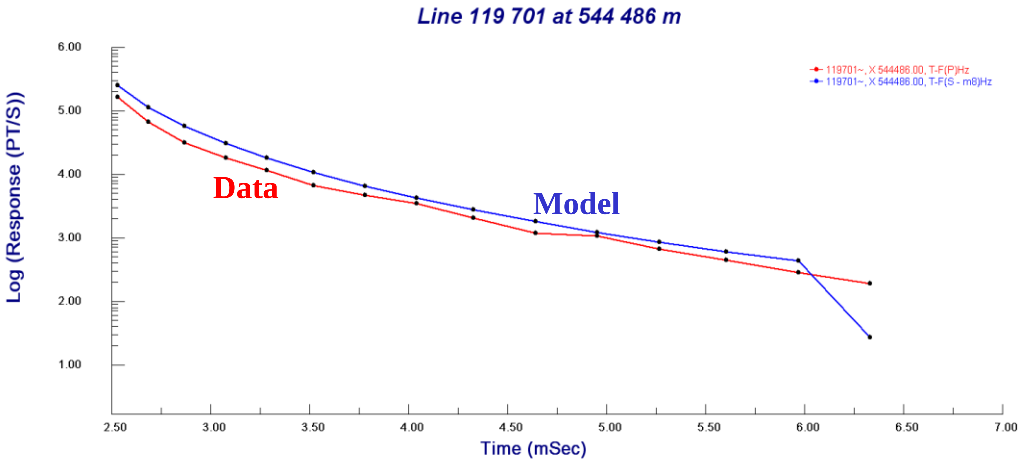


Airborne Model

Resistivity (Ohm m)	**Thickness (m)**
100,000	50
10,000	100
1,000	110
850	200
1,000	370
5,000	500
50,000	

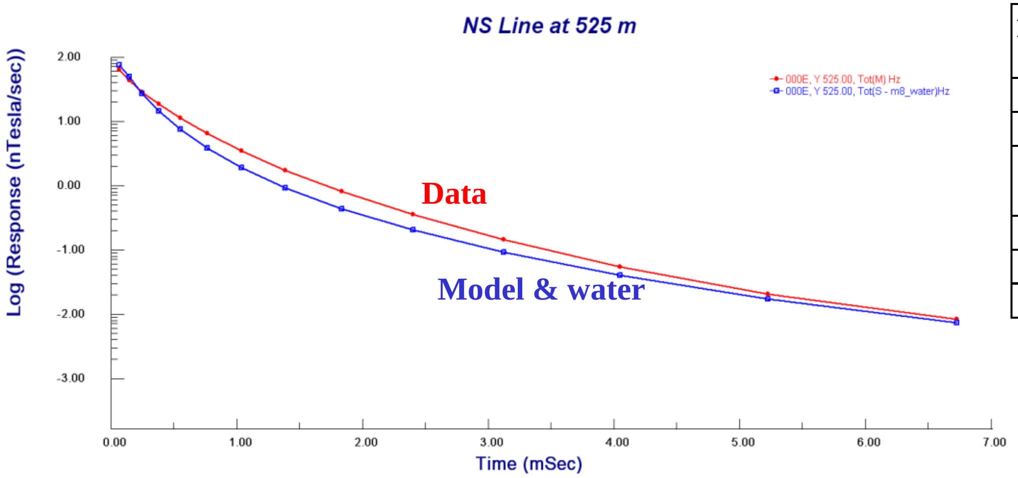
HB-05-12 Further Modeling

Airborne Data



Further modeling focused on finding a model to fit both data sets. A thin conductive layer was added to the model for the ground data to raise the amplitude of the response. An overall better model (Model 8) was found; however, the amplitude of the response from the model is too large for the airborne data, and still too small for the ground data.

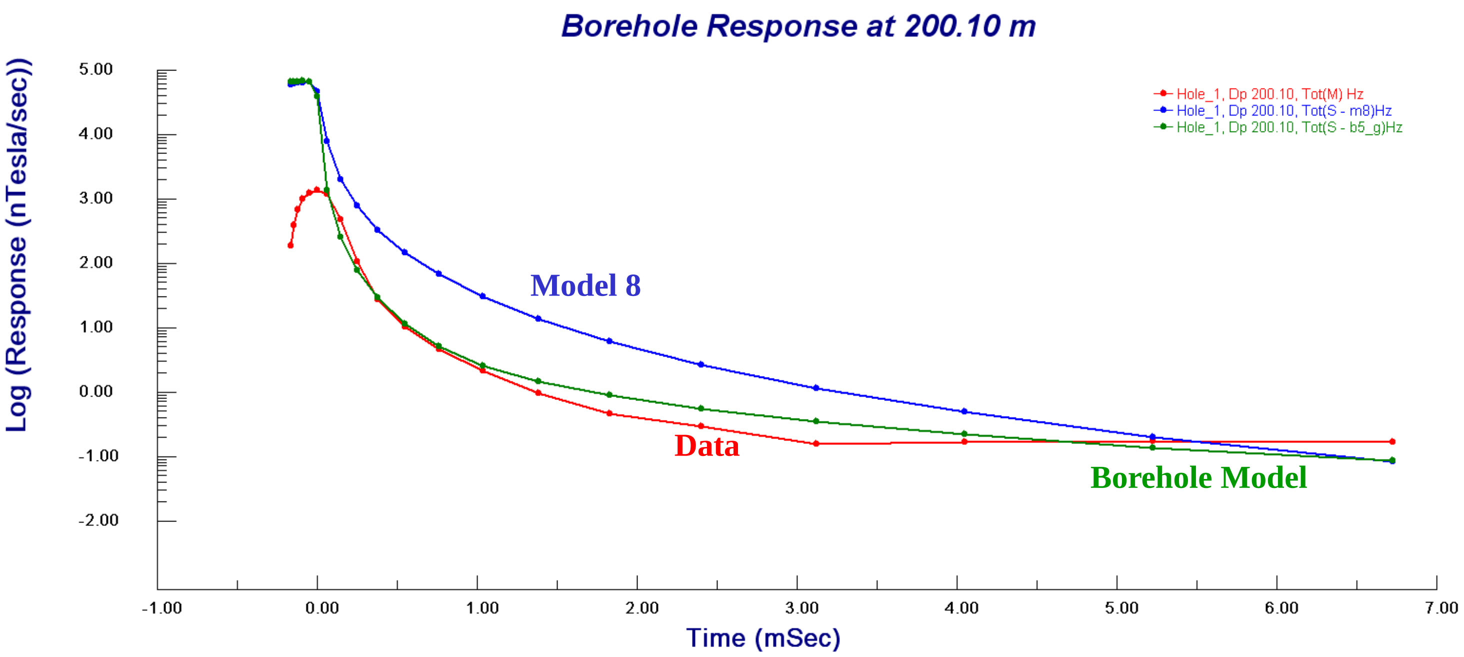
Ground Data



Model 8

Resistivity (Ohm m)	Thickness (m)	Vertical Depth (m)	Lithology
100,000	50	-50	overburden/sandstone
10,000	100	-150	sandstone
625	310	-460	sandstone/conglomerate with mudstone interbeds
1,000	370	-830	regolith/basement
5,000	500	-1,330	basement
50,000			

HB-05-12 Borehole Model

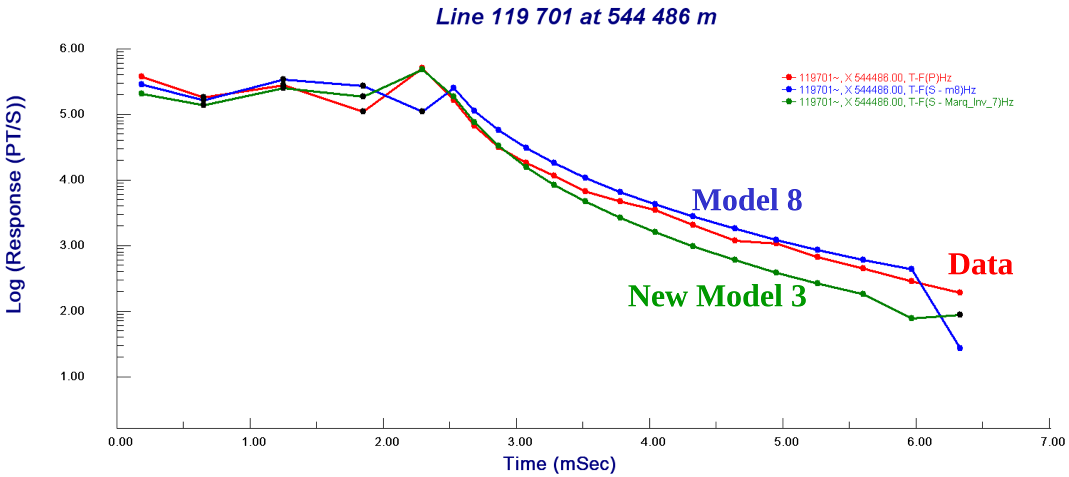


Model 8 does not fit the borehole data very well. The amplitude is too large and the shape of the curve does not match the data well at later time channels. A new model was created that fits the borehole data quite well in the off-times. The resistivity was increased at mid-depths to make the curve steeper at early times, and a conductor was added at depth to make the curve shallower at late times. However, the amplitude of the model is significantly greater than the data in the on-time channels. This may be due to a problem with the data in the on-time.

Borehole Model

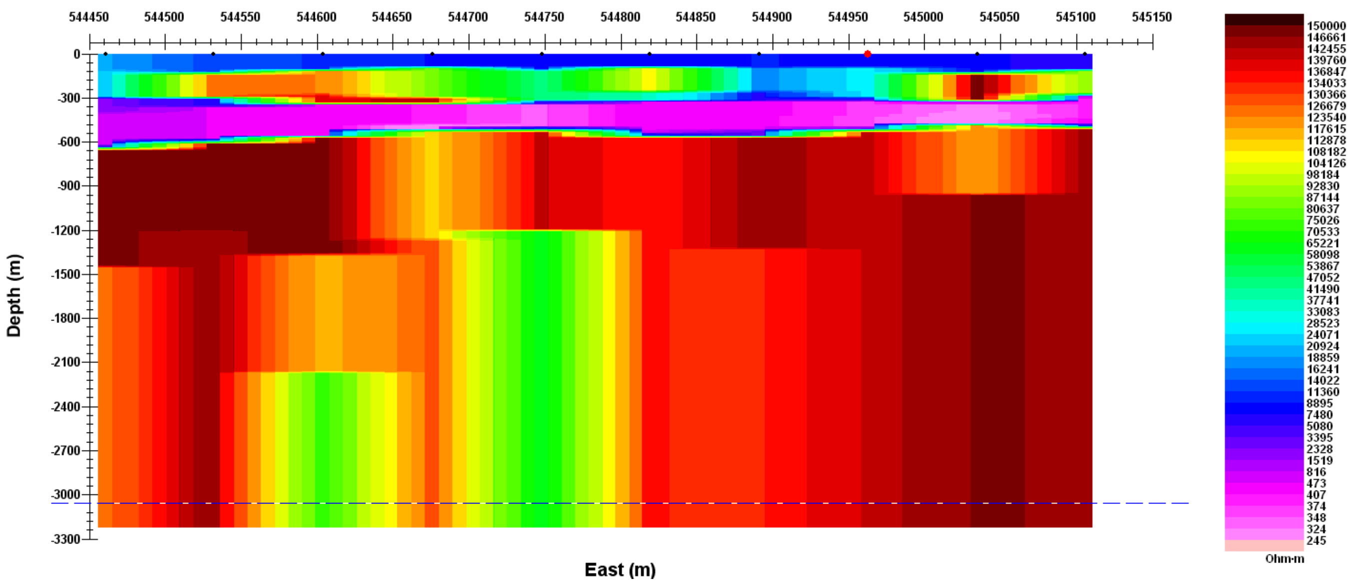
Resistivity (Ohm m)	**Thickness (m)**
100,000	50
10,000	100
3,000	680
10,000	1,200
500	

HB-5-12 Airborne Inversion

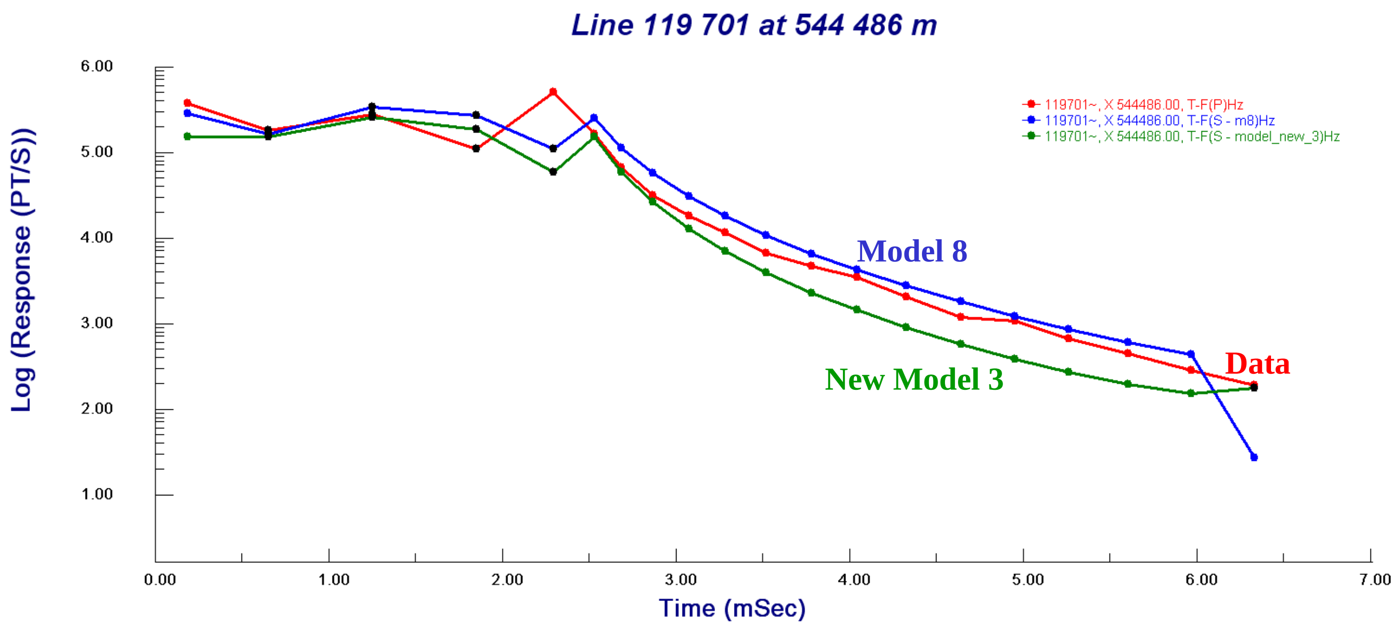


In previous work, inversions were performed on the ground data. Marquardt inversions on the airborne data were used to investigate the structure of the subsurface. Of interest in these inversions is the presence of a good conductor from about –300 m to –500 m, a very resistive basement, and a conductor at depth in the western part of the region.

Marquardt Inversion, Line 119 901



HB-05-12 Airborne Modeling

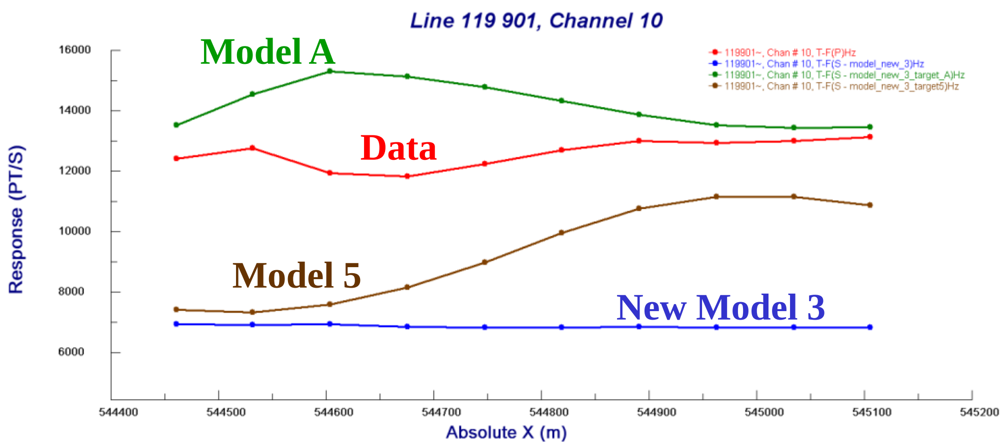


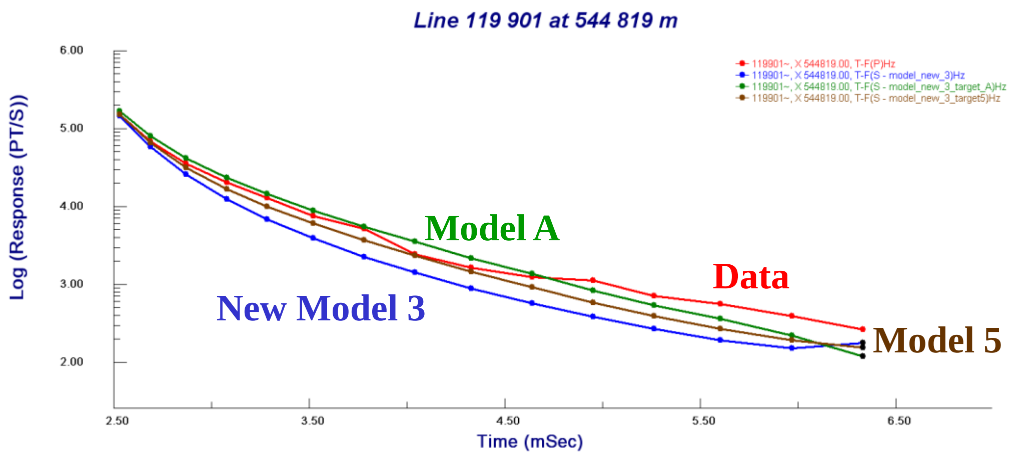
Based on the results of the inversion, a new layered earth model was developed, containing a less resistive overburden and higher resistivities at depth. As shown in the decay curves, this results in a lower response than Model 8.

New Model 3

Resistivity (Ohm m)	Thickness (m)	Vertical Depth (m)	Lithology
4000	100	-100	Overburden/Sandstone
8000	200	-300	Sandstone
400	150	-450	Sandstone/Siltstone
10000			Basement

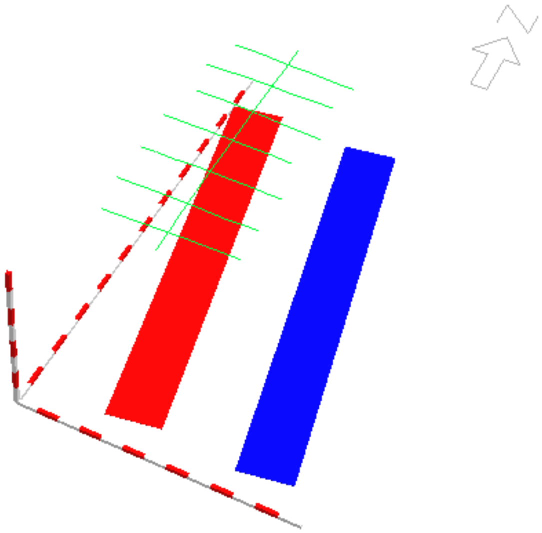
HB-05-12 Airborne Modeling with Targets





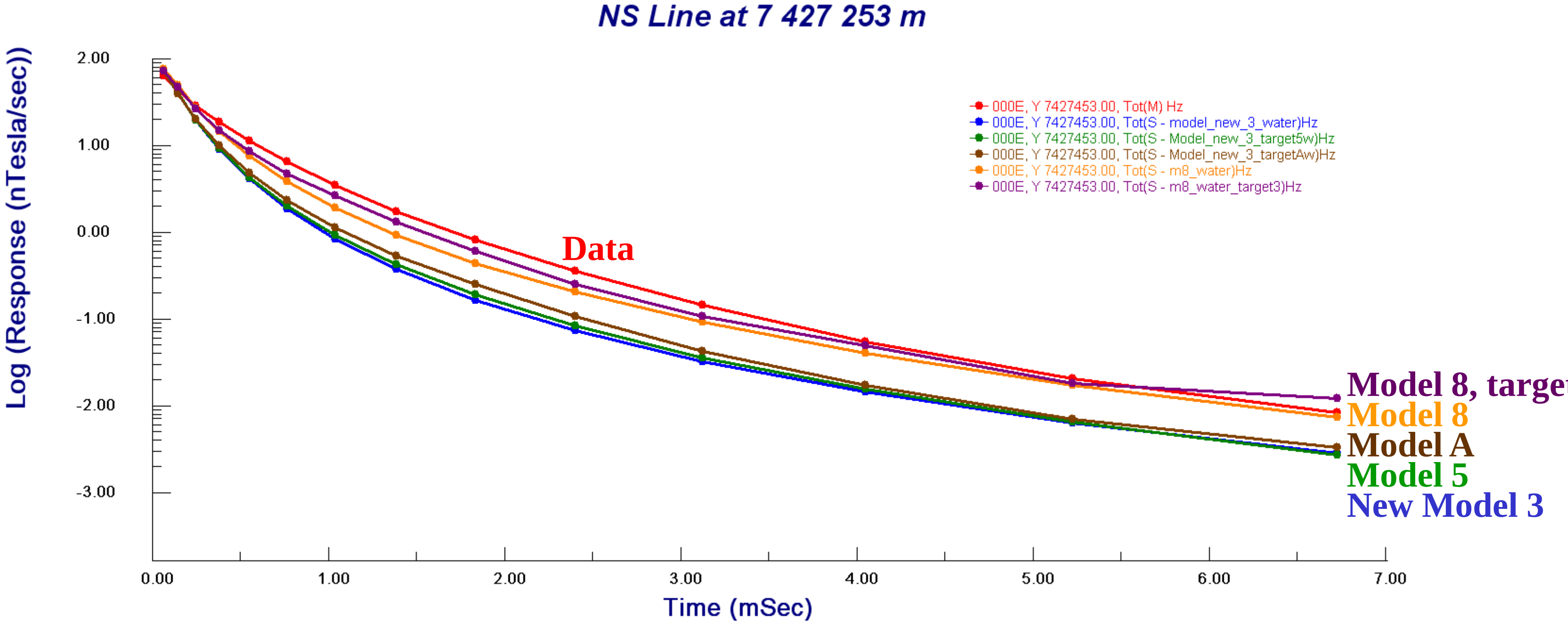
Based on the Marquardt inversion, a target was added to the new layered earth model, which increased the response of the model. Model A contains two flat plates at 600 m depth. Model 5 contains a dipping plate.

Model A



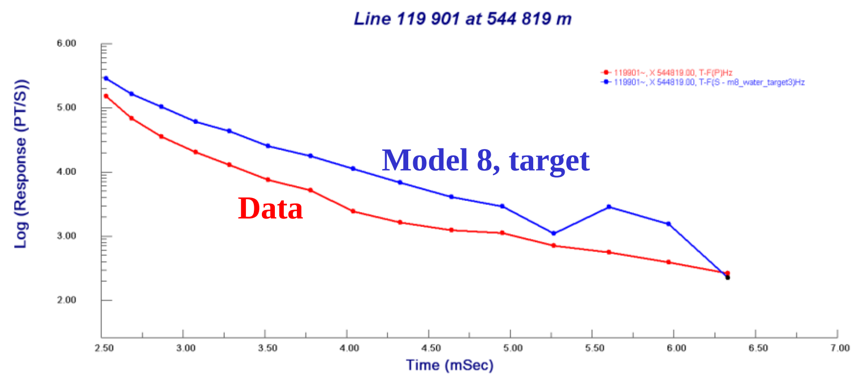
HB-05-12 Ground Modeling with Targets

Ground Data

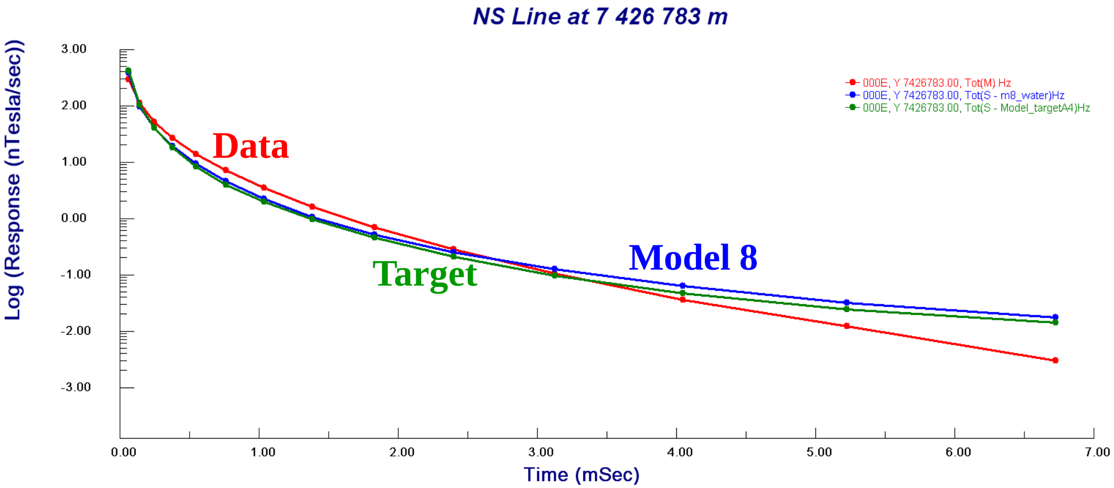


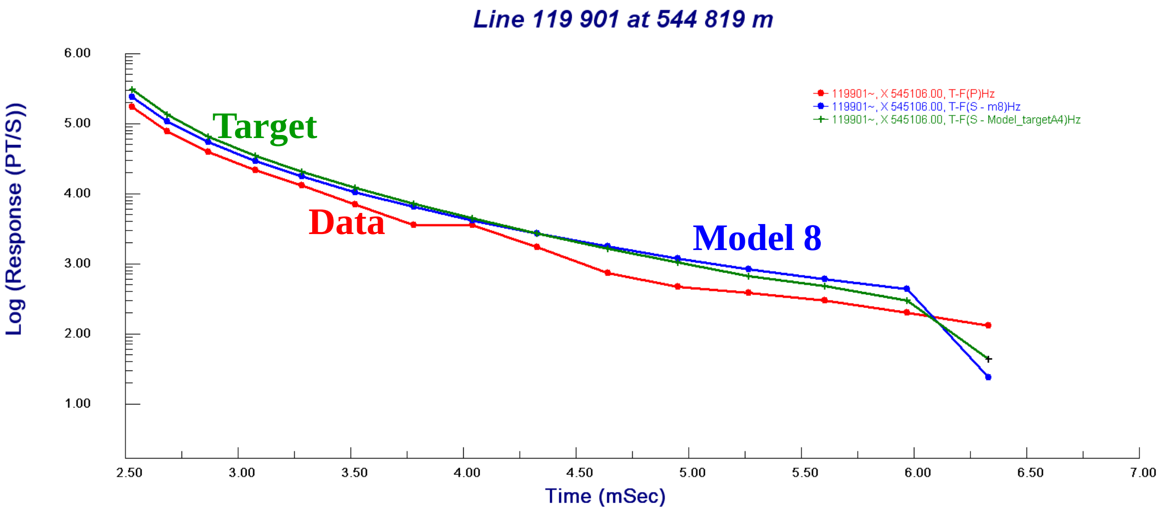
The amplitudes of the responses for Model A and Model 5 are too small for the ground data. The previous layered earth model, Model 8, fits the data much better. When a long, horizontal target was added at –440 m to Model 8, the response fit the data slightly better than Model 8; however the amplitude of the curve was too large for the airborne data

Airborne Data



HB-05-12 Further Modeling



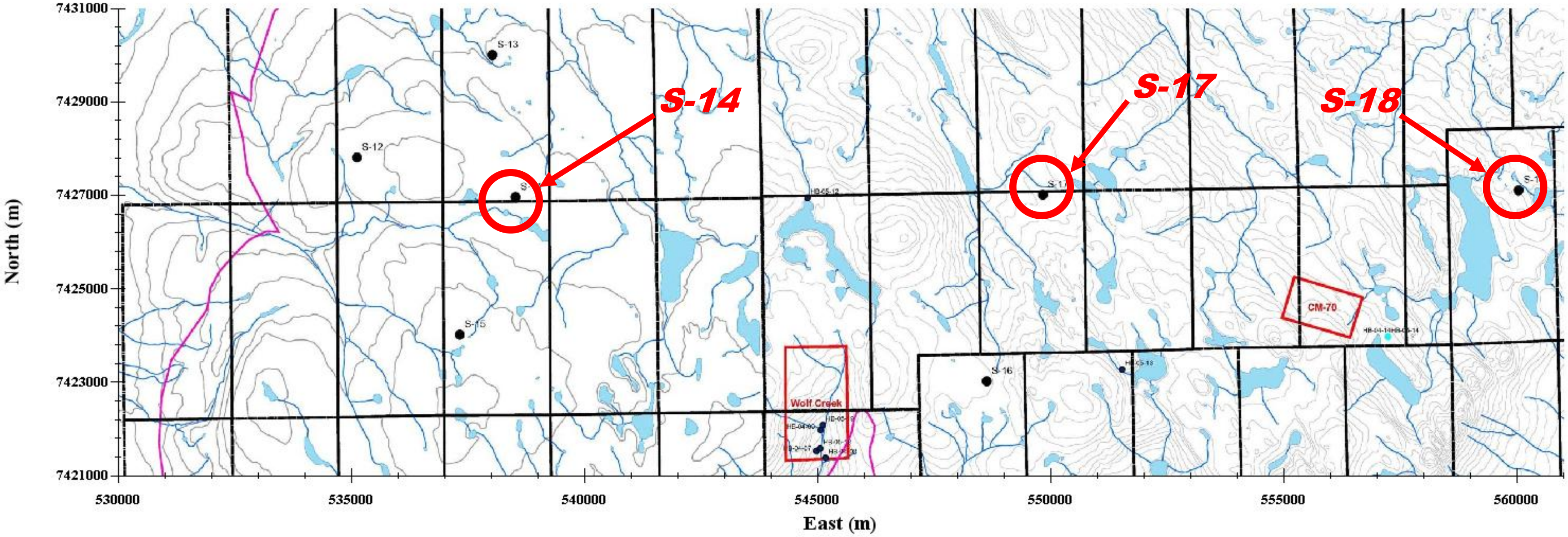


The new layered earth model was modified so that it would fit the ground data better. A target, like the one that was added to Model 8, was put into the new layered earth model. This new model not fit the data better than Model 8. Additional modeling may assist in developing a slightly better layered earth model and target to fit the different types of data; however, it has been very difficult to find a model that matches both the airborne and ground data in current modeling.

HB-05-12 Conclusions

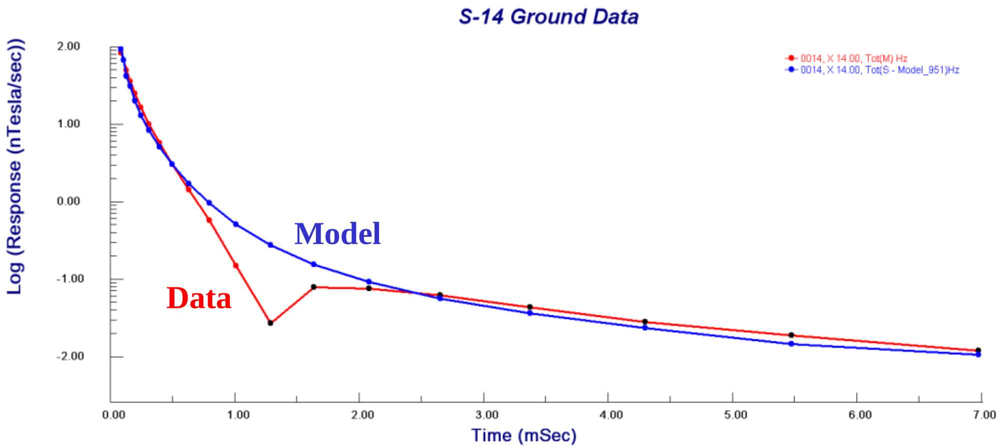
- The previous model for HB-05-12 fits the ground data very well, and can be simplified to 7 (rather than 11) layers without producing any significant changes in the response.
- A good model was developed for the airborne data, with higher resistivities at a few hundered meters than the model for the ground data.
- The mismatch between the MegaTEM and ground data for HB-05-12 is very similar to that for HB-05-13. In both cases, a good model for the ground data produced a response with a similar shape, but a much greater amplitude, than the airborne data. For both boreholes, this was partially accounted for by water at the surface when the ground survey was performed. In both cases, the final model matched the ground data well at very early times, and at late times, but the response was too low between 0.5 s and 3 s.
- Model 8 was developed to fit both the ground and airborne model as well as possible. It contains a resistive sandstone underlain by a more conducting sandstone interbedding with siltstone/mudstone, and a resistive basement.
- Model 8 does not match the borehole data very well. The amplitude is too large at most time channels, and the shape of the curve is not a good fit at late times. A better model for the borehole data contains more resistive layers at a few hundred meters, and a conductor at depth.
- Adding targets to the subsurface improved the fit with the airborne data, which can be observed particularly in the profile plots. However, these models did not match the ground data well, and a model with a target that fit both the airborne and ground data better than Model 8 was not found.

S-14, S-17 and S-18

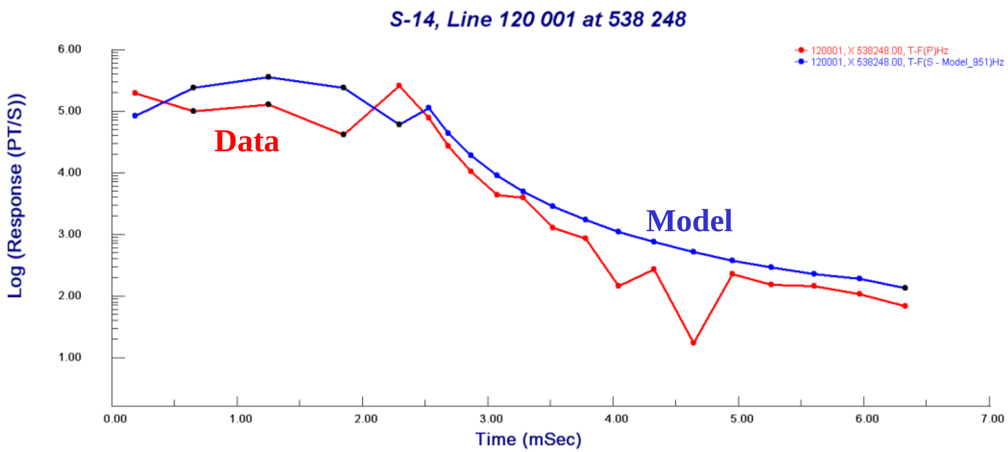


It was noted that in some locations in the region, the model for the ground data fit the airborne data reasonably well, but in other areas, it did not. For both HB-05-12 and HB-05-13, and to some extent S-16, the model for the ground data had too large of an amplitude when compared to the MegaTEM data. However, in CM-70, the two data sets correlated well. S-14, S-17, and S-18 were examined to see how the amplitudes of the response correlated. For each of this points, ground data was taken only at the center of the loop.

S-14



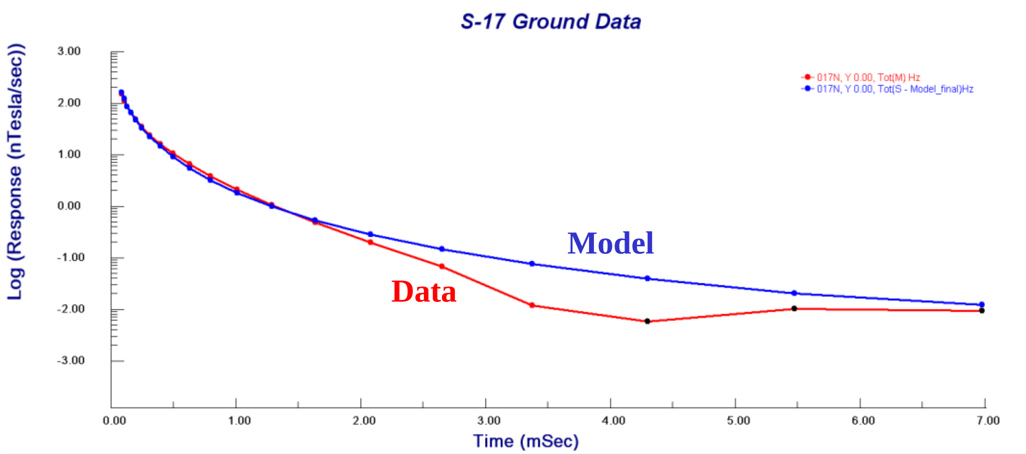
The ground model for S-14, developed with the assistance of a Marquardt inversion, contains a resistive sandstone layer above the basement and a conductor underlying the basement. The amplitude of the ground model is slightly too large for the MegaTEM data.

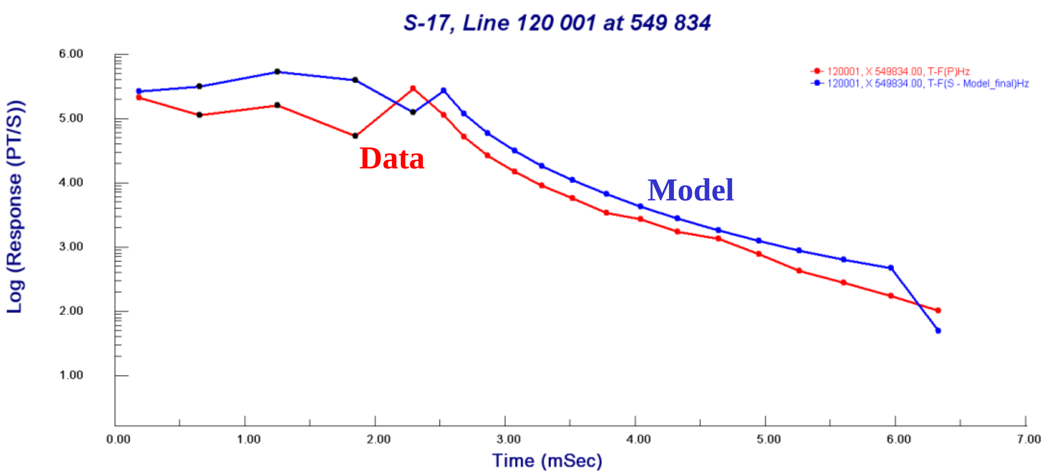


Ground Model

Resistivity (Ohm m)	Thickness (m)	Depth to Bottom (m)	Lithology
1900	1000	-1000	Sandstone
15000	1000	-2000	Basement
310			Conductor

S-17





The ground model for S-17 contains sandstone and less resistive sandstone with mudstone interlayers above the basement. The amplitude of the ground model is too large for the MegaTEM data, but the discrepancy is not as large as it is for HB-05-12 and HB-05-13.

Ground Model

Resistivity (Ohm m)	Thickness (m)	Depth to Bottom (m)	Lithology
1710	192	-192	Sandstone
1060	39	-231	Sandstone
680	450	-681	Sandstone/ Siltstone
5000			Basement

S-18-3

Loop: 400x400
Stations:
  NS - 3 - inside
  EW - 9 – inside/outside
Symmetric : No
On Channels: 6
Saturated: Yes
Negative Off:
  Inside: 1
  Outside: 0

S-18-3, as in some other soundings, was collected with a non-standard time delay between the end of the current shut-off (ramp or turn-off).The normal time delay places the 20 time channels in a basically logarithmic sequence during the off-time (current off). For a variety of reasons, it can be useful to measure during the turn-off (sometimes termed "the pulse"). As a result, Geonics in an attempt to match competitors abilities have allowed an operator shift in the delay time to allow for measurement during the ramp. This ability is almost necessary for borehole data and can be very effective for ground data to discriminate weak and strong conductors.

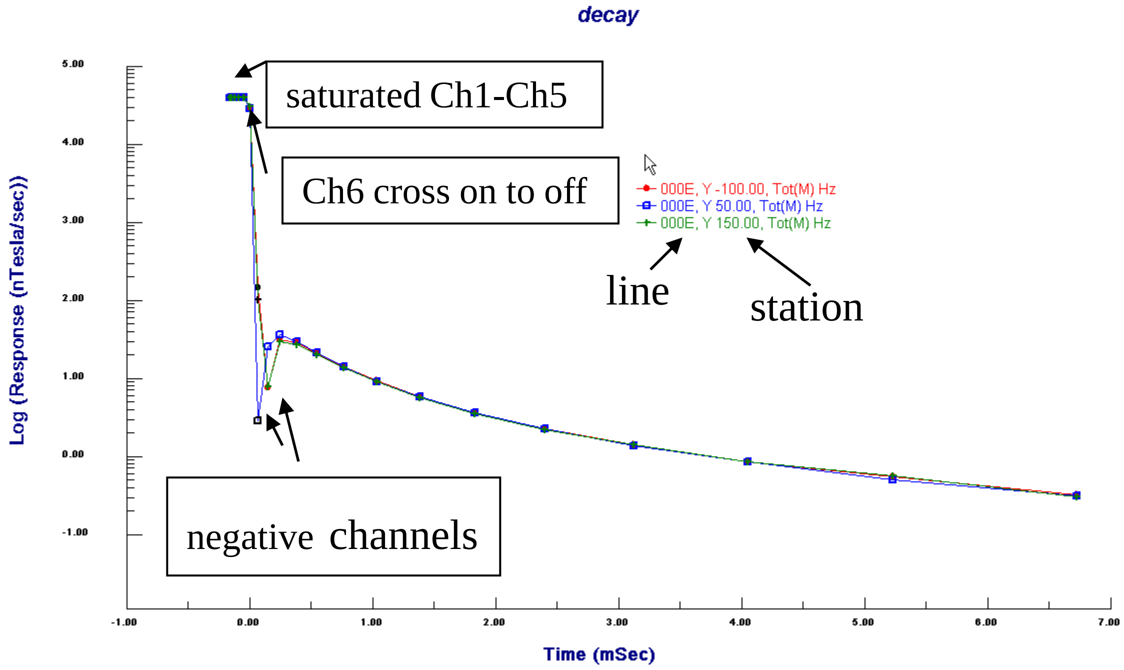
However, there are potential problems with system saturation inside the loop and near the wires. This is what is seen in S-18-3. In addition, S-18-3 shows other problems such as early off-time negatives. This report will try to illustrate these points.

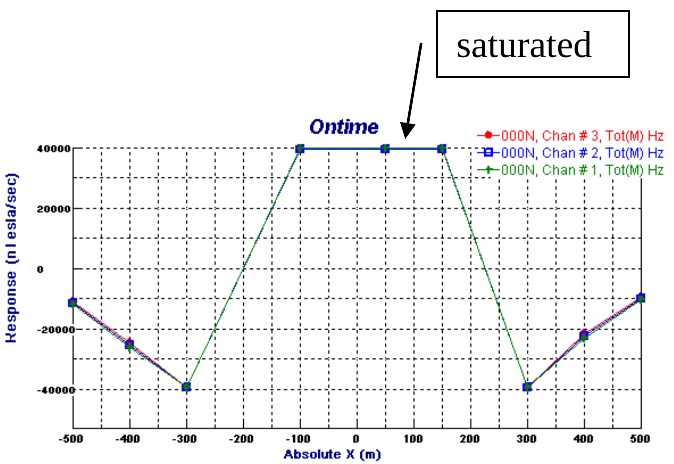
from preliminary report

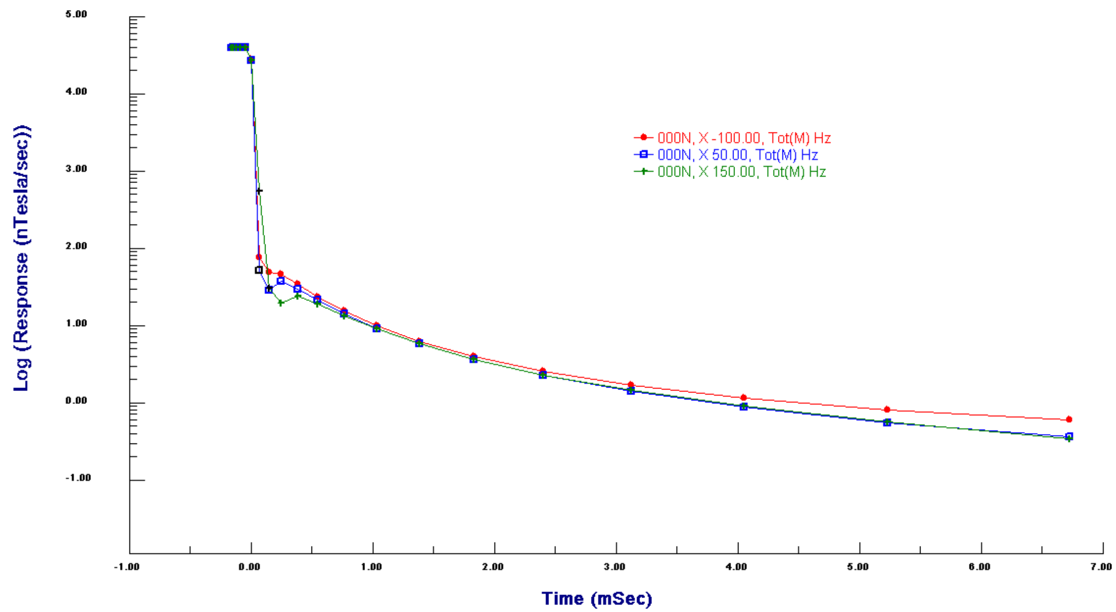
in loop decays –NS and EW lines

S-18-3

Loop: 400x400
Stations:
  NS - 3 - inside
  EW - 9 – inside/outside
Symmetric : No
On Channels: 6
Saturated: Yes
Negative Off:
  Inside: 1
  Outside: 0







from preliminary report

S-18-3

Additional Comments:

Saturated ON channels

Non-symmetric measurements

No centre loop measurements (ie. (0,0))

Outside Loop data – OK, Inside Loop data – problematic

Line 000N:

All inloop stations have saturated ON-time measurements

Early off-time data are negative and problematic decays and curvatures

CH10 and greater are okay for inloop stations

All off-time data good for out-of-loop stations

Line 000E:

All inloop stations have saturated ON-time measurements

Early off-time data are negative and problematic decays and curvatures

CH10 and greater are okay for inloop stations

No out of loop measurements

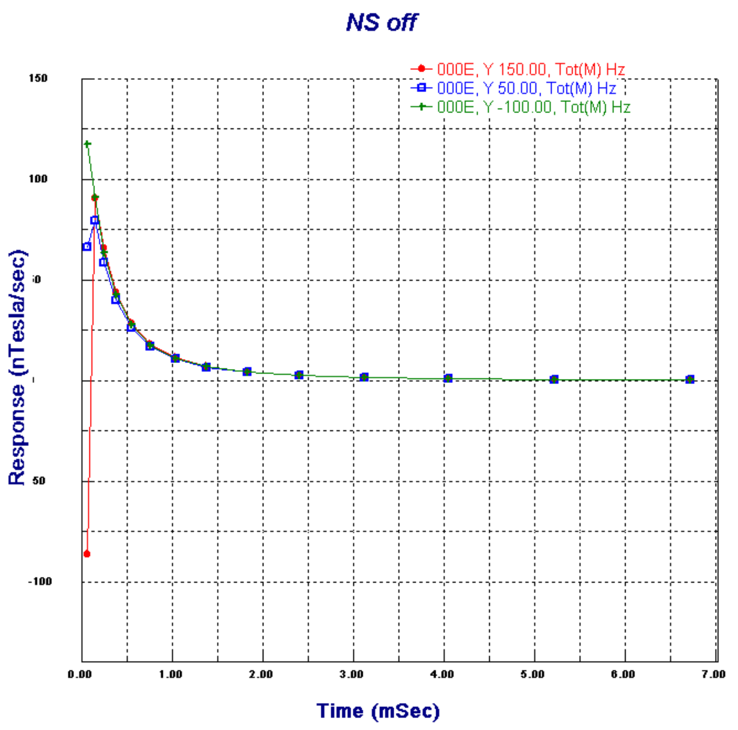
from preliminary report

S-18-2 (May)

S-18-2 was first read on May 20, 2005 and then again on June 13, 2005. The first of these surveys will be termed – S-18-2 (May) and the second S-18-2 (June).

Loop: 200x200
Stations:
  NS - 9 (inside,outside)
  EW – 3 (inside only)
Symmetric : No
On Channels: 6
Saturated: Yes
Negative Off:
  Inside: 3 stations
  Outside: 0

Most interior stations have Ch7<Ch8 with data appearing that they are recovering from a negative early in-time. This transition is normally seen outside the loop as the current migrates out past the station. But, the outside loop stations do not show this passing of the current during the migration process. This would appear to be some system response arising from the saturated on-time data.100E is the only inside loop station with apparently good off-time data for all channels. Whether the remaining off-time channels inside the loop needs to be discussed with the instrument manufacturer.



from preliminary report

S-18-2 (May)

Additional Comments:
Saturated ON channels
Non-symmetric measurements
No centre loop measurements (ie. (0,0))
Outside Loop data – OK, Inside Loop data – problematic

Line 000E:
Early off-time data are negative and problematic decays and curvatures
CH8 and greater appear satisfactory for inloop stations
All off-time data good for out-of-loop stations

Line 000N:
All inloop stations have saturated ON-time measurements
Early off-time data are negative and problematic decays and curvatures
CH10 and greater are okay for inloop stations
No out- of- loop measurements

from preliminary report

S-18-2 (June)

S-18-2 was first read on May 20, 2005 and then again on June 13, 2005. The first of these surveys will be termed – S-18-2 (May) and the second S-18-2 (June).

Loop: 400x400 Stations: EW – 11 (inside/outside) Symmetric : Yes On Channels: 3 and 0 Saturated: Yes ON Negative Off: Inside: 3 stations Outside: 0

In June, the EW line was read twice. Once, with on-time channels (2 plus a crossing channel) and once with standard delays and thus no on-time.

The on-time channels (2) are saturated inside the loop and Ch3 which crosses the turn-off is also problematic. Although, Ch4 is not negative inside the loop, all Ch4 data both inside and outside is questionable. However, the balance (16 channels) appear good both inside and outside.

For the standard readings with 20 off-time, the first channel is obviously bad. This is a system issue and it is unclear whether there is some relation to the bad early off-time data when the starting channels are set to be during the turn-off ramp.

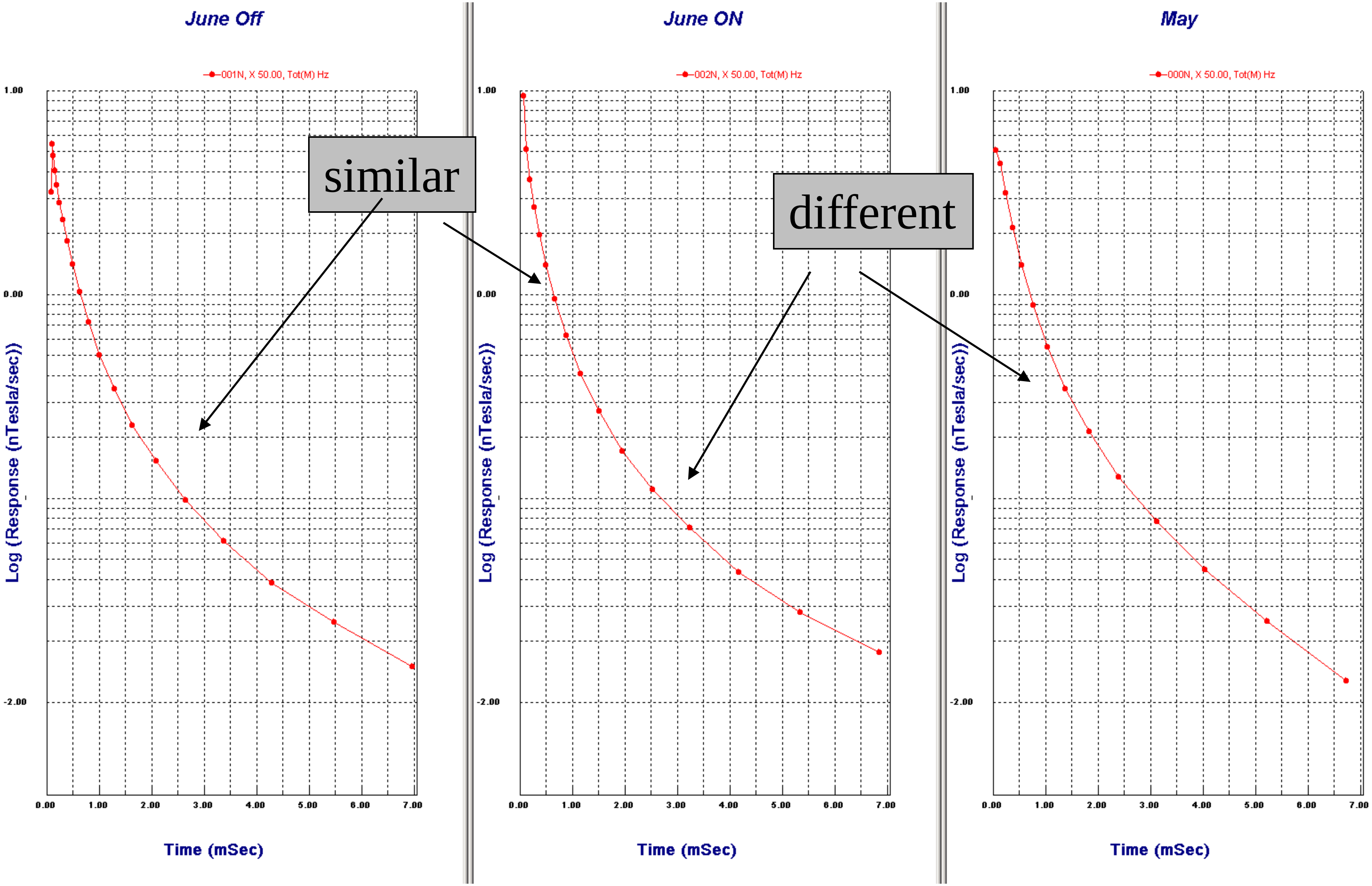
Thus, there are 3 comparisons to be made at this stage for the EW line. Off-time from the May survey and off-time from the two June readings.

from preliminary report

S-18-2 (May/June)

from preliminary report

At 50E on EW Line



June – from On

June – from Off

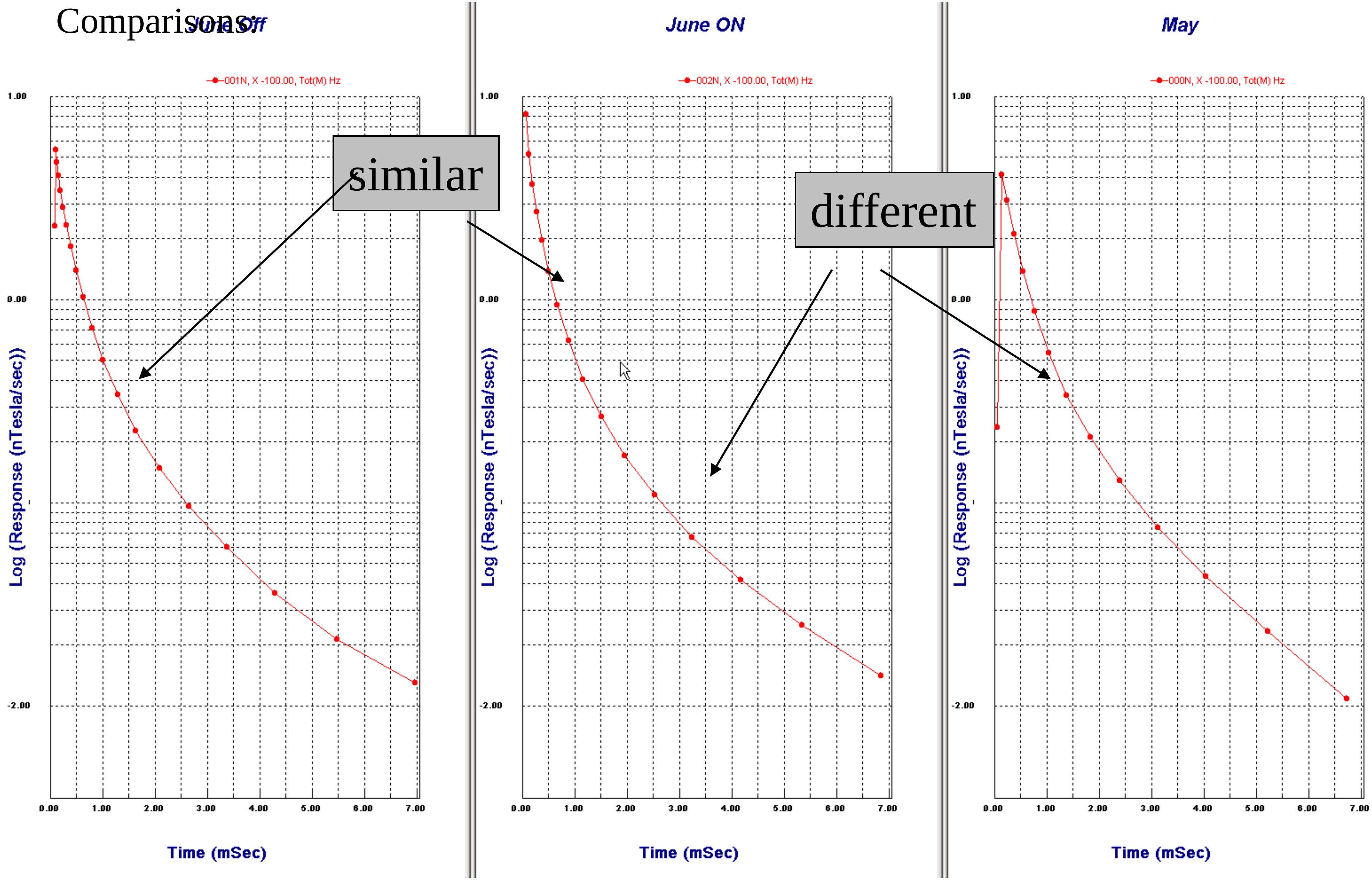
May

S-18-2 (May/June)

At 100W on EW Line

***from preliminary report**

Comparisons:



June – from On

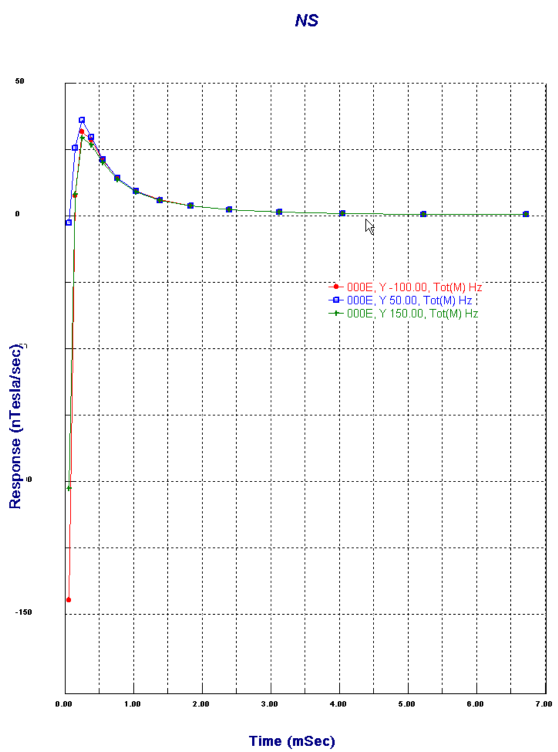
June – from Off

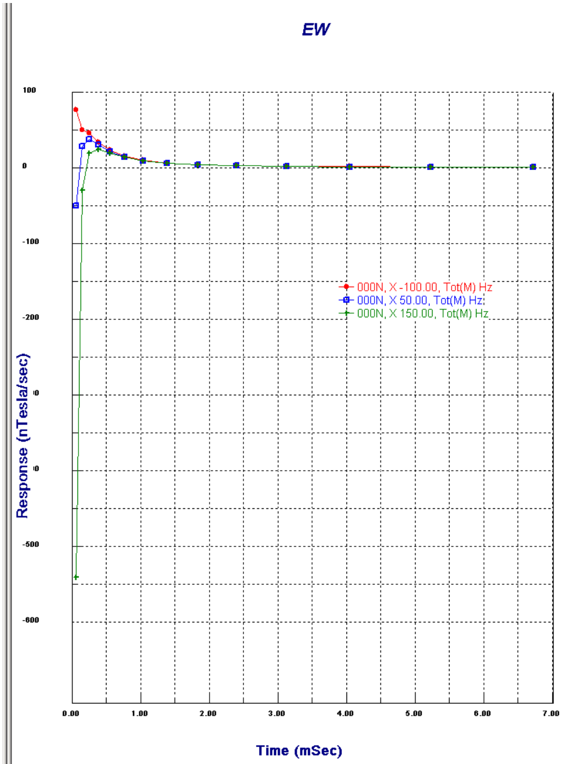
May

S-18-1

Loop: 400x400
Stations:
  NS - 3 - inside
  EW - 9 – inside/outside
Symmetric : No
On Channels: 6
Saturated: Yes
Negative Off:
  Inside: 5
  Outside: 0

All inside points in NS line go below zero and then recover by Ch9. 2 stations on EW are similar while the other station has odd Ch7-8 response.



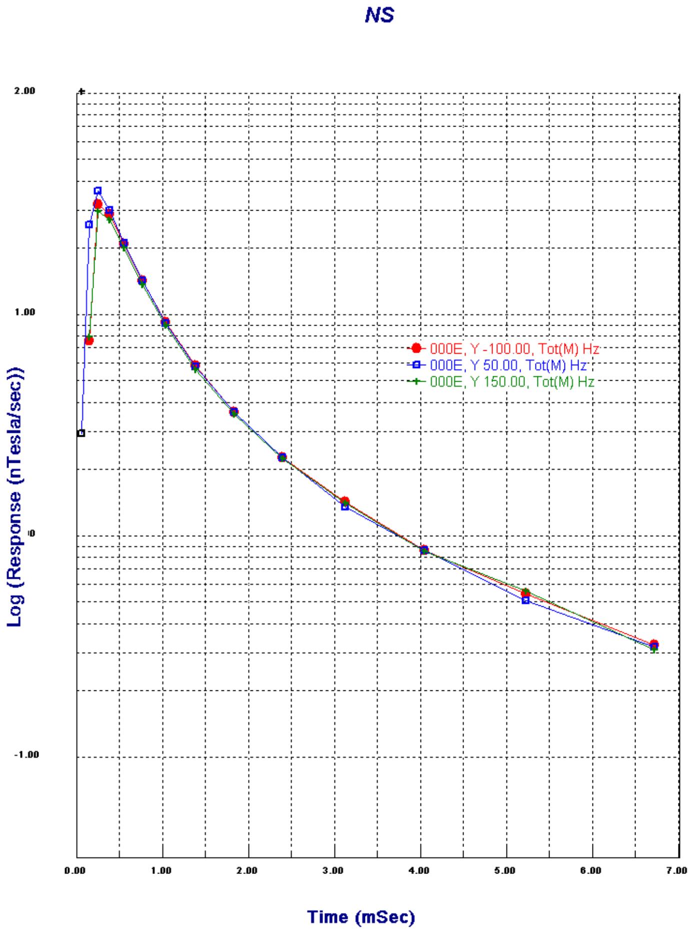


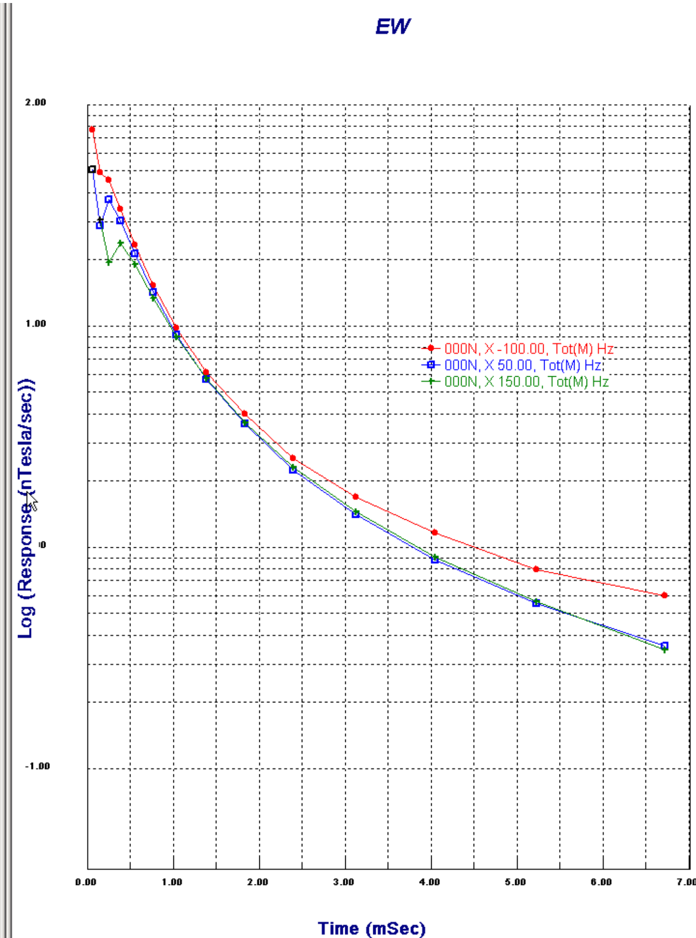
from preliminary report

linear-linear

S-18-1

From Ch9-20, all stations on NS line (inside loop) are similar.
2 stations on EW line are comparable but 100W is quite different.

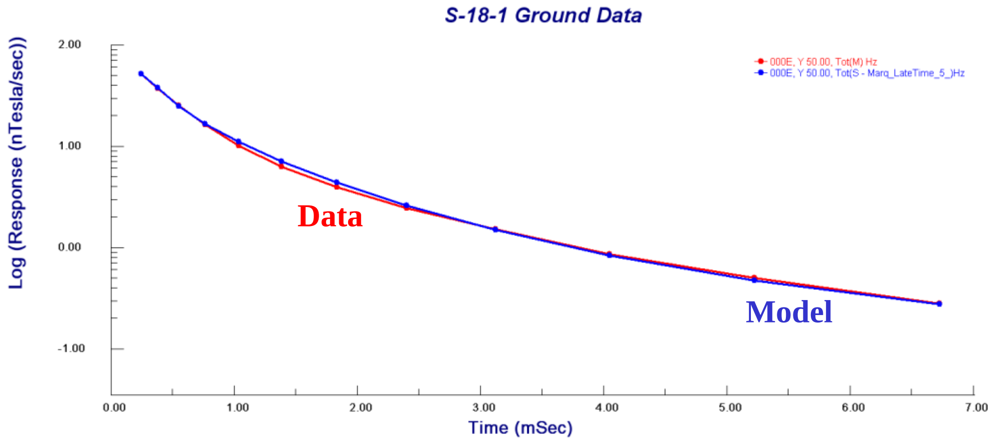




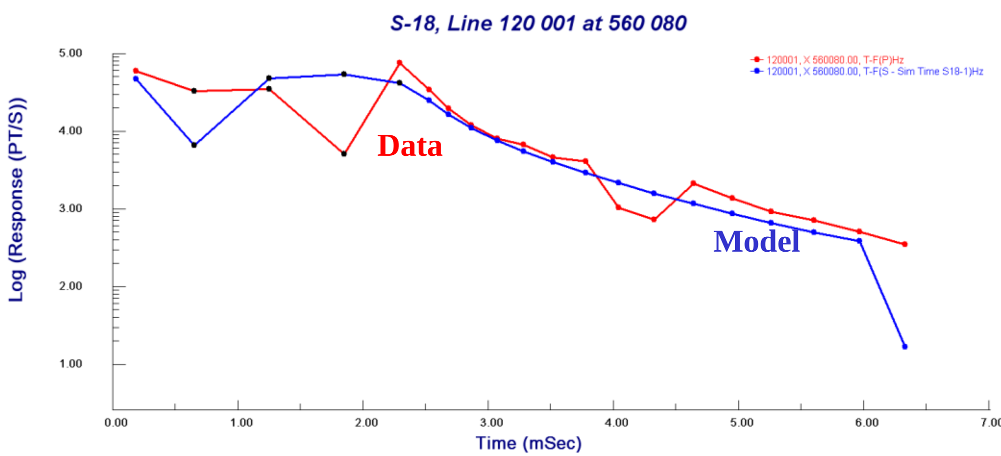
from preliminary report

linear time –log amplitude

S-18



The ground model for S-18-1, developed usinga Marquardt inversion, contains a resistive sandstone layer and a conductor underlying the basement. The amplitude of the ground model approximately the correct amplitude for the MegaTEM data.



Ground Model

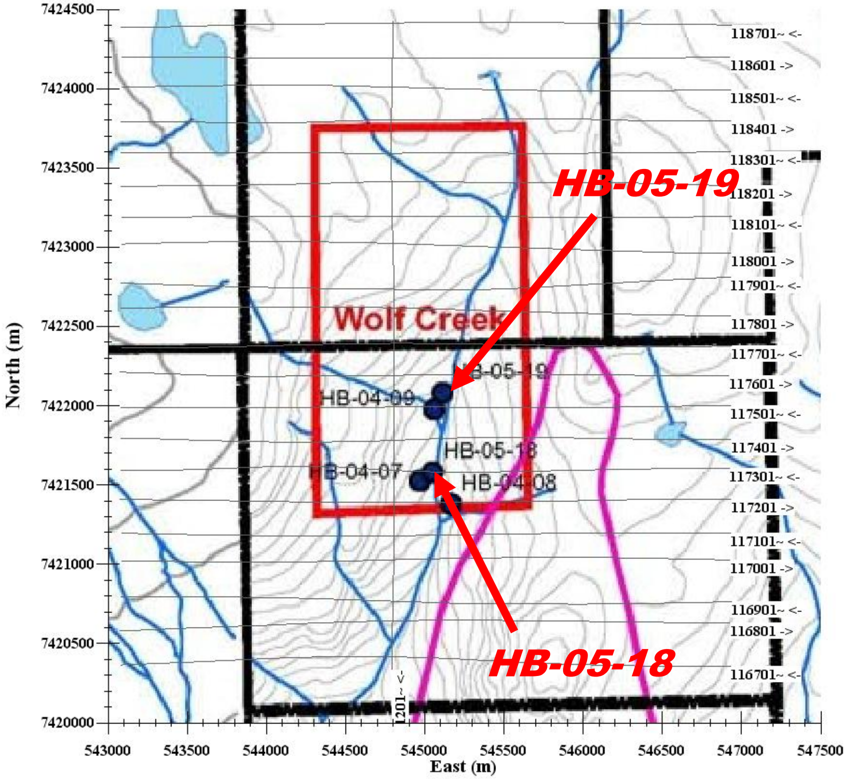
Resistivity (Ohm m)	Thickness (m)	Depth to Bottom (m)	Lithology
23768	283	-283	Sandstone
81993	312	-595	Sandstone
51875	244	-839	Basement
394	1281	-2120	Conductor
37			Conductor

Conclusions for S-14, S-17 and S-18

- The amplitude of the ground data is slightly too large for the MegaTEM for S-14 and S-17, but is the correct amplitude for S-18.
- For both S-14 and S-18, the ground model contains resistive sandstone overlying the basement, and a possible conductor below the basement.
- For S-17, the ground model contains a less resistive sandstone/siltstone layer above the basement, and no conductor at depth.
- The poor correlation between the airborne and ground TEM data at some locations may be related to structure.

Resistivity Information for Wolf Creek

HB-05-18 (545 027 m, 7 421 557 m)
HB-05-19 (545 089 m, 7 422 057 m)



TEM data were used to develop a model of the resistivity of the subsurface. Several types of data are available for Wolf Creek: MegaTEM, ground TEM for HB-05-19, and borehole data for both HB-05-18 and HB-05-19. Core data is available for both of these boreholes as well. Forward modeling was performed, with the user creating a model, comparing the synthetic data to the TEM data, and modifying the model as needed. Inversions were also used to assist with the interpretation. Good models were compared with all sets of data, as an appropriate model should fit the ground, borehole and airborne TEM data.

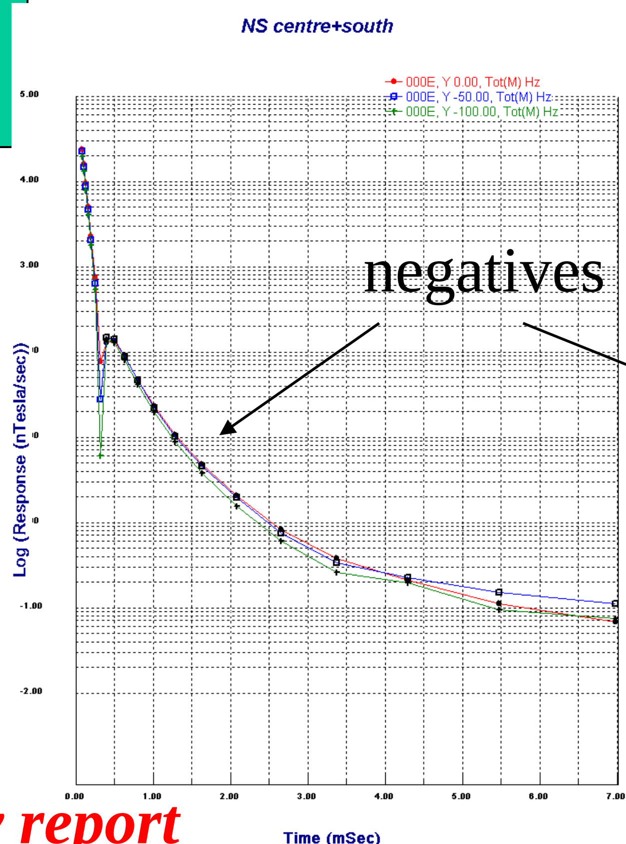
- Loop: 400x400
- Stations:
- NS - 13
- EW – 13
- Symmetric :
- No On time Channels
- Saturated: no
- negatives in early time and late time
- possible IP effects

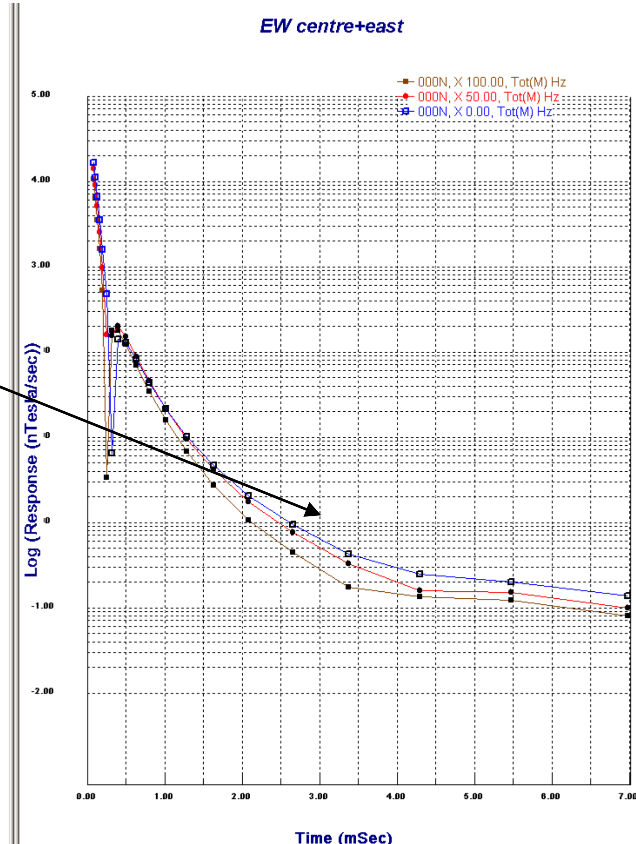
HB-05-19

Decays for NS and EW near centre of loop

response crosses over and stays negative

log amplitude
vs linear time



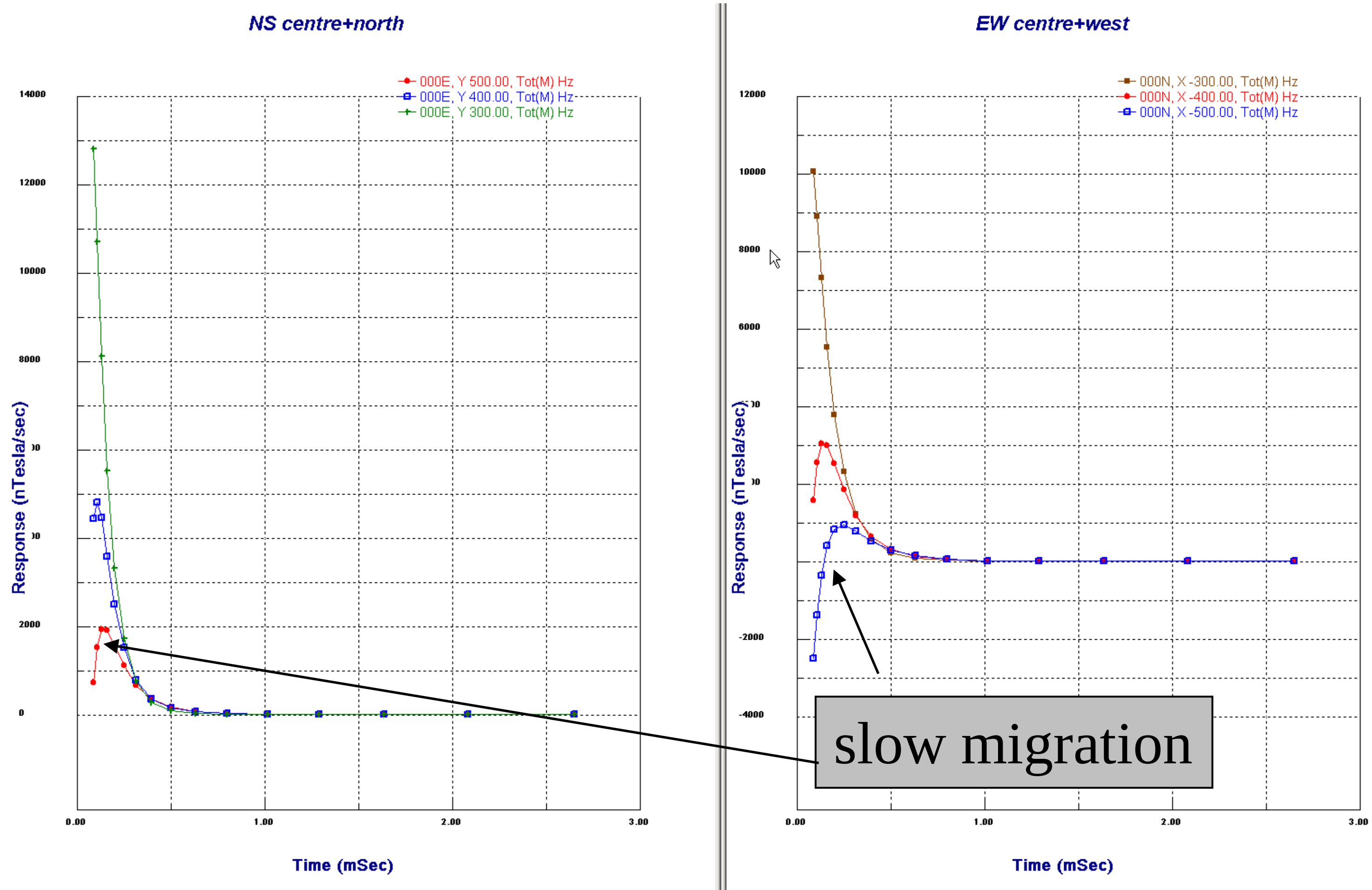


***from preliminary report**

Decays for NS and EW outside loop

NS to north of loop, EW to west of loop

"slow migrations" = conductive cover



linear amplitude
vs linear time

****from preliminary report***

Comments:

-likely conducting cover which is polarizable
- poor late-time data inside loop
- outside loop data better in late time

Consideration: the early time data inside the loop goes negative but the characteristics and consistent with a polarizable cover. Thus, the in-loop IP effects and near wire effects are more significant than out-of-loop. Again, the symmetry of the data collection combined with data on both lines outside as well as repeat measurements at the center give more room to manouver in the intrepretation.

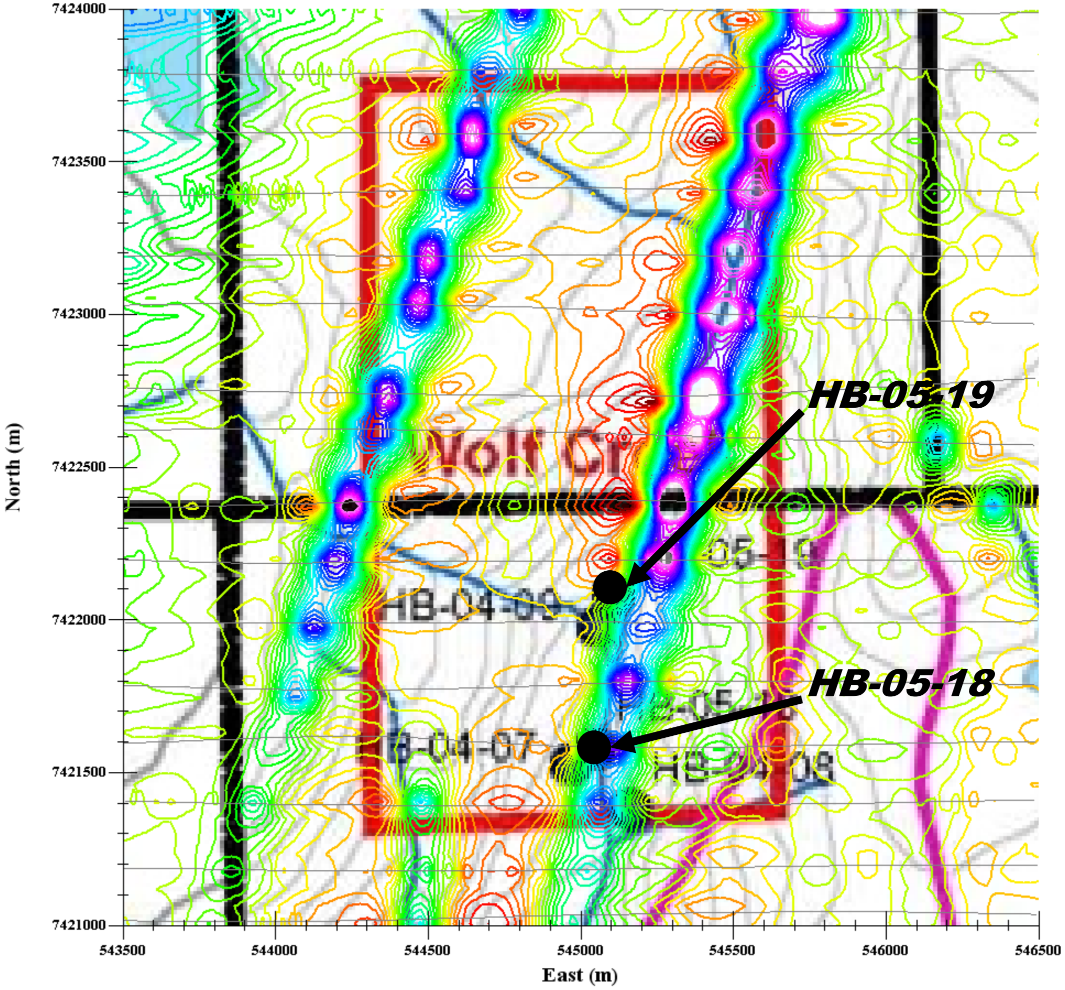
The possibility arises that the other early time negatives could be also due to IP effects but not so easy to classify due to the much more resistive cover.

Warning: There is no software to invert the data for IP effects in the resistivity structure. Forward modelling exists but is much more labour intensive.

from preliminary report

Wolf Creek Aeromagnetic Data

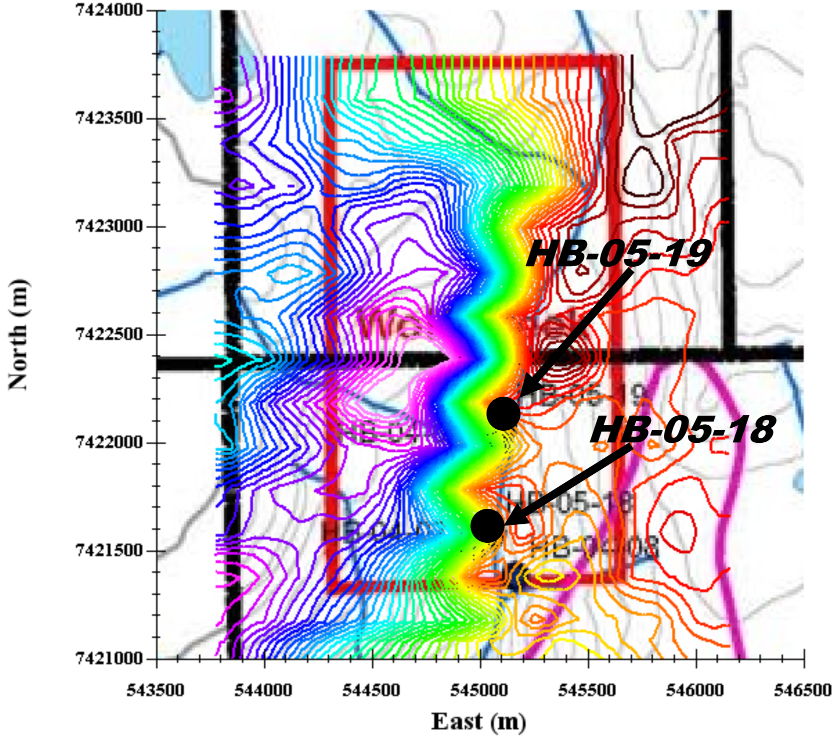
Aeromagnetic Data, Btz

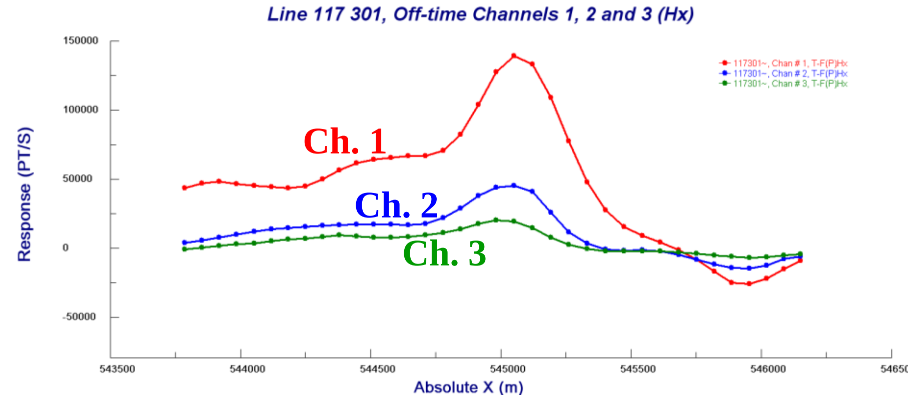


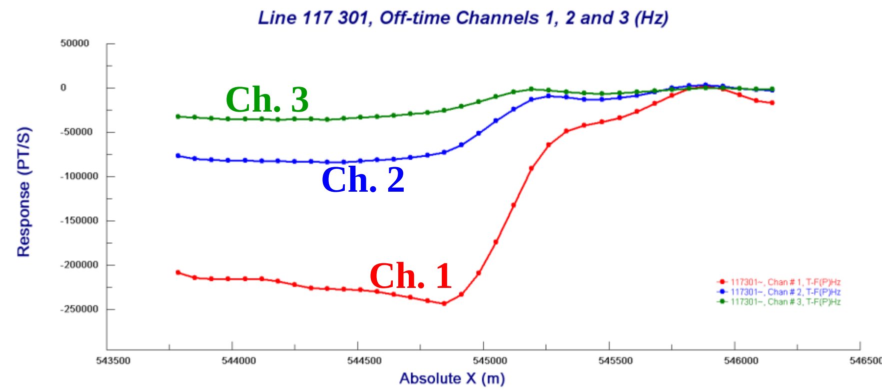
The aeromagnetic data over Wolf Creek shows two significant features, as seen in the contour plot of the derivative in the z-direction. These features are linear, relatively narrow, and nearly parallel. The magnetic response from these features seems to taper off at the south end of Wolf Creek.

Wolf Creek MegaTEM Data

Off-Time Channel 3



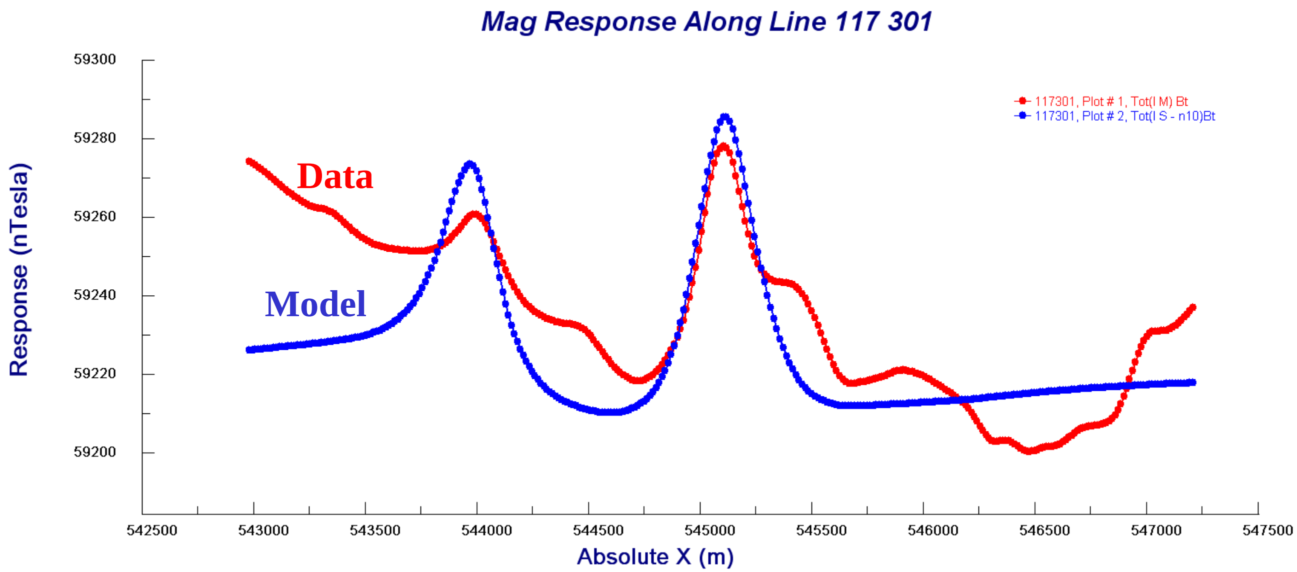




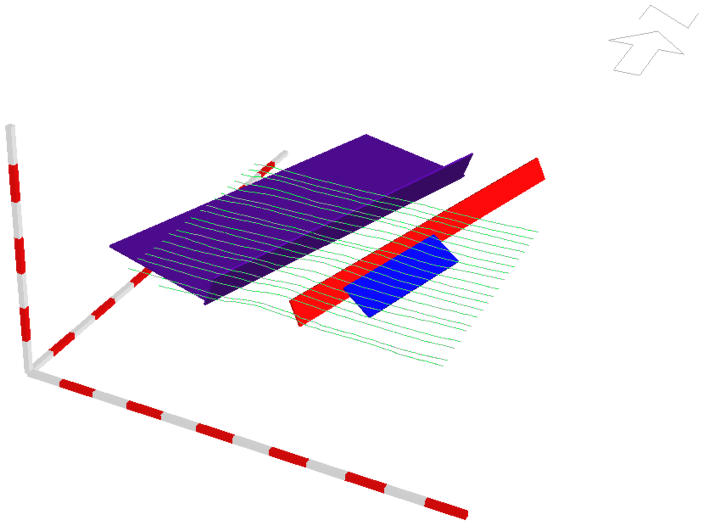
The MegaTEM data also suggests structure in the Wolf Creek area. As observed in a contour plot for off-time channel 3 (time channel 8), there appears to be a contact or fault around 545 000 m. The plots show a change in the amplitude of the response around this point.

* The zig-zag shape in the TEM data occurs because adjacent profile lines were flown in opposite directions, causing the receiver to obtain the response at different locations.

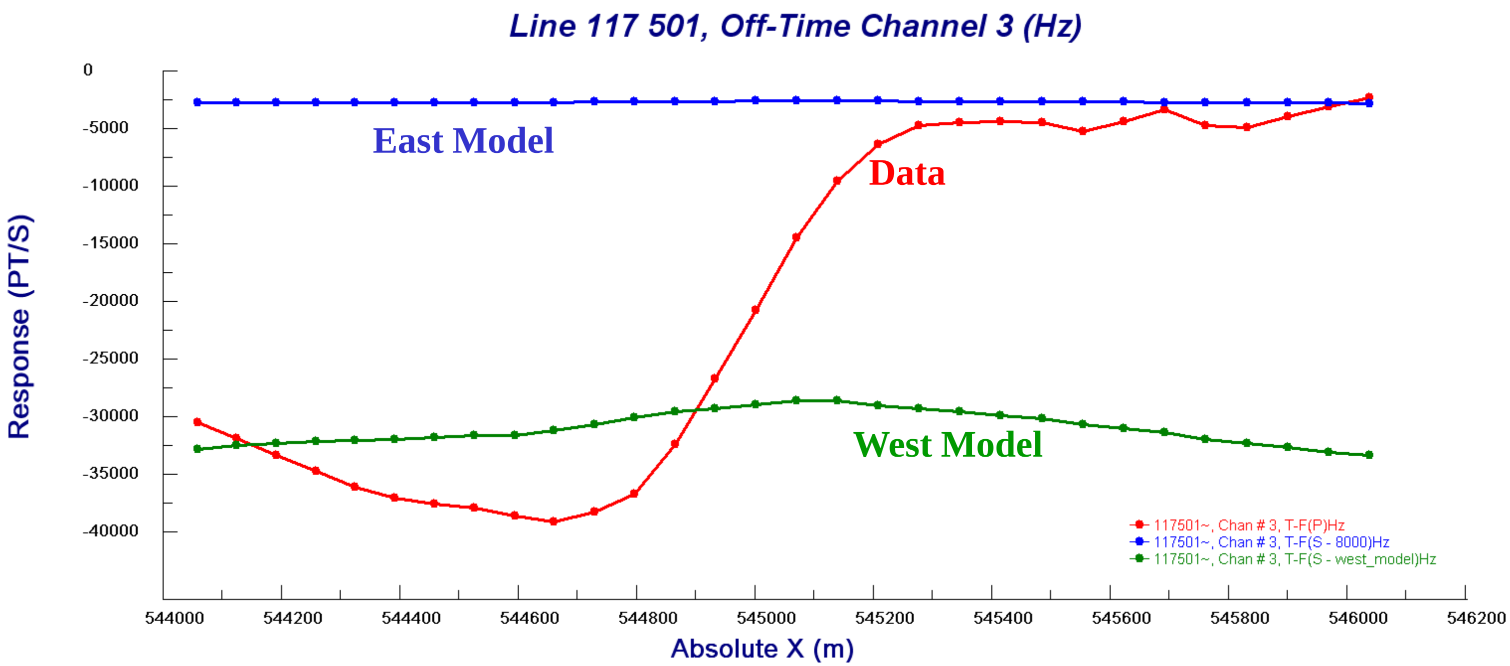
Wolf Creek Aeromagnetic Modeling



A rough model for the aeromagnetic data over Wolf Creek was developed to determine the location and approximate propeties of the structures causing the two main anomalies in the magnetic response. These features are long, narrow, fairly shallow, and have susceptibilities from 0.035 to 0.06. The magnetic model was used to assist with the modeling of the TEM data.



Wolf Creek MegaTEM Modeling

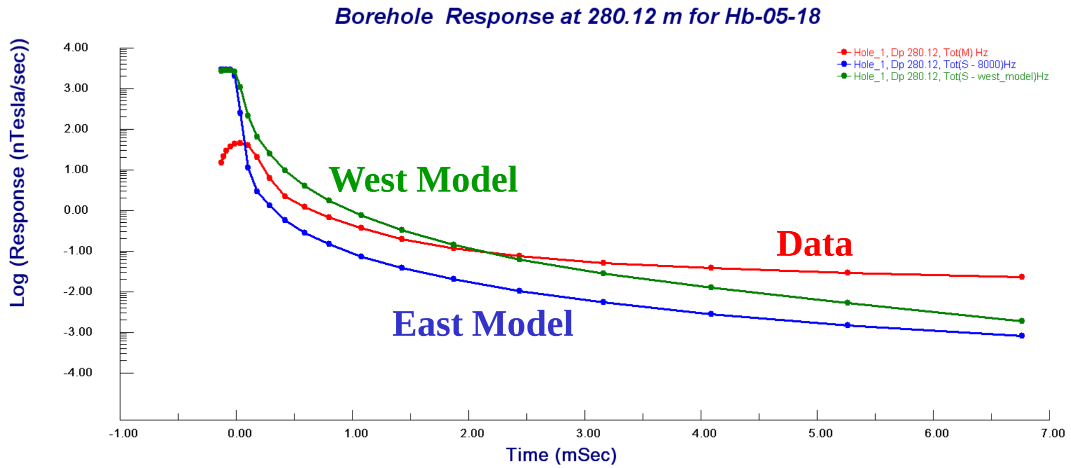


Initial modeling focused on developing separate layered earth models for the east and west sides of the region. The response on the east, which has a lower amplitude, was modeled by a half-space with a resistivity of 8000 Ohm m. To the west, the response was modeled by a 500 m layer with a resistivity of 1080 Ohm m above the basement, which has a resitivity of 8000 Ohm m.

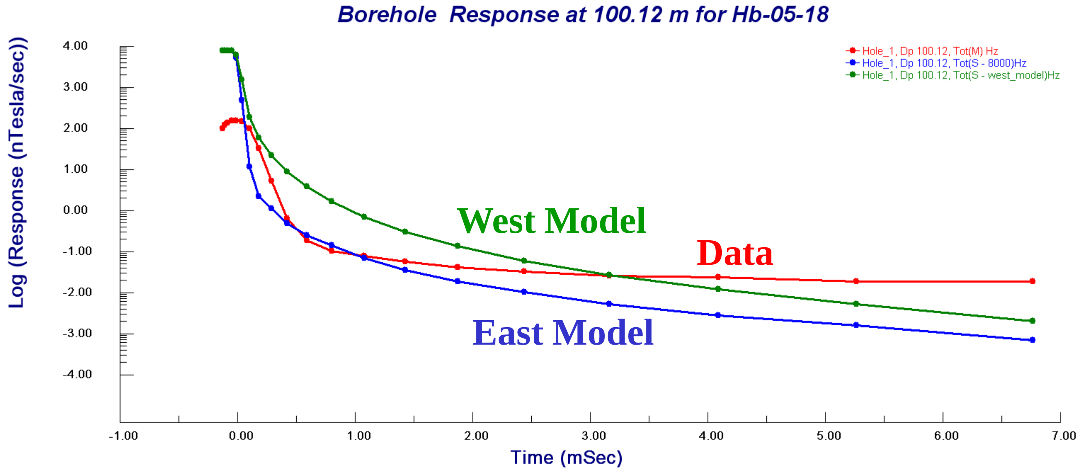
Core Data

Lithology description	Vertical Depth (m)
Overburden	-20.0
HB sandstone and siltstone	-140.0
HB conglomerate	-147.2
Regolith	-161.6
Basement rocks (Mc Tavish volcanics)	-173.4
Graphitic mudstone	-192.7
Mafic dyke	-205.0
Graphitic breccia	-221.3
Basement rocks (Mc Tavish volcanics)	-254.9

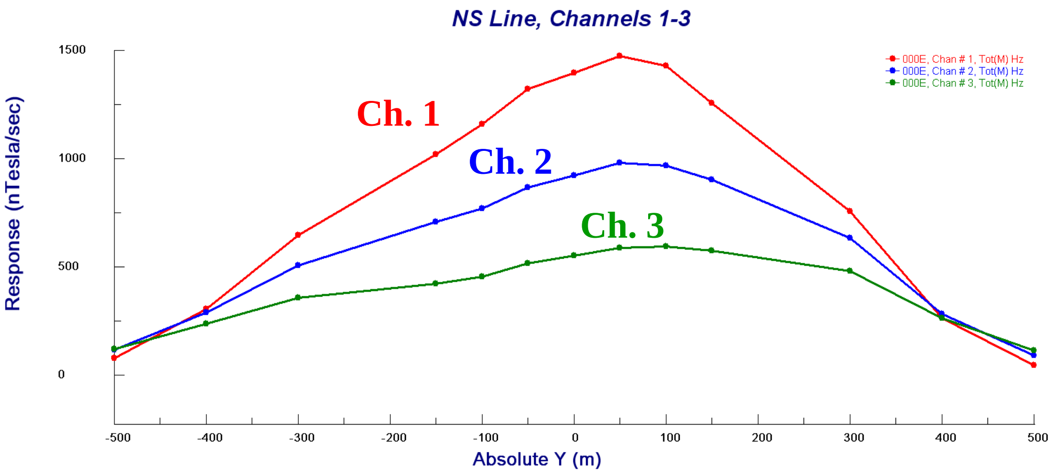
HB-05-18 Borehole Modeling

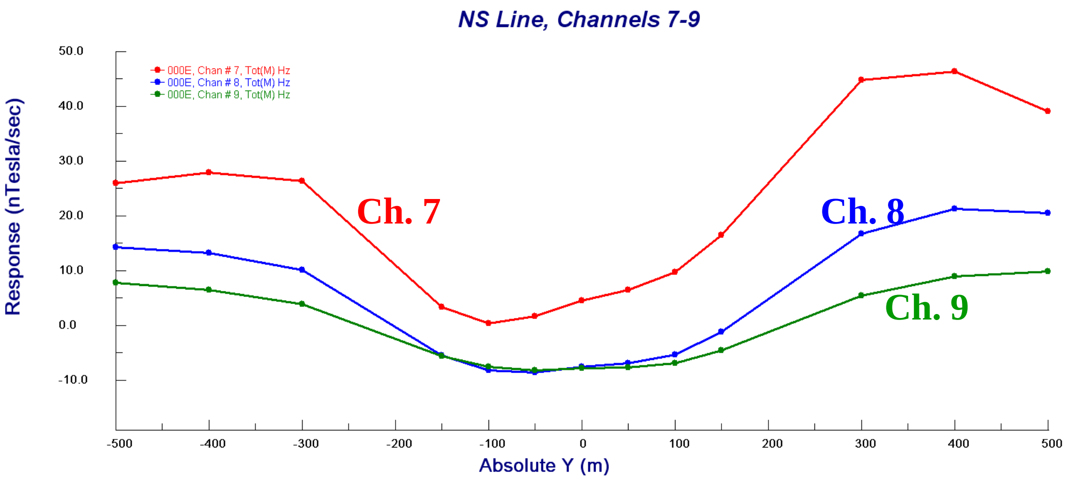


The west model developed for the MegaTEM data fits the borehole data for HB-05-18 fairly well near the bottom of the borehole. The east model (resistive half-space) fits the borehole data better at shallower depths.



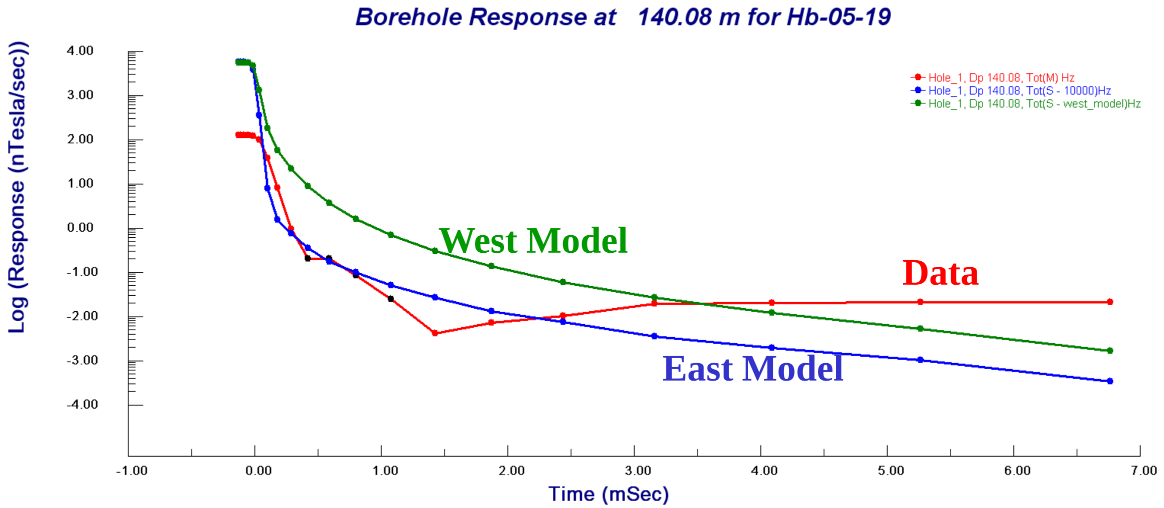
HB-05-19 Ground Data



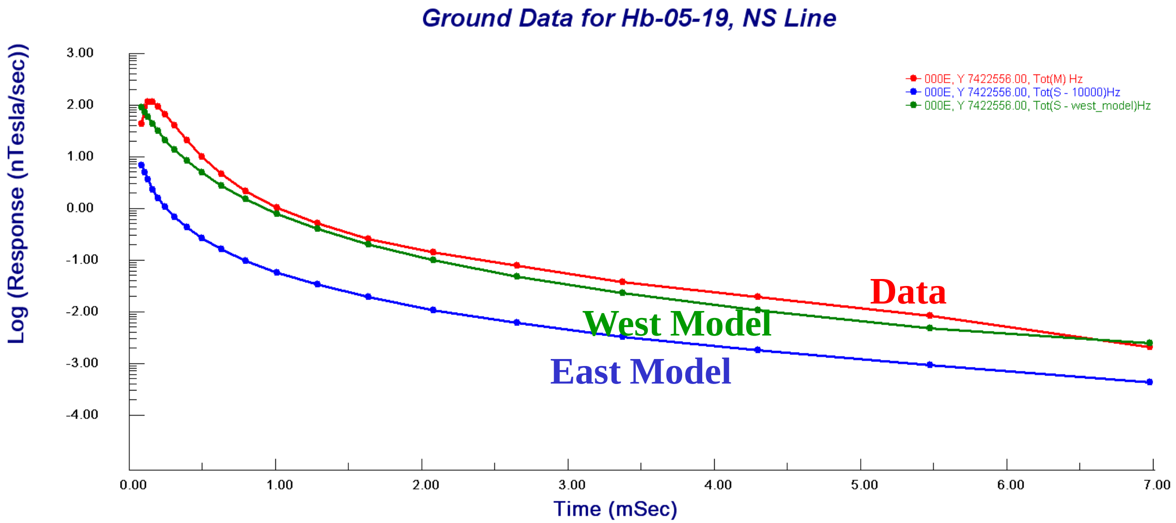


The ground TEM data used a fixed loop of about 400 m by 400 m. Measurements were taken along a north-south and an east-west line running through the center of the loop. There were 7 stations inside the loop and 6 stations outside the loop along each line. Asymmetry inside the loop can be observed along both lines at early times, suggsting 3-D structure. The response inside the loop was smaller than the response outside the loop beginning at mid-times. This may be due to a system response.

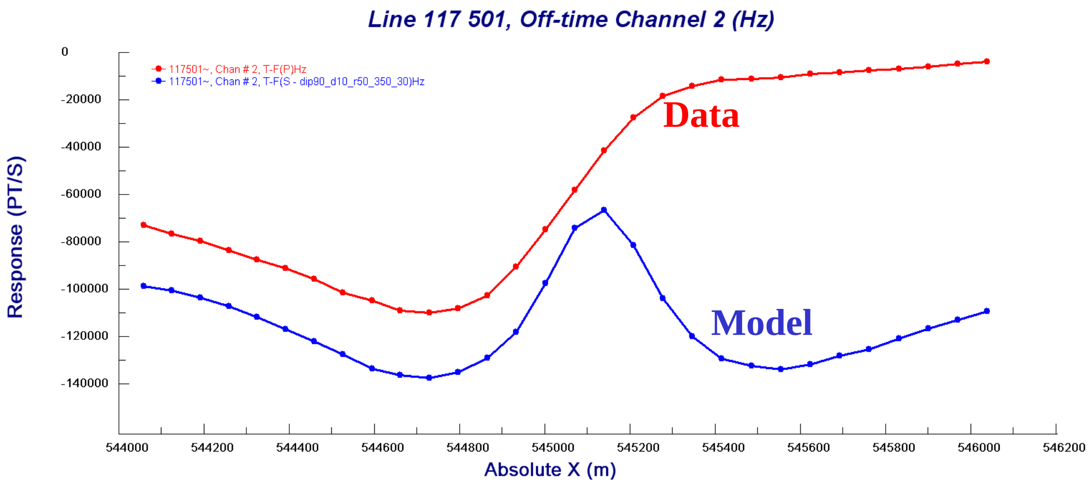
HB-05-19 Ground and Borehole Modeling

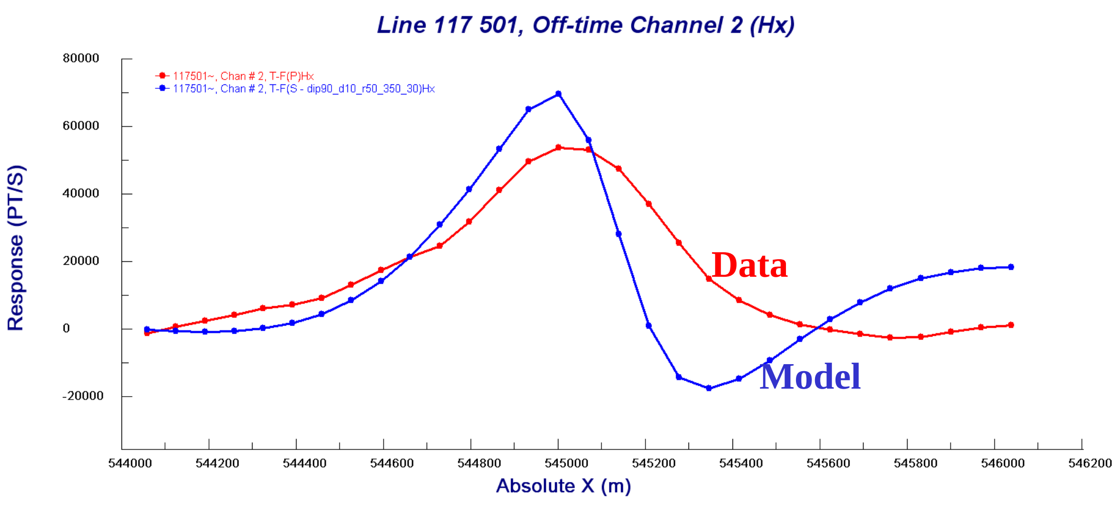


The borehole TEM data fo HB-05-19 is modeled fairly well by the east model throughout the borehole. However, the amplitude of the east model is too low for the ground data, which is better modeled by the west model.

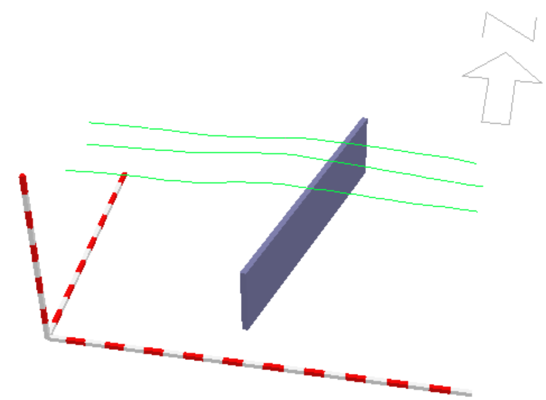


Wolf Creek MegaTEM Modeling

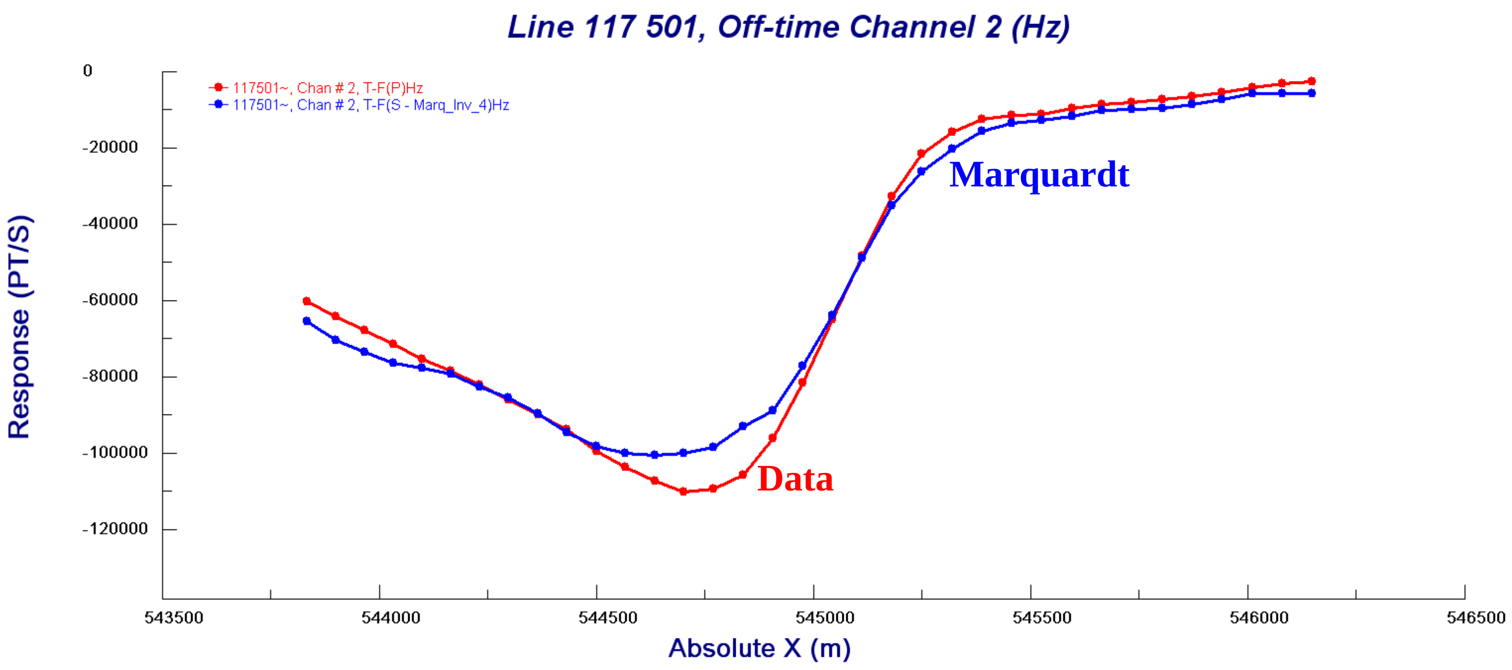




The prism in the magnetic model that causes the eastern anomaly was used to model the TEM data. The prism was inserted into a simple layered earth model with a 500 m thick, 1000 Ohm m layer over a resistive basement. Its properties were adjusted so that it matched the TEM data more closely. It was found that a model containing a narrow prism with a resistivity of 50 Ohm m, a dip of 90^0, and a dip extent of 350 m fit the response near the contact fairly well.



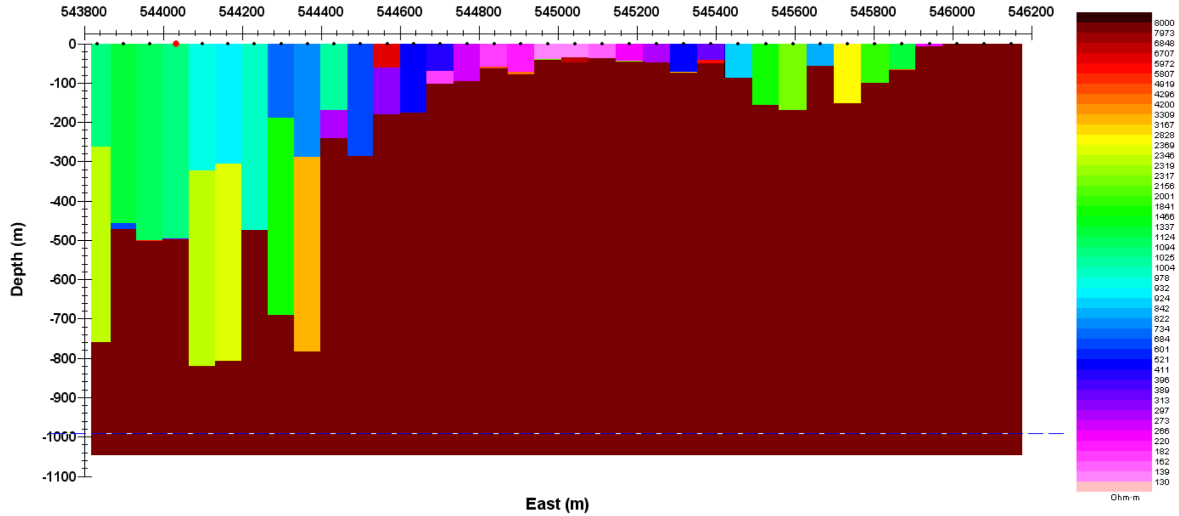
Wolf Creek MegaTEM Inversions



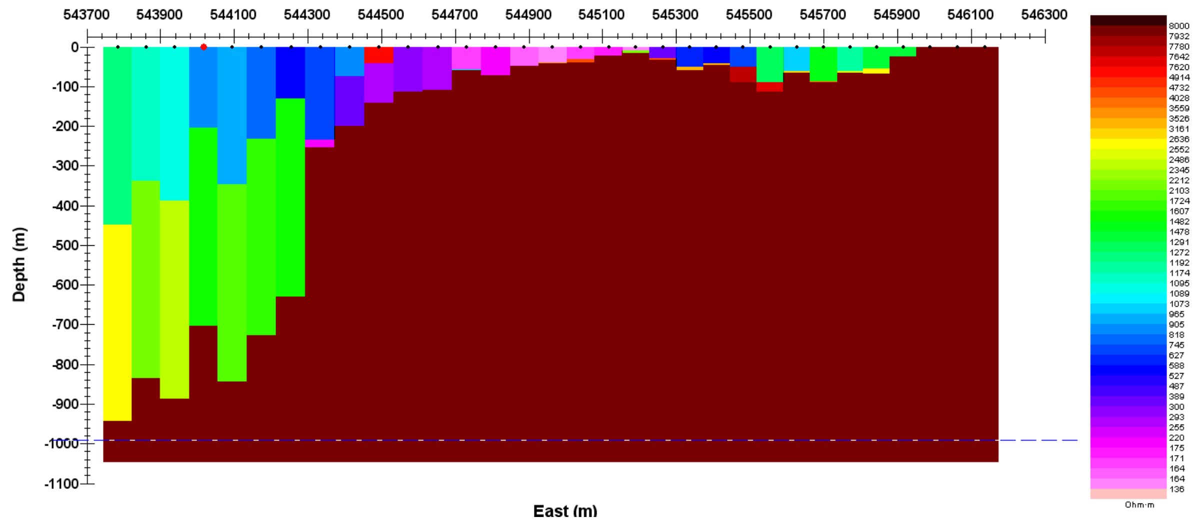
A Marquardt inversion for Hz was performed on a section of the MegaTEM data. Three layers were used. The top two layers were inverted, and the bottom layer was given a resistivity of 8000 Ohm m, based on the resistivity of the basement in previous modeling. As in the modeling, the inversion suggests a different subsurface structure on the east and west side of the survey area. The east side is very resistive beginning at a fairly shallow depth. The west side contains material with a resistivity of about 1000 Ohm m at the surface. The resitivity increases somewhat with depth, and the resistive basement begins at a few hundred meters.

Wolf Creek MegaTEM Inversions

Marquardt Inversion, Line 117 501



Marquardt Inversion, Line 117 601



Wolf Creek Conclusions

• The aeromagnetic data shows that there are two linear features in Wolf Creek, which were modeled by narrow, shallow prisms.

• There is significant variation in the MegaTEM response across the Wolf Creek region. To the eastern side of the region, the amplitude of the response is small, and the data can be modeled by a resistive half-space. To the western side of the region, the response is larger, and a more conductive layer was added above the basement. This variation in response is probably due to a contact or fault, and its location roughly corresponds to the eastern magnetic feature.

• The borehole TEM data for HB-05-18 was best modeled by the east MegaTEM model near the surface and the west MegaTEM model at depth.

•The borehole TEM data for HB-05-19 was best modeled by the east model, and the ground data was best modeled by the west model. HB-05-19 is near the the contact, and the differences between the ground and borehole models may be due to the different geometries of the systems, which ‘see’ the subsurface differently.

• By adjusting the properties of the eastern magnetic target, a model was created that matched the response near the contact for the MegaTEM data.