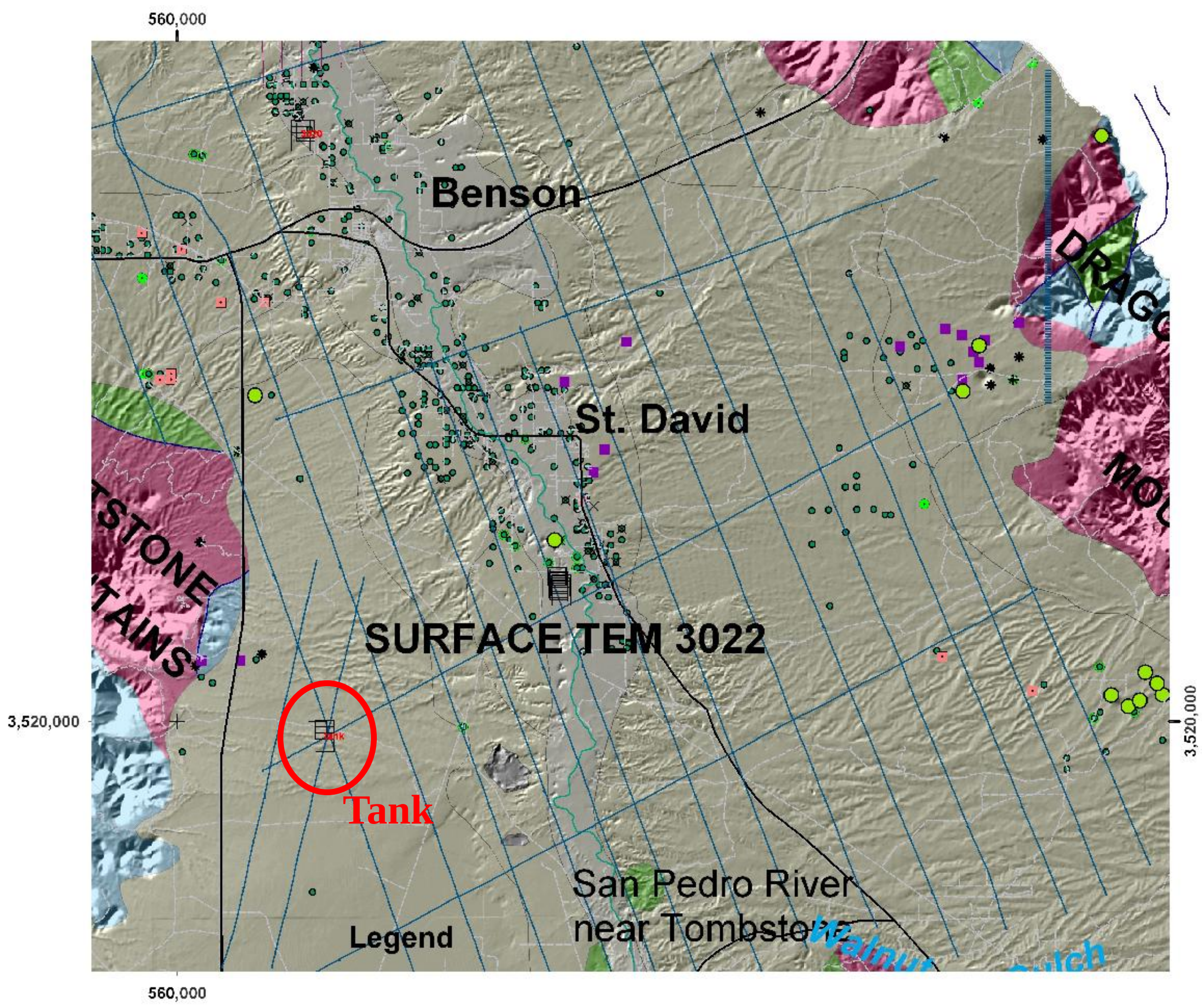
San Pedro Benson:
Tank Site

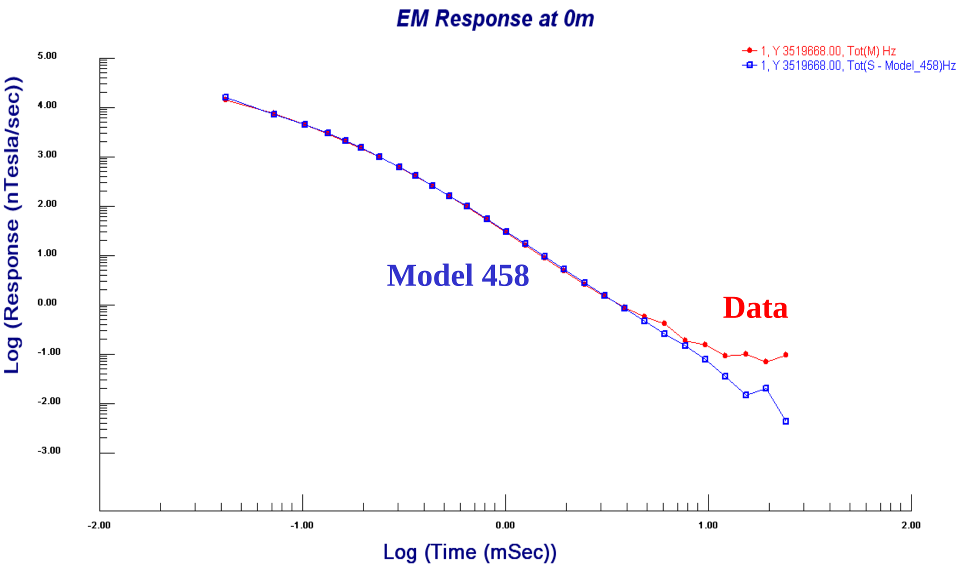
Eikon Technologies LTD

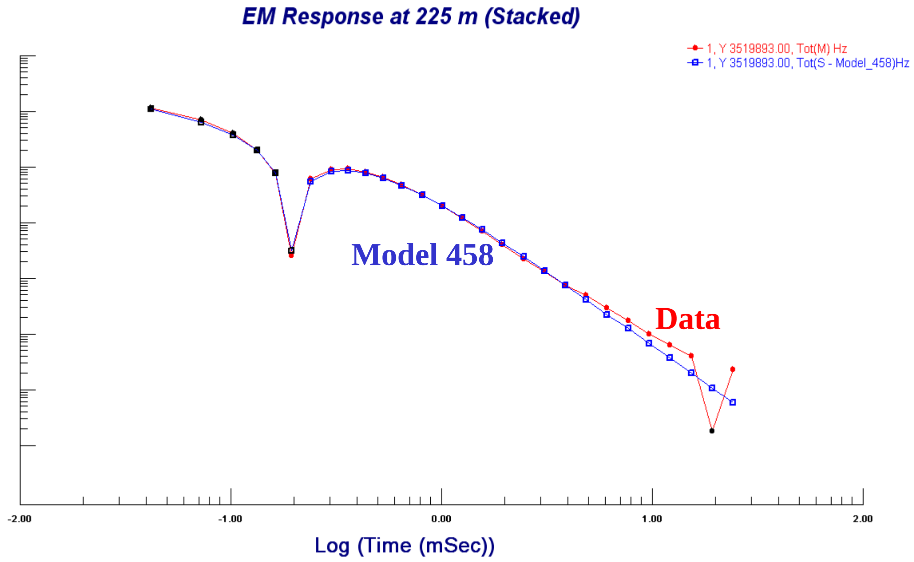
Location



560,000
Benson
St. David
SURFACE TEM 3022
Tank
Legend
San Pedro River
near Tombstone
3,520,000
3,520,000
560,000

Ground Data – 8Hz





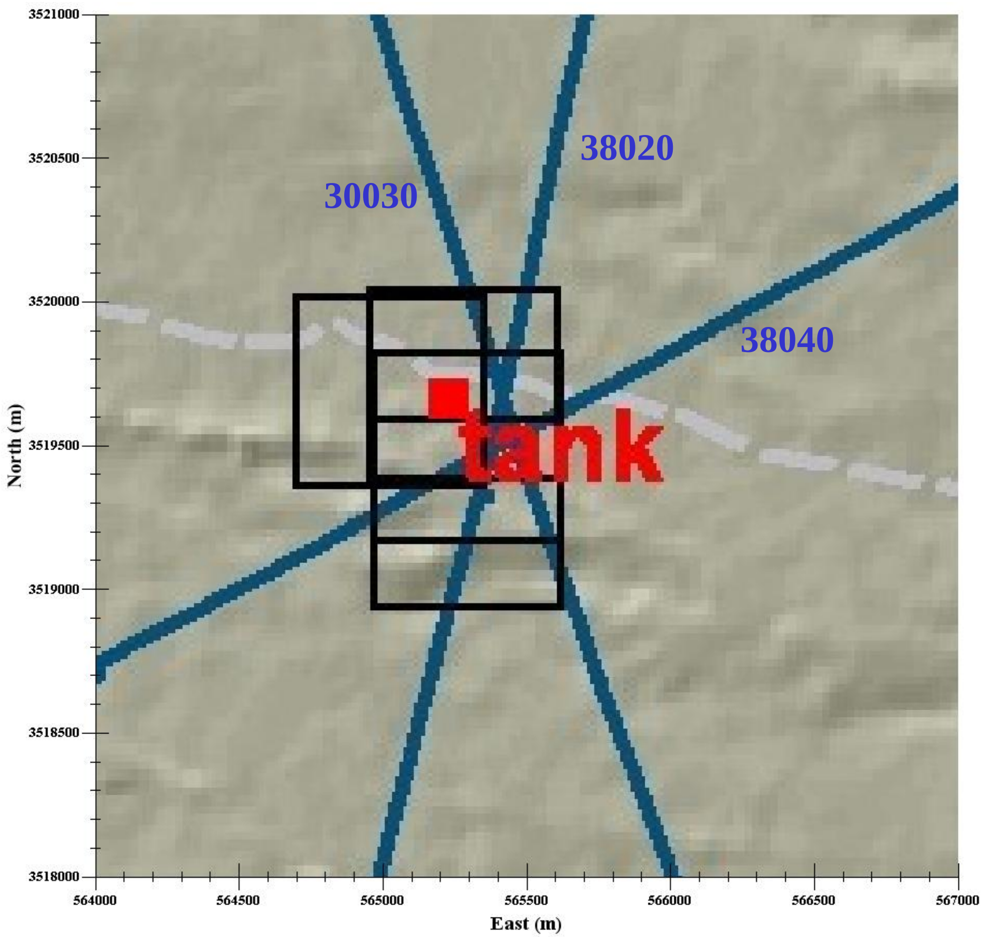
Model 458

Layer	Resistivity (Ω m)	Thickness (m)	Depth (to bottom) (m)	Lithology (m)
1	100	30	-30	Overburden
2	20	36.3543	-66.3543	Clay/silt
3	80			Bedrock

The Tank ground TEM data points are located at the centre of the loop, and 225 m north and south of this point. The data at 225 m was stacked for modeling purposes. Model 458 was developed for the tank ground data. It fits the data well at both 0 m and 225 m (except at very late time channels). Some inversions were performed using Model 458 as a starting model, but did not improve the fit at later times.

Note: 16Hz data corroborates the 8Hz

Location of Loop and GeoTEM

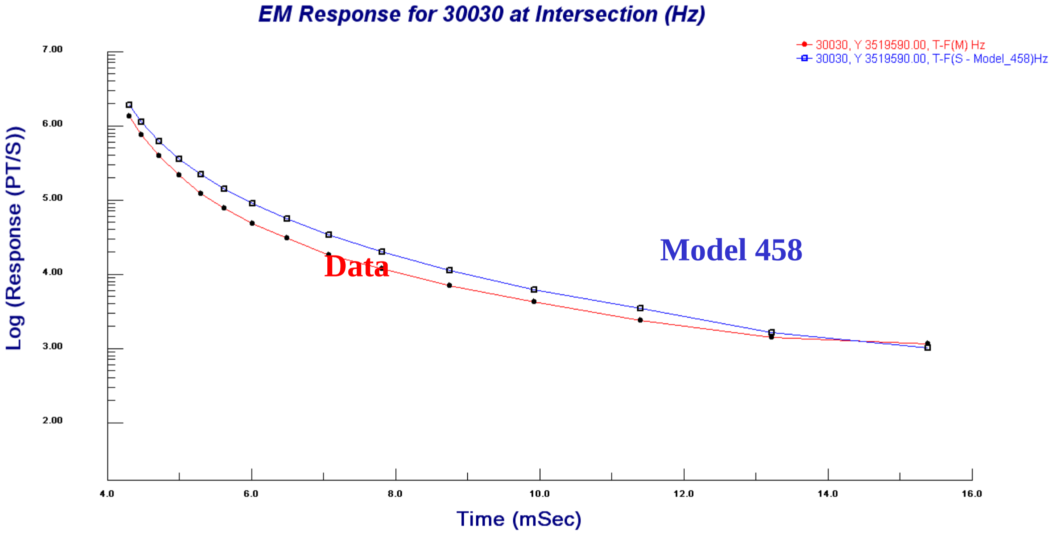


The center of the loop (marked in red) for the ground survey is located very close to the intersection of Lines 30030, 38020 and 38040 in the GeoTEM survey. The airborne survey in this region was compared to the ground data for tank.

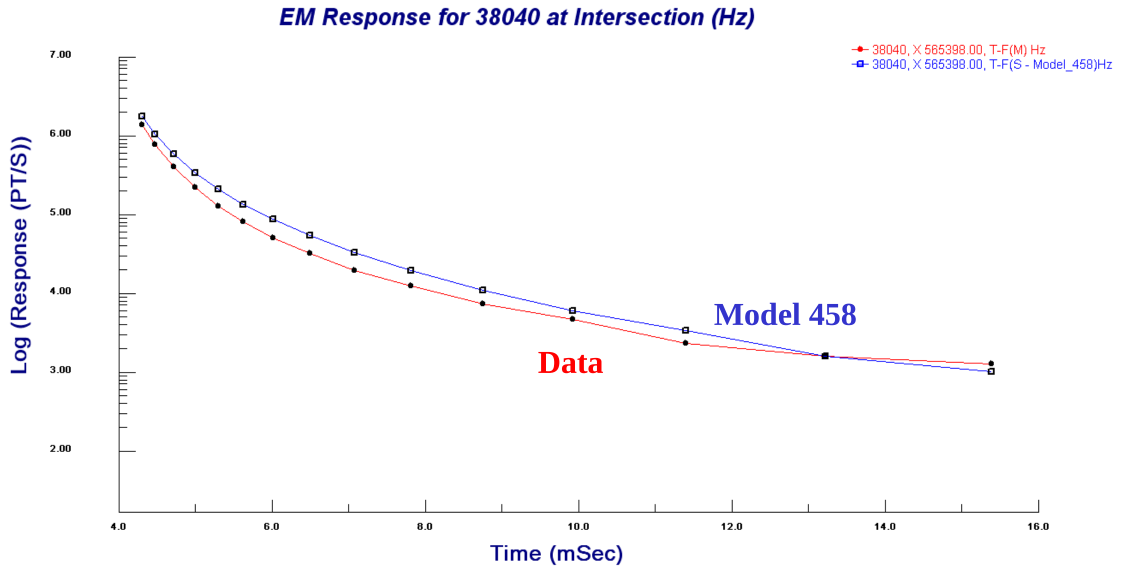
■ Location of loop center:
UTM East: 565217
UTM North: 3519668
(NAD83)

GeoTEM Data (Hz component)

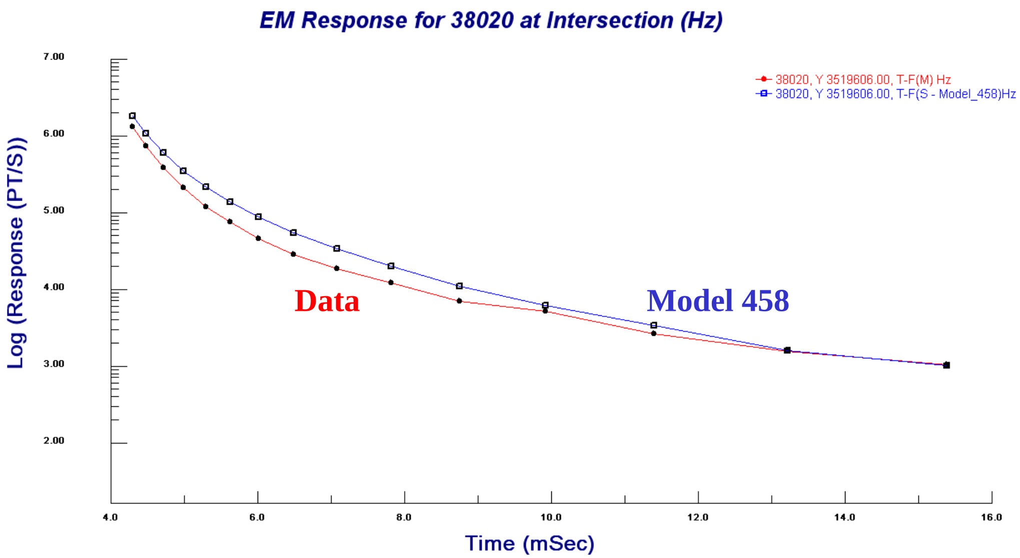
comparison to ground TEM model



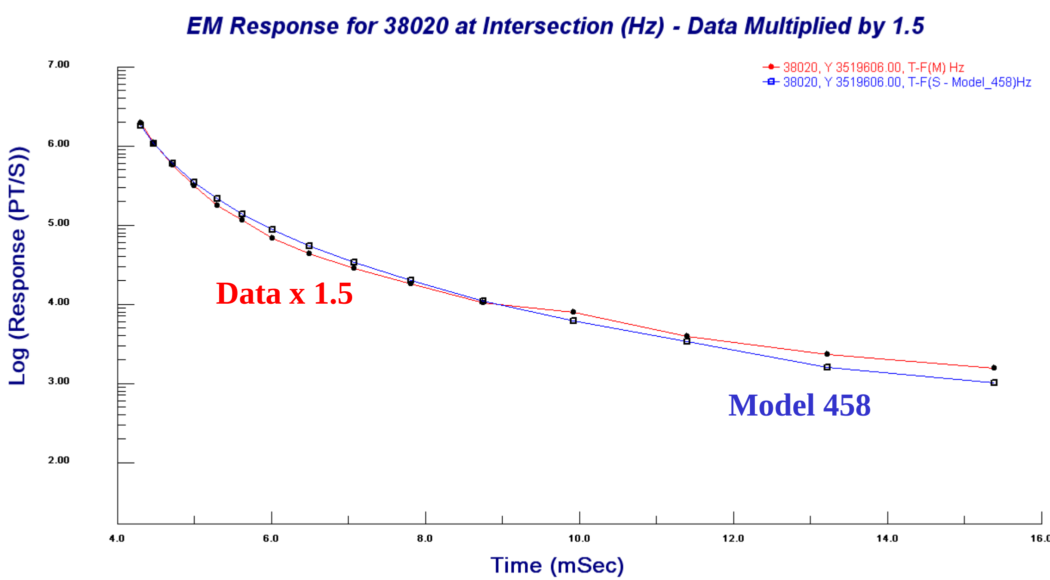
The response of Model 458 (from the ground data) is too large for the Hz in airborne data across all time channels, as shown for Lines 30030 and 38040. (38020 is shown on the following page).



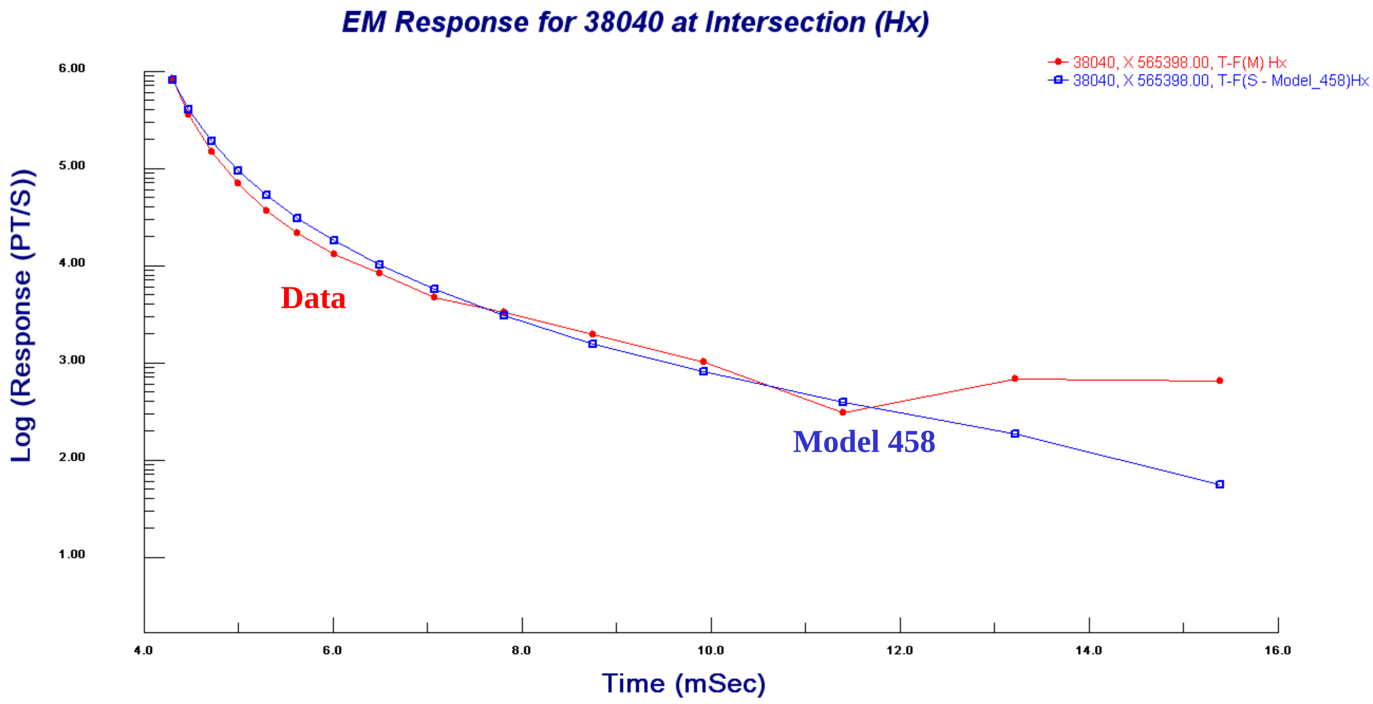
GeoTEM Data (Hz)



When the Hz component of the GeoTEM data is multiplied by 1.5, the model nearly matches the data on all of the lines, as shown for 38020 below.

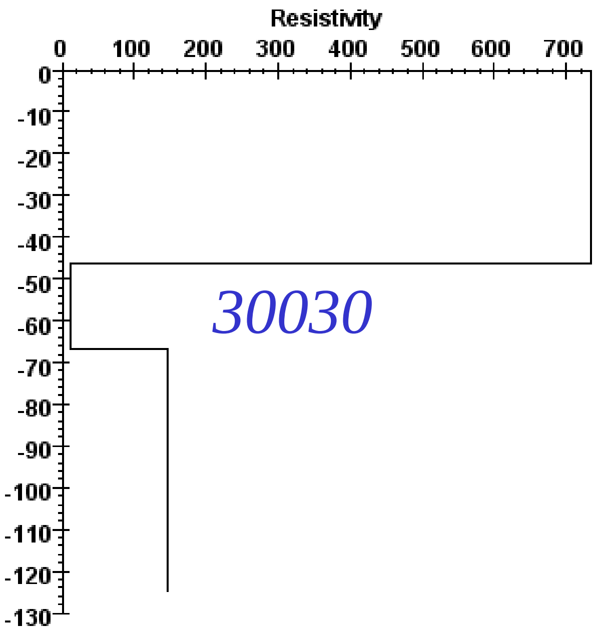


GeoTEM Data (Hx)
comparison to ground model

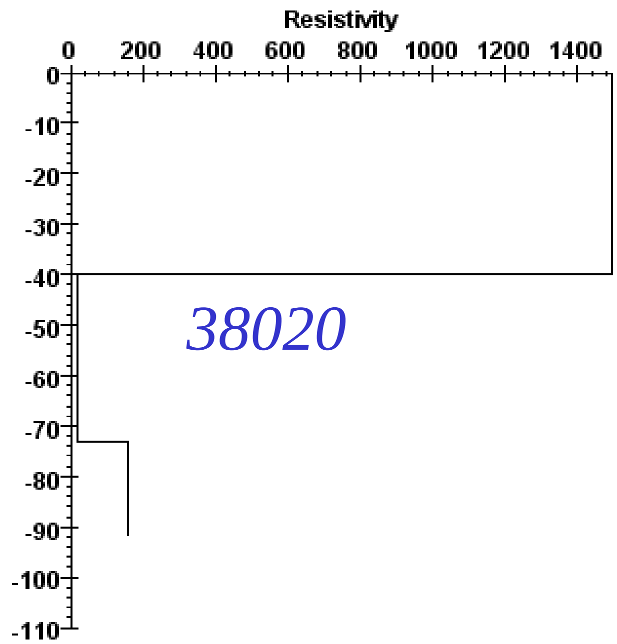


Model 458 matches the amplitude of Hx in the airborne data better than the amplitude of Hz, although the shape of the ground tem model response does not quite fit the shape of the Hx response particularly in off-time Chs 3-6.

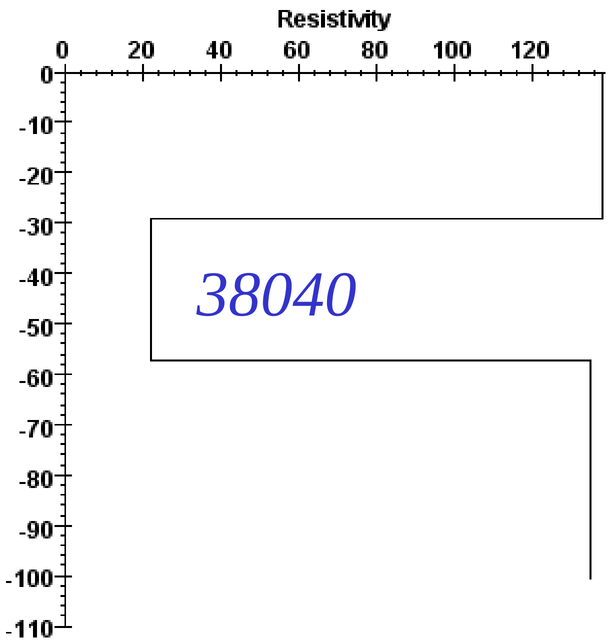
GeoTEM Inversion



30030 : y=3519590



38020 : y=3519606



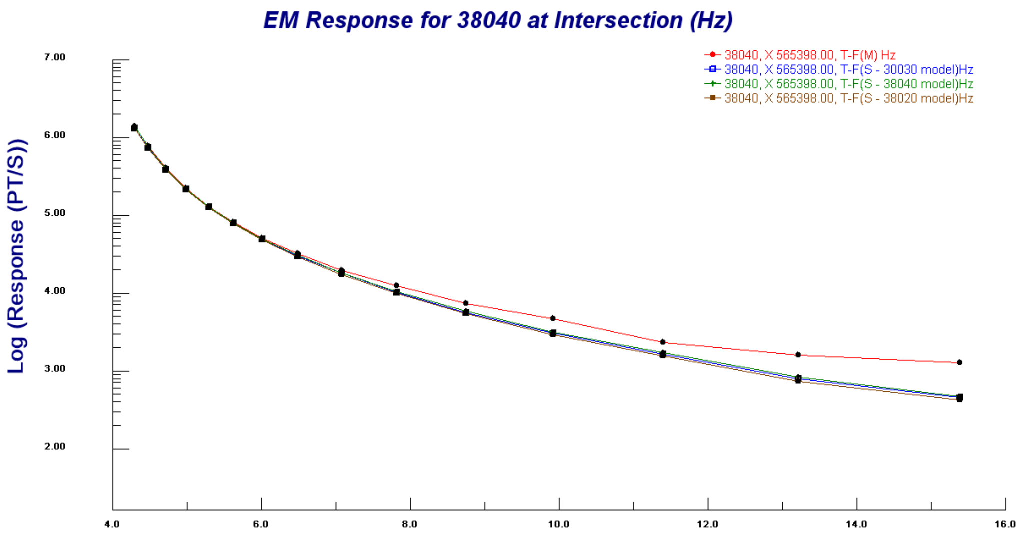
38040 : x=565398

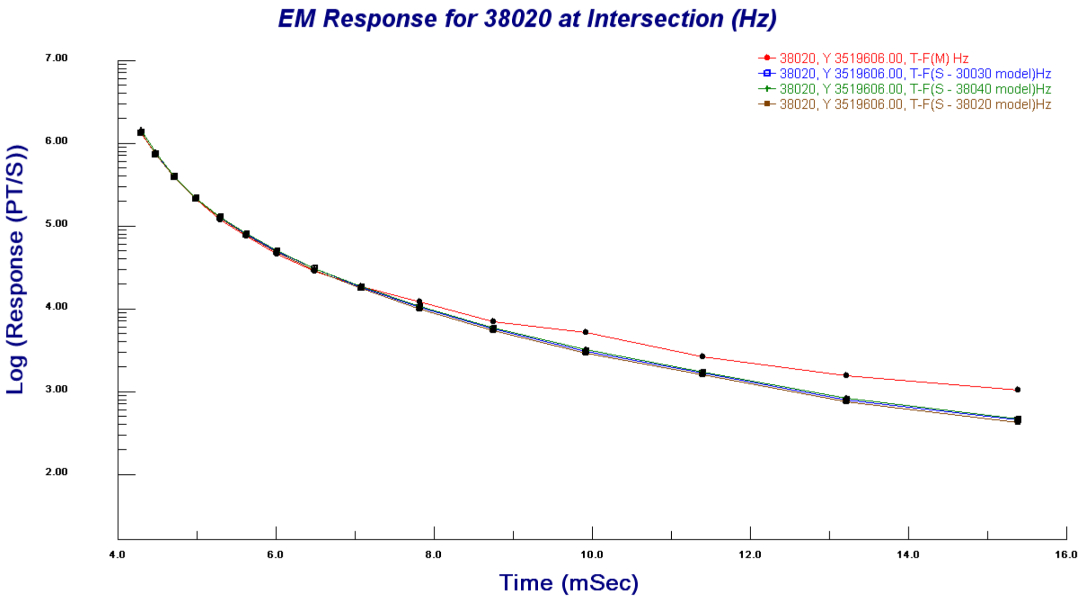
30030		38020		38040	
Resistivity (Ohm m)	Thickness (m)	Resistivity (Ohm m)	Thickness (m)	Resistivity (Ohm m)	Thickness (m)
734	46	1497	40	138	29
13	20	20	33	22	28
146		157		135	

The results of a 3-layer inversion on the first 10 offtime channels for the GeoTEM Hz data near the intersection are shown above. While the models differ, they all show a resistive layer down to about 40 m, followed by a region of increased conductivity to about 60 m.

The basement resistivities are comparable.

GeoTEM Inversion model comparisons





Data

30030

38040

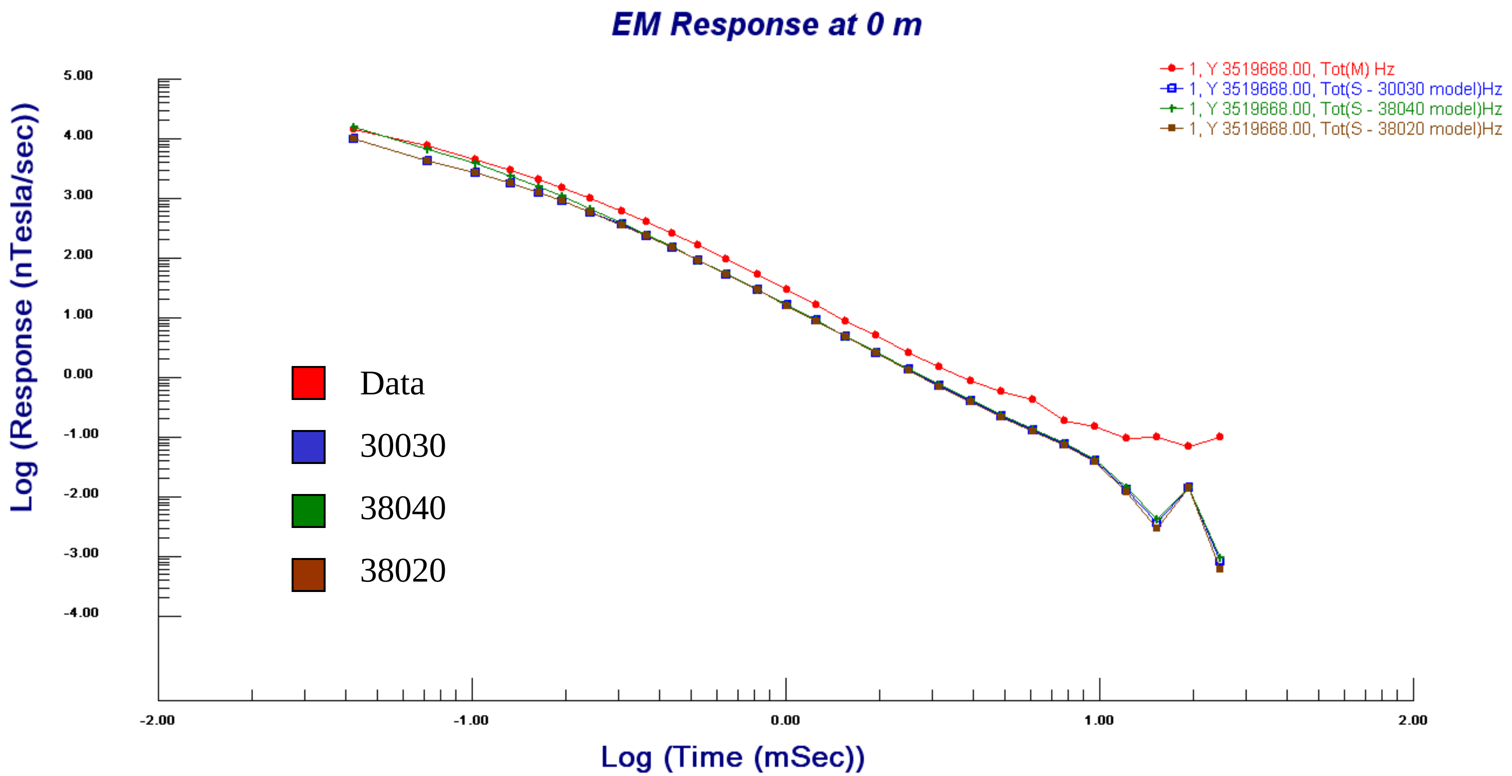
38020

The fits of the three models shown on the previous page to the GeoTEM data are shown at the intersection for 38040 and 38020. Despite the differences between these models, they have nearly identical responses. This is also true for line 30030.

It is our opinion that this result which shows that the 3 different Resistivity models are indistinguishable exemplifies one problem with the airborne data. That problem is the inadequate windowing of the data in the off-time, reducing the resolution capabilities of the airborne data.

It is important to note that the data could be windowed to provide 20 time channels in the off-time and the windows could be more focused in the early to mid-times to provide enhanced resolution to the depths required.

Airborne Inversion Models and Ground Data



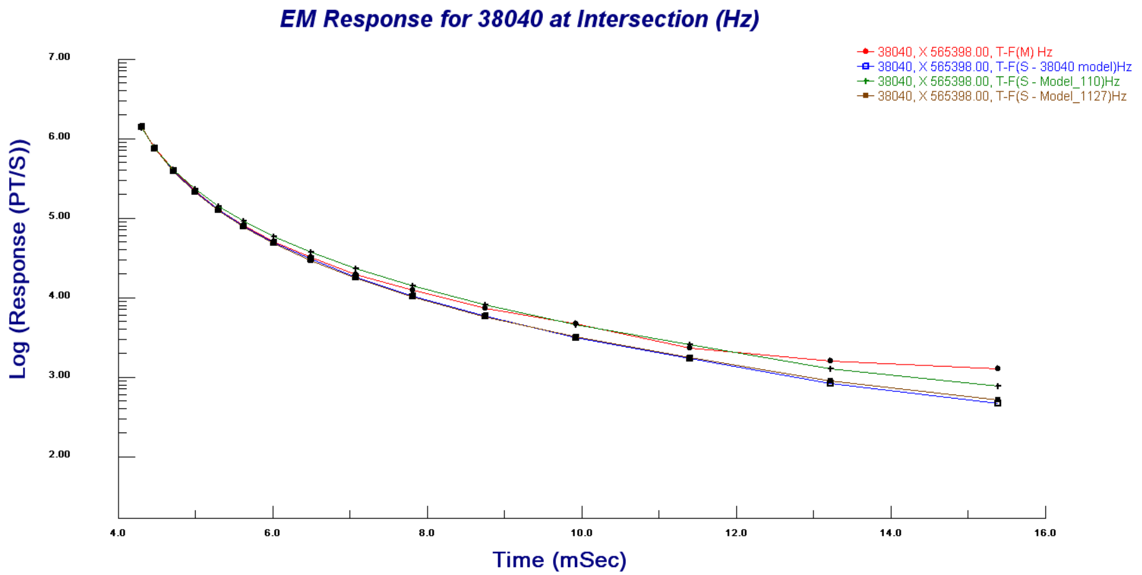
Here we show the simulated response of the 3 airborne models to the ground system.

The models from the inversion of the GeoTEM data do not have large enough responses for the ground data. Note that although the differences between the fit of models were very small for the airborne data, the model for 38040 is noticeably different in the early time from the others for the ground data. In fact, model 38040 is quite similar to the ground model except for the basement resistivity. This model response at early times matches the data better especially for the first 3 early time channels.

Ground Data and GeoTEM

1.The model for the ground data and the models for the airborne data show a similar geological structure. They all have a resistive layer to 30-40 m, which the ground data suggests has a resistivity of about 100 Ωm (the airborne response is not as sensitive to this value). This is followed by a more conductive layer (about 20 Ωm) to around 60 m, which is underlain by a more resistive layer. The ground model has a resistivity of 80 Ωm at depth, while the airborne models show a resistivity of around 145 Ωm.

Further modeling focused on trying to explain the differences between the models and trying to develop one model to fit both the GeoTEM and the ground data.



2. One possibility is that the GeoTEM survey cannot see a deeper, more conductive layer that is picked up with the ground survey. A layer of 80 Ωm was placed below the 135 Ωm layer in the model for 38040 to investigate this. However, it was found that even if the 135 Ωm layer was 100 m thick, the 80 Ωm was still detectable at early-mid times. For a thickness of 500 m, the difference is minimal in the airborne data though, but a model with 135 Ωm for a few hundred meters would not fit the ground data giving a significant misfit in late time for the ground data.

- Data
- 38040
- 135 Ωm for 100 m
- 135 Ωm for 500 m

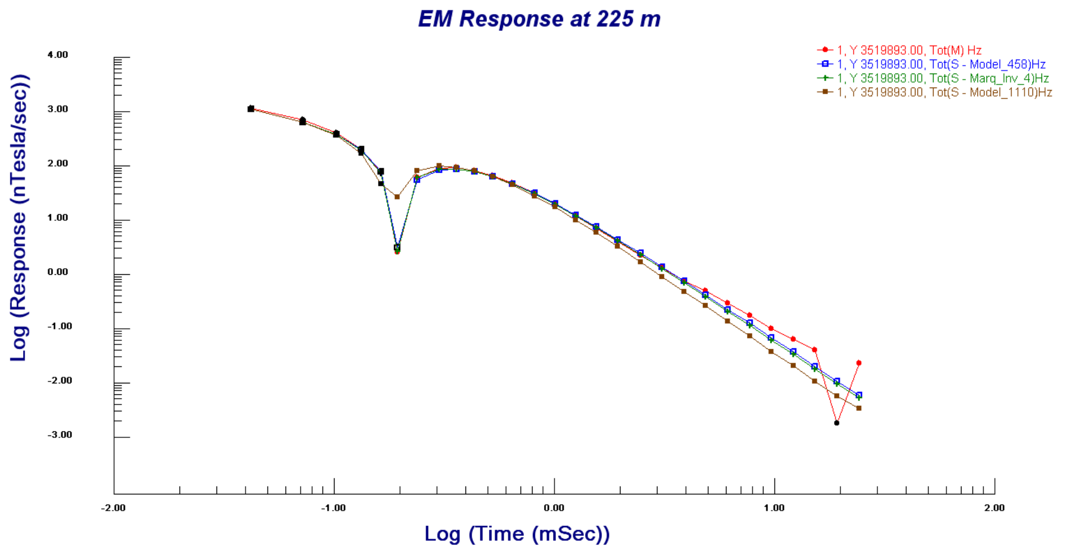
Ground Data and GeoTEM

An inversion was performed on the ground data, using a modified version of Model 458 with a layer of 135 Ωm (from model 38040) above the 80 Ωm layer of the ground model. Only the resistivity of the bottom layer and the thickness of the 135 Ωm layer were allowed to vary in the inversion. The goal was to determine if a model for the ground data with a higher resistivity (similar to that seen in the airborne models) below the conductive layer could be found to fit the data. However, the inversion produced a model quite similar to Model 458, with the 135 Ωm layer having a very small thickness which disputes the airborne data.

- Data
- Model 458
- Marq_Inv_4
- Model 458 with 135 Ωm instead of 80 Ωm

Ground Model from Inversion (225 m)

Resistivity (Ohm m)	Thickness (m)	Depth to Bottom (m)
100	30	30
20	36	66
135	0.1	66.1
88		



Summary

The data suggest a general model as follows:

- To about 30-40 m, resistivity is around 100 Ωm. (Although some of the airborne models suggest that this resistivity could be much higher, it must be around 100 Ωm to fit the ground data).
- From 30-40 m to about 60 m, resistivity drops to around 20 Ωm.
- Below 60 m, resistivity increases to about 100 Ωm. However, the airborne data suggest a higher resistivity (around 135 Ωm) for this layer than the ground data.

Modeling of the airborne data suggests that a layer with a resistivity of about 135 Ωm (below the conductive layer) should be at least a few hundred meters thick. However, the ground data suggests that the resistivity should be about 80 Ωm below the conductive layer, and any layer with a resistivity around that given by airborne data would have to be very thin to fit the data well. Therefore, a suitable model for both the ground and airborne data could not be found.

There also seems to be some discrepancy between the Hx and Hz components in the GeoTEM data, with the ground model more closely matching Hx.

Conclusions:

1. re-windowing of the airborne data could provide enhanced shallow resolution
2. this site indicates a shift factor in the airborne data

Suggestions

It appears from this site that the shift factor can be accounted for by adjusting the amplitude of the airborne data to match the basement resistivities given by the ground data. One problem with this procedure would be that there may be insufficient ground coverage to do this adequately. However, it is our opinion at this point that what adjustment that can be made would provide more reliable airborne inversions.

The other suggestion is to have Fugro re-window the data to provide more suitable positioning of the time windows and more off-time windows. Our present experience with the re-windowing procedure is that it would provide enhanced shallow resolutions.
It is noted that “shallow” in this case means depths to several hundred meters.

With the present windowing, there are only about 10 channels which can be used reliably for the inversions. Re-windowing could increase this to as much as 20 windows.