Analyses of SkyTem inversions
comparisons to ground TDEM

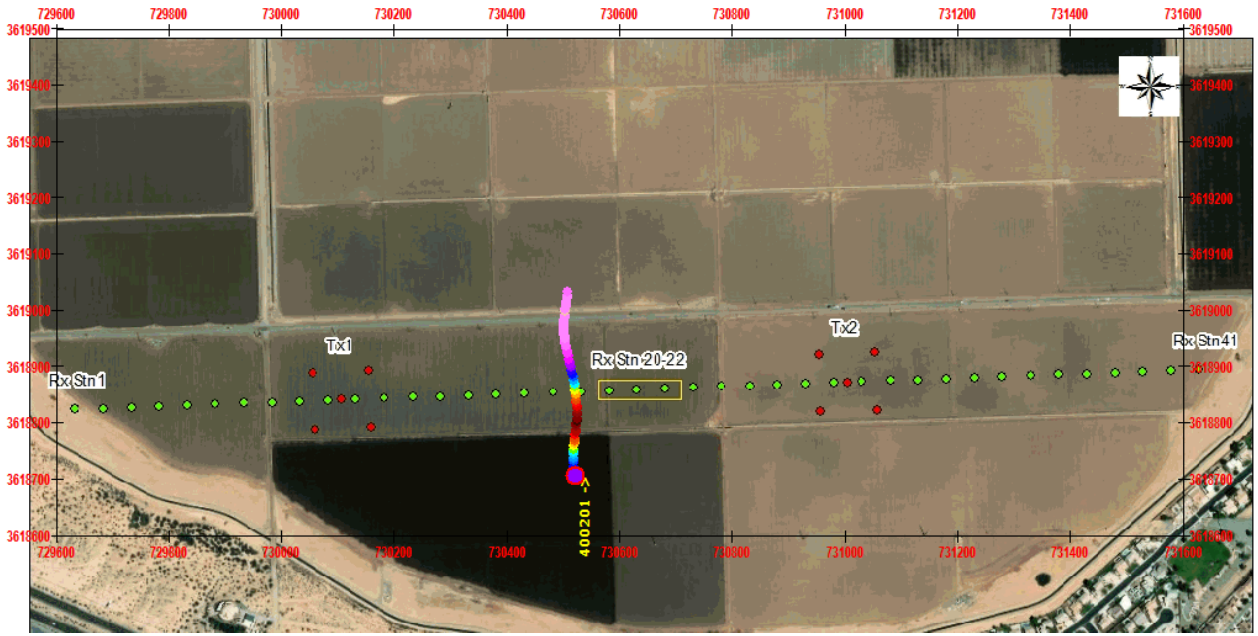
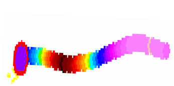


Figure 1

Survey Perspectives:

- ground stations
- loop corners

 340m section of SkyTEM line 400201

Comment:

This is a very preliminary examination of the Zonge ground data as well as the SkyTEM data. We have only the inversion for one SkyTEM position. However, the data in the subset of the data shown in the previous figure is very similar to the data at the exact intersection.

Additionally, we have no calibration information for the Zonge equipment.

Intersection Station:
730528 East
3618855 North

SkyTEM models

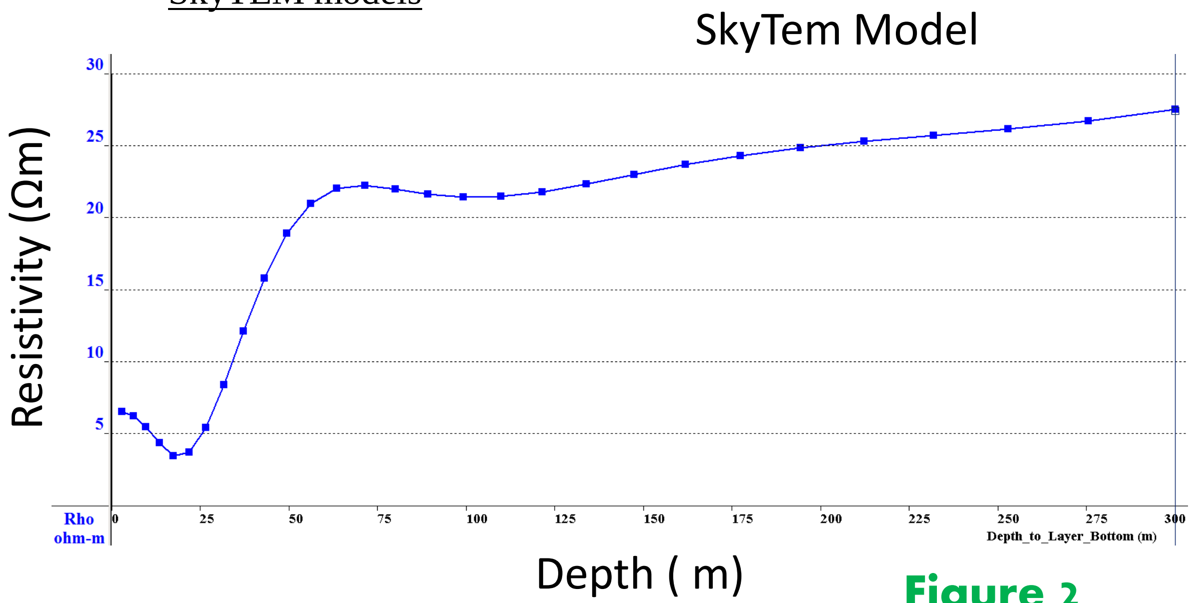


Figure 2

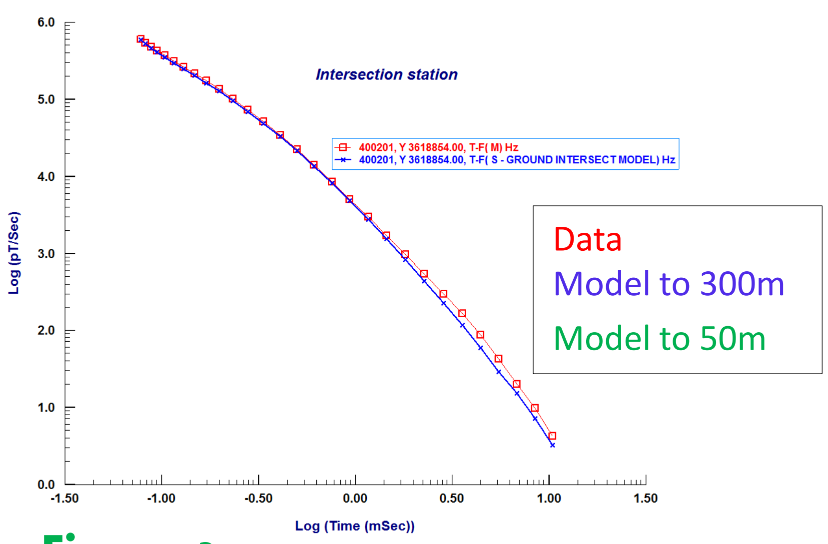


Figure 3

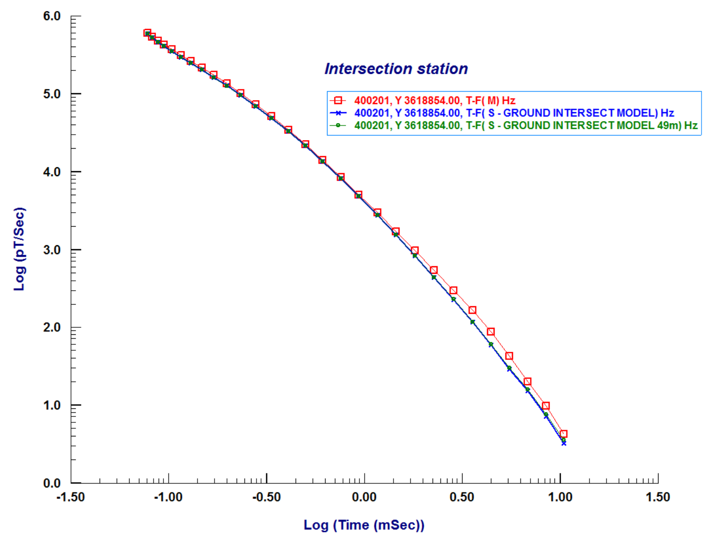


Figure 4

Comparison of SkyTEM model simulation to data

SkyTEM models

Intersection Station:

730528 East

3618855 North

Comments :

1. SkyTEM model is essentially a halfspace below 50m
2. SkyTEM model does not it the data in the late time
3. Visual examination indicates a change n resistivity at 20
4. SkyTEM model cut at a depth of 50m produces equivalent response to full model
5. SkyTEM inversion technique has at least 2 limitations
   a) number of layers and layer thickness are fixed and set for the entire inversion
   b) variation in resistivity with depth must be smooth

Intersection Station:

730528 East

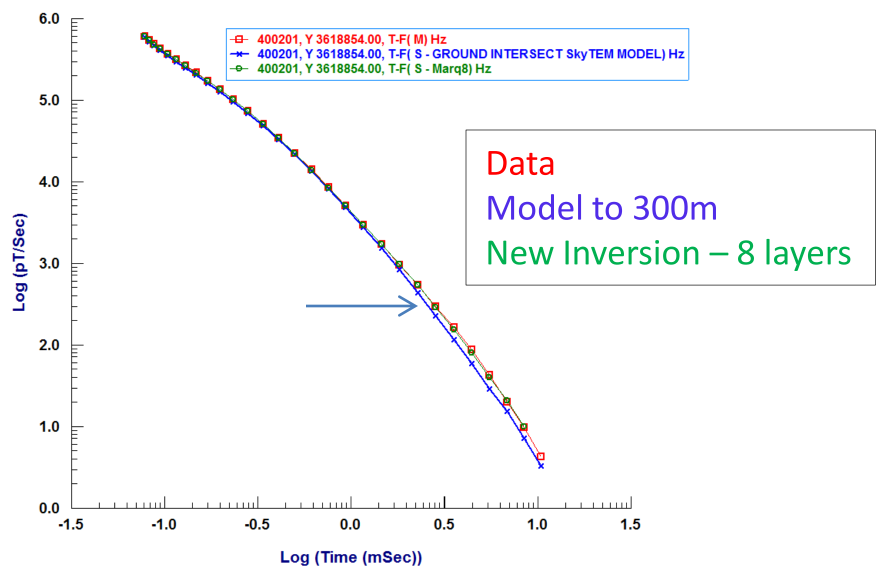
3618855 North

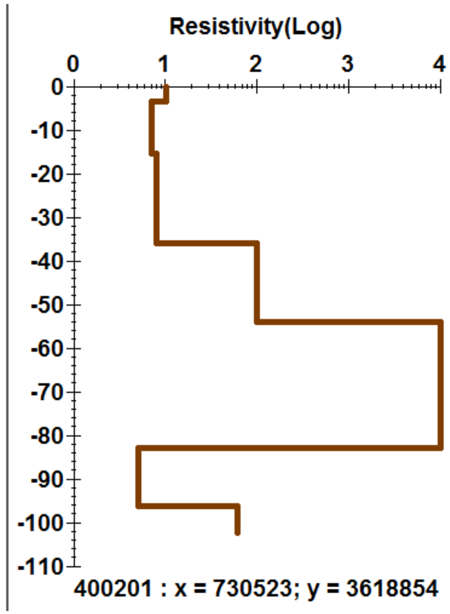
Another Inversion Approach

Underparametrized Inversion:

-inversion model has less parameters (number of layers x 2) than data

- thickness of layers not pre-defined and thus depth not pre-defined
- inversion allows discrete changes in resistivity with depth (ie. more realistic)





Intersection Station:

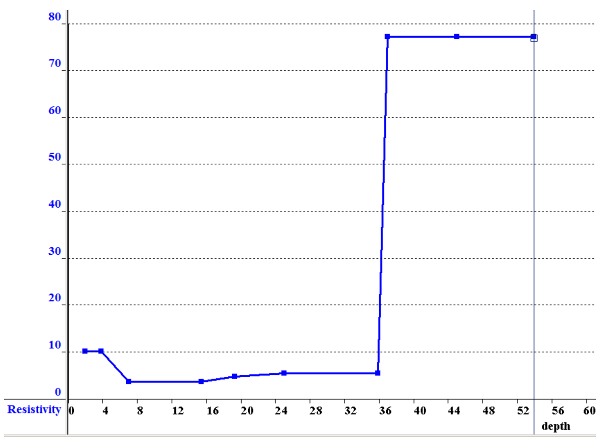
730528 East

3618855 North

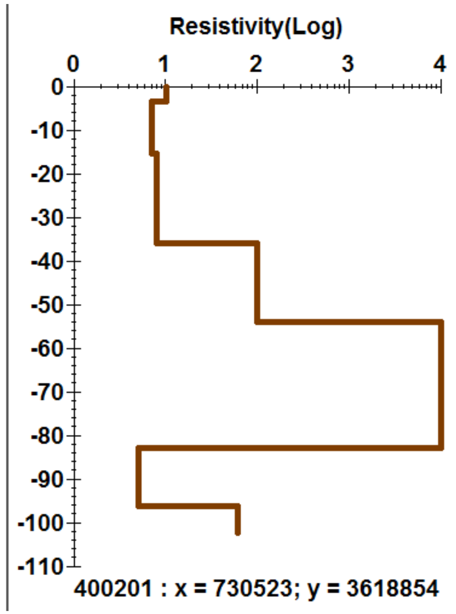
Another Inversion Approach

Comments on Differences between Models

- new model fits the data in the late time
- there is a sharp change in resistivity at 54m to a resistive layer before return to a more conductive layer than at shallow depths
- resistivity of the resistive layer is not well define
- depth to top and bottom of resistive layer is well defined
- shallow resistivities are similar but there is not a smooth transition to resistive at 50m
- however, it must be understood, that in-loop TEM 1D inersions are not unique



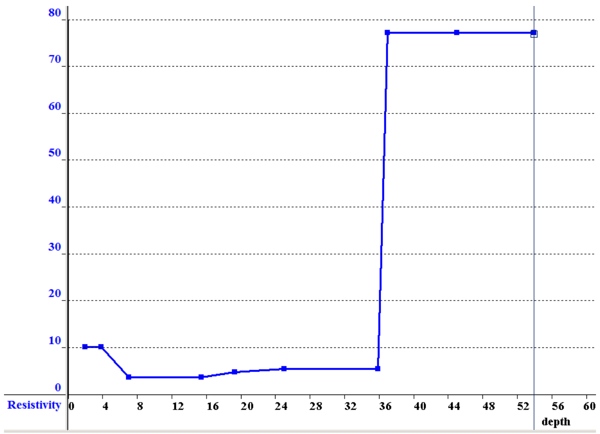
shallow model – additional points added to illustrate model



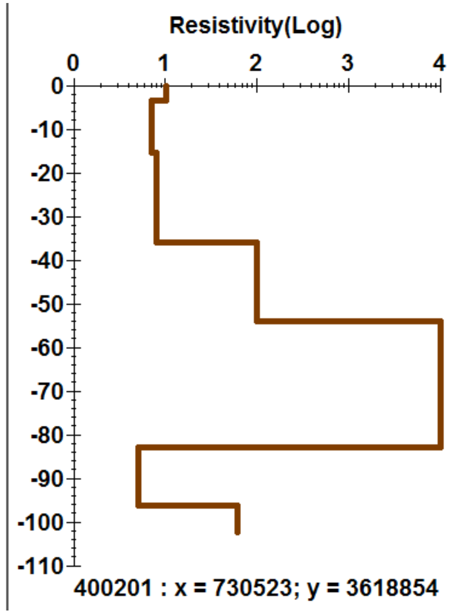
Intersection Station:
730528 East
3618855 North

Comparison to Ground Data

Comments on Differences between Models
- new model fits the data in the late time
- there is a sharp change in resistivity at 54m to a resistive layer before return to a more conductive layer than at shallow depths
- resistivity of the resistive layer is not well define
- depth to top and bottom of resistive layer is well defined
- shallow resistivities are similar but there is not a smooth transition to resistive at 50m
- however, it must be understood, that in-loop TEM 1D inersions are not unique



shallow model to start of resistive layer
– additional points added to illustrate model



Ground Data

Short comments on ground instrumentation

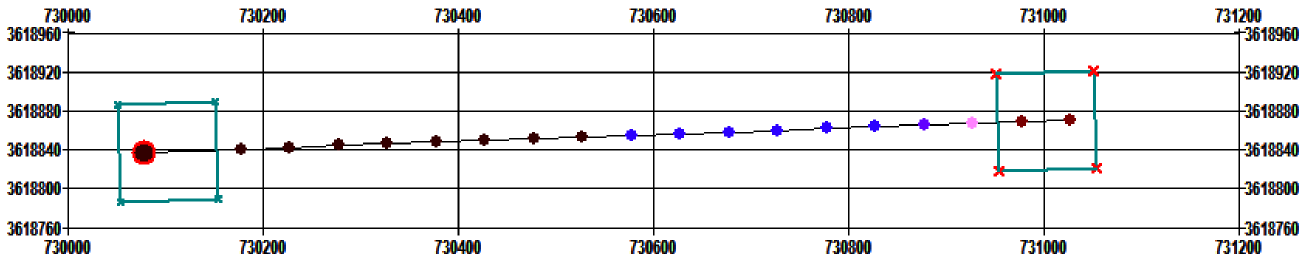
- current waveform: unlike the SkyTEM system, we do not have a definite definition of the details of the current in the transmitter during each cycle

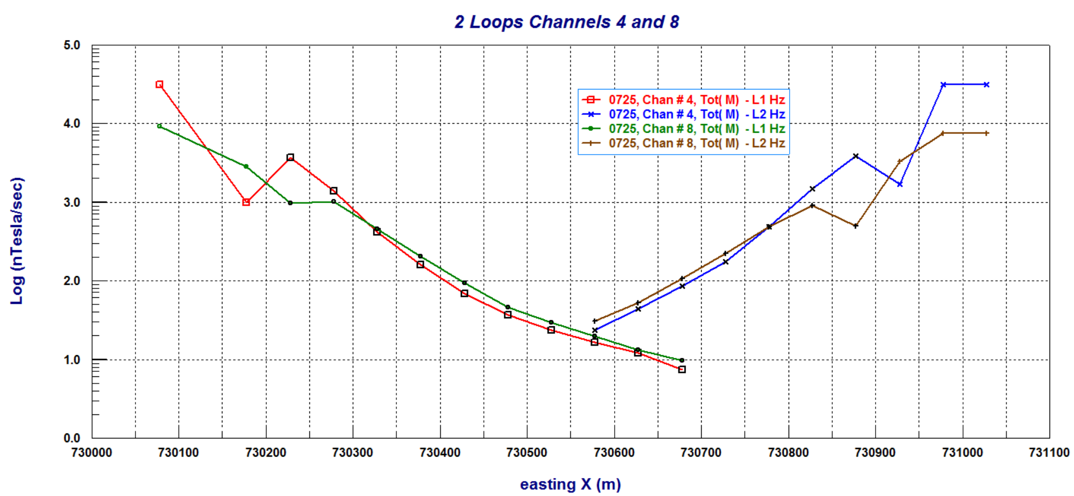
-the ground system, does not have a controlled turnoff as in the SkyTEM system but is a exponential decay where the decay constant is a function of the inductance and resistance of the loop and the amount of back electromagnetic pulse from the ground response

- the time windows are given with respect to the "end of the current turnoff". However, as there is no current turnoff but rather a continuously decreasing exponential, we do not know exactly where these time windows are located
- experience and experimentation allows us to estimates the decay constant of the turnoff and the position of the windows with respect to the beginning of the turnoff.
- the SkyTEM results help in this process
- but, this process is time consuming and not exact

Examination of Ground data:

- We show the 2 transmitters and the data locations leading to the opposite transmitter. There is an overlap of 3 stations at the center. We wish to compare the data between loops at similar offsets in order to determine the dimensionality and variation in the ground response from the 2 loops.
- at the very early channels, the west loop response is slightly higher. At channel 8, the short offset data is similar the west loop response is lower outwards from the loop.
- There is therefore some 3D response into later time. This could be the effects of the contact between the fields and the edges of the field. The west tx is closer to the edge of the fields.





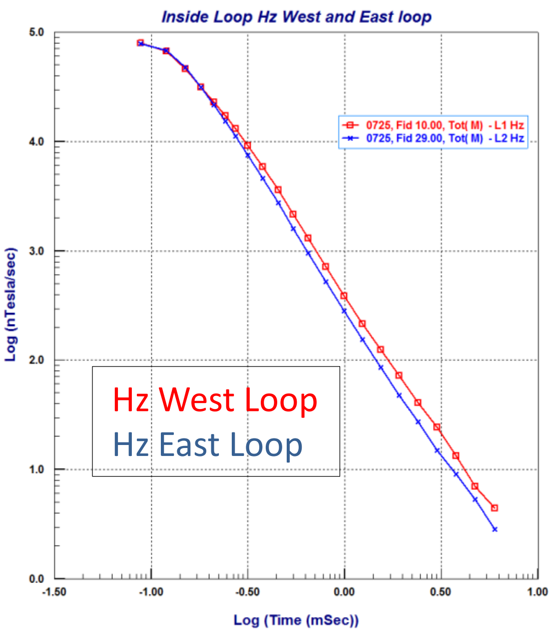
Hz Ch4 West Loop
Hz Ch8 West Loop
Hz Ch4 East Loop
Hz Ch8 East Loop

The Hz response for both loops at Chns 4 and 8

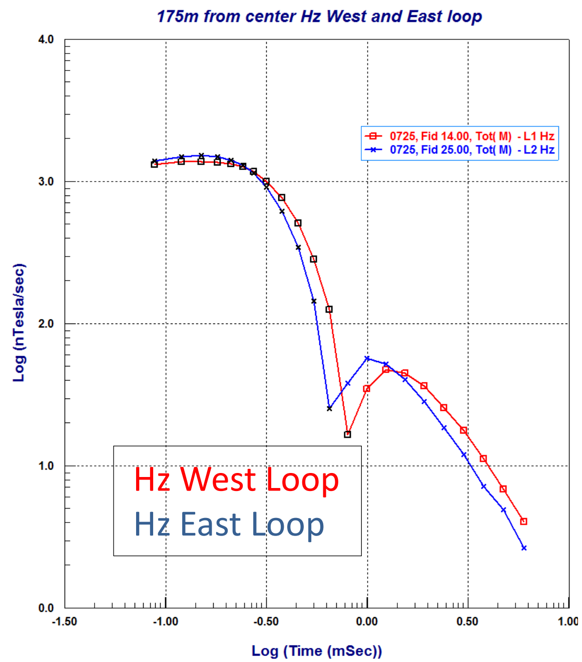
Ground Data

Examination of Ground data:

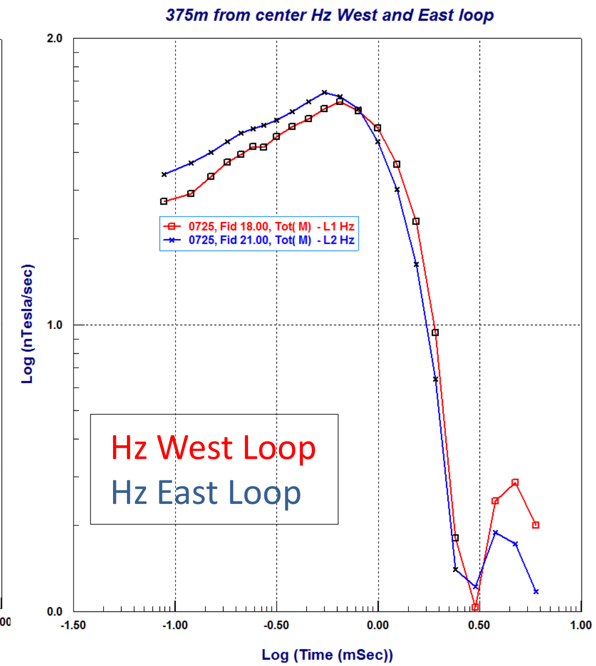
- The center loop response show very similar early time responses but the west loop indicates a slightly higher conductivity and at a shallow depth. The responses at 175m from the center show a similar result as do the response at 375m from the center.



The Hz response inside loops



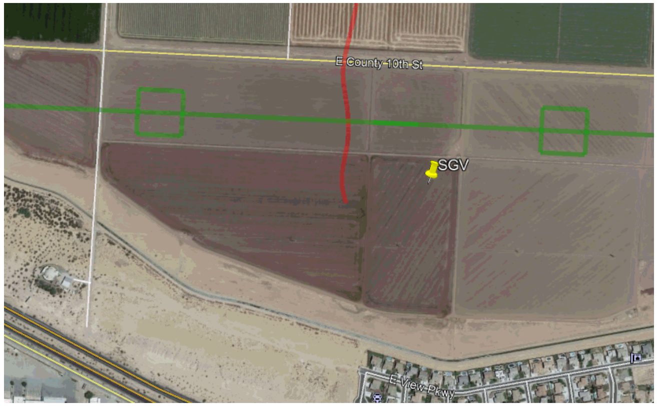
The Hz response 175m from center

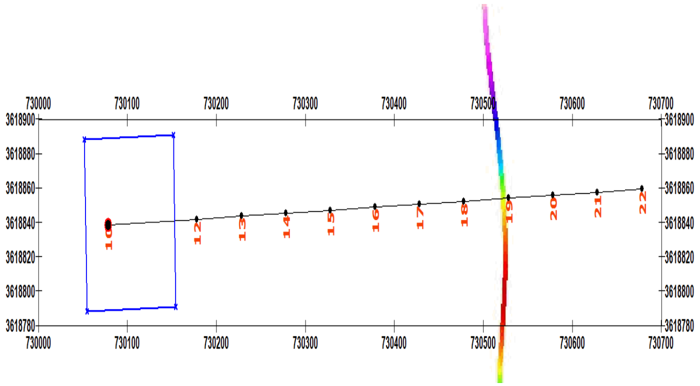


The Hz response 375m from center

Comparison of Ground data to SkyTEM models:

- In this second example, we use the SkyTEM inversion model provided by the contractor again and compare it to the ground data from the western loop utilizing the stations from the center of the loop to the eastern edge of this data.

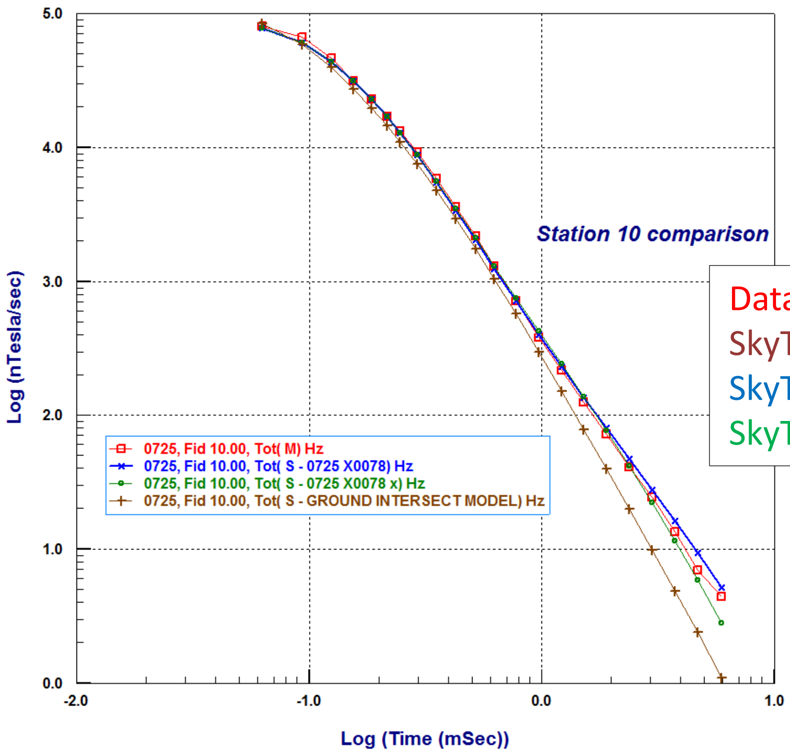


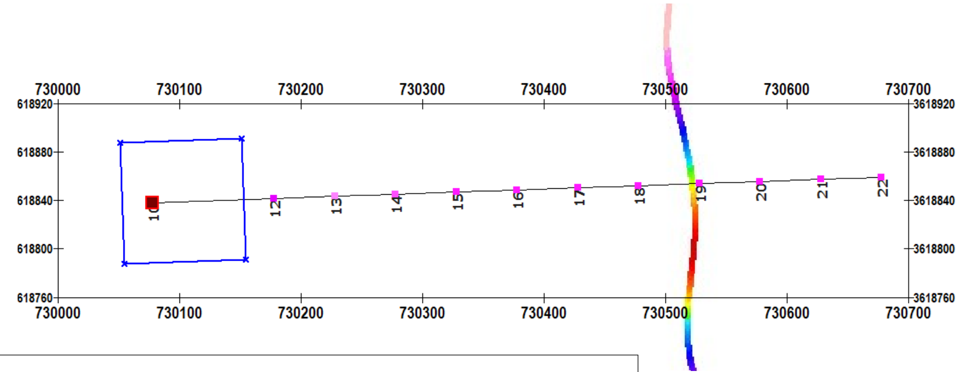


The loop for the west data is much closer to the edges of the field than the east loop and therefore may be more affected by the contrast in resistivity between the fields and the dry sand on the edges.

Comparison of Ground data to SkyTEM models:

- As we have seen, the early time responses for both loops both inside the loop and to intermediate offsets from the loop, are extremely close in value. So, as an example, we will look at the data from the west loop as shown below. The intersection of the airborne data is shown near Station 19 about 400m from the center of the loop.
- The actual turn-off of the current in this system is not known to a high degree of accuracy. But, utilizing previous work for such systems and using the airborne models for calibration, we have arrived at our best solution for describing the current turnoff and the position of the time channels. The current turnoff is a simple exponential with a time constant of 0.03msec and the time channels begin at 0.06282msec after the beginning of turn off. The time differences between the further channels and the first channel are kept as described by the manufacturer.





Data Hz
SkyTEM model contractor
SkyTEM model EMIGMA
SkyTEM model EMIGMA basement modified

With respect to the above system settings, we have computed the response of the airborne data models near the intersect with ground line. The delivered model from the contractor is too conductive starting early and continuing to late time which is a similar result to the airborne data. The model computed from the airborne data by the more accurate inversion technique is very close to the data until the last 5 time channels. The data indicates the ground is more conducting at depth then derived by the airborne data and we have adjusted the model to be more conducting at in the basement. However, it must be remembered that we now know the ground is slightly 3D at depth.