Red Dike
Report on VTEM Data

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South Rim Pipes
Report to Uranium One and Vane
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Petros Eikon

Red Dike - 4-36

Miller Pipes – 37-63

SBF Pipe – 64 - 89

Introduction

Four known breccia pipes in the South Rim are located within the VTEM survey flown by Geotech in the spring of 2007: Miller, Miller SW, Red Dike, and SBF. This report is a preliminary analysis of the VTEM data (magnetic and electromagnetic data) over the Red Dike. This pipe is owned by Vane Minerals.

The purpose of studying the airborne data over these known South Rim pipes is to determine if they are associated with any magnetic or EM anomalies, which could assist in finding unknown pipes using geophysics.

Red Dike is on the edge of a topographic low (a wash). There is an EM anomaly at early times associated with this wash. The anomaly extends about 8 km, with some discontinuities. Some modeling work suggests that this anomaly is caused by a shallow structure, and it could be directly related to the wash (i.e., maybe due to more conducting sediments). There is also a difference in the mid-late time response on either side of the wash, which could represent a fault. There is no local EM anomaly at Red Dike. There is a sharp magnetic anomaly on the line closest to Red Dike, but this is likely due to drilling equipment.

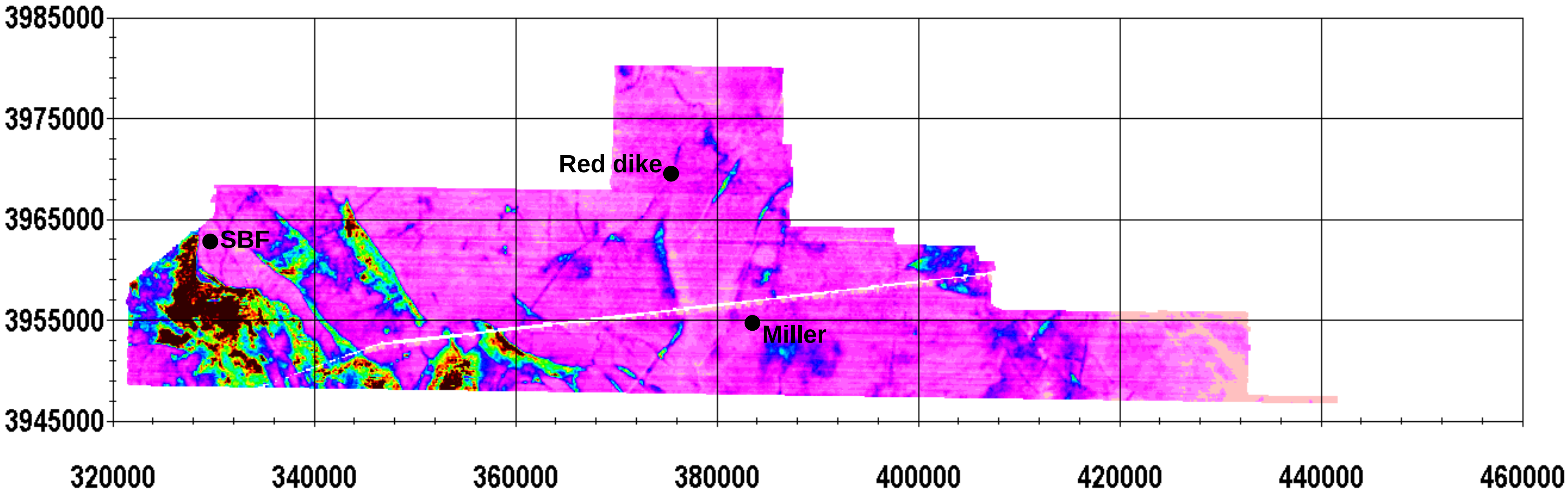
The results at Red Dike are different from those at other known pipes. A model of the EM anomaly at Findlay Tank is 60-80 m deep, 180 x 180 m, and weakly conductive. It is thought to be a more conducting zone at the top of the pipe, possibly sulfides. Two other South Rim pipes, Miller and Miller SW, are also associated with a wash, but there is a localized EM anomaly at Miller. This anomaly is probably caused by two structures: a very shallow conductor (possibly Moenkopi over the pipe) and a conductor at -50 m. We are not sure of the geological significance of the second structure. While SBF, another pipe in the South Rim, also is near to a linear EM anomaly, that anomaly is very different in character from the one at Red Dike.

Location

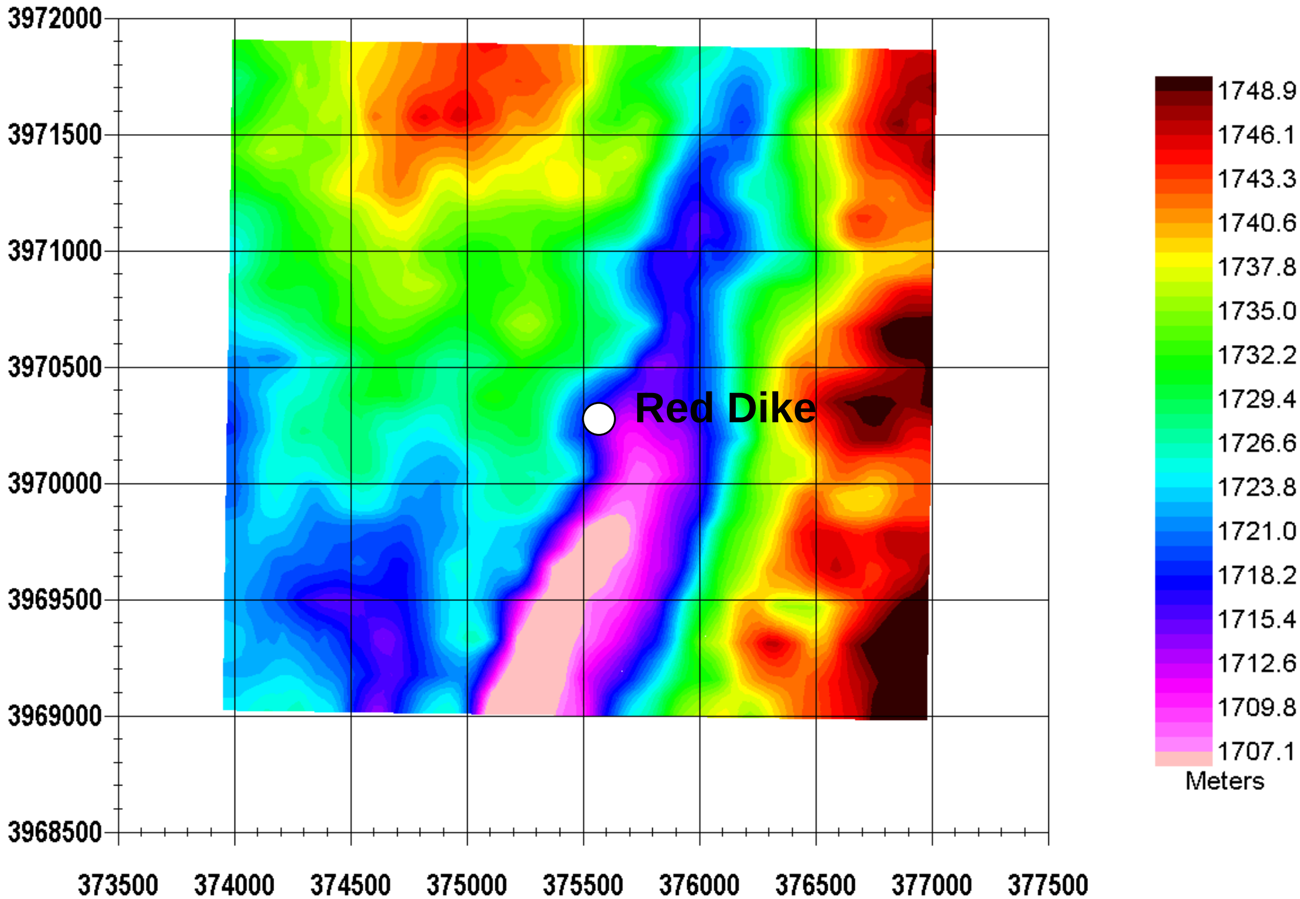
Location in Nad27:
(375640, 3970095)

Location in Nad83:
(375576, 3970295)

Red Dike is located in the South Rim. The co-ordinates of these pipes were provided in Nad27, and were transformed to Nad83 because this is the datum of the VTEM data.



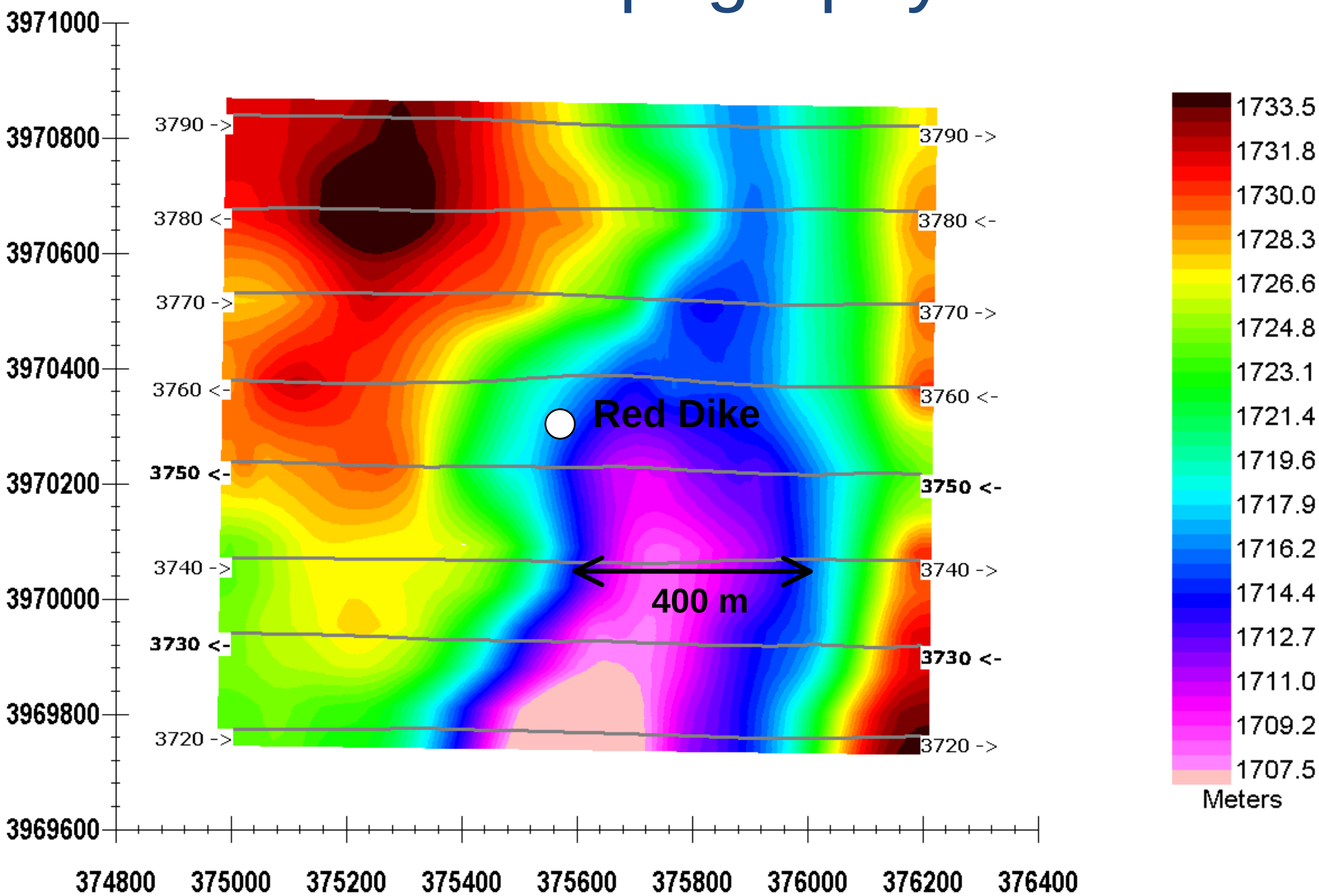
Topography



The digital terrain model was calculated from the altitude and GPS Z channels in the VTEM data. Red Dike is on the edge of a low in the topography.

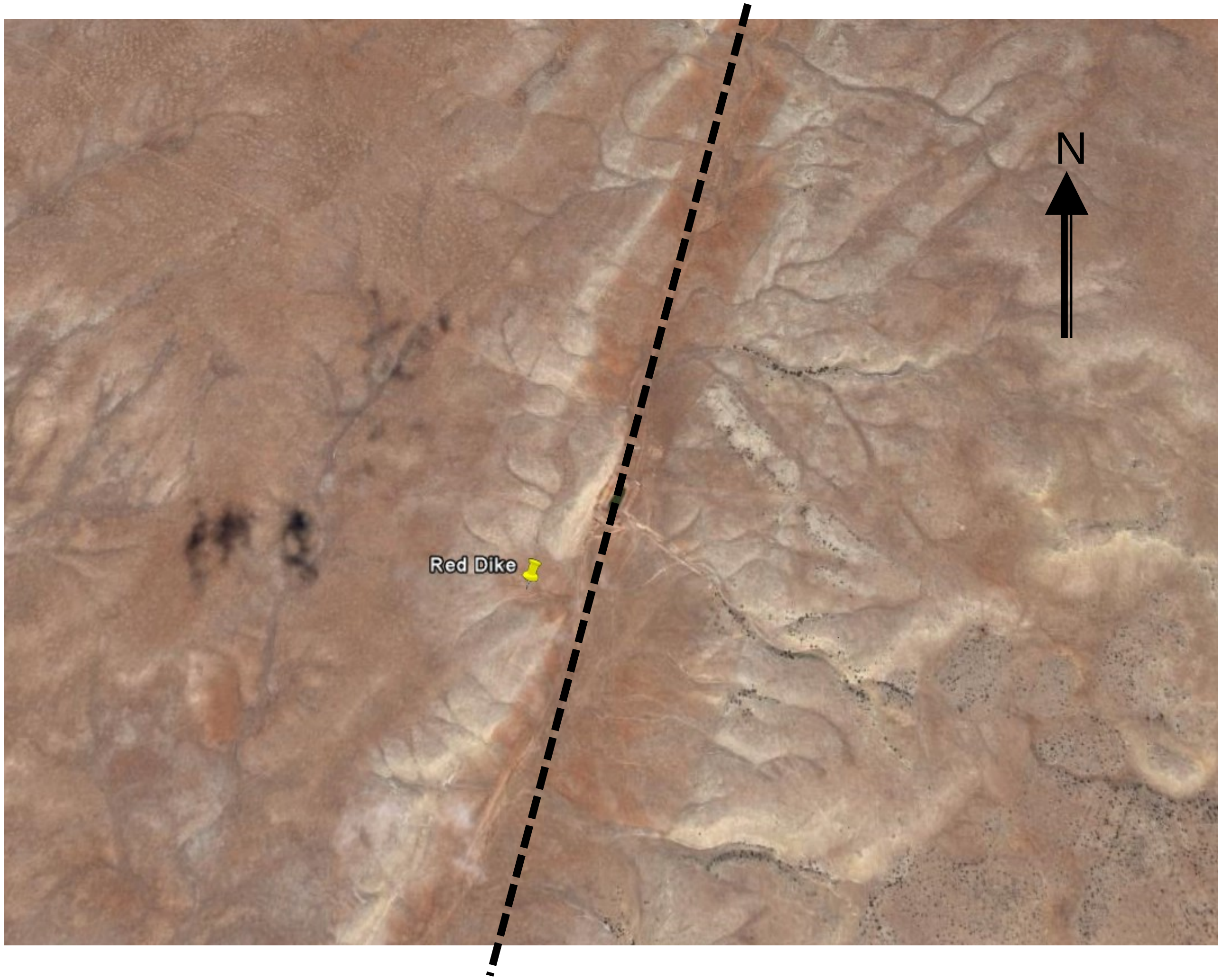
Miller and Miller SW are also associated with a topographic low.

Topography

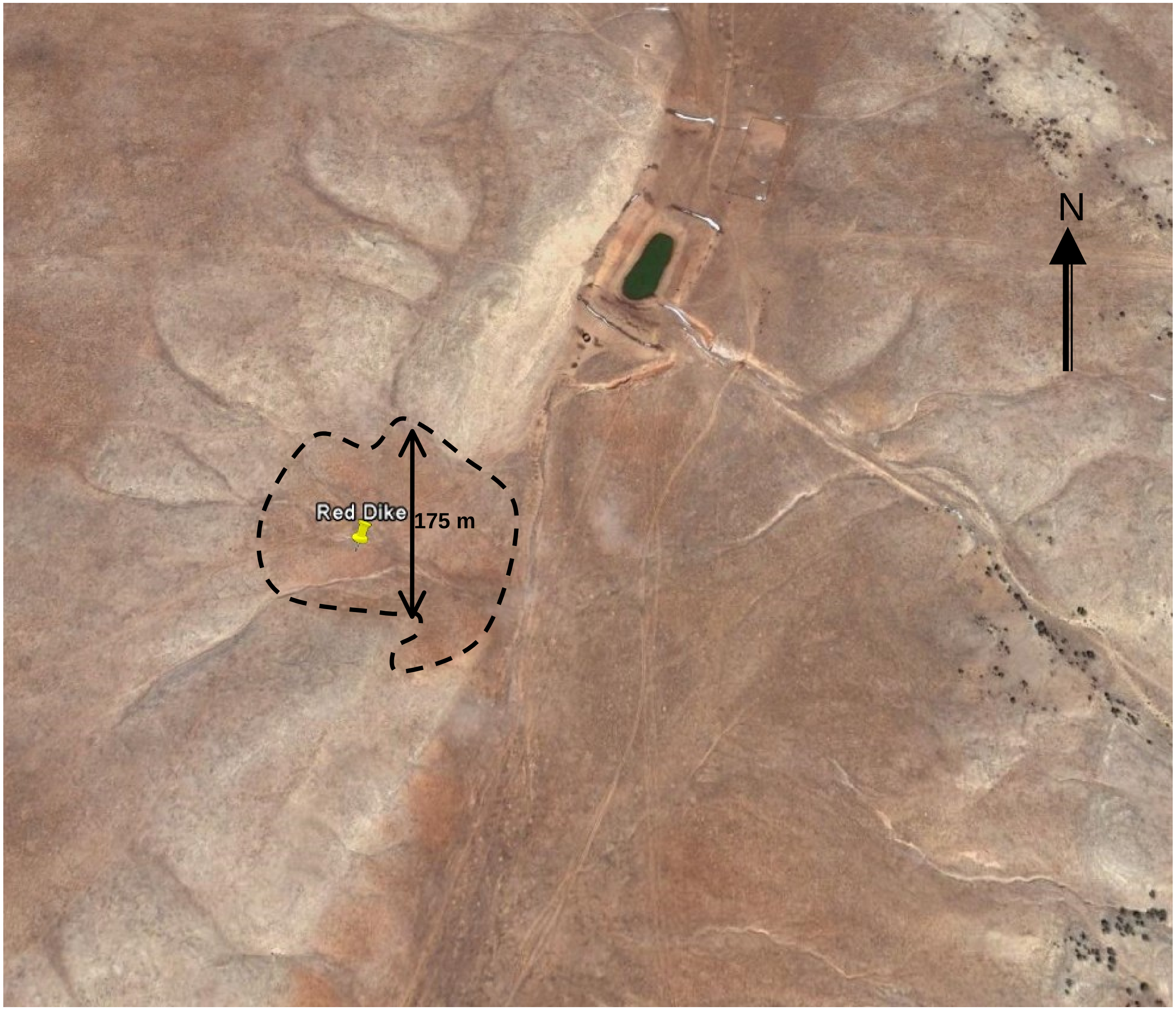


Close-up of the digital terrain model, showing the flight lines.
Red Dike is between Lines 3750 and 3760.

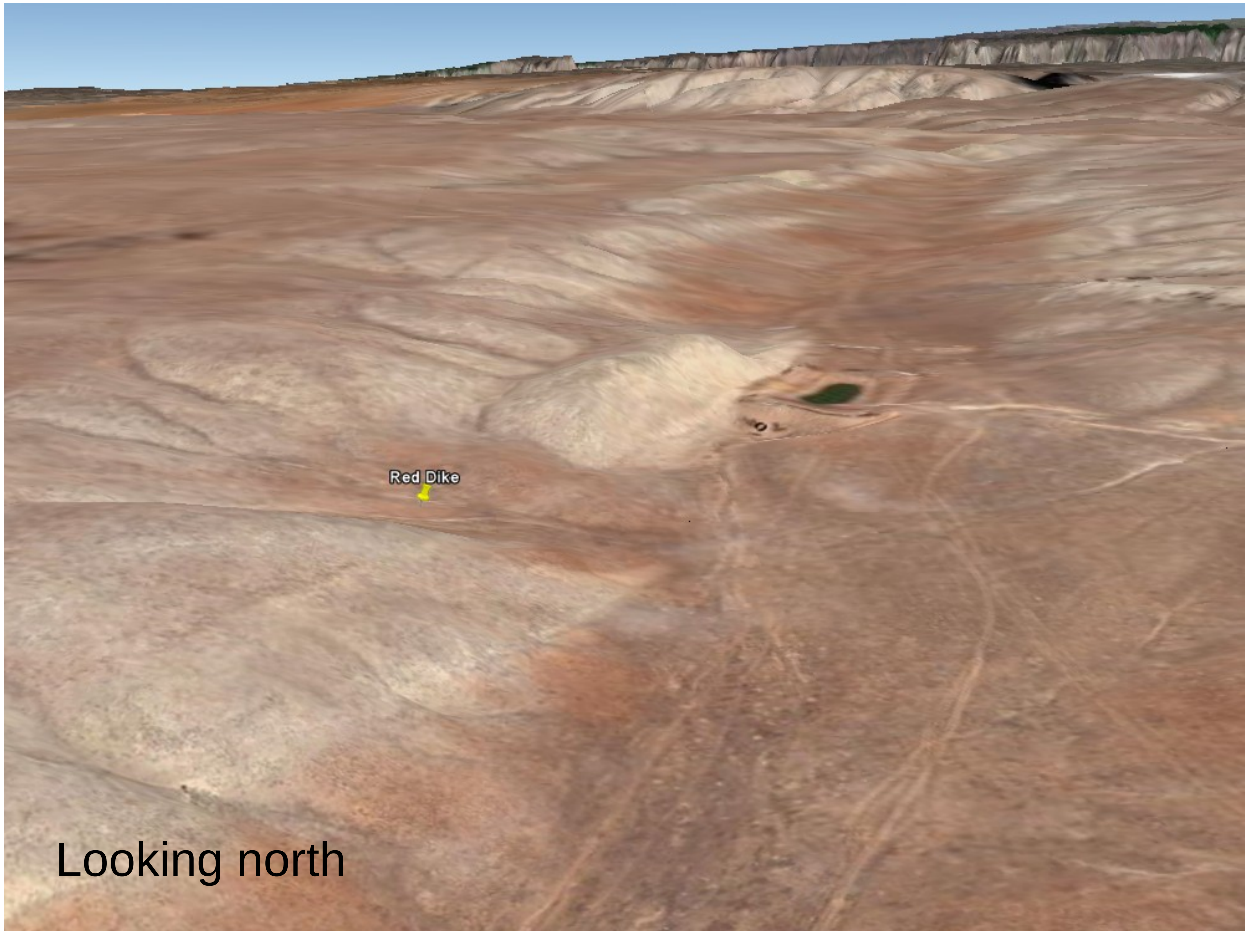
Topography



4 km x 3 km satellite image from Google Earth. Dashed line approximately marks the center of the topographic low. It appears slightly redder than its surroundings.

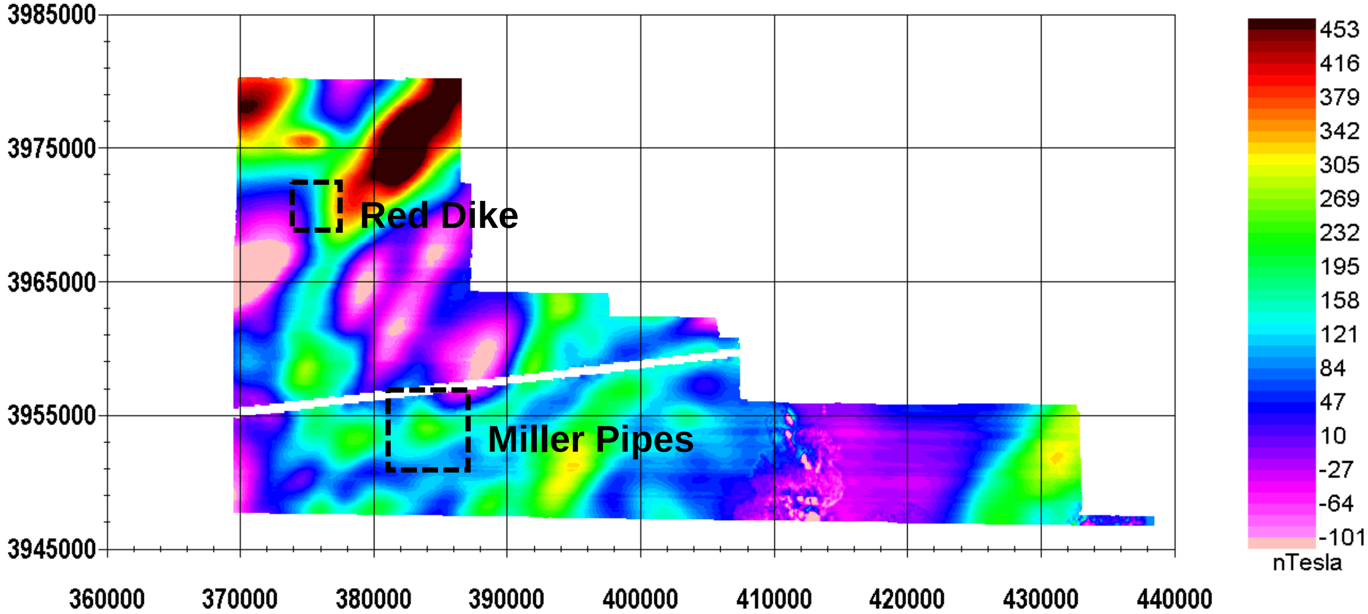


1x1km close-up. Red dike is associated with a somewhat-circular depression (about 200 m across) on the edge of a wash, as marked. Red Dike Pond is about 300 m to the northeast.



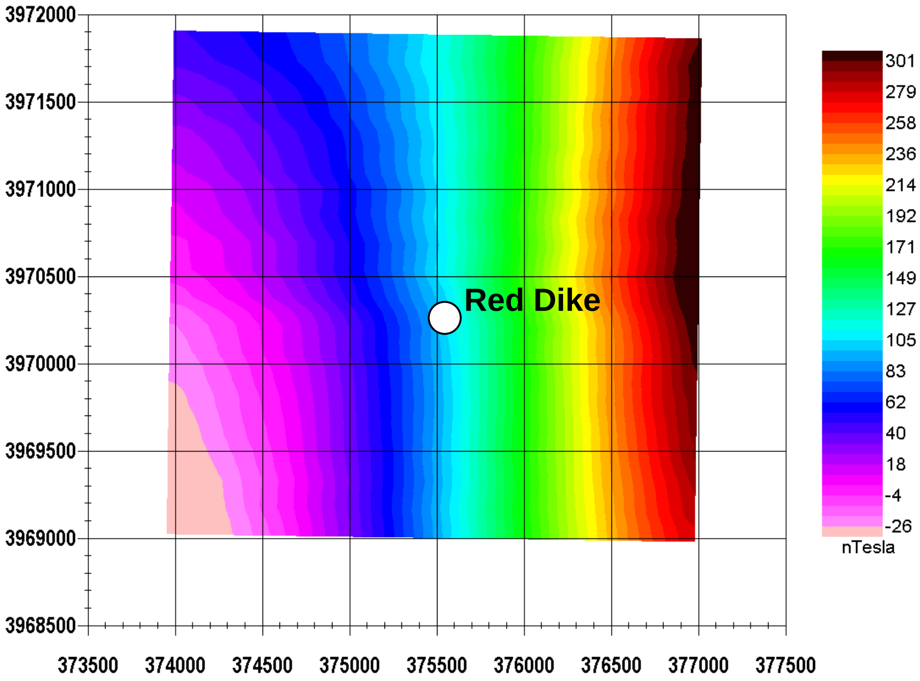
3-D view of terrain near Red Dike with vertical exaggeration of 3. View is looking north. The depression around Red Dike is visible, as is the gentle slope into the wash. Surficial material is reddish within the topographic low, and white on either side of it.

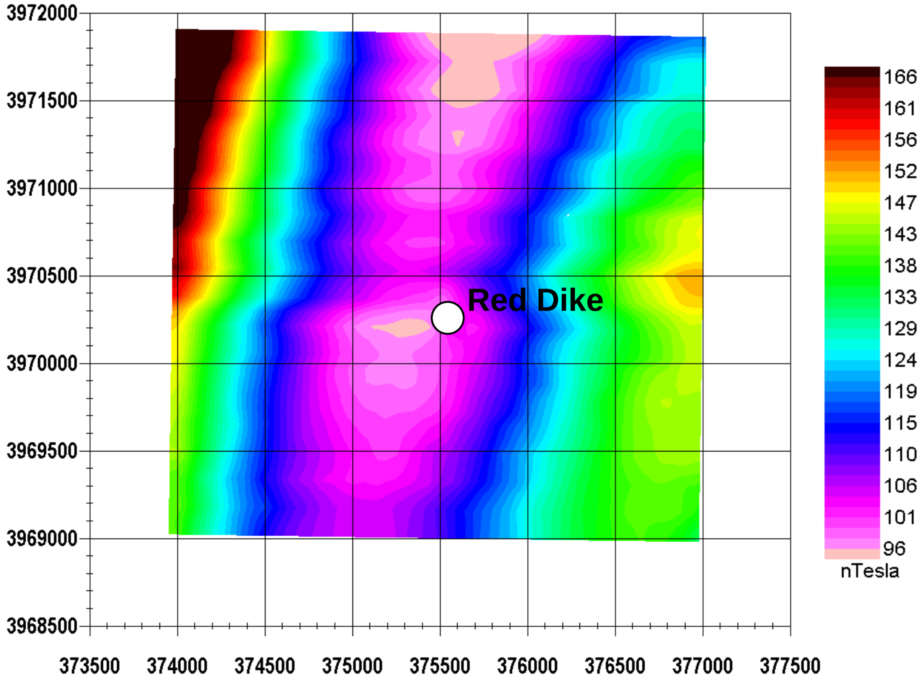
Magnetic Data



Magnetic field with background (IGRF) response removed over the NE section of the VTEM survey. Red Dike is on the edge of a large magnetic high.

Magnetic Data

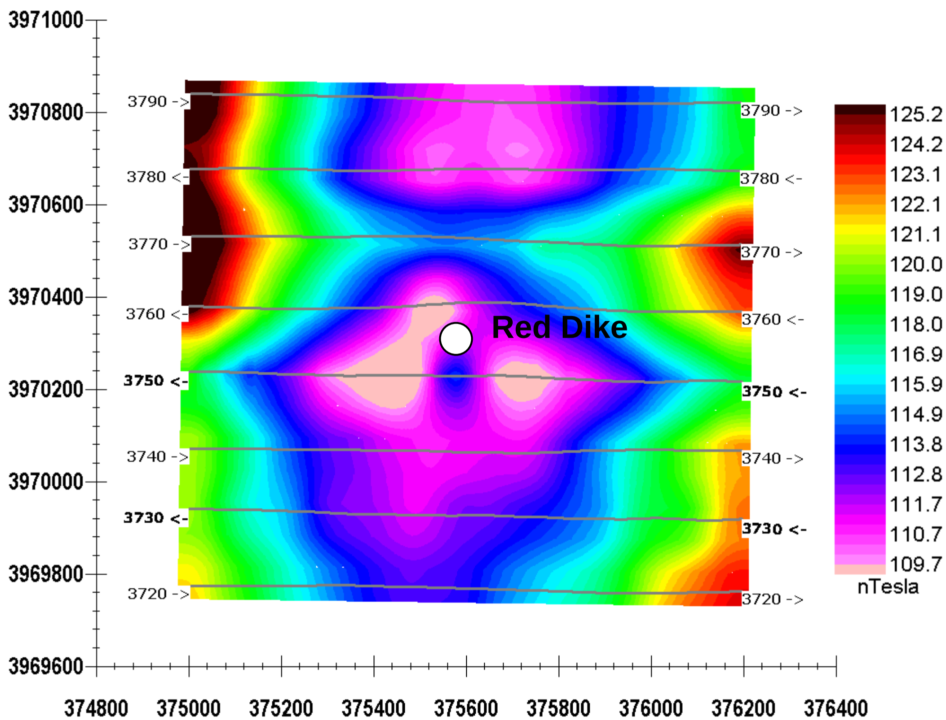


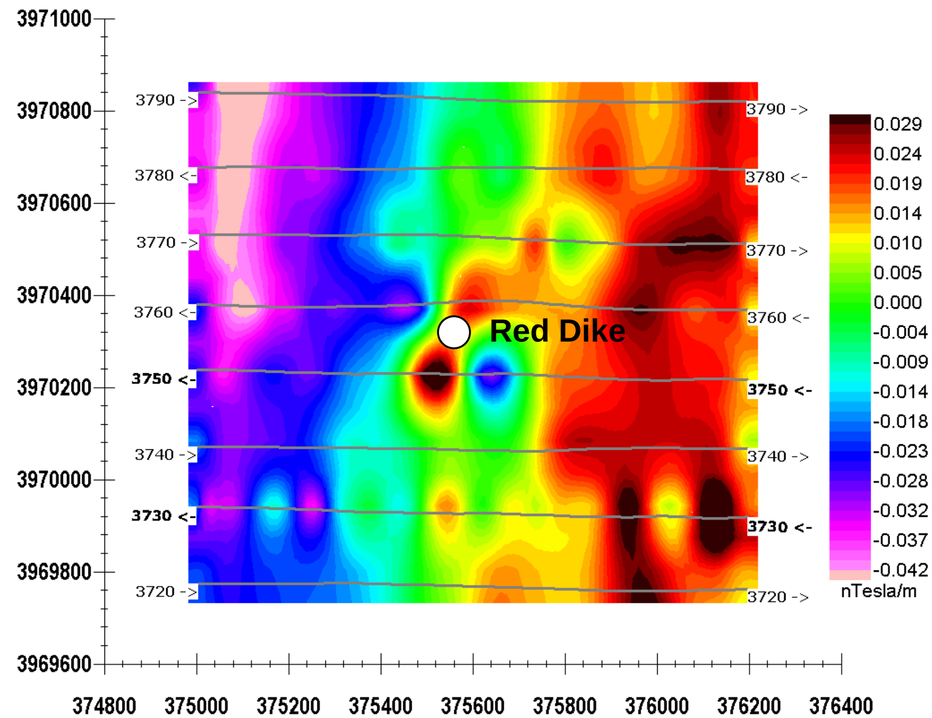


Left: Magnetic field near Red Dike. Background field has been subtracted. The dominant trend is a decrease response towards the west.

Right: Magnetic field with the regional gradient removed.

Magnetic Data

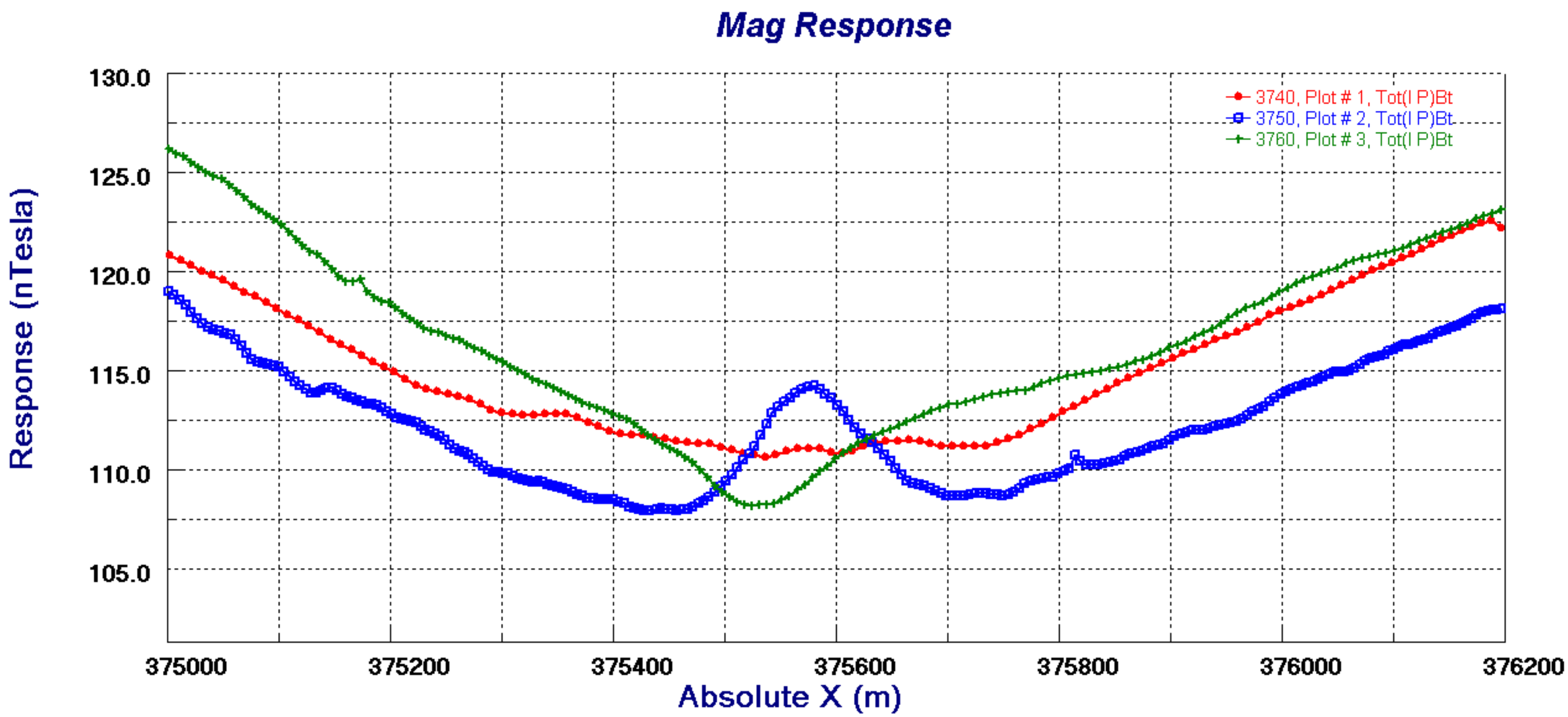




Left: Close up of the magnetic response around Red Dike with the gradient removed. In this contour plot, there is an anomalous high just south of Red Dike. **While this anomaly appears south of Red Dike, Red Dike is half-way between Lines 3750 and 3760, which are 150 m apart. Due to this line spacing, there is limited resolution of the response north-south.

Right: In-line horizontal derivative of the gradient-removed magnetic data. The anomaly is clearly observed in the derivative.

Magnetic Data



Plot of the magnetic data (gradient removed) along Lines 3740-3760. Red Dike is in between 3750 and 3760.

The anomaly seen in the total field and derivative maps on the previous page is visible only on Line 3750 and has an amplitude of 6 nT. On Line 3760, there is a slight low at this location as well, possible related to the same structure.

Line 3740
Line 3750
Line 3760

Magnetic Data

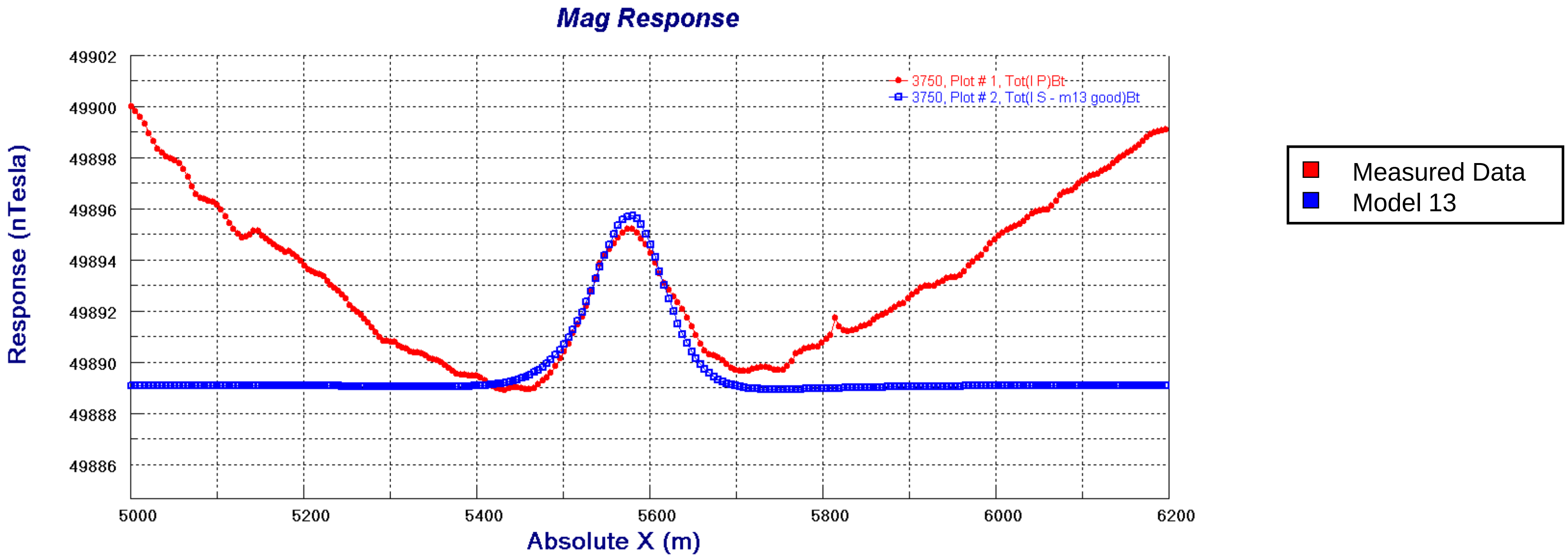
Vane Minerals has recently conducted exploration work at Red Dike. Drill hole 698-1 was completed in May 2007, and drill hole 698-2 was completed in June 2007, according to a report prepared for Vane Minerals by SRK consulting. As the VTEM survey was flown in May-June 2007, presumably drilling equipment would have been on site at the time. This may be the source of the magnetic anomaly, particularly given the localized extent of the anomaly.

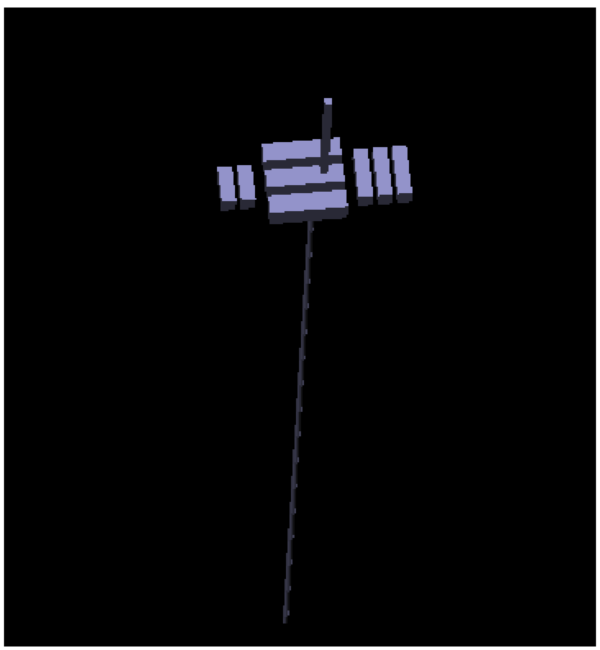
Comparisons of the magnetic response at Red Dike to other sites with manmade objects also support this hypothesis:

At Findlay Tank SE, there is a magnetic high in the vicinity of the pipe in the VTEM. A model of drill rods was developed to fit a high-resolution ground mag survey, and this model was also run for the VTEM system. It contains 7 drill rods with very high susceptibilities, and accounts for the high in the VTEM. The peak response is about 17 nT on one of the VTEM lines, and a few nT on neighboring lines. This is somewhat larger in amplitude than the response at Red Dike, but it is caused several drill rods.

The mag response in the GeoTEM at Kanab North, where there are man-made objects at the surface, peaks at 30 nT above the background is the anomaly is about 300 m wide. This is a higher amplitude and broader anomaly than at Red Dike, but there are likely more objects at the surface. At Deer Tank, where there is a metal tank, the magnetic response is 5-6 nT and less than 200 m across. The response at Red Dike is very similar to that at Deer Tank.

Magnetic Data





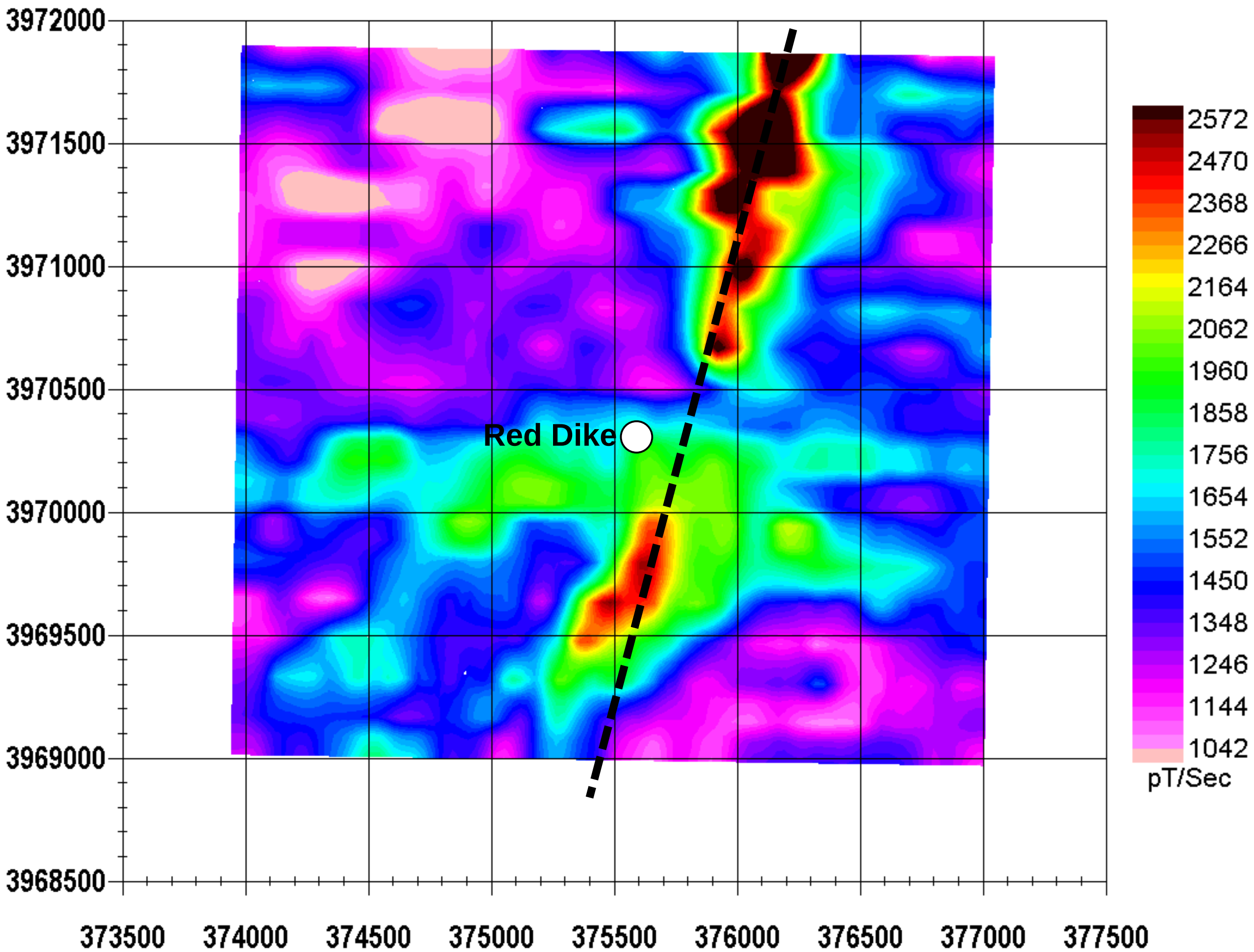
In the report for Vane Minerals by SRK Consulting, it mentions that equipment at the drilling site included:

Drill rig (mounted on 10-wheel truck)
10-wheel water truck
10-wheel pipe truck
Light trucks
Backhoe

In Figure 9.7 of the same report, which shows the drilling equipment at the Miller pipe, there appear to be eight vehicles on-site.

A model of the drilling equipment was created with eight vehicles of different sizes, a drill rig, and a drill rod (see left). Each object was given a susceptibility of 10. This model creates a similar response to that observed on Line 3750.

EM Data

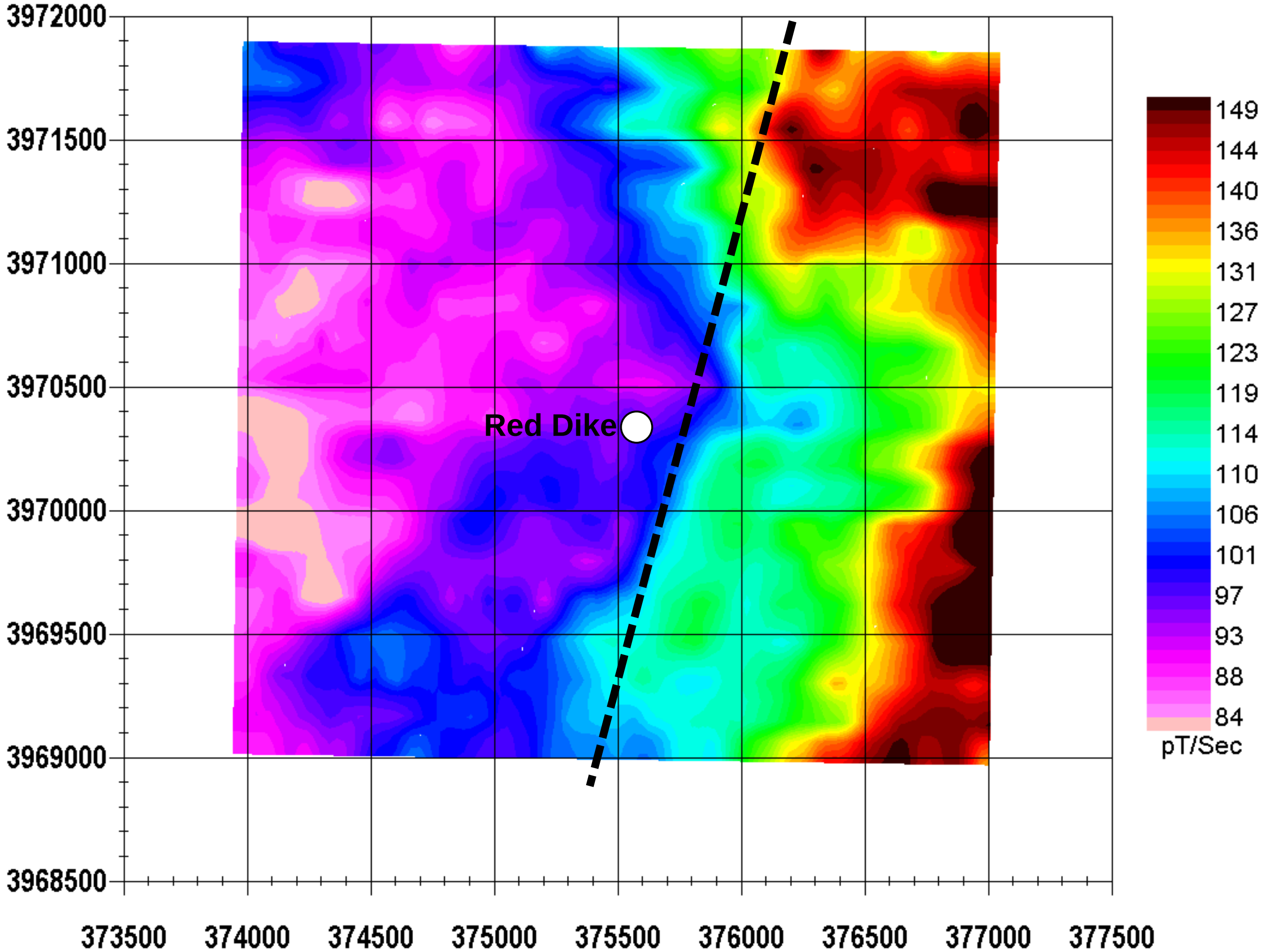


Ch 1

Map of the early time (channel 1) data over a 3 km x 3km area around Red Dike. The most prominent feature is a linear high to the east of Red Dike with a trend of about 15^0. The dashed line approximately follows the center of this anomaly. There is a break in the anomaly at about the northing of Red Dike.

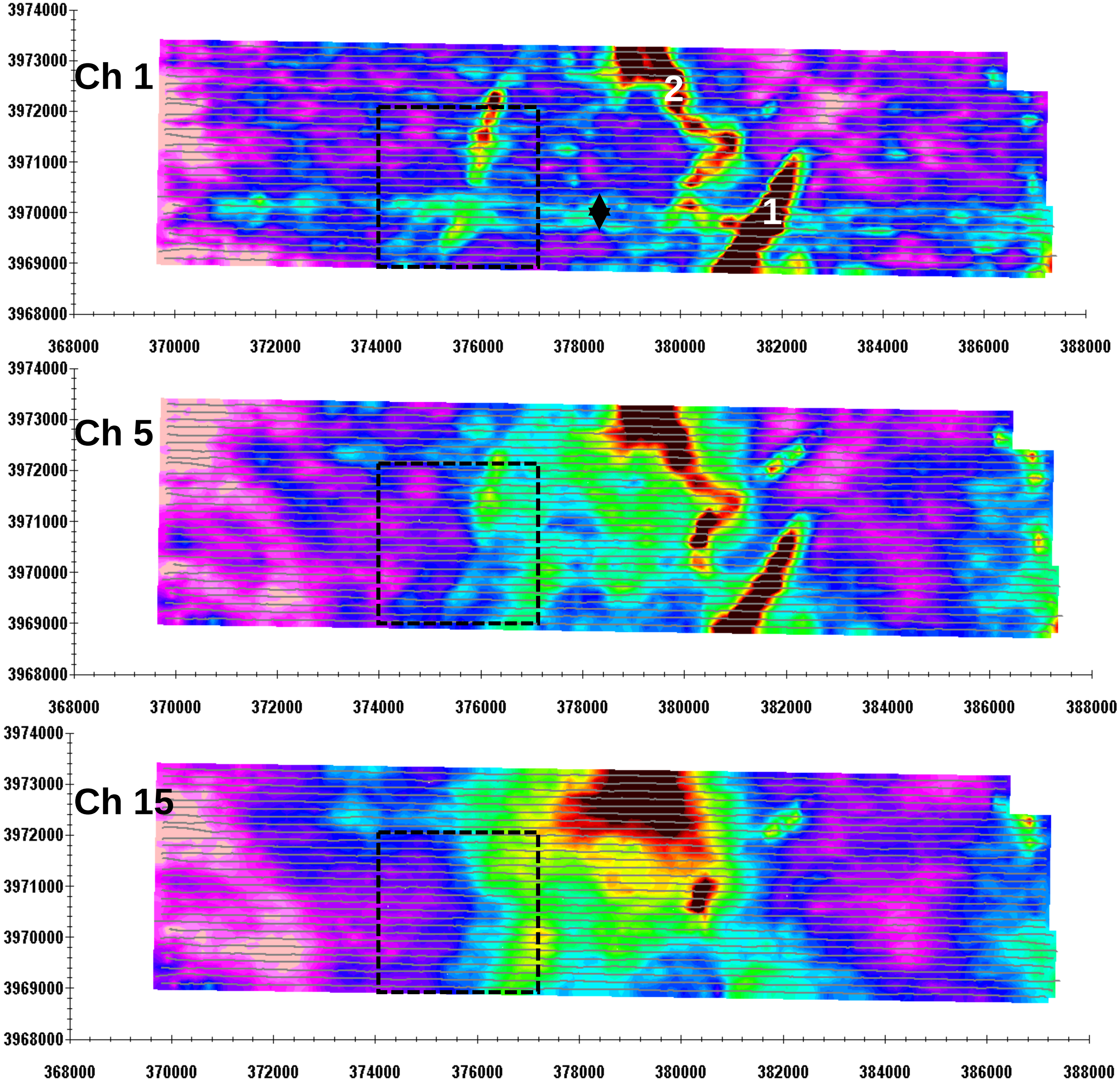
The response also appears slightly higher across the entire map between a northing of 3969800 and 3970400. It is thought that this could be due to bad early-time data on certain lines.

EM Data



Ch 10

Map of the mid time (channel 10) data over a 3 km x 3km area around Red Dike. The linear high that was visible at early times (position marked by dashed line) is not seen here; however, to the west of the early-time anomaly, the response is much lower than to the east.

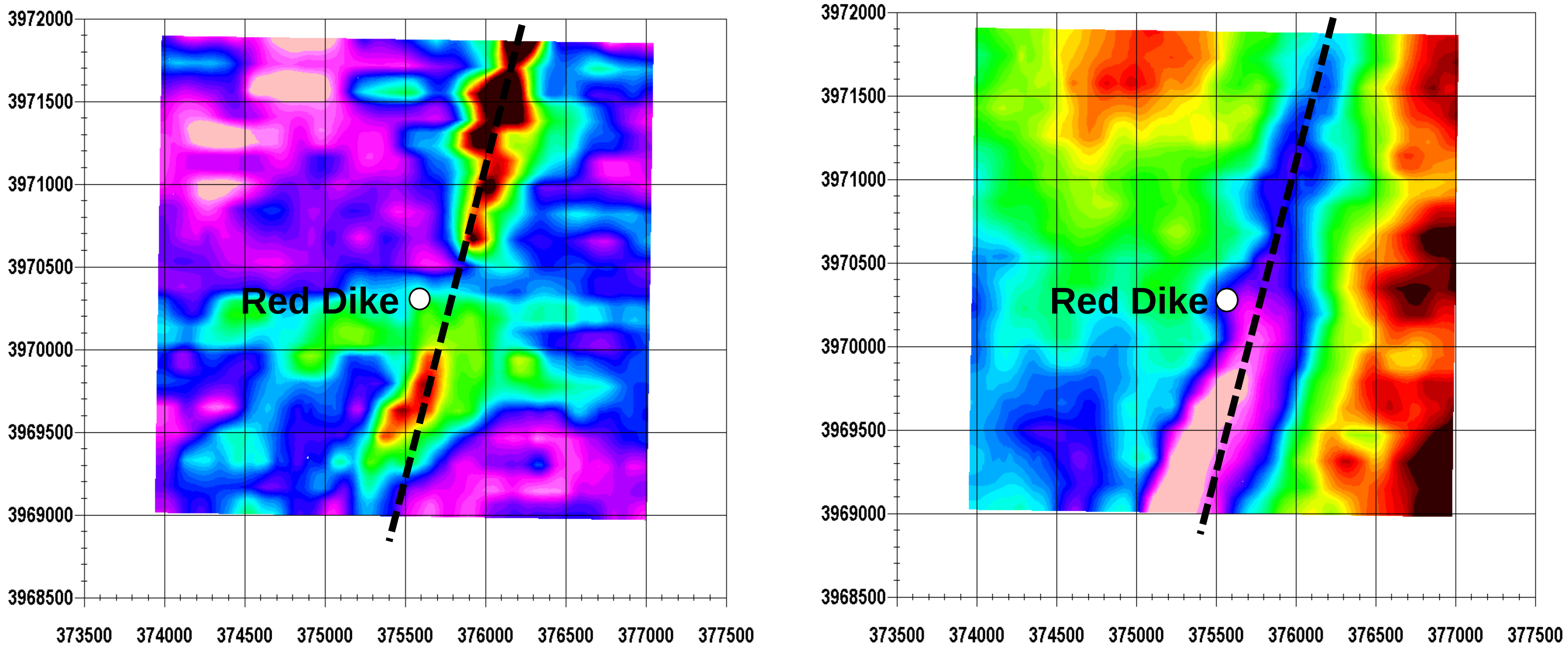


EM response at three different channels over a larger (18 km x 4 km area). At early channels, there are other linear anomalies to the east, one trending at a similar azimuth to the anomaly near red dike. Another linear anomaly (**2**), trends approximately northwest.

Later in time, the response between the anomaly near Red Dike and (**1**) is elevated. This area of generally higher response (about 6 km wide) persists until late times.

*Also of note in Ch 1: The response appears elevated across several lines near a northing of 3970000, as mentioned on page 15. It is assumed that this is not due to a change in the subsurface, but is due to an issue with early time data.

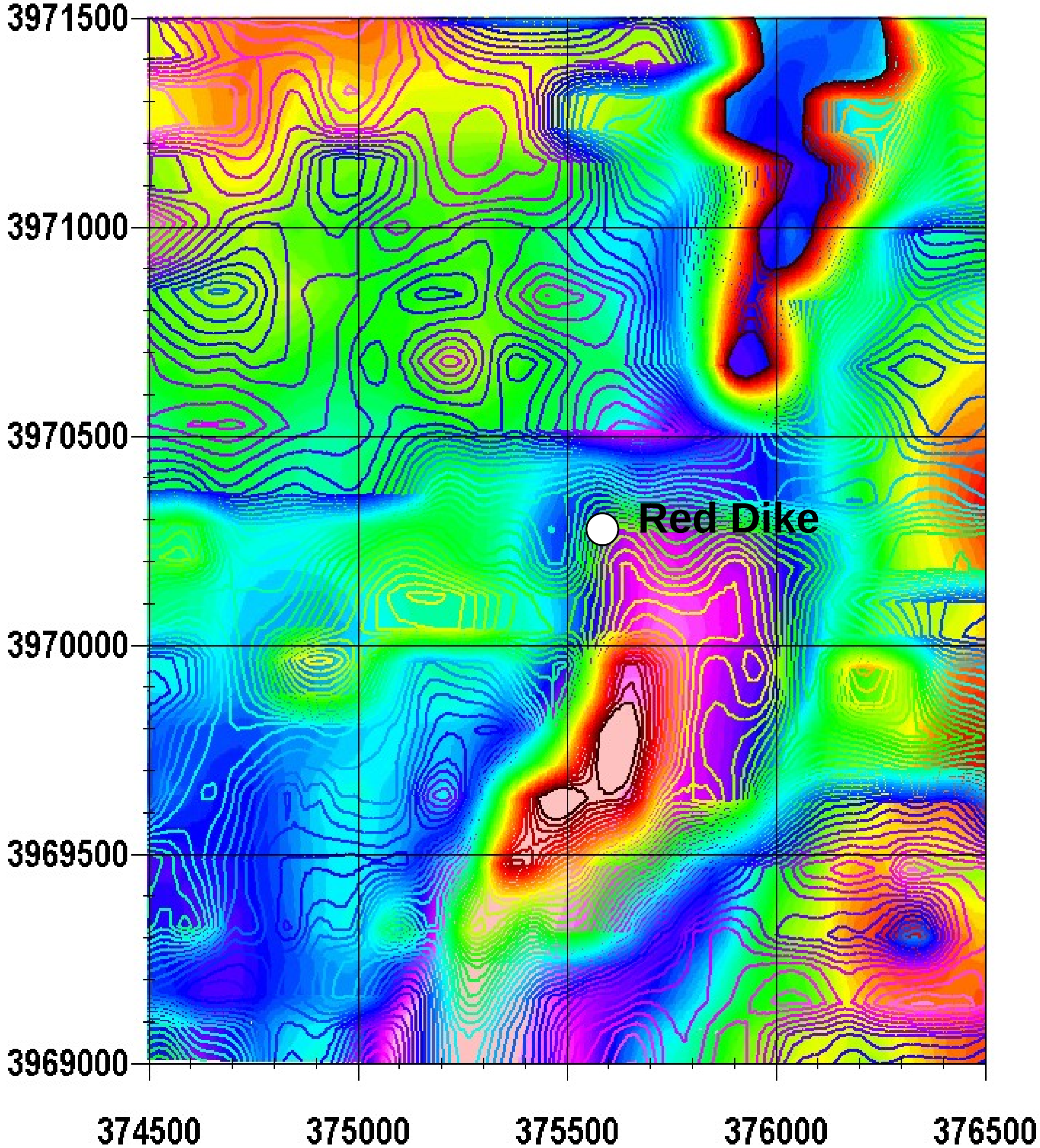
EM Data vs. Topography



Comparison of the EM data with the digital terrain model. There is a clear correlation between the linear high in the EM data at early times and the area of low topography (a wash).

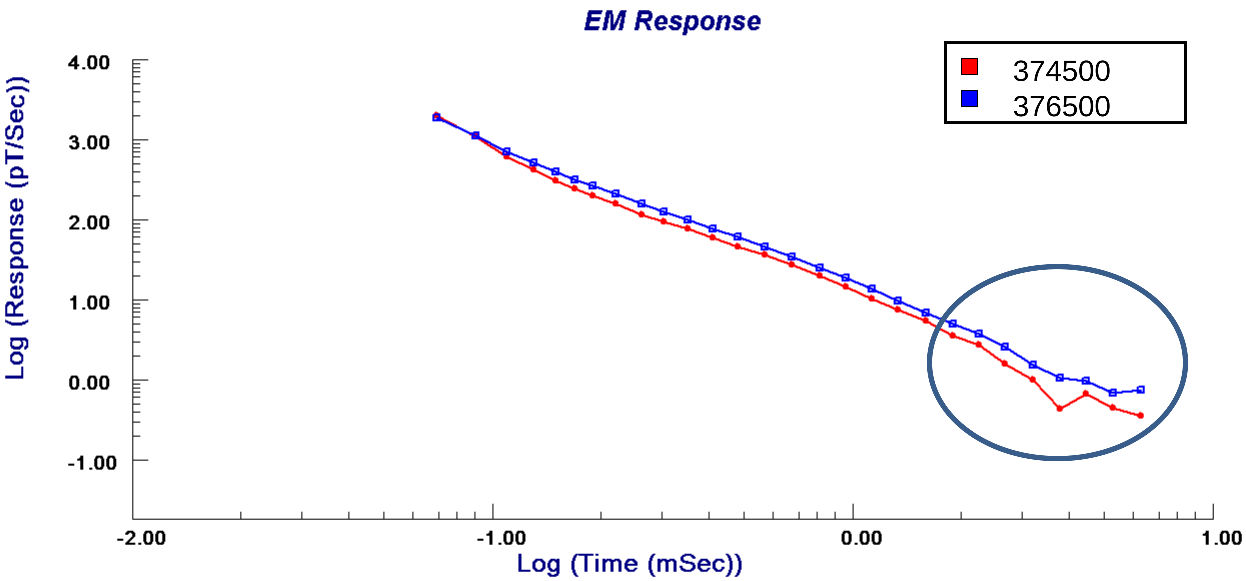
The EM anomaly may be directly related to the wash, or may be due to a deeper structure, (which may have caused the wash to form in that location).

EM Data vs. Topography



Close-up comparison of the first channel of the EM data (contour lines) with the digital terrain model.

EM Data



The plot shows two decays along Line 3750, the first at 374500 (red), which is west of the linear anomaly, and the 2 km east at 376500 (blue), which is east of the linear anomaly. Note the difference between them – the decay at 376500 has a greater amplitude across all but the earliest time channels. This suggests a difference in structure at depth.

The late time data in both decays (circled) is noisy.

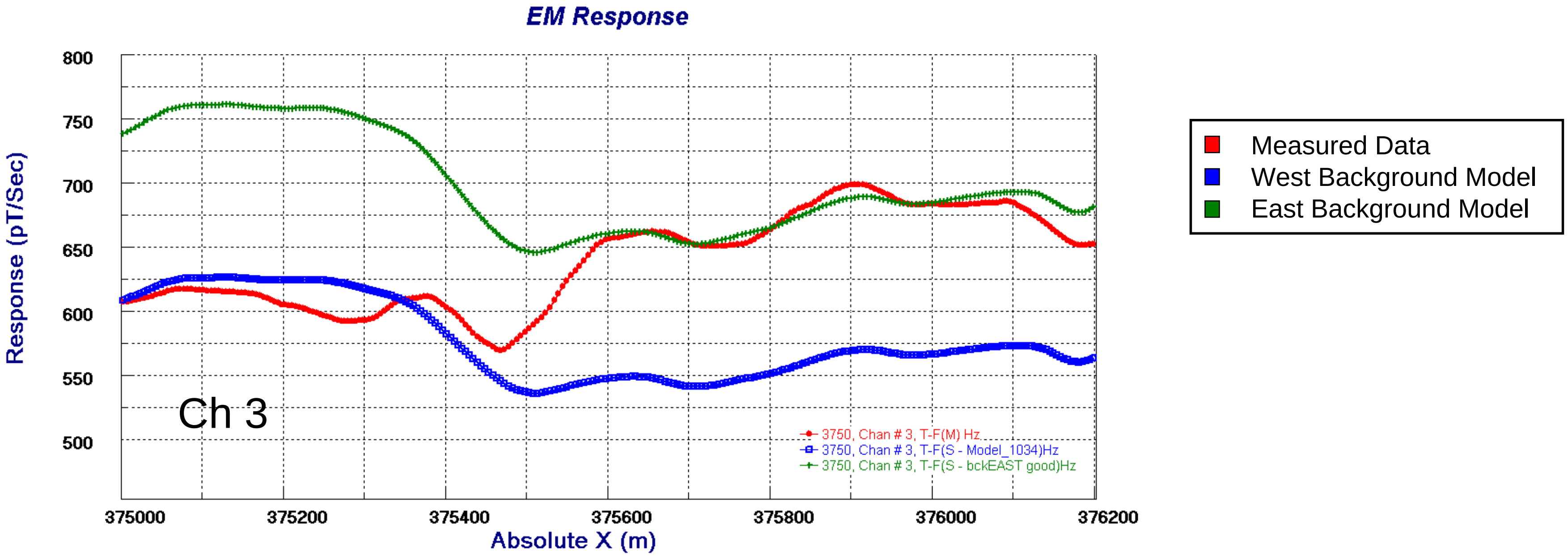
EM – Layered Modeling

West Background Model

Resistivity (Ωm)	Thickness (m)	Depth to Bottom (m)	Formation
20	7	-9	Overburden
10000	310	-269	Kaibab/Toroweap
25	20	-279	Coconino
550			Hermit

East Background Model

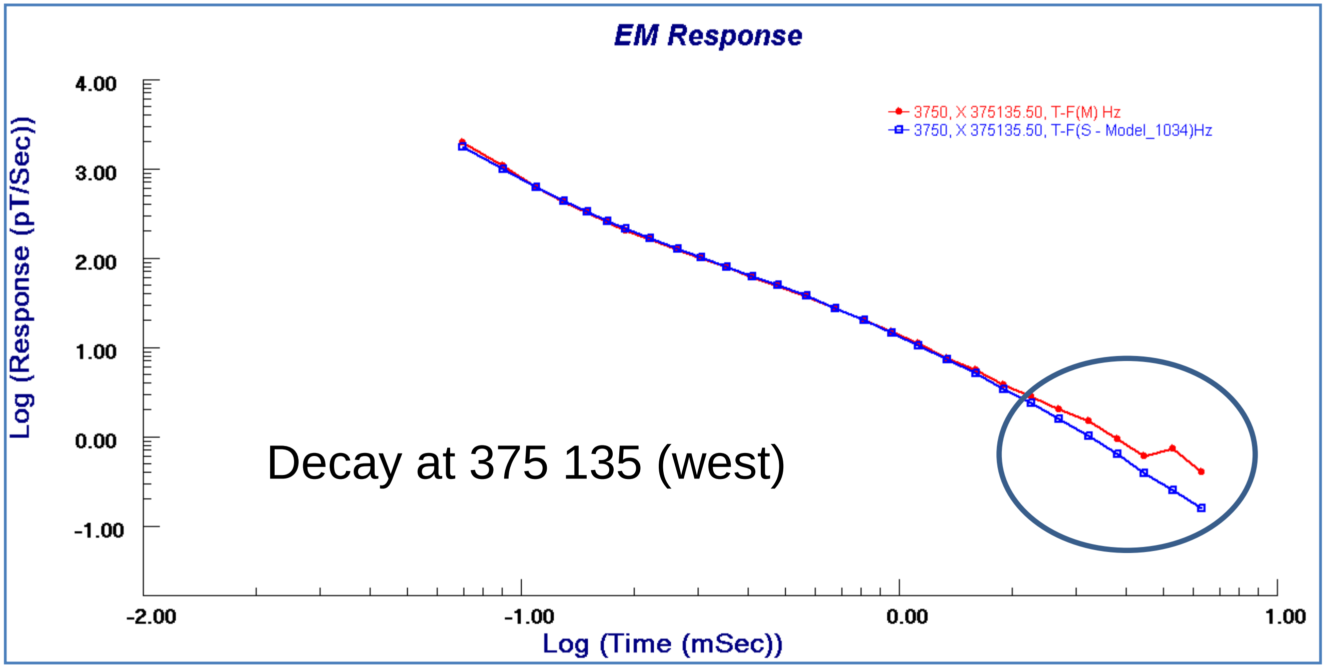
Resistivity (Ωm)	Thickness (m)	Depth to Bottom (m)	Formation
20	7.5	-9	Overburden
10000	270	-224	Kaibab/Toroweap
25	20	-234	Coconino
550			Hermit

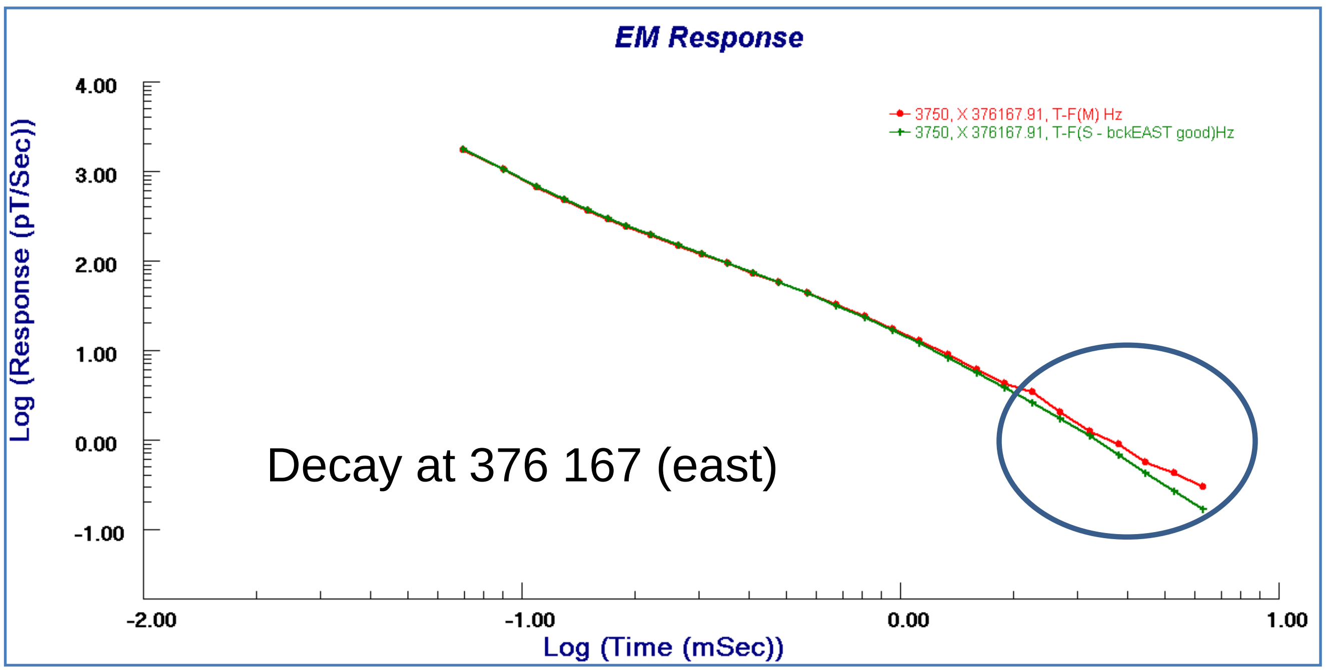


Two models were needed to fit the background EM response near Red Dike. One model fits the data to the west of the anomaly, and the other fits the data to the east of the anomaly. In both of these models, resistivity varies only with depth. The two models have the same four layers, but the model for the east section has a thinner resistive layer (270 m vs. 310 m) and a slightly thicker overburden. This increases the EM response.

The plot above shows the measured data vs. the simulated response to these two models along Line 3750 at Channel 3. One model fits the measured data east of about 375600, and the other fits the west part of the line.

It is thought that there could be a fault in the topographic low (i.e., at the EM anomaly) which resulted in the rock to the west being shifted downwards.





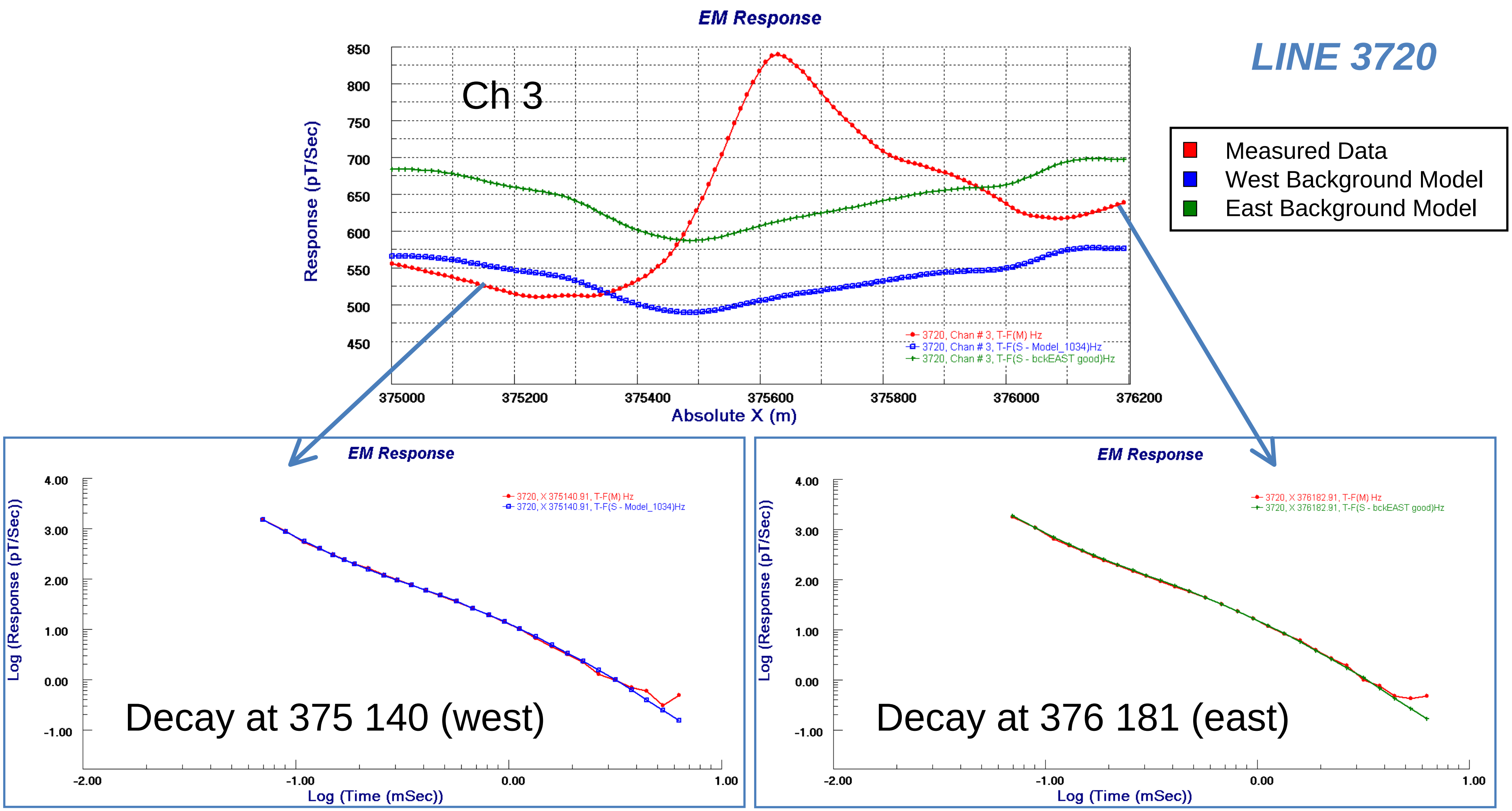
LINE 3750

- Measured Data
- West Background Model
- East Background Model

The top plot shows the fit of the west background model to the measured data at a point west of Red Dike. The bottom plot shows the fit of the east background model to the measured data at a point east of Red Dike.

At both points, the models have a lower response than the measured data at late times (~8 channels). This is because the late time response along Line 3750 is higher than on neighboring lines (likely a data quality issue). These models fit the late-time decay better on lines other than on 3750.

Comparison of the late-time response of the models against the measured also shows the noise in the last few channels of the data.

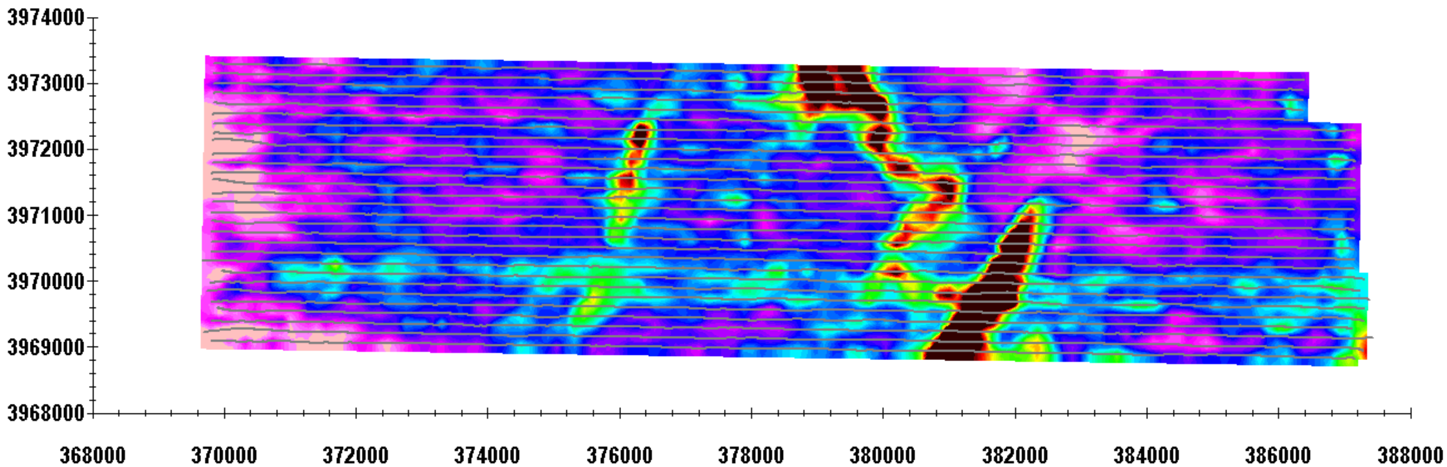


These two background models fit the data along Line 3720 well. Unlike on Line 3750 (previous page), they fit the late-time response of the data, although the last 4-6 channels are noisy.

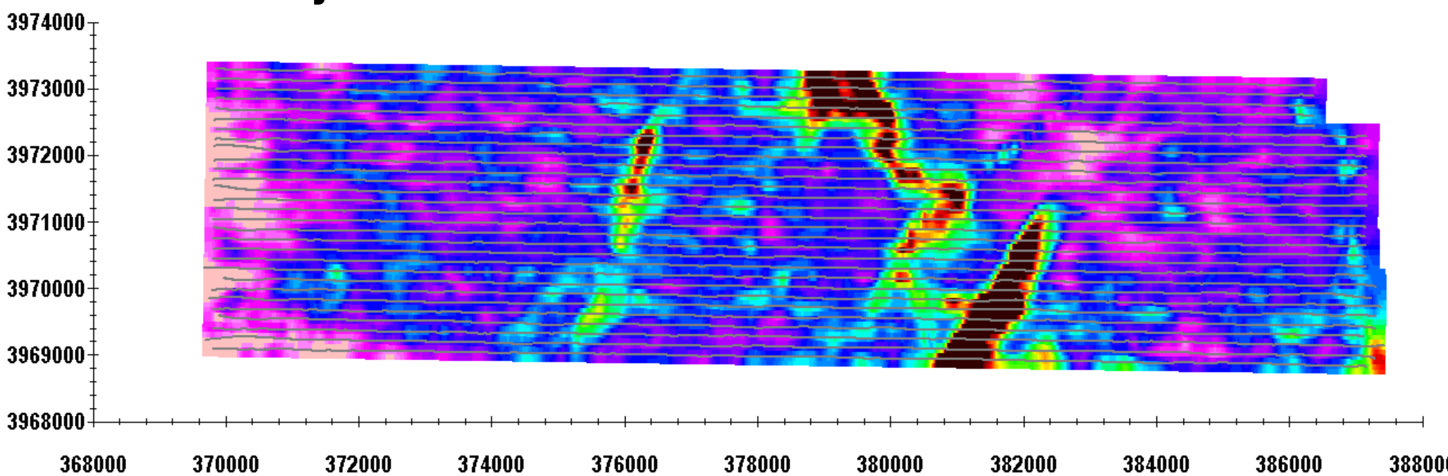
Early-Time Data

As seen on Page 17, the response along several lines near Red Dike appears shifted from neighboring lines at early times. To correct for this, the first two channels of data on Lines 3720-3750 were shifted based on the response of nearby lines, to create a cleaner map and make it easier to identify anomalies.

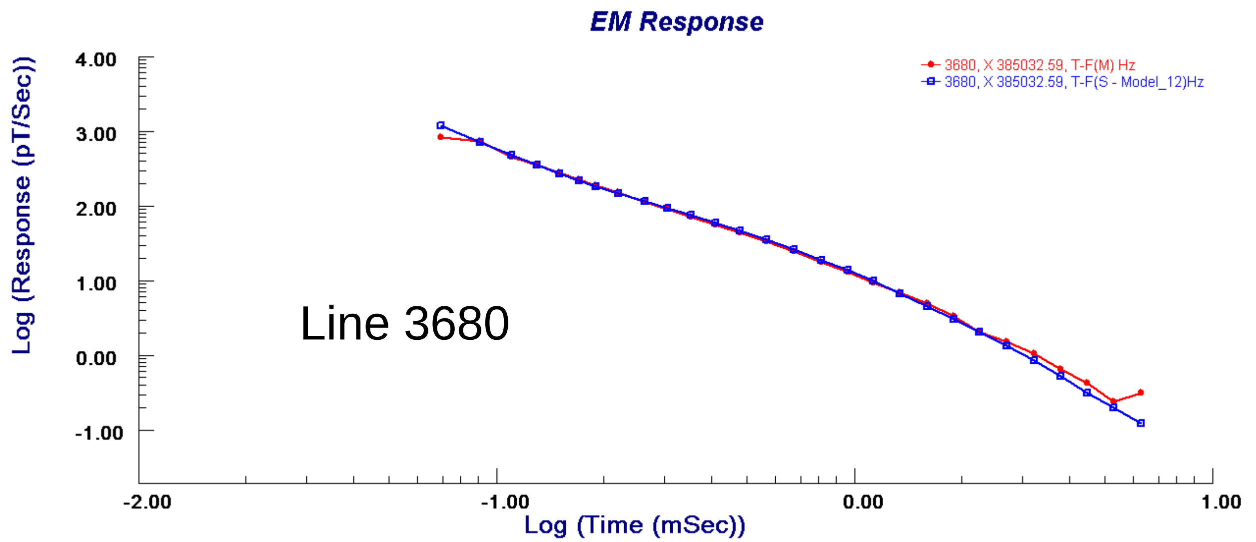
Ch 1

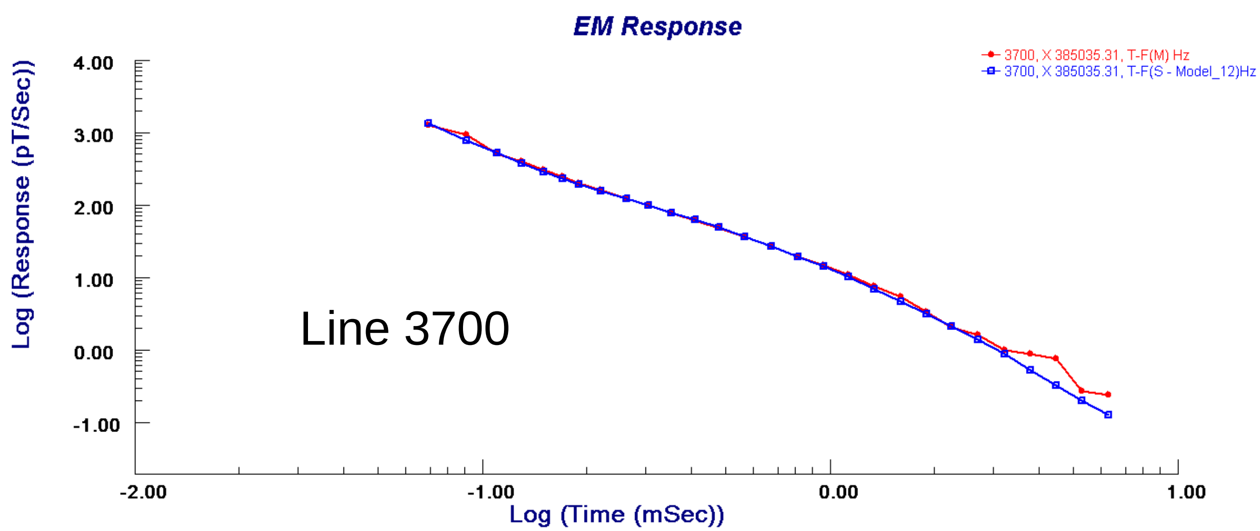


Ch 1 - adjusted



Early-Time Data



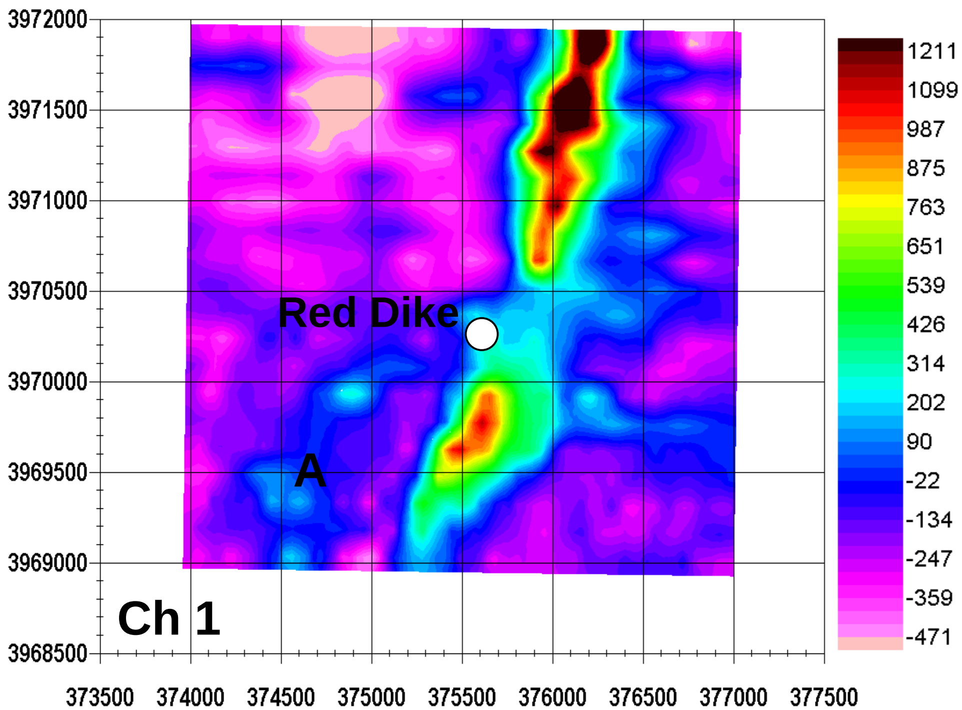


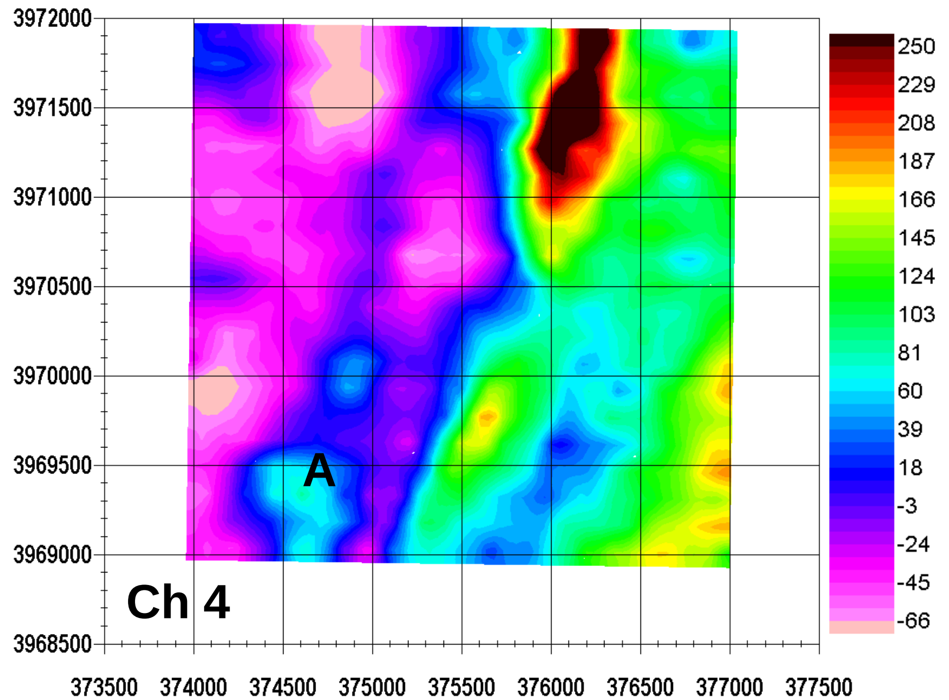
Measured Data
Model 12

Because of the issues with the early time data on certain lines, as seen on the previous page, as well as some difficulty with matching early-time data in modeling, the response was studied more carefully on a series of lines at an easting where there are no significant anomalies.

Model 12, a 4-layer resistivity model, fits the data reasonably well on Lines 3670-3920 at 385 000E. However, although it fits the early channels (1 and 2) well on some lines, it does not fit at least one of these channels on several lines, such as 3680 and 3700, shown here. Inversions on these two lines near 385 000E were unable to fit both early channels on these lines as well.

Because this problem is only seen in the first two channels, it is thought to be due to a problem with the early time data, and not 3-D effects (i.e. limitations of matching the decay with a 1D model). The quality of these first two channels varies across this part of the survey and the problem is not clearly associated with particular flights.

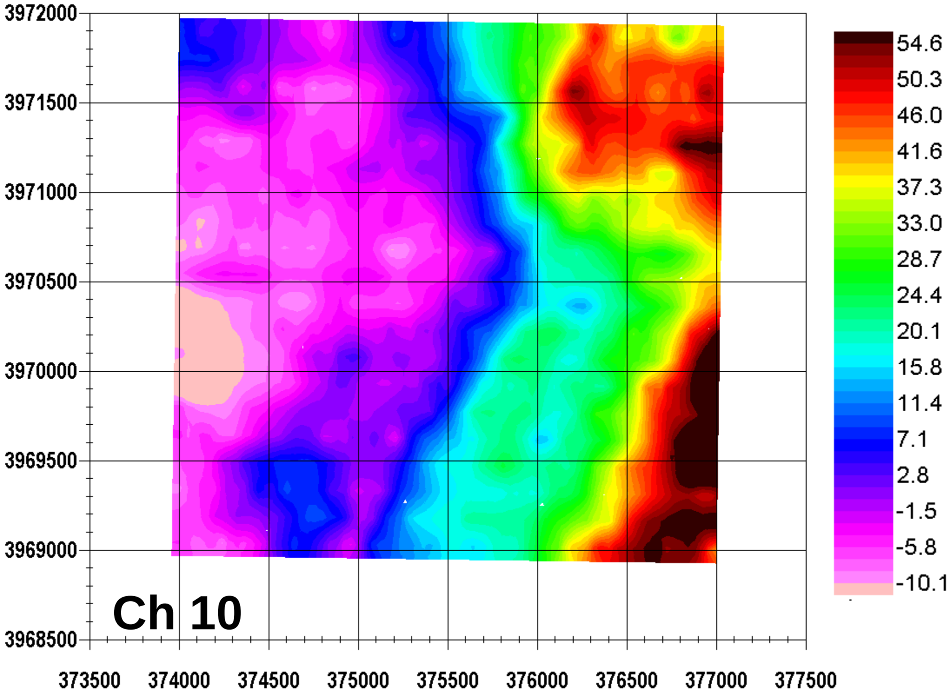


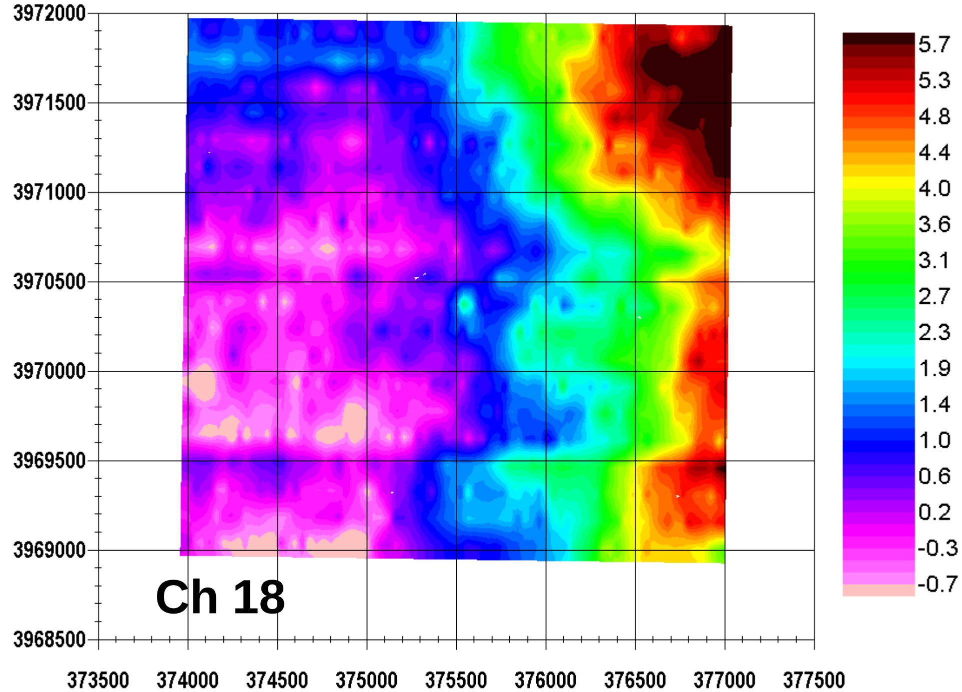


Maps of the data in which the response of the West Background model has been removed (this removes effects due to altitude variation of the plane). The data on lines 3720-3750 has been shifted so that Channel 1 matches the rest of the data (as on page 24).

At Channel 1, the linear anomaly weakens between 3970000 and 3970500, but does not disappear completely.

The feature at A in both maps, which is more obvious with the background removed, is associated with a small topographic low (like the main EM anomaly).

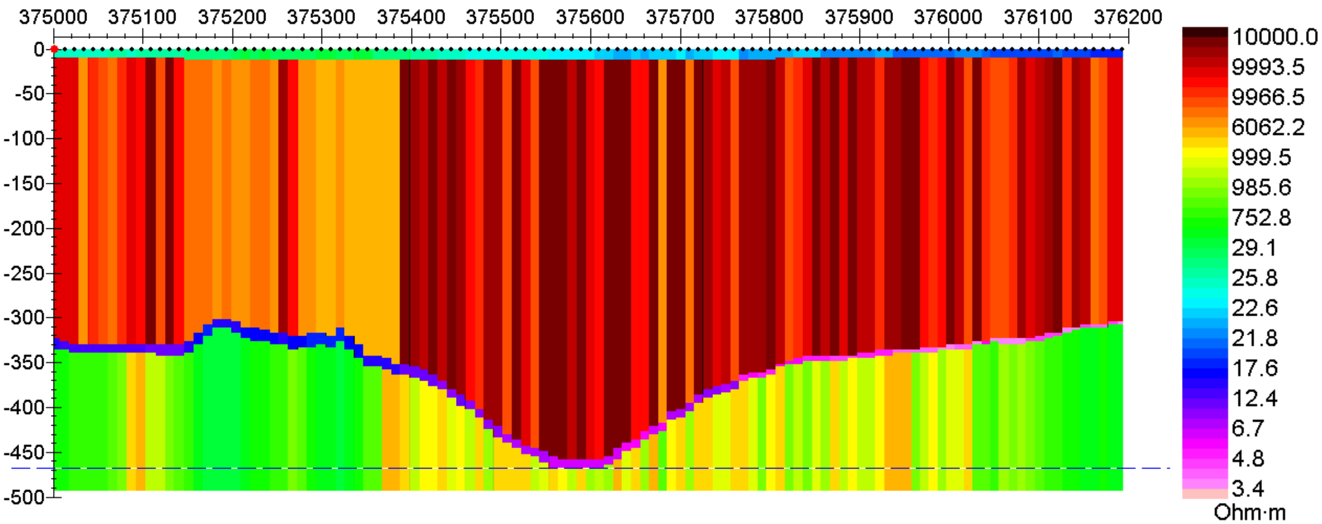


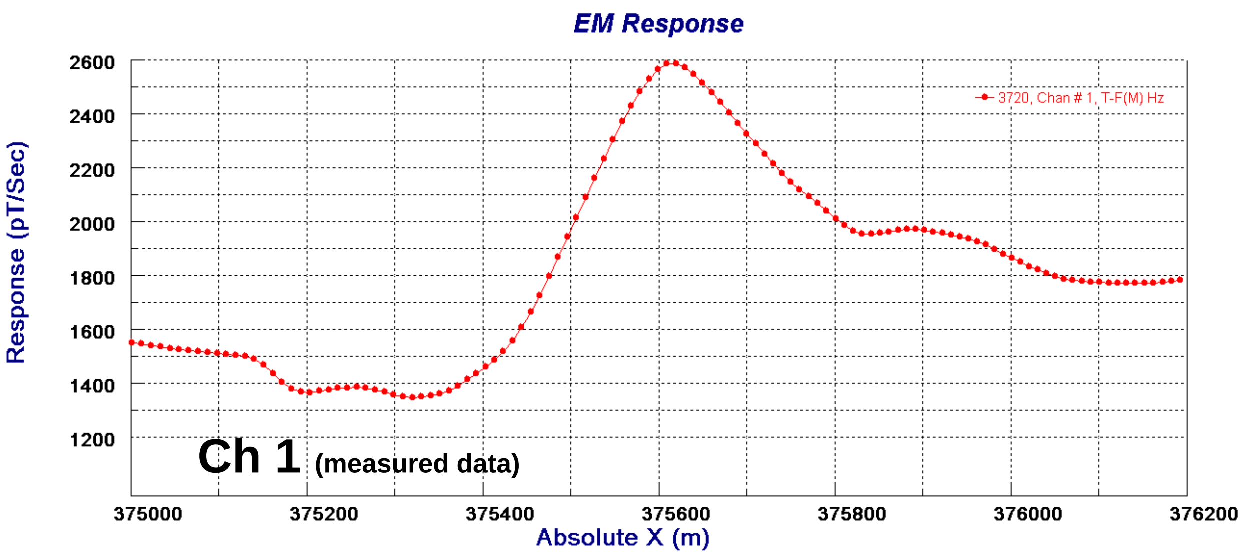


Maps of the mid-late time data with the response to the West Background model removed.

1D Inversions

LINE 3720





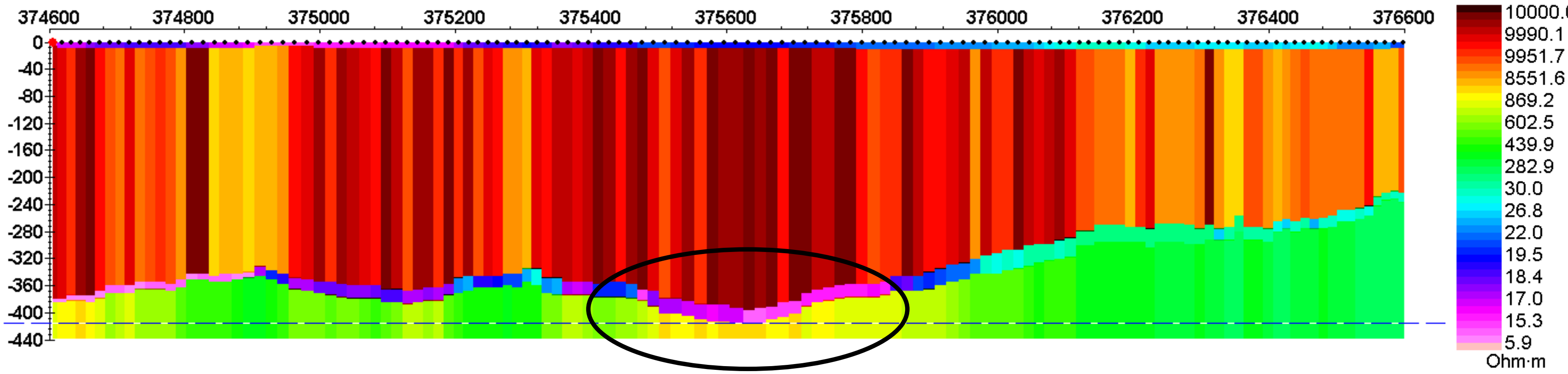
The image on the left shows a series of stacked 1D inversions on Line 3720. There is a thickening of the resistor below the anomaly by about 100 m. There is also a slight thickening of the overburden over the anomaly, although it is difficult to see in this image. Based on further modeling results, it is thought that the structure at depth is an artifact of the 1D inversion, and is not true structure. The inversion pushes the Coconino deeper because the increased thickness of the overburden causes a greater response into mid-times, and increasing the thickness of the resistor negates this effect. Likely the inversion can not fit the data well here due to 3D effects.

This is similar to what was observed in the inversions at Findlay Tank and Miller: the stacked 1D inversions showed structure at depth, but it was determined to be due to limitations of the 1D inversion.

In the forward modeling described previously for Red Dike, different models were developed for area east and west of the anomaly. However, the inversion shown here has fairly similar models both east and west of the anomalies. The increased conductivity of the overburden and Coconino to the east increase the response to the east.

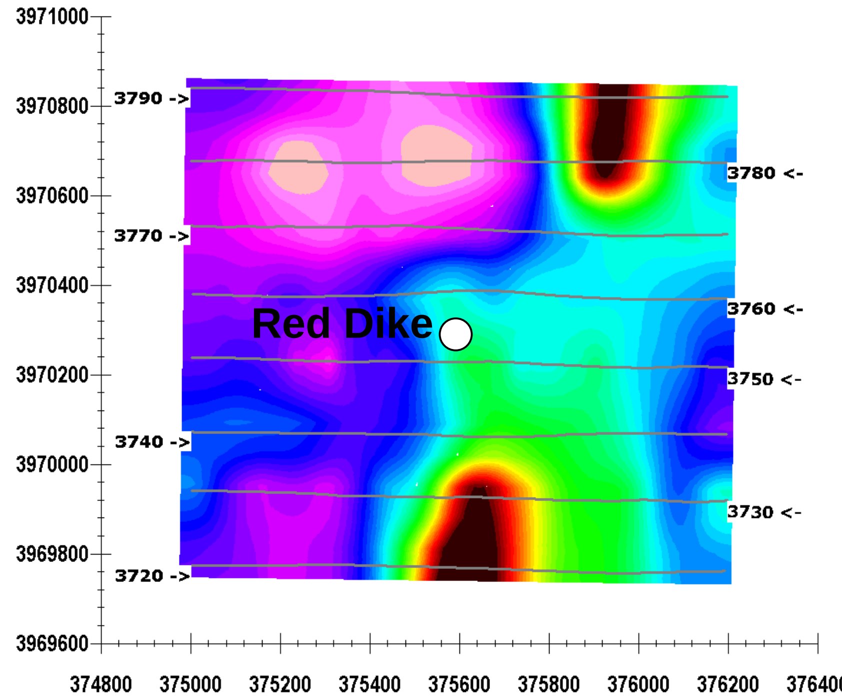
1D Inversions

LINE 3750



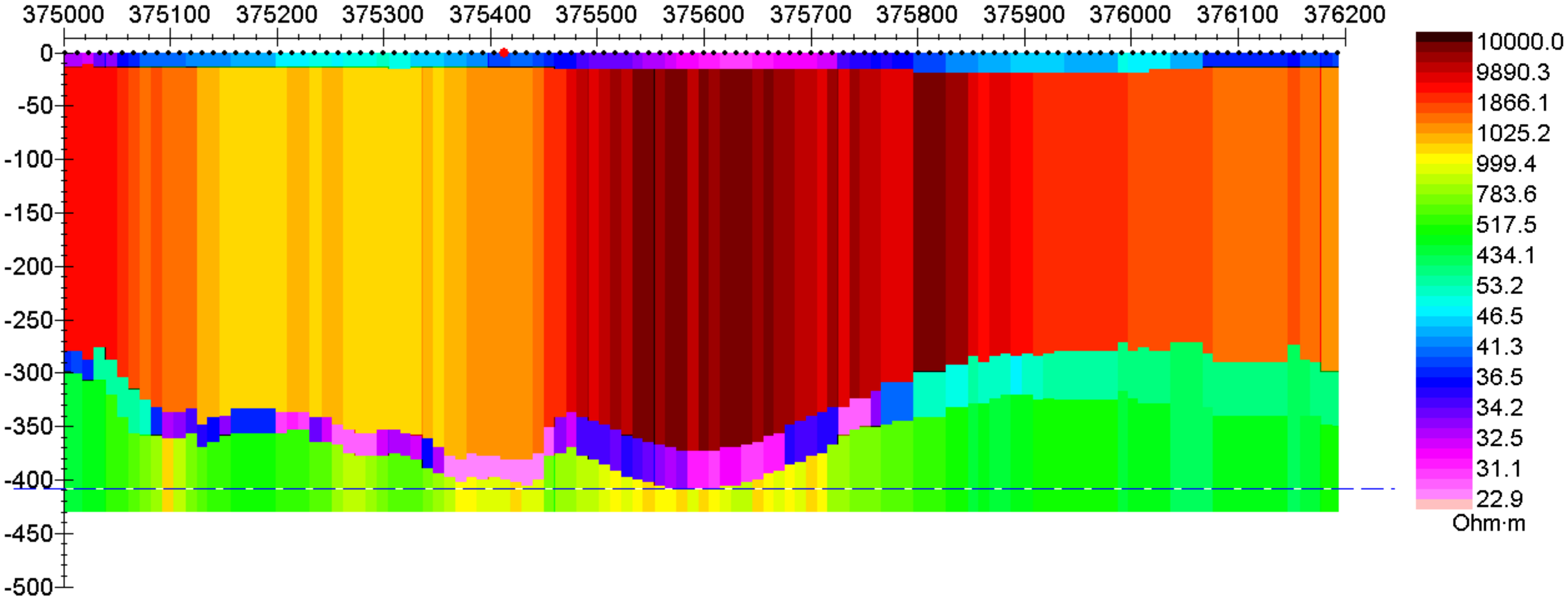
Above is a stacked 1D inversion over Line 3750, which is about 60 m south of the pipe. (A slightly longer section of the line was inverted than on 3720). Note the thinning of the resistive layer to the east.

There is a slight thickening of the resistor and increased conductivity of the Coconino around 375600. This is the location of the EM anomaly. The anomaly is much smaller on Line 3750 than on Line 3720, but is still seen at early times. (See map of channel 1 on the left, with background removed and early time data shifted). The thickening of the resistor at this location was observed in the inversion on 3720 to a greater degree, and was assumed to be due to limitations of the 1D inversion. As on Line 3720, the inversion does not fit the data on Line 3750 as well in the vicinity of the anomaly.



1D Inversions

LINE 3720



For the previous inversions, the data in channels 1-24 were inverted. Channels 25-28 were not used due to the noise in the data. Channels 1-2 were included because they appeared consistent with the rest of the data channels on these lines (see decays on pages 22 and 23 – layered earth models match the first two channels) although these channels do have some quality issues (page 25) across the survey area.

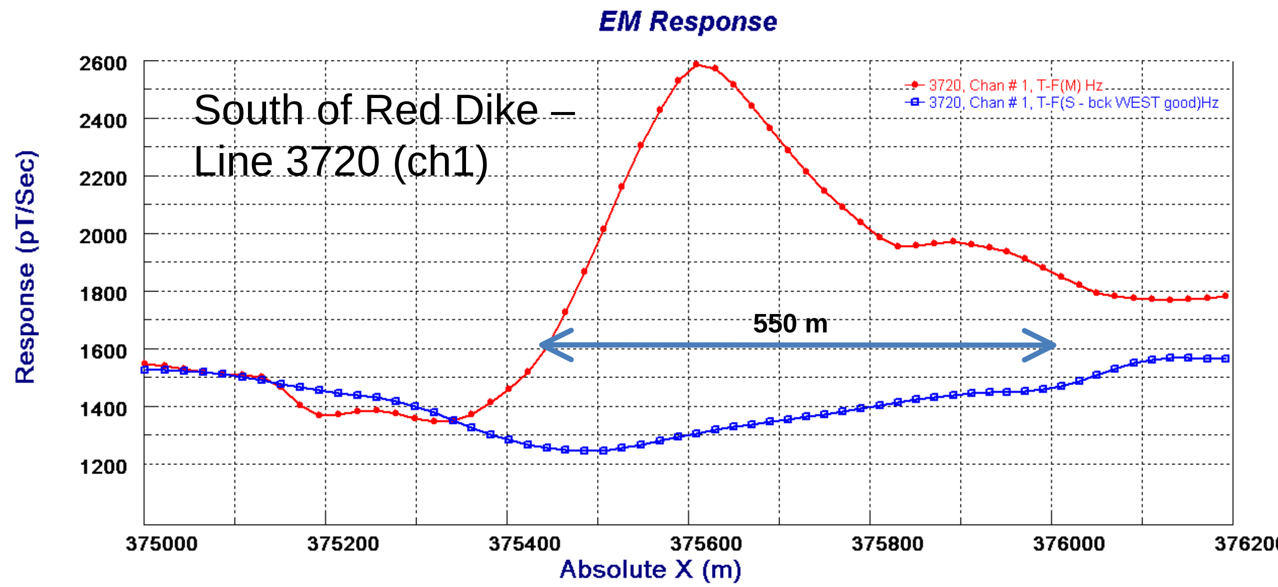
For the inversion of the data on Line 3720 shown here, the first two channels were not inverted. While the result still contains a slight thickening of the resistor near 375600, it is much less pronounced. This inversion fits the data better at 375600 than the initial inversion at all channels but the first two, at which it has too low of a response. This suggests that the image of structure at depth seen in the previous inversions was mainly due to the inability of the 1D inversion to fit the first two channels.

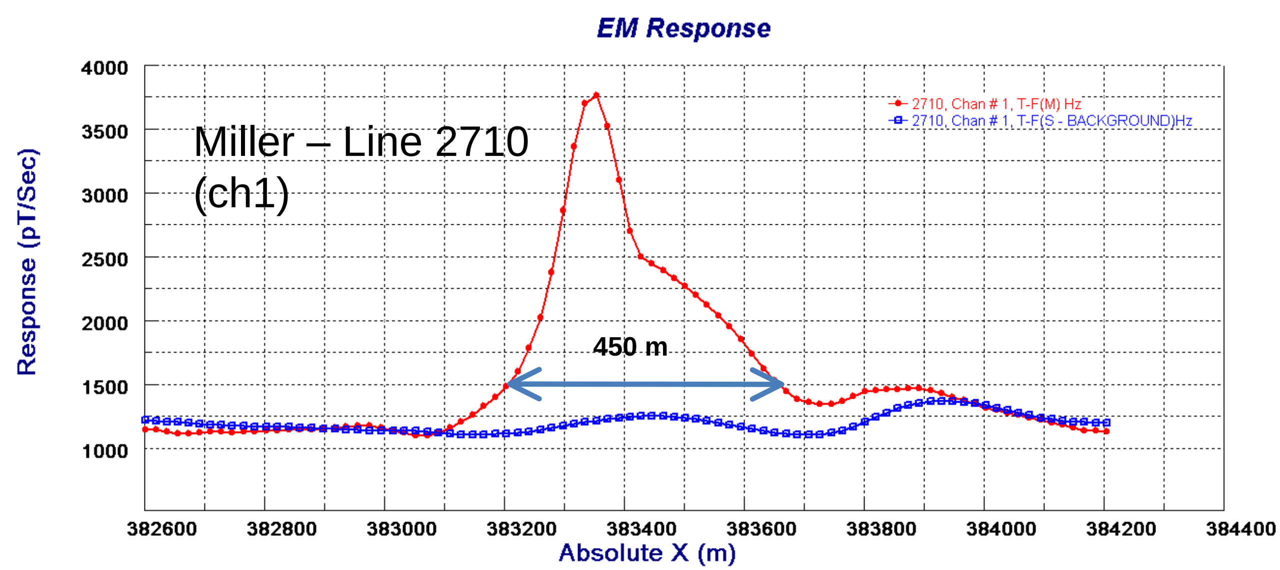
A layered earth model similar to the West Background Model, but with an overburden thickness of 8.7 m rather than 7 m also fits the decay over the anomaly reasonably well, but again, the response is too low at the first 2-3 channels.

EM Modeling

It is possible that the EM anomaly relates directly to the wash. It could also be related to deeper structure that follows the wash, perhaps associated with the fault. A better understanding of the anomaly is required to determine if it could have some relation to the pipe.

The shape of the anomaly at Red Dike is somewhat similar to that seen on Line 2710 over the Miller pipe. However, the anomaly near Red Dike follows a topographic low for about 8 km, with some discontinuities, while the anomaly at Miller was much more localized. It is thought that the anomaly at Miller is caused by two features: a very shallow structure (possibly Moenkopi above the pipe), and a deeper structure at about 50 m.



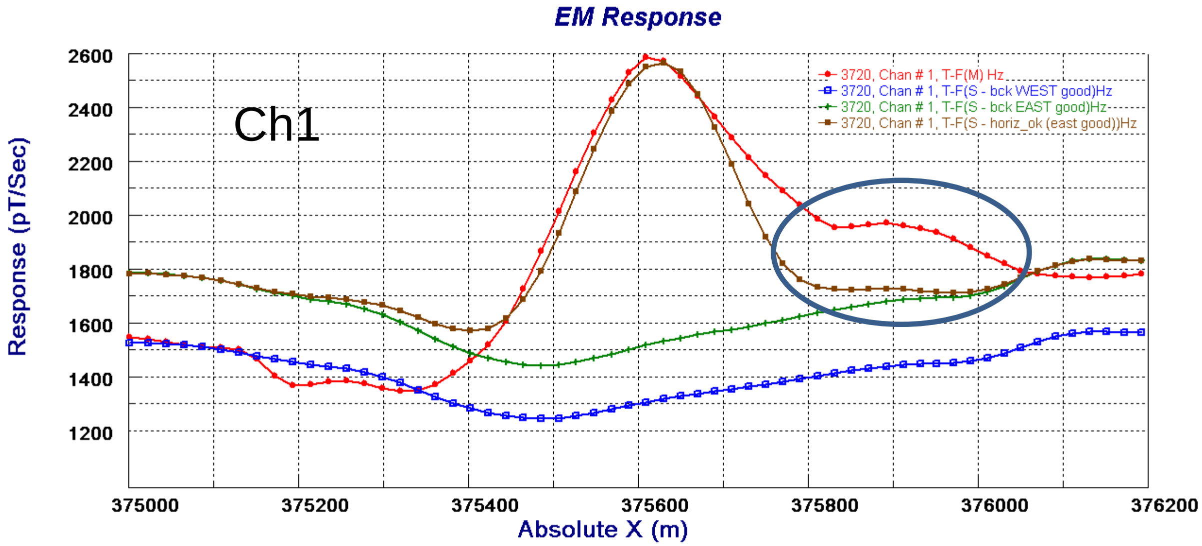


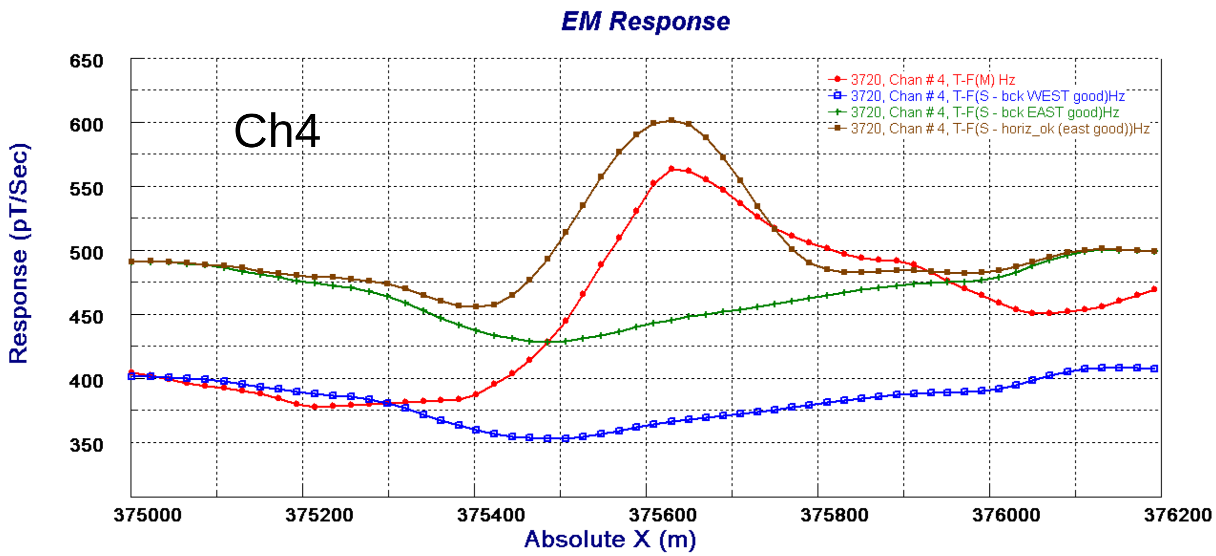
EM Modeling

The stacked 1D inversions are inadequate for understanding the linear EM anomaly and how it relates to geology, so some modeling of the anomaly was performed.

The response to a shallow, horizontal model just below the overburden with a conductance of 0.17 S approximately matches the main part of the anomaly on Line 3720. The model needed to be quite shallow to fit the early-time response. The response to the model does not match the lower-amplitude section of the anomaly near 375900 E (circled), suggesting the structure could be dipping to the east. However, a dipping model has to be much more conductive to have the same early-time response as the horizontal plate, and this gives it too large of a response at late times. Furthermore, the decays near 375900 match the East Background Model except at the first 2-3 channels, suggesting it is caused by a very shallow feature.

Because the EM anomaly appears to be caused by a very shallow conductor, it is thought that it is related to the wash – perhaps conductive sediments that have accumulated in the topographic low.





- Measured Data
- West Background Model
- East Background Model
- Plate Model *with east background

Conclusions

Magnetics:
Red Dike is on the edge of a large, elliptical magnetic high. We have also observed several other pipes that are on the edge of large-scale magnetic anomalies.

There is a short-wavelength magnetic anomaly on Line 3750 near Red Dike. It is thought that this is due to man-made objects because Red Dike was being drilled by Vane at the same time that the VTEM survey was flown, and it is very likely that there was drilling equipment on the ground. The character of the anomaly is similar to what would be expected for an anomaly caused by near-surface man-made objects, based on the response at Findlay Tank, Kanab North, and Deer Tank, as well as magnetic modeling results.

Electromagnetics:
Red Dike is on the west edge of a topographic low, and an early-time, linear EM anomaly appears to be coincident with this topographic low. The anomaly is lower in amplitude on Lines 3740-3760. This anomaly follows the topographic low, with some discontinuities, for about 8 km. Based on modeling results, it is caused by a very shallow conductor. It is likely related to accumulation of conductive material in the wash.

This anomaly is not seen at later times, but a greater EM response is observed to the east of the wash than to the west of it. Layered resistivity models and 1D inversions suggests a thinner limestone sequence to the east (270 m thick rather than 310 m thick). Due to the large difference in models on either side of the wash, it is thought that there could be a fault at the location of the wash.

Thus, this pipe does not seem to be directly associated with any geophysical anomalies, although it is on the edge of a wash that has an EM response. While this anomaly is somewhat similar to the one at Miller, the EM anomaly at Miller has a much smaller extent (a few hundred meters vs. several kilometers) and modeling of that anomaly suggests a deeper structure (about 50 m deep).

References

Moran, A.V., and Rasmussen, J.C. (SRK Consulting), 2007. Uranium Breccia Pipe Exploration NI 43-101 Technical Report. Retrieved Nov. 2008, from http://www.vaneminerals.com/?page=downloads

Miller and Miller SW
Preliminary Report on VTEM Data

Laura Davis and Ross Groom

PetRos EiKon Inc.

November 2008

Introduction

Four known breccia pipes in the South Rim are located within the VTEM survey flown by Geotech in the spring of 2007: Miller, Miller SW, Red Dike, and SBF. This report is a preliminary analysis of the VTEM data (magnetic and electromagnetic data) over the two Miller pipes.

The goal in studying these known South Rim pipes is to see if they are associated with any airborne magnetic or EM anomalies, and to understand these anomalies, which could assist in finding unknown pipes using geophysics. A previous report looked at the ground EM and VTEM response at Findlay Tank SE in the North Rim, and a model was developed for the observed EM anomaly. This serves as a comparison for the two Miller pipes.

Miller and Miller SW are located on the edge of a magnetic anomaly and there is also an EM anomaly (a few hundred meters across) near Miller. Modeling of the EM data suggests that there are two different structures. A very shallow conductive zone may be due to Moenkopi over the pipe. Another flat-lying conductor at 50 m depth has a large lateral extent. While it approximately follows a section of the wash, there is not an EM anomaly along the rest of the wash, only near Miller. The geological significance of this structure is not known, but it is definitely in the vicinity of the pipe. The conductance is 0.27 S, and it is noted that this conductance is consistent with a thin layer with a low concentration of pyrite.

While preliminary work has resulted in a good initial model, further work is need to better characterize the structures (including depth extent).

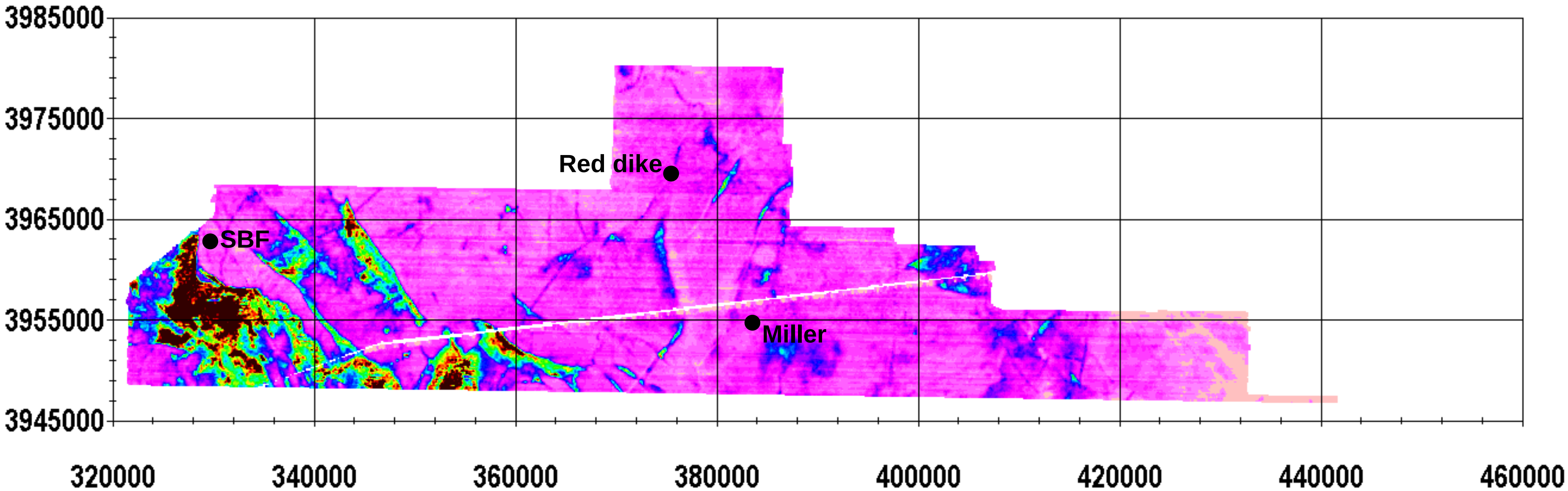
Location

Location in Nad27:
Miller: (383400, 3954300)
Miller SW: (383150, 3954150)

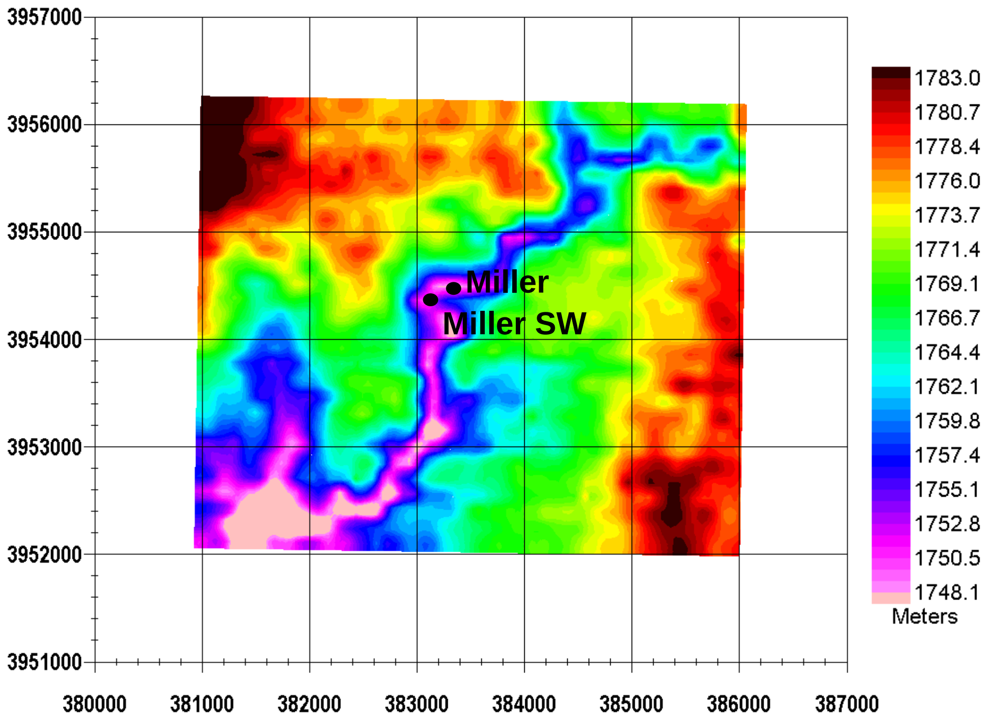
Location in Nad83:
Miller: (383336, 3954500)
Miller SW: (383086, 354350)

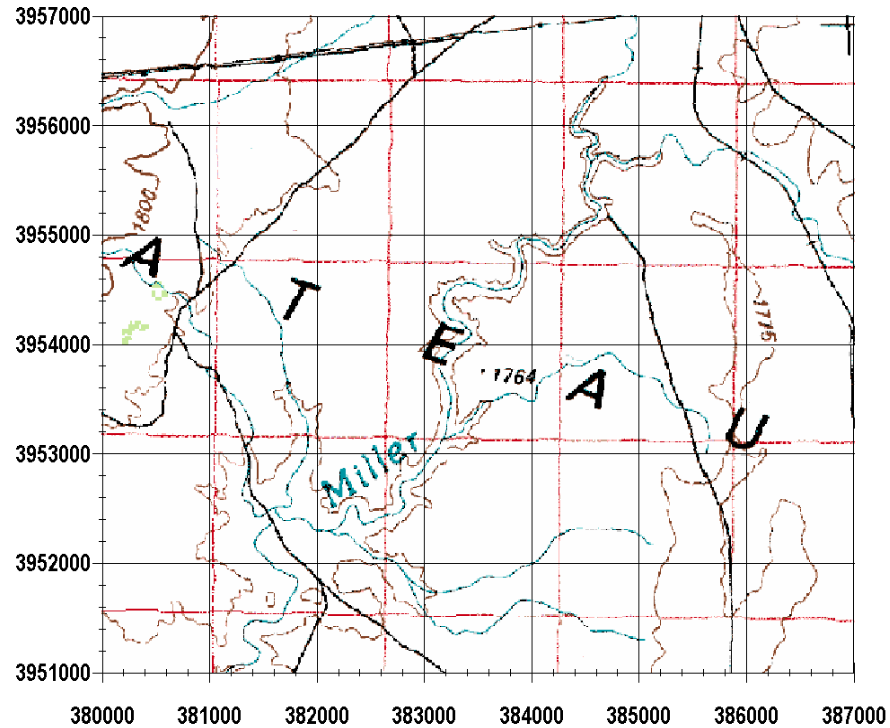
The Miller pipes are located in the South Rim. The location of these pipes is marked on a map of the north section of the VTEM data. Miller SW is about 300 m SW of the Miller pipe.

*The co-ordinates of these pipes were provided in Nad27, and were transformed to Nad83 because this is the datum of the VTEM data.



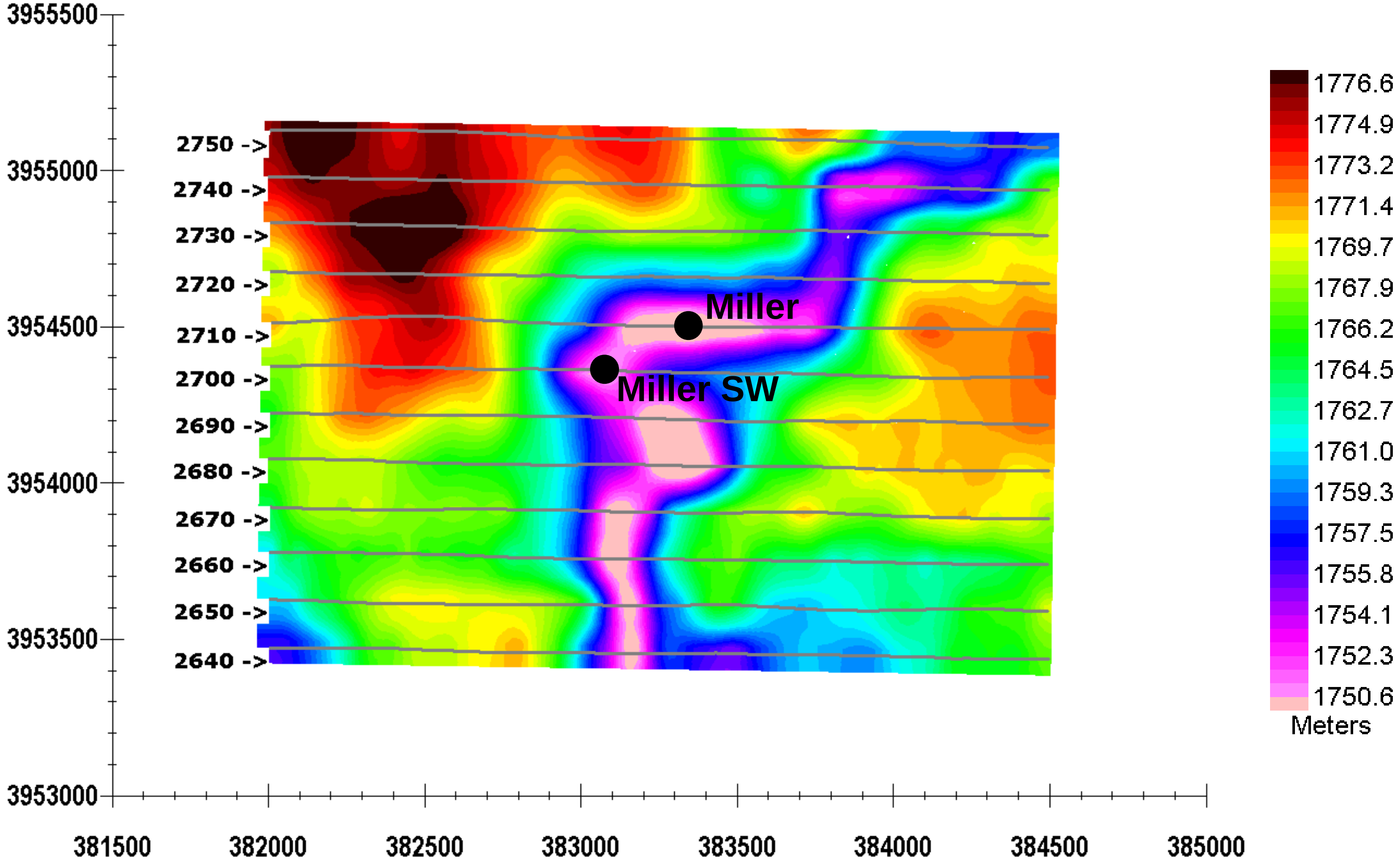
Topography





The digital terrain model on the left was calculated from the altitude and GPS Z channels in the VTEM data. Both of these pipes appear to be in a small canyon, with an elevation about 15 m below that of the surroundings. According to Google Maps, this is the Miller Wash.

On the right is a section of a 1:100,000 topographic map over the same area.



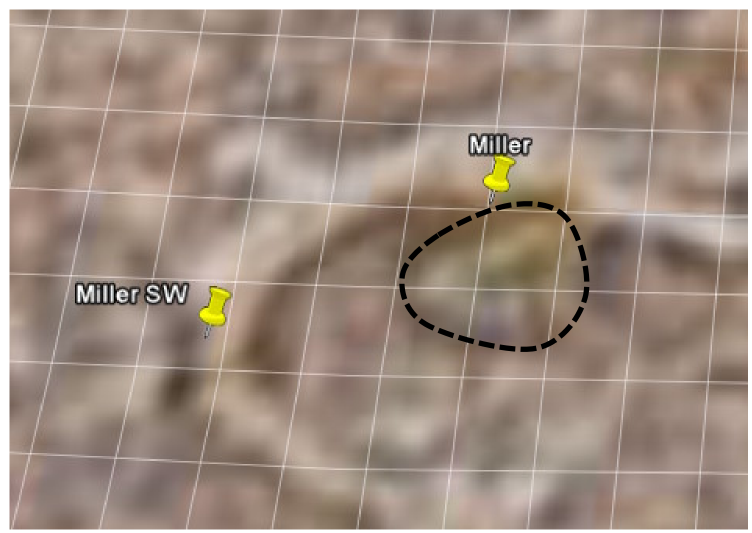
Close-up image of the digital terrain model, with the pipe locations marked.

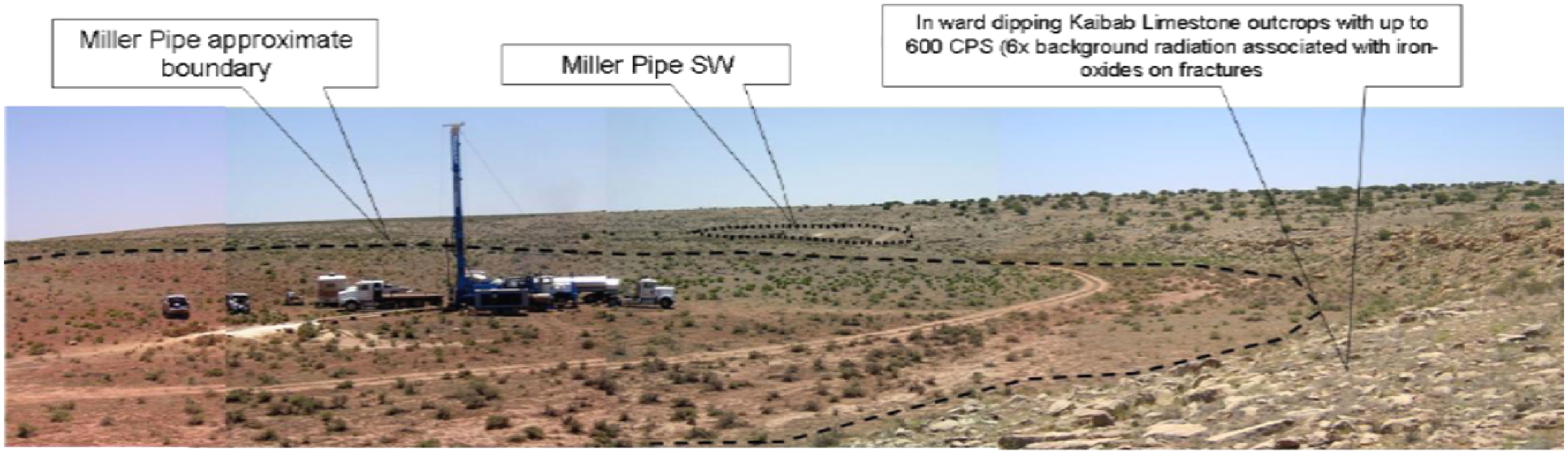
The flight lines of the VTEM survey are shown. They run east-west with a line spacing of about 150 m. *This limits the resolution of this terrain model in the north-south direction.

1.5 km

2.3 km

This is a satellite image from Google Earth. Miller and Miller SW are marked. While the resolution is not good, the Miller Wash is still clearly seen. There also appears to be a somewhat circular feature just south of the marked location of Miller. This is shown in the close-up view on the right. It is about 150 m across. While it is within the topographic low (based on the dtm shown previously), it appears to be south of the wash. It is thought that this could correspond to the area around the pipe, as seen in the photo on the following page. It may be visible due to different surficial cover over the pipe.

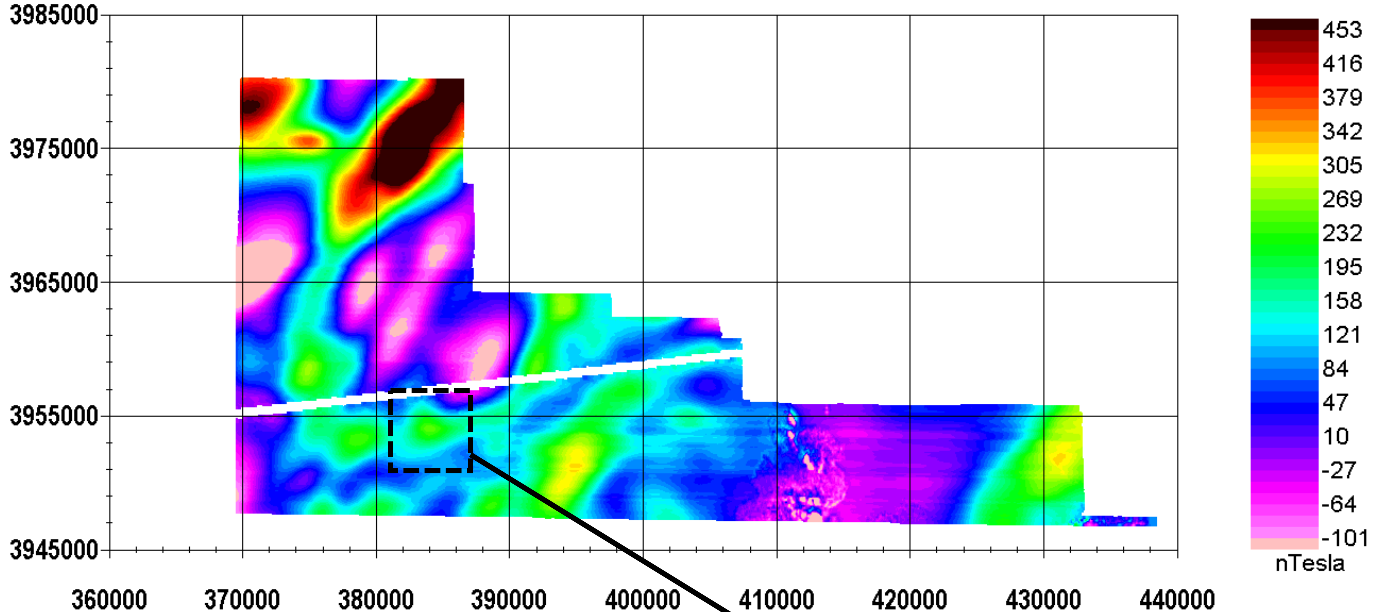




Red Moenkopi mudstone down-dropped into shallow surface depression of inward dipping Kaibab limestone – Miller Pipe; Drilling in progress on VANE drill hole #691-2; view looking southwest

From Figure 9.7 in Uranium Breccia Pipe Exploration NI 32-101 Technical Report for Vane Minerals (Moran and Rasumussen, 2007) – drilling on #691-2. In Figure 5.1 of the same report, it appears that drill hole #691-2 is within the estimated bounds of the breccia pipe, towards the north part of the pipe. Photo was taken looking south.

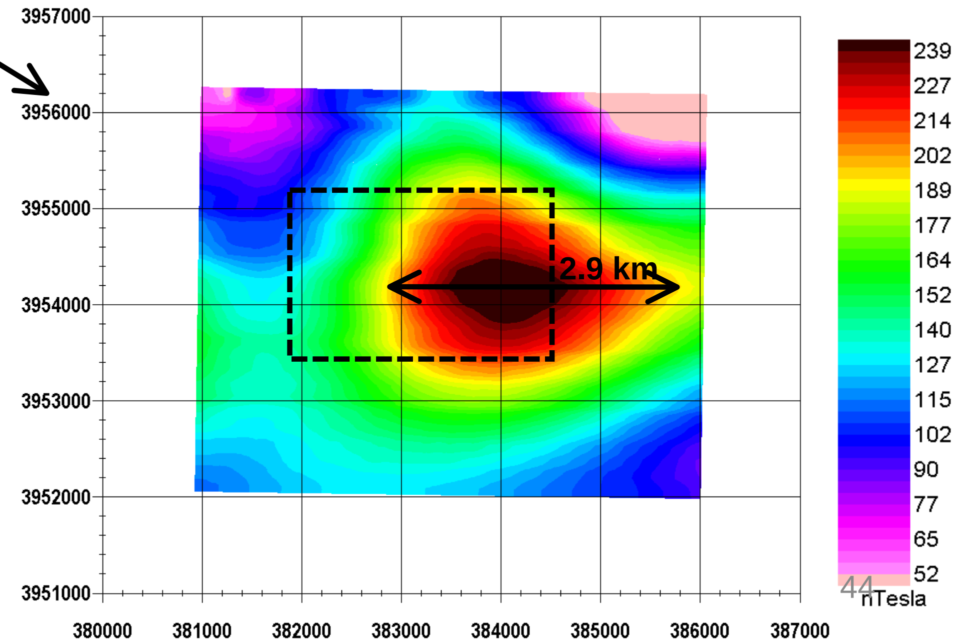
Magnetic Data



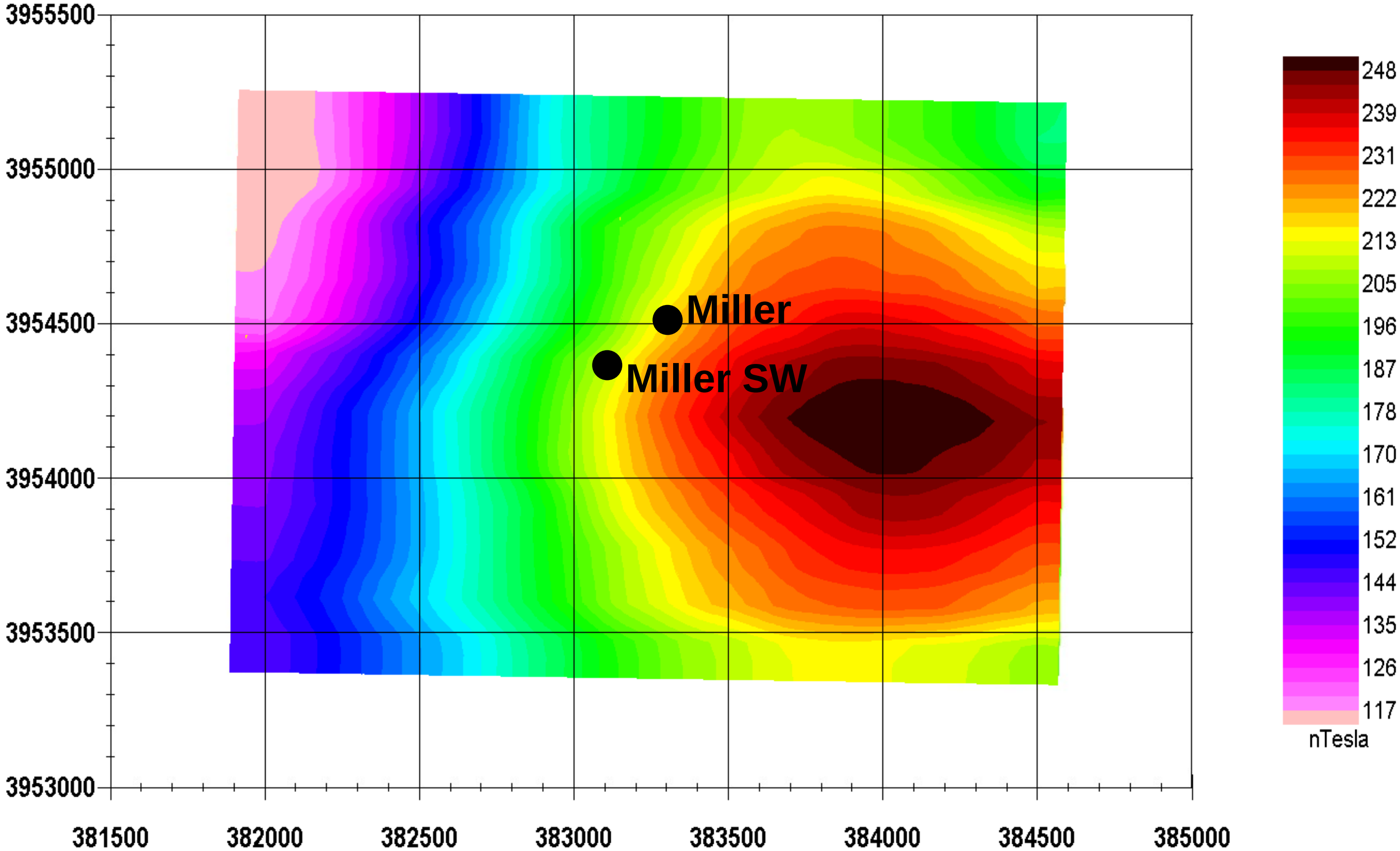
Above: Magnetic field with background response removed over the NE section of the VTEM survey.

Right: The Miller Pipes are located on the edge of a magnetic high, which is a couple km across and has a response up to 250 nT. The dashed line marks the close-up area seen on the following page.

*Note that the color ranges are different for these two figures.

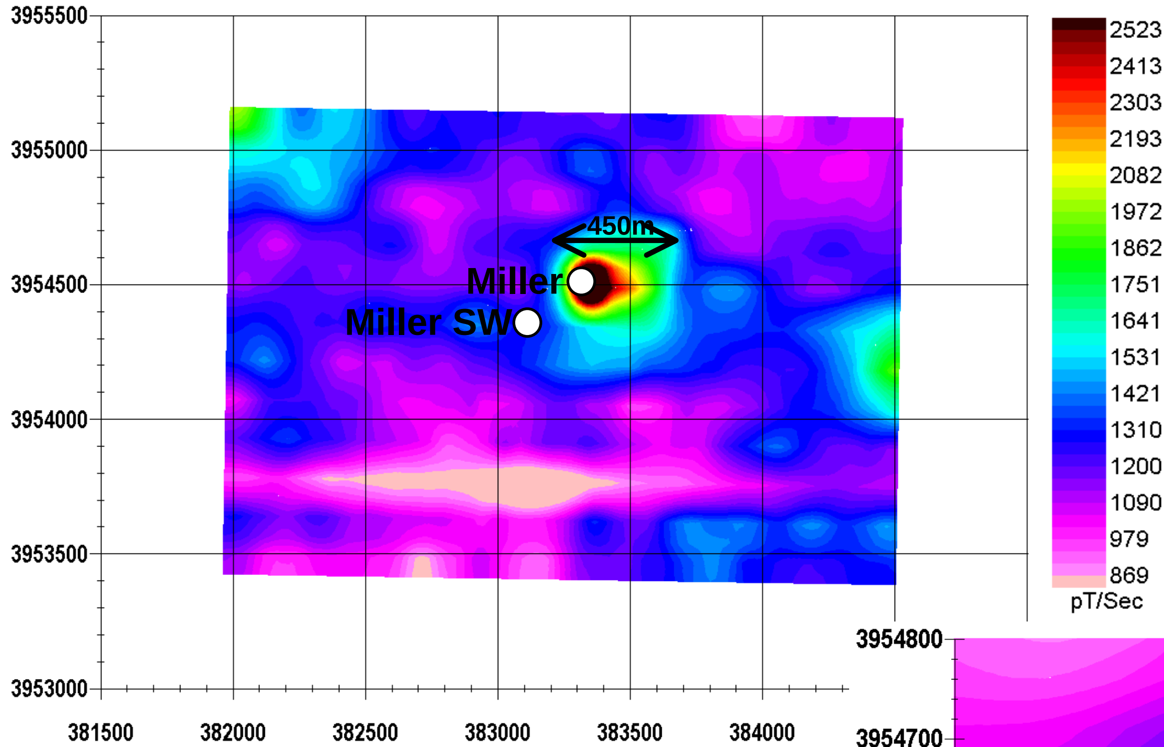


Magnetic Data



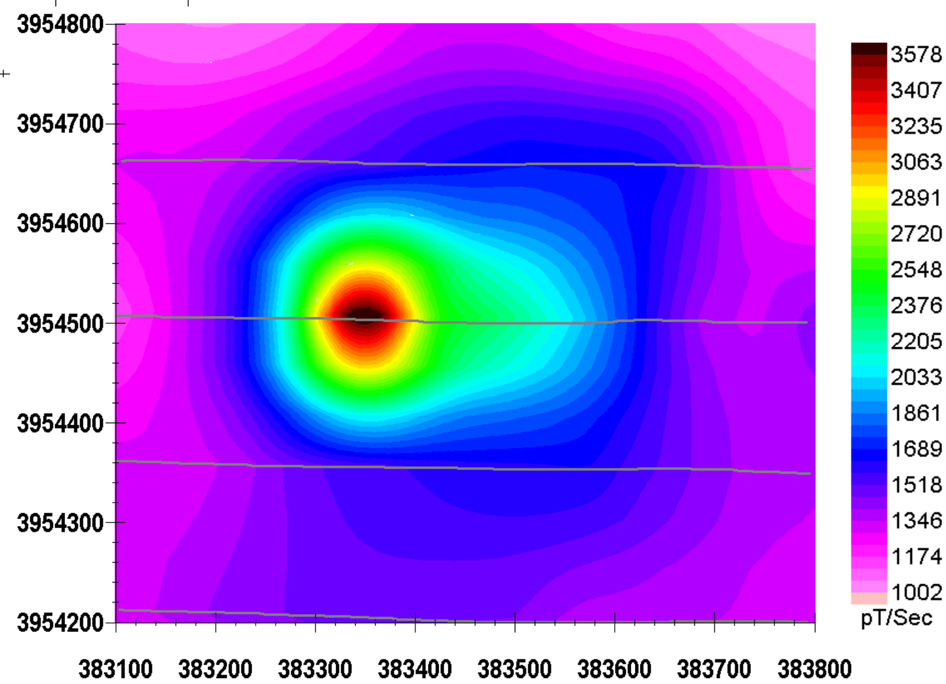
Close-up of magnetic response (2.5 km x 2km area) near the Miller pipes. These pipes are on the edge of a magnetic anomaly much like all of the known pipes on the North Rim.

EM Data early time

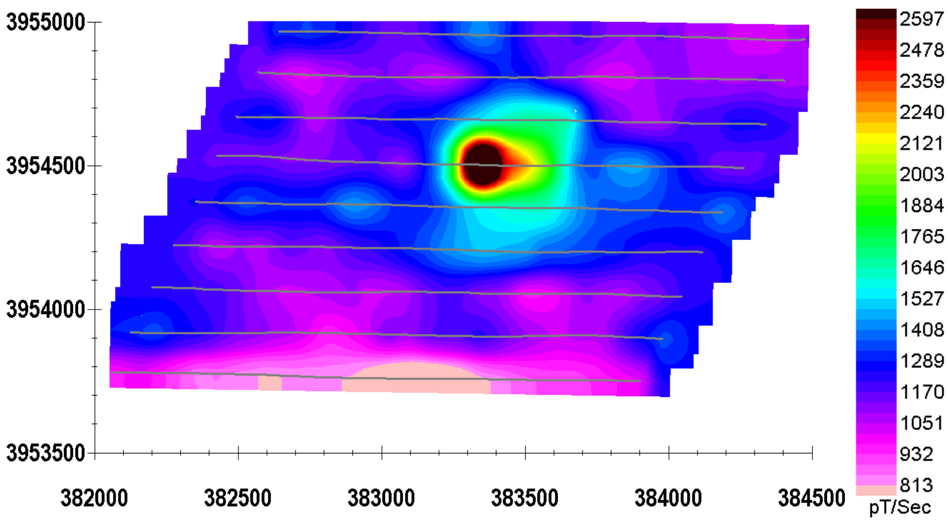


Above: The first channel of the EM data over the same area as the magnetic data shown on the previous page. There is a strong anomaly in the vicinity of the Miller pipe covering a relatively large area.

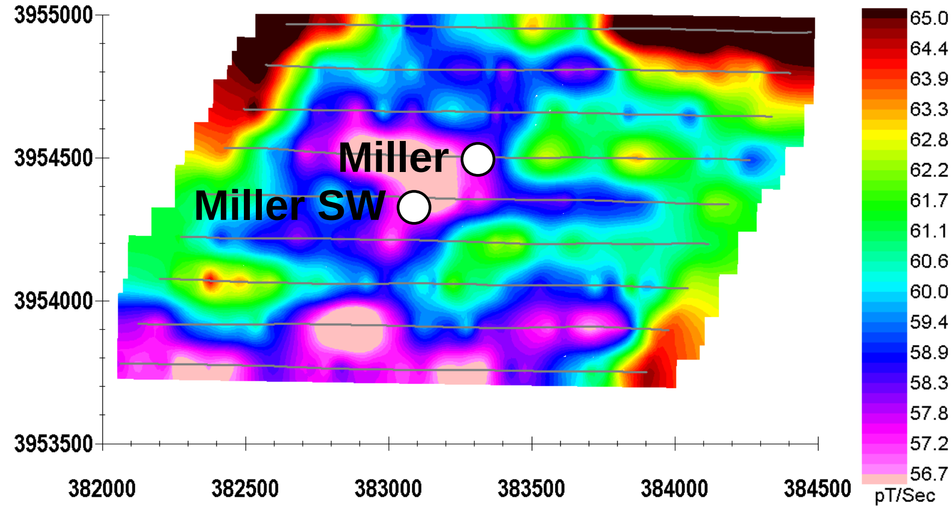
Right: Close-up of the anomaly with larger data range.



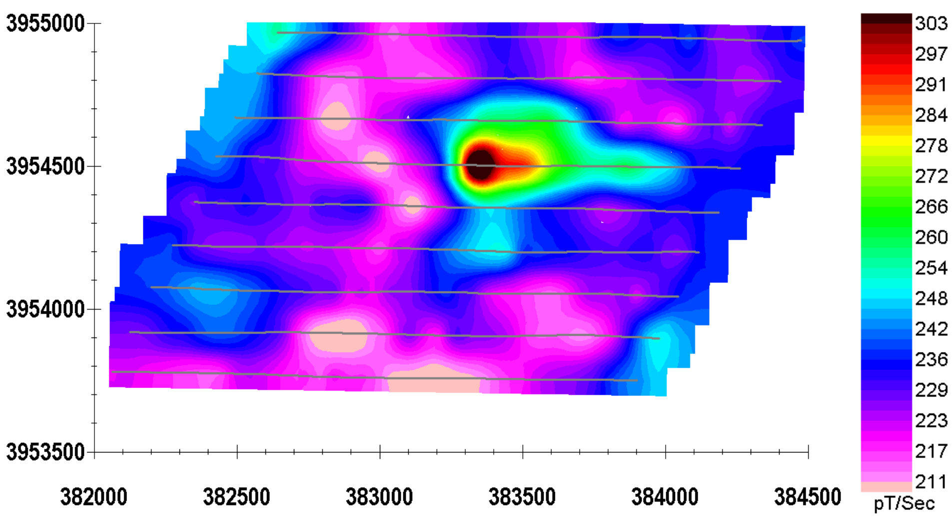
EM Data



Ch1



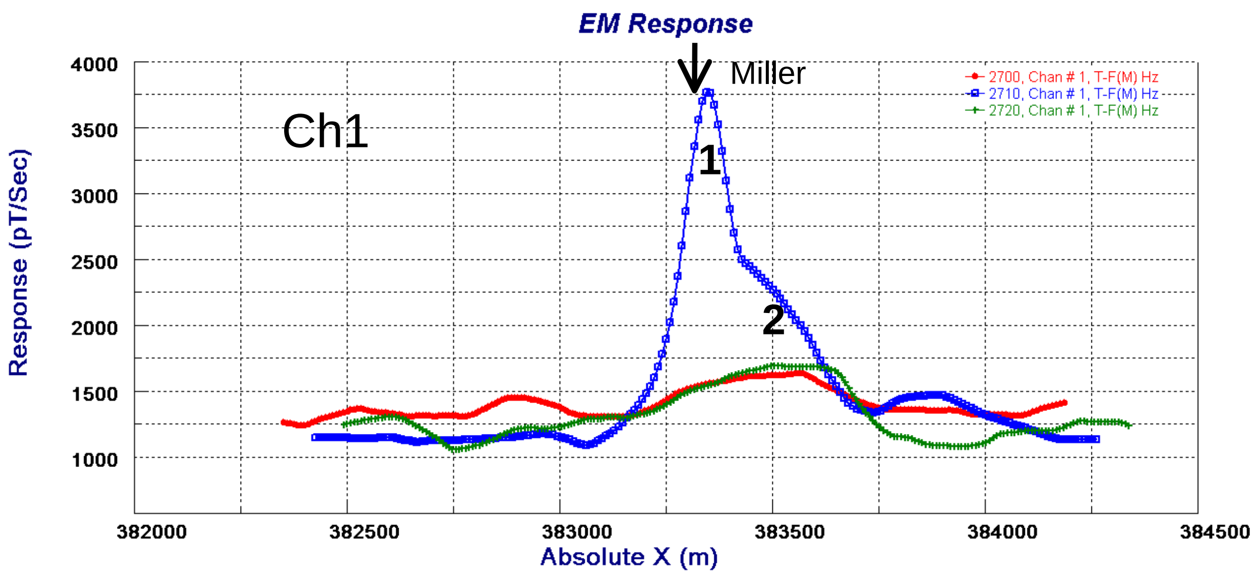
Ch10

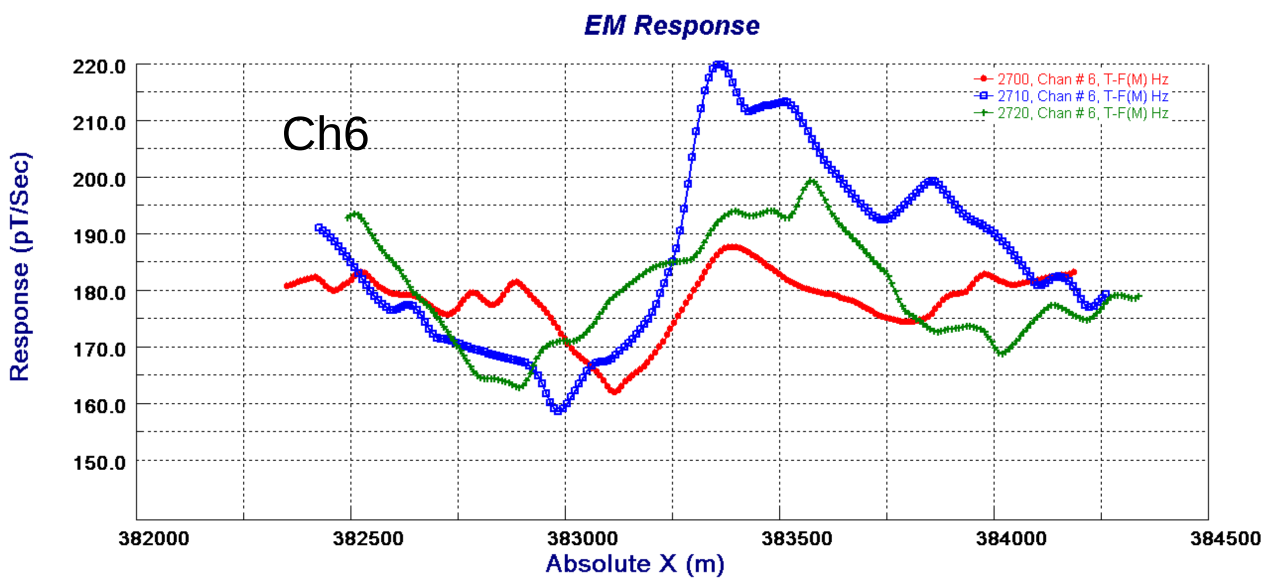


Ch5

EM response at three different channels over the two pipes. Line 2710 runs through the anomaly. The anomaly around Miller is clearly seen at early channels, but is barely visible by channel 10 although there persists a structural anomaly but not so circular in form and similar to other anomalies in the area.

EM Data





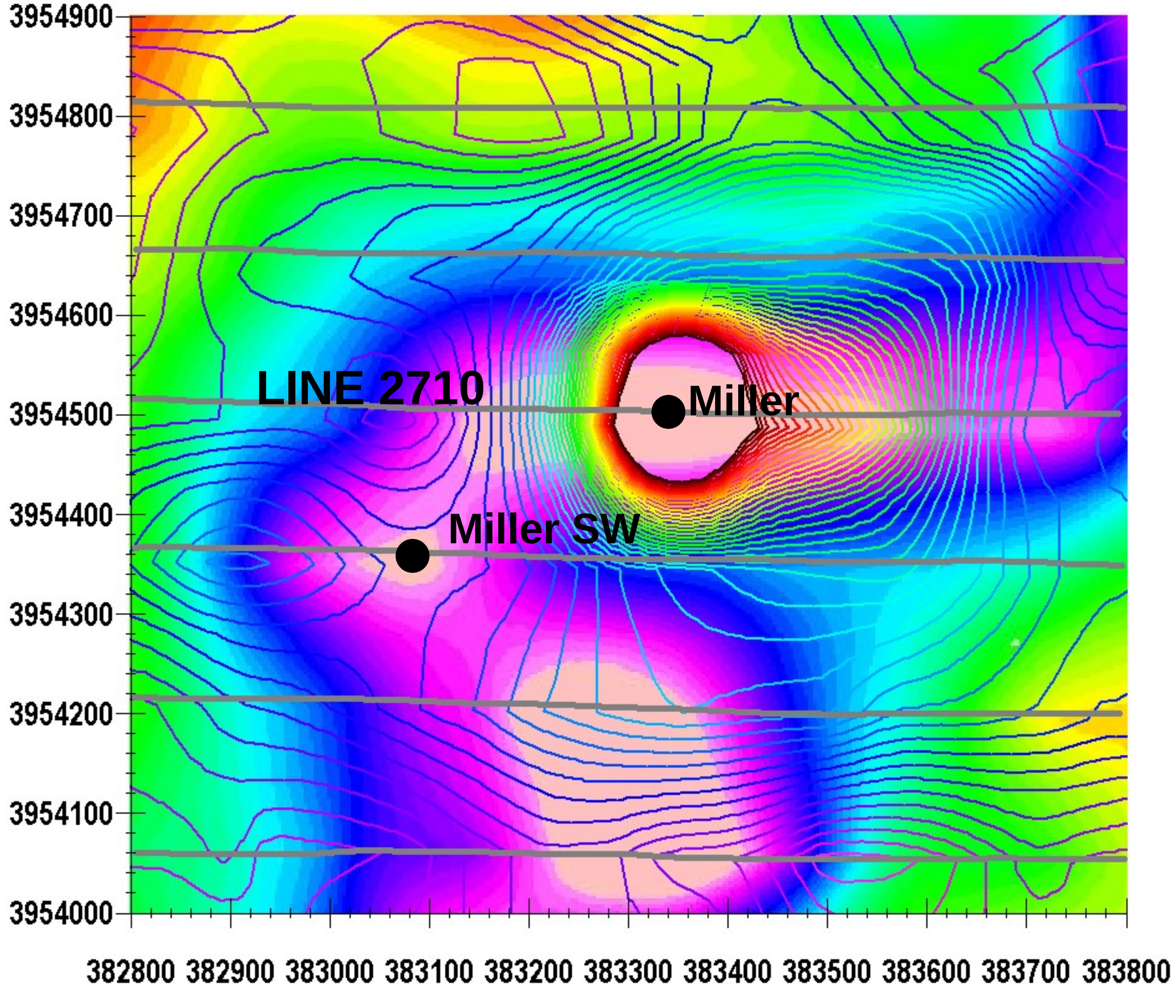
These plots show the response on Lines 2700-2720. Line 2710 is at a northing of about 3954500, the same northing as the Miller pipe. The anomaly is predominantly seen on Line 2710. It is also present on neighboring lines, but is much more subtle.

The anomaly is observed mainly at early times. By channel 6, the amplitude of the anomaly has decreased substantially.

The shape of the anomaly does not suggest a simple horizontal or vertical plate, but a more complex structure. At channel 1, it appears that there are two parts to the anomaly. The first is a peak at 3750 pT, about 150 m wide and centered approximately at the location of the pipe. The second has a lower amplitude, and is about 500 m wide. The question is whether these are due to the same structure, or separate structures.

Line 2700
Line 2710
Line 2720

EM Data vs. Topography

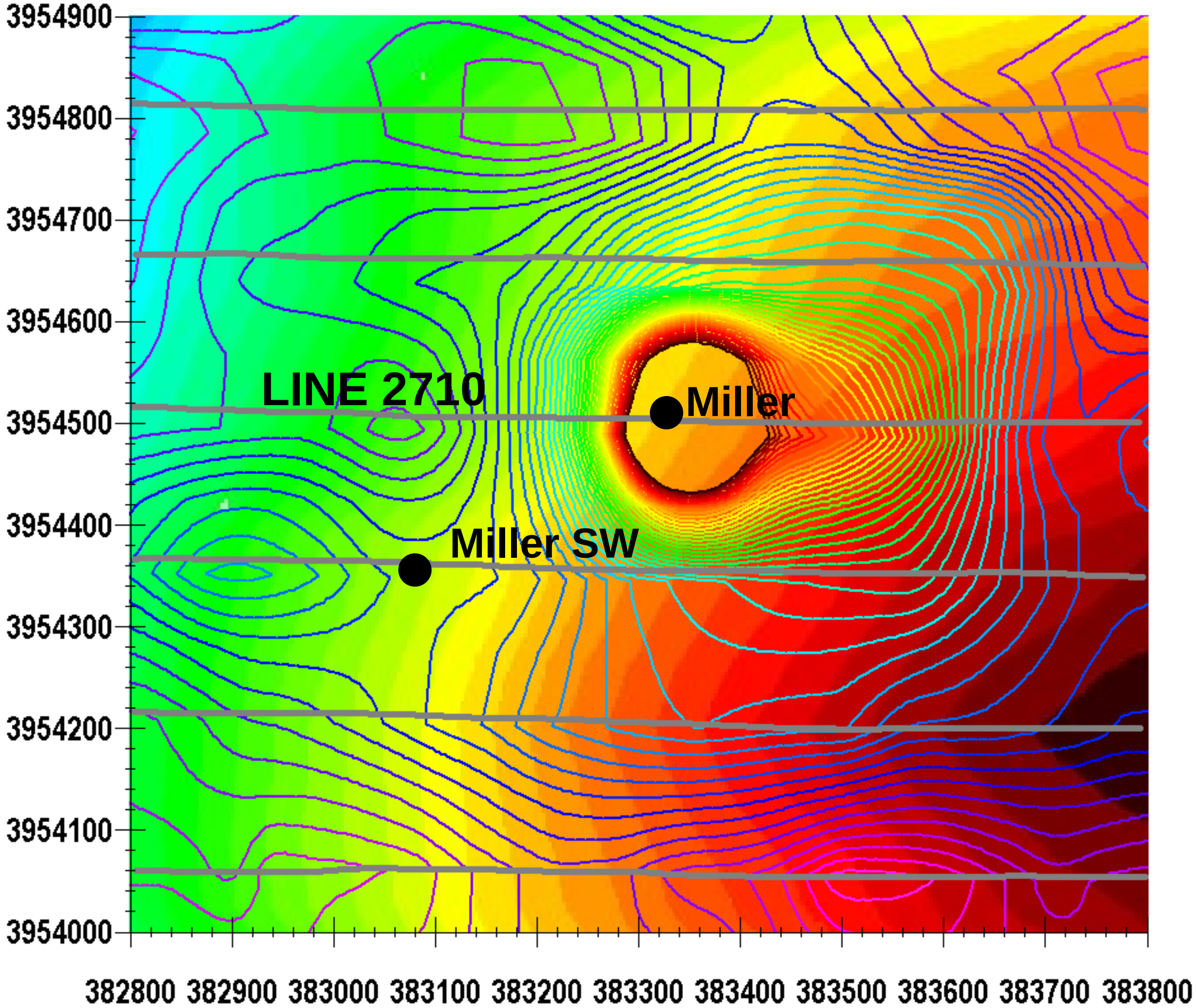


Comparison of the first channel of the EM data (contour lines) with the digital terrain model. Survey lines are also shown.

The EM anomaly trends east-west and approximately follows the wash. **Note that there is not an EM anomaly along the entire wash, but only where the wash is trending east-west near Miller pipe.

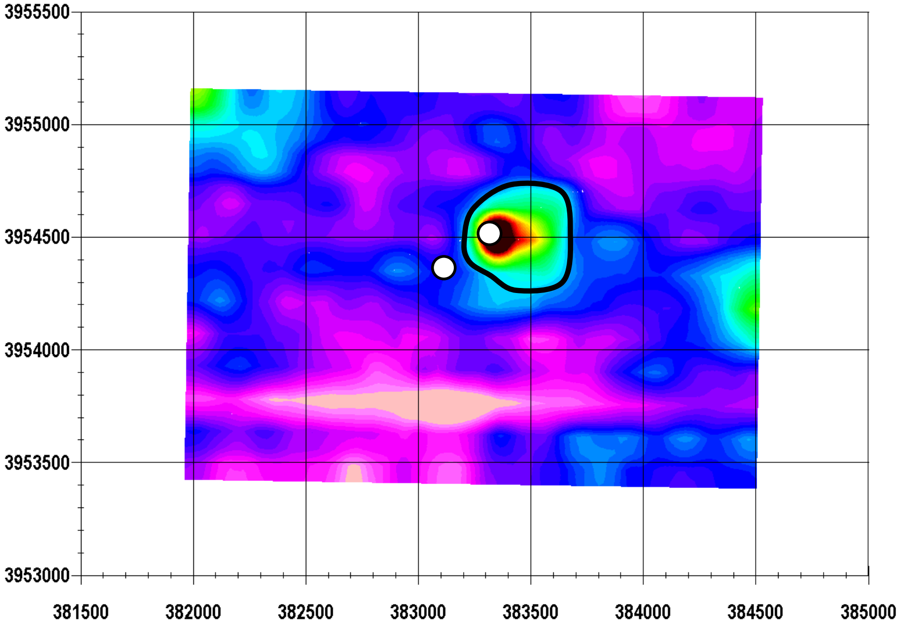
The main part of the EM anomaly is slightly wider than the wash; however, the spacing of the VTEM lines is only 150 m, so there is limited resolution north-south.

EM Data vs. Mag Data

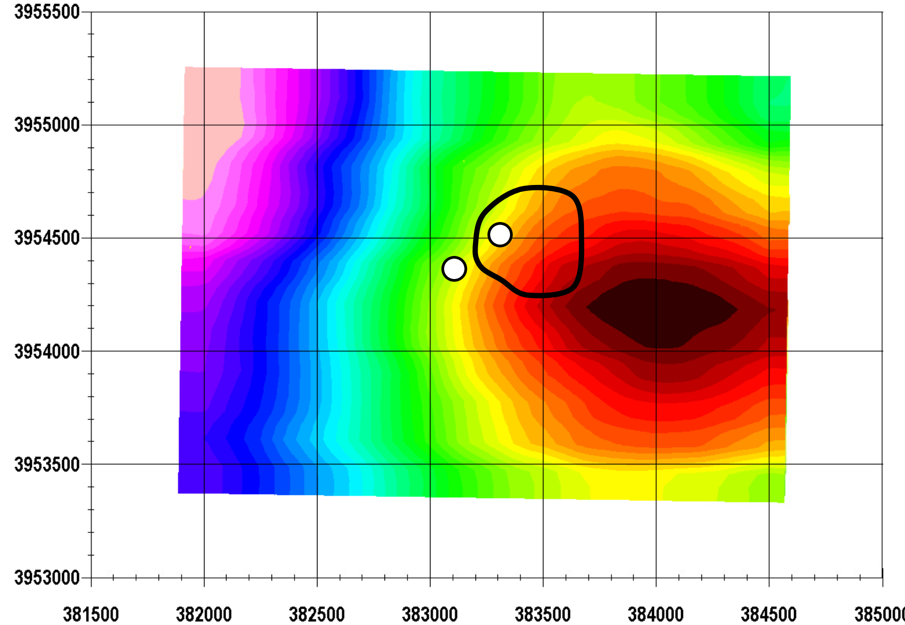


Comparison of the first channel of the EM data (contour lines) with the magnetic field. Survey lines are also shown.

EM Data vs. Mag Data



EM Data – ch1

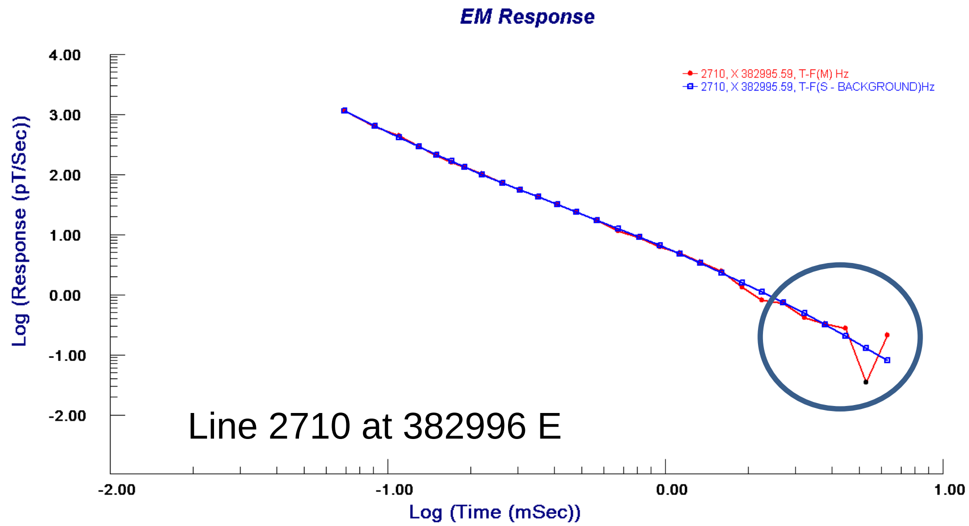


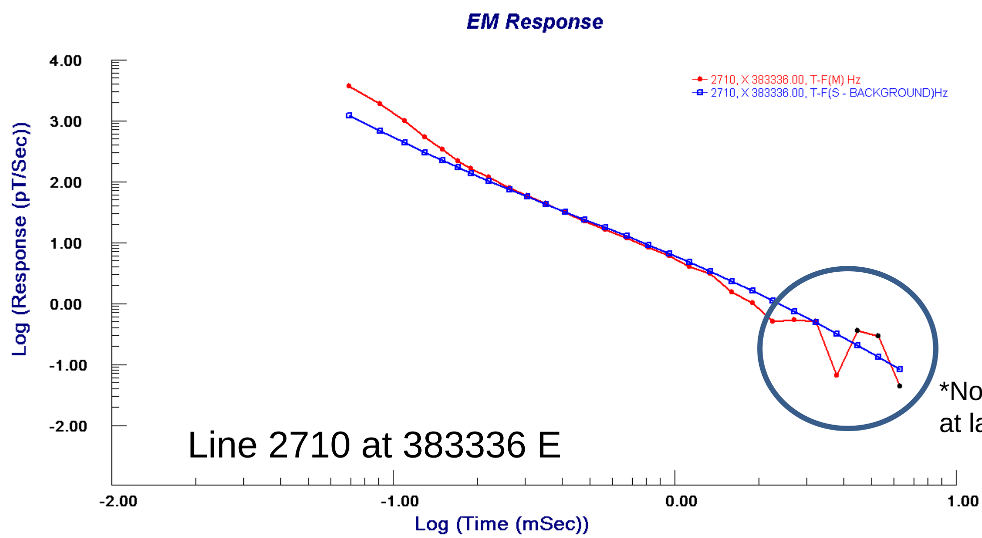
Magnetic Field

Comparison of the EM and magnetic response from the VTEM. The outline of the main part of the EM anomaly is marked on both contour plots.

From comparison of the EM, mag, and terrain data, the Miller pipes are associated with a large magnetic structure a few km across, and Miller is near the centre of a smaller, early-time EM anomaly a few hundred meters across. Miller SW is about 300 m southwest of Miller, and both are located in a wash.

EM – Layered Earth Modeling & Data Quality





*Noise in the data at late times.

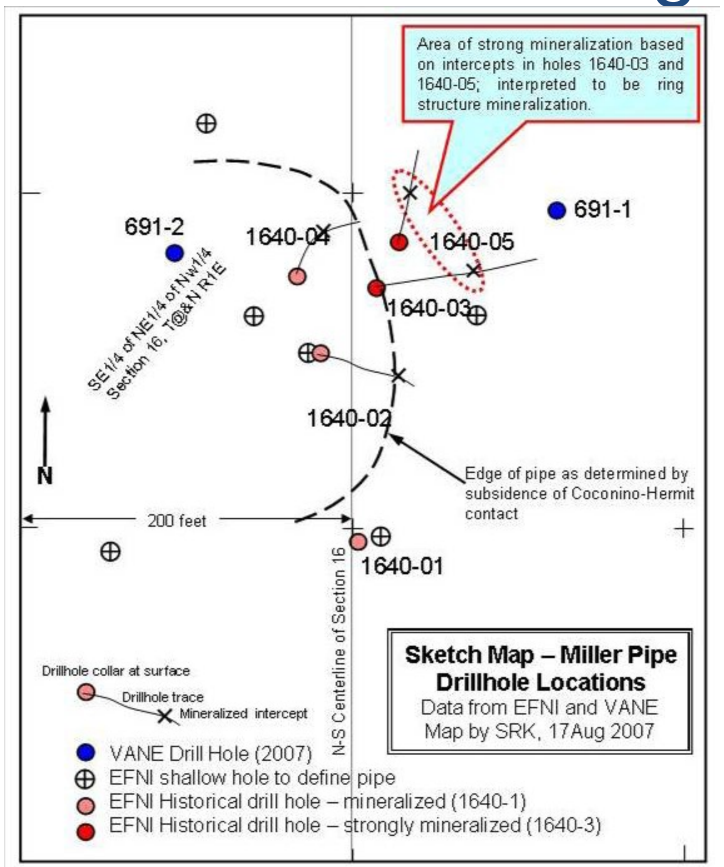
Resistivity (Ωm)	Thickness (m)	Depth to Bottom (m)	Formation
3.0716	0.9321	-0.9321	Overburden
9295.92	214.798	-215.7301	Kaibab/Torowea
991.525	82.749	-298.4791	p
48.9658	4.6825	-303.1616	Coconino
627.614			Hermit

The table describes a simple 1D model that fits the data on Lines 2700-2720 outside of the anomaly. Resistivity varies only with depth. The top plot is a decay a few hundred meters west of the anomaly, where the model fits the data very well. The bottom plot is a decay at the easting of the Miller pipe, which is within the EM anomaly. The model fits the data well at mid-late time channels, but has too low of a response at early times.

The noise in the late time data can be seen particularly well when the measured decays are compared to the layered earth model. The last 10 channels are fairly noisy. The quality of the VTEM data is not as good as at the Findlay Tank test site.

Measured Data
Background Model

Drilling Results & Geology



From Moran and Rasmussen, 2007 – Figure 5.1: locations of Historic Drillholes at Miller Breccia Pipe

Miller pipe was first drilled by Energy Fuels in the 1980's and mineralization was detected in 1640-5 at about 1290 ft (393 m) and in 1640-3 at about 1270 ft (387 m) (Moran and Rasmussen, 2007). Recent exploration work has been undertaken by Vane Minerals.

Energy Fuels drill holes 1640-1 (1500 ft or 457 m) and 1640-2 (1780 ft or 542 m) both reached the Supai Formation (see table from Moran and Rasmussen, 2007). 1640-3 reached the Coconino-Hermit contact at 1233 ft (376 m). Several drill holes encountered pyrite.

While the surface formation in the general vicinity of the Miller pipes is the Kaibab Limestone, there is Moenkopi at the centre of the Miller pipe, so many of the drill holes began in the Moenkopi.

From Moran and Rasmussen, 2007 – Table 5.1:Historical Drillholes at Miller Breccia Pipe

Drillhole No.	Total Depth (ft)	Notes from Lithologic Log
1640-1	1,500	Moenkopi to Supai; sparse pyrite to 5%; sparse to abundant hematite
1640-2	1,780	Moenkopi to Wescogame Member of Supai Formation; breccia, highly fractured clasts; mostly oxidized; trace pyrite, trace to strong hematite, some malachite, azurite
1640-3	2,255	Moenkopi breccia to Supai; trace limonite, hematite; trace to 2% pyrite, trace bornite, trace malachite, azurite, Coconino-Hermit contact at 1,233ft; 2 to 3x background CPS in Hermit, Esplanade, and at 2,240-2,260ft
1640-4	2,464	Moenkopi breccia to Supai; trace limonite, hematite; trace – 1% Cu 385-400ft; 2x background CPS at 710-1,020ft and 1,640-1,660ft with trace pyrite; trace malachite
1640-5	1,940	Geological log not available
MI-1 Miller SW Pipe	710	into Coconino; dissolution cavities; sparse hematite; 5-10% pyrite 410-420ft; 10x background CPS in upper Coconino
MI-2	430	Breccia, strong oxidation, sparse pyrite; malachite, hematite; lost circulation at 430ft
MI-3	160	Moenkopi, Kaibab sandy limestone breccia at TD; trace hematite, trace pyrite
MI-4	180	Moenkopi, Kaibab; alteration, trace pyrite; reduced below 100ft.
MI-5	80	Moenkopi, sandstone, limestone: trace to 2 to 20% pyrite
MI-6	160	Moenkopi, sandstone; trace to 5% pyrite

Drilling Results & Geology

Comparison of Layered Earth Model to Geology

The table on the previous page provides some limited information on the lithology to compare with the resistivity model developed to fit the VTEM.

Near Miller, Kaibab Limestone is at the surface, although there is Moenkopi in the depression at the pipe. The EM model contains a very thin, conductive overburden which is assumed to be weathered rock at the surface or possibly a thin cover of Moenkopi mudstones.

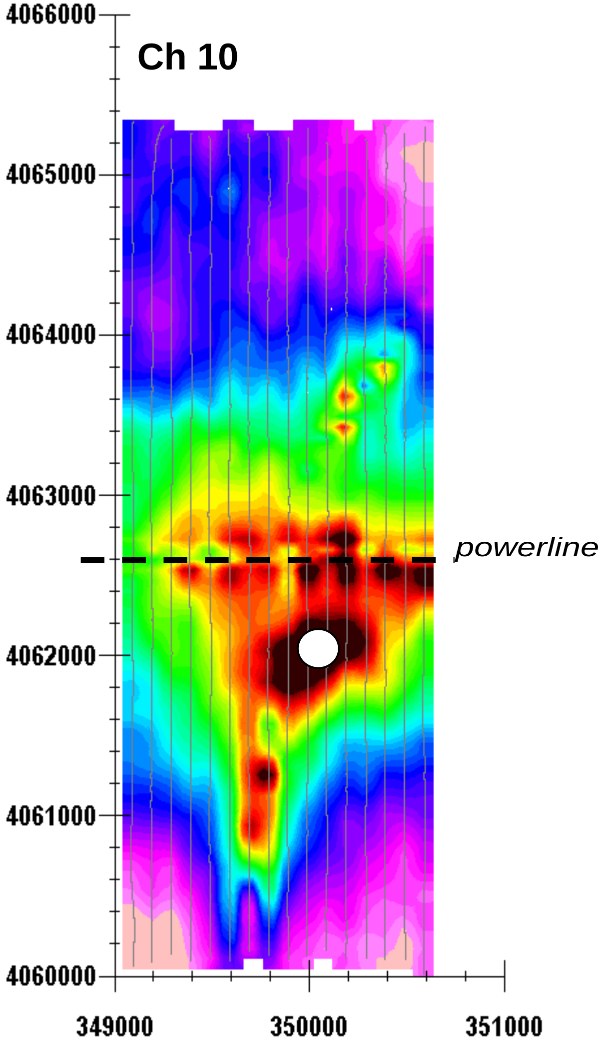
At drill hole 1640-3, the depth to the Coconino-Hermit contact is 376 m, which is somewhat greater than the depth in the layered resistivity model of 303 m. **According to the figure on the previous page, this drill hole is near the edge of the pipe, and so the depth to this contact may be slightly deeper at this location due to inward-dipping beds. This may account for some of the discrepancy, but a drop of 70 m seems unlikely. However, due to the noise in the VTEM data beyond early times, resolution at depth is limited.

Drill hole 1640-1 reached the Supai by 457 m. In modeling, we did not attempt to resolve the layers below the Hermit. We do not believe that the quality of the data is sufficient to locate the bottom of the Hermit.

Resistivity model

Resistivity (Ωm)	Thickness (m)	Depth to Bottom (m)	Formation
3.0716	0.9321	-0.9321	Overburden Kaibab/Torowea
9295.92	214.798	-215.7301	Kaibab/Toroweap
991.525	82.749	-298.4791	p
48.9658	4.6825	-303.1616	Coconino
627.614			Hermit

Comparison with Findlay Tank



*The white circle marks the approximate center of the pipe, based on drill hole results.

The enhanced EM response in the vicinity of the Miller pipe is similar to that observed at Findlay Tank in the North Rim.

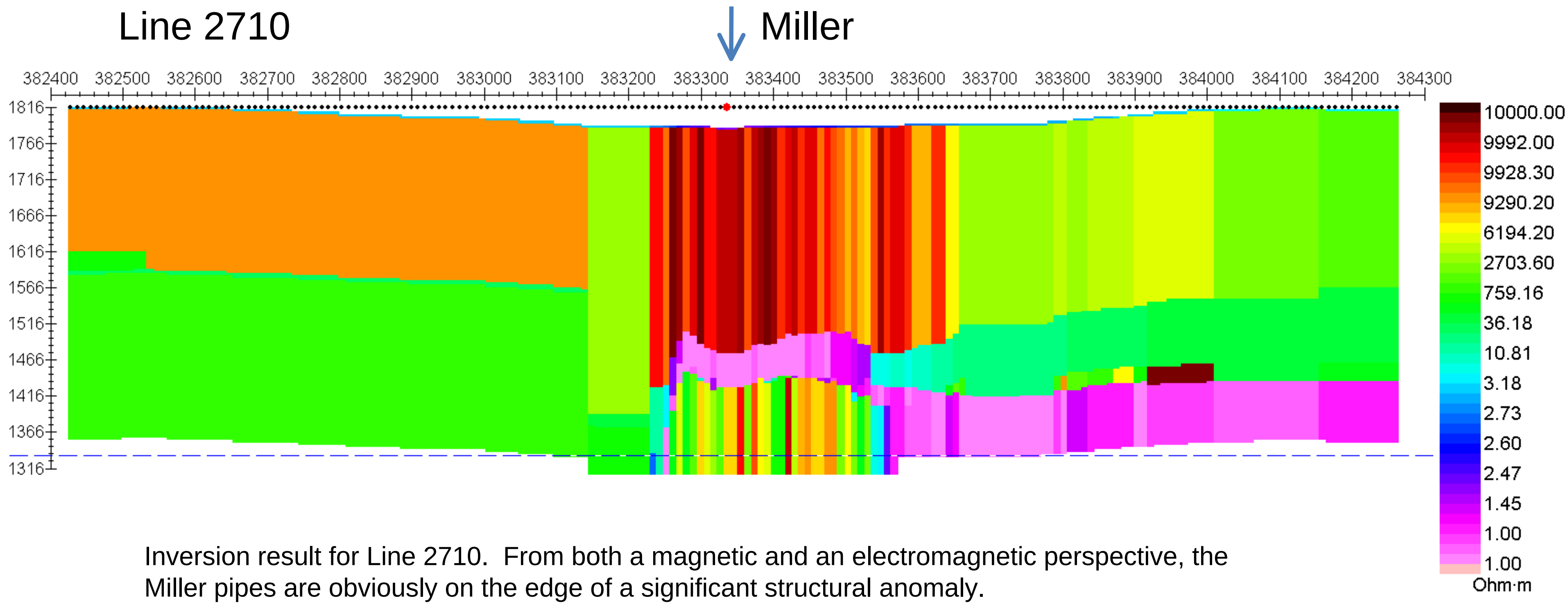
VTEM data was collected over the Findlay Tank area in the North Rim in May 2007. The map on the left shows the data at the tenth channel. There is generally a high response over a large portion of the Findlay Tank area, with a particularly elevated response near FT SE. This anomaly persists slightly later in time than the anomaly at Miller.

Ground time-domain EM data was collected at FT SE in May, 2007. Modeling of the anomaly in this data resulted in the 3D model described in the table below. This model also fits the VTEM data reasonably well. The model is at the bottom of the Moenkopi, which extends to about 80 m at Findlay Tank, based on drill hole results. The ground survey could not discriminate whether it in fact entered the limestone sequence, or was confined to the Moenkopi. It is thought that this could represent a more conducting alteration zone at the top of the pipe.

The background geology is somewhat different at Miller than at Findlay Tank: the layered earth modeling results on the previous page suggest only a very thin overburden above the limestone sequence at Miller, rather than the a relatively thick Moenkopi. Thus, the source of the anomaly at Miller is likely within the limestone sequence, rather than in the Moenkopi as at FT SE. The results of the inversion and modeling work at Miller on the following pages are compared with the findings at Findlay Tank.

Orientation (deg)	Strike	90
	Dip	0
Size (m)	Strike length	180
	Dip extent	180
	Thickness	20
Location (m)	x (centre)	350025
	y (centre)	4062000
	z (to top)	-60
Conductivity (S/m)		0.1

EM – Inversion



Inversion result for Line 2710. From both a magnetic and an electromagnetic perspective, the Miller pipes are obviously on the edge of a significant structural anomaly.

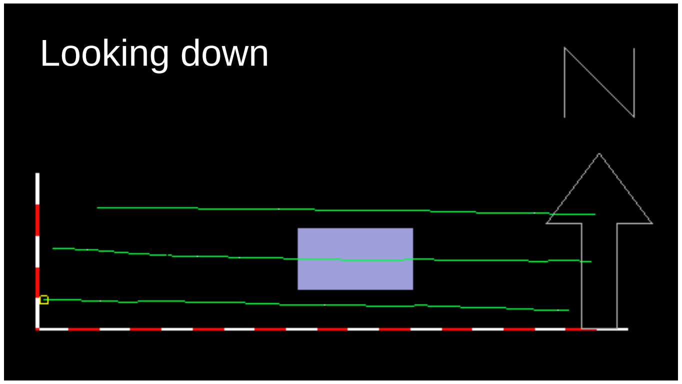
Note: While the inversion clearly shows a structural anomaly in the vicinity of Miller, the anomaly appears to be significantly 3D in nature and the stacked 1D inversion approach is not considered to be sufficiently accurate. This is analogous to the response at FTSE.

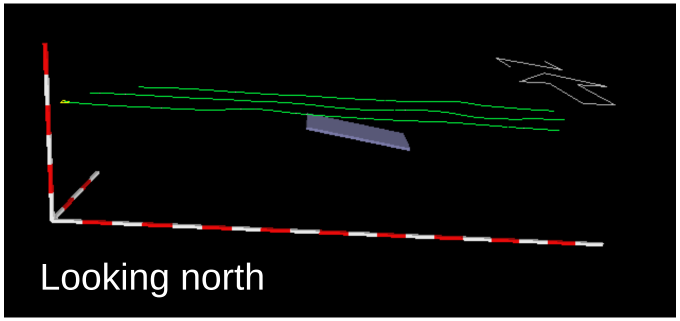
The following pages describe 3D modeling work to better understand the source of this EM anomaly.

EM – 3-D Modeling (1)

Some preliminary modeling of the anomaly resulted in Model 16_1. This is a shallow prism, dipping to the east. The response of this model is compared to the data on the following pages.

Orientation (deg)	Strike	0
	Dip	9
Size (m)	Strike length	200
	Dip extent	375
	Thickness	10
Location (m)	x (centre)	383260
	y (centre)	3954504
	z (to top)	-10
Conductivity (S/m)		0.04

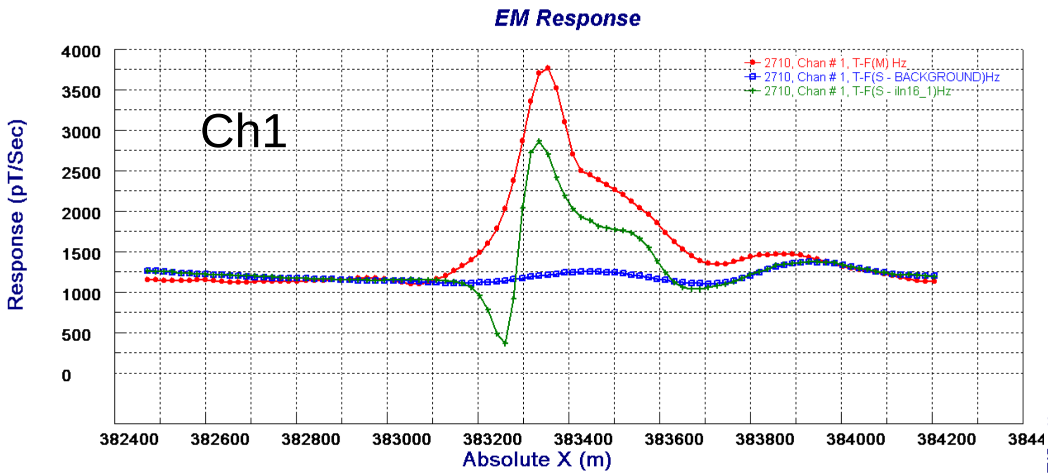


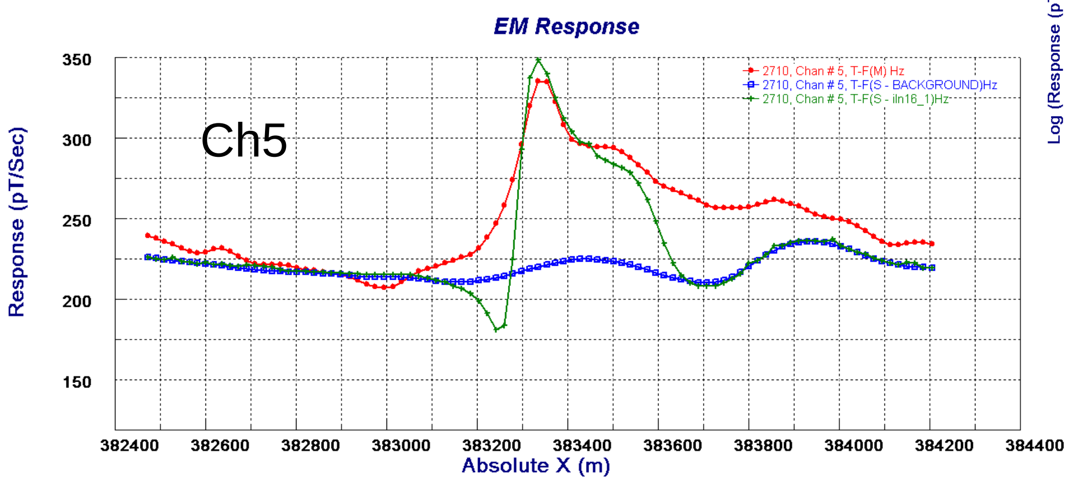


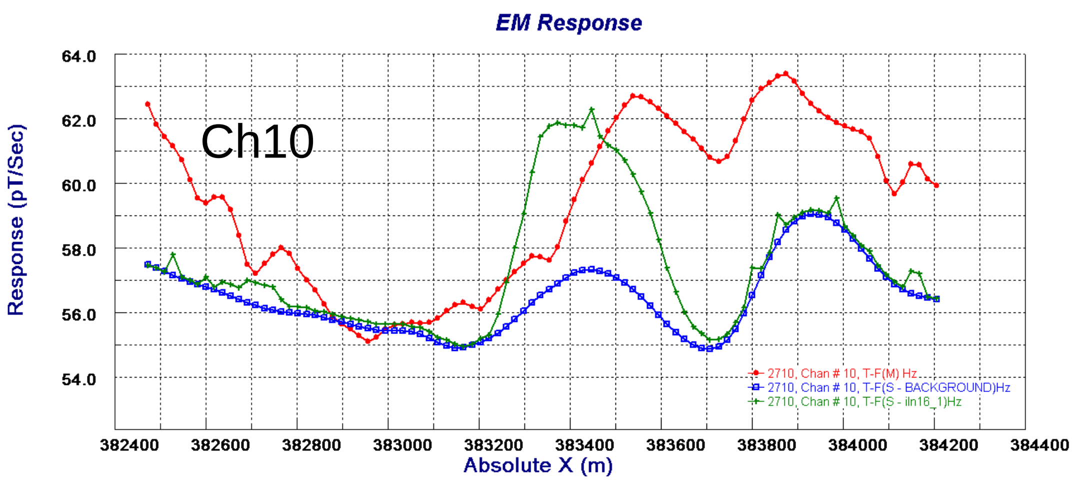
Comparison to Findlay Tank Model:

The anomaly in the VTEM at Findlay Tank is a single peak, in contrast to the more complex shape of the anomaly at Miller (see page 12). To fit the shape of this response, the model dips to the east, whereas the Findlay Tank model is flat-lying. Both models are similar in depth, however: the Findlay Tank model is at 60-80 m depth whereas this model dips from 10 m to 80 m depth. This puts the Findlay Tank model in the Moenkopi, while the Miller model is in the underlying limestone. The Miller model is also much larger than the Findlay Tank model (280 m x 375 m vs. 180 m x 180 m).

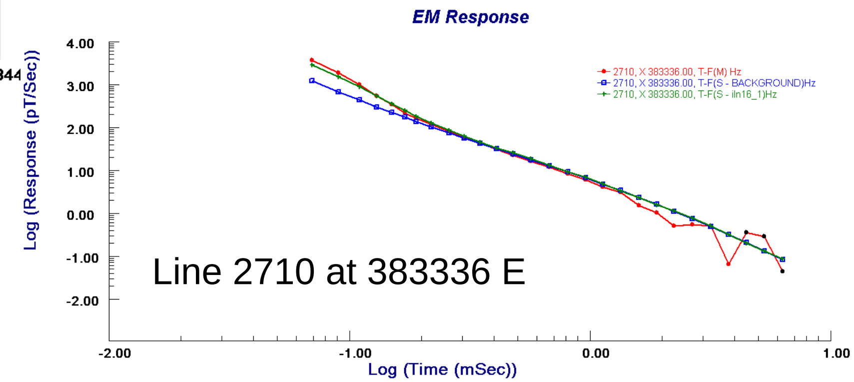
EM – 3-D Modeling (1) *LINE 2710*







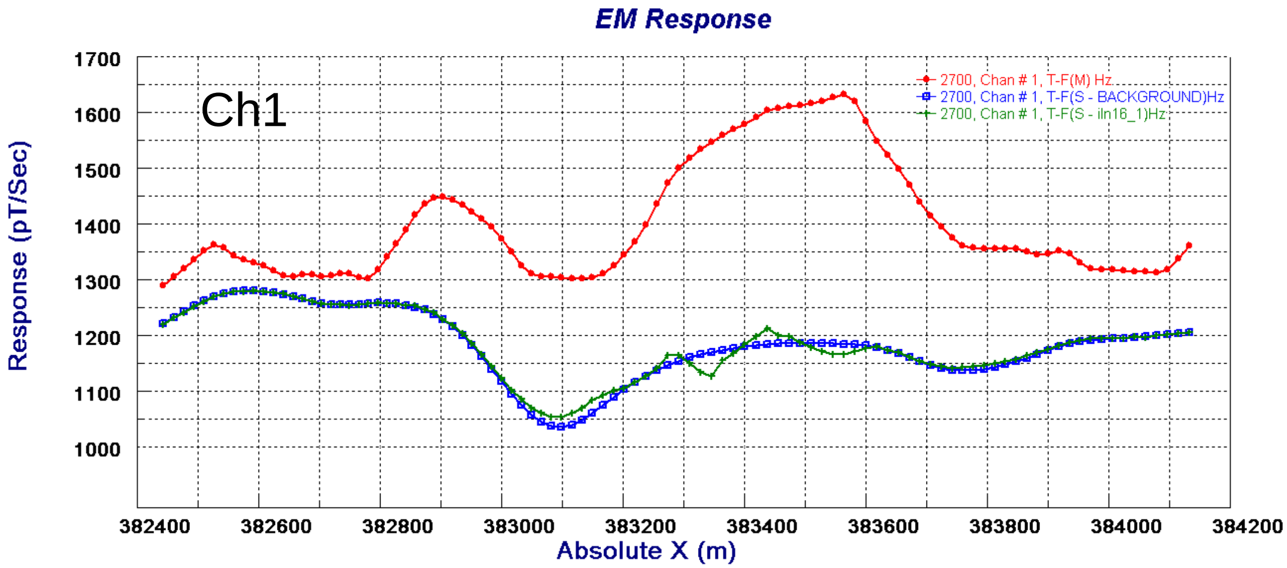
Measured Data
Background Model
Model 16_1

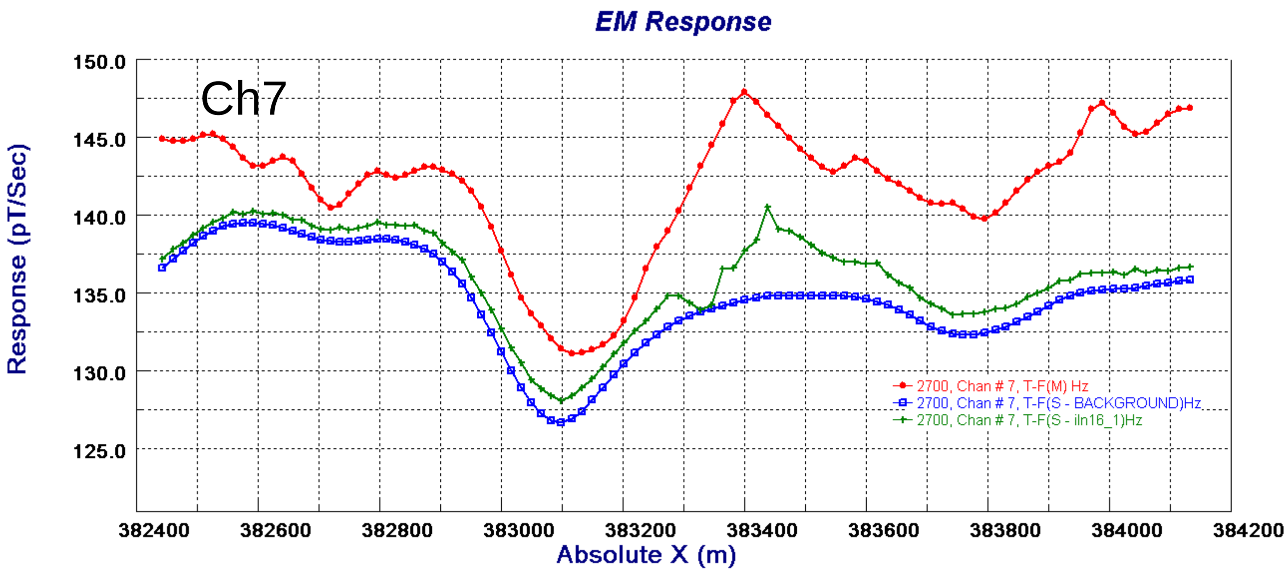


On the left: comparison of the measured data to the background model and prism model for three different time channels along Line 2710. The model fits the general shape of the anomaly. The response of the model is slightly too small for the first three channels.

Above: Decay at the easting of the Miller pipe, within the EM anomaly. The decay of the prism model matches the measured data reasonably well, increasing the response of the background model at early times.

EM – 3-D Modeling (1)





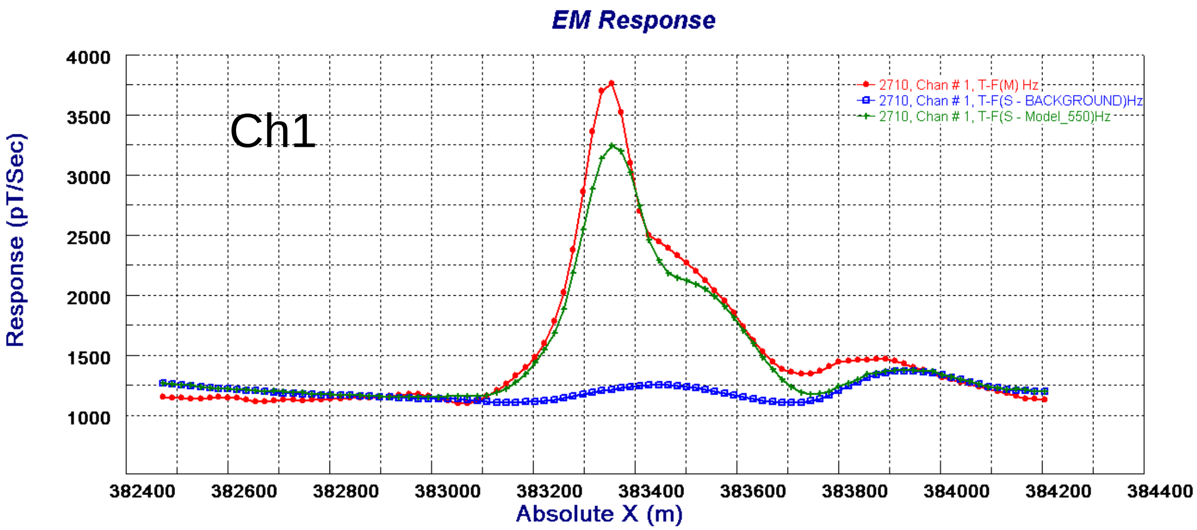
LINE 2700

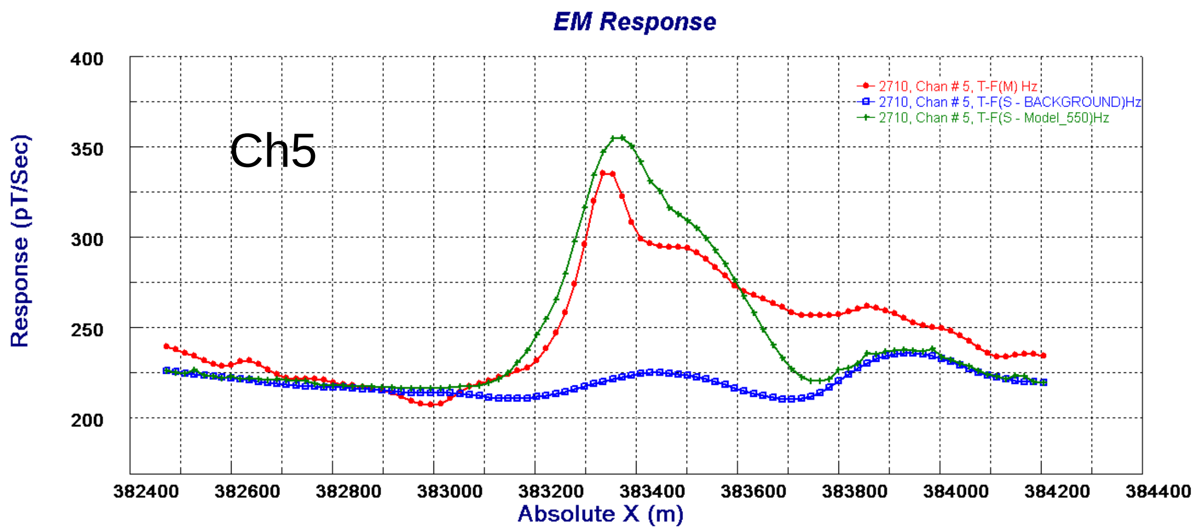
Measured Data
Background Model
Model 16_1

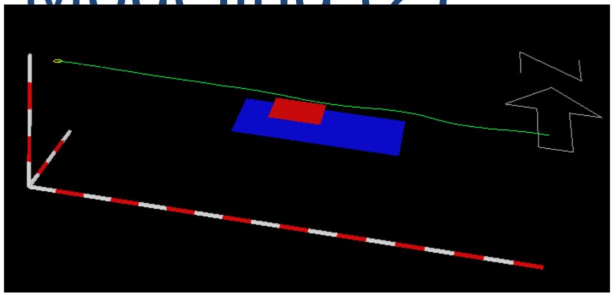
The plots show the response along 2700 (south of 2710). Model 16_1 has a small response on this line. The anomaly in the measured data is somewhat larger, especially at very early channels.

The dipping model at Miller, Model16_1, is somewhat larger in extent than the Findlay Tank Model, and dips at 9^0 to the east. It is not known what could cause such a dipping structure. There are commonly inward-dipping beds around a pipe; however, this structure dips from 100 m west of the pipe to about 275 m east of the pipe. It is possible that this model could be a fracture in the rock, and the increased conductivity could be due to alteration along the fracture.

EM – 3-D Modeling (2)







Measured Data
Background Model
Model 550

Model 550 is an alternate model to fit the anomaly on Line 2710. Rather than one target dipping to the east as in Model 16, Model 550 contains two targets, one small, shallow target, and a deeper target.

Shallow Plate

Orientation (deg)	Strike	0
	Dip	0
Size (m)	Strike length	180
	Dip extent	180
Location (m)	x (centre)	383350
	y (centre)	3954504
	z (to top)	-1
Conductance		0.35

Deep Plate

Orientation (deg)	Strike	0
	Dip	0
Size (m)	Strike length	300
	Dip extent	575
Location (m)	x (centre)	383433
	y (centre)	3954504
	z (to top)	-50
Conductance		0.27

EM – 3D modeling & Geology (2)

One of the reasons for making Model 550 is that the drilling results show that there is Moenkopi above the pipe. At Findlay Tank SE, the Moenkopi had a resistivity of 50-130 Ωm, which is much more conductive then the Kaibab and Toroweap. Thus, if Moenkopi were present above the pipe, one might expect to see an EM anomaly. The upper plate in Model 550 was meant to represent the Moenkopi over Miller.

The top of the structure has to be quite shallow to cause the sharp peak in the response at early times – within a few meters of the surface. Thus, it would be reasonable for it to be caused by the Moenkopi.

The second, deeper structure in Model 550 is quite large, at 300 m x 575 m. We are unsure of its geological significance and how it relates to the pipe. While this structure follows the east-west trend of the wash near the Miller pipe, it is too deep (50 m below the surface) to be caused by the wash. This structure is also not seen elsewhere along the wash, only near Miller. It is thought that this could be due to something flowing out from the pipe along a fracture.

This deeper structure is similar in depth to the model at Findlay Tank SE, and has a lower conductance (0.27 S vs. 2 S at Findlay Tank). It is also much larger in lateral extent. The character of the anomaly is much different for the Miller and Findlay Tank models because they are in different formations: the Miller model is in the resistive limestone, while the Findlay Tank model is in the more conductive Moenkopi.

The conductance of the deeper structure (0.27 S) is consistent with the conductivity of a thin layer with a few percent pyrite. We understand that pyrite was encountered in several drill holes at Miller, though we have limited information on its depth and lateral extent.

Although Model 550 is a good base model for the EM response, there is still more work to be done to better understand the nature of the response. The depth extent of the lower target has not been determined, and this is necessary to calculate the conductivity from the conductance. Also, while we suspect that the upper target is due to the Moenkopi, we need to investigate the possibility of there being a relationship between this structure and the deeper one.

Conclusions

Magnetics:

The two Miller pipes are on the edge of a magnetic high about 3 km across. Several other pipes have been observed on the edge of large magnetic anomalies. There may be a subtle magnetic anomaly over the Miller pipes but we are not yet certain.

Electromagnetics:

Outside the pipe, the response fits a simple structural resistivity model in which the resistivity only varies with depth (i.e. layered model). This model consists of a very thin conductive overburden (3 Ωm) and a 300 m thick resistive formation (limestone sequence) overlying more conductive layers (likely the Coconino and Hermit). This matches the drilling results, which found Kaibab at the surface, except at center of the pipe, where there was more conductive Moenkopi at the surface. The thickness of the limestone sequence is somewhat less in the model than the drill results at Hole1640-3. However, quality issues with the late-time data make it difficult to develop an accurate model at depth. Note: data quality on the South Rim generally is not as good as the test data over Findlay Tank.

There is a VTEM EM anomaly with the peak response centered approximately at the location of Miller. This anomaly is seen primarily along Line 2710, but also on neighboring lines although somewhat weaker. This anomaly is seen distinctly in the first eight time channels. At least a portion of the target must be relatively shallow to get the large and narrow early time response. However, at later times , the anomaly broadens and thus there must be a deeper extent to the target. The anomaly has a strong 3D character, and stacked 1D inversions are not considered sufficient to characterize the target. In fact, the 1D inversions tend to product an image of the structure which places it at depth much like the inversion images from Findlay Tank.

The anomaly is probably caused by two separate features. The narrow peak seen along Line 2710 is likely due to Moenkopi sediments that have collapsed into the pipes. According to the report prepared for Vane, there is known to be Moenkopi above the Miller pipe (Moran and Rasmussen, 2007). This was modeled by a very shallow structure, 180 m x 180 m wide, centered almost directly over the co-ordinates given for the pipe in the report. It is not known how large the extent of the down-dropped Moenkopi is in the vicinity of the pipe, and whether this model fits with the geology in that respect. A second target was modeled at 50 m depth, 300 x 575 m. This is similar in depth to the model at Findlay Tank SE, though much larger in extent (Findlay Tank model was 180 m x 180 m). This model is too large in lateral extent to be only the breccia pipe or top of the pipe. We are not sure what this conductive region could represent geologically nor have we concluded on the depth extent of the target. While this structure follows the wash, it is too deep to be caused by the wash. Furthermore, there is not an EM anomaly present along the entire wash, but only in the vicinity of Miller.

These results suggest that it may be possible to locate pipes using geophysics where there is Kaibab on the surface, but Moenkopi down-dropped above the pipe because these pipes may have an early-time EM anomaly. However, this situation is not applicable to all pipes. While the data suggests another structure at Miller that is clearly in the vicinity of the pipe, we are not sure of the relationship between this structure and the pipe.

References

Moran, A.V., and Rasmussen, J.C. (SRK Consulting), 2007. Uranium Breccia Pipe Exploration NI 43-101 Technical Report. Retrieved Nov. 2008, from http://www.vaneminerals.com/?page=downloads

Analyses of VTEM Magnetic and EM data in the area of the SBF Pipe
December, 2008
Ross Groom, Petros Eikon Incorporated

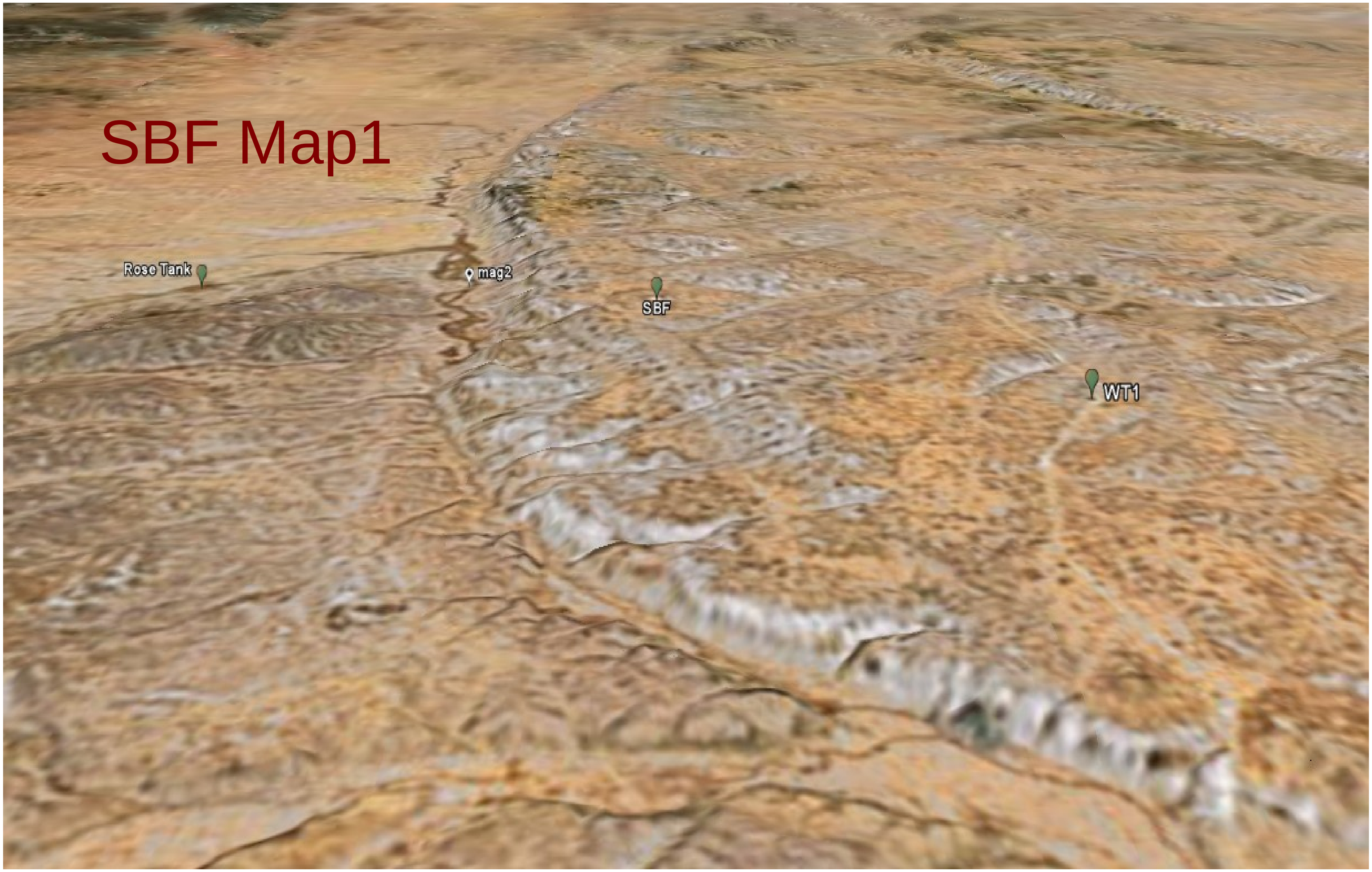


Figure 1: *SBF Pipe,View from the south* This is an image derived from Google Earth with the elevation enhanced 3:1. The area shows what appears to be a shallow wash (about 2m deep) passing along the edge of a not to large topographic step (about 30m). The elevation information from Google Earth and that obtained from the VTEM airborne data agree reasonably well. There are 2 water tanks in the area – Water Tank 1 (WT1) and Rose Tank. The position of an unusual magnetic anomaly is shown as (mag2). A prominent linear feature is observed just to the west of SBF and striking from NNW to SSE. Two dirt tracks appear on Google Earth. One proceeds NS crossing the wash near the bottom right of the figure and proceeding towards WT1. The other appears at the bottom of the figure and travels along the edge of the wash towards Mag2 before veering to the west to reach Rose Tank.

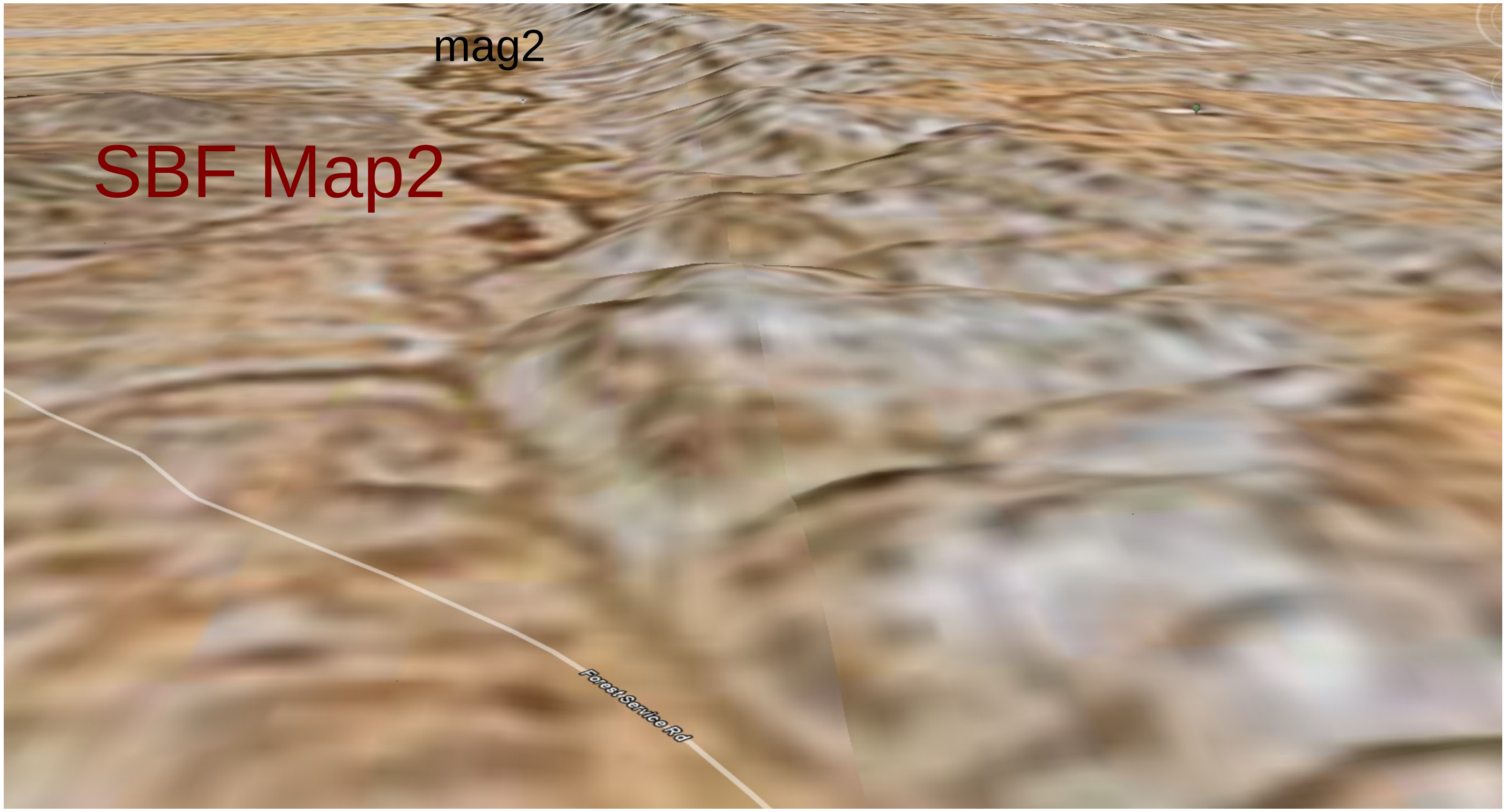


Figure 2: ***Close-up further north*** This view is somewhat further north, where the service road veers away form the base of the hill towards Rose Tank. SBF is seen in the top right and Mag2 straight ahead in the dark patch near the top of the figure.

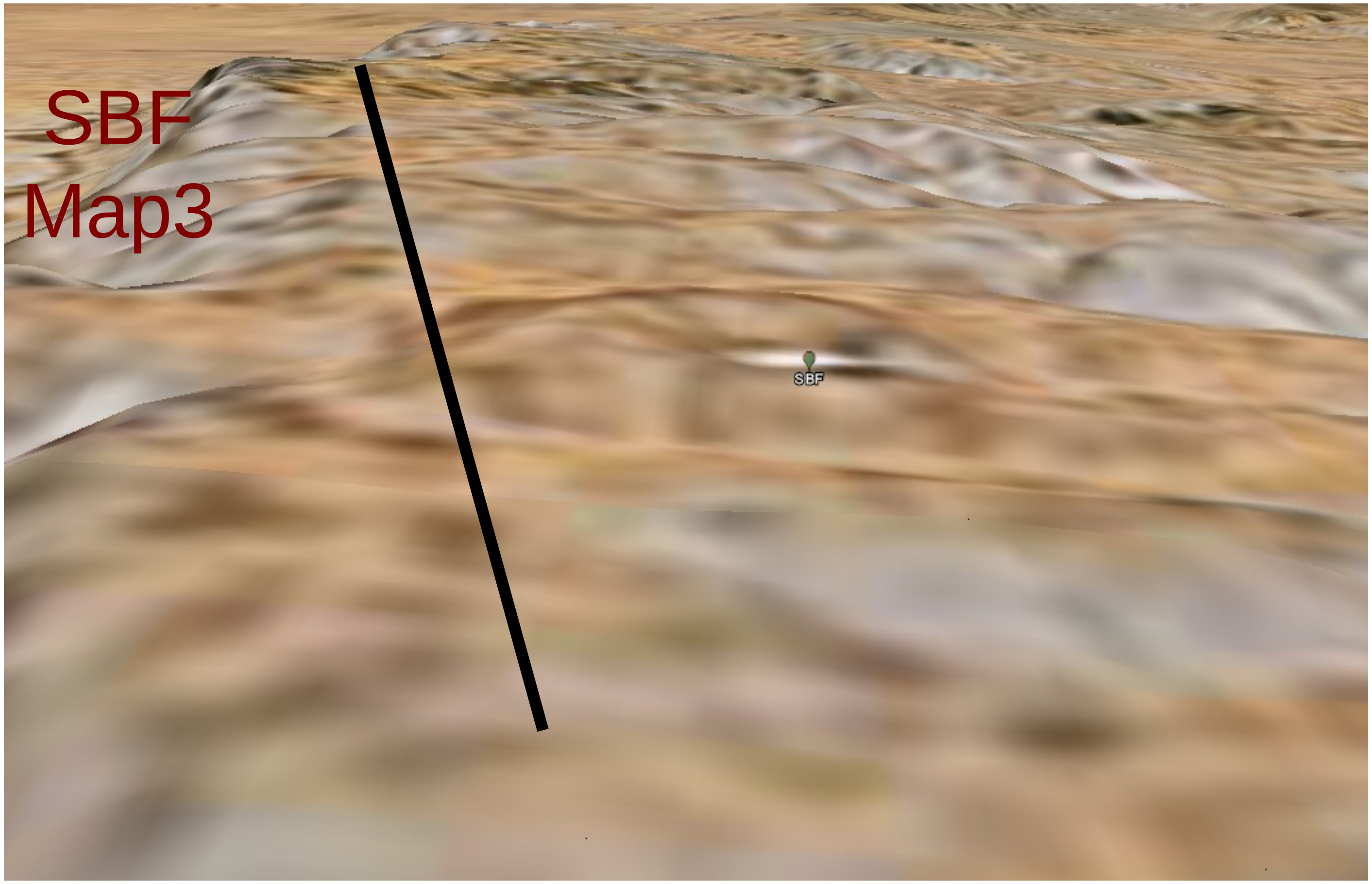
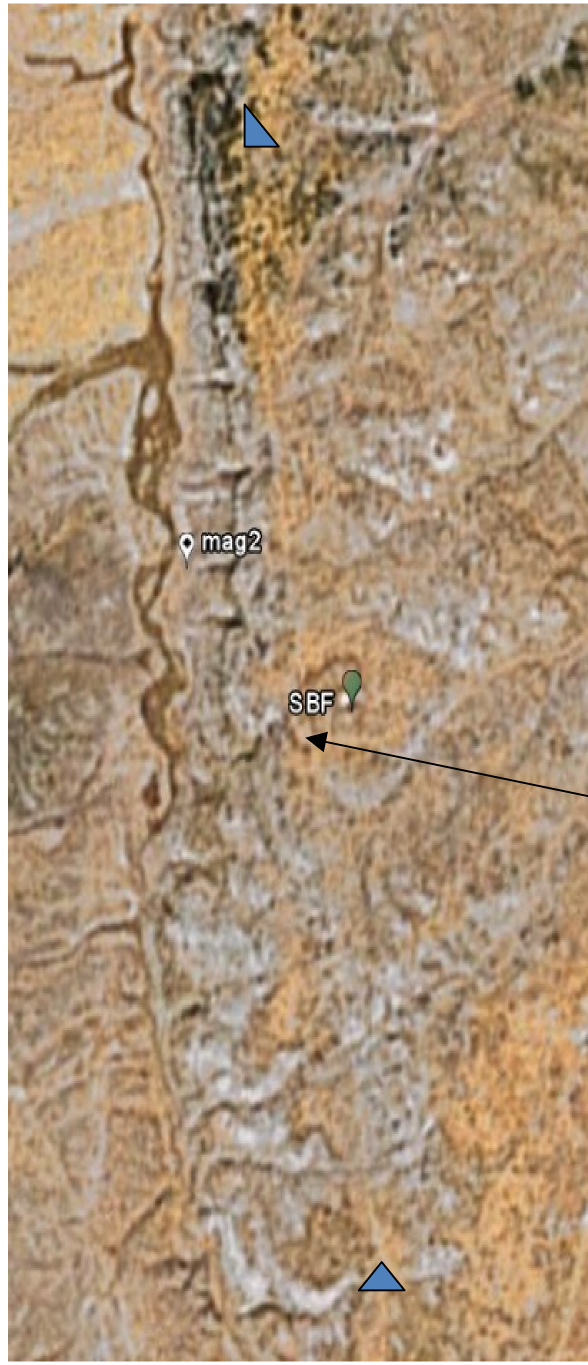


Figure 3: ***SBF*** The coordinates given to us for SBF are (329500E, 3972750N NAD27) which converts to (329437E, 3962950N NAD83). These coordinates place the pipe on the southern portion of a ridge which surrounds a depression as shown in the figure. According to Google Earth, the centre of the white circular area surrounded by a slight small hill is at (329420E, 3963006N WGS84). Note: WGS-84 and NAD83 are virtually identical for our purposes. The circular depression surrounded almost entirely by a small hill (200m is diameter) is contained within an approximately rectangular area surrounded by a depression. The north, south and west portion of this depression are shown in the figure. The rectangular area is approximately 500m (NS) by 700m (EW). The previous illustrated linear feature is outlined by a black line in the figure above.

Figure 4: ***Linear Feature*** The linear feature to be discussed later in this report shows well is this figure. Several coordinates along the feature are given here.
Two by the green triangles and the third by end of the black arrow.

SBF
Map4



(328664, 3965425)

(329210,3962941)

(329880, 3960543)

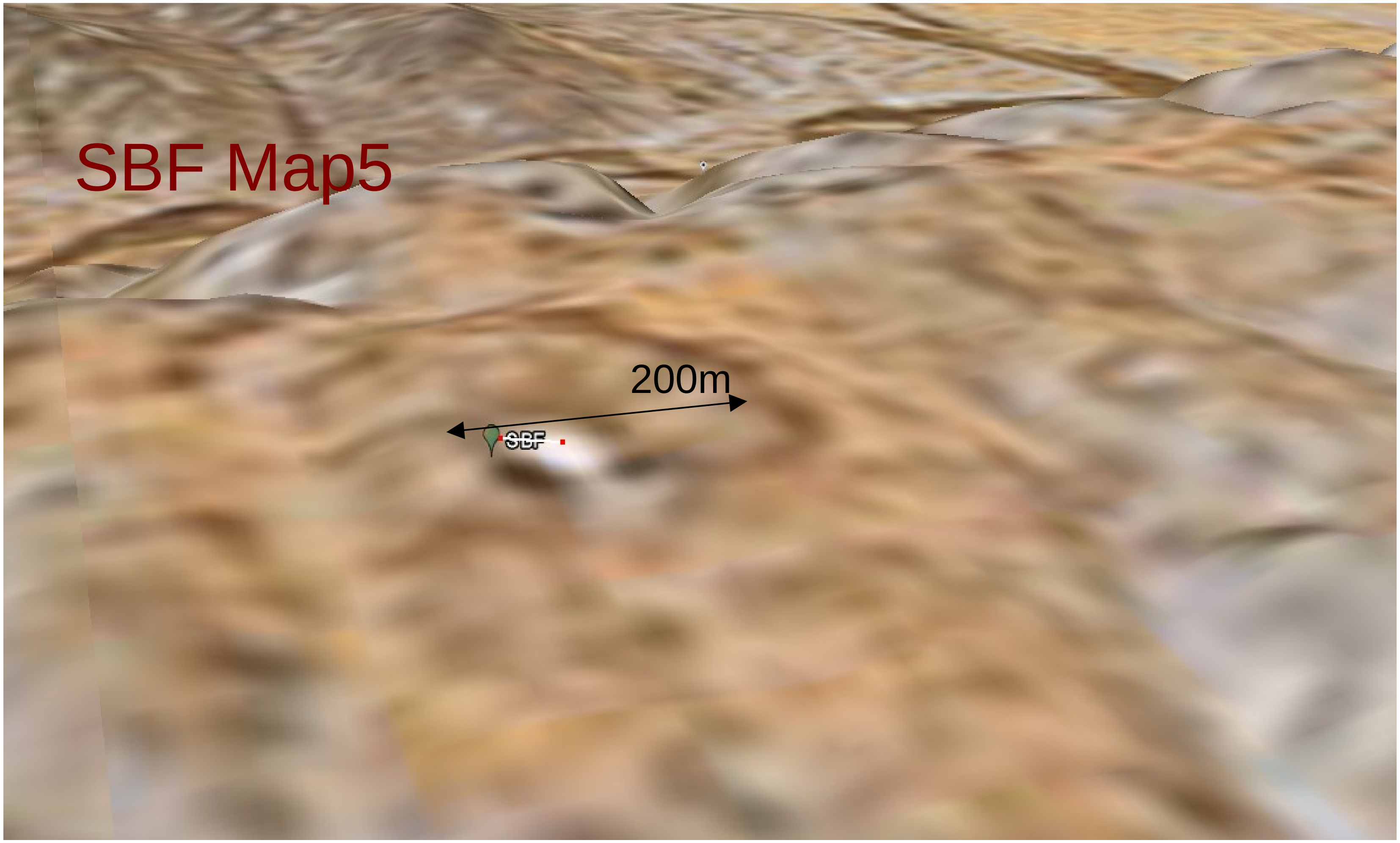
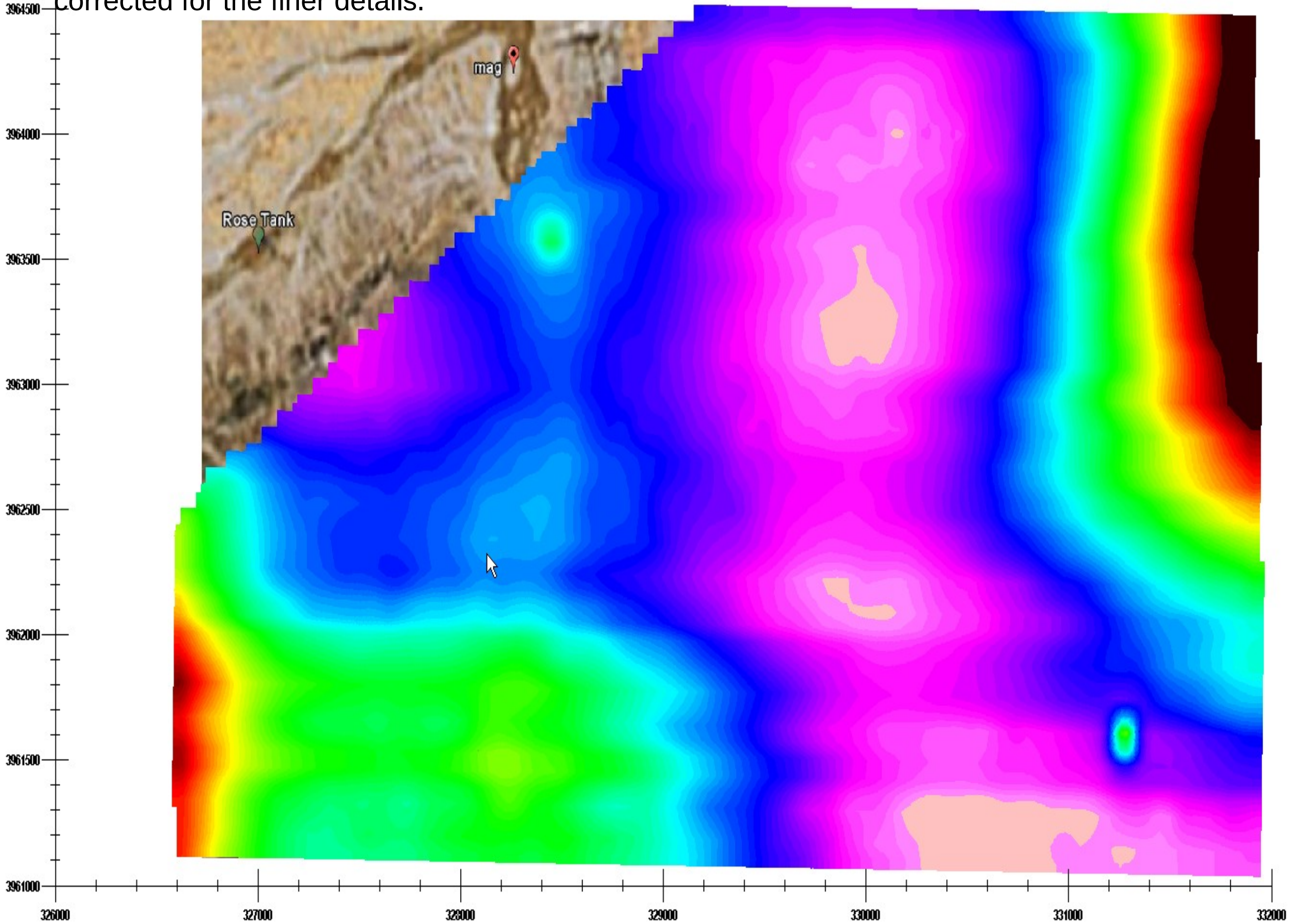


Figure 5: ***<u>SBF from East</u>*** The region around SBF is shown in detail. The green balloon indicates the position of the pipe as previously given to us.
From this position to the centre of the pales circular depression is approximately 50m almost directly to the north. The diameter of the small hill encircling the depression is approximately 200m. One can observe the rectangular depression surrounding this entire area although the eastern edge of this depression is not visible in this figure.

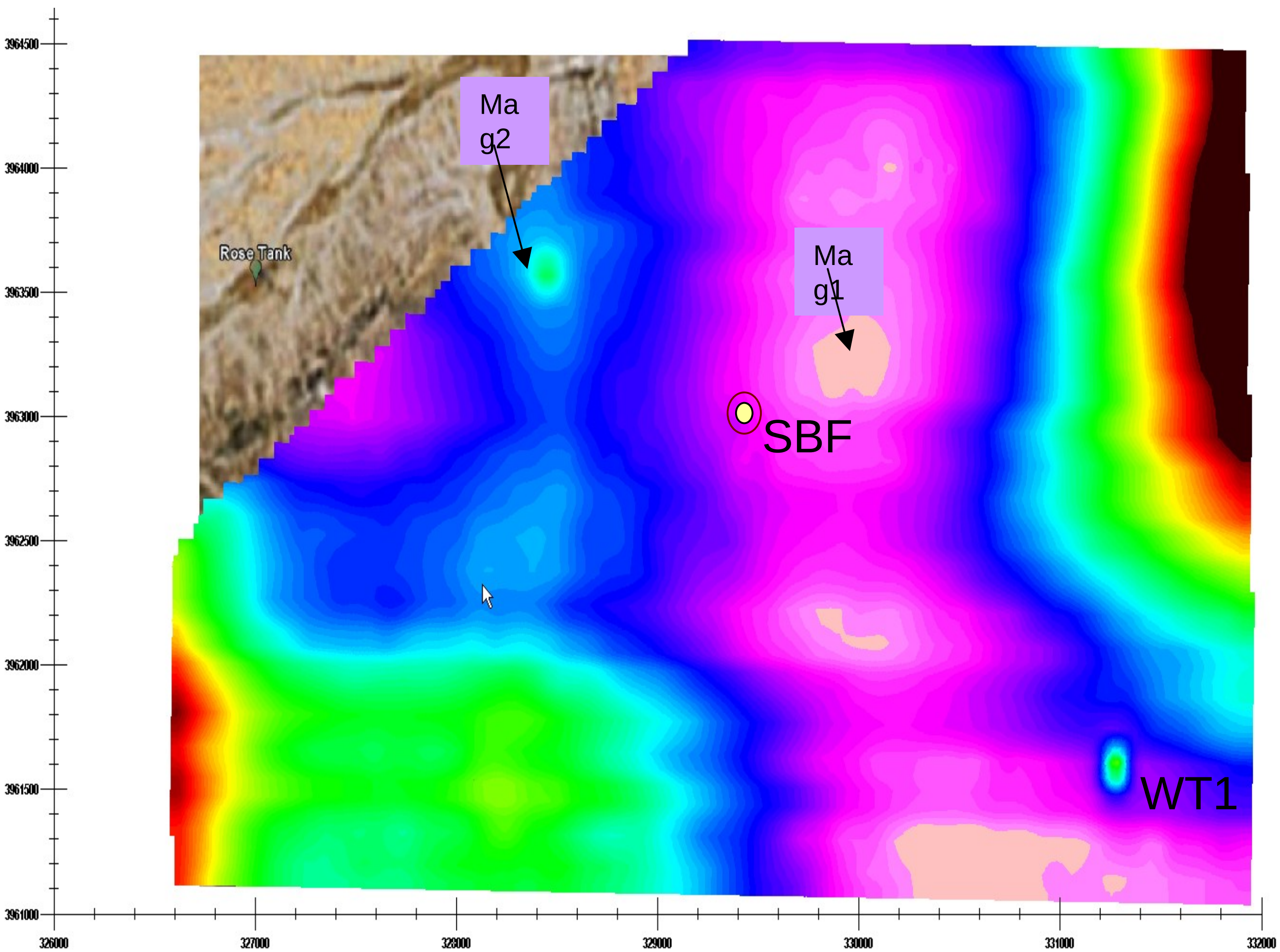
SBF Magnetics 1

Figure 6: ***SBF TMI:*** SBF is very close to the western edge of the VTEM survey lines. The magnetic data from the aerosurvey is not of normal, modern standards. The instrument showed flight direction effects as well as instrument drift effects beyond those normally expected. While, the major aspects of these problems have been corrected in the cut-outs of the regions around the pipes, the entire survey has not been corrected for the major faults in the data and none of the data has been corrected for the finer details.

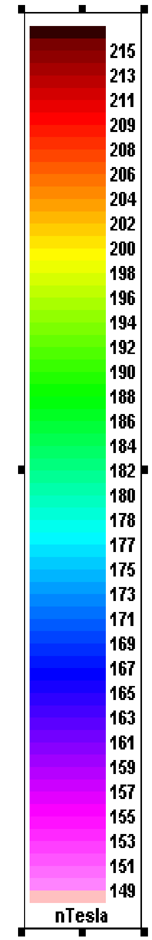


SBF Magnetics 2

Figure 7: ***SBF TMI:*** The figure below shows the TMI (total magnetic intensity) for a region about 5km by 3km about the SBF pipe. The figure below shows the TMI with the principle regional gradient removed.

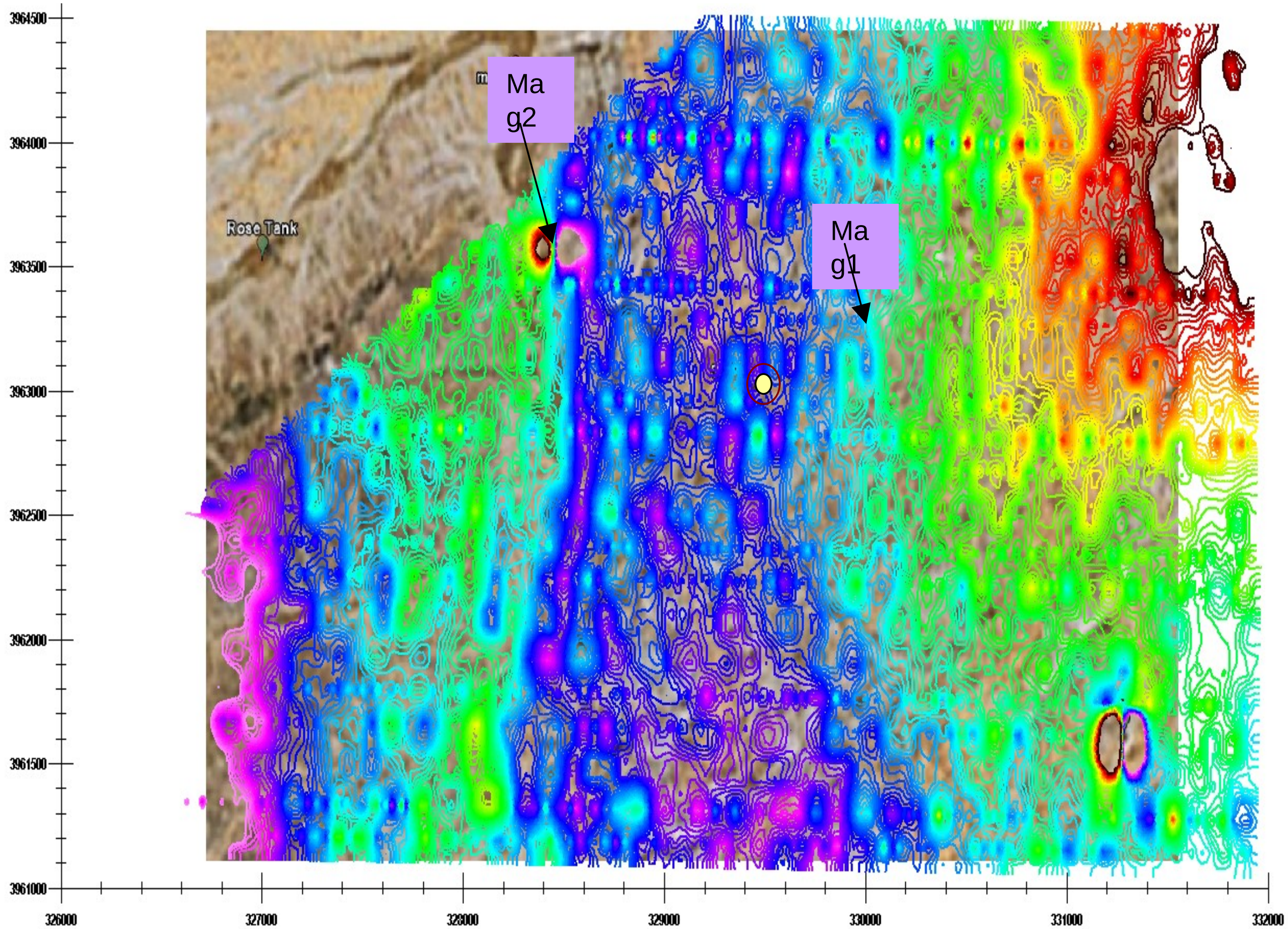


WT1 shows distinctly as a high magnetic response but there is an additional relatively strong magnetic positive anomaly shown as Mag2 along the wash to the NW of SBF. Generally, there appears a long NS low (pink) running down along 330000E. There is a 200m magnetic anomaly low just to the NE of SBF (Mag1) and additionally 2 other weak anomalies identified centrally to the map. One anomaly is a weak high south of Mag2, another a weak low south of Mag1



SBF
Magnetics 3

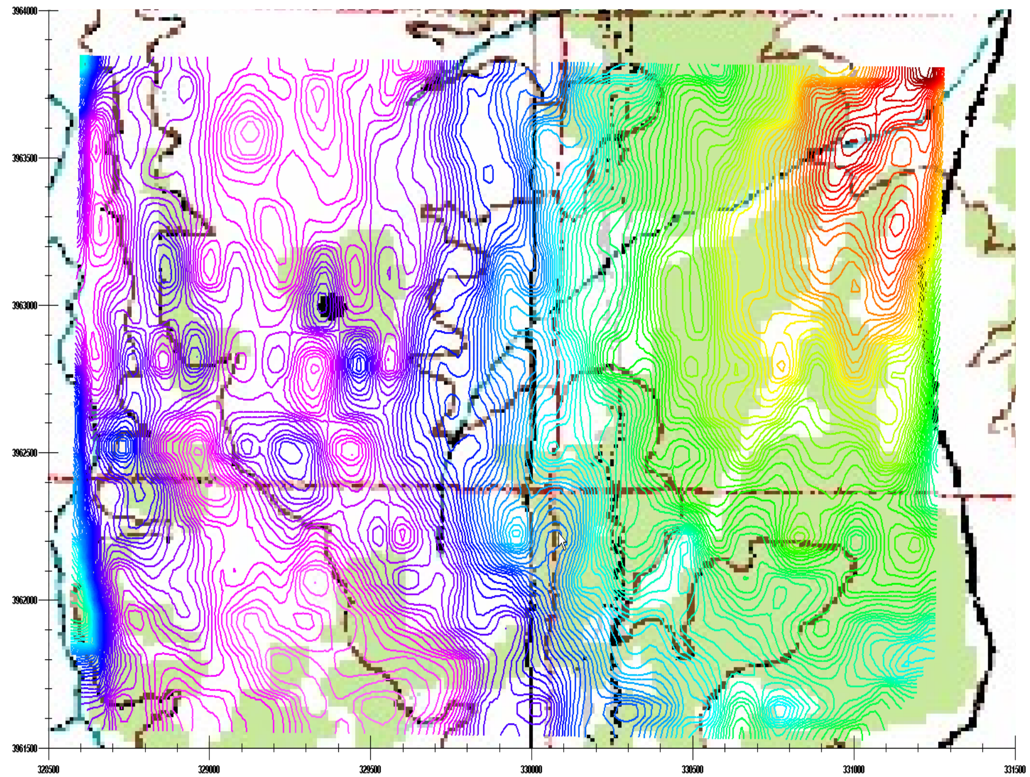
Figure 8: ***SBF Horizontal Derivative of TMI:*** The figure below shows the TMI (total magnetic intensity) variation along the flight direction (Horizontal derivative). This derivative is a processed derivative and not a measured derivative.



WT1 and Mag2 show distinctly from this figure. There is a long linear trend following generally the wash which flows along the bottom of the hill. Some of the weakness can be seen in the data by the line of dots running along 3964000N as well as the dots running EW just below SBF. These are weaknesses in the data. However, there appears a series of anomalies along the broad NS low in which Mag1 lies and there appears the slight hint of an anomaly around SBF.

SBF
Magnetics 4

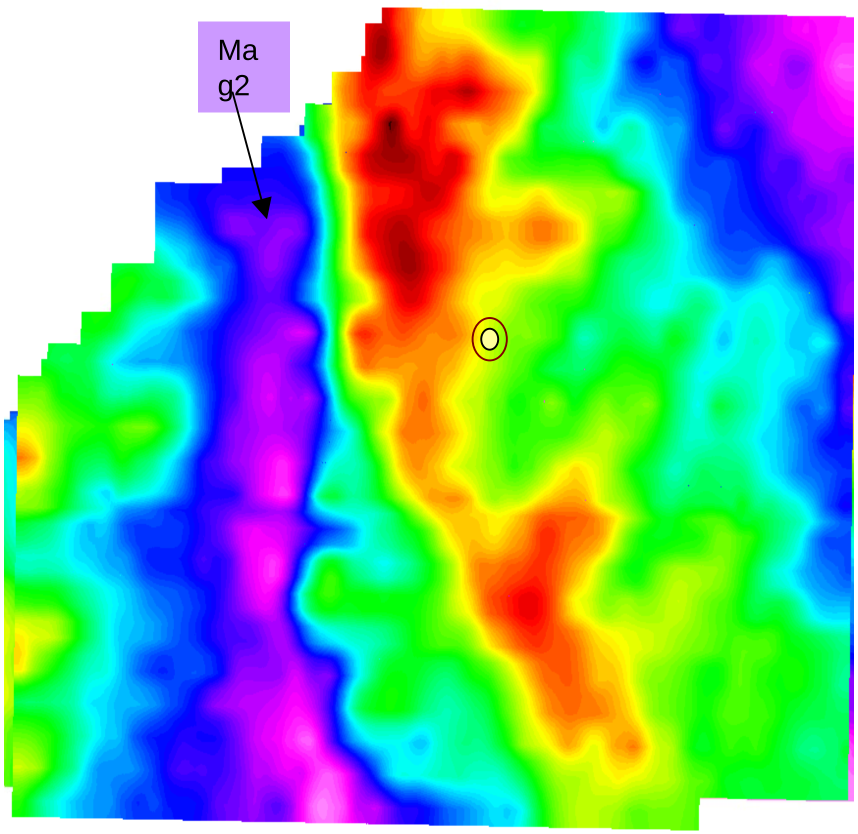
Figure 9: ***<u>SBF Local Horizontal Derivative of TMI:</u>*** The figure below shows the TMI (total magnetic intensity) variation in an area very local to SBF (large black dot). The map underlain is the digital topography map available from the state of Arizona.



Although, there is some subtle anomalous features in the area of SBF. The quality of the data even with enhanced processing is such that there can be, in our opinion, no certainty of identifying a magnetic anomaly immediately around SBF. However, the detailed processing did make the anomaly low just 500m to the NE of SBF an almost certainty. (previous map)

SBF Topography

Figure 10: ***SBF Topography:*** This figure shows a local model of the DTM that is derived from data of the airborne survey. These channels are the GPS elevation channel and the altimeter channel. This DTM model agrees reasonably well with Google Earth considering the DTM is derived from very different data types. There is an abrupt elevation change to the east of the wash and then SBF pipe is seen to be on the edge of the highest elevated structure in the area.



Note: Mag2 is positioned at the location of a local minimum in the digital elevation model.

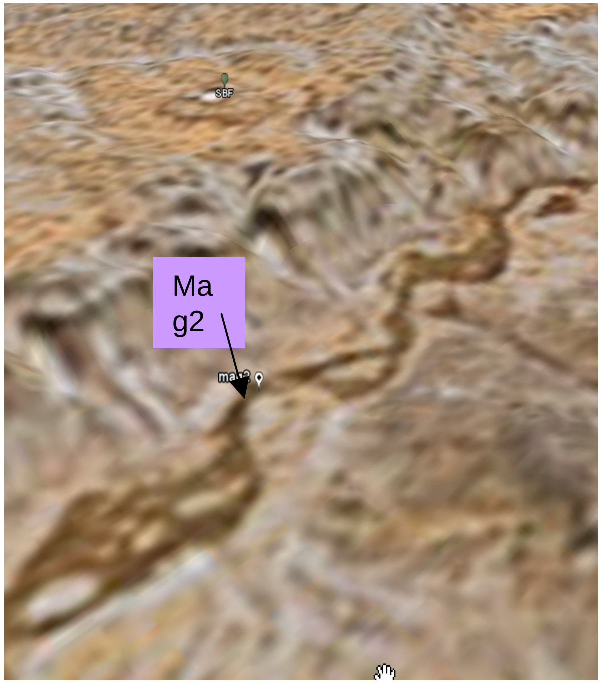
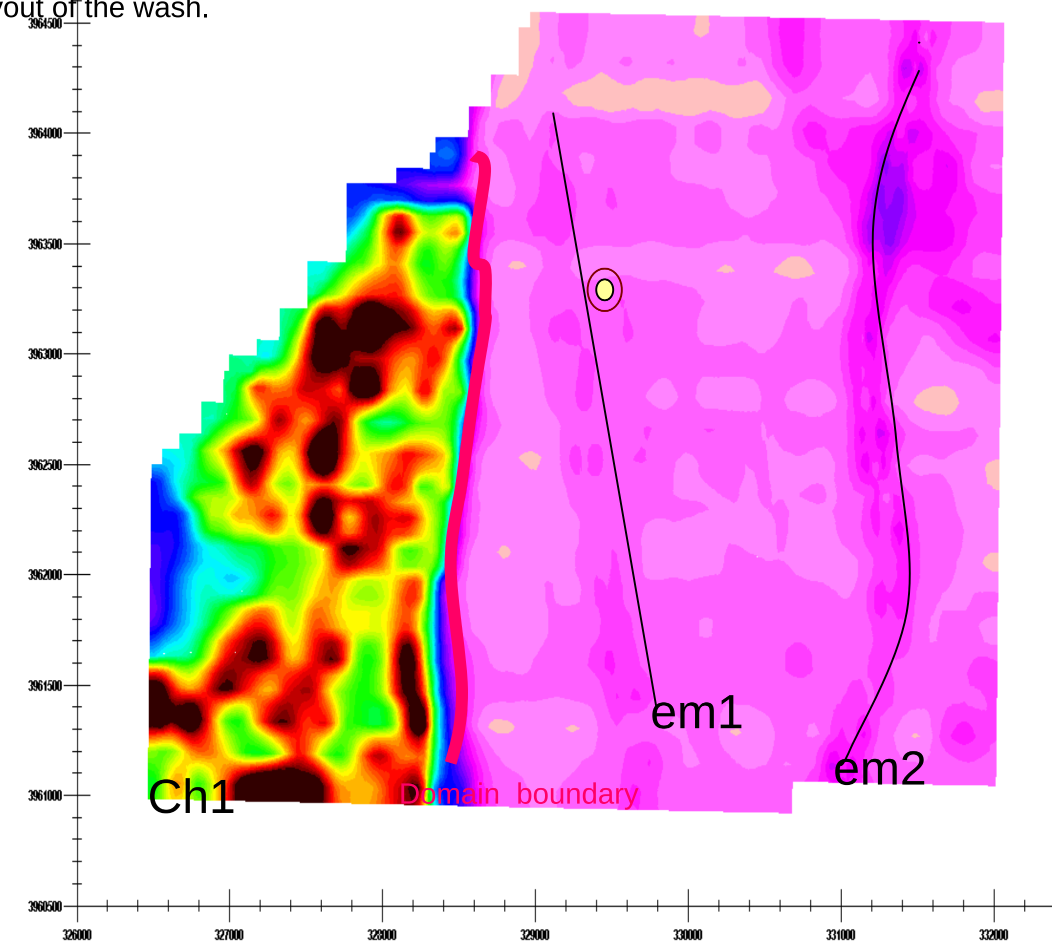


Fig 11: View of Mag2 from the NW.

SBF EM1

Figure 12: ***Early Time EM:*** The figure shows the early time (generally due to shallow structure) EM response from the VTEM (airborne EM) survey. The response shows the change between dramatically different environments on the west to the east. The early time response to the west of the domain boundary is much larger than to the east. This indicates that the surface material down to some depth is significantly different to the west than on the east. The resistivity depth structure has not been investigated for this report. However, such electrical changes are normally indicative of faulting.

The boundary of these domains primarily follows roughly the topographic shift to higher elevations along the NS hill but this boundary does not follow the topography in the southern portion of this area as will be shown later. However, it does roughly follow the layout of the wash.

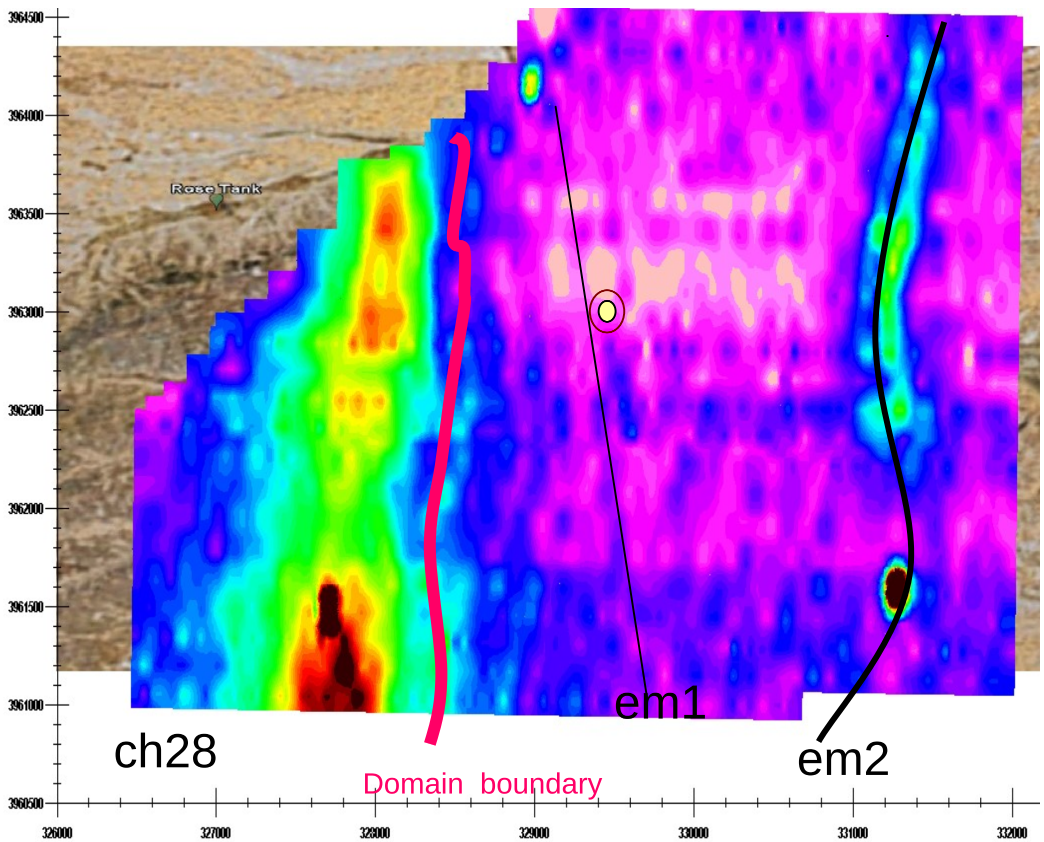


In addition to the NS boundary between the two different domains, there appears a linear EM anomalies in the eastern domain. One of these anomalies (em1) lies close to SBF and will be studied further. This EM anomaly is very unusual in any geological environment but particularly in this portion of Arizona.

EM1 AND EM2 ARE MOST LIKELY AQUIDUCTS

SBF EM5

Figure 16: ***<u>Late-Time EM:</u>*** The figure shows the late time (greatest depths) EM response from the VTEM (airborne EM) survey with a registered map produced from Google Earth. The surficial domain boundary as shown by the early time EM response is marked in red.



The high response west of the surficial domain boundary appears more like a valley at late time.

EM2 stands out more prominently at late time and this indicates a conducting anomaly even more so than EM1 which will be discussed more fully later. EM1 was studied in some detail due to its proximity to SBF.

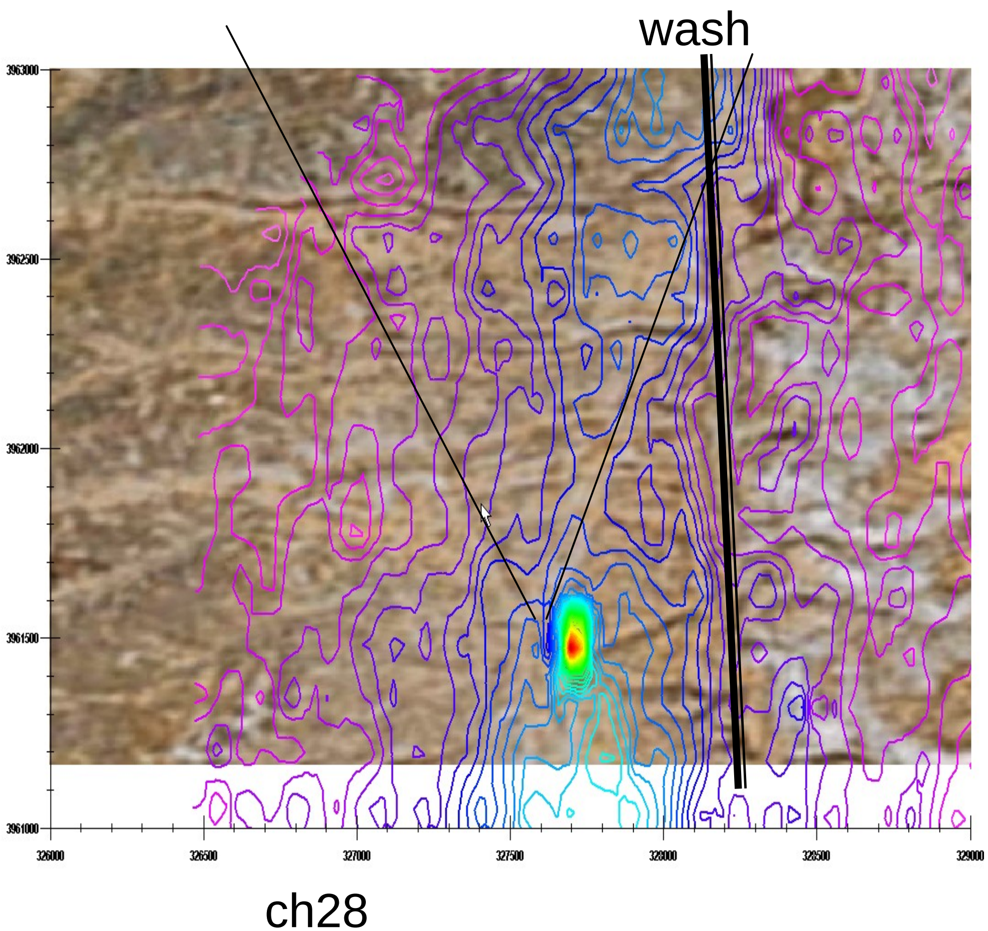
The region around WT1 now appears to have a distinct late-time EM response. While, the strong magnetic response at WT1 indicates a metallic structure at this location, the spatial size of the late time EM anomaly may bear further investigation. Comparison to other metal tank structures may be useful.

At the north of EM1, there appears a circular anomaly not identified by either the magnetic data or early time EM responses. Further study is suggested if this area is of exploration interest.

At the south end of the high response valley to the west of the surficial domain boundary, appear 3 additional EM anomalies. Of particular interest is the most northerly one which is shown in close-up in the next slide. The cluster of 3 at 3962500N is of significance as well as the more northerly anomalies.

SBF EM6

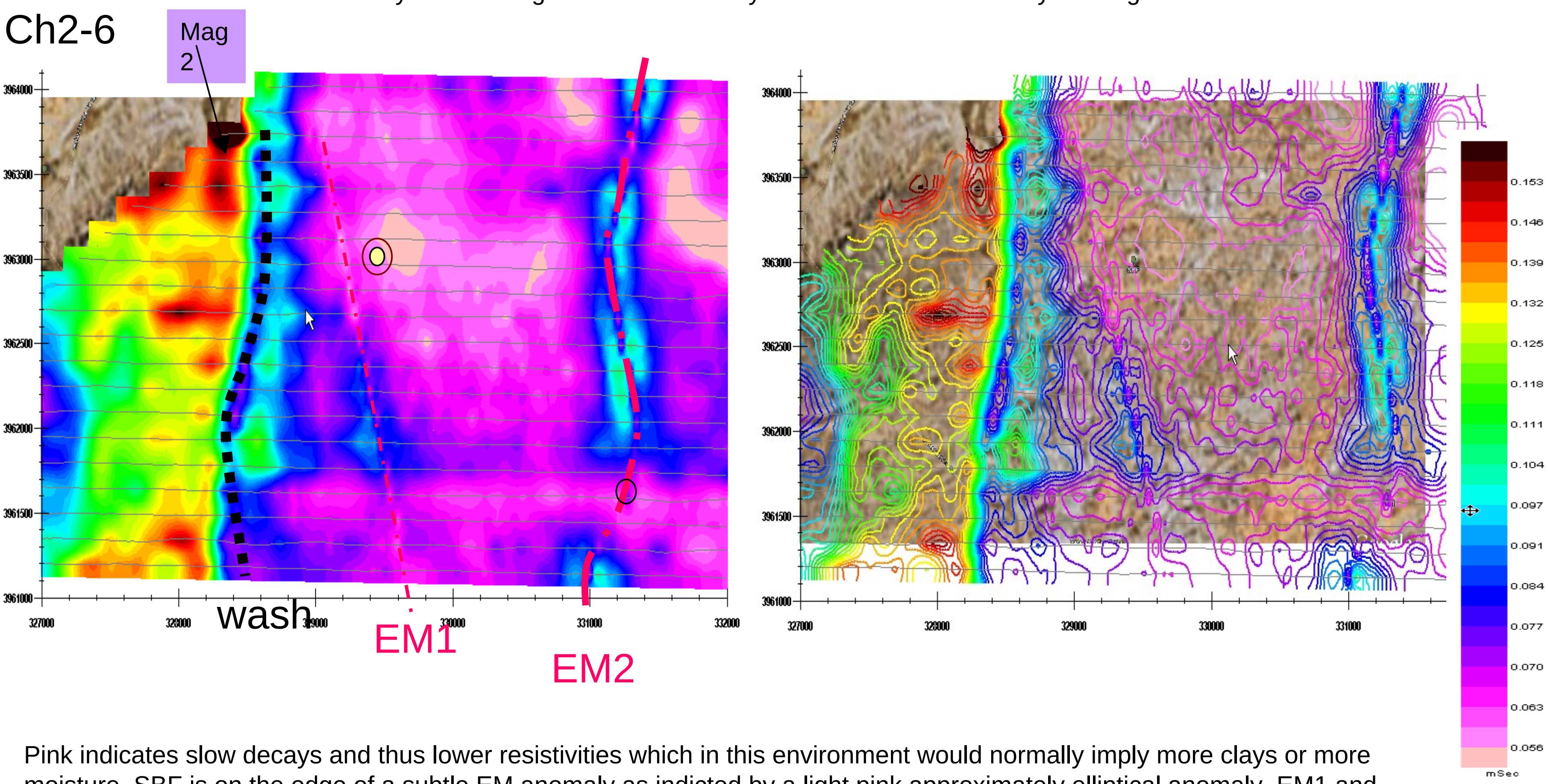
Figure 17: ***Late-Time EM:*** The figure shows the late time (intermediate depths) EM response from the VTEM (airborne EM) survey with a registered map produced from Google Earth in the vicinity of the anomaly identified within the conducting valley.



The anomaly response mentioned on page 16 is quite distinct at this late time and appears to be at the intersection of 2 linear features appearing in the Google map.

SBF Decay Rate1

Figure 18: ***Early-Time Decay EM:*** The figure shows the decay rate of the VTEM data during early time gates (depths to about 100m).
The transmitter mounted in the airborne system induces currents to flow in the ground. The currents eventually decay to noise. The slower the rate of decay then the higher the conductivity or the lower the resistivity of the ground.

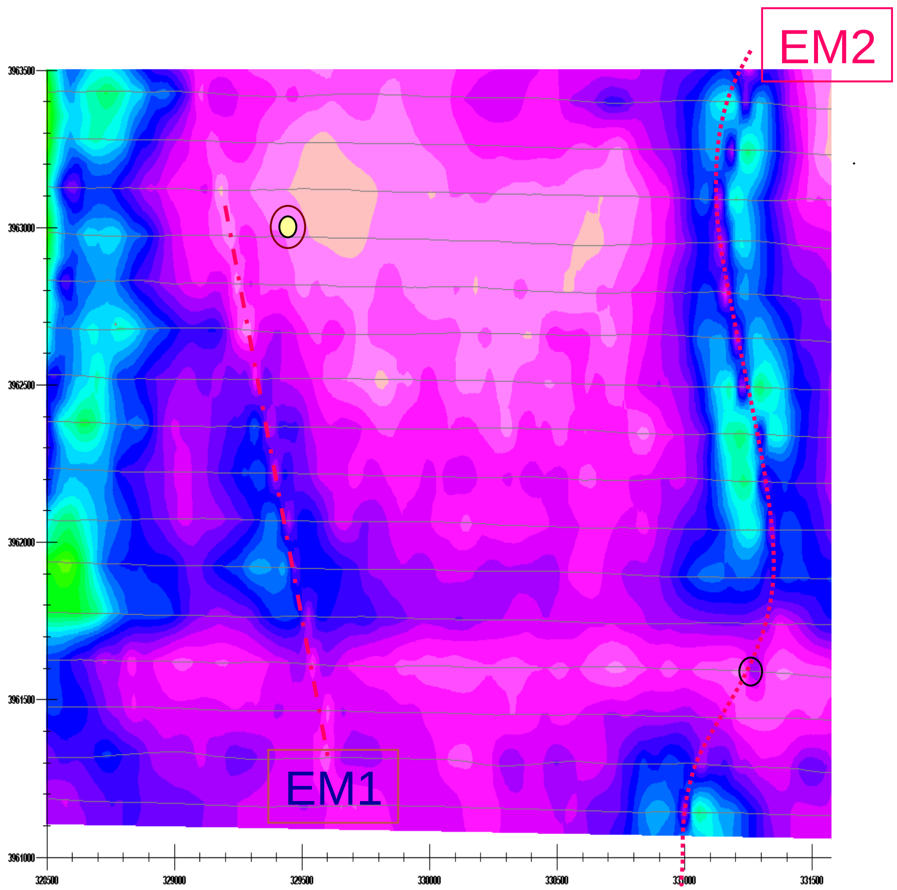


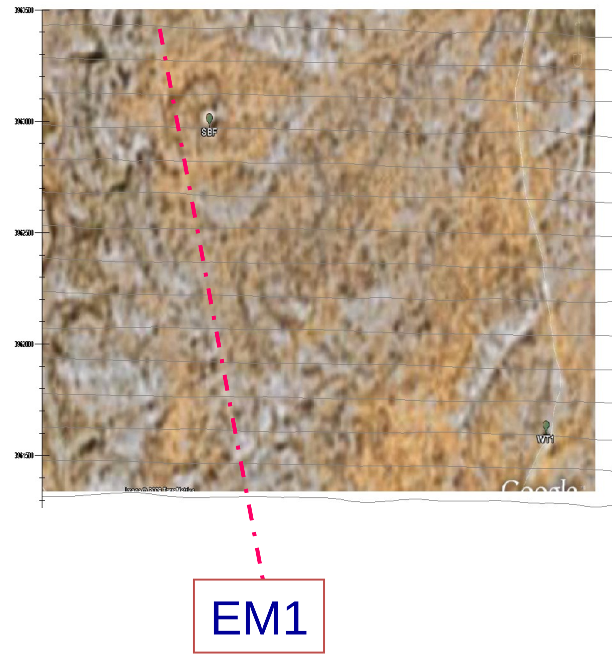
Pink indicates slow decays and thus lower resistivities which in this environment would normally imply more clays or more moisture. SBF is on the edge of a subtle EM anomaly as indicted by a light pink approximately elliptical anomaly. EM1 and EM2 show up quite clearly in this image. Note that WT1 appears only slightly in this image. There is an EM anomaly very close to the magnetic anomaly (Mag2) but they are not completely coincident. However, this data is right at the end of the flight lines.

SBF Decay Rate2

Figure 19: ***Early-Time Decay EM:*** The figure again shows the decay rate of the VTEM data during early time gates (depths to about 100m) as in the previous figure. However, here we show a close-up of EM1, EM2, SBF, and WT1.

Ch2-6

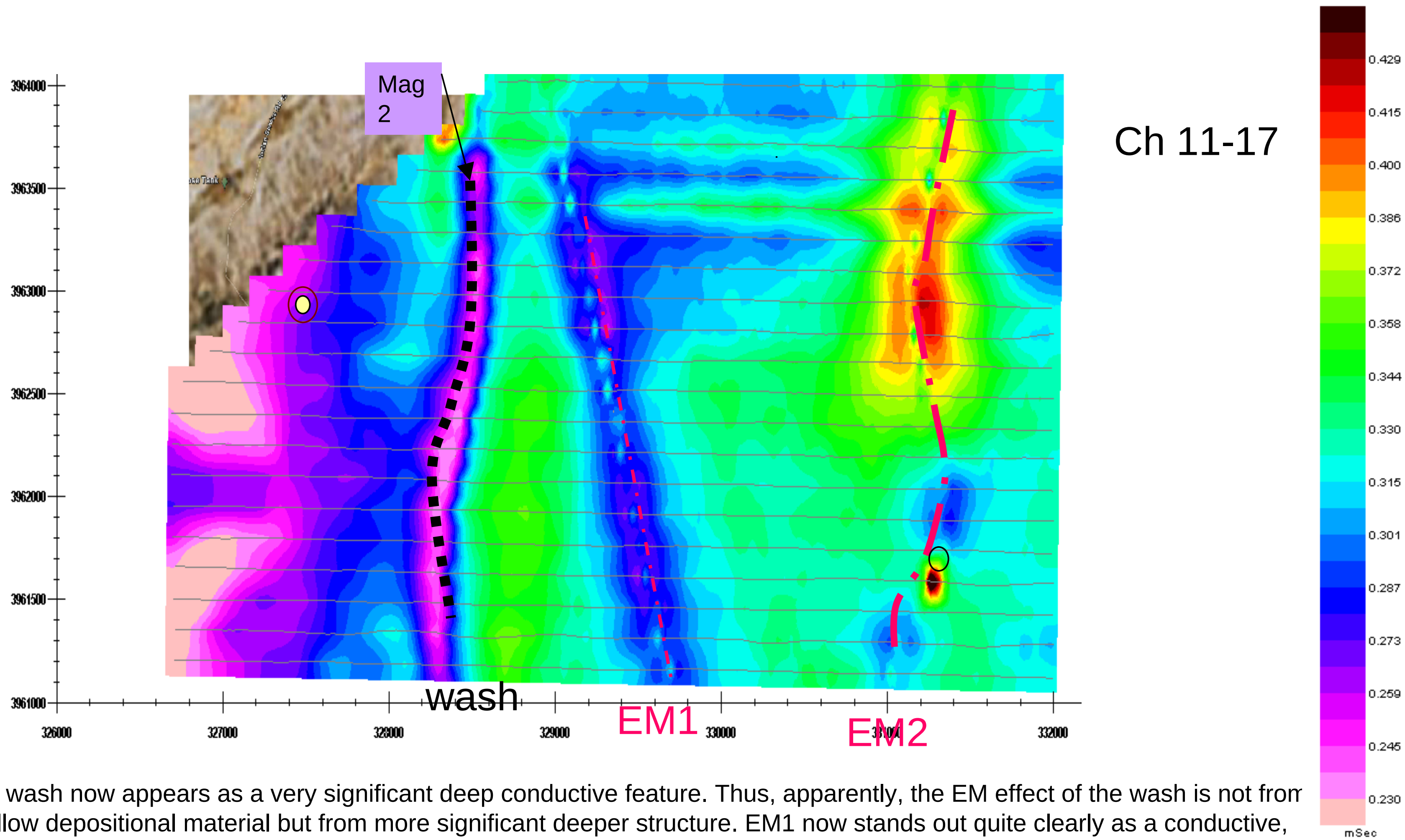




The EM1 anomaly follows very closely to a linear feature which appears in the Google satellite image. A track service road follows along the EM2 anomaly. The strength of the EM2 anomaly is much stronger than EM1 but has a very similar type of response. As EM1 is close to SBF, we focus more on the nature of the EM1 response. However, the shape of the response indicates quite clearly a near vertical dipping structure as does EM2. Thus while the service road is consistent with the outline of the EM2 anomaly, the service road, itself, cannot be the reason for the anomalous EM response (EM2).

SBF Decay Rate3

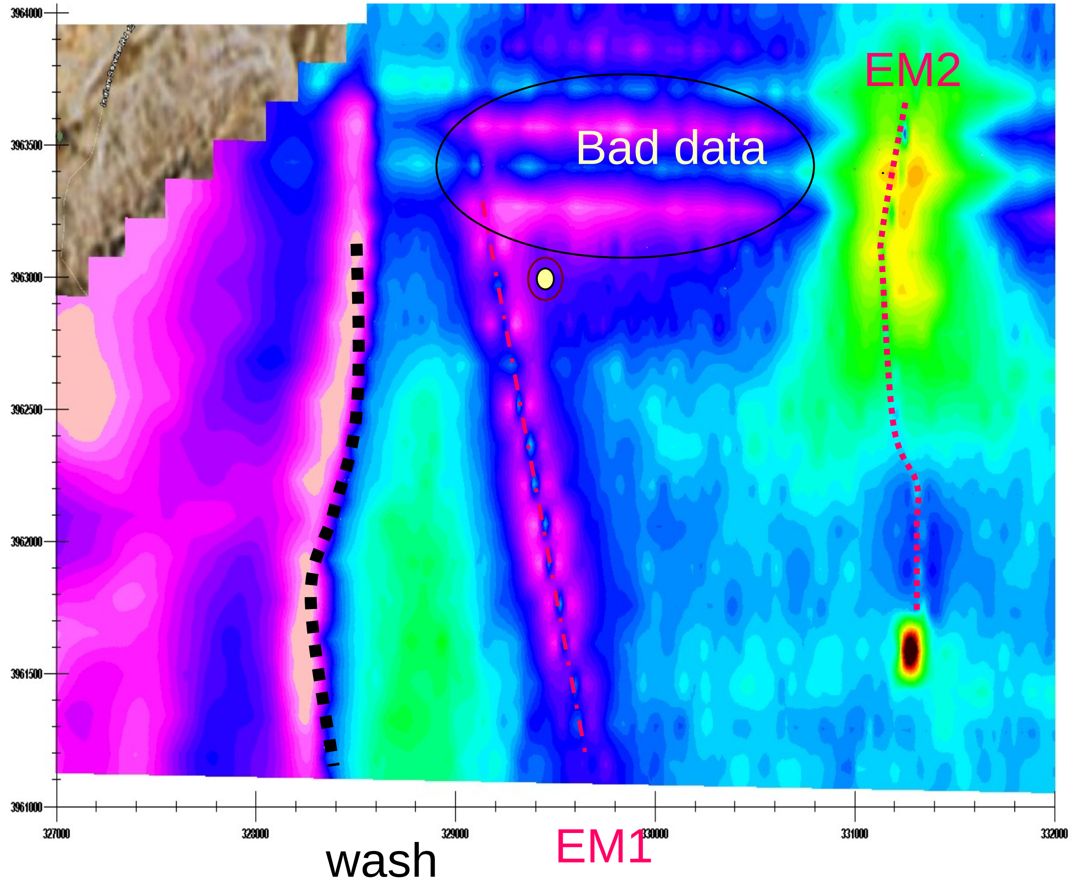
Figure 20: ***Mid-Time Decay EM:*** The figure shows the decay rate of the VTEM data during mid- time gates (depths greater than 200m).



The wash now appears as a very significant deep conductive feature. Thus, apparently, the EM effect of the wash is not from shallow depositional material but from more significant deeper structure. EM1 now stands out quite clearly as a conductive, linear features. EM2 while still prominent is decaying quite quickly. The meaning of this is not clear to us at this time. WT1 stands out quite strongly at this late time and it is not clear as to whether this is man-made or natural but our opinion is that it is both man-made and natural.

SBF Decay Rate4

Figure 21: ***Late-Time Decay EM:*** The figure shows the decay rate of the VTEM data during late- time gates.



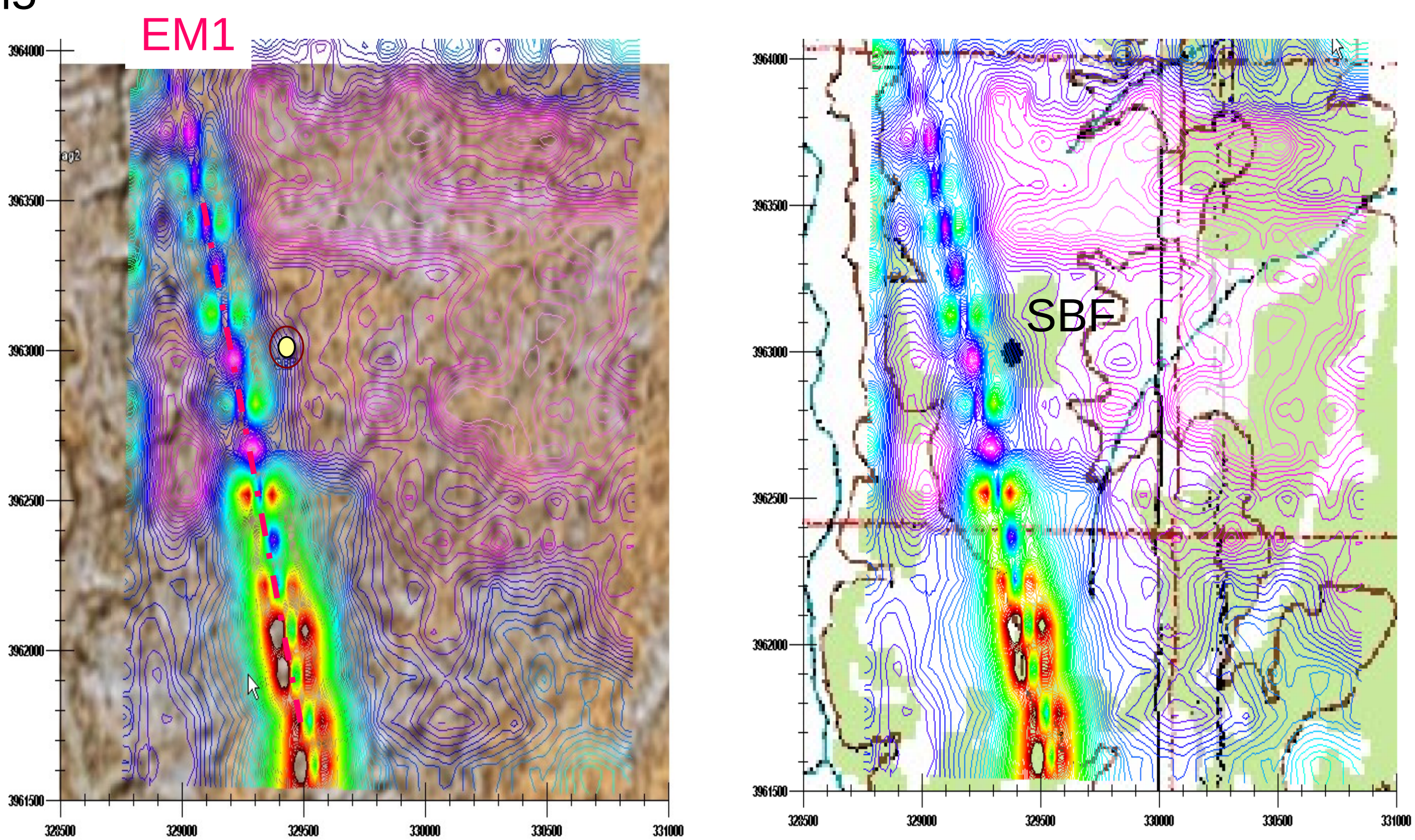
Ch 15-20

The response of the wash area stays strong but is not so continuous and does not follow exactly the wash outline at surface. EM1 appears more significant and EM2 breaks into more distinctive areas. WT1 still appears as a very significant anomaly but is more elongated NS. EM1 although a long feature is made up of several shorter portions of different concentrations of conductive material.

SBF Focus
EM1

Figure 22: ***Late early-time EM:*** The figure shows the the VTEM response at Channel 5 (off time).

Ch5



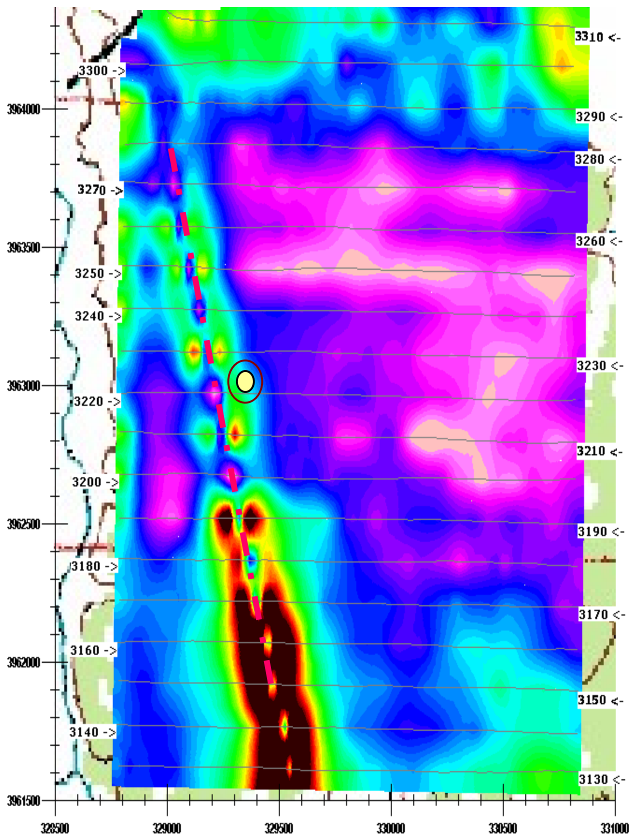
The VTEM Ch5 response (an early time response but slightly deeper) is shown with both the Google satellite image and the state DTM map underlain. The response of the linear conductive feature is quite clear and it can be seen that the response of the linear feature spreads over the SBF feature disturbing what may be a local response.

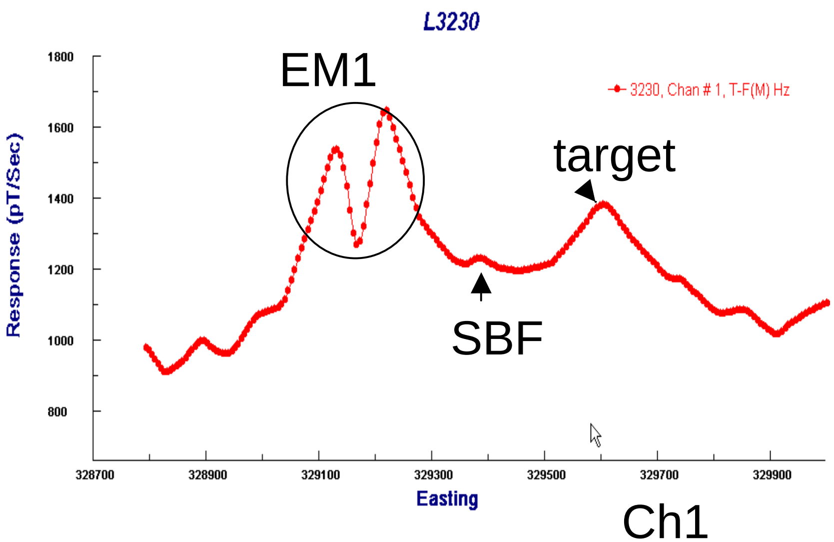
SBF Focus
EM2

Figure 23: ***Late-early time EM:*** The figure shows the the VTEM response at Channel 5 (off time).

Ch5

EM1



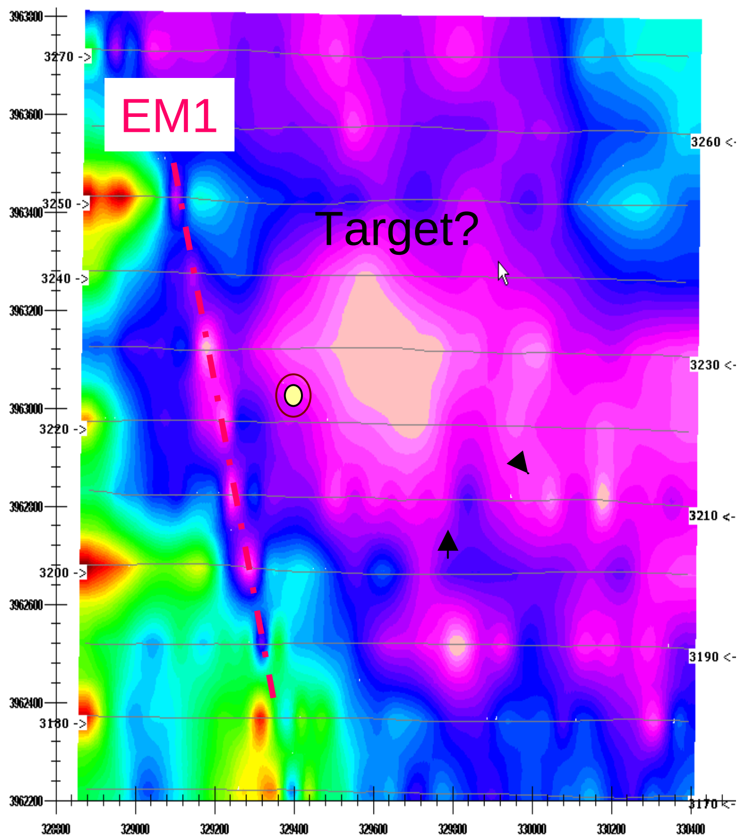


The VTEM Ch5 response shown on the left shows that the EM1 response masks the area of the SBF pipe. On the right is shown the VTEM Ch1 in profile mode. The strength of the EM1 response and its definite vertical dip is obvious. For the system configuration of the VTEM system, a double peak anomaly almost certainly must be a thin vertical structure. There is a slight response near the easting of SBF although this line is slightly north of the determined co-ordinates. There is a larger anomaly slightly to the east at 329600E. The centre of the pink elliptical structure shown in Figure 19 is centered near the anomaly as indicated by the term – "target" in the figure above and to the right.

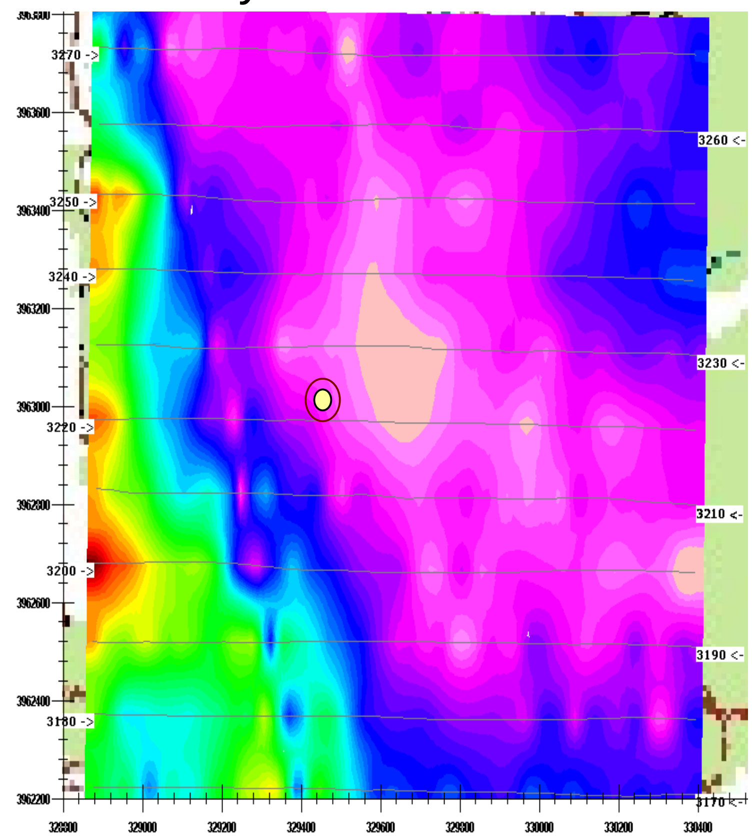
SBF Focus
EM4

Figure 25: ***Late early time EM:*** The figure shows the the VTEM decay responses at the later “early” times.

Decay Channels 2-6



Decay Channels 4-8



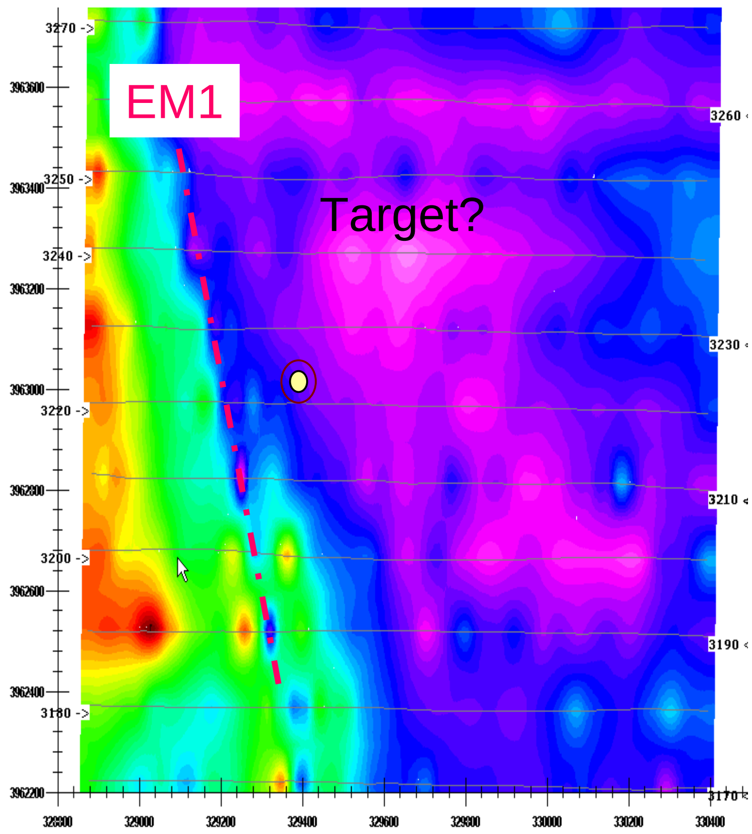
On page 23 we showed that there is a distinct anomalous response along L3230 just east of the location of SBF. Here, maps of early time decays are shown. There is an area of low decay response to the east of SBF and covering 3 flight lines. An area of low decay rates indicates a region of higher conductivity (lower resistivity) such as would be caused by a thickened Moenkopi. As shown in the previous figure, there is only a tiny response at the location given to us of SBF but a much more significant anomaly less than 200m to the east. The small anomaly at SBF disappears by Ch2 but the anomaly at 329600E continues to late channels.

SBF Focus

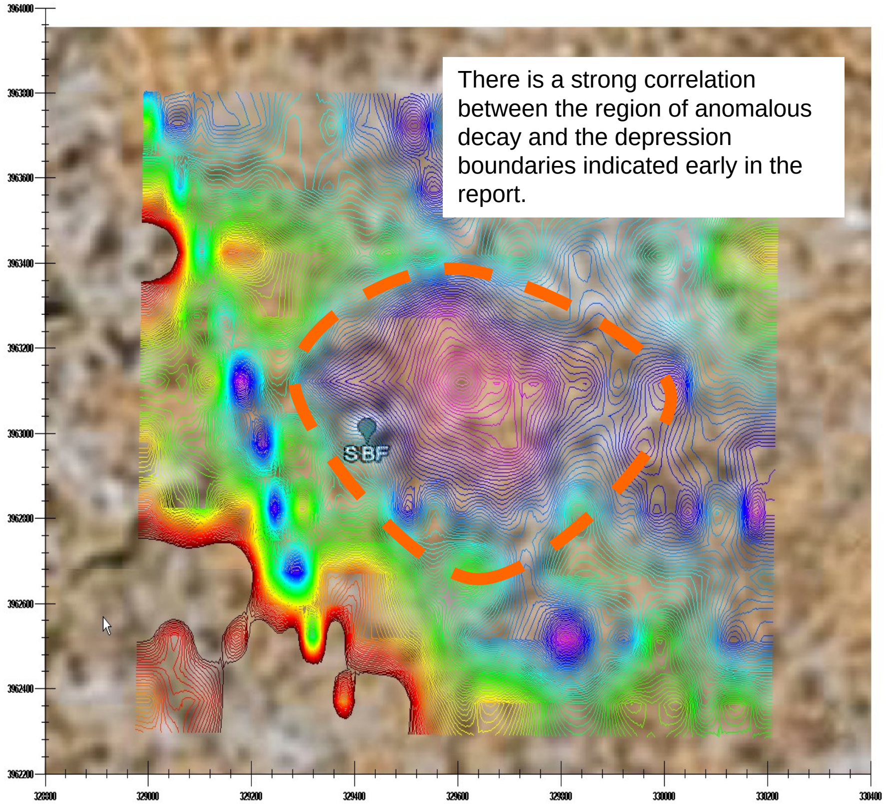
EM5

Figure 26: ***Late early time EM:*** The figure shows the the VTEM decay responses at somewhat later early-times.

Decay Channels 5-9



Decay Channels 2-6



Progressing slightly later in time, the anomaly at 329600E is much less clear. However, it should be noted that the data in the area around SBF is strongly affected by the response of EM1. EM responses like this are not point by point measurements of materials at surface and in the subsurface but rather volume measurements. The larger the physical anomaly and the stronger its response then the more widespread is the area over which the data is affected. Such is the case with the response of the linear target – EM1.

SBF Inversion Studies 1

Figure 27: ***Inversion Studies along 3 lines – L3220, L3230, L3240***.

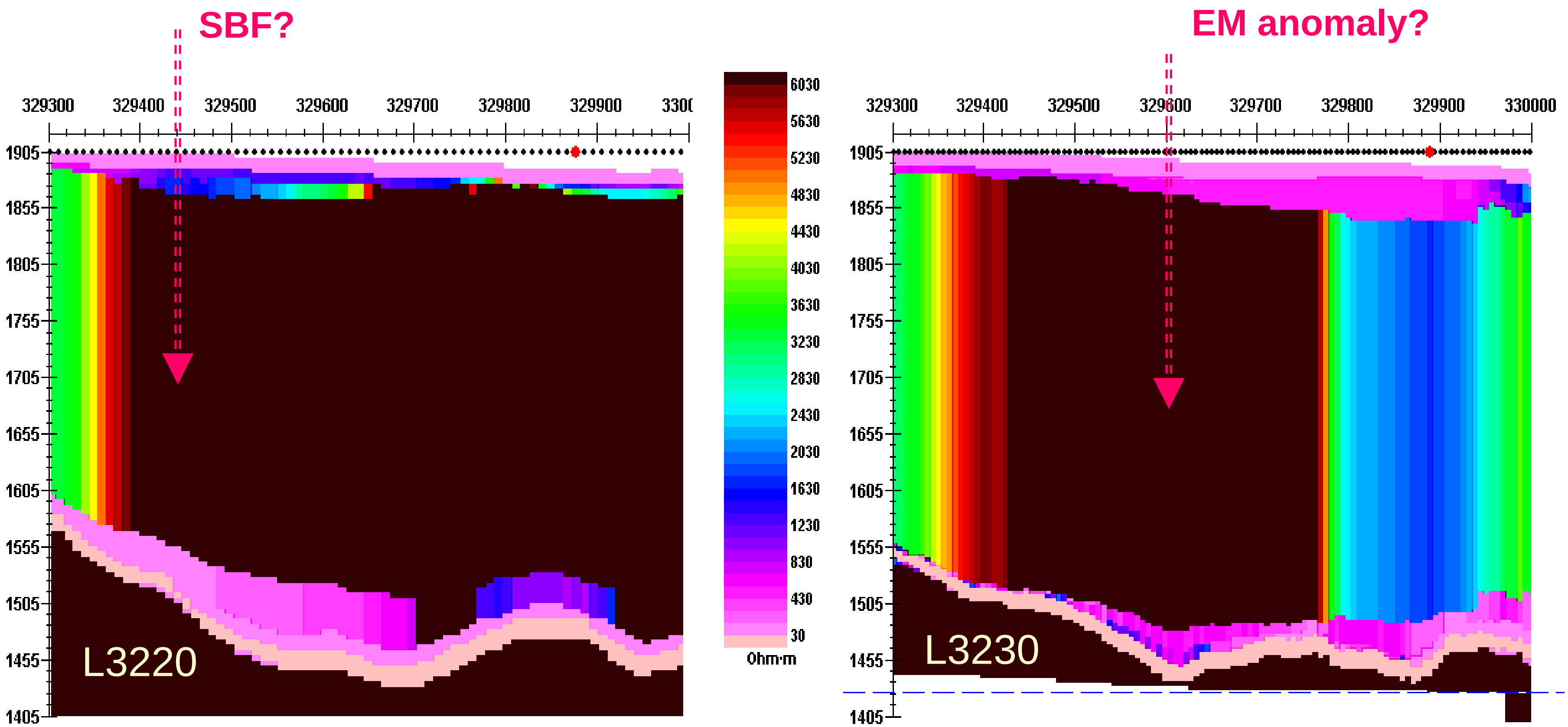
Survey Lines with Google Map

EM1

The flight direction for L3220 and L3240 was West to East while L3230 was East to West. In the figure above, the black circles represent the average position of every 3 data stacks (measurements). One can see from this as well as other information that the helicopter was moving significantly slower when traveling east to west (almost certainly due to wind speed). Also, likely due to the wind speed the instrument was lower to the ground on the east to west traverses averaging in this area 47m for traverses west to east and 43m for traverses east to west. This height difference is not considered a significant difference for ground resistivity resolution but the slower ground speed would improve data reliability.

SBF Inversion Studies 2

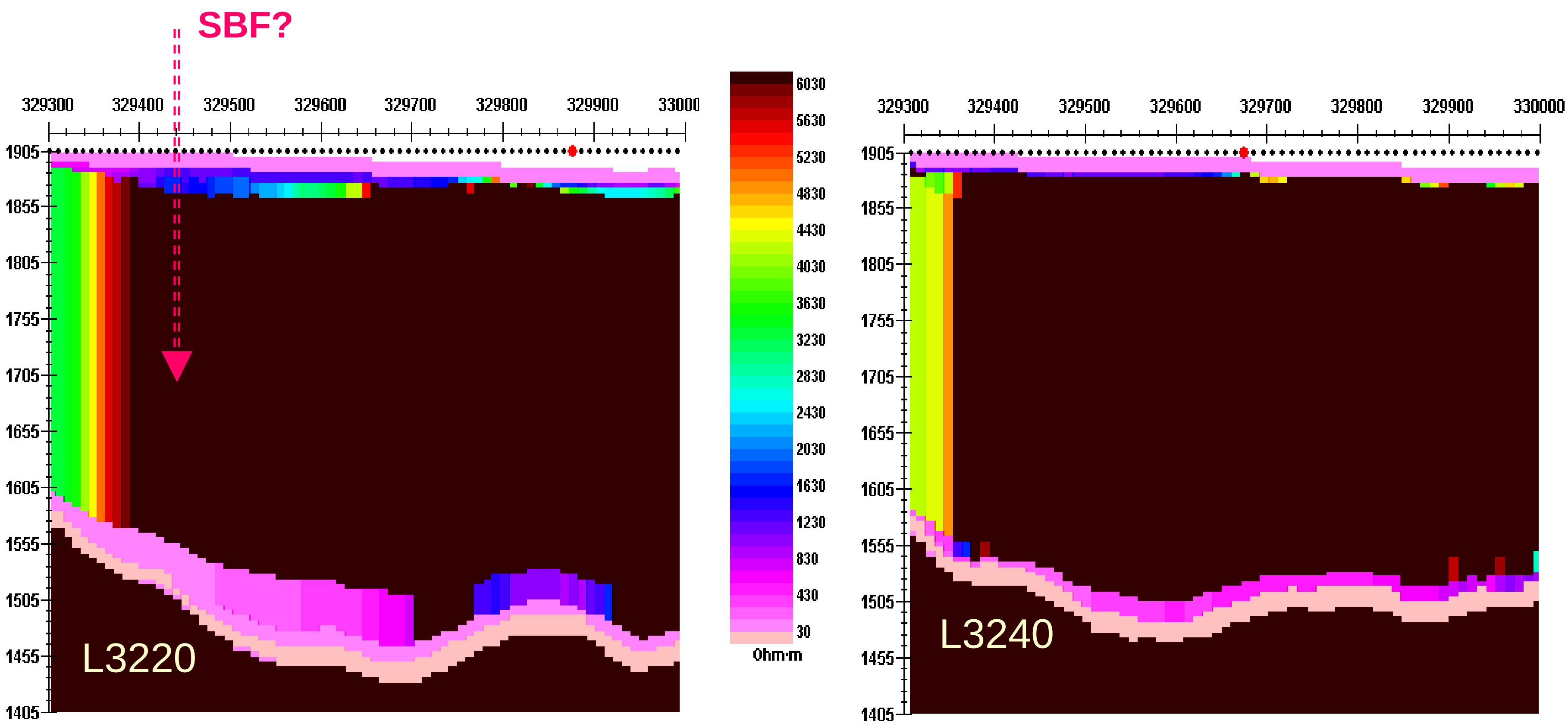
Figure 28: ***Inversion Studies along 3 lines – L3220, L3230, L3240***.



Inversions indicate a modestly conducting cover around 40 ohm-m increasing first to a zone of about 1000 ohm-m and then into a resistive zone. It should be noted that the resistivity of the 3rd zone (greater than 2000 ohm-m) cannot be resolved well which is a general limitation of such data (VTEM configuration over GeoTEM configurations). However, the decreasing resistivity of this zone to the west is consistent from line to line. This may be caused by the effects of the strong EM1 anomaly more to the west. Further studies would be required to determine more precisely. Below the resistive zone is first a zone of decreasing conductivity (approx 500 ohm-m) (bright pinks and blues) and then a thin strong low resistivity zone of about 10 ohm-m or possibly lower. The resistivity of this thin zone is consistent with the resistivity seen for the Coconino north of the Grand Canyon. Below, this thin zone (Coconino?) there is a more resistive zone but this resistivity is poorly resolved due to the data quality of the very late time channels.

SBF Inversion Studies 3

Figure 29: ***Inversion Studies along 3 lines – L3220, L3230, L3240***.



Inversion comparisons for L3220 to L3240. L3240 is approximately 300m north of L3220.

Conclusions

There are several magnetic anomalies in the area but none associated with the SBF pipe.

There is no EM anomaly associated with the location as indicated to us for the SBF pipe. However, there is an EM decay anomaly just slightly to the NE of the given co-ordinates of SBF.

There are 2 strong linear anomalies in the area – EM1 and EM2. Modeling of the EM1 anomaly indicates an extremely conductive target with a conductance often associated with strong VMS targets or strong graphitic anomalies but due to the several aquiducts through the area, it is much more likely that these are the responses of aquiducts.

Recommendations

A visual inspection of the SBF pipe area is recommended with a check of the co-ordinates.

A visual inspection of the linear anomalies , EM1 and EM2 plus more research on possible sources of such a strong conductor.

Ground EM follow-up might be useful on both the SBF pipe and the EM1, EM2 anomalies if these targets are of significant exploration interest.

A follow up on the ground of the magnetic anomalies seen in the area may also be useful.