November/December 2010
Ground Geophysics 1
Warrior Mine Site

Prepared for:
CiTiGOLD Corporation Ltd

Prepared By:
Laura Davis , BSc
Ross Groom, PhD
Petros Eikon Incorporated
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Ground Magnetic Survey
Data Processing and Quality Control

Introduction

Between December 4 and December 13, 2010, ground magnetic data were collected with a Geometrics 859 by Petros Eikon. The purpose was to fill in missing areas from the 2008 ground survey and to also survey further south, west and east of the 2008 survey (e.g., west of Bluff road).

Although UTS airborne data (1999) is available over this area (north-south lines at a 50 m line spacing), it does not have the fine resolution of the ground data due to

1) The altitude of the survey
2) Spatial smoothing filtering performed by the airborne company

Note also that the UTS data over the northeast section of the ground data was required to be flown at an altitude of 300 m, but the remainder of the UTS data was at about 50 m altitude.

Survey

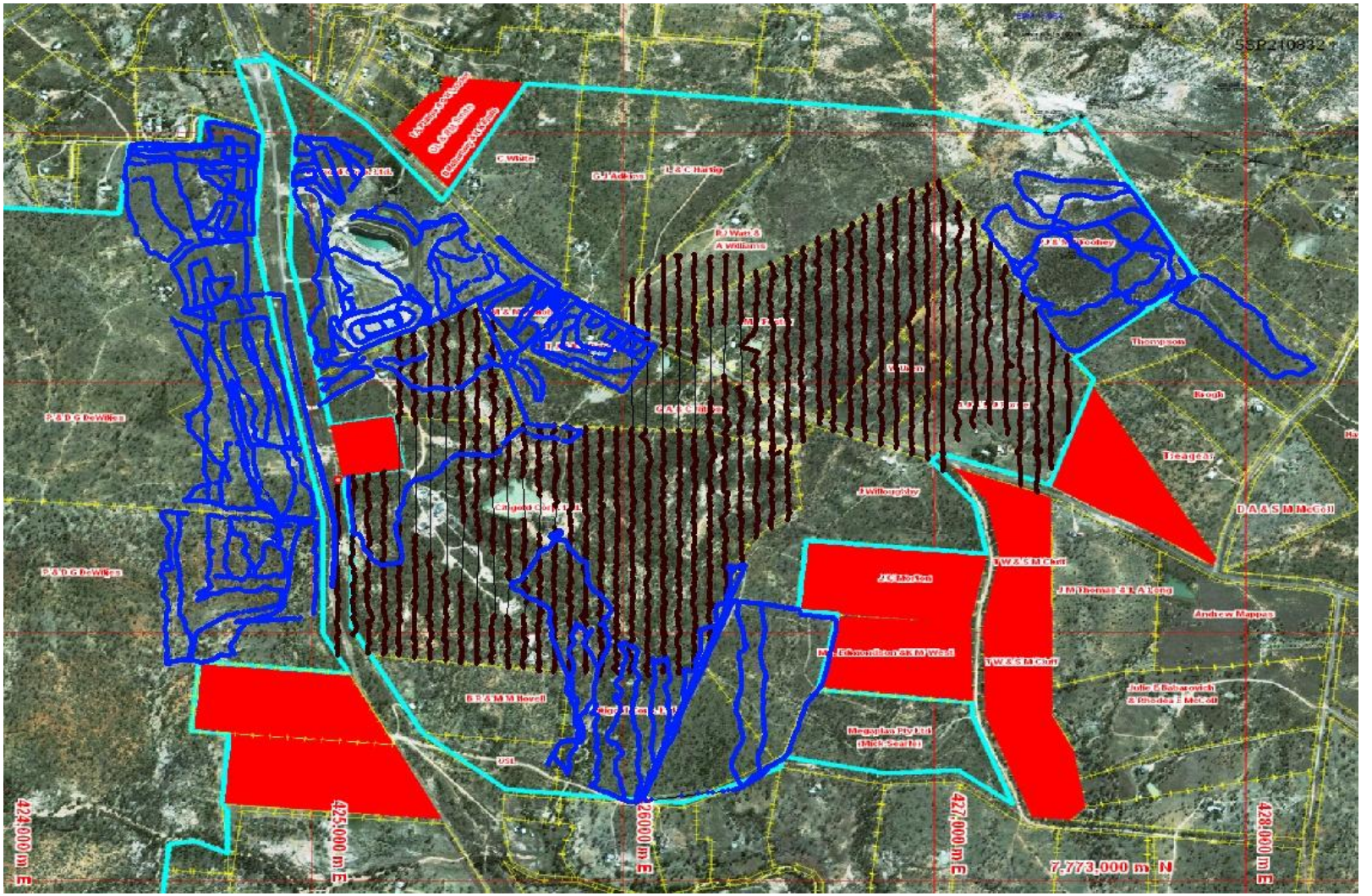


Figure 1: *2008 and 2008 ground magnetic data vs property boundaries*

Property map showing the 2008 ground magnetic lines (black) and 2010 ground magnetic lines (blue).

2010 Survey Issues

1) The Geometrics 859 was rented without a base magnetometer, which limited our ability to perform diurnal and drift corrections.

Typically a base station is placed at a fixed location and the magnetic field is recorded throughout the duration of the ground survey. The background magnetic field varies with time, and with base station data, this variation can be removed from the survey data. This is called a diurnal or daily correction.

Despite the lack of a base station, some diurnal corrections were performed based on calibration loops performed in the survey. The readings at intersections and overlying lines were compared.

2) There were frequent drop-outs (readings of 0 nT) in the data which is an issue with the sensor obtained from the rental company. Some lines contained a significant number of drop outs. Spikes were frequently observed as well. These were removed as the first step in the data processing.

3) The 859 is a so-called walking magnetometer with a built-in GPS; however, the GPS cannot be viewed while operating the instrument. It was difficult for a single operator to navigate straight lines without either picketed grids or a second operator navigating by a handheld GPS unit.

4) Despite these issues, we believe with out exhaustive processing reliable data has been obtained.

2010 Ground Magnetic Processing

Below are the basic processing steps performed on the 2010 ground magnetic data:

1) Spike removal
2) Gaussian filtering
3) Diurnal corrections within a given day, if possible
4) Shift between days where lines overlap
5) Shift to the level of the 2008 data (this shift is required due to the variation in the Earth's magnetic field over the two years).

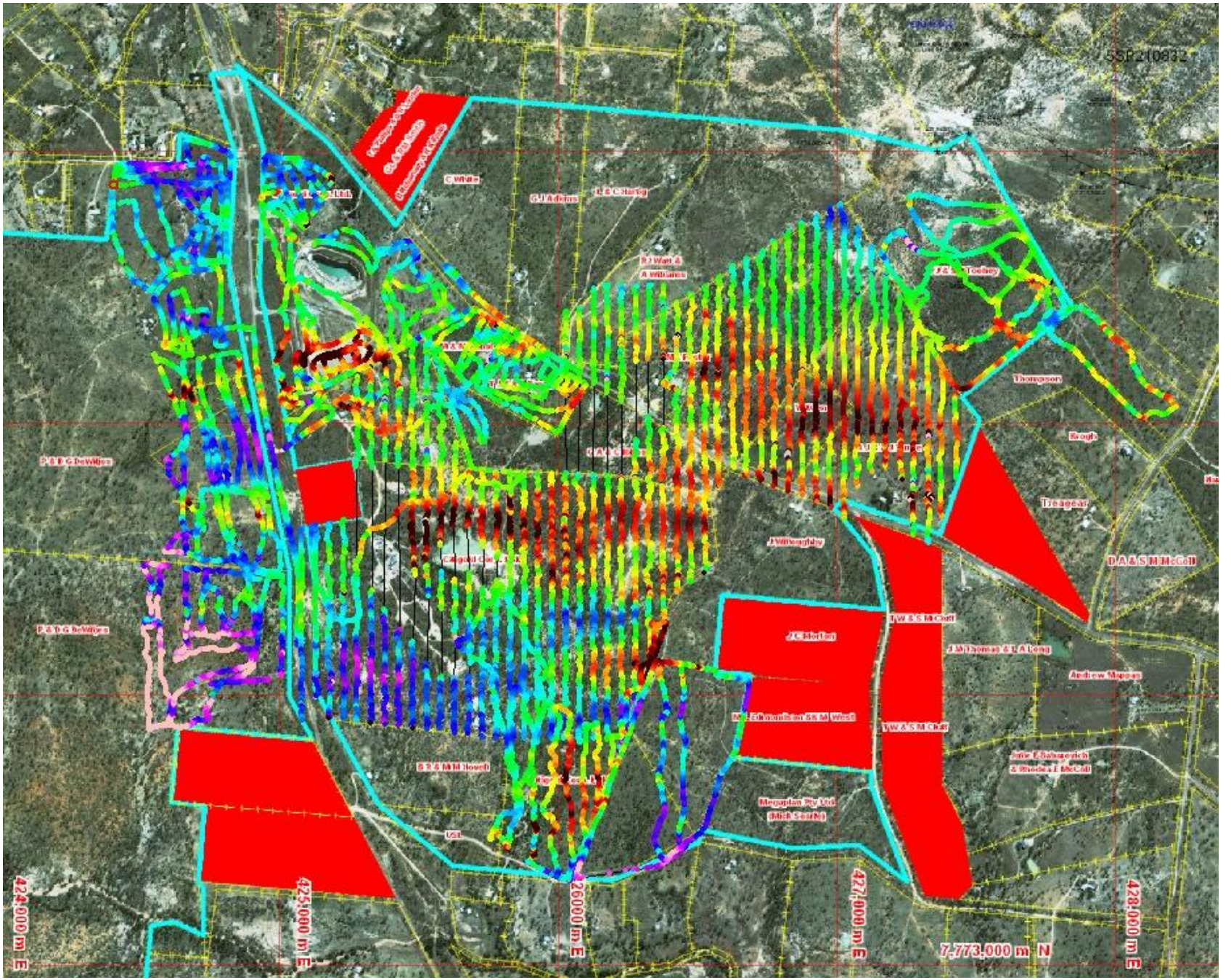
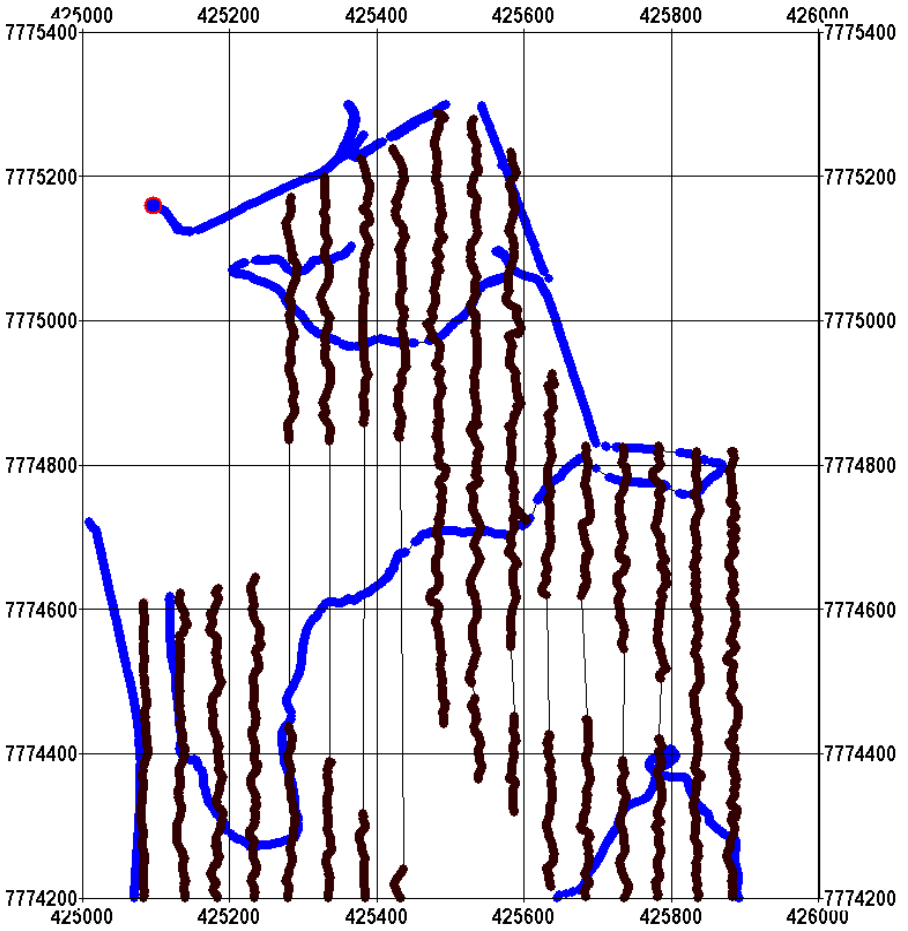


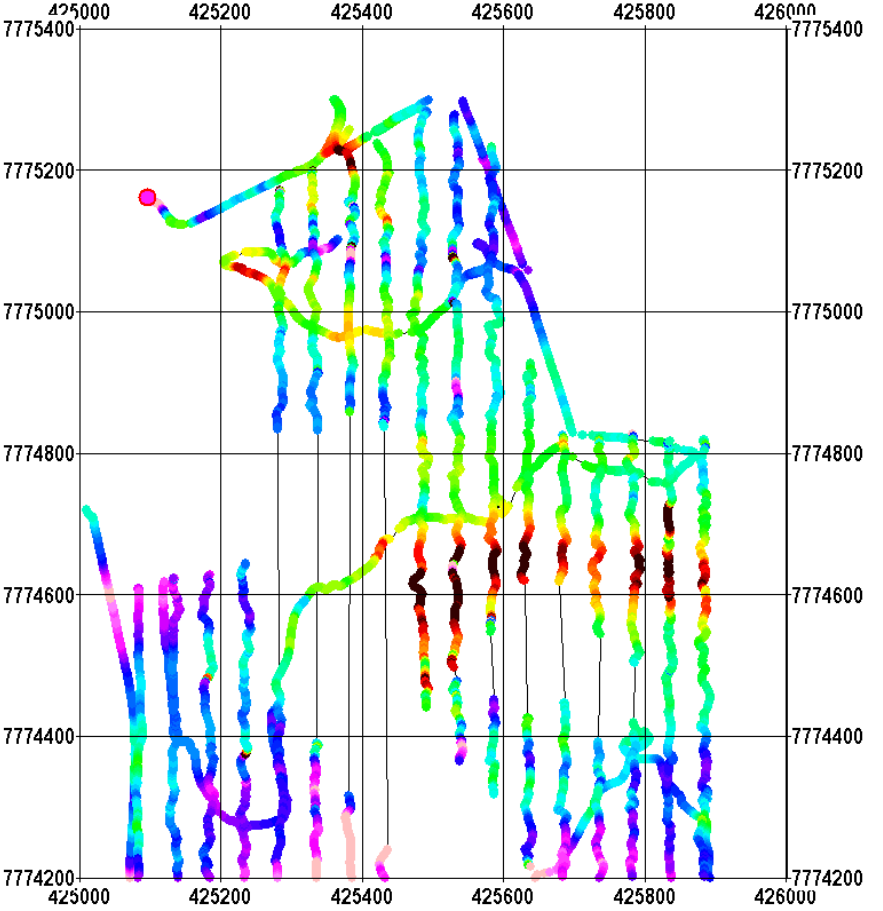
Figure 2: Final Processed 2008/2010 Data

2008/2010 - Northwest

Figure 3: 2008/2010 ground magnetic analyses



Black-2008 lines, Blue-2010 lines

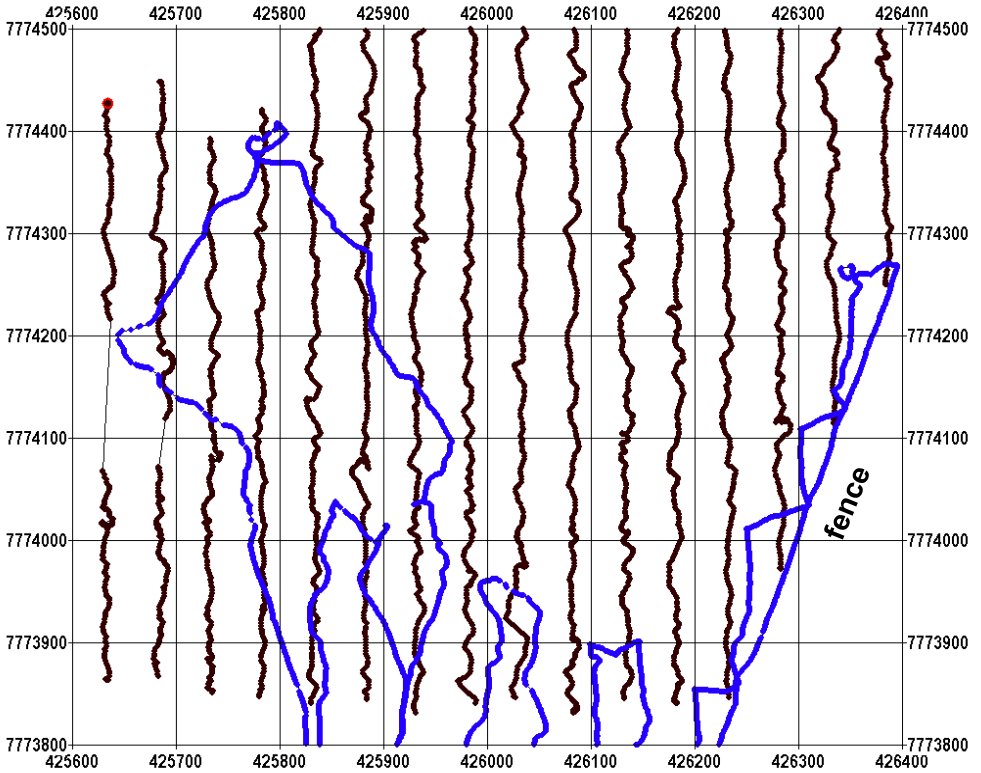


Processed data

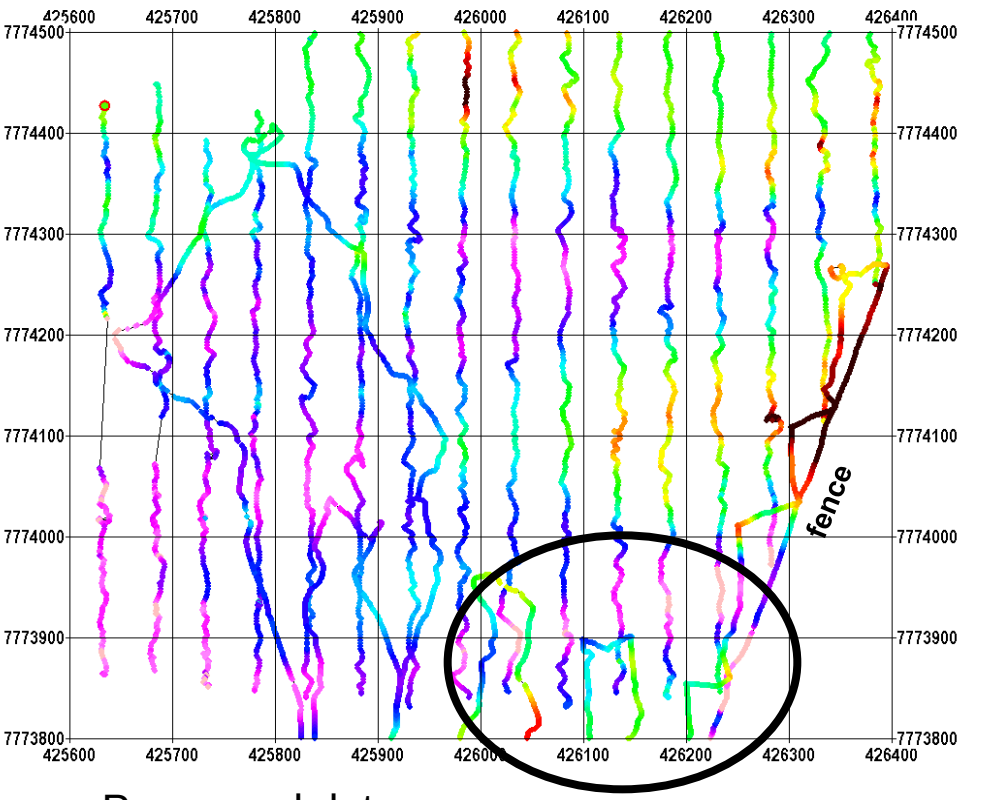
The 2010 data was shifted to the level of the 2008 data as the final step in the processing. The data was later compared at intersections and nearby lines in two areas to check for agreement: 1) Northwest and 2) South.

The agreement in the northwest (shown here) is excellent.
The values were compared at nine intersection points, and all were within 5 nT, most within 3 nT which is well within the repeatability levels of the Geometrics instrument.

2008/2010 - South



Black-2008 lines, Blue-2010 lines



Processed data

Figure 4: 2008/2010 ground magnetic analyses

The other area with significant overlap is in the southern area. Results agree very well to the except to the southeast part of the south section. The reason for this discrepancy is not known. Note, however, that all of the 2010 data that is in disagreement was collected on the same morning and not likely to be affected by significant instrument drift.

Merged Ground Data (2008/2010)

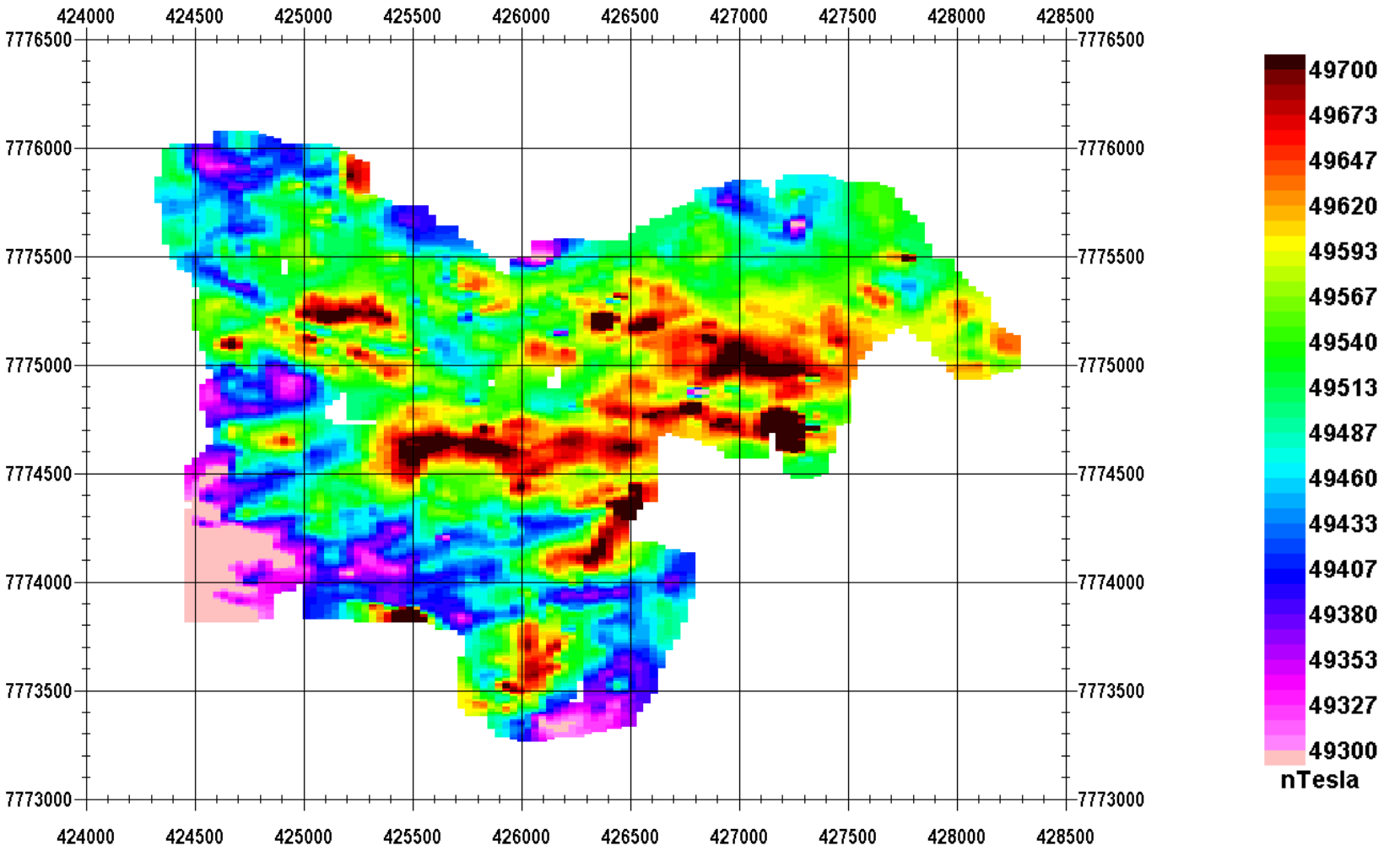


Figure 5: ***Final Processed 2008/2010 Data – Interpolated.***

Merged Ground Data (2008/2010)

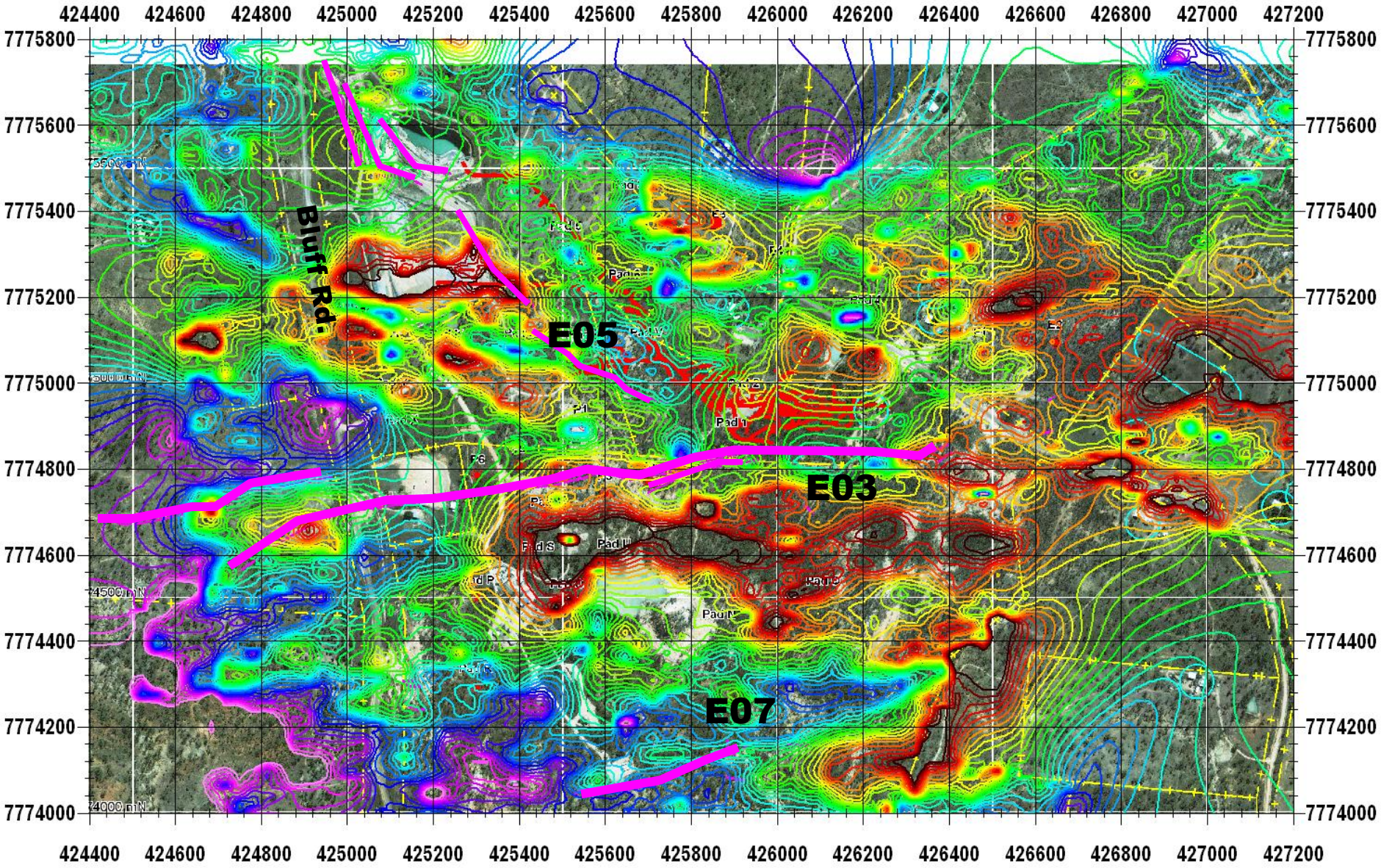


Figure 6: ***2008/2010 Data – Contoured with Satellite Underlay***
Outcrops of structures shown in pink

Ground Magnetics RTP

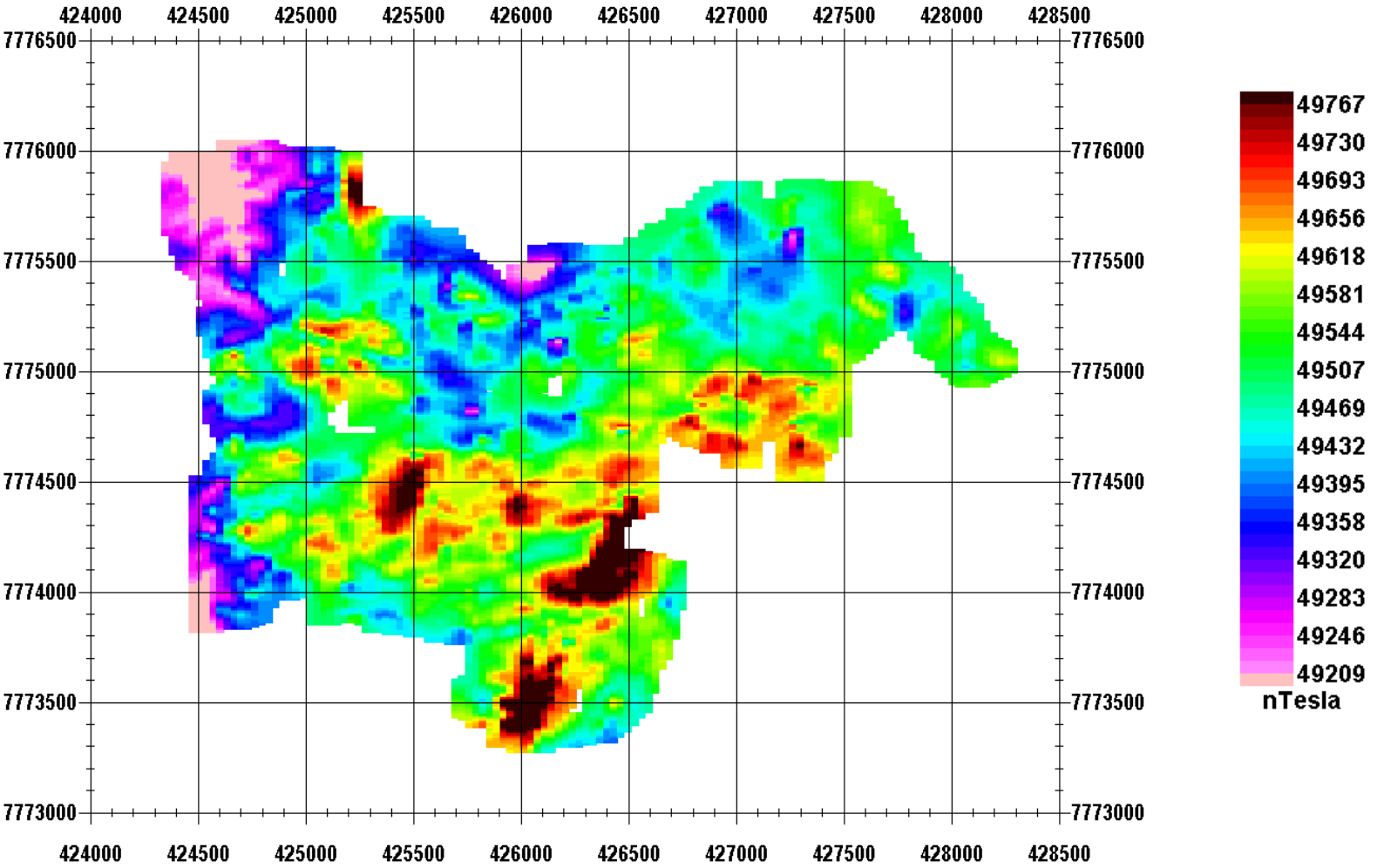


Figure 7: 2008/2010 Ground data, Reduced to Pole, Total Field

Note: Reduction to the pole is a technique that shows the response if the data had been collected at the North Pole. It is helpful for locating the source of the anomalies. See the Interpretation section for further detail.

Merged Ground Data (2008/2010)

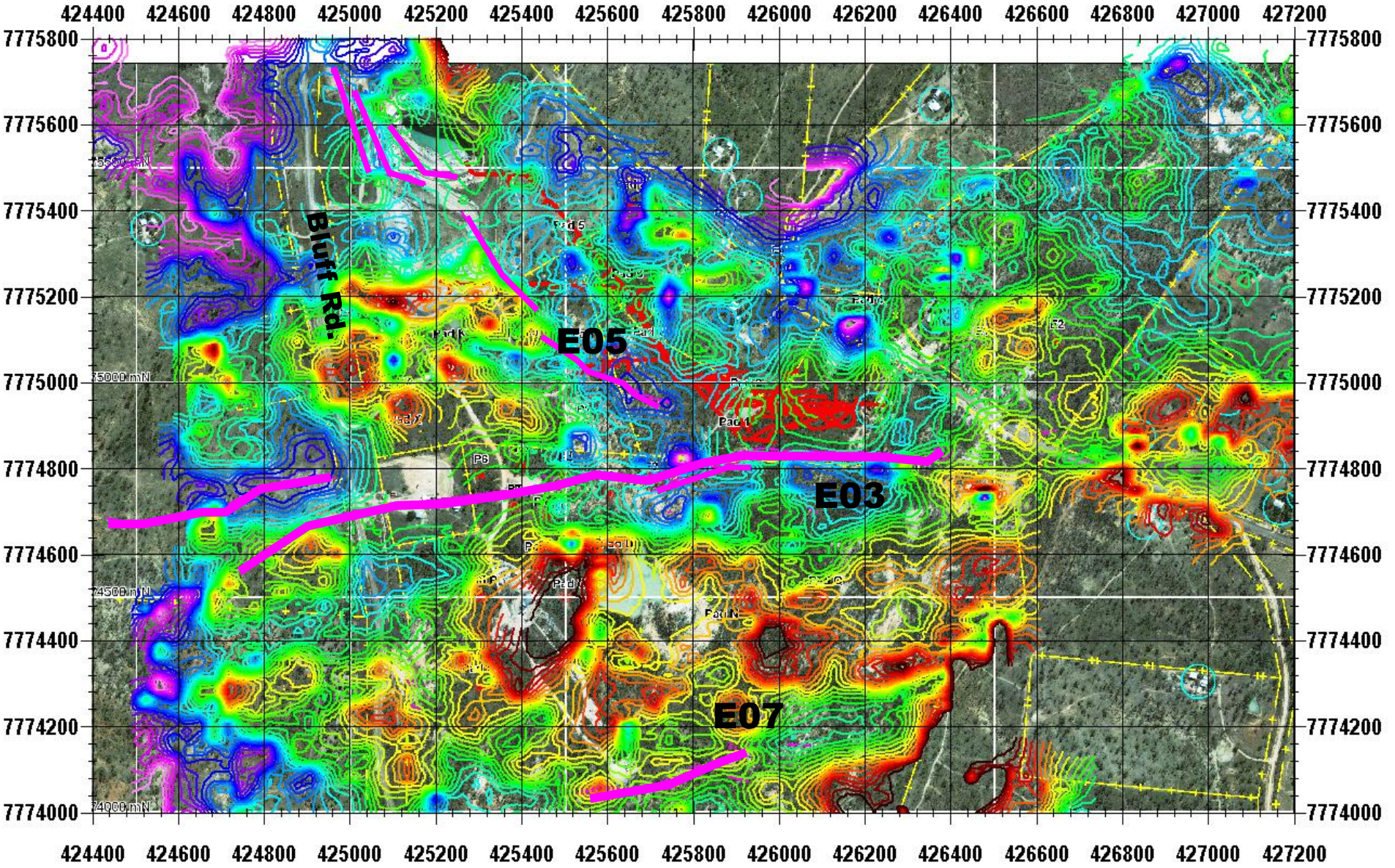


Figure 8: ***2008/2010 Data, RTP – Contoured with Satellite Underlay***
Outcrops of structures shown in pink

Merged Ground Data – 2008/2010

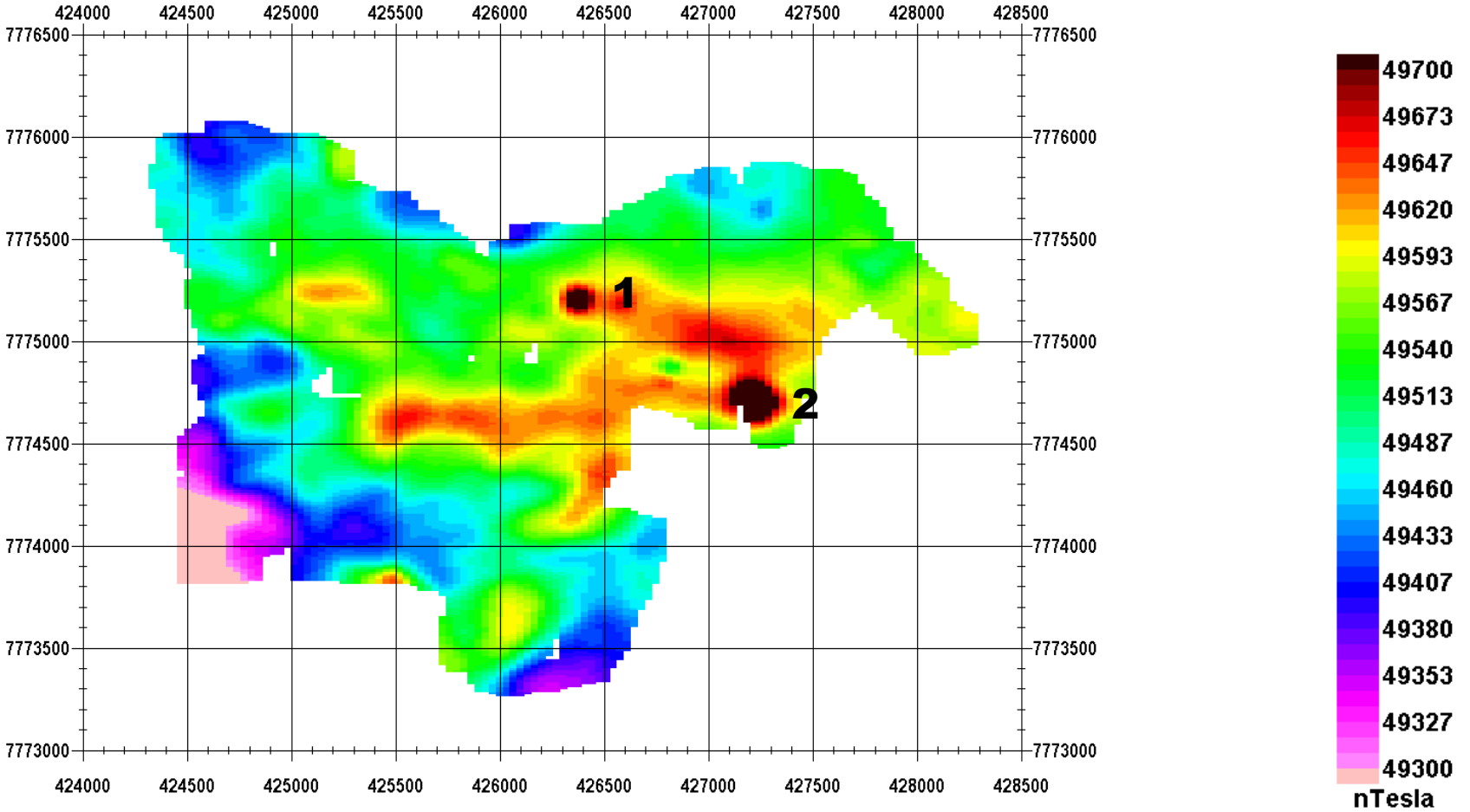


Figure 9*: 2008/2010 Ground Data – Upward Continued to 50 m*

The integrated data is processed to produce the estimated response if measured at an elevation of 50m equivalent to the average of the 1999 (UTS) data. The two dark circles are artifacts of man-mad structures caused by inadequate data sampling and gridding effects as discussed later in the report.

Ground Magnetic Data

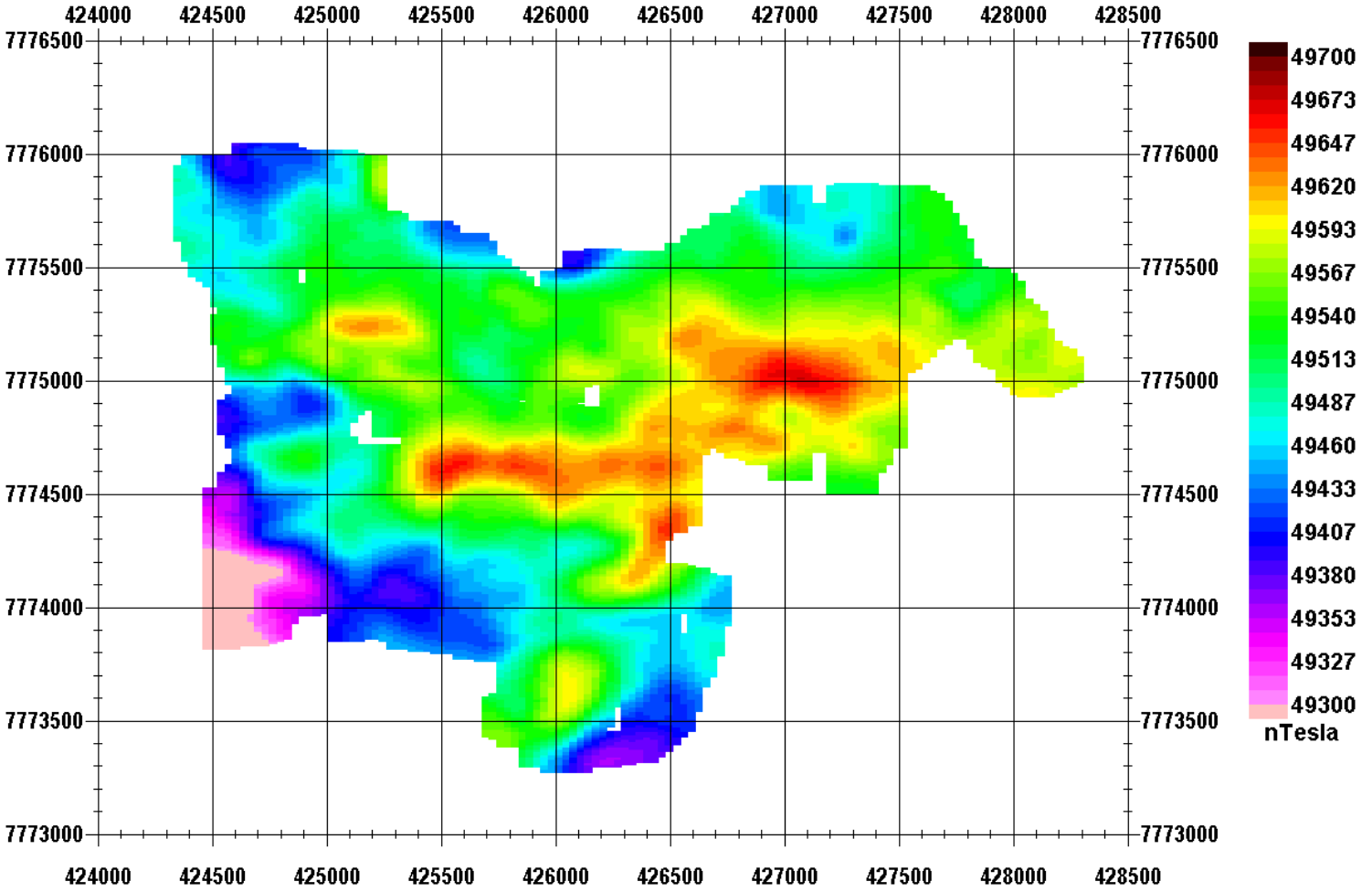


Figure 10: 2008/2010 Ground Data – Upward Continued to 50 m - REPROCESSED

The ground data near (1) and (2) on the previous page was examined. Both (1) and (2) are very close to buildings, and there are data missing as a result of the buildings. The strong, localized anomalies were the result of an increase in the mag response as the lines approached the buildings, and gridding artifacts where data was missing. Once the data is cleaned to remove anomalous readings where the lines approach buildings, these anomalies are not seen in the gridded data.

Ground Magnetic Data

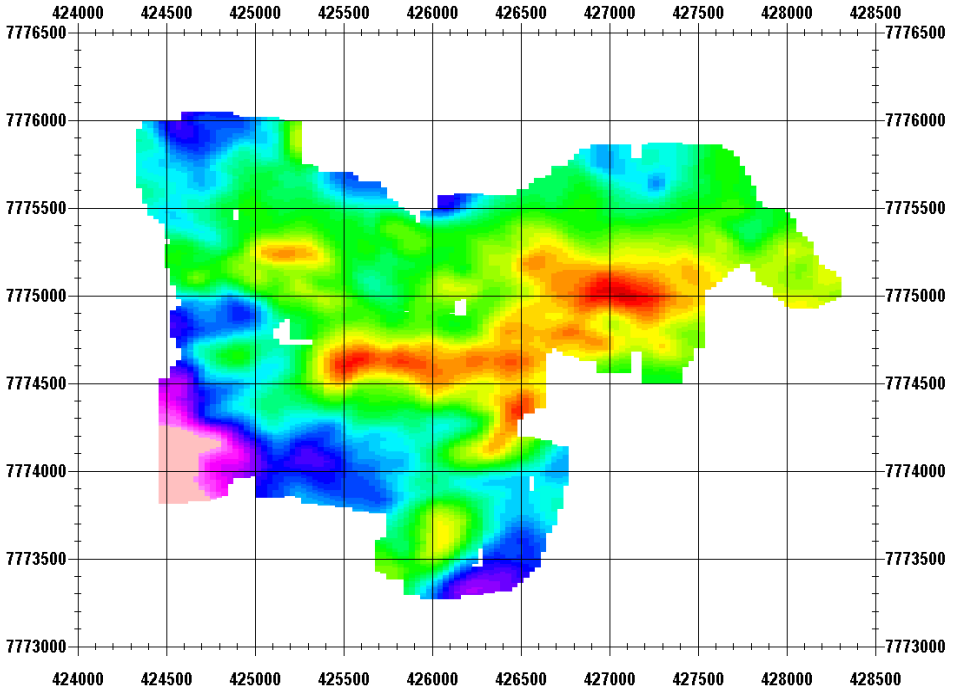


Figure 10: 2008/2010 Ground Data – Upward Continued to 50 m – REPROCESSED (from previous page)

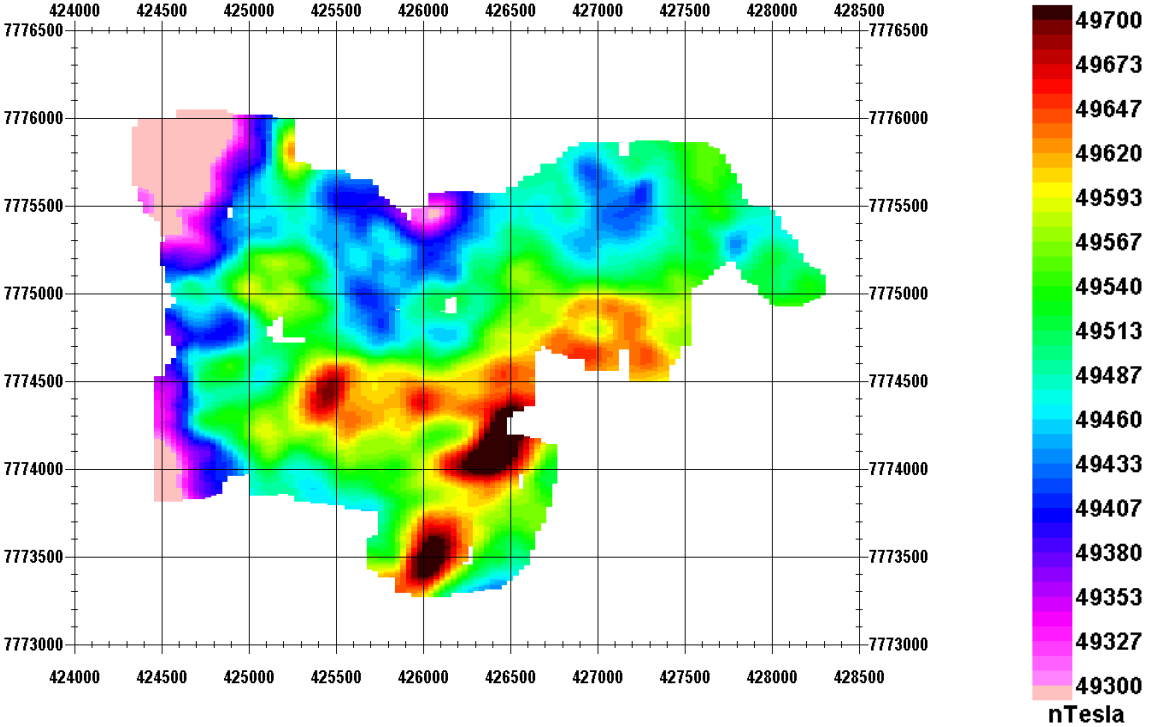


Figure 11 2008/2010 Ground Data – Upward Continued to 50 m, RTP – REPROCESSED

A close-up is shown on the following page to better identify the structures.

Note: The angle of the earth's field at these latitudes strongly shifts the position of the magnetic data anomaly from the source of the anomaly. These figures are presented here primarily for data quality purposes and not interpretation purposes.

Ground Mag

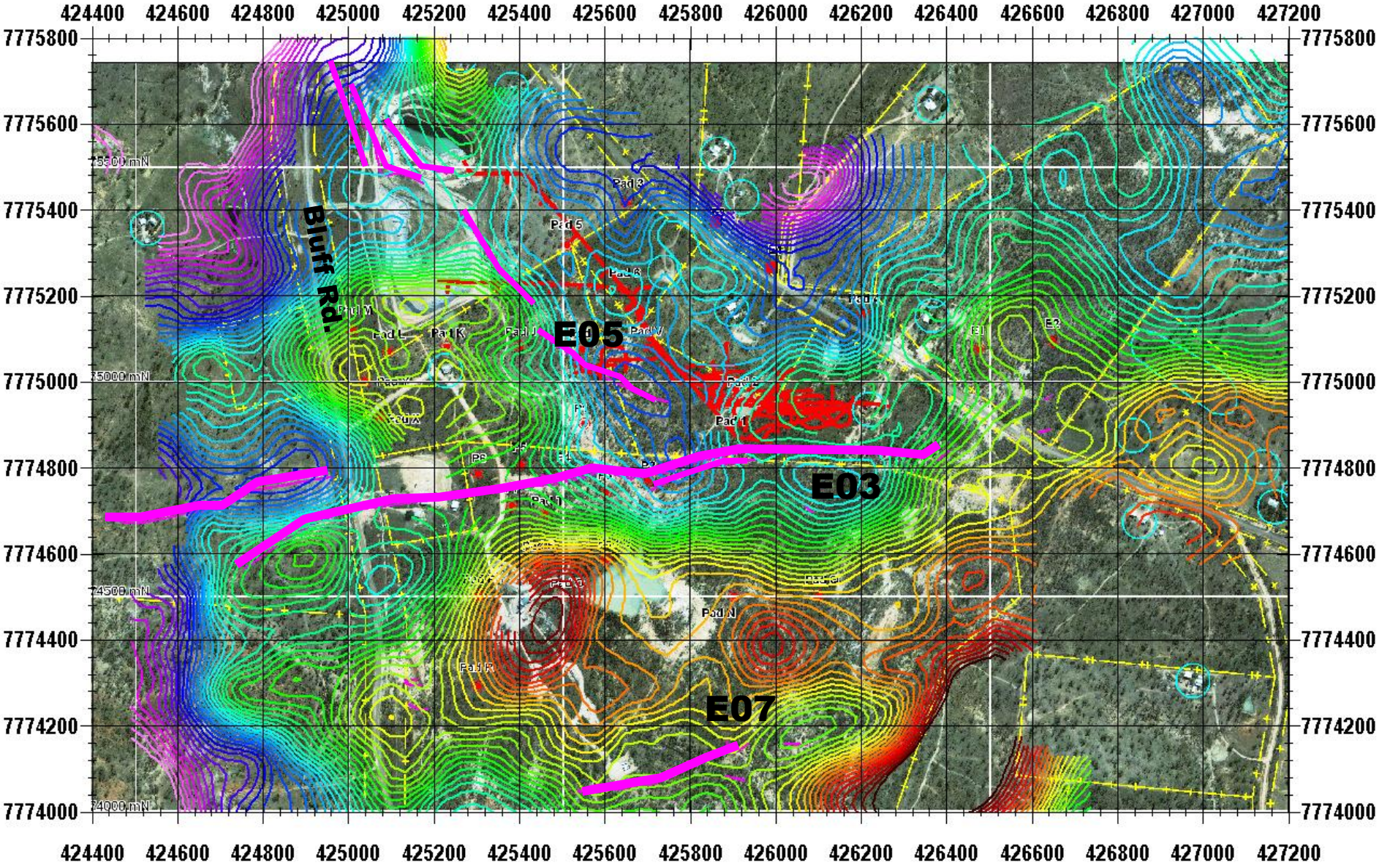


Figure 12: 2008/2010 Ground Data – Upward Continued to 50 m, RTP – REPROCESSED, Close-up with satellite underlay. E03, E05 and E07 structures are shown in pink.

Merged Ground Data

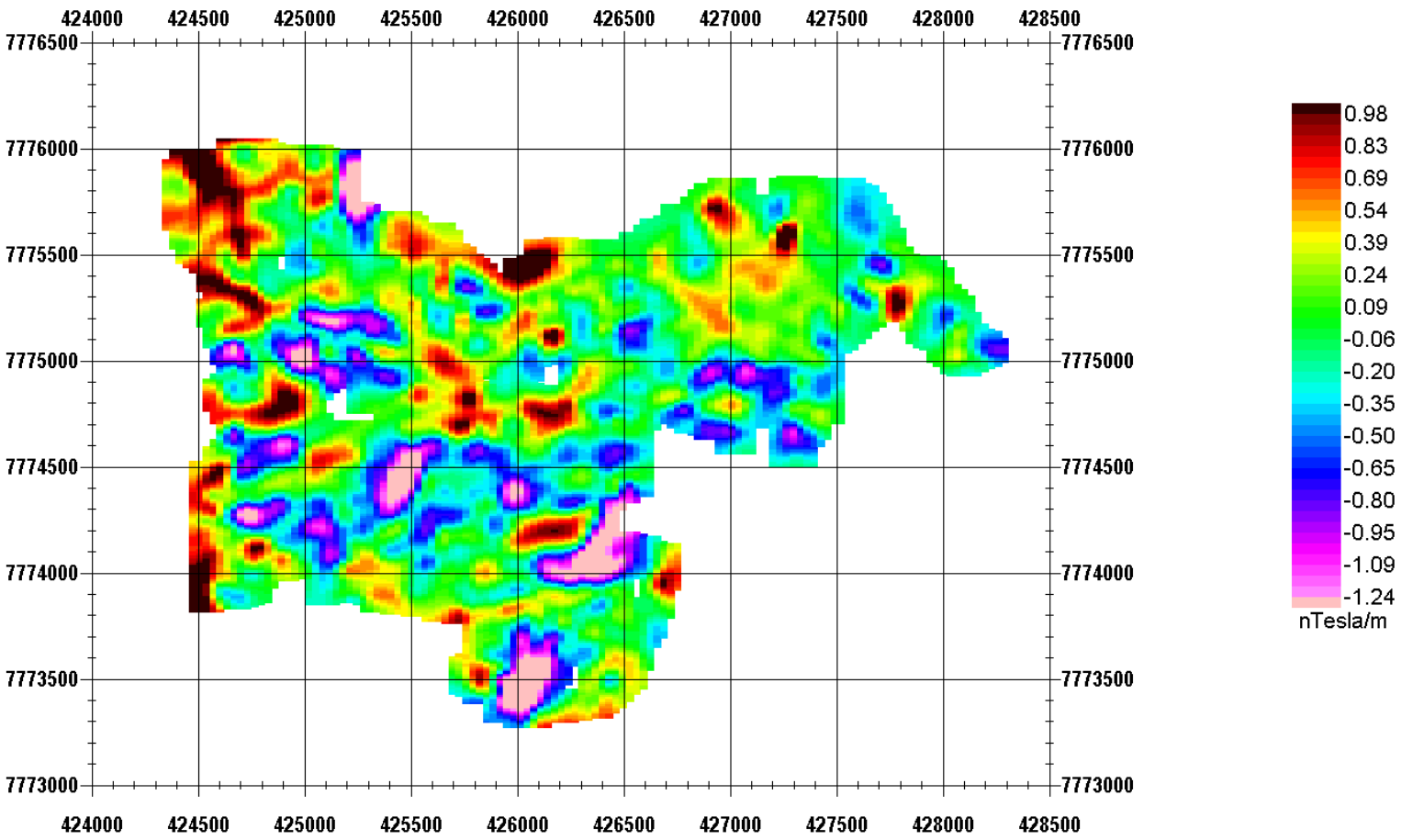


Figure 13*: 2008/2010 Ground Data – Upward Continued to 50 m, Vertical Derivative*

Ground Data Comparison with 1999 Airborne Data

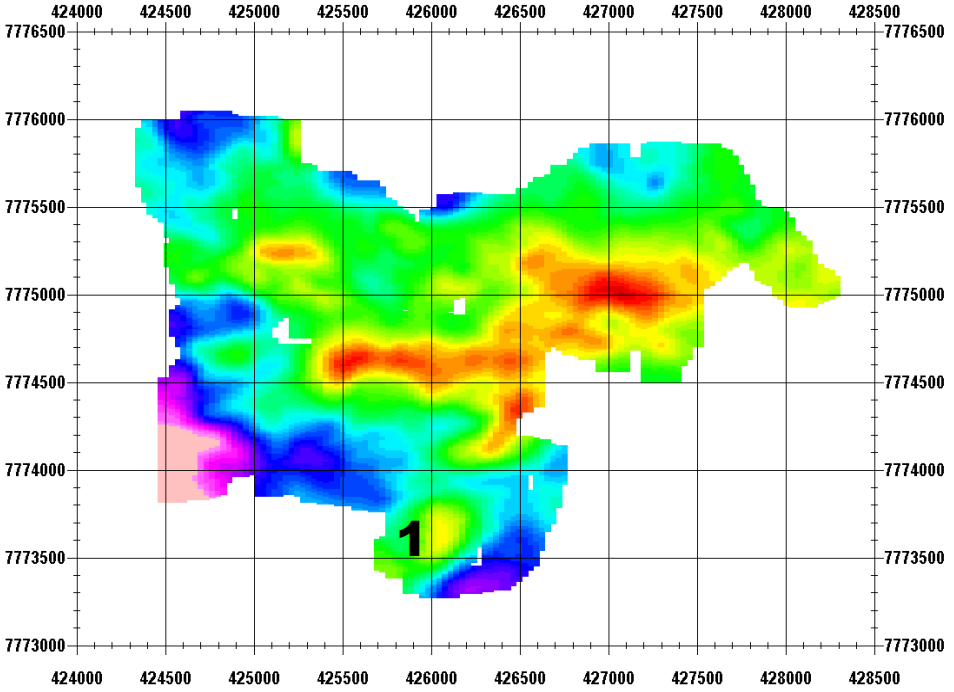


Figure 9: 2008/2010 Ground Data – Upward Continued to 50 m

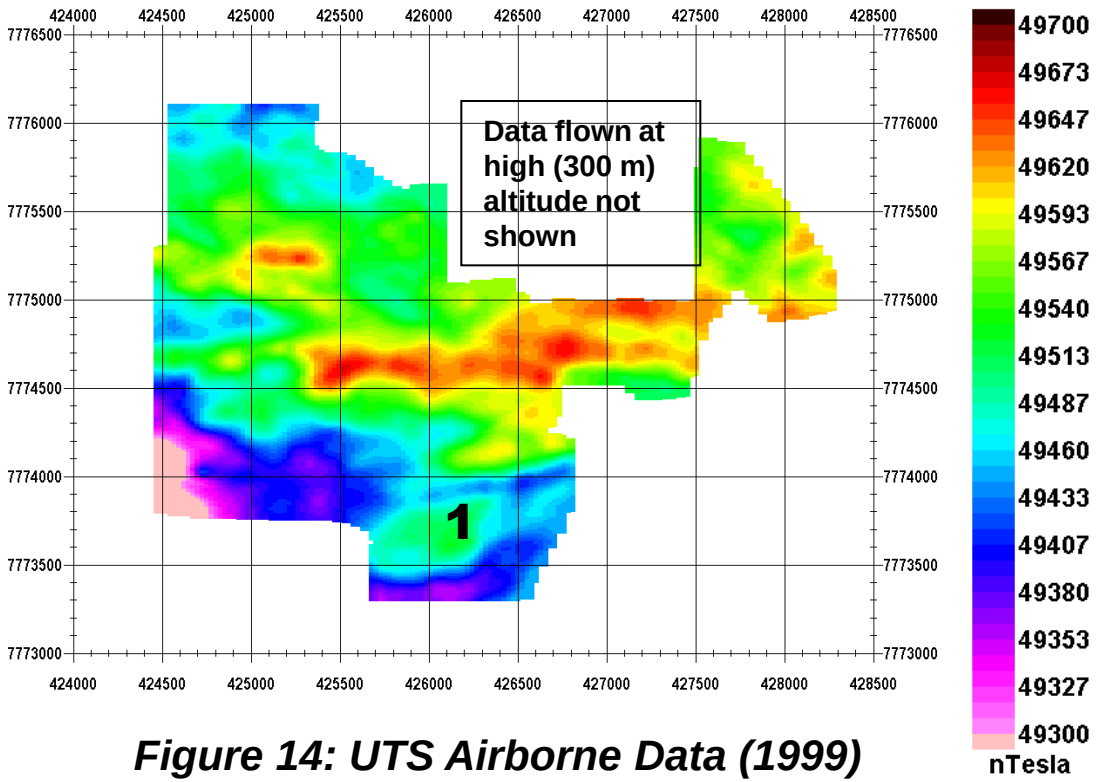


Figure 14: UTS Airborne Data (1999) Average Altitude: ~50 m

Comparison of the upward-continued ground data with the UTS airborne data over the same area. The level of the airborne data has been adjusted by -290 nT to match the amplitude of the ground data due to the variation in the Earth's field in the intervening years. The background magnetic field varies over time, and this is close to the difference in response expected between 1999 and 2008 at this location.

Overall, the datasets agree very well, though there are some small differences. Both datasets have a high at position (1), but it is more significant in the ground data than in the airborne. Note that this is near the area where the 2010 data disagreed with the south end of the 2008 .These results suggest that there may be some issues with the 2010 data here.

Comparison with Airborne

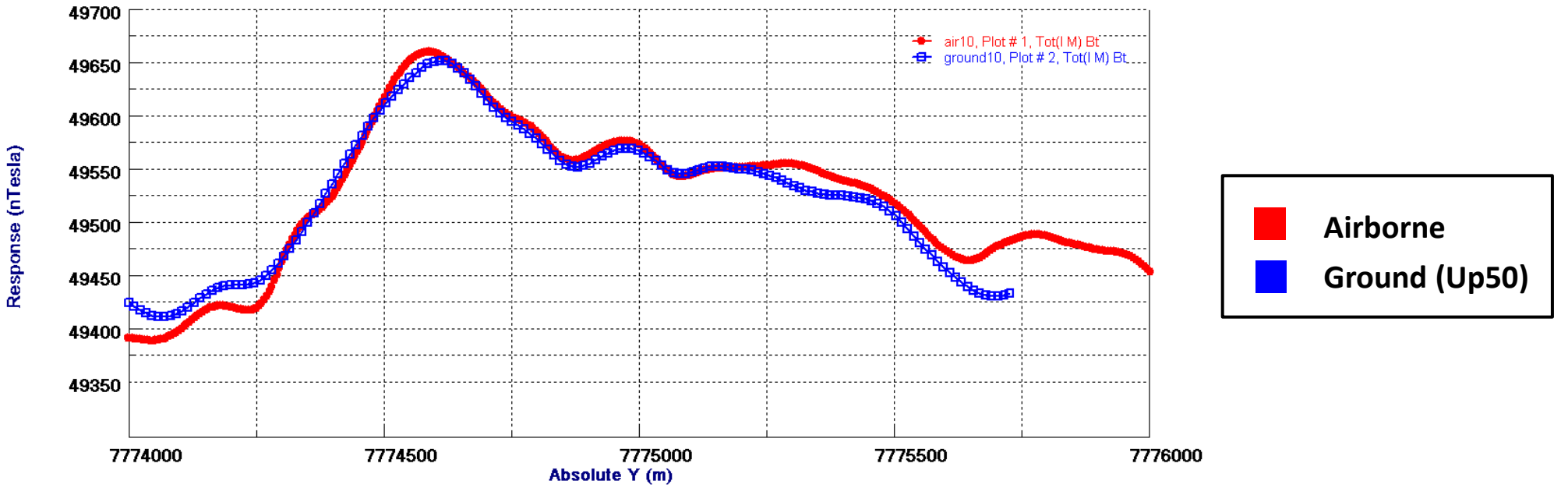


Figure 15*: Profile response comparisons of upward continued ground data to airborne data*

On the previous page, grids of the upward-continued ground data and the airborne data were compared, and the datasets generally agreed.

The upward-continued grid of the ground data was also exported to north-south profiles, and these were plotted against the data along corresponding lines in the airborne survey to allow for a more direct comparison. Line 100710 in the airborne is shown. This line is over the 2010 data. The two datasets agree very well.

*Note: Some differences would be expected due to the variable height of the airborne system, which typically varies between 40 m and 60 m over a line.

Comparison with Airborne

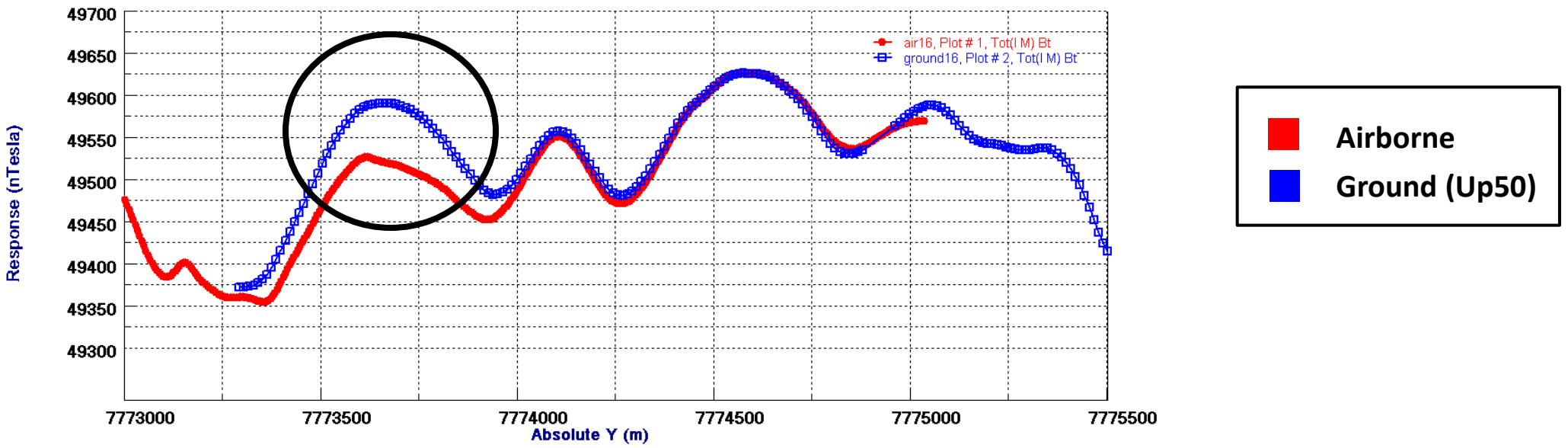


Figure 16*: Profile response comparisons of upward continued ground data to airborne data*

A second example – Line 100580. The upward-continued ground data agree very well with the airborne except for the south anomaly (circled). This is the same feature marked at (1) on page 57.

Ground Magnetics Conclusions

The processed 2010 data was integrated with the 2008 ground data, and was determined to be of good quality after extensive processing with comparison with the 2008 data and the UTS airborne data. Agreement between overlapping sections of the 2008 and 2010 datasets is good. The upward-continued ground data is in agreement with the UTS data based on comparison of the gridded data and along profiles. Therefore, despite the issues with the 2010 ground survey, including the lack of base station, the data is of good quality based on its agreement with overlapping areas of the 2008 survey as well as with the UTS airborne data.

Further ground magnetic data could be collected to the northeast of the 2008/2010 data, and west of Bluff Road if desired. However, the airborne data is of good quality, and this is not considered a priority.

Further study of the ground data should focus on whether the fine features on the ground (which are not observed in the airborne data) are of interest.

Interpretation

On the following pages, some interpretation of thee magnetic structures is provided, focusing on the airborne magnetics (UTS).

Reduction to the Pole Processing

Reduction to the pole (RTP): a processing technique that shows how the data would look if collected at the magnetic north pole rather than at the latitude of the survey. The direction of the magnetic field varies over the Earth, and it is vertical (downward) at the north pole. Thus, this processing tends to move the magnetic anomalies over the actual structures causing them. For the geophysical reader, the processing technique was an enhanced FFT technique designed for low latitudes.

At Charters Towers, due to the direction of the background field, the structures causing the magnetic anomalies are south of the peaks of the anomalies. But after reducing the data to the pole, the structures will be approximately coincident with the locations of the anomalies. Thus, the advantage of reducing to the pole is that it better illustrates the position of the magnetic structures. This is illustrated in the plot below. Red is the response to the target at the north pole, and blue is the response at Charters Towers.

Before RTP, the edge of the magnetic high was approximately coincident with the Warrior surface expression, but the RTP data has moved it further south by about 200 m (black line). The original data is misleading when trying to locate the positions of magnetic structures.

Thus, Warrior is neither within the high in the total magnetic field, nor on its edge.

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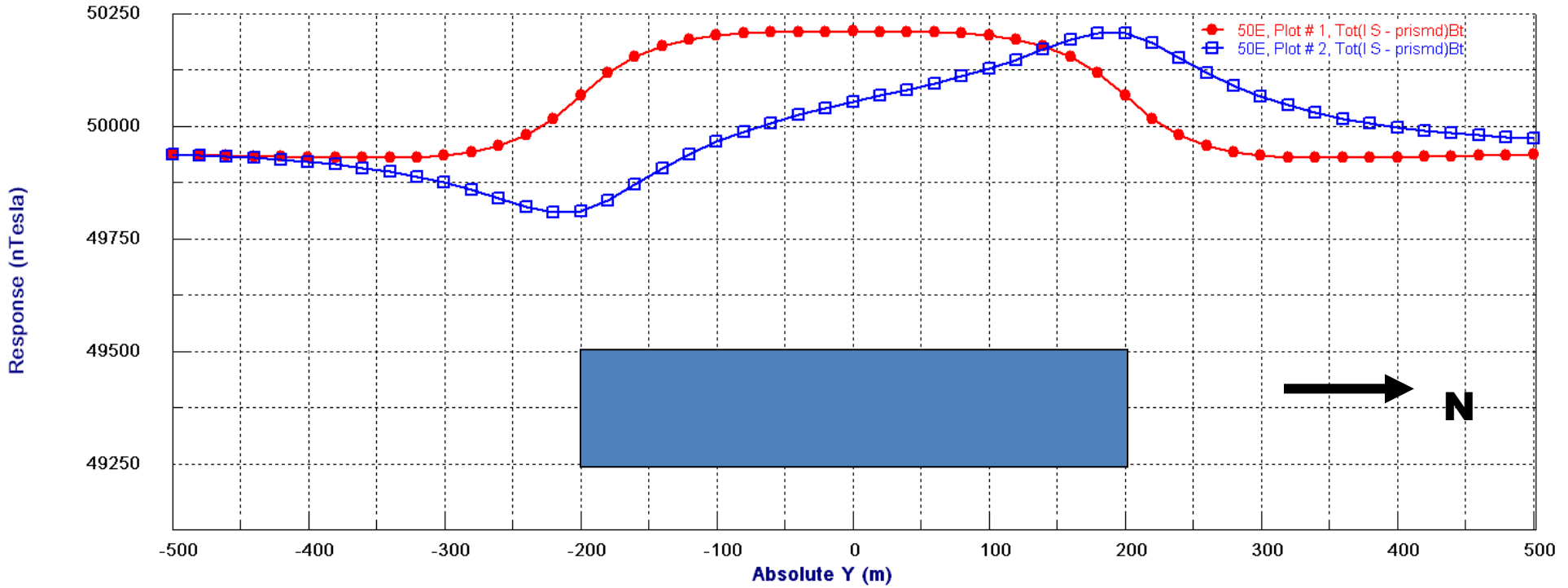

Figure 17:
Comparison of magnetic response for a model at the north pole (red) and near Charters Towers (blue)

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Reduced to the Pole - UTS Airborne Mag

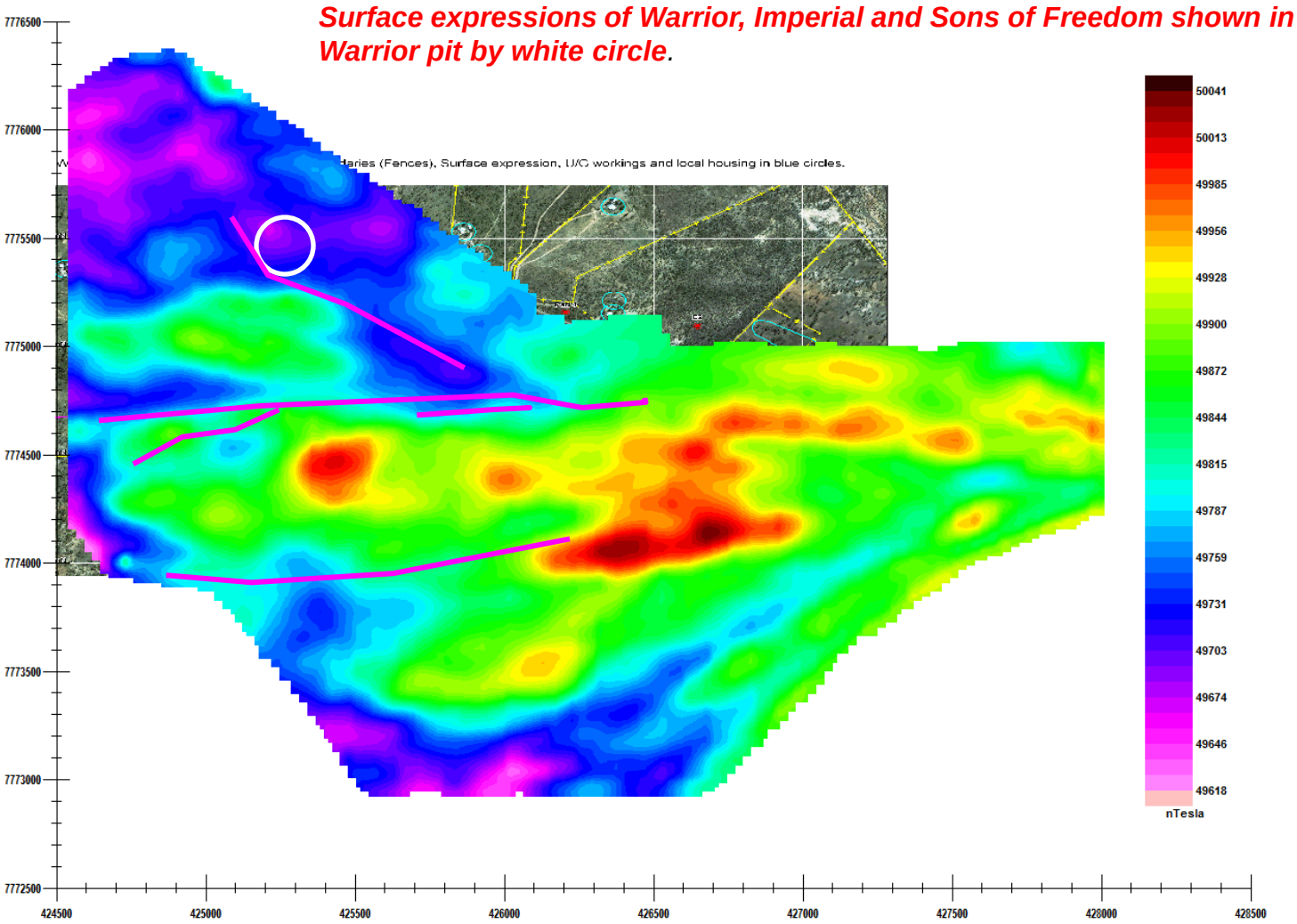

Figure 18: 1999 UTS AeroMag Data, Reduced to Pole, Total Field

All of the known structures correlate with local lows in the RTP TMI data. The reasons for the highs south of warrior are not known. According to the this image, Warrior could extend much further east. The low on the west side of the extended Warrior structure ends abruptly just off this map. Additional interesting structures are the linear SW-NE structures on the SE of this map , the circular low just NW of the pit and the linear structure from the pit over past Woodchoppers. It would be useful to know the state of the mining operations and other structures in the vicinity in 1999.

Reduced to the Pole - UTS Airborne Mag

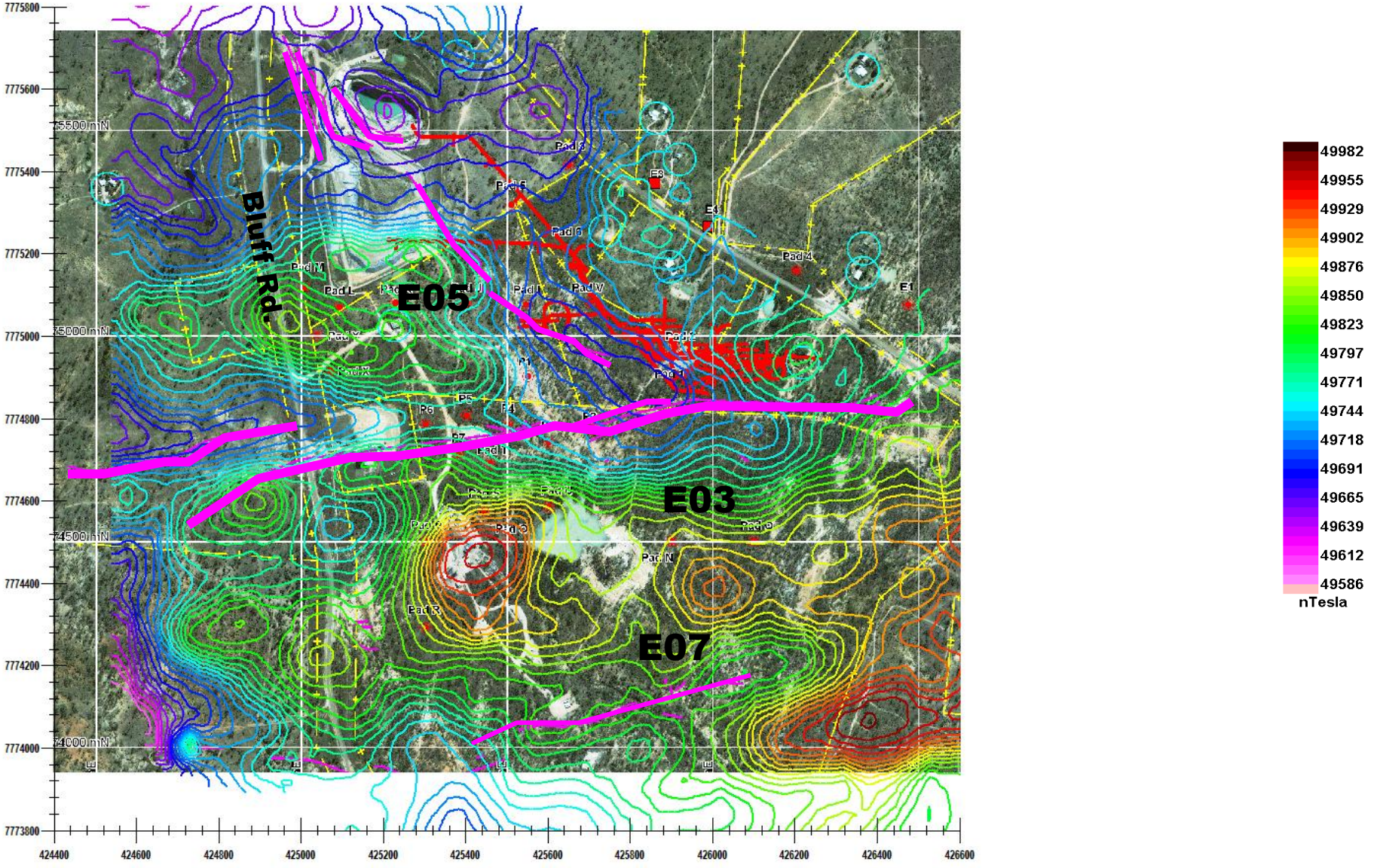

Figure 19: 1999 UTS Mag Data, Reduced to Pole, Total Field

Same map as previous but focused with contours to allow satellite image through.

Reduced to the Pole - UTS Airborne Mag

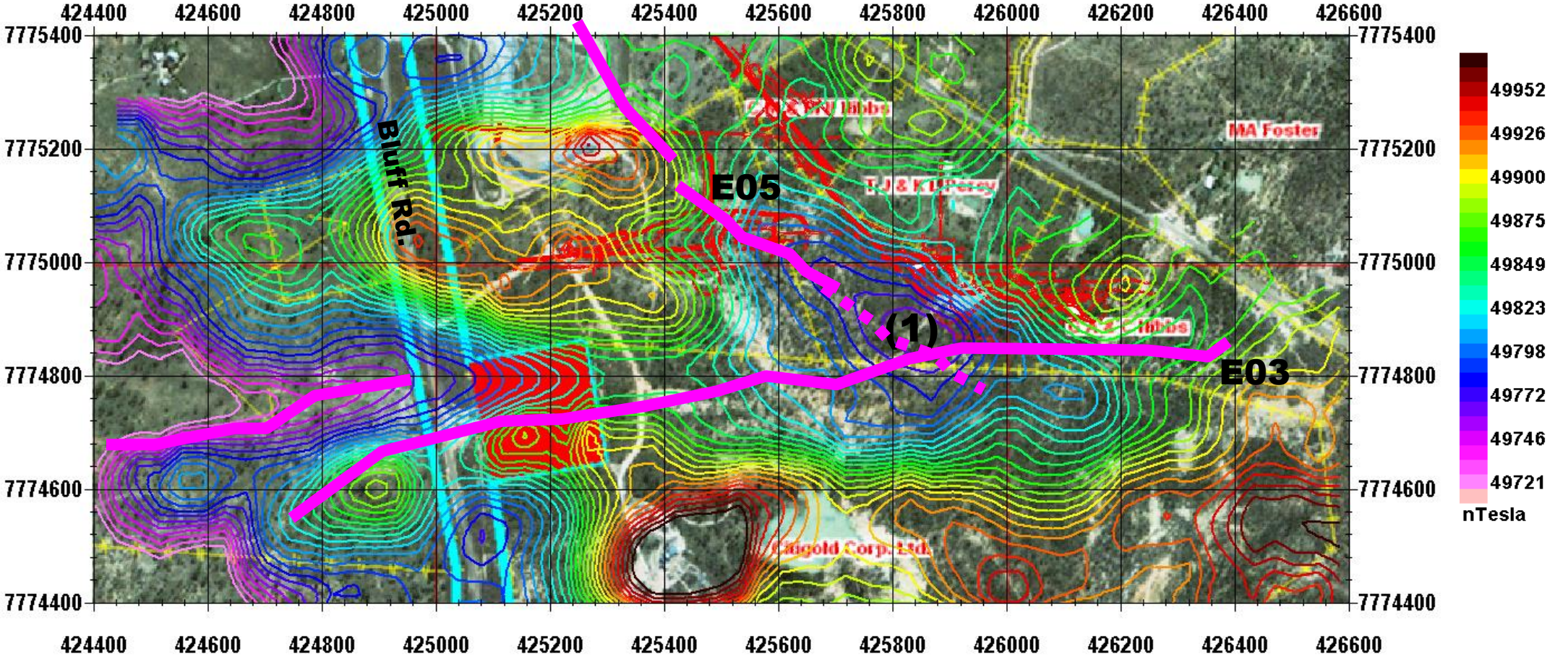

Figure 20: 1999 UTS Mag Data, Reduced to Pole, Total Field – Focus on Warrior Area

Surface expressions in pink and complete mine workings in red.

Of note: The low at (1) is focused just west of the Warrior East workings, but also south of the Son's of Freedom surface expression. The significance of this is not known.

It is suggested from the magnetics that E05 continues south to intersect E03 and possibly E10

RTP Vertical Derivative UTS Airborne Mag

The magnetic field is a rather diffuse field from a source structure. The vertical derivative enhances boundaries between structures with different magnetic properties and has better discrimination of the structures. The vertical derivative will be negative on top of a structure with high susceptibility, and positive off of the structure.

Highs in the vertical derivative, i.e., a low susceptibility are coincident with E03, E05, and E07 surface expressions. These highs in the vertical derivative are near the edge of the high in the total field.

There are two similar highs in the vertical derivative to the southeast (dashed lines), which might be of interest for further exploration. These derivative highs correspond generally to magnetic field lows analogous to the responses over the Warrior structure.

RTP Vertical Derivative UTS Airborne Mag

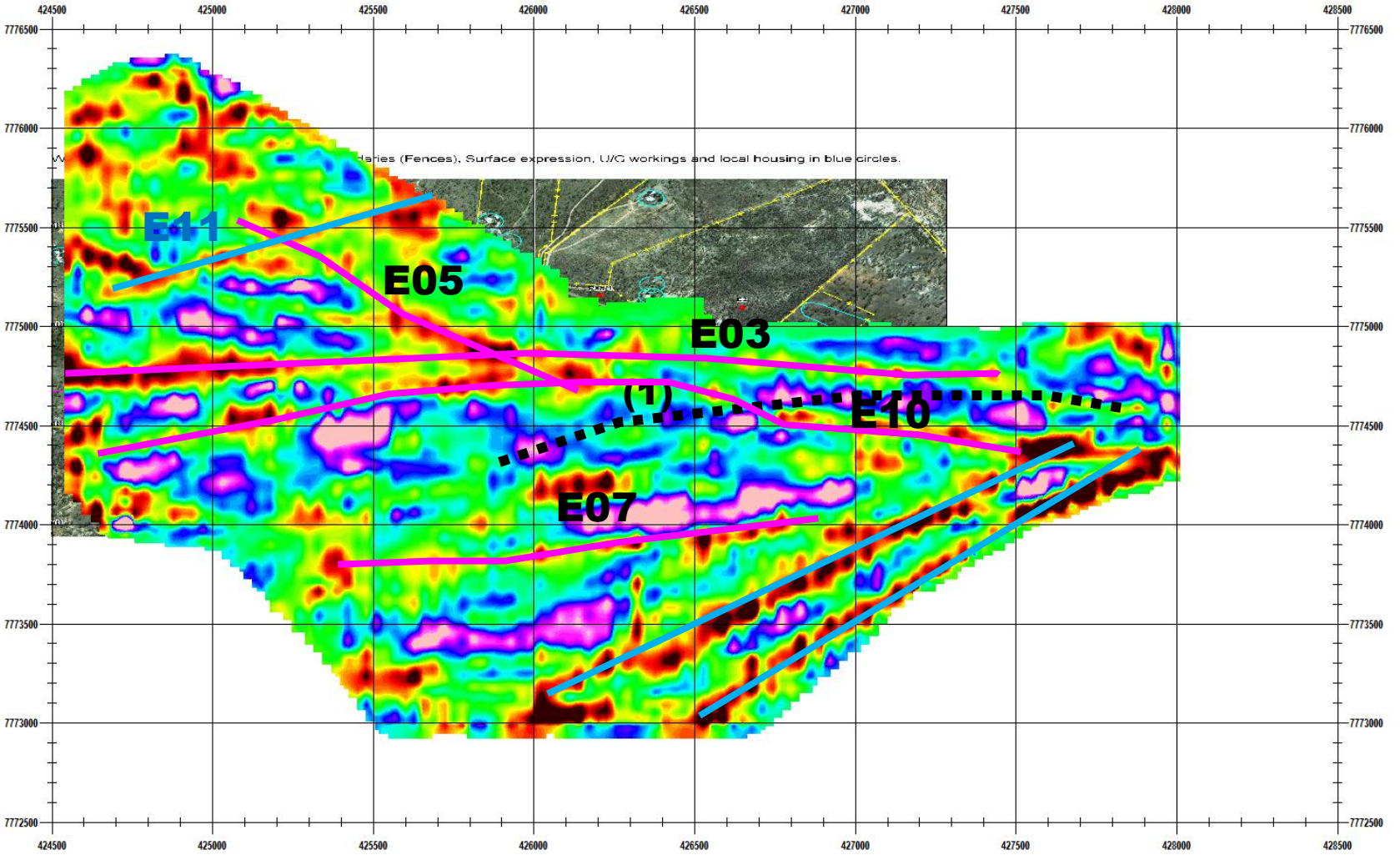

Figure 21: 1999 UTS Mag Data, Reduced to Pole, Vertical Derivative with Interpreted Structures

The vertical derivative of the RTP UTS data is shown. Note: Highs (red) imply magnetic lows while lows (blue) imply magnetic highs. We have interpreted this data to show the extent of E03,E05,E07 and E10. Note: these interpretations of the structures are consistent with the EM models (following page). Possible new structures are shown by the blue lines. (1) dashed black line is a series of magnetic highs. The reasons for these highs are not known. The magnetic lows associated with the structures are possibly due to the dykes in the structures being Non-magnetic. Lab-analyses of the dykes is suggested if not already available.

**The derivative marks the tops of the structures. There appears to be very limited sensitivity to the depth extents of the structures. We suspect this is at least in part due to the limitations of the magnetic method.

RTP Vertical Derivative UTS Airborne Mag

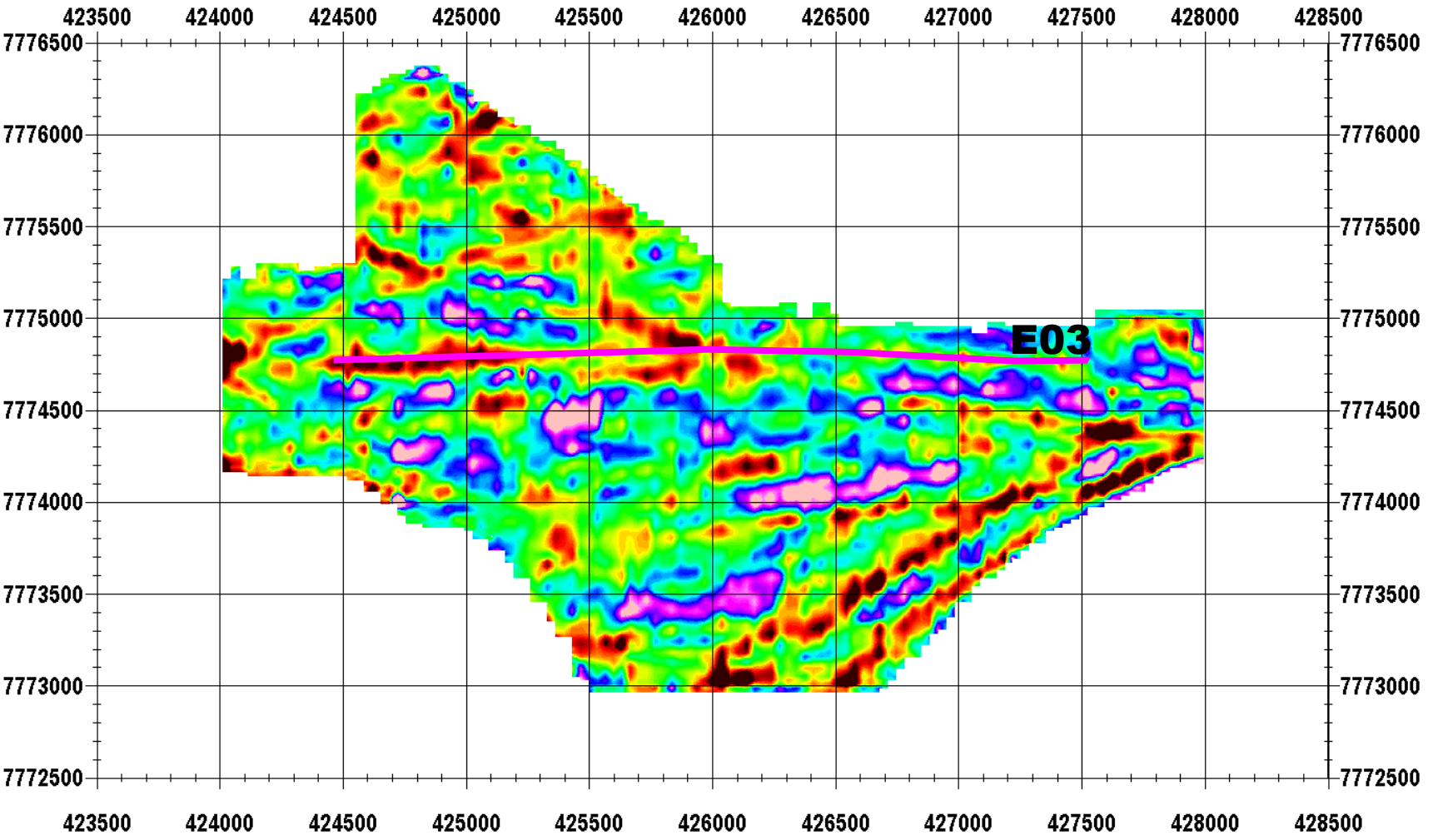

Figure 22: 1999 UTS Mag Data, Reduced to Pole, Vertical Derivative with West Extent

The vertical derivative of the RTP UTS data is shown, covering the area seen in Figure 21, and 500 m further west. The magnetic feature associated with E03 ends just west of 424500E. (Note: on an even larger scale, there are indicates the E03 starts up again further west until it intersects another structure). We now feel that we can identify an additional structure (E11) which crosses E05 just north of the Warrior pit and has a SW-NE strike and intersects the western projection of E03 just at the western edge of this map at (7774750N).

RTP Vertical Derivative UTS Airborne Mag

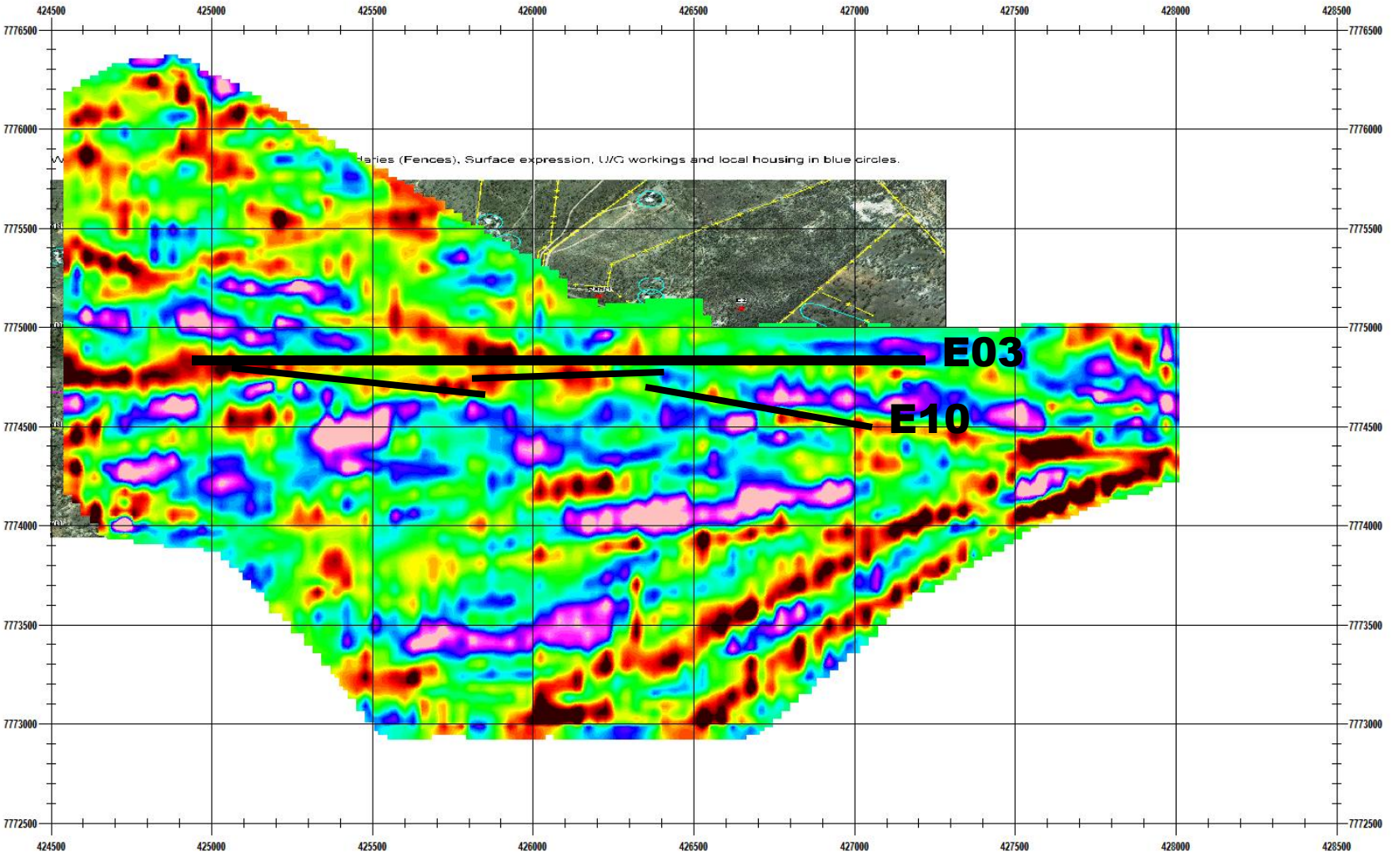

Figure 23: 1999 UTS Mag Data, Reduced to Pole, Vertical Derivative with Tops of EM Structures

The vertical derivative of the RTP UTS data is shown with E03 and E10 as presently modeled to the ground TEM data for Loop 1. Although the initial magnetic and EM interpretations were made separately (and indeed, the magnetic interpretation on the previous page was made without seeing the final TEM model for E10), they agree very well. Preliminary inversion and modeling of the magnetic data shows a satisfying correlation of the magnetic and EM structures while indicating possible new understandings of the structures.

Preliminary Magnetic Conclusions

1) 1999 Airborne data is of exceptional quality for the time period and seemingly will serve Citigold well with exploration and interpretation not only in the vicinity of the Warrior mine but over the entire area of the survey.

2) Ground magnetic data and airborne data agree extremely well. Some additional detail is found in the ground data. Ground data should be considered only when increased resolution is required over targets.

3) Reduction-to-the-Pole carried out with specialized low latitude algorithms (EMIGMA) places the magnetic anomalies over the surface projections of the known shear structures. The vertical derivative of this process better identifies these structures. New information on known structures has been determined and several new structures have been identified.

4) At this stage, there is good correlation between the geometries of the EM structures from modeling and the geometries of the magnetic structures. Apparently, the shear (fracture) structures are both conductive and magnetic negatives when compared to the background structures. This now provides us with two geophysical parameters by which to identify and describe these zones.