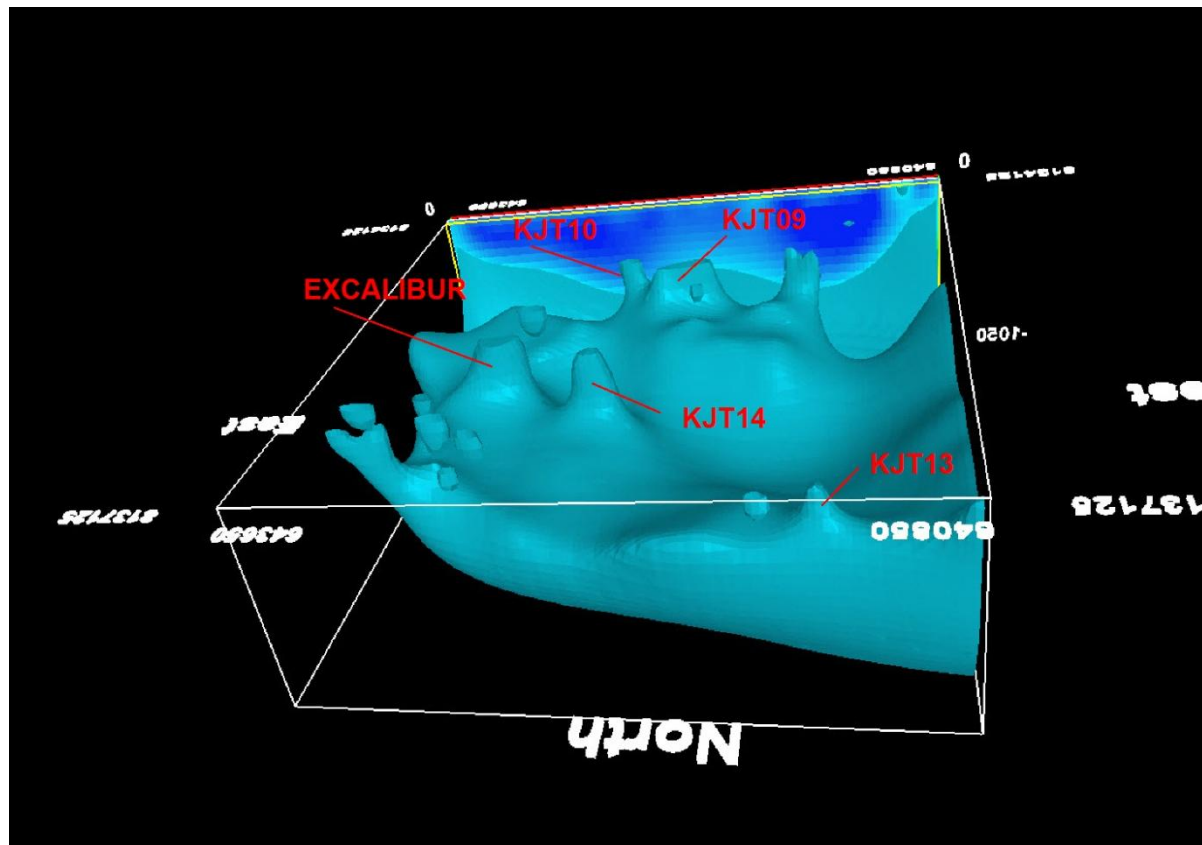


A REPORT ON AN ASSESSMENT OF GEOPHYSICAL DATA IN THE MERLIN KIMBERLITE FIELD, NORTHERN TERRITORY



Undertaken on behalf of
North Australian Diamonds Limited

Keith Jones
Geophysical Consultant
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Summary

A review of geophysical data in the Merlin Kimberlite Field has resulted in the selection of 13 possible kimberlite targets. The analysis of the data has focussed on the initial aeromagnetic survey data which was flown prior to any significant magnetic cultural features being present in the area. Previous exploration in the Merlin Field has focussed on the EM data following the considerable success achieved in using the EM34 ground magnetic system as a follow-up to GEOTEM and DIGHEM airborne surveys in locating kimberlites. This study has shown that the majority of the known kimberlites have a distinct magnetic response despite the presence of the highly magnetic pisolitic gravels at the surface of the Merlin plateau. Reference to the EM data has been made throughout the study. 3D inversion of the magnetic data has proven useful in defining anomalous responses.

The last major survey conducted at Merlin was the flying of the Falcon Gravity Gradiometer by BHPB. This dataset has been reviewed as part of this study but has proven to be of lesser value than other datasets. The reason for the apparent inability of the Falcon system to recognise the kimberlites is in part explained by the fact that many of the pipes had been mined when the survey was conducted but pipes such as Ector which is one of the largest in the Merlin cluster were relatively undisturbed and were not detected by Falcon. Based on a review of historical ground gravity profiles it would appear that those kimberlites which were surveyed prior to mining had an associated Bouguer gravity "low".

It is probable that some of the targets selected from this study will be due to increased thicknesses of pisolitic materials in depressions at the surface and indeed some of the responses observed over the known pipes may well be due to accumulations of this lateritic material in the depressions associated with the kimberlites.

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Introduction

This report discusses an assessment of geophysical data which is derived from both airborne and ground surveys at the site of the Merlin Diamond Mine near Borroloola in the Northern Territory. Exploration has a fairly protracted history which commenced back in 1986 when CRAE undertook the first airborne magnetic survey specifically directed at diamond exploration and also conducted heavy mineral sampling. This led to the discovery of the Emu pipes. Some 7 years later the Merlin pipes were discovered to the south of the Emu pipes following further geophysical and heavy mineral sampling surveys. In total 17 pipes were discovered including the two breccia pipes.

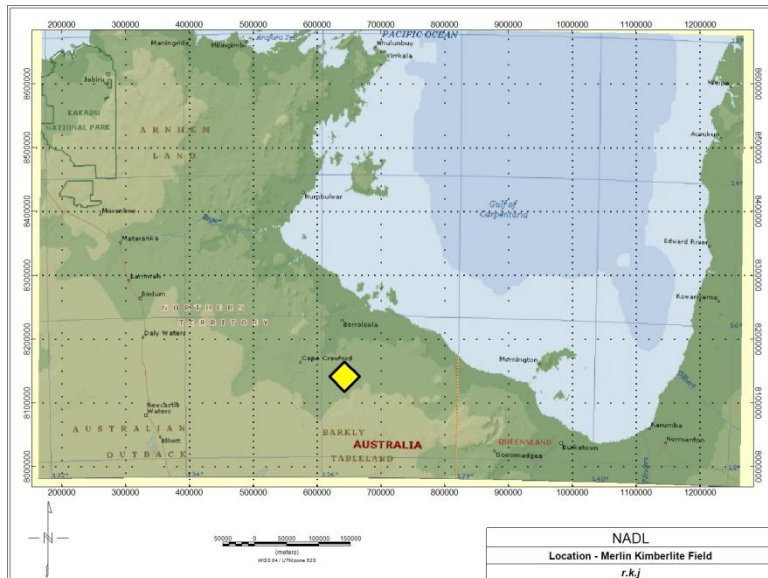


Figure 1-Location Merlin Kimberlite Field

The original 300 metre spaced aeromagnetic survey which was flown by CRAE in 1983 located the Emu pipes and also identified the Kay/Ector kimberlites but drilling by CRAE failed to locate the location of the associated Kay/Ector airborne anomaly on the ground.

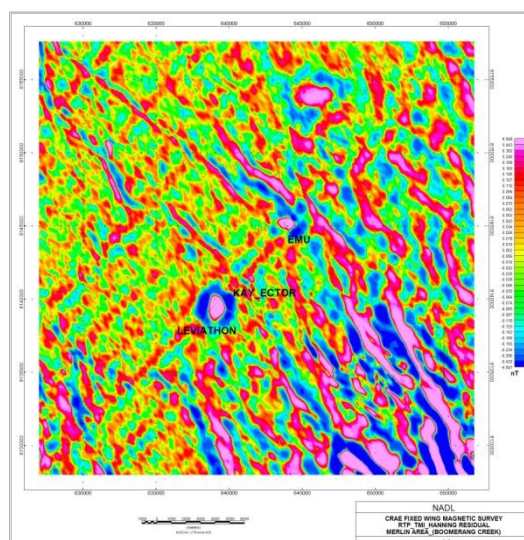


Figure 2-Original CRAE Survey which assisted in the discovery of the Emu kimberlites

Following the discovery of the Excalibur pipe at Merlin various ground geophysical methods were tested followed by the first airborne geophysical survey flown by Ashton Mining in May 1993. The airborne survey was a fixed wing magnetic/radiometric survey flown along lines spaced 100metres apart in N-S direction at a nominal flying height of 70metres. This survey was flown prior to the presence of any significant cultural anomalies being present and has been used extensively in this assessment of the area. This survey was followed in July 1993 by a GeoTEM survey in July 1993 which identified the Emu, Kay-Ector and Gareth kimberlites. Ground EM34 surveys were undertaken to follow up the GeoTEM anomalies. In August 1994 when 8 kimberlites had been identified using the GeoTEM and EM34 systems Ashton commissioned Dighem to fly a HEM survey which identified all known pipes at the time and two additional pipes. The EM34 ground surveys which eventually totalled approximately 1220line km proved to be the most cost effective ground technique at Merlin and identified additional kimberlites to those which the airborne surveys identified. These surveys in conjunction with geological mapping and heavy mineral sampling led to the discovery of the entire Merlin kimberlite field. Other ground geophysical methods were trialled during the course of exploration and these included GPR (Ground Penetrating Radar), ground gravity, Sub-Audio Magnetics (SAM) and seismic reflection.

Prior to the take- over of the Merlin Mine by Rio Tinto BHP undertook a FALCON gravity gradiometer survey in 2000 over the Merlin and Emu kimberlites and the survey was subsequently reprocessed by BHP in 2003. This survey was the last major detailed (50m line spacing) airborne survey conducted over the area within which the pipes occur. A semi regional 400m line spaced NTGS airborne magnetic /radiometric survey was flown in 2002 which included the Merlin Kimberlite Field.

Regional Geophysical datasets

The main focus of this study is the detailed exploration that has been undertaken at Merlin. The following images are regional surveys which extend well beyond the Merlin area and provide a useful overview of the region surrounding the project area. These data sets include regional topographic, aeromagnetic and bouguer gravity surveys acquired principally by NTGS (Northern Territory Geological Survey) and GA (Geoscience Australia).

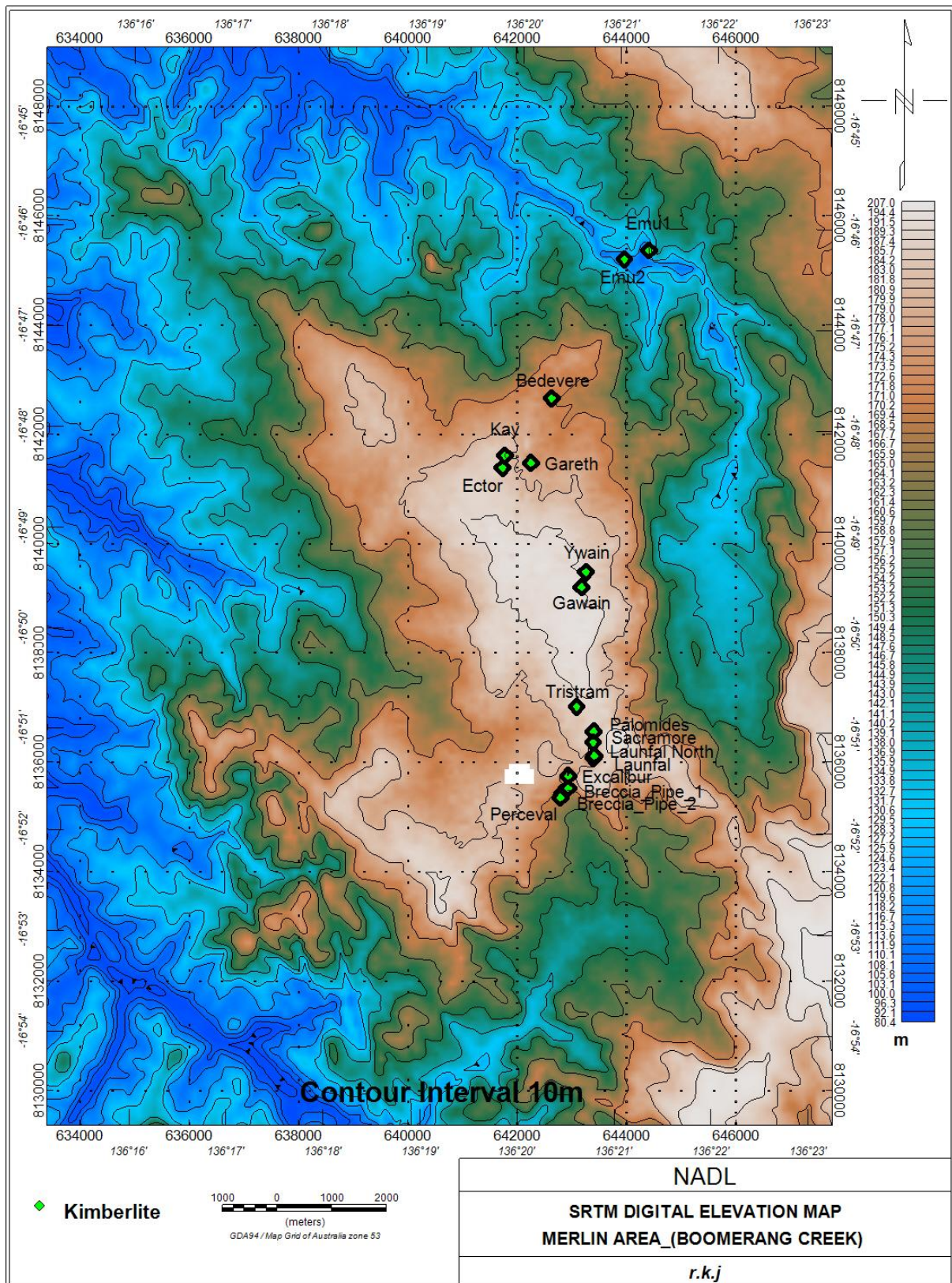
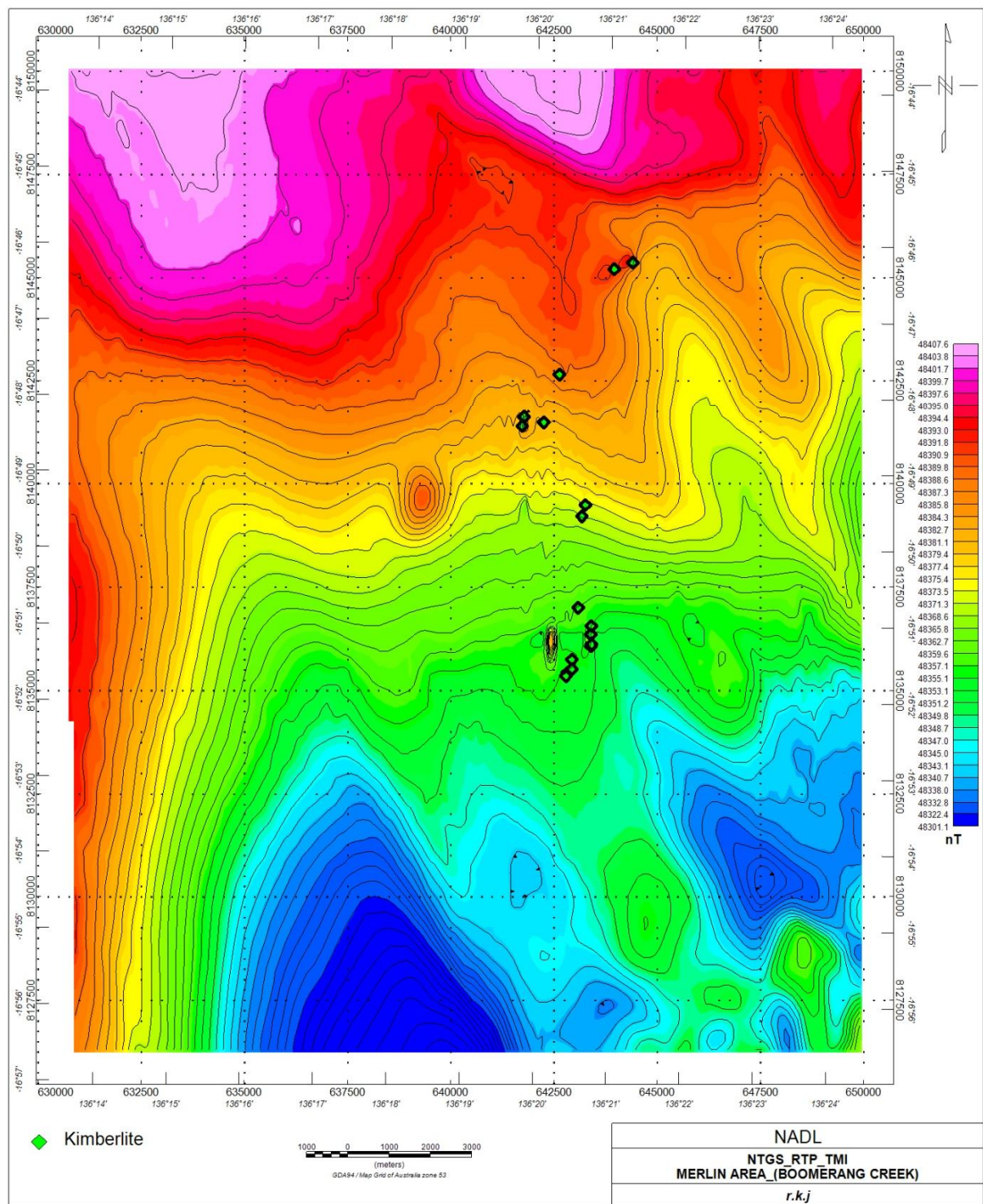


Figure 3- Digital Terrain Image of the region surrounding the Merlin Kimberlite Field



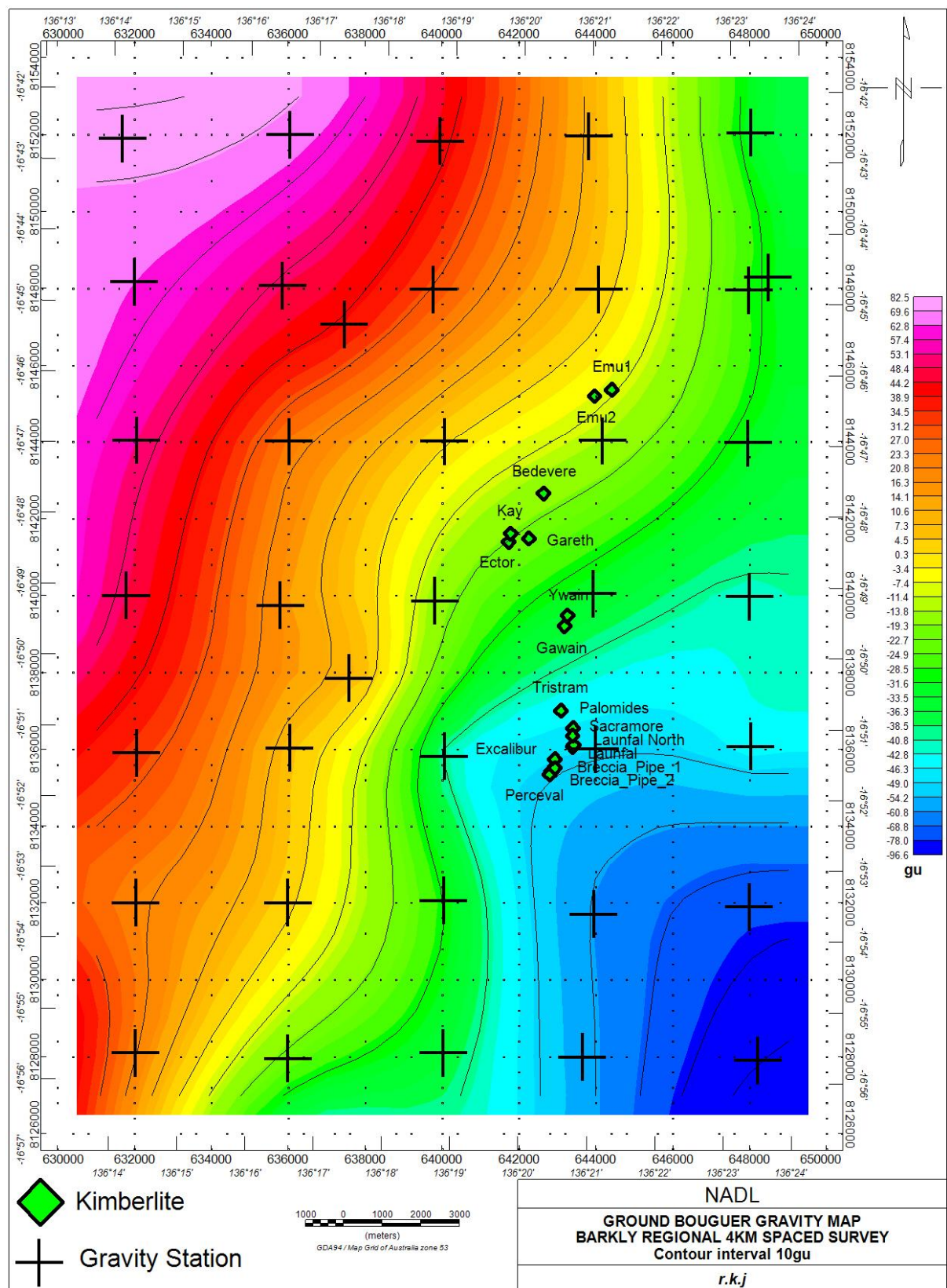


Figure 5- Regional Bouguer Gravity Image – NTGS BARKLY 4KM spaced ground gravity survey

Discussion of Specific Historical Surveys

The following presents images of the major surveys that have been conducted at Merlin with various filtered products that have been applied during the course of the interpretation of the data. Brief summaries are included of some of the ground magnetic surveys which have been conducted over parts of the kimberlite field.

Ashton Mining Initial Fixed Wing Survey

The initial Ashton Mining fixed wing magnetic /radiometric survey totalled 995 line km. Flight lines were flown N-S at intervals of 100m with tie-lines at 10km intervals. The following image is the RTP transformation of the original TMI data.

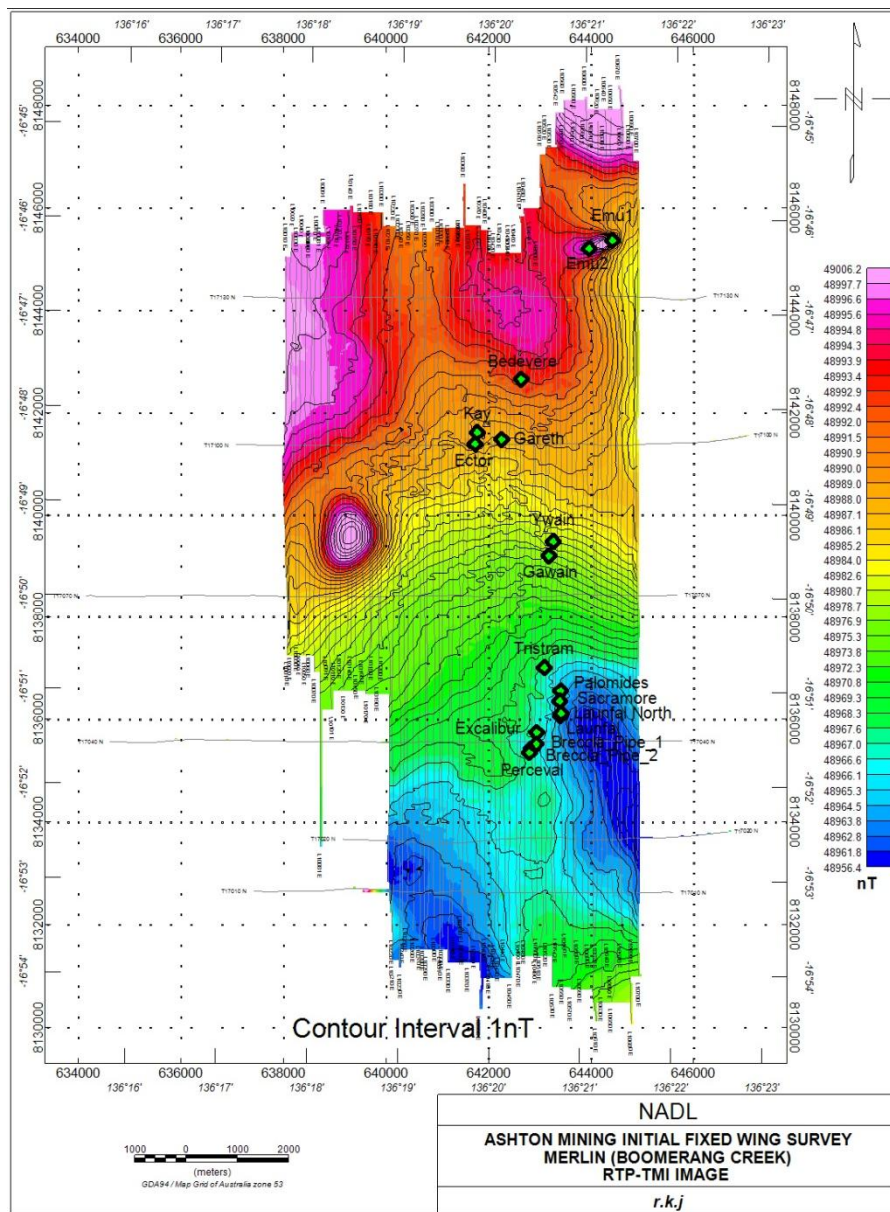


Figure 6– RTP_TMI Image of Initial Ashton Mining Survey flown in 1993-100m line spacing, nominal flying height 70m

Figure7 Hanning Residual RTP_TMI Image highlighting the presence of magnetic laterite on the Merlin Plateau. The majority of kimberlites occur close to the edge of this lateritic surface.



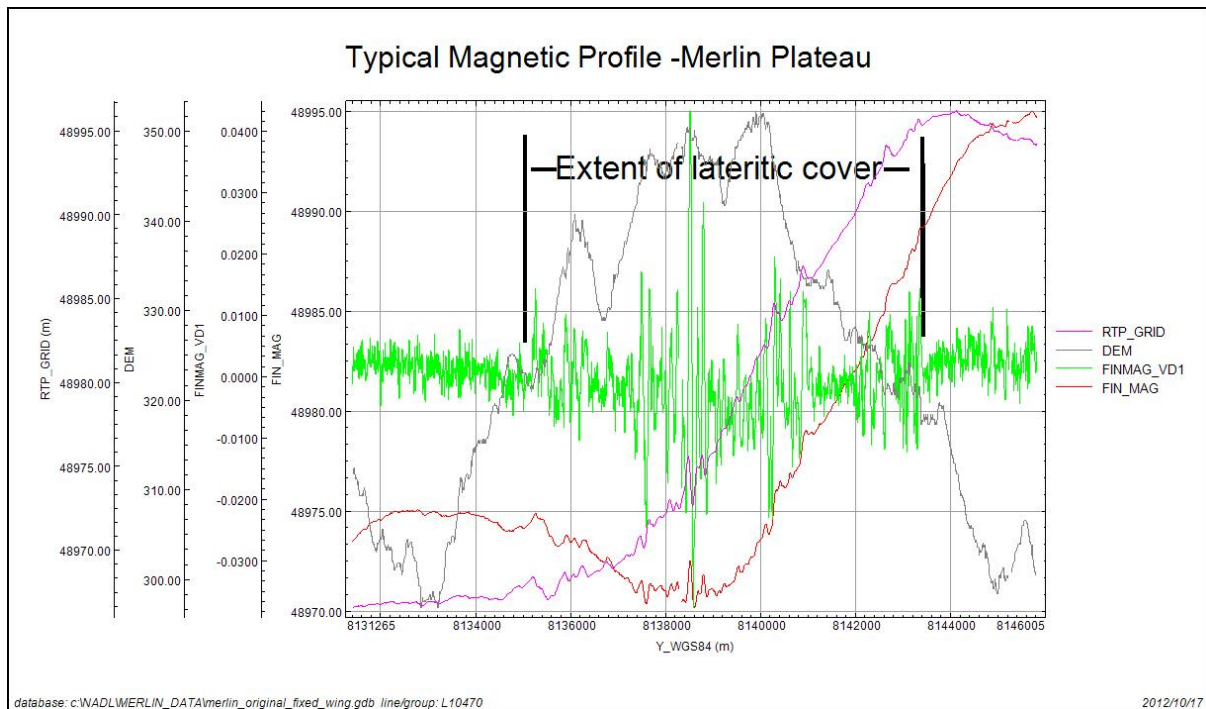


Figure 8 – showing extent and magnetic response of lateritic cover on the Merlin Plateau. The green profile is the 1VD _TMI profile which highlights the extent of the highly magnetic pisolitic laterite on the Merlin Plateau

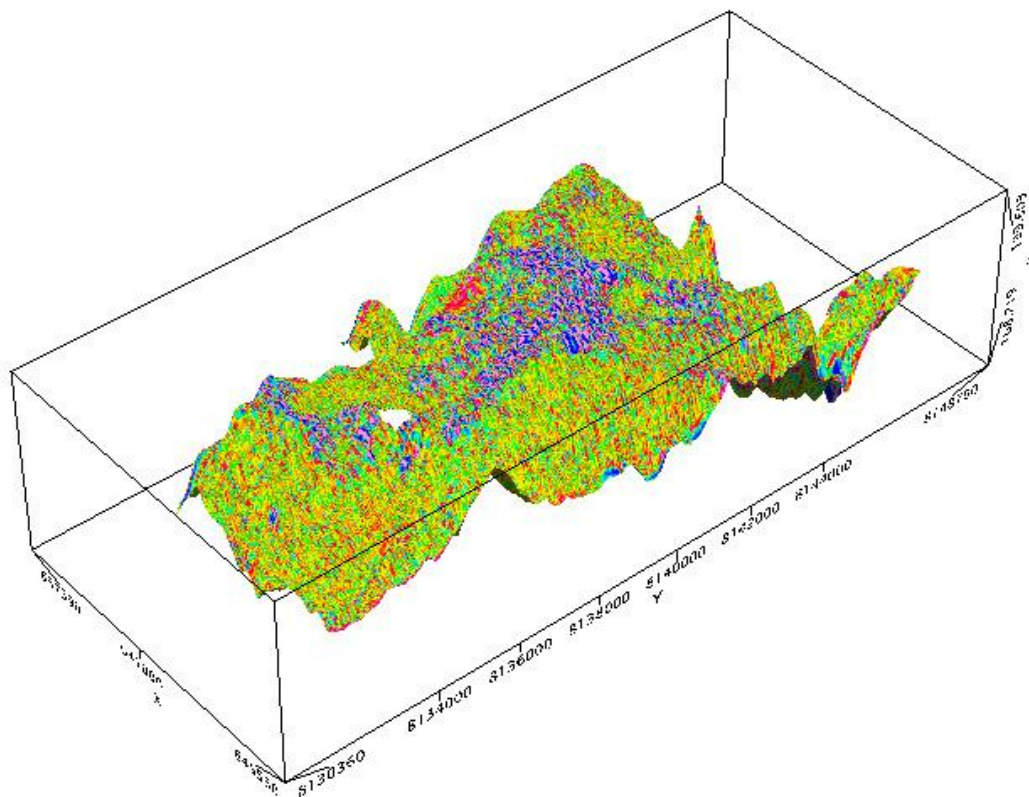


Figure 9 – showing Residual (Hanning) RTP_TMI superimposed on the DTM of the survey area. It highlights the presence of the highly magnetic laterite on the higher ground.

Fixed-wing Magnetic Response of Merlin Kimberlites

The initial Ashton aeromagnetic survey was acquired prior to the presence of significant man-made cultural anomalies and as such offers possibly the best magnetic data-set to assess the magnetic responses of the kimberlites that have been discovered. In light of the success of the HEM and subsequent EM34 surveys and the problems associated with conducting ground magnetic surveys in areas of highly magnetic lateritic materials the magnetic data was not extensively utilised in the search for kimberlites. The following figures show the fixed wing aeromagnetic responses of the kimberlites and highlight the fact that the majority of kimberlites have a distinctive magnetic signature (a notable exception is the Gareth kimberlite).

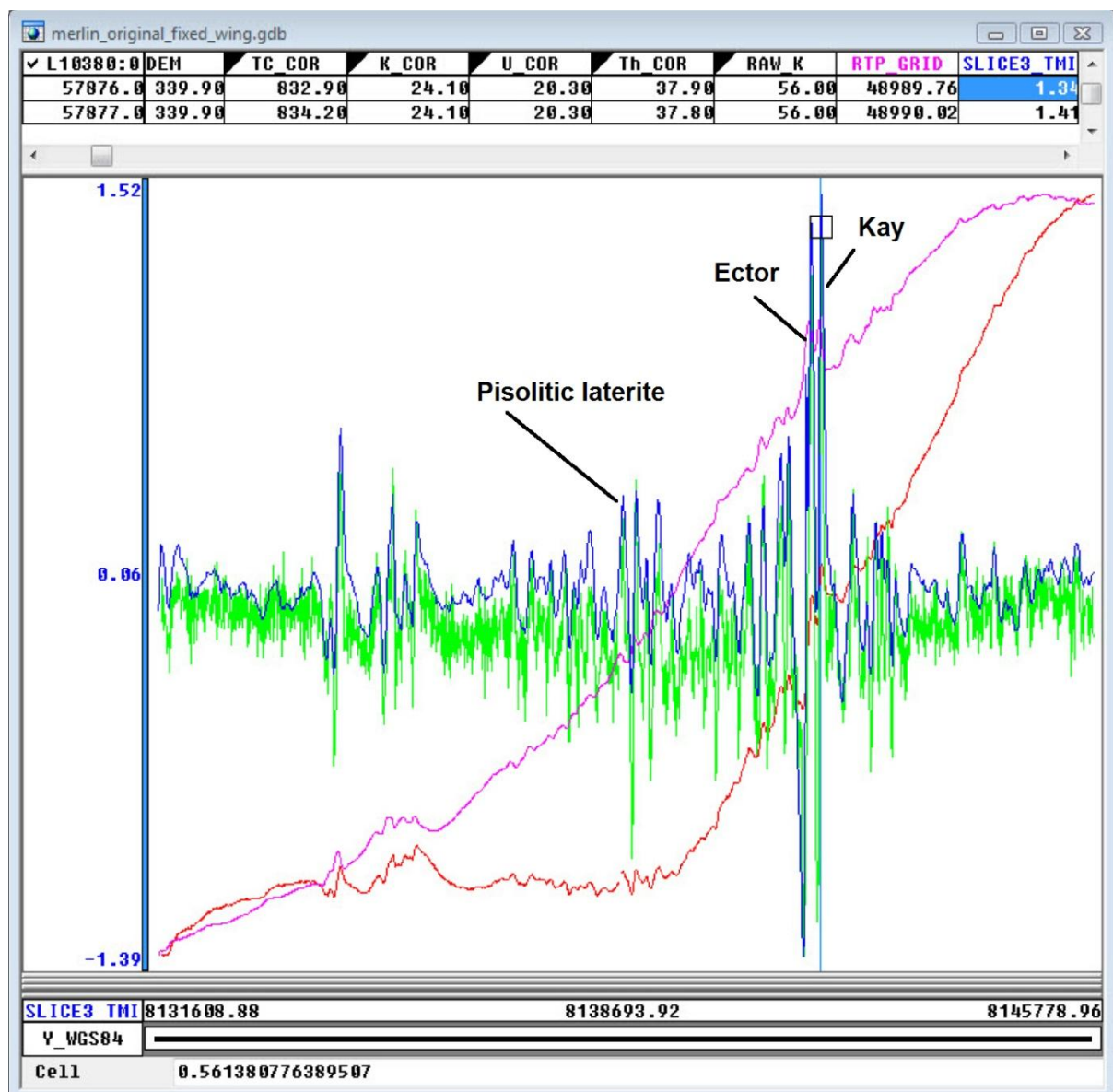


Figure 10– Fixed-wing aeromagnetic response of Kay Ector Kimberlites. Red profile is TMI, magenta is RTP_TMI, green is 1VD_TMI and blue is TMI Slice 3(based on matched filtering)

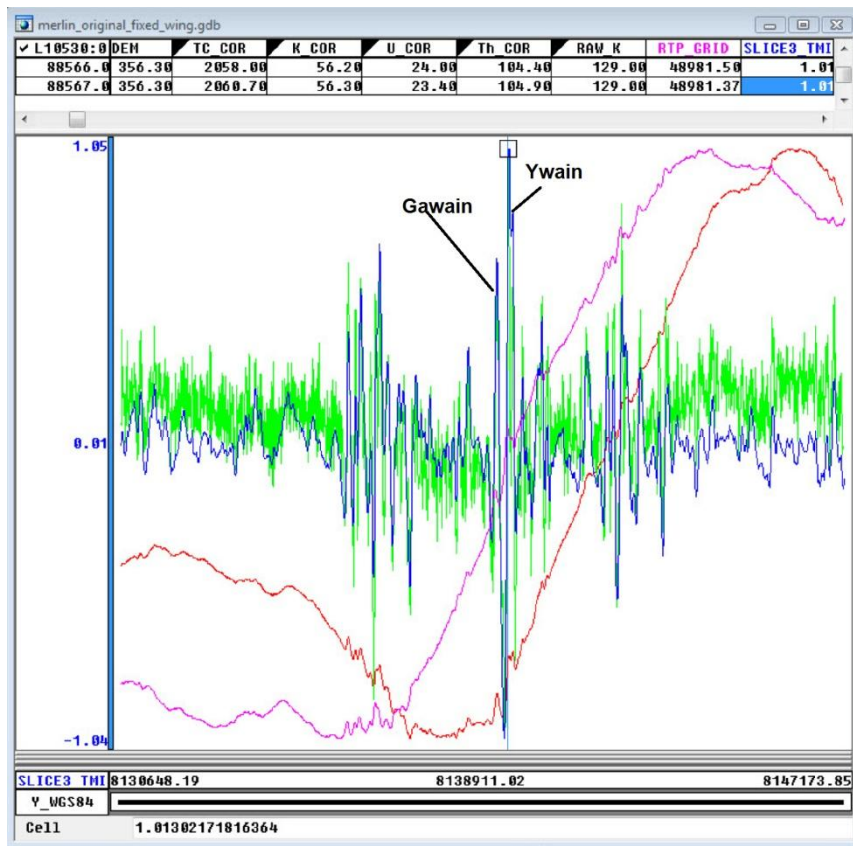


Figure 11– Ywain-Gawain fixed-wing magnetic response

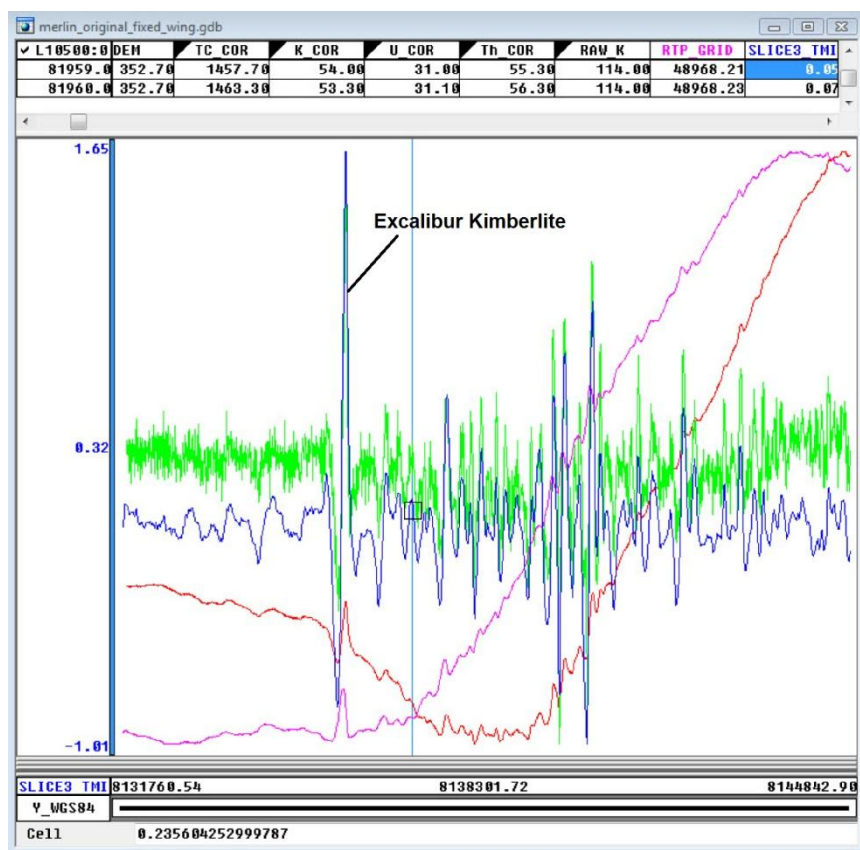


Figure12 – Fixed wing aeromagnetic response over the Excalibur kimberlite

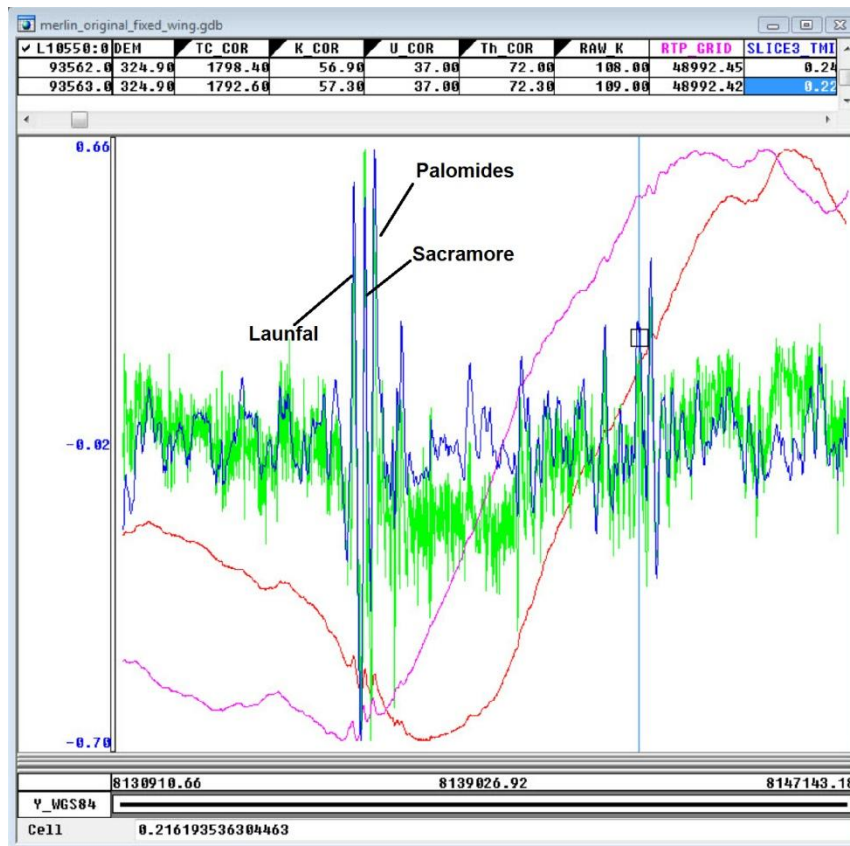


Figure13 – Fixed-wing aeromagnetic response Launfal-Sacramore-Palomides kimberlites

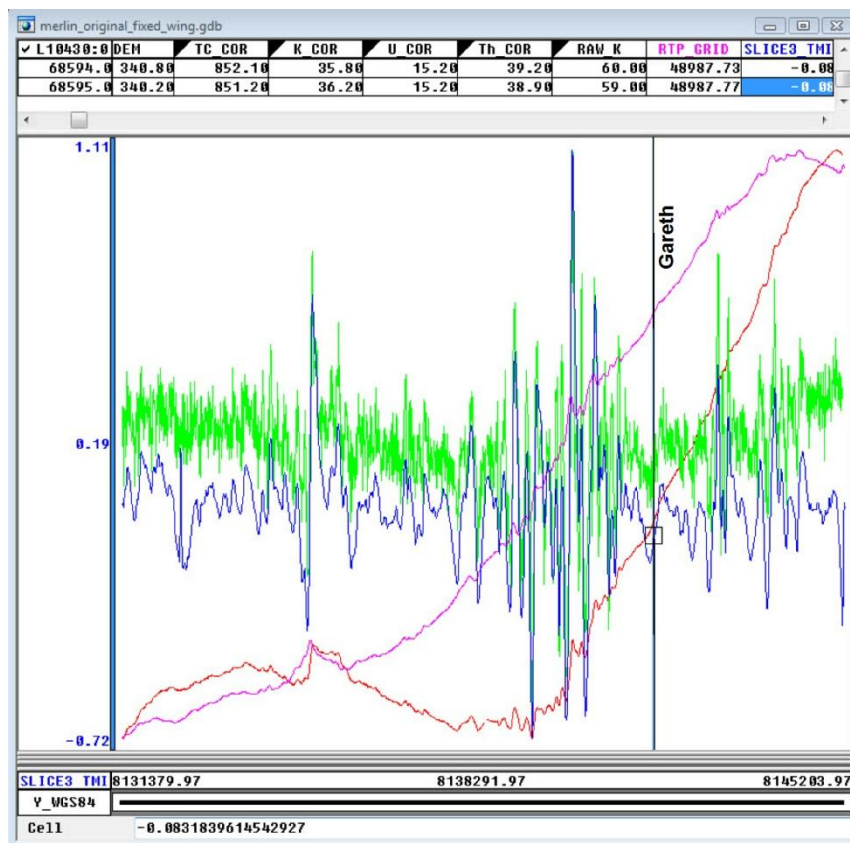


Figure14– Fixed-wing aeromagnetic response –Gareth Kimberlite

Matched Filters of RTP_TMI –Initial Ashton Mining Survey

In order to assess the frequency content of the RTP_TMI response a series of matched filters have been applied to the RTP data and three separate frequency slices have been constructed which highlight the frequency content from long wavelength to short wavelength(high frequency) . These frequency slices are shown in the following images.

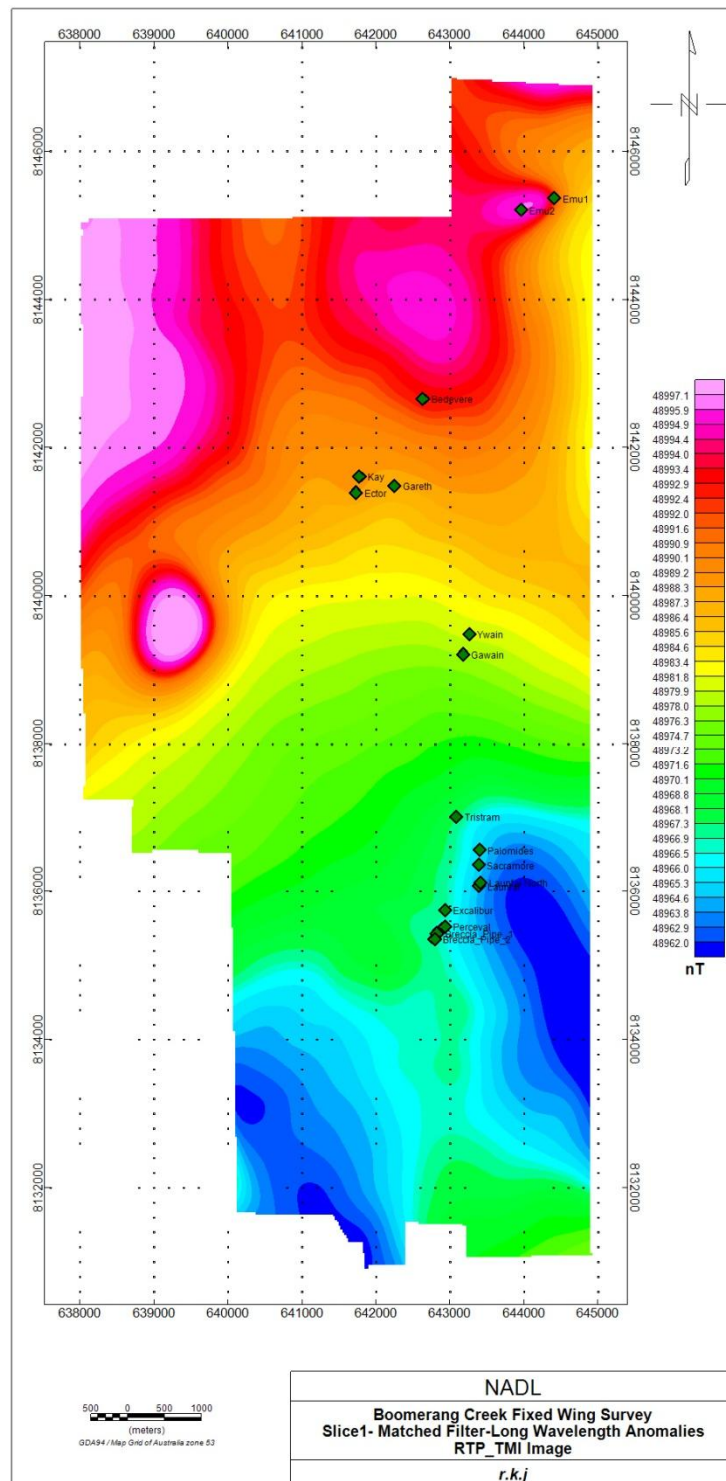


Figure 15– Frequency Slice 1 showing longer wavelength anomalies in RTP_TMI data

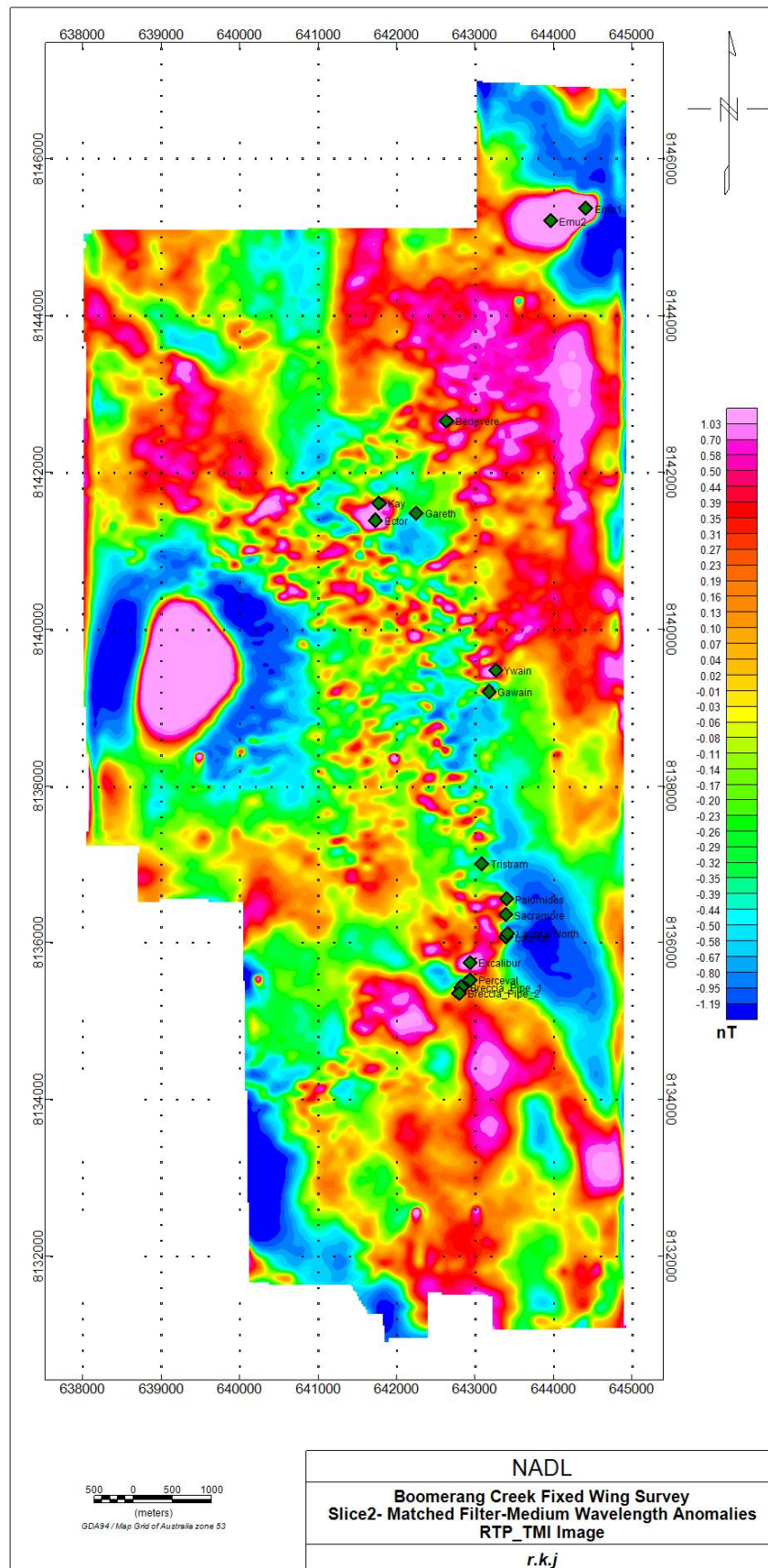


Figure16 – Frequency Slice 2 –medium wavelength anomalies RTP_TMI data

EM Surveys

Time Domain Airborne Surveys

The first airborne EM survey flown was a GeoTem survey flown in July 1993. This survey which was flown along N-S flight lines spaced 200m apart identified a number of the kimberlites but the original data has not been made available for this study. The following image shows the GeoTem response over the Ector kimberlite which shows the responses occurring in the early and on time channels (channels 17,18 and 19).

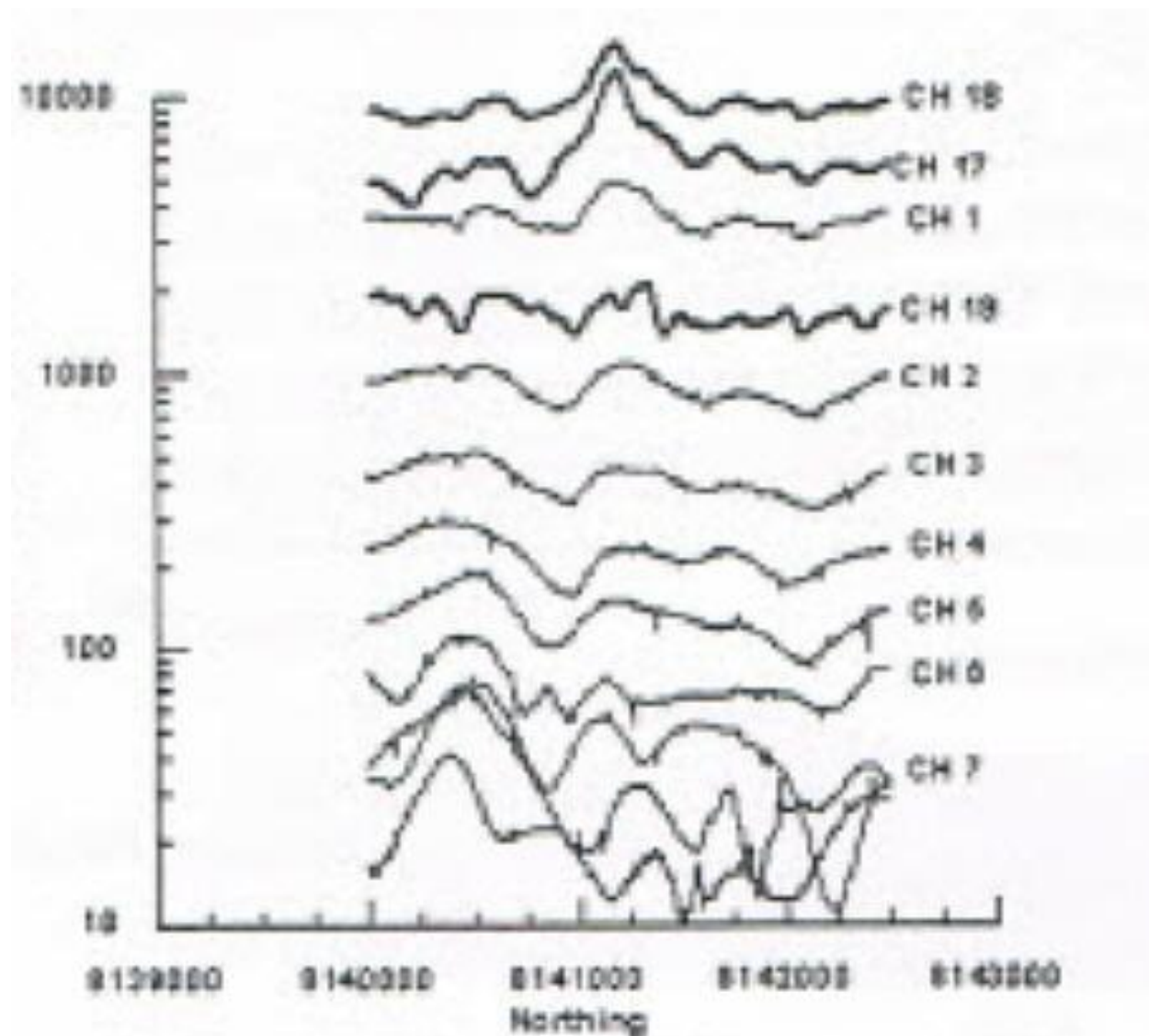


Figure 18– GeoTEM response over the Ector Kimberlite showing responses in the very early (Ch1) and the on-time channels (Ch17-19). Note: - Easting coordinates are in AGD66AMG53

In 1994 Ashton Mining conducted a Dighem HEM survey over the main plateau area where heavy mineral indicators (and diamonds) were shown to be draining from. The survey was flown along N-S traverses at intervals of 200m with the EM sensor at a nominal height of 30m. The following image is of the calculated 56000Hz resistivity.

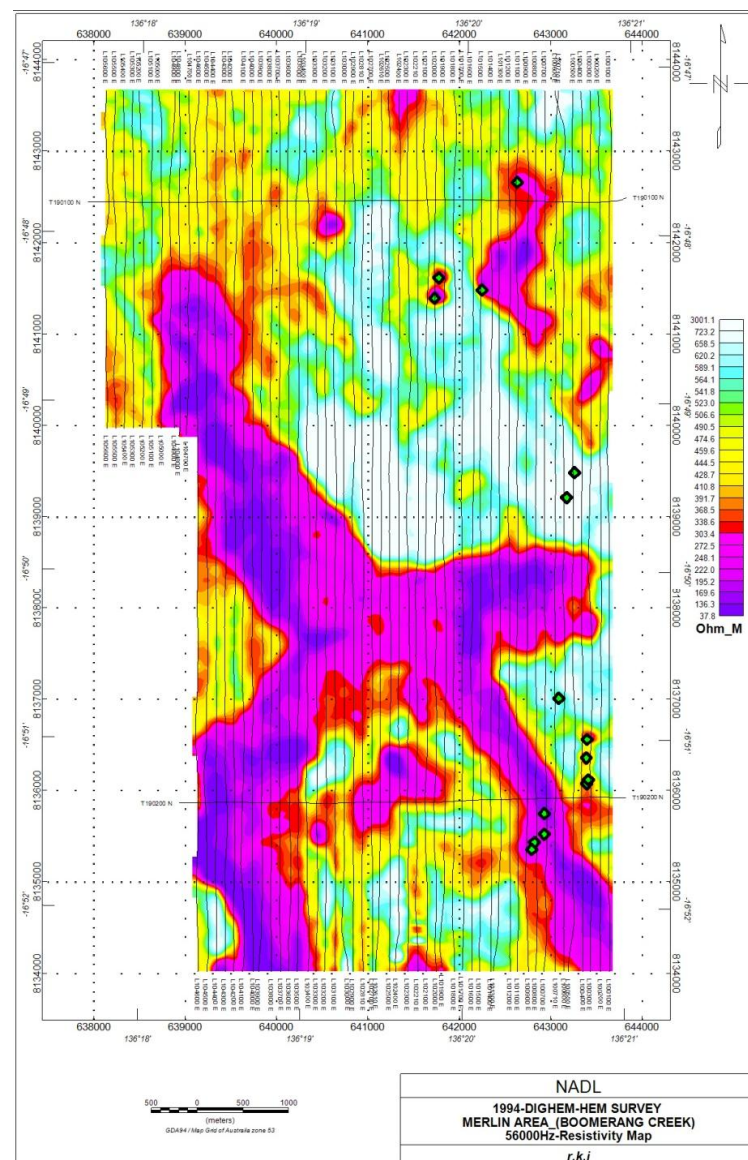


Figure 19 – 56000Hz Resistivity Image from 1994 DIGHEM Survey. This image which reflects the conductivity of the shallow near surface geology shows that the Bukalara Sandstone includes both resistive and conductive horizons. This image also highlights the conductive response of some of the kimberlites

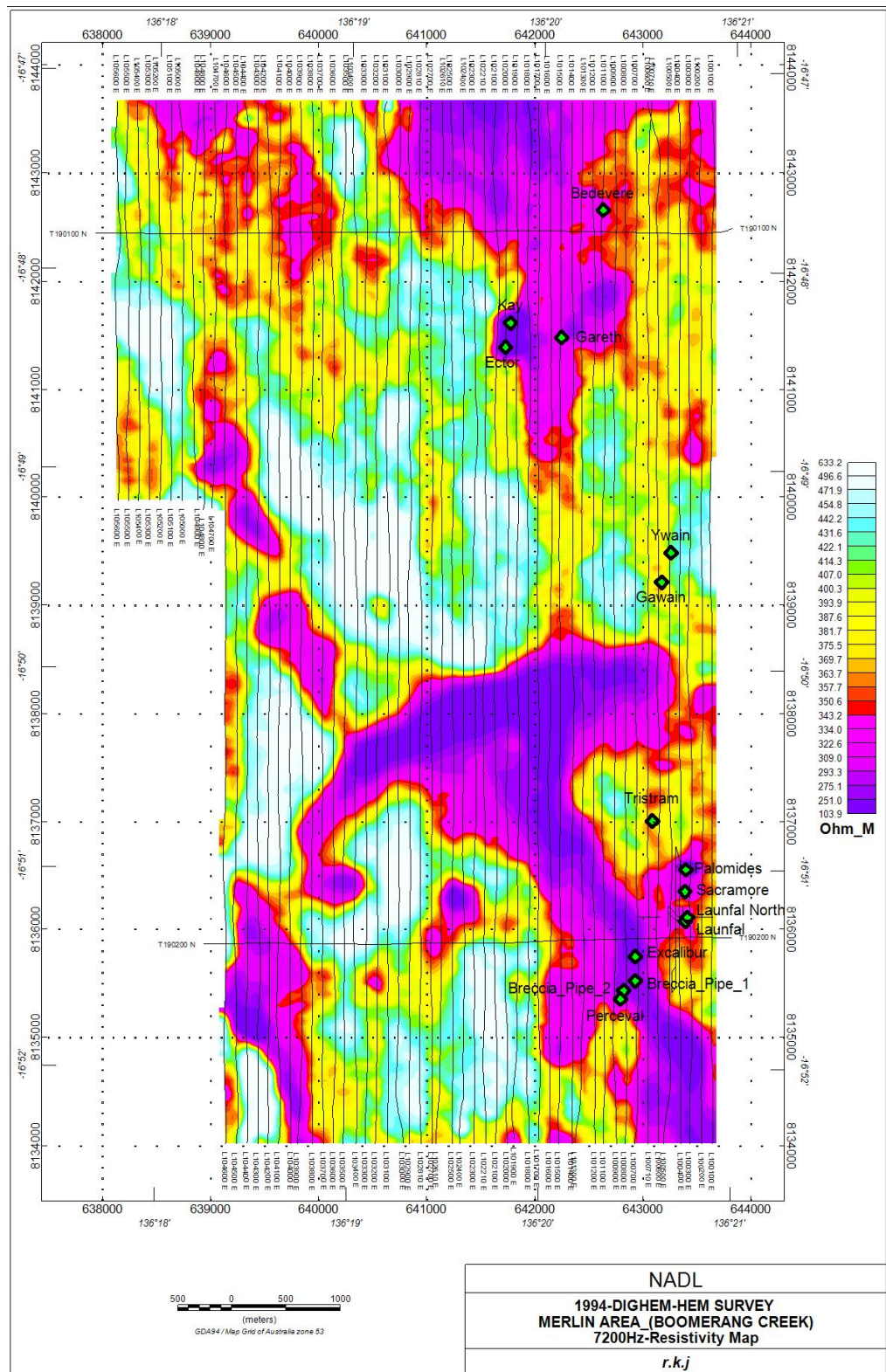


Figure 20 – Merlin 7200Hz calculated resistivity response over the Merlin Plateau

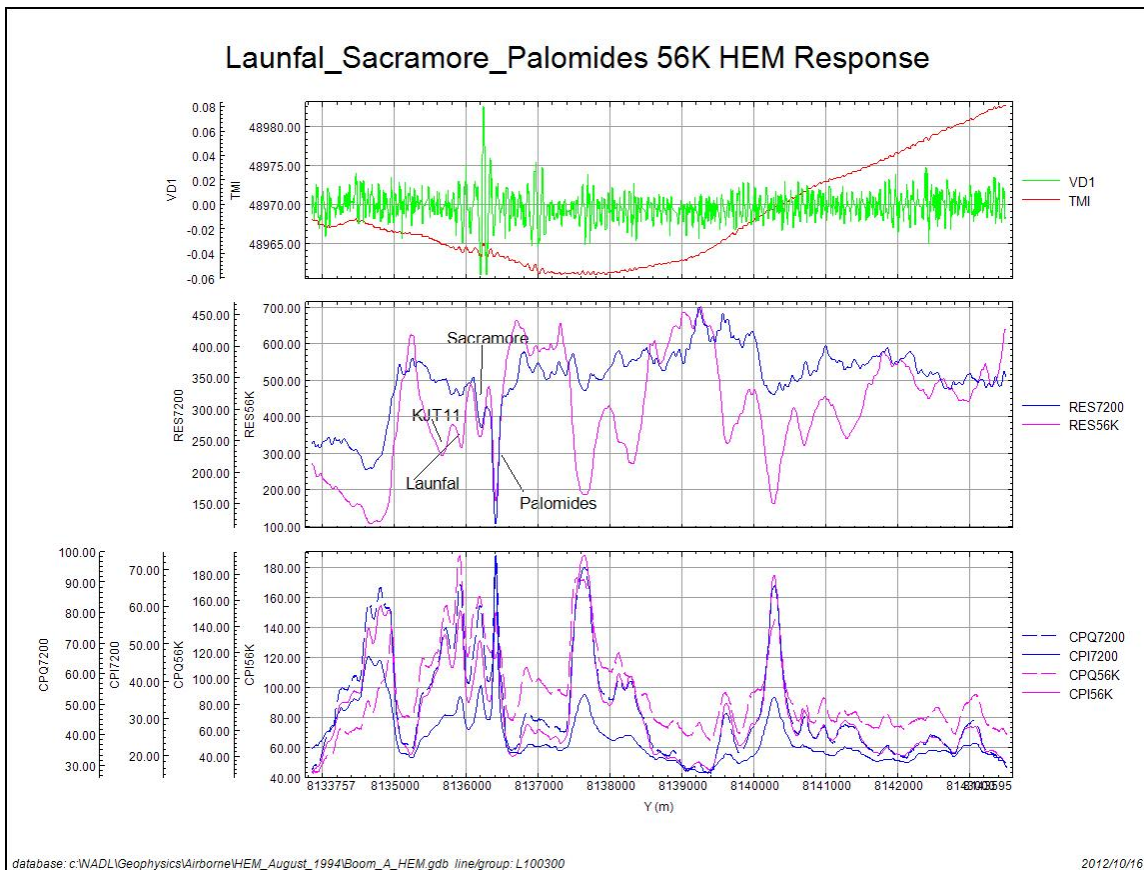


Figure21 – HEM Profile through the Launfal-Sacramore-Palomides kimberlites showing the amplitude and frequency of the kimberlite responses relative to conductive Bukalara Sandstone

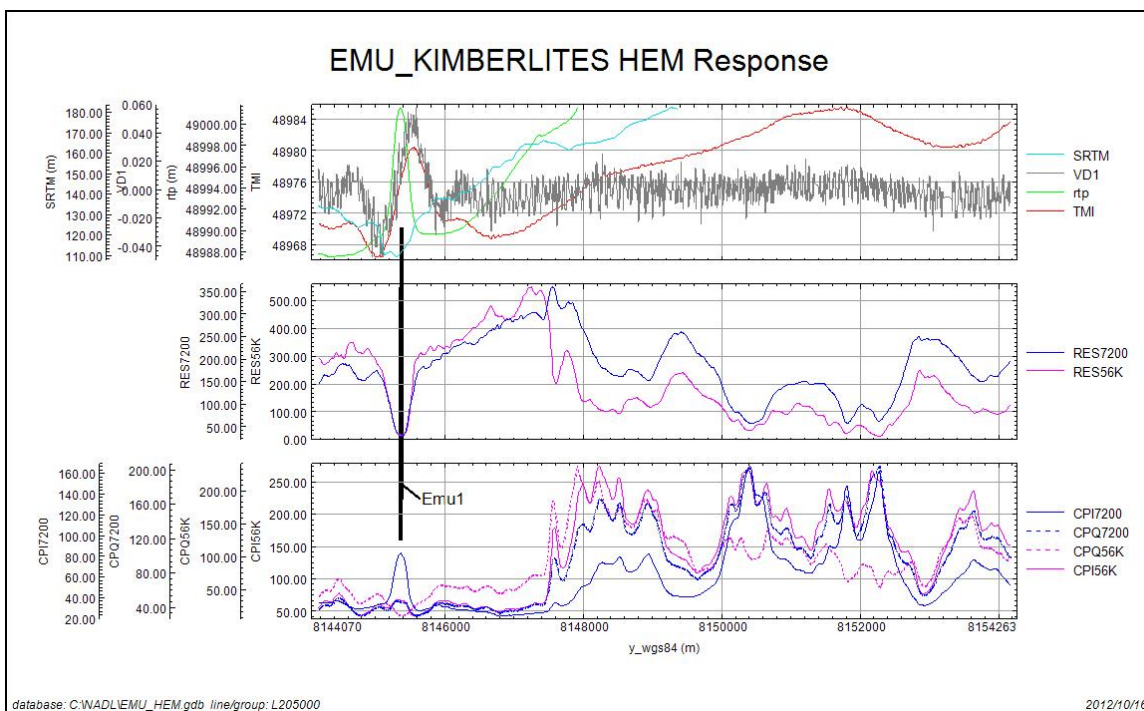


Figure22 – HEM PROFILE across the Emu1 kimberlite showing the magnetic, resistivity and conductivity plots.

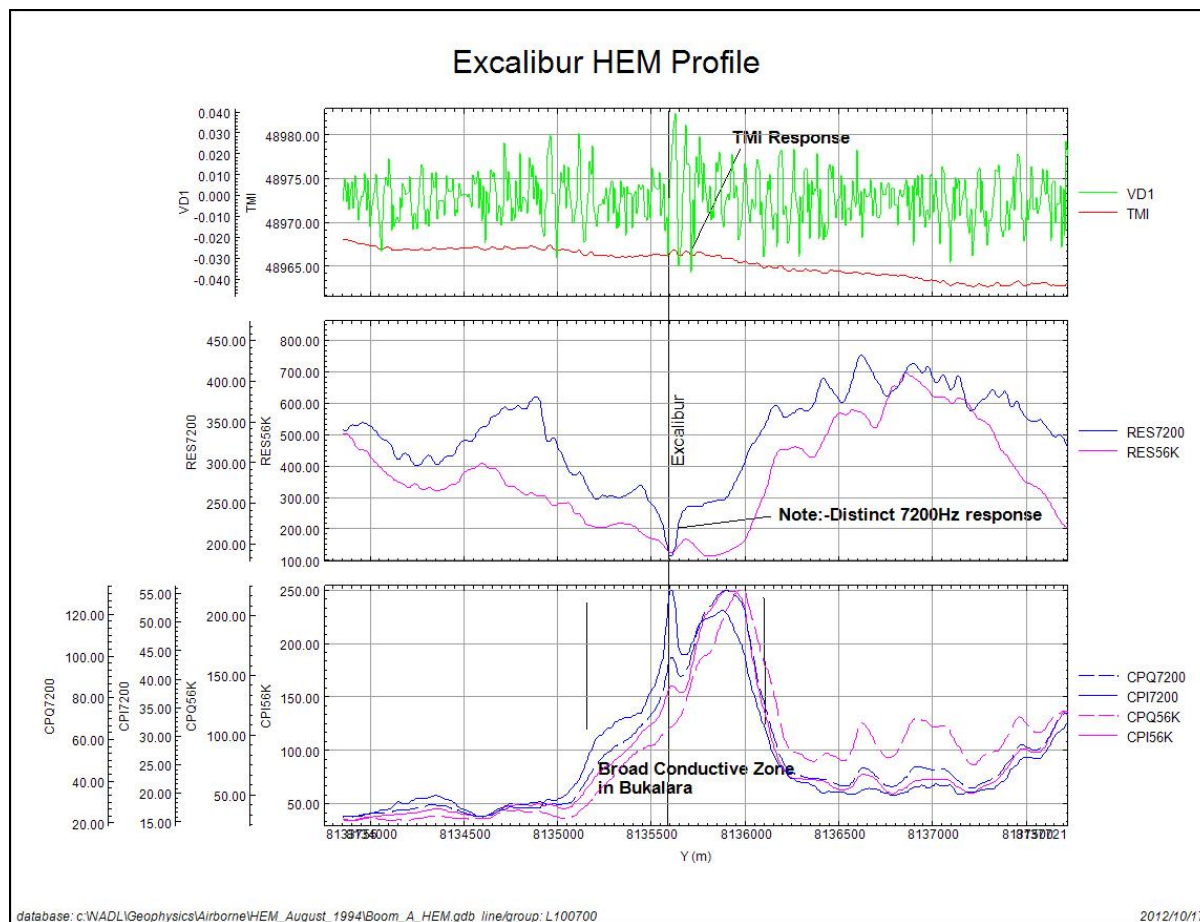


Figure23 – HEM Profile across Excalibur Kimberlite showing strong 7200Hz response in broad conductive Bukalara sandstone

Ground EM Surveys

Following the success of initial trials at the site of the Excalibur kimberlite and the successful follow up of the GeoTEM survey EM34 surveys were undertaken over virtually the entire Merlin Plateau which not only confirmed the airborne anomalies but also led to the discovery of additional kimberlites. This proved to be a very cost effective method of exploring for kimberlites



Figure24 – showing likely configuration of the EM34 coils for the Merlin surveys

It is thought that the majority of the EM34 surveys at Merlin were undertaken with a 20metre separation with the coils in the horizontal dipole mode (i.e. coils aligned perpendicular to ground)

The following image shows the merged EM34 conductivity plot.

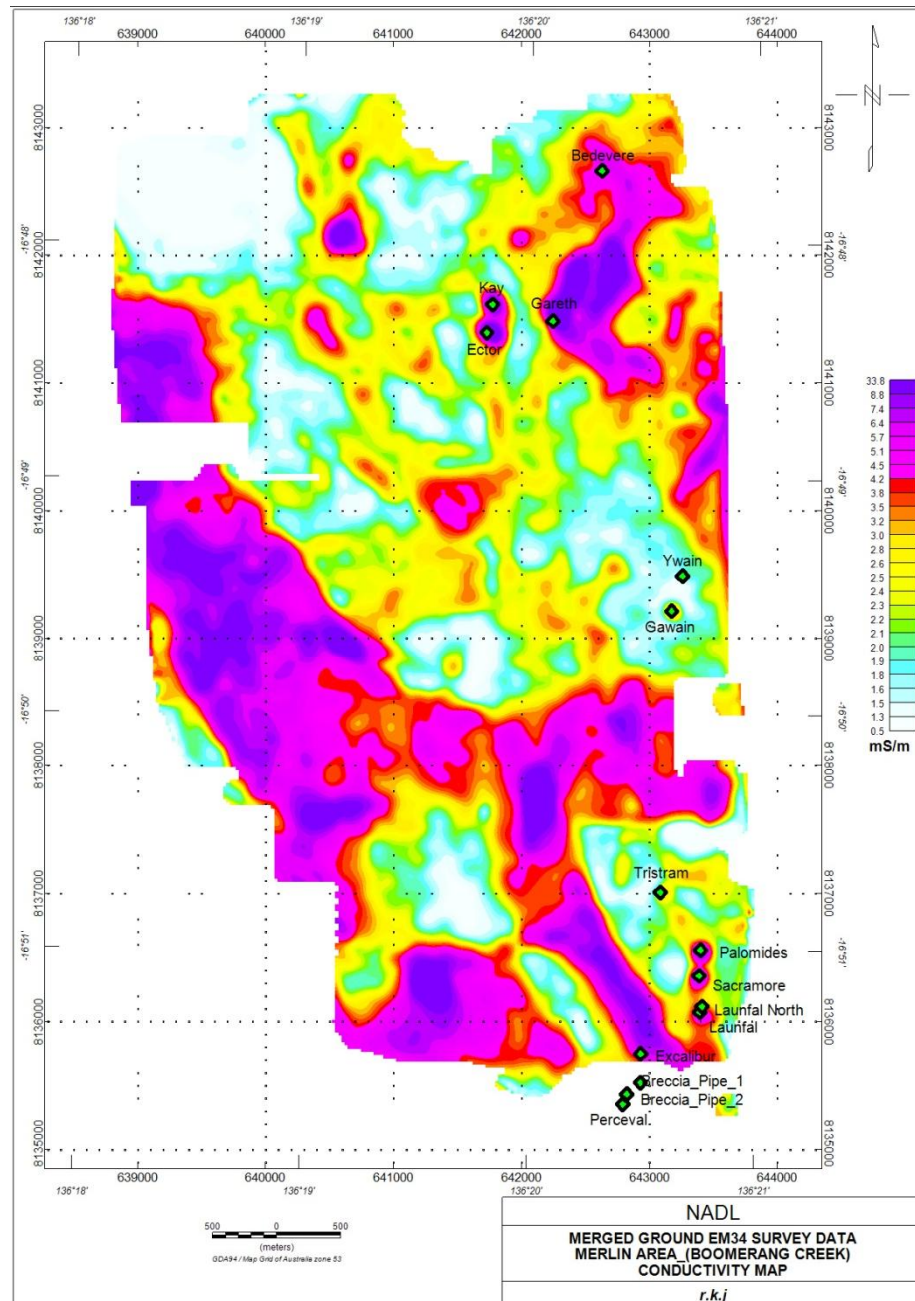


Figure25 – EM34 Conductivity Image of the Merlin Plateau compiled and merged from a number of smaller surveys. It is believed that the above image represents surveys conducted with the coils in the horizontal dipole mode with a coil spacing of 20m.

The following images compare the response of EM34 and Dighem HEM data over the Bedevere kimberlite. The EM34 profile is an E-W profile and the Dighem HEM is N-S profile.

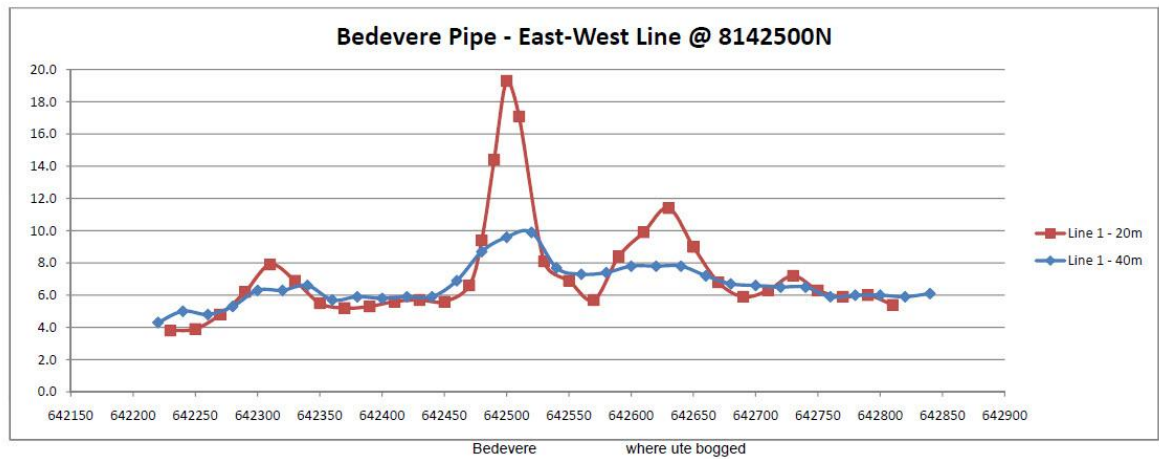


Figure26 – West to East EM34 profile across Bedevere kimberlite with 20m coil separation in red and 40m coil separation in blue. (Note the northing in the above figure is in AGD66AMG53).

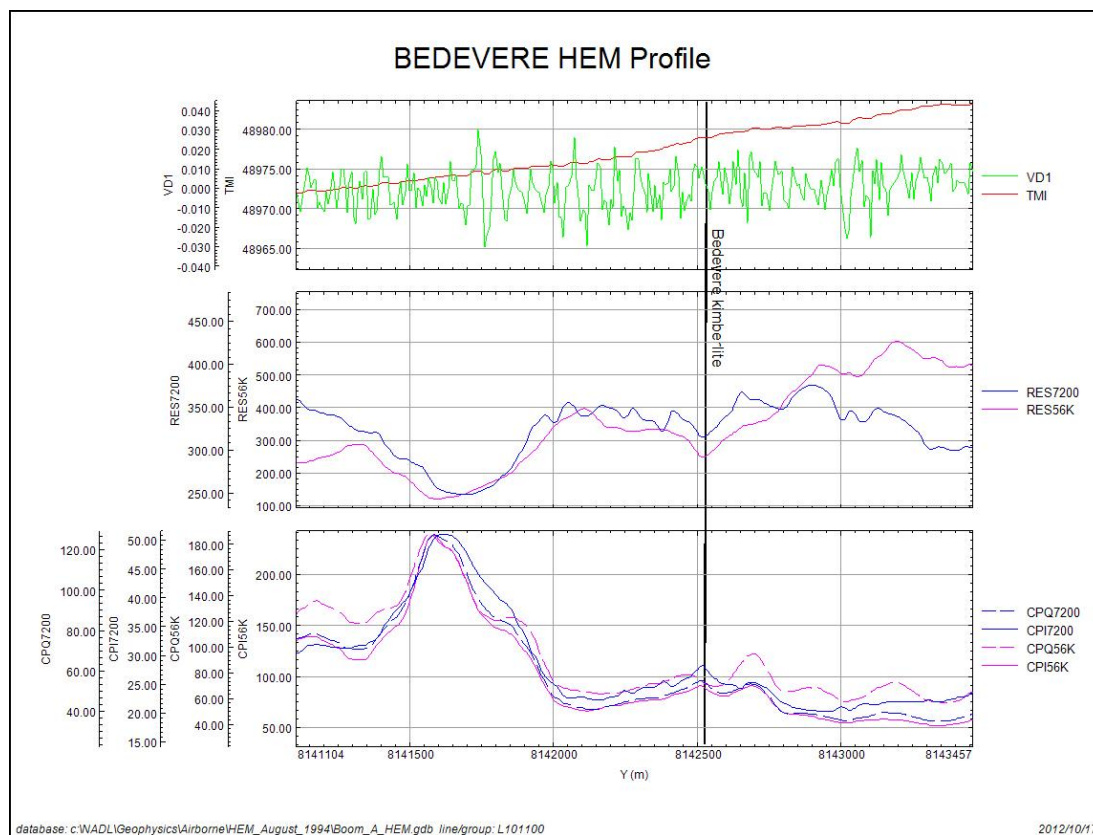


Figure27 – N-S HEM profile across Bedevere Kimberlite. The HEM response is present at both 56000Hz and 7200Hz. The amplitude of the kimberlite is significantly less than conductive Bukalara to the south. A slight TMI response is present over the kimberlite (red profile).

Gravity Surveys at Merlin

Both airborne and ground gravity surveys have been conducted at Merlin with varying success. In 1999 Ashton Mining undertook ground gravity surveys over selected kimberlites and further ground gravity work was undertaken to the west by Rio Tinto following the takeover of Ashton Mining by Rio Tinto.

A Comparison of Falcon Data with Ground Gravity data.

The following image is of the ground Bouguer response of the Ywain and Gawain kimberlites. The precise status of the kimberlites at the time of the survey is not known but it is assumed that the kimberlites had not been extensively mined. The following image is of the bouguer gravity at Ywain and Gawain kimberlites.

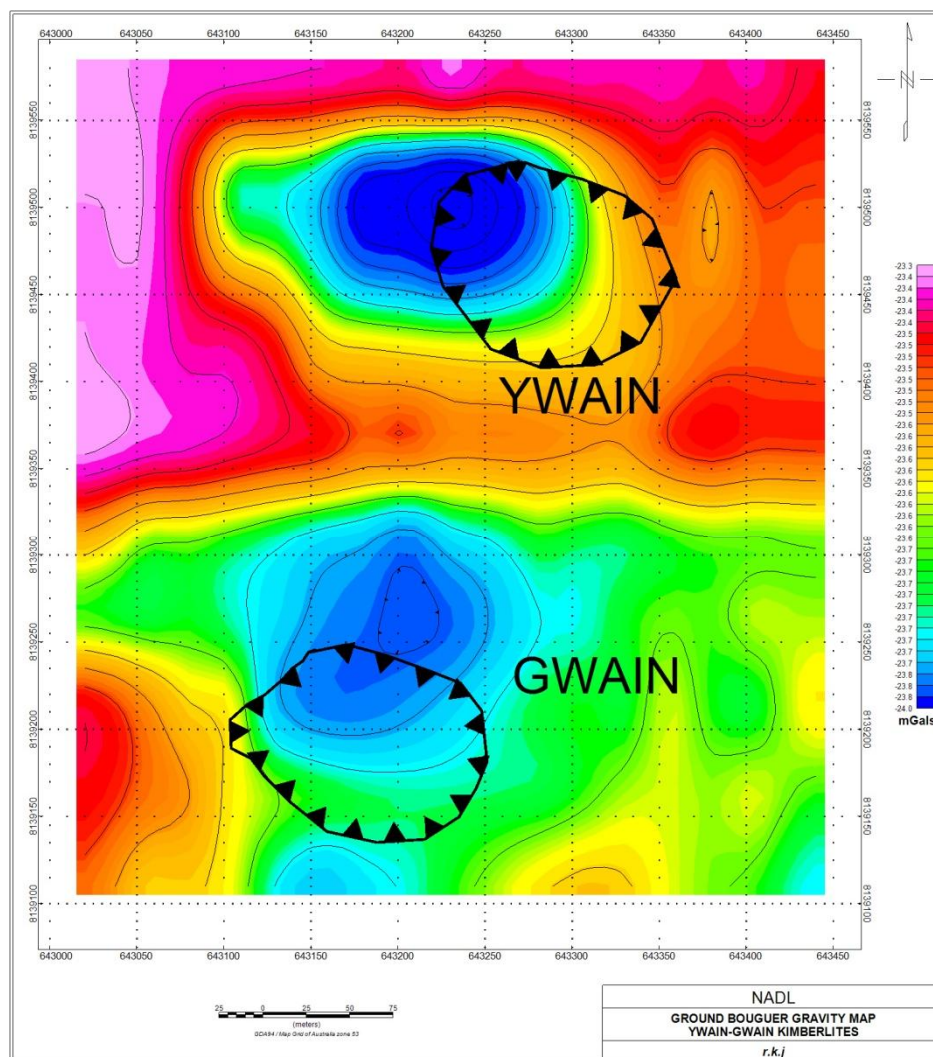


Figure28 – Ground Bouguer gravity images of survey conducted in 1999 at the site of the Ywain and Gawain kimberlites. The outline of the kimberlites is based on a digital terrain image compiled by BHP as part of the Falcon survey conducted in 2000. Both datasets are in datum and projection GDA94MGA53 and the relatively poor correlation is not fully understood.

In 2000 prior to the takeover of the project by Rio Tinto BHPB flew the Falcon gravity gradiometer system over the Merlin kimberlites to evaluate the response of the airborne gradiometer system. BHPB flew the survey at no cost and retained the ownership of the data. In 2003 BHPB reprocessed the data and have subsequently made the digital data available to NADL. The following image is of the GDD component calculated assuming a density of 2.1 for the Bukalara Sandstone. At the time of this survey a number of the kimberlites had been mined which may explain the poor correlation between the kimberlites and the GDD response.

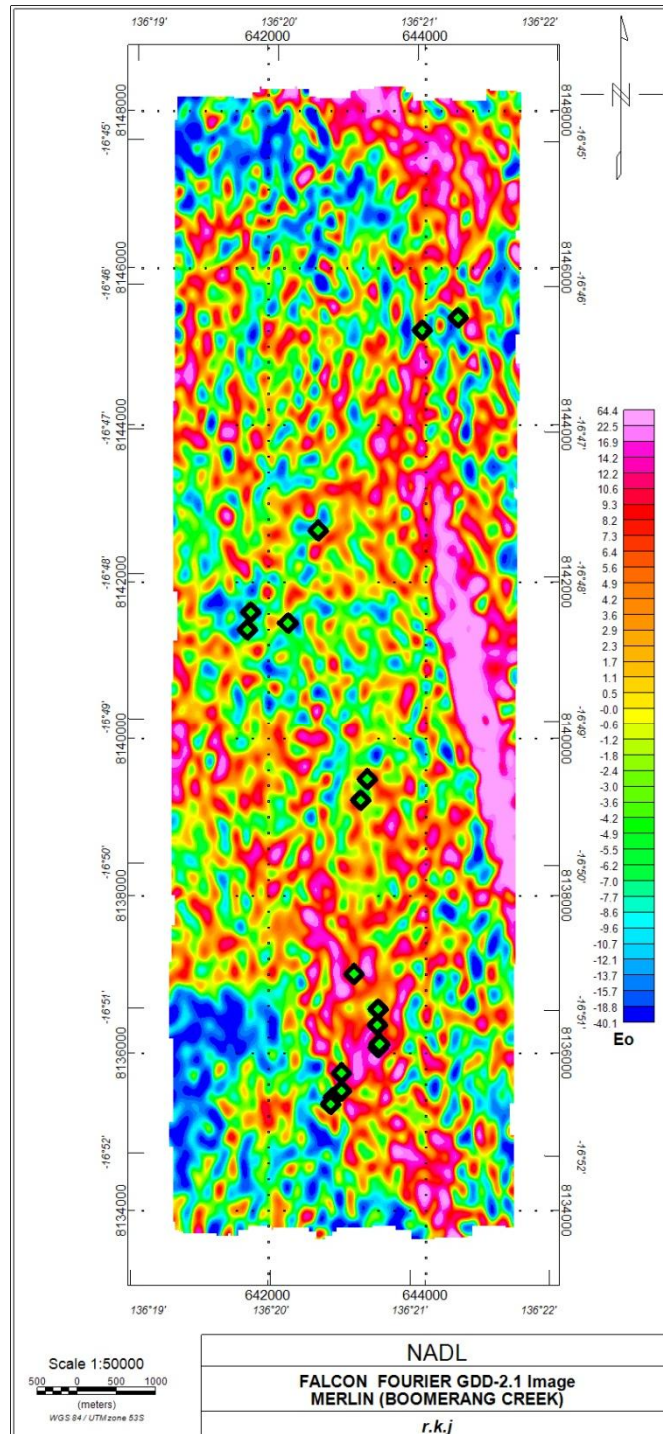


Figure29 – Falcon Fourier GDD 2.1 Image

The following images show a comparison of the ground gravity at Ywain and Gawain with the GDD response from Falcon.

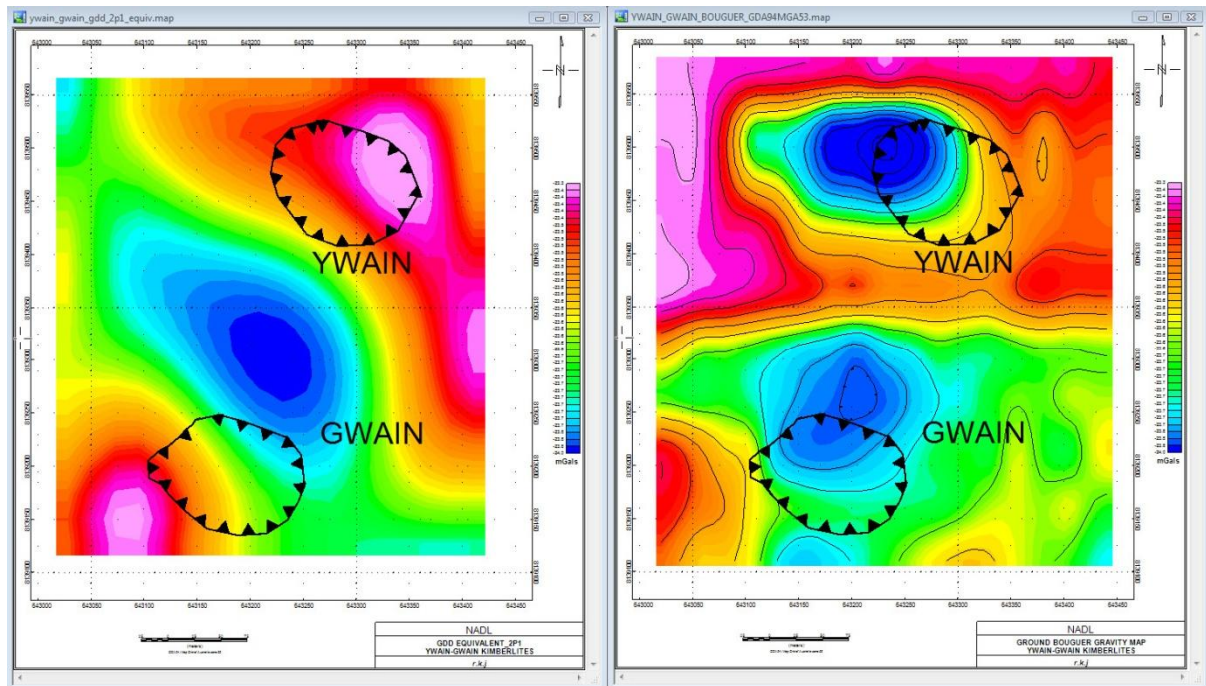


Figure30 – showing comparison of Falcon and ground gravity surveys at Ywain-Gawain kimberlites. N.B the BHPB DTM from the Falcon survey suggests that at the time the Falcon survey was flown the kimberlites had been quite extensively mined.

At the time of the Falcon survey it appears from the Falcon DTM that the Ector kimberlite had not been extensively mined. An earlier ground gravity profile across Ector showed a gravity “low” of approximately 3.5gu (0.35mGals) (see Figure 31).

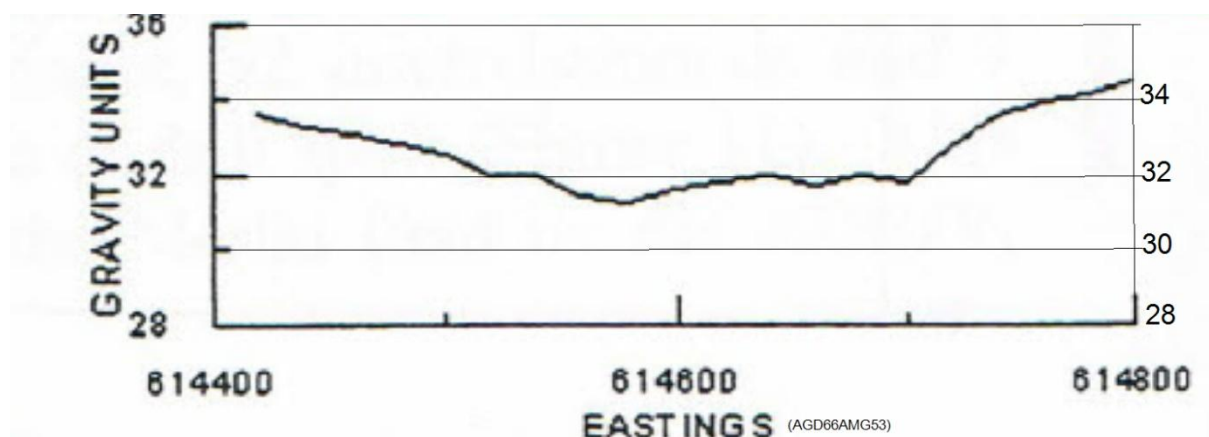


Figure31 - showing W-E Bouguer Gravity Profile across Ector Kimberlite. Note:-easting coordinates are in datum and projection AGD66-AMG53.

The following image shows S-N Falcon Profile across the Ector pipe prior to any extensive mining of the kimberlite.

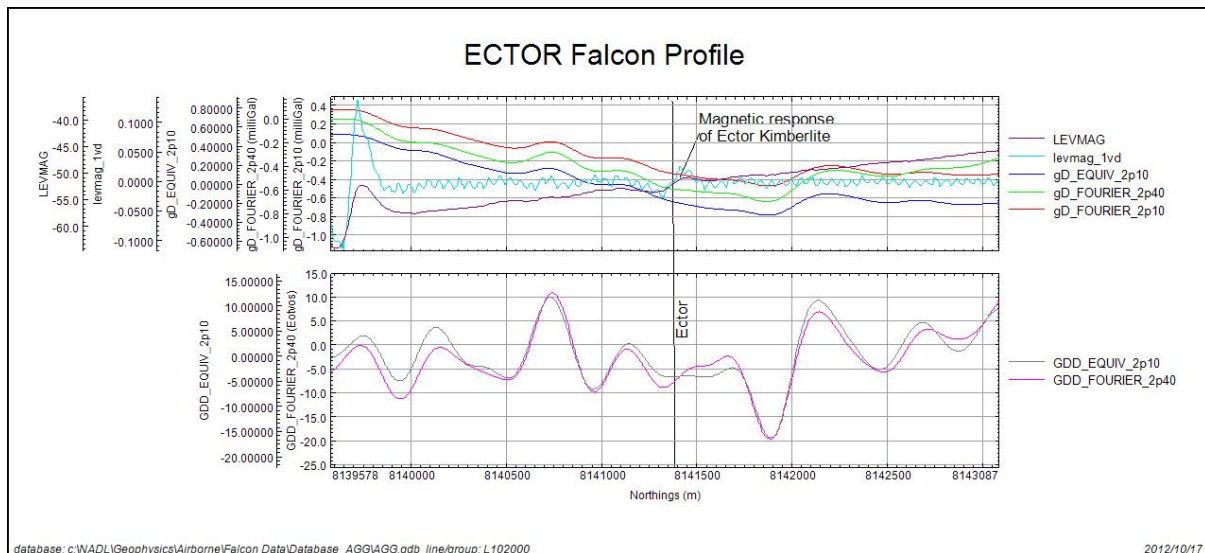


Figure32 – gD/GDD Falcon profile across the Ector kimberlite prior to any extensive mining. Note the lack of any obvious gravity response and the subtle but clearly defined magnetic response of the kimberlite.

N.B:-As the following figures will show kimberlites over which ground gravity profiling was undertaken showed a characteristic and expected gravity "low".

Other ground geophysical surveys conducted at Merlin

Following the discovery in 1992 of the Excalibur kimberlite a number of different ground geophysical methods were applied to test the response of the kimberlite

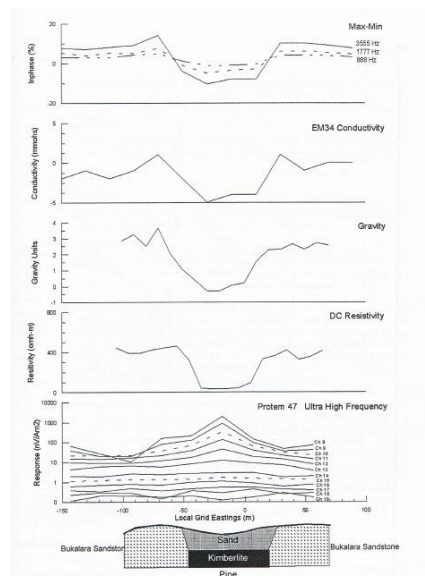


Figure33 – Ground Geophysical Response of Excalibur Kimberlite. Note the prominent 0.3mGals (3gu) negative bouguer gravity response (centre panel) and conductive signature of kimberlite.

The following figure combines the ground and airborne geophysical responses of the Ector kimberlite. Note the pipe is also visible on the Time Domain airborne EM data which was not available for this study. Also note the prominent Bouguer gravity response (Top Right Profile).

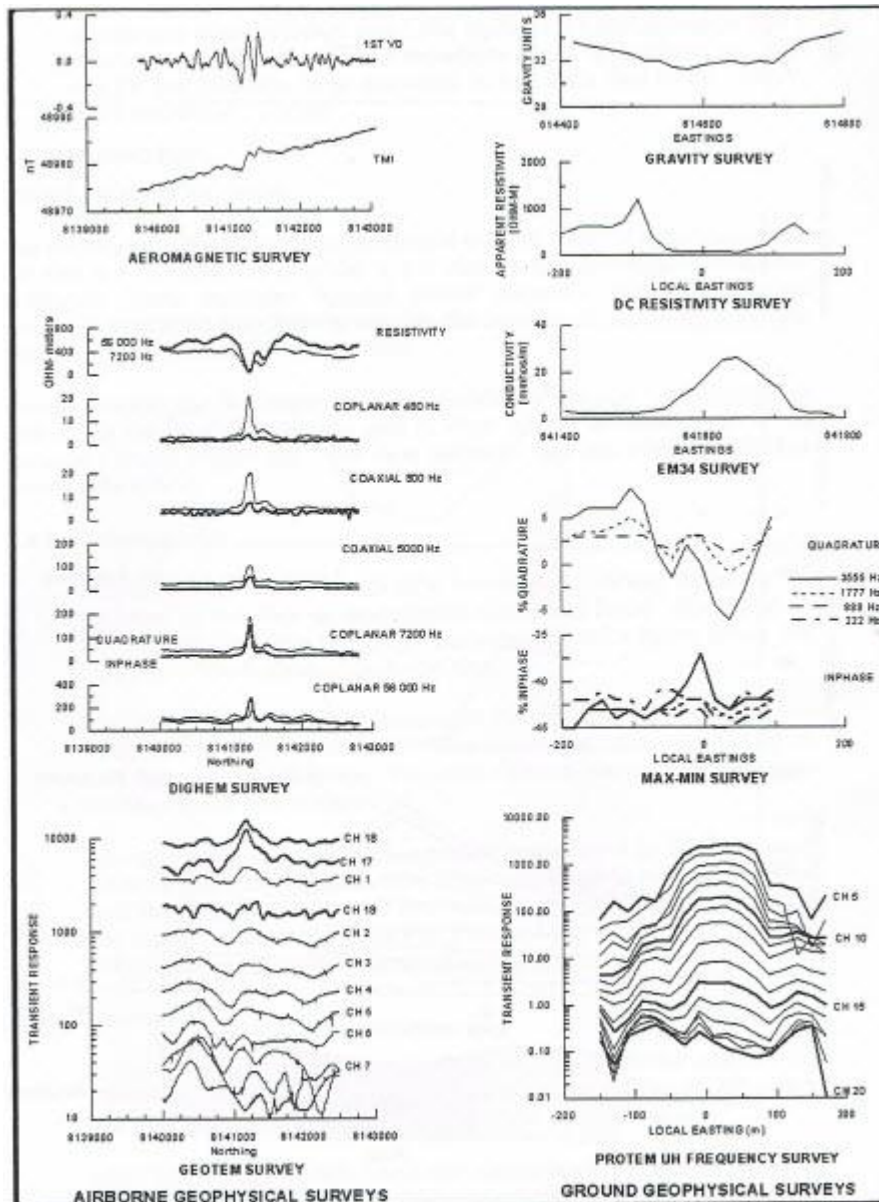


Figure34 – showing both ground and airborne geophysical responses of the Ector pipe.

(Source –Reddiciffe-Diamond Exploration Techniques Conference July 1999)

Discussion of Selected Anomalies

The identification of potential kimberlite targets is based largely on the interpretation of the initial aeromagnetic data which is relatively free of any significant cultural anomalies and the frequency domain Dighem HEM data. The time domain data has not been available for the study. The BHP Falcon airborne gravity gradiometer data has also been referenced but comparisons between ground gravity surveys and the Falcon data show little correlation. This may well be due to the fact that many of the kimberlites had undergone trial mining prior to the Falcon survey and much of the low density infill material had been removed. A comparison of the Falcon response with ground profiling at the Ector kimberlite, where little significant mining had occurred at the site of the Ector kimberlite, shows very little response in the Falcon data but a 0.3mGal Bouguer "low" anomaly in ground gravity profiling.

The interpretation of the data has followed fairly conventional lines with analysis primarily of profile data provided by NADL. Images have been created of the magnetic and HEM data including transformations of the TMI magnetic data to RTP_TMI images.

The magnetic data has been subjected to 3D inversion which has proven to be a very useful and informative way of visualising the magnetic data.

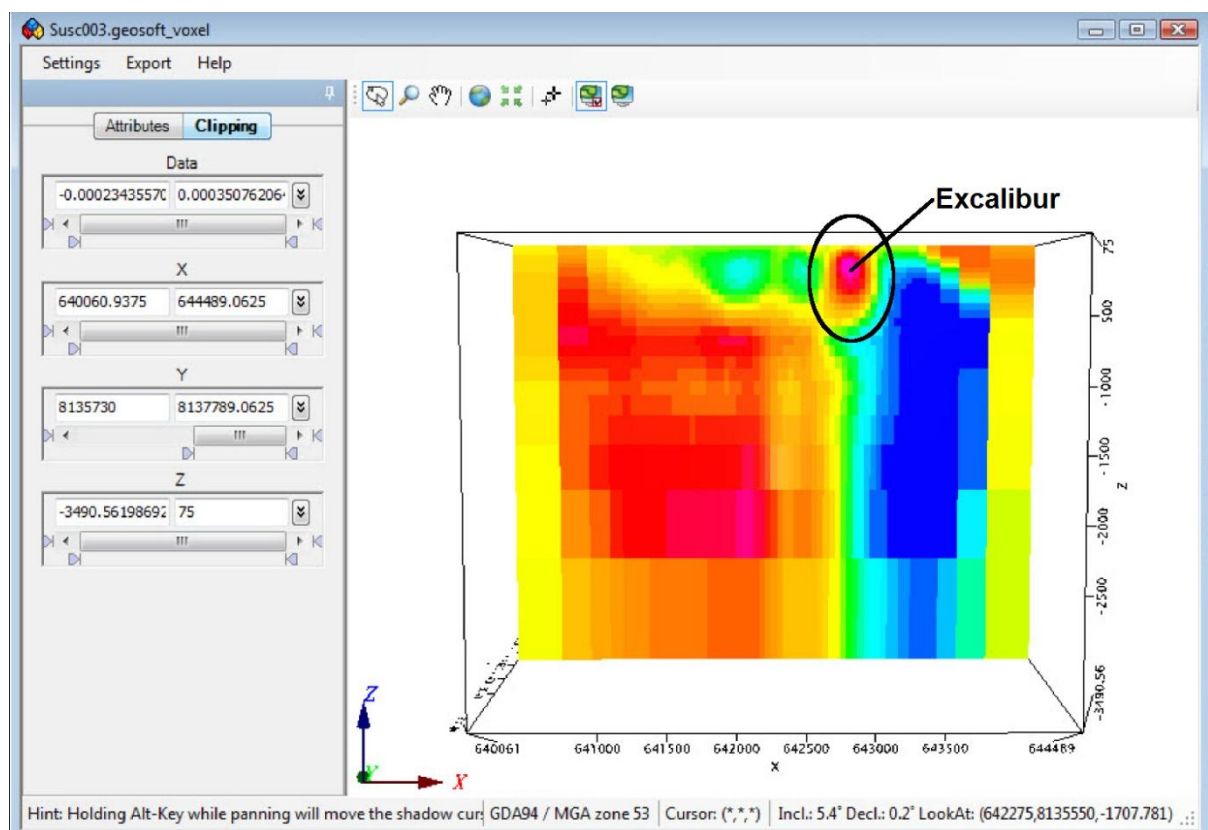


Figure 35- Example of 3D-Inversion of TMI data-Excalibur Kimberlite

Selected Targets

It is highly probable that in light of the discovery success of the EM method at Merlin those obvious and even subtle EM responses have been followed up on the ground with EM34 surveys and possibly drilling. As such it is probably unlikely that undiscovered kimberlites may have different responses to those of the known kimberlites. The majority of the selected targets are based on magnetic responses as these may have been overlooked in favour of priority EM responses.

Note: None of the locations of historical drilling at Merlin has been made available for this study and as such there is no information included regarding whether any of the selected targets may have been previously tested.

The following is a listing of the anomalies which have been selected from this study. The following figure shows the locations of these targets relative to known kimberlites.

Table1-List and Locations of Selected Anomalies – Datum/Proj-GDA94MGA53

Anomaly	Easting	Northing
KJT01	641320E	8141054N
KJT02	642230E	8139230N
KJT03	642220E	8139925N
KJT04	642625E	8140900N
KJT05	643000E	8141680N
KJT06	642725E	8142420N
KJT07	Anomaly Removed from list	
KJT08	641555E	8134895N
KJT09	642140E	8135005N
KJT10	642395E	8134920N
KJT11	643385E	8135840N
KJT12	642800E	8136605N
KJT13	642795E	8136855N
KJT14	642420E	8135895N

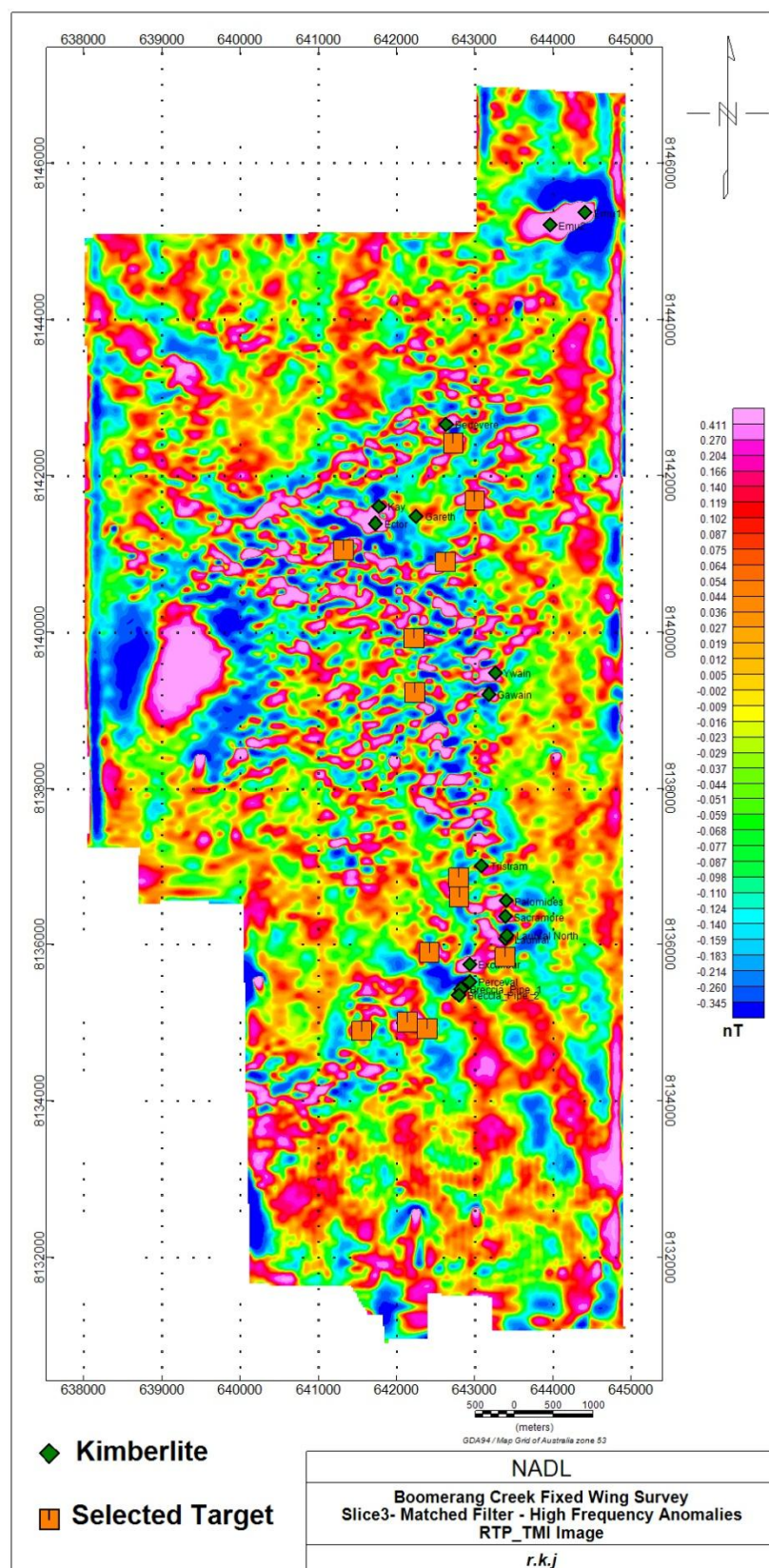


Figure 38 – Locations of selected anomalies superimposed on Frequency Slice3 –RTP_TMI

Discussion of Individual Anomalies

This section describes the individual anomalies selected primarily from the aeromagnetic, HEM and ground EM34 survey data. A series of images are included for each of the anomalies which show the magnetic and EM characteristics of each.

KJT01 (641320E, 8141054N)

Located 500m SW of the Ector pipe the anomaly lies within a “noisy” magnetic background and marginal to an EM34 response. A well defined anomaly in 3D inversion of the data (see below).

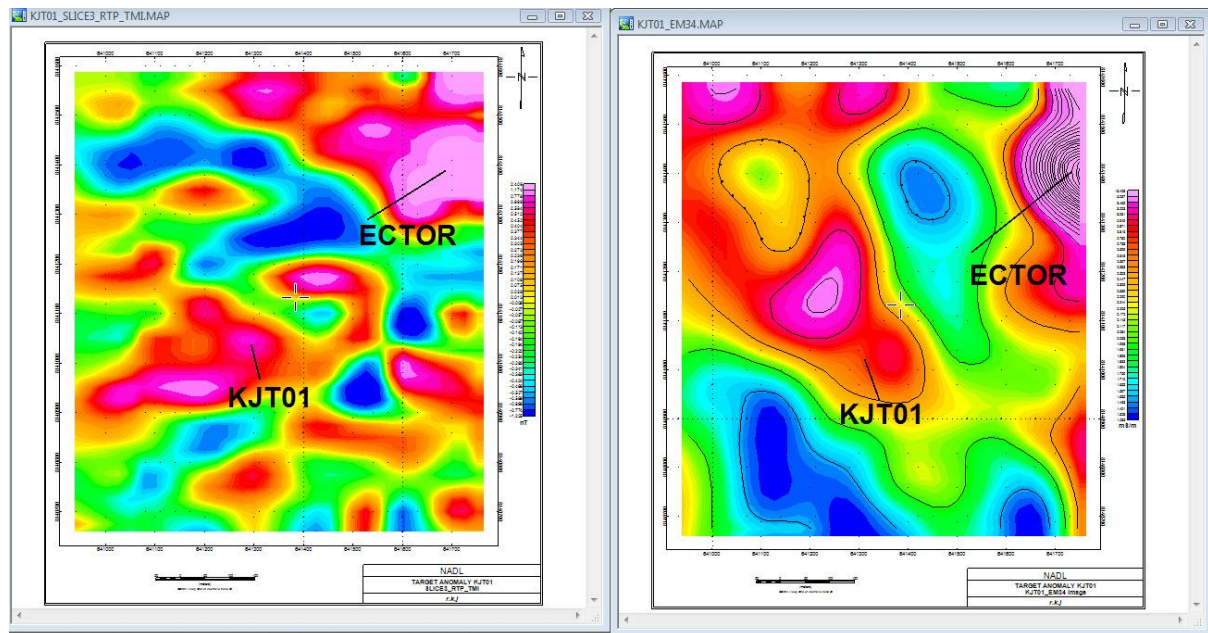


Figure39-KJT01-TMI and EM34 response

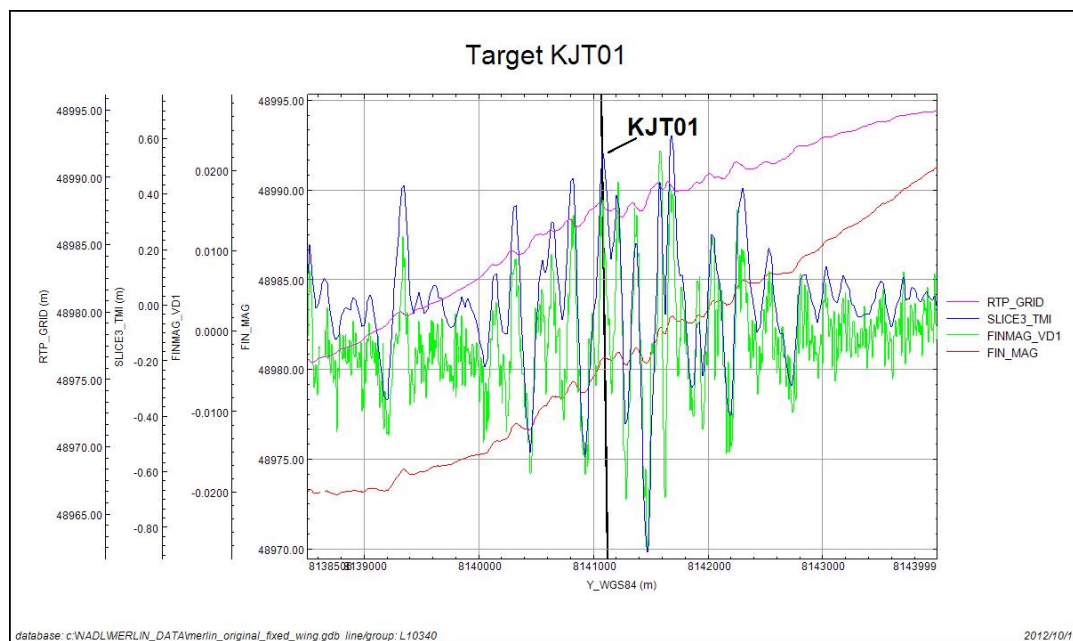


Figure40 - Magnetic Profile across KJT01

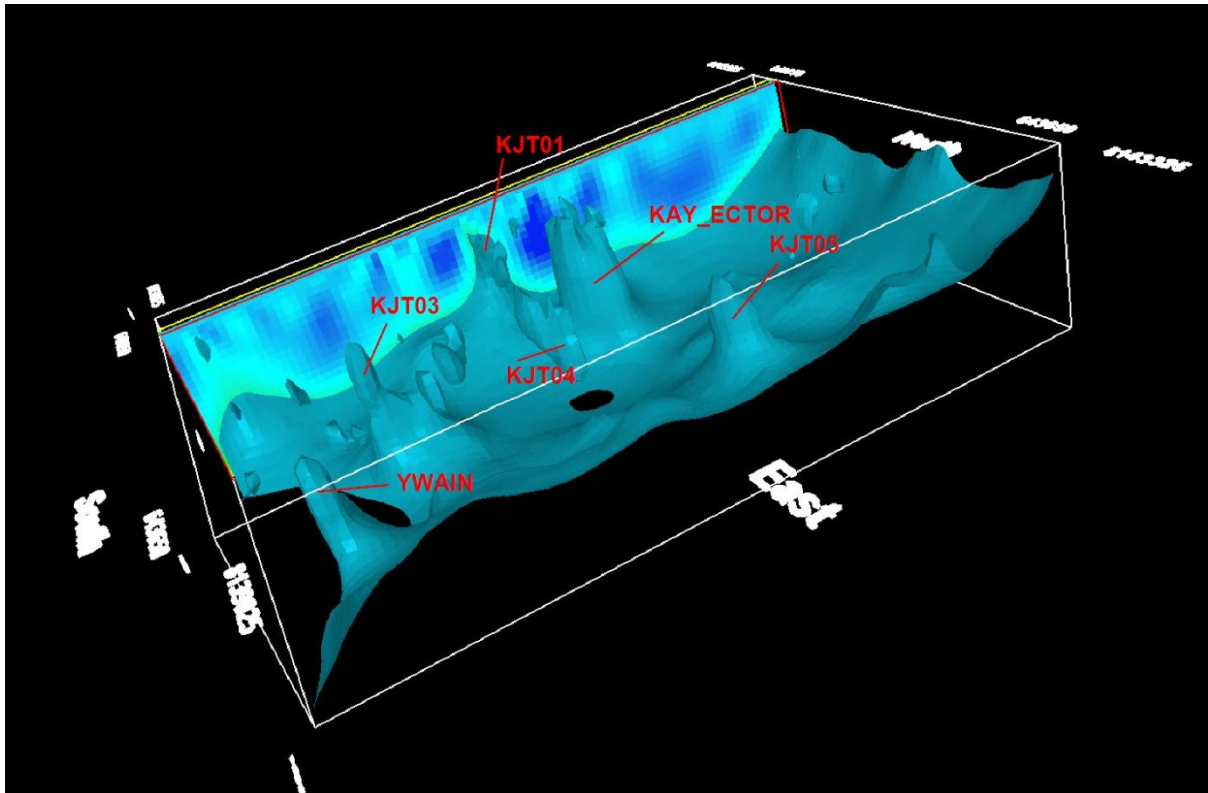


Figure 41 – 3D Inversion showing well defined anomaly at KJT01

KJT02 (642230E, 8139230N)

KJT02 is located 1000m west of Ywain and Gawain at the SE end of the landing strip.

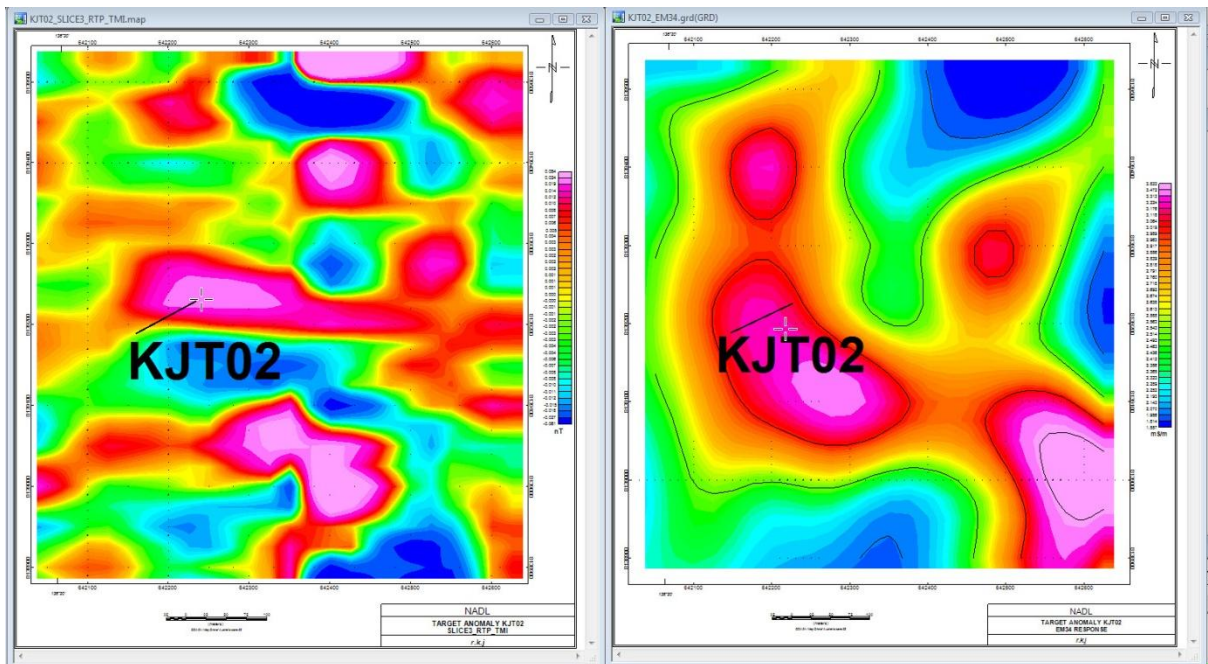


Figure 42- TMI and EM34 responses of Target KJT02.

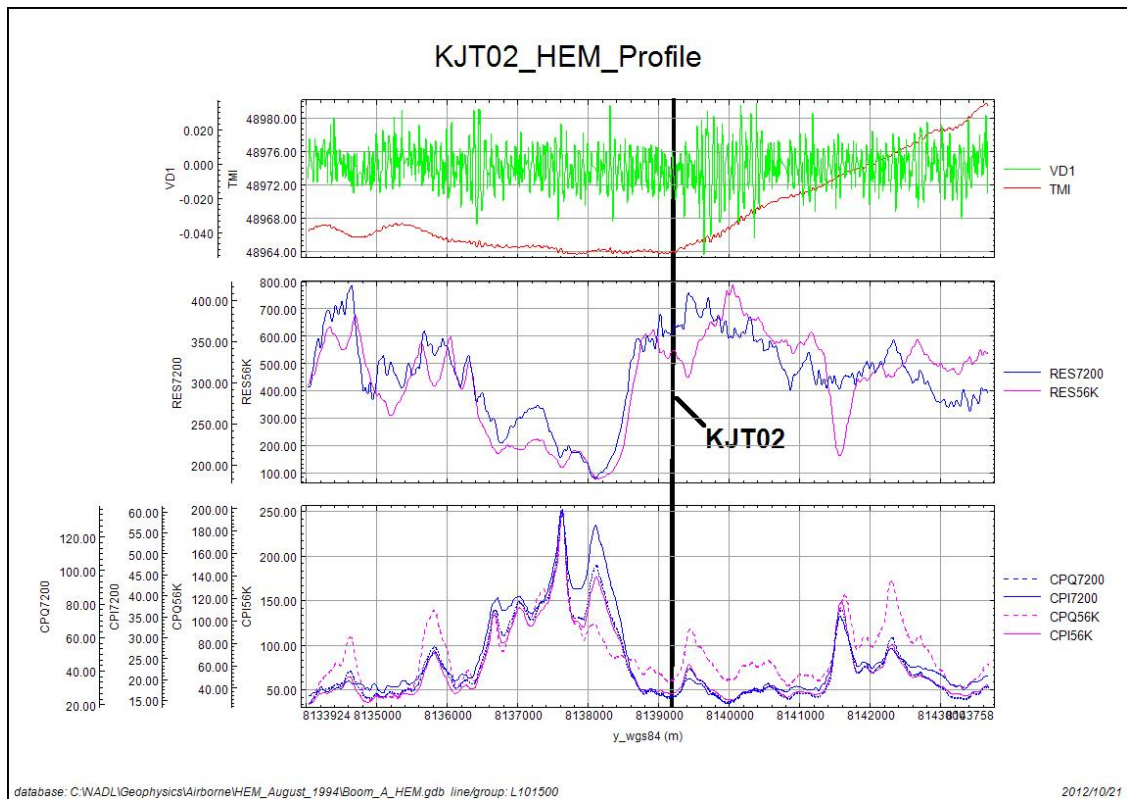


Figure 43 – HEM response KJT02

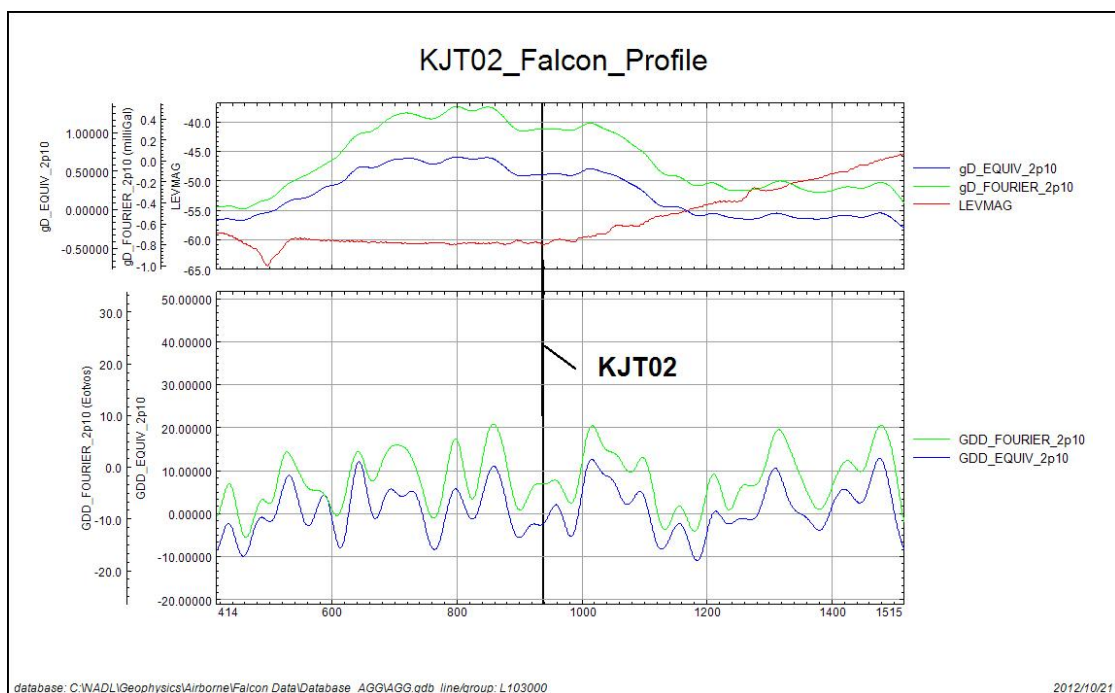


Figure 44 – Falcon Profile across KJT02

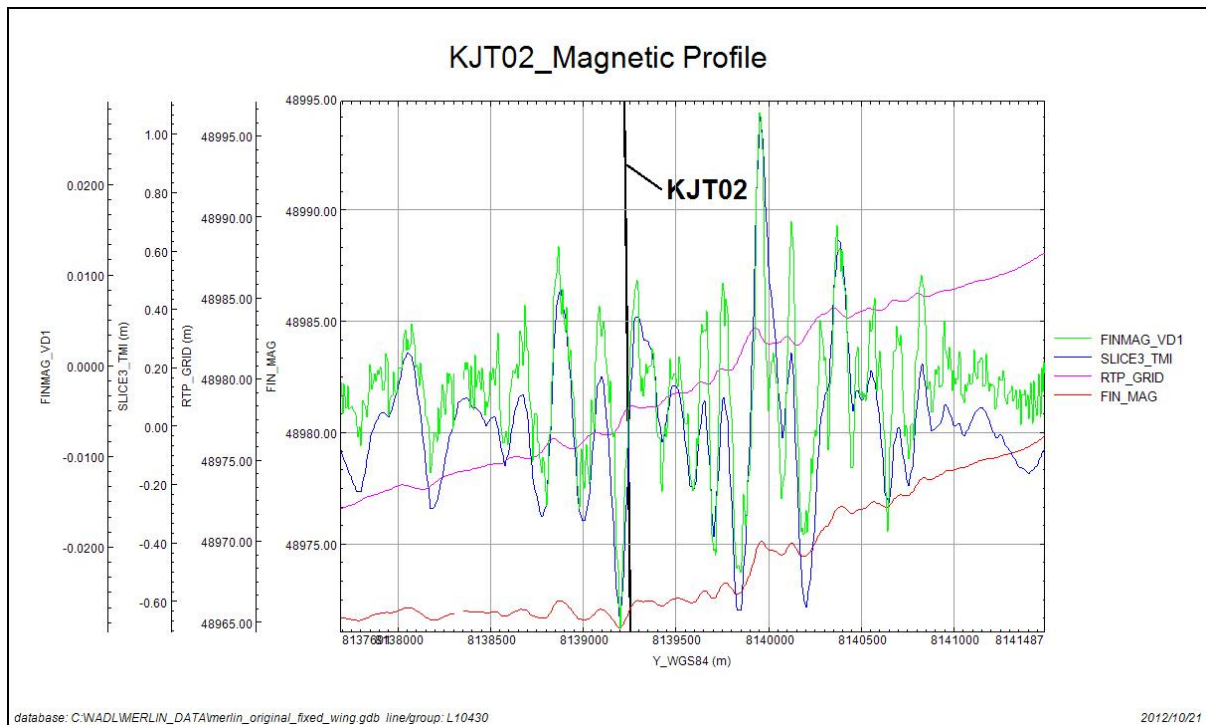


Figure 45 – Magnetic Profile across KJT02

KJT03 (642220E, 8139925N)

A near coincident magnetic/EM anomaly located 1100m NW of kimberlites Ywain and Gawain. A discrete anomaly on the 3D inversion images (See Figure 41 above).

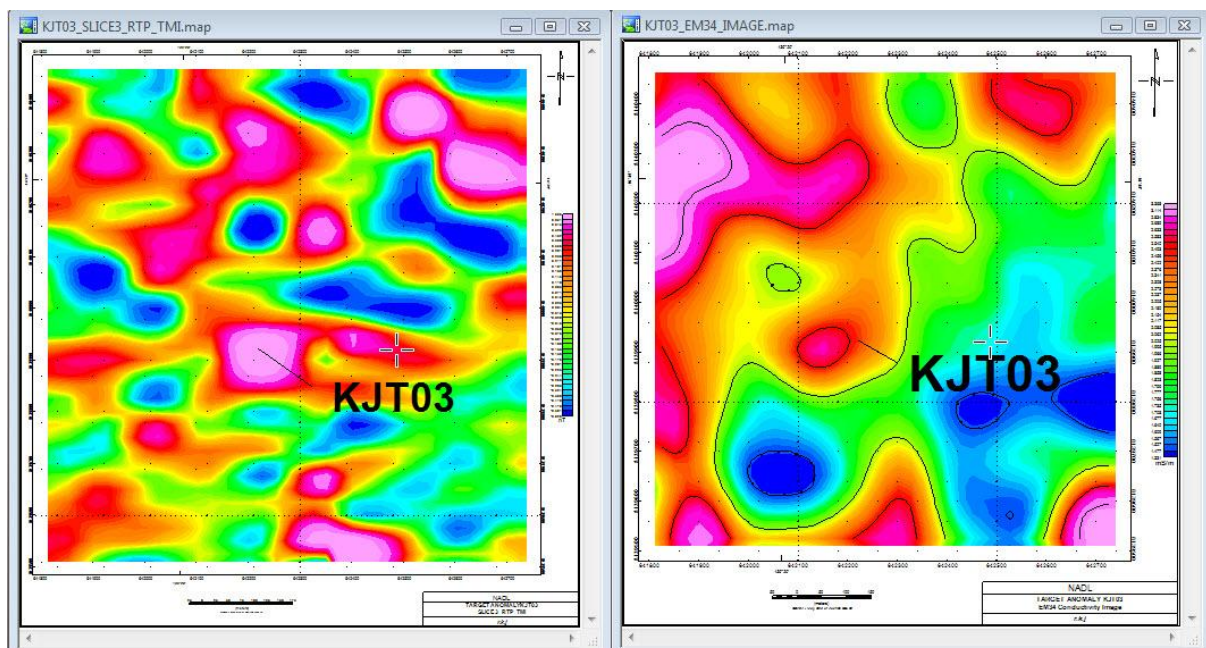


Figure 46 – TMI and EM34 responses KJT03

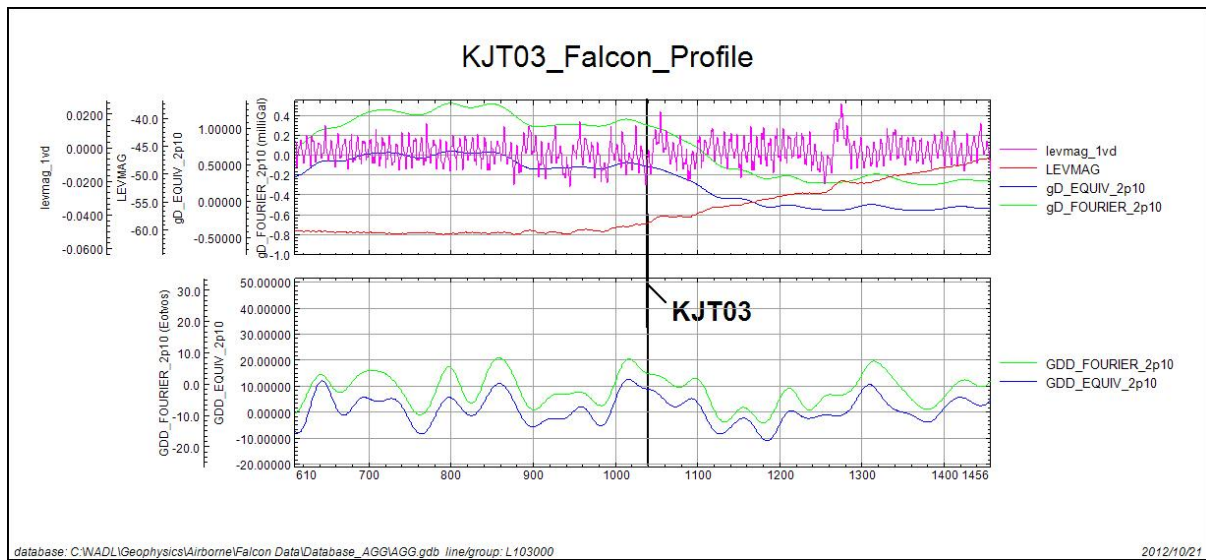


Figure 47 – Falcon Profile across KJT03

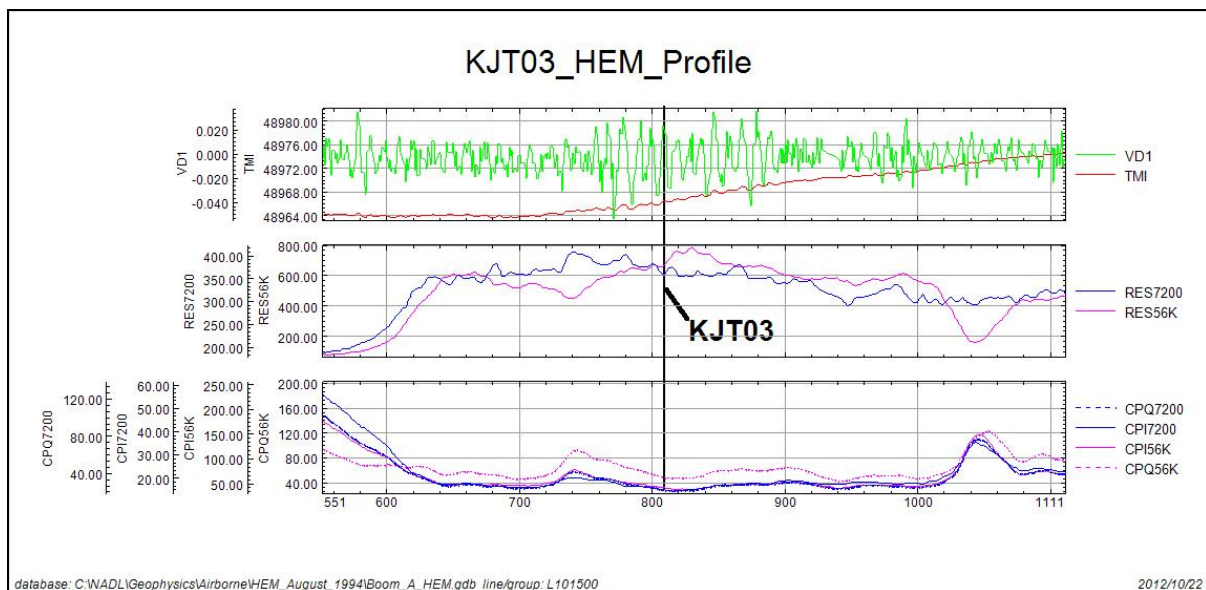


Figure 48 – HEM response KJT03

KJT04 (642625E, 8140900N)

The target anomaly is located 725m SSE of the Gareth kimberlite. A linear magnetic anomaly is associated with a subtle EM34 response.

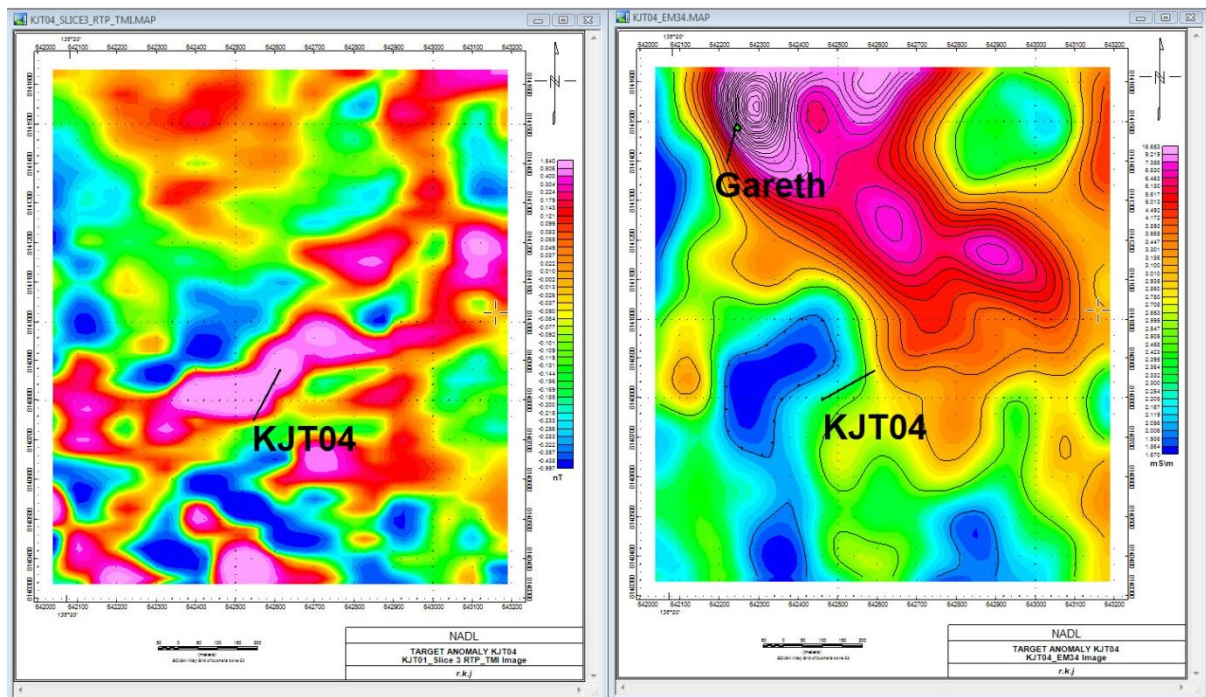


Figure 49 – TMI and EM34 responses of KJT04

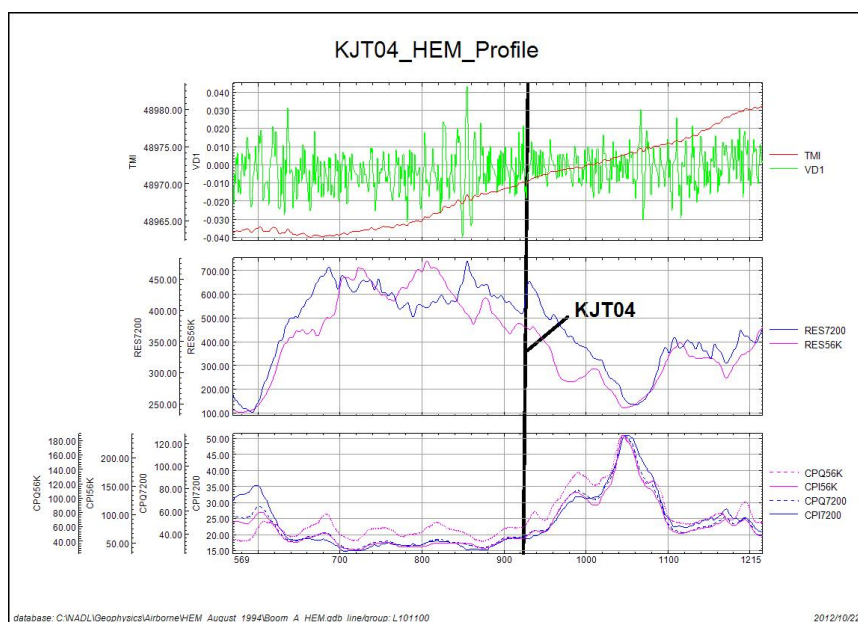


Figure 50 – HEM Profile KJT04

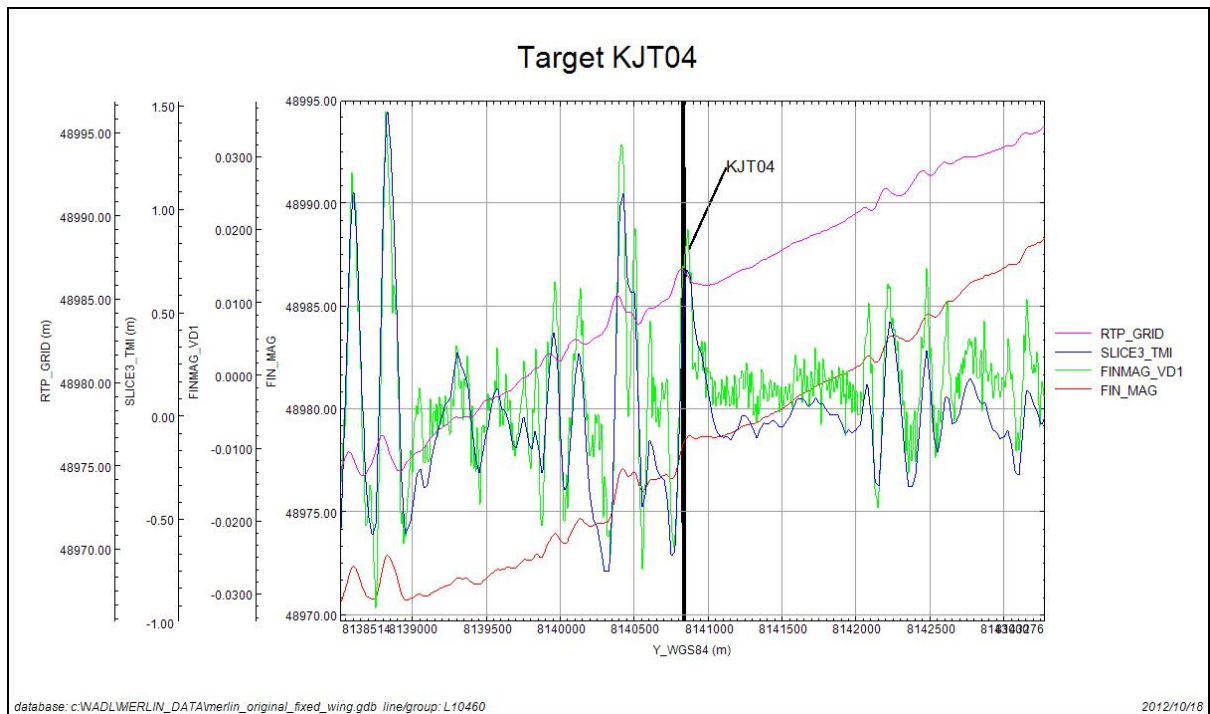


Figure 51 – TMI Magnetic Profile across KJT04

KJT05 (643000E, 8141680N)

A coincident TMI and weak EM34 response located 770m ENE of the Gareth kimberlite. This anomaly forms a well defined feature on 3d inversion of the magnetic data.

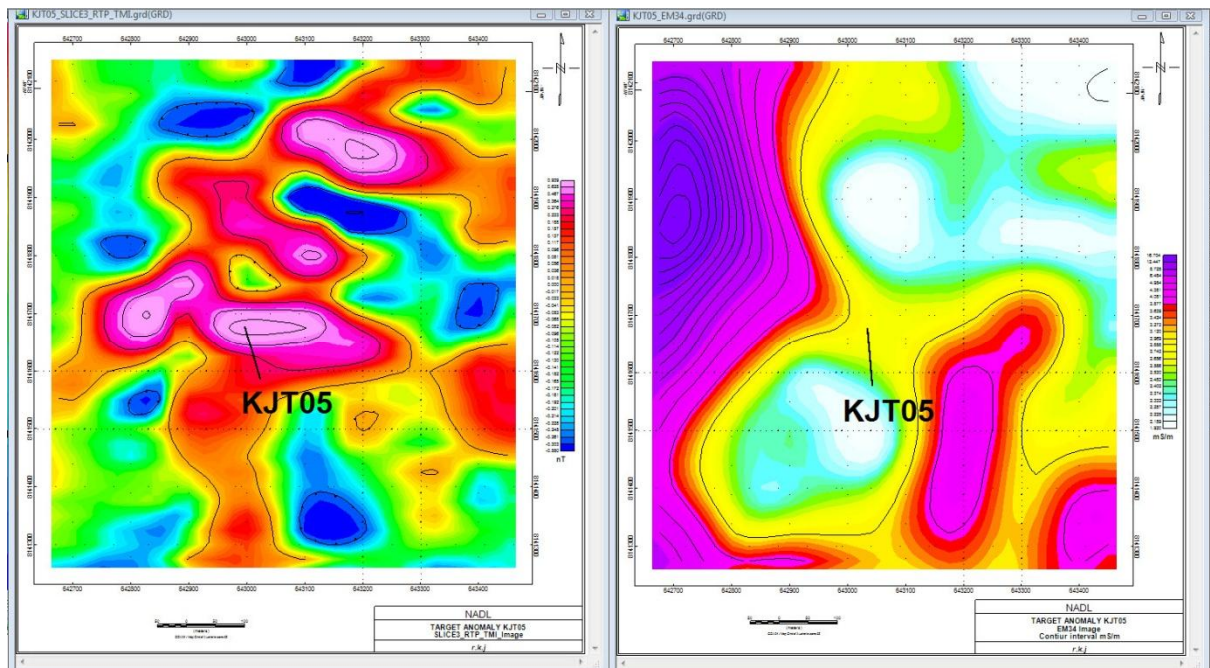


Figure 52 - TMI and EM34 responses KJT05

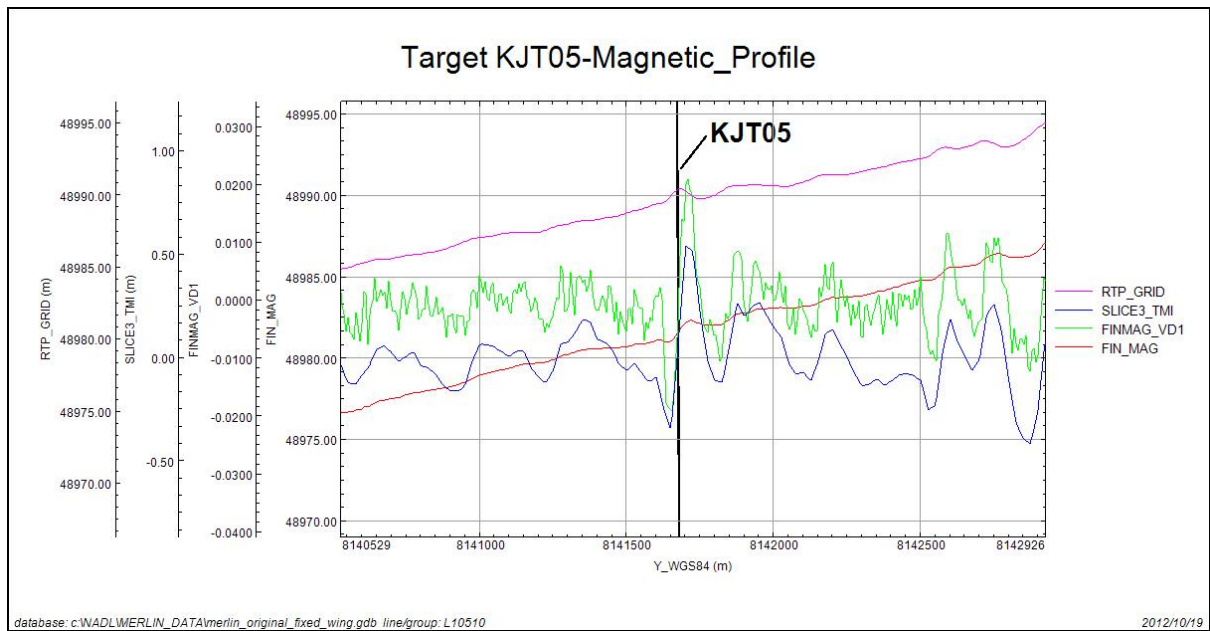


Figure 53 – Magnetic TMI Profile across Target KJT05

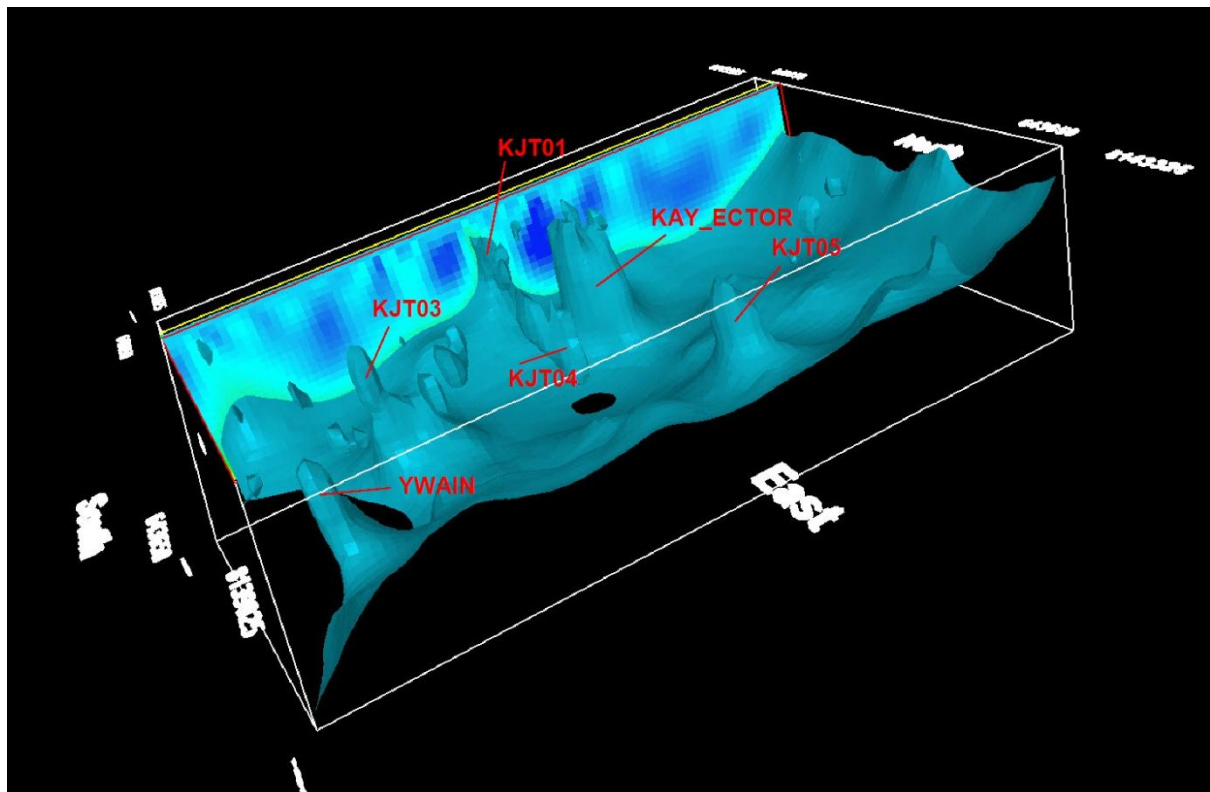


Figure 54 – 3D Inversion Image showing a well defined anomaly at KJT05.

KJT06 (642725E, 8142420N)

A distinct magnetic anomaly located 235m SSE of the Bedevere kimberlite.

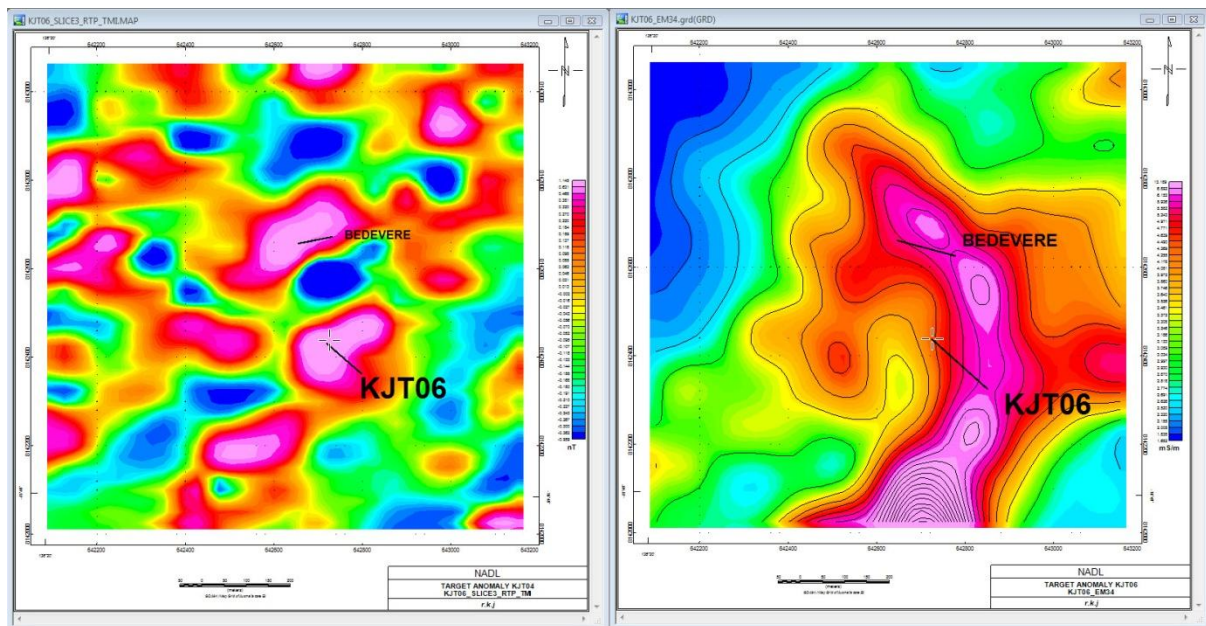


Figure 55 – TMI and EM34 responses of Target KJT06

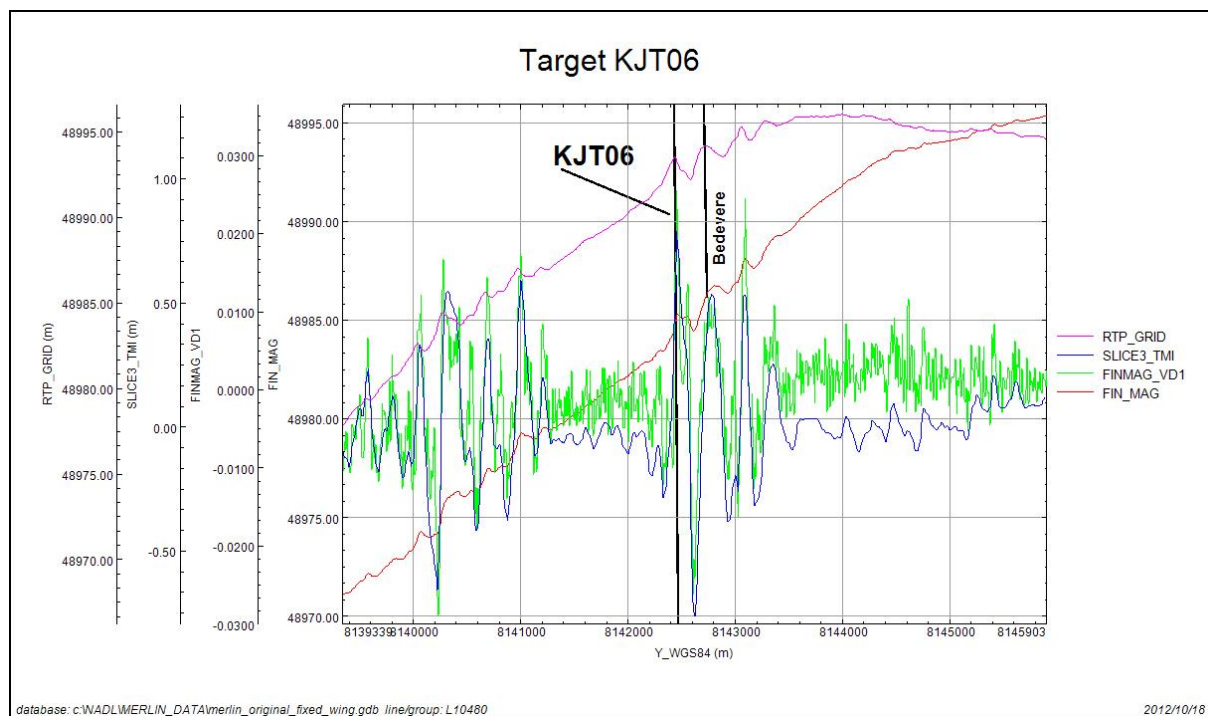


Figure 56 Magnetic Profile across Anomaly KJT06

KJT07 –This anomaly has been removed from the list of targets due to a revised assessment.

KJT08 (641555E, 8134895N)

There is no EM34 coverage available over this anomaly but HEM data is available as shown in the images below.

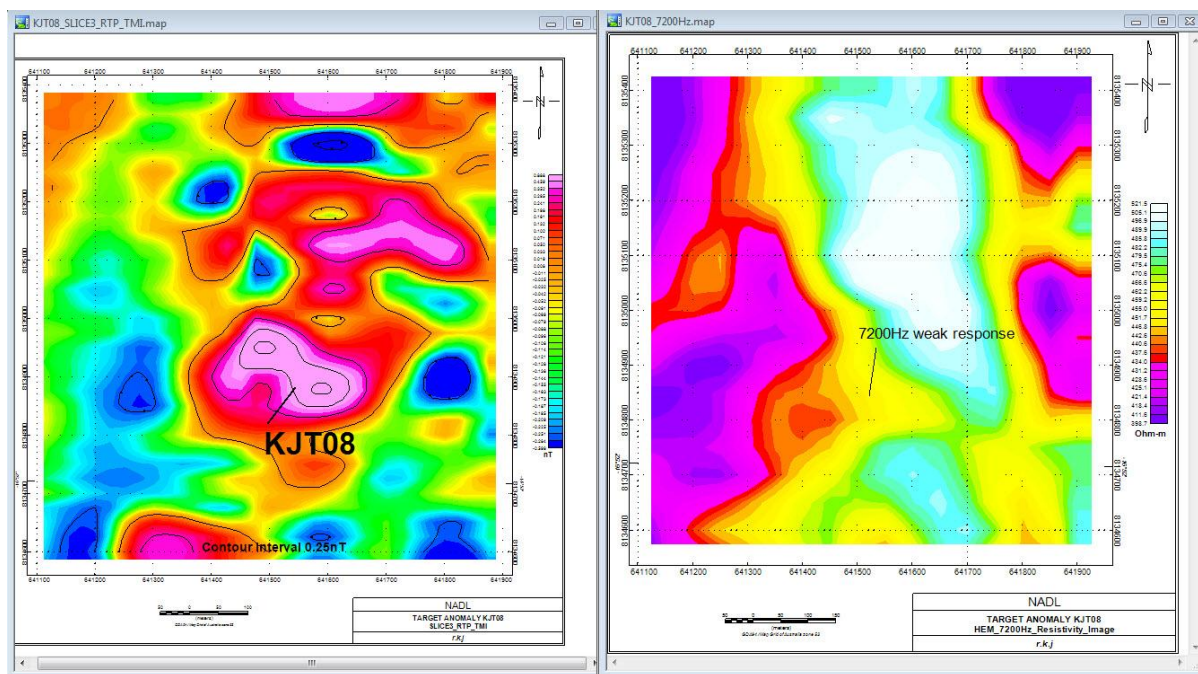


Figure 57 – TMI and HEM 7200Hz responses of Target KJT08

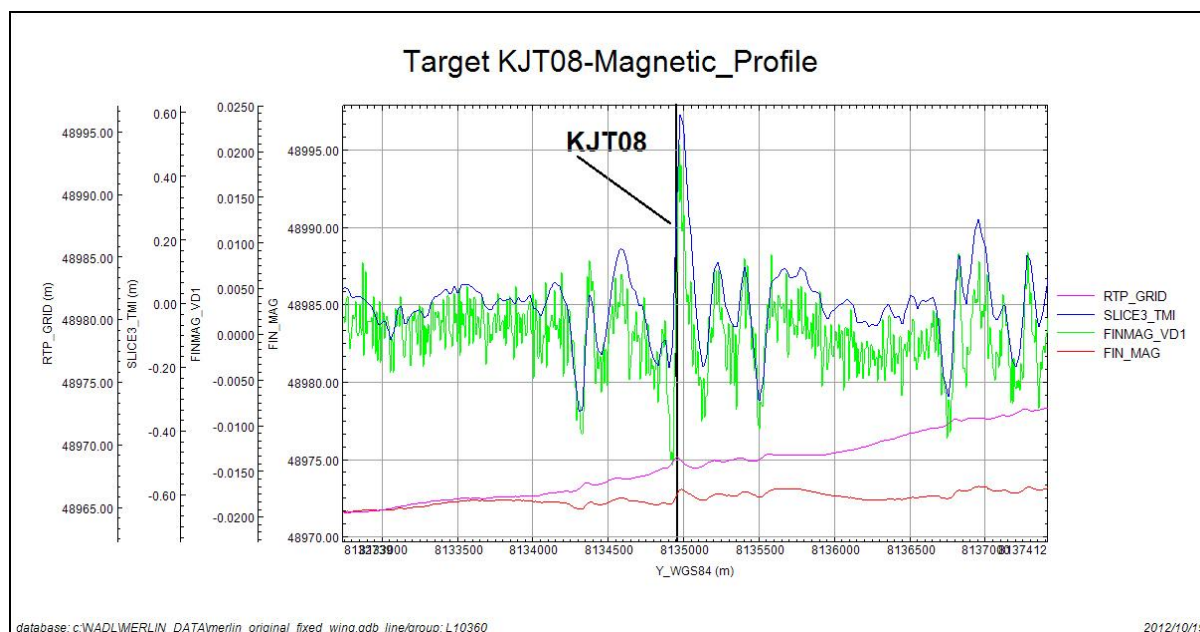


Figure 58 – TMI magnetic profile across Target KJT08

KJT09 (642140E, 8135005N)

KJT09 is a well defined magnetic anomaly with a coincident HEM resistivity "low".

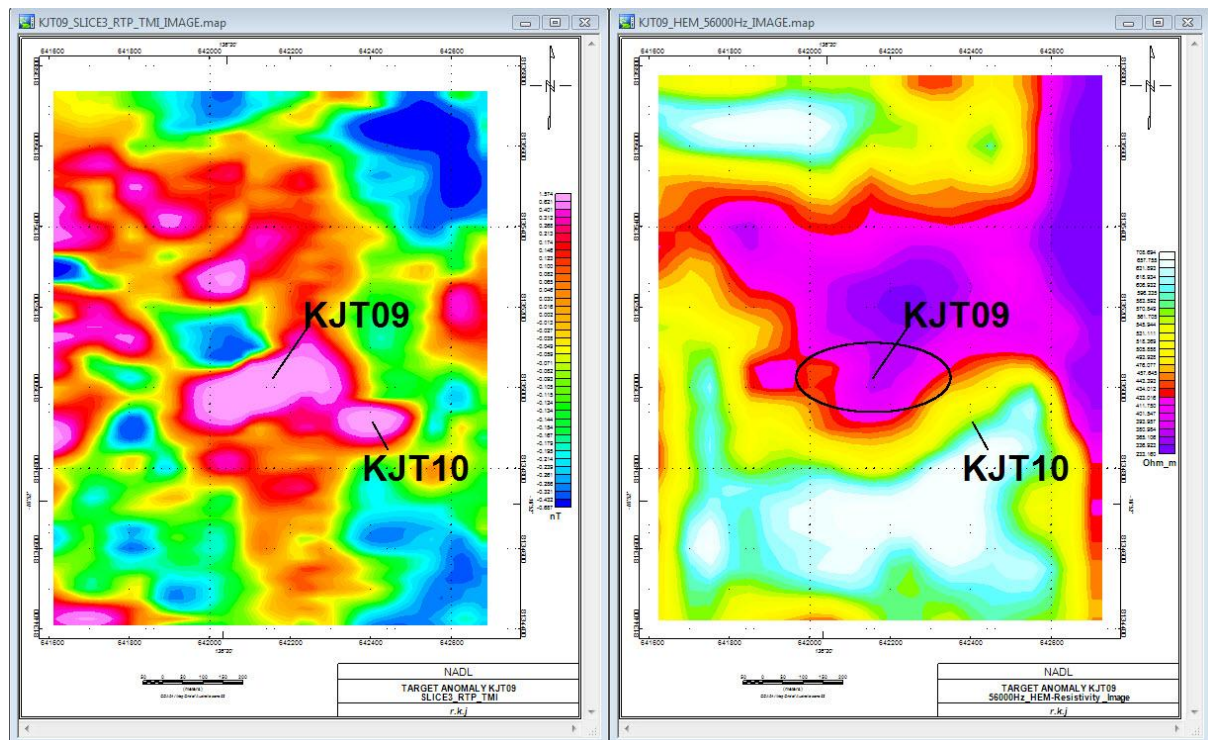


Figure 59 – Comparison between RTP_TMI and HEM 56000Hz response of Target KJT09

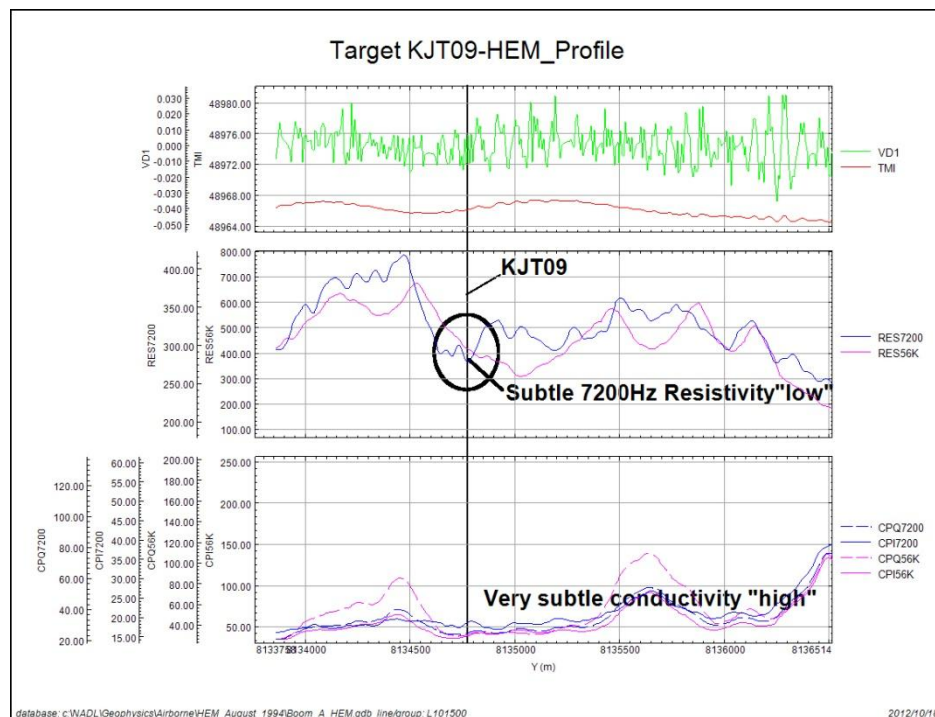


Figure 60 – Magnetic-HEM Profiles across Anomaly KJT09

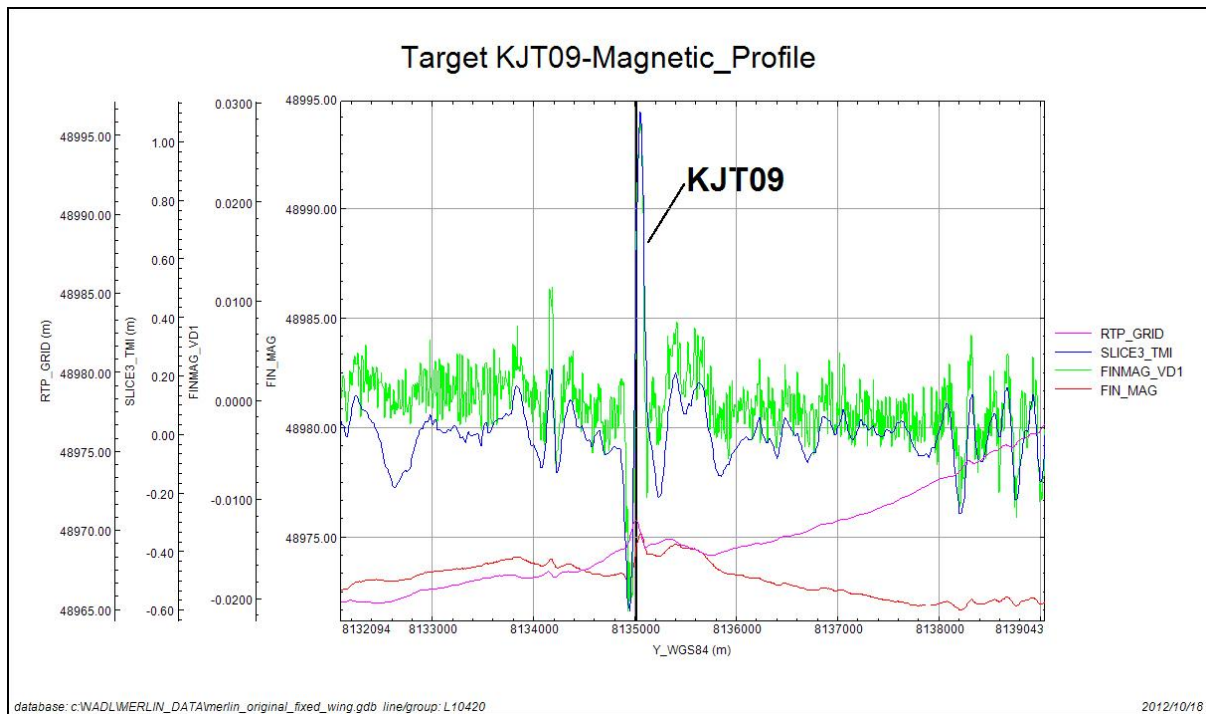


Figure 61 – Fixed Wing Aeromagnetic Profile across KJT09 showing distinct discrete magnetic anomaly

KJT10 (642395E, 8134920N)

This anomaly is located 300m SSE of KJT09. There is a well defined discrete magnetic response but the coincident resistivity low observed at KJT09 is not present.

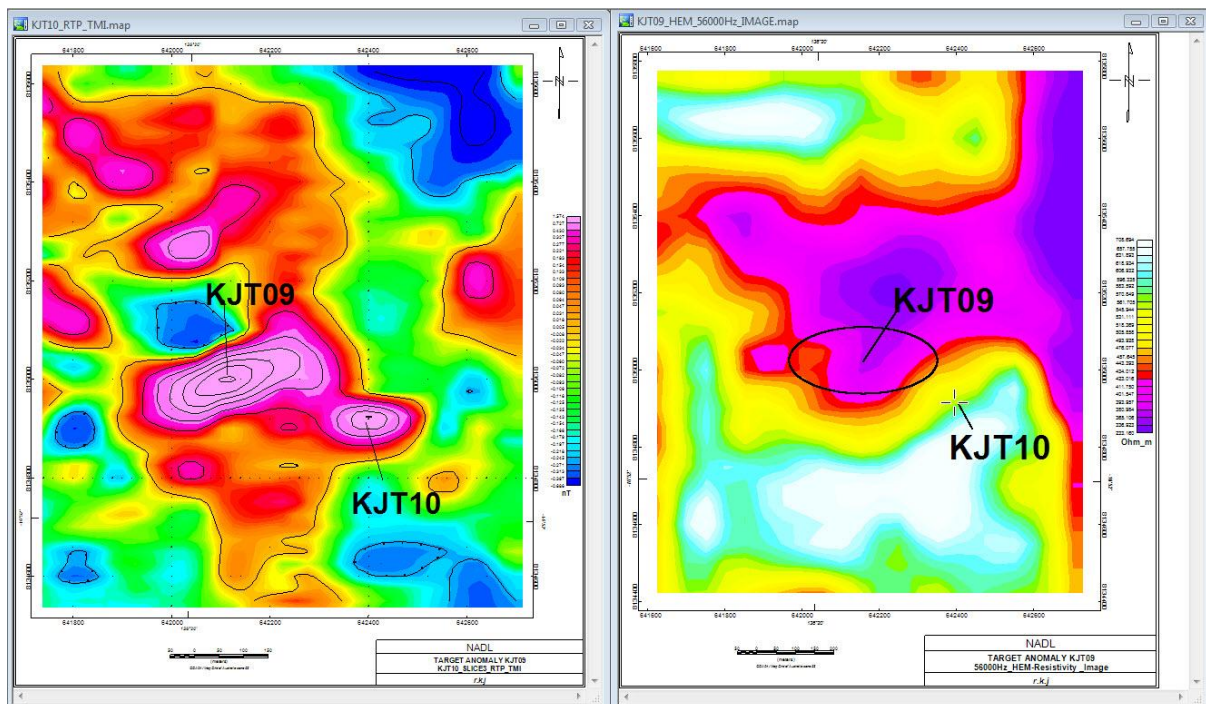


Figure 62 – RTP_TMI and HEM 56000Hz resistivity response of KJT10.

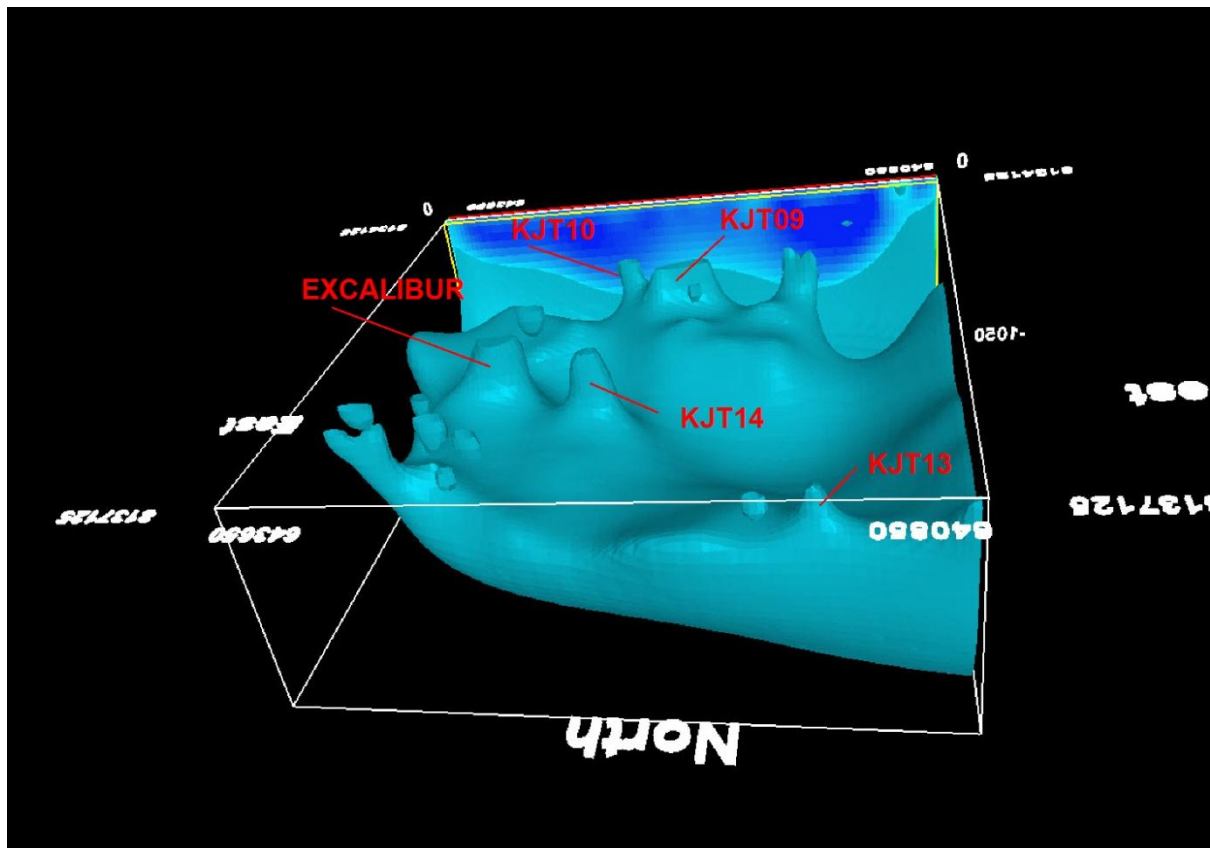


Figure 63 – 3D Inversion of magnetic data showing anomalies KJT09 and KJT10 at southern end of inverted cube.

KJT11 (643385E, 8135840N)

KJT11 forms a non-magnetic, conductive HEM anomaly south of and directly in line with Launfal, Sacramore and Palomides.

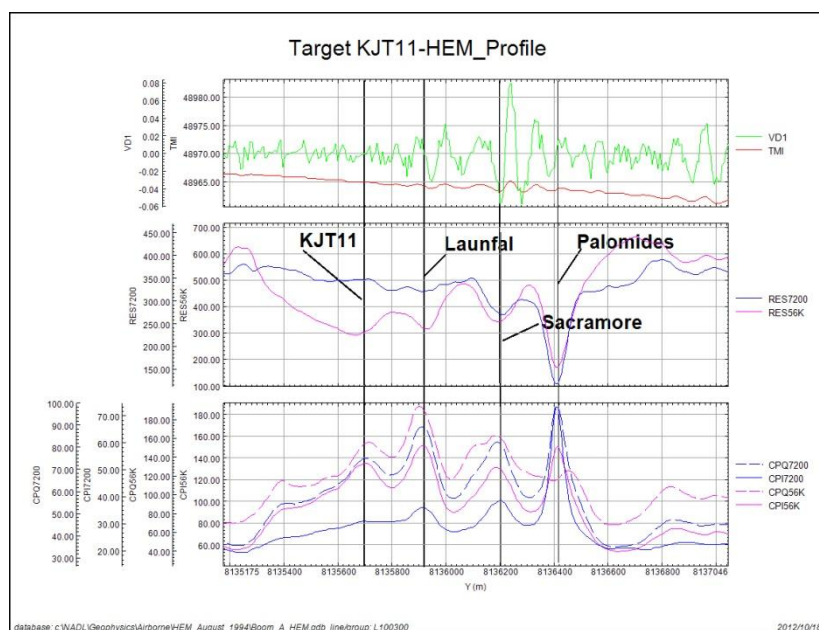


Figure 64 – HEM Profile across KJT11, Launfal, Sacramore and Palomides

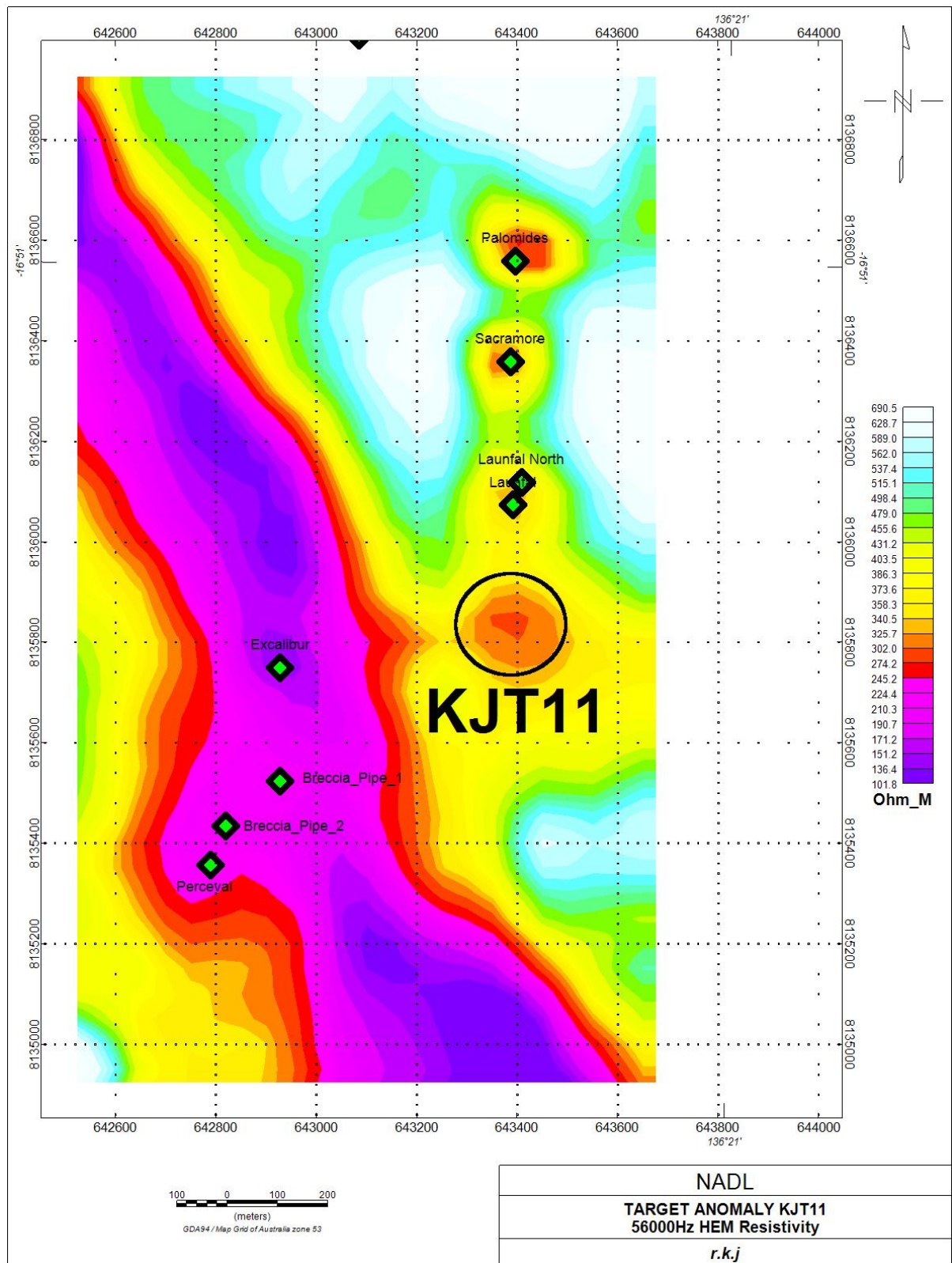


Figure 65 – 56000Hz resistivity plot of KJT11

KJT12 (642800E, 8136605N)

KJT12 is a linear NW trending magnetic anomaly with no obvious EM response. This is a low priority target unless a dyke-like target is envisaged.

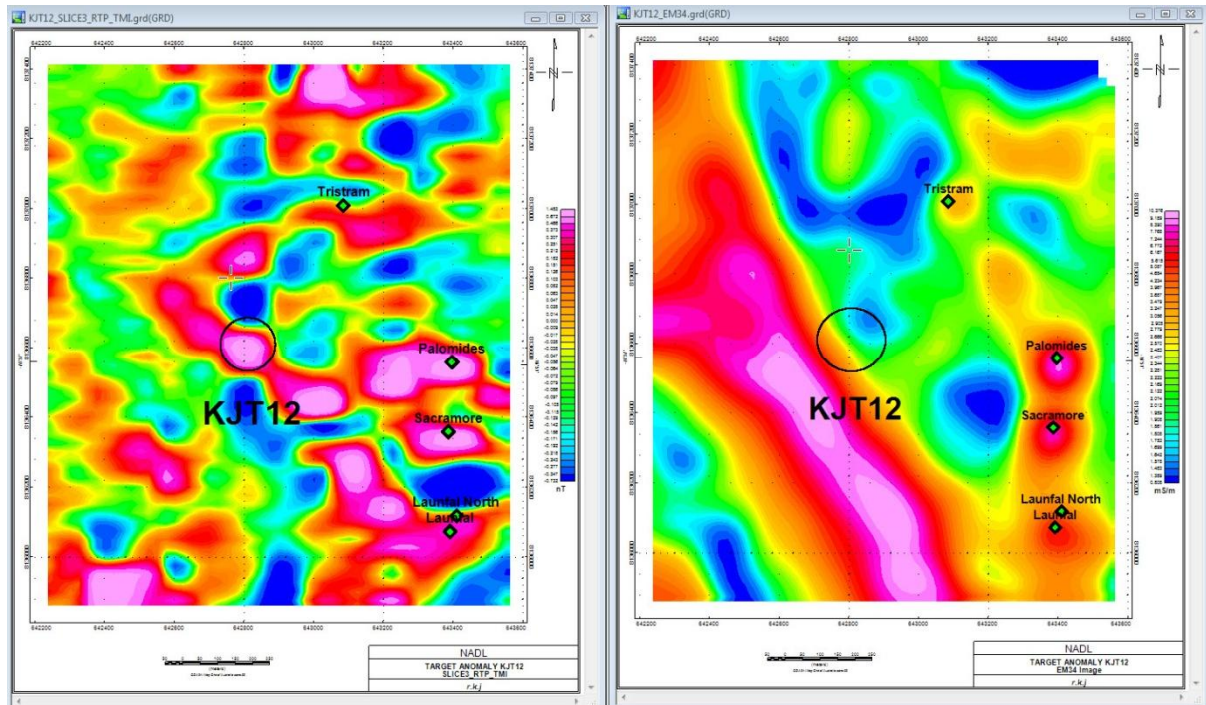


Figure 66 – RTP_TMI and EM34 response –Target KJT12.

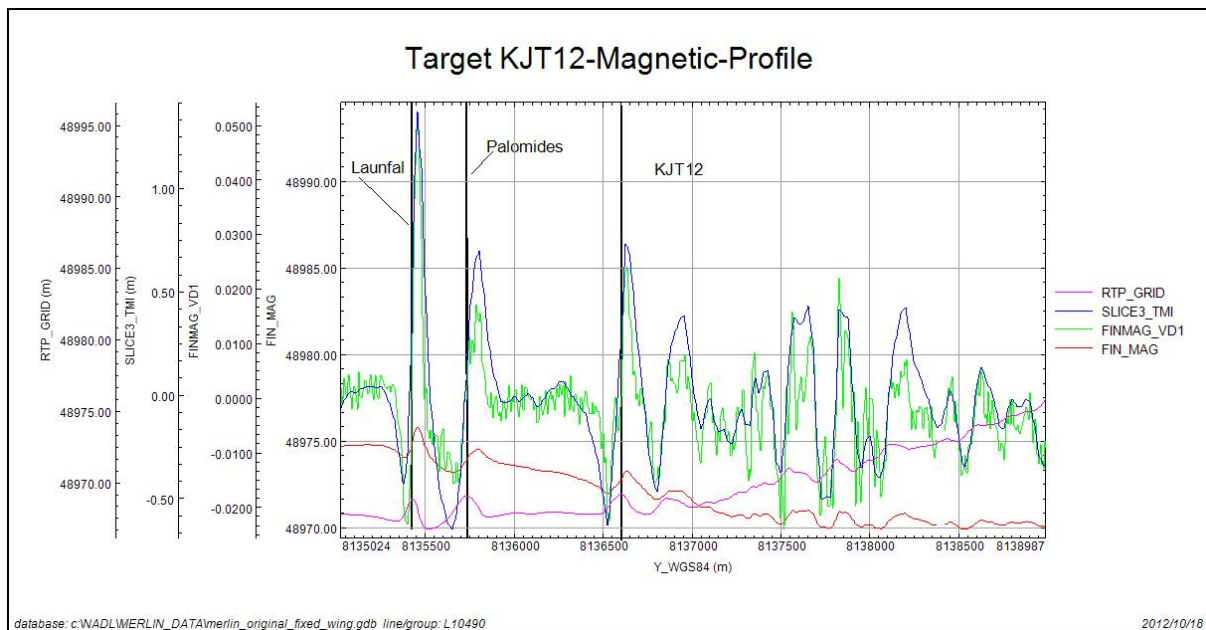


Figure 67 – Magnetic Profile across KJT12

KJT13 (642795E, 8136605N)

This is a coincident discrete magnetic, weak EM34 target located 340m WSW of the Tristram kimberlite.

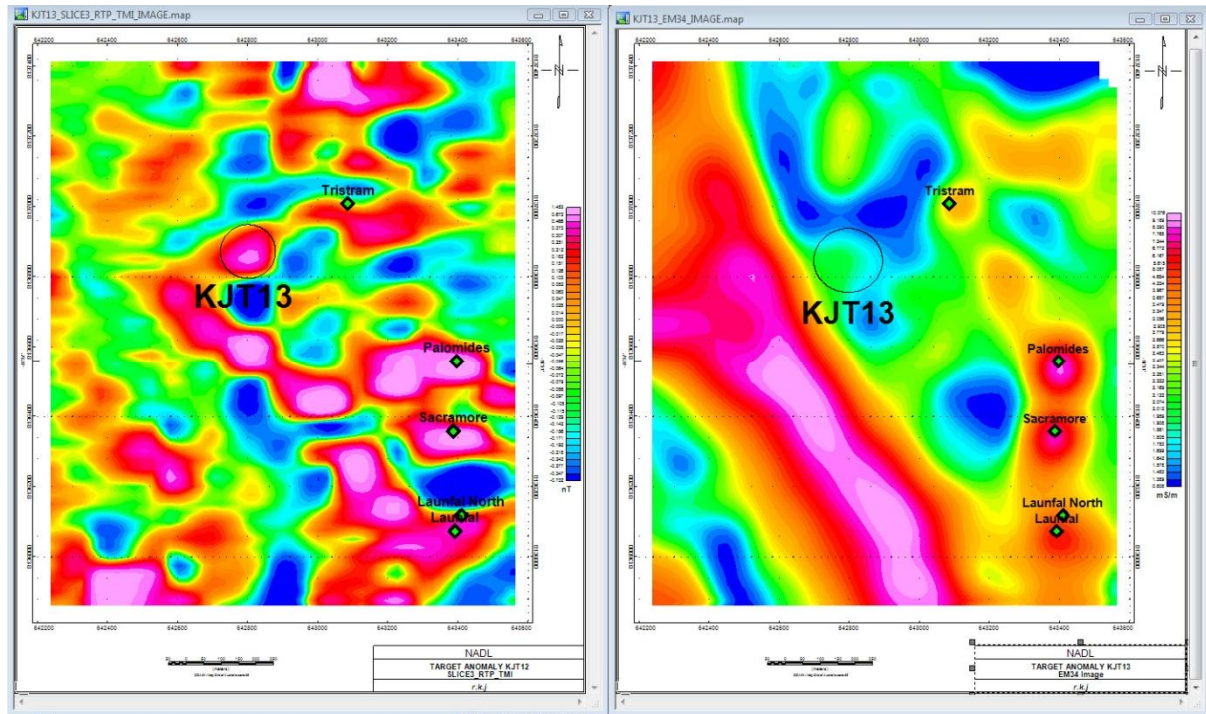


Figure 68 – RTP_TMI and EM34 responses of anomaly

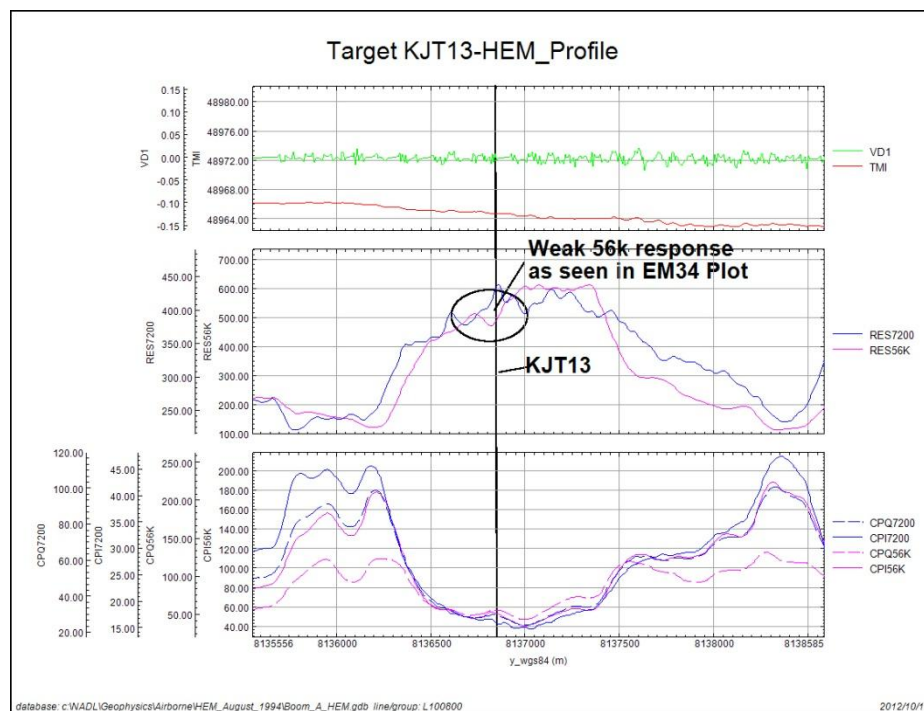


Figure 69 – showing weak 56000Hz response with associated weak magnetic “high”

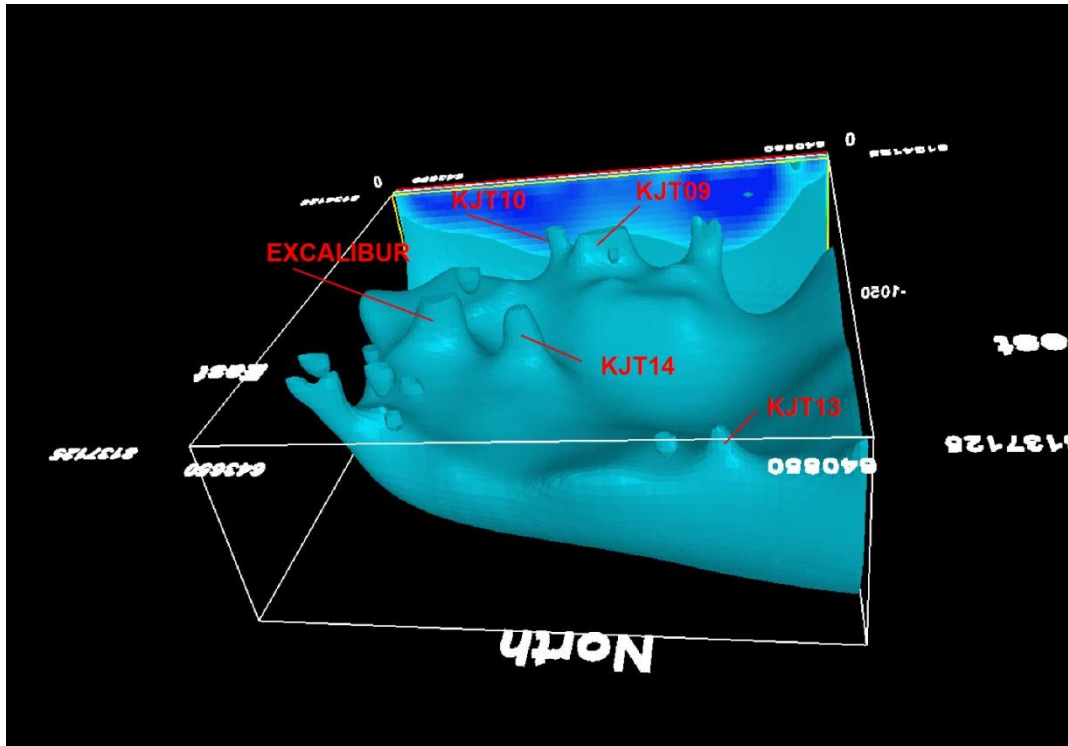


Figure 70 - showing KJT13 response in 3D inversion of magnetic data. KJT13 is located on the northern wall of the inverted cube.

KJT14 (642420E, 8135895E)

This is a coincident TMI_HEM anomaly located 520m west of Excalibur. The 3D Inversion shows considerable similarity to Excalibur.

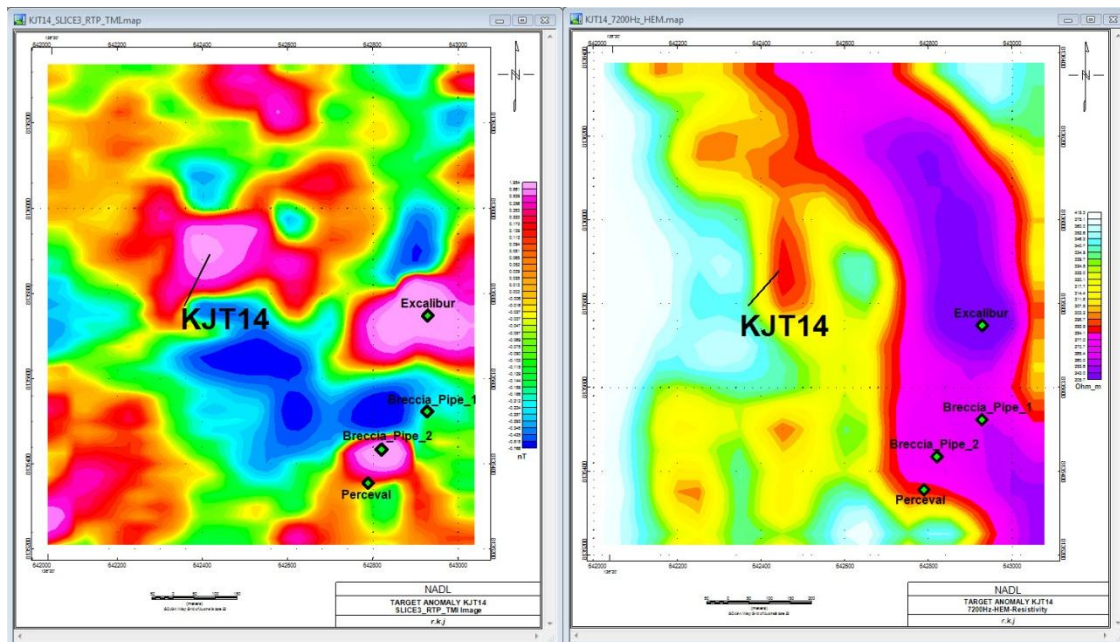


Figure 71 – KJT14-coincident magnetic/EM response.

