Allegiance Metals P/L

Helimag Survey in Western Tasmania

by
Fugro Airborne Surveys

Quality Control Report
and
Preliminary Interpretation
by
Steve Webster P/L
February, 2004

1 Introduction

An airborne magnetic and radiometric survey was conducted over the three areas in western Tasmania during January, 2004. The survey was contracted by Allegiance Metals P/L to **Fugro Airborne Surveys** (Fugro) and utilised a Jet Ranger helicopter, provided by **HeliAust Pty. Ltd.** from its Sydney base. The contract was prepared and supervised with quality control by Steve Webster P/L.

An **Operations and Processing Report** has been prepared by Fugro to outline the procedures taken to complete the project.

This report, by Steve Webster P/L, provides additional technical information on:
i) equipment installation, operations and contract performance
ii) certain processing procedures needed to enhance the data and map presentation
iii) a preliminary interpretation of the results to verify that the data sets will meet the Allegiance Metals objectives to assist geological mapping and define exploration targets.

The survey areas are located in the west of Tasmania, as shown in figure 1. The survey flight plans are shown in figures 2 a-c, with East – West flight lines spaced 50m apart and North – South tie lines spaced 500m apart, except for the Zeehan/Trial Harbour area where lines are orthogonal to the above.

2 Survey progress

The survey areas are located in the West Coast district of Tasmania, Figure 1. The actual helicopter flight plans are shown in figures 2 a-c, with East - West flight lines spaced 50m apart for the **Renison East** and **Heazlewood** areas and North - South tie lines spaced 500m apart. For the **Zeehan-Trial Harbour** area the flight lines are oriented North – South at 50m spacing and tie lines flown East – West.

The survey equipment was installed at Sydney in the HeliAust Jet Ranger III aircraft in January, 2004. The magnetometer was in located in a stinger (as shown in accompanying photographs) mounted in the front of the helicopter to remove it as much as possible from the magnetic effects of the aircraft. These effects were further reduced by calibrations that allow real-time computations of the magnetic effects of aircraft maneuvers—described in the following section 3a.

The aircraft and crew mobilised to Tasmania on 13^{th} January, 2004. The survey statistics, as itemised in the accompanying table 1, show that the progress of the survey included 8 production days (~3 – 6 hours/day) and 2 days were lost due to bad weather, Figure 2d. Aircraft maintenance problems were fixed in Hobart on 17 & 18th January and 2.5 days were lost due to these problems. Thus in operation mode the survey averaged 360 km per production day.

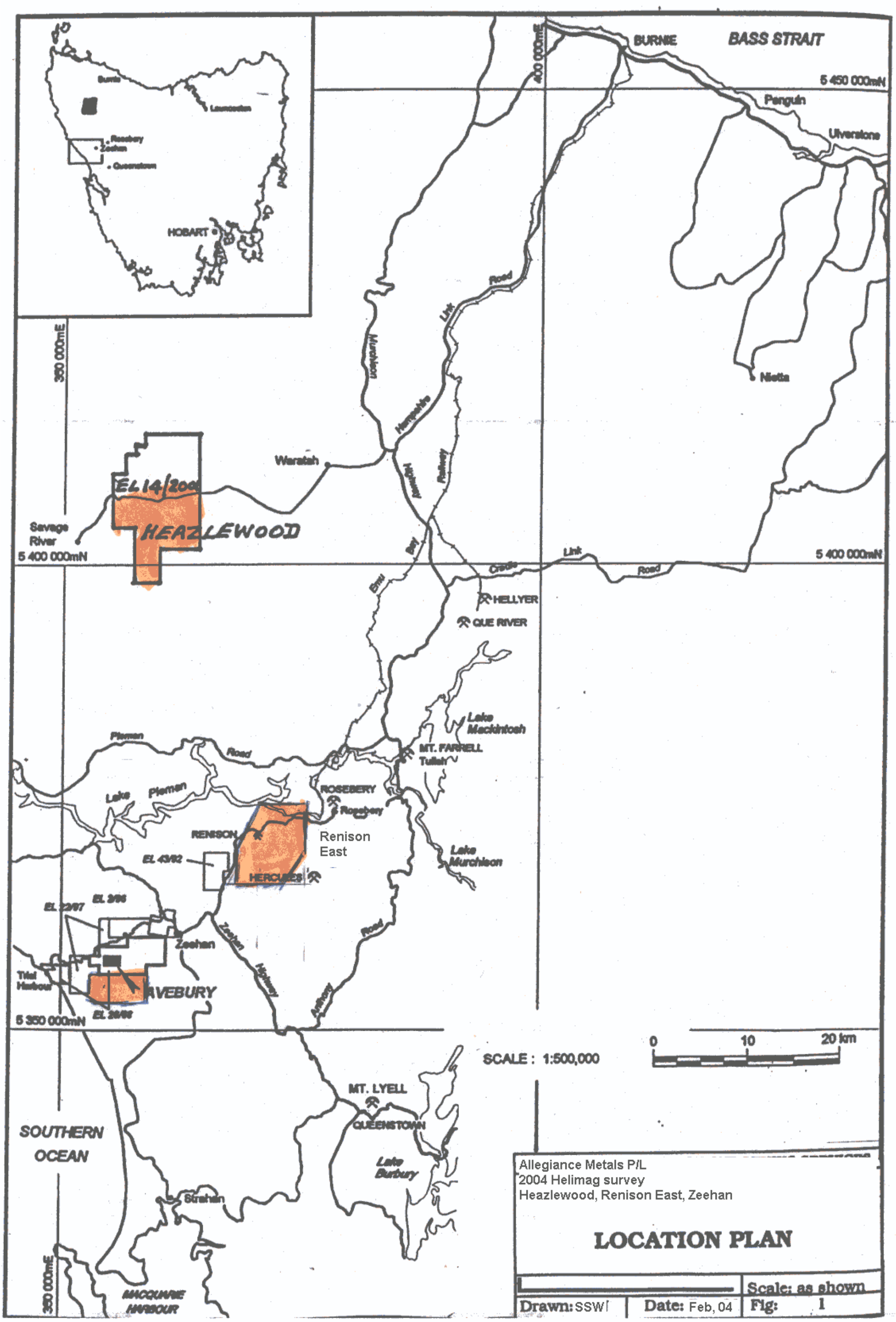
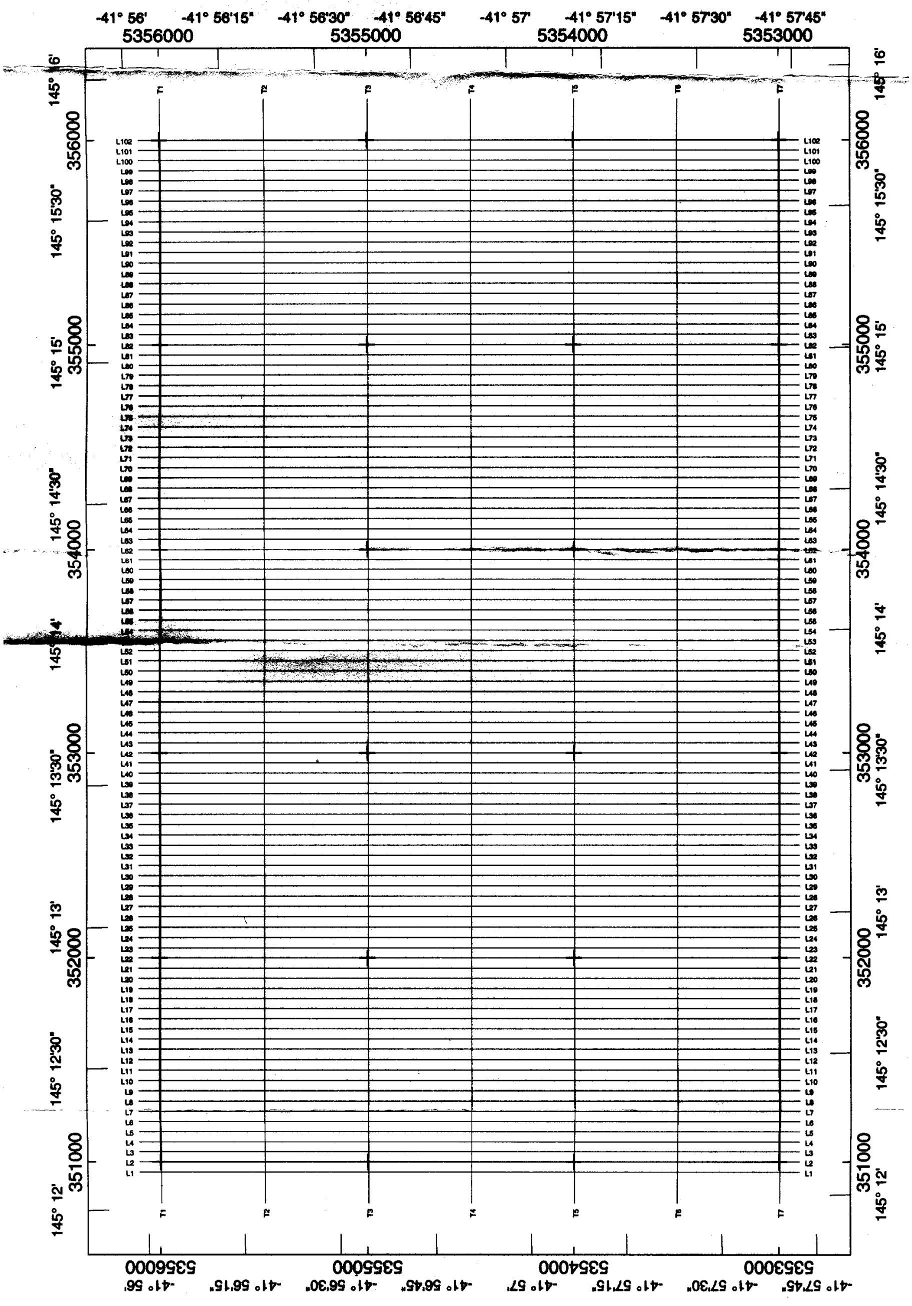
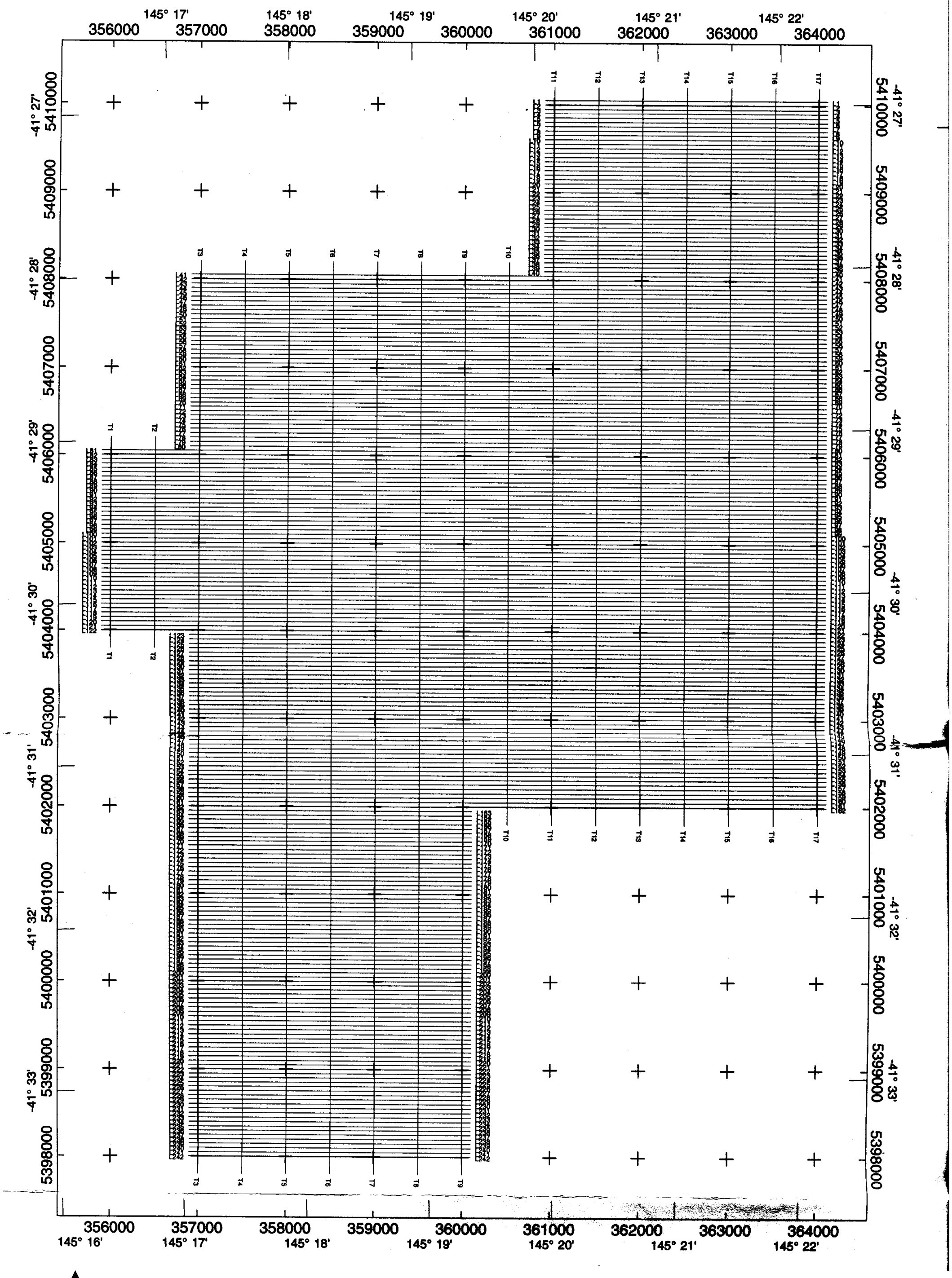


Figure 1. Location map of 2004 Helimag survey areas



North ←

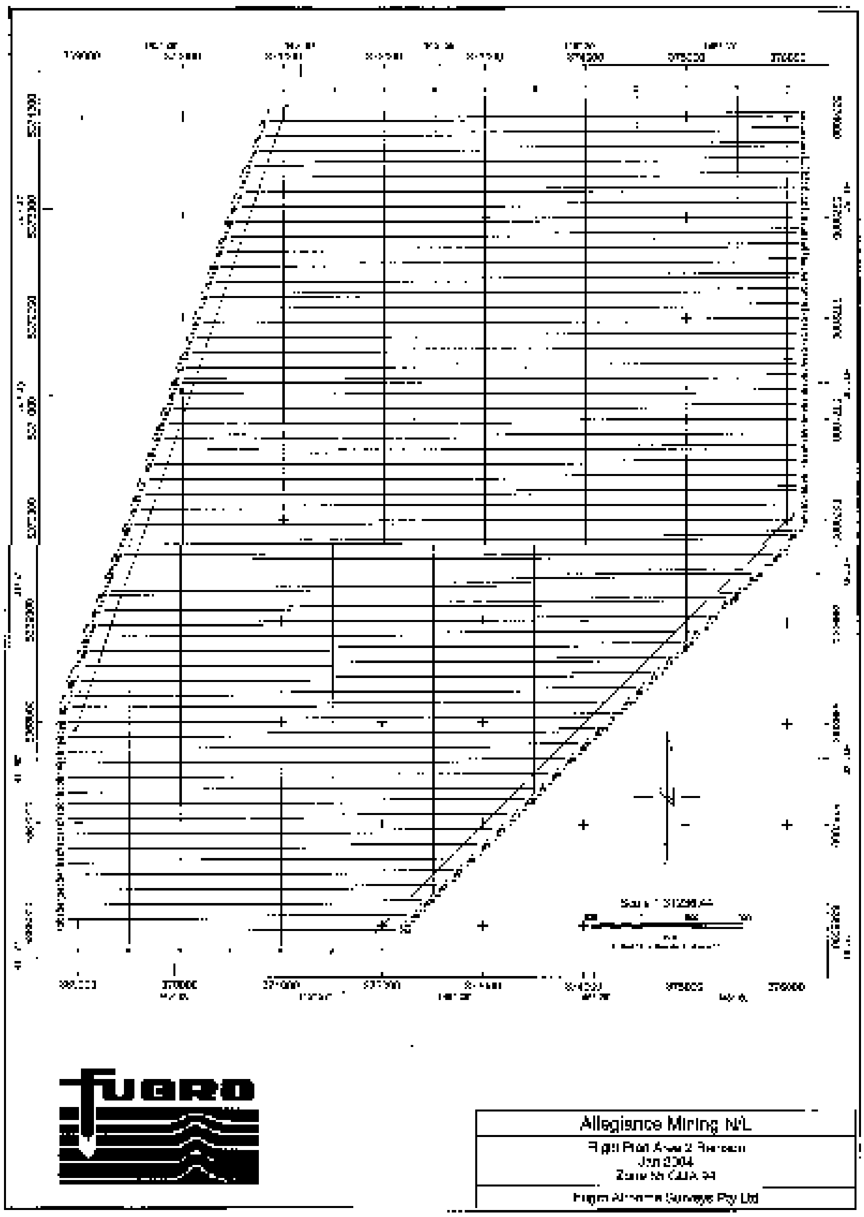
Figure 2a
Flight pan for Zeehan/Trial Harbour area
Provided by Fugro Airborne Surveys P/L



North

Figure 2b
Flight pan for Heazlewood area

Provided by Fugro Airborne Surveys P/L



North

Figure 2c
Flight pan for Renison East area
Provided by Fugro Airborne Surveys P/L
For Allegiance Metals P/L

Date	Flights	hours	Km. flown	total flown	Km remaining	Comments
13-Jan	1	1.4			2870	mob & calibrations
14-Jan	2,3 & 4	5.1	344	344	2526	
15-Jan	5,6 & 7	6.2	349	693	2177	
16-Jan	8	3.4	233	926	1944	
17-Jan				926	1944	helicopter repairs
18-Jan				926	1944	helicopter repairs
19-Jan	9 & 10	6.5	466	1392	1478	
20-Jan	11	0	0	1392	1478	weather
21-Jan	12	2.9	150	1542	1328	
22-Jan		0	0	1542	1328	repairs & weather
23-Jan	13 & 14	7.0	529	2071	809	
24-Jan	15 & 16	6.0	439	2518	352	
25-Jan	17	5.4	352	2870	0	

Table 1. **2004 survey operation statistics**

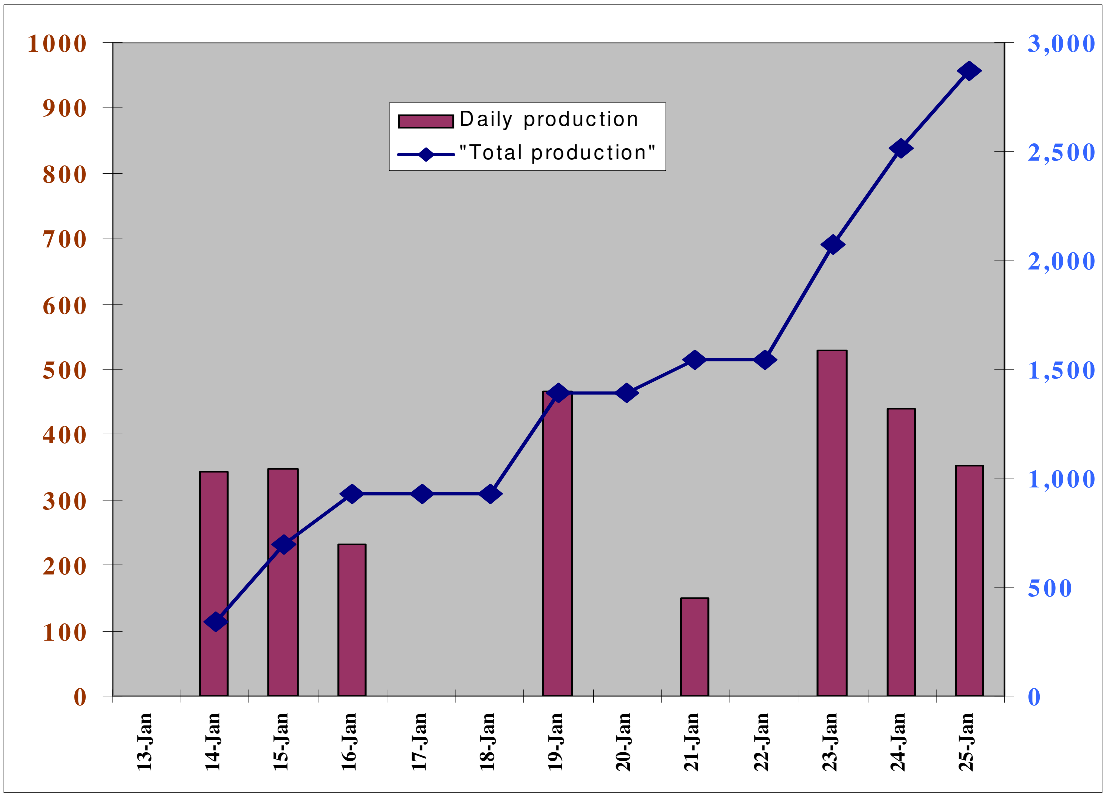


Figure 2d. Graph of daily and cumulative flight production

Figure 3a Helicopter with stinger instrument mount

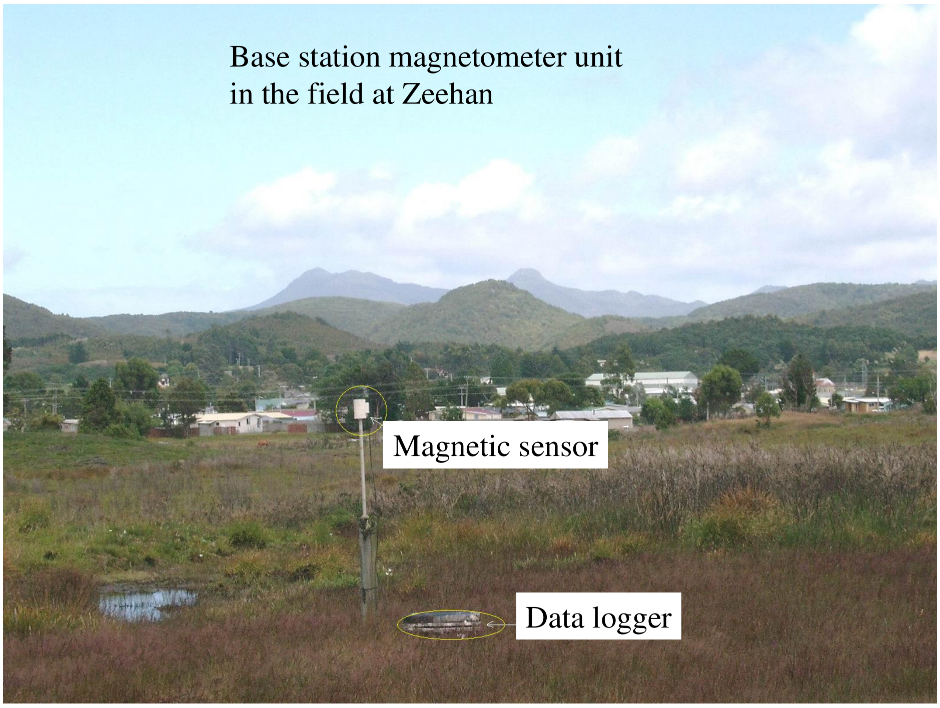


Figure 3b Base station magnetometer

Console of Fugro AS data acquisition system to record magnetic and GPS survey data.
The compact unit is mounted behind the pilot's seat.

Figure 3c Helimag data acquisition unit

3 QUALITY CONTROL

a) Survey Aircraft Figure-of-Merit (FOM)

The only quantitative parameter utilised in airborne magnetic surveys as an estimate of survey data quality is the Figure of Merit (**FOM**). This parameter is an estimate of the compensation required to correct the airborne magnetic measurement for the effects induced by the aircraft manoeuvres as it acquires data.

The procedure to compute this parameter is described by Ward & Hood (1969) as follows:

"It is necessary to carry out a series of pitches and rolls of the aircraft in low gradient areas in order to separate the effects of the various components. The excellence of compensation of a given aircraft is measured by its ***figure of merit***. This index is obtained by summing the amplitudes of the 12 magnetic anomalies recorded when the aircraft carries out 20° rolls, 10° pitches and 10° yaws peak-to-peak on N, E, S, and W headings."

There is not a number cited in the literature as an absolute standard for this parameter and *quality control experts* variably quote a number from 1.2nT to 2.4nT.

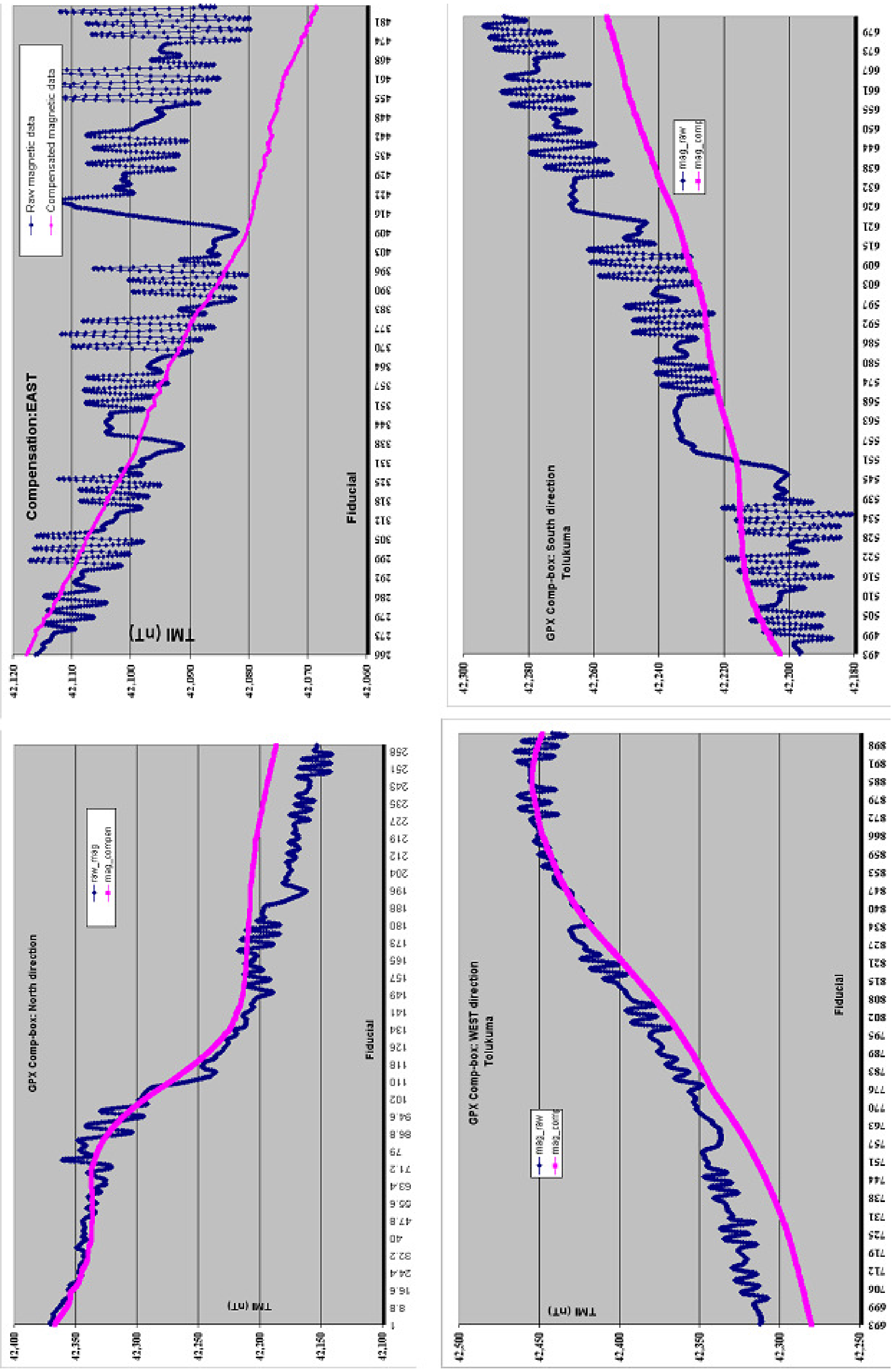
Fugro AS has a standard procedure, termed a '*compensation box*", to estimate ***FOM*** and this requires the aircraft to be put through a set of 5 pitches (of 10° to 20°), 5 rolls (up to 10°) and 5 yaws along line and 5° and 10° from both sides of line direction. Thus five sets of readings are averaged for each manoeuvre in the four principal directions. For the **Allegiance Metals** project, the FOM determination was made at the start of the flying programme and the FOM value was less than 1nT.

The original FOM procedure was designed for regional and petroleum surveys where the magnetic data were to be used for mapping basement geology and required the effects of surface and shallow geology to be effectively eliminated. Thus the surveys were flown at relatively high altitude (in excess of 1,000 feet) and wide line spacing (equal to depth-to-basement) and the FOM was a measure of compensation to low frequency responses.

Modern surveys for mineral exploration, however, are designed to measure a wide range of responses from shallow sources through to basement and a new parameter needs to be introduced to quantify the compensation of high frequency anomalies. The standard 'comp. box' data can be analysed to derive the high frequency component of the manoeuvre noise and the reduction obtained by compensation. The data are high-pass filtered to remove the geology derived signal and the noise level is then computed by rms analysis.

For the Allegiance survey data, the averaged 'raw' FOM value is 0.82nT and compensated (average) FOM is 0.045nT. The absolute value of 'raw' FOM of less than 1nT is encouraging, but the noise reduction factor of 15 to 20 times reduction to less than 0.1nT is significant. To maintain this accuracy, for final corrected data, requires low noise levels in the raw magnetic data and high compensation parameters to reduce the noise to much less than the minimal anomaly signal.

Tolukuma, 2003: airborne geophysical survey
magnetic compensation tests by GPX Airborne Surveys



4 Additional Processing--Reduction to Pole

Magnetic anomalies can vary considerably in pattern depending on several factors, including:

i) inclination of the inducing Magnetic Field vector, which changes with latitude
ii) the presence and attitude of any **magnetic Remanence** component
iii) strike and dip of the magnetic source material.

The inclination of the earth's magnetic field varies from vertical at the poles to horizontal at the equator. As shown in the sketch, the lines of (Primary Field) force may be assumed to intersect the susceptible body at the angle of inclination and polarise the source to generate a secondary magnetic field. This secondary field will either add to or subtract from the Primary Field producing an anomaly that is measured by the magnetometer in the aircraft.

The resulting anomaly patterns for a symmetrical body may be grouped into three types, as shown in the accompanying sketch:

Polar: with vertical inclination, the secondary field will be adding to the primary field over the source and subtracting from the primary only at some distance from the source. Thus the pattern is for a strong ***positive anomaly over the source*** with a weak flanking negative aureole.

Equatorial: with a horizontal primary field the pattern will be reversed as the secondary field will add to the primary ***over the source giving a negative anomaly*** with a flanking positive aureole.

Mid-latitude: for other latitudes the primary field will be intersecting the polarisable body at an angle giving rise to an asymmetric secondary field that will be mainly positive at steep inclinations and mainly negative at shallow inclinations. The positive and negative pattern is termed a dipolar anomaly.

The *reduction to pole* technique is a filtering procedure that recomputes the observed data set to that which would have been observed if the inclination were vertical, ie at the pole. The result is to remove the negative component of the anomaly and re-locate the positive peak to a position over the source with a symmetrical shape. The RTP data set should be easier to interpret as the patterns are less complicated and superimposed anomaly patterns, ie shallow upon deep sources, more easily separated.
In the attached figure 3, showing part of the TMI and RTP data for western Tasmania (**inclination = -72° S**), there are two anomaly patterns that illustrate the benefit of the procedure:

Anomaly one is located to the east of Renison, and the anomaly pattern is a magnetic 'low' due to the Exe Granite. The RTP process results in the 'low' shifting to the south and becoming more symmetrical—typical of a non-magnetic granite signature.

Anomaly two shows the dipolar anomaly on the western side of the Huskisson Syncline, with the negative components in the TMI image changing shape but still present to indicate a dip to the north.

If there is a remanent component in the magnetic anomaly pattern then the RTP process will not totally remove the dipole pattern and an asymmetric anomaly will still be evident. There are several anomalous zones in the RTP data set that have residual dipole patterns. **A strong 'negative' anomaly pattern** is observed over the interpreted extent of the Pine Hill Granite and this 'low' is stronger that would be expected for the presence of non-magnetic granite. It is proposed that this intrusive has re-set remanent magnetism in the vicinity and increased the amplitude of the negative anomaly.

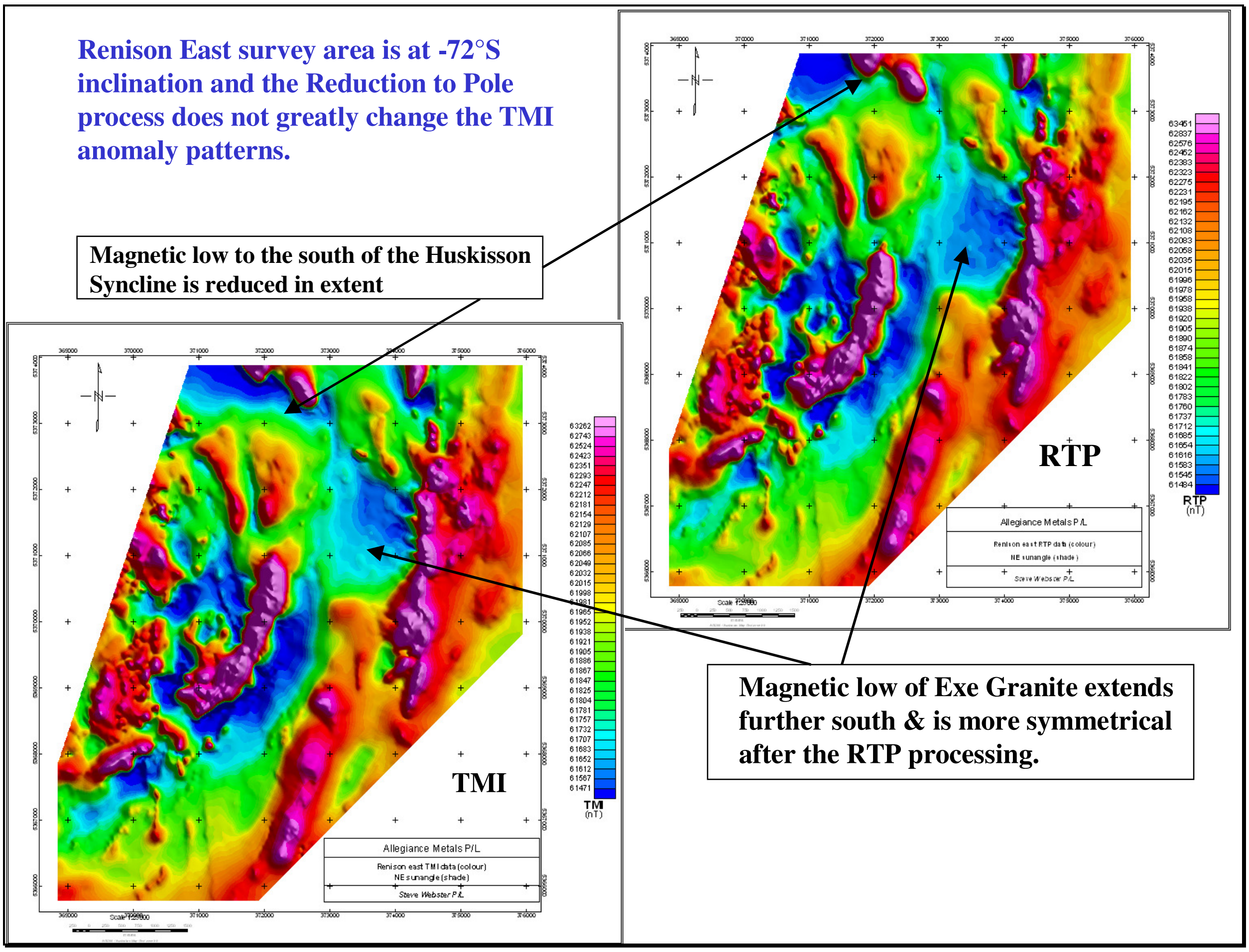


Figure 4. Comparison between Total Magnetic Intensity (TMI) and Reduced to Pole (RTP) magnetic images for the Renison East area survey area, illustrating the extent of changes in anomaly shape with RTP conversion.

5 Preliminary Geological Interpretation and Notes on Targets – Renison East

Compilation of geological mapping in the Renison East area (by Allegiance Metals P/L) shows that two main belts of ultramafic complex trend approximately north – south through the tenure area. These ultramafic units are located between the Cambrian Dundas Group metasediments and the Eocambrian Crimson Creek or Success Creek units, perhaps marking the limbs of a major synclinal fold.

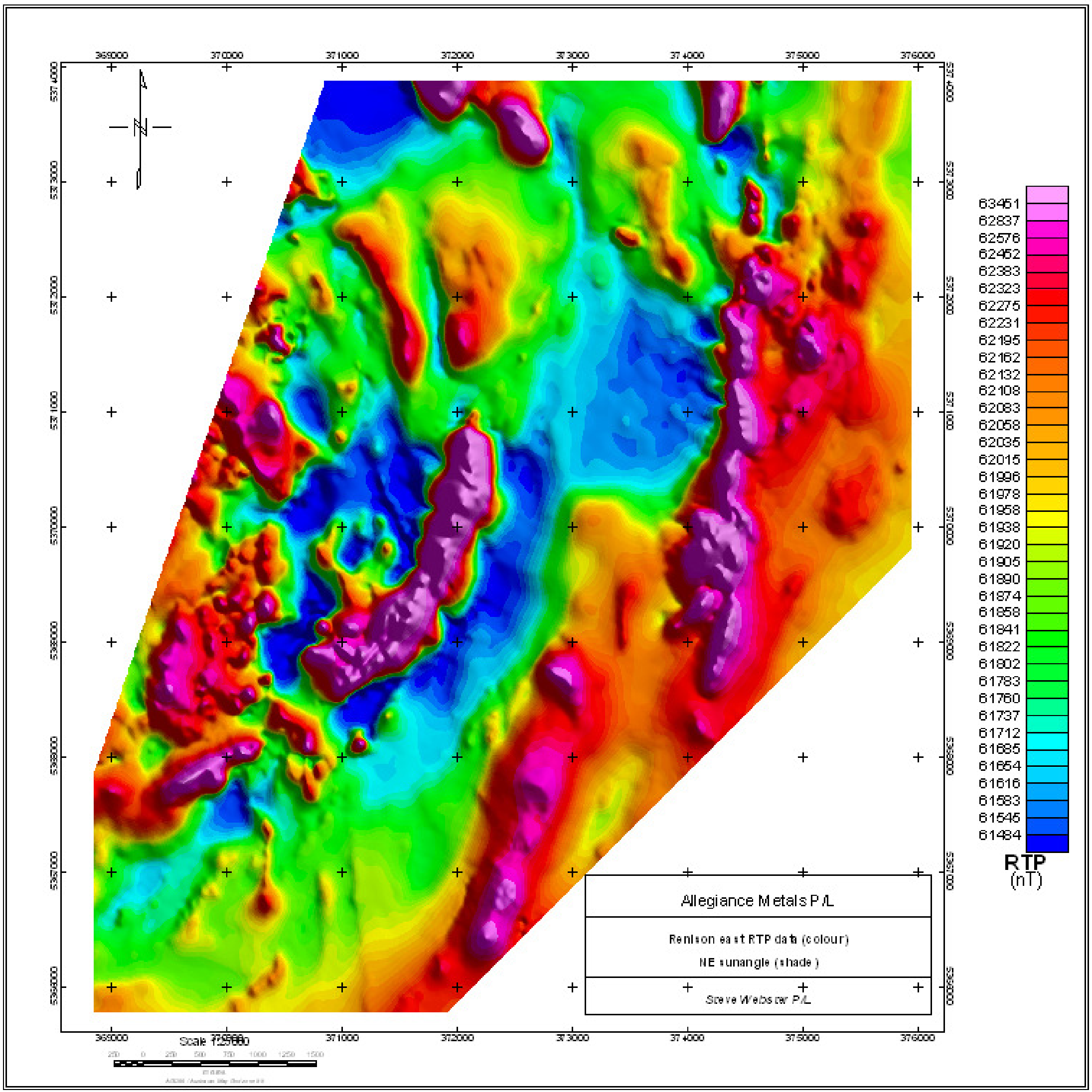


Figure 5. Reduced to Pole magnetic image for the Renison East area

A brief overview of figure 5 indicates that linear, strong magnetic anomalies reflect the extent of ultramafic units. The fragmented magnetic highs in the west of the survey area reflect the location of the Crimson Creek units, where the apparent magnetic susceptibility has been influenced by the thermal alteration effects of granitoids. The zones of low magnetic relief (green shading) marks the Dundas Group units, while the stronger magnetic lows (blue shading) indicate areas that are interpreted to be intruded by Devonian granite. This synopsis is schematically illustrated in Figure 5a.

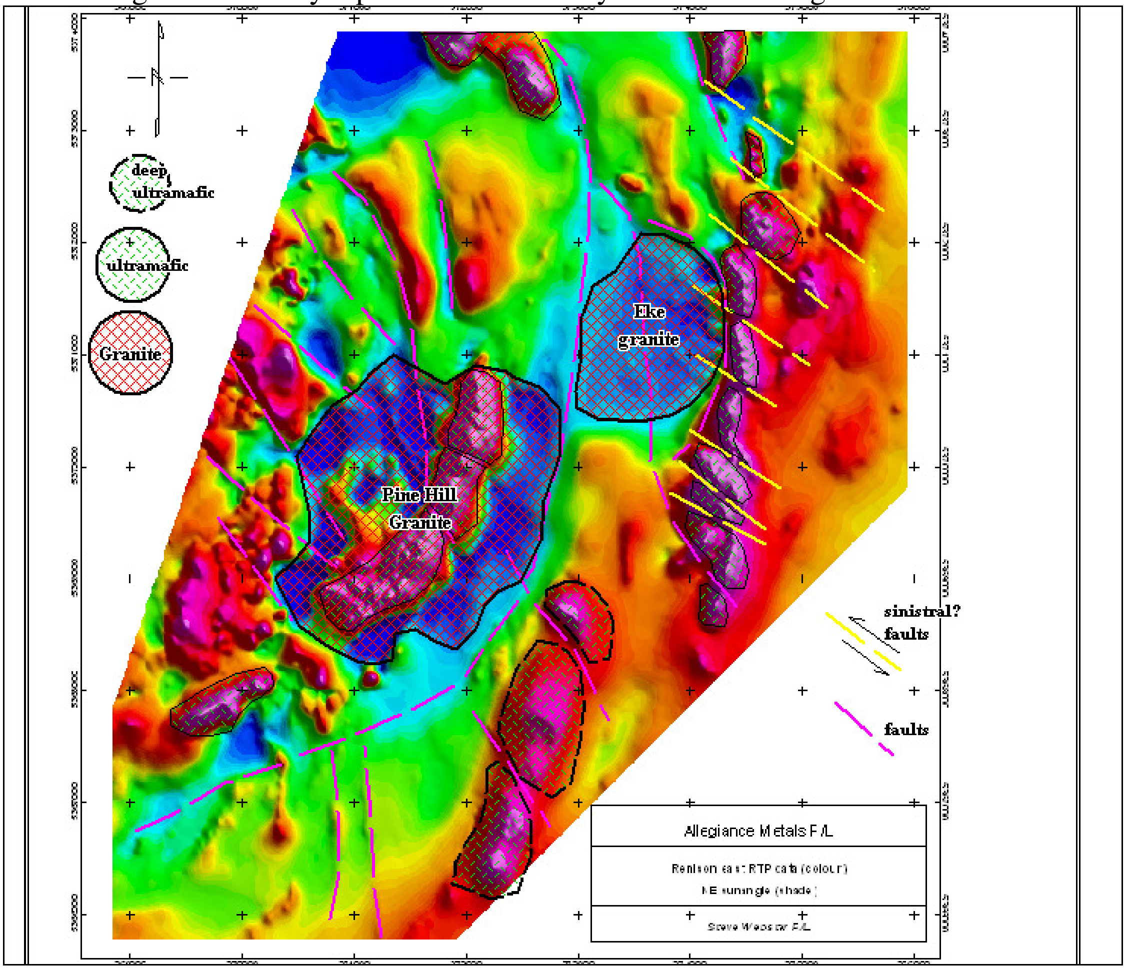


Figure 5a. Schematic interpretation of RTP magnetic data, Renison East

The ***eastern ultramafic unit*** is shown to be discontinuous, as its trend is broken by several NW-SE trending faults, which are probably sinistral in orientation. The magnetic ‘low’ to the west of the ultramafic is interpreted to reflect the presence of a non-magnetic granite, called the Exe granite. Several magnetic profiles (figures 5b and 5c) across this zone have been modelled and the presence of granite is required to explain the lower magnetic background in the western portion of the traverses.

The northern modelled line (along 5,371,725N) shows a limited amount of ultramafic, at shallow depth, causing a 2,000nT anomaly, with some magnetic (Crimson Creek?) lithology in the east at Colebrook Hill. The Exe granite is required in the west to explain the 500nT shift in base magnetic level. The central modelled line (along 5,371,000N) shows a vertical ultramafic with greater depth extent (750m) to explain a 3,000nT anomaly. The southern modelled line (along 5,369,900N) has a 5,000nT anomaly and requires a more extensive ultramafic, at shallow depth, extending more that 1,250m in depth. A steep dip of the ultramafic to the east is implied from the data unless remanent magnetism is present, as the direction of remanence would confuse dip interpretation.

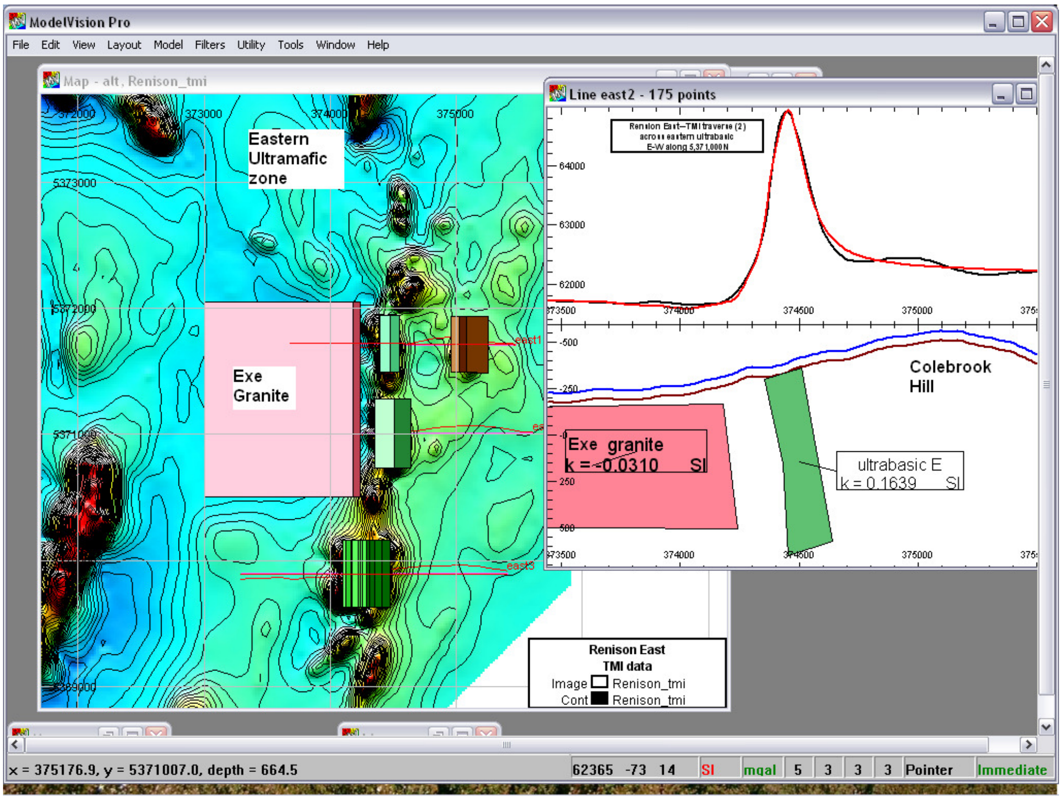


Figure 5b. Interpretation of magnetic data near Colebrook Hill.

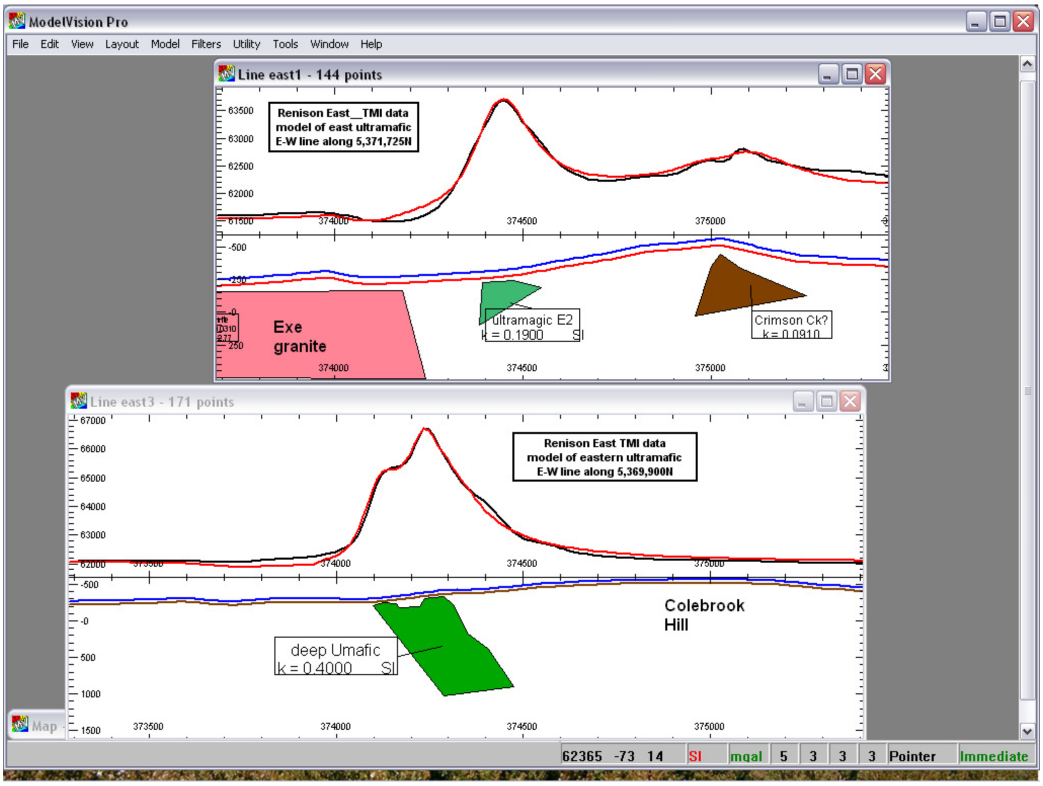


Figure 5c. Interpretation of magnetic anomalies near Colebrook Hill

Quantitative Interpretation of Renison East TMI data

		anomaly	<-----------	ultramafic unit	---------->		<---other sources
Magnetic Zone	**model profile**	**amplitude (nT)**	**interpreted k (SI)**	**depth (to top)**	**depth extent**	**attitude**	**granite**
east ultramafic	east1	2000	0.19	outcrop	300m	unsure	yes
	east2	3500	0.164	outcrop	750m	vertical	yes
	east3	4500	0.4	outcrop	1250m	dip to east	no
Central ultramafic	central1	4500	0.385	100m	1100m	vertical	no
	central2	3000	0.25	outcrop	1200m	vertical	yes
	central3	2500	0.2214	100m	1000m	vertical	yes?
Southern U/mafic	southern u/m	2000	0.167	<100m	1250m	dip to west	yes
South-East U/M	south-east U/M1	1000	0.2	150m	1200m	dip to west	maybe?
	south-east U/M2	1000	0.2	250m	1600m	dip to west	no

The ***central ultramafic*** has been modelled using 3 traverses as shown in figures 5d (which shows the traverse relative to the TMI data) and 5e. The traverse in figure 5d is interpolated across the ultramafic in a NW-SE direction and may also cross the Pine Hill granite, which is now assumed to me more extensive than previously mapped. The ultramafic anomaly is 2,500nT in amplitude and is shown to be due to a complex source some 300 metres wide but narrowing in depth to greater than 1,000m deep. The interpreted susceptibility is only moderate, for this lithology, at k=0.22 SI. The lower magnetic background to the east is assumed to be due to the presence of granite; however, this may also be explained by the low susceptibility of Dundas Group sediments.

To the north, along 5,370,000N, an east-west traverse (figure 5e) across the central ultramafic crosses the interpreted Pine Hill granite (which is modelled to have a lower ‘negative’ susceptibility than on the traverse modelled in figure 5d). The ultramafic exhibits a 3,000nT anomaly, is 200m wide and narrows as it deepens to a depth in excess of 1,000m. The interpreted susceptibility of 0.25SI is an average value for ultramafics in the area.

Another traverse along 5,370,500N crosses the central ultramafic where the amplitude is stronger, at 4,500nT, and requires a higher susceptibility of 0.385 SI that may indicate skarn development. The interpreted width of the shallow ultramafic is 200m, and a depth extent of 1km is assumed. This line is located at the upper extent of the Pine Hill granite and may be located in a better position to fulfil the conditions for the development of a nickel deposit of the Avebury type.

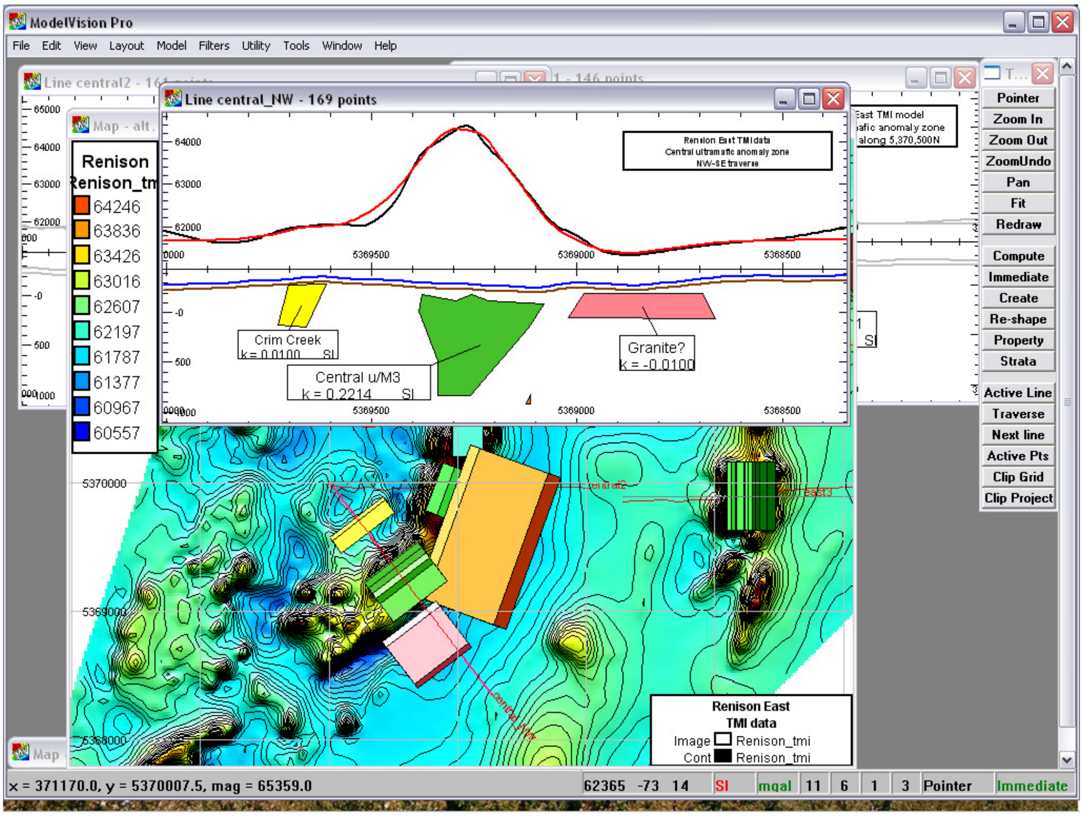


Figure 5d. TMI data and NW-SE profile across Central ultramafic

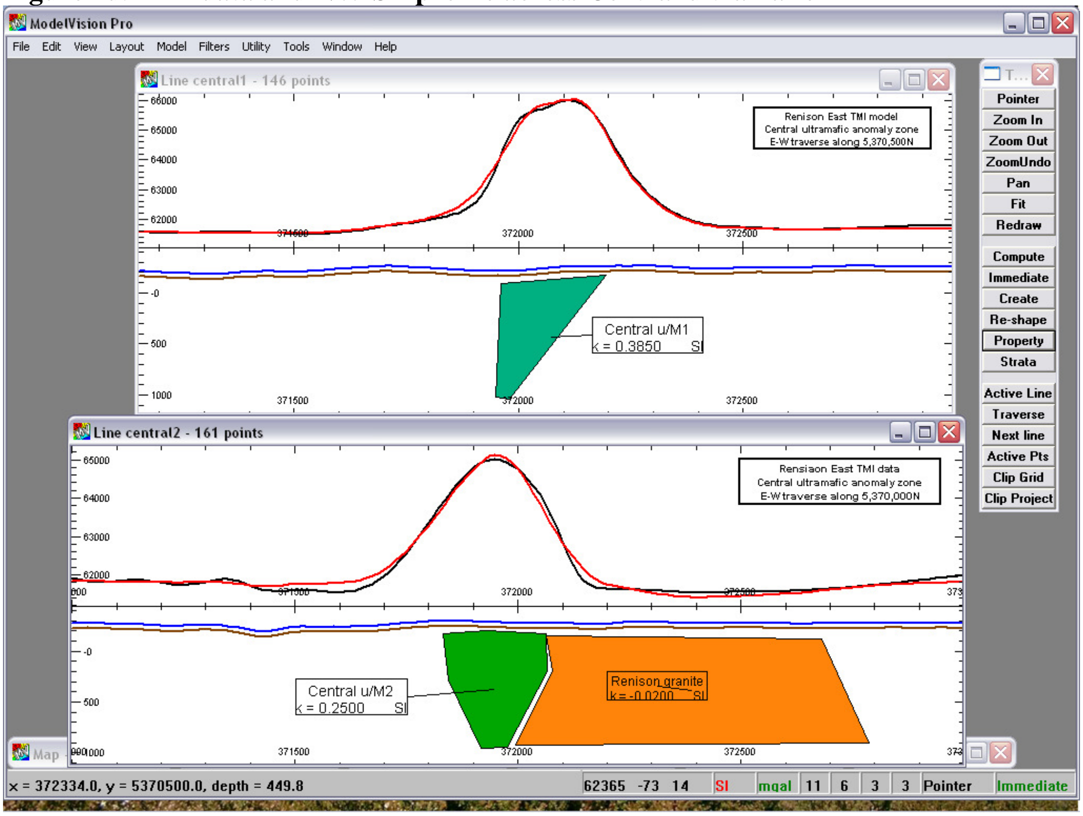


Figure 5e. Models of TMI traverses across the Central ultramafic

The ***western ultramafic*** is mapped as continuous to the south of the outcrop of Pine Hill granite, however, the magnetic anomaly trend is broken in this vicinity and the anomaly intensity is reduced in amplitude to less than 2,000nT. The anomaly of the south-western continuation of the trend is modelled in Figure 5f, with a traverse that is aligned NW-SE, as a NW dipping unit (of average serpentinite susceptibility of 0.20 SI) that is less than 200m wide and thins in depth. The magnetic low to the SE has been labelled as granite (with susceptibility 0.02 SI units lower than background) but this would not be the Pine Hill granite and may be Dundas Group units Cdbr(?).

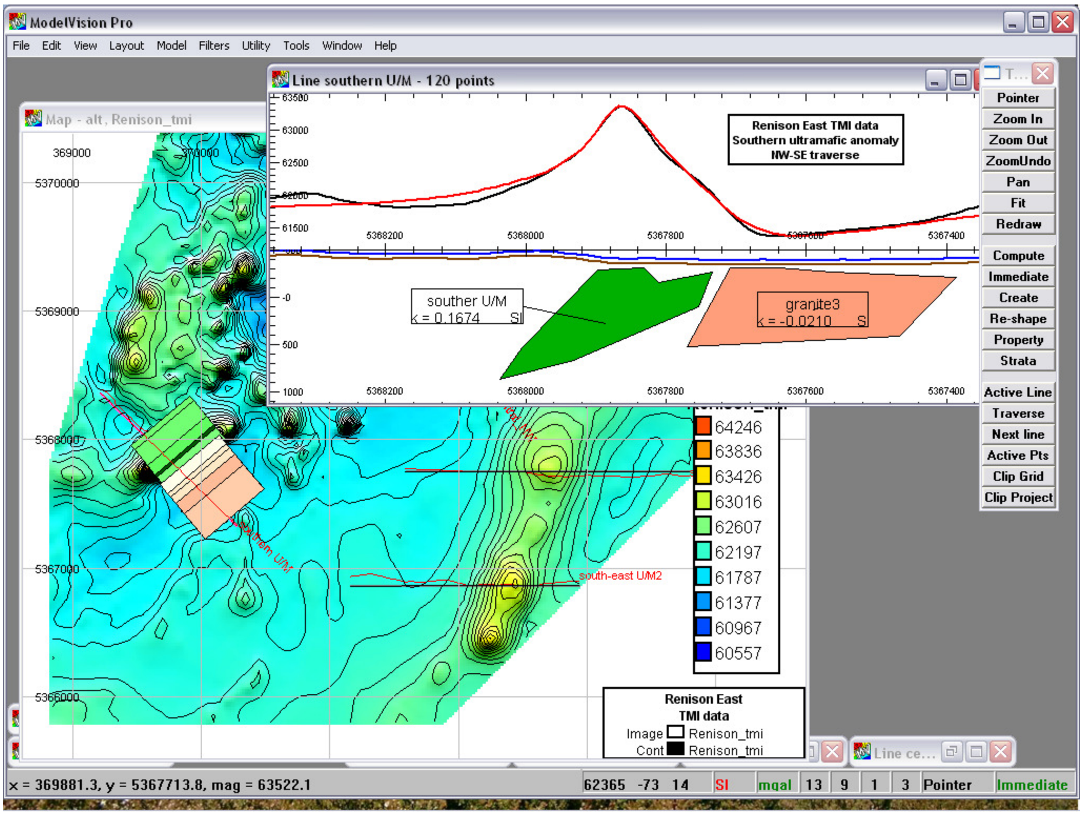


Figure 5f. TMI data and profile over southern ultramafic anomaly

The ***south-eastern TMI anomaly zone*** may reflect a displaced continuation of the eastern ultramafic, as it is a deeper anomaly trend that is off-set to the west of the other feature. Two traverses across this trend are modelled in figure 5g. Both anomalies can be explained by simple geometric sources of average susceptibility (0.2 SI units), less than 200 metres width, dipping to the west. The sources are modelled at depths of the order of 200 – 300m below surface. The northern of the two lines has a (western) magnetic background that is 250nT lower than the eastern background and may reflect some influence from the Pine Hill granite magnetic 'low'.

Structure

Several major structural features are noted from the magnetic data (Fig 5a) including an arcuate feature that may extend through the whole area. A N-S trending structure is observed to be located between the Exe granite and Pine Hill granite and this feature is extrapolated to pass to the west of the southern ultramafic and then swing to the SW, defining the southern extent of the Pine Hill granite. An example to support this feature: two parallel structures (linear magnetic highs) trend N-S from the southernmost extent of the survey, however, they terminate at the extrapolated position of this arcuate feature.

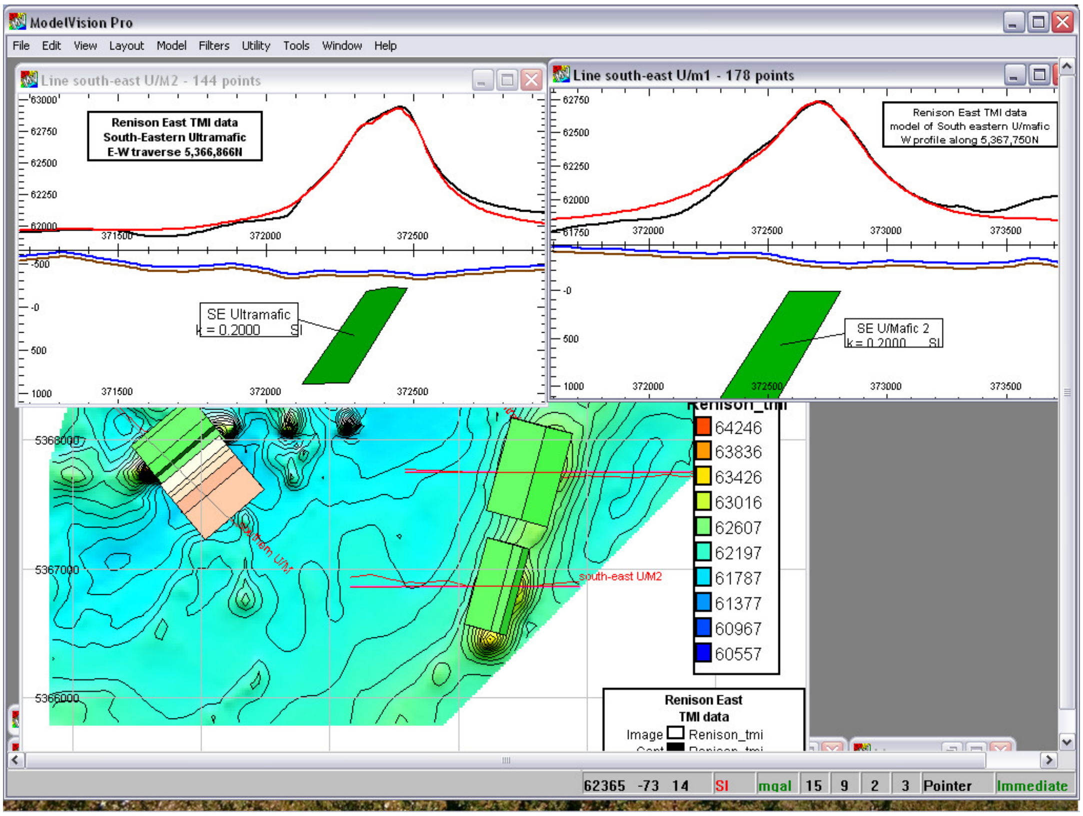


Figure 5g. **TMI data and model profiles for the SE anomaly zone**

Proposed targets

i) the eastern ultramafic sub-crops for most of its strike length, thus cannot fit the Avebury model for cap-rock to trap mineralising solutions and form a massive sulphide Ni deposit. However, the strong structural deformation revealed by the current survey may provide alternate fault-trap locations for a deposit to occur.

ii) The central ultramafic is ideally located in close proximity to the Pine Hill Granite and a favourable structural zone may be the preferred site for exploration.

iii) The south-western ultramafic is not contiguous with the central ultramafic and is removed from the Pine Hill Granite and thus where covered could fit to the Avebury model.

iv) the south-eastern ultramafic is shown to be non-outcropping and would be not too far removed from the Pine Hill Granite to be excluded from exploration follow-up, if located within Allegiance tenure.

6 Conclusions

The high-resolution helimag survey of three areas in Tasmania provided greater definition of geological features than was available from the reconnaissance MRT data set. A preliminary interpretation used the new data in conjunction with the MRT data and collated geological information to indicate prospect areas for exploration follow-up. The preliminary interpretation needs to be reviewed to define targets for Avebury style nickel mineralisation.

At Renison East the new data revealed the extent of the Exe granite and its impact on the eastern ultramafic unit, in particular the structural deformation that could provide traps for mineralisation that differ slightly from the standard Avebury model. In addition, the revised extent of the Pine Hill Granite is defined by magnetic lows that probably equate to thermal metamorphic impact on the country rocks, which should assist in locating zones of high exploration potential.