INCREASED MINERAL PROSPECTIVITY IN THE SOUTHEAST OF NSW

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SUMMARY

Understanding the relationship between mineralisation and magnetic intrusive complexes is pivotal in an exploration program. With the recent release of high resolution airborne geophysical data over the southeast of New South Wales, it is timely to complete a detailed study of the magnetic data that will assist the geological mapping and further understanding of the structure of the area.

Preliminary studies in determining the depth to magnetic source have been completed, including analysis of both manual and semi-automatic methods. Results are consistent and viable, and show general agreement between various modelling applications. A more detailed and exhaustive study is underway that will include comparisons using both line and grid data, and with various commercial semi-automatic magnetic modelling packages.

Key words: mapping, magnetic data, modelling, southeast NSW, Euler, Naudy

INTRODUCTION

The government-funded Southeast Lachlan airborne magnetic and radiometric survey in the southeast of NSW was completed in June 2011. It covered more than 24,000 square kilometres and over 120,000 line kilometres of data in the Eden, Bombala, Delegate, Cooma, Adaminaby, Tumut and Brindabella regions.

Analysis of the airborne geophysical data by staff of the Geological Survey of New South Wales (GSNSW) has identified the southern extensions of Silurian volcano-sedimentary rocks that host a number of volcanic-hosted massive sulfide deposits including the Woodlawn and Captains Flat base metal deposits. It has also better defined the extensive Silurian- to Devonian granites that host intrusion-related deposits such as Yambulla (gold) and Whipstick (molybdenum–bismuth–gold). In addition, the survey covered the southern part of the poorly understood Eden–Comerong–Yalwal rift zone which is prospective for epithermal gold–silver and silver–base metal deposits such as Pambula and Wolumla. Other deposit types known in the survey area include orogenic gold and base metal deposits, auriferous placers and minor skarn-type mineralisation.

The new data have assisted in the mapping of prospective rock units under cover, and provide a much clearer understanding of the regional tectonics of the area. Several areas are now recommended for further follow-up by explorers.

The interpretation is supported with Encom™ ModelVision modelling of selected anomalies that indicate basement depths of <100m, in many cases within 50m of surface. The semi-automated Naudy and Euler methods were applied for solution of basement (magnetic) depth.

REGIONAL GEOLOGY

Following geological mapping of the 2nd edition Braidwood 1:100 000 map sheet, it was clear that more geological mapping should be carried out further south, to cover the Silurian–Devonian extensional basins of the south-eastern Lachlan Orogen. This would enhance the understanding of the geological history and mineral systems of the Southern Tablelands region of New South Wales.

The Michelago 1:100 000 map sheet (Figure 1) was last mapped in the 1970s (Richardson, 1979) — the available mapping products were published before detailed regional airborne geophysics became available. The GSNSW has recently released detailed regional magnetic and radiometric data over the Michelago sheet area as part the Southeast Lachlan airborne geophysical survey (Figure 2).

Southwest of Goulburn, extensive exposure of the (middle to Late Silurian) lower parts of the rift basins, which host carbonate sequences and felsic to bimodal volcanic centres, are known to host economic VHMS mineralisation (e.g. Woodlawn, Captains Flat, Currawang). The widespread exposure of the middle to Late Silurian syn-rift sequence is a result of either the removal of overlying Devonian sequences during Middle Devonian basin inversion (Tabberabberan Orogeny) and/or deep water volcaniclastic sedimentation being spatially restricted in the south-eastern Lachlan Orogen during the Early Devonian.

The Goulburn Basin is a significant VHMS province with mineralisation hosted by Late Silurian volcanic and volcano sedimentary sequences. These were the focus of intensive exploration during the 1960s–70s which led to the discovery of the world class Woodlawn Cu–Pb–Zn–Ag–Au orebodies and nearby economic deposits at Currawang. The recent discovery of mineralisation at the McPhillamys prospect, near Blayney, has sparked renewed interest in gold-bearing base metal mineral systems in Late Silurian rift basin sequences, including the lower parts of the Hill End Trough and Goulburn Basin stratigraphy.

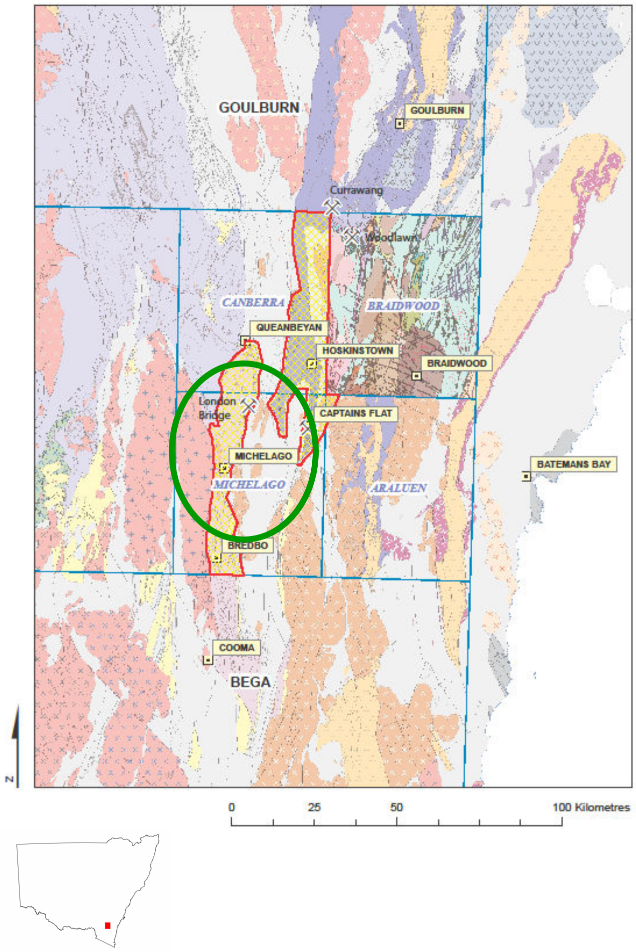

Figure 1. Location of the Michelago project area (green outline) on a backdrop of geology.

METHOLOGY

The Encom™ ModelVision application enables rapid depth-to-basement source estimation. The module is based on a refined version of the Naudy dipping tabular body inversion method that provides quality geological information for depth, magnetic susceptibility, thickness and dip. This method uses a realistic geological model for steeply dipping, semi-linear magnetic bodies such as volcanic rocks, ironstone formations and dykes.

The Intrepid Euler Deconvolution tool creates a depth-to-basement solution set from a grid dataset. It calculates the location, depth below sensor and reliability for each solution as well as error estimates in the form of standard deviations. Each model contains solutions of a particular structural type, defined by the structural index parameter. In the extended Euler process, the solution calculates structural type as the structural index output field. It also assumes that within a window, all gradients are caused by just one body. This body has simple shape with an integer-power drop off for the structural index (Fitzgerald et al., 2004, 2006).

For the Michelago 1:100 000 sheet, Intrepid's Euler 2 Equation solver (XYZ, SI, b) was run on 50m ERMapper grid of the TMI RTP data. A window width of 7 points was used — an 11 point window width was too small to detect many of the narrow linear magnetic anomalies. The solution sorting in Euler used a minimum/maximum depth of zero to 1000m with a clustering point separation of 300m. Finally a set of strike symbols was generated using Discover and all point-solution locations and depths were overlain so that the solutions could be compared to the estimated geological strike. This was only completed for the subset area as a test to combine the solutions and structural data in a GIS.

The Naudy method was run on a 400m line x 50m station dataset created from the 50m resolution TMI (not the RTP) grid. A clearance channel was created in the database at a constant height of 60m. Naudy was run in Dyke mode looking for solutions between 20 and 1000m depth below surface. Trends were calculated to improve the solution accuracy (i.e. correct body strike) and Naudy dips <30º were allowed. Adjustment was followed by a 5 iteration inversion. Snaps of the solution depths, similarities (model fit) and the calculated trends illustrate the type of results that were obtained.

RESULTS

1. Modelling of discrete magnetic zones

Using the Southeast Lachlan airborne magnetic dataset, the Encom™ ModelVision application enabled a rapid magnetic depth-to-basement source estimation of ten anomalous zones. Figure 2 shows the locations of the ten anomalous zones studied and the Appendix 1 a and b shows the modelling details for anomalous zones 1 & 3 retrospectively, which lie near to the Michelago map sheet. Figure 3 shows the distribution of modelled magnetic source depths for 44 discrete anomalies that were modelled within the ten anomalous zones and illustrates that 70% of the modelled anomalies have a magnetic source depth of less than 100m.

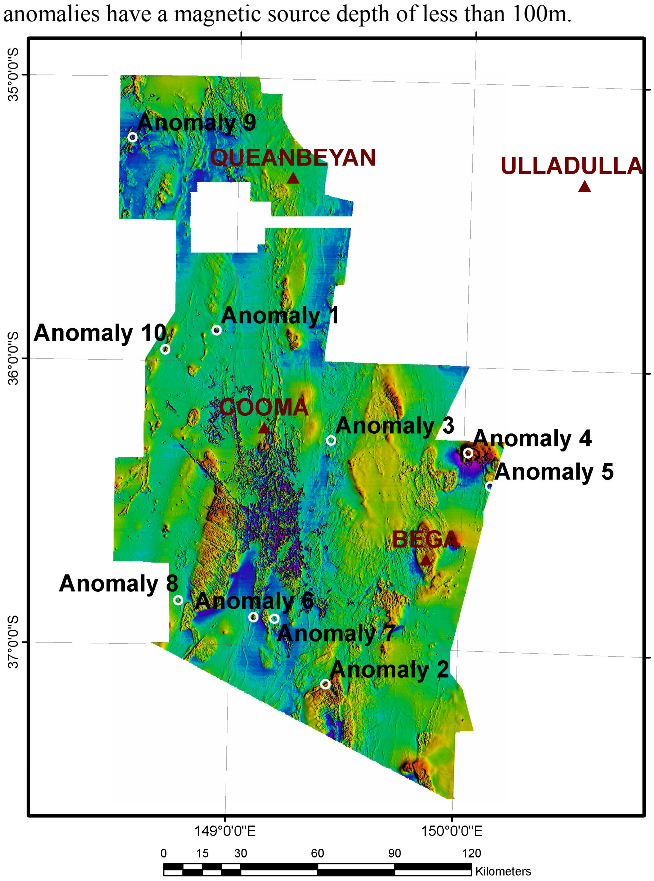

Figure 2. Colour image of the magnetic data for the Southeast Lachlan Survey showing the location of the ten anomalous zones modelled with Encom™ ModelVision.

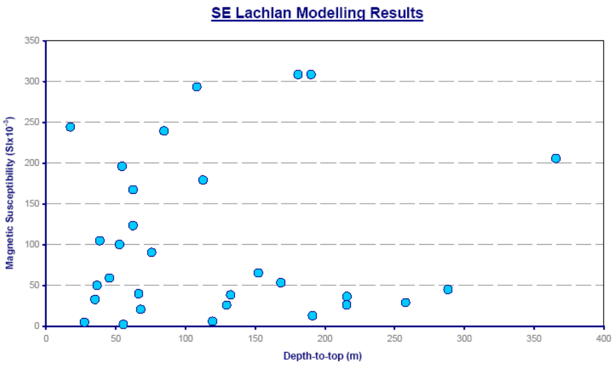

Figure 3. Plot of magnetic susceptibility against depth to magnetic source for the forty four magnetic anomalies modelled with Encom™ ModelVision.

2. Magnetic models for the Michelago sheet area.

The depth to magnetic source data calculated using Intrepid's Euler 2 Equation solver for the Michelago map sheet area were run on 50m ERMapper grid of the TMI_RTP data. The results in Appendix 2 show the magnetic source depths (or elevation), on a backdrop of the pseudocolour image of the magnetic data (TMI RTP). Although many solutions were calculated there is a consistent range of magnetic source depths for each of the anomalous zones. To assist in evaluating the outcomes, the following summary plots were compiled:

a) Elevation (depth) vs. elevation (depth) frequency (Figure 3)

From over 640,000 solutions of depth to magnetic source, the mean magnetic source depth was defined at 90.6m below surface. The mode highlights that the most common magnetic source depth is less than 50m.

b) Elevation (depth) vs. structural index (Figure 4)

Summary statistics from this scatter plot show a mean structural index of 0.12 that implies the magnetic source is generally due to a steep dipping tabular body.

c) Euler reliability vs. reliability frequency (Figure 5)

From the histogram plot a mean reliability index of 0.13 confirms that the source is a steep dipping tabular body. As the histogram plot is fairly uniform (not diffuse) over the range of index values of 0.110 to 0.155, it implies that the derived solutions are near equal and consistent.

d) Euler structural index vs. structural index frequency (Figure 6)

A structural index of -0.25 to 0.25 strongly indicates a contact or edge solution for the modelled sources. This would be expected and again indicates that the derived solutions are realistic and reliable.

e) Euler singularity index (Figure 7)

The solution for a least squares best fit involves a Singular Value Decomposition, where each term being solved for has a singular weight. The ratio of the maximum of these weights to the minimum is known as the singularity ratio and reflects (partly) the likelihood of the causative body being 2-dimensional. It also has an element of poor conditioning and signal strength. Tests indicate that solutions with high singularity ratio (>2000) are likely to be less plausible solutions.

f) Euler strike (Figure 8)

A rose diagram of the Euler strike indicates a strong north–south trend. This is consistent with the Michelago geological map.

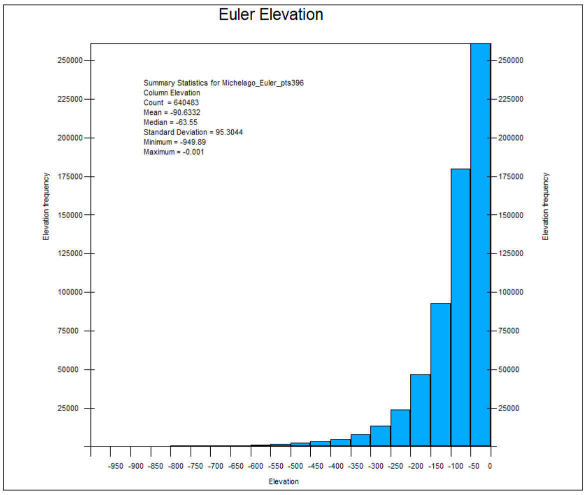

Figure 3. Elevation (depth) vs. elevation (depth) frequency

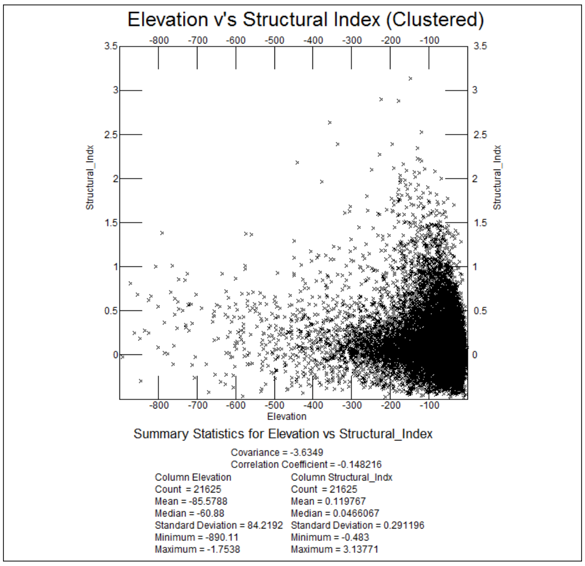

Figure 4. Elevation (depth) vs. structural index

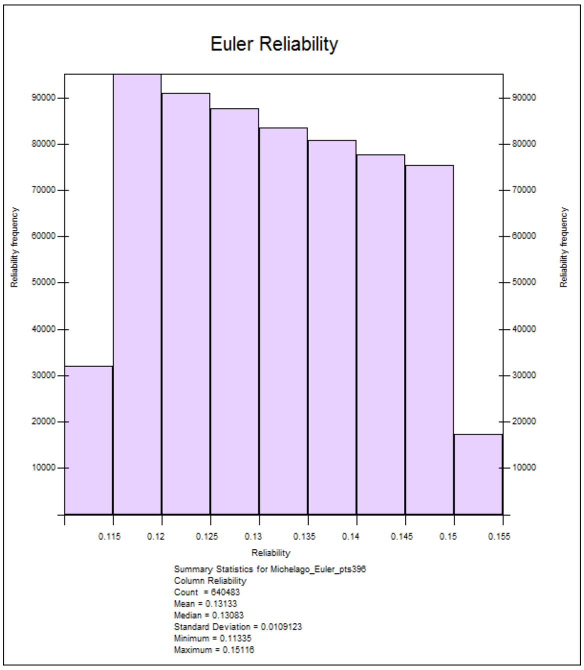

Figure 5. Euler reliability vs. reliability frequency

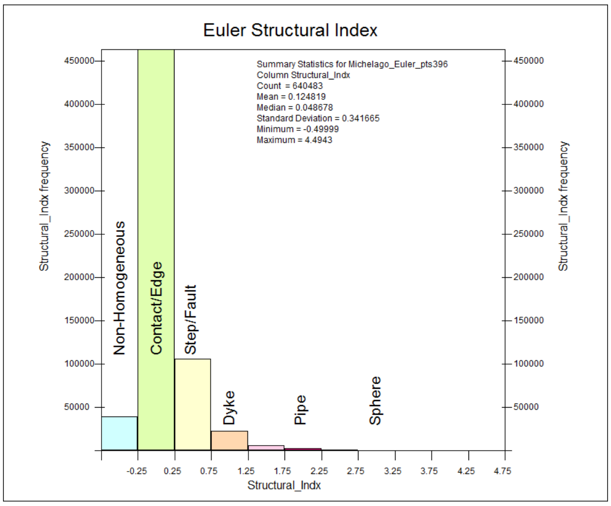

Figure 6. Euler structural index vs. structural index frequency

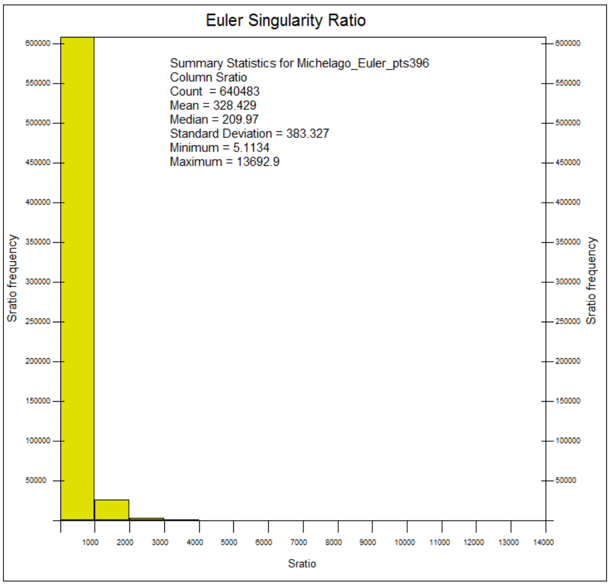

Figure 7. Euler singularity index

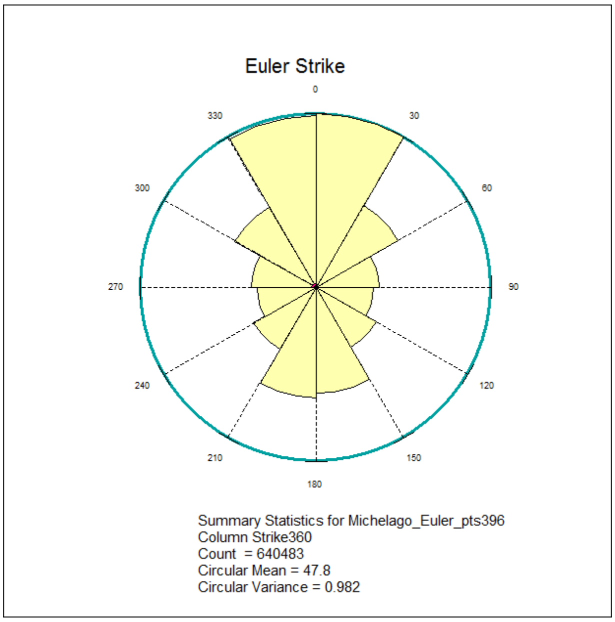

Figure 8. Euler strike as a rose diagram

CONCLUSIONS

Coincidence between mineralisation and magnetic intrusive complexes is of great interest to mineral explorers. Although further investigation is required, a key tool in this study is to refine the geological mapping of prospective areas with a study of the recently released high resolution airborne magnetic data over the south-eastern New South Wales.

Assisting explorers in determining the depth (and dip) of magnetic sources aids mapping and leads to a better understanding of the structure of the area. As a first pass, small selections of magnetic anomalies over the survey area were individually modelled using Encom™ ModelVision. With the need to more adequately and efficiently cover an area, this abstract reviewed a preliminary application of a semi-automated method of calculating the depth to magnetic source.

As the Michelago 1:100 000 scale map sheet area is a current GSNSW mapping project area. Intrepid's Euler Deconvolution and Naudy methods were applied there. Although this study has started, the preliminary results are consistent and broadly agree with the depths obtained by individual modelling of anomalies. A more precise and detailed study has just begun that will include studies of grid and line data and include further analysis of the reliability (goodness), depth error and structural index of the solutions. Besides comparisons with grid and line data, it will also involve comparisons with other semi-automatic methods such as Encom™ AutoMag technique.

Ultimately, this study is expected to lead to a far better understanding of the stratigraphy that will in turn allow the targeting of specific horizons and possibly identify heat sources to VHMS systems.

ACKNOWLEDGMENTS

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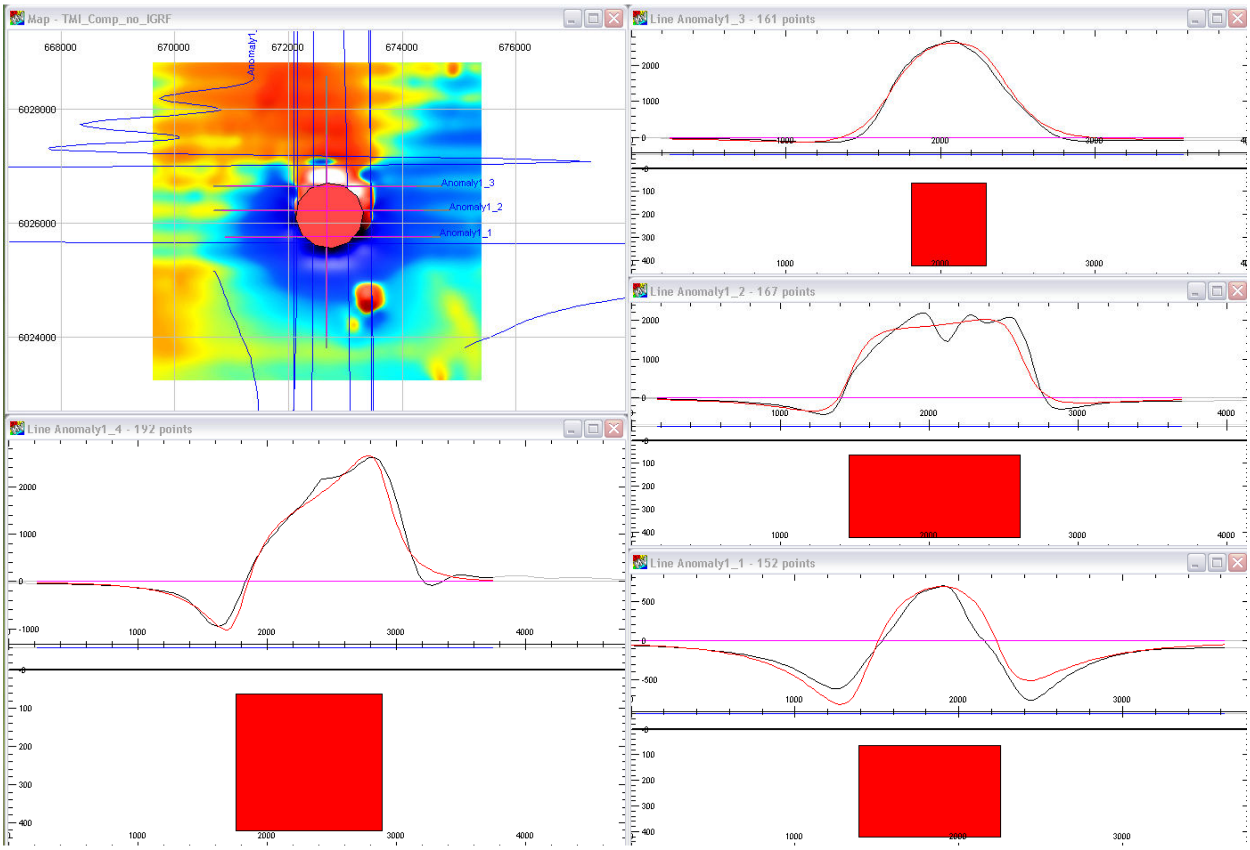
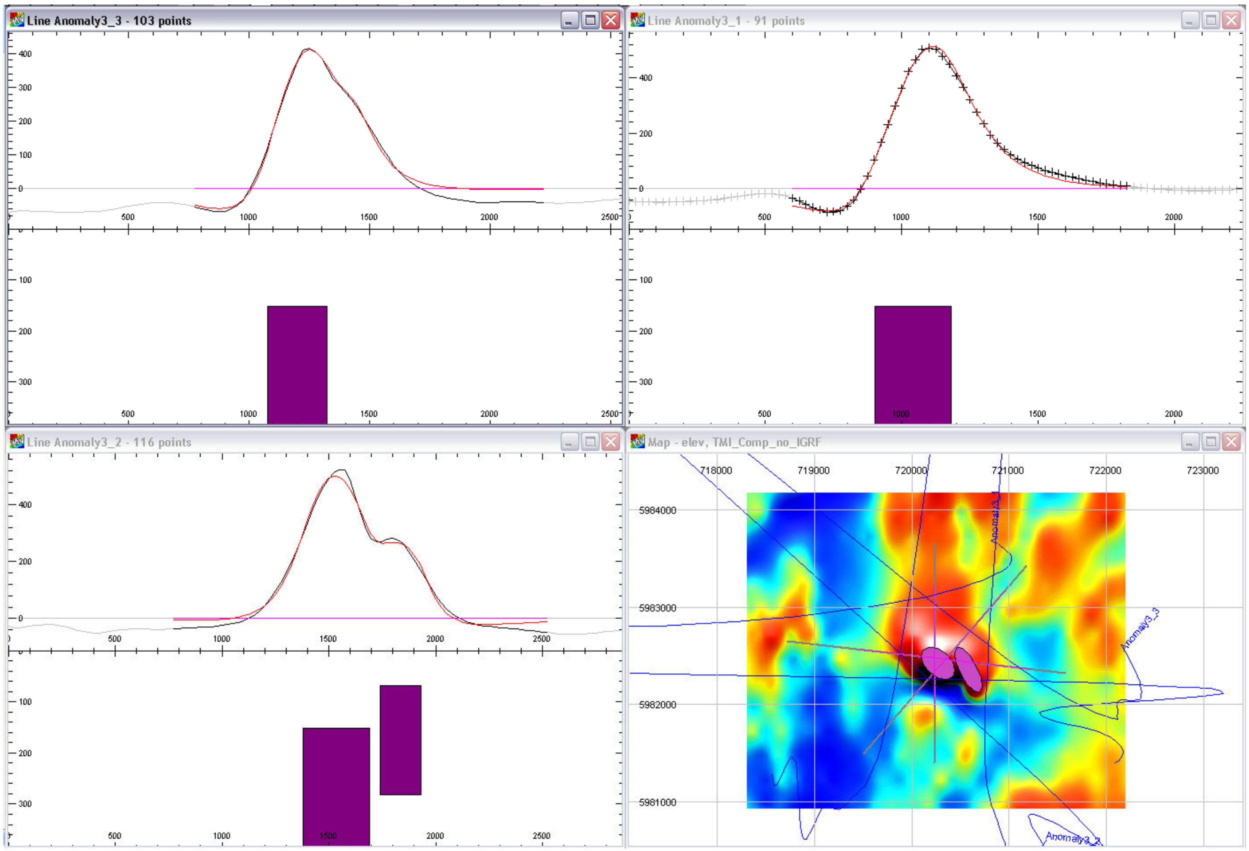
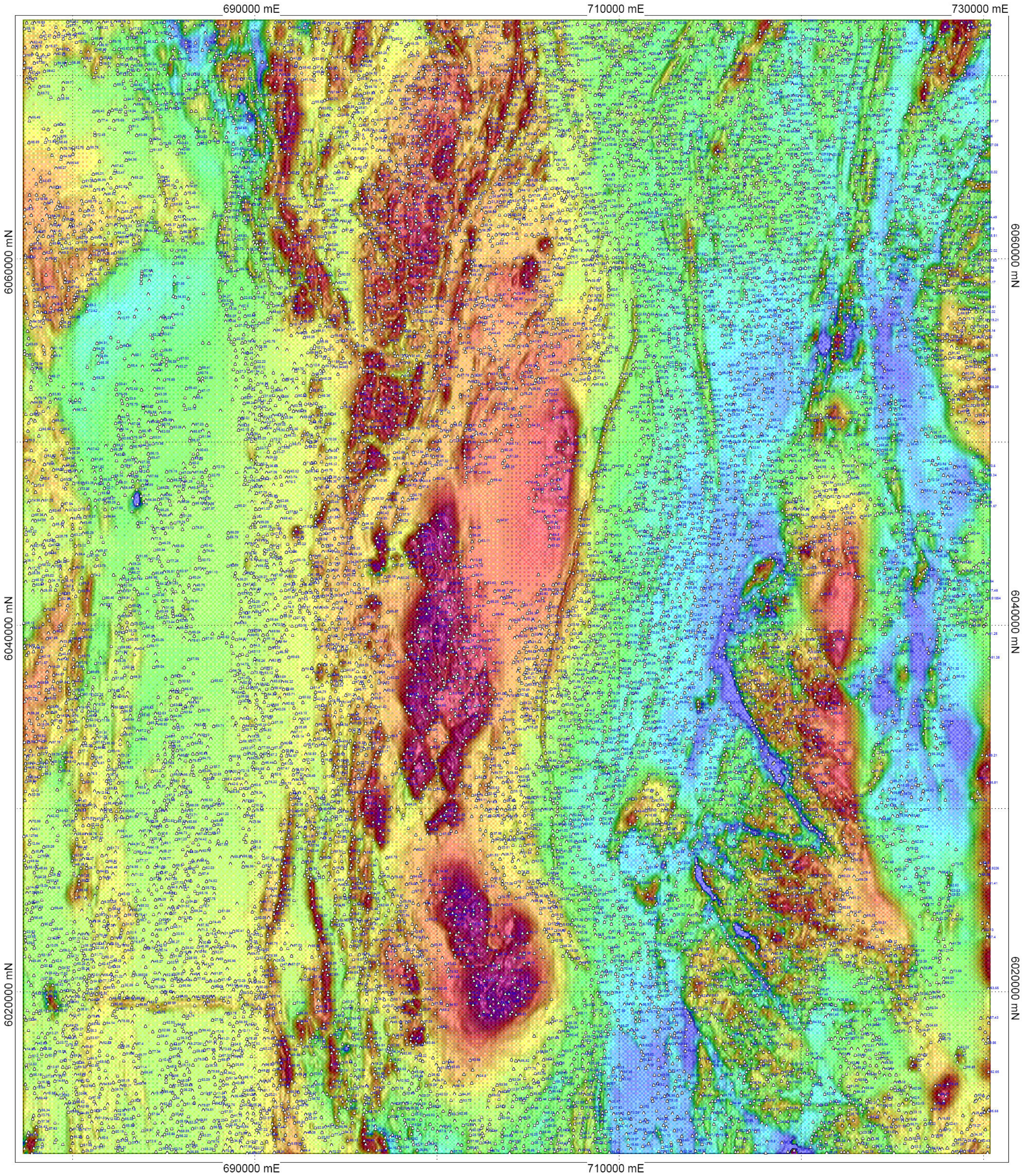


Appendix 1. (a) Results of Encom™ ModelVision magnetic modelling of anomalous Zone 1.



Appendix 1. (b) Results of Encom™ ModelVision magnetic modelling of anomalous Zone 3.



Appendix 2. Preliminary results of Euler modelling of the Michelago map sheet area – elevation (depth) to magnetic source overlain on a pseudocolour image of the TMI RTP data.