
SHREE EXPLORATION LIMITED

MT BERTHA AEROMAGNETIC SURVEY REPROCESSING AND PRELIMINARY INTERPRETATION

By:

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1 Executive Summary

This report describes the results of data enhancement and preliminary interpretation of semi-regional aeromagnetic data and radiometric data covering the Shree Minerals Mt Bertha tenement EL42/2004, in northwest Tasmania.

The project has involved enhancement of magnetic signatures utilising the latest data enhancement and analysis techniques, estimation of magnetic source depths and mapping of major magnetic elements and lineaments. No single filter contains all the information on magnetic sources. A range of wavenumber and spatial filters were applied to both grid and profile data. Hanning residual filtering and wavenumber domain fractional order derivatives provided the best separation of shallow sources. The terraced magnetic intensity provides an effective combination of amplitude in colour with good textural content. Gradient maxima/strike plotting provided excellent mapping of contact features, although the data resolution was not good enough for prospect scale. 3D Euler deconvolution provided source depth information.

The second part of the project involved a more quantitative approach, using magnetic profiles rather than gridded data. This has involved filter enhancement of magnetic profile data and modelling/inversion of selected profiles. Stacked profiles help resolve issues seen in images, as amplitudes are clearer. The 1st vertical derivative profiles are dominated by the Tertiary Volcanics but the low pass filtered profiles give a clear picture of basement anomaly trends. Modelling/inversion of the Pieman Fault magnetic anomaly suggests a thin tabular source, dipping at low angle to the southeast. Modelling/inversion of a high amplitude anomaly close to the southern border of the tenement suggests a vertical tabular source, with a width of 140 m and apparent susceptibility of 0.0223 cgs units. This may indicate base metal potential for the more magnetic unit in the west of the tenement.

The structural location along part of the Arthur River Metamorphic Complex is considered to be favourable for base metal and other commodities such as magnesite. Unfortunately, there is no evidence of high amplitude magnetic anomalies similar to Savage River.

As a first step, a comprehensive phased program of integrating the magnetic and radiometric results with surface mapping is recommended. This should be supported by susceptibility measurements on outcrop

Consideration should be given to a low level cropduster aeromagnetic survey as an alternative to ground magnetic surveys.

2 Introduction

2.1 Introduction

The Shree Minerals Mt Bertha project consists of a single tenement, EL42/2004, located in the northwest of Tasmania, 20 km northeast of the Savage River Iron Ore Mine and about 50km southwest of Burnie.

Figure 1 shows the location of the project and Figure 2 an image of Landsat TM bands 7,4,2. The Landsat appears to be dominated by vegetation with any geological information likely to be subtle. Figure 3 shows the altimetric DTM with 10 m contours.

2.2 Regional Geology

Figure 4 shows the geology of the area from the 1:250,000 scale Burnie geological map SK55-3. The tenement is dominated by the Arthur River Metamorphic Complex, an elongate northeast–southwest striking, and high metamorphic grade geological belt/tectonic boundary that occurs in NW Tasmania between the Rocky Cape and Dundas/Sheffield stratotectonic elements. The 1:250,000 geological map shows major northeast to east–northeast faulting, including the Pieman Fault system.

The Proterozoic sequence strikes north–northeast in the north of the area to northeast in the south and dips and faces to the east. The oldest rocks are the Mesoproterozoic Rocky Cape Group, which only occur in the northwest of the tenement. The Rocky Cape Group consists of marine shelf clastics of the Cowrie Siltstone, overlain by a monotonous sequence of siltstones, sandstones and carbonaceous mudstones of the Detention Subgroup, Irby Siltstone and Jacobs Quartzite. The Rocky Cape Group is unconformably overlain by the Neoproterozoic Togari Group and Ahrberg Group and correlates. A basal sequence of dolomites and shales with subordinate sandstones and conglomerates is overlain by a thick sequence of turbidites with layers of tholeiitic basalts, followed by more dolomites and a mixed siltstone/shale sequence. The Ahrberg Group contains the Savage River Iron ore deposit 20 km south of the tenement and also hosts the magnesite deposits near the tenement.

Several Permian tight grabens overlie the Proterozoic basement. The Permian sequence includes variable clastics and limestone and shales including the Tasminite Oil Shale.

The Proterozoic and Permian sequences are covered by an extensive cover of Tertiary basalts which masks about 60% of the tenement, making exploration difficult

2.3 Airborne Survey Data

Geoinstruments were contracted to fly a semi-regional helimag survey covering the area of interest in 2001. The helimag/radiometric survey was flown along east–west lines with 200 m line spacing at a nominal flight height of 80 m. Tie line spacing was 2000 m. The magnetometer was mounted in a forward pointing boom in a Bell 206 helicopter platform. Navigation was GPS, differentially corrected in real time. The magnetometer system was a Geometrics G822A cesium vapour magnetometer with 0.001nT resolution and an AADC compensator operating in real time. The magnetometer was sampled 10 times a second corresponding to approximately 7 m sampling

The Exploranium GR-820 gamma ray spectrometer used 33.6 litres of detector crystal. The spectrometer sample interval was 1 second, corresponding to 70m sampling.

The field strength is approximately 61900 nT, inclination is 72° and declination –12°. Average terrain clearance was 75 m with a range of 45 to 142 m. The located data were gridded at 50 m mesh size using bi-directional spline gridding.

QC on the airborne data revealed few problems apart from some minor level issues, seen as flight line striping. The process of removing the flight line noise is called "decorrugation" and was corrected by wavenumber filtering.

Figure 5 shows the flight path.

2.4 Gridding

Gridding of line data is always a compromise between honouring closely spaced data along line and producing smooth and continuous interline interpolation between widely spaced flight lines. Problems in gridding include interline interpolation between widely spaced flight lines, loss of subtle trend information and suppression of low amplitude anomalies. Flight lines are normally flown perpendicular to the dominant geological trend of the area and this minimizes aliasing in the cross line direction. However, where multiple trends are present or where we have local trends, aliasing is directional and cross profile aliasing may be severe. A problem, common to all gridding methods, is that linear trends at an acute angle to lines tend to produce 'bull's-eyes' at line intersections. This results in the 'string of beads' and 'stepladder' artifacts seen along linear anomalies such as dikes.

3 Enhancement and Analysis Methods

3.1 Grid Analysis Techniques

Reduction to the pole has not been routinely applied to the data as there is clearly some remanent magnetization and reduction to the pole will distort anomaly shapes. At a field inclination of -72° , reduction to the pole has limited effect. Comparison of reduced to pole data, total magnetic intensity and 3D analytic signal suggests that reduction to the pole has had little overall effect on the data and the analytic signal amplitude centres anomalies over the source without any assumptions about magnetization directions.

Data enhancement and analysis were designed to assist in delineation of major magnetic domains and structures and estimation of magnetic source depths to assist the structural interpretation of the area and to provide a resource for future more detailed interpretation. The enhanced images and plots are available for further analysis when an area is being reinterpreted or new drillholes are completed etc.

A range of different spatial and wavenumber filters were applied to the data to try to deconvolve anomalies of interest. Derivatives are used routinely to highlight local anomalies and attenuate longer wavelength anomalies and as input to interpretation techniques such as location of gradient maxima. Scalar horizontal gradient maxima of the TMI data have been plotted as magnetic strike symbols, colour coded to reflect relative amplitudes. The plots are an effective way of mapping contacts, faults etc. from aeromagnetic data and also map circular or elliptical anomalies as closed clusters of strike symbols. The plot highlights the main linear and curvilinear anomalies and also maps a number of discrete anomalies. The gradient maxima results are an important component of pluton and alteration anomaly target screening.

The Hanning residual is a high gain 3x3 spatial filter, which produces output data with similar curvature to a second vertical derivative filter. The filter enhancement has no directional bias and is very effective in highlighting local detail in areas of subdued magnetic relief.

The 3D Analytic Signal is a linear combination of the partial derivatives in x,y and z of the total magnetic intensity. The parameter used is the amplitude of the complex analytic signal. The method removes dipolarity from magnetic anomalies without making any assumptions about magnetisation directions.

3D Euler deconvolution results provide a good indication of depth to shallow magnetic source information as well as mapping the position of major features.

The terracing method is a technique for direct geological mapping from aeromagnetic or gravity data developed by USGS, which transforms pseudo-gravity or gravity data into a step function. The method transforms smoothly varying anomalous fields into domains of uniform properties separated by sharp boundaries, more like a geological map. Gradient information is shown as white lines.

Analytical operations on the gridded data included:

- ⇒ Horizontal gradient in x & y directions and vertical gradient
- ⇒ Fractional vertical derivatives and a balanced derivative.
- ⇒ Profile curvature as an alternative to residual filters
- ⇒ Amplitude of the 3D analytic signal of the vertical integral.

- ⇒ Hanning residual total magnetic intensity to enhance shallow sources. This is a spatial filter so it does not suffer from the edge effects seen in the FFT methods.
- ⇒ Matched filter regional to suppress the Tertiary Volcanics
- ⇒ Gradient maxima/strike vector plotting
- ⇒ 3D Euler deconvolution
- ⇒ Terracing
- ⇒ Magnetic Ridgelets

3.2 Profile Analysis Techniques

Analysis of the located data included:

- ⇒ Wavenumber filtering - various filters, high-pass, separation filter etc.
- ⇒ Spatial filters including non-linear filter
- ⇒ Modelling/inversion of selected profiles

4 Results

4.1 Aeromagnetics

Figure 6 shows a magnetic intensity colour shade image. Magnetic intensity data range from 62176 nT to 64396 nT, a dynamic range of 2220 nT. The most striking feature in the magnetic data is the Arthur River Metamorphic Complex cutting across the magnetostratigraphy of the Proterozoic basement. The dominant trend of the Proterozoic sequence anomalies is approximately north–northeast, especially in the north of the area, whereas the Arthur River Metamorphic Complex has a well defined northeast linear magnetic fabric. There is a pervasive high-frequency magnetic overprint due to widespread cover of Tertiary Volcanics. The highest amplitude linear and curvilinear anomaly zones seen in the data may be due to basic volcanics in the Proterozoic sequence. Several discrete anomalies with relatively high amplitude are likely to be basic plugs. A prominent linear magnetic high correlates with the trace of the Pieman Fault. The source of the Pieman Fault magnetic anomaly and other northeast trending linear anomalies is unknown. There are several large reversely magnetized zones which image in blue tones in Figure 6 but these are in areas of Tertiary Volcanics so are not considered targets at this stage. The similarity to Mt Leyshon could make them interesting as alteration targets. The Permian basins are marked by zones of reduced magnetic amplitude and bland texture.

The fractional order 0.5 vertical derivative colour shade image (Figure 7) provides better resolution of local anomalies than the total magnetic intensity. Figure 7 is a ternary image of vertical derivatives of orders 0.5, 1.0 and 1.5. Fractional order 1.5 (blue) highlights the high-frequency signal due to the Tertiary volcanics, which have a characteristic light blue tone and active texture. Fractional order 0.5 (red) focuses on basement anomalies which image as red-yellow tones. Figure 9 shows a colour shade image of the 3D analytic signal amplitude. The analytic signal amplitude has removed anomaly dipolarity and also removed the long wavelength anomalies. The analytic signal amplitude highlights the response of the Tertiary volcanics but also shows detail on some of the northeast Arthur River Metamorphic Complex trends of interest. Figure 10 shows a Hanning residual filter as a greyscale image, which provides better resolution of local sources. Unfortunately, the residual filter image is dominated by the Tertiary volcanics as it has similar curvature to a 2nd vertical derivative and is a bit noisy. Figure 11 shows a profile curvature image, which provides better continuity of local anomaly trends. Both the residual and profile curvature images highlight north–northwest cross trends as well as highlighting linear Arthur River Metamorphic Complex trends.

Figure 12 shows the results of terracing the vertical derivative as described in 3.1. Terracing preserves amplitude information while sharpening up anomaly responses. Although the terracing has significantly improved resolution of local anomaly trends compared to the original magnetic intensity, the high-frequency overprint due to the Tertiary volcanics limits the improvement in resolution of important basement trends. Gradient maxima/strike vectors (MAXSPOT) shown separately in Figure 13 can be overlaid on the terraced TMI image to highlight edges. The gradient maxima plot maps contacts clearly and indicates more pervasive north–northwest lineaments than seen in most images. Figure 14 shows a matched filter regional image, which has suppressed the Tertiary volcanic overprint, highlighting basement trends. For local detail, the magnetic ridgelet image (Figure 15) is probably the best product.

Figure 16 shows a colour circle plot of 3D Euler deconvolution depths. The Euler results are colour coded in steps of 50 m, so results range from small black circles indicating depths in the 0-50m range to larger blue circles for depths greater than 300m. 3D Euler deconvolution suggests that the Tertiary volcanic cover is quite variable in thickness with some important basement target horizons at depths of 100 m. The Euler results clearly map the larger Permian basin in the northeast. The Euler depths should be a very effective tool for selecting basement drill targets by focusing on shallow anomalies.

4.2 Radiometrics

The radiometric K, eU, eTh RGB composite (Figure 17) provides useful information on major rock units but requires ground truth to get full value from the data. Radioelement values are quite low. K has a range of 0.3-1.3%, eU a range of 0.19-2.3 ppm and eTh a range of 0.66-9.9 ppm. The highest values are over the Rocky Cape Group with typical values of K=0.8%, eU=1.7 ppm and eTh=6ppm. The ternary image suggests slight K enrichment, east of Mt Bertha, seen as red tones. Figure 18 is an attempt to classify and simplify the radiometrics using k-means cluster analysis.

Segments of the Savage River slurry pipeline track are clearly visible in the radiometrics.

4.3 Structural Synthesis and Target Generation

Filter enhancement of magnetic profile data provides a better display of anomaly amplitudes and shapes than filtered images. Stacked profiles help resolve issues seen in images as amplitudes are clearer. The 1st vertical derivative profiles (Figure 19) are dominated by the Tertiary Volcanics but the low pass filtered profiles (Figure 20) give a clear picture of basement anomaly trends.

The widespread Tertiary volcanics cover makes both target generation and follow-up quite difficult. There is a need for an integrated interpretation of the aeromagnetic and radiometric data along with available geology to better define zones of interest. At this stage we have provided a structural framework based on the magnetics and selected some features of interest as preliminary targets. Figure 21 shows interpreted major fractures superimposed on the fractional order 1.5 derivative greyscale image. The tabular targets selected include the linear magnetic high along the Pieman Fault and the high amplitude, faulted magnetic high zone in the west of the tenement, interpreted as a basic or ultramafic target with base metal potential. Possible plug targets are also included in Figure 21.

4.4 Modelling/Inversion

Selected anomalies have been inverted using a single tabular body using the Geosoft Magmod3 software. This provides a quick estimate of body parameters but is limited to a single anomaly. Where there are clearly multiple bodies, results on body widths will only be approximate. Figure 22a shows Magmod3 inversion results for the Pieman Fault magnetic anomaly, which suggests a thin tabular source, dipping at low angle to the southeast. Figure 22b shows modelling/inversion of a high amplitude anomaly close to the southern border of the tenement, selected as a possible plug target. Results suggest a vertical tabular source, with a width of 140 m and apparent susceptibility of 0.0223 cgs units. This may indicate base metal potential for the more magnetic unit in the west of the tenement.

5 Conclusions and Recommendations

Data enhancement and preliminary interpretation of semi-regional aeromagnetic and radiometric data covering the Mt Bertha project in northwest Tasmania has been completed.

The project has involved enhancement of magnetic signatures utilising the latest data enhancement and analysis techniques, estimation of magnetic source depths and mapping of major magnetic elements and lineaments. No single filter contains all the information on magnetic sources. A range of wavenumber and spatial filters were applied to both grid and profile data. Hanning residual filtering and wavenumber domain fractional order derivatives provided the best separation of shallow sources. The terraced magnetic intensity provides an effective combination of amplitude in colour with good textural content. Gradient maxima/strike plotting provided excellent mapping of contact features, although the data resolution was not good enough for prospect scale. 3D Euler deconvolution provided source depth information.

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6 Bibliography of Potential Field References

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7 List of Figures

Figure	Description	Image & Vector Files
	(Regional A4 Figures)	(**=NB)
1	Location	Topo
2	Landsat TM, bands 7,4,2	L742
3	Altimetric DTM image and contours	DTM+DTMContours
4	Geology	Geology
5	Flight path.	Path
6	Magnetic intensity colour shade image	**_TMI
7	Fractional order vertical derivative colour shade image	**_Dz05
8	Ternary image of vertical gradients	**_DZternary
9	Analytic signal amplitude colour shade image	**_ANS3D
10	Hanning residual filter greyscale image	**_Residual
11	Profile curvature filter greyscale image	**_Profilecurvature
12	Terraced magnetic intensity colour image	**_Terrace
13	MAXSPOT gradient maxima/strike plot	**_MAXSPOT
14	Matched filter residual magnetics colour shade image	**_Matchedfilter
15	Magnetic Ridgelets	**_Ridgelets
16	3D Euler deconvolution source depth plot	**_EUL3D
17	K, eTh, eU RGB radiometric ternary image	**_RadTernary
18	Radiometric cluster analysis thematic image	**_Radclust
19	1 st vertical derivative stacked profiles	**_1VDPRF
20	Low pass filtered stacked magnetic profiles	**_Lop
21	Major magnetic elements and targets	Multiple
22	Magmod3 modelling/inversion	