SHREE EXPLORATION LIMITED

NELSON BAY AEROMAGNETIC AND GROUND MAGNETIC SURVEYS 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 ground magnetic data covering the Nelson Bay iron ore project, 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 aeromagnetic interpretation, using magnetic profiles rather than gridded data and analysis of the available ground magnetic data. The available semi-regional aeromagnetic data are not really suitable for prospect scale interpretation but help to provide a framework. The project has involved estimation of magnetic source depths using Werner/Euler deconvolution, filter enhancement of magnetic profile data and modelling/inversion of selected profiles.

Werner/Euler deconvolution interpretation of magnetic profile data has been used as a first pass technique to extract the maximum amount of structural information from the data. This involved interactive picking of good clusters of solution on the combined Werner/Euler cross-sections. The depth results confirm the 3D Euler deconvolution results, indicating that the central iron deposit anomaly is relatively shallow but becomes much deeper to the north. The significance of the depth variation is uncertain but may be a combination of plunge variation and variable oxidation levels.

Modelling/inversion of selected anomalies indicates significant variation along the strike length of the deposit. Some profiles require the addition of a deeper body below the shallow iron deposit. Depth extent estimates are also variable with some anomalies indicating limited depth extent but others indicating an infinite depth tabular body.

As a first step, a comprehensive phased program of integrating the magnetic data with surface mapping is recommended. This should be supported by susceptibility measurements on drill core.

A petrography study and some rock magnetic property measurements are recommended to help understand the nature of the Iron Deposit and subsequent alteration. This could be followed by analysis of magnetic profile data to help to classify magnetic anomalies.

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

2 Introduction

2.1 Introduction

The Shree Minerals Nelson Bay Iron Ore project includes two contiguous tenements, EL41/2004 (Nelson Bay River) and EL54/2008 (Rebecca Creek), located in the northwest of Tasmania near the seaside locations of Couta Rocks and Temma, about 70km southwest of Smithton. The Nelson Bay Iron Ore Project covers the Nelson Bay Magnetite deposit with Inferred Mineral Resources currently standing at 6.8Mt @ 38.2% magnetite at a 20% magnetite cut off.

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 Birnie geological map. The bedrock geology consists of Early Neoproterozoic autochthonous marine shelf clastics of the Cowrie Siltstone, member of the Rocky Cape Group. The monotonous sequence of siltstones, sandstones and carbonaceous mudstones have been metamorphosed to lower greenschist facies. The regional strike of the Cowrie Siltstone sequence is approximately northwest so the Nelson Bay Iron Deposit is clearly discordant. There are a few patches of Tertiary volcanics

2.3 Airborne Survey Data

Tesla Airborne Geoscience Pty Ltd were contracted to fly a semi-regional airborne survey covering the area of interest in 1996. The Arthur-Pieman aeromagnetic/radiometric survey was flown along east west lines with 200 m line spacing at a nominal flight height of 90 m, using a Cessna 210 platform. Tie line spacing was 2000 m. Navigation was GPS utilising a Novatel 951R GPS receiver, differentially corrected in real time. The magnetometer system was a Scintrex CS-2 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 72 m with a range of 63 to 137 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.

⇒ 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.
- ⇒ Gradient maxima/strike vector plotting
- ⇒ 3D Euler deconvolution
- ⇒ Terracing

3.2 Profile Analysis Techniques

Analysis of the located data included:

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

4 Results

4.1 Nelson Bay Main Area Aeromagnetics

Figure 6 shows a magnetic intensity colour shade image. Magnetic intensity data range from 62165 nT to 64517 nT, a dynamic range of 2352 nT. Moderate amplitude linear and curvilinear anomaly zones dominate the aeromagnetic data with the northern part of the Nelson Bay Iron deposit having the highest amplitude. The dominant trend of these anomalies is approximately northwest to north-northwest. Indicated dips are steep, but in the absence of information on rock magnetism, we are unable to correct for the effects of remanence and anisotropy of magnetic susceptibility (AMS). The Nelson Bay Iron Deposit anomaly has a total strike length of around 3.5 km. The northern zone, with a strike length around 1.5 km has higher magnetic amplitudes, up to 2250 nT, although the highest amplitudes are only on one flight line. The southern zone has lower amplitudes, up to 360 nT. The smaller anomaly just west of the Nelson Bay Iron Deposit has amplitudes up to 520 nT and is considered a target zone. The Rebecca deposit has amplitudes up to 600 nT.

The fractional order 0.5 vertical derivative colour shade image (Figure 7) provides better resolution of local anomalies than the total magnetic intensity and has been scaled to emphasize higher amplitude anomalies. Figure 8 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 Nelson Bay and Rebecca occurrences and shows the marked differences between the north and south parts of the Nelson Bay deposit. Figure 9 shows a Hanning residual filter as a greyscale image, which provides better resolution of local sources.

Figure 10 shows the results of terracing the vertical derivative as described in 3.1. Terracing preserves amplitude information while sharpening up anomaly responses. The terracing has dramatically improved resolution of local anomaly trends, indicating a 70° trending fault terminating the Nelson Bay Iron Deposit to the north. Gradient maxima/strike vectors (MAXSPOT) shown separately in Figure 11 can be overlaid on the terraced TMI image to highlight edges. For local detail, the magnetic ridgelet image (Figure 12) is probably the best product.

Figure 13 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 much of the Nelson Bay deposit is relatively shallow, but the northern part is significantly deeper and there are clear source depth variations along strike, which may suggest some potential for hematite-goethite. The Euler depths suggest that much of the area is accessible to RAB drilling with depths in the 0-100 m range, apart from the northern extent of the main north anomaly.

4.2 Nelson Bay Main Area Radiometrics

The radiometric K, eU, eTh RGB composite (Figure 14) provides useful information on major rock units but provides no obvious information on the Iron Deposit. Because of the lack of definitive information on the Iron Formation, the radiometric data were downgraded.

4.3 Nelson Bay Region of Interest Area

The available semi-regional aeromagnetic data are not really suitable for prospect scale interpretation but help to provide a framework. Figure 15 shows magnetic ridgelets superimposed on the residual magnetics greyscale image. Figure 16 is a plot of magnetic intensity stacked profiles. The profiles show the variations in anomaly amplitude and wavelength along strike, discussed in section 4.1. The Nelson Bay Iron deposit is visible on 16 flight lines whereas the small western anomaly is only visible on 3 flight lines. Figure 17 shows the DTM as a colour image with 10 m contours. The DTM shows that the southern anomaly zone is located on a small ridge but the main northern part is partly across the Nelson Bay River. The highest amplitude anomalies plot on a small ridge next to the river.

4.4 Modelling/Inversion

Determination of depth extent from magnetic data is not a simple exercise as the top of the layer dominates the magnetic signal and the contribution from the lower surface is small. A further limitation is that the magnetization-thickness product defines the equivalent layer and a priori information on thickness will be needed in order to provide estimates of variation in layer magnetization.

Selected aeromagnetic and ground magnetic profiles have been analysed using Werner/Euler analysis. Based on these results, 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 BIFs, results on body widths will only be approximate. Figure 18 shows Magmod3 inversion results for 3 selected anomaly profiles. Figure 18a shows the results for flight line 100910, close to the highest amplitudes in the centre of the Iron Deposit. Because of ambiguity in dip estimation because of remanence, the dip has been fixed based on drilling information and the remanent magnetization vector calculated by inversion. The Magmod3 results favour a relatively wide, low susceptibility body at a depth of 28 m. Depth extent is quite large but subject to a high degree of uncertainty. Figure 18 b from flight line 100890 conforms the rapid increase in depth to magnetic source at the northern end of the deposit and suggests a near vertical dip. Figure 18c shows results for the southern anomaly zone. The results suggest a relatively shallow dipping tabular body, dipping steeply to the east.

Figure 19 shows the available ground magnetic data superimposed on the residual filter aeromagnetic image. The numerous small line segments of the ground magnetics make it impossible to plot profiles so the post plot is used instead. The post plot is colour coded with magenta and red tones for high and moderate amplitudes. Note that most of the short lines in the north of the grid are in background, not over the Iron Deposit.

Where there are clearly multiple BIFs, it is possible to use a combination of interactive forward modelling and inversion to refine the interpretation. The drawback is that this procedure can be very time consuming. Also, in the absence of any constraints, source widths are likely to be only approximate. Magnetic anomaly amplitude is proportional to the product of magnetization (susceptibility) and source width, so without constraints from mapping or drilling, it is not possible to determine either uniquely. The Interference between closely separated anomalies is the other problem in interpretation.

Figure 20 shows the results of interactive modelling/inversion for selected ground magnetic anomalies. Figure 20a is a high amplitude anomaly in the centre of the deposit. To fit the observed data, requires a shallow and deeper body. The shallow body is very shallow, almost at surface and has limited depth extent. With a calculated width of 13 m, the apparent magnetic susceptibility is 0.1 cgs units. Figure 20b is a difficult profile to model but clearly shows the increase in source depth between the main northern and southern bodies. The actual source width is likely to be less than calculated and susceptibility higher. Figure 20c on the southern anomaly zone indicates a very shallow narrow steeply dipping tabular body plus a deeper, wider body to fit the anomaly flanks. The indicated dip is steep to the east but in the absence of information on remanence has a high degree of uncertainty.

4.5 Magnetite and Hematite-Goethite in Magnetic Surveys

Understanding the magnetic properties of iron ore deposits and host rocks is a prerequisite for quantitative magnetic interpretation and unfortunately we don’t have access to any studies on rock magnetic properties. Magnetic interpretation of magnetite deposits is complicated by high intrinsic anisotropy of magnetic susceptibility, resulting in a strong dependence of anomaly shape and amplitude on dip of the unit, together with the effects of significant remanence which is may be either pre or post folding. Magnetic expression of hematite ore is relatively subdued but depends on the hematite / magnetite ratio as a small amount of magnetite has a significant effect.

Magnetic interpretation of possible magnetite beneficiation targets is relatively direct. After corrections for anisotropy of magnetic susceptibility, magnetic anomaly amplitudes or calculated apparent magnetic susceptibilities provide a direct signature of high magnetite content. The amplitude of the analytic signal can be used to locate possible 'magnetite' hot spots'.

Magnetic interpretation of possible hematite deposits is more indirect. Although the hematite ores have much lower magnetization than the host magnetite deposits, the magnetic signal from underlying unoxidized magnetite overprints the magnetic low due to the hematite deposit resulting in a subtle reduction in magnetic amplitude signal instead of a clear magnetic low. Unfortunately, changes in the oxide/silicate ratio produce major changes in magnetic properties. The rocks frequently contain both magnetite and hematite in varying proportions and the magnetite/hematite ratio also has a major influence on magnetic properties. Because of its much higher intrinsic magnetization, magnetic properties are dominated by magnetite even when the opaque oxides of the sample are volumetrically dominated by hematite. Bulk magnetic susceptibility varies considerably throughout iron deposits.

Criteria for identifying possible iron ore targets include:

(a) Local magnetic highs, especially those adjacent to major dykes

(b) Changes in magnetic anomaly amplitude along strike as the hematite/magnetite ratio varies.

(c) Subtle increase in estimated depth to magnetic source because the host magnetite deposit is deeper because of the oxidized layer.

(d) Tight folding and sheath folds interpreted from high-resolution aeromagnetic data may indicate favourable fold closures. Mineralized areas are generally more structurally complex than neighbouring unmineralised areas

(e) Major faults interpreted from aeromagnetic data may indicate favourable structural settings, especially where magnetic interpretation indicates magnetite destruction.

5 Conclusions and Recommendations

Data enhancement and preliminary interpretation of semi-regional aeromagnetic data and ground magnetic data covering the Nelson Bay iron ore 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. 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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