Shree Minerals Limited
Nelson Bay, Rebecca Creek Projects.

3D Aeromagnetic Inversion

Prepared for

Shree Minerals Limited

By:

Cowan Geodata Services

Email: cowangeo@bigpond.net.au

Report dated August 2012

Disclaimer: The conclusions and recommendations in this note are the opinions of the authors based on the data available to them. The opinions and recommendations provided from this information are in response to a request from the client and no liability is accepted for commercial decisions or actions resulting from them.

Non-Linear Geophysics Pty Ltd – ABN 55-058-106-540

Table of Contents:

Executive Summary

3D magnetic models of the Nelson Bay and Rebecca Creek Iron Projects have been produced as follow-up to preliminary targets. Inversion using the MGInv3D software inversion used the DTM as a topographic surface for Nelson Bay but assumed a plane surface for Rebecca Creek. This report contains summary plots of the 3D magnetic models. For Nelson Bay, the complete inversion models with drill holes can be used using the 3D viewer supplied. Results have also been supplied as x,y,z,susceptibility data for import into Discover 3D or Surpac.

The focus was on the magnetite ore bodies, but changes in the model magnetic susceptibility provides useful information on the hematite/magnetite ratio. Comparison of aeromagnetic and ground magnetic data suggests that the airborne data were flown too high to be of any value in locating possible detrital deposits.

The results of MGInv3D magnetic models are presented as depth slices, north–south sections and east–west cross-sections. Selected data have been included in this report and the large amount of images archived on DVD.

Software tools have been provided to view the models as well as x,y,z,susc files for import into Discover 3D or Surpac. Meshtools3D can be used to view data in UBC MAG3D format. This is useful to visualized local changes in magnetic susceptibility but is not a very good manipulation tool. 3Dmodeller can be used to view MGINV3D models as rendered bodies. This is a fully interactive 3D modelling tool.

Reconciliation of the 3D magnetic model results with previous drill holes and assays is recommended as a first step. This should be relatively easy in Discover 3D, Micromine or Surpac.

Following this evaluation, planned drill holes can be added to the 3D magnetic model, either in 3DModeller or Discover 3D.

A petrography study and some rock magnetic property measurements are recommended to help understand the nature of the Iron Deposit and subsequent alteration. Measurements of remanent magnetization on drill core would help resolve the ambiguity in dip determination. This could be followed by further 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.

1. Introduction

1.1 Objectives

The objective of the project was to provide 3D magnetic models of the Nelson Bay and Rebecca Bay Prospects. The focus was on the magnetite ore bodies, but changes in the model magnetic susceptibility provides useful information on the hematite/magnetite ratio.

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.

1.2 Regional Geology

The geology of the area is shown on 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.

The Nelson Bay iron mineralisation is hosted by a wide mafic dyke, trending NW, which cuts across the stratigraphy.

1.3 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 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 aeromagnetic data were microlevelled prior to data enhancement and preliminary interpretation.

Data are in MGA 94 zone 55 projection.

1.4 Nelson Bay Region of Interest Area

The available semi-regional aeromagnetic data provide an excellent resource for district scale exploration but are marginal for prospect scale interpretation. Figure 2 shows magnetic intensity with a linear scale, showing that the highest amplitude anomaly on one flight line totally dominates. Figure 3 is a plot of 2nd vertical derivative of magnetic intensity stacked profiles. The profiles show significant variations in anomaly amplitude and wavelength along strike. The Nelson Bay Iron deposit is visible on 16 flight lines whereas the small western anomaly is only visible on 3 flight lines.

1.5 Rebecca Creek Region of Interest Area

The available semi-regional aeromagnetic data are not really suitable for prospect scale interpretation but provide a framework. Figure 4 shows magnetic intensity with a linear scale, showing that the highest amplitude anomaly on one flight line totally dominates. Figure 5 is a plot of 2^{nd} vertical derivative of magnetic intensity stacked profiles. The profiles show significant variations in anomaly amplitude and wavelength along strike. The Rebecca Creek Iron Prospect is only visible on 7 flight lines.

.

2.3 Physical Properties

There are problems in reconciling magneto-tectonic interpretation with mapped geological units. Magnetic surveys simply map the distribution of magnetic minerals (principally magnetite) in the earth's crust. Interpretation involves drawing inferences from the magnetic data about the geology and ore potential and 'ground truth' is needed to achieve this with a high degree of confidence. There is a fundamental problem in classification of rock types based on differences in silicate and carbonate mineralogy and magneto-tectonic units based on opaque oxide mineralogy. Opaque oxide minerals are usually only minor accessory minerals, often less than 1% by volume of the whole rock, so it is unlikely that conventional lithological boundaries based on silicate/carbonate mineralogy will agree exactly with magneto-tectonic boundaries.

In metamorphic rocks, rock magnetic properties are complex and result from both the primary composition of the rocks and the metamorphic history. Secondary magnetite is produced by breakdown of Fe-Mg silicates such as biotite during prograde metamorphism and depends mainly on composition and oxygen fugacity. Total iron places an upper limit on magnetite generation while the oxidation state controls partitioning of iron between oxide and silicate phases. Prograde metamorphism involves mechanical deformation as well as heating and this can cause primary opaque oxides to recrystallize to coarse textures. Coarsely crystalline magnetite has higher magnetic susceptibility and lower remanence than finely crystalline magnetite, due to the increased ease of magnetic domain boundary movement. The various mechanisms increase with metamorphic grade and have maximum effect in the upper amphibolite and lower granulite facies.

Hydrothermal alteration can lead to either magnetite creation or destruction depending on conditions. Potassic (biotite rich) alteration often involves magnetite creation and significantly increased magnetization. Alteration associated with epithermal systems tends to demagnetize the host rocks.

Magnetic petrology combines rock magnetism and petrology to help understand all the processes involved in creation, modification or destruction of magnetite in rocks that affect magnetic signatures. Some magnetic measurements combined with some opaque oxide mineralogy would be very useful.

2. Aeromagnetics

2.1 Airborne Data

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 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.

2.2 Windowed Magnetic Data

Magnetic profiles and grids covering the preliminary target magnetic anomalies were windowed out from the micro levelled data. Grid locations are shown in Figure 1.

2,3 3D Magnetic Modelling/Inversion

For discrete anomalies, inversion programs can provide quick solutions without the need to prepare complex input model data. In more complex situations, multi-body forward modelling and inversion are necessary and this is very time consuming. Interference from adjacent anomalies limits the effectiveness of modelling and inversion as the information on the flanks of anomalies is critical for determining depth extent.

Modelling problems are often intrinsic, reflecting the following problems:

1. Fundamental ambiguity of potential field interpretation,
2. The insensitivity of magnetic data to depth extent,
3. The poor accuracy of magnetic source depth determination for certain combination of depth/width
4. The use of simple geometric models such as the dipping tabular body.

In many cases, forward models based on drilling results and using simple models fail to match the observed magnetic profiles in both anomaly shape and amplitude. The most likely explanation is that the source geometry is more complex than the simple model used with irregular shapes and variable magnetization likely. When the underlying structures are truly 3-dimensional, a fully 3-dimensional approach becomes necessary to produce more realistic models using a cell-based approach but this is time consuming.

Inversion involves calculating the optimum distribution of magnetic sources to fit the observed data. The problems are described as inverse because they are the opposite of forward modelling. In the magnetic case, the observed data consists of observations of the magnetic field from an aircraft, on the ground or in boreholes. Inversion manipulates the observed magnetic field data to determine the subsurface distribution of magnetic susceptibility and help to define geological structures and possible mineralized targets.

The University of British Columbia Geophysical Inversion Facility provides a solution to the 3D inverse problem. In the MAG3D software, the basic structure used by the UBC is a rectangular prism, which is split into regular cells in the x, y and z directions with each cell having a constant susceptibility value. Inversion consists of finding the distribution of susceptibility values for each cell for which the magnetic response calculated for the full model matches the specified observed data values. Initially we used the UBC code to invert the Shree data, but upgraded our 3D software to the MGInv3D software from Scientific Computing and Applications in Adelaide as this is more robust.

This formulation of the inverse problem clearly precludes any manual process of modifying individual cell susceptibility values to match the observed data since the number of cells in a reasonably sized model is simply too large. The inversion process successively refines a 3-dimensional susceptibility model until the TMI calculated for the model matches the observed TMI data to the desired accuracy. The software only calculates the induced TMI response for the model, so any remanent component in the observed TMI data has to be modeled using a distribution of susceptibility for which the induced TMI response matches the observed remanent response. To overcome this problem the analytic signal of the vertical integral can be used. The magnetic kernel function is relatively insensitive to depth extent so a depth weighting method is used to force the algorithm to look deeper.

3. 3D Magnetic Models

3.1 Introduction

MGInv3D 3D magnetic models were prepared for subgrids to cover the target anomalies. This is necessary as the 3D inversion software involves serious number crunching, with individual grids taking several hours to run. Results are archived with depth slice images, east–west and north–south sections in MapInfo format.

The MGInv3D software assumes magnetization in the present earth's field. Remanent magnetization and anisotropy of magnetic susceptibility affects magnetic anomaly shapes, resulting in ambiguity in source dip estimation.

3.2 MGInv3D Magnetic modelling/inversion

Figure 6 shows the results of MGInv3D magnetic model results for Nelson Bay, as a 3D rendered body. Figure 7 shows a depth slice, an east–west cross-section and a north–south cross-section. Figure 8 shows the results of MGInv3D magnetic model results for Rebecca Creek, as a 3D rendered body. Figure 9 shows a depth slice, an east–west cross-section and a north–south cross-section. Note that the model depths for Rebecca Creek are depths below an assumed plane surface as we don't have an accurate DTM. MapInfo cross-section and depth slices are on DVD in folders. Depth slices are labeled elevation_Depth or Topo_Draped_Depth. East west section are labeled by northing and north south cross sections by easting

3.4 Viewing the 3D magnetic models

Software tools have been provided to view the models as well as X,Y,Z,susc files for import into Discover 3D or Surpac. X,Y,Z, susc files are on DVD in folder XYZ

Meshtools3D can be used to view UBC MAG3D models. This is useful to visualized local changes in magnetic susceptibility but is not a very good manipulation tool. Run Meshtools3D and load the .msh and .sus file. 3DViewer can be used to view MGINV3D models as rendered bodies. This is a fully interactive 3D modelling tool. Install 3Dviewer and patch then load the .bin files.

3.5 Nelson Bay MGInv3D Modelling Interpretation

There are 41 depth slices, 84 north–south cross sections and 102 east–west cross section through the 3D model available on DVD. The results show significant variations in susceptibility, depth to top, depth extent, width and dip along strike. To the north, the body can be traced to 5443175N where it is at a depth of 206 m below sea level. The southern body extends south to around 5440325N where the top of the body is at 130 m below sea level. Maximum susceptibilities of 0.25 SI units for the northern body are at 5442325N and 0.05 SI units for the southern body at 5440930N.

The northern body appears to be near vertical in the south and becomes steeply dipping to the west further north. The northern body is at surface from 5442275N to 5442425N, then plunges to the north going northwards.

3.6 Rebecca Creek MGInv3D Modelling Interpretation

There are 41 depth slices, 70 north–south cross sections and 50 east–west cross section through the 3D model available on DVD. The results show significant variations in susceptibility, depth to top, depth extent, width and dip along strike. There is less continuity of susceptibility values compared to Nelson Bay and lower susceptibility values. The northern part of the anomaly appears shifted by a NE fault and appears as a separate lower susceptibility unit. The main body can be traced north to 5438075N where faulting cuts it off and south to around 5437025N where the top of the body is at 100 m below surface. Maximum susceptibilities of 0.01 SI units for the main body are at 54375755N where the body is quite narrow and is depth limited at 270 m below the surface.

The main body appears to be near vertical in the south and becomes steeply dipping to the west further north. The main body is at surface from 5437325N to 5437825N.

3.7 Detritals

Comparison of aeromagnetic and ground magnetic data suggests that the airborne data were flown too high to be of any value in locating possible detrital deposits. The magnetic field due to detritals attenuates rapidly with height.

4. 3D Magnetic Modelling Results and Drilling, Nelson Bay

Figure 10 shows the results of MGInv3D magnetic model results for Nelson Bay, as a 3D rendered body with all drill holes added.

Figure 11 shows the results of MGInv3D magnetic model results for Nelson Bay, as a 3D rendered body, with RC drill holes only added.

Figure 12 shows the results of MGInv3D magnetic model results for Nelson Bay, as a 3D rendered body with diamond drill holes added.

Figure 13 shows a series of east–west cross-sections across the north body. The sections show increasing depth to source from north to south and steeper dips. The cross sections do show drill holes but the original MapInfo workspaces are much clearer.

A special set of MapInfo workspaces has been provided each with an east–west cross section and drill hole traces where drill holes are present.

5. Conclusions and Recommendations

5.1 Summary and Conclusions

3D magnetic models of the Nelson Bay and Rebecca Creek Iron Projects have been produced as follow-up to preliminary targets. Inversion using the MGInv3D software inversion used the DTM as a topographic surface for Nelson Bay but assumed a plane surface for Rebecca Creek. This report contains summary plots of the 3D magnetic models. For Nelson Bay, the complete inversion models with drill holes can be used using the 3D viewer supplied. Results have also been supplied as x,y,z,susceptibility data for import into Discover 3D or Surpac.

The focus was on the magnetite ore bodies, but changes in the model magnetic susceptibility provides useful information on the hematite/magnetite ratio. Comparison of aeromagnetic and ground magnetic data suggests that the airborne data were flown too high to be of any value in locating possible detrital deposits.

The results of MGInv3D magnetic models are presented as depth slices, north–south sections and east–west cross-sections. Selected data have been included in this report and the large amount of images archived on DVD.

Software tools have been provided to view the models as well as x,y,z,susc files for import into Discover 3D or Surpac. Meshtools3D can be used to view data in UBC MAG3D format. This is useful to visualized local changes in magnetic susceptibility but is not a very good manipulation tool. 3Dmodeller can be used to view MGINV3D models as rendered bodies. This is a fully interactive 3D modelling tool.

5.2 Recommendations

Reconciliation of the 3D magnetic model results with previous drill holes and assays is recommended as a first step. This should be relatively easy in Discover 3D, Micromine or Surpac.

Following this evaluation, planned drill holes can be added to the 3D magnetic model, either in 3DModeller or Discover 3D.

A petrography study and some rock magnetic property measurements are recommended to help understand the nature of the Iron Deposit and subsequent alteration. Measurements of remanent magnetization on drill core would help resolve the ambiguity in dip determination. This could be followed by further 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.

6. List of Figures

7. References

7.1 Magnetics

Cordell, L. and Grauch, V.J.S., 1985, Mapping basement magnetization zones from aeromagnetic data in the San Juan basin, New Mexico: in Hinze, W.J., Ed., The utility of regional gravity and magnetic maps. Society of Exploration Geophysicists. 181-197.

Cooper, G.R.J., and Cowan, D.R., 2003, The application of fractional calculus to potential field data: *Exploration Geophysics,* **34** , 51–56.

Cooper, G.R.J., and Cowan, D.R., 2009. Terracing Potential Field Data: *Geophysical Prospecting*, **57**,1067-1071.

Cowan, D.R and Cowan, S. (1993). 'Separation Filtering applied to aeromagnetic data'. Exploration Geophysics 24, 429-436.

Flis, M.F. and Cowan, D.R., (2000), 'Aeromagnetic drape corrections applied to the Turner Syncline, Hamersley Basin': Exploration Geophysics, **31**, 84-88.

Haggerty, S.E. (1979). 'The aeromagnetic mineralogy of igneous rocks'. Can. J. Earth Sci., 16, 1281-1293.

Ishihara, S. (1977) 'The magnetite-series and ilmenite-series granitic rocks'. Mining Geology 27, 293-305.

Ishihara, S. (1981) 'The granitoid series and mineralisation'. Economic Geology, 75th anniversary volume,, 458-484.

Keating, P. (1995), 'Automated trend reinforcement of aeromagnetic data'. Abstracts, 57th EAEG meeting, Glasgow, May 1995.

Jacobsen, B.H (1987). 'A case for upward continuation as a standard separation filter for potential-field maps'. Geophysics 52, 1138-1148.

Li, Y. and Oldenburg, D.W., 1996, 3-D inversion of magnetic data: Geophysics, 61, 394-408.

Miller, H.G., and Singh, V., 1994. Potential field tilt – a new concept for location of potential field sources: *Journal of Applied Geophysics* **32**, 213-217.

Mitasova, H., and Jarosalav, H., 1993. Interpolation by Regularized Spline with Tension: II. Application to Terrain Modeling and Surface Geometry Analysis: *Mathematical Geology* **25** (6) 657-669.

Phillips, J., 2000, Locating magnetic contacts: A comparison of the horizontal gradient, analytic signal, and local wavenumber methods: 70th Meeting, SEG, Calgary, Expanded Abstracts, 402-405.

Phillips, J., Hansen, R.O., and R.J. Blakely, 2006, The use of curvature in potential field interpretation: AESC 2006, Melbourne, Australia. Expanded Abstracts.

Pilkington, M., 1998, Magnetisation mapping in rugged terrain: Exploration Geophysics, **29**, 560-564.

Sexton, M.A., Morrison, G.W., Orr, T.O.H., Foley, A.M. and Wormald, P.J. (1995) The Mt Leyshon magnetic anomaly. Exploration Geophysics 26, 84-91.