# Magnetic Modelling of BIF Hill including Drill Data and Remanence

*Western Desert Resources (WDR)*

## Executive Summary

**WDR target BIF Hill is a gravity and magnetic high located near Tennant Creek, Northern Territory (Australia). Drillholes based on modelling of the gravity target are currently being completed.**

**Real time modelling of the magnetic target incorporating drilling data, generic mineralisation model and utilising a new CSIRO developed method to determine magnetisation vector of remanently magnetised sources has been performed.**

**Results of the interpretation and model match the observed drilling data and suggest the magnetic host is part of a folded ironstone unit with thickening and upgrading controlled by EW structure(s).**

**Modelling suggests that recently proposed hole DDH5 may be targeting the core of the interpreted fold.**

**A new hole, C, has been proposed to test the interpreted centre of the magnetic target.**

**Downhole magnetic tensor gradient data would give the most accurate location of the centre of the magnetic source.**

## Background

The BIF Hill target presents in the geophysical data as both a gravity and magnetic high. WDR has done modelling of the gravity anomalism and designed drillholes to test the target which are being completed currently.

The magnetic anomaly however was not modelled, so for completeness both AsIs International and Montana GIS modelled the magnetic data as if it were a 'green-field' prospect. The modelling results were similar but it was noted that remanent magnetic properties of the target likely affected the result. At that point Montana GIS employed a technique to minimize the effects of the remanence on the modelling by filtering the data with a Vector Remanent Magnetic Intensity operator. A hole was subsequently planned (referred to as Hole DDH5 in this report).

Drillholes 12DH001 and 12DH002 had been completed at this point, with geological logs and magnetic susceptibility readings taken from drill core. This allowed information to fed back into the magnetic modelling including source geometry and magnetic susceptibility.

As well as the drillhole data being made available, a geological model of gold bearing ironstones in the Tennant Creek region was conferred by the WDR geologists. The model usually involves an EW structure and thickening and mineralisation of fold hinges.

The CSIRO are running a program focussing on interpretation of magnetic and EM anomalism. The author witnessed a presentation given by team member Clive Foss describing a method to achieve better models of remanently magnetic sources and thought it could be applied to the BIF Hill target and checked against the observed drilling data.

## Structural and Geological Interpretation

The supplied magnetic data has been high pass filtered using various operators to identify subtle features. One of the advantages of airborne magnetic data (as opposed to the disadvantage of distance from source) is the absence of noise making high frequency pass filtering effective (without amplifying noise). Due to the presence of remanence the analytic signal filtered magnetic data has been used for the interpretation.

Using the comments from the WDR geologists regarding the Tennant Creek Au-Cu-Bi generic model an interpretation has been performed.

The interpretation aims to indentify linear features apparent in the observed data (albeit the filtered products). Key features are interpreted magnetic marker horizons, interpreted faults/structures and interpreted zones of increased magnetic intensity (mineralisation?).

Figure 1 shows the interpretation. The interpreted marker horizons show the iron rich units could form part of a folded unit. From current observation there are at least 3 episodes of folding apparent, with two in the XY plane and one in the XZ plane complicating the geology.

Several structures/faults have been interpreted through the target area, offsetting the interpreted magnetic marker units. Most interesting are the EW structures interpreted as they are considered important control on other Tennant Creek ore deposits.

The main magnetic anomaly is located on the northern edge of the interpreted EW structure(s). A vertical derivative of the Analytic Signal of the TMI magnetic data shows some detail that suggests a folded nature of the intense magnetic source.

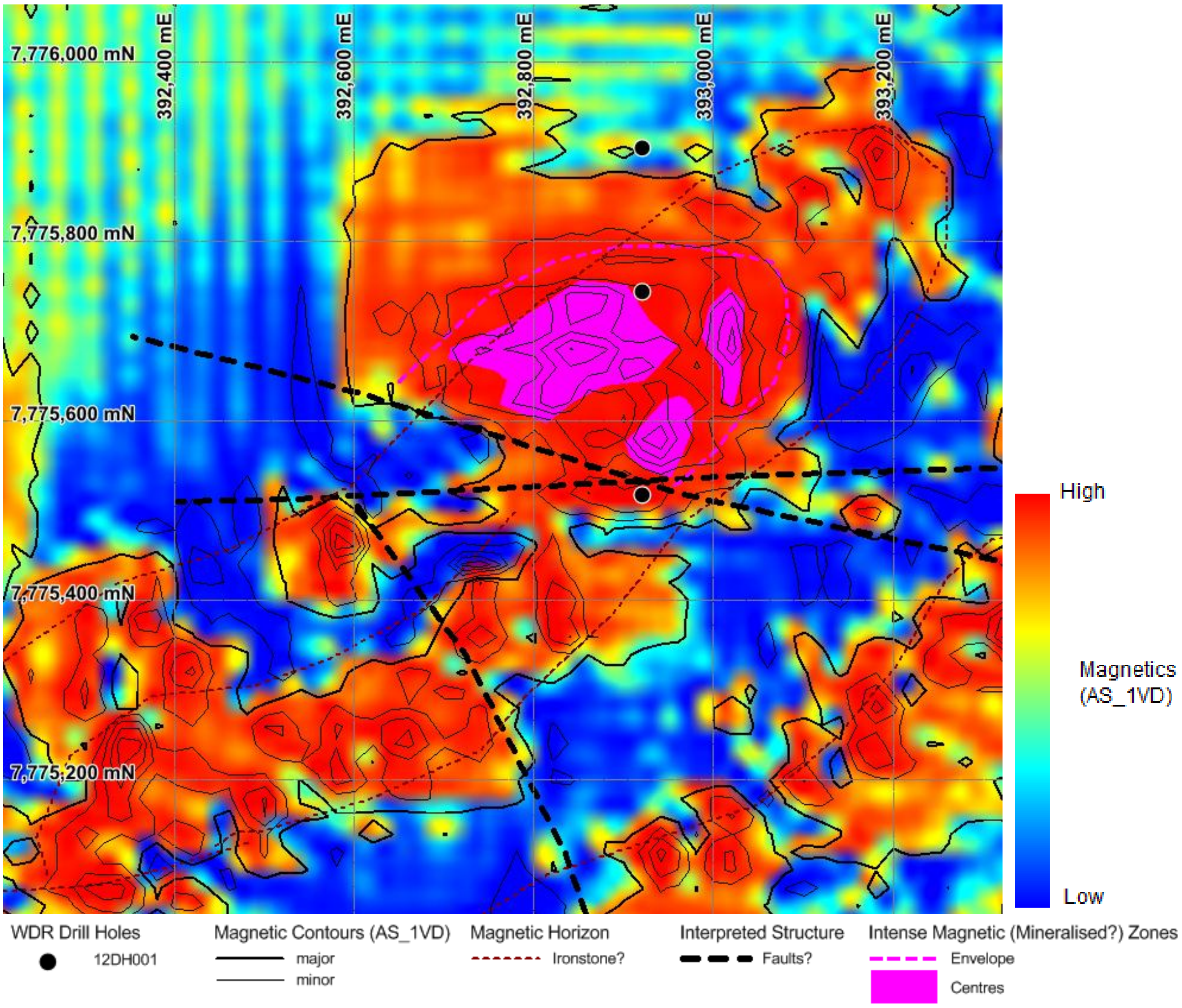


Figure 1. Structural and geological interpretation of BIF Hill.

## Methodology and A Priori Information

The drilling data provided information including

A. the geometry of the body - varying steep dip organised in discrete layers

B. the magnetic susceptibility of the body

The magnetic susceptibility data is summarised in Table 1 and shows that when averaging data into 10m samples the average bulk magnetic susceptibility encountered down the holes is 0.045-0.067SI.

| | 12DH001 | | 12DH002 | |
|---|---|---|---|---|
| Depth (down hole) | Mag Susc (x10-5) | Average | Mag Susc (x10 -5) | Average |
| 10 | 22 | | 236 | |
| 20 | 779 | | 17 | |
| 30 | 151 | | 245 | |
| 40 | 0 | | 0 | |
| 50 | 8 | | 1051 | |
| 60 | 614 | | 494 | |
| 70 | 811 | | 225 | |
| 80 | 1 | | 43 | |
| 90 | 13 | | 30 | |
| 100 | 8 | | 3 | |
| 110 | 29 | | 13 | |
| 120 | 143 | | 3395 | |
| 130 | 1767 | | 6736 | |
| 140 | 565 | | 645 | |
| 150 | 920 | | 2304 | |
| 160 | 15 | | 1828 | |
| 170 | 33 | | 667 | |
| 180 | 27 | | 640 | |
| 190 | 87 | | 219 | |
| 200 | 1472 | | 1939 | |
| 210 | 19386 | | 4933 | |
| 220 | 9067 | | 9782 | |
| 230 | 0 | | 4112 | |
| 240 | 15735 | | 8397 | |
| 250 | 5513 | | 17175 | 44834 |
| 260 | 19984 | | 5 | |
| 270 | 2321 | | na | |
| 280 | 724 | | na | |
| 290 | 12170 | | na | |
| 300 | 1398 | | na | |
| 310 | 22 | | na | |
| 320 | 5638 | | na | |
| 330 | 698 | 6724 | na | |

Table 1. BIF Hill magnetic susceptibility reading from drill core.

The generic model for Tennant Creek Au-Cu-Bi deposits includes enhancement of fold axes controlled by EW structures. These features have been interpreted at BIF Hill and are incorporated into the modelling, especially the folding concept with an approximate steep NNW dip set for the interpreted NNW limb.

The CSIRO have proposed a methodology for magnetic interpretation of remanently affected source bodies as shown in Figure 2. The method involves initial positioning and geometry from analytic signal data, determining magnetization direction and then revising. One complication of the technique (and indeed magnetic modelling in general) is that 'compact' sources are not generally sensitive to subtle adjustments in geometry, leading to inaccuracy of the modelled geometry. Ellipsoid geometry has been shown to approximate compact sources most efficiently.

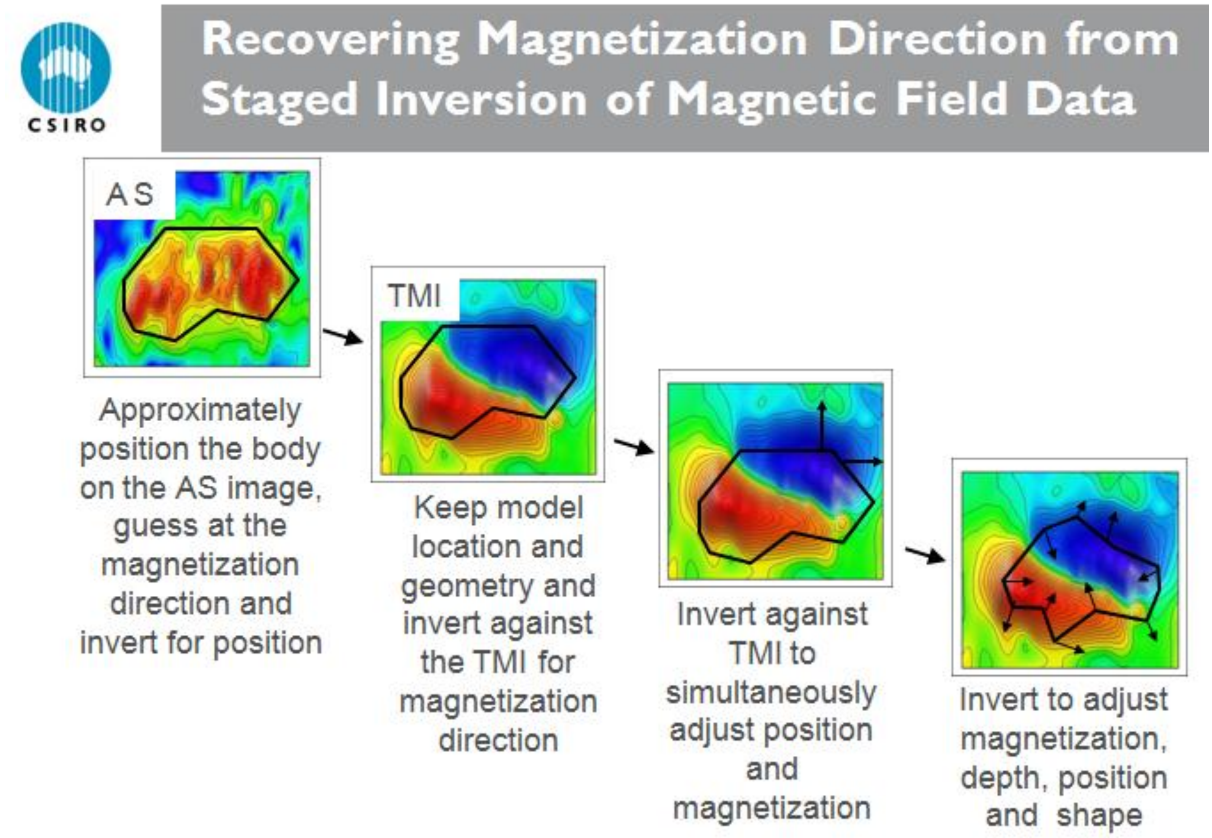


Figure 2. A method for modelling remanently magnetized bodies as suggested by CSIRO (Clive Foss pers comm).

The methodology outlined above was employed using magnetic susceptibility determined from drill core measurement (~0.6SI). Even before refinement there was an immediate correlation between the model and the observed data from drilling.

## Results

The modelling went smoothly and although there were many small adjustments made the final result reflects the starting model well, with some fine adjustments. Modelling where remanence is considered is more complicated based on the addition of extra variables.

Once the approximate position and geometry (elliptical pipe) were set the resultant magnetisation direction was determined by both manual and inversion methods with remarkably similar results. The final resultant magnetization achieved in both cases was comparable in strength to the inducing field, with a declination just west of south and a steep inclination. The final field, which is consistent across the model, has a field strength of ~90% of the induced field, with a declination of 200 degrees and an inclination of -77 degrees.

The bodies' location and geometry (in this case azimuth, and radii) was then inverted to better fit the observed anomalism with small manual input to ensure that the drilling data was honoured.

The result is shown in Figure 3, with 8 original data lines and 3 grid-sampled sections presented. The WDR drilling is shown as well as drillholes proposed by both AsIs International and Montana GIS. A final proposed hole - hole C - is proposed and shown in section. All sections are 2km long (with south on the left), have a dynamic range (magnetics) of 4950-5400nT and a 1:1 horzontal:vertical section panel.

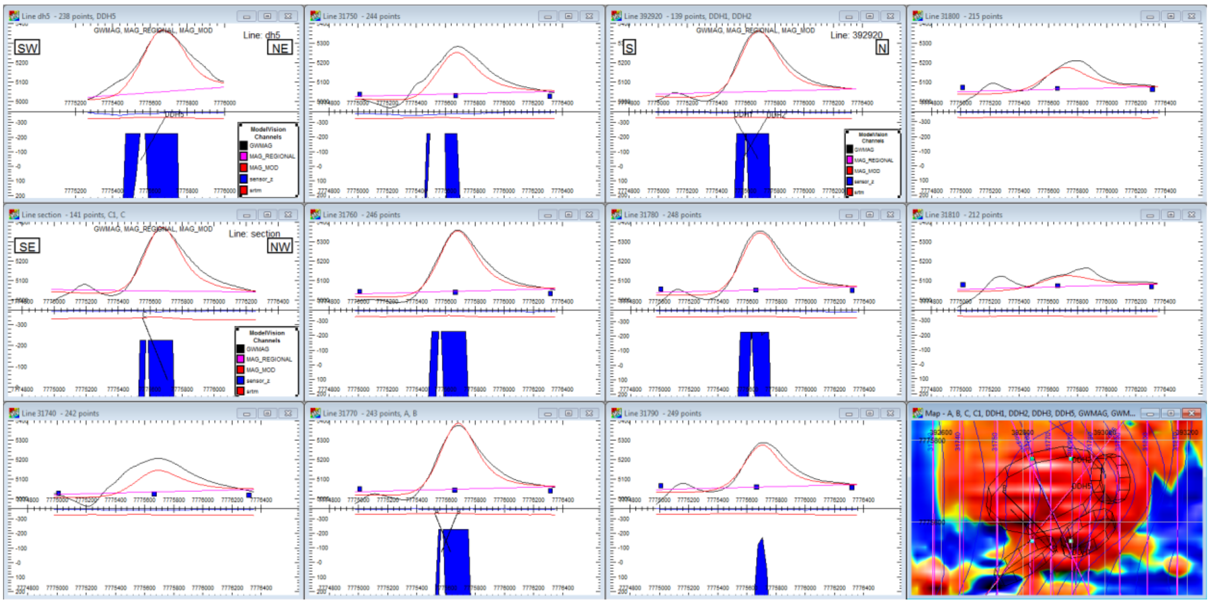


Figure 3. Model session showing 9 original data lines and 2 grid sampled sections with completed and proposed drillholes.

The target models as a tight fold of sorts. It appear that the northern limb of the fold is the most intensely enriched. It is interpreted that the northern limb dips dips steeply to the NNW and the southern limb dips steeply to the SSE but there is no drilling data to support this model, indeed the drilling suggests that if a southern limb exists it dips at a more shallow angle to the SSE.

The susceptibility of the modelled bodies is 0.0625SI which is within the 0.045 - 0.067SI observed in drill core measurements.

While the original survey did not fly down easting 392920, the gravity modelling suggested two drill holes on this line and so a profile was extracted from the gridded data for modelling and comparison with WDR holes 12DH001 and 12DH002. The section is shown in Figure 4. The modelling suggests a folded magnetic unit. The correlation of the northern limb and the WDR drilling is very good. While hole 12DH001 intersected the ironstone unit at 200m the model suggests 170m. This can be explained by a fold at depth in the geology (meaning the top of the ironstone dips SE in real geology) that has not been replicated in the modelling. The model suggests a southern limb should be intersected by hole 12DH002 and has not. This indicates that the southern limb is not real or that the dip of the southern limb is more shallow to the SSE. The modelling also suggests that the ironstone unit should continue at depth past the end of 12DH001.

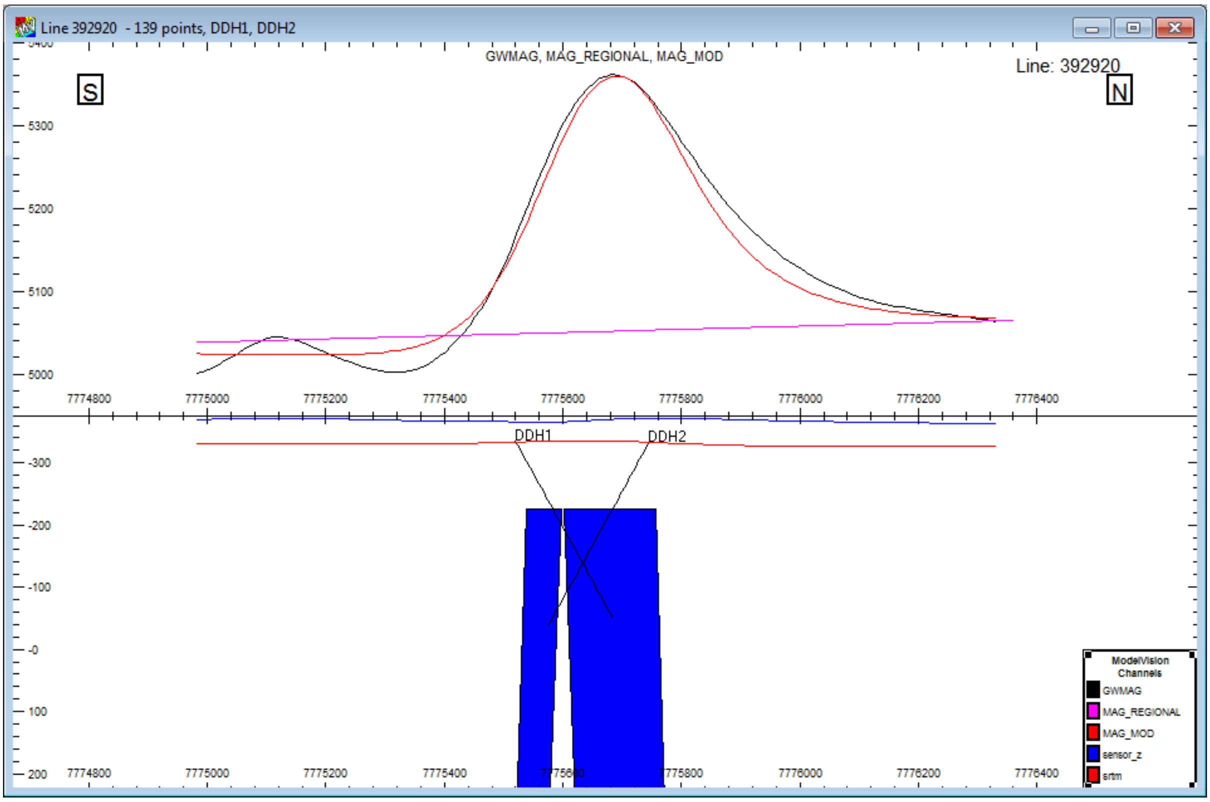


Figure 4. Model section through BIF Hill along 392920mE showing WDR drilling 12DH001 and 12DH002.

Figure 5 shows a section with the drillhole recently proposed by Montana GIS - referred to as DDH5 (392920mE 7775680mN, azi 220, dip 60 as conferred by C Gaughan pers comm). The section shows that if the source is a fold, DDH5 should intersect the northern limb but then penetrate through into the core of the fold, as seen in 12DH002.

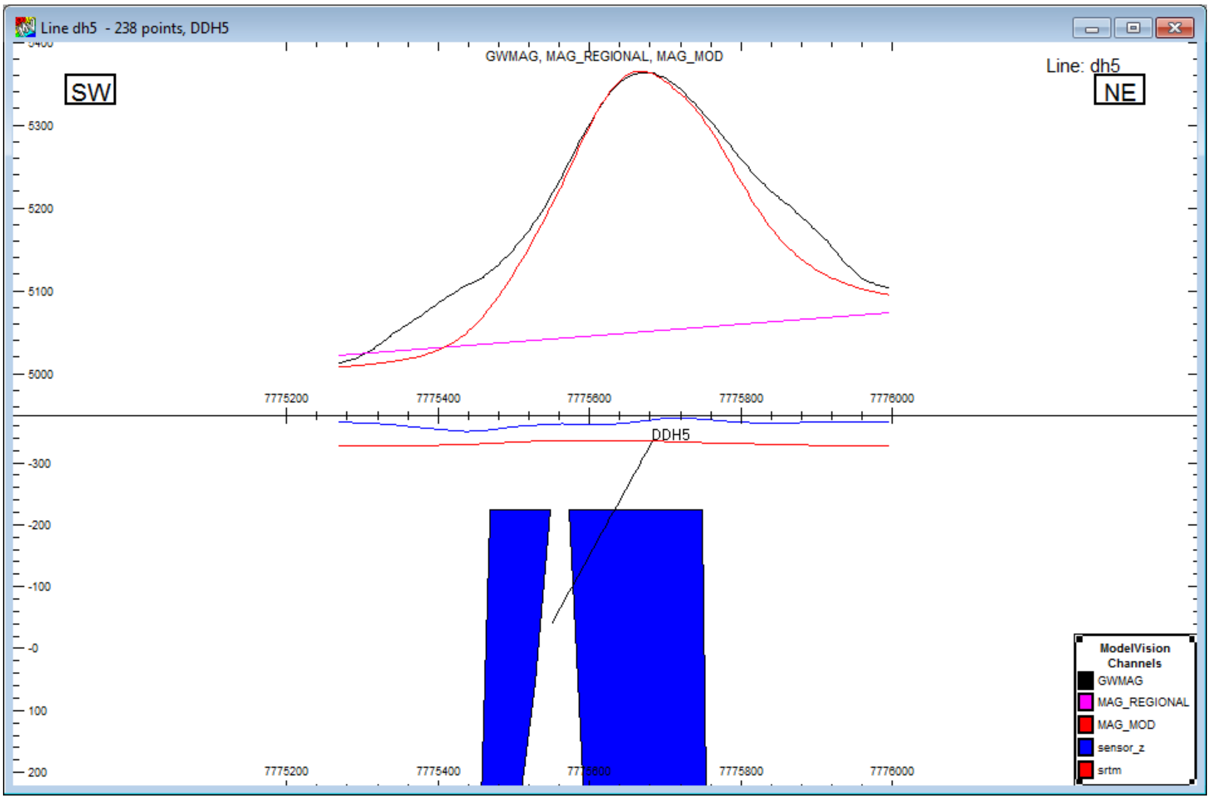


Figure 5. Model section showing proposed hole DDH5.

Figure 6 shows the modelled bodies overlain on the previously discussed structural/geological interpretation. The figure shows that the model suggests the thickest and most intense point of the magnetic source is interpreted west of the current drilling. A drillhole - hole C - has been proposed to intersect the fattest point on the model. The azimuth of the hole is 340 degrees and dip of 60 degrees. While indications are that the ironstone may dip to the NNW, the steepness observed in the completed drilling suggests that drilling 'downdip' should not occur with a 60 degree hole. Figure 7 shows a model section with hole C (392905mE 7775550mN, Azi 340, dip 60).

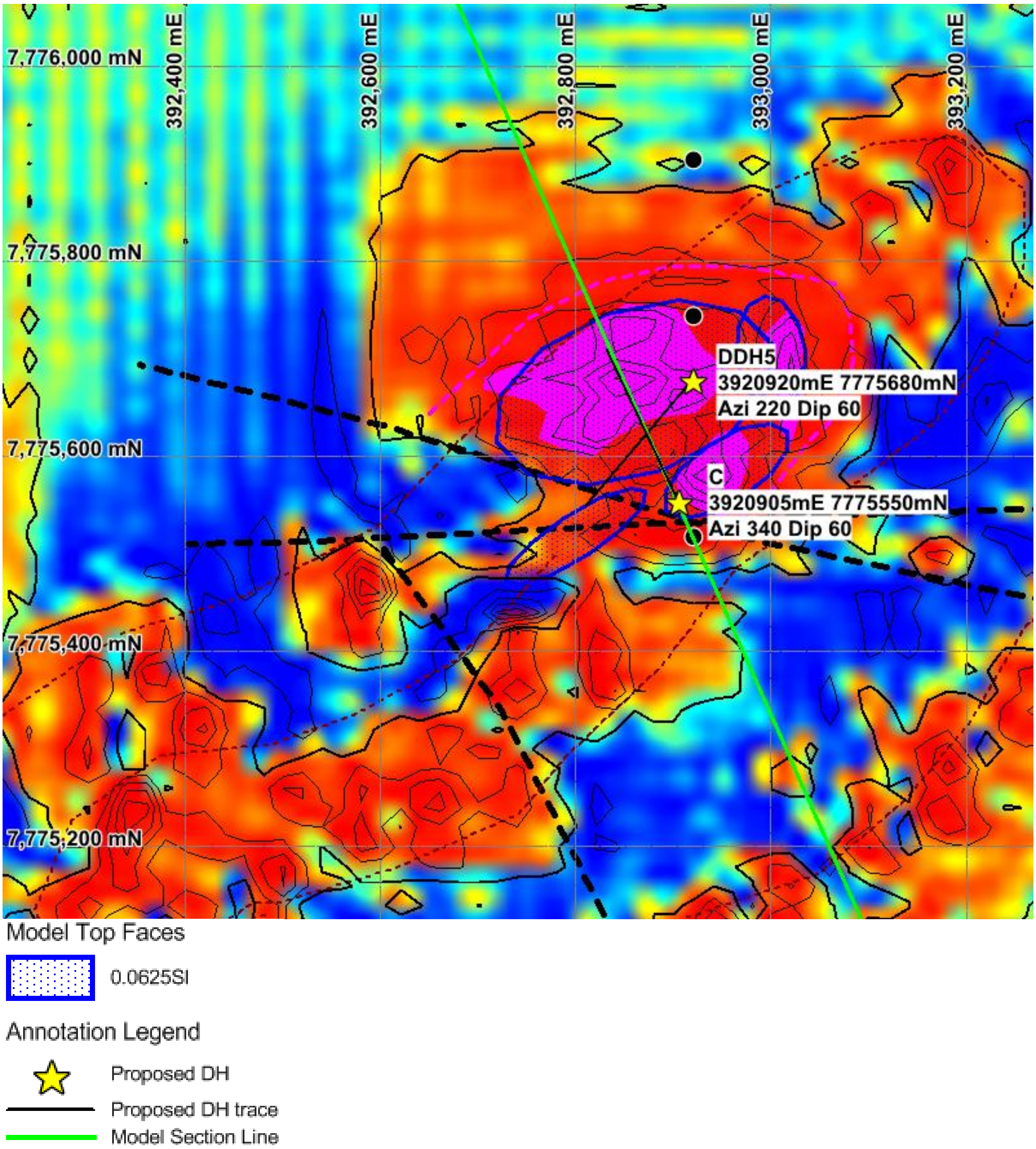


Figure 6. Summary plan of modelling showing interpretation, model top faces and proposed drillholes.

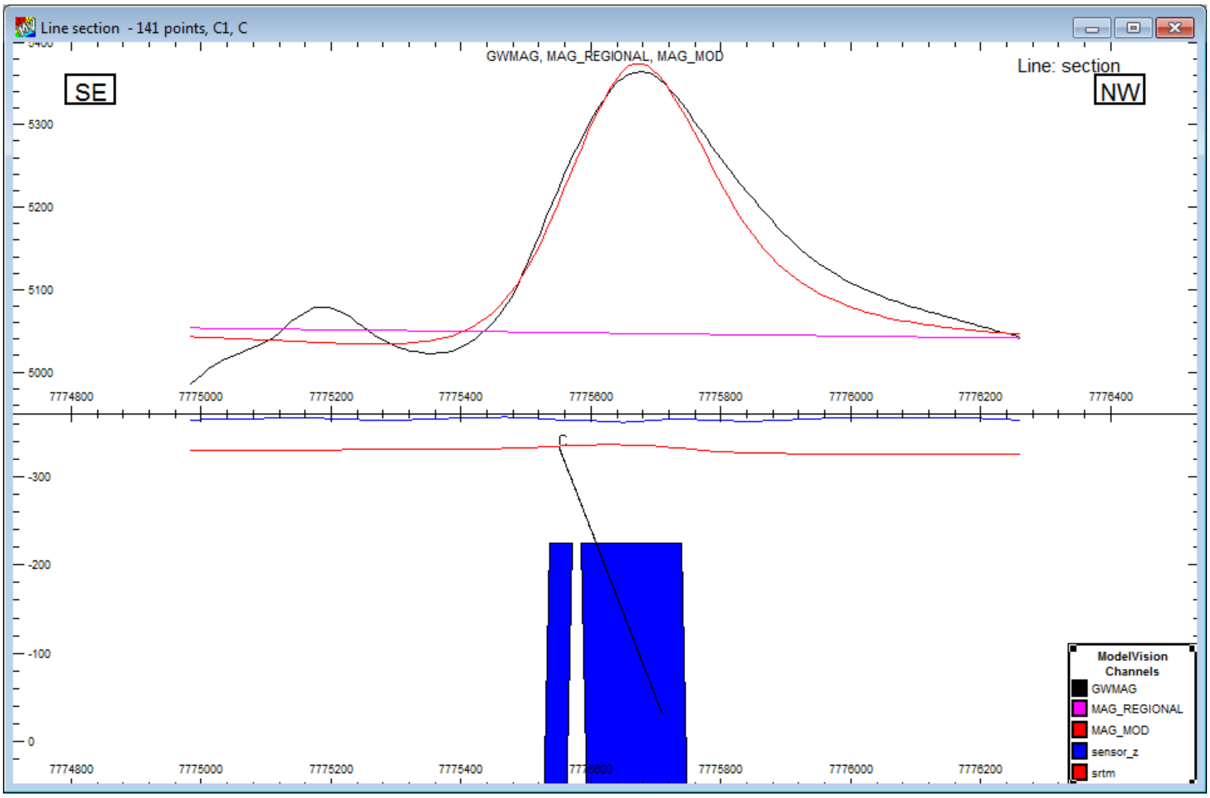

Figure 7. Model section showing proposed hole C.

## Discussion and Recommendations

The remanent magnetisation of BIF Hill required a more robust magnetic model to be created, utilising techniques to determine magnetization direction and incorporating data from completed drilling and generic geological models of the target style.

Modelling using CSIRO methodology to determine magnetisation vector has resulted in a model that matches observed drillhole data.

The modelling is based on a fold geometry and suggest a southern limb that has not yet been identified in drillholes.

The modelling suggests proposed hole DDH5 may be targeting the core of the fold.

A hole C has been proposed to test the centre of the new magnetic model.

It is recommended to acquire magnetic tensor gradient data downhole to accurately locate the centre of the magnetic source. The CSIRO would be the best organisation to contact regarding acquiring such data.