

# Constrain modelling in Iron Ore Exploration

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## Abstract

This paper aims to discuss the concept of magnetic modelling, particularly the non-unicity of inverted solutions, showing in practice the ambiguity of the methodology and the importance of constrain models.

Besides, it discusses the difference between the pre drilling models and post drilling models, and the true fact that most exploration projects do not contain previous drilling.

The field example is located at Piauí State – Brazil.

## Introduction

Ground magnetics was acquired and inverted in order to find drilling locations for direct exploration of magnetic Iron Ore (magnetite).

We will present modelling pre and post drilling, and will discuss the ambiguity of models and the actual magnetic body compared to models.

## Ground data and pre drilling modelling

Figure 1 shows the Total Magnetic Field (TMI) of the target.

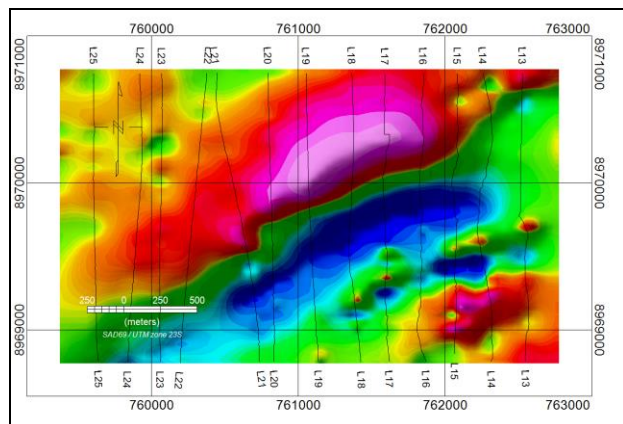


Figure 1: Total Magnetic Field.

From the TMI, we have performed magnetic modelling using the state-of-the art softwares to understand the subsurface sources and drill aiming to intercept magnetic rock. Similar approach is related in Cordani 2011.

Figure 2 shows pre drilling modelling using two different softwares: Modelvision and Voxy MVI IRI. The model represented in blue is the pre drilling model from Modelvision, while the magenta blocks are the results of Voxy MVI IRI inversion.

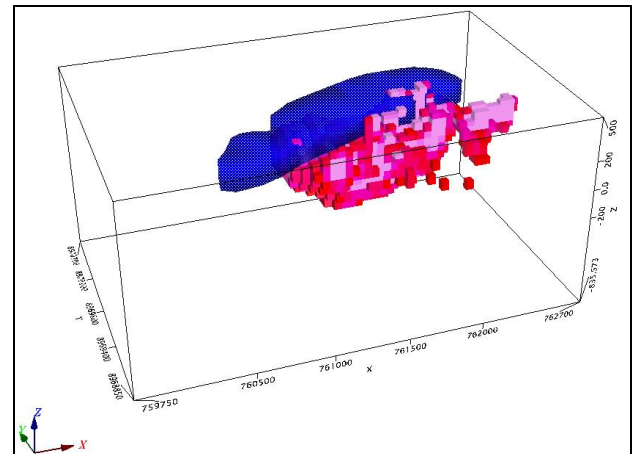


Figure 2: Magnetic models. Suscep of "blue model" is 0.1 SI.

Although there is a small region where both models are coincident, it is possible to notice that the Modelvision body is very much shallower than the Voxy MVI IRI models. And in spite of there is a great difference between the models, the predicted field of both have a good fit with the actual data in Figure 1. Figure 3 shows the predicted field due to the Modelvision model, while Figure 4 shows the predicted field due to Voxy MVI IRI model.

Both models present a reasonable fit, with advantage for Voxy, whose comparison with actual data is impressive good. It is necessary to point out the basic concept of non unicity in inversion: infinite solutions fit the actual data, but in the real subsurface only one is the reality. Up to this moment we have two solutions, but which one is the best representation of the reality? Where to put the drill holes, and after how many meters should we expect to intersect the magnetic sources?

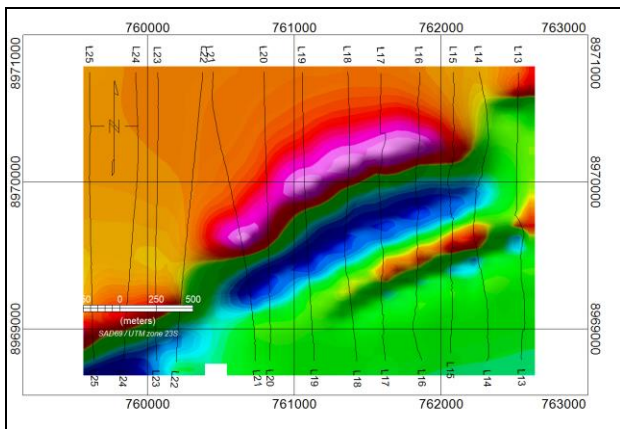


Figure 3: Predicted Field (field that would be observed if blue model existed in fact)

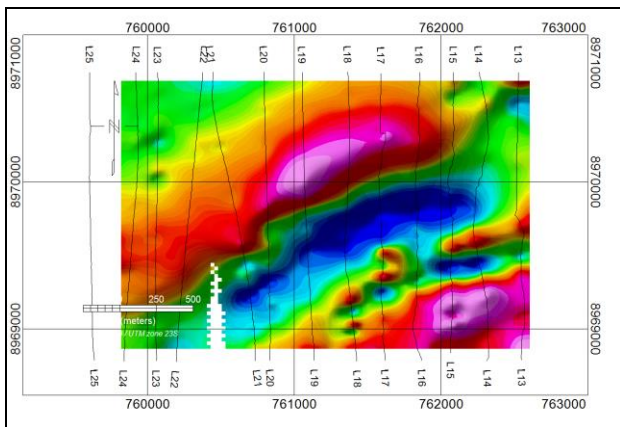


Figure 4: Voxy MVI IRI Predicted Field

**Drilling and the reality**

Figure 5 shows the position of the five vertical drill holes, over the map projection of Modelvision blue model.

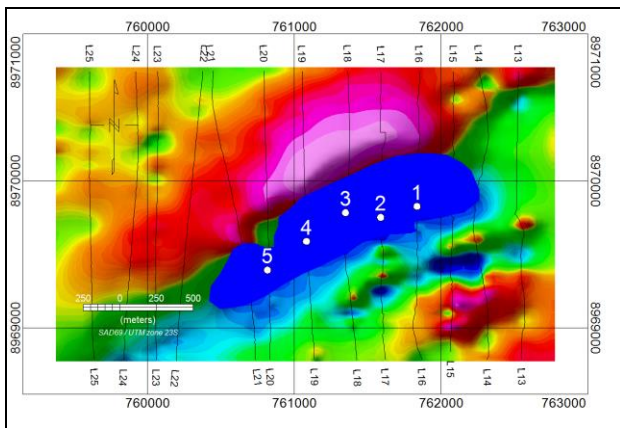


Figure 5: Location of drill holes.

Drill holes 1, 2 and 3 intercepted magnetite, while drill holes 4 and 5 did not. Figure 6 shows a 3D view of drill holes, with non-magnetic rock represented in red and magnetite in black.

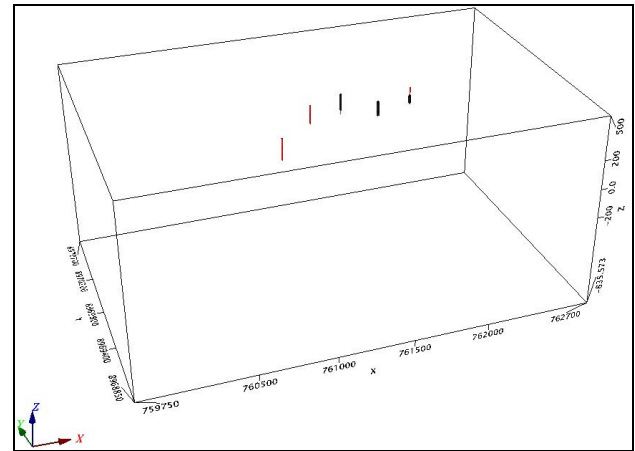


Figure 6: 3D view of drill holes. Red: non-magnetic rock; black: magnetic rock.

Summary of results:

- Drill hole 1 intercepted Modelvision model, Voxy model and magnetic rock.
- Drill hole 2 intercepted Modelvision model and magnetic rock, but did not intercept the Voxy model.
- Drill hole 3 intercepted Modelvision model and magnetic rock, but did not intercept the Voxy model.
- Drill hole 4 intercepted Modelvision model, but did not intercept Voxy model and magnetic rock.
- Drill hole 5 intercepted Modelvision model, but did not intercept Voxy model and magnetic rock.

Figure 7 shows the drill holes and the models at the same 3D view.

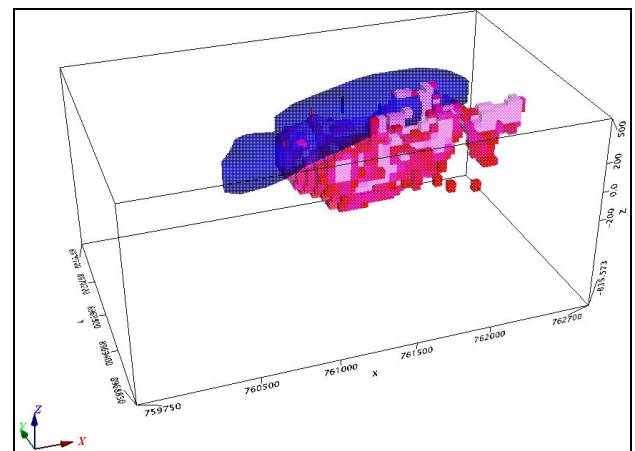


Figure 7: 3D view of drill holes and models

### Evaluation of the pre drilling models and execution of a post drilling constrain model.

Drilling results show that modelvision body was very coincident to the depth of the top and depth thickness of the actual body in drill holes 1, 2 and 3. On the other hand, the modelvision body did not match the results of drill holes 4 and 5.

Voxy MVI IRI model did match the top of the body for drill hole 1, and the absence of magnetic sources for drill holes 4 and 5. Voxy models were much more deeper than reality for sources in drill holes 2 and 3, and for the depth extension in drill hole 1.

Considering the results, we have performed a post drilling constrain modelling using modelvision. Figure 8 shows the results, and Figure 9 shows the predicted field due to the green bodies. Note that the post drilling models are smaller and higher susceptibility than old blue pre drilling model.

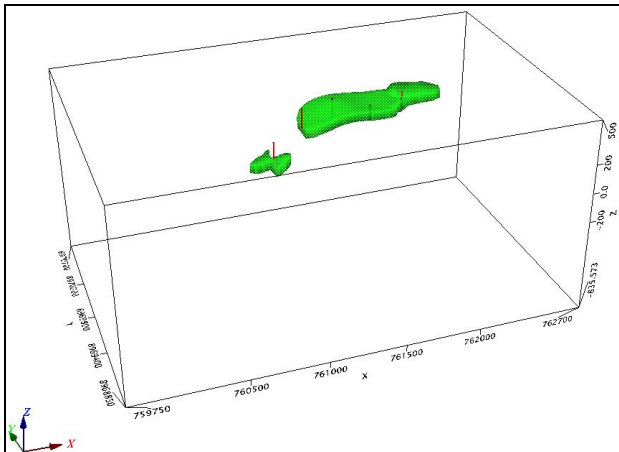


Figure 8: post-drilling models (Susceptibility of green models is 0.25 SI)

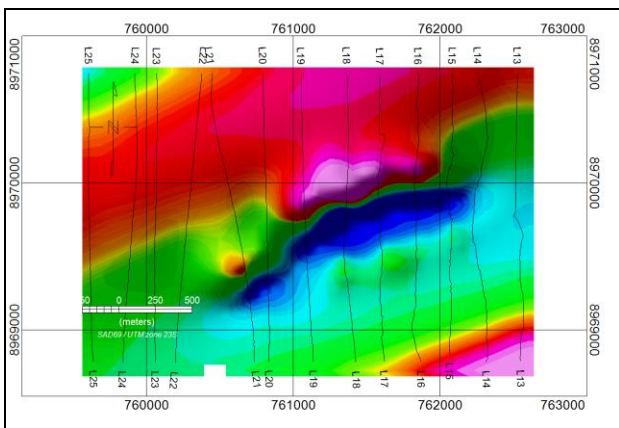


Figure 9: Predicted Field (field that would be observed if green models existed in fact)

### Conclusions

First of all I would like to point out that the concept of “non unicity” in inversion is very important. Even if you have a very good fit, you may not be so confident.

The Modelvision modelling showed a better determination of the depth of the top of the body parameter, while Voxy model positioned the sources much deeper than the reality, even using the function IRI (this IRI function should concentrate more the sources).

On the other hand, Voxy modelling was better to not recommend the drill holes 4 and 5.

Post drilling modelling showed that is still necessary to exist a magnetic source to explain the anomaly over drill hole 5, therefore it suggest that this drill hole should be done deeper.

At last, I would like to stress the fact that the great majority of exploration projects do not have previous detailed information nor previous drillings. Therefore, it is important previous pre drilling models to help first locations, but is also very important to come back to the models (now the constrained ones) after drilling for the continuity of the exploration programme.

### Acknowledge

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### References

Cordani, R. 2011. Gravity 3D modelling: a kimberlite case history and inversion methodology discussion. 12<sup>o</sup> CISBGF.