Combined potential field and airborne electromagnetic interpretation to unravel the geological history of the Curaca Valley Region, Bahia, Brazil

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SUMMARY

Integrated geological-geophysical interpretation offers a robust way to answer geoscientific questions by providing better and faster decisions on where to explore in a regional context, and ultimately on local-scale targets. In particular, regional scale geophysical datasets can be used in areas of extensive cover and limited outcrop to quickly develop three dimensional geological models that can serve different purposes such as targeting or hypothesis testing via forward modelling. To show these concepts, we present a case study from the Curaçá Valley Cu region in Bahia, Brazil. A large geophysical data set including airborne gravity, magnetic and airborne electromagnetics was used and combined with existing 2D regional geology from different sources to produce a 3D integrated model.

Key words: integrated modelling, geophysics, potential fields, targeting, regional, Cu deposits

INTRODUCTION

By combining standard geophysical data (e.g. gravity, magnetics, AEM) it is possible to quickly advance a large area of interest from regional to prospect scale with an ongoing and data driven 3D integrated model to test hypotheses regarding geology and mineralization events. This approach therefore eliminates ambiguity and decreases uncertainty within 3D models that are supported and cross-validated by multiple data sets.

This report presents preliminary results of integrating a recently surveyed area of 130 km × 30 km within the large Curaçá Valley Region, in northern Bahia, Brazil using airborne gravity, magnetic and time-domain airborne electromagnetic (AEM) data. The Curaçá Valley is prospective for copper, and well-known deposits including Vermelhos, Surubim and Pilar among others provide impetus for exploration. By combining the geophysical interpretation with previously existing 2D geology from different sources, it was possible to construct a robust model to be used by mineral explorers to query specific areas, test hypotheses and ultimately to select drilling targets

METHOD AND RESULTS

SkyTEM AEM, aeromagnetic data and airborne gravity (Sander AirGrav) data were collected at the prospective belt in the Curaçá Valley during 2018. Coverage of each technique was approximately 21,000 line km at a line spacing of 200 m.

Gravity data played a key role in the construction of the geological model due to its marked response to lithological domains. The workflow to generate a model from gravity included: (a) establish relationships between geology maps and geophysical responses (b) check for consistency among different datasets (c) infer/interpret preferred dip directions from potential fields and AEM data (d) address the most prominent potential field response first to develop simple 3D representations and forward modeling this to compare against measured ground gravity. The sequence then repeats by moving onto less prominent response areas up until the majority of gravity responses are reproduced within a plausible geological framework.

This model was then used as a geological constraint for quantitative three-dimensional (3D) forward modelling and inversion to isolate and reconcile residual gravity response possibly associated with localised mafic/ultramafic domains.

Magnetic data processing and modelling included an apparent susceptibility inversion, magnetic vector amplitude (MVA) analysis and geologically-constrained inversion, constrained by the 3D model derived from the gravity interpretation described above.

AEM interpretation consisted of a combination of anomaly picking including estimation of conductor quality and dip, limited plate modelling and one-dimensional (1D) inversion. A pseudo-3D model was generated by stitching together 1D inversions of the SkyTEM data.

There are numerous very extensive conductivity anomalies in the area, which are of stratigraphic origin. These are most likely to be graphitic, possibly with associated sulphides such as pyrite. This is supported by the lack of any associated magnetic anomalies.

EM plate modelling was completed on a number of high priority targets, in order to provide detailed targets for follow-up drilling. The areas modelled were selected either by the local geological team or highlighted by the interpreter based on visual examination of the data profiles and other supporting data such as the geological maps and the airborne gravity data.

CONCLUSIONS

Based on the integrated analysis of different geophysical datasets including gravity, magnetic, AEM and combining this with existing, locally derived geological knowledge it has been possible to create a powerful regional integrated model (Figure 1). Salient features are:

A regional 3D geological model has been developed through careful analysis of the gravity, magnetics, radiometrics, AEM and geological maps, using a process referred to as integrated interpretation (Pears et al., 2017). The process is iterative involving a combination of conventional interpretation techniques and 3D geological modelling, coupled with potential field forward modelling and inversion

Gravity data played a key role in the development of the model. At various stages of model development, major formations in the model are validated by forward modelling against the gravity data. Positions of geological boundaries are supported by the other datasets (e.g. aeromagnetics, radiometrics, mapping). Dips are incorporated according to interpretation of AEM and aeromagnetic anomalies, as well as 3D gravity modelling. The model represents a true integration of information from various datasets.

Due to a lack of subsurface geological control, the model is largely conceptual. However, it is clearly an advancement to the existing 2D geological maps. The model itself provides a regional geological framework for exploration, and localised density and susceptibility variations within the geological model derived from inversion can be interpreted in terms of various targeting criteria such as alteration, presence of mafic-ultramafic units, and so on.

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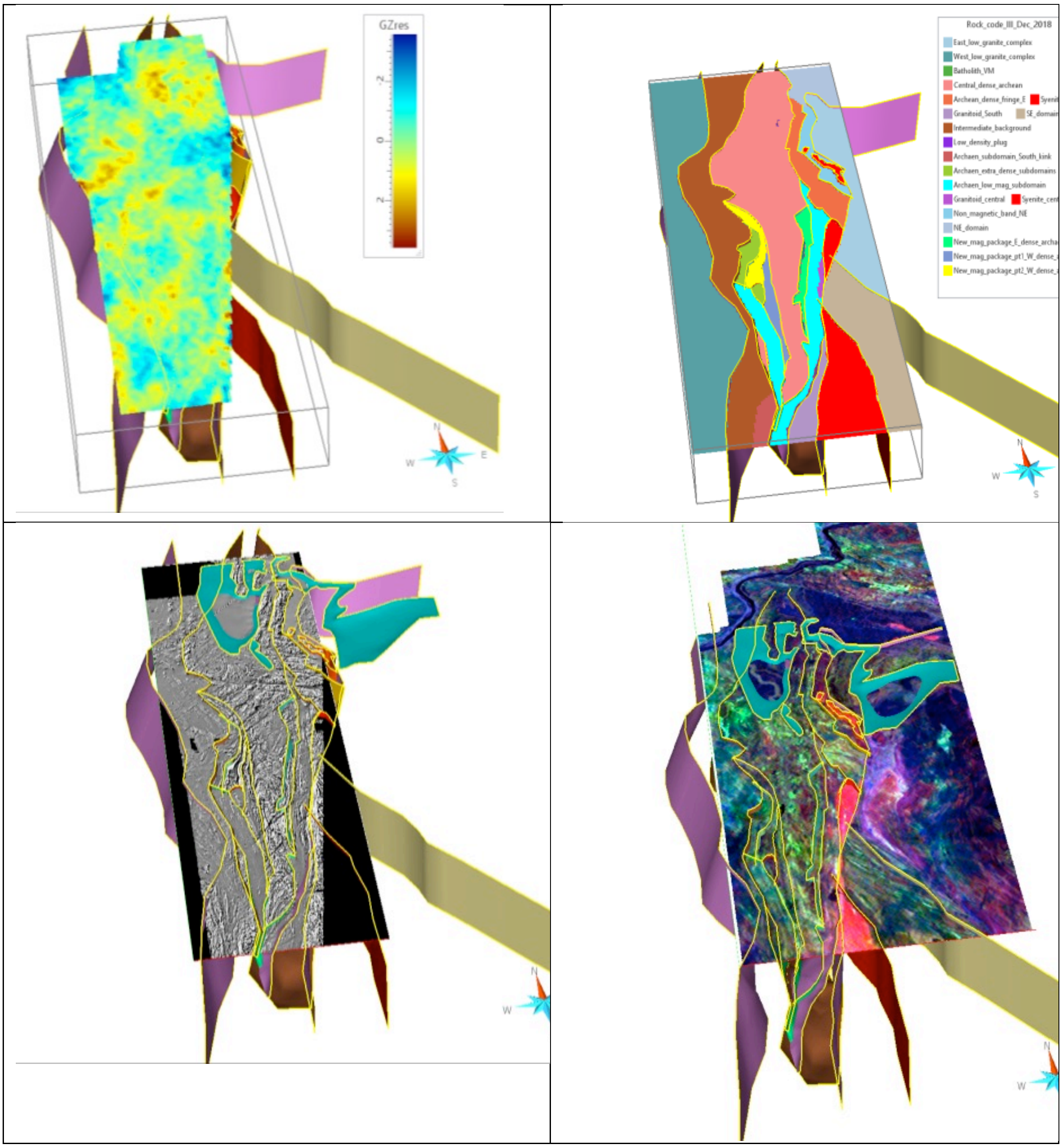

Figure 1. Curaçá Valley Region regional 3D integrated model representation. Top left: residual gravity overlain on modelled lithological domains; Top right: classifying different lithological compartments to assign physical properties for further modelling; bottom left, Total Magnetic Intensity (TMI) with lithological overlay, and (bottom right) lithological grouping overlaid on radiometric image to cross-check correct lithological classification.