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Geophysical Modeling – Inversion Strategies in Defining the Geological Framework of the S16 Deposit

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Introduction

The complex geological context of the Carajás Mineral Province has always posed a challenge to the geoscientific world: initially, in its formation context and currently in the correlations between mineralizations and their forming processes. One of the most intriguing scenarios occurs in the S11D complex, which holds the title of the largest iron mining project in operation in the world. To the south of this complex lies the S16 target, which has significant geophysical signatures associated with the predominant presence of Banded Iron Formation, the lithotype that constitutes the main host of high-grade iron ore deposits in the region. Understanding its behavior at depth is essential to add value to the prospect.

With the advancement of computational technology, geophysical inversion techniques are becoming faster, more robust, and increasingly contributing to mineral exploration. Each geophysical method responds to different physical phenomena and, consequently, different physical properties and has its intrinsic limitation in terms of resolution, depth of investigation, and non-uniqueness of solutions. To reduce uncertainties and improve spatial resolution, a promising approach is the use of cooperative or constructive inversion techniques that enable the creation of more realistic geophysical models of the geological framework.

Method and/or Theory

The methods of magnetometry, time-domain electromagnetometry, and gravimetric gradiometry comprise the scope of the input data used. The spacing between flight lines varies from 100 to 300 meters. The interpretation of the available geophysical data demonstrates a strong relationship between geological structures and the arrangements of geophysical signatures. The use of geological regularization constraints to control the convergence of the geophysical inversion model was not applied. The central idea of this process is to combine geophysical methods using the full efficiency of each physical parameter in the inversion and verify the representativeness of the geophysical model when compared to the geological framework, refining regions where geological uncertainty is greater or there is a lack of direct information.

Results and Conclusions

The executed 3D modeling presented satisfactory results in the misfit, and the objective function was efficiently minimized. In addition to meeting the physical and mathematical rigor pertinent to the inversion process, the products of the methodology employed in the inversion of geophysical data were ideal, and their comparison between geophysical and geological sections and geophysical and geological models and grades allowed, besides checking the convergence of the inversion model, to propose regions for adjustment and refinement of the geological framework geometry.