The AEM Method Applied for Iron Ore Targeting in The Carajás Mineral Province

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Abstract

The Airborne Electromagnetic Method (AEM) is not commonly used for exploring iron ore deposits in supergene enriched environments, like the one in the S11D project in Pará State, Brazil. Despite the limited number of studies, recent research has shown the significant potential of this methodology for iron ore exploration. One important study was conducted a few years ago by the Fortscue Metals Group, which reported that a SkyTEM survey in the Hamersley Province, Western Australia, demonstrated high resistivity contrast between the iron ore mineralization strongly affect by weathering process, in comparison with their country rocks. Although geologically distinct, in the Carajás Mineral Province, historical AEM data demonstrated a similar contrast between known mineralized iron formation bodies and their mafic surrounding host rocks, even though this methodology has been historically used for base metals exploration, and no extensive study was conducted on inductive electromagnetic methods for iron ore exploration have been conducted in VALE to this moment.

In this study, we present a Helitem² survey test with variable configurations to determine the most suitable combination of Helitem systems for mapping iron ore mineralized zones in Carajás Mineral Province, specifically, in this case, the S11D project. The tests involve the permutation of two dipole-moments and two base-frequencies: High-Moment (HM) with 560 kNIA, Low-Moment (LM) with 260 kNIA, 15 Hz, and 30 Hz, respectively. The tests were planned over targets in the study area, which are associated with resistive domains identified in previous historical AEM data (both time and frequency domains). This approach is supported by petrophysical data from wireline resistivity surveys, which indicated significant resistivity contrast between the undivided banded iron formation, the mineralized iron-crust, and the altered mafic units. The iron formation exhibits higher resistivity contrast compared to these mafic domains.

The LM configurations show lower signal-to-noise ratio and poor definition of resistive bodies in the deepest portions of the Differential Conductivity™ models. Conversely, the HM configurations yield opposite results. Both the HM-15Hz and HM-30Hz configurations exhibit higher signal levels over a known iron ore target and in the surrounding areas of the S11D body, suggesting a continuation of the ore towards unexplored zones of the mine. Both configurations indicate possible zones of Induced Polarization (IP) effect over the known iron ore target and the mafic units related to the Parauapebas Formation. Over the mafic units, these configurations exhibit full negative decays, suggesting a strong IP-effect in this area. However, the HM-30Hz configuration shows negative values in the late times in a clearer way in comparison with the HM-15Hz configuration over portions of the iron ore target, due to the lower signal-to-noise ratio in later times intervals for lower frequencies. Therefore, the HM-30Hz configuration was chosen for this study. Further analysis is currently focusing on the IP-effect anomalies to improve the resistivity models of the area and contribute to reducing ambiguities in the geological mapping of unexplored or poorly explored regions in S11D. These analyses are currently being reproduced in other iron ore mineralization zones in the Carajás Mineral Province.