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3D multi-parameter geophysical modelling applied to Luanga deposit in Carajás Mineral Province, Pará - Brazil

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Introduction

The Luanga deposit, located in the Carajás Mineral Province of northern Brazil, is a layered mafic-ultramafic intrusion hosted in Archean greenstone terrain, with a strike length of approximately 8 km. Originally explored by Vale in the late 1990s and now under active development by Bravo Mining Corp., Luanga is a polymetallic deposit containing platinum group metals (PGMs), gold, nickel, and copper. The mineralization is subdivided into several distinct zones, including the Main Sulfide Zone (MSZ), the Low Sulfide Zone (LSZ), and chromite-associated PGM layers (Chr-PGM), each with unique geophysical and geochemical signatures. Recent exploration has also identified a new iron oxide–copper–gold (IOCG)–style mineralization within the Luanga complex, particularly in EM targets T5 and T6, where massive sulfide intercepts with high-grade copper and gold (e.g., 11.5 m @ 14.3% Cu, 3.3 g/t Au) were reported. In this study, we integrate 3D inversion modeling of magnetic and electromagnetic (EM) data with geological and geochemical datasets to enhance subsurface interpretation and support mineral targeting. This multi-disciplinary approach enables a more comprehensive understanding of the structural framework and mineralization controls within the Luanga deposit, covering both magmatic sulfide and IOCG-style systems.

Method*s*

Magnetization Vector Inversion – MVI is a geophysical inversion technique used to recover the 3D distribution of the magnetization vector within the subsurface. Unlike traditional magnetic inversions that assume a fixed magnetization direction (typically induced magnetization aligned with the Earth’s field), MVI allows the direction and magnitude of the magnetization to vary spatially. This makes it particularly suitable for interpreting complex magnetic responses associated with remanent magnetization, hydrothermal alteration zones, and structurally controlled mineralization. Besides MVI we also performed TDEM inversion on the HELITEM dataset to generate a 3D electrical conductivity model.

Conclusions

The integration of magnetic vector inversion (MVI) and electromagnetic (EM) inversion played a central role in refining the geological understanding of the Luanga deposit. MVI effectively delineated the geometry of the mafic-ultramafic intrusion, allowing for detailed mapping of the Luanga main sulfide zone. Magnetic susceptibility contrasts captured by MVI helped differentiate mineralized ultramafic bodies from surrounding barren rocks, closely matching known mineralized intervals from drilling. EM inversion contributed significantly to both the magmatic sulfide system and the newly identified IOCG-style mineralization. In the main sulfide zone and adjacent ultramafic units, EM inversion resolved conductive zones associated with disseminated and semi-massive sulfide mineralization, reinforcing the interpretation provided by MVI. In the T5 target area (IOCG style), EM inversion was essential for imaging compact, high-conductivity bodies related to massive sulfide mineralization, which were later confirmed by integrated drillhole information. Together, the combined use of MVI and EM inversion enabled precise targeting and a more comprehensive understanding of the multi-style mineralization at Luanga. These results underscore the value of integrated geophysical workflows in polymetallic systems, supporting both advanced resource delineation and greenfield discovery within the same geologic complex.