Submission code: VBDRL5Q7B5

See this and other abstracts on our website: https://home.sbgf.org.br/Pages/resumos.php

GEOPHYSICAL FOOTPRINT OF JACURICI'S VALLEY CHROMITE DEPOSITS THROUGH AUDIOMAGNETOTELLURIC METHOD

Leonardo Ornellas (Federal University of Bahia), Liliane Panetto (Observatório Nacional/Universidade Federal Rural do Rio de Janeiro), Marcos Alberto Rodrigues Vasconcelos (UFBA), Florivaldo Sena (Servigeo), José Haroldo Sá (UFBA)

GEOPHYSICAL FOOTPRINT OF JACURICI'S VALLEY CHROMITE DEPOSITS THROUGH AUDIOMAGNETOTELLURIC METHOD

Please, do not insert author names in your submission PDF file

Abstract

The chromite deposits from the Jacurici's Valley have been mining since the '70s. This work aimed to apply audiomagnetotelluric data analysis over (i) Southern Block, where we had previous knowledge of the chromite ore in depth through drill holes; and (ii) Northern Block, where just an overall mapping was carried out. The geology is comprised of igneous and metamorphic rocks aligned following a N-S strike. The chromitites are cm- to m- layers hosted on ultramafic rocks. Based on the signature found in terms of electrical conductivity in the subsurface of the Southern Block, we identified potential anomalies with similar behavior in the Northern Block. Through inversion, 11 principal conductors were identified in both Blocks, correlated with geological information.

Introduction

This work aims to provide some contributions to chromite research through acquisition, processing, and inversion of integrated audiomagnetotelluric (AMT) data. Two areas have been chosen: 1) The Southern Block, with active chromite exploitation, was used to calibrate the footprint of the chromite ore deposits; 2) The Northern Block, not yet exploited, have a similar geological environment and similar geophysical response. We used the footprint of Southern Block to predict the potential of mineralizations of Northern Block.

The Jacurici's Valley chromitite thickness is around 8 meters and is part of a much larger (approximately 300 meters in thickness) mafic-ultramafic sill, surrounded by Paleoproterozoic/archean orthogneisses and metassediments (gnaisses, diopsidites, marbles and amphibolites) from Santa Luz complex in São Francisco craton (Marque e Filho, 2003; Marques et al., 2003). To date, there are many disconnected folded mafic-ultramafic sources, some of which may contain mineralization (Almeida et al., 2017). Given the dimensions involved, it is clear that the problem of finding a geophysical signature for these deposits is to determine the responses of the whole mafic-ultramafic body containing chromite mineralization. It is expected that this system with interconnected chromite will improve average conductivity in the entire volume of rock (Sun et al., 2021; He et al., 2018).

The AMT is a frequency domain geophysical method based on simultaneous surface measurements of orthogonal induced electric and magnetic fields with the objective to determine the distribution of electrical resistivity in subsurface. The impedance tensor establishes a relationship between the two measured fields and the conductivity. To provide an in-depth model of conductivity distribution, it is necessary to perform the inversion of data. Given the multiplicity of different models possible, it is desired that the final model provided by inversion has two principal characteristics: 1) Minimizes the misfit between the calculated and observed data, and 2) properly explains the geological features observed in the area.

Methodology

Acquisition

The AMT data were collected in three campaigns during july/august of 2022, october/november of 2023, and january/february of 2024. The avarage acquisition time was 45 minutes for both areas. Three induction coils, four plumb electrodes and one V8 receptor were used for data of Line 3, while the other data were acquired using MTU-5C, all made by Phoenix Geophysics. The electrodes were aligned in north-south and east-west directions in a distance of 50 meters from receptor. In Southern Block the AMT stations were closer to aproximately 150 meters near the mineralization and around 250 m far from mineralized zones. In Northern Block, all stations had the same distance each other: 100 meters. The distance between Lines was approximately 500 m for both blocks (Figure 1). The Lines were enumerated in increasing order from north to south starting from Southern Block and the stations were enumerated in increasing order from west to east.

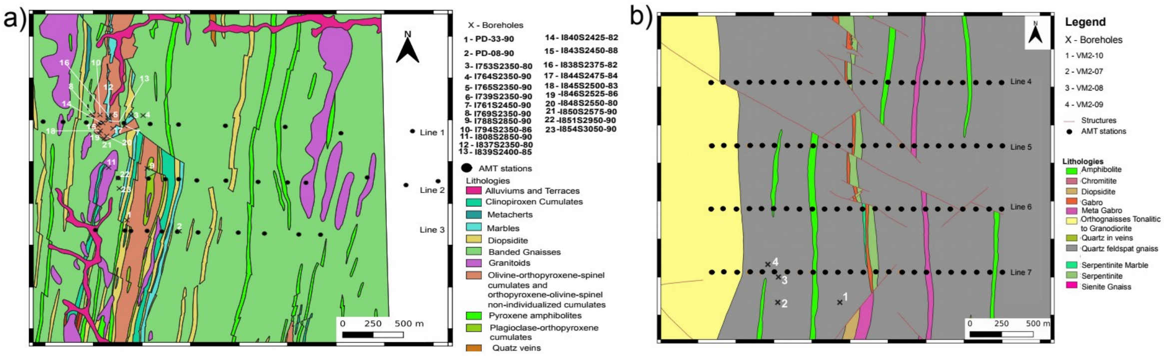

Figure 1 – Geological maps of Southern (a) and Northern (b) Blocks.

Processing

We used Phoenix Geophysics' softwares EMpower to processing the data acquired using MTU-5C and SSMT in the case of those acquired with V8 receptor. Robust processing were applied using electric chanel as reference and a filter of 60 Hz in order to attenuate the effect of noise due to humam activity. Magnetic declination was -22º and periods above 1 s were descarted. The main objective of processing were to obtained smooth curves of apparent resistivity and phase as function of frequency or period. Based on that, after processing, we edited the curves by eliminating points inconsistent with the general pattern in crosspower spectra. Later, some curves of Northern Block passed through additional adjustment by application of Rho+ program (Parker and Brooker, 1996), bringing outliers to the tendency of the curves in xy and yx components.

Inversion

For inversion were used the program ModEM (Kelbert et al., 2014), writen in Fortran 95 language. This program uses a non-linear conjugate gradient algorithm for 3D inversion and finite diferences method to solve foward problem.

In all cases, the four components of impedance tensor (Zxx , Zxy , Zyx and Zyy) were inverted. The error were stipulated as a maximum between the original error of the data and 5% of the square of absolute value of Zxx and Zxy or Zyy and Zyx, for principal diagonal elements and 10% of absolut value of secondary diagonal elements for those components.

For Lines 1 and 2, the initial model had a resistivity of 10^3 Ohm.m with a grid of 100x100x71 in x,y and z directions, respectively. The depth of first layer was 1.0 meter, and initial horizontal dimensions were 100x100, with increasing factor of 1.2 in z direction and 1.3 in horizontal directions. The covariance in all directions was 0.2 and all periods between 10^{-4} to 1.0 seconds were used in inversion. In relation to Line 3, the only differences were the grid. For that Line, were used 80x80x67 cells.

In Northern Area, all four lines were inverted together. Only station 0409 needed to be excluded. The initial model for that area consisted of a resistiivty of 10^4 Ohm.m with 80x80x73 cells with initial 50 m in x and y directions and with 2.0 m thickness for the first layer. The other parameters were iqual to those of Southern Block.

Results

Curves of Southern Block were less smooth than those of Northern Block. That is due to human activity noise, which is more intense in southern area. For inversion, different models and configurations were tested. The RMS obtained after inversion were 2.198246, 2.229075 and 1.793937 for models of Lines 1 and 2, Line 3 and Northern Block, respectively. The geological model of mineralization (based on boreholes information) is partially coincident with conductive anomaly C1 of Line 1 (Figures 2, and b).

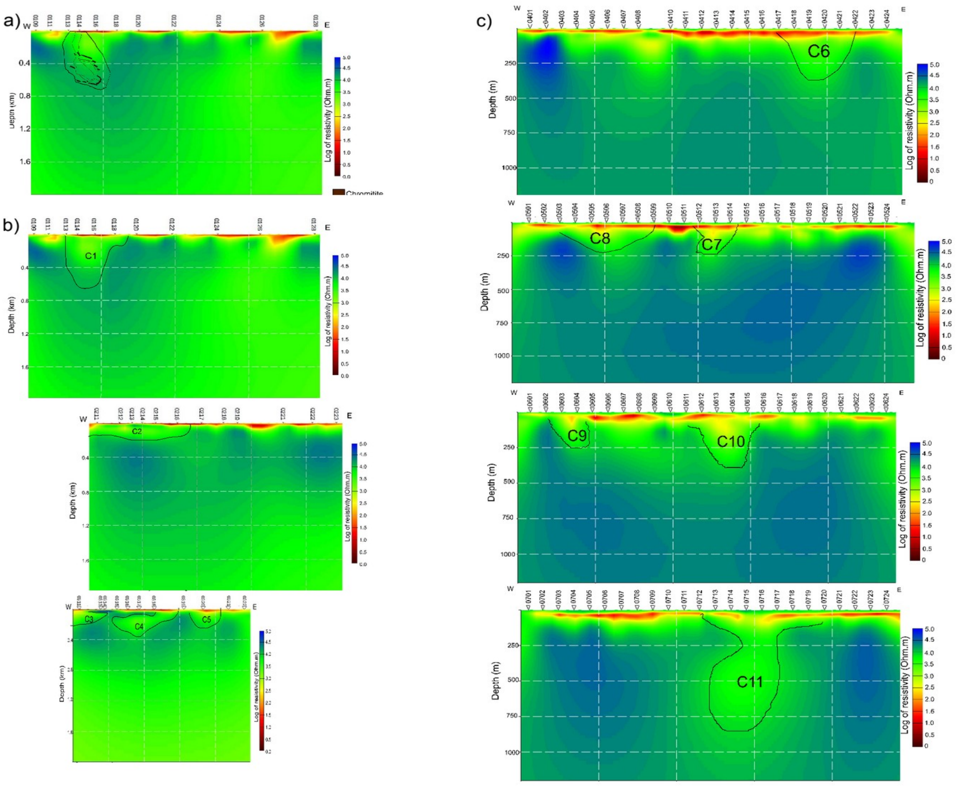

Figure 2: AMT sections obtained for both Blocks. a) Integrated AMT section with geological model of the deposit, constructed based on boreholes information. b) AMT sections obtained for the 3 lines of Southern Block c) AMT section obtained the 4 lines of Northern Block.

As can be seen, the conductive pattern characterizing the whole mafic-ultramafic is a medium conductive anomaly extending itself downward in a more resistivity medium. Based on that, the anomalies of Norther Block were identified (Figure 2, c). The anomalies C11 and C10 attract more attention due to its dimension, shape and correspondence with geological bodies identified as chromite-hosting rock in the region.

Conclusions

Based on comparative analyses between geoelectric sections of Southern and Northern Blocks, we conclude that anomalies C10 and C11 have more potential to be associated with chromite mineralization in Northern Block given their similarities with those responses obtained for chromite deposits of the south. The low RMS and geological backgroud information were essential for us to arrive that conclusion. Given the uncertainties inherently present in inversion process, more geophysical data could be integrated to the AMT in order to improve interpretation.

References

de Almeida, H. L.; Cabral, E. B. e Bezerra, F. X. (2017) Evolução deformacional das rochas do vale do jacurici: implicações para a estruturação dos corpos cromitíferos máfico-ultramáficos, Geologia USP. Série Científica, 17(2):71–88.

He, L.; Chen, L.; Dorji; He, Z.; Wang, X.; Xiao, B.; Xu, L.; Zhao, X.; Xi, X.; Yao, H. et al. ,2018, Mapping chromite deposits with audio magnetotellurics in the luobusa ophiolite of southern tibet: Geophysics, 83(2):B47–B57.

Kelbert, A.; Meqbel, N.; Egbert, G. D. e Tandon, K. (2014) Modem: A modular system for inversion of electromagnetic geophysical data: Computers & Geosciences, 66:40–53.

Marques, J.; Ferreira Filho, C.; Carlson, R. e Pimentel, M. (2003) Re–os and sm–nd isotope and trace element constraints on the origin of the chromite deposit of the ipueira–medrado sill, bahia, brazil: Journal of Petrology, 44(4):659–678.

Marques, J. C. e Filho, C. F. F. (2003) The chromite deposit of the ipueira-medrado sill, são francisco craton, bahia state, brazil: Economic Geology, 98(1):87–108.

Parker, R. L., and J. R. Booker, 1996, Optimal one-dimensional inversion and bounding of magnetotelluric apparent resistivity and phase measurements: Physics of the Earth and Planetary Interiors, 98, 269–282.

Sun, W.; Jiang, J.; Dai, L.; Hu, H.; Wang, M.; Qi, Y. e Li, H. (2021) Electrical properties of dry polycrystalline olivine mixed with various chromite contents: Implications for the high conductivity anomalies in subduction zones: Geoscience Frontiers, 12(5):101178.