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Multivariate Statistical Studies in the Faina Deposit: Insights on Element Association Fluid Composition and Vectoring Within Ore-Bearing Hydrothermal Systems

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The Quadrilátero Ferrífero (QF) is one of Brazil's the most prolific mineral provinces, which hosts several important gold and iron deposits. Northwest of the QF, the Pitangui Greenstone Belt (PGB) hosts the Turmalina orogenic gold deposit comprising several orebodies with contrasting features with gold deposits in the central QF, such as higher metamorphic grade up to amphibolite facies and a distinct geochemical signature. Near Turmalina, there are a number of deposits, including the Faina deposit. This work provides new information on the stratigraphy of Faina and insights on the main pathfinders for gold in the region of the PGB. Because the gold deposits in the NW QF are complex, there is a need for new prospective criteria. We combined drill core description and multi-element geochemistry and multivariate statistical analyses to identify geochemical correlations as a proxy for gold and geochemical gold vectoring. Cores of four drill holes were described, and a total of 770 samples from 9 drill cores were assayed for 49 elements. Faina shows a total of 7 lithotypes from top to bottom. These includethe following: a) Saprolite (oxidized shallow rocks), b) biotite-actinolite-chlorite-schist, c) talc-chlorite-schist, d) amphibole-chlorite-schist, e) carbonaceous phyllite, f) amphibole-rich rocks, and g) carbonate-rich hydrothermal rocks. Bulk geochemical results were used to divide the samples into two major alteration zones, an oxidized zone (*n* = 138) and a hypogenic zone (*n* = 632). A subset of 15 elements was chosen (Au, Ag, As, Bi, Cr, Cu, Mo, Ni, Pb, S, Sb, Sn, Tl, W, and Zn) as representative of the geochemical signature; those elements can be related to gold mineralization depending on the deposit model. Assays results were then transformed by centered log-ratio (CLR) before applying Principal Component Analyses (PCA), Hierarchical Cluster Analyses, and Factorial Analyses. Two high-grade (>0.684 ppm) intervals with different behaviors were identified, one at the oxidized zone hosted by the saprolite, which displays a distinctive Au-As-W-S association, and a second at the hypogenic zone hosted by amphibole-chlorite-schist, which presents an Au-As-W-Sb-S association. The two geochemical associations suggest at least two different mineralization styles at Faina. At the hypogenic zone, drill core description revealed the presence of arsenopyrite at high-grade zones, which may explain the observed relationship between Au, As, and S. Moreover, the element association of the hypogenic zone is attributed by some authors to a typical fluid chemistry consisting of S-rich reduced fluid that selectively transport this group of elements, although further analyses are necessary to test this hypothesis. The multivariate statistical methods are hence suitable for reducing complexity of large and complex geochemical datasets to identify a correlation between elements and provide vectors towards gold mineralization in a context of mineral exploration.