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Structural and Lithological Controls on Gold Mineralization at the Pilar Mine, Rio das Velhas Greenstone Belt, Brazil

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The Pilar underground mine (Jaguar Mining Inc.) is located in the eastern portion of the Quadrilátero Ferrífero, within the Neoarchean Rio das Velhas greenstone belt. The area was affected by multiple deformational and hydrothermal events. The structural and stratigraphic complexity of the region requires detailed mapping to constrain the primary controls on gold mineralization.

Underground mapping at a 1:100 scale, combined with macroscopic logging of 584 m of drill core, allowed identification of several lithotypes, including: metachert; BIF in oxide, carbonate, and silicate facies; quartz veins with sulfides and mafic minerals; quartz-carbonate veins; carbonaceous schist; chlorite-schist; chlorite-quartz-schist; and talc-schist. The hydrothermal alteration styles include carbonation, chloritization, silicification, and sulfidation. Gold mineralization is hosted within BIF and mafic schists, being composed by replacement-style sulfide zones as well as quartz-sulfide veins. Ore minerals include chalcopyrite, pyrrhotite, pyrite, and arsenopyrite. Structural analysis reveals two deformational phases: (1) an early Archean event responsible for penetrative foliations and isoclinal folds with SW-NE vergence and ENE-WSW axial planes dipping to the SW; and (2) a Paleoproterozoic event associated with localized shear zones, producing open to asymmetric folds with SW-NE vergence and NNE-SSW axial planes dipping to the SE-SW.

In this framework, BIF units acted as preferential fluid conduits due to their rheological contrast, whereas carbonaceous schist behaved as an impermeable barrier, promoting fluid trapping, quartz vein development, and sulfide precipitation near lithological contacts. Two generations of quartz-sulfide veins were distinguished. The first is more deformed, sulfide-rich, and devoid of carbonate minerals, developing boudinage and folding. The second shows intense carbonation, lower sulfide content, better preservation of primary textures, and lower strain, reflecting a later hydrothermal pulse.

These combined geological, structural, and textural observations indicate that gold deposition at Pilar was controlled by the interplay between progressive deformation, lithological contrasts, multiple episodes of hydrothermal fluid flow.