

Relationship Between Geological Contacts and Dilution in Cuiaba Mine, a World-class Gold-deposit: Contribution of Geological Model in Mining Quality Control

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The Cuiabá Mine, located in the Quadrilátero Ferrífero, Minas Gerais, Brazil, is a world-class orogenic-gold deposit currently operating at depths of approximately 1,600 m, where ore extraction presents significant geotechnical and operational challenges. Gold mineralization is predominantly hosted in pyrite within hydrothermally altered schists and banded iron formations, with minor quartz lodes carrying free-milling gold. The deposit exhibits significant structural complexity, encompassing a variety of geometrical configurations with centimeter to meter scale flat and low angle mineralized zones to thick (5-20 m), folded mineralized layers, conditions that results in high planned dilution and, in certain areas, considerable operational (unplanned) dilution. In 2022, a Multidisciplinary Mining Quality Committee was established to improve the understanding of excavation behavior and dilution controls. This initiative integrated expertise from mine geology, mine planning, rock mechanics, and operational teams. Key outcomes include the development of an integrated lithological model encompassing host rocks, hydrothermal alteration zones, and a refined ore model that supports daily decision-making. Preliminary analyses reveal correlations between dilution and lithological contacts, the orientation of D2 foliation, and fracture sets within underground excavations. These findings provide essential insights for optimizing stope design, improving compliance with planned geometries, and reducing dilution. In underground mining operations, dilution represents a significant cost factor, as it increases the volume of waste material that must be handled during haulage, shaft hoisting, and downstream ore processing. Excessive dilution not only increases operating costs but also reduces the overall ore grade delivered to the plant, thereby negatively impacting metallurgical recovery and mine productivity. Therefore, integrating high-resolution geological data—such as structural models, grade distributions, and geomechanical domains into mine planning and stope design is essential for minimizing unplanned dilution. This study presents cases of dilution associated with the geological framework and demonstrates how integrated datasets contribute to operational decision-making, ultimately improving performance indicators.