The Flow of Geological Information in the Mining Value Chain and Its Use for Operational Optimization

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A comprehensive understanding of the orebody and uncertainties associated with geology is fundamental to the success of mining operations. Orebody knowledge (OBK), which includes insights into grade, mineralogy, and alteration, supports critical decision-making across the entire Mining Value Chain (MVC), from exploration to marketing and sales. Despite its intrinsic value, geological information is often overlooked or disconnected from downstream processes. Identifying and addressing this disconnect is essential for improving decision-making and optimizing operations. This research integrates insights from literature, professional experience, and expert input from across the mining value chain, from exploration to closure, to construct a flow diagram that traces the path of geological information throughout an open-pit porphyry copper operation. The research emphasizes the interconnectedness between geological data, and it's use in direct and indirect forms, to enable decision making across the MVC including geotechnical, mine planning, and metallurgy others.

The number of connections between datasets and the use of empirical and absolute data in resulting models have been quantified, providing insights into which models are more robust, and which rely more heavily on empirical information. As example of the utility of different types of information collected during exploration we highlight VNIR-SWIR (Visible to Near and Shortwave Infrared) hyperspectral data. This data enables the identification of clay minerals, informing vectors to mineralization, geotechnical and mineral processing. and indicators of environmental concerns such as acid mine drainage. These insights are essential for exploration, extraction, re-mining, waste management, and rehabilitation. Finally, to illustrate the integration of geological data in decision-making, a preliminary case study is presented. It demonstrates the use of a geological proxy related to feldspar destruction, CCNK (calcium, carbon, sodium, and potassium), as a predictor of throughput. The study explores how machine learning models, trained on hyperspectral data (SWIR), can predict this proxy and support operational decisions.