Evaluating flat long-hole open stoping using integrated stability and dilution analysis at Bellevue Gold Mine

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ABSTRACT

Mining method selection is a critical engineering decision in underground mining because it influences ore recovery, dilution, productivity, geotechnical risk and project value. Long-hole open stoping (LHOS) is widely applied in competent, steeply dipping hard-rock orebodies; however, its suitability becomes less certain in shallow-dipping environments where restricted gravity flow, ore loss, dilution and excavation stability can significantly affect performance. These challenges are relevant to the Viago Lode at Bellevue Gold Mine, where flat-dipping mineralisation creates conditions that differ from conventional LHOS applications.

This paper presents an integrated engineering framework for evaluating whether flat LHOS remains technically suitable when compared with alternative underground mining methods. The Methodology of the thesis combines empirical geotechnical assessment, dilution analysis, production reconciliation and a multi-criteria decision analysis within a single decision-support process. Rock mass quality is assessed using established classification systems, with representative stopes evaluated using the Mathews-Potvin stability graph approach. Dilution performance is assessed using Equivalent Linear Overbreak/Slough (ELOS), cavity monitoring survey data and reconciliation of planned versus actual stope performance. Reverse engineering is then applied to compare predicted and measured outcomes, identifying the controlling factors affecting stability, dilution, ore recovery and operational performance. These results are incorporated into an Analytic Hierarchy Process based multi-criteria decision framework to compare LHOS with alternative methods using geotechnical, operational, economic and safety criteria

The framework addresses an industry gap where mining method selection, empirical stability assessment, dilution analysis and reconciliation are often undertaken independently. By linking design assumptions with measured operational performance, the approach provides a more defensible basis for validating mining method suitability and identifying optimisation opportunities. Although developed for Bellevue Gold Mine, the methodology is transferable to narrow-vein and shallow-dipping underground operations where dilution control, recovery and geotechnical performance are key constraints.