Combining Geological and Grade Uncertainties in Drill-Hole Spacing studies

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ABSTRACT

Drill-hole Spacing (DHS) Optimizations and Mineral Resource Classification Criteria derive from varying forms of modelling and quantification of risk within mineral resources. While grade traditionally takes precedence in such assessments, recent years have emphasized that uncertainty in mineral resources extends beyond grade alone. Despite this recognition, practitioners still lack a practical methodology to incorporate other sources of uncertainty effectively in such studies. Geological uncertainty, often linked directly to estimation domains, represents a significant additional source of variability. Domaining can be established based on various geological properties such as lithologies, alterations, structural controls or grade-thresholds, depending on the context of the mineral deposit.

This study advocates for a probabilistic modelling approach that integrates categorical and grade simulation methods to provide a more comprehensive assessment of uncertainty. Utilizing Hierarchical Truncated Pluri-Gaussian (HTPG) for categorical simulation nested with Sequential Gaussian Simulation (SGS) for grades. Using a one-to-one nesting methodology, this technique generates a continuous realization of grade for each simulated geological scenario. The HTPG-based categorical simulation approach encompasses sufficient parameters and steps to ensure robust domain modelling of different deposit types in terms of spatial orientation, anisotropy and variances per domain,

The results of this advanced technique are compared against traditional grade-only simulation from datasets of distinct mineral deposits, like gold and iron ore. The diverging outcomes for both techniques related to Optimal Drill-hole Spacing definition, mineable panels and Resource Classification are exemplified. Certain deposits exhibit domains with higher uncertainty, while others demonstrate greater variability in grades. Nonetheless, the workflow integrating categories and grades offers a more comprehensive and realistic approach to risk management and should be applied provided expertise and processing resources are available.