Consuming *in situ* uncertainty into mine planning processes: From reserve calculation to dynamic decision-making

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ABSTRACT

The 3D resource model provides the foundation for decision-making in mining operations. This model represents our understanding of the *in situ* resource and serves as the cornerstone for critical aspects such as mine planning, geotechnical analysis, water management, financial assessments, and eventual closure strategies. However, these 3D models are constructed based on imperfect information and therefore contain uncertainties.

Conditional simulations are known to be the best technique for quantifying uncertainty in complex non-linear systems. However, they have not found much application in the mining industry due to the inability to integrate them into mine planning processes.

This work advances the state of “consuming” geological scenarios from simple reserve calculations and box-and-whisker plots of monthly tons into an actual emulation of the processes and decisions that will be made when real variability and uncertainty impact operations and planning.

The importance of *in situ* uncertainty quantification for mine planning is demonstrated through a real iron ore deposit consisting of four pits feeding into a single crusher with multiple stockpiles of different quality materials. This work focuses on 2-year budget mine planning, particularly on scheduling and operational aspects of mining.

First, 100 realisations for each pit have been generated using the latest advancements in geostatistics. Each realisation is then used as an *in situ* reality to emulate the mine planning process and operations. The initial resource model is developed using conventional estimation process. Every month, new grade control information is collected (sampled from a realisation) and used to update the short-term model. The updated model is used to re-optimise scheduling decisions and material flow. This process is repeated for all 24 months for each realisation and analysed in terms of the implications of uncertainty and variability for additional rehandling costs, bottlenecks, product quality, and potential delays due to insufficient materials in stocks.