Boosting Geological Confidence through a Digital Twin: Effective Integration of Modeling, Simulation, and Machine Learning Technologies

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ABSTRACT

With the increasing demand for critical minerals, base, and precious metals, the mining industry faces the challenge of rapidly evaluating and developing new and often unconventional deposits. To navigate this challenging landscape, developing and implementing innovative techniques and technologies are crucial to shorten the development cycle and promote the efficient storage and exchange of knowledge and experience, which is critical to overcoming the skills challenge of the industry, as the number of qualified professionals underscores the demand for new deposits. Mineral exploration traditionally relies on data governance, visualisation applications, and expert interpretation skills. While various technologies have been developed and are currently in use to tackle these tasks and the inherently uncertain nature of mineral exploration and resource modelling, they often operate in isolation, limiting the integration of valuable data and knowledge. The holistic concept of a digital twin offers a promising solution to address integration challenges and bridge the industry's knowledge gap. Inspired by its successful implementation in industries dealing with uncertain conditions, complex data interpretation and extensive simulation. Digital twins can provide a collaborative platform to address exploration and mineral deposit development challenges. This research introduces role that a fully integrated geological modelling solution can play within a digital twin environment. Integrating cutting-edge technologies and ensuring that the digital lifecycle of the models can be tracked and adjusted as needed, this geological modelling tool functions within a unified platform and allows a workflow stream that takes advantage of the collaboration agility of cloud-based applications, the speed of process automation, the capability of machine learning for pattern recognition to increase the knowledge of the deposit behaviour under uncertain conditions/features, and the power of simulation to test different hypotheses to reduce decision latency and increase confidence in geological interpretations.