Dynamic Structural Modelling for near real time inputs for Geotechnical risk management and optimisation

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# ABSTRACT

Structural complexities such as folding, faulting, jointing, and shear zones heavily influence the stability of open pit slopes in iron ore mining. As orebodies become more complex and business goals of de-carbonisation and heritage responsibility grows, technology-driven solutions are essential for increasing predictability and adaptability in mining operations. Achieving optimal pit design requires a thorough understanding and modelling of geological structures. However, managing geological uncertainty and variations in orebody geometry remains challenging. Pit face mapping generally employed to provide input into the uncertainty has very long lead times and is high risk. This often results in a reactive approach as mining progresses, leading to unforeseen geotechnical risks or ore sterilisation.

Traditional approaches that rely primarily on drillhole data and resource modelling fall short of capturing the structural detail needed to identify uncertainty and complex structural domains. As such, a pit-scale structural model is necessary for effective slope design and management.

By employing automated "drone in a box" (DIB) UAVs for data capture and advanced implicit modelling, detailed, local-scale pit models can be created to better address these uncertainties using predictive analysis. Pit face mapping, conducted safely and efficiently using UAVs, provides data for dynamic structural models, which work in near real-time and can integrate orientation data to predict kinematic behaviours. This enhances safety and operational efficiency.

Structural domains informed by this pit mapping, along with resource model data, allow for accurate predictions of rock behaviour under varying extraction conditions. These models are continuously updated as new mapping and drillhole data becomes available, reflecting real-time geology and reducing the risk of encountering unexpected ground conditions, which boosts safety and ore recovery.

Incorporating these technologies, alongside predictive analytics, significantly reduces operational uncertainties, optimizes resource extraction, and lowers costs by automating repetitive tasks and reducing human exposure to hazardous areas.