Challenges of Accurately Characterizing the Ore and Host Rocks of Deep Mineral Discoveries

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A key focus for recent mine developments has been very large, low- to moderate-grade orebodies occurring below the practical limits of open-cut mining. Such deposits require economic extraction utilizing methods such as block and panel-caving—including sublevel caving. Caving is preferable due to lower operating costs but has associated reduced flexibility.

There are many technical challenges associated with sufficiently defining the geology of any deep discovery for accurate prediction of geological conditions. Yet, while the methods of exploring at greater depth are attracting considerable research attention, the parallel challenges of accurately characterizing the ore and host rocks of deep discoveries are not. The technical problems of safely accessing, mining, and managing deep resources in geologically challenging environments (high stress, high geothermal gradient, lithostructural complexity, and large disseminated orebodies) will require greatly enhanced geological skills and technical knowledge.

While these issues are likely to be greater than those facing deep exploration, they have received little research attention. Through in-depth analysis of "whole of mine" data comprising all exploration, feasibility study, mine design, geotechnical, and production data sets (including the initial propagation phases), and a wide-ranging review of accepted industry practices, the Geology and Mass Mining Project of the BRC has sought to define the geological challenges and to develop strategies that will allow geologists to address them. The project sought to (1) identify the most important geological factors requiring consideration for successful underground mass mining, (2) assess the effects of deposit geology (lithostructural architecture) on cave propagation and mining design, (3) define and codify the place of the geologist and geoscientific data in the planning, design, and production phases, (4) identify the types of geological data required to plan a caving operation, the sectors where particular data types and collection strategies are needed, and what the geological modeling emphases should be, and (5) filter mining and production "artifacts" in cave propagation and performance (e.g., draw rate) to distil those factors that are influenced and controlled by the geology of the mineralized system.

The role of the geologist in planning and operational teams has been brought into sharp focus by the study. Most of the risk associated with developing deep deposits lies in the understanding of the geology of the ore and host rocks. The primary interpretative models developed by geologists are the only predictive tools on which mine design can be based, and on which future risk can be evaluated. Such models are particularly important in block caving because the method requires only minimal underground development (basal extraction and undercut levels). This equates to a heavy reliance on drilling data for deposit modeling and geotechnical data collection. It also translates as increased uncertainty in geological models, with the potential to significantly impact block-cave performance outcomes (e.g., propagation, surface subsidence, fragmentation, and long-term extraction level stability). "Derived models," such as geotechnical block models and infrastructure conceptual layouts, will all be based on the primary geological framework.

A key finding is that the collection of information needed to meet the challenges of deep mining should start during exploration. Much of the information that may later be needed to investigate cave

underperformance (e.g., interaction of subsidence and the surface) will be located in exploration drill holes. If the relevant data was not collected, then new drilling may be required.