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Mining as a complex system: Do we need a new model?

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ABSTRACT

Geological heterogeneity is one dimension of complexity in mining. Significant effort is put into developing an understanding of this complexity so it can be used in resource estimation, mine planning and economic modelling. However, over the decadal lifespan of a mining venture, many other dimensions add to the complexity of a mining operation. These include: technological evolution, market fluctuations; investor confidence; social norms; local expectations; and ecosystem functionality. As with geology, these factors are all heterogeneous, uncertain, time varying and represented through sparse, incomplete datasets. However, they are generally regarded as externalities in economic modelling and their variability is managed as a risk during the mining process.

This is appropriate if the major concern is about short (1 – 5 year) productivity. However, increasingly researchers, investors and experience would suggest that corporations operating in the resources sector need to be actively planning for positive outcomes in multiple dimensions and over longer terms.

What does this mean over the life of a mine? The interactions between geological, operational, social, environmental and market dimensions are themselves complex and vary over the mine lifecycle. The mine therefore becomes a true complex system with emergent or unpredictable outcomes as stakeholders, operations and the marketplace rub shoulders over a particular piece of ground and over tens of years. And yet, we rarely contemplate all these different dimensions in a similar frame.

The paper will propose a conceptual model that, rather than disaggregating the different dimensions of mining, offers a way of considering the future of mining as an integrated system.