Geometallurgy

Introduction

Bridging the gap between geology and metallurgy to optimise the extraction of valuable minerals underpins what Geometallurgy is all about. As the mining sector grapples with increasingly complex and highly variable orebodies, the importance of geometallurgy as a tool for efficient and profitable mineral extraction of these valuable minerals is becoming increasingly more important.

Depleting volumes of high-grade ores and more stringent environmental laws require mining and processing operations to be more eco-friendly while processing increasingly complex orebodies (Aasly & Ellefmo, 2014). Geometallurgy has grown in popularity as a proactive solution that allows operations to mine economically by predicting orebody variability and subsequently optimizing downstream mining and processing activities accordingly to maximise operational efficiencies and mineral/metal recovery (Dominy, et al., 2018).

Geometallurgy has evolved since its introduction in the 1980s. However, its fundamental definition as an interdisciplinary collaboration of multiple technical fields to develop a spatial 3D block model capable of providing predictive information for use in the mining and processing of an orebody remains the same. Traditionally, only geological and metallurgical processing data were included in geometallurgical models. Recently, this has expanded to include mining, geotechnical, mineral economics, and geo-environmental data “to maximise the economic value (e.g., NPV) of a mining project, reduce risk and to build operational resilience” (Dominy, et al., 2018).

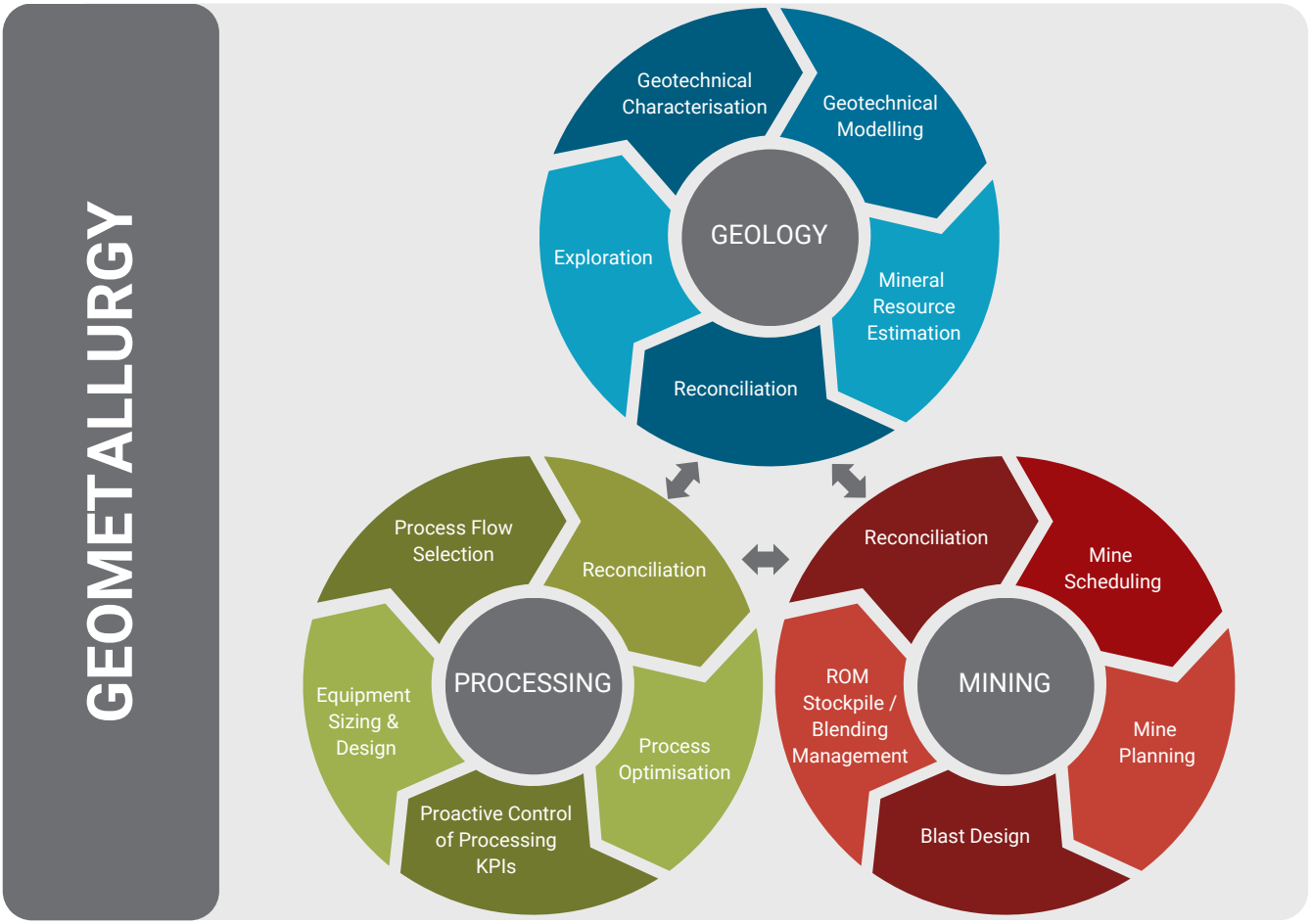
Advantages

Through the application of geometallurgy, mines can adopt a strategic approach across the life of mine, resulting in:

- Optimised mine planning and ore blending;
- Efficient new processing plant designs capable of weathering orebody variability and maximising recovery;
- Optimised existing processing operations that can adjust operational parameters timeously to maximise recovery; and
- Improved control and management of mine waste and tailings facilities by identifying deleterious materials and allowing mines to develop strategies to protect the health of surrounding community members, manage water reticulation, and inform post-mining rehabilitation and closure costs (Dominy, et al., 2018).

Aim & Purpose of Geometallurgy

The aim of geometallurgy is to create a link between multidisciplinary data inputs pertaining to an orebody – geological, mineralogical, geotechnical, geo-environmental, and metallurgical, to name a few – and develop a spatial model that can predict orebody variability (Dominy, et al., 2018).



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Geometallurgy Model Input & Output

Inputs to a geometallurgical model include primary and responsive variables. Primary variables are characteristics that are native to the rock such as its mineralogy, commodity, grades, and rock properties, while responsive variables are related to the rock's amenability and response to beneficiation processes, such as comminution-related characteristics, liberation, recovery, and throughput. The input data is obtained from analysis of samples and from metallurgical testwork results and are modelled on a block-by-block basis (Dominy, et al., 2018).

Geometallurgy outputs consist of a 3D spatial blockmodel that shows several attributes and features at each drill core sample location (Dominy, et al., 2018). The model outputs are able to inform:

- Mine planning;
- Mine scheduling and ore blending strategies (optimised plant feed);
- Life of mine forecasting;
- Process flow sheet selection;
- Processing equipment sizing and design;
- Option analysis;
- Economic evaluations;
- Optimised mine and processing plant operation (proactive approach to day-to-day operational decision making); and
- Metal accounting and reconciliation.

The accuracy of the geometallurgical model must continuously be tested to ensure that predicted and real-world outputs are well integrated.

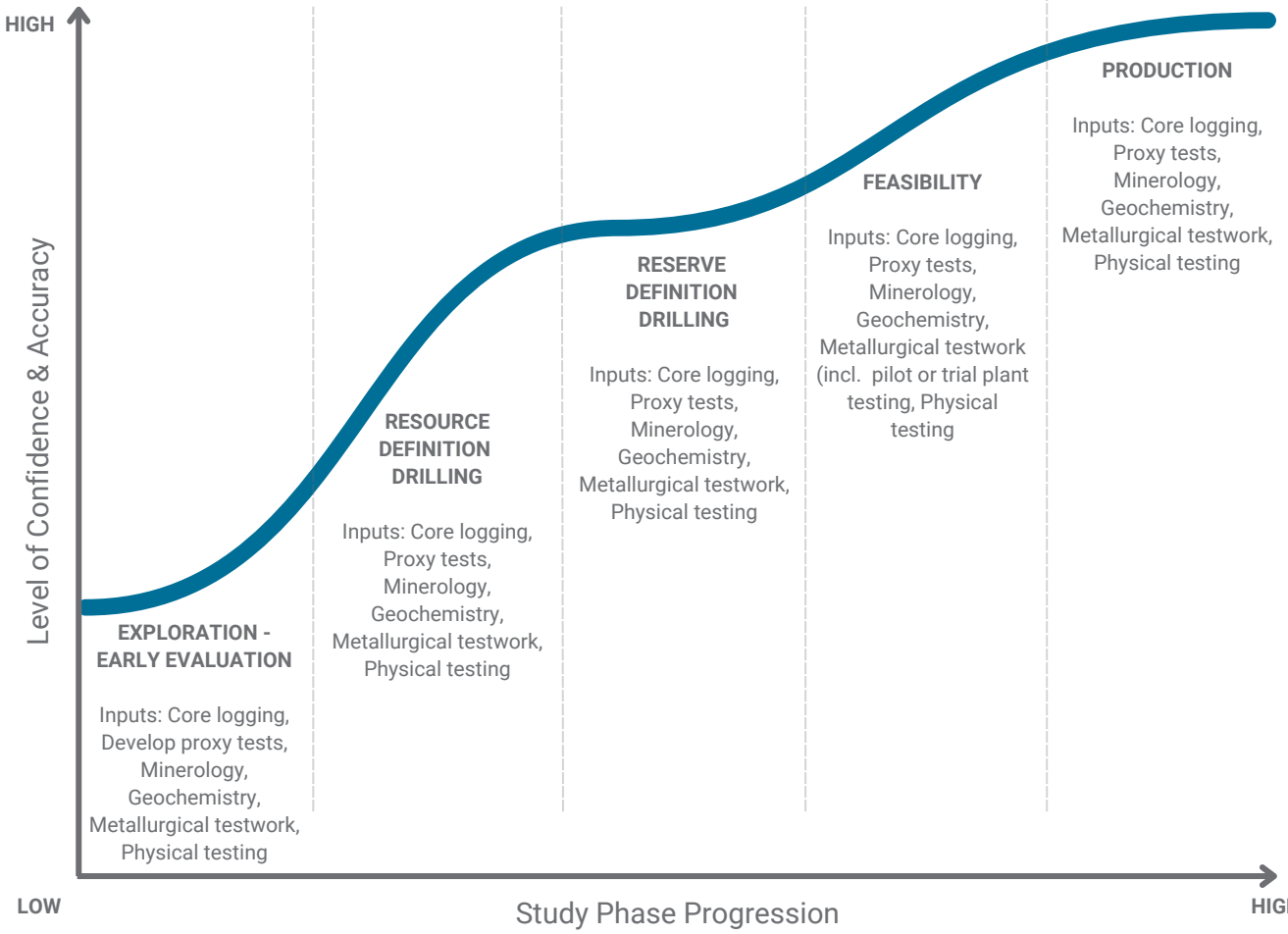
Geometallurgical Activities by Study Phase

The development of a reliable geometallurgical model is dependent on accurate sampling and metallurgical testwork results among other inputs. The type and accuracy of input data increases the geometallurgical model's output capabilities from one study phase to another.

During initial study phases geometallurgical models are solely predictive - only giving output information based on characterisation data. During mine operation, geometallurgical models become dynamic through the integration of feedback loops from actual operation; this keeps the models updated and relevant.

Geometallurgical Activities by Study Phase

STAGE	EXPLORATION - EARLY EVALUATION	RESOURCE DEFINITION DRILLING	RESERVE DEFINITION DRILLING	FEASIBILITY	PRODUCTION
SUDY	Scoping Study	Pre-Feasibility Study (PFS)	-	Feasibility Study (FS)	Grade / ore control (Expansion Studies)
RESOURCES / RESERVES	Inferred Mineral Resources	Inferred and Indicated Mineral Resources	Mineral Resources and Ore Reserves		
ACTIVITIES	Develop orebody knowledge, Drilling and sampling	Develop orebody knowledge, Drilling and sampling, Data analysis and modelling			



OUTPUTS	Establish database, Prelim mineralisation characterisation, Geological Model, Geo-environmental	Expanded database, Domains, Block Model, Prelim mine plan, Models, Prelim process design, Geo-environmental	Expanded database across all disciplines	Expanded database, Domains, Block Model, Mine plan, Models, Flow Sheet, Scenario & Economic analysis, Geo-environmental	Expanded database, Domains, Block Model, Mine plan models, Economic analysis, Forecasts, Reconciliation, Geo-environmental

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Our Value Proposition

VBKOM is a provider of innovative business and technical consulting services and solutions for the mining and capital-intensive industries. We challenge ourselves to apply fresh thinking and to utilise our experience and technology in pioneering new ways to deliver forward-thinking solutions.

The VBKOM team is highly capable and experienced in offering geometallurgical services. We aim to provide quantitative predictions of the variability of the ore, concentrate and tailings to ensure better utilisation of the resource. Due to VBKOM's diverse pool of expertise, we can offer our clients specialised skills within a one-stop-shop culture. Our multidisciplinary capabilities make us an ideal partner to the mining, petrochemical, agricultural, and construction industries.

Our focus on long-term client relationships combined with our technical skills ensures that our clients can fully optimise their value chain.

At VBKOM the quality of our work is guided by a simple philosophy – our success is driven only by the success of our clients and the achievement of our professionals. By using cutting-edge technology and the most advanced computer modelling systems on the market our technical expertise comes unrivalled. Our capacity and continuity have earned us the trust of some of the world's most prestigious mineral resource companies. By staying true to our core values; by utilizing our vast project-specific experience and qualifications; along with applying proven world-class methodologies and processes the VBKOM team is a dynamic, flexible and innovative team with a track record standing as solid proof of our competitive edge in our field.

VBKOM has been successful in providing solutions of an independent nature to a range of clients in the mining industry. Our consultants have developed a good understanding of the needs and opportunities of both open pit and underground studies and operations and we look forward to adding value to your company. We believe that independent consultants can provide optimal solutions to the Client without any risk of providing a solution with an inherent conflict of interest. The VBKOM strategy is to form part of the owner's team to define and protect the owner's interest within our area of influence and control. VBKOM is committed to adding value to each client through innovative, practical, and trustworthy engineering solutions.

References

Aasly, K. & Ellefmo, S., 2014. Geometallurgy applied to industrial minerals operations. *Mineralproduksjon*, Volume 5, pp. A21-A34.

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