President's Corner

Raising the geometallurgical flag

The papers in this edition of the *Journal* have been written on excellent research work carried out in the field of geometallurgy, presented at the SAIMM's Geometallurgy Conference, held in Cape Town in August 2018.

This conference followed a similar conference held some years earlier, in Johannesburg, and the difference in the quality and content of the papers clearly illustrates how this relatively new discipline has progressed over the last decade.

It is particularly pleasing that the papers include contributions from universities, companies, and presenters from many different countries, including South Africa, Finland, Georgia, Australia, Chile, Botswana, and the United Kingdom. This illustrates a common accord across the globe to collaborate to increase knowledge in this field, in order to improve the efficiency and value of our mining operations.

So, what is geometallurgy, and what is the potential impact? Essentially, it provides a linkage between geology and metallurgy, in that it identifies critical characteristics of an orebody and ore morphology that need to be managed in order to stabilize the metallurgical process and improve metallurgical recoveries.

In terms of orebody morphology, geometallurgy can relate to the size and shape of the orebody and its host rock, and the impact of dilution, mining recovery, and facies boundaries. The characteristics of the dilution material itself can have a profound influence on metallurgical plant efficiency in terms of throughput and recoveries.

Ore morphology has significant impact in terms of mineralogy and mineralogical characteristics, and the effect of different mineralogical units on recovery, grindability, power and reagent consumption, and plant stability. All of these have important ramifications in terms of costs, revenues, and obviously, profitability.

Some of the most significant studies performed in the past have been on base metal deposits. In the Copperbelt deposits of Zambia and the DRC, the first, simple differentiation has to be between oxide and sulphide ores, where the preponderance of one or the other dictates the plant design in terms of either leaching or roasting processes, respectively. This is very simplistic, and simply implies that mine planning and design should keep these ore types separate, and treat them in different plant processes. However, the reality is very much more complex. Many different minerals, being carbonates, oxides, and sulphides, including cuprite, malachite, azurite, chrysocolla, chalcocite, and chalcopyrite may exist, hosted in different units which may be talcose, dolomitic, or wadiferous, all with different hardnesses, densities, and acid-consuming characteristics. Further complicating the situation is the presence of cobalt, in varying grades, depending on the rock unit.

This seemingly complex, multivariate problem could result in fertile ground for endless research, but in reality requires a pragmatic approach that demands an accurate yet practically exploitable geological and geometallurgical model and mine plan, coupled with a stockpiling strategy that allows appropriate blending into the plant within reasonable ranges of variability, to ensure that the metallurgical manager knows what ore is in the pipeline and how to manage and control the plant for optimal performance.

Similar issues and opportunities for improvement exist in most other base metals, but what about other commodities and mineral types?

Papers in this edition illustrate the impacts and opportunities in heavy mineral sands, diamonds, iron ore, and PGMs. This indicates that the field is expanding to all commodities, which is the experience of the writer.

In the coal industry, while it would seem obvious that planning should result in optimal blending of coal to meet market requirements, whether for export or for supply to Eskom, in terms of calorific value in particular, the reality may be quite different. Where seams have narrowed and dilution is included in the mining process, and/or where burnt coal has to be mined, these characteristics will impact severely on

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the washability and saleability of the product. As we have seen, unfortunately, the current Eskom crisis has been exacerbated by the poor quality of coal supply that has resulted from certain illicit and corrupt dealings that have clearly created a situation where the coal supply is far out of specification.

In the diamond business, it is important to understand the diamond grades and characteristics that may be associated with different diamondiferous facies, whether kimberlitic, shale, or breccia. These not only have differing diamond contents, but also significantly different hardnesses, meaning that if the mix of facies is unknown or unstable, milling costs will increase and recoveries will be erratic. The writer experienced an operation where particularly large diamonds, although very few and far between, could be crushed unless means to 'protect' these facies were put in place, coupled with optical sorting.

In the PGM industry, while the separation of UG2 and Merensky ores should be relatively simple, other characteristics, such as variable chrome content, can have a significant impact on recovery in the smelting and refining circuits. While means can be put in place to reduce chrome content, sampling underground could include chrome sampling, to illustrate where subtle changes are occurring, and the data incorporated in a geometallurgical model, such as to optimize recoveries.

The gold industry, especially in the tabular reef environment, has not given a great deal of direct attention to geometallurgical impacts, although they do exist. Obviously, mixing of different reefs is of significance, and if necessary, should be adequately managed. However more subtle factors such as varying channel widths, carbon contents, refractory ore characteristics, grain sizes, and varying amounts of deleterious minerals such as pyrophyllite can occur across the orebody, and can impact on final recoveries. These factors can all be modelled, based on sampling, leading to modifications to the mine plan in order to optimize the plant feed.

The writer was privileged to be a member of the organizing committee for the Cape Town event, and also to be asked to present a paper at the conference. Although the audience was predominantly made up of mineralogists and metallurgists, there were a few miners among the delegates. This indicates a 'missing link' in the geometallurgical discipline. The writer pointed out that while the papers illustrated very deeply researched mineralogical data, and a very precise metallurgical response, the value chain includes a component which is anything but precise – that is, the mining part of the operation. It is therefore vital to develop a value-chain-based approach to geometallurgy that allows for the practical application of the requirements, in terms of issues such as the size of mining equipment (as this affects selectivity), bench heights in open pits, blasting optimization, infrastructural constraints, stockpiling and blending capacity, rock engineering and ventilation constraints, as they impact on scheduling, and sampling frequency and quality.

Geometallurgy is therefore a totally multidisciplinary field, including not only geology and metallurgy, but also mineral resource management, mine planning and design, mining, and engineering. So, perhaps it's just another aspect of 'optimization'?

This year sees the Sixth International Seminar on Geometallurgy, Procemin-Geomet 2019, combined with the 15th International Mineral Processing Conference, to be held in Santiago, Chile, in November. The SAIMM has been invited to participate, and we will be lobbying to become a permanent partner in this international event, in order to bring it to Southern Africa at some stage in the future.

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