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Forecast the mineral processing destinations based on spatial interpolation of geometallurgical variables

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ABSTRACT

Production forecasting is a vital step in mine planning, scheduling, energy consumption and cost analysis that leads to optimize the profitability and bankability in a mining project, in which the market demand is supportable in a more decent way. The accuracy of this procedure deeply depends on a reliable block model, produced by spatial analysis of corresponding variables that define the geological, metallurgical, mineralogical and chemical behavior of the deposit. Geometallurgical responses, for instance, develop advanced forecasting activities that not only optimizes the mineral production and processing but also increase the certainty in future mine sustainability. These variables in the copper deposits can be defined as the total copper and soluble copper grades, for which the latter is the fraction of the former; therefore, the complex interrelation such as geological constraint unavoidably exists between them. The constructed block model based on those variables are applicable to forecast four destinations of mineral processing steps: flotation plant, leaching plant, low-grade pile, and dump. However, the conventional approaches for the establishment of such a map are always challenging and lead to unacceptable biases. One of the idea to overcome this impediment is to utilize the method of change of variables by converting the original values (total and soluble copper grades) to the new values (total copper grade and solubility ratio) in order to make the variables free of geological constraint. Due to having a strong correlation between total copper grade and solubility ratio, the co-kriging approach can be used for spatial modeling and then through a back-transformation step, the estimated values can be converted to the original space. In this context, the co-kriging system is built on the direct and cross-variograms (e.g. linear model of coregionalization), which their inference is somewhat cumbersome and time-consuming. An alternative is factor-based approaches such as minimum/maximum autocorrelation factoring (MAF) that is on the basis of the decorrelating the cross-correlated variables through a matrix decomposition. In this paradigm, variogram analysis can be implemented on the factors and each factor can be separately estimated. The intrinsic correlation is then restituted by applying the inverse of the same matrix decomposition on the estimated values. This algorithm is employed in a copper deposit to construct a reliable block model and then forecasting the abovementioned destinations for corresponding mineral processing plants. The results are compared with the ones obtained from traditional co-kriging and are corroborated that the cross-correlation can be reproduced satisfactorily through MAF analysis while the geological constraint is effectively preserved.