VALIDATING THE DESIGN OF BLENDING PILES THROUGH A REAL CASE STUDY

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ROM grade variability is one of the most important factors influencing plant product recovery. Due to the influence of grade variability on mine profits, it is deemed important to guarantee a proper homogenization of the ore through a well-planned blending and homogenization pile system from which the ore is reclaimed at an acceptable grade fluctuation. This study tests geostatistical simulation efficiency in predicting in situ grade variability. The methodology is illustrated using a data-set from a large phosphate mine in central Brazil. Additionally, real data obtained at the mine site during January and February 2007 were used to derive the actual grades of each pile formed during this period. Each pile was formed by a selection of blocks within a dig line and these lines mined along the year 2007 were also made available. Given the real grades, it was possible to reconcile and validate the results predicted by the proposed methodology. The main outcome of this study is the opportunity to check the geostatistical simulation as a tool to quantify the variability of the homogenization system.

Methodology

A 3D grade block model was built using sequential Gaussian simulation (sGsim) (Isaaks, 1990). This algorithm generates multiple, equally probable, scenarios for the grade spatial distribution and statistically reproduces the spatial continuity and histogram. Each of the equally probable 3D block models was used to estimate the mean grade for all piles formed within January and February 2007.

In addition, real data obtained from the mine during January and February 2007 were used to derive the actual grades of each pile formed during those months. Each pile was formed by a selection of blocks within a ‘dig line’, according to the mining plan design. The results from these lines, mined during 2007 were also available as was the variance as a measure of uncertainty (Isaaks and Srivastava, 1989). The methodology suggested in this study quantifies the variability of the homogenization system by using multiple equally probable realizations derived from a geostatistical simulation of the grade block model.

Geostatistical simulation methods aim primarily at reproducing in situ variability, provided that the spatial continuity of the input data-set is respected. Conditional simulation honours values at the sampled points while reproducing the same dispersion characteristics of the original data-set, the mean, variance and semi-variogram functions.

The equally probable realizations will generate a group of possible values for the blocks that form each homogenization pile. Finally, it is possible to predict the in situ grade variability, given the real grades. The methodology is illustrated using a data-set from a large phosphate mine in central Brazil.
average grade mined within each dig line.

Simulations provide the means to determine the range of possible grade values. A set of simulated grade values for a pile can be compared against the ‘real’ grade values obtained in a sampling system located in the processing plant. A proper correct predictive model would include the ‘real’ values as part of the solution.

The methodology can be summarized as follows:
• Generate a certain number of equally probable 3D models for P_2O_5 grades, using a geostatistical simulation algorithm. Sequential Gaussian (sGsim) was used in this case
• Select the blocks defined within a dig line which will comprise a given pile (for one selected simulation model). These dig lines are determined preferably by an optimization scheduling algorithm
• Calculate the grades for each pile by averaging the blocks included in the dig line which are associated to the pile
• Repeat point above for the remaining simulated block model.

Comparing the predicted pile grade derived using SGSIM with the sampled ‘real’ grade

The simulated block models must be validated prior to their use in constructing the blending piles. Validation of stochastic models comprises: visual checking to verify the correct reproduction of the spatial continuity and data conditioning, histogram and variogram reproduction and their ergodic fluctuations. Figure 2 depicts the input histogram for the data and two histograms for different realizations which were randomly chosen. Note the similarity among the plots and the statistical information reproduced by the simulations.

In terms of spatial continuity, the models were checked for variogram reproduction. Figure 3 shows the modelled variogram for the data obtained for one of the geological models included in the simulations and the variograms modelled for ten simulations. Note again the adequate reproduction of the spatial continuity.

Each blending pile is formed by ore derived from a different zone and those zones are within ten different parts of the deposit. The simulated blocks were flagged using the dig line wireframes. These dig lines select only blocks, that exist within a given blending pile. Averaging grades for the selected blocks leads to the pile’s mean grade. Repeating the process for a different simulation provides a different pile grade due to the uncertainty of the block grade. This process allows one to assess the so-called space of uncertainty from the grades associated with each pile for the year.

When a given pile is reclaimed at the industrial area to feed the processing plant, its real grade is determined by averaging the grades from samples collected along time intervals. The average grade is the benchmark or real grades against which the simulated values will be plotted.

Figure 4 is a plot of 11 standard real grades for 11 piles.
formed during January and February 2007. For each pile, multiple simulated scenarios were used to derive equally probable values for each pile. Assuming a 95% confidence interval, the upper and lower confidence limits were determined. The efficiency of the simulation methodology can be observed as the solution proposed includes always the real grades sampled. This means the space of uncertainty includes the real solution, proving the simulation method is adequate to assess risk associated with block grades.

Conclusions

The influence of grade variability on mine profits is significant and it is important to reduce the head grade variability feeding the processing plant. The homogenization system has a variability that the usual methods of estimation are not capable of predicting.

The use of conditional sequential gaussian simulation to predict in situ grade variability has proved to be a successful methodology. The space of uncertainty mapped
by the method was compared against the real grades obtained at from the sampling homogenization system. The results matched adequately.

The entire process was validated as a tool to properly predict in situ grade variability and emulate a chevron type blending system.

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References


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