Grades simulation to access the in situ variability and its influence in the blending system and processing plant

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Introduction

• The performance of a processing plant heavily depends on the low variability of the ore feed grades.
  – Oil shale plant
  – P$_2$O$_5$ mine

• Moreover, it needs to receive ore with a minimum grade value, which enables processing.
Introduction

• Blending piles are used in order to reduce ore grades variability. However, it is necessary to know the deposit in situ variability to design the piles properly.

• Geostatistical simulation has been exhaustively used to evaluate in situ ore variability in many applications.
Aims

Evaluate in situ ore variability through geostatistical simulation.

Knowing which blocks form the piles according to the mine schedule plan, measure the uncertainty range associated with each pile.

Calculate the probability that each pile will not reach the required threshold ($9\% \text{ P}_2\text{O}_5$).
Dataset

- Phosphate mine
- 5200 diamond drillholes. Composites of 5m
- The samples are located on a roughly regular grid at a spacing of 35x35m
- 16354 samples
- 1 Interest variable: $P_2O_5$
- 6 geostatistical domains
Mine
Methodology

• Declustering with the cell declustering method (cell 35x35x5m similar to the samples spacing)
• Standard normal transform
• Variography of the normalized data
• Realization of sequential gaussian simulation
• Back-transform the simulated data
• Validation of the results
• Analysis of the simulated values
Variography

- Nugget effect: measured using a variogram DTH (down the hole)
- Directional variograms: calculated for 8 directions
Results Validation
Results Validation
Blending piles

A group of mined blocks with different grades will form a blending pile, which will feed the processing plant afterwards.
Results

• Through the simulations, 100 equiprobable scenarios were obtained for each block (5x5x5m).
• The simulated values enables to calculate the probability that the blocks does not reach 9% $P_2O_5$. 
Results: Wireframes separately

Probability of $P_2O_5$ wireframe grade be lower of 9%

Wireframe Number

$P \leq 20$

$P > 20$
Base map
Results: Blending Piles

Probability of $P_{2}O_{5}$ pile mean grade be lower of 9%

Blending piles

- $P<20$
- $P>20$
* 42% of the mined blocks does not reach the expected value of 9% of $\text{P}_2\text{O}_5$.

* Only 8% of the piles does not reach the threshold of 9% of $\text{P}_2\text{O}_5$. 
Conclusions

• When analyzed separately, 42% of the mined blocks did not reach the value of 9% P$_2$O$_5$, with 80% of confidence.

• The blending piles showed much better results. Only 4 (8%) out of the 50 piles studied did not achieve the value of 9% P$_2$O$_5$, with 80% of confidence.
Conclusions

• The blending piles proved to be a very effective way of reducing the variability of the grades that will feed the processing plant.
• Sequential Gaussian Simulation proved to be very suitable to access *in situ* ore variability.
References


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• Cnpq
• LPM/UFRGS