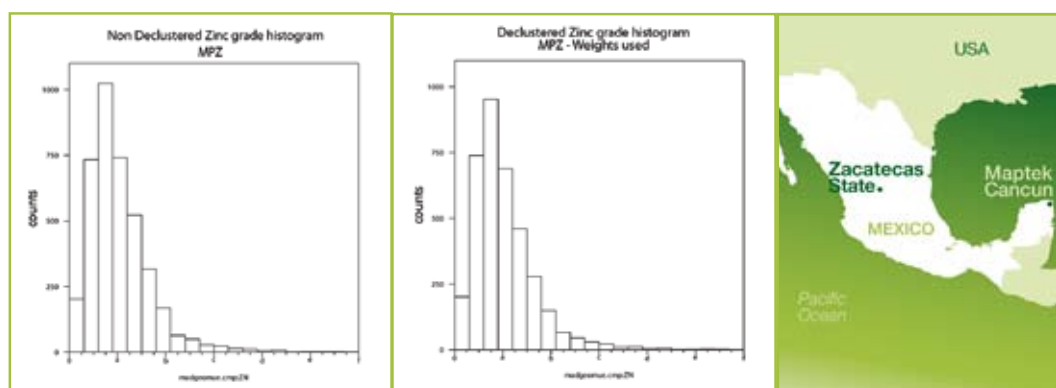


# Geostatistics approach to simulating Zinc grades

The Sequential Gaussian simulation module in Maptek Vulcan™ was used to study the uncertainty in the zinc grades for the Francisco I. Madero deposit. Work was performed as part of the Geostatistics Citation Program that Maptek offers in conjunction with the University of Alberta.



Unweighted and declustered histograms

## HIGHLIGHTS

- Vulcan ideal for projects as well as establishing better processes
- Variograms calculated using Vulcan Directional Variography tools
- Simulation and modelling tools include various options and methods

Francisco I. Madero deposit is located in Zacatecas state, Mexico. Peñoles geologists, Angel Castro and Leopoldo González, studied the uncertainty in the zinc grades.

The two main objectives were to:

- assess the uncertainty in the Zn grades in the main ore rock and produce a model that could be used later to evaluate the economic risks in the reserves, and
- establish a methodology for future studies of mineral resource and reserve estimation.

The Gaussian Simulation and Cokriging module was used to build both kriging and simulation models. The grade (kriging) model was constructed using a block model with 196, 220 and 278 blocks on x, y and z axes respectively, rotated 25 degrees to the east. The database consisted of 3920 composites with zinc grade values.

The main steps for the simulation were:

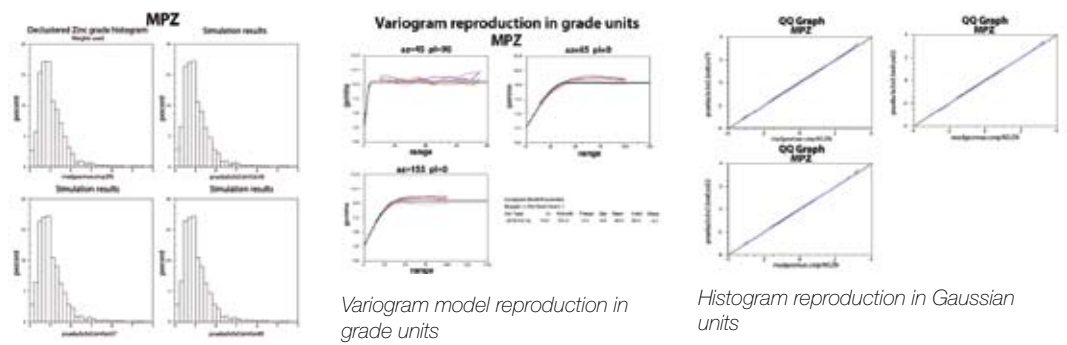
- Statistical analysis of the data
- De-clustering for a representative distribution

- Trend analysis
- Structural analysis in Gaussian Units
- Sequential Gaussian Simulation
- Validation
- Post processing of simulated model

Simulation was performed using a block model with smaller blocks than the grade estimation block. This was done so that later the change of volume support can be performed by simply re-blocking the simulation block model to the same block size as the kriging model.

Vulcan supports cell declustering and declustering by global estimation weights, which also allows for polygonal declustering. For this project, the cell declustering method was used to ensure a more representative distribution.

Variograms were calculated using Vulcan Directional Variography tools. Although this allows for the data to be transformed to Gaussian units on-the-fly, the Gaussian transformation was pre-calculated and the results were stored in a new variable in the Isis database.



Simulation histogram reproduction

Variogram model reproduction in grade units

Histogram reproduction in Gaussian units

## Advanced Geostatistics

Maptek regularly hosts Geostatistics Citation Programs run in conjunction with the University of Alberta.

Classroom lectures and project work combine academic input with industry experience.

All mining professionals, regardless of proprietary software background, are encouraged to register to attend.

Vulcan provides Stepwise Conditional Gaussian transformation and Normal Scores Gaussian transformation. The drift analysis showed no strong drifts so it was deemed unnecessary to build a drift model. Normal Scores Gaussian transformation was therefore used. If a strong drift were found, then the Conditional Stepwise Gaussian transformation would have been considered.

Gaussian variograms were calculated and fitted. For this, the Directional Variography and Directional Autofit options were used to calculate and find the directions of anisotropy. Directional variography has a convenient tool that calculates a series of orthogonal directions to a given vector. This helps in finding the semi-major and minor directions for variography.

The Directional Autofit option produced fast and good quality variogram models automatically. Several constraints can be used for the resulting model which is then best-fitted to the three main directions of anisotropy.



Autofit panel showing the constraints tab

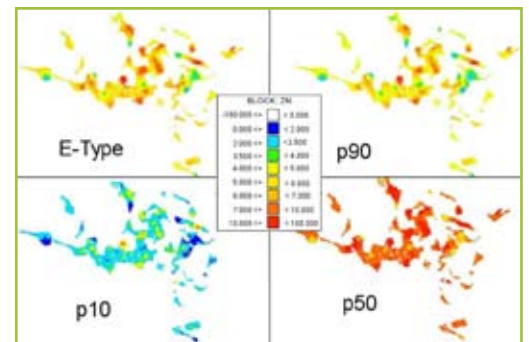
One hundred realisations were produced in the block model. Validation was carried out to check data, variogram and histogram reproduction.

Multi-display variograms and block model variography options were extensively used to facilitate checking of variogram reproduction. QQ plots were also used to check the distributions. This validation was performed in both Gaussian and grade space.

After the model was validated, the volume support was corrected by reblocking the model to the same block size as the grade (kriging) model. Several outputs were produced with the standard simulation post-processing tools in Vulcan.

Among these outputs, maps of the 10<sup>th</sup> and 90<sup>th</sup> percentile were used to highlight the zones most likely to be ore and waste respectively. Uncertainty histograms were also created for both grade and tonnage above the cutoff grade. Only global joint uncertainty was considered as part of the project, however the output model is not limited to this - it can also be used to evaluate joint uncertainty in different regions in the mine.

In this way, the risk can also be quantified for production planning in the medium and long term.



E-type and quartile maps for a given bench

Many tasks relating to uncertainty management were applied using Vulcan in this project. The ability to create and store many realisations in a single block model is an advantage as there is no need for multiple files. Gaussian transformations and back-transformation can also be applied for a large number of realisations using a single friendly parameters editor panel.

The simulation module was useful for this project as it facilitated the steps required to obtain, validate and process a valuable model that can be used to assess the grade uncertainty in this deposit.