# *Pangeos*

*Geostatistical Simulation and Optimization for the Mining Industry*

**Statios**
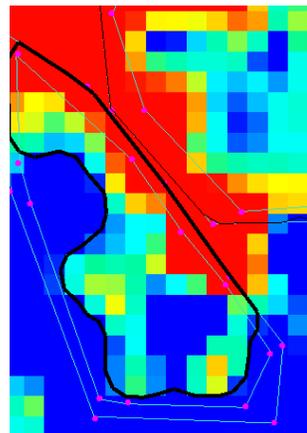*Software and Services*

## Geostatistical Simulation

- All required preprocessing (declustering, debiasing, and trend modeling)
- Multiple rock types with hard and soft boundaries
- Multivariate simulation of any number of variables
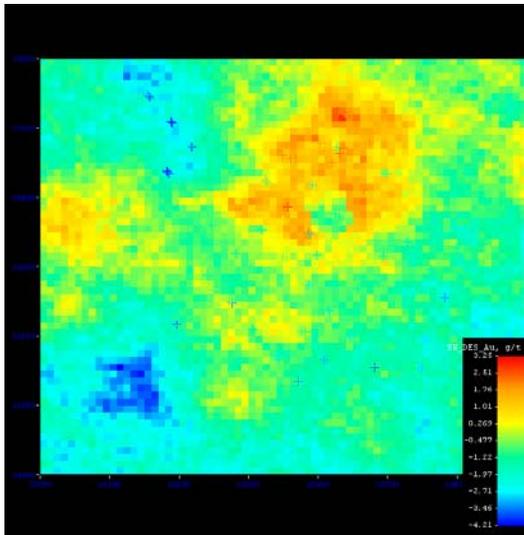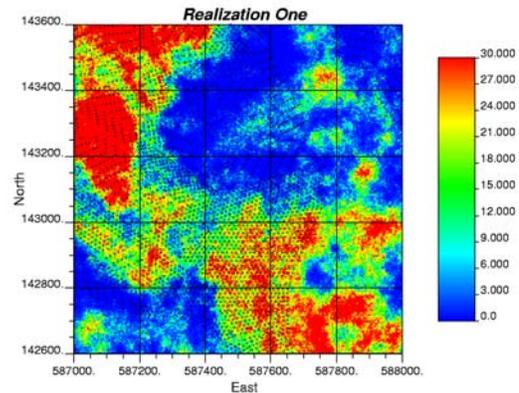


## Postprocessing and Optimization

- Recoverable reserves calculation
- Resource/reserve classification
- Dig limit optimization

## The Place for Pangeos

There is a number of general mine planning (GMP) software packages on the market. GMP software is well-suited to data management, conventional geologic modeling, visualization, and mine planning tasks. There is a number of specialized geostatistics software packages on the market; however, there are no geostatistical software packages that provide a satisfactory solution to the problems of (1) reliably generating geostatistical realizations of multiple variables within multiple rock types, and (2) providing optimized solutions to reserve estimation and grade control in presence of uncertainty quantified by multiple geostatistical realizations. Pangeos meets the need for focused *mining geostatistics simulation and optimization* software.

## Data Analysis

The necessary plots and graphics for understanding your data and validating your model including:
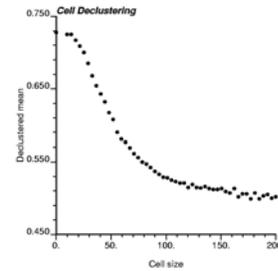- Histograms and probability plots
- Q-Q plots and scatterplots
- 2-D slice maps and interactive 2-D visualization
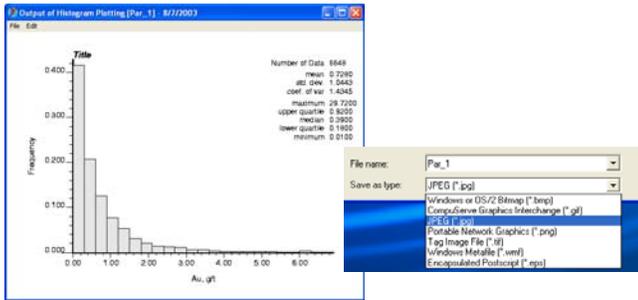


## Preprocessing Tools

The required tools to prepare data for simulation:
- Declustering (cell, nearest neighbor, kriging,…)
- Debiasing with secondary data
- Despiking and transformation (normal/stepwise)
- Trend modeling



## Variogram Calculation and Fitting

The required tools to calculate and fit variograms:
- Variogram volumes
- Directional variogram calculation
- Semi-automatic variogram fitting
- Histogram and variogram scaling (affine, ILC, DGM)
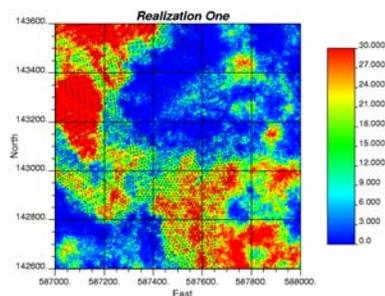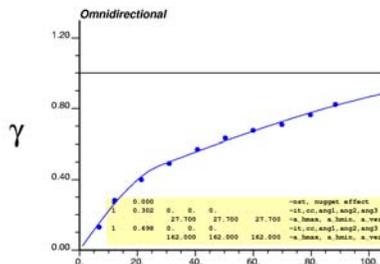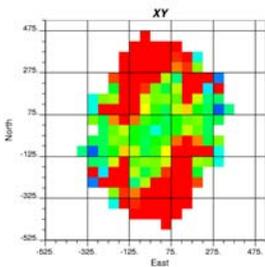


## Geostatistical modeling

Essential 3D model building tools including cross validation:
- Kriging and simulation
- Hard and soft geological boundaries
- Simultaneous handling of multiple variables



## Postprocessing

Model postprocessing and checking:
- Validation and distribution transformation
- Recoverable reserves calculation
- Classification
- Reporting within arbitrary volumes and time periods
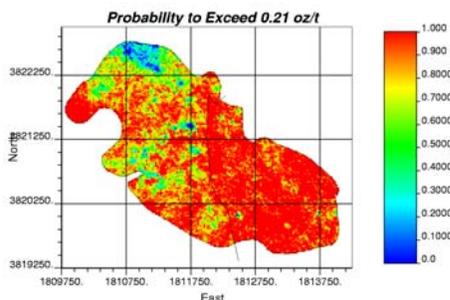


## Grade Control

The tools for optimizing dig limits including:
- Expected profit calculation
- Interactive polygon digitizing
- Simulated annealing-based dig limit optimization
- Reporting of ore/waste within arbitrary polygons
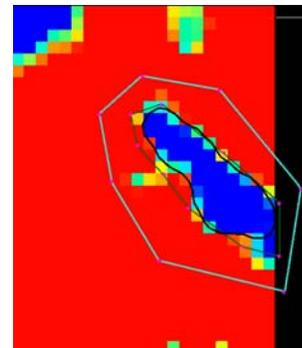
## Design

Pangeos is an integrated Windows based software application. The user interface is based on the Microsoft® Windows and .NET standards for buttons and dialogs. The management of data and parameters is similar to most e-mail programs such as Outlook® making Pangeos familiar to geologists and engineers and ensuring efficient usage.

## Visualization

The focus of Pangeos is reliable construction of simulated realizations and optimization for mine planning. The required visualization capability for model verification and presentation of results is provided.
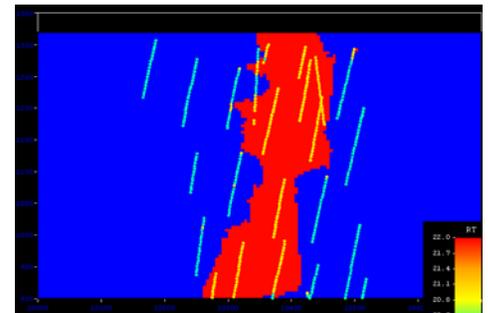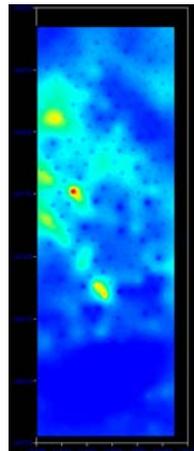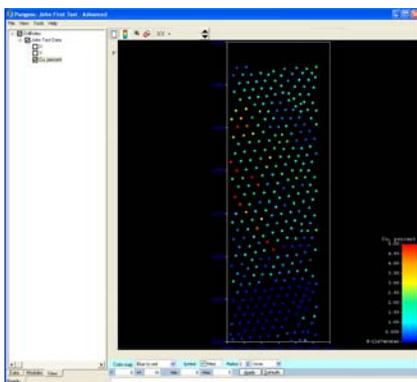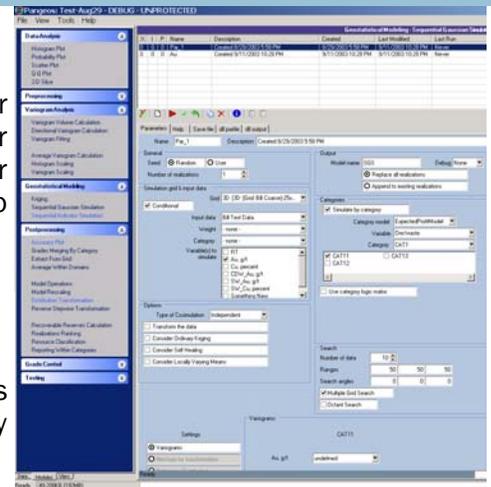
## Some More Details

Modern geostatistical simulation tools are very dependent on the right choice of geological populations or rock types (stationarity), establishing large scale trends, declustering to get representative distributions, and transformation to establish variables that are suitable for geostatistical simulation. A complete set of tools for these purposes is presented in preprocessing.

The faithful variogram remains the main tool to quantify spatial correlation. The reasonableness of geostatistical simulation depends on anisotropy detection with variogram volumes, flexible calculation of directional variograms and correlograms, effortless variogram fitting, and error-free transfer of those fitted models to kriging and simulation. A complete set of variogram analysis tools is available in Pangeos.

Kriging and Gaussian simulation within rock types are the core tools for geostatistical modeling. The fast and efficient processing of multiple rock types, multiple variables, and multiple realizations is essential in modern geostatistical simulation and optimization. A complete set of kriging and cosimulation tools is provided.

The creation of a set of geostatistical realizations is just the beginning in modern geostatistical simulation and optimization. Realizations must be checked for data and statistics reproduction, block averaged to varying selective mining unit (SMU) sizes, and combined with various calculations. Recoverable reserves must be calculated for reporting and mine planning for SMUs or arbitrary volumes and time periods. The blocks may be classified according to measured, indicated and inferred using probabilistic criteria. Pangeos aims to provide the required postprocessing tools.

One interesting aspect of modern geostatistical simulation is the calculation of risk-qualified profit for optimal ore/waste classification and grade control. An important second step is the determination of optimal dig limits that account for the mining conditions and equipment. Tools are provided in Pangeos for this purpose.

## Origin of the Software

Many of the tools in Pangeos were written specifically for Pangeos and are not based on any specific seed code. Certain numerical engines in Pangeos are based on the latest versions of GSLIB and related research programs, mostly from the Centre for Computational Geostatistics at the University of Alberta. The software was heavily modified from the initial versions released to all CCG industrial affiliates.

Teck Cominco and Placer Dome provided seed funding for Pangeos. Peter Rolley and the resource management from Teck Cominco had the original vision of this software.

## Statios



Statios was launched in 1996 and incorporated in 1999. WinGSLIB has been on the market since 2000 (over 300 sales). Statios also undertakes custom software development and project work. Emmanuel Schnetzler and Clayton Deutsch are principals with contract programmers and support hired on an as-needed basis.







Slice 32 with a Tolerance of 5
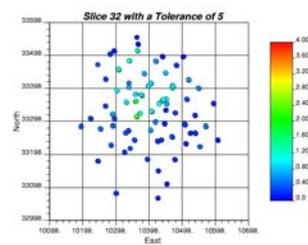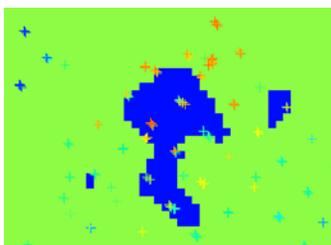
## Future Enhancements

The steps to construct reliable geostatistical models are complex and interdependent. We are planning a workflow manager that will make it straightforward to construct geostatistical models.

Some areas that are under active development include visualization, model operations and profit calculation, flexible import and export of volumes and models, and documentation of software functionality and common workflows.

The software will evolve into an easy-to-use tool for mine site geologists and engineers for (1) uncertainty calculation for medium and long term planning, and (2) day-to-day grade control.



**Expected Profit**



Inferred

Indicated

Measured
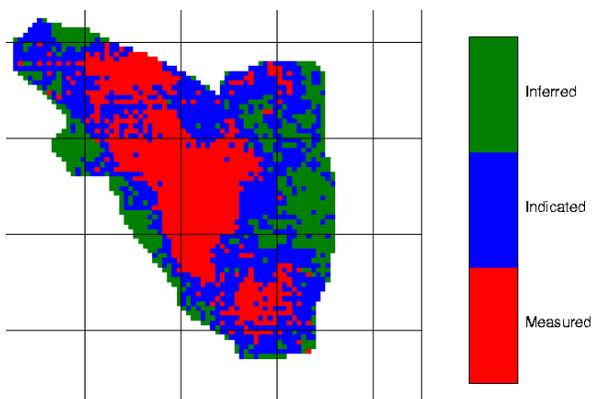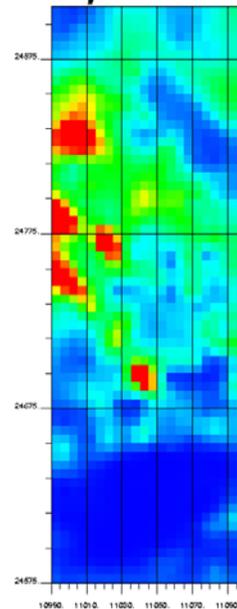
**On the web:**

- Check out      **www.pangeos.com**
- Send e-mail to   **sales@pangeos.com**