



Geovariances
Where no one has gone before



CONSULTING **SERVICES**

for the mining industry

- Resource estimation
- Resource classification
- Risk analysis
- Drill hole spacing analysis
- Review of estimation projects

Expert Services

Our consultants deliver relevant, practical and robust consulting solutions. Their software expertise helps them wisely choose the most suitable methods and tools to process your data properly, deliver controlled and safer models and optimize the results which help your decision making process. They have extensive knowledge of communication requirements worldwide and are qualified to prepare independent technical reports in many international jurisdictions.



Geological domain definition with Machine Learning

We use

- **Define domains** using multivariate analysis, with techniques such as unsupervised machine learning, Principal Component Analysis (PCA), and Multidimensional Scaling (MDS).
- **Model the geology** using indicator kriging or geostatistical simulations.

You gain

- **More accurate domain definition**, improving subsequent grade and tonnage estimates.



Mineral resource estimation and classification

We do

- **Interpret and model the orebody geology** using different approaches, such as implicit modeling.
- **Estimate the resources** using ordinary kriging, multiple indicator kriging, or localized uniform conditioning.
- **Classify the resources** using geometric methods such as sampling density variance or geostatistical techniques such as kriging variance or uncertainty assessment with conditional simulations.

You gain

- **Robust resource estimation and classification** into inferred, indicated, and measured categories according to the chosen technique.



Recoverable mineral resource estimation

We do

- **Apply non-linear geostatistics** such as Localized Uniform Conditioning (LUC), Multiple indicator kriging (MIK), and conditional simulations.
- **Estimate the tonnage**, metal quantity, and grade above chosen cutoffs.
- **Generate an SMU model** by localization with consistent grade-tonnage curves.

You gain

- **A better understanding** of the part of the deposit that is technically recoverable.



Analysis of grade uncertainties with conditional simulations

We do

- **Quantify local and global uncertainties** with conditional simulations.
- **Perform risk analysis** on the estimated grades and tonnages for a series of cutoffs.
- **Identify the areas** which show higher grade uncertainty and variability and most urgently need additional drilling.
- Assess the grade uncertainty within production volumes.

You gain

- **Better decision-making.**
- **Improved mine-production reconciliation.**
- **Guidance** for mining production based on uncertainty.



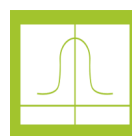
Drill hole spacing analysis (DHSA) using geostatistical simulations

We do

- **Quantify the model uncertainty** for different drill hole spacing configurations based on specific production parameters.
- **Identify the ideal sampling distribution** for a given uncertainty level for different objectives, which may include resource classification optimization or better grade control.

You gain

- **Reduction of ore/waste misclassification.**
- **Optimized sampling budget.**
- **Support to prioritize** drilling targets in terms of value to the resource model.



Change of support studies

We do

- **Estimate the smoothness** between data versus the scale of interest, which is equivalent to predicting how the grade distribution changes with the scale, from points (samples) to the scale of interest (SMU or panels).

You gain

- **A consistent result** when performing sensitivity analyses of contained metal and tonnages using different cut-off levels in the relevant support.



Today, exploring a deposit or exploiting a mine cannot be optimal without geostatistics. Geovariances has conducted several high-quality studies for Kazzinc thanks to a rigorous, precise and constructive dialogue between both companies.

Pierre Vix, **Consultant**

We have required Geovariances to work with us on several occasions over the past 10 years, especially to apply and adapt non linear methods of geostatistics to our estimation issues and to help us value our specific orebodies. Each time, we enjoyed their great **service and support**, their consultants being **very professional and flexible** with our schedules.

Monique Le Guen, **Eramet**



Evaluation of the combined use of short and long-term data in estimations

We do

- **Quantitative analysis to control input data quality**, for example, when one wants to integrate the use of blast hole data into the resource estimation workflow.
- Study the possibility of **combining short and long-term data** to propose a solution to the classic dilemma of using short-term data in the estimation of long-term models or vice versa.

You gain

- **Optimized estimates** using the full potential of your data set.



Optimization of short-term estimates

We do

- **Review and validate** the short and long-term databases.
- **Review the estimation parameters** (variogram and search neighborhoods), optimizing the short-term model estimation workflow.

You gain

- **A more accurate short-term model** with higher reliability of the grade estimates.
- **A more precise definition** of the mining blocks between ore and waste.
- **Better decision-making** in mine planning and grade controlling.



Automation of personalized estimation routines

We do

- **Review** your current process.
- **Build workflows** using Isatis.neo and Python coding and external libraries (such as Scipy and Scikit-learn).
- **Provide you with a workflow** to be launched from Isatis.neo using a customized user interface, a command line interface, or a third-party software solution using Python.

You gain

- **Faster model updating.**
- **A workflow fully tuned** to your process.
- **Automated routines** that require minimum people effort to be run.



Conversion of estimation routines (Isatis or other software) to Isatis.neo

We do

- **Implement your internal workflows** in Isatis.neo using batch capacity, Python libraries (e.g., Scipy and Scikit-learn), and scripting.
- **Provide you with a series of batch files** to be launched from Isatis.neo or a command line interface.
- **Assure knowledge transfer** via short courses adapted to the client level in coding.
- **Further support** during the execution of implemented workflow.

You gain

- **Automated routines** integrated into your process.

Expert Team

Our consultants have the industry experience to handle various issues with a best practice approach. They know your business and understand your challenges. They are recognized in their respective fields of expertise and regularly contribute to international industry and academic conferences and professional journals.



Solid experience as a mine geologist in long, medium, and short-term modeling. Specialist in Machine Learning.

Gabriel MOREIRA MSc.



Strong experience in process automation, data science, database management, and Machine Learning.

Arthur ENDLEIN MSc.



Several years of experience in advanced geostatistics for drill hole mesh analysis and mineral resource estimation.

Silvia MISK



Expertise in geostatistics, geological modeling, and drill hole mesh optimization.

Luigi CARBONI MSc.



Expert in multivariate modeling, data integration, grade control and simulations.

Cristina ARAÚJO Ph.D.



Expertise in implicit geological modeling, ore estimation, and simulations.

Roberto ROLO Ph.D.



Experience in geological modeling, Mineral Resource Estimation, geometallurgy, and reconciliation.

Giulia CERQUEIRA MSc.



Over 10 years of experience conducting consultancy work in a range of commodities.

David BARRY MSc.



Strong experience in geological modeling and contamination characterization.

Yvan ASSY MSc.



Experience in Python coding. Interested in new methods to interpret geophysical data and geological information.

Pedram MASOUDI Ph.D.

Geovariances, who we are

Founded in 1986, Geovariances is the **premier provider of accessible advanced geostatistics** to the natural resources industries. Geovariances' solutions deliver clients **exceptional reliability and scientific rigor** thanks to an exclusive 35-year partnership with the Center of Geosciences of the Paris School of Mines, the birthplace of geostatistics.

Our mission is to **help our customers improve production and economic performance and make better risk-informed decisions** by supporting them in integrating advanced geostatistics in their business process.

Our flagship software product, Isatis.neo, is **technology-advanced and designed for the highest performance**, with an intuitive user interface and cutting-edge parallelized algorithms. It makes users deliver controlled and safer models and free up their time. The software enables thorough data analysis and visualization, produces high-quality maps and models and allows carrying out extensive uncertainty and risk analyses to make better-informed decisions. It also features batch scripting capabilities for task automation that, when combined with Python coding, allow for a **high degree of software customization, giving it tremendous capabilities**.

Contact us

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