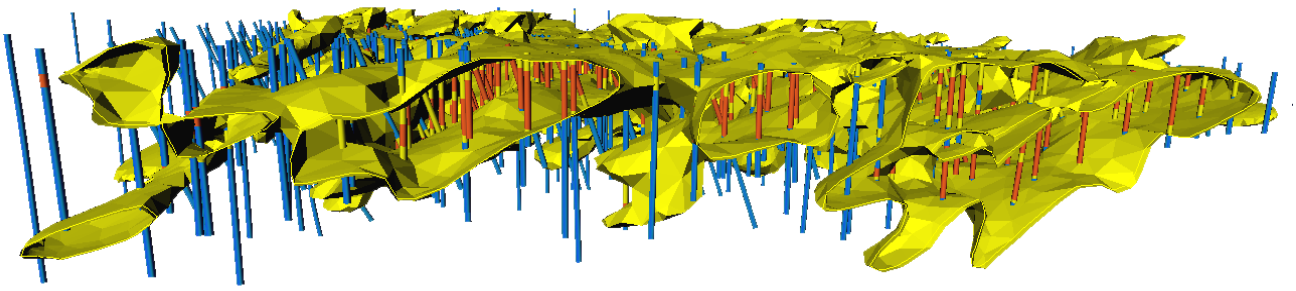
minestis THE ROUTE TO RESOURCE ESTIMATES

Estimation domain modeling

The modeling of coherent estimation domains is a major area of integrated Mineral Resource Estimation. The description of variable behavior associated with mineralization processes helps delineating spatial envelopes, which facilitate grade interpolation, and fully defines mineralized tonnages.

In that context, Minestis, Geovariances all-in-one software solution for Mineral Resource Estimation, offers a unique geostatistics-based application for estimation domain modeling.

Domain modeling in Minestis is operated in two steps. **Samples are first clustered into domains** using an exclusive automatic procedure before the **domain 3D envelopes are interpolated**.



KEY POINTS

- **Objective sample clustering** introducing scientific rigor to a traditionally subjective procedure based on manual clustering and cross-plots interpretation.
- **Robust domaining and implicit domain modeling** based on genuine multivariate geostatistics combining drill hole data, structural data and geological interpretation.
- **Quality control** and **uncertainty assessment** of the domain envelopes.
- **Flexible and reproducible** procedure.

BENEFITS

- **Time saving** thanks to automatic domaining and implicit modeling.
- **Improvement** of domain understanding.
- **Easy integration** of new data and **fast updating**.
- **Consistency ensured** between domain model and resource model.
- **Better informed mining decisions** through combined analysis of the uncertainties attached to the domain envelopes and the ones attached to resource estimates.

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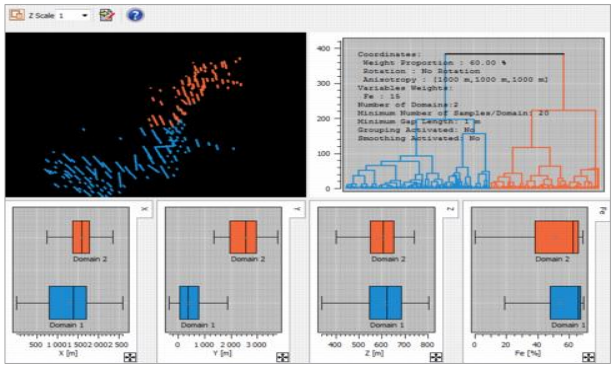
Fast sample clustering into domains

Grouping boreholes samples into domains has never been so easy and fast than with Minestis Domaining application.

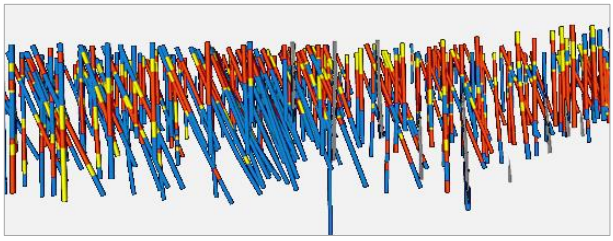
The software automatically identifies zones with homogeneous grade profiles and assigns each drillhole sample to a given domain.

The process is based on an innovative **machine learning algorithm** derived from the *geostatistical hierarchical clustering algorithm* (GHC). First samples, and then cluster of samples, are compared two by two and grouped according to their spatial dependency and their degree of similarity. Similarity is based upon a difference value calculated from input information including grade, lithology and distance between samples; the importance of each variable being moderated via a weighting scheme.



Minestis delivers dendrograms showing the hierarchical relationship between samples. Similar samples are linked together.

The procedure is iterative and merges gradually the least dissimilar samples into domains and ends when the number of domains you have specified is reached. Post-processing allows possible refining and merging operations if required.

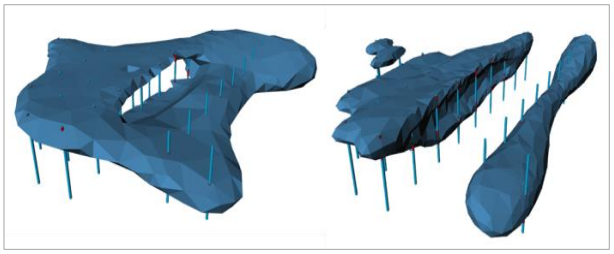


Minestis automatically assigns a domain to each borehole sample combining grade, lithology and structural information.

Domain implicit modeling

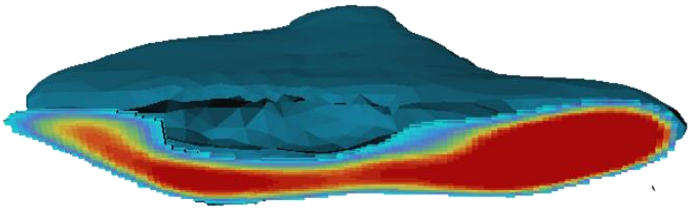
Minestis Domain Modeling application uses previous domaining information to interpolate domain boundaries.

Minestis bases its process on the *Potential Field method* which uses drillhole intercepts and orientation data to model domain boundaries through co-kriging. The model benefits from additional geological or structural information for more realistic envelopes.



Domain shape is captured through the variogram model

A key point of interest is that, besides the cokriging variance, the technique allows **mapping the probability that a specific location lies within the domain**.

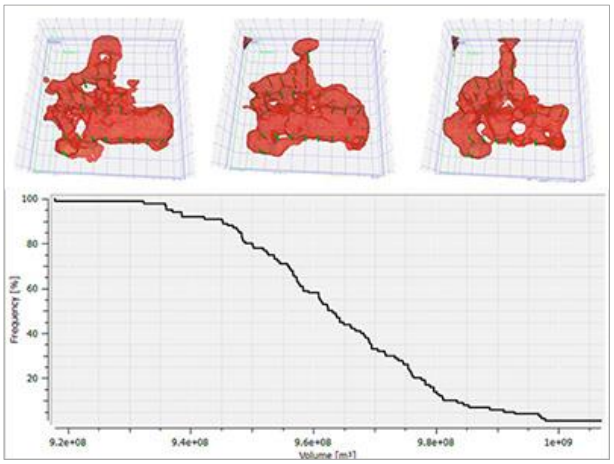


Minestis maps the probability to be inside a domain

Domain quality control and uncertainty analysis

Whether built with Minestis or imported from external mining packages, **possible overlaps or voids between domain envelopes** are verified and can be fixed for improved consistency prior to resource estimation.

Besides, **Minestis allows genuine uncertainty assessment on the domain volumes** based on conditional simulations.



Minestis computes volume curves from simulated envelopes