Conditional Simulations for optimizing the cement production in a mining exploitation

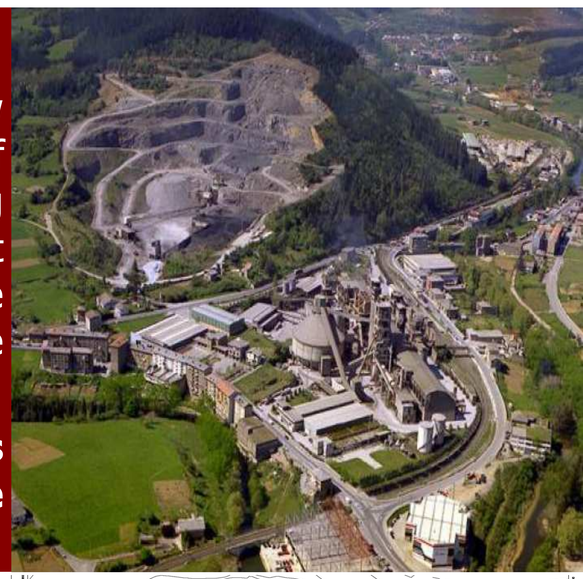
Authors: Carlos Badiola, Cementos Lemona (ES); JI. Coullaut, CRS Ingeniería (ES); S. Godoy, CRS Ingeniería (ES).

GEOSTATS2016

Objectives:

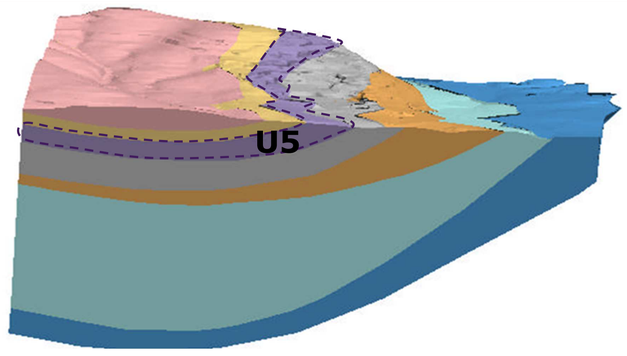
Combining statistical and geostatistical treatment of the data collected in the field with new software developments allows to accurately estimate the materials required in the production of cement, according to the available raw materials on site and the configuration of the mining exploitation. Ordinary Kriging has been performed to estimate the mean grades of each component of interest in order to plan the future exploitation of the quarry and the cement production. The conditional simulations method has been performed to analyze the uncertainties associated to these estimates and to anticipate the economic risk of the production process.

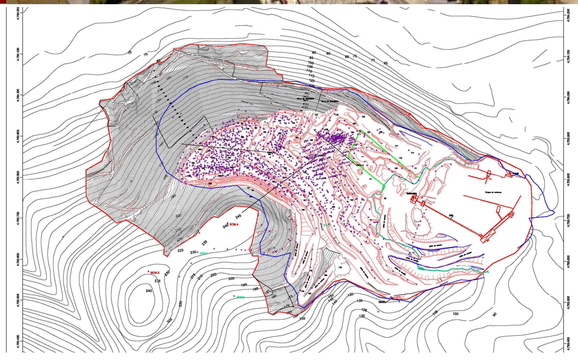
This study compares the results of the resource model performed in 2014 with the results obtained during the 2015 quarry exploitation and shows the advantages of the geostatistical treatment in order to optimize the quarry exploitation.



Context:

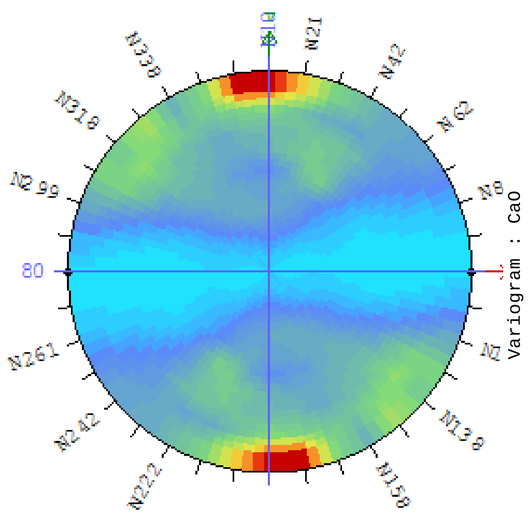
Marl quarry exploiting the Marl Unit (U5a / U5b) containing the needs in CaO and Fe_2O_3 for the cement production and supplying raw material to the factory. Each year, the resource estimation model is updated taking into account the new blasting samples.

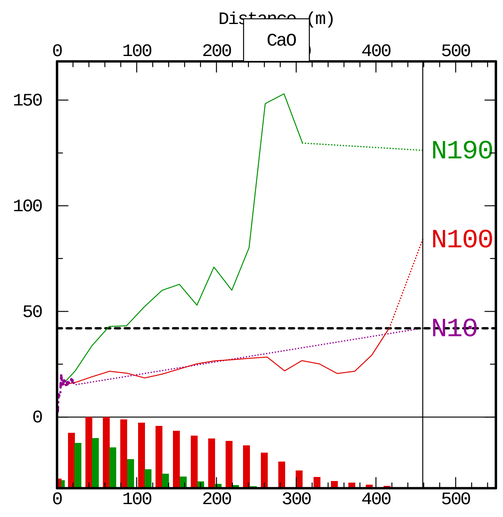




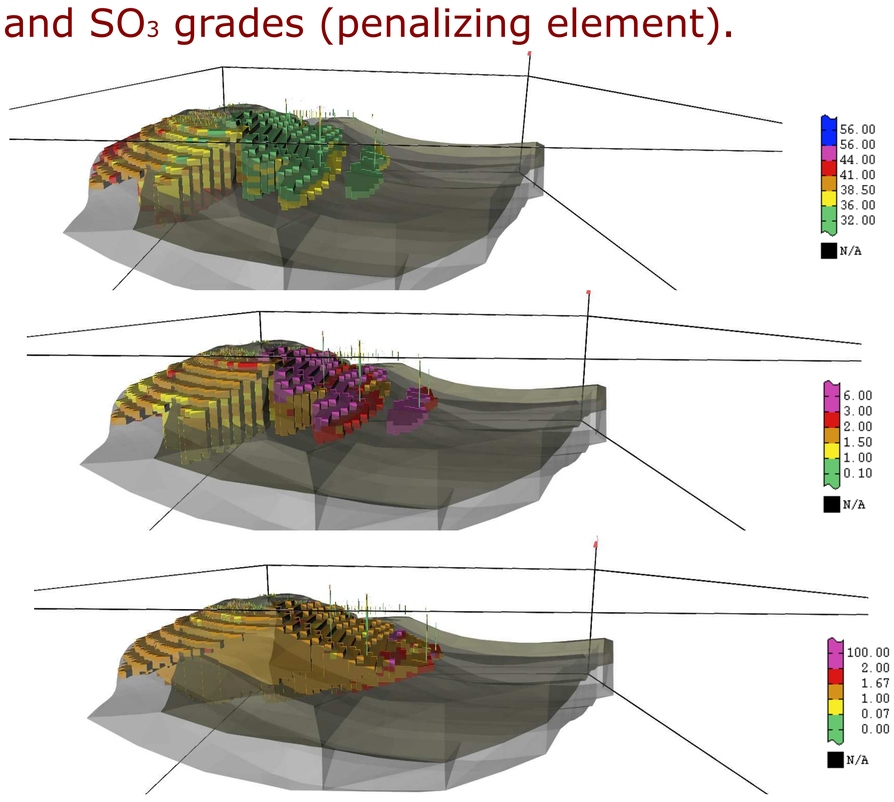
Methodology:

1. Variography and modeling:
   - Identification of structural anisotropies
   - Construction of the experimental variograms
   - Modeling the experimental variograms
   - Cross-validation of the models





2. Kriging the results in the Unit 5: CaO, Fe_2O_3 grades (mineral) and SO_3 grades (penalizing element).



Kriging of the CaO grades

Kriging of the Fe_2O_3 grades

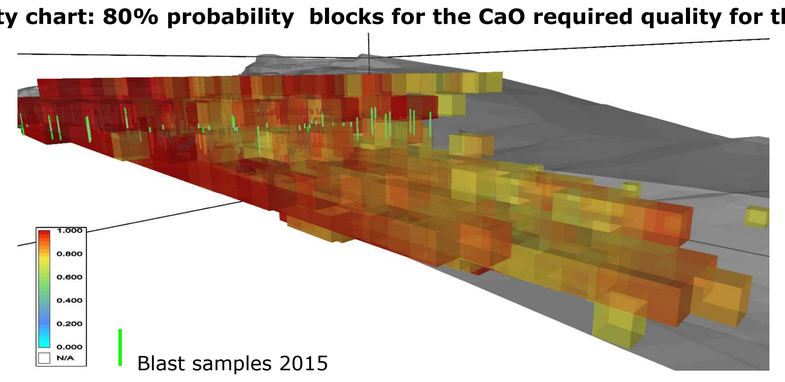
Kriging of the SO_3 grades

3. Assessing the uncertainties performing the conditional simulations method:

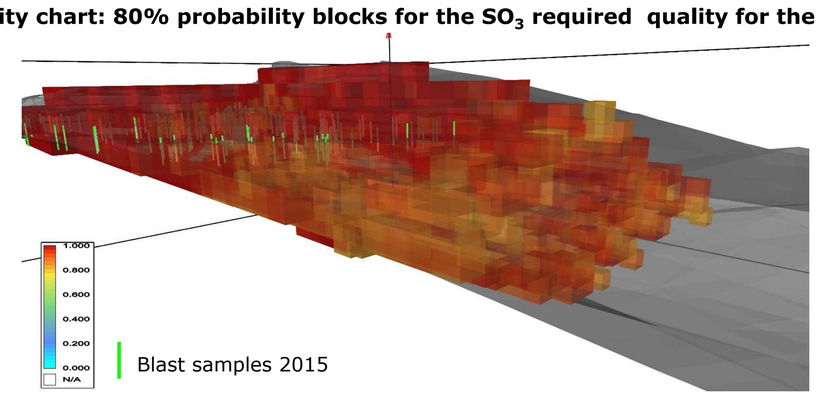
Confidence estimates according to the quality needs of the cement production by performing probability charts.

New blasting samples are located in areas with 80% probability or more of accomplishing the required threshold in the cement production.

Probability chart: 80% probability blocks for the CaO required quality for the cement production



Probability chart: 80% probability blocks for the SO_3 required quality for the cement production

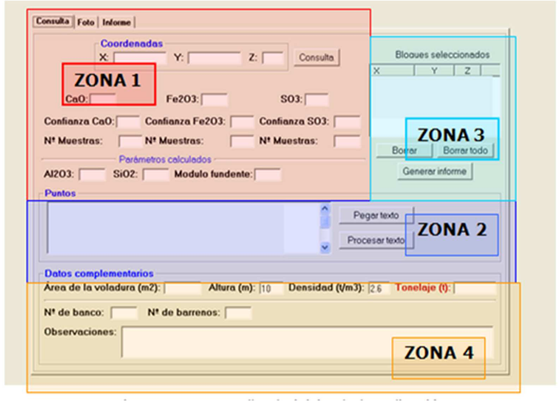


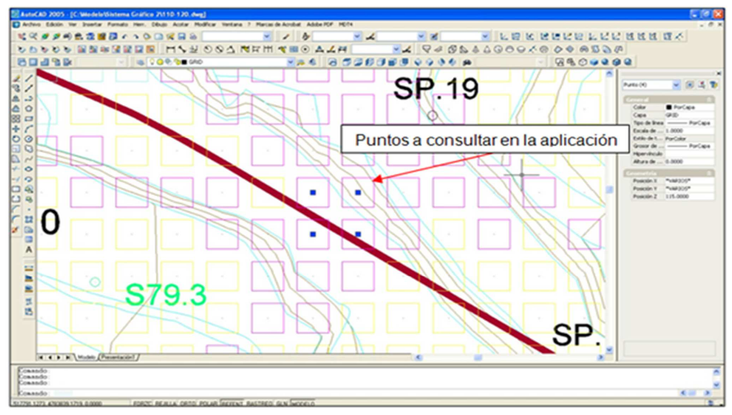
4. Results validation

Geological Unit U5a (180 new blasting samples compared with 2014 results)			
RESULTS	**CaO (%)**	**Fe_2O_3 (%)**	**SO_3 (%)**
Mean of the blasting results 2015	37,28	1,77	1,36
Mean of the kriging results 2014	37,83	1,74	1,37
Mean error percentage	1,45%	1,31%	0,47 %
Conditional simulations 2014 : probability to accomplish the quality cut-off	CaO>36%	Fe_2O_3>1,5%	SO_3<1,67%
	81%	91%	98%

Tools:

Specific software application adapted for the client needs allowing to visualize the resource estimation results to better plan the exploitation of the quarry.





Conclusions:

- ✓ The optimization in the cement production process includes the necessity of assure the quality standards of the marls in the quarry in order to guarantee the supplying of the cement factory.
- ✓ Performing a geostatistical analysis allows to assure and to anticipate the homogeneity of the factory supply and to optimize the quarry exploitation with a minimal error by analyzing the mineral distribution and the uncertainties of the estimates.
- ✓ Simple tools can be designed to understand the resource estimates and to better plan the exploitation of the quarry.
- ✓ Quality control from the exploitation and annual feedback in order to control the process.

Contact: jicoullaut@crsingenieria.es