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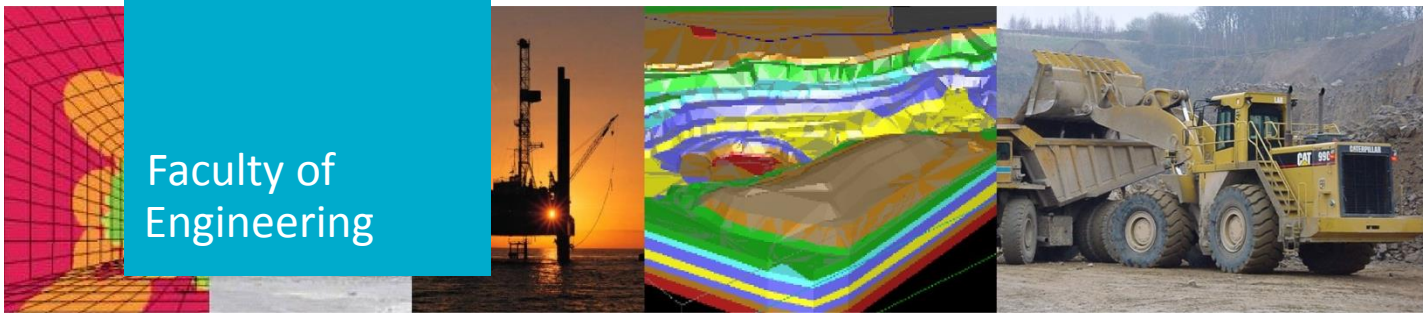

Assessing the orebody reserves by means of geological modelling

Geologica Belgica Conference

Brussels September 11-14 , 2012

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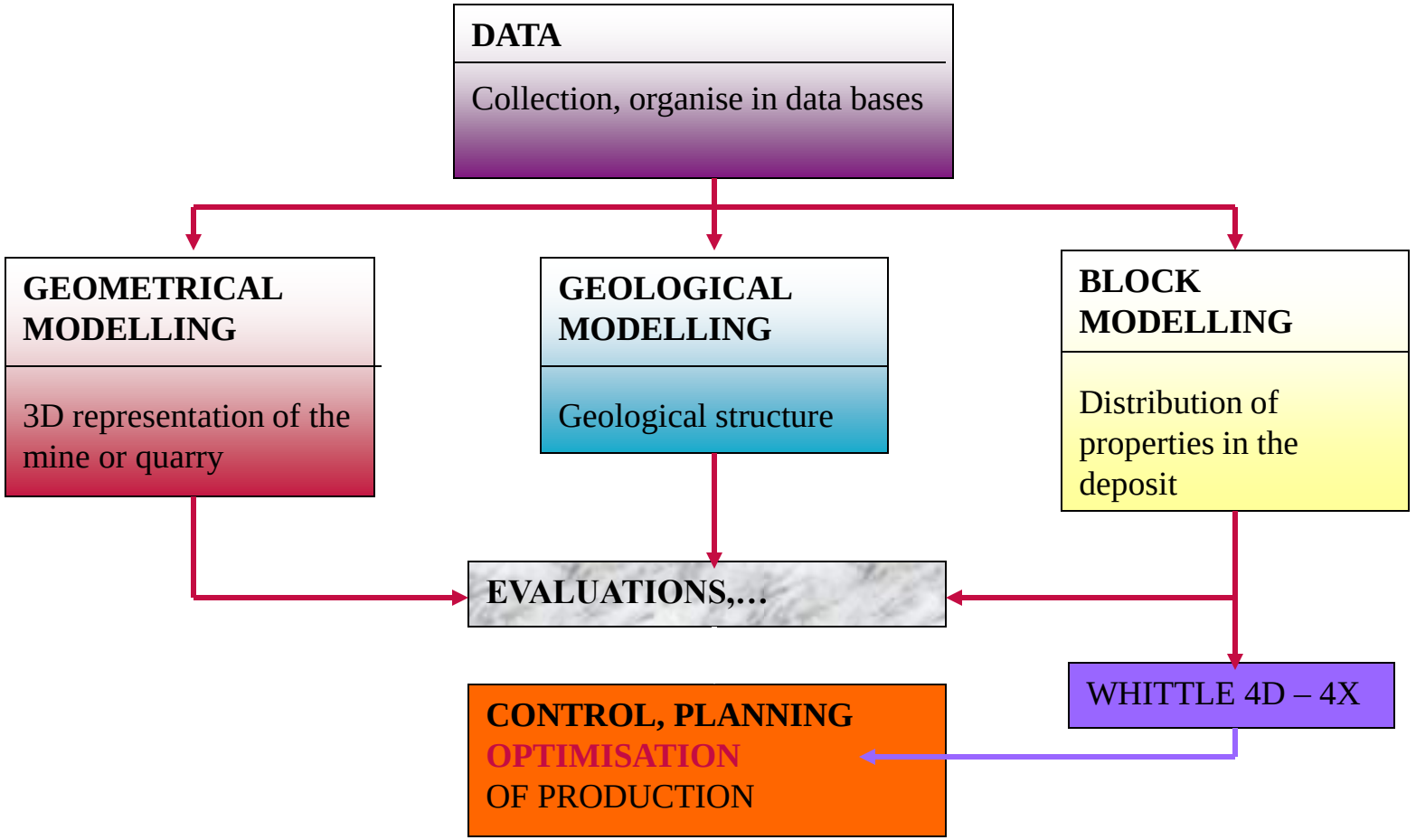
POLYTECH MONS

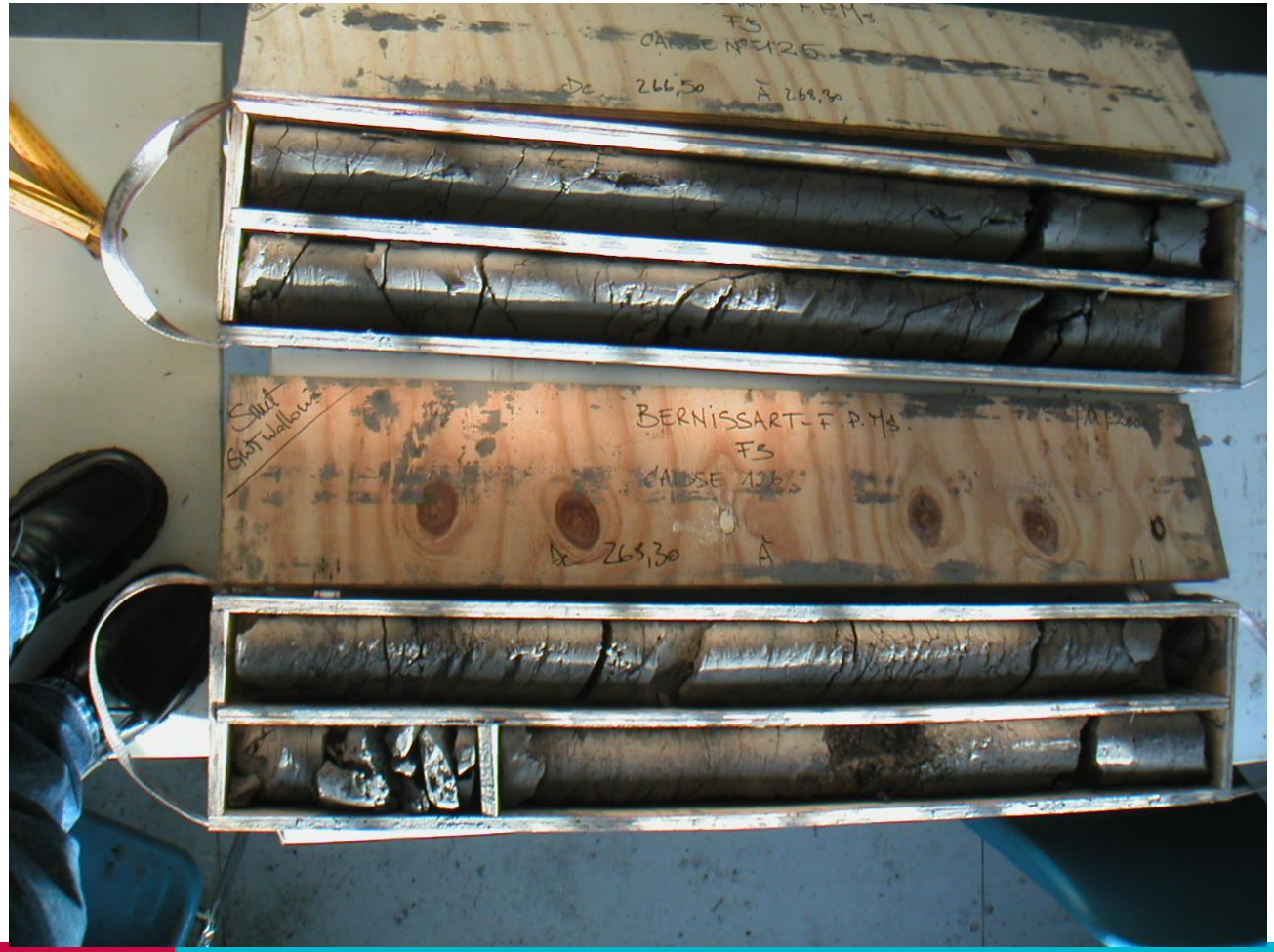
Overview of the presentation

1. Some definitions and structure of a mining project
2. Pertinent data and their management
3. Geometrical and geological modelling
4. Block modelling

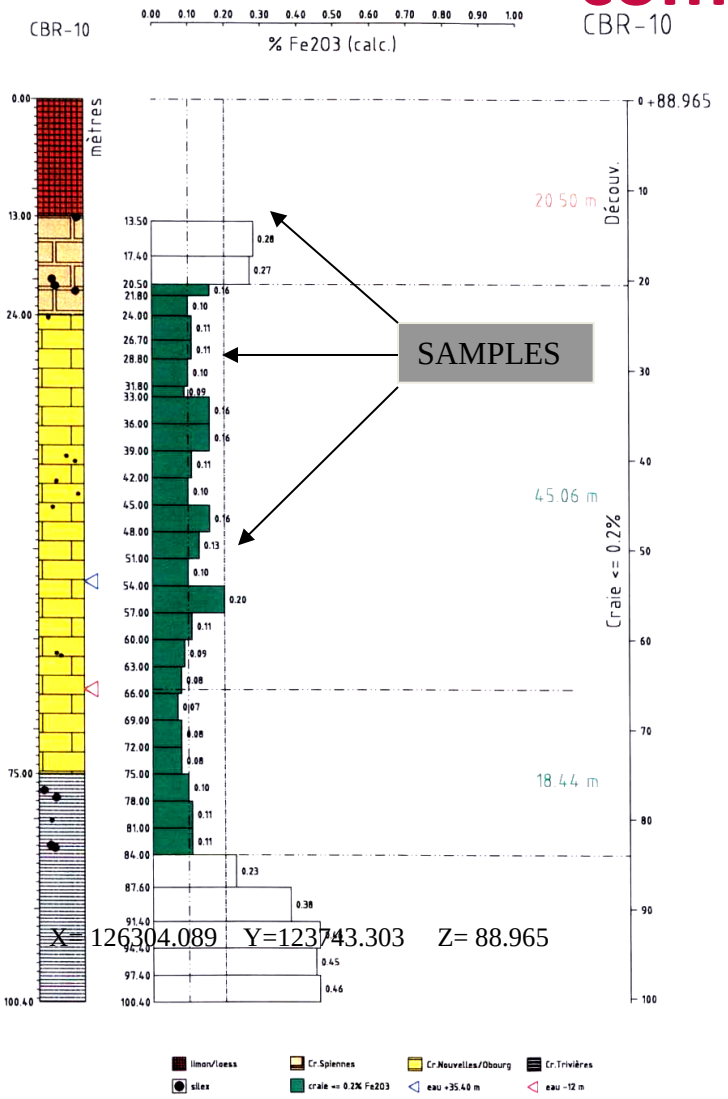
Project structure in a mine planning package



Collecting pertinent data – cores and core analysis: grades, density, mechanical properties…



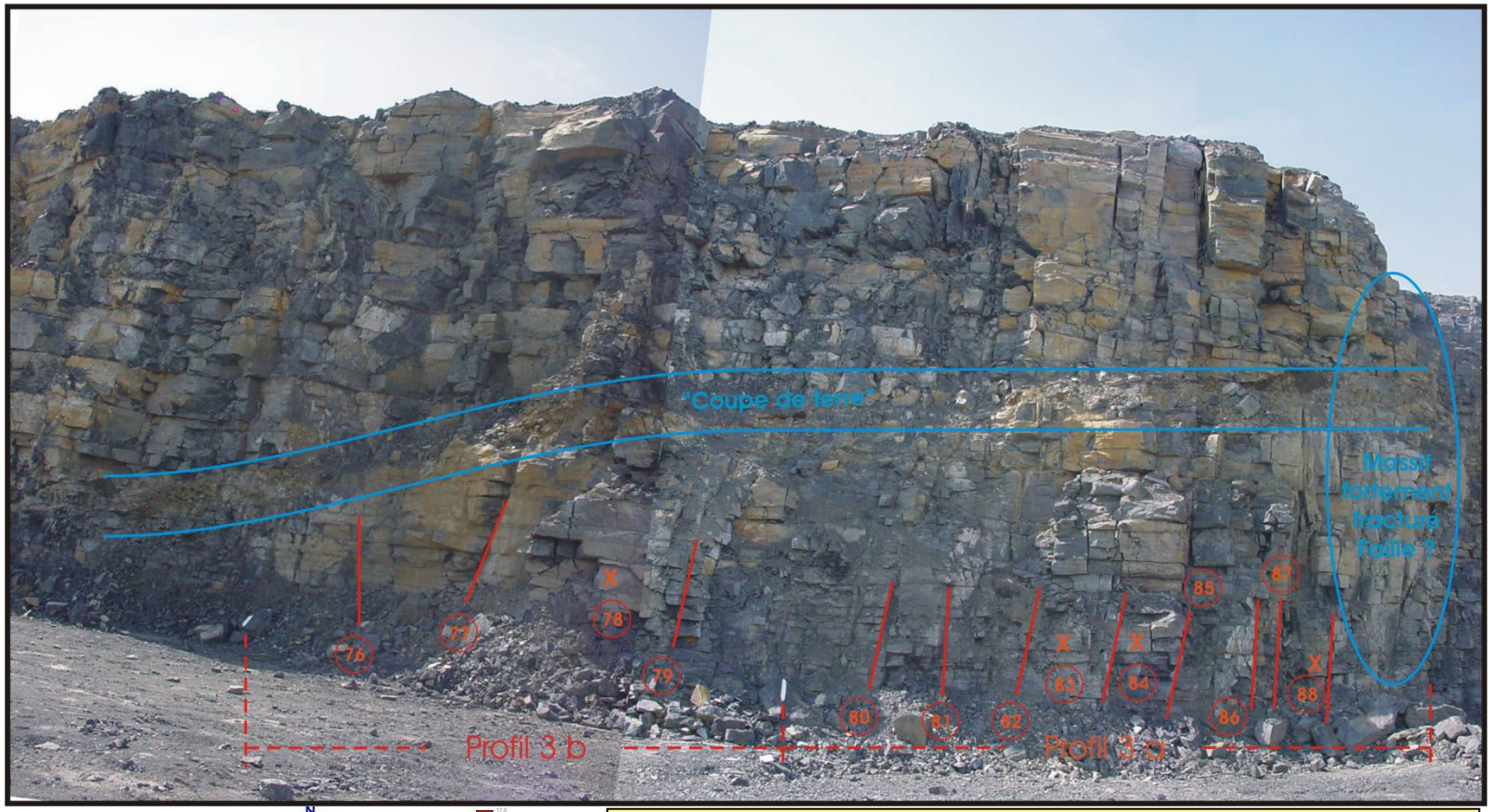
An example of data: grade or chemical composition

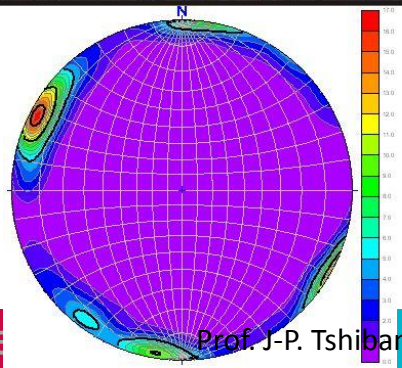


Case of white cement production by CBR – Harmignies:

The iron oxides content is to be prohibited to avoid coloring the white cement.

Analysing the rock mass fracturing





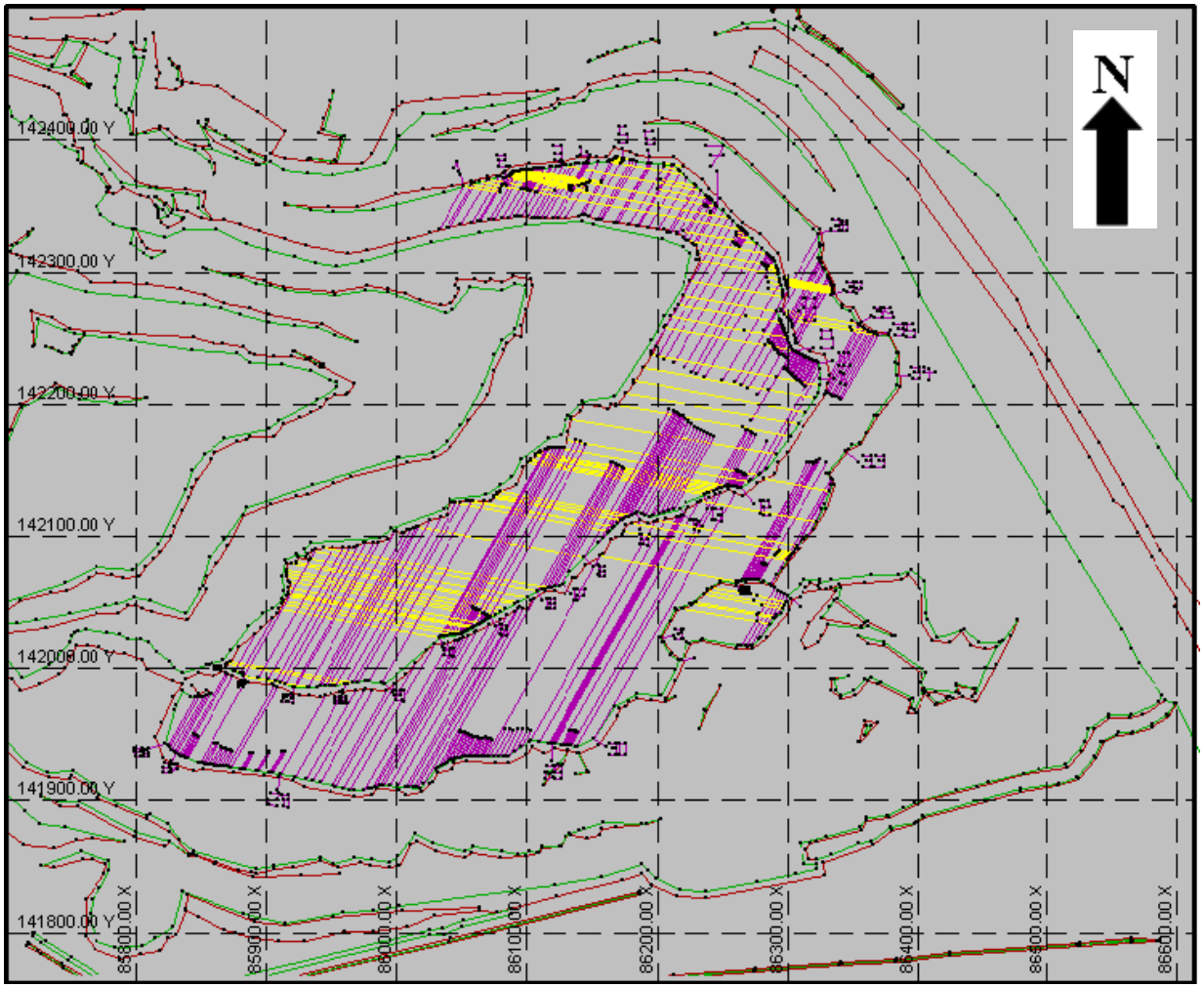
S1: N30°E

S2: N100° - 120°E

S3: Stratification

} Dipping > 80°

Mapping the main directions and density – Milieu's quarry Tournai



N30°E

N100°E

Qualification of the rock mass by the GSI index: the colour code

INDICE GEOLOGIQUE DE RESISTANCE : GSI

A partir des codes-lettres décrivant la structure et les conditions de surface de la masse rocheuse (tableau 10.17 précédent), prendre la case appropriée dans ce tableau. Estimer la valeur moyenne de l'Indice Géologique de Résistance (GSI) à partir des contours. Ne pas essayer d'être très précis. En effet, définir un intervalle de GSI allant de 36 à 42 est plus réaliste que de donner une valeur GSI = 38.

CONDITIONS DE SURFACE

TRES BON - Très rugueux, surfaces fraîches non altérées

BON - Rugueux, légèrement altéré, surfaces présentant une coloration ferrugineuse

ASSEZ BON - Surfaces lisses, modérément altérées

PAUVRE - Surfaces luisantes, fortement altérées avec revêtement compact ou remplissage par

TRES PAUVRE - Surfaces luisantes, fortement altérées avec recouvrement ou remplissage argileux tendre

STRUCTURE

QUALITE DE SURFACE DECROISSANTE

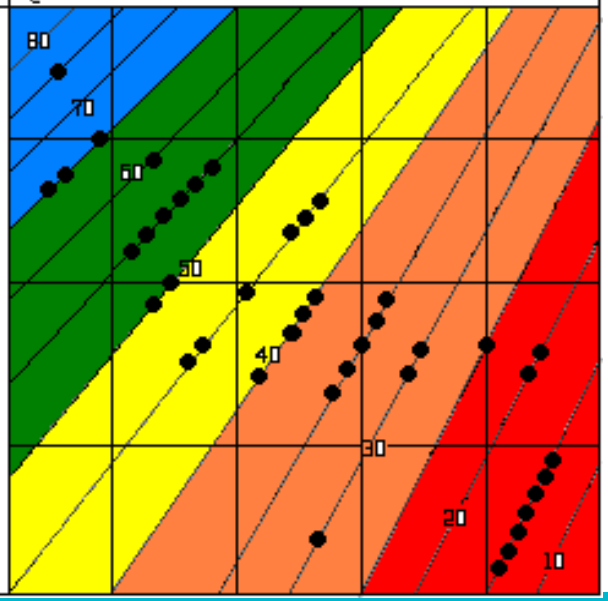
BLOCAGE DECROISSANT DES PIECES DE ROCHE

BLOCAILLEUX – masse rocheuse non perturbée, très bien inter-bloquée consistant en des blocs cubiques formés par 3 familles de discontinuités orthogonales

TRES BLOCAILLEUX- masse rocheuse inter-bloquée, partiellement perturbée avec des blocs anguleux multi-facettes formés par 4 familles de discontinuités ou plus

BLOCAILLEUX/PERTURBE – plissé et/ou faillé avec des blocs angulaires formés par beaucoup de familles de discontinuités qui se recoupent

DESINTEGRE – pauvrement interbloqué, fortement cassé avec mélange de pièces angulaires et arrondies



Mechanical logging by measuring drilling parameters – Milieu's quarry Tournai

An Ingersoll-Rand T4 production drilling rig has been equipped with a real time monitoring system (Lim system).

<u>Measured parameters:</u>

-Depth from top (each cm)

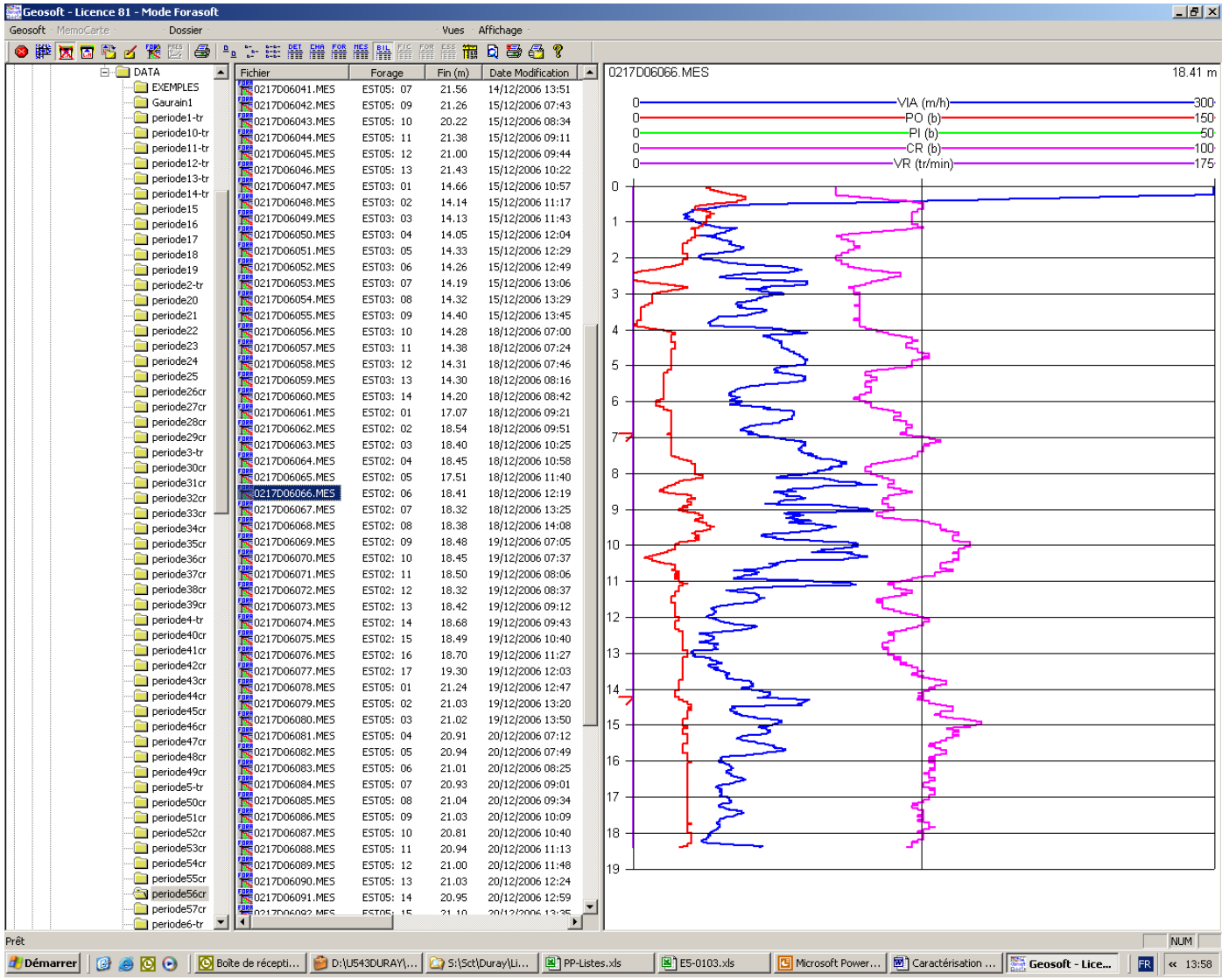
-Rate of penetration (Va)

-Hydraulic pressure on the bit (Po)

-Rotation speed (Vr)

-Rotation Torque

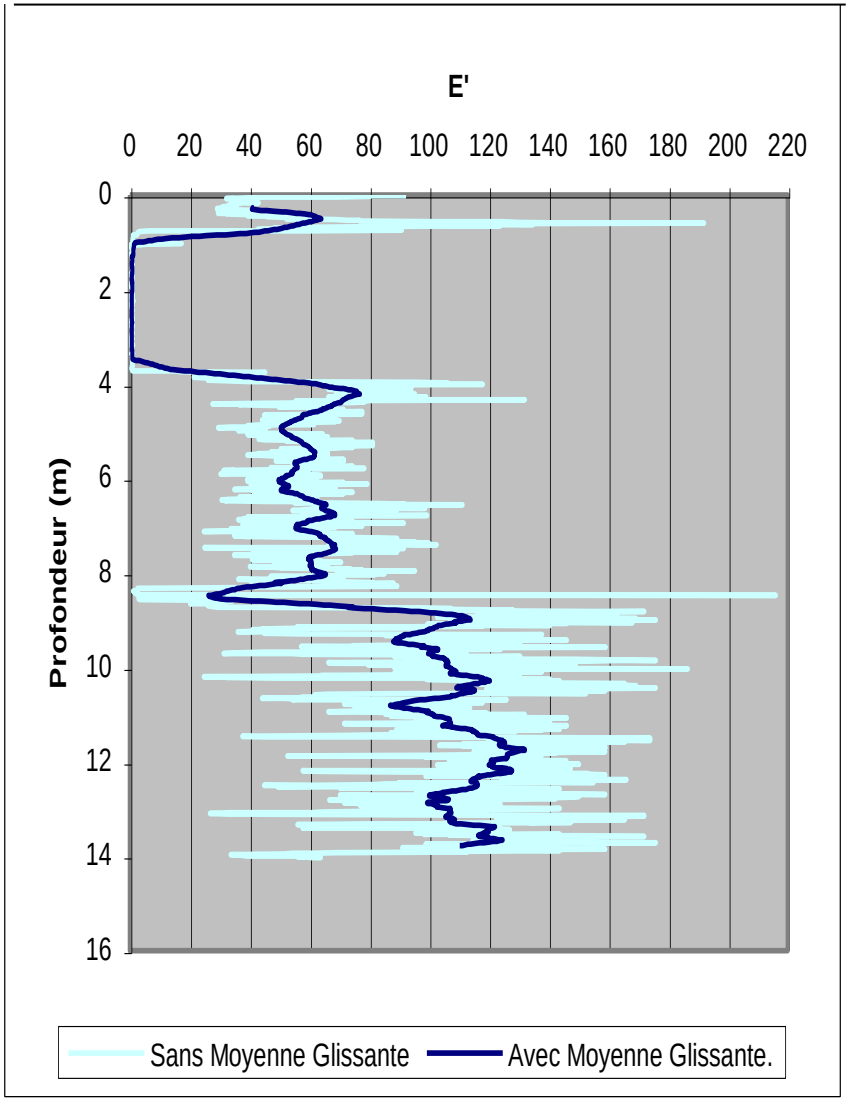
Raw data collected from log measurements



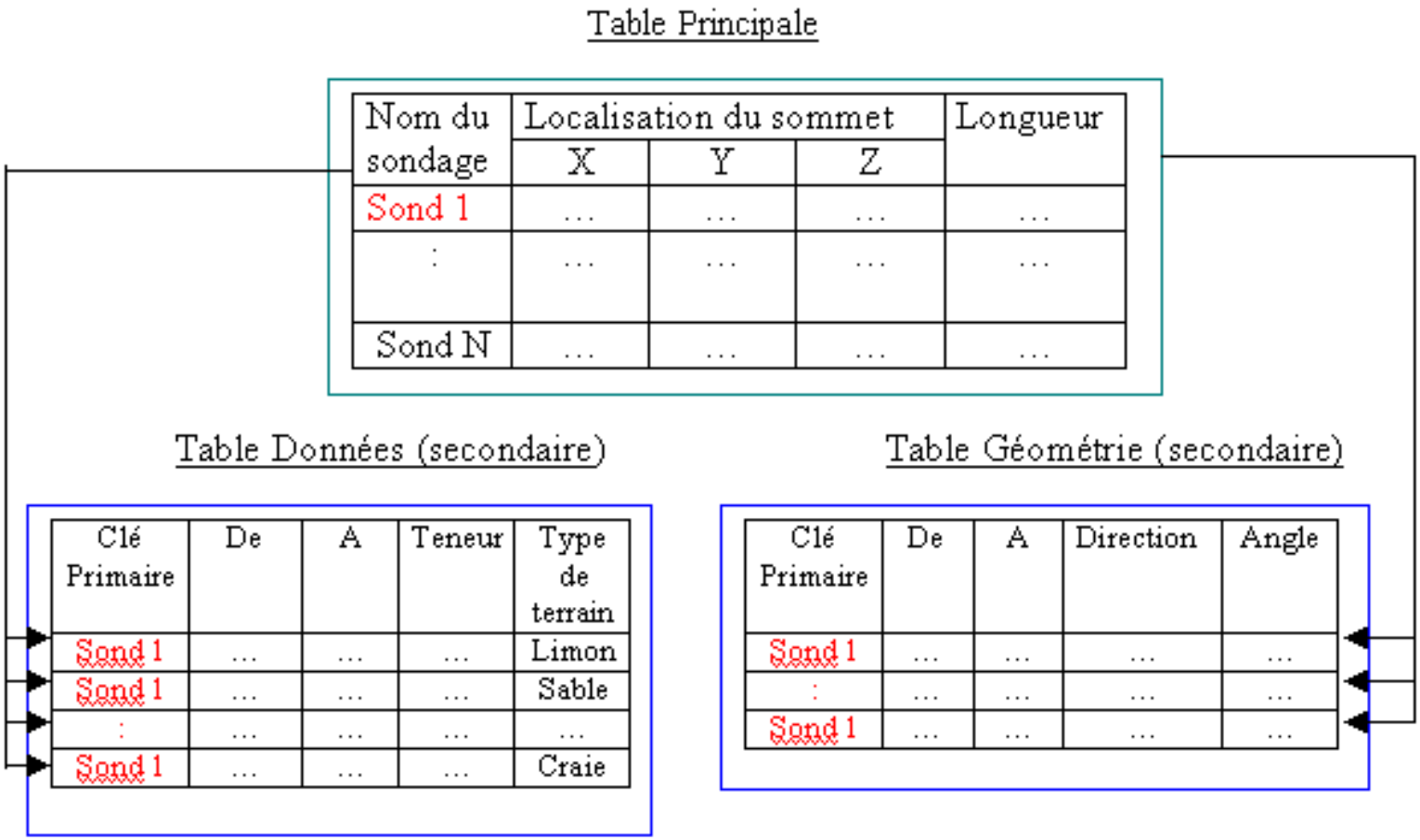
Drilling data processing:

- Identification of the hole number
- Calculate the mechanical strength of the rock using the E' concept
- Performing sliding means to smoothen the curves
- Plot the variation of E' parameter

=> Identification of quality zones.

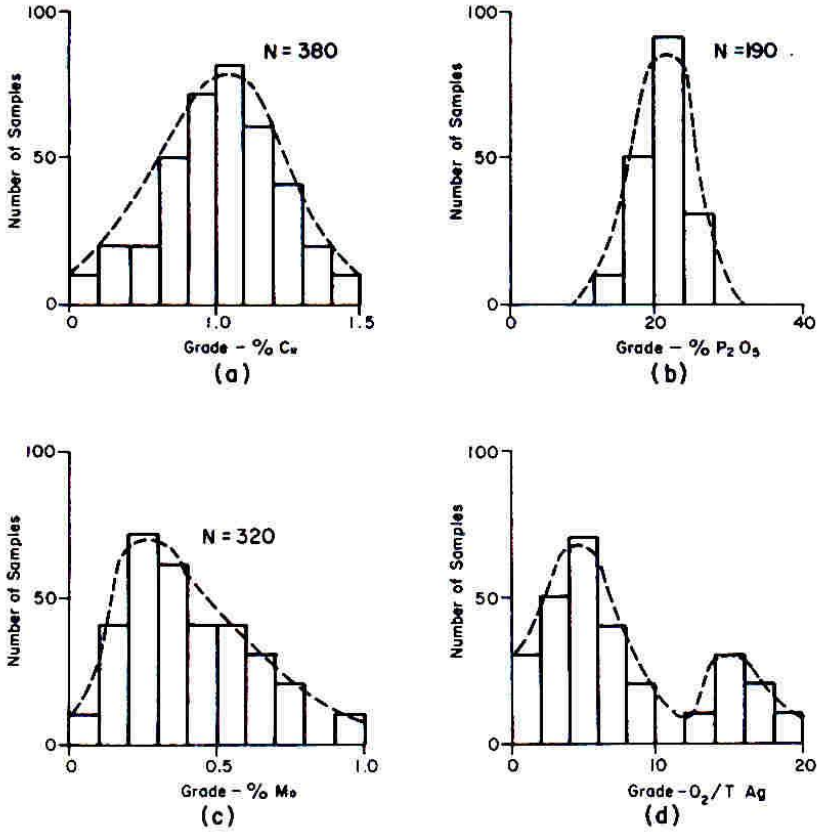


Database: Workspace

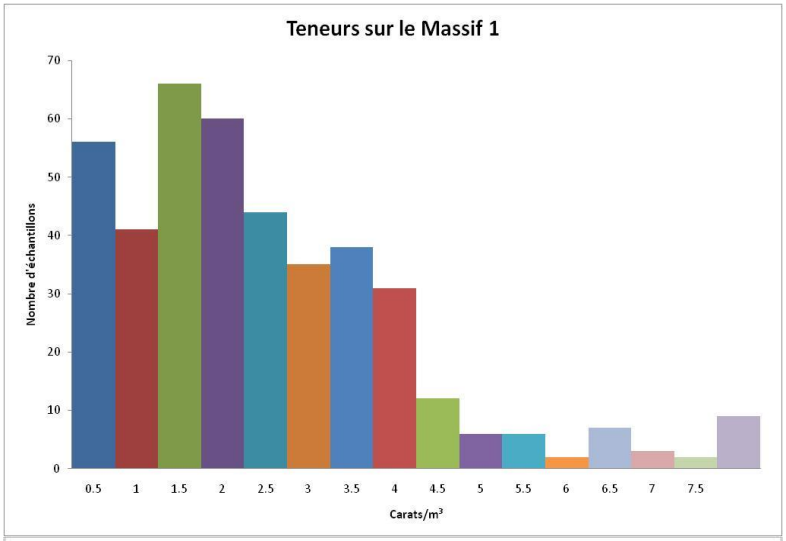


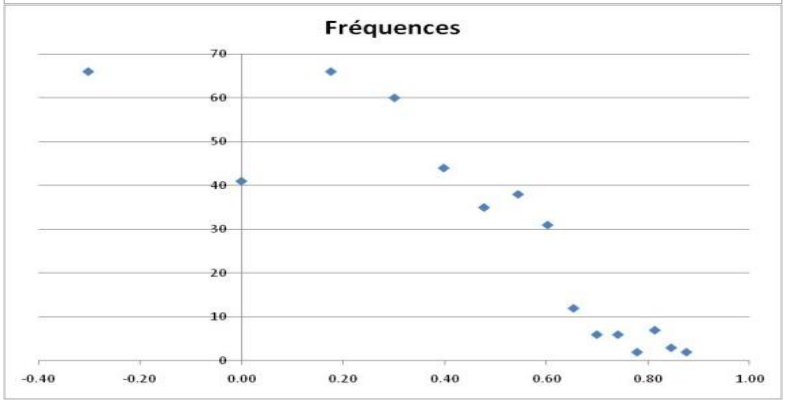
Statistical analysis of data: distributions

General theory



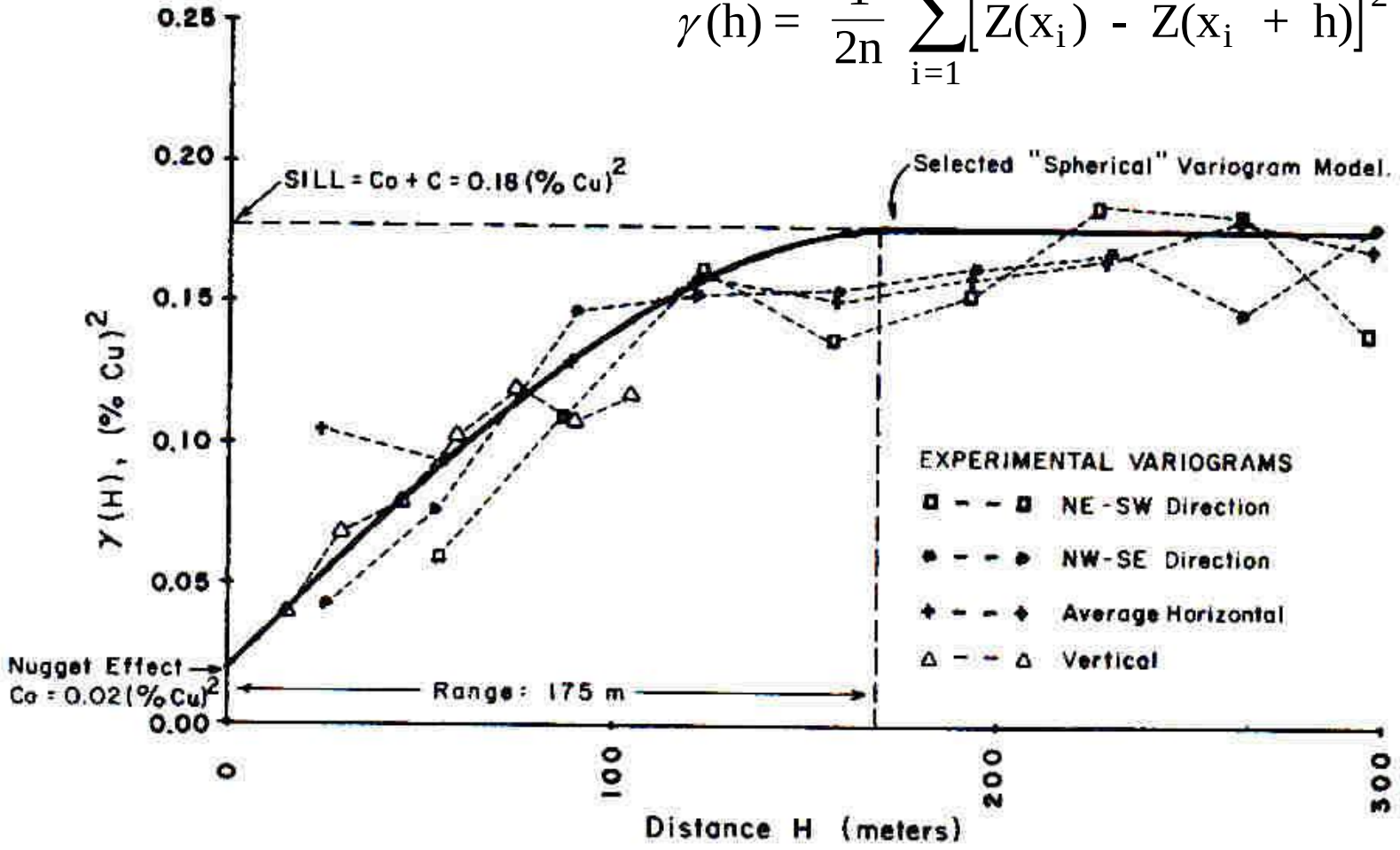
Application on the Massif 1 kimberlite pipe of MIBA



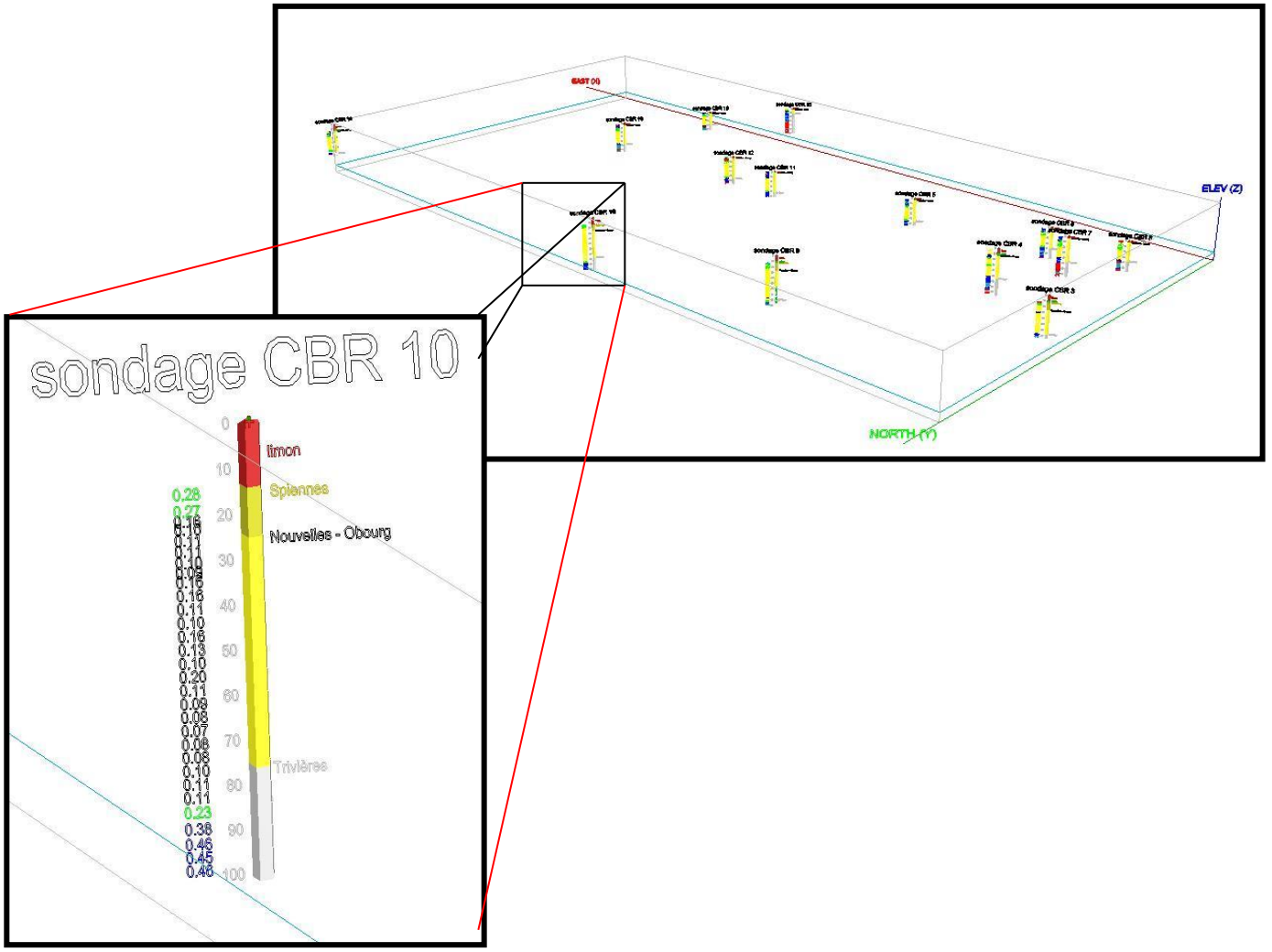


Geostatistical analysis: setting the variogram

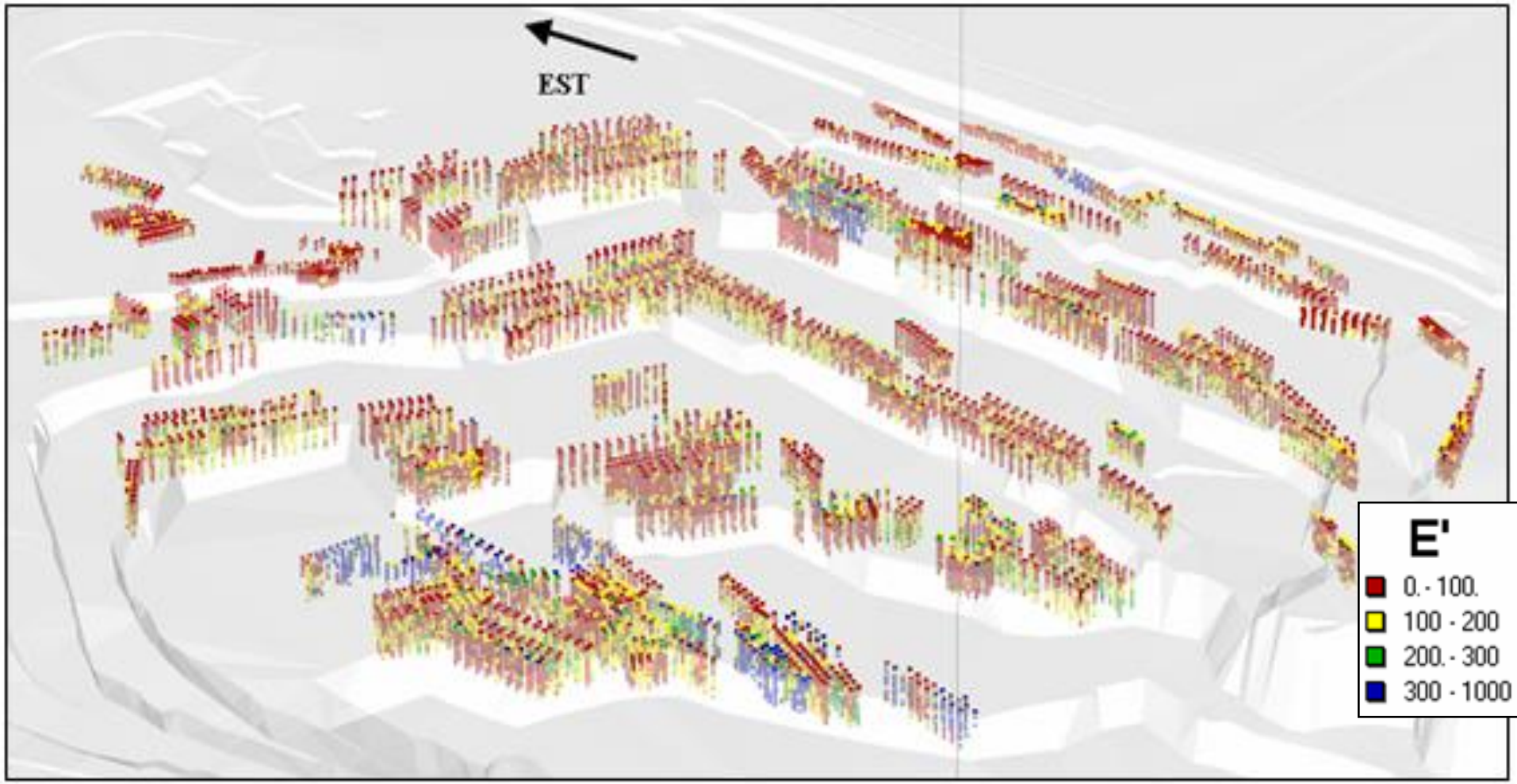
$$\gamma(\vec{h}) = \frac{1}{2n} \sum_{i=1}^{n} \left[Z(x_i) - Z(x_i + h) \right]^2$$



Harmignies: representation of drillholes on the deposit and corresponding characteristics

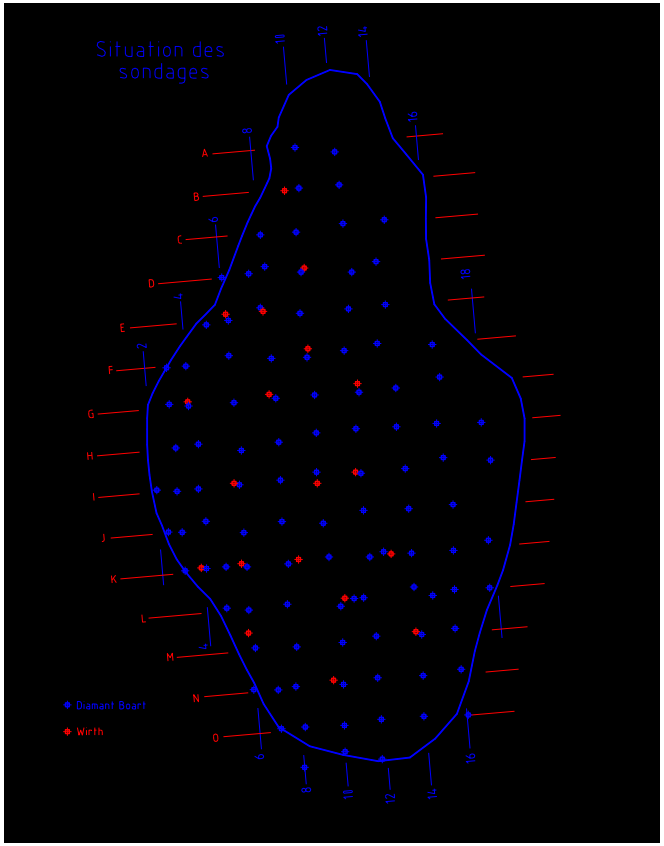


Mapping of the E’ energy factor per meter on the Milieu’s quarry in Tournai Belgium

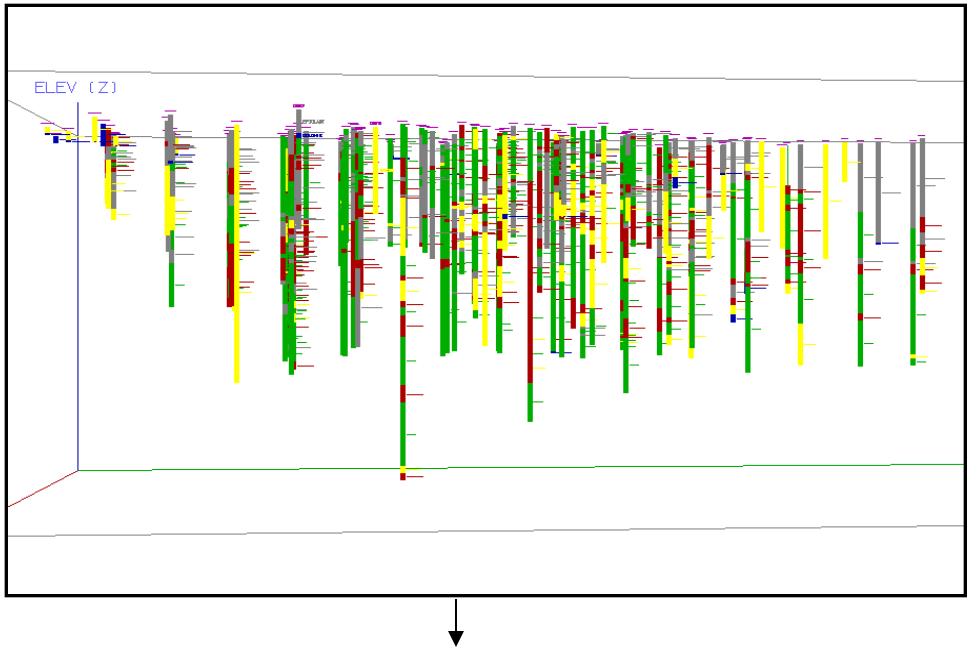


Mapping of drillhole data in terms of grade (ct/m³) on the Massif1 Pipe of MIBA - DRC

Position of drillholes



→ Grade variation



Geometrical and geological modelling

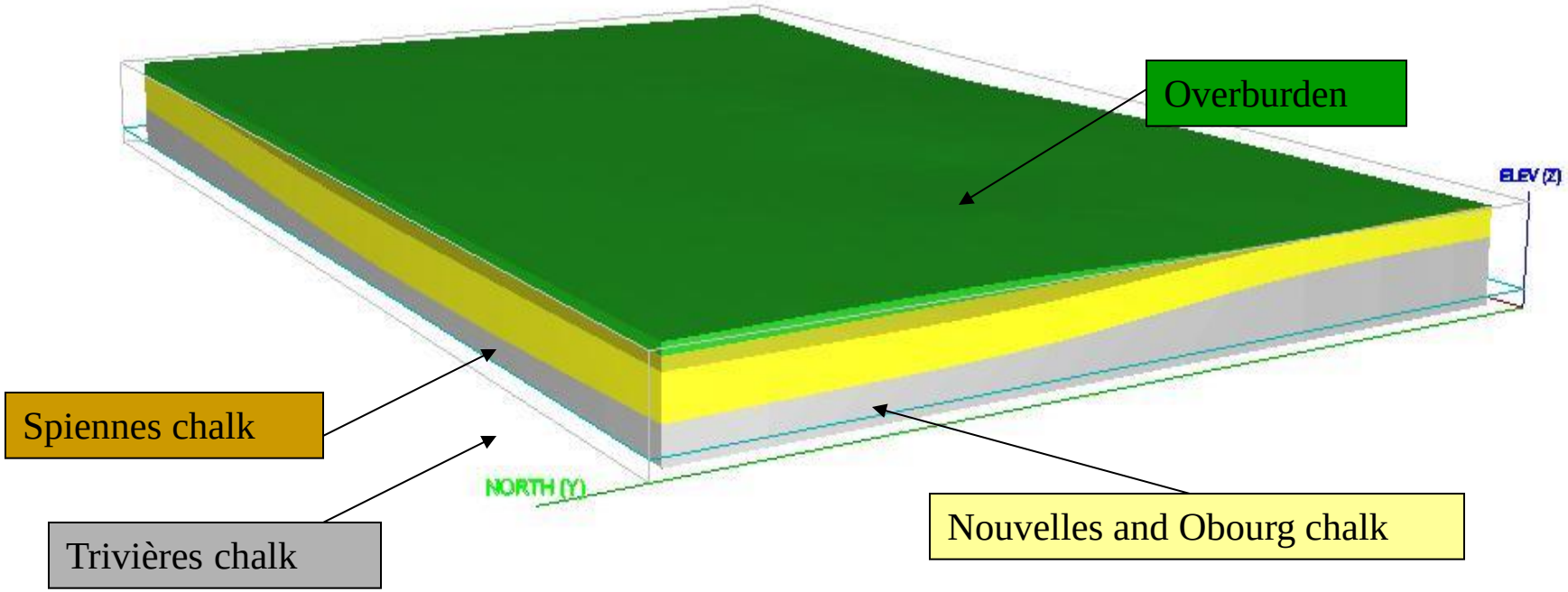
Used to create topographical sufaces, faults, roof and footwall of seams, distribution of parameters on a given plane, slope faces, etc.

Used methods for horizontal or low-dipping seams :

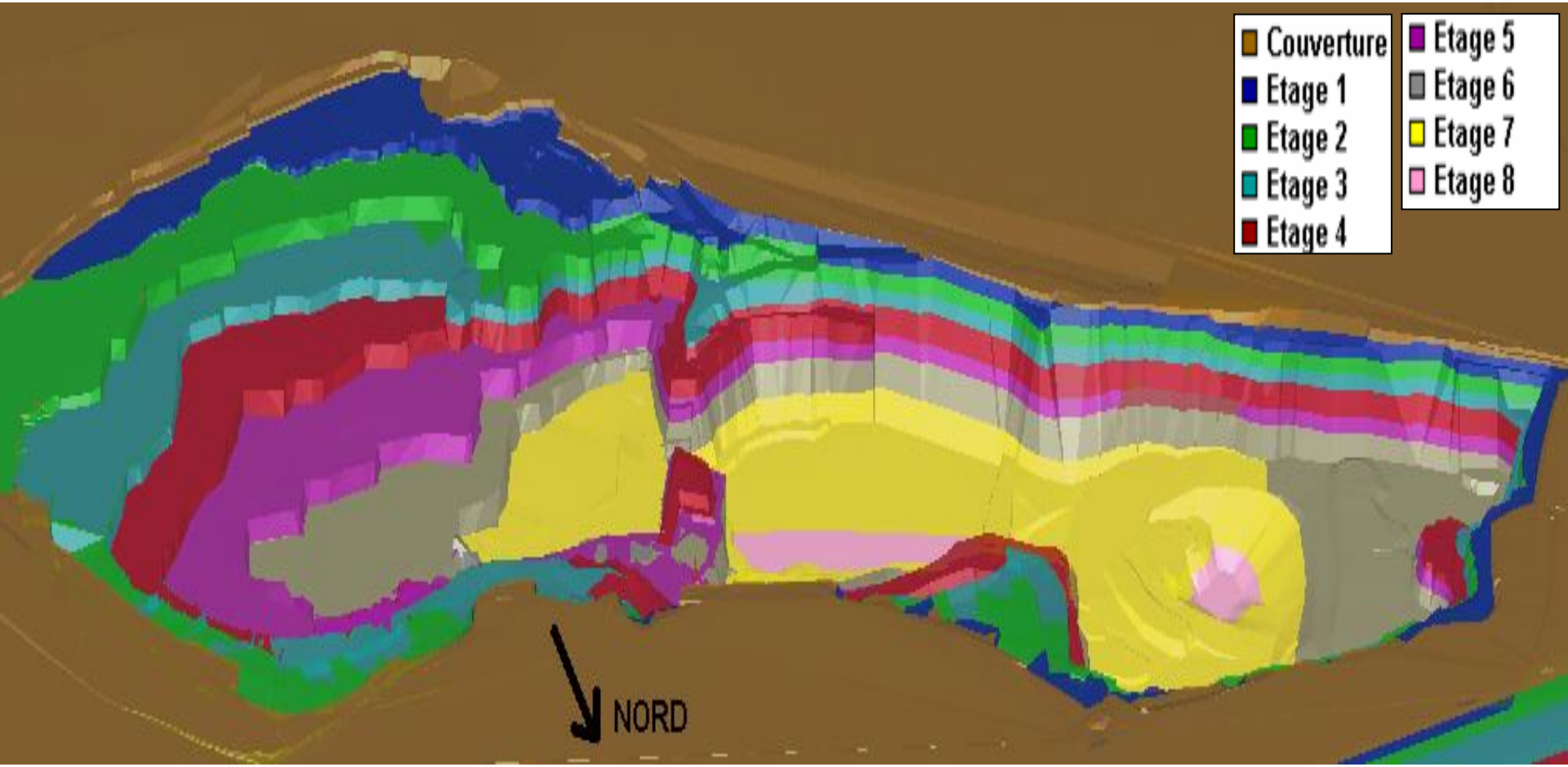
a. Triangulation
b. Laplace's grids

For more complicated shapes: 3D rings are recommended

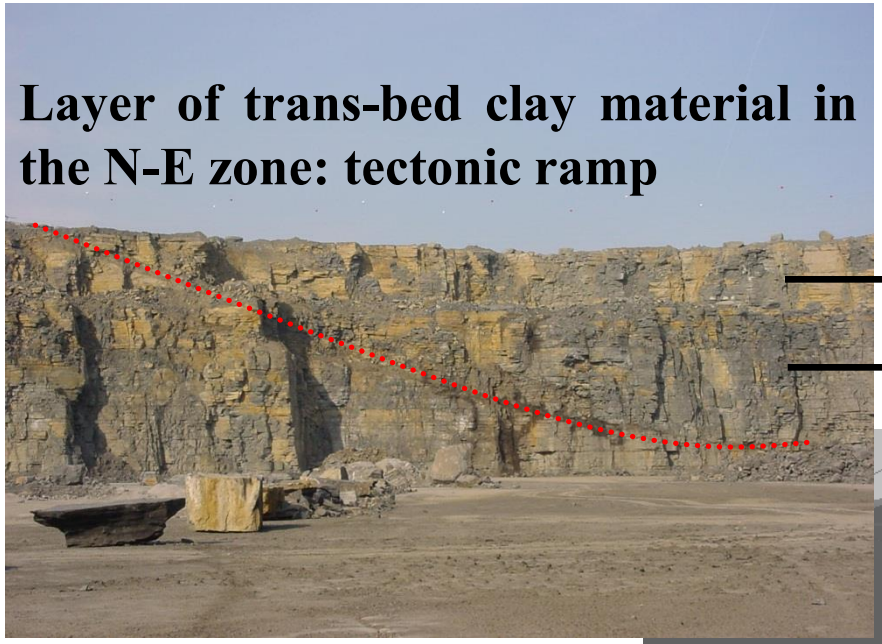
Harmignies: geological model built using Laplace's grids



Milieu: combination of geology and surface topography



Taking into account some particular tectonic structures

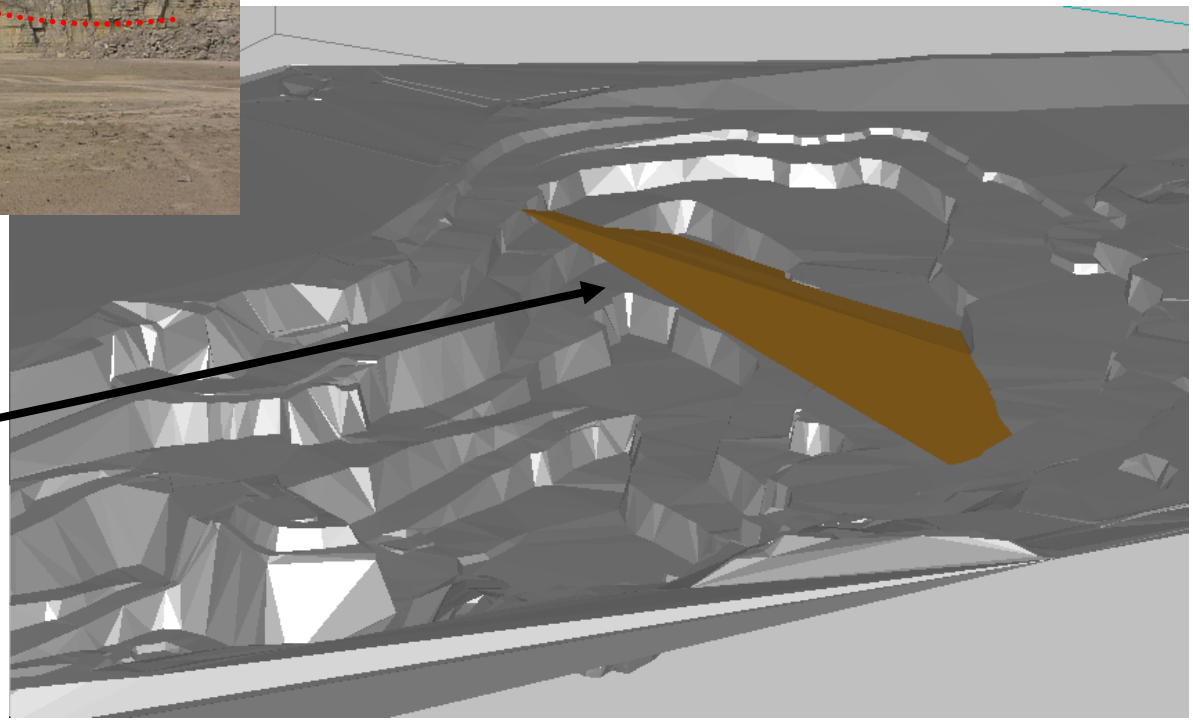


East 3

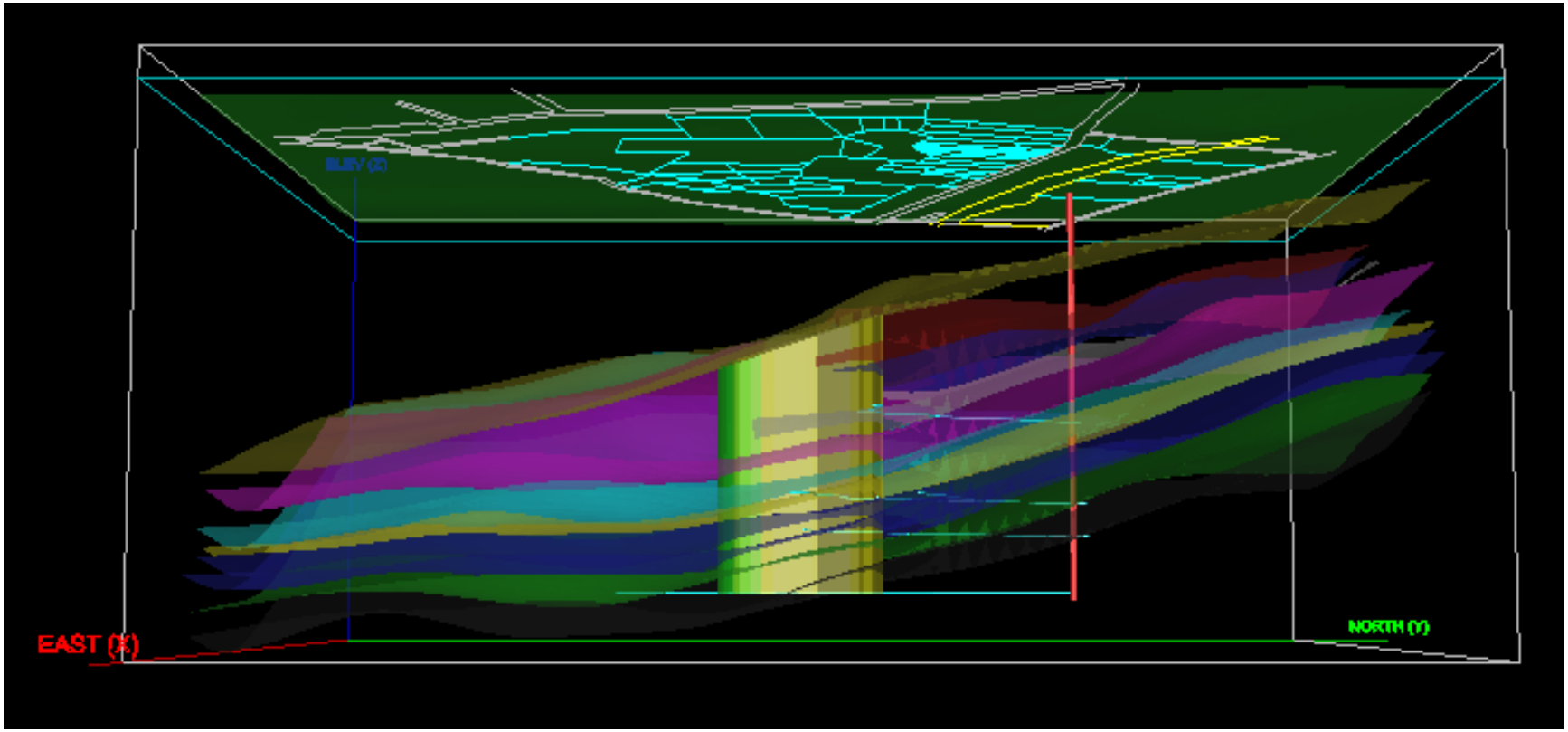
East 4

The surveyed points exhibiting this characteristics seem to belong to the same plane

Hypothetic plane of the tectonic ramp in a 3D model.

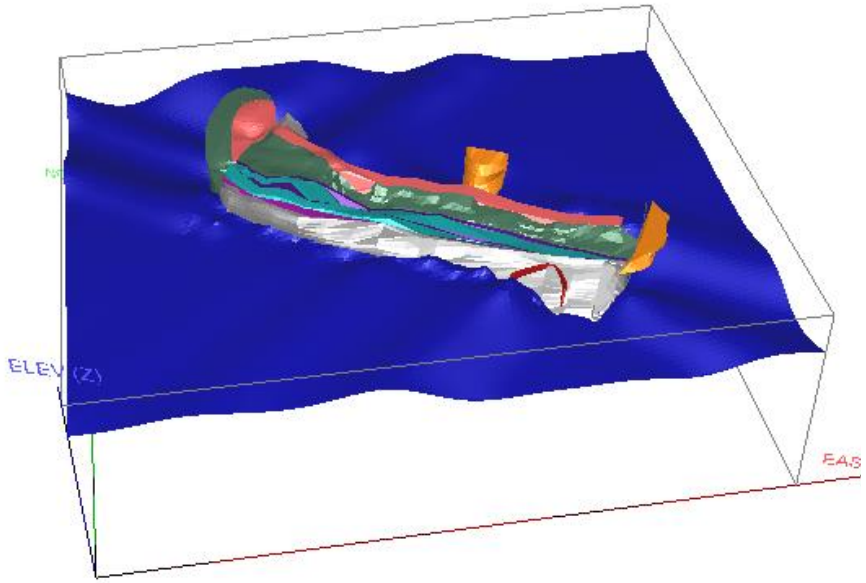


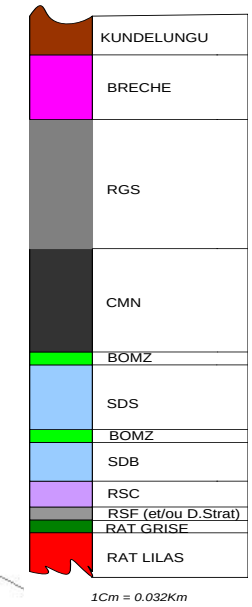
Bernissart: underground mine

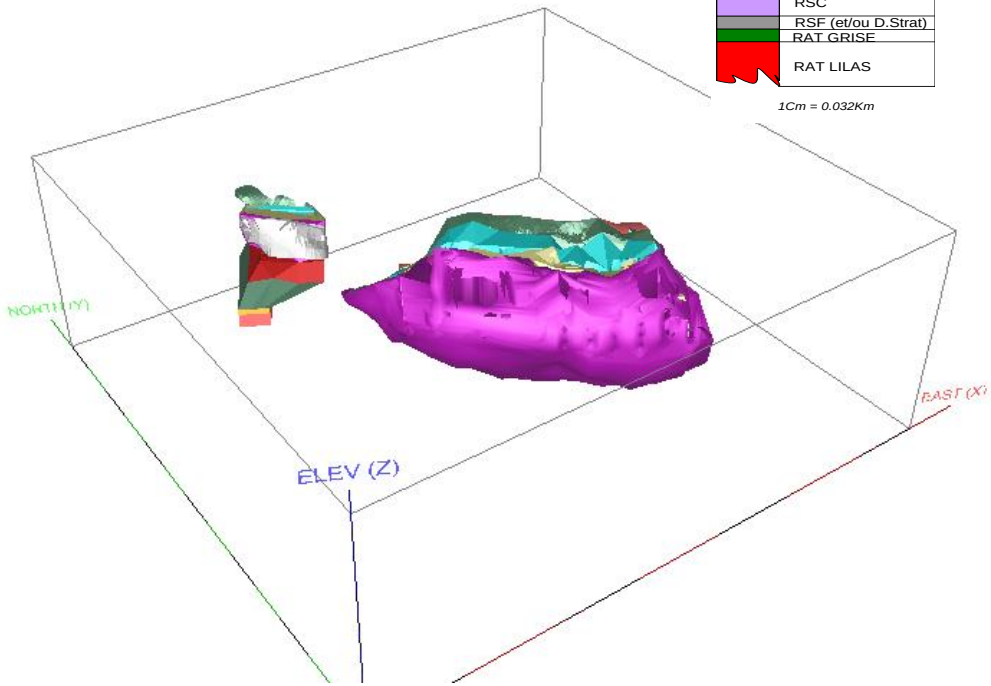


Ruashi copper deposit: example of a complex geometry

Ruashi 1







Ruashi 2 et 3

Block modelling

Three methods can be used:

a. Nearest point method (Massif 1 kimberlite pipe D.R. Congo)

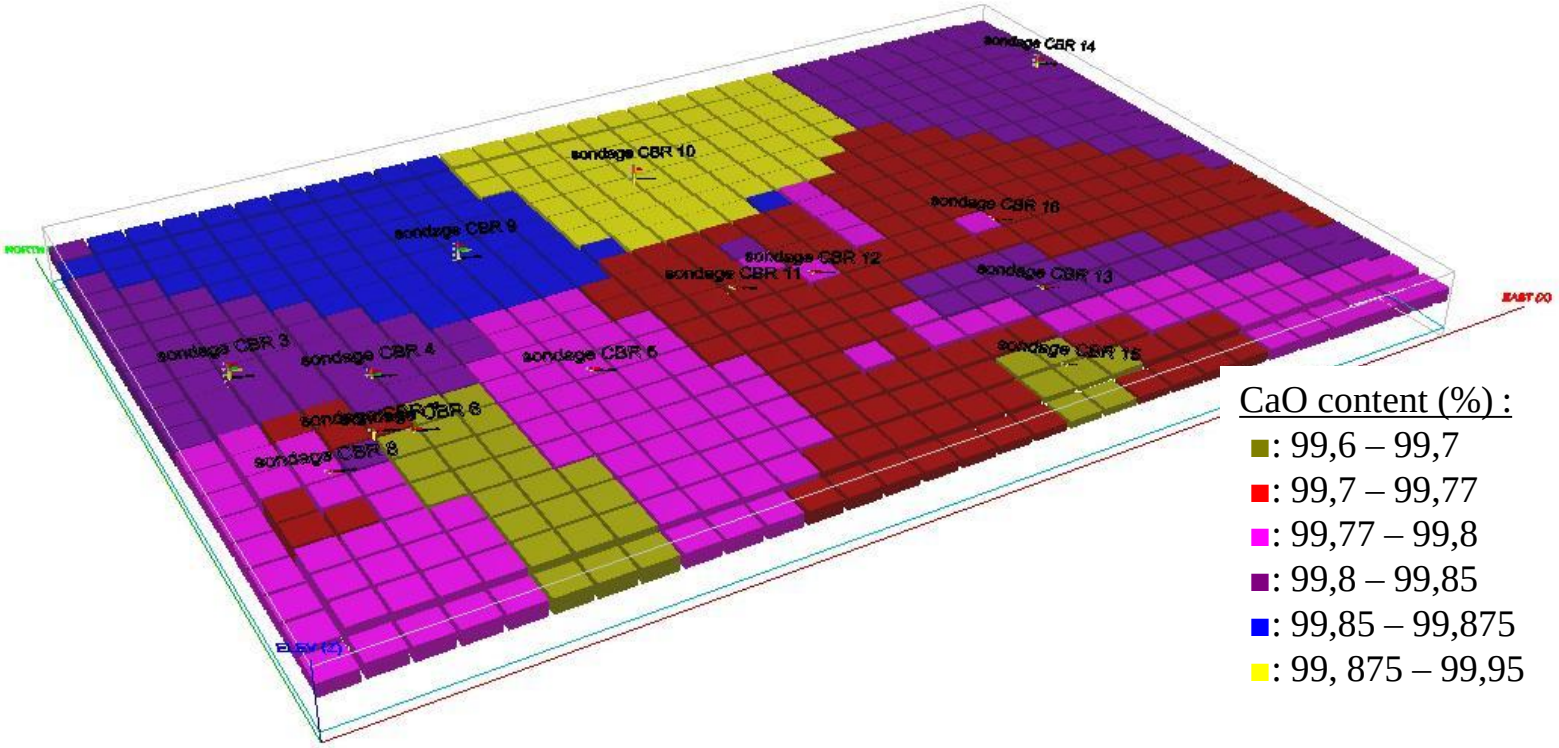
b. Inverse distance

c. Geostatistical kriging

For the inverse distance and the geostatistical methods the estimator of the unknown variable (grade, density, strength, etc.) if of the form:

$$Z^* = \sum_{i=1}^{n} \lambda_i \, x_i = \lambda_1 x_1 + \lambda_2 x_2 + \lambda_3 x_3 \ldots + \lambda_n x_n$$

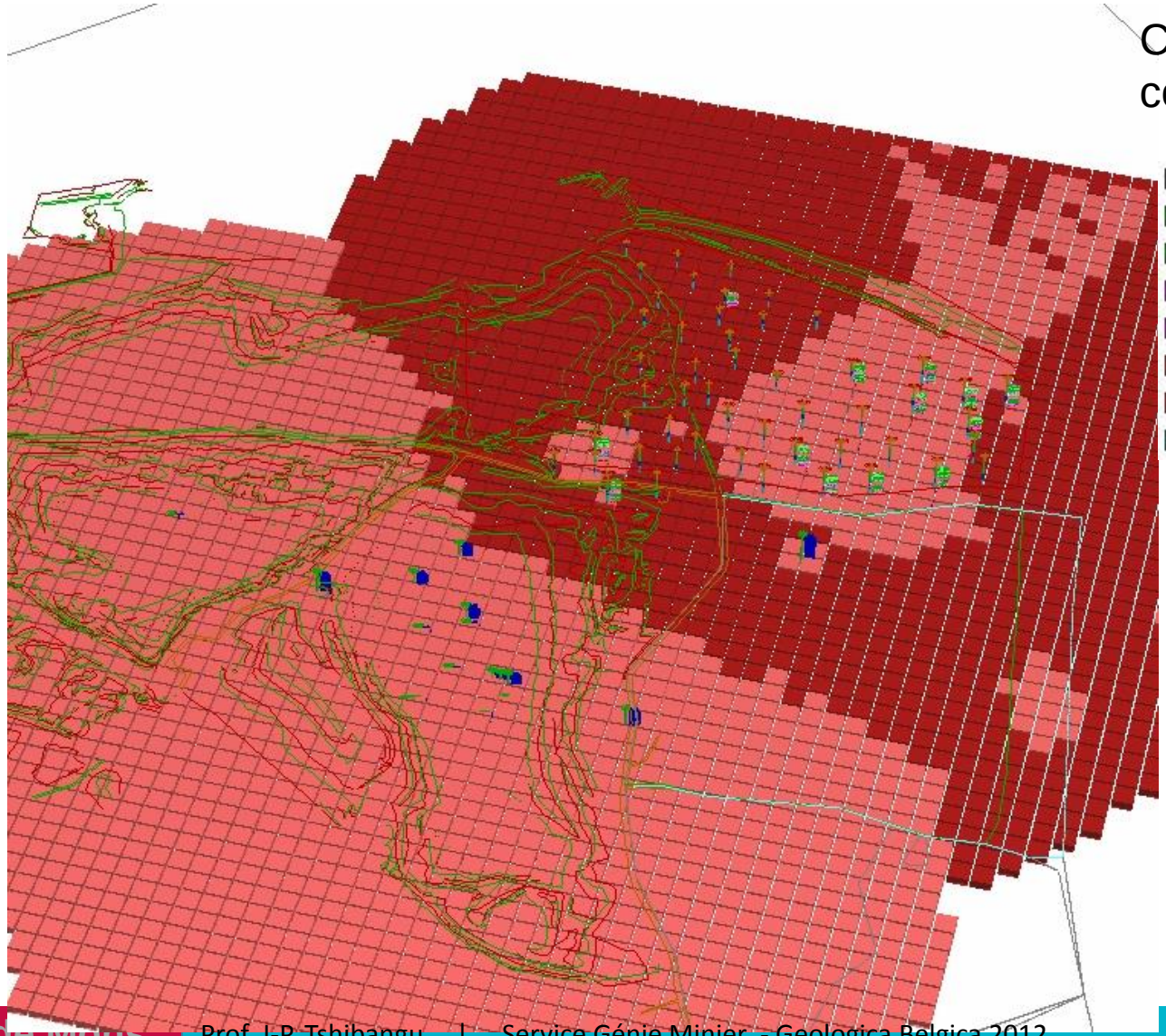
Chemical composition modelling on the Harmignies chalk quarry



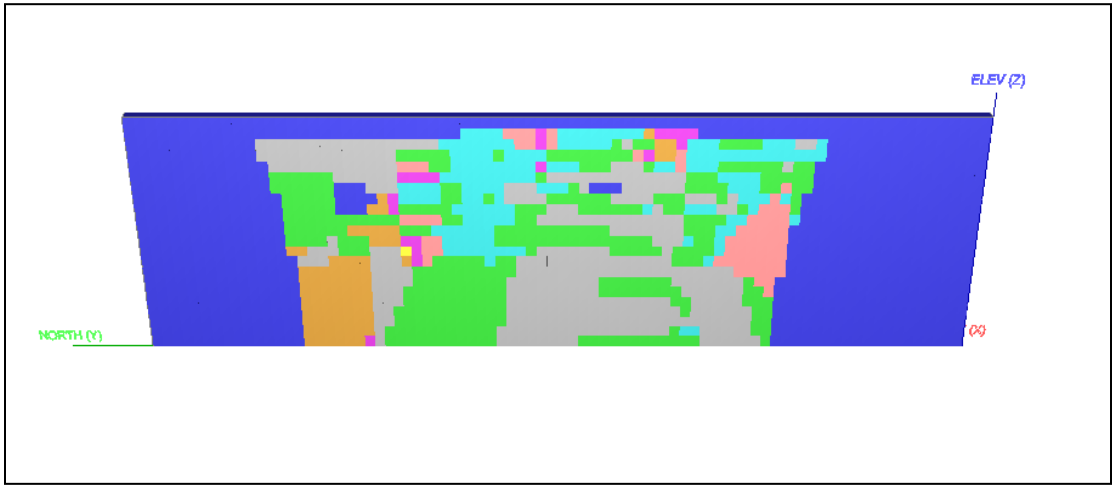
CaO content (%) :

- : 99,6 – 99,7
- : 99,7 – 99,77
- : 99,77 – 99,8
- : 99,8 – 99,85
- : 99,85 – 99,875
- : 99, 875 – 99,95

Distribution of CaO content ont the Tournai's region, case of Pont-a-Rieu layer



Massif 1 pipe – Miba : Distribution of grades



Average grades:

-sandstones, sand : 1.31 cts/m³

-Epiclastites : 1.9 cts/m³

-Xenokimberlites : 2.04 cts/m³

-Green Kimberlites : 2.76 cts/m³

- 0-0.1 cts/m³
- 0.1-1 cts/m³
- 1-2 cts/m³
- 2-3 cts/m³
- 3-4 cts/m³
- 4-5 cts/m³
- 5-6 cts/m³
- 6-7 cts/m³
- 7-15 cts/m³

Thank you for attention