

On Measuring the Spatial Sampling Density of a Deposit for Mineral Resource Classification

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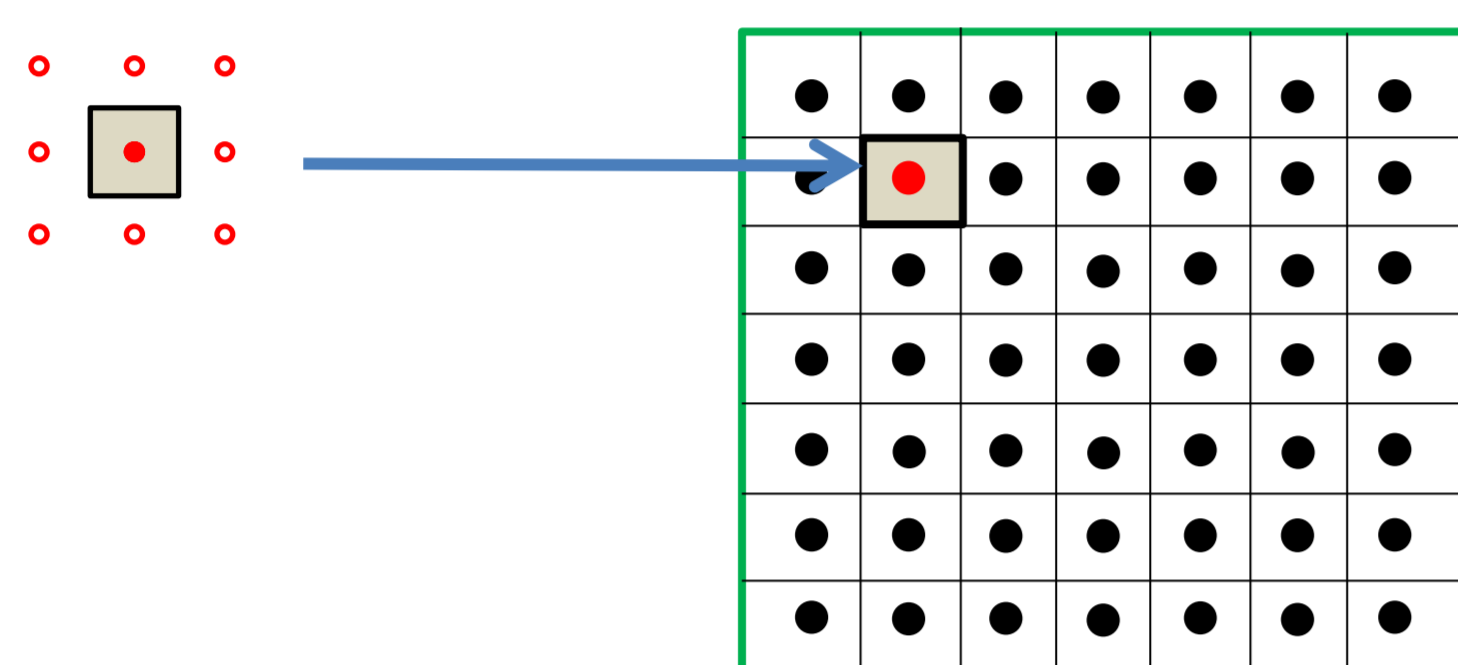
Spatial Sampling Density (regular sampling)

From estimation variance

(additive resource $Z(x)$ with variogram $\gamma(h)$ and mean M)

block v estimated by its center

domain V estimated by the mean of N regular samples



$$\sigma_e^2(Z_v) \Rightarrow \sigma_e^2(Z_V) = \frac{\sigma_e^2(Z_v)}{N} = \frac{\sigma_e^2(Z_v)|v|}{|V|}$$

to Spatial Sampling Density Variance (SSDV):

$$\sigma_e^2(Z_V)|V| = \sigma_e^2(Z_v)|v| = SSDV$$

or Specific Volume (Area in 2D):

$$V_0 = \frac{SSDV}{M^2} = \frac{\sigma_e^2(Z_v)|v|}{M^2}$$

The same for v and V , they do not depend any longer on the number of blocks N
They measure the efficiency of the sampling pattern, irrespective of the size of the domain

Use of SSDV for resource classification:

A Nickel Laterite deposit example

SSDV and V_0 allow computing estimation variance and coefficient of variation (CV) for a given volume V (e.g. production)

$$\sigma_e^2(Z_V) = \frac{SSDV}{|V|}$$

$$CV = \frac{\sigma_e(Z_V)}{M} = \sqrt{\frac{V_0}{|V|}}$$

Focus on the earthy saprolite

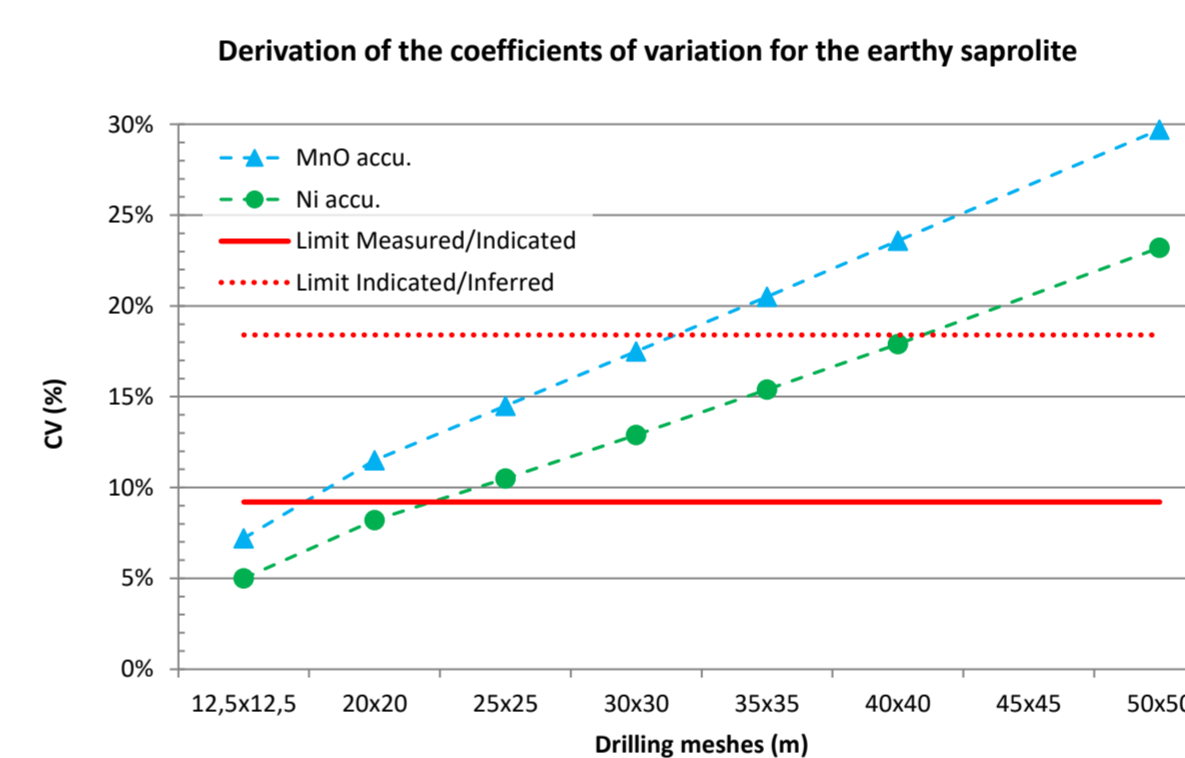


✓ Choice to work in 2D for each layer

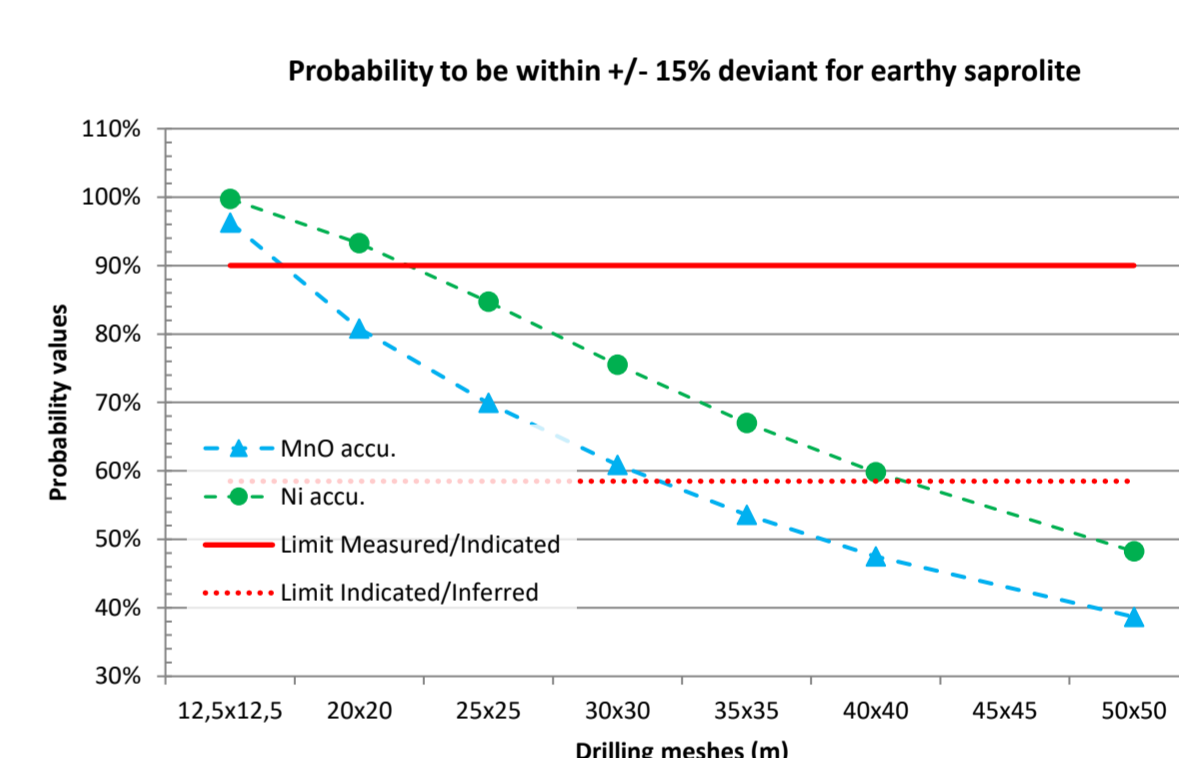
Thickness
Nickel (Ni) accumulation
Manganese oxide (MnO) accumulation

Drilling meshes (m)	Accu.	12.5x12.5	25x25	50x50
Earthy saprolite	MnO	135	553	2324
	Ni	66	292	1415

Values of the specific areas in m^2 for different drilling meshes



Evolution of the coefficient of variation with the drilling mesh for the earthy saprolite

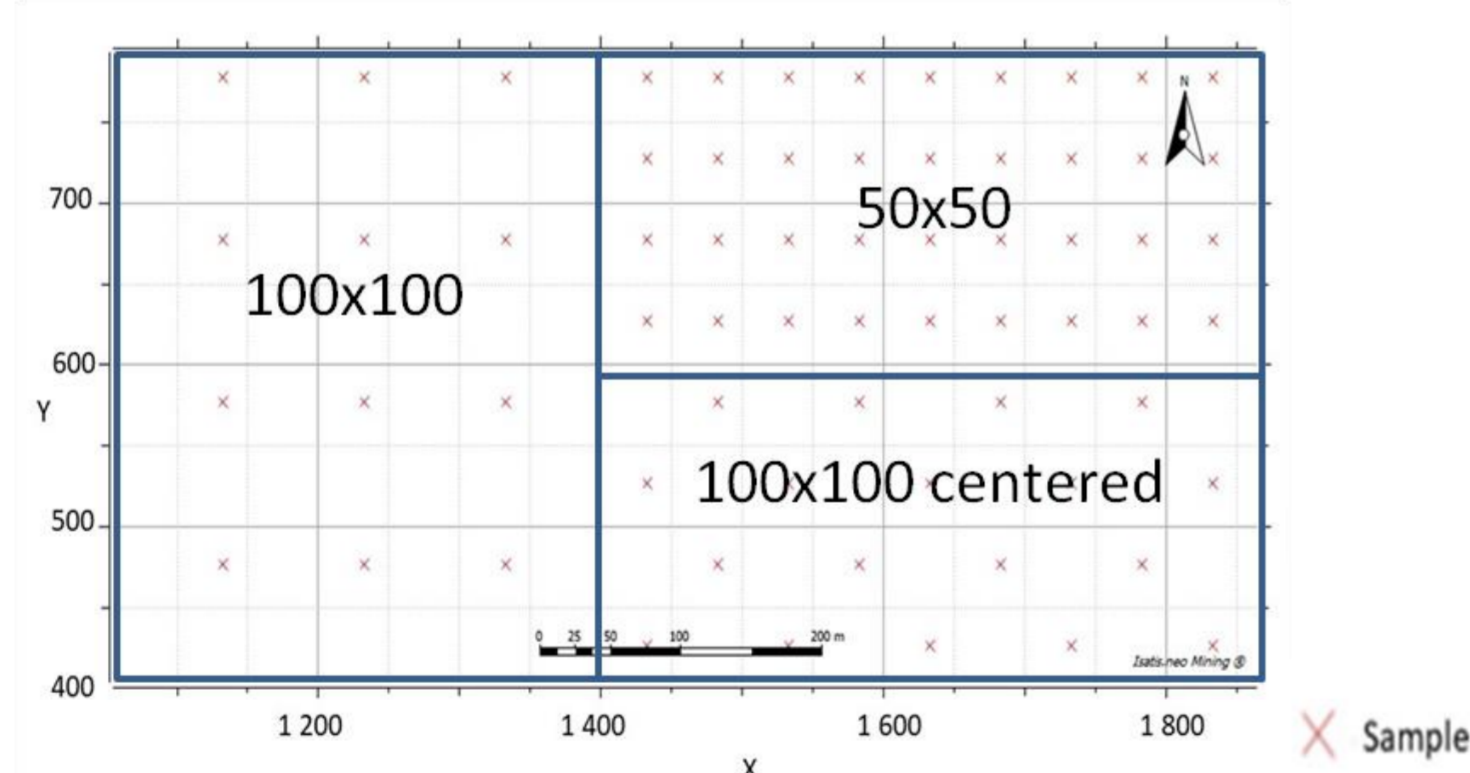


Results can also be displayed in terms of probability

Classification using specific area has been compared to classification using geostatistical simulation: results are in close agreement

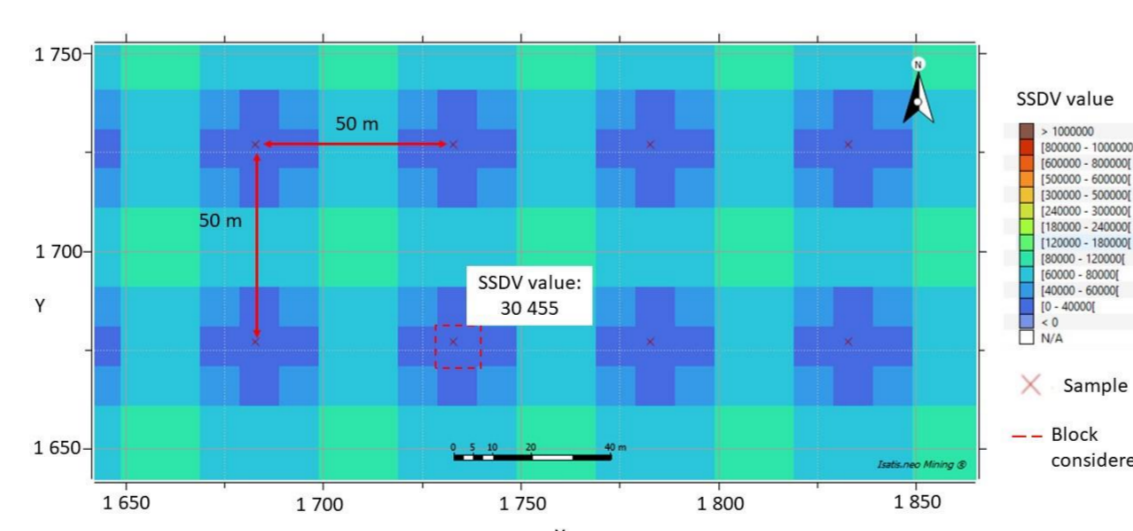
Isatelle, F., Rivoirard, J. (2019). Mineral Resources classification of a nickel laterite deposit: Comparison between conditional simulations and specific areas. *Journal of The Southern African Institute of Mining and Metallurgy*, 119 (10)

Mapping Spatial Sampling Density when refining regular grids

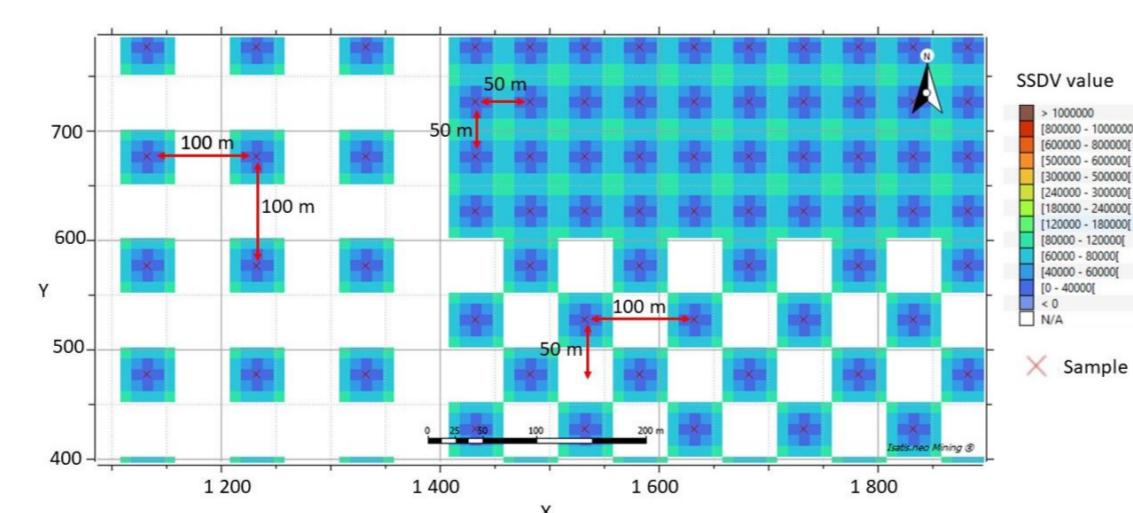


Mapping using a moving superblock having the size of the mesh. Here 50 m x 50 m

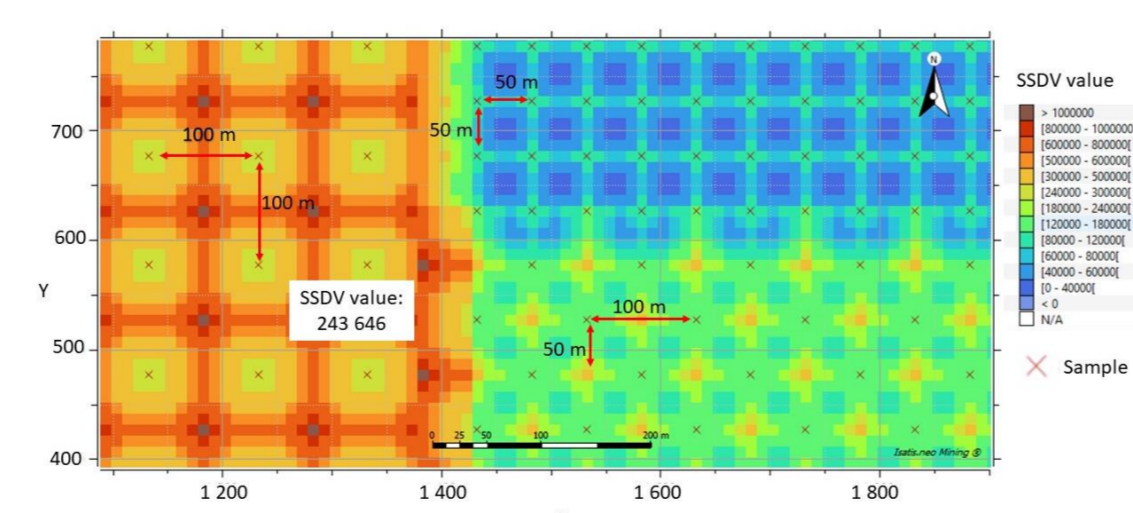
- Correct for superblock centered on sample
- Undesirable fluctuations otherwise



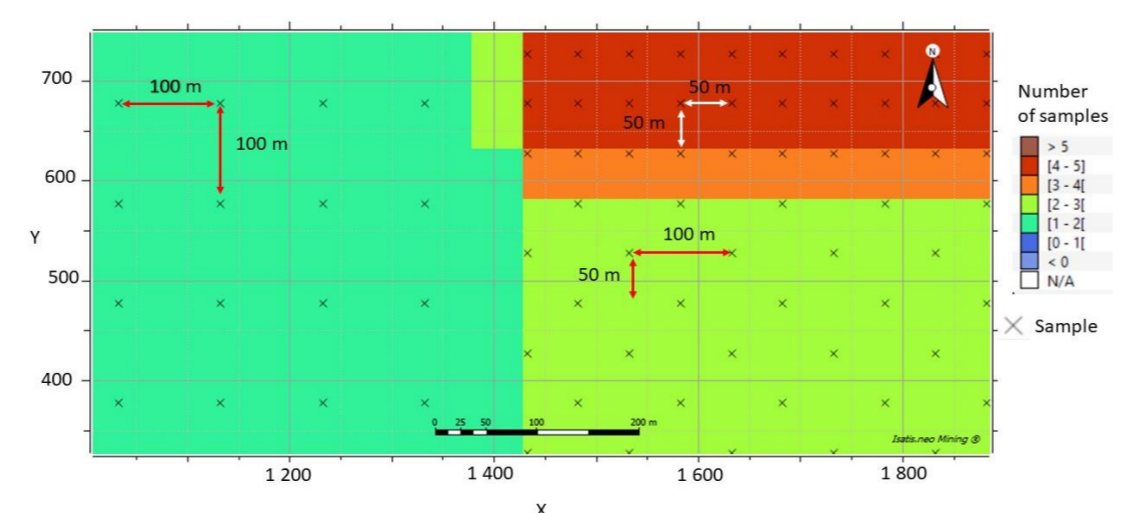
50 m x 50 m superblock
➤ Too small for larger meshes



100 m x 100 m superblock
➤ Best but not ideal
In particular for centered 100 m x 100 m grid



➤ Prefer direct SSDV computation for each regularly sampled area to its mapping. Suppose delineation of areas. Here is the number of samples in a moving 100 m by 100 m superblock

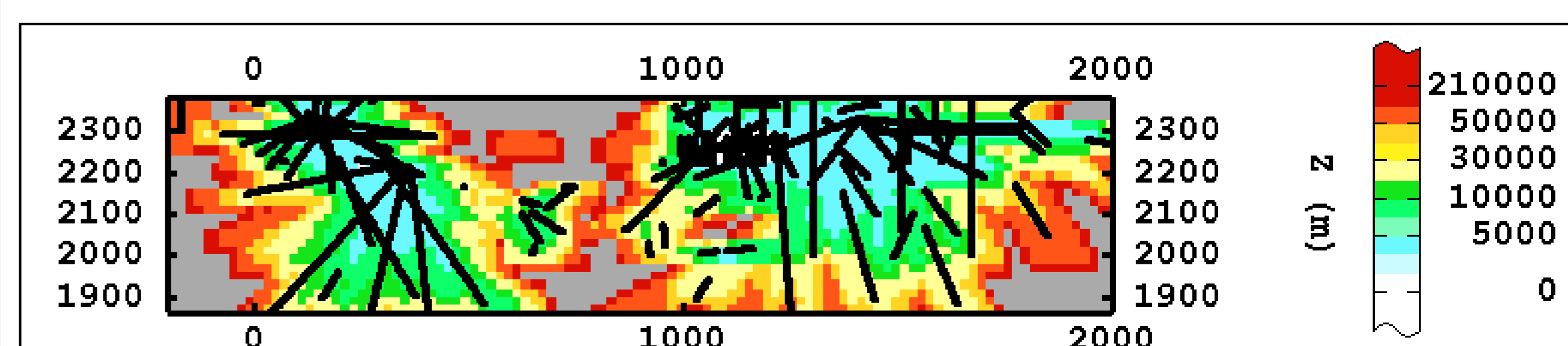


Spatial Sampling Density

(irregular sampling)

Mapping SSDV using moving superblock

The choice of the size of superblock is important



Cross-section, El Teniente porphyry copper deposit