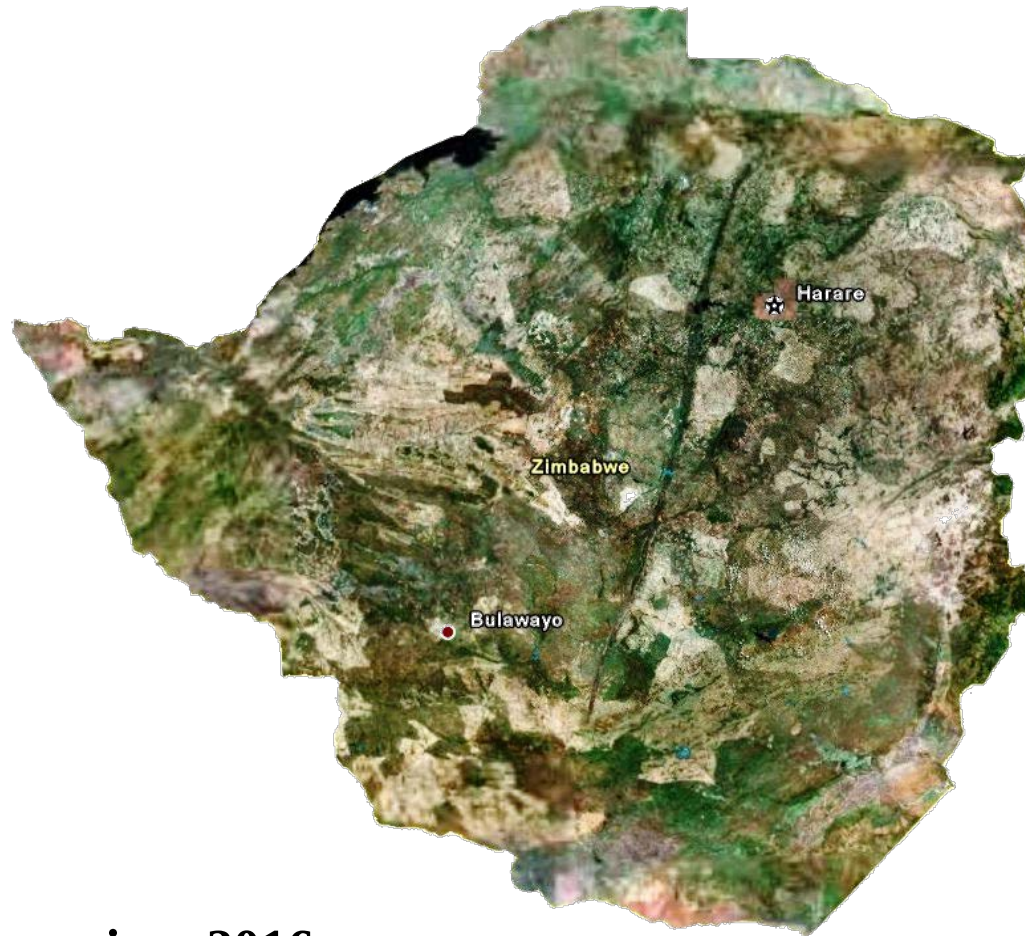


Mineral Resource Estimation techniques for shallow dipping ore bodies - A case of the Great Dyke



Background

Objective : Mineral Resource estimation forms the basis for proving or otherwise dis-proving, the viability of any mining project.

Common Pitfalls:

- Overestimation may lead to the construction of a mining operation where no profitable ore body exists.
- Underestimation - potentially feasible operation being disposed of when it actually represents a potentially profitable mine or lifespan prematurely shortened

Grade Estimation

Grade Estimation Components:

- Geological modelling
- Geostatistical modelling
- Classification (JORC, 2012)

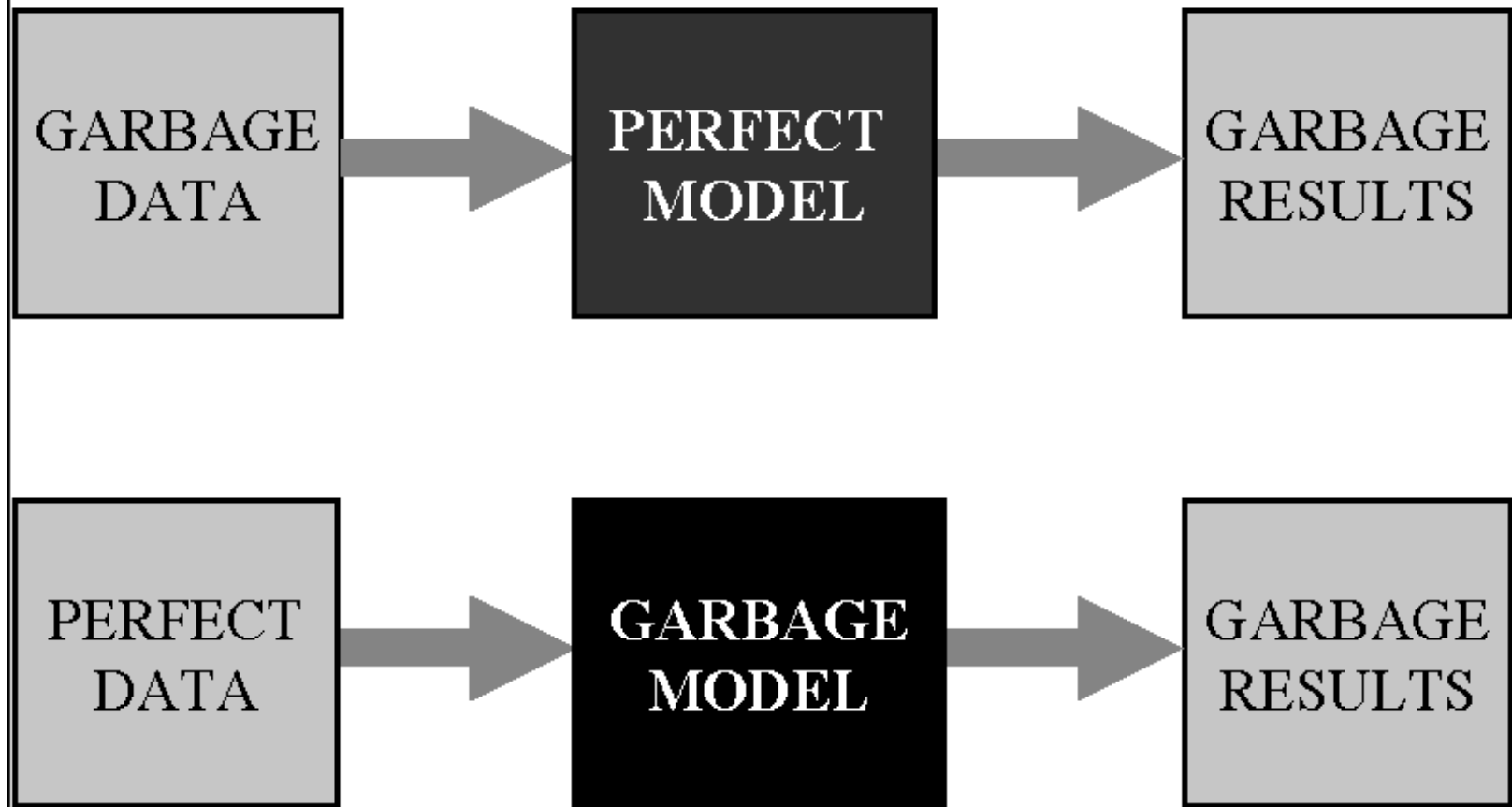
Considerations

- Sampling density
- Reliability of data
- Specific purpose of estimation
- Required accuracy

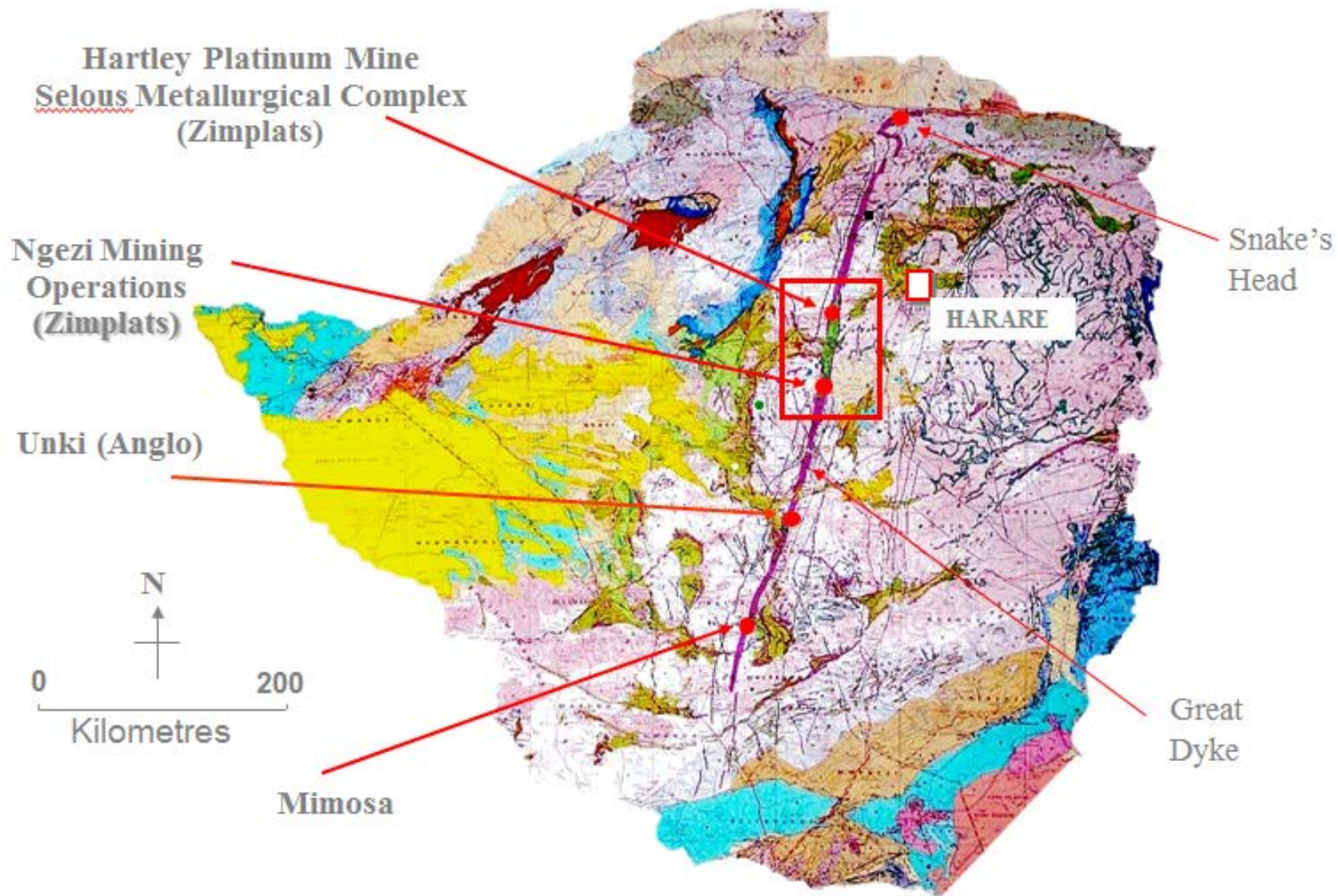


MODEL CALCULATIONS

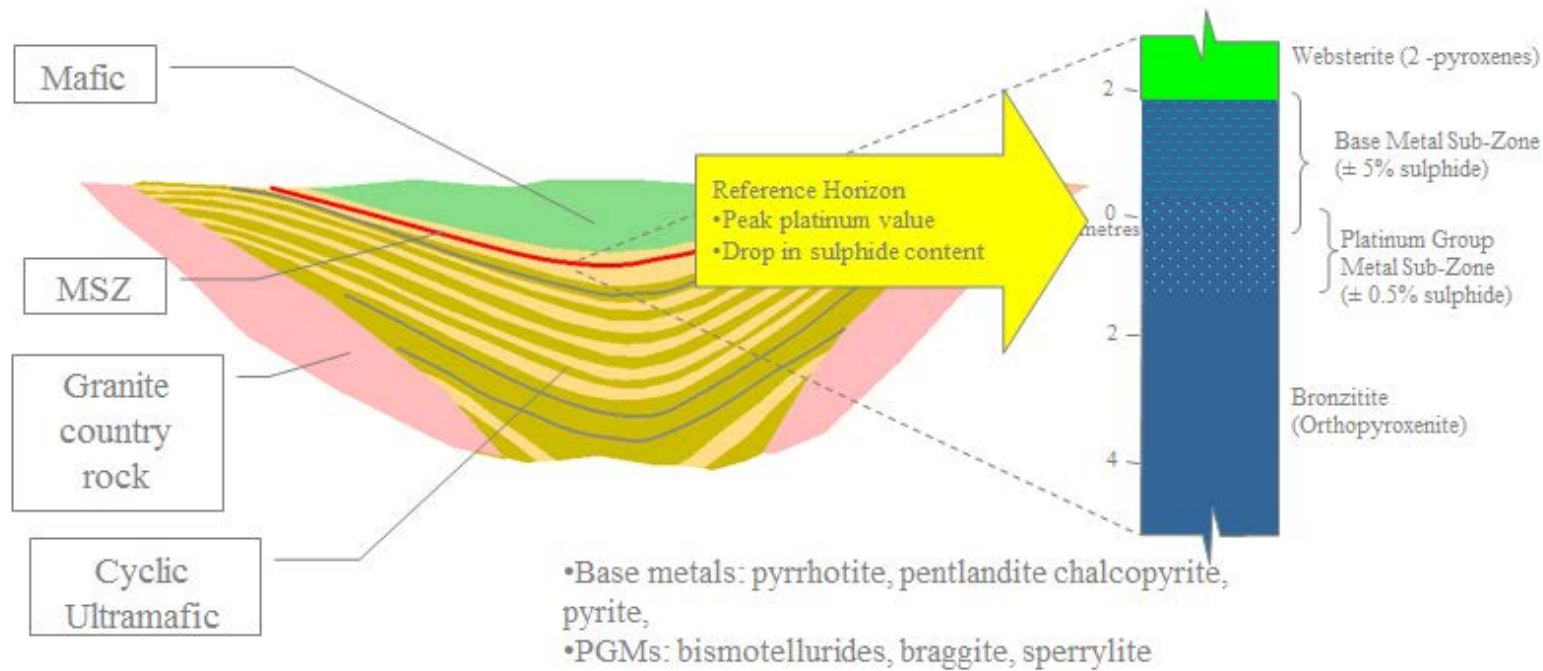
”Garbage In-garbage Out” Paradigm



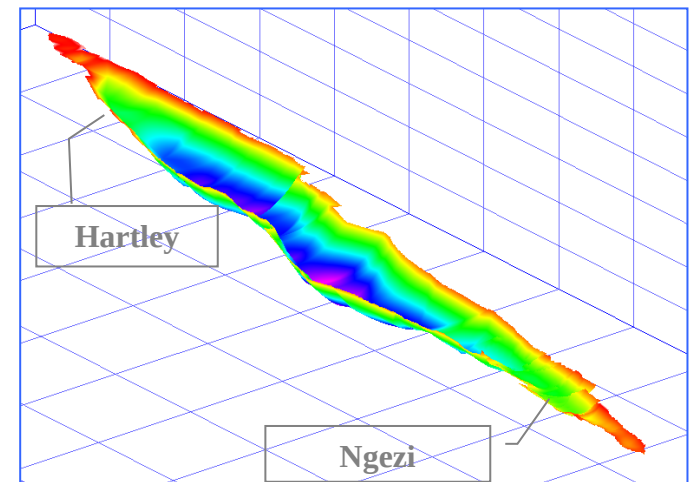
Platinum on the Great Dyke



Diagrammatic Cross Section



3 Dimensional Structure



- Most mining associated with central flat zone 0-11° .
- The steeper flanks of between 11-21° host a substantial resource.

Geological Modelling: Domains

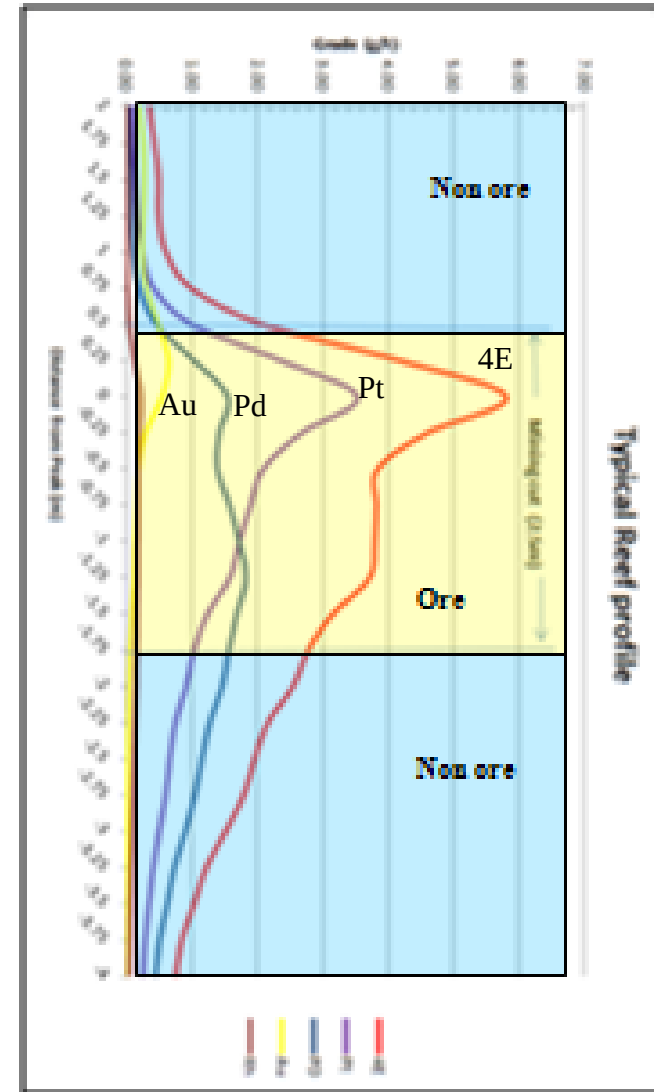
Domain represents an area or volume within which the characteristics of the mineralisation are more similar than outside the domain.

- Ore /non ore,
- Oxide/sulphide
- High grade/low grade

Hard boundary

- characterized with a sharp ore and non-ore boundary
- Ore/Non-ore domain corresponding to the mining cut.

Traditional Block Model

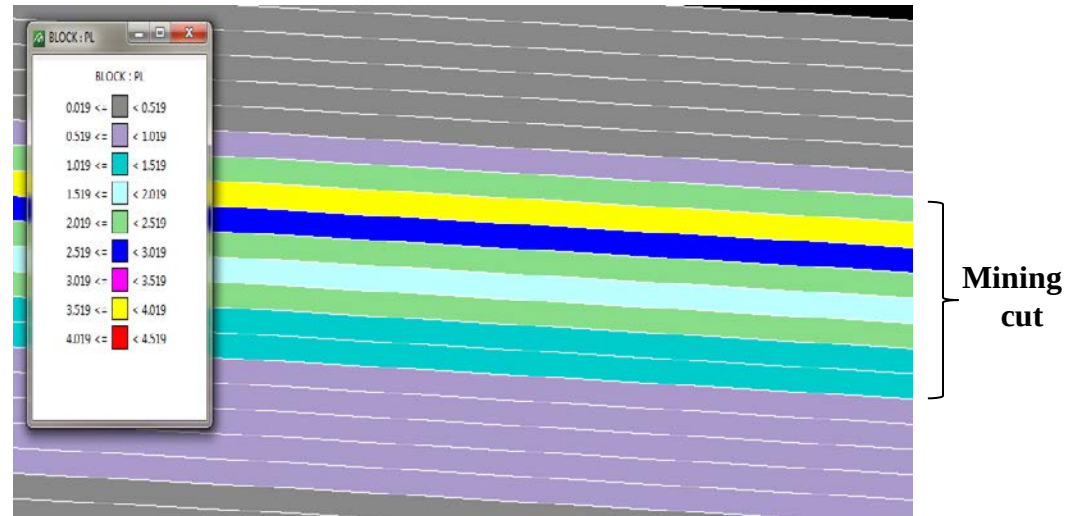
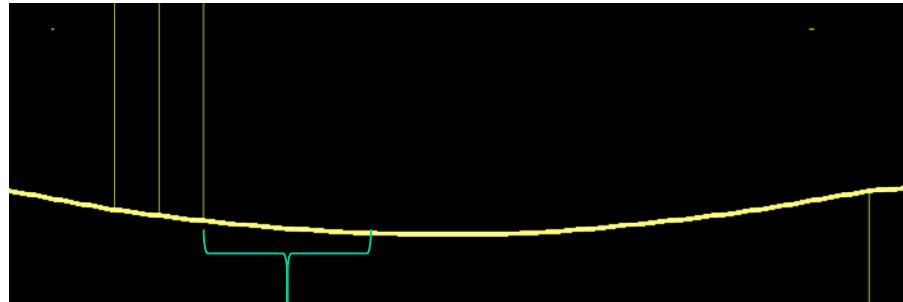


Domains – Soft boundary

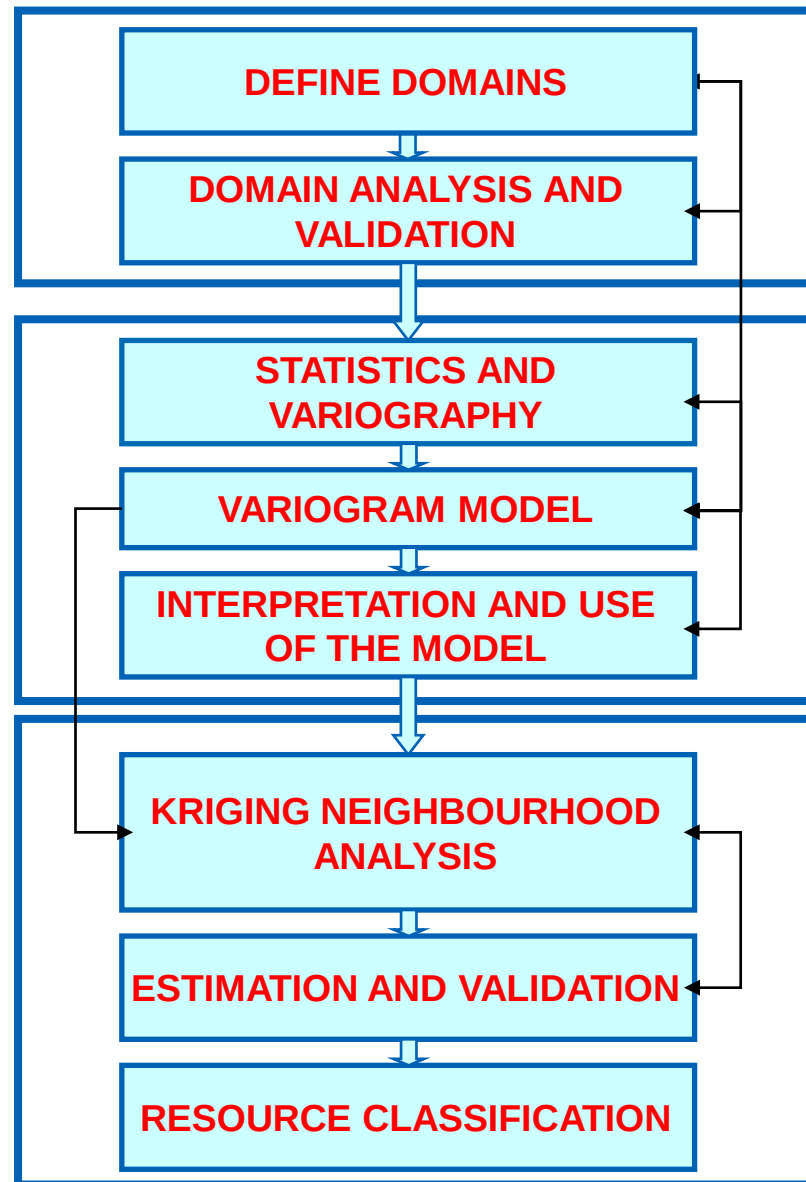
Soft boundary

- allow for grades from either side of the mining cut, to varying degrees
- sampling intervals
- HARP – Horizon Adaptive Rectangular Prism

HARP Model

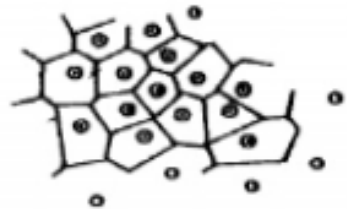


Geostatistical Modeling - Flow Chart

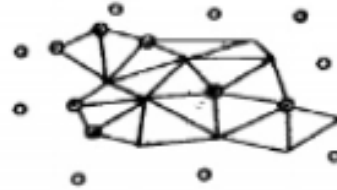


Geostatistical Modelling - Methods

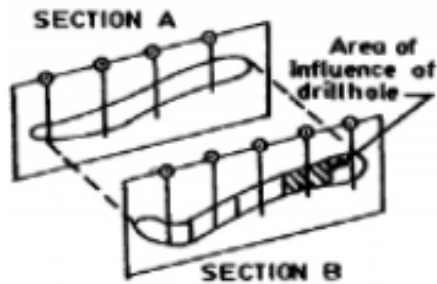
Traditional



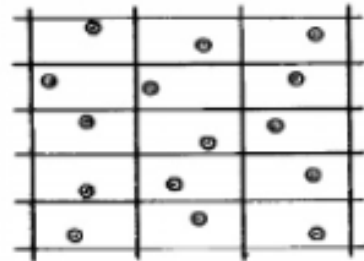
1. POLYGONAL METHOD



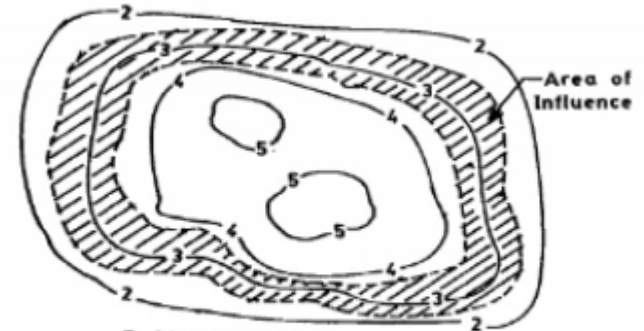
2. TRIANGULAR METHOD



3. SECTIONAL METHOD



4. RANDOM STRATIFIED GRID METHOD.



5. CONTOURING METHOD

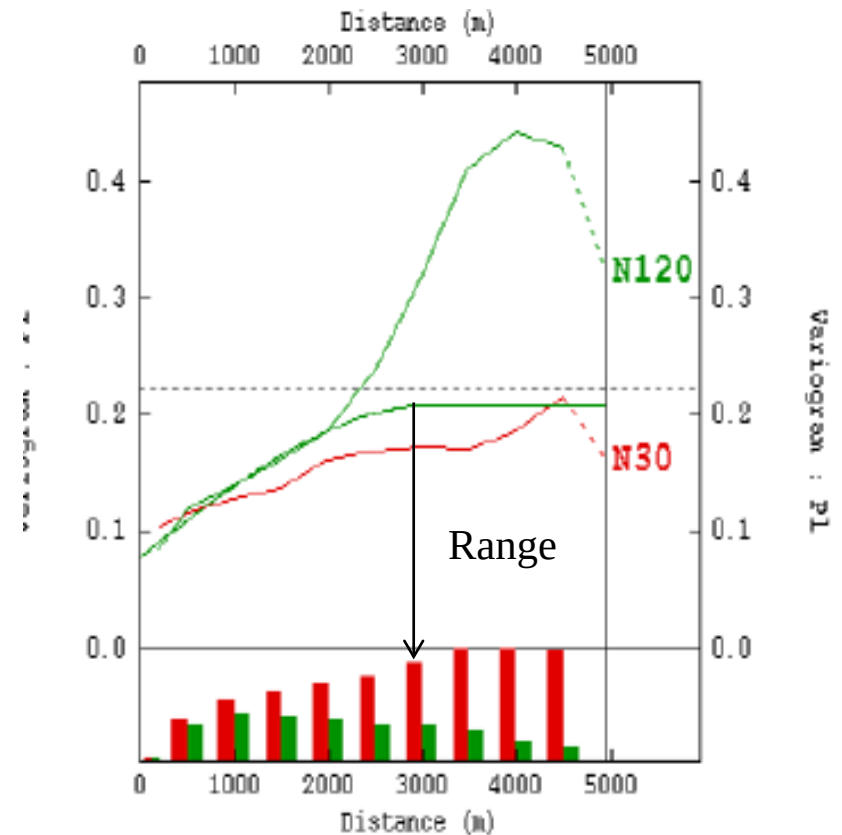
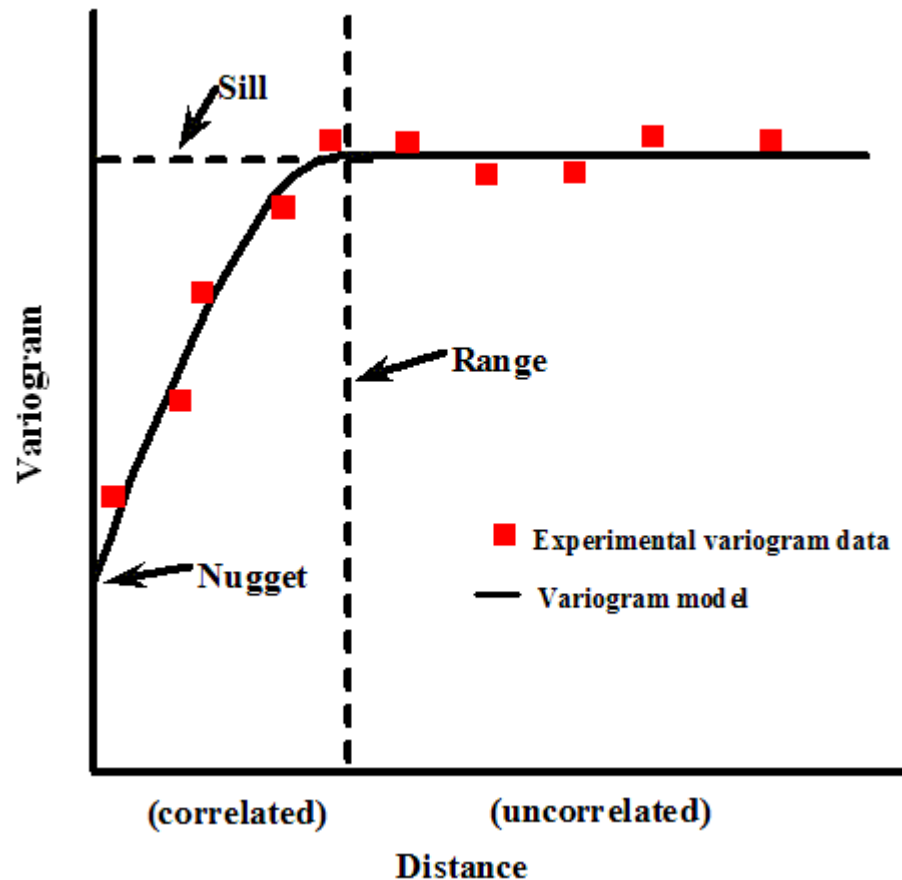
● Ore Intersection ○ Barren Intersection

Geostatistical

- Inverse Distance Weighting
- Ordinary kriging - known mean,
• moving neighbourhood
- Simple kriging – known mean
- Simulations

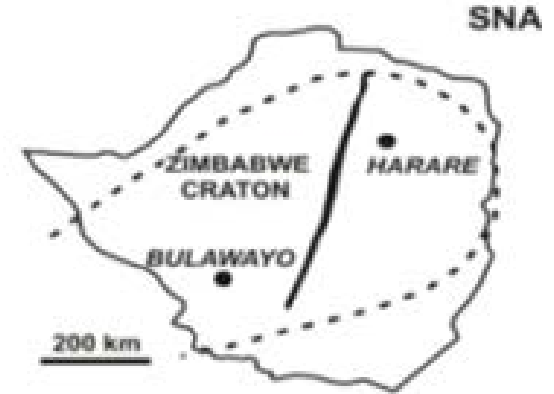
Geostatistical modelling - Variograph

A variogram quantifies the spatial variability by factoring distance and direction.

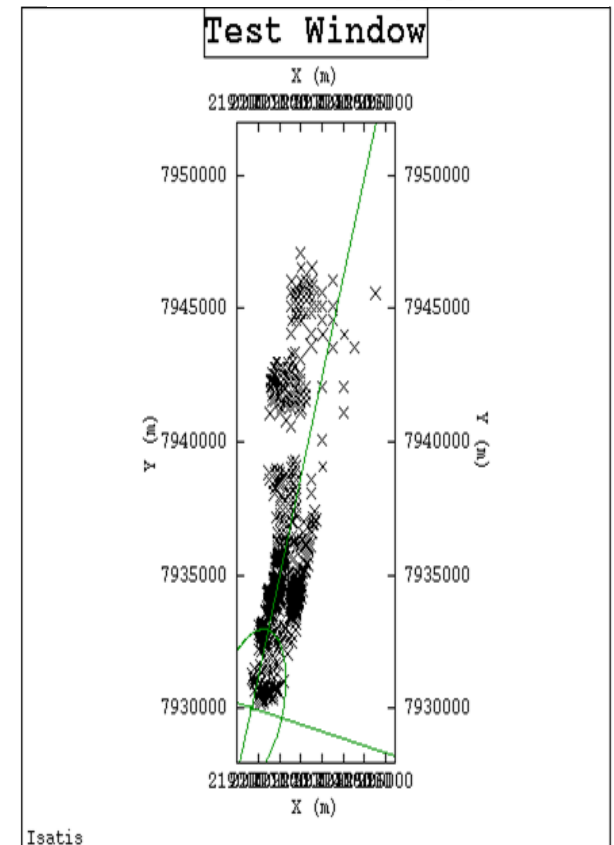


Geostatistical Modelling – Anisotropy

- At Zimplats anisotropy was identified at 30° corresponding to the long axis (NNE trend) of the Great Dyke. This corresponds to the East-West variation in profile.



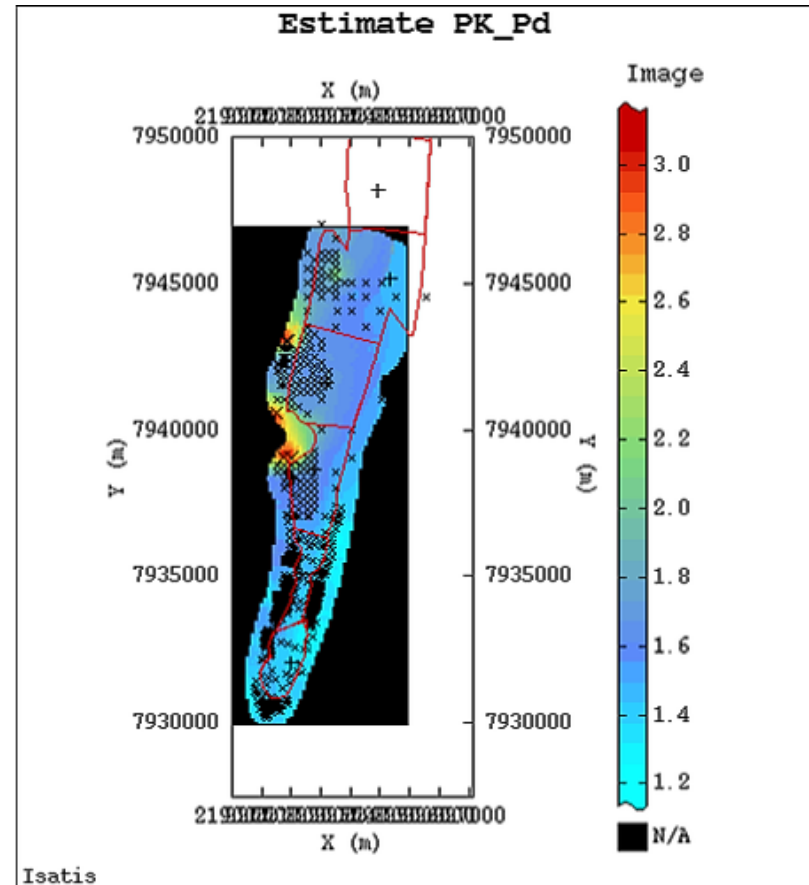
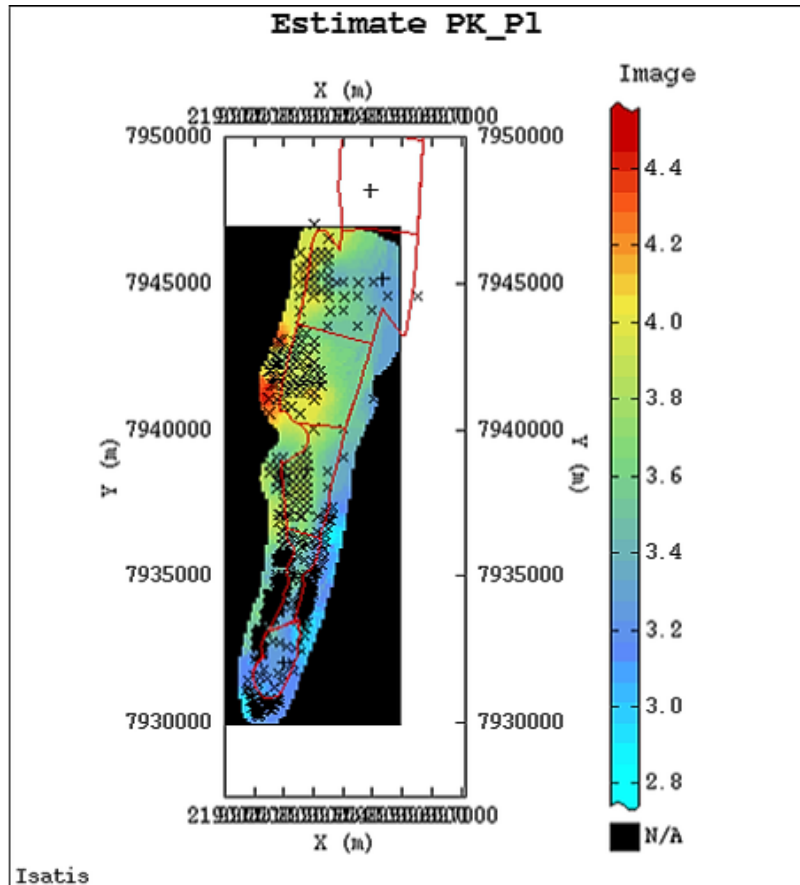
Search ellipsoid Parameters		
	Run 1	Run 2
X Radius	750	3000
Y Radius	325	1500
Z Radius	3115	3115
Rotation Z	30°	30°
Number of Sectors	4	4
Minimum # information	8	8
Optimum # information	Variable by element and layer	Variable by element and layer
Discretisation X	5	10
Discretisation Y	5	10
Discretisation Z	1	1



Isatis

Geostatistical Modelling – Bull's eye

- Can reveal some subtle controls on mineralisation not immediately evident in the geology.
- Mulota Hill – Disrupted mineralisation profile. Characterised by elevated grades to give an impression of high grade zone



Resource Classification

- Resources classified based on geological knowledge and surface drilling density in line with JORC code.

Category	Geological Confidence	Ore Body and Grade Continuity	Data Quality	Horizontal Drill Spacing
Measured	High	Confirmed	Detailed/Reliable	Up to 250m by 250m
Indicated	Reasonable	Assumed	Sufficient	Greater than 250m by 250m up to 1,000m by 1,000m
Inferred	Low	Unknown	Uncertain	Greater than 1,000m by 1,000m



Thank You.