A comparative analysis of implicit modelling and geostatistical methods for geometallurgical block modelling and resource estimation

T Chauke
Affiliation: University of South Africa

25 – 26 June 2025

4TH DIGITAL TRANSFORMATIONIN MINING CONFERENCE

Define tomorrow.

UNISA college of science, engineering and technology

Introduction

- Geometallurgy combines geology, engineering, metallurgy, and environmental aspects.
- Geometallurgical block models integrate grade, ore hardness, and recovery attributes in 3D.
- These models support mine planning, blending, extraction, and processing decisions.

Common estimation methods:

- Geostatistical methods (preferred)
- Implicit methods
- Simulation methods

Research Gap and Objective

- Many geometallurgical variables show complex, non-linear spatial behaviour.
- Implicit modelling techniques like FastRBF are underexplored in this context.
- There is limited comparative analysis of implicit and geostatistical method for geometallurgical estimation.

This study therefore fills this gap by comparing the two methods in terms of their ability to estimate geometallurgical variables (TCo, BWI, and RQD), capture spatial variability, define grade classification boundaries, and support operational decision-making.

Dataset Overview

Data type: Secondary drillhole dataset (All quality checks of the data was perfomed)

Sources:

- Iverland Mining reported by Mboyo (2018). Cobalt exploration data (DRC)
- Dehaine et al. (2021) and Mambwe et al. (2022). Geometallurgical parameters

Modelled variables:

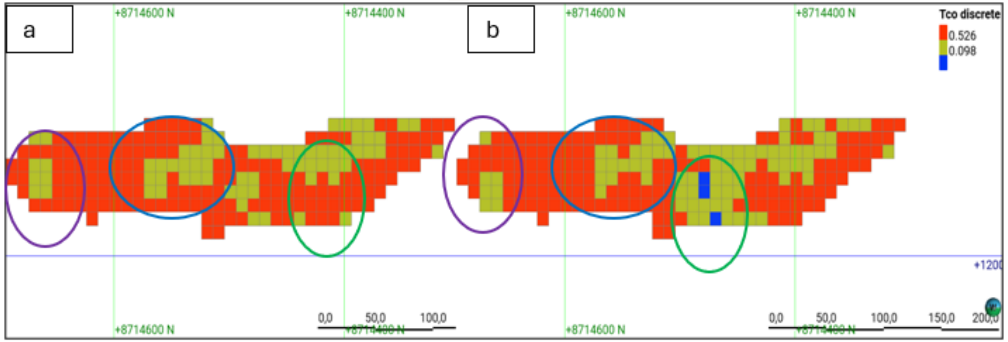
- Total Cobalt (TCo): Mean = 0.80%
- Bond Work Index (BWI): Mean = 11.12 kWh/t
- Rock Quality Designation (RQD): Mean = 49.58%

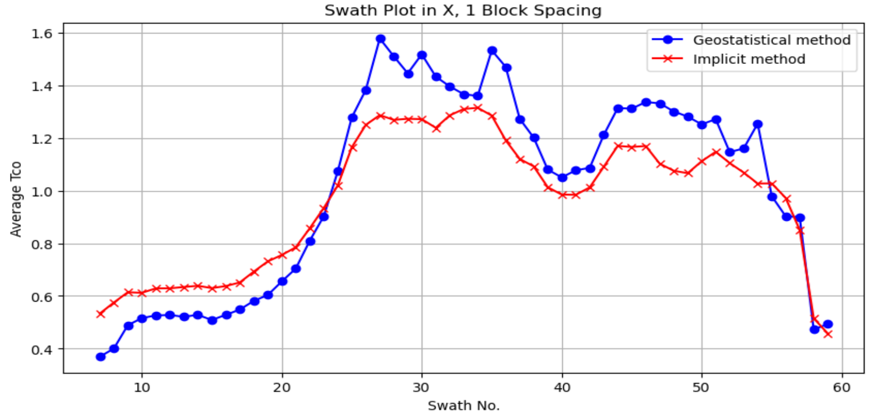
Methodology Overview

Component	Details
Software	Leapfrog Geo Edge
Estimation Methods	FastRBF (Implicit Modelling) Ordinary Kriging (Geostatistical Modelling)
Input Data	Composited drillhole dataset
Compositing	2 m fixed interval Intervals <50% length excluded
Variogram Model	Spheroidal Range: 200 m Sill: 1.081 Nugget: 0.1781
Block Model	Grid size: 10 × 10 × 10 m Total blocks: 6,416

Total Cobalt (TCo) Results

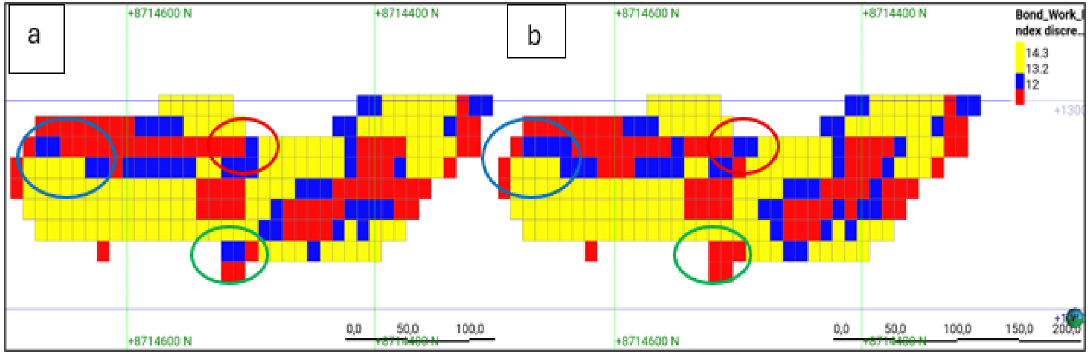
Metric	FastRBF	OK
Mean (%)	0.99	1.04
Max (%)	8.79	6.92
Std Dev (STD, %)	0.71	0.85
Coeff. Variation	0.71	0.81

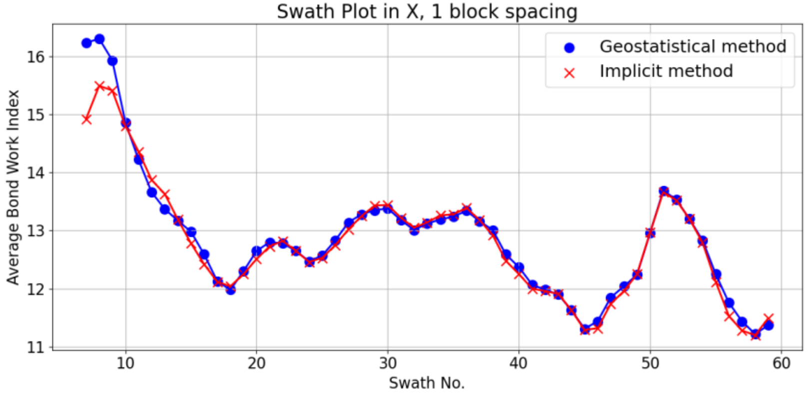




Bond Work Index (BWI) Results

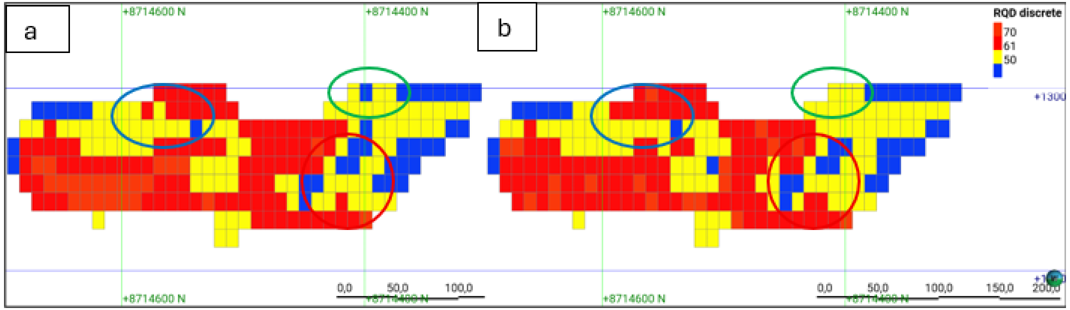
Metric	FastRBF	OK
Mean (kWh/t)	12.79	12.82
Max (kWh/t)	19.97	19.42
Std Dev (STD, kWh/t)	2.02	1.95
Coeff. Variation	0.16	0.15

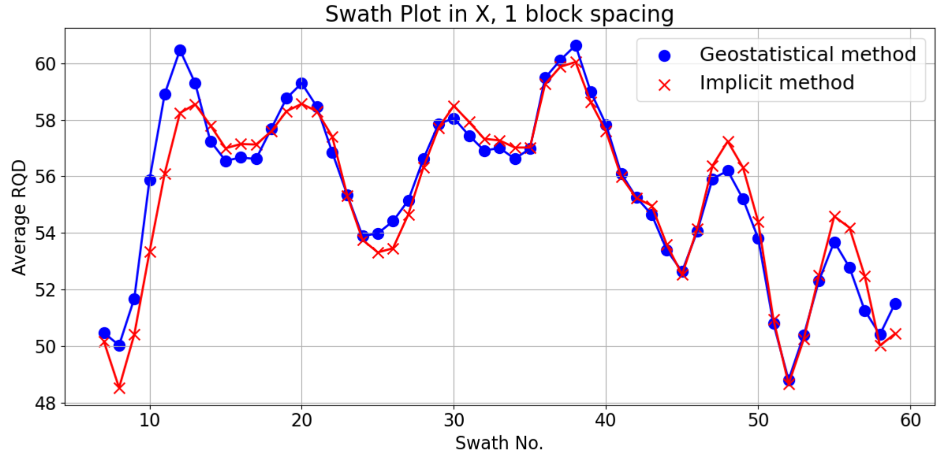




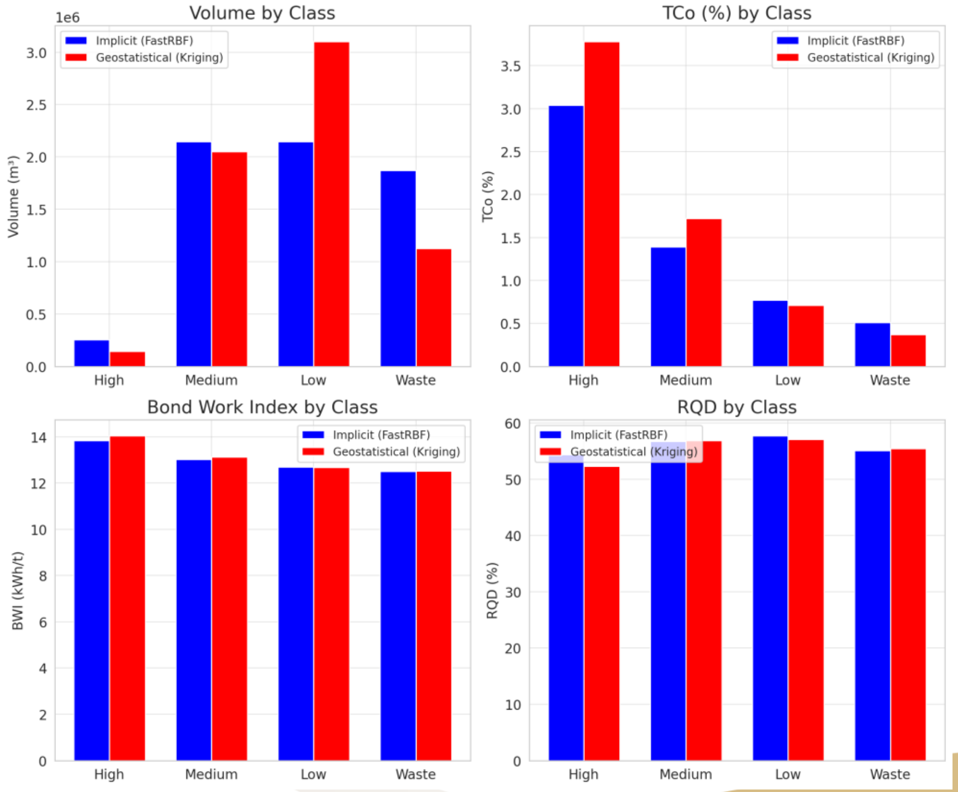
Rock Quality Designation (RQD) Results

Metric	FastRBF	OK
Mean (%)	56.49	56.62
Max (%)	75.85	71.31
Std Dev (STD, %)	10.41	10.04
Coeff. Variation	0.18	0.18





Resource Classification



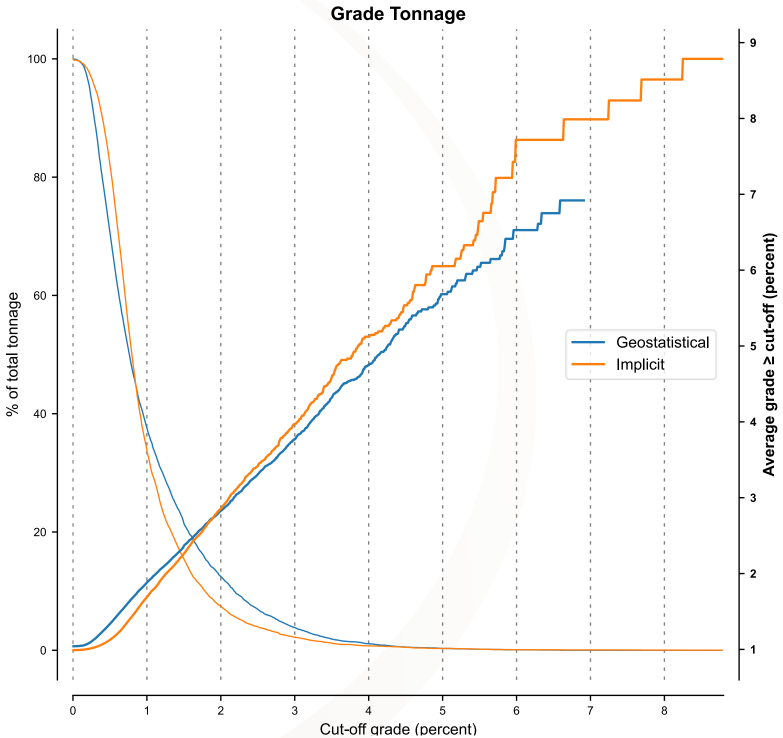
FastRBF: Broader classification, more waste.

OK: sharper classification, more high-grade precision.

Grade-Tonnage Curve

At 0.5% TCo cut-off:

- **FastRBF:** 11.29 Mt @ 1.12%
- **OK:** 11.36 Mt @ 1.34%



Economic Impact of Modelling Choice

- **OK** increases definition of high-grade zones. Supports selective mining.
- **FastRBF** smooths estimates. Reduces early-stage project risk.

Variability in BWI and RQD affects:

- Comminution circuit energy costs
- Crusher liner life
- Support strategy in stopes
- Model selection can shift NPV, IRR, and throughput targets.

Summary of Key Differences

Feature	**FastRBF**	**Ordinary Kriging**
Grade Smoothing	High - Medium	Low - Medium
High-grade Detection	Lower	Stronger
Waste Classification	Excessive	Tighter
Economic Risk Buffer	Better for exploration	Better for mine design

Conclusion

- Both methods are valid; each fits a different stage of the project.
- OK: Best for feasibility, production planning, and cost control.
- FastRBF: Better for early decisions, scoping studies, and trend visualisation.
- Combining both can optimise accuracy and efficiency.

Thank You