Exploring Block and Grid Modelling Philosophies in Stratiform Geology

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BATHURST
RESOURCES LIMITED

Modelling Choice Reflects Geology – But Historical Practice And Speed Often Shape The Framework

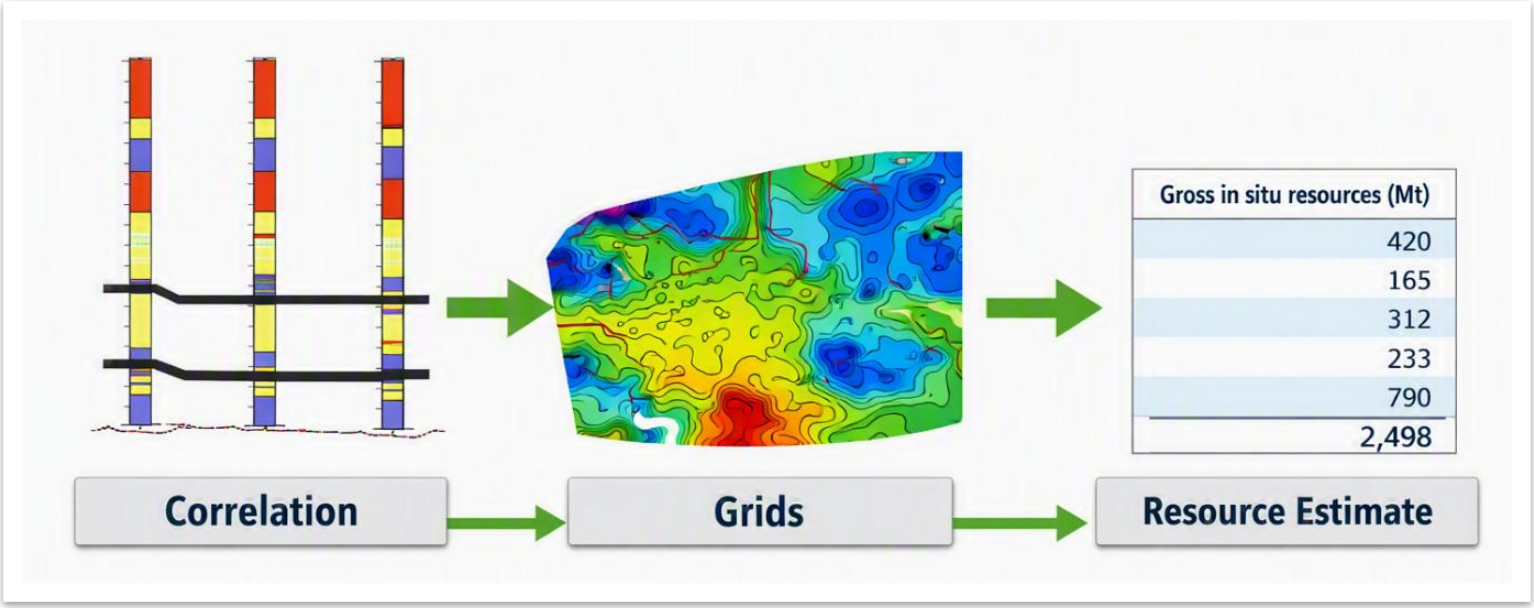
	2D Grid Based Models	Block Models
Deposit Type	Stratiform, laterally continuous seams (coal, lignite, potash, phosphate).	Irregular, massive, or structurally complex orebodies (hard-rock metals, polymetallic deposits).
Geometry	Simple, conformable layers with minimal faulting or folding.	Complex geometry with strong vertical variation, faulting, or intrusive contacts.
Data Structure	Borehole data with clear stratigraphic sequence; interpolation across 2D grids per seam.	Drillhole and assay data interpolated volumetrically in 3D; supports variable block sizes and sub-blocking.
Compositing method	Seam-based compositing — one averaged value per seam per borehole.	Fixed-length compositing — divides borehole data vertically for detailed grade control.
Outputs	Seam-wise tonnage, thickness, and quality averages.	Per-block attributes (grade, density, rock type, recovery, economic value).
Historical Practice and Modelling Speed Often Drive Framework Selection		

Where My Modelling Thinking Started

- Sasol Mining, Secunda – South Africa
- Located within the Karoo Supergroup's Highveld Coalfield.
- Comprises five underground mines across an area of approximately 4,600 km²
- Coal is extracted using the bord-and-pillar mining method
- Operations form part of Sasol's integrated coal-to-liquid (CTL) production chain
- Mining focused on laterally continuous coal seams typical of the Highveld geology



Laterally Continuous Seams Made Grids Fit For Purpose, While The Software Ecosystem Reinforced That Choice



- Geological drivers:
  - Stratified deposit, laterally continuous coal horizons
  - Underground mining strongly focused on the mining horizon

- Practical Constraints
  - Geological modelling tools historically lacked the capability to generate 3D block models
  - Mine planning and scheduling systems did not support block-model inputs, reinforcing reliance on 2D seam grids

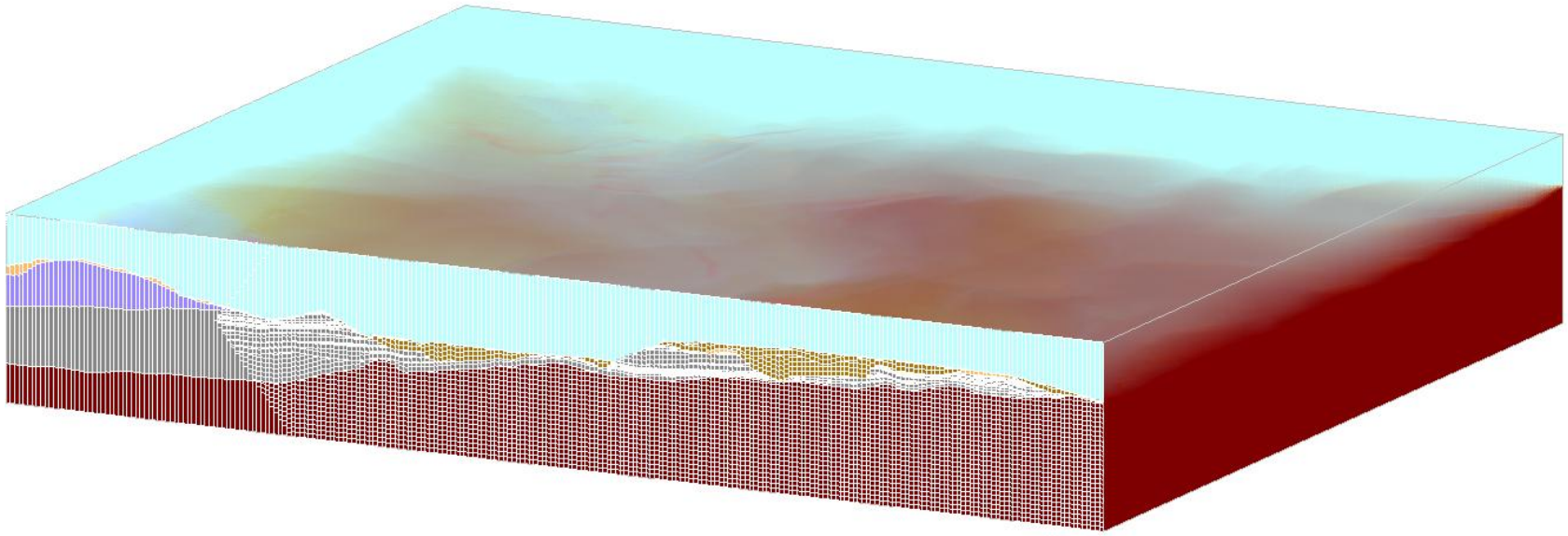
A New Geological And Mining Context Changed The Modelling Framework I Worked Within



- Bathurst Resources – New Zealand
- Operates across the Southland, Waikato and the West Coast
- Portfolio includes multiple open-cast mines.
- Supplies coal to key domestic industrial sectors (steel, dairy, food processing, energy)
- Mines hosted within faulted, structurally complex coal measures typical of NZ geology

Bathurst Retains Stratigraphic Surfaces But Uses Them To Construct A 3D Block Model Framework

Validated Geological Input → Defined Fault Blocks → Gridded Stratigraphic Surfaces → Triangulations → Block Model



The Block Model Framework Supports Both Resource Attributes And Mining – Related Reserve Attributes





The Block Framework Becomes Valuable When Questions Require Volumetric, Integrated Or Repeated Spatial Interrogation

MULTI PASS GRADE ESTIMATION

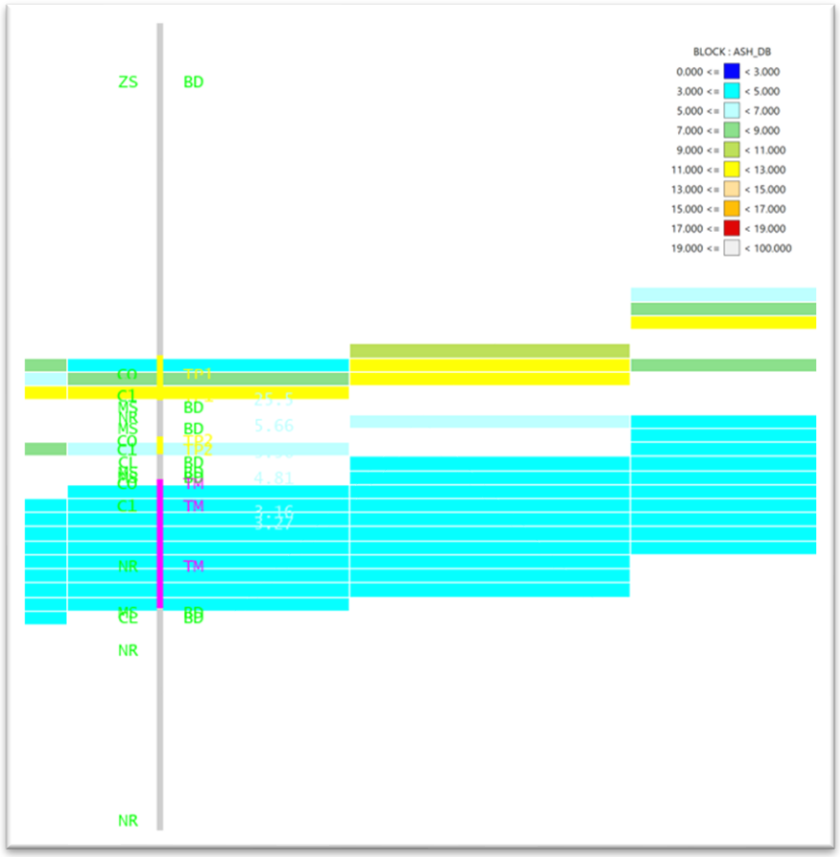
PROPORTIONAL VOLUMETRIC TONNAGE

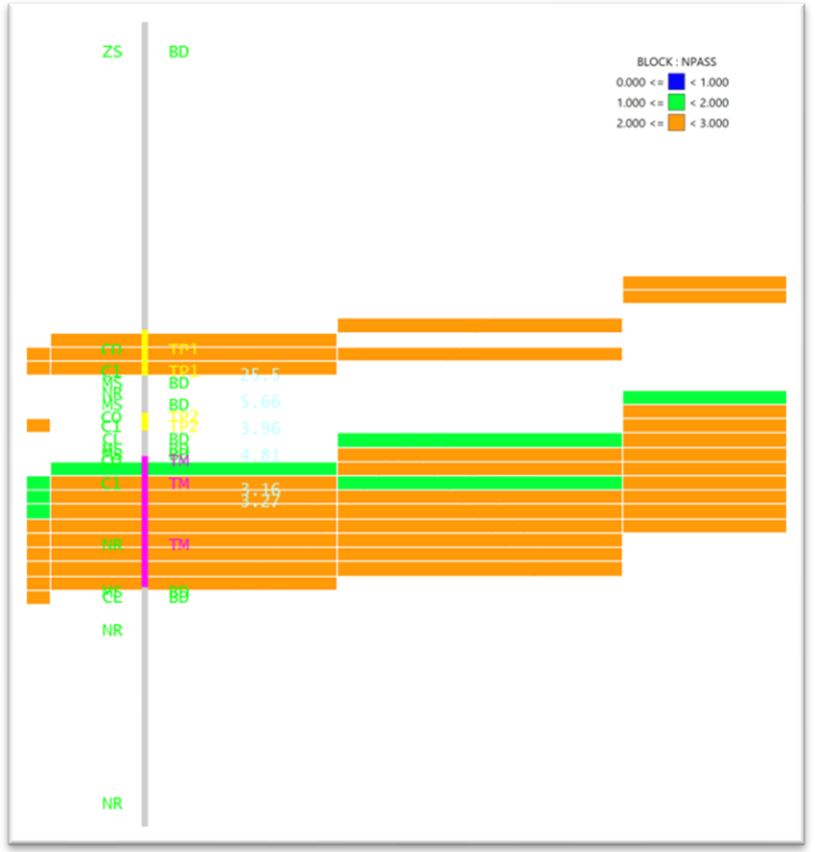
INTEGRATED SPATIAL ATTRIBUTES

PIT OPTIMISATION

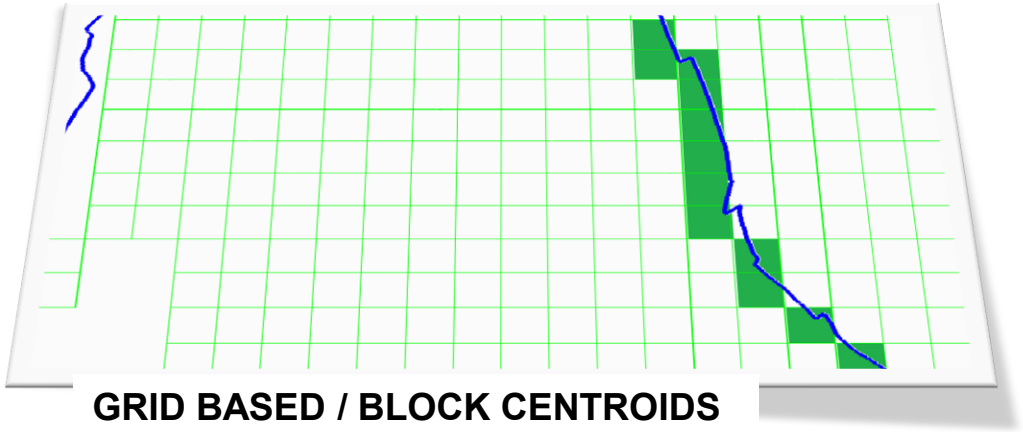
Multi-Pass Estimation Makes The Spatial Support For Each Block Estimate More Visible

Multi-pass estimation highlights where each block was informed by nearby data and where more distant samples were required.

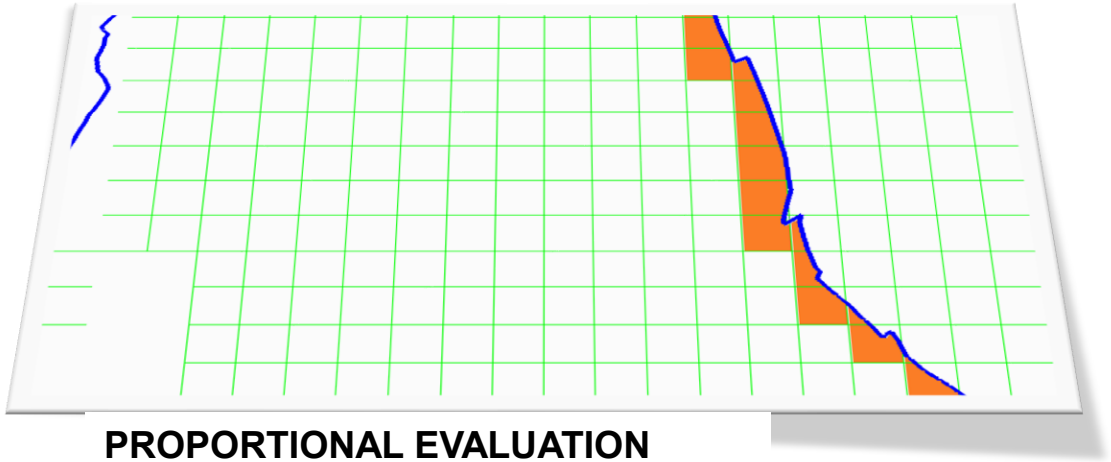




Proportional Volumetric Tonnage Improves Mining Geometry Cuts Through Model Cells



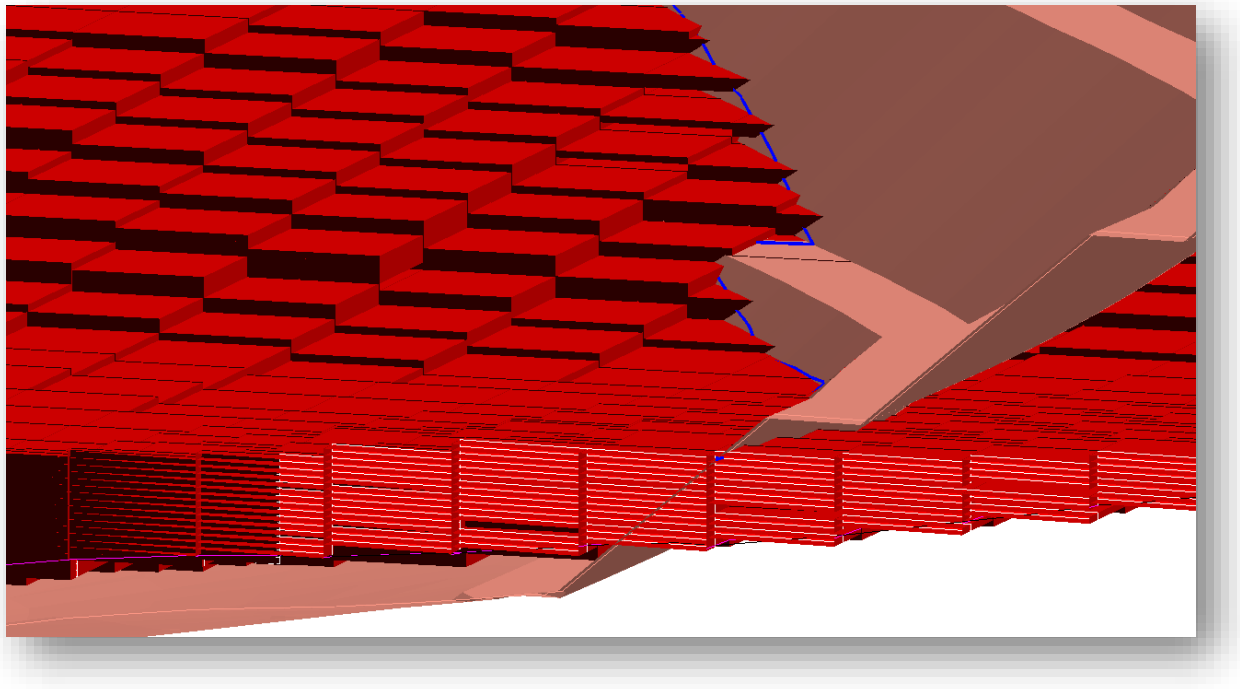
GRID BASED / BLOCK CENTROIDS



PROPORTIONAL EVALUATION

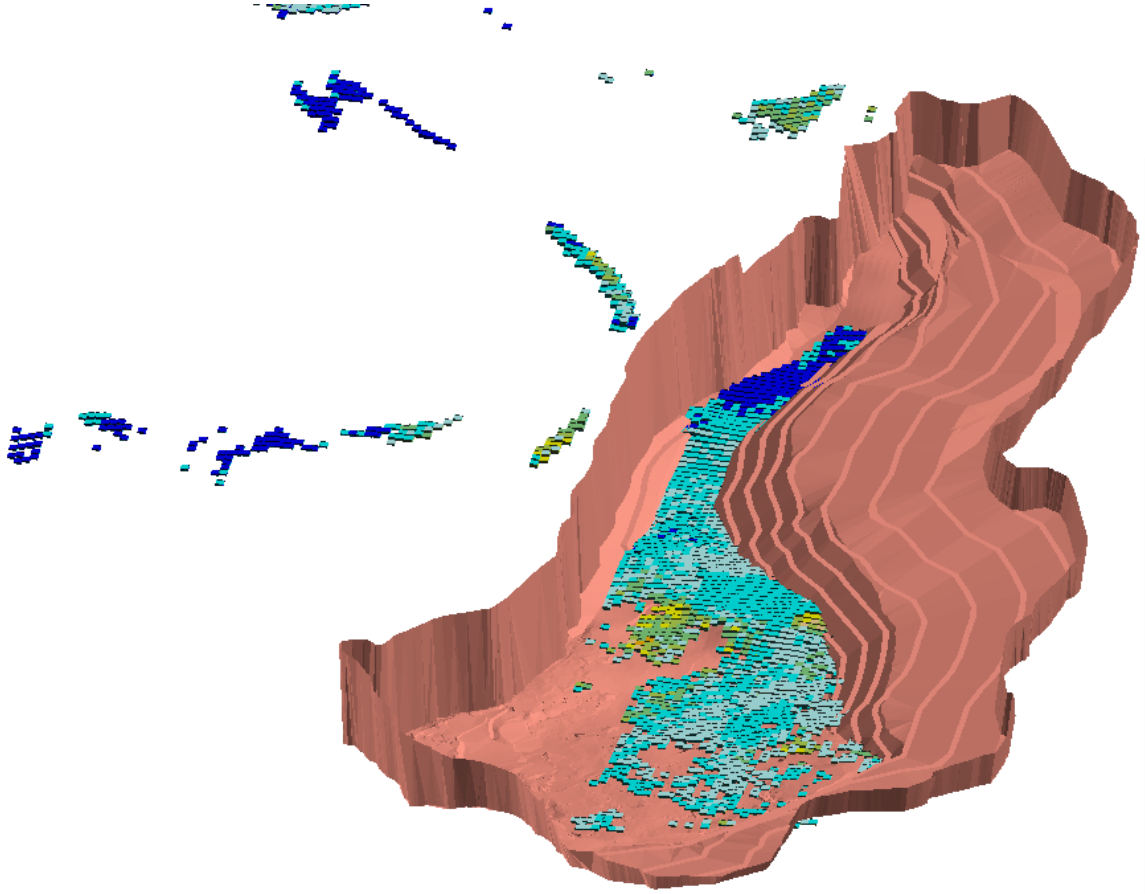
Centroid rules are sensitive to cell size; proportional depletion is sensitive to actual geometry

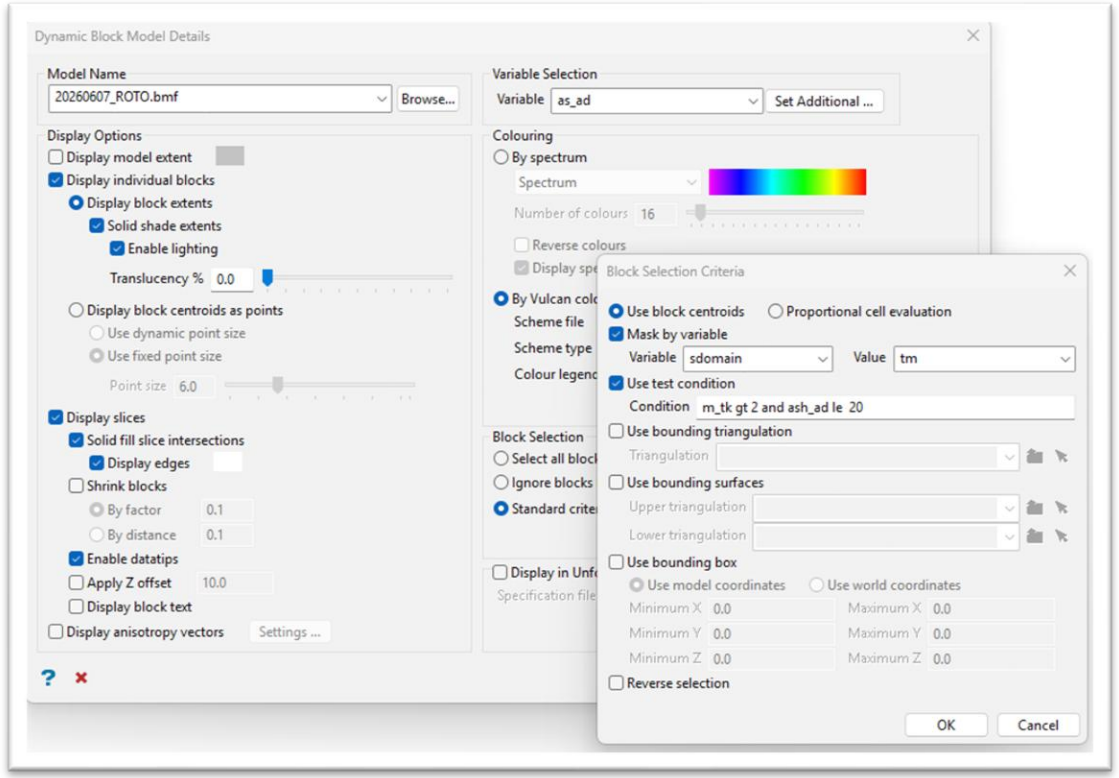
Proportional volumetric depletion gives a more consistent account of irregular boundaries than centroid-based grids



Integrated Spatial Attributes Allow For Targeted 3D Interrogation

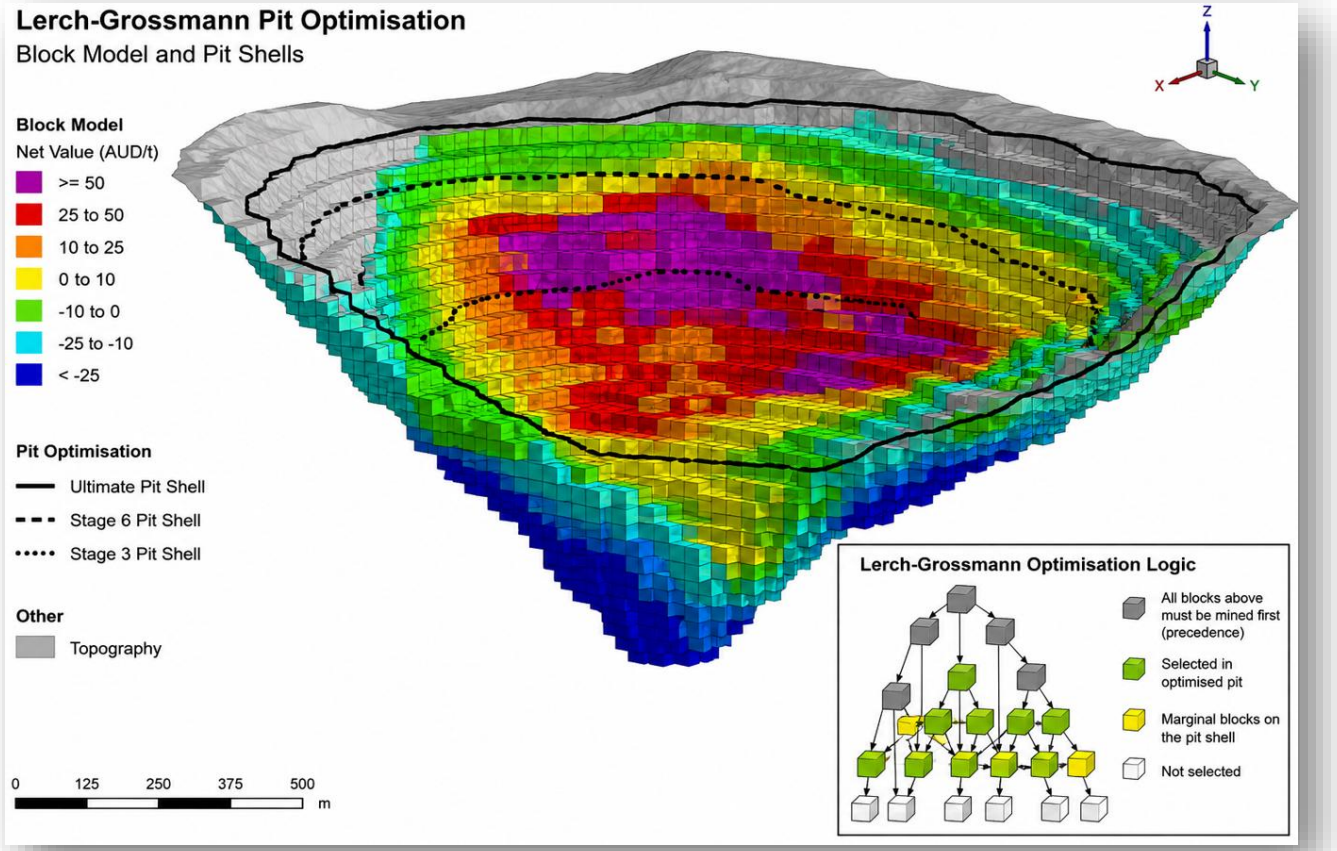
- Block models store geology, quality, mining conditions and modifying factors in the same spatial unit – enabling one to filter or interrogate the model using multiple variables at once





Pit Optimisation Links Geology, Economics And Mining Constraints To Evaluate Economic Pit Limits

- Extends the geological model with economic and mining parameters
- Evaluates potential economic pit limits within the mining constraints
- Allow the geological model to directly support downstream decisions



Looking back: Three Questions I would Approach Differently Now

Case 1

Resource Depletion Using Polygons

Case 2

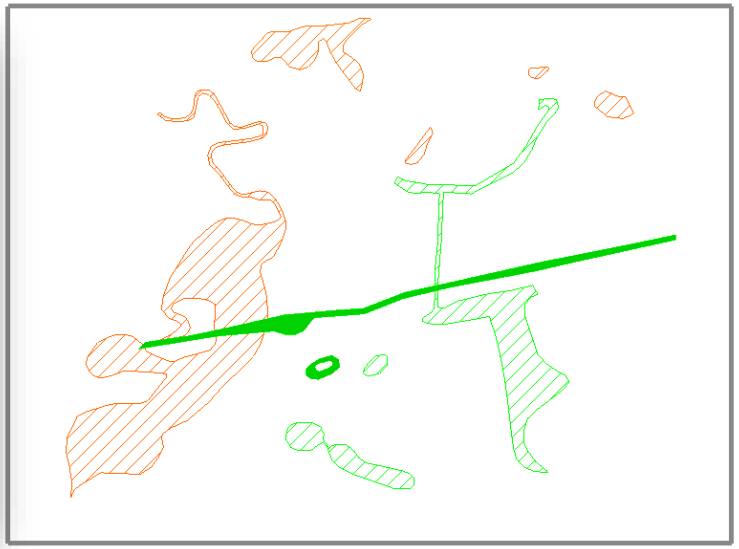
Evaluating Mining Selectivity

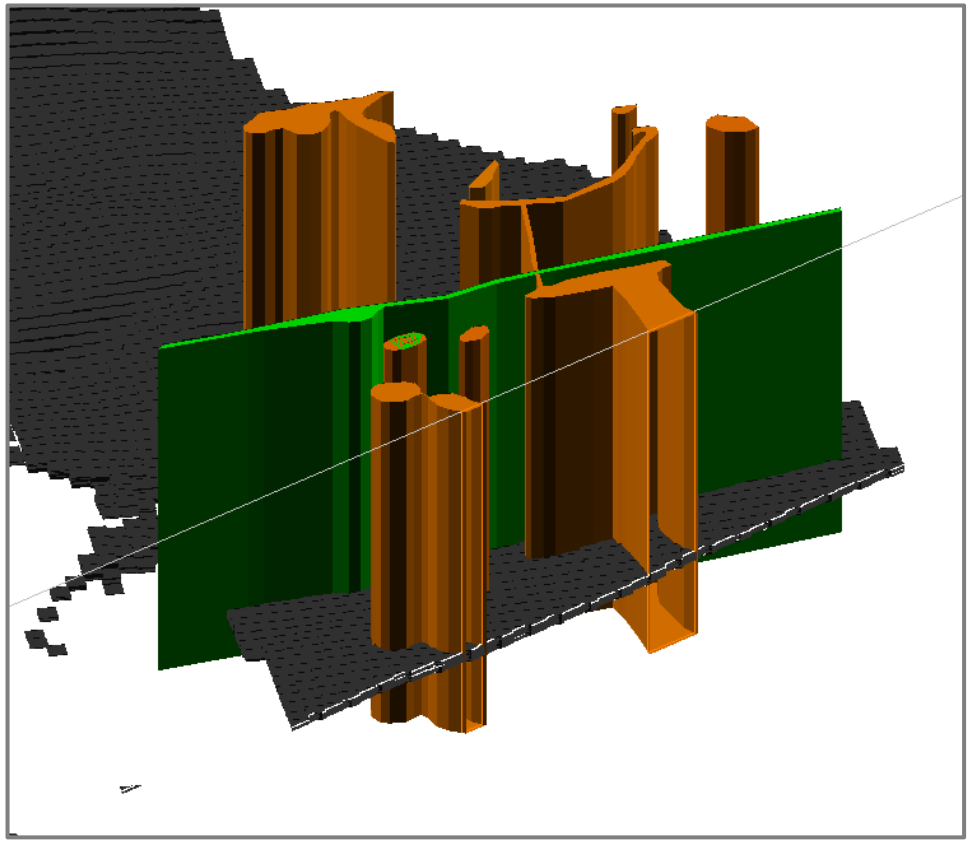
Case 3

Ground Conditions Matrix

Case 1: Proportional Volumetric Reporting Could Make Irregular Resource Depletion Within Polygons Easier To Quantify Consistently

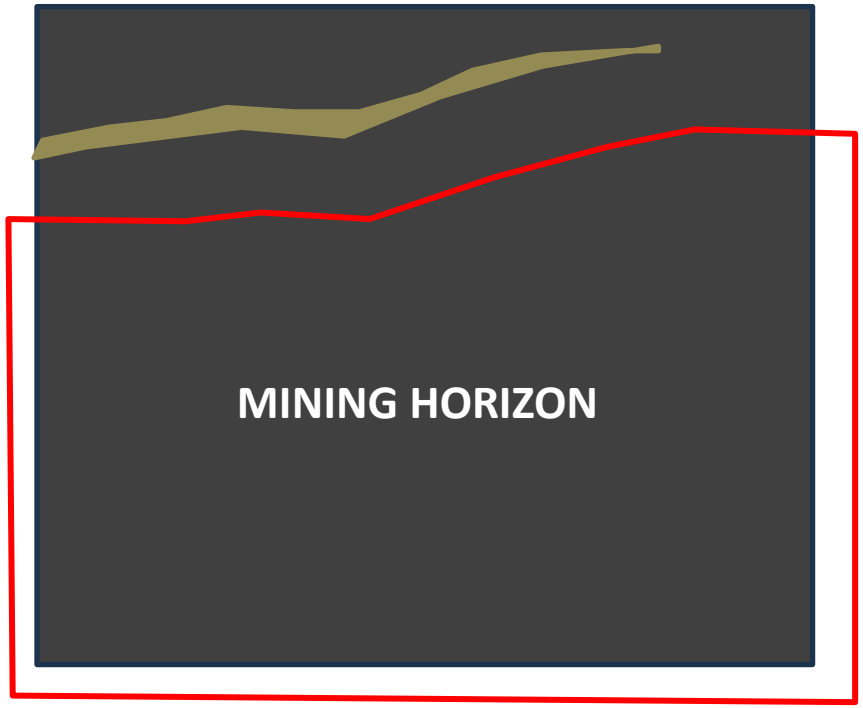






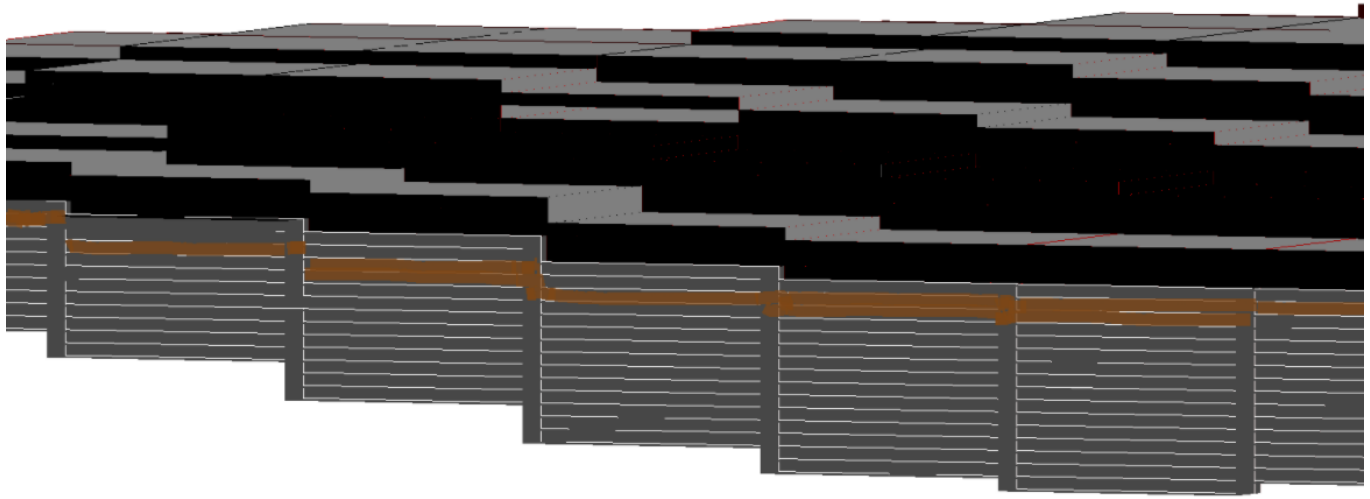
For complex dolerite-affected zones, proportional depletion provides a more representative account of the interpreted volume than centroid rules.

Case 2: A Vertically Resolved Model Can Make Repeated Mining Selectivity Scenarios Easier To Test



Boreid	From	To	Class	Seam	Thick
A	41.53	41.53	1	C4T	0
A	41.53	44.72	1	C4M	3.19
B	40.51	40.51	1	C4T	0
B	40.51	42.9	1	C4M	2.39
C	53.55	53.55	1	C4T	0
C	53.55	57.5	1	C4M	3.95
D	48.96	48.96	1	C4T	0
D	48.96	52.62	1	C4M	3.66
E	80.42	80.42	1	C4T	0
E	80.42	84.53	1	C4M	4.11
F	77	77	1	C4T	0
F	77	80.9	1	C4M	3.9
G	73.51	73.51	1	C4T	0
G	73.51	77.3	1	C4M	3.79
H	50.65	50.65	1	C4T	0
H	50.65	54.45	1	C4M	3.8
I	64.11	64.11	1	C4T	0
I	64.11	68.08	1	C4M	3.97
J	77.7	77.7	1	C4T	0
J	77.7	81.76	1	C4M	4.06

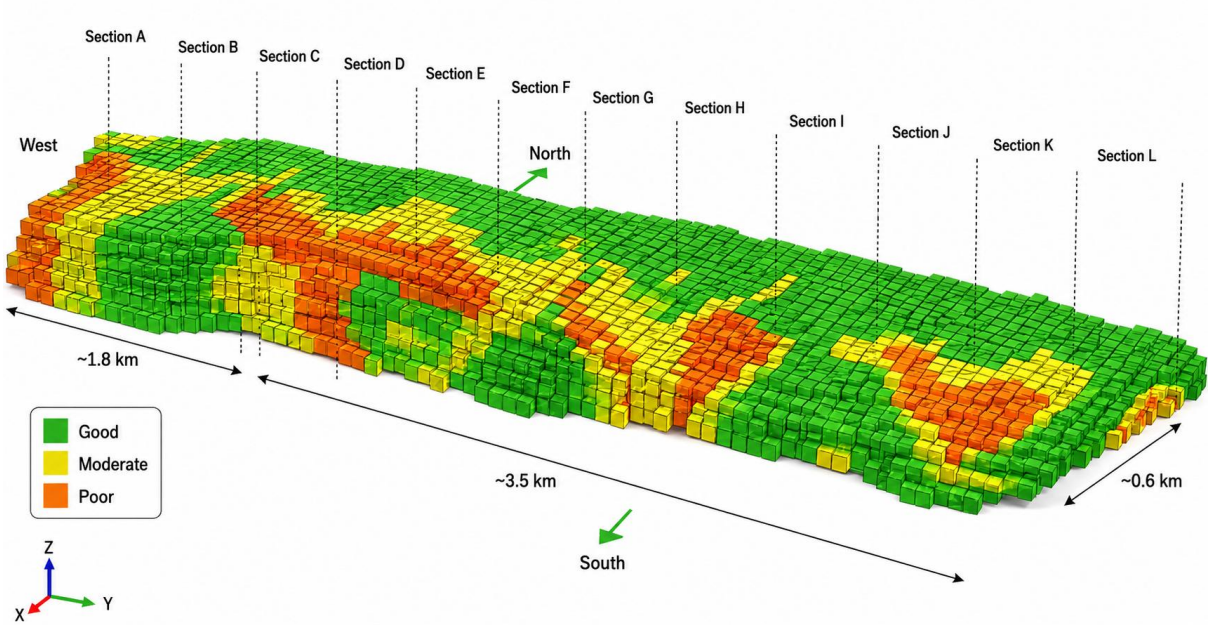
om	To	Thick	Horizon	Main	Sub	Sampled	Sample ID
0	4.1	4.1	OVB	OVB			
4.1	18.52	14.42		SST			
18.52	18.75	0.23		SH			
18.75	19.25	0.5	C5L	C	C5L	S	
19.25	25.3	6.05		SST			
25.3	50.74	25.44		SH	SST		
50.74	51.8	1.06		SST			
51.8	52.22	0.42	C4H	C	C4H	S	
52.22	52.78	0.56		SH	SST		
52.78	53.55	0.77		SST	GRT		
53.55	54.17	0.62	C4L	C	GMS	A	F
54.17	54.34	0.17	C4L	SH		A	E
54.34	54.72	0.38	C4L	C	GMS	A	D
54.72	55.01	0.29	C4L	CSH		A	C
55.01	56.25	1.24	C4L	C	GES	A	B
56.25	57.5	1.25	C4L	C	GEH	A	A
57.5	60.3	2.8		SST			
60.3	123.45	63.15		SST			
123.45	143.62	20.17	DO8	DO			
143.62	149.78	6.16	DW	TIL			
149.78	151.75	1.97	VK	GR			
151.75	151.75	0	EOH	EOH			



Case 3: Co-Locating Ground Condition Variables Could Turn A Matrix Score Into A Spatially Interrogable Model Attribute

	Section Conditions	De rating factor	Frequency	Discount
Overburden/Pre Karoo/Floor Dips	Overburden <80 m (very thin OVB)	5.00	0	0.00
	Potential sporadic floor rolls or minor dips (<2°)	2.00	0	0.00
	Moderate dipping seam/Moderate Rolls (3-4°)	5.00	0	0.00
	Severe seam dips/Severe Rolls >5°	10.00	0	0.00
Major structures	Stringers projected or mining in a stringer zone	10.00	0	0.00
	Mining towards or after a dyke (within a distance of 50 meters)	10.00	1	10.00
	Dyke orientation impacting ground conditions (oblique)	10.00	0	0.00
	Mining towards or after a sill structure (within a distance of 50 meters)	10.00	0	0.00
	Major structure parallel to mining (Fault or Dyke that would otherwise needs SW)	10.00	0	0.00
	Mining with stoneworks	10.00	0	0.00
	Mining towards a devolatilised coal zone (poorer ground)	10.00	0	0.00
C4H-C4L Interburden Thickness	<0.6 m	5.00	0	0.00
	0.6 - 0.8 m	2.00	0	0.00
	>0.8 m or merged	0.00	1	0.00
Methane	Proximity to known high methane-carrying structures	10.00	0	0.00
	Mining towards devolatilised coal zone > 20 m thick	10.00	0	0.00
In-seam stone	≥0.5 m in-seam stone (singular or multiple partings)	10.00	0	0.00
Floor conditions	>0.2 m soft rock in the floor	5.00	1	5.00
Roof conditions	Sill in roof <10m	5.00	0	0.00
	False roof skin (removed up to competant layer)	5.00	1	5.00
	Lenticular bedded roof	5.00	0	0.00
	Total Discount			20.00
	Block (%)			0.92
	Block Rank			Good

Once the inputs are model attributes, the ground condition category can be generated spatially and updated more efficiently than a manual Excel exercise.



Ground Conditions

	Aug-26	Sep-26	Oct-26	Nov-26	Dec-26	Jan-27	Feb-27
Section 15	Good	Moderate High	Good	Good	Good	Good	Good
Section 20	Good	Good	Good	Good	Moderate High	Moderate High	Moderate High
Section 21	Good	Good	Good	Good	Good	Good	Good
Section 39	Good	Good	Good	Good	Good	Good	Good
Section 50	Moderate High	Good	Moderate High	Moderate High	Moderate High	Moderate High	Moderate High
Section 51	Moderate High	Good	Good	Good	Good	Good	Good
Section 61	Good	Moderate High	Moderate High	Good	Moderate High	Moderate Low	Moderate Low
Section 75	Moderate High	Moderate Low	Moderate High	Moderate High	Moderate High	Moderate High	Moderate High
Section 78	Good	Good	Good	Good	Good	Good	Good
Section 81	Good	Good	Good	Good	Good	Good	Good
Section 82	Good	Moderate High	Moderate High	Moderate High	Moderate High	Moderate High	Moderate High
Section 85	Moderate Low	Moderate High	Moderate High	Moderate High	Moderate High	Moderate High	Moderate High

The Modelling Framework Should Be Chosen For The Geology, Mining Method And The Decisions It Must Support



GEOLOGY

Does the deposit lend itself to stratigraphic surfaces ?



MINING METHOD

How does the mining geometry interact with the deposit ?



DECISION

What must the model answer now - and next ?

Fit for purpose without implying more certainty than the data support