Why Your Quarry Matters

IEEE-IAS/PCA 2023 | Morgan Lane, PE, MBA

Introduction

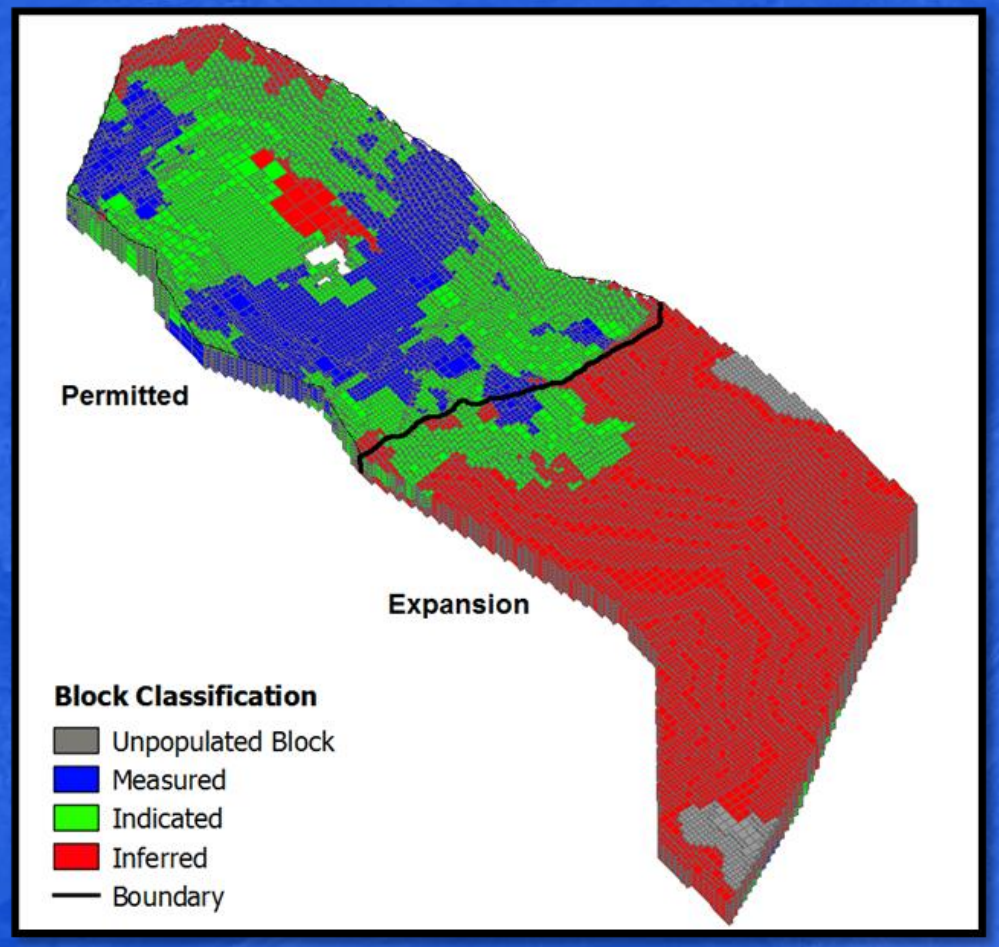
- At a cement operation, the plant is KING!
- Quarries provide approximately 90% of the raw materials, but only account for 10% of the total costs
- It is not uncommon to see Quarry Managers with limited mining experience.

What we will cover

- What is a block model?
- What information can you get out of a block model?
- What is a mine plan?
- What Information can you get out of a mine plan?
- Real life examples of how a block model and mine plan helped an operation

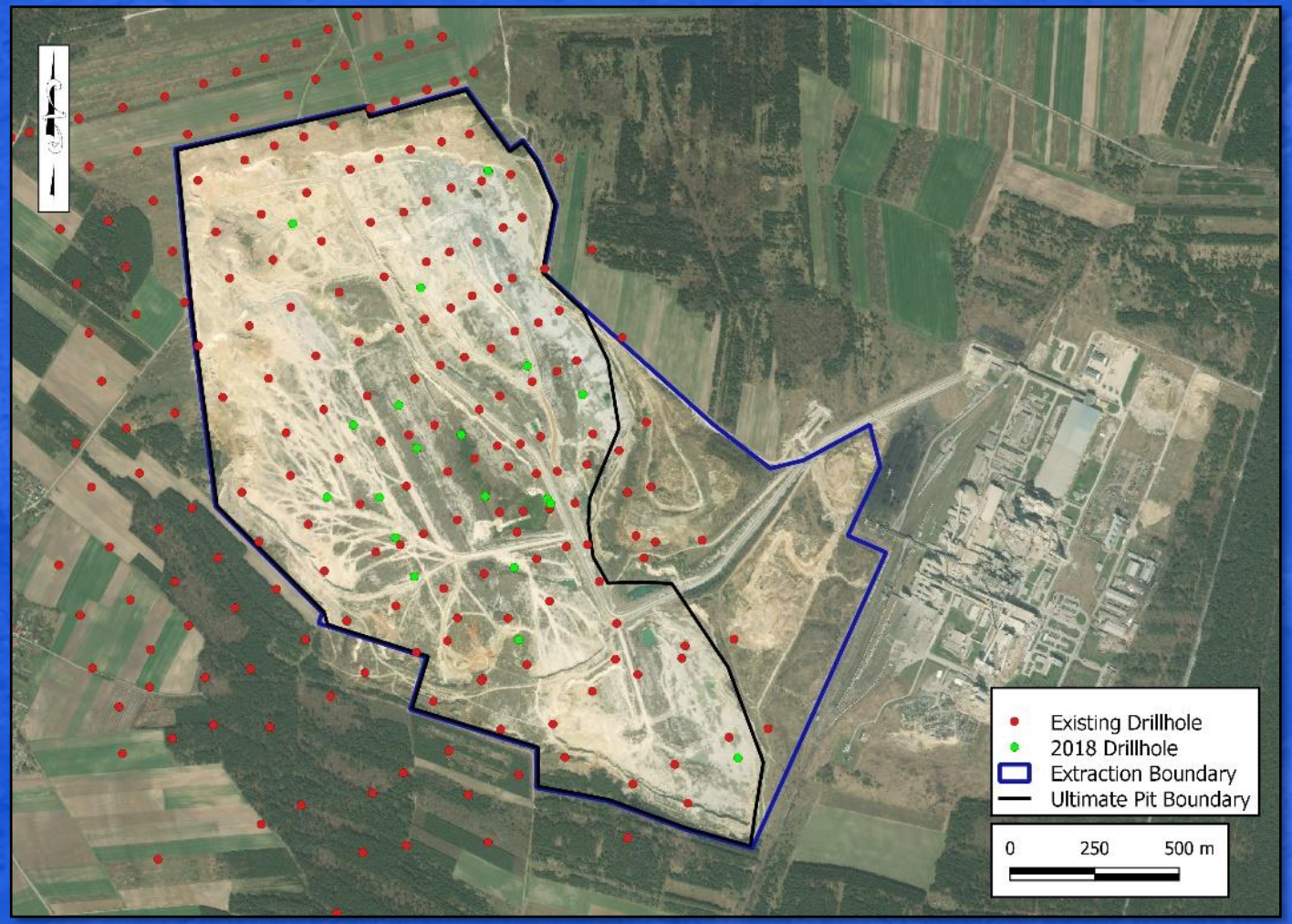
What is a Block Model?

Model Estimation



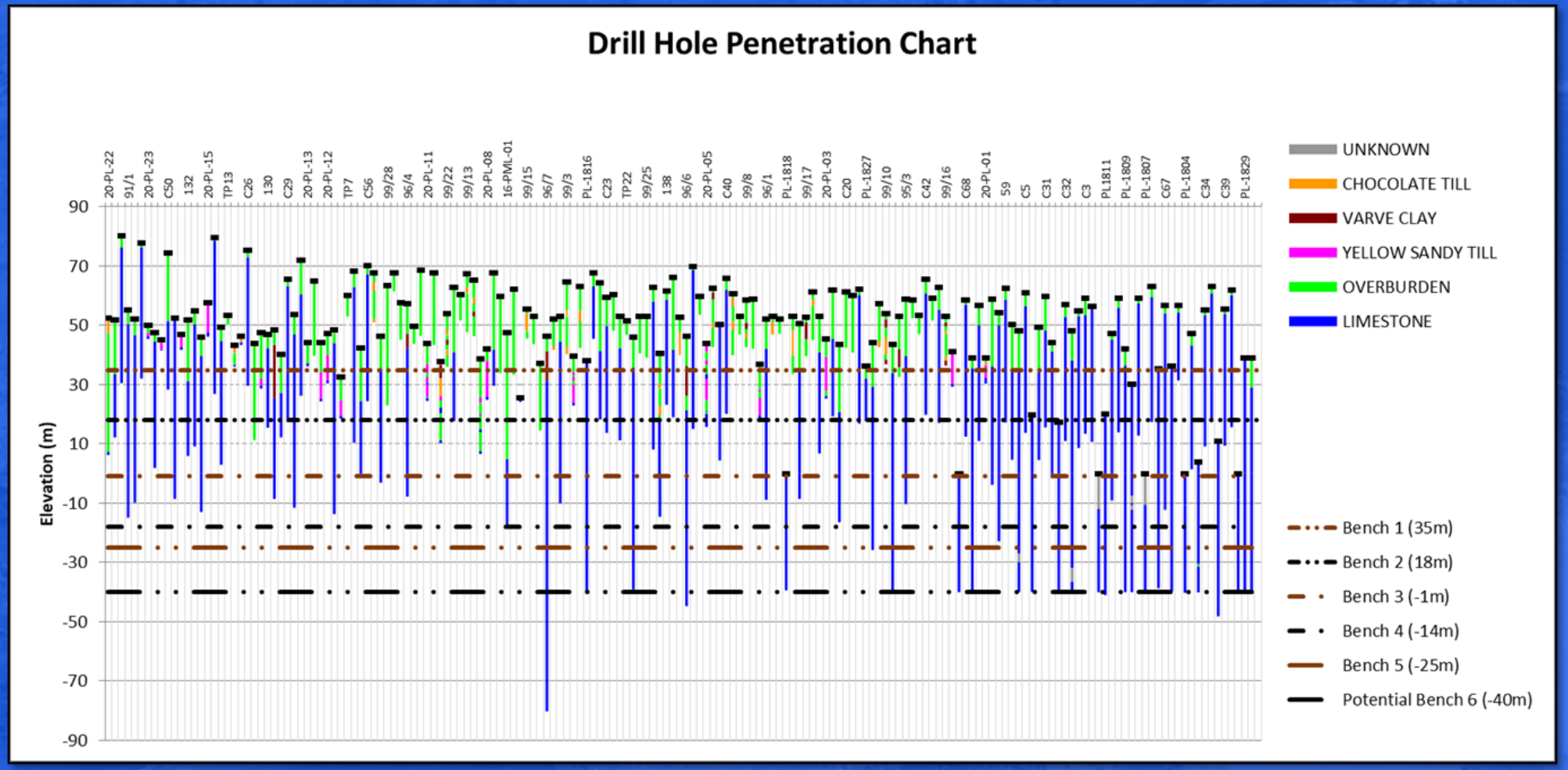
Block Classification	Confidence Level	Description
Unpopulated	None	Blocks that were unable to be estimated using estimation procedures
Measured	High	Can be converted to “Proven” material with mining considerations
Indicated	Medium	Can be converted to “Probable” material with mining considerations
Inferred	Low	Can be converted to “Potential” material with mining considerations

Exploration Drilling



- The most critical element to understanding your quarry
- Drilling in a grid is ideal but not necessary for development of a block model

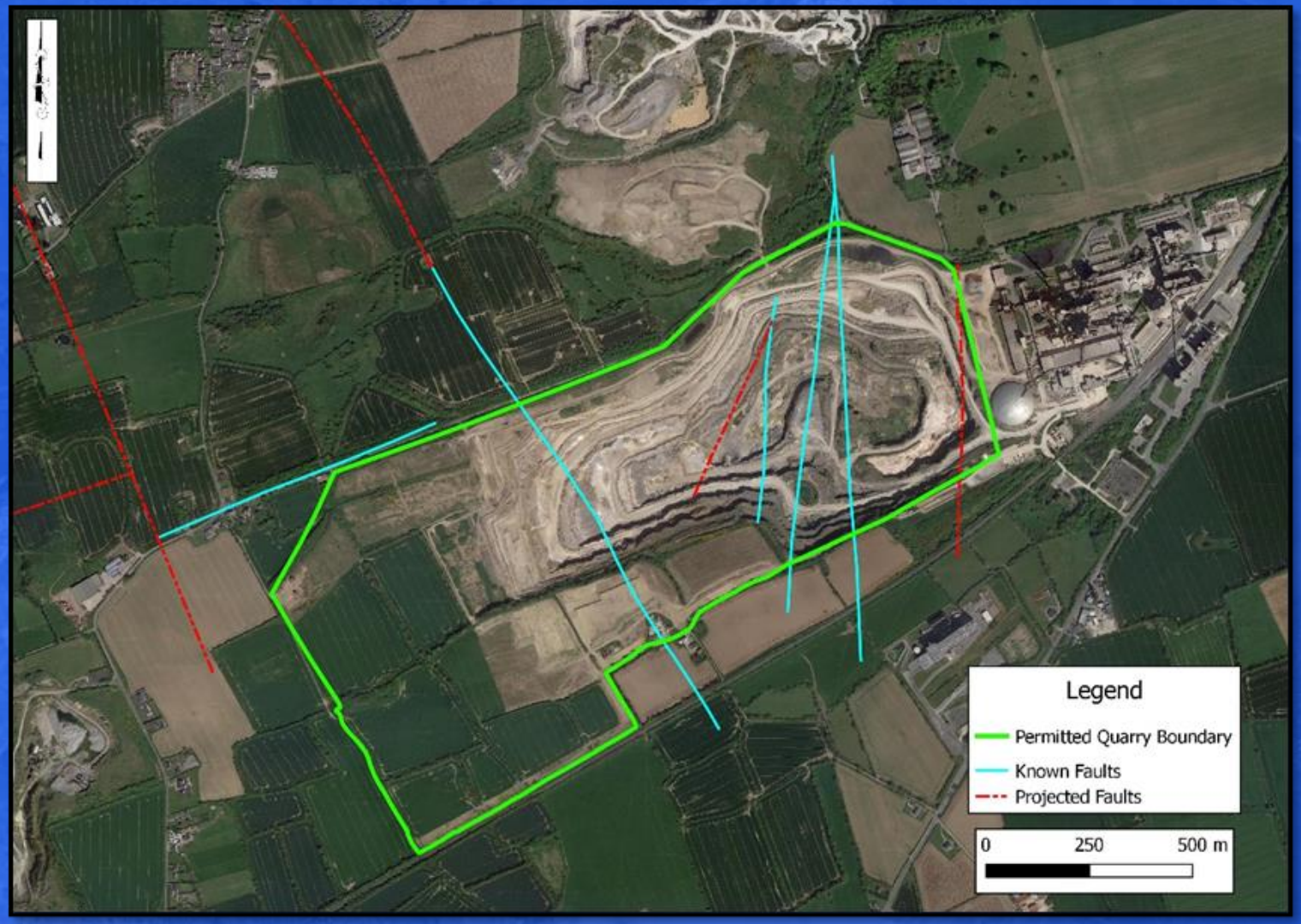
Exploration Drilling Cont.



- Drilling needs to be deep enough to fully penetrate the pit floor

Faulting

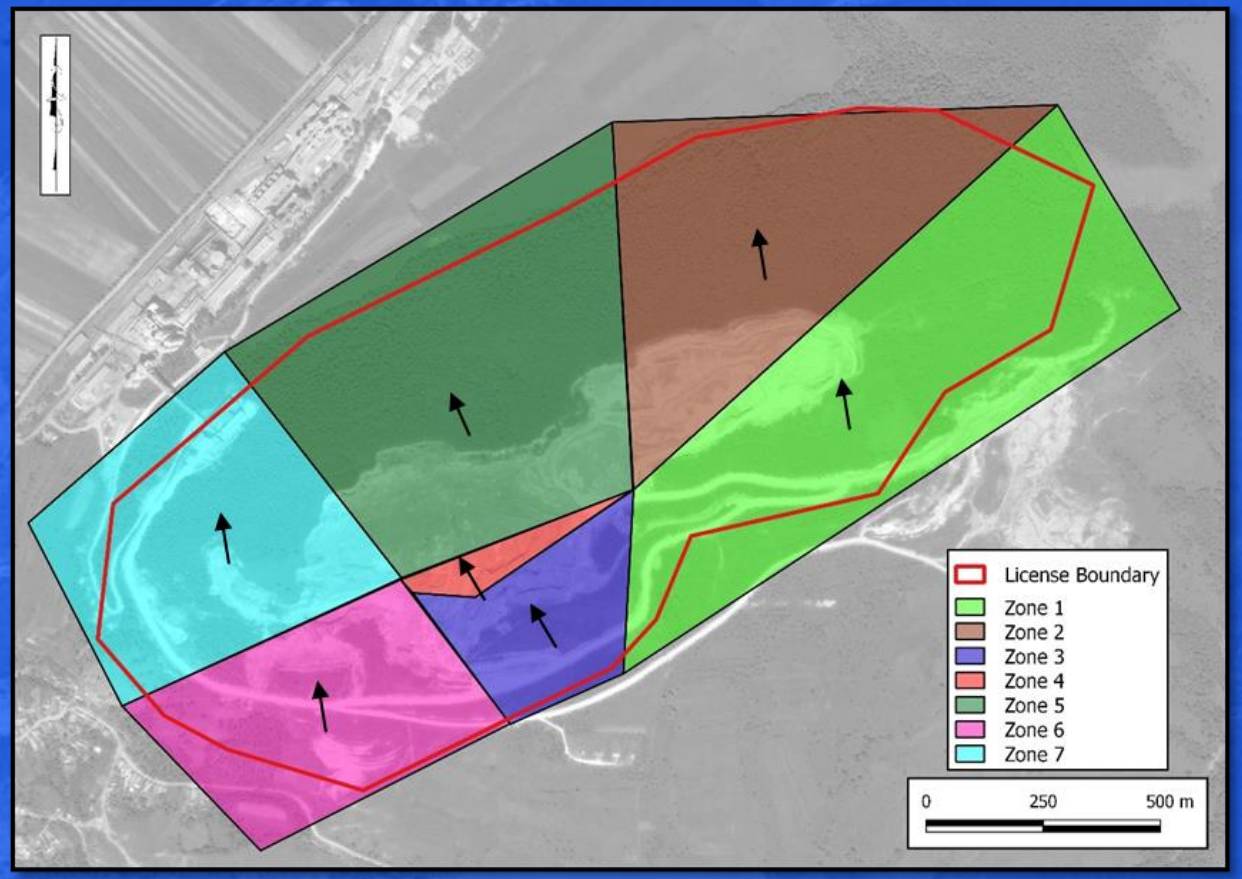
- Exploration drilling can identify fault systems within your quarry
- It is not uncommon to see material appear on one side of a fault but disappear entirely on the other side of the fault.



Faulting Cont.

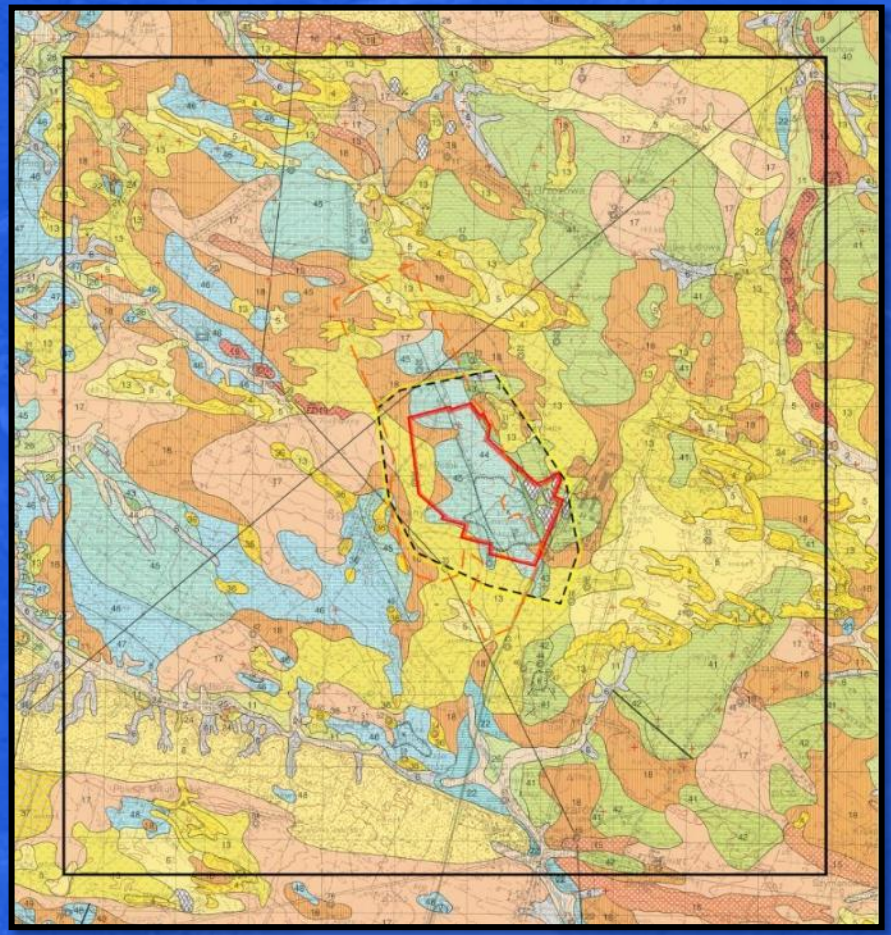
- Quarries can be complex with many different fault blocks.
- Each fault block is modeled independently

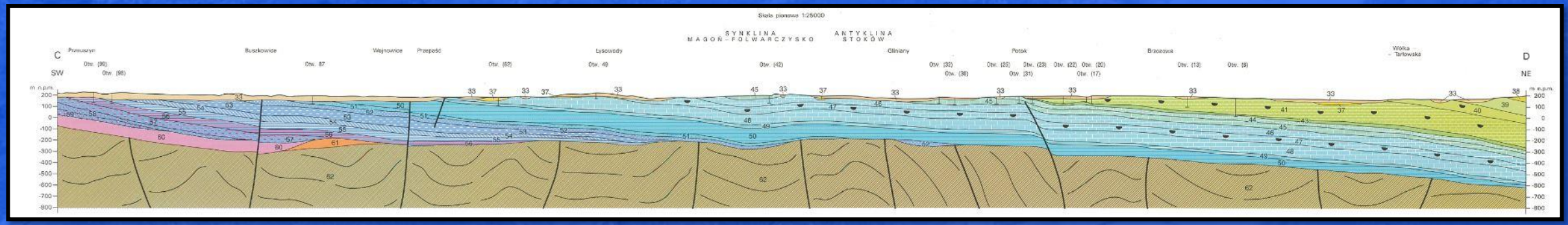
Fault Zone	Strike	Dip*
1	80	30
2	80	50
3	60	30
4	60	40
5	65	50
6	80	30
7	80	60



Geologic Bedding

- Is a deposit “massive” or geologically bedded
- If bedded, is there a strike and dip direction?





What information can you get out of a Block Model?

Resources and Reserves

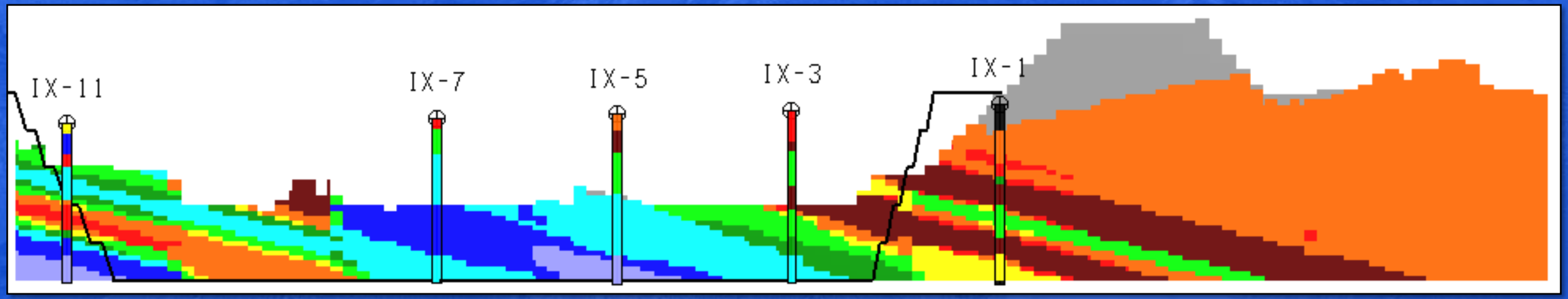
Limestone						
Classification	Tons (Mt)	Al_2O_3 (%)	CaO (%)	Fe_2O_3 (%)	MgO (%)	SiO_2 (%)
Measured	146.09	0.25	52.34	0.40	1.95	1.70
Indicated	3.19	0.66	50.38	0.48	1.99	4.07
Grand Total	149.28	0.26	52.30	0.41	1.95	1.75

Limestone						
Bench	Tons (Mt)	Al_2O_3 (%)	CaO (%)	Fe_2O_3 (%)	MgO (%)	SiO_2 (%)
1	9.22	0.26	51.81	0.56	2.25	1.97
2	25.91	0.23	52.11	0.42	2.13	1.40
3	44.91	0.28	52.32	0.40	1.93	1.70
4	35.59	0.27	52.44	0.38	1.87	1.80
5	33.65	0.26	52.41	0.38	1.84	1.96
Grand Total	149.28	0.26	52.30	0.41	1.95	1.75

- **A block model can potentially help understand alternative materials within the quarry that were historically wasted or not used.**

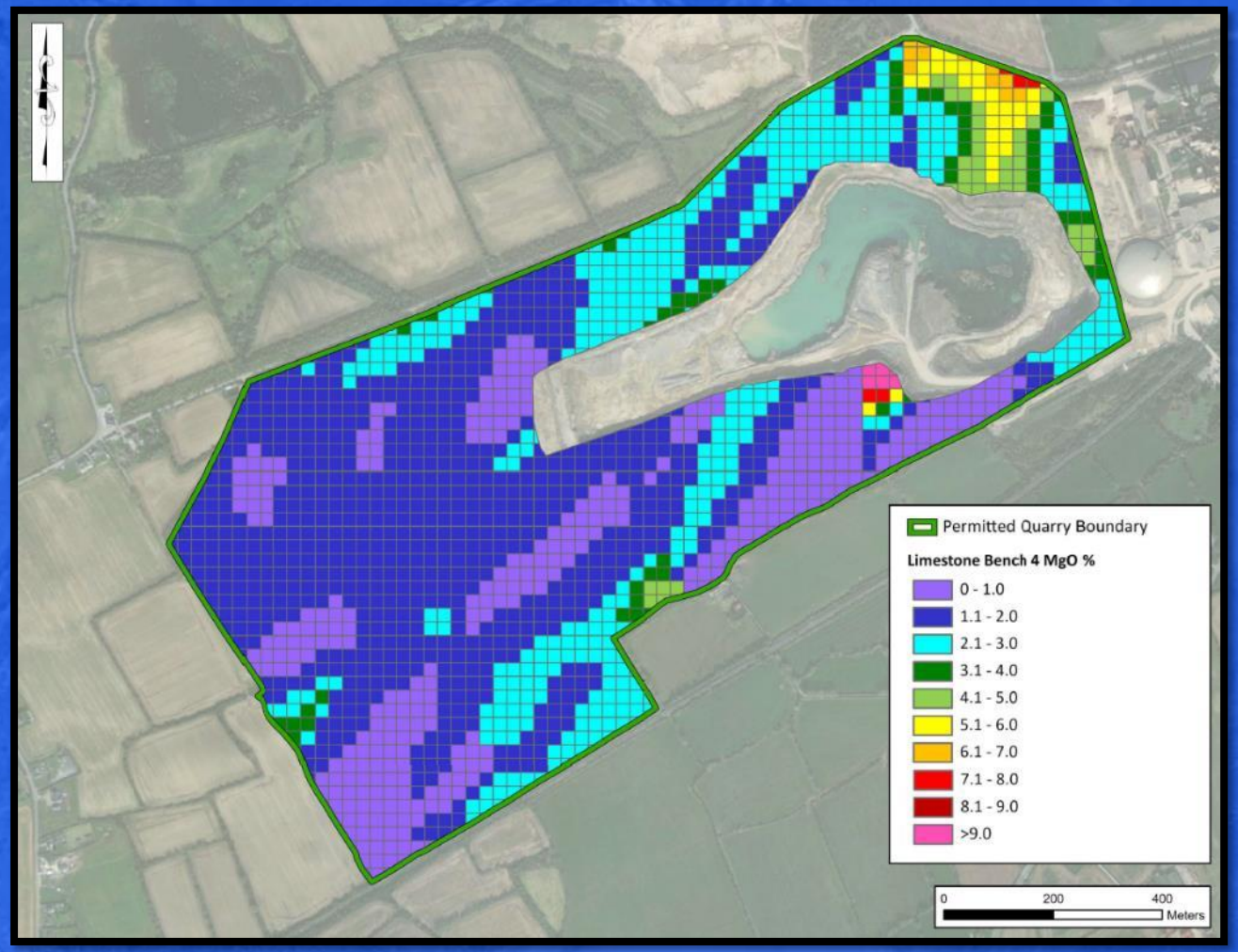
Cross Sections

- A slice across the block model
- Can help identify trends or hotspots within the quarry



Chemistry Grade Maps

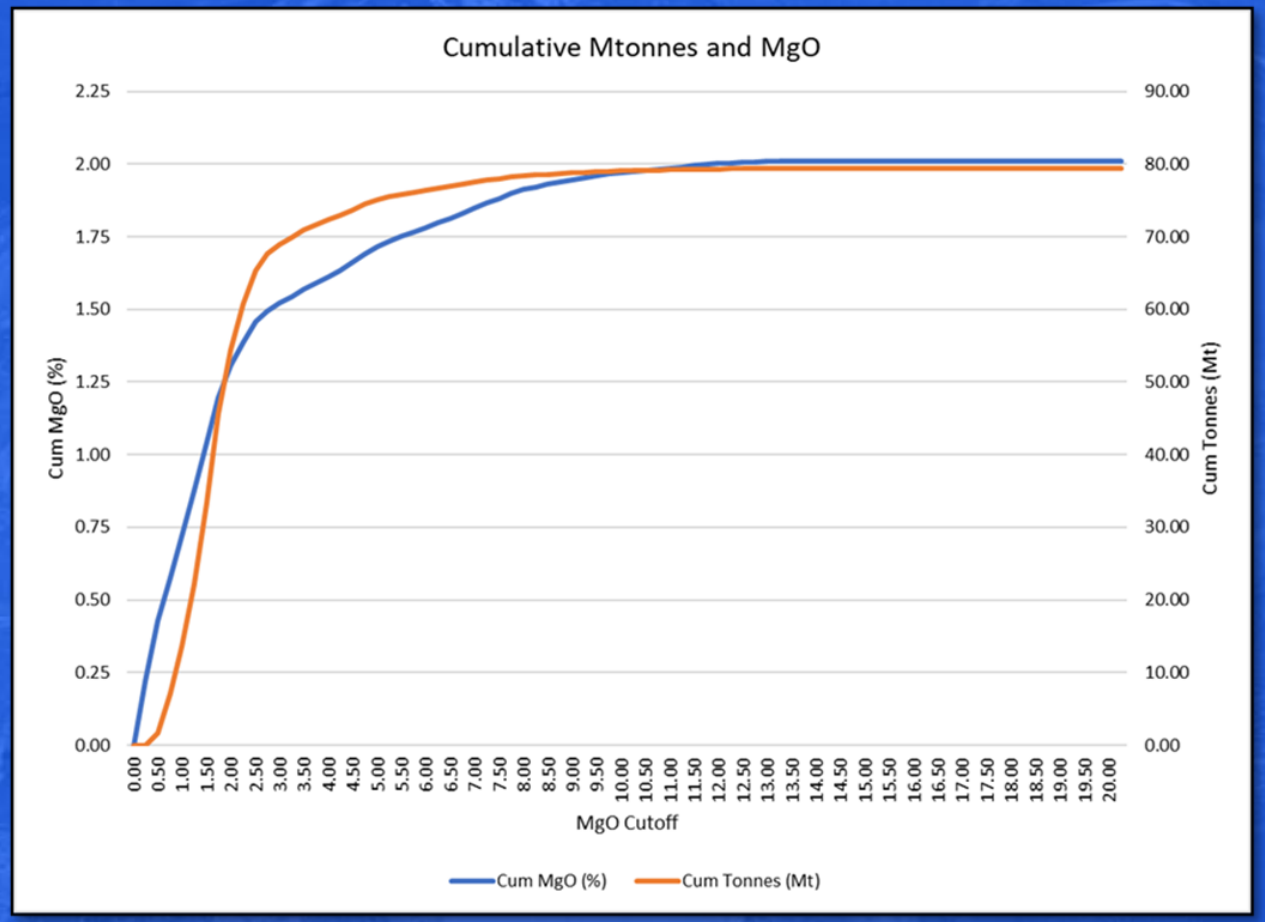
- Concentrations for a specific chemistry
- Can help identify hotspots within the quarry



Sensitivity Analysis

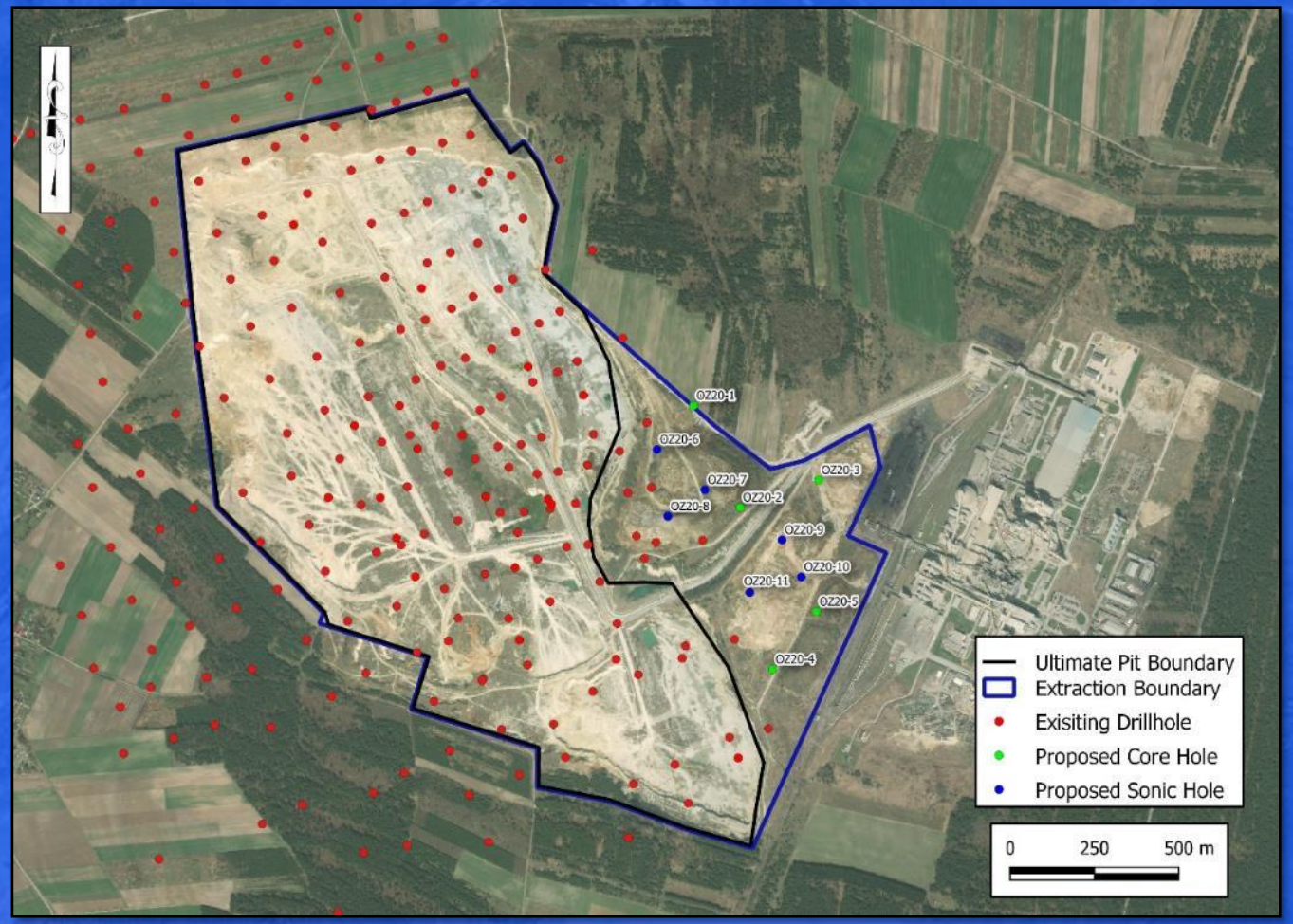
Cumulative MgO Cutoff (%)	Incremental Mtonnes	Cumulative Mtonnes	Mtonnes above Average Grade	Quarry Life (1.9Mt/yr rate)
1.50	67.61	67.61	11.78	35.6 yrs
1.75	8.20	75.81	3.58	39.9 yrs
2.00	3.48	79.29	0.10	41.7 yrs

- Can help determine the sensitivity of the quarry's potential life for various chemical cutoff parameters
- Shows the potential impact of high grading your quarry



Future Exploration Drilling

- A block model can help identify areas that are of low confidence where additional drilling may be needed.



What is a Mine Plan?

What is a Mine Plan

- **It can be many different things:**
  - A sequential design
  - A guidance for the total available material
  - A valuation of property
    - Investments (e.g. additional kiln lines)
    - Lawsuits

- **Understanding the quarry's needs and providing those needs is CRITICAL in a mine plan**

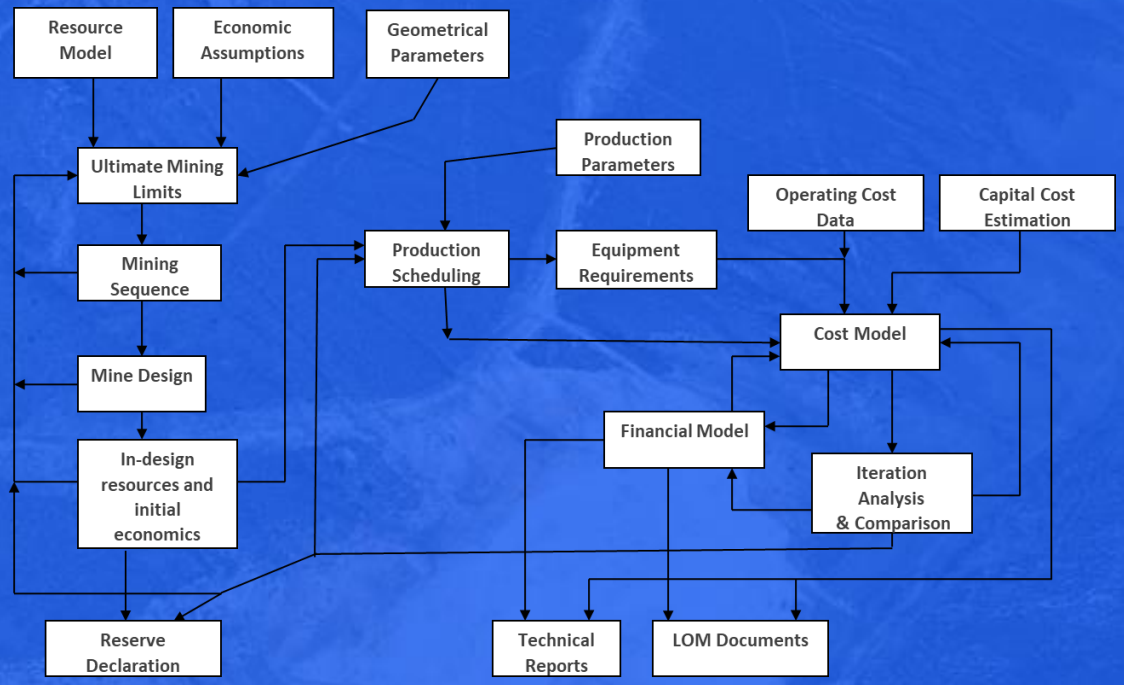
- **Must consider the Mining Method**

Mining Methods

- **Surface**
  - Open Pit Truck and Shovel
  - Contour Mining
  - Dragline Strip Mining
  - Others
- **Underground**
  - Room and Pillar
  - Cut & Fill
  - Long-Hole Stoping
  - Vertical Crater and Retreat
  - Longwall
  - Others

Mine Planning

- **Relates to mining of the deposit, but includes other disciplines and work**
  - Geologists / Resource Estimation Specialists
  - Hydrological and Geotechnical Engineers
  - Environmental Scientists and Engineers
  - Financial Analysis, Taxes, and Permitting
- **Usually includes**
  - Ultimate mining limits
  - Access roads and ramps
  - Quantity and quality of the deposit
  - Mining / development of waste material
  - Life-of-mine schedule
  - OpEx and CapEx costs
  - Cash-flow analysis (required for the statement of reserves)

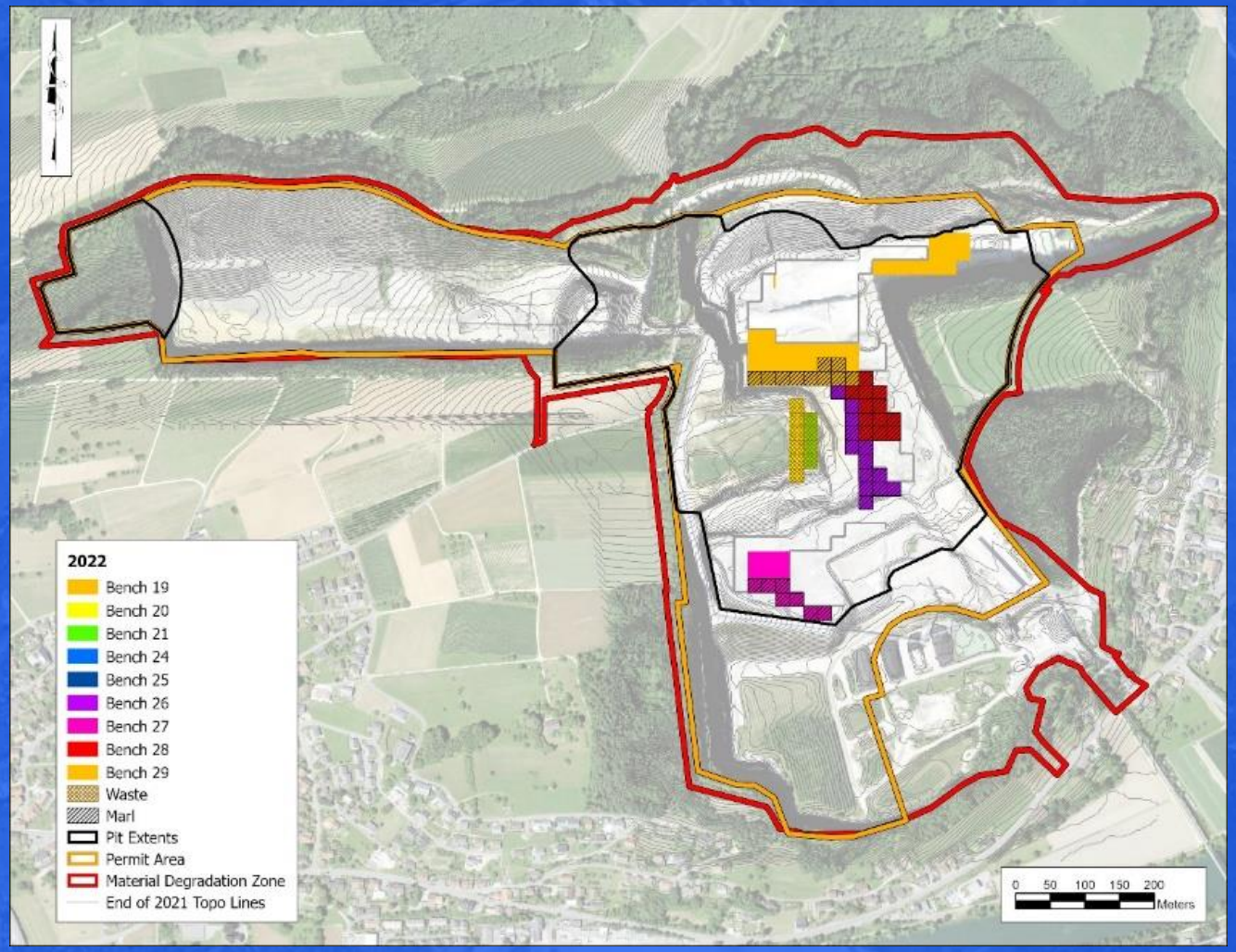


What Information can you get out of a Mine Plan?

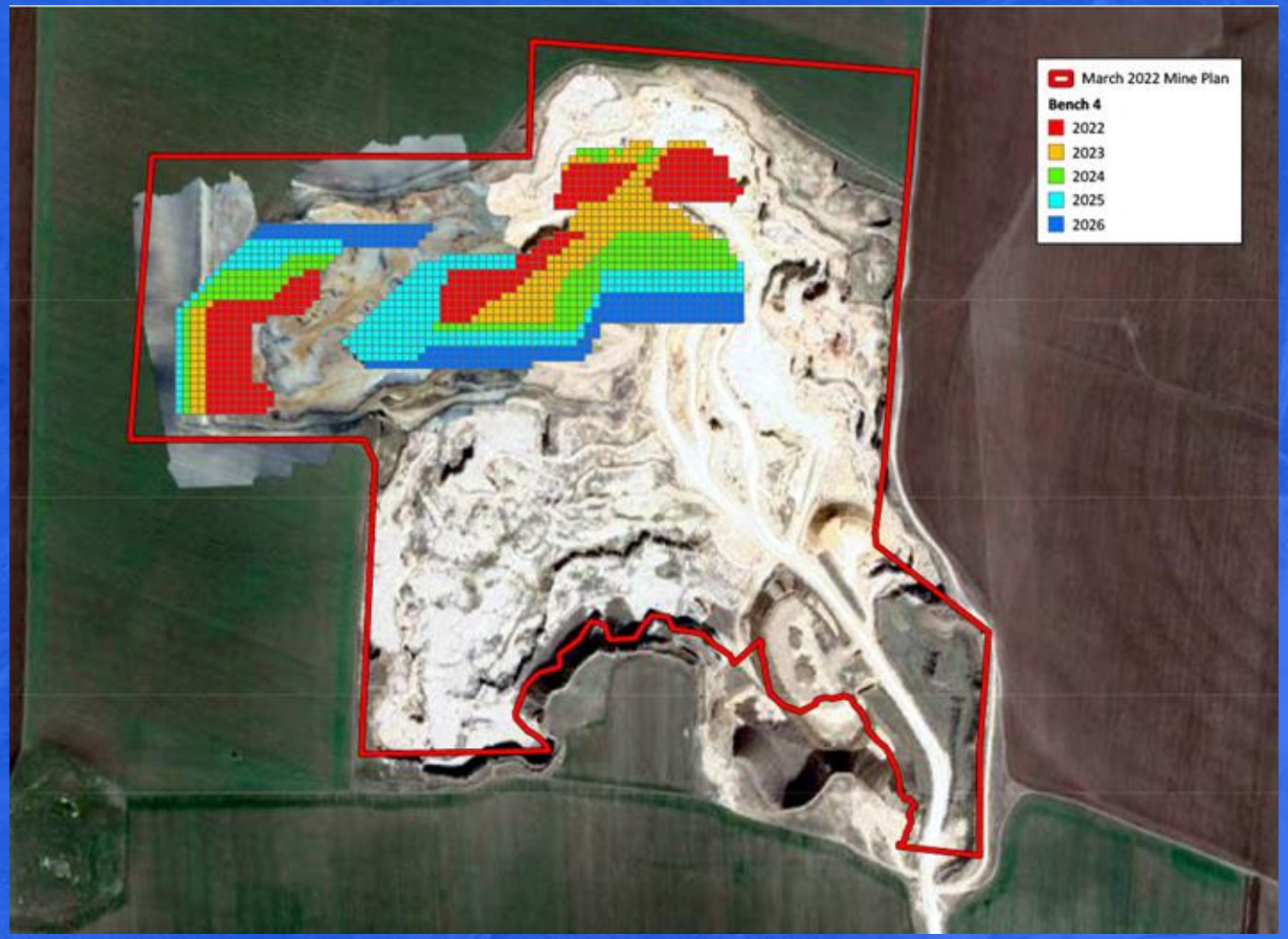
Annual Progression Maps

- Shows where and how much of each bench will be mined
- Can be helpful in planning a transition into a new phase of quarry development

End of Year 2022



Annual Progression Maps Cont.



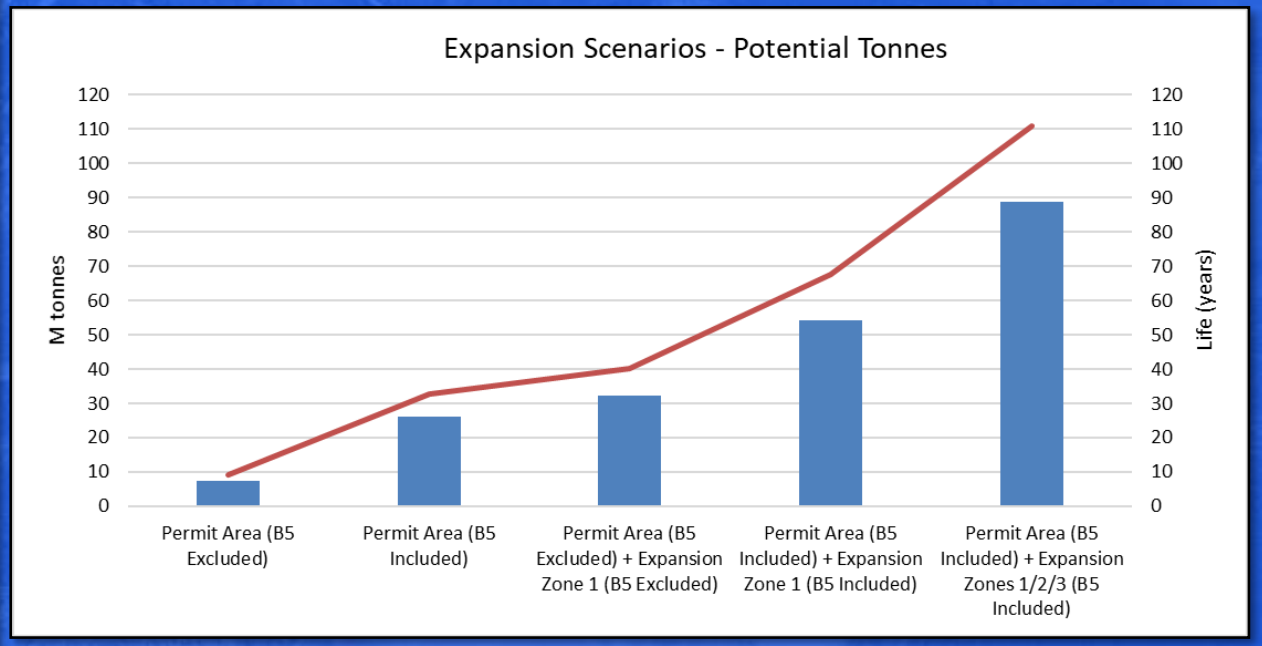
Material Schedules

Year 2023						
Material	Tons (Kt)	Al_2O_3 (%)	CaO (%)	Fe_2O_3 (%)	MgO (%)	SiO_2 (%)
Karst	320	3.31	12.04	1.92	0.50	55.52
Marl	642	2.99	38.74	1.30	1.59	19.99
Limestone	2,233	0.61	53.65	0.26	0.44	2.05
Grand Total	3,195	1.36	46.49	0.64	0.68	11.01

Year 2023						
Bench	Tons (Kt)	Al_2O_3 (%)	CaO (%)	Fe_2O_3 (%)	MgO (%)	SiO_2 (%)
1	211	3.27	6.59	1.61	0.38	61.25
2	543	2.19	46.23	0.90	1.04	10.80
3	2,440	0.97	50.25	0.47	0.61	6.40

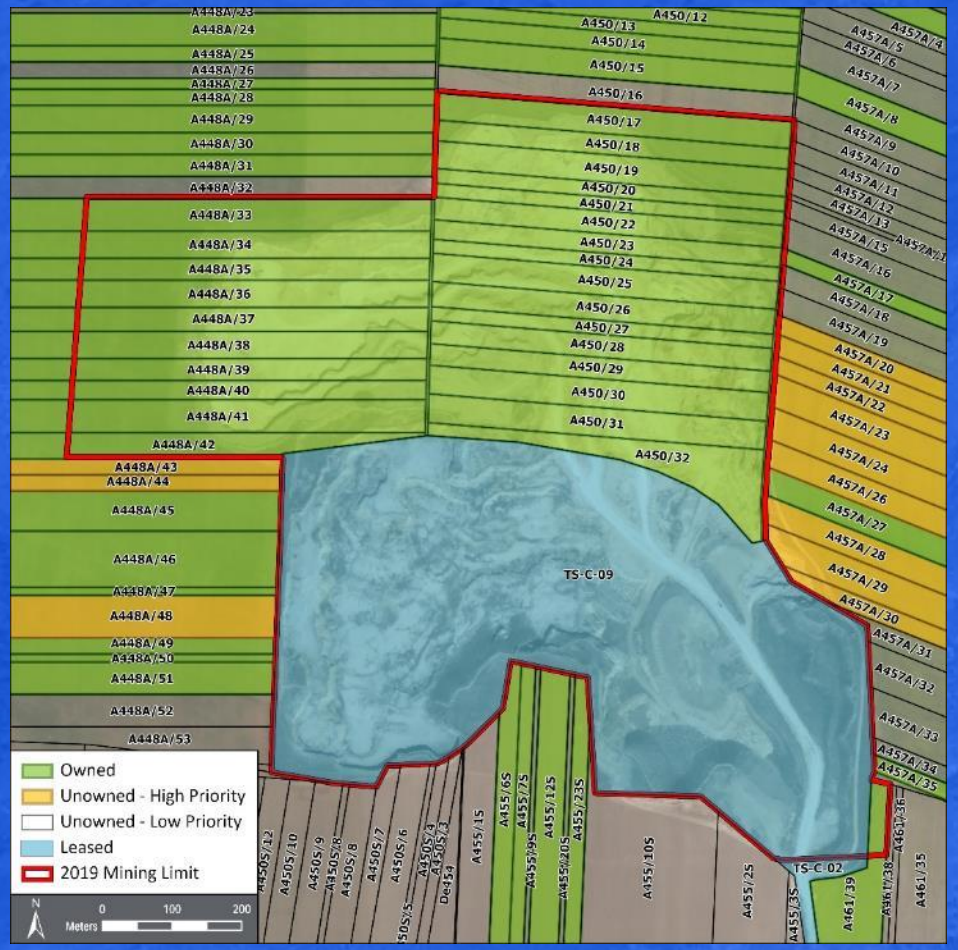
Real Life Examples of How a Block Model and Mine Plan Helped an operation

Identified Additional Reserve Areas and Faulting

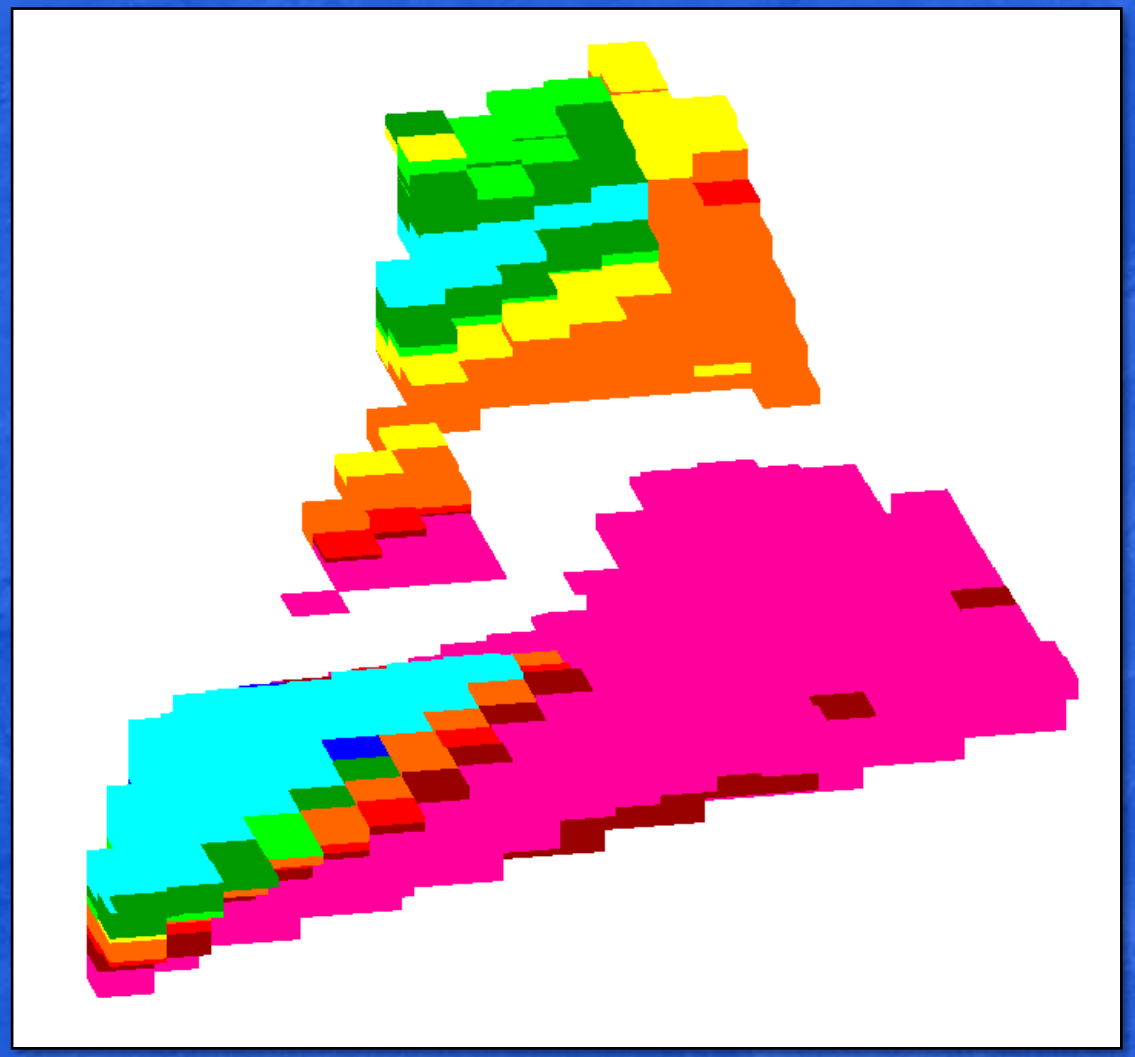


“Unblendable” Material Left in the Quarry

Avoided Hard to Handle Material Historically



Quantified Unusable Material



- Approximately 8 Mtons of Chert material represents approximately 4 years of mine life.

In conclusion, the block model and mine plan are tools to help understand and maximize the value the quarry.

Questions?

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