

Tools to Effectively Evaluate and Communicate the Potential Value of Mineral Projects

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Management and Economics Society

MES

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CIM MES – Management and Economics Society of CIM



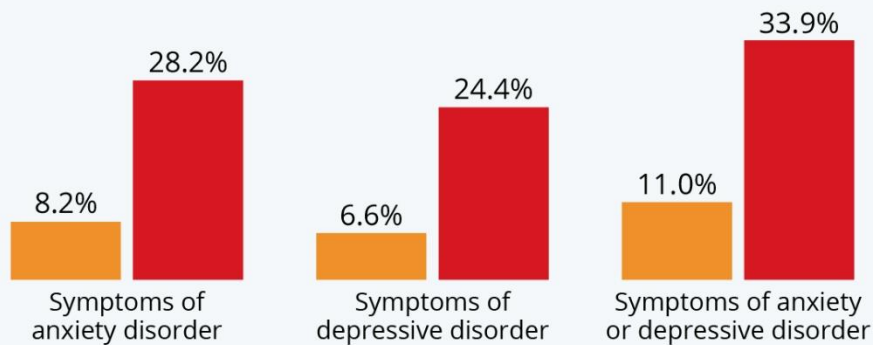
- CIM MES actively works towards furthering education in mineral economics. For over 20 years, CIM MES has used the funds it raises to support various educational initiatives and programs in mineral economics at Canadian universities.
- CIM MES sponsors various events throughout the year across Canada and internationally (Hong Kong) that provide industry professionals with the opportunity to share experiences, insights and ideas on topics relating to the economics, management and financial aspects of the business.

Safety Share: Check yourself and your loved ones

Pandemic Causes Spike in Anxiety & Depression

% of U.S. adults showing symptoms of anxiety and/or depressive disorder*

■ January-June 2019 ■ May 14-19, 2020



* Based on self-reported frequency of anxiety and depression symptoms. They are derived from responses to the first two questions of the eight-item Patient Health Questionnaire (PHQ-2) and the seven-item Generalized Anxiety Disorder (GAD-2) scale.

Sources: CDC, NCHS, U.S. Census Bureau

Canada-wide mental health resources

The resources below are available for youth and adults across Canada in need of mental health support.

PHONE, TEXT, CHAT

Kids Help Phone

Text Services: Text "CONNECT" to 686868 (also serving adults)

Chat Services: <https://kidshelpphone.ca/live-chat/>

Youthspace.ca (NEED2 Suicide Prevention, Education and Support)

Youth Text (6pm-12am PT): (778) 783-0177

Youth Chat (6pm-12am PT): www.youthspace.ca

Crisis Services Canada

Toll Free (24/7): 1 (833) 456-4566

Text support (4pm-12am ET daily): 45645

Canadian Crisis Hotline

1 (888) 353-2273

APPS AND ONLINE SERVICES

Better Help www.betterhelp.com

Online access to professional counsellors

On the web, and available for iPhone and Android users

The LifeLine App www.thelifelinecanada.ca

Direct access to phone, online chat, text, and email crisis support

E-counselling, self-management tools, access to crisis centres across Canada

Available for iPhone and Android users

ONLINE PEER SUPPORT

Big White Wall Canada

Big White Wall Canada www.bigwhitewall.ca

Anonymous peer support community accessible anytime, anywhere



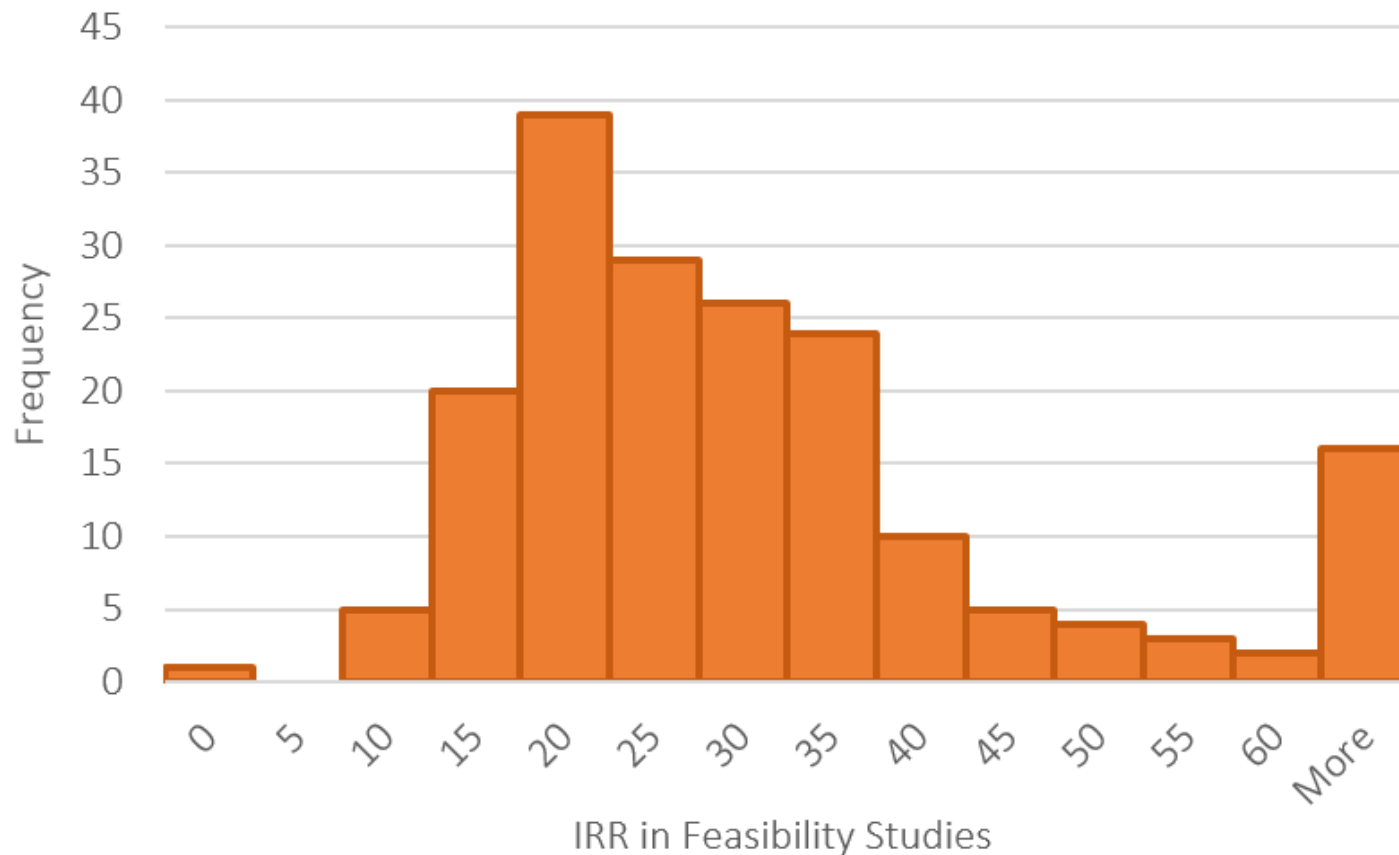
Abstract

There are hundreds of exploration companies that are actively marketing their mineral projects as future profitable mines. A few key metrics can highlight the intrinsic value of a given project. A dozen drill holes can be used to evaluate the exploration potential, in-situ value, geometrical/grade continuity, thickness, applicable mining/processing method and cost structure for a given prospect. Most projects, however, also contain an inherent challenge or technical difficulty that makes them uneconomic or unacceptable for investment. Quickly discovering what those are, and evaluating the potential impact to revenue, cost and implementation is the key to a successful project evaluation workflow; this exercise requires a diligent and multidisciplinary team. It is easy and safe to say that the project is worse than advertised, they mostly are. The difficult part is establishing whether the investment opportunity outweighs the technical risk.

Technical evaluations need to be staged to avoid spending too much time on aspects that are low risk or on projects that lack merit. Effective reporting tools are fundamental to the process. Decision makers are often technically peripheral to mining; their objective is to understand the risk and potential reward of a given project. Reports therefore, must distill and translate the technical information into a succinct and visually impactful format to enable decision makers to quickly grasp the economic potential for the current stage of review, and make a call to advance or discard the opportunity.

SHOCKING STATEMENT #1

Not all of the ≈ 1200 exploration companies on the TSX or ASX have economic projects.



WHERE MINING STUDIES STUMBLE

(2018-2020 Osisko Technical Team Database)

50 Project Sample

Geology	41%
Mining	37%
Processing	22%
Smelter	4%
OPEX	26%
CAPEX	41%
Environment Social Governance	41%



49% are incurable

TYPICAL GEOLOGY FAILURE

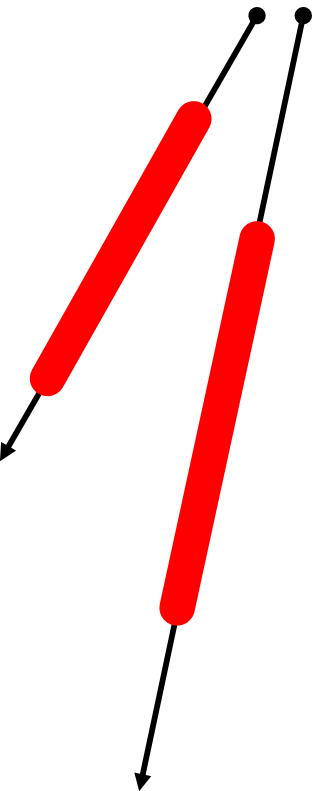


6 separate gold mining projects have cut their head grade or reserves by 20% or more in the last 12 months.

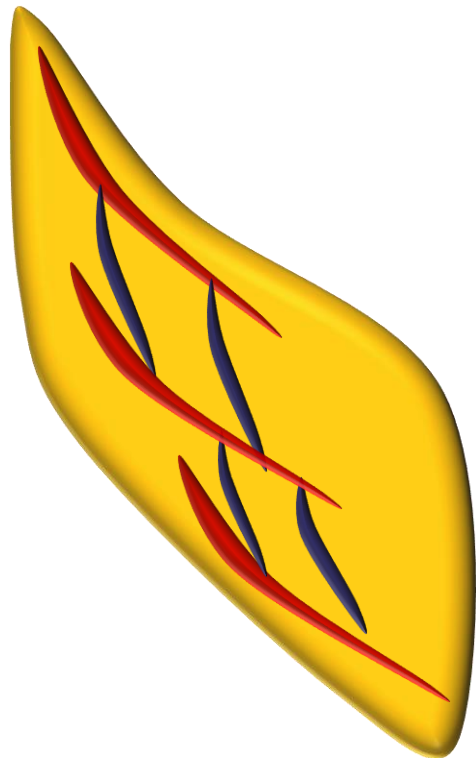
This is not due to geological instability...
Humans engineered these disasters.

TYPICAL GEOLOGY FAILURE

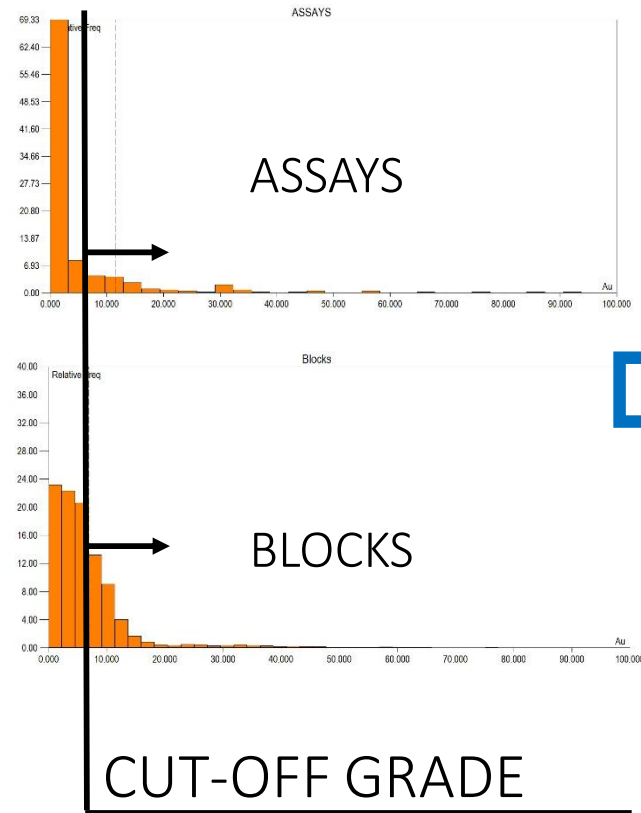
Insufficient Drilling



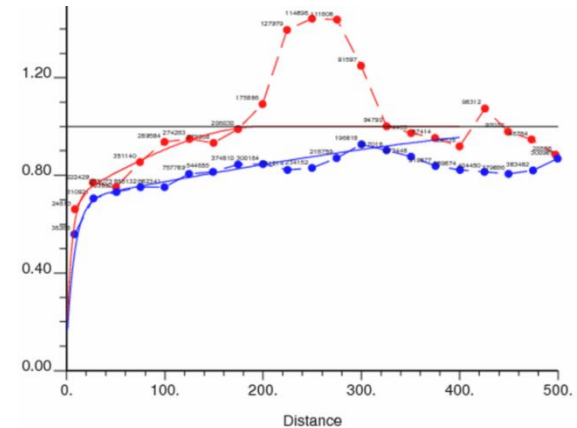
Expansive Geology Model



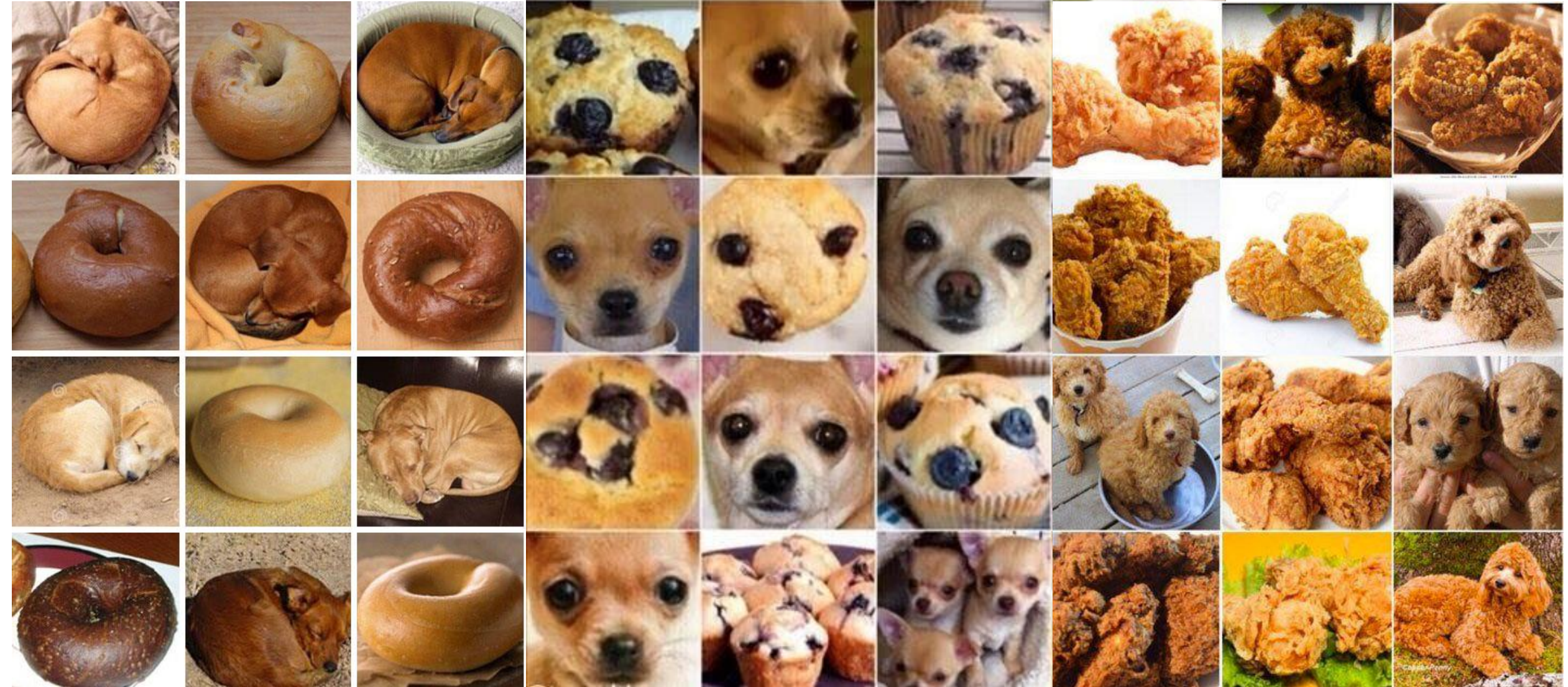
Estimation Tends Towards Average



Optimistic Classification



Identifying dogs early will free you up to find opportunities.



Killing Dogs Early: Search within Biggest Slices

- Start with highest cost aspects of project
 - High Capex:
 - Construction too short
 - Camp cost underestimated
 - Earth works and Indirects underestimated
 - High Stripping Ratio
 - Unreasonable mining cost or huge rebate for waste
 - High Opex
 - Insufficient Staff or Salary
 - Too few expats (e.g. Africa)
 - Transport of fuel or concentrate



Killing Dogs Early: Operational Challenges

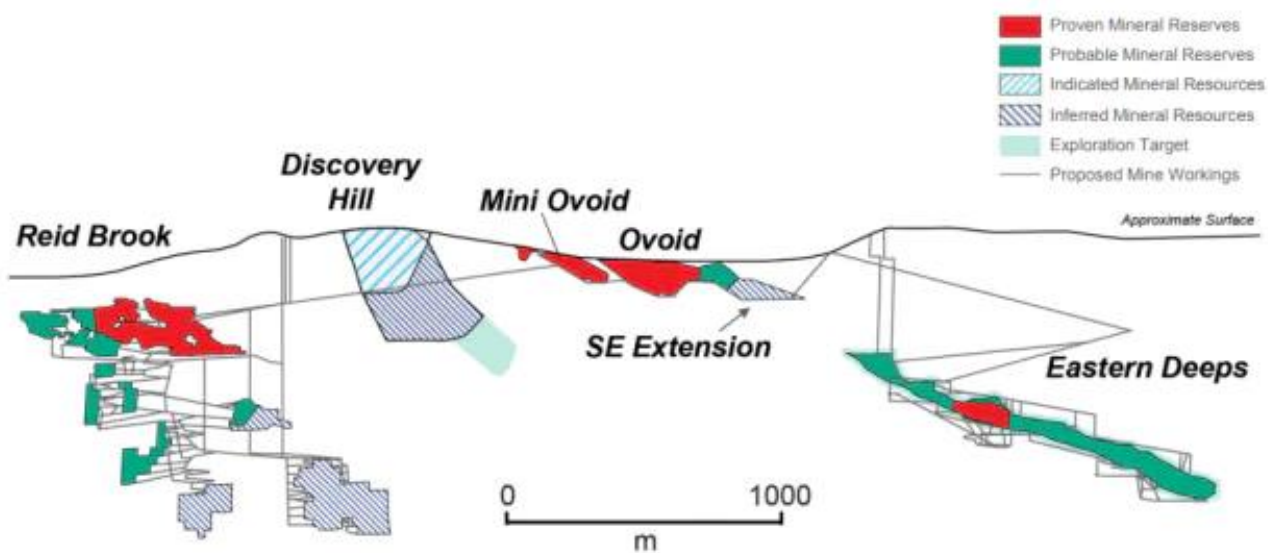
- Look for operational bottlenecks
 - Larger mill means low unit costs
 - Is the mine capable to deliver? Thin and discontinuous zones.
 - Ore Hardness will limit throughput and/or recovery
 - Appropriate or sufficient metallurgical samples?
 - Sufficient buffer between stages?

“The Company implemented smaller mining benches and split pushback phases to accelerate access to the main ore body... the smaller operating areas resulted in reduced productivity rates from increased congestion and delays in drill-blast-load cycles.”



SHOCKING STATEMENT #2

Slam dunk projects (High value, Simple mining and processing, good jurisdiction) are extremely rare and usually not available for investment (e.g. Voisey's Bay)



Finding Value Beyond the Superficial Faults

Flawed asset

Incomplete information

Risk adjusted bids

Competitive environment



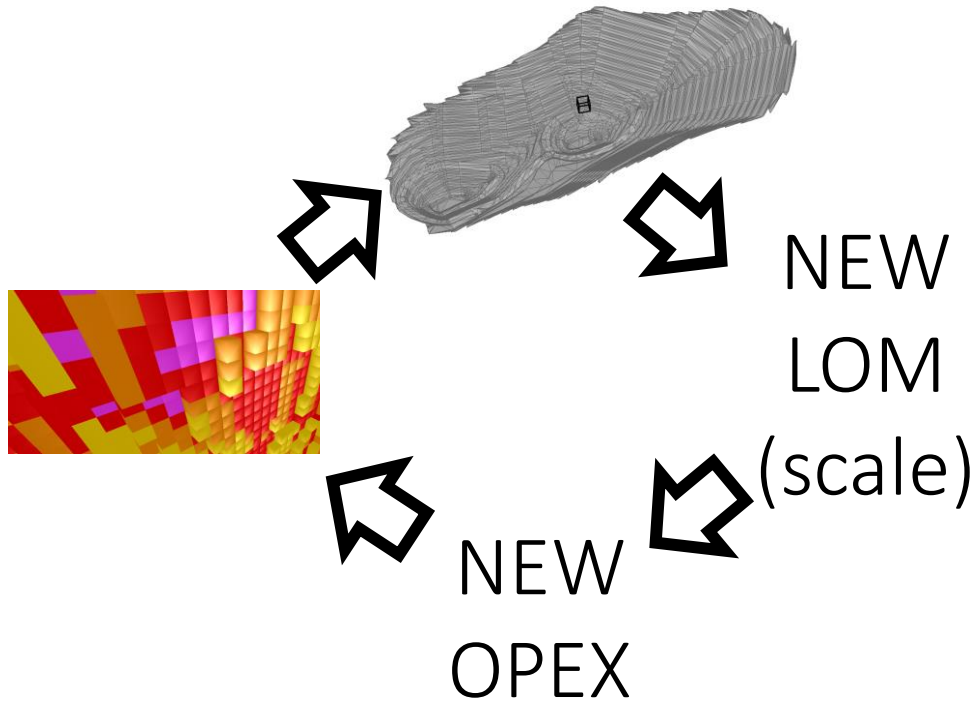
Finding Value Beyond the Superficial Faults

- Is there a technology that can save the day?
 - Ore sorting
 - Continuous mining
 - Automation
 - Oxidation Technology



Finding Value Beyond the Superficial Faults

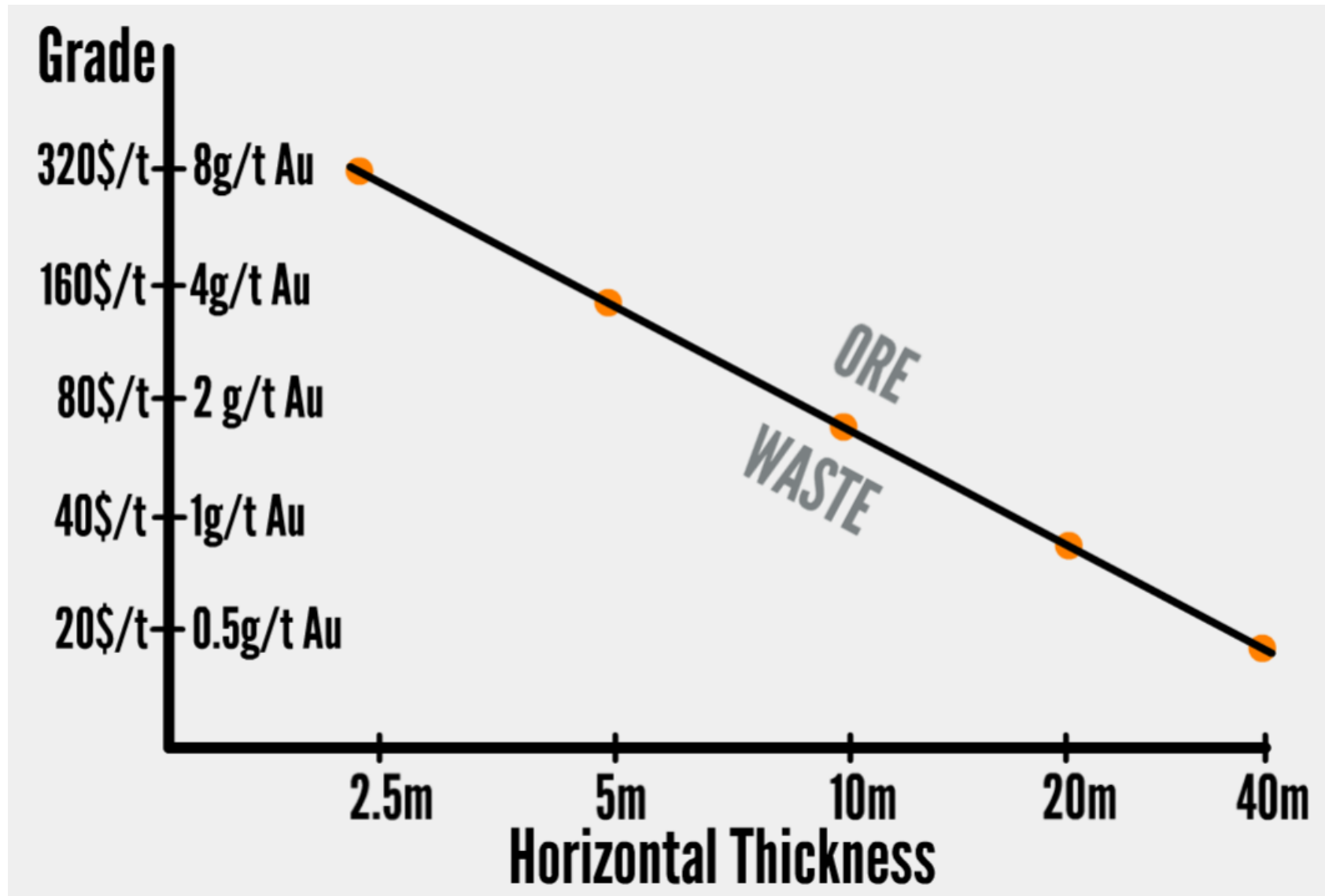
- Most difficult to quantify the impact.
 - Easy to trash a project, harder to see the value.
 - Some changes will need iterative evaluation.
 - How to adjust REVENUE OPEX or CAPEX?



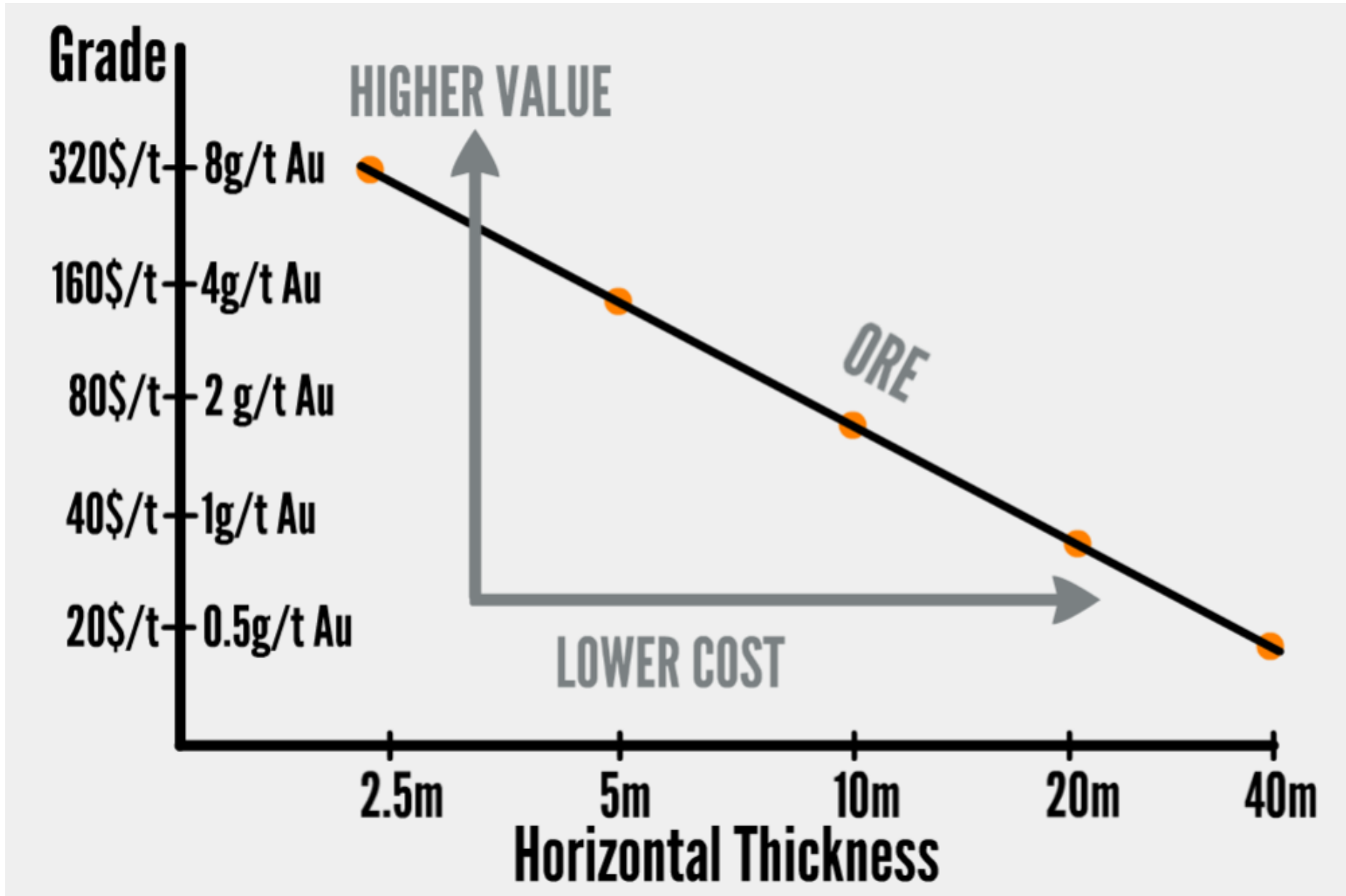
ECONOMIC METRICS

1. Grade and Thickness with Continuity
2. Metal Associations and Grain Size as a predictor of Recovery
3. Profit Based Cut-Off Grade (more than marginal)
 1. Profit margin per tonne
 2. Geological flexibility to cut-off
4. Profitability Index (NPV/CAPEX)
 1. Along with NPV, IRR, Payback, CAPEX...
5. Time to Actual Construction

METRIC #1 :GRADE-THICKNESS



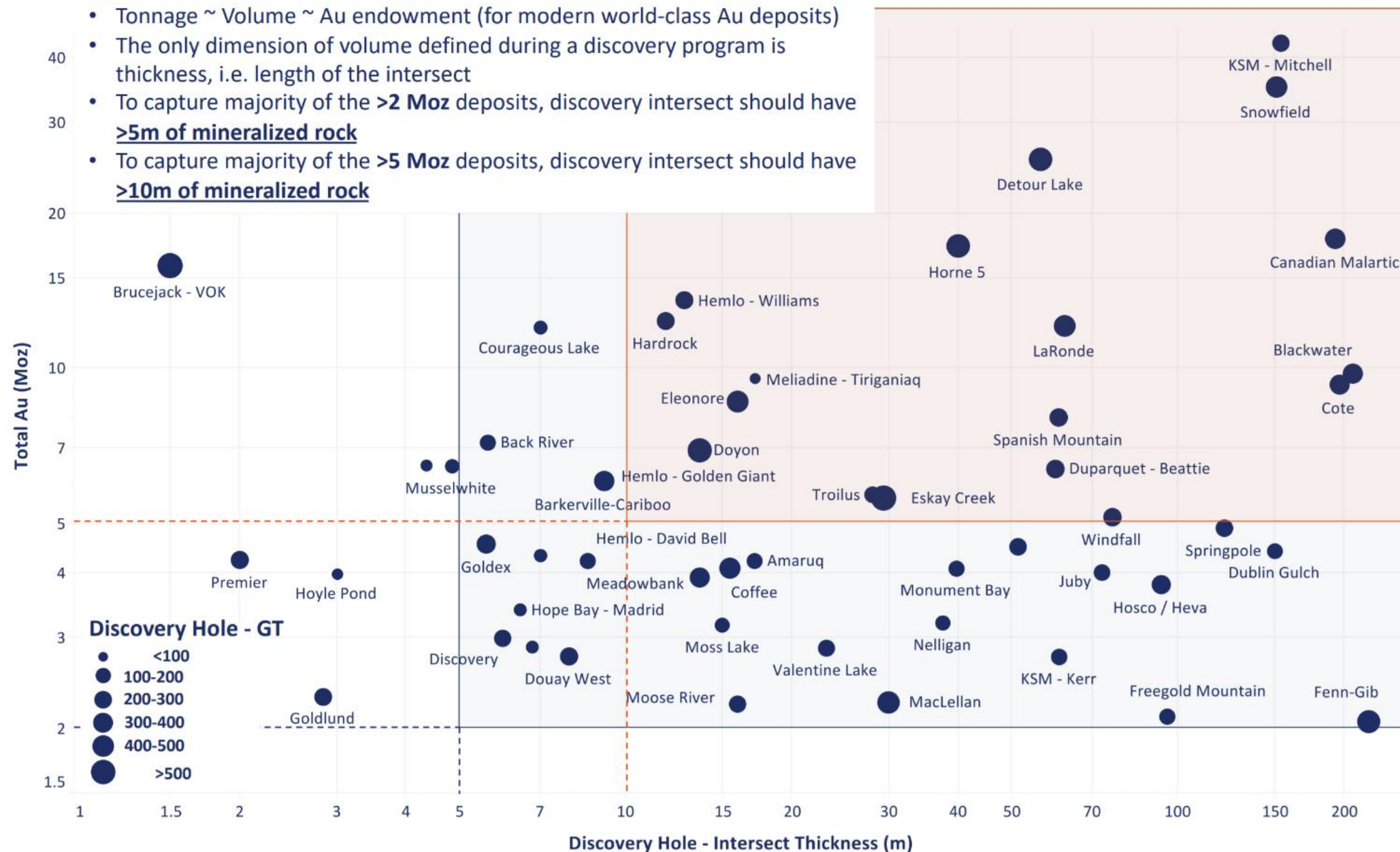
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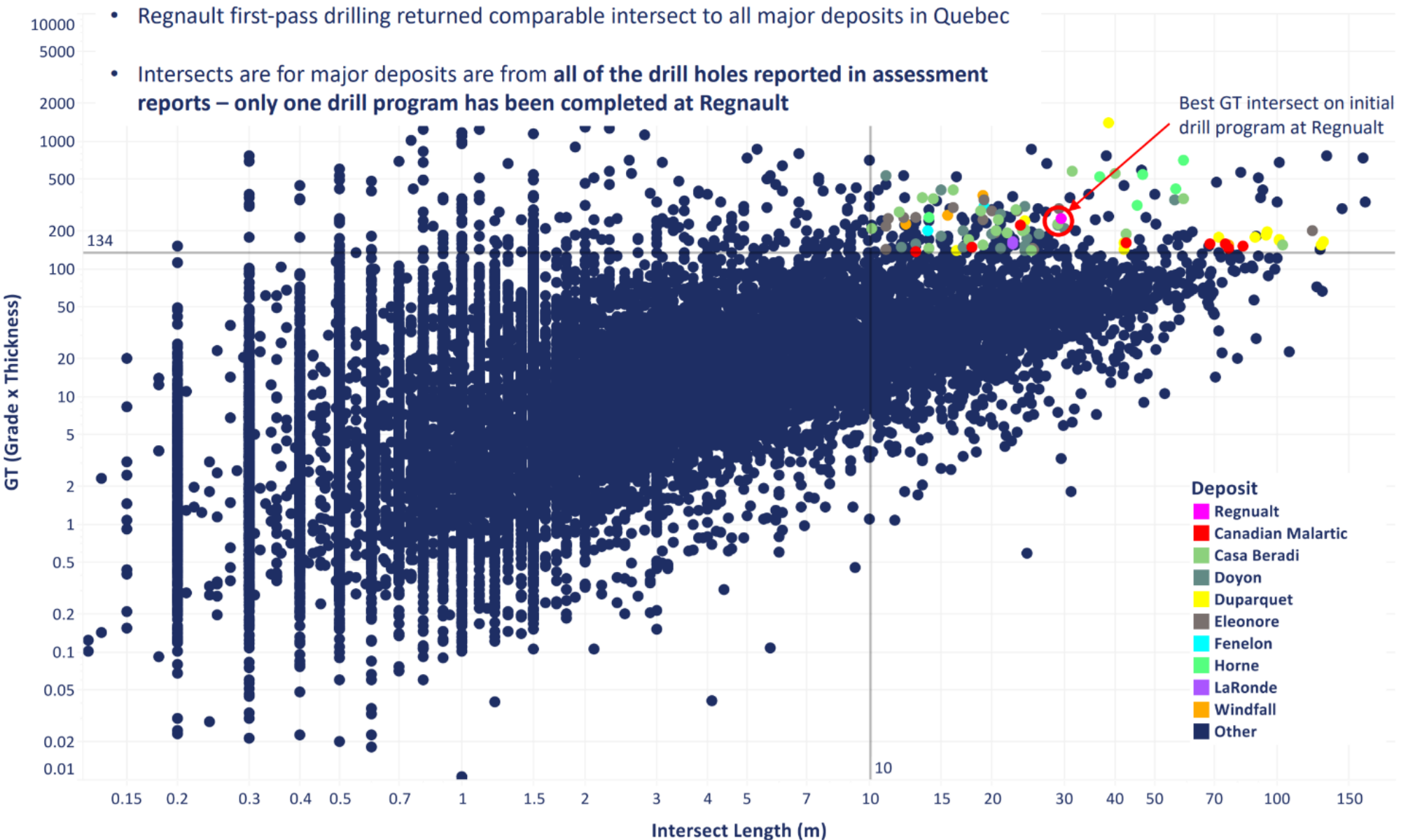
Discovery Intersect Length vs. Gold Endowment



- Tonnage ~ Volume ~ Au endowment (for modern world-class Au deposits)
- The only dimension of volume defined during a discovery program is thickness, i.e. length of the intersect
- To capture majority of the >2 Moz deposits, discovery intersect should have **>5m of mineralized rock**
- To capture majority of the >5 Moz deposits, discovery intersect should have **>10m of mineralized rock**

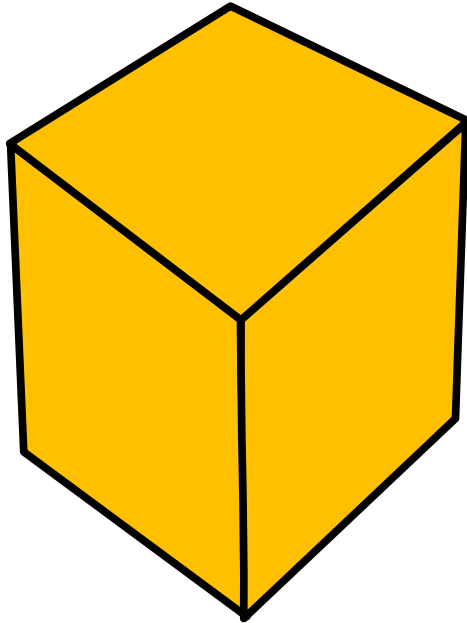


Quebec Drilling GT Intersects of major Au deposits

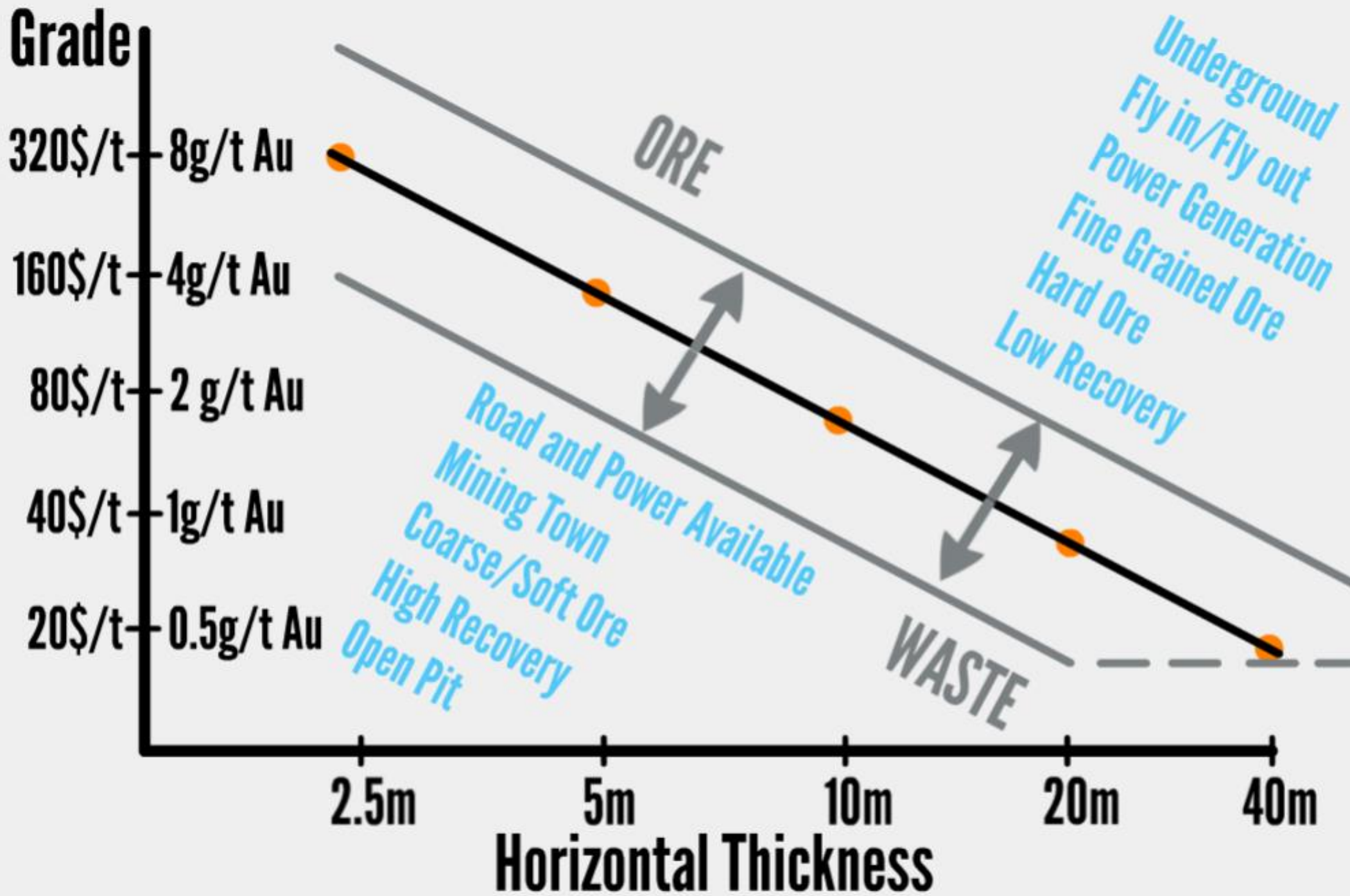


What is a tonne of metal worth

1 tonne of
pure metal

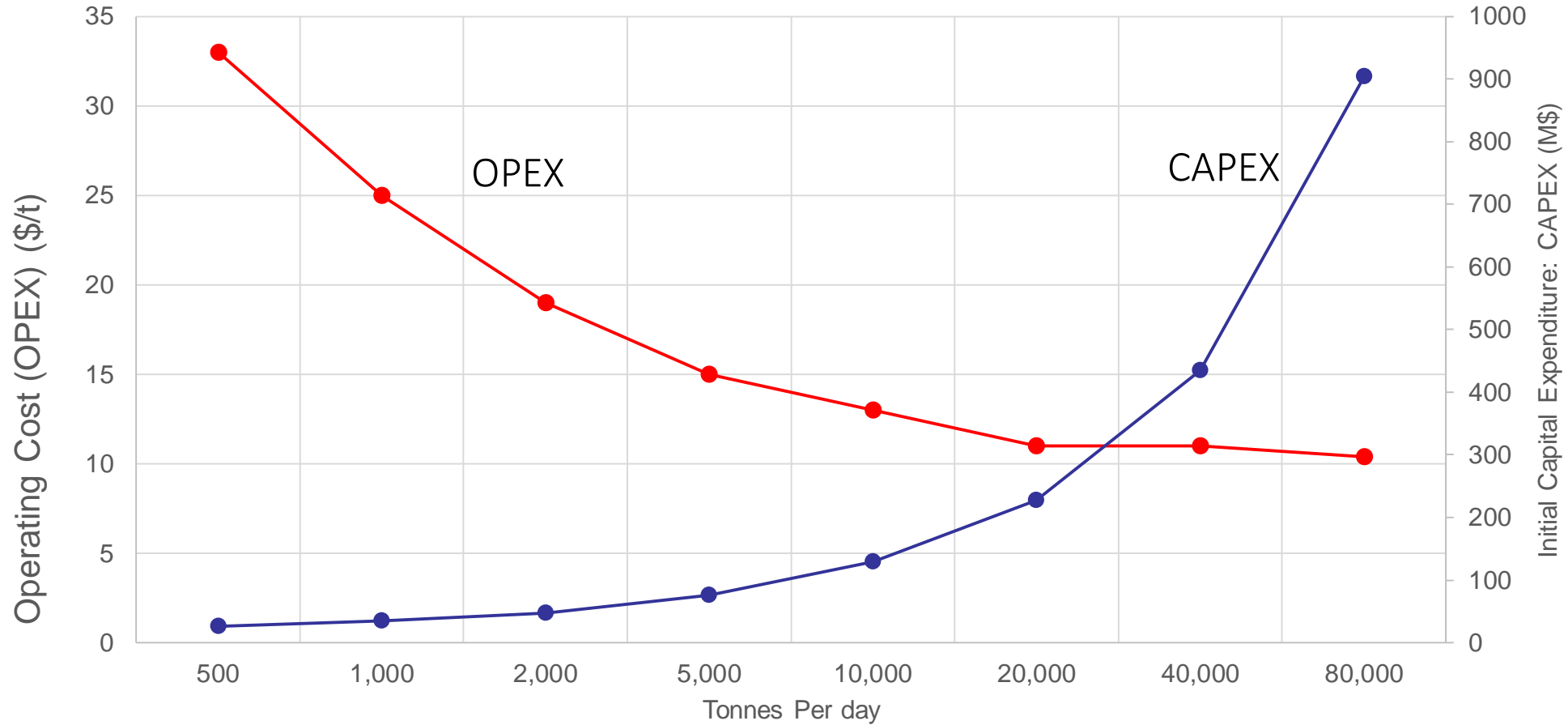


		Consensus Commodity Forecast Prices		
		2016 (actual)	Average forecast	
		Avg. Price	2017	
10,000x	50,000,000\$/t	Gold (US\$/oz)	1,250.33	1,245.16
	500,000\$/t	Silver (US\$/oz)	17.13	17.79
		Platinum (US\$/oz)	988.87	1,017.45
		Rhodium (US\$/oz)	680.95	807.00
		Palladium (US\$/oz)	614.71	750.32
		Aluminum	0.73	0.83
	50,000\$/t	Cobalt	11.57	17.75
	5,000\$/t	Copper	2.21	2.55
		Iron Ore (US\$/t)**	56.70	63.66
		Lead	0.85	1.01
		Molybdenum	6.37	7.18
	10,000\$/t	Nickel	4.36	5.05
		Tin	8.16	9.35
	2,500\$/t	Zinc	0.95	1.23
	Uranium **	26.41	31.15	

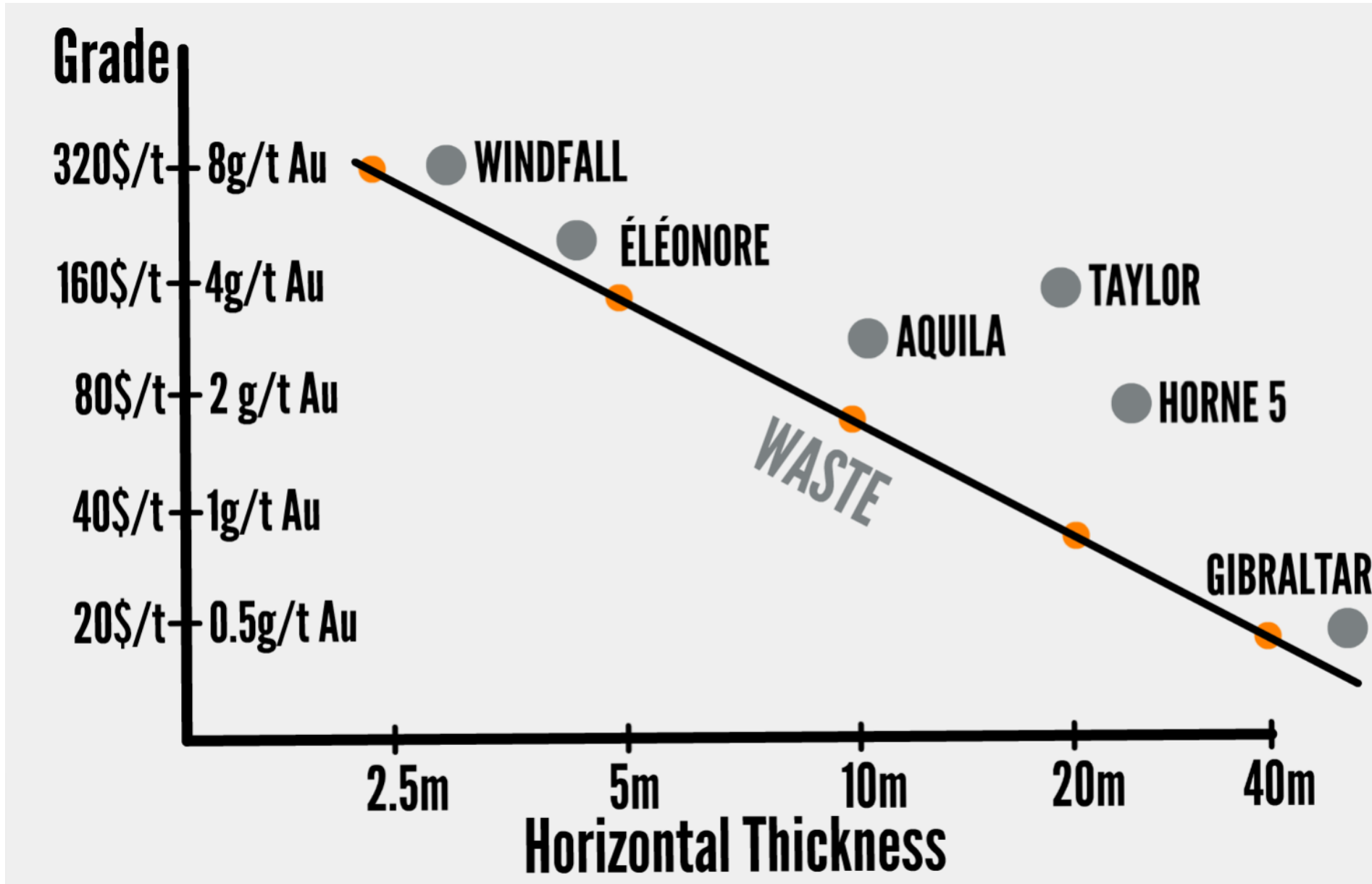


Capex flotation processing by scale

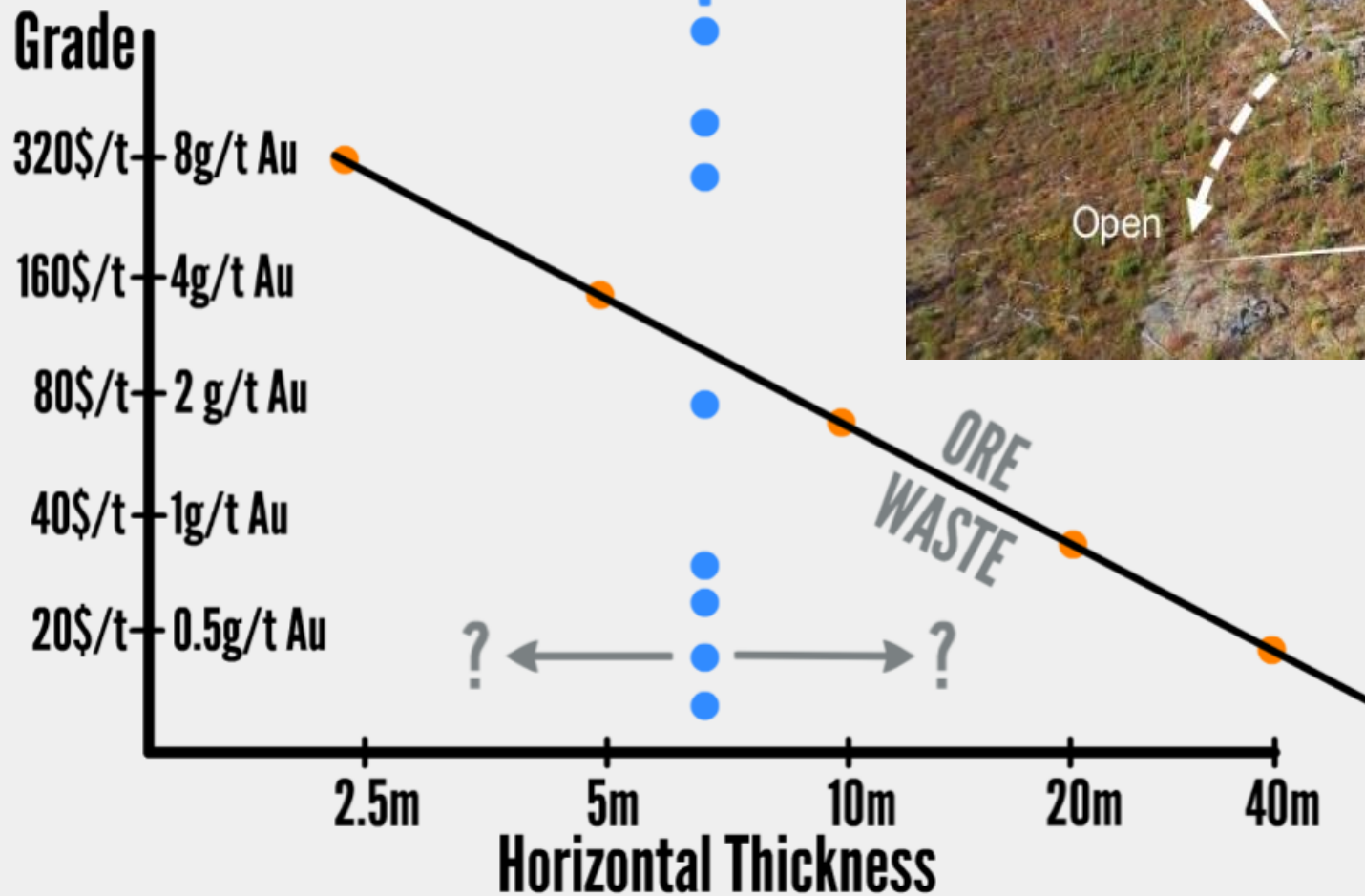
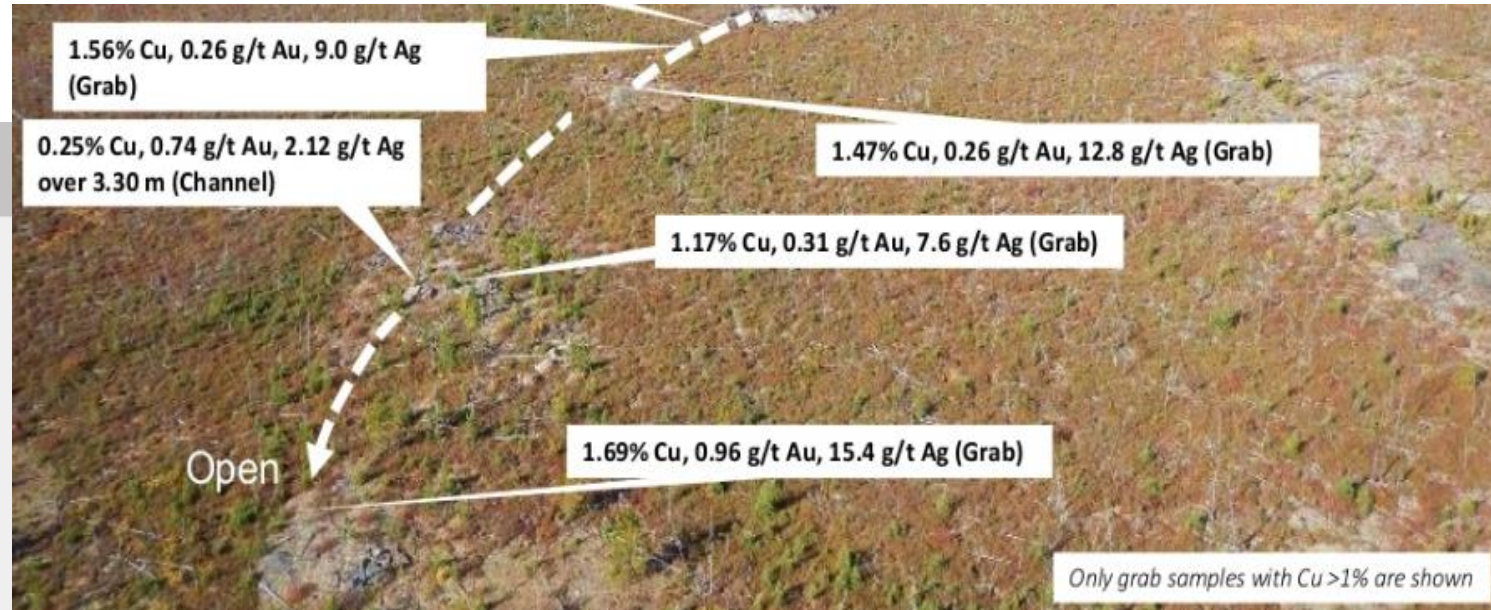
CAPEX and OPEX for Flotation Mill



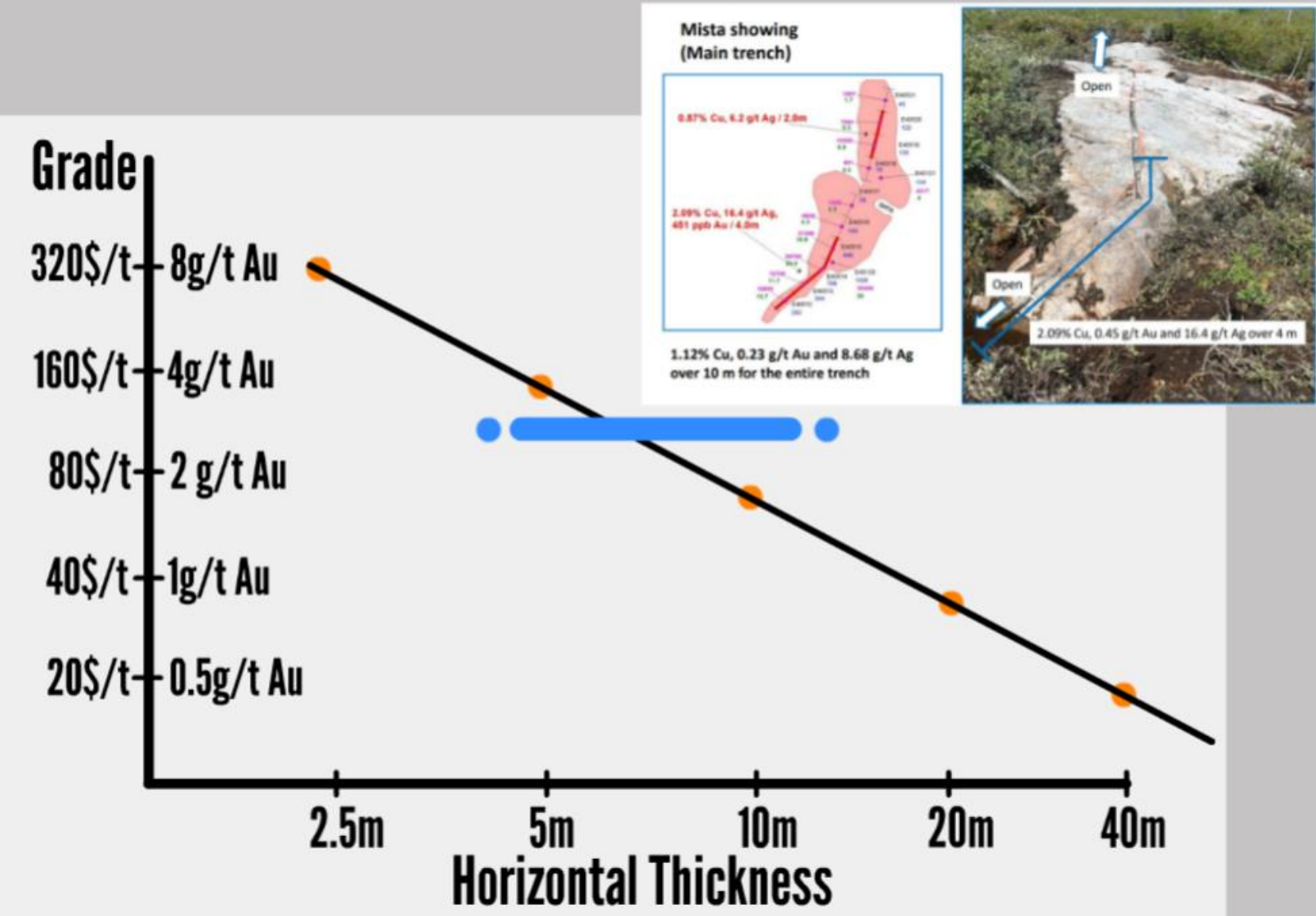
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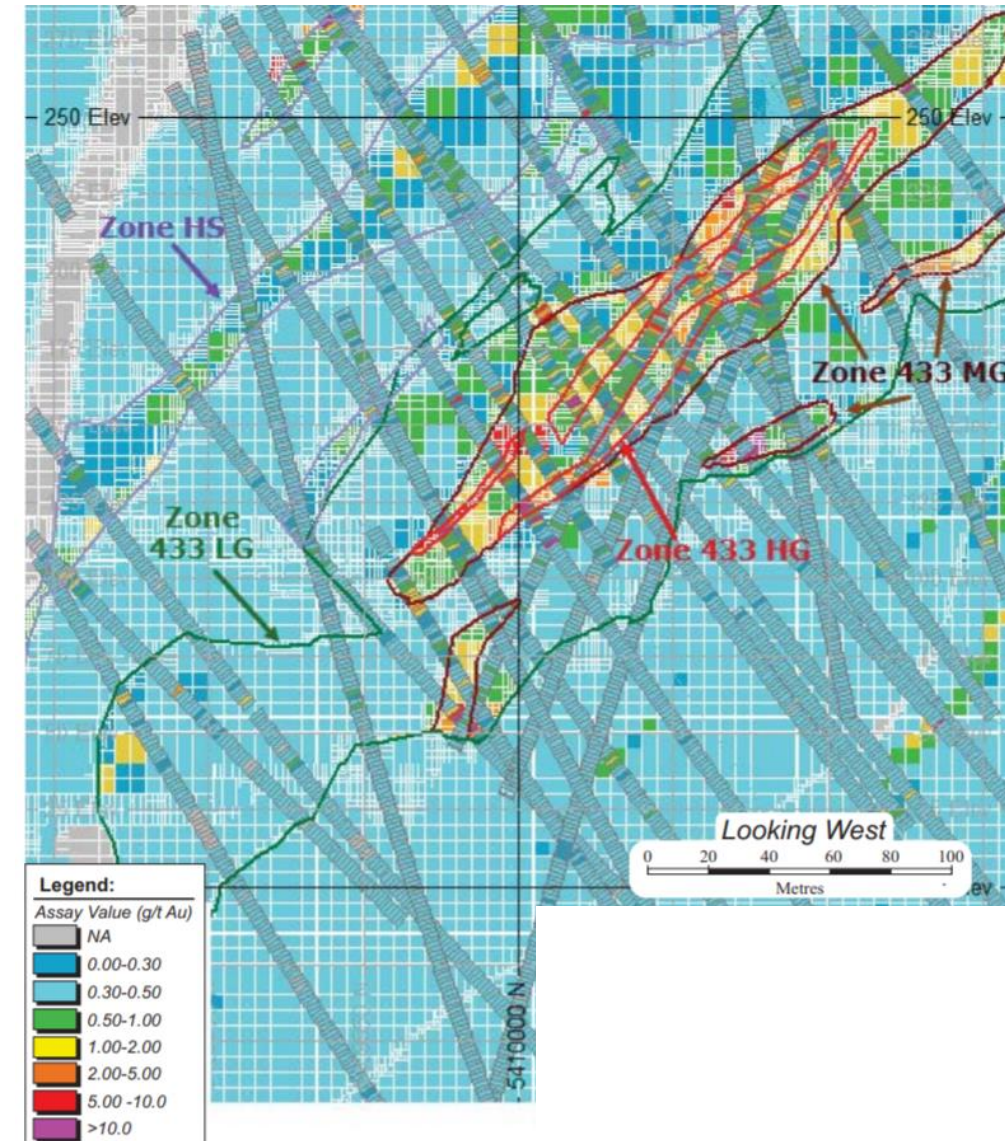
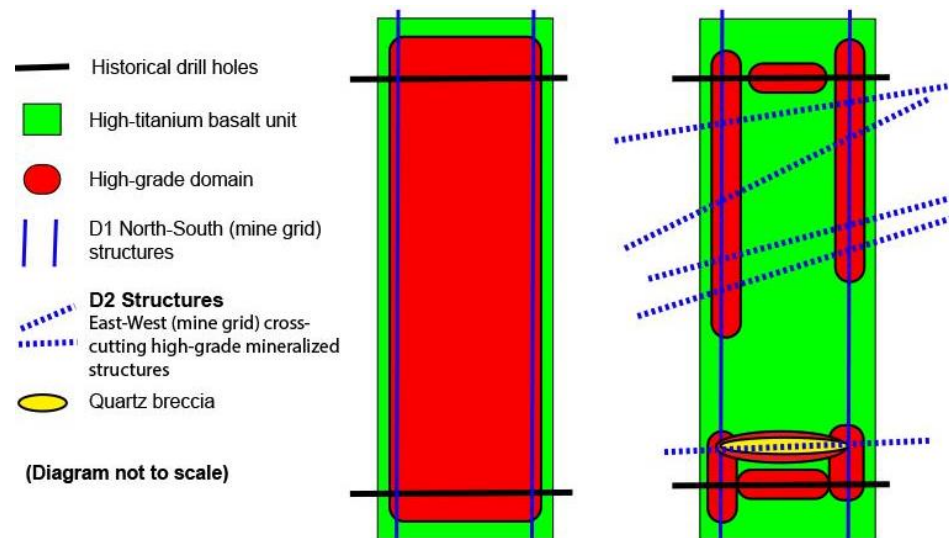


METRIC #1 : GRADE-THICKNESS



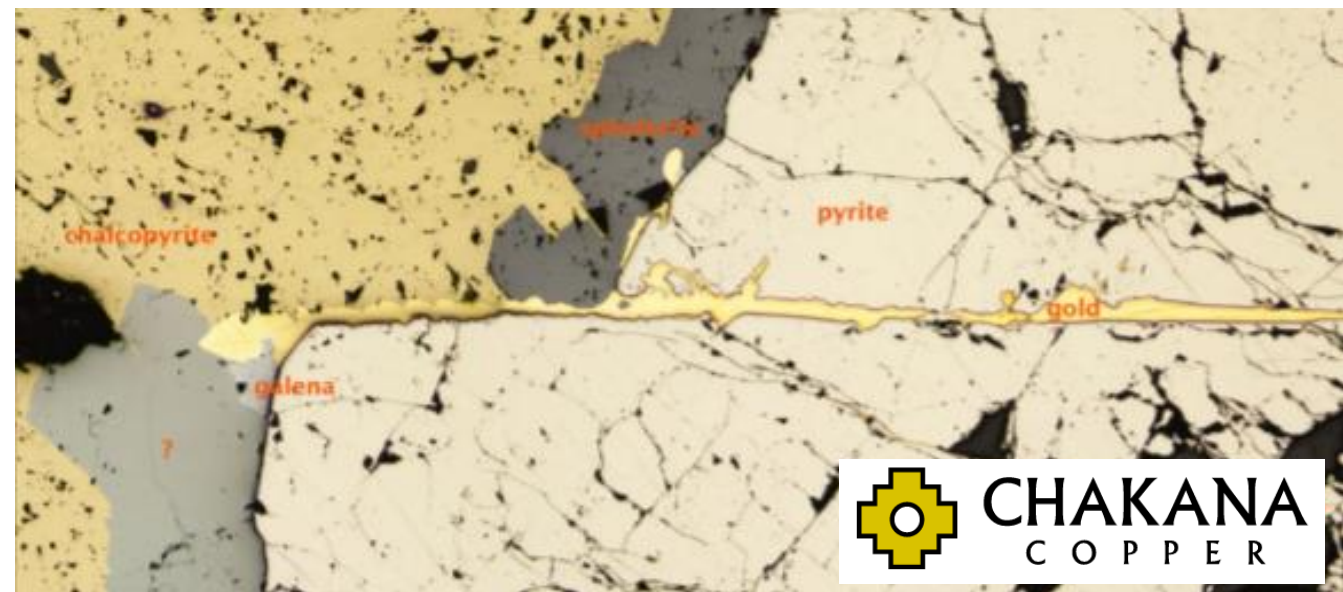
METRIC #1: Verify Grade Continuity

- Looking at the data for geometrical continuity
 - Mining selectivity requires consistent tabular shapes of ore grade over several 10's of meters
- Histogram of assays within ore solid
- Median of grade (mean is misleading for lognormal distributions)



METRIC #2: Grain Size and Mineralogy

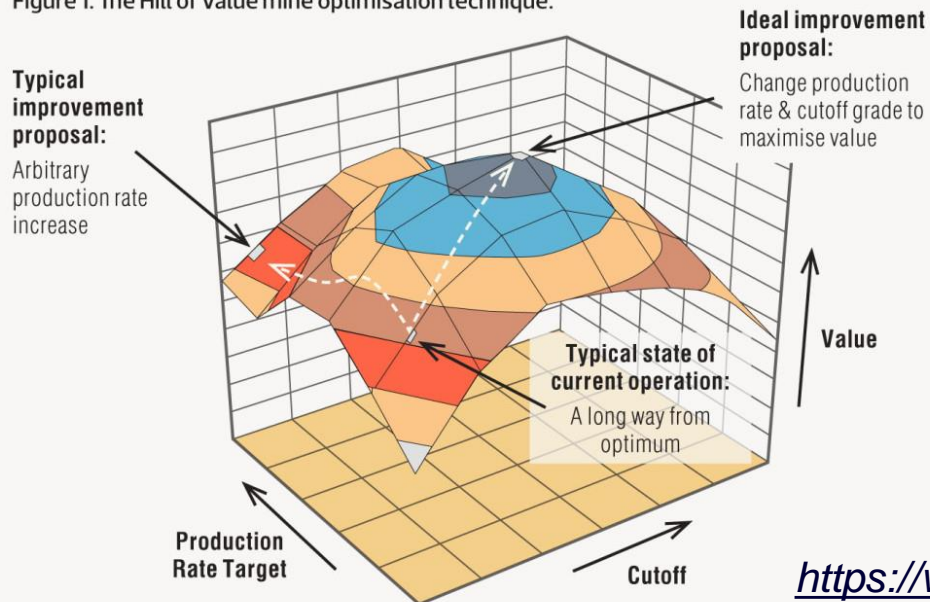
- High Capex and Opex for Fine Grinding
 - Forces a trade-off between cost and recovery
- Precious Metals value depends on where in the minerals they end up in terms of recovery and payability:
 - Gravity > Cu con > Pyrite con >> Zn con



METRIC #3: Profit Margin Cut-off Grade

- The industry standard “Marginal Cut-Off” does not pay for CAPEX.
 - For pits, the cost of mining is often not considered at all
- Target an Average Profit Margin per Tonne > 100%
 - E.g. If all costs are paid for by 3g/t, a robust project will have >6g/t.

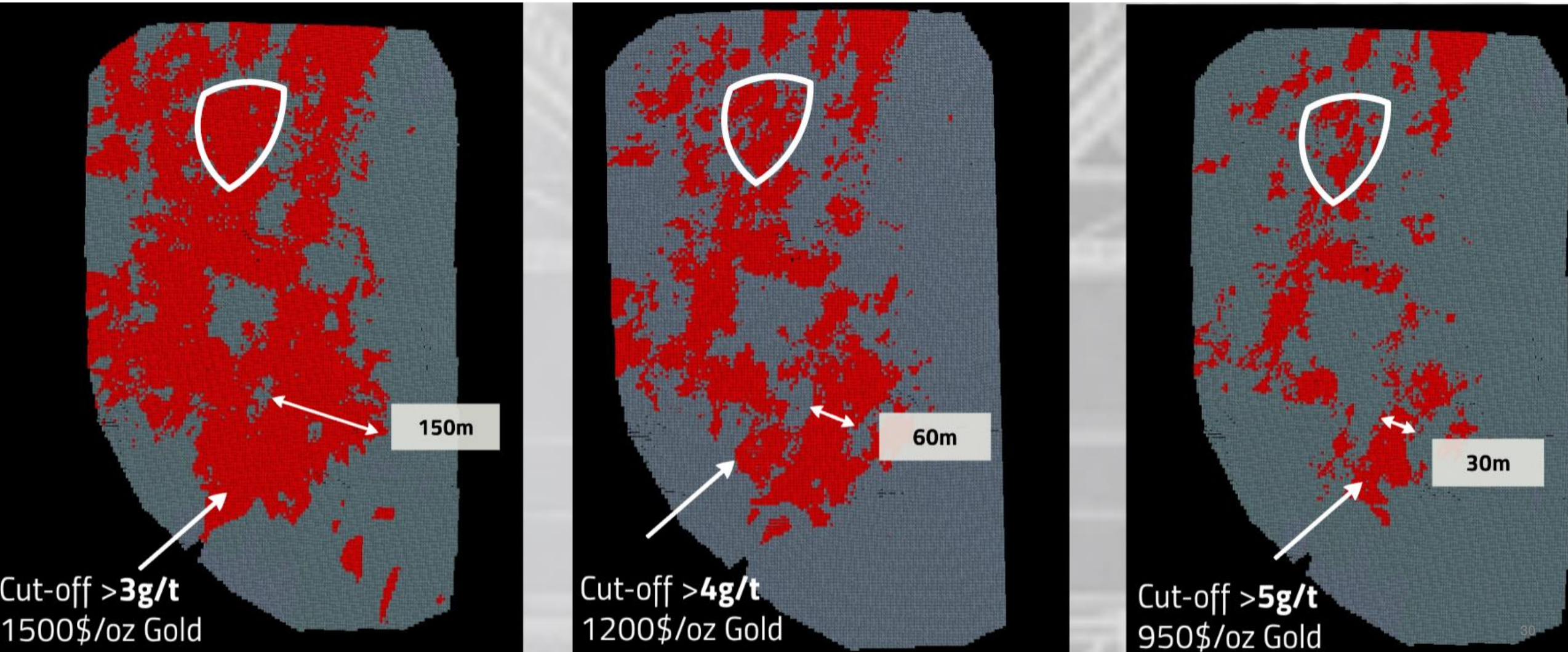
Figure 1. The Hill of Value mine optimisation technique.



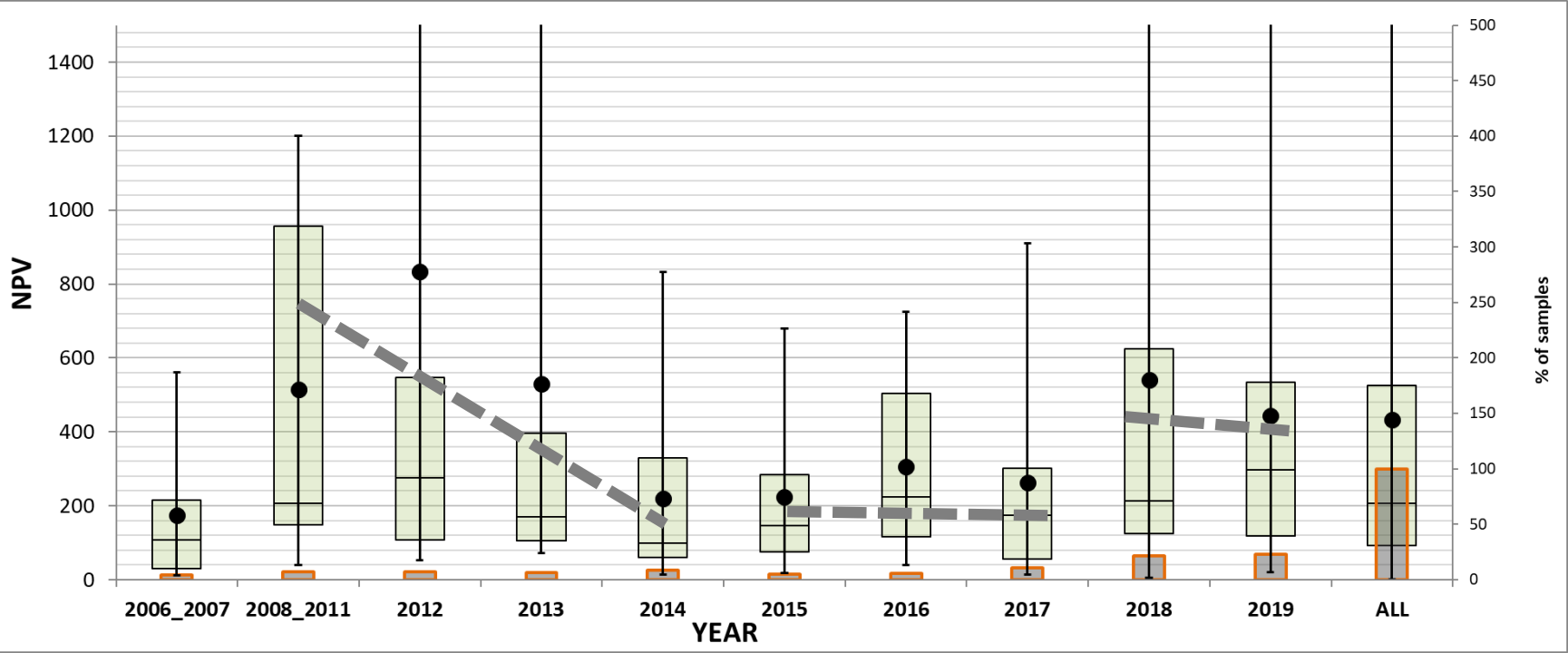
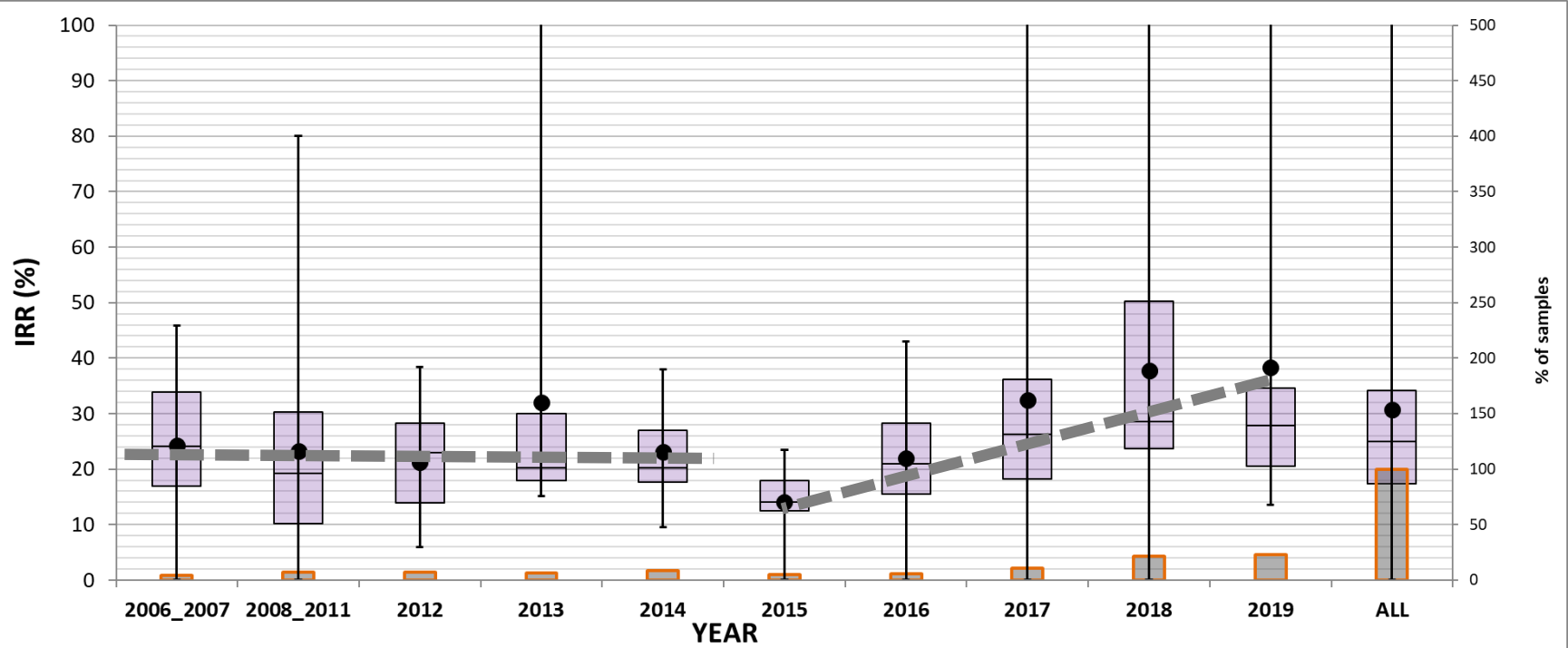
<https://www.ausimmbulletin.com/feature/the-role-of-mine-planning-in-high-performance/>

The Geology will Impose a Ceiling to the Cut-Off

Veza gold deposit illustrating how continuity is lost at higher cut-off grades.

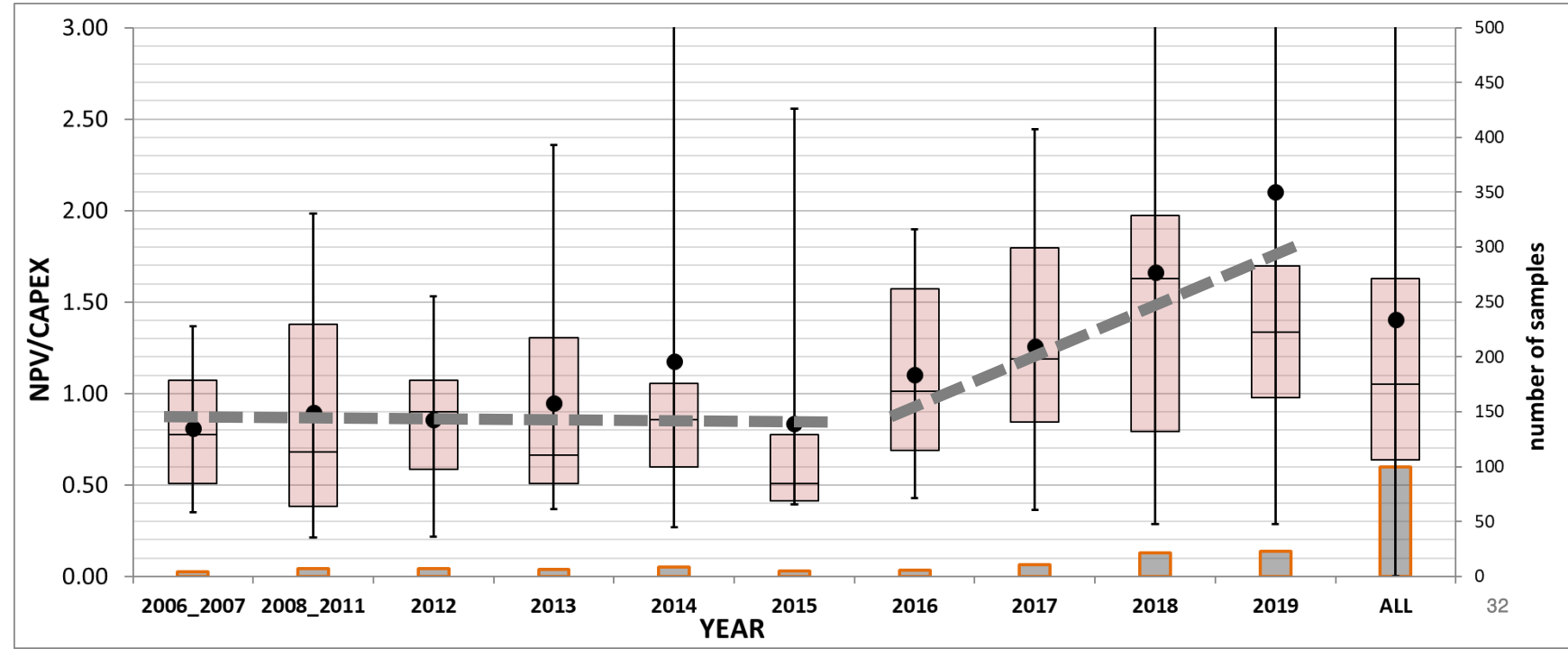
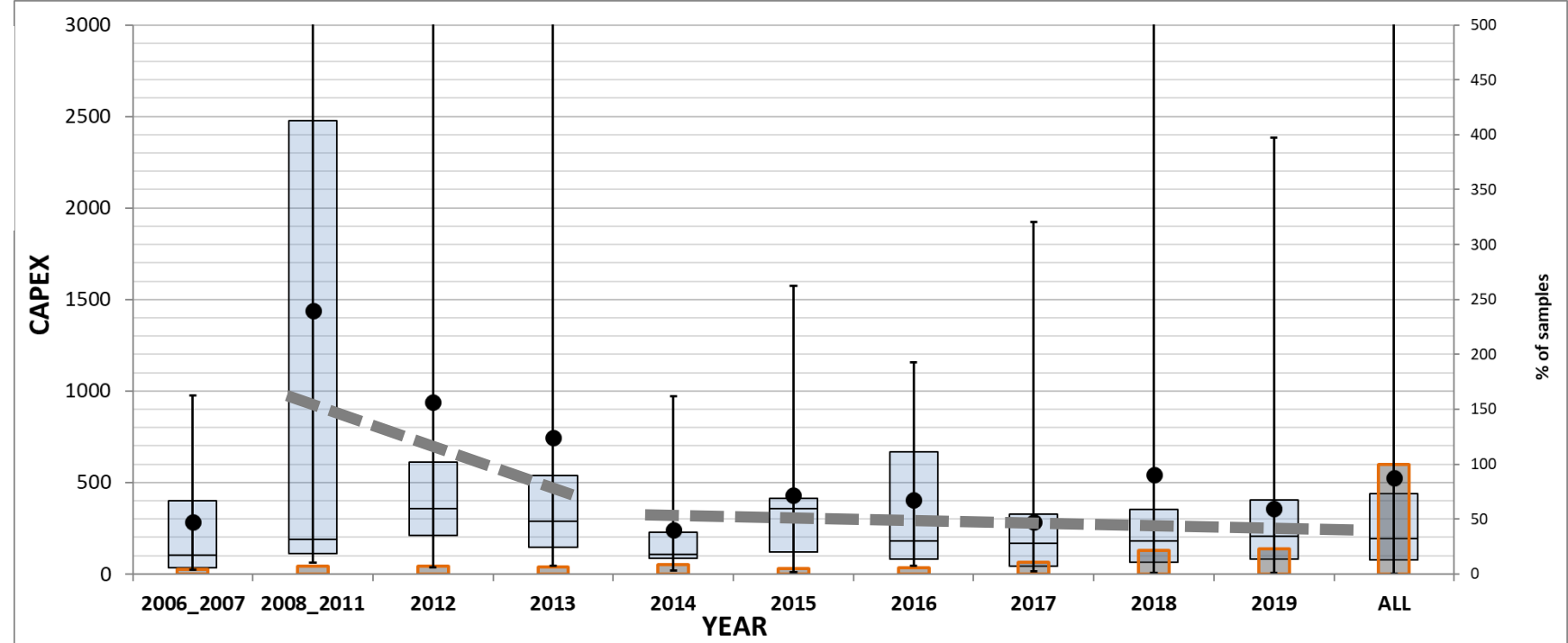


Trends in
Traditional
Measures of
Economics
(184 Feasibilities
for Base and
Precious Metals)



METRIC #4: Profitability Index

POST-2016
BIG projects cannot be
financed: forces higher
“Profitability Index”
(NPV/CAPEX)



Metric #5:

Time to ACTUAL Production



PEA 2020

FS Q1 2021

Permitting
Q2 2022

Construction
Q4 2022

First Gold
Q2 2023

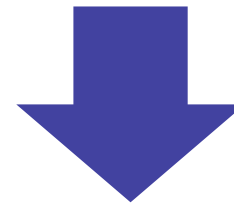
Metric #5: Time to ACTUAL Production



Insufficient
Indicated/Measured
Resources



Appeals
Elections
“Minor” Permits



PEA 2020

FS Q1 2021

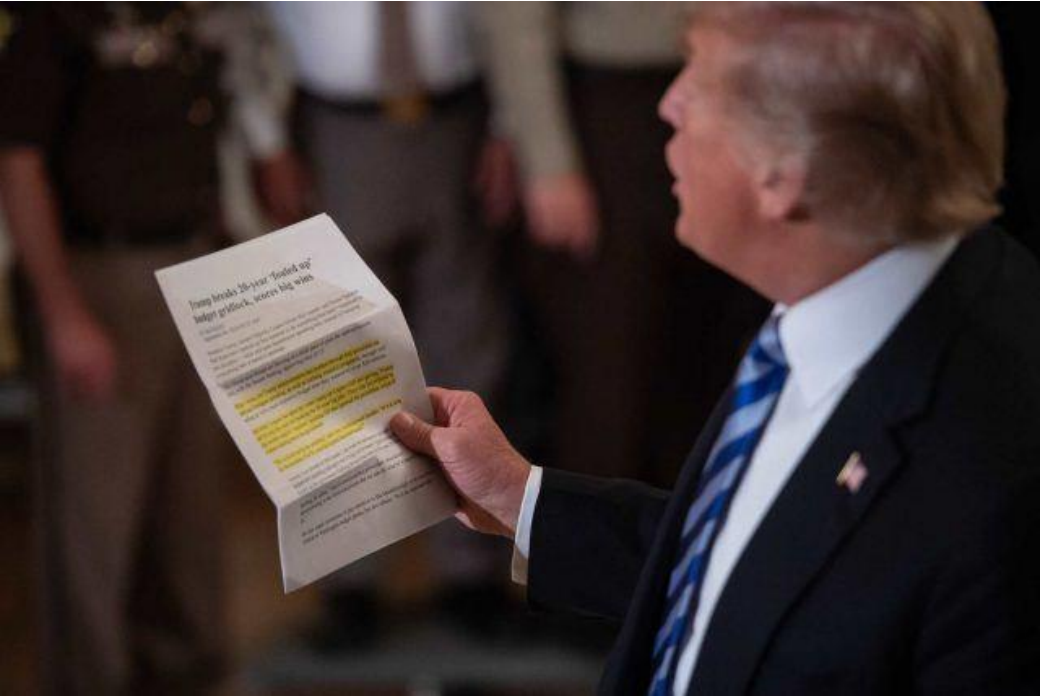
Permitting
Q2 2022

Construction
Q4 2022

First Gold
Q2 2023


SHOCKING STATEMENT #3

Decision makers will not read your 40 page report.




DASHBOARD ENABLES REVIEW OF PROJECT RISKS AT A GLANCE


Even at a high level we can see the difference between these projects. Each project we have looked at would have this one page document that can provide key risk metrics for communication and decision making.



Evaluation made by: Guy Deshaunais
Project Name & Company: Example Project
Project Status:
Date: 2020-03-01



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Project Name & Company: Example Project
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GEOLOGY: Block Model and Understanding of Controls on Mineralization								
1	2	3	4	5	6	7	8	
1	2	3	4	5	6	7	8	
ISSUES:								
RECOMMENDED:								
MINING METHOD AND OPEX								
1	2	3	4	5	6	7	8	
1	2	3	4	5	6	7	8	
ISSUES:								
RECOMMENDED:								
PROCESSING METHOD AND OPEX								
1	2	3	4	5	6	7	8	
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GRADE ABOVE CUT-OFF: Profit Margin per Tonne of Ore								
1	2	3	4	5	6	7	8	
1	2	3	4	5	6	7	8	
ISSUES:								
RECOMMENDED:								
CAPEX REQUIREMENTS								
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1	2	3	4	5	6	7	8	
ISSUES:								
RECOMMENDED:								
INFRASTRUCTURE AND TAILING								
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1	2	3	4	5	6	7	8	
ISSUES:								
RECOMMENDED:								
CORPORATE CAPABILITY: HR, Reputation, Community Relations								
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ISSUES:								
RECOMMENDED:								
EXTERNAL FACTORS: Political, Social, Financing								
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ISSUES:								
RECOMMENDED:								
UPSIDE								
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ISSUES:								
RECOMMENDED:								

RISK GAUGE: RED BAD, GREEN GOOD

“MINING METHODS AND OPEX” has a high likelihood to be a significant contributor to project failure.

MINING METHOD AND OPEX							
1	2	3	4	5	6	7	8
							8
ISSUES:							
RECOMMENDED:							

PROCESSING METHOD AND OPEX							
1	2	3	4	5	6	7	8
1							
ISSUES:							
RECOMMENDED:							

“PROCESSING METHOD AND OPEX” has a low likelihood to be a significant contributor to project failure

HOW WELL HAVE WE MEASURED THE RISK?

NARROW BAR = high certainty (we know what we are getting into)

WIDE BAR = low certainty (need more study by them or us, or it represents a key inherent risk)

We have enough information, and have taken sufficient steps to be certain (width of “GRADE ABOVE CUT-OFF” =1) and we know it is a relatively low risk for the project (3 out of 8).

GRADE ABOVE CUT-OFF: Profit Margin per Tonne of Ore							
1	2	← 3 →	4	5	6	7	8
ISSUES:							
RECOMMENDED:							
CAPEX REQUIREMENTS							
1	← 2	3	4	5	6 →	7	8
ISSUES:							
RECOMMENDED:							

We have insufficient information, and/or have not dug into the guts of the project to be certain (width of the “CAPEX REQUIREMENT” =5) and we know it is a moderate risk for the project (somewhere between 2/8 and 6/8).

MORE DETAIL AND RECOMMENDATION

Who did, and when was the last review and based on what information.

CAPEX REQUIREMENTS					+	Francois	November 2017, PEA PR release.
1	2	3	4	5	6	7	8
ISSUES: Metallurgical recoveries are based on a flowsheet that requires a regrind after flotation. Plant missing regrind circuit and cyanide destruction.							
RECOMMENDED: Increase Plant Capex by 50M\$ to account for lack of regrind circuit and cyanide destruction circuit.							

Recommended change to the cash flow model for OGR evaluation:
e.g. higher cost, lower recovery, lower price assumption...

Avoid: "in depth study required"

Reason why the risk rank was given, and some information if warranted.

Probability Weighted Exploration Potential

IMPORTANT Prerequisites

- Will be discovered prior to end of life
- Will be produced economically
 - Too deep for pit? Does the grade support underground mining?
 - Is the mine a black swan in the wider geological context (e.g. Kidd Creek)

Probability	Description
<u>P10</u> : 40Mt @ 4g/t	Would not be surprised if it got this high (bull case)
<u>P50</u> : 15Mt @ 3g/t	A likely scenario (base case)
<u>P90</u> : 5Mt @ 3g/t	Would be surprised if it was lower than this (bear case)

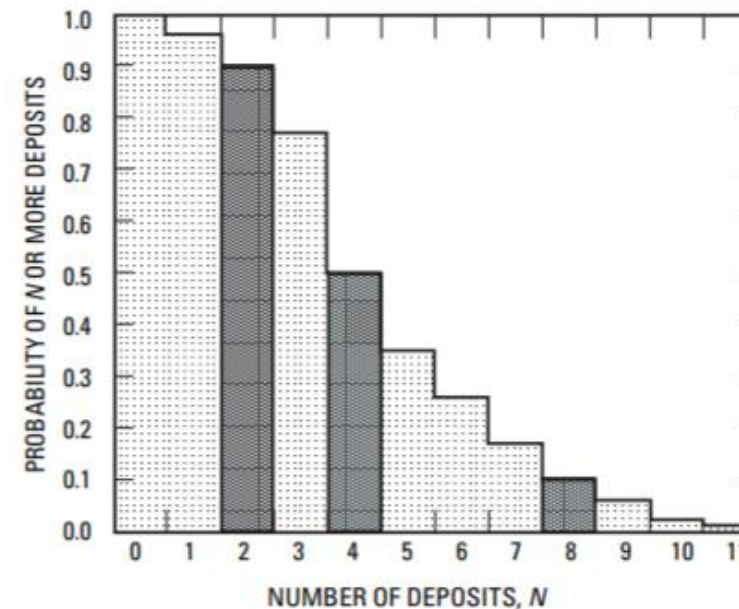
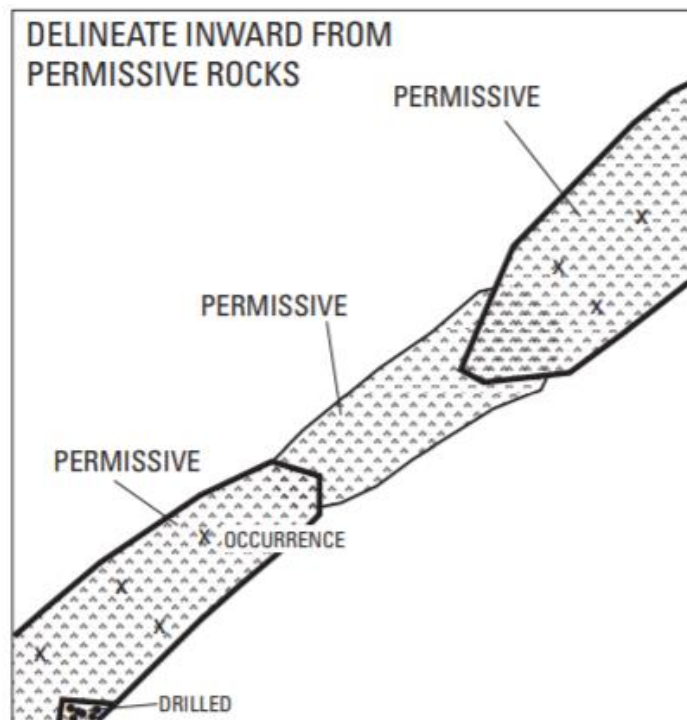
Exploration Potential Risk

Estimating Amounts of Undiscovered Mineral Resources

By Donald A. Singer¹

Abstract

The purpose of the three-part form of mineral resource assessments is to make unbiased quantitative assessments in a format needed in decision-support systems so that consequences of alternative courses of action can be examined. It is argued that the internally consistent descriptive, grade and tonnage, deposit density, and economic models and the design of the three-part form of assessments reduce the chances of biased estimates of the undiscovered resources. One part of three-part assessments, mineral deposit models, is discussed in Singer and Berger (this volume). Here the principal ideas of delineation of tracts of land and estimation of the number of undiscovered mineral deposits therein are presented. Linkage of the models with delineation and with estimation of deposits further reduces possible biases. Additionally, seven guidelines and some examples are provided to reduce biases in estimates of numbers of deposits. Experience from meteorology suggests that consensus schemes perform better than individual estimators and that the best estimates are made when objective estimates such as those from guidelines are part of the information supplied to subjective estimators.



Percentile	Estimates by participant			
	A	B	C	D
90 percent chance of at least the number of deposits listed	1	1	2	9,000
50 percent chance of at least the number of deposits listed	3	2	4	10,000
10 percent chance of at least the number of deposits listed	6	6	7	11,000

UPSIDE AND RECOMMENDATIONS

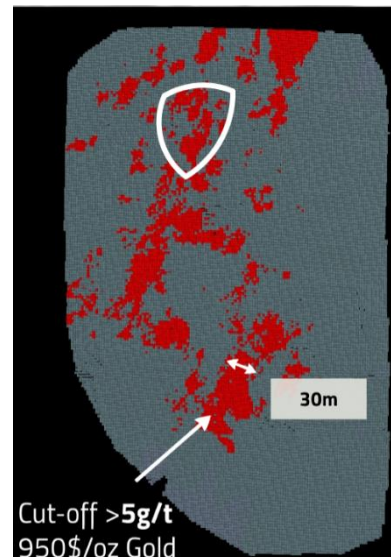
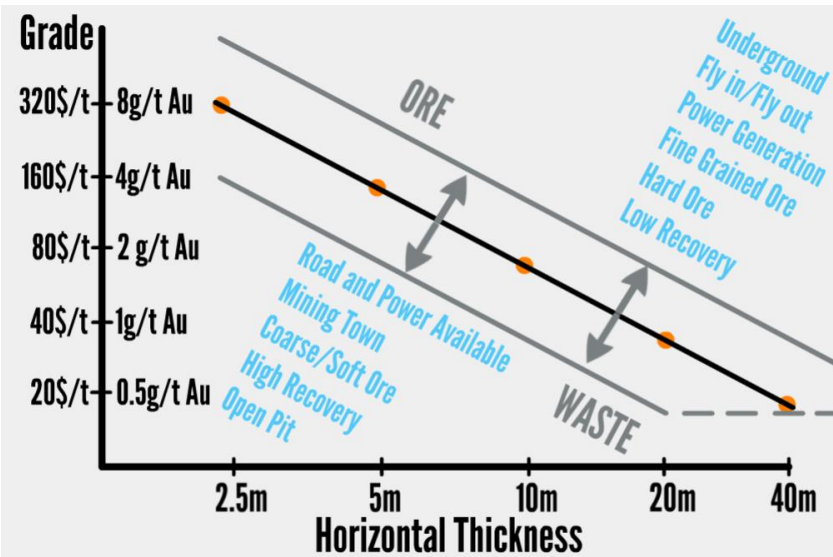
If there is any significant upside to the project (e.g. exploration, or metallurgical opportunity); whether it is highlighted or not by the Project Operator.

UPSIDE							
1	2	3	4	5	6	7	8
ISSUES:		P10: 10Mt@ 4g/t		P50: 30Mt@ 4g/t		P90: 100Mt@ 5g/t	
RECOMMENDED: Exploration potential considered excellent below the pit. There are several high grade holes scattered along strike and at depth with similar attributes to the main mineralized trend. The regional potential is relatively untested, and several geochemical anomalies stand out to the north.							
RECOMMENDATION: This project has a solid mineral inventory, but the cost structure for processing is onerous given the current lack of ore accessibility. This should be short term given the major stripping that is planned and budgetted for. This project merits investment, contingent on a site visit and more detailed due diligence on the mine schedule.							

Overall impression, and next steps or milestones for OGR regarding this project.

SUMMARY

- Most project studies are flawed.
- Quantifying adjustments to the financial model requires an experienced multidisciplinary team.
- Rigorous staged evaluations with clear and comprehensive reporting allows for optimal decision making.



OSISKO GOLD ROYALTIES		Evaluation made by: Guy Desbarnais	
		Project Name & Company: Example Project	
		Project Status:	
		Date: 2020-03-01	
GEOLOGY: Block Model and understanding of Controls on Mineralization			
ISSUES	RECOMMENDED	1	2
MINING METHOD AND OPEX			
ISSUES	RECOMMENDED	1	2
PROCESSING METHOD AND OPEX			
ISSUES	RECOMMENDED	1	2
GRADE ABOVE CUT OFF: Profit Margin per Tonne of Ore			
ISSUES	RECOMMENDED	1	2
CAPEX REQUIREMENTS			
ISSUES	RECOMMENDED	1	2
INFRASTRUCTURE AND TAILING			
ISSUES	RECOMMENDED	1	2
CORPORATE CAPABILITY: HR, Reputation, Community Relations			
ISSUES	RECOMMENDED	1	2
EXTERNAL FACTORS: Political, Social, Financing			
ISSUES	RECOMMENDED	1	2
UPSIDE			
ISSUES	RECOMMENDED	1	2

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EXTERNAL FACTORS: Political, Social, Financing			
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UPSIDE			
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