THE BUSINESS OF MINING

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ANGLO AMERICAN PLATINUM LIMITED

Real Mining. Real People. Real Difference.

AGENDA FOR THE MORNING

1. Introducing the Core Concept

2. The Platinum Value Chain

3. Platinum Geographic Landscape & Resource characteristics

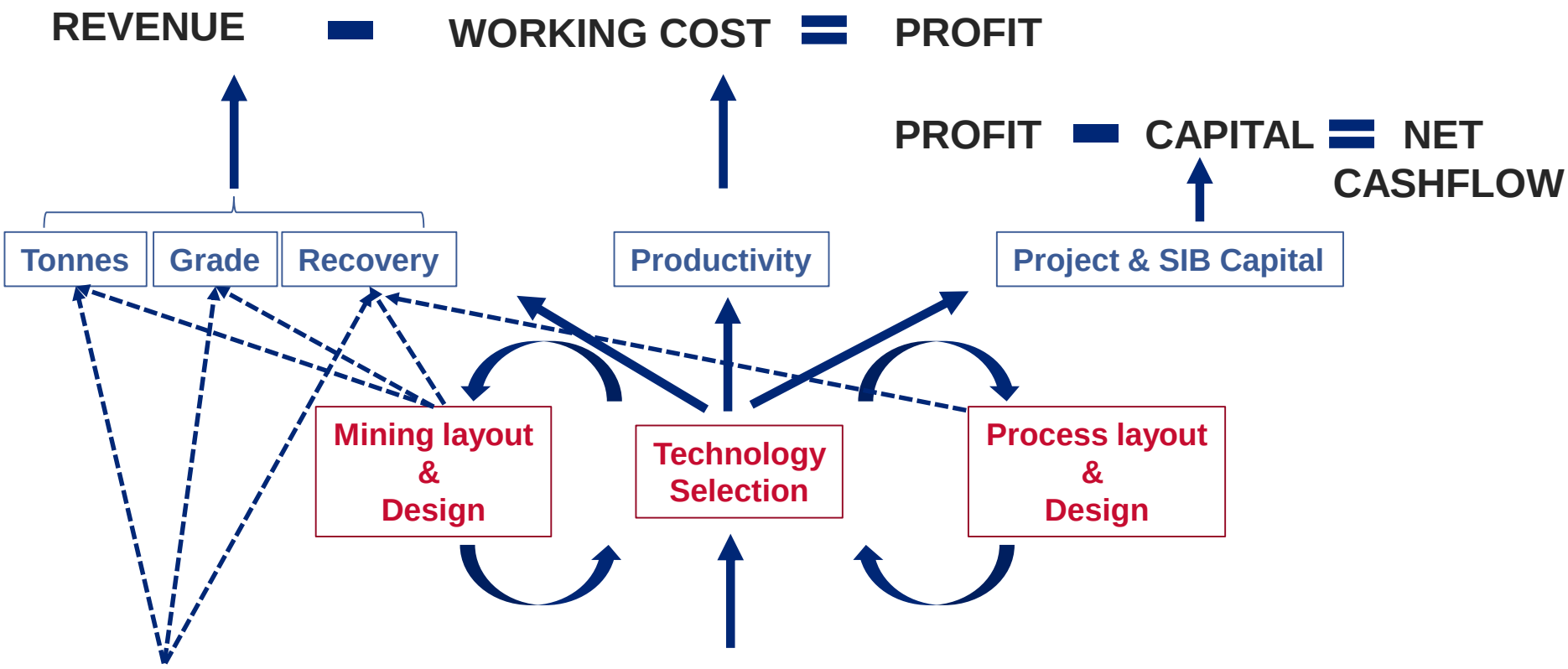
4. Mining Methods
   - Design
   - Development
   - Capital Intensity
   - Technology

5. Drivers of Value

6. Conclusion

7. Consolidation: Interactive discussion of cost curves

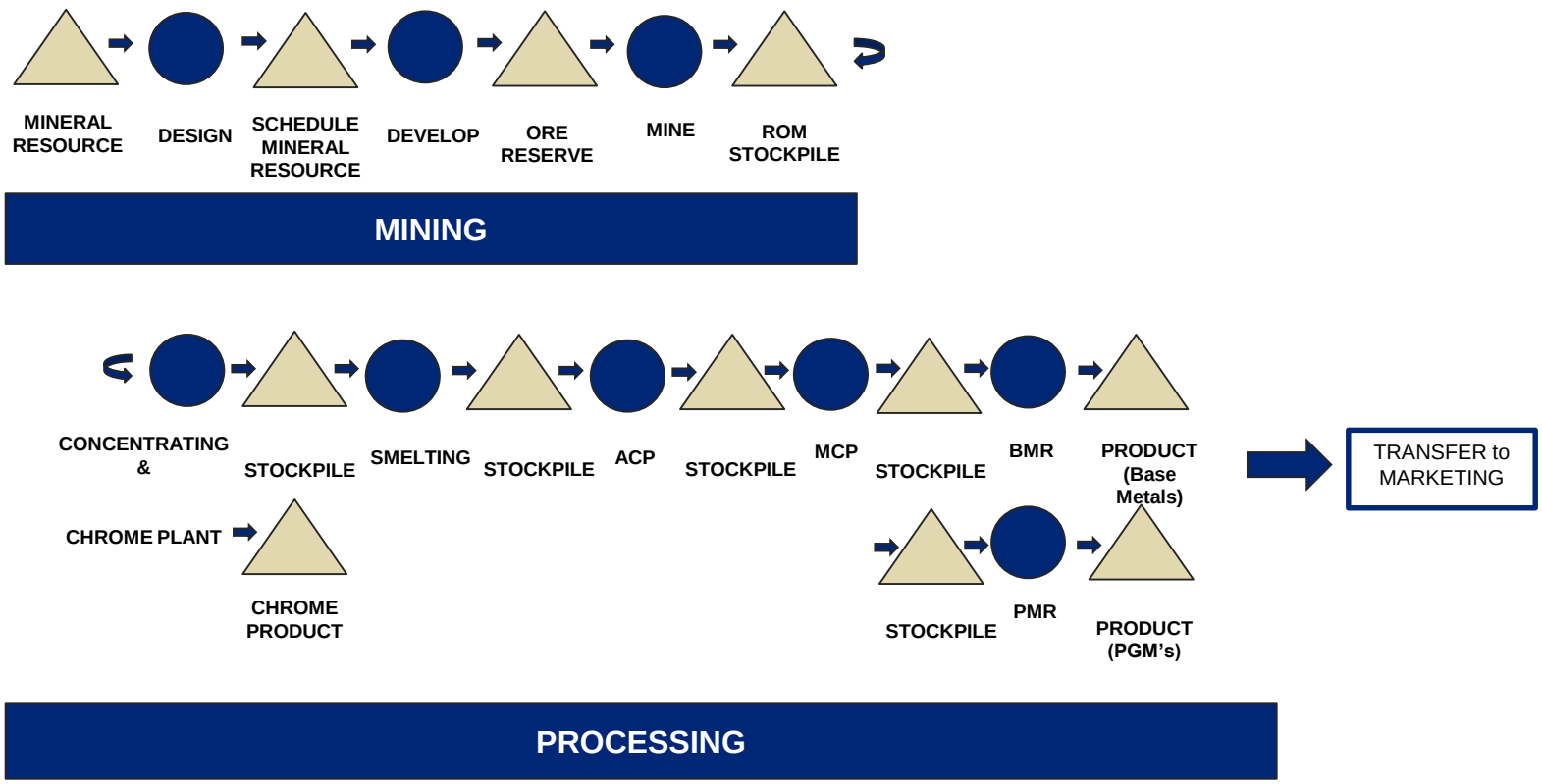
THE CORE CONCEPT



Orebody Characteristics

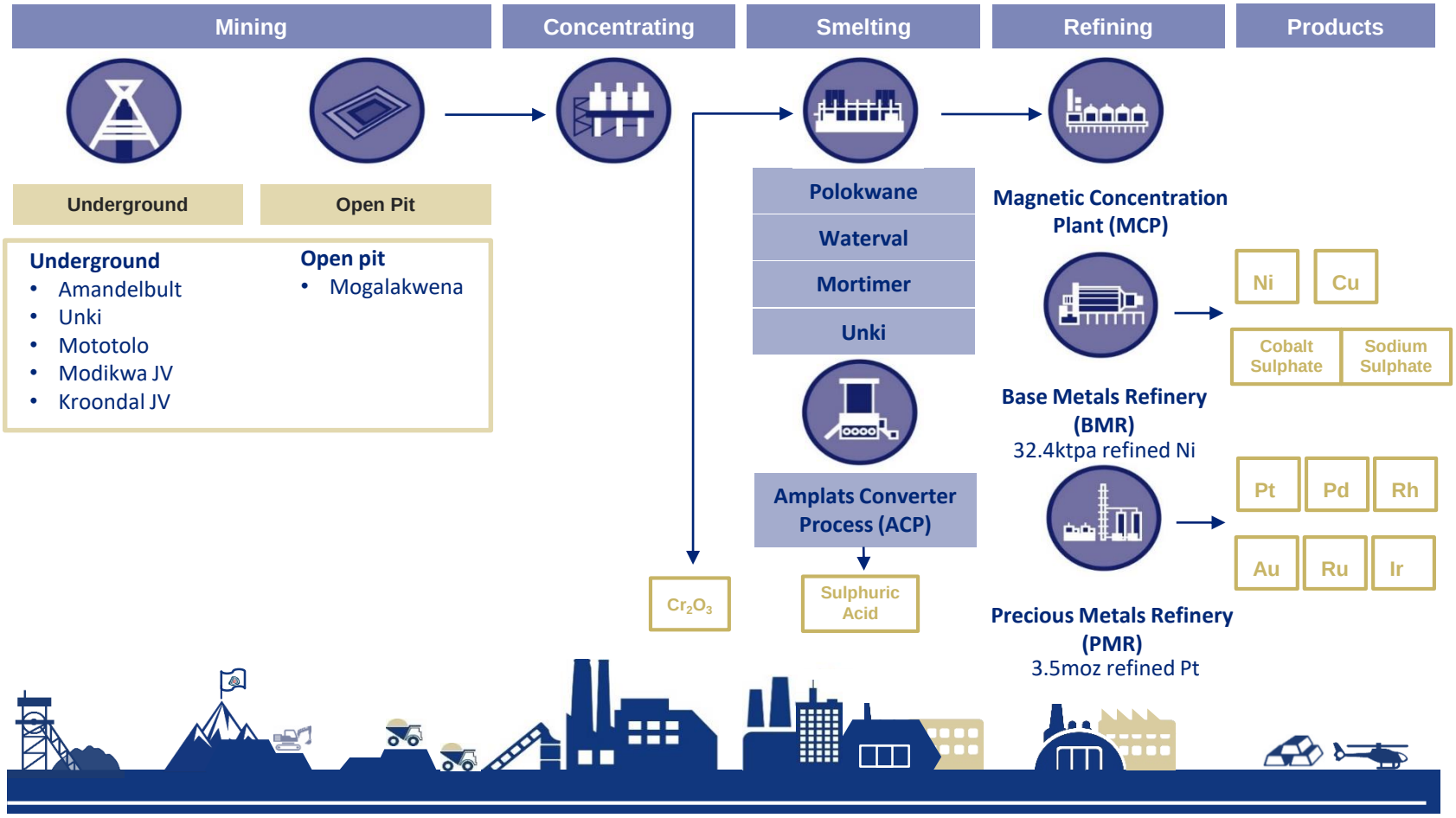
- Geometry
  - Geometallurgy
    - Physical characteristics (dip, strike, width, depth, orientation)

PLATINUM VALUE CHAIN (MAPPING VIEW)

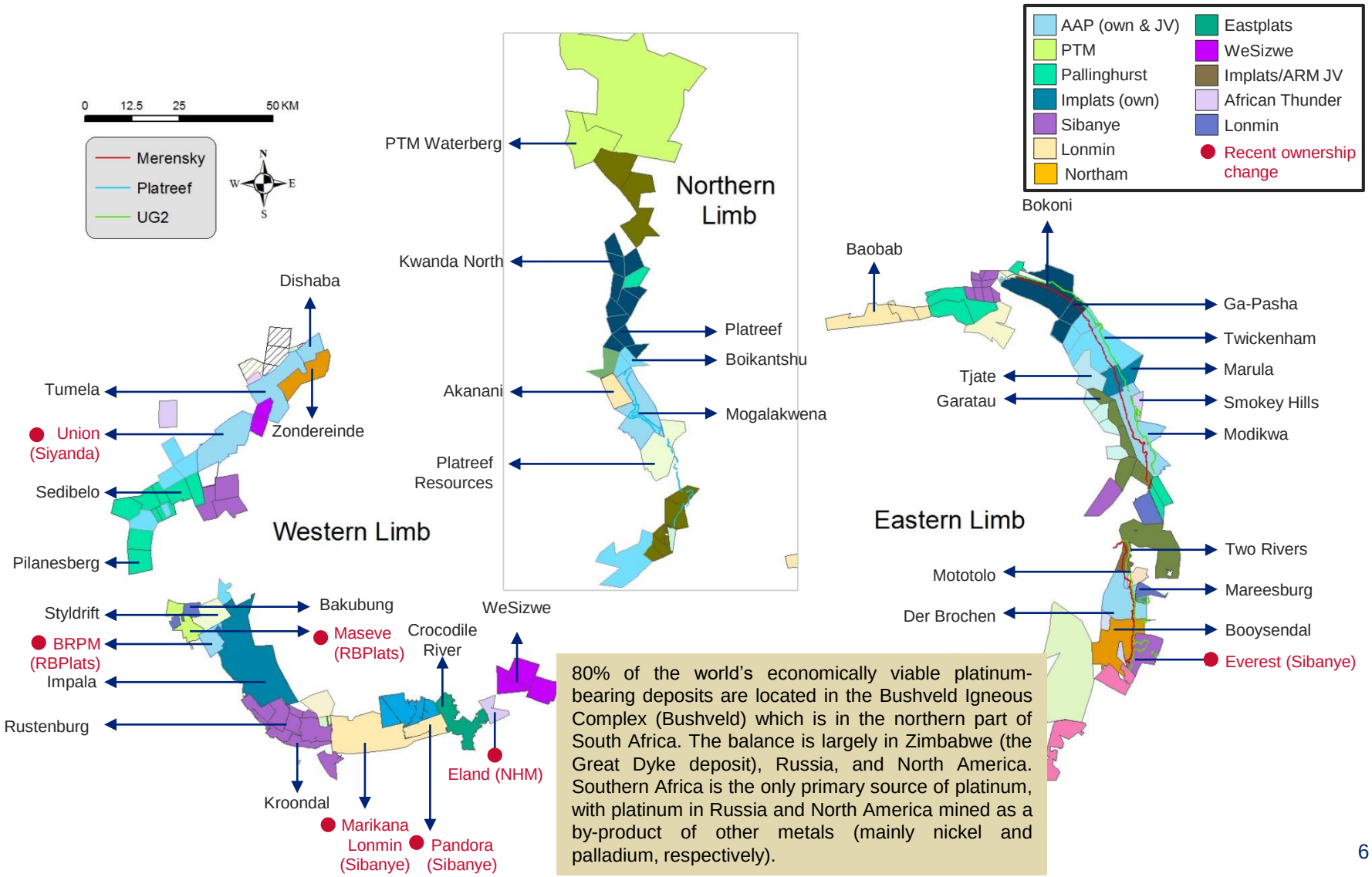


Notes: ACP – Anglo Converter Process, MCP – Magnetic Concentrator Plant, BMR – Base Metals Refinery

ANGLO AMERICAN PLATINUM VALUE CHAIN
(Infographic View)



SOUTH AFRICAN GEOGRAPHIC PGM LANDSCAPE



80% of the world's economically viable platinum-bearing deposits are located in the Bushveld Igneous Complex (Bushveld) which is in the northern part of South Africa. The balance is largely in Zimbabwe (the Great Dyke deposit), Russia, and North America. Southern Africa is the only primary source of platinum, with platinum in Russia and North America mined as a by-product of other metals (mainly nickel and palladium, respectively).

DIFFERENCES IN REEF LOCALITY

PGM production in Southern Africa comes from different regions. Each presents different opportunities and challenges in respect of ore mix, grade, proximity to surface infrastructure and depth of resource.

Zimbabwe

Great Dyke - *Developing*
Key Metals: PGMs & Nickel Reefs: MSZ
• Expansion potential in shallower underground shafts • Complex cross-boarder logistics

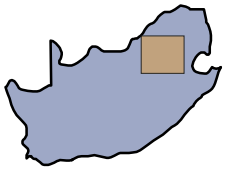
South Africa: Bushveld Complex

Northern Limb - *Developing*	Western Limb - *Mature*	Eastern Limb - *Developing*
Key Metals: PGMs & Nickel Reefs: Platreef	Key Metals: PGMs & Chrome Reefs: Merensky & UG2	Key Metals: PGMs & Chrome Reefs: Merensky & UG2
• Lowest grade and revenue per tonne of ore • Large volume open pit mining • Undeveloped Nickel-dominated deposits • Infrastructure & Utilities challenges	• Highest grade and revenue per tonne of ore • Limited production expansion opportunities (mostly Brownfield replacement) • Deepest shafts • Fully developed infrastructure • Primary processing hub for all major competitors	• Largest expansion potential • Shallower underground shafts • Infrastructure & Utilities challenges

SOUTH AFRICA'S BUSHVELD COMPLEX

SA PGM production comes from three regions; the Western Limb is the most developed with multiple brownfield opportunities and the highest ratios of Platinum.

SA Bushveld Complex



Northern Limb - *Growing*

- High proportion of Base Metal
- Mostly open pit mining
- Approx. **250** years of remaining production at current levels
- Pt:Pd Ratio – 1:1

Eastern Limb - *Growing*

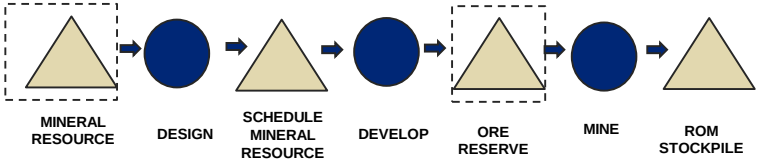
- High proportion of Palladium and Rhodium
- Mostly underground mining
- Mostly greenfield opportunities
- Approx. **250** years of remaining production at current levels
- Pt:Pd Ratio – 1:1

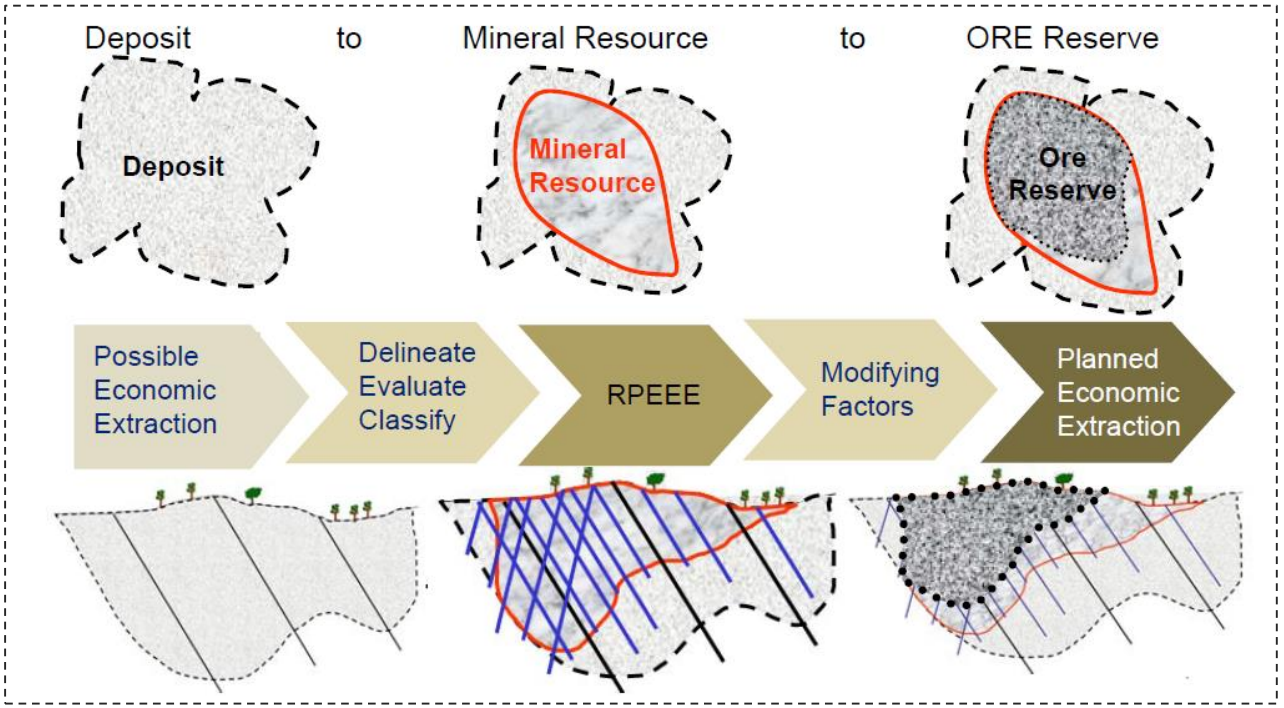
Western Limb - *Developed*

- High proportion of Platinum
- Mostly underground mining
- Mostly brownfield opportunities
- Approx. **40** years of remaining production at current levels
- Pt:Pd Ratio – 2:1

Notes: Years of production based on reserves and inferred resources given production for each in 2008.

MINING: MINERAL RESOURCE

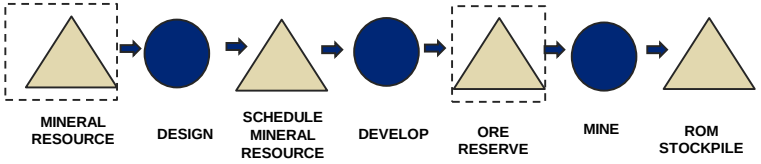


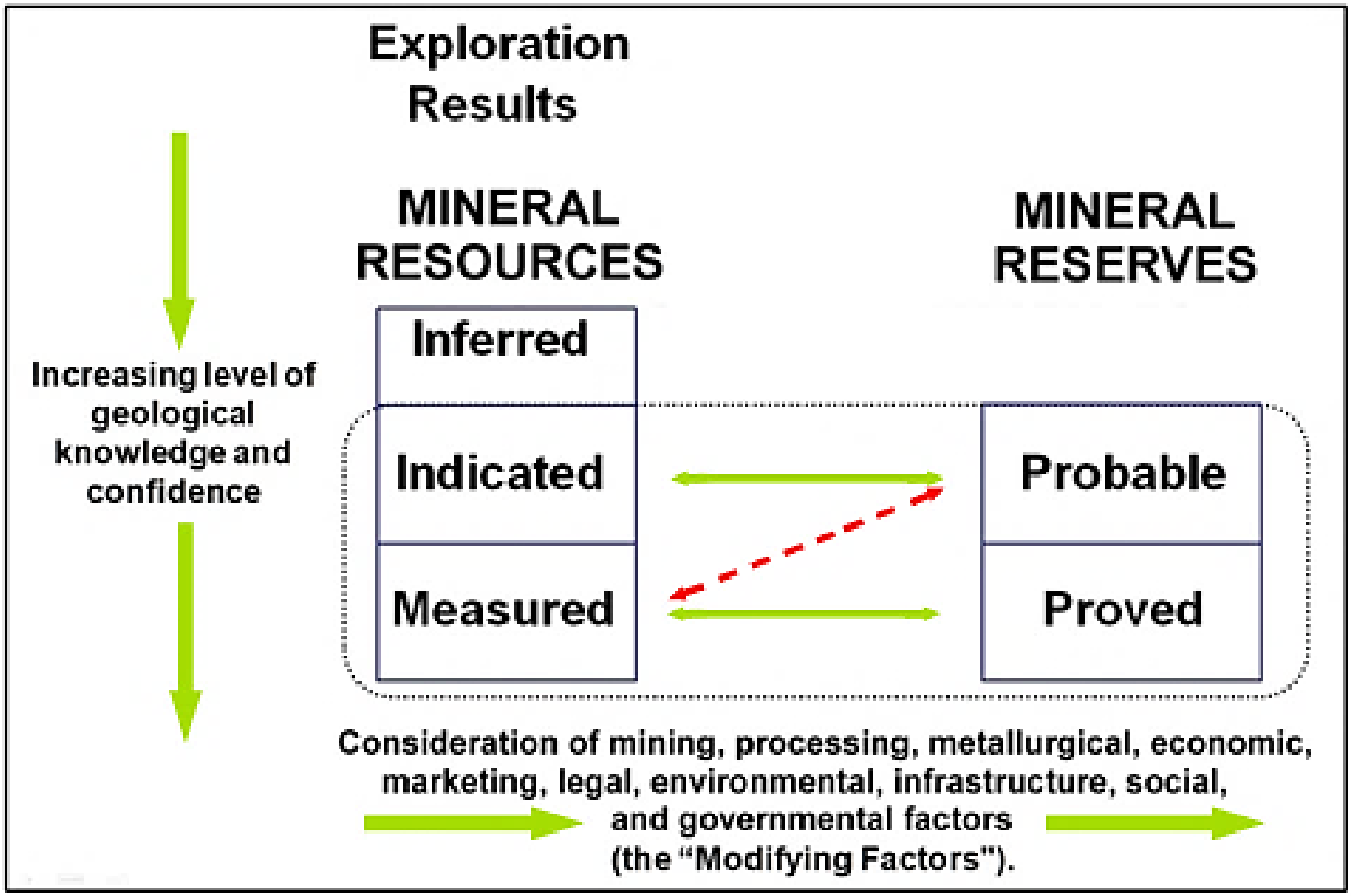


A **Mineral Resource** is a concentration or occurrence of material of economic interest in or on the earth's crust in such form, quality and quantity that there are reasonable prospects for eventual economic extraction (RPEEE).

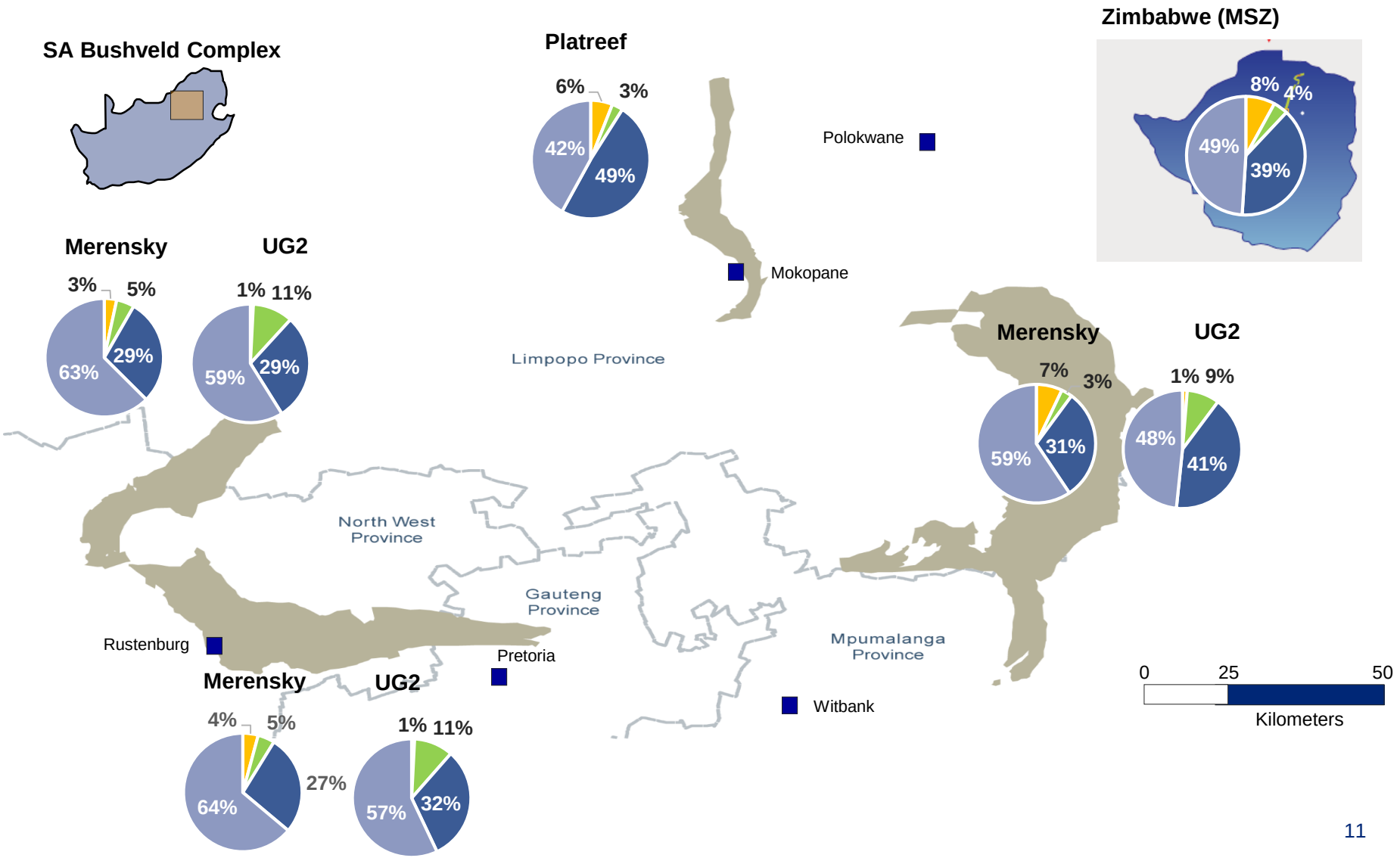
A **Mineral Reserve** is the economically mineable part of a Measured and/or Indicated Mineral Resource. It includes diluting materials and allowances for losses, which may occur when the material is mined or extracted and is defined by studies at Pre-Feasibility or Feasibility level as appropriate that include application of Modifying Factors. Such studies demonstrate that, at the time of reporting, extraction could reasonably be justified.

THE SAMREC CODE



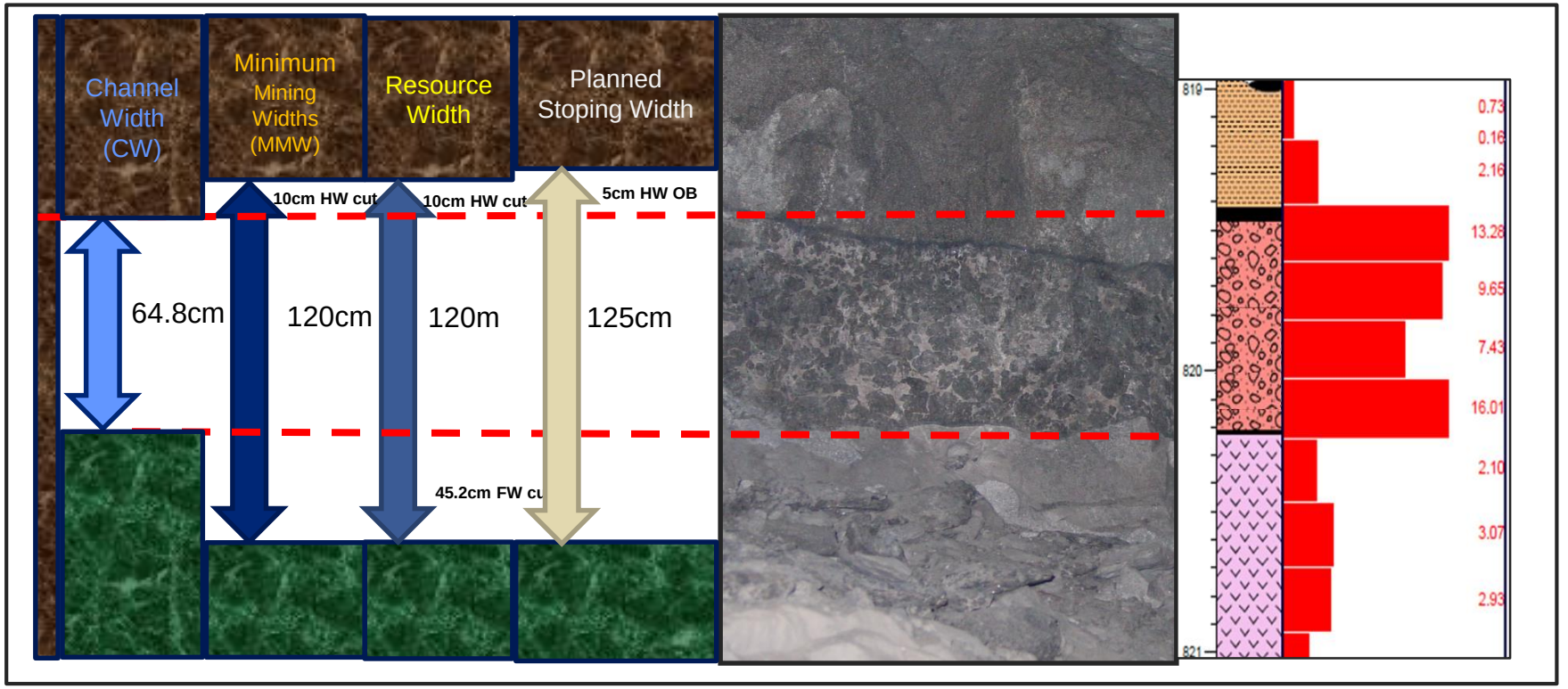


SOUTHERN AFRICAN PGM 4E METAL RATIOS



Notes: Estimates based on metal splits of resources declared

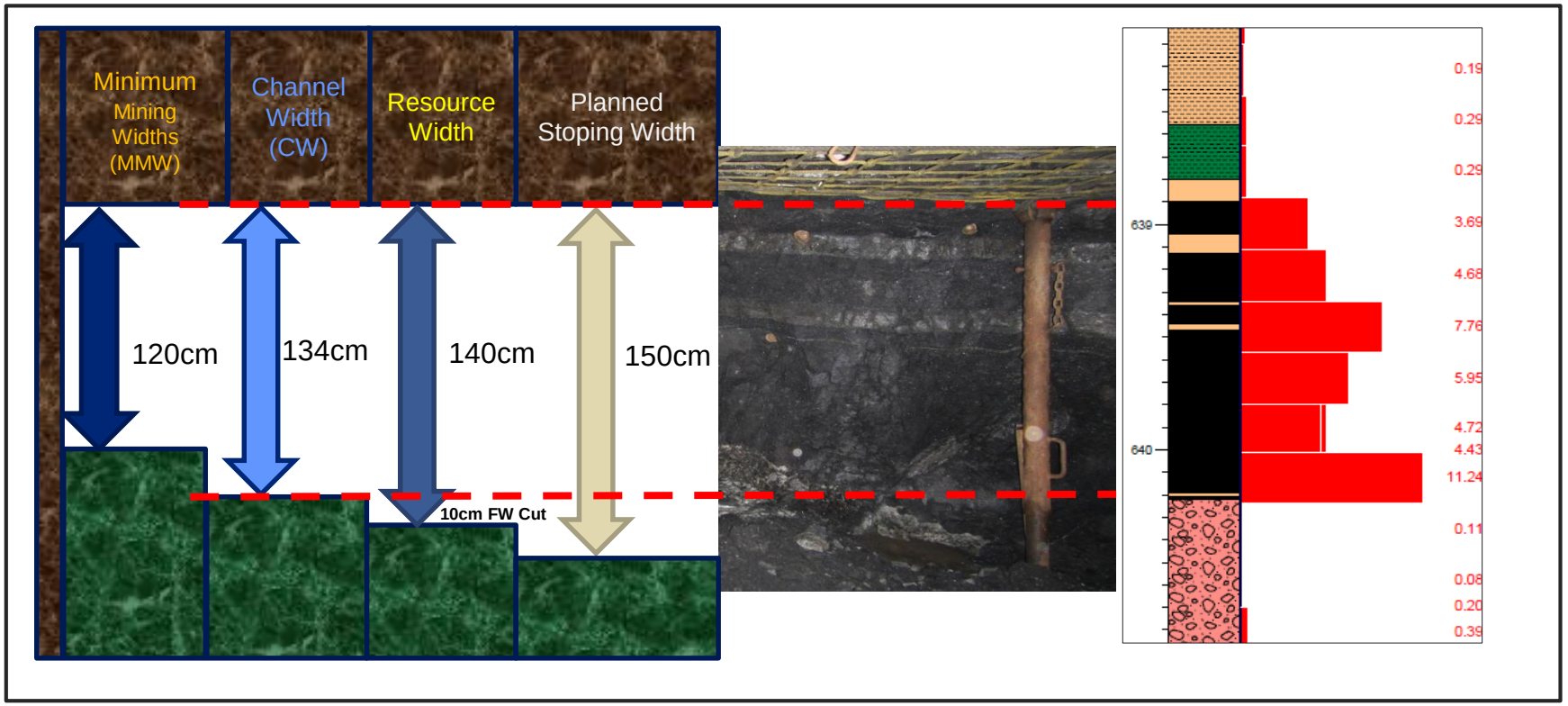
MERENSKY REEF PROFILE



Merensky: ***Closest to the surface***

- Relatively flat seam (reef dip 9 to 23 degrees)
- Narrow seam (seam width 0.2 to 1.8 m)
- Hardest ore body
- Highest proportion of Platinum

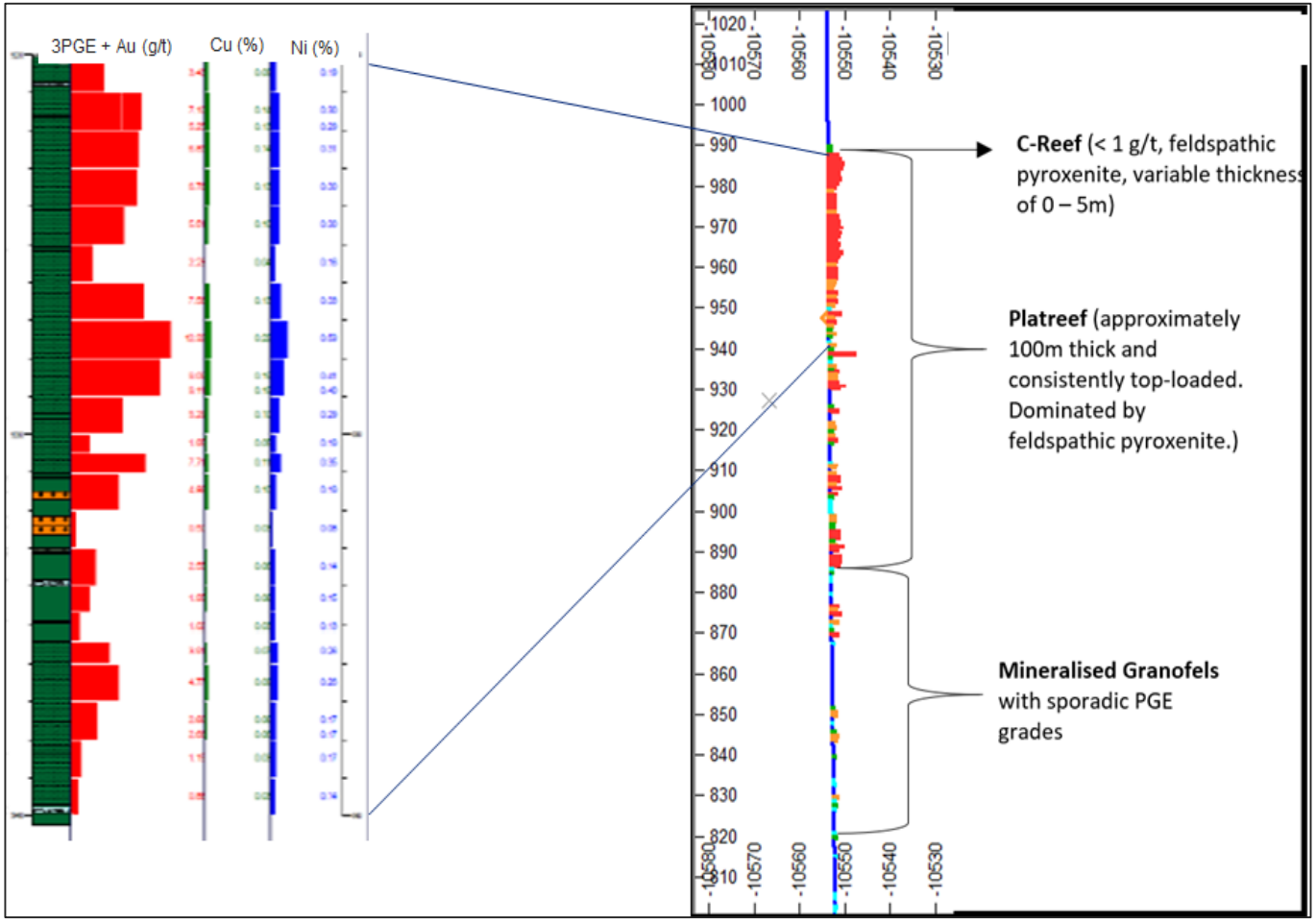
UG2 REEF PROFILE



UG2: *Rests below Merensky*

- Relatively flat seam (reef dip 9 to 23 degrees)
- Narrow seam (seam width 0.6 to 1.6 m)
- Less hard than Merensky
- High Rhodium and Chromite content
- Distance between Merensky and UG2 reefs varies significantly, e.g. Rustenburg 130m, Amandelbult 30m, Twickenham 450m

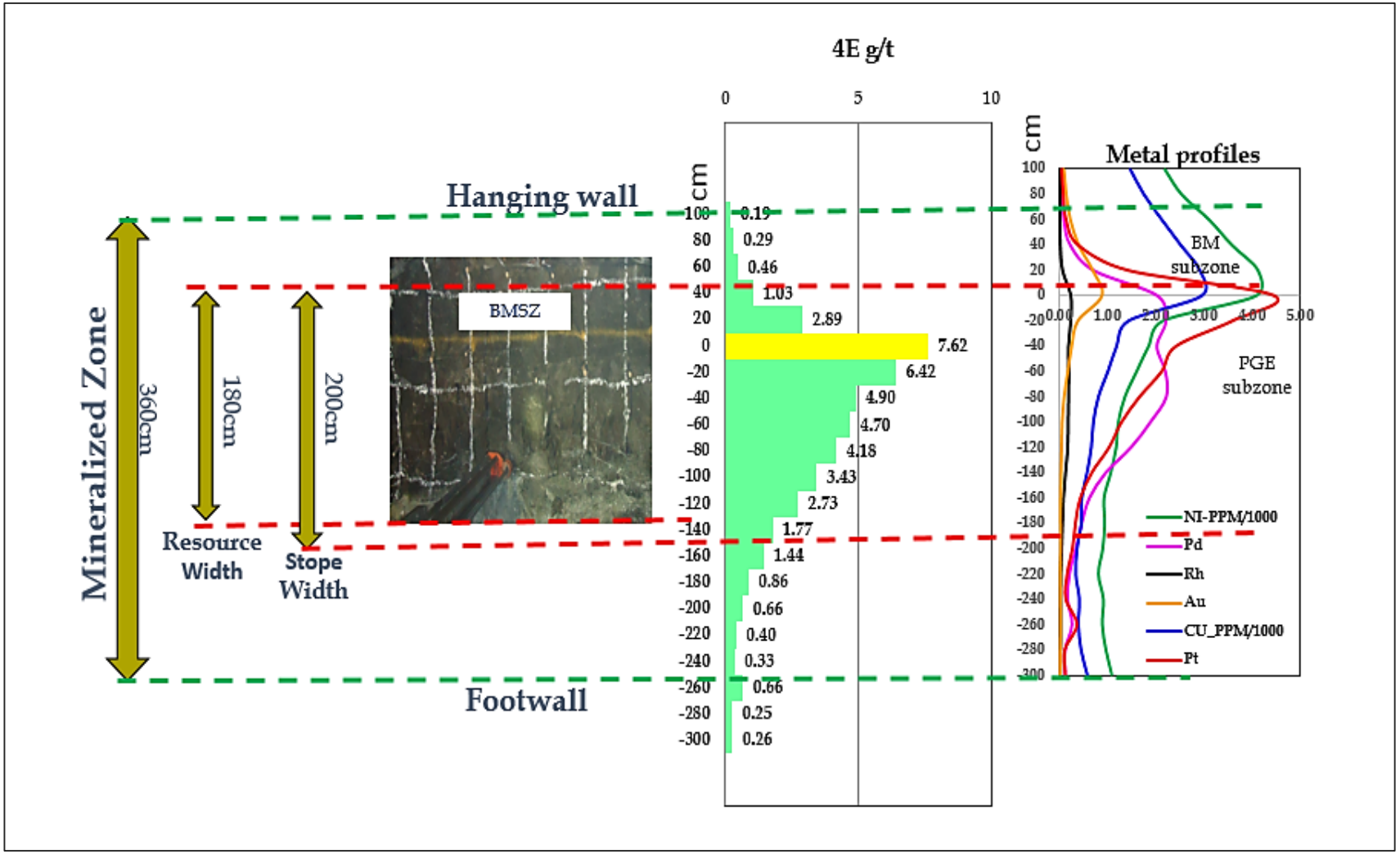
PLATREEF PROFILE



Platreef: *Relatively shallow deposit*

- Steepest seam (up to 35 degrees dip)
- Widest seams
- Mining by means of Opencast
- Only located in the Northern limb
- High Nickel content

MSZ REEF PROFILE

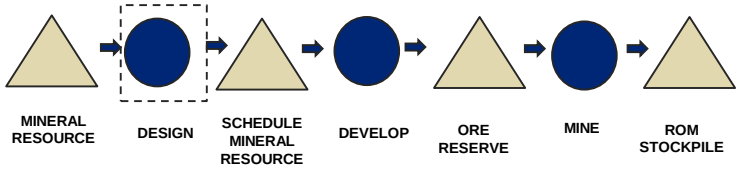


GEOLOGY INFLUENCES MINING METHODS

Underground Methods	Unsupported					Supported		Caving		
Factor	Narrow Tabular	Room & Pillar	Stope & Pillar	Shrinkage Stoping	Sublevel Stoping	Cut & Fill Stoping	Square Set Stoping	Longwall Stoping	SubLevel Caving	Block Caving
Ore Strength	Moderate /Strong	Weak/ Moderate	Moderate/ Strong	Strong	Moderate/ Strong	Moderate/ Strong	Weak	Any	Moderate/ Strong	Weak/ Moderate
Rock Strength	Strong	Moderate/ Strong	Moderate/ Strong	Strong	Fairly Strong	Weak	Weak	Weak / Moderate	Weak	Weak / Moderate
Deposit Shape	Tabular	Tabular	Tabular / Lenticular	Tabular / Lenticular	Tabular / Lenticular	Tabular / Irregular	Any	Tabular	Tabular / Massive	Massive / Thick
Deposit Dip	Low/ Moderate	Low / Flat	Low / Moderate	Fairly Steep	Fairly Steep	Fairly Steep	Any	Low/ Flat	Fairly Steep	Fairly Steep
Deposit Size	Large / Thin	Large / Thin	Any	Thin / Moderate	Thick / Moderate	Thin / Moderate	Usually Small	Thin / Wide	Large Thick	Very Thick
Ore Grade	High	Moderate	Low / Moderate	Fairly High	Moderate	Fairly High	High	Moderate	Moderate	Low
Ore Uniformity	Uniform	Uniform	Variable	Uniform	Uniform	Variable	Variable	Uniform	Moderate	Uniform
Depth	Shallow / Deep	Shallow / Moderate	Shallow / Moderate	Shallow / Moderate	Moderate	Moderate/ Deep	Deep	Moderate/ Deep	Moderate	Moderate

Source: Dr HZ Harraz (modified)

MINING: DESIGN



Access Systems:

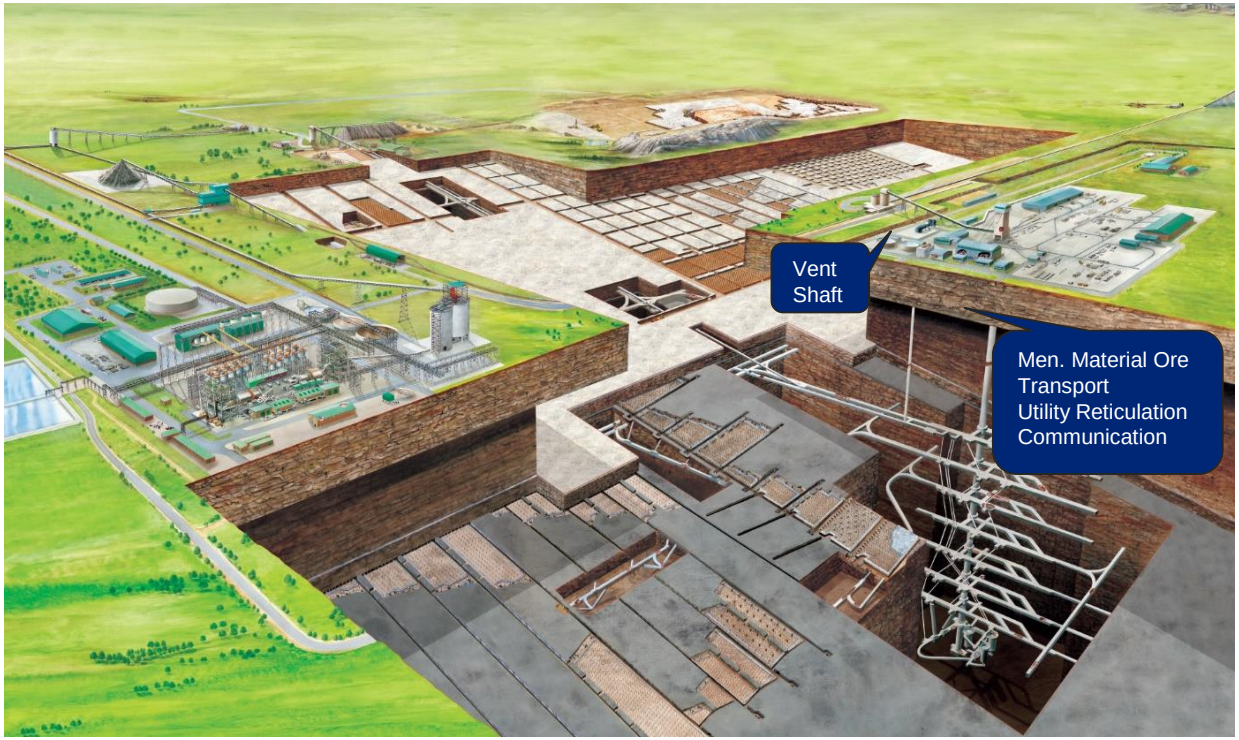
1. Vertical Shaft Systems
2. Decline Shaft Systems.
3. Open Cast

Block Design:

1. Scattered breast mining and up-dip, down-dip with track bound ore removal – conventional layout
2. Bord and Pillar – mechanised layout
3. Open cast – surface excavation represented by highwalls and benches – mechanised layout

Mining Methods:

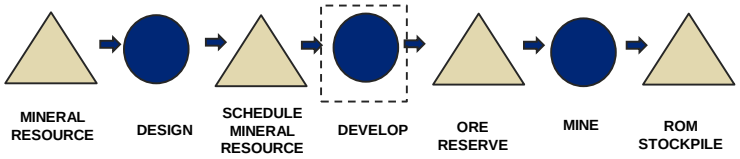
1. Conventional Underground Mining.
2. Hybrid Underground Mining.
3. Mechanised Underground Mining.
4. Open Cast Mining.



Salient Features:

1. Conventional mining can be done any reef dip
2. Mechanised mining typically never gets done when the reef dips more than 10°
3. Conventional mining can be done at mining widths upto 2,0 metres, whereas Mechanised can be done above 2.0 metres
4. Shaft systems, the sequence is 1st Gen, 2nd Gen, etc. The sequence is highly dependent on the orebody outcropping

MINING: DEVELOP



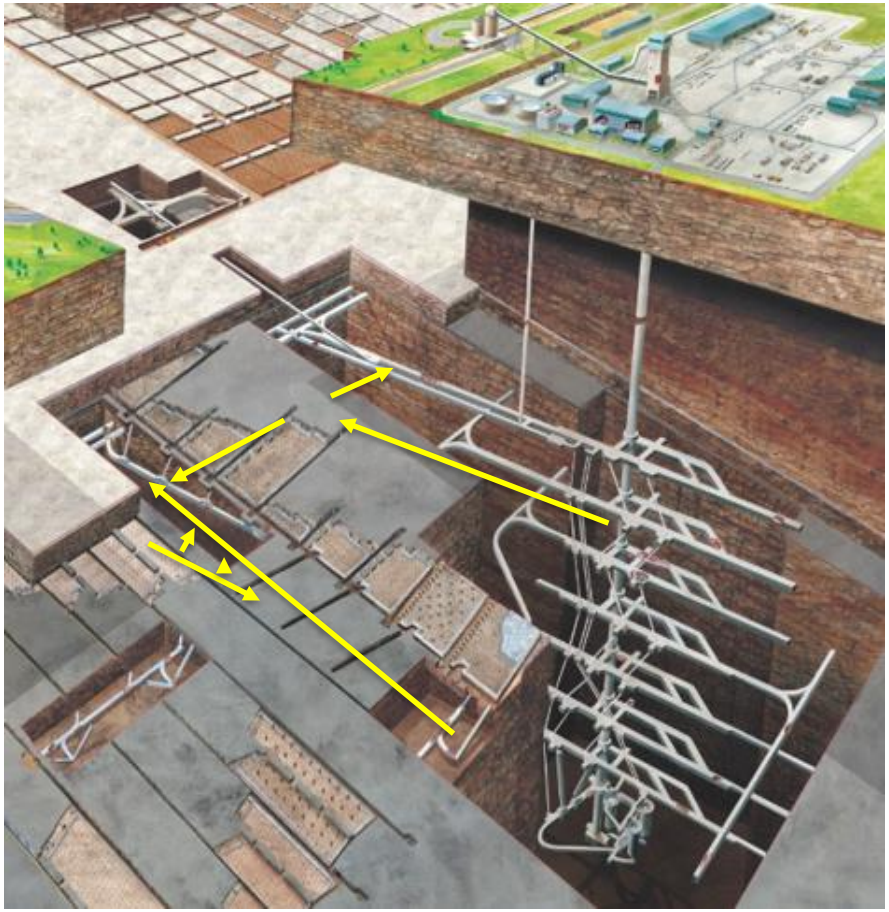
Salient Features:

1. Development gives access to the Ore Body – generation of Ore Reserves to Mine

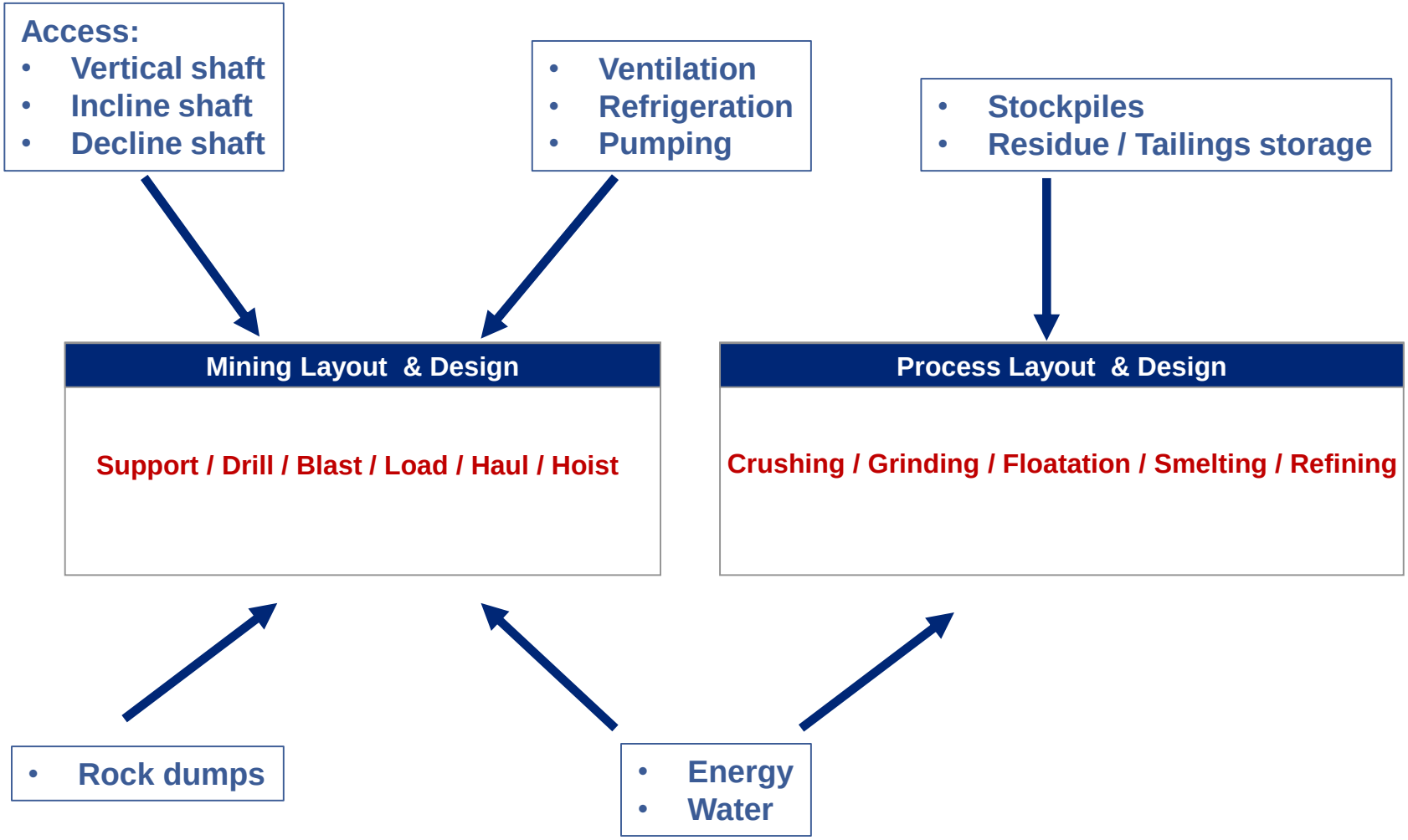
2. It facilitates logistics wrt Men, Material and Ore movement.

3. All mine design criteria must be taken into consideration to ensure safe optimal mine extraction of ore:
   - Mining method and dimensions
   - Geological model
   - Rock engineering model and criteria
   - Ventilation model and criteria
   - Engineering criteria
   - Mine boundary and investment centre boundaries

Development Traits	
Title	**Description**
Classes	Any Development will fall within 1 of the following 4 Classes: a. Vertical Shaft Sinking b. Primary Development c. Secondary Development d. Tertiary Development
Categories	Any Development will fall within 1 of the following 3 Financial Categories: a. Project Capital b. Stay in Business (SIB) Capital c. Working Cost
Types	Development Types are named fundamentally according to their function. The following are examples of Types of development: a. Haulage b. X/Cut, c. Raises & Winzes d. Cubbies e. Etc.
Characteristics	All Development has 1 of the following 3 Characteristics: a. Reef b. Waste c. Off Reef (when on the Reef Horizon)



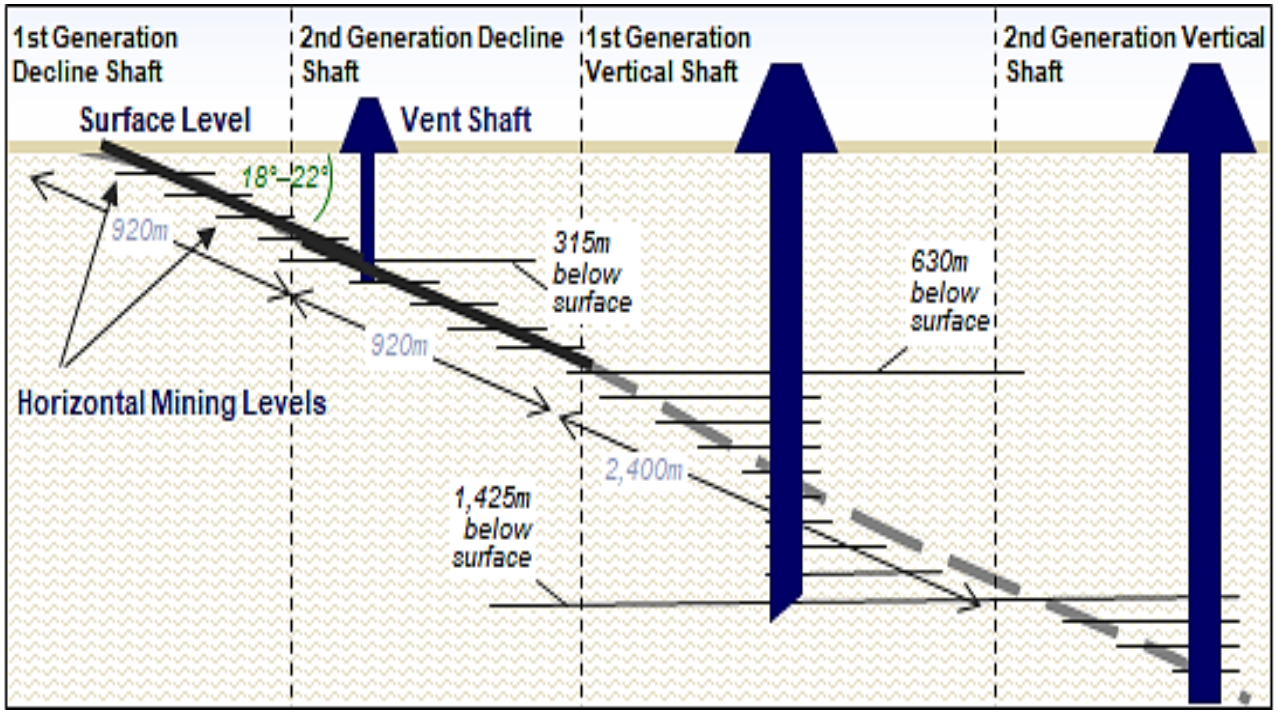
SUMMARY DESIGN ELEMENTS



CAPITAL INVESTMENT IN PGM MINING

In underground PGM mining, timing of investment in vertical shafts is critical to avoid reduced operational efficiency and stranded ore deposits.

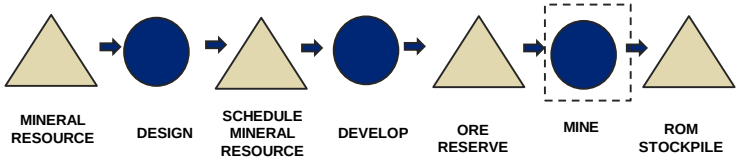
Indicative PGM Underground Mining

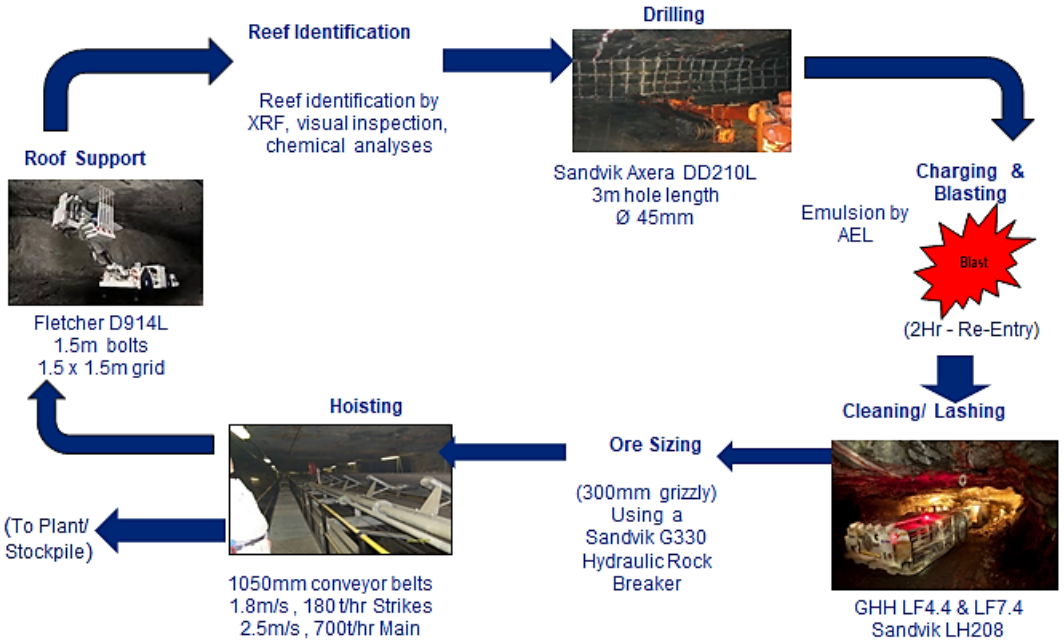


Comments

- There is a significant time lag between project definition, decision making, breaking ground and production start
- Beyond the optimal point to employ a vertical shaft, mining productivity declines and may result in pockets of uneconomic ore deposits
- Different types of vertical shafts are used depending on need:
  - Ventilation
  - Men & Material only
  - Rock Hoist only
  - Men, Material & Rock Hoist

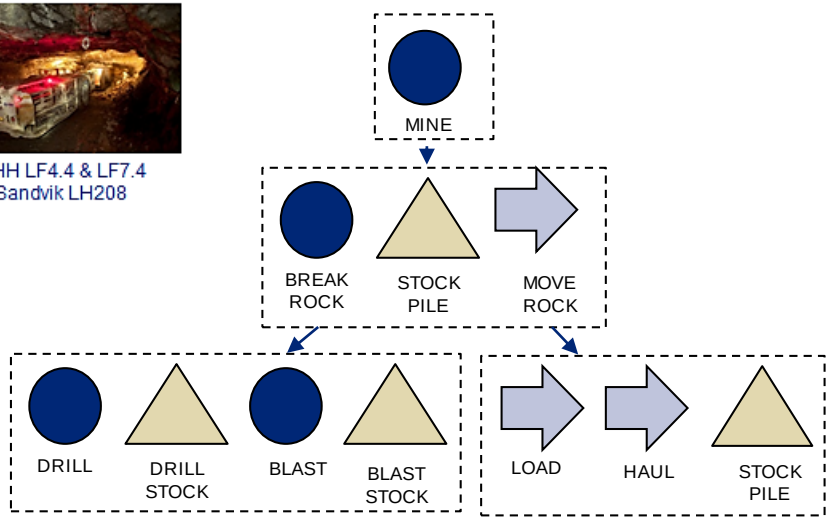
MINING: MINE





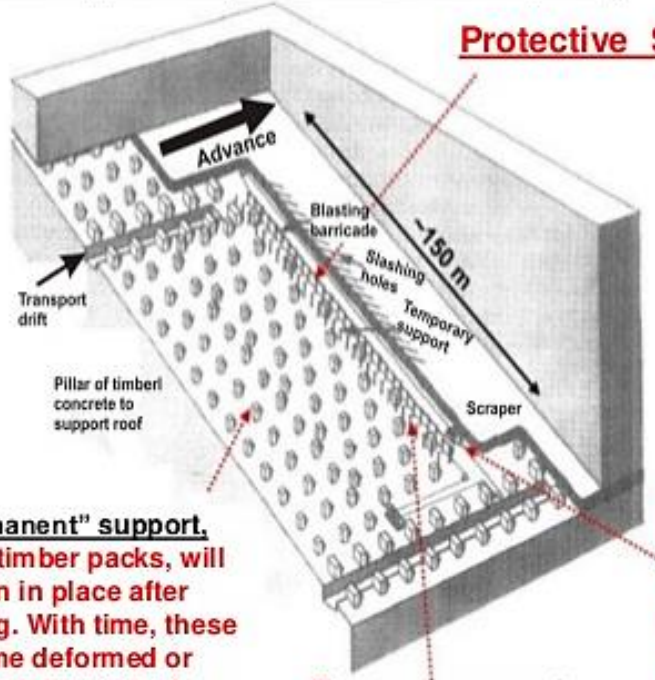
1. Primary function is to break and remove rock safely from all reef and waste horizons.

2. Underground mining refers to Stoping – excavation of ore on the plane of the reef horizon.



SUPPORTING SLIDE: UNDERSTANDING MINING

Schematic of Longwall Panel
(Hangingwall Stripped Away For Illustrative Purposes)



"Permanent" support, often timber packs, will remain in place after mining. With time, these become deformed or completely crushed –as part of the "controlled" closure of the panel.

Temporary support near the working face: often hydraulic props.

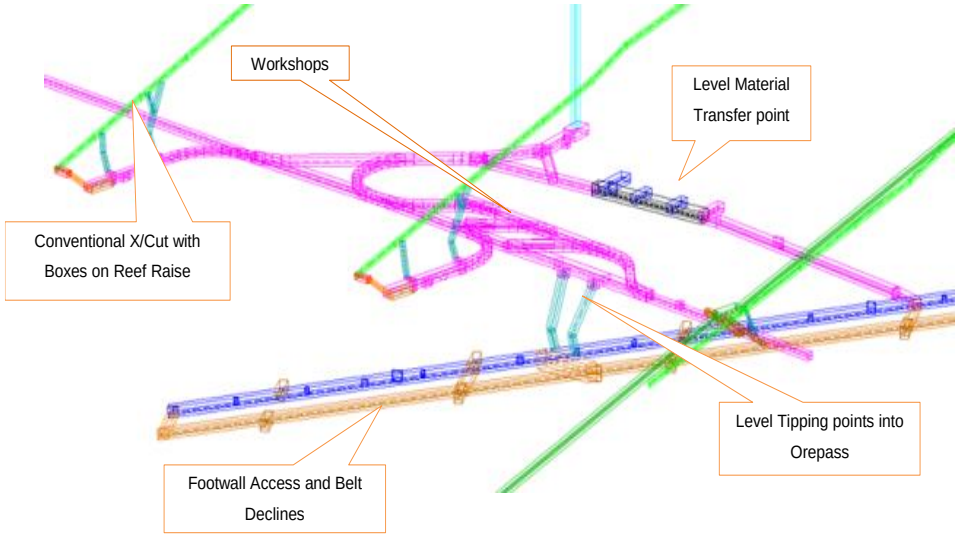
In hard-rock minerals mining a "*scraper*" is pulled down the length of the stope face after drilling and blasting, to collect the fragmented ore rock.

In coal mining, a mechanized cutting device is run along the length of the coal face.

Figure from Hartman and Mutmansky, 2002.

Prof. Dr. H.Z. Harraz Presentation
Mining Methods

UNDERGROUND MINING: NARROW TABULAR CONVENTIONAL

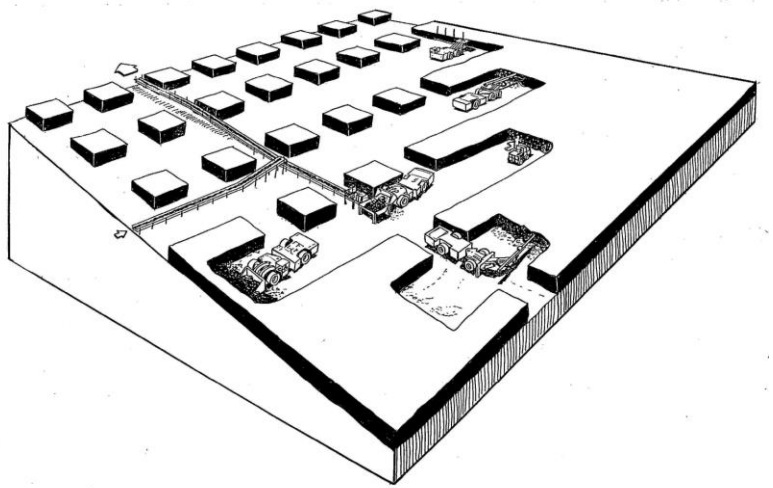


- Can mine narrow reef widths
- Reef dip not a constraint
- Equipment access not a constraint
- Faulting and potholes can be negotiated
- Most common application

Parameter	2018 Range *
Productivity – centares per employee costed	15-50
Productivity – tonnes milled per employee costed	200-420
Unit Cost (R/t)	1100-1700

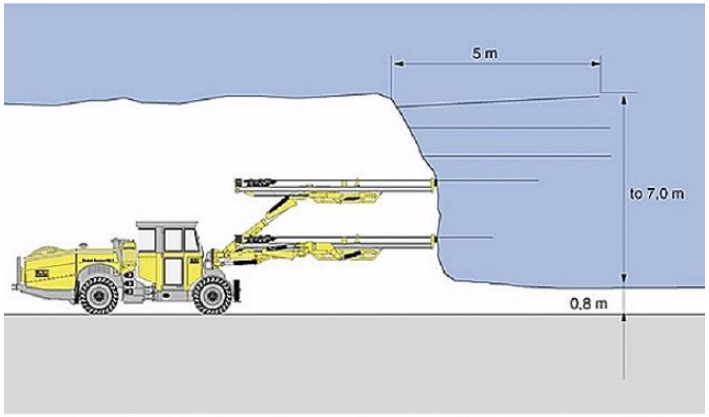
Source: * Noah Capital

UNDERGROUND MINING: TRACKLESS MECHANISED



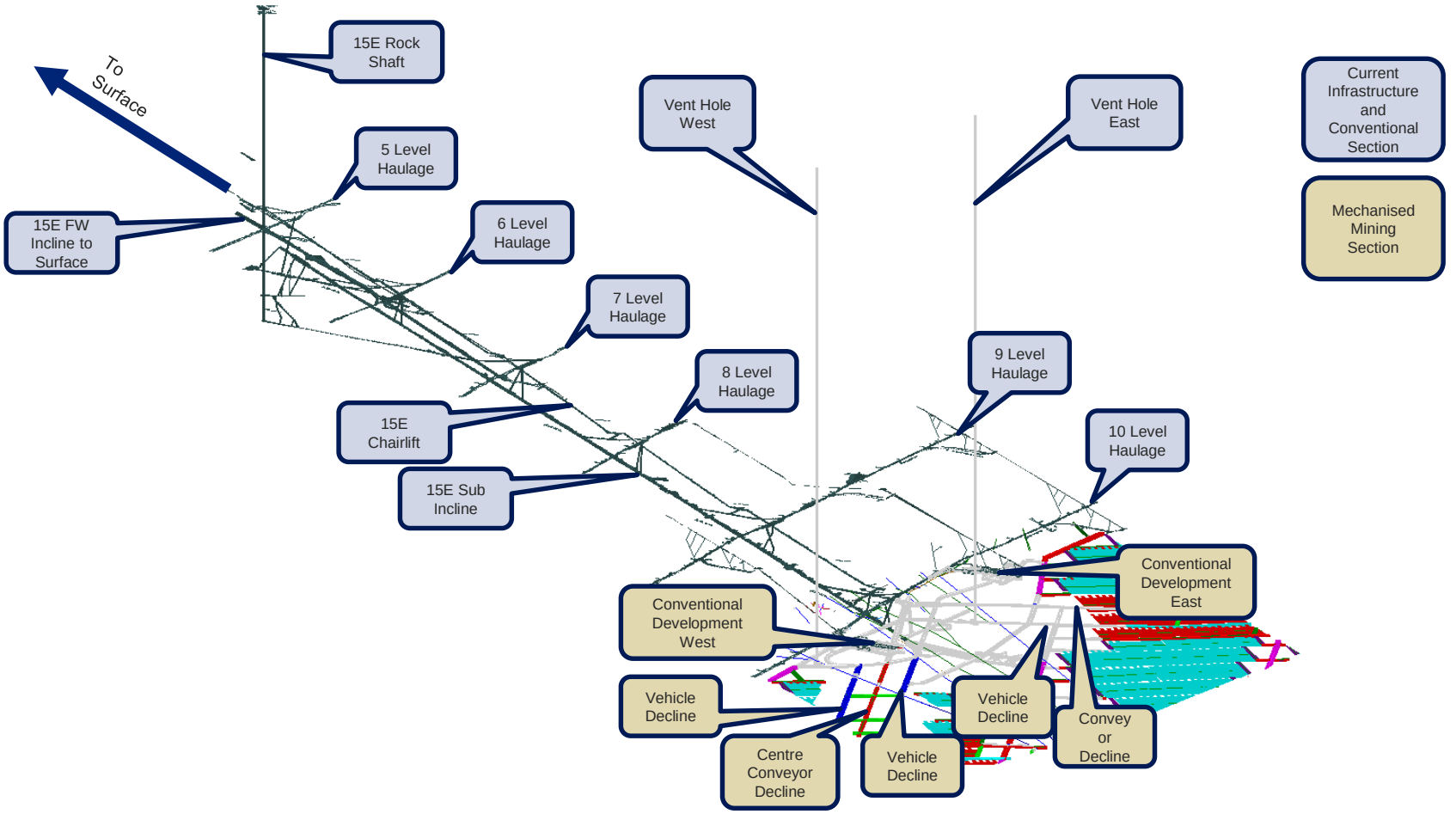
- Reef width > 1.6m
- Dip less than 10 degrees
- Direct access from surface for large mechanised equipment
- Few faults and potholes

Parameter	2018 Range*
Productivity – centares per employee costed	95-430
Productivity – tonnes milled per employee costed	640-3000
Unit Cost (R/t)	400-900

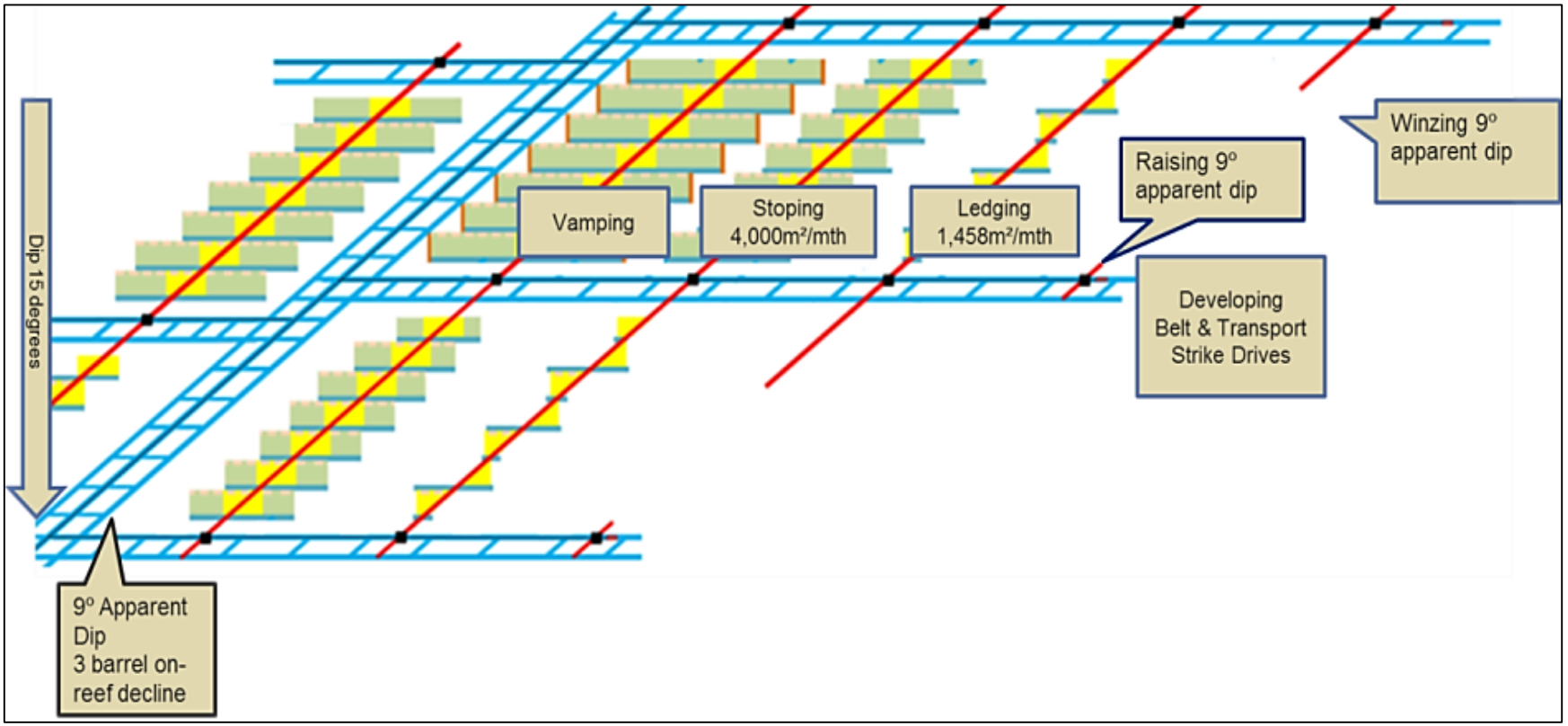


Source: * Noah Capital

CURRENT AND PROJECT INFRASTRUCTURE



MECHANISED MINING LAYOUT (ON REEF)

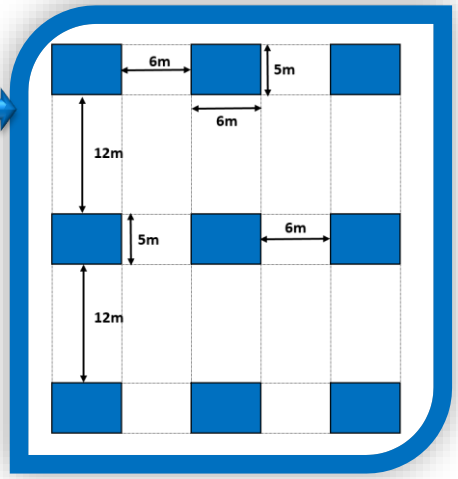


MECHANISED ROOM AND PILLAR

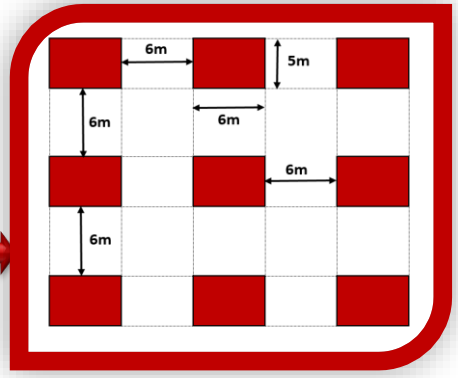
Design considerations

Parameter	Standard	Poor Ground Zones
UCS (MPa)	172	172
K – Value (MPa)	57	57
Bord Size (m)	12	6
Split Size (m)	6	6
Planned SW (m)	2.00	2.00
Extraction (%)	82 – 74	75%
Depth	Shallower	Deeper

Geo-technical designs

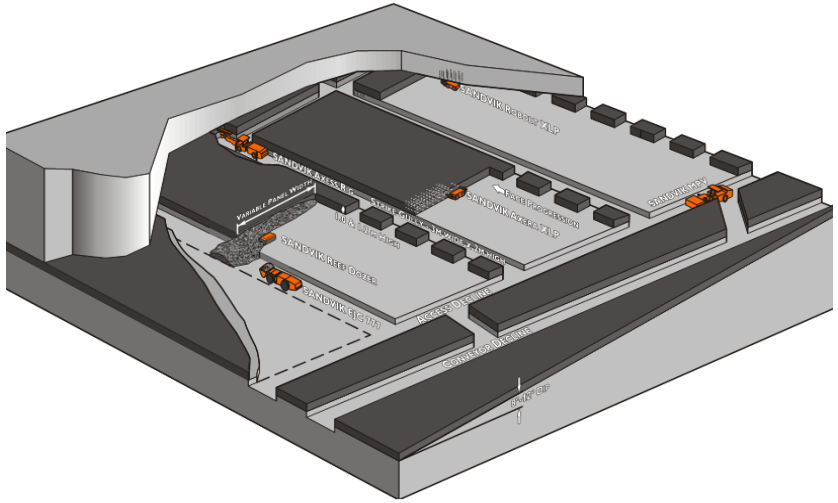


Extraction Ratio
85.3%



Extraction Ratio
75.2%

UNDERGROUND MINING: HYBRID



- Combines best attributes of trackless mechanised and conventional hand-held stoping
- Difficult to implement at shafts with existing conventional stoping access layouts

Parameter	2018 Range*
Productivity – centares per employee costed	50-100
Productivity – tonnes milled per employee costed	460-1100
Unit Cost (R/t)	1000-1220

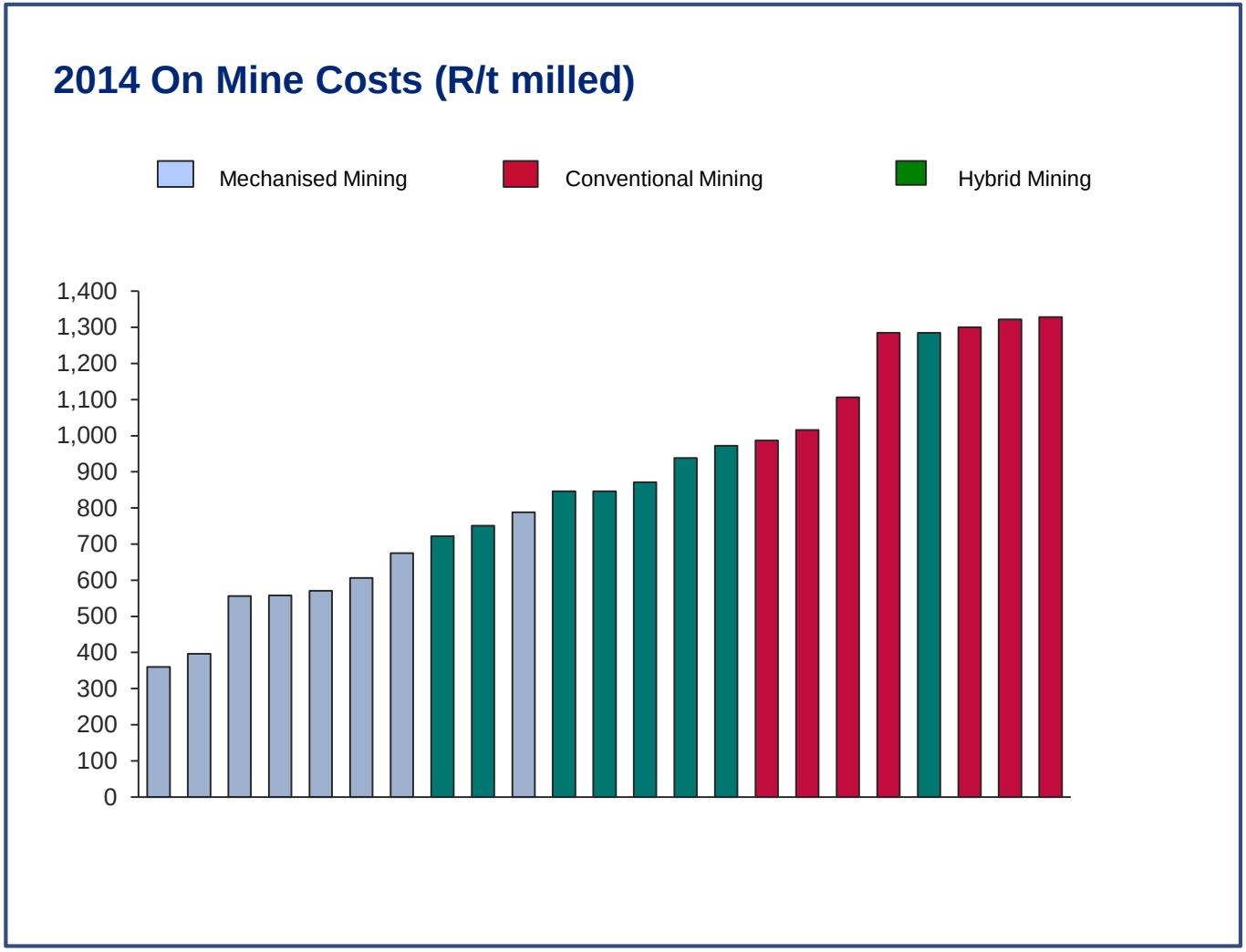
Source: * Noah Capital

INDICATIVE IMPACT OF DIFFERENT TECHNOLOGY ON THE SAME OREBODY

	Stoping Width (cm)	Avg grade	m^2 / Half Level	m^2 / TEC	Tonnes per Half Level (kt)	Half Levels	Steady State Ore Tonnes (kt)	Average Cost (R/t)
Conventional	105	5.3	3400	8.5	15	12	180	1050
LP (Low Profile)	210	2.6	3000	14.5	22	9	200	540
XLP (extra-low profile)	120	4.0	5400	17.4	37	6	220	750
ULP (ultra-low profile)	95	4.4	5400	17.3	34	6	200	760
Longhole Stoping	95	4.3	4900	16	37	6	220	800
Slotborer	95	4.3	4700	15	37	6	220	900
Rock Cutting (1)	110	4.6	6200	20	33	6	200	930
Rock Cutting (2)	120	4.0	5400	17	37	6	220	750

Notes: TEC is Total Employee Costed

CLUSTERING MINING METHODS BY COST



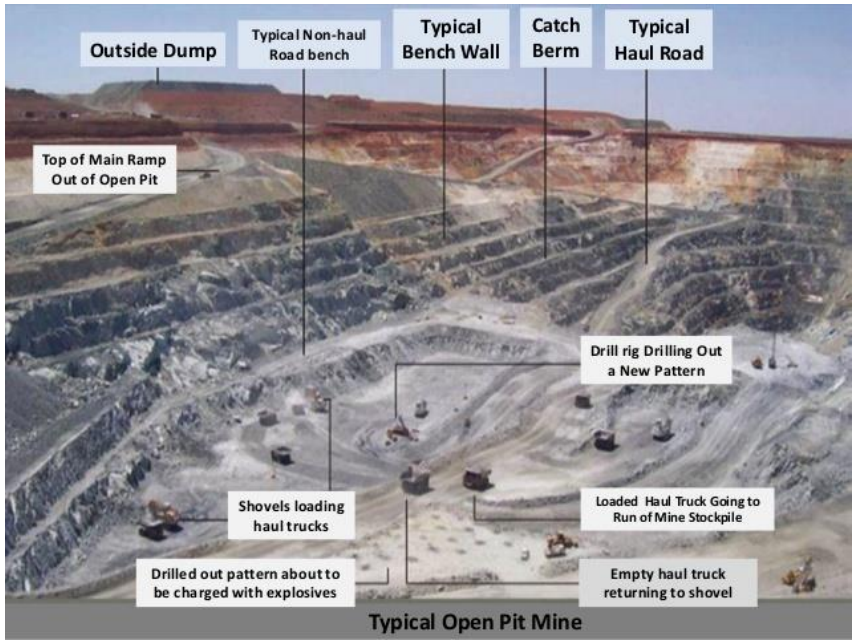
Source: Estimates and Company reports (2014)

INDICATIVE CAPITAL REQUIRED FOR SAME PRODUCTION

	NORMALISED CAPEX	Production Ramp-up (years)
Conventional	1.82	11
XLP (extra-low profile)	1.10	5
ULP (ultra-low profile)	1.15	6
Longhole Stoping	1.00	6
Slotborer	1.40	6
Rock Cutting (1)	1.30	5
Rock Cutting (2)	1.25	7

Notes: Relative Capital estimates of equipment costs, stoping, ledging and development costs

OPEN-PIT MINING

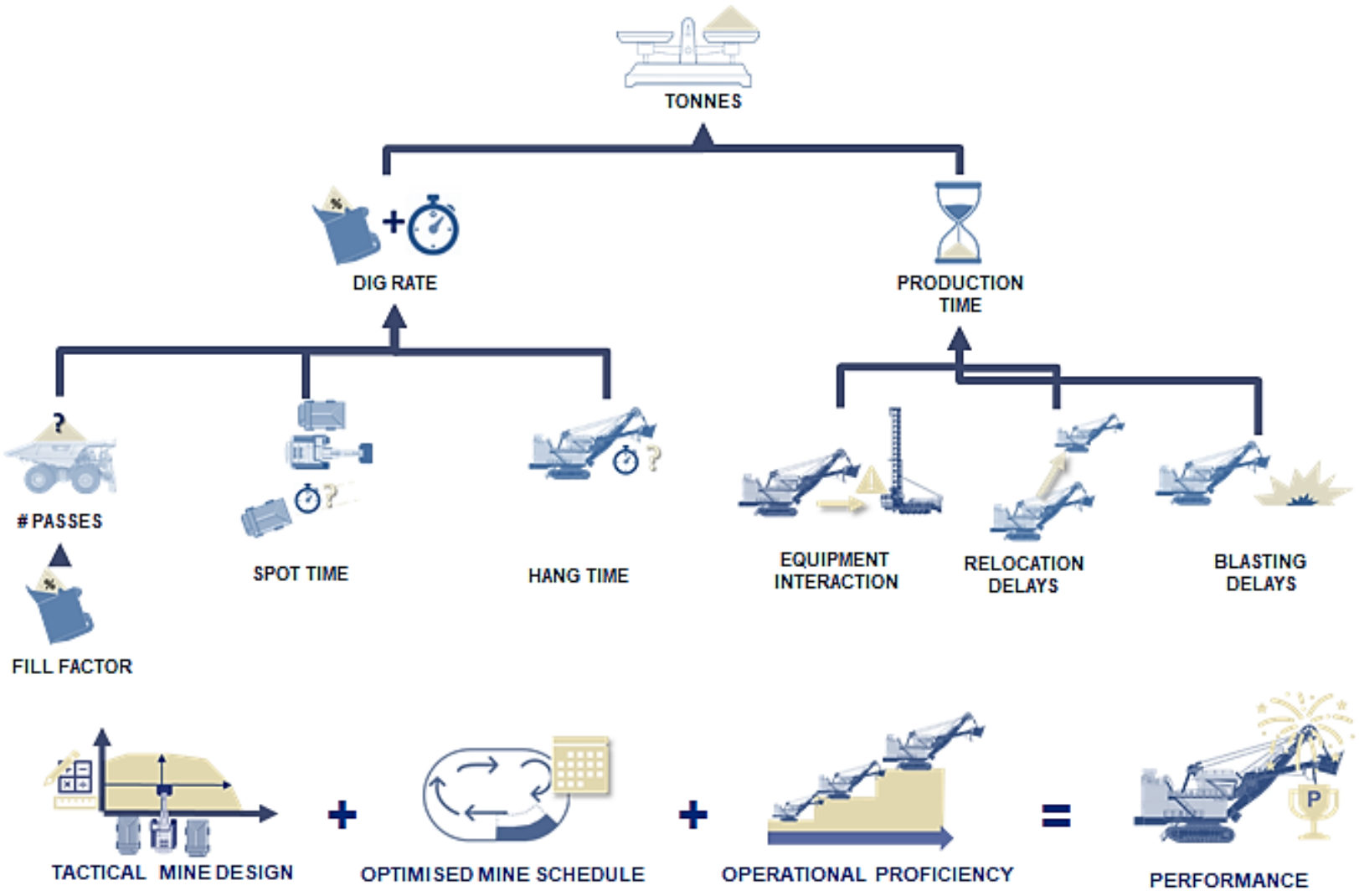


- Method of choice when ore body is close to surface
- Ore is exposed by removing overburden waste rock
- Low cost mining method
- Large environmental burden

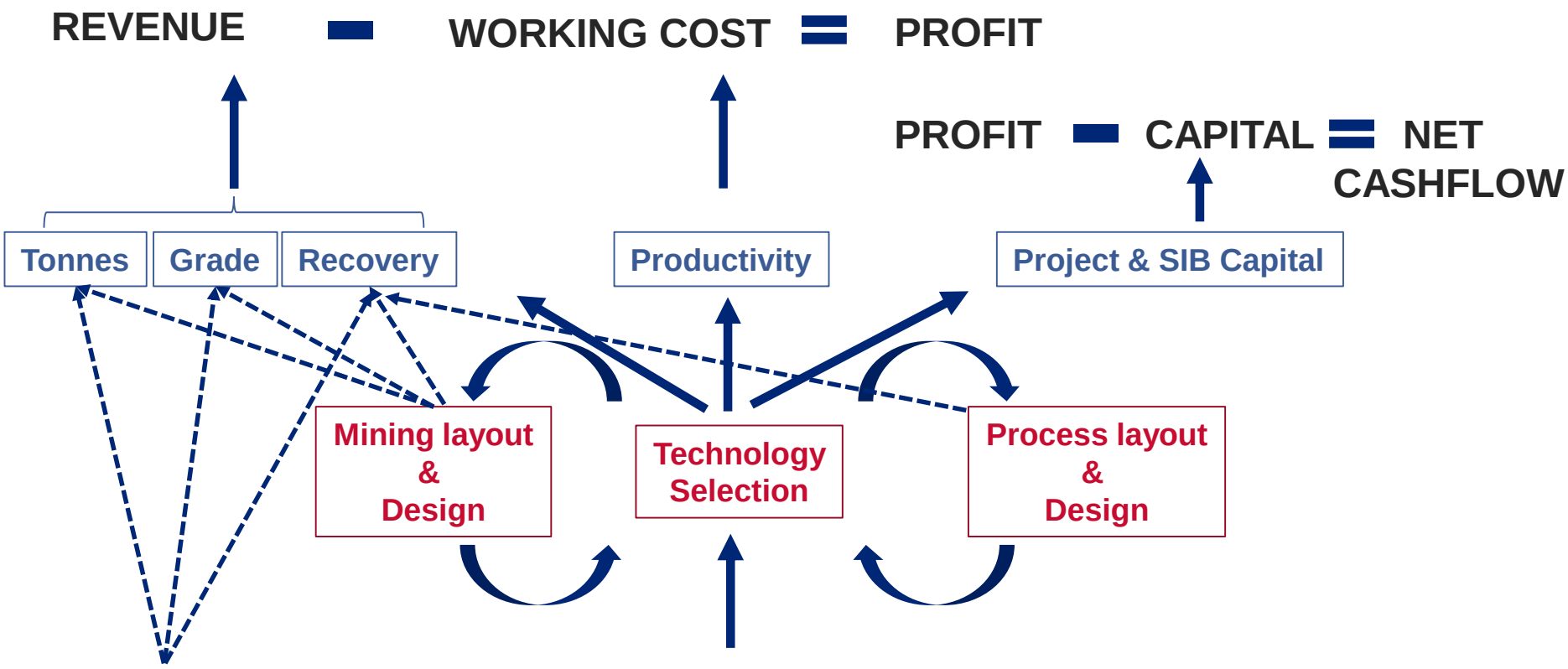
Parameter	2018 Range
Productivity – centares per employee costed (estimated – not comparable to u/g operations)	930*
Productivity – tonnes milled per employee costed	6400*
Unit Cost (R/t)	250-455**

Source: * Noah Capital, **Estimates based on Hard Rock Open Pit operations

EXAMPLE: UNDERSTANDING DRIVERS OF VALUE – OPEN PIT SHOVEL PERFORMANCE



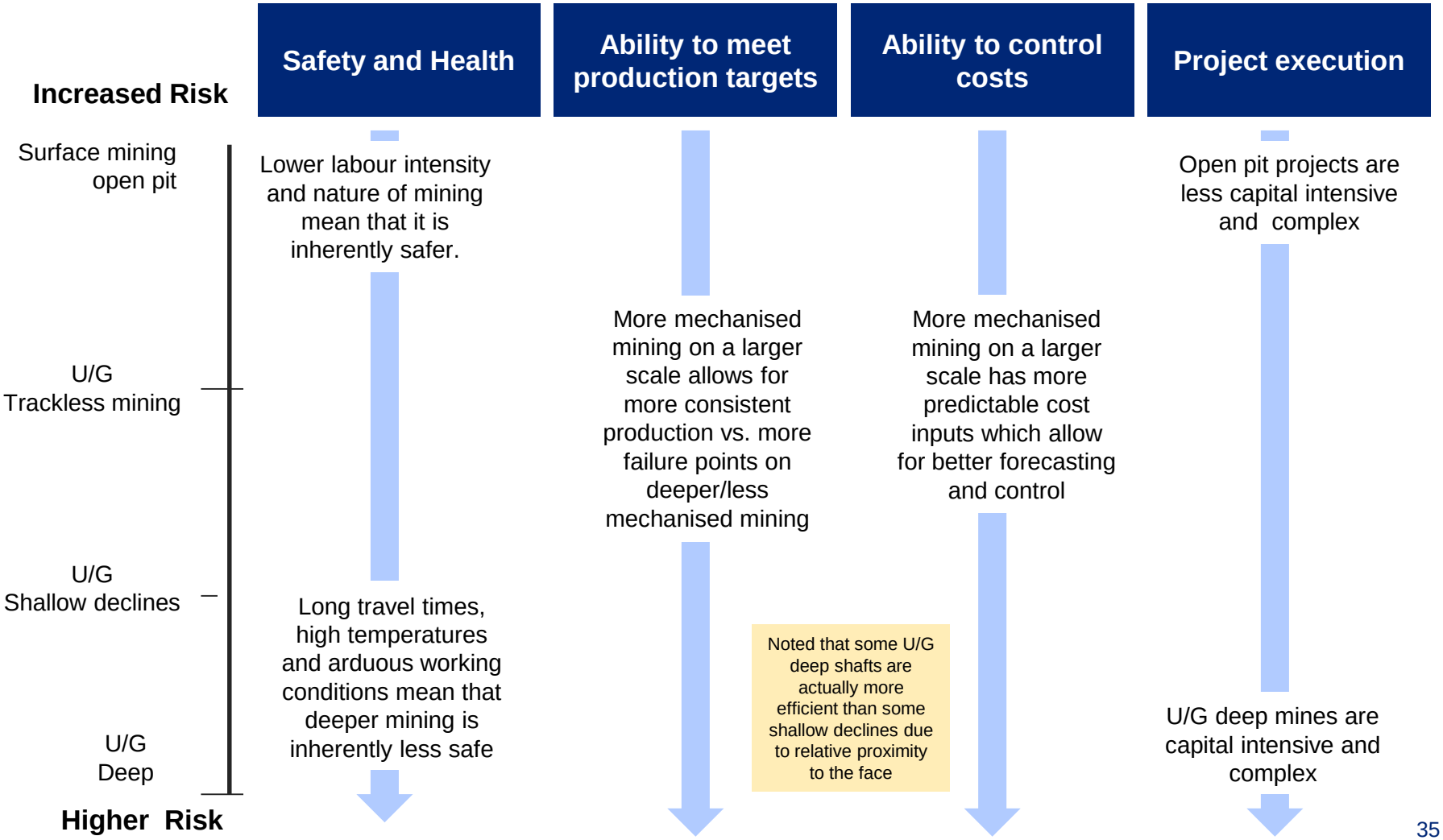
THE CORE CONCEPT



Orebody Characteristics

- Geometry
  - Geometallurgy
    - Physical characteristics (dip, strike, width, depth, orientation)

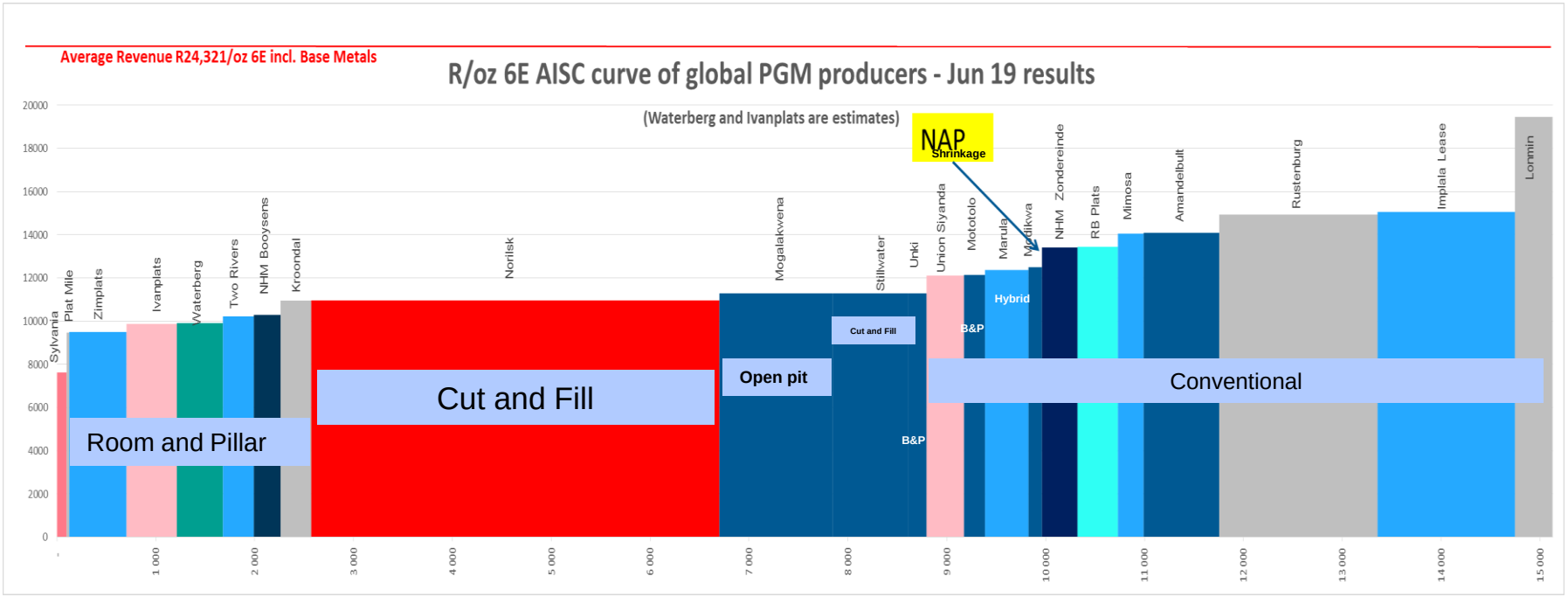
UNDERGROUND DEEP MINES TYPICALLY CARRY THE HIGHEST SAFETY, PRODUCTION, COST AND PROJECT RISK



IN CONCLUSION

- Understanding the orebody characteristics is key
- Selected mining and processing methods are a result of orebody characteristics and technology “fit”
- Technology selection defines Capex and Opex profiles
- For similar orebodies and mining methods, superior performance is driven by leadership and operational excellence

CONSOLIDATION – HOW MINING METHODS AFFECT EFFICIENCIES



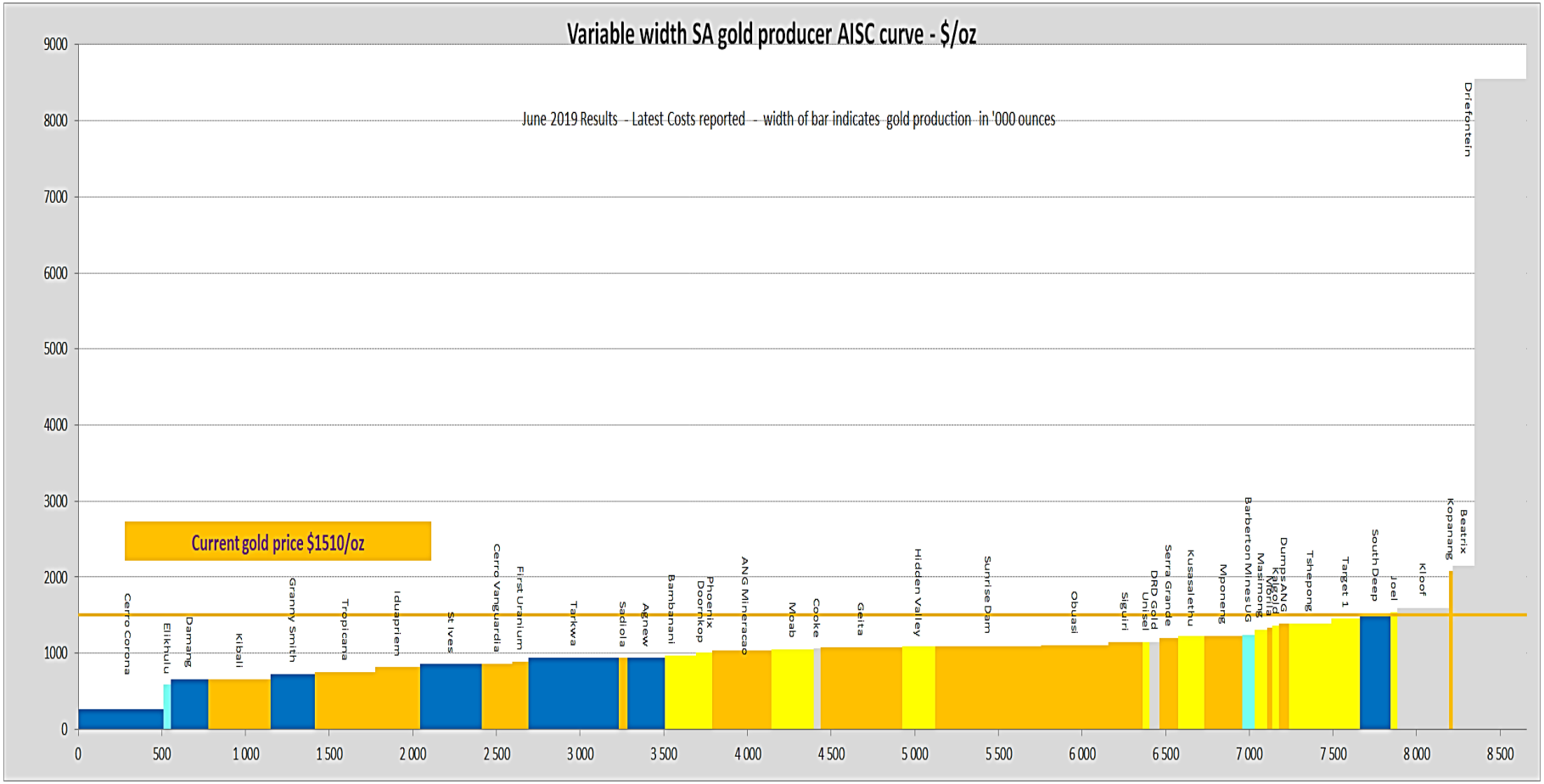
Source: JM, SFA, Noah

CONSOLIDATION - INTERACTIVE DISCUSSION OF COST CURVES

- What are cost curves?
- Why are they useful?
- What are some of their shortfalls?
- How are they calculated?
- What are the drivers of advantaged positions on the cost curves?
- What are some of the complications in their calculations?
- What are some of the recommendations that can be made from this analysis?

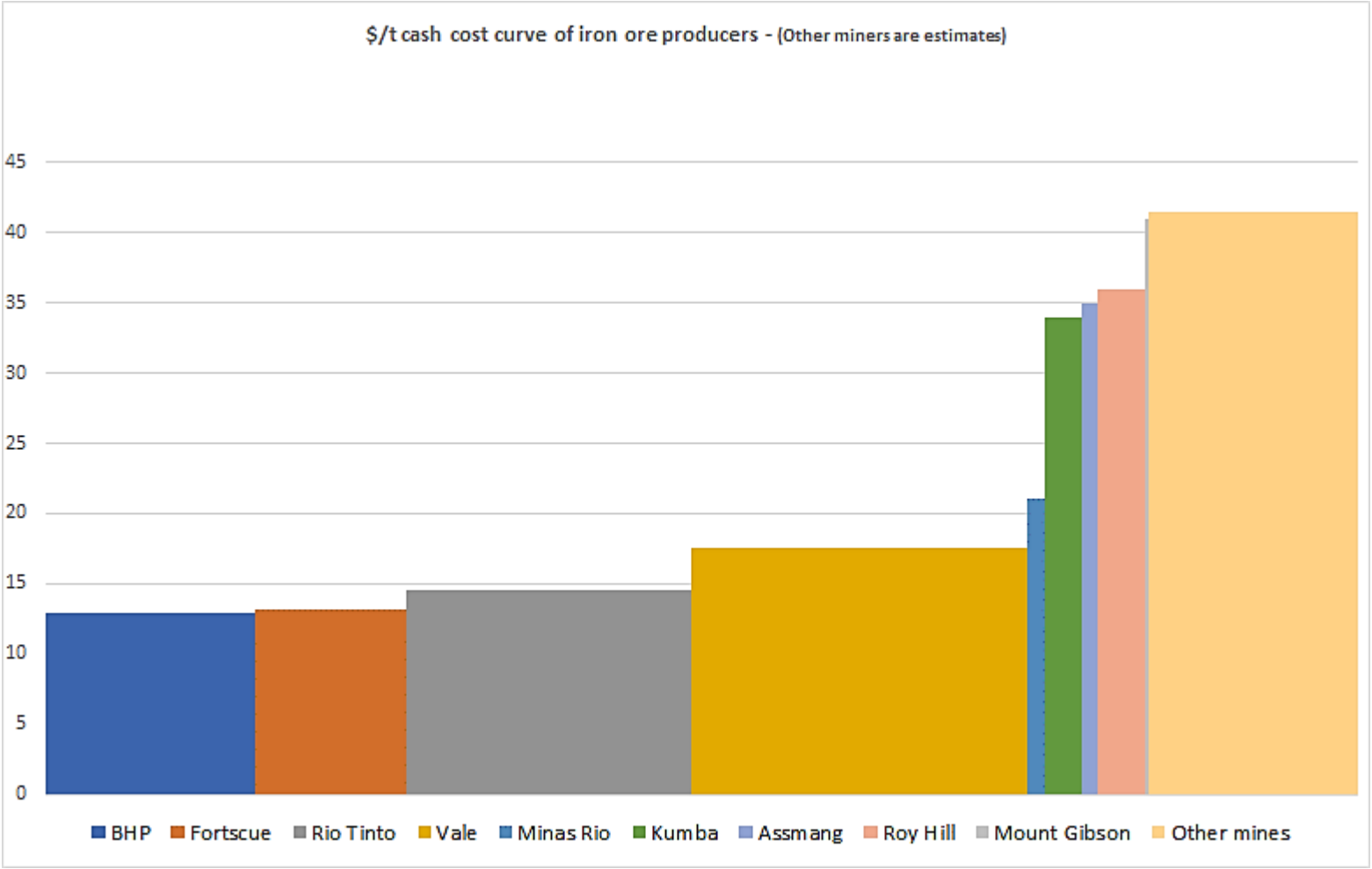
ADDITIONAL SUPPORTING SLIDES

COST CURVE: GOLD



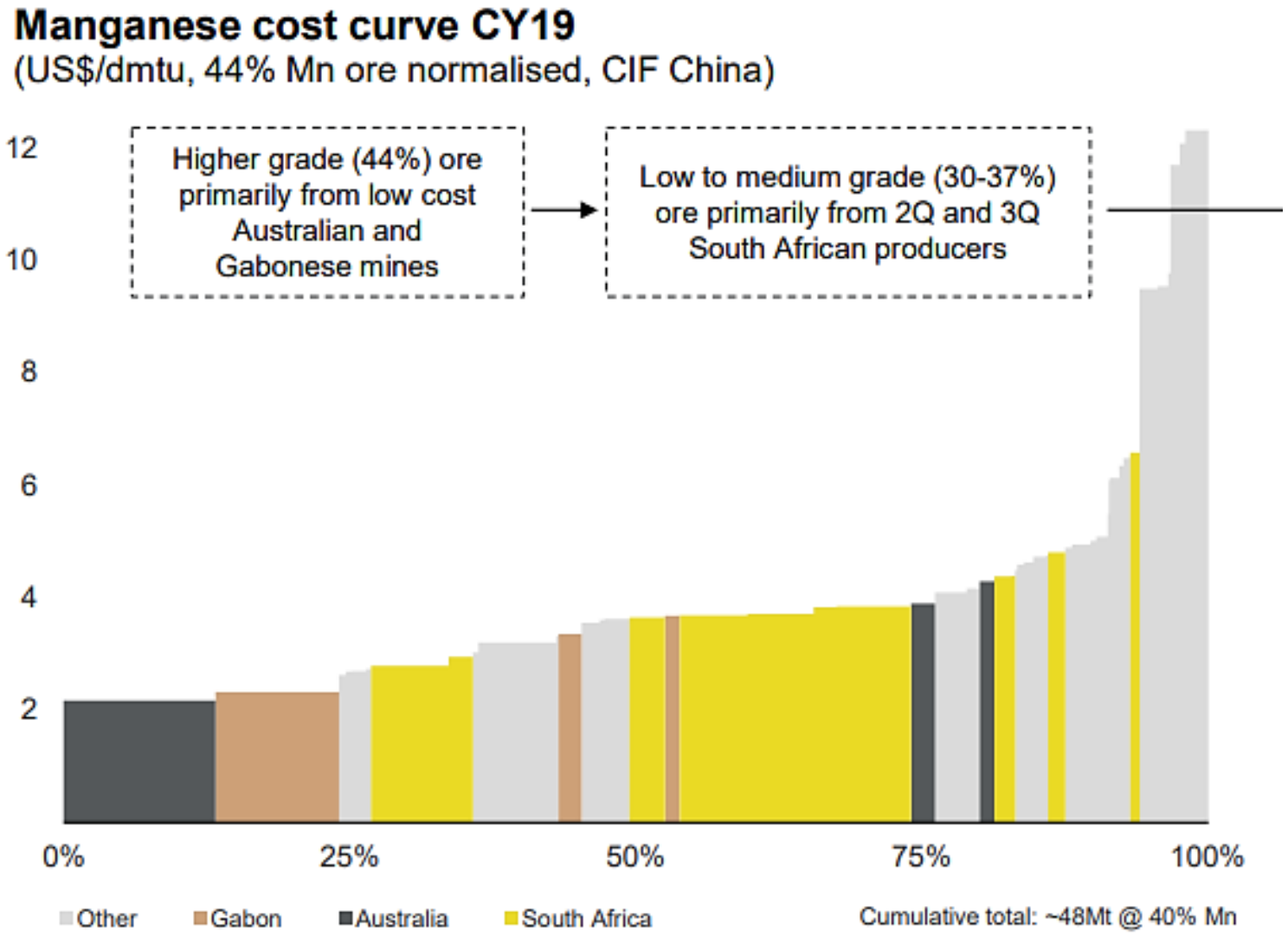
Source: Noah Capital

COST CURVE: IRON ORE



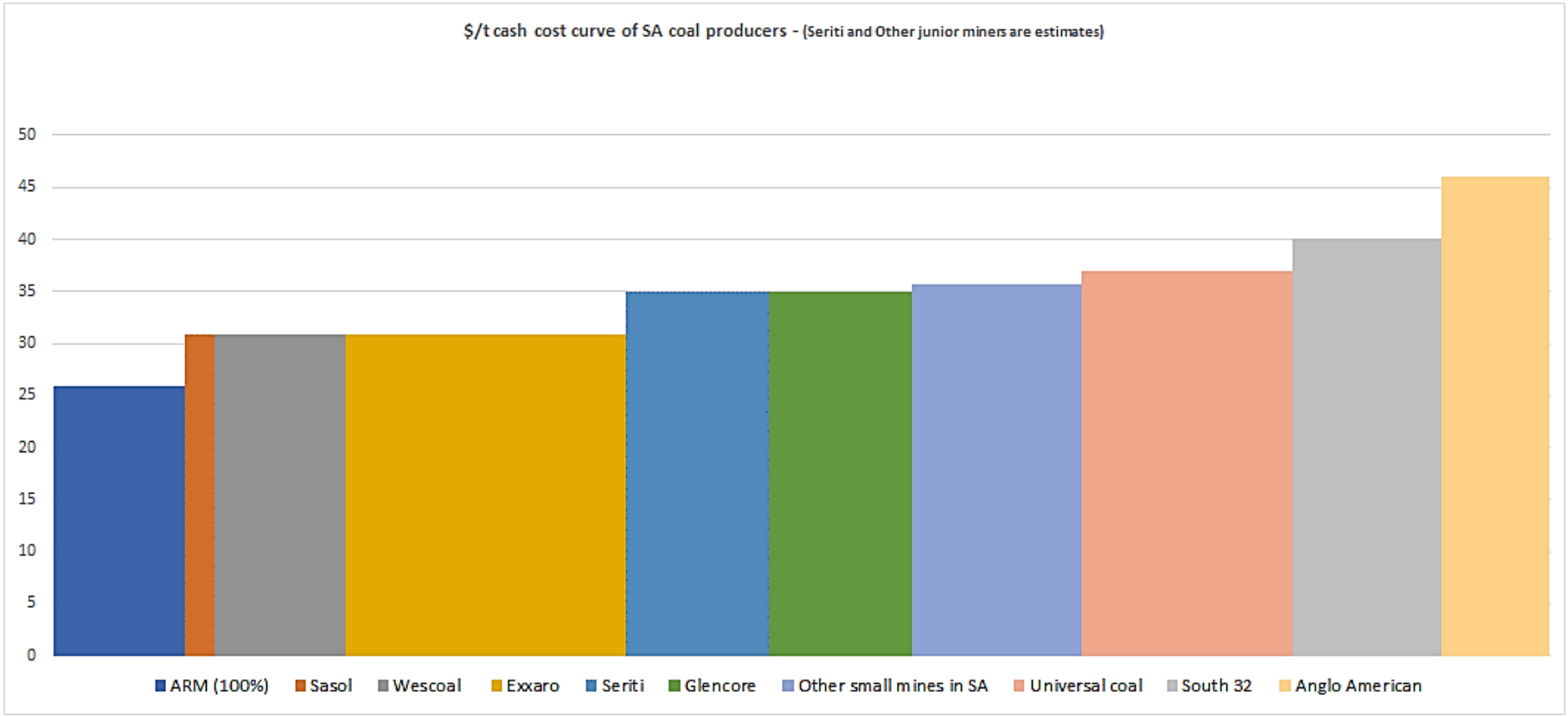
Source: Noah Capital

COST CURVE: MANGANESE



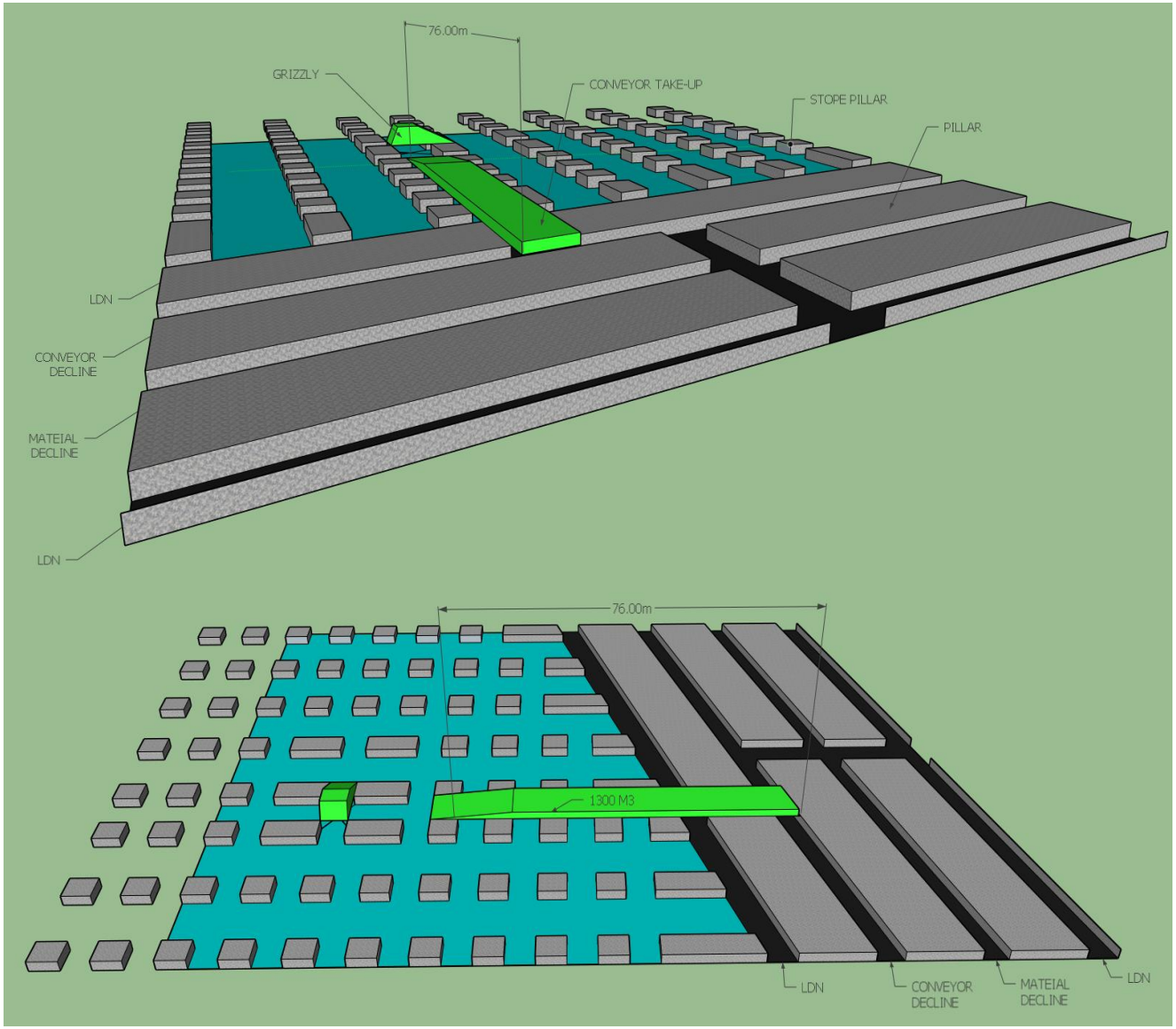
Source: Noah Capital

COST CURVE: SA THERMAL COAL



Source: Noah Capital

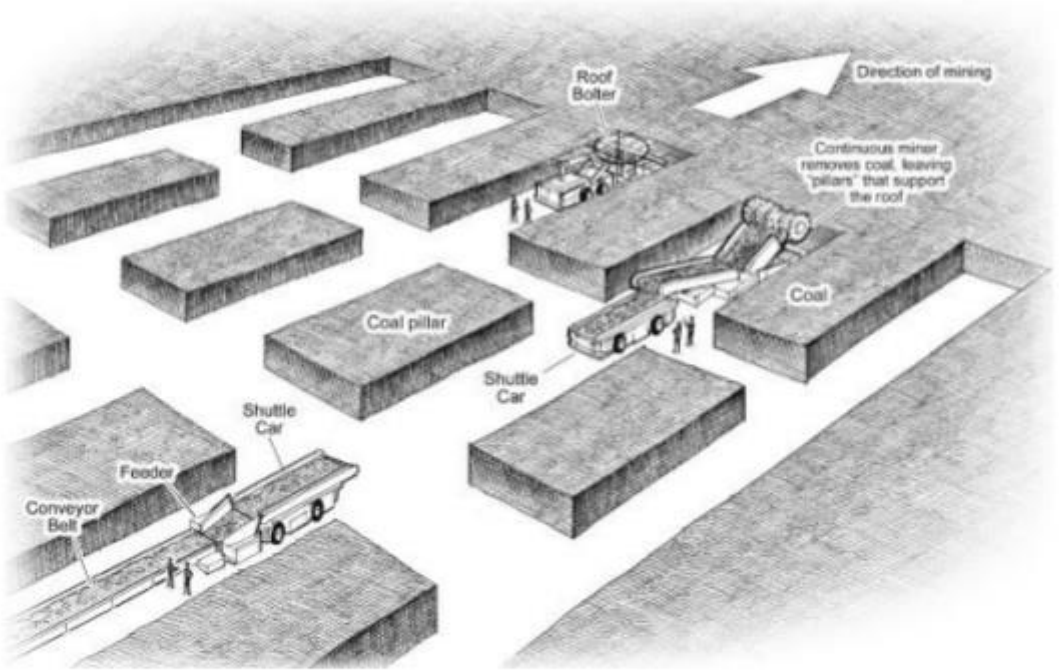
BORD & PILLAR DEVELOPMENT LAYOUT



Legend

- Development crew 1
- Ledging crew
- Development crew 2

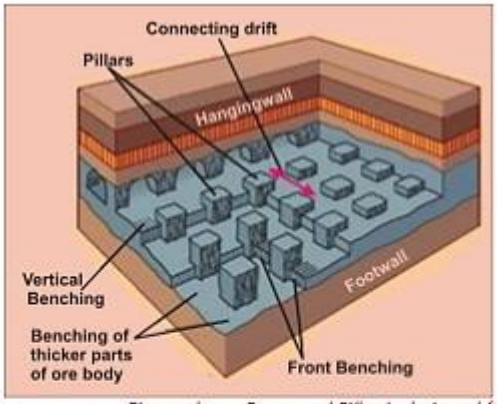
ROOM & PILLAR MINING

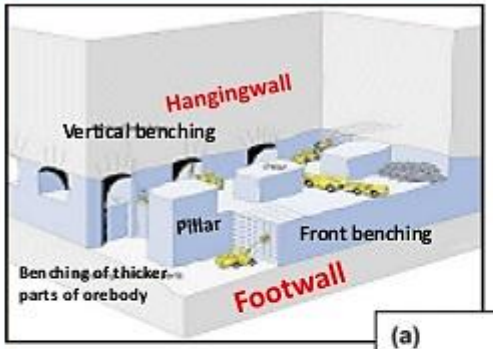


Room and Pillar Mining

ROOM & PILLAR MINING

Underground mining: room-and-pillar mining of thick seams –"Benching"





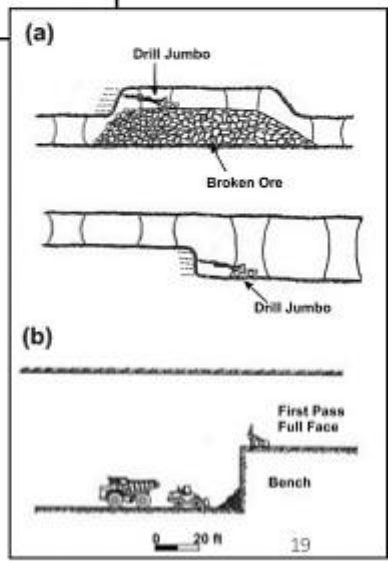


Figure shows Room and Pillar is designed for mining flat, bedded deposits of limited thickness.

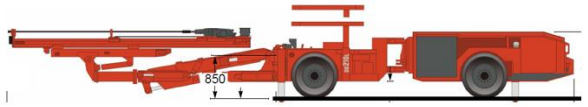
- Different approaches allow either the top or bottom part of the seam to be mined out first.

Note: the ***"hangingwall"*** is above the mining cavity, and the ***"footwall"*** is below it.

Figures from Hartman and Mutmansky, 2002.

LOW PROFILE MECHANISED EQUIPMENT

LHD



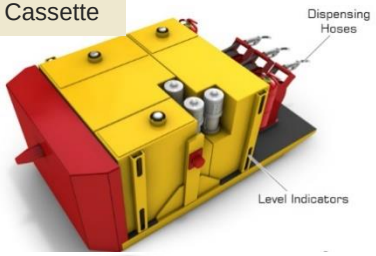
Drill Rig

Bolter

General Purpose Cassette

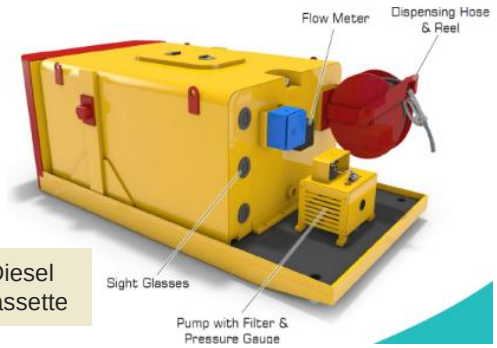
Utility Vehicle

Lube Cassette



Emulsion Cassette

Storage Cassette



Diesel Cassette

SUBLEVEL STOPING

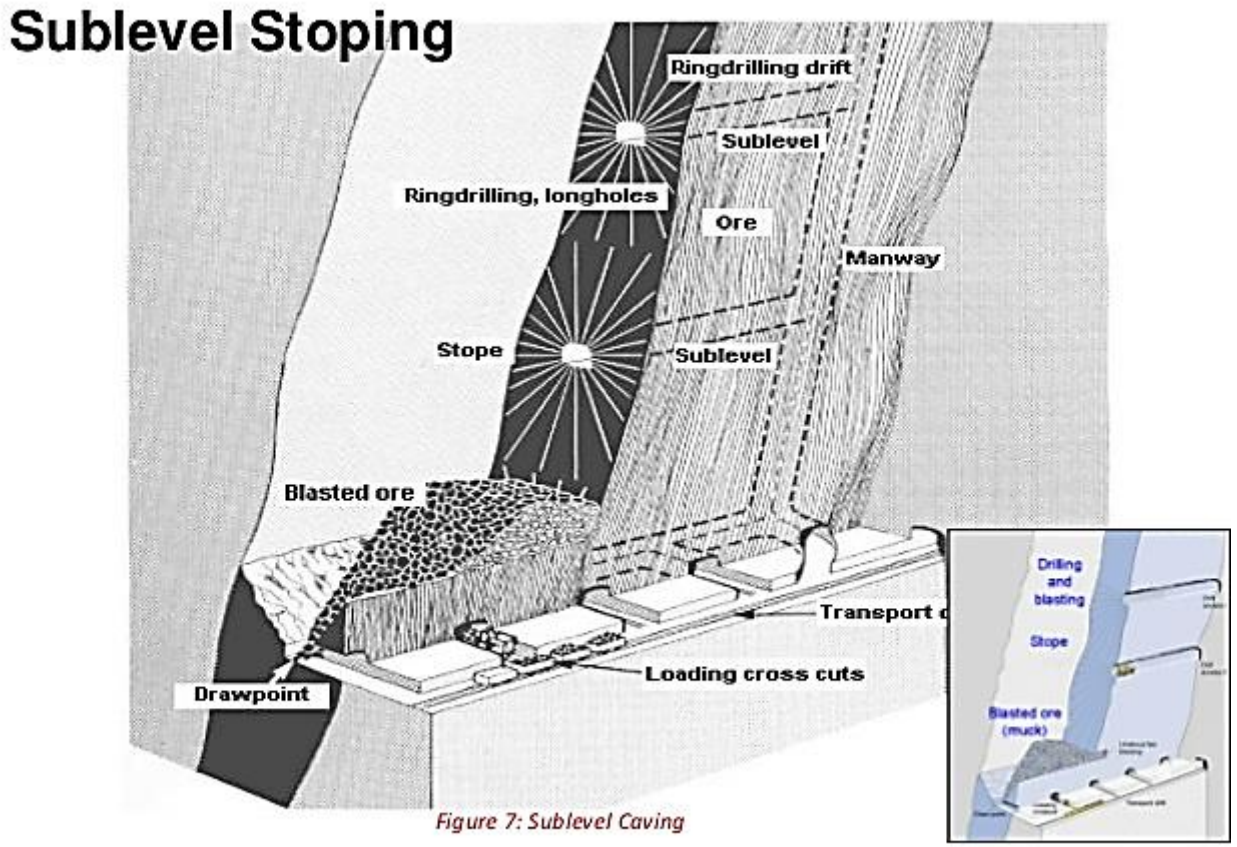


Figure 7: Sublevel Caving

Prof. Dr. H.Z. Harraz Presentation
Mining Methods

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