

Stope Optimisation in Critical & Key Minerals: Conceptual to LOM Case Studies

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Stope Optimisation – Introduction

- Developed by Chris Alford, Alford Mining Systems and defined as:
“Mineable Shape Optimiser (MSO) is a strategic mine planning tool that automates the design of stope shapes for a range of stoping methods for underground mines. Using constraints, detailing mining method and design parameters MSO provides the optimal stope shape design to maximise the value of an orebody”
- Advanced functionality and parameter definition from early “floating stope” and “mineable reserve optimiser (MRO)
- Present a number of critical mineral case studies showing some key functionality.

Stope Optimisation – Key Features

Block Model Settings

Input Block Model:

Optimization Field: Default: 1

Density Field: Default: 2.6

Dip and Strike Controls

Default Values

Default Dip: Default Strike:

Use Dynamic Dip and Strike Control

Use Control Surface

Triangle File:

Point File:

Use Model Fields

Default Dip: Default Strike:

Use Stope Naming

Type	Configuration	Width	Justify	Decimals	Padding	
Field Name	ZSTOPE	4	Left	0	-	✗
Field Name	YCENTRE	8	Left	0	-	✗
Fixed String	ACC_PLR	8	Left	0	-	✗
Field Name	STOPENUM	2	Right	0	-	✗

Click here to add new item

Stope Name Length : 22

Material Configuration

Exclude Material 1

Attribute:

Material:

Maximum Allowable:

Default:

Data Fields

Field Name	Default	Report	Accumulation	Category	Scaling
LITH		<input type="checkbox"/>	weightbymass	no	1
LI_PRC	0	<input checked="" type="checkbox"/>	weightbymass	no	1
SN_PRC	0	<input checked="" type="checkbox"/>	weightbymass	no	1
W_PRC	0	<input checked="" type="checkbox"/>	weightbymass	no	1
RESCAT	0	<input checked="" type="checkbox"/>	weightbymass	dominant	1
LI_EQ	0	<input checked="" type="checkbox"/>	weightbymass	no	1
EXCL	0	<input type="checkbox"/>	weightbymass	no	1

Additional Reporting Fields Used: 5

Output Stopes

Wireframes File Name (tr/pt):

Outline Strings File Name:

Number of Cross Section Intermediate Slices:

Colors Use Default Customize

Stope Shapes: 43

Section Strings: 14

Plan Strings: 9

Cross Section Slices: 25

Cross Section Intermediate Slices: 11

Framework Type

Slice Method - Vertical - Stopes Along Framework Y Axis (YZ)

Section and Level Intervals

Standard Frameworks Advanced Frameworks

Sections (U)

Fixed

Increment: Number:

Variable

Optimization Method for MRGN_TON

Objective

Maximize Stope Grade/Value Above Cutoff (Recommended)

Maximize Total Metal/Value

Method

Cut-off Grade

Cut-off Value

Cut-Off

Discrete

Value:

Variable

Value from Block Model

Nested

Use Head Grade Target

Levels (V)

Fixed

Variable

Coordinate	Size	
383	20	✗
403	20	✗
423	20	✗
443	20	✗
474	20	✗
494	20	✗
514	20	✗
534	20	✗
565	20	✗
585	20	✗
605	20	✗
625	20	✗
656	20	✗
676	20	✗
696	20	✗
716	20	✗
747	20	✗
767	20	✗
787	20	✗
807	20	✗

Click here to add new item

Gradient Strings

Framework Extents

Same as Block Model Manual Definition

Axis	Origin	Max	Distance	Rotation	Axis	Angle
X	-779450	-778500	950	1	Z	0
Y	-967050	-965100	1950	2	Y	0
Z	300	850	550	3	X	0

Extents Visualization

Fit to Filtered Blocks

Margin:

Import Extents From Block Model

Stope Width

Apparent Width True Width on Section True Width

Minimum

Use Single Value Use Model Field

Value:

Maximum

Use Single Value Use Model Field

Value:

Minimum Pillar between Parallel Stopes

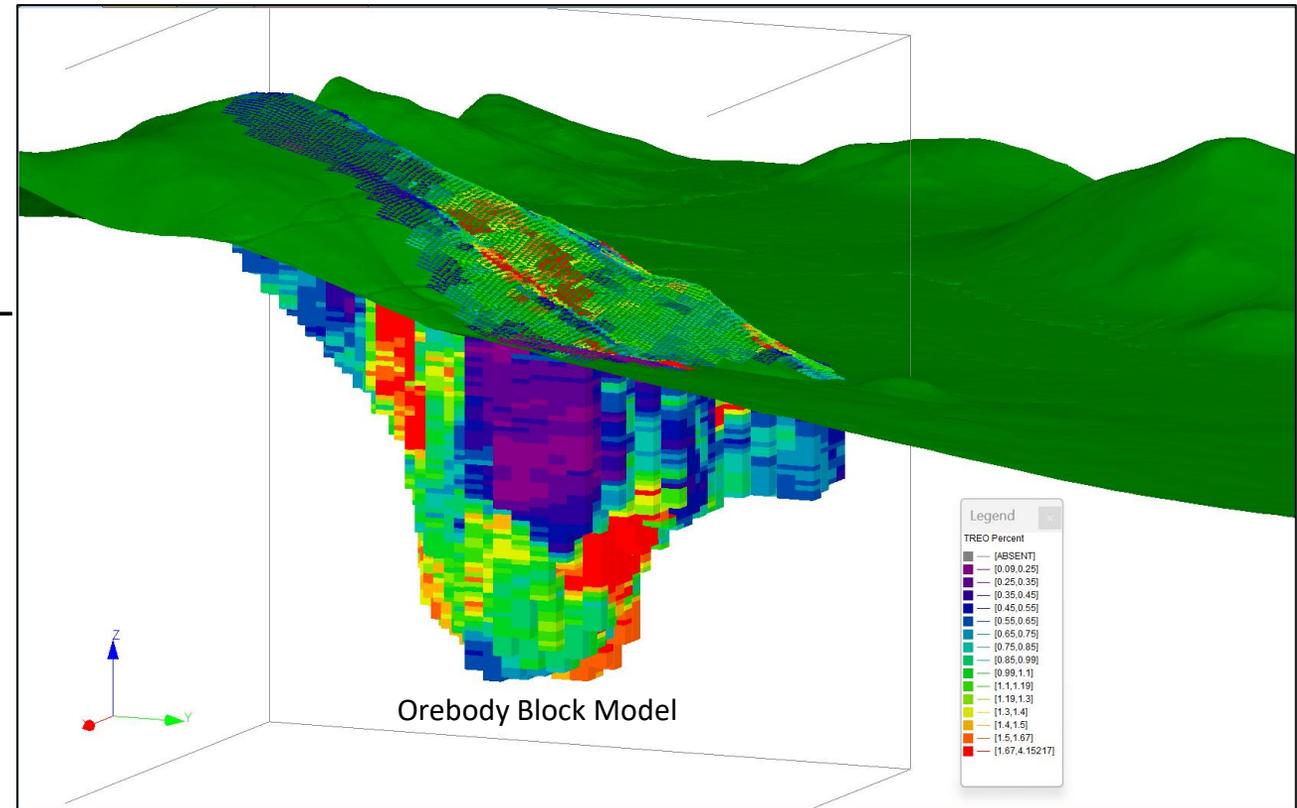
Use Single Value Use Model Field

Value:



Stope Optimisation – Case Study 1

- Minerals: REE
- Where: Southern/Central Africa
- Study Level: Scoping/Conceptual
- Project Background: Completed OP DFS – conceptual/scoping study to cross-check UG option
- Key Aspects:
 - 2 ore types
 - 1 processible other not
 - 2 cut-off grades



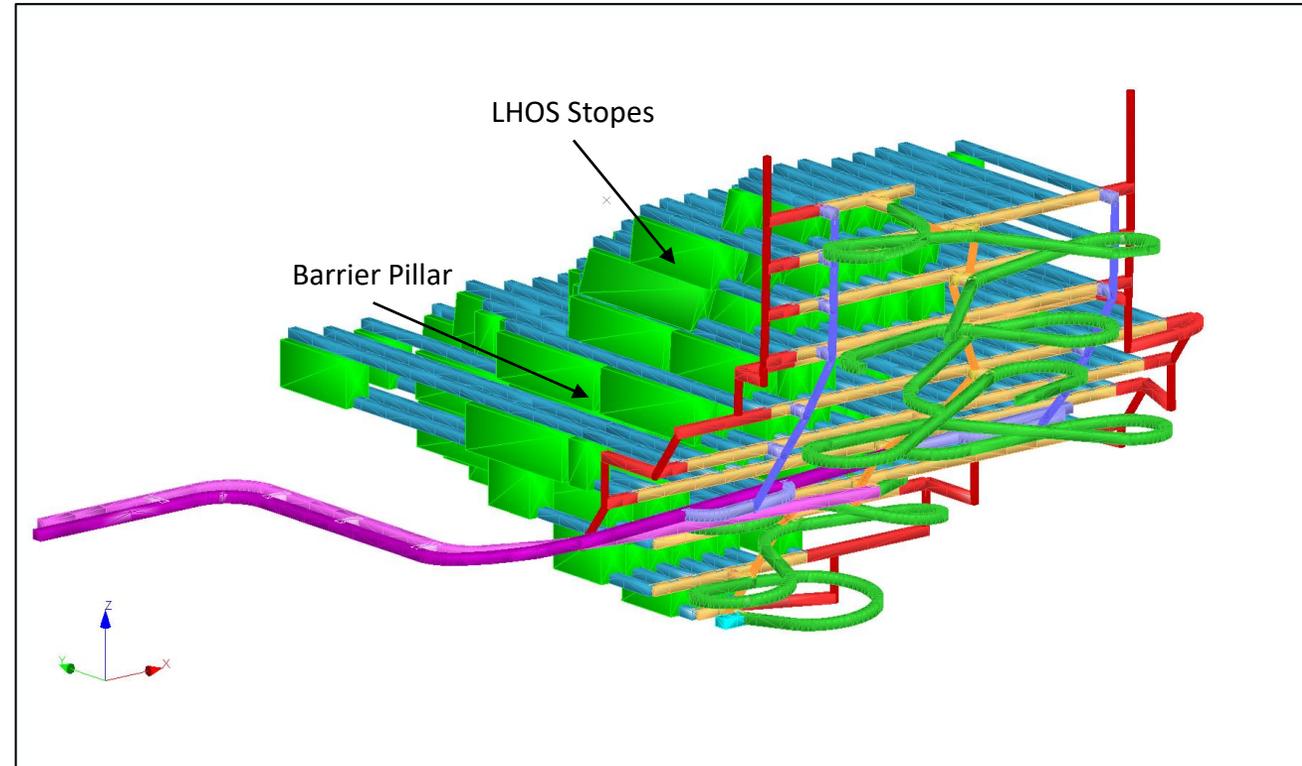
Stope Optimisation – Case Study 1

- Optimisation Parameters:
 - LHOS (25m H, 15m W & to 50m L) – NS
 - 10m rib pillar every 90m
 - 10m sill pillar (max 4 stopes)
 - 20m crown pillar
 - 5m barrier pillar (longitudinal stopes)
 - Full stopes
 - Exclude 2nd ore type but allow as dilution (10-20%)
 - 2 cut-off scenarios (0.6 & 0.8% TREO)



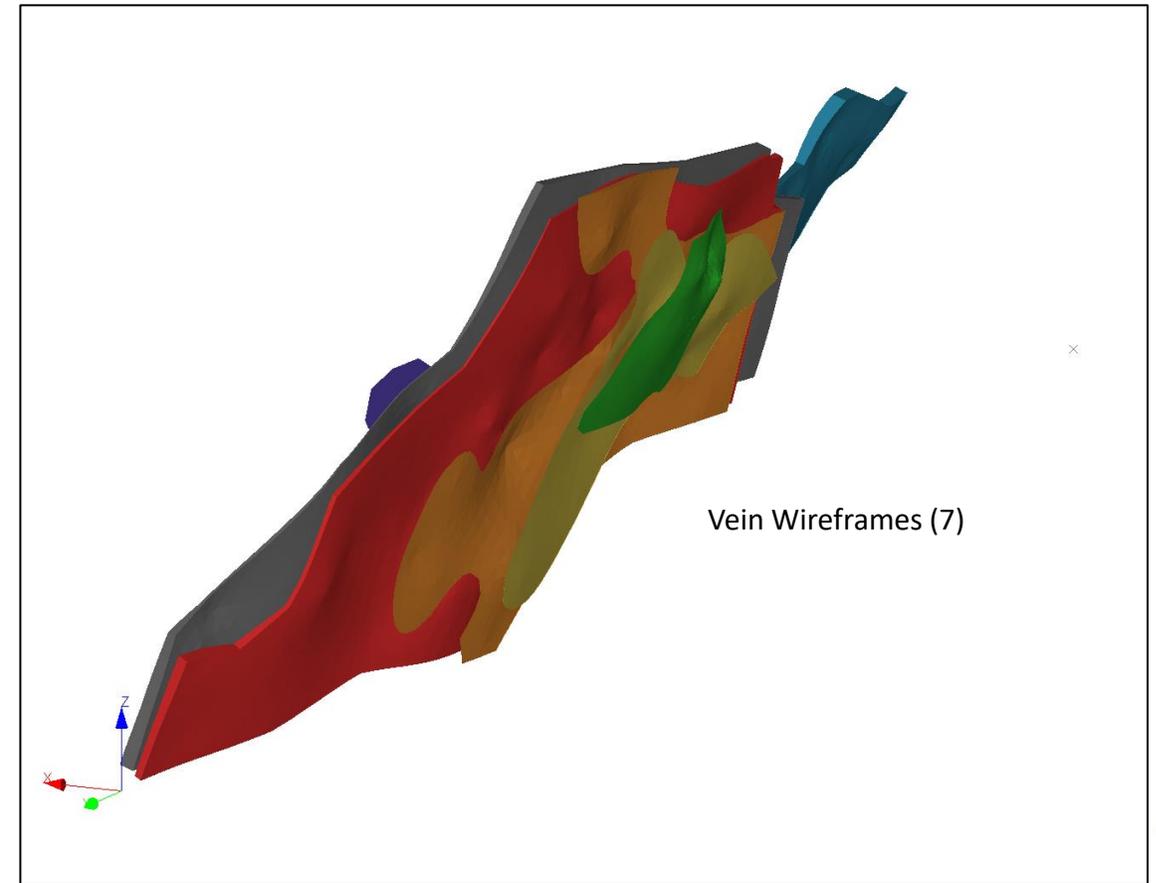
Stope Optimisation – Case Study 1

- Outcomes:
 - Better Mn/Mg ratio than OP
 - No OB removal
 - Minimal un-processible ore type (dilution)
 - Matched pit grade but lower tonnage



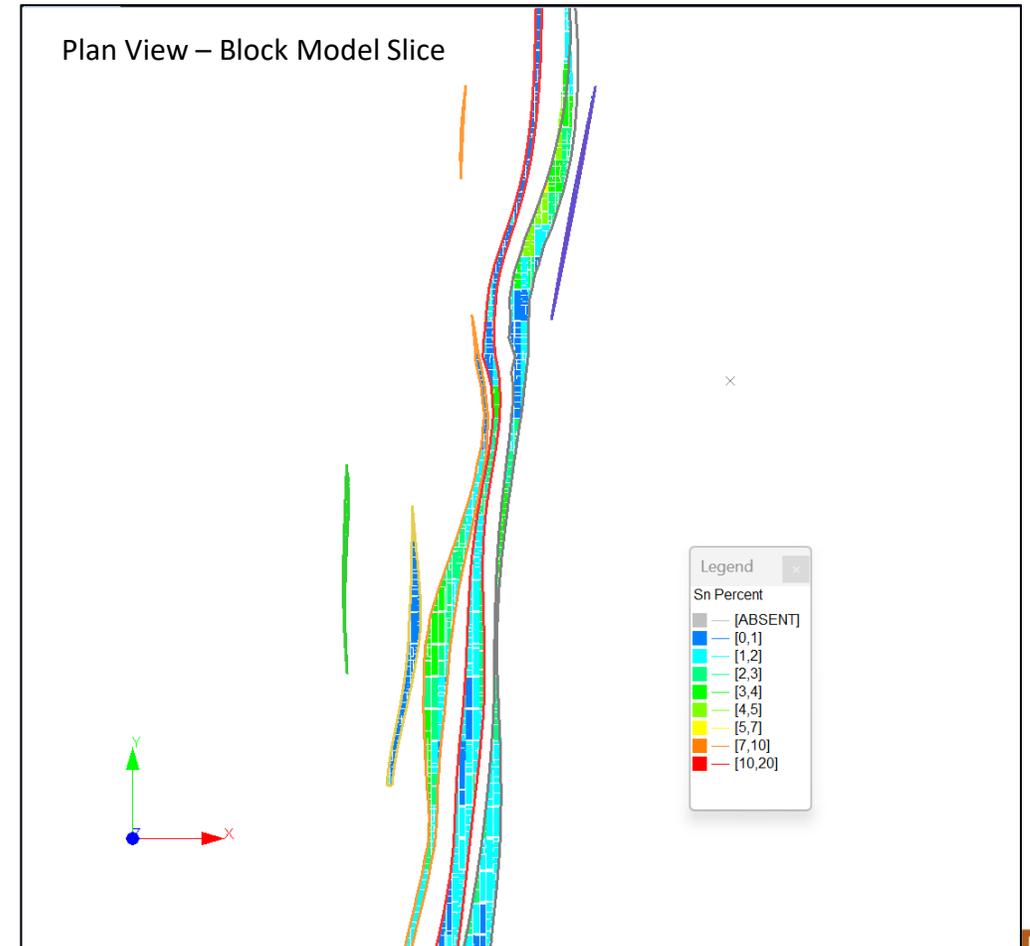
Stope Optimisation – Case Study 2

- Minerals: Sn – with Cu/Pb/Zn/Ag
- Where: Central Africa
- Study Level: Scoping
- Project Background: Assess minimum mining width for equipment selection & identify potential Inferred stopes – existing mine
- Key Aspects:
 - Crown pillar/weathering zone
 - Multiple veins - 7
 - Incremental dilution options/cut-off grades
 - Rotated model
 - Steep narrow veins



Stope Optimisation – Case Study 2

- Optimisation Parameters:
 - Minimum mining width – 2.5m & 4m
 - 0.25m dilution skins
 - Incremental maximum dilution (10% increments)
 - 4 Cut-off grades (0.6, 0.7, 0.8, 1.0% Sn)
 - Stope length – 30m
 - Stope height – 15m
 - Rib pillar – 5m every stope
 - Sill pillar – 8m every 3 stopes
 - 40m weathering exclusion



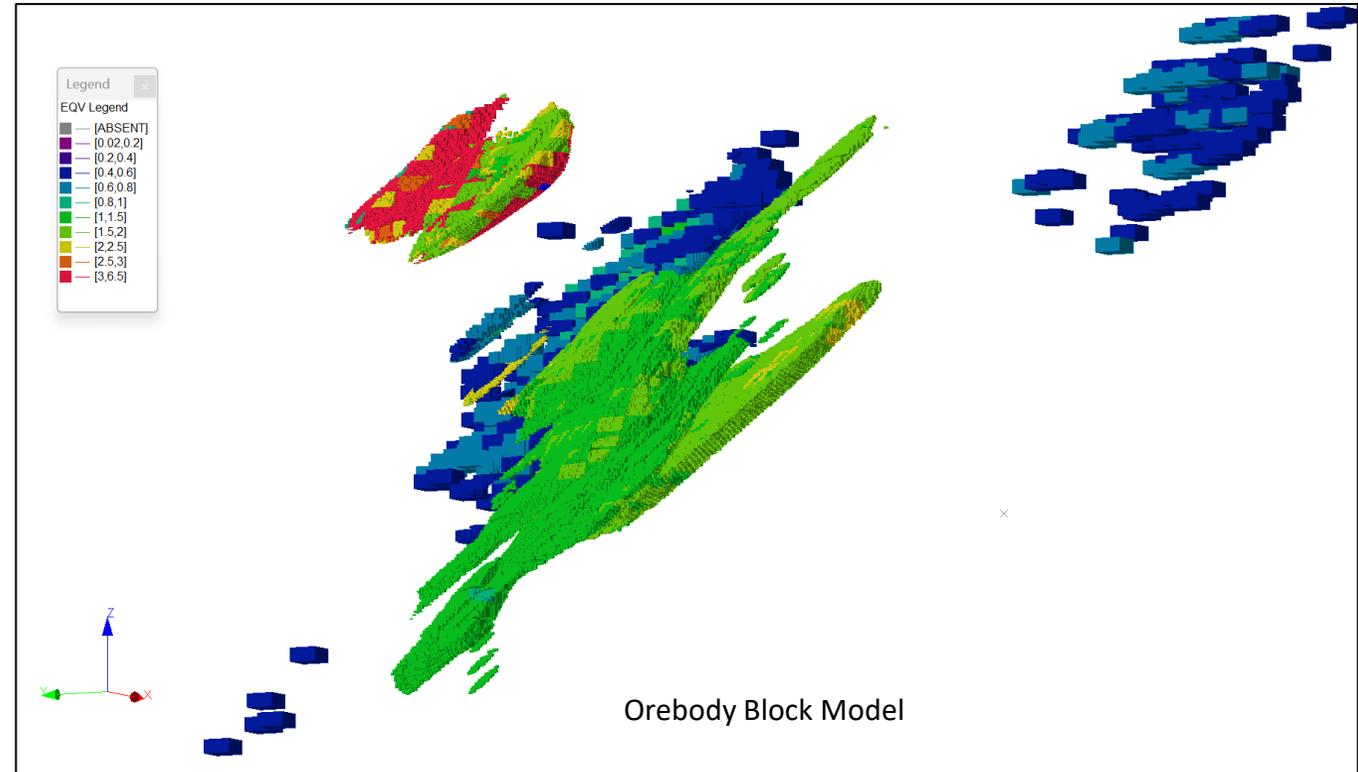
Stope Optimisation – Case Study 2

- Outcomes:
 - 2.5m minimum mining width
 - Current sized fleet (other deposit)
 - 1.0% cut-off
 - Up to 80% dilution
 - Identified Inferred stope potential



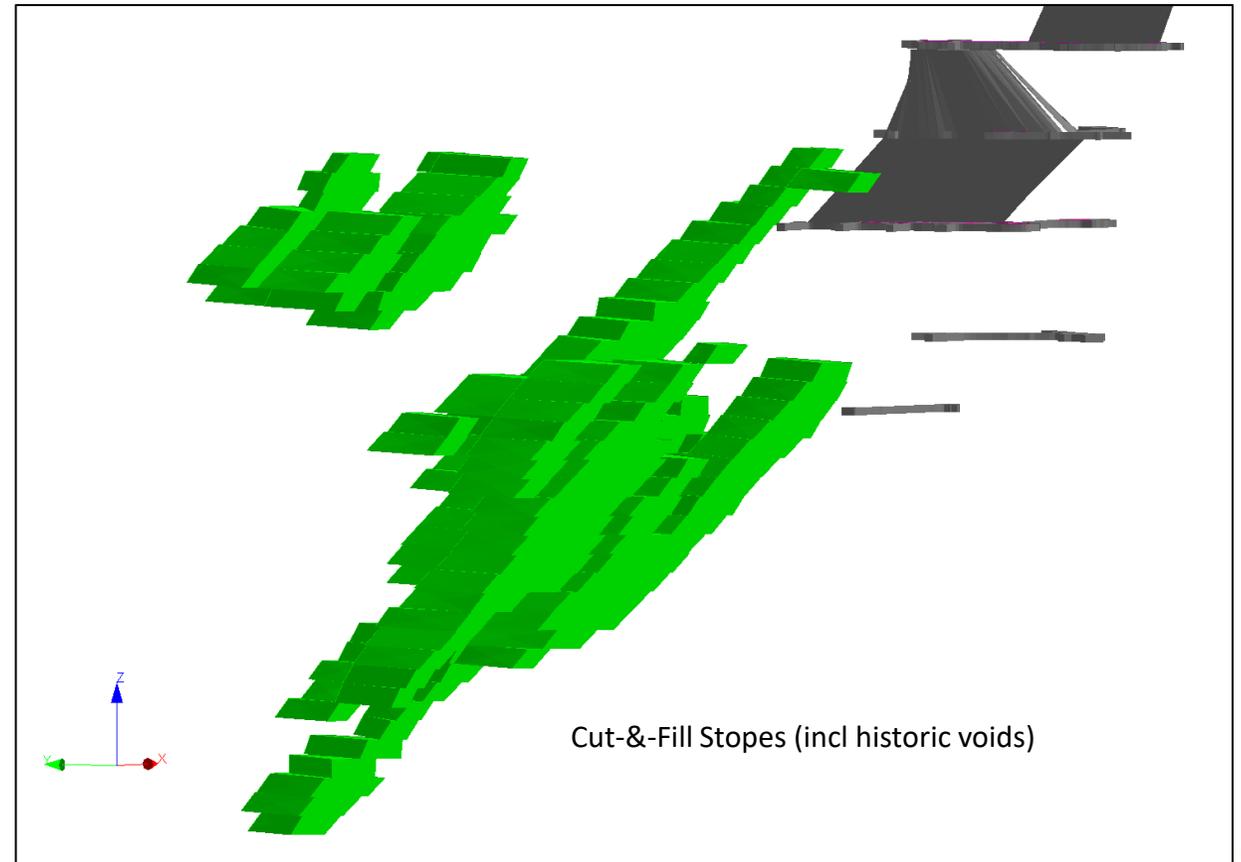
Stope Optimisation – Case Study 3

- Minerals: Vn – with Cu/Pb/Zn/Ag
- Where: Southern Africa
- Study Level: Scoping
- Project Background: Assess mining method (LHOS or C&F); dilution impacts
- Key Aspects:
 - Limit model extent (shadow zones)
 - Dilution increments for both methods
 - 45° dip



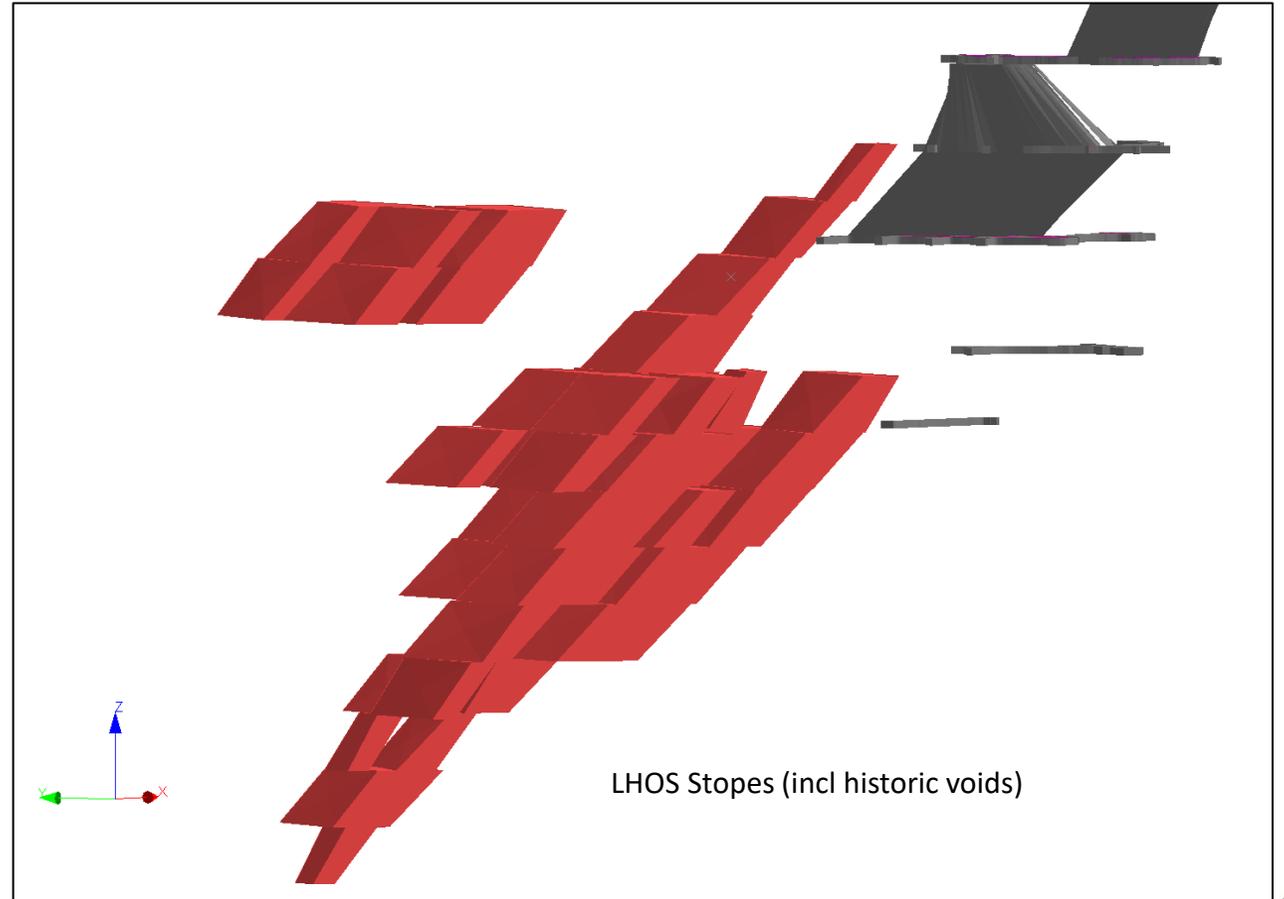
Stope Optimisation – Case Study 3

- Optimisation Parameters:
 - Cut-&-Fill:
 - Cut-Off V_2O_5 EQV – 0.46%
 - Cut height – 5m (15m sub-levels)
 - Min width – 4m
 - Dilution skin – 0.2m
 - LHOS:
 - Cut-Off V_2O_5 EQV – 0.38%
 - Stope height – 15m
 - Min width – 4m
 - Dilution skin – 0.5m
 - Both:
 - 10% dilution increments
 - Model extent restricted to main ore zone



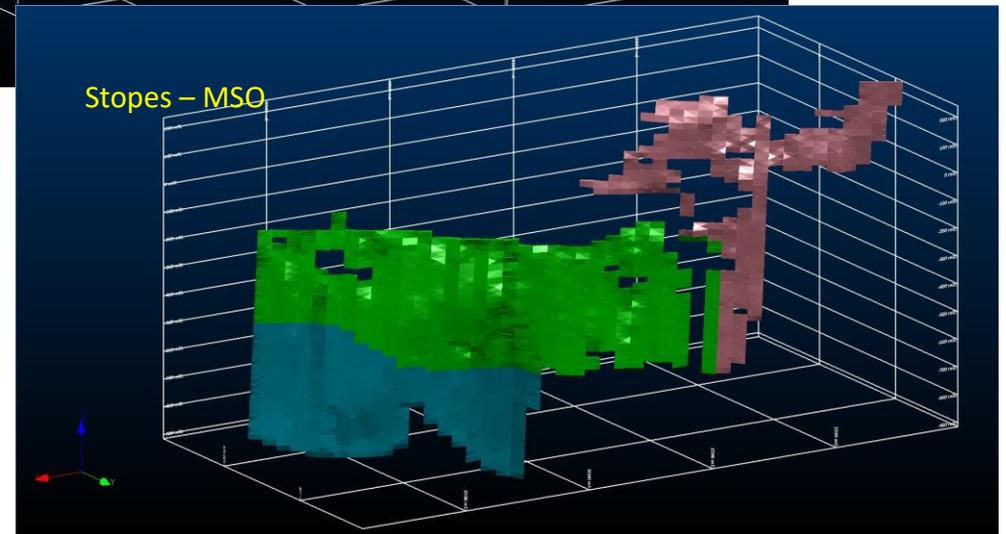
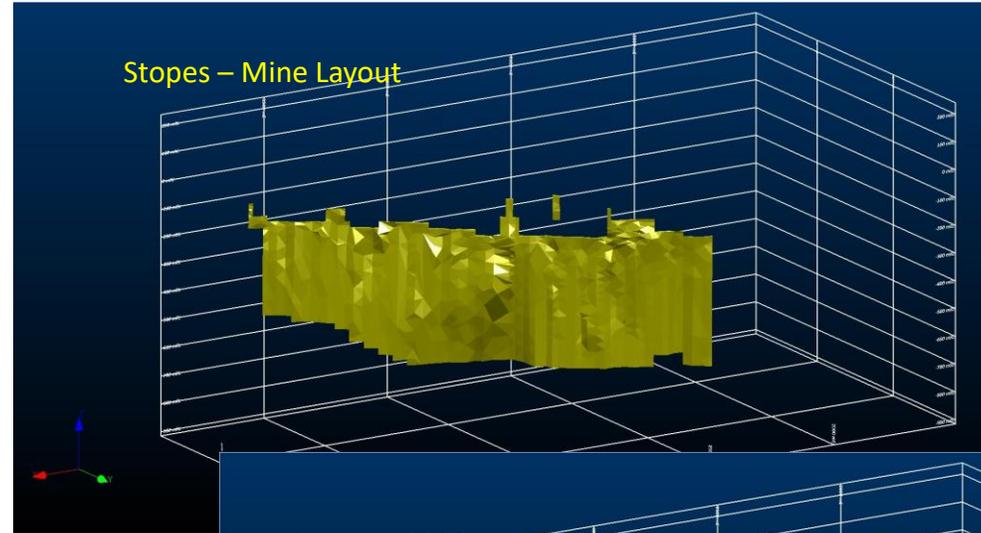
Stope Optimisation – Case Study 3

- Outcomes:
 - MSO & cost modelling of each dilution value
 - LHOS at max 70% dilution best result



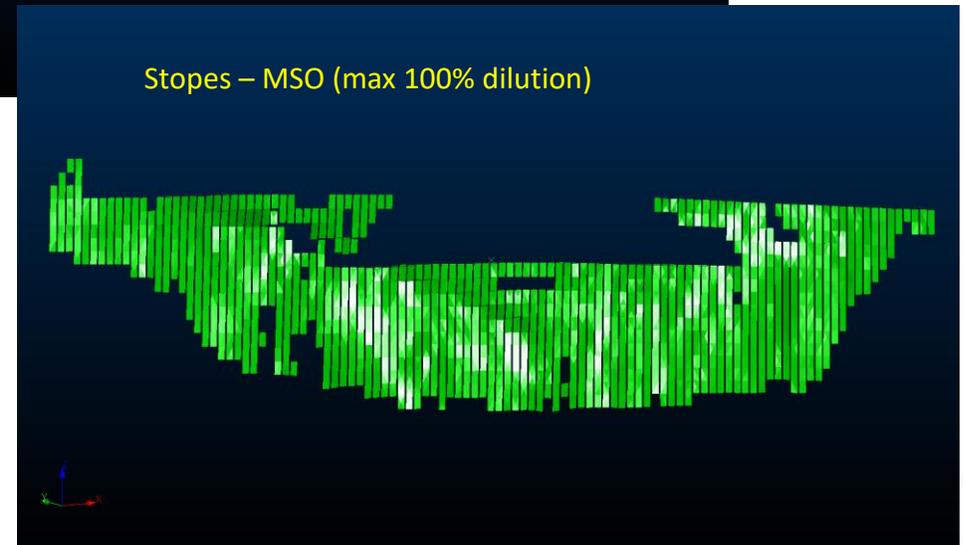
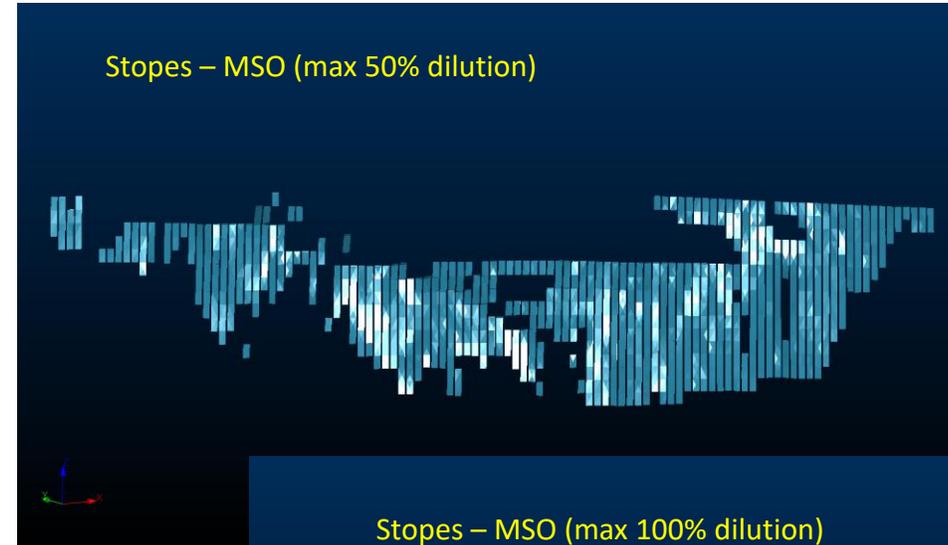
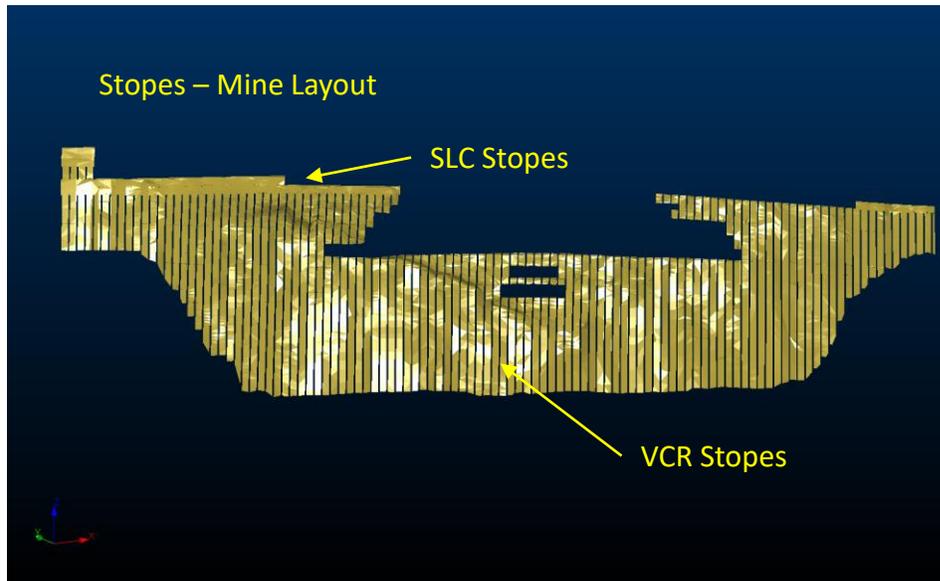
Stope Optimisation – Case Study 4

- Minerals: Cu – with Co
- Where: Central Africa
- Study Level: DD
- Project Background: Check stoping designs using MSO: and ID potential extensions
- Key Aspects:
 - 3 working mines
 - SLC, VCR & MCR (mechanised continuous retreat)
 - Using same parameters
 - Comparative assessment



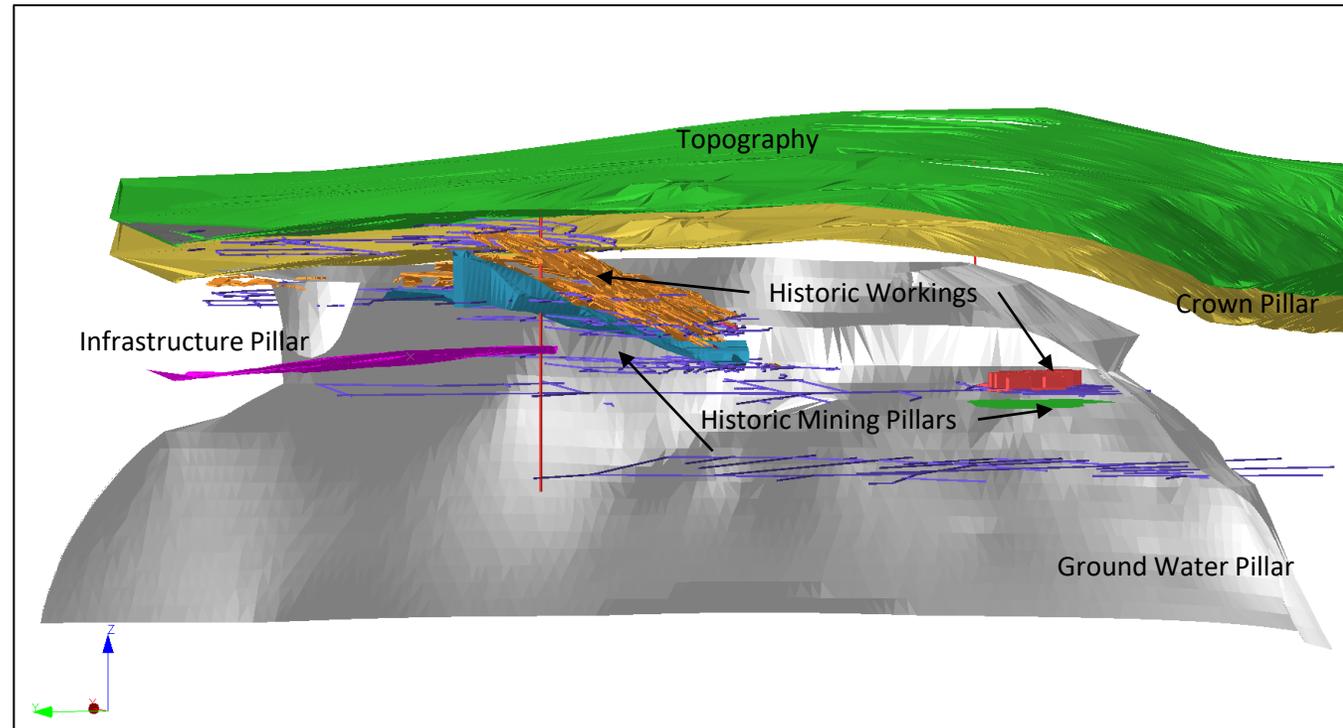
Stope Optimisation – Case Study 4

- Outcomes:
 - MSO & mine stope design generally match at gross scale (local differences)
 - Identify potential extensions/upside



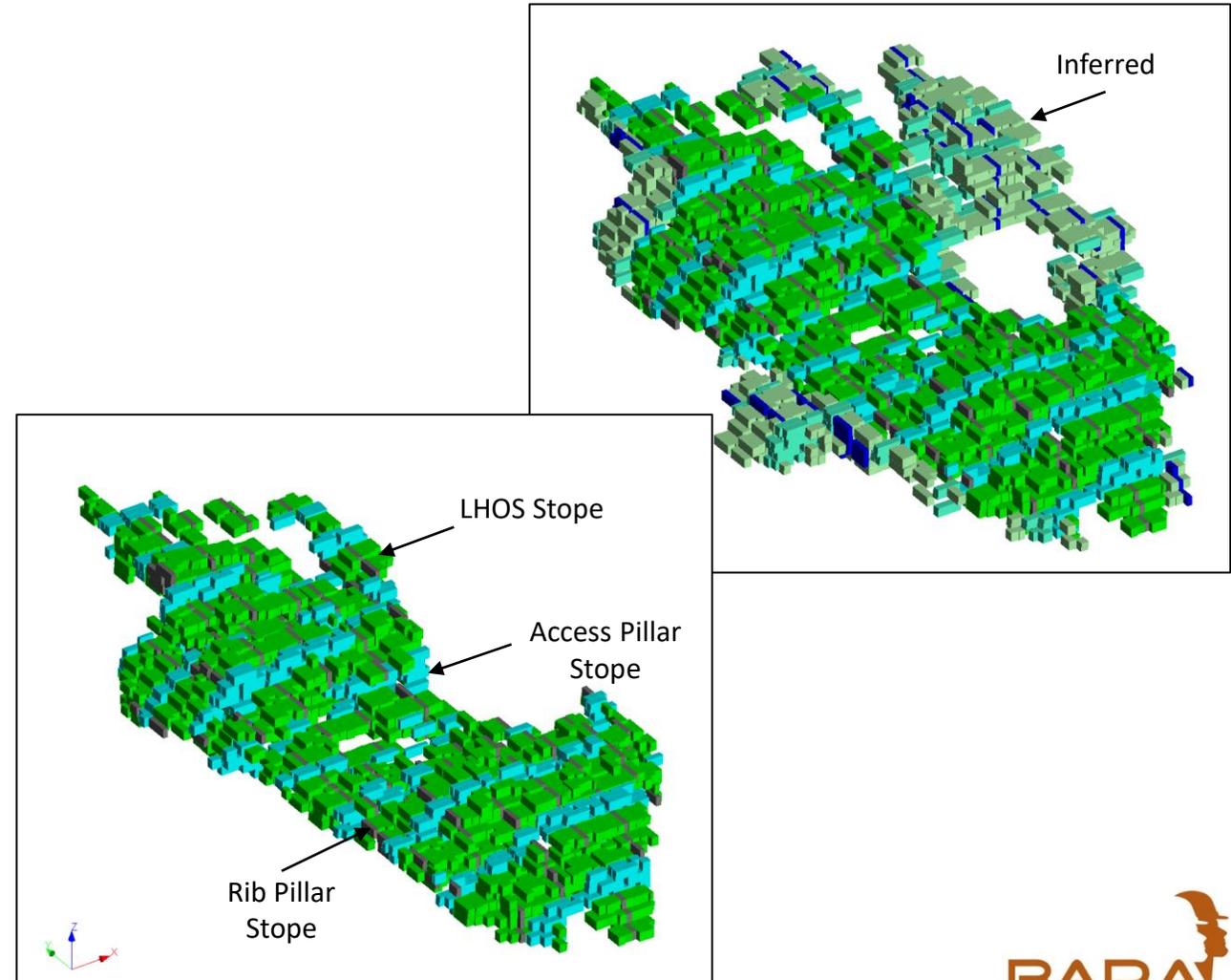
Stope Optimisation – Case Study 5

- Minerals: Li – with Sn/W
- Where: Central Europe
- Study Level: PFS / DFS
- Project Background: DFS & LOM design/schedule; expansion option (Inferred)
- Key Aspects:
 - Multiple exclusion zones – border, crown, surface infra, historic workings (x2), ground water barrier
 - Historic workings & surface infrastructure
 - Different MSO directions
 - ESG limitations



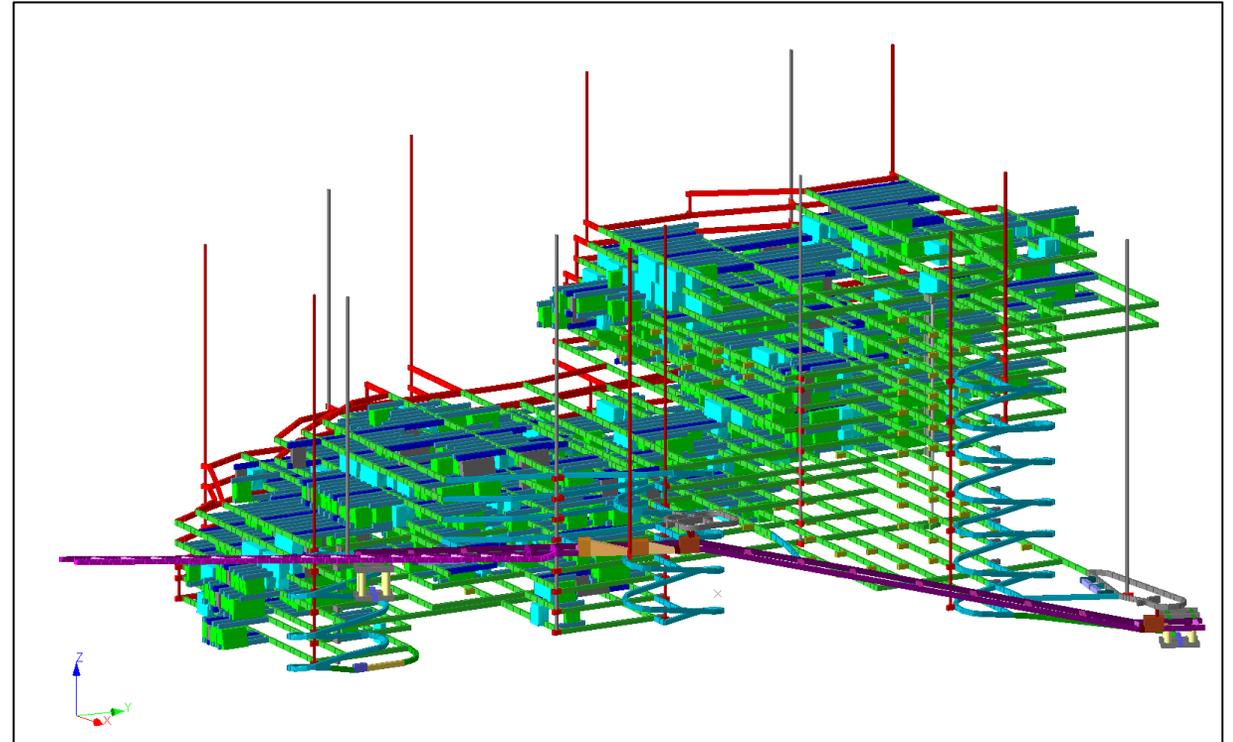
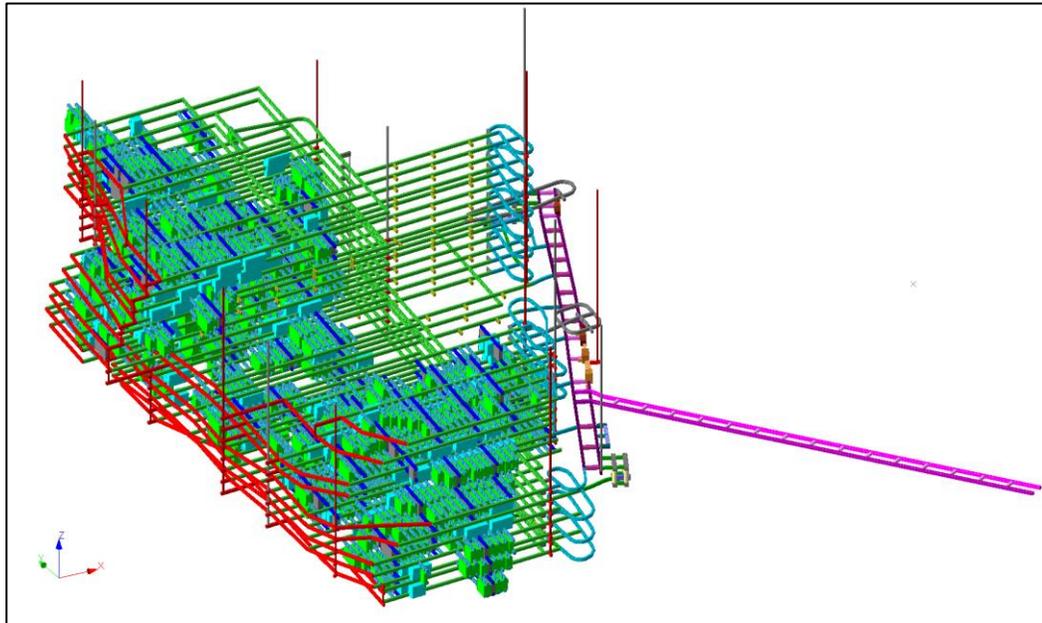
Stope Optimisation – Case Study 5

- Optimisation Parameters:
 - Cut-Off – based on a Margin
 - Longitudinal (NS - stopes & rib pillars) & Transverse (WE - access pillars) direction
 - LHOS – 20m H x 16m W x 50m L (max)
 - Rib pillar every 5 stopes (10m W) - remove
 - Sill pillar every 4 stopes – leave
 - 5m Barrier pillar after 50m length
 - Partial stope option – 10% increments down to ½ width – keep height
 - Access pillar stopes as per LHOS
 - Exclusion zones – non-mining areas



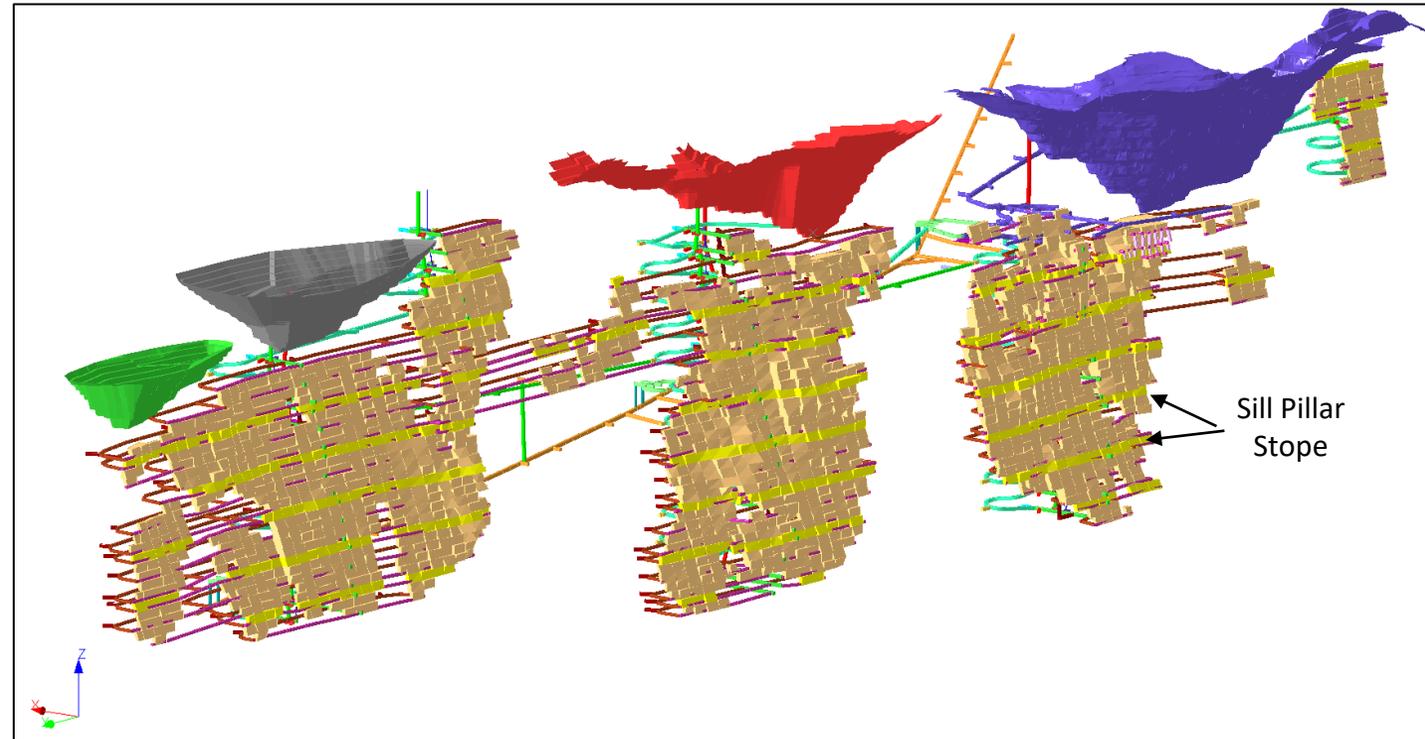
Stope Optimisation – Case Study 5

- Outcomes:
 - Full LOM stopes defined including extractable pillars
 - Inferred (future) stopes defined & catered for



Stope Optimisation – Other Cases

- Minerals: Au/Ag
- Where: SE Europe / West Africa
- Study Level: PFS / Scoping
- Project Background: various Au mines or projects – OP vs UG or OP to UG
- Key Aspects:
 - Test OP cuts vs. UG option
 - Extend mining from OP to UG
 - UG alternative to OP – surface issues restricting OP



Stope Optimisation – Summary

- Useful tool for definition & assessment:
 - All project levels – early resource/potential to LOM/operational design
 - Comparative assessments – DD or OP vs UG
 - Scenario assessments easily & quickly – equipment, cut-off, dilution, mining method, mining widths/dimensions, etc.
 - Can be used in OP not just UG – complex orebodies & define mineable ore blocks within pit shell (dilution)