



OCEANAGOLD

Didipio Underground Q Block Model

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Didipio, Philippines

OUTLINE

- OGPI Didipio Au-Cu Mine
- Q-System
- Methodology
- Q Block Model
- Model Application

RESPONSIBLE GLOBAL MINER



Didipio Au - Cu Mine



Open Pit

TSF

Crusher

Mill

RomPad

Core Yard

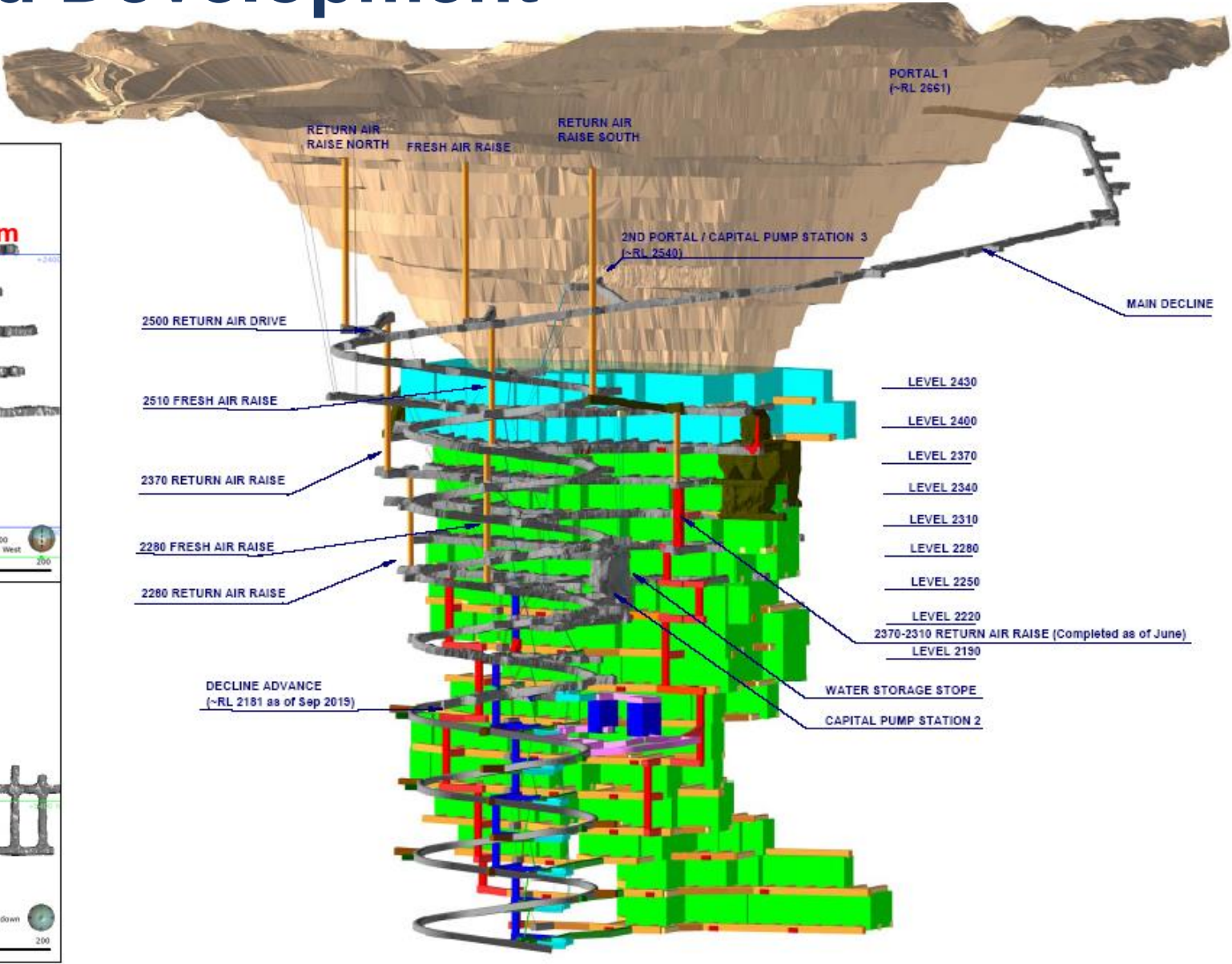
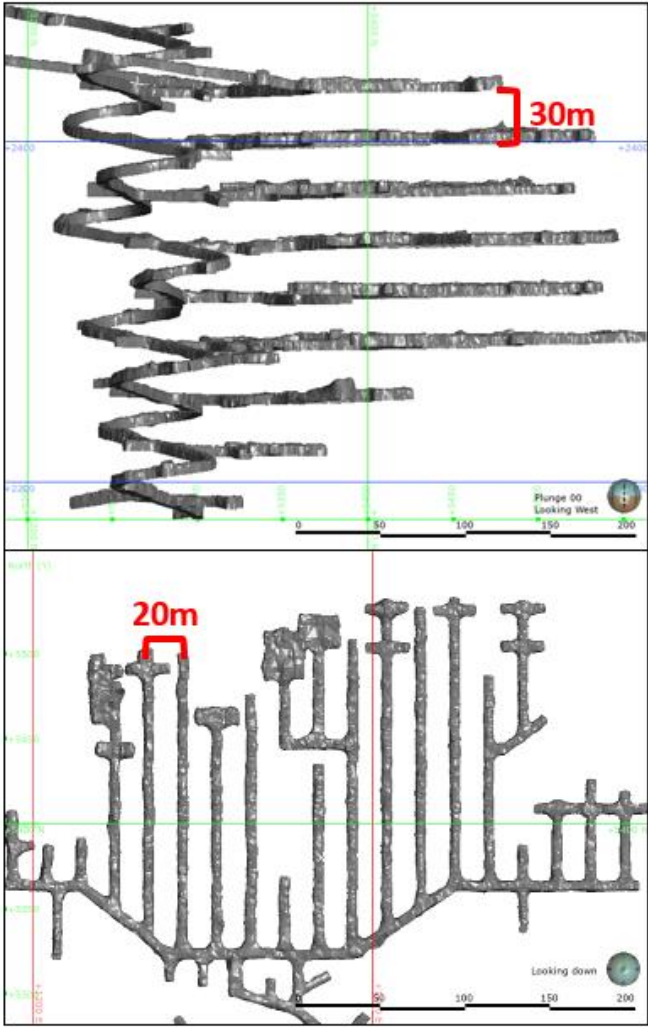
Core Shed

Didipio Au - Cu Mine

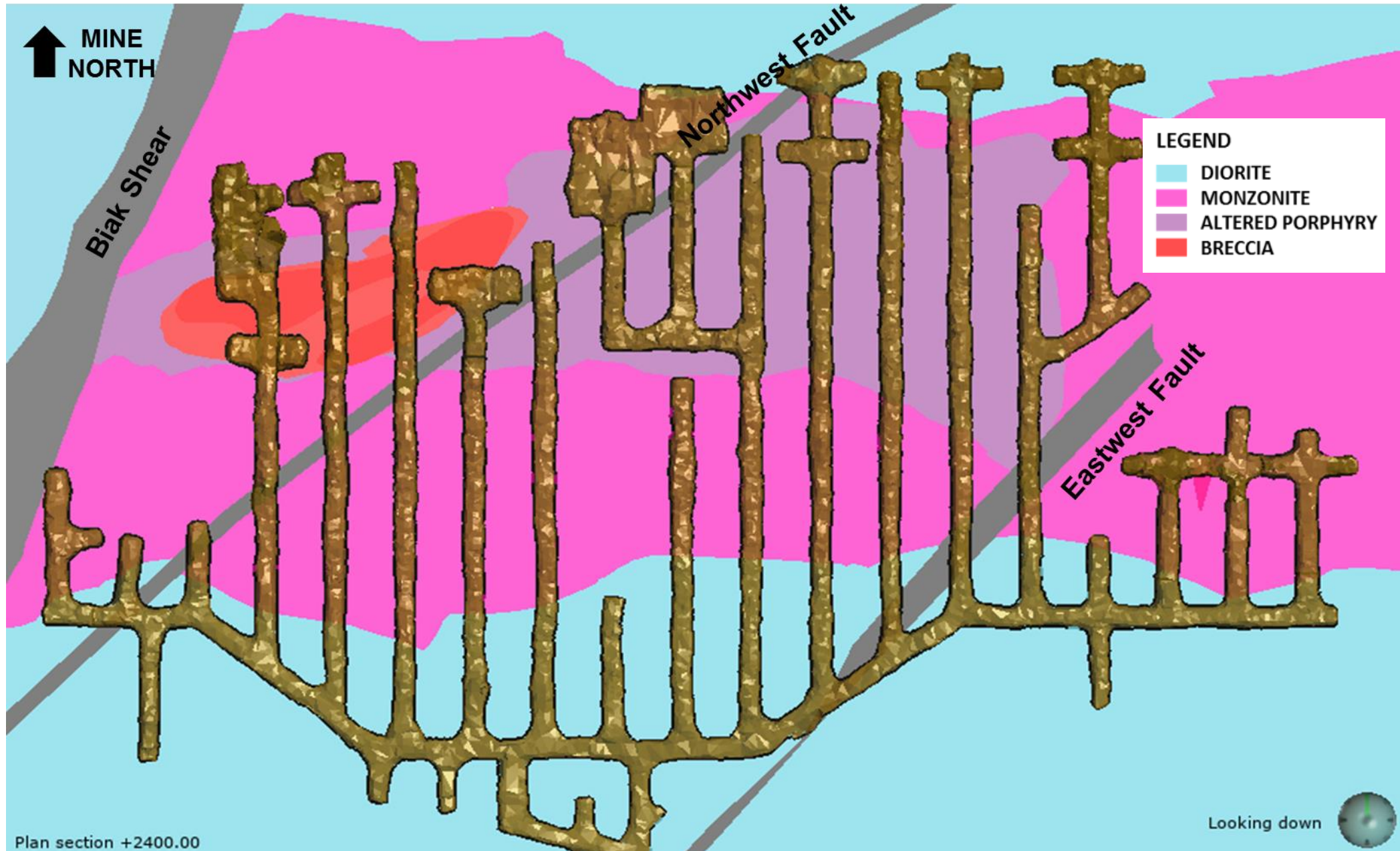
- Started open pit operations in 2013
- Completed open pit in May 2017
- Started underground development in 2015
- Started underground production in 2018
- Underground mining method is sub-level open stoping with paste backfill



Underground Development

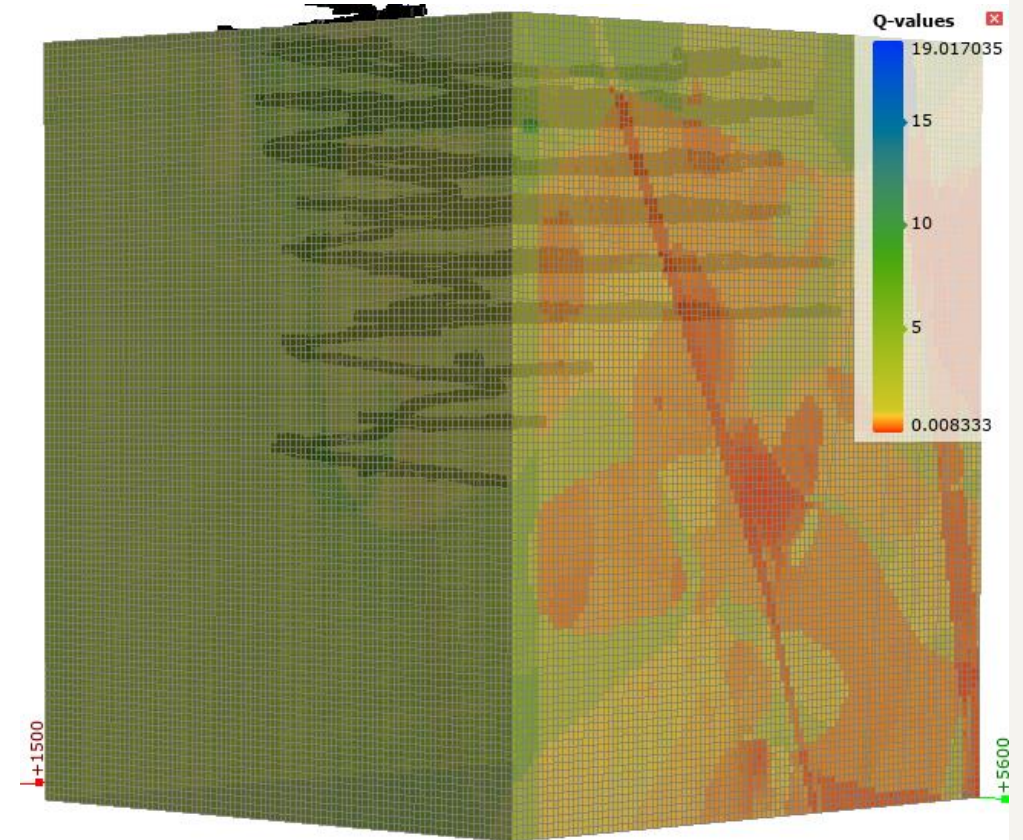


Didipio Underground



Purpose of the Model

- Predicting rock mass condition of planned developments:
 - Headings
 - Raises
 - Infrastructures
- Forecasting ground support requirements
- Optimize the traditional approach in estimating ground conditions for stopes



Q-SYSTEM

Q-System (Barton, 1974)

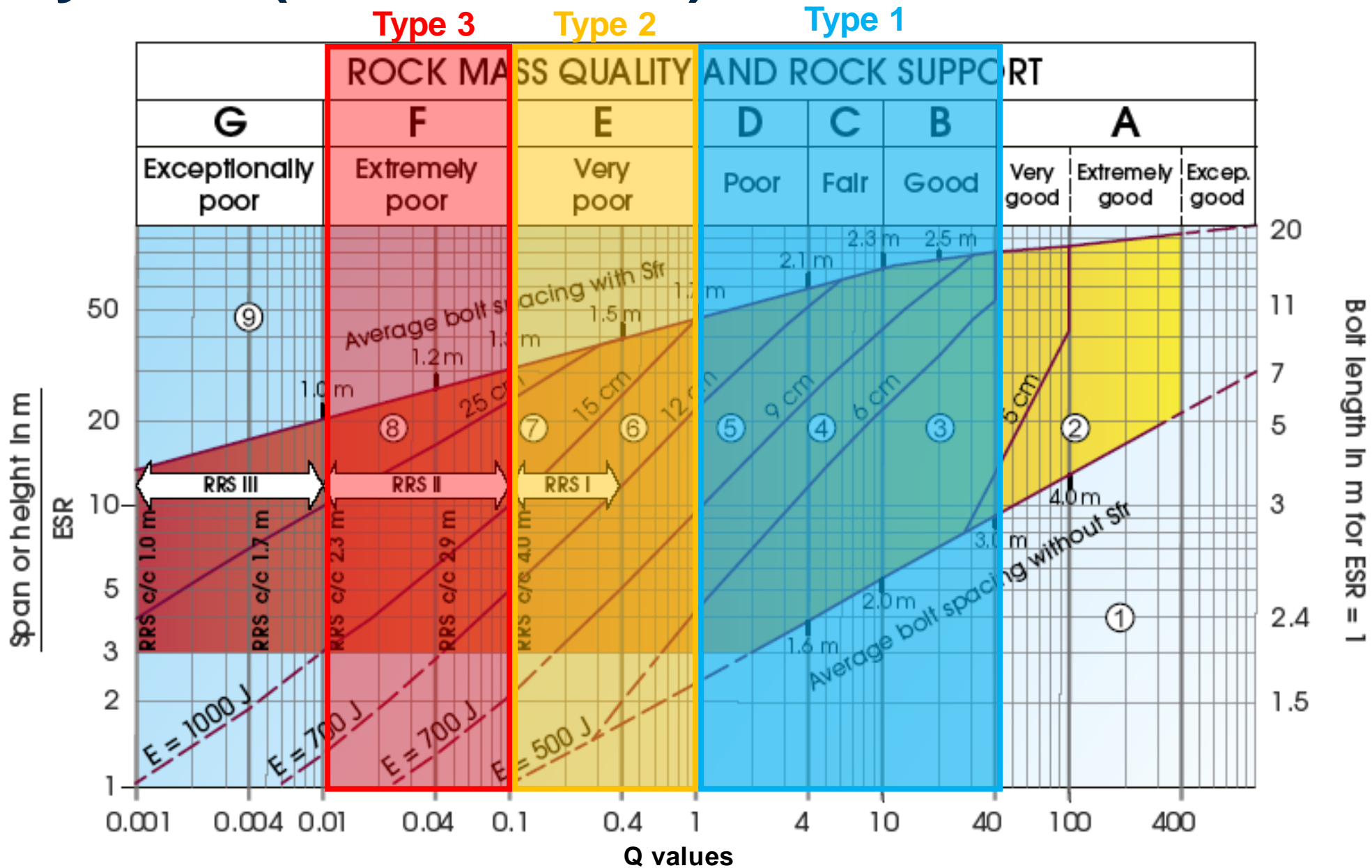
$$Q = \frac{RQD}{J_n} \times \frac{J_r}{J_a} \times \frac{J_w}{SRF}$$

Degree of Jointing Joint Friction Active Stress

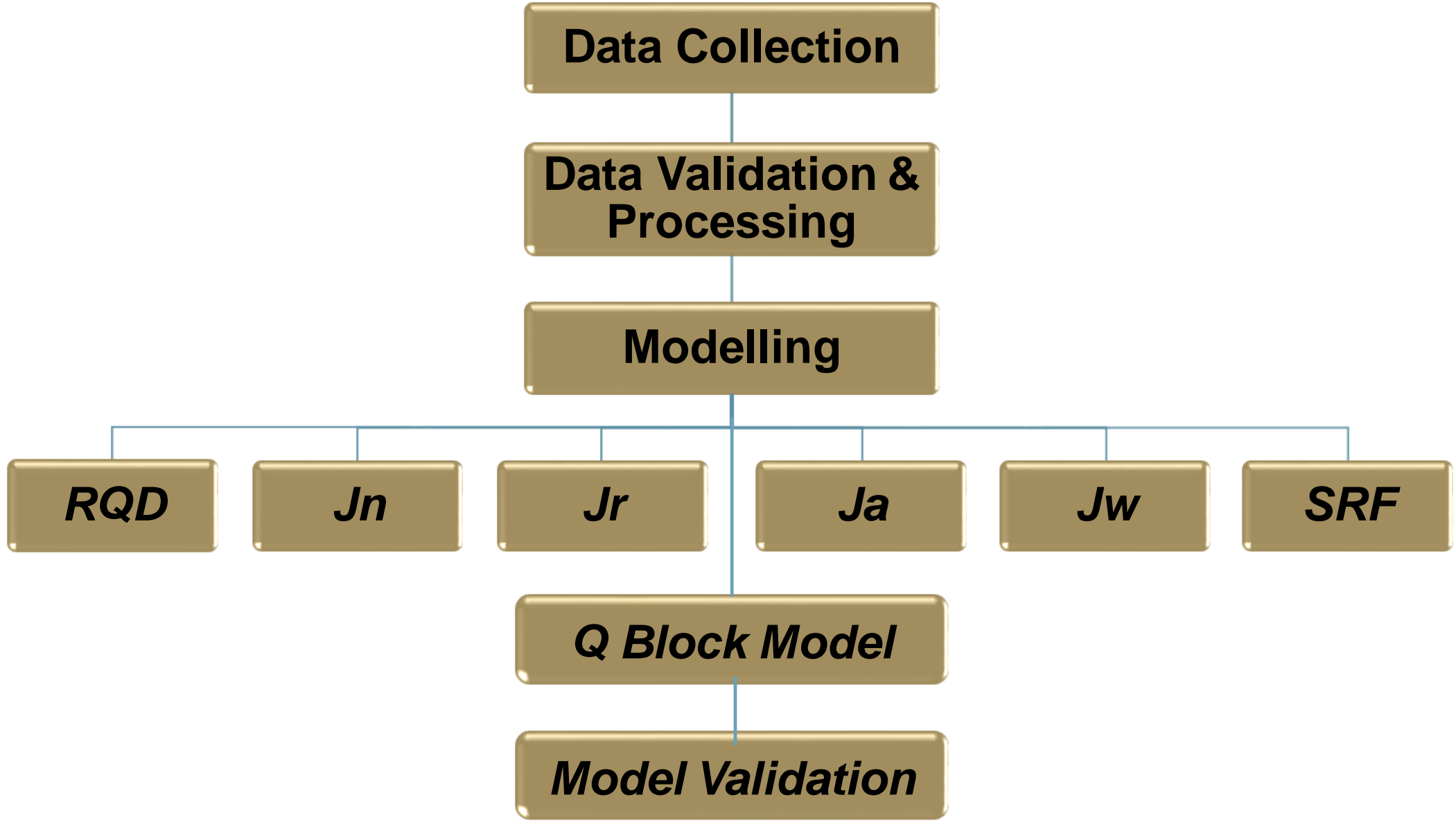
where:

- RQD = Rock Quality Designation
- J_n = Joint set number
- J_r = Joint roughness number
- J_a = Joint alteration number
- J_w = Joint water reduction factor
- SRF = Stress Reduction Factor

Q-System (Barton, 1974)

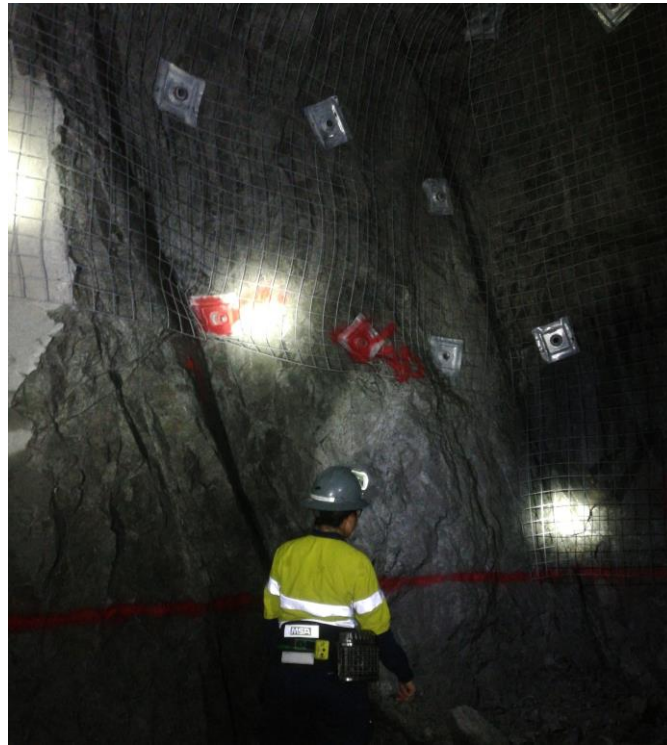


METHODOLOGY



Data Collection, Validation and Processing

1. Core logging – 342 drill holes (51,316 m)
2. Field mapping – 36 drives (4,648 m)
3. Inspection – 721 drive cuts

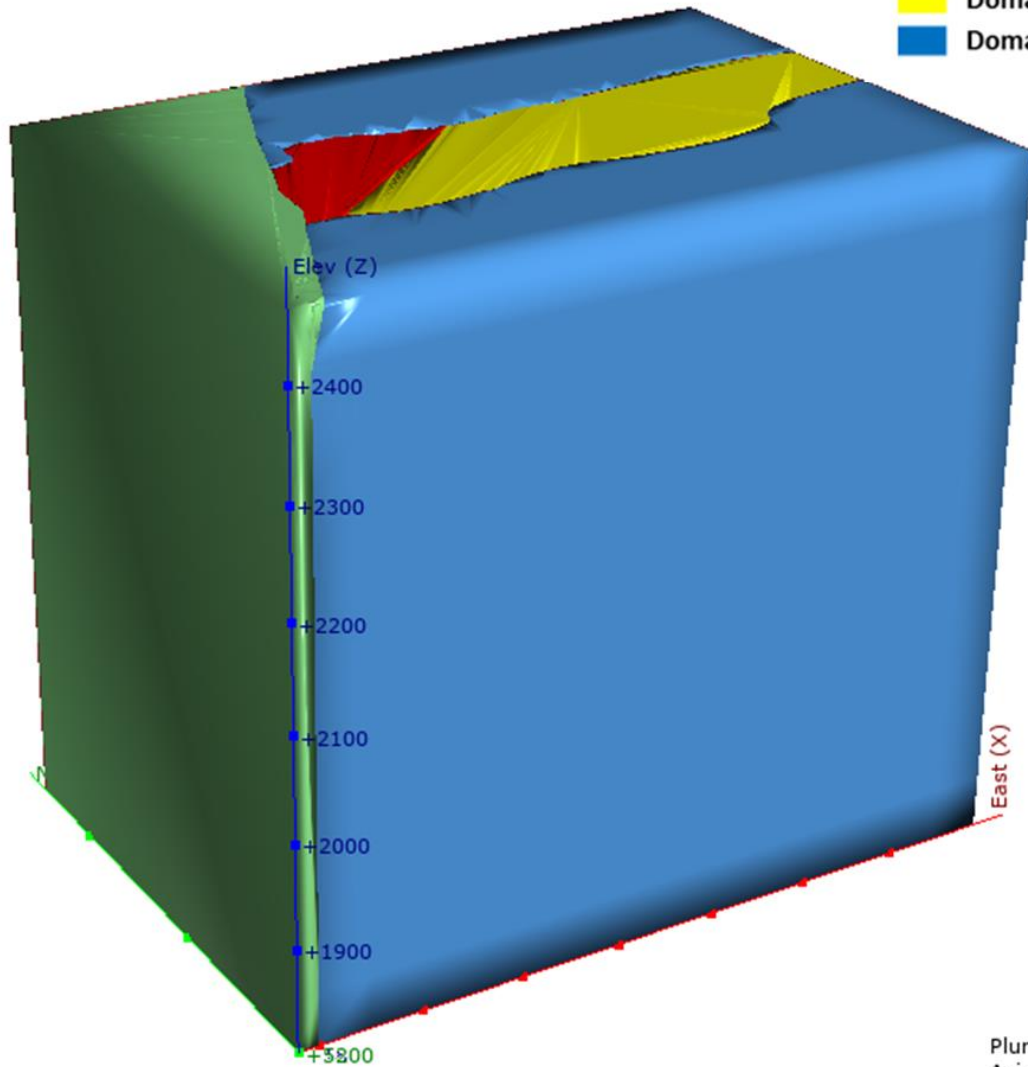


Modelling

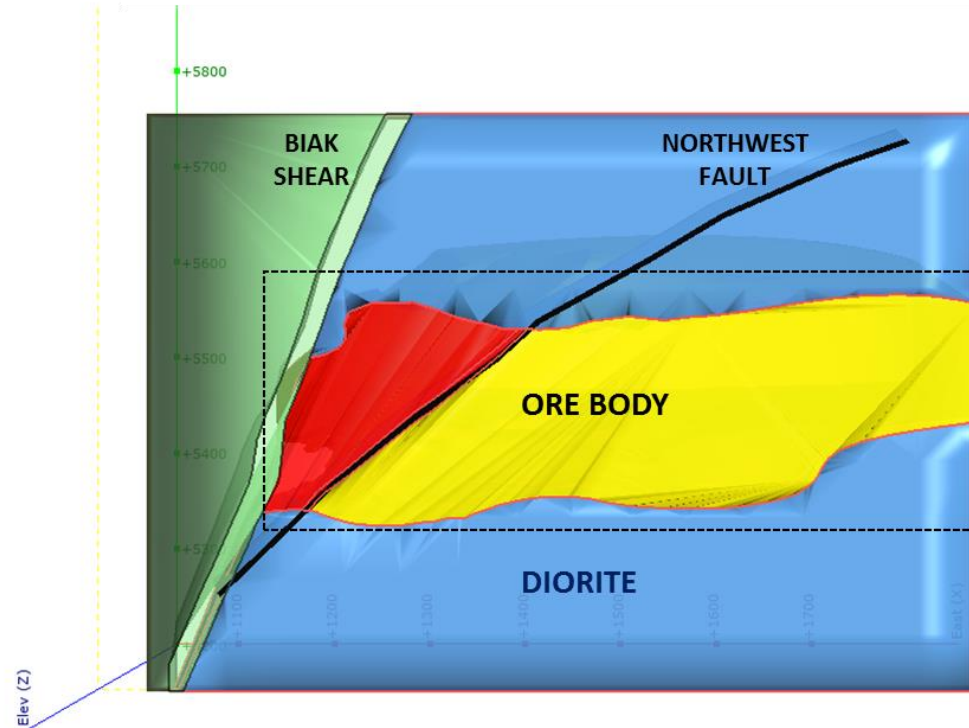
PARAMETER	CODE	MODELLING
Rock Quality Designation	RQD	Interpolation by Ordinary Kriging
Joint Set Number	Jn	Domained by Rating
Joint Roughness Number	Jr	Domained by Rating
Joint Alteration Number	Ja	Domained by Rating
Water Reduction Factor	Jw	Domained by Rating
Stress Reduction Factor	SRF	Domained by Rating

Rock Quality Designation (RQD)

- Domain 1
- Domain 2
- Domain 3
- Domain 4



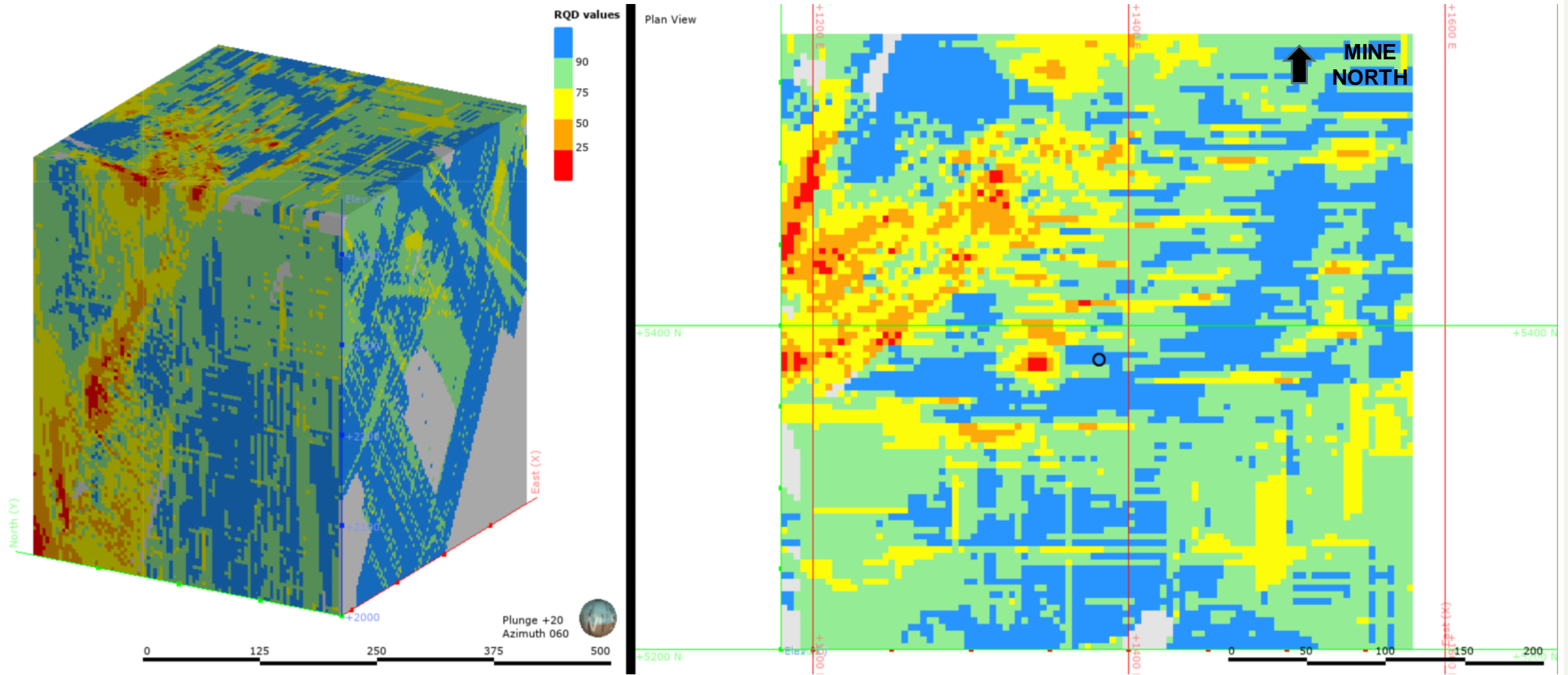
Domain	Area	RQD Values	Description
1	Biak Shear Zone	Poor RQD at Biak Shear	Sparse data
2	Ore body - West of Northwest Fault	0 – 50 %	Poor to very poor RQD value
3	Ore body - East of Northwest Fault	50 – 90 %	Fair to good RQD zone
4	North and south Diorite bodies	> 90 %	Excellent RQD zone



Plunge +25
Azimuth 030



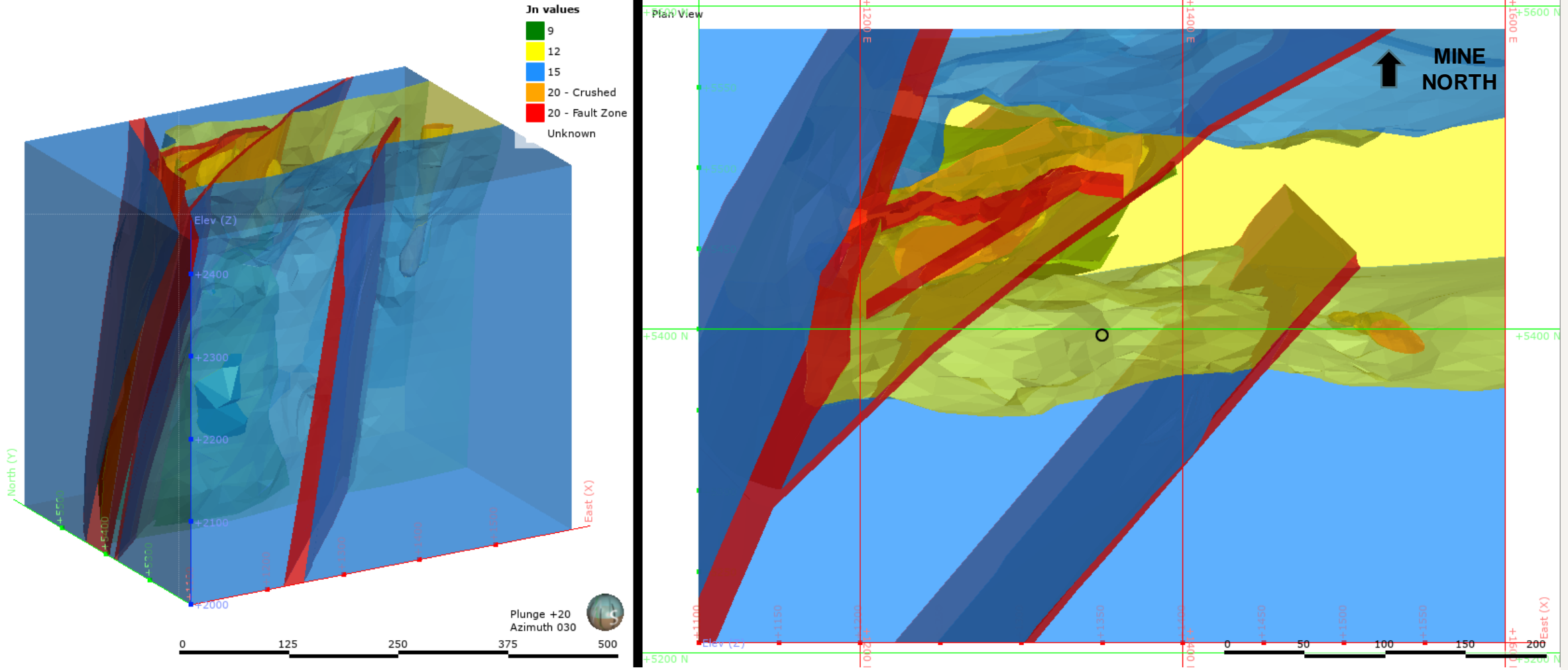
RQD Model



Joint Set Number (J_n)

Domain	Jn Value	Description	Lithology
1	9	3 joint sets	Balut Dyke and Bufu Syenite
2	12	3 joint sets + random joints	Monzonite body and Altered Porphyry
3	15	4 joint sets	North and south Diorite bodies
4	20	Crushed	Breccia (QBX + MBX)
5	20	Fault Zones	Biak Shear Zone, TJM Fault, 270-G Shear, Northwest Fault and Eastwest Fault

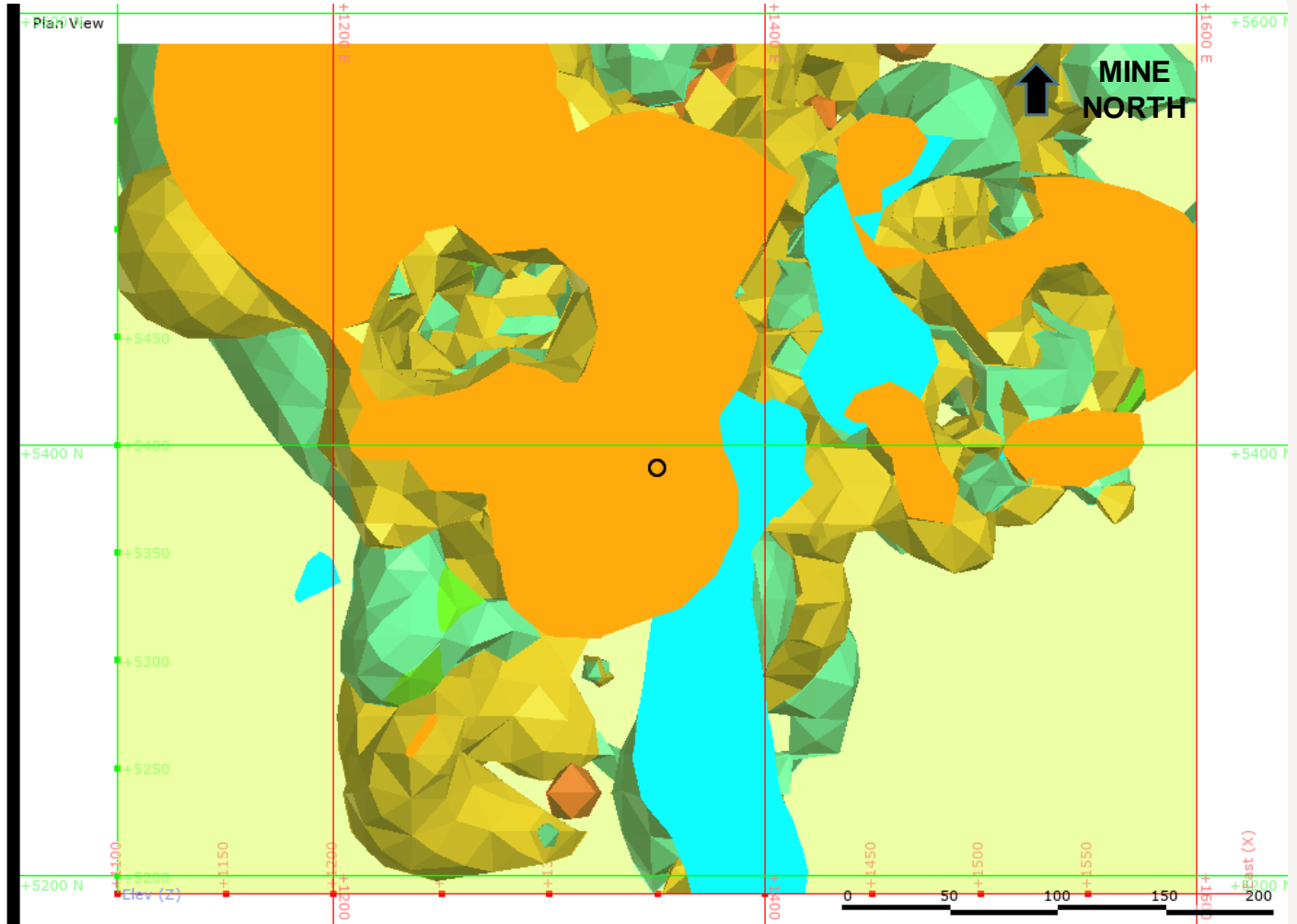
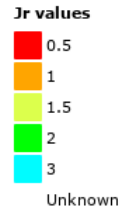
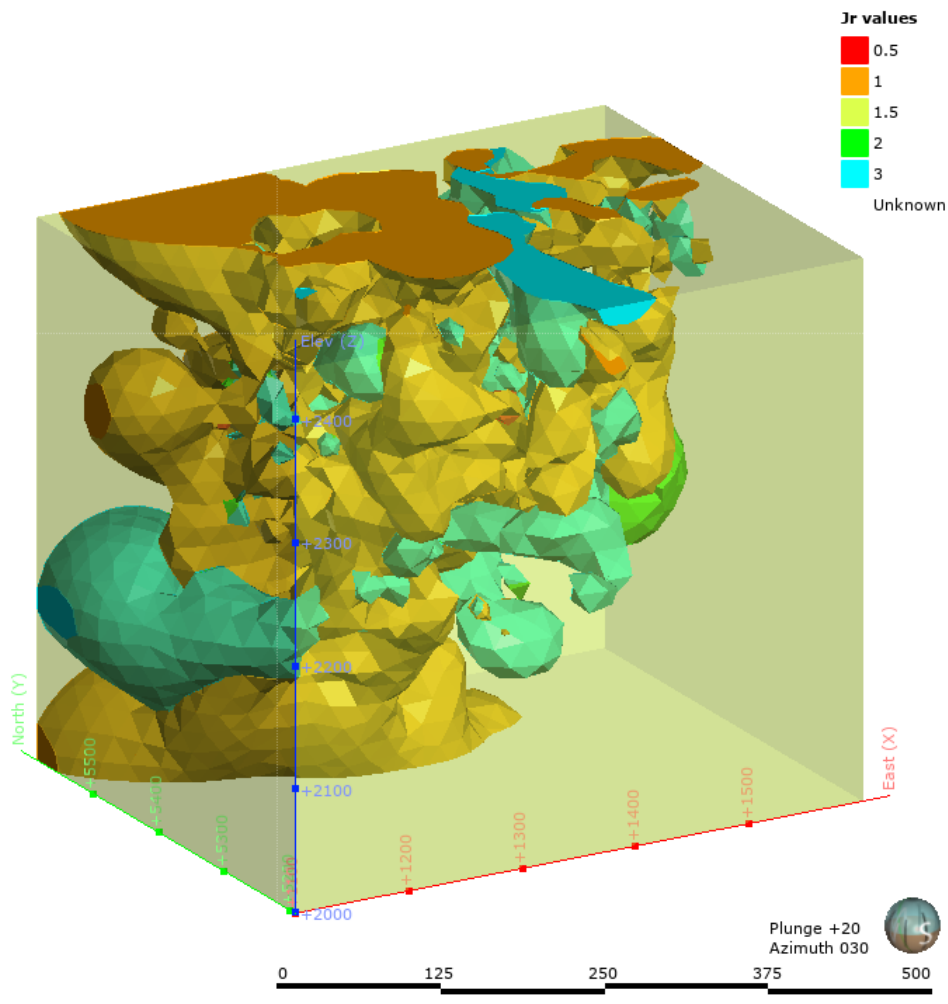
J_n Model



Joint Roughness (J_r)

Domain	Jr values	Description
1	0.5	Planar - Slickensided
2	1	Planar - Smooth
		Zone containing thick clay
3	1.5	Undulating - Slickensided
		Planar - Rough
4	2	Undulating - Smooth
5	3	Undulating - Rough
		Undulating - Stepped

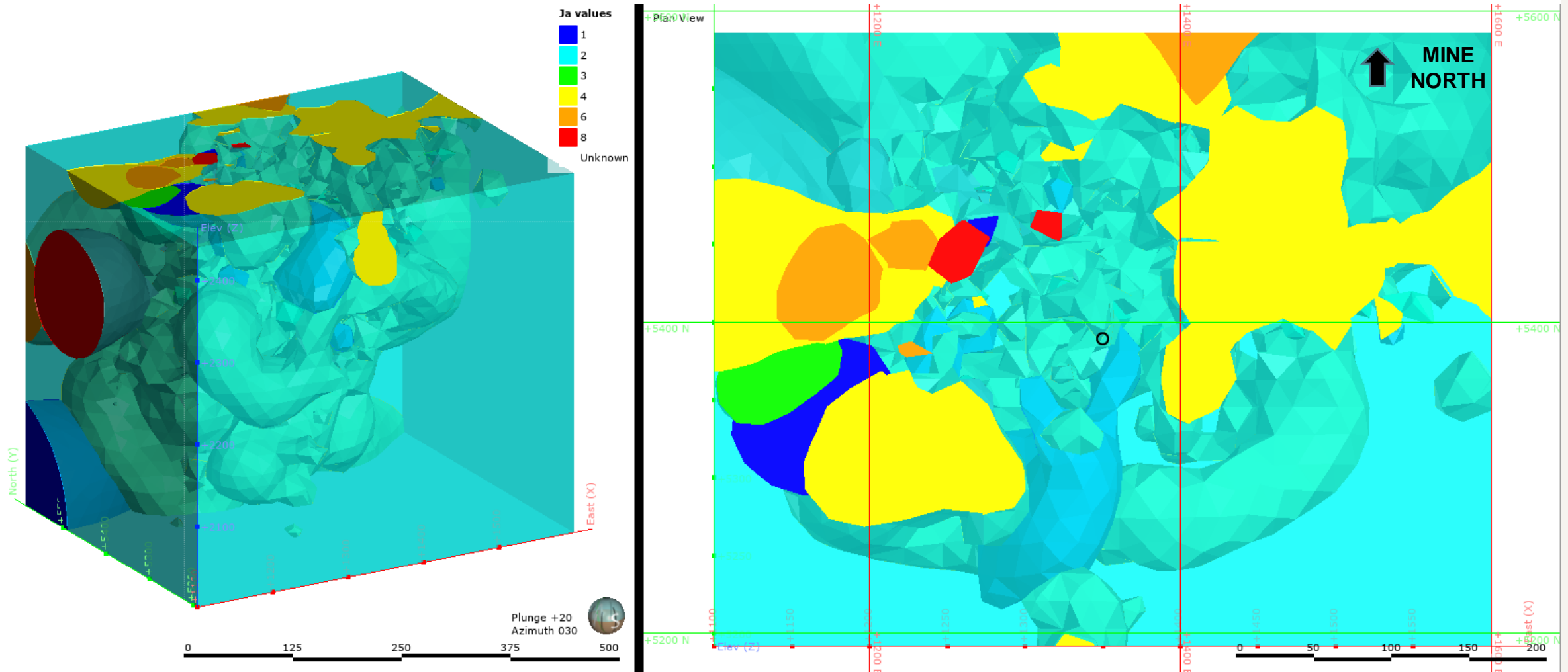
J_r Model



Joint Alteration (J_a)

Domain	Ja Value	Description
1	1	No infill, mineral coatings
2	2	Quartz infill, < 1mm sulphide, orthoclase, carbonates
3	3	<1mm sand and rock fragments
4	4	<1mm clay, and 1-5 mm carbonates, sulphide, orthoclase, sand
5	6	1-5 mm clay and >5mm carbonates
6	8	>5mm clay

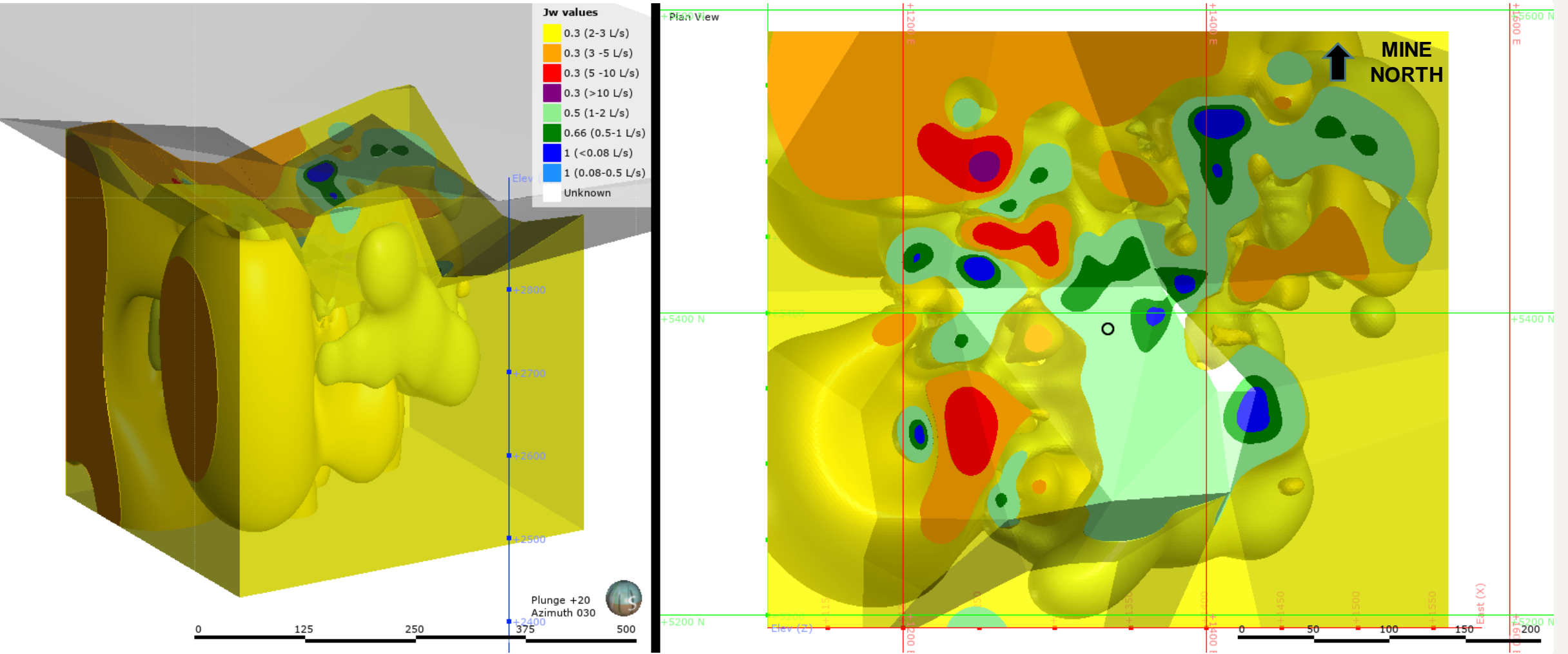
J_a Model



Joint Water Reduction Factor (J_w)

Domain	Jw Value	Description	Didipio Flow Rate
1	1	Dry excavations or minor inflow (humid or a few drips)	< 0.08 L/s
	1		0.08 – 0.5 L/s
2	0.66	Medium inflow, occasional outwash of joint fillings	0.5 – 1.0 L/s
3	0.5	Jet inflow or high pressure	1.0 – 2.0 L/s
4	0.3	Large inflow or high pressure	2.0 – 3.0 L/s
5	0.3	Exceptional high inflow or water pressure decaying with time	3.0 – 5.0 L/s
6	0.3	Exceptional high inflow or water pressure continuing without noticeable decay	5.0 – 10.0 L/s
	0.3		>10.0 L/s

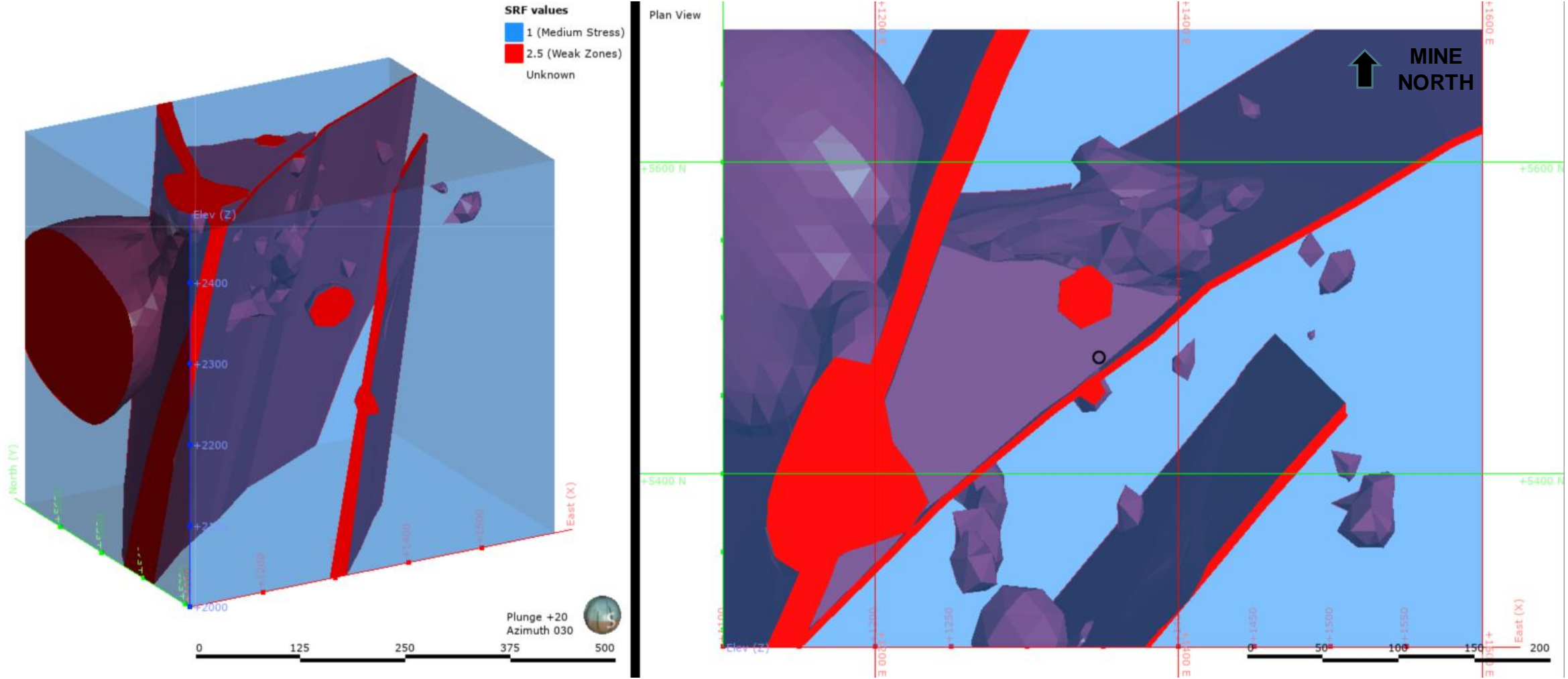
J_w Model



Stress Reduction Factor (SRF)

Domain	SRF Value	Description
1	1	Medium Stress
2	2.5	Weak Zones (Biak Shear Zone, Northwest Fault, Eastwest Fault and Biak-NW-Diorite Triangle)

SRF Model



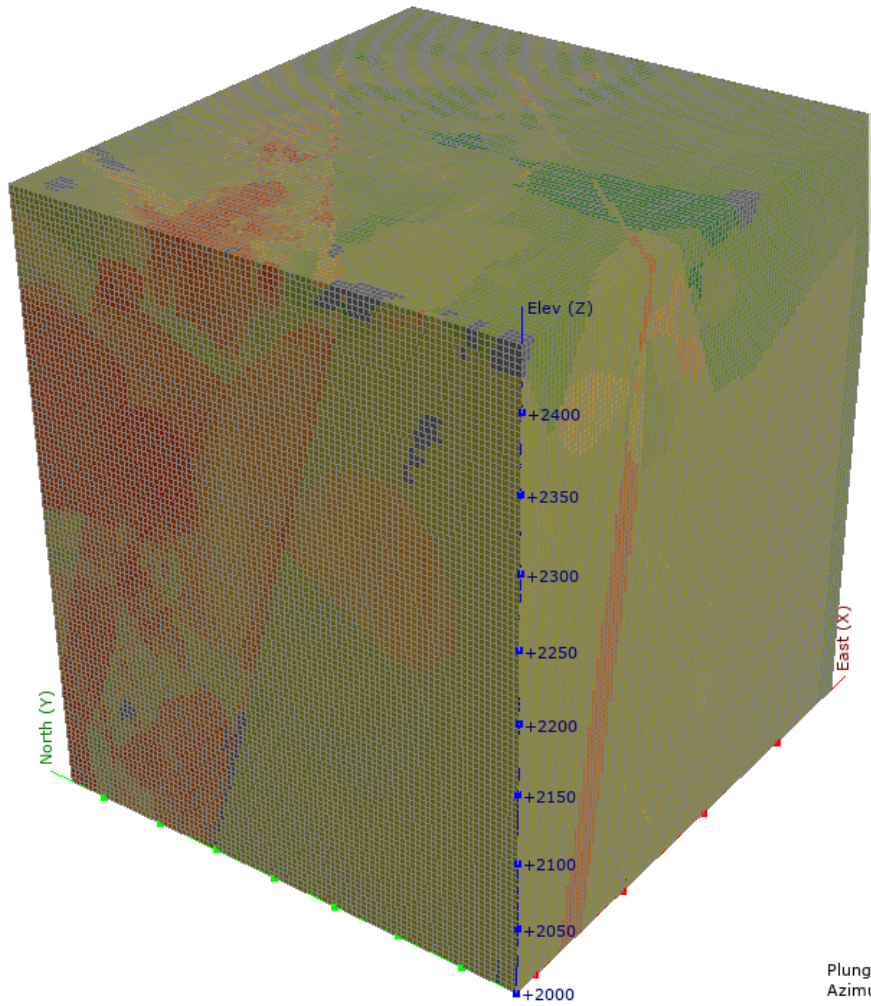
Q Block Model

Q Parameters	Values
RQD	10 – 100
J_n	9 – 20
J_r	1 – 8
J_a	0.5 – 3
J_w	0.3 – 1
SRF	1 – 2.5

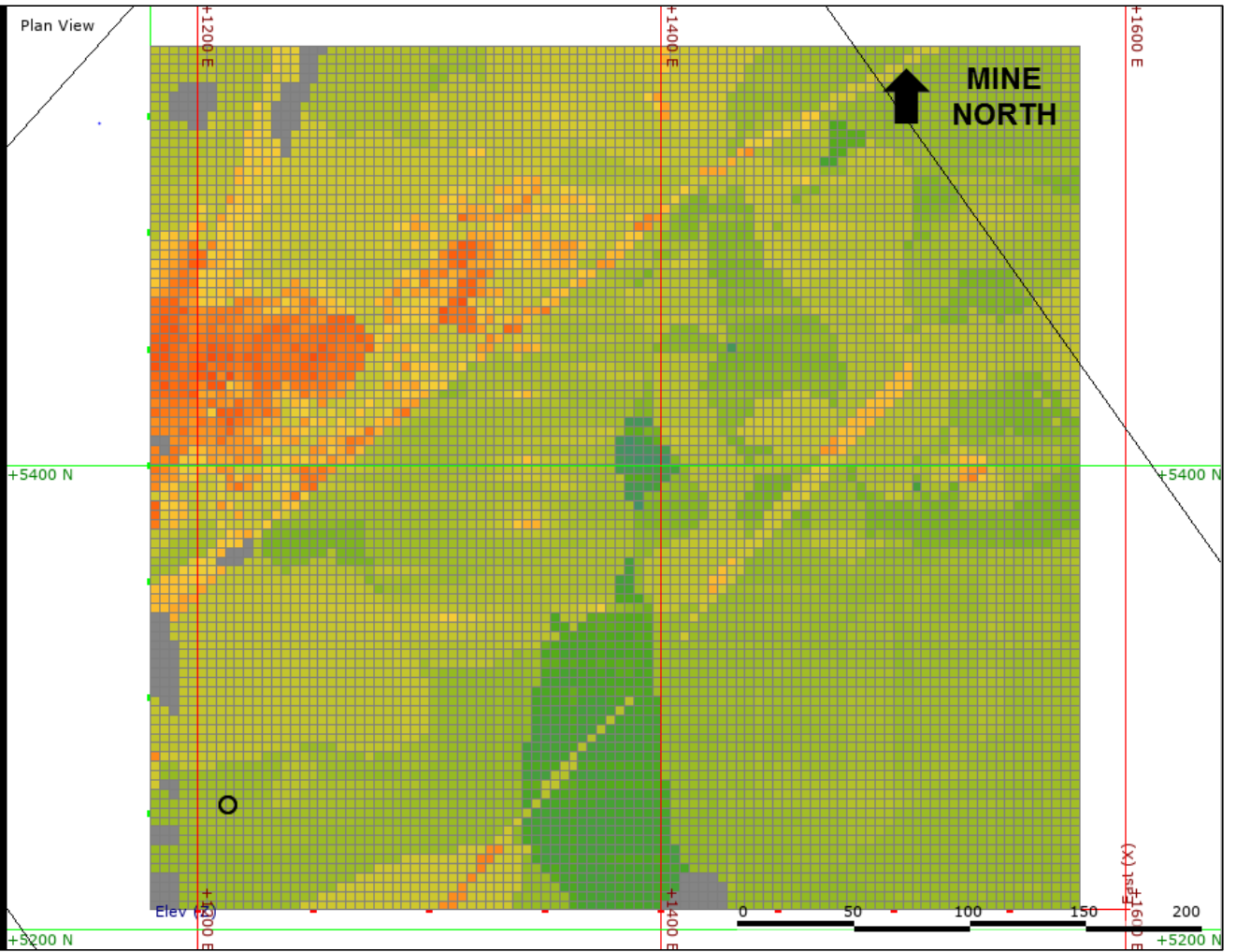


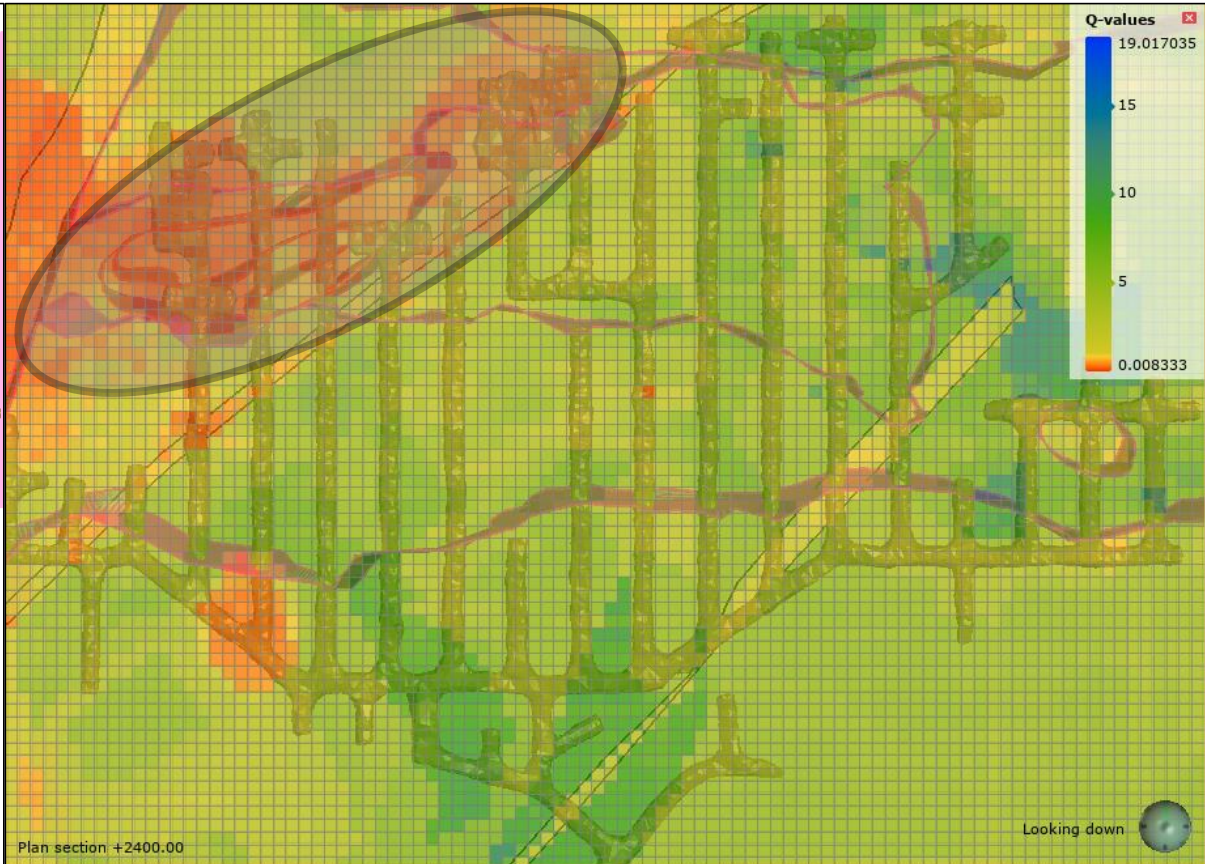
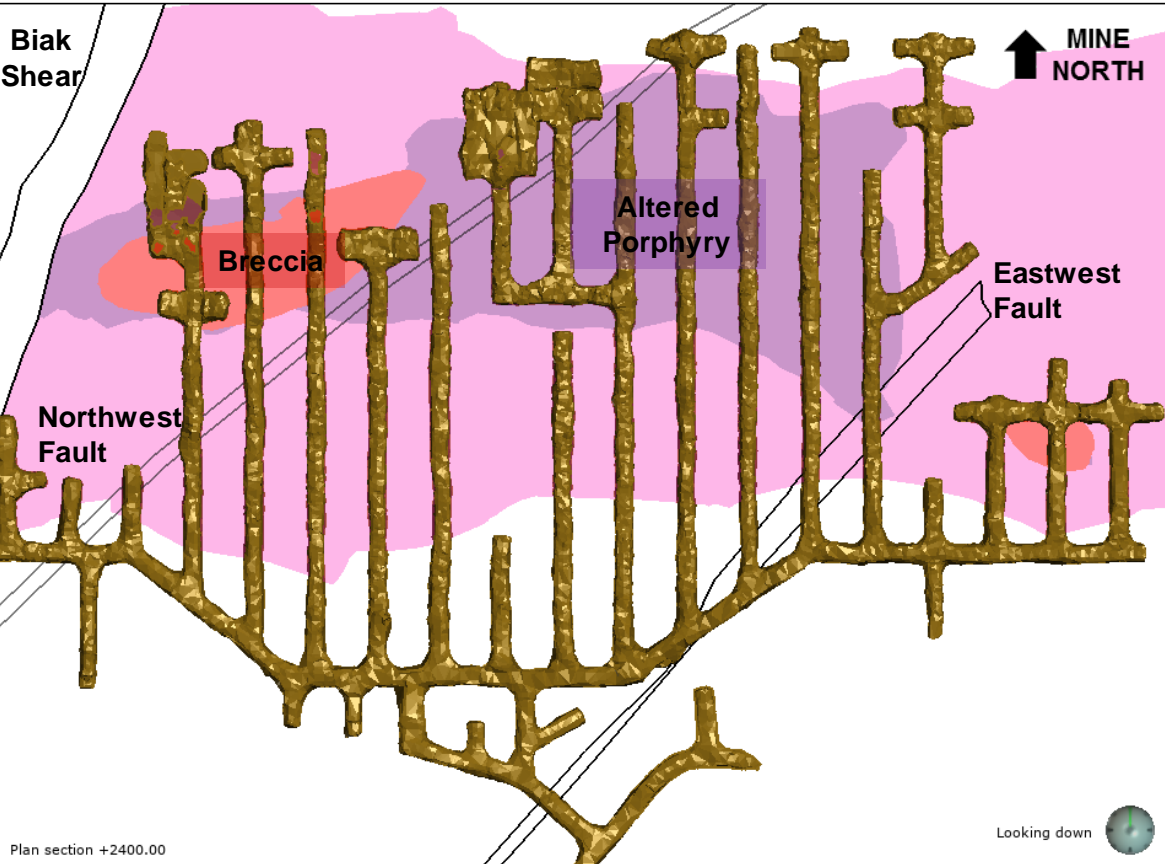
$$Q = \frac{RQD}{J_n} \times \frac{J_r}{J_a} \times \frac{J_w}{SRF}$$

Q Block Model



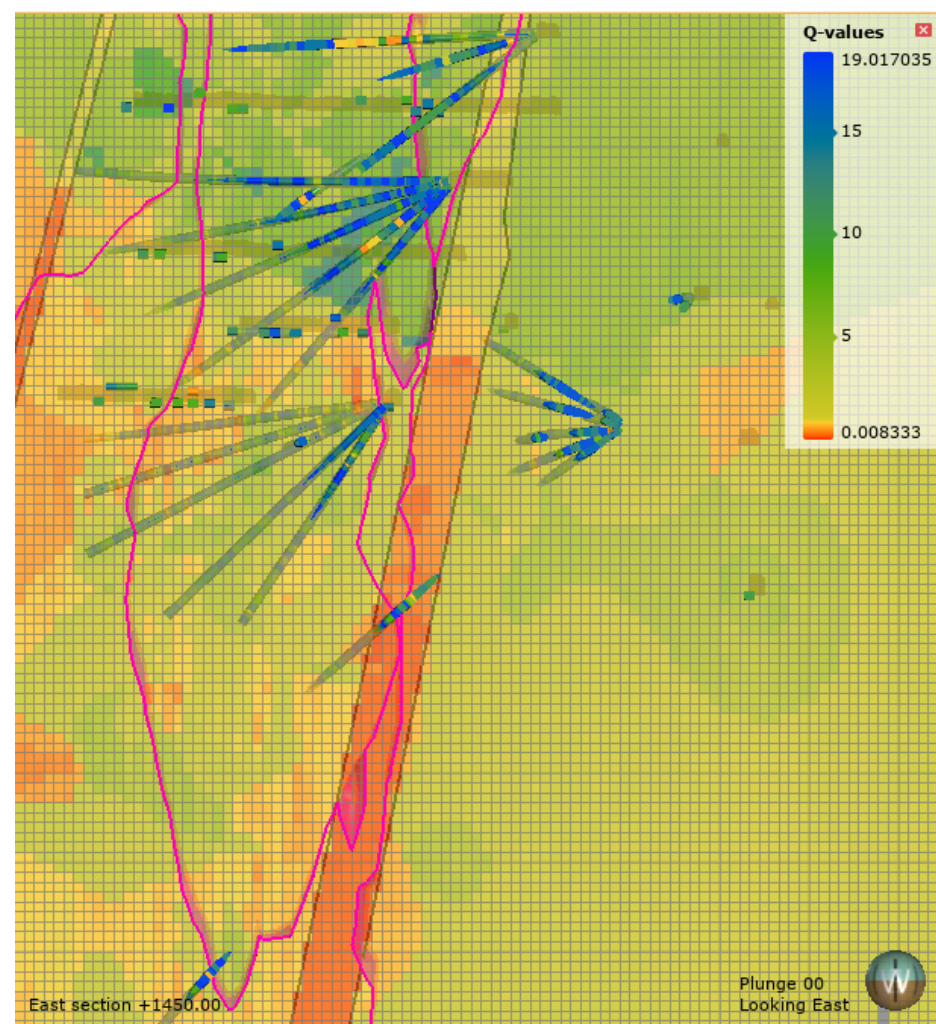
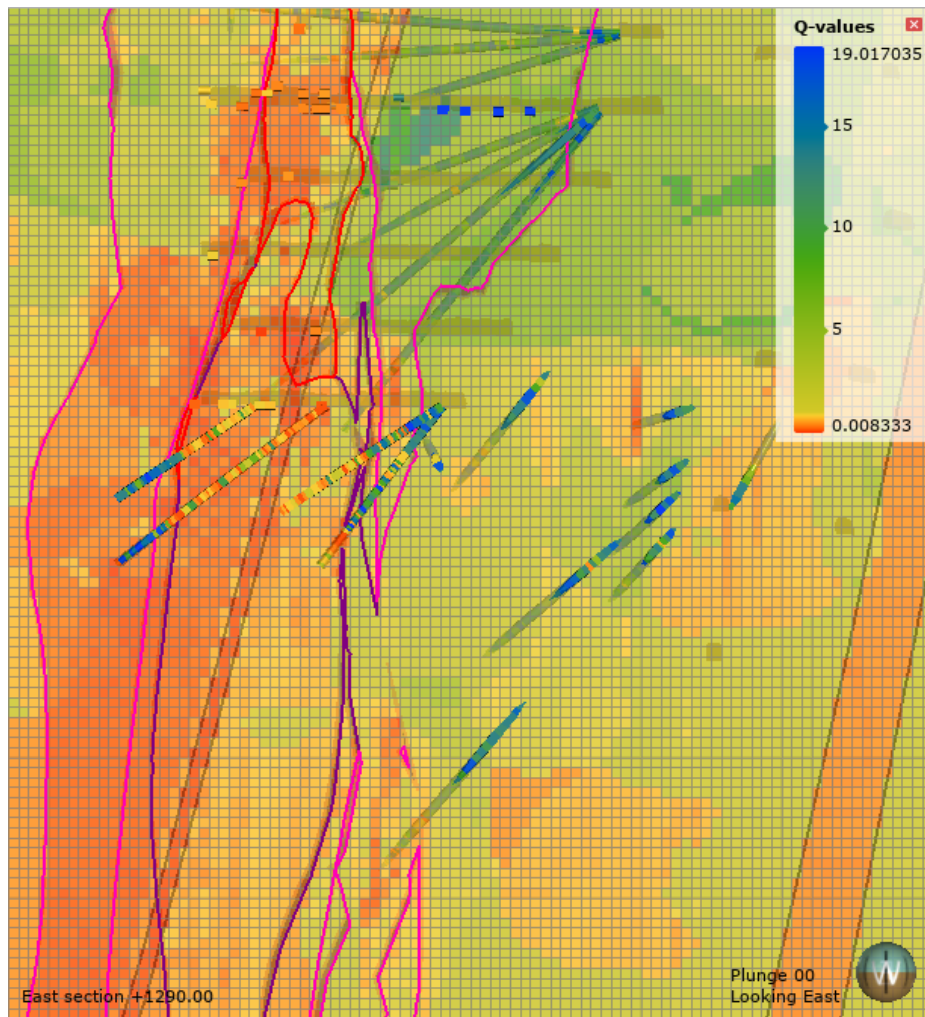
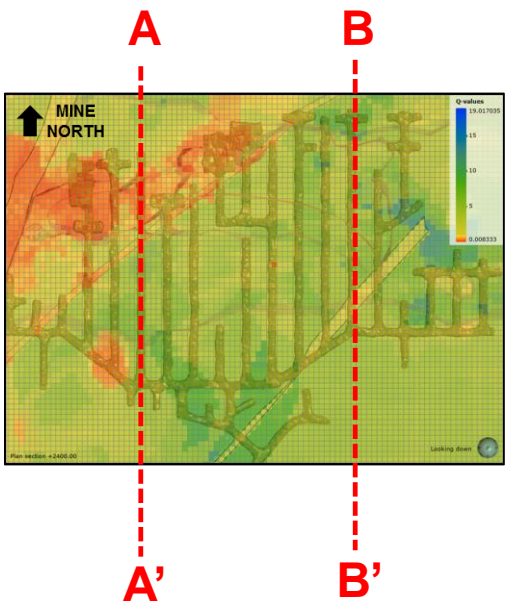
Plunge +30
Azimuth 055



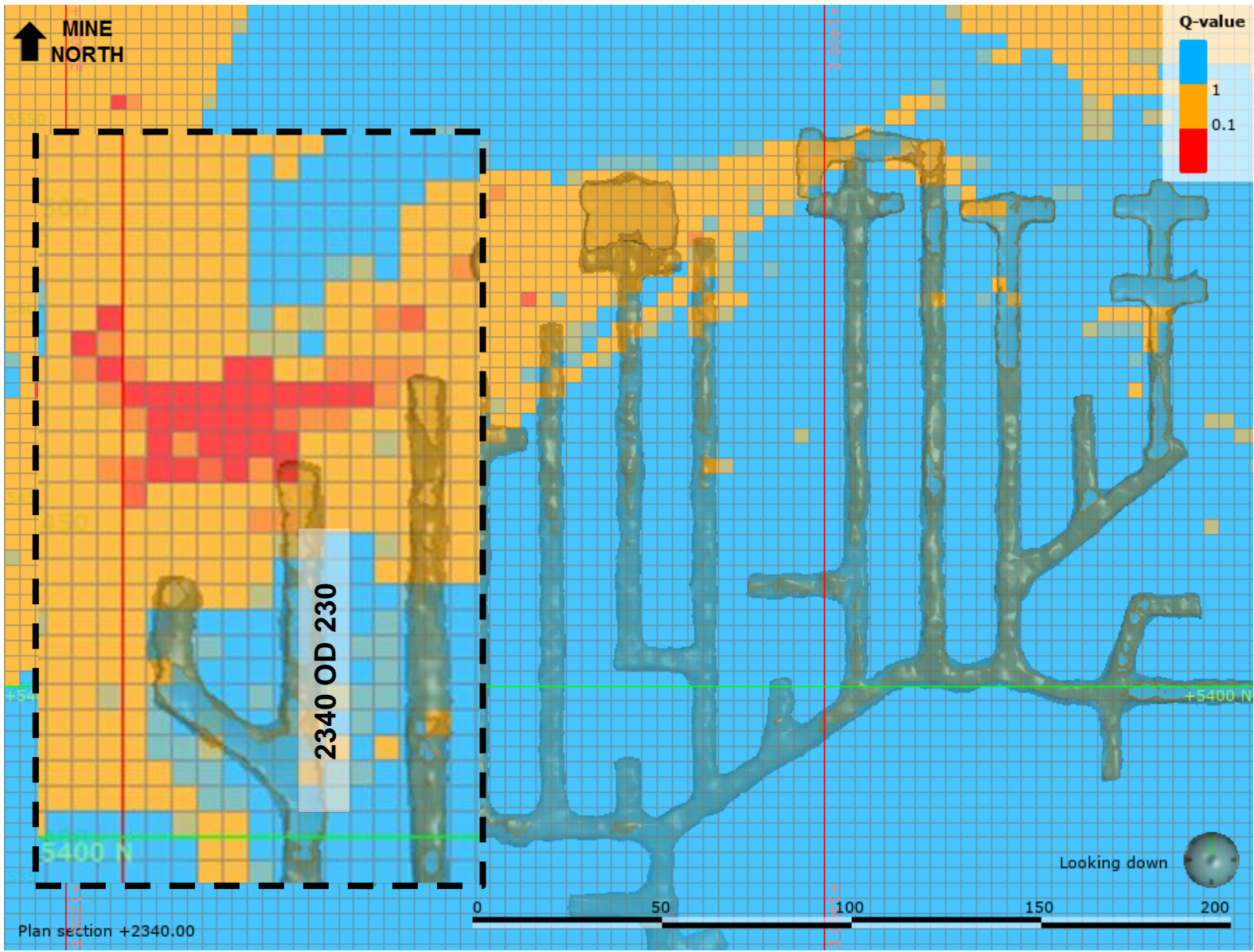


Section A-A'

Section B-B'



Development



Ground Type	Q-values
1	> 1
2	0.1 - 1
3	< 0.1

Development



April 30, 2019 Inspection

INSPECTED BY	JID / EB
DATE AND TIME	April 30, 2019 / 09:38 am
LOCATION	2340 OD 230
CURRENT ACTIVITY	NONE
GSS CODE	TYPE30_FB240_WMFC_SPLCB
GROUND CONDITIONS	<input type="checkbox"/> Type 1 <input type="checkbox"/> Type 2 <input checked="" type="checkbox"/> Type 3
FACE & WALLS SCALED	Yes
WATER FLOW	Damp
LITHOLOGY	<input type="checkbox"/> DIORITE <input type="checkbox"/> MONZ <input checked="" type="checkbox"/> BRECCIA

Notes:

Photo shows the current face of **2340 OD 230**

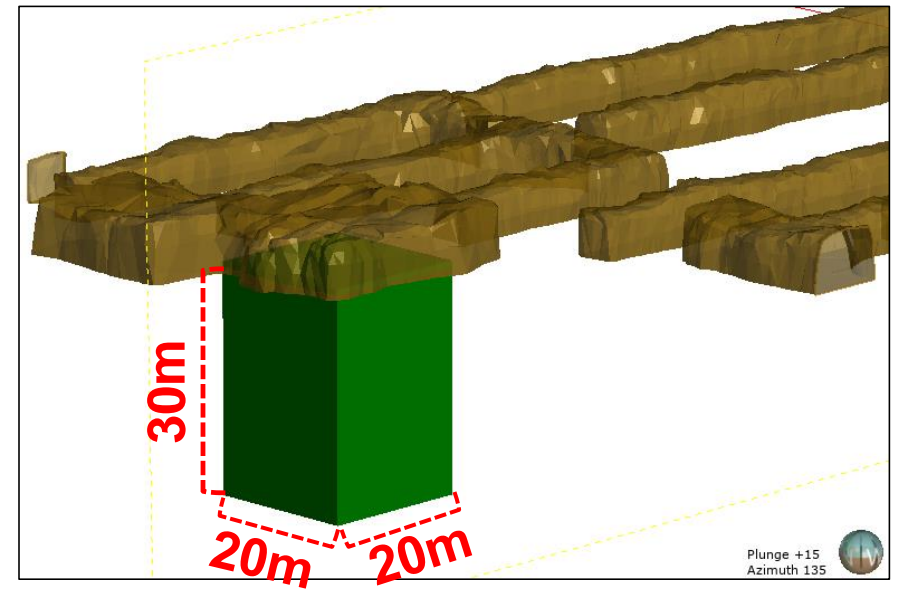
- **Type 3 Quartz Breccia** with an estimated **Q value of 0.1**

- Crumbly clay, slickensided joints and irregular back with an overbreak observed on the LHSW, due to the contact of altd. porphyry and breccia. with impact of **270 G Shear.**

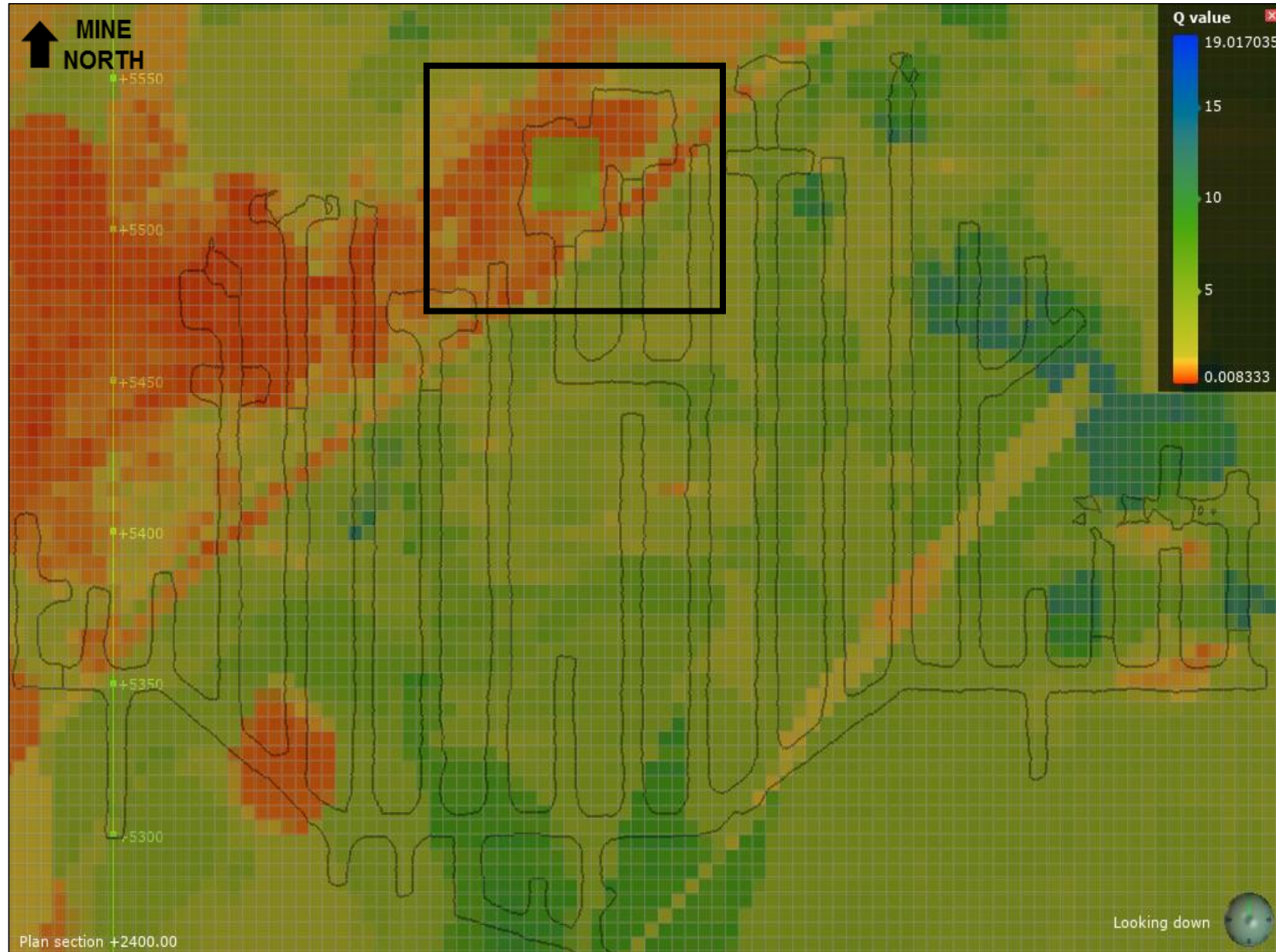
- The next cut will intersect the 270G Shear expect the ground to be worse.

- **Spray 100mm thick fibercrete with 3 wiremesh crosswise, 19 spilling bolts use 3.0m length and 13 friction bolts per ring.**

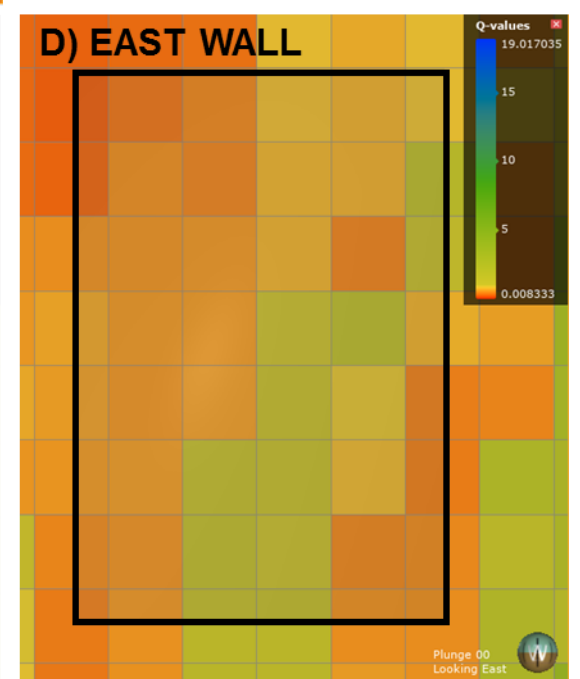
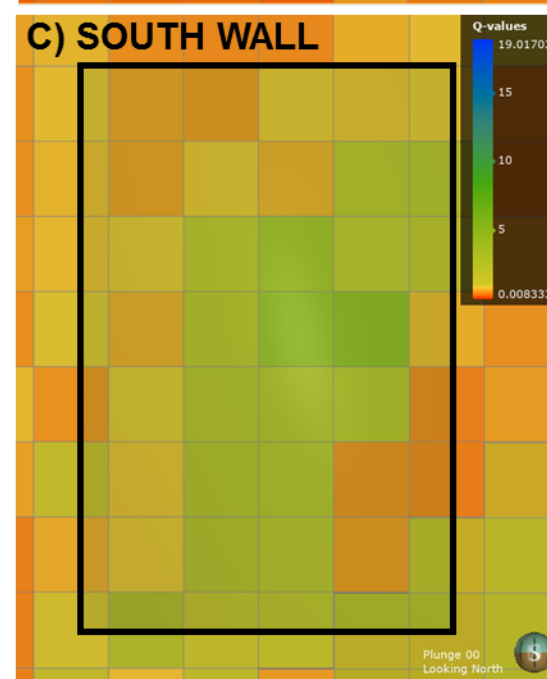
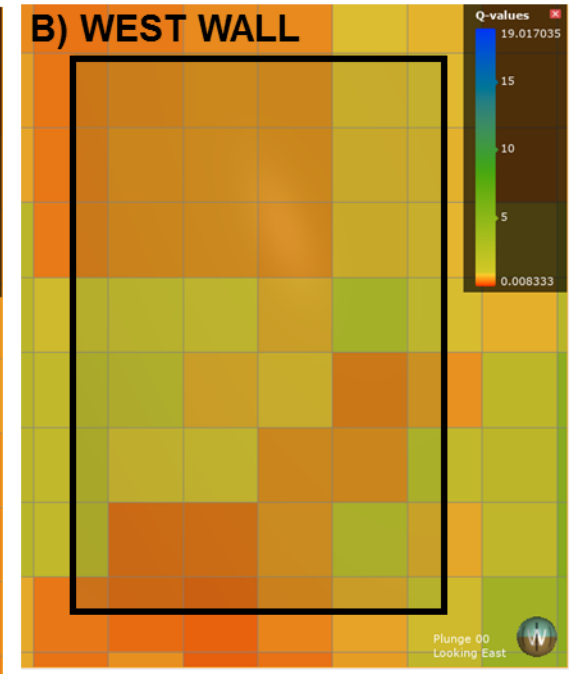
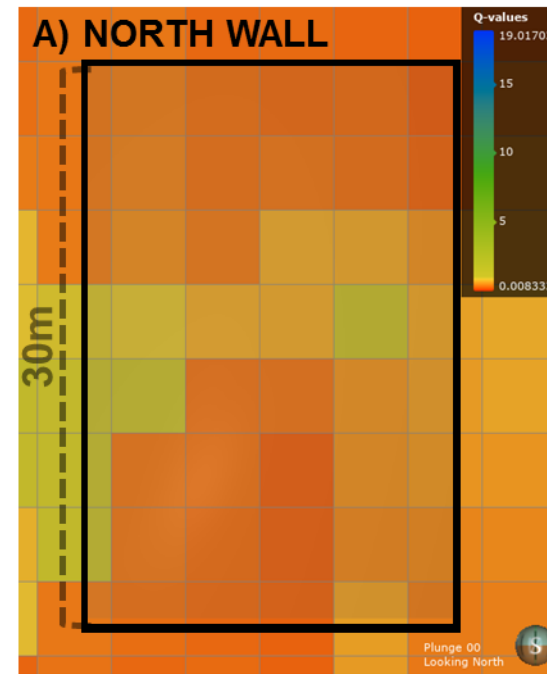
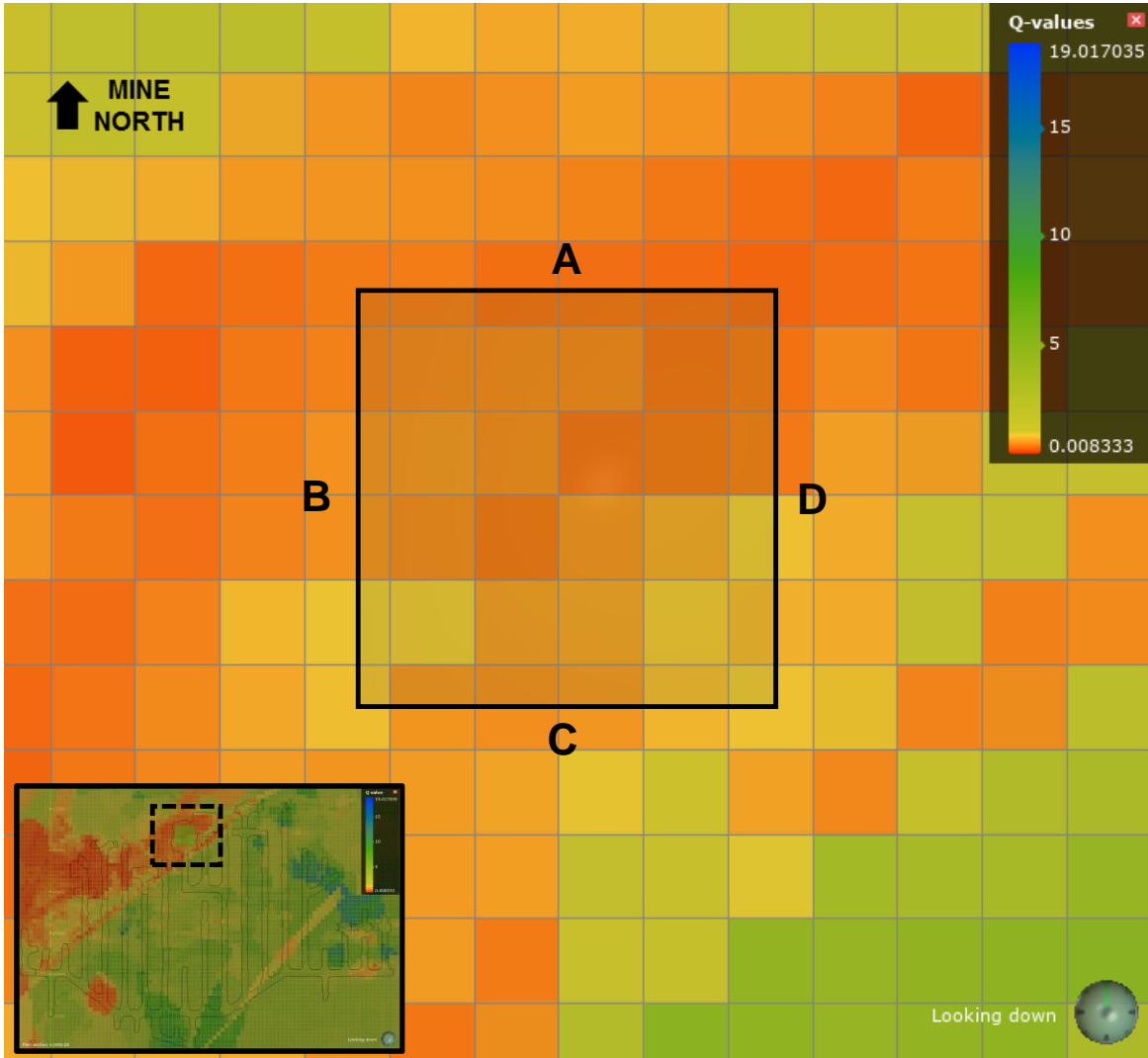
Production



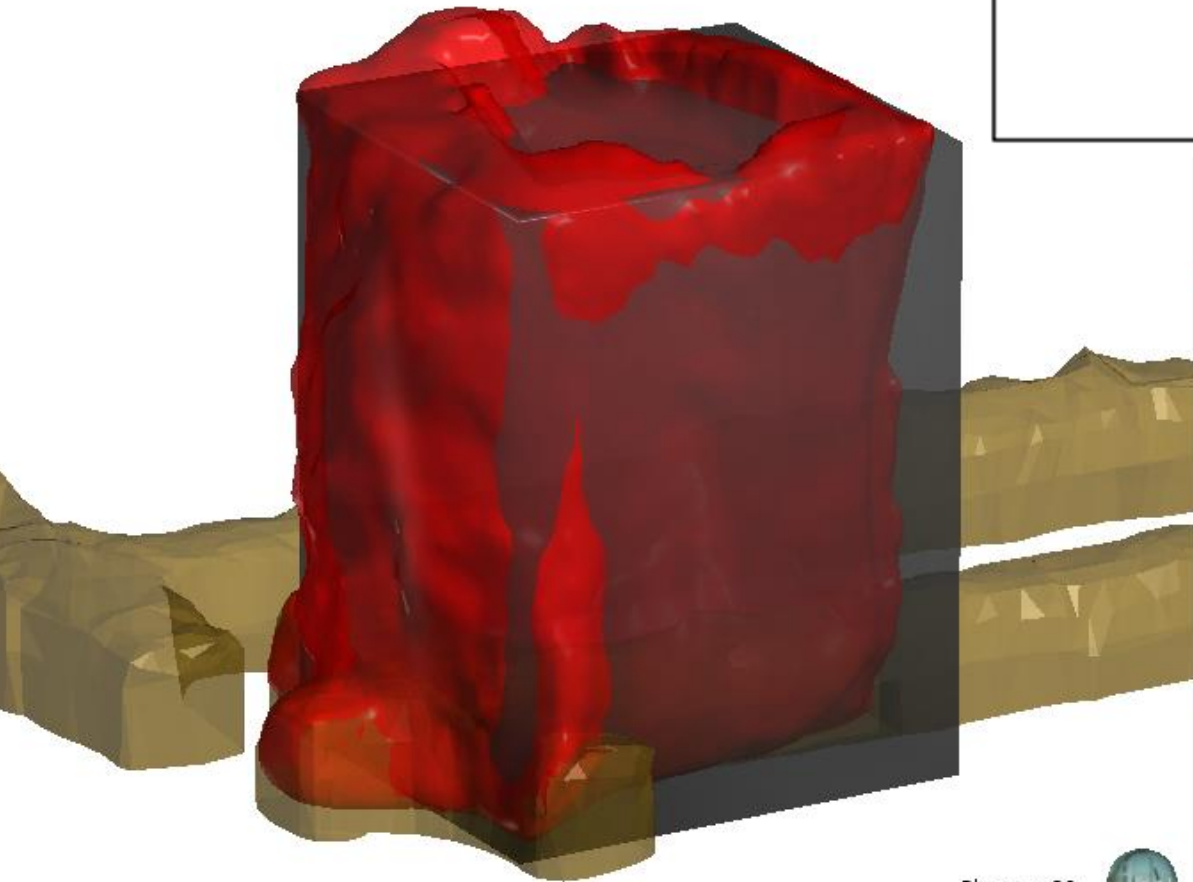
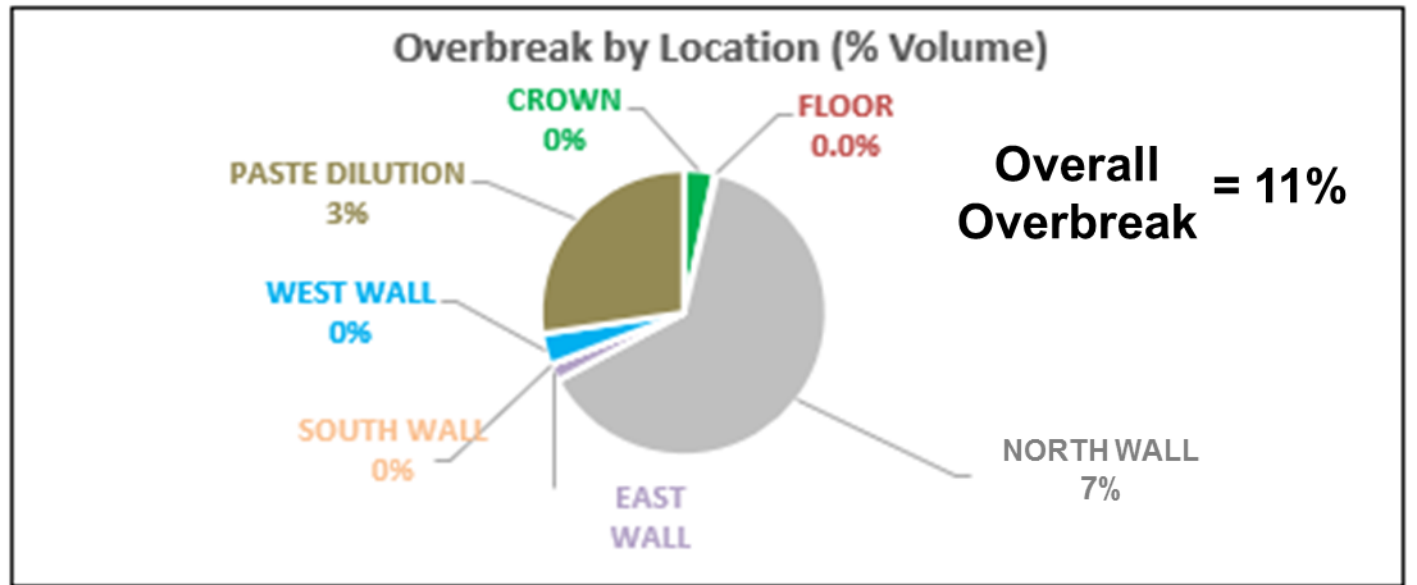
Production



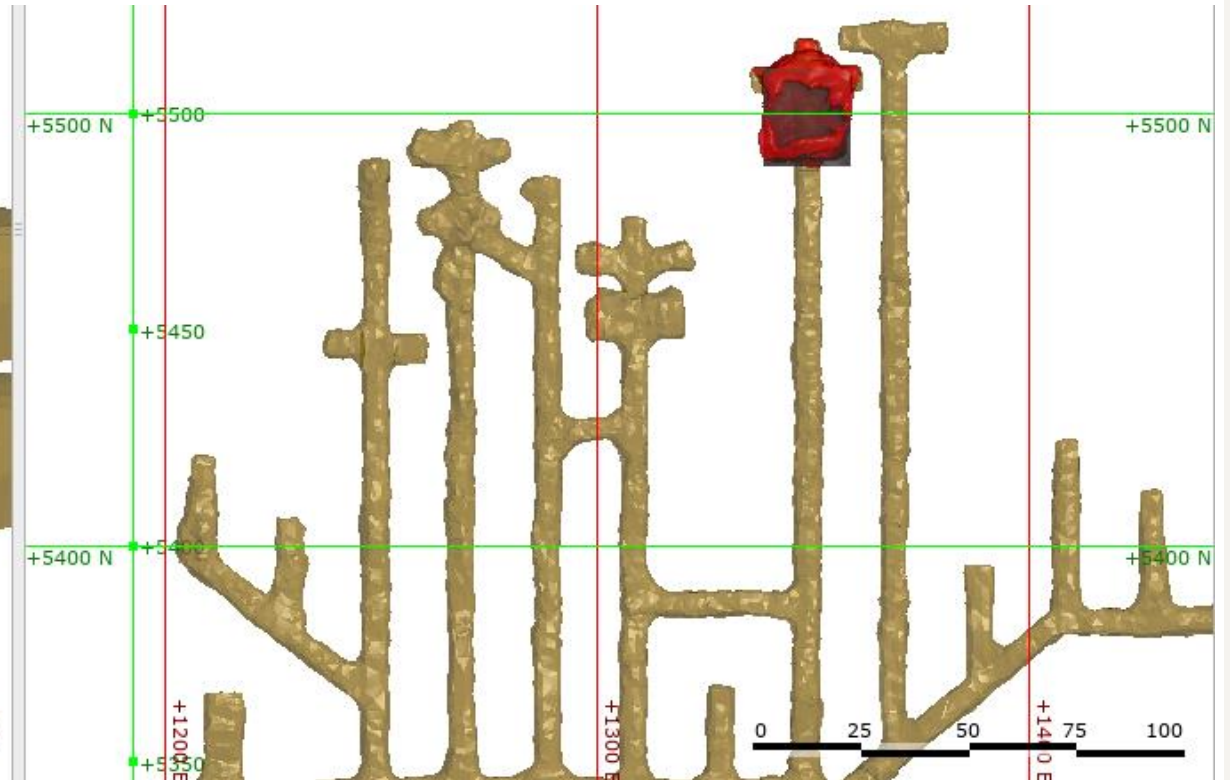
Production



Production



Plunge +20
Azimuth 120



Conclusion

- Q Block Model enables the following:
 - Predict ground conditions ahead of the planned development headings
 - Designate appropriate ground support standard for development and large-scale excavations
 - Predict ground conditions of the stope boundaries to help in determining required blast controls



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