

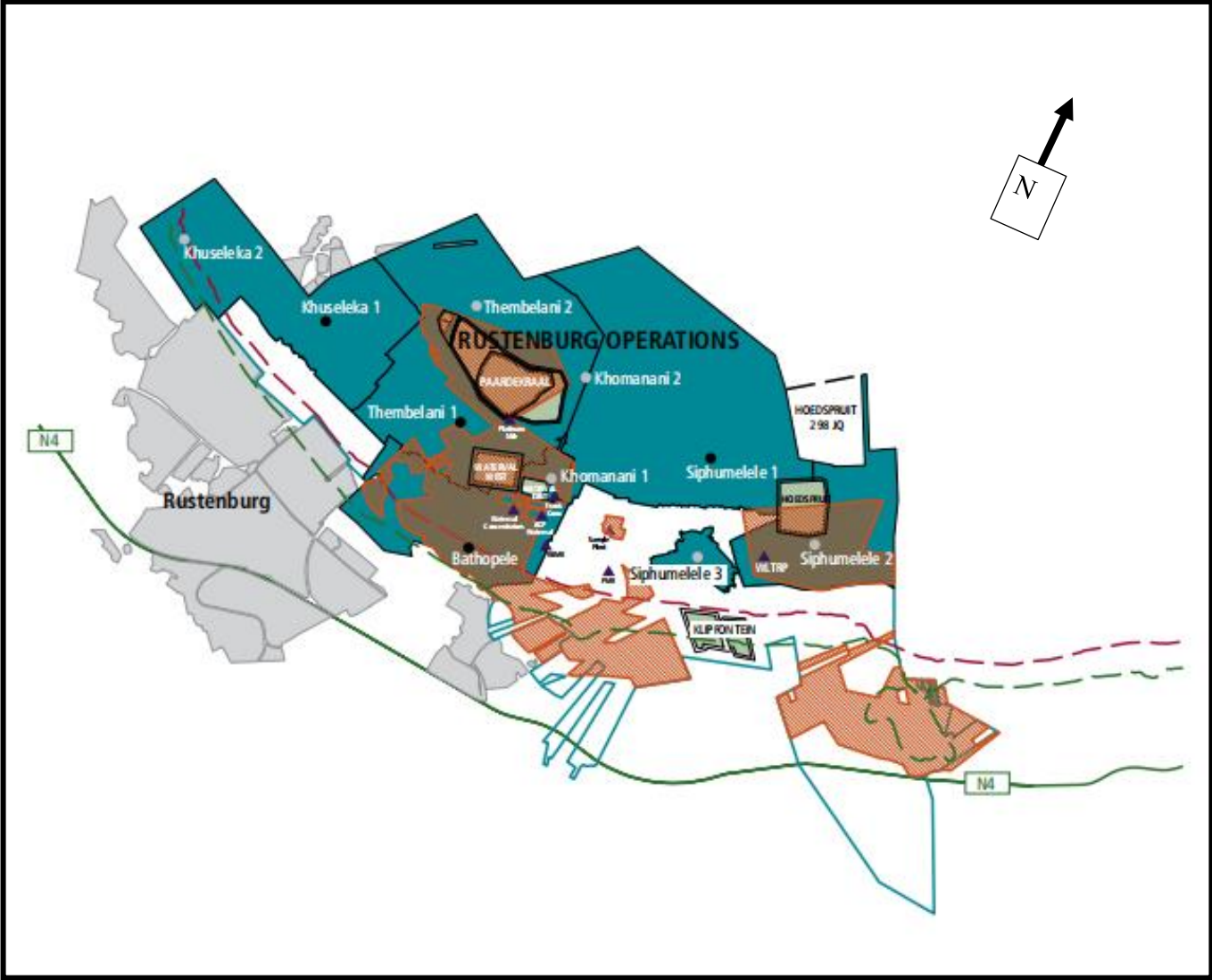


Crush Pillars' Behaviour at Intermediate Depth on Merensky Reef

Hlomani Mthombeni – 23 June 2023

- Siphumelele is in the Western Limb of Bushveld Complex
- Currently mining between 1000 mbs to 1400 mbs
- Intermediate Depth
 - Seismicity
 - Significant Stope Closure
 - Fractured rock surrounding the excavations
- Regional and Crush Pillars provide stability in reef horizon

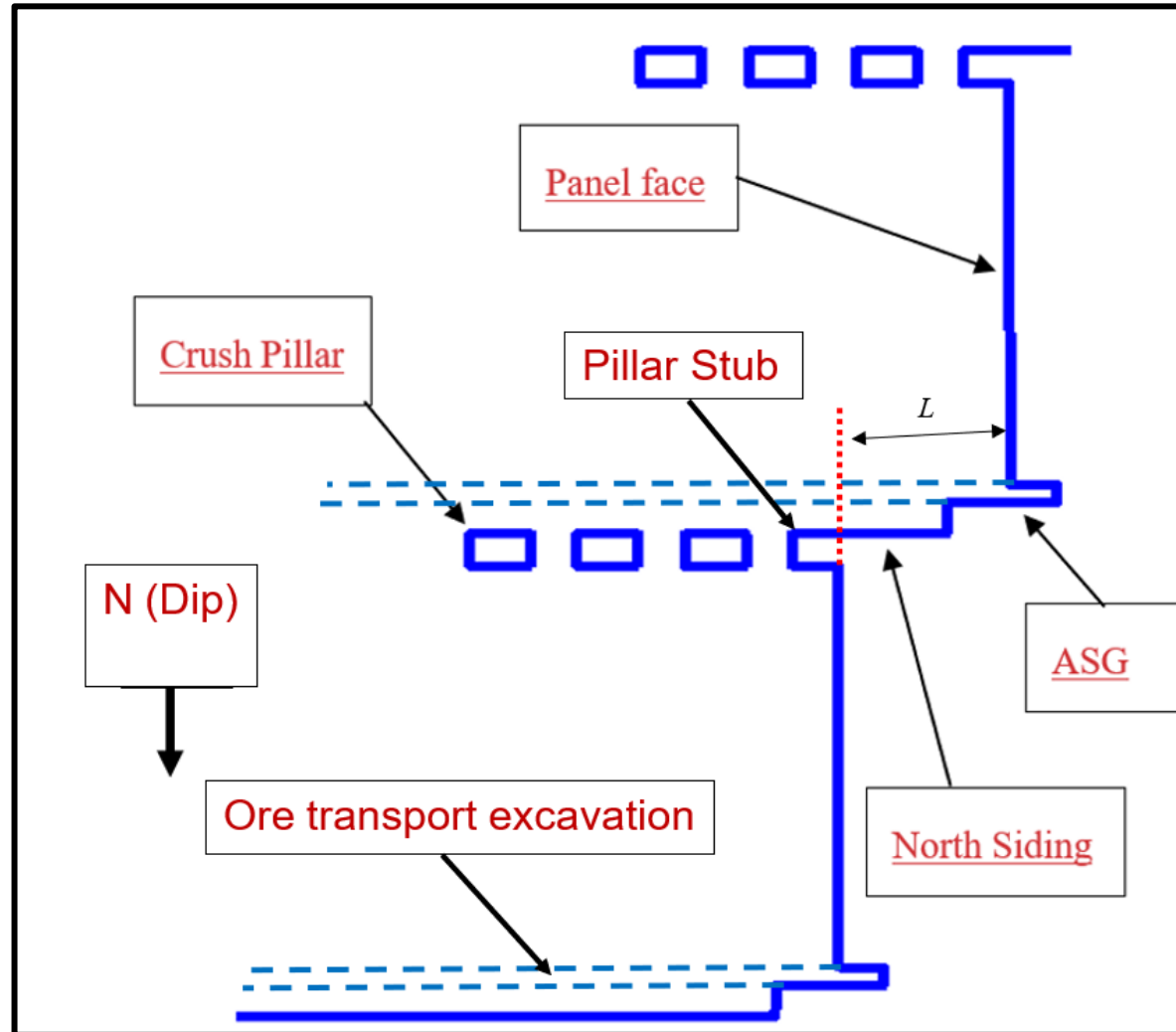
Locality of Siphumelele



Scattered Breast Mining Layout

- Mining Method – Scattered Breast Mining
- Underhand mining Sequence
- Crush Pillars cut along the strike of the orebody – between to panels
- Sidings are established

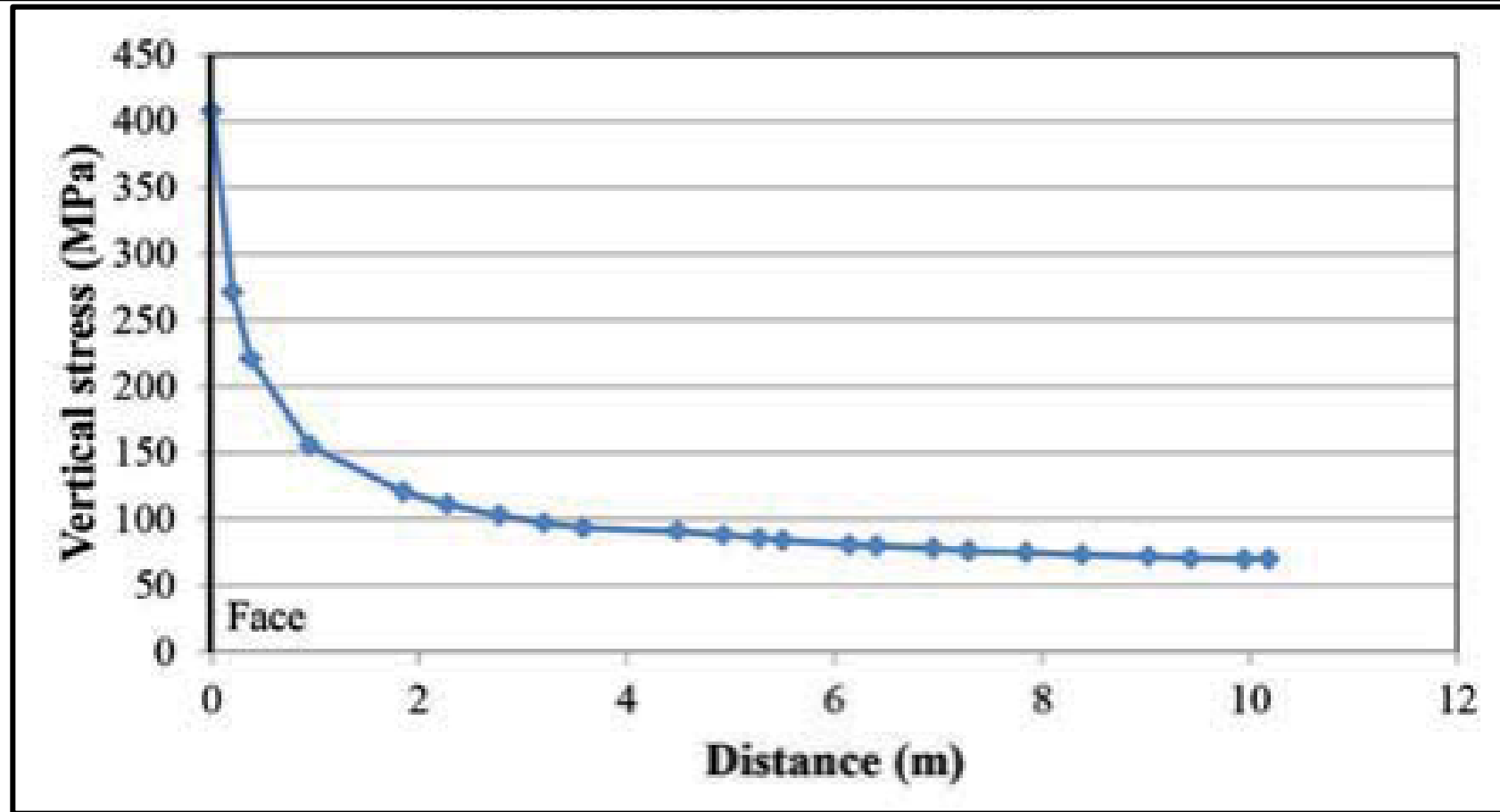
Panel Configuration



- Crush pillars are designed to supports immediate H/W up to 12.0m
- Design is based on W:H of 2.5:1
- Designed to crush to achieve residual strength
- FOS must be less than 1

➤ Pillar Strength = $136 \left[\frac{1.27}{1 + \frac{0.27(w)}{L}} \right] \left[0.59 + 0.41 \frac{w}{h} \right]$ (Watson, Kuijpers, & Stacey, 2010)

➤ Pillar Strength = $136 \left[\frac{1.27}{1 + \frac{0.27(2.5m)}{4.0m}} \right] \left[0.59 + 0.41 \frac{2.5m}{1.0m} \right] = 238.67MPa$



(Du Plessis & Malan, 2018)

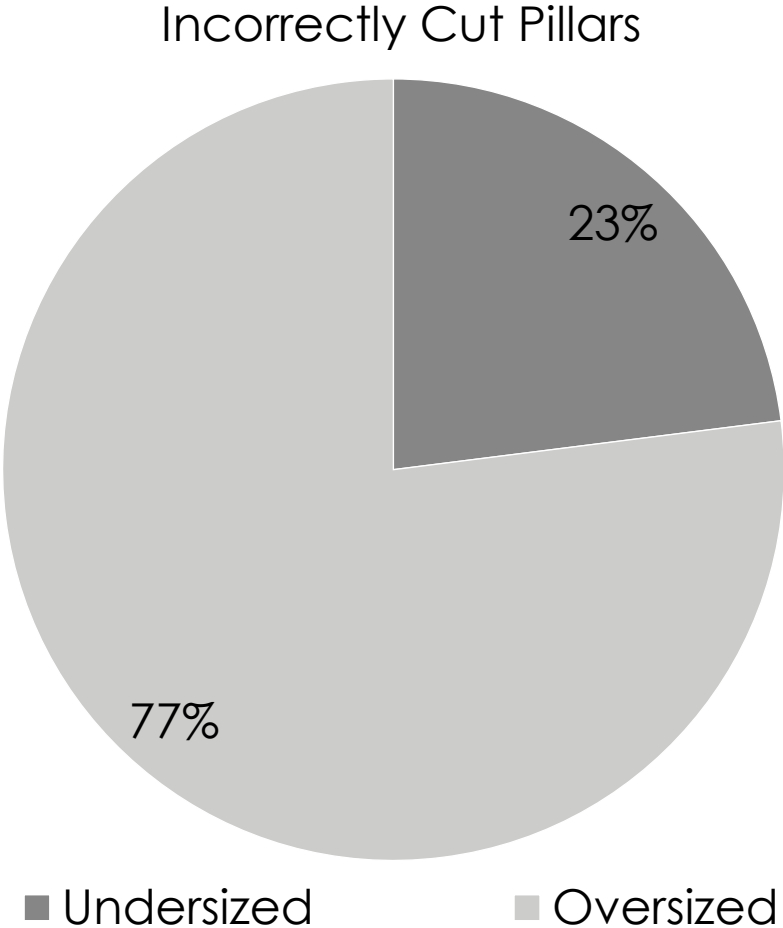
Factors Affecting Pillar Cutting

- Drilling and blasting practices
- Marking of the panel face
- Availability of direction lines
- Geologically disturbed rock mass

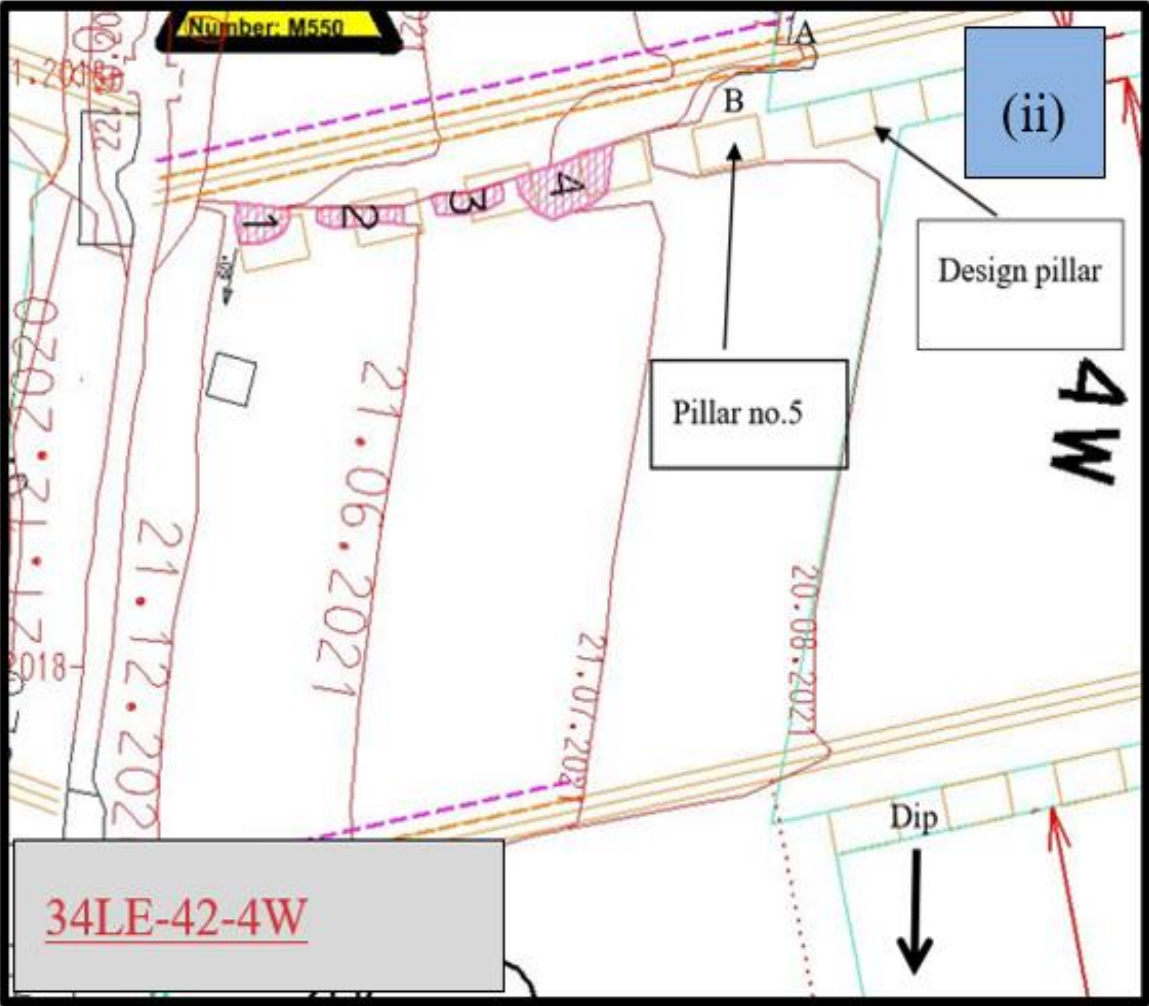
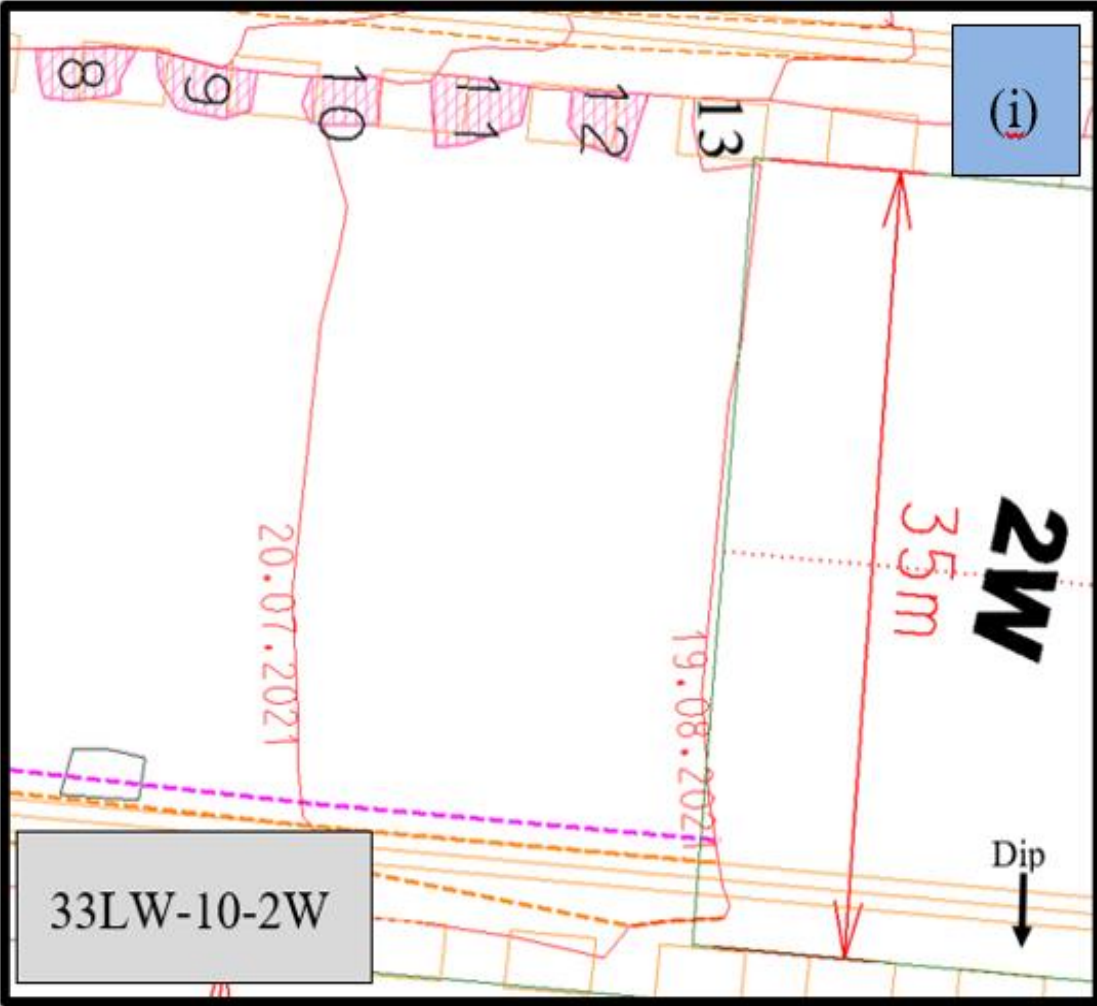
Pillar Cutting Monitoring

Correct	Undersized	Oversized
2.0 to 3.0	Less than 2.0	Greater than 3.0

Pillar-Cutting Performance - Average	
Correctly Cut	70%
Incorrectly Cut	30%



Pillar Monitoring



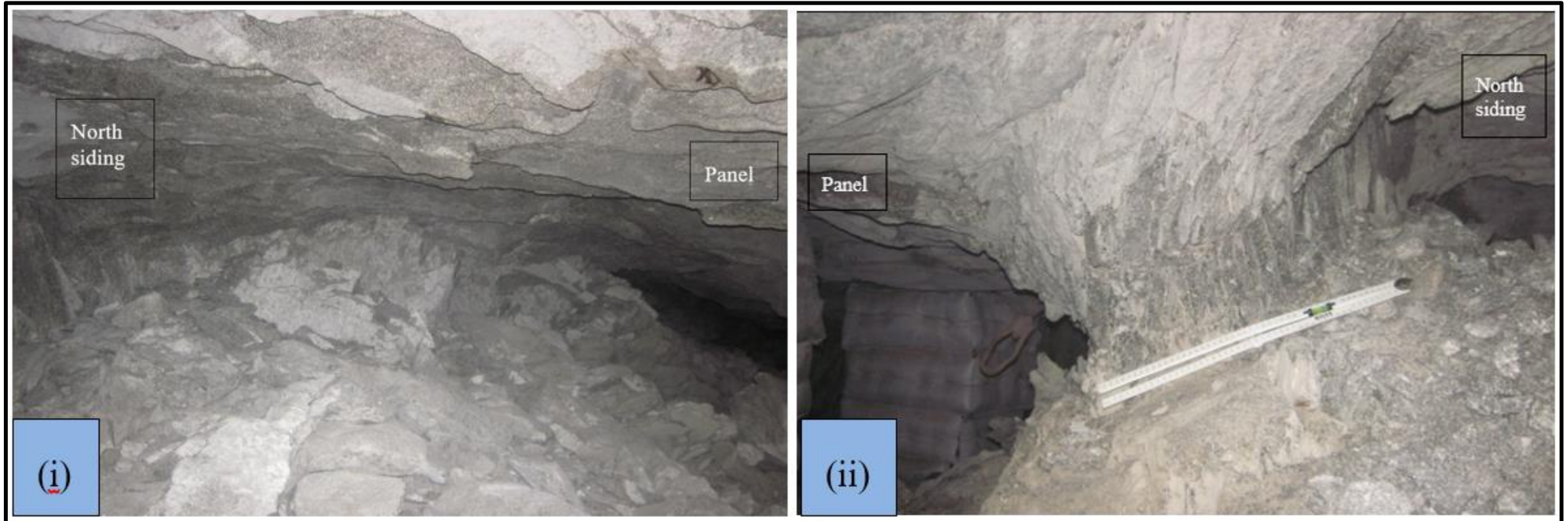
Crush Pillar Monitoring



Crush Pillar Monitoring

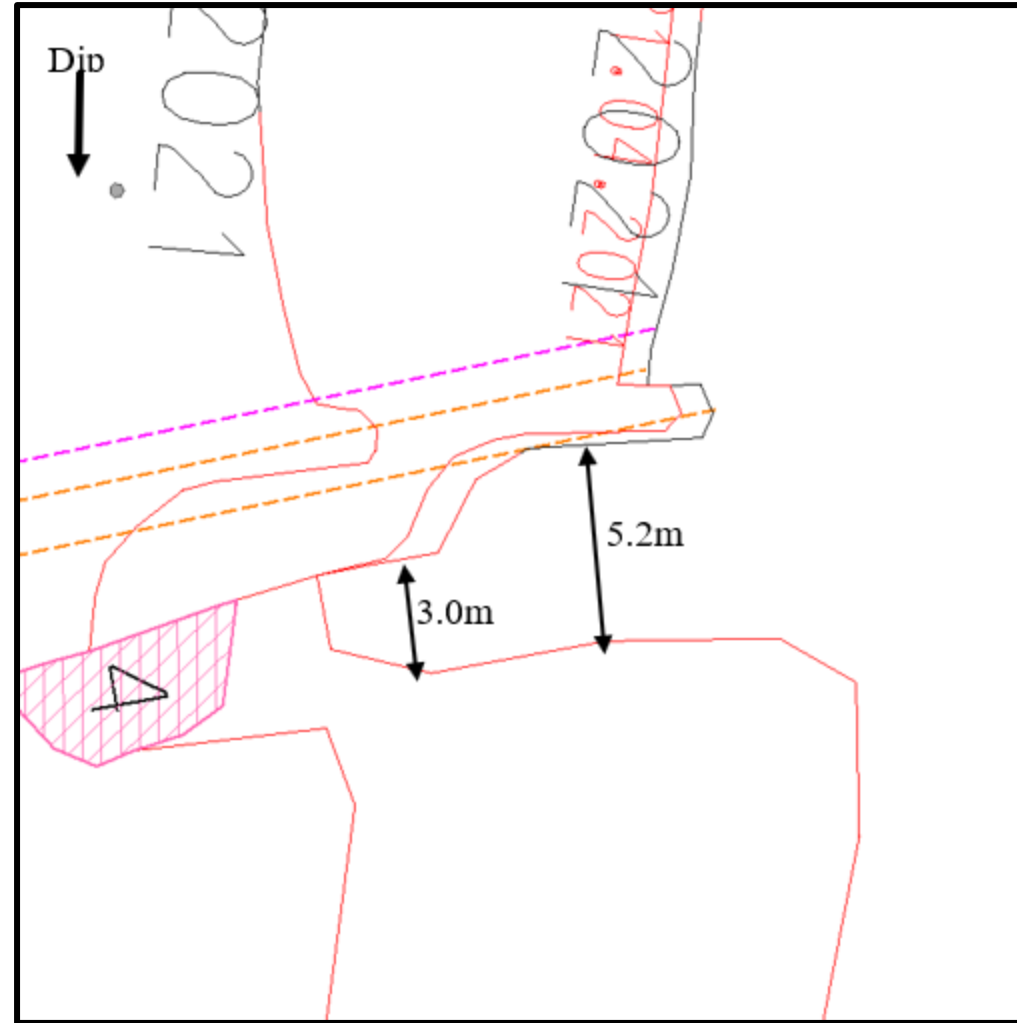


Crush Pillar Monitoring



(i) Pillar no. 5 and (ii) Pillar no. 2

Pillar no. 5
dimensions



- W:H ratio calculation for Pillar no.12 (Correctly cut)
 - Area = 8.2m²
 - Height = 1.1m
 - Perimeter = 11.5m

$$W_{\text{eff}} = (4 \times \text{Area of pillar}) / \text{Perimeter of pillar} = \frac{4 \times 8.2\text{m}^2}{11.5\text{m}} = 2.85\text{m}$$

Therefore W:H ratio = 2.6:1 or 2.6

- W:H ratio of Pillar no.2 (Undersized)
 - Area = 5.4m²
 - Perimeter = 12.5m
 - Height = 1.2m

$$w_{\text{eff}} = (4 \times \text{Area of pillar}) / \text{Perimeter of pillar} = \frac{4 \times 5.4\text{m}^2}{12.5\text{m}} = 1.7\text{m}$$

Therefore W:H = 1.4:1 or 1.4

- Sidings are crucial at intermediate depth
- Abutment stresses initiate fracturing
- Fractures are more defined on the side that was exposed longer -lead/lag
- Oversized pillars are prone to dynamic failure
- Undersized pillar will not achieve the required residual strength
- Correctly cut pillars perform as per design
- Pillar stubs creates highly stressed blocks of ground
 - North siding must be carried in line with panel face
- Mining discipline is crucial and must be enforced

References

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Thank you