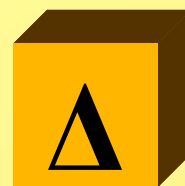


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Back Analysis of Rockburst Damage To Verify Assumed Design Parameters

Lucille Cilliers & Koos Bosman

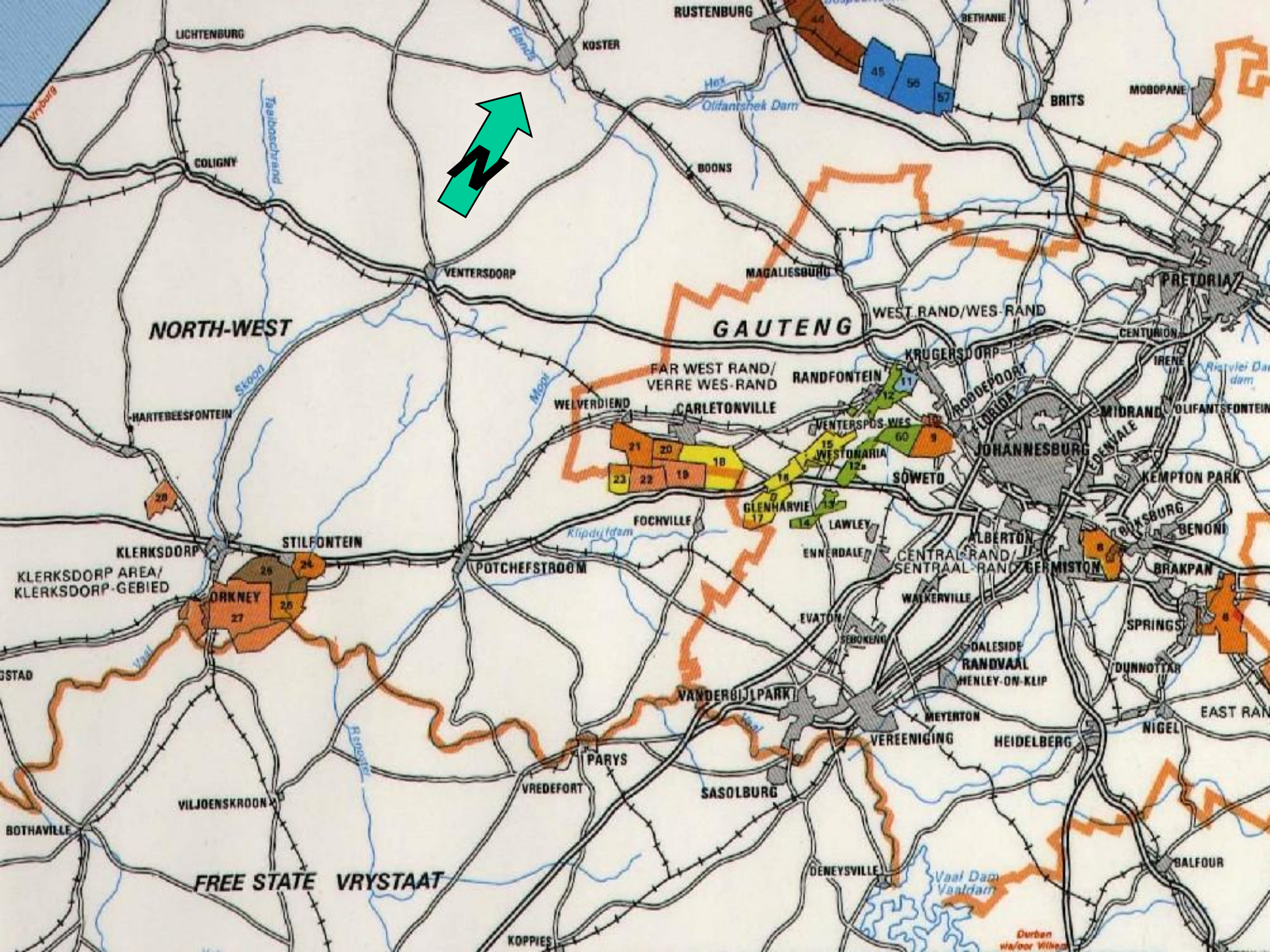
Geotechnical Area

- Klerksdorp area

Ω Ø λ

β OHMS

δ ς Δ Ō



NORTH-WEST



HARTEBESFONTEIN

Skoen

Mool

WELVE

28

KLERKSDORP

KLERKSDORP AREA/
KLERKSDORP-GEBIED

STILFONTEIN

24

ORKNEY

27

POTCHEFSTROOM

Klip

STAD

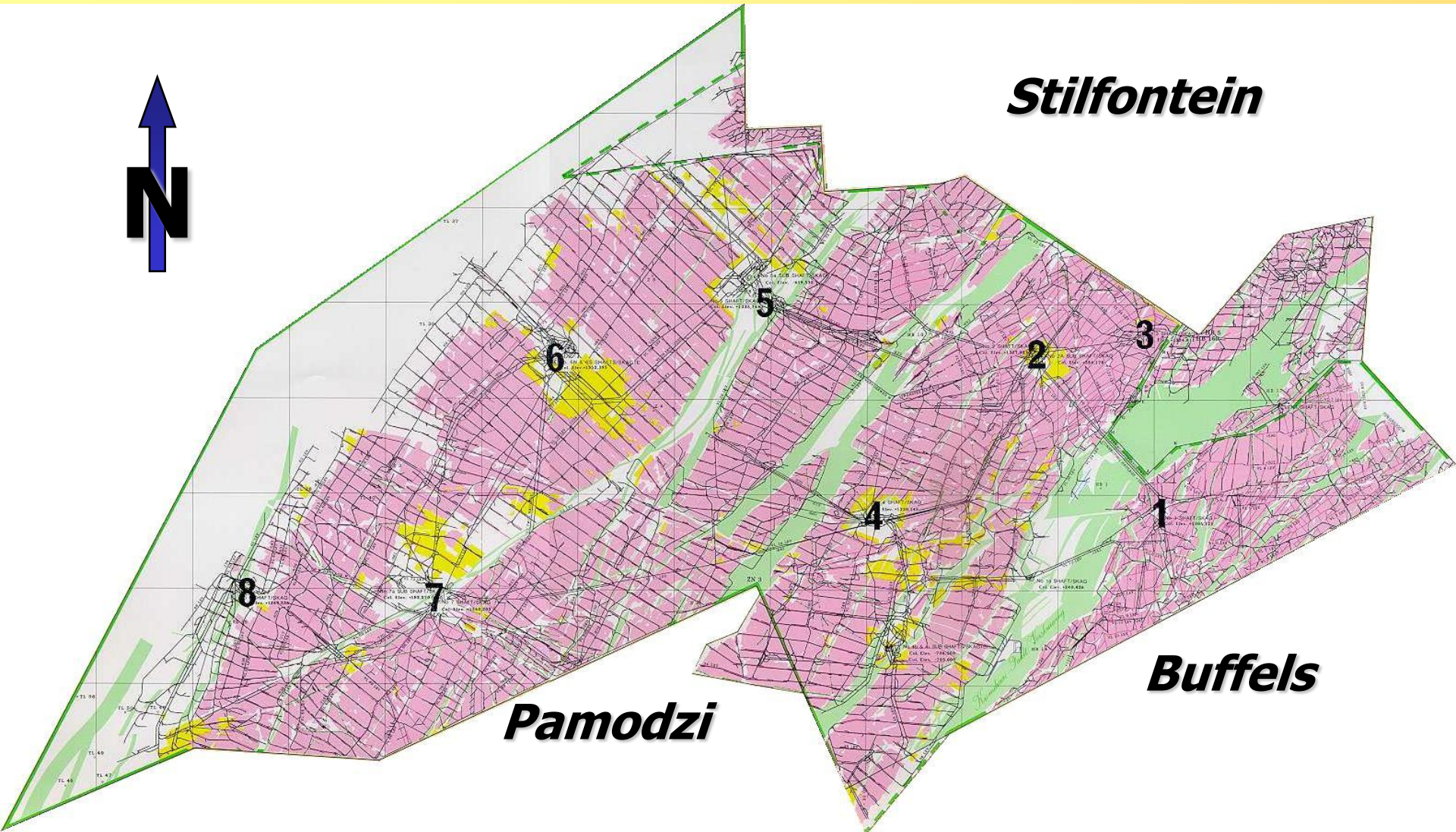
Vaal

Rens

VILJOENSKROON

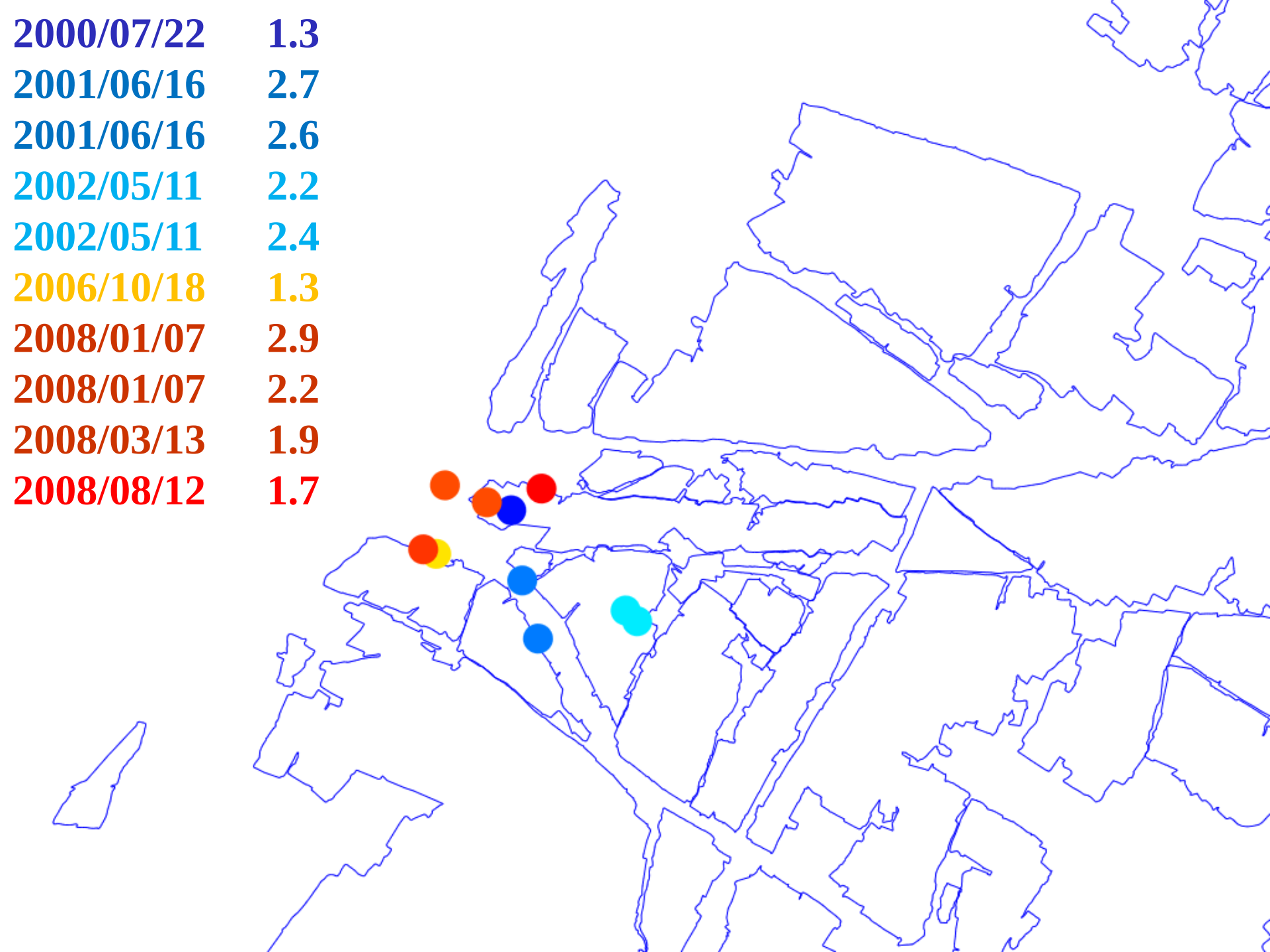
VREDEFORT

Buffelsfontein Gold Mine



Geotechnical Area

- Klerksdorp area
- Depth below surface – 2004m
- Stress – Vertical virgin $\pm 54\text{MPa}$
- Geological structures
- Dimension of the dyke $\pm 30\text{m}$ wide
- Seismicity (history of large seismic events)



Composition of Rock

- Epi-diabase material
- Joint sets
- Wedges
- Blocky ground conditions
- Stress fractures

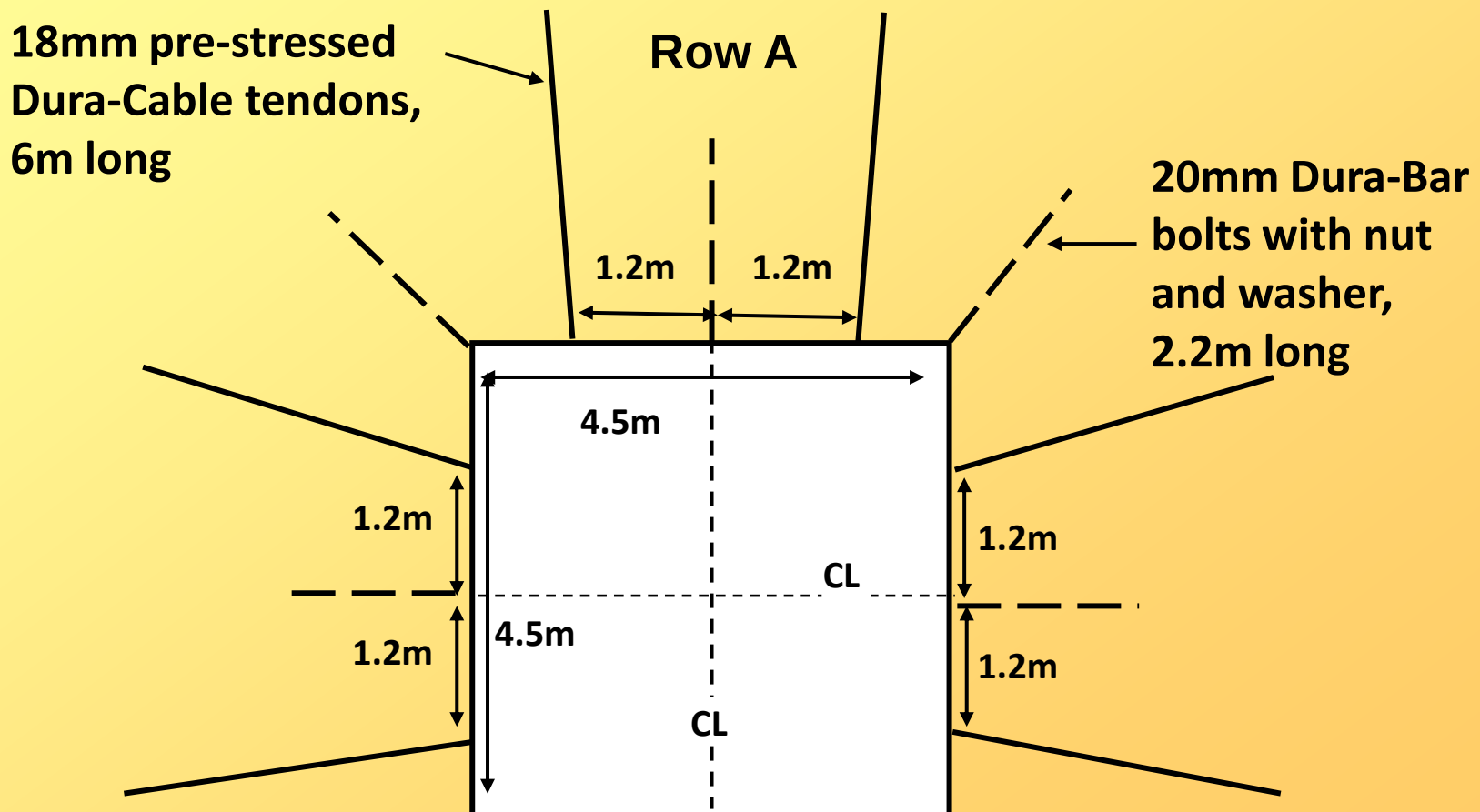
Support

The specified tendon support in the haulage through the dyke

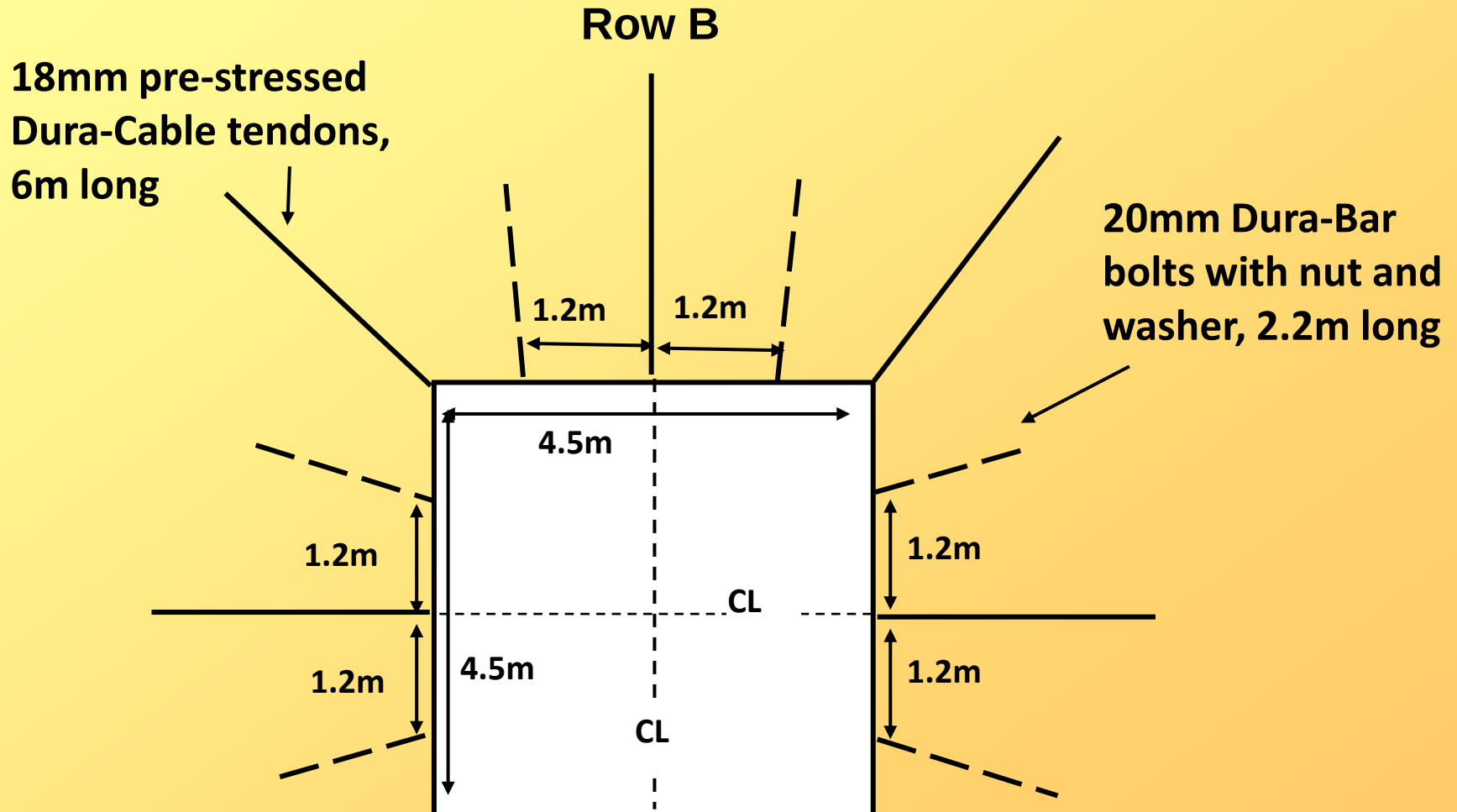
- 18mm dia x 30 ton pre-stressed Duracables, 6m in length (Pre-stressed to 15 tons)
- 20mm dia Durabar bolts with nut and washer, 2,2m in length

Tendon support pattern

Row A and B support patterns to be alternated every 1m



Support pattern



Support Resistance and Energy Absorption

- With 11 x Durabars and 11 x Duracables in a tributary area of 27m^2
- Durabar = 190kN and 35.61kJ
- Duracable = 270kN and 100.91kJ
- Support Resistance = 187kN/m^2
- Energy absorption = 55.61kJ/m^2

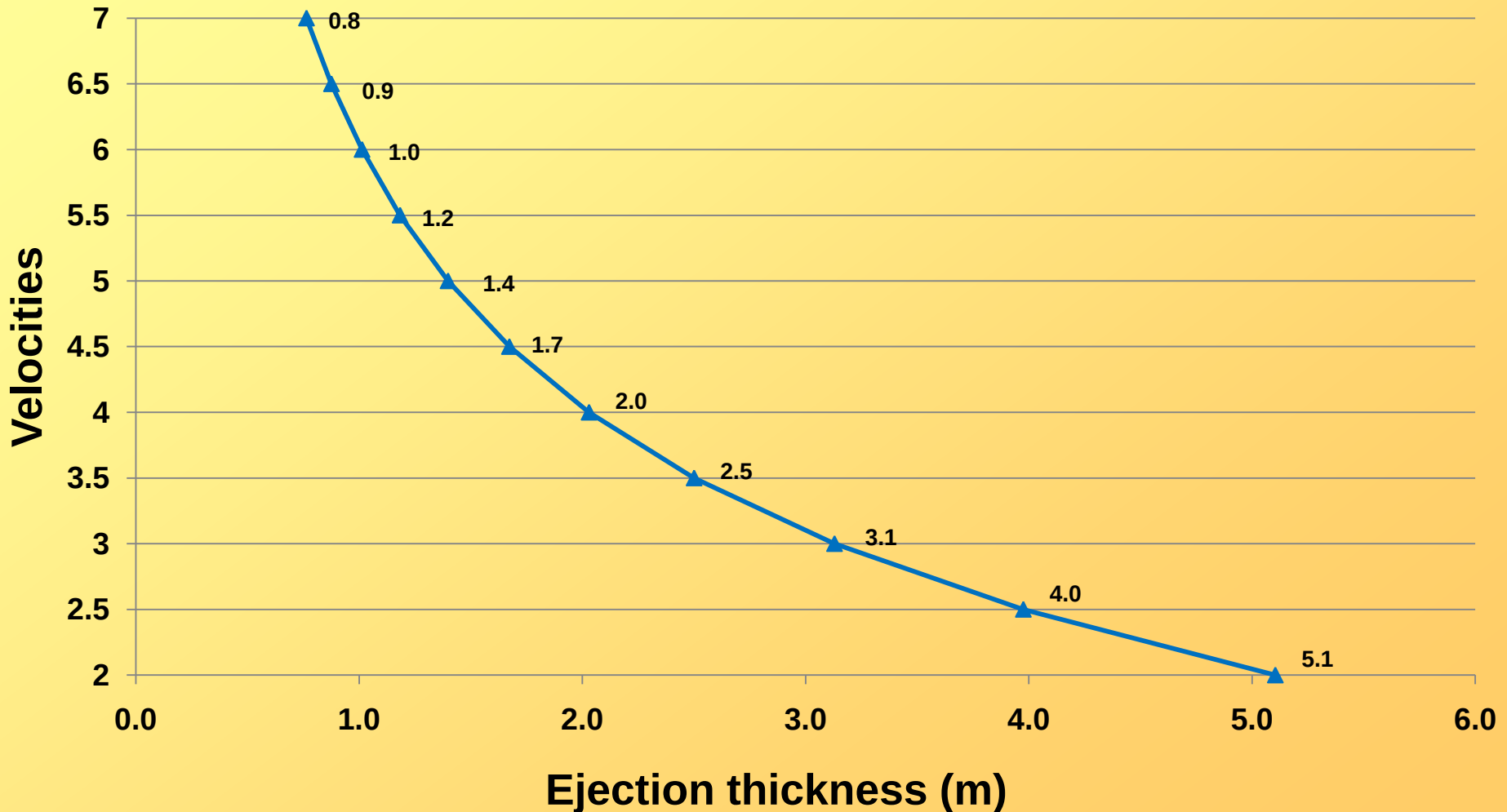
Ω Ø λ

β OHMS

δ ς Δ σ

Potential Ejection Thickness

Velocities vs Ejection thickness



Seismic event

20 May 2009 – Magnitude 0.5 event



Seismic event

20 May 2009 – Magnitude 0.5 event



Seismic event

20 May 2009 – Magnitude 0.5 event



Damage to tendon support

- Ejection volume together with Durabar was estimated to be $1 \times 1.2 \times 0.5\text{m}$
- At 26.98kJ/m^2 for Durabar, the required velocity = 5.66m/s
- The combined system @ an ejection velocity of 5.66m/s is capable to accommodate 1.1m ejection thickness.

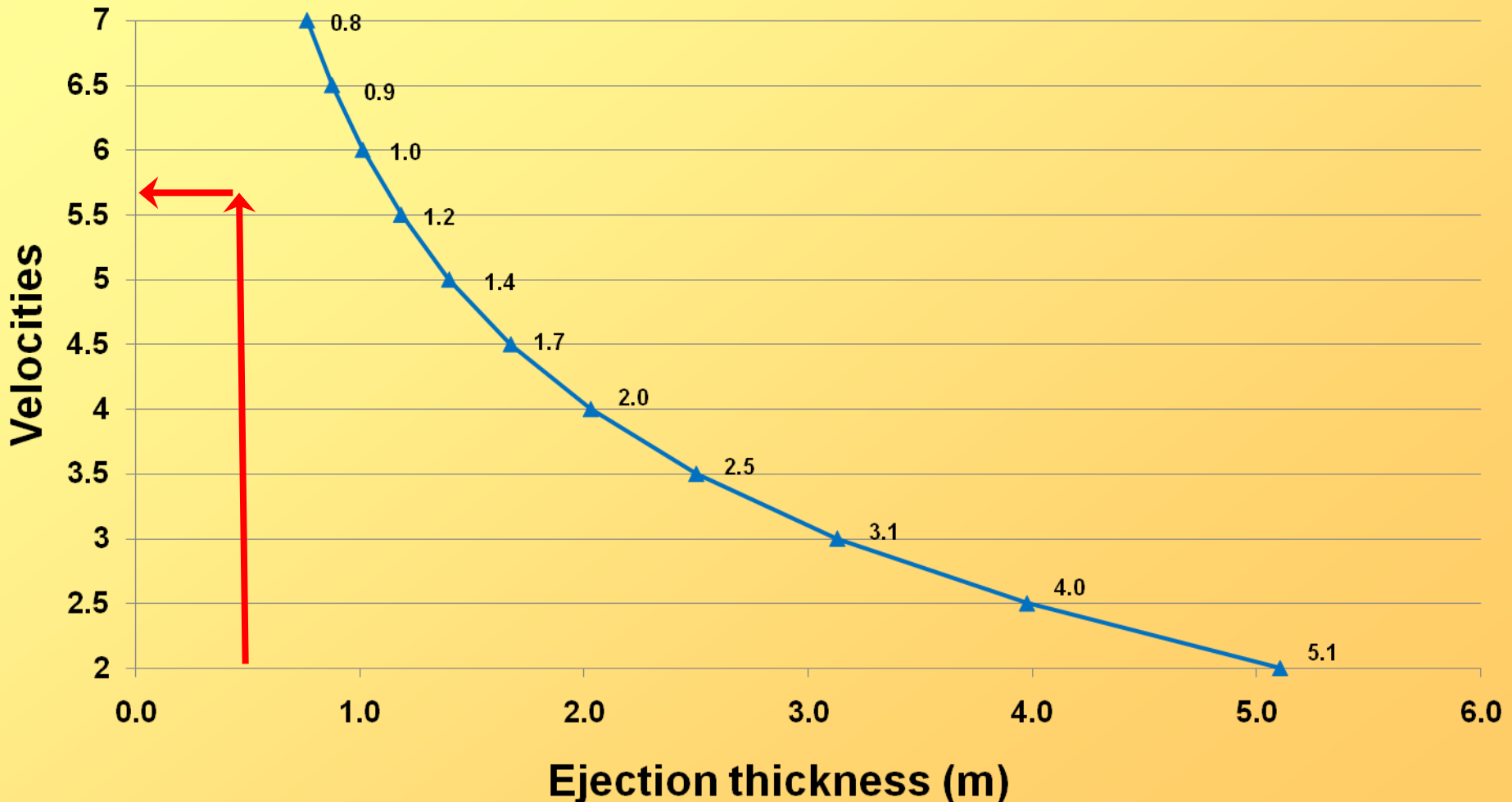
Ω Ø λ

β OHMS

δ ς Δ Ō

Potential Ejection Thickness

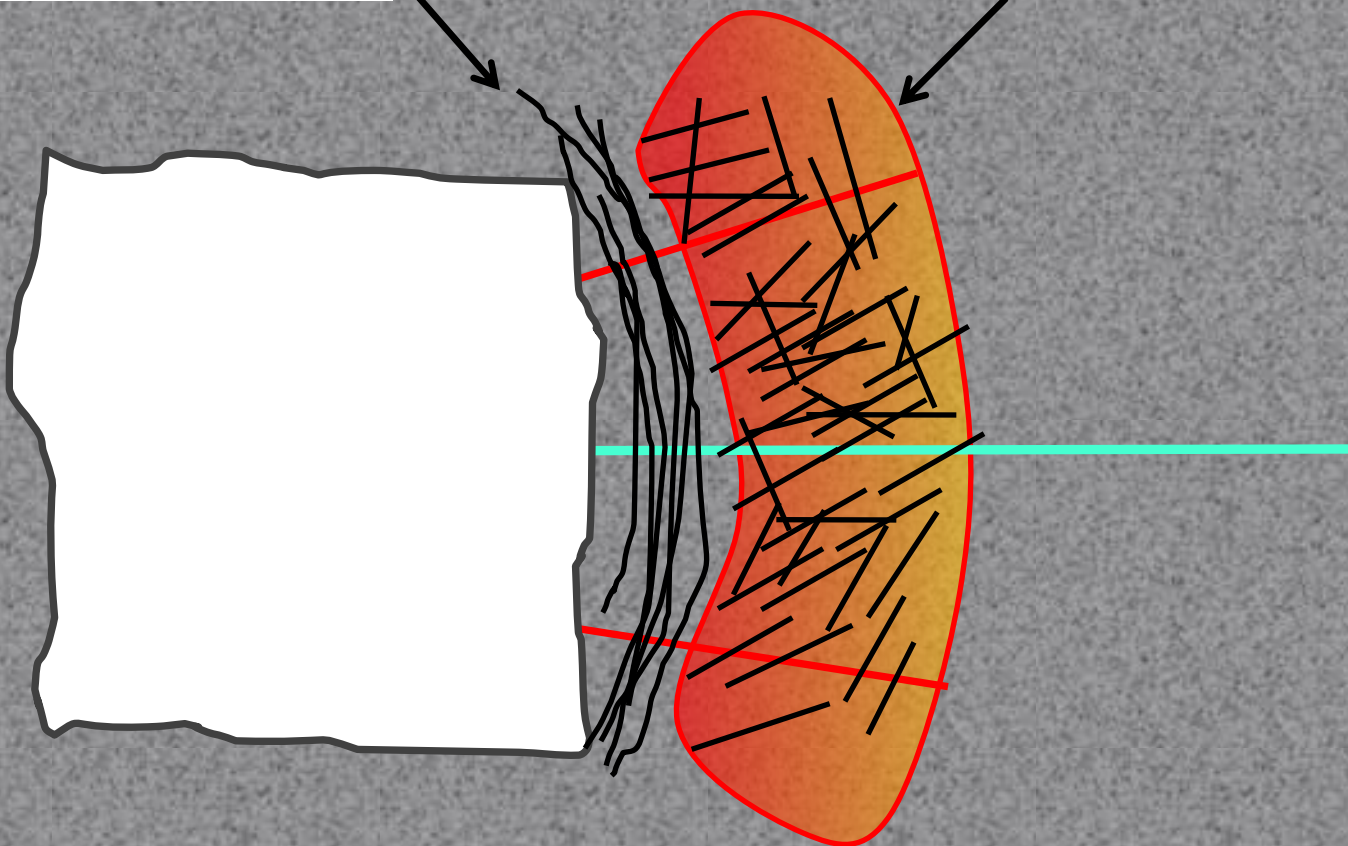
Velocities vs Ejection thickness



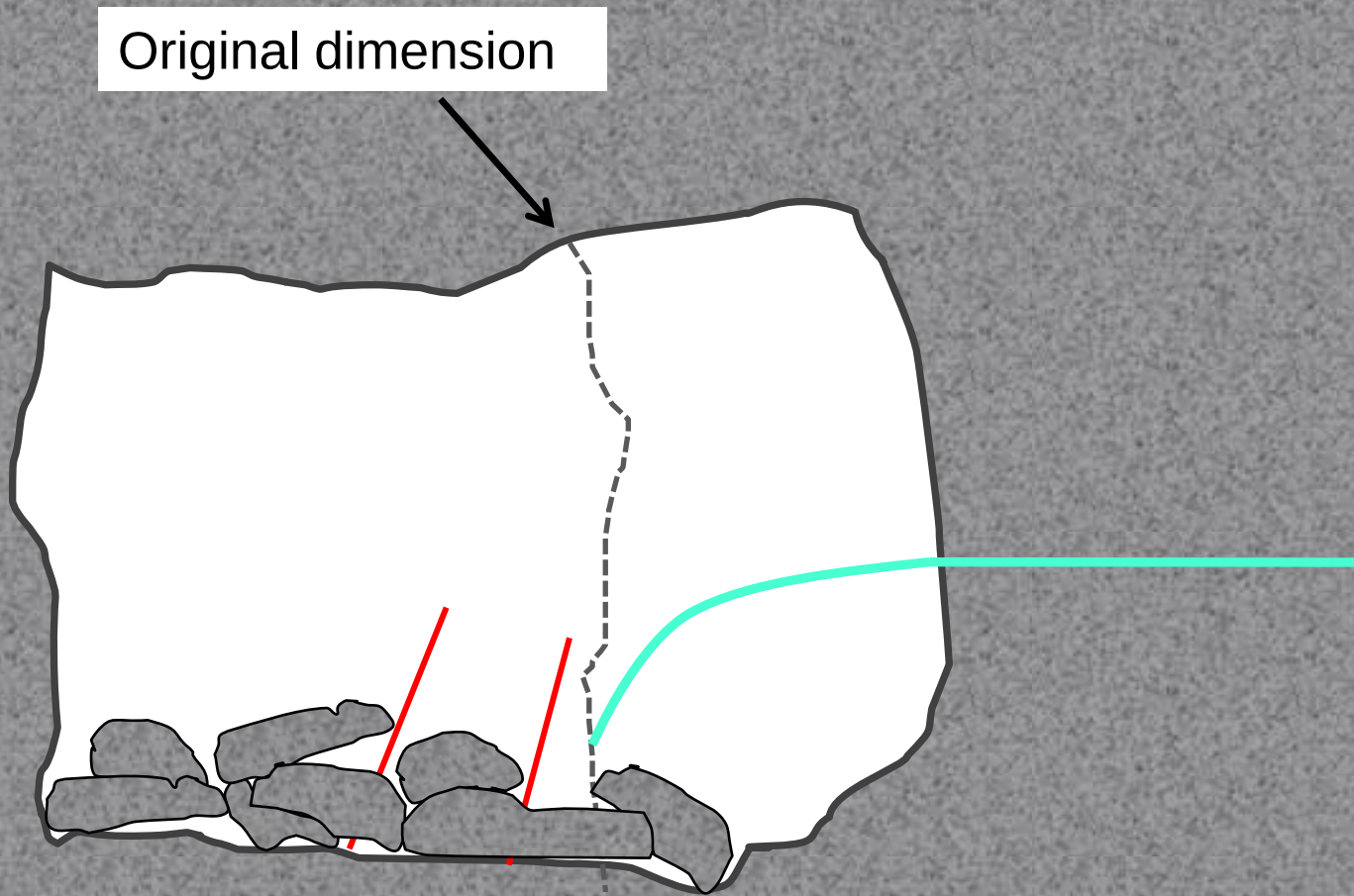
Failure mechanism

Fractured zone
around excavation

Burst fractures
between tendons

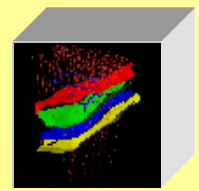


Failure mechanism



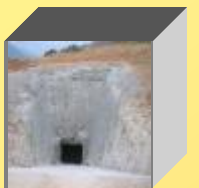
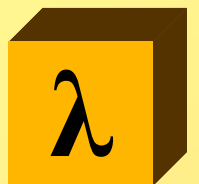
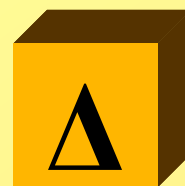
Conclusion

- The tendon support system is adequate in terms of energy absorption capacity.
- The tendon support system alone is inadequate, under these specific rockburst conditions, to contain damage.
- Damage was controlled by brittle nature of the rock mass and the ineffectiveness of the containment support.
- The observed damage suggest a lack of interaction between individual units within the system.



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Questions