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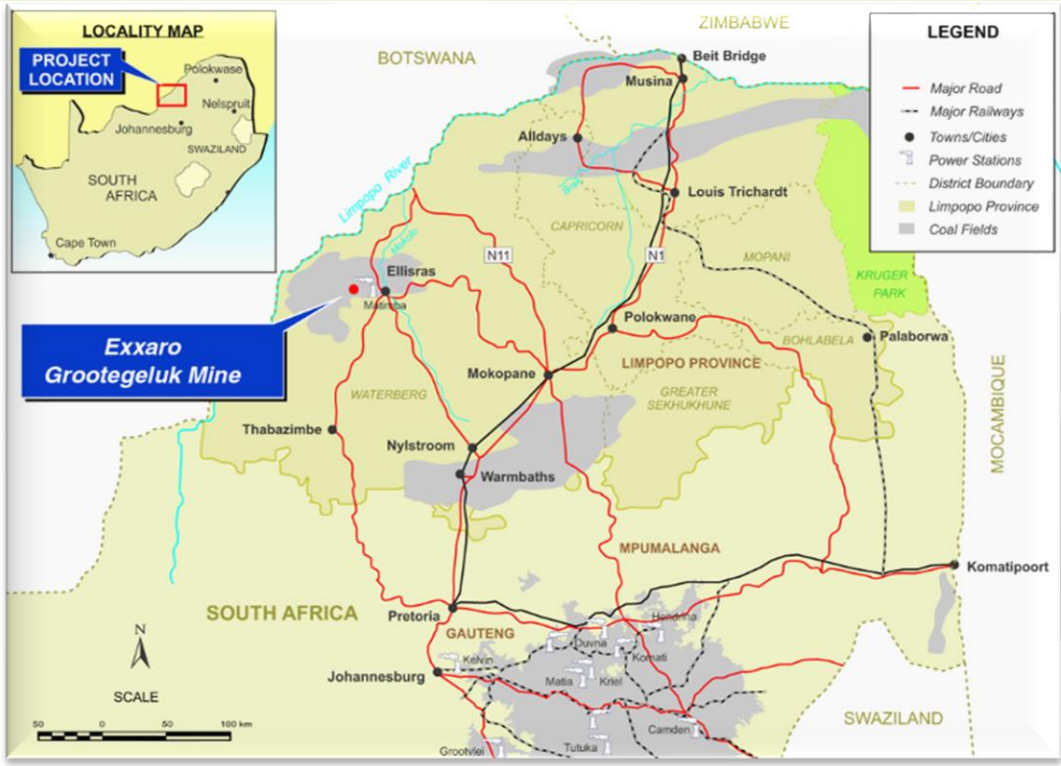
#Consistency is our culture
#Consistency is our identity
#Consistency is our way of work
We commit to be Consistent
– GGC TEAM
“
exxaro
GROOTEGELUK | COAL
#CONSISTENCY
TOWARDS OUR NORTH STAR
Geological Fault Risk Management at Exxaro Grootegeluk Coal Mine
Reginald Mathivha

Contents of the presentation

Introduction

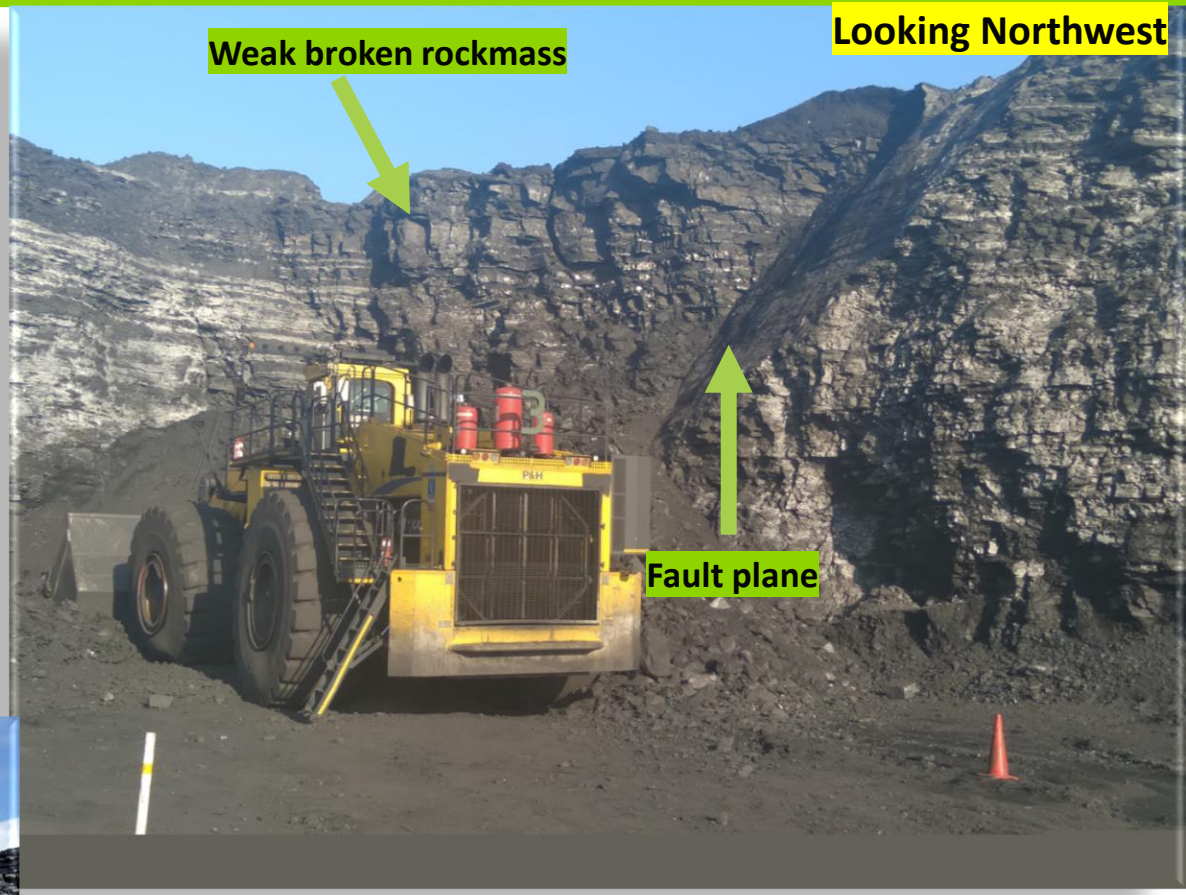
- Geology consists of Volkrust formation and Vryheid formation
- Pit is bounded in the North by the Daarby Fault and Eenzamheid Fault on the South - structurally controlled deposit
- Faults pose a safety risk to mining operations. i.e., Bench scale failures impacting on personnel and equipment, ineffective blast if faults are not considered in the blast design
- Fault risk management – mapping, logging, 3D model, projection onto plan, 2/3D Numerical analysis, operational controls, etc.

	Benches (Previous Model)	Samples	Zones (Current Model)	Schematic (Current Mining of Middle Pit - Not to scale)	Comments
Volkrust Formation	B1A	1A, 1BS	B1A		
	B1B		B1B		
	B1C (B1R + 3m buffer)		B1C (Z11B + 3m buffer)		
	B2	1BC-1D	Z11		
		2-6	Z10		
	B3	7-9	Z9		
		10-14	Z8		
	B4	15A-18	Z7		
		19-21	Z6		
	B5	22A-22E	Z5		
		22FS	Z5IB		
Vryheid Formation	B6	23A-23C	Z4		
	B7A	23AS-23BS	Z4IB		Currently mined as one package
	B7B	24	Z4A		
	B8	24S-25S	Z4AIB		
	B9A	26	Z3A		No SS3 in current Pit - Currently mined as one package
	SS3	SS3 Sandstone Interburden	SS3		
	B9B	27-29	Z3B		
	B10	B10 Sandstone Interburden	B10		
	B11	30A-31	Z2		
	B12	B12 Sandstone Interburden	B12		Only mined in Sump areas
	B13	32	Z1		



Understanding Geological Faults

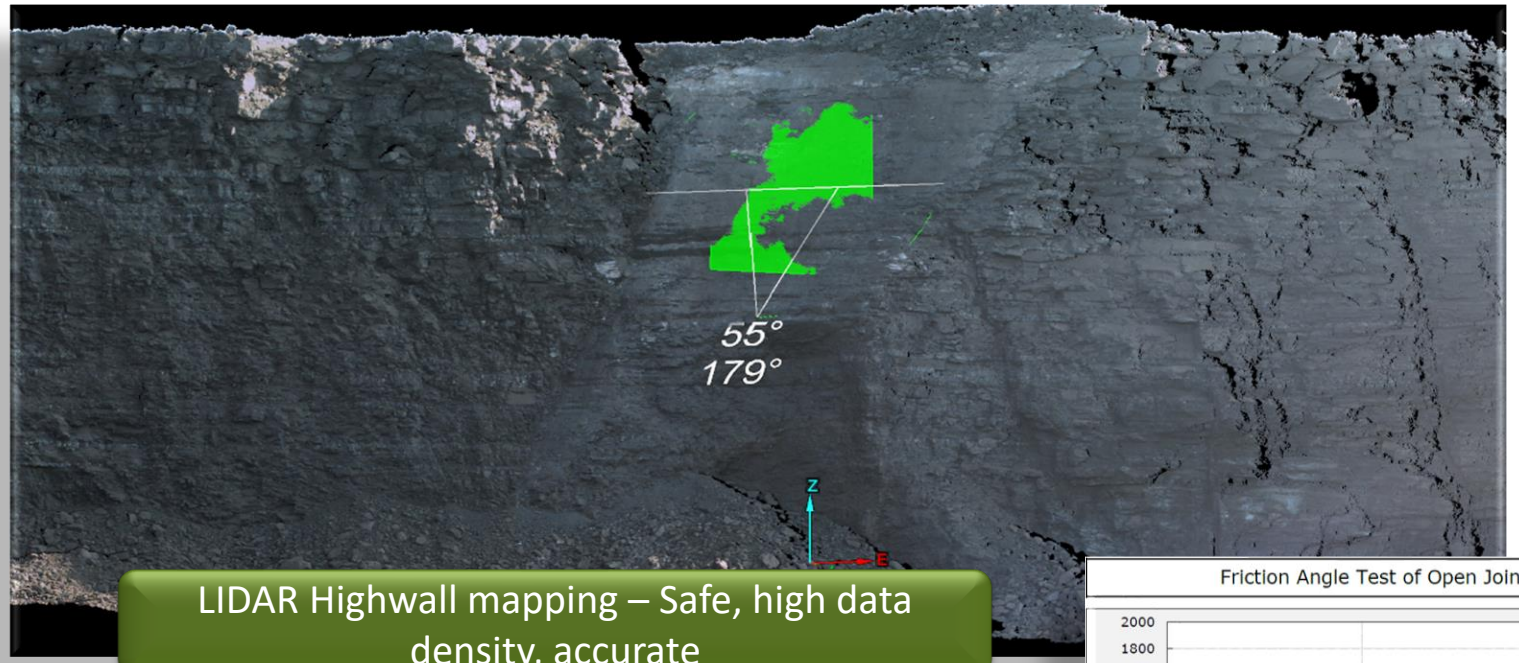
- A fault is a planar fracture or discontinuity in a volume of rock across which there has been significant displacement owing to rock-mass movements.
- Bench scale fault induced fall of grounds impacting negatively on personnel and equipment
- Ineffective blasting outcomes when faults are not considered in blast designs – Frozen blocks
- Conduits for water groundwater – flooding of active mining areas
- Ore dilution



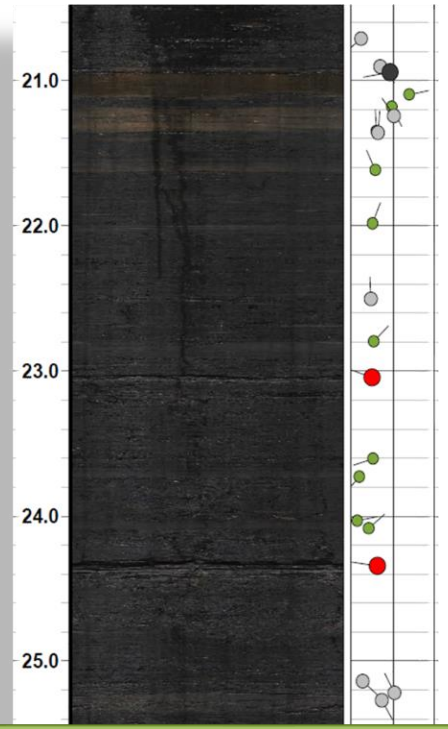
Fault induced Fall of Ground

Frozen Blast Block

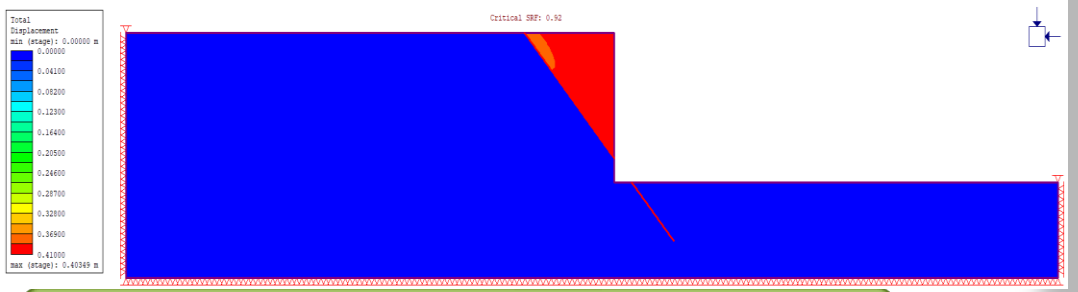
Risk Management - Data Collection



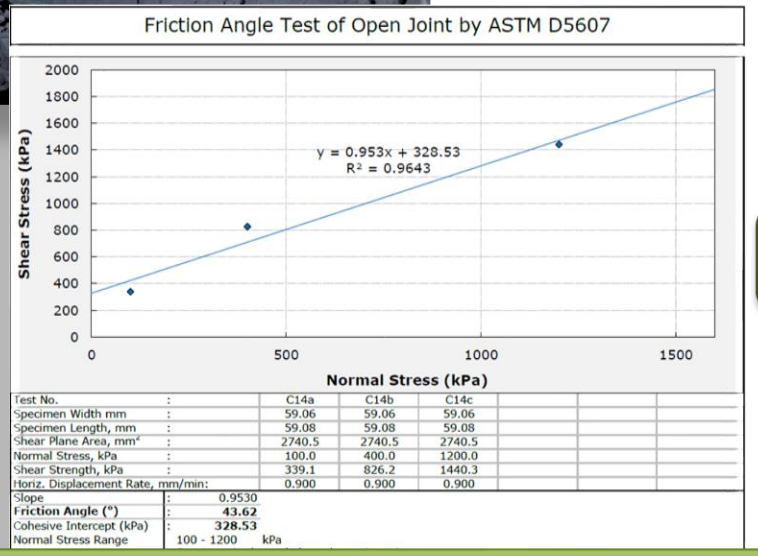
LIDAR Highwall mapping – Safe, high data density, accurate



Downhole Geophysics –Optical Televiewer and Acoustic Televiewer



Failure back analysis – Failure conditions and Shear strength properties verifications



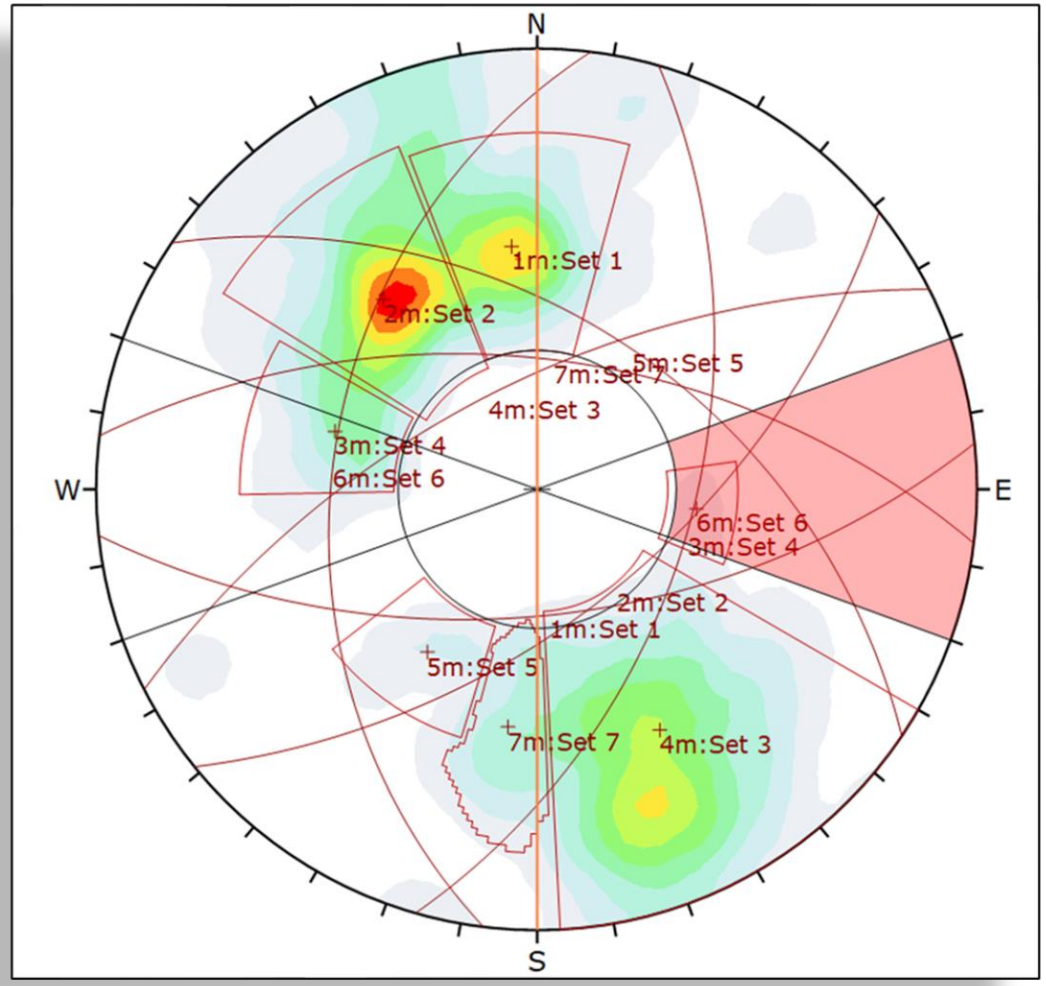
Test No.	:	C14a	C14b	C14c
Specimen Width mm	:	59.06	59.06	59.06
Specimen Length, mm	:	59.08	59.08	59.08
Shear Plane Area, mm²	:	2740.5	2740.5	2740.5
Normal Stress, kPa	:	100.0	400.0	1200.0
Shear Strength, kPa	:	339.1	826.2	1440.3
Horiz. Displacement Rate, mm/min:		0.900	0.900	0.900

Slope	:	0.9530
Friction Angle (°)	:	**43.62**
Cohesive Intercept (kPa)	:	**328.53**
Normal Stress Range		100 - 1200 kPa

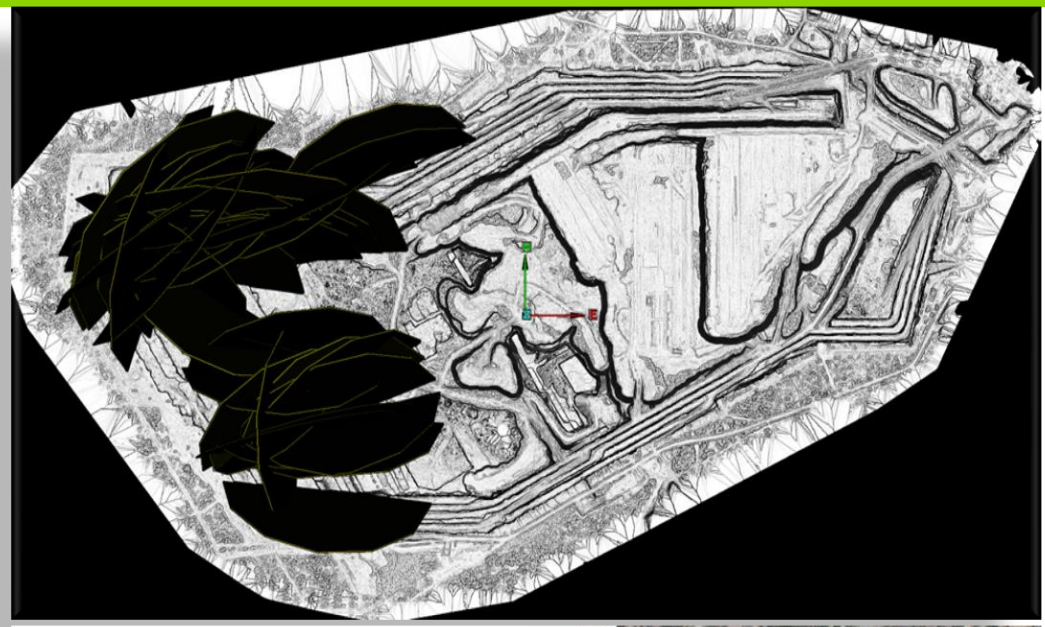
Core logging – Manual core logging, Lab testing (Shear strength)

Risk Management– Fault Characterization

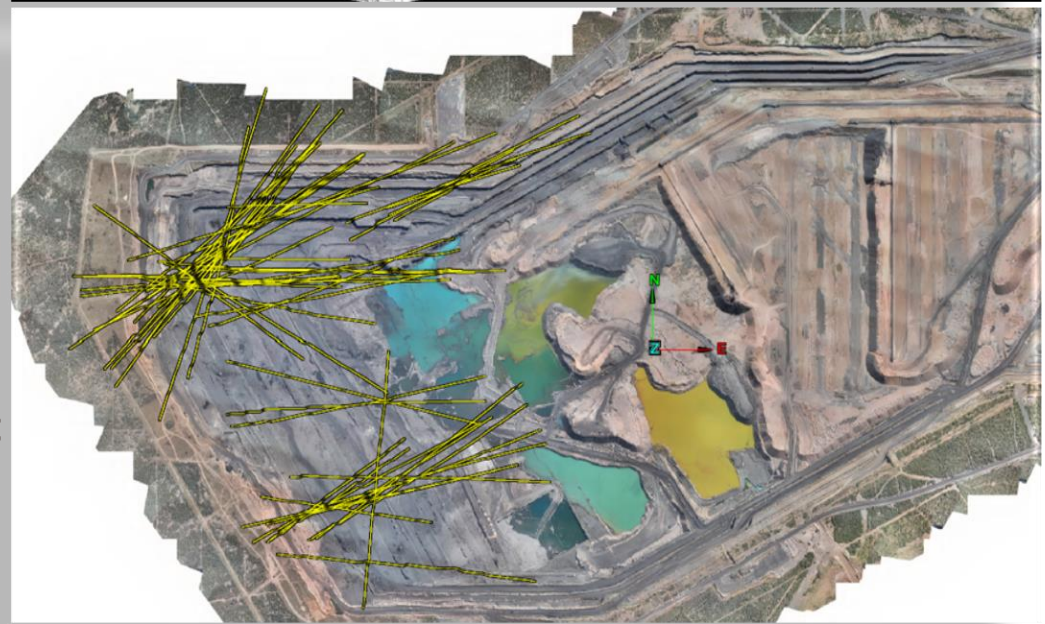
Fault Sets Stereo Plot



3D Fault Model

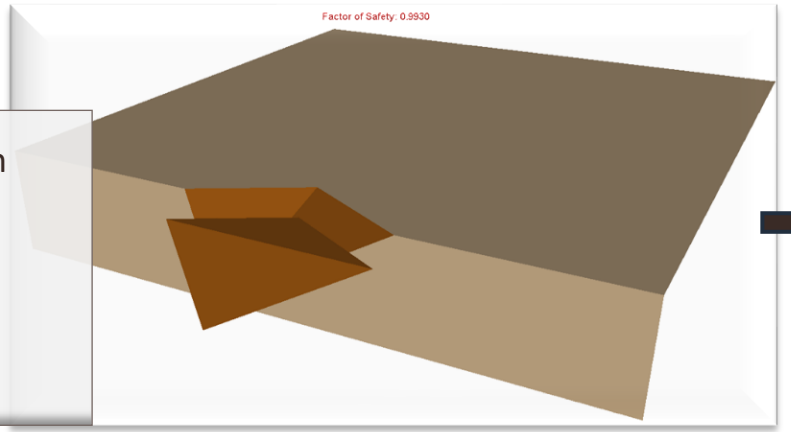


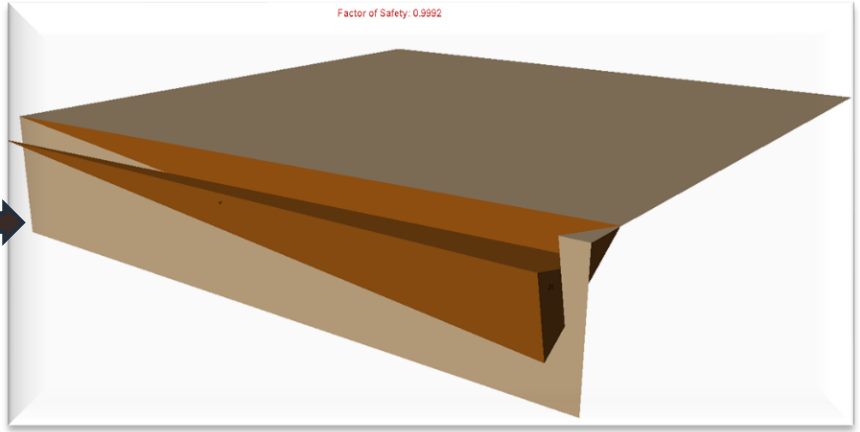
Projected Fault Model -Strike



Risk Management – Kinematic and Numerical Analysis

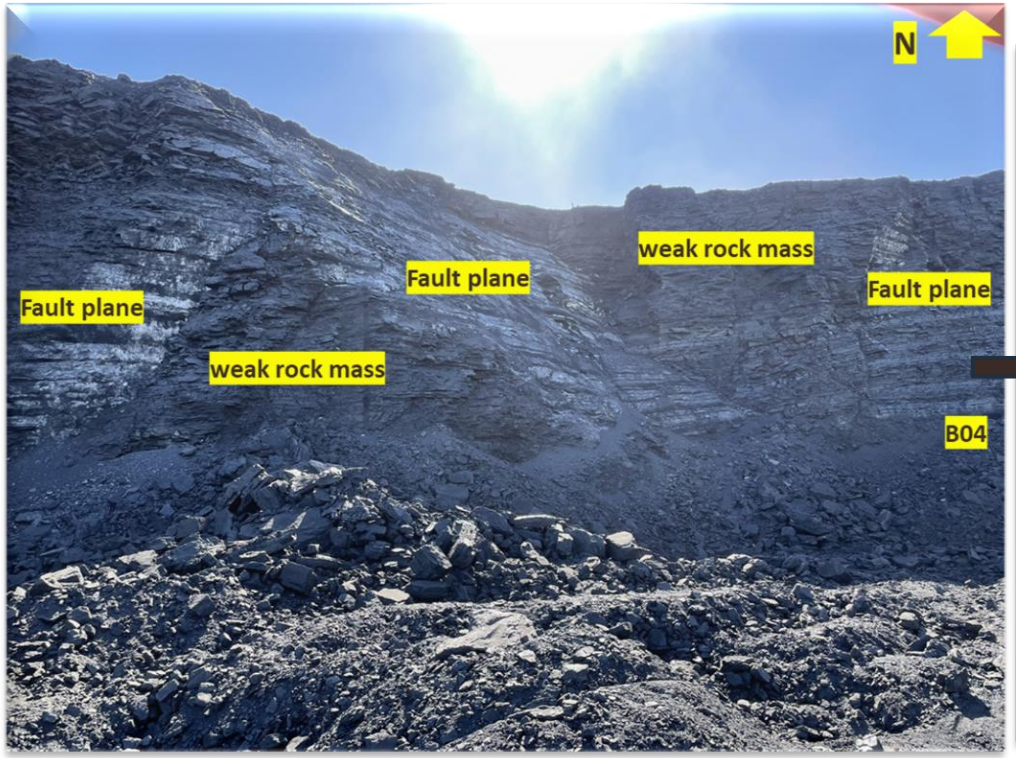
- Current highwall stability analysis– residual risks on active highwalls.
- Future highwall stability - Proactive analysis of projected faults
- Back analysis of failed highwall - Confirmation of failure conditions and strength properties

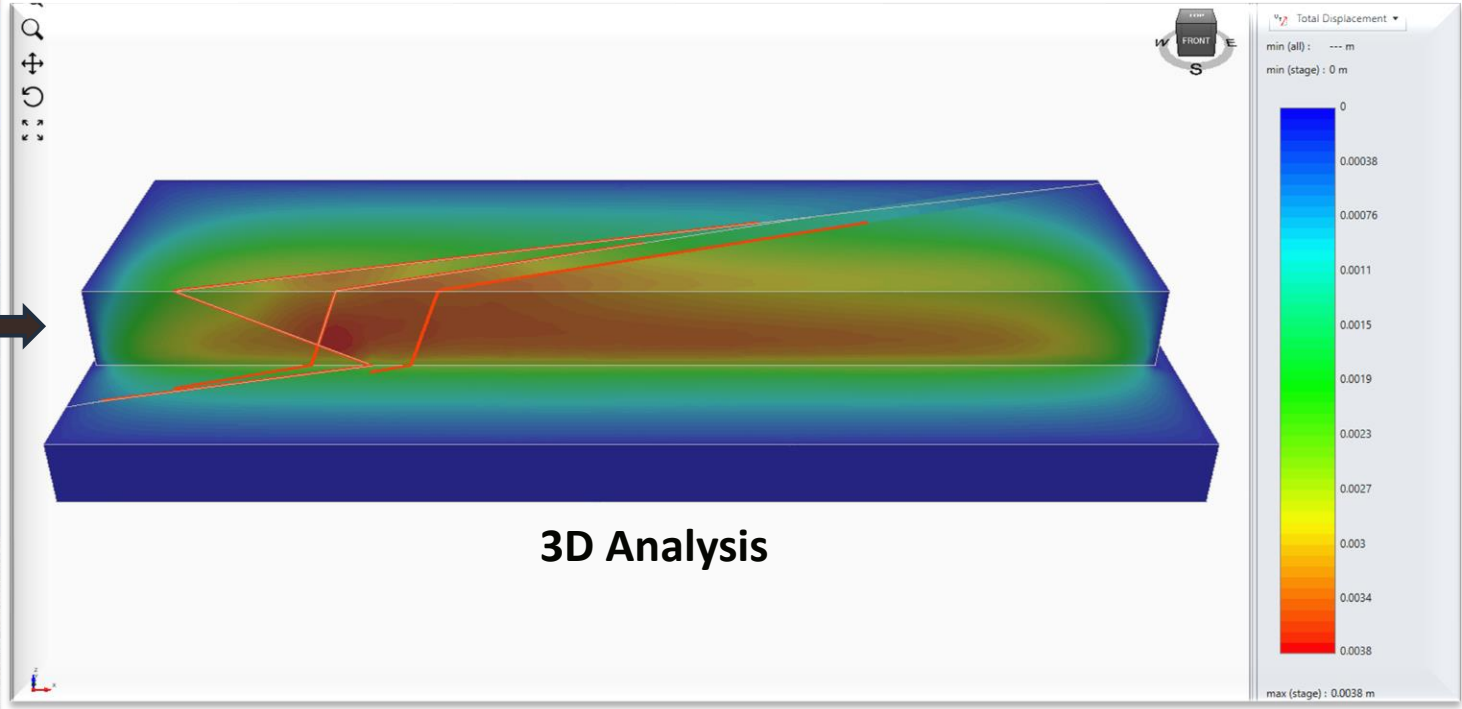




Wedge Failures

Planar Failures



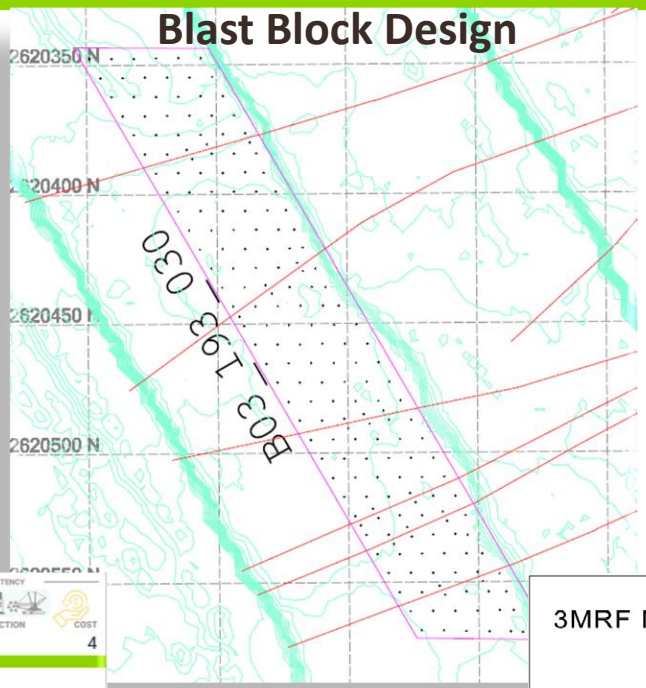


3D Analysis

Risk Management-Strategies

- Crest and Toe demarcation standards
- Mining operations Training
- Inclusion in blast block design
- Proactive numerical modelling and analysis
- Ground control Hazard plan

Blast Block Design



BENCH 7 HIGHWALL – FAULTED GROUND

Risks

- Faults intersected on **B07-181-110 and B07-171-090.**
- Potential Fall of Ground and Slip planes.
- Potential planar failure associated with these faults.
- Not safe for equipment, personnel and infrastructure.

Controls

- **Mini Hira** conducted together with **competent persons** for any work taking place within the standoff distance of the Faulted highwall
- **Demarcate** in accordance with the Highwall Demarcation Standard. This includes using a grader lead with safety poles or safety berms, **ensuring a 10m demarcation from the toe of the highwall.**
- **Demarcate 2m** away from **fault cracks** on the **crest**
- Communicate with Rock Engineering personnel for any rock related issues.

Training Material

Ground Control Hazard Plan

LEGEND
- May
- June
- July
- Powerline
- Escape Routes
- Ground Control Hazards

GROUND CONTROL HAZARDS

No.	AREA DESCRIPTION	CONTROL MEASURE
1	In-Pit Backfill Operations through bench 12	Limited access
2	Accumulated water B13 North	Limited access
3	Faulted area, Northern ramp system	Limited access
4	Fault Slip surface risk Bench 4 & Bench 5	Demarcate crest and toe
5	Fault Slip surface risk Bench 4 East-West	Demarcate crest and toe
6	Risk of UEN slope failure	Divert water away from UEN

3MRF MAY - JULY 2025

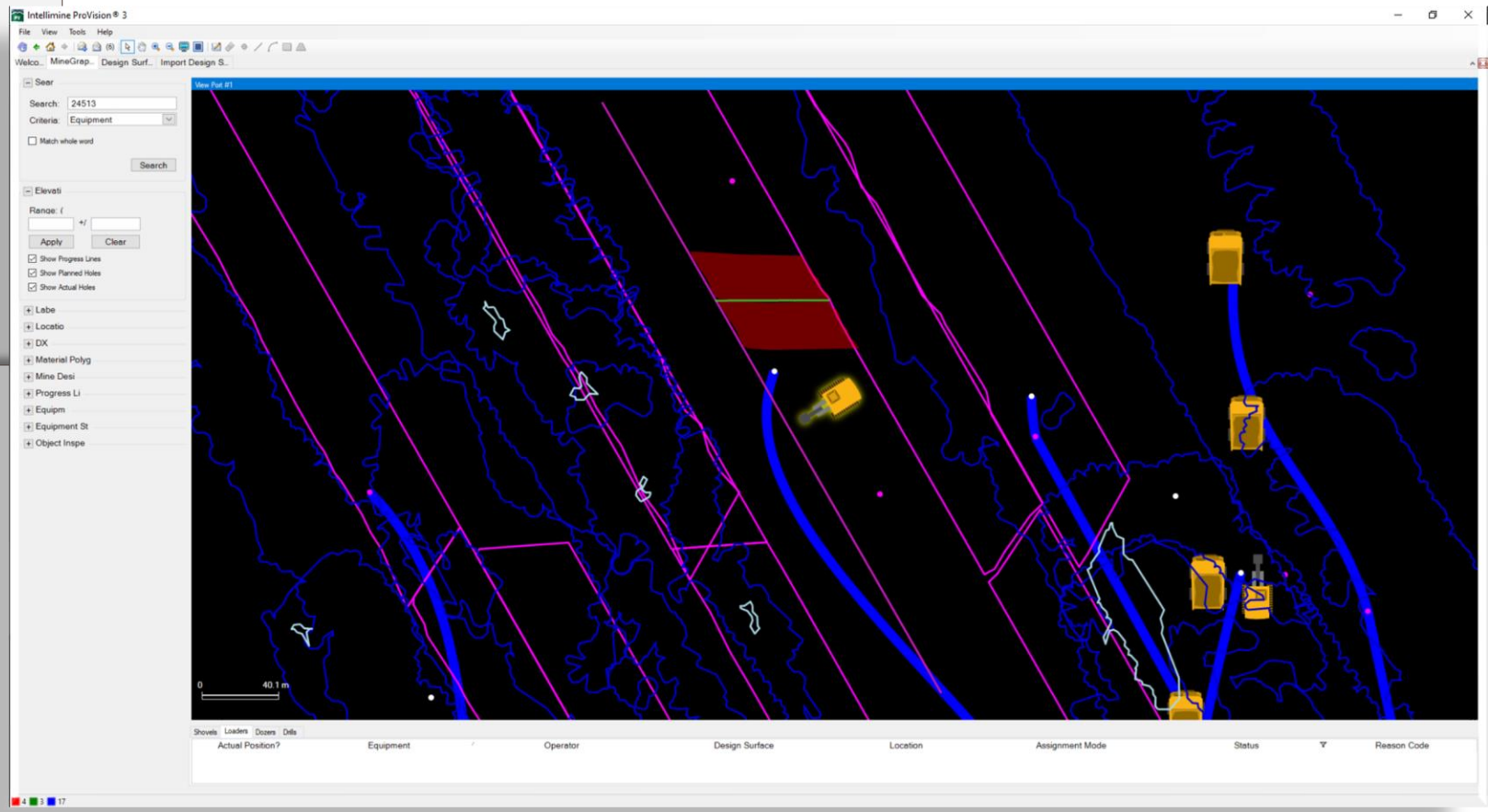
DATE: 2025-05-01
DRAWN: F DENGA
CHECKED: S.P.de WITT
DATA: PIT FACES 2025-04-28

Manager MRM: _____
Manager Mining: _____
Manager Plant: _____

exxaro POWERING POSSIBILITY

Future Management Strategies

- High precision loading system
- Displays the mining block information i.e., block elevation, material types, faulting & boundaries on the in-cabin screen.
- The proximity to faulted ground will be displayed on the screen, that the operator will use as a guide whilst loading.
- The system itself offers guidance to the operator in real-time.



Conclusion

In conclusion, effective geological fault risk management at Exxaro Grootegeluk Coal Mine is paramount for ensuring consistency in safety, production, and cost control. The mine actively addresses fault risks through a comprehensive approach that includes detailed data collection, thorough fault characterization, and advanced kinematic and numerical analyses. Key risk management strategies involve clear demarcation standards, specialized training for mining operations, and the integration of fault considerations into blast block designs and proactive numerical modeling. Looking ahead, Exxaro is committed to enhancing these strategies with high-precision loading systems that provide real-time guidance to operators, further mitigating risks associated with faulted ground and reinforcing the culture of consistency