Kriel Colliery

Intersection Failure Management

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GEARED FOR EXCELLENCE

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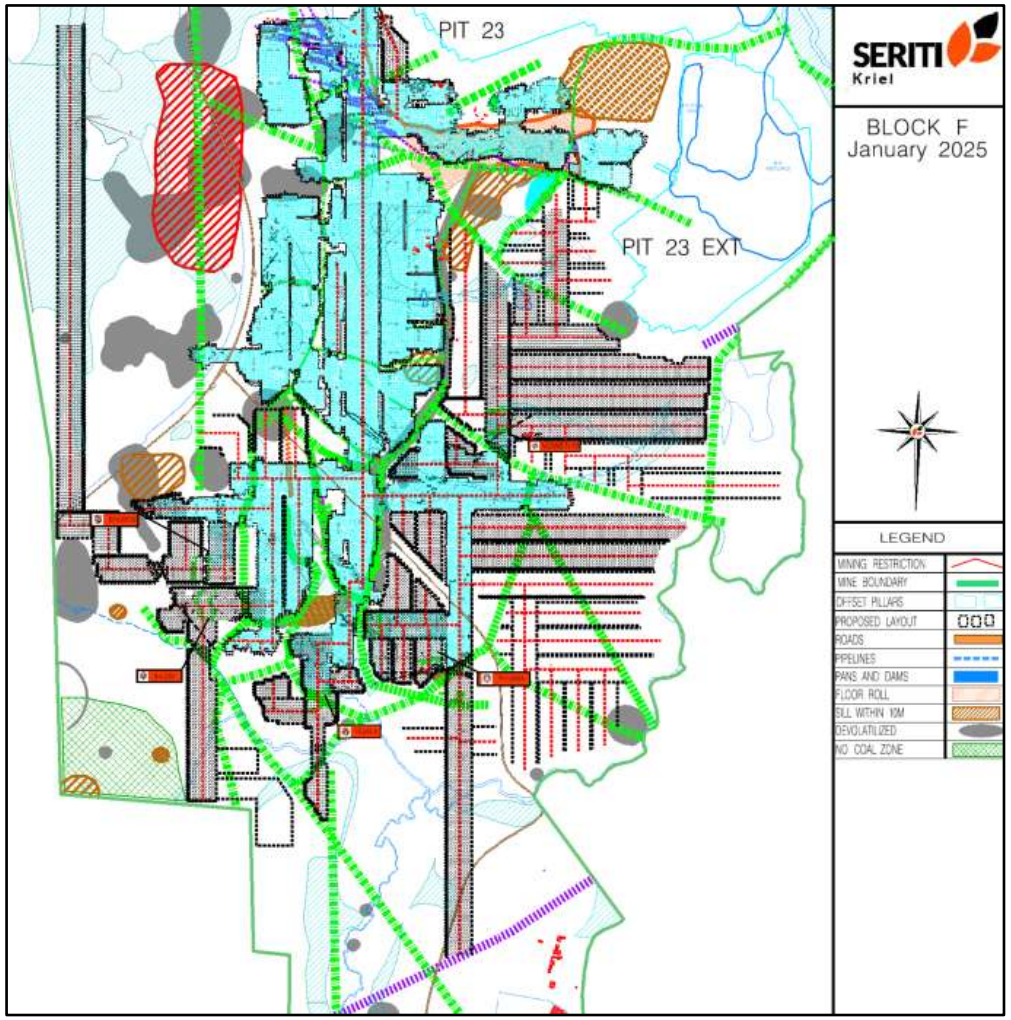
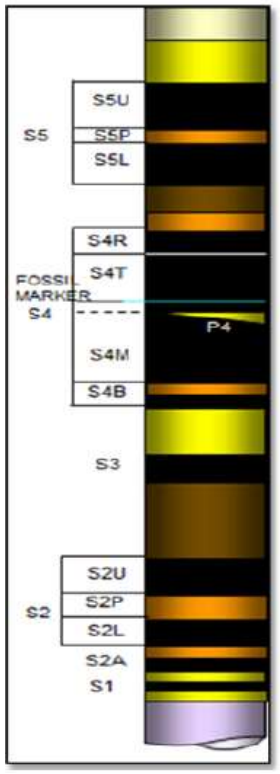
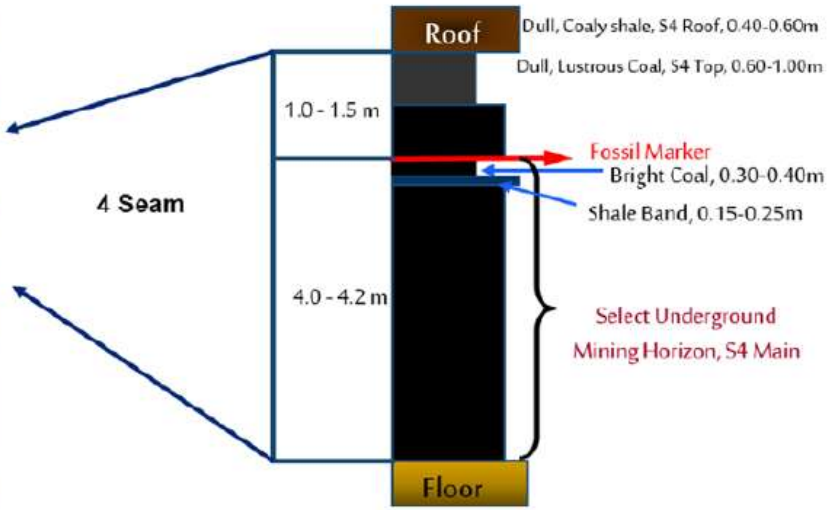
Introduction

Kriel Block F Background





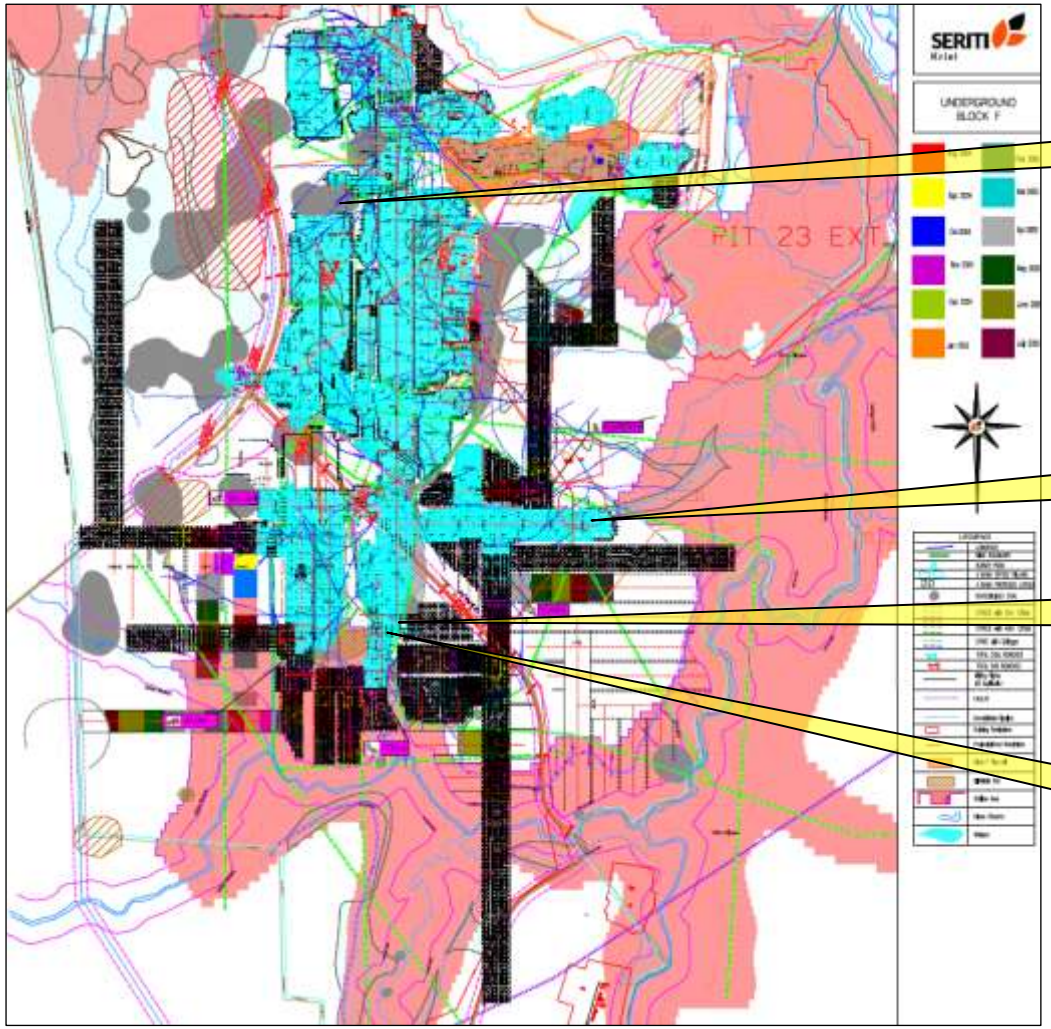


The three principal seams:

- No. 2, 4 and 5 seams.
- Only the No. 4 seam reserves are presently being mined, and these reserves are dedicated exclusively to Kriel Power Station.
- Additional resources contained in No. 2 and 5 seams are not committed in the current Coal Supply Agreement.

Introduction

Kriel Block F Intersection Failures Update



❶ **Fezela**, 02/08/21

❹ **Ngwenya**, 08/07/21

❷ **Fezela**, 17/01/24

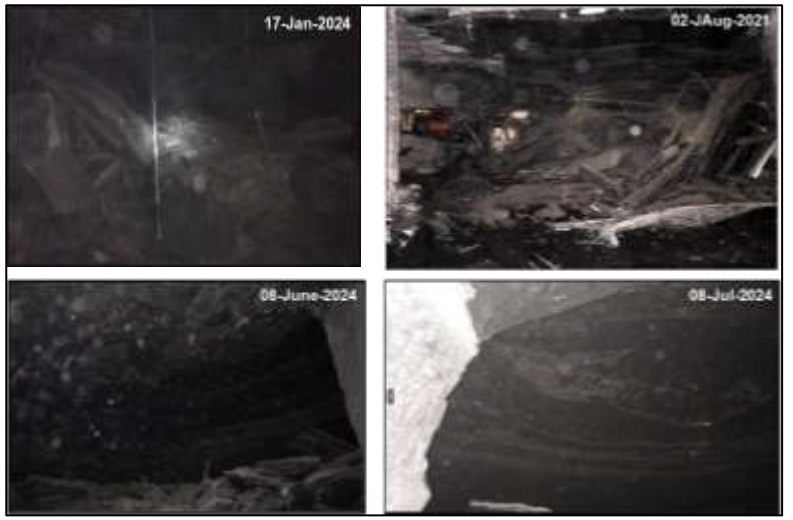
❸ **Fezela**, 08/06/24

One (1) significant FOG event:

- Fezela BF-W4 - 08th August 2021

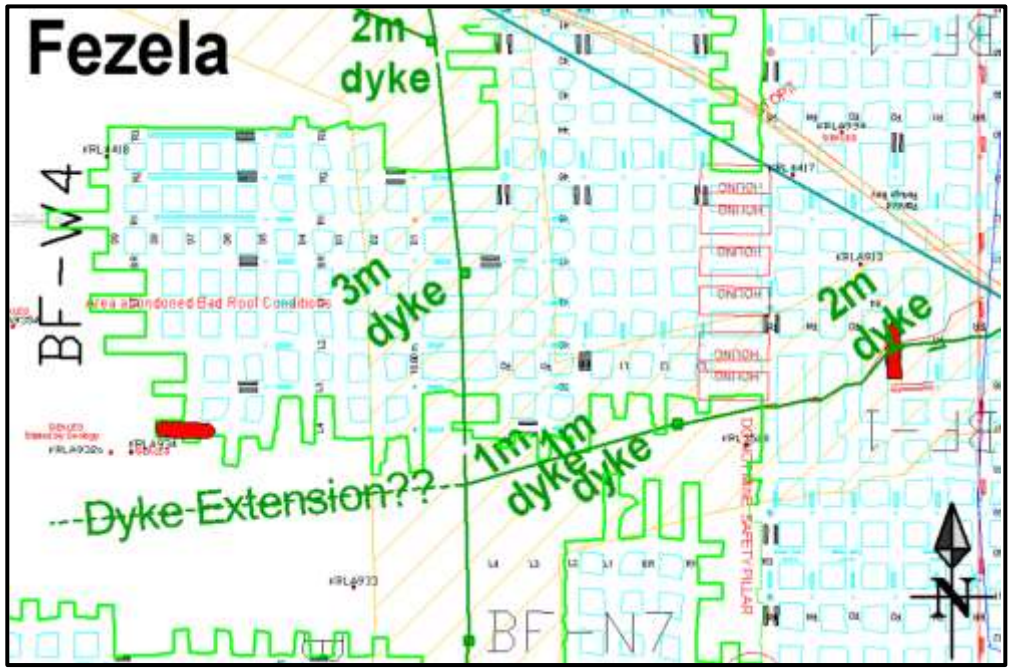
Three (3) significant FOG events:

- Fezela BF-1 - 17 January 2024
- Fezela BF-1 - 08 June 2024
- Ngwenya BF-E7 - 08 July 2024



Intersection Failures

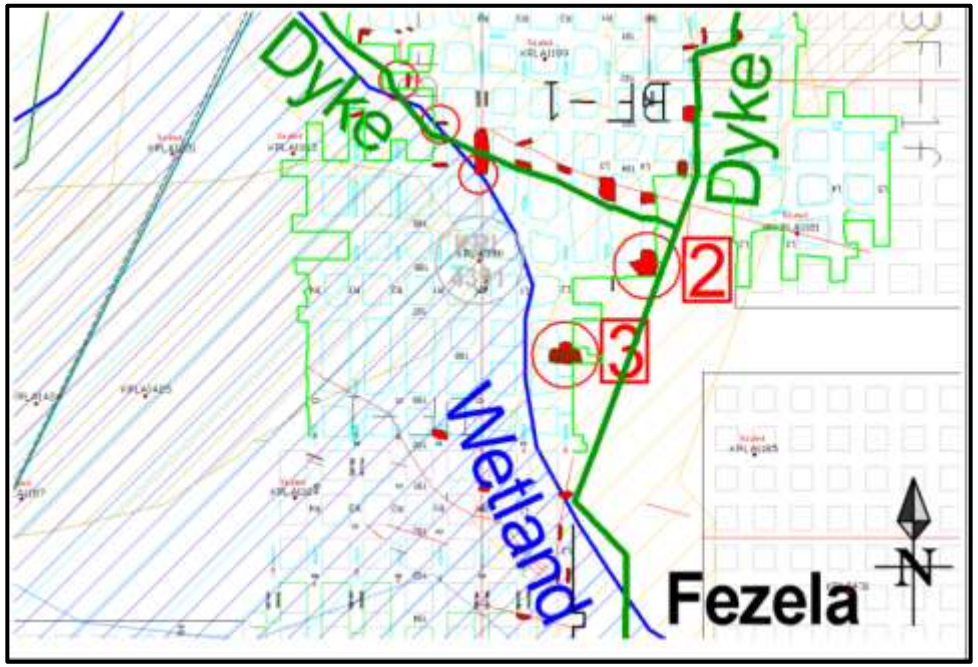
Fezela 02 August 2021 FOG



Parameters	Frequency
Location	BF-W4, Road L4 split 7
Depth	±53m DTF
Bord width	7.2m
Pillar Centres	16m x 18m
Mining height	±4.0m
Bolt length	1.8m x 20mmØ
Additional Information	
Stand-up time	During development.
Roof Lithology	2.79m of interlaminated siltstone, sandstone and shale i.e laminated roof
Geotechnical Anomalies	• Poor ground conditions experienced in neighboring roadways as well as roadway leading up to FoG. • Proximity to a dyke on the southern side. • Dolerite Sill on the floor (devolatilised ground).
Support	• The systematic support pattern reportedly consisted of 5 x 1.8 m long, full column resin (FCR) bolts • Bolts installed concurrent with welded mesh, • support rows spaced ±1 m apart, i.e. 1.33 m² per bolt or 0.77 bolts per m² of roof exposed.

Intersection Failures

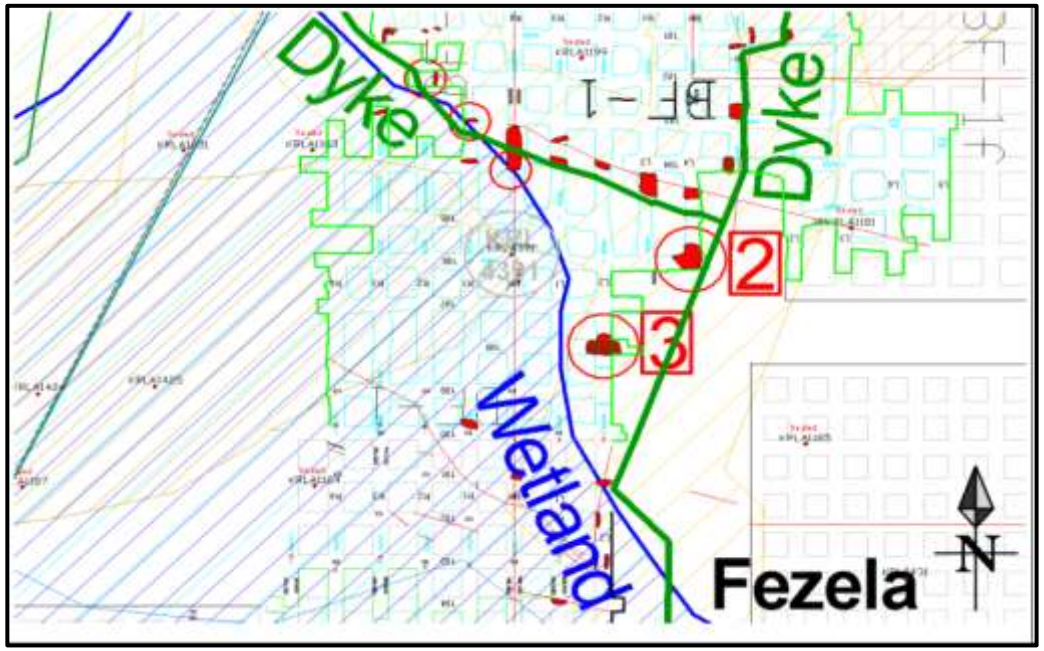
Fezela 17 January 2024 FOG



Parameters	Frequency
Location	Panel BF-1 , BR split 186
Depth	±46m DTF
Bord width	6.8m - 7.2m
Pillar Centres	19m x 20m
Mining height	±4.0m
Bolt length	1.8m x 20mmØ
Additional Information	
Stand-up time	≤ 12 hours after mining
Roof Lithology	• Burnt coal zone, immediately adjacent to a dyke. • Roof strata comprise of interlaminated and interbedded siltstone and carbonaceous shale (2.96m thick).
Geotechnical Anomalies	• NNE-SSE dyke on contact and NW-SE dyke ± 13 m to the north. • Dolerite sill within 10m of #S4 coal seam. • Just outside surface wetland demarcation (i.e. within 100m).
Support	• 6 x 1.8 m long, full column resin (FCR) bolts, installed in consecutive rows, spaced ±1 m apart, • Support installed concurrently with welded mesh i.e. 1.1 m² per bolt or 0.92 bolts per m² of roof exposed.

Intersection Failures

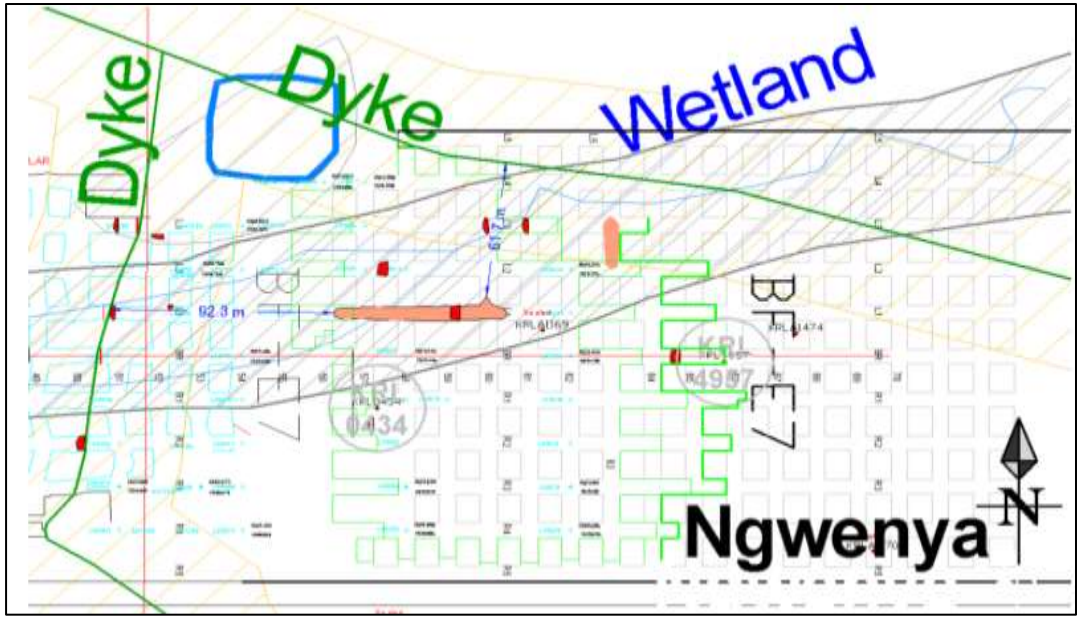
Fezela 06 June 2024 FOG



Parameters	Frequency
Location	Panel BF-1, Road L2 split 188
Depth	±46m DTF
Bord width	6.8m - 7.2m
Pillar Centres	19m x 20m
Mining height	±4.0m
Bolt length	1.8m x 20mmØ
Additional Information	
Stand-up time	± 2 months
Roof Lithology	• Roof strata comprise of interlaminated and interbedded siltstone and carbonaceous shale.
Geotechnical Anomalies	• Adjacent to a dyke on the eastern side. • Slips encountered across split 188. • Dolerite sill in the roof. • Surface wetland proximity.
Support	• The systematic support pattern consisted of 5 x 1.8 m long, full column resin (FCR) bolts, installed in rows spaced ±2 m apart, i.e. 2.88 m² per bolt or 0.35 bolts per m² of roof exposed. • Welded mesh was installed concurrently with the systematic support, reportedly for the coverage of the slip.

Intersection Failures

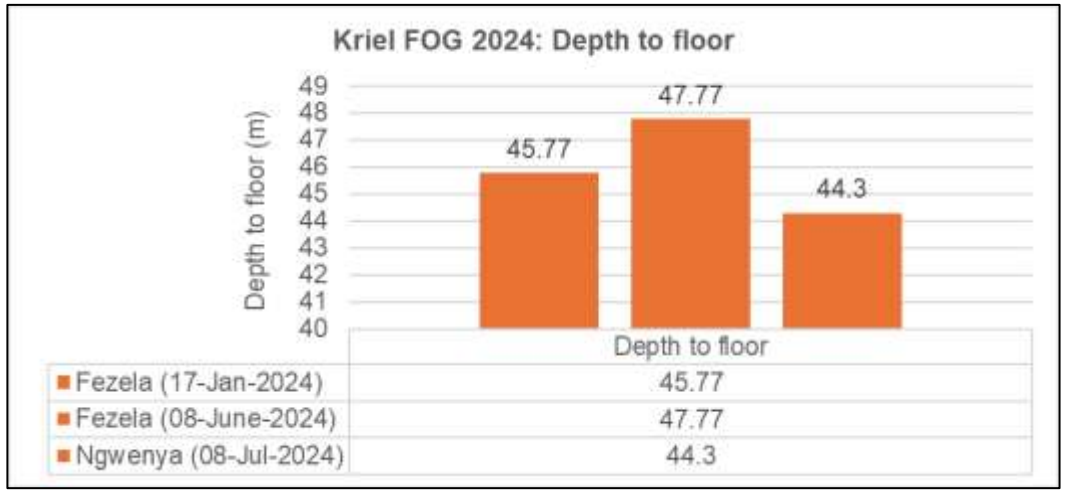
Ngwenya 06 July 2024 FOG

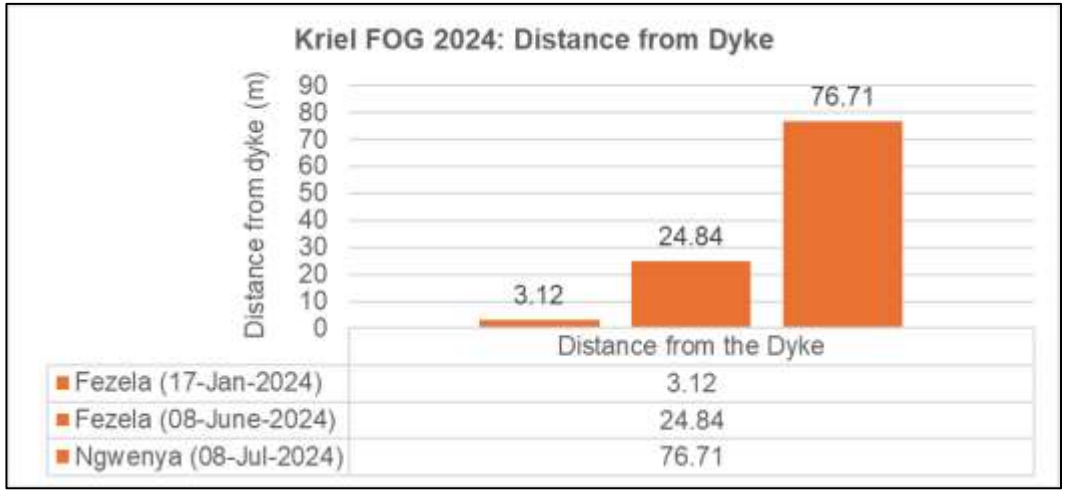


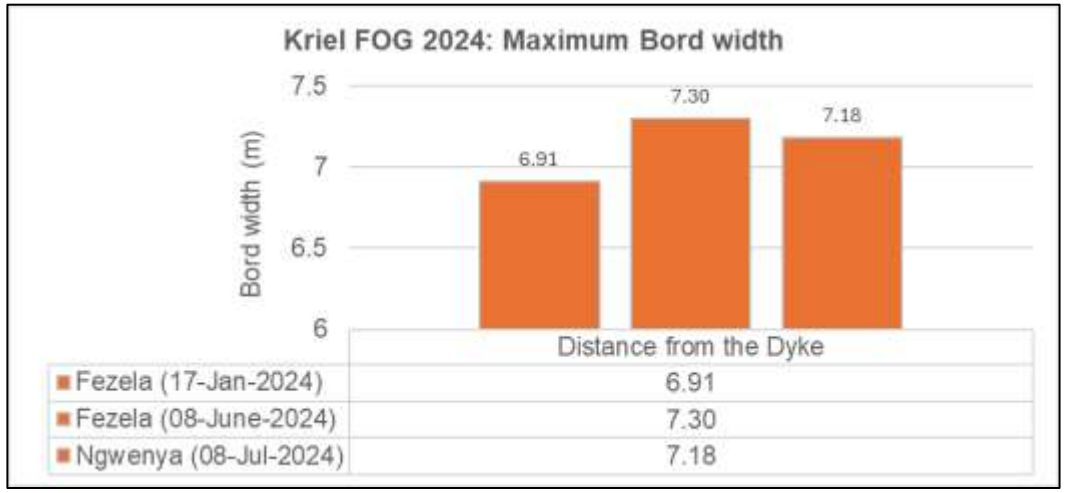
Parameters	Frequency
Location	Panel BF-E7, Road L1 split 58
Depth	±42m DTF
Bord width	7.2m
Pillar Centres	17m x 20m
Mining height	±4.0m
Bolt length	1.8m x 20mmØ
Additional Information	
Stand-up time	±2 – 3 weeks after mining
Roof Lithology	2.95 m thick, carbonaceous fines (siltstone) layers of varying thicknesses within the immediate roof.
Geotechnical Anomalies	• Two dykes in close proximity, WNW-ESE dyke ±62 m to the north and NNE-SSE dyke ±92 m to the west. • Surface stream (Wetland) proximity with significant amount of water in roof. • Significant water pressure and seepage in the roof. • Possible washed out and/or weaker resin bond.
Support	• Systematic support pattern of 4 x 1.8 m long, full column resin (FCR) bolts, spaced 2 m apart, i.e. 3.6 m² per bolt or 0.28 bolts per m² of roof exposed.

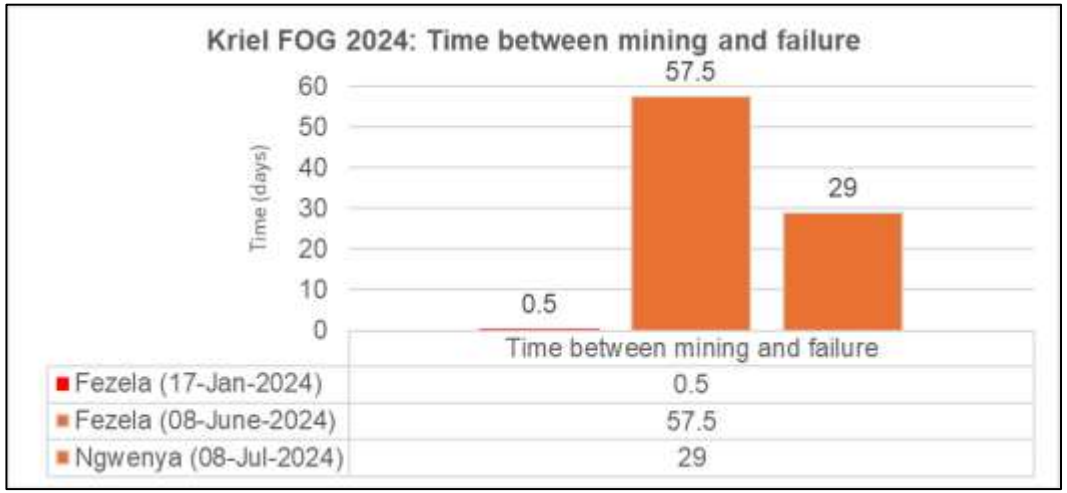
Kriel's FOG Risk: What are we dealing with?

Mining Dimensions









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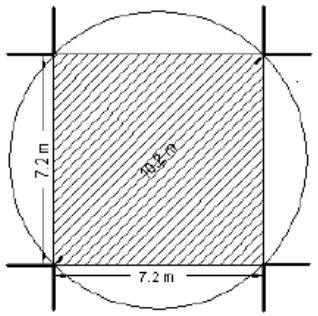
Kriel's FOG Risk: What are we dealing with?

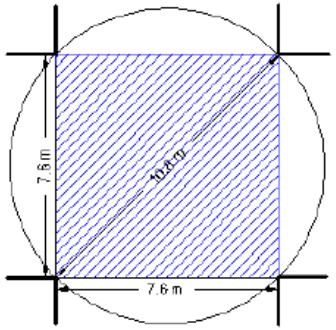
Mining Dimensions – Intersection span

Defining of Intersection Sizes

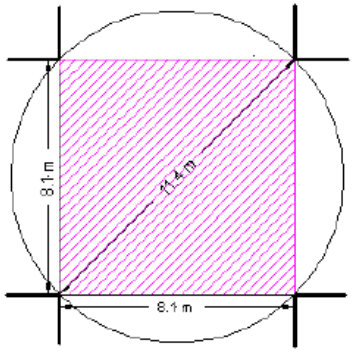
Intersection Class	Road width	Typical offline%	Polygon area	Circle Area
Small	up to 7.2 m	0 %	51.8 m²	81.3 m²
Normal	7.2 m – 7.6 m	6 %	58.2 m²	91.3 m²
Enlarged	7.6 m – 8.1 m	6 % - 12 %	65.0 m²	102 m²
Oversized	8.1 m +	12 % +	> 65.0 m² +	> 102 m² +



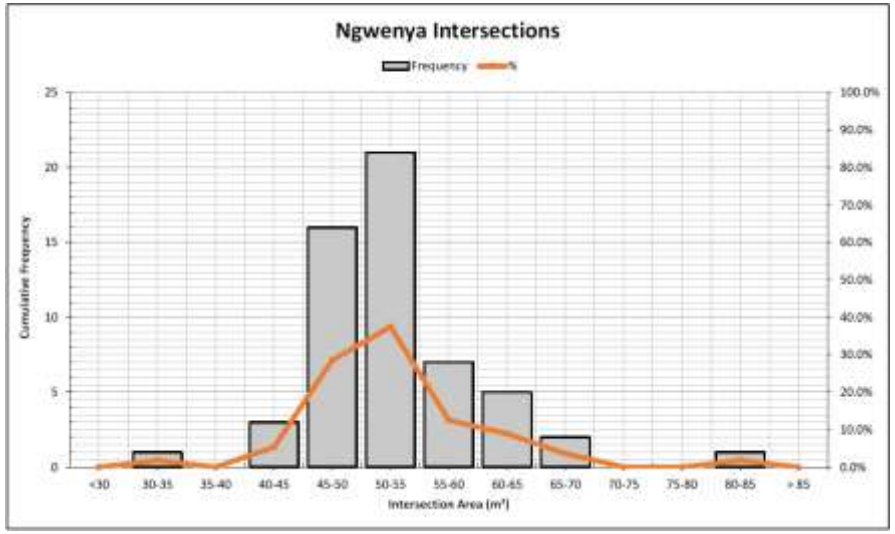
Small

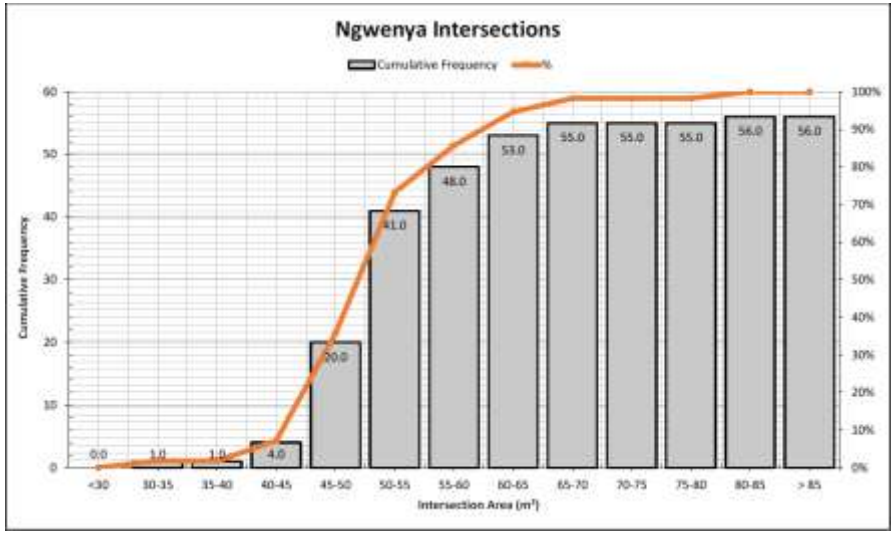


Normal



Enlarged





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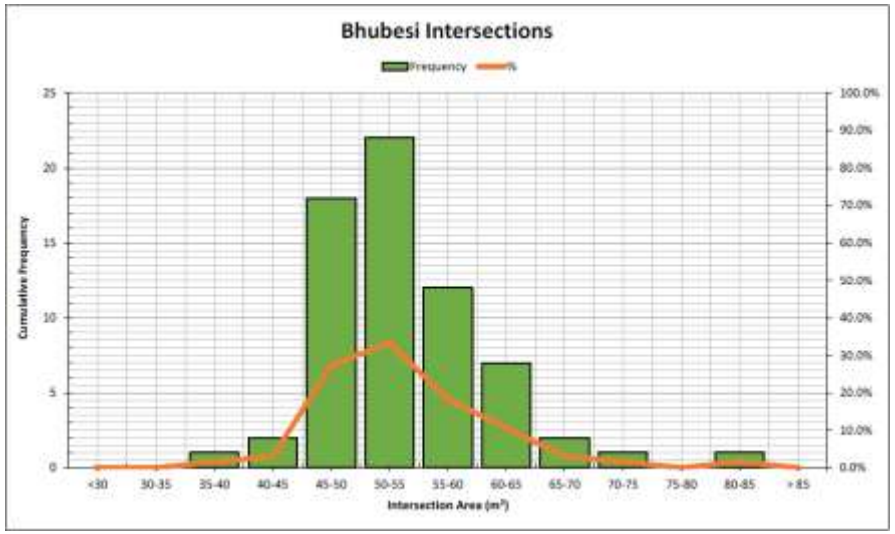
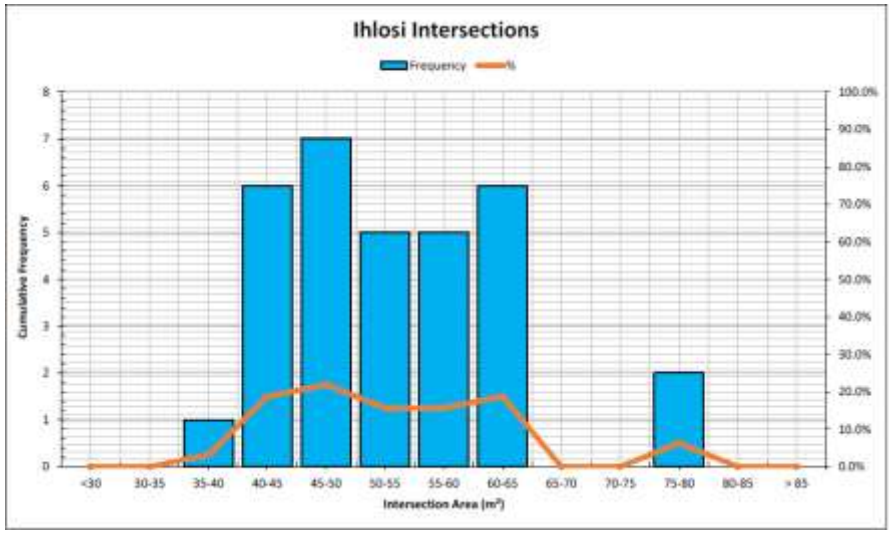
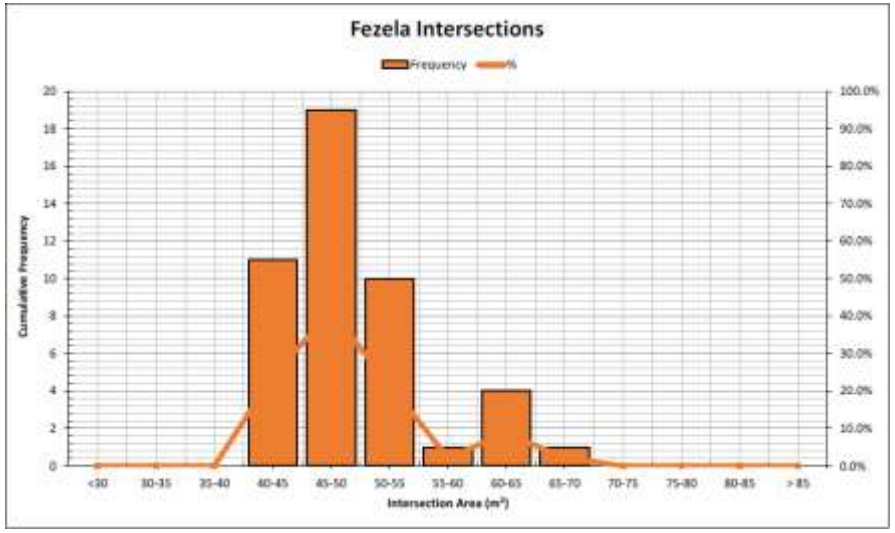
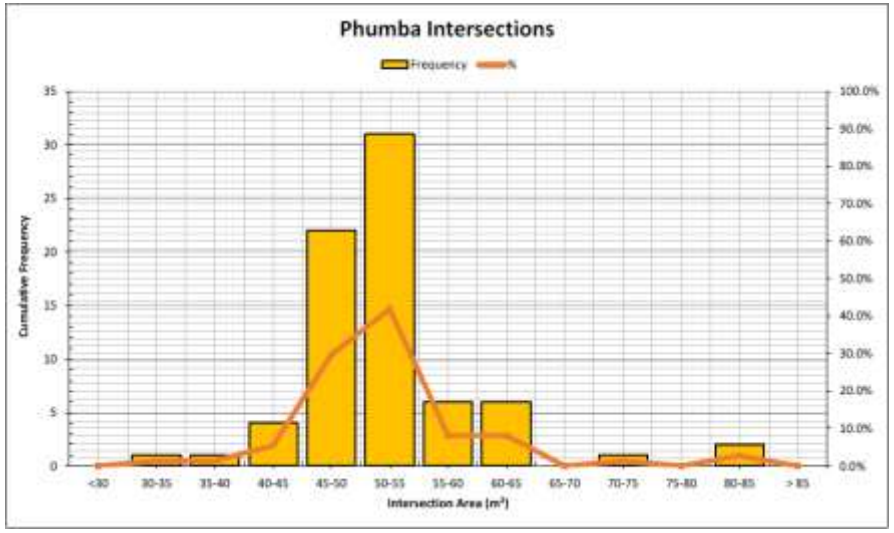
Kriel's FOG Risk: What are we dealing with?

Mining Dimensions – Intersection span









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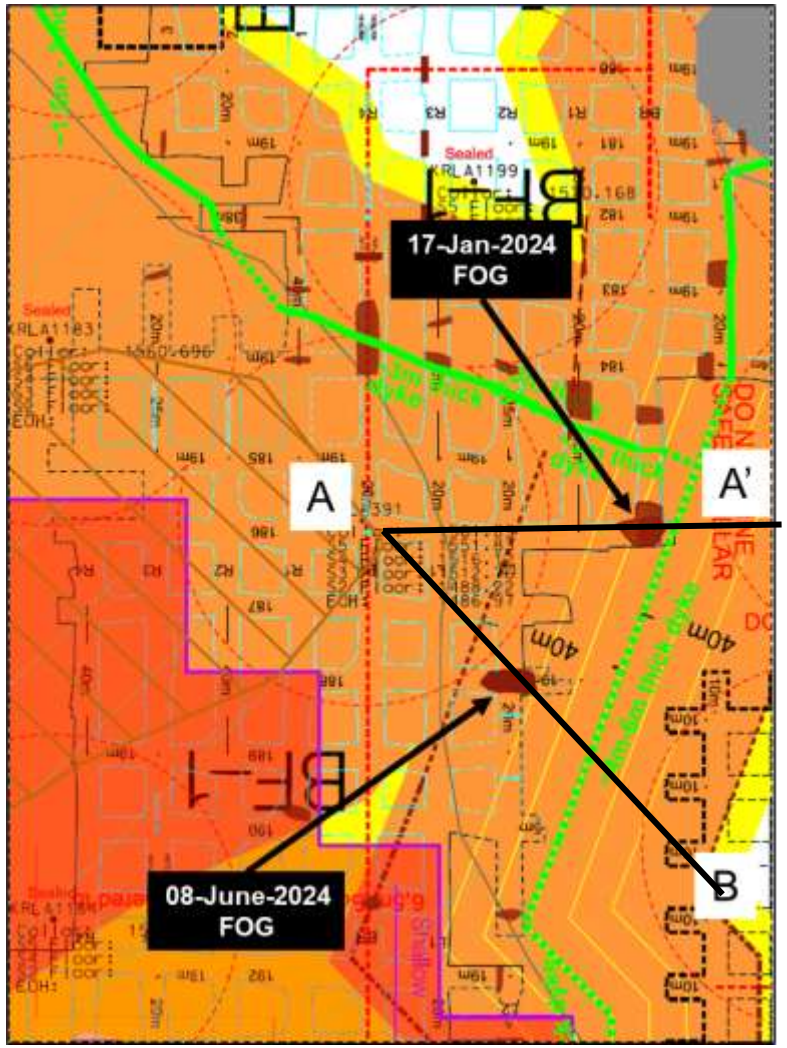
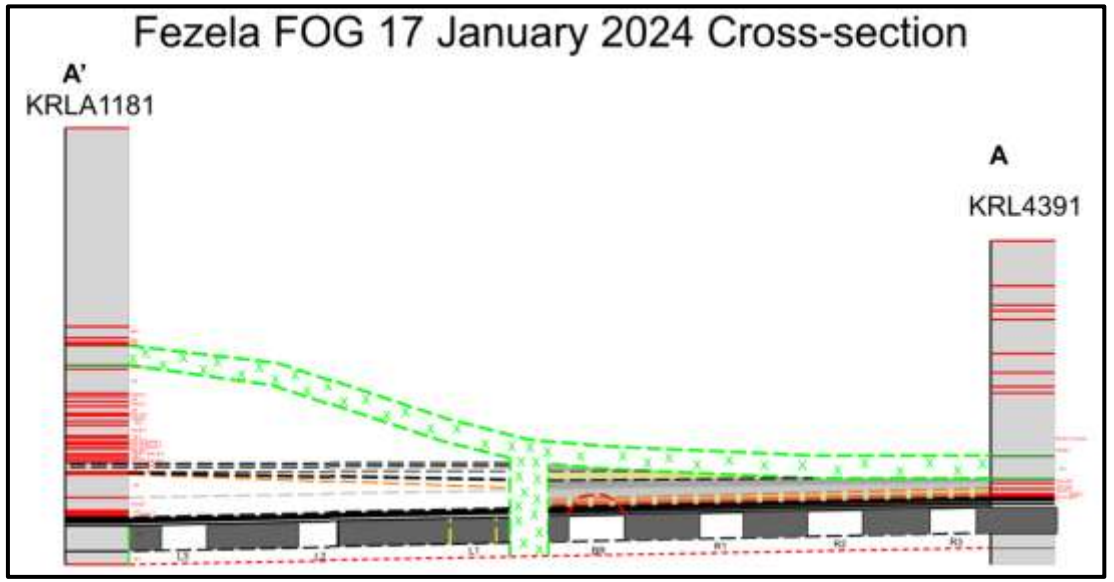
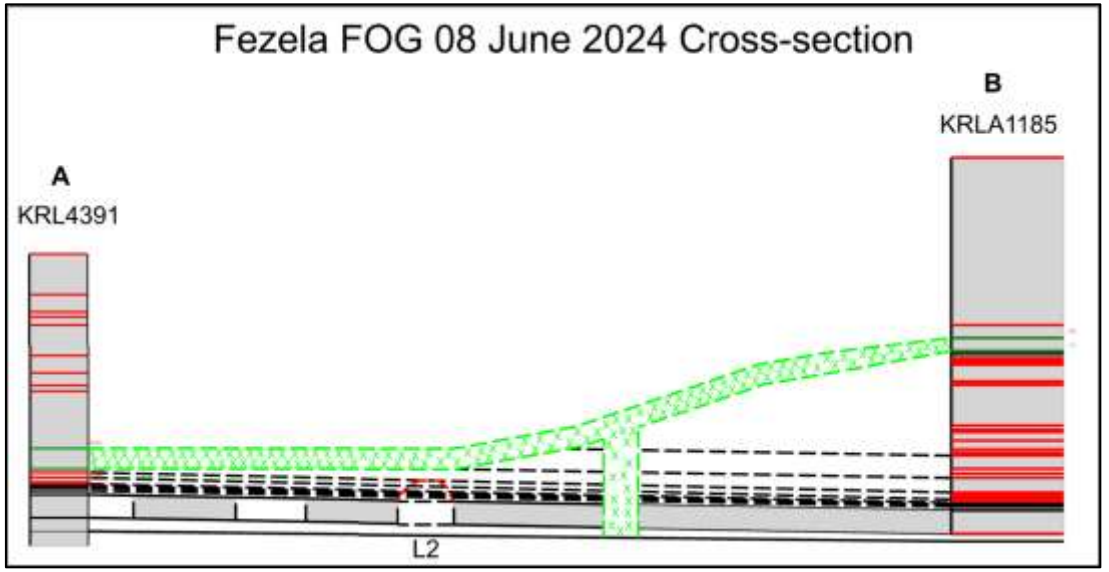
Kriel's FOG Risk: What are we dealing with?

Complexity of the Geology







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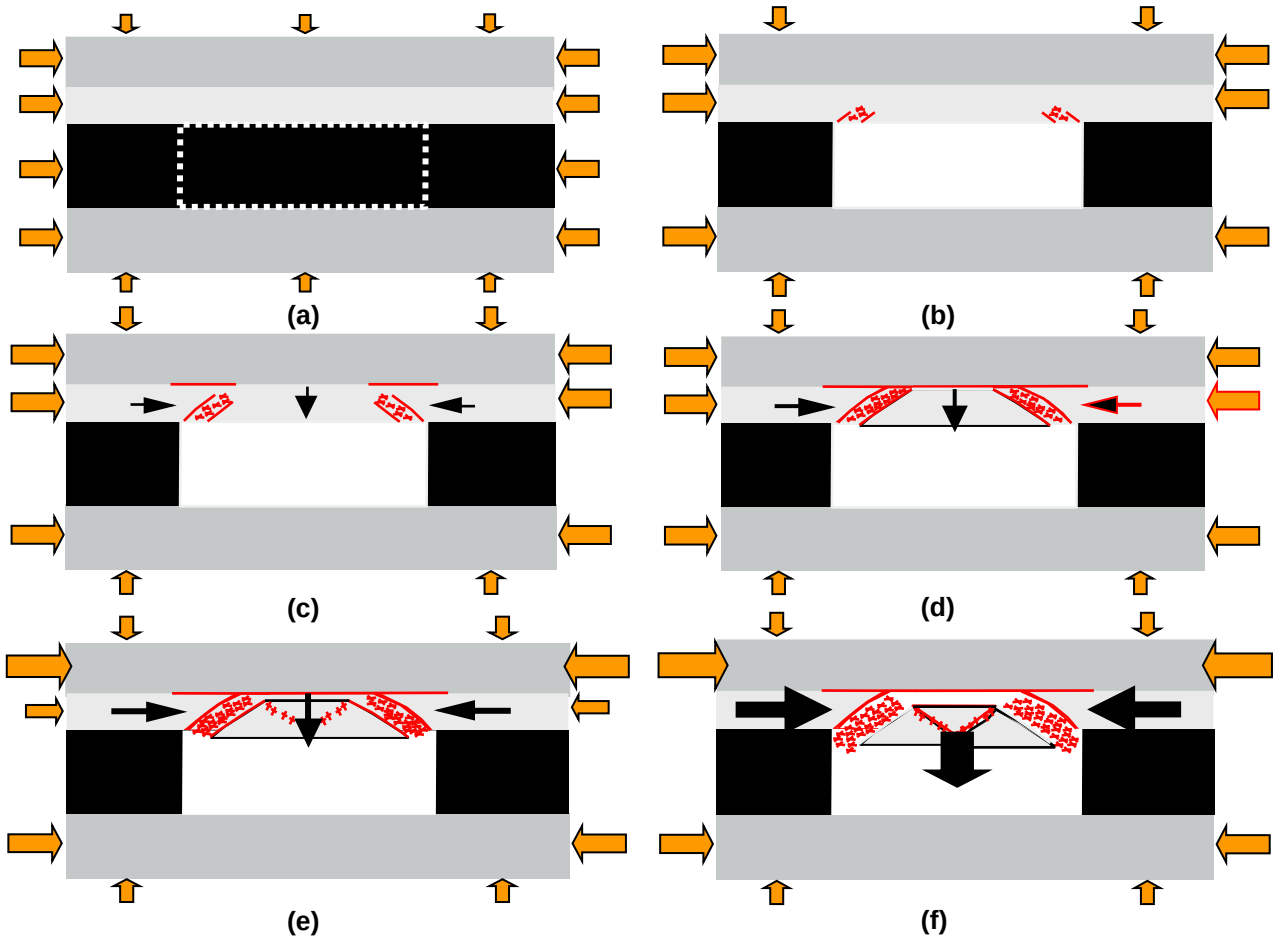
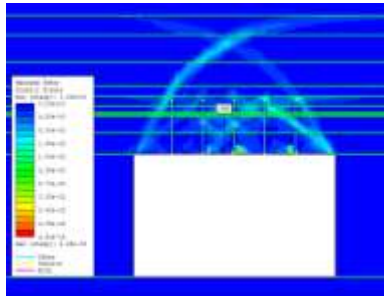
Kriel's FOG Risk: What are we dealing with?

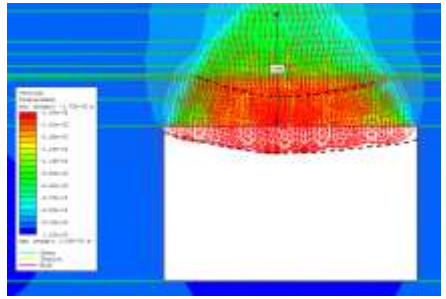
Failure Mechanism



Max Shear strain



Max vertical displacement

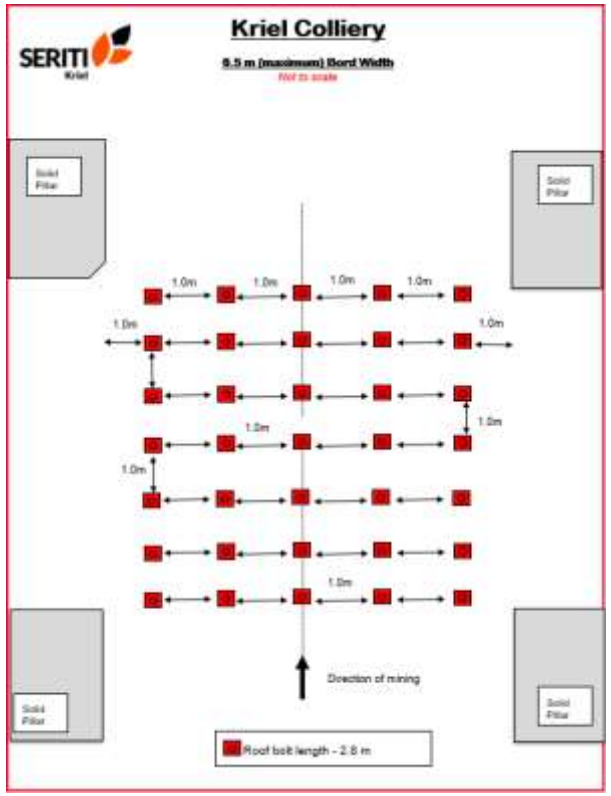


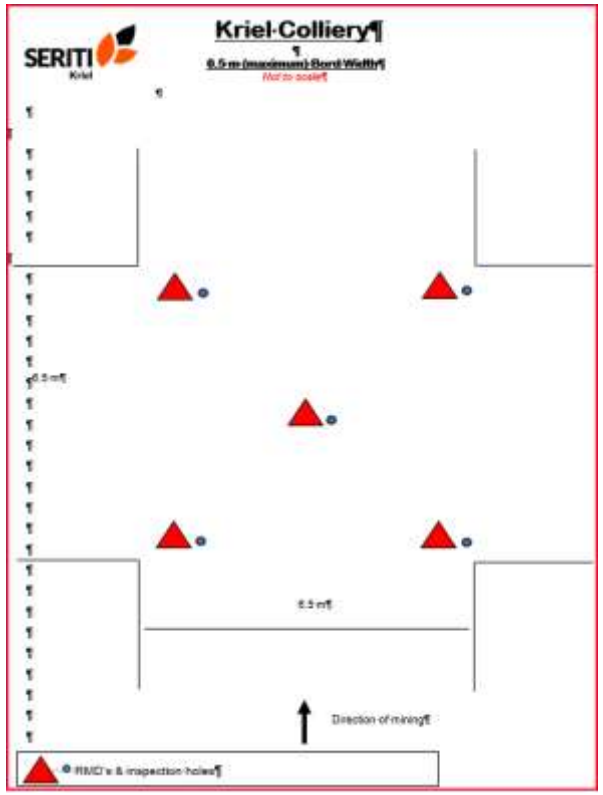
Beam buckling:

- Failure initiates from the corners (max. shear at corners).
- Failure could potentially over-run the installed support (bolts on the edges to far from pillar sidewall).
- Simplified RS2 simulations provided reasonable estimates of the possible failure mechanism.

Intersection Failure Management Strategy

Devolatilised ground – 2.8m bolts secondary support pattern

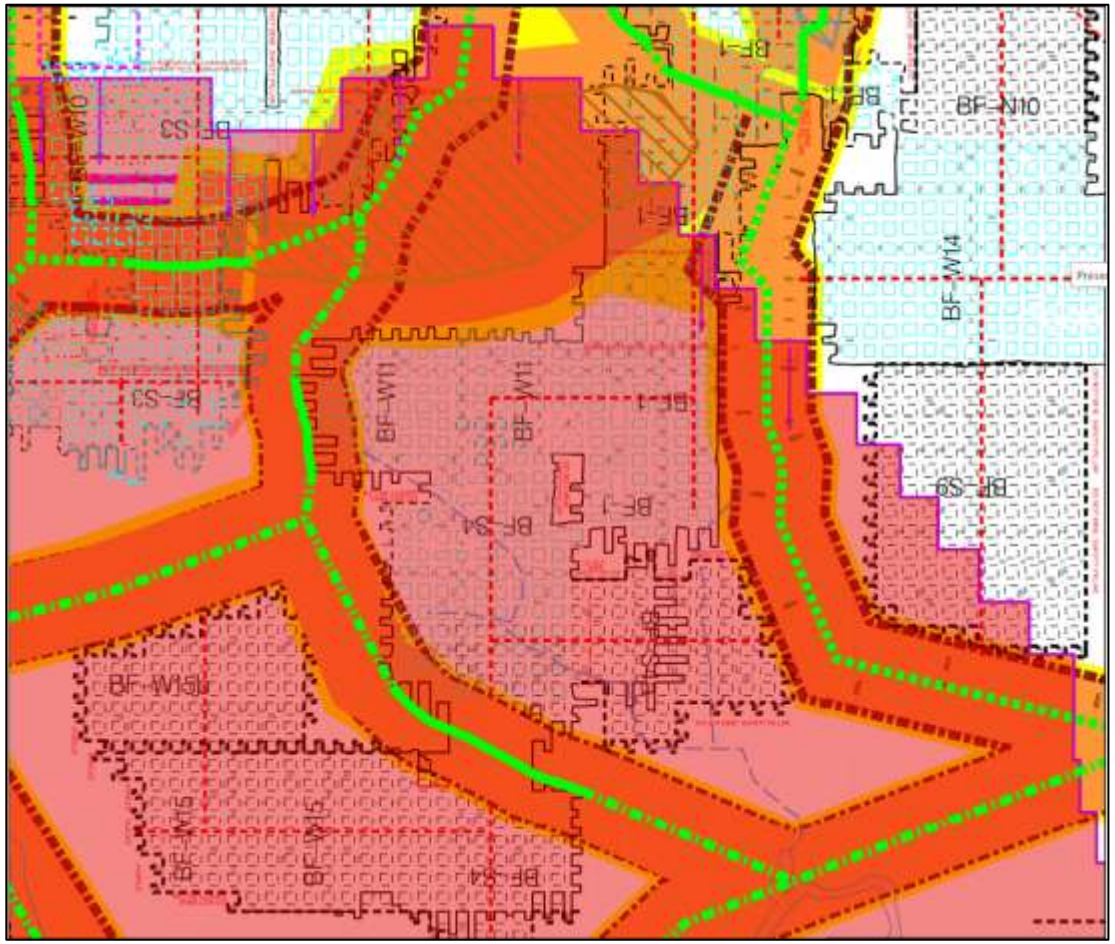




- Learnings from the **Fezela August 2021 FOG**, the following strategy was adopted for dealing with devolatilised ground:
  - Avoid as much as possible mining through devolatilised ground.
  - Where required to mine through devolatilised ground, secondary support consisting of 2.8m bolts must be installed.
  - Intersection support consists of the following:
    - Five (5) 2.8m x 20mmØ FCR bolts per row
    - **1.0m** spacing between individual bolts and **1.0m** spacing between rows.
    - Support installed
  - Intersection Monitoring consists of the following:
    - Five (5), 4.0m LED RMDs

Intersection Failure Management Strategy

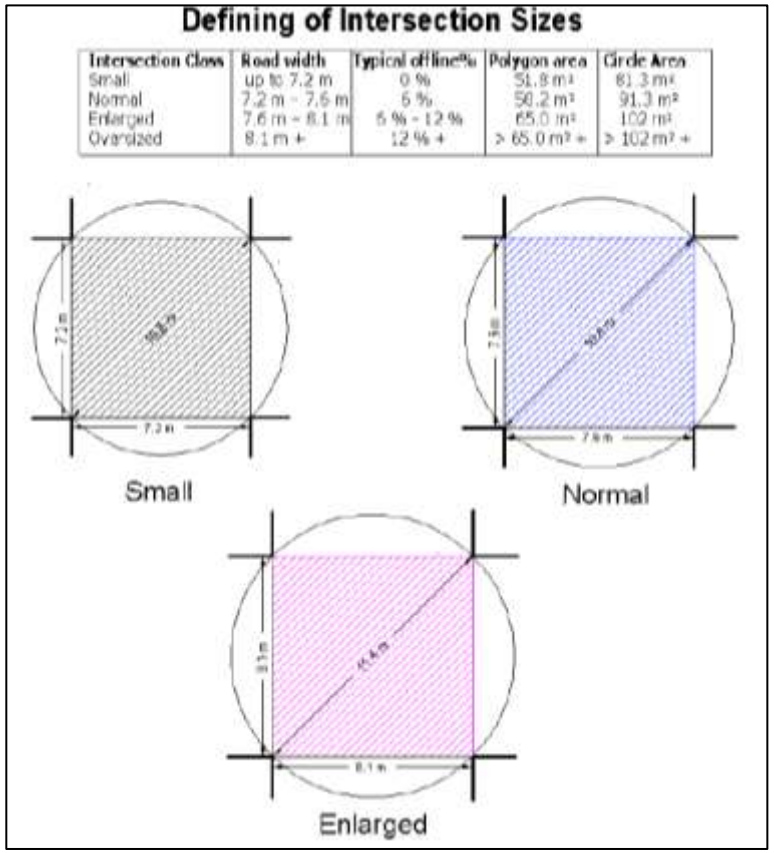
40m zoning around dolerite intrusions

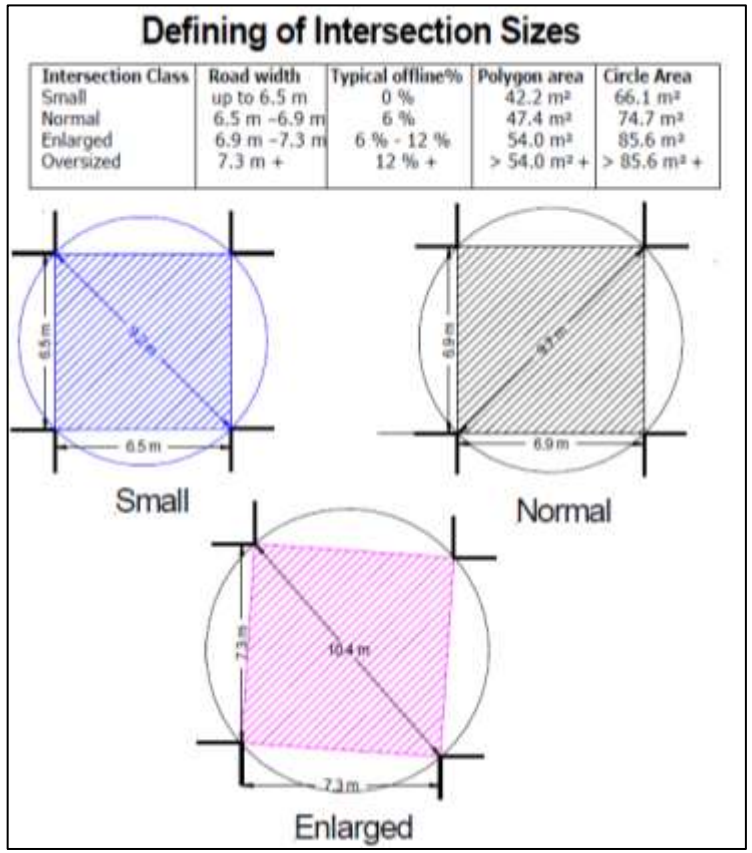


- Learnings from the **Fezela 2024 FOGs**, the following strategy was adopted for dealing with dolerite intrusions:
  - Avoid mining within 40m of any projected dyke if the intention is not to mine through the dyke.
  - Initiate the change in support at the start of the 40m zoning of the dykes:
    - Increase density by reducing the support row spacing.
    - Increase number of bolts per row.
    - Increase the length of bolts (1.8m to 2.8m bolts).
  - This allowed also for more Impact splitting tests to be conducted within the 40m zoning of the dyke to inform the support recommendations.

Intersection Failure Management Strategy

Bord width and intersection span

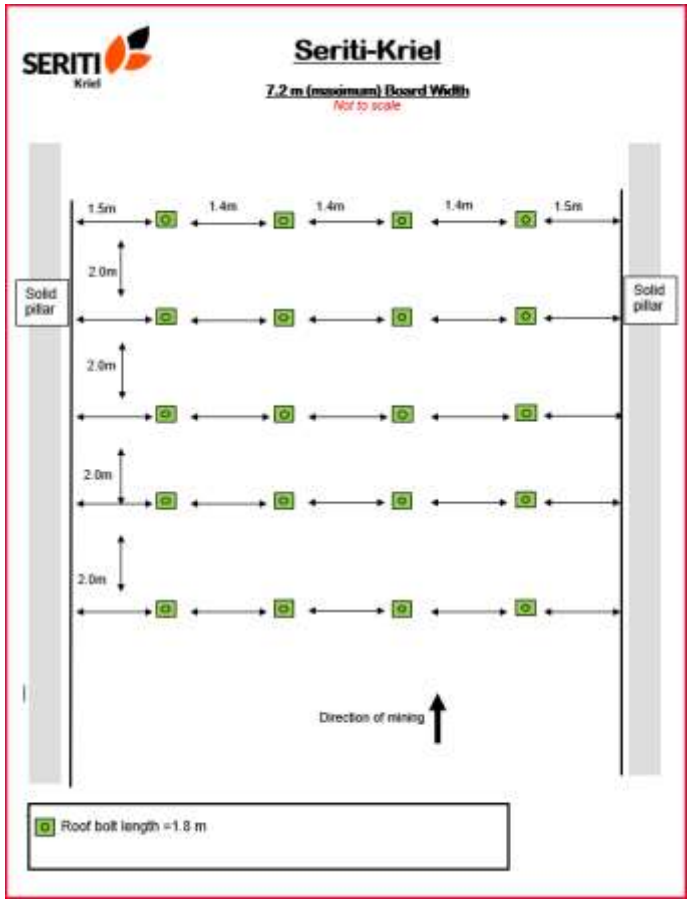


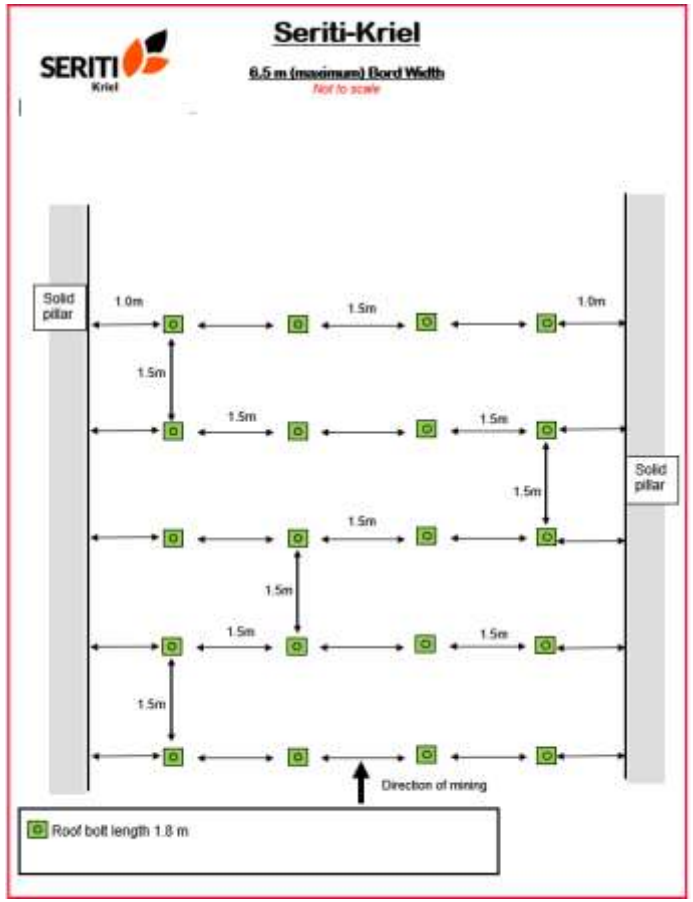


- Learnings from the **Ngwenya July 2024 FOG**, the following strategy was adopted for dealing with dolerite intrusions:
  - Strengthened the use of TARP in critical control verification systems.
  - Reduce the bord width mine wide from 7.2m to 6.5m. This allowed for approximately 18.5% reduction in the polygon area of the normal planned intersections.

Intersection Failure Management Strategy

Systematic Support Pattern





- Learnings from the **Ngwenya July 2024 FOG**, the following strategy was adopted for dealing with dolerite intrusions:
  - **Initial** design consisted of the following:
    - Four (4) 1.8m x 20mmØ FCR bolts per row
    - **1.4m** spacing between individual bolts and **2m** spacing between rows.
    - **1.5m** spacing between the pillar sidewall and the first bolt.
    - Maximum bord width of **7.2m**.
  - **New** Design consists of the following:
    - Four (4) 1.8m x 20mmØ FCR bolts per row
    - **1.5m** spacing between individual bolts and **1.5m** spacing between rows.
    - **1.0m** spacing between the pillar sidewall and the first bolt.
    - Maximum bord width of **6.5m**.

Intersection Failure Management Strategy

Secondary and Specialized Support

- **Fault Development Support at Panel BF-W12:**
  - Systematic support consists 2.8m x 20mmØ FCR only
  - Systematic support installed with welded mesh to provide areal coverage.
  - Specialized support consists of for (4) 6m long full-grout anchors per row at 1.5m x 1.5m grid spacing.
- **4m long anchors currently in the trial phase at Kriel (training of all operators).**

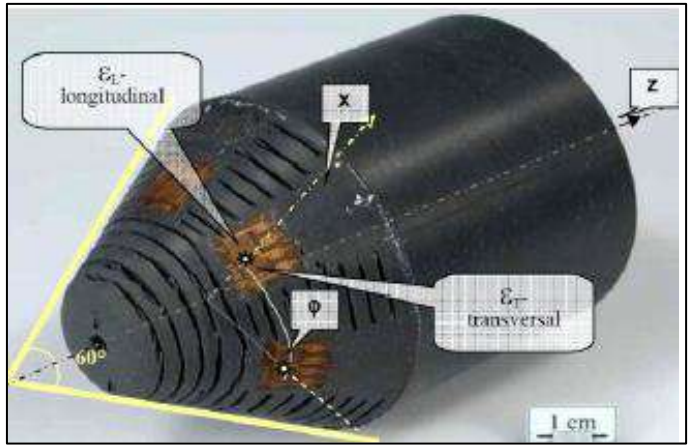
Kriel Block F Future Projects

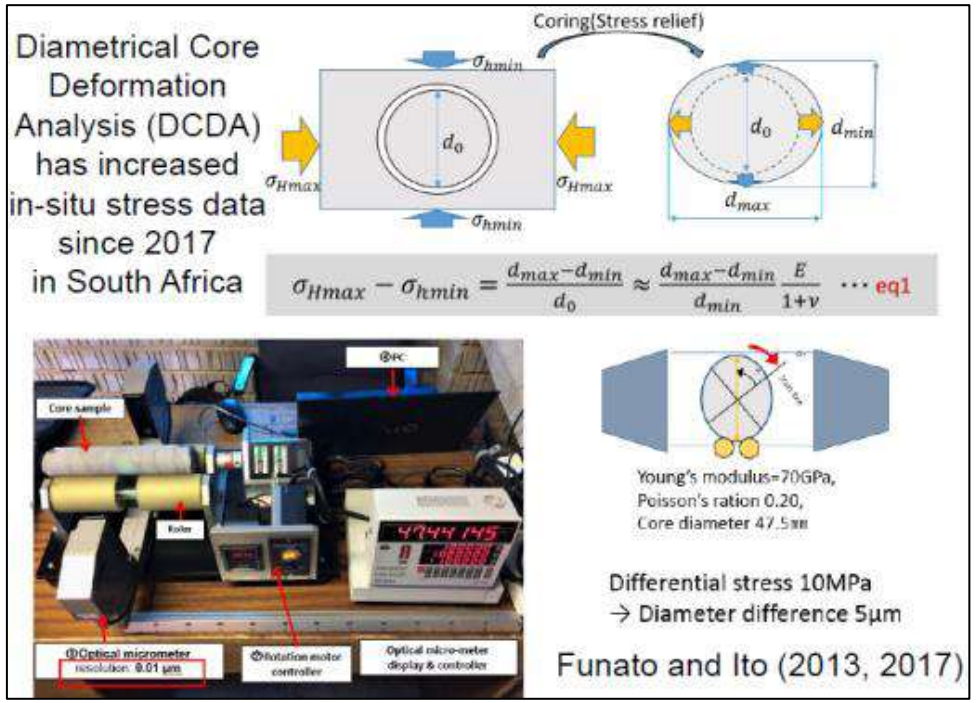
CSIR/Coaltech Stress measurement Project

Aim:

- Measurement of the stress field components as a geologically complex area is approached with the **CCBO (Compact Conical Borehole Over-coring)** method, will contribute to quantify the impact of these structures on the magnitude and / or orientation of the field stress components.

- At the same time, correlating these measurements with measurements obtained using the **DCDA** (**Diametrical Core Deformation Analysis**)method, could allow the drilling of core in a similar rock type where stress components are required (regular basis in very geologically complex areas) and measurement of the stress component magnitudes and orientations





Kriel Block F Future Projects

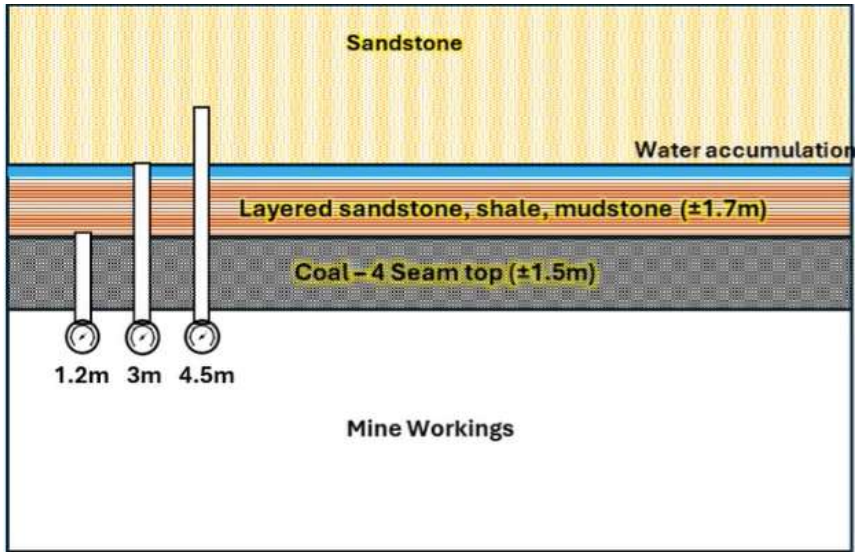
Monitoring of the Hydraulic Pressure in the Roof Using Kleynex Piezometers

Aim:

- Determine the effect of groundwater pressure on roof stability
- Research and develop a special tool to measure the immediate water pressure during routine inspections.
- To determine the impermeable layer that is causing the release of water.
- Dewatering strategy

Requirements:

- Piezometer, consists of a telescopic pipe with a pressure gauge.
- Length of each pipe is 1.5m and extension pipes of 1.5m will be required to reach the required depths.
- Three piezometers capable of monitoring at different formations horizons were proposed.
- Required 38mm holes to be drilled and piezometer diameter is 35mm.
- Maintenance of the piezometers will be required, specifically the pressure gauge to clean sediment build-up.



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Thank you