Mining Gassy Coals
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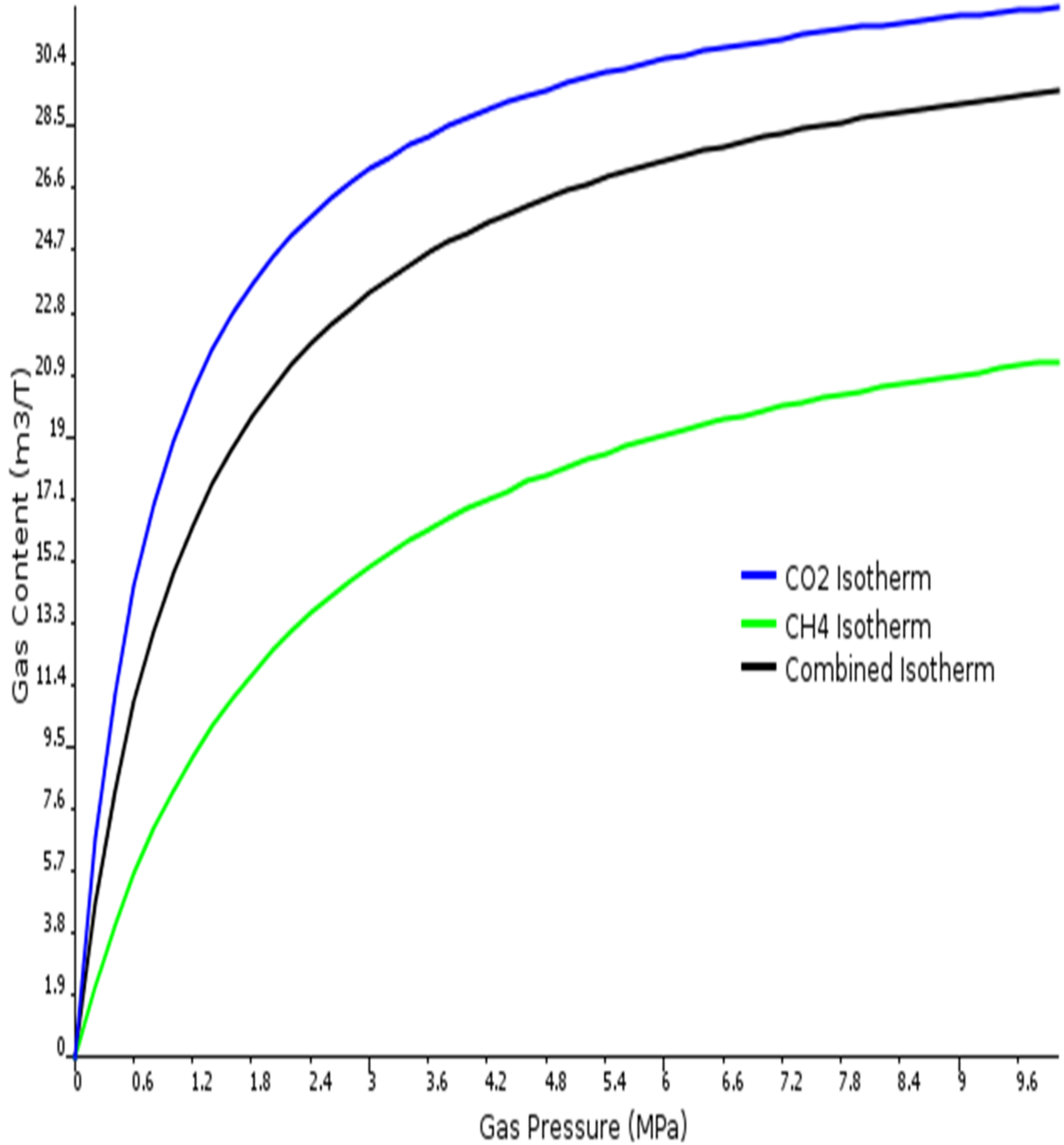
THE IMPORTANCE OF THE SORPTION ISOTHERM

- The sorption isotherm is the relationship between gas content at reservoir pressure
- It is dependent on
  - Coal Type
  - Gas composition
  - Order by which the gas got into the coal?

Mixed Gas Isotherms

- Water and Gas competing for storage
- CH4 vs CO2 vs H2O
- Isotherms obtained by re-absorbtion process
- Have to calculate mixed gas behaviour?
- Theoretical methods IAS and extended Langmuir – these are incorrect
- NATIVE SORPTION ISOTHERMS
  - MEASURE WHAT YOU GET OUT OF COAL ON INITIAL DESORPTION

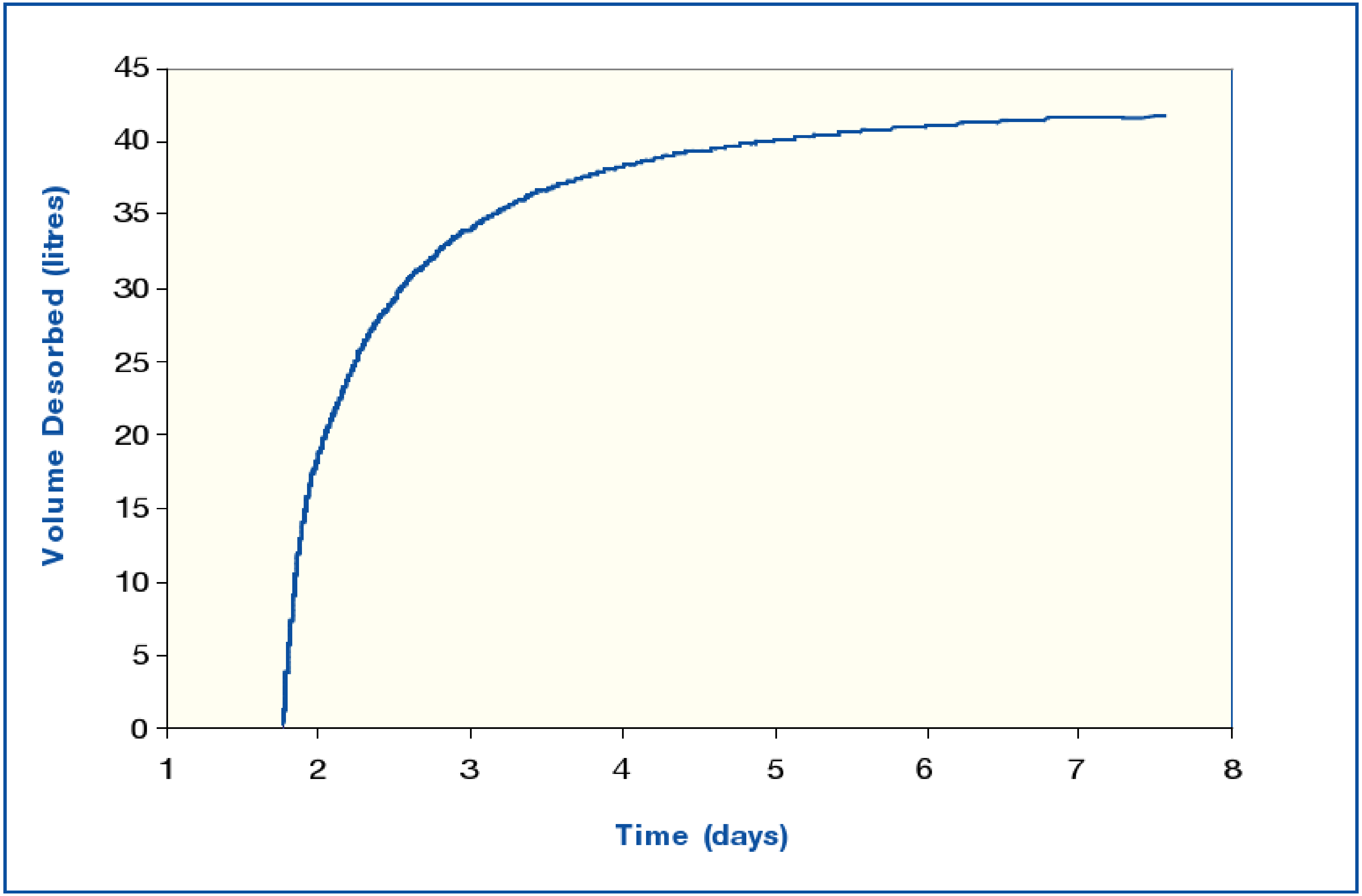
The theoretical isotherm made up from component isotherms is probably wrong!



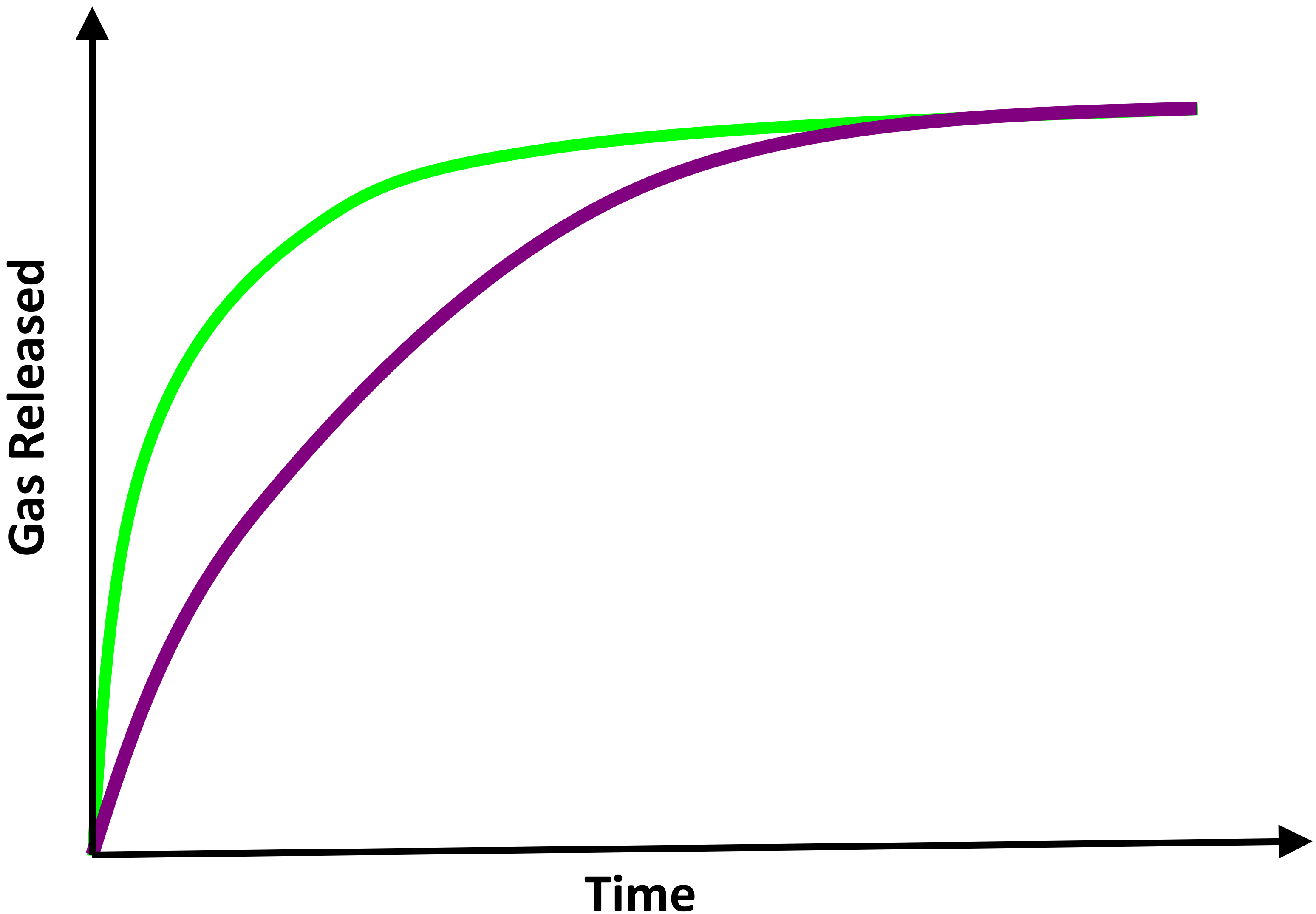
DIFFUSION IS IMPORTANT

- DIFFUSION RATE IS DEPENDENT ON
- GAS CONCENTRATION GRADIENT
- DIFFUSION COEFFICIENT
- Diffusion is the key to gas release from broken coal
  - In an outburst
  - On the face or belt
  - From the goaf

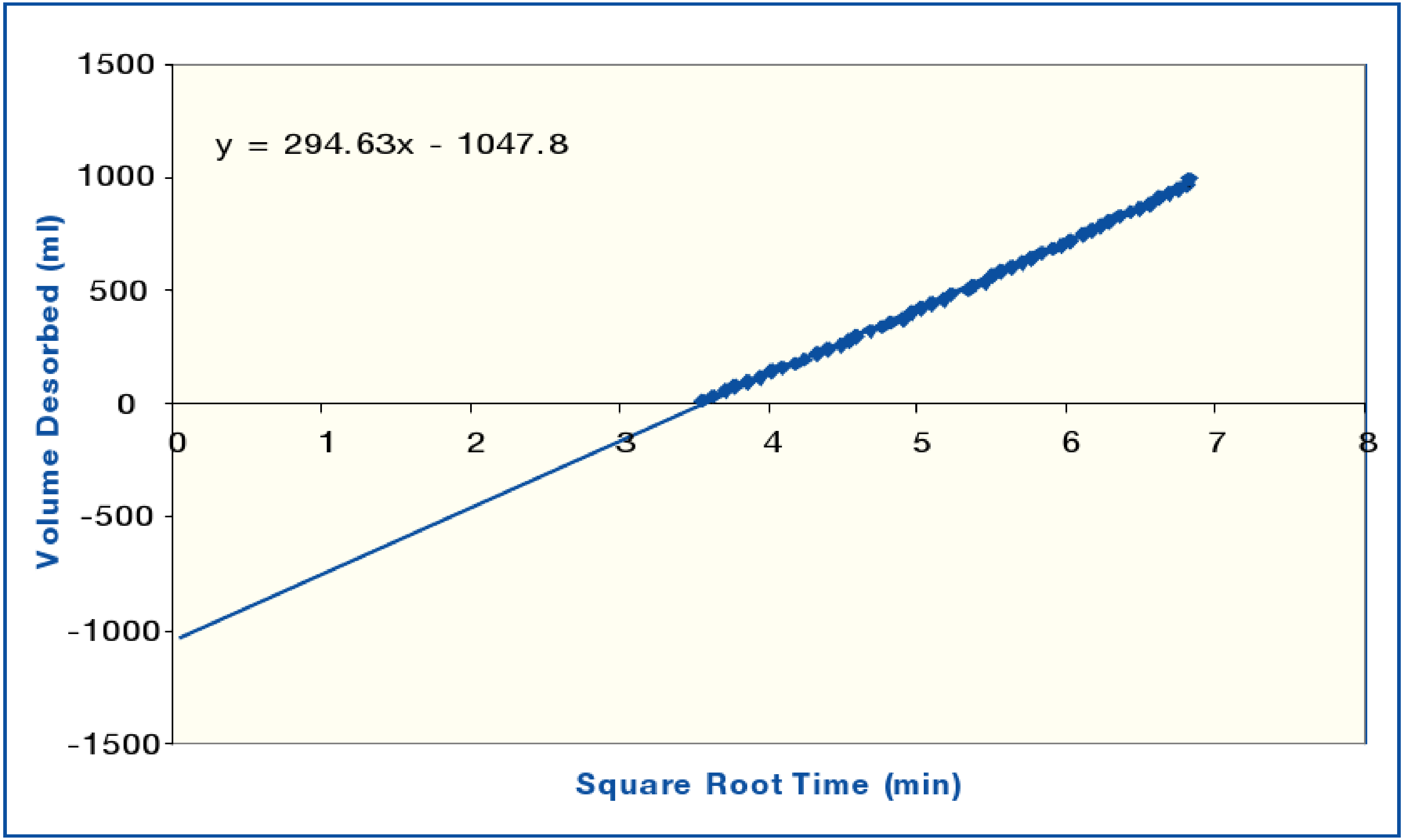
Desorbed Gas Measurement



Core Desorption and Theoretical Diffusion Curves from an Uniform Cylinder



Lost Gas Determination Plot



SHORT TERM DIFFUSION COEFFICIENT

- MAY BE CALCULATED FROM THE SLOPE OF THE INITIAL DESORPTION PROCESS AND THE TOTAL GAS CONTENT OF THE CORE
- IS IN ALL PRACTICALITY A COMBINED MEASUREMENT OF DIFFUSION COEFFICIENT AND CORE FRACTURINFG
- IN HIGHLY FRACTURED CORE WE SHOULD SIMPLY NOTE THE RATE OF DESORPTION OF THE SAMPLE MASS OF COAL

DIFFUSION COEFFIENCENT IS AN IMPORTANT OUTBURST PARAMETER

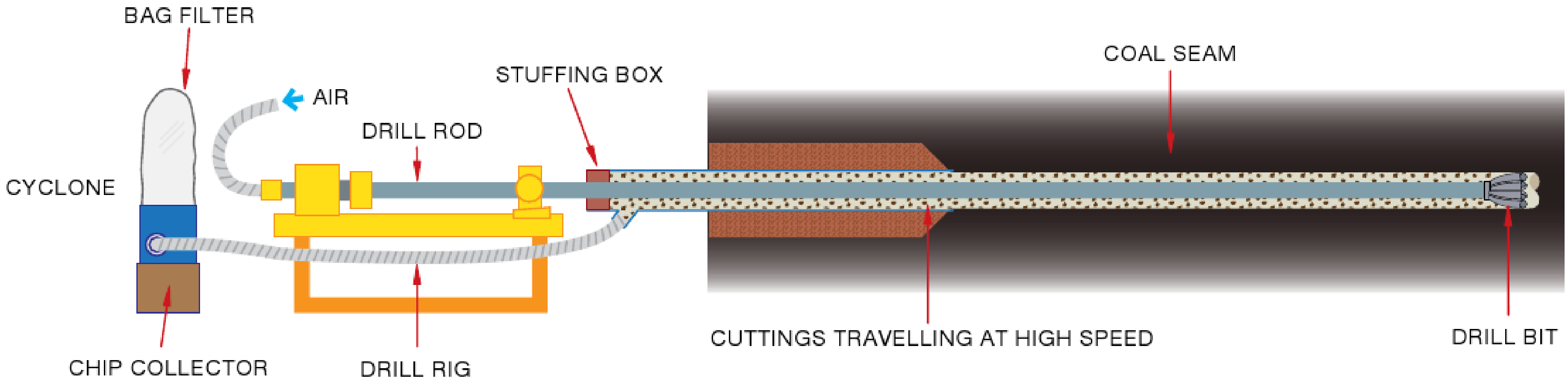
- HIGH GAS CONTENT

  + HIGH DIFFUSION RATES

  + SMALL PARTICLES

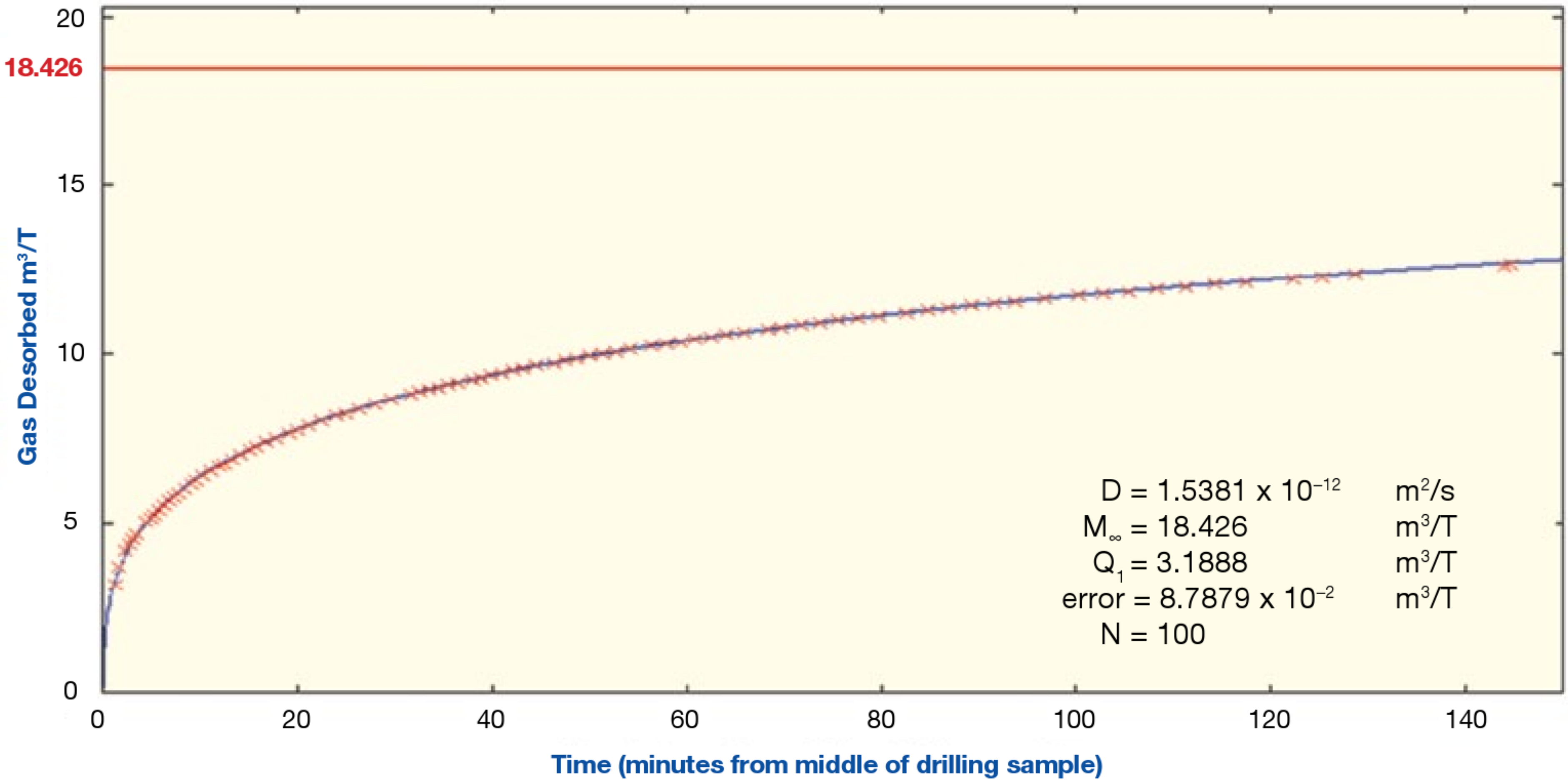
  = HIGH OUTBURST RISK

Dry Drilling Sampling System

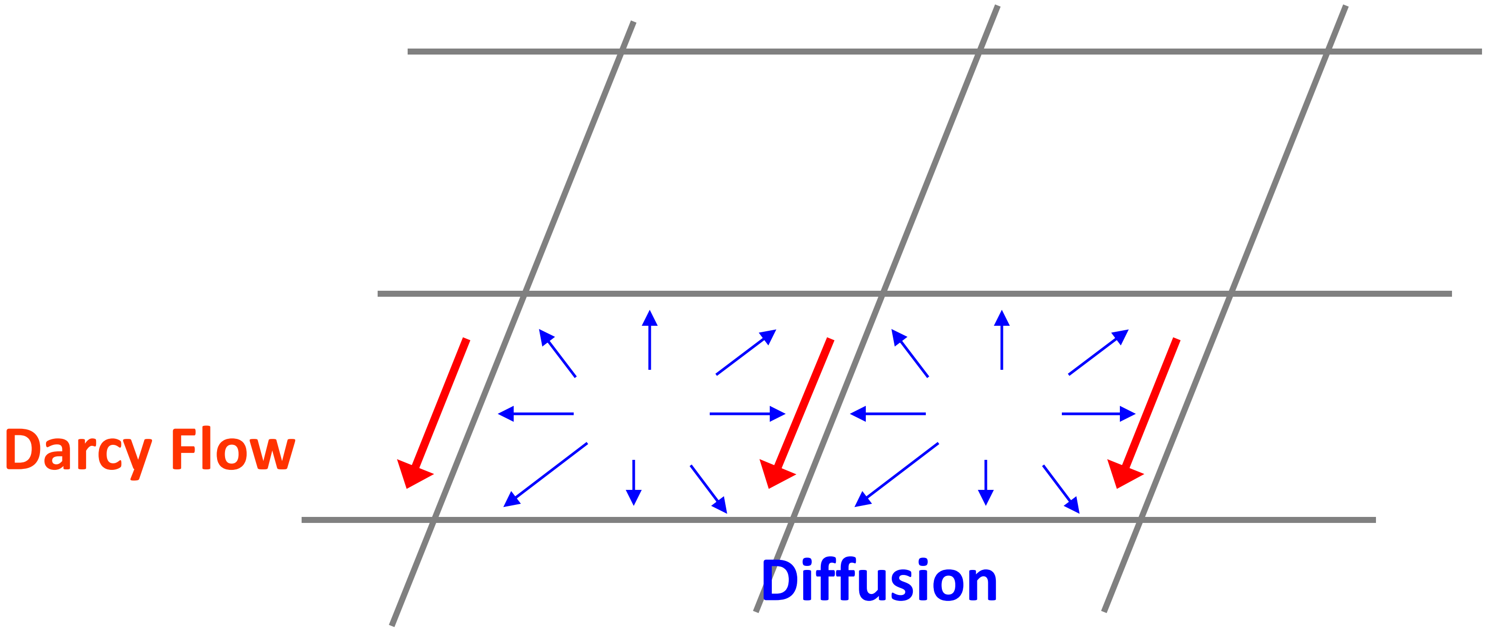


Dry drilling sampling system

Modelled Gas Desorption vs. Recorded Gas Desorption



Gas Flow In Coal



Darcy Flow

$$V = -\frac{k}{\mu} \cdot \frac{dp}{dx}$$

Diffusion

$$F = -D\frac{dC}{dx}$$

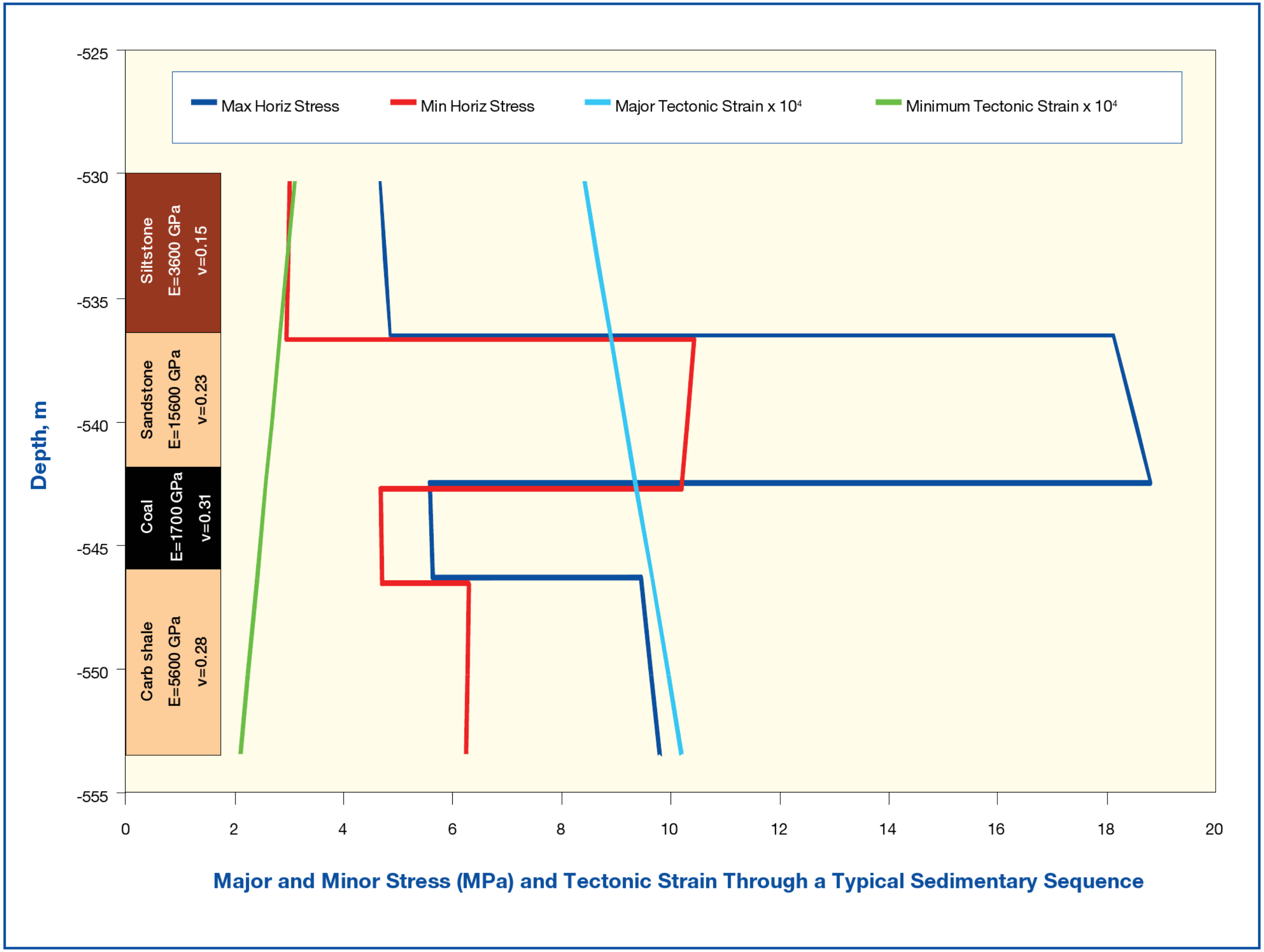
INVOLVES WATER AND GAS THOUGH SOME DRY SEAMS DO EXIST

- DROPPING WATER PRESSURE TO ACHIEVE DESORPTION MUST BE ACHIEVED FIRST IN A WET COAL
- THE RATE LIMITING STEP IN GAS DRAINAGE MAY THEN BE EITHER DIFFUSIVE FLOW OR PERMEABILITY
- DIFFUSION GOVERNS IF THE CLEAT SPACING IS HIGH

LOW PERMEABILITY COALS

- NO CLEATS
- FILLED CLEATS
- HIGHLY STRESSED
  - PERMEABILITY MAY CHANGE BY ORDERS OF MAGNITUDE WITH CHANGES IN EFFECTIVE STRESS

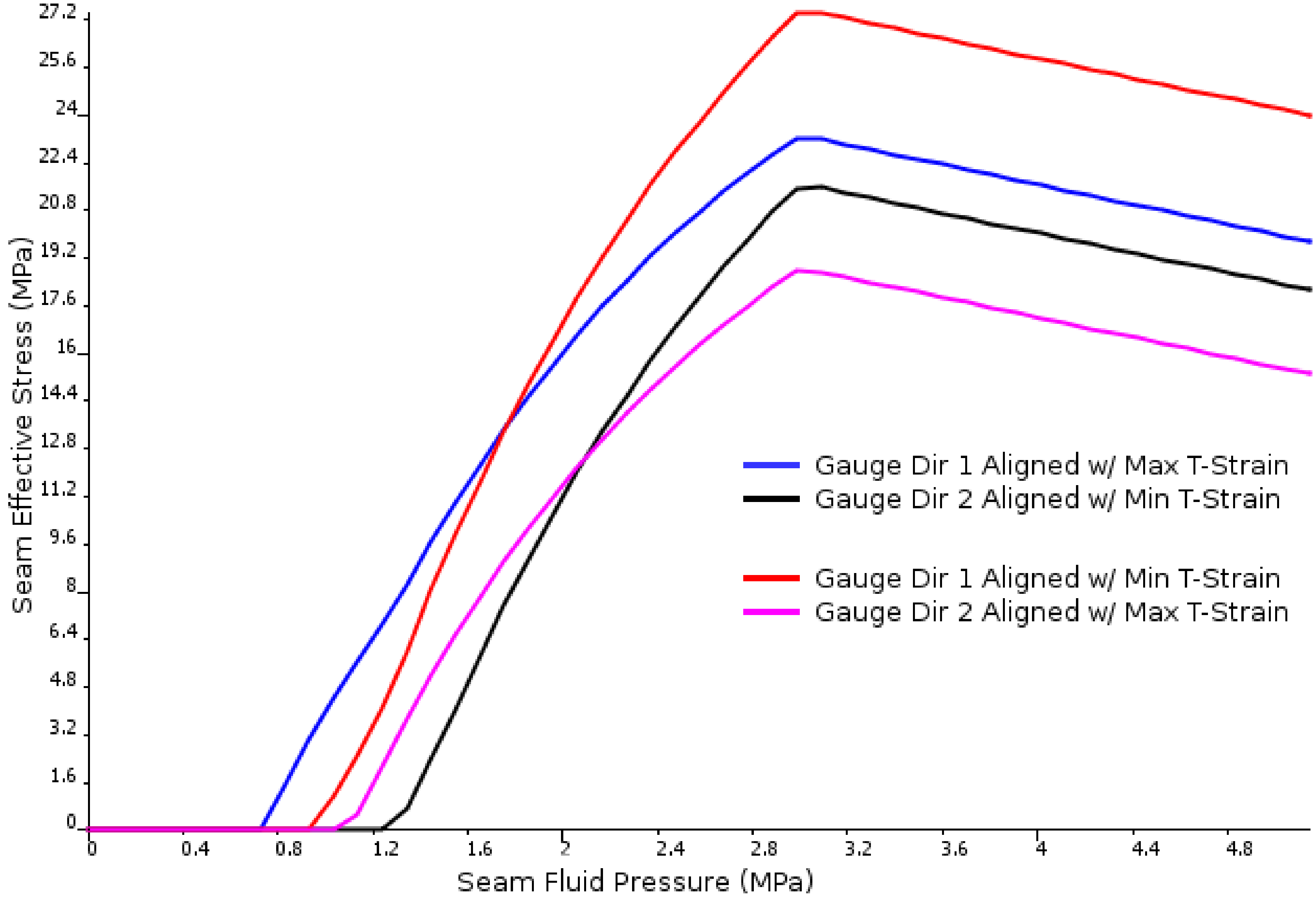
Layered Sedimentary Strata with Varying Stiffness and Poisson's Ratio



THE IMPORTANCE OF STRESS PATH

- THE EFFECTIVE STRESS IN COALS CHANGES WITH DRAINAGE DUE TO LOWERING FLUID PRESSURE AND DUE TO THE EFFECTS OF SHRINKAGE

- WHICH DOMINATES?



Seam Effective Stress (MPa)
27.2
25.6
24
22.4
20.8
19.2
17.6
16
14.4
12.8
11.2
9.6
8
6.4
4.8
3.2
1.6
0
0
0.4
0.8
1.2
1.6
2
2.4
2.8
3.2
3.6
4
4.4
4.8
Seam Fluid Pressure (MPa)
Gauge Dir 1 Aligned w/ Max T-Strain
Gauge Dir 2 Aligned w/ Min T-Strain
Gauge Dir 1 Aligned w/ Min T-Strain
Gauge Dir 2 Aligned w/ Max T-Strain

Mining Tight Highly Gassy Coals

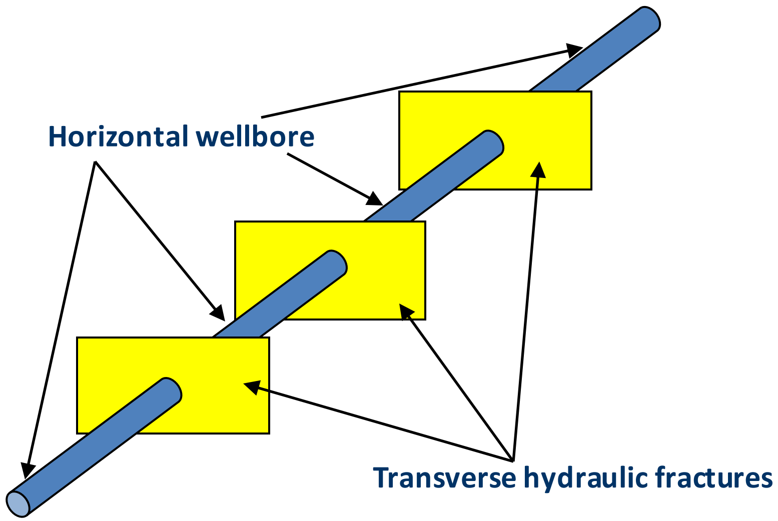
- Old European Practise to mine an initial seam in a sequence
- Mining of one seam de-stresses adjacent seams and permits gas drainage
- Assumes that one seam can be mined safely
- This is mining rate dependent – traditionally the mining rates are low

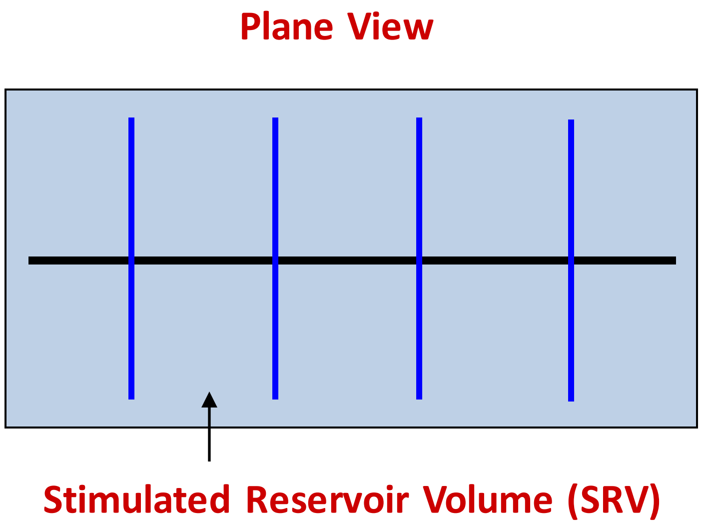
Tight Shale Gas Extraction

- Formation must be gassy
- Drill sub horizontal wells in tight formation
- Undertake multiple hydrofracturing from horizontal well
- Create primary permeability

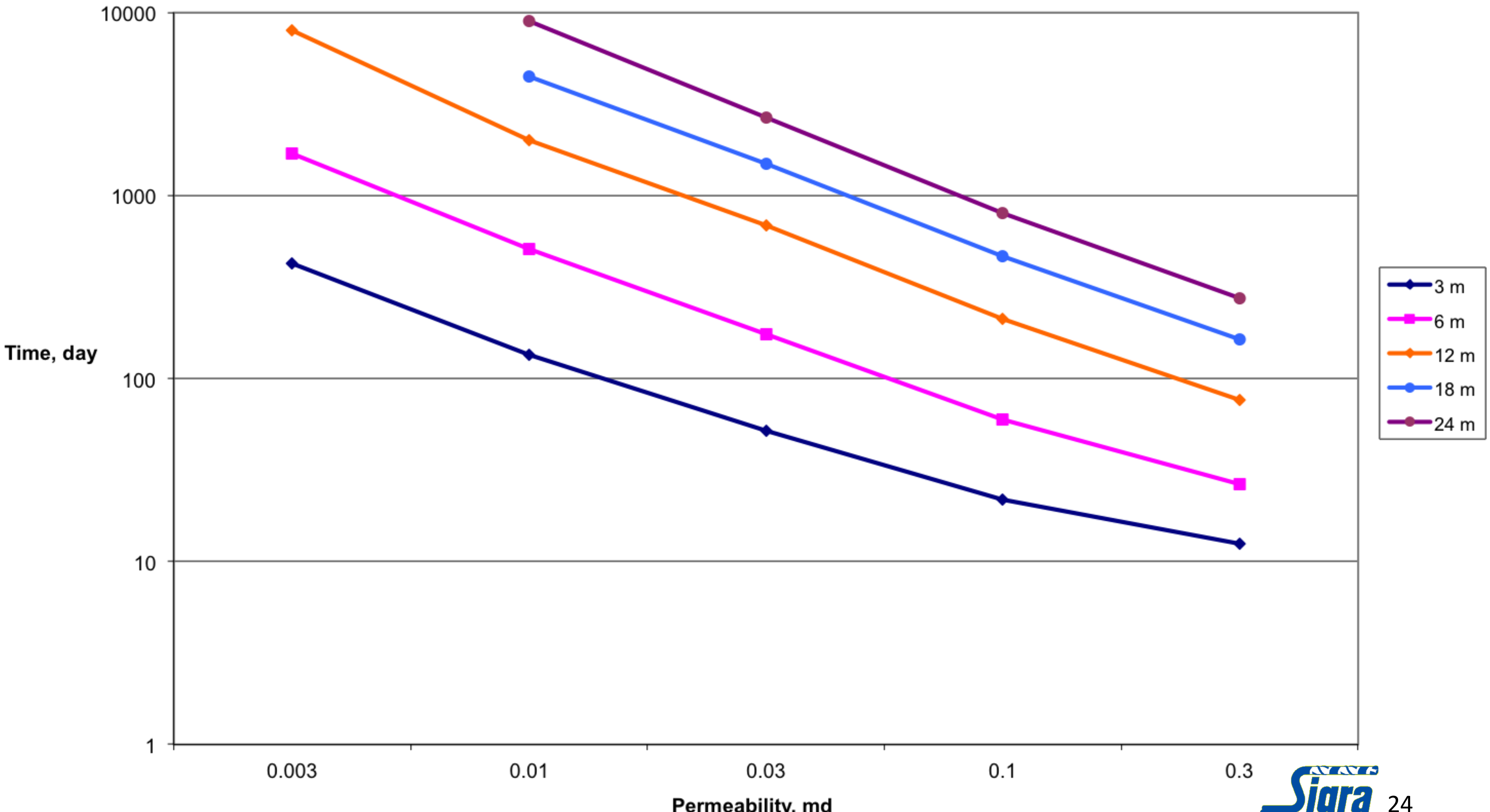
Combine Old European and Tight Gas Practise

Ideal Concept - Horizontal Wells with Transverse Fractures – This is not a normal fracture initiation orientation from a hole.





Drainage times Vs frac spacing for 15 to 3 cu.m/tonne methane



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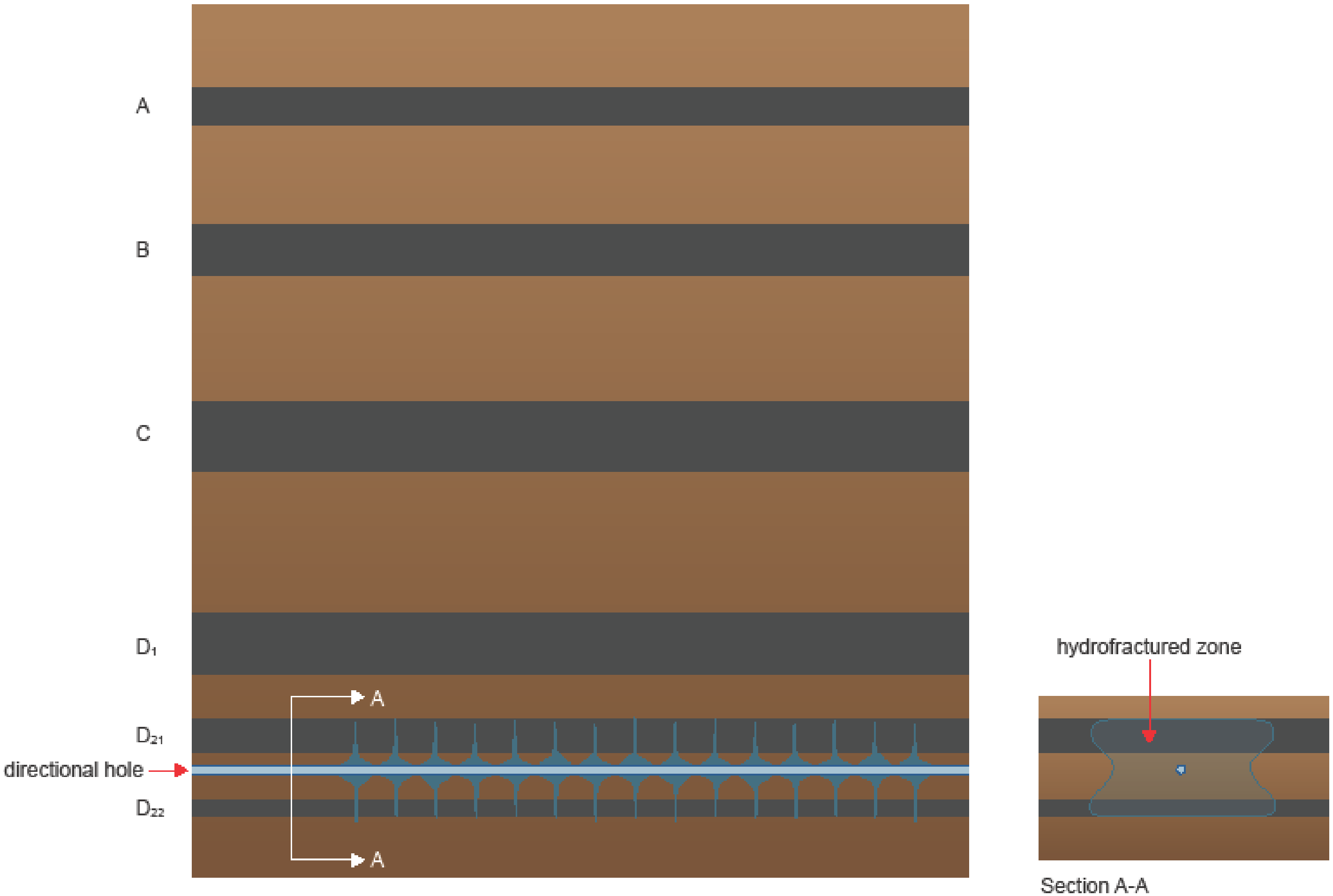


Figure 1: Drill and frac first seam from floor in area of gateroads – elevation. Also note Section A-A.

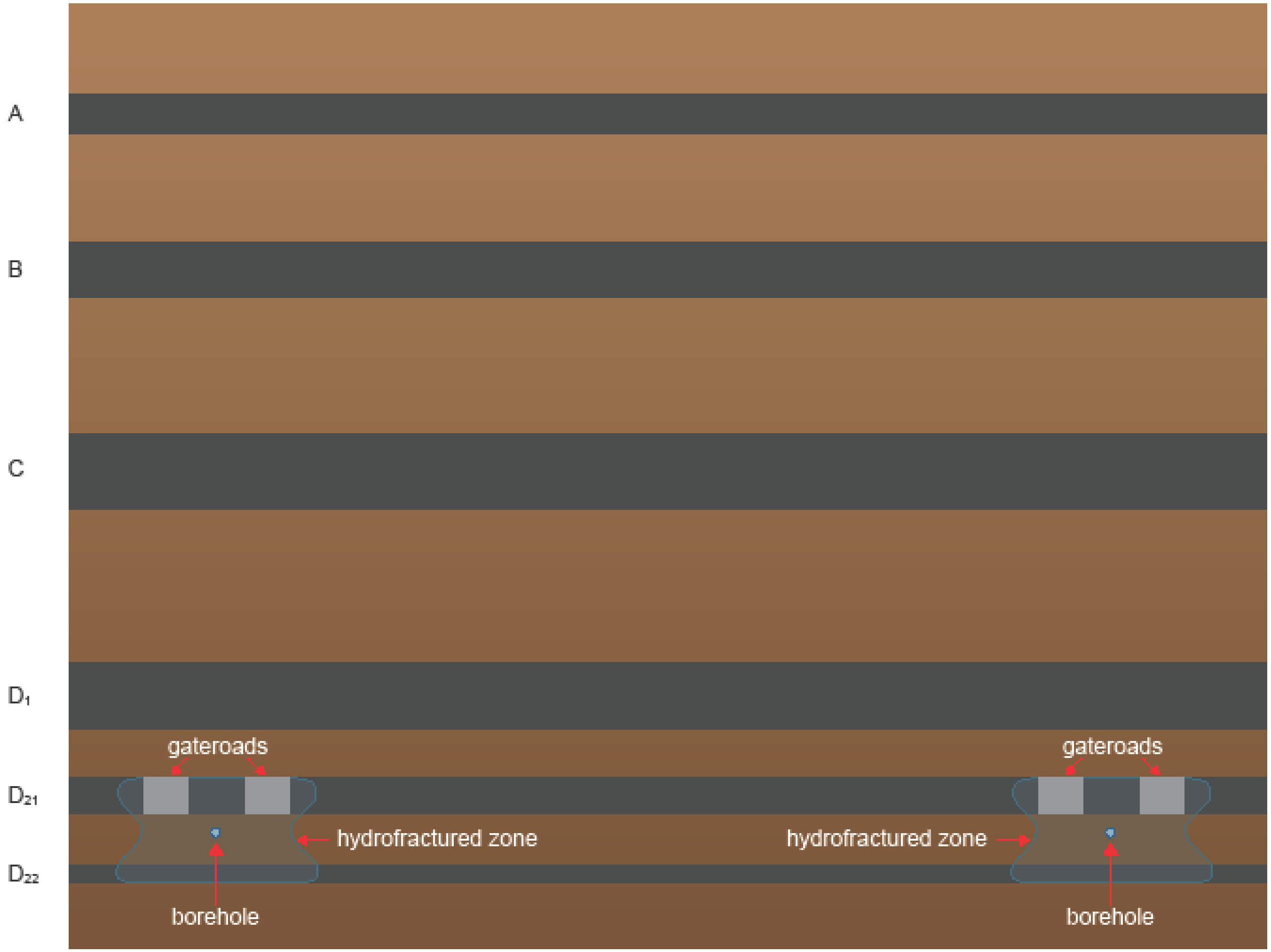


Figure 2: Develop gateroads in drained area – section

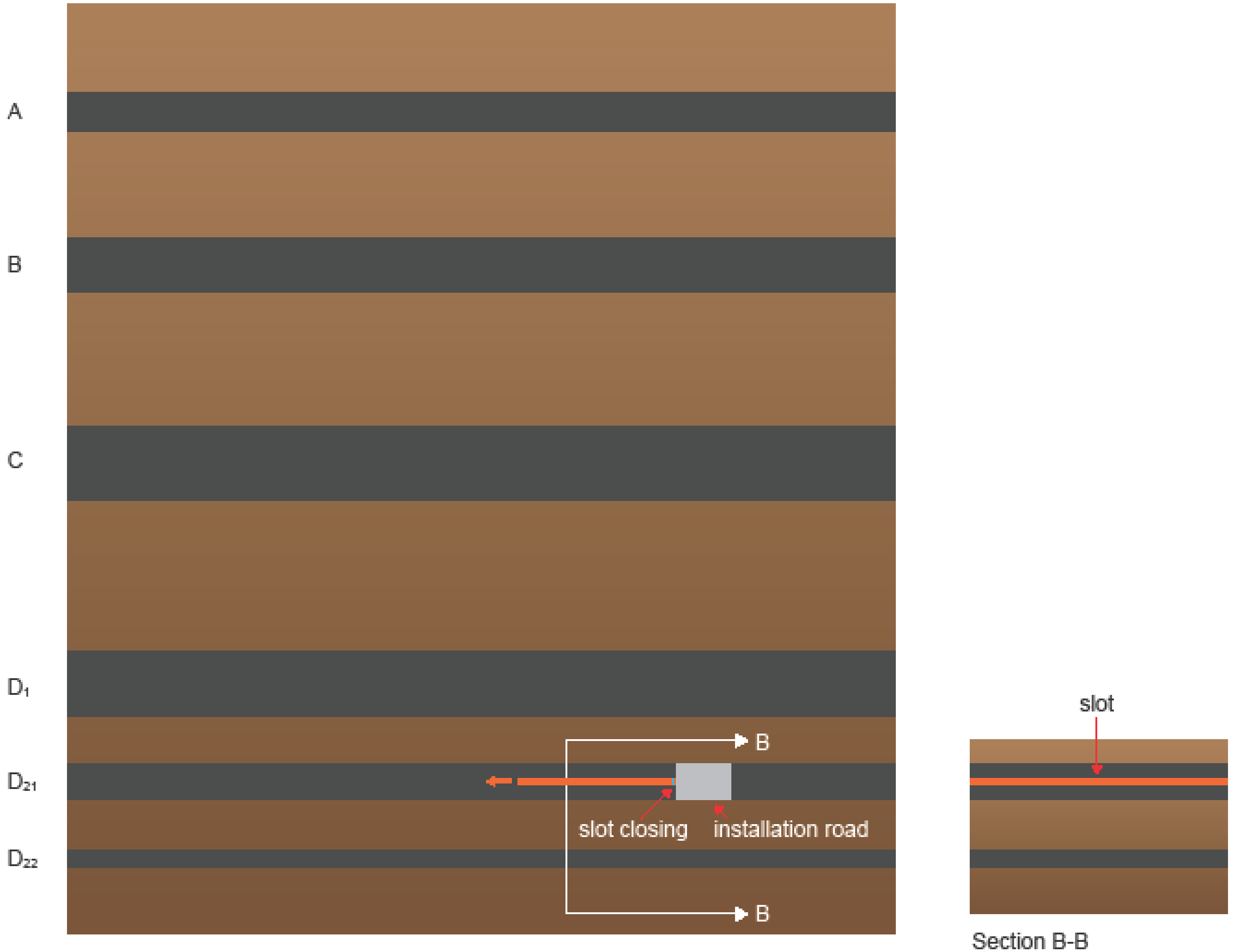


Figure 3: Slot longwall block between gateroads to de-stress and de-gas – elevation

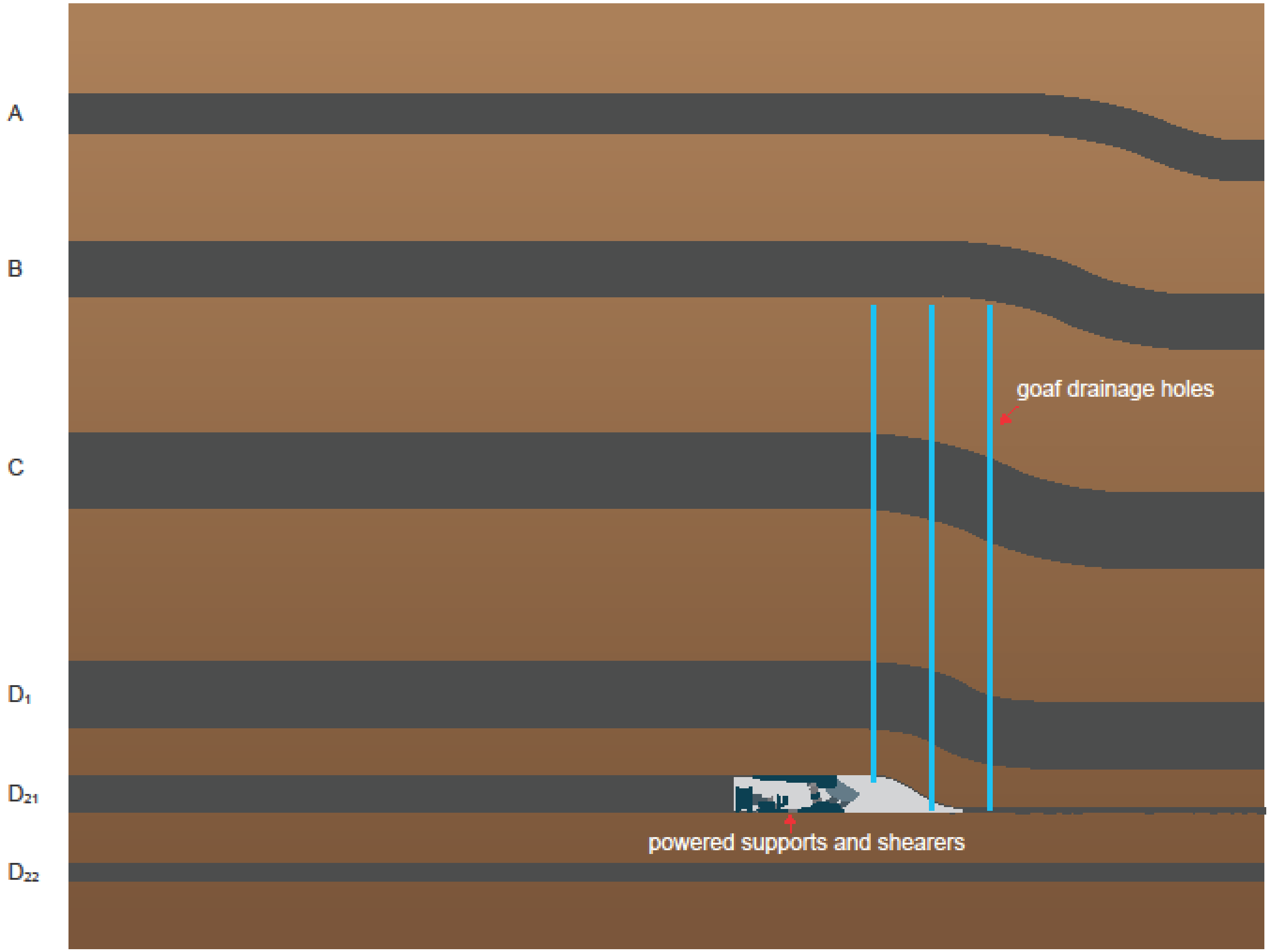


Figure 4: Longwall mining D_{21} with goaf drainage holes – elevation

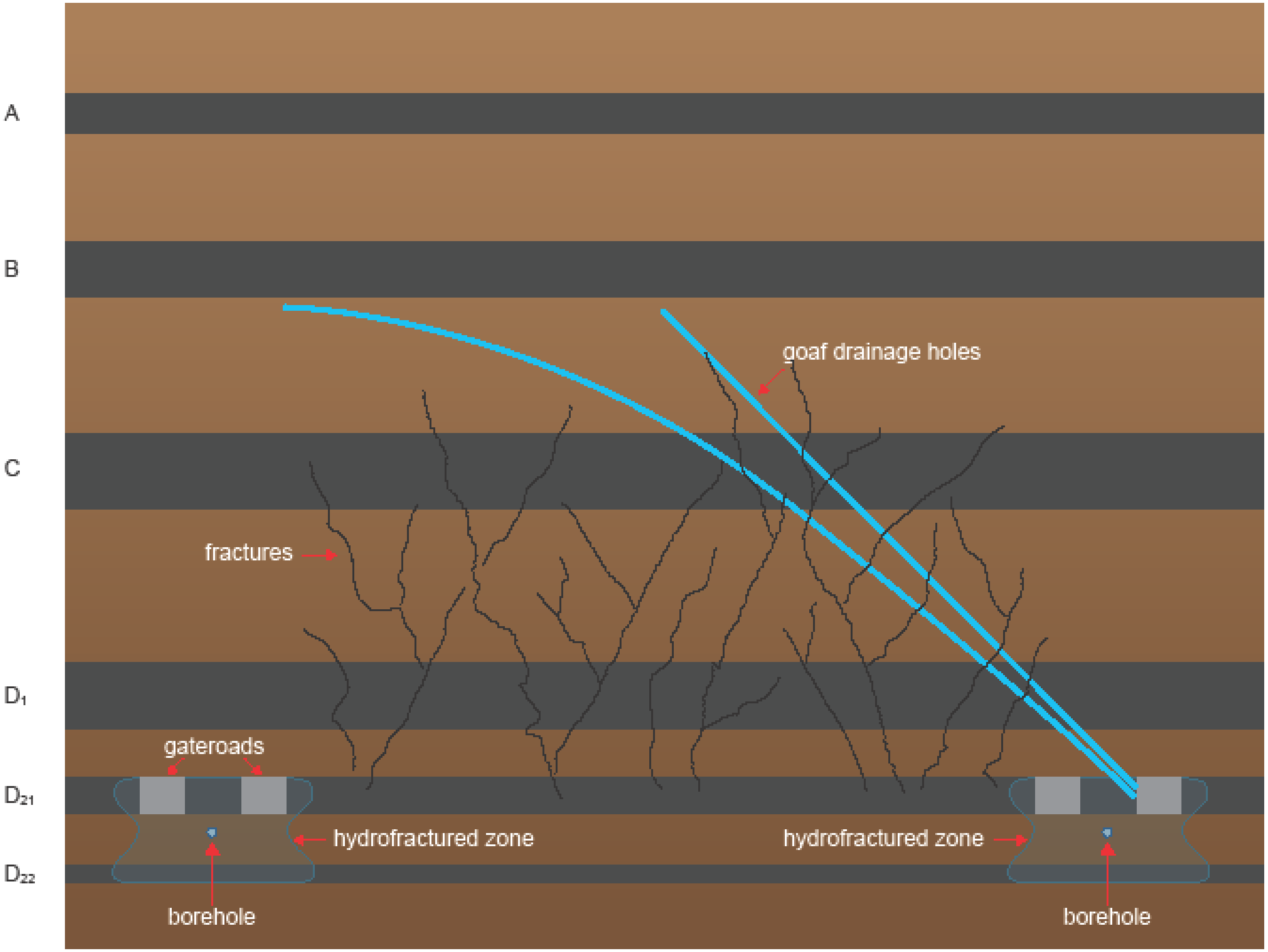


Figure 5: Longwall mining D_{21} with goaf drainage holes – section

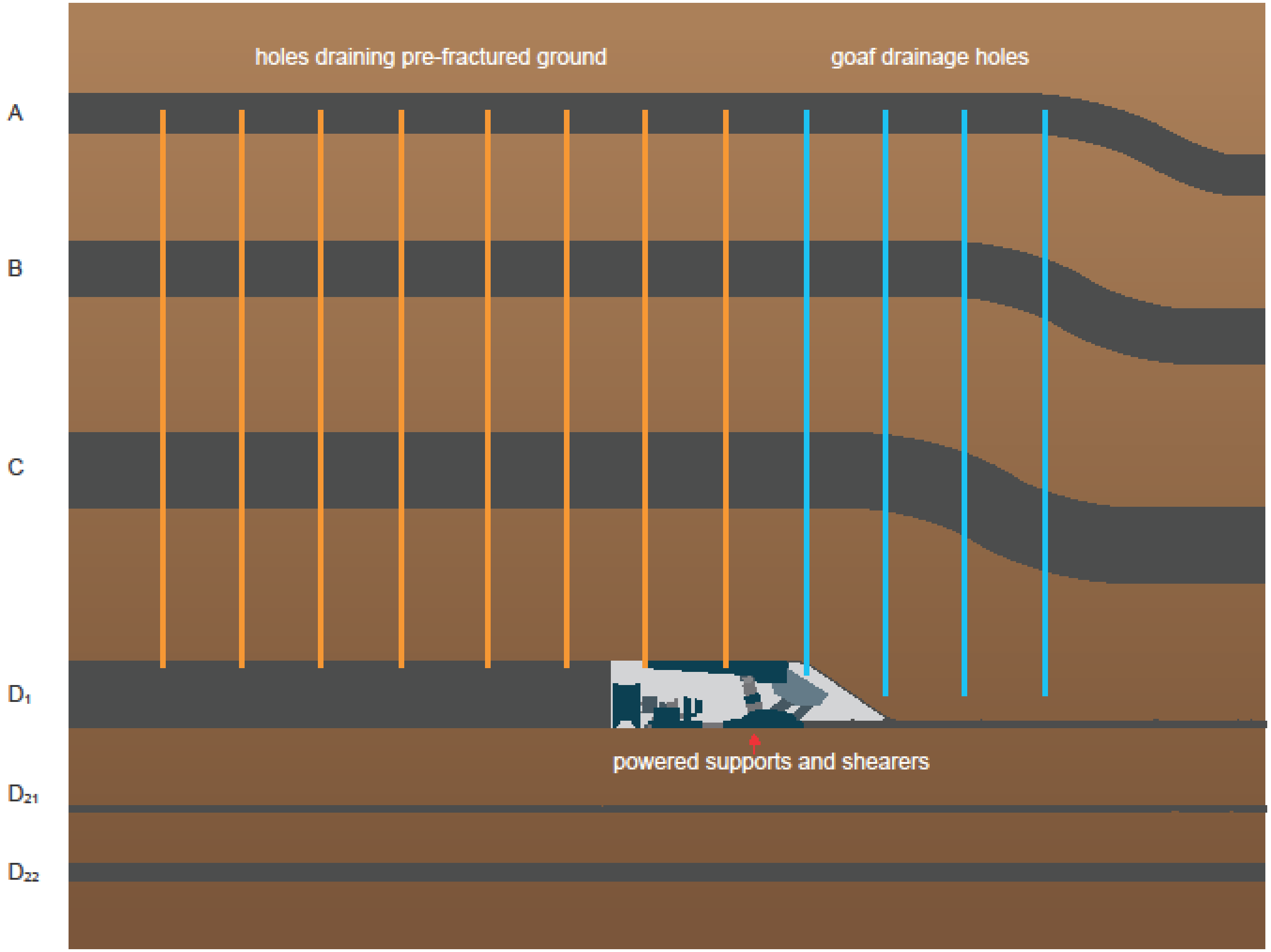


Figure 6: Mining the D_1 seam – elevation

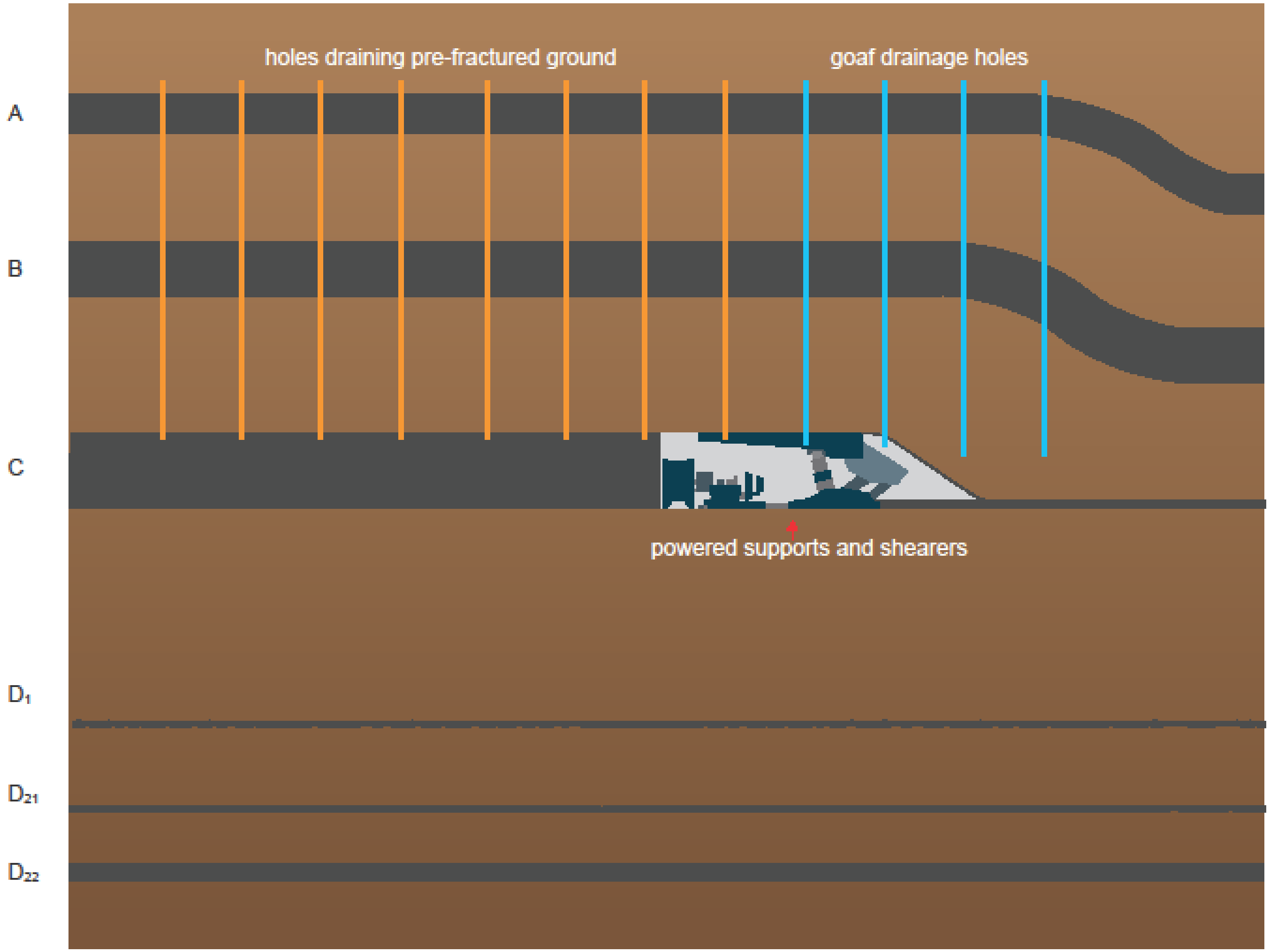
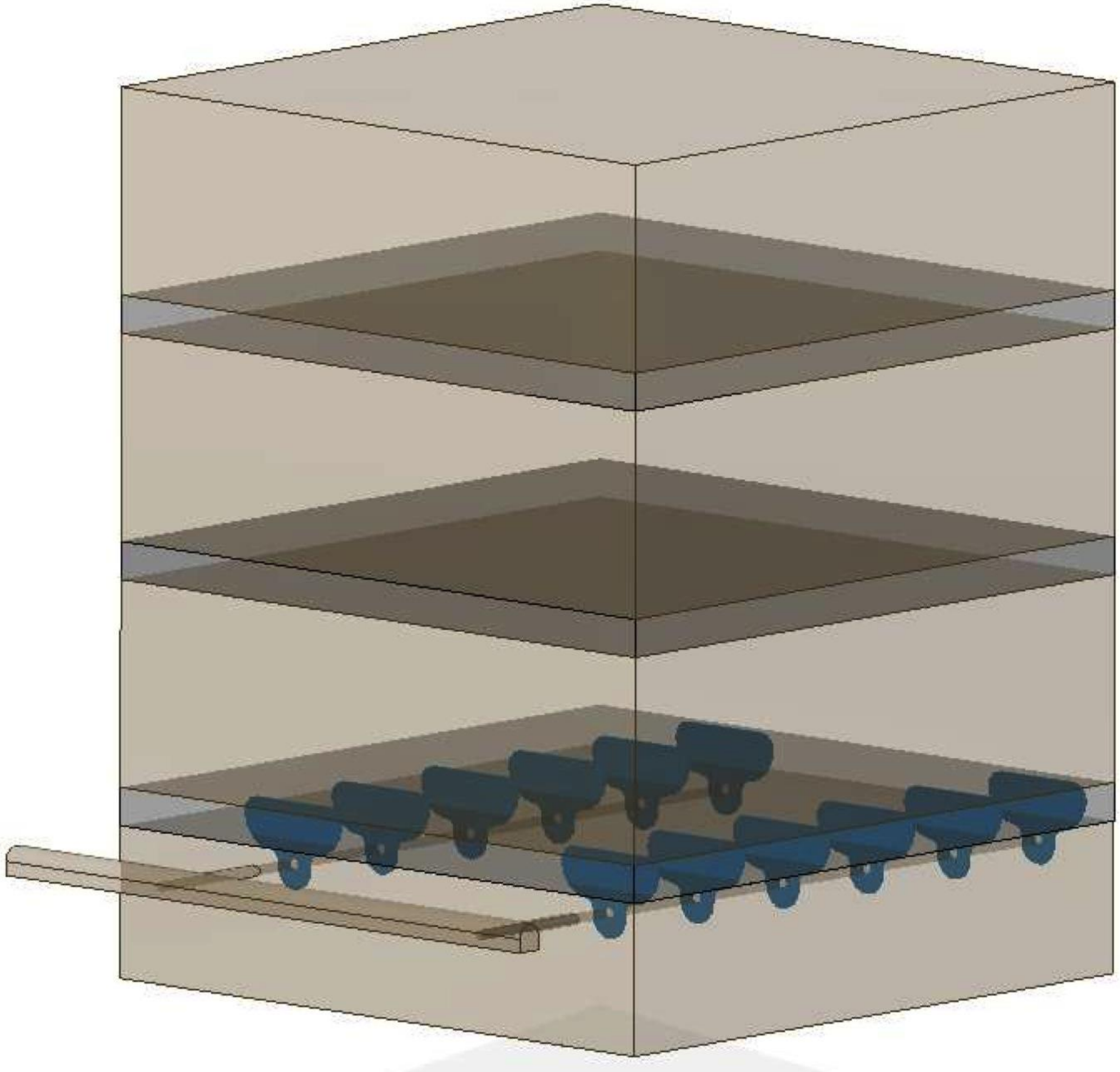
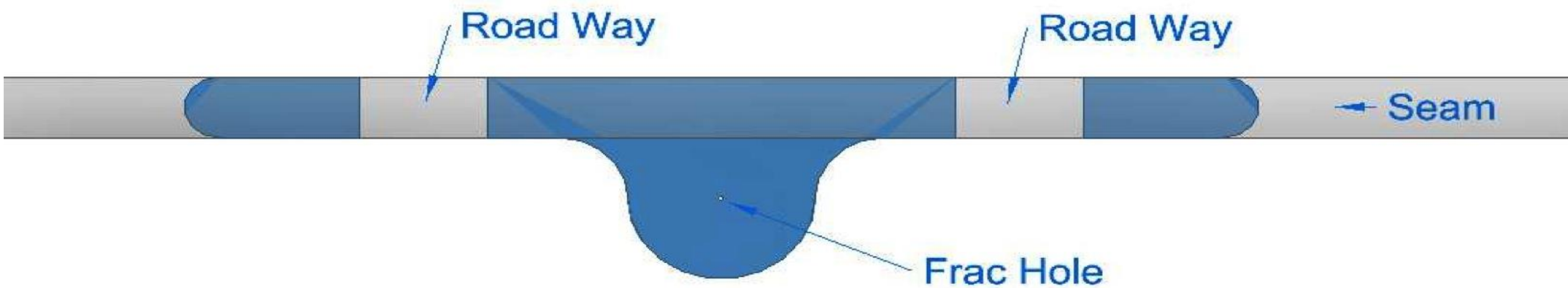
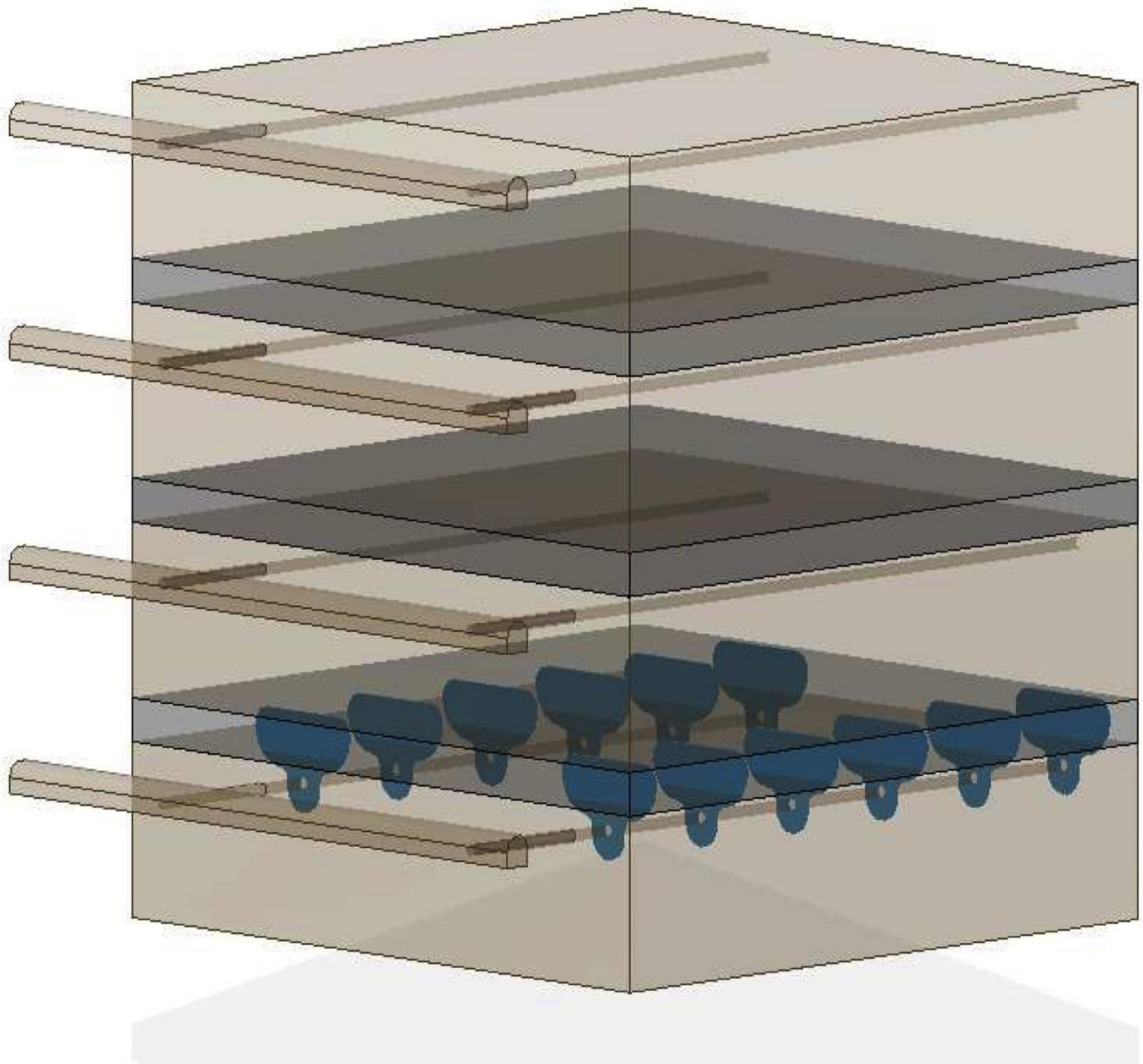
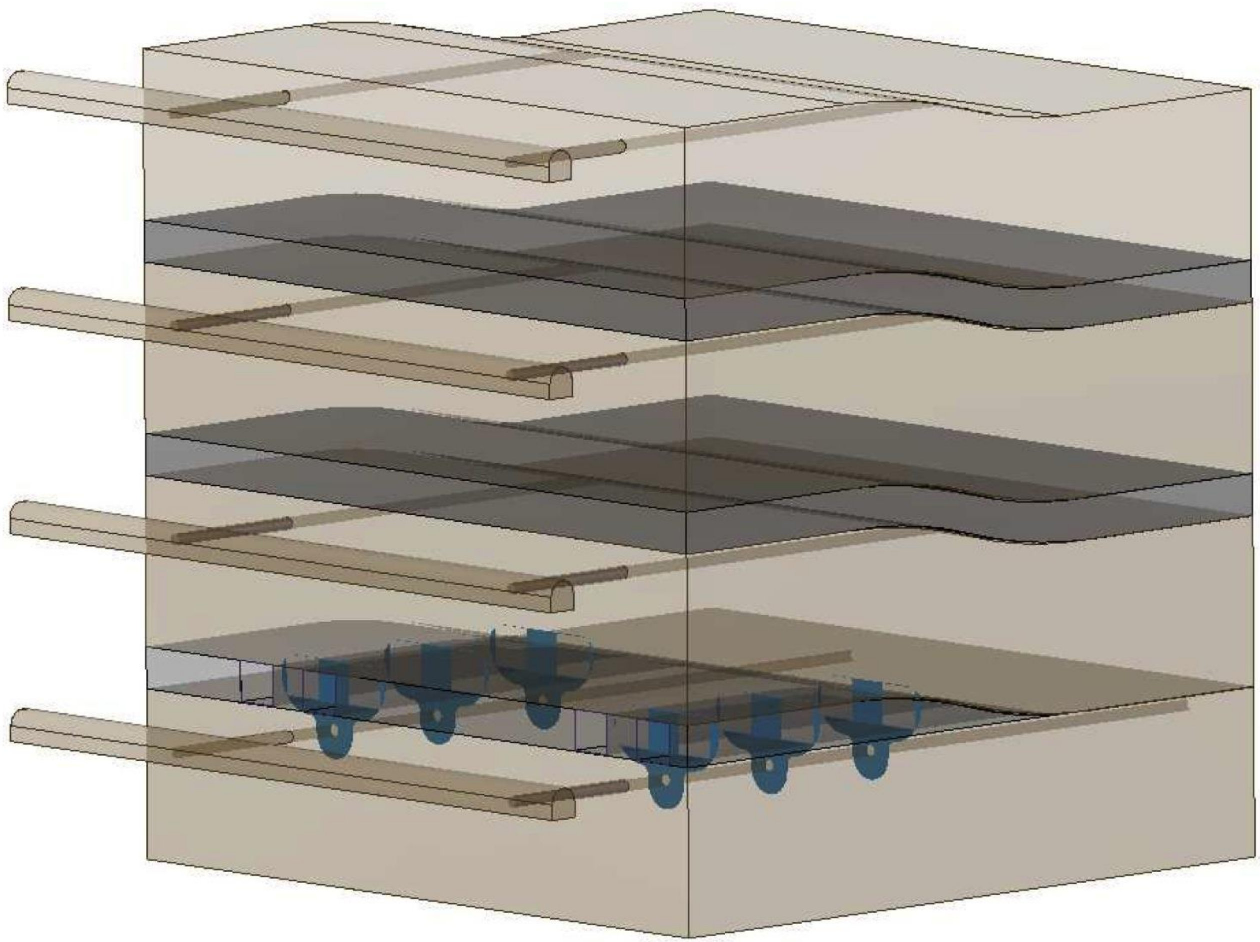


Figure 7: Mining the C seam – elevation




Road Way
Road Way
Seam
Frac Hole





Mining Method

- Multi level mining
- Improves reserve
- Need to mine and entry seam
- Uses mining to de stress other seams
- Need for good goaf drainage
- Consider all drainage from rock drivage

Thank You

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