OPTIMISATION OF THE RECOVERY and USE OF COAL MINE METHANE TO PROMOTE MINE SAFETY, GREENHOUSE GAS MITIGATION and SUSTAINABLE DEVELOPMENT

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Leszek W. Lunarzewski
Lunagas Pty Limited - Australia

Coal mine safety & productivity

Methane emissions in coal mines adversely affects the efficiency of coal production and mine safety

The proper management, engineering tools, modern technology & the techniques could effectively improve those conditions

Engineering tools computer models - simulators

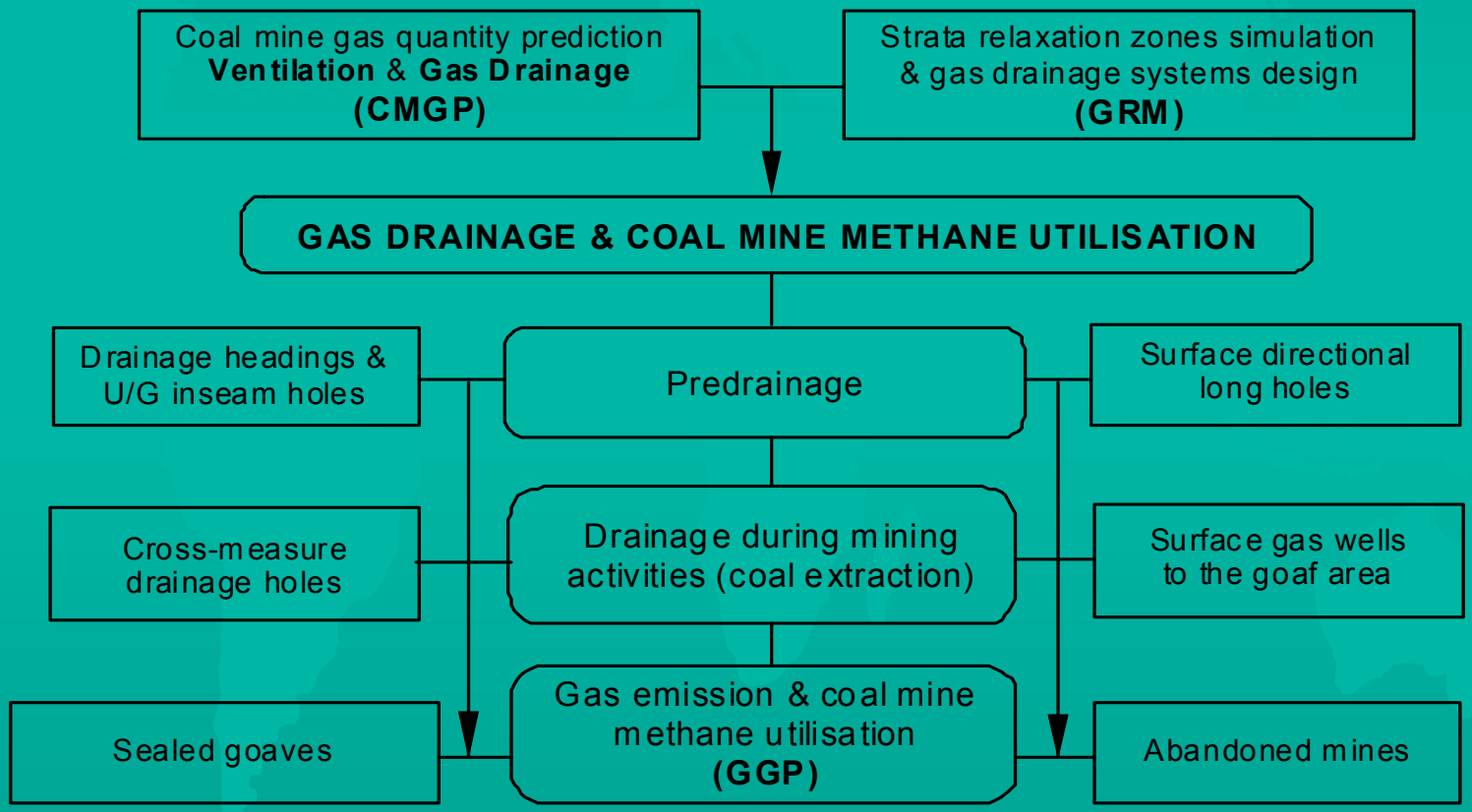
Three specialised computer software developed in Australia allow for coal mine gas quantity prediction & design of optimum parameters for mine ventilation, gas recovery & methane utilisation

I. **Coal Mine Gas Predictor (CMGP)**

II. **Gas Release Model (GRM)**

III. **Goaf Gas Predictor (GGP)**

Gas management chart when using specialised computer models



1. Coal Mine Gas Predictor (CMGP)

Prediction of coal mine gas quantity during mining activities

Based on:

- local geology
- mining & gassy conditions
- coal production level

Outputs :

- Coal mine gas quantity released underground
- Ventilation requirements

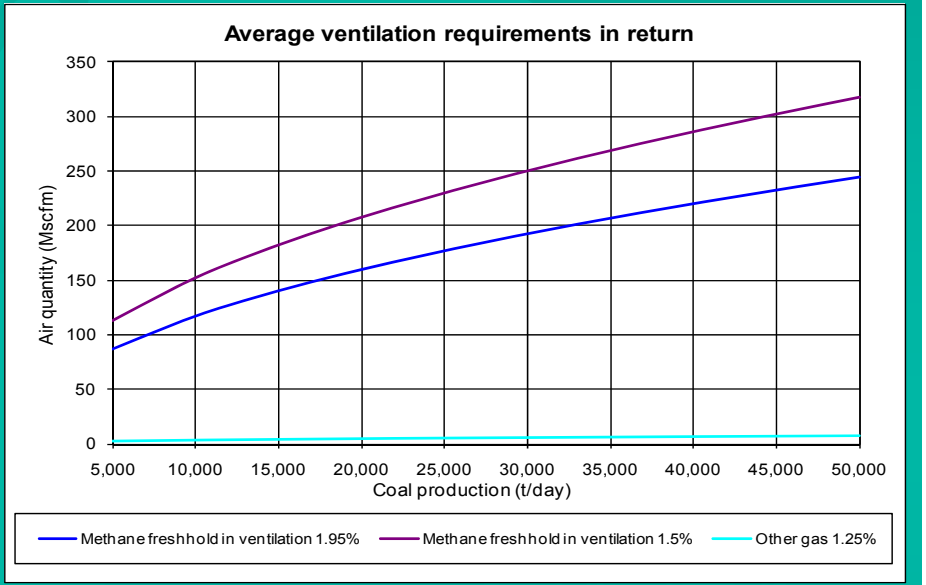
CMGP case study China, USA, Poland

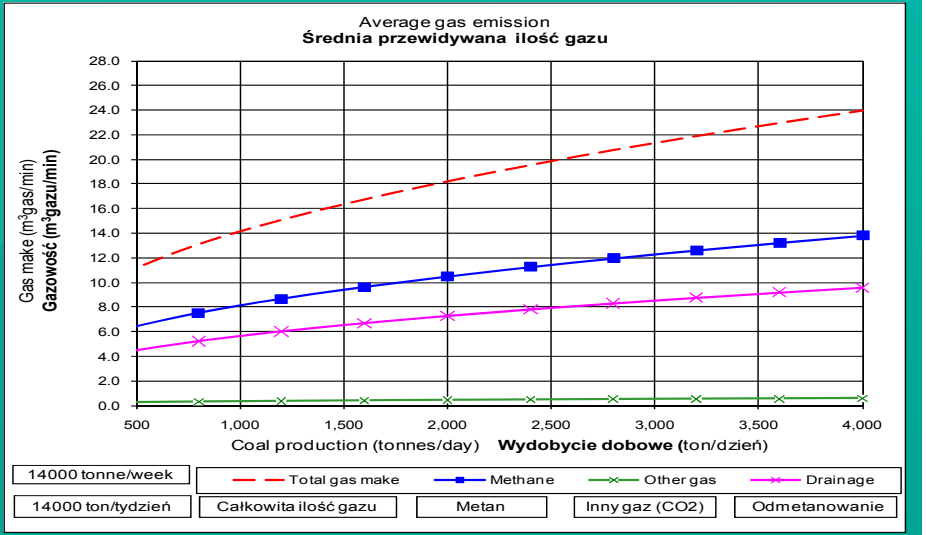
Gas sources & SGE simulation

Units	Coal seams description	In situ gas content	Coal seam thickness (coal only)	Distance from working seam	Strata relaxation range	Gas sources SGE when gas drainage is not used	
						未进行瓦斯抽放时的瓦斯释放量	
						Individual	Contribution to TOTAL
		煤层含气量	煤层厚度	到采掘工作面距离	地层松动范围	本煤层	占总量的百分率
		(m^3gas/t)	(metres)	(metres)	%	(m^3gas/t.mined)	(%)
煤层号	煤层描述	（立方米/吨）	（米）	（米）		立方米/开采1吨	
4	#17	8.35	1.18	124.35	18.83	0.44	3.62
3	#16(?)	10.27	0.45	28.44	87.37	0.95	7.87
2	#15	10.34	0.60	24.80	92.61	1.36	11.21
1	#14	10.63	0.64	10.63	100.00	1.61	13.26
Roof coal seams summary 顶板煤层中瓦斯释放总量		-	2.87	-	-	4.36	35.96
Working coal seam #13-1		7.59	4.23	-	43.50	3.30	27.22
1	#12	10.89	1.11	1.85	100.00	2.86	23.58
2	#11-1(?)	10.95	0.62	3.91	100.00	1.61	13.24
3	#11-2	12.55	1.32	58.98	0.00	0.00	0.00
Floor coal seams summary 底板煤层中瓦斯释放总量		-	3.05	-	-	4.46	36.82
TOTAL: 总计		-	10.15	-	-	12.13	100.00

SPECIFIC GAS EMISSION (SGE)	13.02	Coal mine gas 煤矿瓦斯总量
不同瓦斯释放量（相对瓦斯涌出量 立方米）	12.63	Methane only 甲烷释放量
(m^3 gas per tonne of mined coal) （每采1吨煤排放瓦斯量）	0.39	Other gas only 其它气体

Gas emission & ventilation requirements diagrams





2. Gas Release Model (GRM)

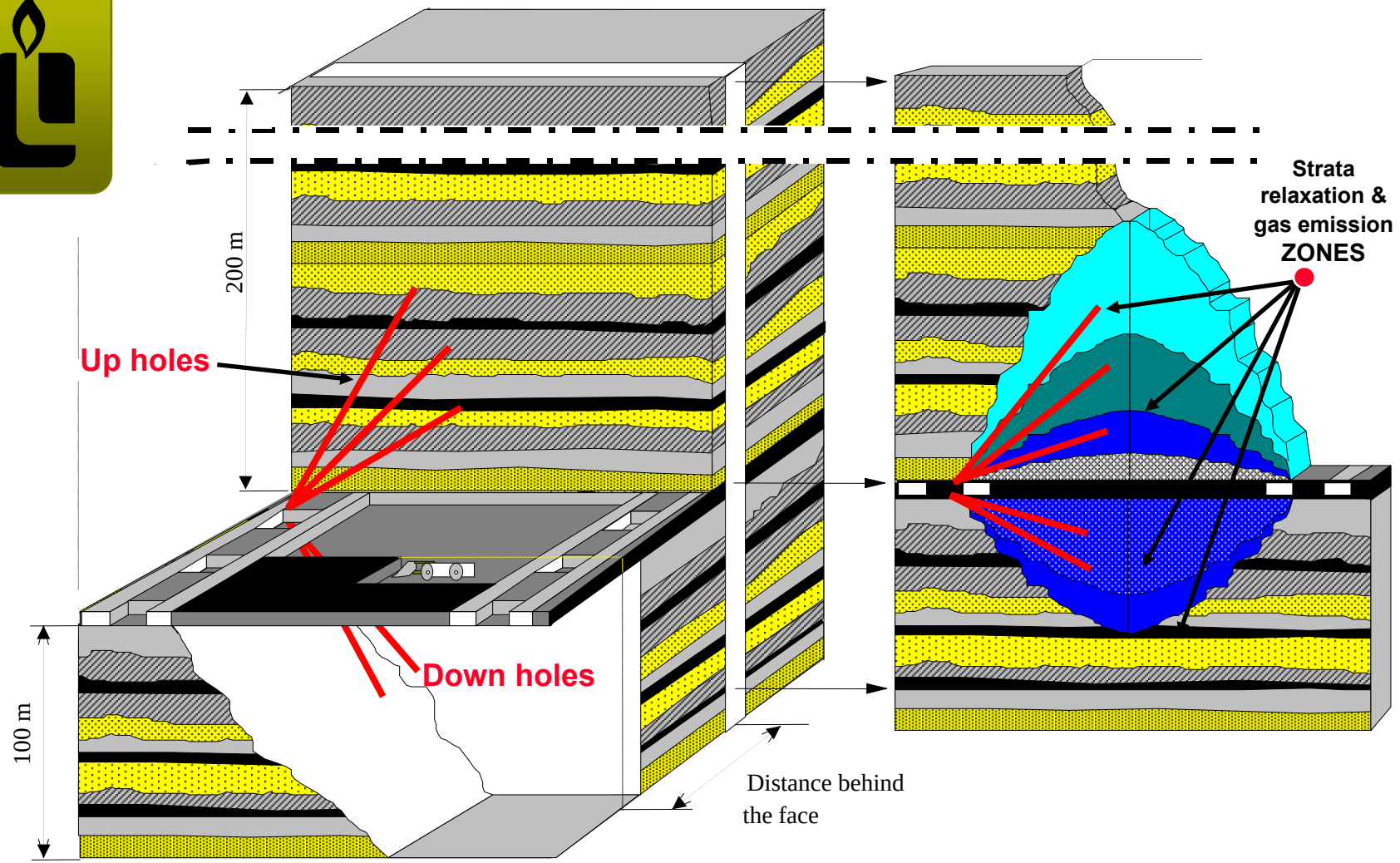
- **Roof simulator** generates a roof strata break-line as a boundary between continuous and discontinuous rock masses
- **Floor simulator** establishes the existing strata stress regime using Boundary Element Principles

Outputs:

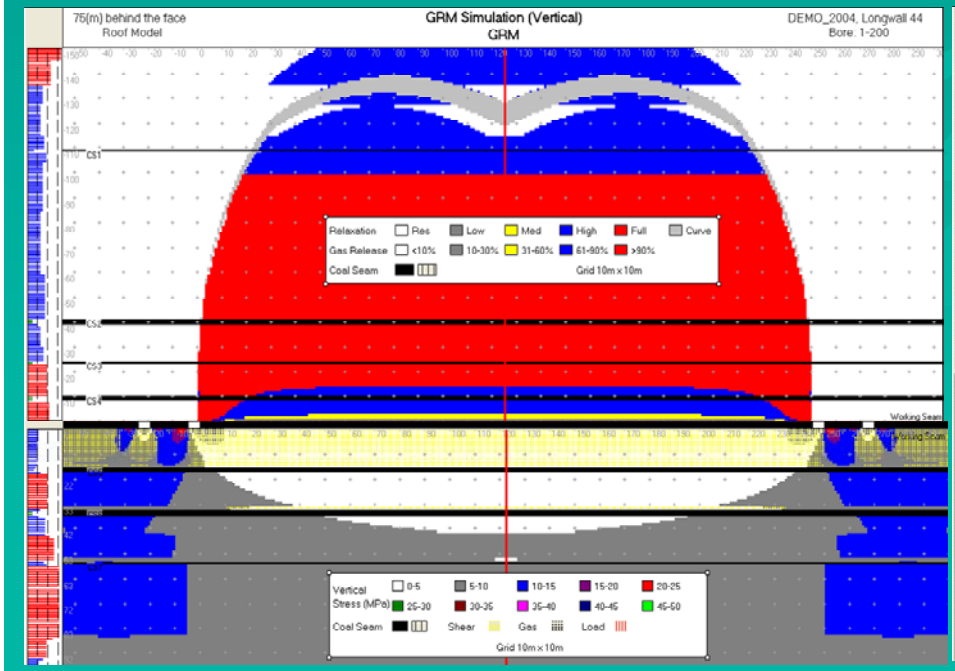
- Colour maps of strata relaxation & gas release zones
- Graphical design & optimisation of gas drainage systems

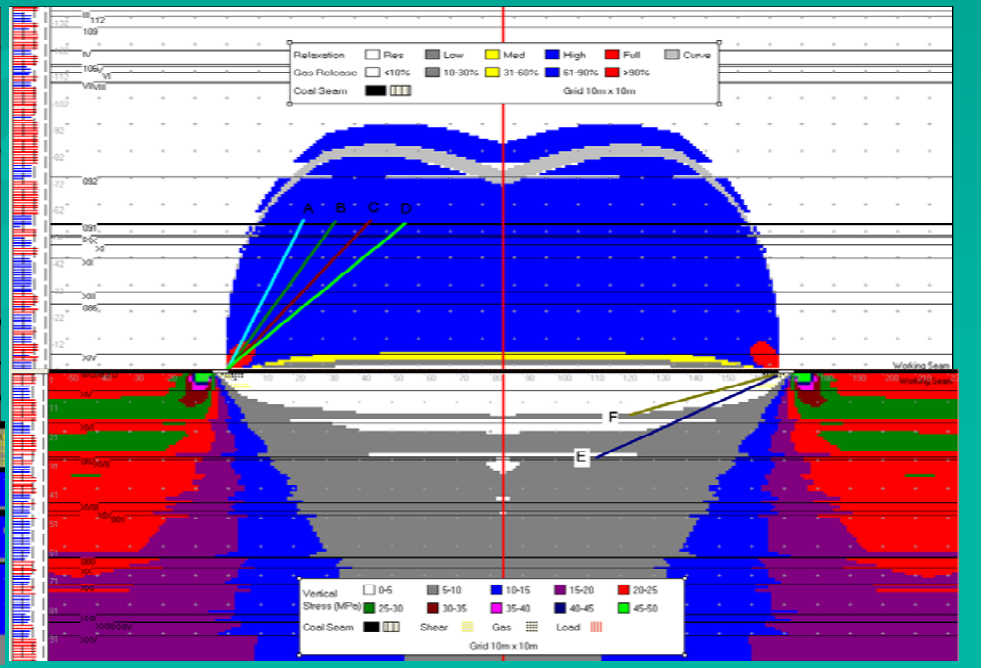
GRM strata relaxation & gas release zones

Simplified concept

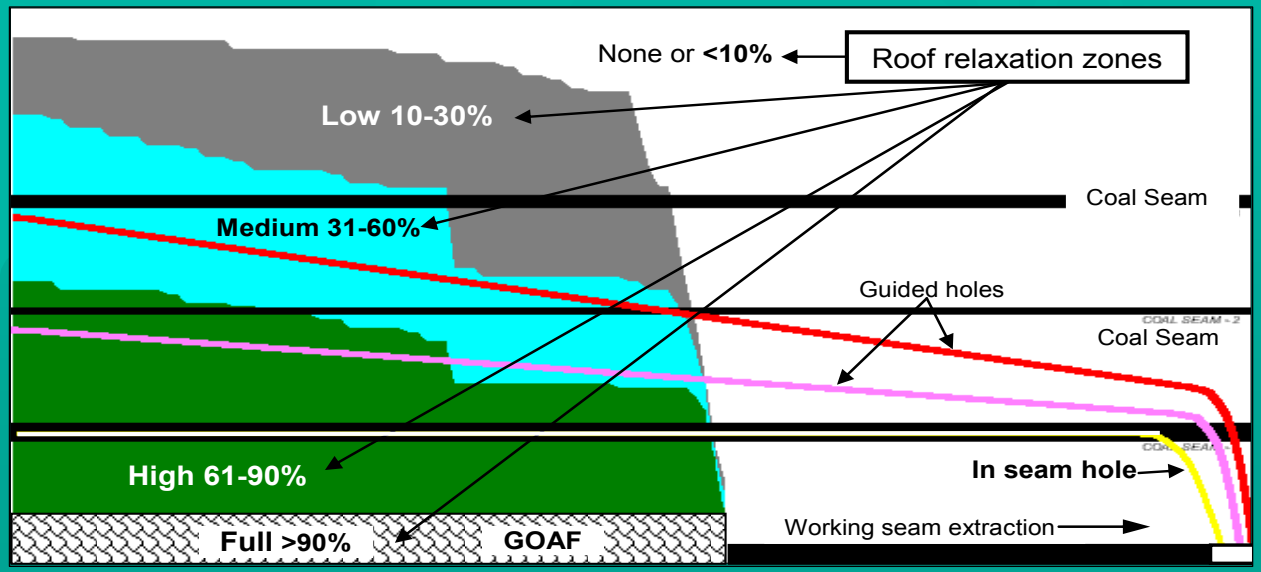


GRM-1 Combine roof/floor simulation outputs



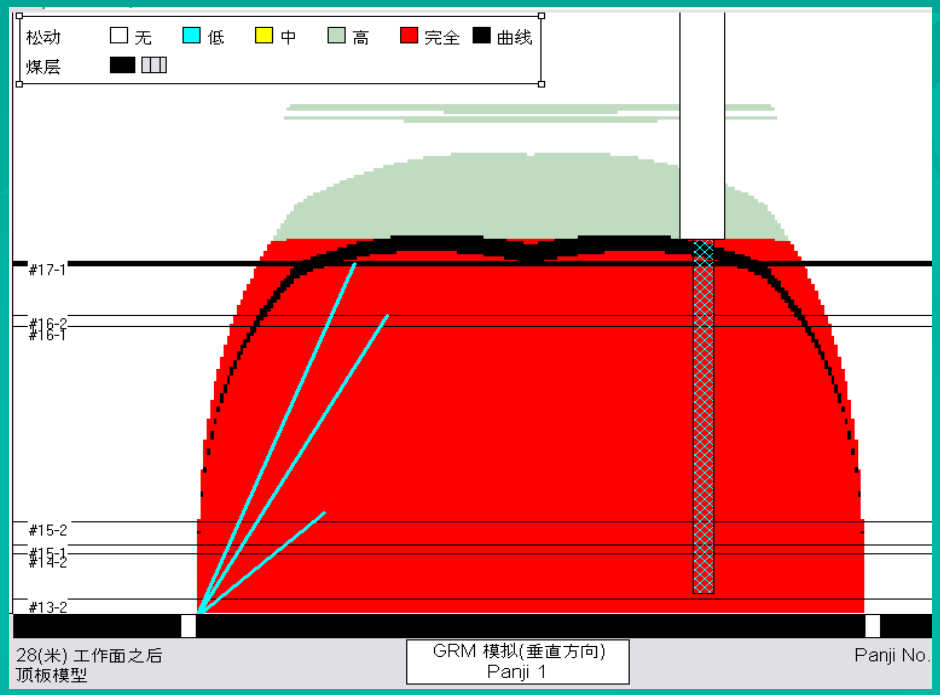


GRM-2 roof vertical cross section along LW block output (U/G directional holes design)

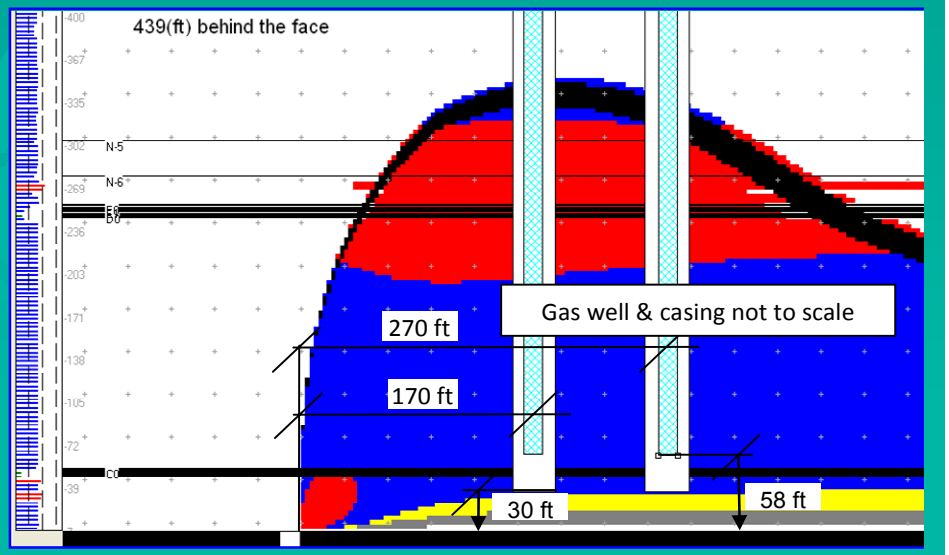


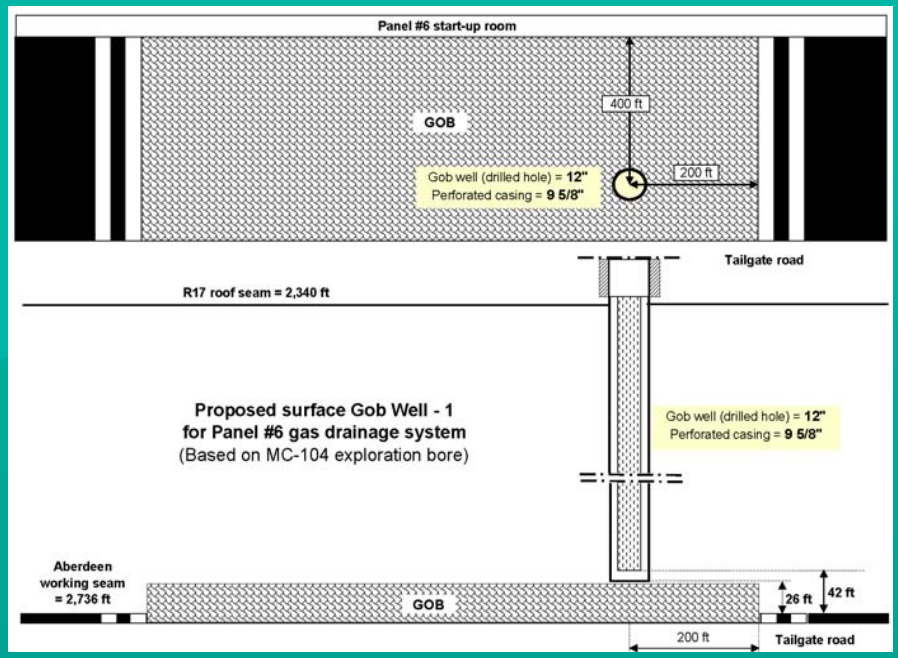
GRM case studies

China, Hainuan

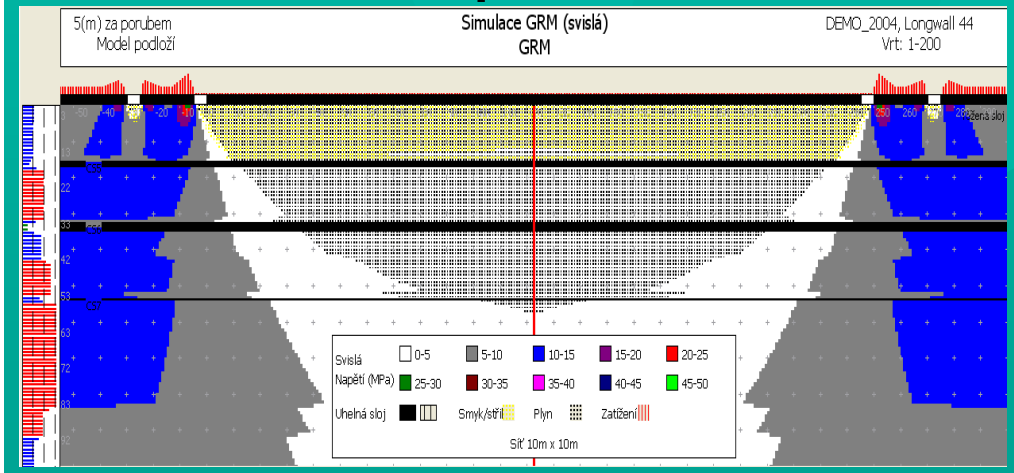


USA, Colorado

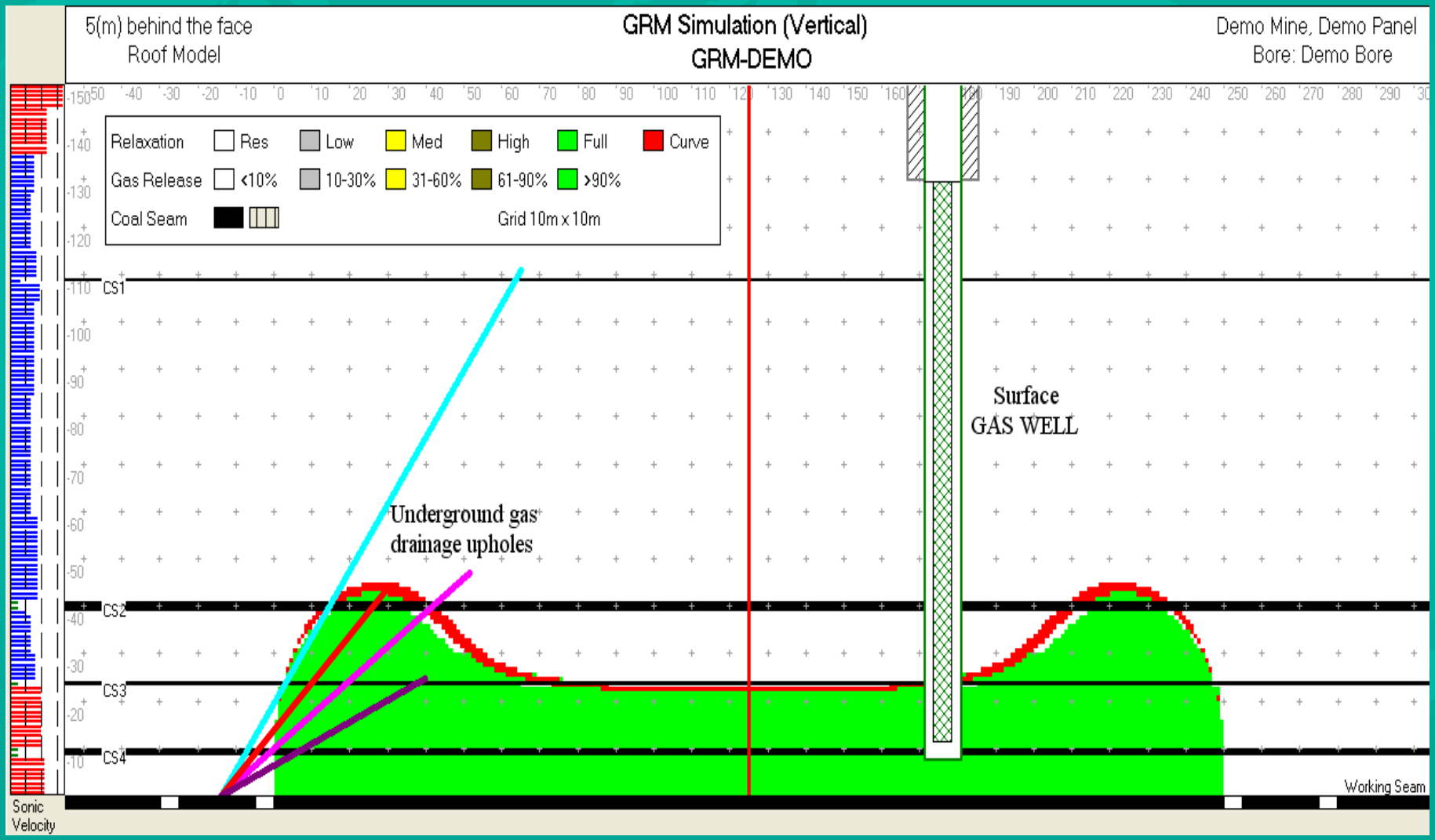




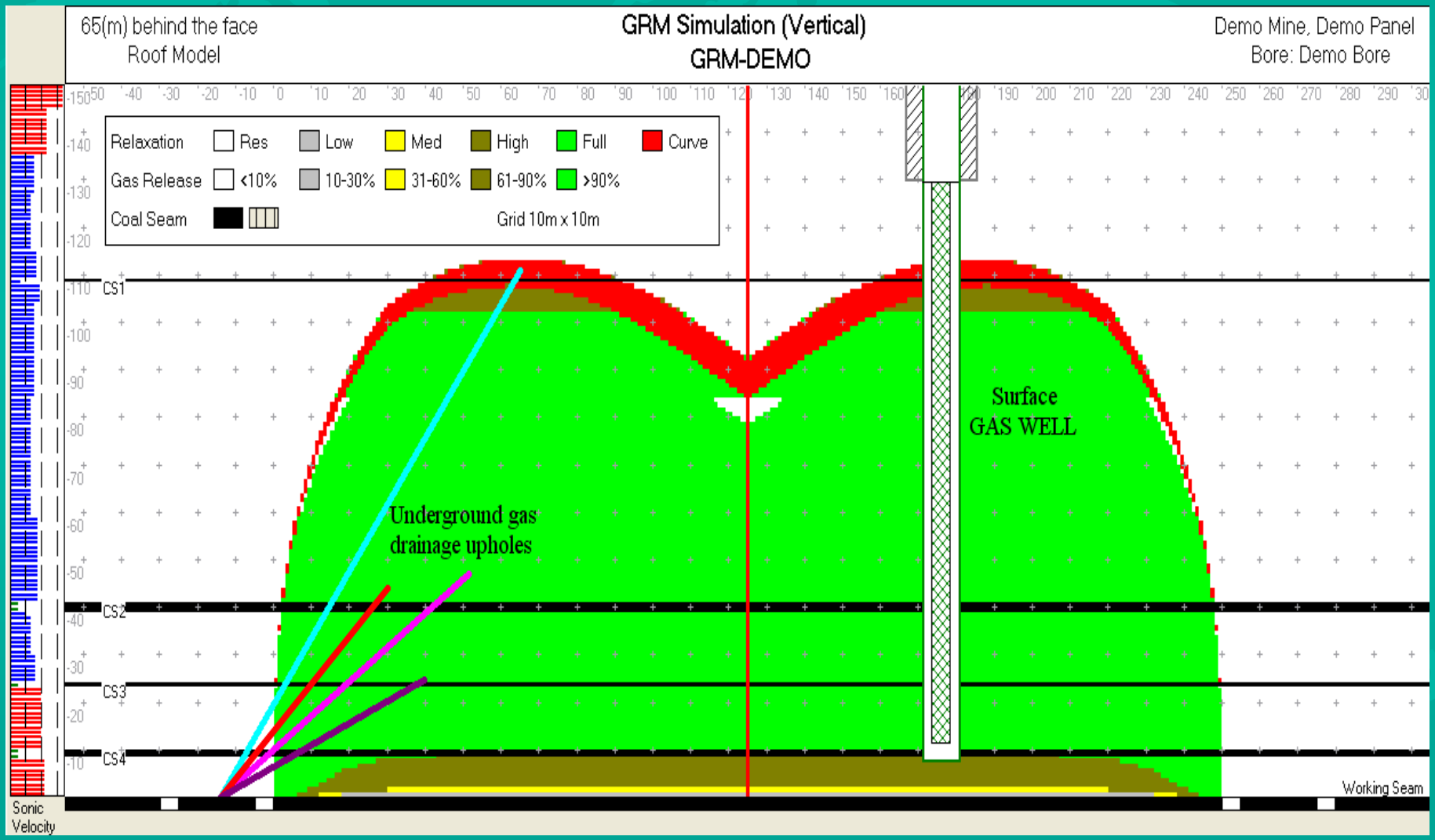
Czech Republic, Ostrava



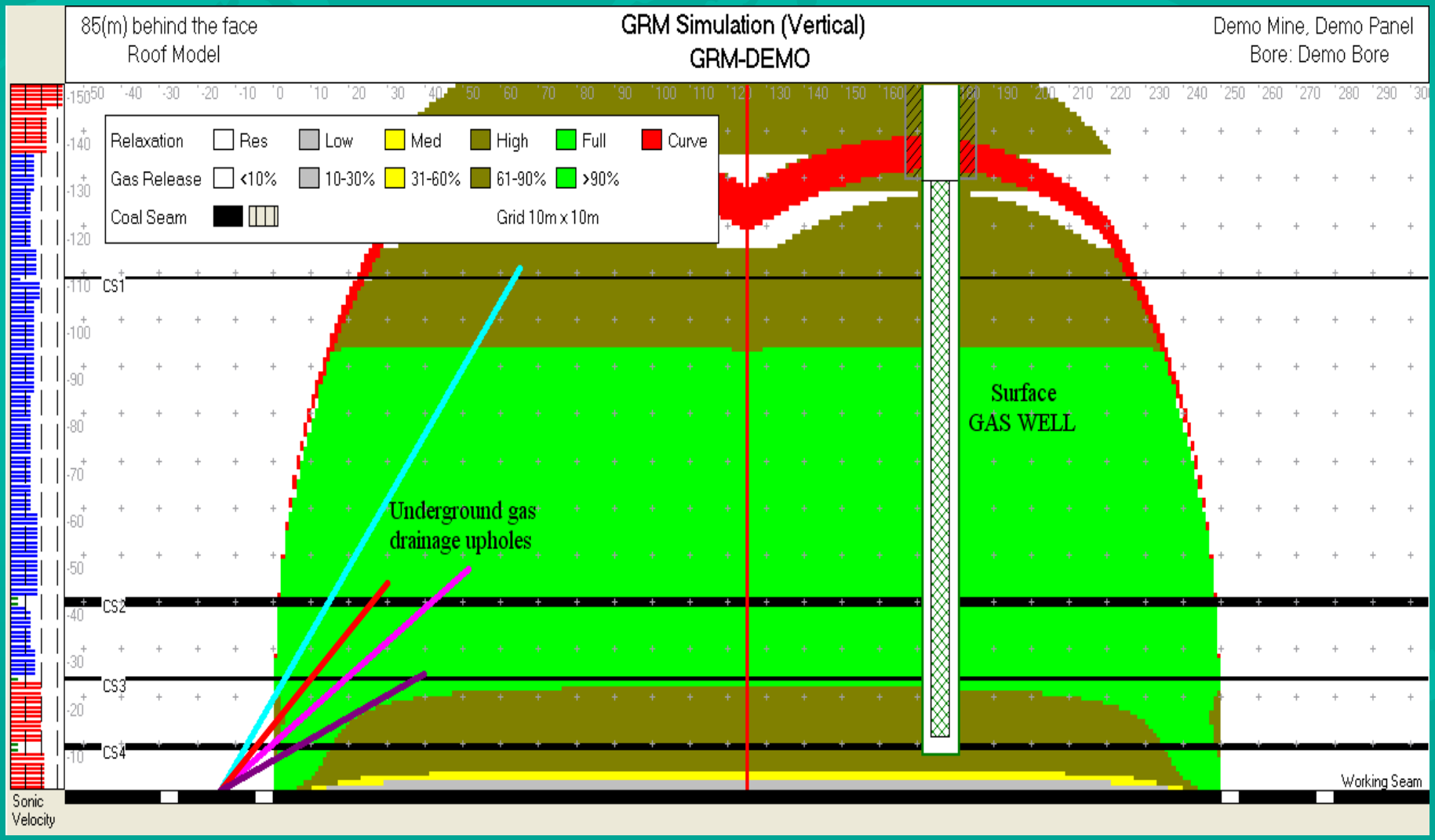
GRM roof simulation
5m behind the face



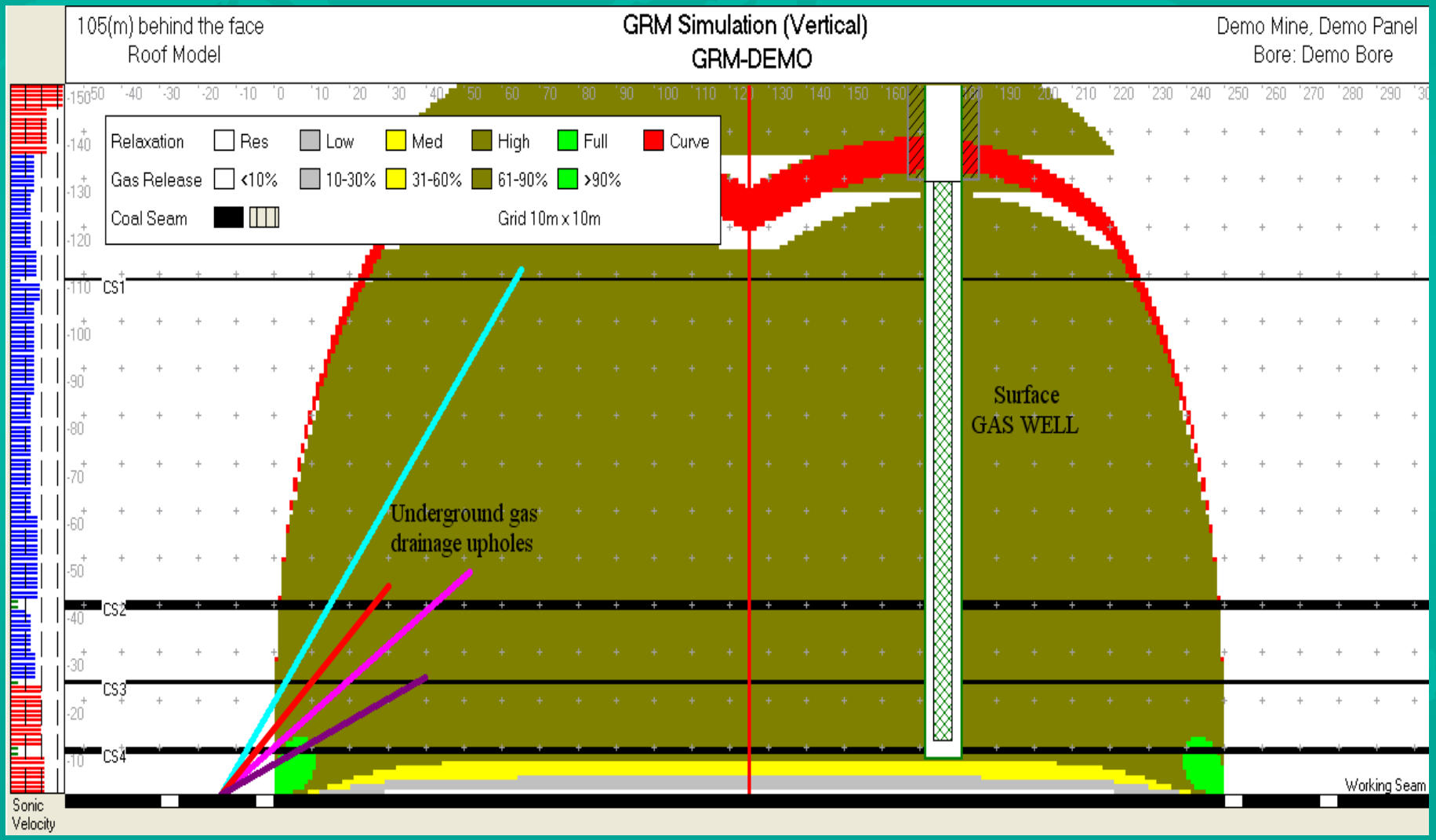
GRM roof simulation
65m behind the face



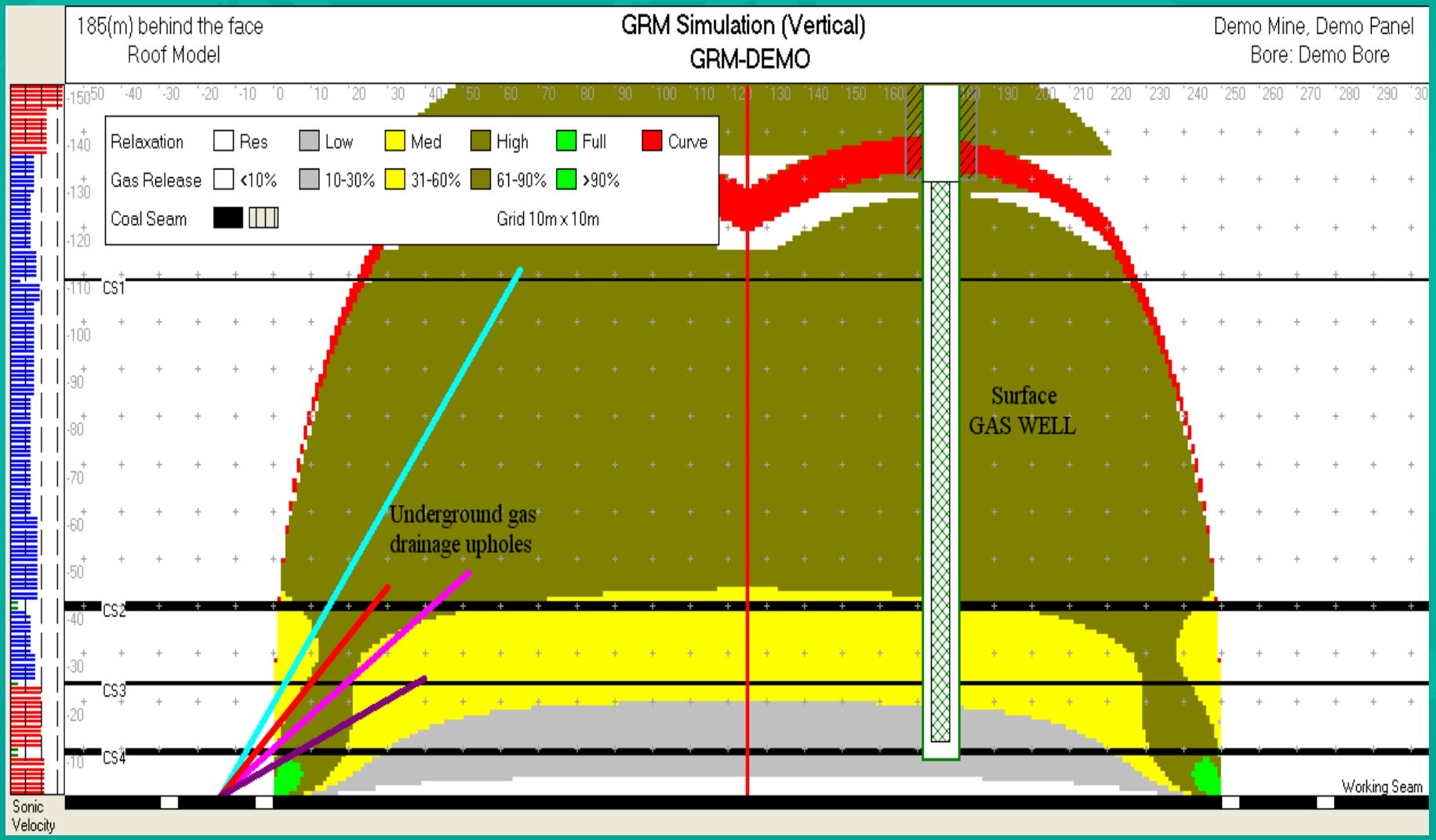
GRM roof simulation
85m behind the face



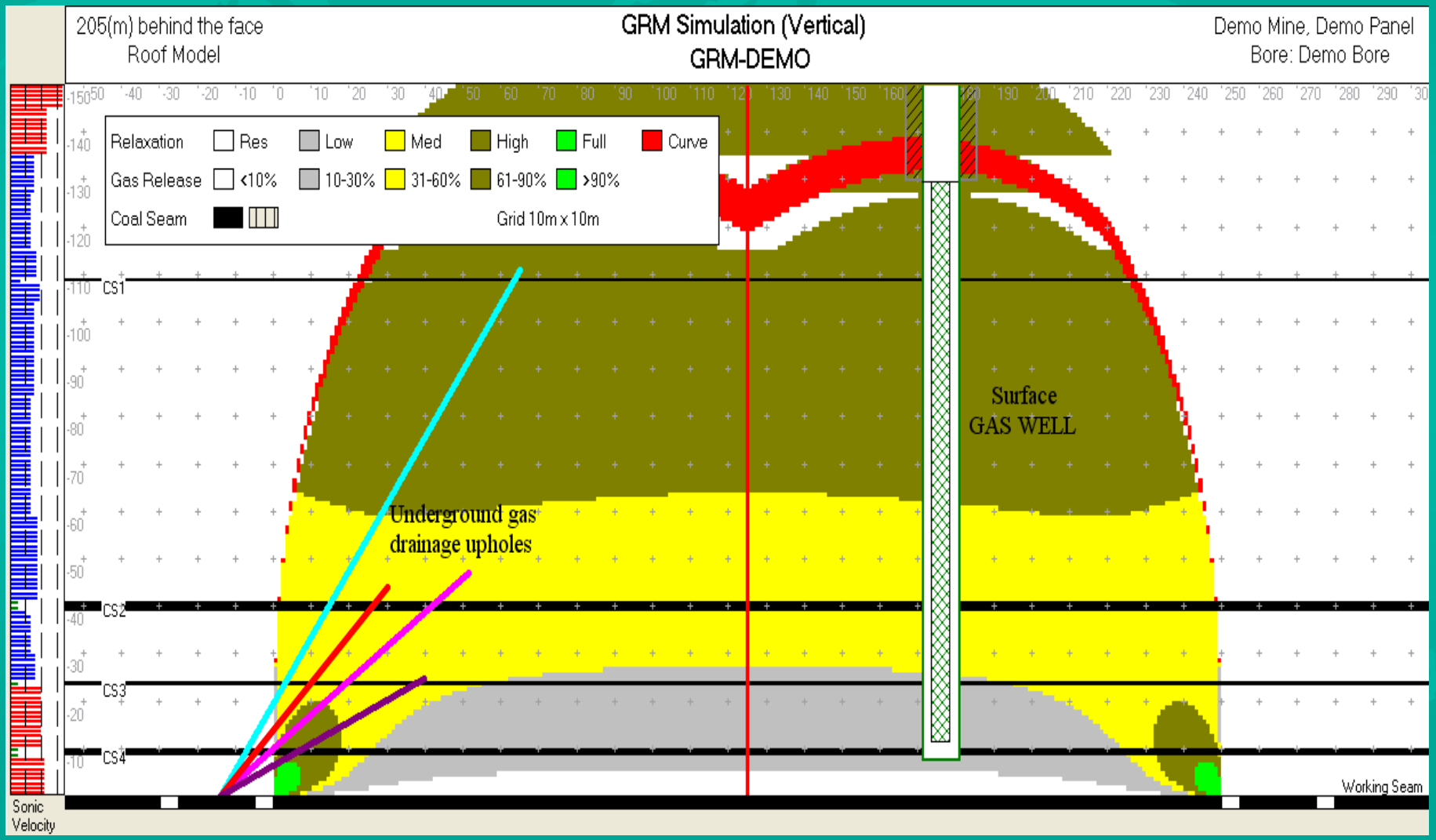
GRM roof simulation
105m behind the face



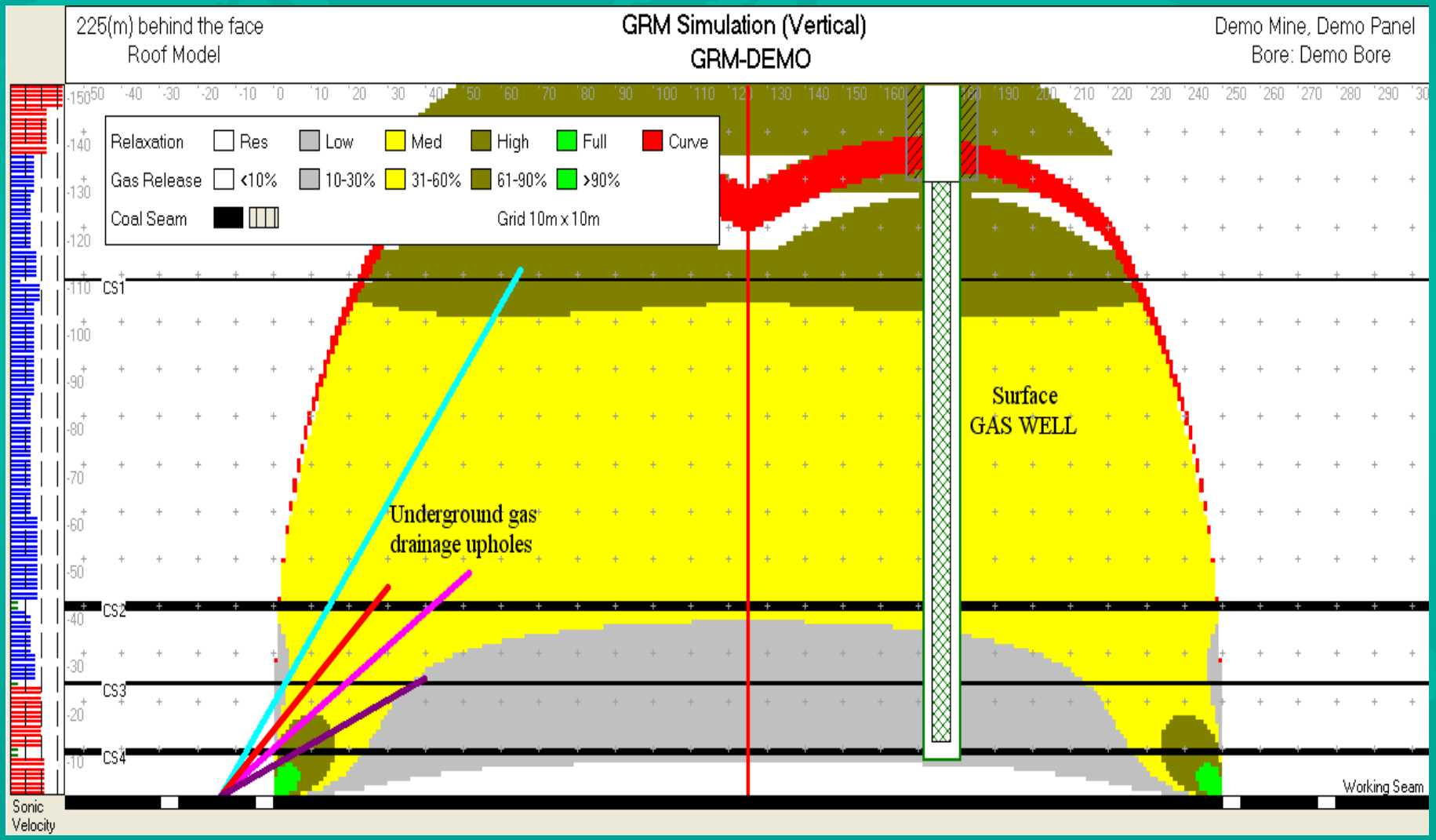
GRM roof simulation
185m behind the face



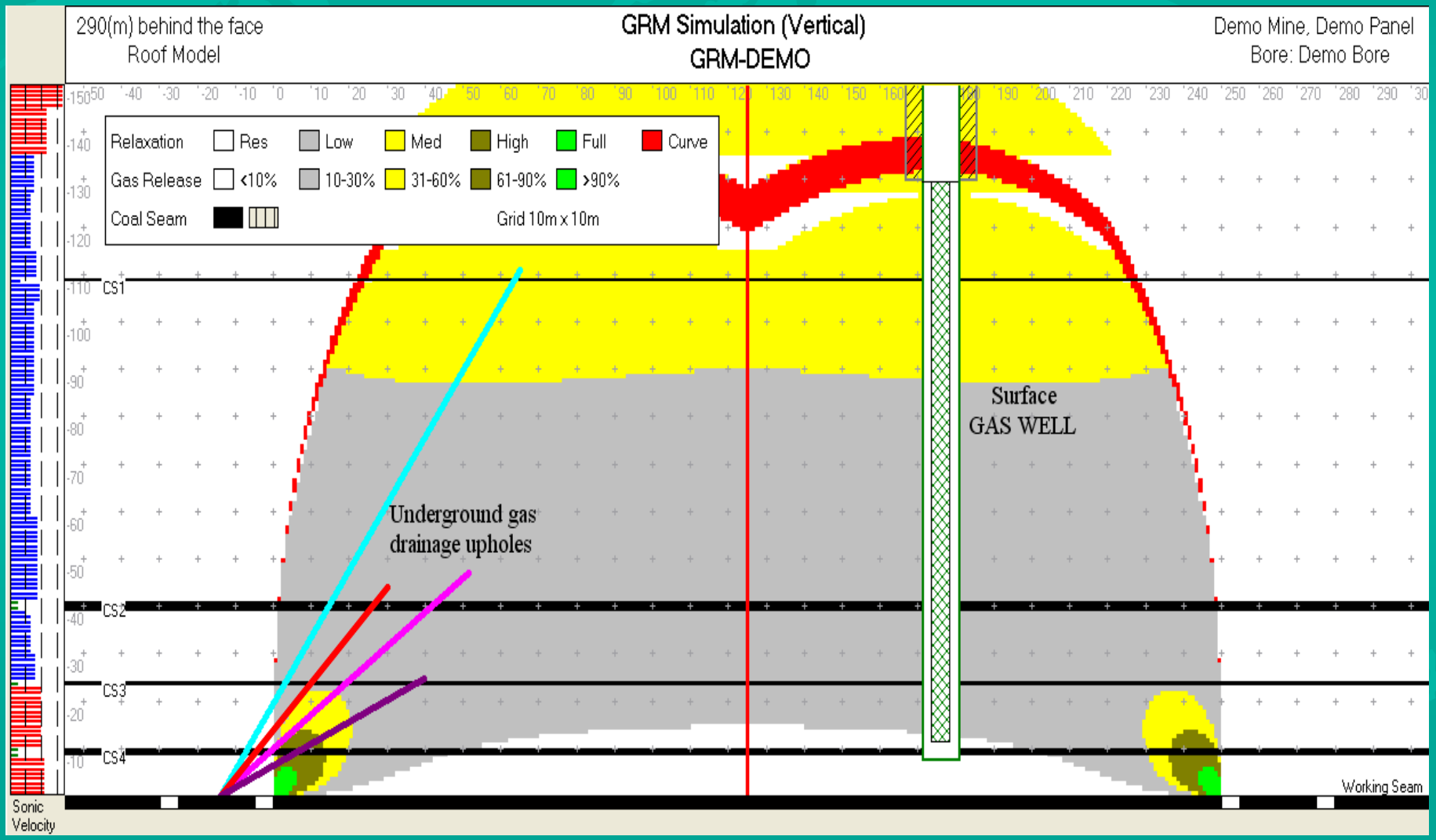
GRM roof simulation
205m behind the face



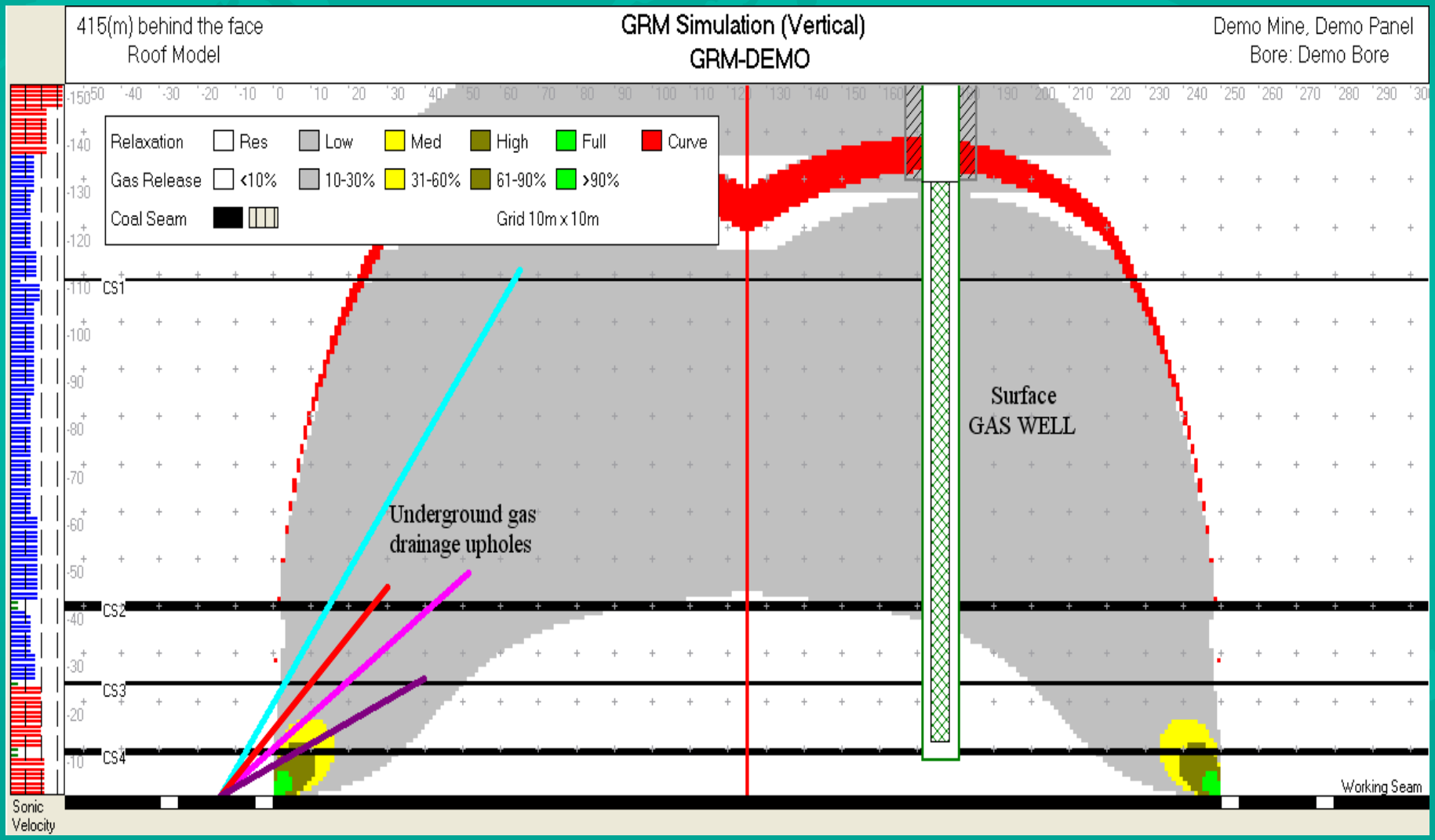
GRM roof simulation
225m behind the face



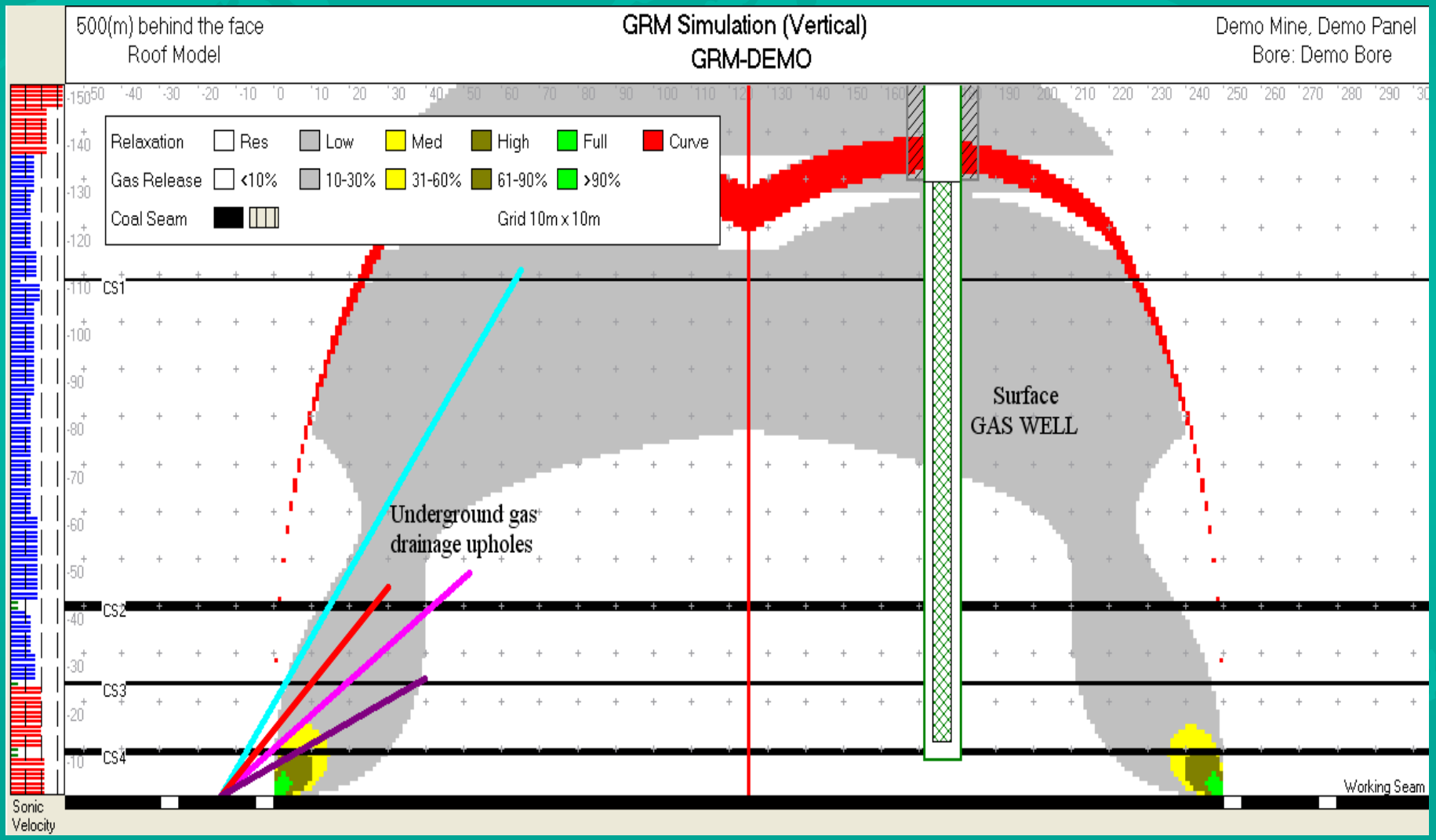
GRM roof simulation
290m behind the face



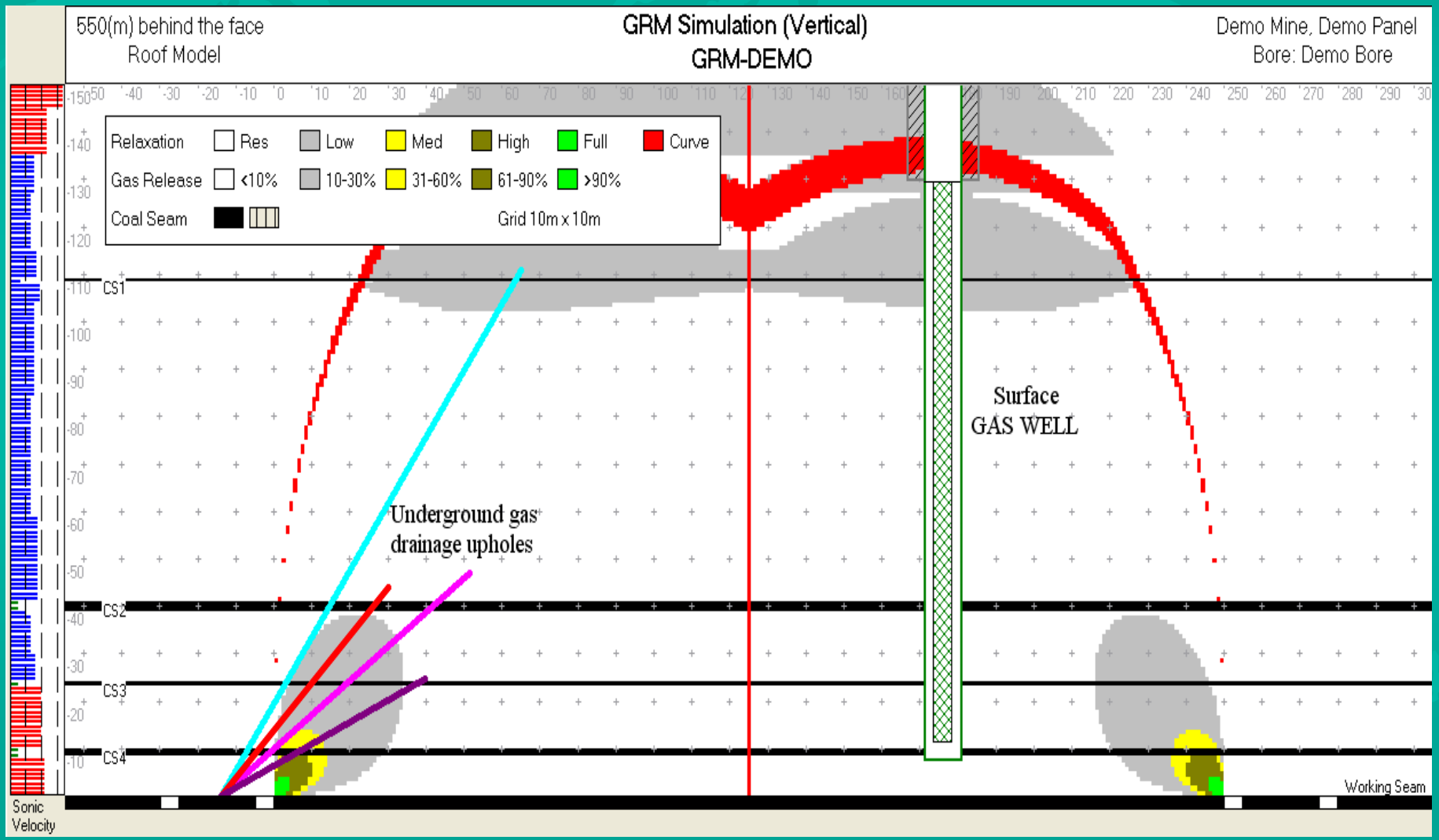
GRM roof simulation
415m behind the face



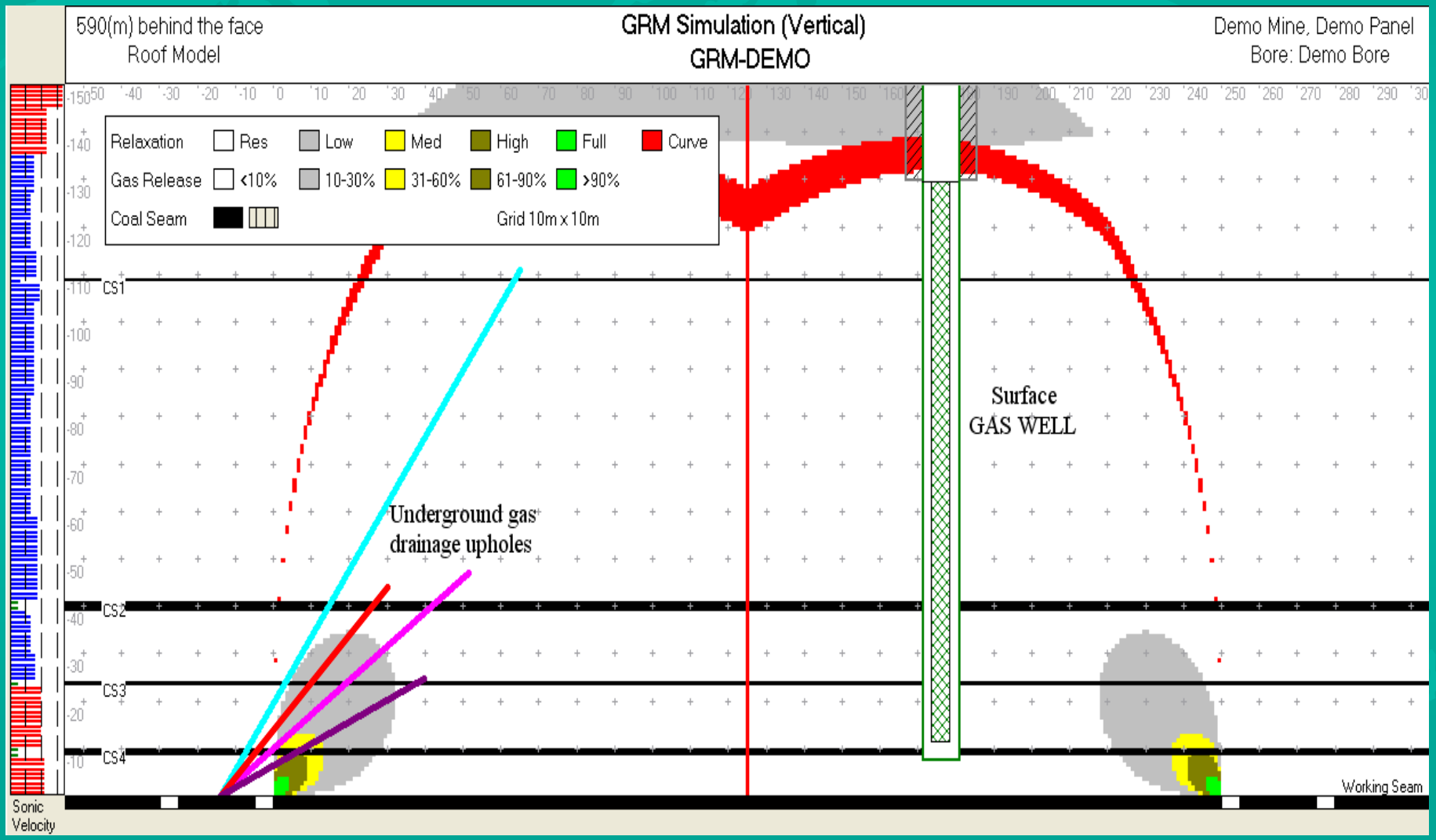
GRM roof simulation 500m behind the face



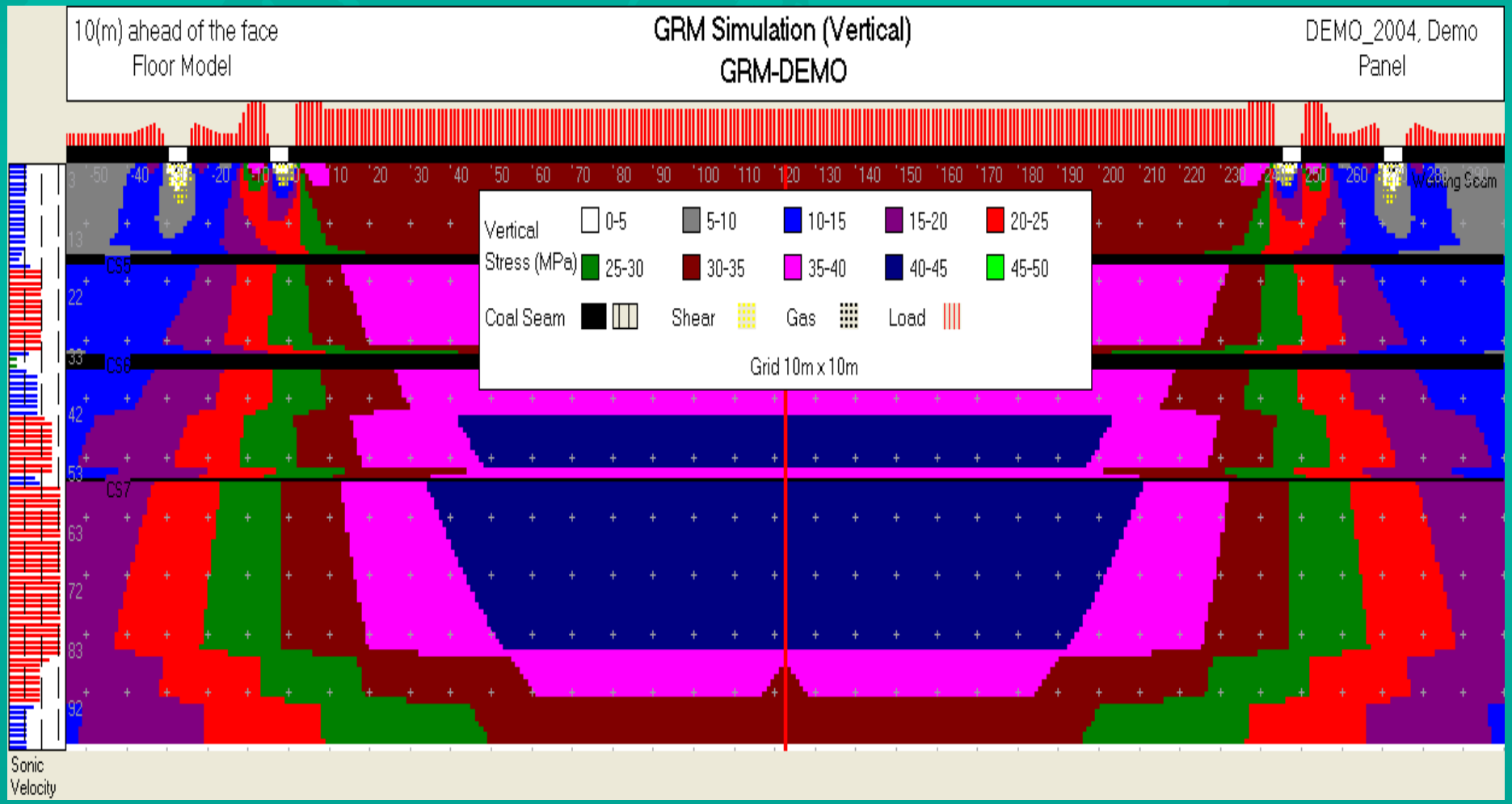
GRM roof simulation
550m behind the face



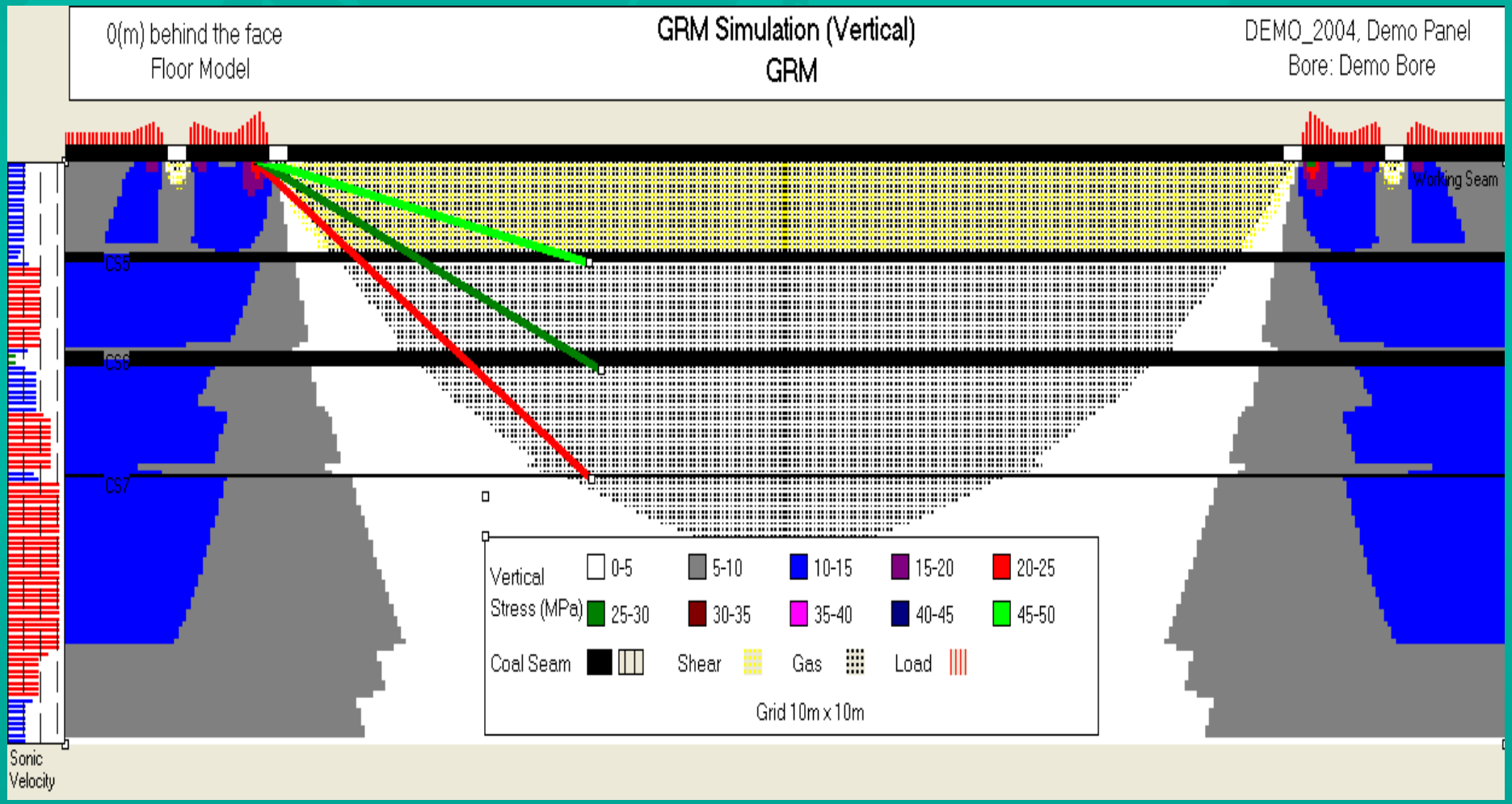
GRM roof simulation
590m behind the face



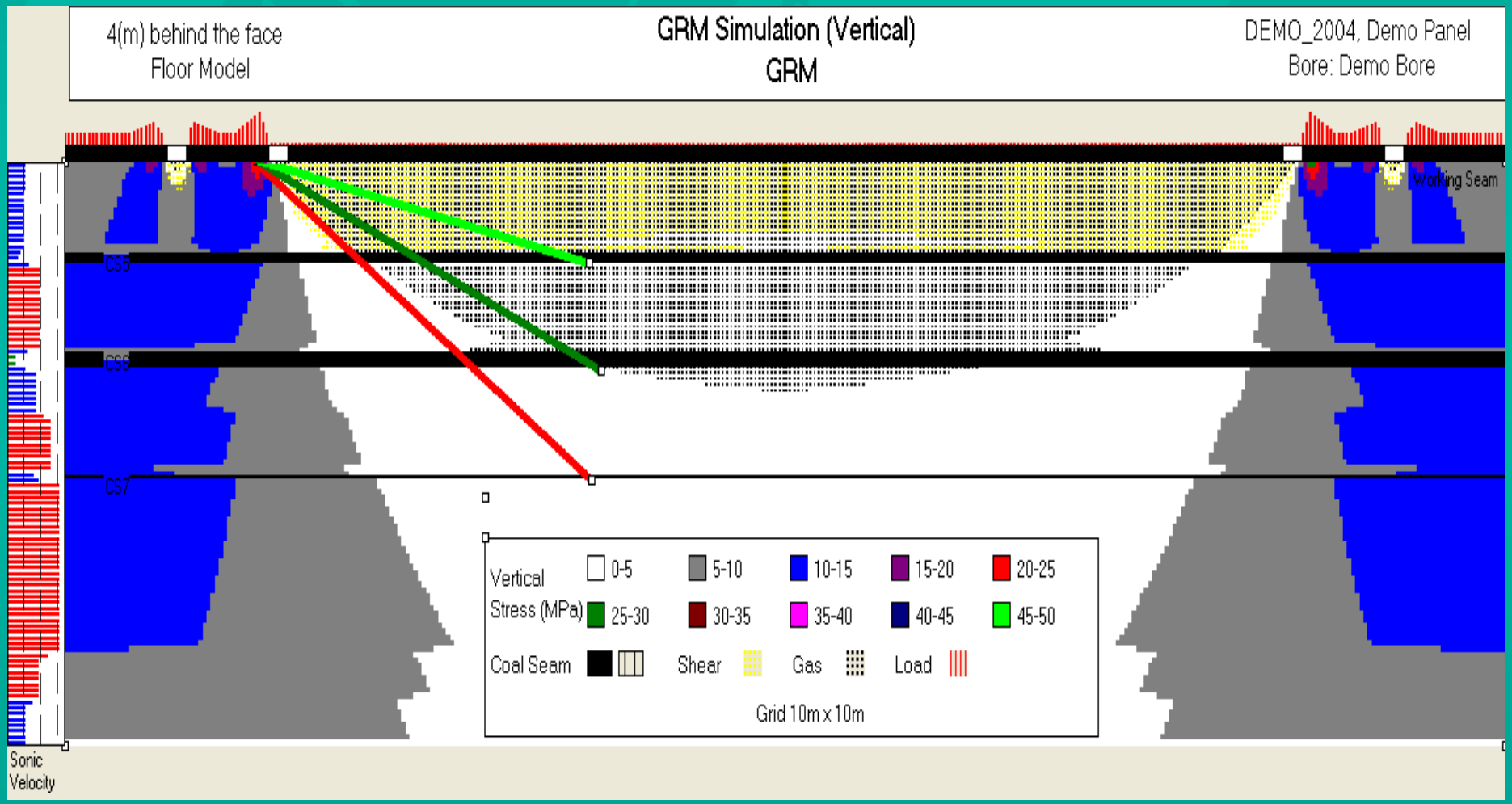
GRM floor simulation
10m ahead of the face



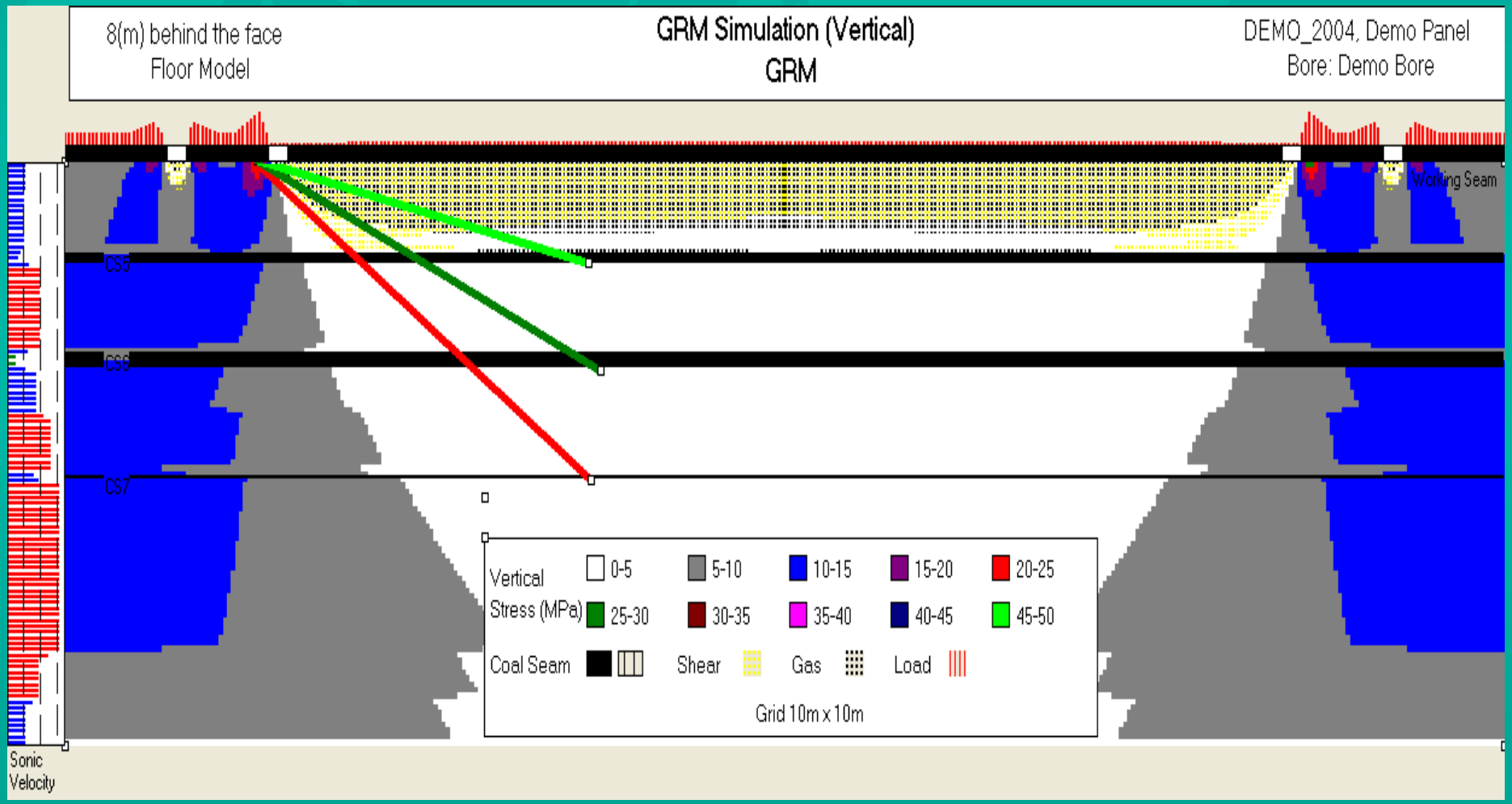
GRM floor simulation
0m behind the face



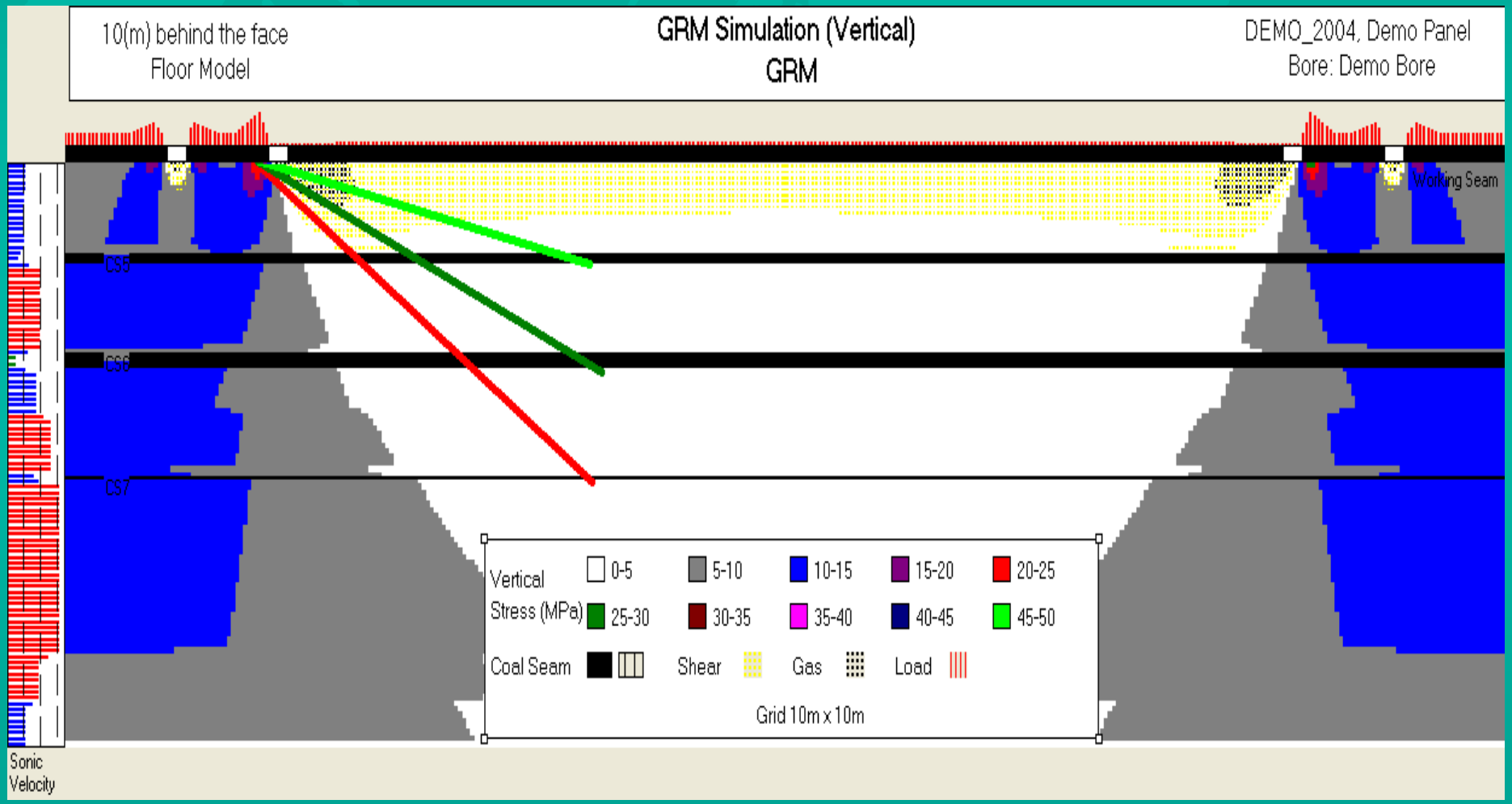
GRM floor simulation
4m behind the face



GRM floor simulation
8m behind the face



GRM floor simulation
10m behind the face



3. Goaf Gas Predictor (GGP)

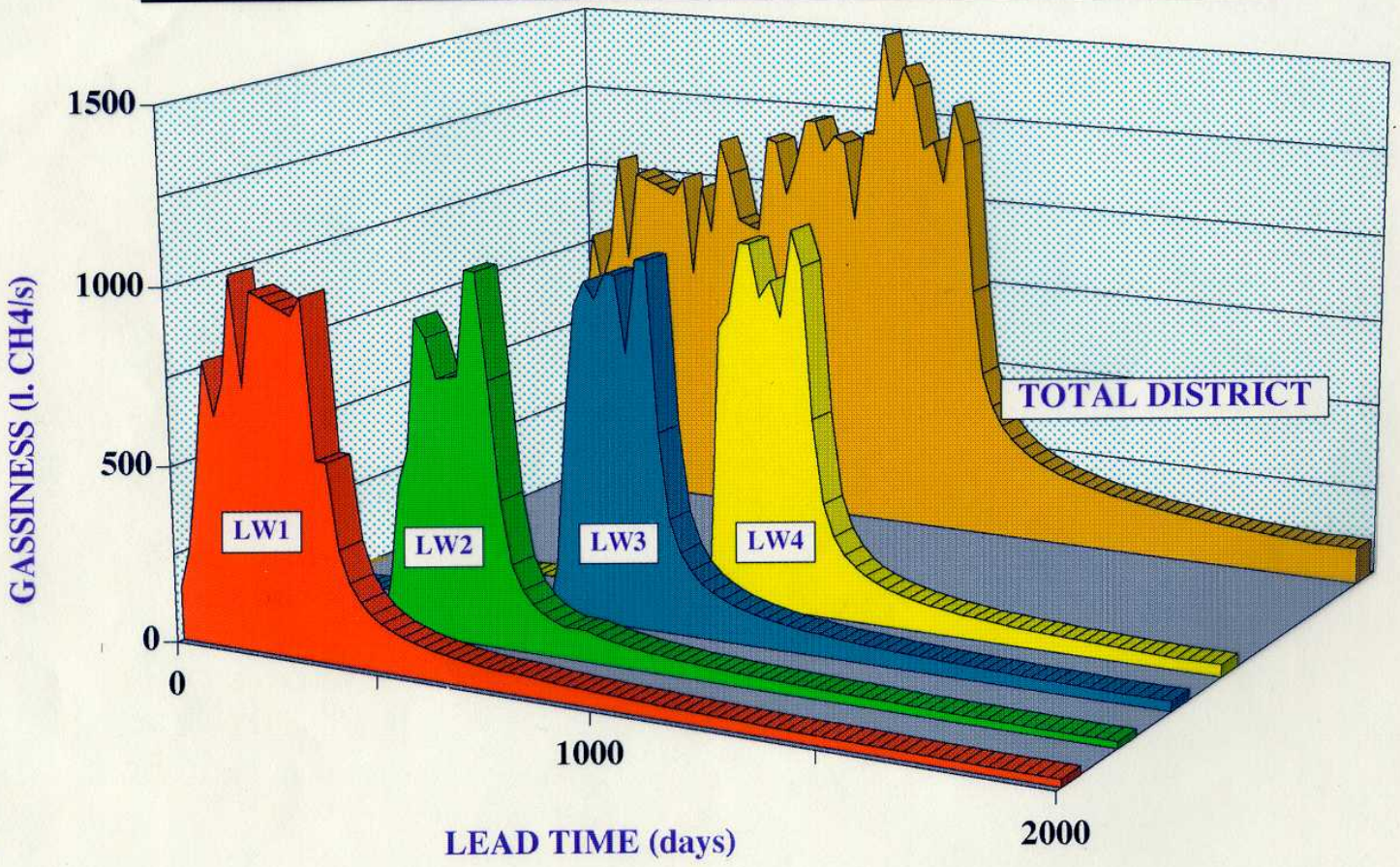
Prediction of coal mine gas quantity from sealed goaves & abandoned coal mines

1. *PRODUCTION GAS* - rapid decline phase
2. *BACKGROUND GAS* - long term decline phase

Outputs:

- Dry & flooded mine gas decline rate versus time
- Methane available in underground gas reservoir

MULTI-LONGWALL GOAF
GASSINESS DECAY



GGP - Coal mine gas emission decline curves equations

Stage 1 3 - 12 months

The logarithmic approximation curve

$$Q = -A * \mathrm{Ln}\,(\mathrm{Time}) + B$$

Stage 2 15 - 30 years

The exponential approximation curve

$$Q = C * e^{-D * (\mathrm{Time})}$$

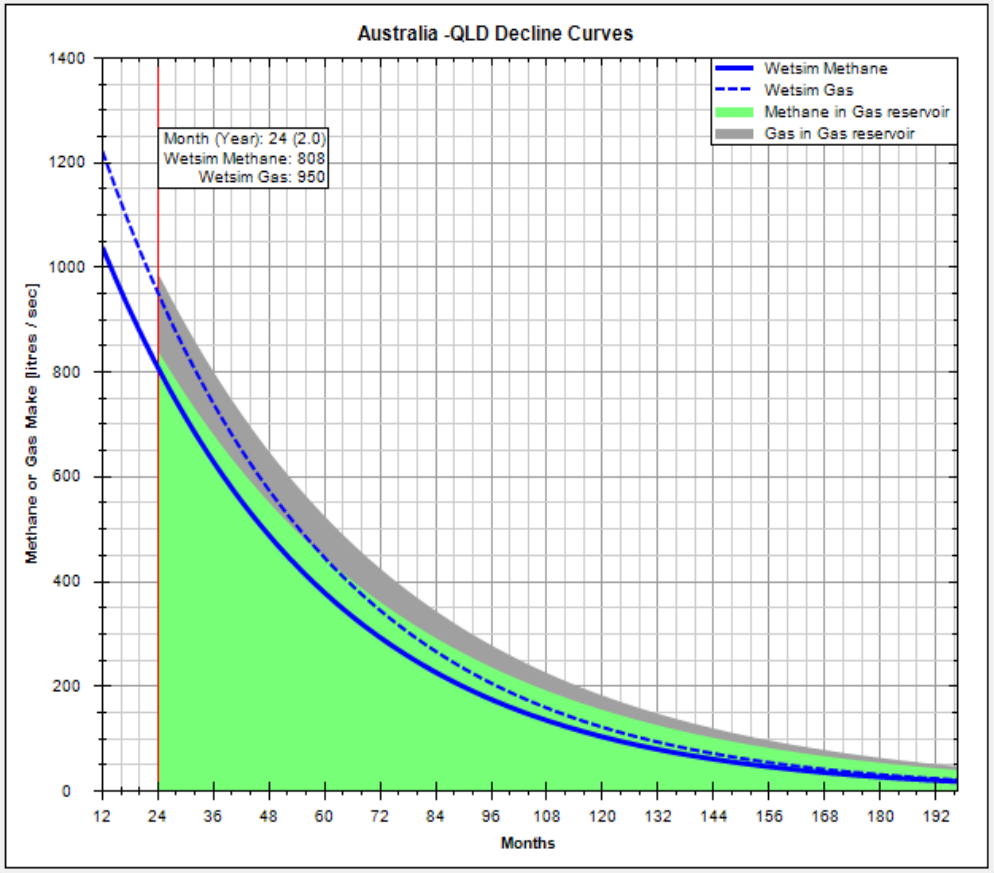
GGP - case study

Australia, QLD

Decline curves simulator | Gas reservoir characteristic

Mine name:	Australia -QLD
Mine category:	(I) High gassy
Final methane make [litres/sec]:	2,046
Gas composition	[CH4 %]: 85 [CO2+other %]: 15
Final gas make [litres/sec]:	2,407
Annual tonnage [kt]:	1,753
Background methane initial quantity [litres/sec]:	1,039
Background gas initial quantity [litres/sec]:	1,222
Void volume [k m³]:	4,986
Total coal extracted [kt]:	39,600
Coal avg density [t/m³]:	1.35
Void volume factor:	0.17
Water inflow [litres/sec]:	5 Select estimate
Flood time [months]:	379
Methane utilisation start time [month]:	
Methane utilised (Drysim) [litres/sec]:	
Methane utilised (Wetsim) [litres/sec]:	

Methane decline curves and gas reservoir



Dry mine | Wet mine | Gas reservoir | CO2

Closed mine parameters, gas decline curves and gas reservoir area graphs for high gassy flooded mine

GGP - case study

Australia, QLD

Decline curves simulator | Gas reservoir characteristic

Mine name:	Australia-QLD
Mine category:	(I) High gassy
Final methane make [litres/sec]:	2,046
Gas composition	[CH4 %]: 85 [CO2+other %]: 15
Final gas make [litres/sec]:	2,407
Annual tonnage [kt]:	1,753
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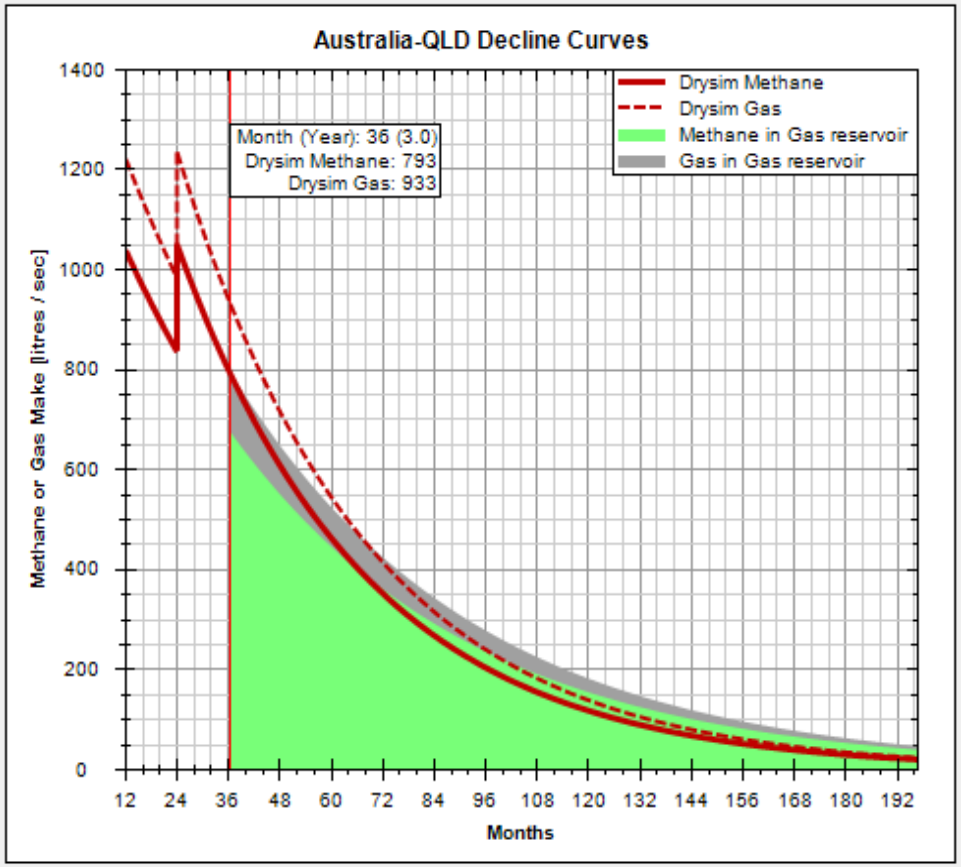
Void volume [k m³]:	4,986
Total coal extracted [kt]:	39,600
Coal avg density [t/m³]:	1.35
Void volume factor:	0.17
Water inflow [litres/sec]:	0 Select estimate
Flood time [months]:	
Methane utilisation start time [month]:	24
Methane utilised (Drysim) [litres/sec]:	1,050
Methane utilised (Wetsim) [litres/sec]:	

Methane decline curves and gas reservoir



Dry mine | Wet mine | Gas reservoir | CO2

Closed mine parameters, gas decline curves and gas reservoir area graphs for high gassy dry mine

GGP - case study

Mongolia, Nalaikh

Coal mine parameters | Gas reservoir characteristic

Districts / Boreholes

Colliery maps

Borehole: Colliery maps

Extracted area [m²]: 1,000,000

Worked seam: IV - WS

Add | Remove

Gas reservoir (Stratigraphy)

Seam	Depth [m]	Thickness [m]	Gas Content [m³/t]
I	251	1.5	(Auto)
II	271	2.6	(Auto)
III	309	3	(Auto)
IV - WS	**320**	**3**	**5**
V	350	8	(Auto)

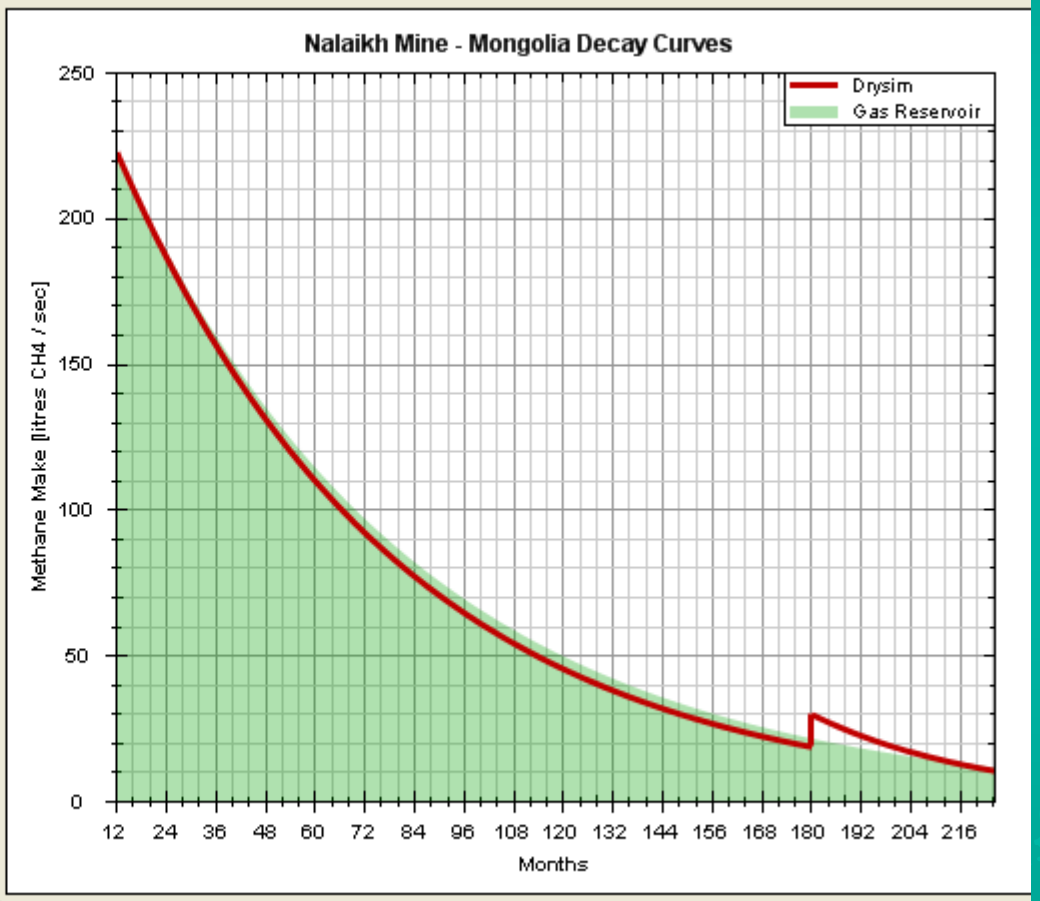
Add | Remove

Gas reservoir

Available methane [M m³]: 42.28

Difference to dry decline curve [M m³]: 2.45

Methane Decline Curves and Gas Reservoir

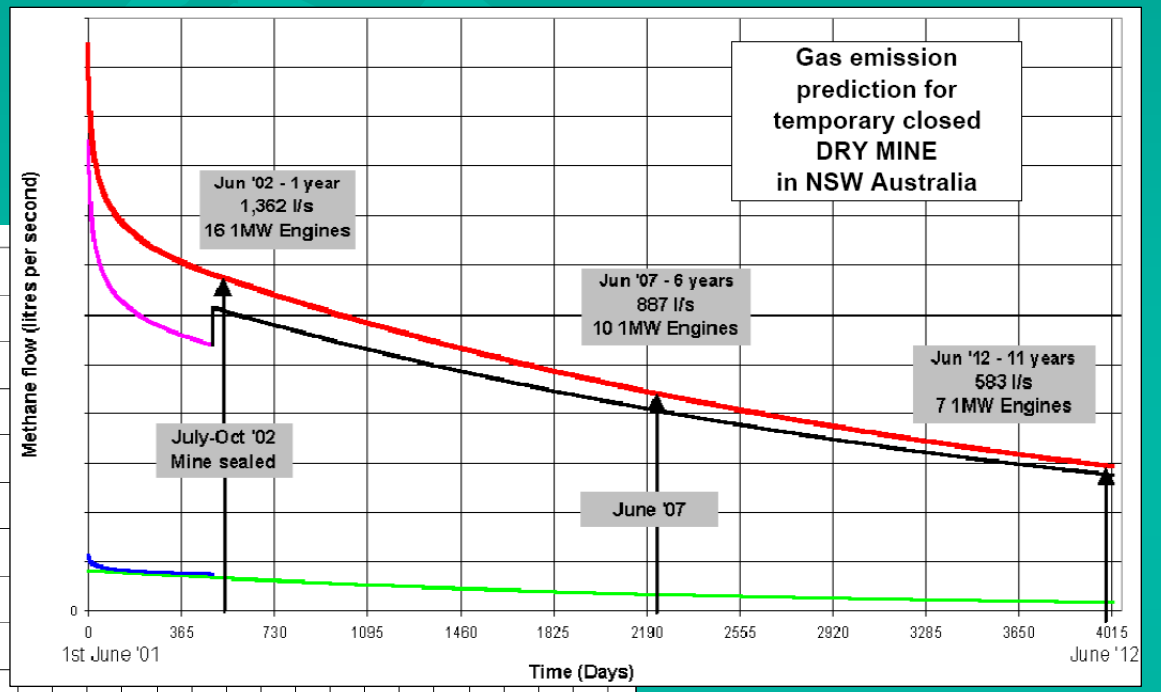


☑ Dry mine ☐ Flooded mine ☑ Gas reservoir

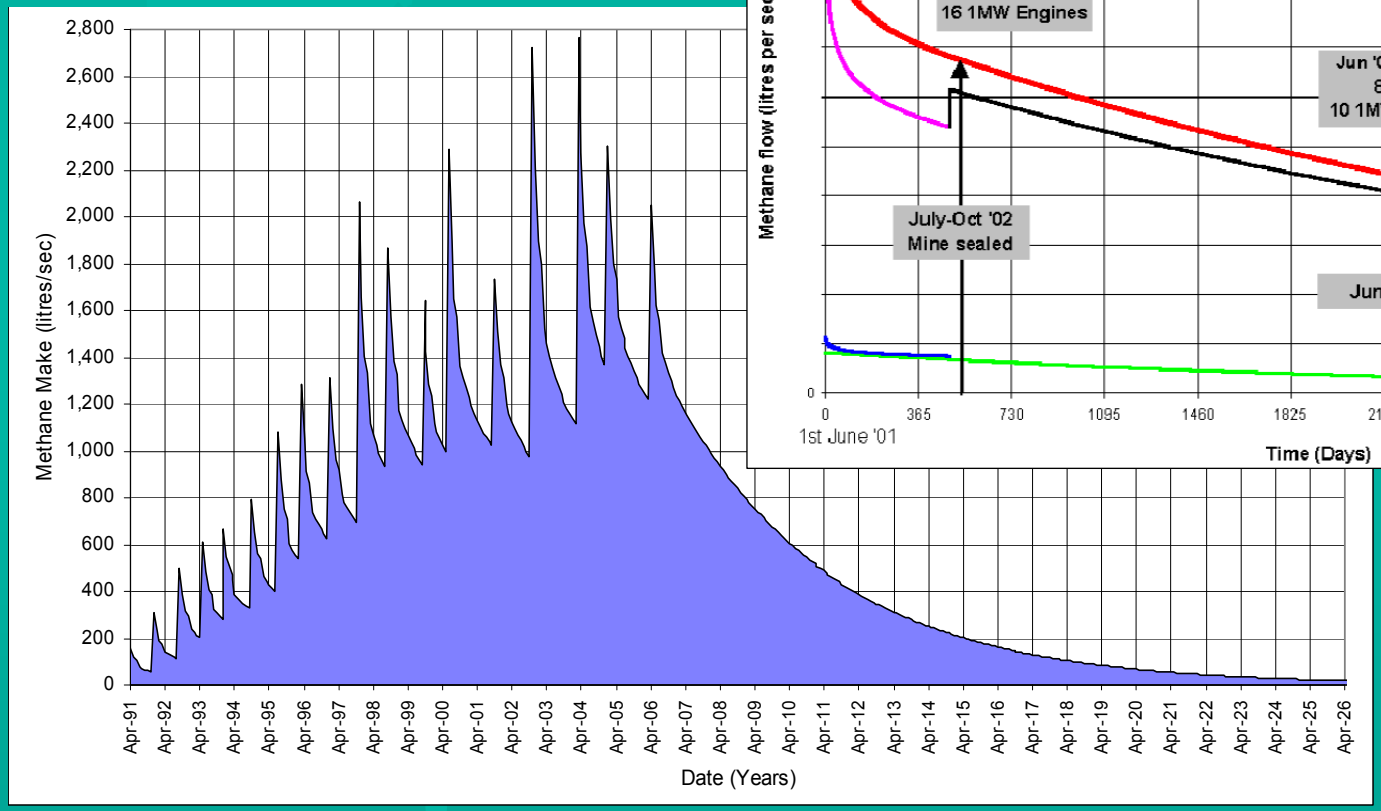
Gas reservoir available methane calculation and decline curve projection for abandoned dry coal mine

GGP - case studies

Australia - NSW



Australia - QLD



Decline curves projection (2001-2012) after mine was temporary closed

Coal mine gas emission during coal production (21 LWs) and projection (2006-2026) after mine was closed

lunagas@ozemail.com.au
Australia