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

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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

- Coal mine gas quantity prediction
  - Ventilation & Gas Drainage (CMGP)
- Strata relaxation zones simulation & gas drainage systems design (GRM)

GAS DRAINAGE & COAL MINE METHANE UTILISATION

- Drainage headings & U/G inseam holes
- Cross-measure drainage holes
- Sealed goaves
- Predrainage
- Drainage during mining activities (coal extraction)
- Gas emission & coal mine methane utilisation (GGP)
- Surface directional long holes
- Surface gas wells to the goaf area
- Abandoned mines
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 emission & ventilation requirements diagrams

**Specific Gas Emission (SGE)**

<table>
<thead>
<tr>
<th>Units</th>
<th>Coal seams description</th>
<th>In situ gas content</th>
<th>Coal seam thickness (coal only)</th>
<th>Distance from working seam</th>
<th>Strata relaxation range</th>
<th>Total gas SGE when gas drainage is not used</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>(m³ gas/t)</td>
<td>(metres)</td>
<td>(metres)</td>
<td>%</td>
<td>(m³ gas/mined)</td>
</tr>
<tr>
<td></td>
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<td></td>
<td>Total Individual Contribution to TOTAL (%)</td>
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<td>4</td>
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<tr>
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<td>0.64</td>
<td>10.63</td>
<td>100.00</td>
<td>1.61</td>
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**Roof coal seams summary**

- 2.87

**Working coal seam**

#13: #

<table>
<thead>
<tr>
<th>Units</th>
<th>Coal seams description</th>
<th>In situ gas content</th>
<th>Coal seam thickness (coal only)</th>
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<th>Strata relaxation range</th>
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<td>(m³ gas/mined)</td>
</tr>
<tr>
<td></td>
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<td></td>
<td>Total Individual Contribution to TOTAL (%)</td>
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</table>

**Floor coal seams summary**

- 3.05

**TOTAL:**

- 10.15

#### Specific Gas Emission (SGE)

- **Coal mine gas**
  - Methane only
  - Other gas only
  - Coal production (tonnes/day)

- **Other gases (CO₂)**
  - Inhy gas (O₂)
  - Drainage

**Coal production (tonnes/day)**

- **Coal mine gas**
  - Methane only
  - Other gas only

**Coal production (tonnes/day)**

- **Gas make (m³ gas/min)**
  - Gazowość (m³ gazu/min)
  - Total gas make
  - Methane
  - Other gas
  - Drainage

**Coal production (tonnes/day)**

- **Gas make (m³ gas/min)**
  - Gazowość (m³ gazu/min)
  - Total gas make
  - Methane
  - Other gas
  - Drainage
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

Up holes
Down holes
Distance behind the face
200 m
100 m
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

Gas well & casing not to scale

Czech Republic, Ostrava
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
8m 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

GASSINESS (L CH4/s)

LEAD TIME (days)

TOTAL DISTRICT

LW1
LW2
LW3
LW4
GGP - Coal mine gas emission

decline curves equations

Stage 1
3 - 12 months
The logarithmic approximation curve

\[ Q = -A \times \ln{(Time)} + B \]

Stage 2
15 - 30 years
The exponential approximation curve

\[ Q = C \times e^{-D \times (Time)} \]
GGP - case study
Australia, QLD

Closed mine parameters, gas decline curves and gas reservoir area graphs for high gassy flooded mine.
**GGP - case study**  
*Australia, QLD*

### Decline curves simulator

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
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<tbody>
<tr>
<td>Mine name</td>
<td>Australia-QLD</td>
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<tr>
<td>Mine category</td>
<td>High gassy</td>
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<tr>
<td>Final methane make [litres/sec]</td>
<td>2,046</td>
</tr>
<tr>
<td>Gas composition</td>
<td>CH4 85%, CO2+other 15%</td>
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<tr>
<td>Final gas make [litres/sec]</td>
<td>2,407</td>
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<tr>
<td>Annual tonnage [kt]</td>
<td>1,753</td>
</tr>
<tr>
<td>Background methane initial quantity [litres/sec]</td>
<td>1,039</td>
</tr>
<tr>
<td>Background gas initial quantity [litres/sec]</td>
<td>1,222</td>
</tr>
<tr>
<td>Void volume [km³]</td>
<td>4,986</td>
</tr>
<tr>
<td>Total coal extracted [kt]</td>
<td>39,600</td>
</tr>
<tr>
<td>Coal avg density [t/m³]</td>
<td>1.35</td>
</tr>
<tr>
<td>Void volume factor</td>
<td>0.17</td>
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<tr>
<td>Water inflow [litres/sec]</td>
<td>0</td>
</tr>
<tr>
<td>Food time [months]</td>
<td>24</td>
</tr>
<tr>
<td>Methane utilisation start time [month]</td>
<td>24</td>
</tr>
<tr>
<td>Methane utilised (Dysim) [litres/sec]</td>
<td>1,050</td>
</tr>
<tr>
<td>Methane utilised (Wetsim) [litres/sec]</td>
<td></td>
</tr>
</tbody>
</table>

### Methane decline curves and gas reservoir

*Australia-QLD Decline Curves*

- Drysim Methane: 733
- Drysim Gas: 933

*Closed mine parameters, gas decline curves and gas reservoir area graphs for high gassy dry mine*
Gas reservoir available methane calculation and decline curve projection for abandoned dry coal mine.
GGP - case studies

Australia - NSW

Australia - QLD

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

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

Gas emission prediction for temporary closed DRY MINE in NSW Australia

Jun '02 - 1 year 1,362 lfs 16 1MW Engines

Jun '07 - 6 years 887 lfs 10 1MW Engines

Jun '12 - 11 years 593 lfs 7 1MW Engines

July-Oct '02 Mine sealed

June '07
lunagas@ozemail.com.au
Australia