Categorisation of Outburst Indicators for Prediction at Metropolitan Colliery

Luke Tonegato

17/11/2016
Opinions and conclusions expressed in this presentation are my own based on my research, and not those of Peabody Energy nor any Peabody employees.
Background

Over 150 outbursts (Harvey 2002)

First outburst in 1895

Last in 2015

3 Fatal incidents (1896, 1925, 1954)

7 total fatalities
Current Management Approach

Outburst is managed in a controlled manner with contemporary methodologies

• Gas drainage & compliance coring
• Threshold criteria
• Geological assessment
• Roles and responsibilities
• Management Plans
Overview

To identify factors that are predictive for outburst events at Metropolitan Colliery

Including:

- Geotechnical
- Geological
- Operational
Overview

Plan

Do

Act

Check

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Methodology

Research
- Outburst Mechanisms
- Metropolitan Colliery

Review
- Categorise outburst parameters

Collect
- Develop outburst database
- Record events

Analyse
- Qualitative
- Descriptive

Conclude
Recorded Incidents

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Recorded Incidents

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Recorded Incidents

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Analysis
Gas and Gas Drainage

Categorisation of Outburst Indicators for Prediction at Metropolitan Colliery
Analysis

Gas and Gas Drainage

Intensity of Outbursts with Associated gas

2015

1886

Intensity (t)

- Mixture
- Methane
- Carbon Dioxide
Analysis

Gas and Gas Drainage

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Metropolitan Colliery Threshold Limit - With outbursts

![Graph showing gas content and methane percentage for different OB numbers.](image)

- **Threshold**
- **Normal Mining**
- **No recorded outbursts**
# Analysis

*Gas and Gas Drainage*

<table>
<thead>
<tr>
<th>Outburst ID</th>
<th>Maximum Core Sample at OB site (m³/t)</th>
<th>Gas Drainage Summary</th>
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<td>44 (1994)</td>
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<td>Core sample drill holes not surveyed, actual core site 30 metres off centre</td>
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Analysis
Gas and Gas Drainage

Outburst 44

Passed core at 3.81 m³/t
Analysis
Gas and Gas Drainage

Outburst 44

Passed core at 3.81 m³/t

Failed core at 17.3 m³/t
## Analysis

**Gas and Gas Drainage**

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Outburst 46

Initial failed core 9.12 m³/t

Failed hole flight path

Last Passed core 5.07 m³/t
Analysis
Gas and Gas Drainage

Outburst 46

Failed Cores from Additional Re-drilling

Last Passed core 5.07 (m$^3$/t)

Failed Hole
## Categorisation of Outburst Indicators for Prediction at Metropolitan Colliery

### Analysis

**Gas and Gas Drainage**

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<tr>
<td>47 (2016)</td>
<td>8.34</td>
<td>Gas drainage unable to lower core content</td>
</tr>
<tr>
<td>48 (2016)</td>
<td>8.35</td>
<td>Gas drainage unable to lower core content on inbye side of structure, encountered boggy conditions whilst drilling</td>
</tr>
</tbody>
</table>
Analysis

Stress Distribution

Stress Angles surrounding Outburst Sites

Roadway Direction
Analysis

Stress Distribution

Minimum 22°

Maximum 50°

Majority (80%) 44° - 50°
Analysis

Stress Distribution

Structure Incidence Angle

- Normal Fault
- Dyke
- Strike-Slip Fault

Marker Size non indicative
Analysis

Stress Distribution

Minimum
25°

Maximum
90°

Majority (50%)
45° - 75°
Analysis

Stress Distribution

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Analysis

Geological Disturbances
Analysis

Geological Disturbances

Number of Outbursts on Particular Structures

- **Normal Fault**
- **Dyke**
- **Strike-Slip Fault**

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Outbursts consistent with disturbed zones

Includes soft coal, mylonite, crushed coal, intense jointing

Caused by origin of fault

Influences gas environment
Analysis

Geological Disturbances
Analysis

Geological Disturbances

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Analysis

Grunching

Hargraves, Hindmarsh & McCoy (1964)
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Analysis

Grunching

Causes:

Areas had high gas content
- Shimmering
- Charges blown out

Grunching procedure
Analysis

Grunching

Grunching (structure)

Occurred due to problems with drainage

Grunching outbursts larger in size

Other outbursts reported as ‘slumpings’
Conclusions

The influence of gas and the importance of minimising the effects of this hazard

- Gas quantities and TLV’s are a critical parameter
- Quality, control and effectives of gas drainage is key to a successful management plan

Outbursts and structures

- Associated commonly with disturbed zone
- Ability of structure parameters to change

Distribution of stress and its interaction with outbursts

- Stress distribution more important than amount of stress

Grunching and its ability to influence outbursts

- Remains viable protection technique
Recommendation

Recording and Storing Data

Documenting details

Maintaining systematic database

• Site specific
• Technical parameters
• Operational parameters

Manage and predict future outbursts
### Recommendation

#### Recording and Storing Data

<table>
<thead>
<tr>
<th>Information</th>
<th>Gas</th>
<th>Geological Disturbances</th>
<th>Cavity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Identification</td>
<td>Primary gas</td>
<td>Structure ID</td>
<td>Location (L/R/Face)</td>
</tr>
<tr>
<td>Date</td>
<td>Gas make (% CO₂)</td>
<td>Name</td>
<td>Volume (m³)</td>
</tr>
<tr>
<td>Gas quantity (in-seam)</td>
<td>Surface Lineament (Y/N, Name)</td>
<td>Description</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Location</th>
<th></th>
<th>Structure Type</th>
<th>Cavity angles ^ (Acute/Obtuse)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Co-ordinates (MGA)</td>
<td>Seam Structure</td>
<td>Strike (°GN)</td>
<td></td>
</tr>
<tr>
<td>Mine location</td>
<td>Seam thickness (m)</td>
<td>Vertical Displacement (m)</td>
<td></td>
</tr>
<tr>
<td>Mining direction (°GN)</td>
<td>Depth of cover (m)</td>
<td>Dip (°)</td>
<td>Extraction method</td>
</tr>
<tr>
<td></td>
<td>Roof strata</td>
<td>Distance to structure (m)</td>
<td>Changes to environment</td>
</tr>
</tbody>
</table>

### Intensity

<table>
<thead>
<tr>
<th></th>
<th>Floor strata</th>
<th>Angle of incidence † (°)</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Tonnes released (t)</td>
<td>Dip of roadway (°)</td>
<td>Structure Angle Side * (L/R)</td>
<td></td>
</tr>
<tr>
<td>Gas released (m³)</td>
<td>Coal Properties</td>
<td>Mylonite (Y/N, Thickness)</td>
<td>Hazard recognition</td>
</tr>
<tr>
<td>Sound duration (s)</td>
<td>Major stress direction (°GN)</td>
<td>Slickenslides (Y/N)</td>
<td></td>
</tr>
<tr>
<td>Sound description</td>
<td>Stress incidence † (°)</td>
<td>Zone thickness (m)</td>
<td></td>
</tr>
</tbody>
</table>

For † * ^ See notes on next page

|                              | Stress Angle Side * (L/R)     | Properties                                     |                              |

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Questions?

References:


Hargraves, A, Hindmarsh, J, & McCoy, A 1964, ‘The control of instantaneous outbursts at Metropolitan Colliery, NSW