Background on Outbursts, & Consideration of Coal Bursts

Dr. Chris Harvey
Background on Outbursts, & Considerations for Coal Bursts
Background on Outbursts, & Considerations for Coal Bursts

• Fatal Outburst at Tahmoor Colliery, 24th June 1985.
• Approx. 330 tonne of coal & roof material ejected from the face.
• Approx. 35,000 m³ of CO₂ released.
• The miner driver died of asphyxiation.
• The outburst was associated with a known dyke structure which had been intersected in three previous panels with increasing thickness from 20 cm to 1m
Background on Outbursts, & Considerations for Coal Bursts

What is an Outburst??

• The sudden release of gas (often large quantity) in conjunction with the ejection of coal and associated rock, into the working face or mine workings.

• Three Primary components:
  • Intense stress within the coal seam
  • High gas content and high gas desorbability
  • Low coal strength
Background on Outbursts, & Considerations for Coal Bursts

Bulli Seam Experience:
• 6 Fatal Outburst incidents since 1896 resulting in 12 fatalities.
• More than 550 recorded outburst incidents for Bulli Seam mines.
• Largest incident involved an estimated 400 tonne of coal with the release of more than 4,000 m³ of CO₂.
### Background on Outbursts, & Considerations for Coal Bursts

#### Fatal Outbursts in the Bulli Coal Seam

<table>
<thead>
<tr>
<th>Colliery</th>
<th>Date</th>
<th>No. Killed</th>
<th>Size (Tonnes)</th>
<th>Gas(s)</th>
<th>Structure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Metropolitan</td>
<td>10 June 1896</td>
<td>3</td>
<td>Unknown</td>
<td>CH$_4$ (firedamp)</td>
<td>Dyke and soft fault zone</td>
</tr>
<tr>
<td>Metropolitan</td>
<td>27 July 1926</td>
<td>2</td>
<td>140</td>
<td>CO$_2$</td>
<td>Fault with 5m throw</td>
</tr>
<tr>
<td>Metropolitan</td>
<td>2 December 1954</td>
<td>2</td>
<td>90</td>
<td>CO$_2$</td>
<td>Normal fault with 0.3m throw</td>
</tr>
<tr>
<td>Tahmoor</td>
<td>24 June 1985</td>
<td>1</td>
<td>400</td>
<td>CO$_2$</td>
<td>Behind a dyke associated with strike slip movement</td>
</tr>
<tr>
<td>South Bulli</td>
<td>25 July 1991</td>
<td>3</td>
<td>300</td>
<td>CO$_2$ &amp; CH$_4$</td>
<td>Thrust fault with 35 cm of mylonitic coal; very high gas pressure.</td>
</tr>
<tr>
<td>West Cliff</td>
<td>25 January 1994</td>
<td>1</td>
<td>350</td>
<td>CO$_2$</td>
<td>Intersection of 2 strike slip structures; 30 cm of mylonitic coal.</td>
</tr>
</tbody>
</table>
# Background on Outbursts, & Considerations for Coal Bursts

## BULLI SEAM OUTBURSTS (2001)

<table>
<thead>
<tr>
<th>Colliery</th>
<th>No. of Outbursts</th>
<th>Size in tonnes</th>
<th>Gas</th>
<th>Geological Structure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Appin</td>
<td>22</td>
<td>2 - 88</td>
<td>mainly CH₄ &amp; CO₂ on dykes.</td>
<td>Predominantly strike slip faults; mylonite zones.</td>
</tr>
<tr>
<td>Brimstone</td>
<td>2</td>
<td>30</td>
<td>CO₂</td>
<td>Mainly dyke related structures with strike slip movement.</td>
</tr>
<tr>
<td>Corrimal</td>
<td>4</td>
<td>12</td>
<td>CH₄ &amp; CO₂</td>
<td>Shear zone associated with minor faulting &amp; dykes.</td>
</tr>
<tr>
<td>Kemira (closed)</td>
<td>2</td>
<td>60 - 100</td>
<td>CO₂</td>
<td>normal fault with mylonite.</td>
</tr>
<tr>
<td>Metropolitan</td>
<td>154</td>
<td>1 - 150</td>
<td>mainly CO₂ with minor amounts of CH₄</td>
<td>Predominantly with dykes &amp; faults that exhibit slicken sides &amp; mylonite.</td>
</tr>
<tr>
<td>South Bulli</td>
<td>7</td>
<td>1 - 300</td>
<td>mainly CO₂</td>
<td>Strike slip faults with mylonite; dyke zones &amp; thrust faults.</td>
</tr>
<tr>
<td>Tahmoor</td>
<td>88</td>
<td>5 - 400</td>
<td>mainly CO₂</td>
<td>Mainly strike slip faults; with dykes (110° - 135°) &amp; thrust faults: mylonite usually present.</td>
</tr>
<tr>
<td>Tower</td>
<td>19</td>
<td>1 - 80</td>
<td>mainly CH₄</td>
<td>Mainly strike slip faults with dykes.</td>
</tr>
<tr>
<td>West Cliff</td>
<td>250</td>
<td>4 - 350</td>
<td>mainly CH₄ with CO₂ to the NE development</td>
<td>Predominantly strike slip faults (100° - 110°) with slicken sides &amp; mylonite; dykes and thrust faults have been associated with outbursts.</td>
</tr>
</tbody>
</table>
Background on Outbursts, & Considerations for Coal Bursts

International experience:

• **Japan;** Yubari New Colliery, at a depth of 1,138 m. approx. 4,000 m$^3$ of coal was ejected along with 600,000 m$^3$ of gas (predominantly methane).
  • As a direct consequence of the outburst 83 miners were killed by suffocation (including 15 people who were trapped in-bye of the coal ejected by the outburst).
  • A further 10 people were killed in a secondary gas explosion caused when a static charge from a sheet of plastic used by the rescue party, which ignited the methane liberated by the initial outburst.

• **Poland;** The largest outburst occurred at the Nowa Ruda Colliery on 22 October 1958, ejecting 5,000 tonnes of coal and an estimated 750,000 m$^3$ of Gas

• **Ukraine;** The largest outburst occurred at Gagarin Colliery in 1969 with the initial mining of the Mazurka coal seam.
  • This seam has an average thickness of 1 m, a dip of 68° at a depth of 710 m.
  • The outburst ejected 14,500 tonnes of coal and liberated 600,000 m$^3$ of gas
Background on Outbursts, & Considerations for Coal Bursts

Threshold Valves & Outburst Management Plans.

• In 1994 following a fatal outburst at West Cliff Colliery Standards in respect of Seam Gas Threshold Values were imposed on ALL Bulli seam mines.

• This required:
  • Gas samples to be taken in advance of mining operations
  • All drainage holes to be surveyed
  • Outburst prone structures to be mapped
  • An authority or permit to mine to be signed off by the mine manager.

• Outburst Management Plan to be developed for each mine to ensure all essential safe-guards are in place.
Background on Outbursts, & Considerations for Coal Bursts

Seam Gas Threshold Values

Remote Mining Operations

Normal Mining Conditions
The success of imposing Outburst Management Plans and Gas Threshold Values on Bulli seam mines
Background on Outbursts, & Considerations for Coal Bursts

Coal Bursts

Coal burst: - An event in a coal mine which involves the release of stored strain energy that causes dynamic failure or displacement of the intact coal/rock, resulting in high velocity expulsion of this broken/failed material into the mine opening.

(NSW Resources Regulator release: “Dangerous Incident- Coalburst or Rockburst”)
Background on Outbursts, & Considerations for Coal Bursts

• They occur in underground coal mining operations throughout the world.

• In USA:
  • From 1936 to 1993; 172 burst were identified with 87 fatalities & 163 injuries (61% occurred in Pillar recovery operations).
  • From 1994 to 2013, 140 events were recorded with a total of 5 fatalities (2 on longwalls, & 3 during Pillar recovery).
  • Progress & large scale pillar failure is considered a “Coal Bursts”
Background on Outbursts, & Considerations for Coal Bursts

Common features of Outburst & Coal Burst

• **Release of Stored Energy:** Sudden release of in-situ gas pressure or strain energy or potential energy within the coal and/or associated rock mass.

• **Ejection of broken / failed material:** Broken /fractured /failed coal material is ejected (usually at high velocity) into the immediate working area along with associated rock from the roof.

• **Sudden and unexpected force or violence:** The energy (either gas pressure or strain energy) is released suddenly, as the surrounding rock mass which contains and restrains the energy source, is taken away due to the advancing mine workings.
Background on Outbursts, & Considerations for Coal Bursts

Common features of Outburst & Coal Burst

**Association with seismic events:** Seismic activity or events have the potential to trigger or induced by an outburst or coal burst event.

**Serious injury or fatal to any nearby workers:** Mine workers in the immediate area are severely or fatally injured by the displaced material and placed in an oxygen deficient or toxic environment.

**Association with Structure:** Often the site of an outburst or coal burst is related to the presence of a fault, dyke or a structure within the seam and surrounding strata which has the potential to concentrate the energy source (either gas or strain energy).
Background on Outbursts, & Considerations for Coal Bursts

WHAT IF

• An outburst occurred due to Tectonics conditions with the gas levels down to threshold values??
  • Largest Bulli Seam incident 400 tonne => 2,400 m³ of CO₂
  • Allowing for only 1/3 to be desorbable => 800 m³ CO₂
  • 10% CO₂ has serious health impacts; 30% CO₂ is instantly fatal.
  • Statutory minimum ventilation levels of 4.5 m³/sec => 99.8% CO₂

Fatalities
Background on Outbursts, & Considerations for Coal Bursts

• What Size tectonic event can induce a danger, with gas down to threshold levels??
  • Assume 2 x minimum ventilation => 9 m$^3$/sec
  • 10% CO$_2$ => 1 m$^3$/sec
  • Desorbable gas level of 2 m$^3$/tonne (1/3 threshold level) => 0.5 tonnes

Any discharge of 5 tonnes or more could be instantaneously fatal.
Background on Outbursts, & Considerations for Coal Bursts

It is unreasonable to consider outbursts as only a gas induced event and disregard the potential for strain energy to be present.

Similarly, it is potentially disastrous to consider coal burst only in terms of strain energy, without taking into account the presence of gas (either CH4 or CO2).

Any mining method or approach, that reduces the exposure of workers Must be progressed.