Opportunities for Better Gas Management

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Opportunities for Better Gas Management

- Gas Management Milestones 1900 to 2000

- Current Gas Management Practices - 2005
  - In-seam drainage economics

- Future Opportunities – 2010?
  - Parametric study of differing drainage strategies
Australian Gas Management – 1900 to 2000

- 1925 Metropolitan Colliery
  - Following fatal outburst, 30 m in-seam holes ahead of face

- 1930+ Balmain Colliery
  - Gas utilisation drainage via vertical wells to 1386m (post closure)

- 1954 State Mine
  - Following fatal outburst, 80 m in-seam holes ahead of face, vacuum on drainage holes, quantitative gas desorption methods (*Biggam, Robinson & Ham*)

- Late 1970’s to early 1980’s
  - Numerous significant studies into gas reservoir character and drainage efficiencies at Leichhardt, Bowen #2, Collinsville (*Gray, Williams*)
  - Initial long-holing drill trials at Collinsville
Australian Gas Management – 1900 to 2000

- **Late 1970’s West Cliff Colliery**
  - Gas drainage feasibility studies for outburst control (*Lama, Marshal, Griffith*)

- **1980 West Cliff Colliery and 1982 Appin Colliery**
  - Surface gas drainage vacuum plants, first mine-wide pre-drainage and post-drainage systems
  - Cross-measure post-drainage of Balgownie and Wongawilli seams

- **1982 West Cliff Colliery**
  - In-seam hole driven to 471 m with Acker “Big John” rig (*ACIRL*)

- **Late 1980’s**
  - Use of down-hole motors, down-hole surveying, in-seam directional drilling to 1000 m
  - In-house drilling teams established, emerging U/G drilling contractors
Australian Gas Management – 1900 to 2000

- 1990’s
  - Industry-wide adoption of fully surveyed, cross-panel pre-drainage holes using DHM technology at 300 m to 450 m (but up to 1500 m)
  - “Maturation” of in-seam drill contracting business

- 1992 Central Colliery
  - Surface vacuum plant for in-seam drainage
  - Mobile goaf drainage plant using liquid ring pump, cased to below tertiary

- 1997 Dartbrook Colliery
  - Surface vacuum plant for in-seam drainage (1996)
  - Mobile CO₂ goaf drainage plants and slider casing to goaf
Current Gas Management - 2005

- 2000’s Moura Seam Gas and Grasstree Colliery
  - Trials of tight radius drilling technologies

- 2001-2004
  - Surface to in-seam medium radius drilling implemented at Moranbah Gas Project by CH4 Pty Ltd and Mitchell Drilling
  - Emerging SIS drilling contractors

- 2005
  - MRD pre-drainage adopted by Oaky Creek, Grasstree, Newlands, Moranbah North, West Cliff and Beltana

- So in summary…..
Current Gas Management - 2005

- Surface to In-seam Pre-Drainage (SIS)
- In-seam Pre-Drainage (UIS)
- In-seam Post-Drainage
- Surface Post-Drainage
- Mains Ventilation Dilution
Current Gas Management - 2005

- **Mains Ventilation Dilution**

  **Pros**
  - Most cost effective (Fractional cents per tonne mined impost)
  - Mature technology – engineered solution, universally applicable
  - Surface based, divorced from mining operations

  **Cons**
  - Suited to “baseload” emissions, not acute emission sources
  - Not readily scalable (beyond additional fans, VVVF drives)
  - Ultimately limited by rising pressure differentials, airway velocities, propensity to spontaneous combustion hazards
  - Drained gas in highly dilute form – not easily utilised
Current Gas Management - 2005

- **Surface Post Drainage**

  **Pros**
  - Cost effective (Cents per tonne mined impost)
  - Potential for useable seam gas purities (>40% CH₄)
  - Surface based (potentially self-powered)
  - Centralised or mobile and modular, as required

  **Cons**
  - Potential for geotechnical constraints and application limits
  - Not divorced from operations, additional hazards to control
  - Suited to “baseload” emissions, not acute emission sources
Current Gas Management - 2005

- In-seam Pre-Drainage (UIS) and Post-Drainage

**Pros**
- Potential for high seam gas purities
- Mature technology – bonus of exploration data
- Potential for optimised permeability and drainage performance
- Can be scheduled to short lead-times (sometimes <100 days)

**Cons**
- **High operating costs** (Dollars per tonne mined impost)
- Drilling schedules and logistics “chained” to development, but also significant impost to mining operations
- Potential for drilling induced hazards to operations
  - Intersection, location and treatment of high flow / blocked boreholes
  - “Stub” emissions / excessive borehole flows
  - Loss and recovery of equipment
  - Spontaneous combustion potential / Water in-rush
- Borehole damage from drilling near desorption pressure thresholds
Current Gas Management - 2005

- **Surface to In-seam Pre-Drainage (SIS)**

  **Pros**
  - Potential for high seam gas purities
  - Potential for optimised permeability and drainage performance
  - Divorced from mining operations
  - Potential for reduction in drainage costs where lead-time permits
  - Drilling at reservoir gas pressures, limited damage to boreholes (potential for under-balance drilling)
  - Increased mining certainty from drill control, exploration data

  **Cons**
  - High, up-front costs (Dollars per tonne mined impost)
  - New technology, new equipment, new management practices
  - The KISS principle
  - Potential for drilling induced hazards to operations
  - Long lead-times required for economic feasibility (+1000 days)
  - May not be applicable given surface constraints, adverse reservoir conditions
Current Gas Management - 2005

- **SIS Pre-Drainage versus UIS Pre-Drainage**
  - SIS pros outweigh cons
  - SIS requires long lead times
  - UIS may induce poor drilling / drainage conditions
  - UIS constrained in logistics, scheduling and application by mining schedule
  - SIS outcomes *potentially* superior given
    - Adoption of the new SIS technologies & management practices
    - Engineered assessment of gas reservoir behaviour
    - Designed “draw-down” strategies
    - Active fitting & re-projection of gas reservoir behaviour during drainage

**Critical factors – common to both approaches**
- Economics
- Potential for drilling induced hazards to operations
Current Economics - UIS Drainage

- 3 km LW, 320 m deep, 250 m face, 40 m pillars
- In-seam development pre-drainage via 10 stubs
- 6 hole fan pattern, 50 m spacing (300 days)
- Holes 330-390 m long (360-430 m with branches)
- Drilling cost per stub (inc conduit, standpipes & cores & delays) = $214,160 (Aus$ 2005) = $95 / m
  - Incl. of stub driveage = $115 / m
  - Incl. of stub preparation = $125 / m
  - Incl. of equipment hire = $135 / m
  - Incl. of stub re-support = $145 / m
  - Incl. of stub gas riser = $180 / m

Total direct cost 10 stubs, 1 LW = $4.56 Million
Current Economics - UIS Drainage

Total direct cost 10 stubs, 1 LW = $4.56 Million

Indirect costs not included:

- Lost development from drilling induced gas contamination of headings
- Losses to development caused by negotiation of in-seam boreholes
- Loss of equipment and delays induced by poor drilling conditions (at gas desorption pressures)
- Internal cost <= $500,000 per annum in dedicated gas management staff and drainage officers
Current Economics - SIS Drainage

- 3 km LW, 320 m deep, 250 m face, 40 m pillars
- 6 SIS holes on 150 m spacing
- Full panel drainage on 2000 day term
- 1000 m laterals in-seam, total ~ 1400 m
- Raw drilling cost ~ $100 / m
- Cost per lateral (inc casing to seam & in-seam casing) = $260,000 (Aus$ 2005) = $260 / m
- Incl. of production well = $347 / m
- Incl. of pump, manual monitor & automated control equip = $417 / m

Total direct cost 6 holes, 1 LW = $2.50 Million
Cost inc manual monitor for term = $4.60 Million
Cost inc remote monitor for term = $4.80 Million
Future Opportunities – Gas Management

- **SIS Pre-Drainage**
  - Costs have actually risen in last 10 years - $70 / m to $100 / m
  - SIS contractors dealing with
    - Chronic manning shortages, high labour costs
    - Higher steel costs
    - Higher fuel costs
    - Higher equipment costs

- Improved economics and drainage outcomes will come from “smarter”:-
  - Reservoir mapping
  - Drainage design
  - Drill execution
  - Hole completion
  - Flow commissioning
  - Drainage operations
Future Opportunities – SIS Parametric Study

- 3 km LW, 320 m deep, 250 m face, 40 m pillars
- Seam thickness 5 m, Seam ash 18.4%
- Seam virgin gas content 10 m$^3$/t CH$_4$
- Target residual gas content 3.5 m$^3$/t CH$_4$
- Gas saturation 89%
- Permeability along major cleat 10 mD
- Permeability across major cleat 30 mD
- Main dip 3°
Future Opportunities – SIS Parametric Study #1

- 6 SIS holes on 150 m spacing
- 1000 m laterals in-seam, total ~ 1400 m
- 6000 m laterals per longwall
- 6 production wells per longwall
- Holes aligned with gateroads (along major cleat)
- Minimal gateroad intersection of laterals
- Effective permeability 10 mD
- Constraints on spacing / drainage optimisation

Parametric Study #1

- Full LW panel drainage on 2000 day term
- Total cost inc remote monitor for term
  = $4.80 Million per LW
Future Opportunities – SIS Parametric Study #2

- 4 SIS holes on 350 m spacing
- 750 m laterals in-seam
- 3000 m laterals per longwall
- 2 production wells per longwall
- Holes aligned with gateroads (along major cleat)
- Minimal gateroad intersection of laterals
- Effective permeability ~10 mD
- Constraints on spacing / drainage optimisation

Parametric Study #2

- Full LW panel drainage on 5500 day term
- Total cost inc remote monitor for term = $7.20 Million per LW
Future Opportunities – SIS Parametric Study #3

- 10 SIS holes on 340 m spacing
- 1200 m laterals in-seam
- 4000 m laterals per longwall
- <2 production wells per longwall
- Holes aligned across major cleat
- Maximum gateroad intersection of laterals
- Effective permeability 30 mD
- Potential for optimising drill patterns

Parametric Study #3

- Three LW panels drained on 2000 day term
- Total cost inc remote monitor for term
  = $3.80 Million per LW
Future Opportunities – SIS Drainage

- Increased hole spacing
- 1200 m laterals in-seam
- 2700 m laterals per LW
- <2 production wells per LW
- Holes aligned across major cleat
- Maximum gateroad intersection of laterals
- Total cost = $3.30 Million per LW
Opportunities for Better Gas Management

- **SIS Pre-Drainage versus UIS Pre-Drainage**
  - Longer drainage terms required for SIS
  - Drainage outcomes might be achieved at comparable cost
  - Given
    - Engineered assessment of gas reservoir behaviour prior to drainage
    - Engineered design of “draw-down” and gas/water production strategies
    - Adoption of the best SIS technologies & management practices
    - Fitting & re-projection of gas reservoir behaviour, and adaptive operations during drainage

There is potential for superior drainage outcomes with SIS

**Challenge remains**
- SIS holes must be oriented to maximise **not minimise** permeability
- Address potential for drilling induced hazards to operations
  - Re-working of holes with dedicated SIS rigs
  - Grouting of holes on completion
- Routine SIS drainage of adjacent seams to facilitate longwall extraction should be considered
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