Pre-Mining Methane Drainage Drilling Applications

Global Methane Initiative
Coal Mine Methane And Coalbed Methane Technical Workshop
June 4, 2015
Bogotá, Colombia

Jonathan R. Kelafant, Advanced Resources International, Inc.
Daniel Brunner, REI Drilling
Pre-Mining Methane Drainage Drilling Applications

- International CMM Industry
- Methane Drainage Considerations
- Surface Based Pre-Drainage Wells
- Longhole Directional Drilling
- Directional Drilling Equipment
- Drilling Capabilities
- Pre-Mining Applications
- Enhancing Gas Drainage from Lower Perm Seams
- Well Interception Technology and Applications
- Wellhead and Gas Collection
- Summary
Coal is the most abundant fossil fuel. IEA predicts continued reliance and consumption of coal increasing by 50% by 2030.

Mining technology continues to evolve resulting in more rapid excavation and production techniques.

We continue to mine deeper, gassier and more challenging coal reserves. This has resulted in a need to improve methane drainage techniques.

Use of surface drilled methane drainage wells has been affected due to surface ownership, approvals, topography, culture, lack of equipment, etc.

Many coal reserves develop multiple coal seams and require flexible methane drainage approach.

Gas collection systems typically use steel pipeline and demonstrate significant erosion of gas quality from wellhead to surface.

There is a recognized need to mitigate methane emissions and demonstrate environmental awareness.

The international CMM industry shows tremendous growth and spread of upstream and downstream technologies.
Methane Drainage Considerations

- The production and recovery of methane prior to mining CBM can greatly improve mine safety and productivity.

- Ventilation vs. Methane Drainage
  - Relative costs versus drainage efficiency

- Source of gas emissions
  - Adjacent gas bearing strata, geologic features or working seam

- Geologic characterization
  - Coal thickness, rank, stress, friability, other mechanical properties

- Reservoir characterization
  - Gas content, permeability, porosity, reservoir pressure, and desorption time constant

- Mining technique and schedule
  - Gate road development, start of LW, available drainage times, multiple seams

- Drainage approach
  - Source, feature, or shield focused

- Logistics
  - Surface and underground access

- Gas Utilization
  - Alternatives, gas quality
  - Market
Surface-Based Degasification Methods

- **Vertical, Stimulated Wells.** Wells drilled from the surface that are generally cased, cemented, and hydraulically stimulated. Studies by the U.S. Bureau of Mines show that up to 73% of the original gas in-place can be produced via vertical wells. These type of wells are ideally suited for multiple, thin seam situations.

- **Horizontal Wells.** These types of well are gaining in popularity and can produce 70 to 80% of the gas in-place. Good application for settings where there is one or two principal seams.
Design of Vertical CBM and CMM Wells
Why Consider Long Hole Directional Drilling?

- Allows longer length and more accurate placement of boreholes for improved methane drainage efficiency and longer drainage times
- Allows implementation of innovative pre-mining drainage techniques
- Ability to steer borehole to stay in-seam or hit specific targets
- Promotes a more focused, simplified gas collection system
- Less labor intensive
- Provides additional geologic information (such as coal thickness, faults, and other anomalies, etc. prior to mining)
Directional Drilling Equipment

Single Piece and Modular Units
Directional Drilling Downhole Equipment
Drilling Capabilities

Placement Accuracy

Mine intentionally cut into borehole and surveyed intercepts

Error was 8.63 ft
-0.1978 Degrees in 2500 ft

- 13 ft in 2,800 ft
Drilling Capabilities

Reach
Reducing GC in Longwall Panels

High Permeability
Reducing GC in Longwall Panels

Low Permeability with Outburst Conditions
Reducing GC Significantly in Advance of Mining

Complementary Approach with Frac Wells
Immediate Impact on Mining

- **Advance Rate (10's of Meters Per Month)**
- **Methane Emissions (1000's of Cubic Meters Per Day)**
- **Airflow Rate (Cubic Meters Per Second)**

**500 m Borehole on Production**

- October: 45
- November: 45
- December: 45
- January: 45
- February: 55
- March: 70
- April: 80
- May: 80
- June: 85

**Months in 1994**
Reducing GC from Adjacent Seams

Profile

- Addressing Stability Issues
- Dual Purpose Boreholes
Reducing GC of Adjacent Seams

Profile - Dual Purpose Boreholes
Enhancing Drainage from Lower Permeability Coals

- Propped fracture treatments along length of 2,500 foot boreholes
- Gas production increased by nearly 50% over a month
- Other enhanced methane drainage techniques
Reservoir Modeling to Assess Benefit of Hydraulic Simulation of In-Seam Boreholes

Fracture Locations

0.1 md, 50 m Spacing
Reservoir Modeling to Assess Benefit of Nitrogen Injection

0.1 md

(N2 Injection Borehole (between 160 ft spaced horizontal boreholes))
Well Interception Using Magnetic Ranging Technology

**Concept**

- Magnetic sub installed immediately behind the bit on the downhole motor
- Rotating magnet generates a time varying AC magnetic field
- Proximity sonde (tri-axial accelerometer and multi-frequency magnetometer) is lowered into a surveyed target well/location. This measures the magnetic field magnitude and orientation.
- The drill bit’s position relative to the proximity sonde is triangulated based on the AC magnetic vectors.
- Magnetic ranging software analyzes the data and determines a corrected borehole path for the drill operator to steer to after each data collection phase.

*Ability to intercept a 5 inch target on any range of borehole lengths*
Applications of Magnetic Ranging Technology

- Medium radius surface to in-seam drilling for pre-mining degasification of gate roads
- Provides for significant gas content reduction in advance of mining
- 150 mm diameter vertical well intercepted by 2 x 1130 m laterals
Applications of Magnetic Ranging Technology

- Underground in-seam boreholes and horizontal gob boreholes drilled in advance of longwall mining intercept vertical wells to eliminate underground gas collection systems.
- Intercepted vertical wells can serve as gob wells post-longwall mining.
Wellhead and Gas Handling

Gas/Water Separator During Drilling

Drilling Configuration

Valve and Blow Out Preventer
Gas Handling and Collection

Post Drilling Gas/ Water Separator

Underground Gas Pipeline with Integrity System

Gas Dilution During Drilling

- Both Ends of Dilution Zone Caution Signs with Fencing
- Coal Rib Lined with Canvas or Cement Block
- Examination Point CH4 <1% at Exit
- Dilution Zone
- Canvas Door
- Line Canvas with Posts (as necessary)

Dilution Zone is Rock Dusted and kept free of Ignition Sources

Return Air

Caution Sign

Proposed Dilution Zone

Return Air
Summary - Benefits of Directional Drilling

- Allows longer length and more accurate placement of boreholes for improved methane drainage efficiency and longer drainage times.
- Also allows implementation of innovative gob gas drainage techniques.
- Ability to steer borehole to stay in-seam or hit specific targets.
- Provides additional geologic information (such as coal thickness/thinning, identification of faults, intrusions, and other anomalies, etc. prior to mining.
- Mapping and survey information.
Contact Information

Felicia A. Ruiz  
Coalbed Methane Outreach Program (CMOP)  
+ 1 (202) 343-9129, ruiz.felicia@epa.gov  
www.epa.gov/cmop

Jonathan Kelafant  
Advanced Resources International, Inc.  
+1 (703) 528-8420, jkelafant@adv-res.com  
www.adv-res.com

Daniel Brunner  
REI Drilling  
+1 (801) 270-2141, dan@reidrilling.com  
www.reidrilling.com

www.globalmethane.org