Design, Operation, and Integration of Methane Drainage Systems at Minerales Monclova S.A. de C.V.’s Underground Coal Mines in Coahuilía, Mexico
Minerales Monclova Operations

Minerales Monclova S.A. de C.V.
Minerales Monclova Operations

Minerales Monclova S.A. de C.V. (MIMOSA):

- Coal Production: 5 Mt per Year
- Product: Metallurgical Coal
- Mining Method: 4 Underground Longwall Mines
- Depths: Less than 220 m
- Coal Seam: Double Seam (Upper Cretaceous)
- Conditions: Gassy (High Permeability, High GC)
- CH4 Control Systems: Ventilation, Pre-Mining Degasification, and Gob Gas Drainage
Main Purpose of CMM Drainage:
Control Through Mine Ventilation

- Principal Means of Controlling Underground Emissions
- Exhausting Ventilation Systems at all Mines
- Dilutes Methane Concentrations to Permissible Limits (< 1% by volume)
- Ventilation Systems Liberate more than 80 Mm³ of Methane per Year
- Average Exhaust Methane Concentration: 0.5% Methane in Air

Minerales Monclova S.A. de C.V.
Methane Drainage Experience

Reservoir Characterization and Numerical Models:
- Performed in 1989 on Adjacent Property by Resource Enterprises, Inc.
- Direct Gas Content Tests Show High GC (>13 m³/t)
- Injection Tests Indicate High Permeability (>30 md, 180 meters depth)
- Numerical Modeling Indicates Benefits of In- Seam Boreholes Drilled in Advance of Mining
- Pressure Test with PEMEX (3.9 md, 300 meters depth)
- Modeling Projections: 50% Reduction in In-Situ Gas Content in 1 Year, real 48%.

Minerales Monclova S.A. de C.V.
Methane Drainage Experience

- Degasification with Long In-Seam Boreholes in Advance of Mining:
  - Boreholes Reduce Gas Emissions During Gate Road Development

Minerales Monclova S.A. de C.V.
Methane Drainage Experience

- Degasification with Long In-Seam Boreholes in Advance of Mining:
- Contractor Proves Benefit of Directionally Drilled Boreholes in Double Seam

Minerales Monclova S.A. de C.V.

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

Months in 1994:
- October: Emission/Airflow/Advance Rate = 45
- November: Emission/Airflow/Advance Rate = 45
- December: Emission/Airflow/Advance Rate = 45
- January: Emission/Airflow/Advance Rate = 45
- February: Emission/Airflow/Advance Rate = 55
- March: Emission/Airflow/Advance Rate = 70
- April: Emission/Airflow/Advance Rate = 80
- May: Emission/Airflow/Advance Rate = 80
- June: Emission/Airflow/Advance Rate = 85

500 m Borehole on Production
Methane Drainage Experience

- Degasification with Long In-Seam Boreholes in Advance of Mining:
  - REI Drilling, Inc. Directionally Drills Over 26,000 m of In-Seam Boreholes in 4 Mines

- Gate Entry Shields
- Lengths: 305 - 900m
- Spacing: 150m

Minerales Monclova S.A. de C.V.
Methane Drainage Experience

- Underground Gas Collection:
  - Underground Pipelines Installed to Bring Gas to the Surface
  - Liquid Ring Vacuum Pumps Installed on Surface
  - Methane is Vented to the Atmosphere

Minerales Monclova S.A. de C.V.
Methane Drainage Experience

- **Additional Developments:**
  - Underground In-Seam Cross-Panel Rotary Drilling Program with Acker Mid-John Drill
Methane Drainage Experience

Additional Developments:

- Successful Implementation of Vertical Gob Wells

Minerales Monclova S.A. de C.V.
Recent Developments

In-House Directional Drilling:
- Procured Refurbished Drill from REI Drilling, Inc. in 2004

Acker Big John Drill, Capacity: 900 m

Minerales Monclova S.A. de C.V.
Recent Developments

In-House Directional Drilling:

- REI Drilling, Inc. Provides Training to MIMOSA Engineers and Field Personnel Under Technology Transfer Program
Recent Developments

- In-House Directional Drilling:
  - Wellhead Safety and Control, Drill Site Installation, Training

Minerales Monclova S.A. de C.V.
Recent Developments

- **In-House Directional Drilling:**
  - Drill Operation, Directional Control, and Borehole Surveying, Training

![Image of drilling equipment and diagram](image-url)

Minerales Monclova S.A. de C.V.
Recent Developments

- In-House Directional Drilling:
  - Downhole Tool and Drill Maintenance, Training
Recent Developments

- **In-House Directional Drilling:**
  - Drilling Plans for Mine 7 Following Training
Recent Developments

CMM Use:

- Volume Drained from Mine Esmeralda, Mine 6, 7, and 8

Mines Drain currently over 5 Mm$^3$ per year (70,000 TCO2e)

Average Concentration at Vacuum Pump is 60% Methane in Air

Minerales Monclova S.A. de C.V.
Recent Developments

**CMM Use:**
- Generation of Heat for Mine Esmeralda Bath House

- 7.5 kW Wellsite Compressor Transports Gas to Boiler Via 38 mm Pipeline
- System Capacity is Approximately 1,440 m³/day of Methane

*Minerales Monclova S.A. de C.V.*
Methane Use Options at MIMOSA Mines

Use of CMM from In-Seam Drainage and Gob Wells for Power Generation:

CMM Power Plant

Courtesy of G.A.S. Energy

Minerales Monclova S.A. de C.V.
The Potential of Using VAM at MIMOSA’s Mines is High:

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Minerales Monclova S.A. de C.V.
Methane Use Options at MIMOSA Mines

- Use of VAM from Mine Ventilation Systems for Power Generation:
  - Reactor Converts Low Quality Methane to Heat

Courtesy of MEGTEC Systems
Future Capacity CMM

Phased Project to Generate Power for Self Use:

- **Phase I:**
  1 – 1.3 MW Power Plant Fueled by CMM from the Esmeralda Mine

- **Phase II:**
  Expand Esmeralda Project by 1 – 1.3 MW
  4 MW Power Plant Fueled by CMM from Mine 7
  5 MW Power Plant Fueled by VAM from Mine 7

- **Phase III:**
  5 MW Power Plant Fueled by VAM for the Esmeralda Mine, 4 MW Power
  4 MW Power Plant Fueled by CMM from Mine 8
  Expand Plants Based on Supply

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Future Capacity CMM & VAM

Power Generation Potential (CMM and VAM) of MIMOSA’s Mines:

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Key Barrier to Use of CMM in Mexico

- Drainage of the gas is only a technical issue, we are succeeding.
- In Mexico the state owns the gas (Arts. 27 & 28)
- Need to have government authorization to use the CMM & VAM.
Conclusions

- The Use of Coal Mine Methane Liberated from Safety Systems Implemented at MIMOSA’s Mines is a Priority for the Company

- Advanced Drilling Technology and Developments in CMM and VAM Use Technology will Lead to the Successful Use of this Greenhouse Gas

- MIMOSA, in Conjunction with Equipment Manufactures, have Investigated Methane Use Alternatives (Combustion Engines, Turbines, VAM Reactors, Etc.), Specifically Power Generation Options

- MIMOSA’s CMM and VAM Resource has Tremendous Potential for Development for Years to Come

- MIMOSA can Partner with a Domestic or International Investor to Use this Low Quality Resource Currently Vented to the Environment

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Minerales Monclova S.A. de C.V.

Mimosa has to have degasification for safety, also to protect the environment.

Gracias!