Methane Seepage: Measuring the Flux, Recovering Lost Resources, and Protecting the Environment*

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Search and Discovery Article #80107 (2010)
Posted September 30, 2010

*Adapted from oral presentation at AAPG Rocky Mountain Section 58th Annual Rocky Mountain Rendezvous, Durango, Colorado, June 13-16, 2010

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Abstract

Since the mid-1990’s, the seepage of methane has added complexity to how production companies are required to operate in Colorado. Residents near methane seepage are demanding that governments understand this reservoir seepage; how methane impacts human health and the environment; what impacts the loss has on unrecovered mineral resources; and the effects on global climate change. Recent rule changes in Colorado have been promulgated in an attempt to address these concerns.

Monitoring methane seepage in La Plata County, Colorado, has been performed with an overriding goal of quantifying the temporal changes in the magnitude and extent of the flux. The objectives of the monitoring program are: to understand how seepage affects vegetation, coal fires, and explosion hazards; evaluate losses in production; identify preferential pathways; verify seepage model predictions; and evaluate contributions to greenhouse gas emissions.

Recent application of methane flux equipment has aided in better quantifying seepage rates. With more than 10 years of data, methane seepage, primarily from 5 discreet areas, along a 23-mile stretch of the San Juan Basin north rim, is estimated at approximately 6,000 MCFD.

Quantifying methane seepage has focused efforts toward implementation of mitigation measures by county governments, the COGCC, the Southern Ute Indian Tribe, and CBM operators. Mitigation is currently being performed or evaluated through surface and subsurface capture and changes to county building codes. Development of mitigation approaches is evolving and may include strategic CBM production (infill or near the outcrop), potential carbon credit incentives, and local conversion to electricity.
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JOHN PETERSON-PRESENTED TO RMS-AAPG JUNE 16, 2010
Pine River – San Juan Basin
Purgatoire River – Raton Basin
North Fork Texas Creek – San Juan Basin
Weston – Raton Basin
Weld County – DJ Basin
EFFECTS OF SEEPAGE

• Accumulation of explosive vapors
• Dead vegetation through $O_2$ displacement in the root zone
• Water well / shallow aquifer impacts
• Inefficient reservoir production
• Greenhouse gas emissions
• Property value impacts
• $H_2S$ gas generation
SAN JUAN BASIN BACKGROUND

- Covers 6,700 mi² of land area.
- Second largest natural gas reserve in U.S.
- Since the 1980’s, the Fruitland Formation (Kf) has been the major source of CBM—1.32 TCF produced in 2008 (USEIA, 2009).
HISTORICAL SEEPAGE

- Seepage has occurred for nearly 100 years.
- Seepage most active along the northern rim in La Plata County.
- Most commonly found where drainages transect the Fruitland Formation outcrop.

Map showing locations:
- Arizona
- Denver
- Florida River Area
- Pine River Area
- Basin Creek Area
- Texas Creek Area
- BP Highlands Area
- Durango
- Carbon Junction Area
REGULATORY FRAMEWORK

• ~1997 - 3M (Mapping, Modeling, Monitoring) established to understand and evaluate seepage

• April 2000 – COGCC Issues Order 112-156 & 112-157
  • Establishes Buffer Zone for No Drilling
  • Requires Outcrop Monitoring
  • Requires Water Well Baseline and Post Drilling Sampling

• 2006 – 4M (Mapping, Modeling, Monitoring, Mitigation) established to continue work of 3M but also evaluate mitigation alternatives
REGULATORY FRAMEWORK

• April 2009 – COGCC Amends rules to include Rule 608 for all CBM development statewide
  • Outcrop Monitoring
  • Natural Spring Surveys
  • Abandoned Well Surveys
  • Water Well Sampling
  • Bradenhead Testing
  • Static Pressure Monitoring
MONITORING METHODS

Probes
Shallow subsurface, fixed-point, concentration, flow

Flux Chambers
Surface, fixed-point, flow

Monitoring Wells
Subsurface (reservoir), fixed-point, gas/water pressures

MONITORING METHODS

Pedestrian Surveys
Surface, variable-point, concentration

Subsurface Temp Probes
Subsurface, variable-point, concentration, flow

Detailed Mapping
Subsurface, variable-point, concentration
MONITORING METHODS

IR Imaging & Field Verification
Subsurface, variable-point, concentration

Spring Surveys
Surface water, fixed-point, concentration, flow

Road Surveys
Ambient air, variable-point, concentration, wind direction
MONITORING METHODS

Aerial Natural Gas Emission Lidar (ANGEL)
Full land surface coverage, concentration

Portable Flux Meter
Surface, fixed-point grid, mass flux

Source: www.ssd.itt.com/angel/
METHANE FLUX VALUES - SJB

2009 Monitoring Data

4,150 MCFD – N Ute Line

??? MCFD – S Ute Line

~10,000 Total

Source: 3M CBM Model Report (Questa, 2000)
MITIGATION

Protecting public safety, groundwater, greenhouse gas emissions, and recovering lost resources prompts the need for mitigation of methane seepage.
MITIGATION FOR SAFETY

• P&A Well Surveys (ensure proper abandonment procedures)

• Bradenhead Testing (ensure proper completion procedures)

• County Building Codes

• Annual Surveying (monitoring)

• Water Treatment Systems

• Water Sampling
MITIGATION FOR RECOVERY

- Infill Drilling
- Strategic Drilling
- SUIT "Picket Fence Wells"
- OGCC "Green Fields"
“Picket Fence”

- Picket Fence Well
- CBM Wells
- P&A Gas Well
- Water Well
“Green Fields”

Install recovery pipes to capture gas, pull vacuum to enhance recovery, gas-fired generator creates electricity...

Surplus electricity delivered to power grid
CONCLUSIONS

• Methane seepage impacts the public safety and welfare, the environment, and resource recovery.

• Quantifying seepage rates is critical to fully assessing the impacts.

• Mitigation will ultimately be the focus in addressing these impacts.

• Regulators are accounting for impacts from seepage to safety, groundwater protection, GHG emissions, and mineral recovery as they permit resource development.

• The costs associated with these issues may need to be considered in the economic analysis for development.