Evaluating a groundwater supply contamination incident attributed to Marcellus Shale gas development

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A. Case History

B. Location & Hydrogeologic Setting

C. Impacts
   • Natural Gas
   • Foam
   • GCxGC-TOFMS Results

D. Mechanisms of Migration

E. Significance
General Timeline

- **Spring - Summer 2009**: Drill Welles 1 series and pit leak.
- **Summer 2009**: Drill Welles 2 series.
- **Winter – Spring 2010**: Drill Welles 4 – 5 series.
- **Spring – Summer 2010**: Impacts along Paradise Rd & River
- **Spring – Summer 2010**: Impacts observed along valley.
- **Late Summer 2010**: Installation of replacement groundwater wells & gas well remedial activities.
- **2010 – 2012**: PADEP/Gas Company Investigations
- **Spring 2011**: PADEP cites gas company for O&G Act & Clean Streams Law Violation.
- **Spring 2012**: Civil Suit & Settlement
- **Summer – Fall 2012**: GCxGC-TOFMS sample collection
Site Location & Geology

Active Gas Wells

Abandoned Gas Wells

Plaintiffs Potable Wells
Site Location & Geology
Site Location & Geology
Ambient GW Flow
AQT Drawdown – Topographic Position Index

7 Hour Duration
6.8 gpm (37 m³/day)
Impacts – Natural Gas
Impacts – Natural Gas

- Welles 2, 3, 4, 5 Gas Wells
- Annular Gas
- Impacted Water Wells (Wells 1, 3 and 5) (Dissolved Methane)
- Pre-drill Private Well Data

- Sub-Surface Microbial Gas (CO₂ Reduction)
- Near-Surface Microbial Gas (Fermentation)
- Thermogenic Gas ("Natural Gas" & Coal Gas)

Oxidation Effect
Impacts – Natural Gas
Impacts – Foam
Impacts – Foam
Impacts – Foam
Water Well 1 - GCxGC-TOFMS
Background - GCxGC-TOFMS
No Indication of Brine in Well Water
Mechanisms of Migration

Explanation

- **Yellow**: Documented Gas Show
- **Red**: Cement Squeeze/Plug
- **Gray**: Cement (Partial Bonding)
- **Light Gray**: Cement

AKOP: Approximate Kickoff Point (beginning of horizontal lateral turn)

All gas wells part of the Welles series (2 wells per pad)

Well construction consists of:
1. 20" conductor casing
2. 9-5/8" surface casing
3. 5-1/2" production casing

Highest Recorded Annular Pressures (psi) & Dates
- 1-3H: 19 (unknown) 3-5H: 700 (05-26-10)
- 1-5H: 4 (unknown) 4-2H: 490 (05-24-10)
- 2-2H: unknown 4-5H: 500 (05-01-10)
- 2-5H: unknown 5-2H: 225 (09-09-10)
- 3-2H: 940 (06-14-10) 5-5H: 250 (09-09-10)
Significance

• GCxGC-TOFMS application to O&G development to explore water quality impacts to water resources….or to refute them!

• Multiple lines of evidence are critical in evaluating alleged impacts
  – Baseline water quality data and time-series analysis
  – Natural gas isotopes
  – Well construction & excessive annular pressure
  – Logical timeline of events
  – Good conceptual model of geology that adequately explains contaminant migration
  – GCxGC-TOFMS!!!!!

• Transparency…..Dissemination of data from gas drilling incidents to the general public is critical to gain more wide-spread acceptance and development of policies that effectively address O&G shortcomings and improve industry standards
Thank you......Questions?