Lines-of-Evidence Approach to the Evaluation of Stray Gas Incidents

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Methane in Groundwater: Anthropogenic or Natural?

KEY POINT: Multiple sources of methane in shallow groundwater. Source identification challenging.
Practical Guidelines for Evaluation of Methane Impacts on Groundwater

• **Case Study:** Marcellus, NE PA

• **Problem:** Asserted that Marcellus shale gas extraction was causing stray gas impacts on water wells

• **Lessons Learned:** Lines of Evidence for Stray Gas Studies
FINDINGS

- 78% of water wells contain methane
- Higher concentrations in valleys vs. uplands
Mechanism for Methane Accumulation in Valleys?

Methane from Shallow Subsurface Valley Faults and Fractures

Gaining (effluent) Stream

runoff:
overland flow

baseflow

groundwater flow

http://science.kennesaw.edu/
**Underlying Geology of Northeastern PA: Non-Producing Gas-Bearing Units**

### Key Strata

- **Glacial Till**: Contains Microbial Gas
- **Catskill & Lockhaven Formations**: Thermogenic gas-charged sandstone deposits (with extensive fracture networks)
- **Marcellus shale**: Gas at ~6000 ft below surface.

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**Geologic Cross Section: Susquehanna County**

- **Shallow Gas Charged Strata**
- **Gas Shows and Gas Production**: Harvey Lake Field
- **Bradford Sands**
- **Elk Tully**
- **Mahantango**
- **Marcellus Onondaga**
- **Sandstone Water well**
Organic seams in Catskill formation are potential source of thermogenic gas.
Question: Barriers to gas migration from deeper units or structural connections?
Historic Locations of Gas Shows: 200 years

- Salt Springs, pre-1800
- Lovelton Gas Field, 1965
- Shrewsbury Gas Field, 1969
- Harveys Lake Gas Field, 1956

Key Point

Shallow gas shows observed in water and gas wells for over 200 years
Salt Springs State Park, PA:
Historic Bubbling Spring

Inscription on rock wall behind spring:
“JMK 1862”
WATER WELLS:
- Most wells penetrate the Catskill Sandstone
- Open hole completions, draw water from fractures

GAS WELLS:
- All pass through Catskill and Lockhaven
- Surface casing
- Open annular spaces
- Casing integrity

Source: PA DCNR, 2012
Isotope Analyses: **Source Gases Identified by Pennsylvania DEP and Cabot**

**Source Gases**
- **Marcellus Production Gas** (PA DEP & Cabot)
- **Upper / Middle Devonian Gas Above Marcellus** (PA DEP)
- **Dissolved Gas Identified as Upper/Middle Devonian** (PA DEP)

**KEY POINT:** Local Marcellus shale gas may be distinguished from shallower overlying Upper and Middle Devonian gases.
KEY POINT: Dissolved gases from local water wells are most consistent with microbial or shallow thermogenic sources.
Lessons Learned: Lines of Evidence for Stray Gas Investigations

Geology/Hydrogeology
- Presence of gas-bearing strata, fault and fracture systems, aquifer dynamics

History
- Prior oil and gas activity, stray gas incidents and evidence of naturally-occurring gas seeps.

Regional Patterns
- Regional patterns of methane occurrence and composition.

Well Construction
- Construction and completion details for affected water wells and nearby gas wells.

Geochemical Fingerprinting
- Analyses of composition and isotopic signatures of gas sources.
OBJECTIVE:

Effective approach for evaluation of potential impacts of shale gas development on GW resources.

Credit: Bennett V/Flickr