Where in New York are the Marcellus and Utica Shales??

How do they get to the gas resource and how do they get the gas out of the ground?

What are the concerns about this entire process and what can/should we do about it?

Bill Kappel
USGS
Ithaca, NY
wkappel@usgs.gov
Figure 1: Gas Shale Basins of the United States

- Niobrara
- Green River, Mancos, Baxter
- Mowry, Hilliard
- Gammon
- Bakken
- Excello
- Antrim 35-76 tcf
- Marcellus/Devonian 225-516 tcf
- New Albany 86-160 tcf
- Chattanooga
- Floyd & Conasauga
- Cane Creek
- Monterrey
- McClure
- Lewis & Mancos 97 tcf
- Paio Duro
- Barnett & Woodford
- Barnett 25-252 tcf
- Woodford 4-7 tcf
- Haynesville/Bossier 264 tcf
- Fayetteville 17 tcf

Schlumberger, Inc
Depth and extent of the Marcellus Shale

Marcellus, NY type section
Thinning of Oatka Creek
and Union Springs members

Thickening of Oatka Creek

East-West Geologic Section of the Marcellus Shale Across Southern New York

Lash and Engelder, 2009
North-South Geologic Section Across New York State

- Marcellus Shale
- Utica Shale

Approximate Location of Cross Section

- Shale
- Sand
- Sand and Shale
- Limestone
- Dolomite
- Evaporites
- Grenvillean Basement
Marcellus Stratigraphy

Oatka Creek

Cherry Valley

Union Springs
## New York State Stratigraphy

<table>
<thead>
<tr>
<th>PERIOD</th>
<th>GROUP</th>
<th>UNIT</th>
<th>LITH.</th>
<th>THICKNESS</th>
<th>PRODUCTION</th>
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<tbody>
<tr>
<td>DEVONIAN</td>
<td>Connewango</td>
<td>Riceville</td>
<td>Sh, ss, cgl</td>
<td>700'</td>
<td></td>
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<tr>
<td></td>
<td>Conneaut</td>
<td>Chadakoin</td>
<td>Sh, ss</td>
<td>700'</td>
<td></td>
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<tr>
<td></td>
<td>Canadaway</td>
<td>Undiff</td>
<td>Sh, ss</td>
<td>1100 – 1400</td>
<td>Oil, Gas</td>
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<td></td>
<td></td>
<td>Perrysburg</td>
<td>Sh, ss</td>
<td>1100 – 1400</td>
<td>Oil, Gas</td>
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<tr>
<td></td>
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<td>Dunkirk</td>
<td>Sh</td>
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<td></td>
<td>West Falls</td>
<td>Nunda</td>
<td>Sh, ss</td>
<td>385 – 1250</td>
<td>Oil, Gas</td>
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<td></td>
<td></td>
<td>Rhinestreet</td>
<td>Sh</td>
<td></td>
<td>Gas</td>
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<td></td>
<td>Sonyea</td>
<td>Middlesex</td>
<td>Sh</td>
<td>0 – 400’</td>
<td>Gas</td>
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<tr>
<td></td>
<td>Geneseo</td>
<td>Geneseo</td>
<td>Sh</td>
<td>0 – 450’</td>
<td>Gas</td>
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<tr>
<td>?</td>
<td>Tully</td>
<td>Ls</td>
<td>0 – 50’</td>
<td>Gas</td>
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<td></td>
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<td>Sh</td>
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<td>Sh</td>
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<tr>
<td>MIDDLE</td>
<td>Hamilton</td>
<td>Skaneateles</td>
<td>Sh</td>
<td>200 – 600’</td>
<td>Gas</td>
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<td>Marcellus</td>
<td>Sh</td>
<td></td>
<td>Gas</td>
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<td></td>
<td></td>
<td>Onondaga</td>
<td>Ls</td>
<td>30 – 235’</td>
<td>Gas, Oil</td>
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<td>Strallato</td>
<td>Tristates</td>
<td>Ss</td>
<td>0 – 40’</td>
<td>Gas</td>
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<td></td>
<td>Heldergen</td>
<td>Manlius</td>
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<td>Gas</td>
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<tr>
<td></td>
<td></td>
<td>Rondout</td>
<td>Dol</td>
<td>0 – 15’</td>
<td>Gas</td>
</tr>
<tr>
<td></td>
<td>Akron</td>
<td>Dol</td>
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<tr>
<td>SILURIAN</td>
<td>Salina</td>
<td>Camillus</td>
<td>Sh, gyp</td>
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<td></td>
<td>Syracuse</td>
<td>Dol, sh, silt</td>
<td>450 – 1850’</td>
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<td>Vernon</td>
<td>Sh</td>
<td></td>
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<td></td>
<td>Lockport</td>
<td>Lockport</td>
<td>Dol</td>
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<td>Gas</td>
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<td>UPPER</td>
<td>Clinton</td>
<td>Rochester</td>
<td>Sh</td>
<td>125’</td>
<td>Gas</td>
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<td></td>
<td></td>
<td>Irondequoit</td>
<td>Ls</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Sodus</td>
<td>Sh</td>
<td>75’</td>
<td>Gas</td>
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<tr>
<td>LOWER</td>
<td>Medina</td>
<td>Grimsby</td>
<td>Sh, ss</td>
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<td>Gas</td>
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<td></td>
<td>Whirlpool</td>
<td>Ss</td>
<td>0 – 25’</td>
<td>Gas</td>
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<tr>
<td></td>
<td>Queenston</td>
<td>Oswego</td>
<td>Ss</td>
<td>1100 – 1500’</td>
<td>Gas</td>
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<td>Lorraine</td>
<td>Lorraine</td>
<td>Sh</td>
<td></td>
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<td>UPPER</td>
<td>Trenton-Black River</td>
<td>Utica</td>
<td>Sh</td>
<td>900 – 1000’</td>
<td>Gas</td>
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<td>Trenton</td>
<td>Ls</td>
<td>425 – 825’</td>
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<td></td>
<td>Black River</td>
<td>Ls</td>
<td>225 – 450’</td>
<td>Gas</td>
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<tr>
<td></td>
<td></td>
<td>Tribles Hill</td>
<td>Ls</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Primary Black/Gray Shales
- Dunkirk
- Rhinestreet
- Geneseo
- Marcellus
- Rochester
- Sodus

### Lorraine
- Utica (estimated 4,500 ft. deep in vicinity of Dayton)
Oil and Gas wells are not new in Pennsylvania and New York....... 

...and there are different regulations in and within each state.
Multiple steel casings with high-strength cement to isolate well from surrounding aquifers and bedrock units.
What is different about Marcellus/Utica shale gas development?
East-northeast trending J1 fractures more closely spaced and cross-cut by less well-developed, northwest-trending J2 fractures.

Dual porosity gas reservoir where fractures drain rapidly and matrix drain slowly.

Free gas and adsorbed gas in matrix.

Connect matrix porosity to the wellbore by intersecting multiple J1 fractures.

Drill horizontal wells to the north-northwest, or south-southeast that cross and drain densely developed J1 fractures.
Marcellus Shale Gas Development
Horizontal Drilling in Black Shale with High-Volume Hydraulic Fracturing
Marcellus Shale – Ex. 1 (Single Cluster)

Meyer (2009)
Microseismic Monitoring of Hydraulic Fracturing

Horizontal well stimulation in plan view.
Horizontal well, multi-stage stimulation in shale indicates interaction and overlap between stimulation stages.
“Typical” Drillpad Design

Water-source pond

Drill cuttings pond
Drilling Phase – drillrig, pumps, supplies, frack tanks
(a month or two)
Hydro-fracking Phase – (a week or two)

Injection pumps, supplies, and many frack tanks for fresh and flowback waters
Where do you get the water for fracking?

Each source has its own set of concerns…….
What is the quality of the frack and flowback water?
Typical Components of Frack Fluid
For a 1.5 million frack job, the 0.5 percent is equivalent to 7,500 gallons of “chemistry”.

Source: Compiled from Data collected at a Fayetteville Shale Fracture Stimulation by ALL Consulting 2008.

(Arthur, Bohn, Layne, 2008, ALL Consulting)
What do we do with the **flow-back water** after the hydrofrac process is complete, and the **formation water** as gas is produced from the well?
### Frack Water Return – (Flowback Water)
Total volume injected (1.5 million gal), returned over a 2-week period of time.

(From a well in SW Pennsylvania.)

<table>
<thead>
<tr>
<th>Constituent</th>
<th>1st Third</th>
<th>2nd Third</th>
<th>Final Third</th>
<th>Units</th>
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<tr>
<td>Bromide</td>
<td>124</td>
<td>479</td>
<td>753</td>
<td>MG/L</td>
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<td>Chloride</td>
<td>18,600</td>
<td>80,500</td>
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<td>Sulfide</td>
<td>&lt;0.50</td>
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<td>T. Dissolved Solids</td>
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<td>133,620</td>
<td>192,000</td>
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<td>Temperature</td>
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<td>29.4</td>
<td>25.3</td>
<td>Degrees C</td>
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<td>Barium</td>
<td>668</td>
<td>6,100</td>
<td>8,730</td>
<td>MG/L</td>
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<td>Iron, Total</td>
<td>23</td>
<td>31.3</td>
<td>71.9</td>
<td>MG/L</td>
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<tr>
<td>Magnesium</td>
<td>69.3</td>
<td>572</td>
<td>890</td>
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<tr>
<td>Gross Alpha</td>
<td>1,159</td>
<td>22.41</td>
<td>18,950</td>
<td>pCi/L</td>
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<tr>
<td>Gross Beta</td>
<td>6,500</td>
<td>9.68</td>
<td>7,445</td>
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<tr>
<td>Radium 226</td>
<td>33</td>
<td>2.58</td>
<td>4.67</td>
<td>pCi/L</td>
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<tr>
<td>Radium 228</td>
<td>4.66</td>
<td>1.15</td>
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<td>pCi/L</td>
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<td>1.8</td>
<td>2.79</td>
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<td>&lt;0.0002</td>
<td>&lt;0.0002</td>
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<td>Molybdenum, Total</td>
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<td>0.72</td>
<td>1.08</td>
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<td>Nickel, Total</td>
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<td>0.07</td>
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<td>Selenium, Total</td>
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<td>Silver, Total</td>
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<td>Thallium, Total</td>
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<td>Titanium, Total</td>
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<td>Zinc, Total</td>
<td>0.036</td>
<td>0.028</td>
<td>0.035</td>
<td>MG/L</td>
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</table>
DISPOSAL OF FRACK WATER BY DEEP WELL INJECTION

Marcellus Shale

Utica Shale

Trenton-Black River carbonates

Potsdam sandstone
DISPOSAL OF FRAC WATER -
BY MUNICIPAL WASTEWATER TREATMENT PLANTS
AND DISCHARGE TO SURFACE WATER

Previous Maximum Specific Conductance

Specific conductance, in uS/cm
Proposed “Black box(es)” pretreatment systems to remove ‘constituents of concern’ prior to other treatment, reuse, or discharge.
New Concepts to Reduce Flowback Volume

Reuse / Recycle the flowback

Reduce frack volumes
Use minimal frack volumes followed by a freshwater for application of frack pressures

Leave more frack fluid in the hole
Assumes down-hole gas will pass through the spent frack fluids

Use of liquefied propane instead of water
LP turns back to a gas and can be recovered for reuse.

Bottom Line – The gas industry wants to reduce the volume of water used.
Local Water-Resource Concerns

- Protection of surface water and groundwater during entire process
- Drill pad construction, storm runoff, chemical storage, and handling
- Drilling & hydro-fracturing process – cuttings and fluid handling
- Transportation of water & waste fluids to and away from site
- Flowback disposal -- Variable mineral and water-quality characteristics – Brines, oil & grease, heavy metals, radiochemicals, organics
- Site remediation when done

Bottom line – we need water-quality data prior to, during, and following drilling to determine the impact, or lack thereof, on the resources of NYS
Regional Water-Resource Concerns

• What are the regional characteristics of black shale bedrock formations throughout the Marcellus, Utica, and other potential gas-bearing units?
  • Geologic nature – thickness of units, fracture tendencies, faults, etc.?
  • Geochemical nature – how variable are the mineral and water-quality characteristics?
  • Radiochemical nature – what radioisotopes are present and are they mobile, or made-mobile during drilling and fracking?

Proposed – A regional Marcellus Play database wherein data from across the play is entered into a USGS-maintained database and is available to be accessed by all.

Bottom line – We need to understand/document existing conditions prior and during the gas development/production process to assess and monitor our water, air, environmental resources.
Pipeline infrastructure and land disturbance
Existing Major Pipelines

Potential new pipelines in Pennsylvania

These are only the major transmission pipelines, not the gathering or intermediate pipelines.

- **Columbia Gas Transmission** “Appalachian Expansion Project and 1711 Expansion” Volume and timing TBD
- **National Fuel** “Appalachian Lateral Project” 625 MMcfd by 1Q 2012
- **Texas Eastern Transmission** “TEAM, TEMAX and Time III Projects” 300 MMcfd by 1Q 2012
- **Tennessee Gas Pipeline** “300 Line Expansion Project” 200 MMcfd by Q1 2012
- **Dominion** “Dominion Keystone Project” 500 MMcfd – 1 Bcf/d by 1Q 2012
- **KM/Rockies Express Pipeline** “REX-East Project” 250 MMcfd by 1Q 2012

Range Resources, 2009
Considerations in relation to what a Village, Town, or County can and can’t do in relation to shale-gas development within their jurisdiction.

Regulation of Oil, Gas, and Solution Mining Drilling and Production
Environmental Conservation Law (ECL), Article 23, Titles 1 to 13, Title 19
Regulation 6 NYCRR Part 550-559

New York’s Oil, Gas and Solution Mining Law specifically supersedes all local laws or ordinances relating to the regulation of the oil, gas, solution mining, and brine disposal industries, but reserves to local governments jurisdiction over local roads and the rights of local governments under the Real Property Tax Law.
Under the Oil Gas and Solution Mining Law the jurisdiction can:
(this interpretation is by a hydrogeologist, not a lawyer – “Caveat emptor”)

Table 15.1 - Oil, Gas, Solution Mining and Brine disposal - Interagency Coordination

Regulate the use and bonding of local roads (with proper documentation)

Tax “value” of gas or oil from production wells – information provided by NYS Office of Real Property Services

Regulate, to a degree, the location of new wells (DEC) and gas pipelines (PSC) near agricultural districts, wetlands, & water supplies through SEQRA reviews.

Regulate the use (sale) of municipal water (from that jurisdiction) for the drilling and hydrofracking processes.

Regulate the disposal (road spreading) of brine on roadways and use of the jurisdictions’ wastewater treatment plant(s) to treat flowback/formation waters.

Follow-up on Oil and Gas complaints but only after County Health Department does their assessment – local jurisdiction has a secondary role.
Questions?