COALBED METHANE IN THE UNITED STATES: A GIS STUDY

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PROJECT OVERVIEW

- Built map of Coalbed Methane (CBM) fields in US
  - Created CBM field outlines from states’ well data
  - Expanded upon GTI’s 2001 CBM Resource Map
- Compared CBM basins by:
  - Past production, present reserves, future resources
  - GIS helps visualize basin differences
- Integrated Coal Mine data into map
  - Characterized basins by active mine gas emissions
GTI’s 2001 CBM Resource Map
Coalbed Methane (CBM) defined

- Natural gas generated by & stored within coal seams underground
- Recoverable by conventional gas wells
- CBM - gas recovered from virgin coal seams using gas wells
- CMM - “Coal Mine Methane” – when released during mining operations
CBM History & Importance

- History of gas production from coal seams
  - Began as projects to remove CMM for miners’ health & safety; vented to atmosphere
  - Captured as local power source
  - 1980’s: large-scale commercial CBM production

- Importance of CBM to US gas supply
  - 8% of US gas production (EIA, 2003)
  - 10% of US gas reserves (EIA, 2003)
  - 15% of undiscovered US gas resources (PGC, 2002)
Coal Basins of the US

- CBM within coal basins
- USGS: coal basin update underway
  - Tully (1996) OFR #96-92, for Lower 48 States
  - Milici (1995) NOGA, for E. Coast basins
  - Prof. Papers 1625 A-D (1999-2002) for Rockies & IL
- Alaska DNR: coal basin update underway
  - Merritt & Hawley (1986), coal resources
  - Ehm (1983), oil & gas basins
- Classify basins by rank = thermal maturity of coal
Create CBM field outline layer from well data

- Obtained digital well data from 18 states:
  - Web download - 5
  - Purchased - 3
  - Obtained works in progress – 7
  - USGS or PTTC source – 3

- Buffer wells with a radius in ArcGIS, then union polygons by FIELD_NAME
How determine Buffer Distance?

- Buffer dist. = function (standard well spacing unit size)
- States’ minimum well spacing rules as starting point
  - NM: 320 ac/well in San Juan, 160 ac/well in Raton

<table>
<thead>
<tr>
<th>Stand. Spacing Unit (ac / well)</th>
<th>Corresponding Buffer Radius</th>
</tr>
</thead>
<tbody>
<tr>
<td>20</td>
<td>933'</td>
</tr>
<tr>
<td>40</td>
<td>1320'</td>
</tr>
<tr>
<td>80</td>
<td>1867'</td>
</tr>
<tr>
<td>160</td>
<td>2640'</td>
</tr>
<tr>
<td>320</td>
<td>3734'</td>
</tr>
</tbody>
</table>

- Automate with VBA (code by K. Kuykendall)
The Big Map

Available at [www.eia.doe.gov](http://www.eia.doe.gov) > Natural Gas > Resources & Reserves > Maps
CBM Annual Gas Production by Basin...The Past

Data from States’ Oil & Gas Commissions
- Classify production by basin

Data accuracy caveats….usually under-reported:
- Some states track production by lease, not well
- If CBM field names not unique from non-CBM, difficult to separate production
- Wells recompleted from non-CBM zones may not be recorded
- Older wells: didn’t separate CBM from non-CBM
- Some states don’t enforce reporting rules
Annual CBM Production by Basin

[Diagram showing annual CBM production by basin from 1980 to 2002, with various basins such as 8 Smaller Basins, Raton, Uinta, Cent Appal, Powder River, Black Warrior, and San Juan depicted. The y-axis represents BCF gas/year, with values ranging from 0 to 1,600.]
CUMULATIVE US COALBED GAS PRODUCTION (BCF)
(12-31-2002)

TOTAL CUMULATIVE PRODUCTION = 12,953 BCF GAS
CBM **Proved Reserves by Basin** .......The Present

- **Source:** 2002 EIA Reserves Survey
  - Classify by basin

- **Data Caveats**
  - Does not include small operators
  - Uinta + Piceance basins aggregated for operator confidentiality
2002 CBM Reserves (BCF) - Energy Information Administration

Total 2002 CBM Reserves = 18,491 BCF
CBM Undiscovered Resources by Basin..... The Future

- Source: Potential Gas Committee, 2002
  - Volunteer experts (gas industry, govt. agencies, academics)
CBM RESOURCES (TCF)  
2002 POTENTIAL GAS COMMITTEE

Sum of Most Likely Estimates of CBM Resources = 163.3 TCF
The Side Panel
- Production
- Reserves
- Resources

Available at www.eia.doe.gov > Natural Gas > Resources & Reserves > Maps
Coal Mine data sources at regional scale

- Active Mines: ~1500 (USGS, MSHA, EIA)
  - Approx. equal #’s underground & surface (strip)
    - Portal vs. centroid
  - Locations only partially verified
- Abandoned mines: >20,000 (USGS)
  - Only a partial estimate
- 15 CBM states have detailed mine data
  - More upgrade $ since 2002 Quecreek, PA accident
Coal Mine Gas Emissions

- US Bureau of Mines- measure emissions for safety
  - Irani et al. (1972, 1974), Trevits/Finfinger et al. (1993)
  - ~ 500 mines, most in Appalachian region
- Good correlation between mine gas emission rate & coal production rate
  - Normalize to compare “gassiness” of mines: Specific Emissions = annual CF gas emitted/ ton coal mined
- All of above: no digital files, no locations
EPA’s Coalmine Emission Outreach Program (CMOP)

- Track “gassiest” active underground coal mines to promote CMM recovery since 1994
  - For profit & greenhouse gas reduction
    - methane = 21 X potency of CO2 as greenhouse gas
- 2001 EPA emission data for 121 gassy mines
  - Measured by MSHA 4x per year
  - Link by MSHA-ID to:
    - Mine location shapefile
    - File with tons coal mined/yr
- Calculate Specific Emissions & map
Specific Emissions of Methane (CF/Ton) From 121 "Gassiest" US Coal Mines
2001 EPA Data

Gassiest Coal Mines (2001 EPA)
CF Gas Per ton Coal
- < 200
- 200 - 500
- 500 - 1000
- 1000 - 2000
- 2000 - 5000
- > 5000

Coal Basins (USGS)

Greater Green River Basin
Picance Basin
San Juan Basin
Illinois Basin
N. Appalachian Basin
Cent. Appalachian Basin
Black Warrior Basin

Geographic NAD27
Location of the “Gassiest” Coal Mines (EPA data)
Mean Mine Emissions by Basin (EPA) vs. Typical Gas Content (GTI)

The correlation is not too bad, except for Black Warrior (probable measurement error).
Conclusion

- CBM Fields in the US mapped
  - Big map available from EIA as pdf
  - Field outline shapefile available on request
- CBM Production/Reserves/Resources
  - Summarize with maps & charts
- GIS used to
  - Characterize coal basins by mine gassiness