Barnett Shale-Woodford Shale play of the Delaware basin - is it another giant shale gas field in Texas?

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Delaware basin shale play

- Thick section of Mississippian and Devonian shales known to West Texas players
- Generally referred to as Barnett and Woodford shales, separated by a dense “Mississippian Limestone” interval
- Leasing play kicked off 2 to 3 years ago by eog Resources and Tom Brown Inc.
Delaware basin

Scholle, 1999
Delaware basin players

- EnCana – 560,000 to 850,000 acres under lease
  - 4 wells drilled in 2005, all tight holes
  - inherited play via purchase of Tom Brown Inc.
  - looking for a J.V. partner
- Chesapeake – 385,000 ac in Reeves & adjacent counties
  - acquired from Alpine/K2X
- Quicksilver – 310,000 ac in N. Jeff Davis Co. & S. Reeves-Culberson
- EOG Resources – 150,000 ac, mostly in Culberson Co.
  - 8 wells permitted, 3 drilled or currently drilling
- ConocoPhillips – 35,000 ac in central Reeves Co.
  - acquired from Burlington Resources
  - one repletion IP at 2 MMCFD
  - one new drill IP at 3.1 MMCFD
- Southwestern Energy, PetroHunt, Carrizo Oil and Gas, Devon, Hallwood, Forest Oil, Riata Energy, and others
  - Several large acreage positions, details are sketchy
  - 35 wells permitted or drilled
- Chevron has a 200,000+ acre fee land position in the play (TXL Ranch)
  - deal with Anadarko recently announced
Delaware Basin 2005-6 activity

9 wells drilled & completed
30 active wells
18 new loc’s
Our study objectives

► Compile a comprehensive well database
► Provide digital logs for all wells with density or sonic logs across the shale section
► Correlate the major stratigraphic units; map gross and net shale thicknesses
► Map the basic petrophysical properties of the section including density, transit time, resistivity
► Estimate TOC, porosity and gas-in-place from logs using Ft Worth basin analog model
► Spec project, completed in July 2006
Study deliverables

- Digital database as a Petra project file
  - Header data and operator tops
  - Our stratigraphy
  - Digital land grid and overlays
  - Digital logs (also as LAS files)
  - Computed curves (TOC, GIP)

- Over 75 maps and cross-sections

- Brief report explaining methods used

- Available off the shelf immediately
What can we do with logs?

- Map gross unit thickness
- Map net unit thickness above some cutoff (GR or bulk density usually)
- Map the basic log properties and infer trends from them
- Estimate TOC from bulk density or synthetic density logs
- Estimate GIP given certain assumptions about the system
Data available

- approximately 4600 wells in project area
- 452 confirmed Barnett penetrations (10%)
- ~330 wells with useful well logs, 270 digitized
- mudlogs, sample descriptions, scout data
- no cores – new wells are all tight holes
- no cuttings sampled
  - at least two prior groups have sampled the cuttings collections and could have high graded the sample sets
basin dip section
basin strike section
Depth to base Woodford Sh
Depth to top of gas window

Data from USGS OFR-2005-1171
Woodford gross thickness
Mississippian Ls thickness
Barnett gross thickness
What is NET shale??

- In organic rich black shale sequences, it might be useful to separate the net organic rich interval from the low TOC shale background.

- GR logs show a rough correlation to TOC:
  - Uranium is preferentially deposited on sedimentary organic matter, mostly as organometallic complexes.
  - PITFALL: amount of U associated with TOC is variable.

- Simplest is to map net thickness over a GR cutoff that roughly corresponds to minimum TOC of interest.
GR vs. TOC
New Albany Shale, EGSP data

total organic carbon (wt %)

Gamma ray (API)
Woodford net “hot” shale
(>150 API, ~2% TOC)
RhoB vs TOC, Ft. Worth Barnett Shale model

The relationship between bulk density (g/cm³) and total organic carbon (% TOC) is shown in the graph. The equation of the line is

\[ y = -30.784x + 85.902 \]

with an \( R^2 = 0.8144 \). A threshold of 2.65 g/cm³ is indicated, with values above 4% TOC considered significant.
Woodford avg. bulk density
(includes synthetic RhoB from sonic logs)
Woodford average TOC
Barnett net “hot” shale
(>150 API, ~2% TOC)

note low GR in this area
Barnett avg. bulk density
(includes synthetic RhoB from sonic logs)
Barnett average TOC

low $\rho_b$ predicts high TOC
GIP analysis method

- compute TOC curve from bulk density log
- compute reservoir pressure and temperature curves
- compute GIP (scf/ton) curve from Langmuir equation
  - \( VL = f(TOC), \ PL \sim \text{constant}, \ P = f(\text{depth}) \)
  - temperature effects were ignored (for lack of data)
  - used Ft Worth basin data set for calibration
- Sum the GIP curve to determine GIP in BCF/section
Woodford average GIP (scf/ton)
Barnett average GIP (scf/ton)
Total GIP Barnett + Woodford (BCF/ sq mile)
Total play GI P

► we calculated 800 TCF over the 12,000 sq mi area!
► enough gas in ground to support 1000’s of wells even at low recovery factors
► over 100 yrs of potential drilling activity at Ft Worth basin velocity, assuming a comparable rig fleet
► *However*, much of the area is probably too deep to be commercial
Summary

- Play was mapped using a digital log database and a Ft Worth basin log model.
- Maximum organic rich shale occurs in a NNE-SSW trend across Reeves County.
- Reeves County is the GIP sweetspot.
Culberson County has lower scf/ton due to shallower depths (lower pressure) and lower average TOC.

Relative $$ advantage is not so obvious due to differences in drilling & completion costs.

Core data will be required to locally calibrate the model.

NONETHELESS, directionally the maps are valid.
Whether this shale can actually deliver gas at commercial rates remains to be seen:

- shale permeability is difficult to assess from the available data
- no information on the in situ stresses or “fracability” of the shales

Will take at least 50 wells before industry knows if it can deliver like the Ft. Worth basin Barnett Shale.