

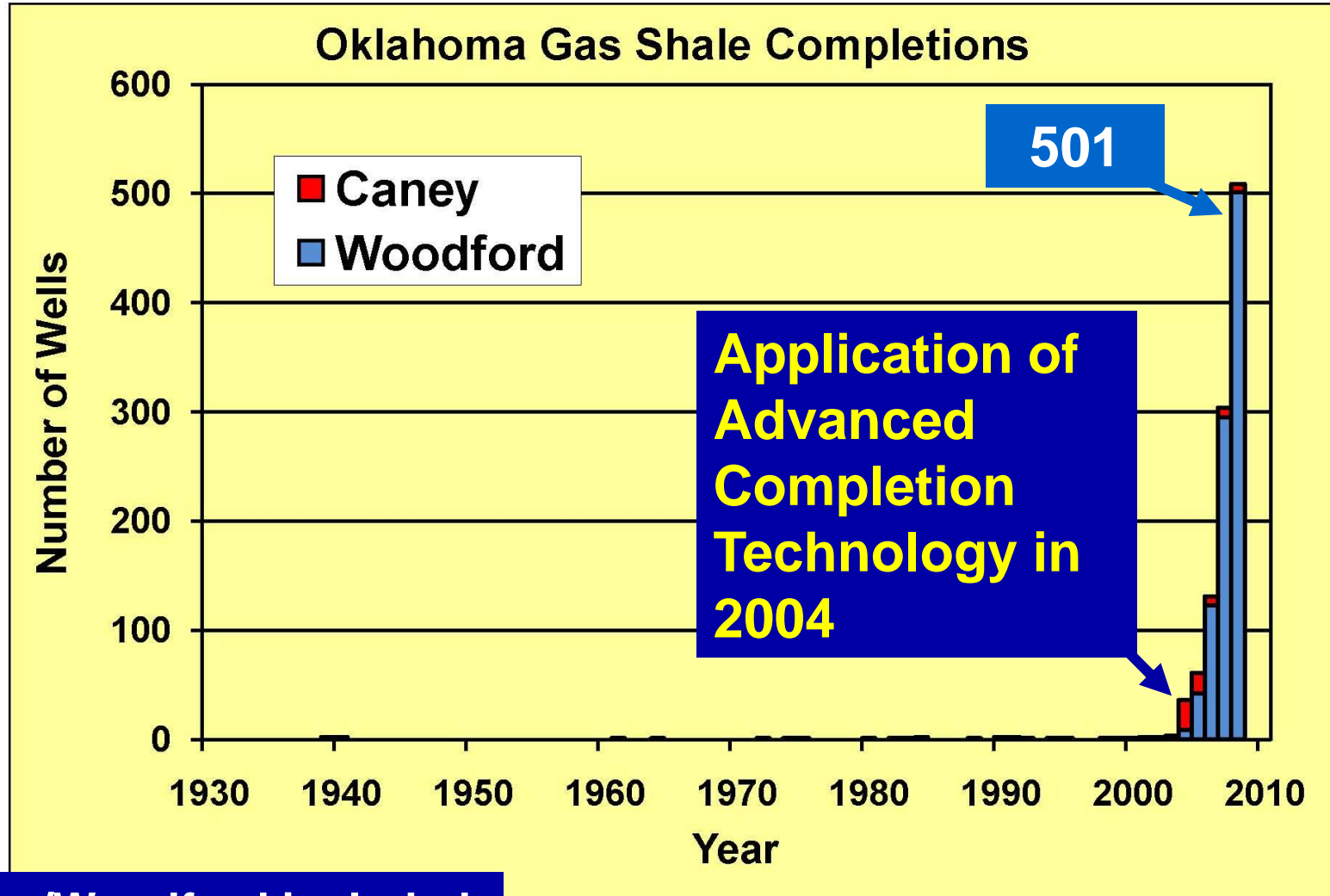
# Woodford Gas-Shale Plays of Oklahoma



**Brian J. Cardott**  
**Oklahoma Geological  
Survey**

# Oklahoma Shale-Gas Well History

1,092 Wells, 1939–2008

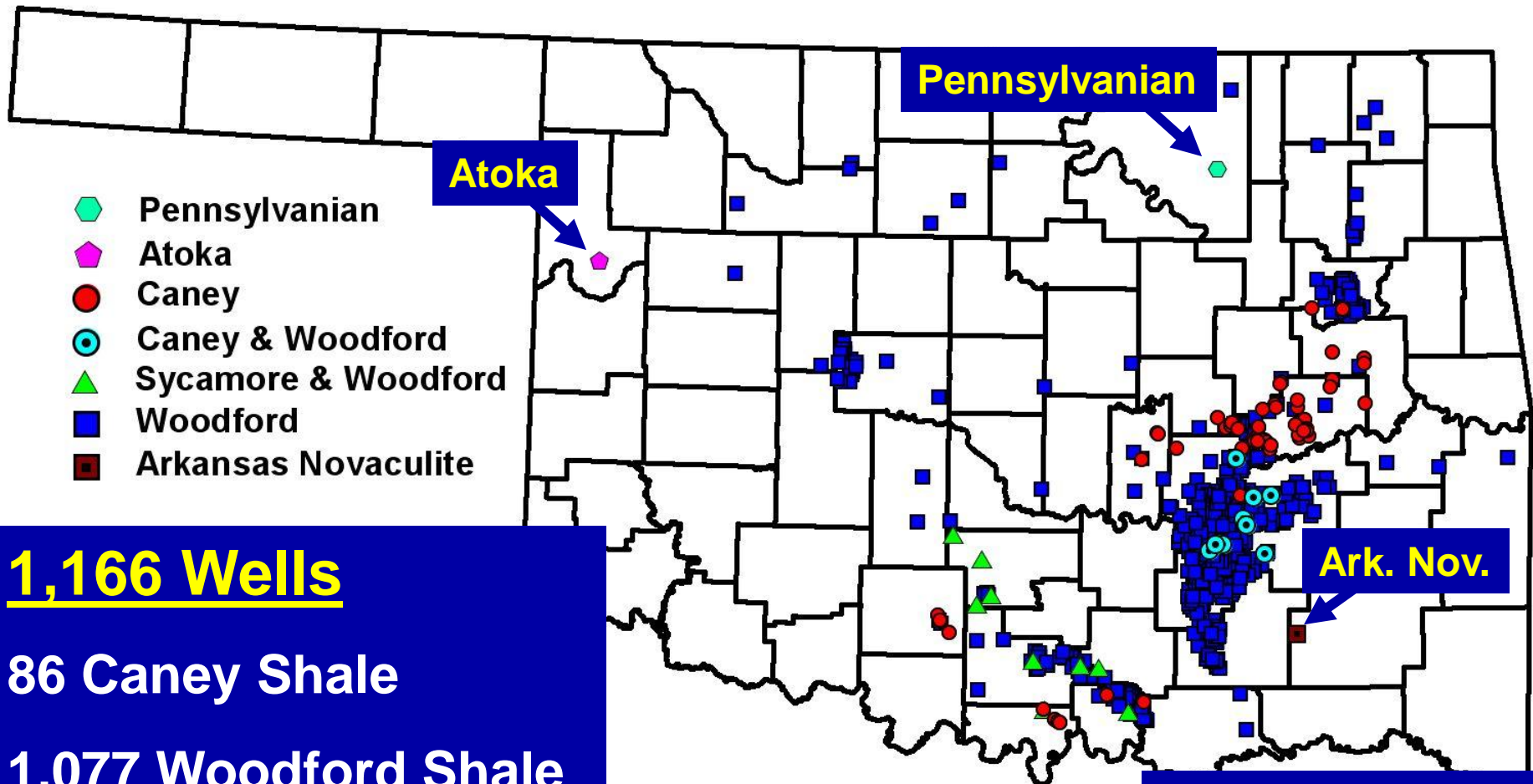


Caney/Woodford included  
with Caney

Updated 4/24/2009

# Oklahoma Gas-Shale Wells Completed 1939-2009

## Oklahoma Gas Shale Completions (1939-2009)



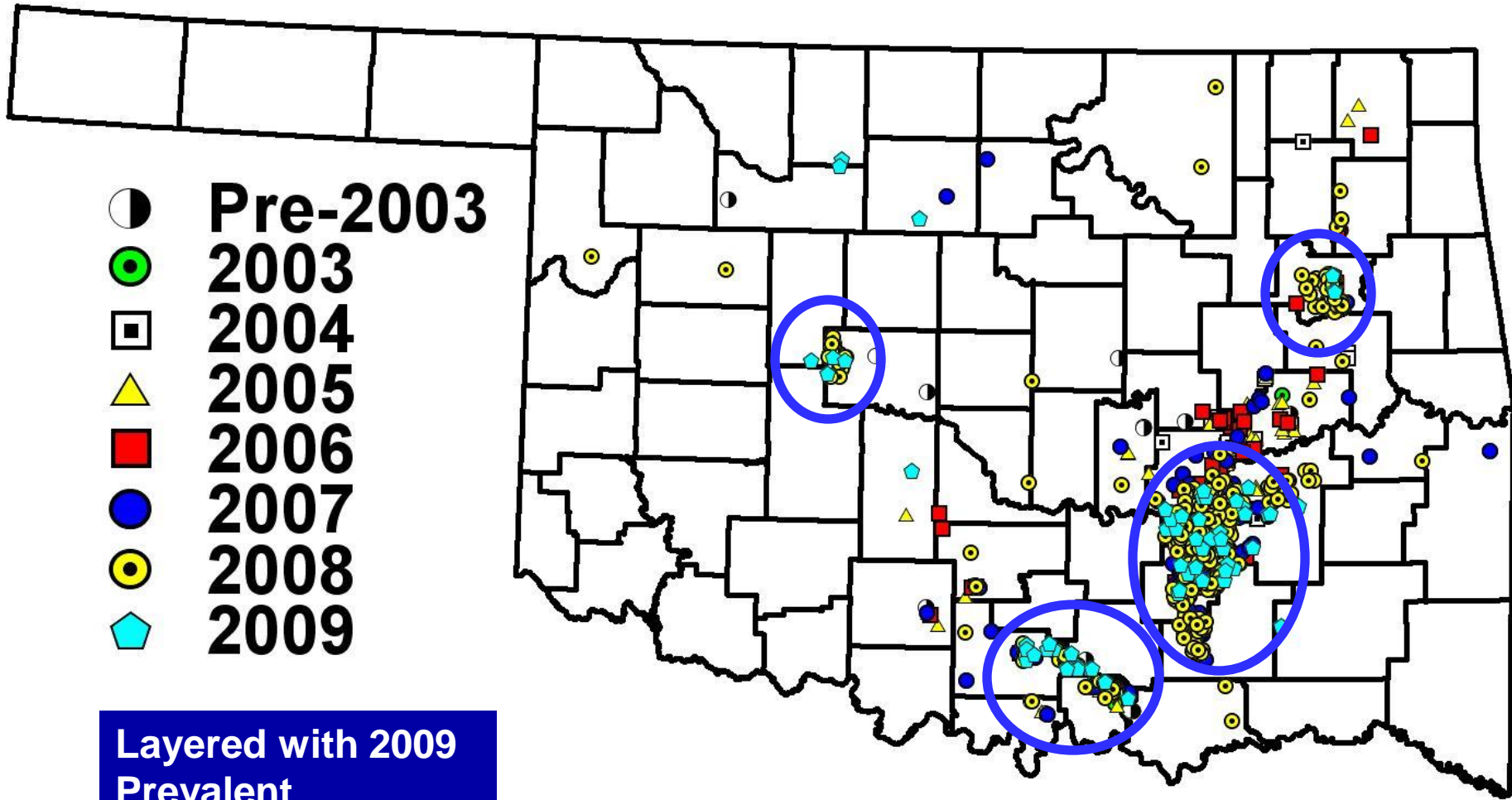
**1,166 Wells**

**86 Caney Shale**

**1,077 Woodford Shale**

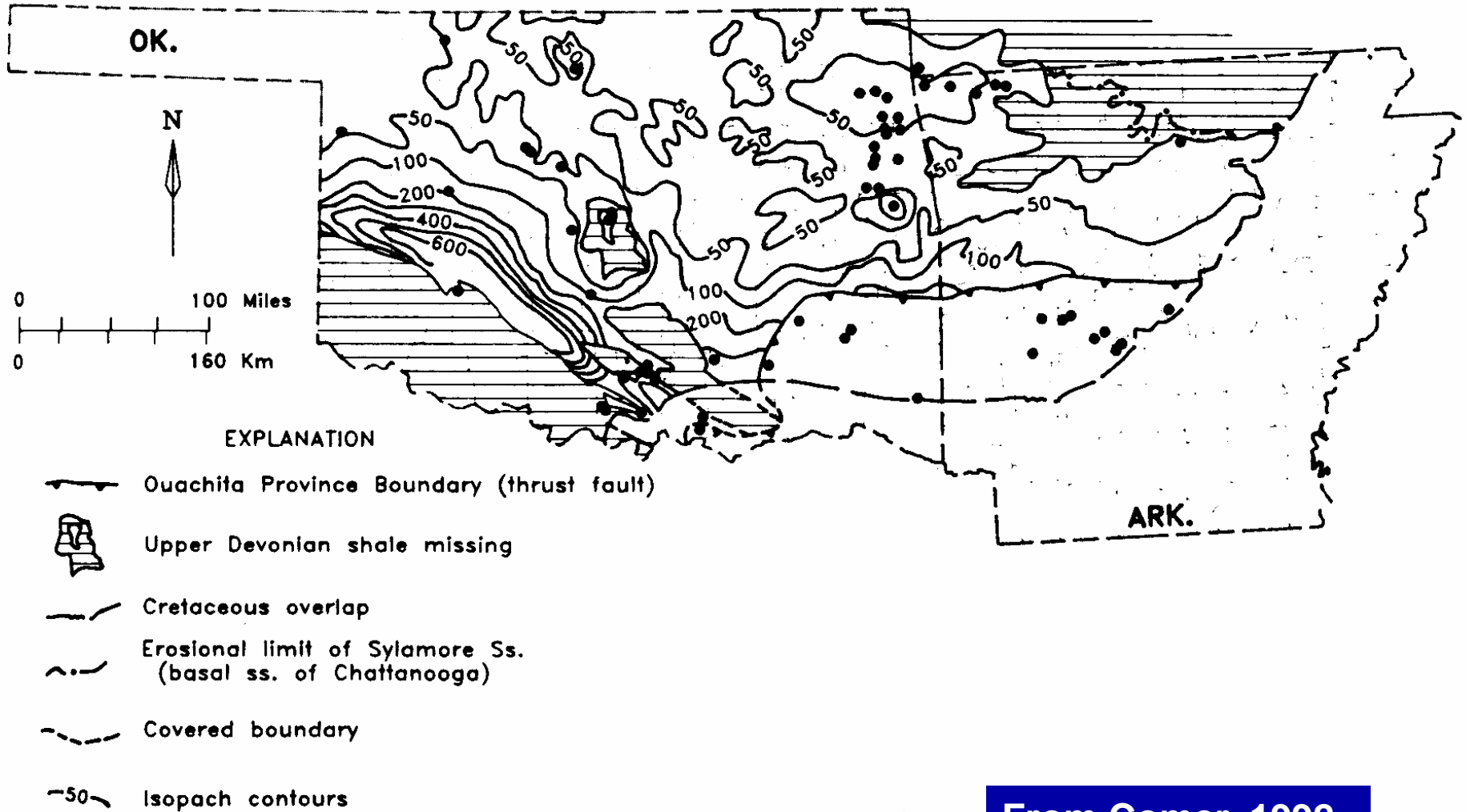
Updated 4/24/2009

# Oklahoma Gas-Shale Wells by Year (1939-2009)



Updated 4/24/2009

# Isopach Map of Woodford Shale



From Comer, 1992

# Woodford Mineralogy

<b>[grab samples]</b>	<b>A</b>	<b>B</b>	<b>C</b>	<b>D</b>	<b>E</b>
<b>Quartz</b>	<b>63-68%</b>	<b>29-87%</b>	<b>30-60%</b>	<b>9-61%</b>	<b>27-53%</b>
<b>K-Feldspar</b>	<b>4%</b>	<b>0-2%</b>	<b>2-10%</b>	<b>2-42%</b>	<b>0-2%</b>
<b>Plagioclase</b>	<b>3%</b>				<b>1-4%</b>
<b>Calcite</b>	<b>10%</b>		<b>5-25%</b>	<b>0-7%</b>	<b>0-11%</b>
<b>Dolomite</b>	<b>6-9%</b>	<b>0-56%</b>	<b>0-5%</b>	<b>0-10%</b>	<b>0-6%</b>
<b>Pyrite</b>	<b>5-7%</b>	<b>0-1%</b>	<b>0-5%</b>	<b>2-30%</b>	<b>1-13%</b>
<b>Total Clays</b>	<b>12-14%</b>				
<b>Illite</b>		<b>8-35%</b>	<b>2-5%</b>	<b>7-53%</b>	<b>13-40%</b>
<b>Illite/Smectite</b>			<b>2-20%</b>		
<b>Kaolinite</b>		<b>1-7%</b>	<b>2-5%</b>	<b>0-2%</b>	<b>0-5%</b>
<b>Chlorite</b>			<b>2-5%</b>	<b>0-40%</b>	<b>0-5%</b>

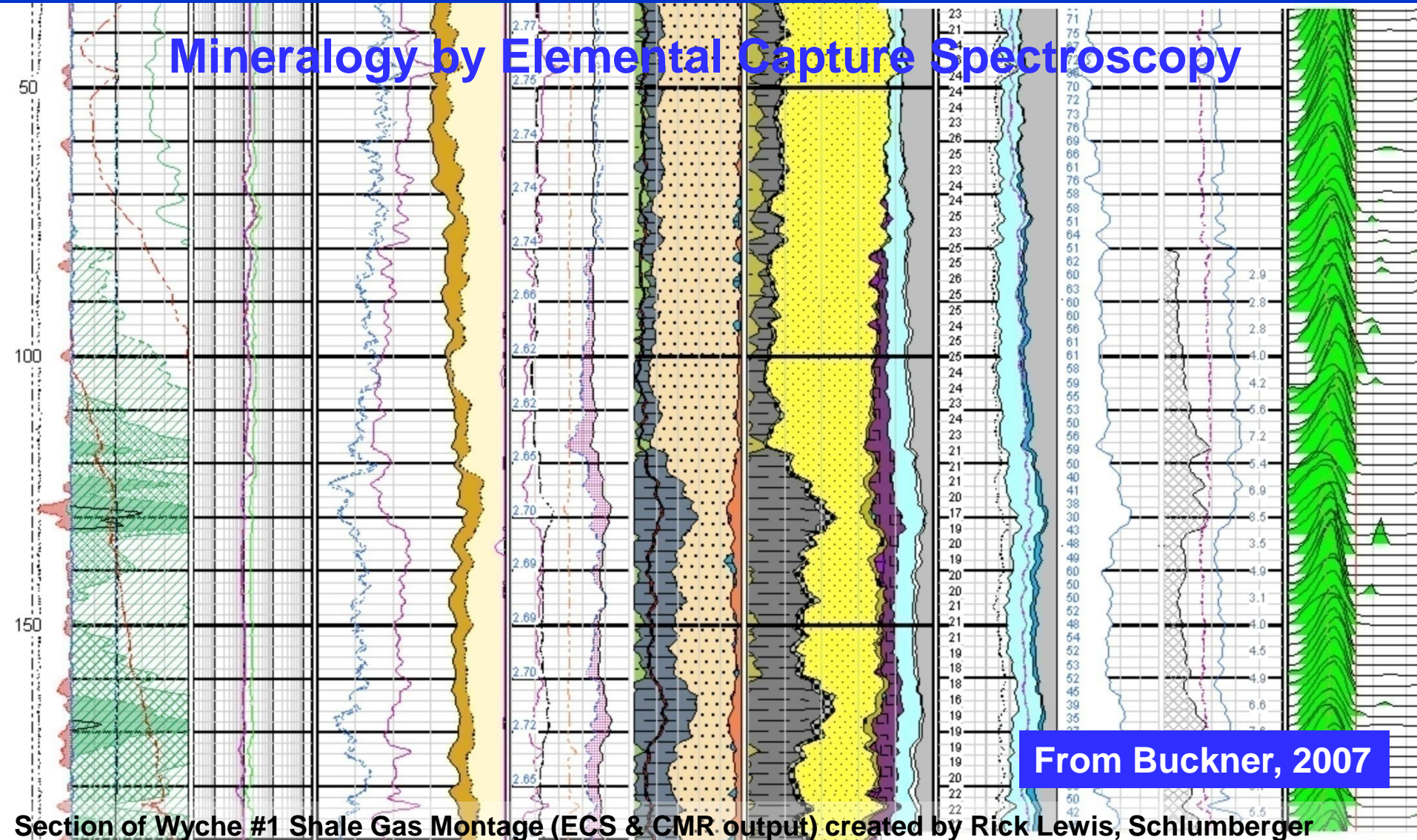
A. O'Brien & Slatt, 1990; B. Kirkland et al., 1992; C. Greiser, 2006;  
D. Branch, 2007; E. Abousleiman et al., 2008



# Example of ECS & CMR Log Data, Woodford Shale

- Higher silica content in upper portion of Woodford (above 120 ft)
- Very high porosity (unlike that found under reservoir conditions)

## Mineralogy by Elemental Capture Spectroscopy

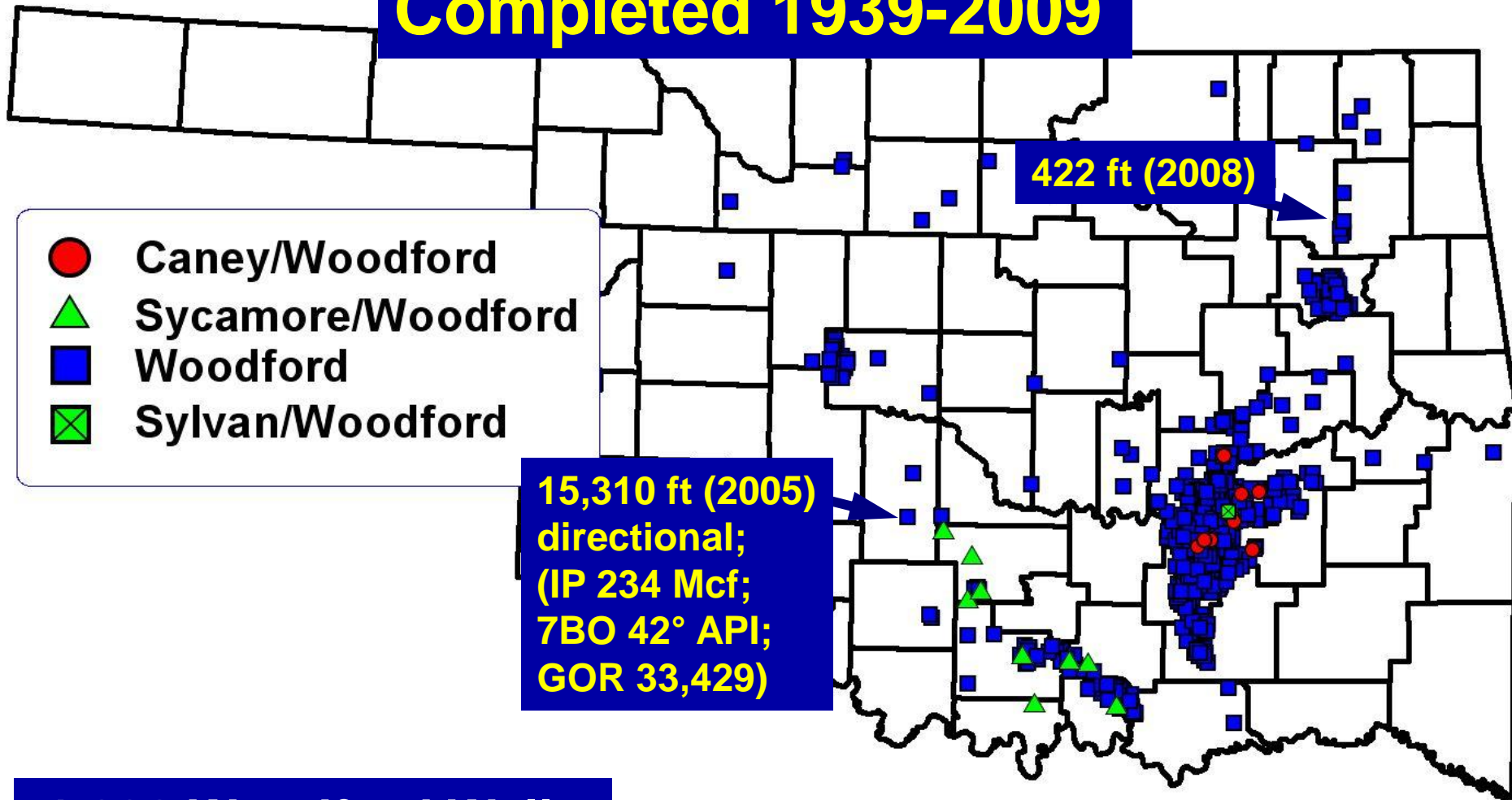


From Buckner, 2007

Section of Wyche #1 Shale Gas Montage (ECS & CMR output) created by Rick Lewis, Schlumberger

# Woodford Gas-Shale Wells

Completed 1939-2009



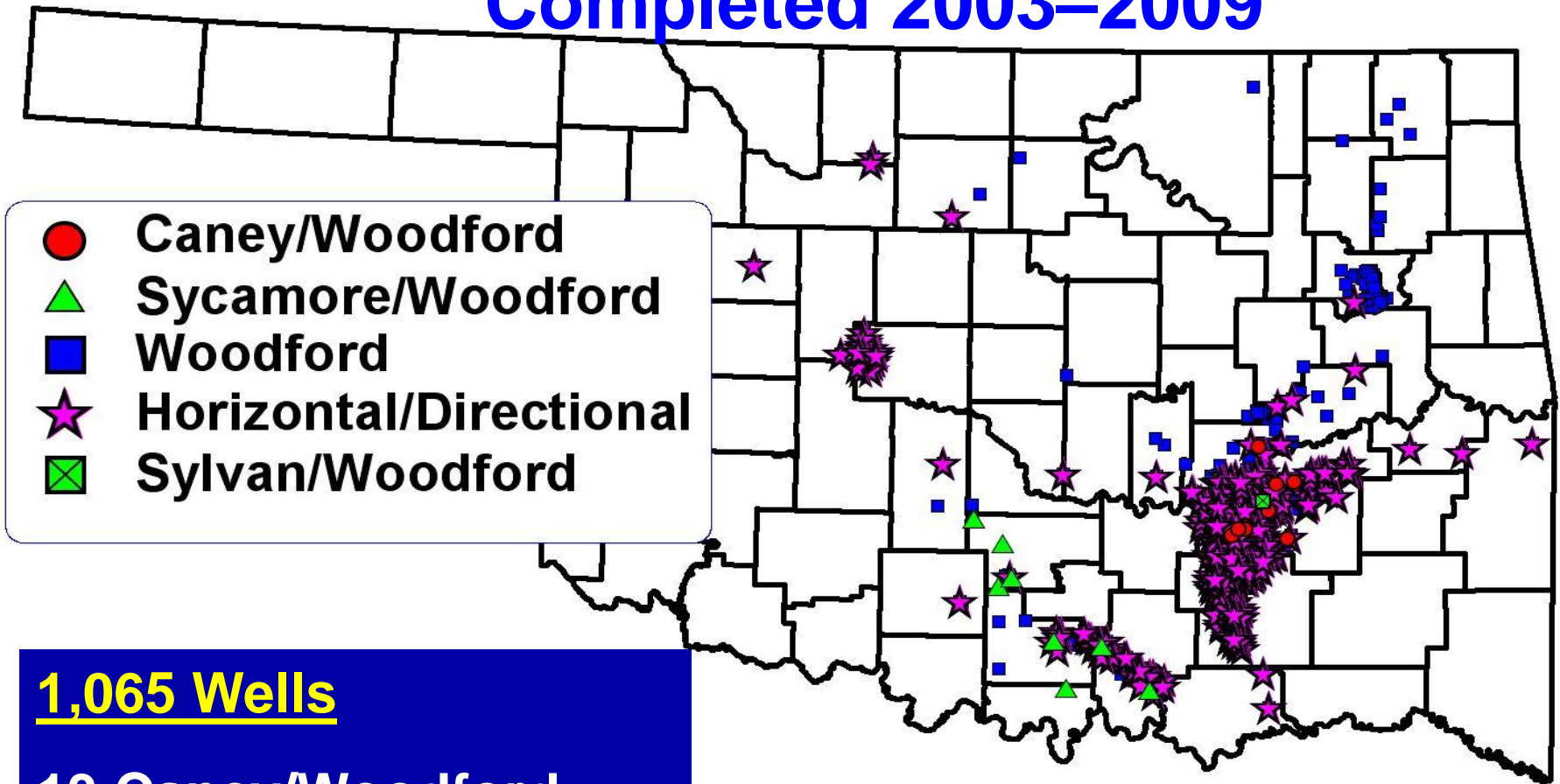
1,090 Woodford Wells

Updated 4/24/2009



# Woodford Gas-Shale Wells

Completed 2003–2009



1,065 Wells

13 Caney/Woodford

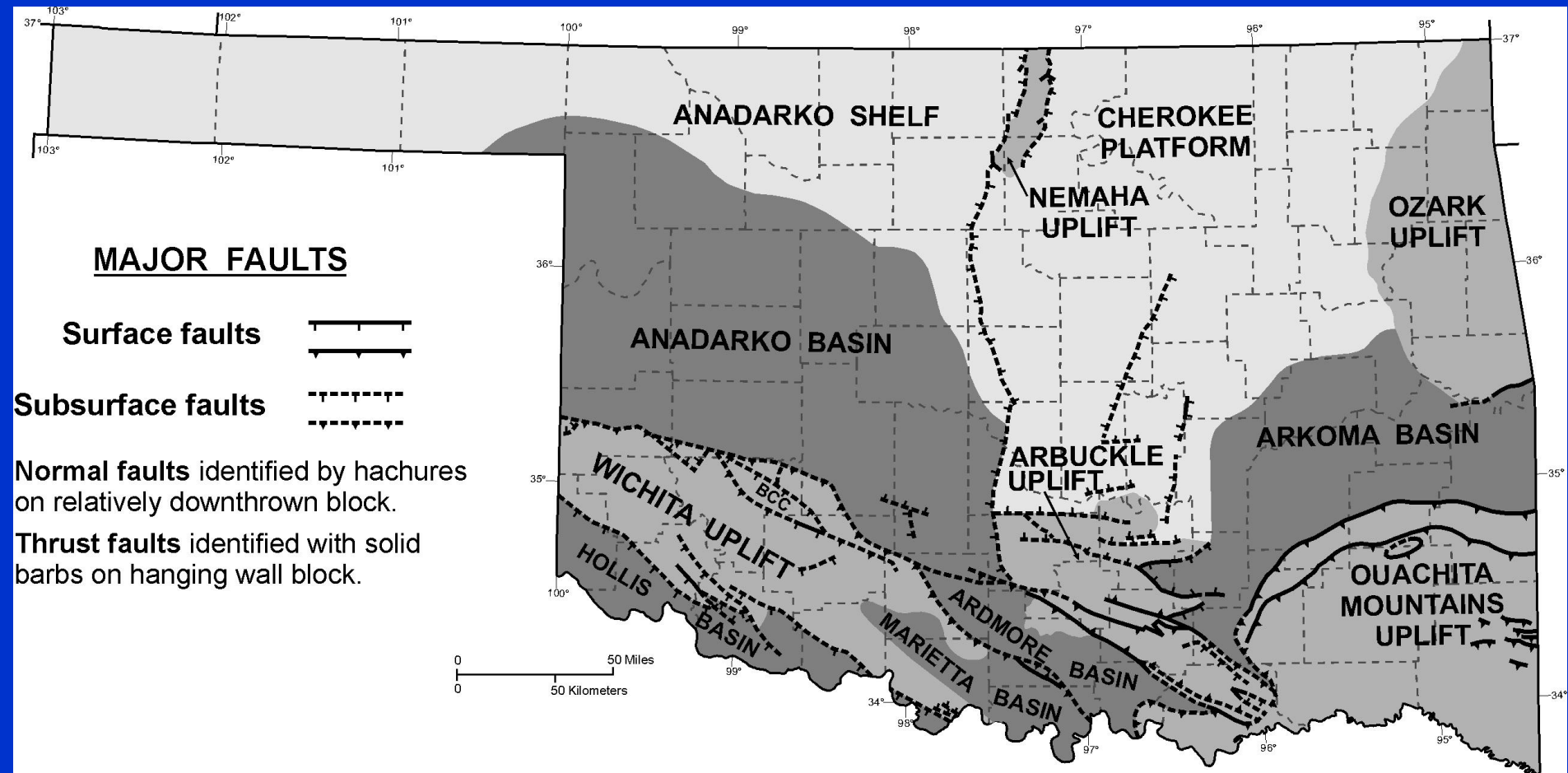
8 Sycamore/Woodford

259 Vertical Woodford

784 Horizontal/Directional  
Woodford (74%)

1 Sylvan/Woodford

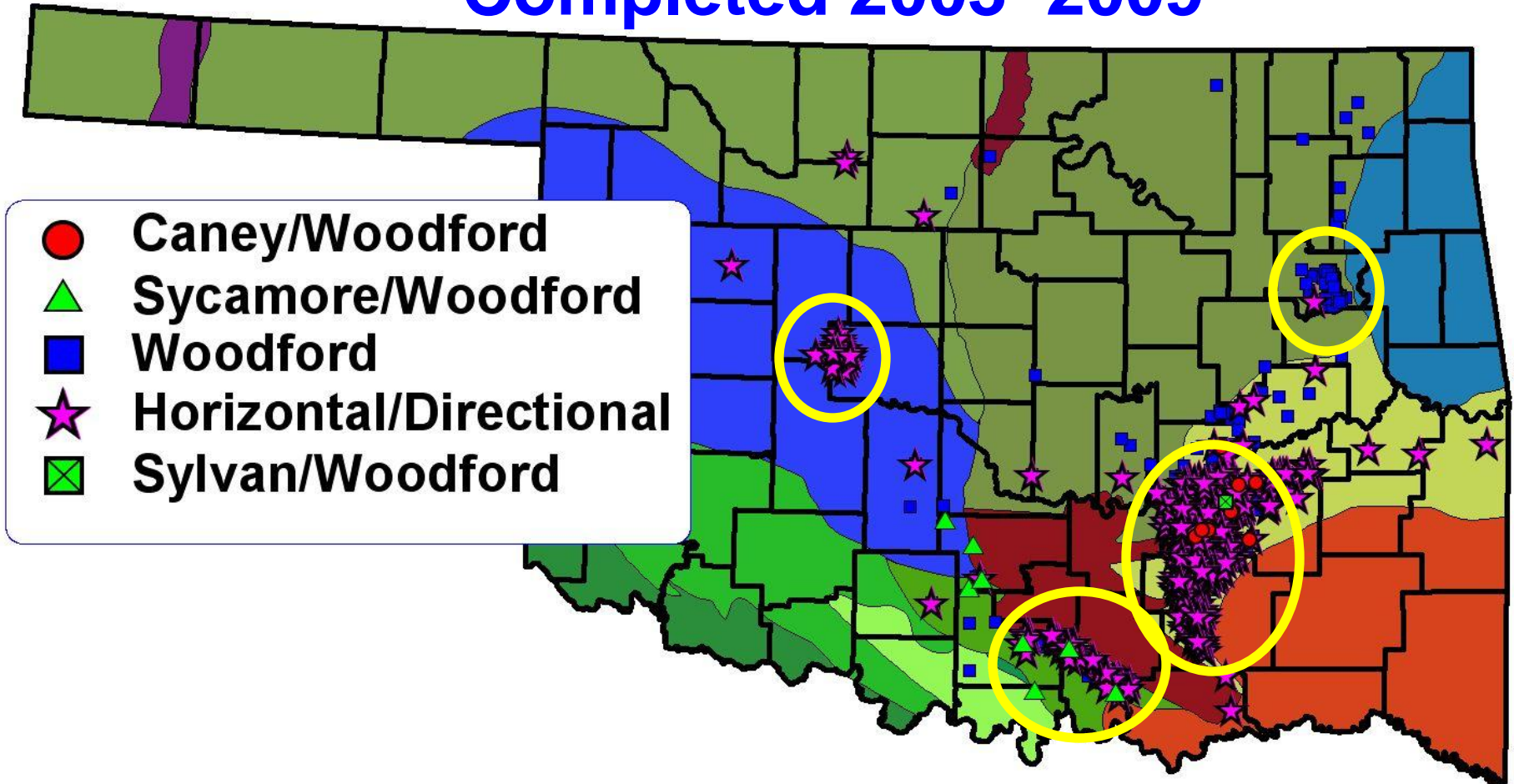
# Geologic Provinces of Oklahoma



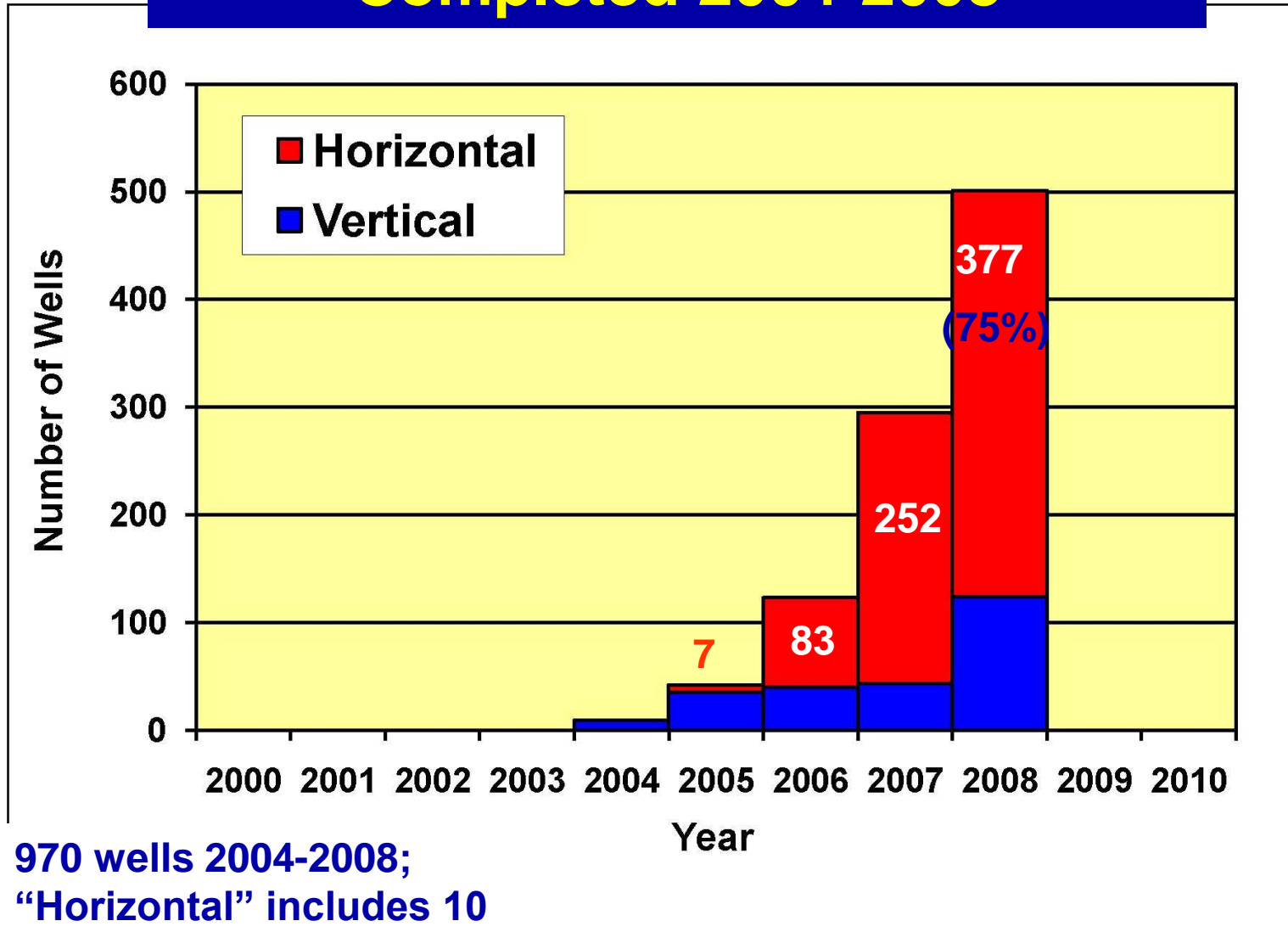
Northcutt and Campbell, 1995

# Woodford Gas-Shale Wells

Completed 2003–2009



# Woodford Shale-Only Wells Completed 2004-2008

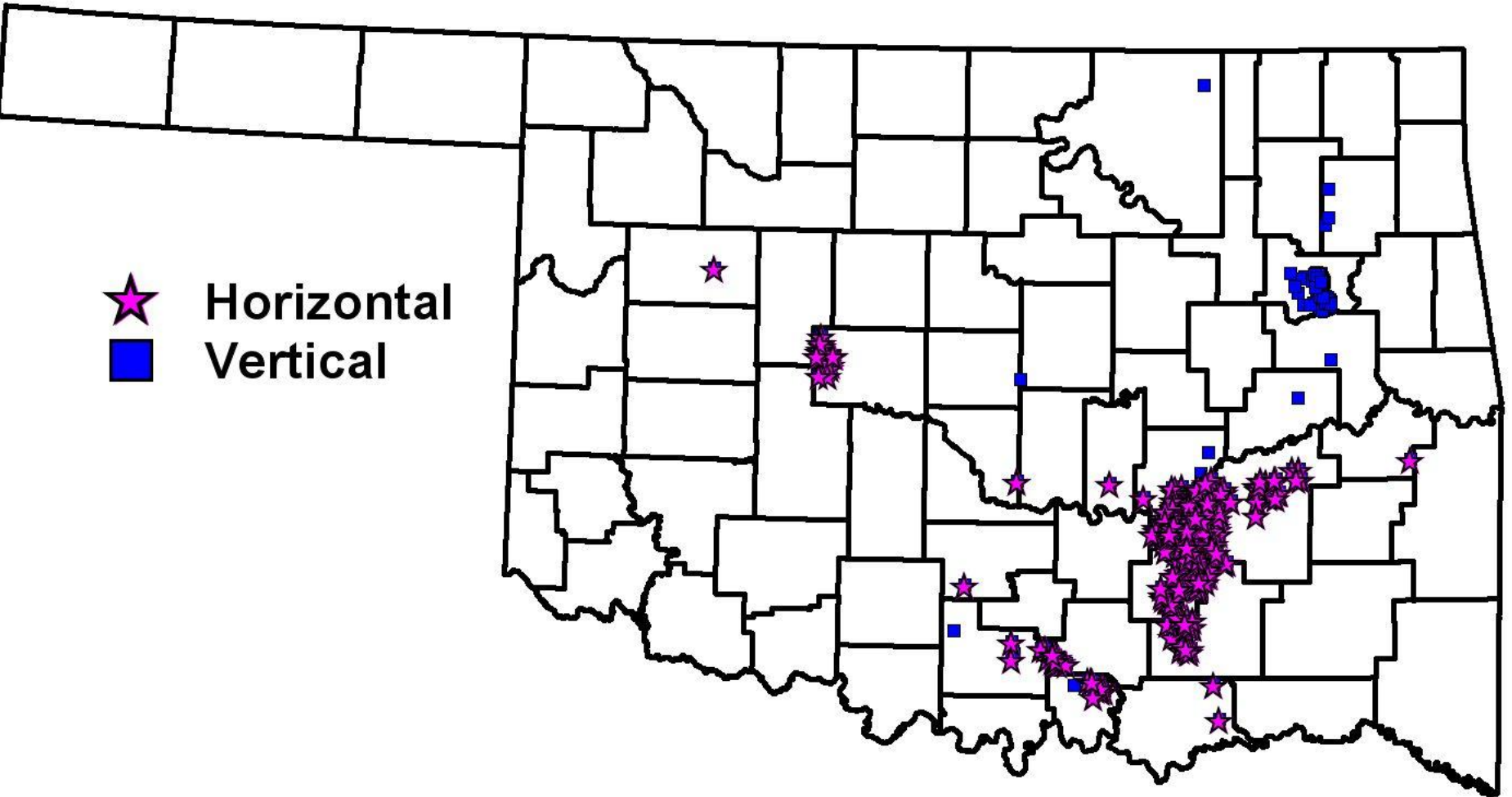


970 wells 2004-2008;  
“Horizontal” includes 10  
directional wells



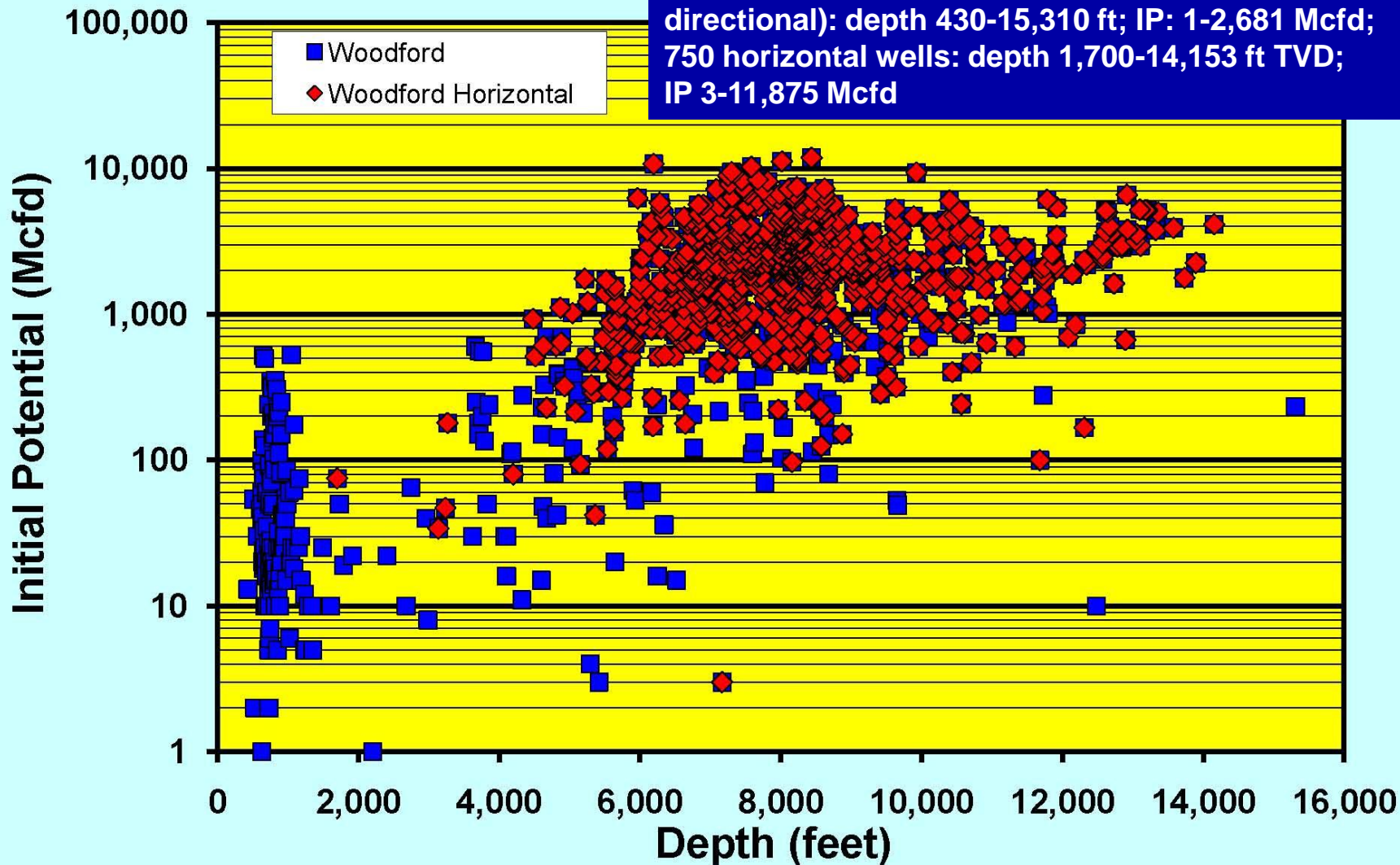
# Woodford Shale-Only Wells Completed 2008

★ Horizontal  
■ Vertical

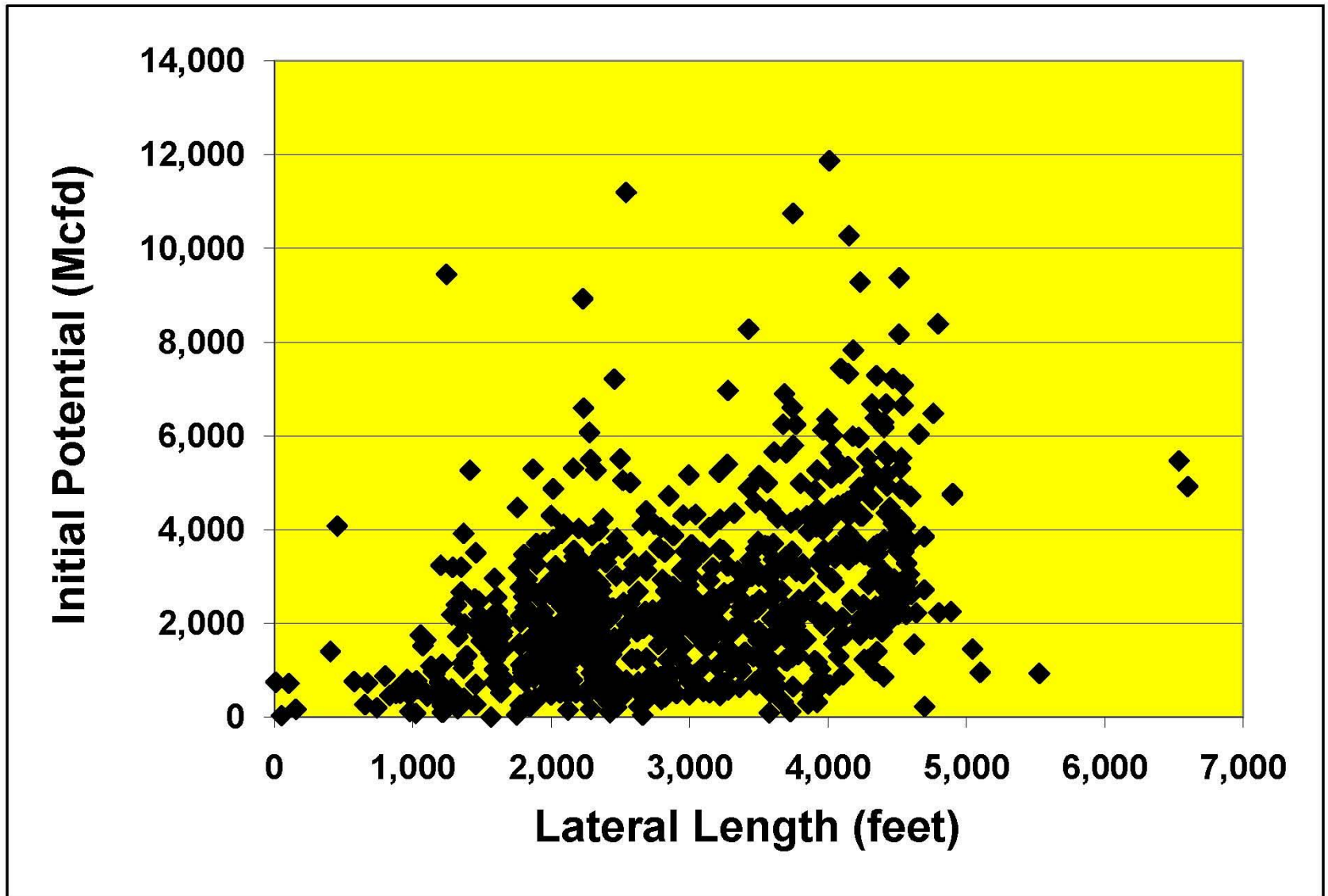


# Woodford Shale Gas Wells, 2004-2009

995 Woodford-only wells: 245 vertical (includes directional): depth 430-15,310 ft; IP: 1-2,681 Mcfd;  
750 horizontal wells: depth 1,700-14,153 ft TVD; IP 3-11,875 Mcfd

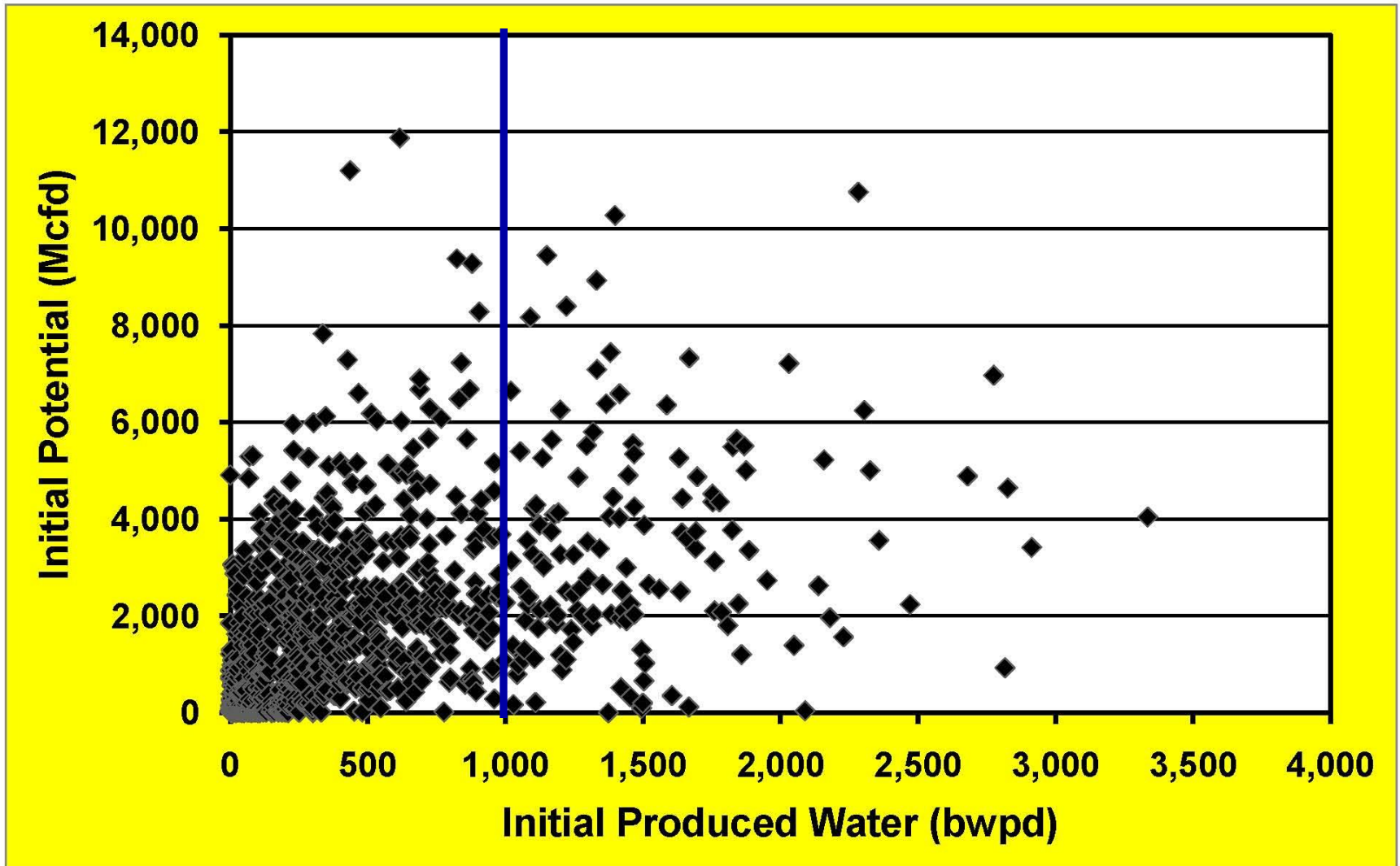


# Woodford Shale Horizontal Wells



**751 wells**

# Woodford Shale Produced Water

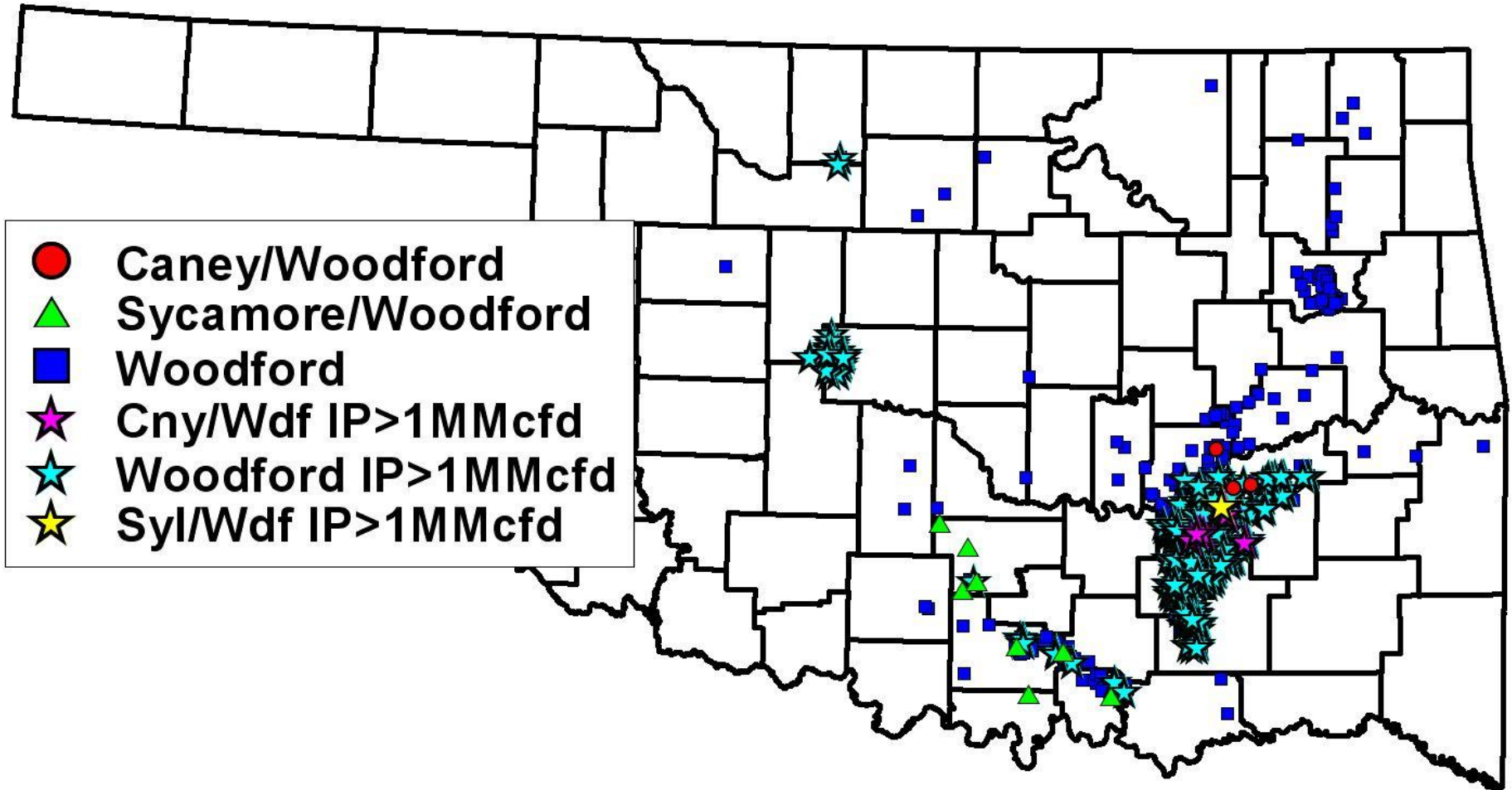


**943 wells (excluding two wells, 11,644 & 16,338 bwpd)**

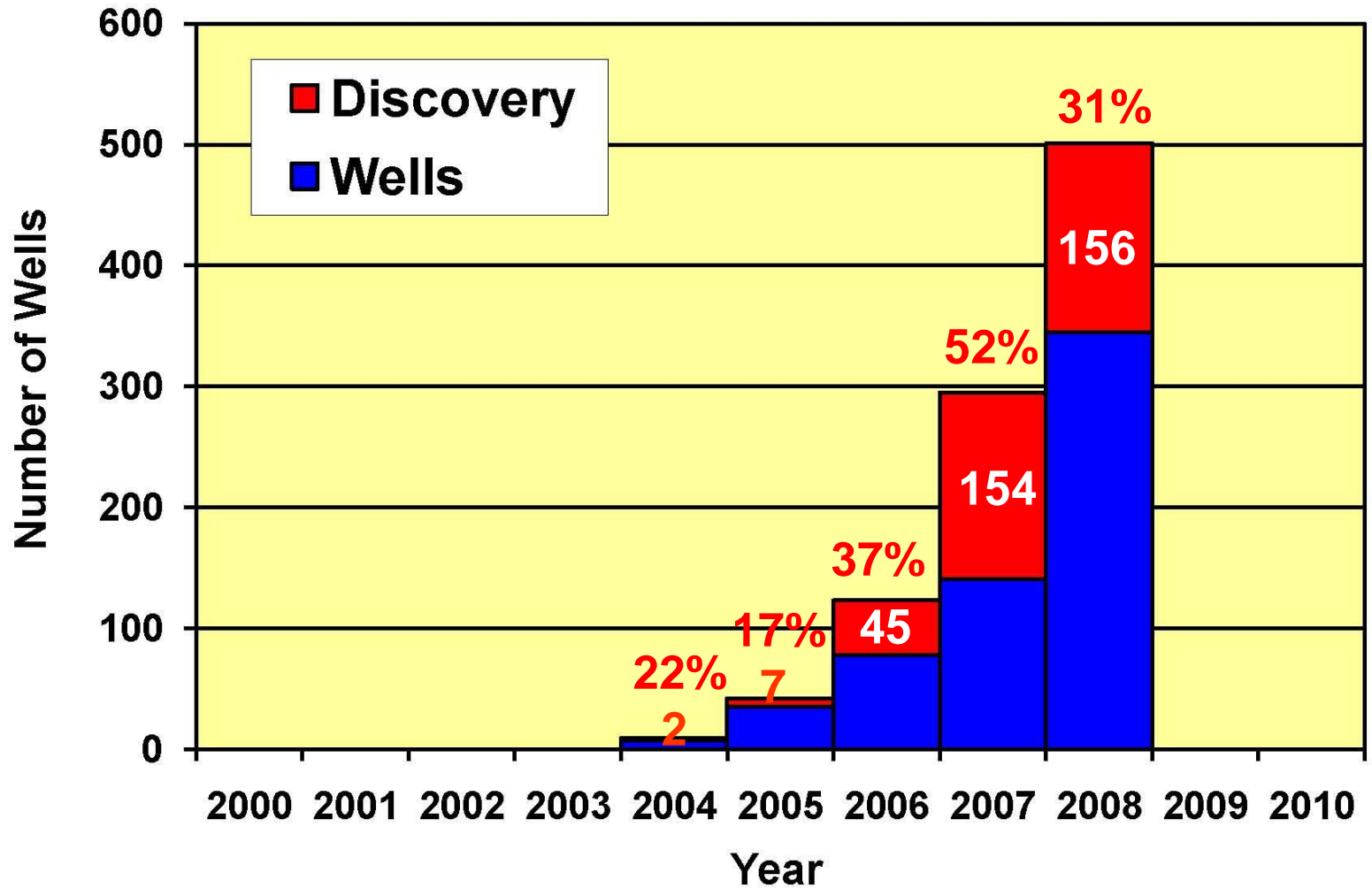


# Woodford IP >1 MMcfd

Completed 2004–2009



# Woodford Shale Discovery Wells (New Field or Extension)



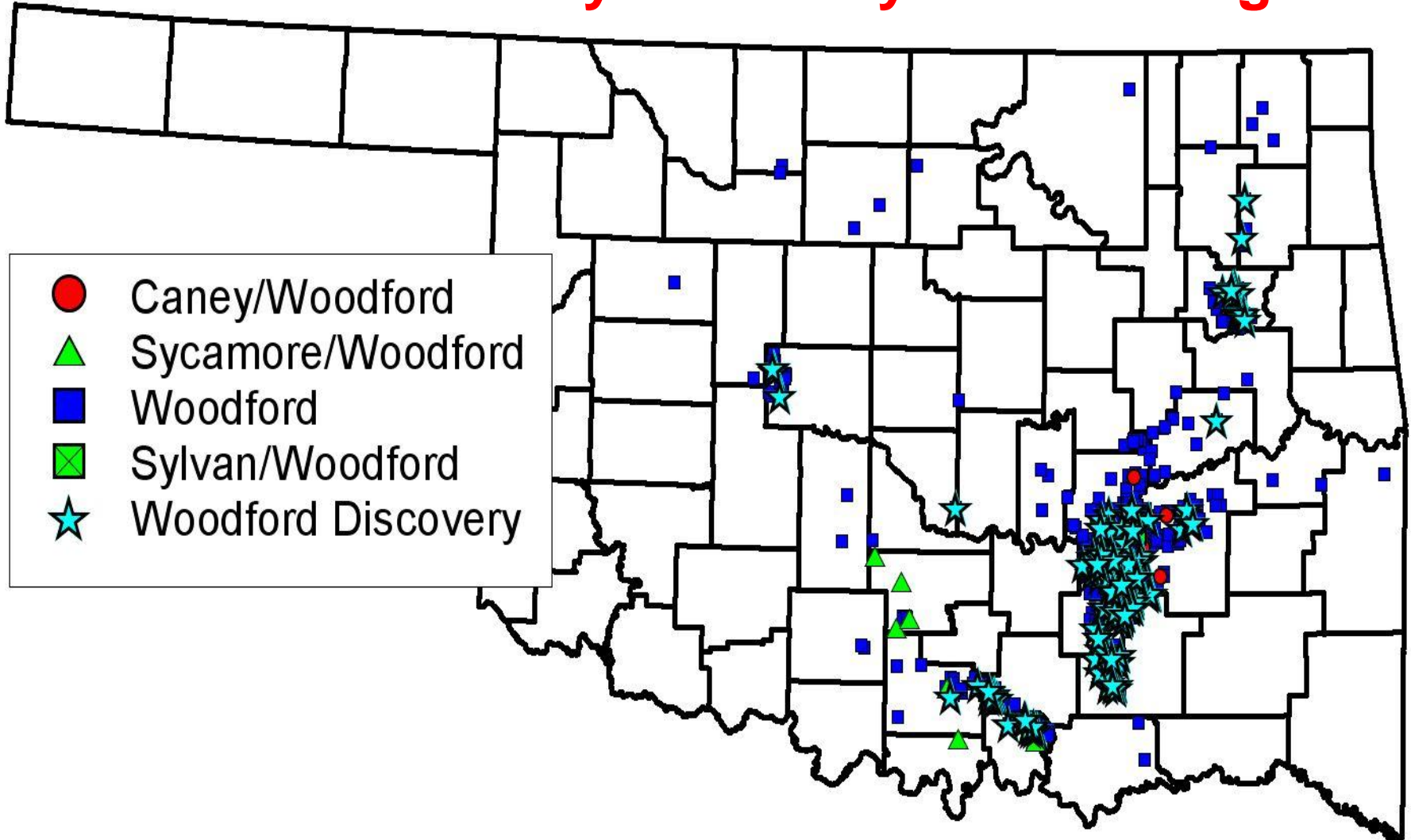
970 Woodford-only Wells

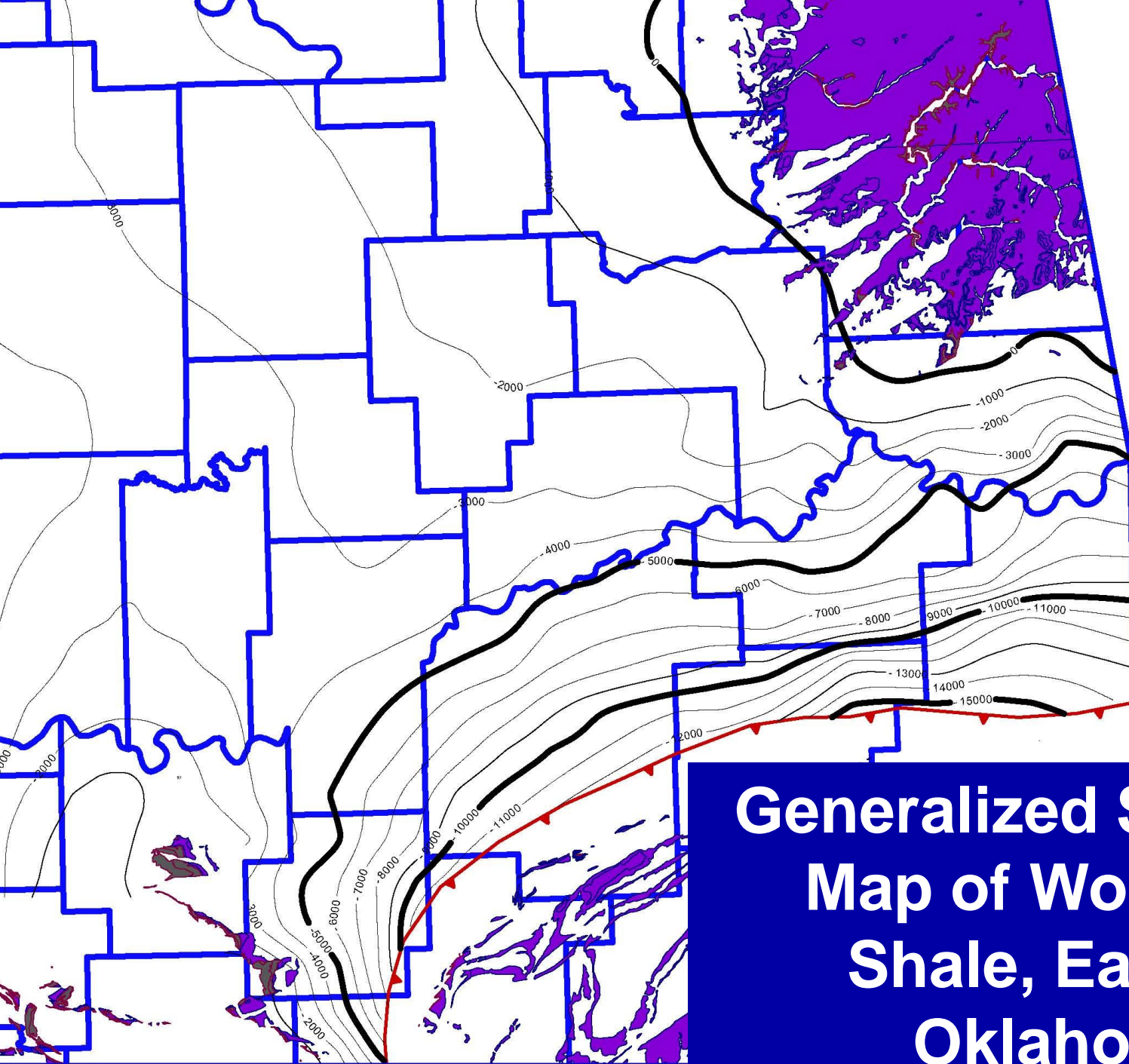
Updated 4/24/2009

# Woodford Shale Discovery Wells

Completed 2004–2008

156 Woodford-only discovery wells during 2008



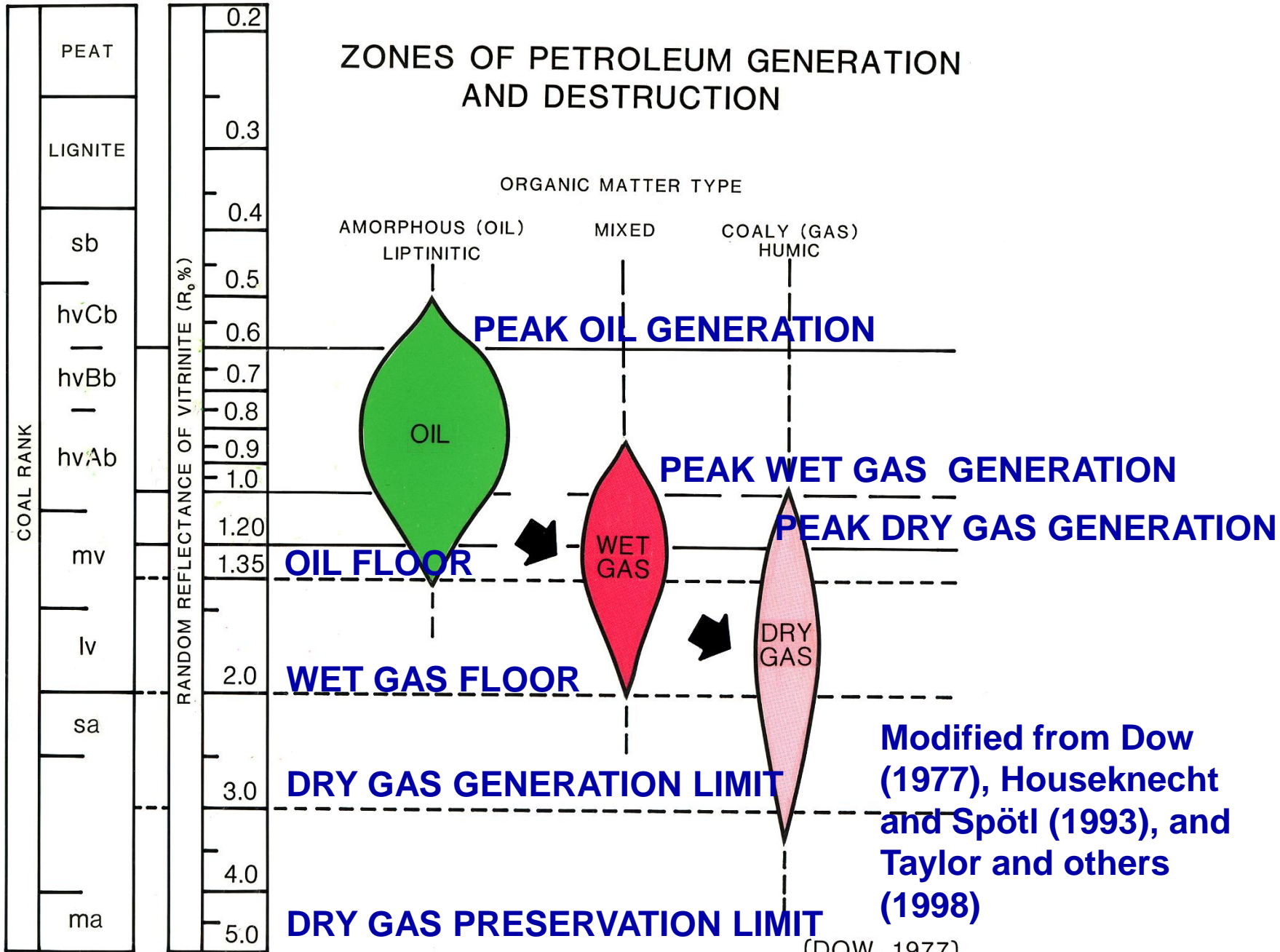


Map prepared  
by R. Vance  
Hall using  
Petra

# Generalized Structure Map of Woodford Shale, Eastern Oklahoma



# ZONES OF PETROLEUM GENERATION AND DESTRUCTION



# Guidelines for the Barnett Shale (Based on Rock-Eval Pyrolysis)

## VRo Values

## Maturity

<0.55%

Immature

0.55-1.15%

Oil Window (peak  
oil at 0.90%VRo)

1.15-1.40%

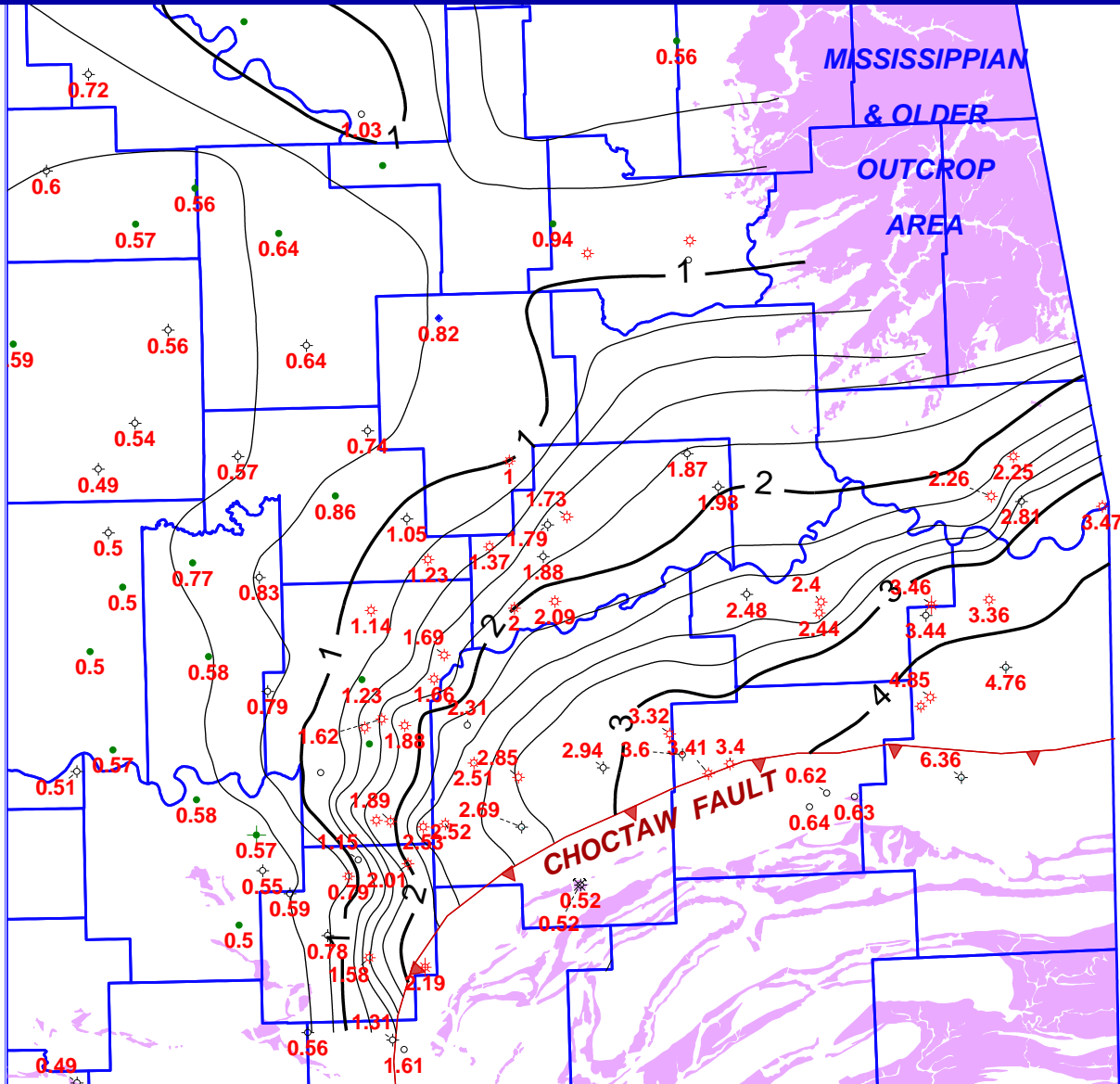
Condensate–Wet-  
Gas Window

>1.40%

Dry-Gas Window

From Jarvie and others, 2005

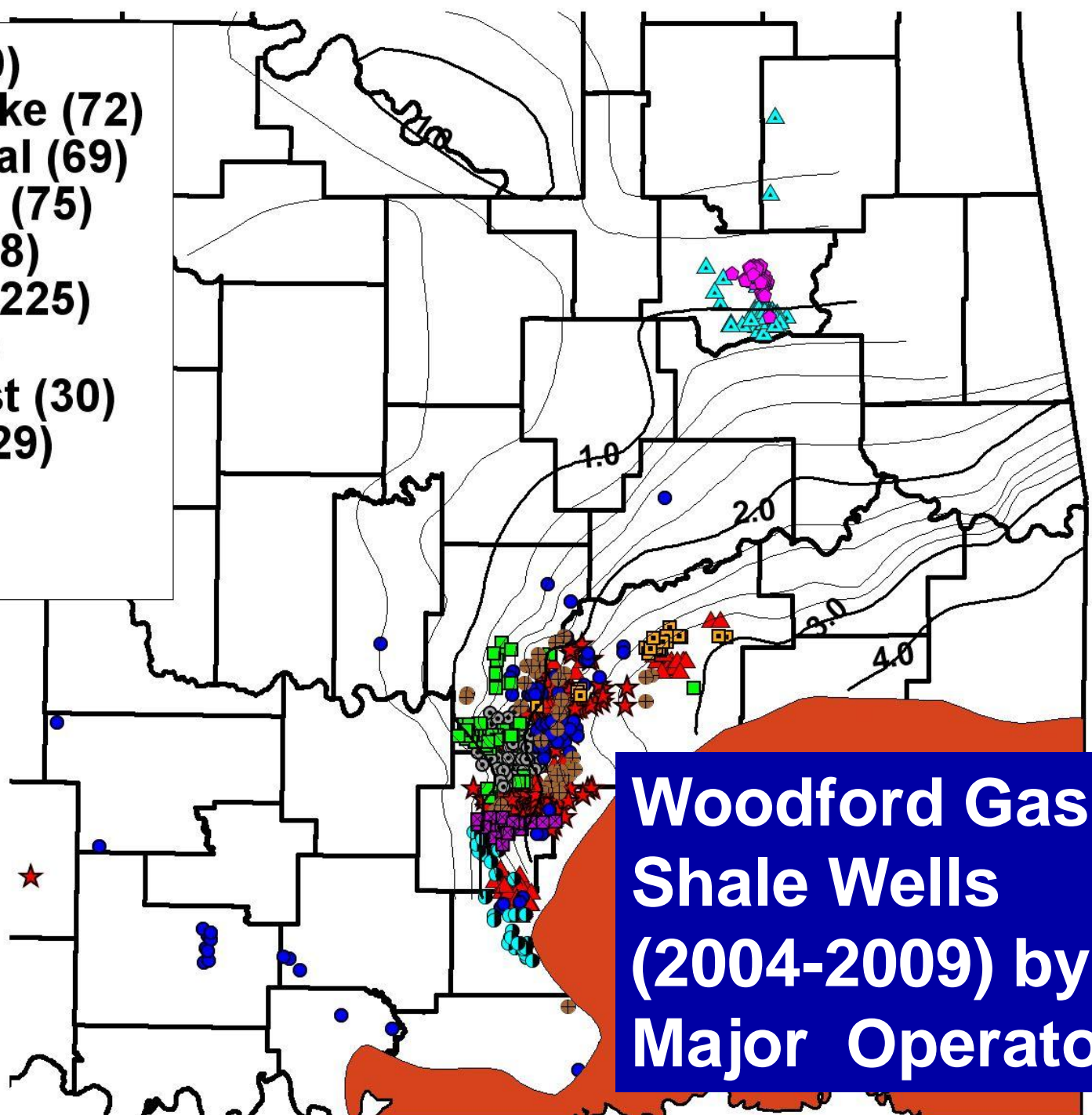
# Isoreflectance Map of the Woodford Shale in Eastern Oklahoma



Map prepared  
by R. Vance  
Hall using  
Petra

Cardott, in  
preparation

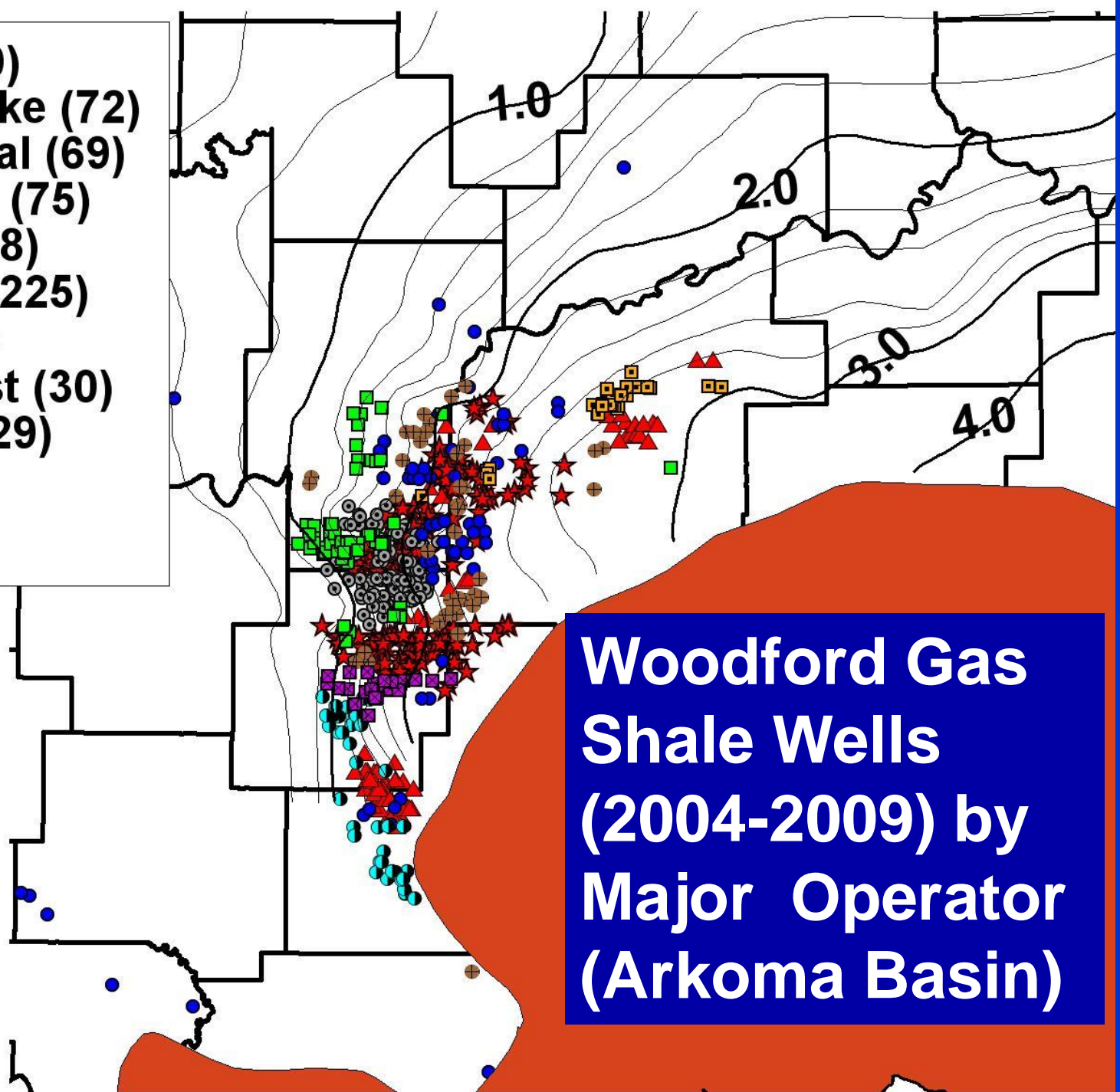
- ▲ Antero (99)
- Chesapeake (72)
- Continental (69)
- ▲ Coronado (75)
- ⊙ Devon (118)
- ★ Newfield (225)
- Pablo (42)
- Petroquest (30)
- ⊠ St. Mary (29)
- ◆ WCT (59)
- XTO (45)



**Woodford Gas  
Shale Wells  
(2004-2009) by  
Major Operator**

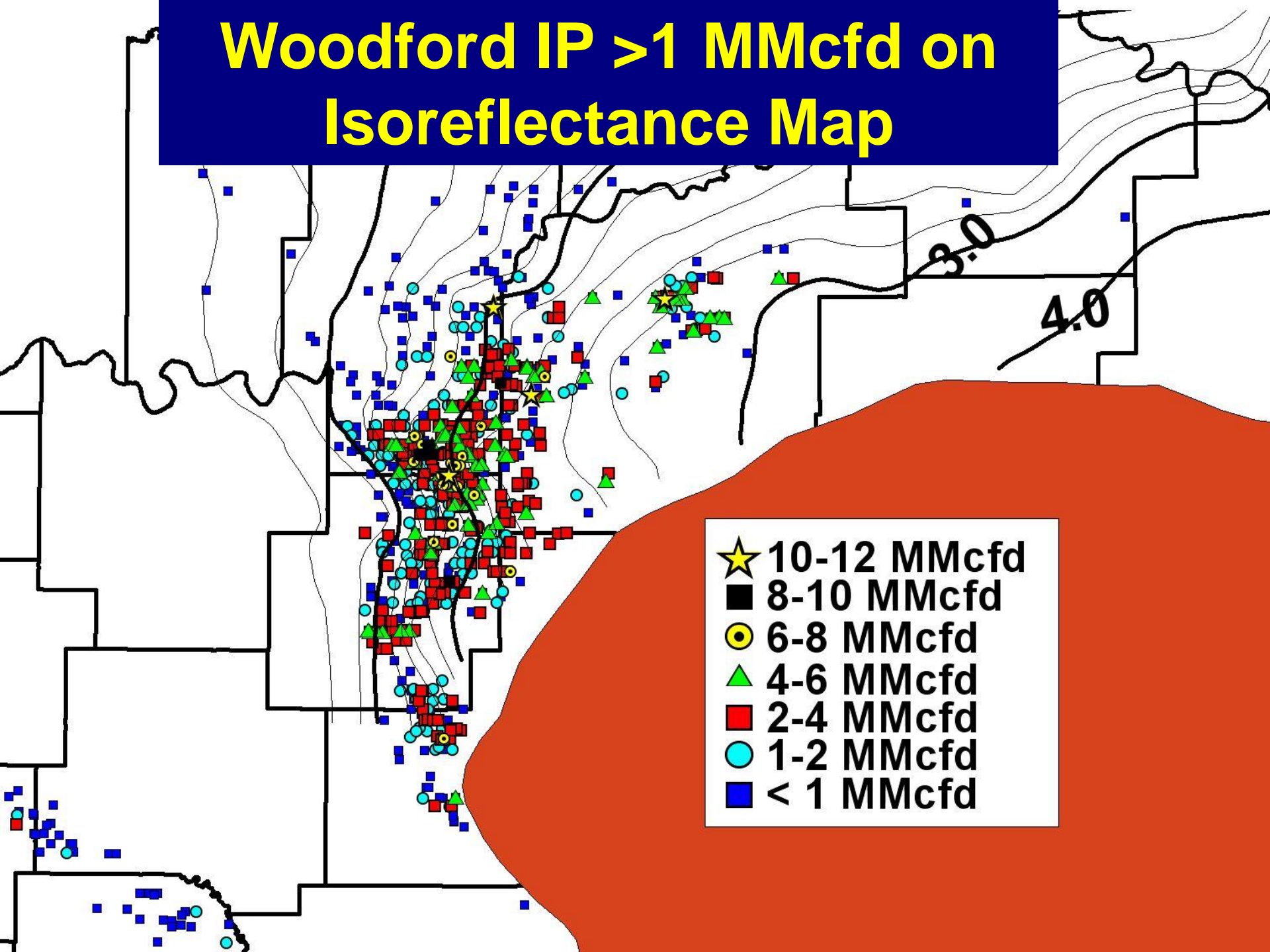


- ▲ Antero (99)
- Chesapeake (72)
- Continental (69)
- ▲ Coronado (75)
- ⊙ Devon (118)
- ★ Newfield (225)
- Pablo (42)
- Petroquest (30)
- St. Mary (29)
- ◆ WCT (59)
- XTO (45)



**Woodford Gas  
Shale Wells  
(2004-2009) by  
Major Operator  
(Arkoma Basin)**

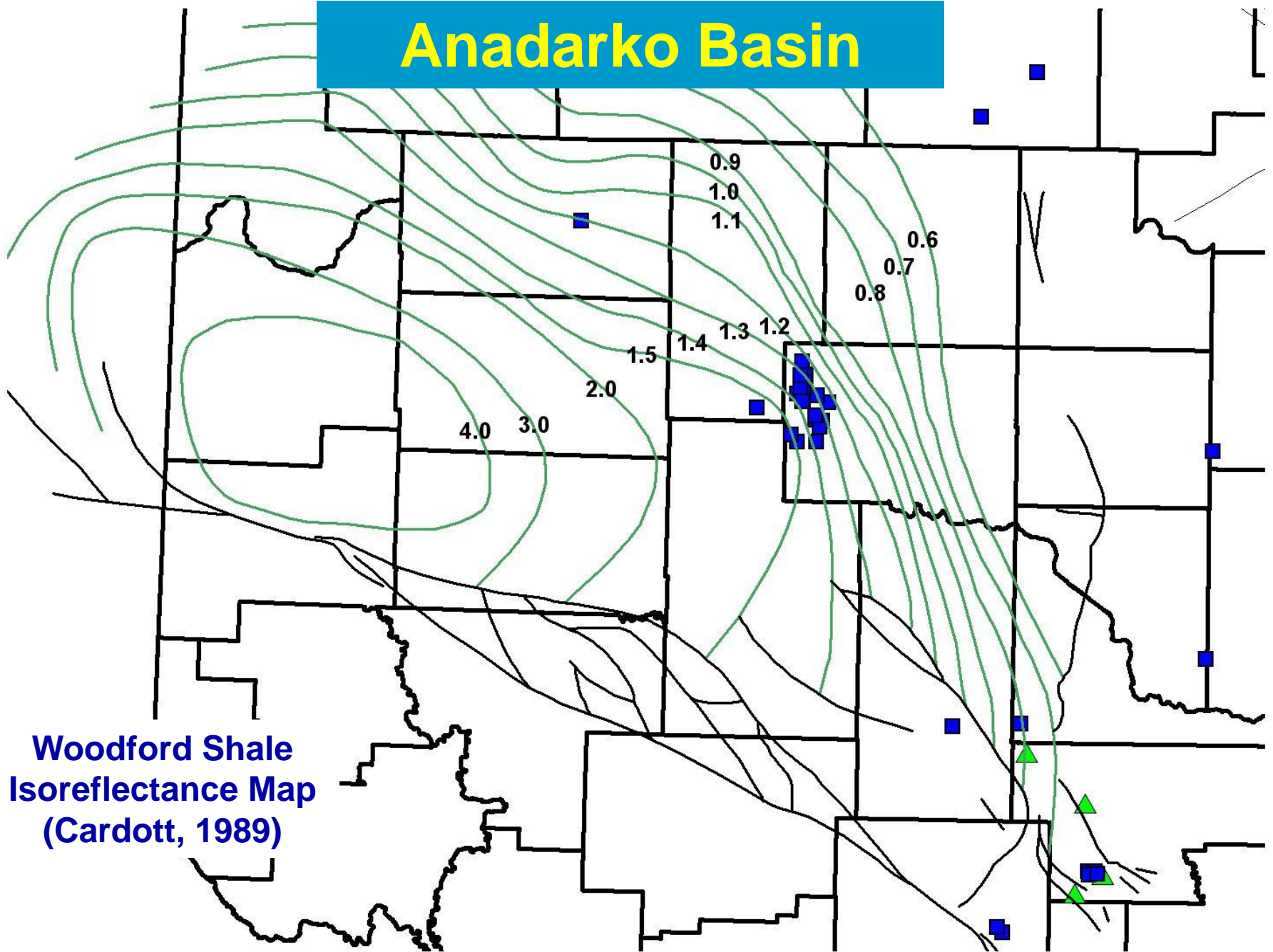
# Woodford IP >1 MMcfd on Isoreflectance Map



**Woodford Gas-Shale Play is primarily in eastern Oklahoma (western Arkoma Basin) where the shale is:**

- (1) in the gas window (pushing the lower thermal maturity limits to the west and upper thermal maturity limits to the east)**
- (2) greater than 100 ft thick**
- (3) relatively shallow (<12,000 ft)**

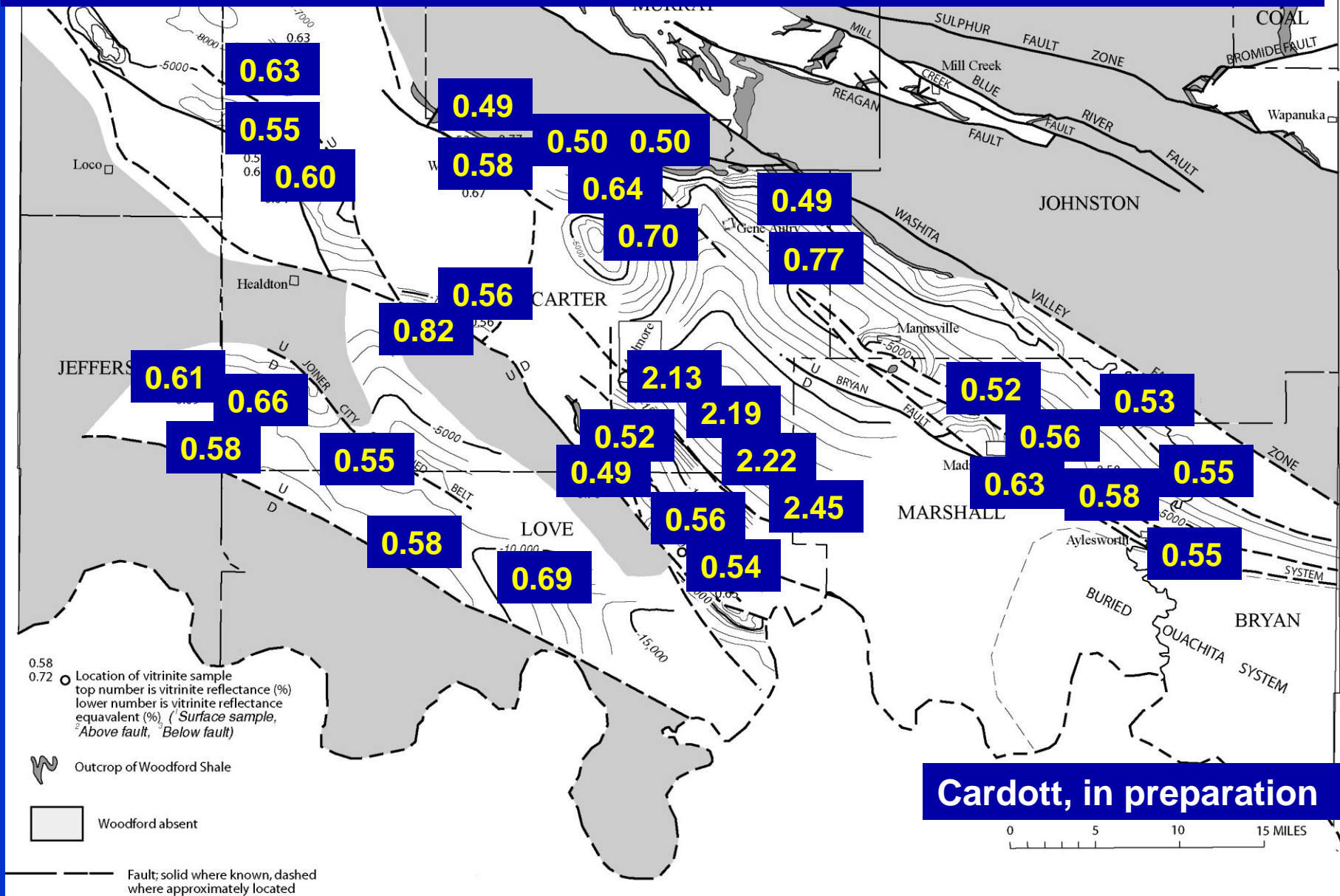
# Anadarko Basin



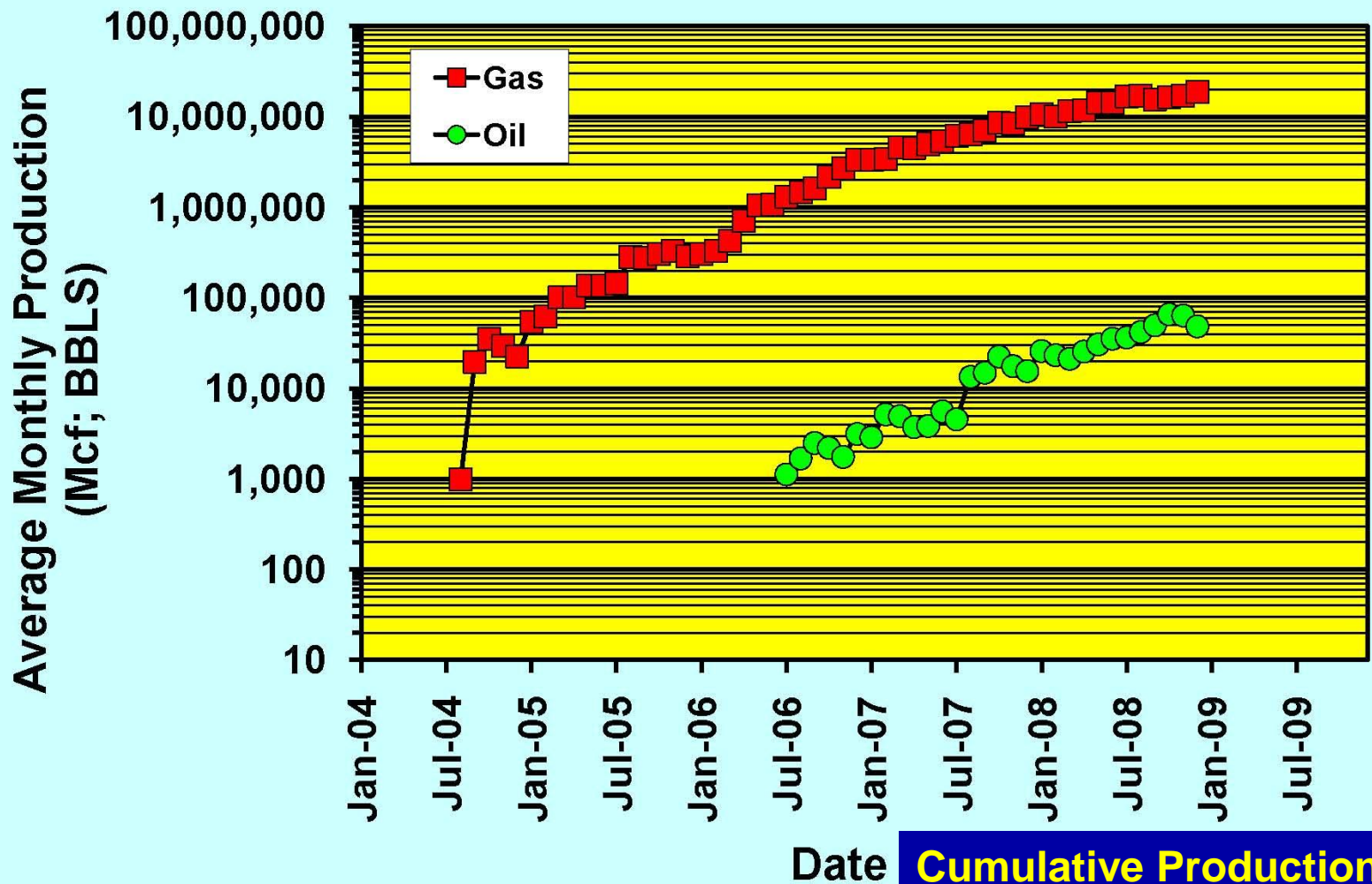
**Woodford Shale  
Isoreflectance Map  
(Cardott, 1989)**



# Structure and Vitrinite Reflectance of Woodford Shale, Southern Oklahoma

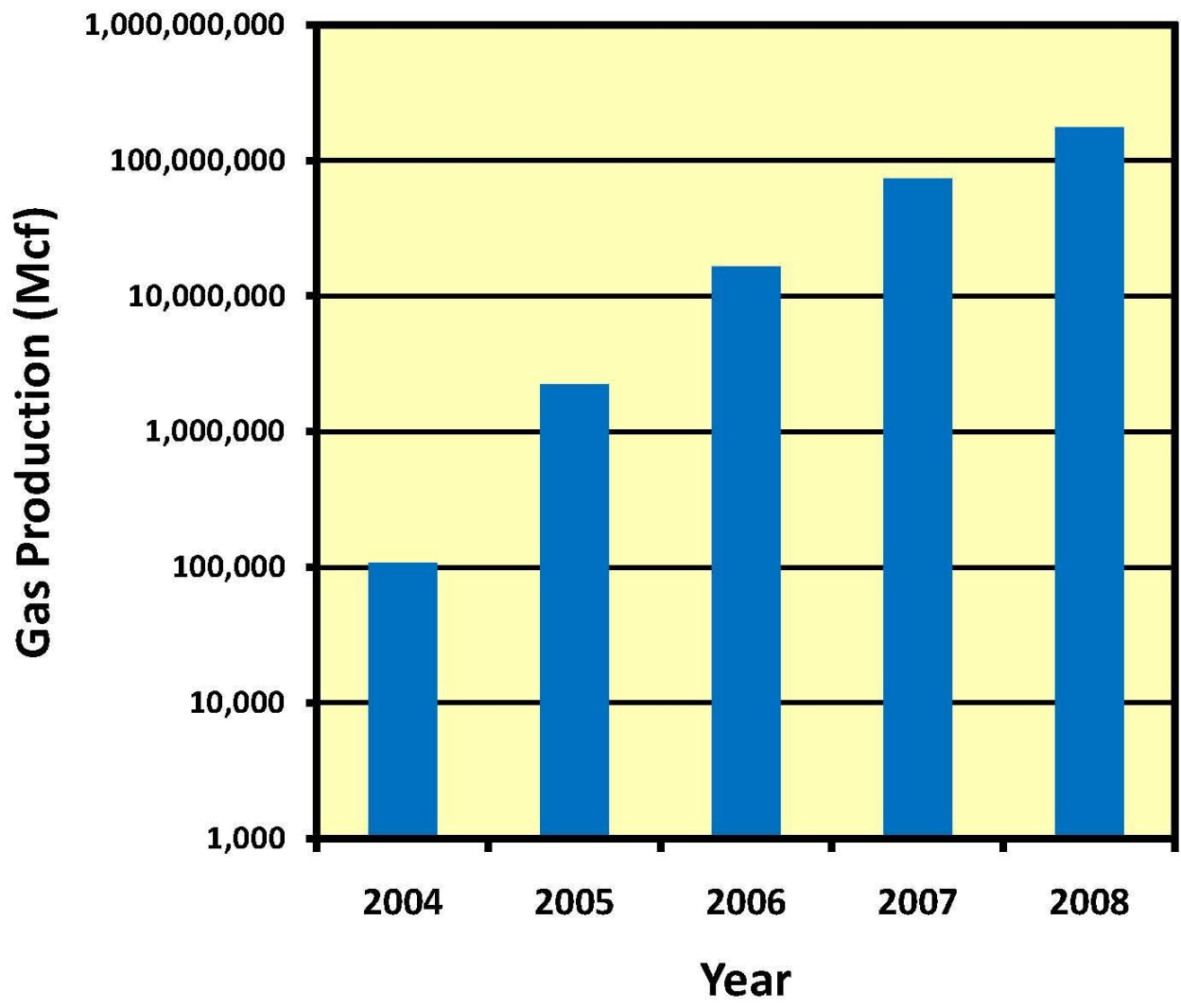


# Woodford Shale Production (2004-2008 wells)

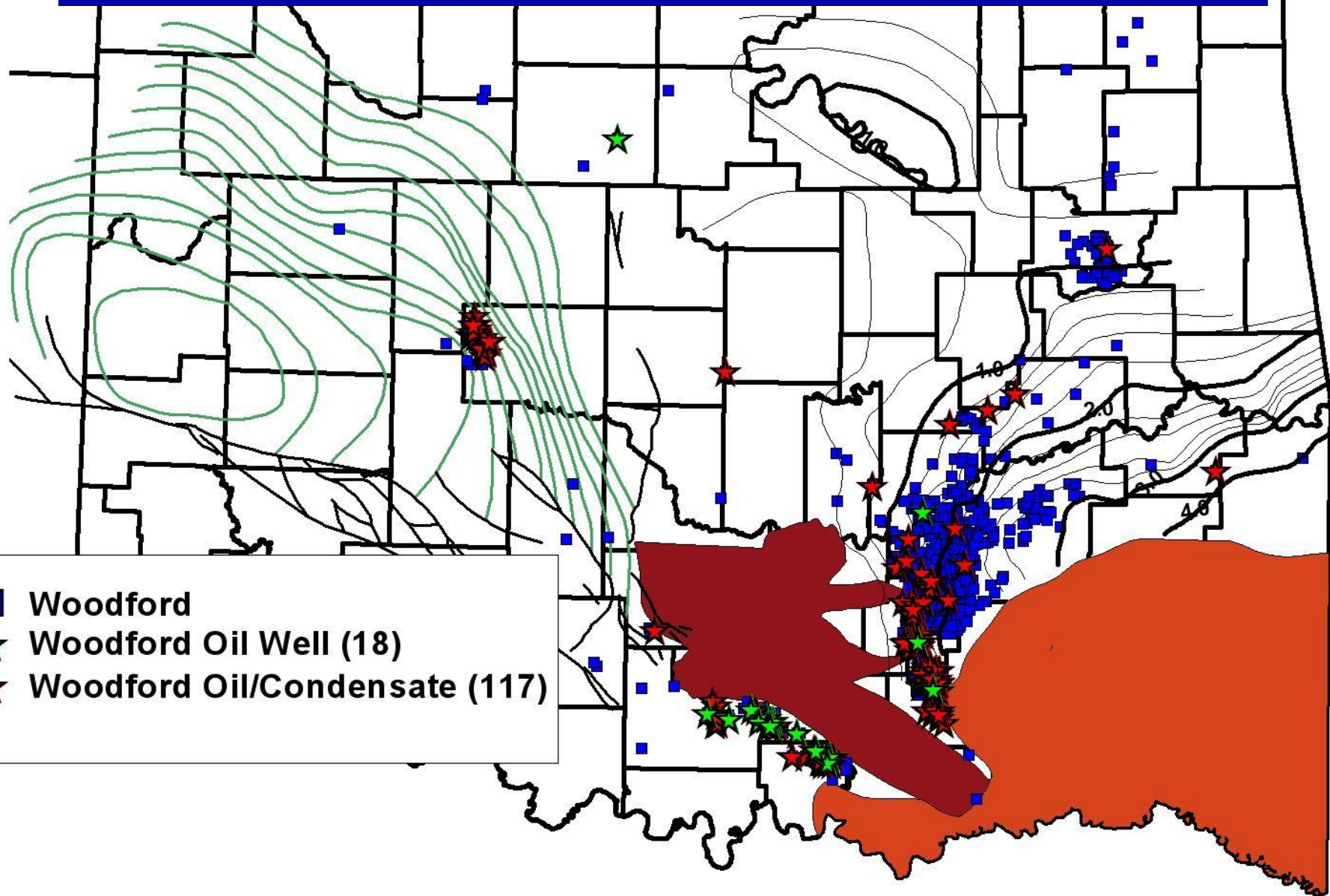


**Cumulative Production**  
283,672,521 Mcf gas,  
597,527 BBLs oil/condensate  
from 808 Woodford-only wells  
(excludes OWWO, D&A)

# Woodford Shale Gas Production, 2004-2008



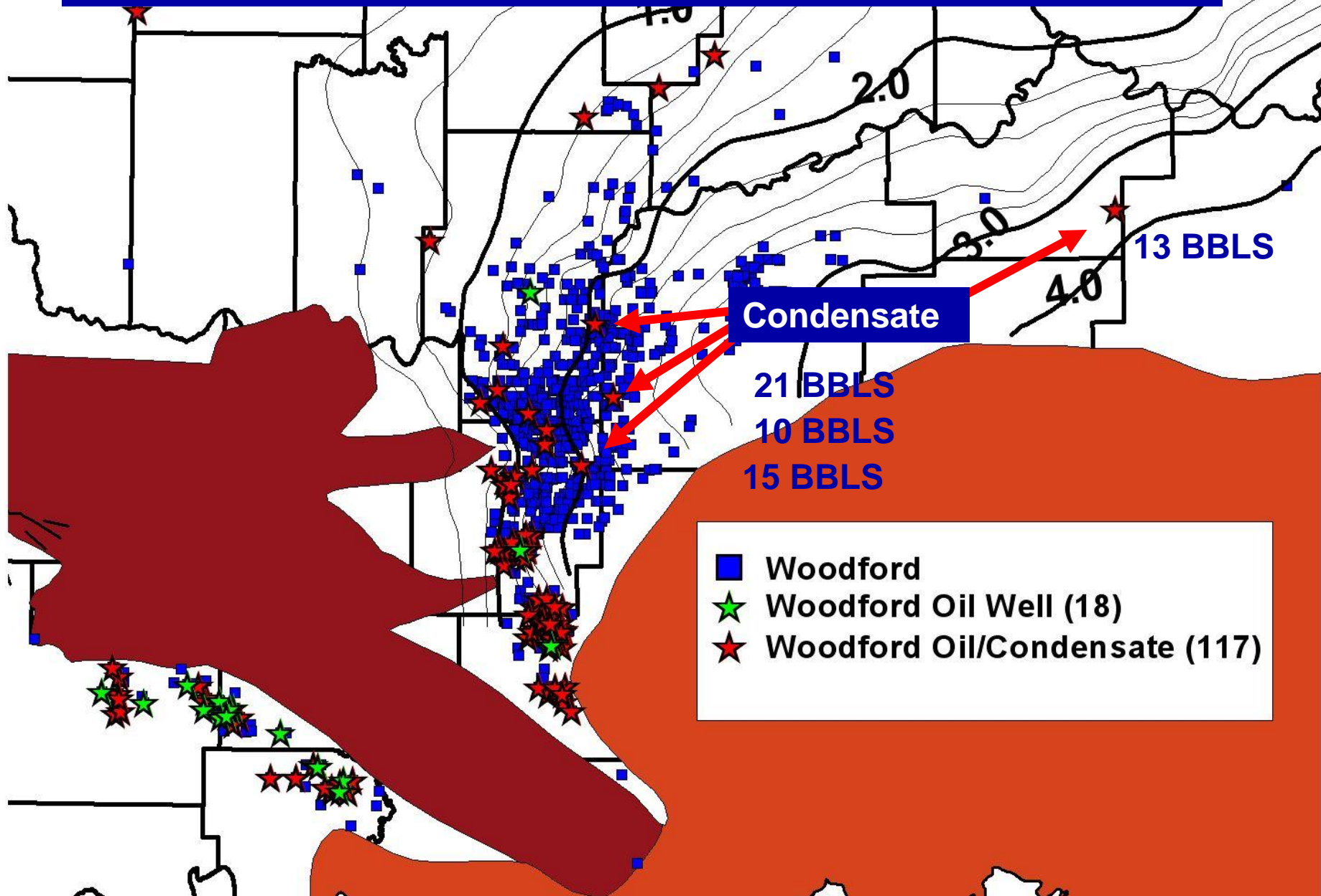
# Woodford Shale Only Oil/Condensate Production (135 of 1,042 wells; 2004-2009)

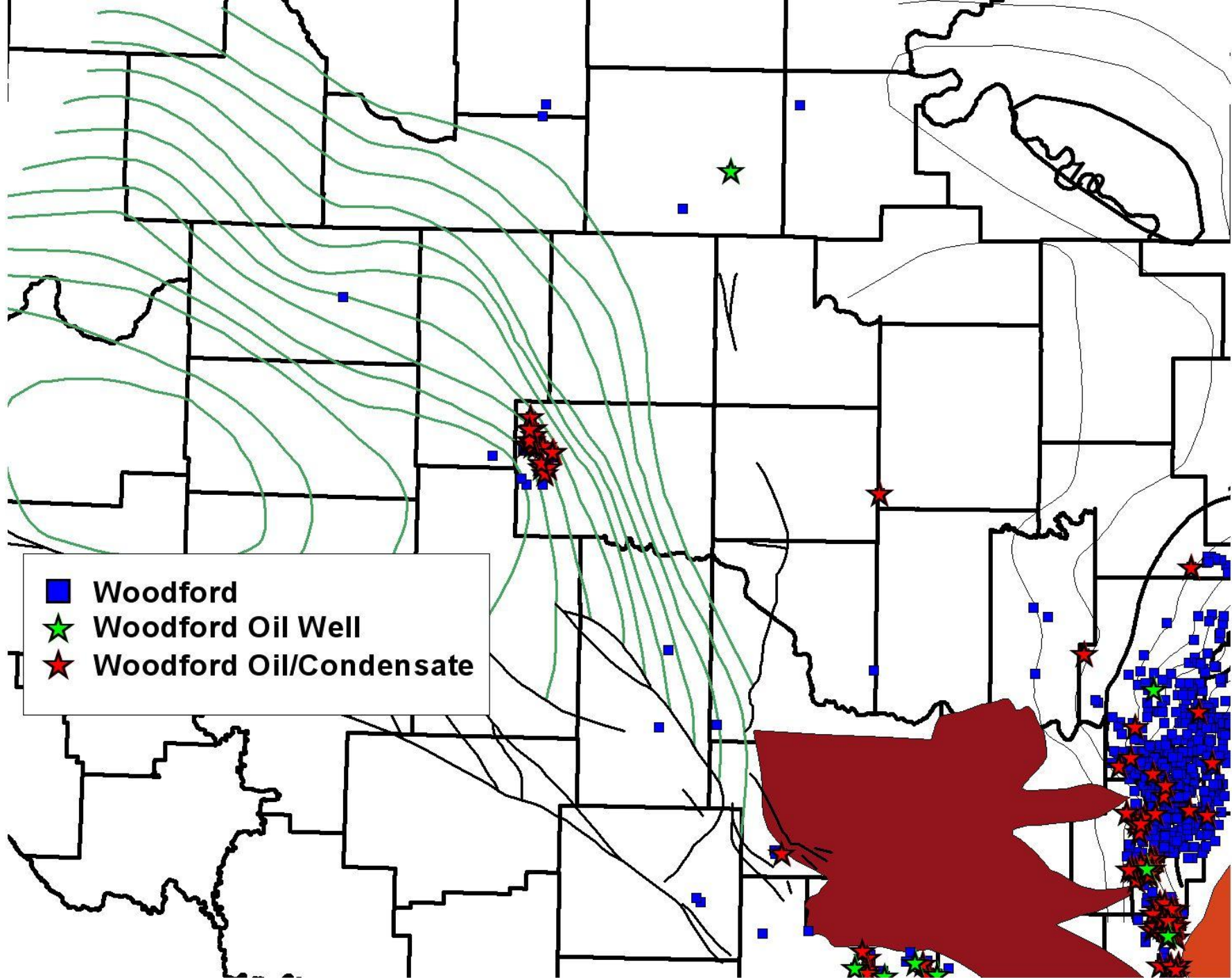


- Woodford
- ★ Woodford Oil Well (18)
- ★ Woodford Oil/Condensate (117)



# Woodford Shale Only Oil/Condensate Production (135 of 1,042 wells; 2004-2009)





# SUMMARY OF WOODFORD GAS SHALE PLAY

- Woodford Shale contains Type II (oil generative) Kerogen with adequate TOC
- Woodford Shale is silica rich (e.g., fracture-able)
- Main Woodford Shale gas play is in eastern Oklahoma at  $>1.1\%$   $R_o$
- Woodford Shale gas play in Anadarko Basin shelf @  $1.2-1.5\%$   $R_o$
- Some Woodford Shale gas potential is in southern and northeastern Oklahoma at  $<1.1\%$   $R_o$

<http://www.ogs.ou.edu>

Contact  
College of Earth and Energy

[Map GM28 Map of Oklahoma Oil and Gas Fields](#), compiled by Margaret R. Burchfield, 1989, revised supplement, 1997. [\(Data files only\)](#)

[Stratigraphic Chart](#) Stratigraphic Guide to Oklahoma  
Boyd  
[Stratigraphic chart, front of chart \(pdf\)](#)  
[Table of Oklahoma Oil and Gas Reservoirs, b](#)

[Sources of OK Data](#)

[OGS Oil and Gas Related Publications](#)

[Type Logs](#)

[Oklahoma Stratigraphic Columns](#)

[Field Discovery Wells](#) (Excel format)

[Links](#)

[Available Publications](#)

[Milestones in the Oklahoma Oil and Gas Indu](#)

For more information,  
please visit the  
Oklahoma Geological  
Survey Web Site

## Oklahoma Hydrocarbon Source Rocks and Gas Shales

[References](#)

[Presentations & Reports](#)

Including October 2008 Gas Shales Workshop Presentations!

[Oklahoma Gas Shale Completions Histogram](#)

[Oklahoma Gas-Shale Completions Map, 1939-2009](#)

[Woodford Shale Gas Well Completions Map, 1939-2008](#)

[Woodford Shale Gas Well Completions Map, 2003-2008](#)

[Gas Shales Database](#)

## Shale Shaker Articles

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[Oklahoma: The Ultimate Oil Opportunity](#)

[\\*NEW 2008 Drilling Highlights](#)