

Oklahoma Gas Shales Conference October 22, 2008

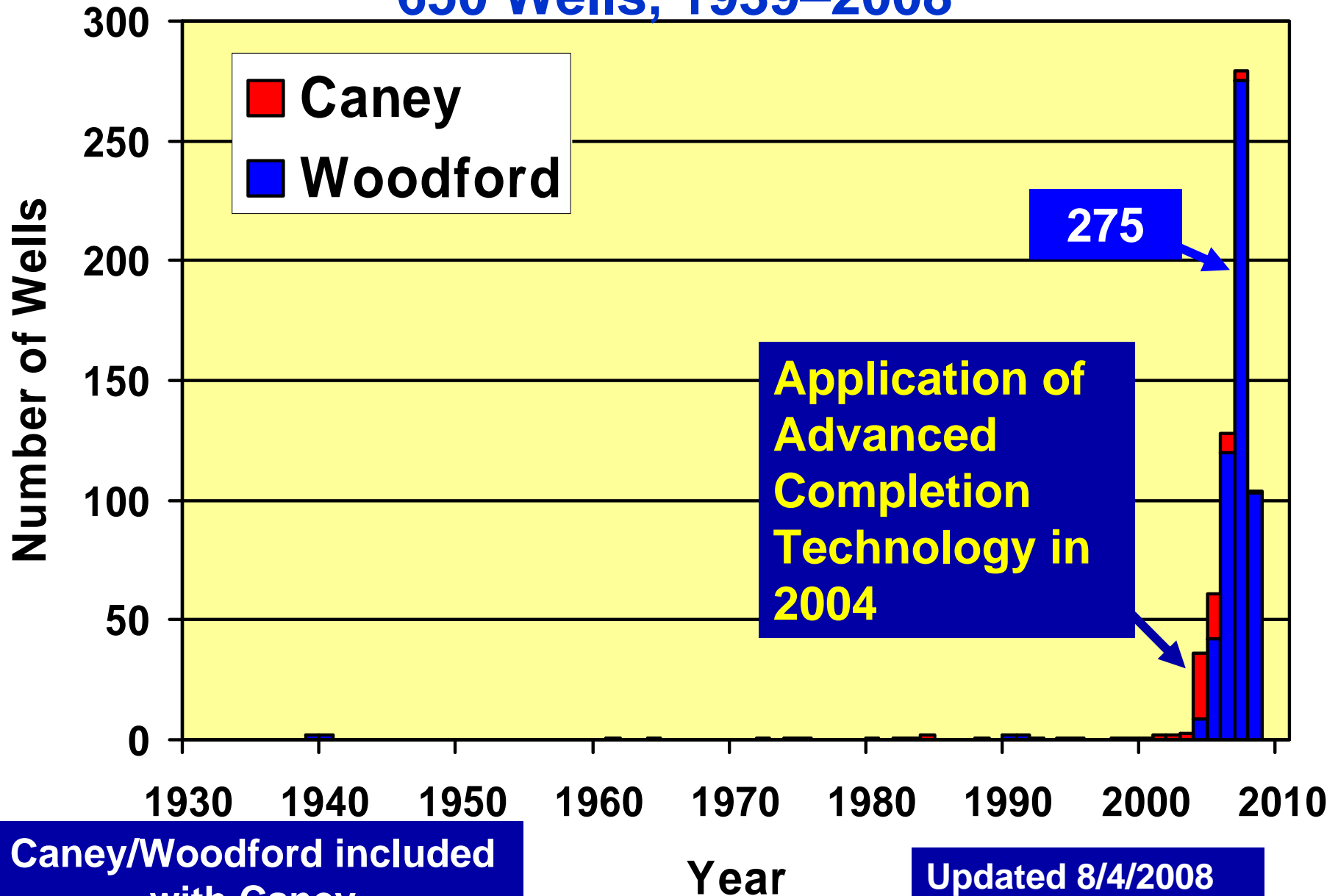
Overview of Woodford Gas-Shale Play in Oklahoma, 2008 Update



Brian J. Cardott
**Oklahoma Geological
Survey**

Oklahoma Shale-Gas Well History

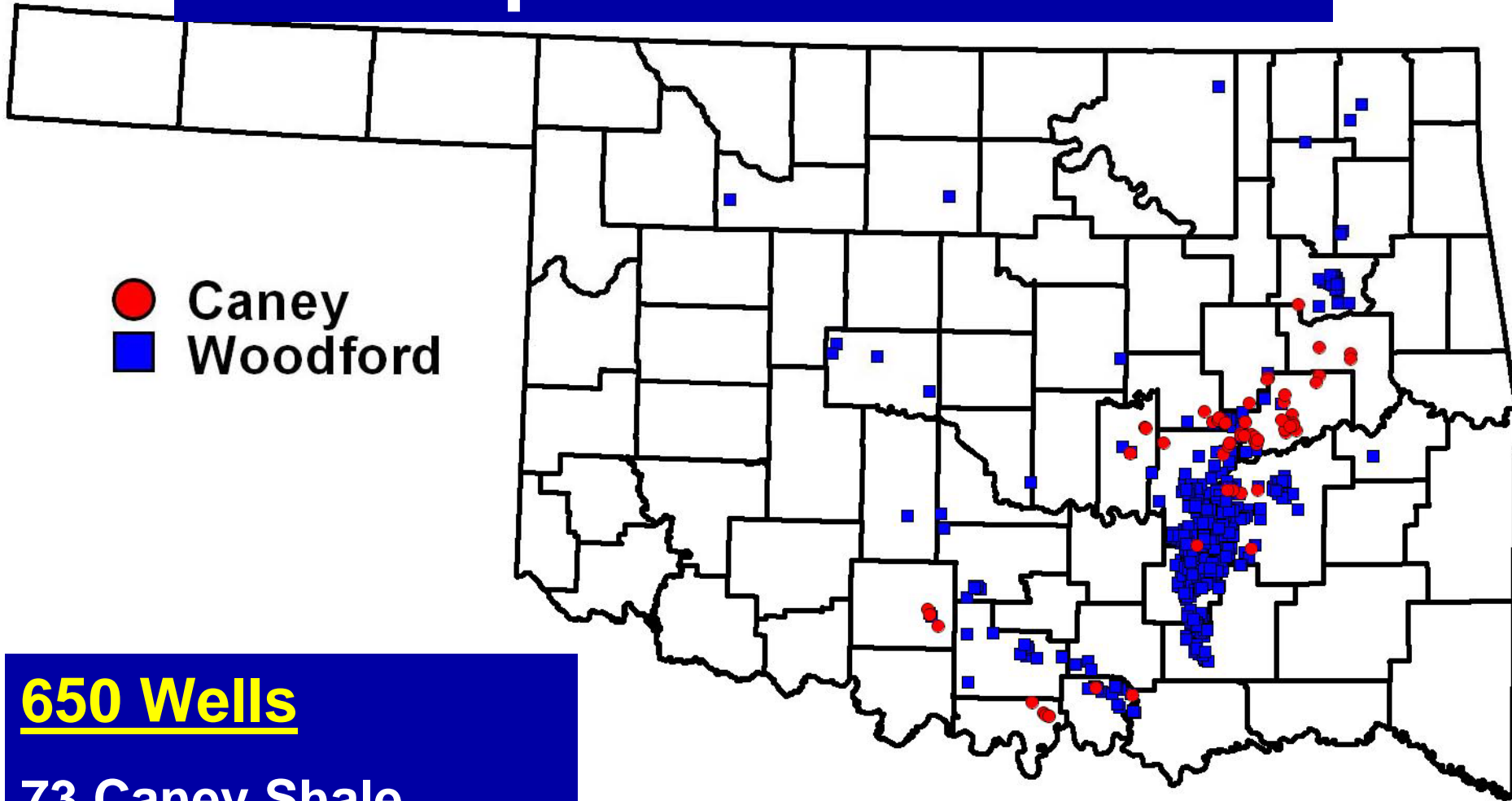
650 Wells, 1939–2008



Caney/Woodford included with Caney

Updated 8/4/2008

Oklahoma Gas-Shale Wells Completed 1939-2008



650 Wells

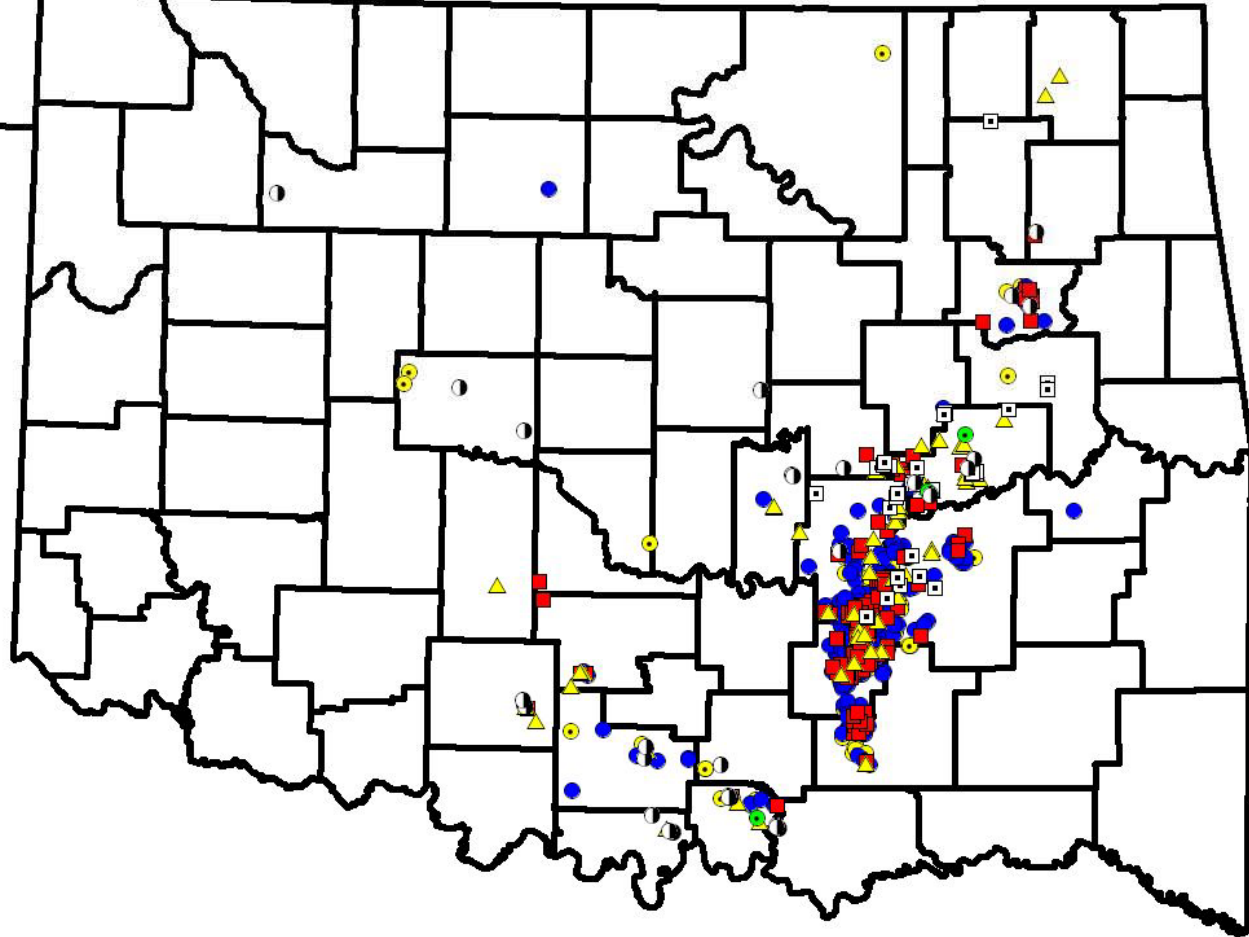
73 Caney Shale

577 Woodford Shale

Updated 8/4/2008

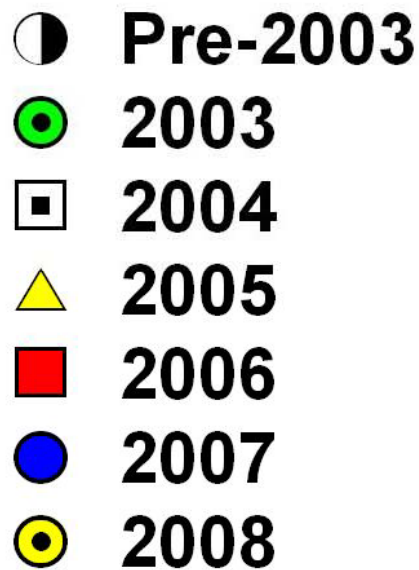
Oklahoma Gas-Shale Wells by Year (1939-2008)

- Pre-2003
- 2003
- 2004
- 2005
- 2006
- 2007
- 2008

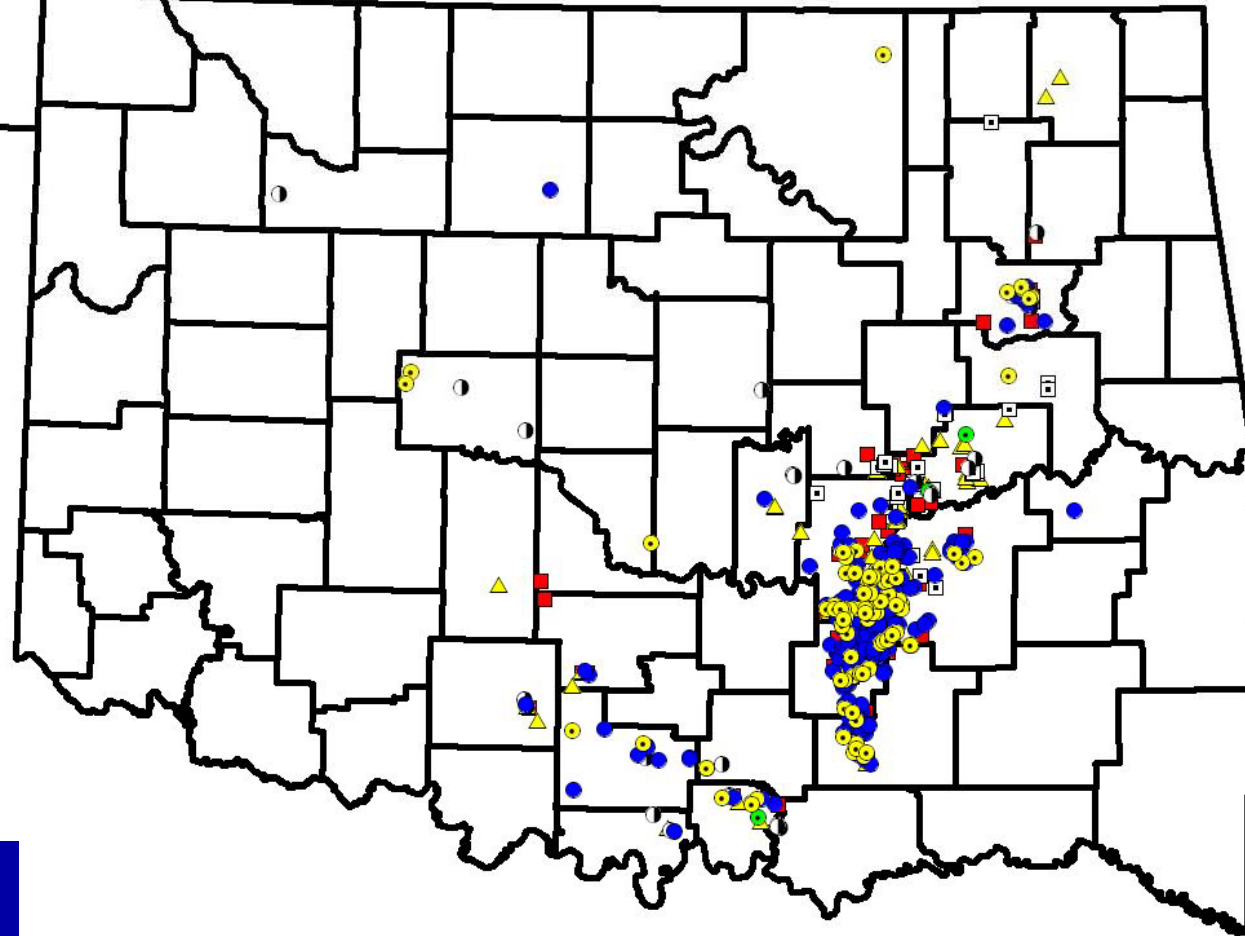


Updated 8/4/2008

Oklahoma Gas-Shale Wells by Year (1939-2008)

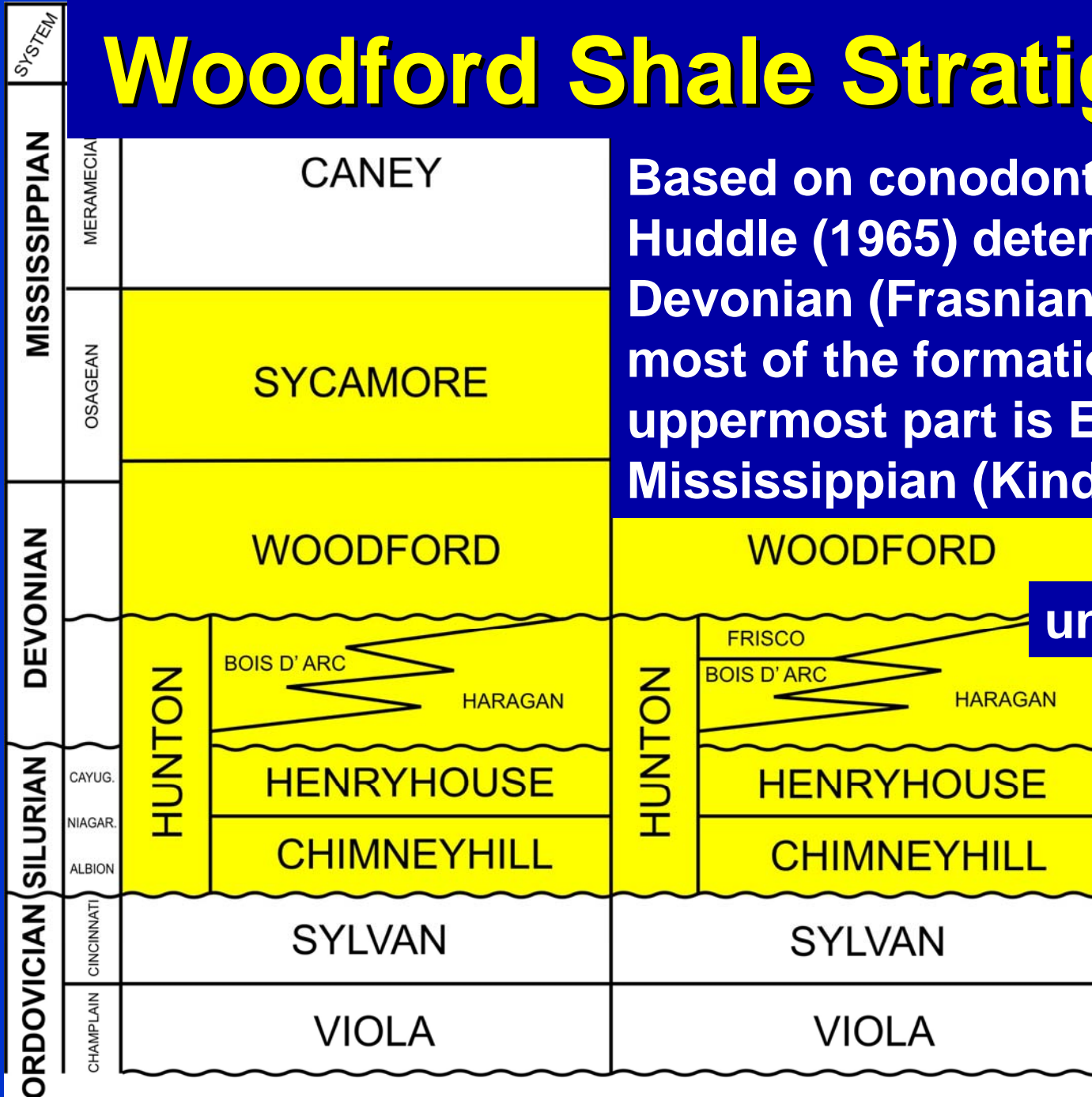


Layered with 2008
Prevalent



Updated 8/4/2008

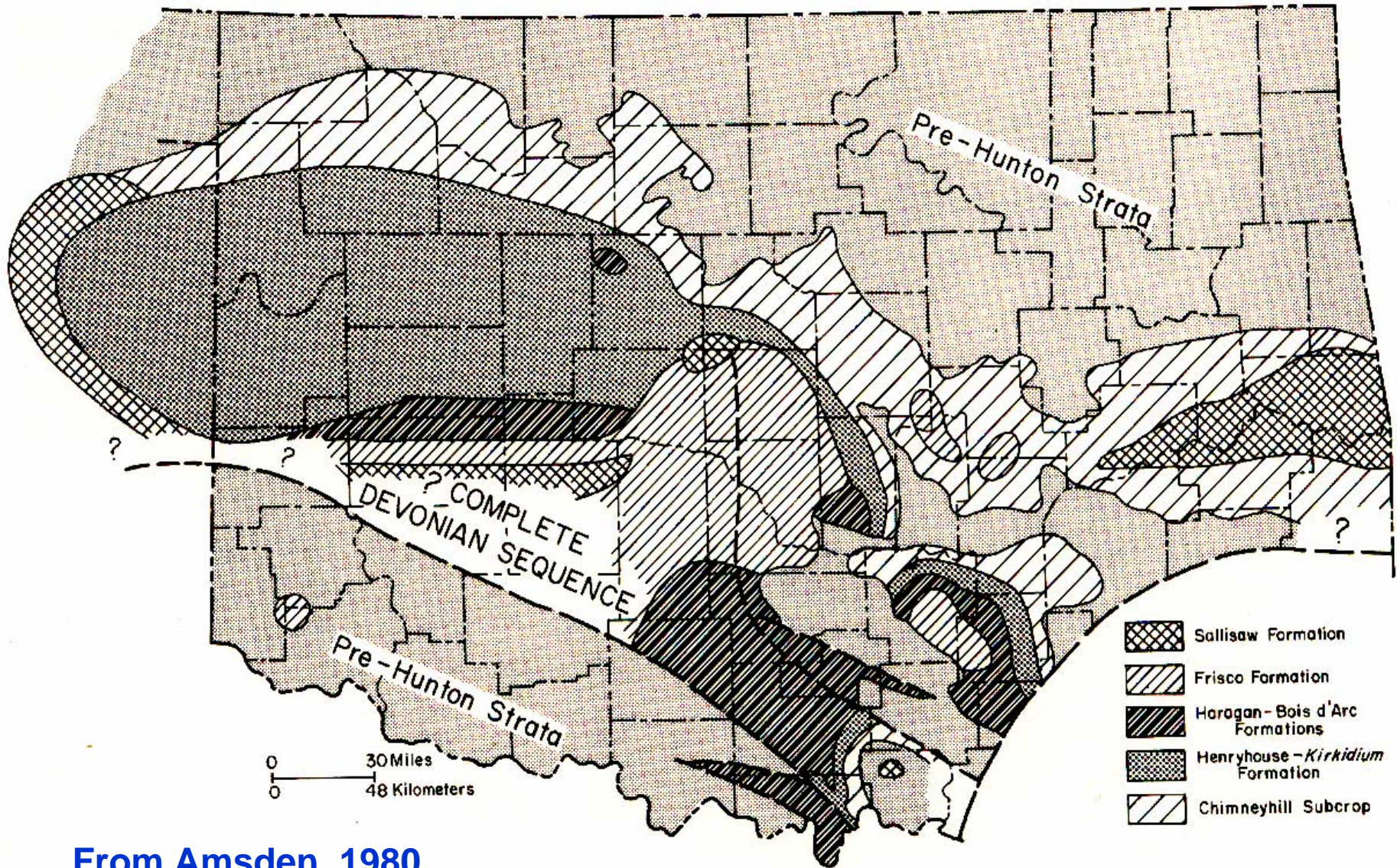
Woodford Shale Stratigraphy



Based on conodonts, Hass and Huddle (1965) determined a Late Devonian (Frasnian) age for most of the formation; uppermost part is Early Mississippian (Kinderhookian)

unconformity

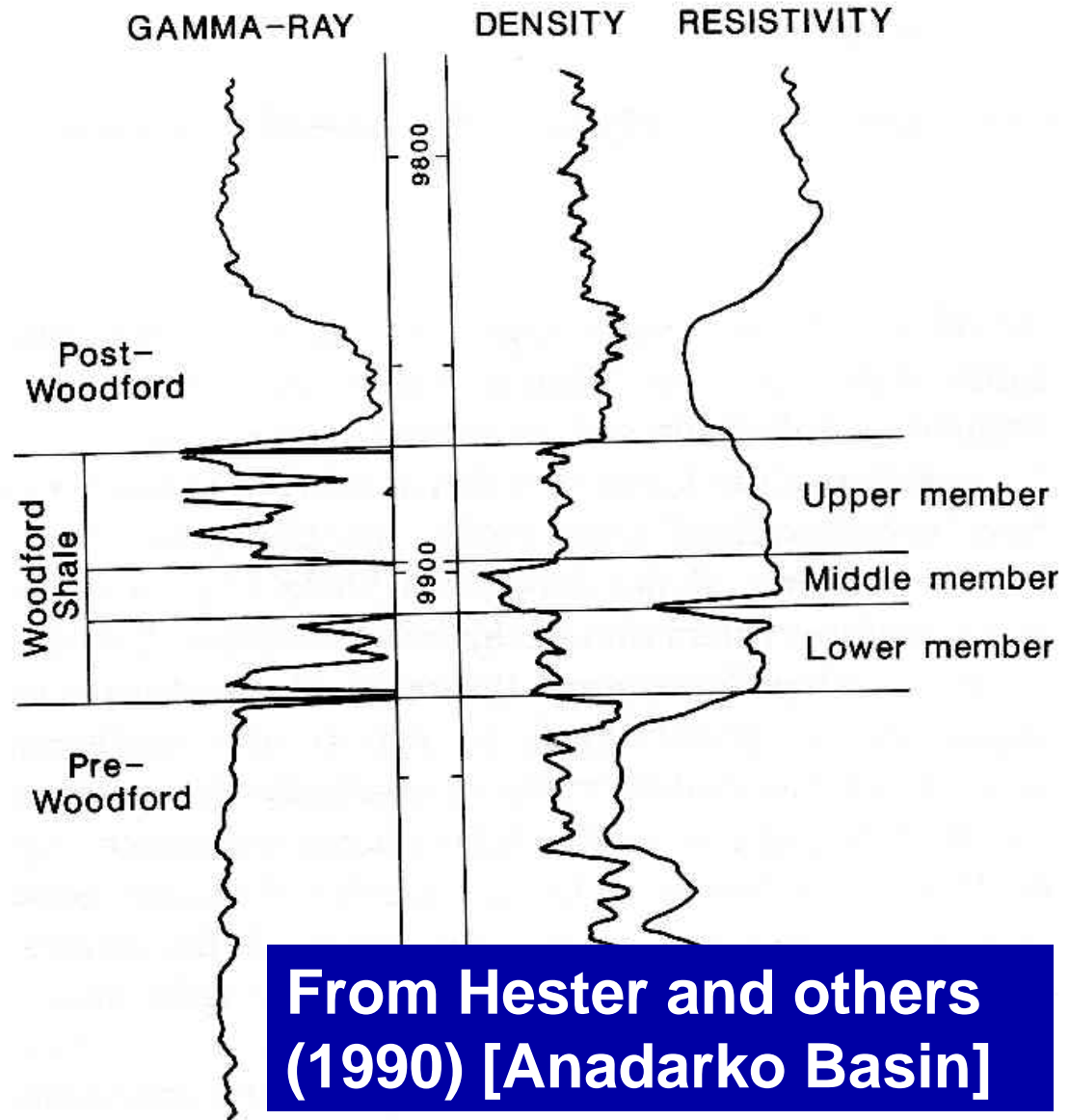
Pre-Woodford Geologic Map



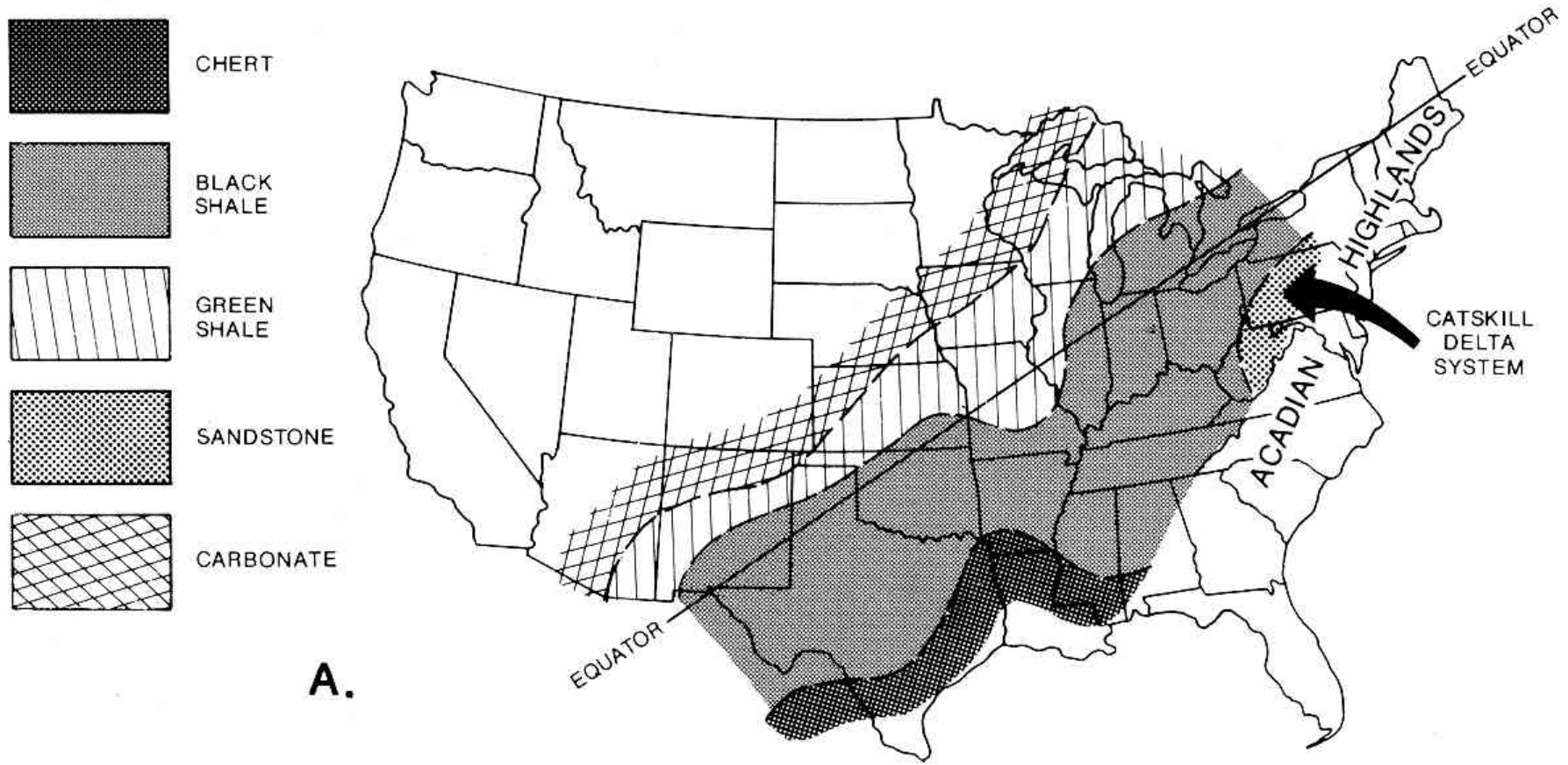
From Amsden, 1980

Woodford Shale Members

Three informal members based on **palynomorphs** (Urban, 1960; Von Almen, 1970), **geochemistry** (Sullivan, 1985), **log signatures** (Hester and others, 1990; Lambert, 1993)

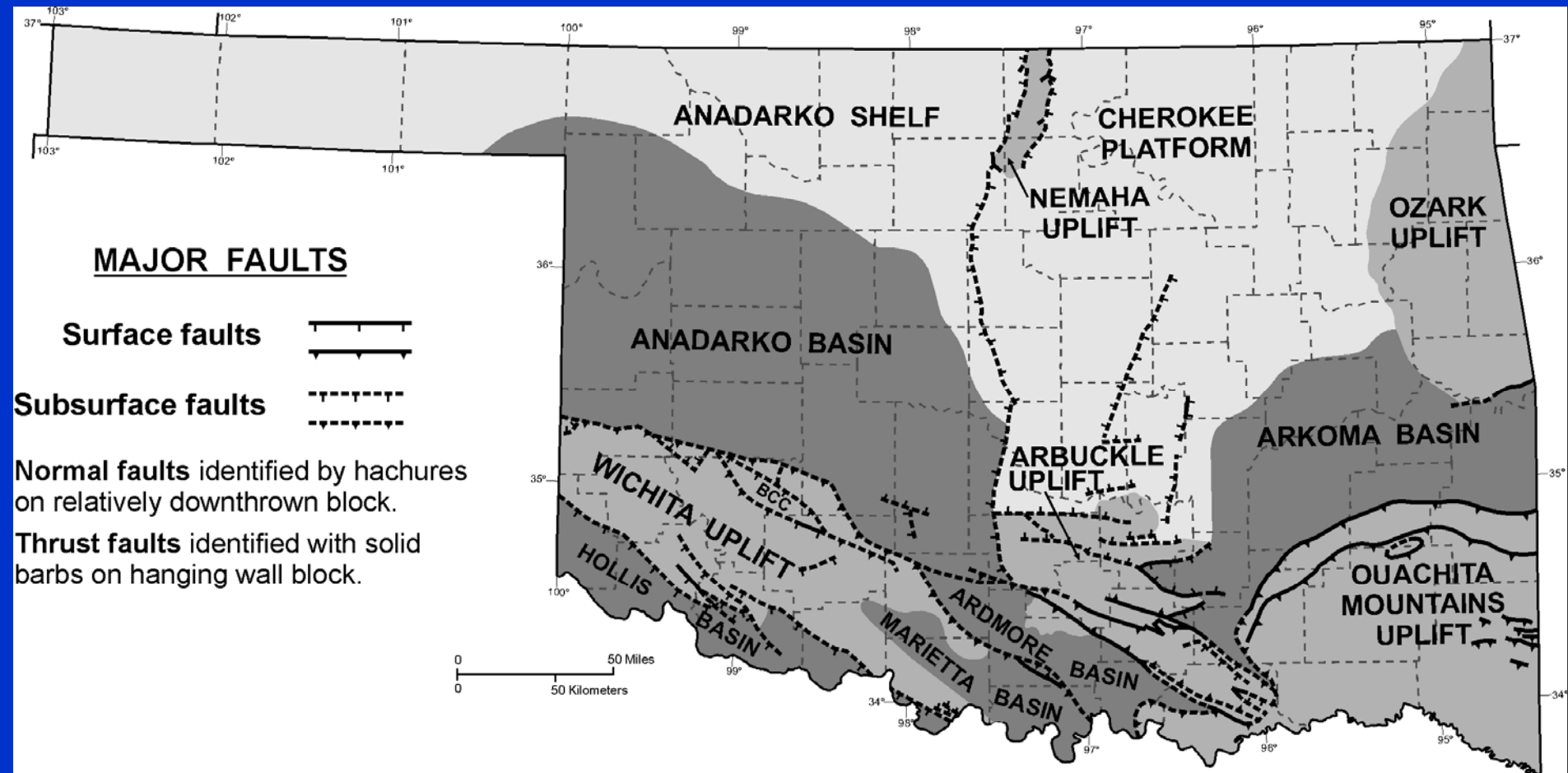


Paleogeography and Facies Distribution in the Late Devonian



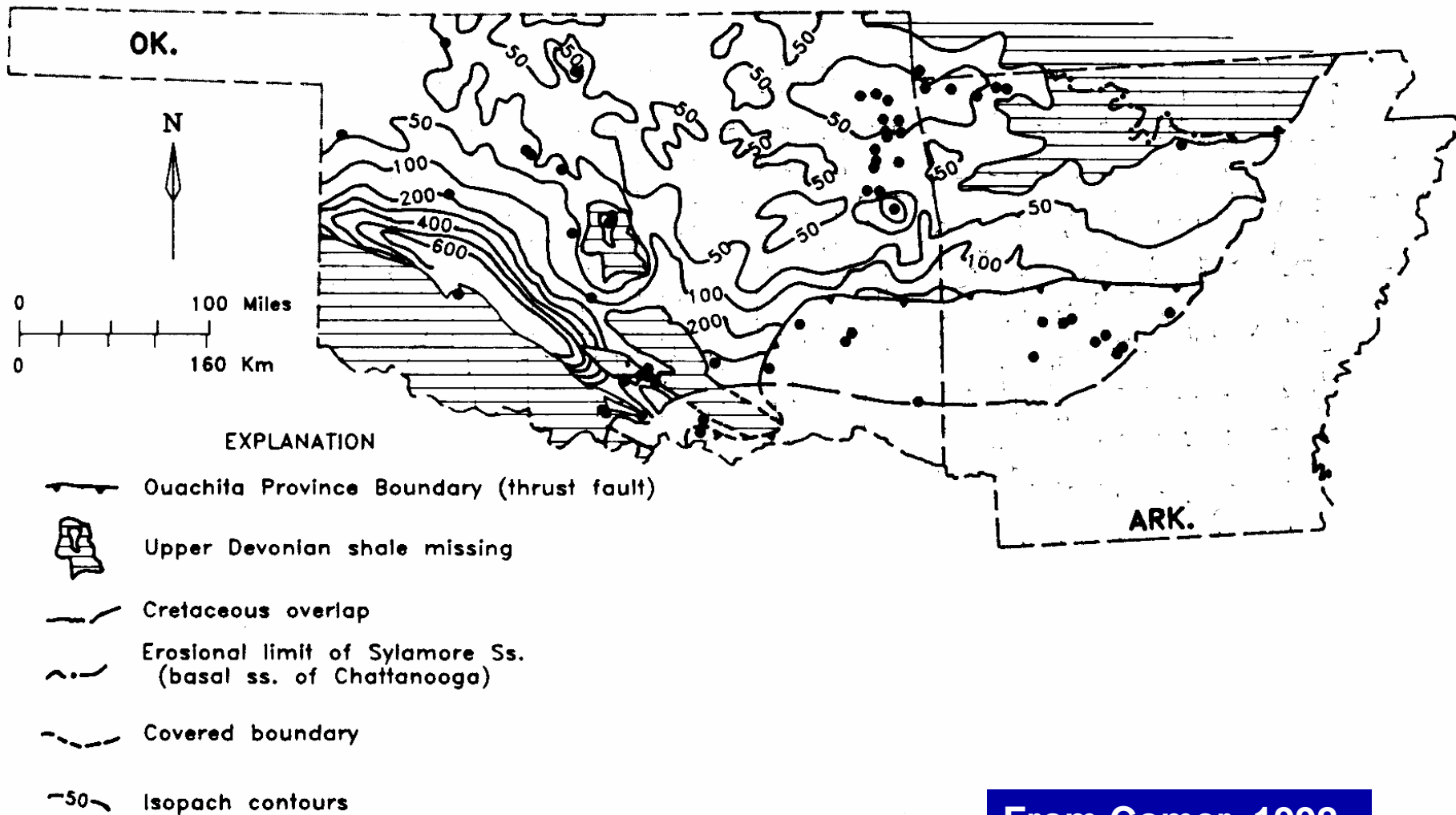
From Kirkland and others, 1992

Geologic Provinces of Oklahoma



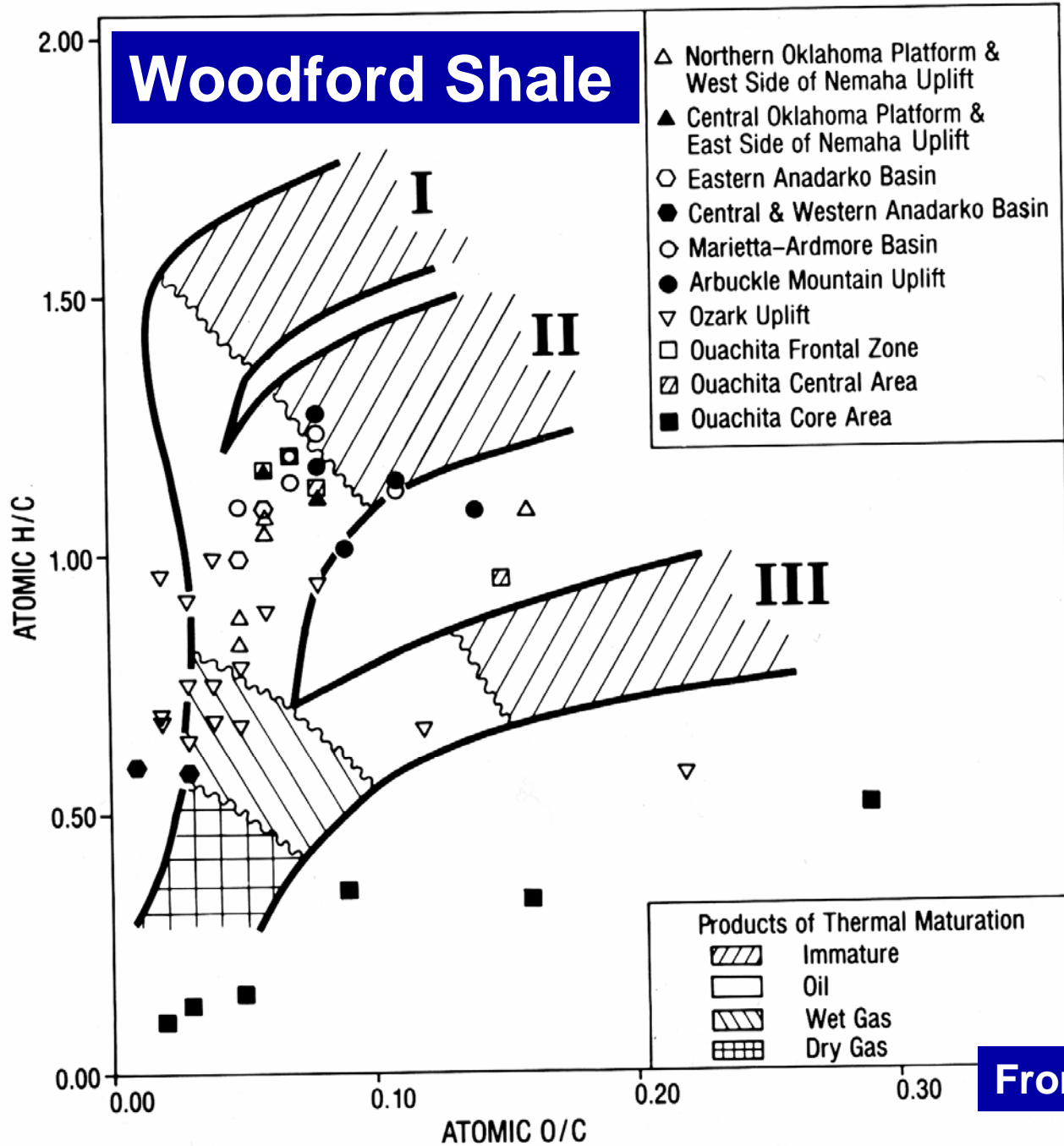
Northcutt and Campbell, 1995

Isopach Map of Woodford Shale



From Comer, 1992

Woodford Shale



From Comer, 1992

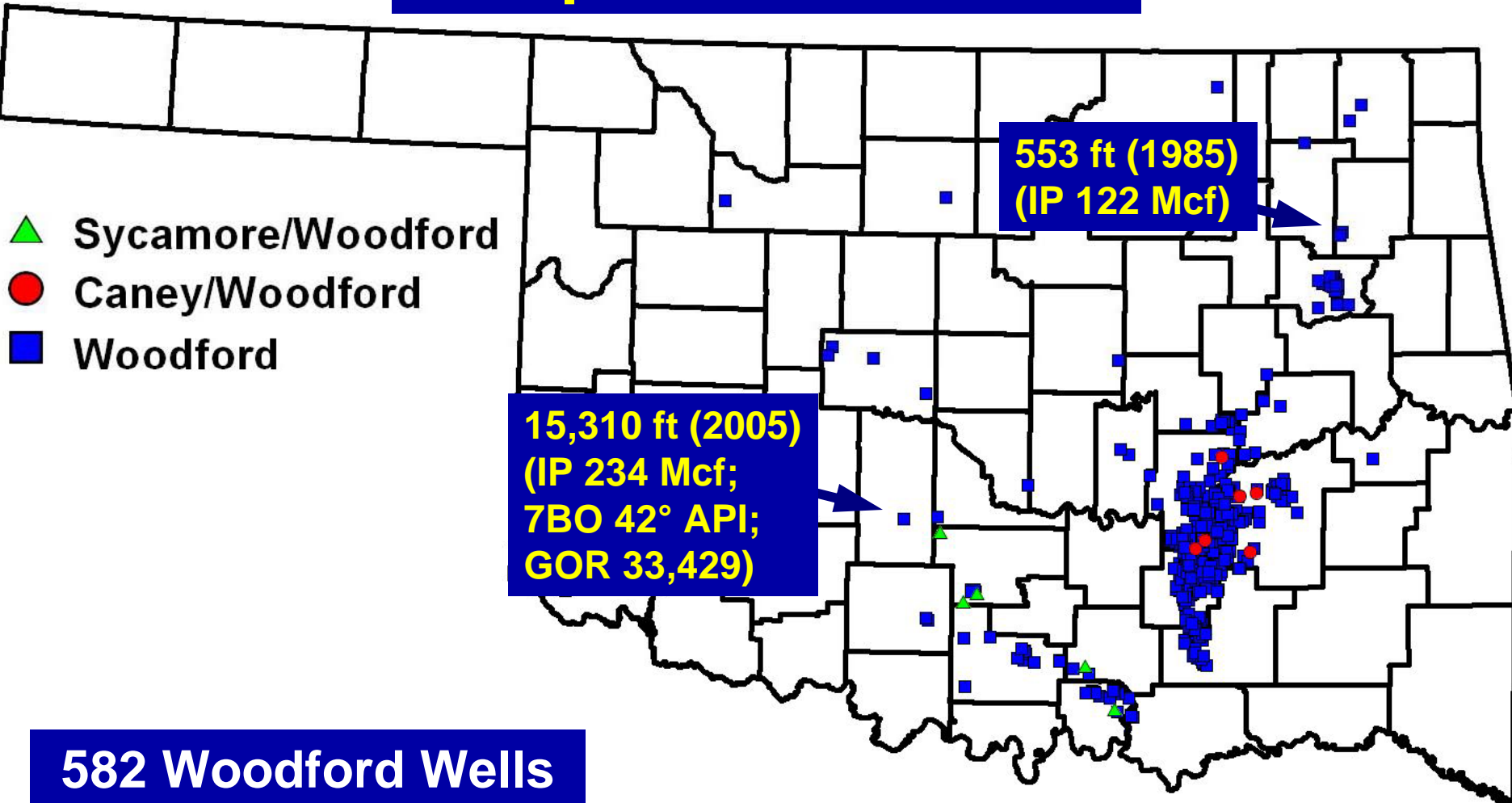
Woodford Mineralogy

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

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

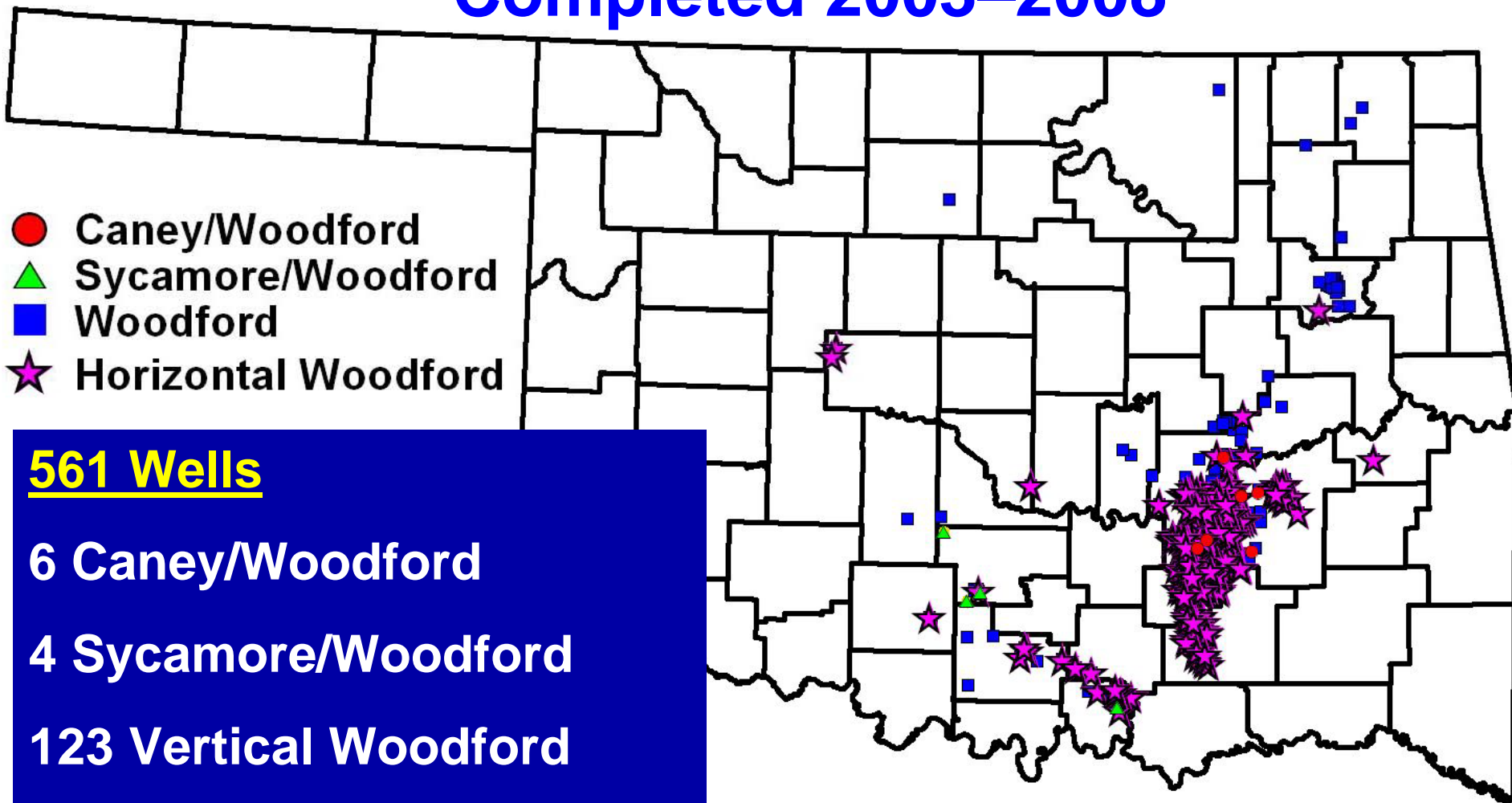
Woodford Gas-Shale Wells

Completed 1939-2008



Woodford Gas-Shale Wells

Completed 2003–2008



561 Wells

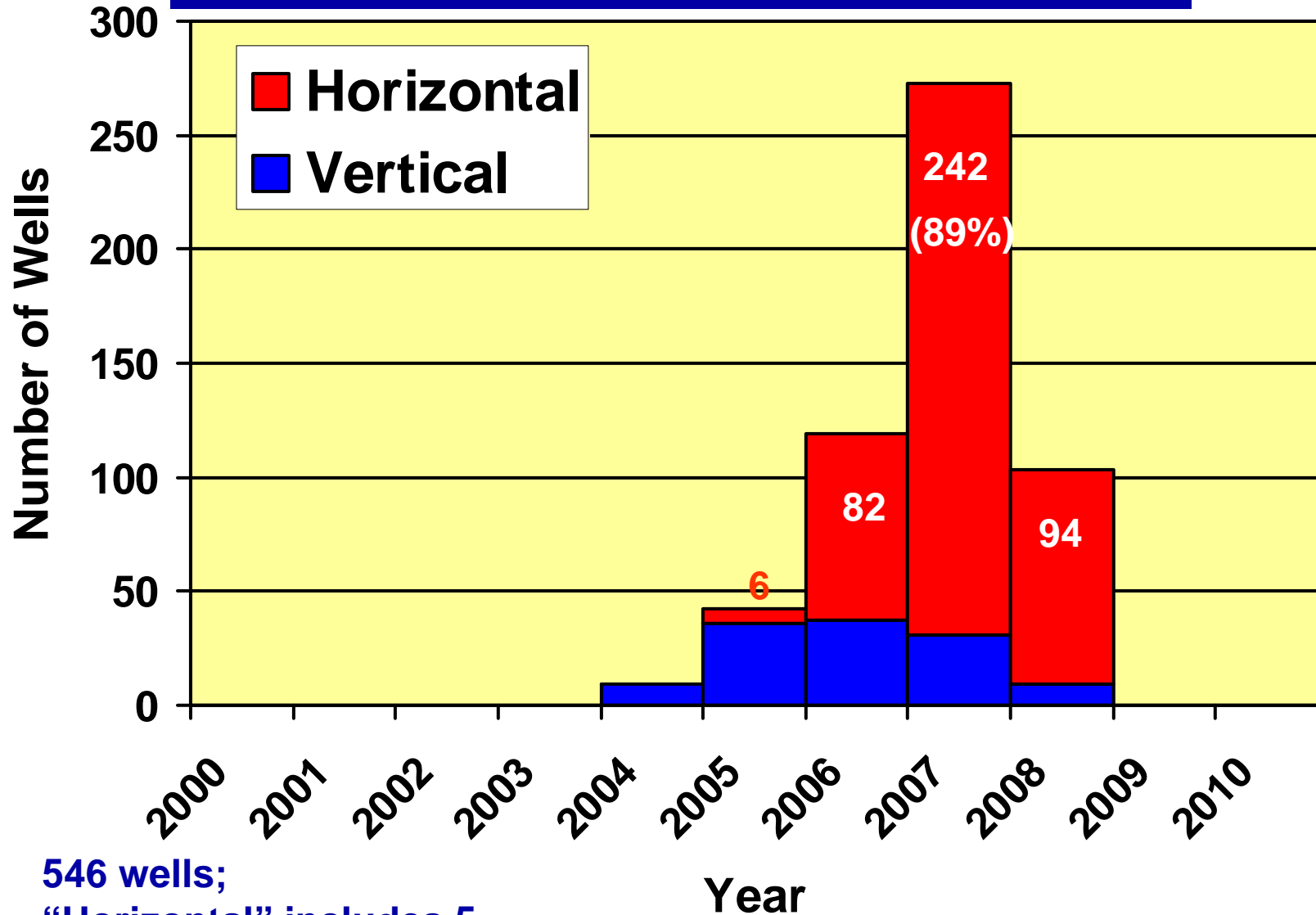
6 Caney/Woodford

4 Sycamore/Woodford

123 Vertical Woodford

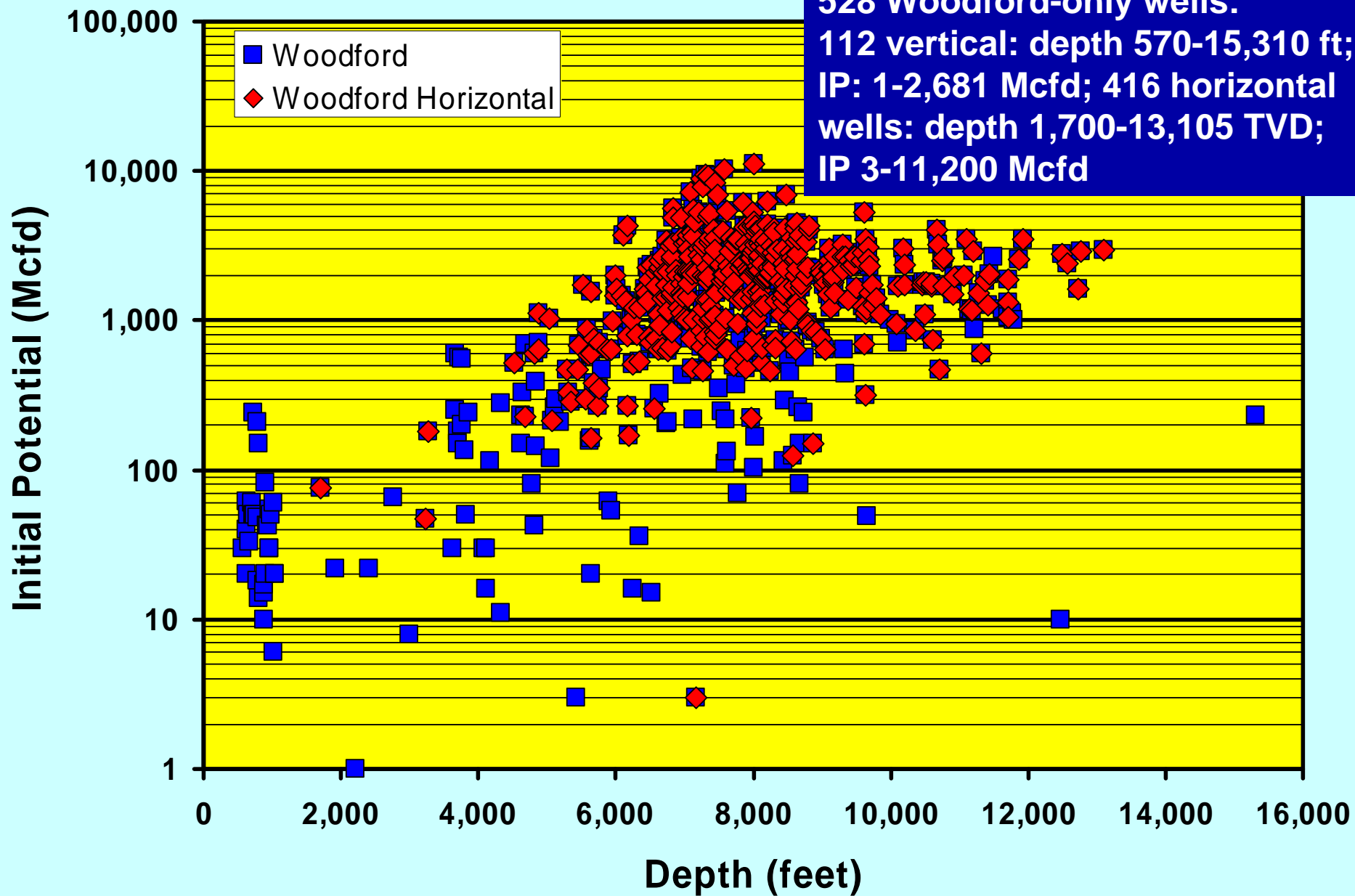
428 Horizontal/Directional
Woodford (76%)

Woodford Shale-Only Wells Completed 2004-2008

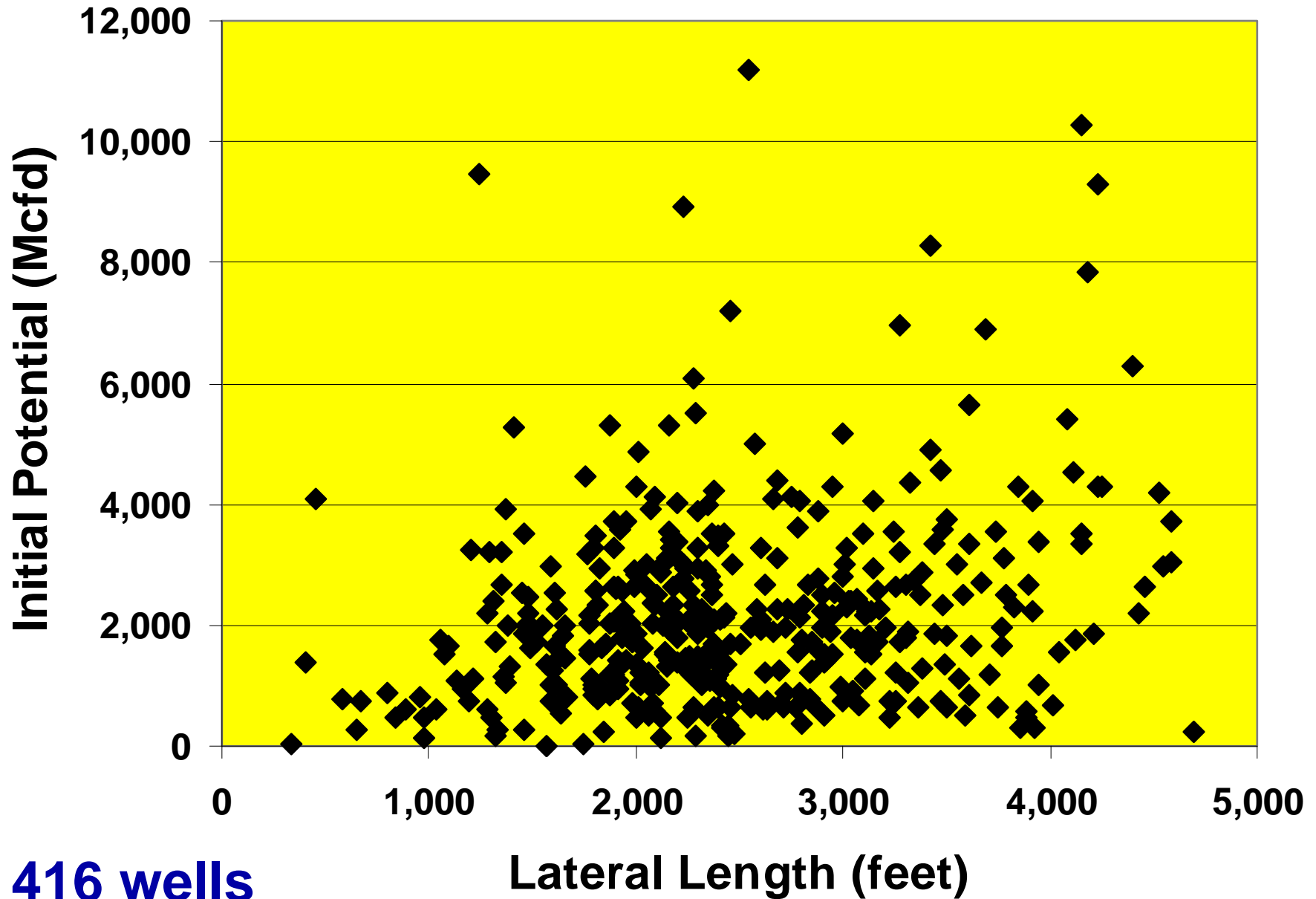


546 wells;
"Horizontal" includes 5
directional wells

Woodford Shale Gas Wells, 2003-2007

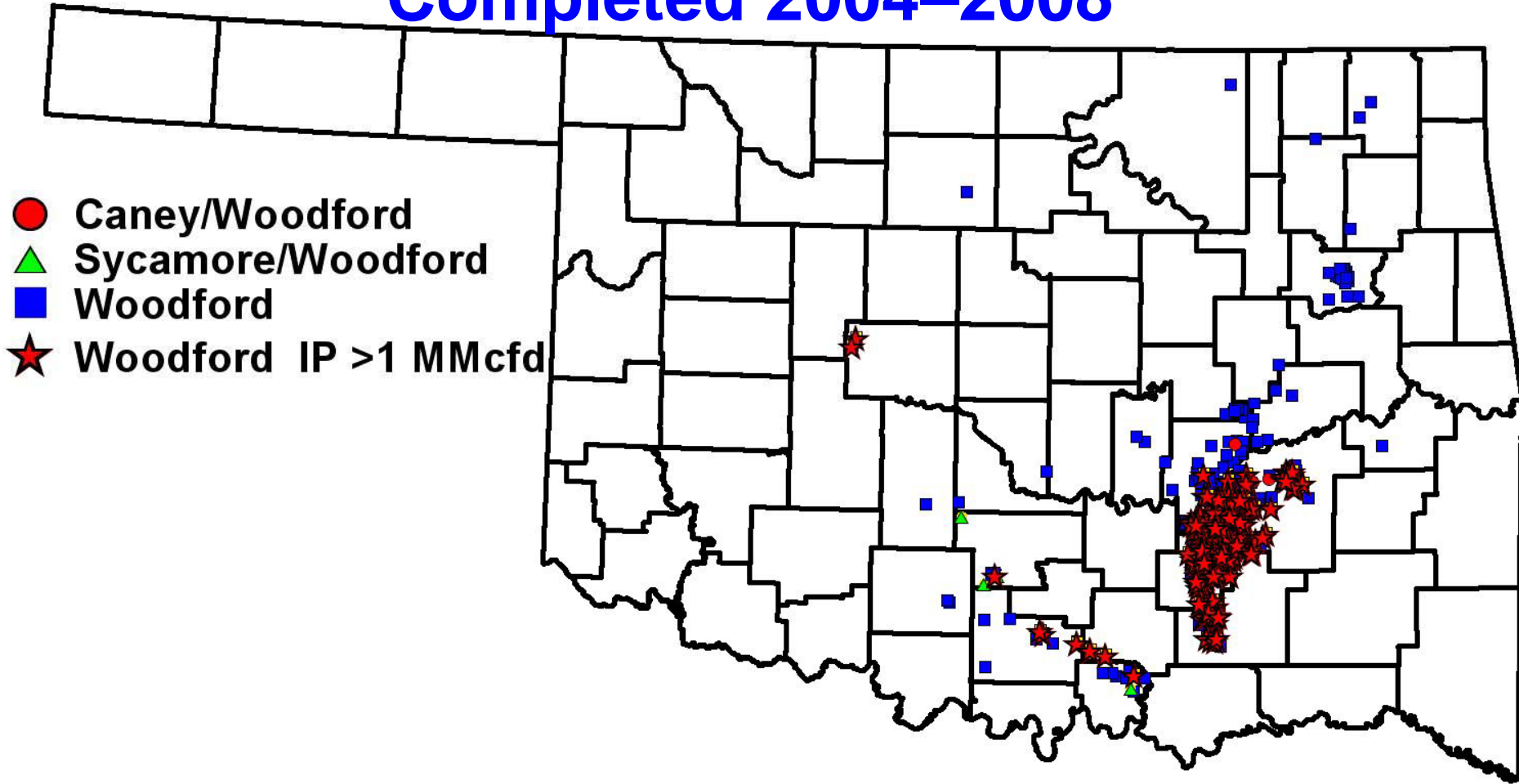


Woodford Shale Horizontal Wells



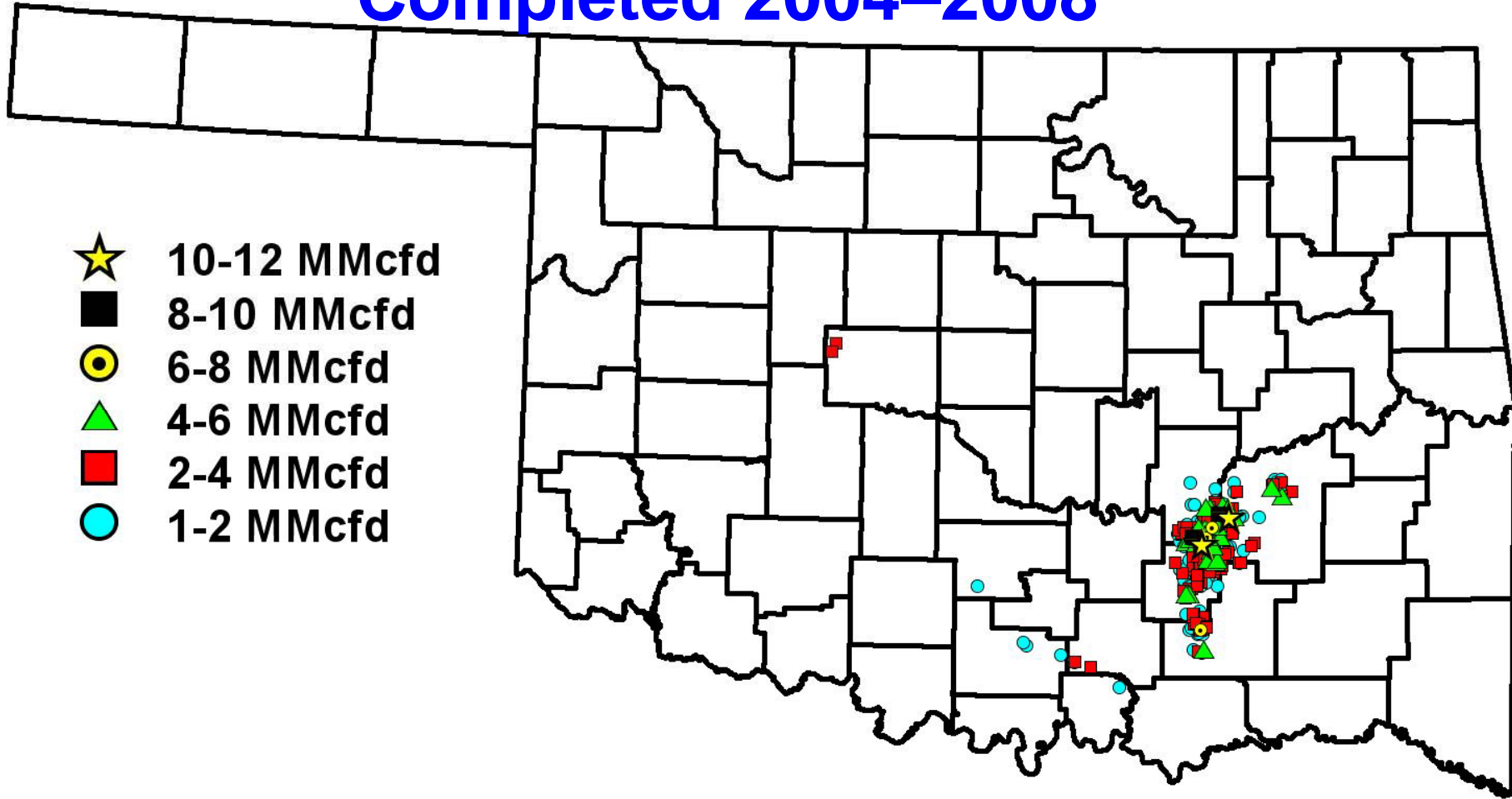
Woodford IP >1 MMcfd

Completed 2004–2008



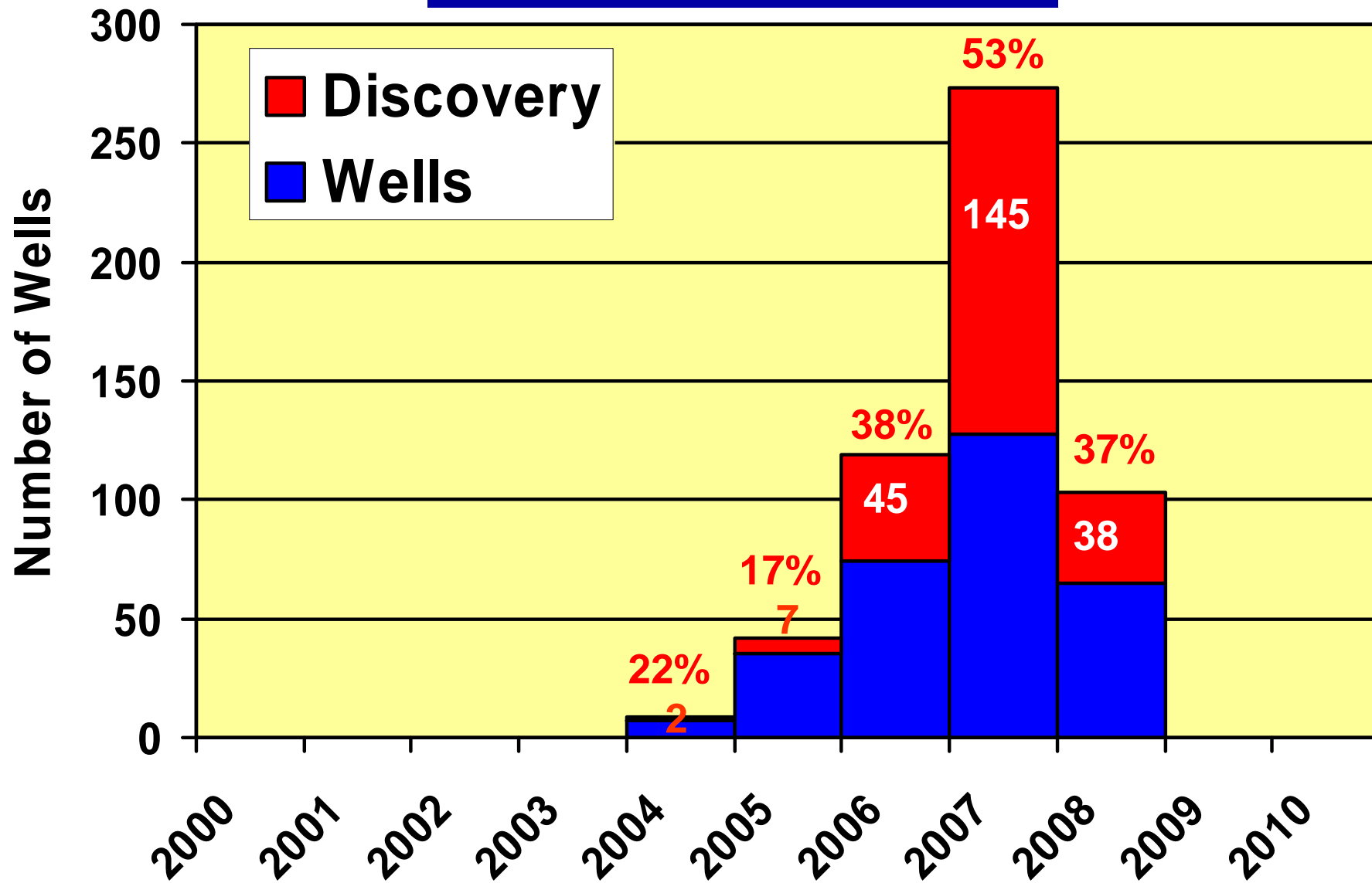
Woodford IP >1 MMcfd

Completed 2004–2008



Woodford Shale Discovery Wells

(New Field or Extension)



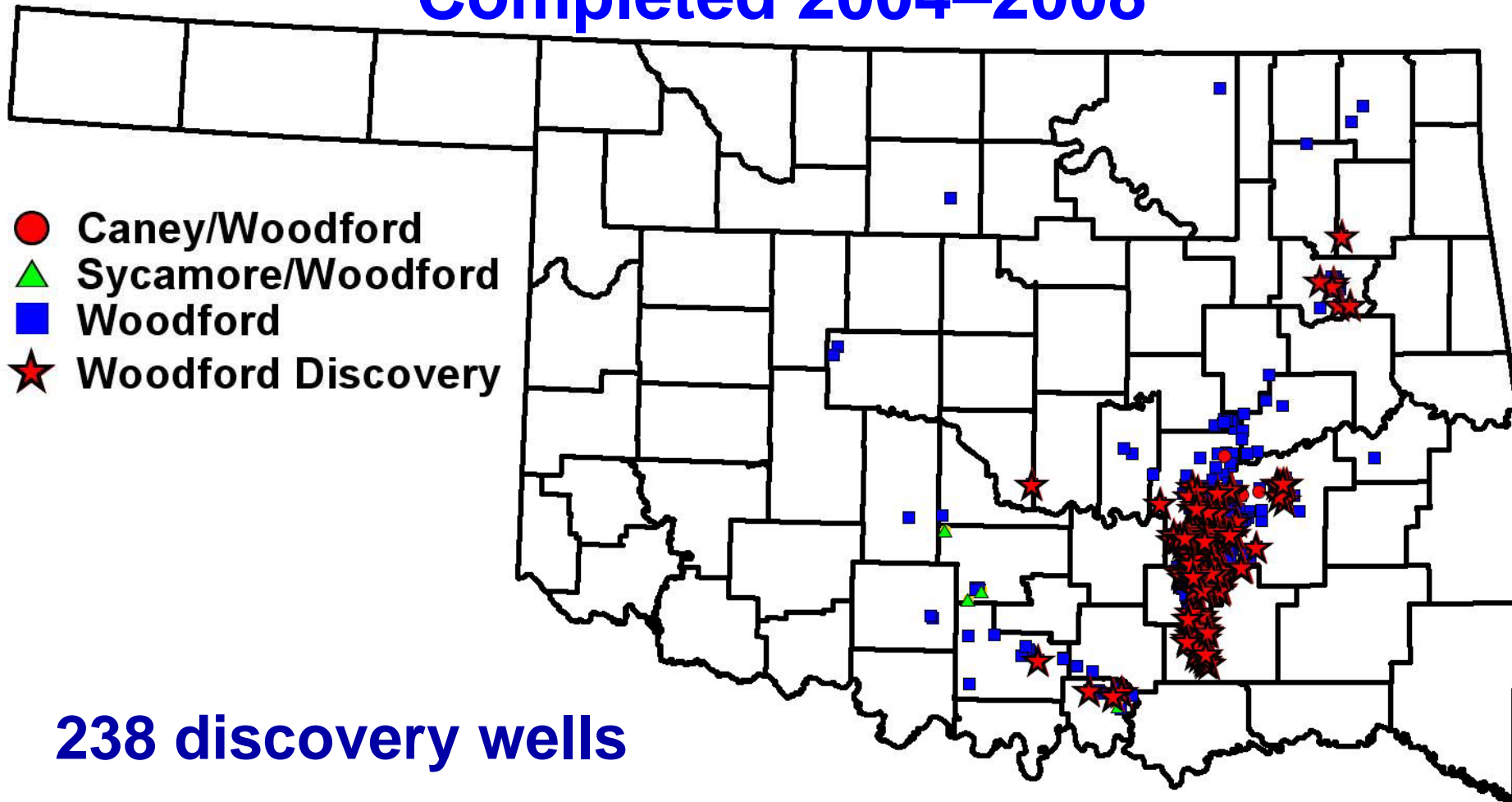
546 Woodford-only Wells

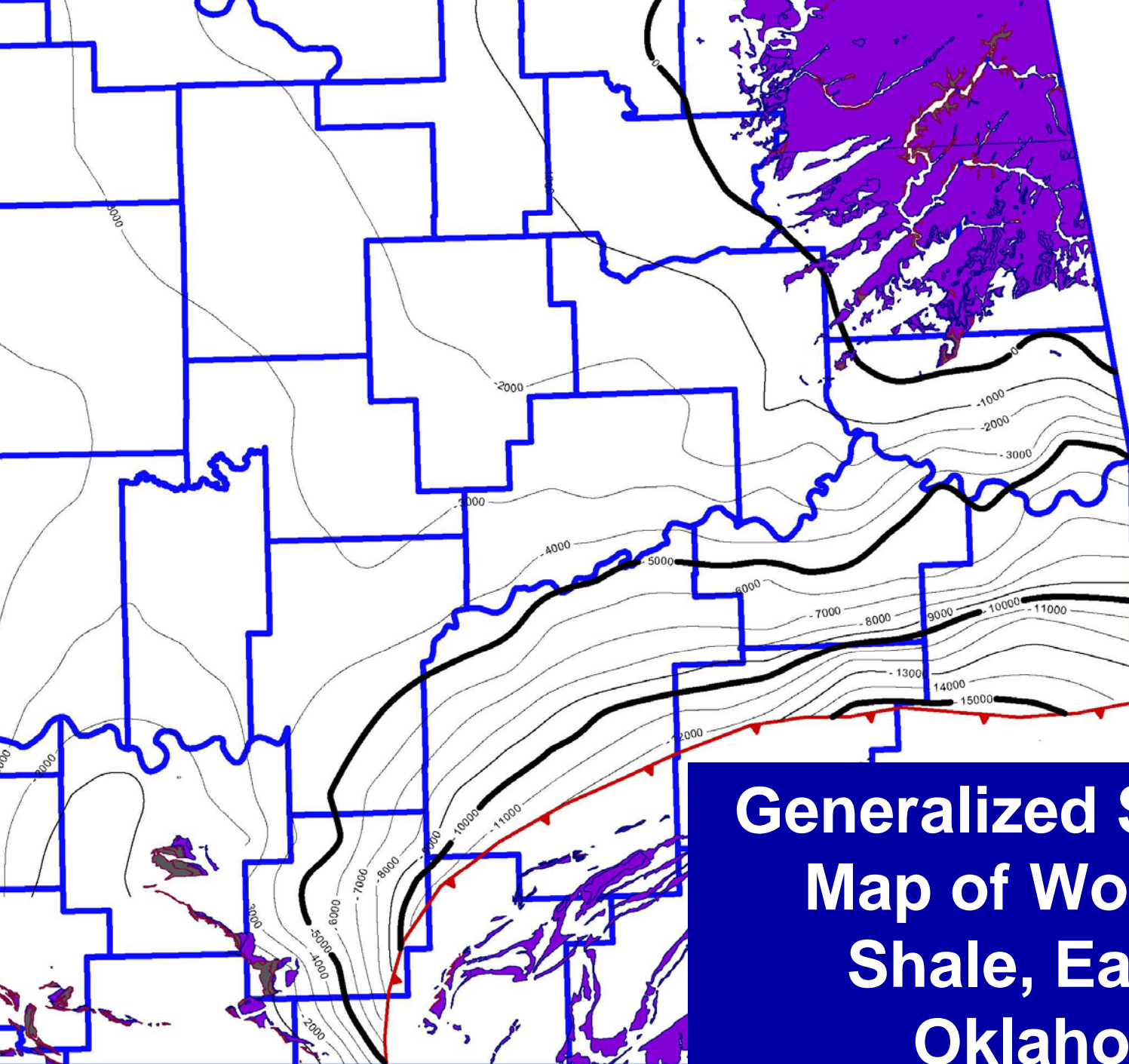
Year

Updated 8/4/2008

Woodford Shale Discovery Wells

Completed 2004–2008





Map prepared
by R. Vance
Hall using
Petra

Generalized Structure Map of Woodford Shale, Eastern Oklahoma

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%

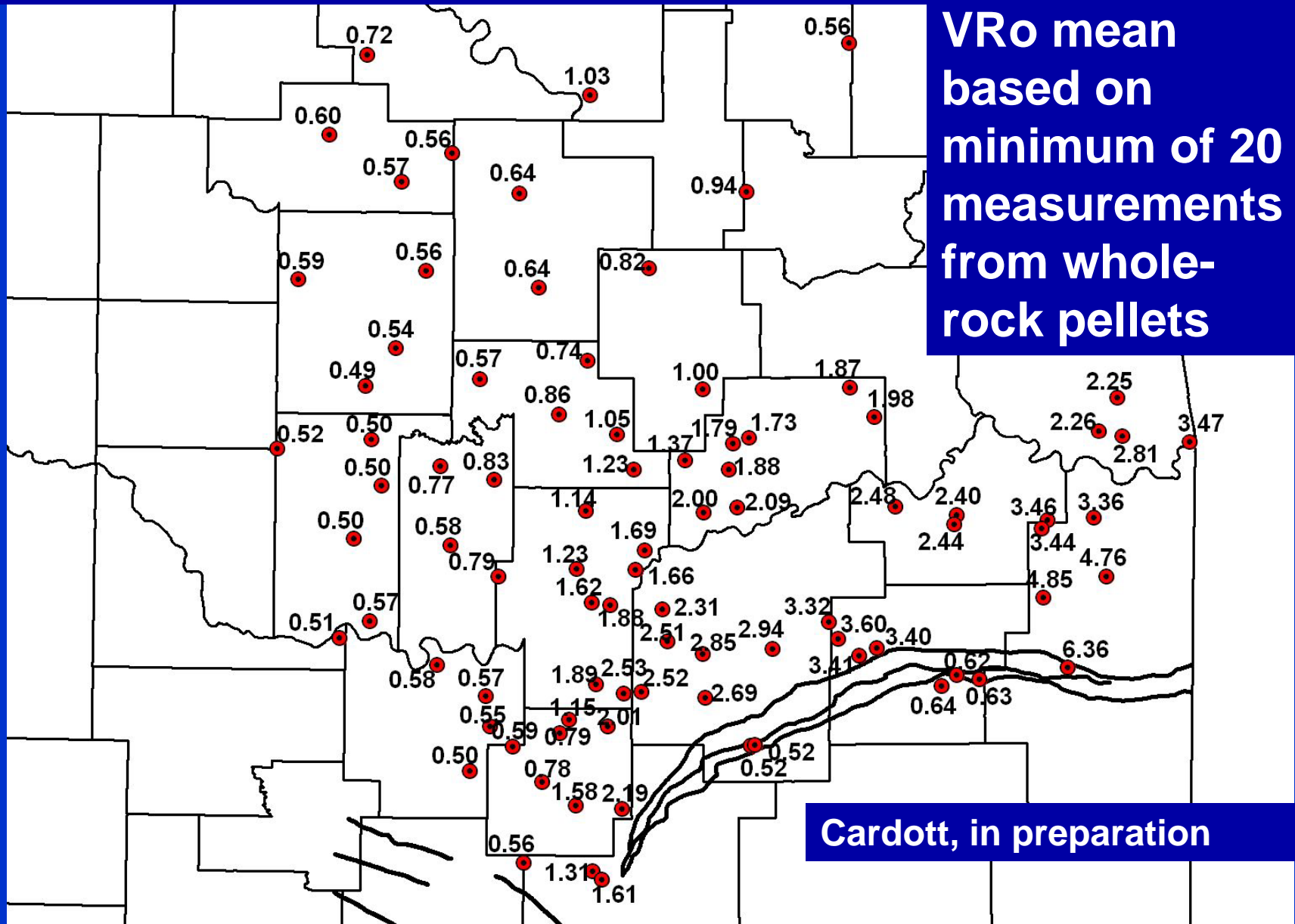
Condensate–Wet-
Gas Window

>1.40%

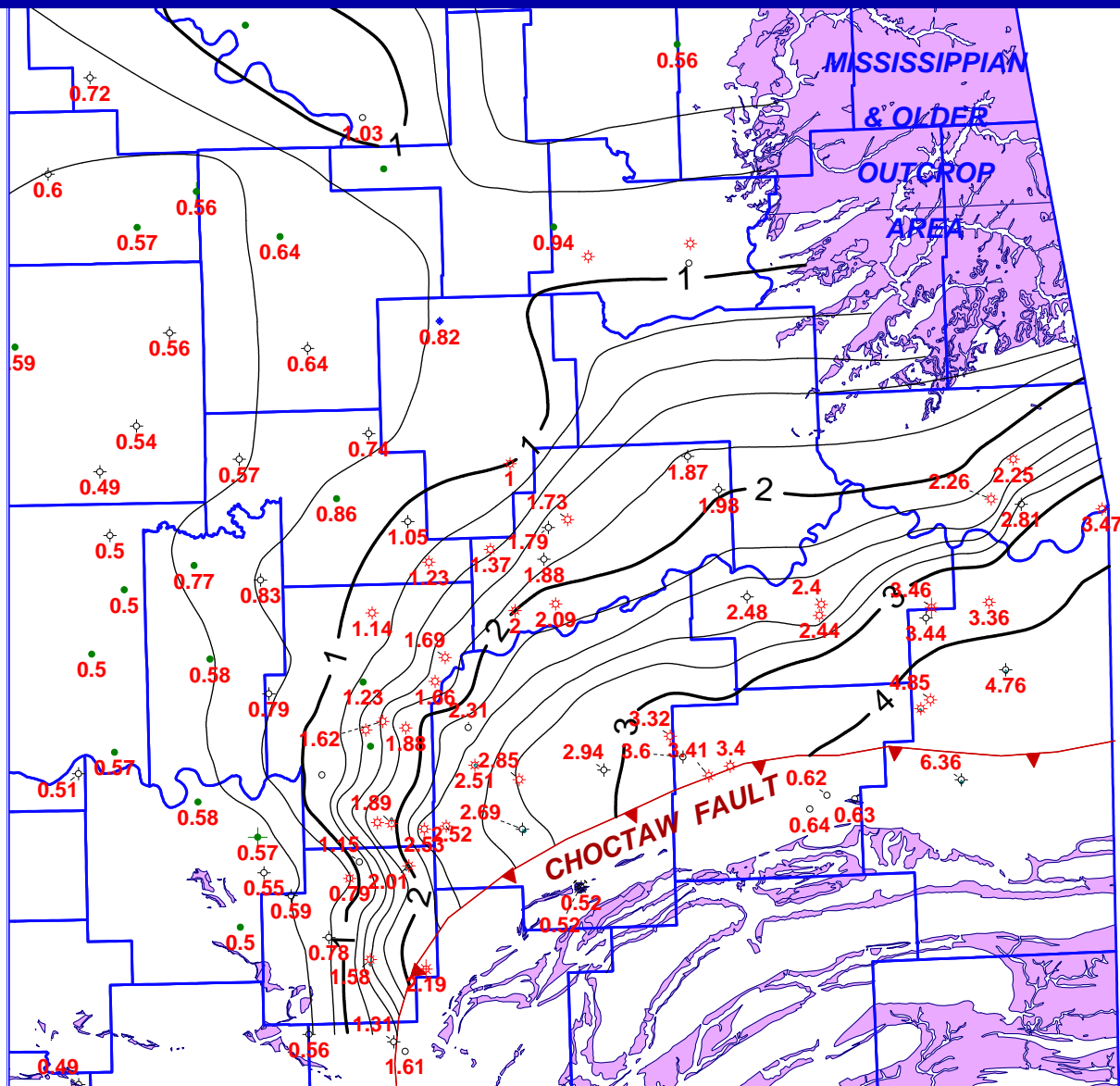
Dry-Gas Window

From Jarvie and others, 2005

Vitrinite Reflectance of Woodford Shale, Eastern Oklahoma

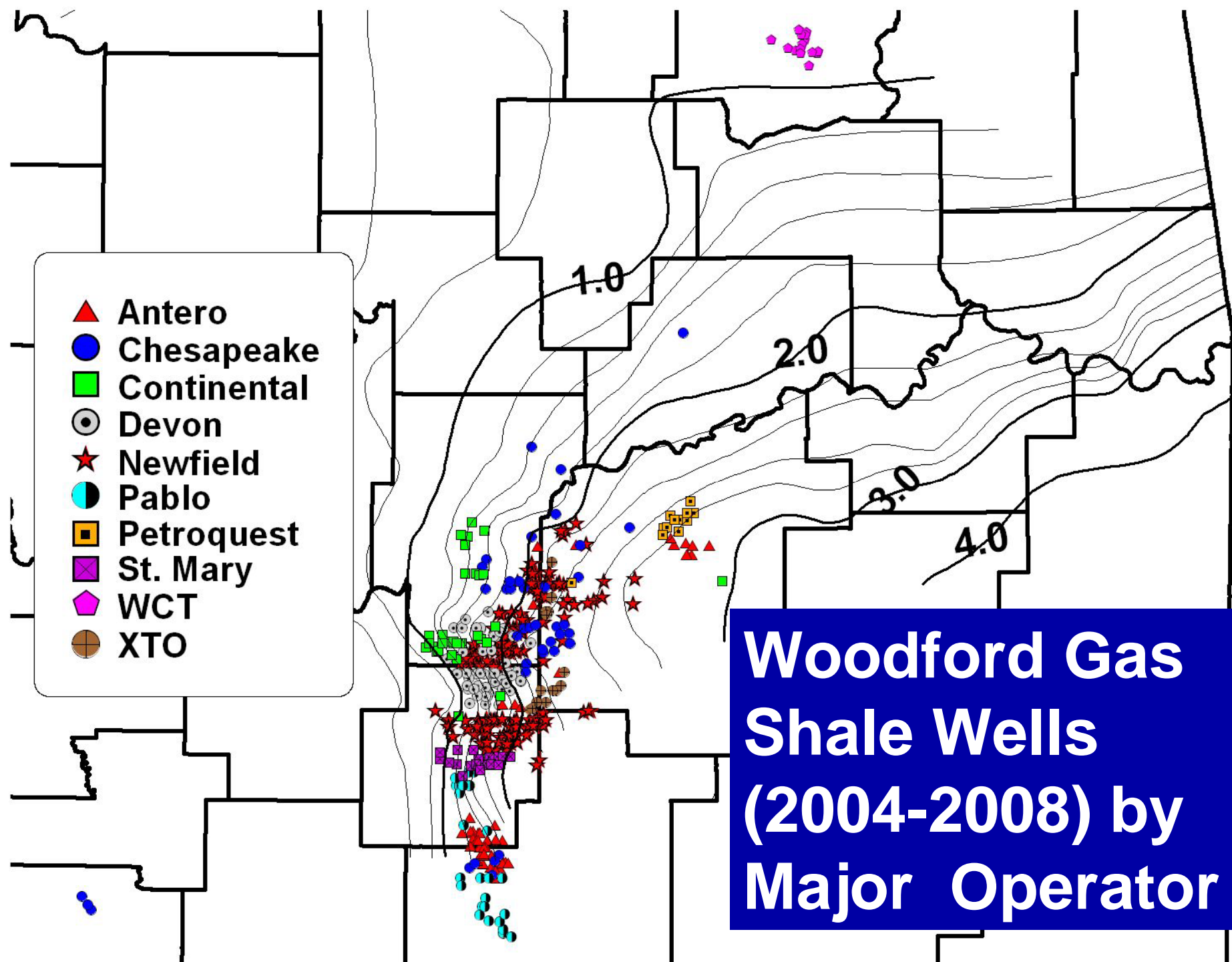


Isoreflectance Map of the Woodford Shale in Eastern Oklahoma



Map prepared by R. Vance Hall using Petra

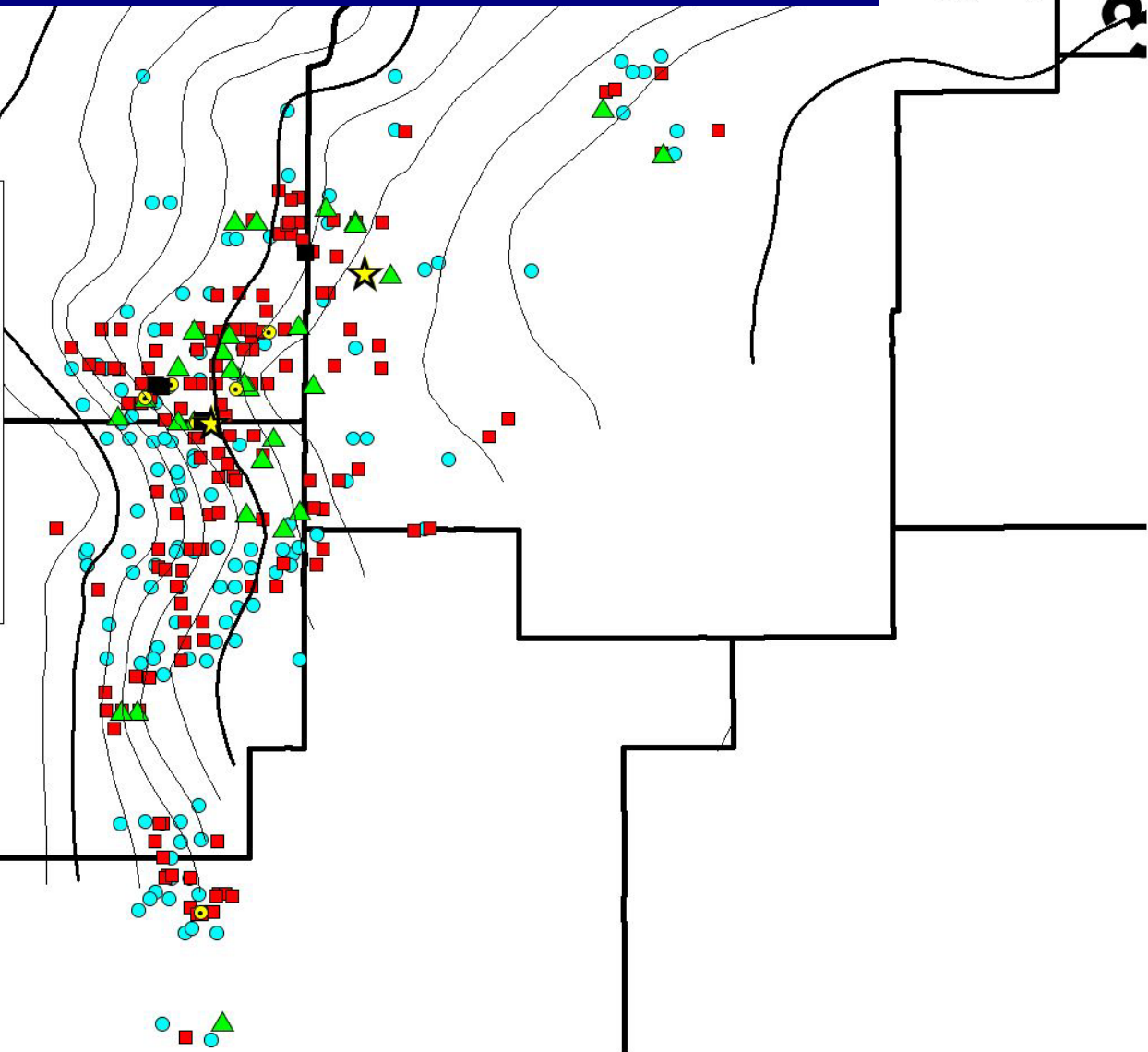
Cardott, in preparation



- ▲ Antero
- Chesapeake
- Continental
- ⊙ Devon
- ★ Newfield
- Pablo
- Petroquest
- St. Mary
- ◆ WCT
- XTO

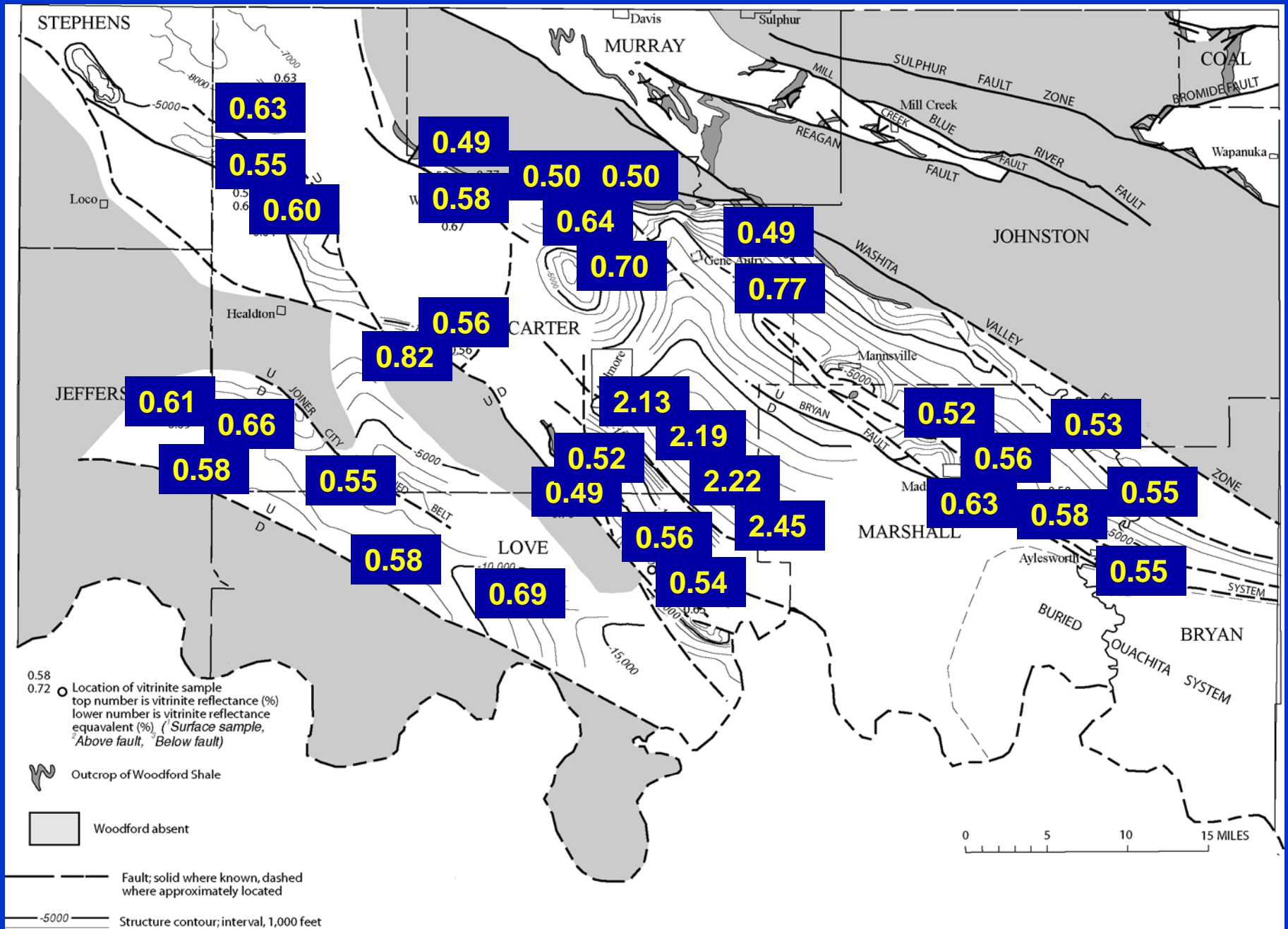
**Woodford Gas
Shale Wells
(2004-2008) by
Major Operator**

Woodford IP >1 MMcfd on Isoreflectance Map

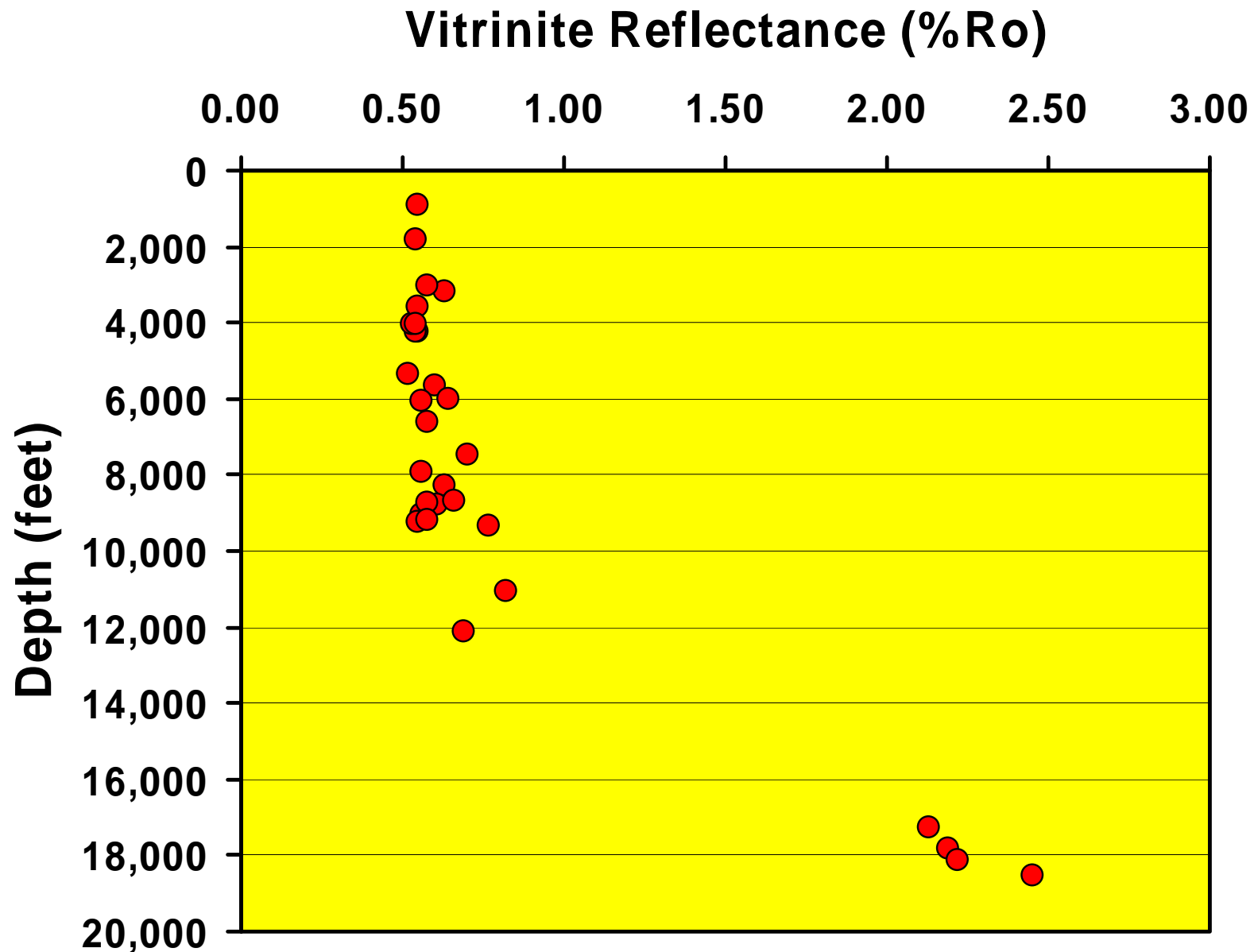


Woodford Gas-Shale Play is primarily in eastern Oklahoma (western Arkoma Basin) where the shale is:

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



Southern Oklahoma VRo vs Depth



Woodford Gas Shales

1939-1996



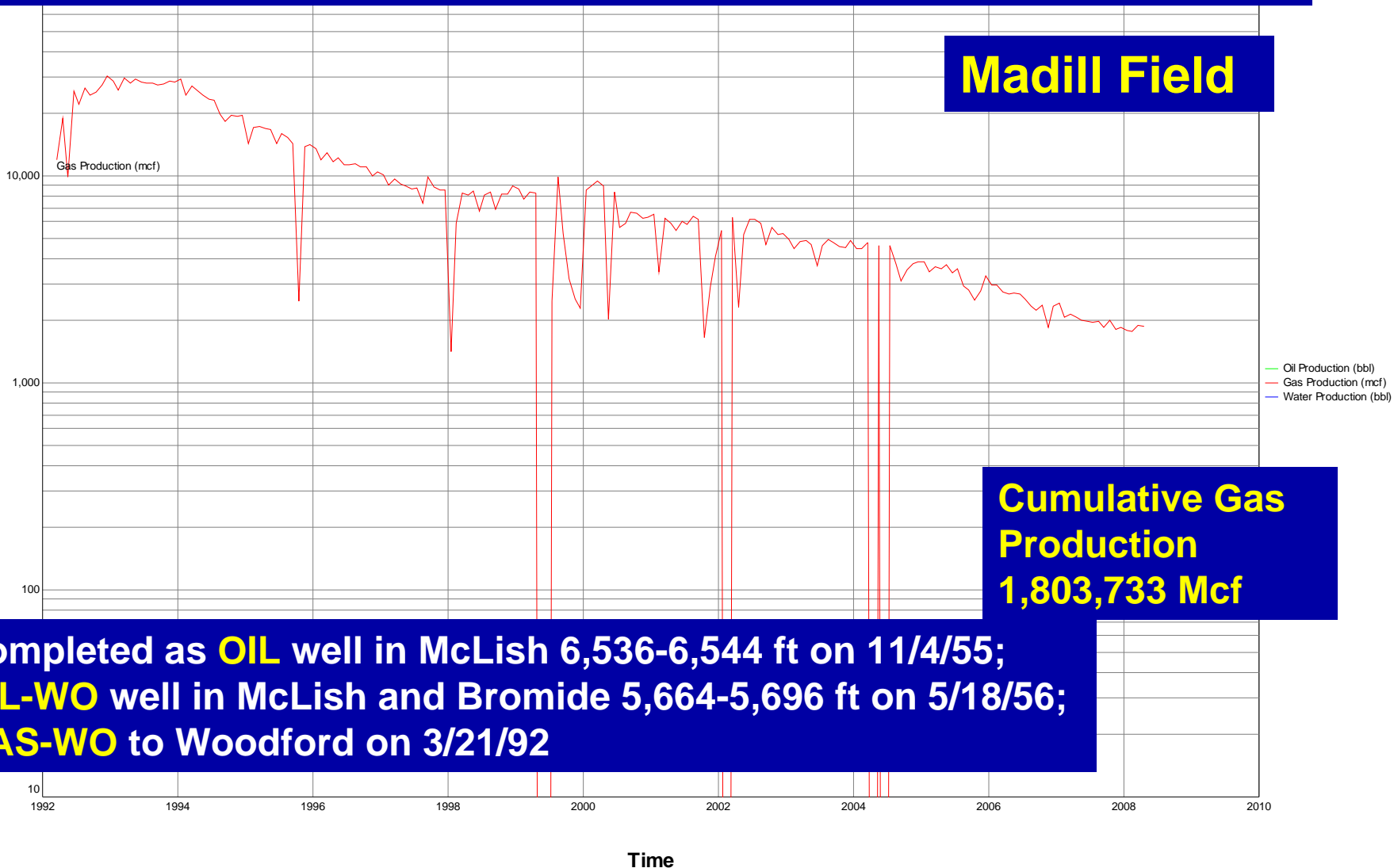
21 Wells

1 Sycamore/Woodford

Cimarex Energy 3 Griffin-Olmstead (Marshall CO, 16-5S-5E; IP 747 Mcfd; 4,052-4,135 ft)

Madill Field

**Average Monthly
Production (Mcf)**

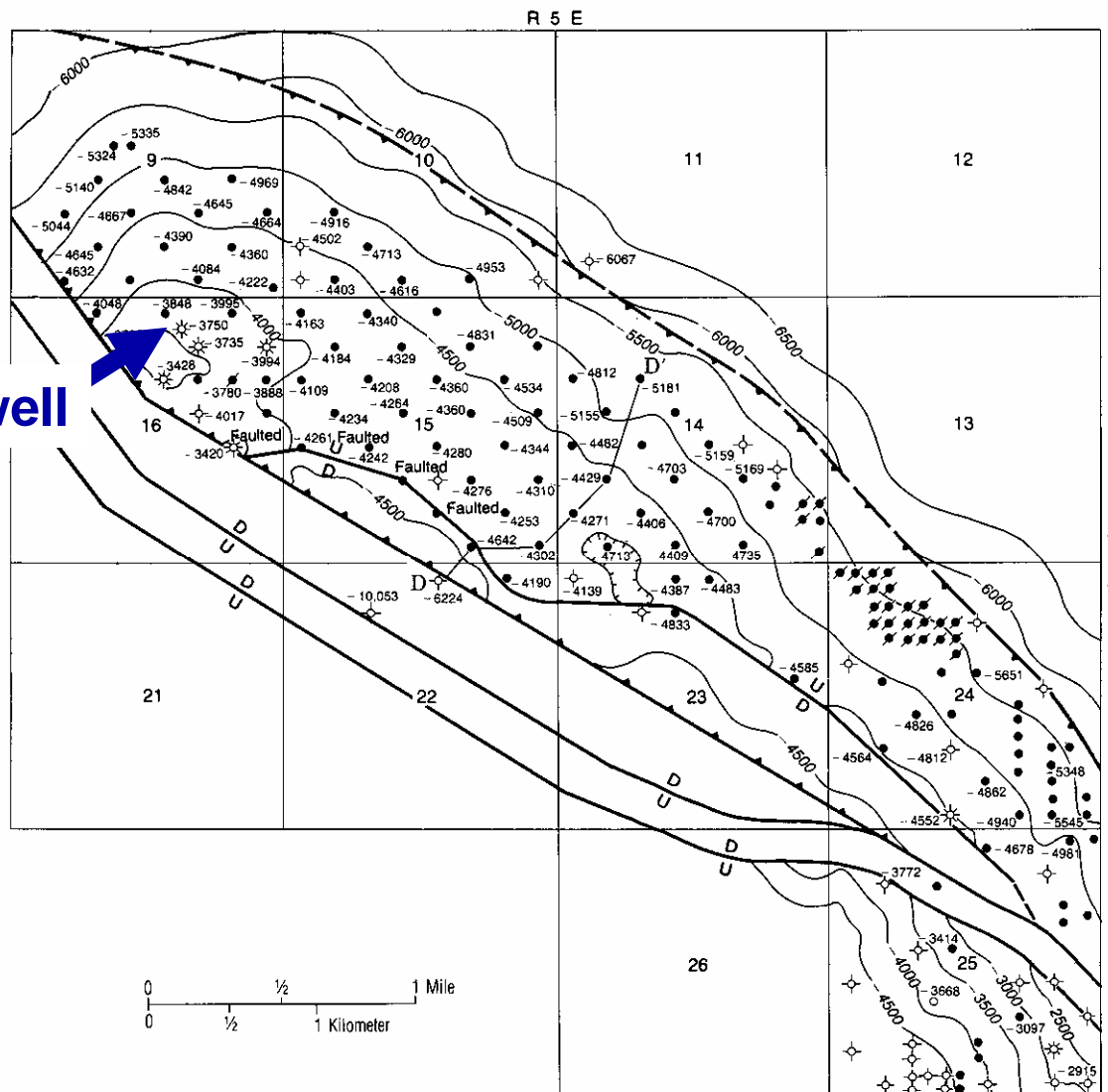


**Cumulative Gas
Production
1,803,733 Mcf**

Completed as **OIL** well in McLish 6,536-6,544 ft on 11/4/55;
OIL-WO well in McLish and Bromide 5,664-5,696 ft on 5/18/56;
GAS-WO to Woodford on 3/21/92

(Gas production data supplied by Petroleum
Information/Dwights LLC dba IHS Energy Group,
© 2007, IHS Energy Group)

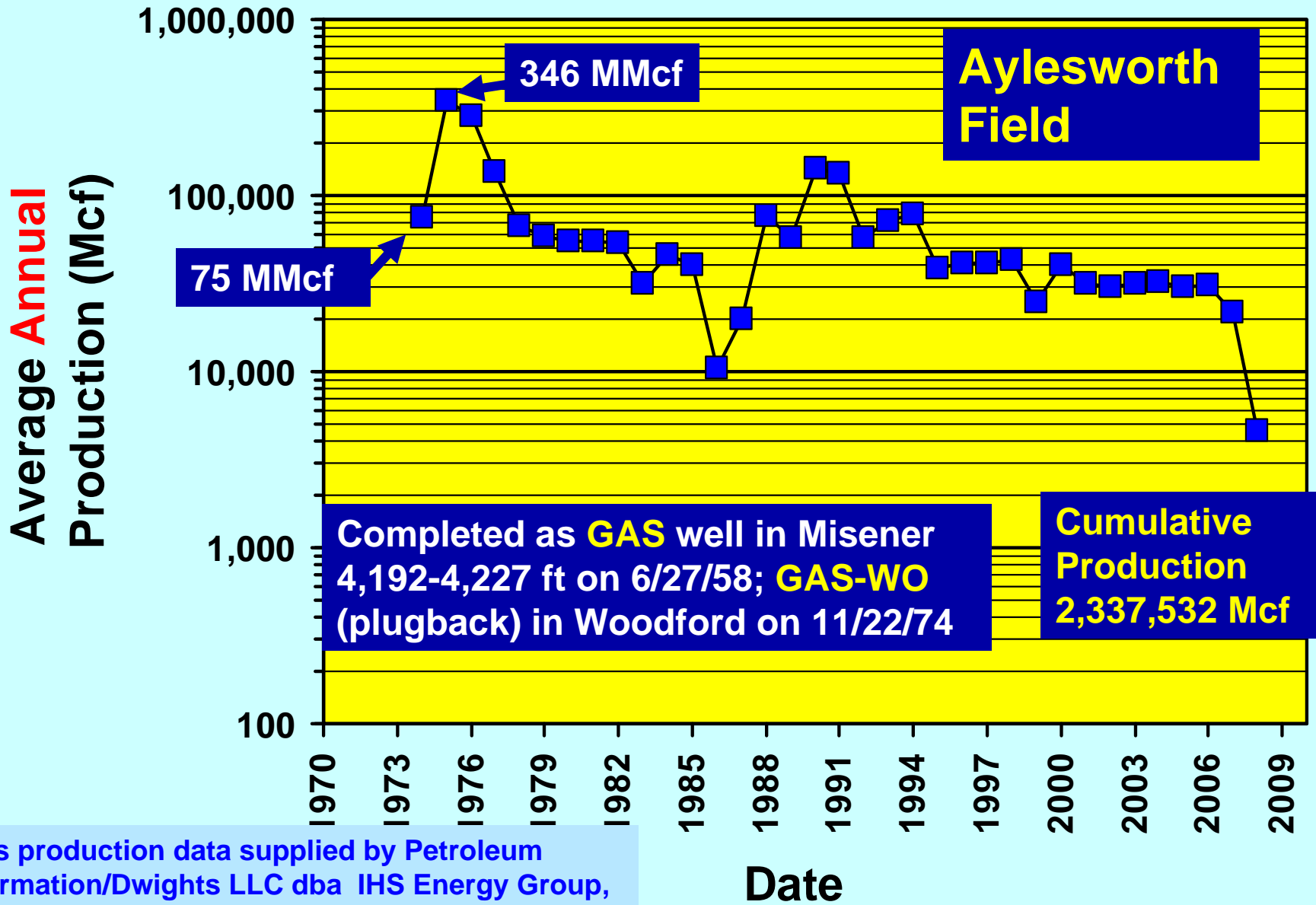
3 Griffin-Olmstead well



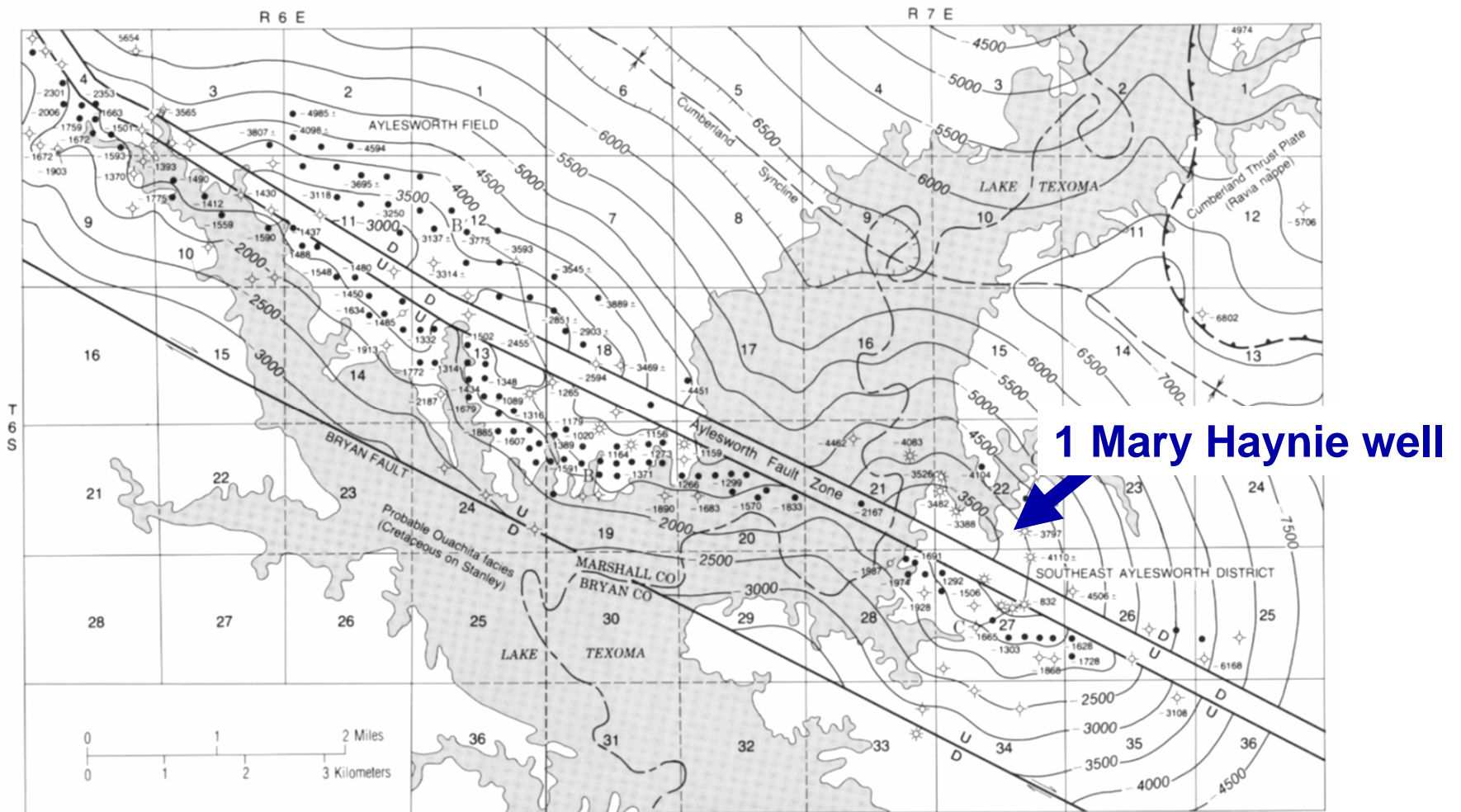
Structure contour map of the top of the Viola Group (Ordovician) in the North Madill field (from Huffman and others, 1987)

Verdad Oil & Gas 1 Mary Haynie

(Bryan CO, 22-6S-7E; IP 962 Mcfd; 3,710-4,054 ft)

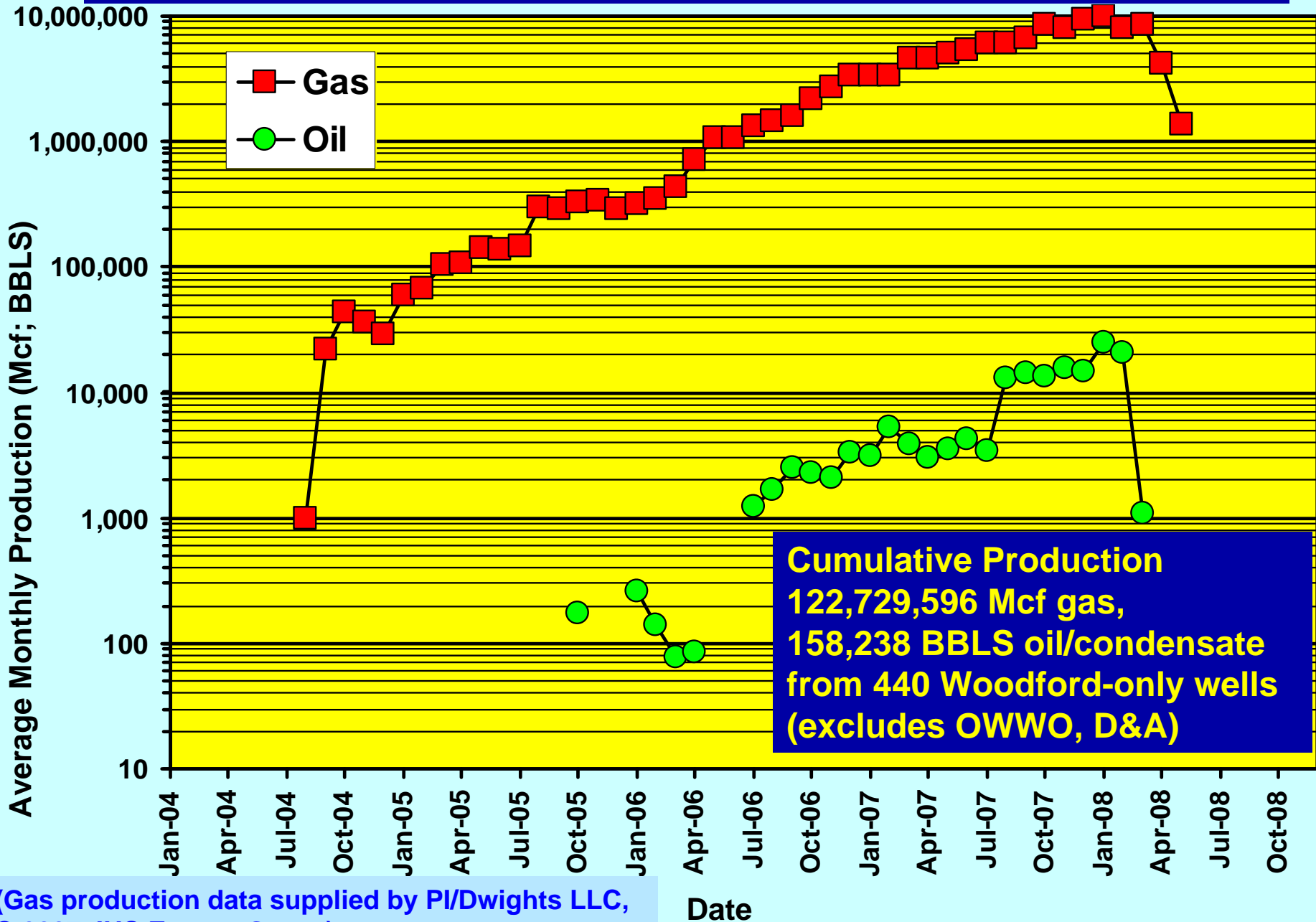


(Gas production data supplied by Petroleum Information/Dwights LLC dba IHS Energy Group, © 2007, IHS Energy Group)



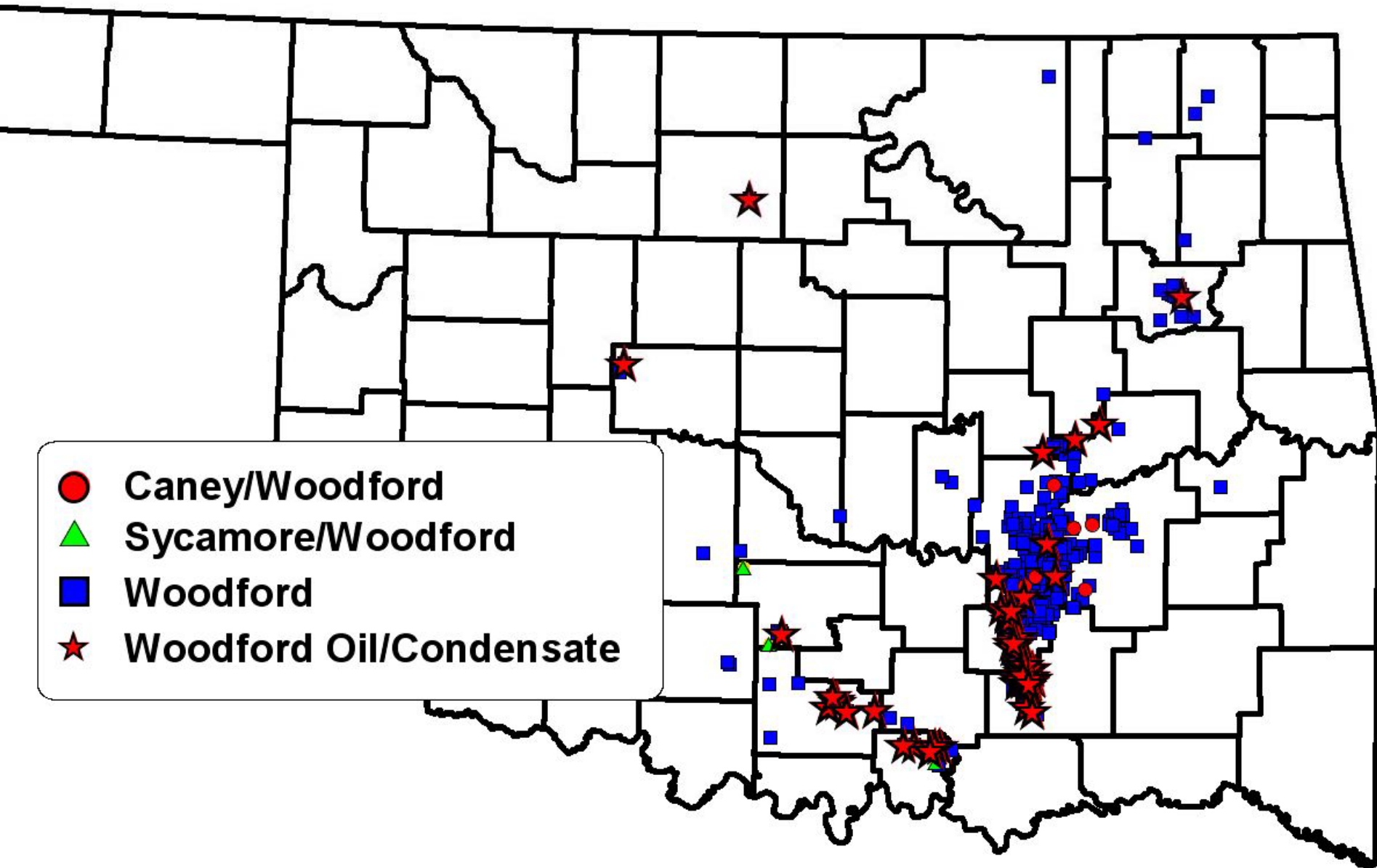
Structure contour map of the top of the Viola Group (Ordovician) in the Aylesworth and SE Aylesworth District fields (from Huffman and others, 1987)

Woodford Shale Production (2004-2008 wells)



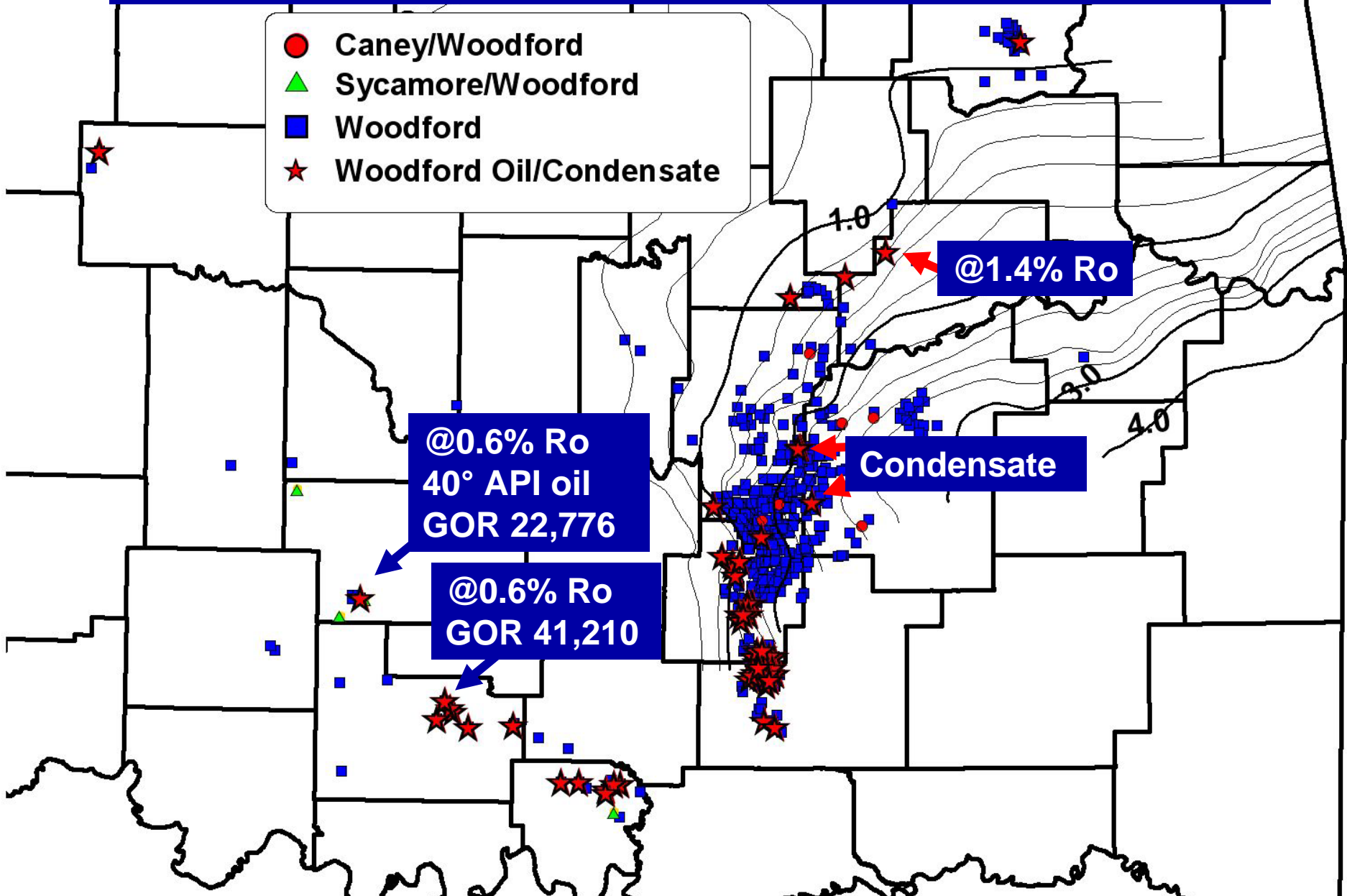
(Gas production data supplied by PI/Dwights LLC,
 © 2007, IHS Energy Group)

Woodford Shale Only Oil/Condensate Production (67 of 440 wells; 2004-2008)



Woodford Shale Only Oil/Condensate Production (67 of 440 wells; 2004-2008)

- Caney/Woodford
- ▲ Sycamore/Woodford
- Woodford
- ★ Woodford Oil/Condensate

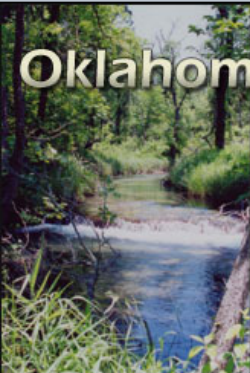


SUMMARY OF WOODFORD GAS SHALE PLAY

- 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
- Some Woodford Shale gas potential is in southern Oklahoma at $<1.1\%$ R_o

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

Oklahoma Geological Survey



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[References](#)

[Presentations & Reports](#)

[Oklahoma Gas-Shale Completions Map, 1939-2007](#)

[Woodford Shale Gas Well Completions Map, 1939-2007](#)

[Gas Shales Database](#)

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

Oklahoma Oil and Gas Management Inc., Kiker #1, Sec 30-8N-8E, Wewoka District, Seminole County, OK. Photo by Dan Boyd.



Gas Well: Mustang Production Co. #1-29 Dobbins, located in Sec. 29-T.15N., R.11W., Blaine County, OK. Photo by Rick Andrews.

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References

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[Bibliography of Caney Shale](#)

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[Bibliography of Woodford Shale](#)

[Bibliography of Oklahoma Asphalt](#)

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Oil and Gas Presentations and Reports

[Woodford Gas-Shale Play Update \(2008 AAPG Poster\)](#)

[Conventional Wisdom Applied to Oklahoma Gas Shales](#) 

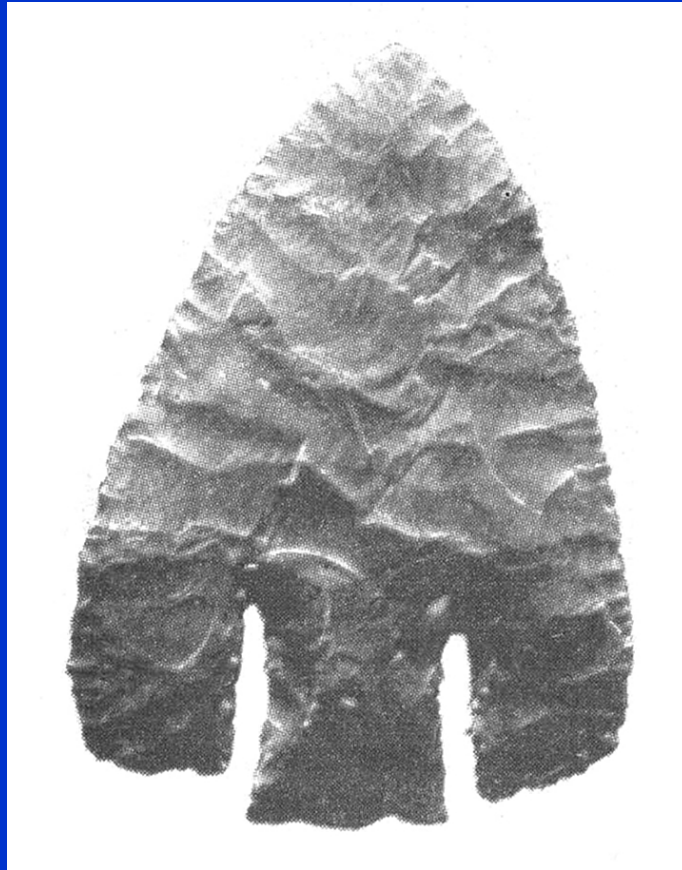
[Overview of Woodford Gas Shale Play \(2007 Conference\)](#) 

[Oklahoma Gas Shales \(2006 CBM Symposium\)](#) 

[Woodford Shale and Caney Shale Reservoir Property Analysis Report](#) 

| V1 Initial_Potential_(MCFD) | | | | | | |
|-----------------------------|--------|--------------|----------------------|-----------------|---------------------|----------|
| | A | B | C | D | E | |
| 1 | Record | API Number | Operator | Completion Date | Well Name | |
| 2 | 412 | 35-063-24000 | Newfield Exploration | | 3H-22 Tollett | |
| 3 | 284 | 35-121-23817 | Newfield Exploration | 4/7/07 | 4H-22 Ellis Sherman | Pine H |
| 4 | 443 | 35-029-20907 | Newfield Exploration | 11/22/07 | 3H-31 Patterson | unnam |
| 5 | 287 | 35-063-23816 | Newfield Exploration | 11/16/06 | 1H-13 Stuart | unnam |
| 6 | 221 | 35-063-23801 | Newfield Exploration | 11/2/06 | 1H-22 Tollett | unnam |
| 7 | 245 | 35-063-23826 | Newfield Exploration | 12/8/06 | 2H-31 Patterson | unnam |
| 8 | 526 | 35-029-20908 | Newfield Exploration | 12/26/07 | 3H-36 Parker | unnam |
| 9 | 442 | 35-063-23936 | Newfield Exploration | 10/5/07 | 2H-28 Sanford | unnam |
| 10 | 222 | 35-063-23785 | Newfield Exploration | 11/4/06 | 1H-23 Tipton | unnam |
| 11 | 184 | 35-005-20301 | Antero Resources | 7/17/06 | 19-1H Pettigrew | unnam |
| 12 | 362 | 35-063-23843 | Newfield Exploration | 2/23/07 | 1H-28 Smith | unnam |
| 13 | 592 | 35-063-24040 | Chesapeake Operating | 3/1/08 | 1-3H Cypert | Hill Top |
| 14 | 427 | 35-063-23915 | Newfield Exploration | 9/19/07 | 2H-27 Whitlow | unnam |
| 15 | 99 | 35-063-23749 | Newfield Exploration | 3/15/06 | 1H-36 Parker | unnam |
| 16 | 305 | 35-121-23792 | Antero Resources | 7/4/07 | 20-1H Silva | unnam |
| 17 | 256 | 35-063-23825 | Newfield Exploration | 1/14/07 | 1H-20 Melvin | unnam |
| 18 | 243 | 35-029-20805 | Pablo Energy II LLC | 2/22/07 | 1H-28 Lemons | Coalg |
| 19 | 229 | 35-121-23742 | Newfield Exploration | 11/20/06 | 1H-4 Elms | Pine H |
| 20 | 246 | 35-121-23797 | Newfield Exploration | 1/28/07 | 1H-6 Grant | Pine H |
| 21 | 251 | 35-063-23819 | Newfield Exploration | 2/18/07 | 1H-32 Gockel | unnam |
| 22 | 270 | 35-063-23803 | Newfield Exploration | 11/14/06 | 1H-35 Turpin | unnam |
| 23 | 495 | 35-029-20817 | Pablo Energy II LLC | 8/13/07 | 1H-29 Ables | Centra |
| 24 | 532 | 35-063-24006 | Newfield Exploration | 12/31/07 | 2H-17 Burton | Ashlan |
| 25 | 273 | 35-029-20820 | Devon Energy | 3/19/07 | 1-15H Sprague | unnam |
| 26 | 444 | 35-029-20862 | Antero Resources | 7/9/07 | 33-1H Brown | Ashlan |
| 27 | 288 | 35-121-23749 | Newfield Exploration | 1/15/07 | 2H-23 McWilliams | Pine H |
| 28 | 475 | 35-029-20921 | XTO Energy | 3/9/08 | 12-25H Lemons | Ashlan |

THANK YOU



**Typical Calf Creek point of Woodford chert found
in Haskell County, Oklahoma
(Norman Transcript, March 11, 2007, p. E1)**