Oklahoma Gas Shales Conference October 22, 2008

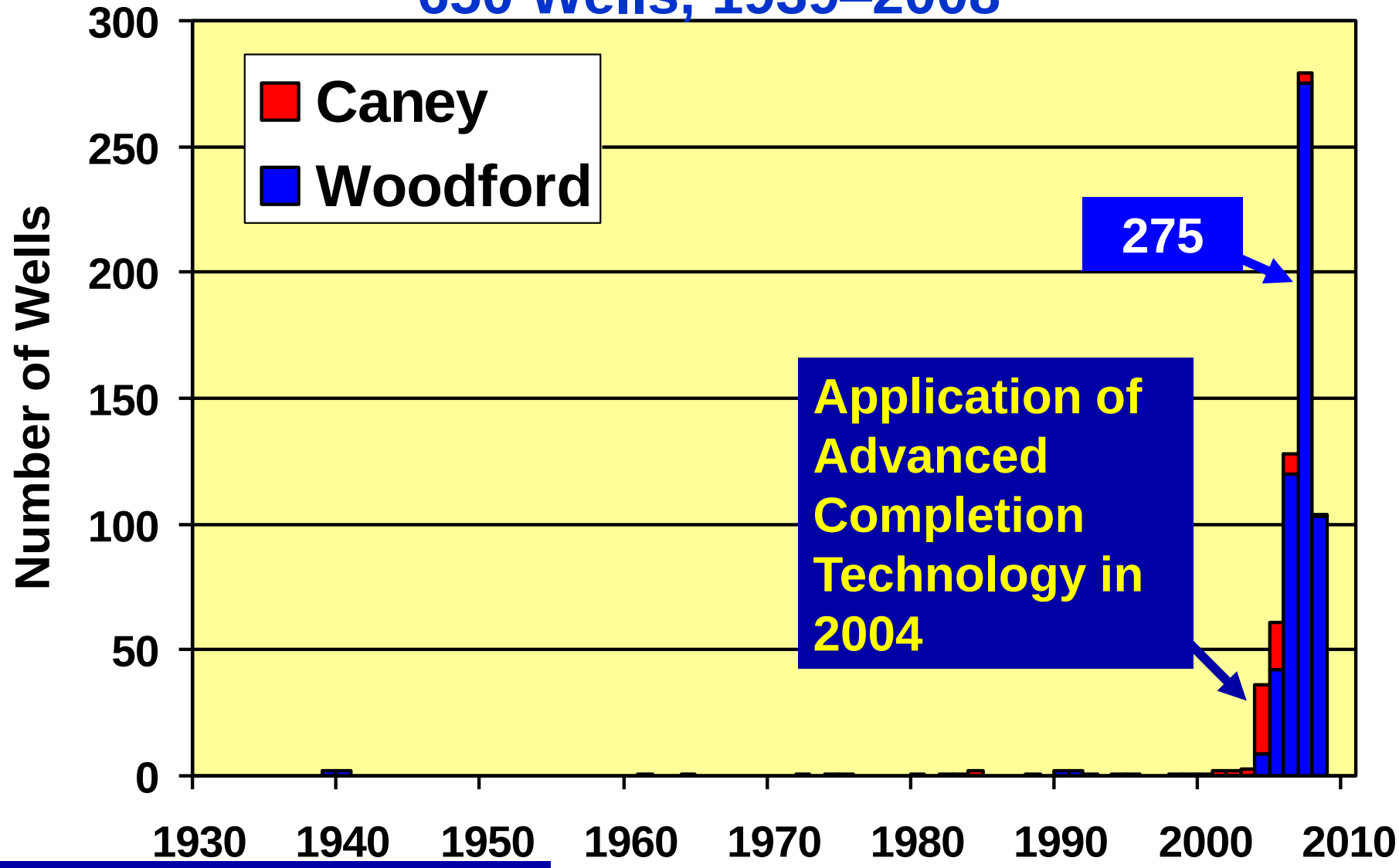
Overview of Woodford Gas-Shale Play in Oklahoma, 2008 Update

Brian J. Cardott

Oklahoma Geological Survey

Oklahoma Shale-Gas Well History

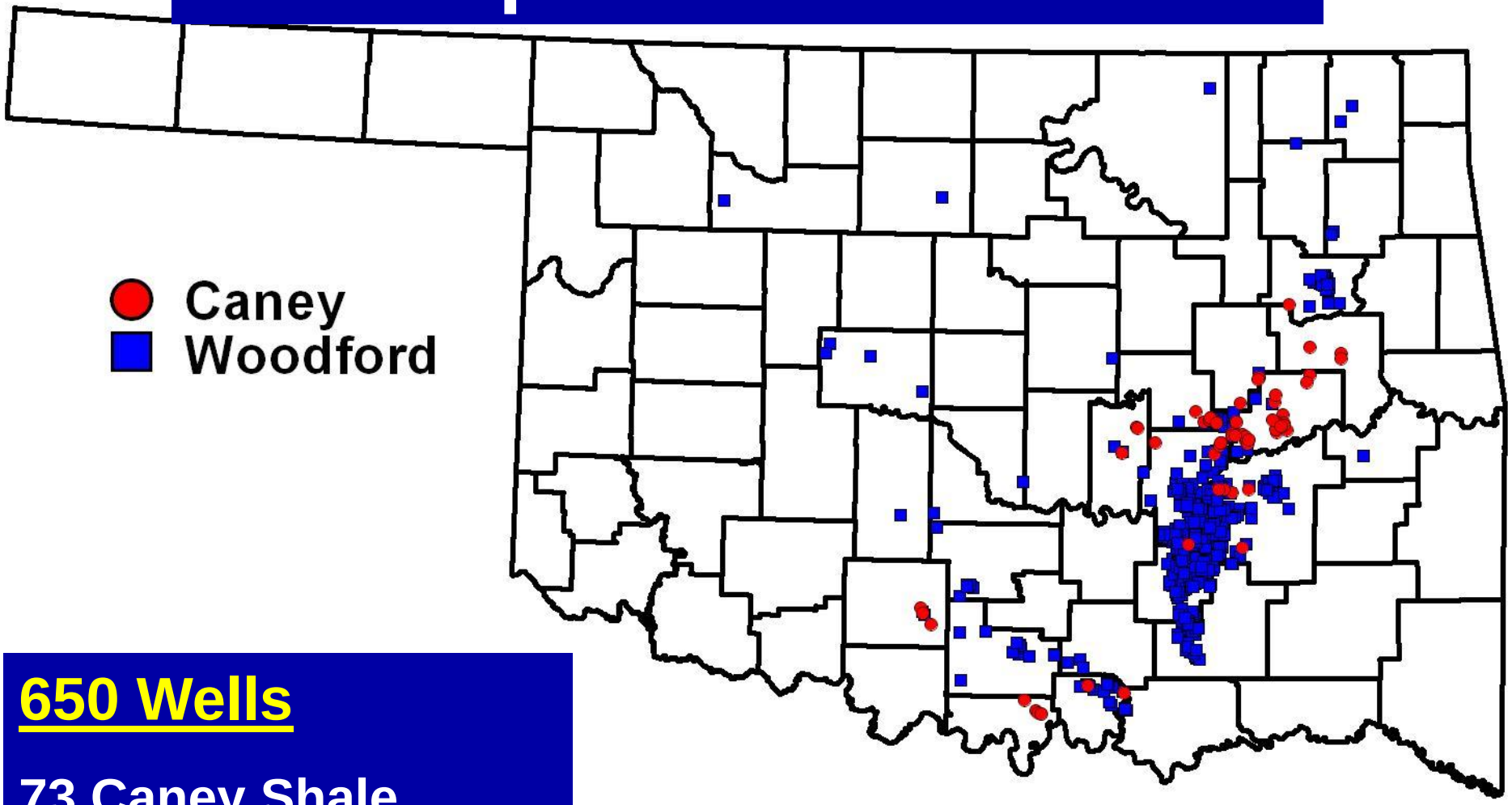
650 Wells, 1939–2008



Caney/Woodford included with Caney

Updated 8/4/2008

Oklahoma Gas-Shale Wells Completed 1939-2008



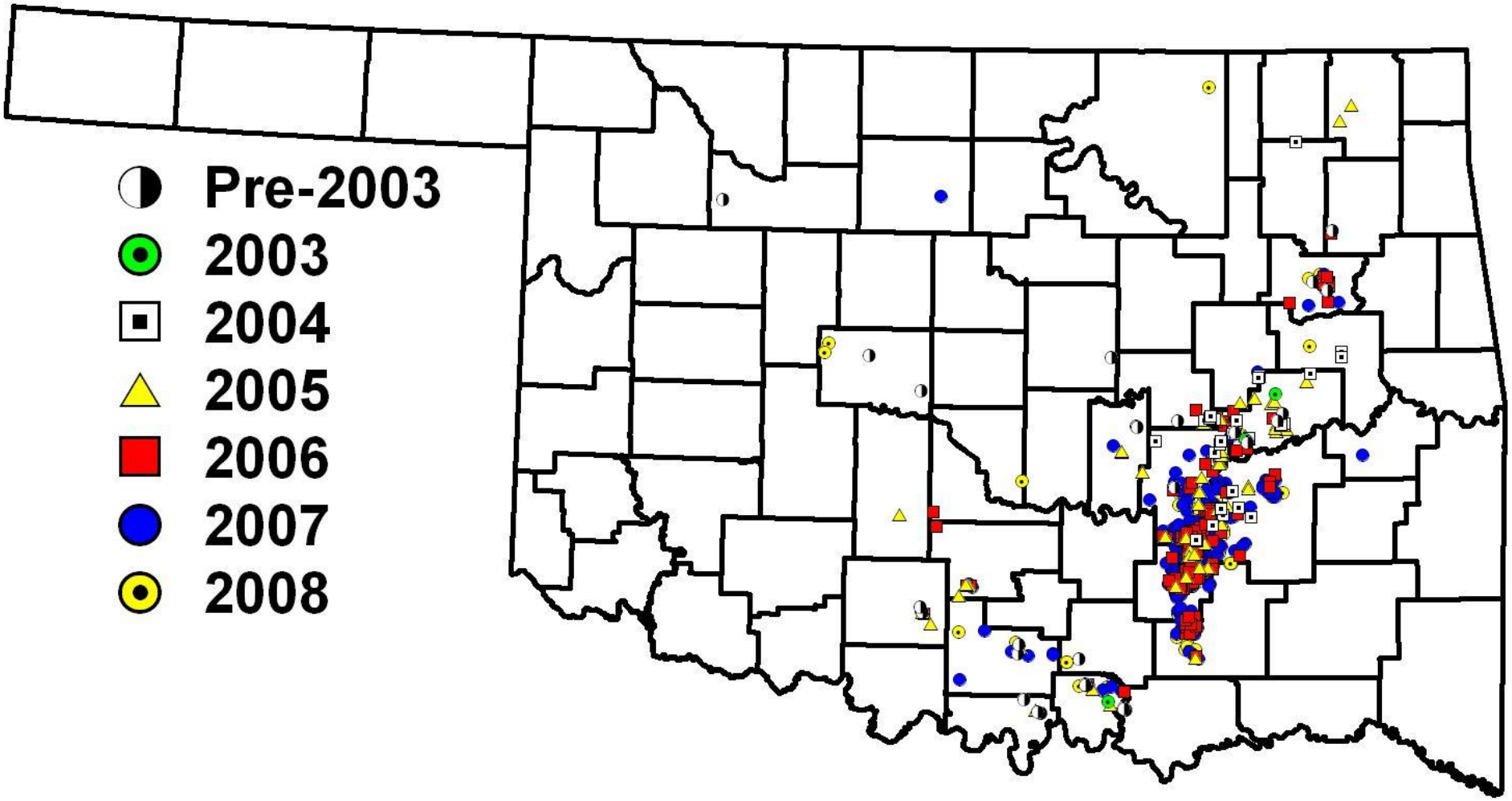
650 Wells

73 Caney Shale

577 Woodford Shale

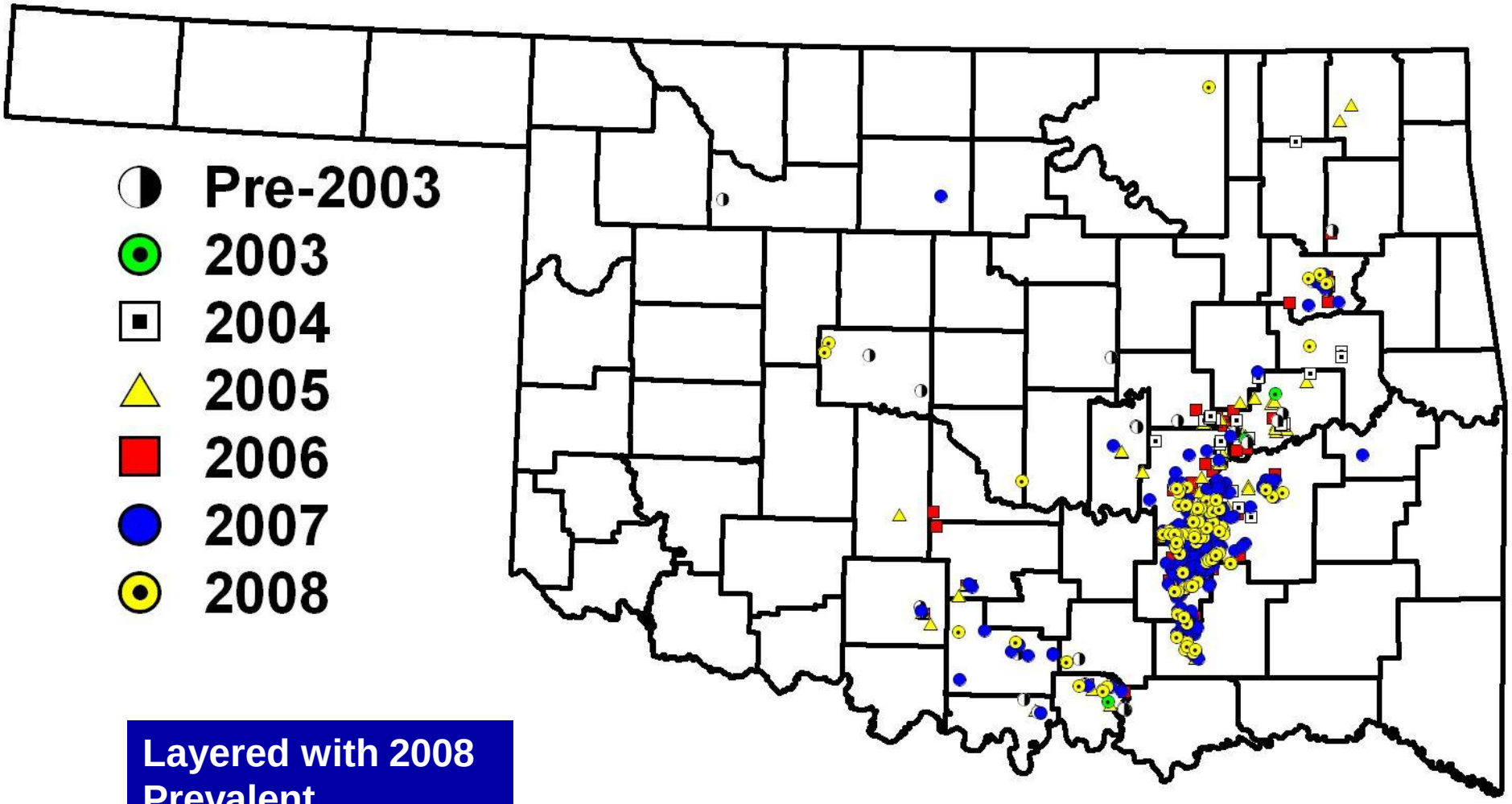
Updated 8/4/2008

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



Updated 8/4/2008

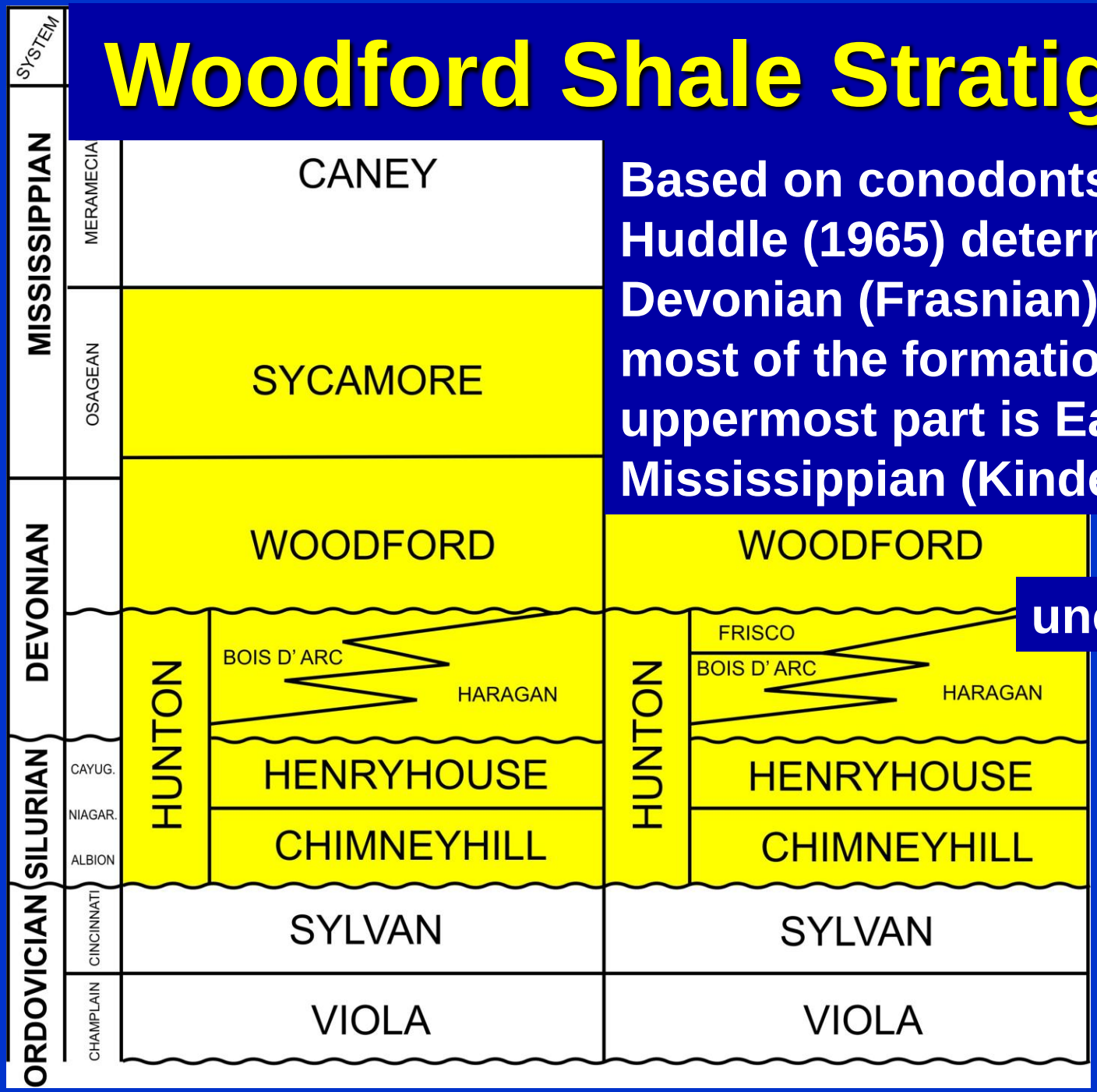
Oklahoma Gas-Shale Wells by Year (1939-2008)



Layered with 2008 Prevalent

Updated 8/4/2008

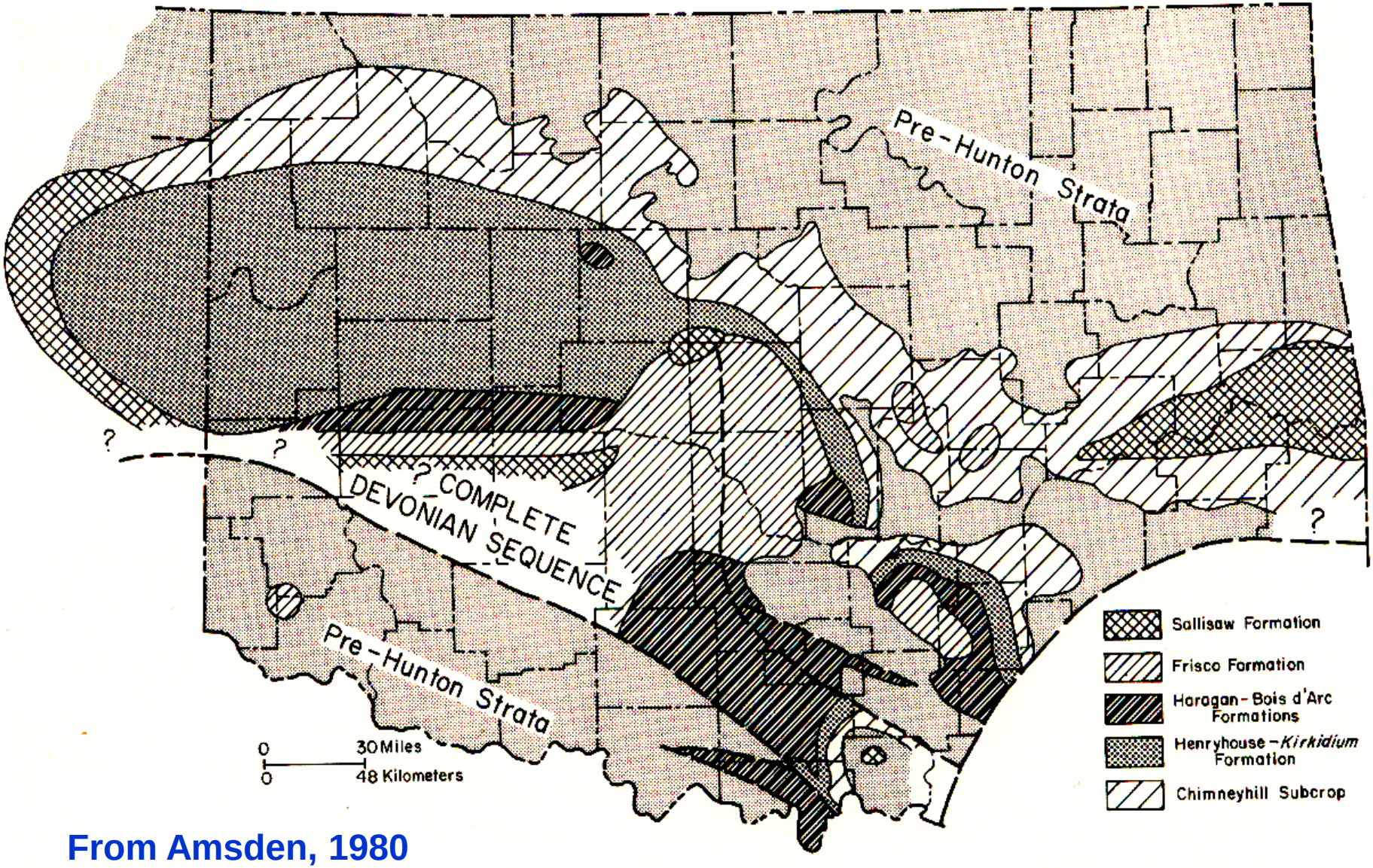
Woodford Shale Stratigraphy



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

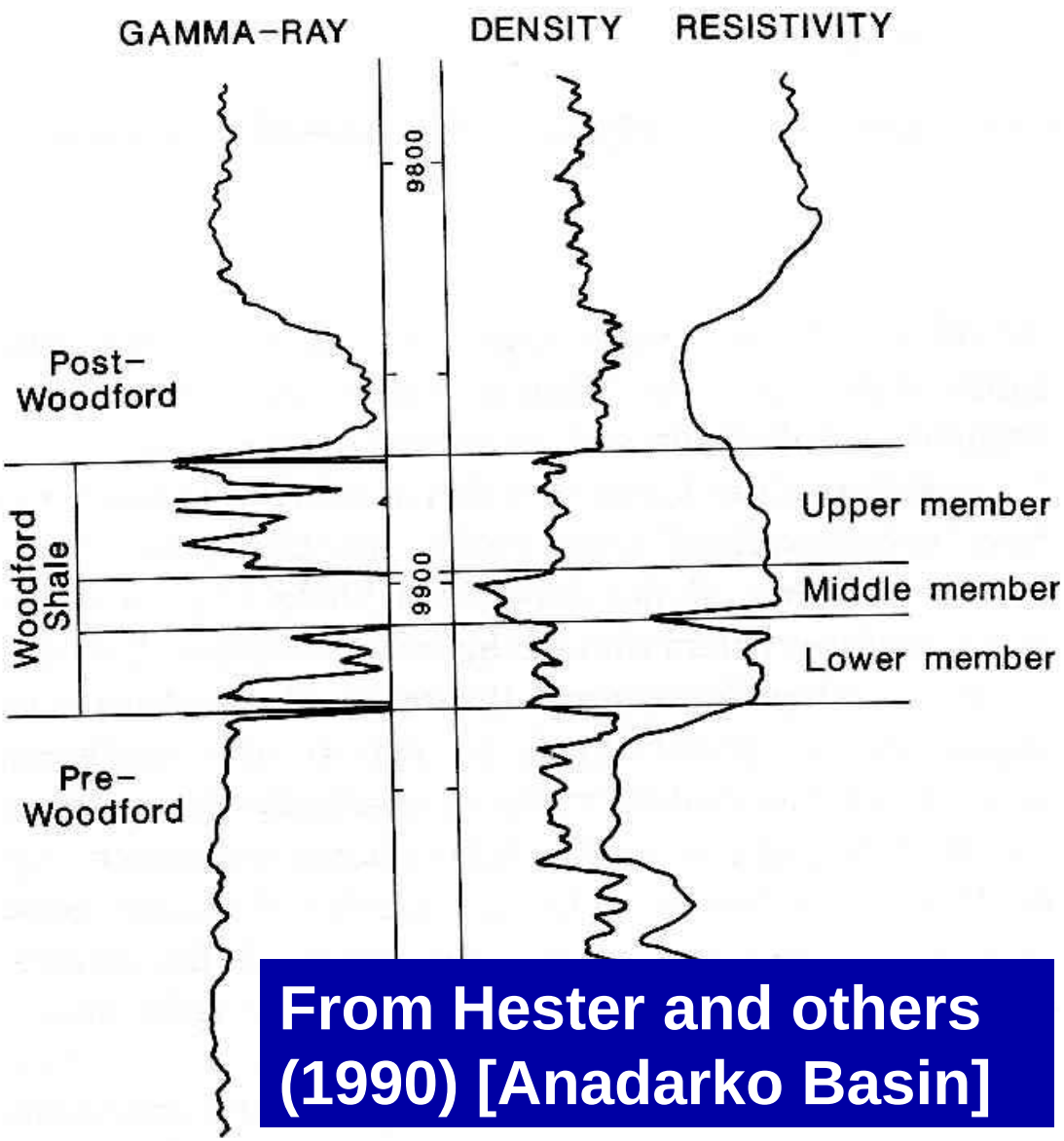
Pre-Woodford Geologic Map



From Amsden, 1980

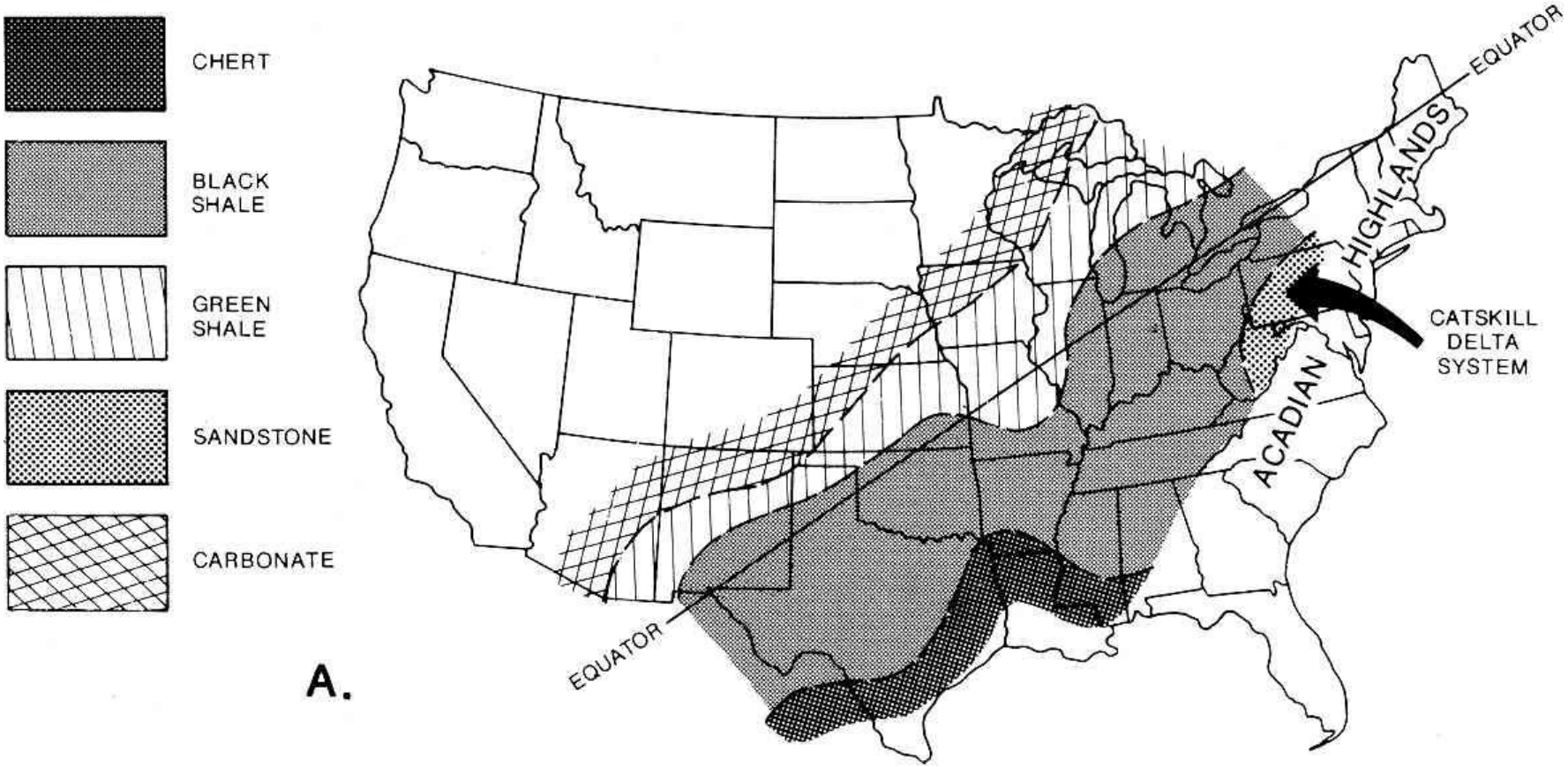
Woodford Shale Members

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



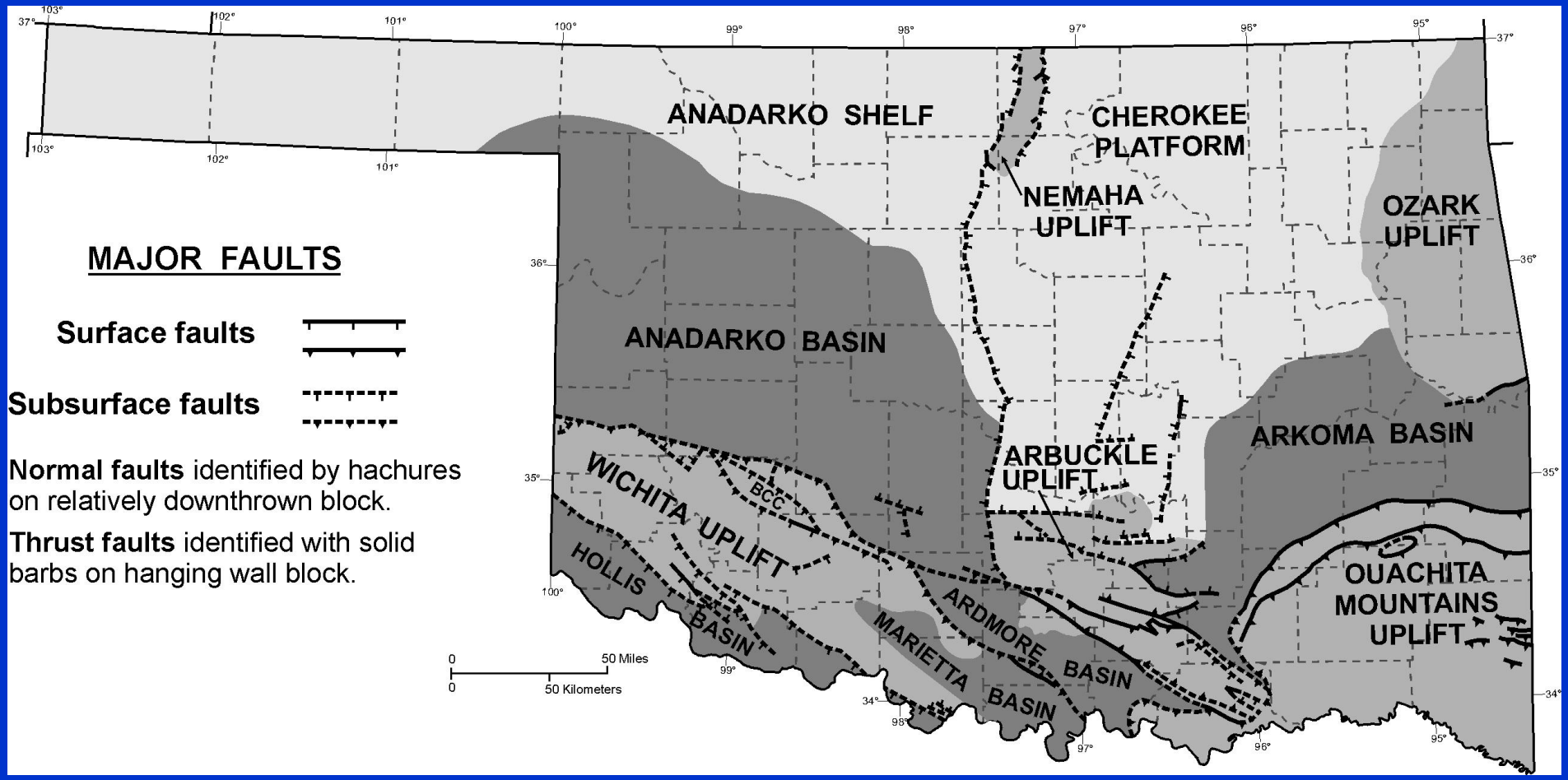
From Hester and others (1990) [Anadarko Basin]

Paleogeography and Facies Distribution in the Late Devonian



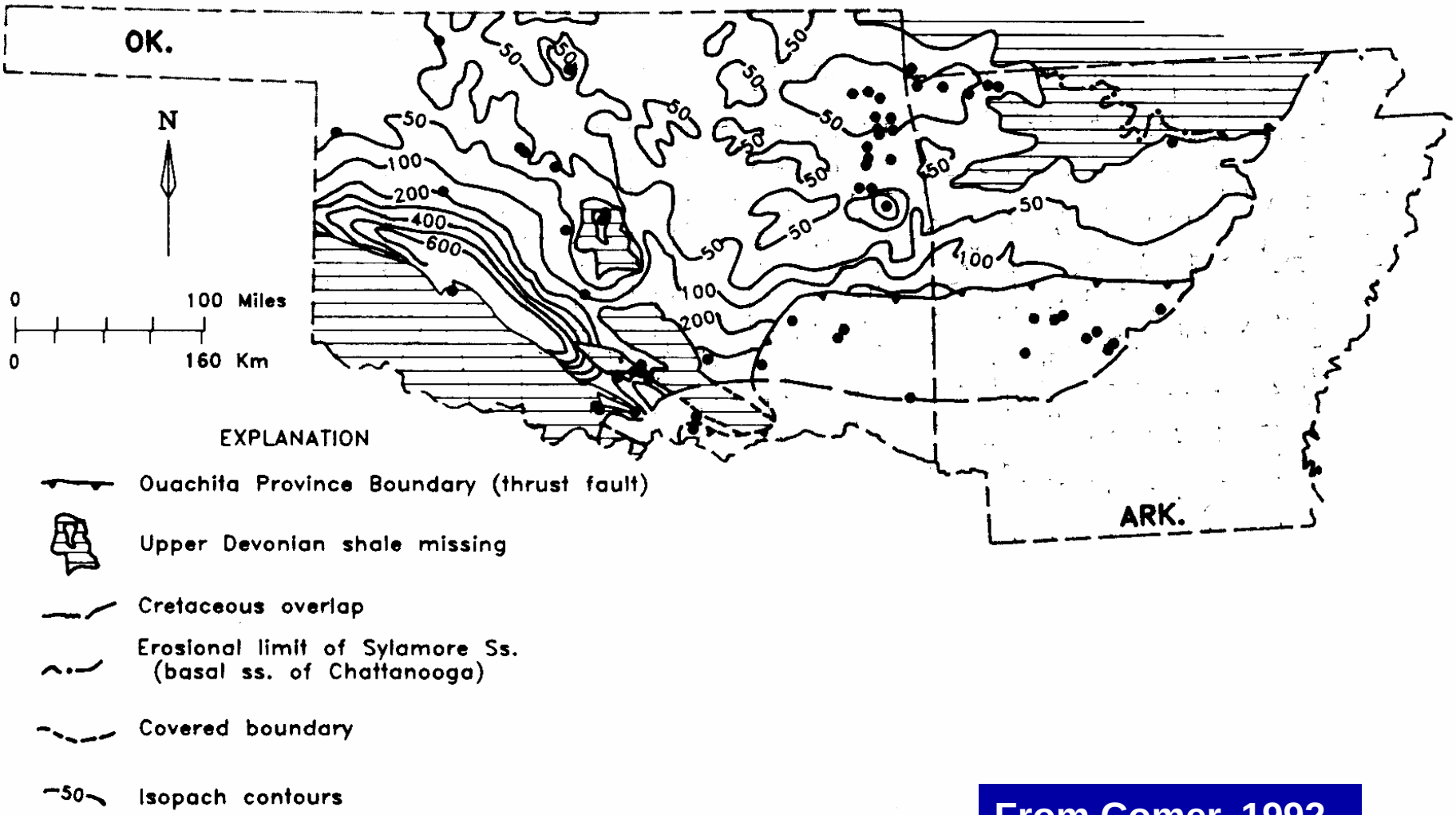
From Kirkland and others, 1992

Geologic Provinces of Oklahoma



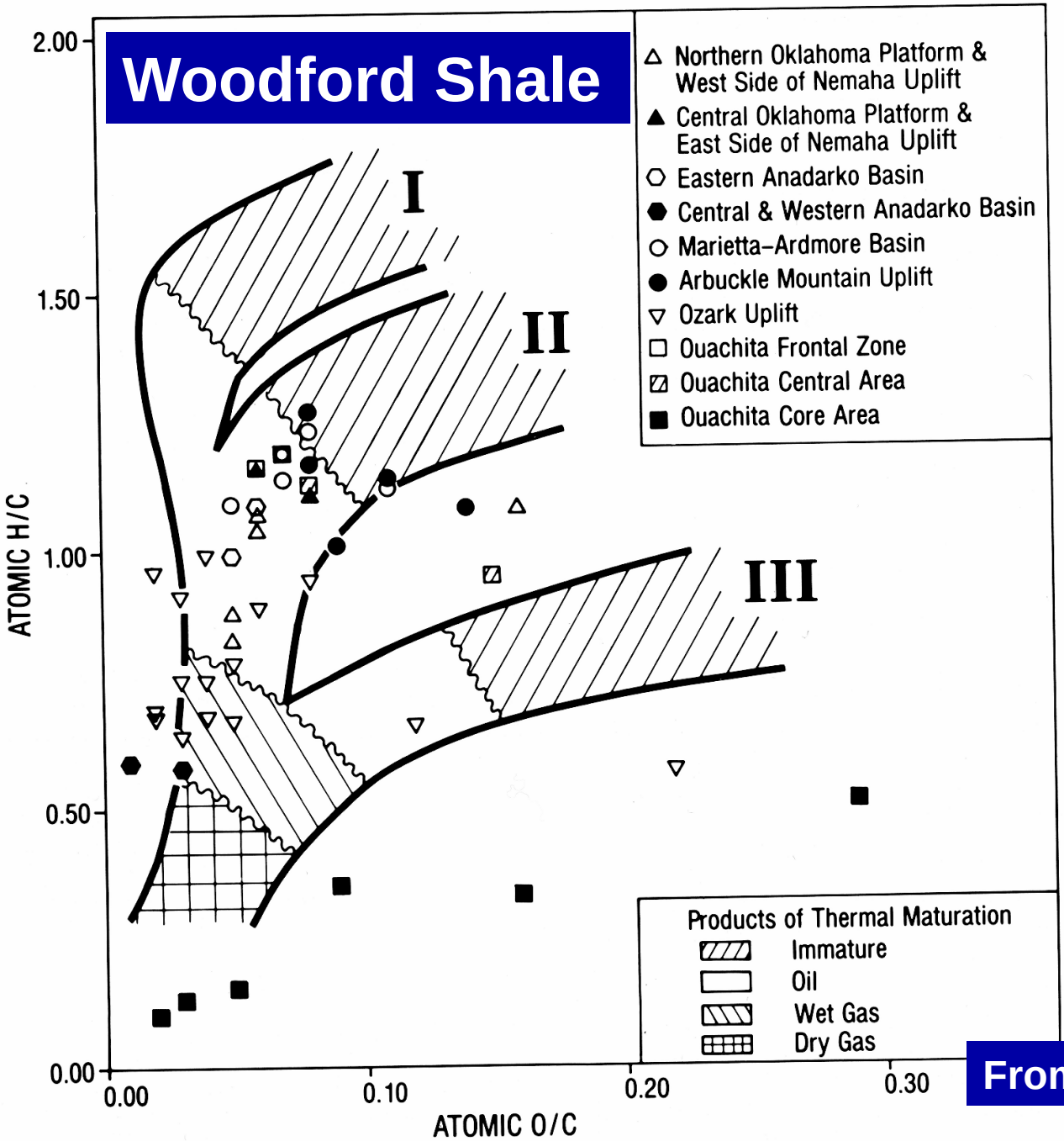
Northcutt and Campbell, 1995

Isopach Map of Woodford Shale



From Comer, 1992

Woodford Shale



From Comer, 1992

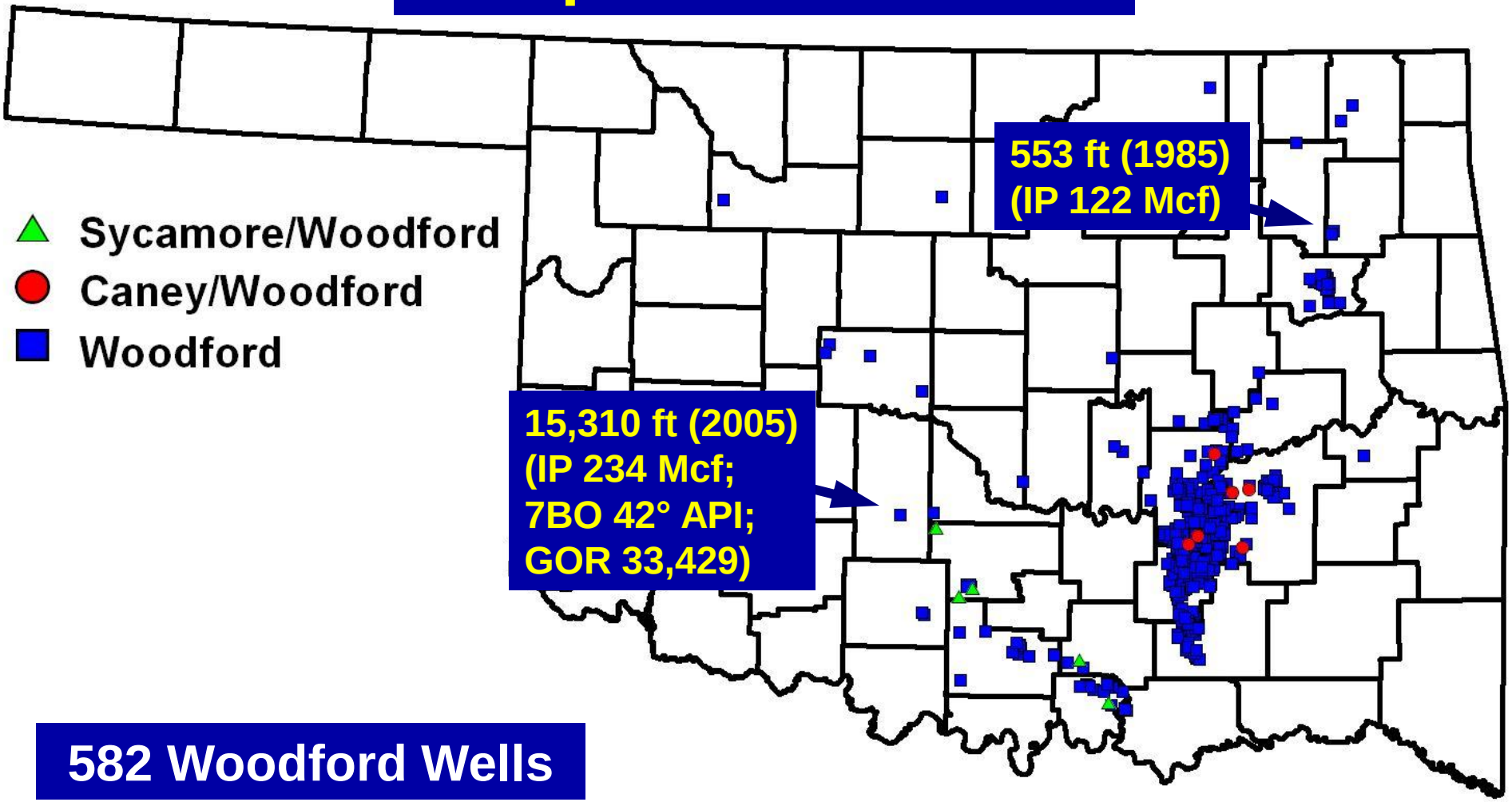
Woodford Mineralogy

[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

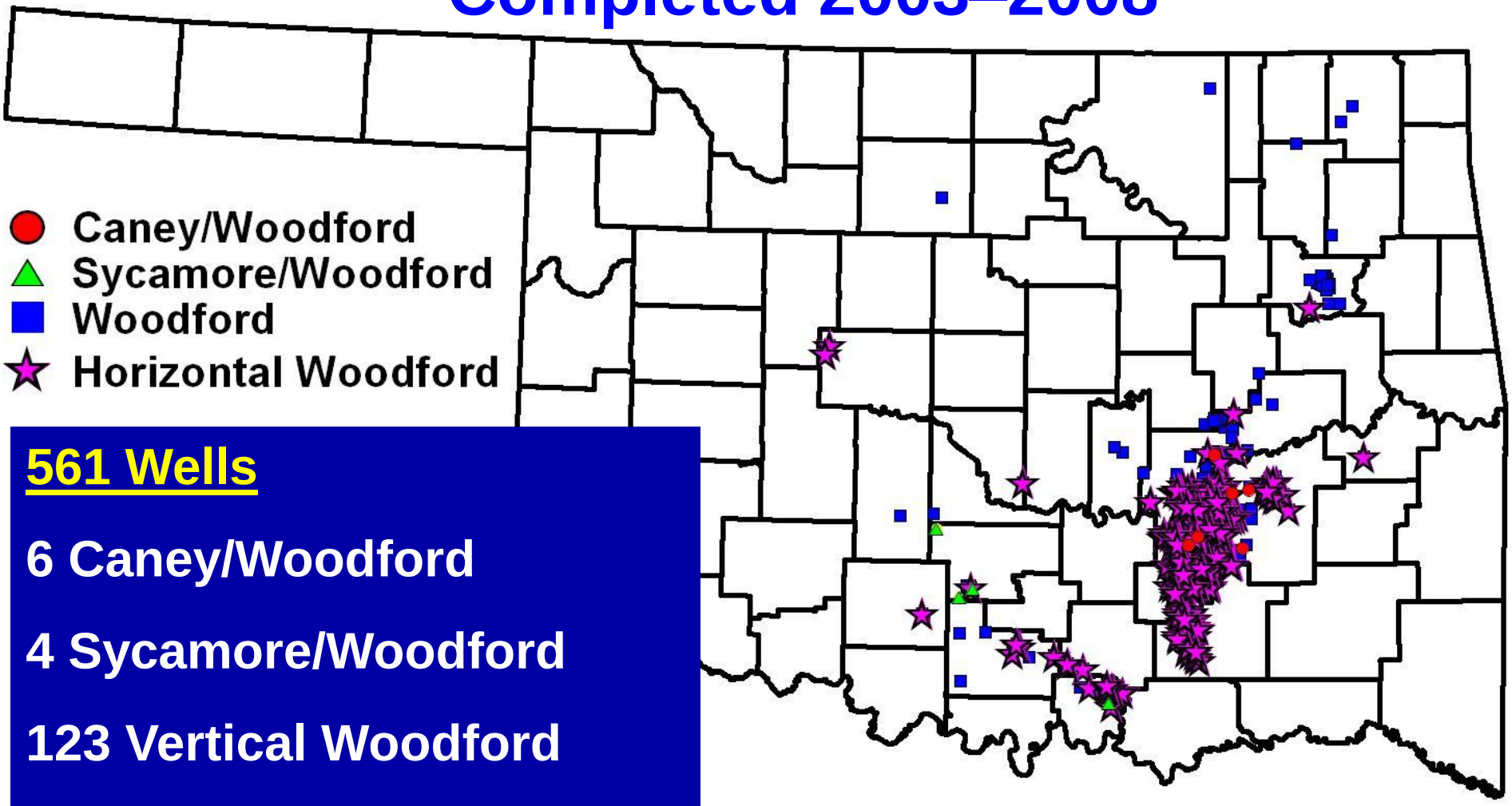
Completed 1939-2008



582 Woodford Wells

Woodford Gas-Shale Wells

Completed 2003–2008



561 Wells

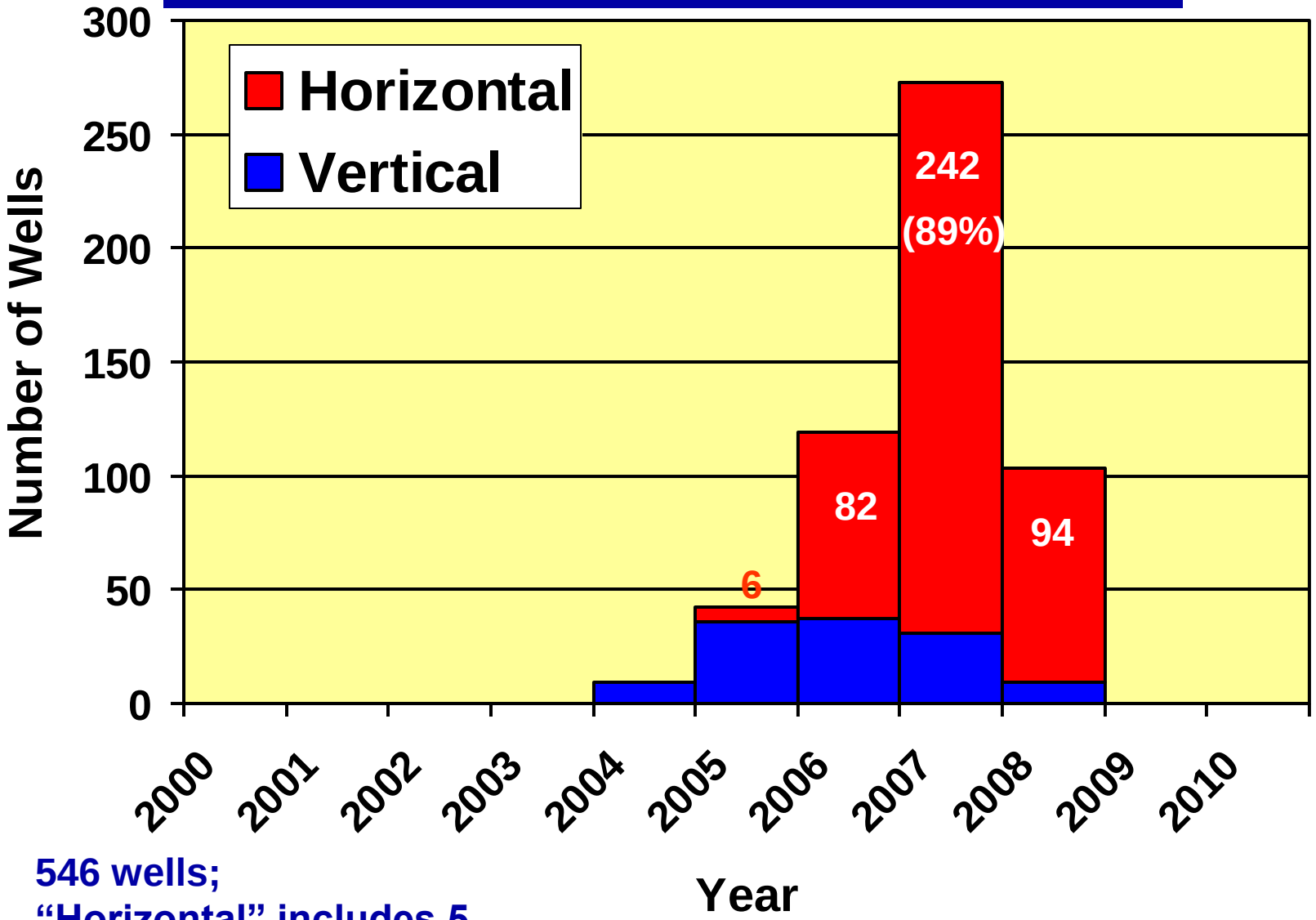
6 Caney/Woodford

4 Sycamore/Woodford

123 Vertical Woodford

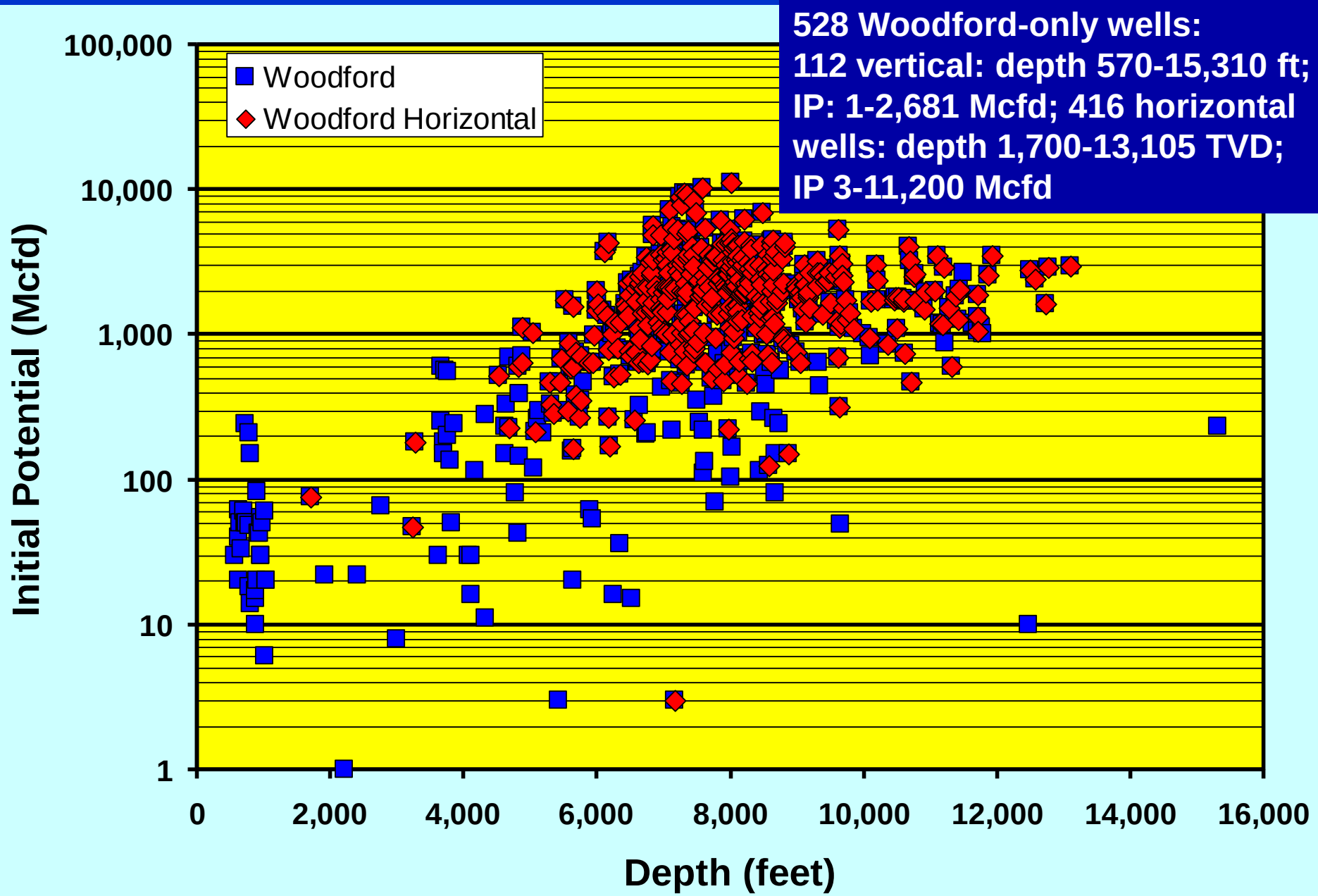
428 Horizontal/Directional Woodford (76%)

Woodford Shale-Only Wells Completed 2004-2008

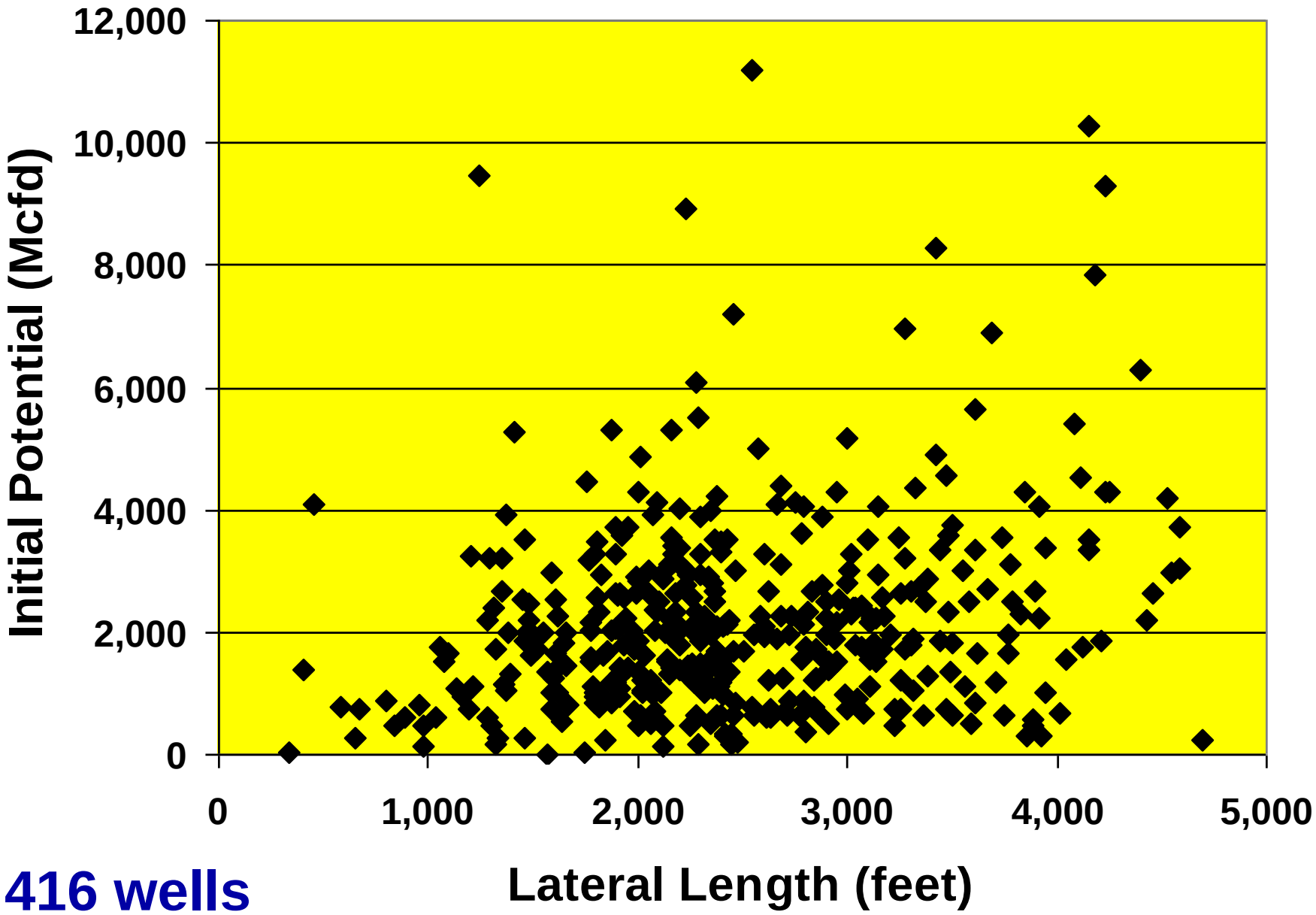


546 wells;
"Horizontal" includes 5 directional wells

Woodford Shale Gas Wells, 2003-2007



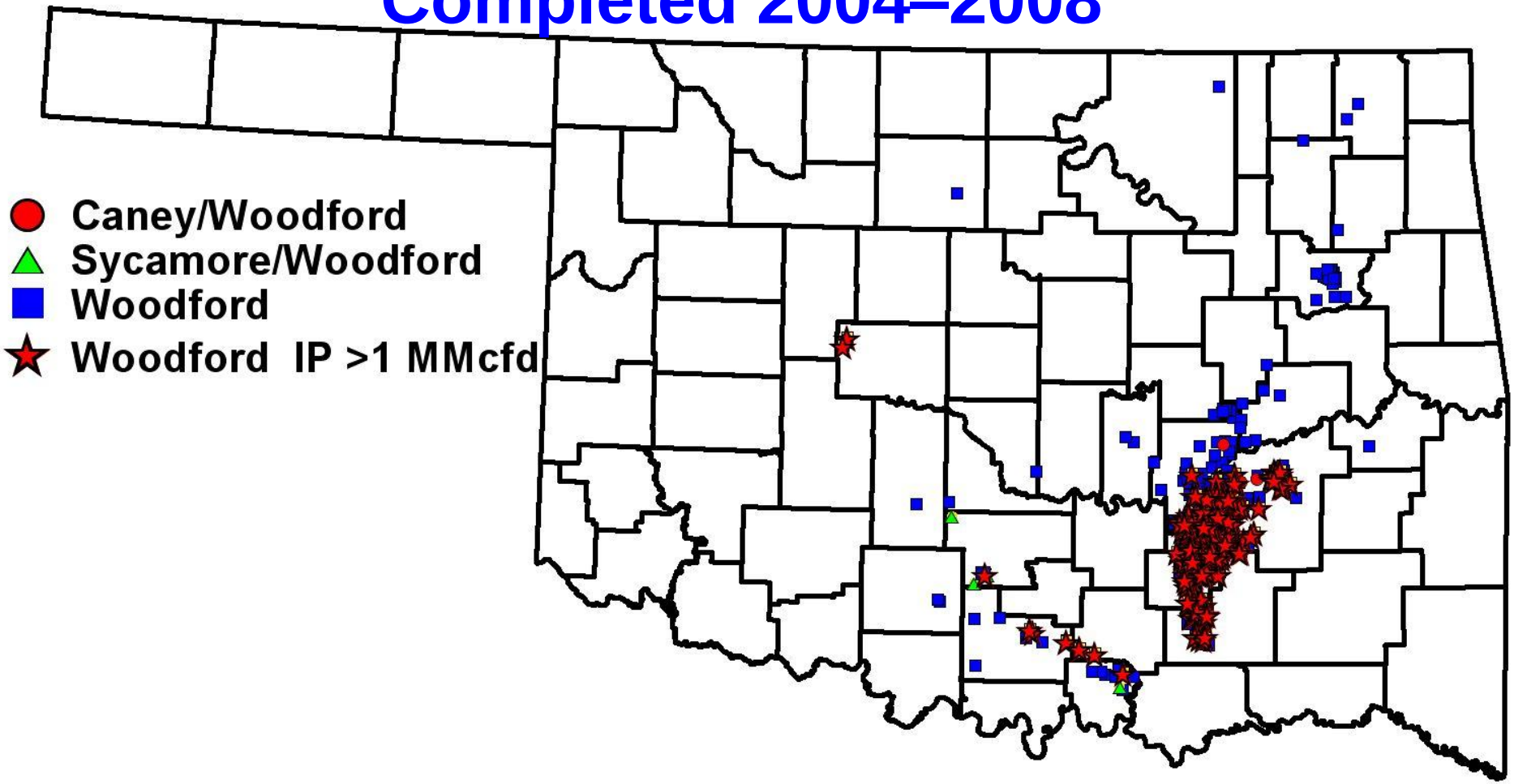
Woodford Shale Horizontal Wells



416 wells

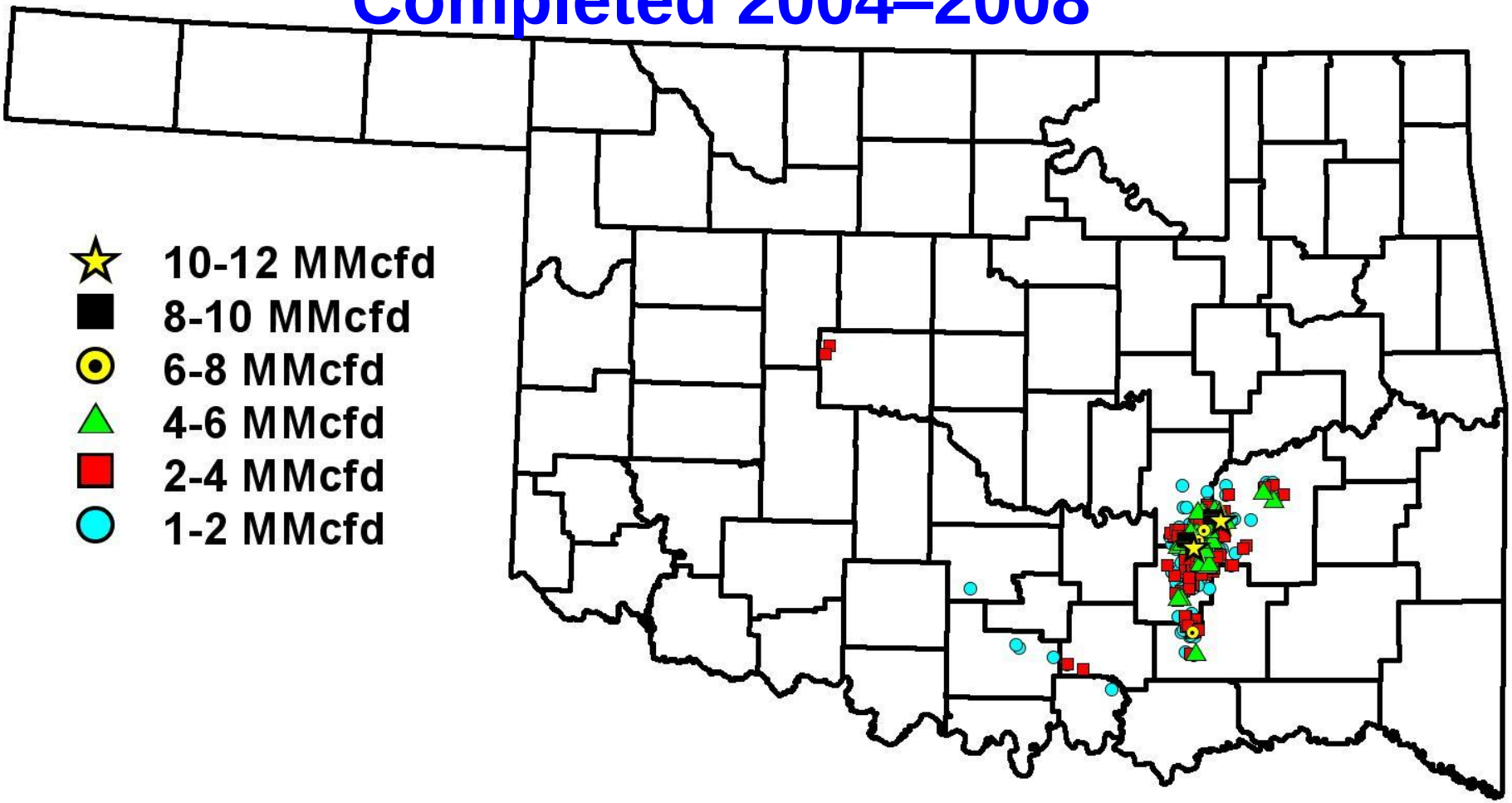
Woodford IP >1 MMcfd

Completed 2004–2008



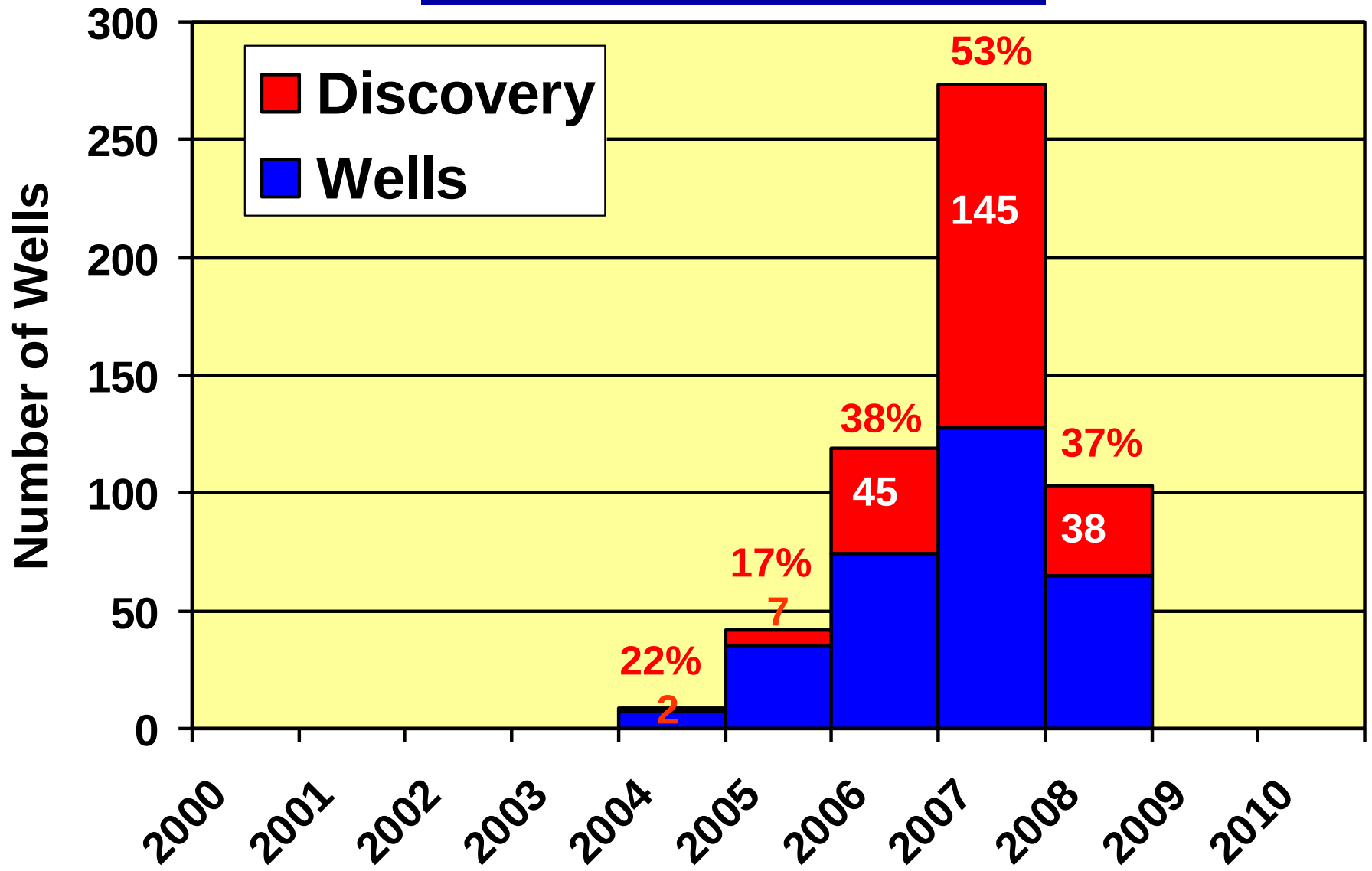
Woodford IP >1 MMcfd

Completed 2004–2008



Woodford Shale Discovery Wells

(New Field or Extension)

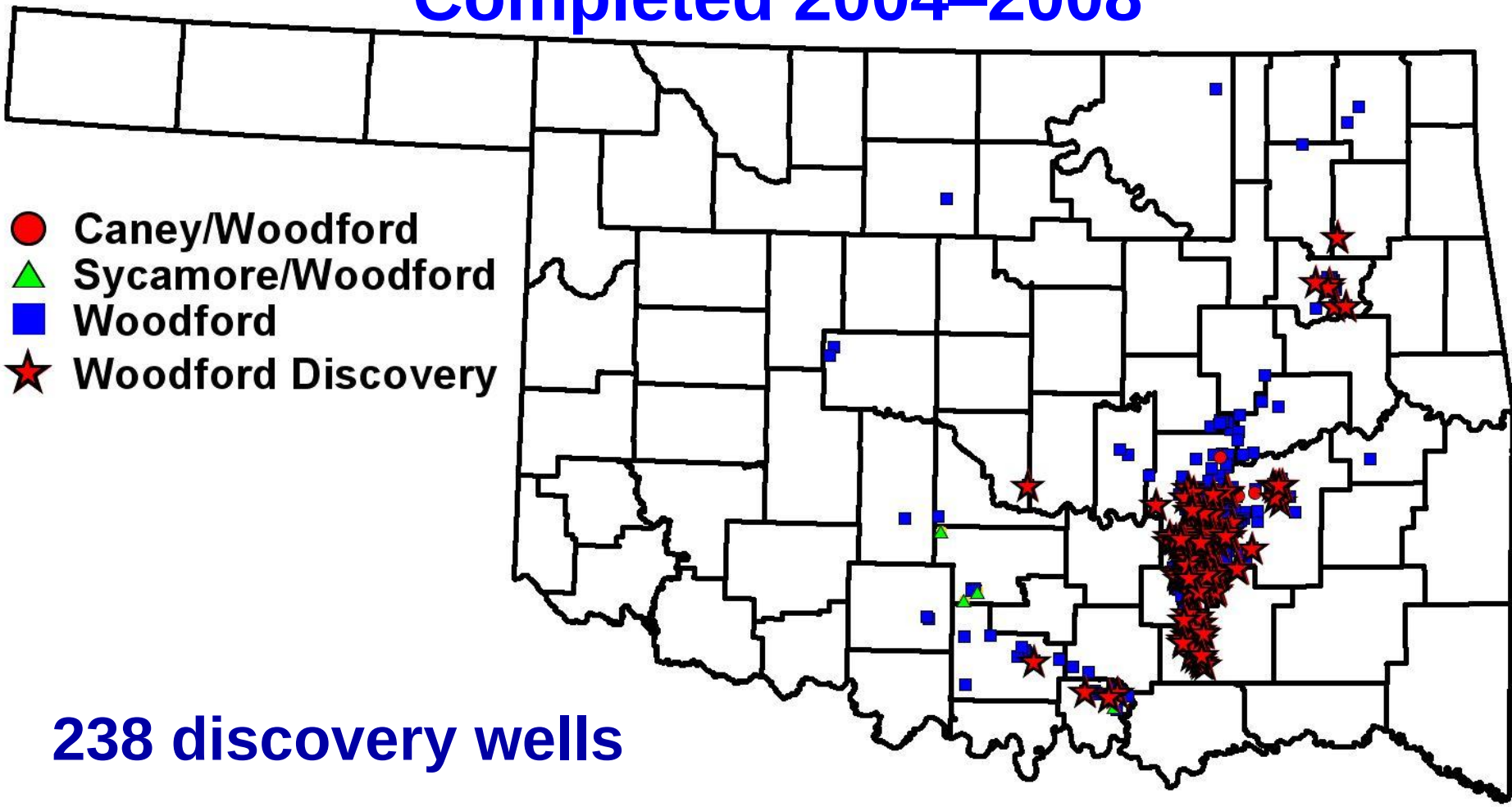


546 Woodford-only Wells

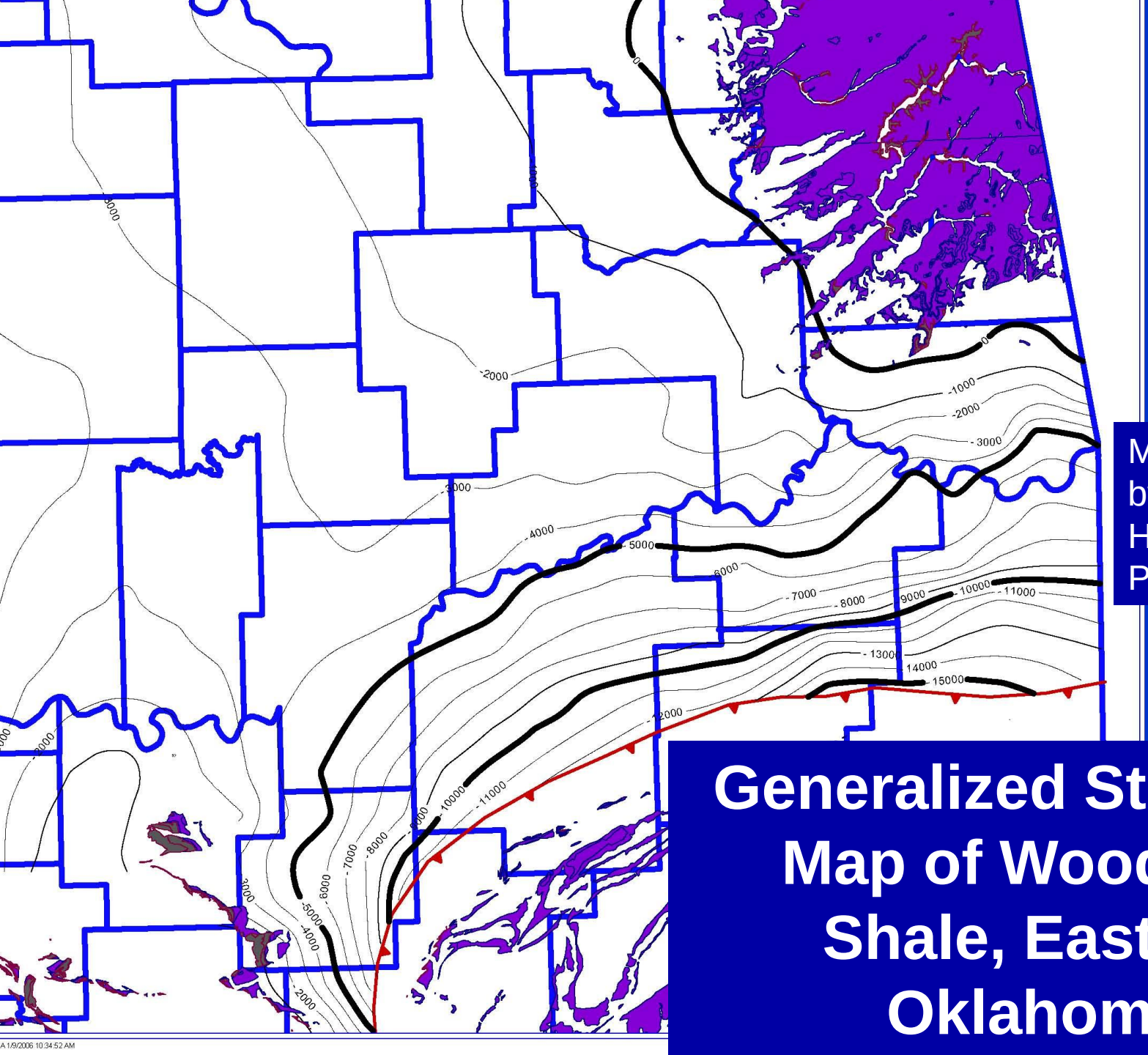
Updated 8/4/2008

Woodford Shale Discovery Wells

Completed 2004–2008



238 discovery wells



Map prepared by R. Vance Hall using Petra

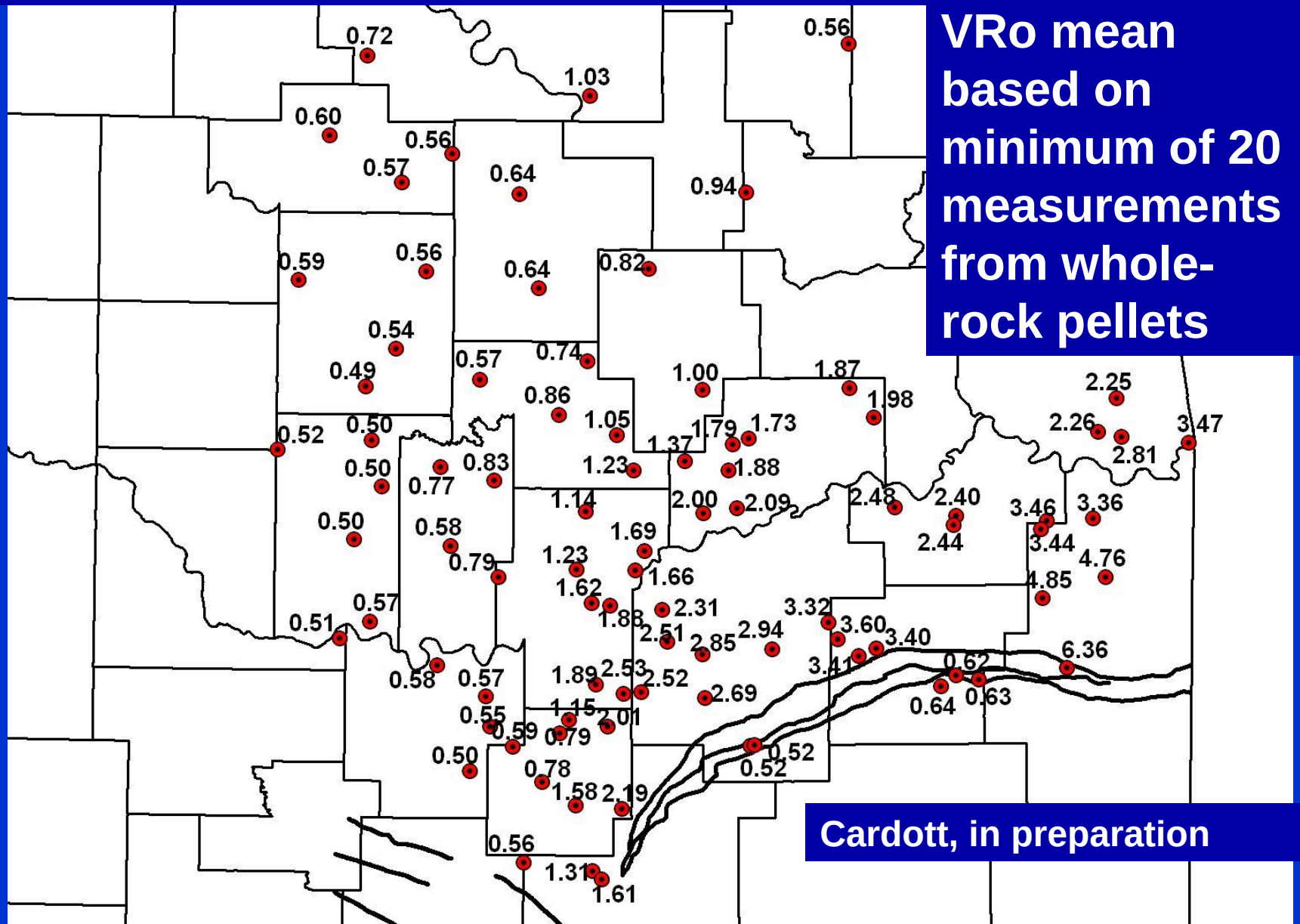
Generalized Structure Map of Woodford Shale, Eastern Oklahoma

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

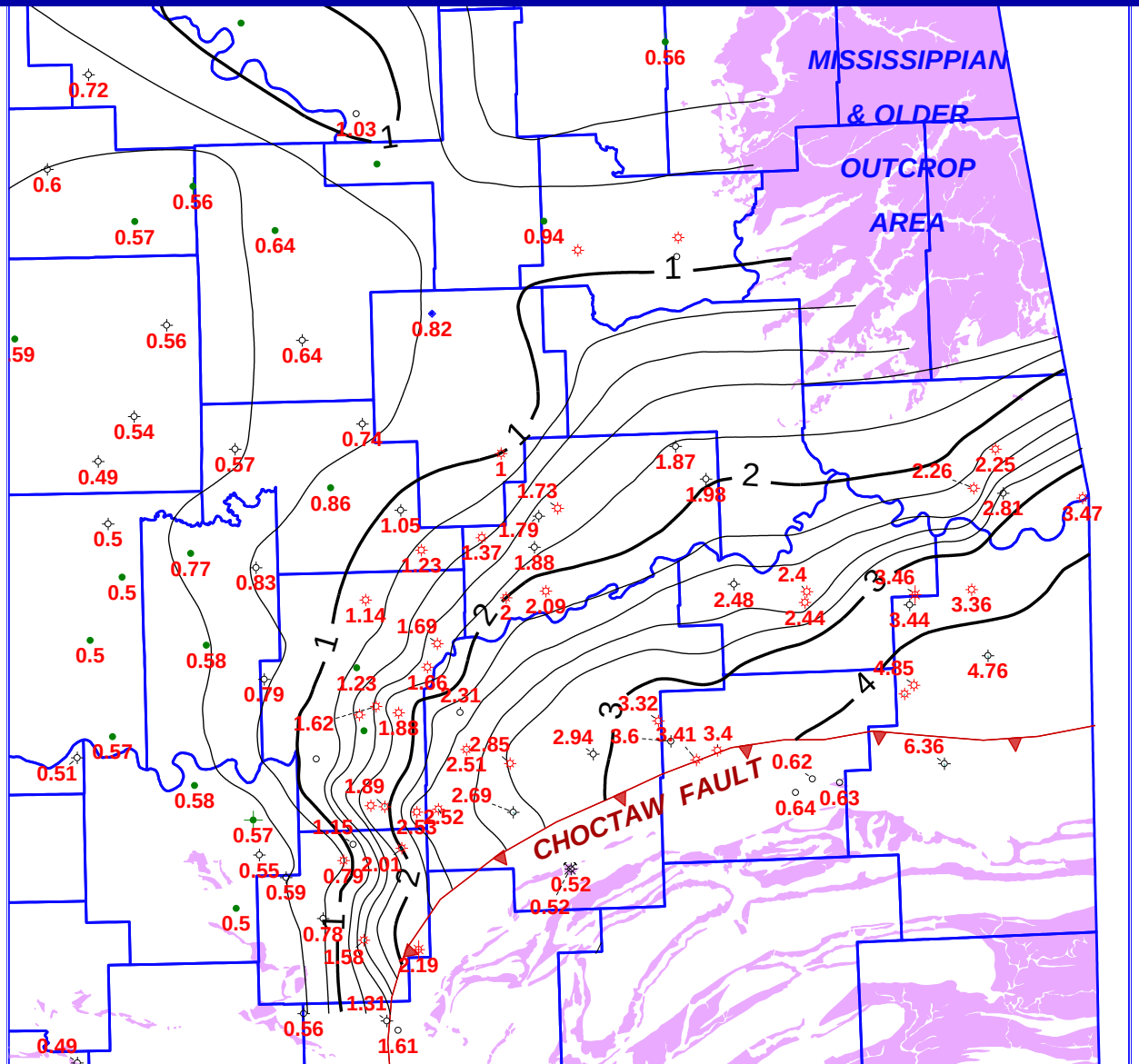
Vitrinite Reflectance of Woodford Shale, Eastern Oklahoma



VRo mean based on minimum of 20 measurements from whole-rock pellets

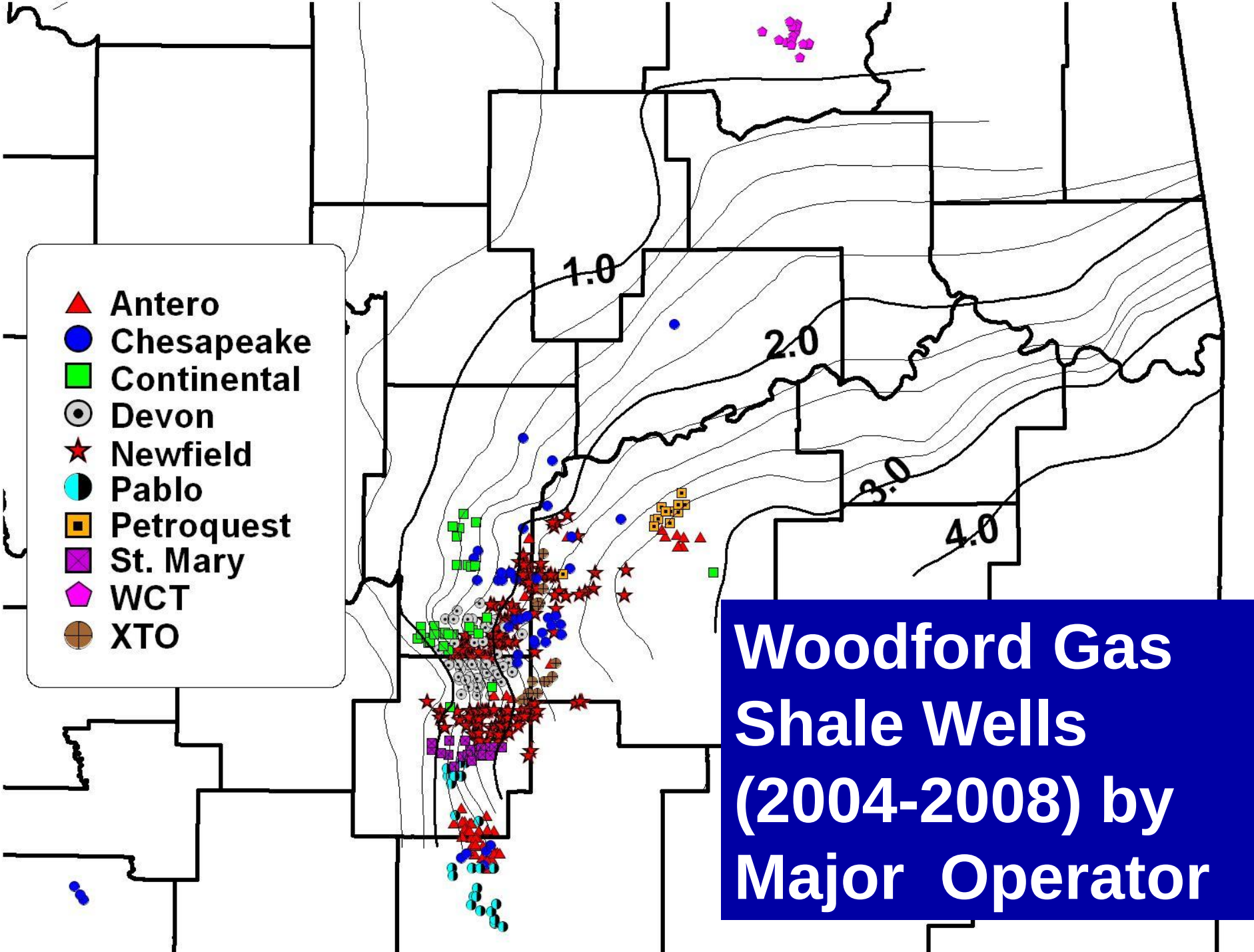
Cardott, in preparation

Isoreflectance Map of the Woodford Shale in Eastern Oklahoma



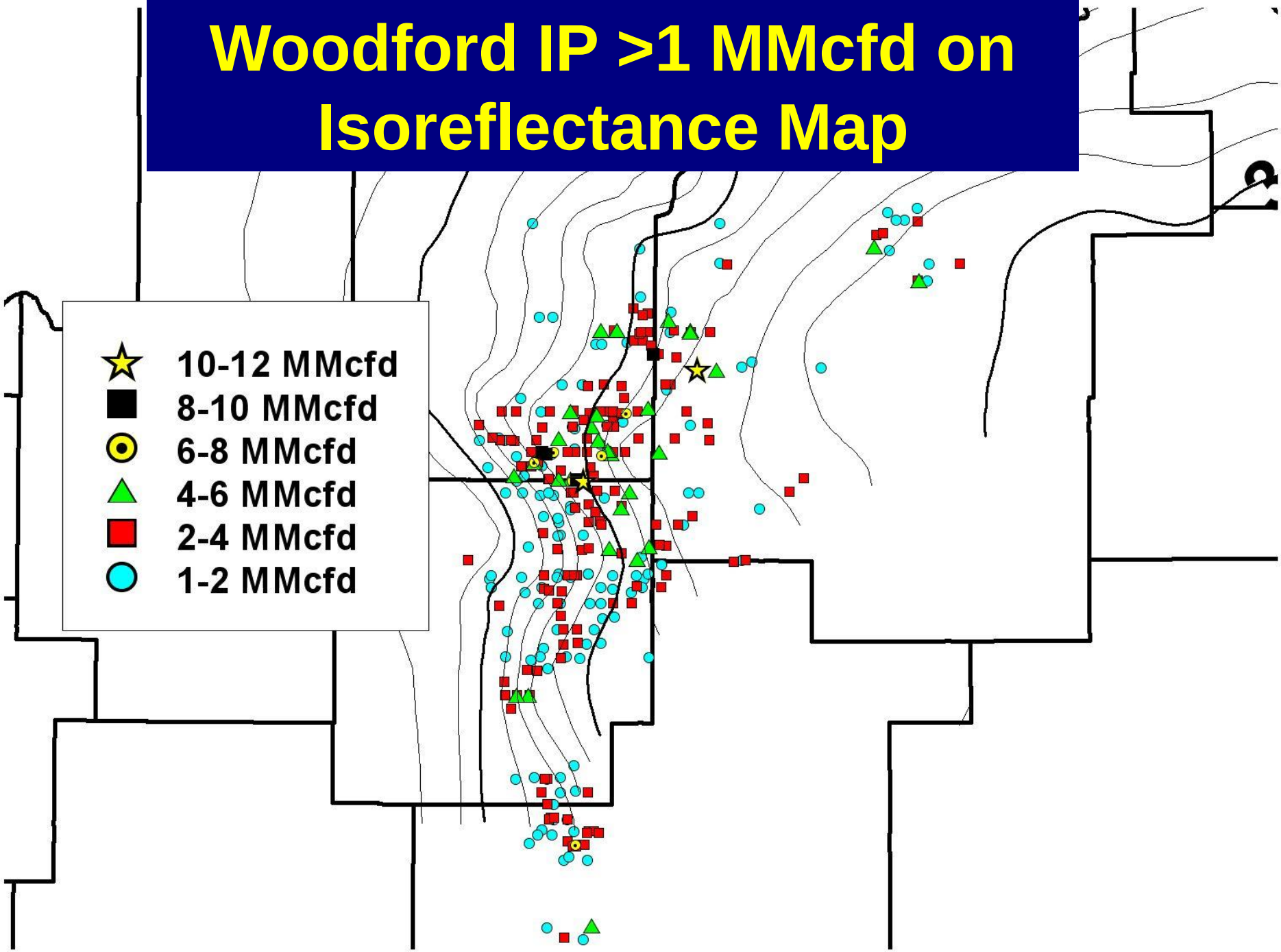
Map prepared by R. Vance Hall using Petra

Cardott, in preparation



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

Woodford IP >1 MMcfd on Isoreflectance Map



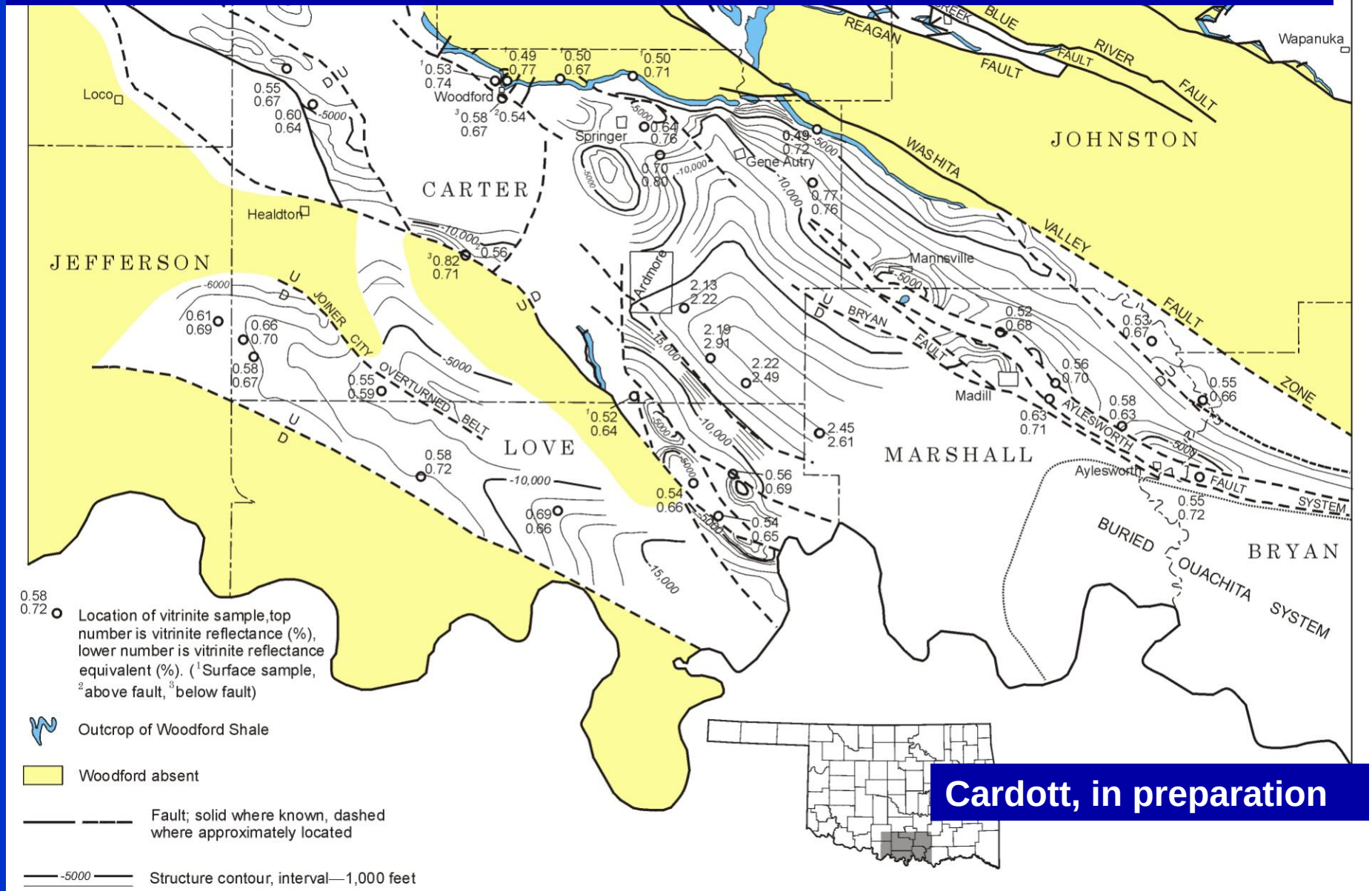
Woodford Gas-Shale Play is primarily in eastern Oklahoma (western Arkoma Basin) where the shale is:

(1) in the gas window (pushing the lower limits to the west and upper limits to the east)

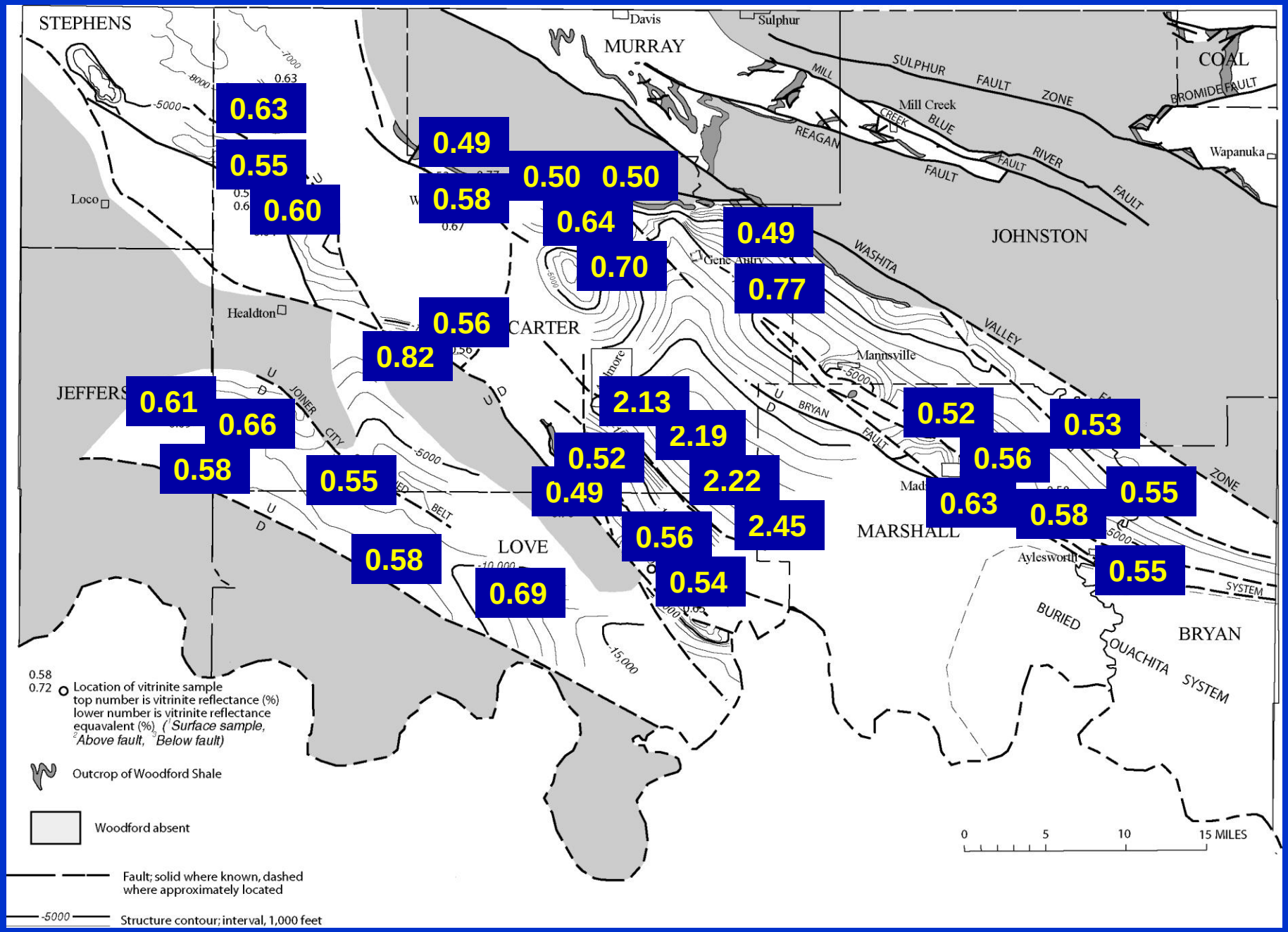
(2) greater than 100 ft thick

(3) relatively shallow (<12,000 ft)

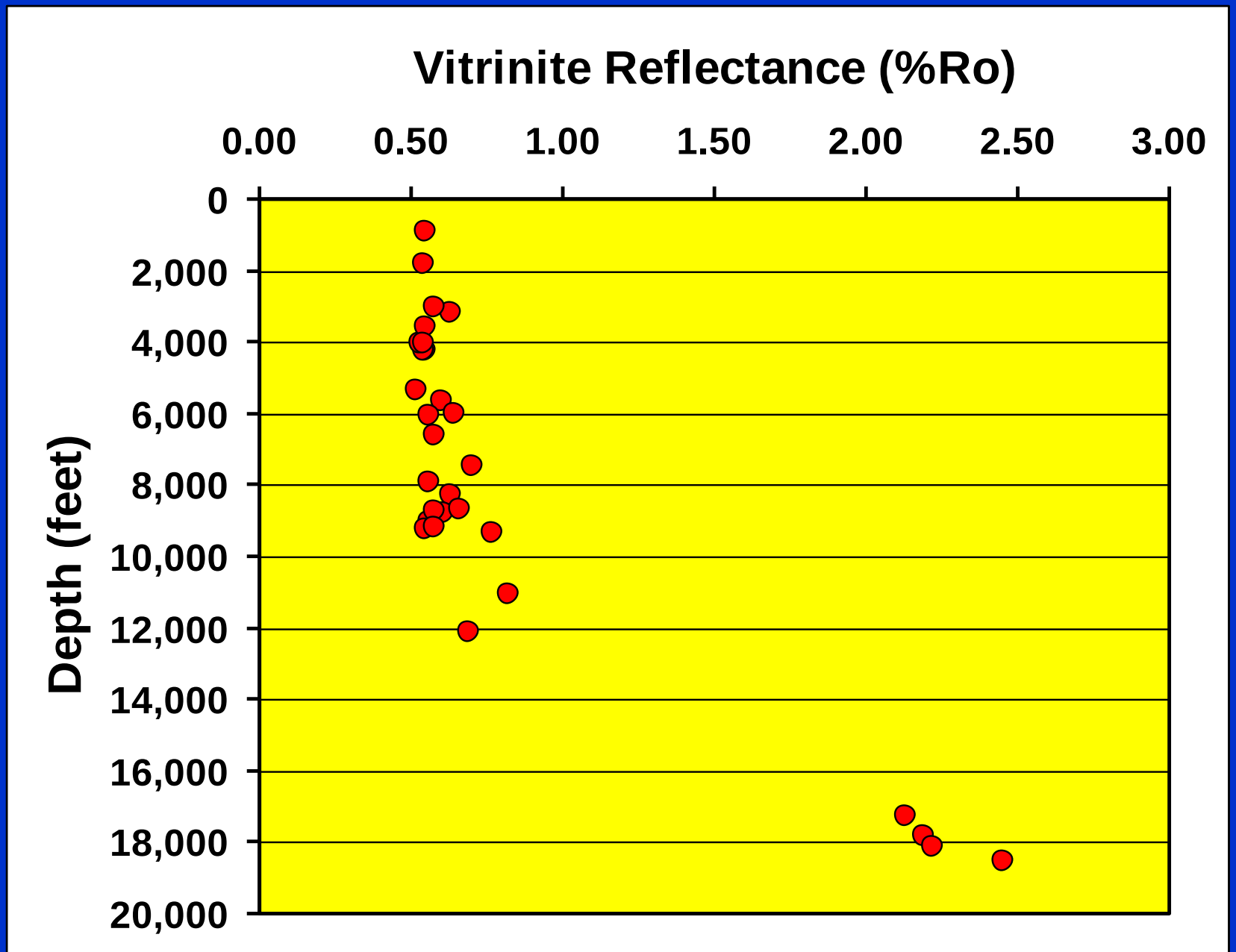
Structure and Vitrinite Reflectance of Woodford Shale, Southern Oklahoma



Cardott, in preparation


STEPHENS
MURRAY
COAL
JOHNSTON
CARTER
JEFFERS
LOVE
MARSHALL
BRYAN
Davis
Sulphur
Mill Creek
Wapanuka
Loco
Healdton
Mannsville
Aylesworth
SULPHUR FAULT ZONE
MILL CREEK
BLUE RIVER FAULT
REAGAN FAULT
BROMIDE FAULT
WASHITA VALLEY FAULT
JOINER CITY BELT
BRYAN FAULT ZONE
BURIED OUACHITA SYSTEM
0.63
0.55
0.60
0.49
0.58
0.50
0.50
0.64
0.70
0.49
0.77
0.56
0.82
0.61
0.66
0.58
0.55
2.13
2.19
0.52
0.49
2.22
0.56
2.45
0.54
0.69
0.58
0.52
0.53
0.56
0.63
0.58
0.55
0.55
0.58
0.72 Location of vitrinite sample top number is vitrinite reflectance (%) lower number is vitrinite reflectance equavalent (%) (1 Surface sample, 2 Above fault, 3 Below fault)
Outcrop of Woodford Shale
Woodford absent
Fault; solid where known, dashed where approximately located
-5000 Structure contour; interval, 1,000 feet
0 5 10 15 MILES

Southern Oklahoma VRo vs Depth



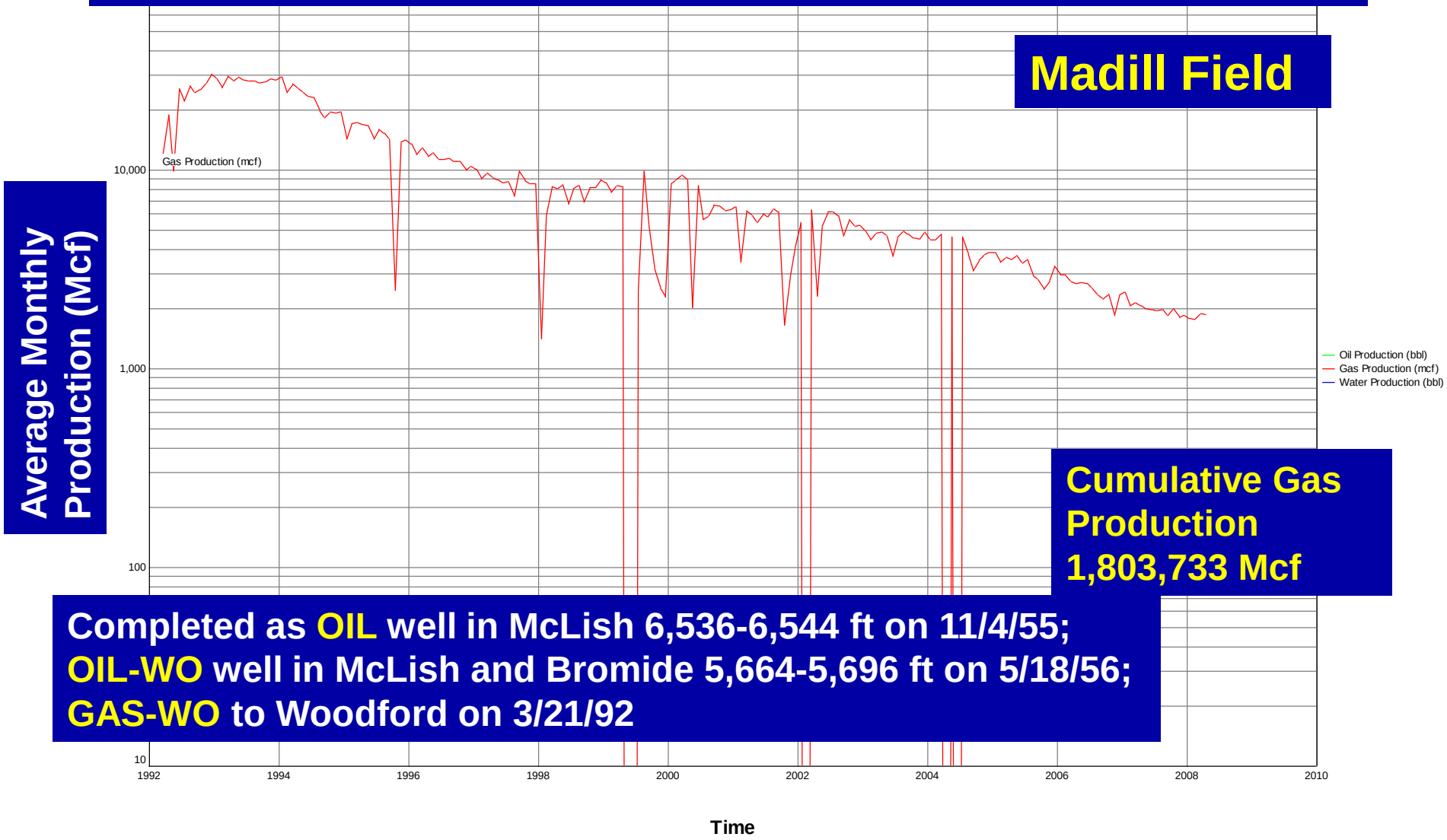
Woodford Gas Shales

1939-1996

21 Wells

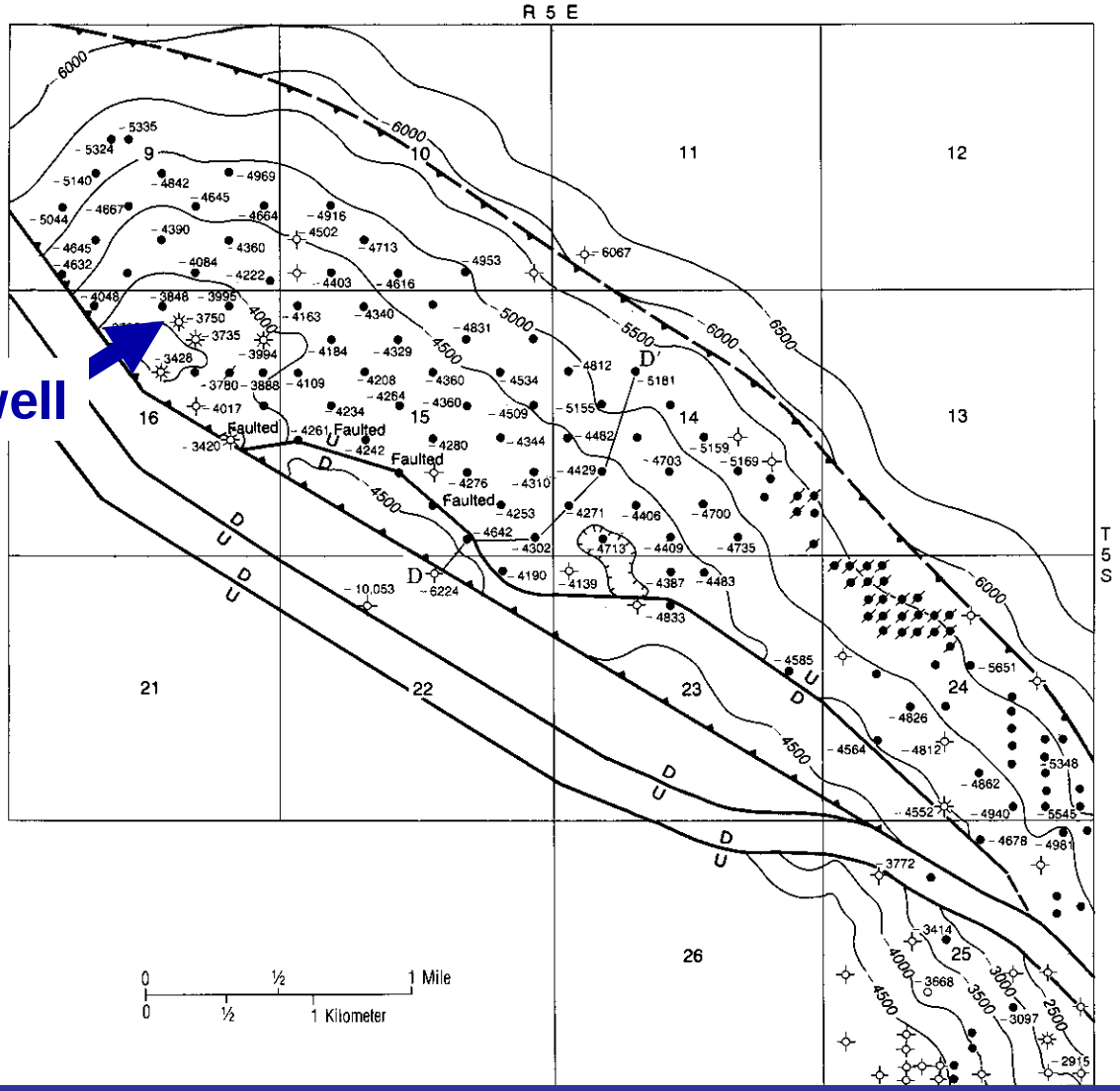
1 Sycamore/Woodford

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



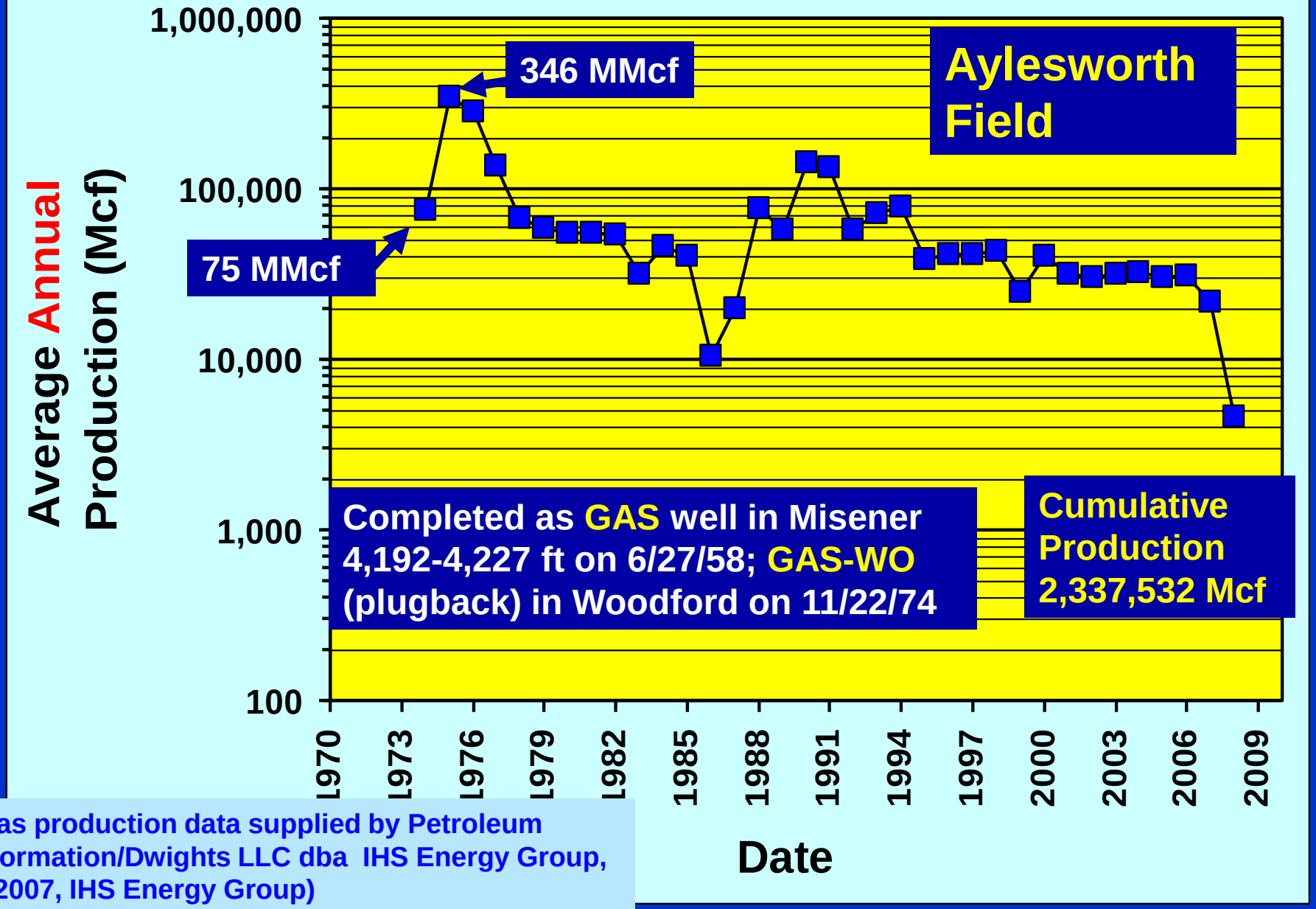
(Gas production data supplied by Petroleum Information/Dwights LLC dba IHS Energy Group, © 2007, IHS Energy Group)

3 Griffin-Olmstead well

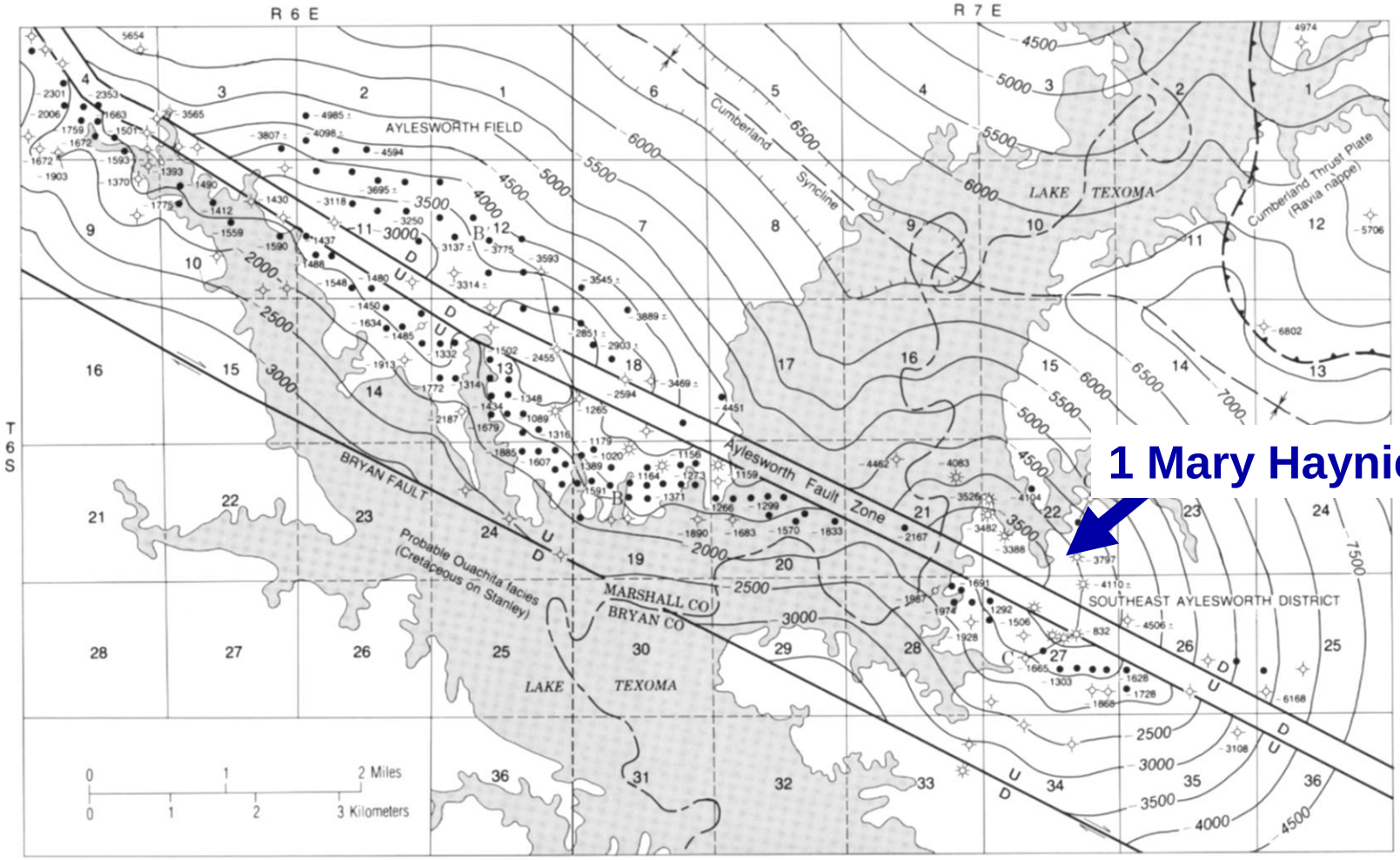


Structure contour map of the top of the Viola Group (Ordovician) in the North Madill field (from Huffman and others, 1987)

Verdad Oil & Gas 1 Mary Haynie
(Bryan CO, 22-6S-7E; IP 962 Mcfd; 3,710-4,054 ft)

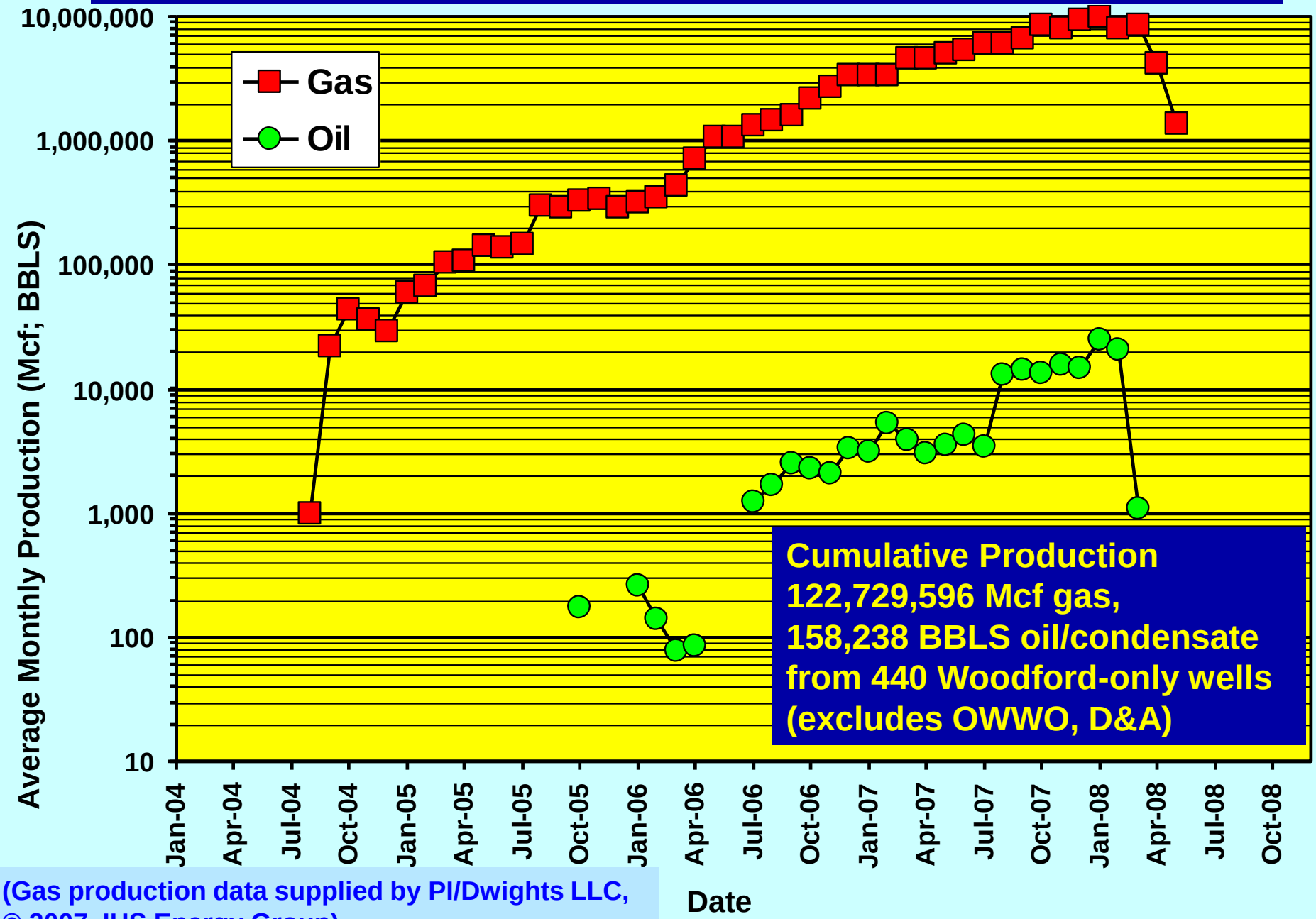


(Gas production data supplied by Petroleum Information/Dwights LLC dba IHS Energy Group, © 2007, IHS Energy Group)



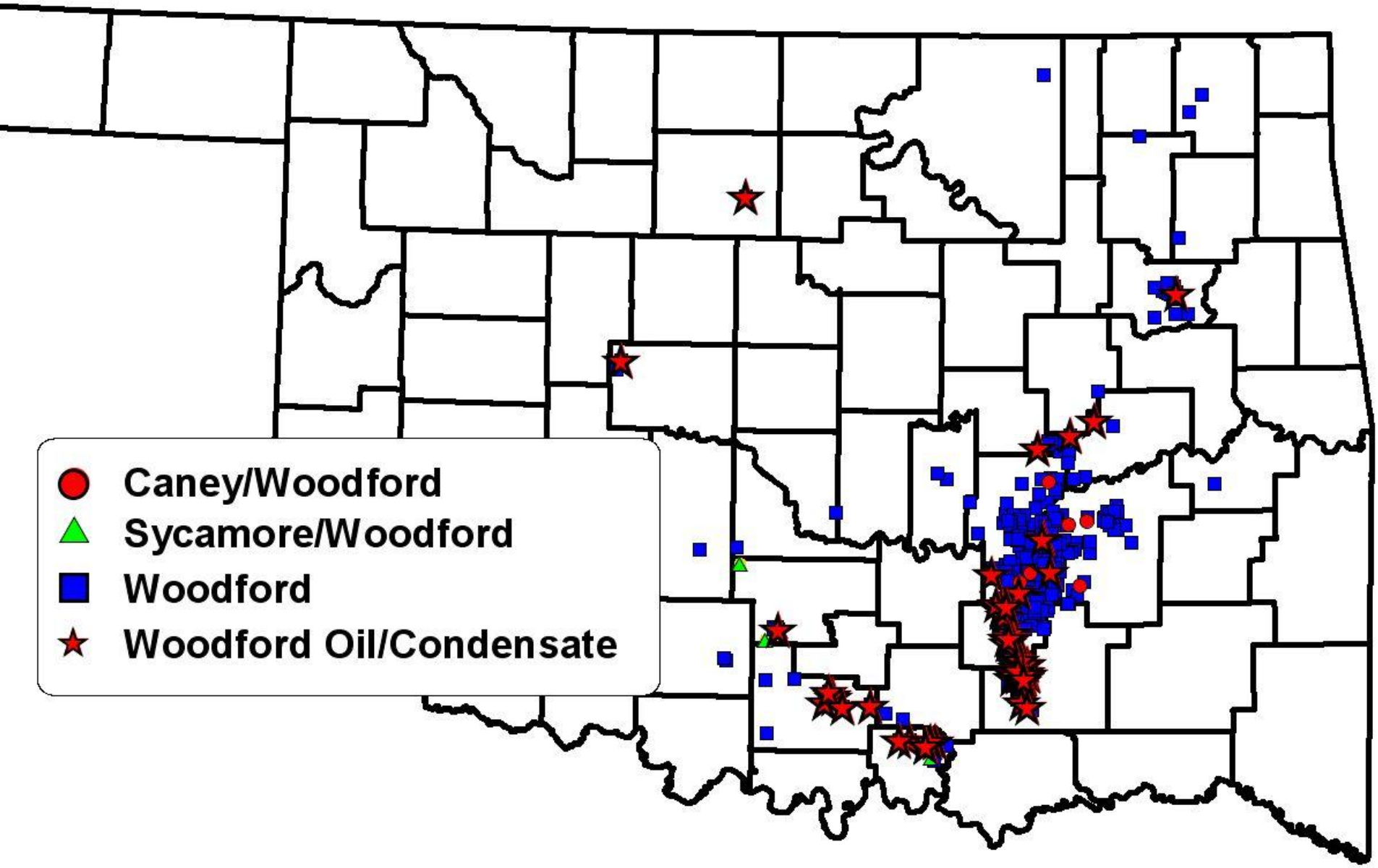
Structure contour map of the top of the Viola Group (Ordovician) in the Aylesworth and SE Aylesworth District fields (from Huffman and others, 1987)

Woodford Shale Production (2004-2008 wells)

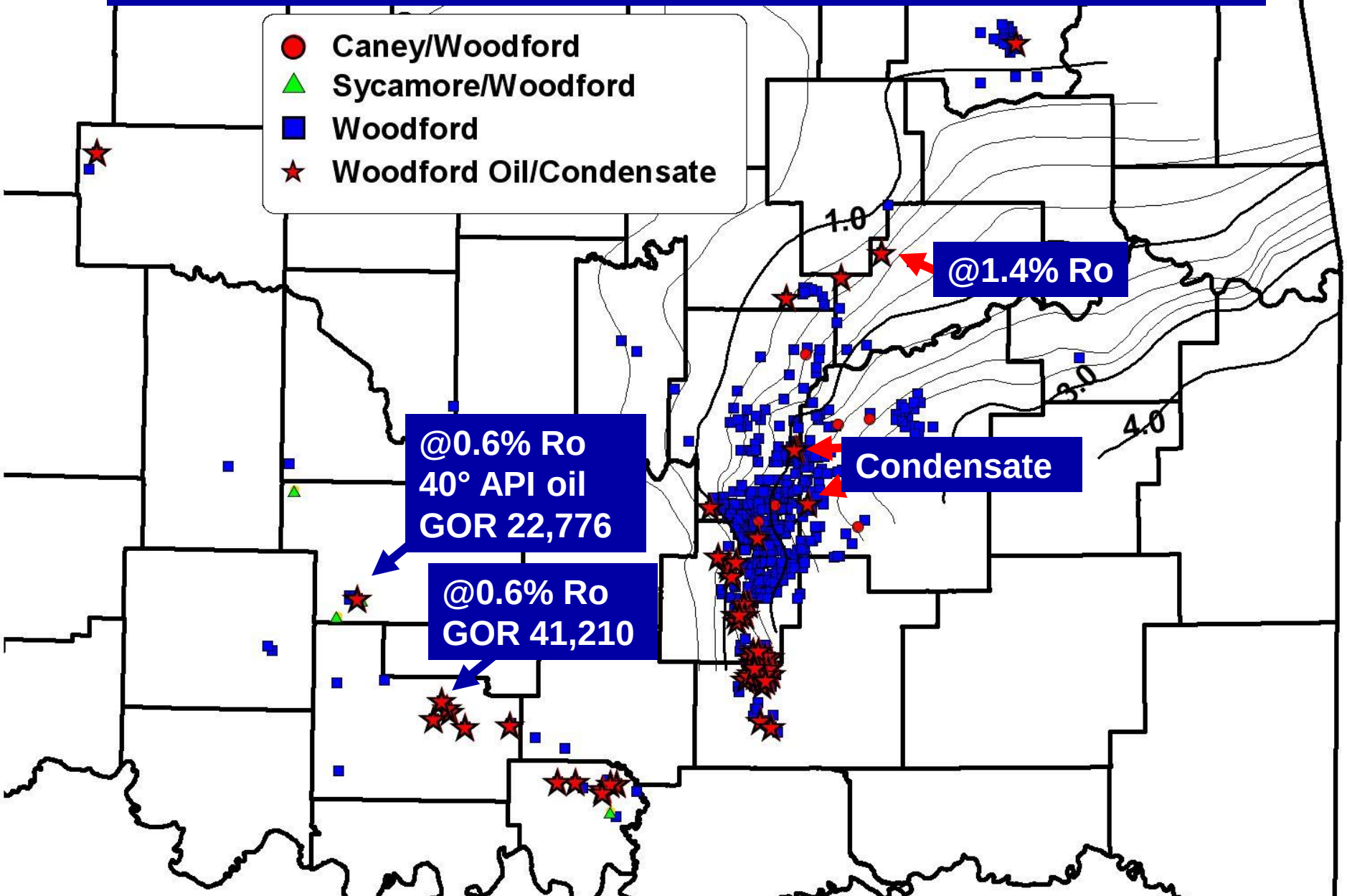


(Gas production data supplied by PI/Dwights LLC, © 2007, IHS Energy Group)

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



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



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% Ro
- Some Woodford Shale gas potential is in southern Oklahoma at <1.1% Ro

http://www.ogs.ou.edu/oilgas.php

Oklahoma Geological Survey

http://www.ogs.ou.edu

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- OGS Oil and Gas Related Publications
- Type Logs
- Oklahoma Stratigraphic Columns
- Field Discovery Wells (Excel format)
- Links
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- Milestones in the Oklahoma Oil and Gas Industry

Oklahoma Hydrocarbon Source Rocks and Gas Shales

- References
- Presentations & Reports
- Oklahoma Gas-Shale Completions Map, 1939-2007
- Woodford Shale Gas Well Completions Map, 1939-2007
- Gas Shales Database

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

Brian J. Cardott
Oklahoma Geological Survey

- Bibliography of Caney Shale
- Bibliography of Excello Shale
- Bibliography of Woodford Shale
- Bibliography of Oklahoma Asphalt
- Bibliography of Oklahoma Rock-Eval
- Bibliography of Oklahoma Solid Hydrocarbons
- Bibliography of Oklahoma Gas Shales
- Bibliography of Oklahoma Hydrocarbon Source Rocks

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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

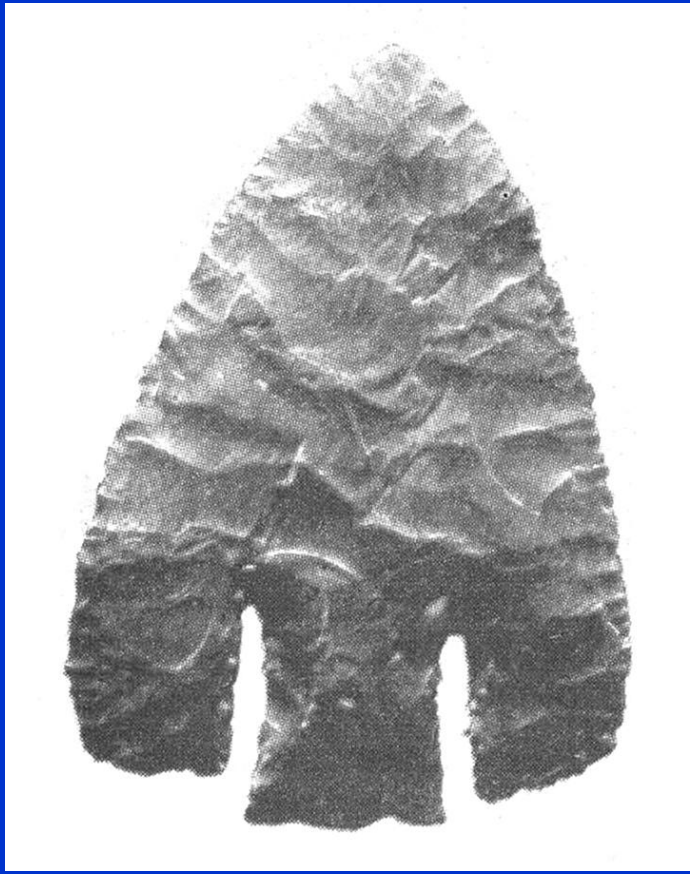
Microsoft Excel - GasShales598-2

File Edit View Insert Format Tools Data Window Help Adobe PDF

V1 | Initial_Potential_(MCFD)

	A	B	C	D	E	
1	ecord	API Number	Operator	Completion_Date	Well_Name	F
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	Coalga
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)