AAPG Mid-Continent Section Meeting

October 12, 2009

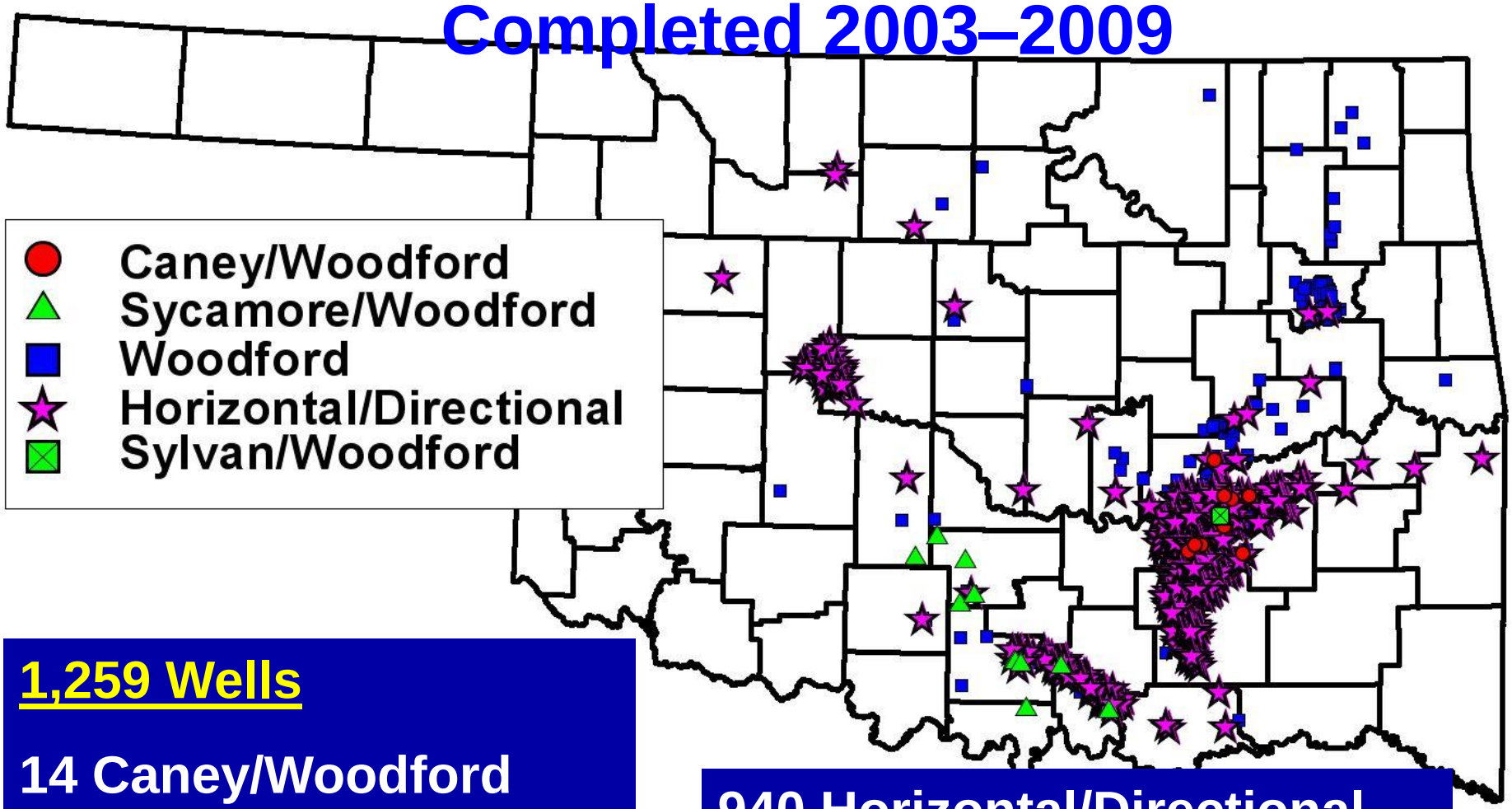
Application of Vitrinite Reflectance to the Woodford Gas-Shale Play in Oklahoma

Brian J. Cardott

Oklahoma Geological Survey

Woodford Gas-Shale Wells

Completed 2003–2009



1,259 Wells

14 Caney/Woodford

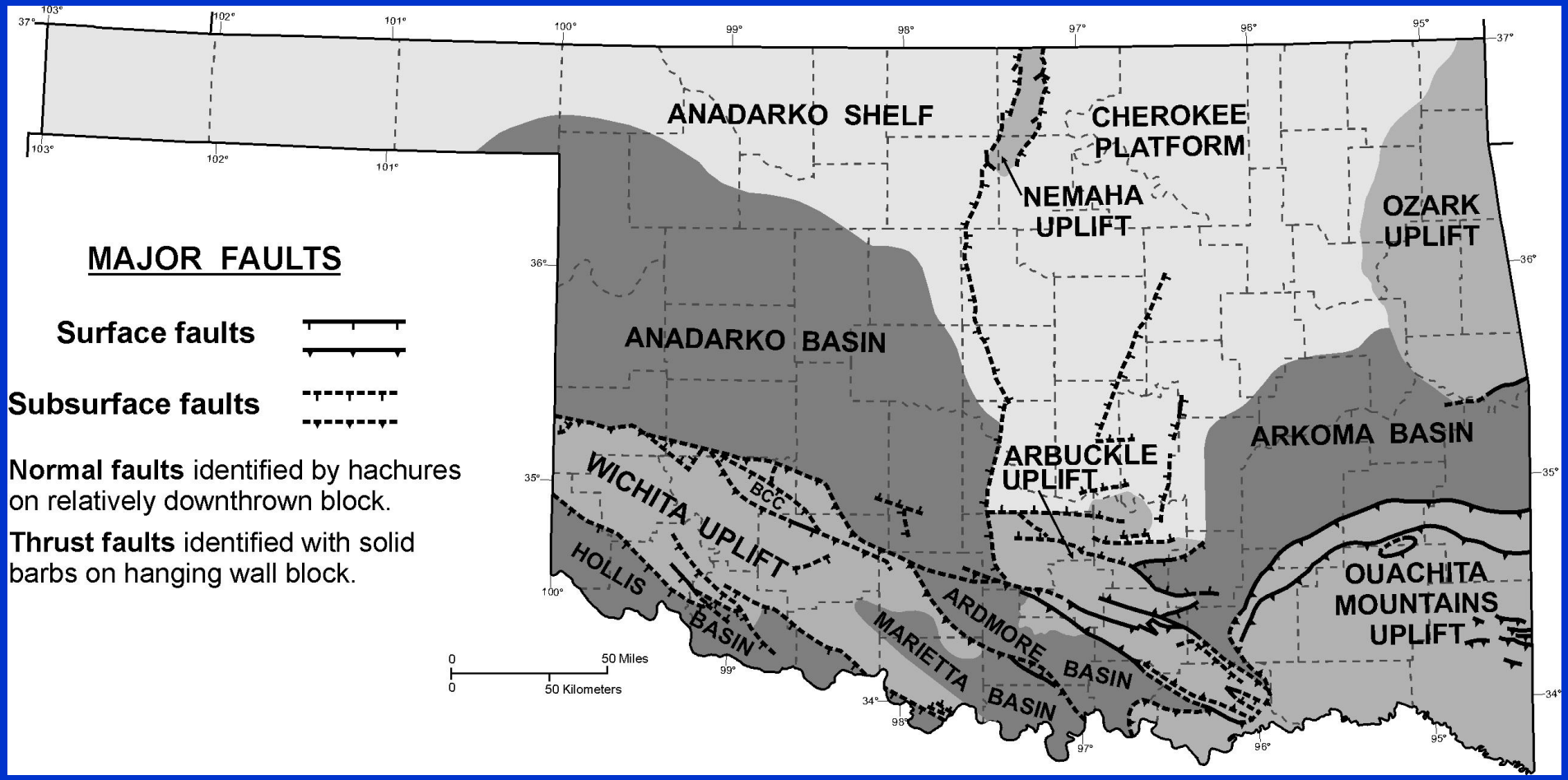
11 Sycamore/Woodford

293 Vertical Woodford

940 Horizontal/Directional Woodford (75%)

1 Sylvan/Woodford

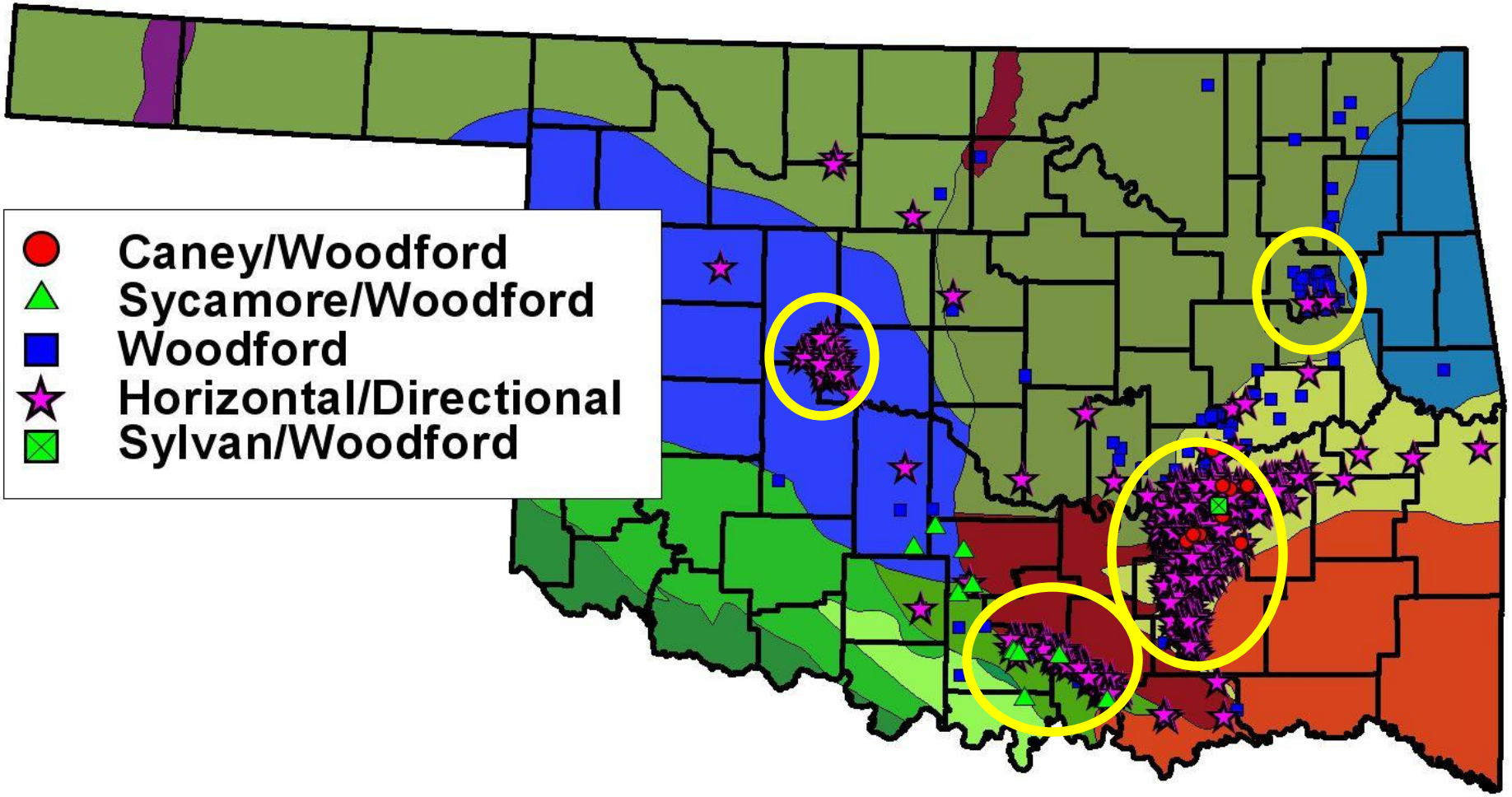
Geologic Provinces of Oklahoma



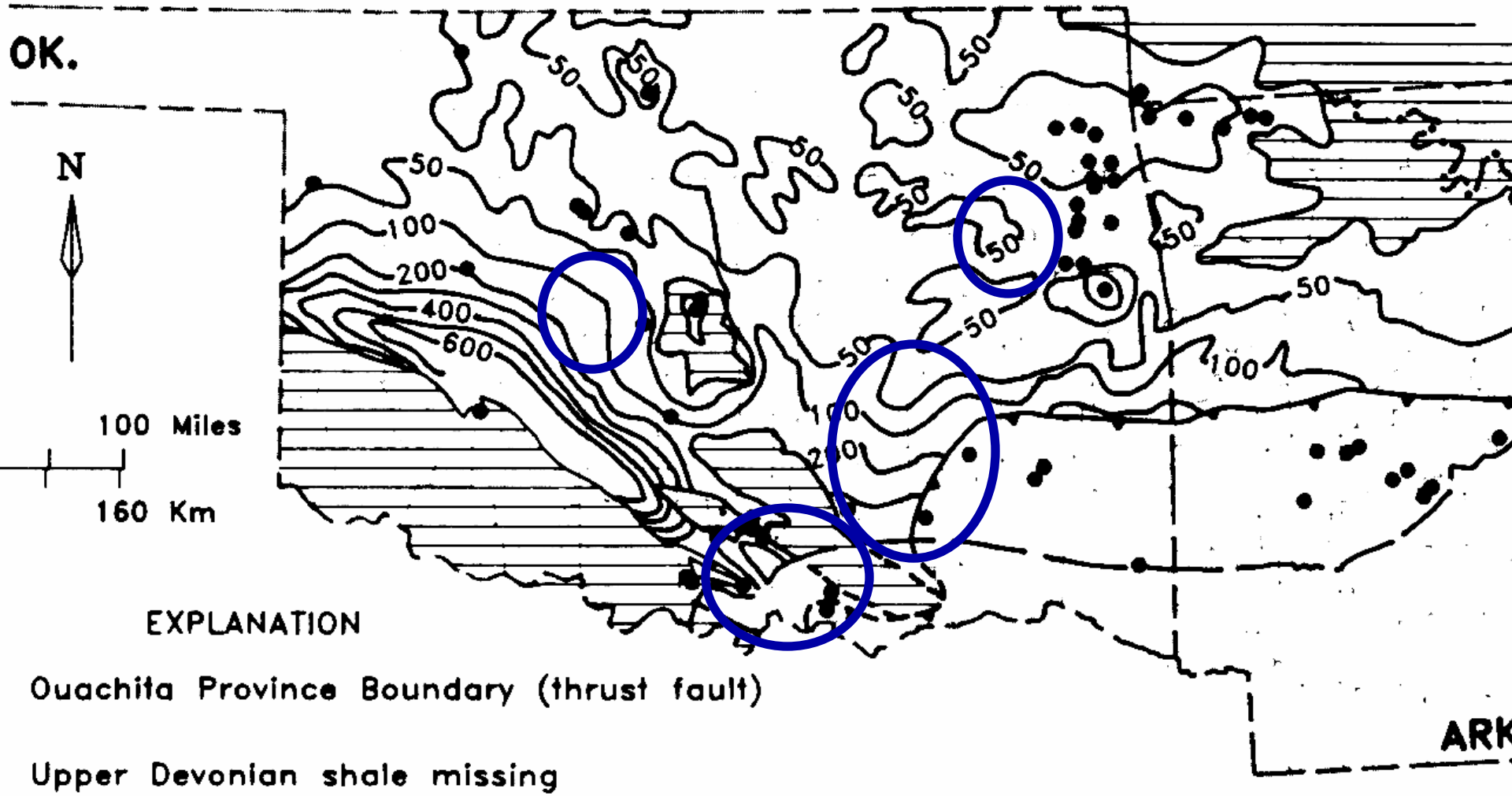
Northcutt and Campbell, 1995

Woodford Gas-Shale Wells

Completed 2003–2009



Isopach Map of Woodford Shale



EXPLANATION

Ouachita Province Boundary (thrust fault)

Upper Devonian shale missing

Cretaceous overlap

Erosional limit of Sylamore Ss.
(basal ss. of Chattanooga)

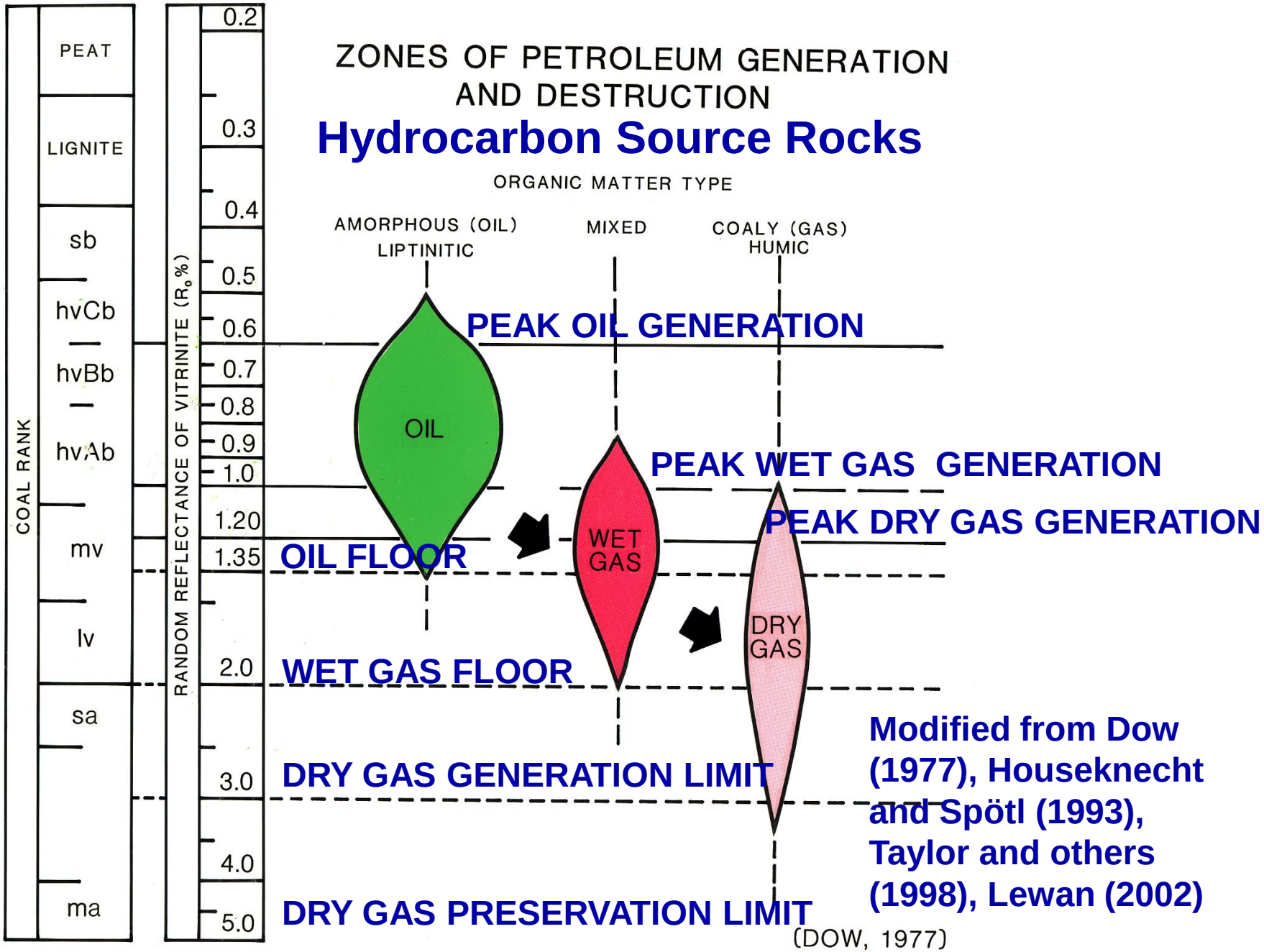
From Comer, 1992

Hydrocarbon generation depends on type, quantity, and thermal maturity of organic matter (kerogen)

What is Vitrinite and Vitrinite Reflectance?

Vitrinite is a coal maceral (organic) derived from the cell wall material or woody tissues of vascular plants (post Silurian)

Vitrinite Reflectance (%Ro) is a measurement of the percentage of light reflected off the vitrinite maceral at high (500X) magnification in oil immersion (average of many values)

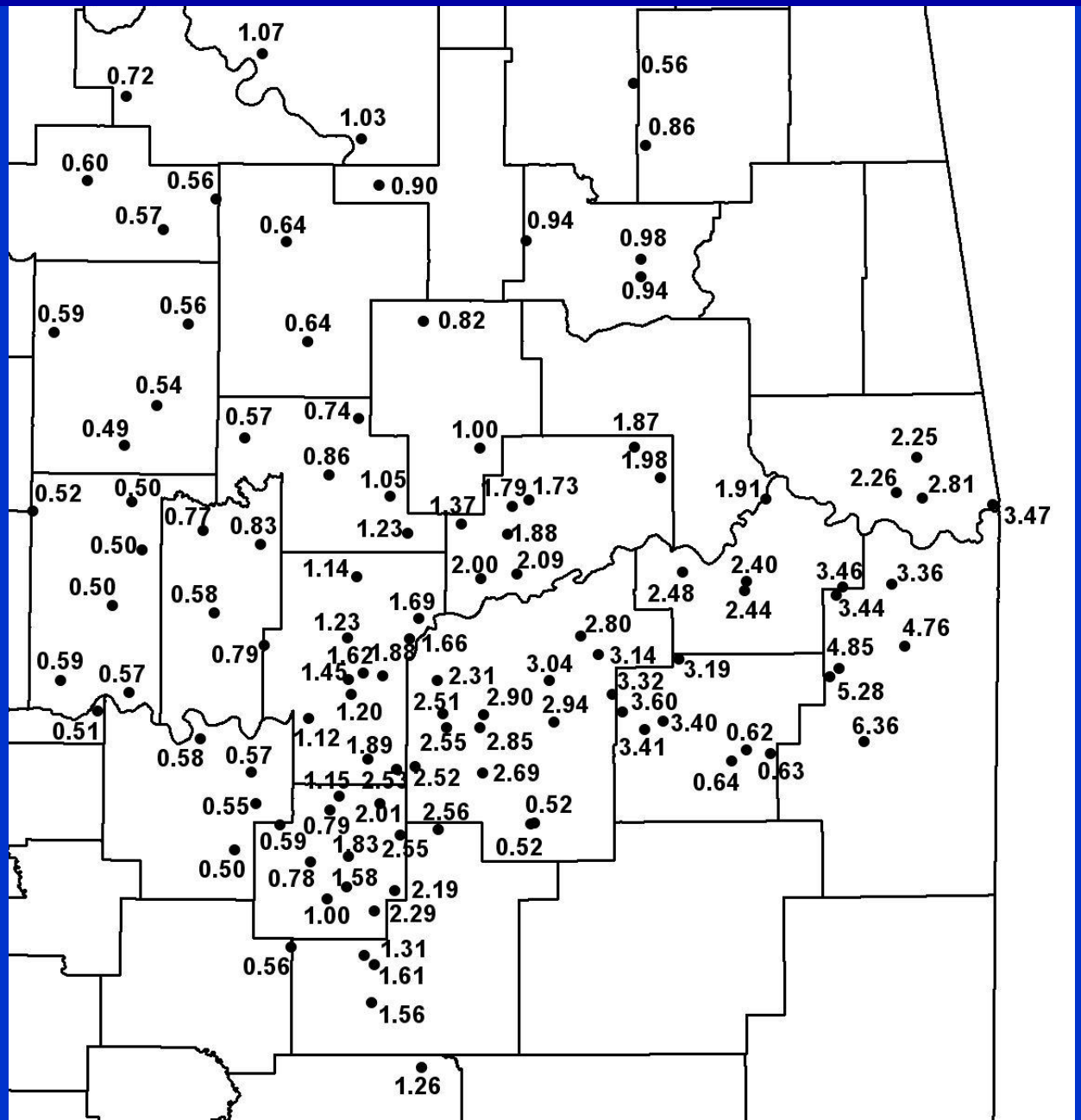

ZONES OF PETROLEUM GENERATION AND DESTRUCTION
Hydrocarbon Source Rocks
ORGANIC MATTER TYPE
AMORPHOUS (OIL) LIPTINITIC
MIXED
COALY (GAS) HUMIC
COAL RANK
PEAT
LIGNITE
sb
hvCb
hvBb
hvAb
mv
lv
sa
ma
RANDOM REFLECTANCE OF VITRINITE (R_o%)
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1.0
1.20
1.35
2.0
3.0
4.0
5.0
OIL
WET GAS
DRY GAS
PEAK OIL GENERATION
PEAK WET GAS GENERATION
PEAK DRY GAS GENERATION
OIL FLOOR
WET GAS FLOOR
DRY GAS GENERATION LIMIT
DRY GAS PRESERVATION LIMIT
(DOW, 1977)
Modified from Dow (1977), Houseknecht and Spötl (1993), Taylor and others (1998), Lewan (2002)

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

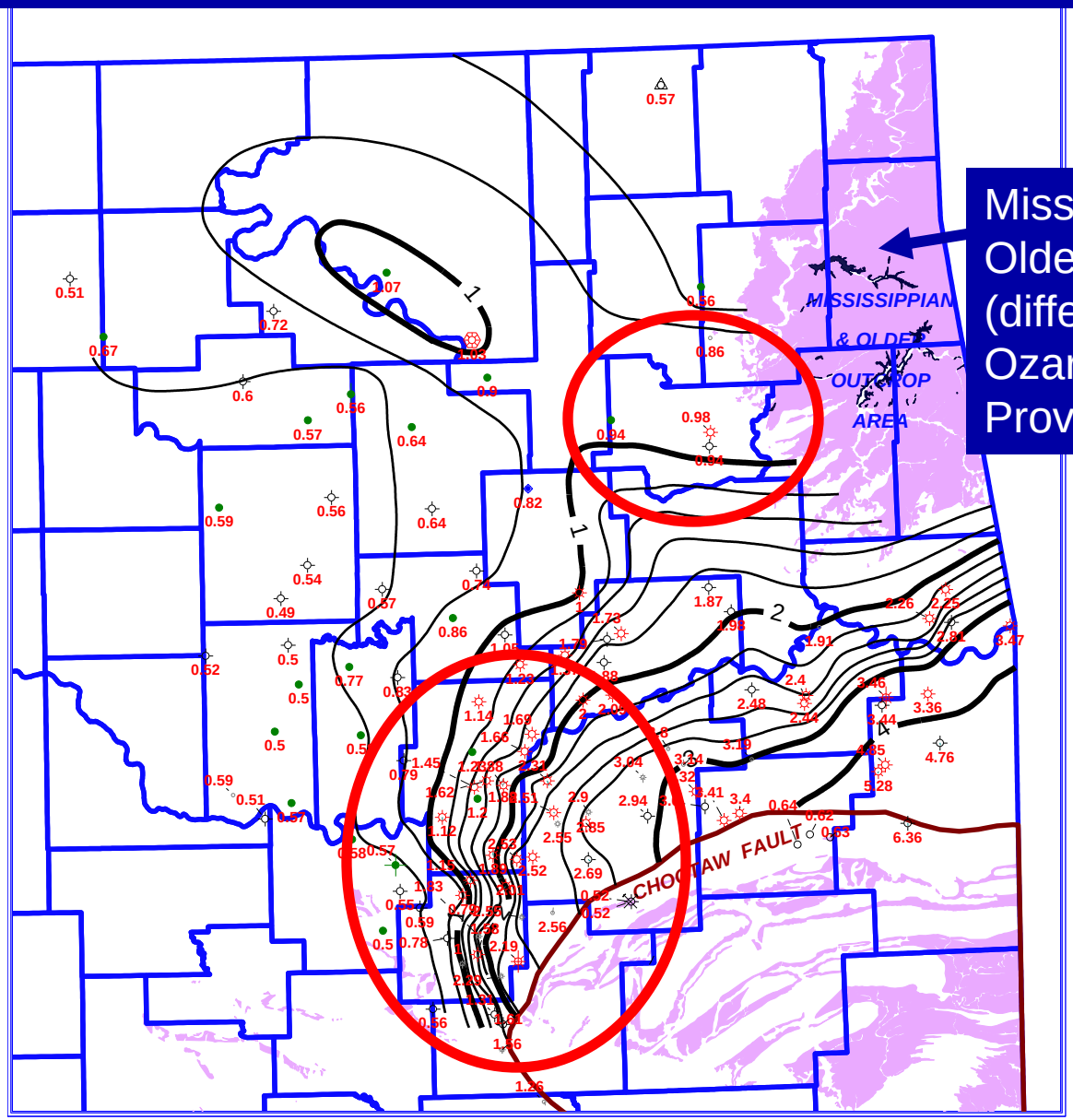
Eastern Oklahoma



Distribution of 112 Woodford Shale samples with vitrinite-reflectance data

Cardott, in preparation

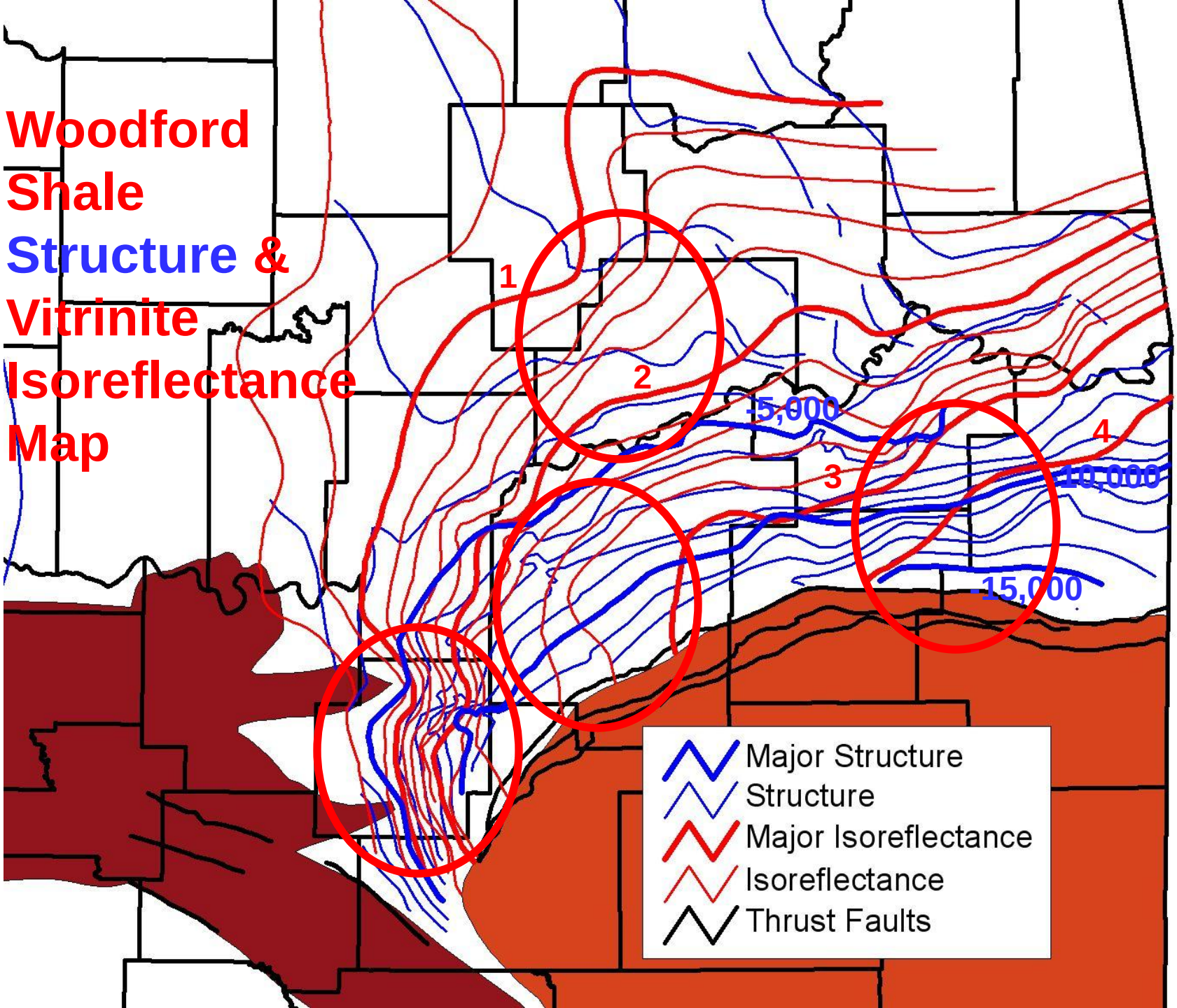
Isoreflectance Map of the Woodford Shale in Eastern Oklahoma (Updated October 2009)



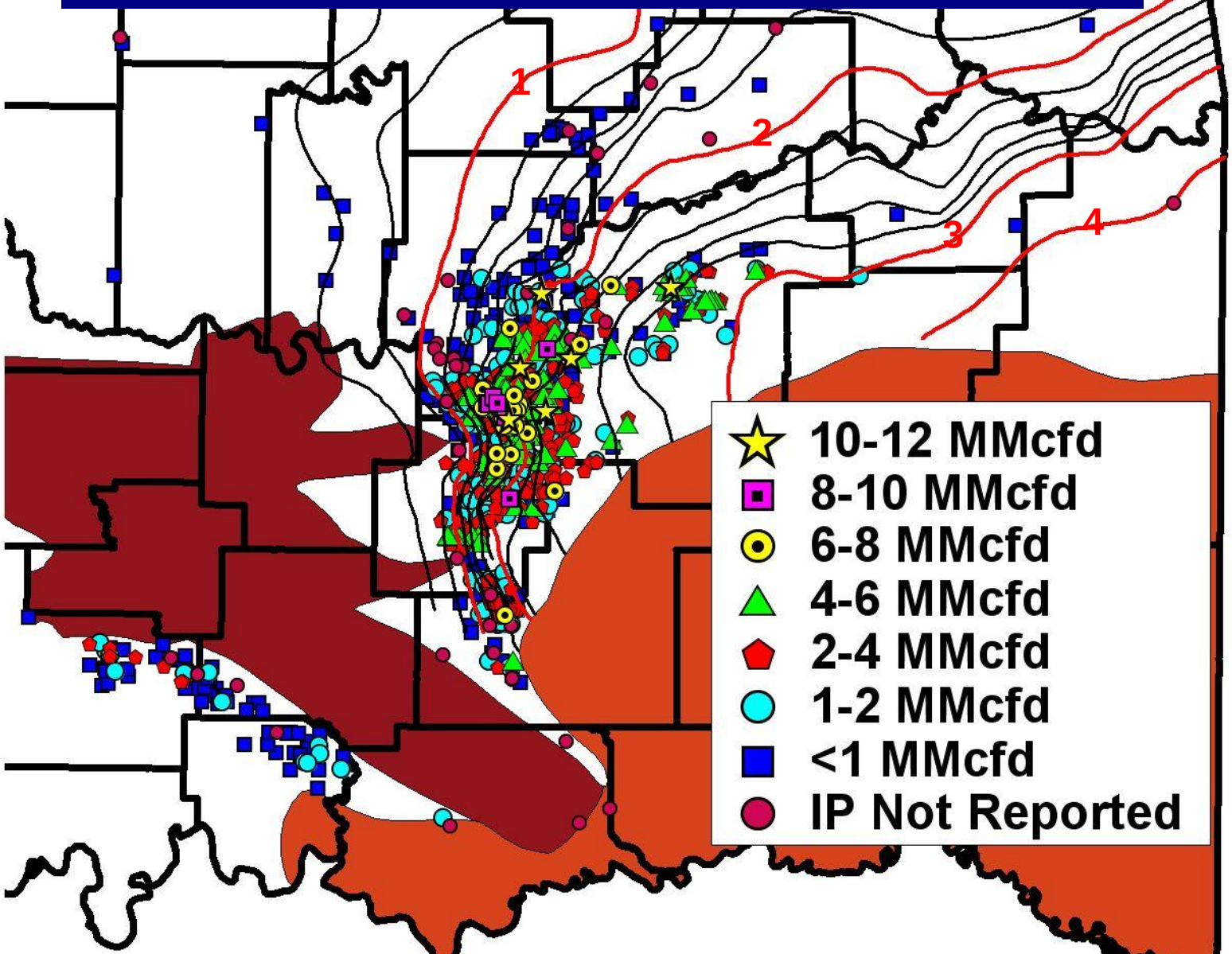
Mississippian and Older Outcrop Area (different than Ozark Uplift Province boundary)

Map prepared by R. Vance Hall using Petra

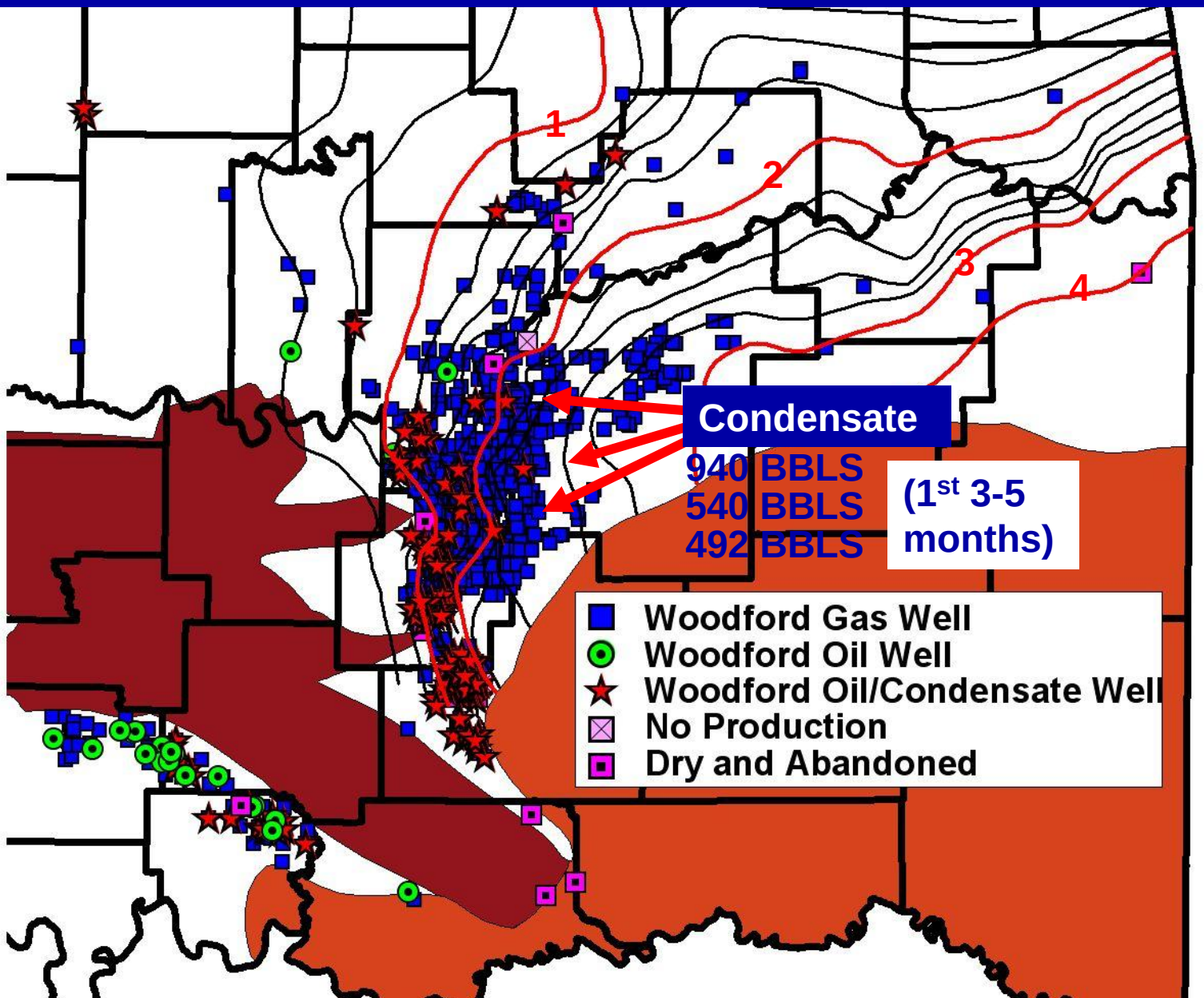
Cardott, in preparation


Woodford Shale Structure & Vitrinite Isoreflectance Map
1
2
3
4
-5,000
-10,000
-15,000
Major Structure
Structure
Major Isoreflectance
Isoreflectance
Thrust Faults

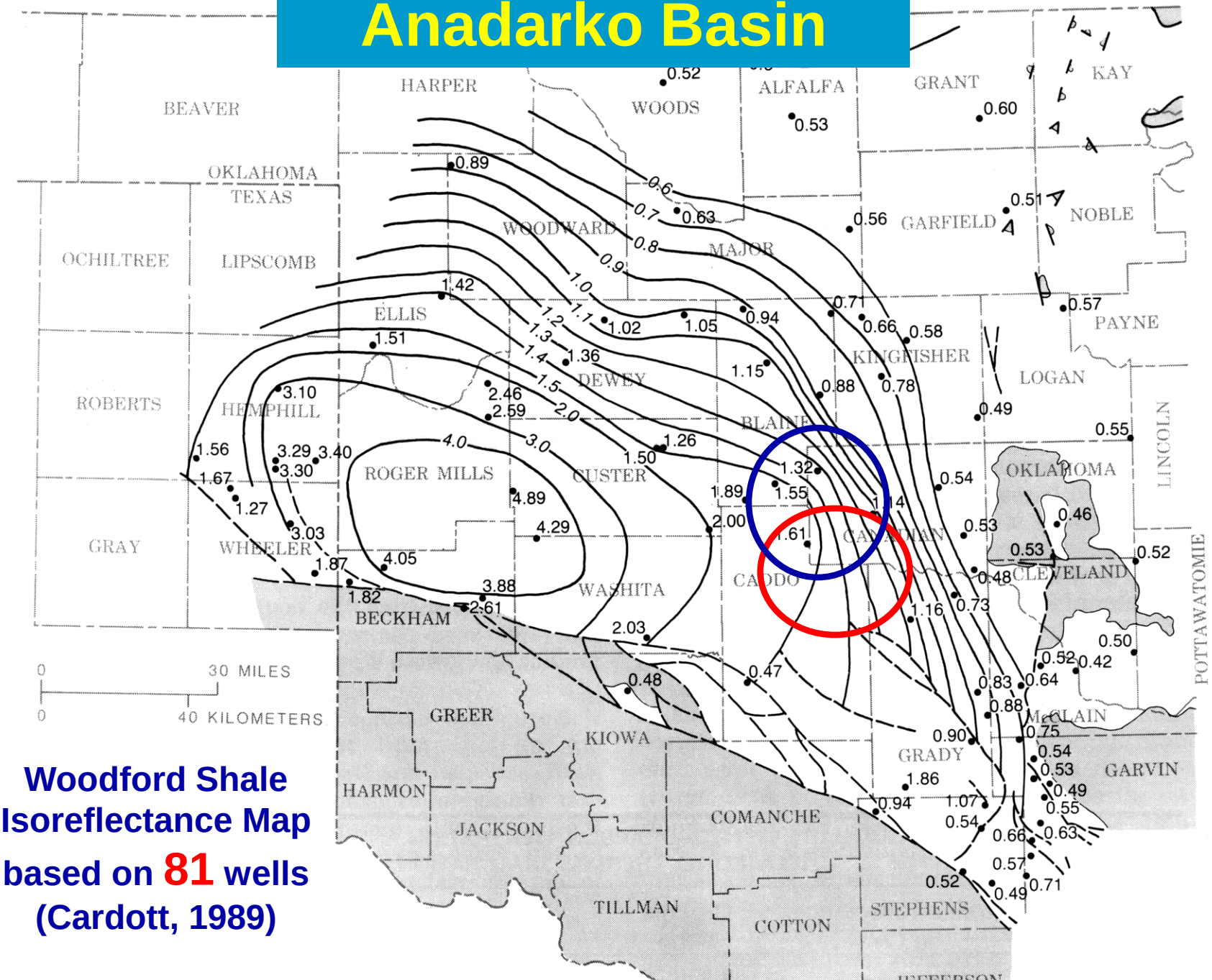
Woodford Initial Production on Isoreflectance Map



Woodford Shale Only Oil/Condensate Production (149 of 1,233 wells; 2005-2009)

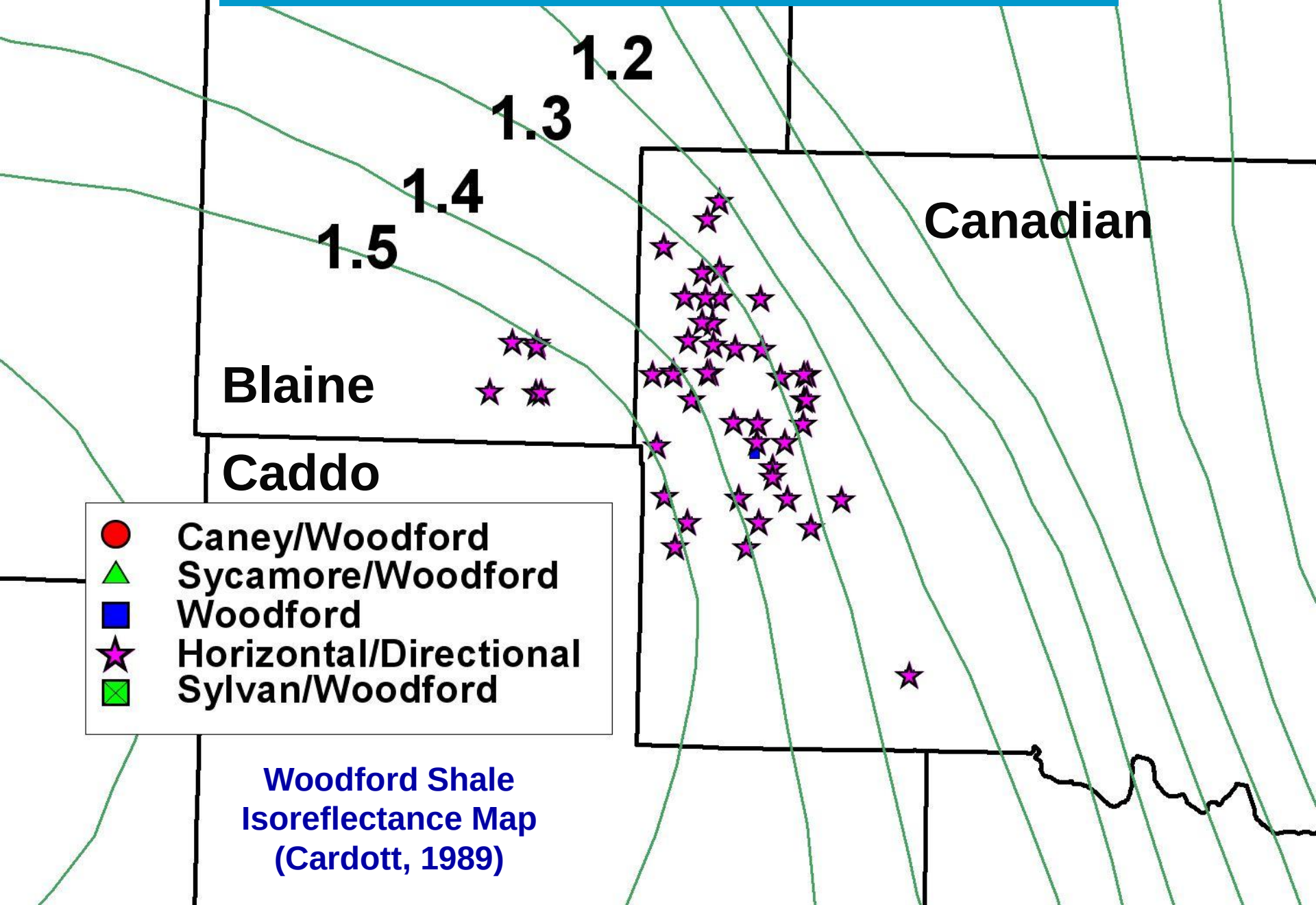


Anadarko Basin

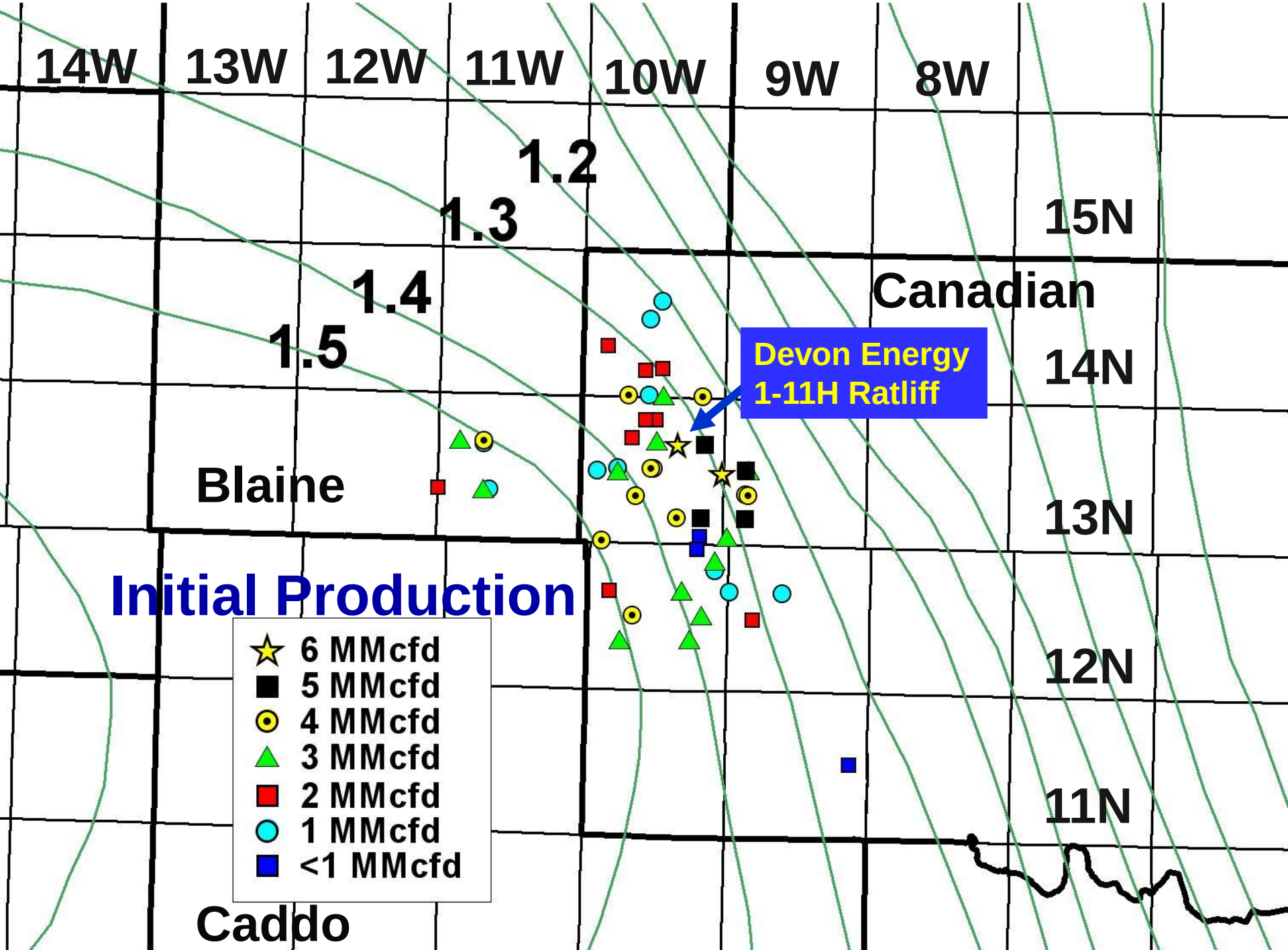


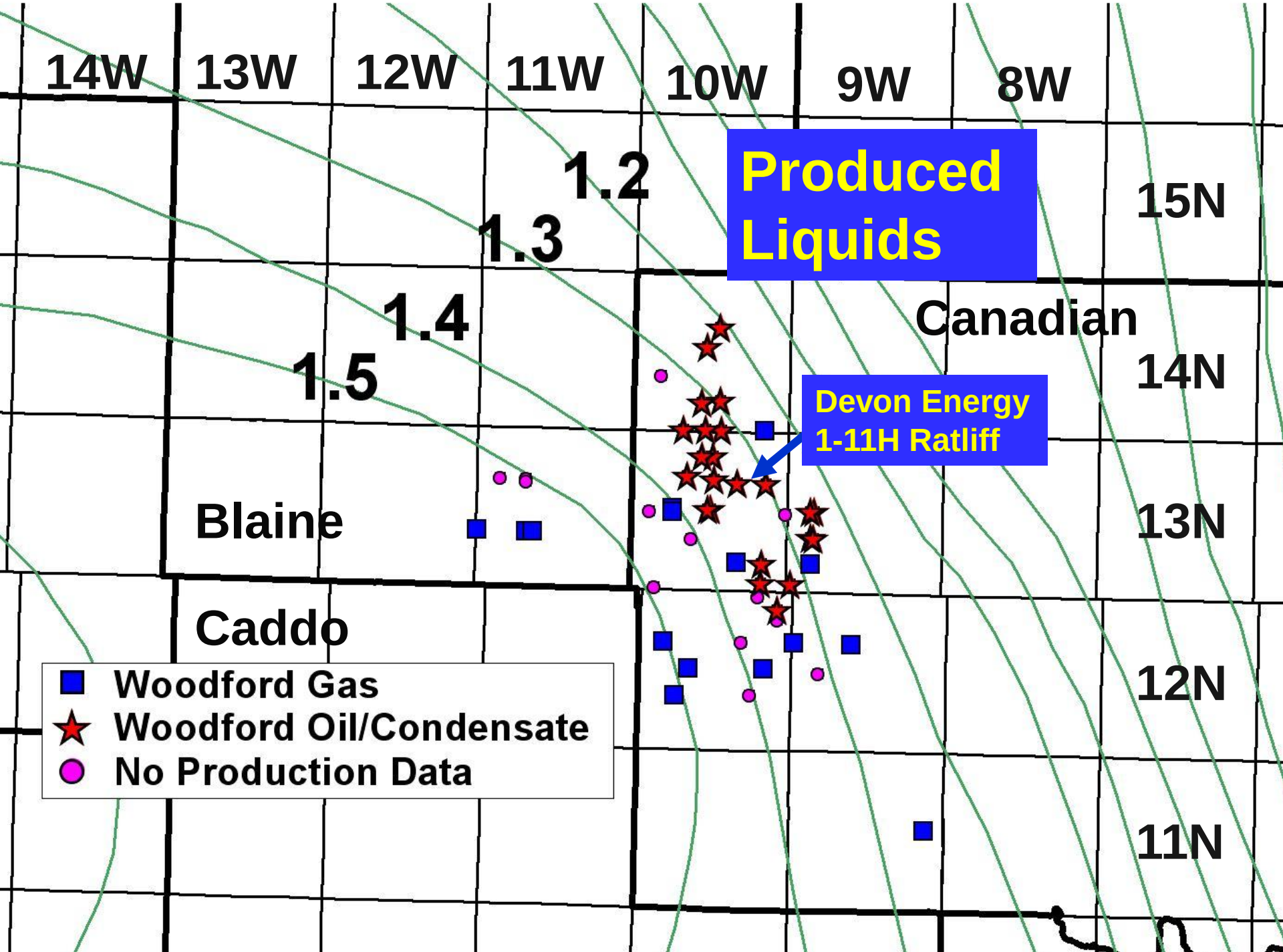
Woodford Shale Isoreflectance Map based on 81 wells (Cardott, 1989)

Anadarko Basin (2007-2009)

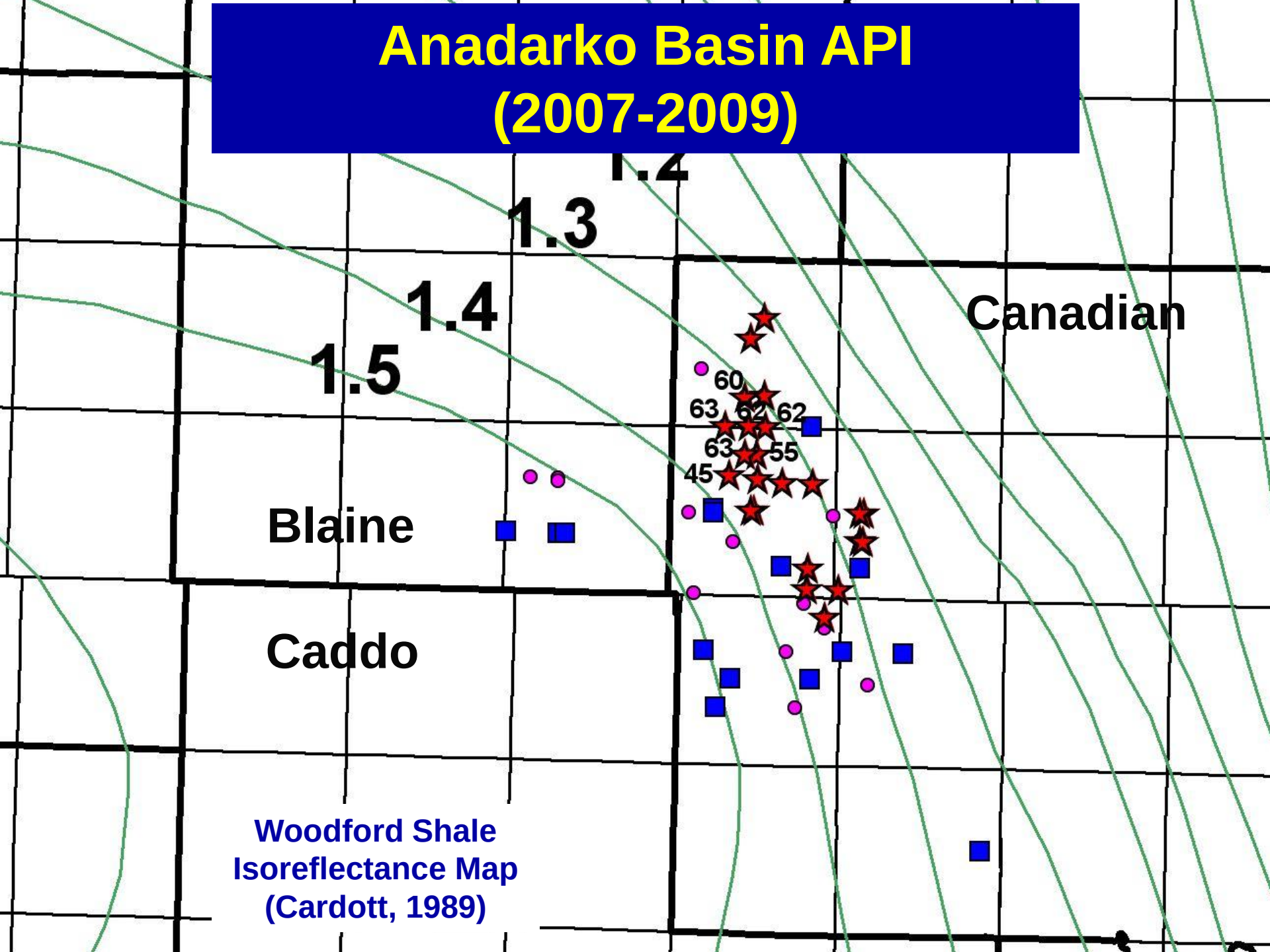


Woodford Shale
Isoreflectance Map
(Cardott, 1989)


14W
13W
12W
11W
10W
9W
8W
15N
14N
13N
12N
11N
1.2
1.3
1.4
1.5
Canadian
Blaine
Caddo
Devon Energy
1-11H Ratliff
Initial Production
6 MMcfd
5 MMcfd
4 MMcfd
3 MMcfd
2 MMcfd
1 MMcfd
<1 MMcfd

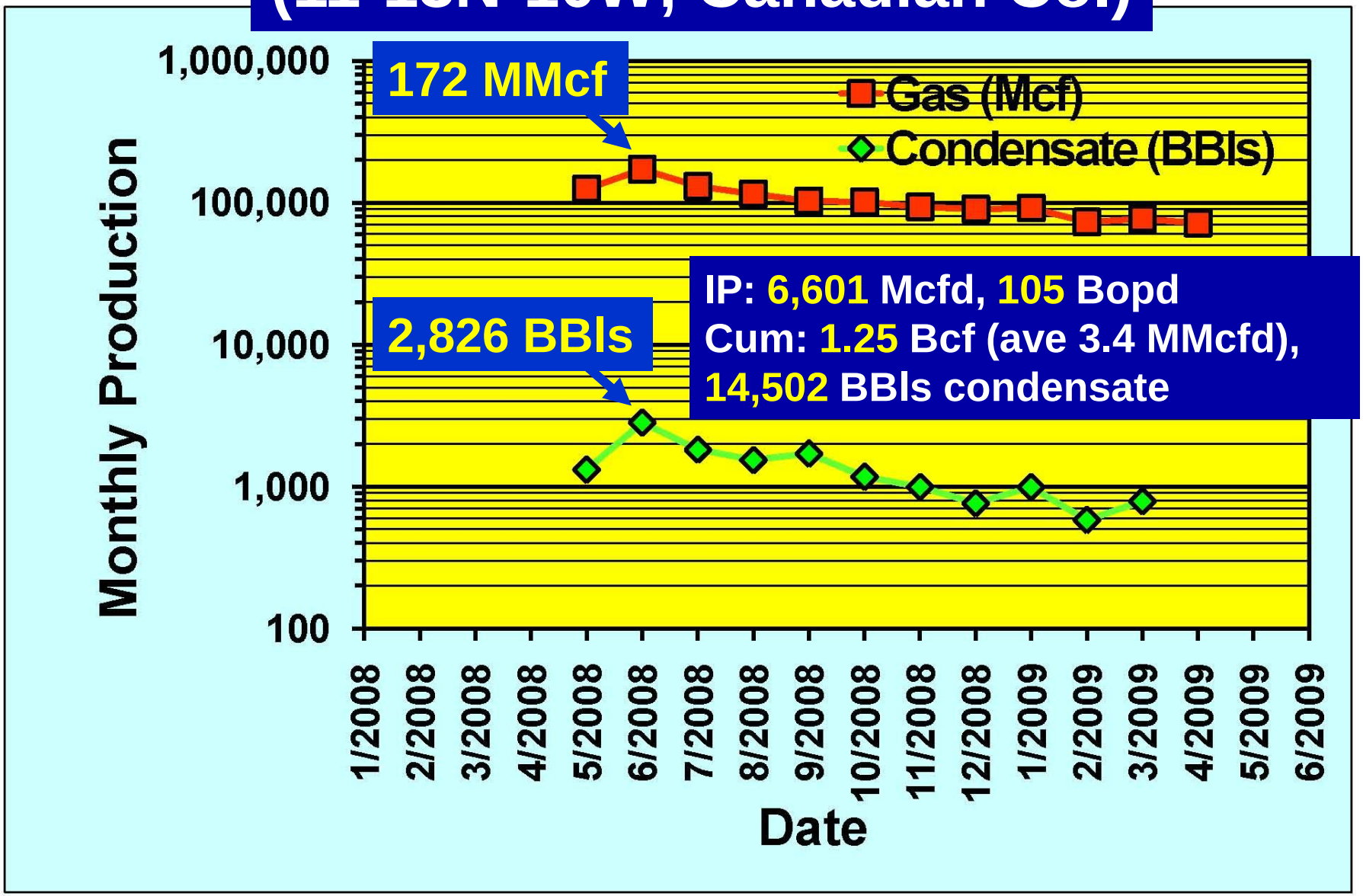

14W
13W
12W
11W
10W
9W
8W
15N
14N
13N
12N
11N
1.2
1.3
1.4
1.5
Produced Liquids
Canadian
Blaine
Caddo
Devon Energy 1-11H Ratliff
Woodford Gas
Woodford Oil/Condensate
No Production Data

Anadarko Basin API (2007-2009)

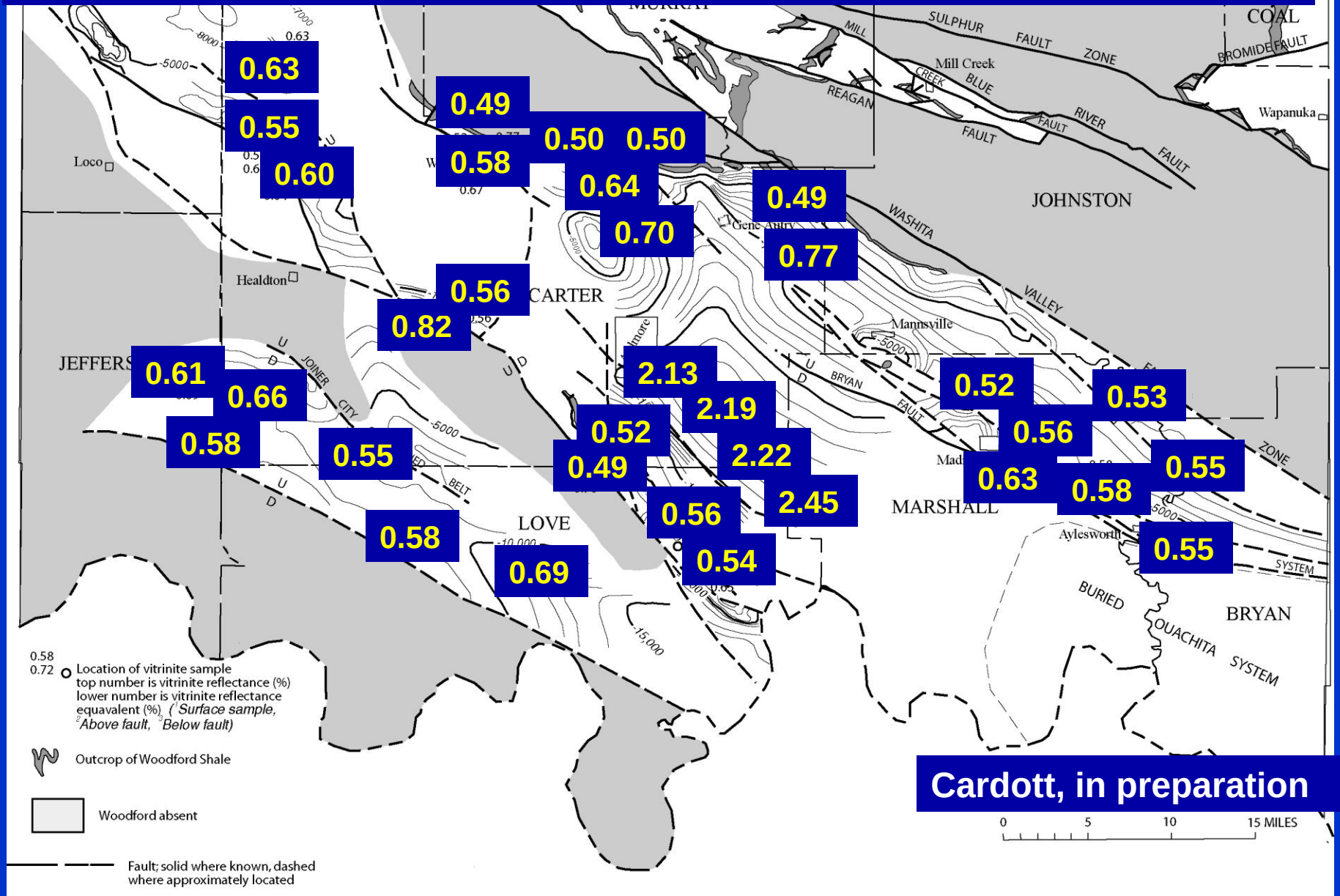


Woodford Shale Isoreflectance Map (Cardott, 1989)

Devon Energy 1-11 Ratliff (11-13N-10W; Canadian Co.)

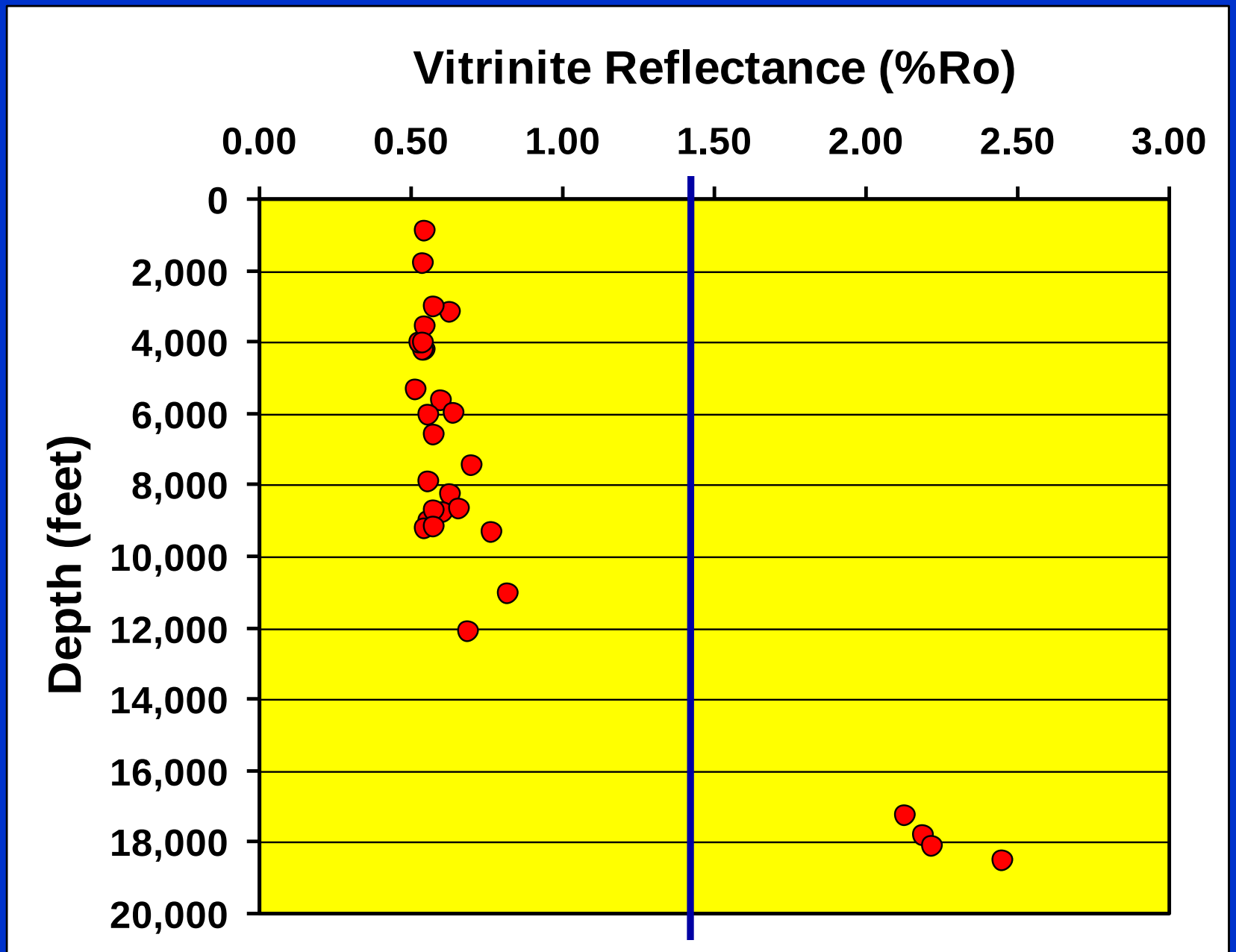


Structure and Vitrinite Reflectance of Woodford Shale, Southern Oklahoma

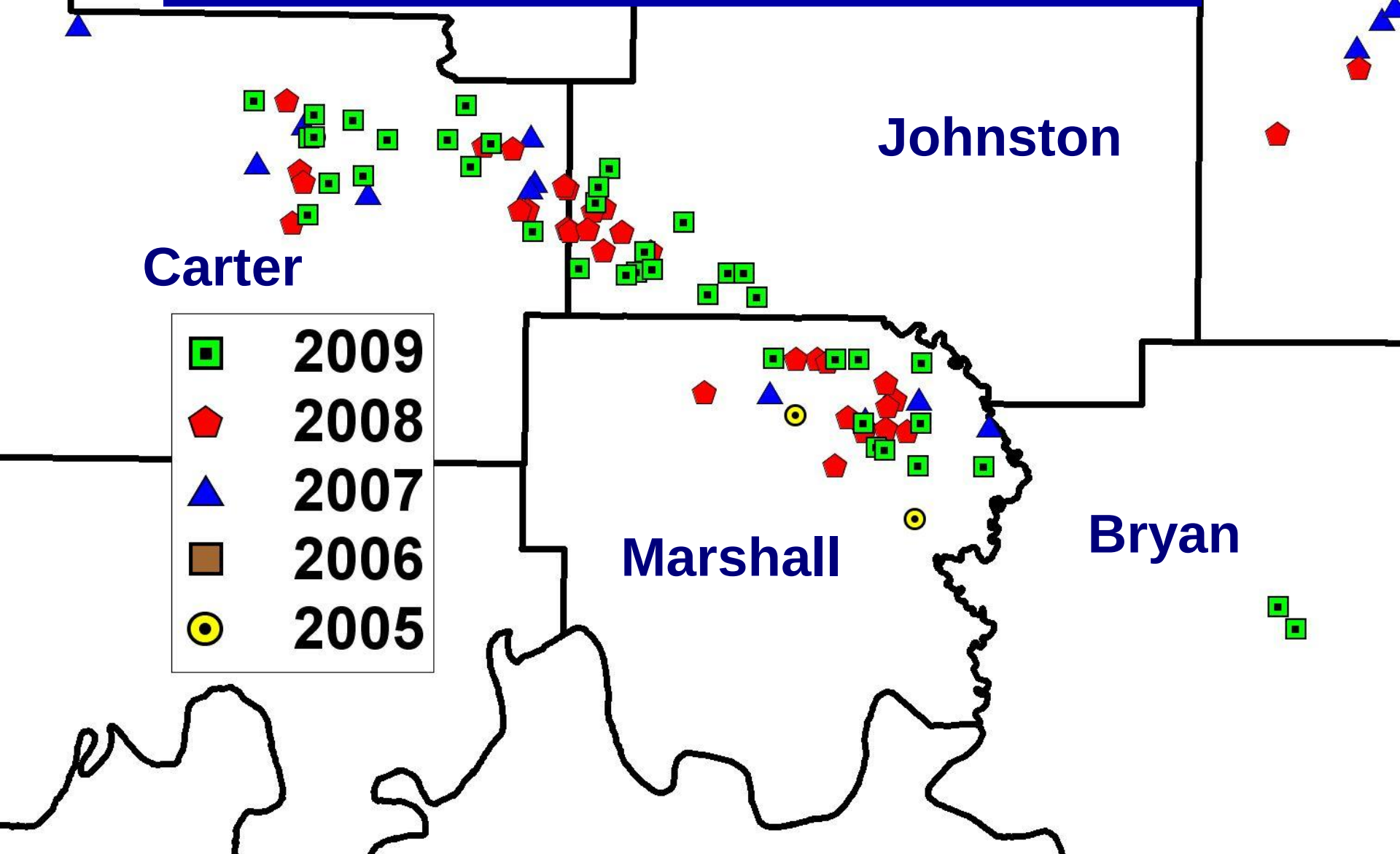


Cardott, in preparation

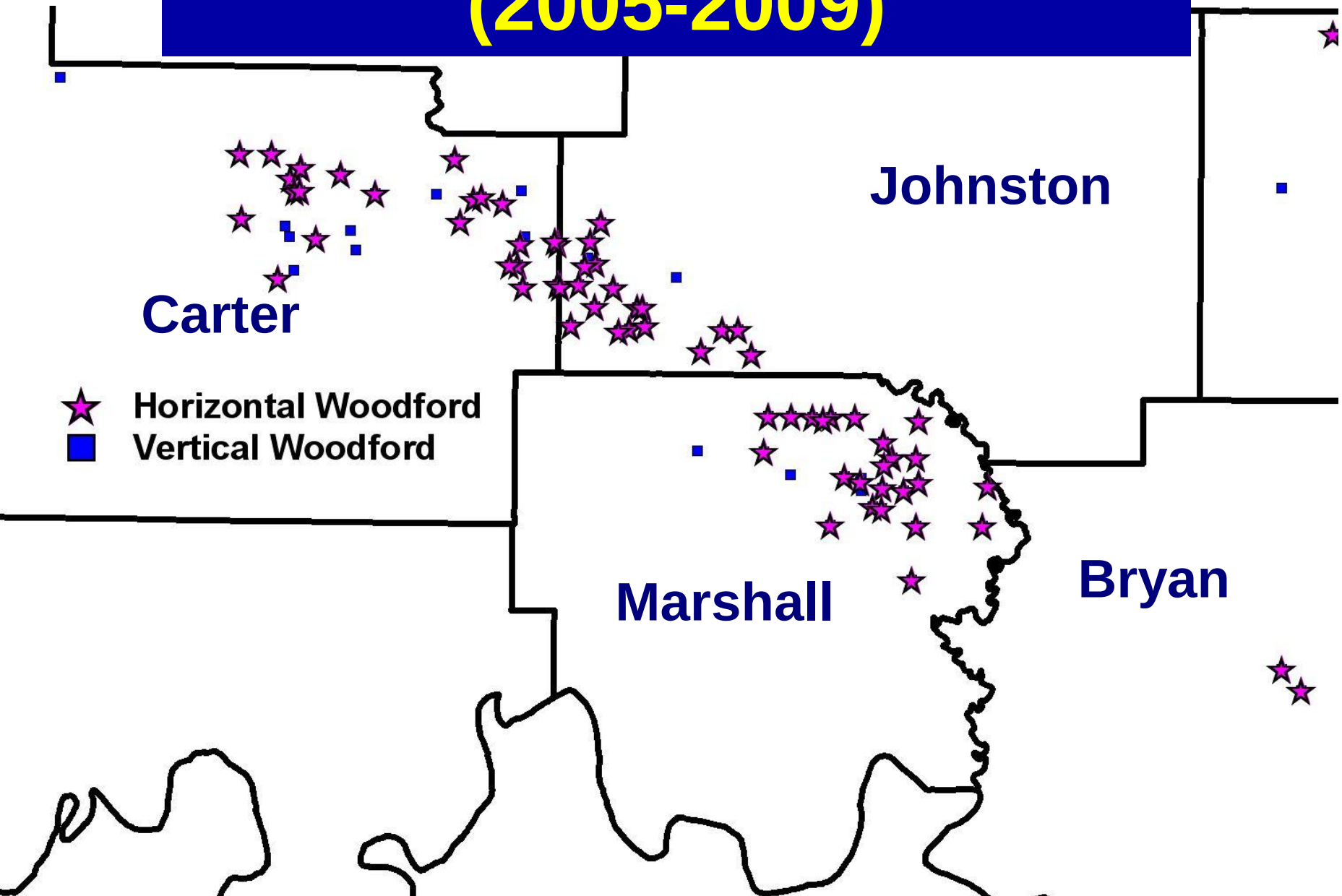
Southern Oklahoma VRo vs Depth



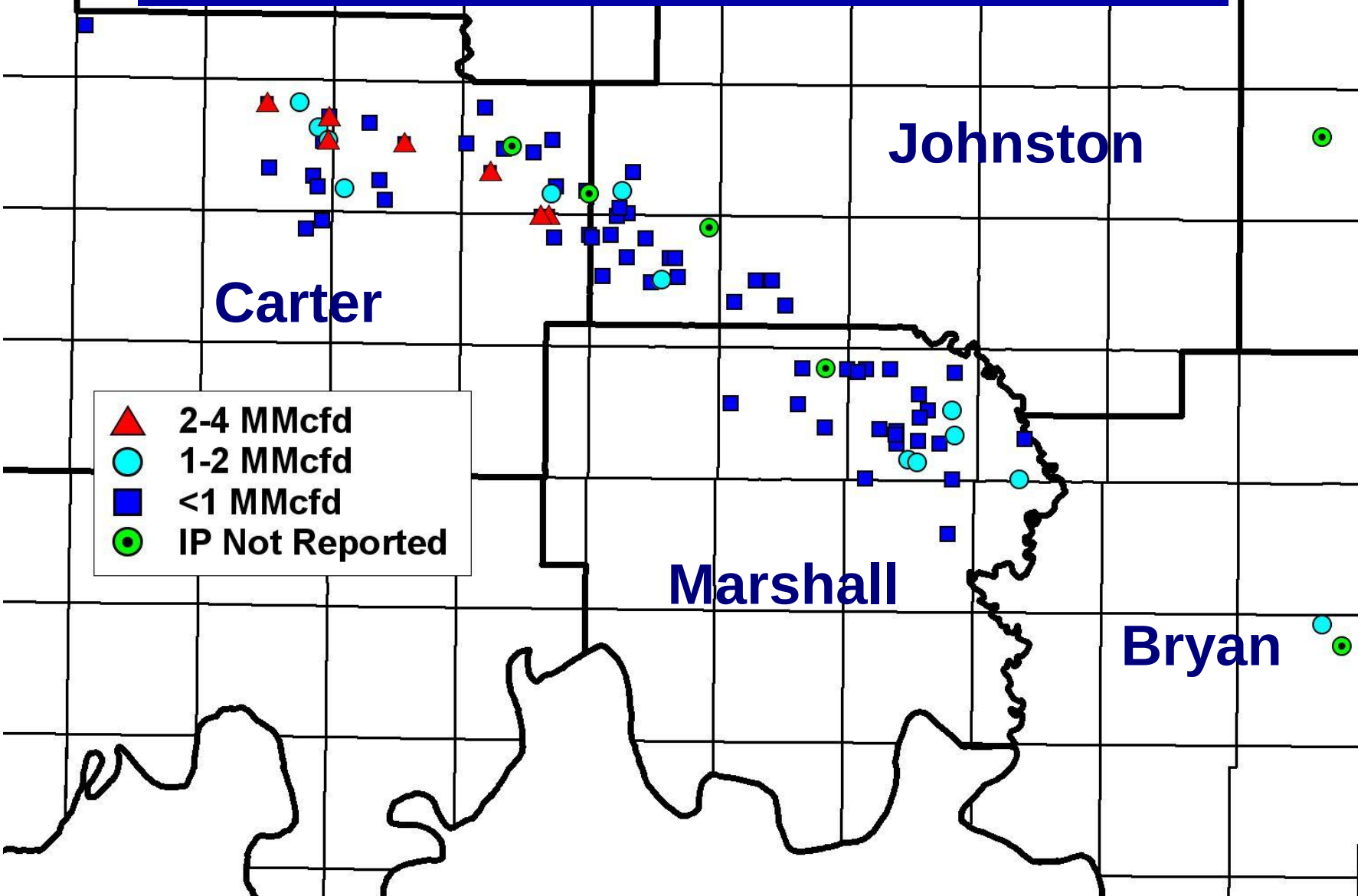
Ardmore Basin Woodford (2005-2009)



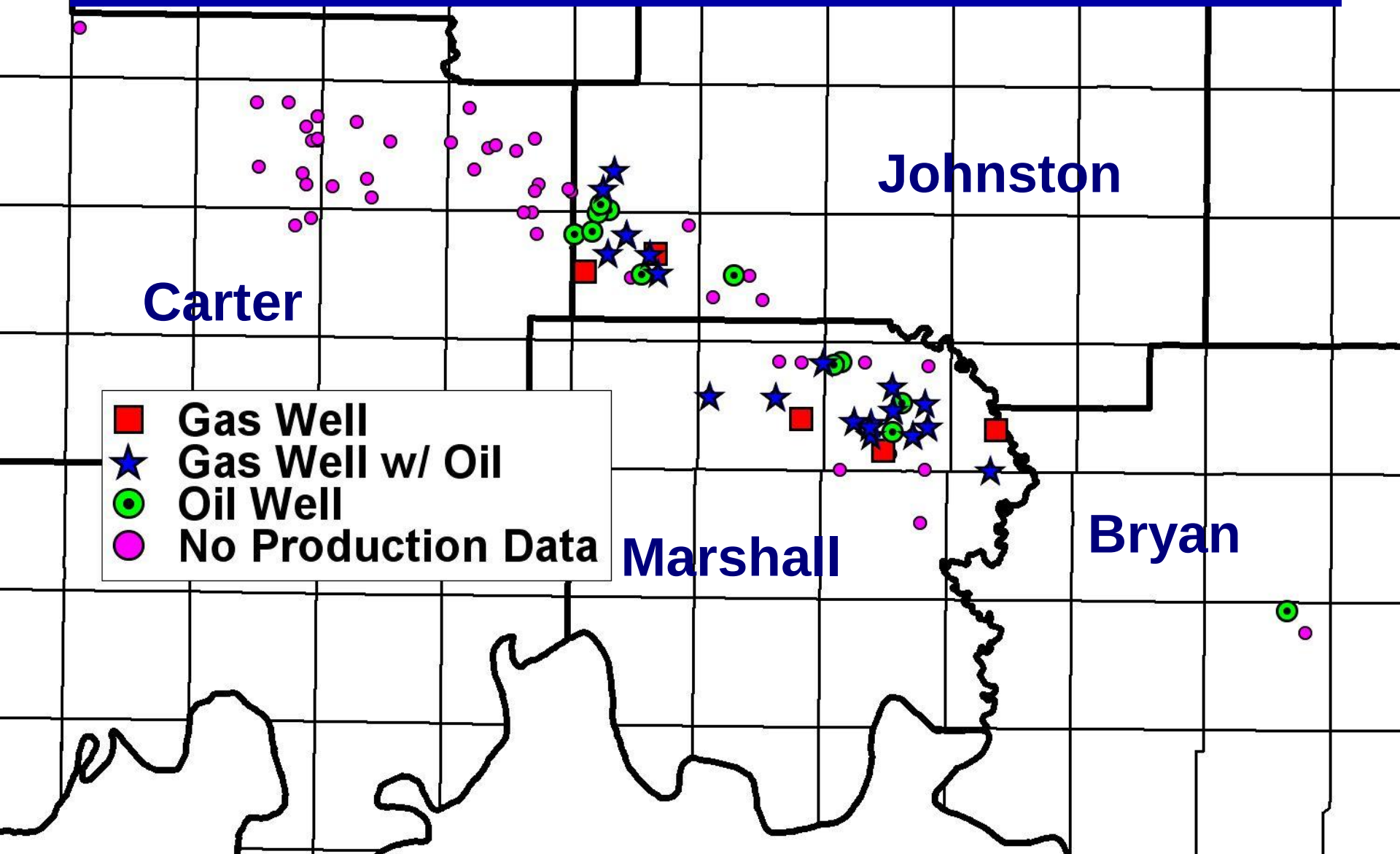
Ardmore Basin Woodford (2005-2009)



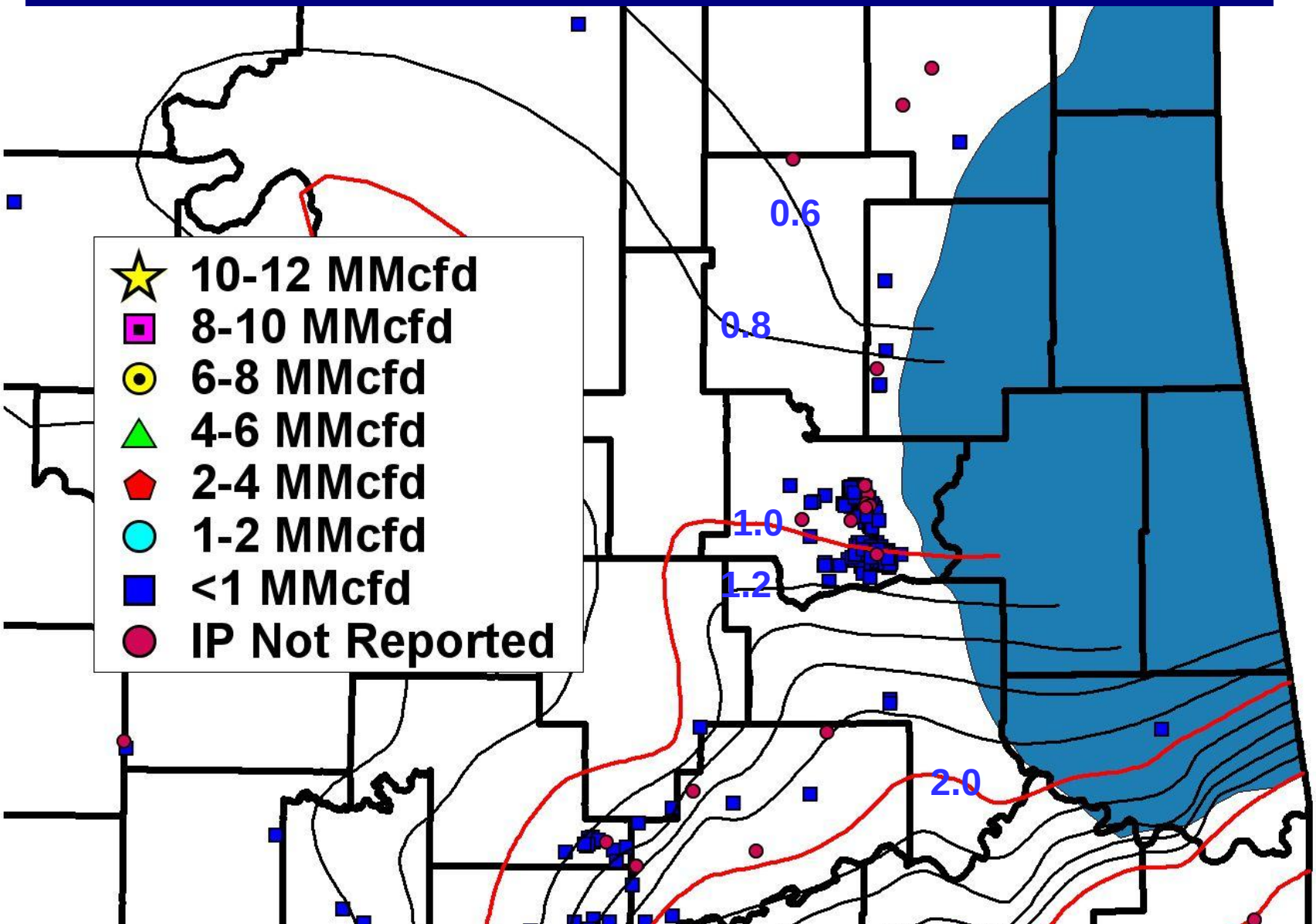
Ardmore Basin Initial Production



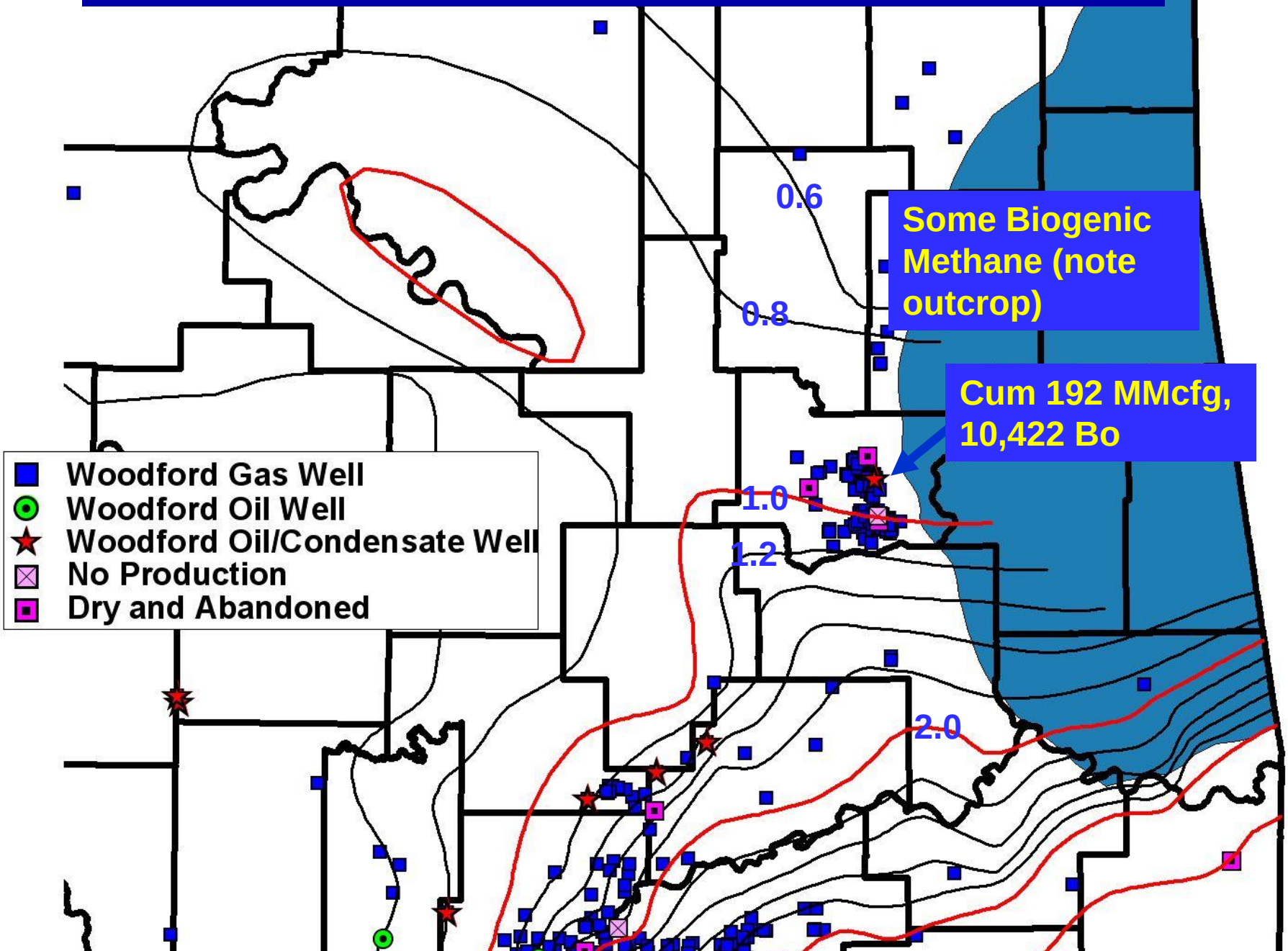
Ardmore Basin (Woodford-Only Production)



NE OK Woodford Initial Production on Isoreflectance Map



NE OK Woodford Shale-Only Production



SUMMARY OF WOODFORD GAS SHALE PLAY

- Main Woodford Shale gas play is in eastern Oklahoma at >1.15% Ro
- Woodford Shale gas play in Anadarko Basin shelf @1.2-1.5% Ro
- Some Woodford Shale gas potential is in southern and northeastern Oklahoma at <1.2% Ro

OKLAHOMA GEOLOGICAL SURVEY

http://www.ogs.ou.edu

HOME
PUBLICATIONS SALES
STAFF
CALENDAR
ABOUT OGS
CONTACT US
LINKS
MEWBOURNE COLLEGE OF EARTH AND ENERGY
UNIVERSITY OF OKLAHOMA

ENERGY | OPIC PETROLEUM INFO | GEOLOGY | EARTHQUAKES | EDUCATION, OUTREACH | MAPPING | MEETINGS

OIL AND GAS
OKLAHOMA GEOLOGICAL SURVEY

Oil and Gas Data and References

Field Discovery Wells (Excel format)

Links to other Web sites with Oklahor

Stratigraphic Chart Stratigraphic Guid

Stratigraphic chart, front of chart (pdf)

Table of Oklahoma Oil and Gas Rese

Currently Available OGS Oil and Gas

All OGS Oil and Gas Related Publicat

Oklahoma Oil and Gas Maps, Cross

Map GM36. Oklahoma oil and gas fiel
methane) , by Dan T. Boyd.(pdf) (data)

Map GM37. Oklahoma oil and gas fiel
Dan T. Boyd.(pdf) (data)

Map GM38. Oklahoma oil and gas fiel

Map GM28 Map of Oklahoma Oil and
supplement, 1997. (Data files only)

Type Logs

Oklahoma Hydrocarbon Source Rocks and Gas Shales

Bibliographies

Presentations & Reports
Including October 2008 Gas Shales Workshop Presentations!

Oklahoma Gas-Shale Completions Map, 1939-2009

Woodford Shale Gas Well Completions Map, 1939-2009

Woodford Shale Gas Well Completions Map, 2003-2009

Gas Shales Database

Oklahoma Oil and Gas History and Activity

Shale Shaker Articles

Oklahoma: The Ultimate Oil Opportunity

Milestones in the Oklahoma Oil and Gas Industry

*NEW 2008 Drilling Highlights

2007 Drilling Highlights

2006 Drilling Highlights

LINKS

Commonly asked questions, royalty owner information

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