The Woodford Shale in southeastern New Mexico: Distribution and source rock characteristics*

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Abstract

The Woodford Shale (Upper Devonian) is 0 to 300 ft thick in southeastern New Mexico. Maximum thickness is in south-central Lea County where it lies at depths of 18,000 ft. The Woodford pinches out to the north and northwest in Roosevelt and Chaves counties, where it is present at depths of less than 7000 ft as it rises out of the Permian Basin. The Woodford Shale is absent from the highest parts of the Central Basin Platform in southeastern Lea County. The Woodford is comprised predominantly of black, organic-rich shales and minor black cherts, siltstones, sandstones and greenish-colored shales. The Woodford unconformably overlies Wristen (Silurian) and Thirtyone (Lower Devonian) carbonates as well as scattered remnants of the pre-Woodford shale (Middle to Upper Devonian). The Woodford is unconformably overlain by the Lower Mississippian limestone.

The black organic-rich shales are a hydrocarbon source facies. Present-day total organic carbon (TOC) ranges from 1.7 to 4.9 weight percent. Original, pre-maturation TOC ranged from 1.8 to 6.8 percent. Both original and present-day TOC are greatest in southern Lea County and decrease to the north and west. The kerogen fraction of the black Woodford shales is dominated by amorphous and herbaceous types. Woody and inertinitic types are prevalent to the north, closer to the Woodford pinchout.

Thermal maturity is greatest in southwestern Lea and southeastern Eddy counties, where the Woodford is within the thermogenic gas and condensate window. Thermal maturity is lower to the north and west where the Woodford is within the oil window. The volume of hydrocarbons generated within the Woodford increased to the southeast along with increasing TOC, thickness and thermal maturity.

The Gladiola Woodford Oil Pool is the only reservoir productive from the Woodford Shale in southeastern New Mexico. This reservoir is located in northern Lea County where the Woodford is within the oil maturation window. Produced hydrocarbons are oil and associated gas, in agreement with the thermal maturity of the Woodford in the area.

The Woodford has been long considered as the source rock for hydrocarbons within carbonate reservoirs of the underlying Wristen Group and Thirtyone Formation. Gas-oil ratios from Wristen reservoirs reflect thermal maturity levels of the Woodford and possibly the geographic distribution of Woodford kerogen types. The composition of Wristen oils may also reflect the distribution of kerogen types.

References

Broadhead, R.F., 2005, Regional aspects of the Wristen petroleum system, southeastern New Mexico: New Mexico Bureau of Geology and Mineral Resources Open-file Report 485, Web accessed 24 June 2011, http://geoinfo.nmt.edu/publications/openfile/downloads/ofr400-499/476-499/485/485_CDROM/Wristen%20petroleum%20system.pdf

Broadhead, R.F., 2010, The Woodford Shale in southeastern New Mexico: distribution and source rock characteristics: New Mexico Geology, v. 32 no. 3, p. 79-90**,** Web accessed 24 June 2011, http://geoinfo.nmt.edu/publications/periodicals/nmg/downloads/32/n3/nmg_v32_n3_p79.pdf

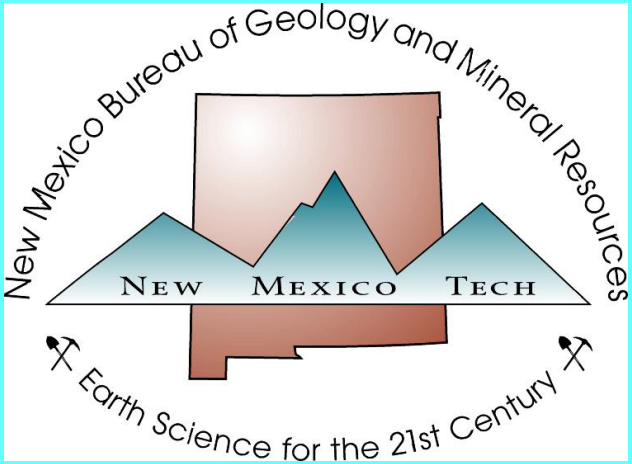
Jarvie, D.M., R.J. Hill, T.E. Ruble, and R.M. Pollastro, 2007, Unconventional shale-gas systems: The Mississippian Barnett Shale of north-central Texas as one model for thermogenic shale-gas assessment: AAPG Bulletin, v. 91/4, p. 475-499.

The Woodford Shale in southeastern New Mexico: Distribution and source rock characteristics

Ron Broadhead

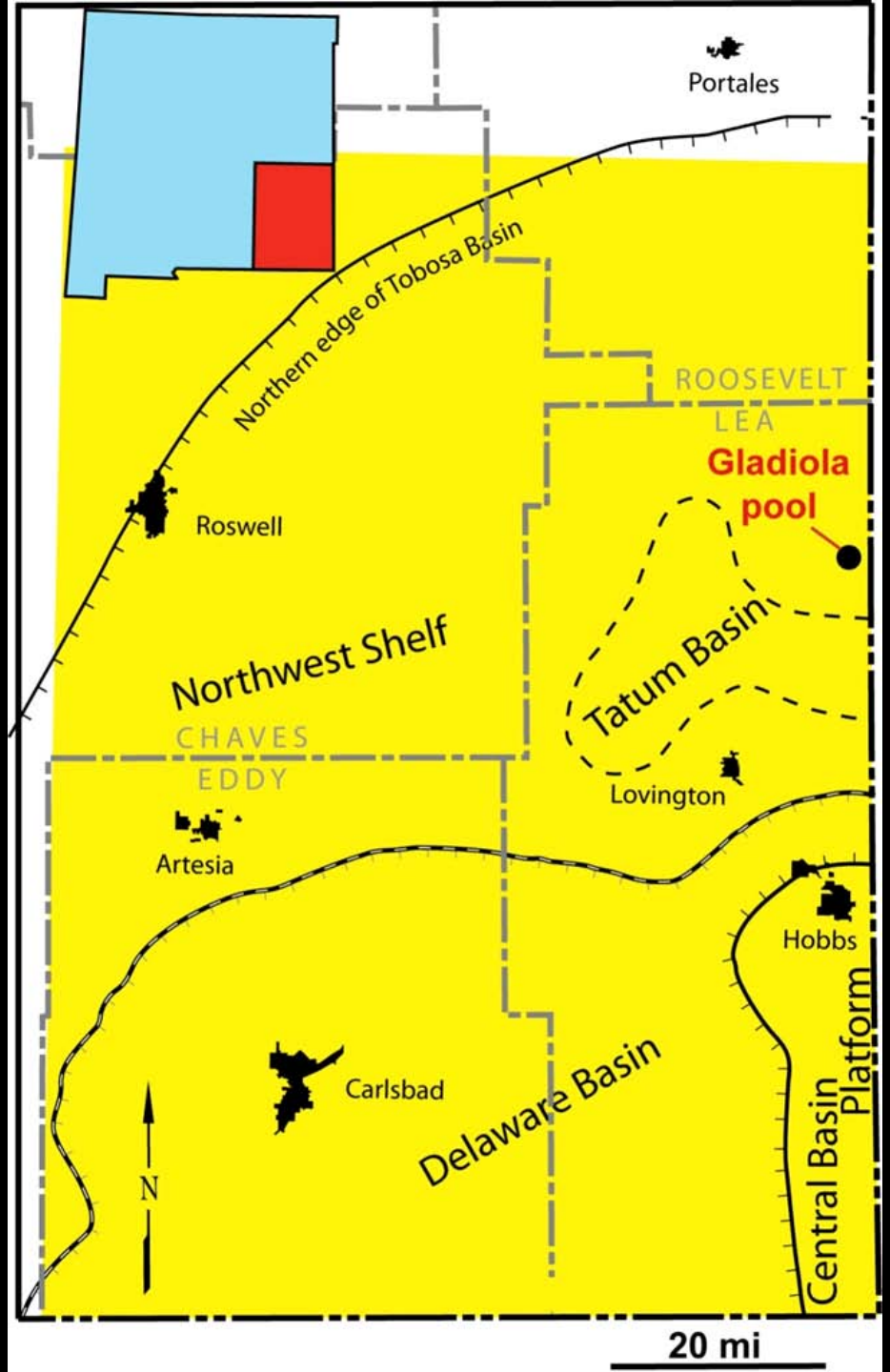
New Mexico Bureau of Geology and Mineral Resources

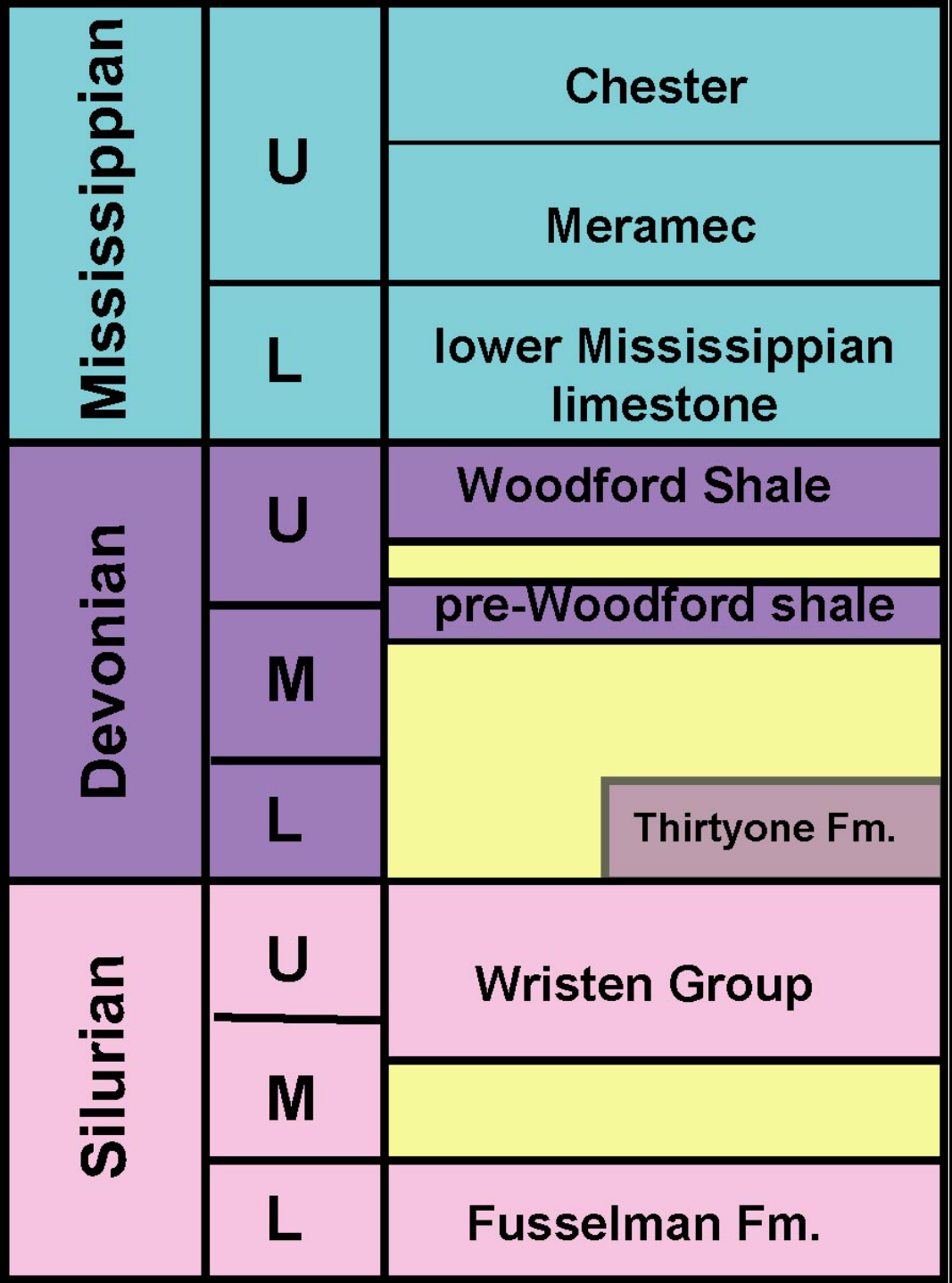
A division of New Mexico Tech

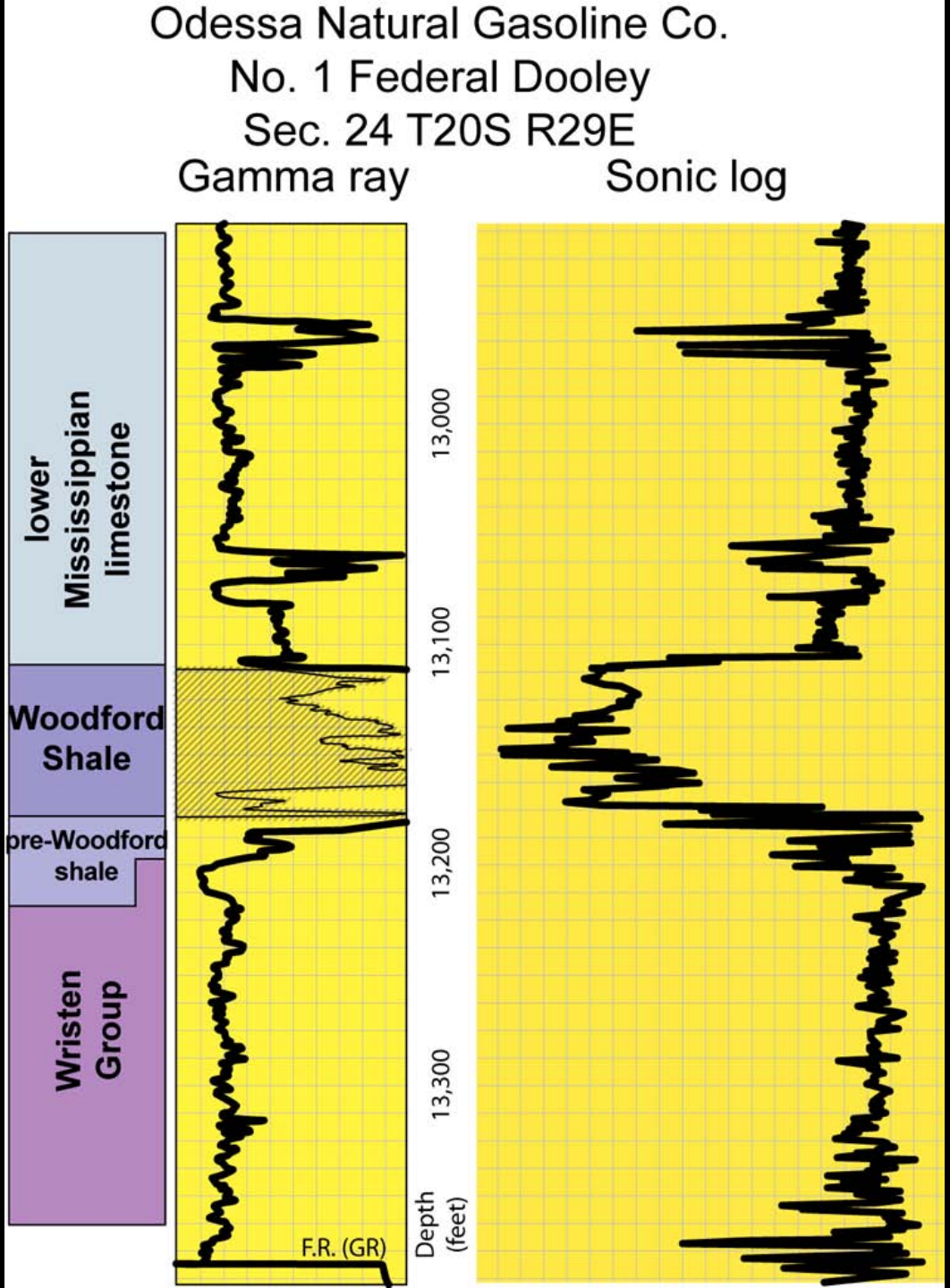


Introduction

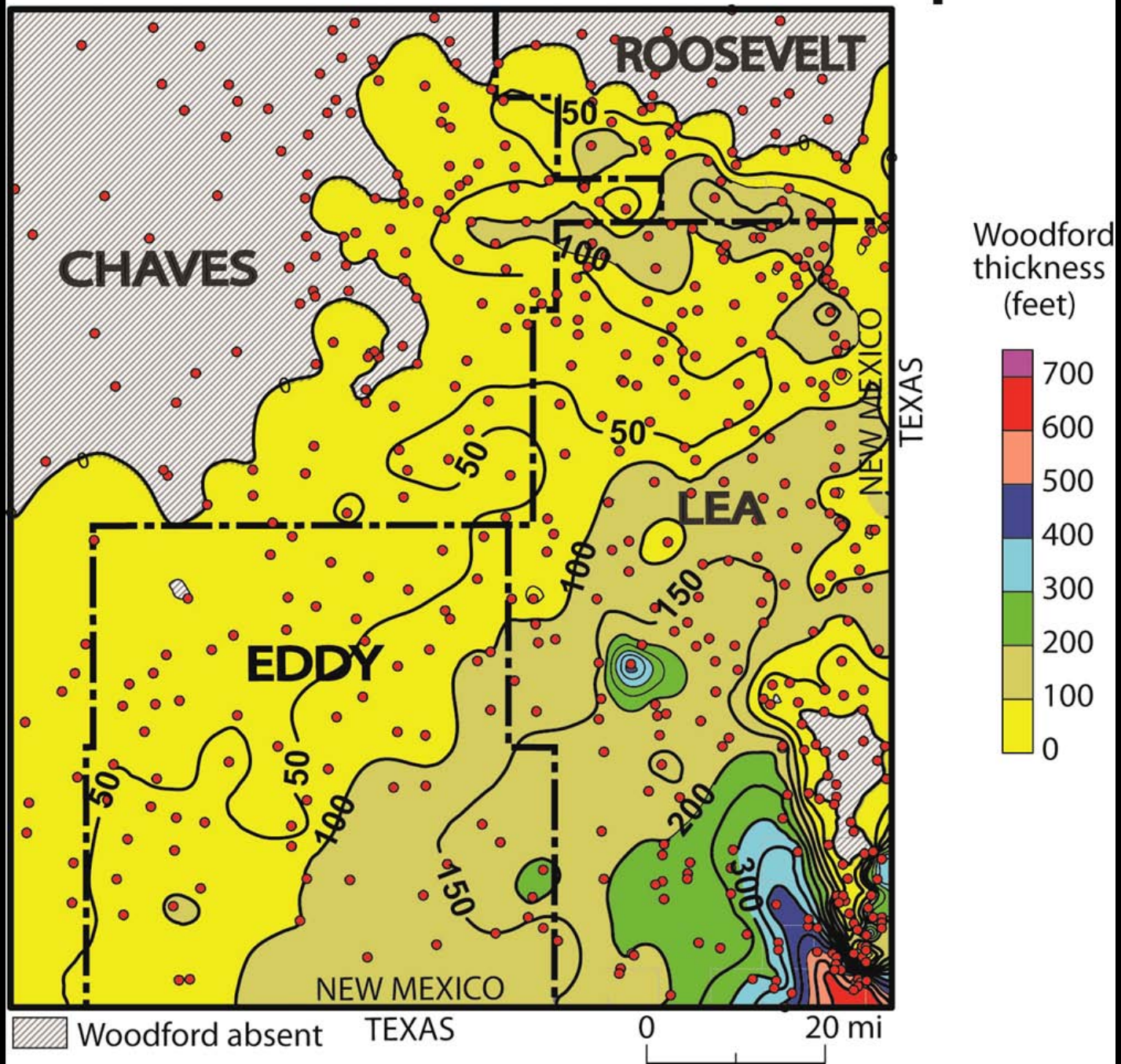
- **Original work undertaken in conjunction with PRRC 2001-2002 as an analysis of the Wristen petroleum system in southeastern New Mexico for development of a Fuzzy expert exploration tool – funded by U.S. Department of Energy & published as New Mexico Bureau of Geology and Mineral Resources Open-file Report 485 (Broadhead, 2005)**
- **Later work in 2008-2009 incorporated new techniques to calculate original TOC and incorporated Woodford production data**
- **This talk abstracted from Broadhead (2010), *New Mexico Geology, v. 32 no. 3, p. 79-90.***
  http://geoinfo.nmt.edu/publications/periodicals/nmg/downloads/32/n3/nmg_v32_n3_p79.pdf


Portales
Northern edge of Tobosa Basin
ROOSEVELT
LEA
Gladiola
pool
Roswell
Northwest Shelf
Tatum Basin
CHAVES
EDDY
Lovington
Artesia
Hobbs
Carlsbad
Delaware Basin
Central Basin
Platform
N
20 mi

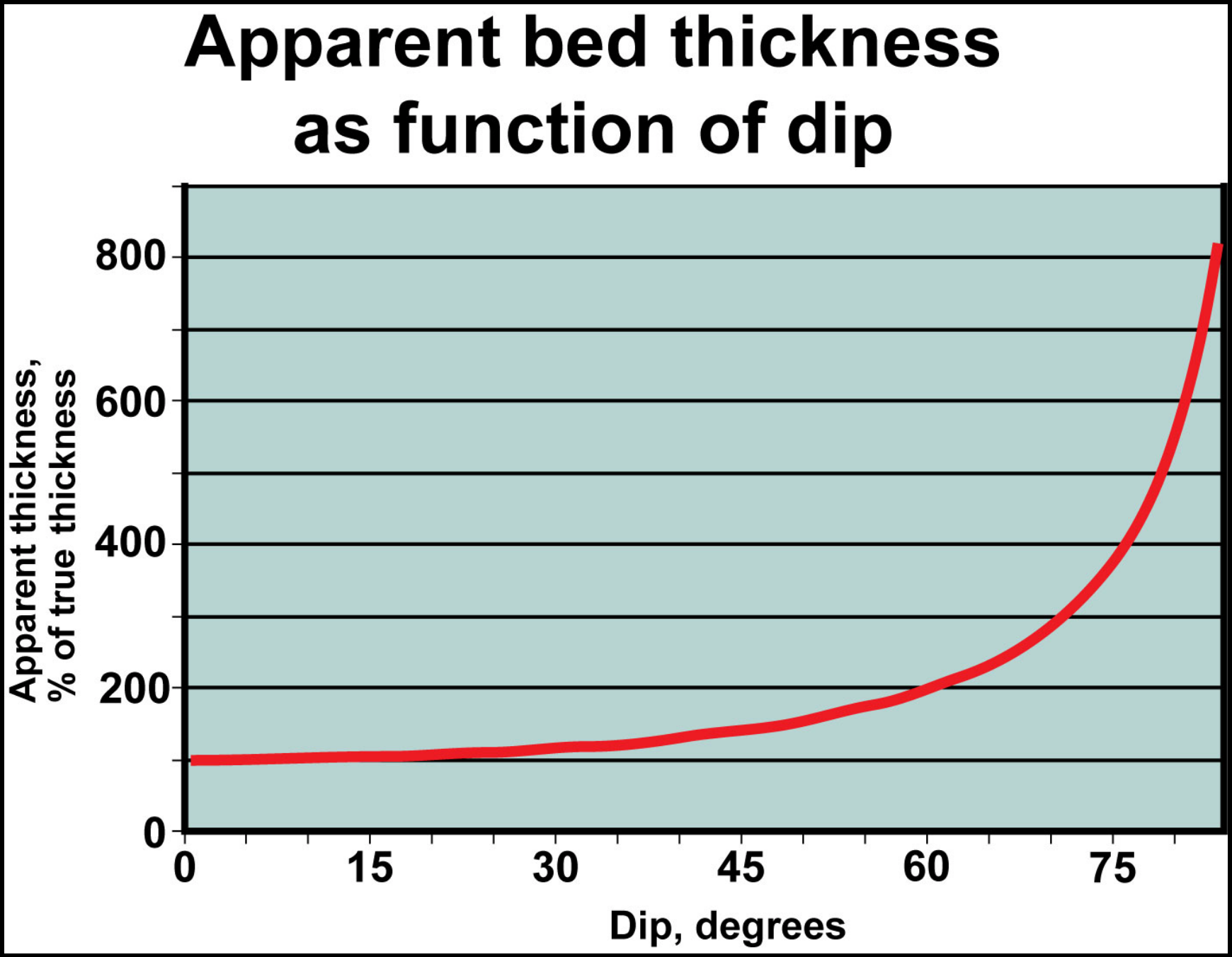

Mississippian
U
L
Chester
Meramec
lower Mississippian limestone
Devonian
U
M
L
Woodford Shale
pre-Woodford shale
Thirtyone Fm.
Silurian
U
M
L
Wristen Group
Fusselman Fm.


Odessa Natural Gasoline Co.
No. 1 Federal Dooley
Sec. 24 T20S R29E
Gamma ray
Sonic log
lower Mississippian limestone
Woodford Shale
pre-Woodford shale
Wristen Group
F.R. (GR)
13,000
13,100
13,200
13,300
Depth (feet)

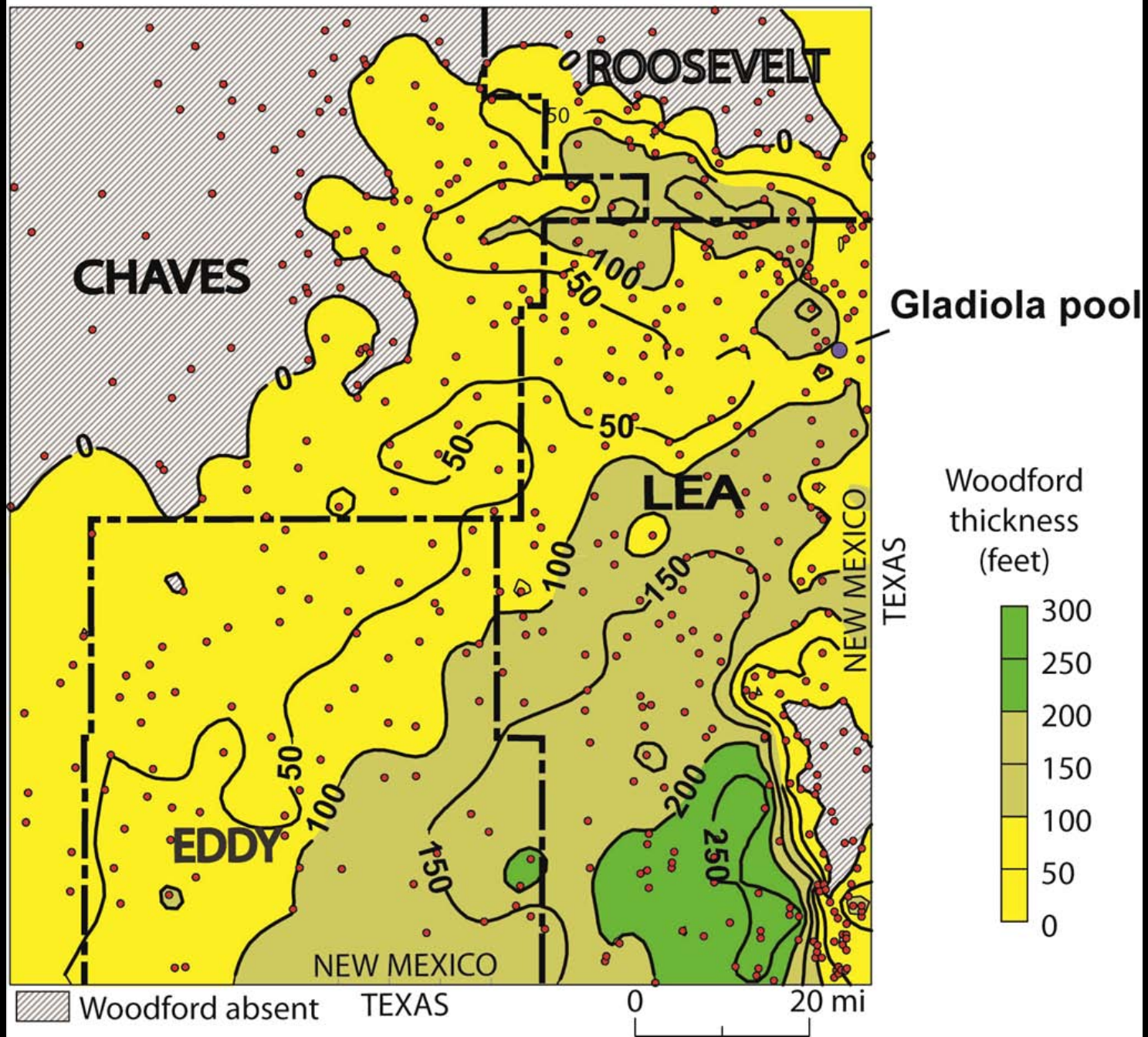
Woodford Uncorrected Isopach



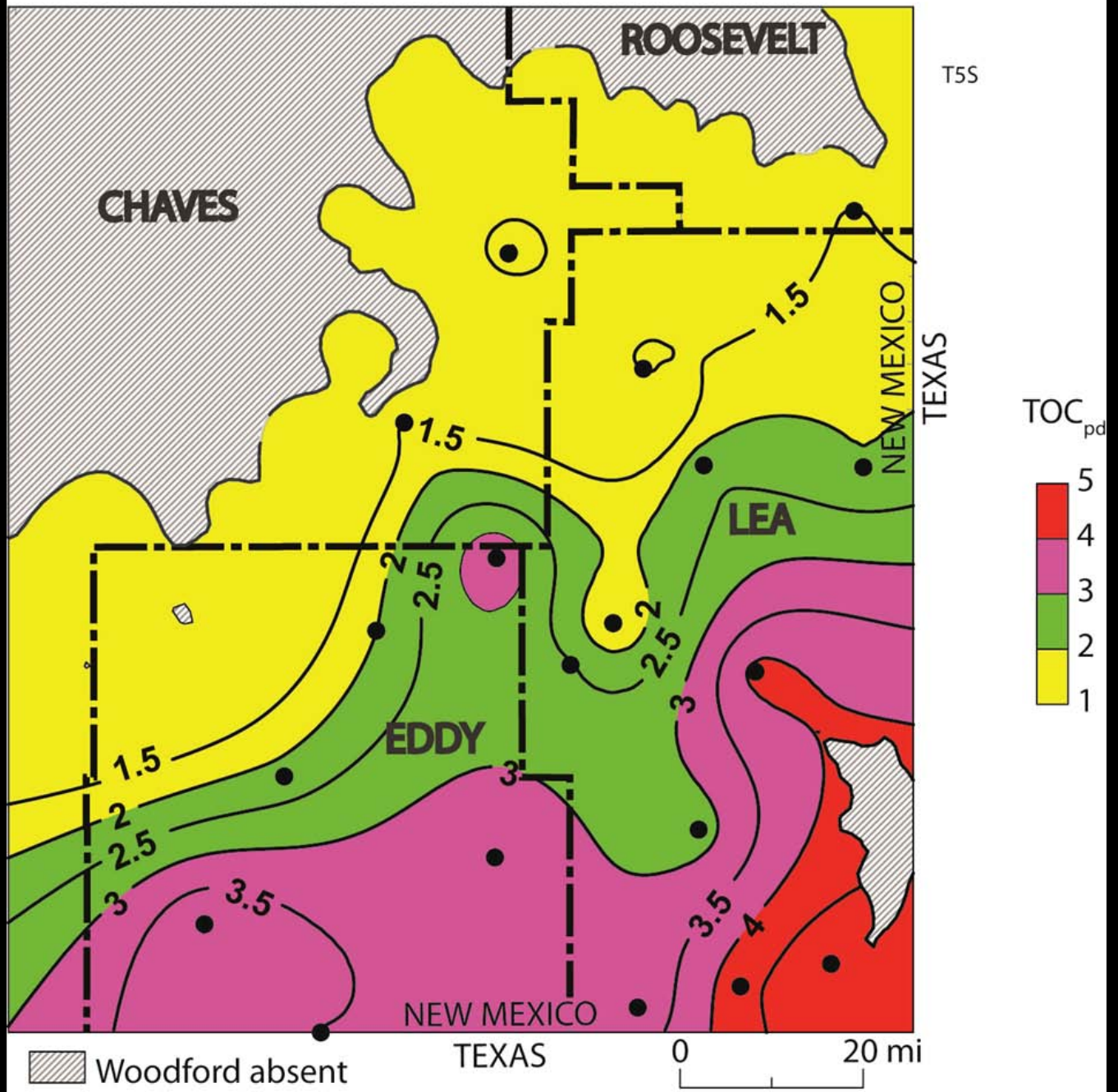
Apparent bed thickness as function of dip



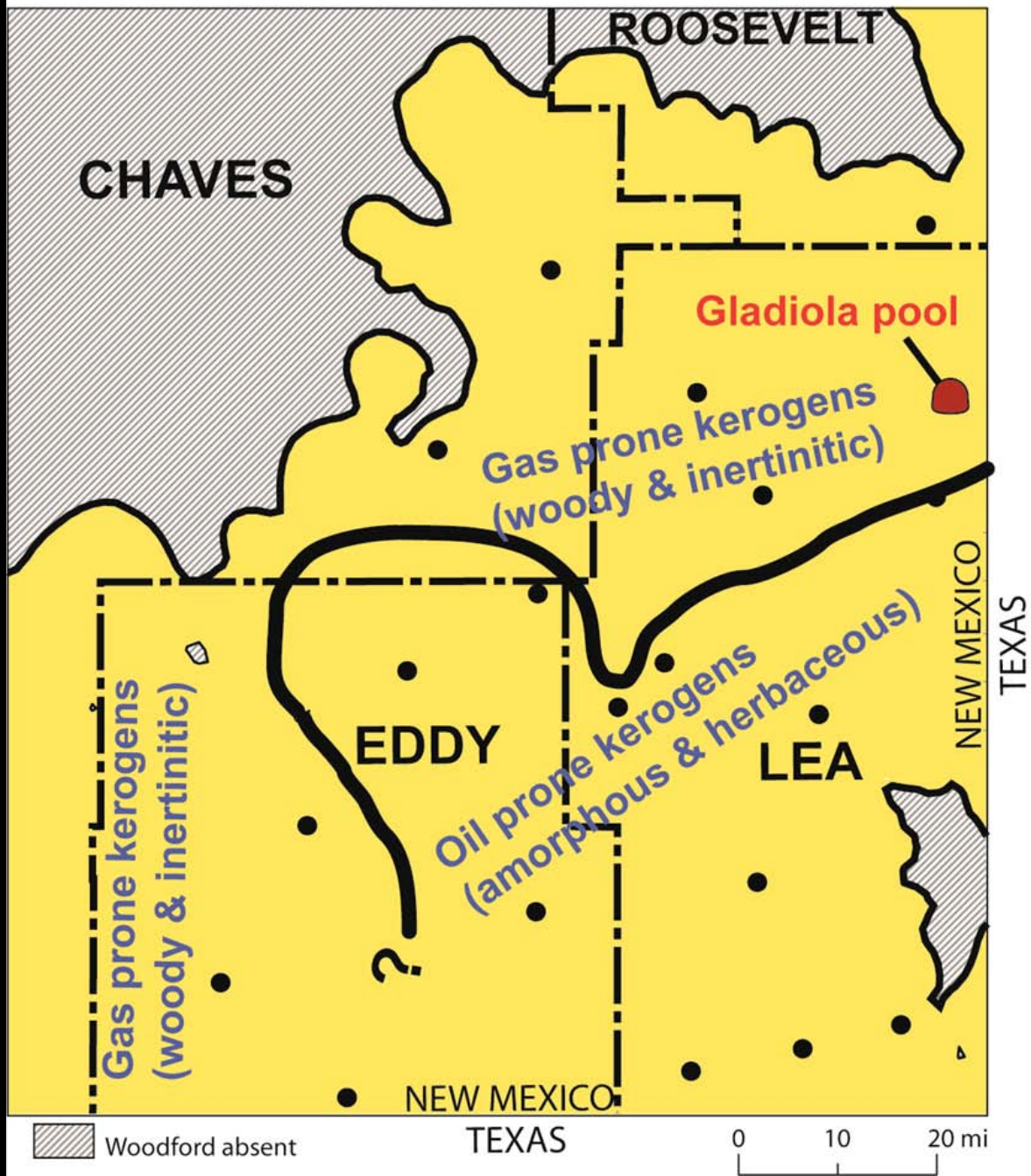
Woodford True Thickness



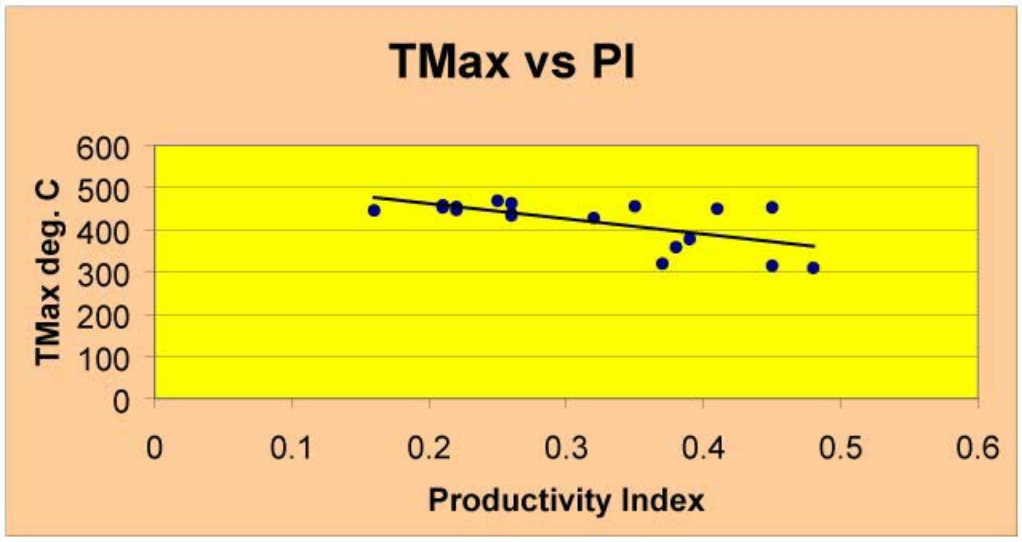
Woodford Present-Day TOC

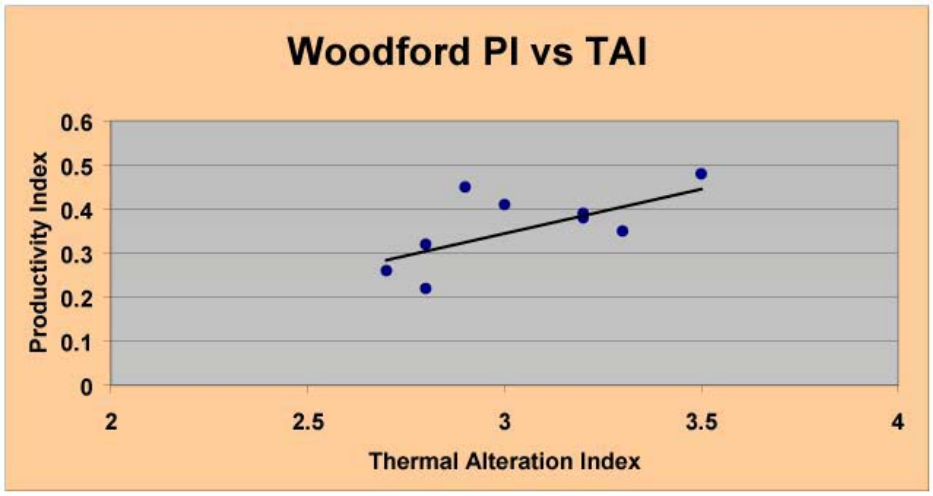


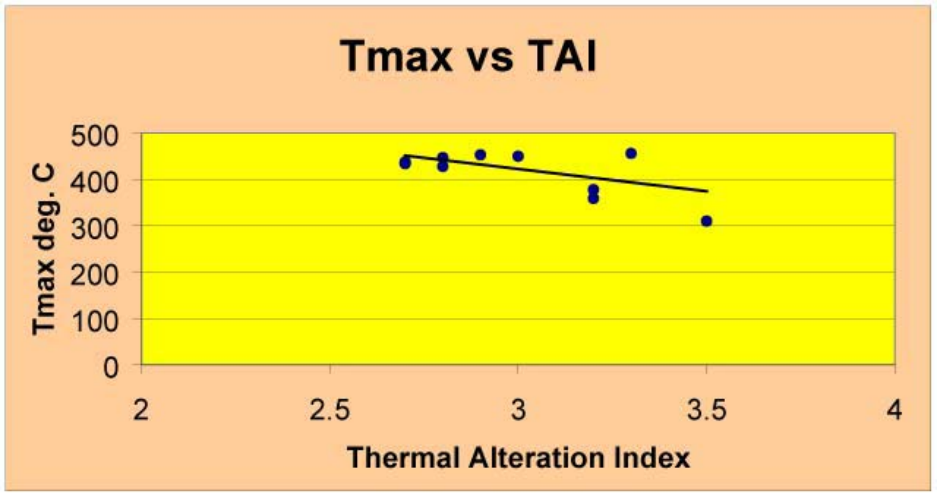
Woodford Kerogen Facies



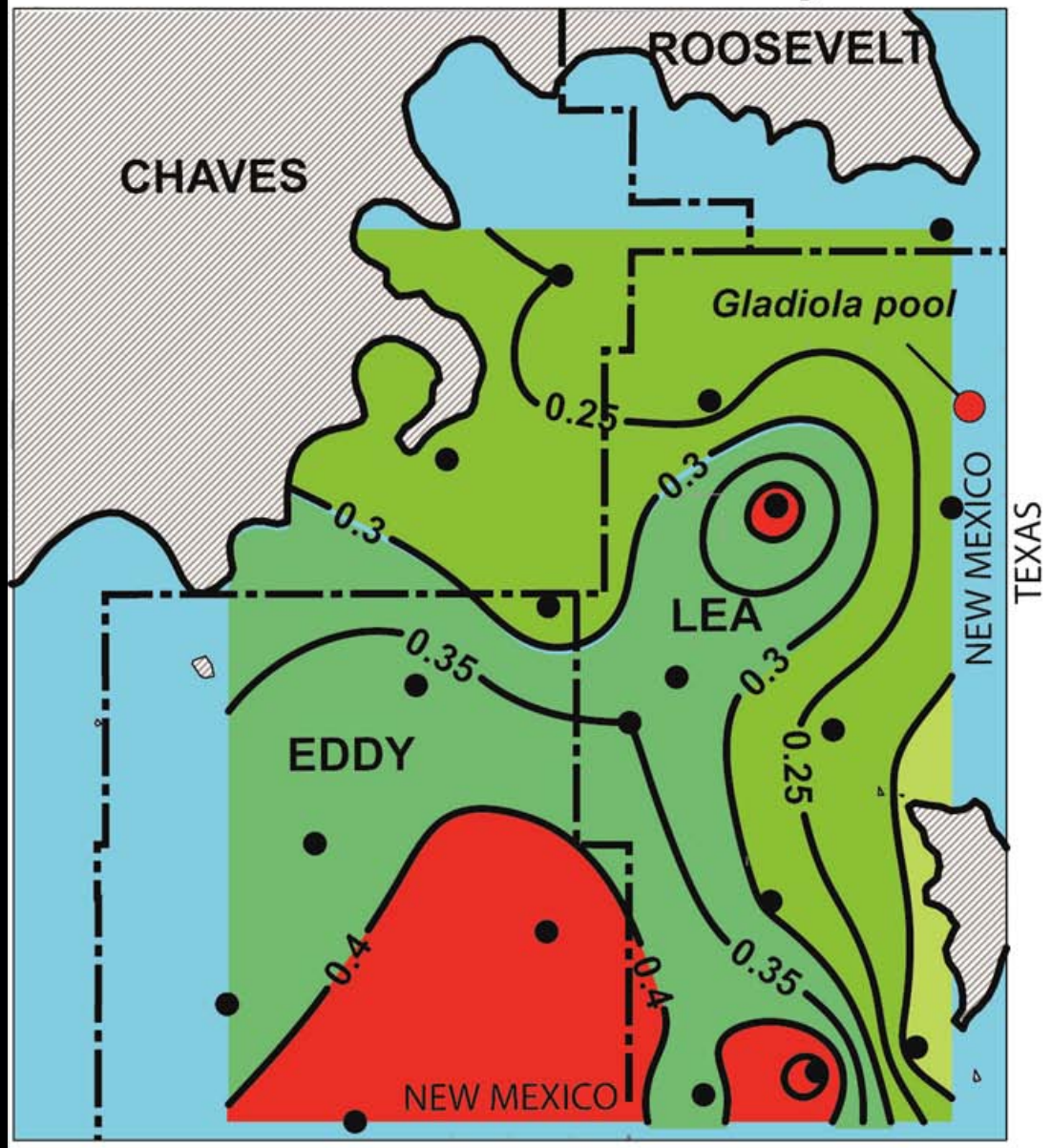
Which Rock-Eval maturation parameter to use? PI or TMAX?







Woodford Productivity Index



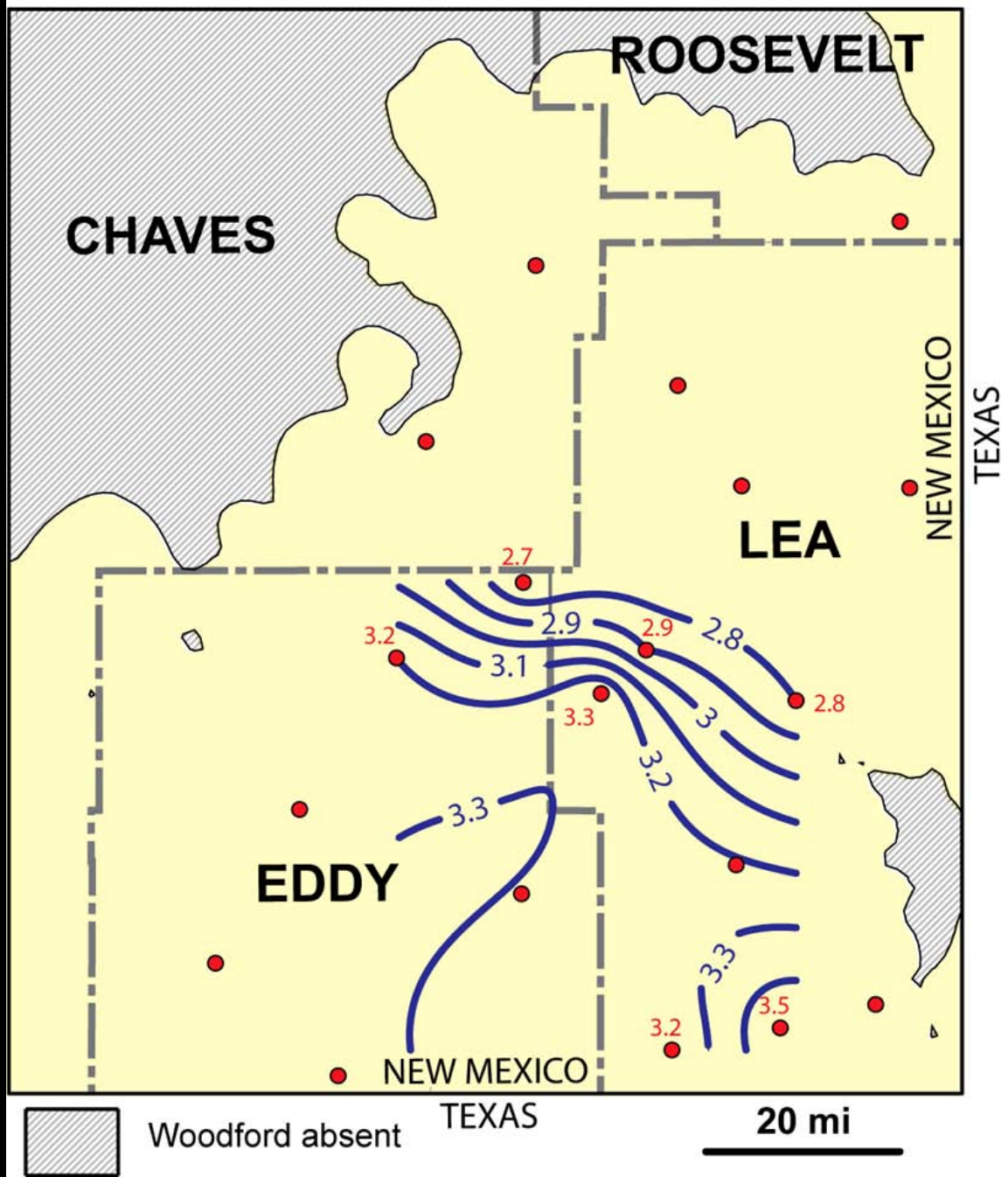
Productivity Index

0.5	overmature (thermogenic gas)
0.45	
0.4	
0.35	
0.3	
0.25	mature
0.2	
0.15	
0.1	
0.05	immature

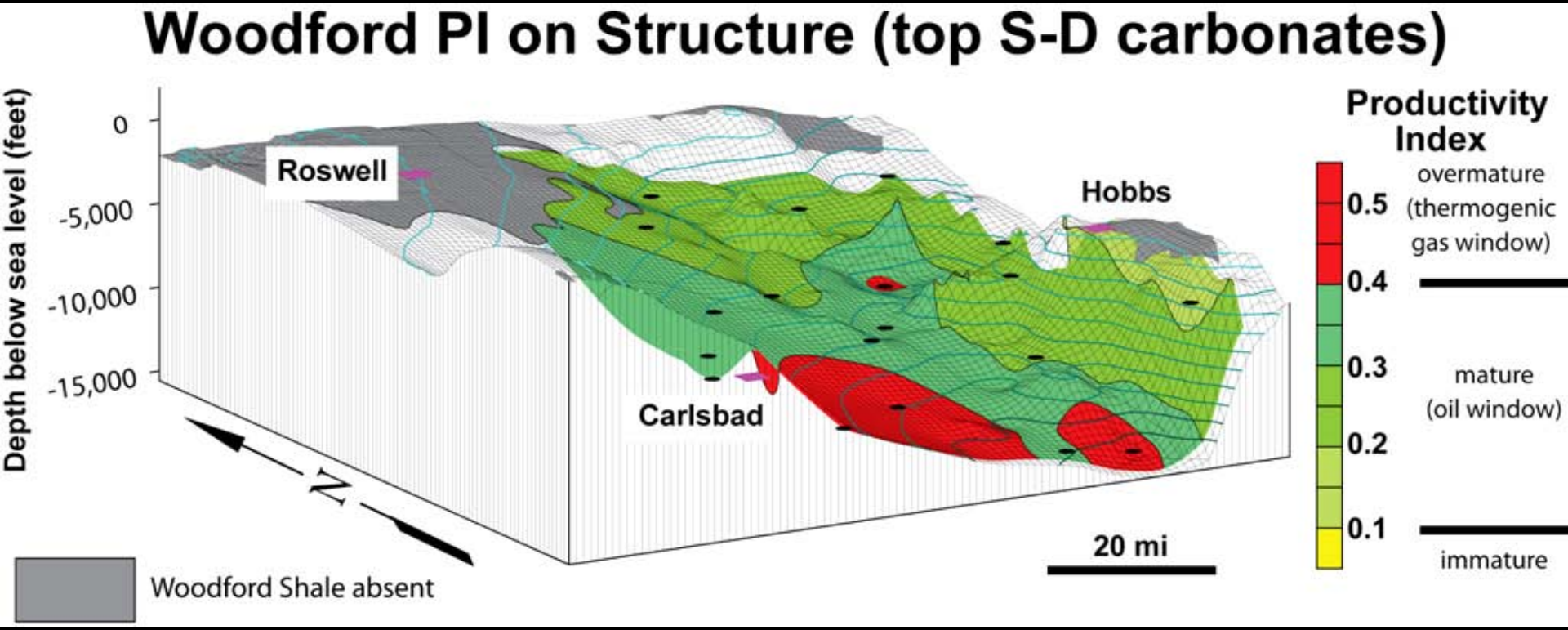
Woodford absent

No Productivity Index data

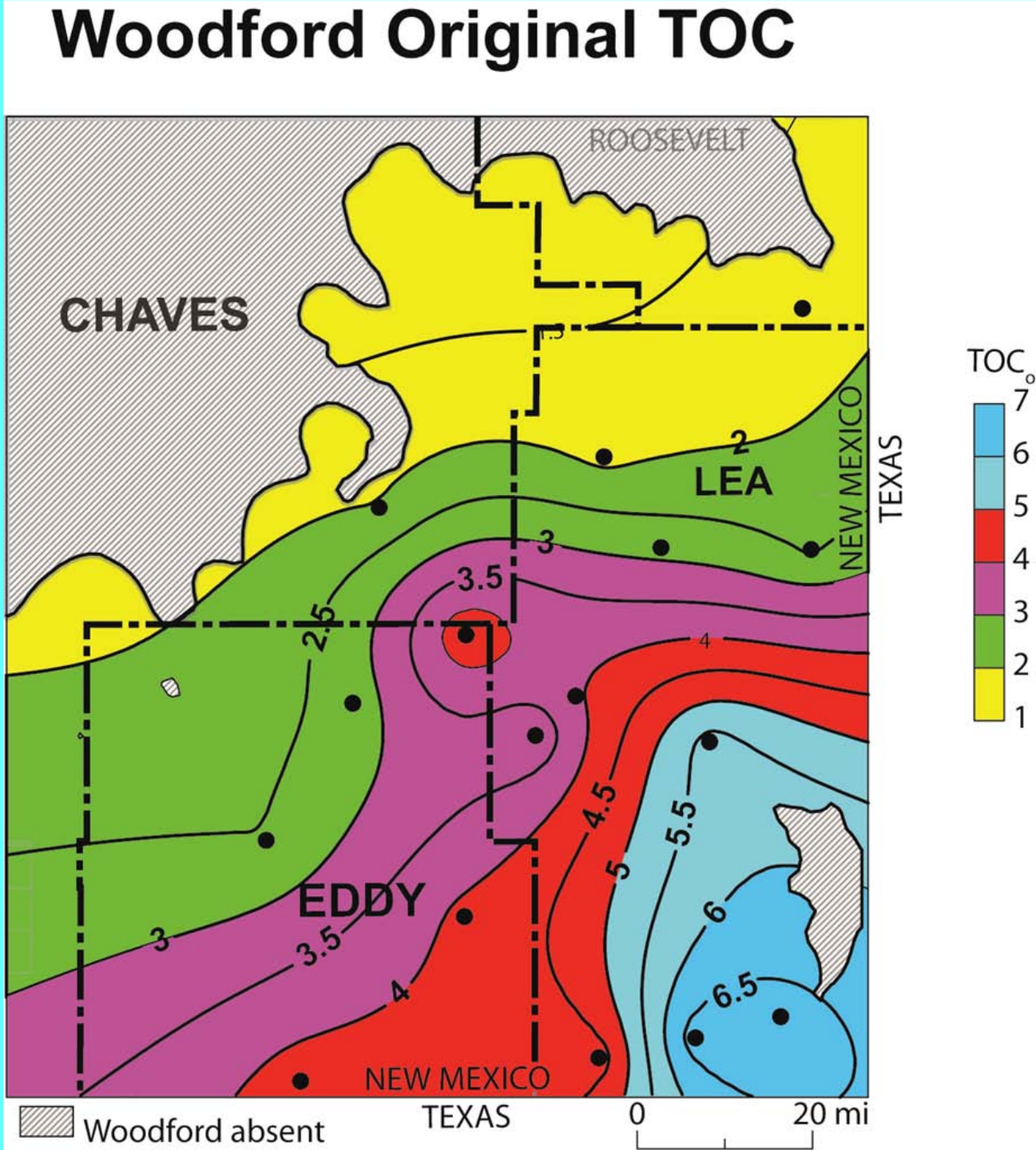
Woodford TAI



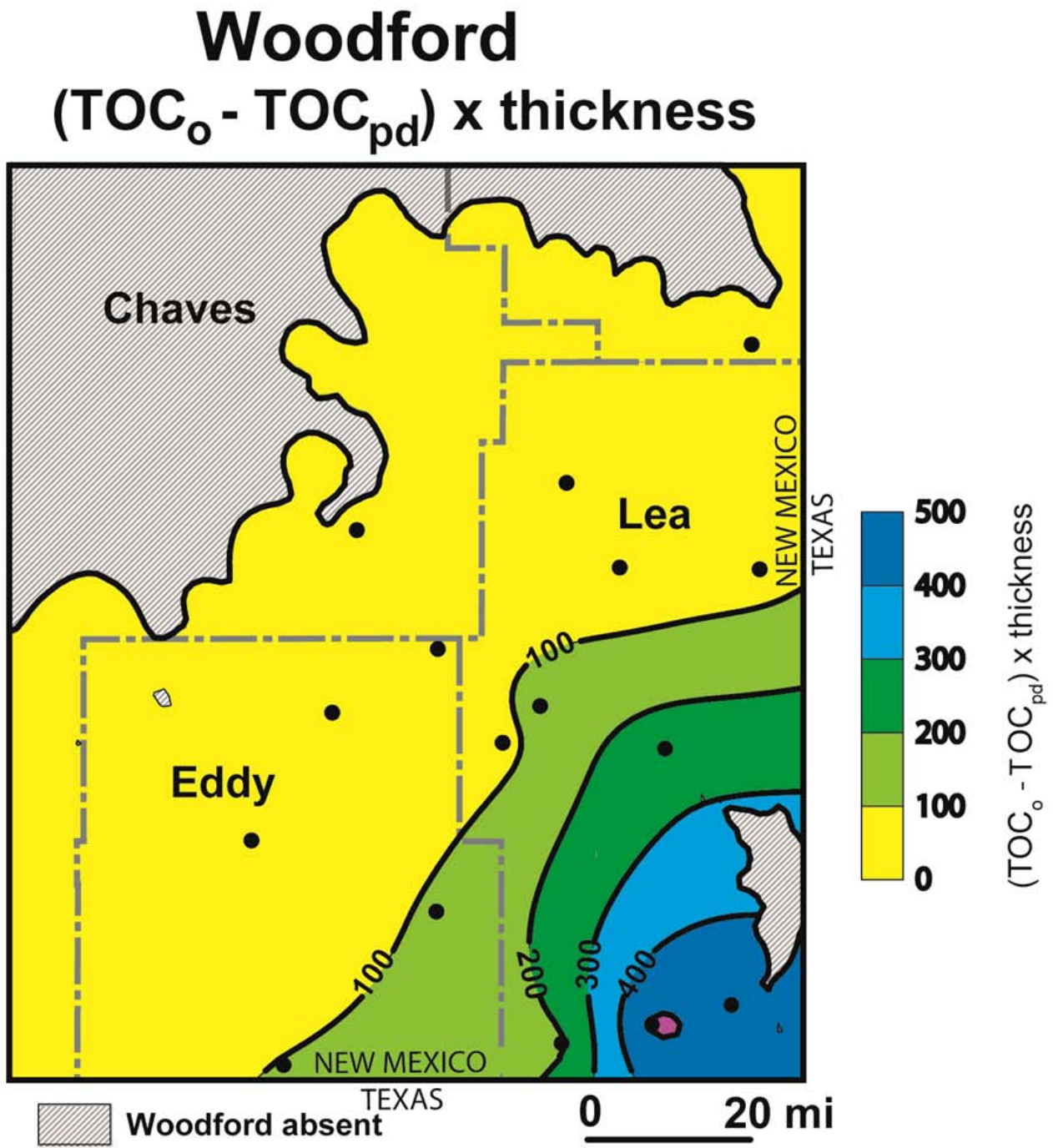
Woodford PI on Structure (top S-D carbonates)

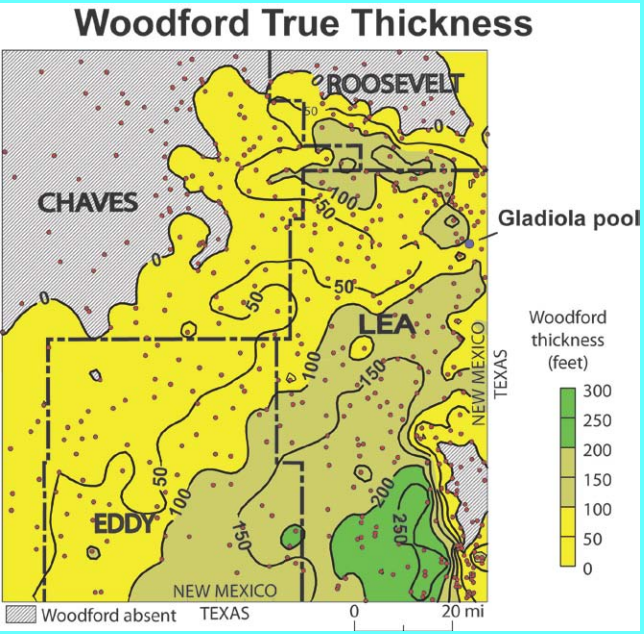


Calculated from original TOC, thermal maturity, & kerogen composition ala Jarvie et al. (2007, AAPG Bulletin)



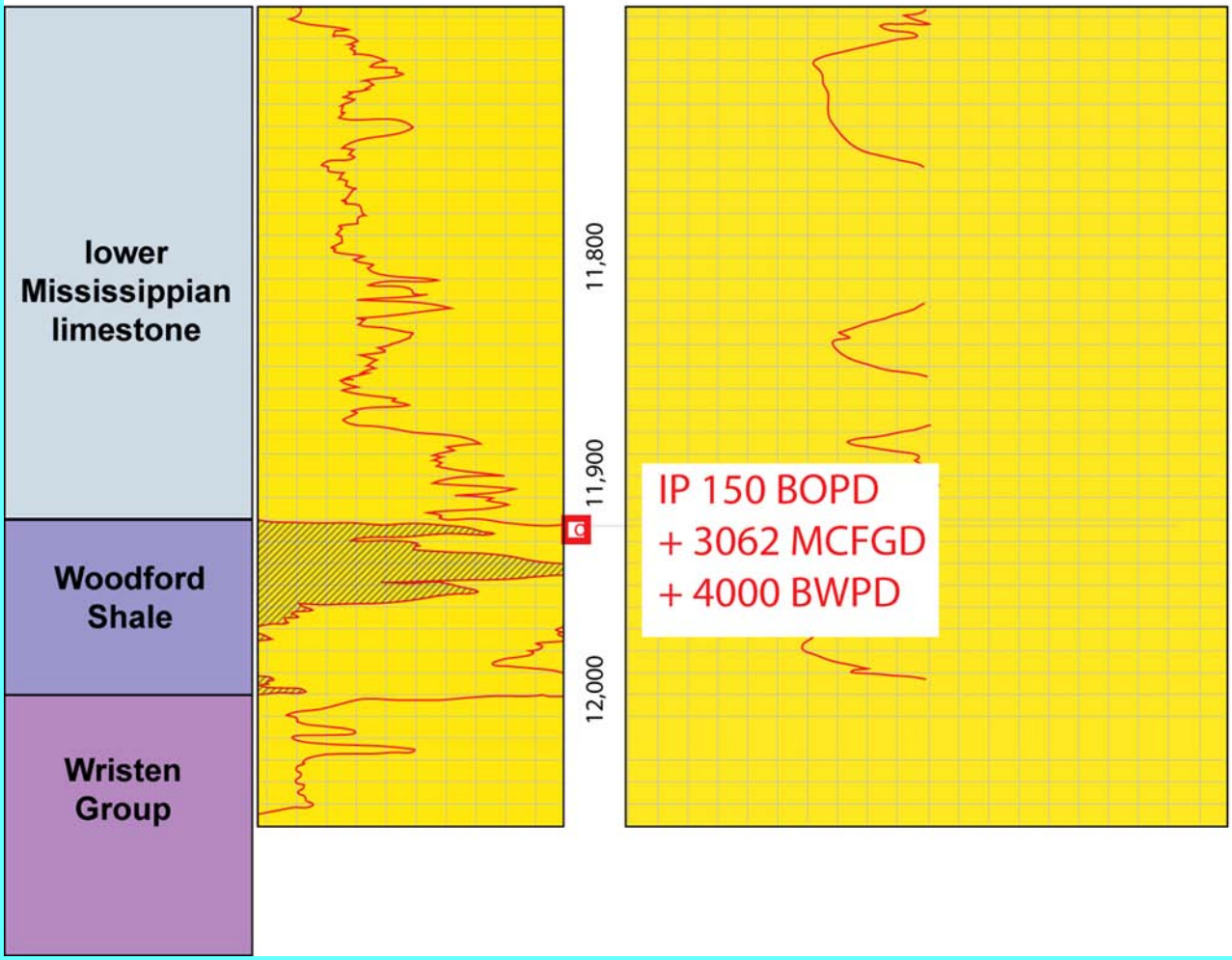
Indication of the relative volumes of hydrocarbons generated and expelled from the Woodford



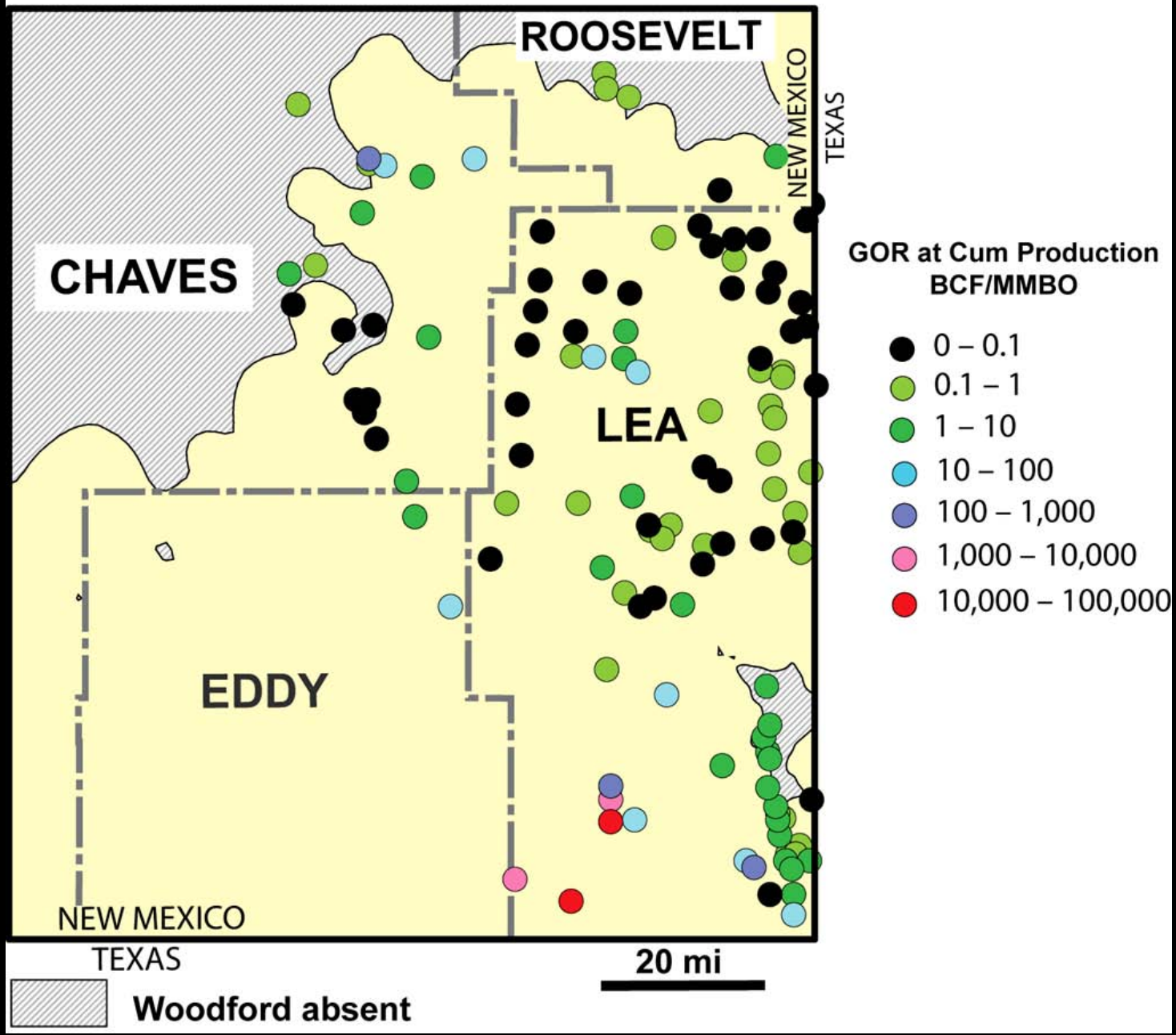


Cum production:
9 MBO
3 MMCFG
436 MBW

Platinum Exploration
No. 2 Angel
Sec. 5 T12S R38E
Gladiola Woodford oil pool (discovery well)



Wristen GOR at Cum Production



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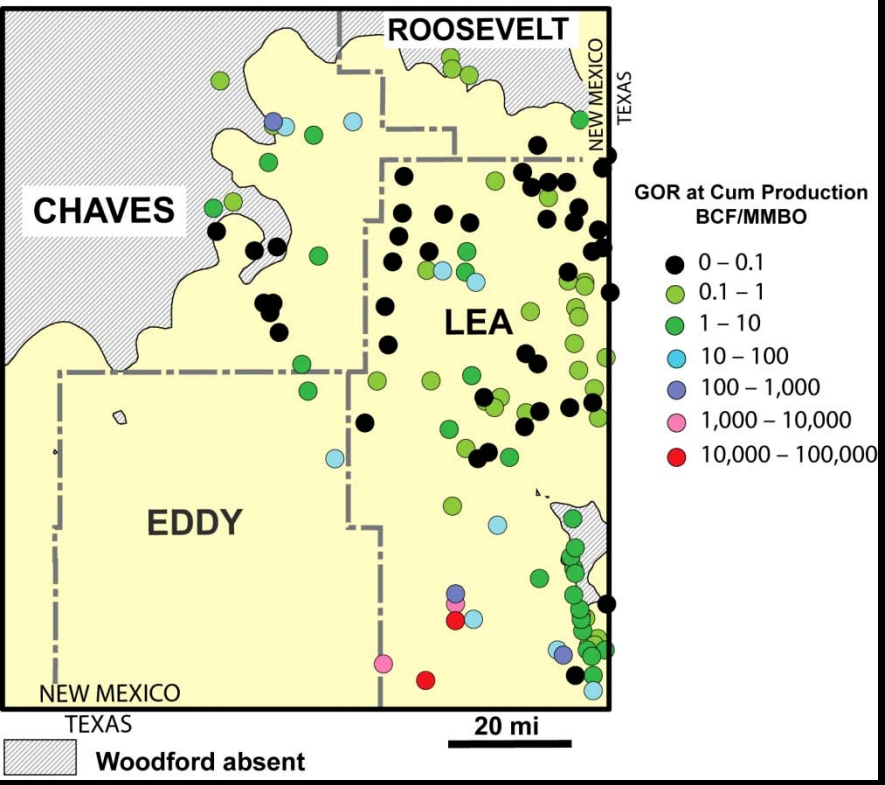
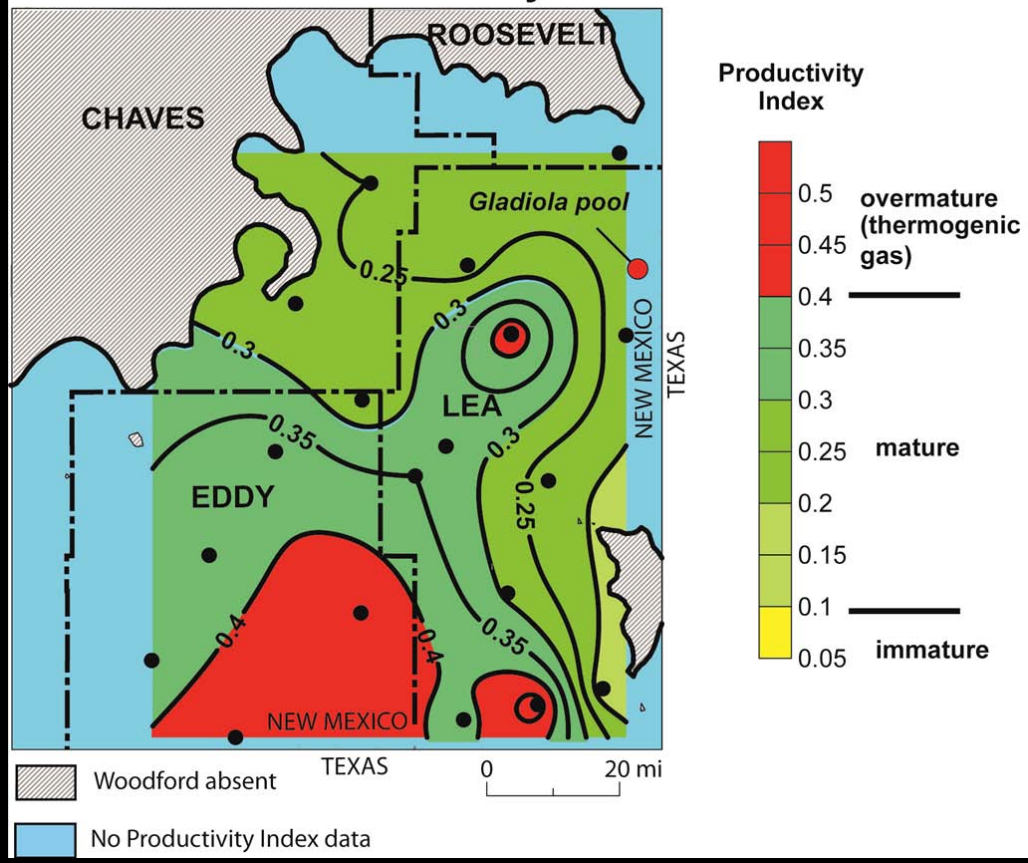


Woodford Productivity Index



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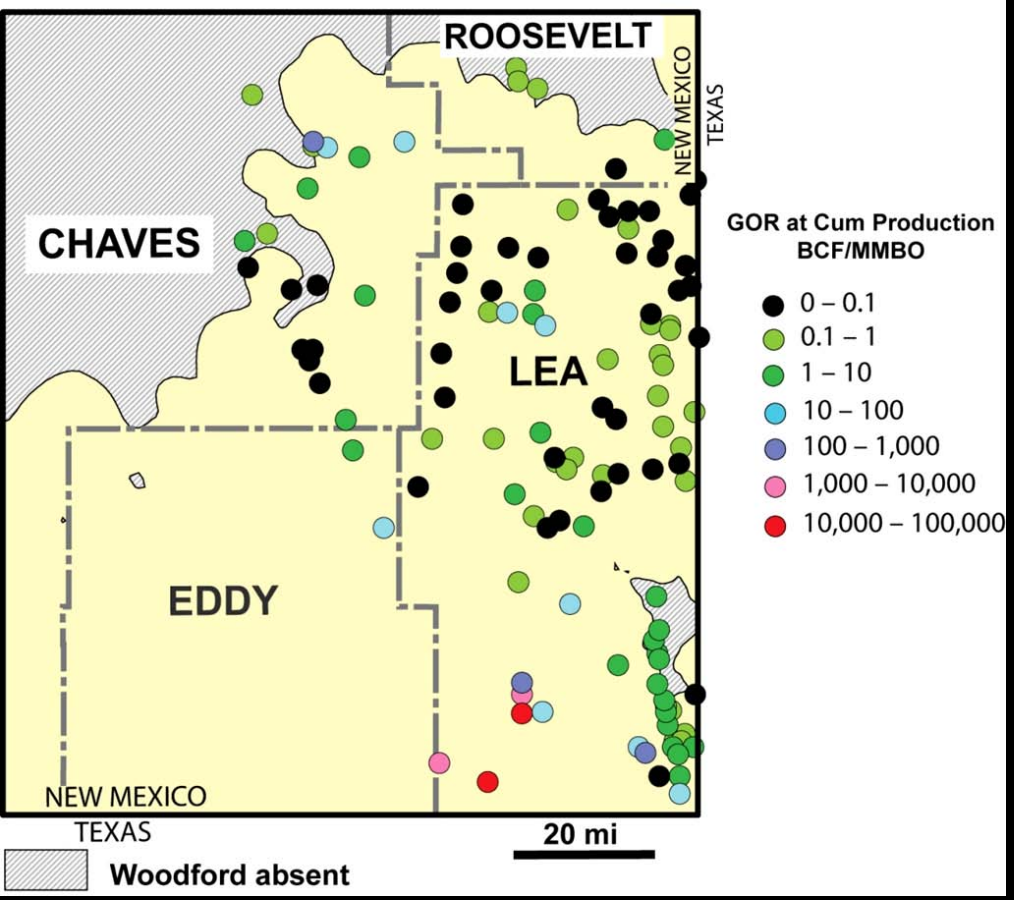
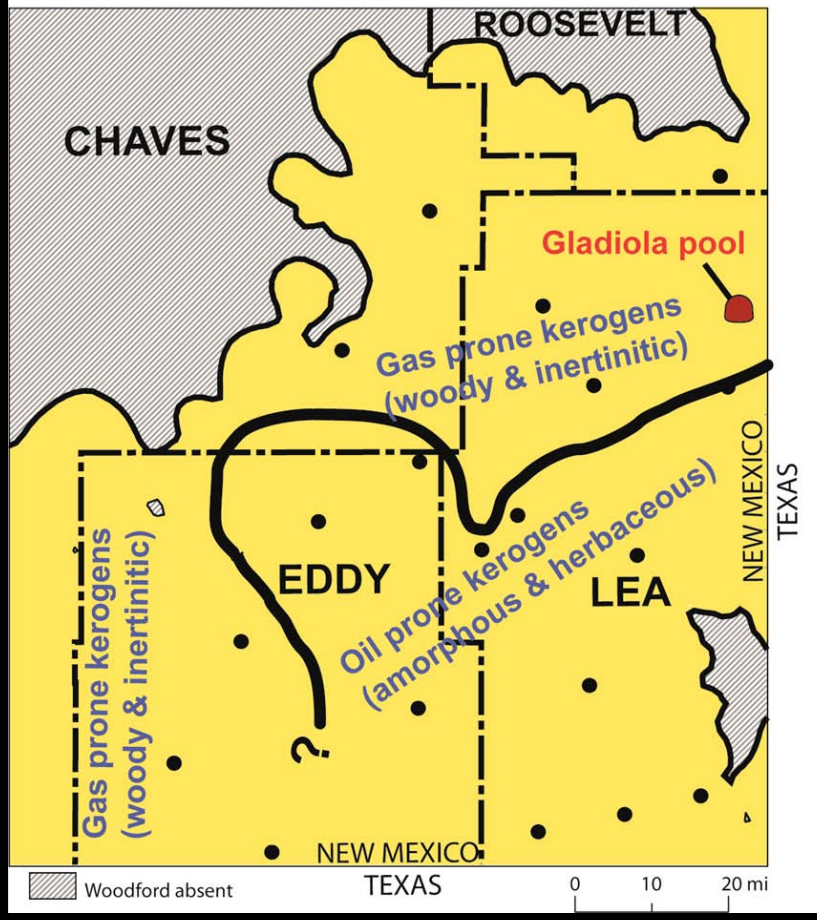


Woodford Kerogen Facies



Woodford Conclusions

- **True Woodford thickness is 0 to 300 ft thick in SE New Mexico**
- **Present-day post-maturation TOC is 1.7 to 4.9%**
- **Original pre-maturation TOC was 1.8 to 6.8%**
- **Present-day TOC and original TOC increase to southeast along with thickness**
- **Thermal maturation increases to south, not entirely depth-associated**
- **Woodford kerogens dominantly oil prone with gas-prone/inertinitic facies present to north and west**

Woodford Conclusions

- **Relative volumes of generated hydrocarbons increase 10x to southeast**
- **The Woodford has produced small volumes of oil with water from the 1-well Gladiola pool**
- **GOR ratios in underlying Wristen reservoirs reflect Woodford thermal maturity as well as northward transition to gas-prone kerogen facies**