

Oil and Natural Gas Potential of the Pre-Cretaceous Section, Raton Basin, New Mexico*

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Search and Discovery Article #10260 (2010)

Posted September 24, 2010

*Adapted from oral presentation at AAPG Rocky Mountain Section 58th Annual Rocky Mountain Rendezvous, Durango, Colorado, June 13-16, 2010

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Abstract

The Raton Basin, which straddles the Colorado-New Mexico border, is an asymmetric north-south elongated Laramide (Late Cretaceous - Early Tertiary) compressional basin that extends into Colfax County, New Mexico, from Las Animas County, Colorado. On the New Mexico side of the basin, coalbed methane has been produced since 1999 from approximately 600 wells in the shallow Vermejo and Raton formations (Upper Cretaceous to Lower Tertiary). The Pierre and Niobrara shales (Upper Cretaceous) have produced gas from four wells in the New Mexico part of the basin, three of which are part of an active play. Pre-Cretaceous strata in the New Mexico side of the basin have been sparsely penetrated by exploratory wells and thus far have not been productive. The Morrison Formation (Jurassic) is present at depths of 900 ft on the shallow eastern flank of the basin to 6200 ft along the basin axis. It includes 300 to 430 ft of fluvial sandstones and nonmarine shales and has a facies belt of dark-gray to black organic-rich shales with mixed oil- and gas-prone kerogens. The Morrison is within the oil window on the shallow basin flanks and within the gas window in the deeper, central parts of the basin. Gas and oil shows have been reported from exploratory wells. The Morrison contains both reservoirs and source rocks.

Triassic nonmarine sandstones and the shallow-marine Glorieta Sandstone (Permian) are characterized by CO₂-water systems instead of hydrocarbon-water systems. Reservoirs are not stratigraphically associated with petroleum source rocks. The CO₂ may have been sourced by the magmas that form the Tertiary volcanic rocks that intruded the deeper parts of the basin. The top of the Triassic is present at a projected depth of 6700 ft along the basin axis and rises to 1300 ft along the shallow eastern flank of the basin. The top of the Glorieta is approximately 300 ft below the top of the Triassic.

Sandstones in Pennsylvanian to Lower Permian strata are targets for hydrocarbon gas exploration. These strata have not been penetrated by exploratory wells in the deepest parts of the basin where they are present at projected depths between 7500 ft and the top of Precambrian basement at 10,500 ft. Thickness data from wells drilled on the shallow flanks of the basin suggest that a Pennsylvanian-age basin may be present underneath the Raton Basin and is a possible southern extension of the Late Paleozoic Central Colorado Basin. Pennsylvanian and Lower Permian clastic sedimentary rocks may be as thick as 3000 ft along the axis of the Pennsylvanian basin. The Pennsylvanian and Lower

Permian sections contain lateral facies belts defined by the presence of organic-rich dark-gray to black shales. These source facies are within the thermogenic gas window in the deeper, axial parts of the basin.

References

New Mexico Bureau of Geology and Mineral Resources, 2003, Geologic map of New Mexico: New Mexico Bureau of Geology and Mineral Resources, scale 1:500,000, 2 sheets.

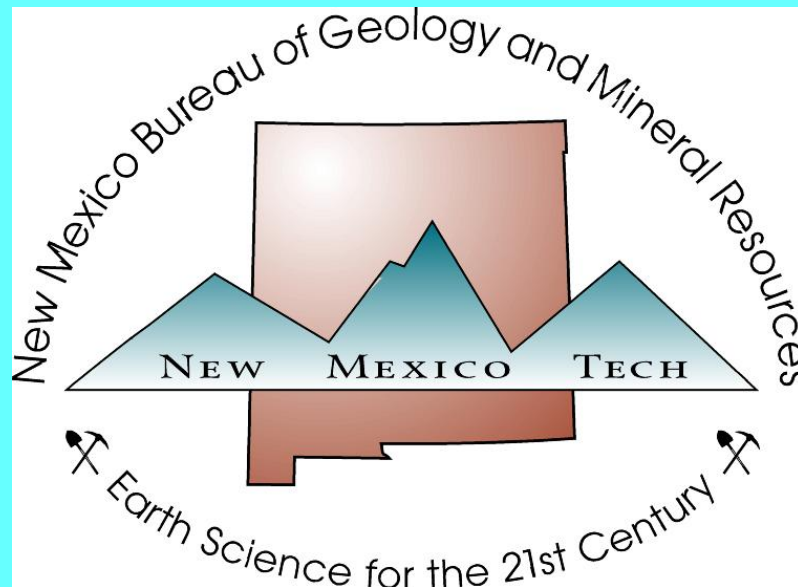
Wilks, M.E., compiler, 2005, New Mexico Geologic Highway map: New Mexico Geological Society and New Mexico Bureau of Geology and Mineral Resources, 1 sheet containing text and figures, scale 1:1,000,000.

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A Division of New Mexico Tech



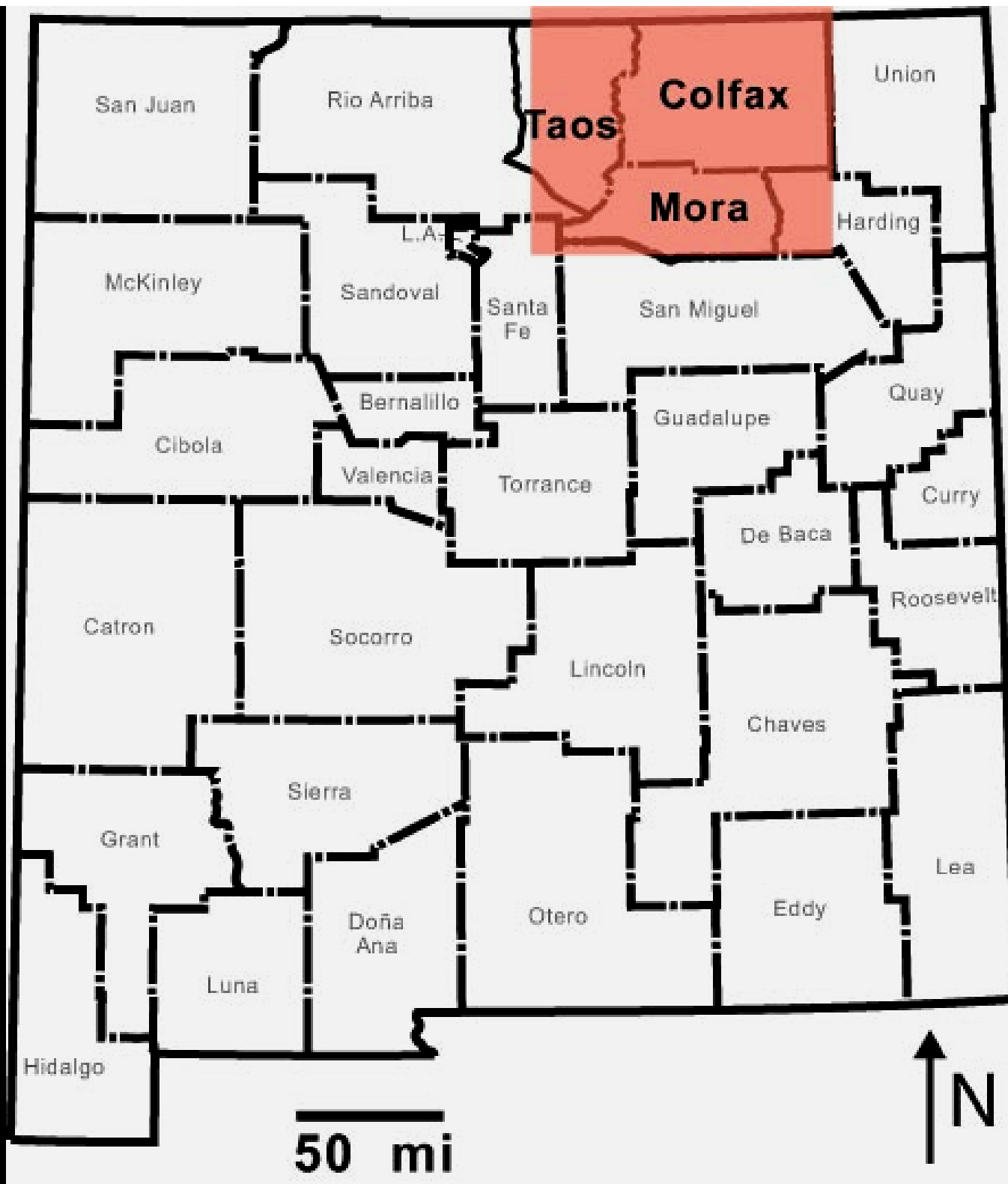
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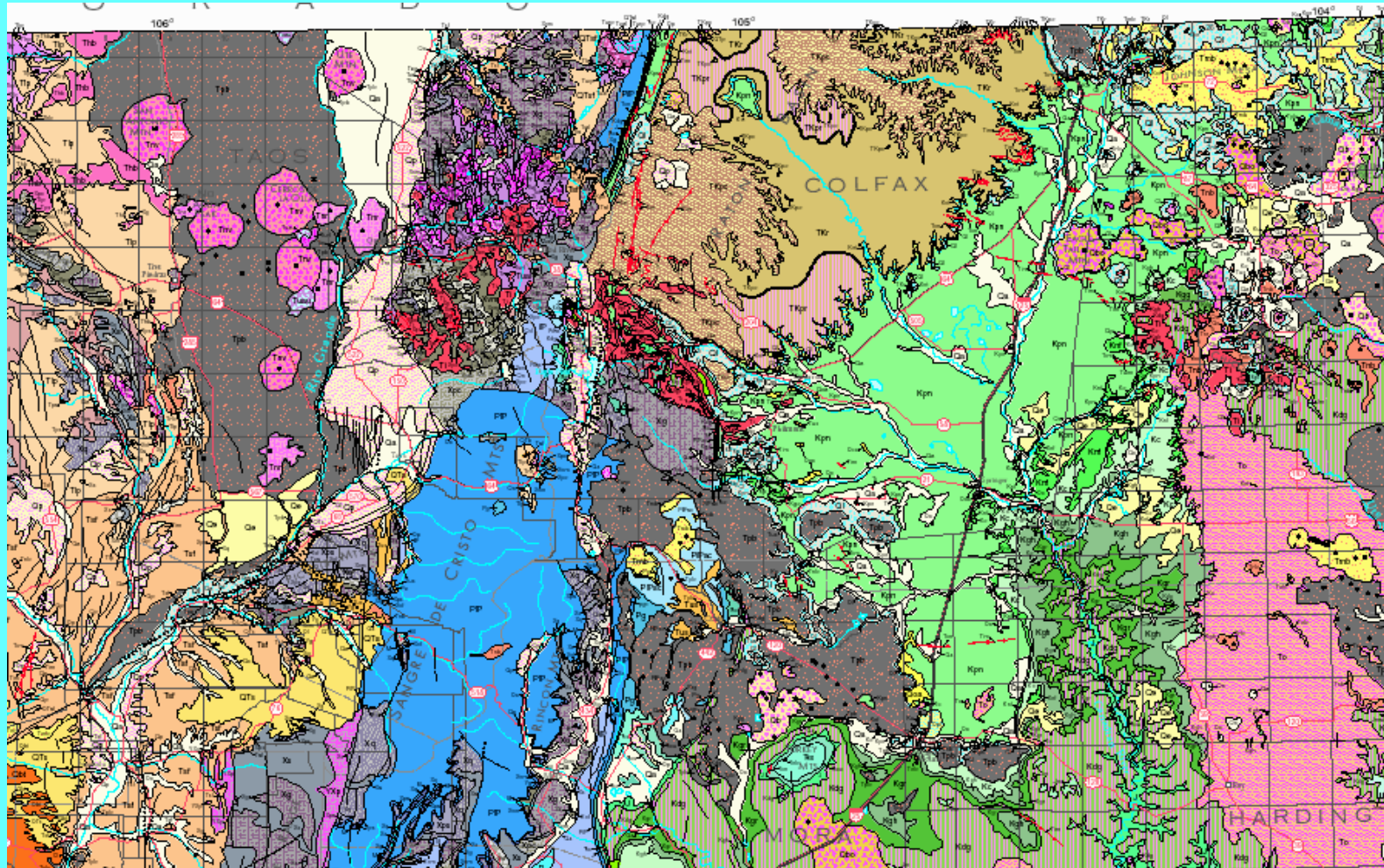
- **New Mexico State Land Office** for providing partial project funding (*The Honorable Patrick Lyons, Commissioner of Public Lands*)

Special Acknowledgment

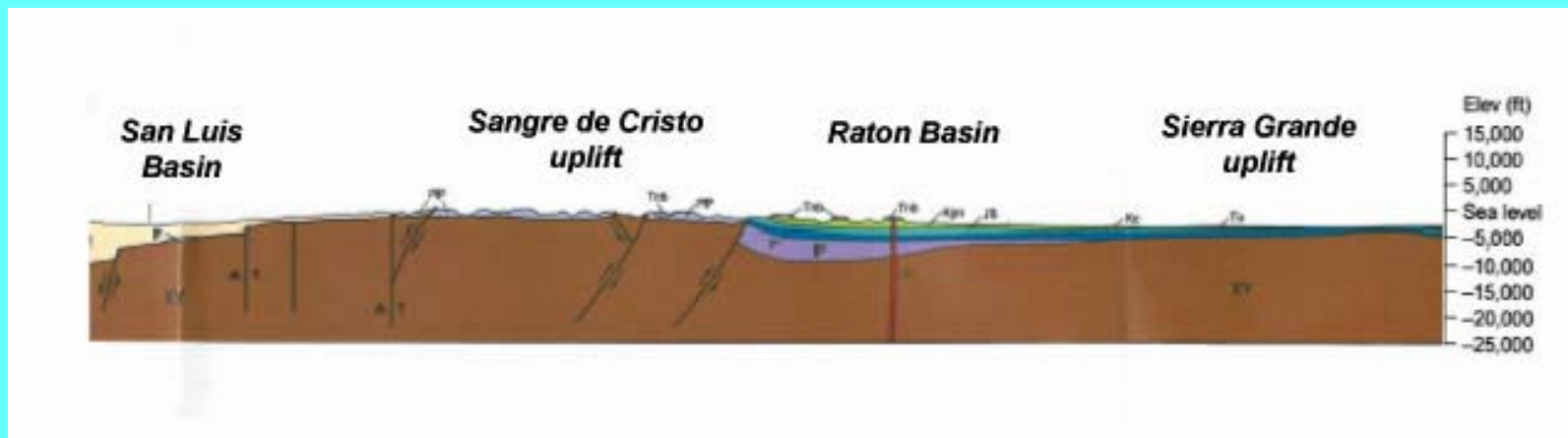


Snoozer the Magnificent



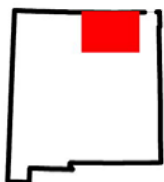
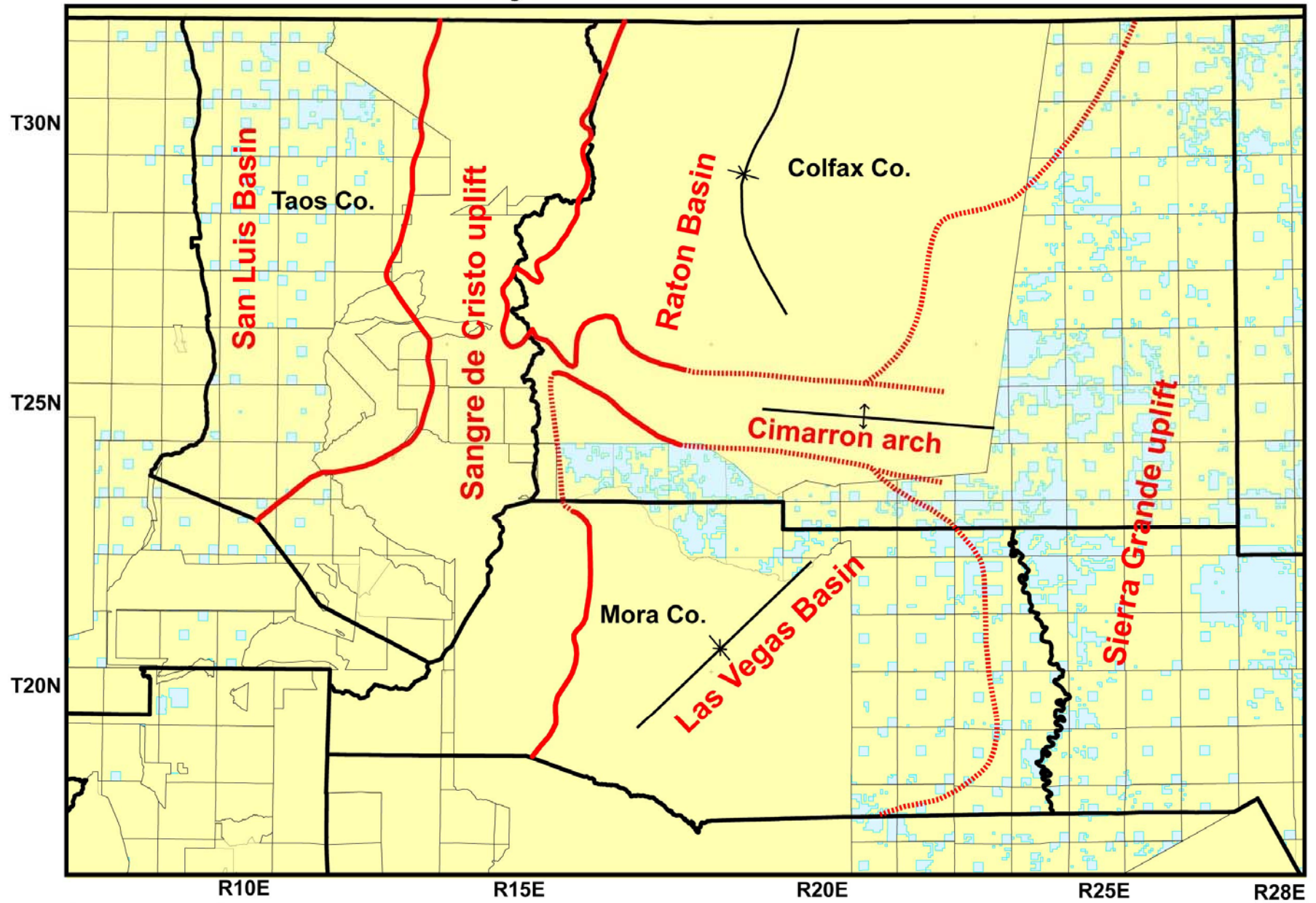


**New Mexico Bureau
of Geology and
Mineral Resources
(2003)**



**Wilks et al.,
New Mexico
Geological Society
(2005)**

Major tectonic elements

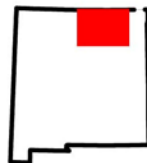
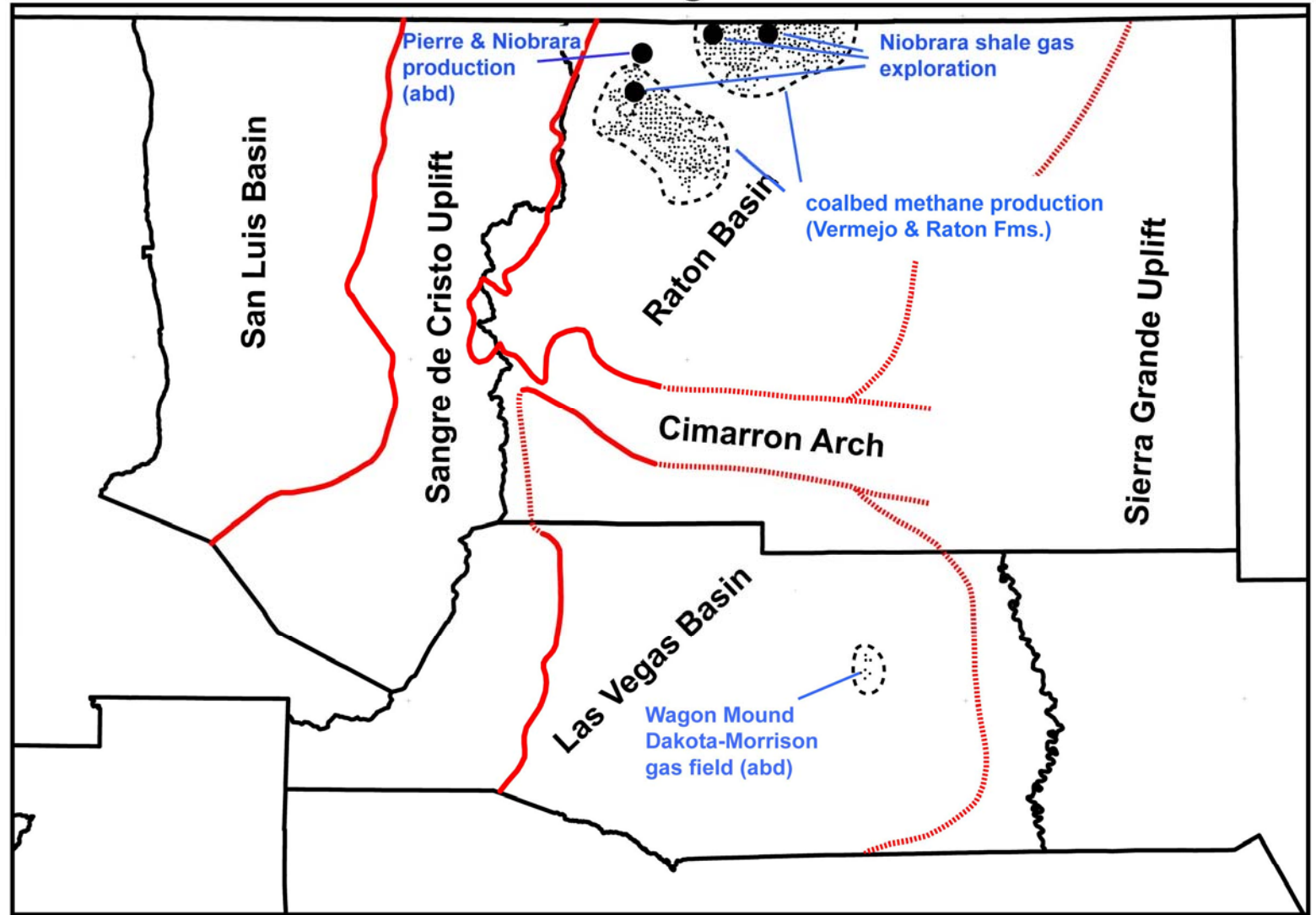


20 miles



NM State Trust land

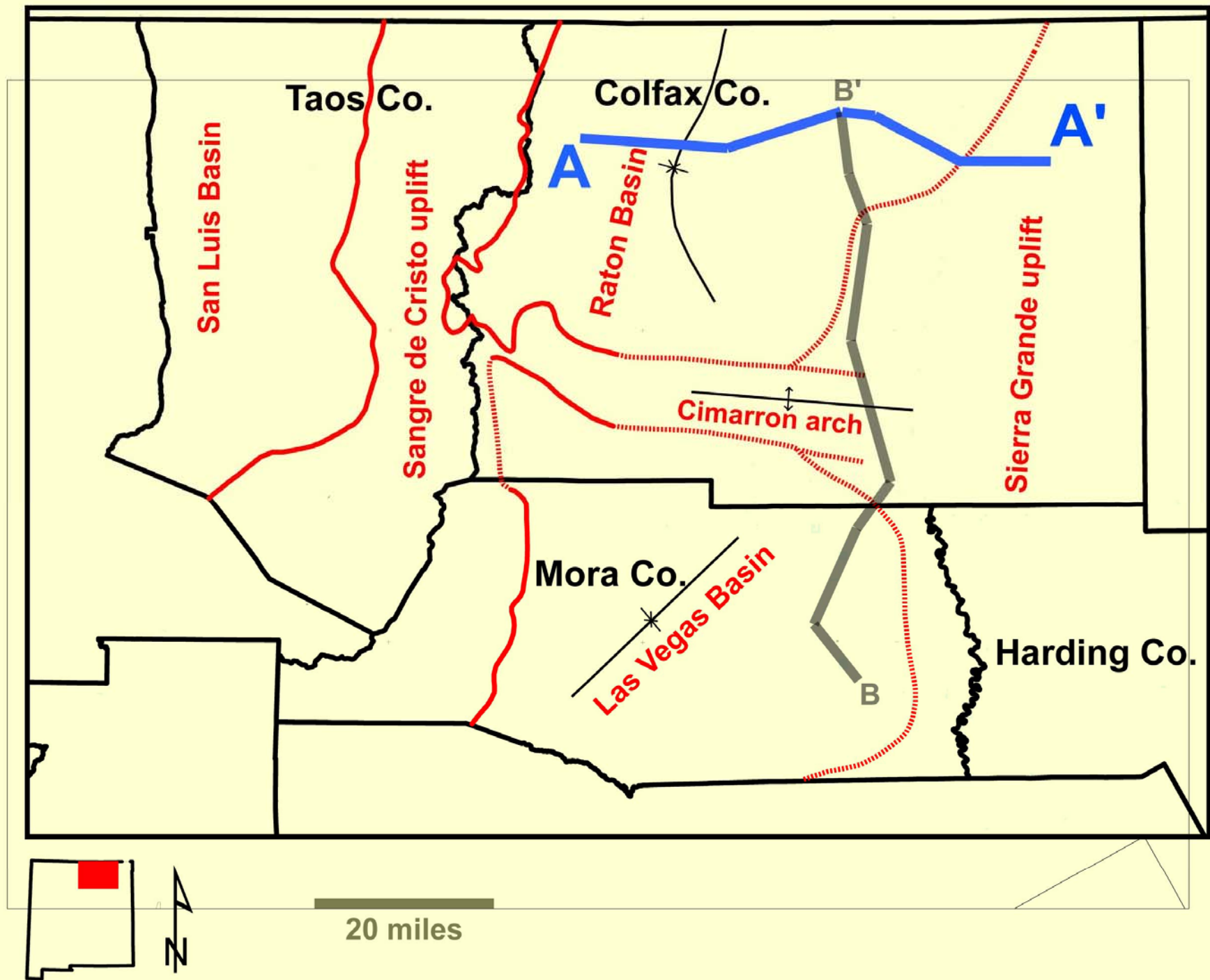
Gas wells and gas fields



20 miles

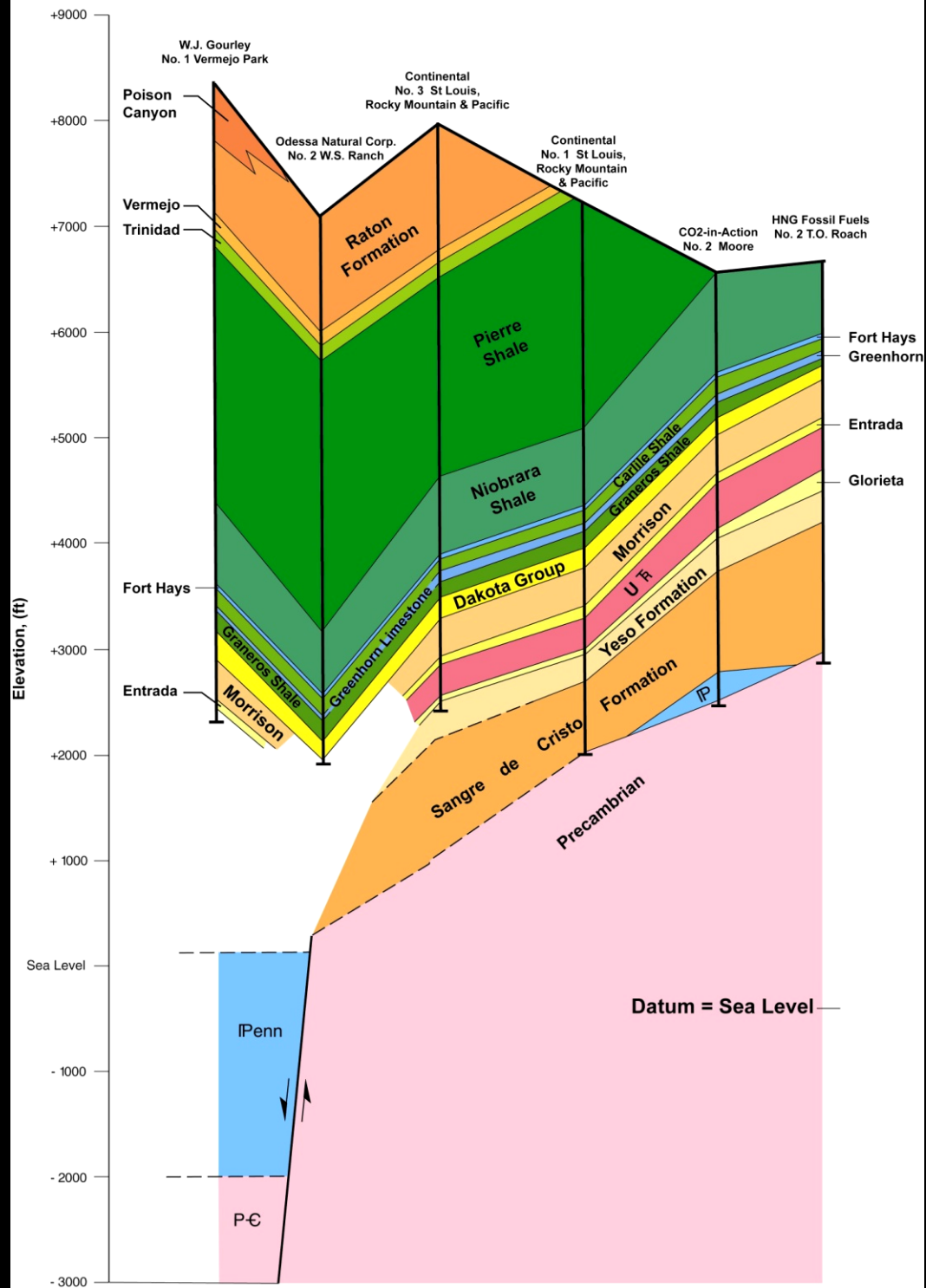
- Productive coalbed methane well
- Shale gas well

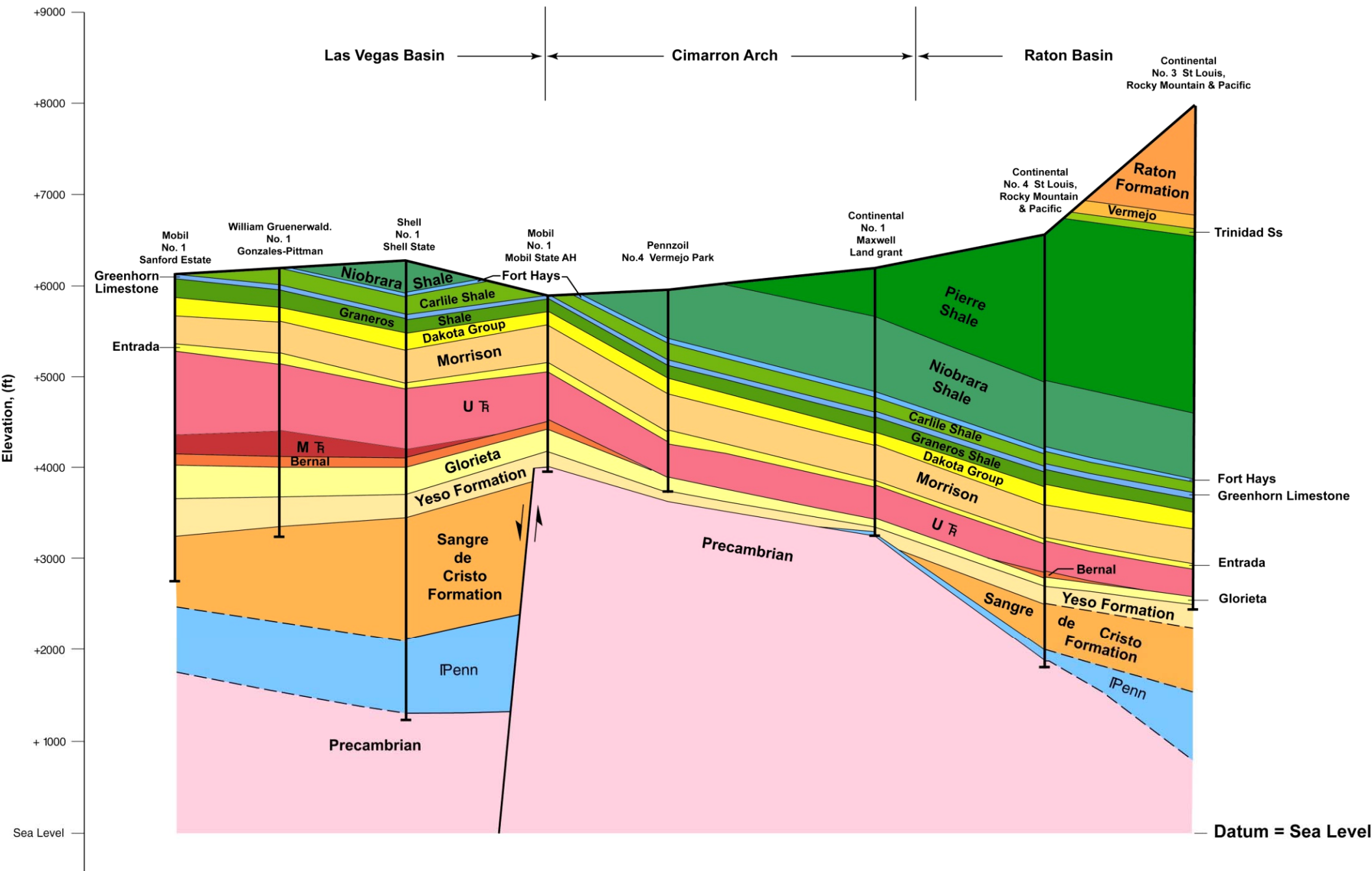
Q	
Tertiary	
	Raton
	Vermejo
Cretaceous	Pierre
	Niobrara
J	
Tk	
P	
PP	
PC	



A
West

A'
East

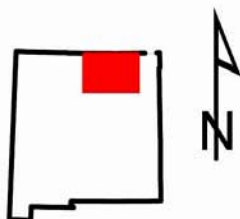
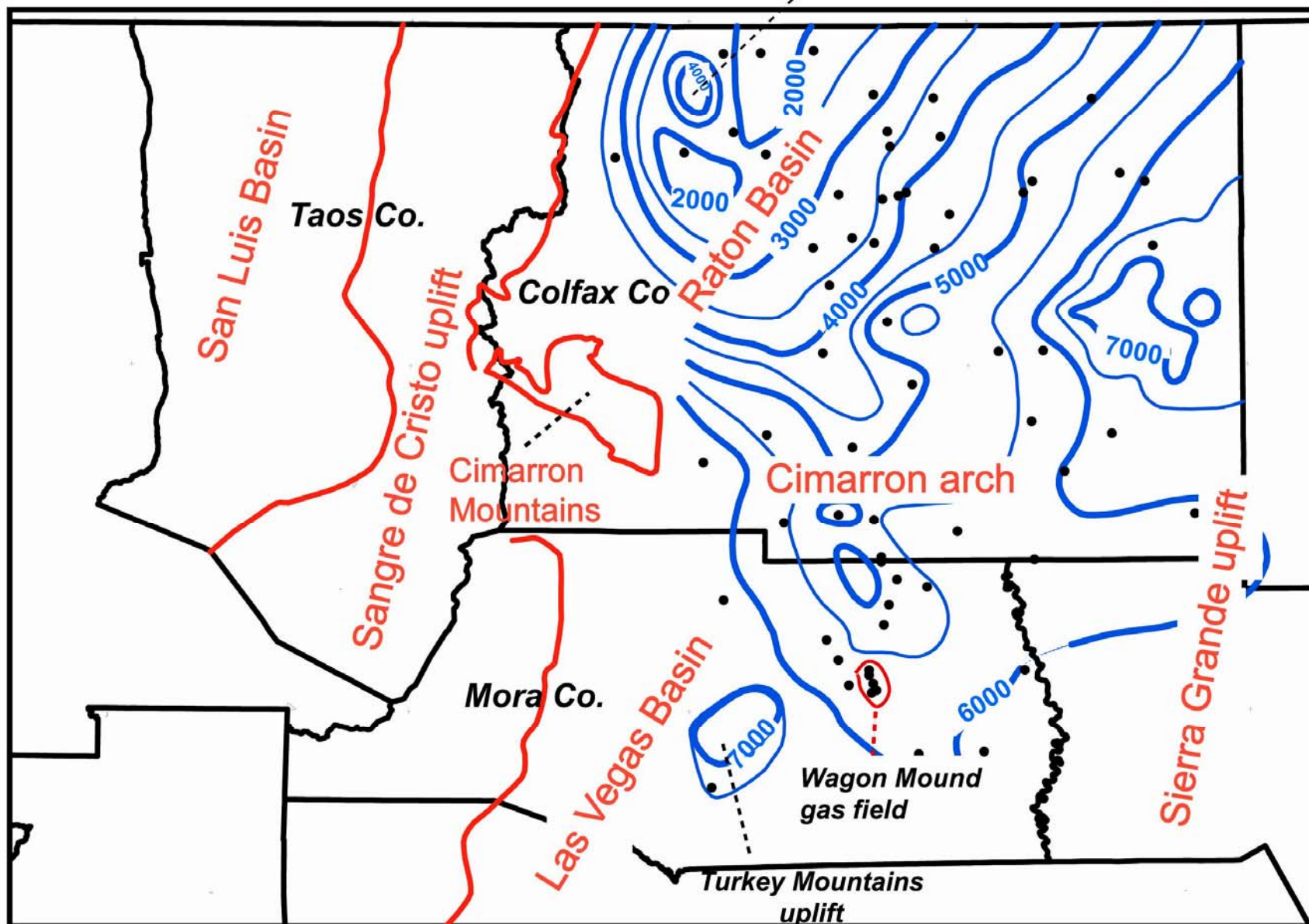


B**South****B'****North**

Dakota structure

Vermejo Park
anticline

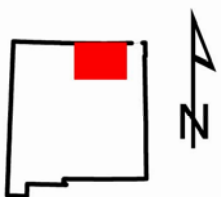
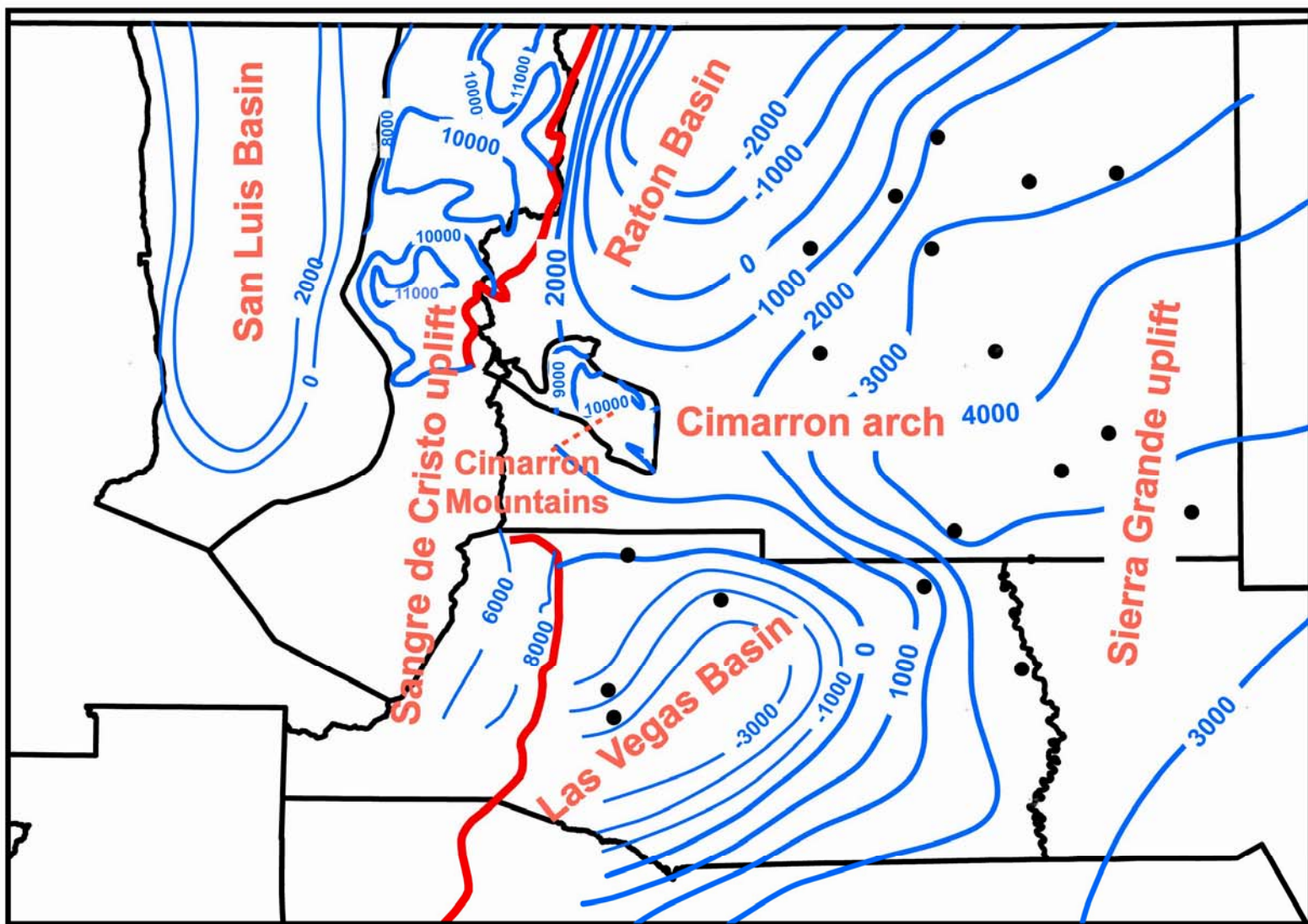
Q	
T	
Cretaceous	Graneros
	Dakota
J	
Tk	
P	
Penn	
PC	



20 miles

Contour interval = 500 feet
Datum = sea level

Precambrian structure



20 miles

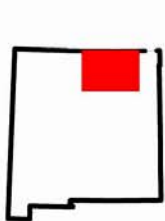
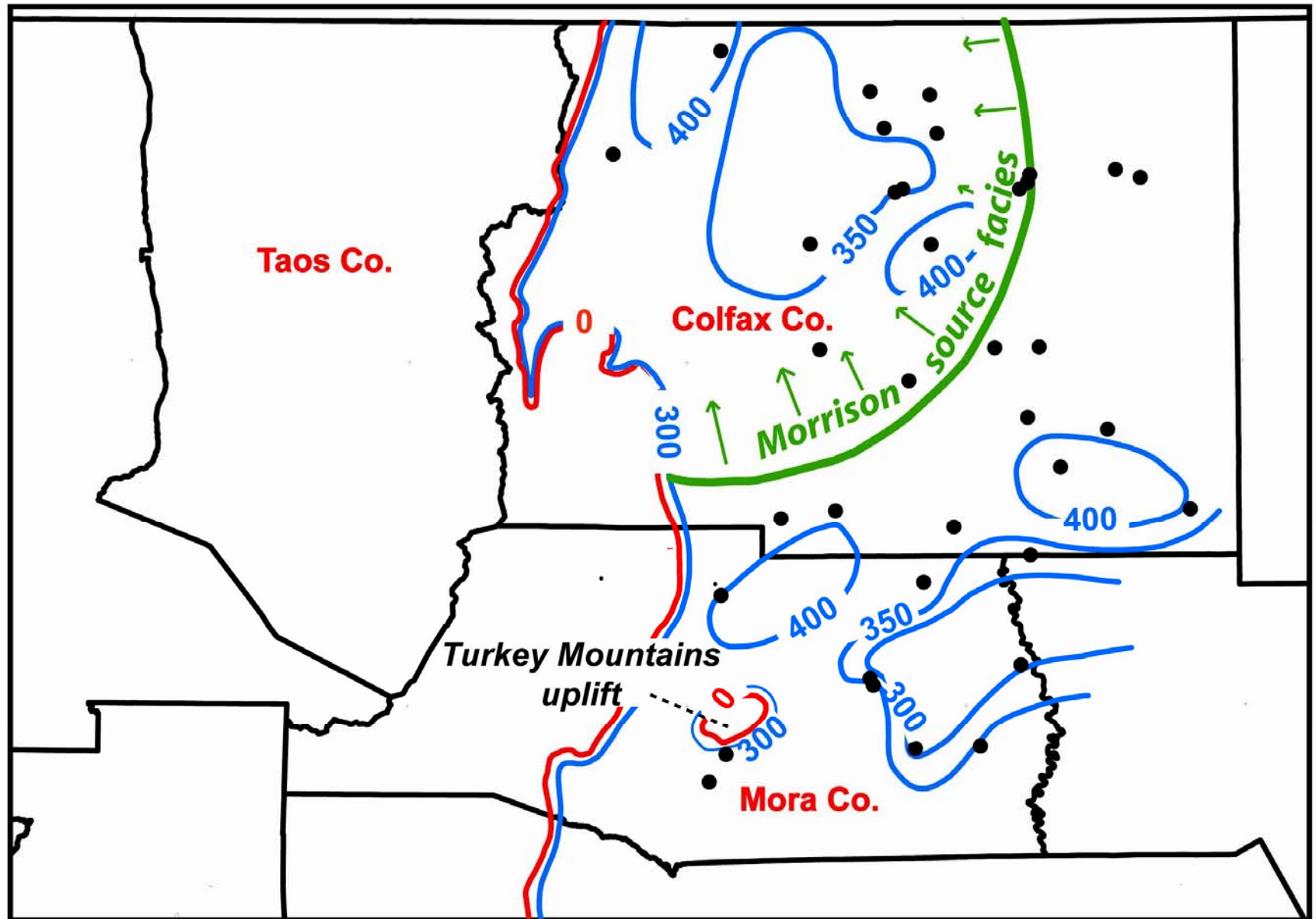
Major reverse/thrust fault at surface

Contour interval = 1000 ft (most places)
Datum = sea level

Q	
T	
K	
J	
Tk	
Perm	
Penn	
PC	

Morrison isopach

Q	
Tertiary	
K	
Jur	Morrison
Tk	
P	
Penn	
PC	

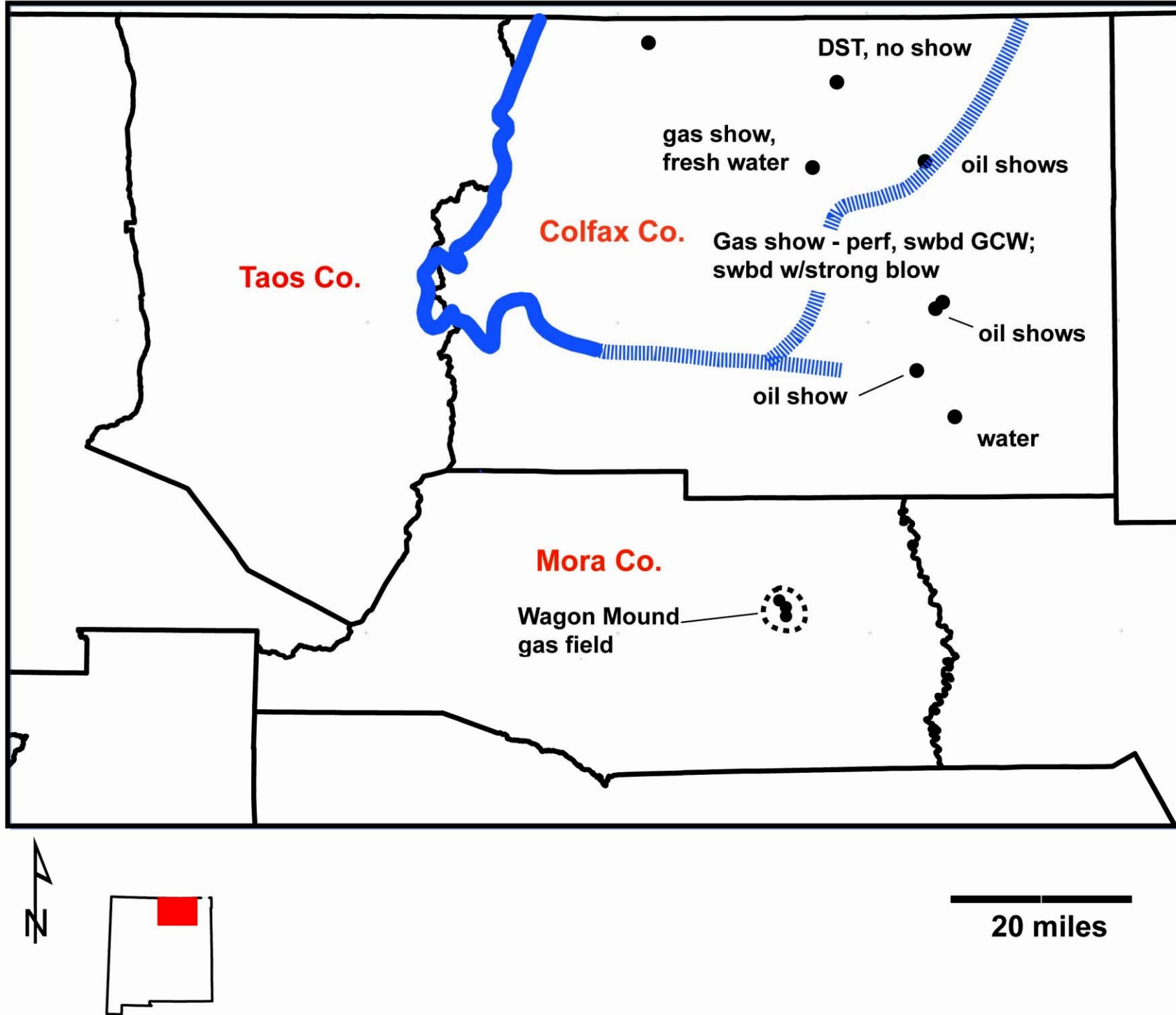


20 miles

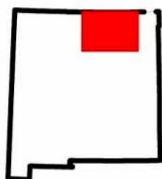
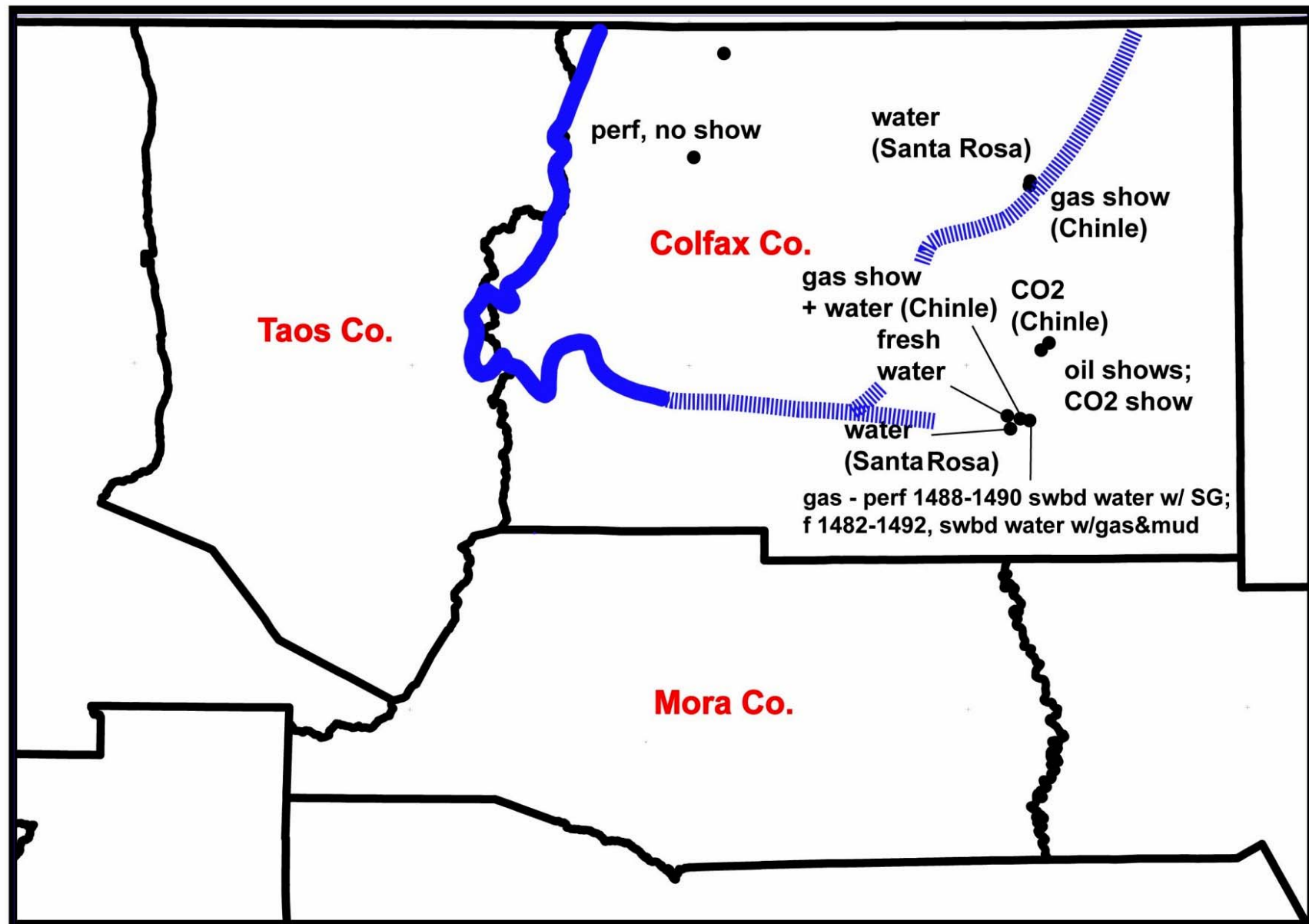
Contour interval = 50 ft in most places

Morrison production, shows & tests in wells

Q	
Tertiary	
K	
Jur	Morrison
Tk	
P	
Penn	
PC	



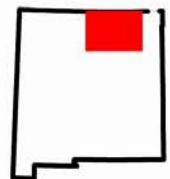
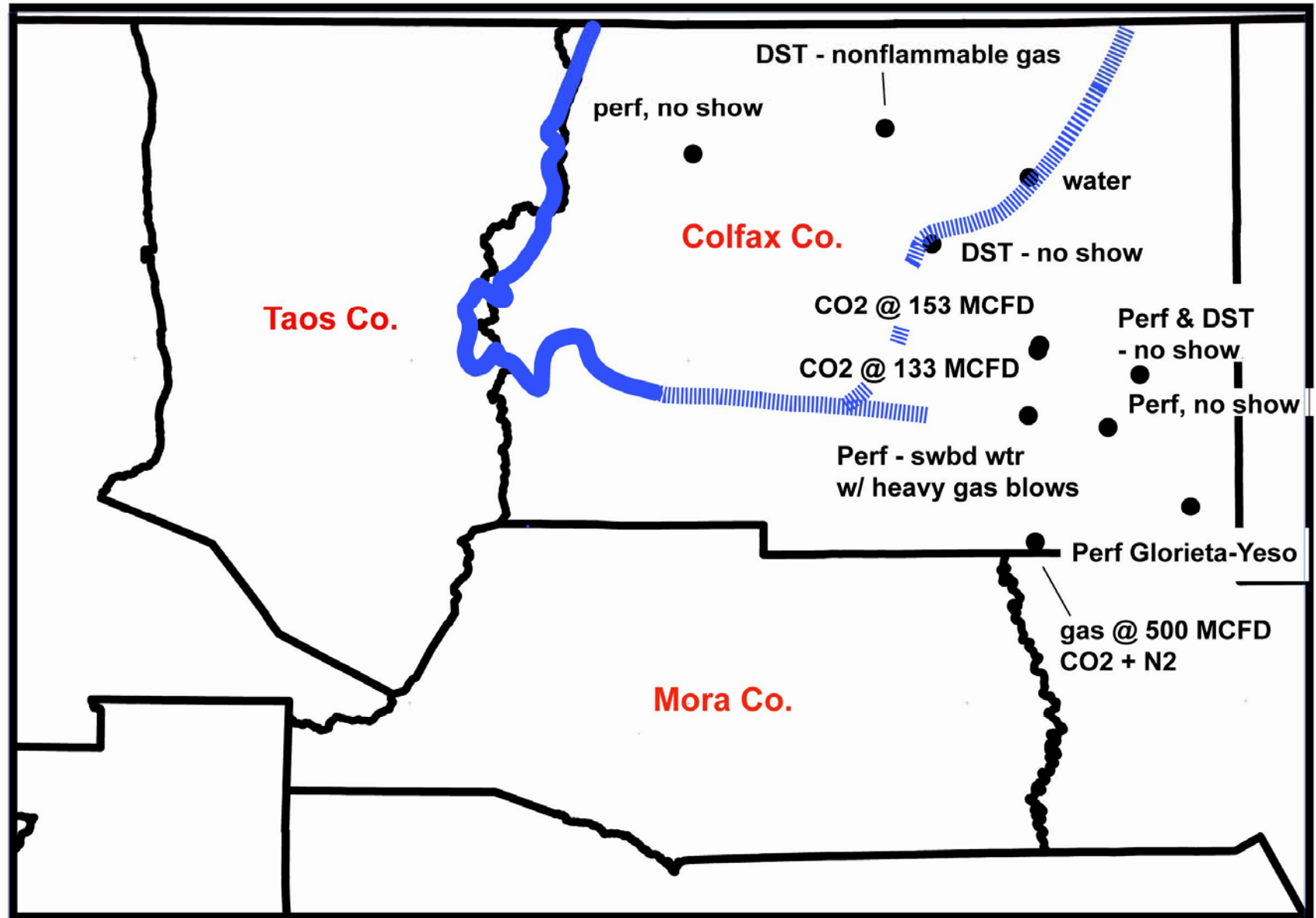
Triassic shows & tests in exploratory wells



20 miles

Q	
Tertiary	
K	
Jur	
Tk	Chinle
	Santa Rosa Ss
P	
Penn	
PC	

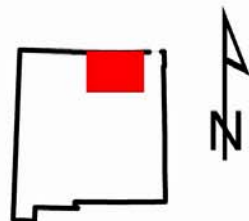
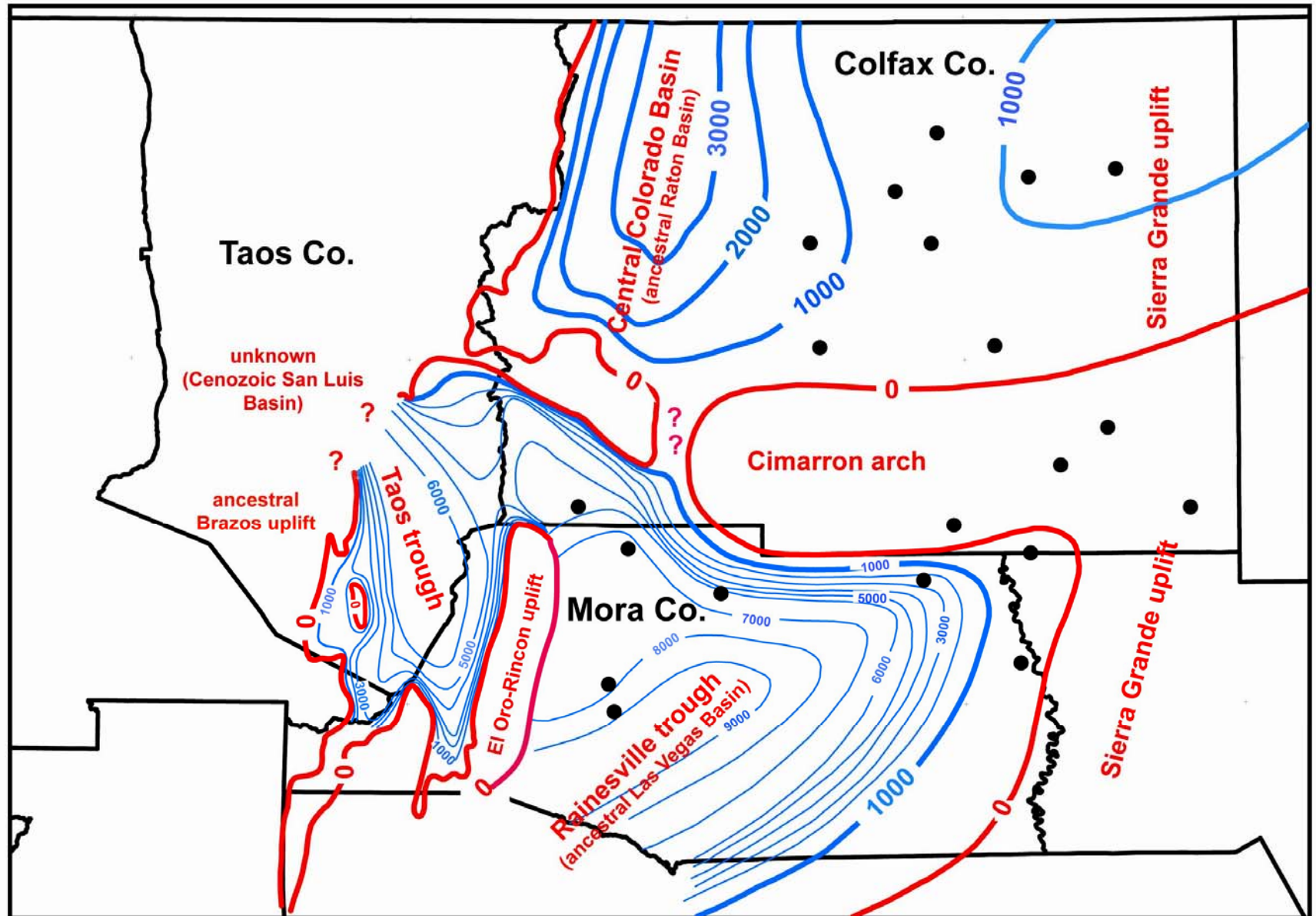
Glorieta shows & tests in exploratory wells



20 miles

Q	
Tertiary	
K	
Jur	
Tk	
P	Bernal
	Glorieta
	Yeso
Penn	
PC	

Sangre de Cristo + Pennsylvanian isopach

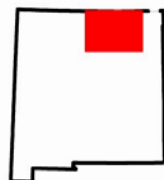
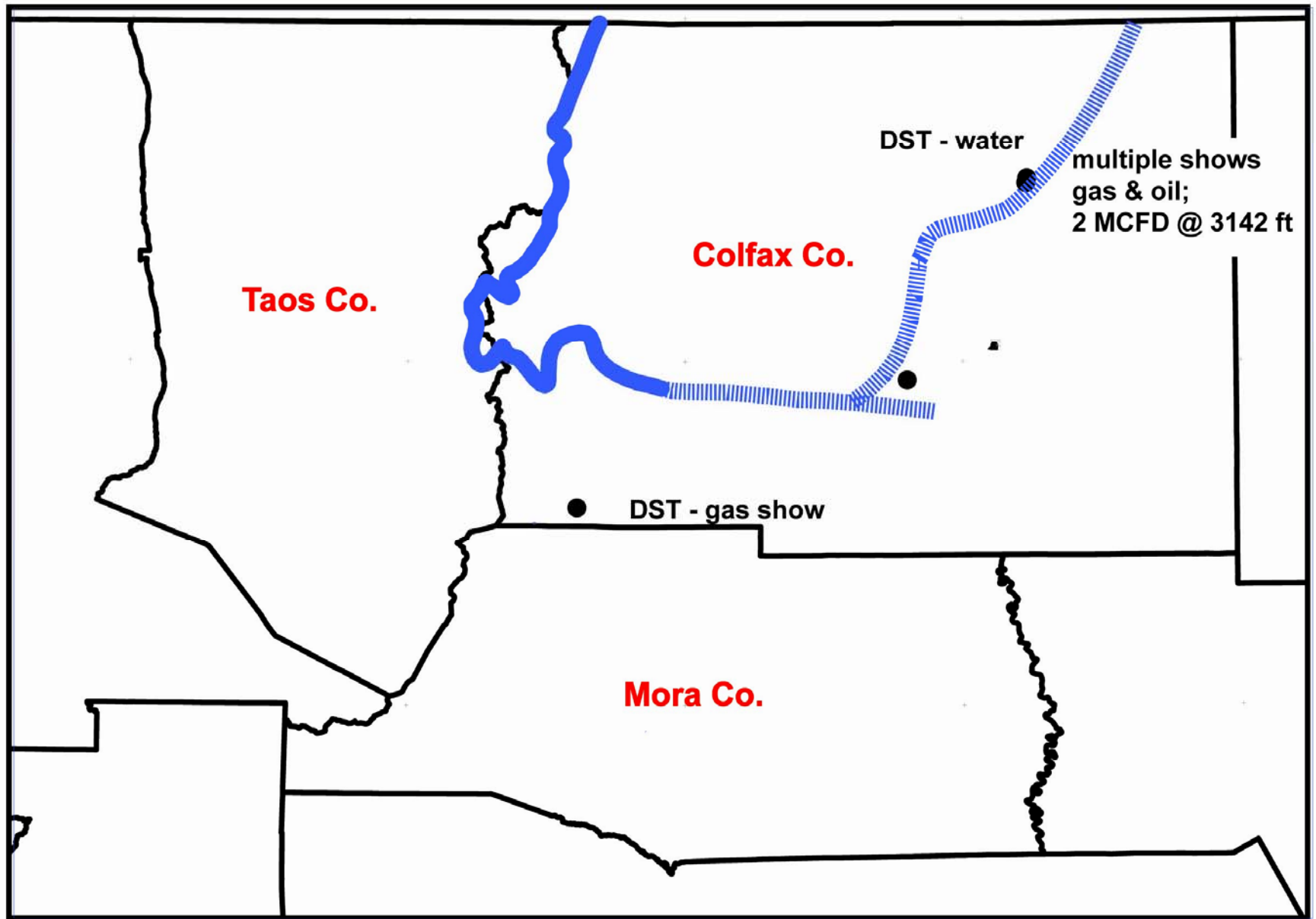


20 miles

Countour interval = 1000 ft

Pennsylvanian & Sangre de Cristo shows & tests in exploratory wells

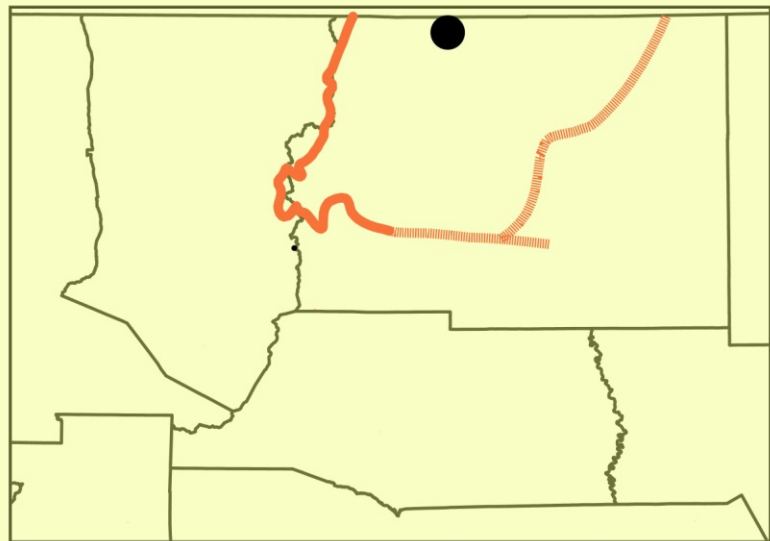
Q	
T	
K	
J	
Tk	
Perm	Sangre de Cristo
Penn	Madera
	Sandia
PC	



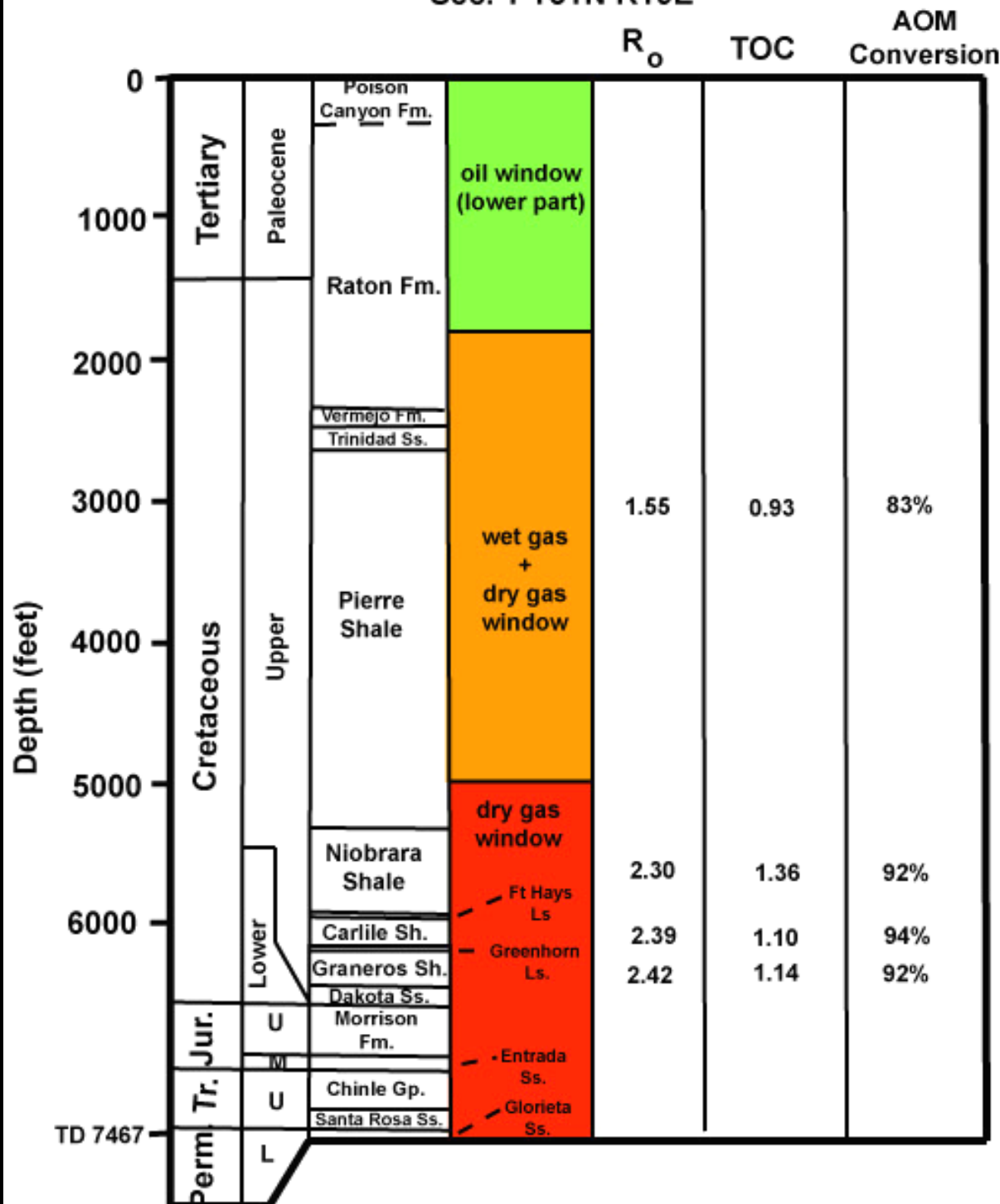
20 miles

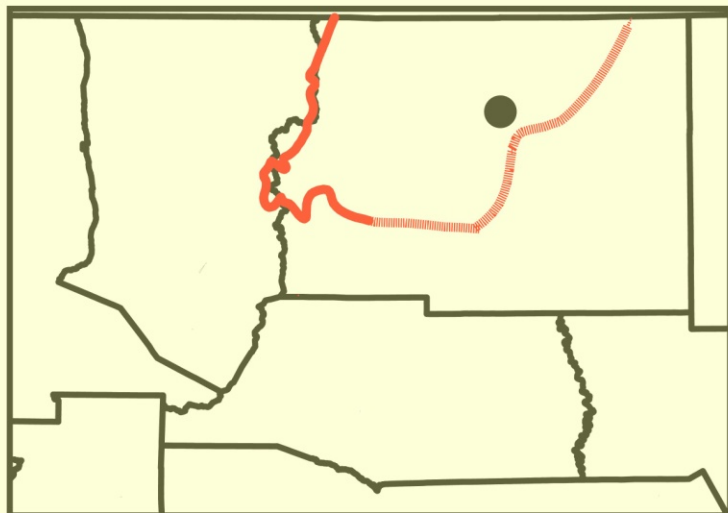
Raton Basin pre-Cretaceous Source Rocks

Stratigraphic Unit		TOC (wt %)	Kerogen types	Show types
Jur.	Morrison	1.1 - 1.5% (source facies) 0.15% (non-source facies)	mixed oil prone + gas prone	HC's
	Entrada Ss.	no source facies		
Trias.	Chinle	0.08 - 0.62%	gas prone	CO ₂
	Santa Rosa Ss.			
Permian	Bernal	no source facies		CO ₂
	Glorieta Ss.			
	Yeso			
	Sangre de Cristo	> 1% (source facies) < 1% (non-source facies) Raton & Las Vegas Basins	dominantly gas prone	HC's
Penn.	undivided	1 - 10% (source facies) Raton & Las Vegas Basins	dominantly gas prone	HC's
Precambrian basement		no source facies		



El Paso Natural Gas
No. 7 WDW VPR A
Sec. 1 T31N R19E





Continental Oil Co.
No. 1 Maxwell Land Grant
Sec. 11 T28N R22E

				TAI	TOC
0	Cretaceous	Upper	Pierre Shale	2.1	1.67
			Niobrara Shale	2.2	2.03
		Lower	Carlile Sh	2.3	1.24
			Graneros Sh	2.3	1.61
			Dakota Ss	2.3	1.28
	Jurassic		Morrison Fm	2.3	1.49
			Entrada Ss		0.15
	Triassic		Chinle Gp		
			Santa Rosa Ss		0.11
	Permian		Glorieta Ss		0.08
TD 2947	Precambrian		Yeso Fm		
			Pennsylvanian		

Conclusions

- The pre-K sedimentary section is up to 4000 ft thick in the deepest part of the Raton Basin.
- Pre-K strata have not yet produced and are an exploration frontier.
- The Morrison Formation (Jurassic) is 300-400 ft thick, contains mature source rocks, reservoirs, and is characterized by oil & gas shows.
- Pennsylvanian strata, up to 3000 ft thick, contain mature source rocks, reservoirs and are characterized by hydrocarbon shows. They have not yet been drilled in the deeper parts of the basin where an elevator basin may be present.
- Gases in Permian and Triassic reservoirs not associated with hydrocarbon source rocks are CO₂. The CO₂ likely originated by de-gassing of rising Tertiary magmas in the deep basin.
- Pre-K section is within the dry gas window in the deep basin and the upper part of the oil window on the basin flanks.