The Mancos Shale in the Albuquerque Basin: A Play Limited by Structure and Associated Thermal Maturity*

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Search and Discovery Article #11274 (2019)**
Posted December 16, 2019

*Adapted from oral presentation given at 2019 AAPG Rocky Mountain Section Meeting, Cheyenne, Wyoming, September 15-18, 2019
 DOI:10.1306/11274Broadhead2019

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Abstract

The Mancos Shale (Upper Cretaceous) has exploratory interest in the nonproductive Albuquerque Basin, a Late Tertiary rift basin formed by dominantly by faults. The Mancos C zone is the primary oil producing unit in the San Juan Basin and is of major interest in the Albuquerque Basin. Evaluation of Mancos C thermal maturity is essential to resource evaluation. The Albuquerque Basin is sparsely drilled with cuttings available only on a few deep wells. To evaluate Mancos C thermal maturity, a published gravity model of Tertiary fill thickness was used to project depth to the Mancos C in undrilled areas. A depth-dependent maturation model based on vitrinite reflectance was developed. Together these two models allowed estimation of thermal maturity throughout the basin. Depth to Mancos C varies widely. The Zianna Uplift in the north bifurcates the basin. A deep arm west of the uplift has higher oil potential with the Mancos C at or near peak oil generation over a 60 mi^2 area. To the east of the uplift lies a divide that separates the Albuquerque Basin from the Santo Domingo Basin to the north. The Mancos C on the divide is at peak oil generation and has higher oil potential of a 30 mi^2 area. The Mancos C has insufficient thermal maturity on the Zianna Uplift and on uplifted blocks east and west of the Albuquerque Basin. To the south of the Zianna Uplift, the basin is deeper, and the Mancos C is within the thermogenic gas window.

The Mancos Shale in the Albuquerque Basin: A play limited by structure and associated thermal maturity

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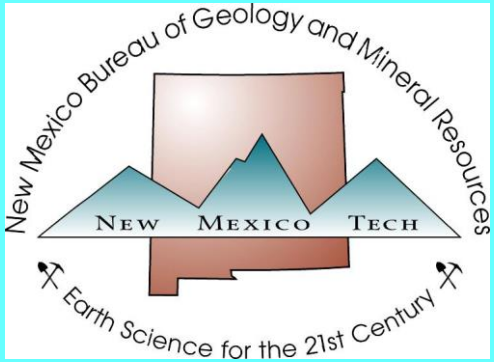
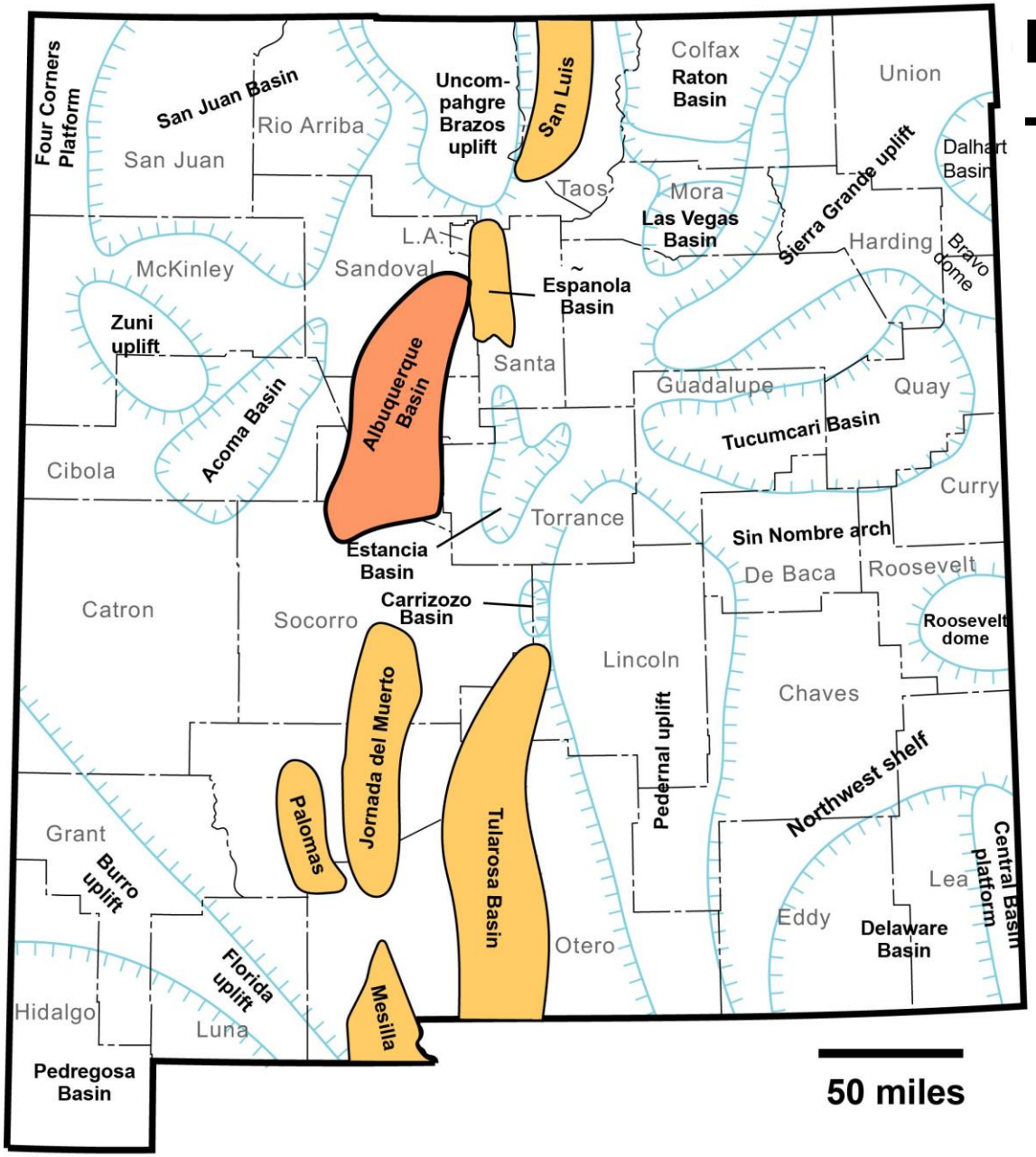


Outline of talk

- Purpose of research
- Geologic framework – structure & stratigraphy
- Thermal maturation profiles of key wells
- Thermal maturation model developed from Ro data
- Model used to project maturation into undrilled areas
- Thermal maturity of southern part of basin where model is invalid
- Summary

Rio Grande rift basins - Late Tertiary



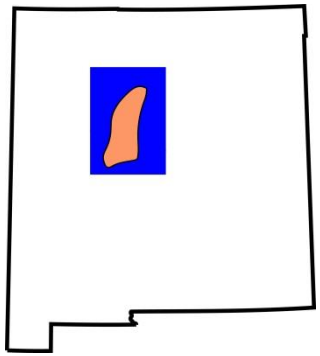
Albuquerque Basin

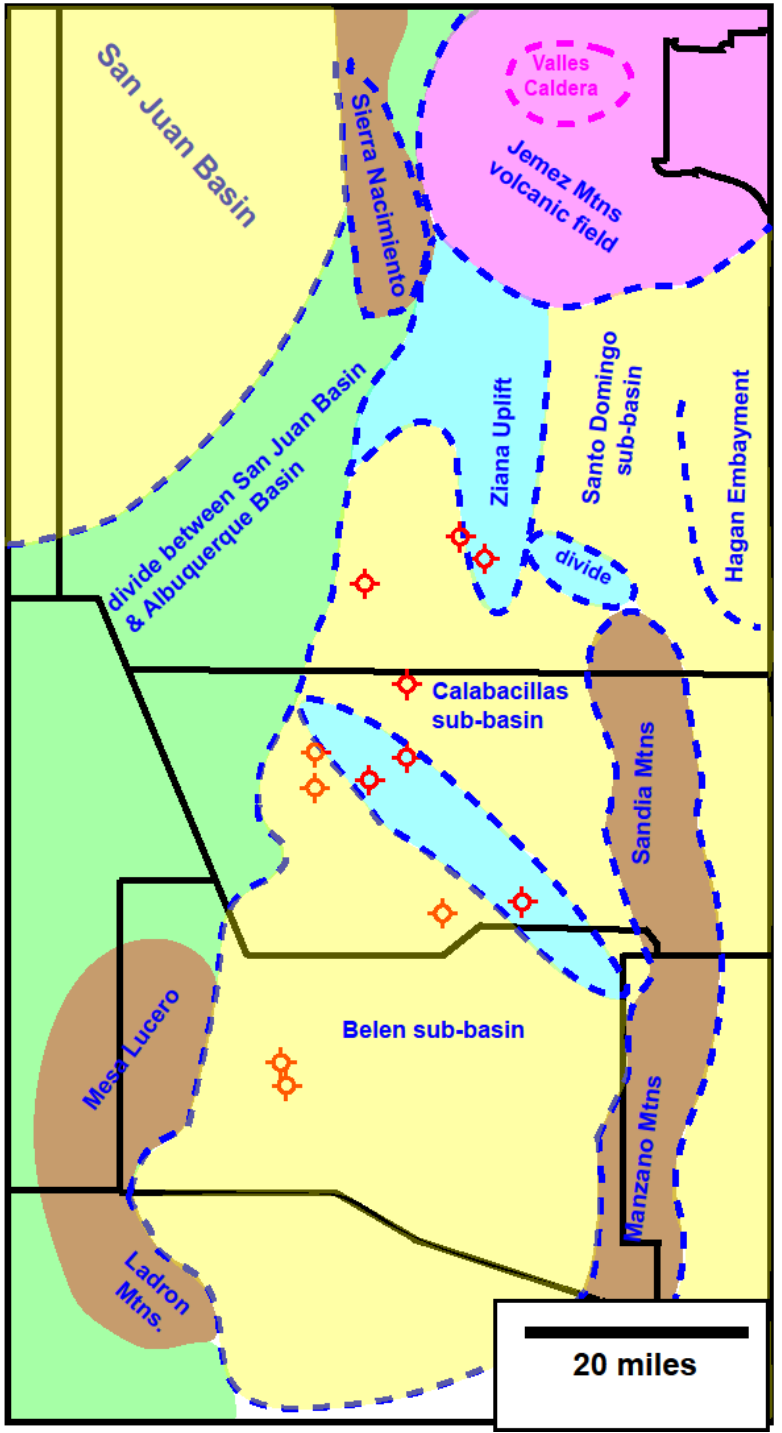
other rift basins

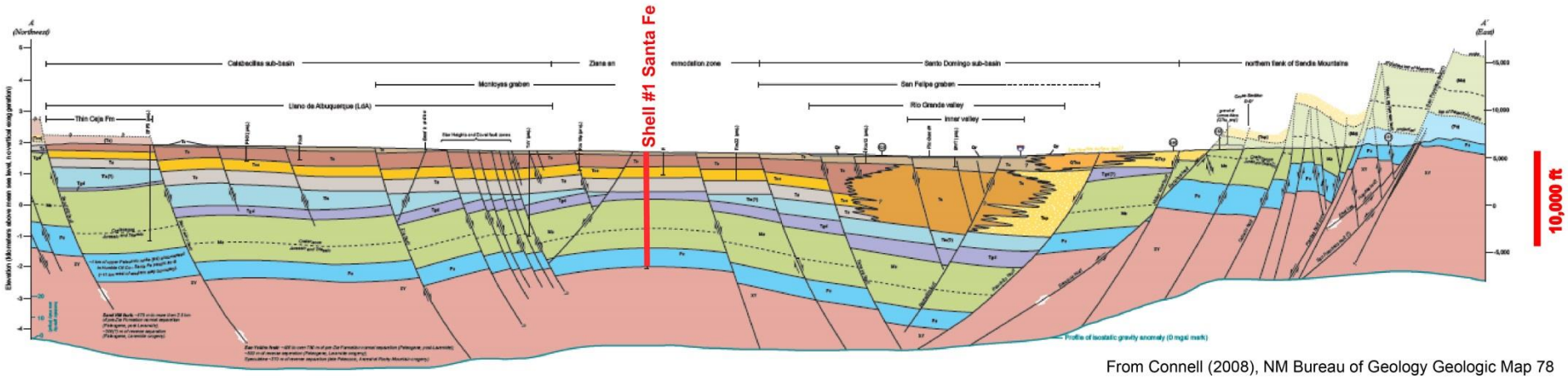
Purpose of Project

A proposed exploratory well intended to test the Mancos Shale near the city of Rio Rancho in south-central Sandoval County raised concerns among citizens groups about the effects of possible drilling and oil production of scarce groundwater supplies in the region. The Sandoval County Planning and Zoning Dept. and the County Commission requisitioned this study of Sandoval County to determine the potential for oil resources, and therefore possible production as well as potential environmental impacts of production on groundwater aquifers. This presentation focuses on the resource potential.

Tectonic subdivisions of Albuquerque Basin

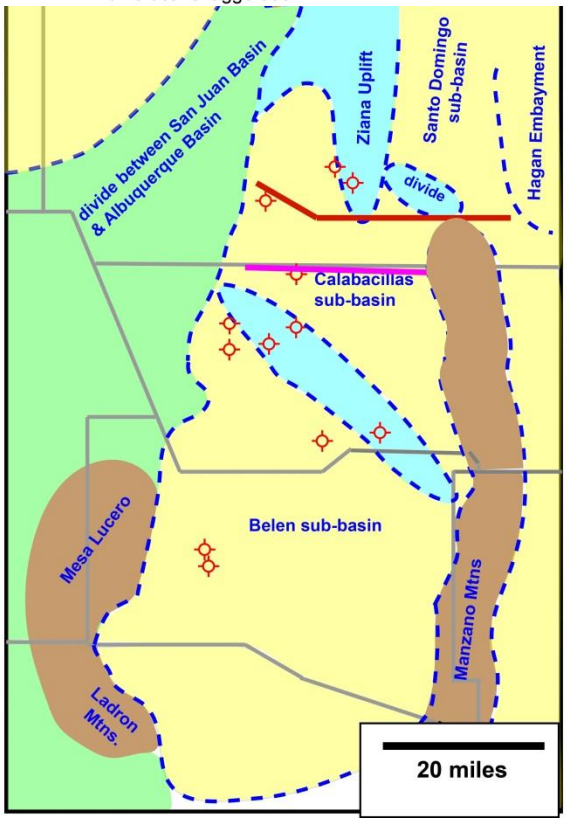




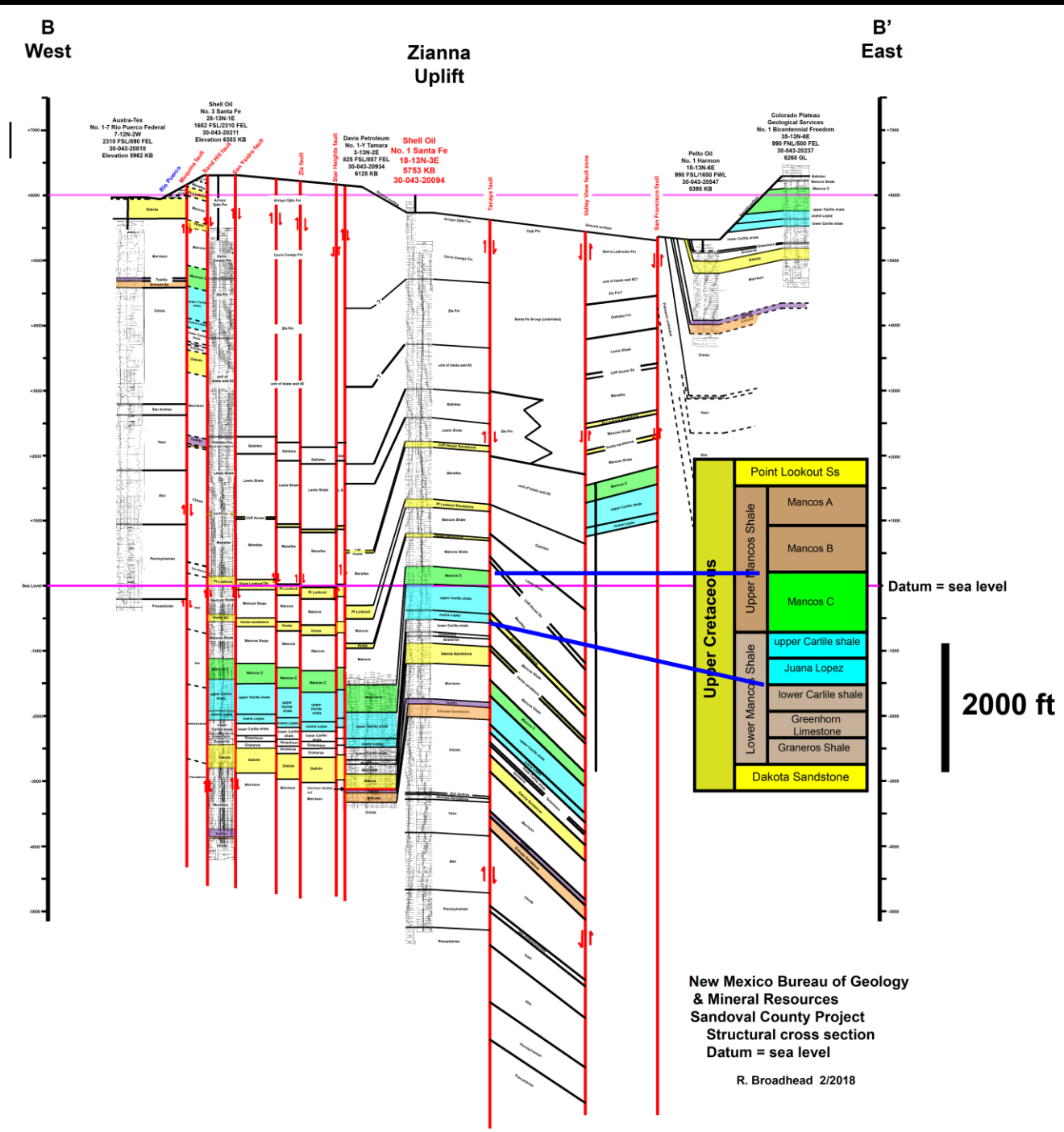


From Connell (2008), NM Bureau of Geology Geologic Map 78

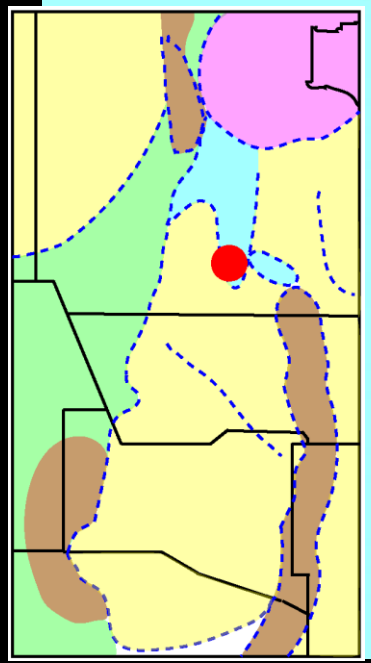
No vertical exaggeration



Shell #1 Santa Fe Mancos C at 5420 ft (+333 ft MSL)


B
West
Zianna
Uplift
B'
East
Austra-Tex
No. 1-7 Rio Puerco Federal
7-12N-2W
2310 FSL/890 FEL
30-043-20818
Elevation 5962 KB
Shell Oil
No. 3 Santa Fe
28-13N-1E
1652 FSL/2310 FEL
30-043-20211
Elevation 6303 KB
Davis Petroleum
No. 1-Y Tamara
3-13N-2E
825 FSL/857 FEL
30-043-20934
6125 KB
Shell Oil
No. 1 Santa Fe
18-13N-3E
5753 KB
30-043-20094
Pelto Oil
No. 1 Harmon
18-13N-6E
990 FSL/1650 FWL
30-043-20547
5395 KB
Colorado Plateau
Geological Services
No. 1 Bicentennial Freedom
35-13N-6E
990 FNL/500 FEL
30-043-20237
6260 GL
Rio Puerco
Montoya fault
Sand Hill fault
San Ysidro fault
Zia fault
Star Heights fault
Tanaya fault
Valley View fault zone
San Francisco fault
Point Lookout Ss
Upper Mancos Shale
Mancos A
Mancos B
Mancos C
upper Carlile shale
Juana Lopez
lower Carlile shale
Greenhorn Limestone
Graneros Shale
Lower Mancos Shale
Dakota Sandstone
Upper Cretaceous
Datum = sea level
2000 ft
New Mexico Bureau of Geology
& Mineral Resources
Sandoval County Project
Structural cross section
Datum = sea level
R. Broadhead 2/2018

Thermal maturation Mancos C
Shell No. 1 Santa Fe well
Sec. 18, T13N, R3E, Sandoval County, NM



increasing temperaure & time

Vitrinite Reflectance: 0.2, 0.4, 0.6, 0.8, 1.0, 1.5, 2.0, 2.5, 3.0, 4.0

Thermal Alteration Index: 1.0, 2.3, 2.7, 3.3, 3.7

Rock Eval TMAX: 430, 440, 470, 530

biogenic methane

wet gas (ethane, propane, butane, etc.)

oil

dry gas (methane)

immature

upper oil window

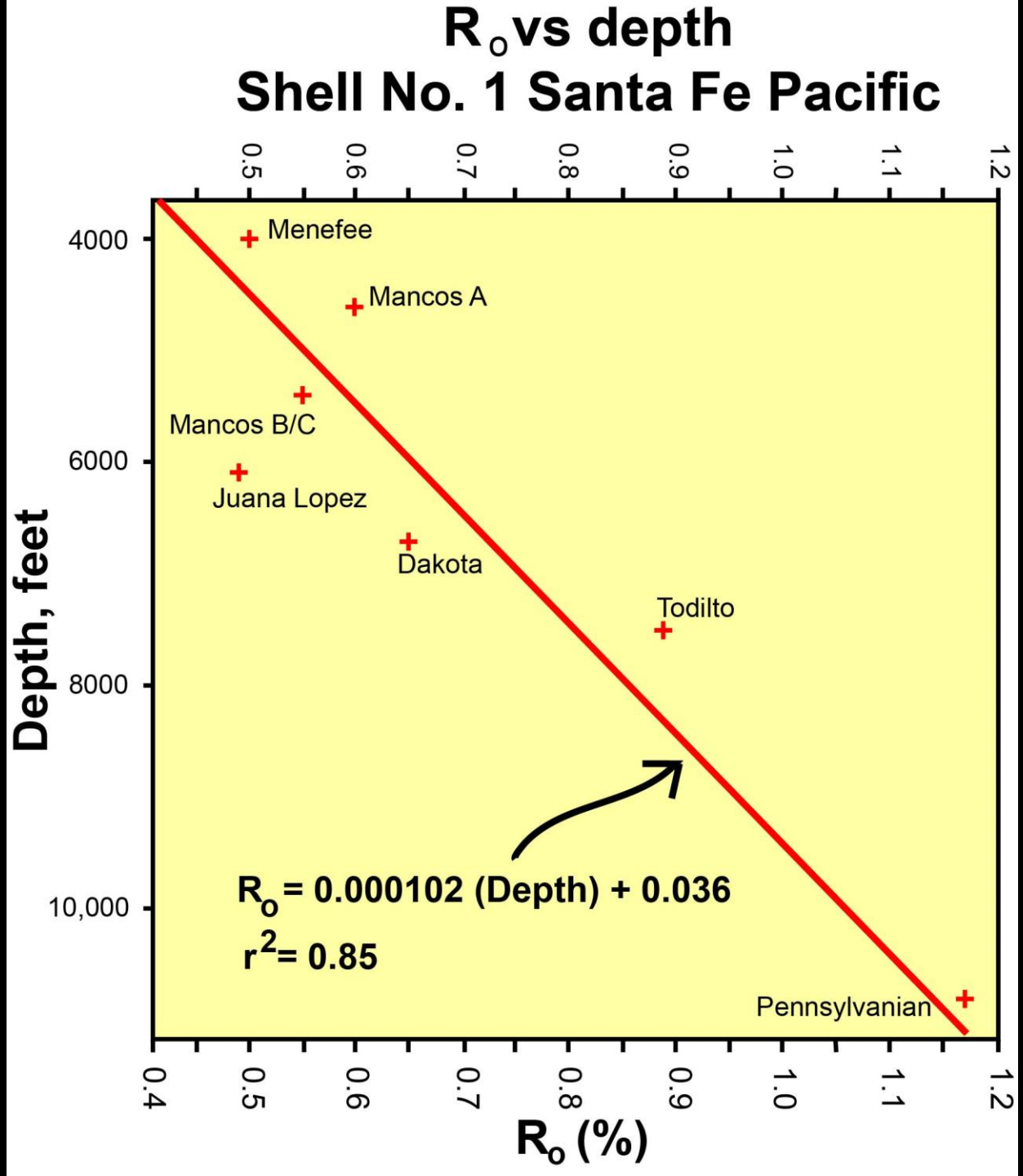
lower oil window

wet gas window

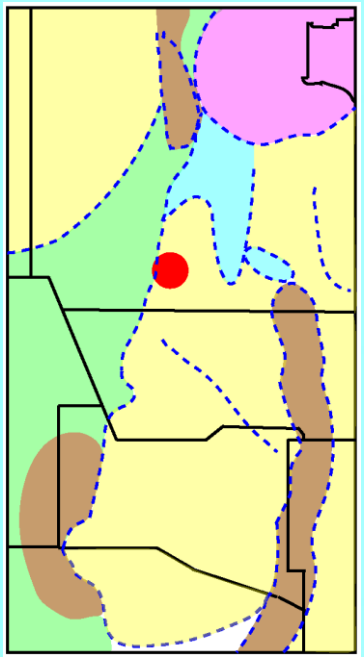
dry gas window

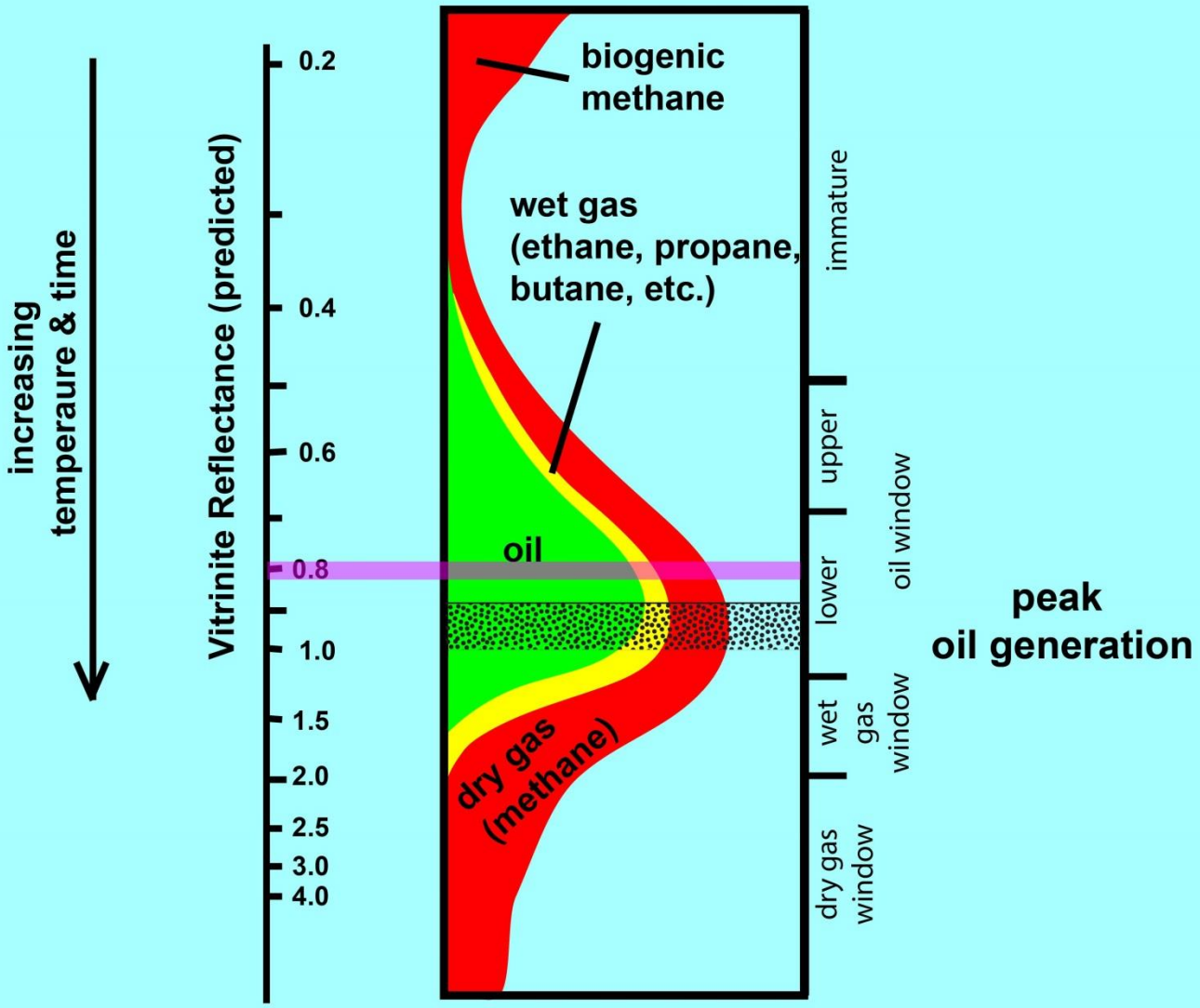
peak oil generation

Mancos C @ 5420 ft


R_o vs depth
Shell No. 1 Santa Fe Pacific
0.5
0.6
0.7
0.8
0.9
1.0
1.1
1.2
4000
6000
8000
10,000
Depth, feet
Menefee
Mancos A
Mancos B/C
Juana Lopez
Dakota
Todilto
Pennsylvanian
R_o = 0.000102 (Depth) + 0.036
r^2 = 0.85
0.4
0.5
0.6
0.7
0.8
0.9
1.0
1.1
1.2
R_o (%)

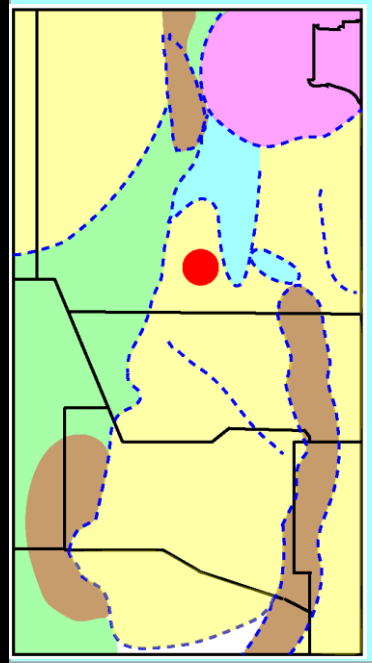
Predicted Thermal maturation Mancos C
Shell No. 3 Santa Fe well
Sec. 28, T13N, R1E, Sandoval County, NM

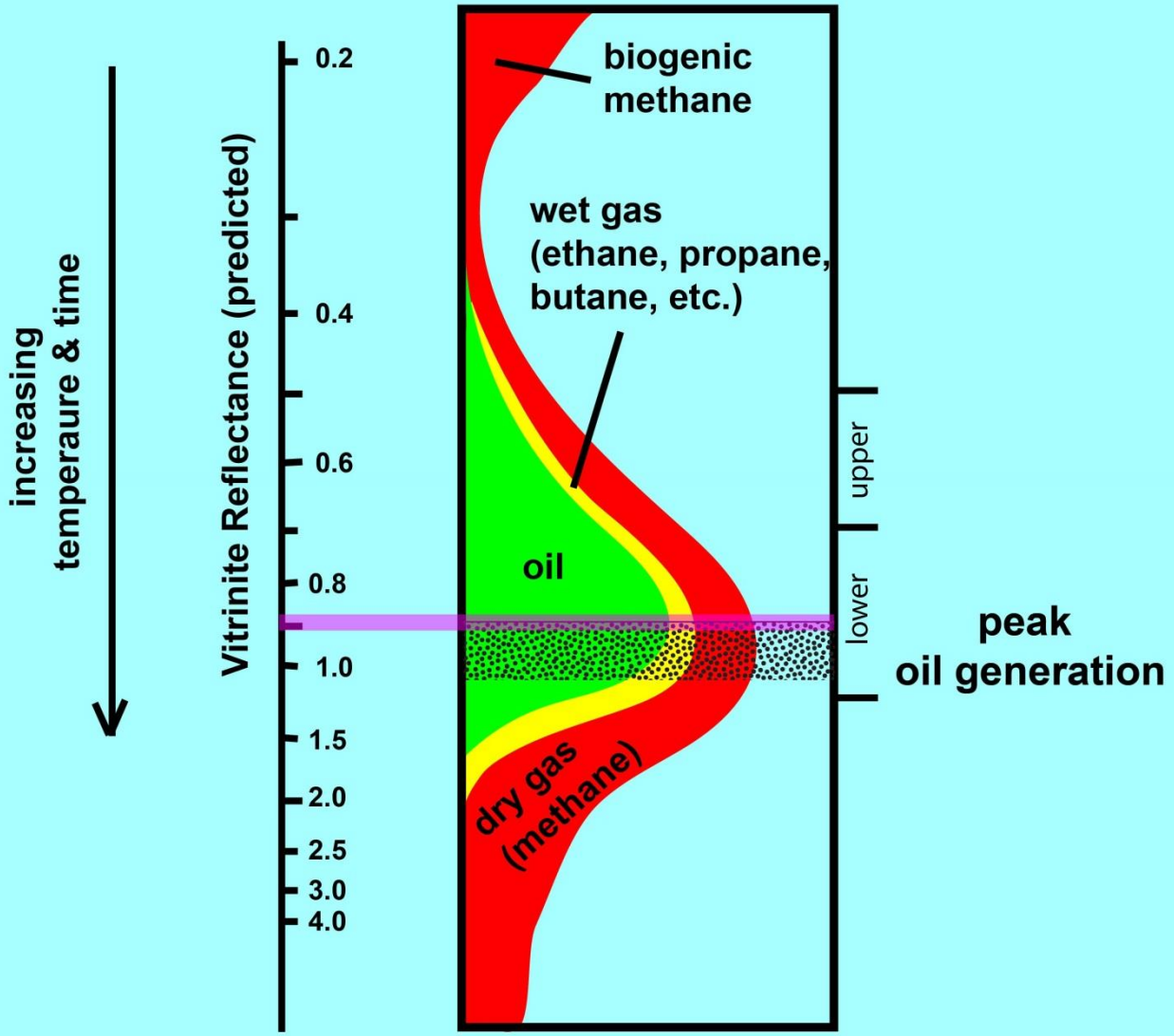




Mancos C @ 7414 ft

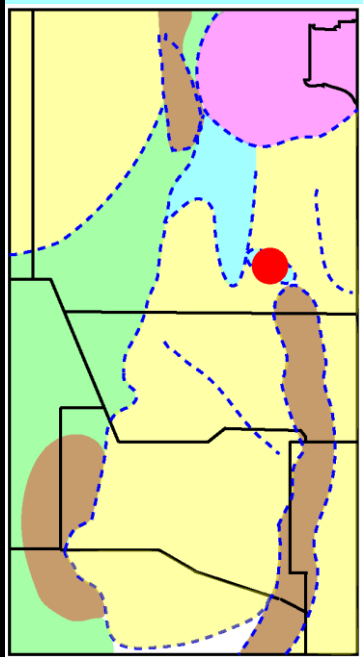
Predicted Thermal maturation Mancos C
Northwest arm Albuquerque Basin
about Sec. 18, T13N, R2E, Sandoval County, NM

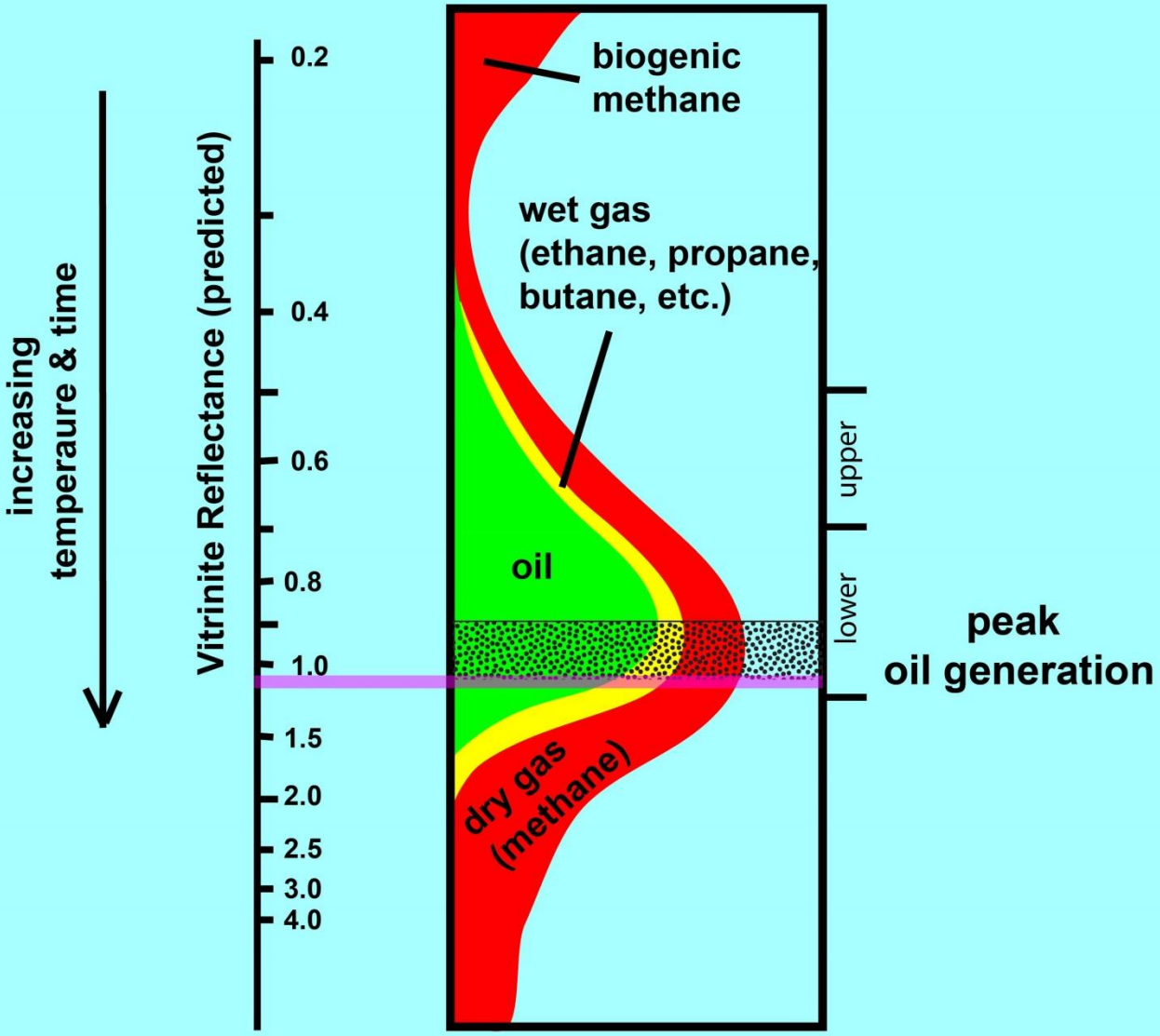




Mancos C est. @ 8230 ft

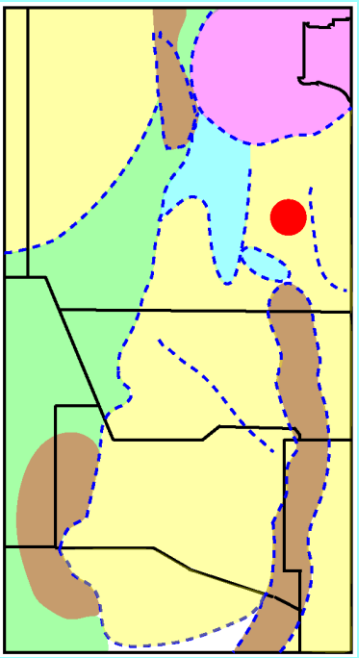
Predicted Thermal maturation Mancos C
Albuquerque-Santo Domingo divide
about Sec. 13, T13N, R3E, Sandoval County, NM

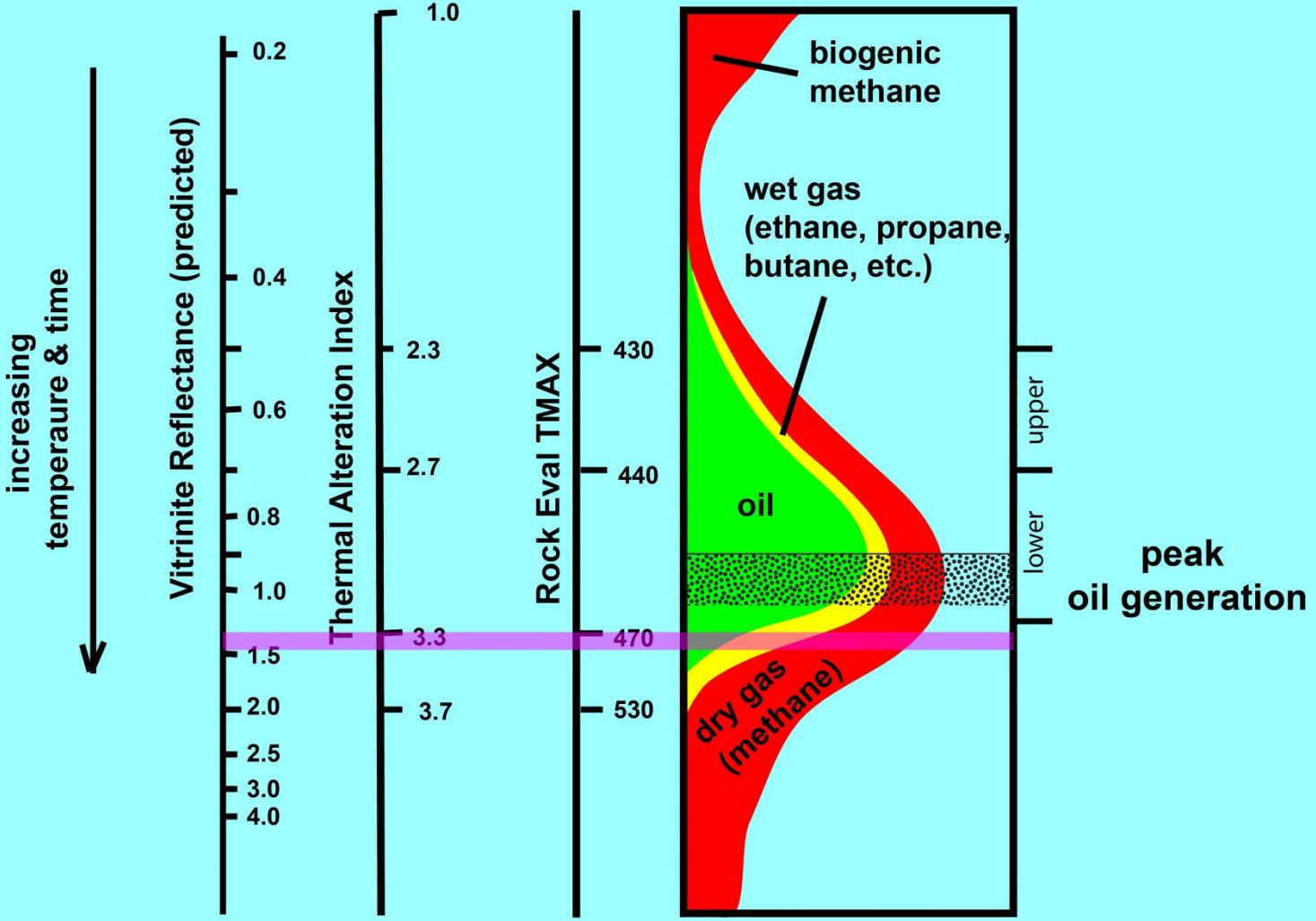




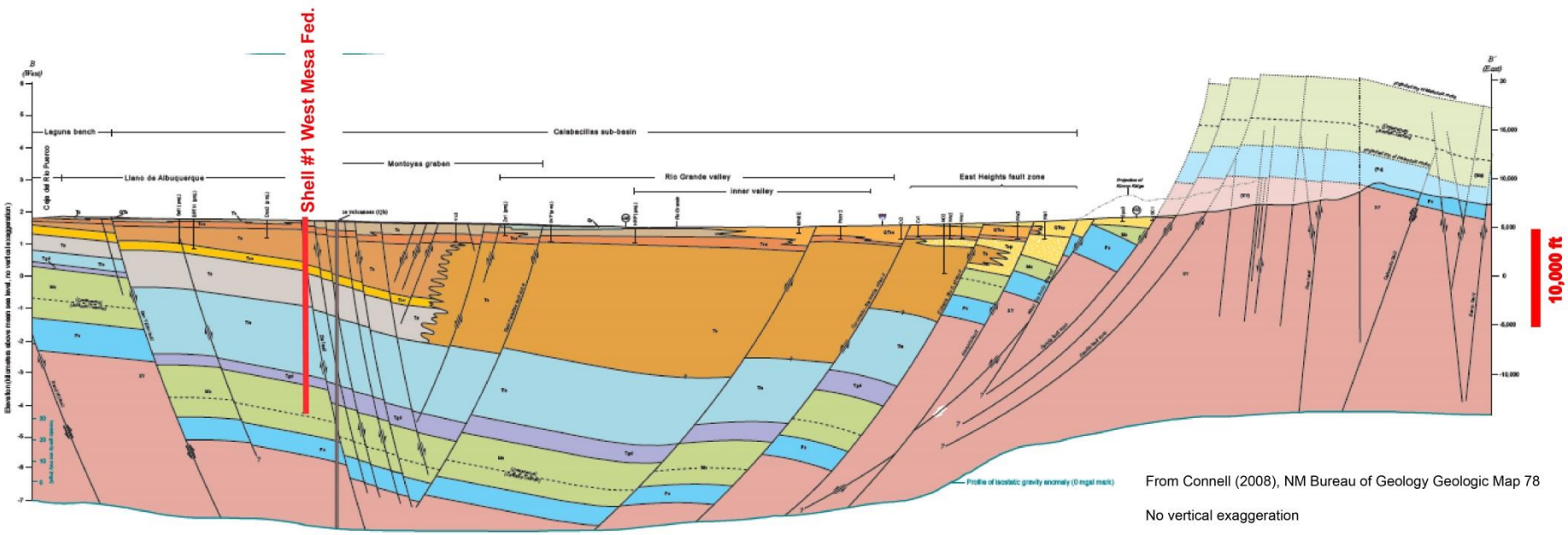
Mancos C est. @ 10,340 ft

Predicted Thermal maturation Mancos C
southern Santo Domingo Basin
about Sec. 32, T15N, R4E, Sandoval County, NM





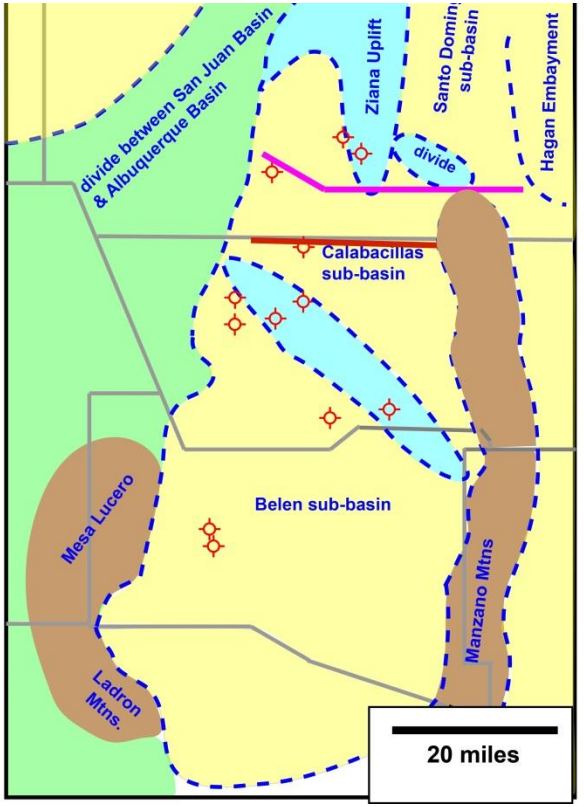
Mancos C est. @ 13,600 ft



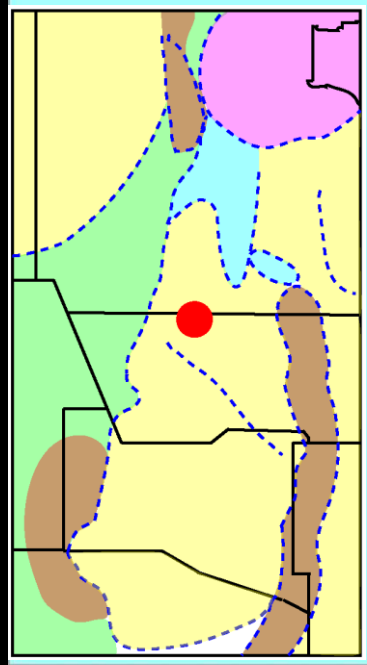
From Connell (2008), NM Bureau of Geology Geologic Map 78

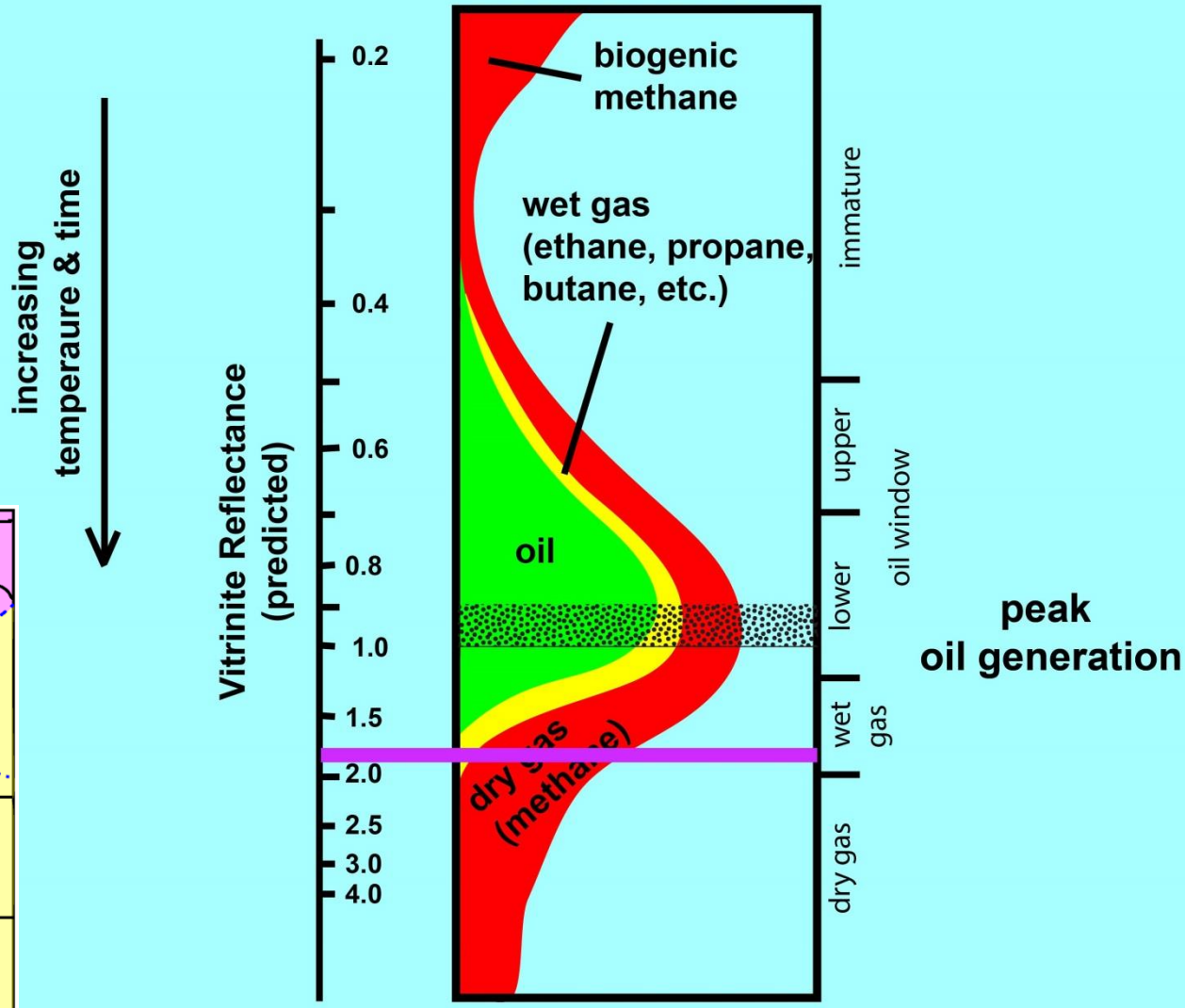
No vertical exaggeration

Shell # 1 West Mesa Federal
Mancos C at 17,780 ft
(- 11,983 ft MSL)



Thermal maturation Mancos C
Shell No. 1 West Mesa Federal well
Sec. 24, T11N, R1E, Bernalillo County, NM



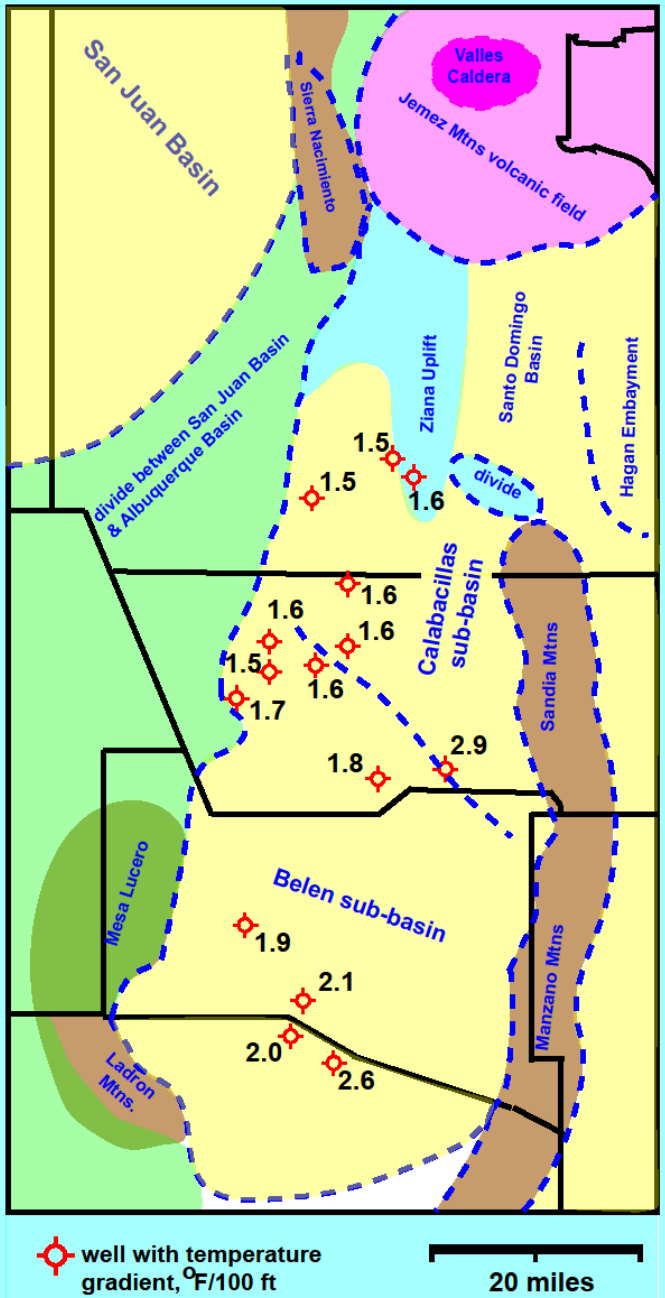


Mancos C @ 17,780 ft

Mancos C Thermal Maturity in Southern ABQ Basin?

- Modern temperature gradient increases to south
- Depth dependent maturation model not applicable in south, but likely that most of southern basin is in the gas window

Geothermal Gradients



SUMMARY

- **Albuquerque Basin is a N-S trending Late Tertiary basin of the Rio Grande rift**
- **Fault blocks have subdivided Albuquerque Basin into several sub-basins**
- **Infilled by Late Tertiary sediments, > 21,000 ft in places, much thinner on shallow fault blocks**
- **A maturation model based on a vertical profile of Ro measurements in one well was used to predict thermal maturity in wells without Ro or in undrilled areas**
- **Mancos C, the predominant Mancos reservoir in the San Juan Basin, is thermally immature on the shallower fault blocks and is within the thermogenic gas window in the deeper parts of the basin**

SUMMARY (cont'd)

- **The Mancos C is within the oil window and at or near peak oil in the northwest arm of the Calabacillas sub-basin (60 mi^2) and on the divide that separates the Calabacillas sub-basin and the Santo Domingo sub-basin (30 mi^2)**
- **Ro measurements are lacking in southern part of basin, but higher present-day geothermal gradients suggest the Mancos C may be widely in the thermogenic gas zone**

Acknowledgements

- Sandoval County Planning & Zoning Department for providing funding
- Mr. Mike Springfield, Director of Sandoval County Planning & Zoning Department
- Dr. Alex Rinehart, NM Bureau of Geology, who worked on environmental aspects of possible future drilling
- Brigitte Felix, NM Bureau of Geology, for GIS support
- Dr. Van Romero & Dr. Dan Fine of New Mexico Tech for facilitating contact with the county