

PS Geology of the Turner Sandstone, Finn-Shurley Field, Powder River Basin Wyoming*

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Abstract

The Finn-Shurley field produces petroleum from the Upper Cretaceous Turner Sandstone of the Powder River Basin. The Turner is a member of the Carlile and is overlain by the Sage Breaks and underlain by the Pool Creek members of the Carlile. The Turner is interpreted to be a shallow marine shelf sandstone deposited along the eastern side of the Western Interior Cretaceous Seaway. Sand-shelf-bar orientation across the field is roughly east-west. Trapping occurs where sandstone beds get shallier up-dip. The field is located along the shallow east margin of the Powder River Basin south of the Clareton lineament. Three to four coarsening upward cycles are present in the Turner in the field. Most of the production comes from the lower two cycles. Each cycle consists of burrowed to bioturbated heterolithic mudstones and sandstones coarsening upwards into fine-grained laminated to burrowed sandstones. Trace fossil present fall into the shelf *Cruziana* ichnofacies. The sandstones are largely litharenites. Porosities range from 11-17% and permeabilities range from 0.06 to 0.5 md. Source rock analysis of the Turner shales indicate Ro values averaging 0.63 and Tmax values of 433°C. Source beds for the oil and gas in the Turner is thought to be the Mowry Formation. The low thermal maturity suggests lateral migration of oil into the stratigraphic trap. The field extends over an area roughly circular in shape of ~65 mi². Productive depths across the field are 4450 to 5700 ft. First production is reported as 1974 and cumulative production from ~750 vertical wells is 22.5 MMBO and 38 BCFG. Cumulative gas oil ratio is 1688 ft³ gas per barrel oil. Average production per well is approximately 30 MBO and 50 MMCFG. Horizontal drilling activity in the field area has recently commenced. Although the production is fair to marginal, the field provides an excellent example of trapping style as well as a depositional model for Turner Sandstone elsewhere in the deeper parts of the Powder River Basin. Recent drilling in the deeper over pressured parts of the Powder River Basin has encountered excellent production from the Turner (> 1,000 bbls oil equivalent per well).

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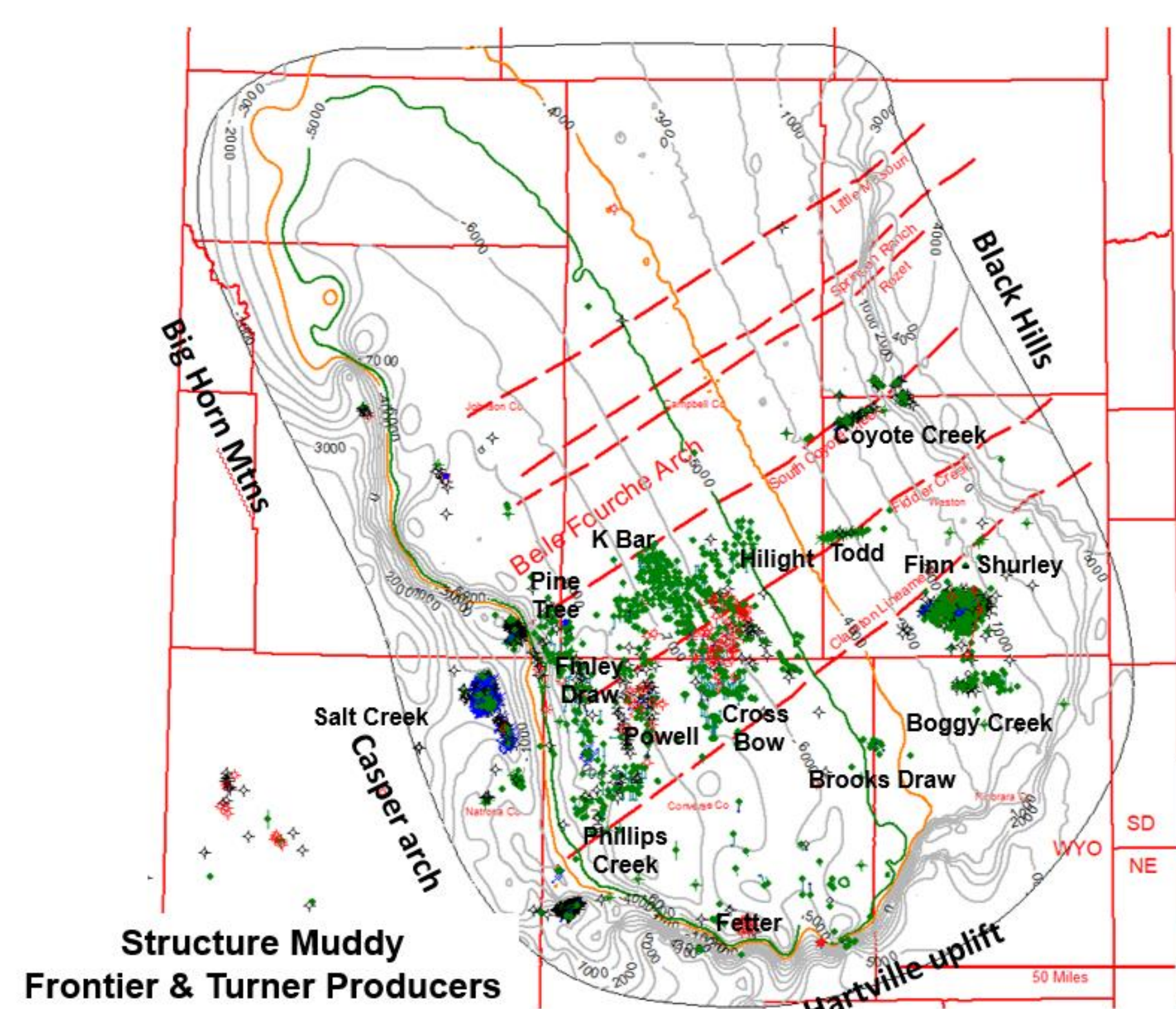
Colorado School of Mines

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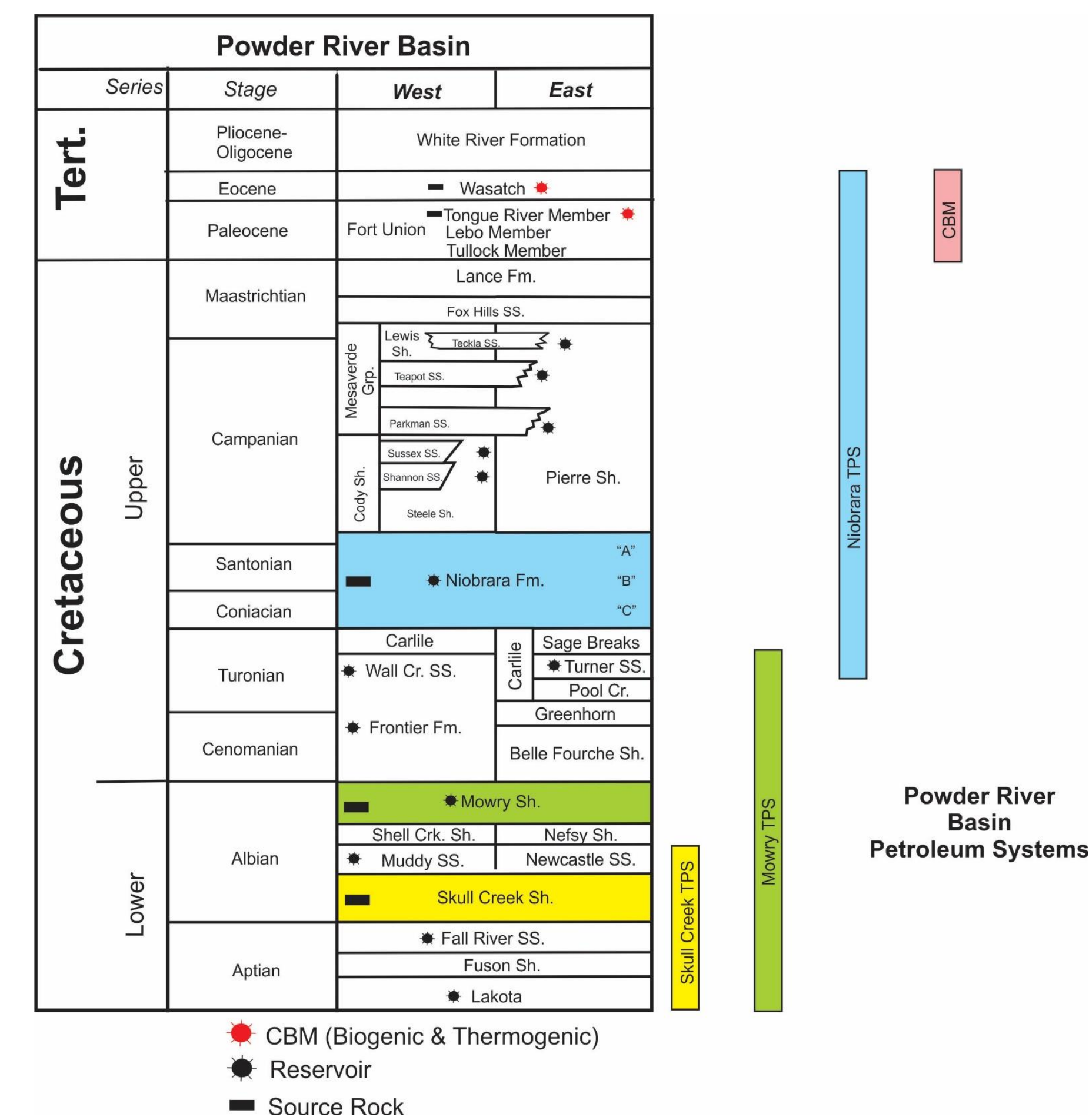
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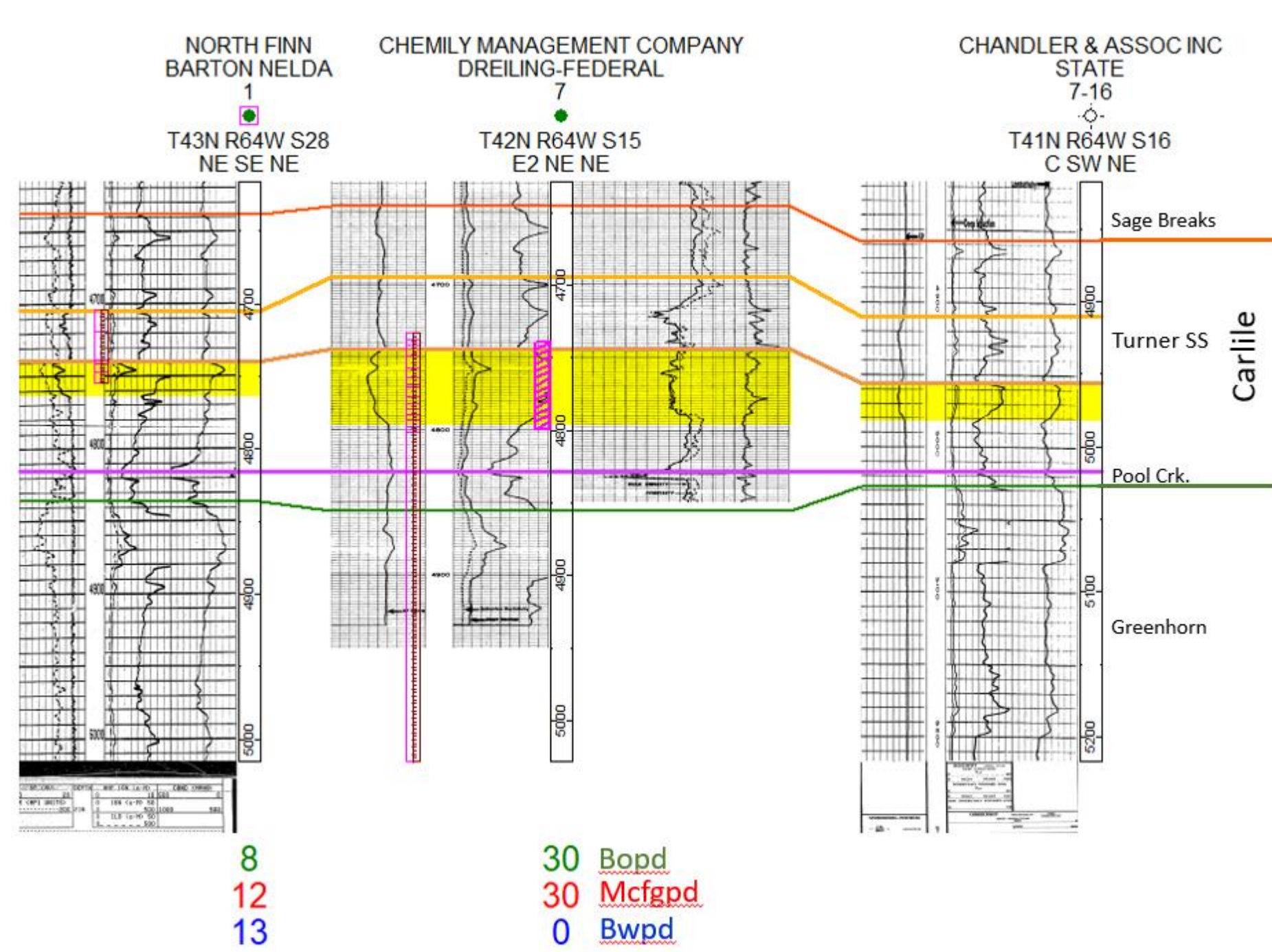
Finn-Shurley Field is part of a continuous accumulation within the Turner Sandstone in the Powder River Basin. Distinct oil-water contacts are not present in the field area. The accumulation is underpressured and regarded as unconventional.



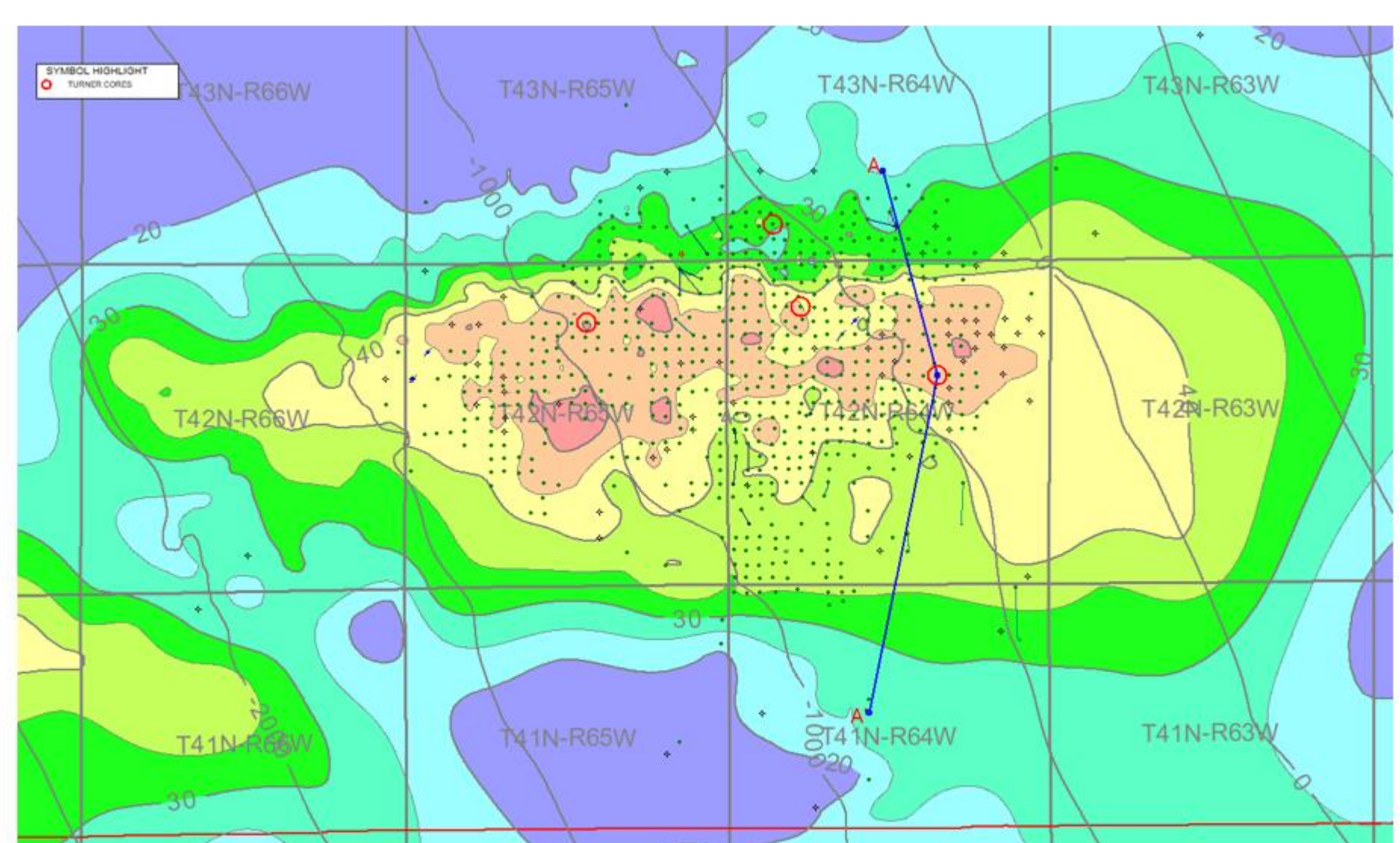
Structure contour map Muddy Sandstone and location of Frontier/Turner producers. Lineaments from Slack, 1981.



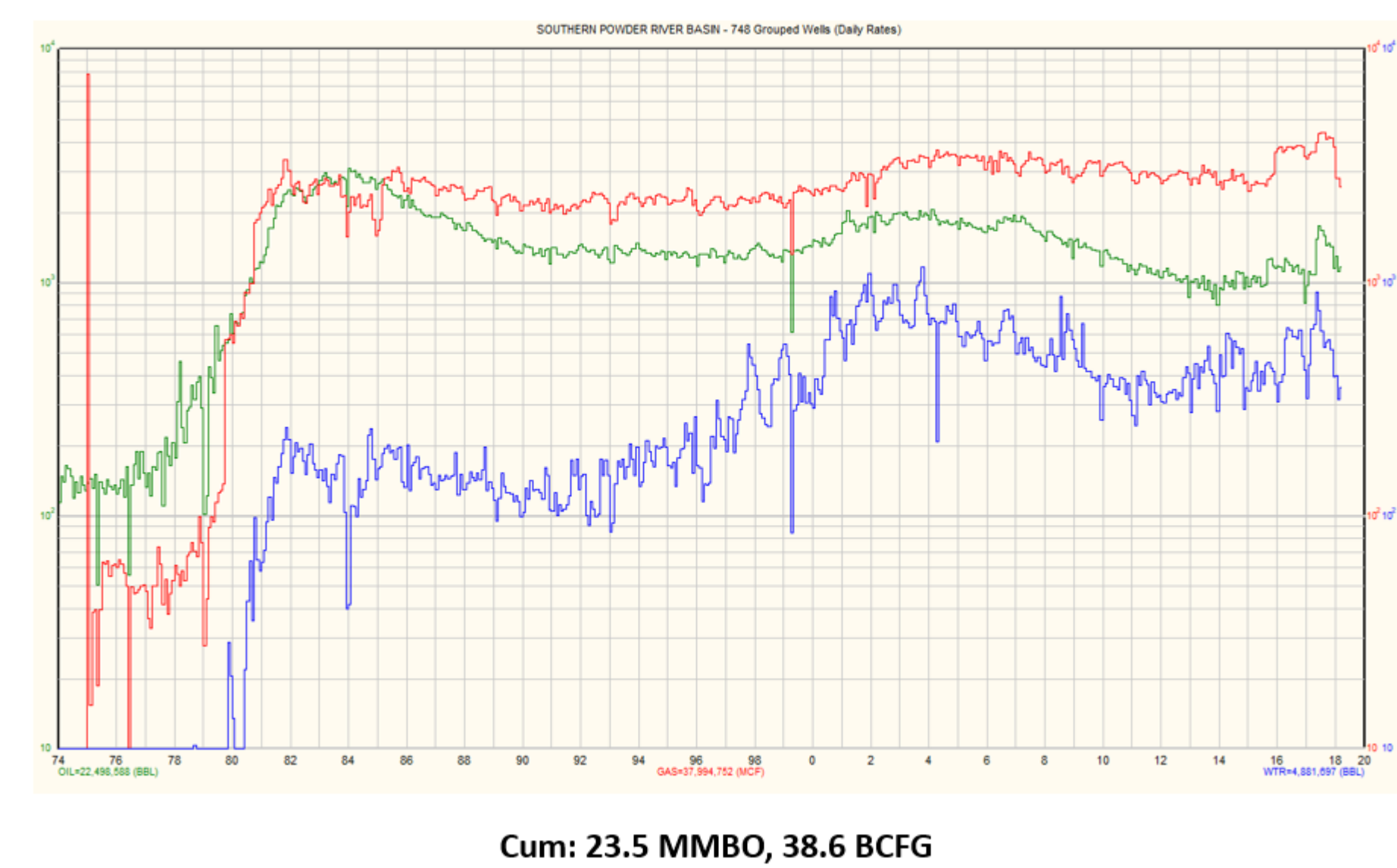
Stratigraphic column for Cretaceous units, Powder River Basin. Also shown various petroleum systems. Turner Sandstone may be sourced by both Mowry and Niobrara.



North to south stratigraphic cross section, Finn-Shurley. Datum is top Pool Creek.



Structure contour map Turner Sandstone and net pay Turner Sandstone.

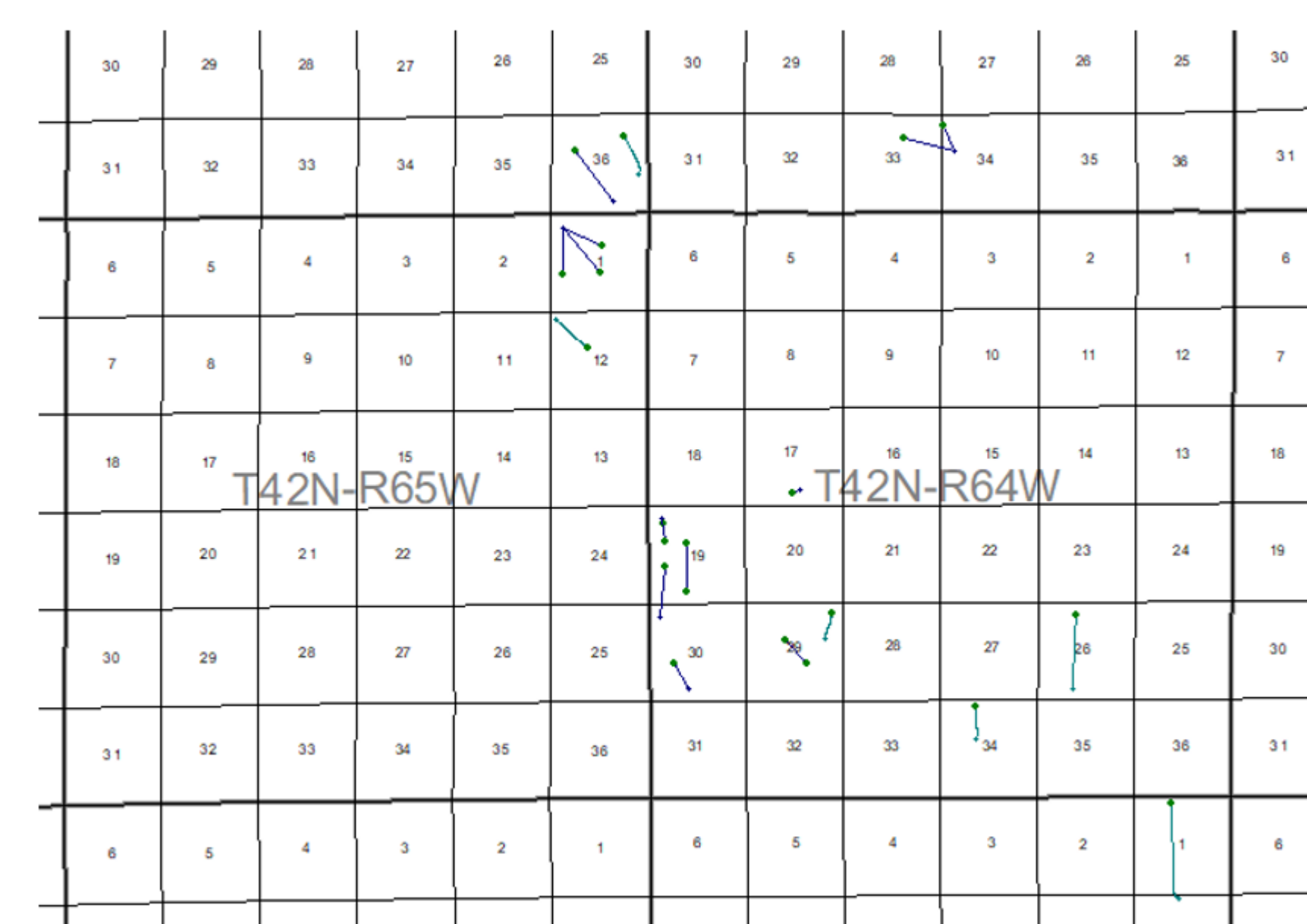


Finn-Shurley Production curve.

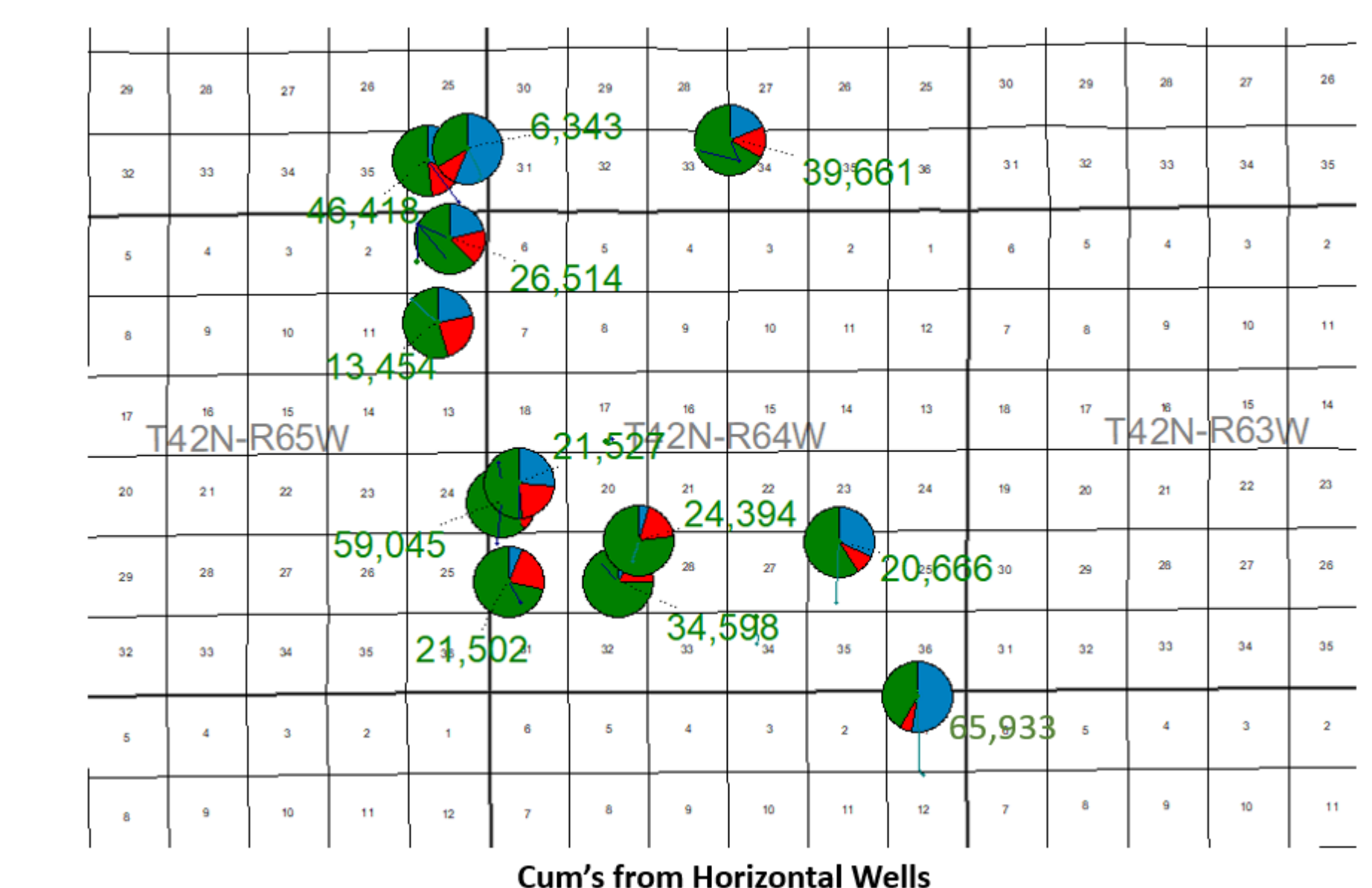
Pertinent Data -Turner SS Finn-Shurley

- Depth 4450-5700 ft
- Area > 65 mi²
- BHT 152 °F
- Gradient 0.366 psi/ft
- Gross sand, ft 10 to 50
- Net pay, ft 10 to 25
- Porosity, % 11-17%
- Permeability, md 0.05 – 0.5
- Original spacing 40 acres
- Refracs

Horizontal Drilling

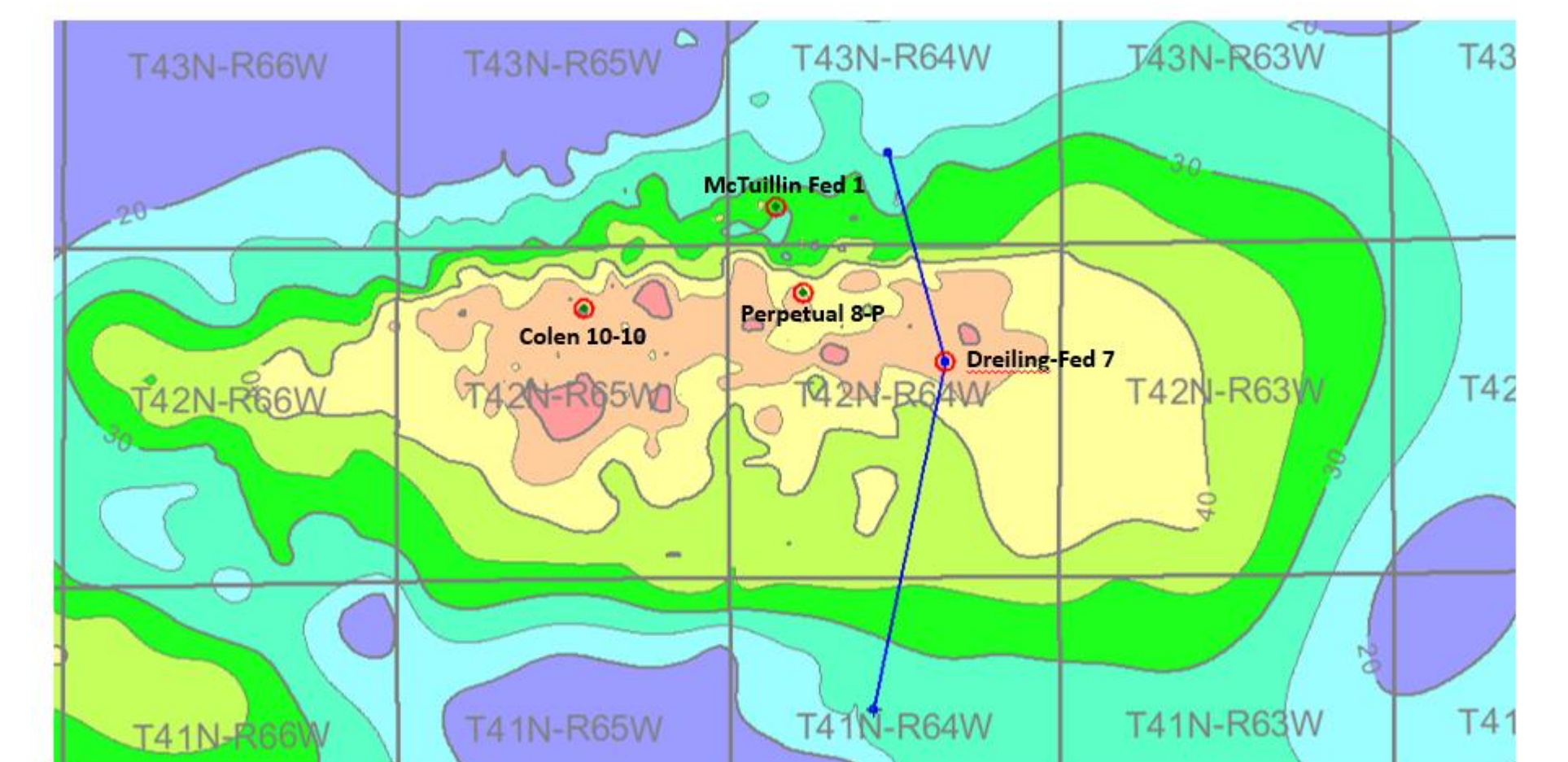


Location map of new horizontal wells, Finn-Shurley field.

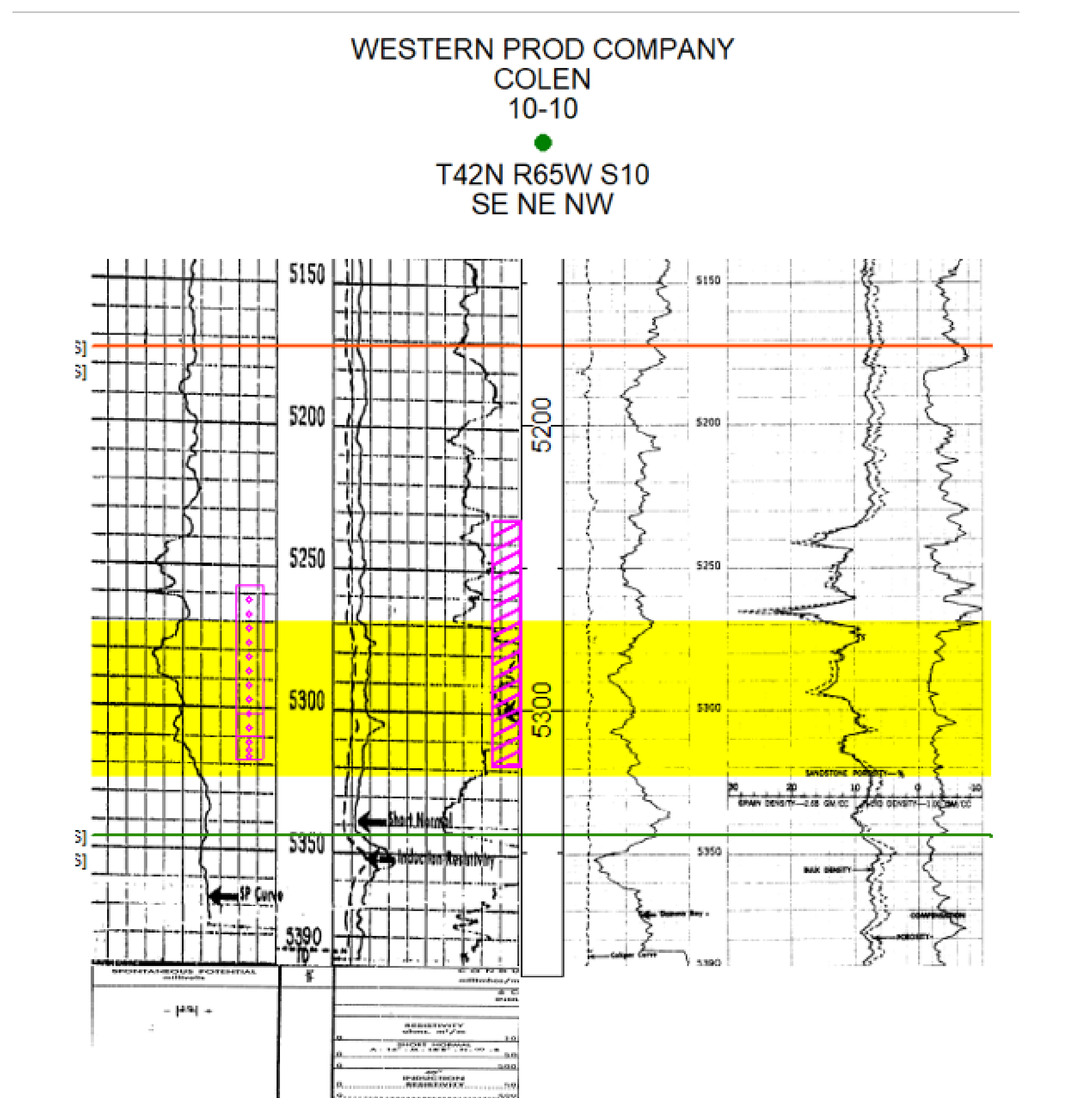


Cumulative production from horizontal wells.

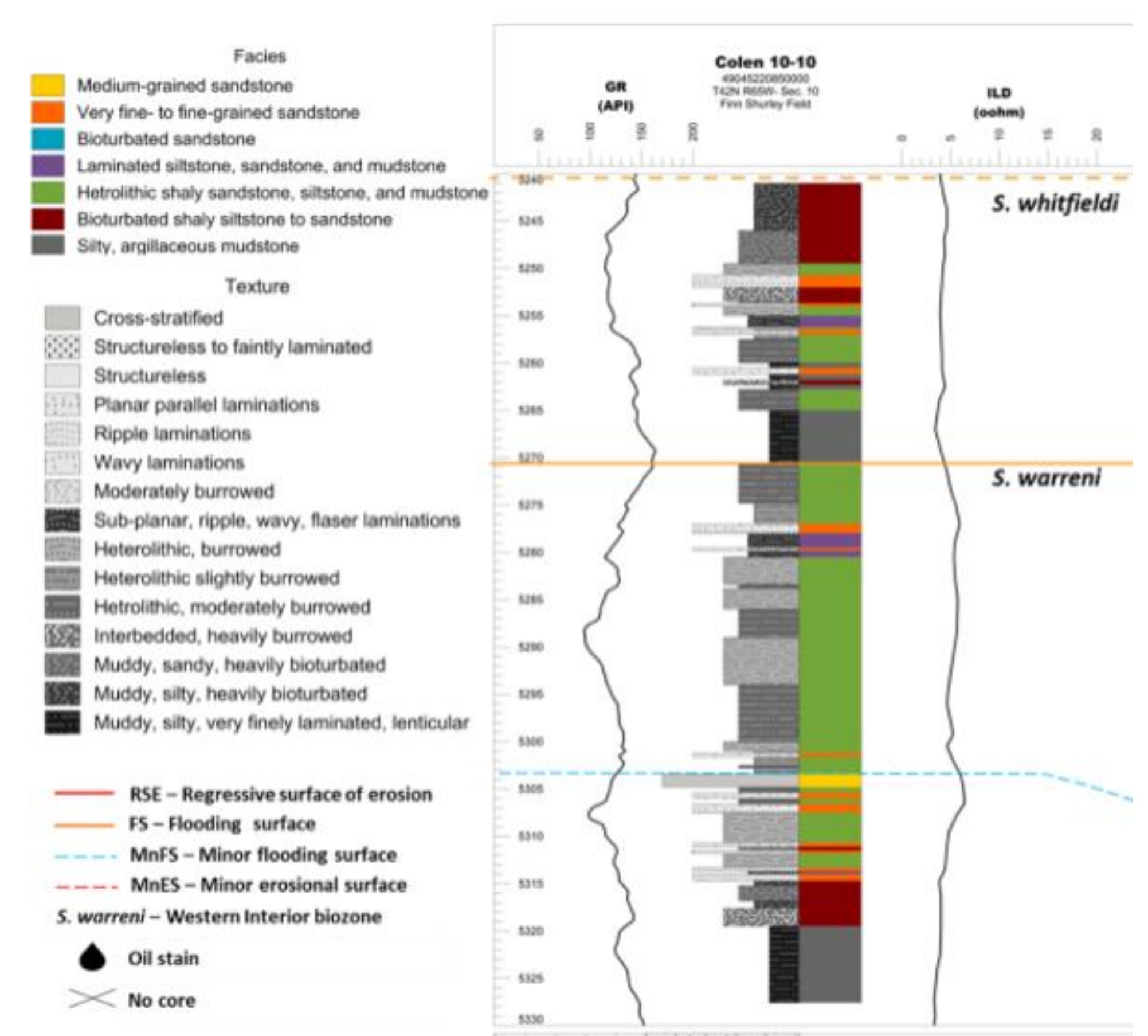
Cores



Isopach Turner Sandstone pay and location of cored wells.

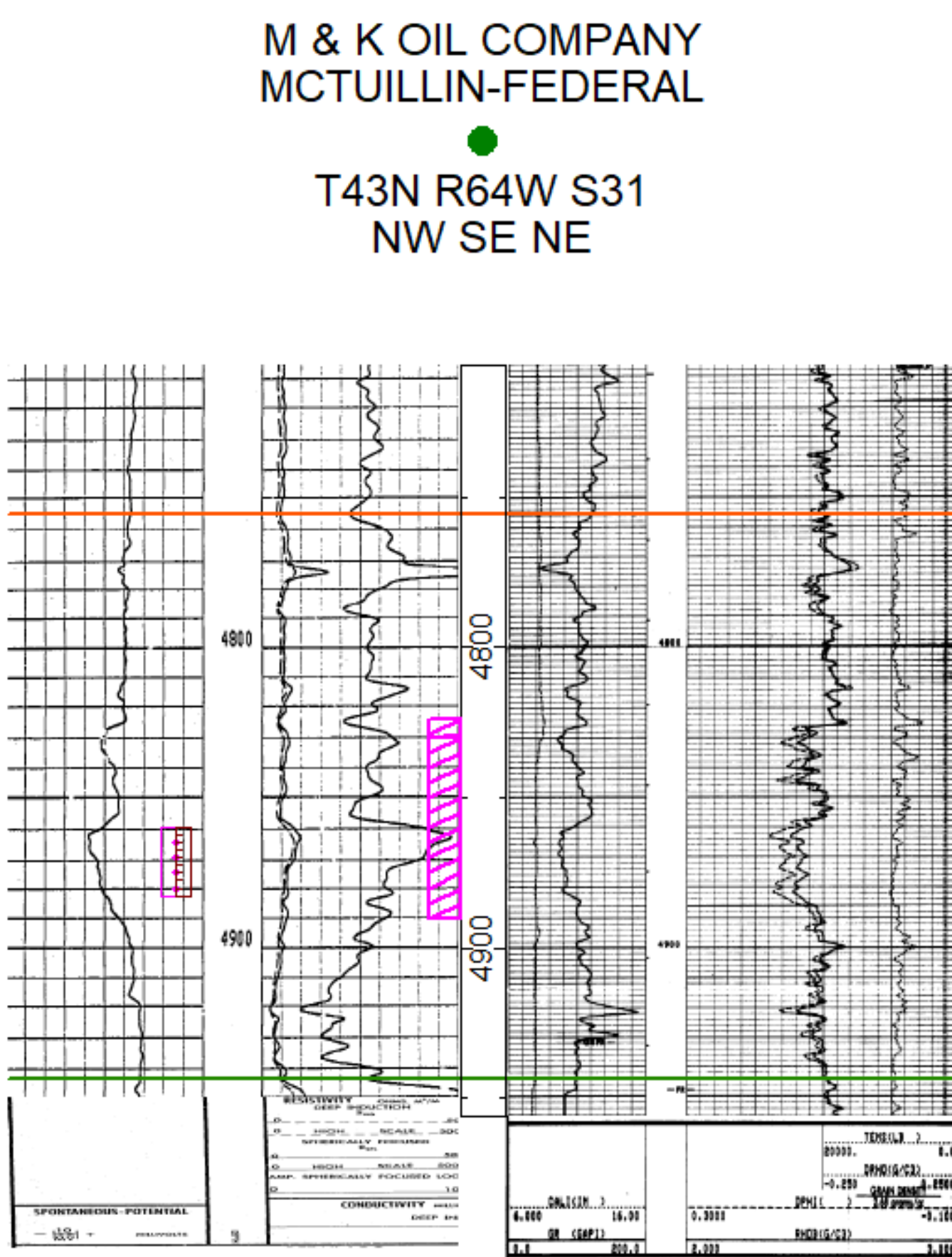
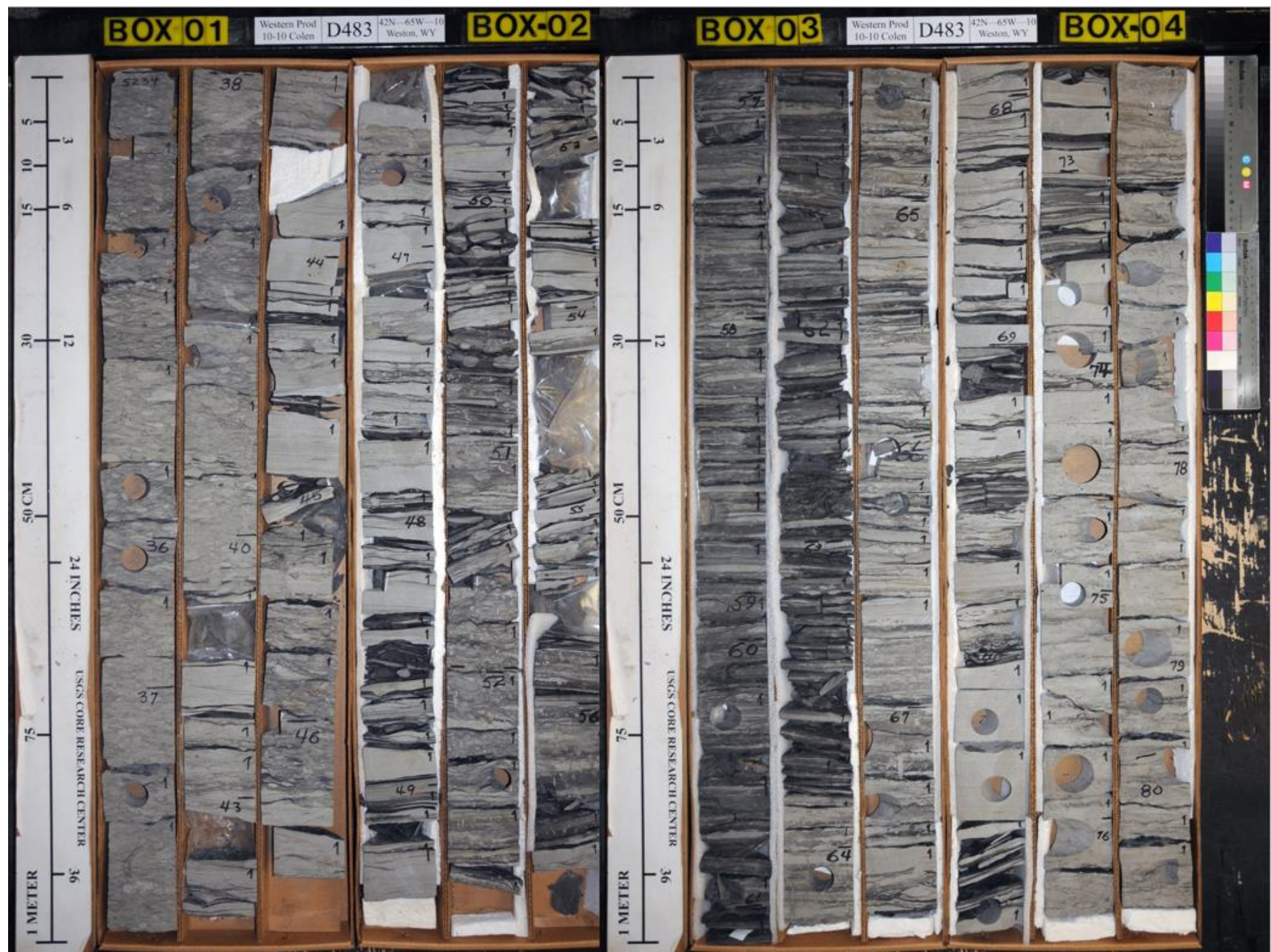


Well logs from Colen 10-10 well. Perf'd interval indicated by red box with small circles. Cored interval purple box with sloping lines.



Core description Colen 10-10 core, from Heger, 2017

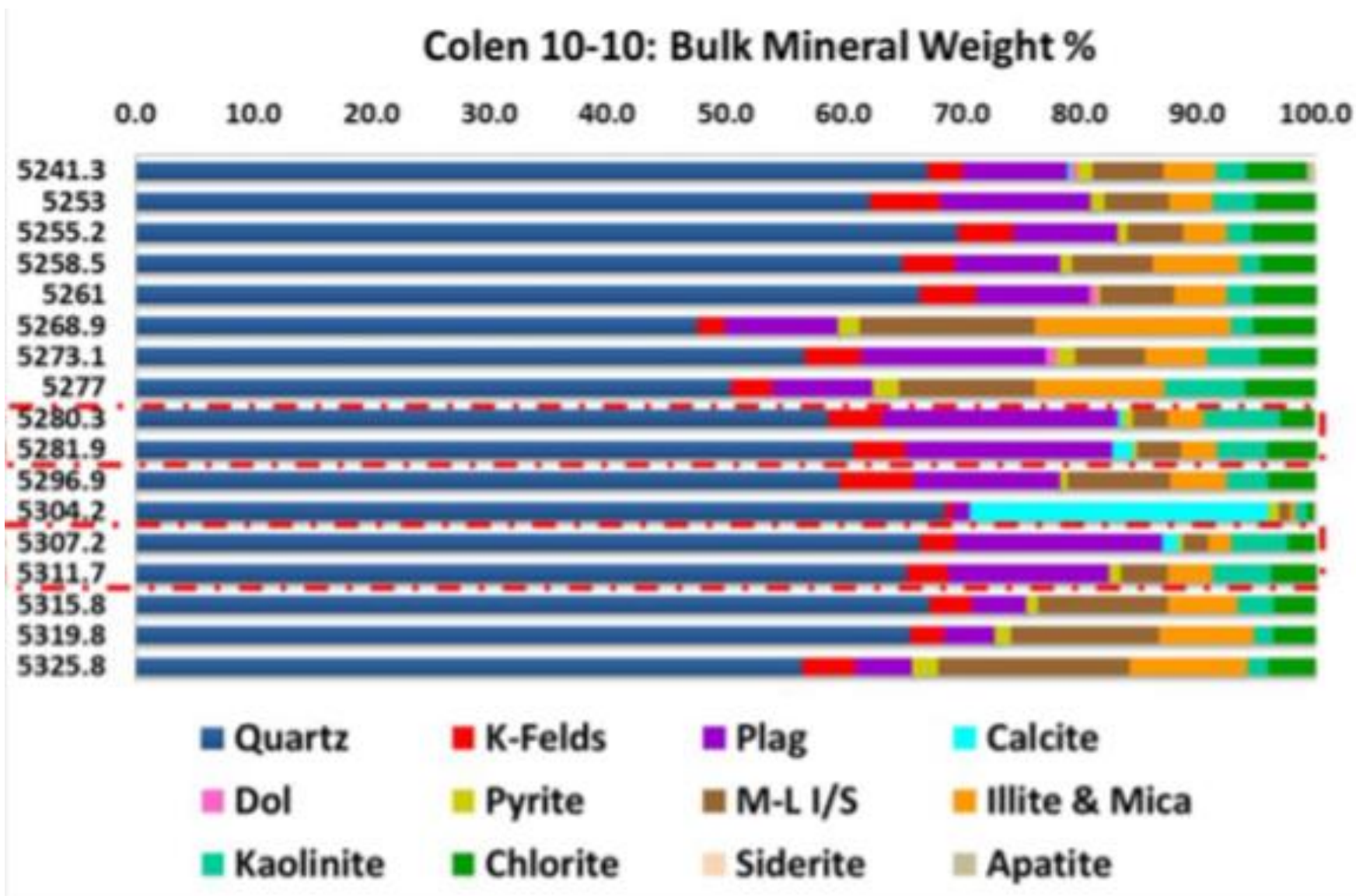
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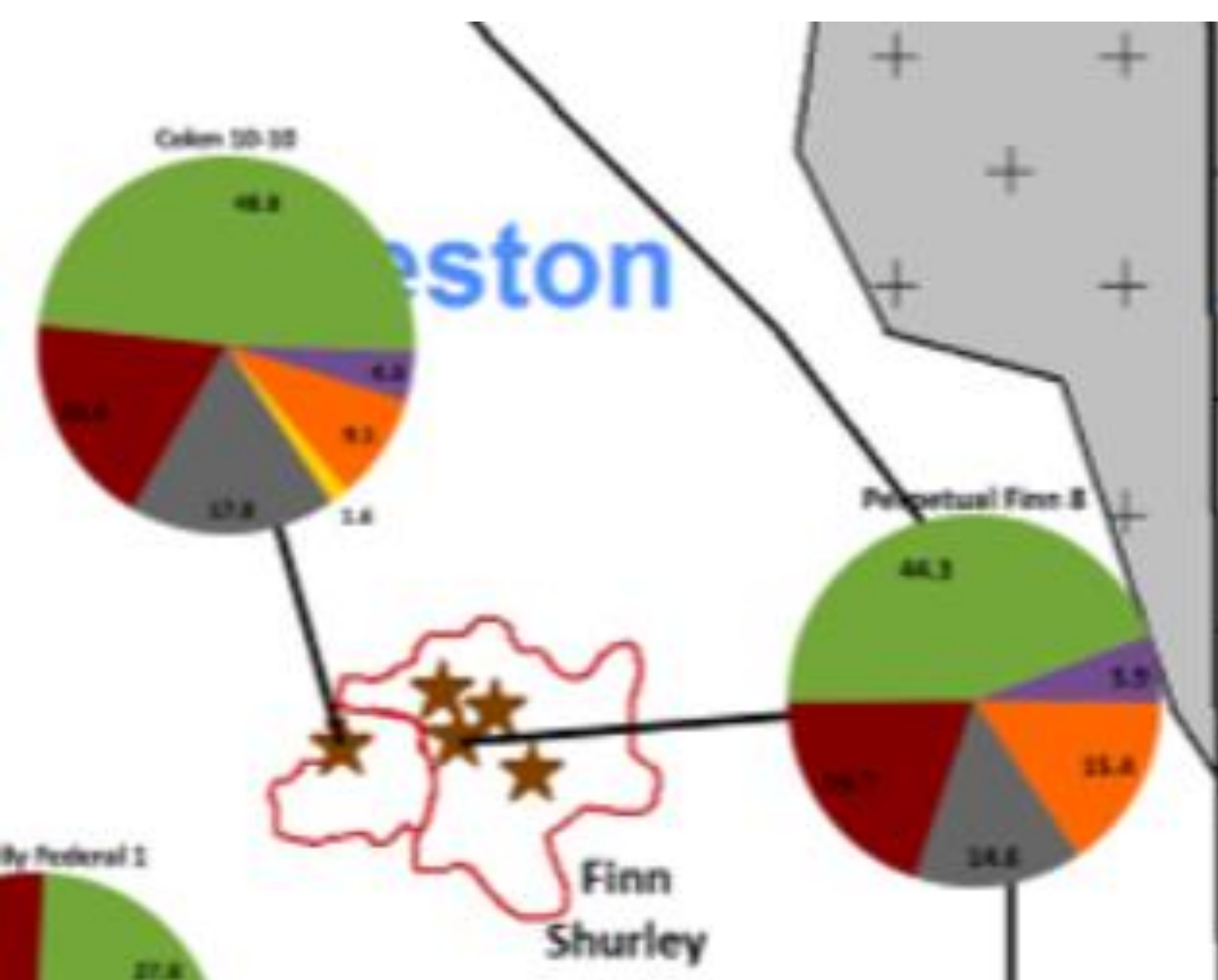
Well-log for McTuillin-Federal. Perfs and cored intervals are shown.



Core photo's Collen 10-10 core.



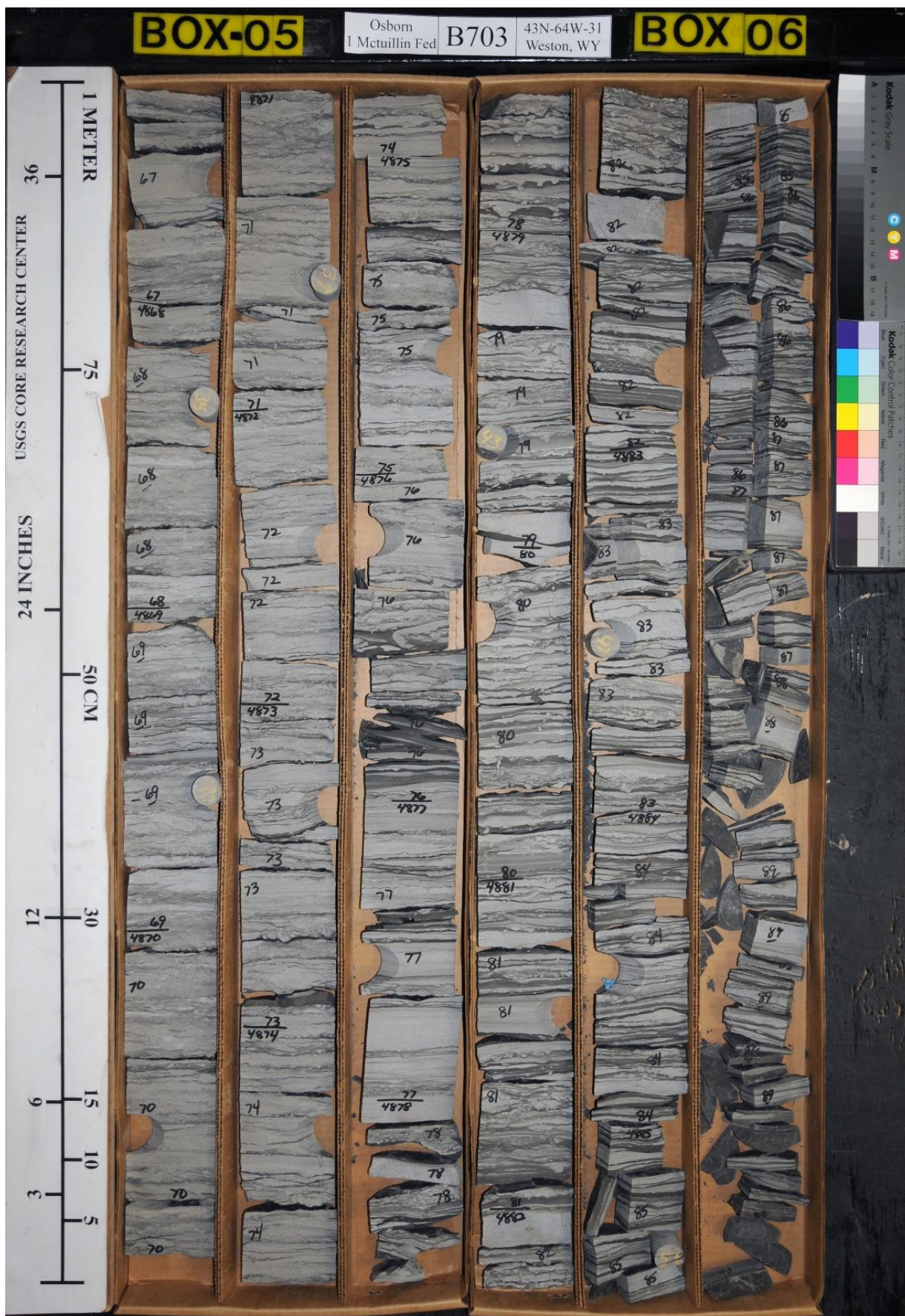
XRD Collen 10-10 Core from Heger, 2017



Facies distributions Finn-Shurley from Heger, 2017. Heterolithic strata are the dominant facies present at Finn-Shurley.



Base



Base

Core photo's McTuillin Federal core.

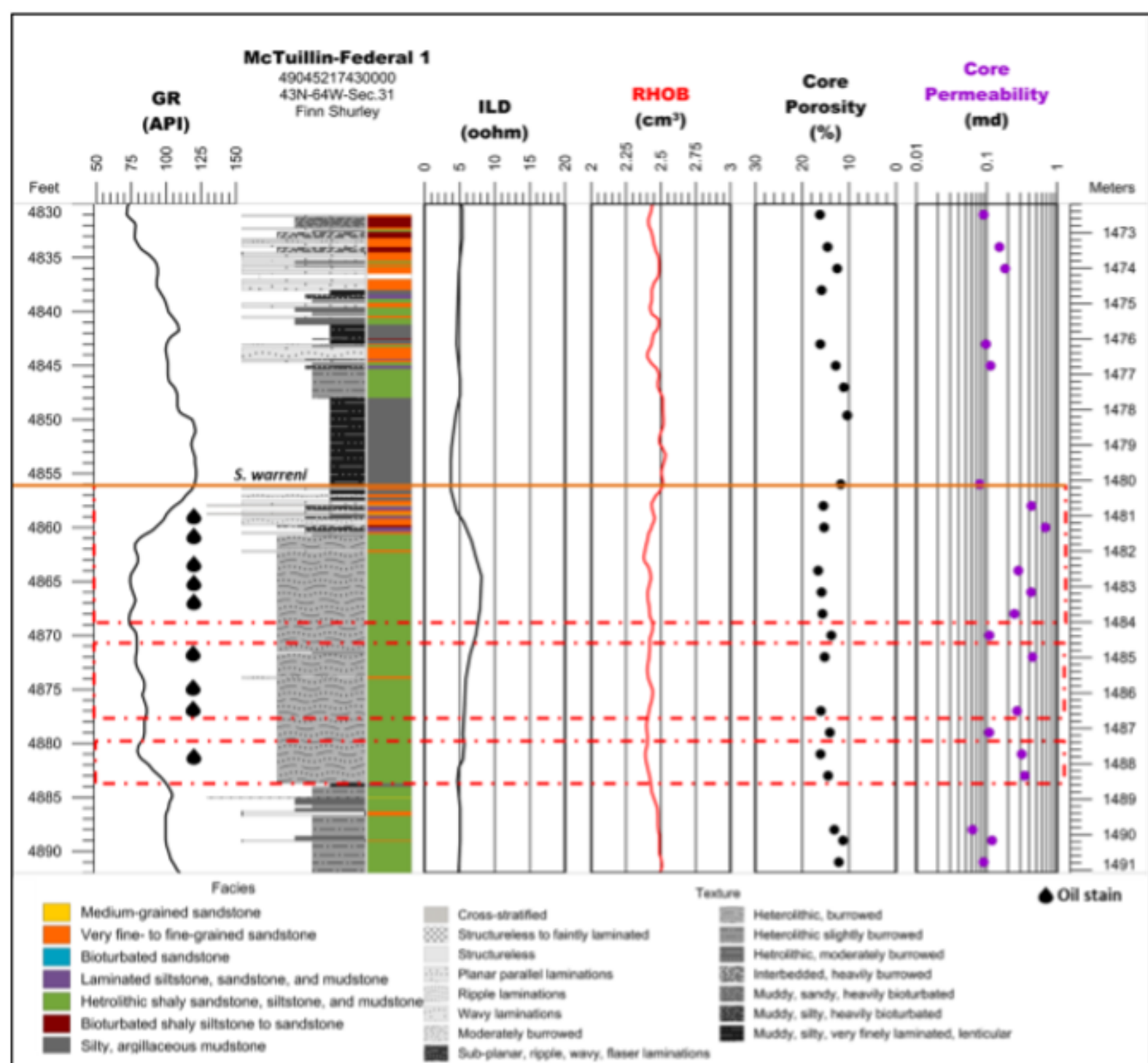
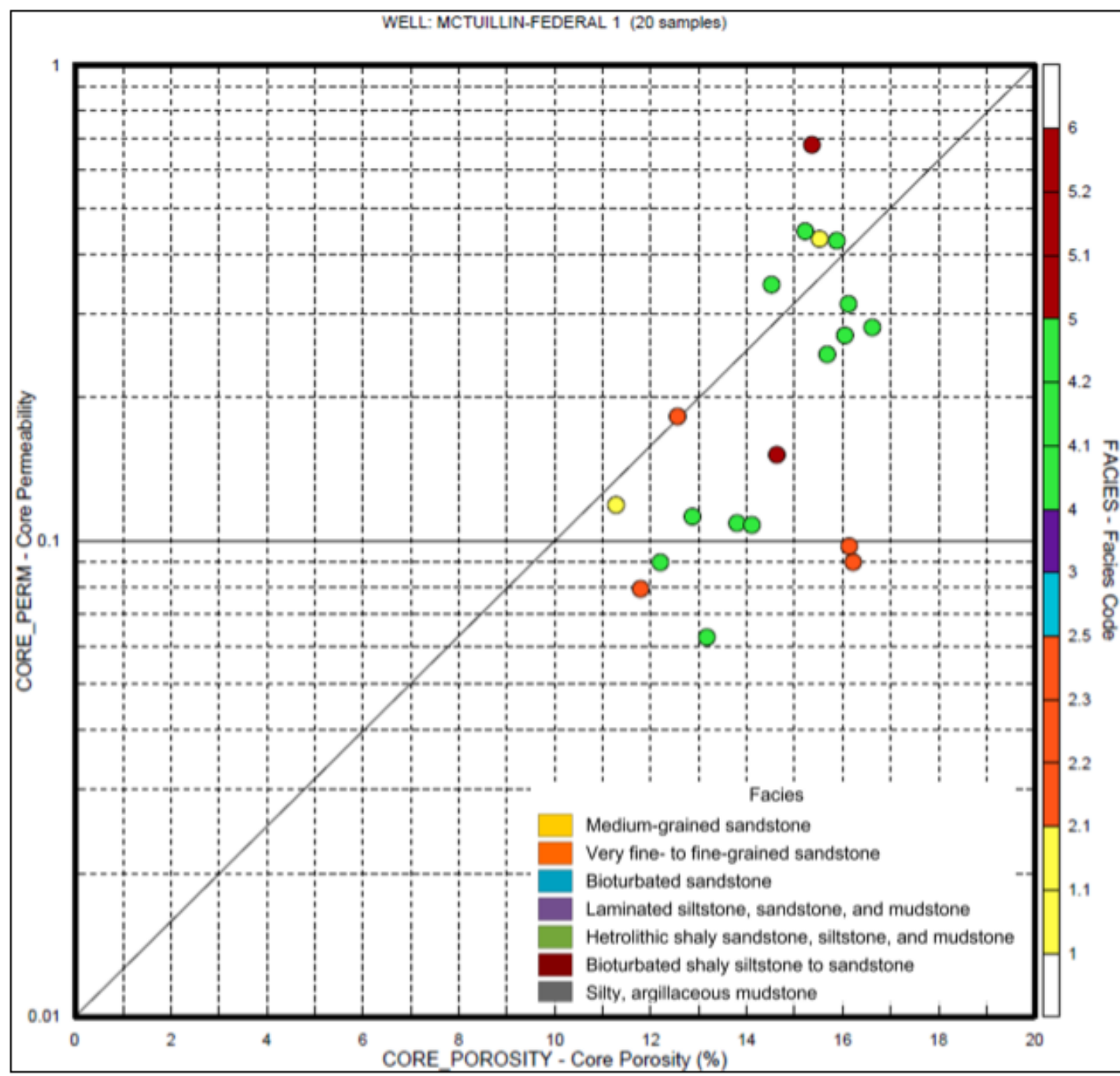
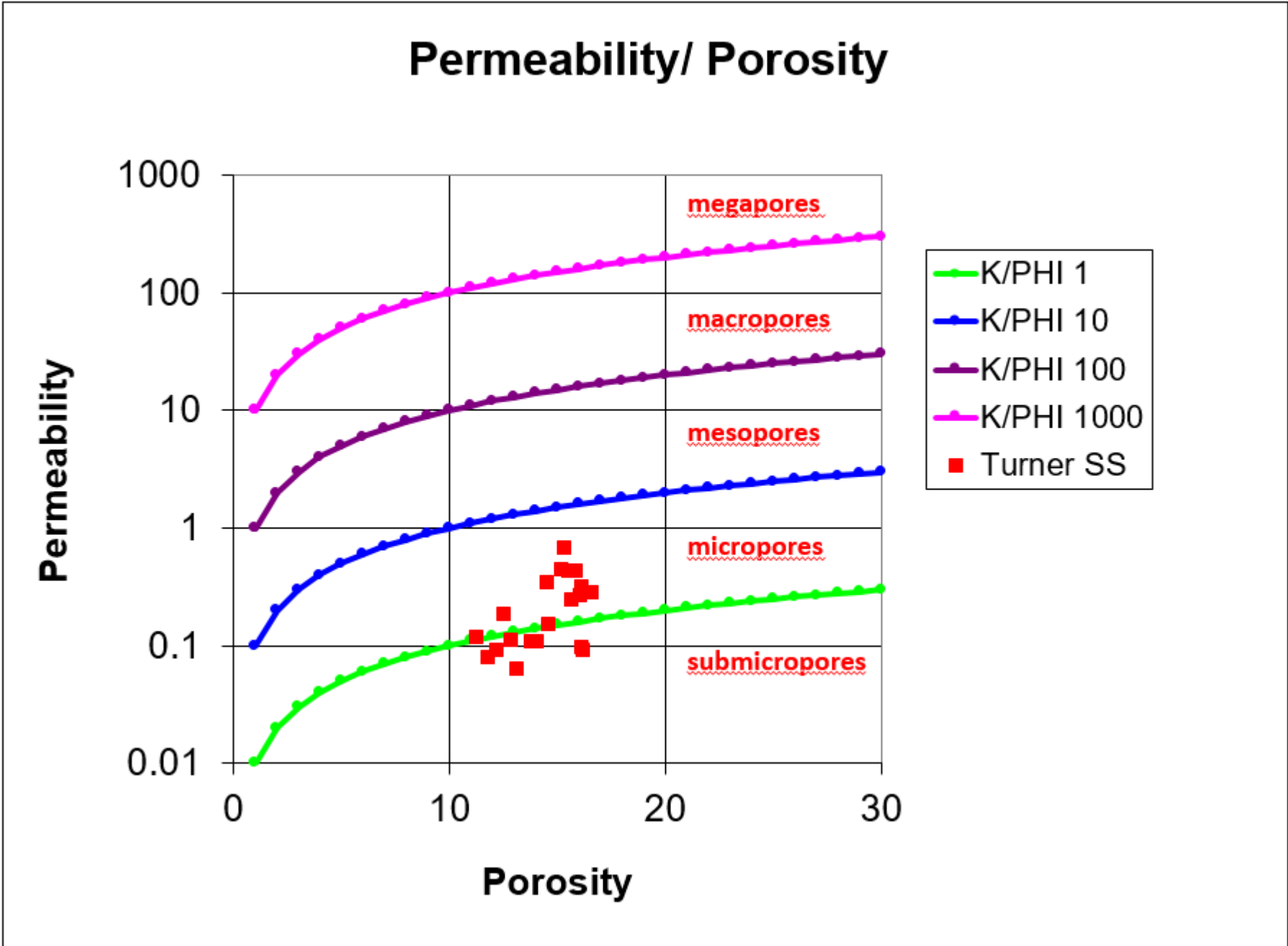


Figure 5.9 Core description and analysis data from the McTuillin-Federal 1, Finn Shurley field. Interpreted potential reservoir intervals are highlighted by red dash-dot boxes.

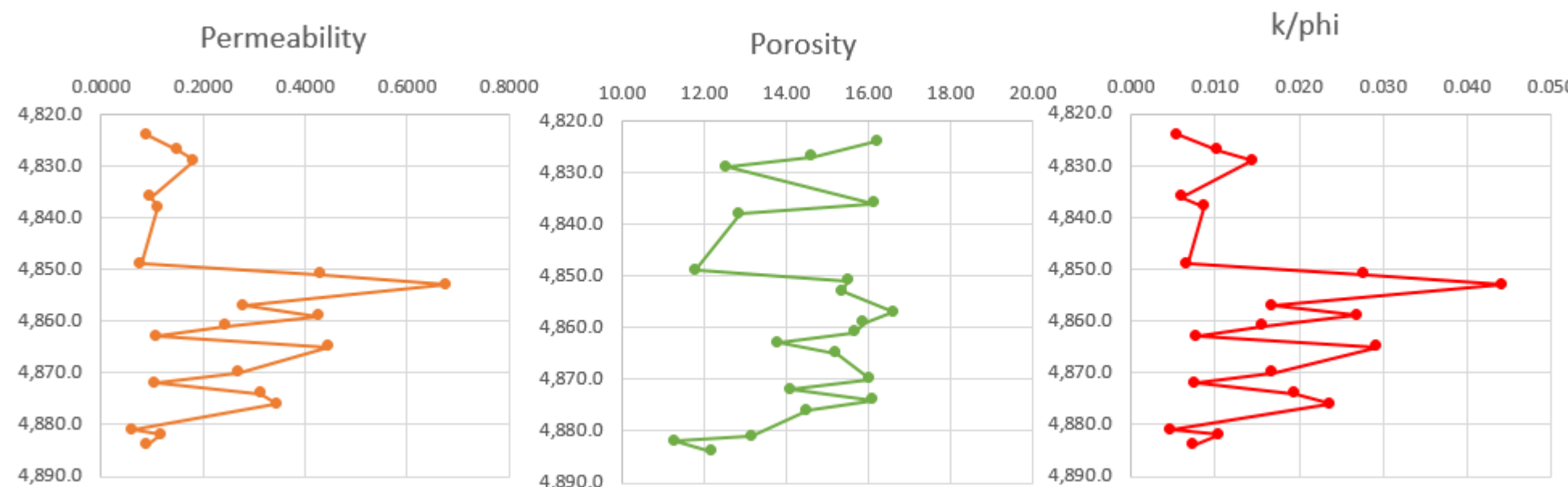
Heger, 2016



Cross plot of porosity and permeability from McTuillin-Federal 1, heterolithic strata show best correlation and reservoir properties (from Heger, 2017)

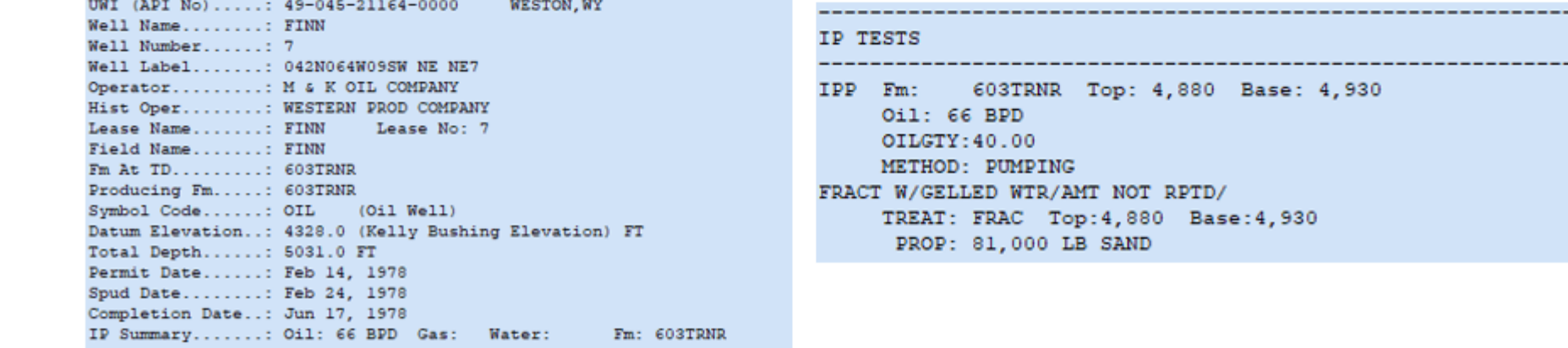
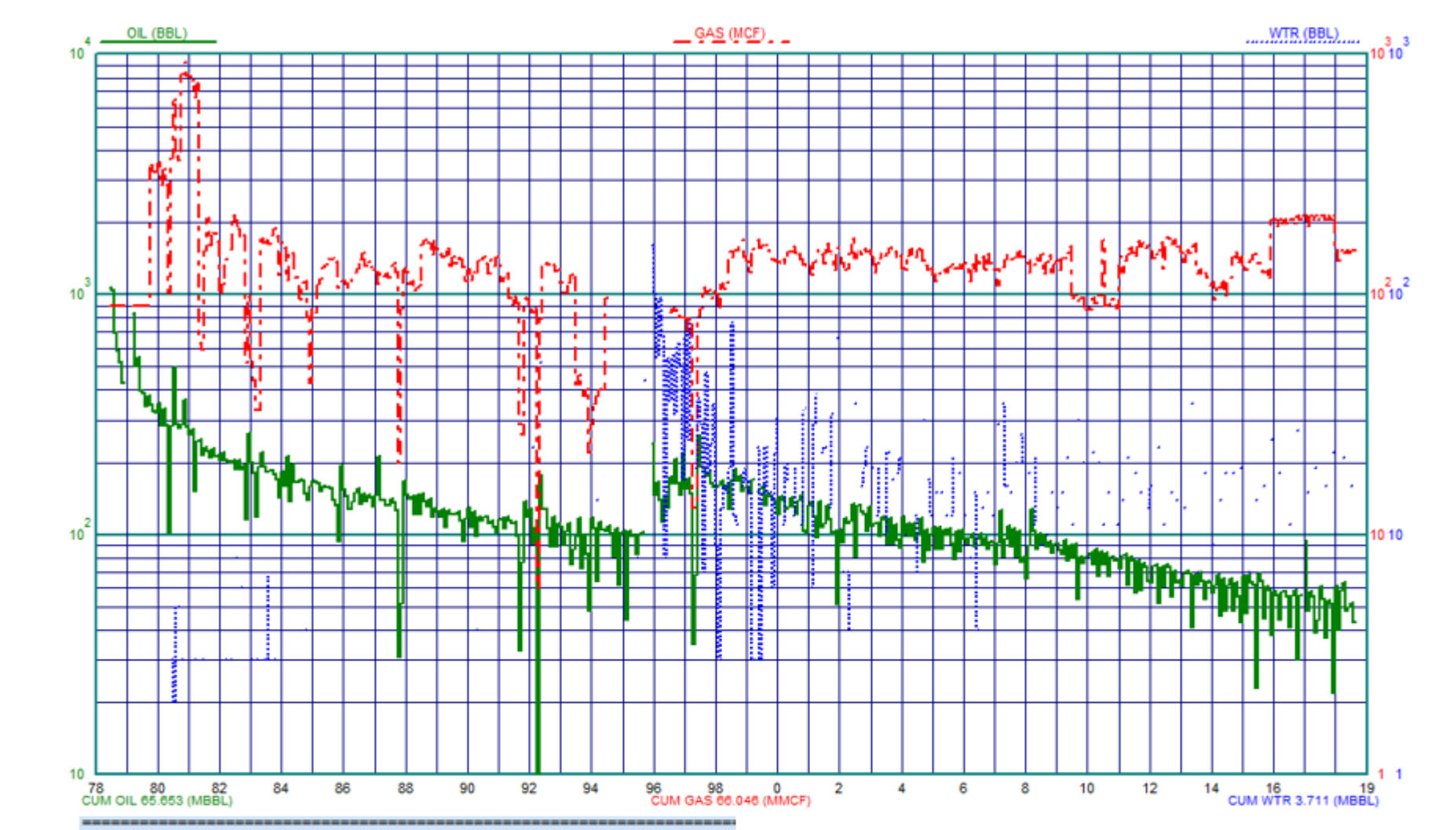
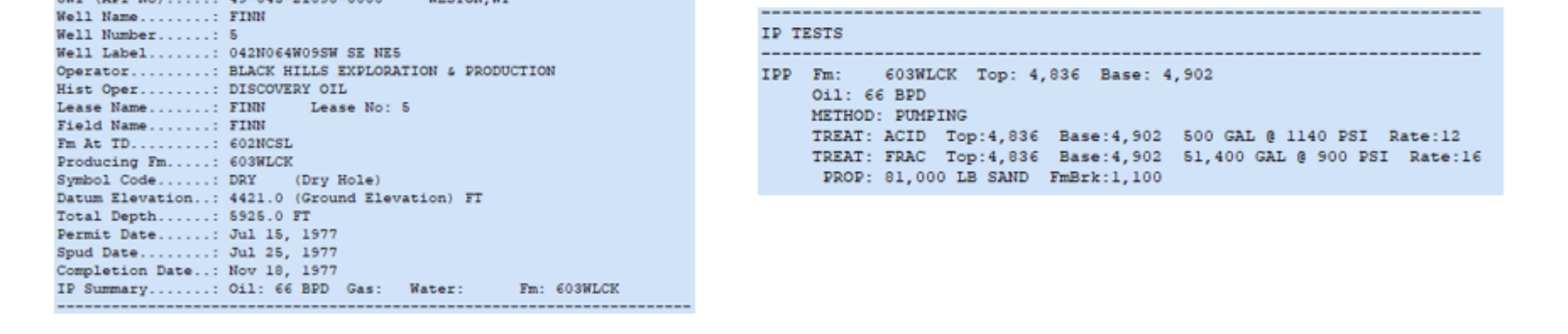
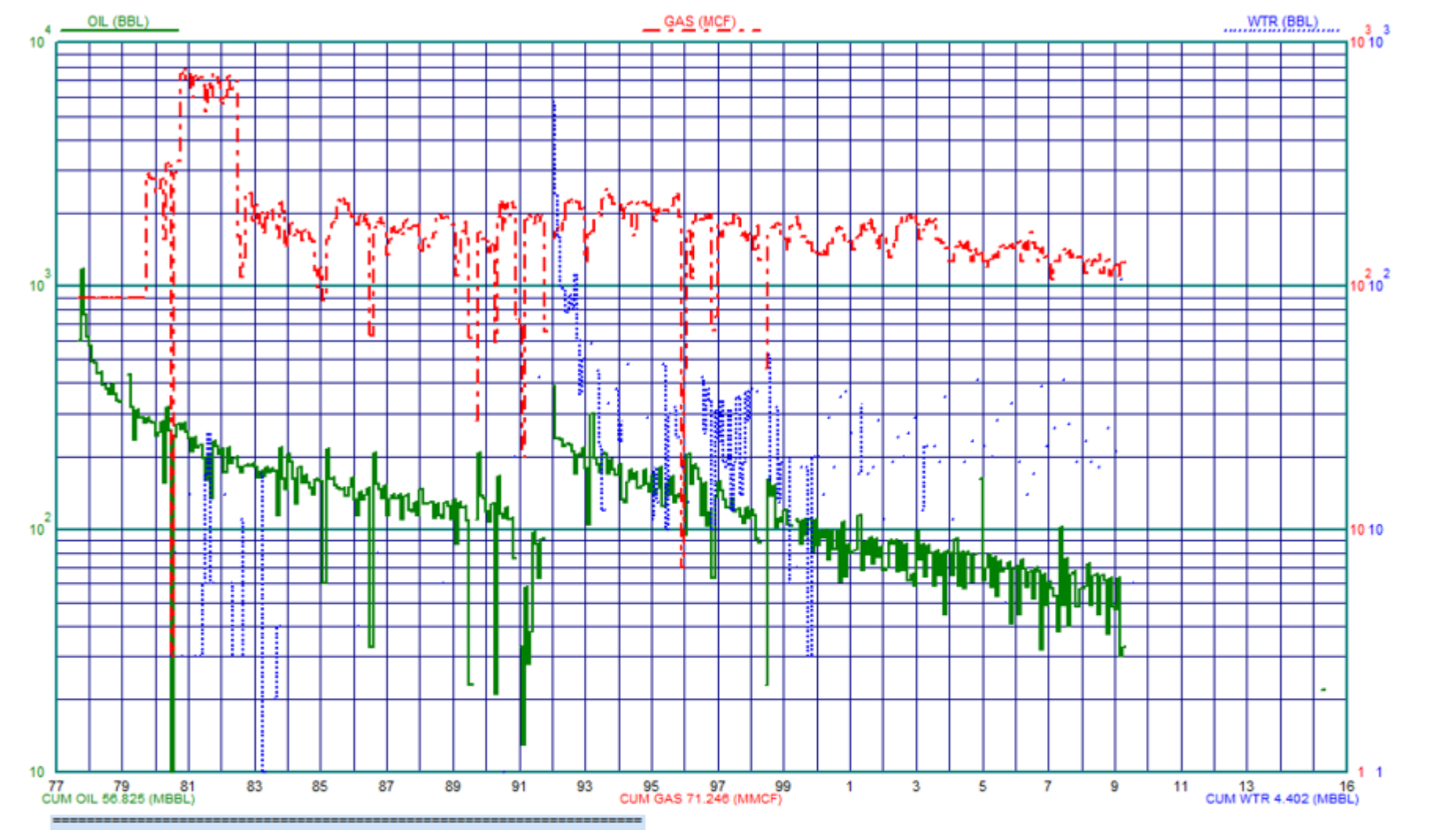
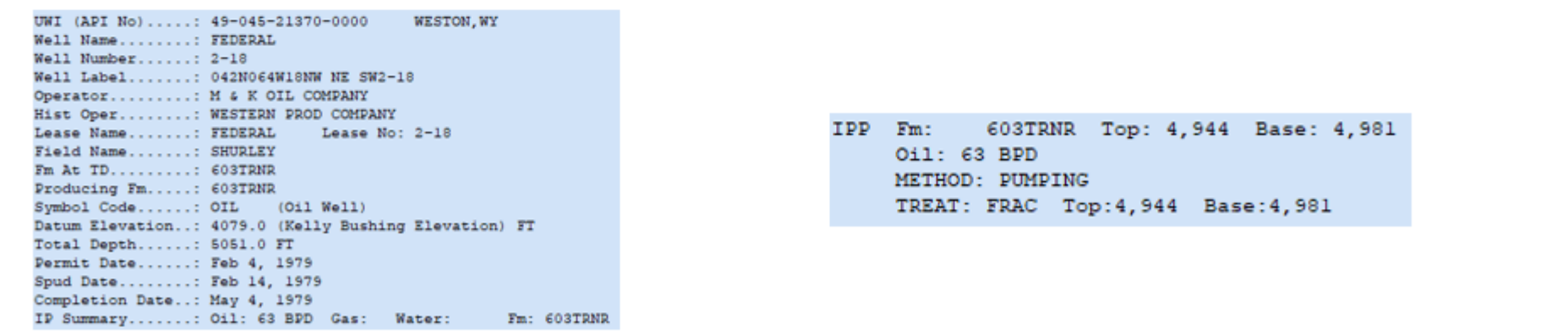
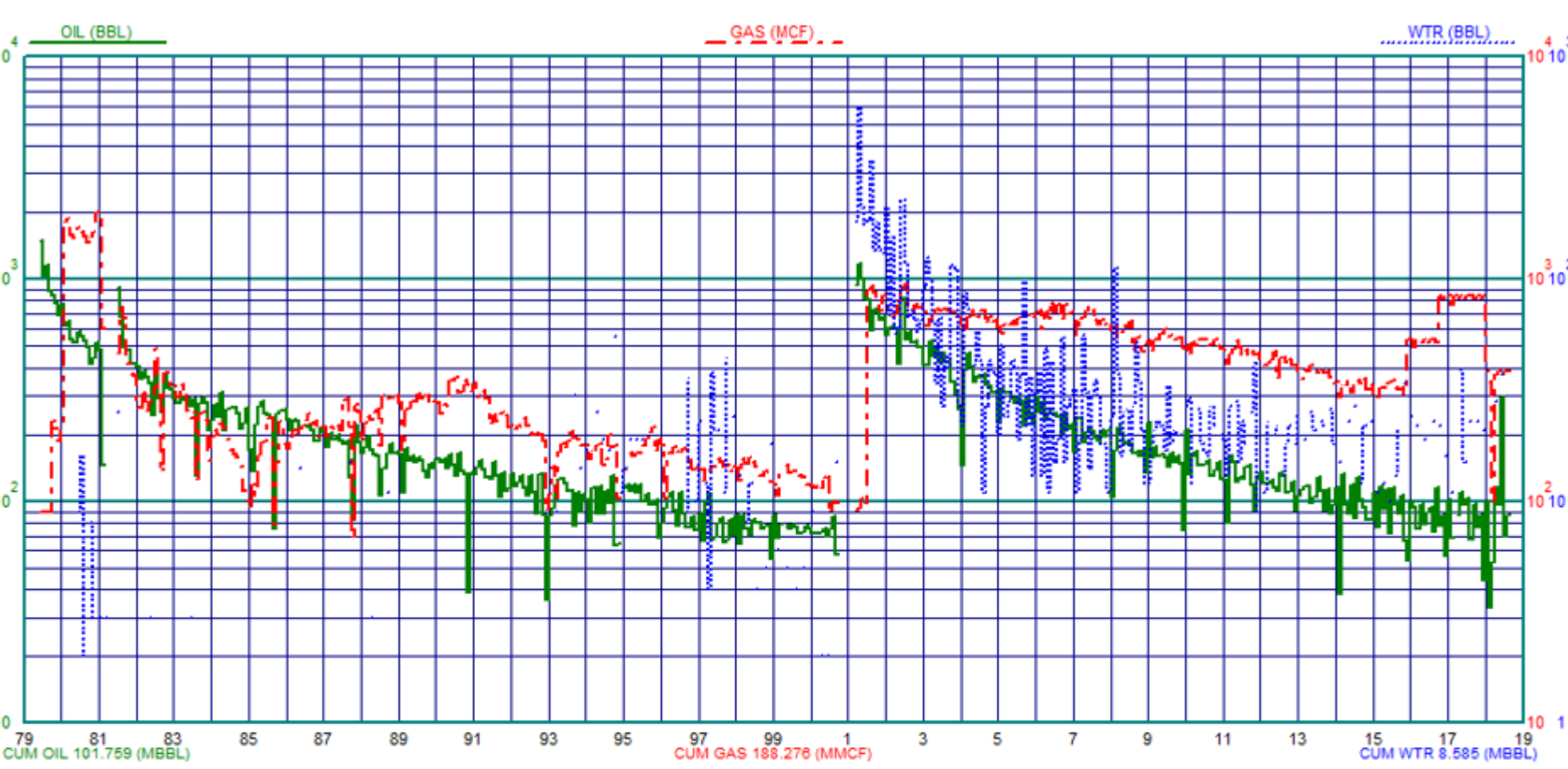
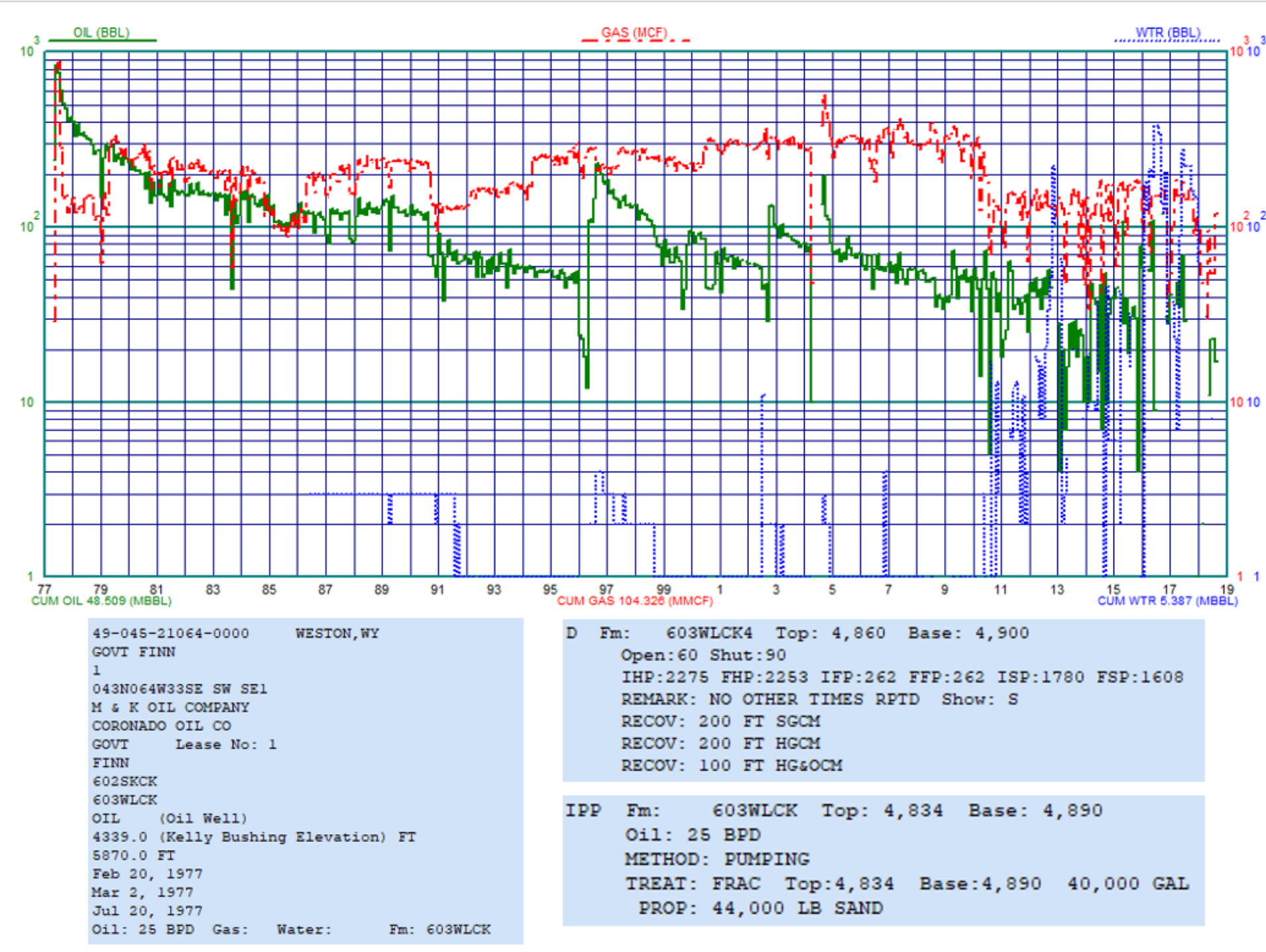


Cross plot of permeability and porosity. Majority of pores are submicropores to micropores.



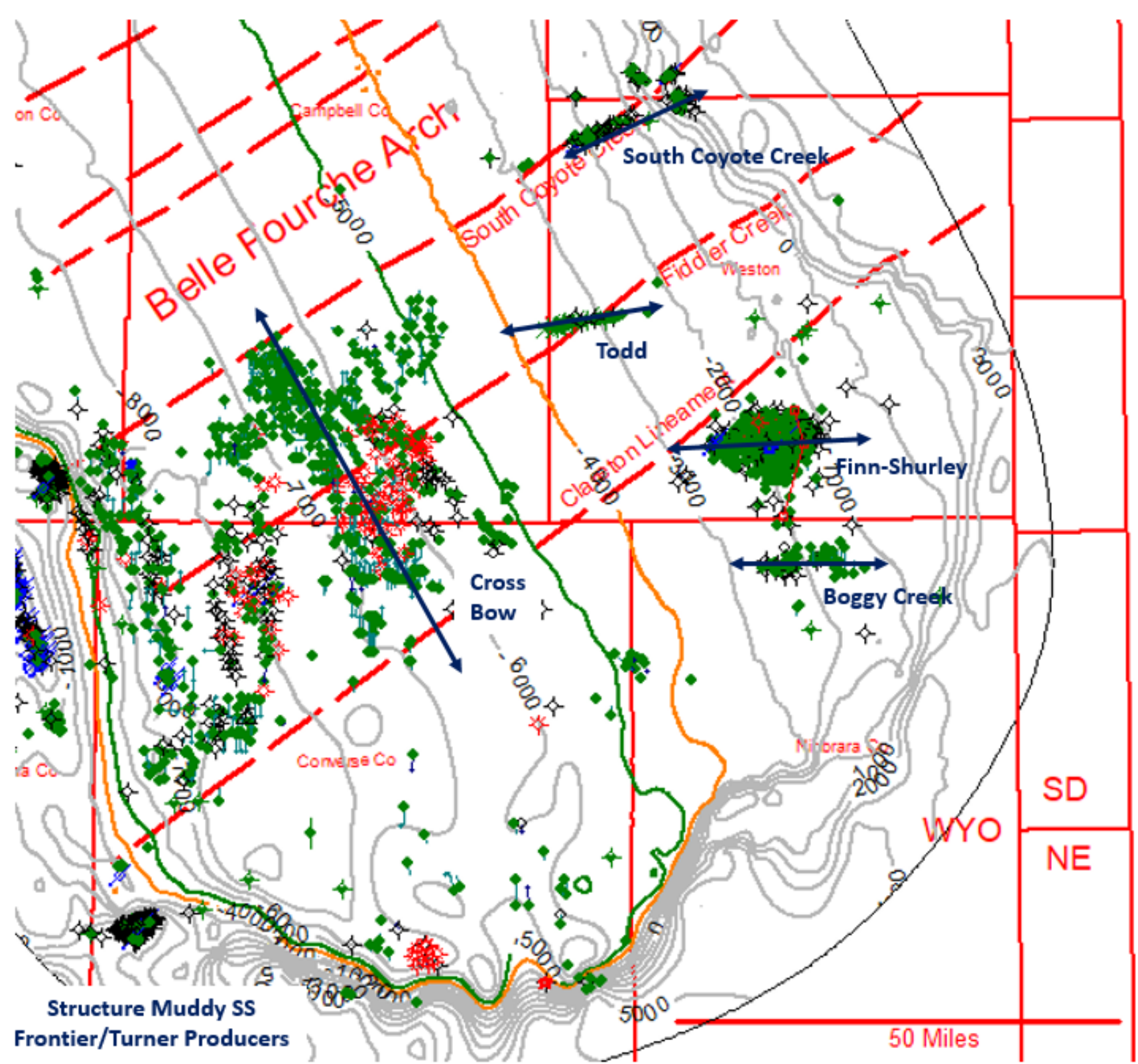
Porosity, permeability, and K/Phi with depth.

Water Re Fracs successful

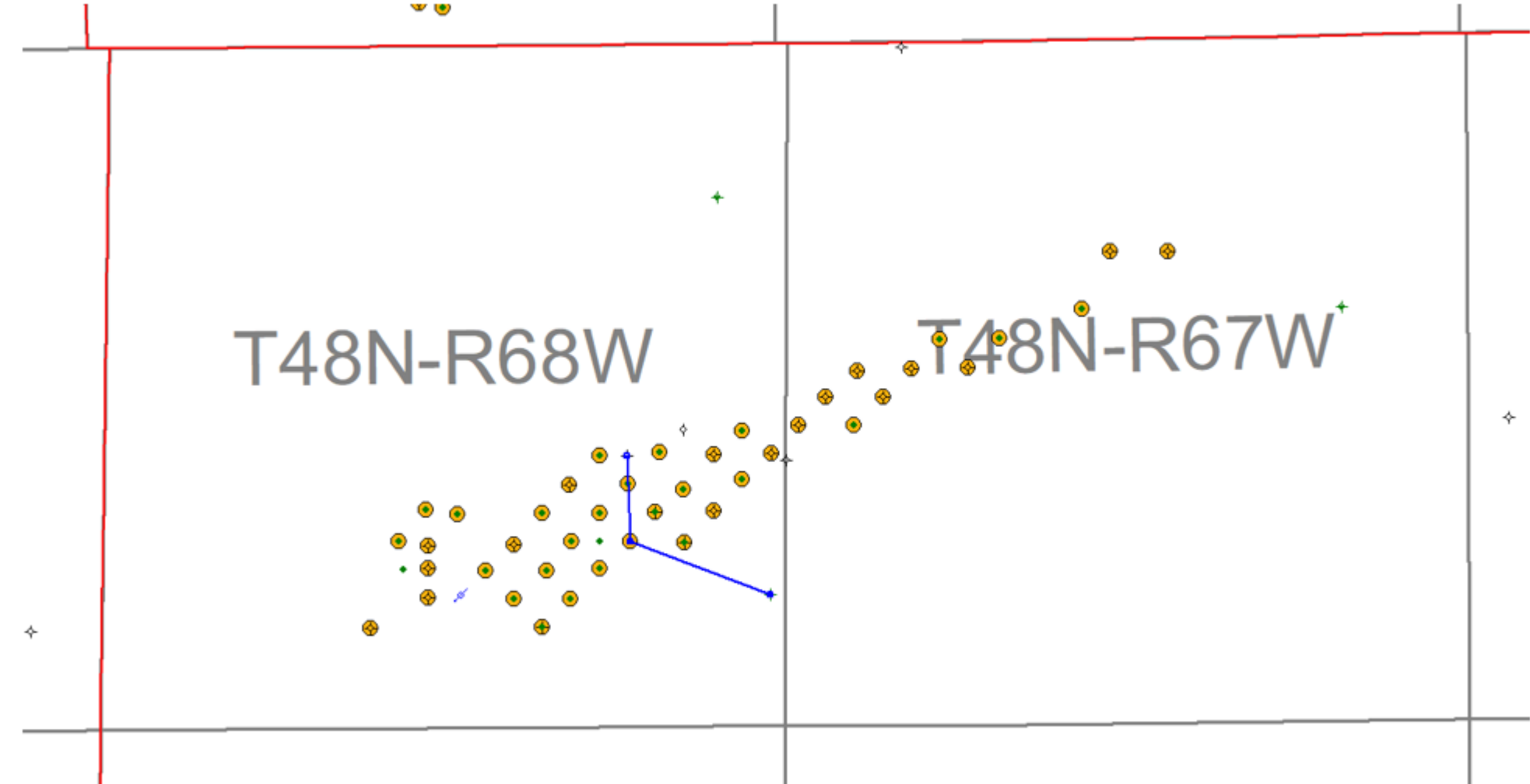


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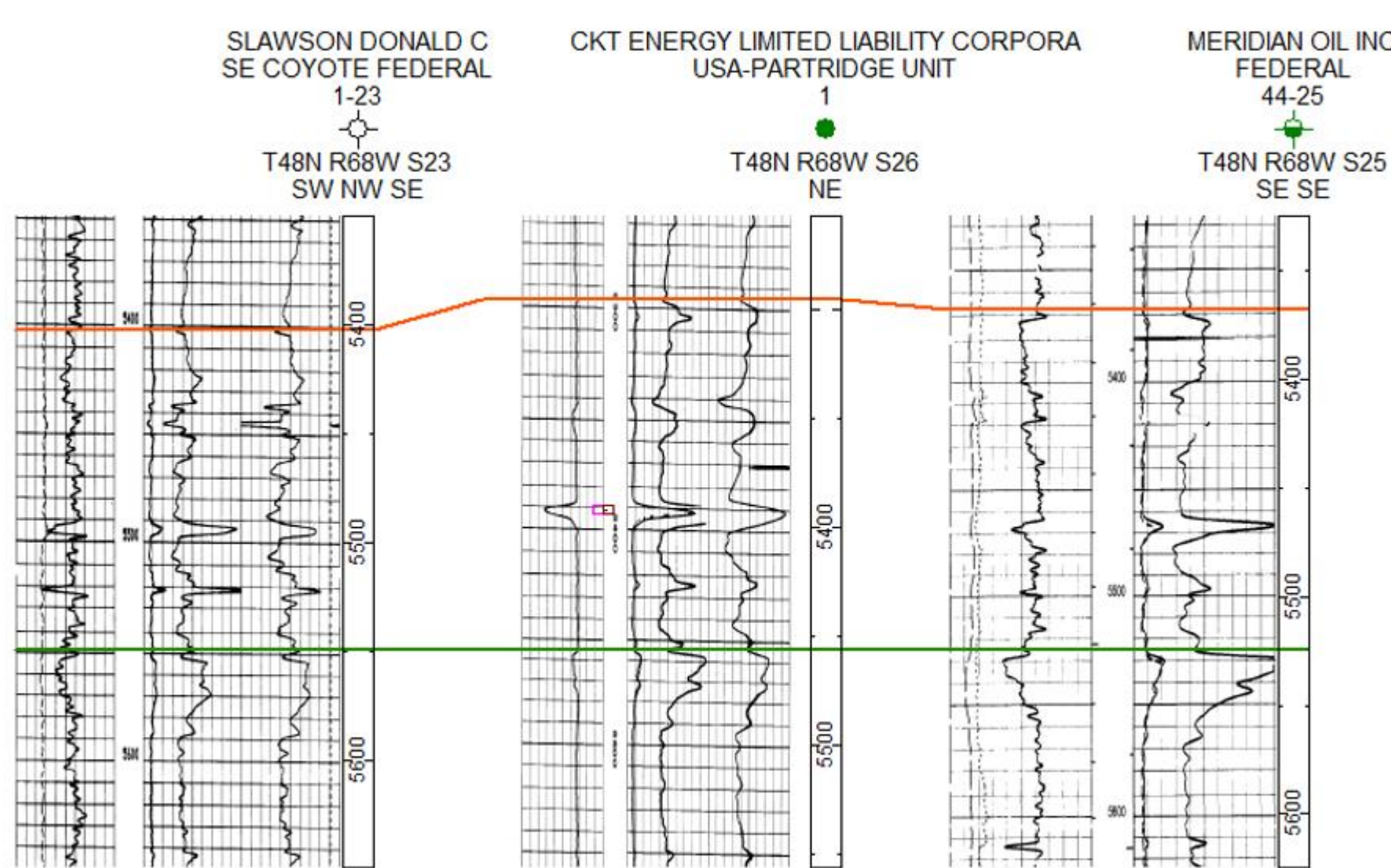
Bar Orientations Eastern PRB



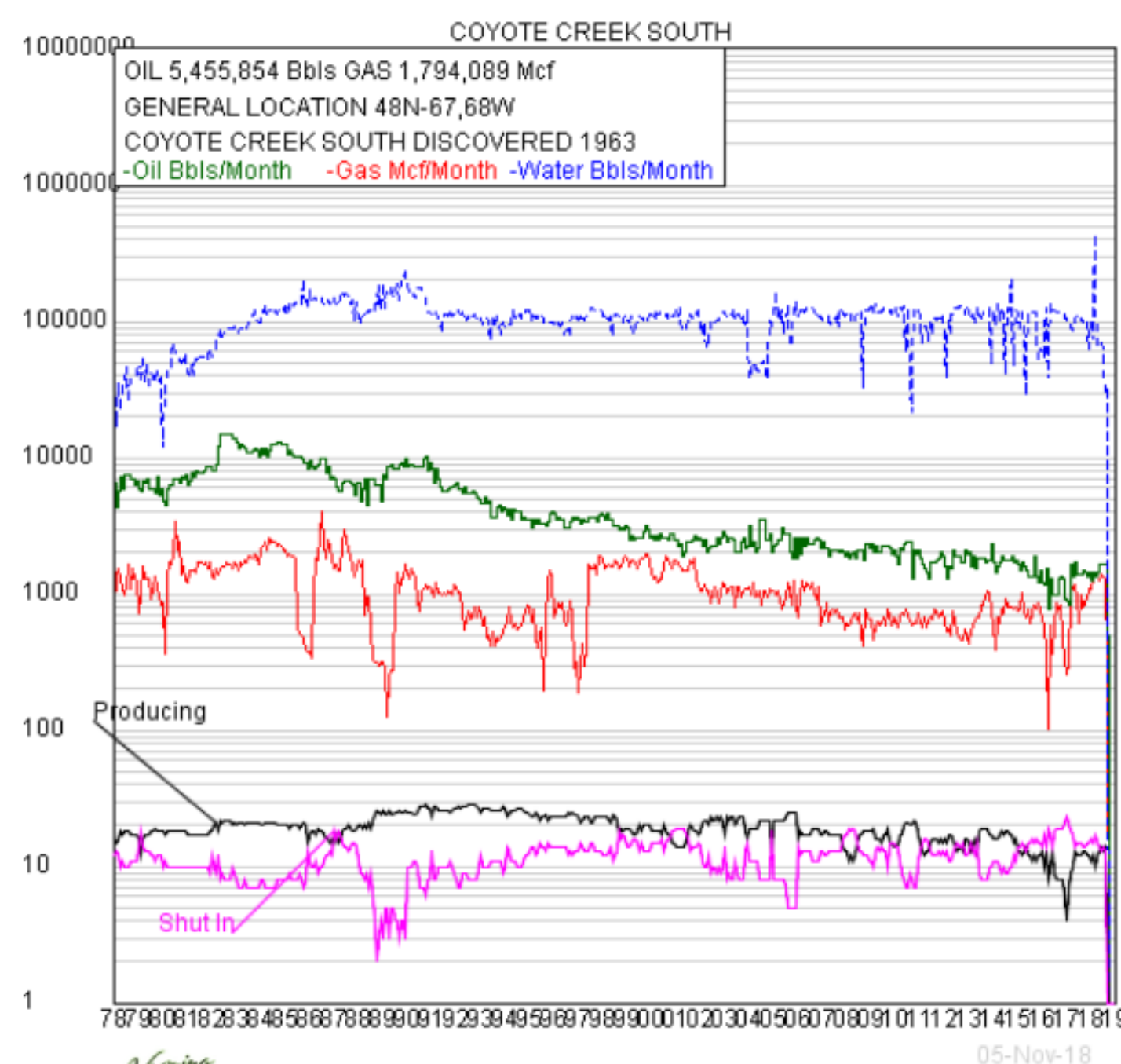
South Coyote Creek



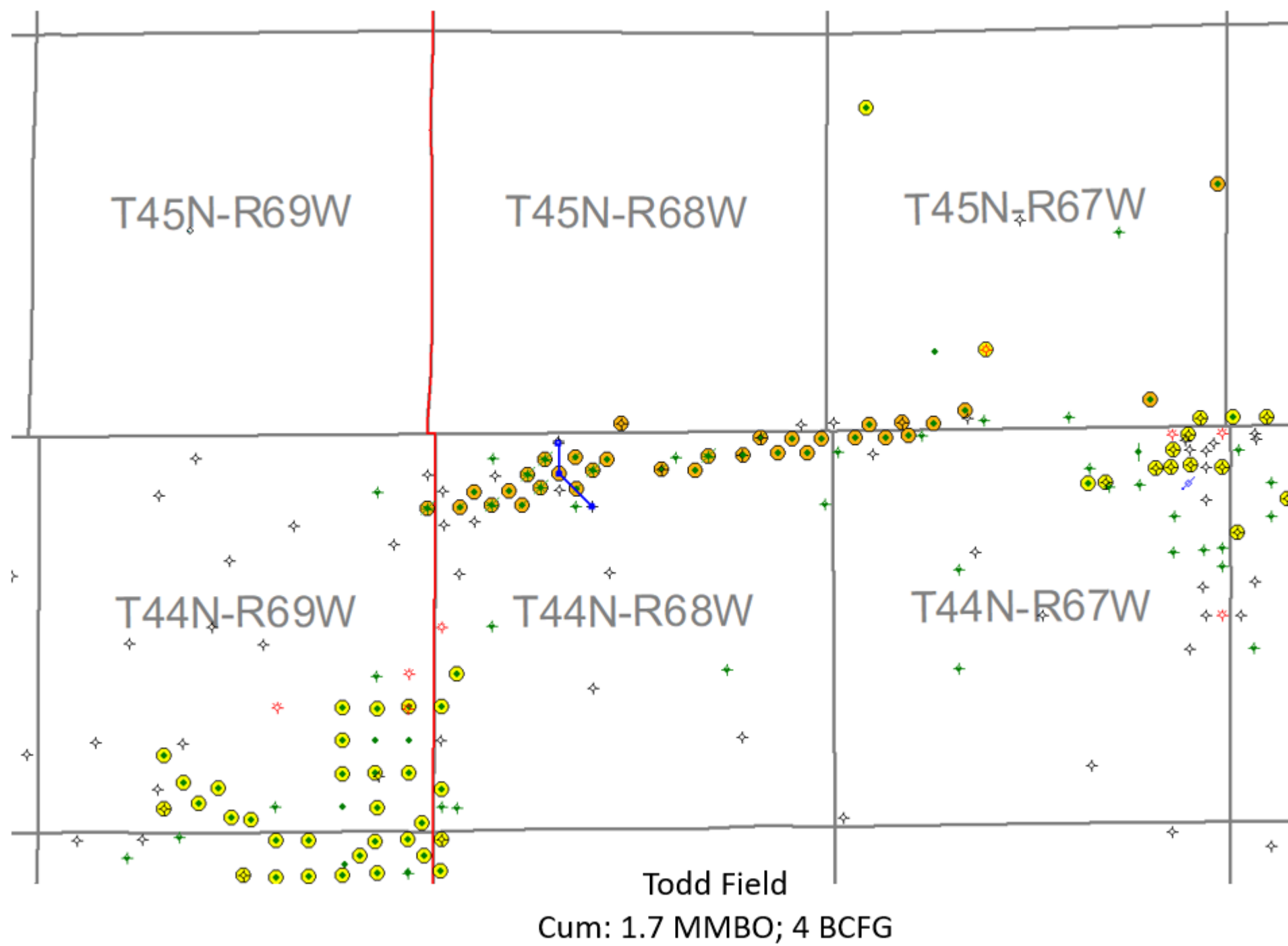
Turner producing field
5.45 MMBO, 1.79 BCFG
Discovered 1963



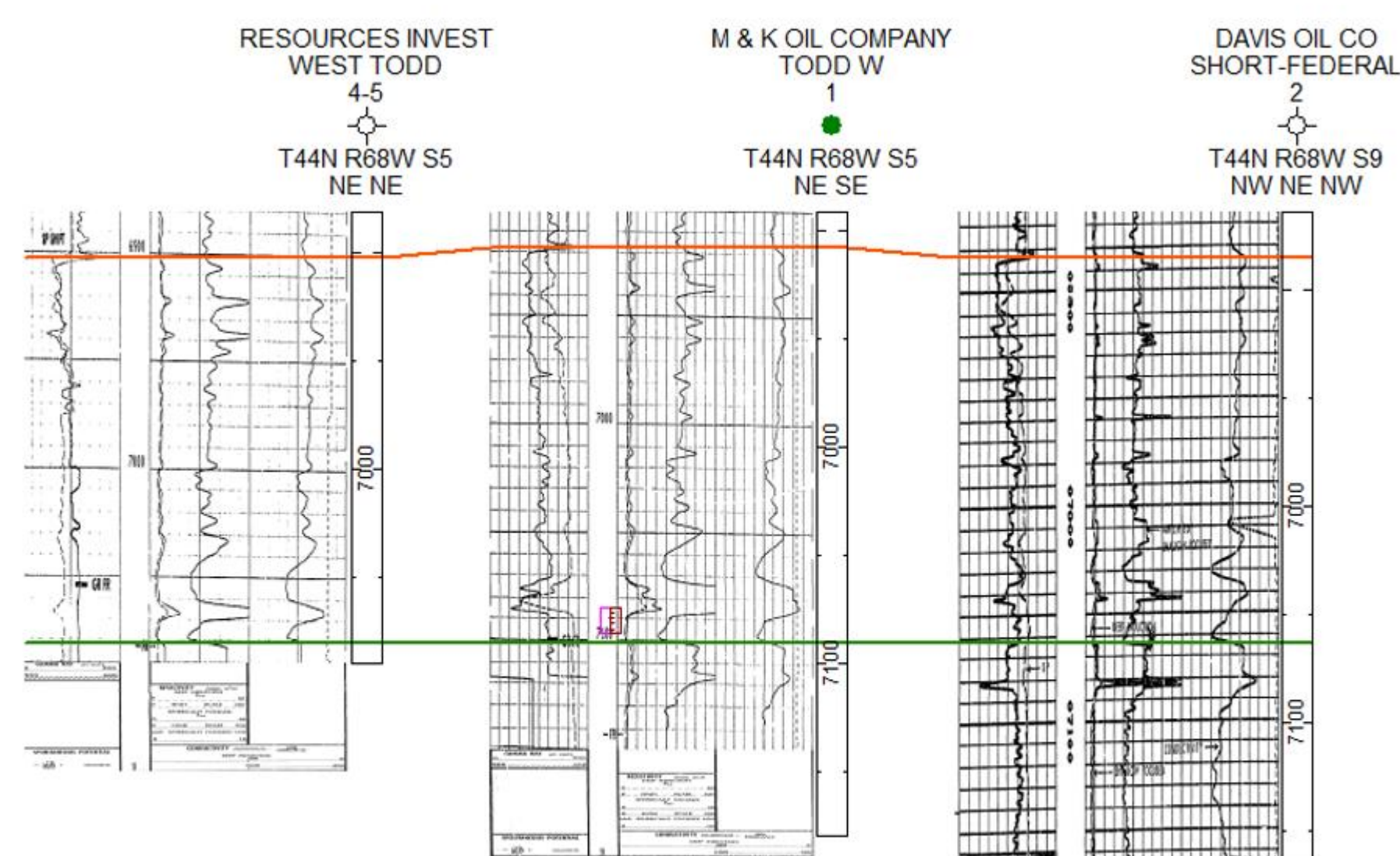
Cross Section, South Coyote Creek



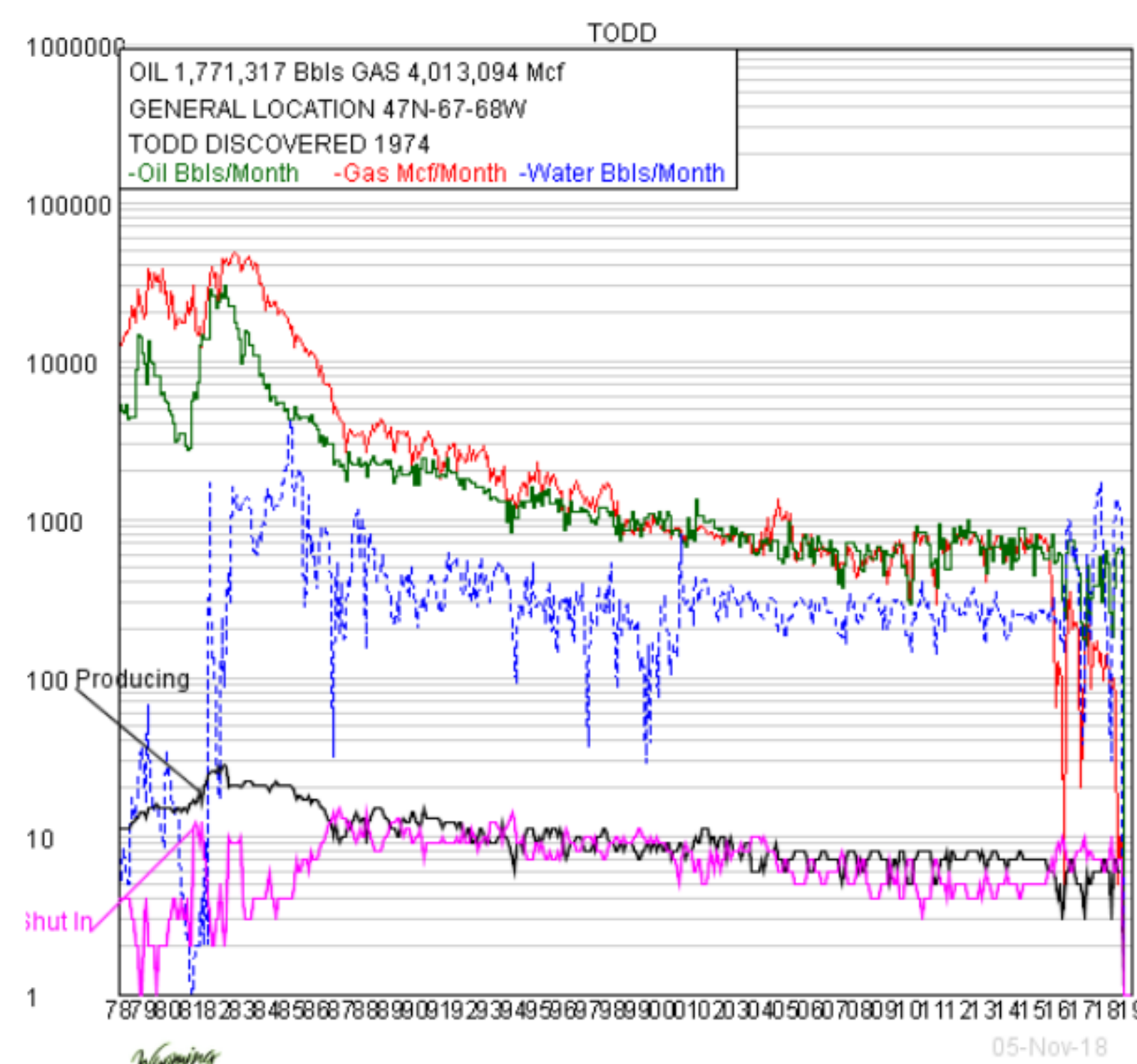
Production curve, South Coyote Creek



Todd Field
Cum: 1.7 MMBO; 4 BCFG

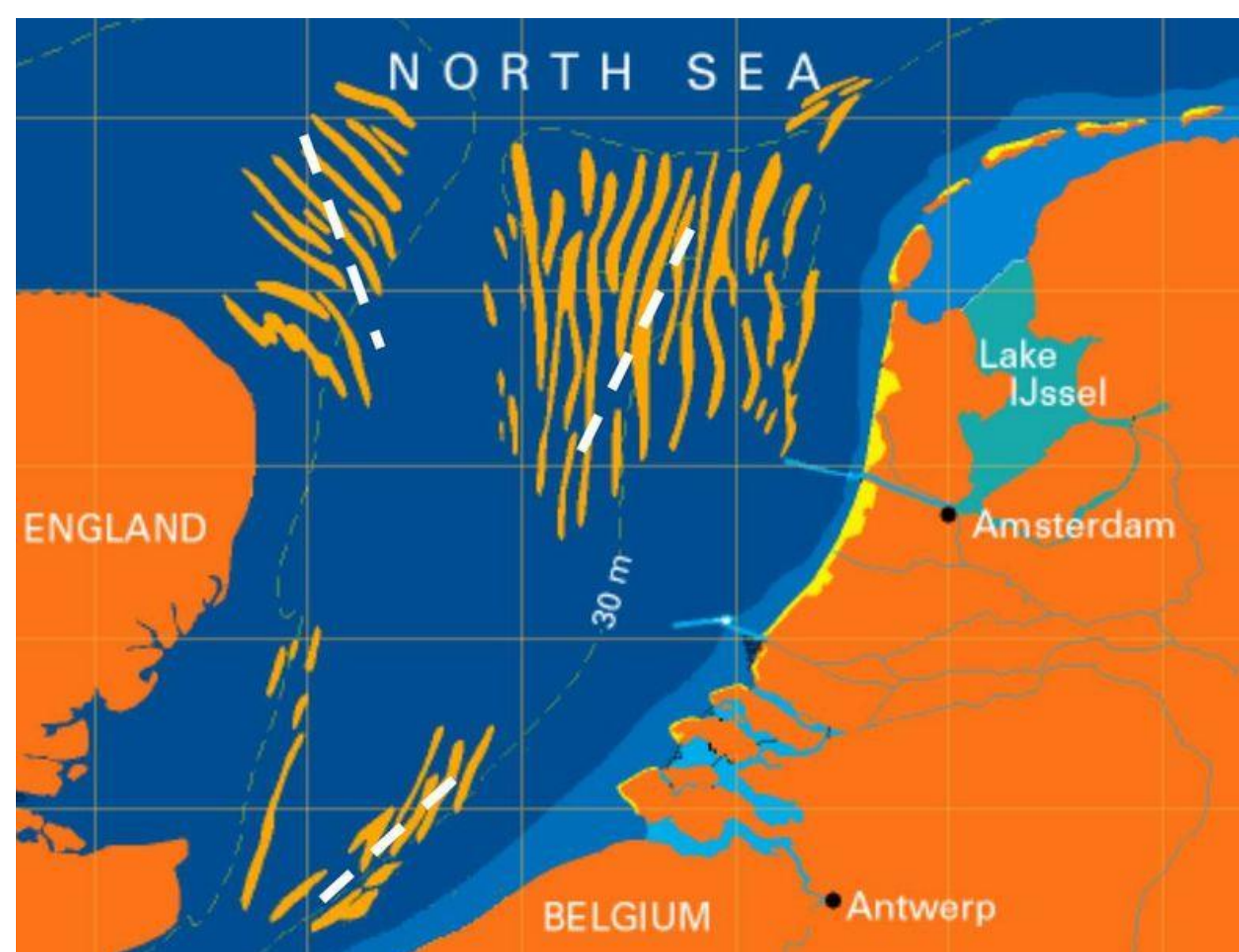


Cross section, Todd Field



Production curve, Todd Field

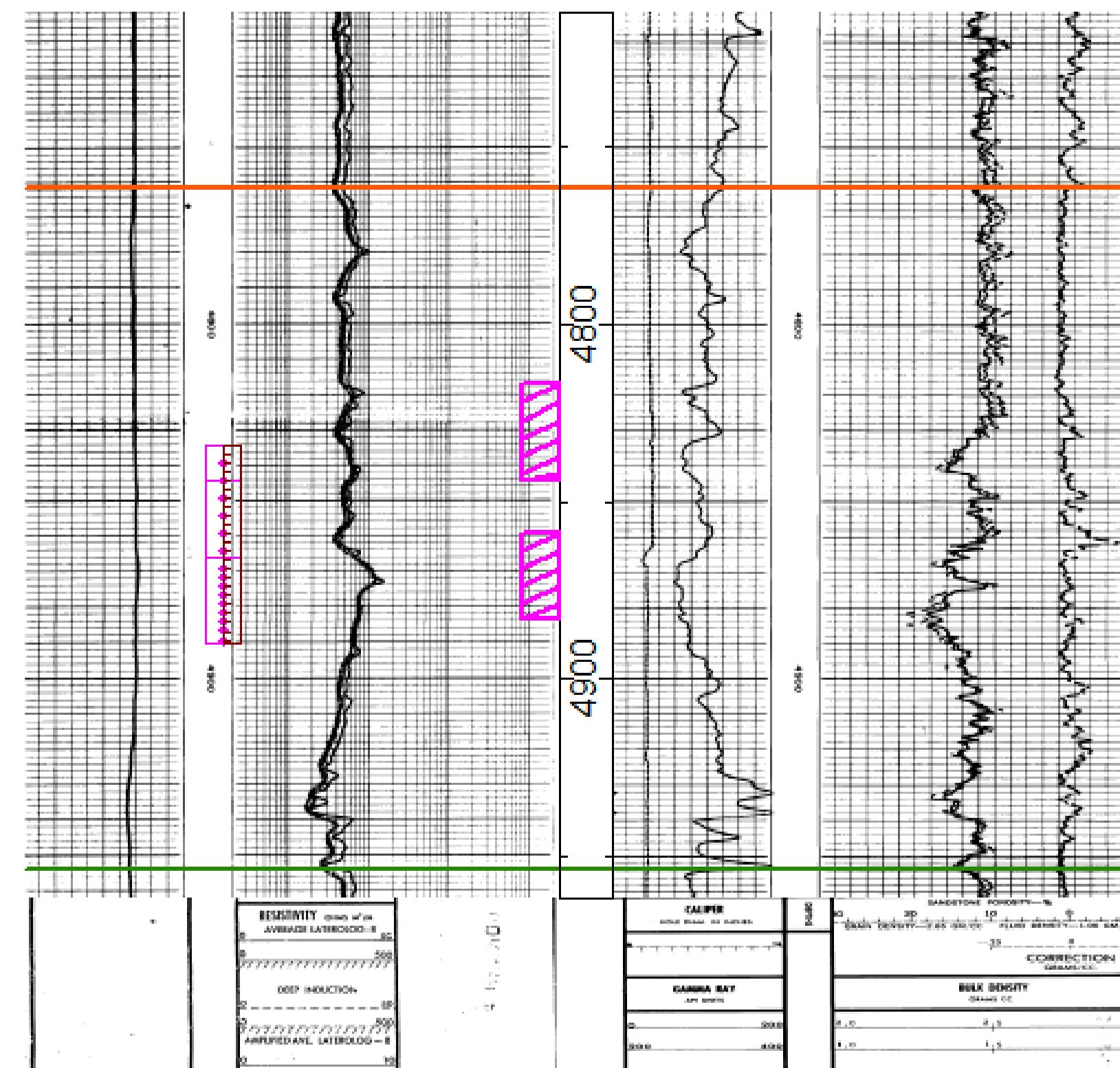
North Sea Tidal Ridges Orientations An Analog?



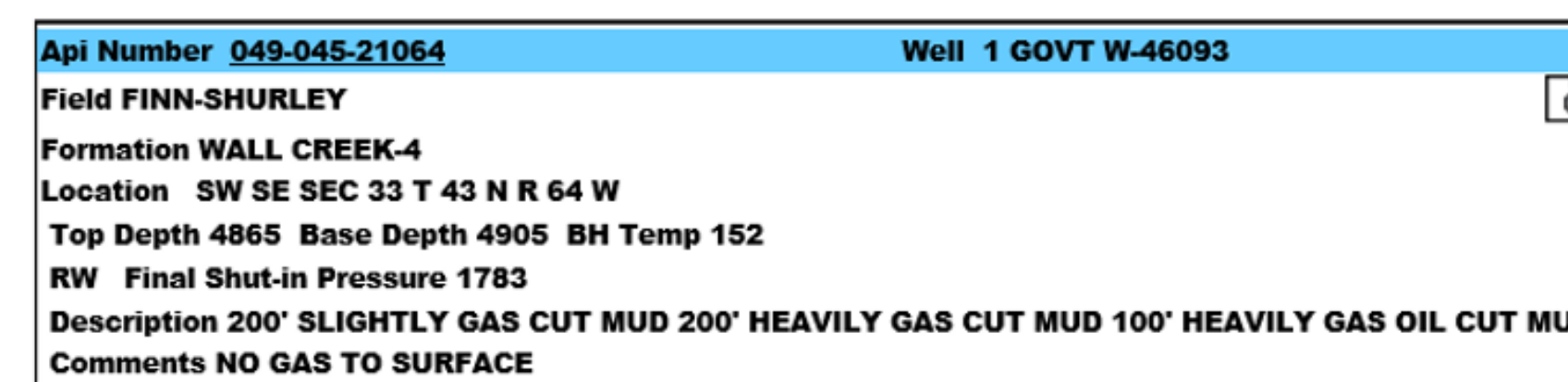
Reservoir Pressure

M & K OIL COMPANY
GOVT FINN

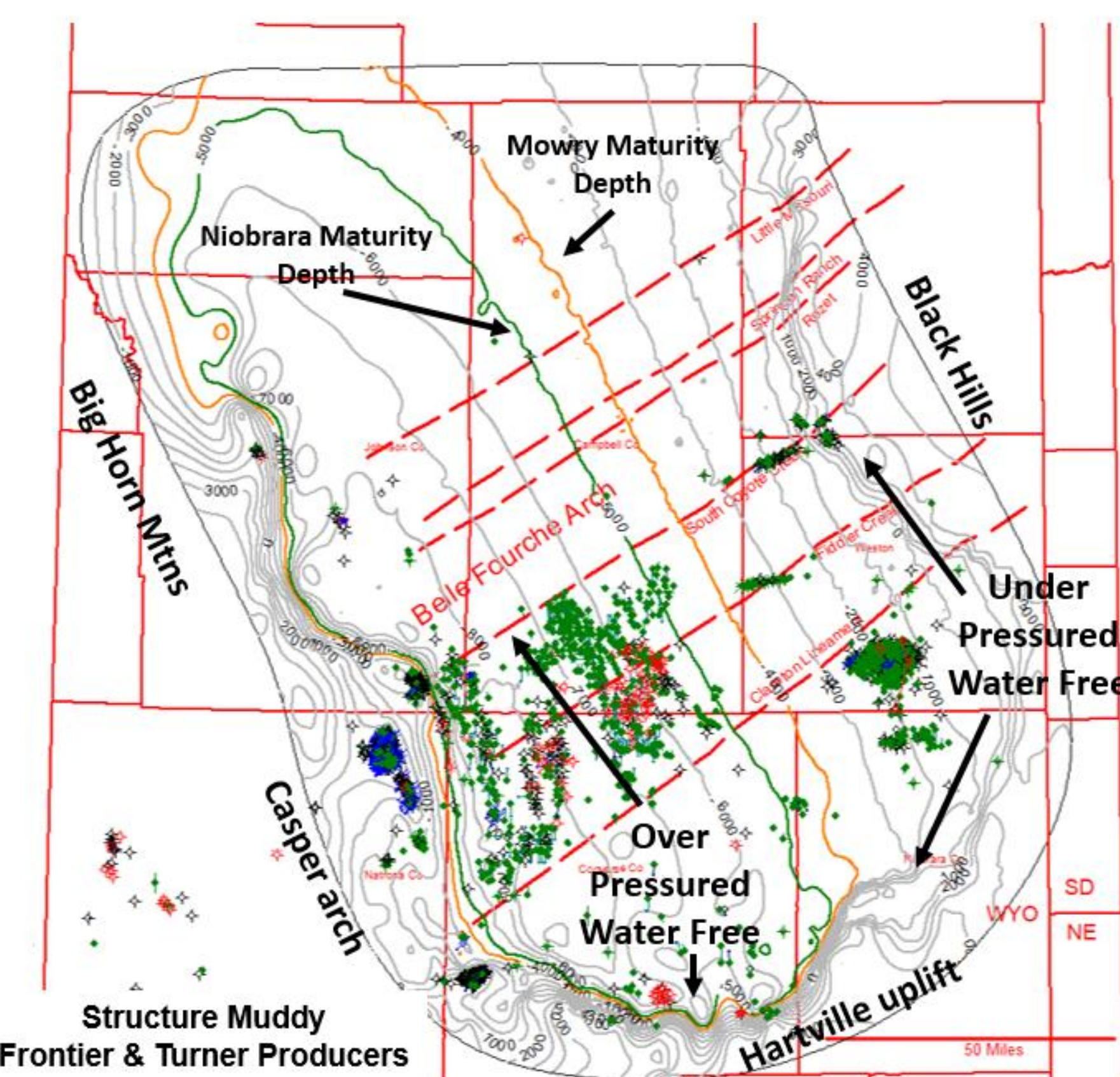
T43N R64W S33
SE SW SE



Pressure gradient= 0.366 psi/ft
Temperature gradient = 3.12 °F/100 ft



Pressure Cells PRB



Finn-Shurley Field is located in an underpressured, essentially water-free area of the Powder River Basin. A continuous-type of hydrocarbon accumulation occurs in this area.

SUMMARY

The Finn-Shurley field produces petroleum from the Upper Cretaceous Turner Sandstone of the Powder River Basin. The Turner is a member of the Carlile and is overlain by the Sage Breaks and underlain by the Pool Creek members of the Carlile. The Turner is interpreted to be a shallow marine shelf sandstone deposited along the eastern side of the Western Interior Cretaceous Seaway. Sand-shelf-bar orientation across the field is roughly east-west. Trapping mechanism is stratigraphic.

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