# What Influences Production from the Wall Creek and Turner Reservoirs, Powder River Basin, Wyoming?*

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## Abstract

The Upper Cretaceous Wall Creek Sandstone Member of the Frontier Formation and the Turner Sandy Member of the Carlile Shale are one of the most prolific unconventional plays in the Powder River Basin (PRB) of Wyoming. From 2017 through 2018, the Wall Creek and Turner reservoirs accounted for 39 percent of the PRB's and 21 percent of Wyoming's oil production. The Turner was also the PRB's highest non-coal gas-producing reservoir during this time period, accounting for 23 percent of all natural gas produced from the basin.

This study evaluated horizontal well drilling and completion practices, in addition to reservoir geology, to determine what factors influence production from the PRB Wall Creek and Turner reservoirs. Wall Creek-Turner oil and gas production is graphically compared to the producing interval lengths and lateral orientations of horizontal wells, completion techniques such as hydraulic fracturing (frac) stages, slurry and proppant volumes, and operator specific trends over time. Interpolated surfaces and contours are used to spatially compare basin-wide production trends to reservoir characteristics, including formation depth, thickness, pressure, temperature, regional structural features, and hydrocarbon compositions such as crude oil API gravity, gas-oil ratios, and gas-fraction ratios. The graphical, spatial, and statistical comparisons of these variables suggest that hydrocarbon production from the complex PRB Wall Creek-Turner reservoir system is more influenced by geology than by horizontal well completion techniques.

## Selected References

Asquith, G.B., and D. Krygowski, 2004, Spontaneous Potential, *in* G.B. Asquith and D. Krygowski (eds.), Basic Well Log Analysis: American Association of Petroleum Geologists, Methods in Exploration Series 16, p. 21-30.

Love, J.D., and A.C. Christiansen, comps., 1985, Geologic Map of Wyoming: U.S. Geological Survey, 3 sheets, scale 1:500,000. (Re-released 2014, Wyoming State Geological Survey.)

Lynds, R.M., and J.S. Slattery, 2017, Correlation of the Upper Cretaceous Strata of Wyoming: Wyoming State Geological Survey Open File Report 2017-3.

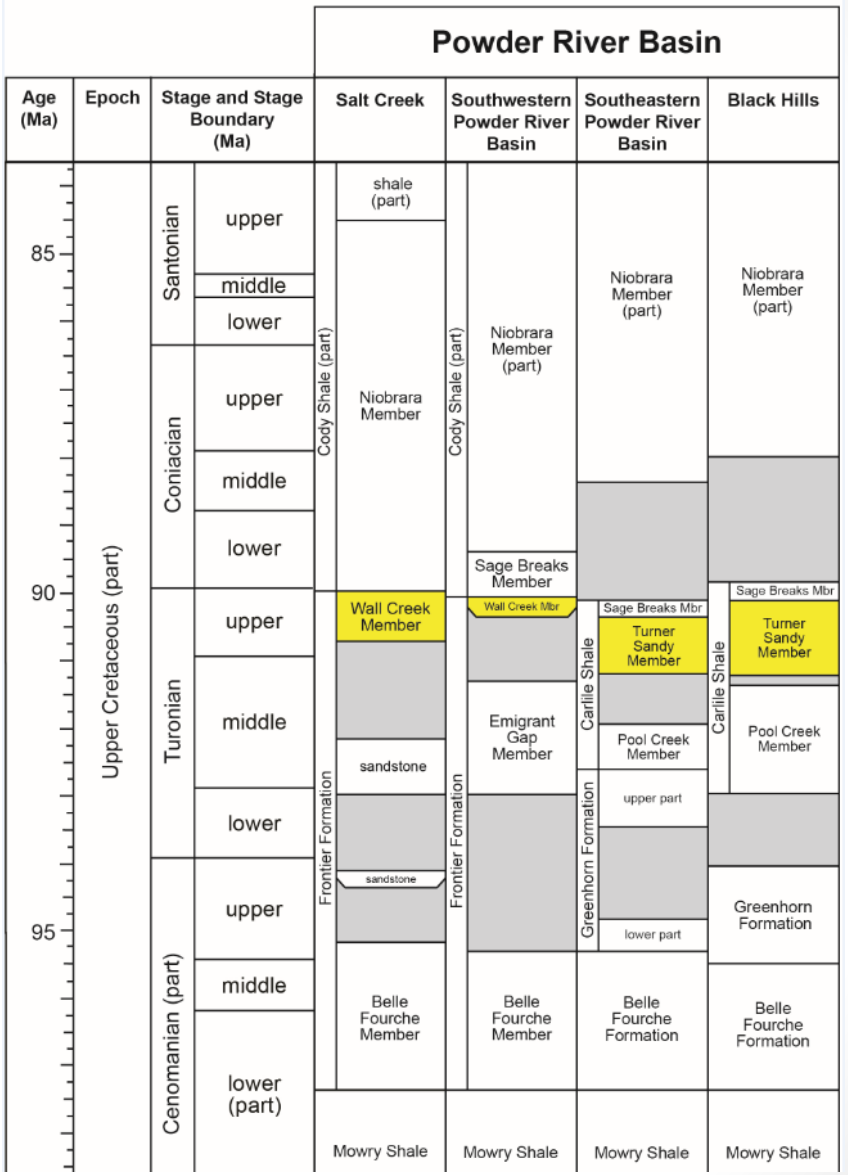
Wyoming Oil and Gas Conservation Commission, 2018, Well Header and Production Data Download. http://pipeline.wyo.gov/legacywogcce.cfm. Accessed November 2019.

# What influences production from the Wall Creek and Turner Sandstone Reservoirs, Powder River Basin, Wyoming?

Rachel N. Toner

# Wall Creek-Turner Sandstones

- Wall Creek Sandstone
  - western PRB
  - member of Frontier Fm
- Turner Sandstone
  - member of Carlile Fm
  - eastern PRB
- Time-equivalents
  (late Turonian ~90Ma)
- Turner distal extension of Wall Creek's deltaic depositional environment

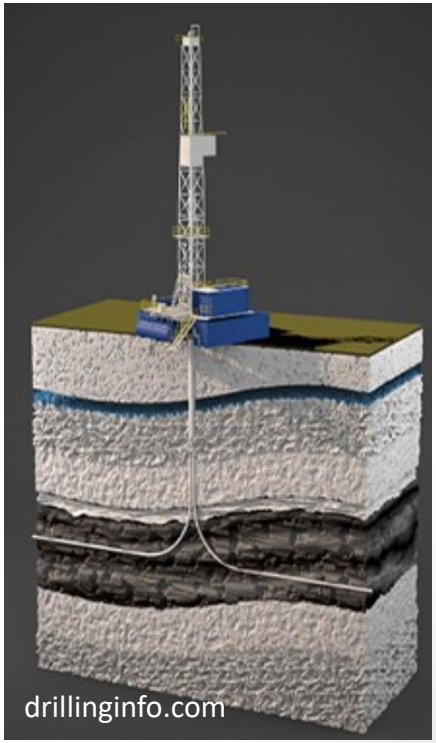



after Lynds and Slattery, 2017

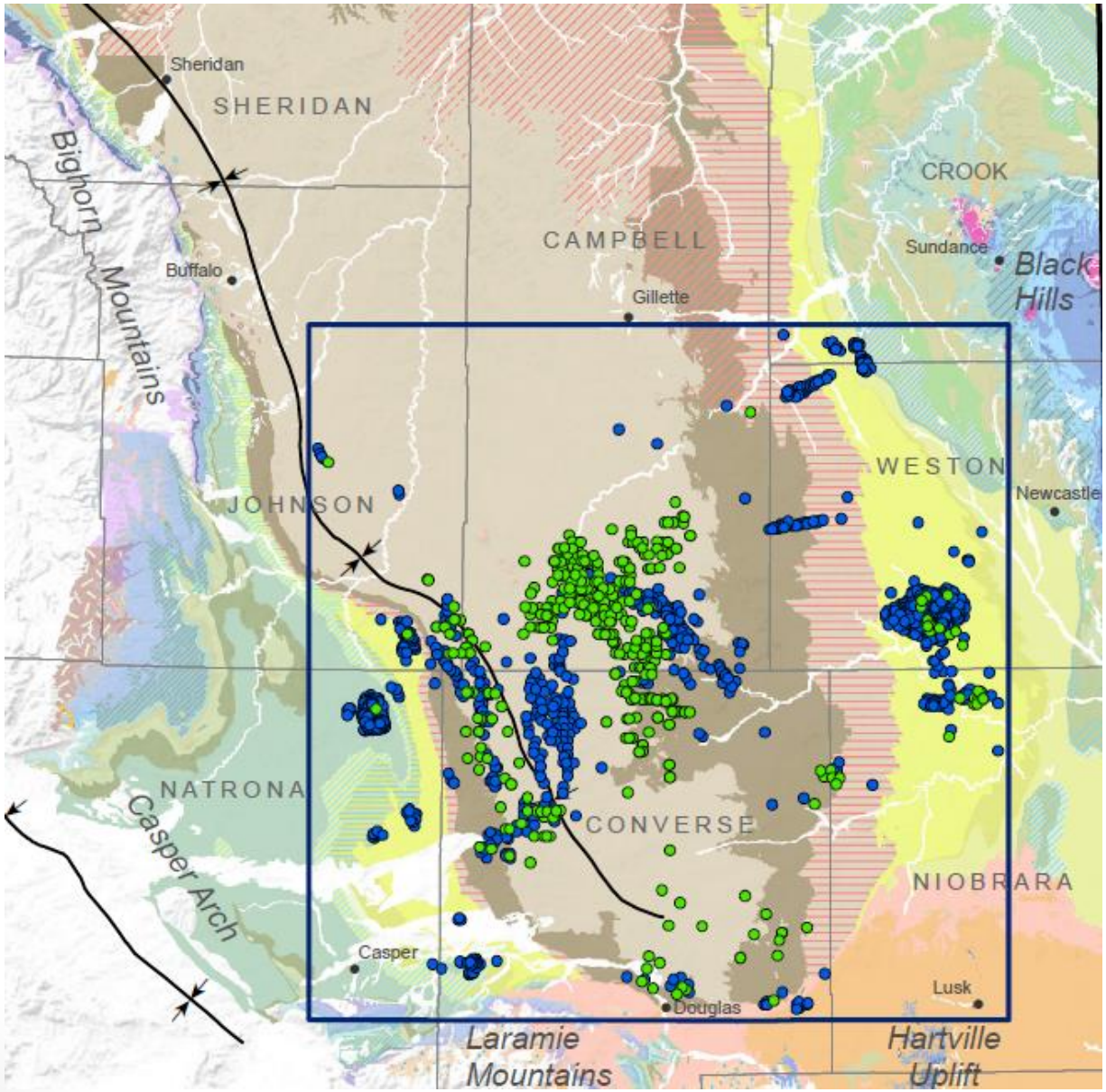
# Wall Creek-Turner reservoirs

- Primary hydrocarbon targets in PRB
  - 2017–2018: 39% PRB oil (21% state oil) and 29% PRB gas
- Since 2014, Turner has been one of top two oil-producing reservoirs in state
- What influences production?
  - drilling/completion techniques?
  - geology?


Wall Creek Member, Rebekah Rhodes


drillinginfo.com

# Wall Creek–Turner wells



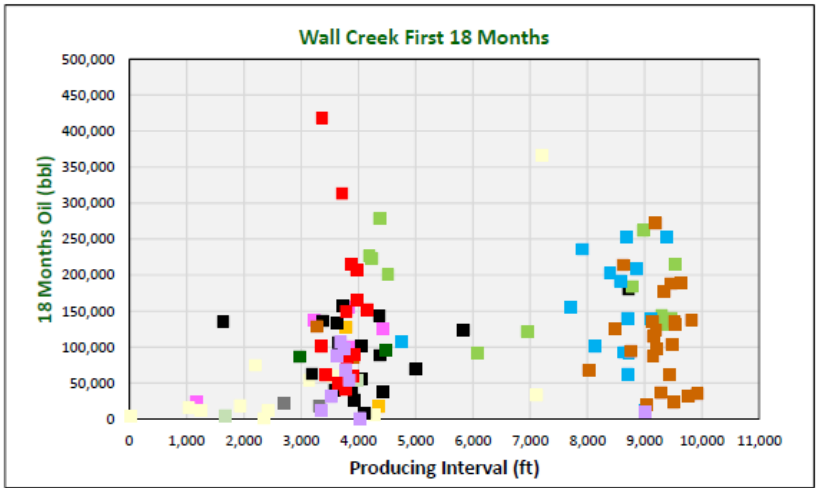
# Wall Creek–Turner horizontal wells

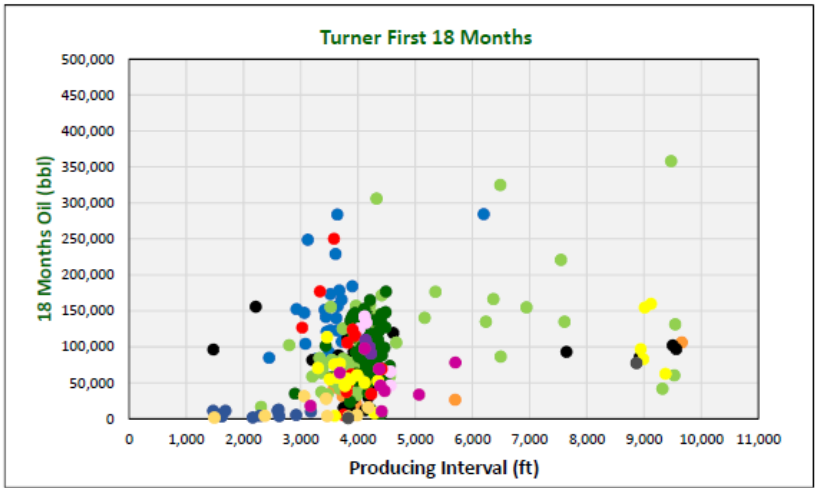
- Producing interval length
  - ➢ longer lengths ≠ increased production

Wall Creek

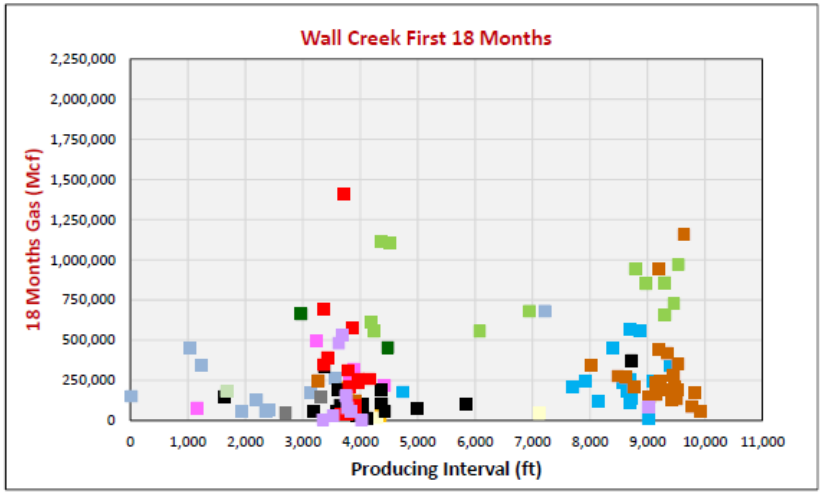
Turner

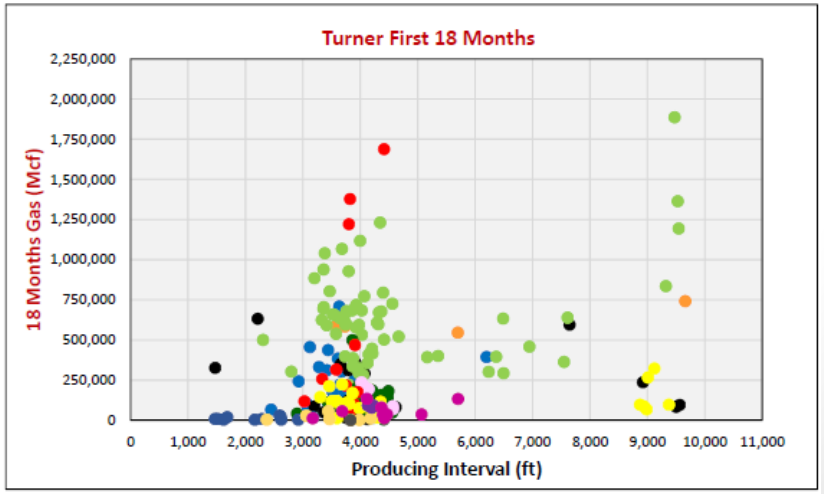
Oil




Gas



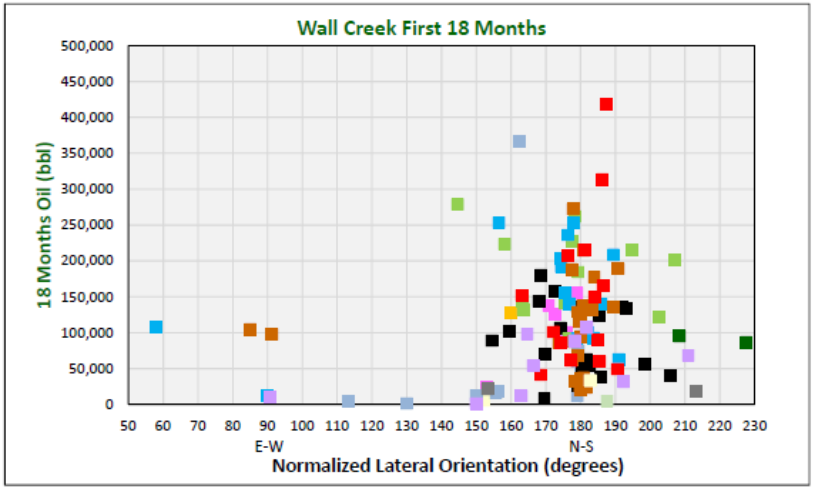
# Wall Creek–Turner horizontal wells

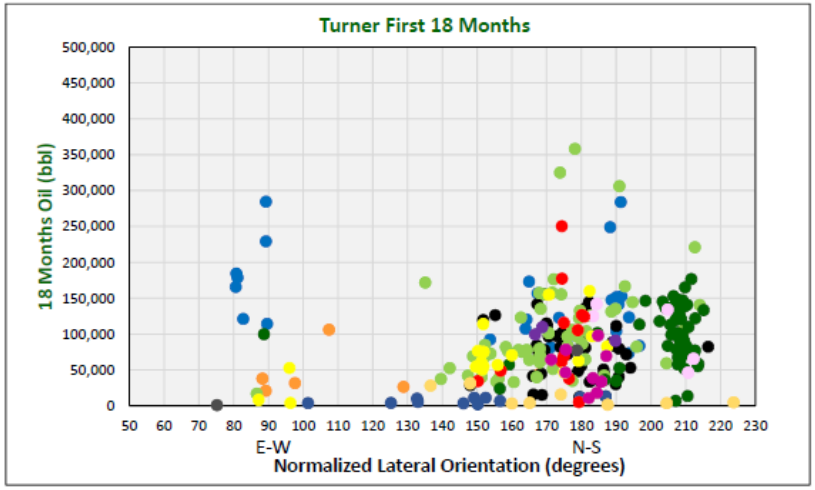
- Lateral orientation
  - ➢ Mostly N–S, but variable success

Wall Creek

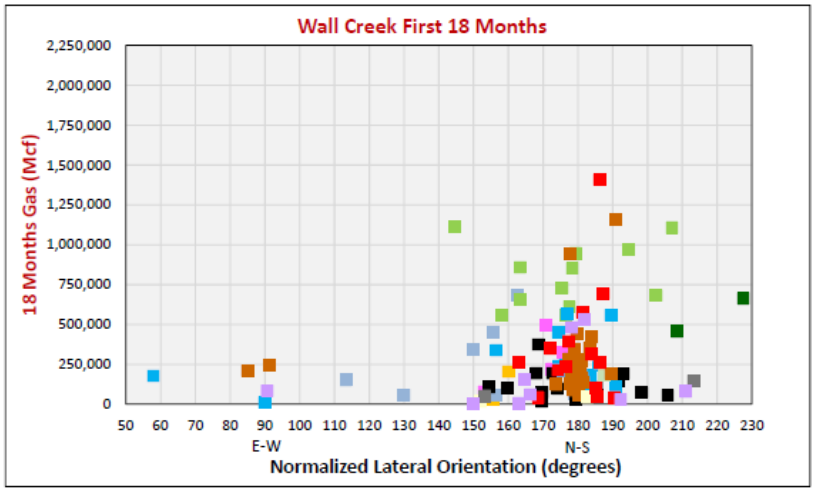
Turner

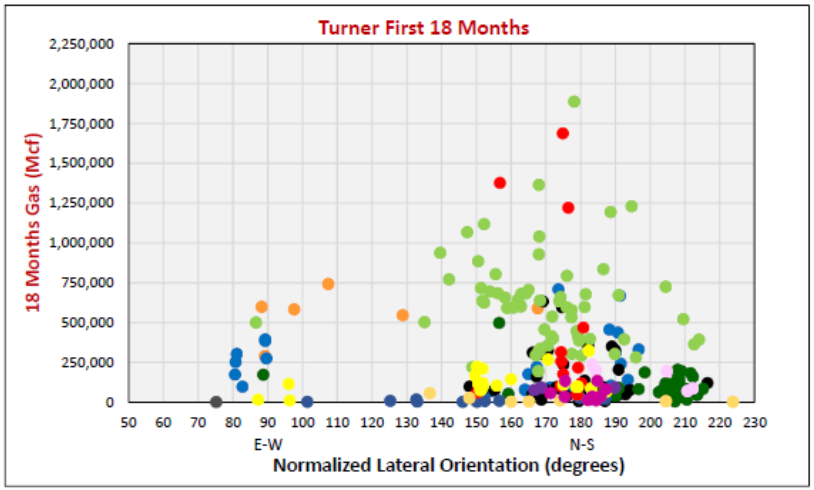
Oil




Gas



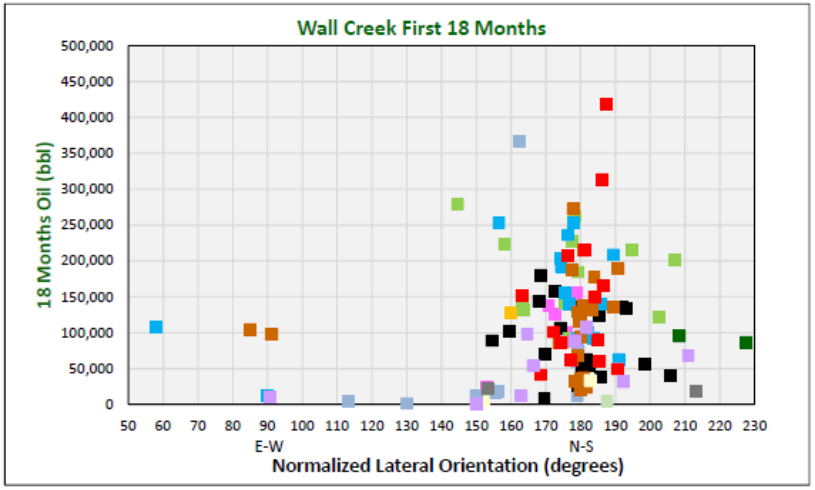
# Wall Creek–Turner horizontal wells

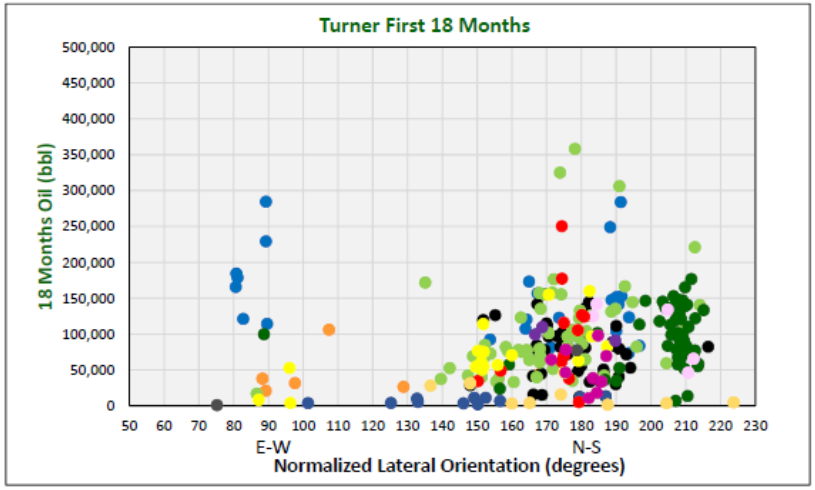
- Lateral orientation
  - ➢ Some E–W Turner wells do just as well

Wall Creek

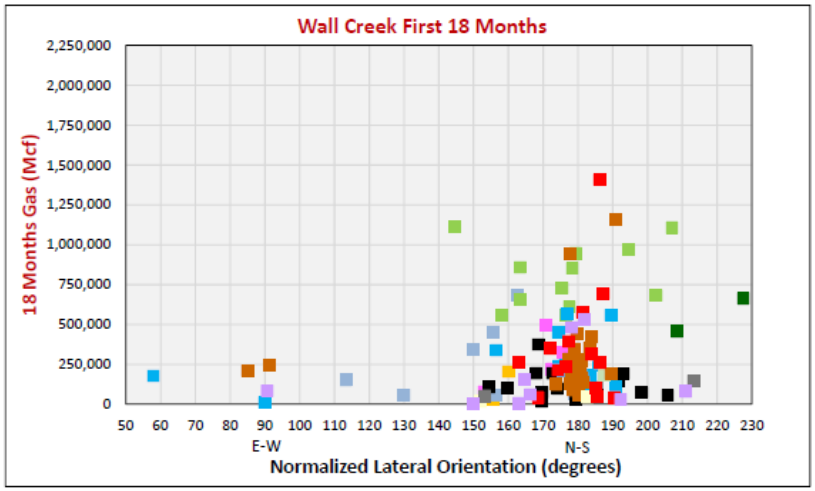
Turner

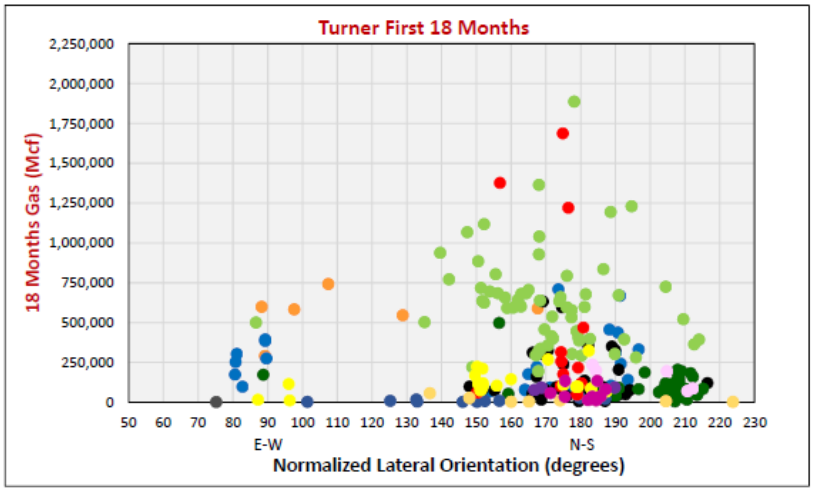
Oil




Gas



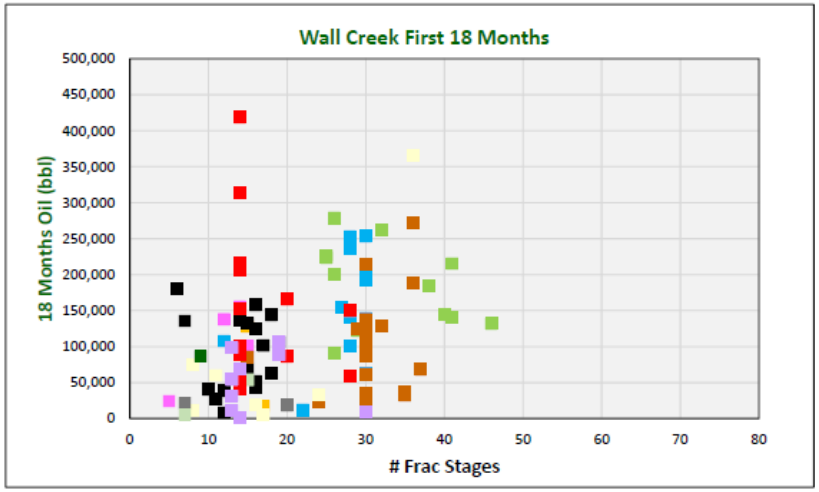
# Wall Creek–Turner horizontal wells

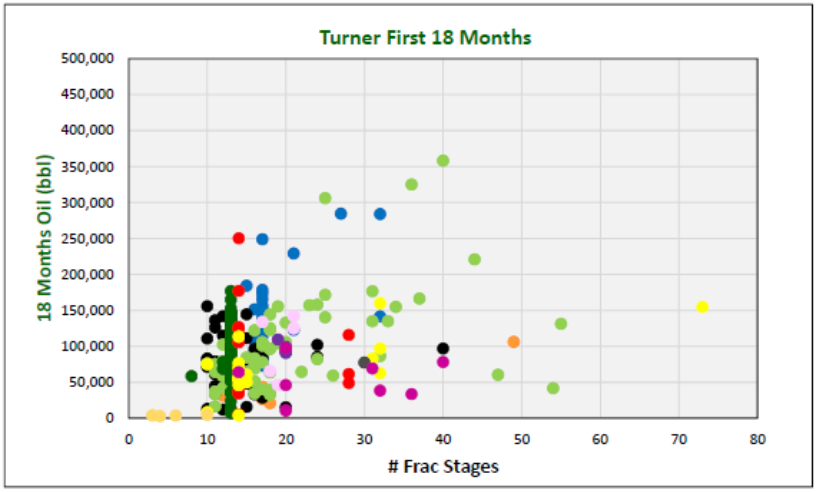
- # of frac stages

Wall Creek

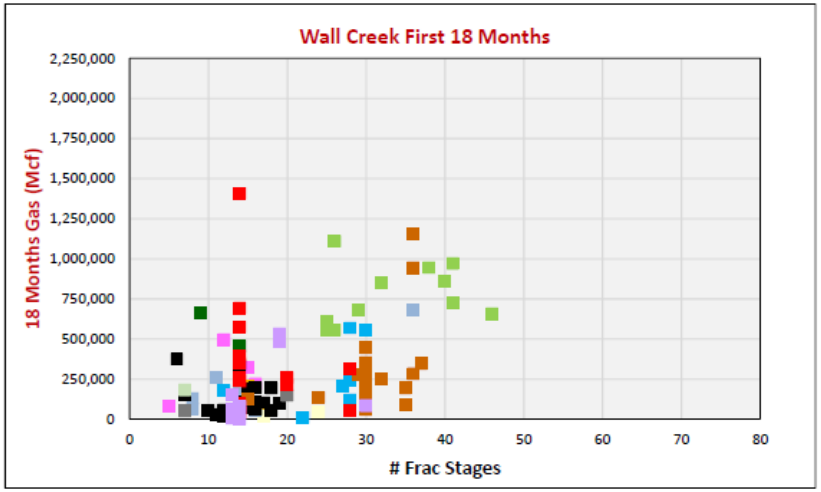
Turner

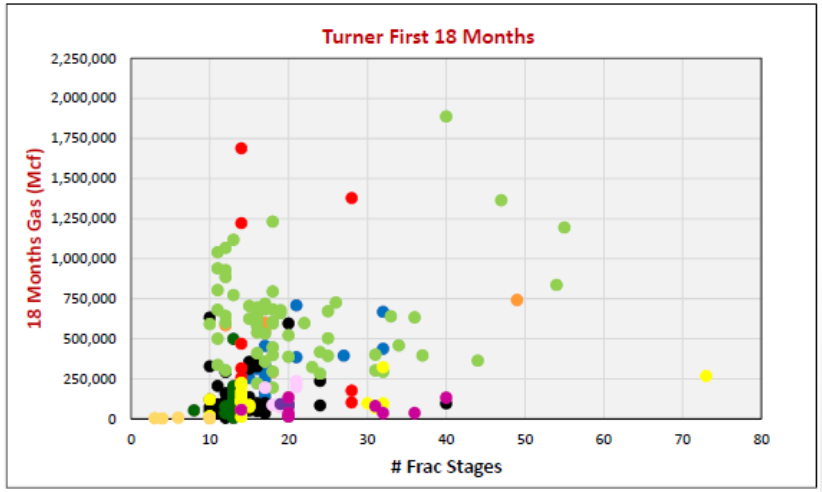
Oil




Gas



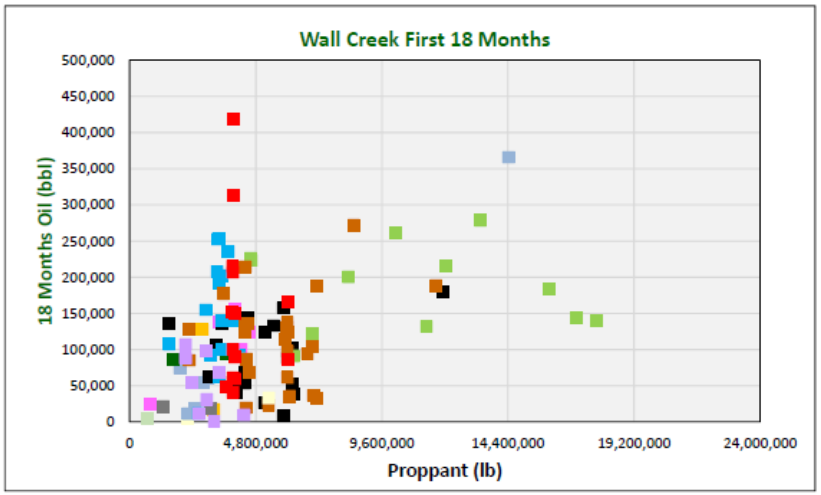
# Wall Creek–Turner horizontal wells

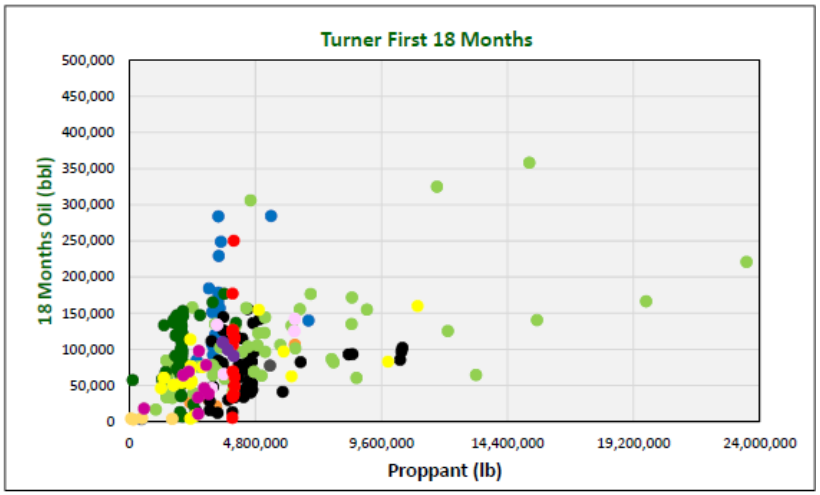
- proppant amount

Wall Creek

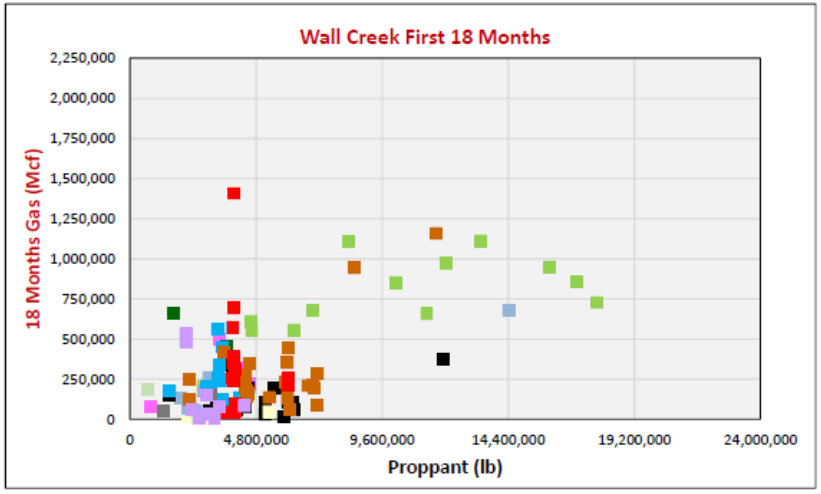
Turner

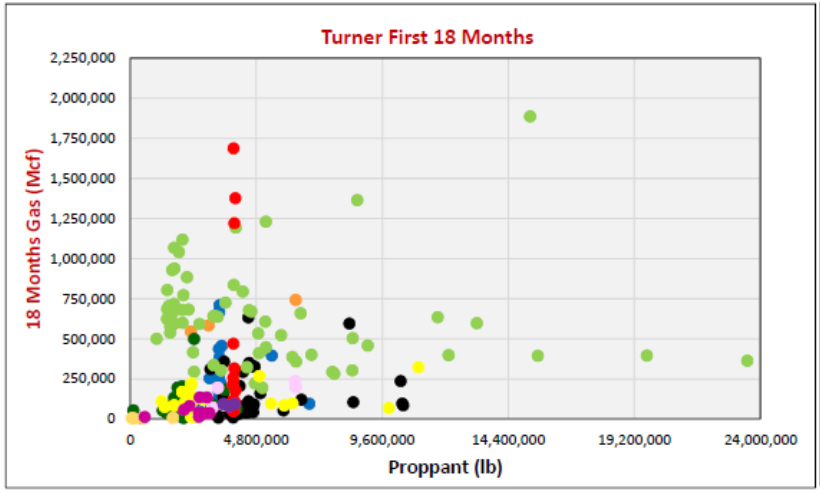
Oil




Gas



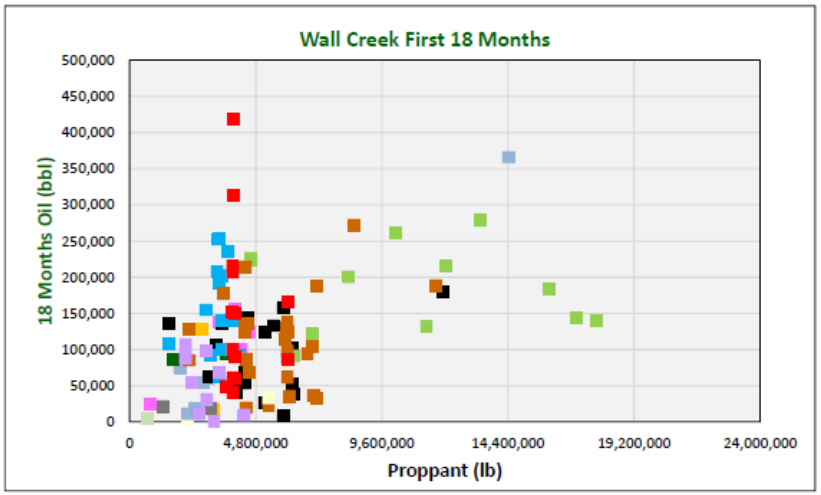
# Wall Creek–Turner horizontal wells

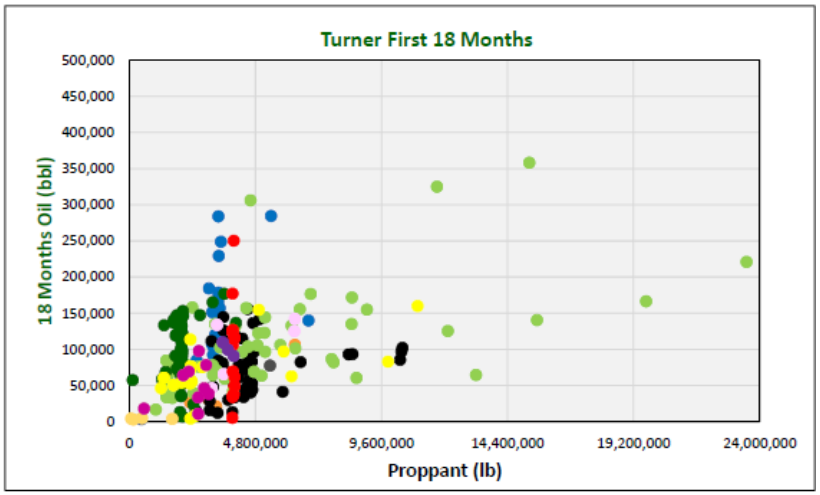
- operators use standard formula
- larger completions ≠ increased production

Wall Creek

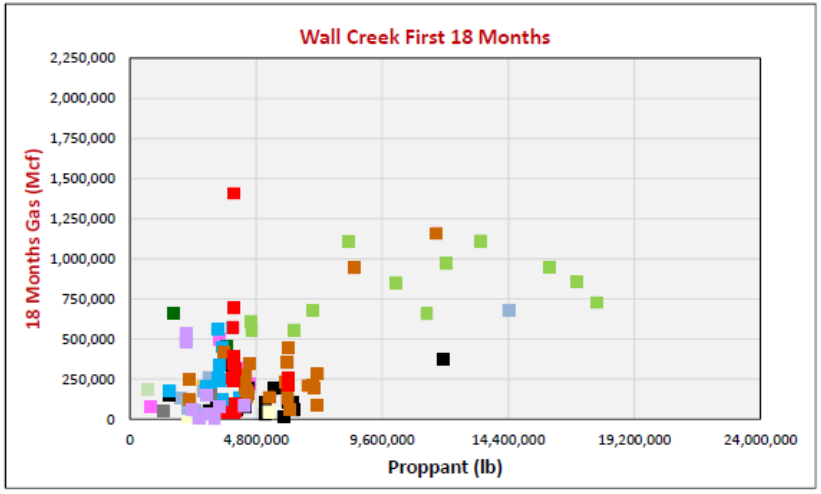
Turner

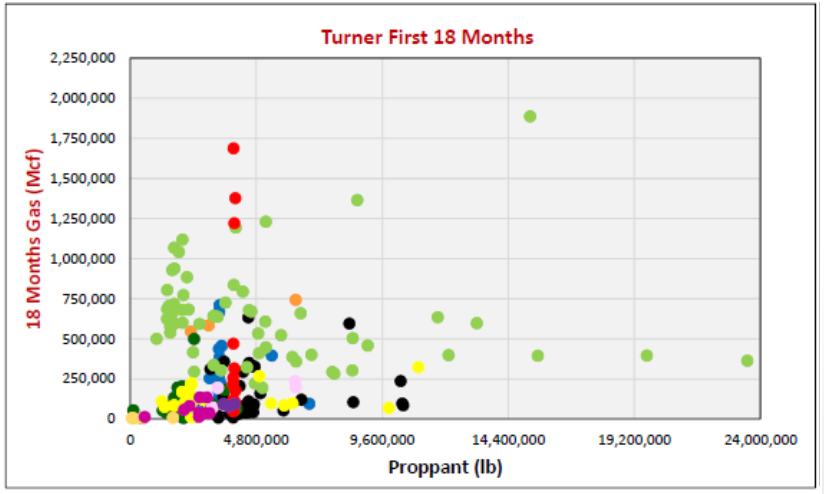
Oil




Gas

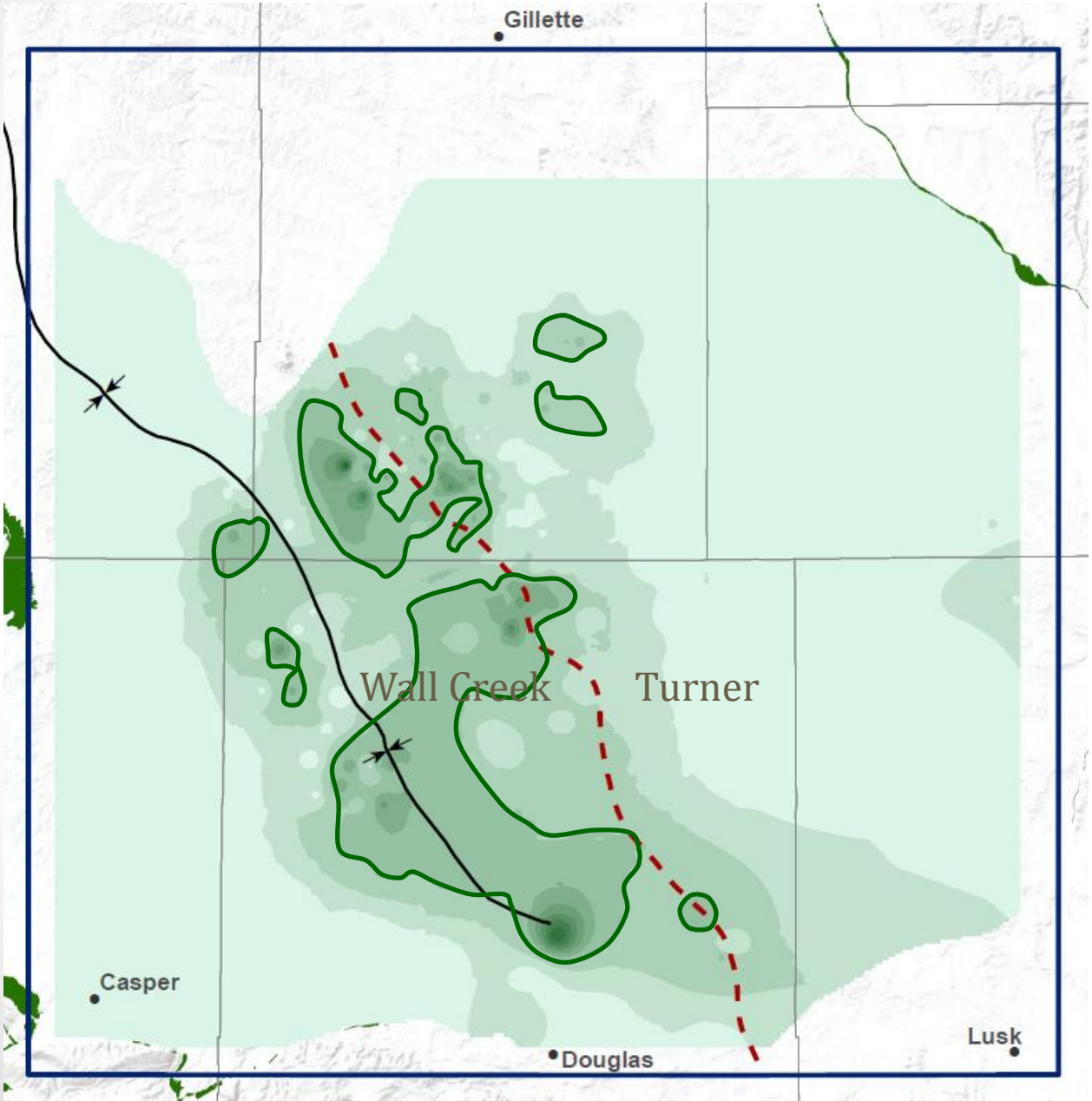


# What about geology?

- depth
- thickness
- gas-oil ratio
- crude oil initial API gravity
- pressure
- temperature

# Wall Creek-Turner 18 months oil (bbl)

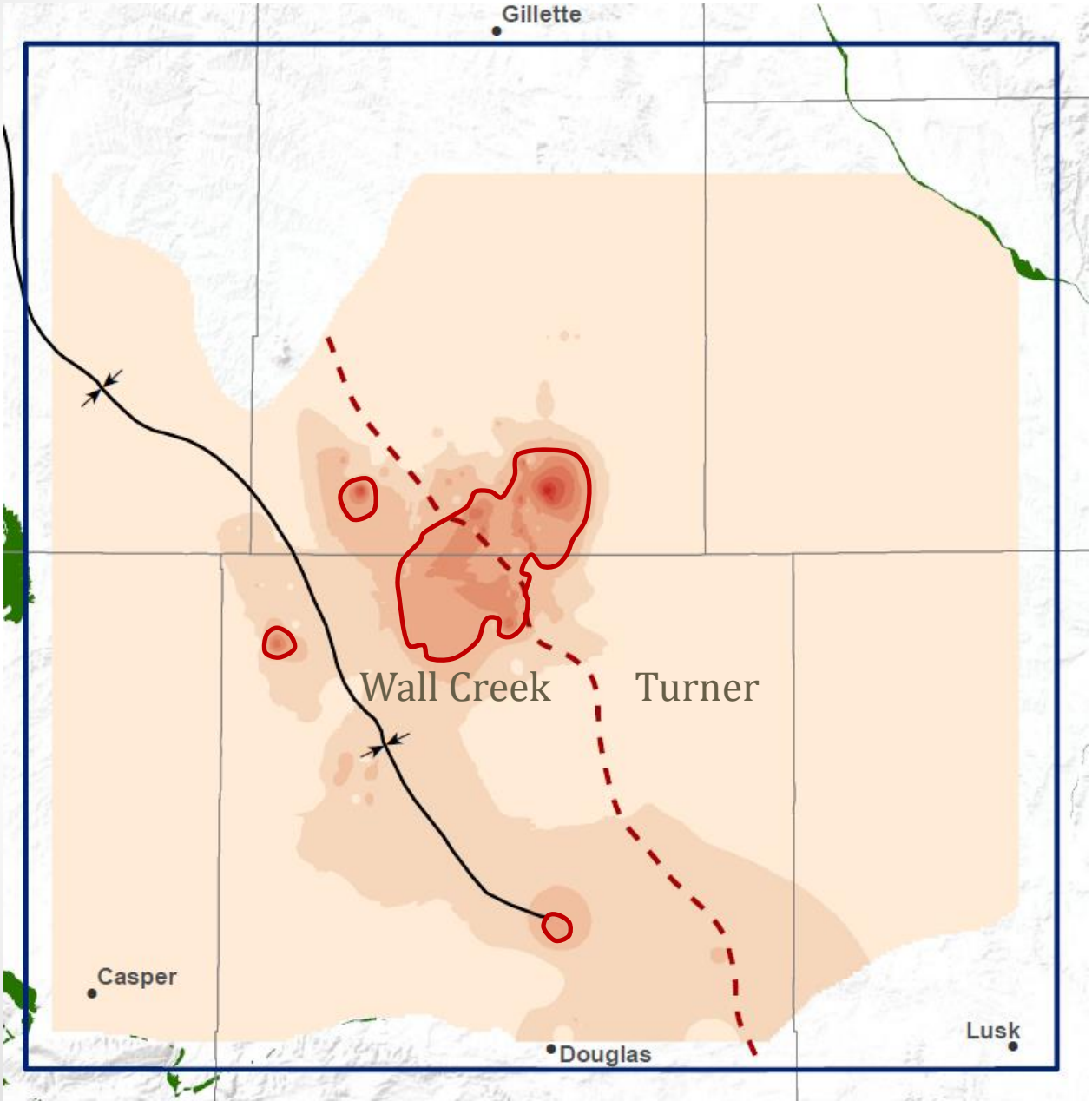



Horizontal well
18 months
oil production
(bbl)

420,000

0

# Wall Creek-Turner 18 months gas (Mcf)

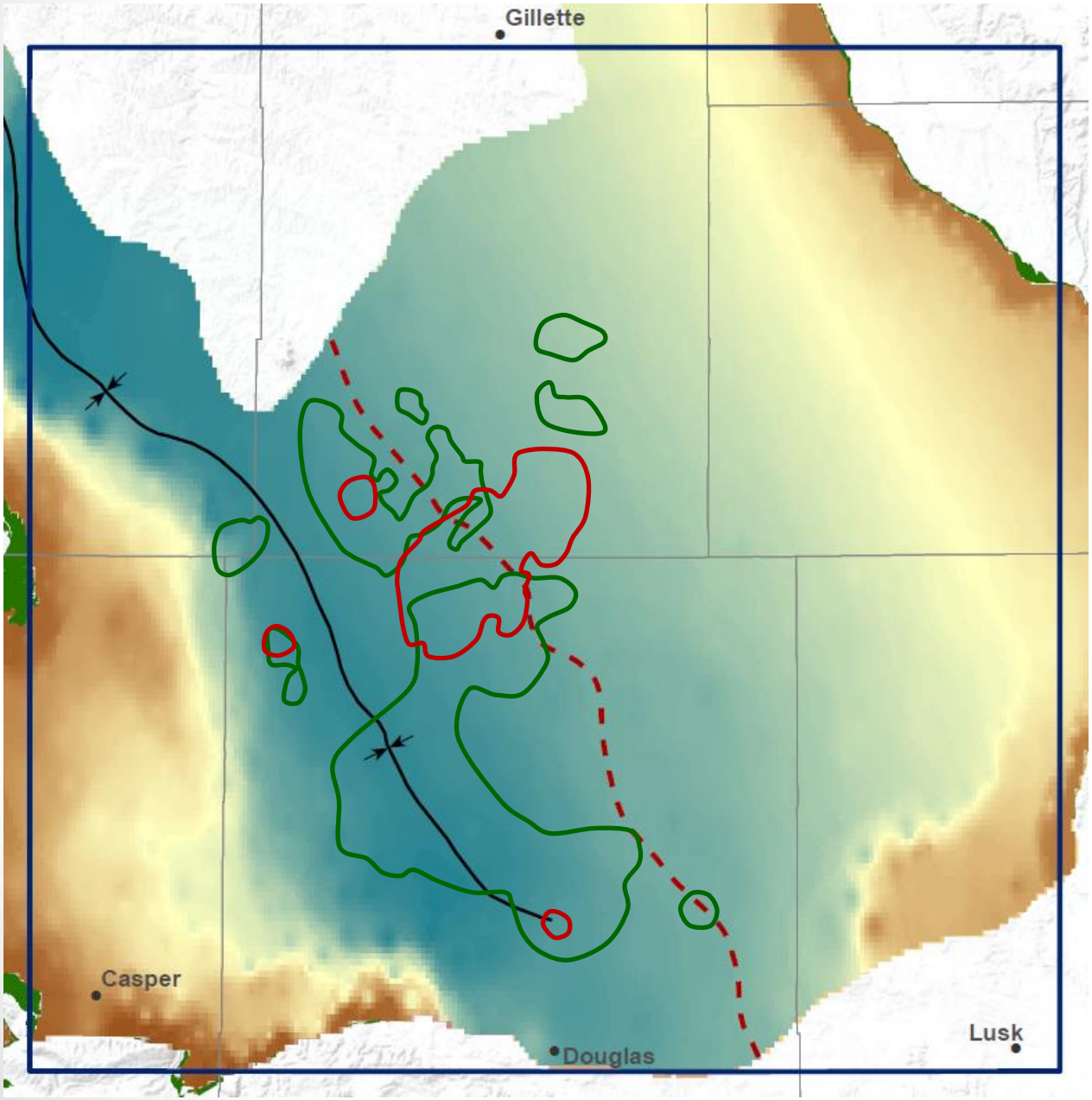



Horizontal well
18 months
gas production
(Mcf)

1,900,000

0

# Wall Creek-Turner depth (ft, MSL)

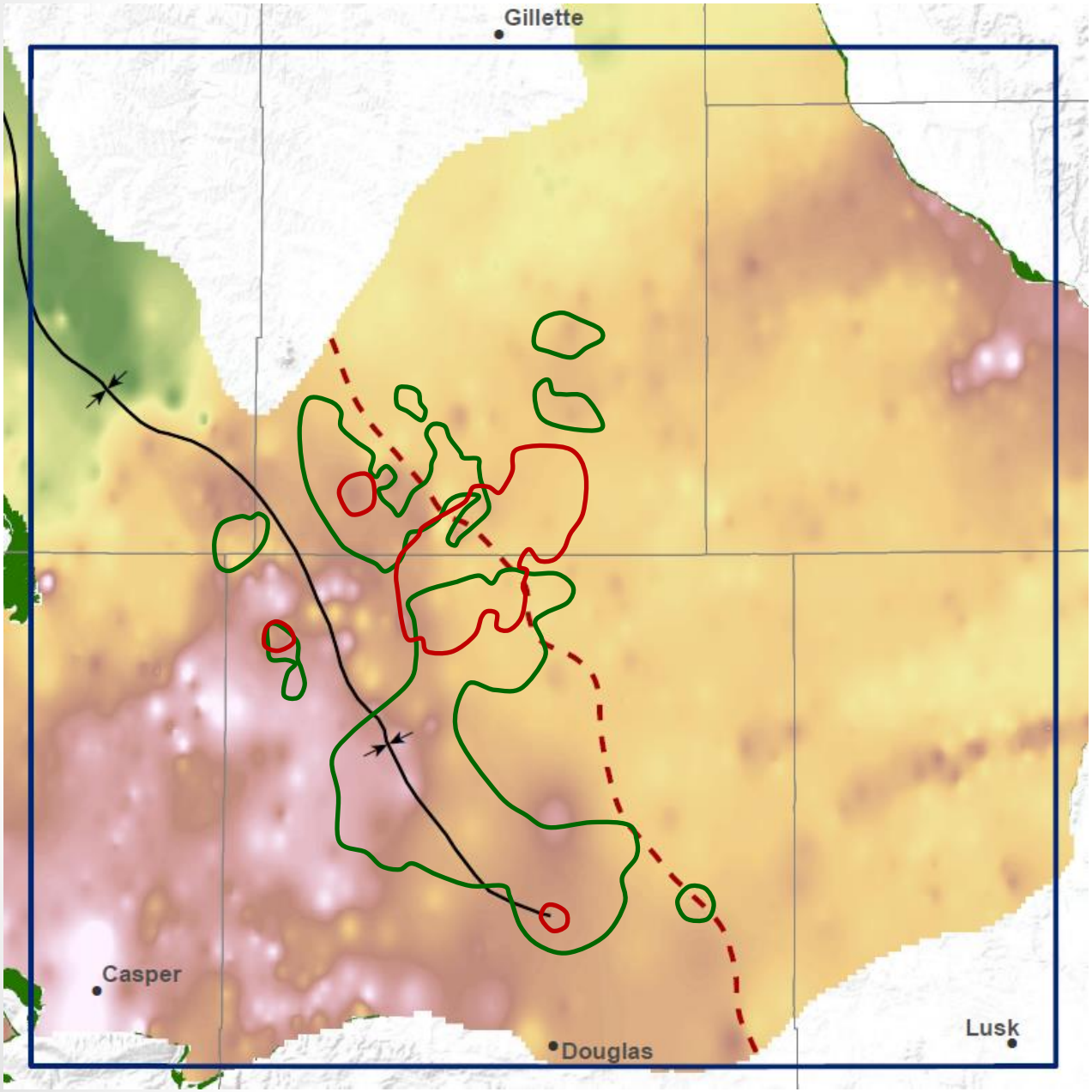



Elevation
(ft, MSL)

6,400

-8,100

# Wall Creek-Turner thickness (ft)




Thickness (ft)

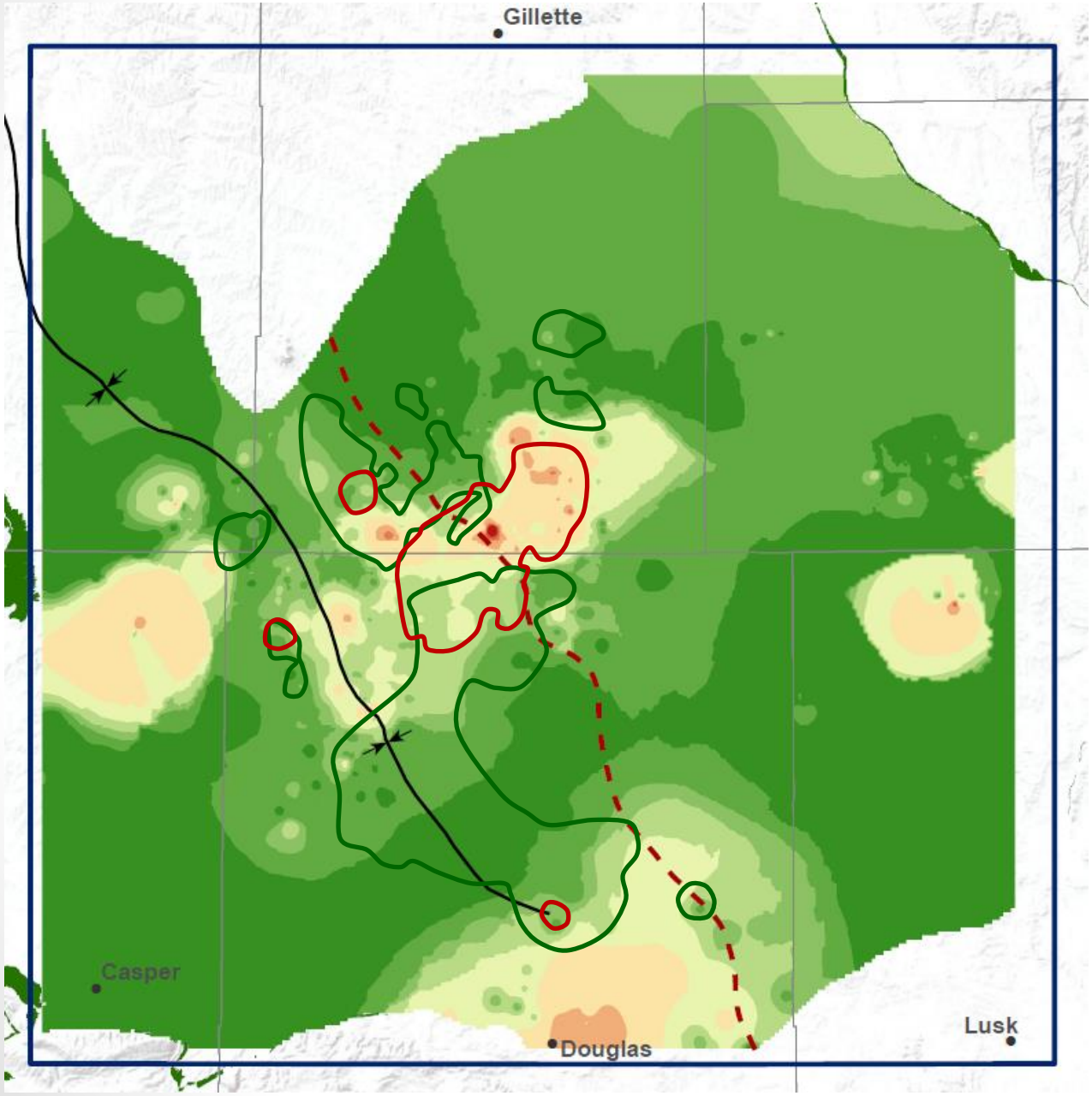
310

20

# Reservoir depth and thickness

- Highest unconventional oil production is located in the Wall Creek in the deepest portion of reservoir
- Highest unconventional gas production concentrated in the shallower Turner and in a thinner section
- Best production from targeting hydrocarbon-rich zones within the reservoir rather than overall reservoir thickness

# Wall Creek-Turner gas-oil ratio ($ft^3$/bbl)




Gas-oil ratio ($ft^3$/bbl)

250,000

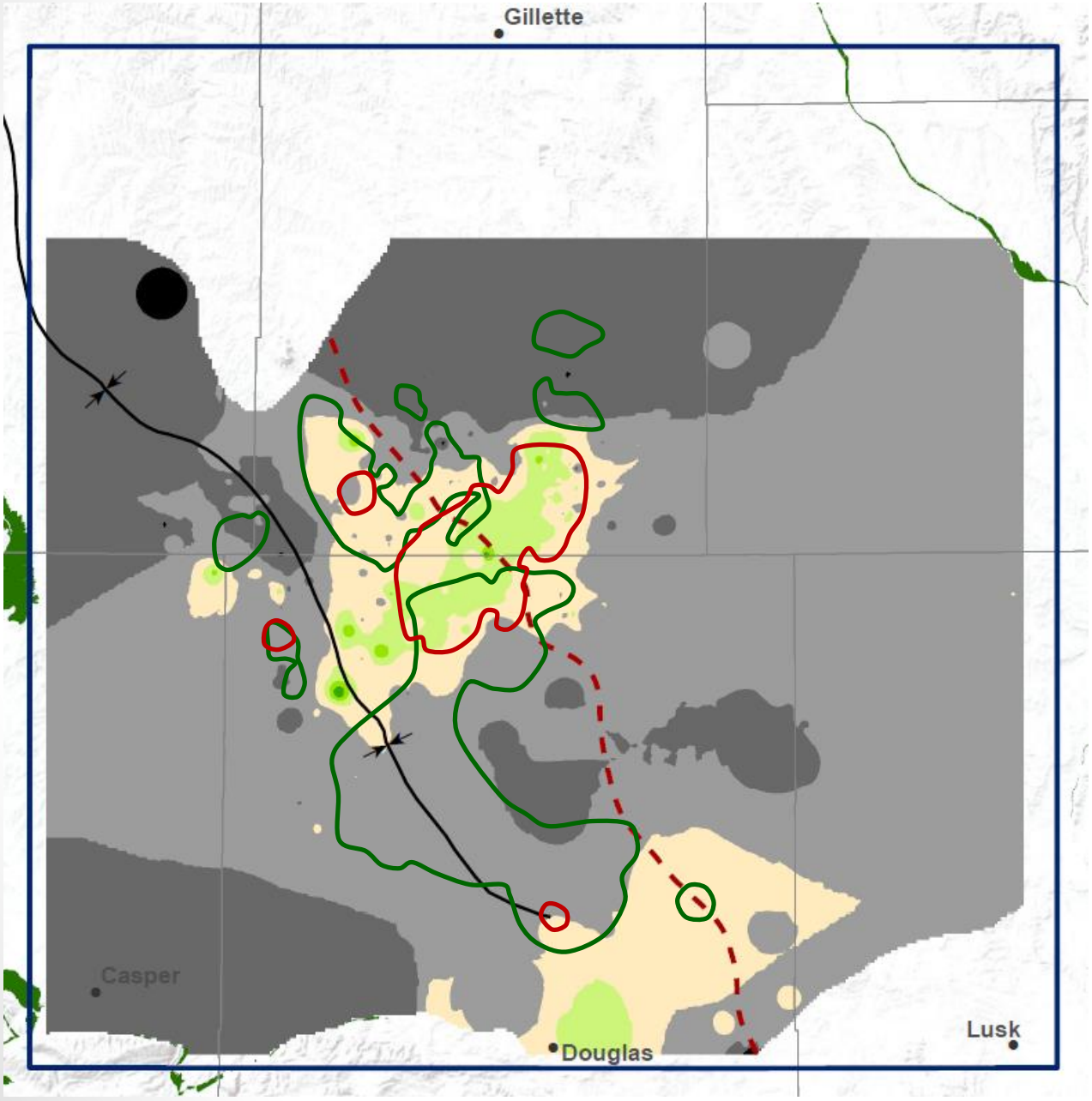
25

# Gas-oil ratio

- highest GOR areas spatially bound the high gas production areas and generally skirt high oil production areas

- may indicate additional, as-yet undeveloped areas where similarly high gas production may be encountered

# Wall Creek-Turner initial API gravity (°)




Initial API gravity (degrees, °)

70

45

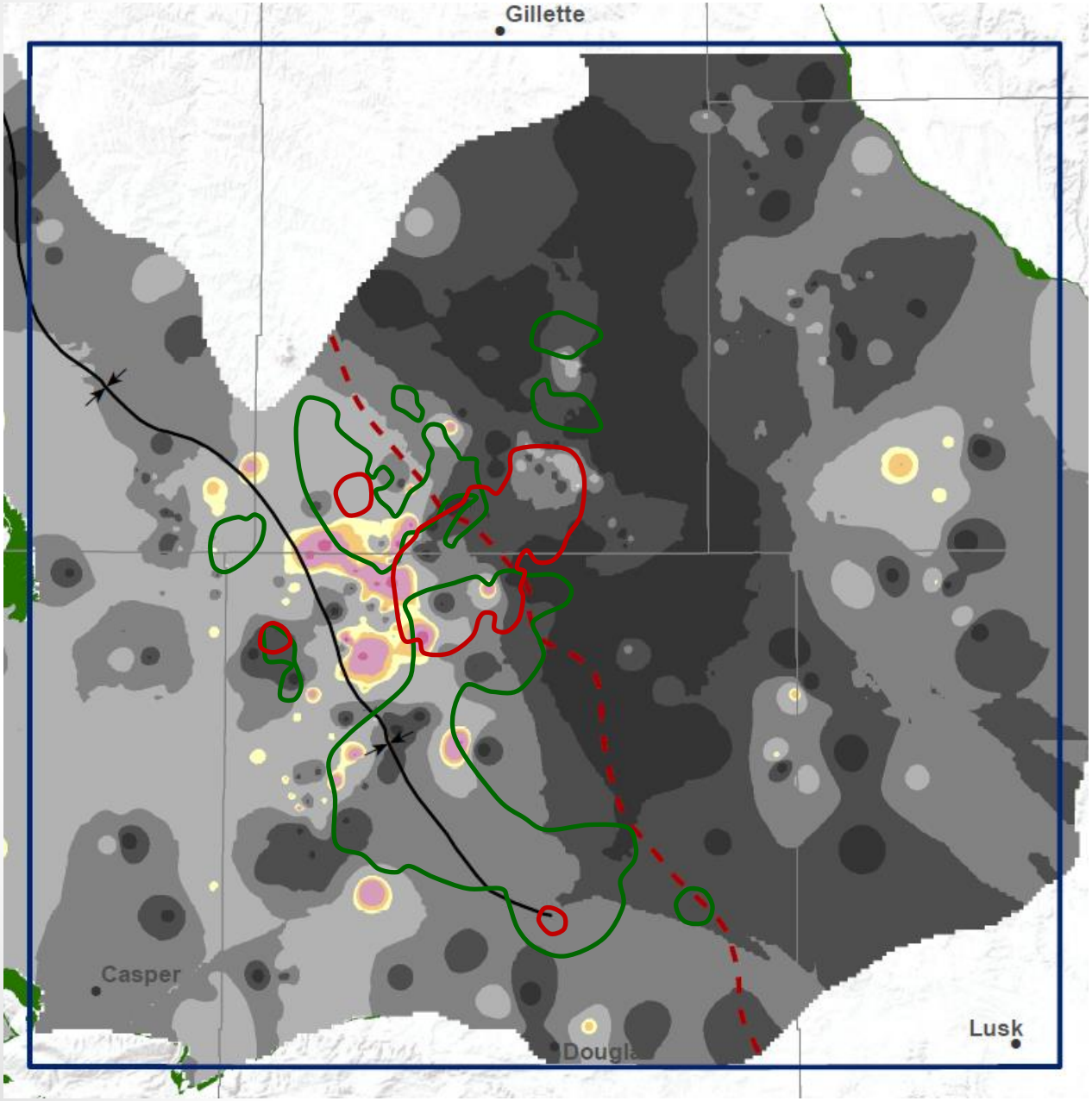
30

# Initial API gravity

- Oil produced from the Wall Creek-Turner reservoir is consistently light and marketable.

- API gravities >45° correlate to high gas production area
  - gas-condensate?

# Wall Creek-Turner pressure (psi/ft)



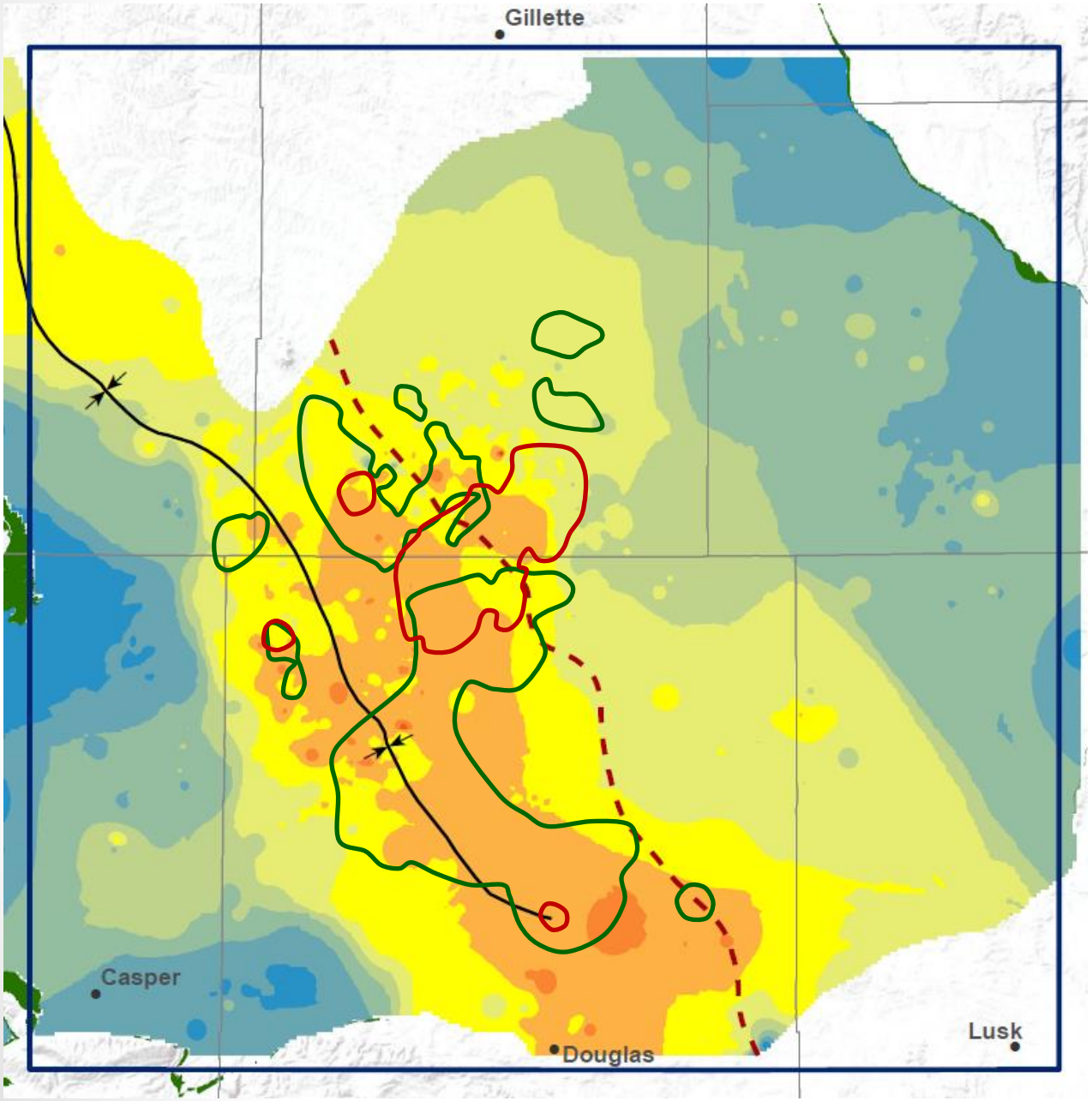
# Reservoir pressure

- Pressure test surveys confirm gas-condensate “sub-reservoir” in southern Campbell County

- Overpressured areas of reservoir not yet targeted by/not an influence on horizontal well production

- But operators have been able to produce significant oil and gas volumes from the Wall Creek and Turner under normally and underpressured reservoir conditions.

# Wall Creek-Turner temperature (°F)




Temperature (°F)

325

45

# Reservoir temperature

- Temperature correlates strongly to production, especially natural gas
- Nearly all oil/gas production at temps >200°
- Temps > 225° outline gas-condensate reservoir
  - Thermal analyses may be useful in identifying other potential gas-condensate sub-reservoirs

# Summary

- PRB Wall Creek–Turner is a complex reservoir system

- Geology has more of an influence on production success than well completions*

  *at this time!

*All data available on WSGS website, including an online map (http://sales.wsgs.wyo.gov/influences-on-oil-and-natural-gas-production-from-the-wall-creek-and-turner-sandstone-reservoirs-powder-river-basin-wyoming-2019/)*