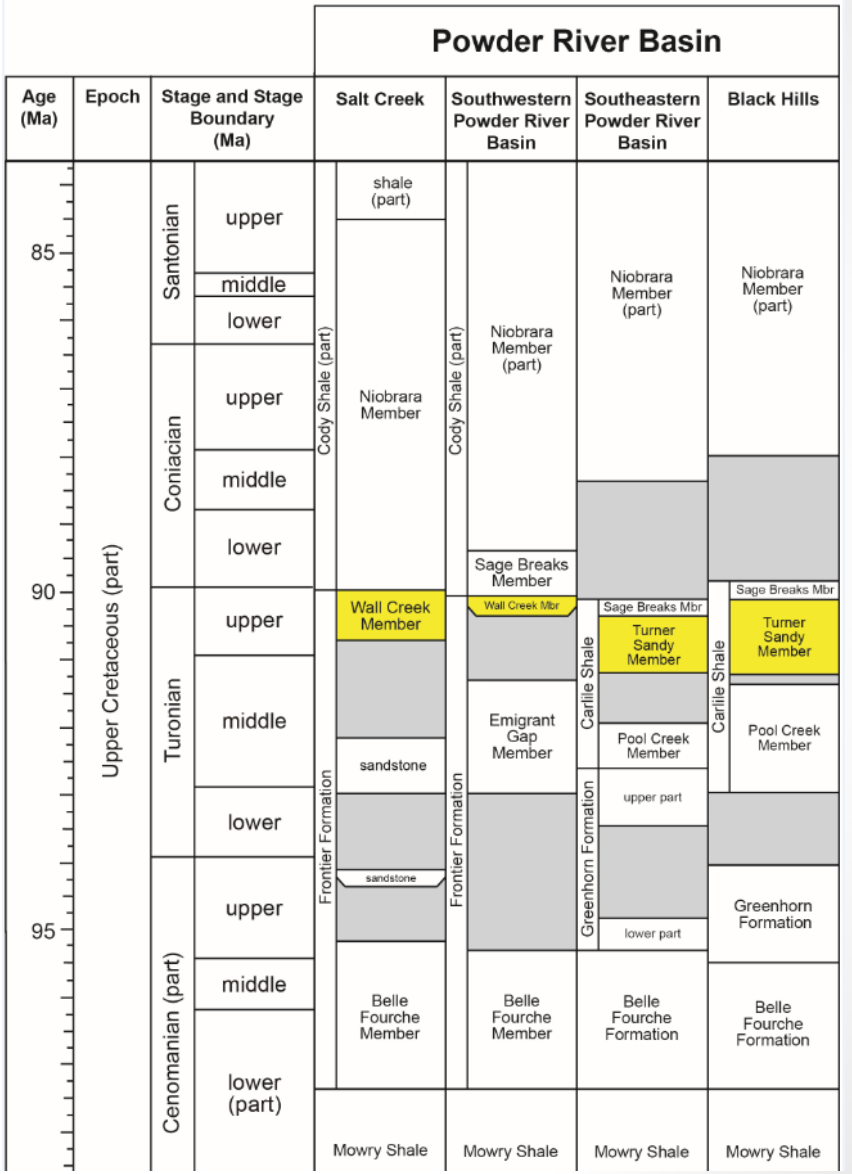
What influences production from the Wall Creek and Turner Sandstone Reservoirs, Powder River Basin, Wyoming?

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

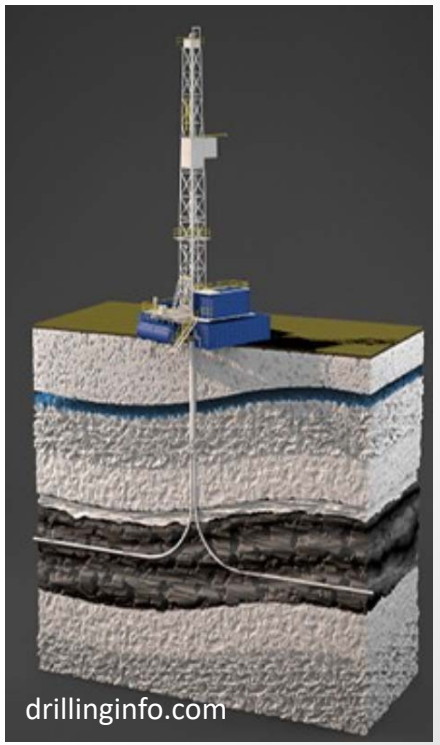


after Lynds and Slattery, 2017

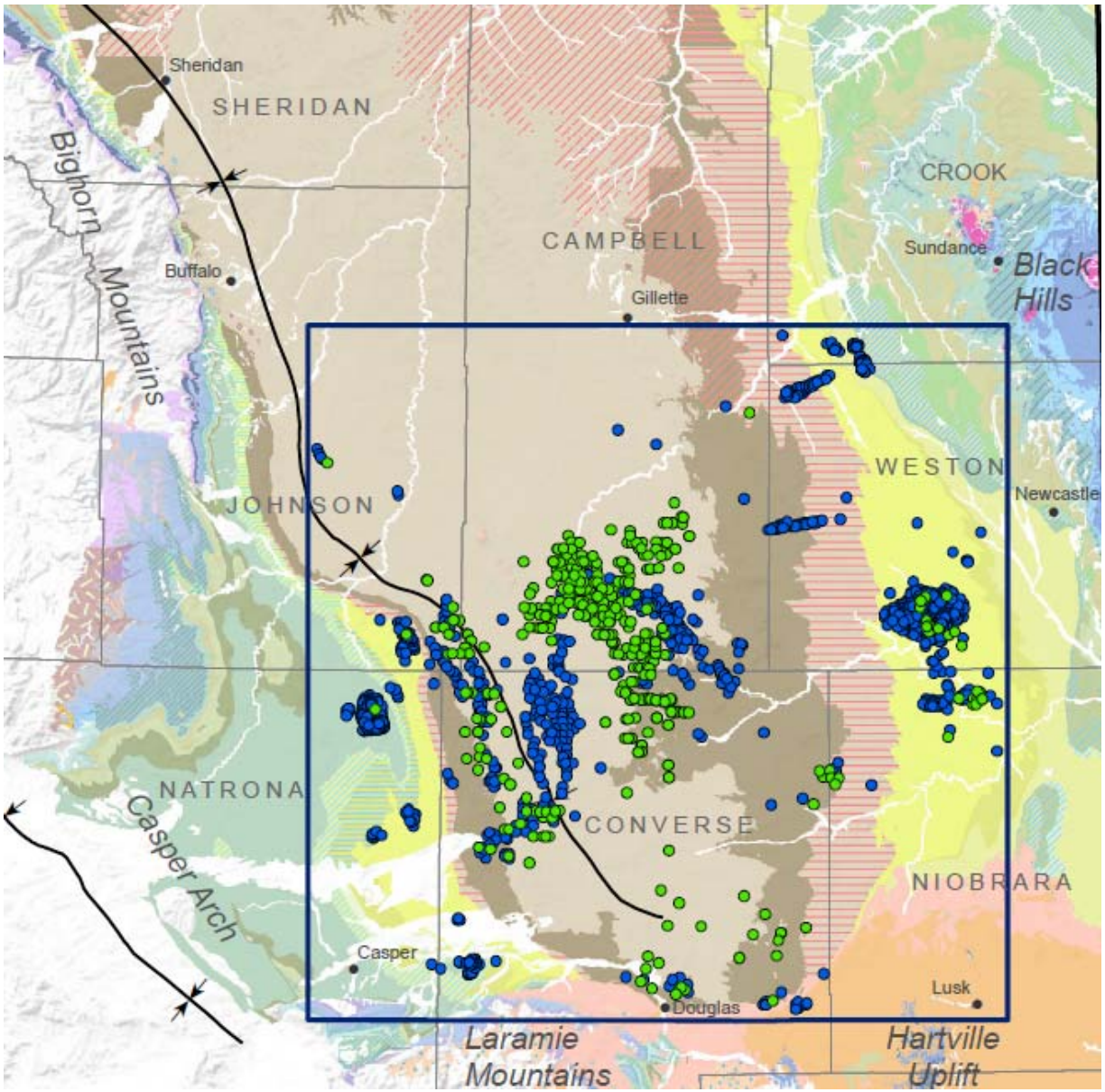
Wall Creek-Turner reservoirs

- Primary hydrocarbon targets in PRB
  - 2018–2019: 45% PRB oil (26% state oil) and 40% PRB gas
- Starting in 2016, Turner has been the top oil-producing reservoir in state
- What influences production?
  - drilling/completion techniques?
  - geology?


Wall Creek Member, Rebekah Rhodes

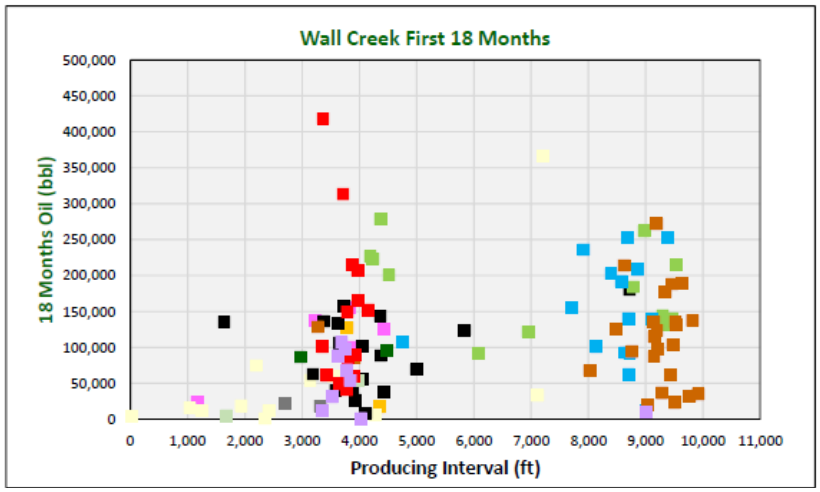
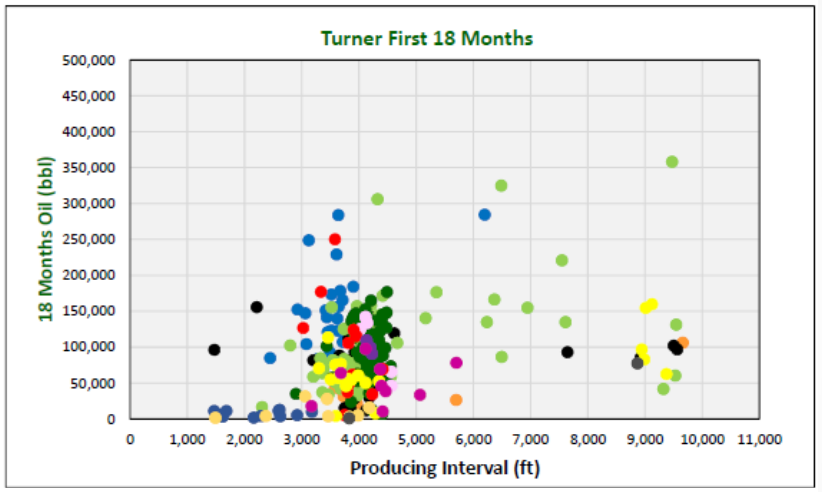
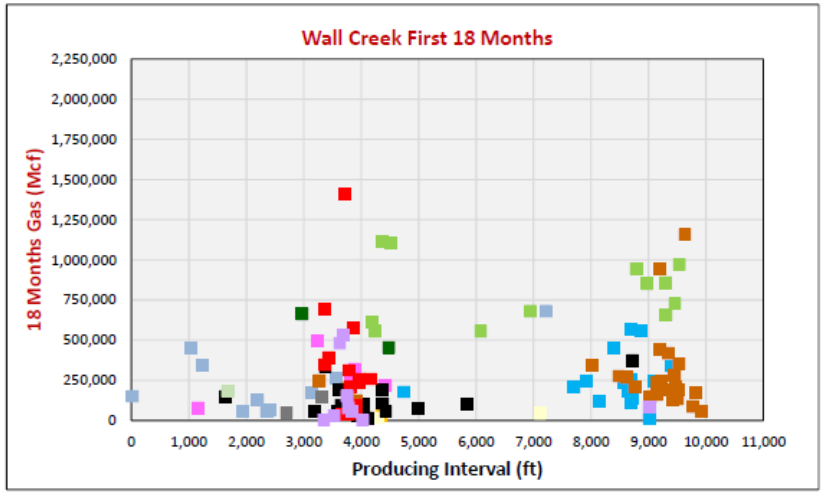
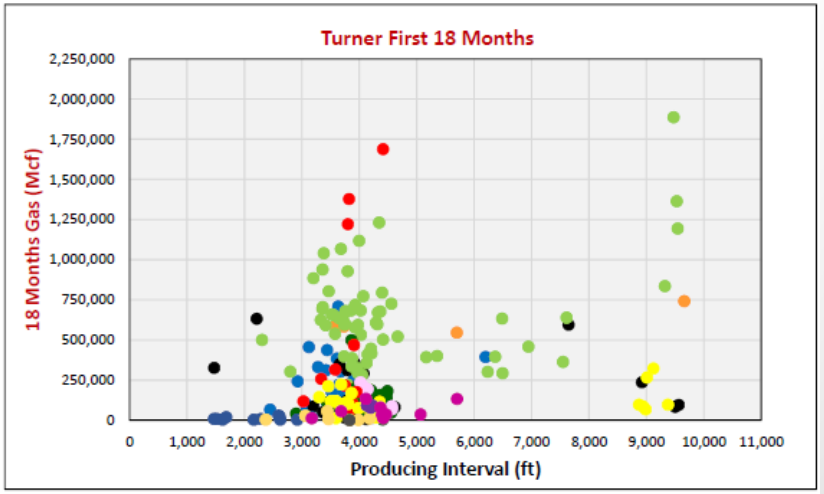

drillinginfo.com

Wall Creek–Turner wells



Wall Creek–Turner horizontal wells

- Producing interval length
  - ➢ longer lengths ≠ increased production

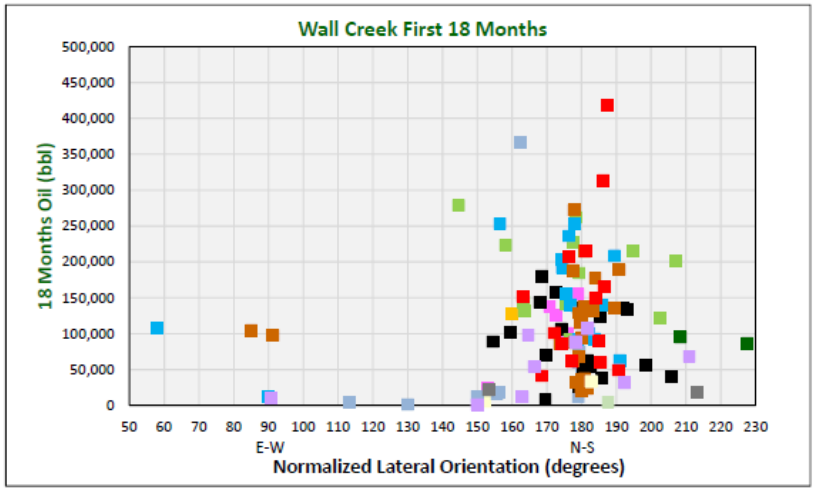
	Wall Creek	Turner
Oil		
Gas		

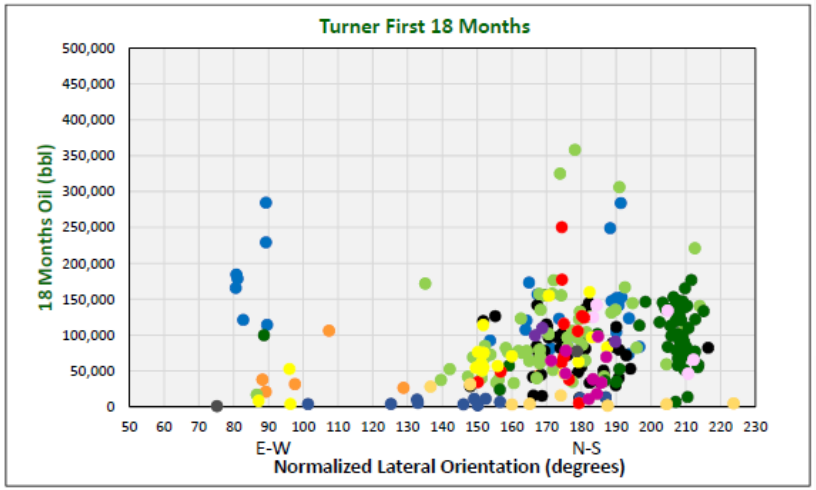
Wall Creek–Turner horizontal wells

- Lateral orientation
  - ➢ Most E-W, but variable direction as well

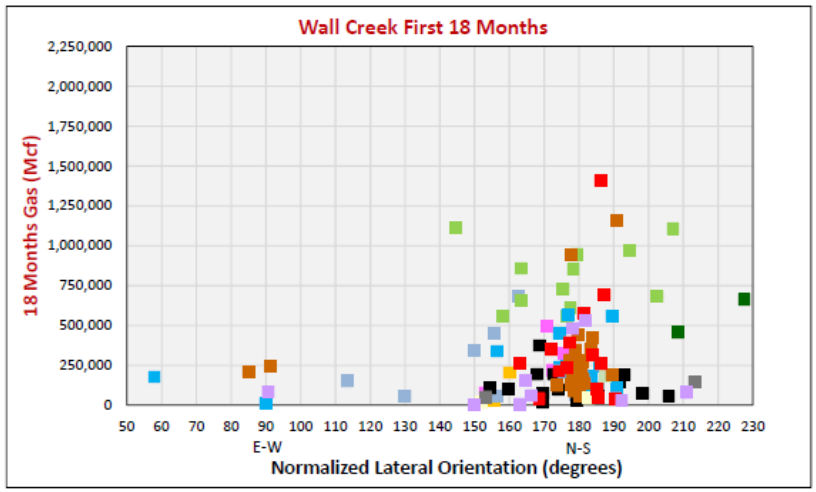
Wall Creek | Turner

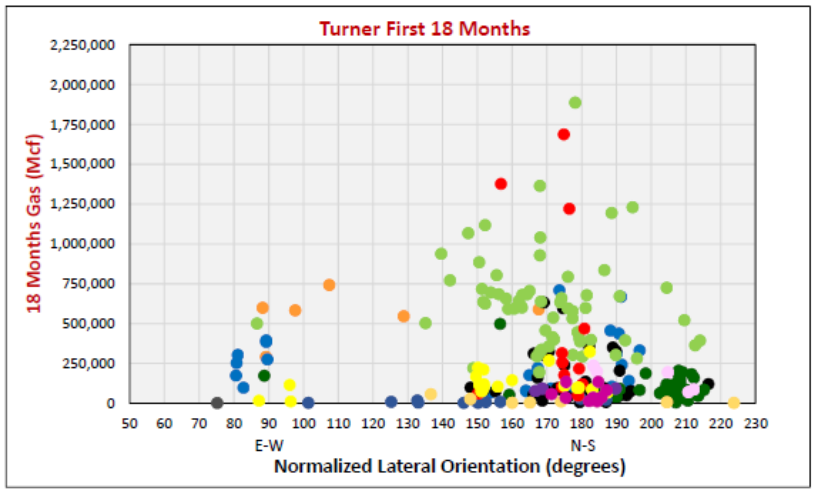
Oil





Gas



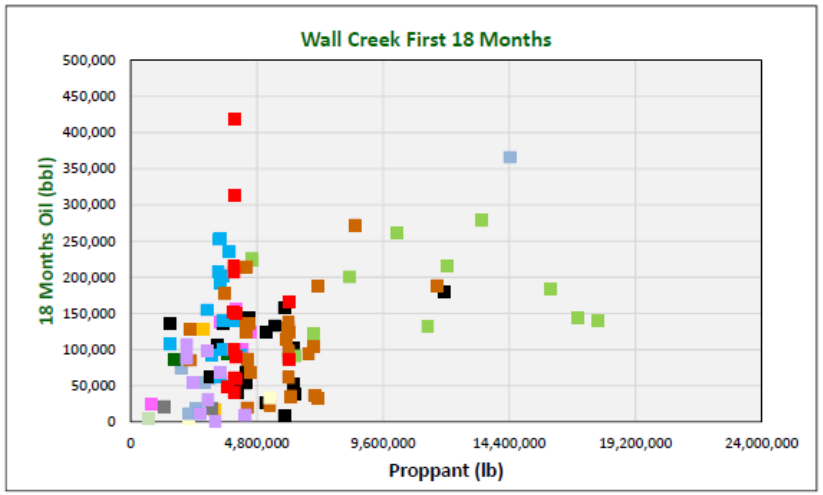


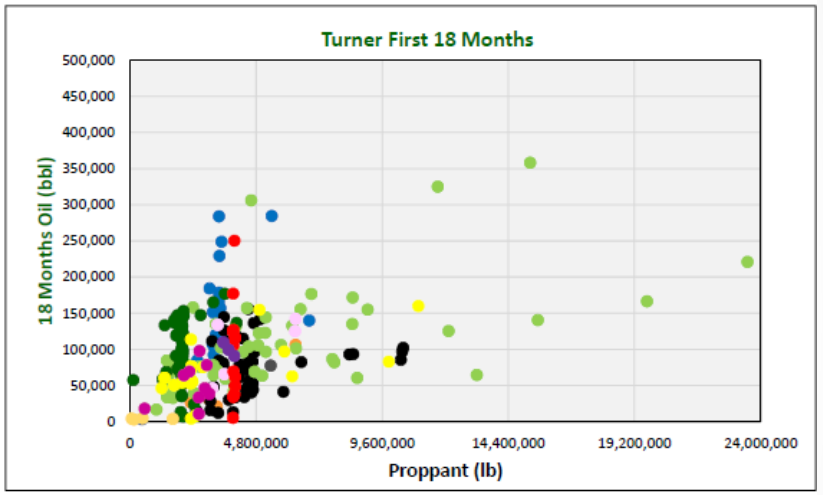
Wall Creek–Turner horizontal wells

- ➢ # of stages ≠ standard formula
  - ➢ larger completions ≠ increased production

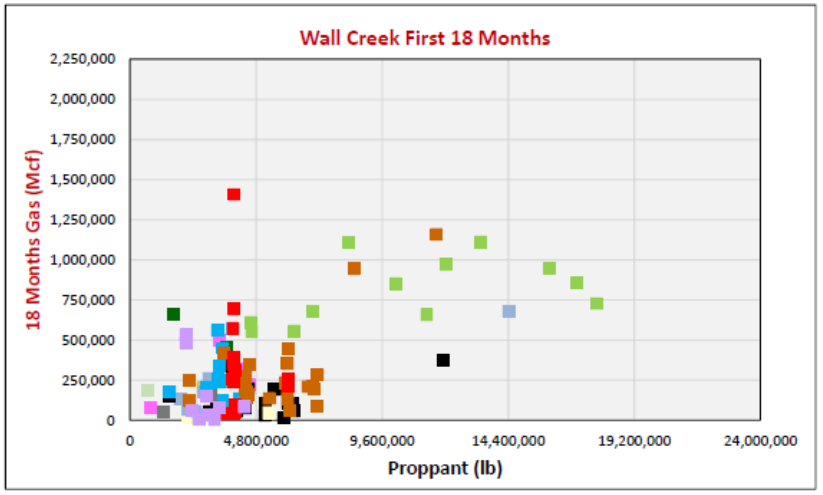
Wall Creek | Turner

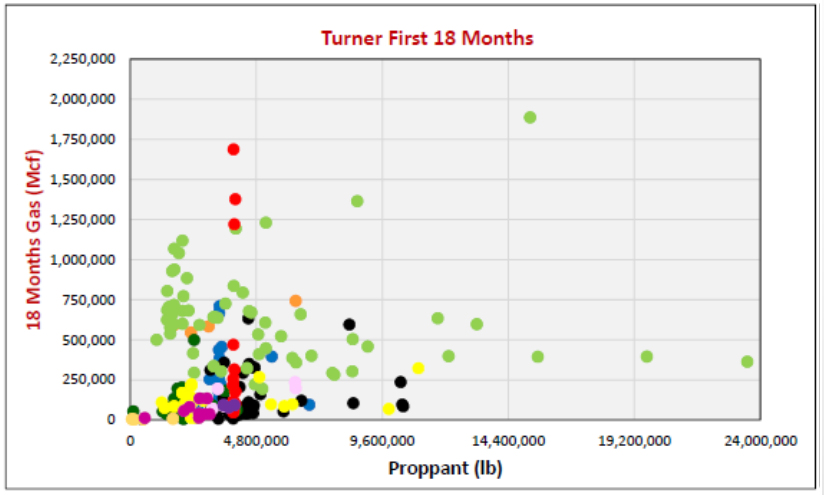
Oil





Gas

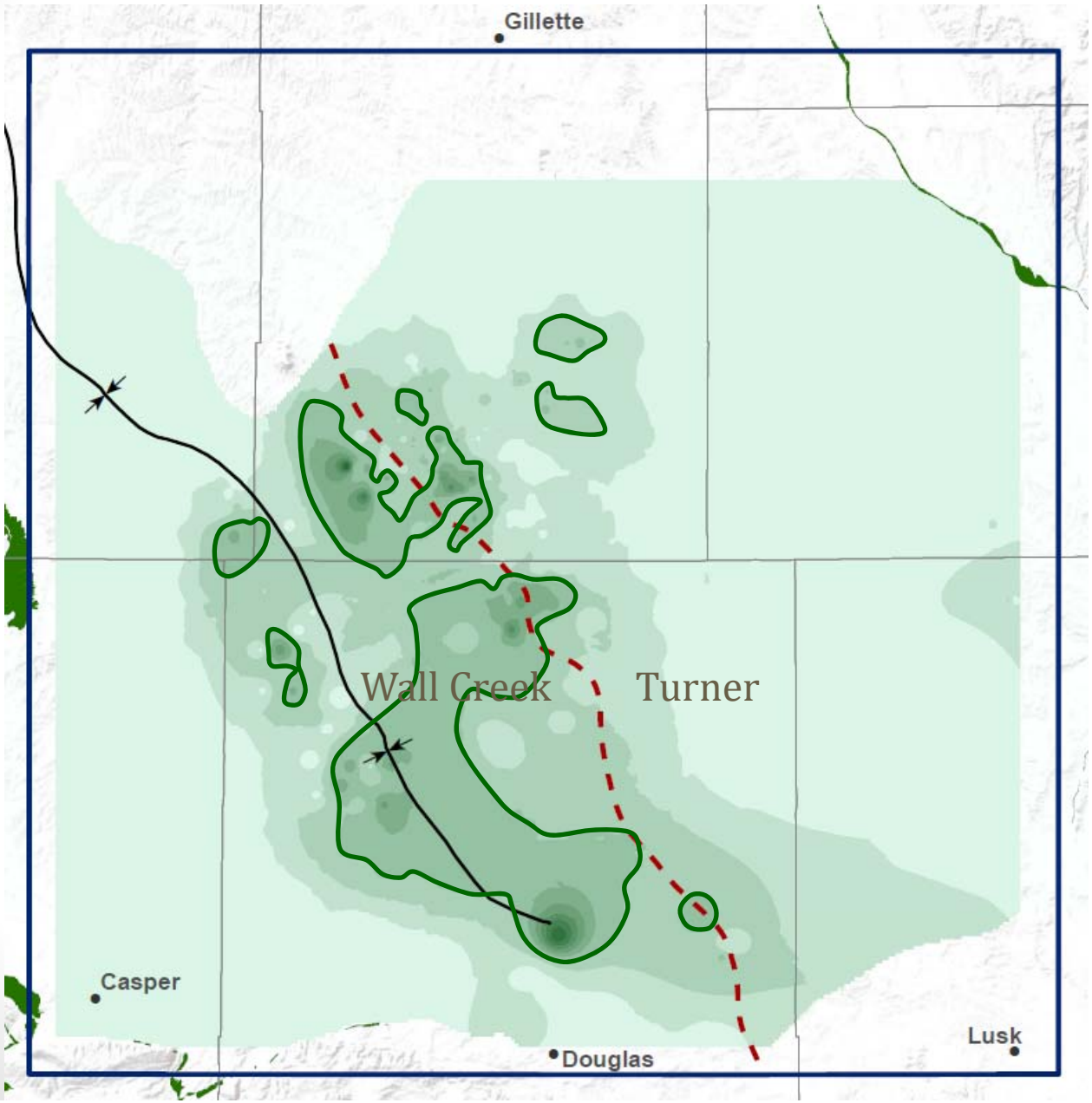




What about geology?

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

Wall Creek-Turner 18 months oil (bbl)

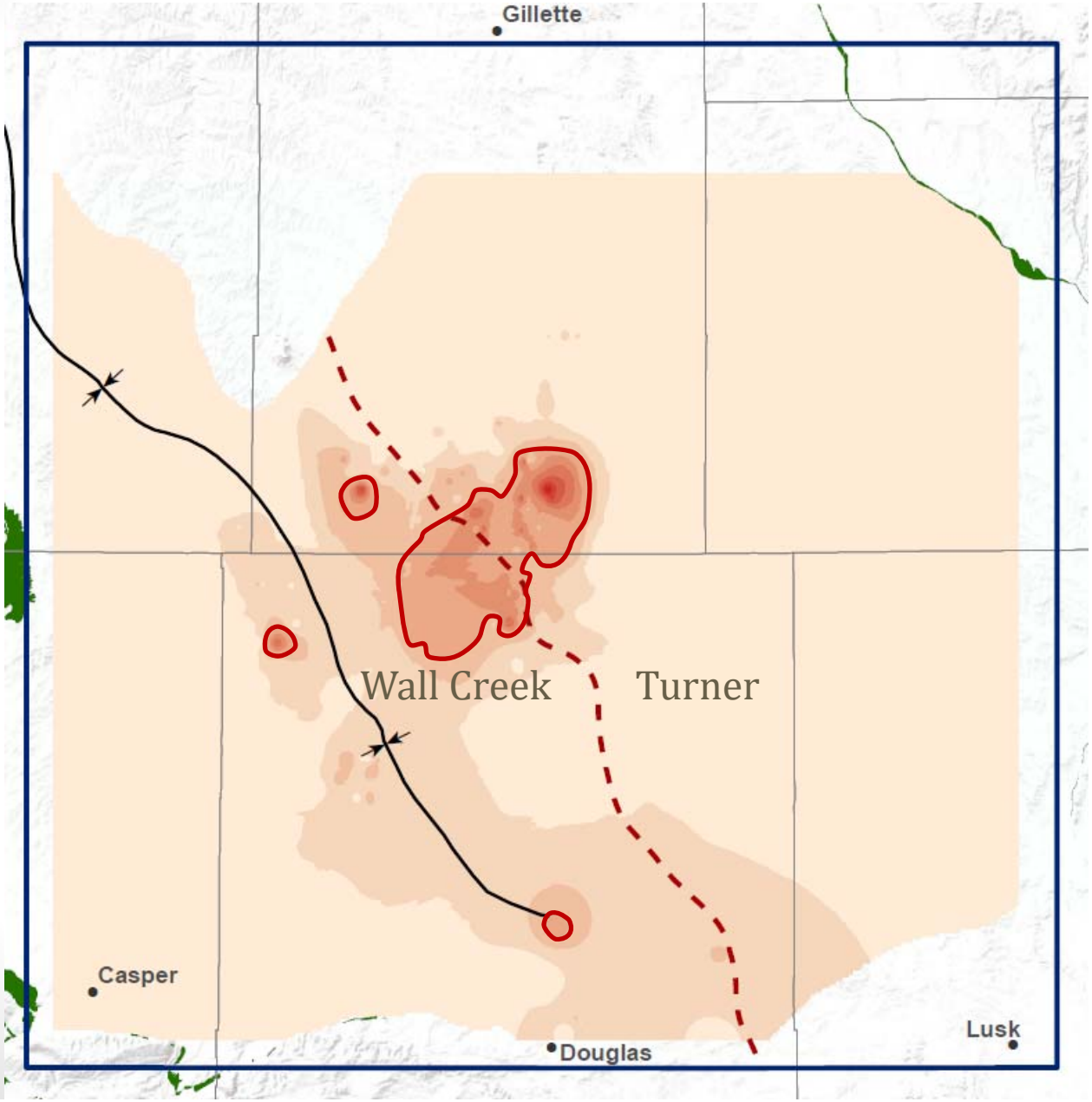


Horizontal well
18 months
oil production
(bbl)

420,000

0

Wall Creek-Turner 18 months gas (Mcf)

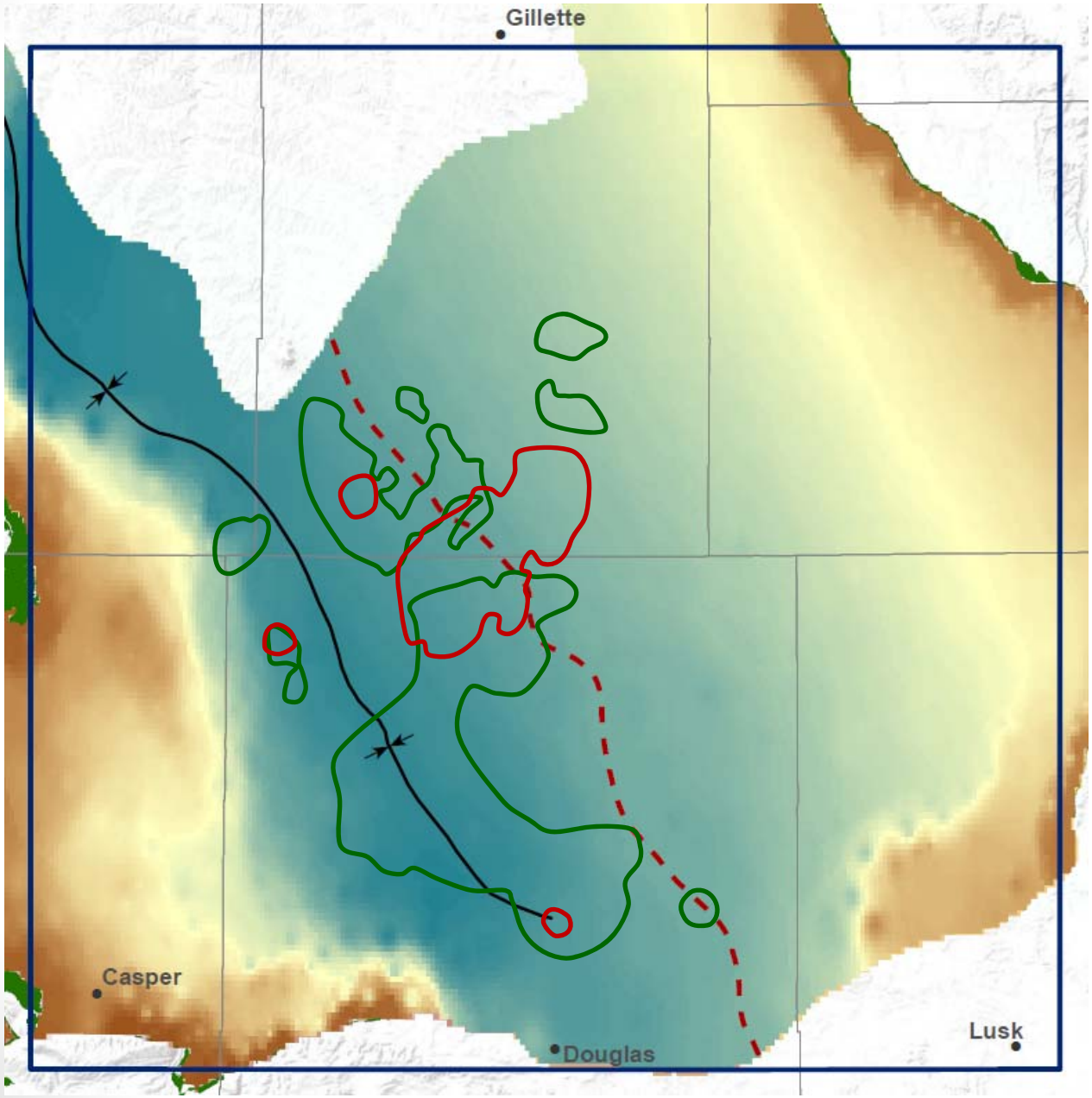


Horizontal well
18 months
gas production
(Mcf)

1,900,000

0

Wall Creek-Turner depth (ft, MSL)

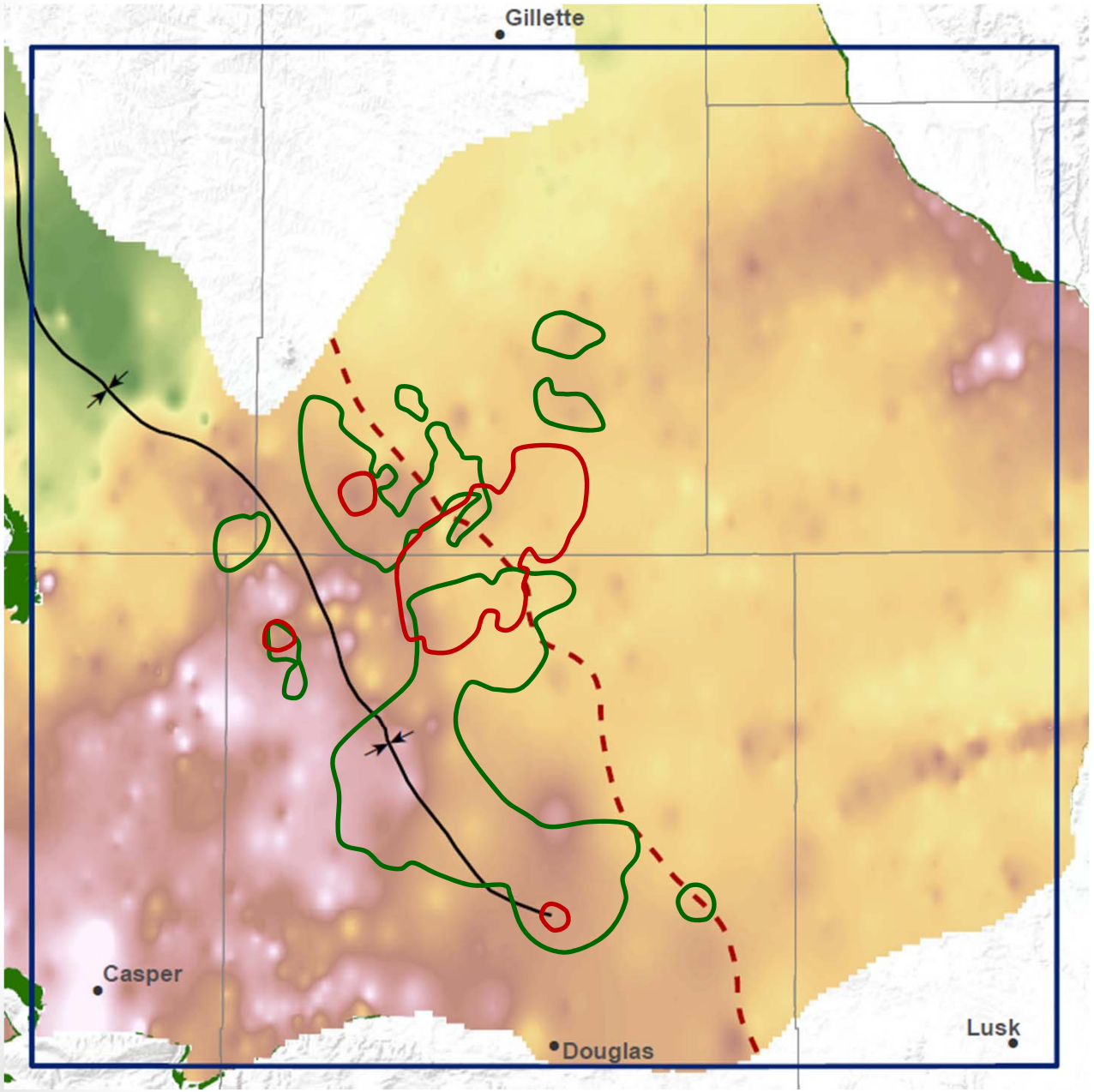


Elevation
(ft, MSL)

6,400

-8,100

Wall Creek-Turner thickness (ft)



Thickness (ft)

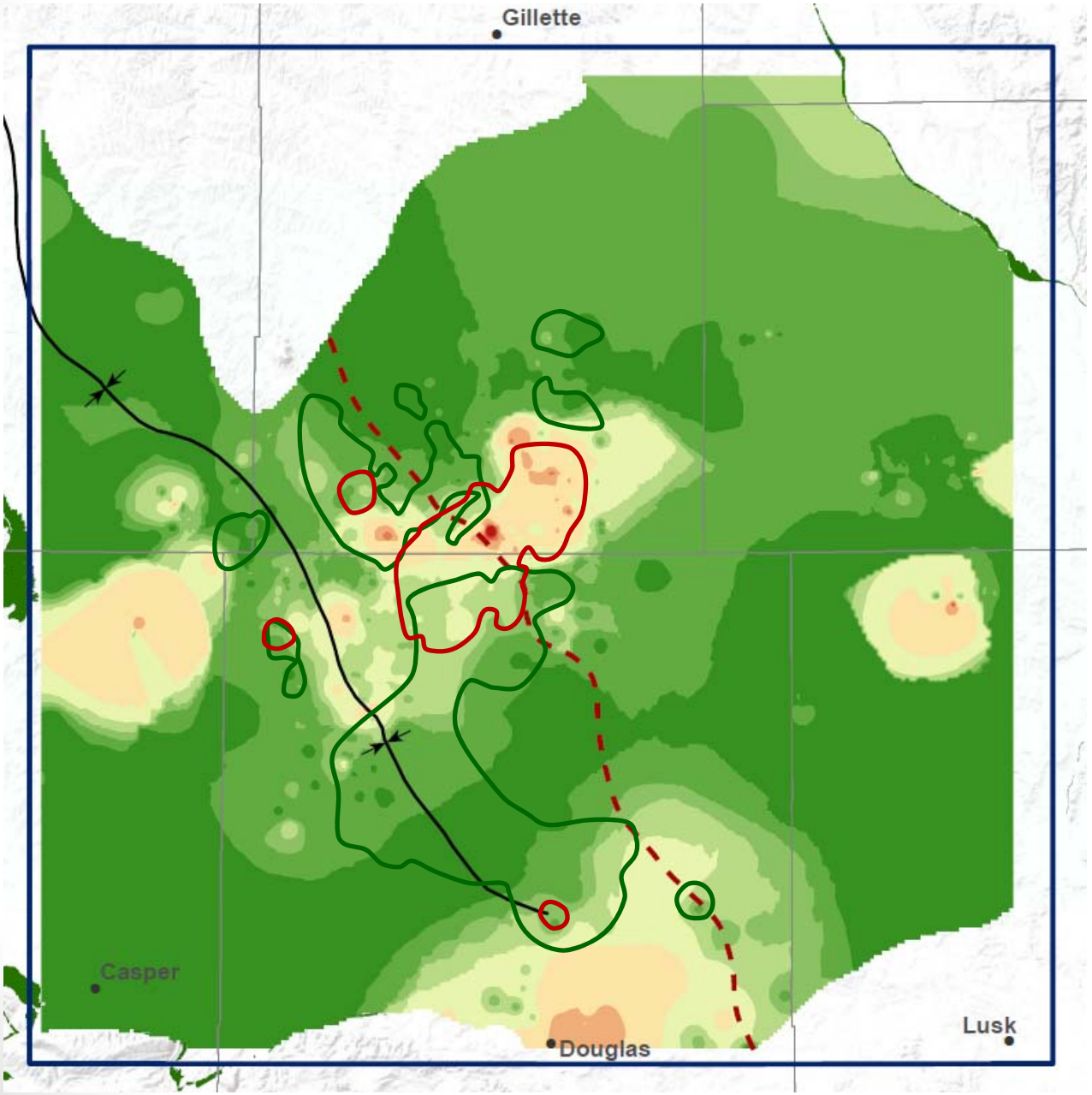
310

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

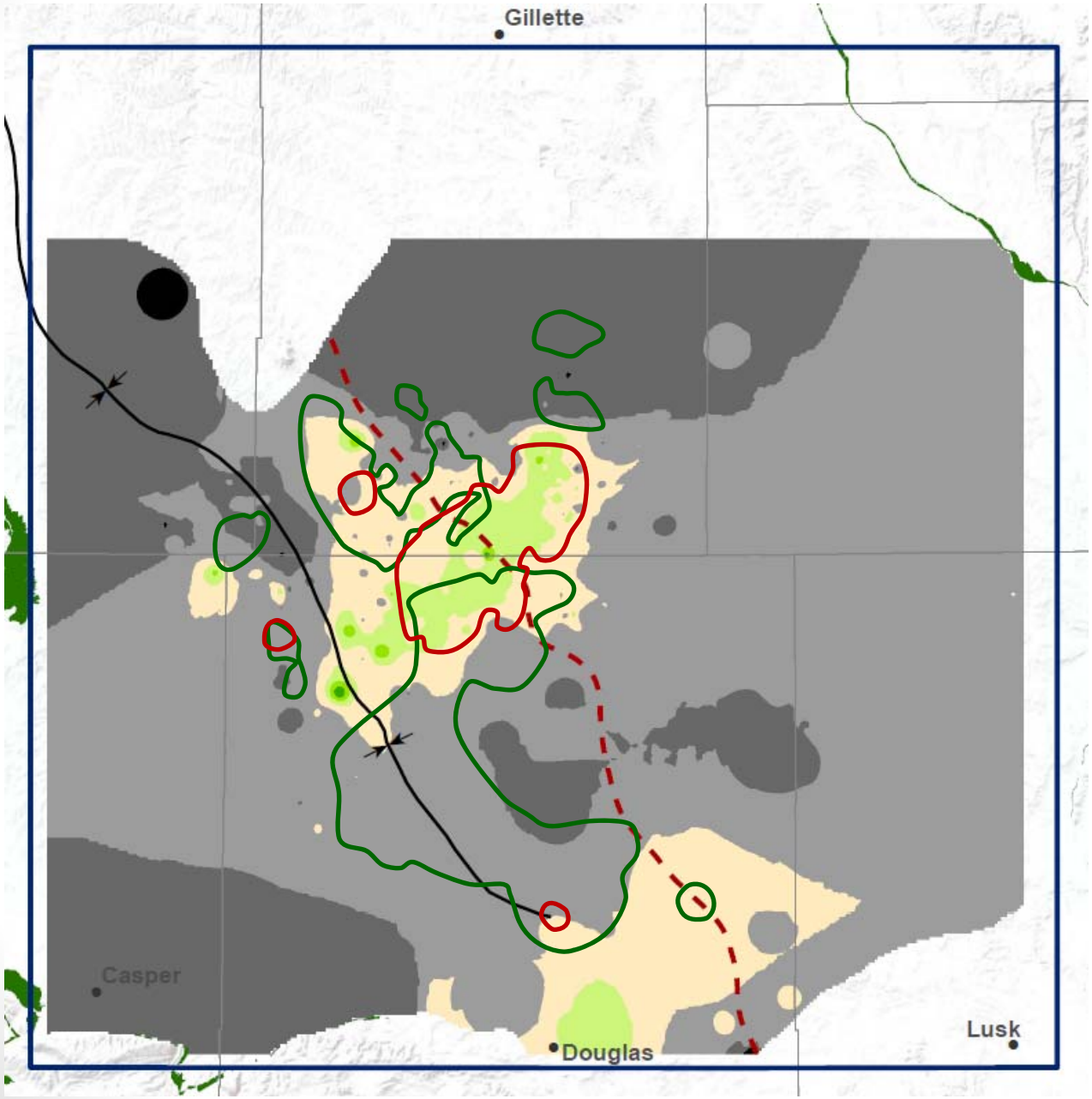
25

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

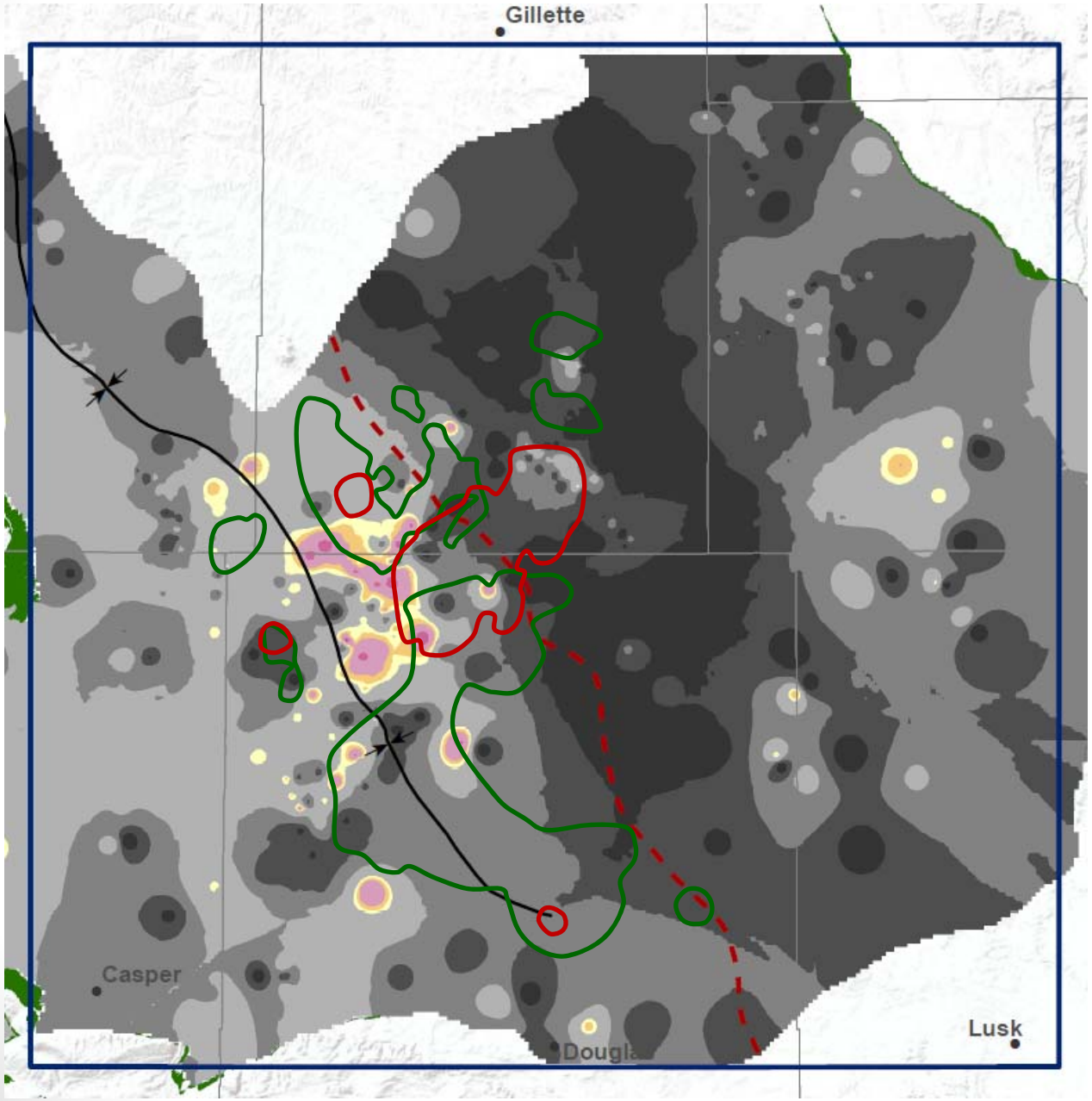
30

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)



Pressure gradient (psi/ft)

1.17

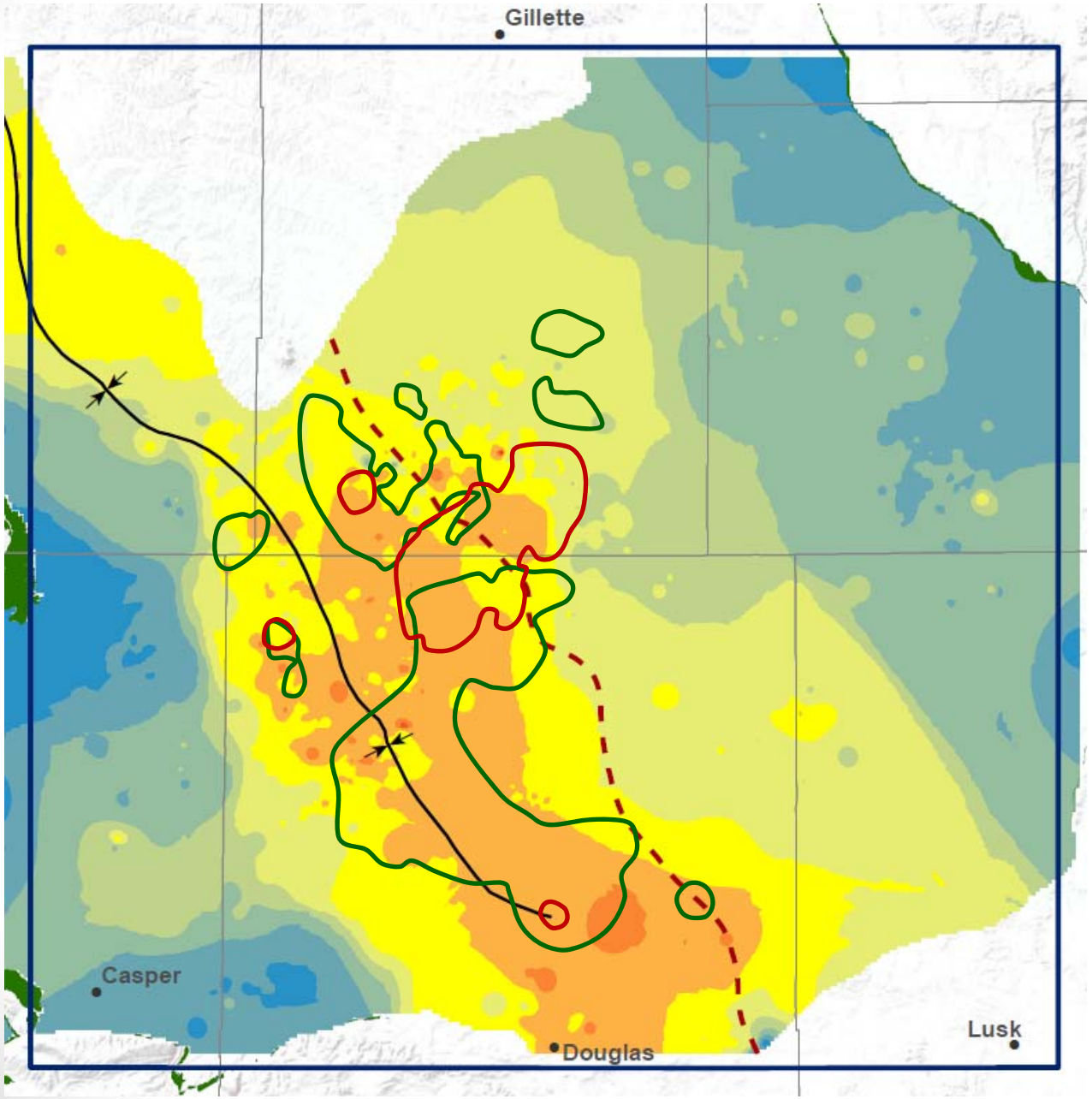
overpressured

0.002

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

Study summary

- PRB Wall Creek–Turner is a complex reservoir system

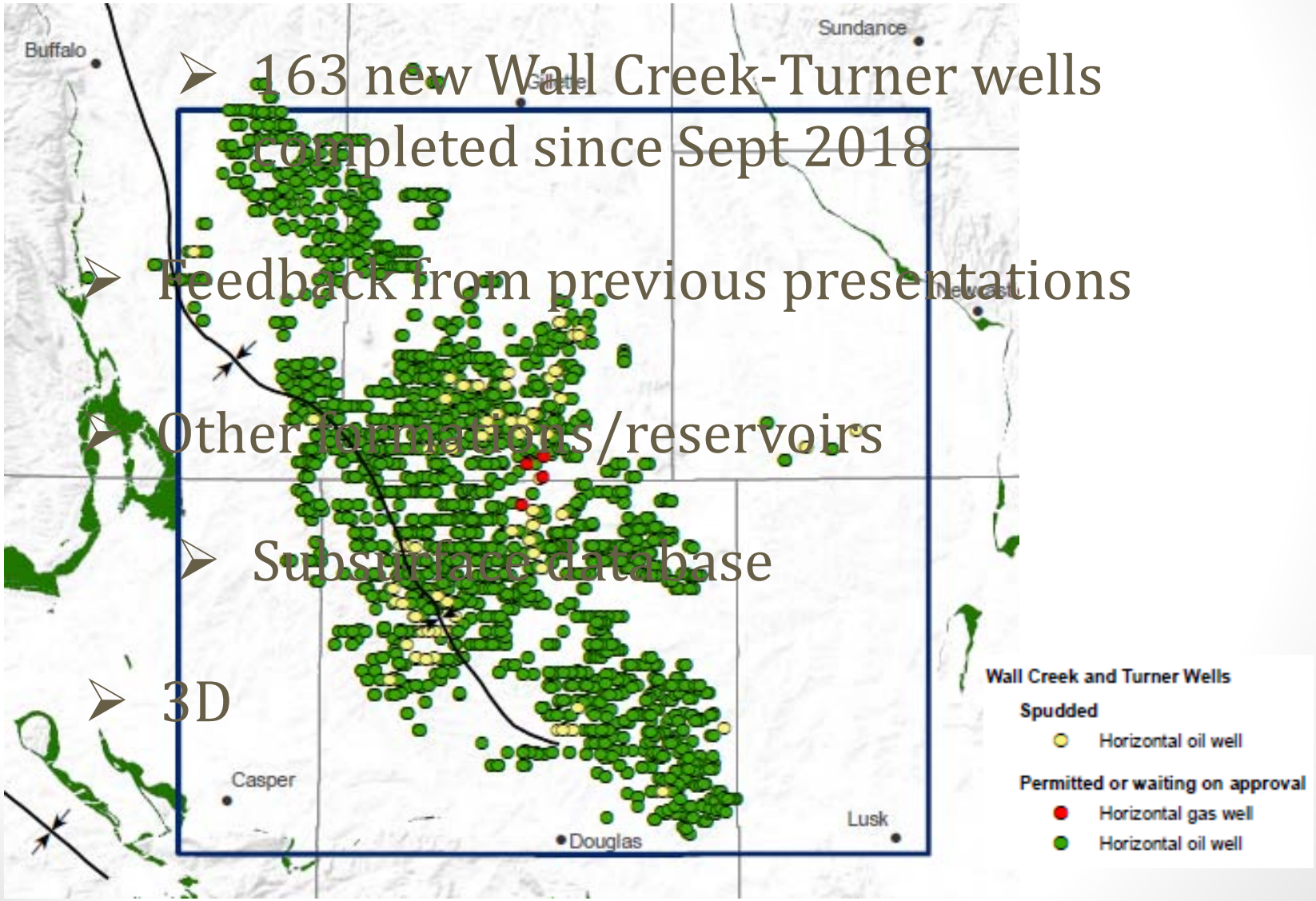
- Geology has more of an influence on production success than well completions*

  *so far!

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/)

What's next?

- Evaluate new wells
  - 163 new Wall Creek-Turner wells completed since Sept 2018
  - Feedback from previous presentations
  - Other formations/reservoirs
  - Subsurface database
  - 3D



Thanks!

Questions?