Company Myths and Field Extension Opportunities, Examples from Cretaceous Reservoirs in the Greater Green River Basin*

Brent Greenhalgh[1]

Search and Discovery Article #70285 (2017)**
Posted September 11, 2017

*Adapted from oral presentation given at AAPG Rocky Mountain Section Annual Meeting, Billings, Montana, June 25-28, 2017

[1]Wexpro Company, Salt Lake City, UT (brent.greenhalgh@questar.com)

Abstract

For the purpose of this presentation, a myth is an over-simplified, but seemingly reasonable explanation for a particular aspect of a field's productive behavior. Myths are common to most producing fields and generally increase in number as fields age. Myths begin as reasonable hypotheses to explain patterns of well results, field limits, water production, stimulation results, or any other characteristic observed during field development activities. The transformation from hypothesis to myth occurs when a hypothesis is accepted by technical disciplines, and/or management, without rigorous scientific testing. With ready acceptance, the myth begins a life of its own as development and operating strategies are implemented around it. Myths are perpetuated by anecdotal stories that pass through generations of geologists, engineers, and management. Myths are detrimental to field development because they are over-simplified explanations for complex petroleum systems.

Acceptance of myths inhibits, or at least delays, the critical thinking and data collection activities required to understand the details of a petroleum system operating in a field. Understanding the details of a particular petroleum system is often the key to identifying additional field development opportunities. Identifying company myths and rigorously evaluating them can provide valuable insights into field redevelopment and extension opportunities. Four examples of myths from the Green River Basin illustrate field development opportunities generated by identifying, and critically evaluating company myths.

References Cited

DigitalGlobe, 2011, Image USDA Farm Service Agency, Imagery Date July 4, 2009.

Google Earth V 7.1.2.2041, October 7, 2013, Sweetwater County, Wyoming, 40°59’ 42.35” N, 108°32’ 23.69”W, Eye alt 33.49 miles.

Hendricks, M.L., 1994, Ravinement surface control on hydrocarbon accumulation in transgressive systems tracts: Almond Formation, Green River Basin, Wyoming: Unconformity Controls Symposium, Rocky Mountain Association of Geologists.

Company myths and field extension opportunities

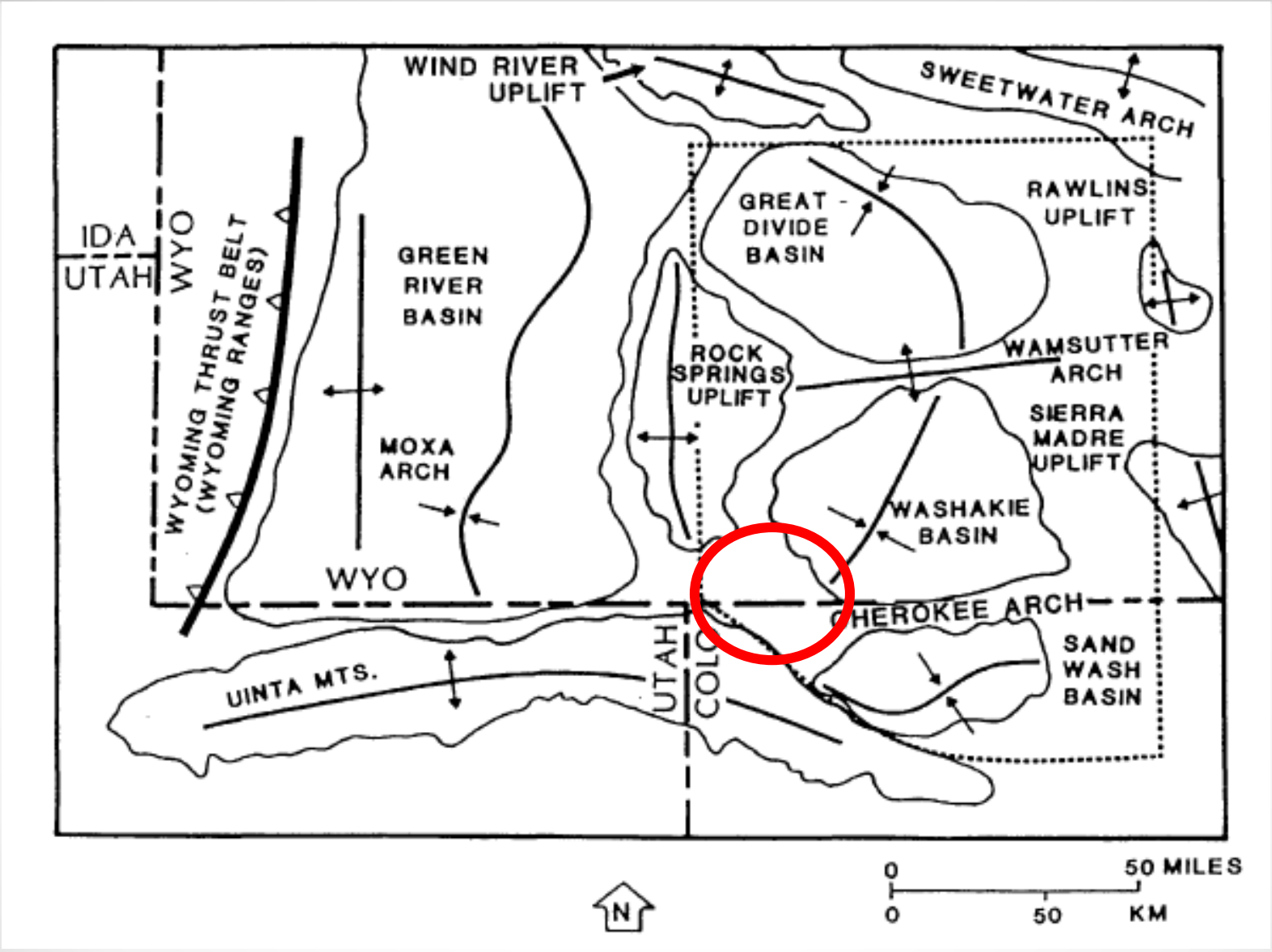
Examples from Cretaceous reservoirs in the Greater Green River Basin

Definitions

- Myth: An over-simplified, but seemingly reasonable, explanation for a particular aspect of a field's productive behavior.

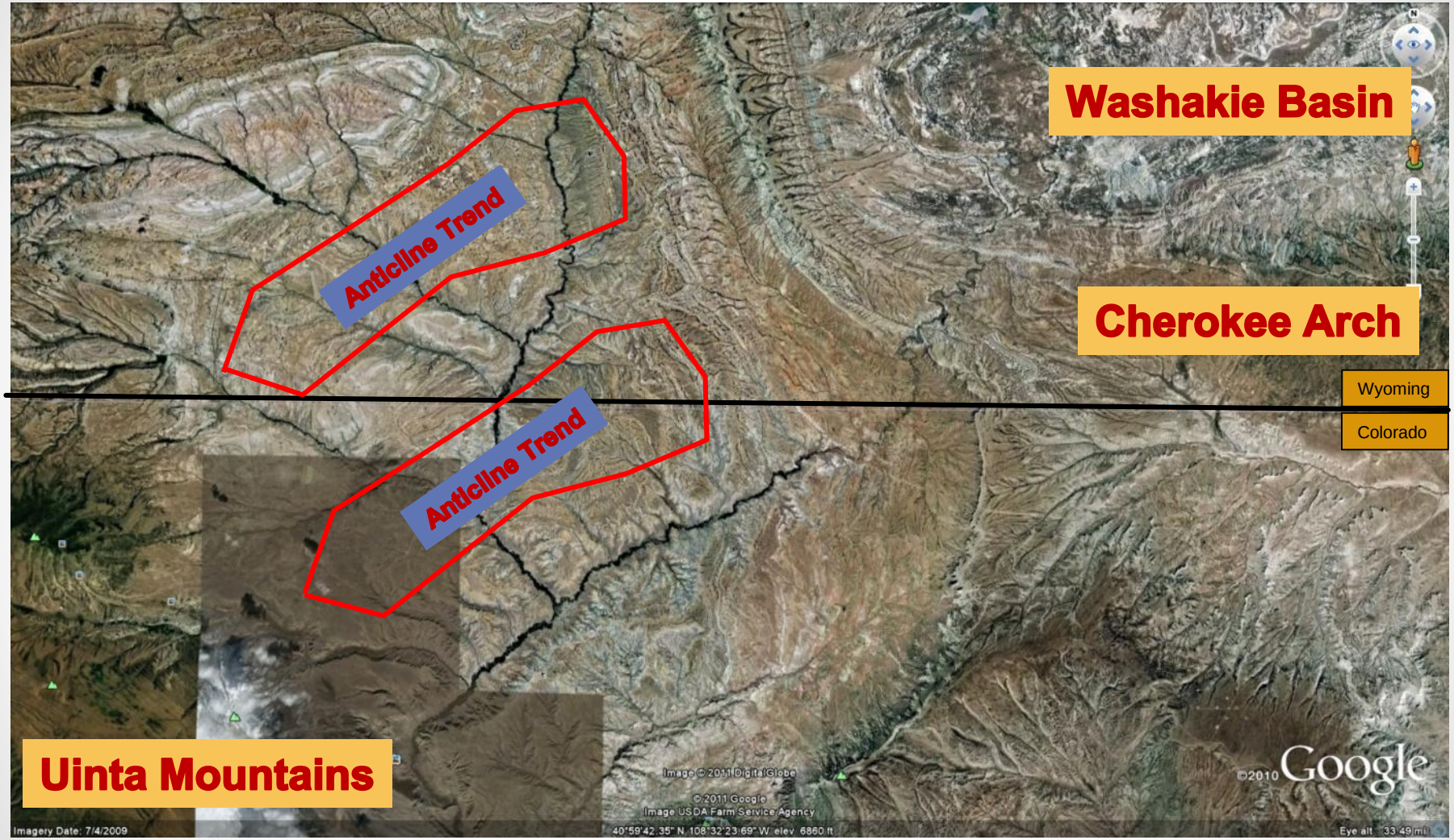
- Myths generate opportunities because they leave critical aspects of a field's productive character unexplained and under-explored

Vermillion Basin



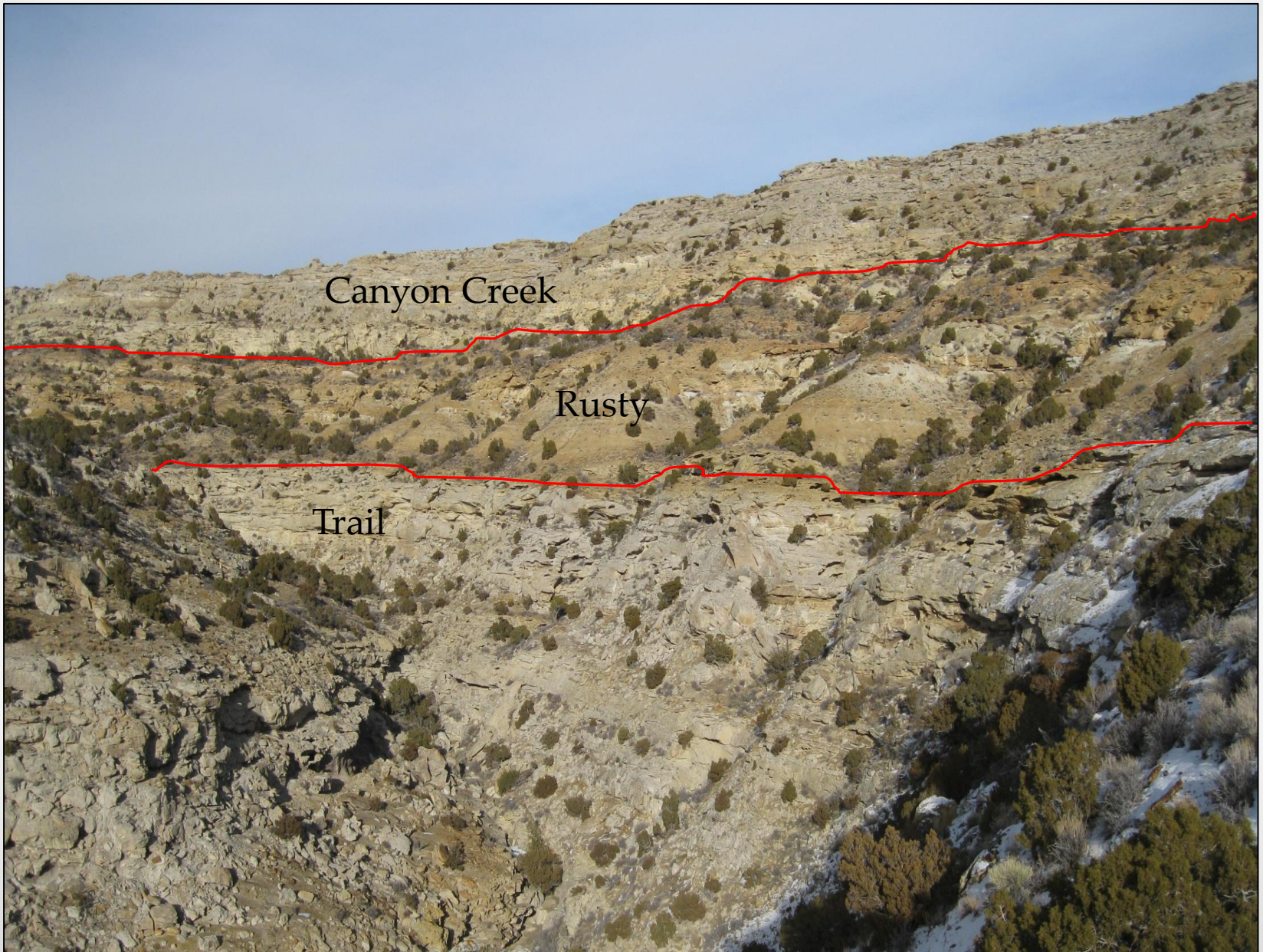
Modified after Hendricks, 1994

Vermillion Basin Satellite Image



Google Earth, 2016

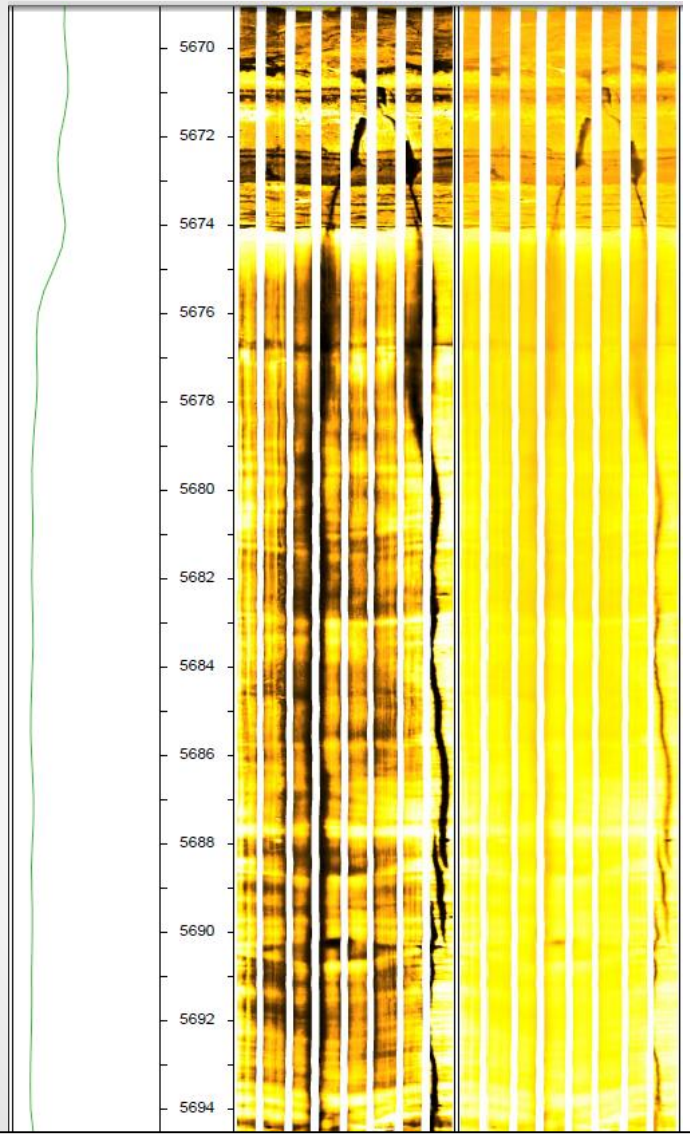
Case 1—Trail Sandstone Fractures



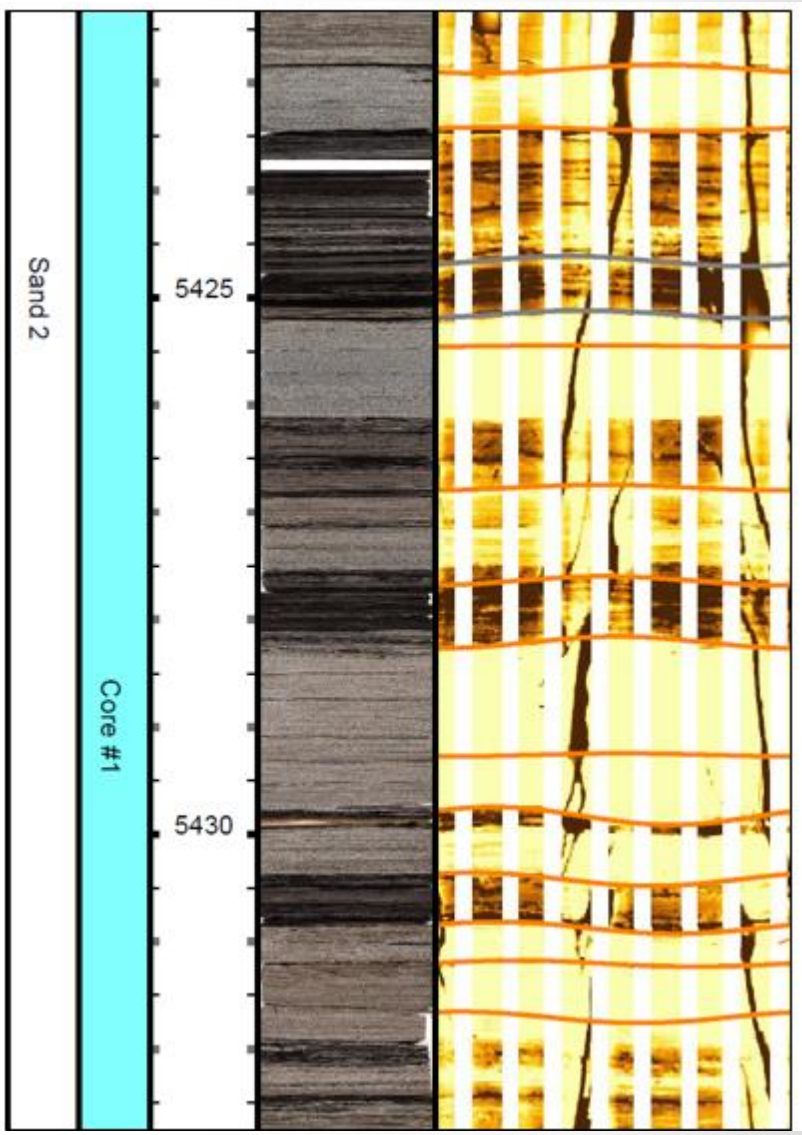
Case 1—Trail Sandstone Fractures

Case 1—Trail Sandstone Fractures

Case 1—Trail Sandstone Fractures



This ~20′ fracture is the only one of it's size we've seen in image logs in the Trail section

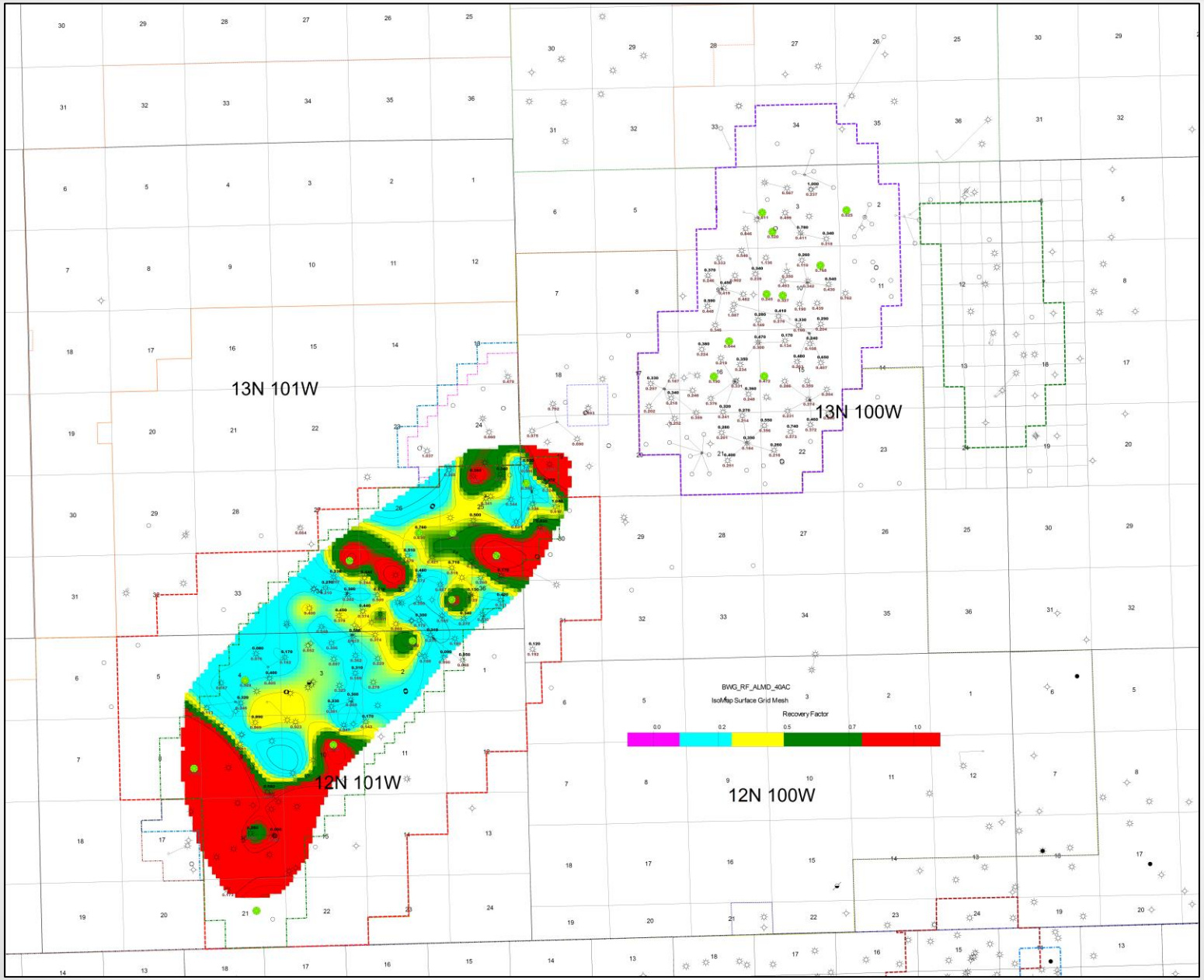


This series of fractures appears in the image logs in the Almond Formation reservoir. No fractures are present in the core

Case 1—Trail Sandstone Fractures

- Based on this fracture concept we began pumping 100-mesh sand in our stimulations
- The design change was effective in preventing screen outs
- No material improvement in the Trial Sand productivity
- Based on outcrop and core, there is significant uncertainty about the Trail Sand being a fractured reservoir
- Is there more to the story?

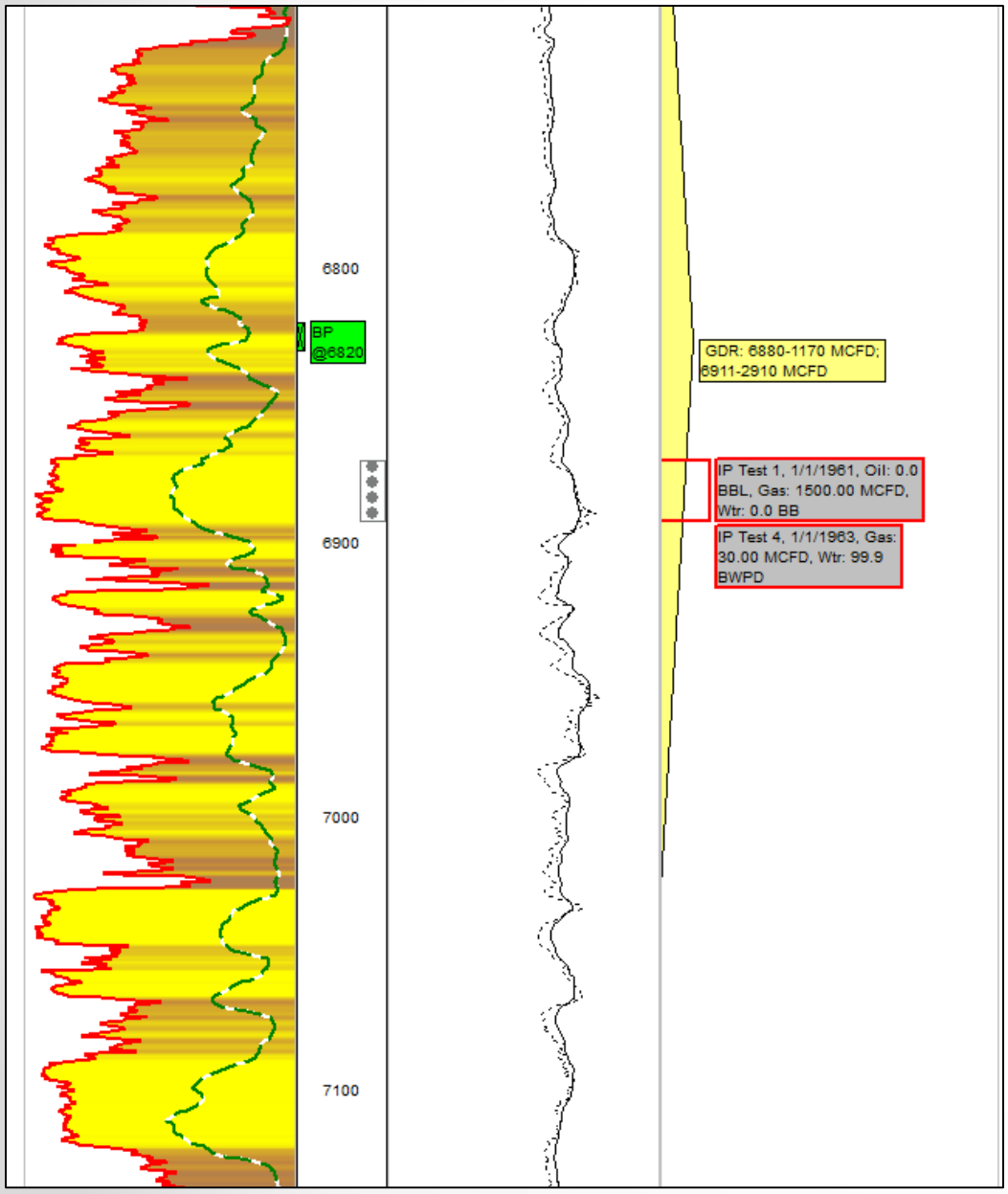
Case 2—Trail Sandstone Drainage



Case 2—Trail Sandstone Drainage

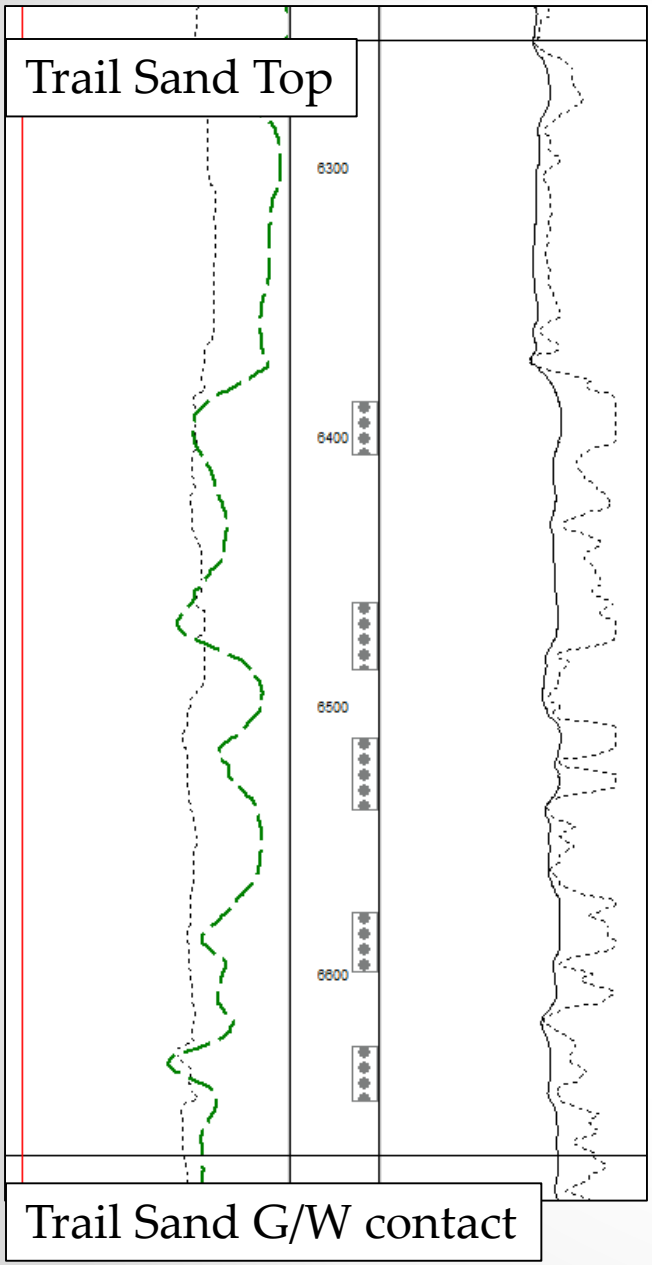
- Development efforts in the Trail Sand seemed to leave a lot of gas behind
- The explanation that became a myth was that the Trail Sandstone was tight
  - If the reservoir was tight, then downspacing would be a ready solution
  - Or horizontal wells with large stimulations could be the answer
- However…

Case 2—Trail Sandstone Drainage



- Gas Drilling Records indicated a zone at 6,880 MD capable of flowing at 1.17 MMcfd naturally
- Initial completion of the zone was for 1.5 MMcfd with no water
- Within two years the gas rate had dropped to 30 Mcfd and water production went up to 100 Bbls/day
- This and other data from our gas drilling records point to a ~consistent gas water contact throughout the field

Case 2—Trail Sandstone Drainage



- This Trail Sand interval was only completed above the newly interpreted G/W contact
- IP at over 4 MMcfd
- Cum 1 Bcf in 5 years
- Rates and pressures declined and the well was recompleted uphole

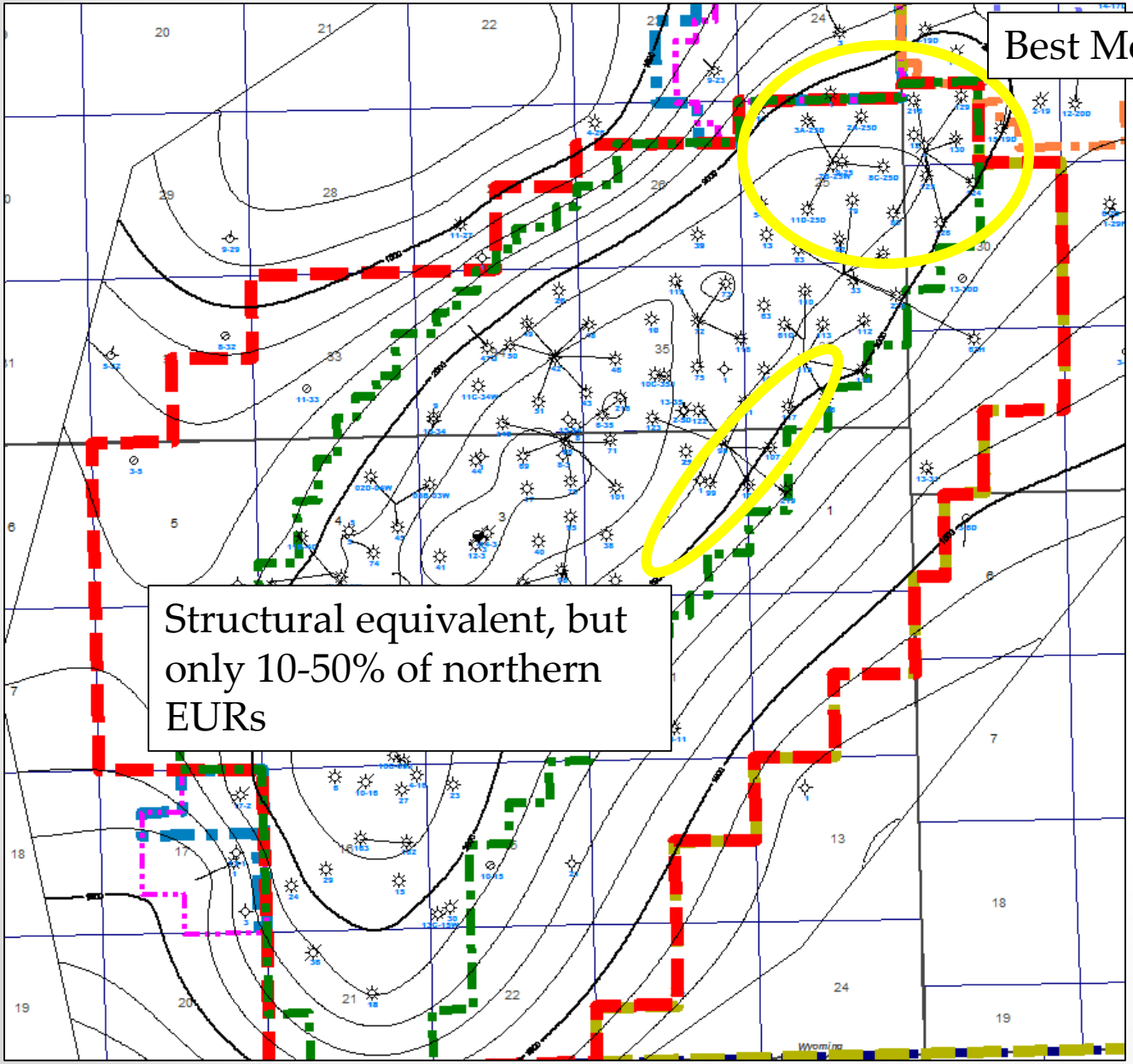
Case 2—Trail Sandstone Drainage

- Historical data points to a high quality reservoir with limited extent
- Outcrops show that the Trail Sandstone package is anything but limited
- Begun outcrop studies to assess the degree of compartmentalization
- Horizontal wells, may be the answer
  - Not because the rock is tight or fractured
  - Perhaps because high quality rock is compartmentalized and simply needs to be linked into one wellbore

Case 3—Northern Canyon Creek

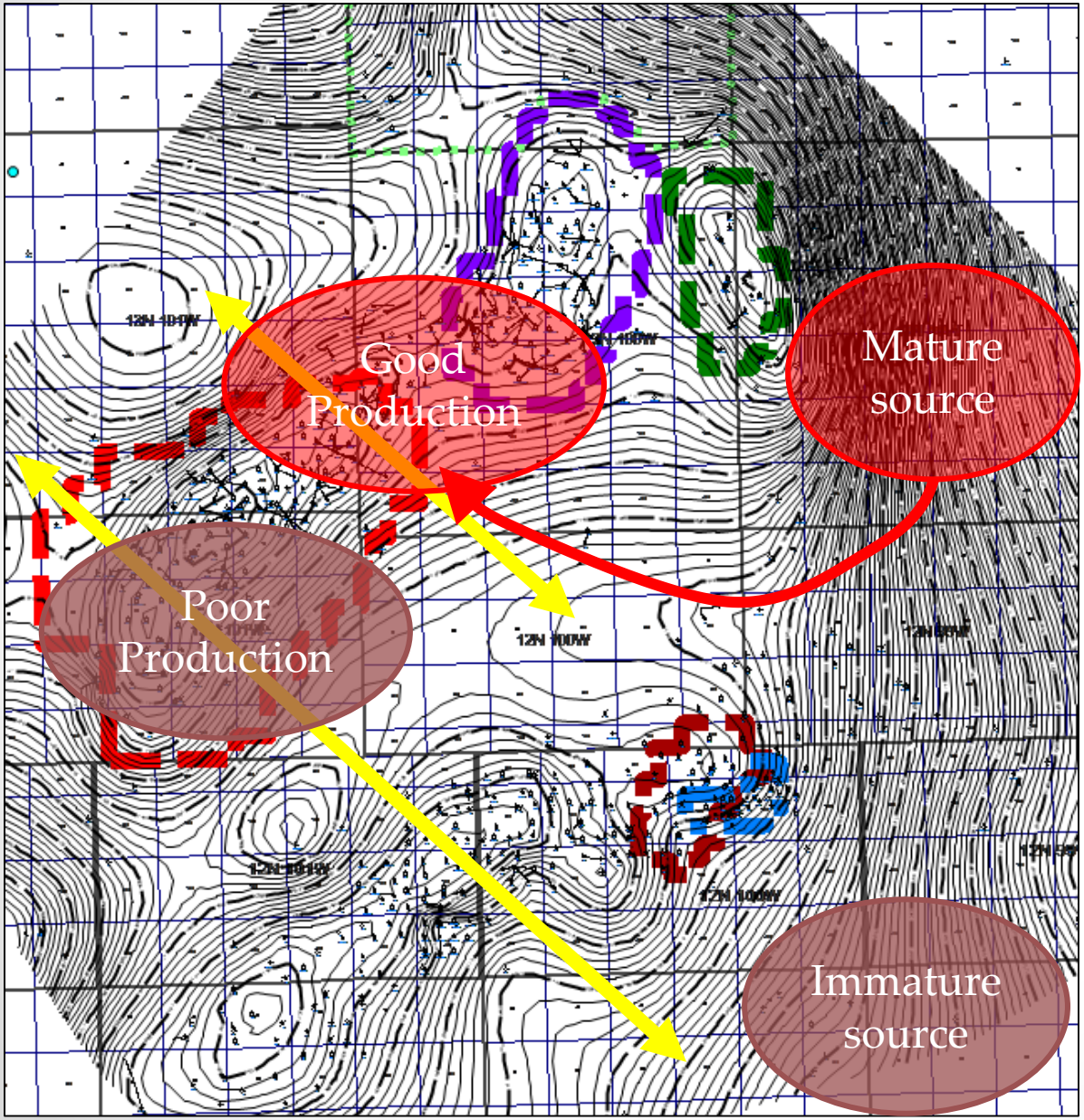
- Between 2009 – 2013 Wexpro drilled about 150 Almond wells in the Canyon Creek and Trail Units
- The northeastern end of Canyon Creek was discovered to be the most productive
- There wasn't a ready explanation for why
  - In most respects, sand quality is worse, but production is better
- Fractures were hypothesized to explain the pattern
  - Due to the curvature of the plunging nose of the structure

Case 3—Northern Canyon Creek



Structural curvature on the northern end of Canyon Creek was hypothesized as a mechanism for increased natural fractures and better reservoir quality

Case 3—Northern Canyon Creek



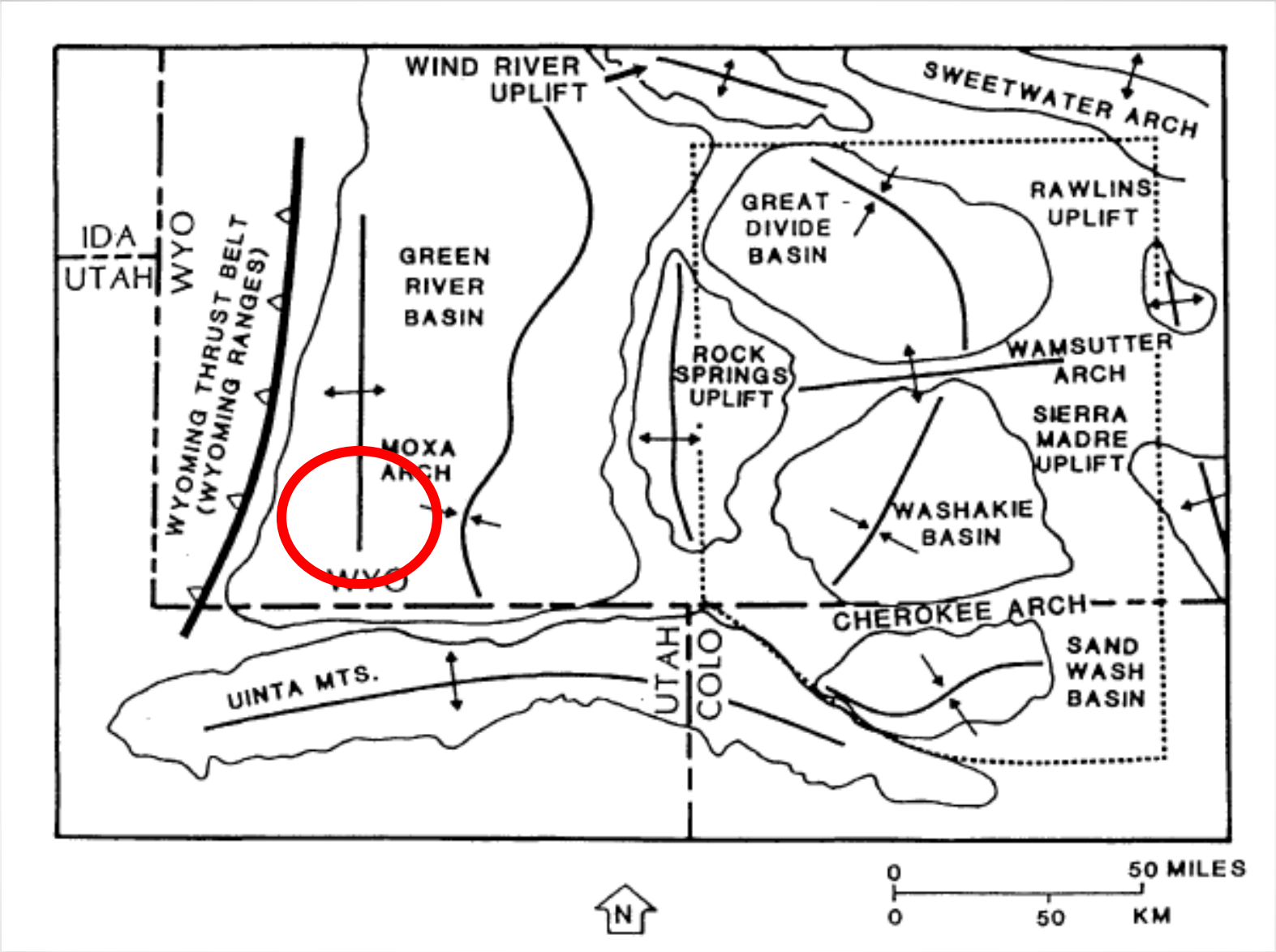
Conventional accumulation model

- Structural/Strat combo trap
- Hydrocarbons sourced in Almond coals in deep Washakie
- Lewis Shale seal
- Almond shorelines are tight gas reservoir and migration pathway
- Shorelines connected to the deep Washakie Basin source area have best productivity

Case 3—Northern Canyon Creek

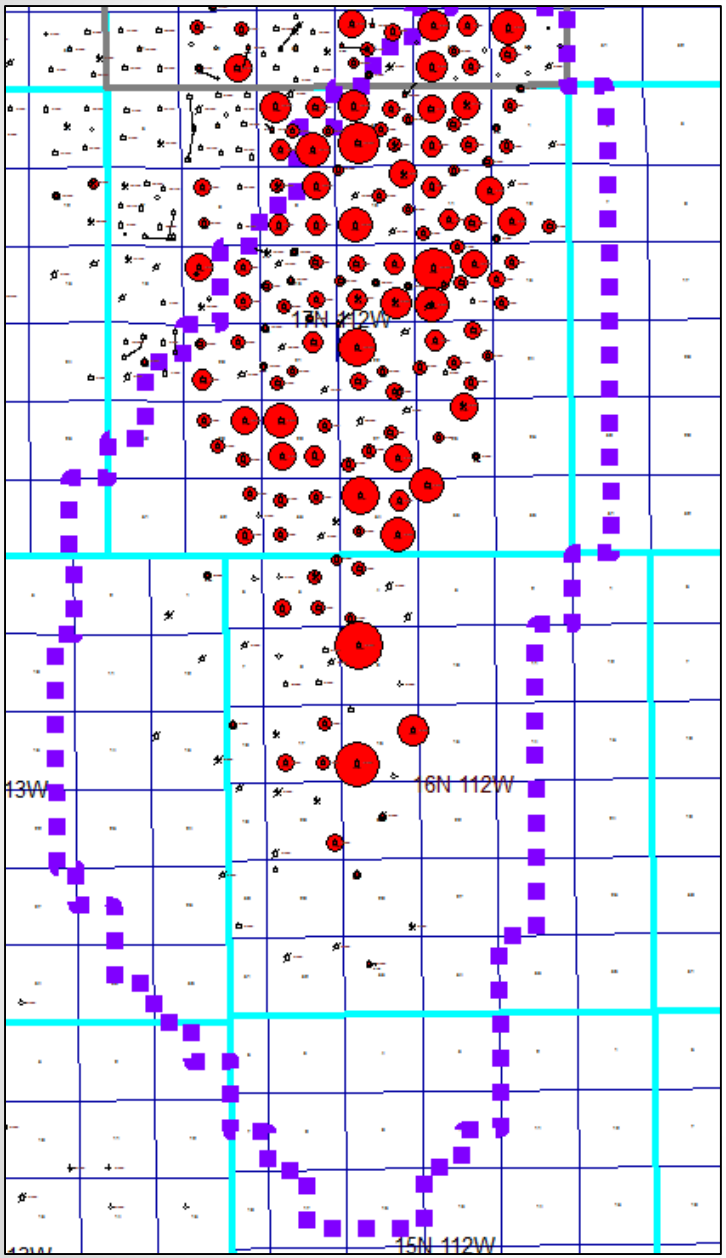
- Fracture interpretation was a nice way to explain the production pattern, but didn't lead to improvements in development or field extension opportunities
- A petroleum system approach has led to a more likely explanation of the production pattern and to field extension ideas

Moxa Arch – Church Buttes



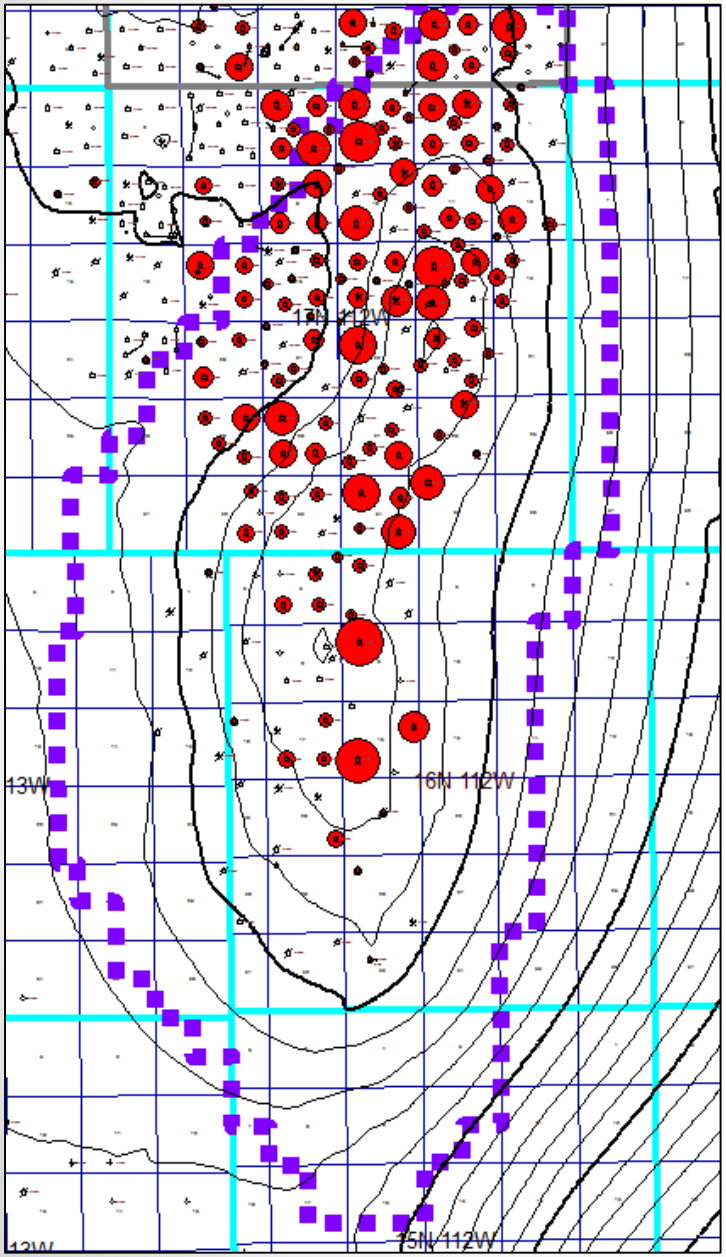
Modified after Hendricks, 1994

Case 4—Church Buttes



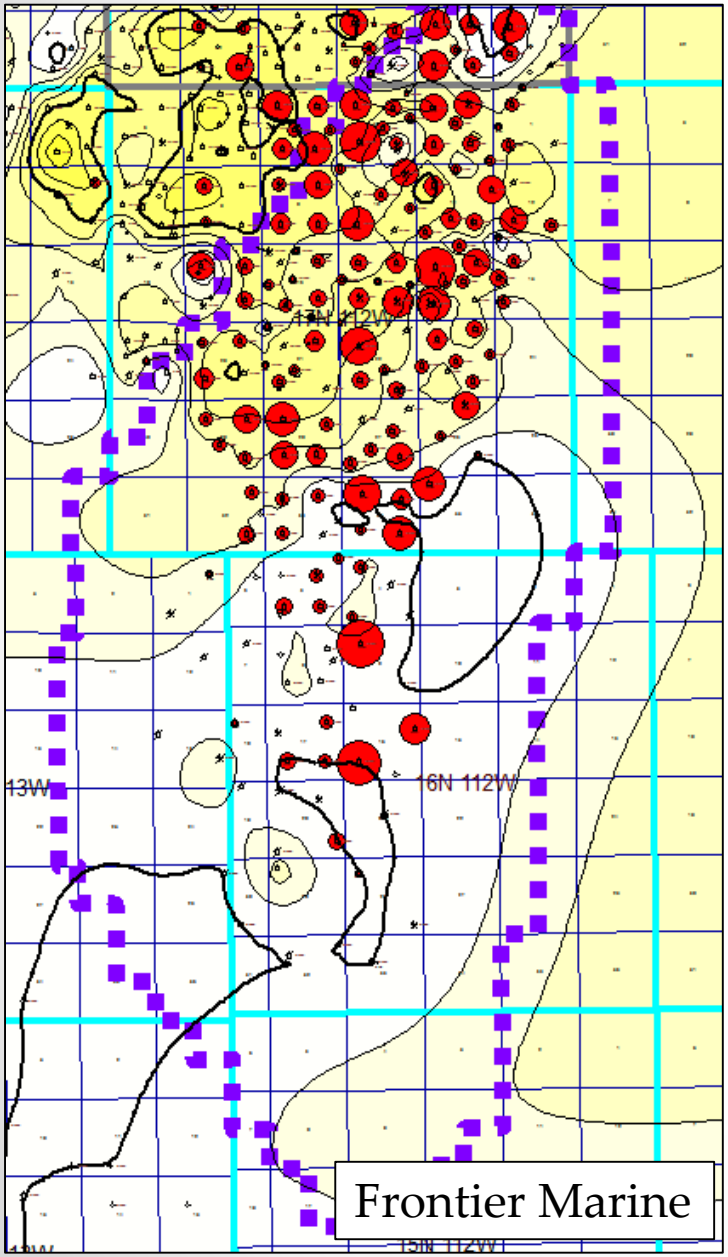
- Frontier development is sparse in the southern half of the Church Buttes Unit
- Company Myth: The Frontier marine sand pinches out, so the reservoir risk is too high

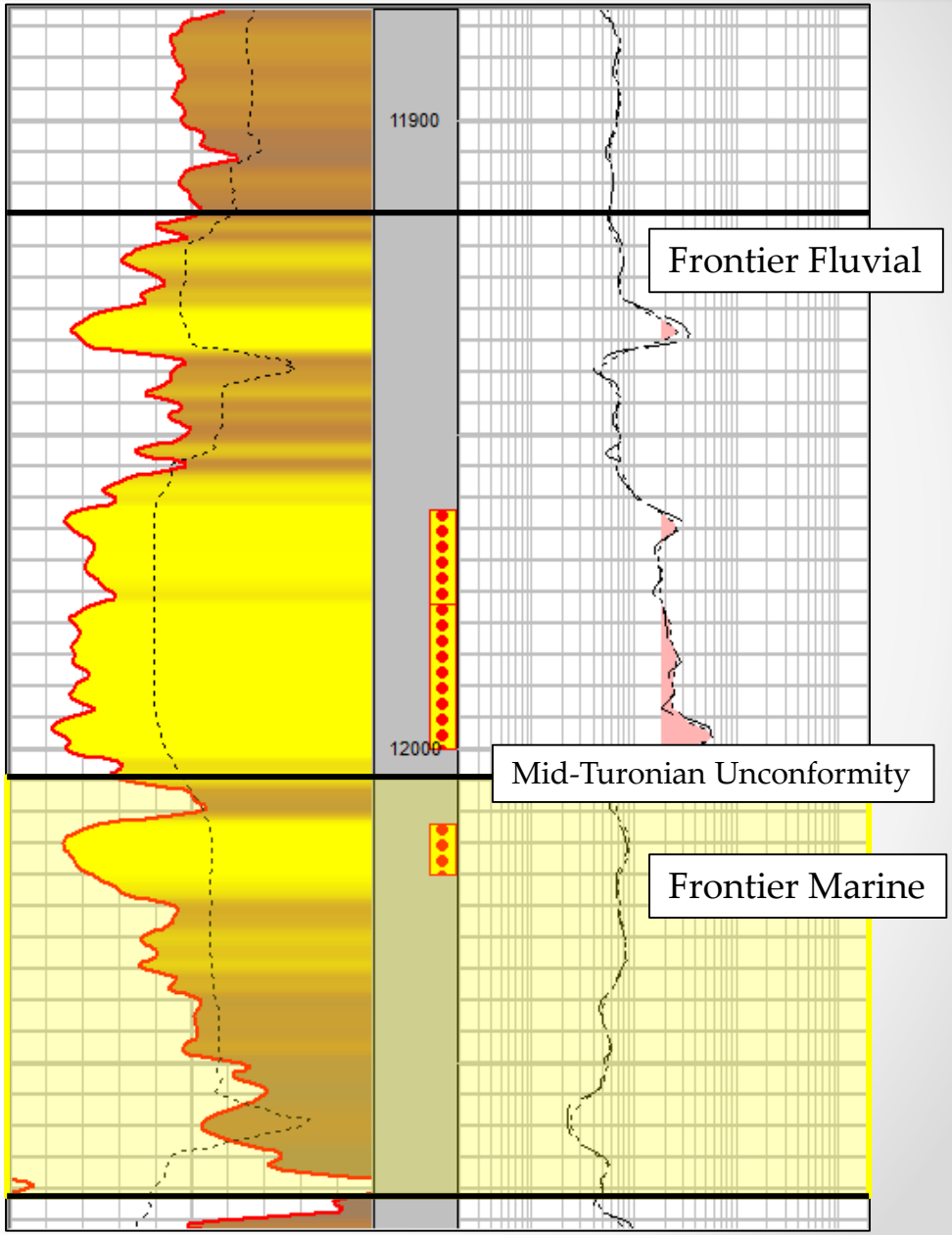
Case 4—Church Buttes



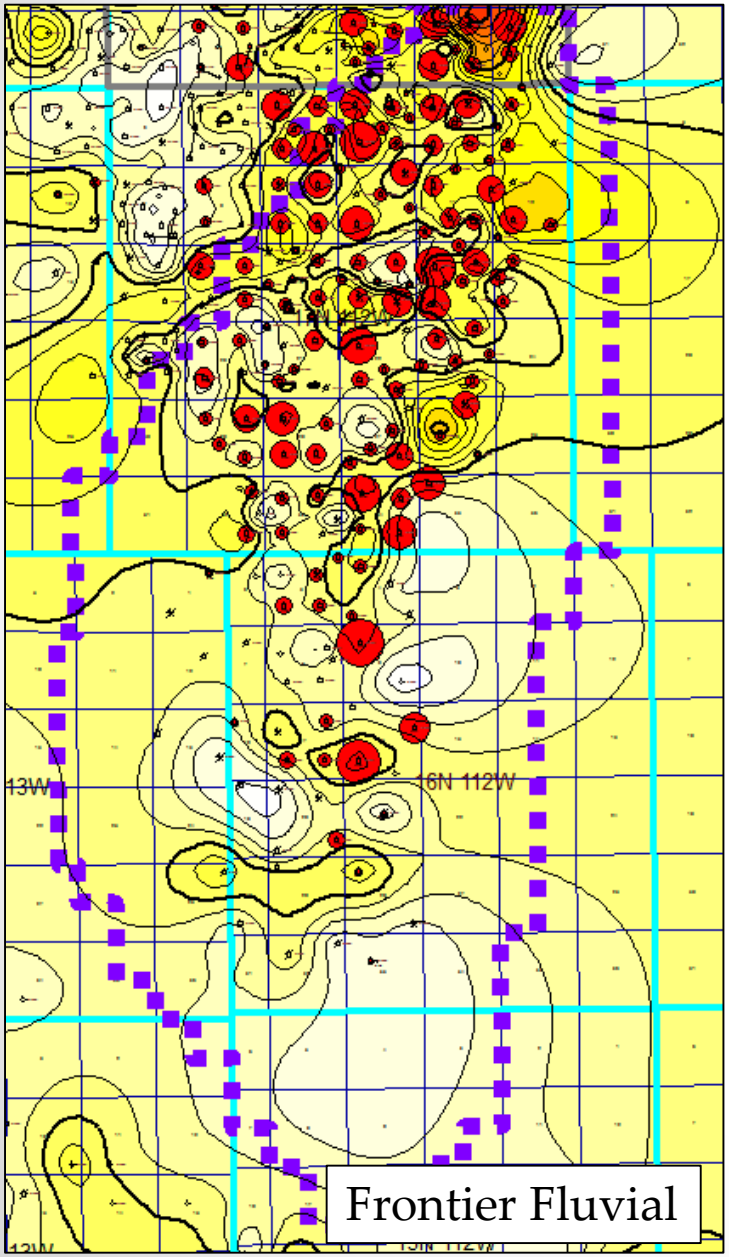
- Accumulation clearly produces outside of closure
- Why do we not see the same trend in the south as we do in the north?

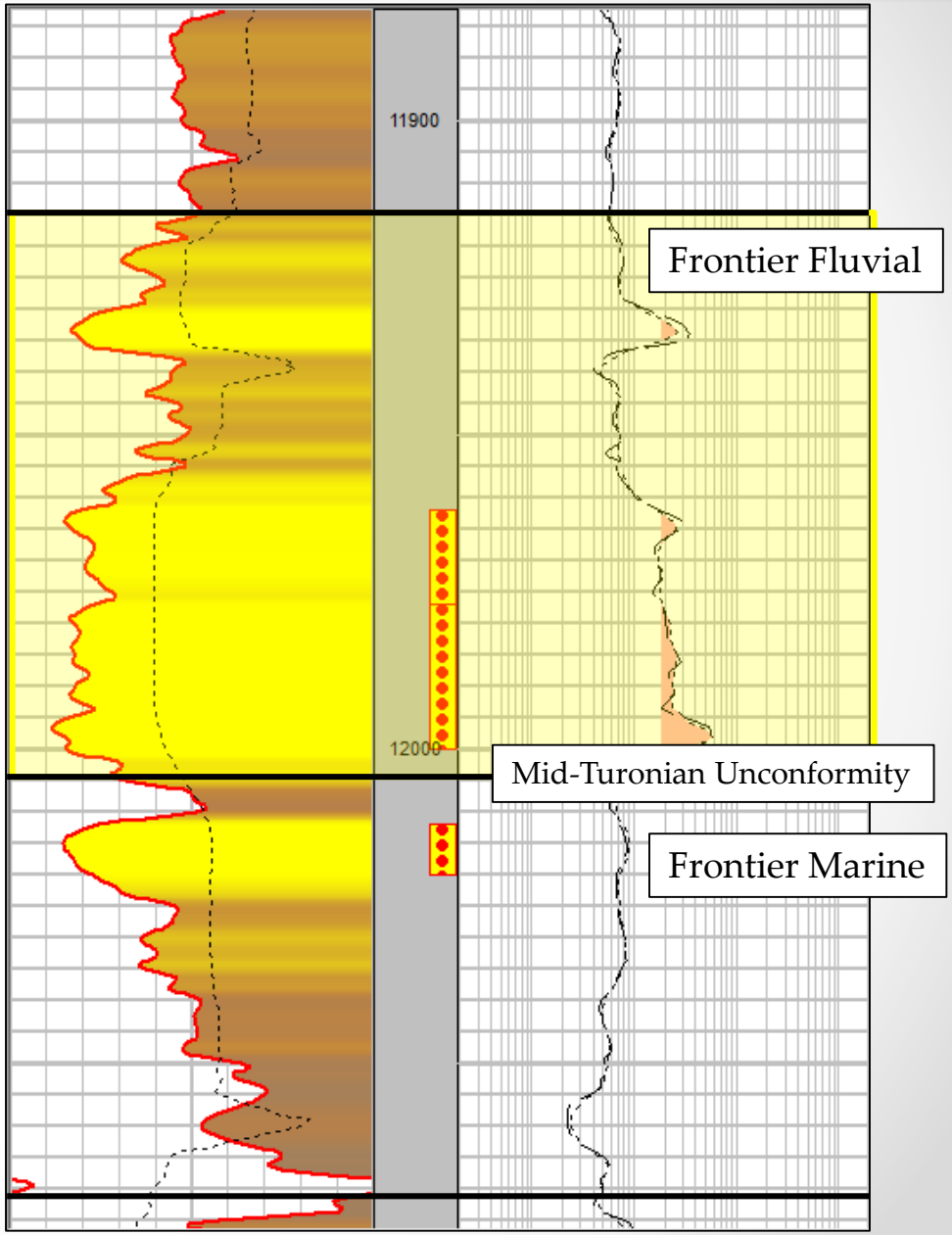
Case 4—Church Buttes



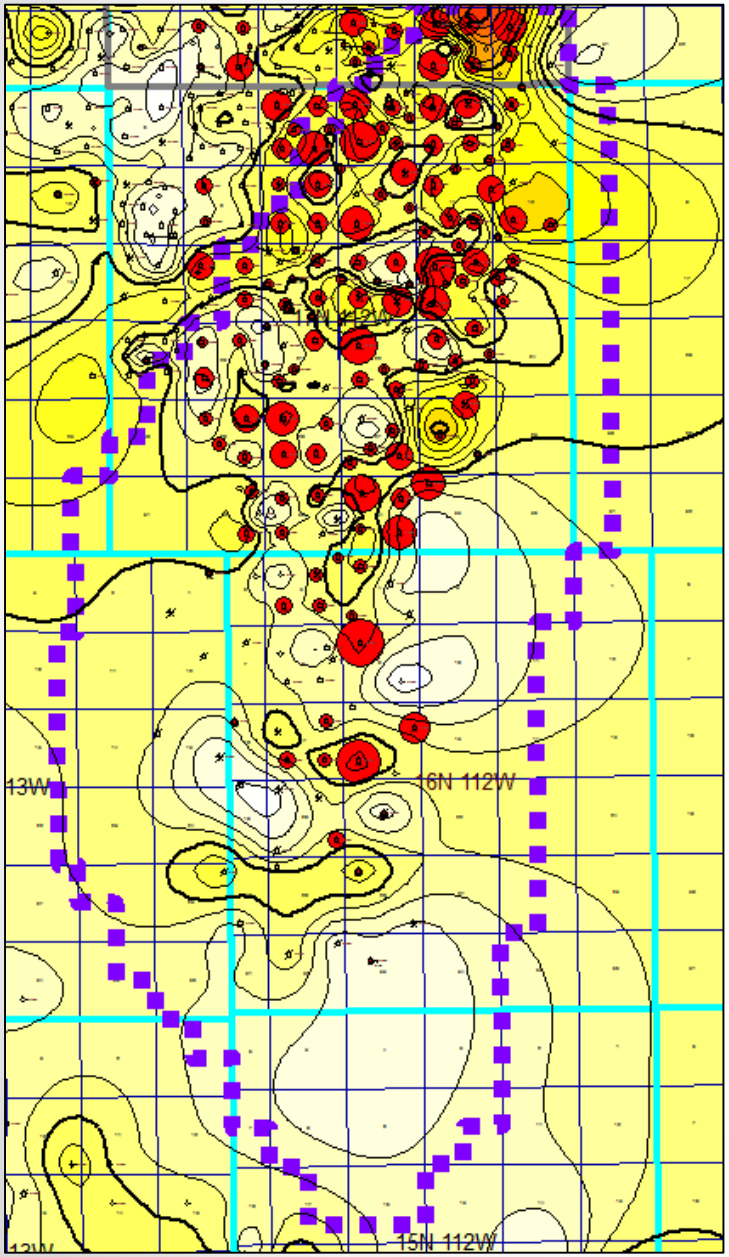


Case 4—Church Buttes





Case 4—Church Buttes



- Company myth: Marine sand pinchout controls production
  - Marine sand pinches out
  - Fluvial sand thickness dominates the EUR trend
- Better predictive tools for the fluvial sand should allow development to extend south

Conclusions

- Company myths abound, particularly in old fields and old companies

- Identifying and rigorously evaluating company myths can be a very productive way to find new development and exploration opportunities

References

- Google earth V 7.1.2.2041. (October 7, 2013). Sweetwater County, Wyoming. 40° 59' 42.35" N, 108° 32' 23.69"W, Eye alt 33.49 miles. DigitalGlobe 2011. Image USDA Farm Service Agency. Imagery Date July 4th, 2009. http://www.earth.google.com [August 30th, 2016].
- Hendricks, M.L., 1994, Ravinement surface control on hydrocarbon accumulation in transgressive systems tracts: Almond Formation, Green River Basin, Wyoming, Unconformity Controls Symposium, Rocky Mountain Association of Geologists.