



Gas Shale Performance: What are the Issues?

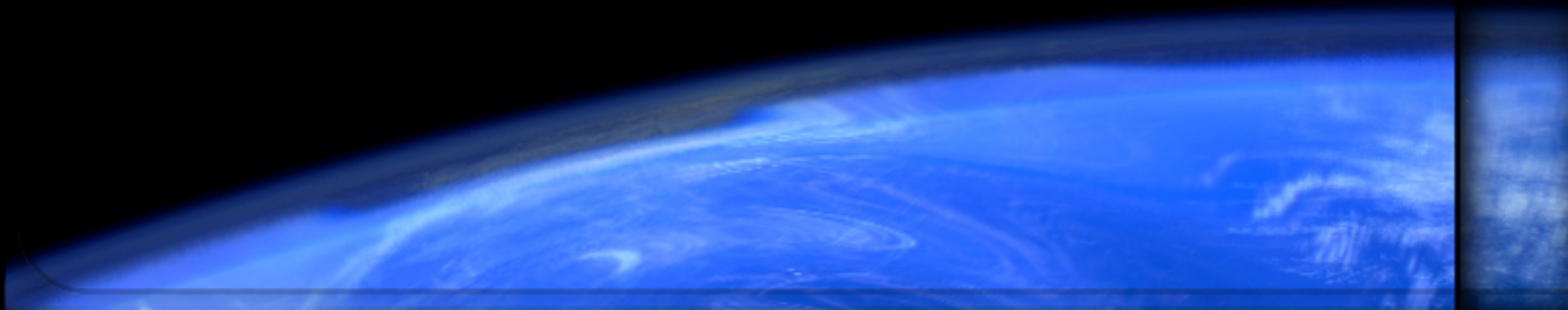
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Introduction

- What is “shale”?
- Geochemistry Issues
- Reservoir Quality Issues
- Issues of Geohazards
- Geomechanical Issues
- Other hydraulic fracturing issues
- Different issues in different shales





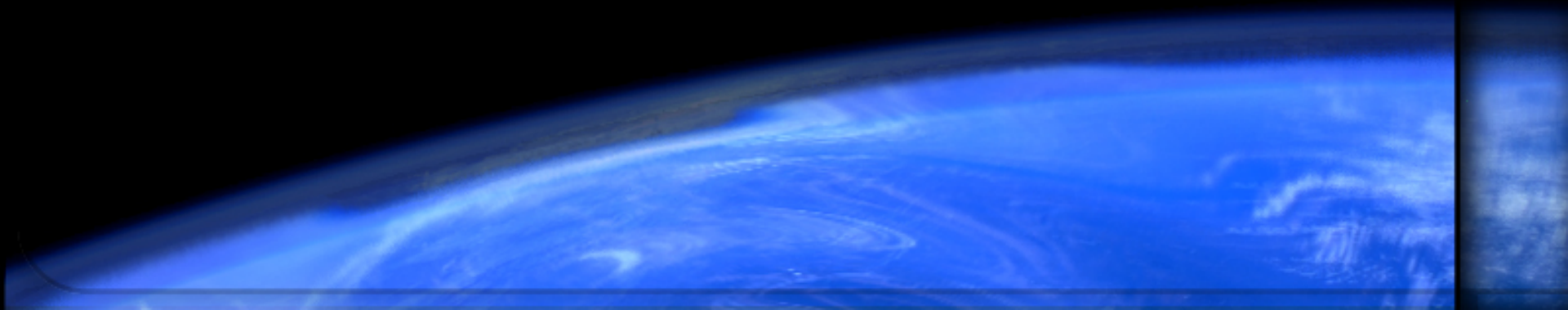
“Shale”

- **Defined by particle size**
 - Finest-grained clastic rocks, e.g. predominantly clay-sized particles
 - Fissile
- **Non-fissile finest-grained clastics are the mudstones or claystones**
- **Variable mineralogy and organic content**
- **Wide range of porosity**
- **Very low and variable matrix permeability**
- **Range of mechanical rock properties**



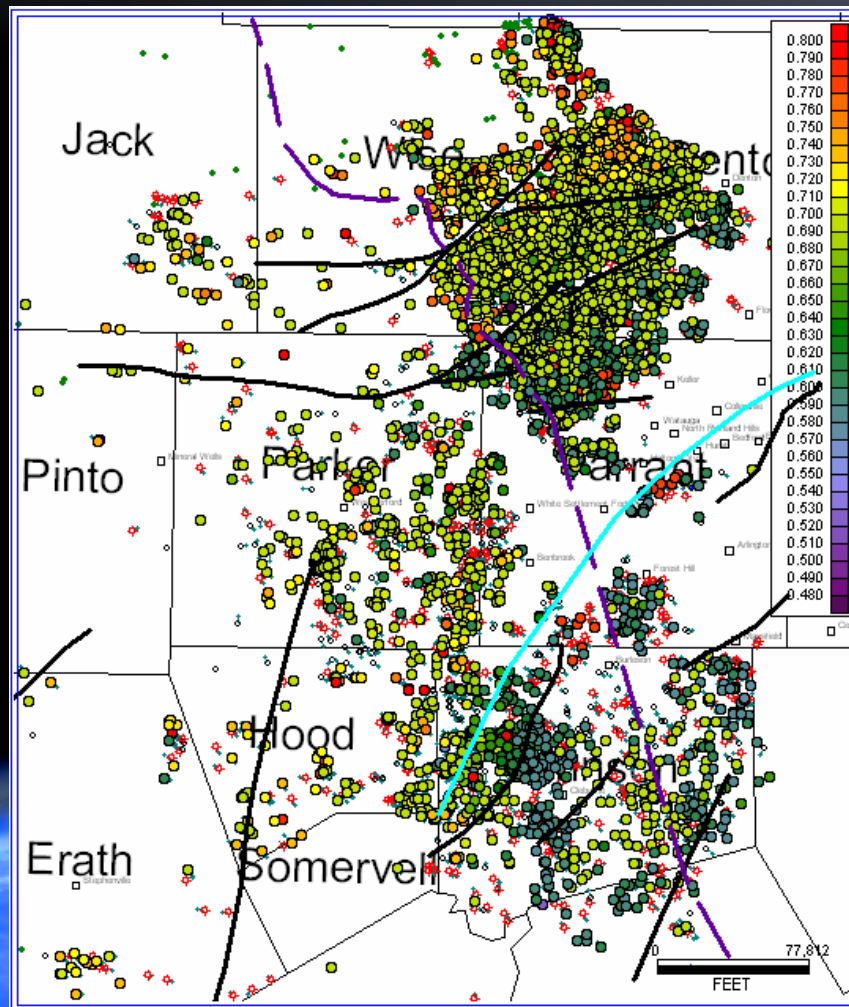
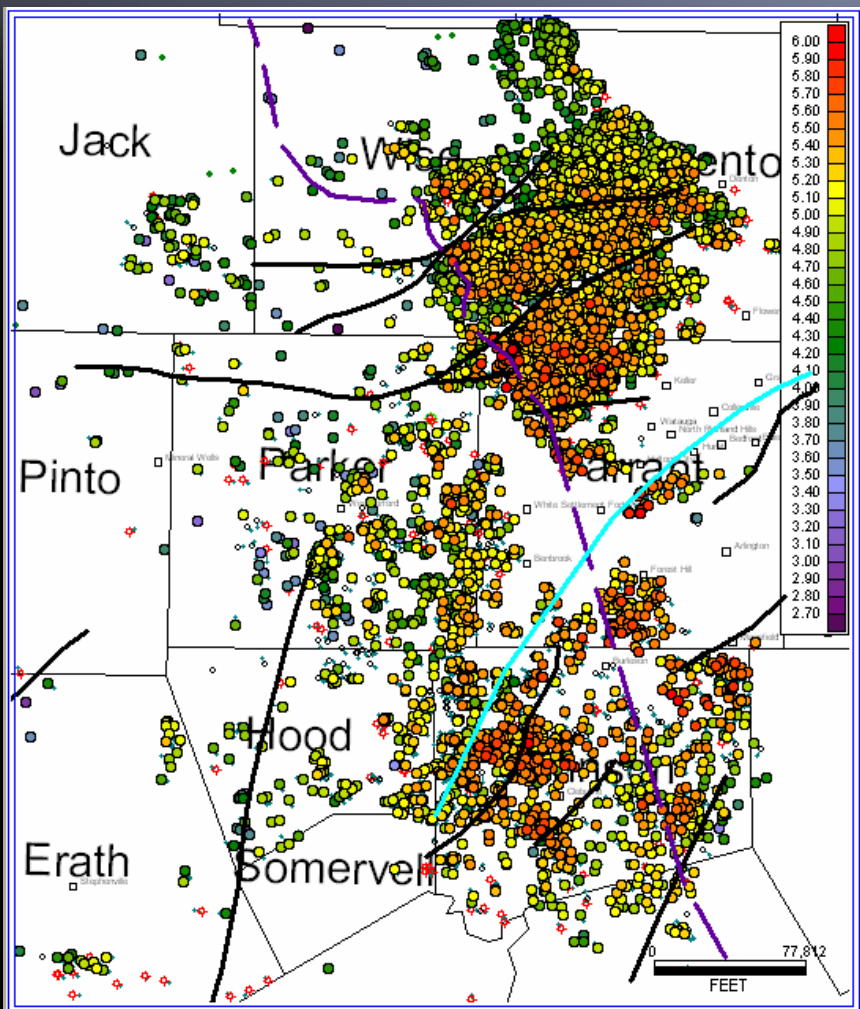
Not all “Shales” are Black Shale

- Barnett mostly mudstone
- Devonian Shales, Appalachian Basin comprised of black shales, grey shales, and siltstones
- Middle Bakken “Shale” comprised of dolomite, sandstone, and shale
- Haynesville samples seen so far are true shales





Comparison of Gas SG with Production and Structure





- GIP

- $G_i = Ah\Phi S_g/B_{gi}$
 - $B_g = 0.0283 ZT/p$

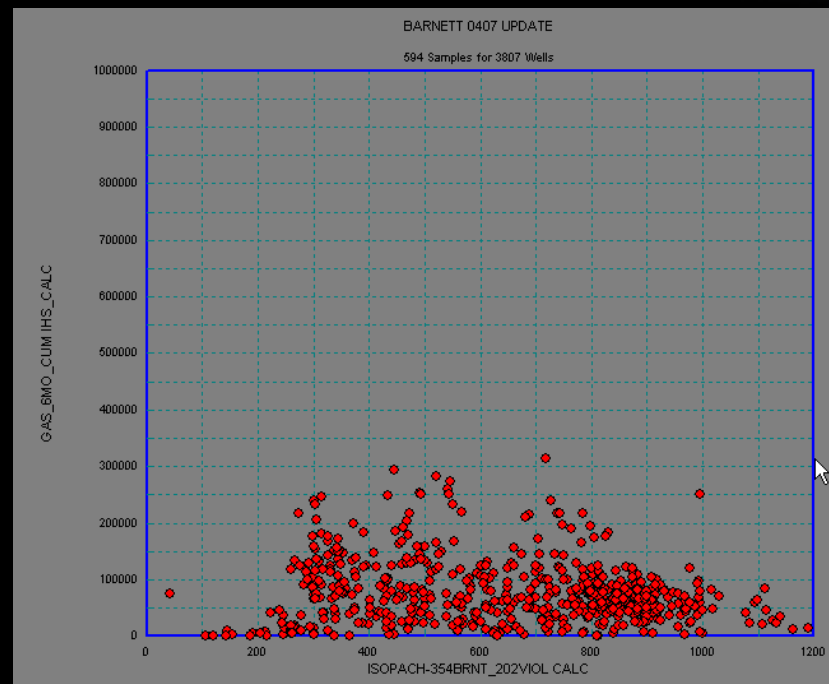
- Deliverability

$$q \approx \frac{2\pi kh(P_{res} - P_{wf})}{u[\ln(r_e / r_w) + S]}$$



Reservoir Quality Issue: Thickness

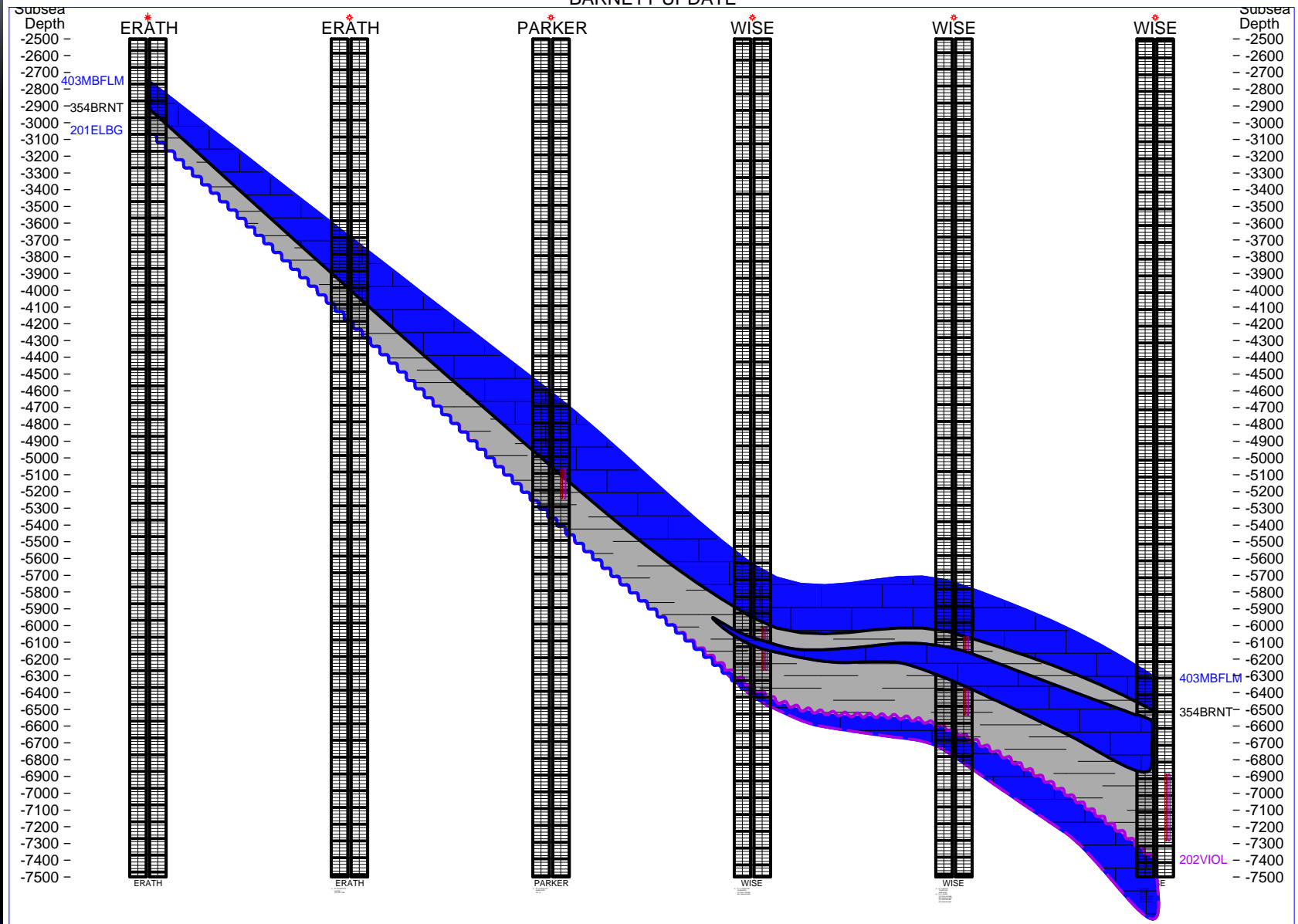
- H is a critical driver in Brnt reservoir quality
 - Both for rate and storage





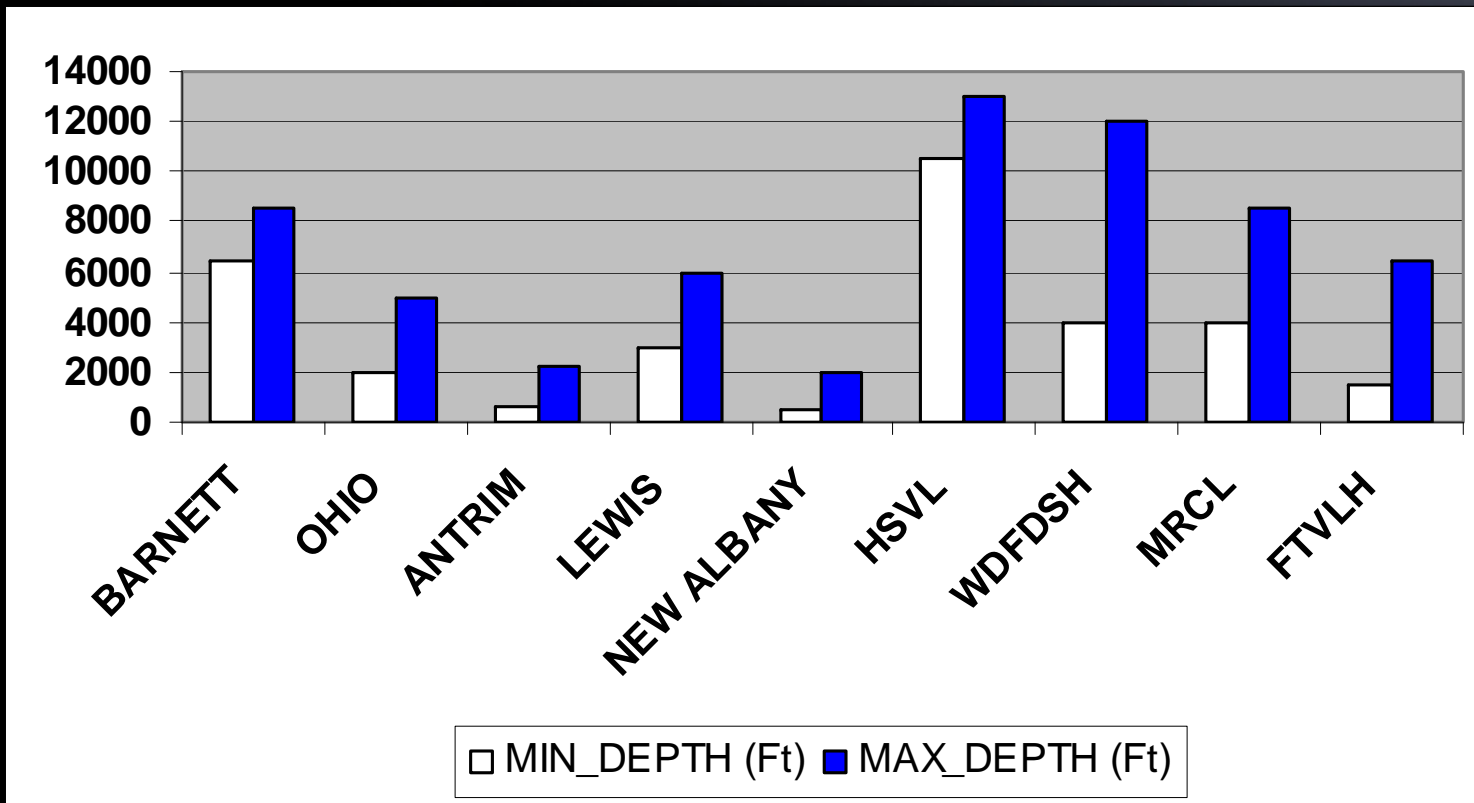
Reservoir Quality Issues: Depth, Pressure

BARNETT UPDATE



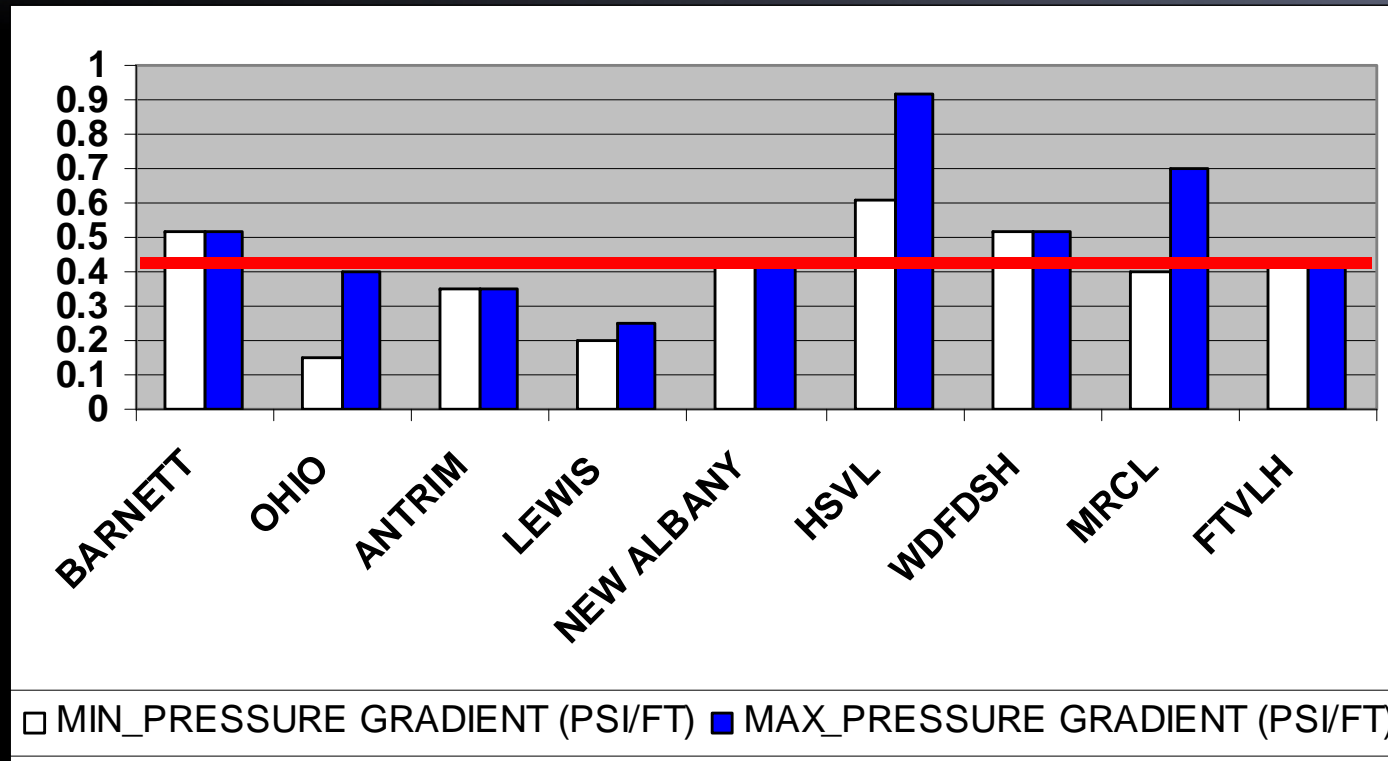


Different Issues in Different Shales: Depth Ranges





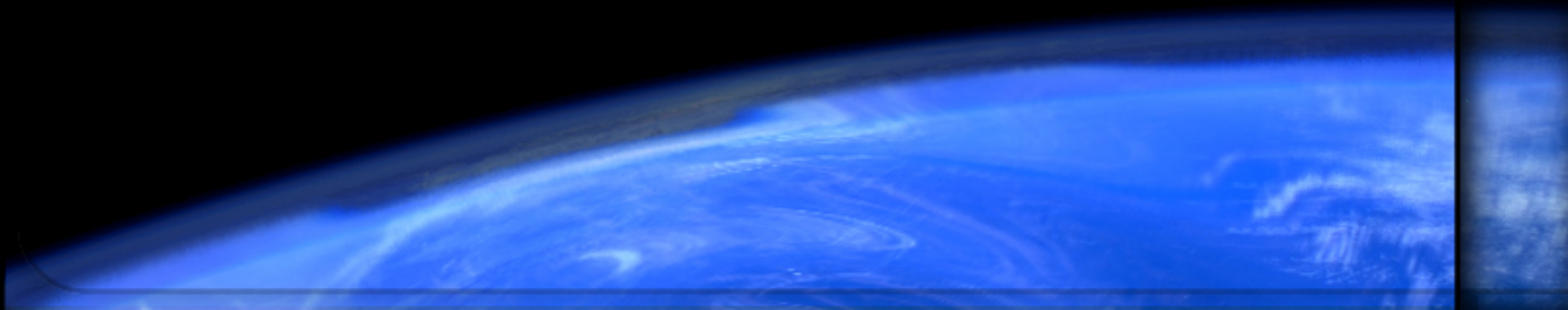
Reservoir Pressure Gradient Range





Geohazards

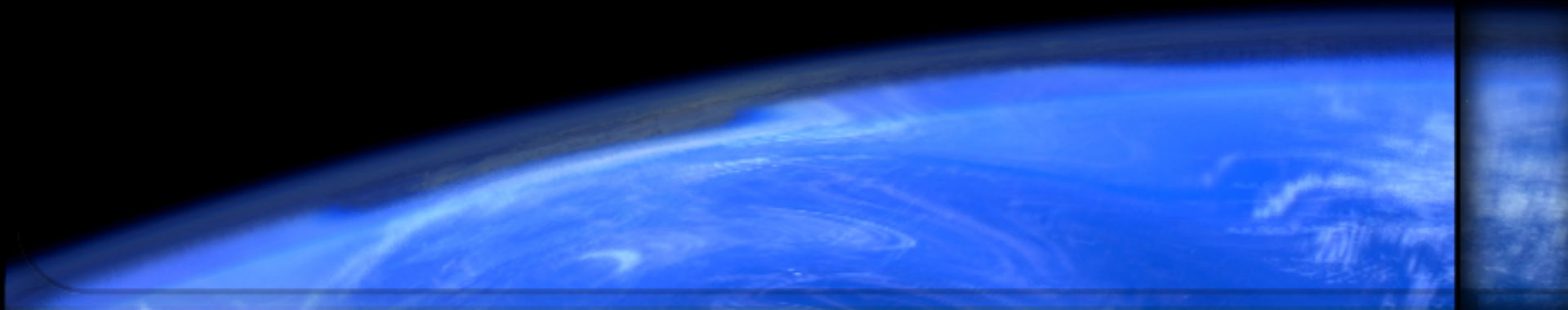
- Barnett contains faults, karsted Ellenberger, resulting in poor wells when touched by the frac treatment
- Similar geohazards aren't being reported (so far) in the Haynesville
- What about the Mt. Enterprise Fault Zone in S. Rusk / SW Panola Counties and the Rodessa Fault Zone in Marion County?





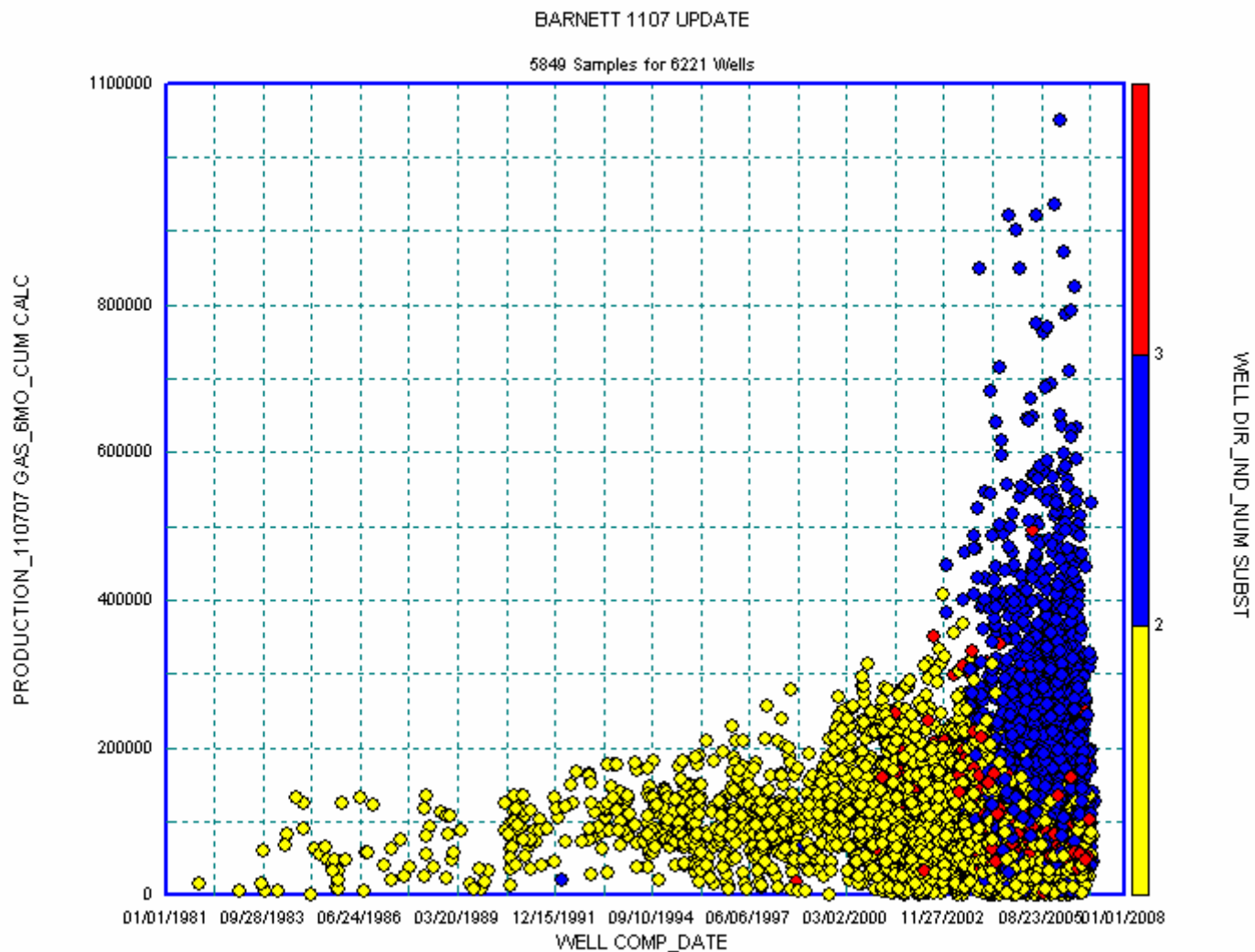
Geomechanical Issues

- Optimum horizontal well architecture
- Complex hydraulic fracturing vs simple hydraulic fracturing
- Formation softening with exposure to frac treatment water contributing to proppant embedment



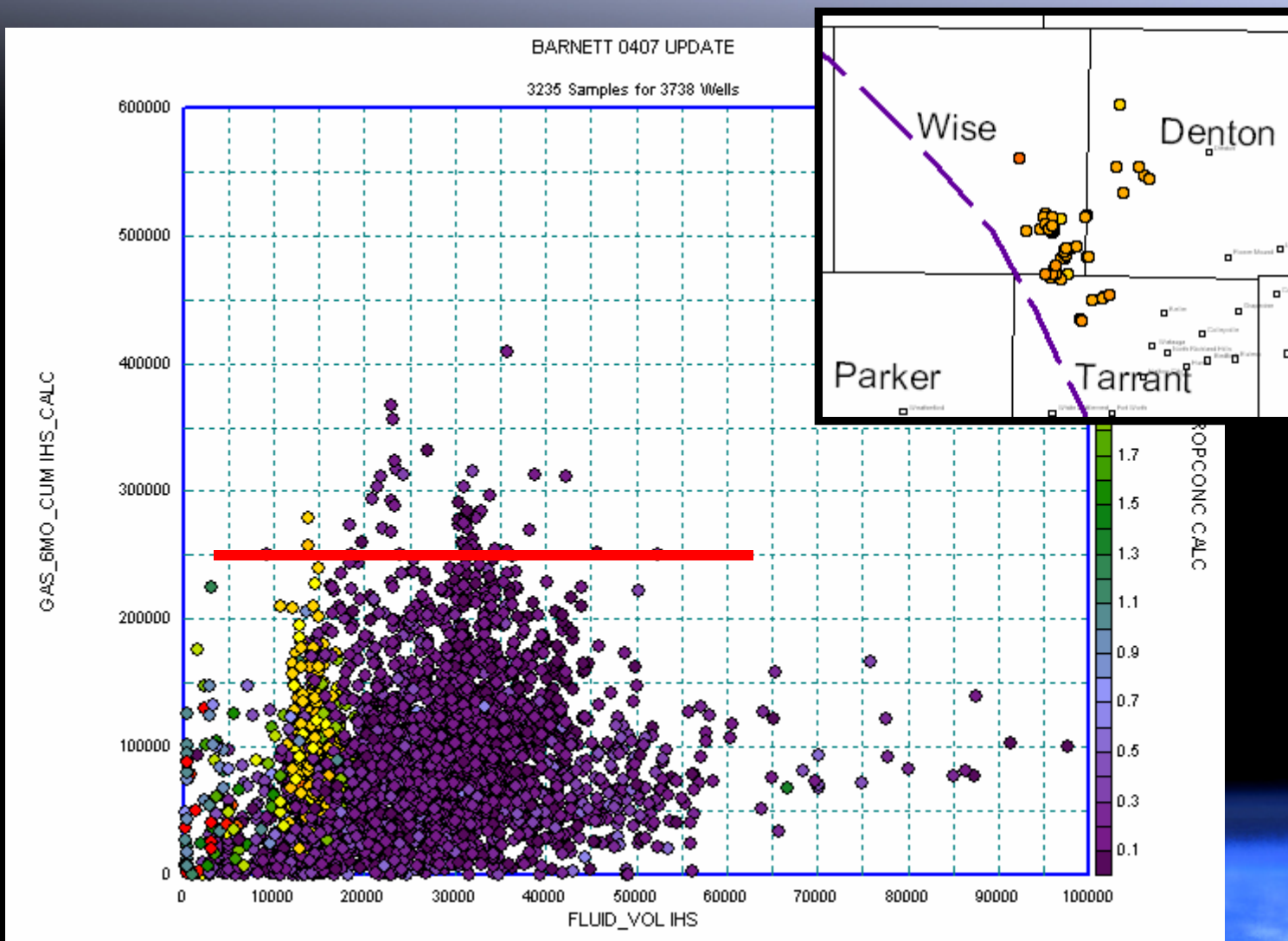


Brnt Horizontals vs Verticals As Of 11/07





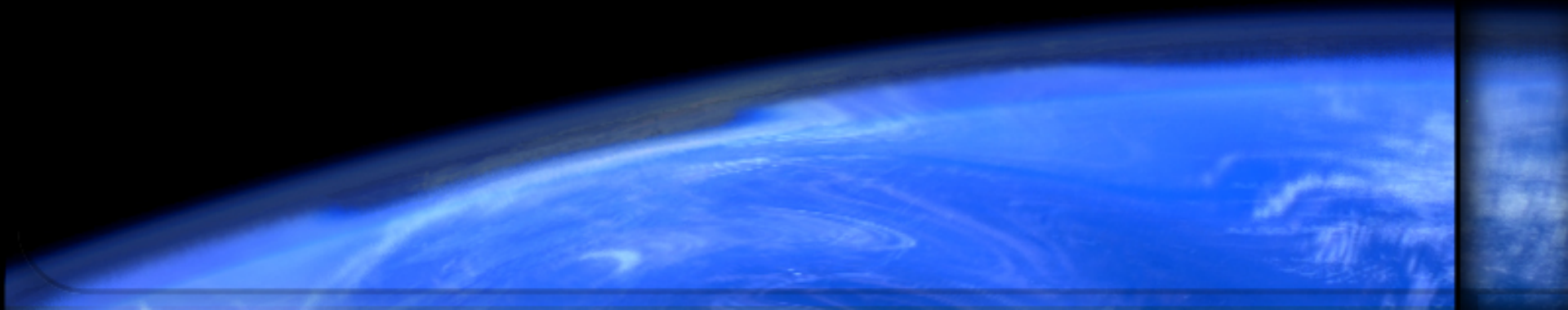
Frac Size vs Production; Color by Prop Concentration






Summary

- Shales have issues
- Different shales have different issues
- “Shales” are comprised of different lithologies
- Geochemistry, reservoir quality, geohazards, geomechanical properties, mineralogy, well architecture, and effective fracture stimulation
ALL matter!



A serene sunset scene over a body of water. The sky is filled with soft, horizontal bands of color, transitioning from deep purple at the top to bright orange and yellow near the horizon. The sun is low on the horizon, creating a bright glow. In the foreground, the silhouettes of trees and reeds are reflected in the calm water. The overall mood is peaceful and contemplative.

Thank You!