“Haynesville Play Next Steps-One Operator’s Perspective”

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Remember the days when a TCF was a lot of Gas?

So we found a few TCF of gas.

Now what do we do?

- 21 Rigs Drilling
- 3 Completion Crews
- Transition to Resource Play Hub (RPH) Development
What Inning are we in?

- Haynesville has grown at an alarming rate in the last 3 years
- Play has evolved quickly and progressively as new techniques and new areas of commercial development have been identified
- We are data rich!......But, many challenges and learnings lie ahead
What We Know……

- Pay Identification → OGIP
- TOC Distribution → Porosity
- Fracability/Containment
- Flow Potential

In Short, Basic Drivers to Well Performance

![Typical Haynesville Well Population](image)

![Petrophysical Workflow](image)

![Log Derived Proxy for TOC](image)
What Drives Haynesville Well Performance
Early Knowledge

Well Performance is driven by connecting reservoir quality rocks to fracture surface area from the stimulation.

You Get what You Frac…

Rate Potential vs. Total Fluid Volume

Rate Potential vs. Proppant Volume
What we are working on……

BUT IS IT REALLY THAT EASY?

- How does the rock fail and what are actual fracture network geometries being created by the stimulation?
- How is the proppant transport determined and mapped?
- How is fracture conductivity distributed around the well bore and does it change with production drawdown?
- What drives fracture conductivity change? Stress…fines or both?
- What is effect of zonal targeting to well performance?
- Is well performance scalable to frac job size and lateral length?
- Does the introduced frac fluid interact with the rock matrix?
- How does the rock matrix behave with production drawdown?
Multiple Porosity Systems
- Skeletal, Intergranular & TOC
- Wettability and Stress Sensitivity the same for both?
- Degree of Connection the same for both?

- Where does our frac water go?
  - Running plug analysis to determine propensity of water to imbibe into matrix.
  - Evaluating whether reservoir parameters are altered from frac fluid imbibition
  - What do production trends tell us?
  - Are permeability systems sensitive to pressure depletion of reservoir pressure
Fracture Propagation Geometry
Understanding Actual Geometry is Difficult

- Complexity of fracture network is difficult to predict
- Degree of complexity will have some effect on proppant settling
- Transport models suggest proppant bottom-loading in Slickwater fluids
- Fracture Conductivity is directly linked proppant loading
- Un-propped fractures likely close and maintain little conductivity

Frac Height contained by Lower Bossier Shale Above and Smackover Below
Zonal Targeting Yields Differing Proppant Distribution

Lower Target provides better contact to proppant pack
Higher targeting covers more vertical pay

- **Low Target**
  - Best NWB conductivity
  - $H \approx 70$, $X_f \approx 215$

- **Mid Target**
  - "Dominate Target"
  - $H \approx 90$, $X_f \approx 175$

- **High Target**
  - Lower NWB conductivity
  - $H \approx 115$, $X_f \approx 100$
Reservoir Simulation Modeling
Matching Outcomes to Reservoir Physics - Set Up

Initial Permeability/Conductivity
- Magenta=Matrix
- Yellow=SRV
- Red=Propped Fracture
- Green/Blues=Un-propped Fracture

- Apply Pressure dependent conductivity and permeability factors over model life
Symmetry Element Modeling
Pressure at 30 Years

- Propped Fracture Areas achieve greatest drawdown but all intervals contribute
Scaling Well Performance to Lateral Length and Completion Stage Count

- Cross Unit Permits Granted in LA
  - 7500’ laterals planned
  - 1st wells spud this year
  - 13% additional recovery from undeveloped setback area
- Positive Surface Use Impact
- Examine and model physical and reservoir constraints
Conclusions

We have come a long way but......We have a lot to learn.

- Continued Completion Trials
- Well Density Pilots Around the Play by All Operators
- Additional Knowledge Around Matrix Behavior
- Frac Understanding....Frac Understanding....and More Frac Understanding
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