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Technology Integration in Hydraulic Fracturing: Being Effective while Remaining Efficient

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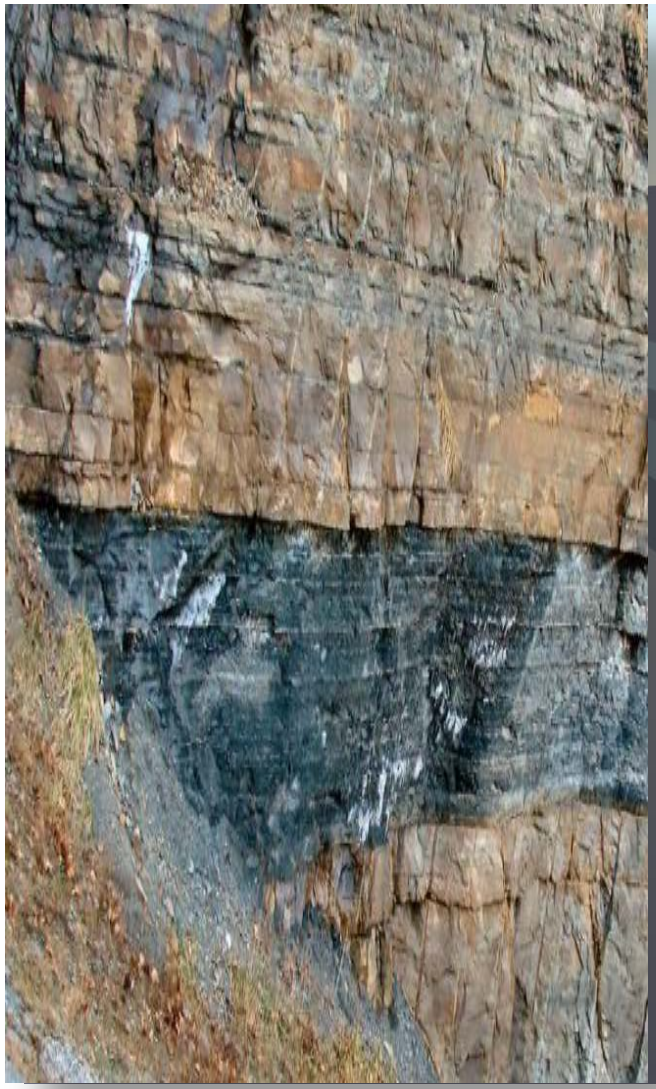
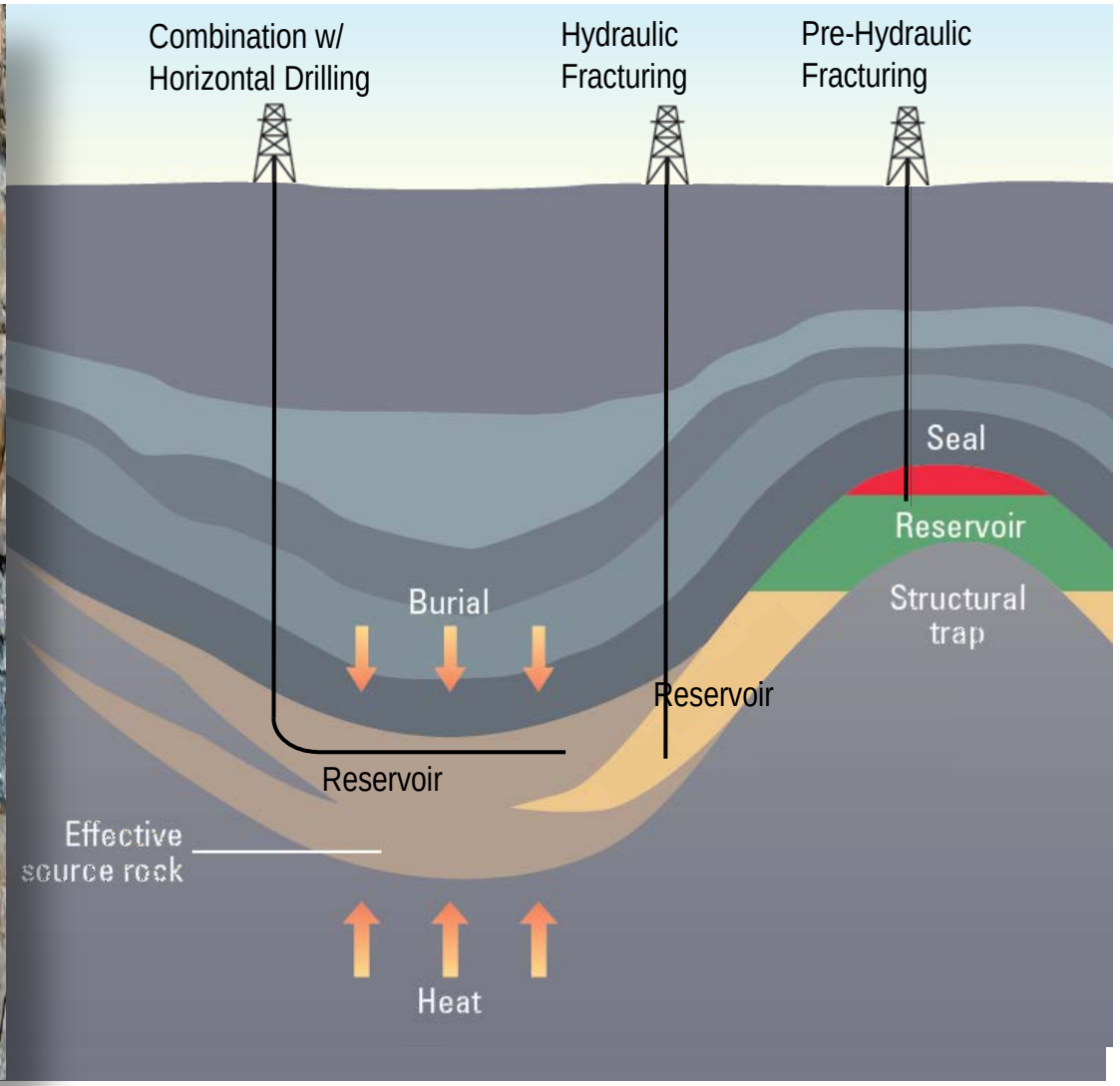
Agenda

- Hydraulic Fracturing and Reservoir Contact
- Reservoir Heterogeneity
- Integrated Engineering Workflow
- Impact of Technology on Production
- Impact of Technology on Resources
- Conclusions

Evolution of Reservoir Rock





Hydraulic Fracturing-Reservoir Contact

Vertical, Perforated Well

Vertical, Perforated Well with Single Frac

200 Ft High x 6” Wellbore

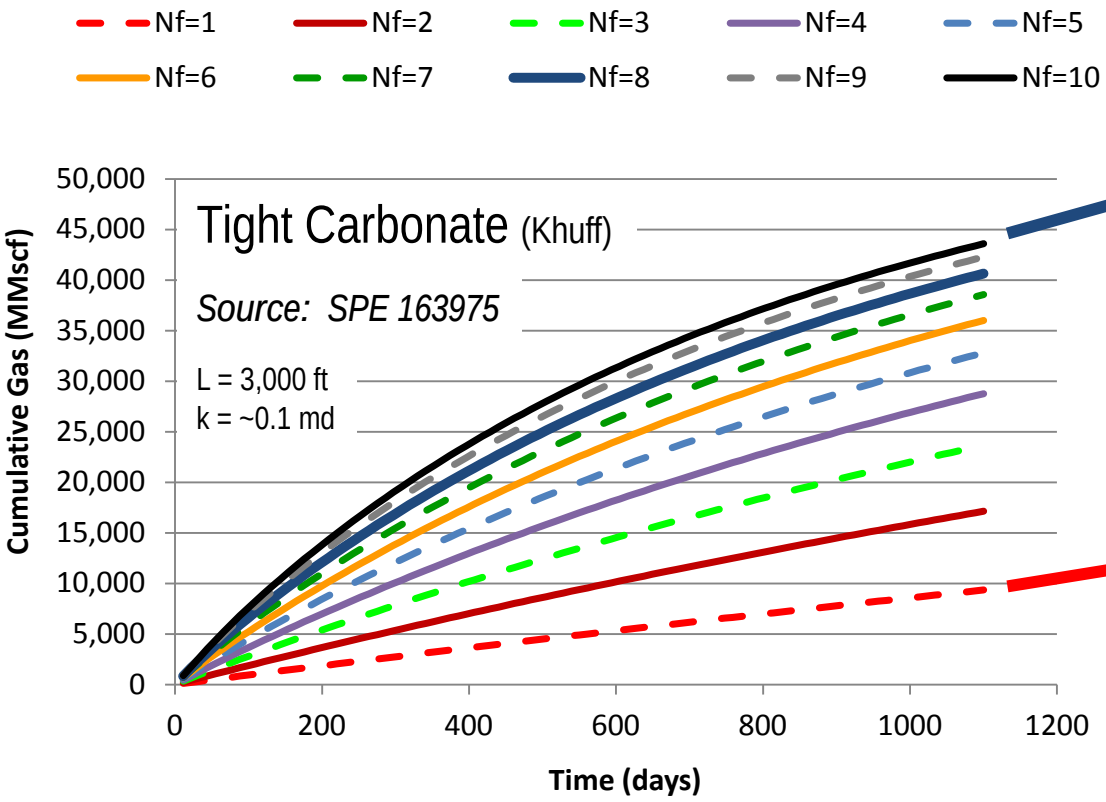
200 Ft High x (1) 200 Ft Frac with 2 Wings Each

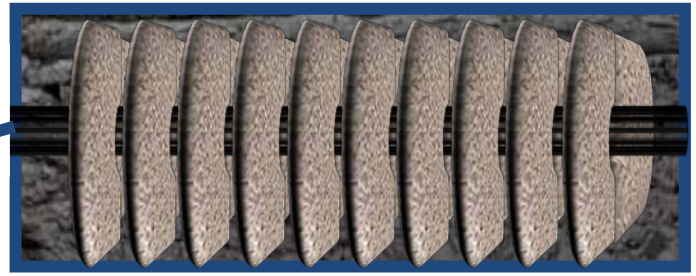
Horizontal, Perforated Well with 15 Frac Stages

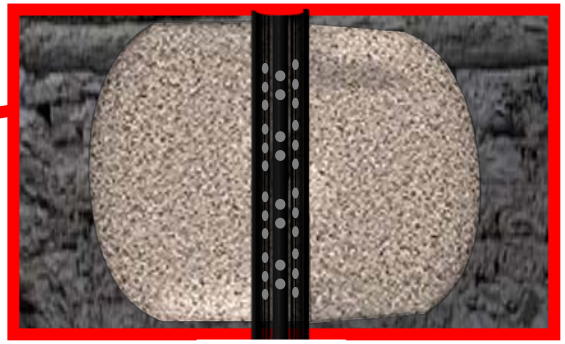
200 Ft High x 6” Wellbore x (15) 200 Ft Frac with 2 Wings Each

Impact of Reservoir Contact

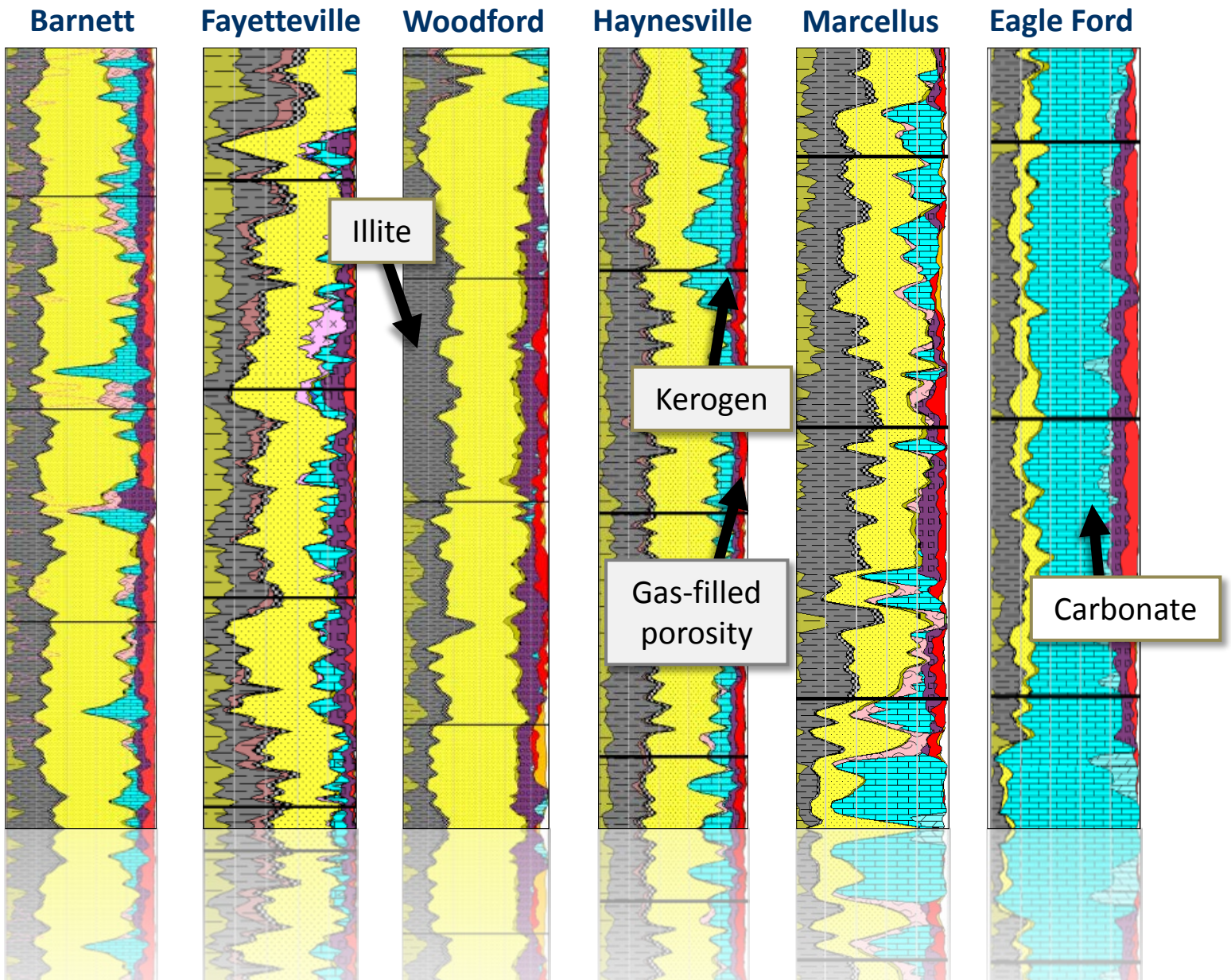
- Increasing Reservoir Contact (surface area) improves production



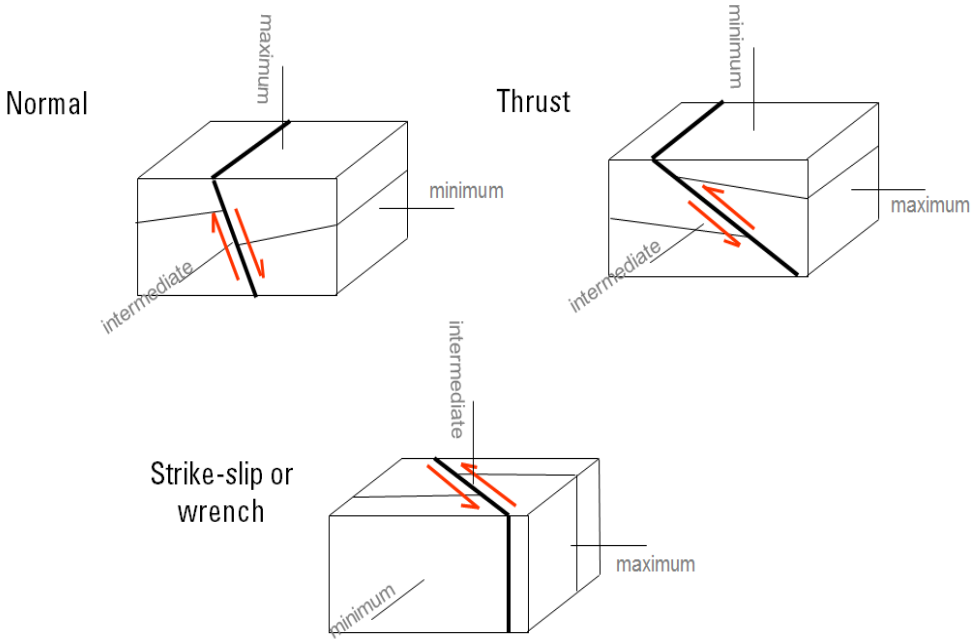




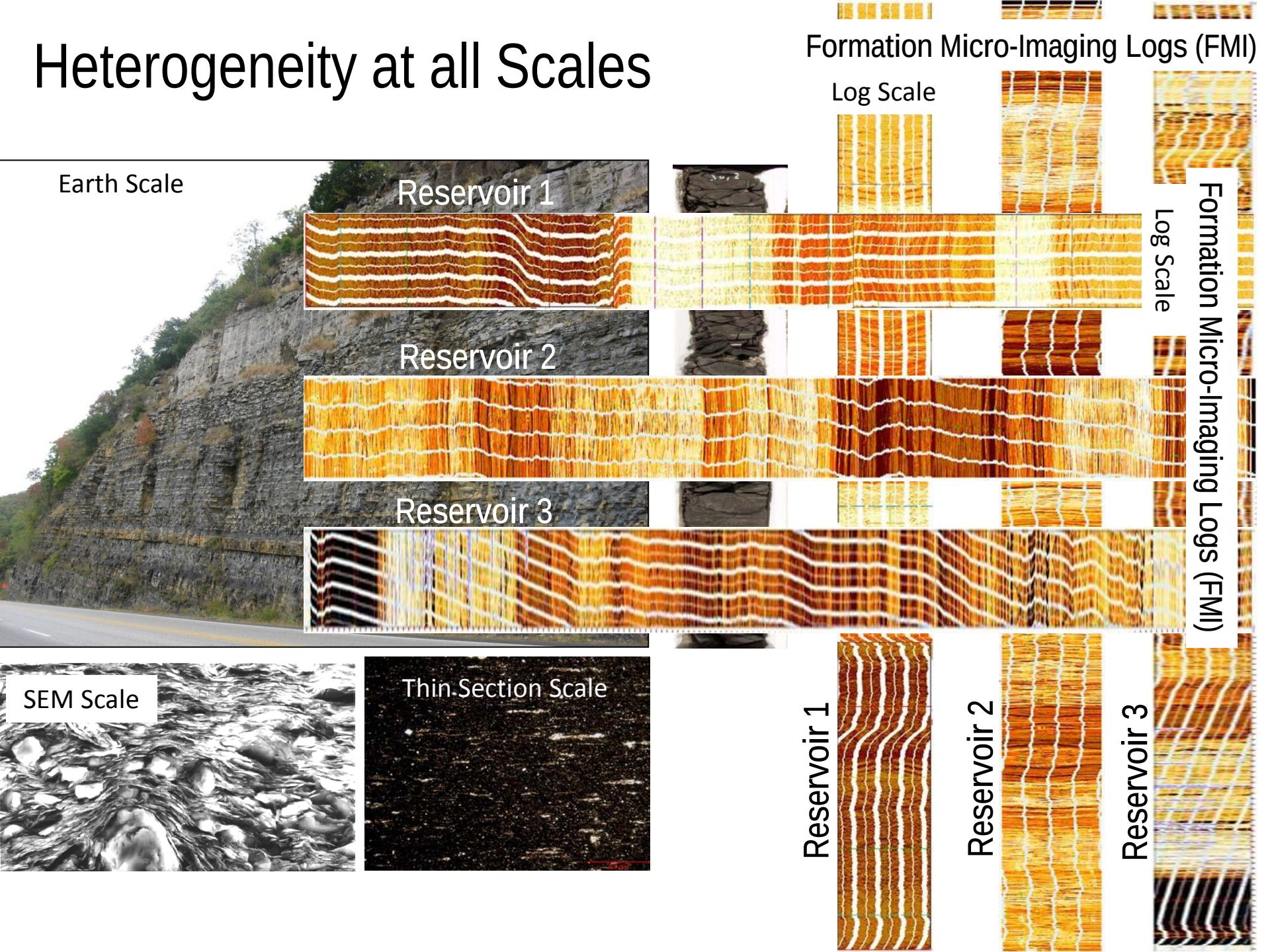
All Reservoirs Are Not the Same



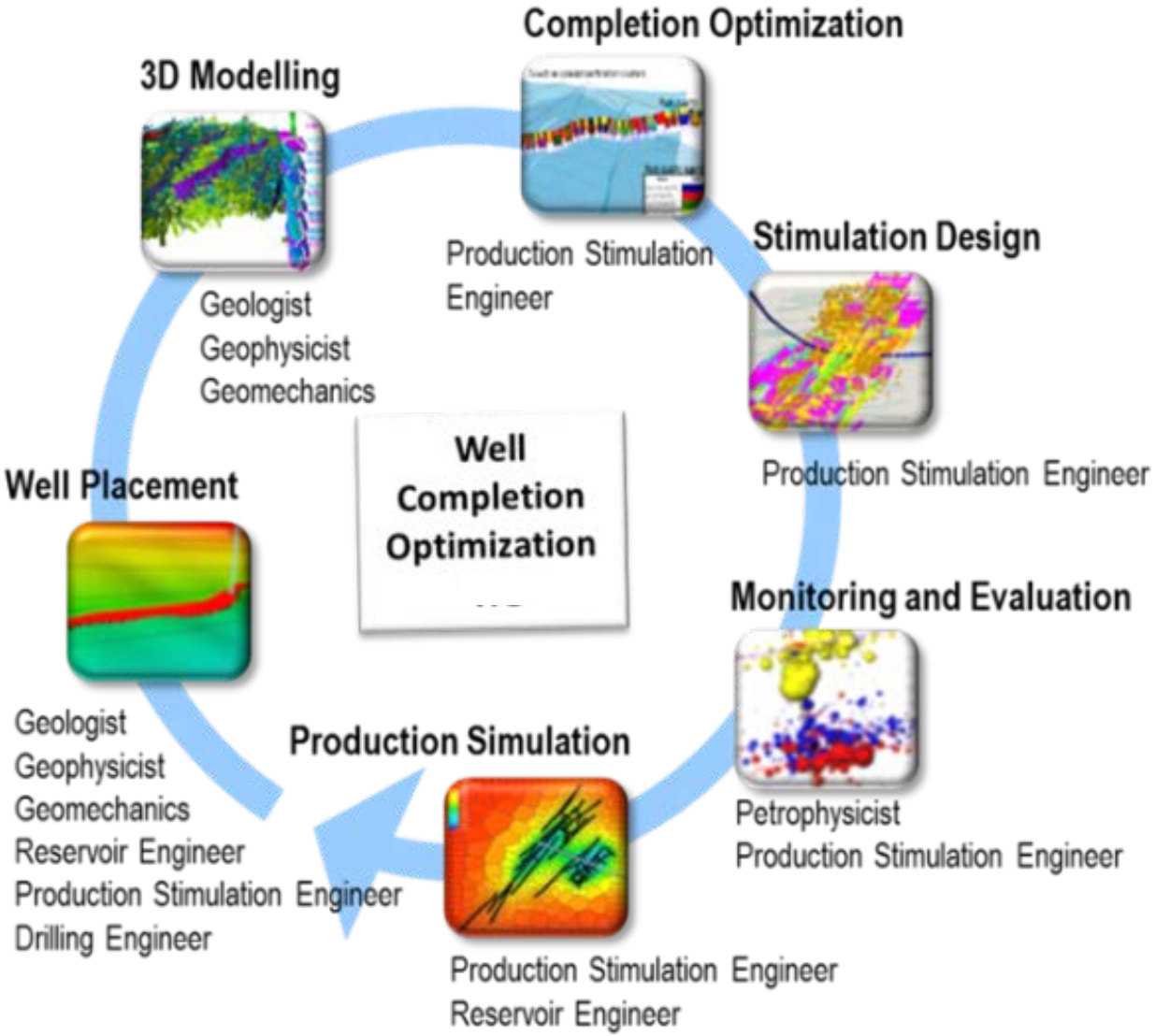
Earth Stresses are Not the Same



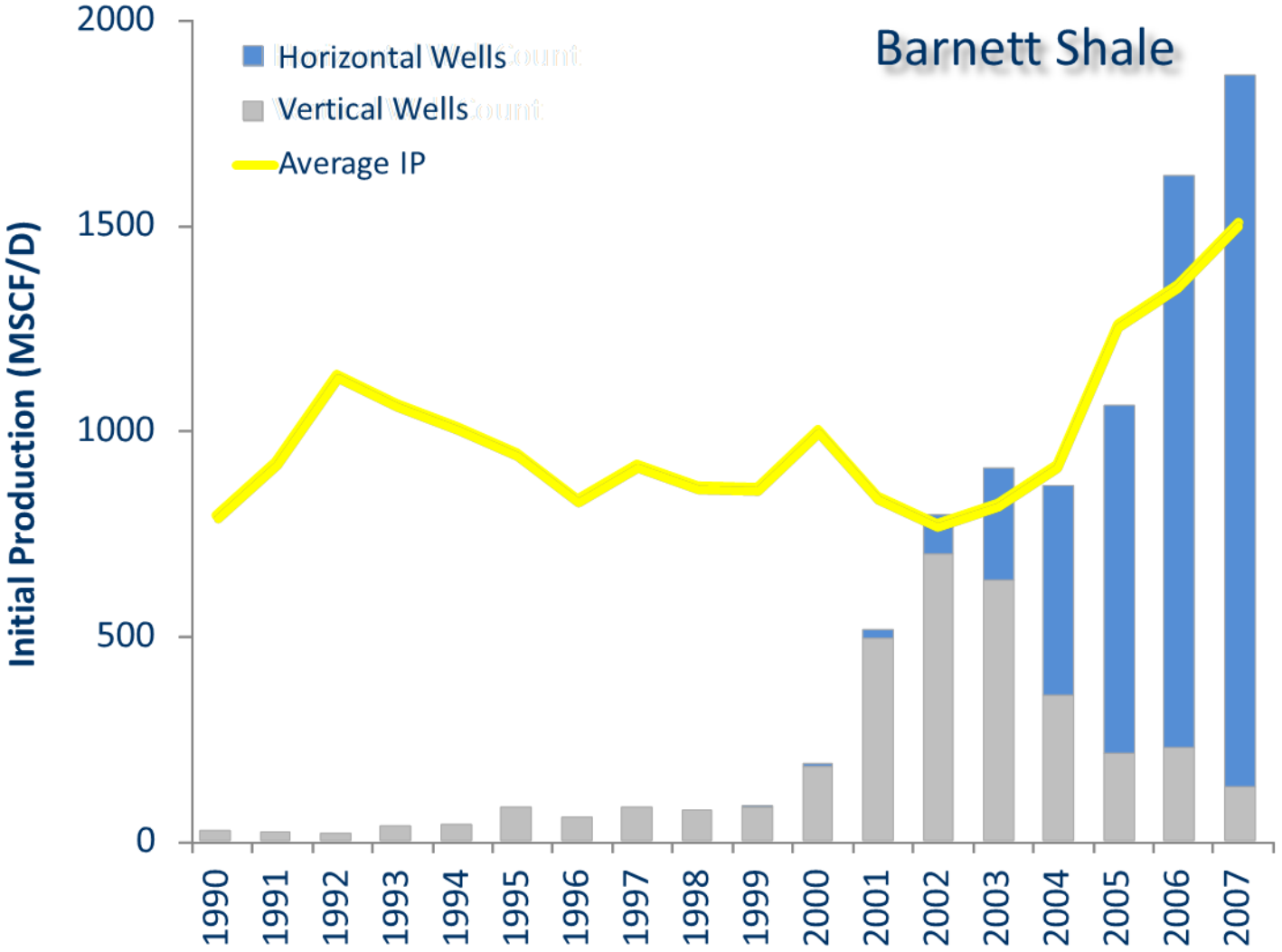
Heterogeneity at all Scales



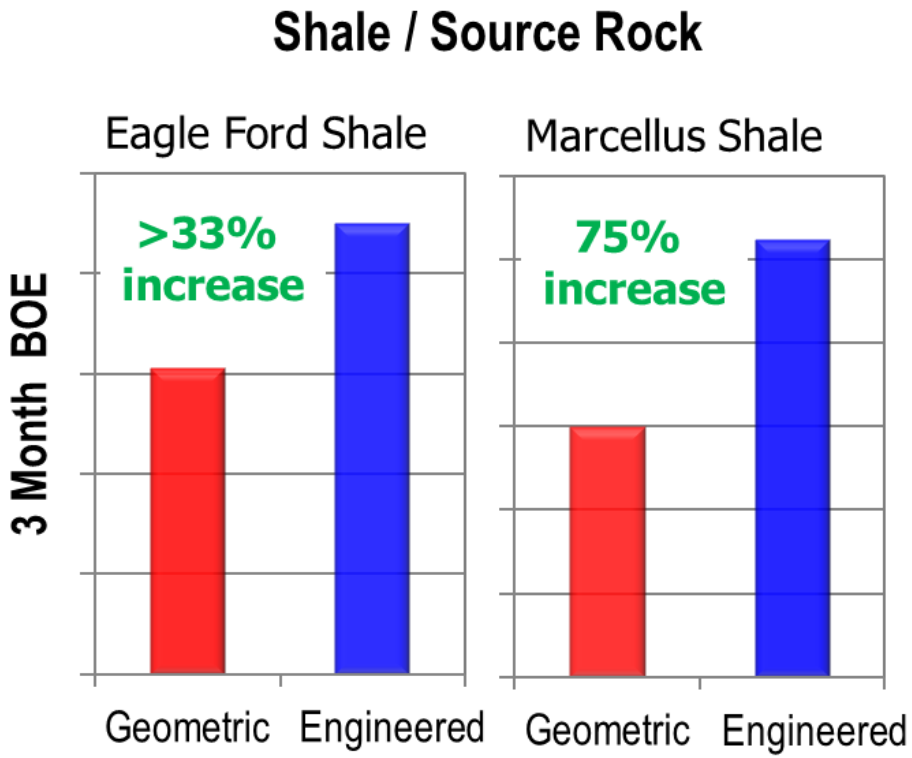
Integrated Engineering Workflow

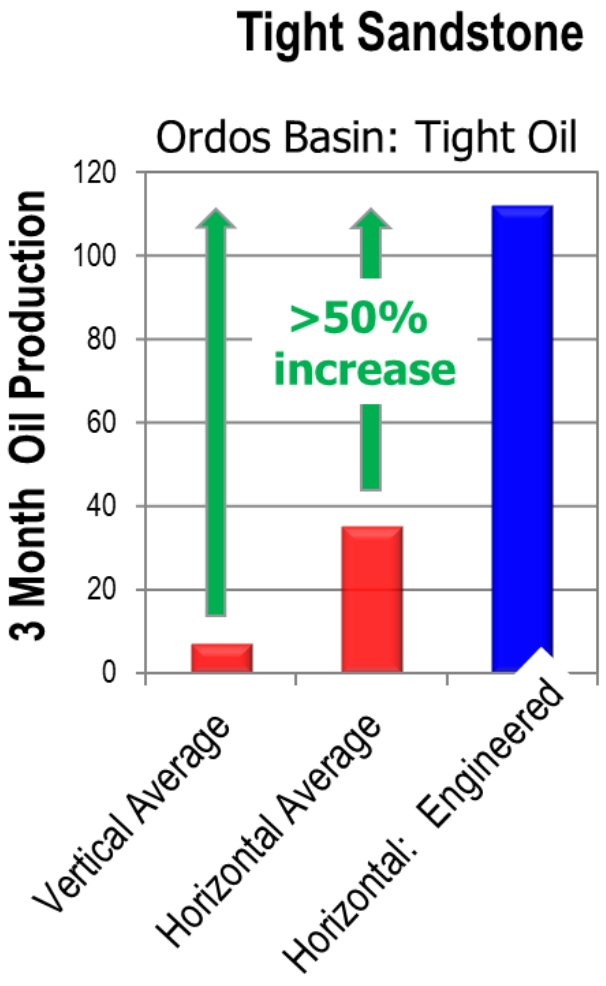


Impact of Technology on Production



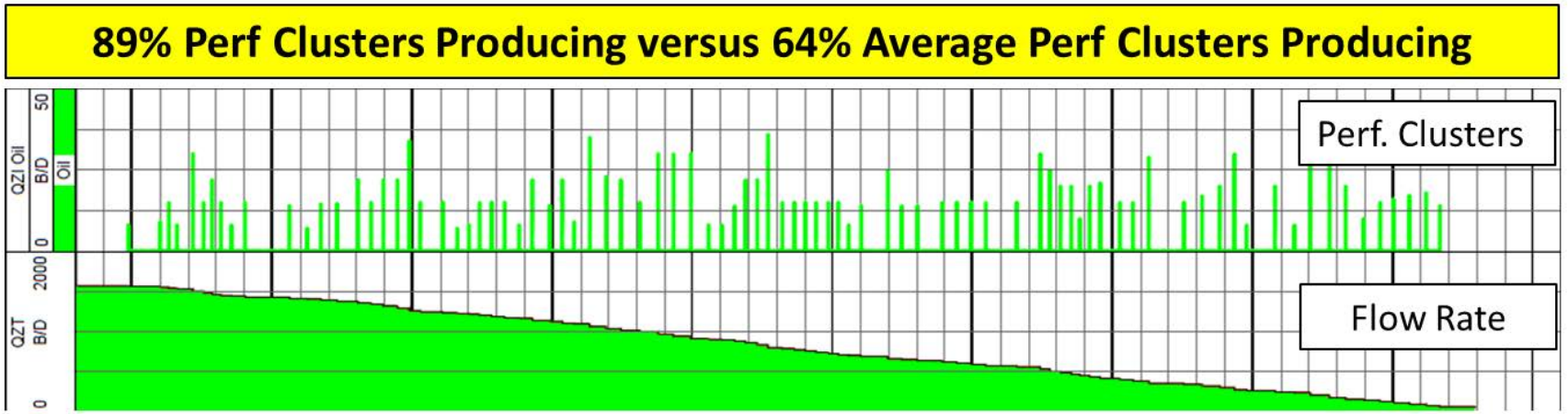
There is only one rule of thumb in fracturing: that there are no rules of thumb in fracturing

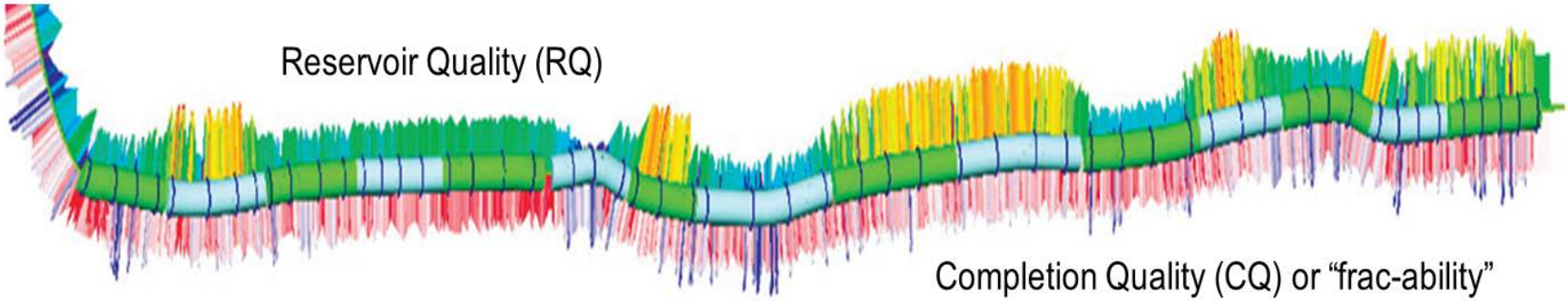




Sources: SPE 158268, SPE 134827, SPE 146872

Impact of Engineering Workflow on Production



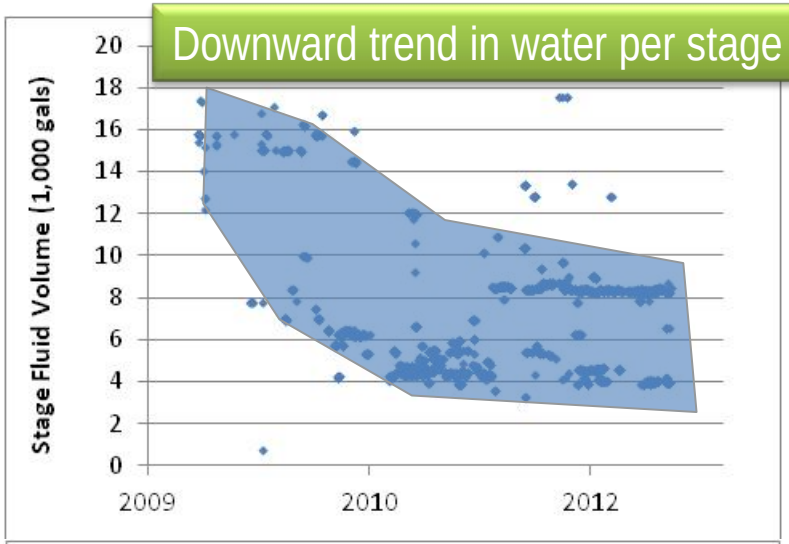


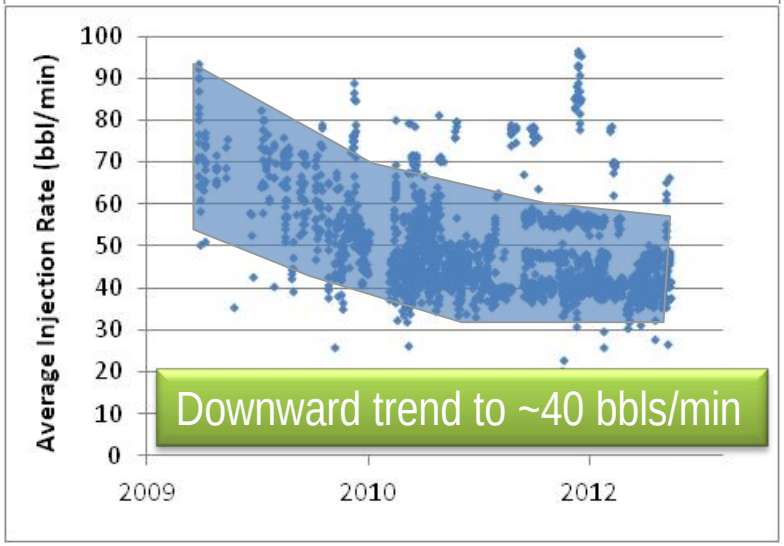
Technology Saving Resources

Channel Fracturing

Conventional fracturing

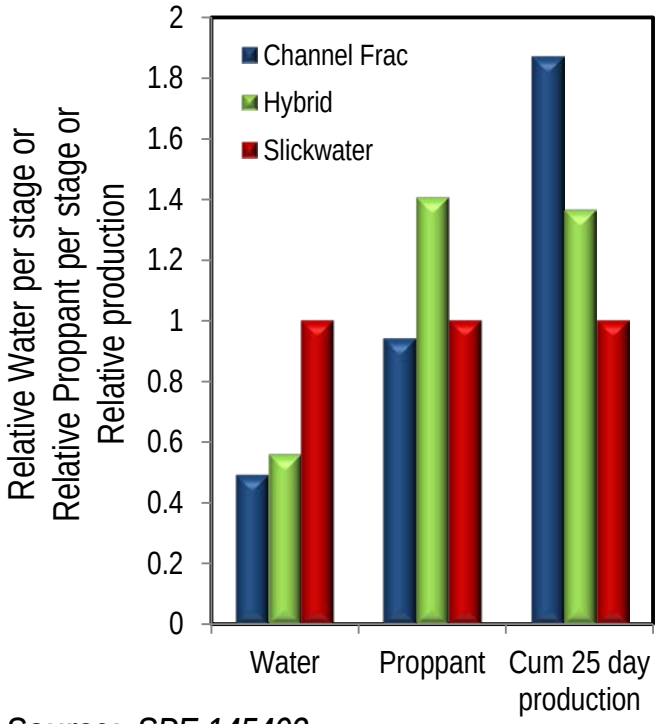
- Trends in the Eagle Ford Shale…





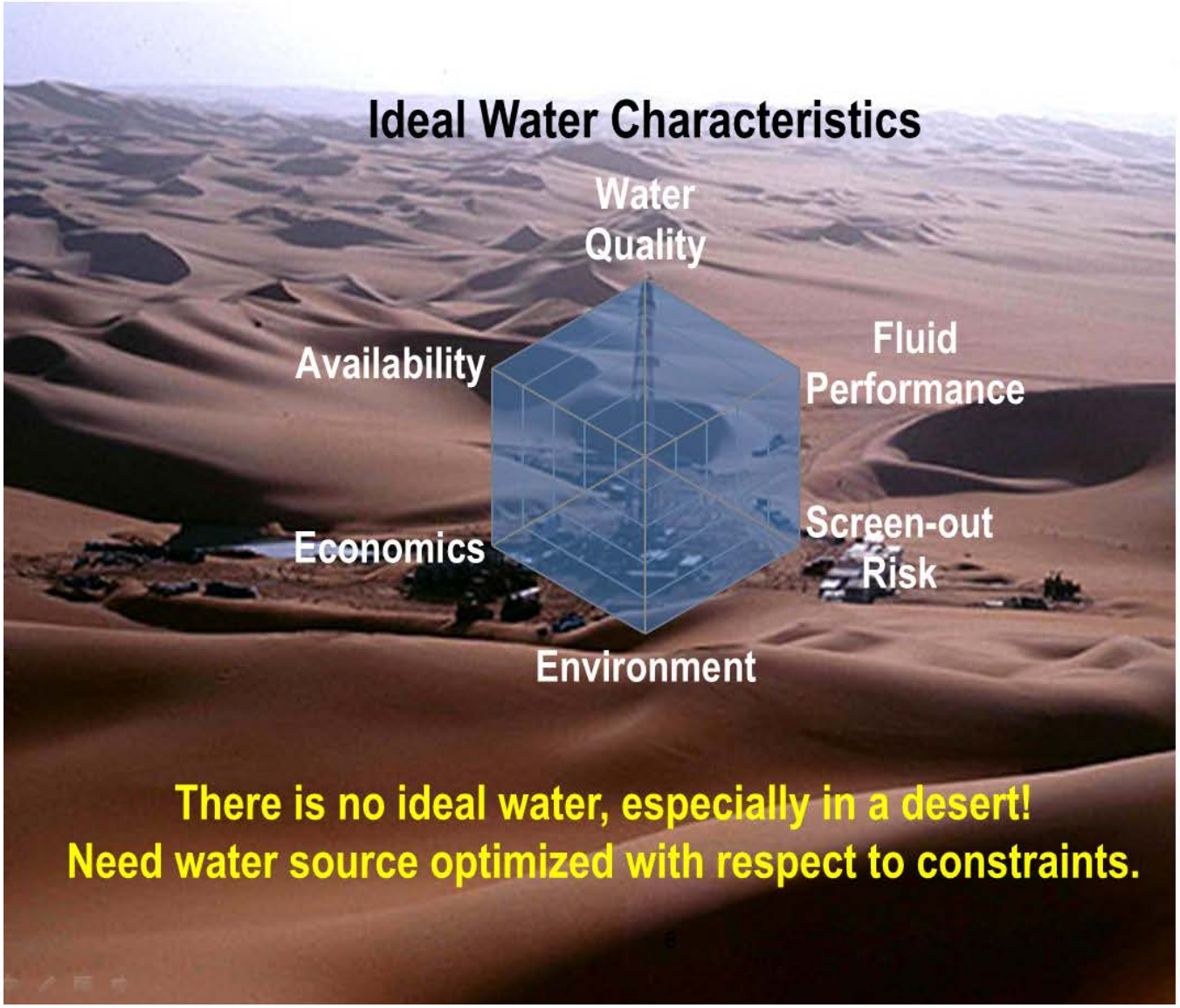
Moving away from slickwater…

- Less Proppant
- Less Water
- More Production



Source: SPE 145403

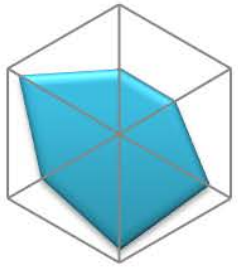
Water Constrains



Fresh Water

Brackish Water

Sea Water



Summary

- Middle East has different stress regimes and infrastructure, technology plays important role in development of unconventional resources
    - Leverage to do “More with Less”
    - Integrate Reservoir data and with Fracture designs to tailor the best treatment for the reservoir, account for heterogeneity
    - Multi-disciplinary, integrated teams with flexibility to optimize
    - Optimize designs for the Reservoir to avoid waste (one solution does not “fit” all
- Water Management strategies
    - Recycle / re-use / treat-for-purpose
    - & technologies more tolerant of poorer water quality