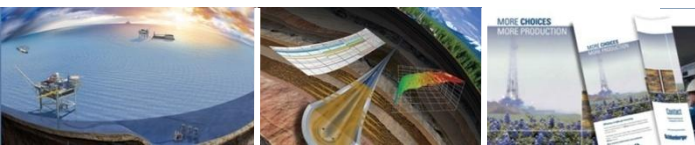


Shale Gas Resources: “Each well could be a PhD thesis”

Valerie Jochen

Unconventional Gas Technical Director

January 25, 2011



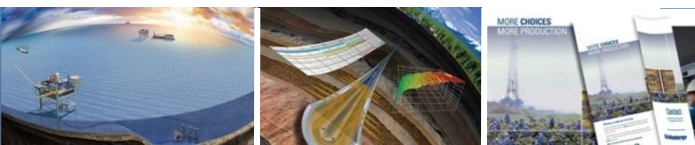
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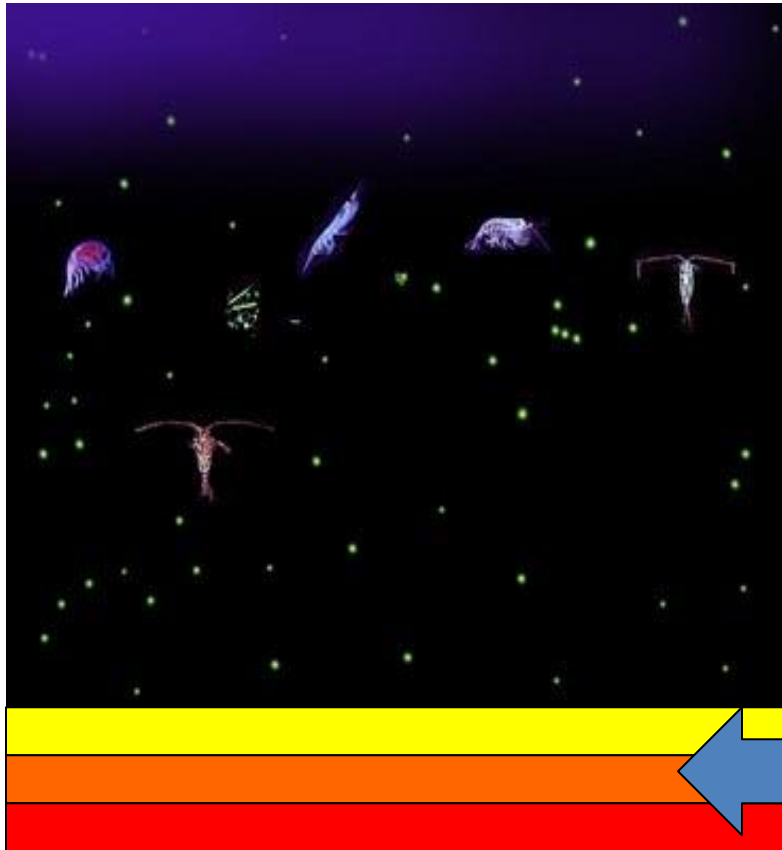


Outline

- Complexity of formations
- Uniqueness of individual field formations
- Re-fracturing required to maintain production

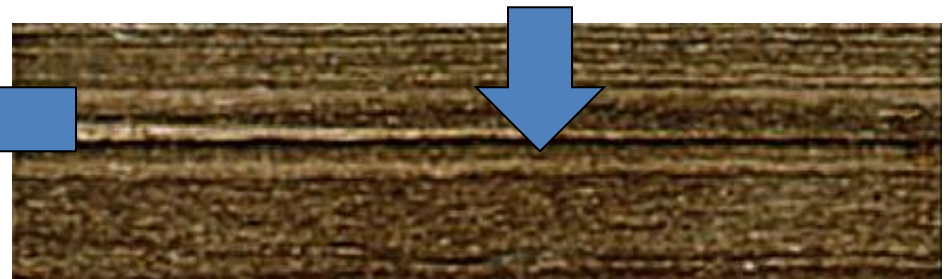


Organic Shale



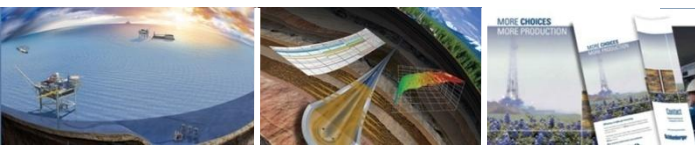
- Deposited in environment with little or no oxygen. Animals can't survive and organic mush accumulates

- Where sediment contains more than 5% organic matter (by volume), it eventually forms a rock known as a **Black Shale**

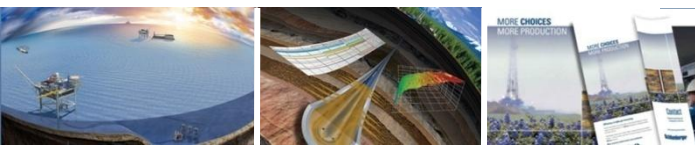
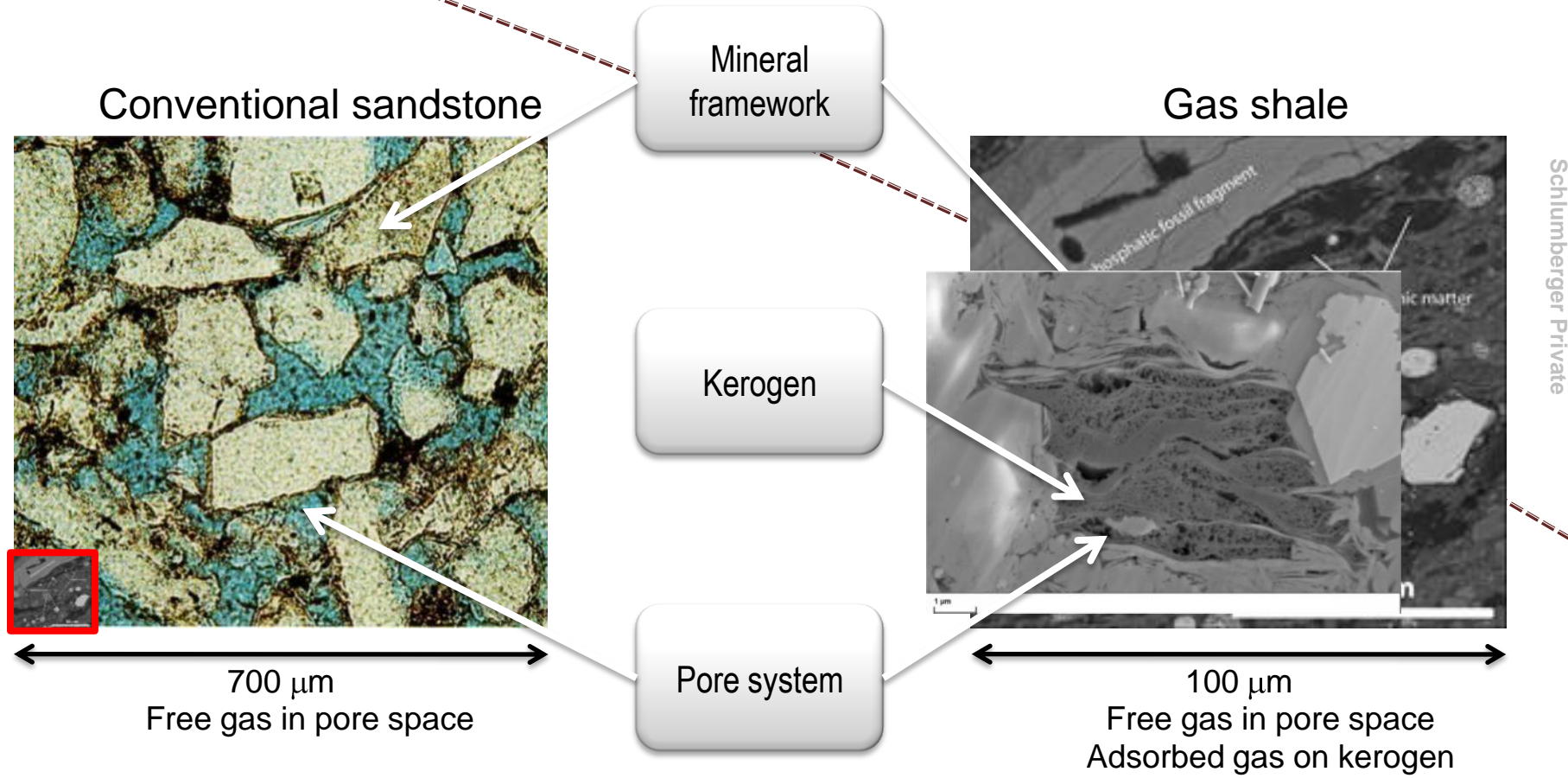


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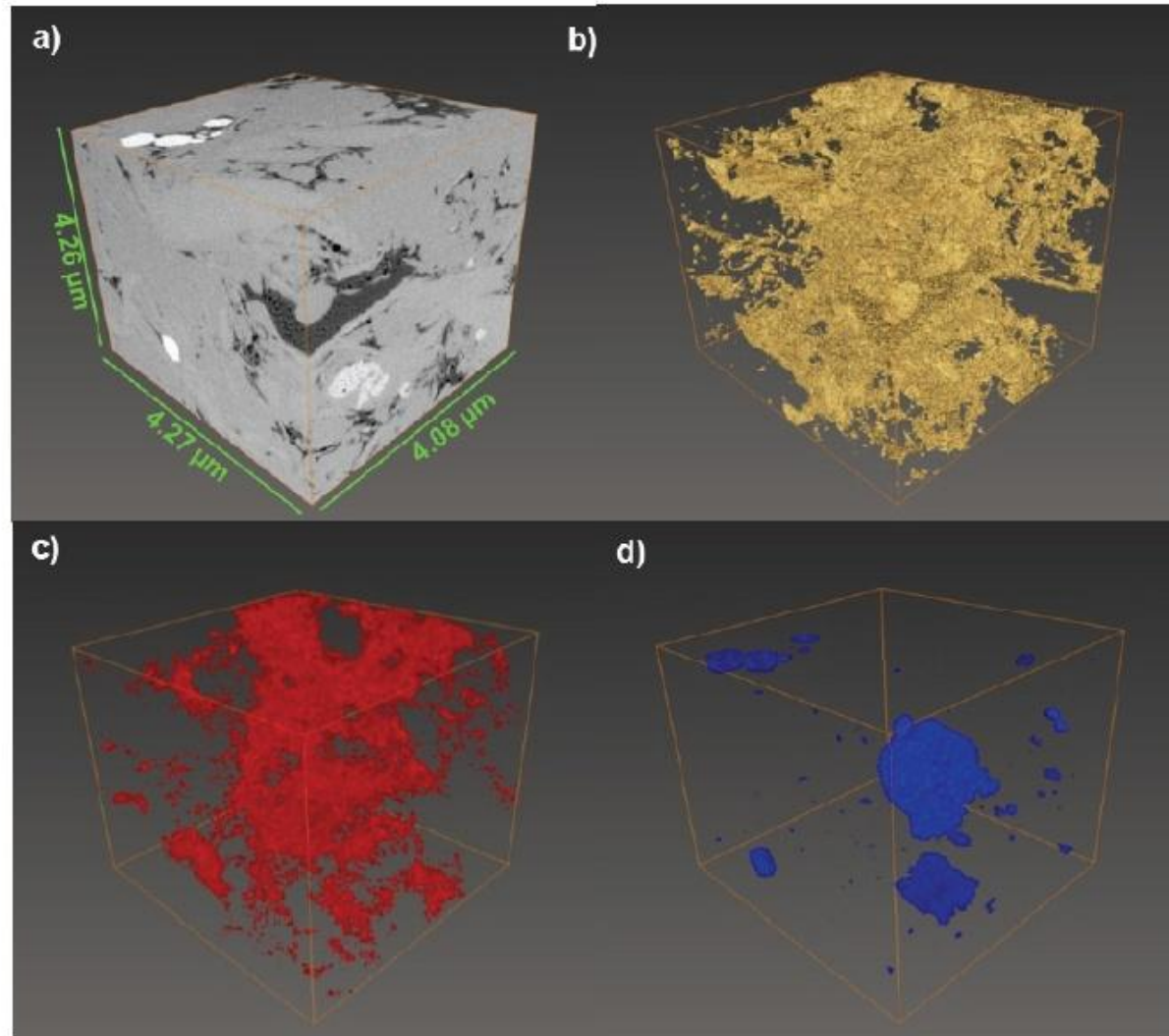
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Factors Controlling Gas Reservoir Quality

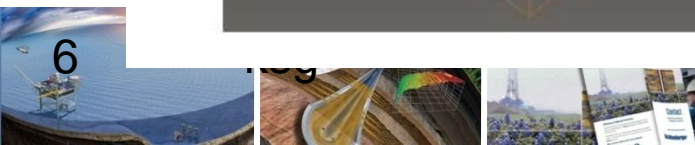


Shale Volume

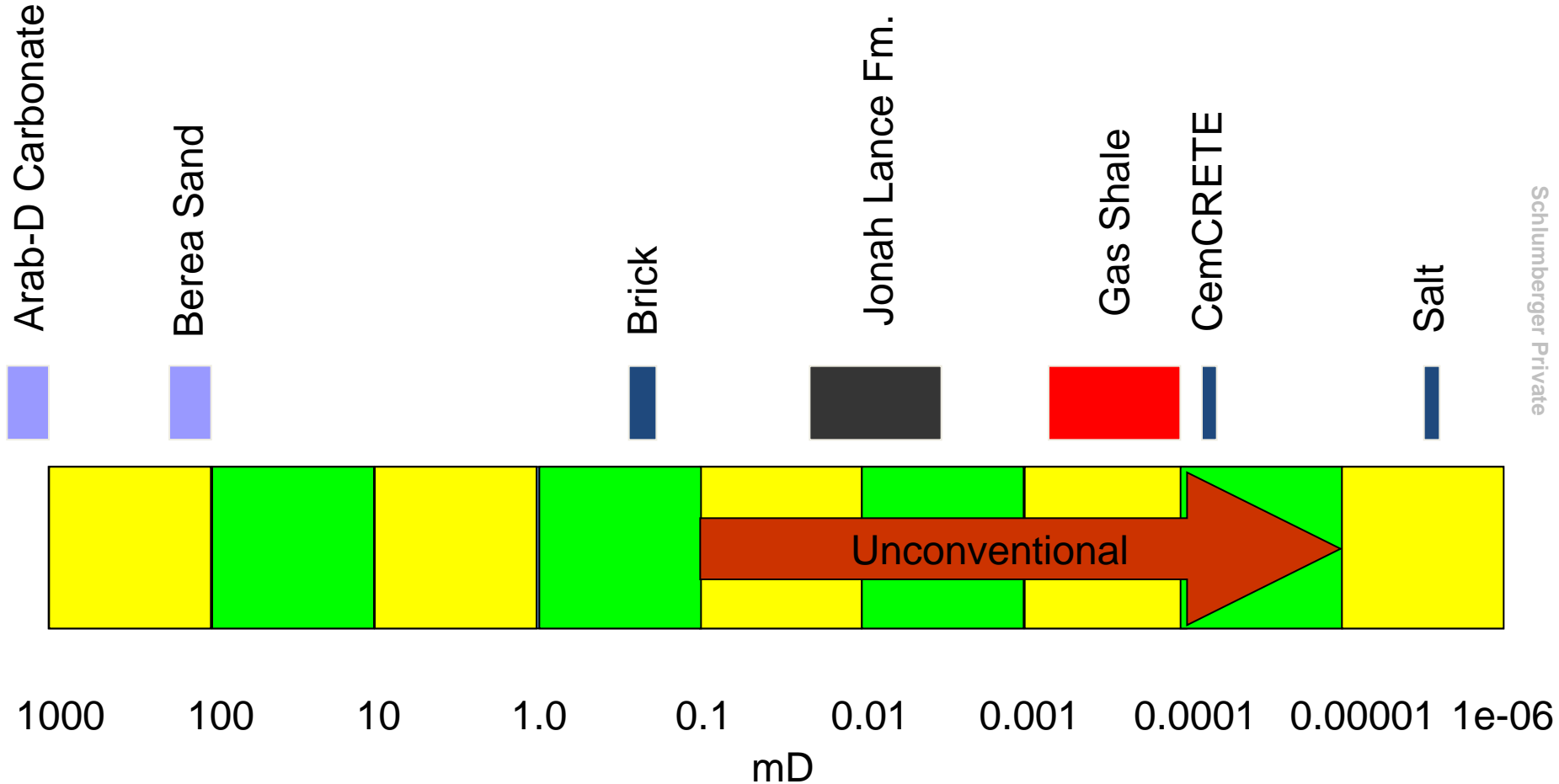


- a) 3d solid
- b) Kerogen
- c) Pores
- d) Pyrite

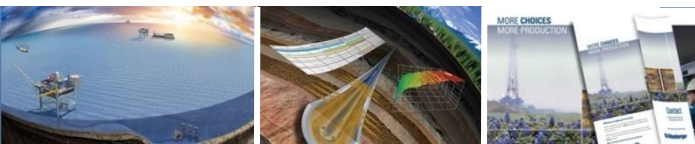
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Shale in Perspective: Permeability

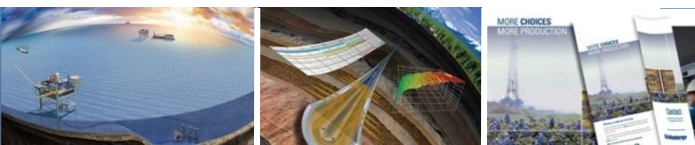
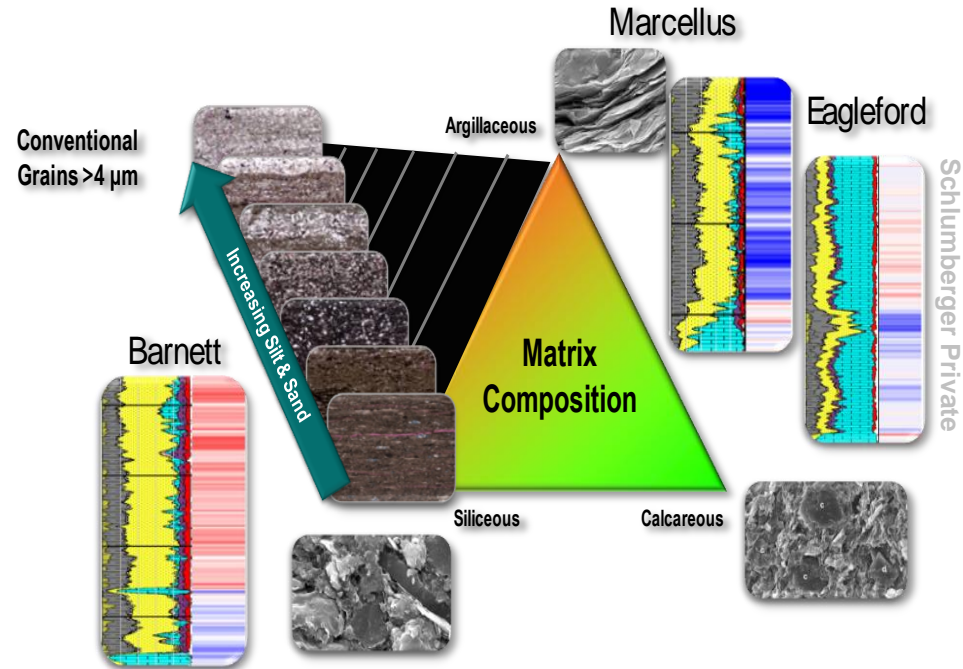


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Understanding Shale Reservoirs

- All shales are different and complex
- Understanding of both reservoir quality and completion quality is critical
- Achieving efficiencies in all aspects of development is needed for success
- Technology requirements vary across plays
- Application of appropriate technology leads to improved production, improved efficiencies, and ultimately improved economic results



Gas Shale Lithology

Woodford

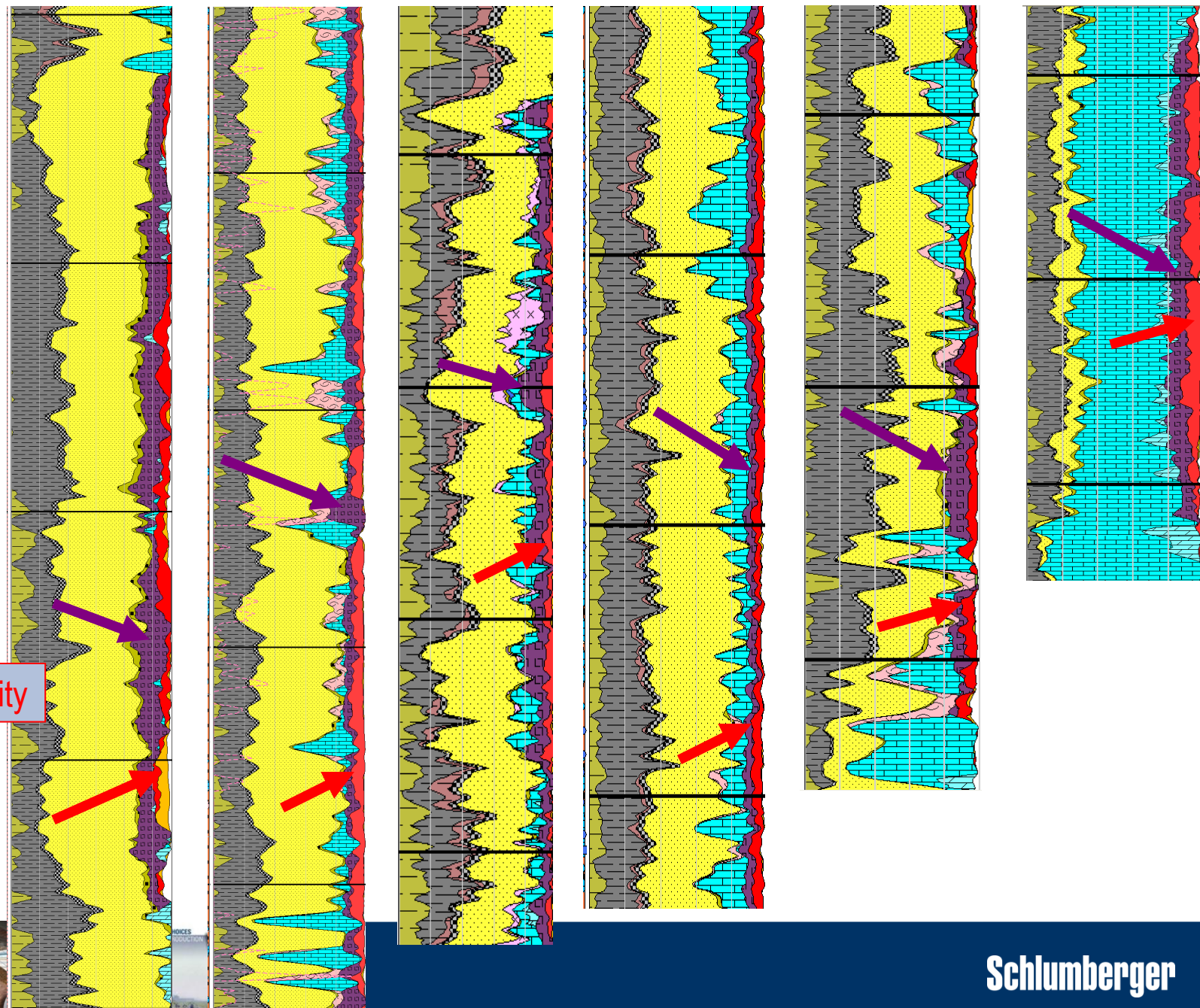
Barnett

Fayetteville

Haynesville

Marcellus

Eagle Ford



Kerogen

Gas-filled porosity

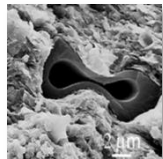


Understanding Reservoir & Completion Quality

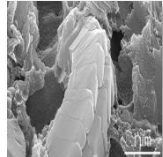
Integration of Core, Log, and Laboratory data at all scales



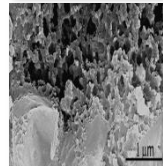
Petrology



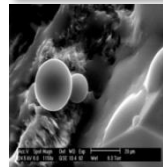
Type II
Marine
Liptinite



Type II
Marine
Microalgae

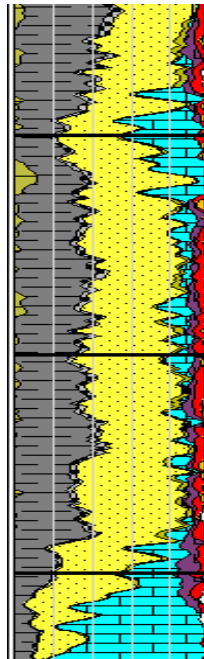


Mixed
Amorphous

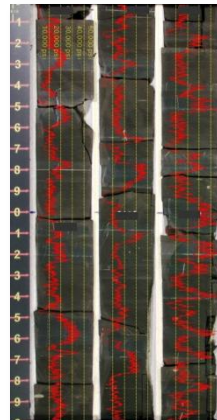


Hydrophobic

Logs

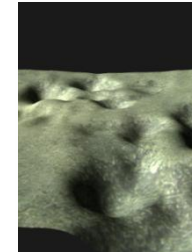
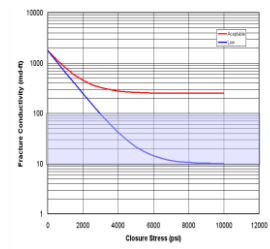


Geomechanics

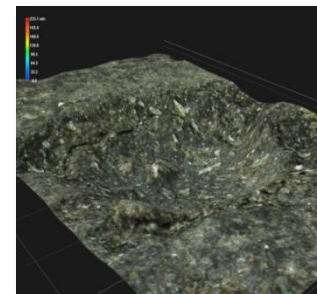


UCS Profile

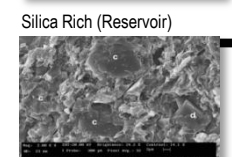
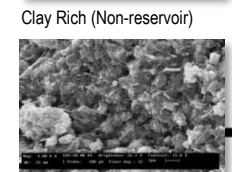
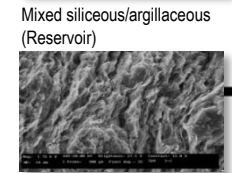
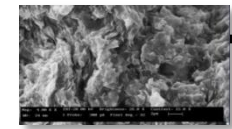
Fluid Sensitivity Fracture Conductivity



Proppant Embedment in Argillaceous Shale

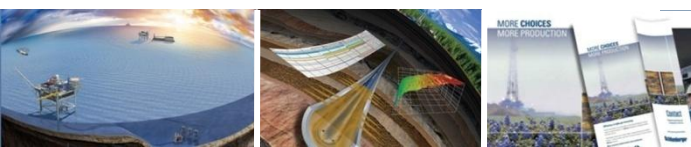


Core to Log Integration

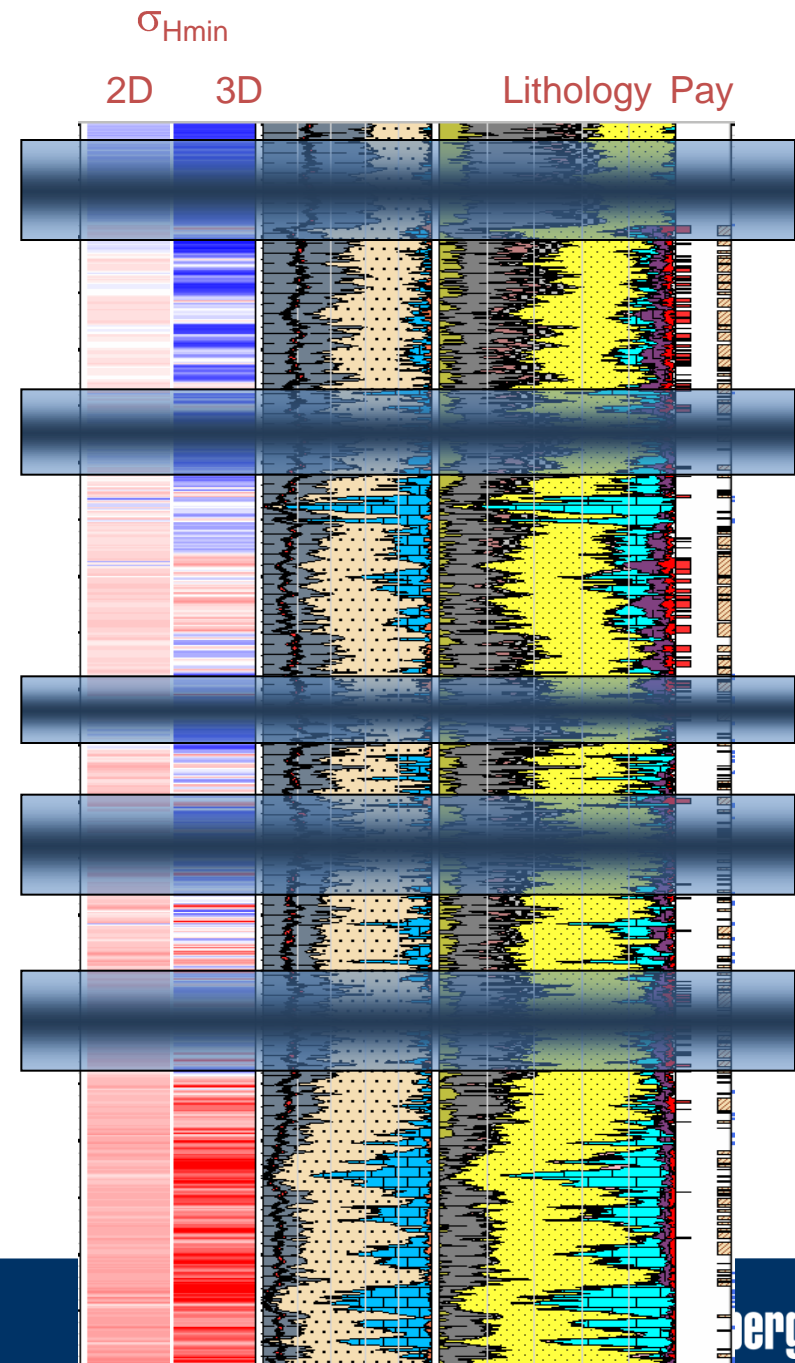


3. Calcite Rich (Non reservoir)

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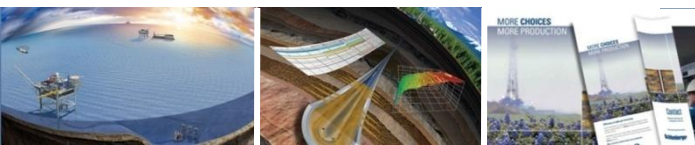


Vertical Heterogeneity

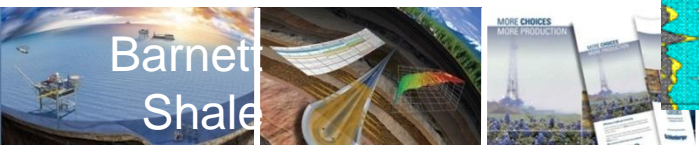
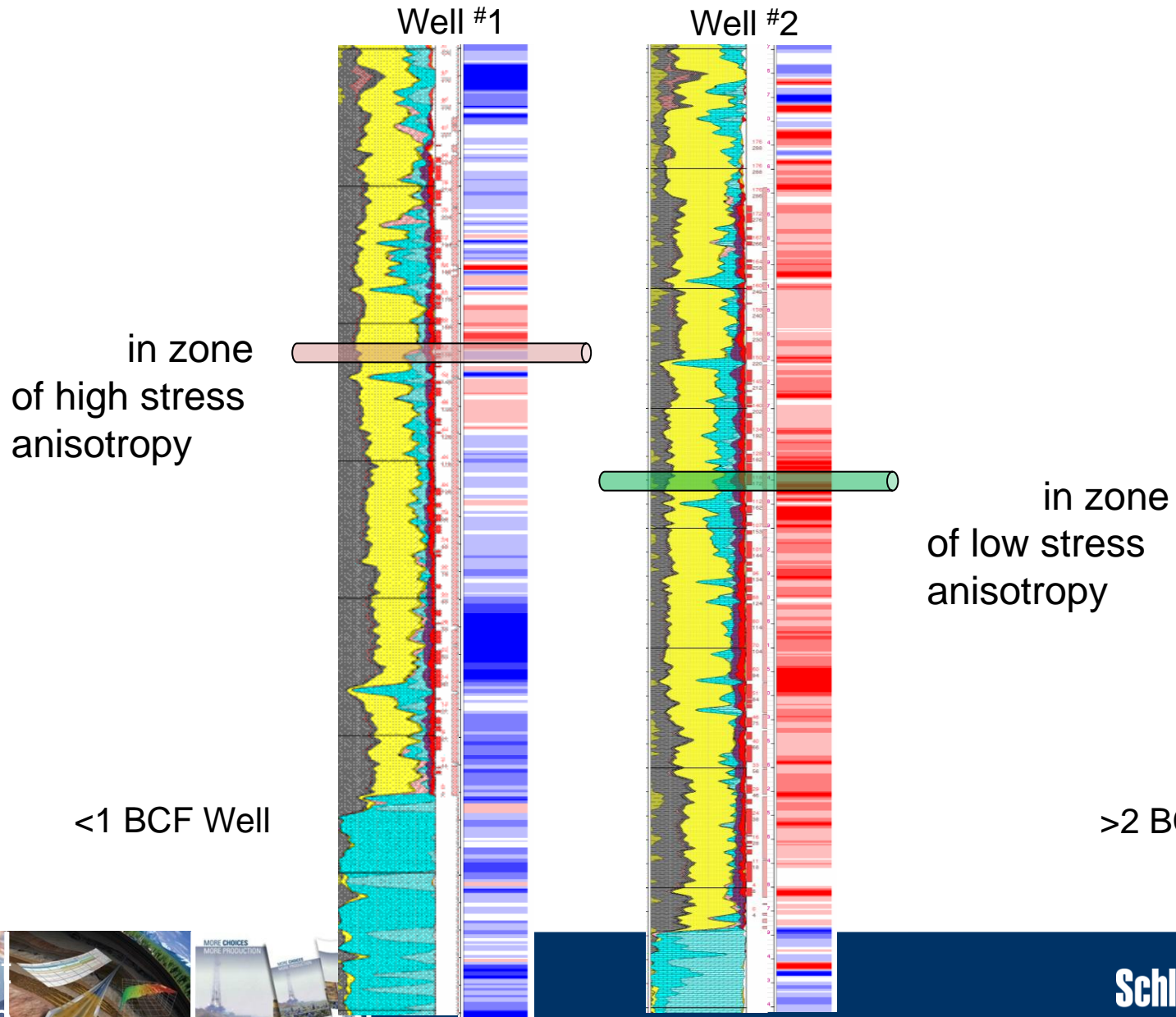


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Red – low stress
Blue – high stress



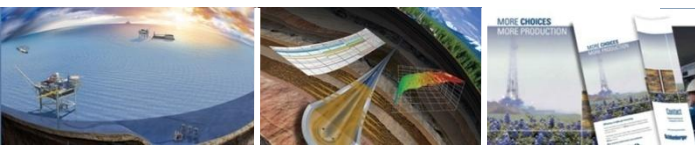
Optimizing Lateral Well Placement



Hydraulic Fracturing



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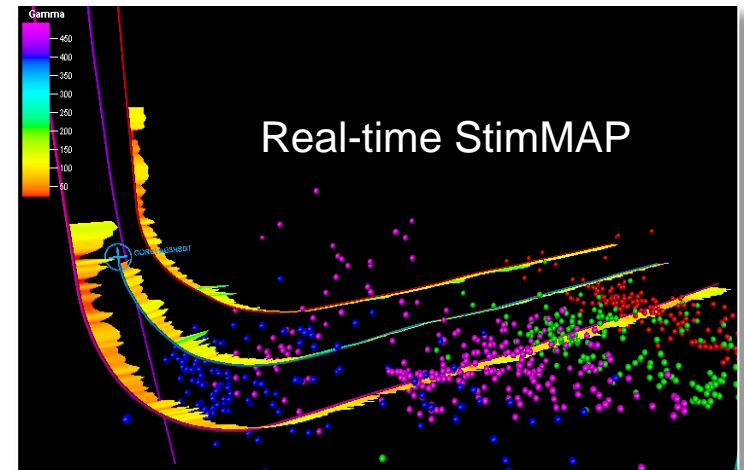


Controlling Fracture Placement

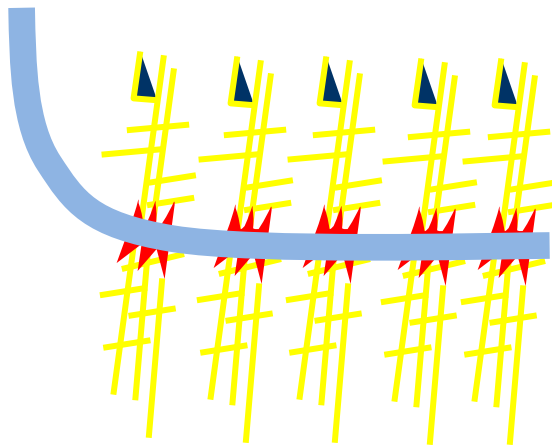
Real-time Fracture Monitoring has already changed the way we stimulate wells

The key now is to be able to use this real-time data and control the fracture propagation path

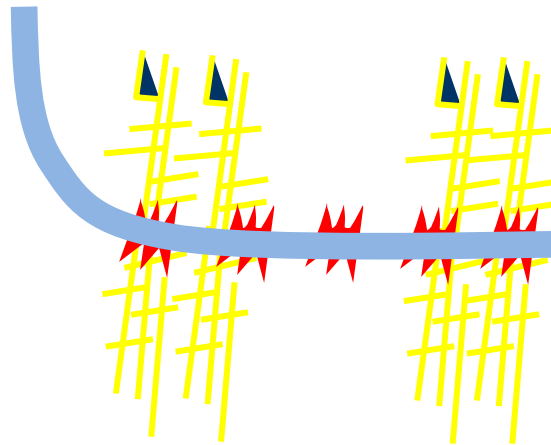
Requires an integrated approach; Simulation, Software, Measurements, Frac technology



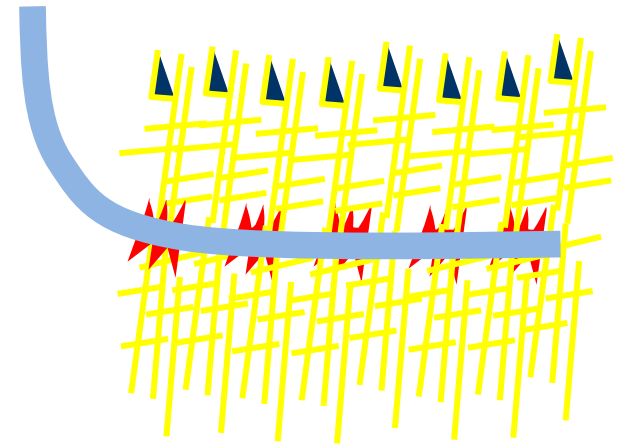
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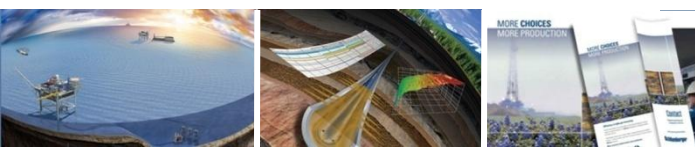
Planned

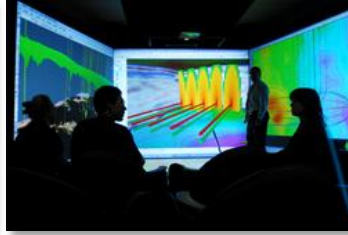


Achieved



Optimized





Thank you

