



# **Applying Stimulation Technology to Improve Production in Mature Assets**

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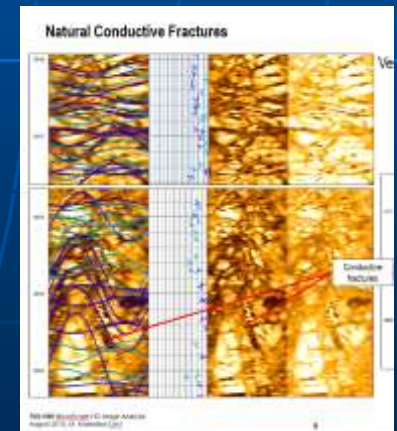
**Society of Petroleum Engineers**

# Agenda

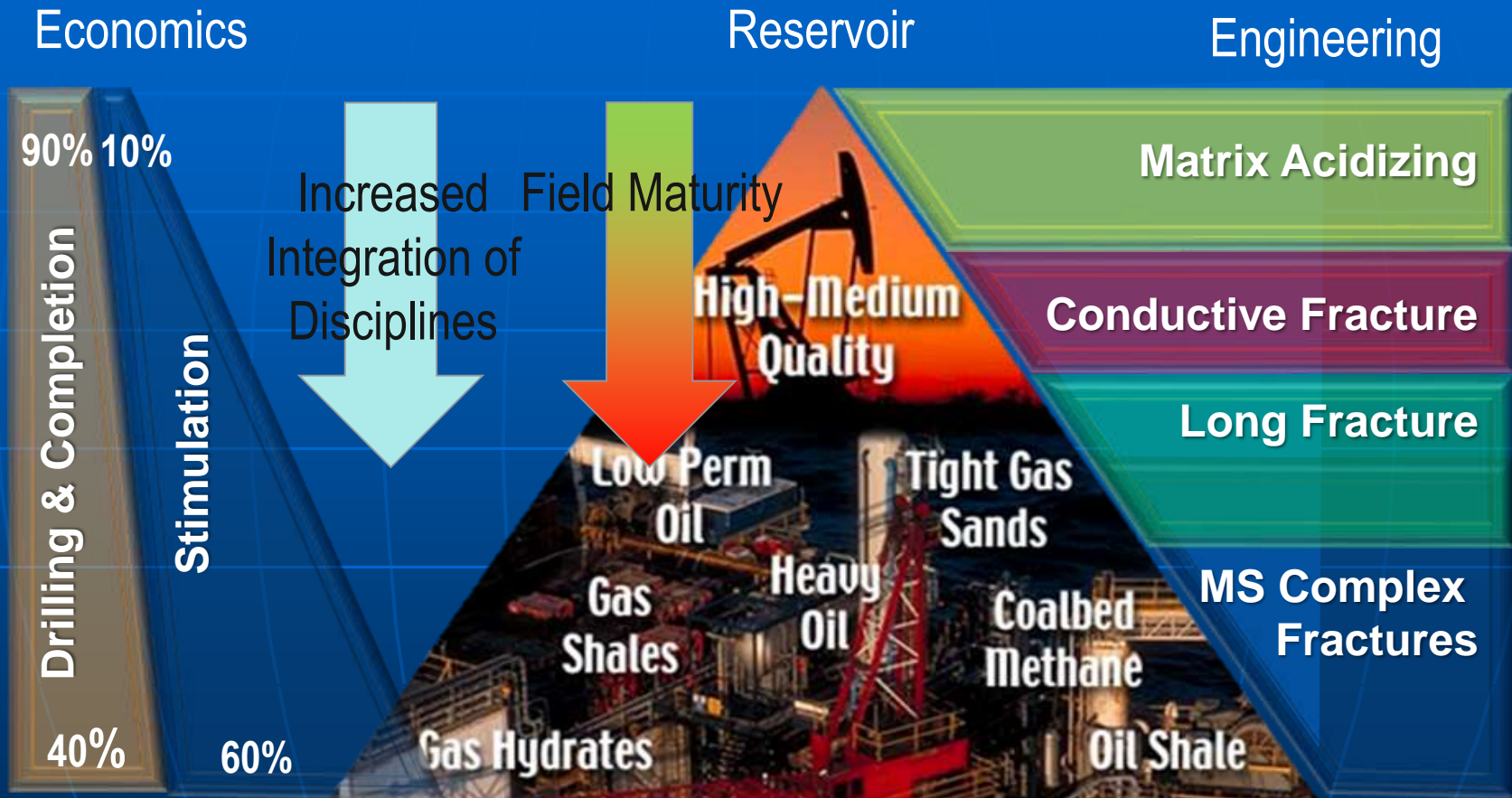
- Formation Complexity
- Why Apply Stimulation in Mature Fields
- Other Advantages to Hydraulic Fracturing
- When to Reconsider Fracture Stimulation
- Key Stimulation Challenges in Mature Fields
- Engineered Design Workflow
- New Role of Stimulation Engineers
- Conclusion

# Formation Complexity

- Pannonian, Carpathian basins
- Complex and variable geological environment
- Challenging formations
- Various reservoir types: basement rock - igneous and metamorphic (granites, fissured mica), sedimentary (conglomerates, sandstones, marl etc.)
- Limited understanding of the reservoir properties
- Low average recovery factors



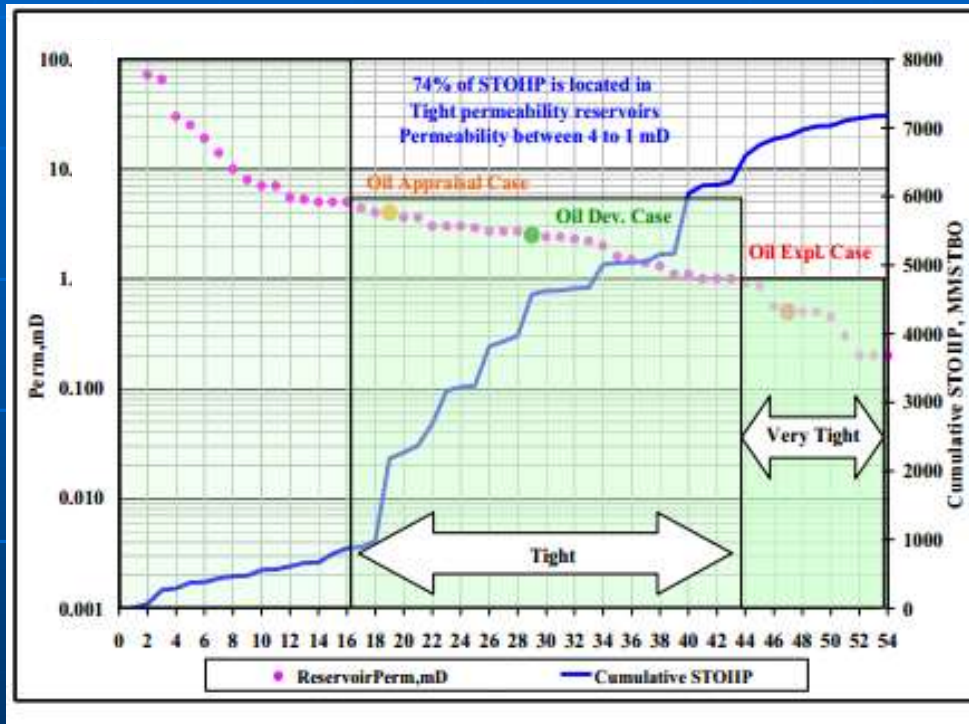
# Why Apply Stimulation in Mature Fields



Holditch, Texas A&M



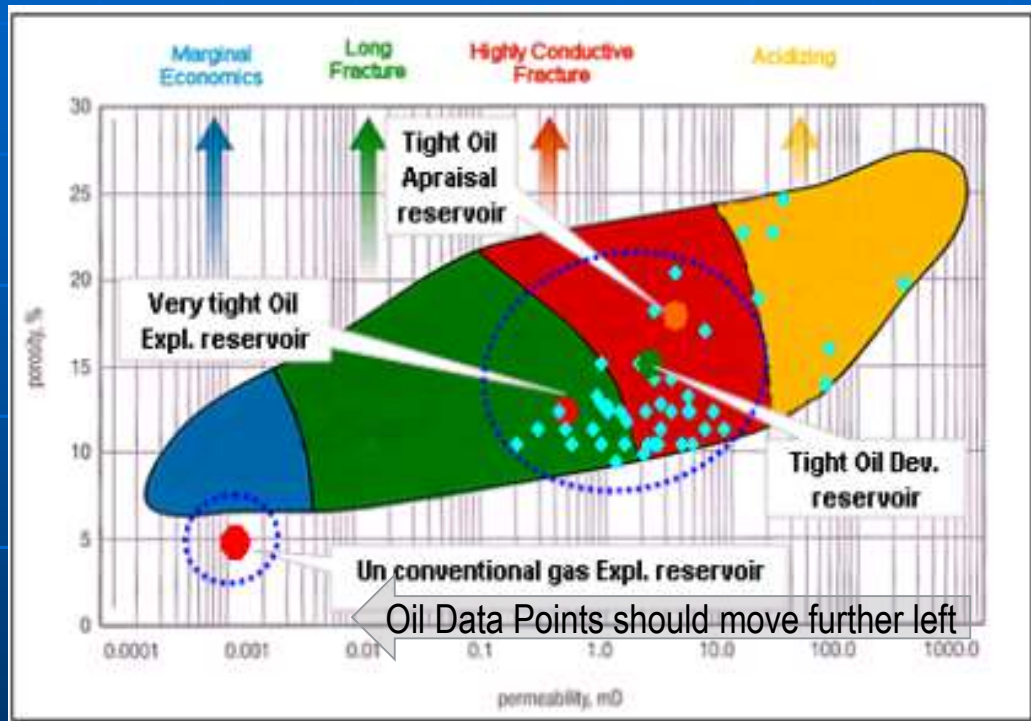
# Mature Assets – Example from Middle East



Ref. G.M. Hegazy et. Al, 2013, SPE 164778

- 74% of STOOIP in tight rock
- Current completion and stimulation design do not allow for recovery
- Likely higher STOOIP in  $k \ll 0.1 \text{ mD}$  as exploration methods evolve

# Understanding Reservoir Properties is Key



Ref. G.M. Hegazy et. Al, 2013, SPE 164778  
Holditch, Texas A&M

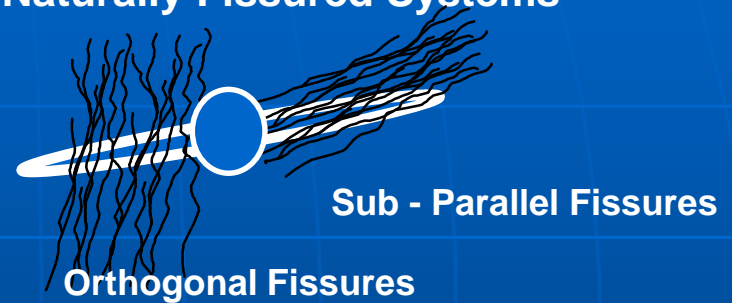
- **Understanding the reservoir properties is critical for stimulation technique selection**
- Example from Middle East:
- Current Approach to maximize production:
  - Long laterals
  - Matrix Acid Stimulation
- Required Approach:
  - Long Fracture
  - Multi-stage Fracturing

# Hydraulic Fracture – Other Advantages

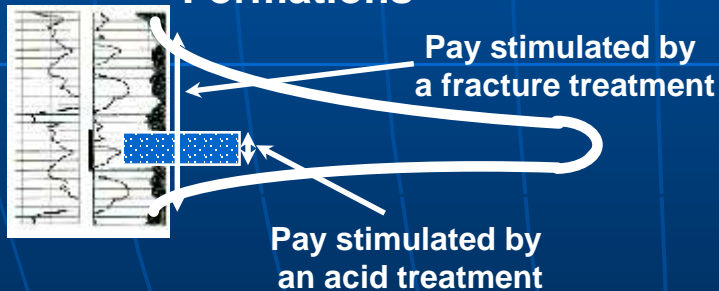
## Connecting Lenticular Reservoirs



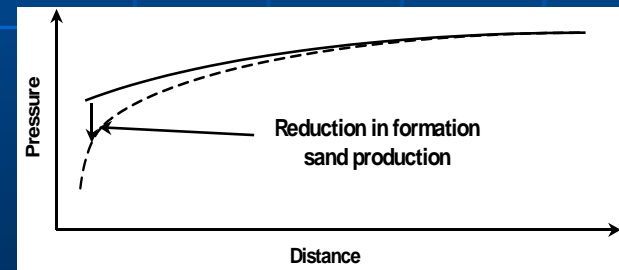
## Naturally Fissured Systems



## Connecting Laminated Formations



## Distribution of Wellbore Drawdown



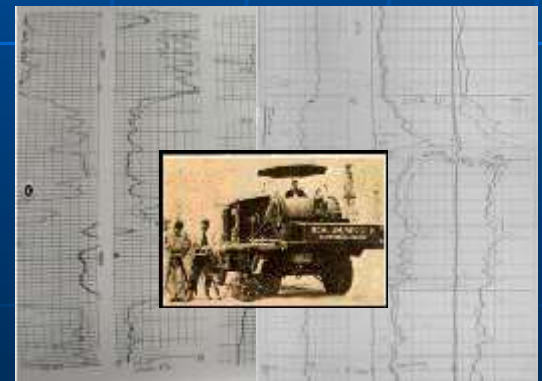
# Reasons to Reconsider Fracturing

1. High risk to connect to water bearing zone
2. Limited or low pressure formation w/o artificial lift
3. High  $k_h$  formations with deep damage
4. Difficult to access damage (gravel-pack, screens)
5. Un-proppable formations (soft rocks)
6. Flowback restrictions (especially true for low pressure gas formations)
7. Weak tubulars (old with questionable integrity or under designed)
8. Bad cement sheath that could lead to well integrity issues



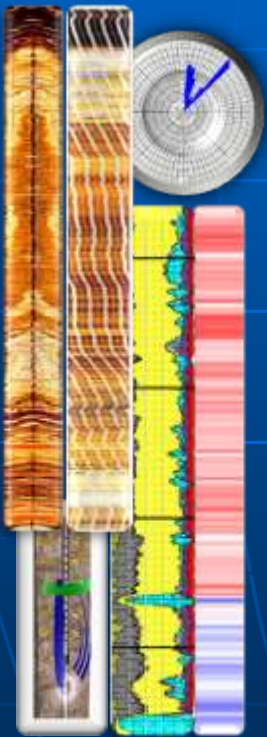
# Key Stimulation Challenges in Mature Fields

- Limited Information
  - Often only SP, GR and/or resistivity logs available
  - Poor understanding reservoir quality
  - Poor understanding of geomechanics
- Complex geological environment
- Brown oilfields - depleted reservoirs
- Reduced oil mobility & higher water production
- Hydrocarbon migration
- Old wells with aging completions
- Limited wellhead pressures

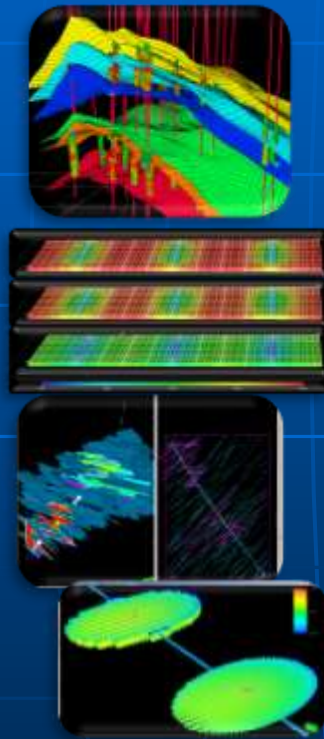


# New Technology can Play a Key Role

**Evaluation**



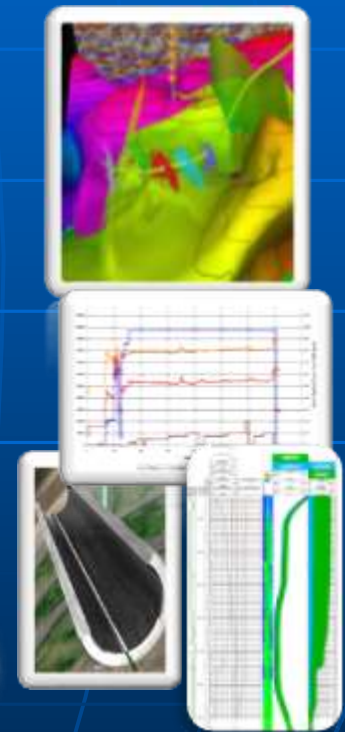
**Modeling & Design**



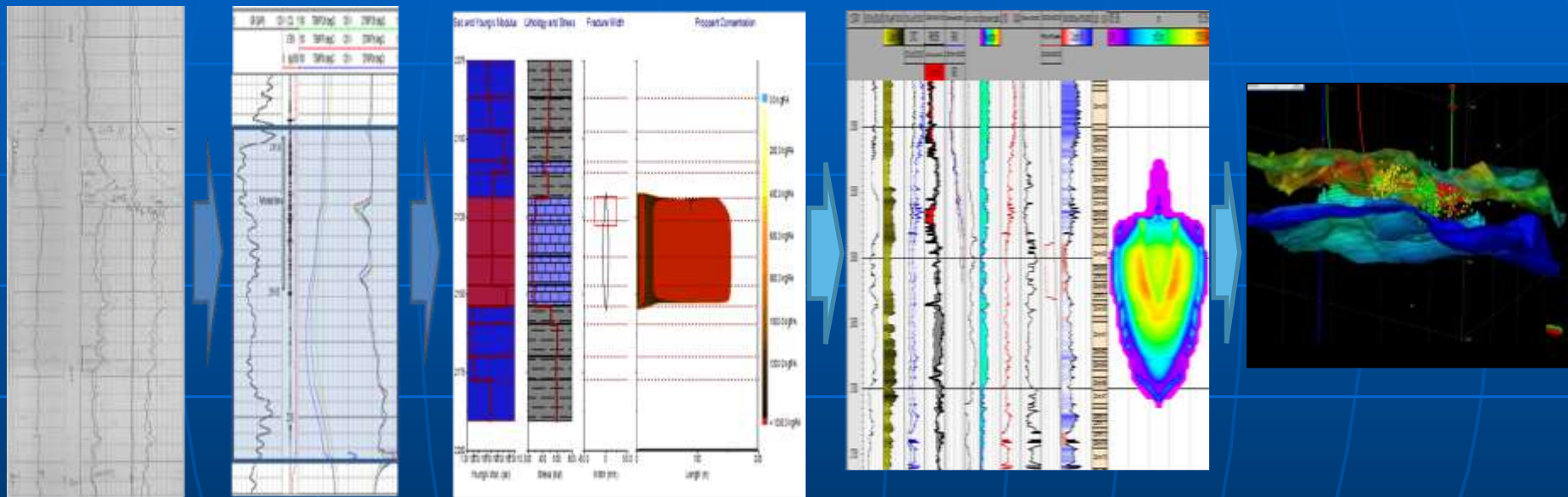
**Chemistry & Materials**



**Measurements**



# Engineered Design with Limited Data

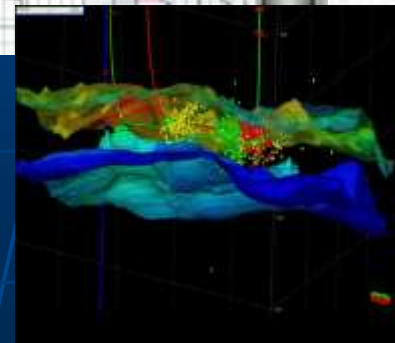
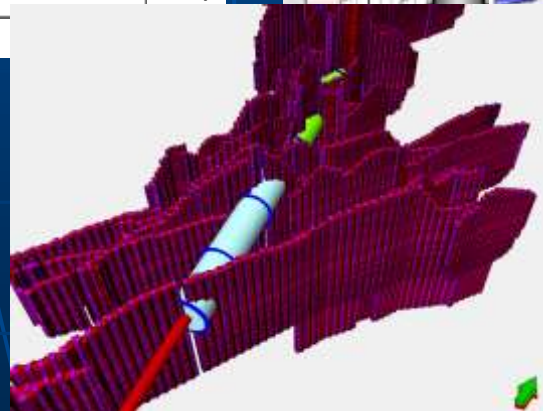
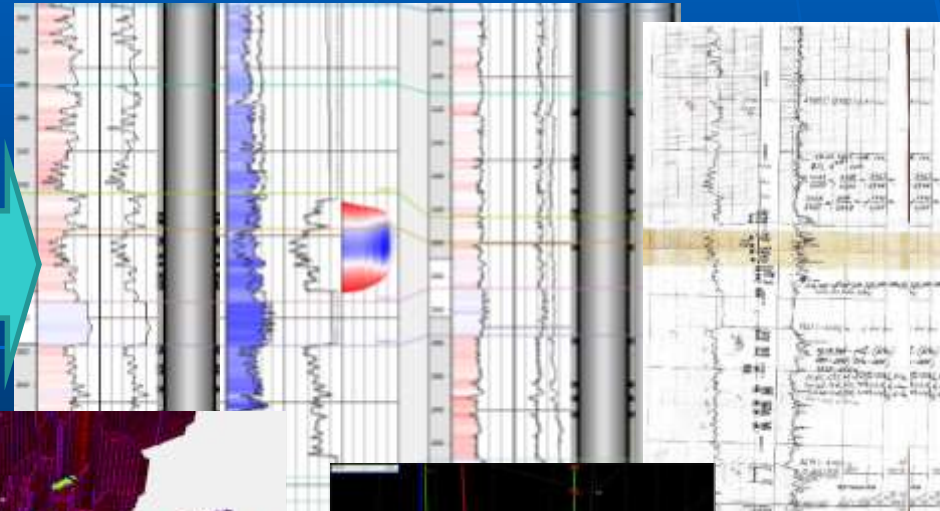
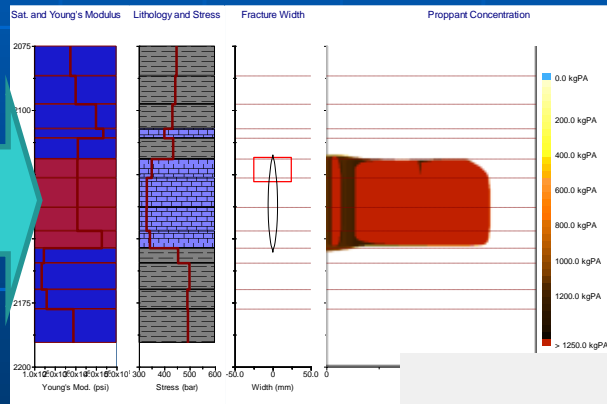


Basic well data + temperature logs + offset sonic + Frac Diagnostic + Stimulation Soft = Develop Field Scale Geomechanics



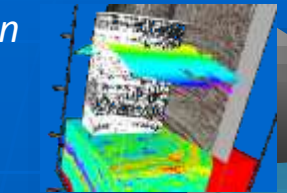
# Integrated Workflow

- Integration of Wells Data to Characterize, Evaluate and Design
- Extrapolation of assumptions and workflows to the field level
- Well to well correlation
- Corrections of the field model based on the production data and well pumping data

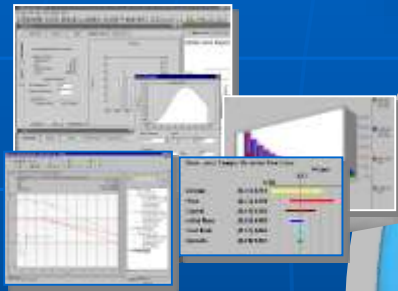


# The New Role of the Stimulation Engineer

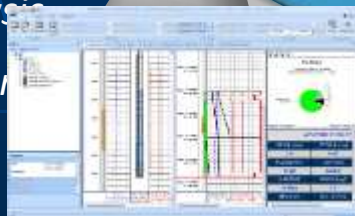
Seismic Interpretation  
Seismic Volume  
Rendering



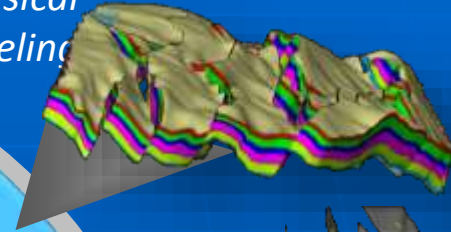
Well Correlation



Stimulation & Real-time  
Completion Analysis  
History Matching



Petrophysical  
Modeling



Facies  
Modeling

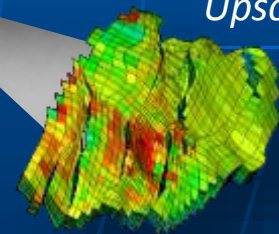


Fault  
Analysis



Uncertainty  
Analysis

Upscaling



Well planning  
Completion design





# Conclusion

- Complex variable geology requires thorough analysis
- Understanding the reservoir quality is a key to choosing the right completion and stimulation approach
- Workflow integration of disciplines required for better evaluation of the reservoir
- Challenges do exist in Stimulation of mature fields
- Limited data and old completions are a challenge not a deal breaker
- Key challenges and key risks can be addressed with the aid of technology and good engineering practice
- Variable geologic environment in CEE is challenging from engineering perspective which creates good conditions for a multilateral development of young specialists

# Questions and Answers

**Questions?!**