

# Workshop on Hydraulic Fracturing – Session 2: Fracture Propagation

Chair: Xiaowei Weng, Schlumberger

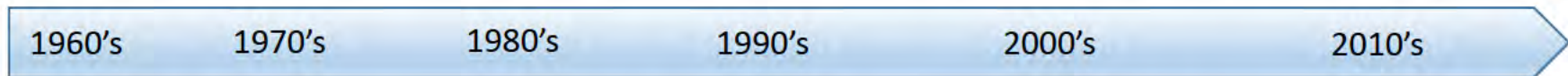
Discussion Leader: Sau-Wai Wong, Shell



# Agenda

- Introduction (Xiaowei Weng)
- Invited Speakers
  - Mark Mack, ITASCA
  - Ahmad Ghassemi, University of Oklahoma
  - Jon Olson, University of Texas at Austin
- Group Discussion (led by Sau-Wai Wong)

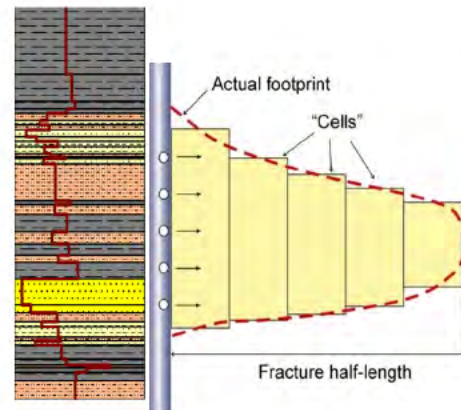
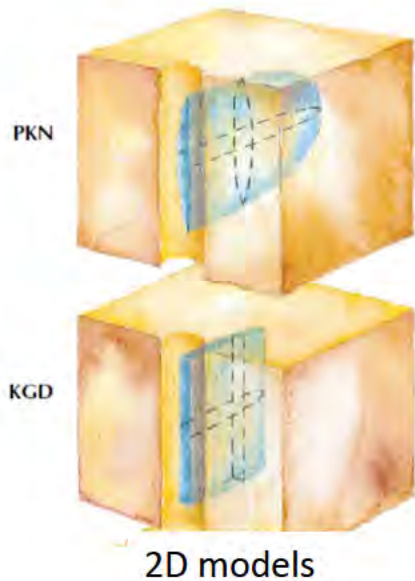
# Evolution of Hydraulic Fracture Technology – A Saga of Never-Ending Quest to Produce Hydrocarbon from Tighter Reservoirs



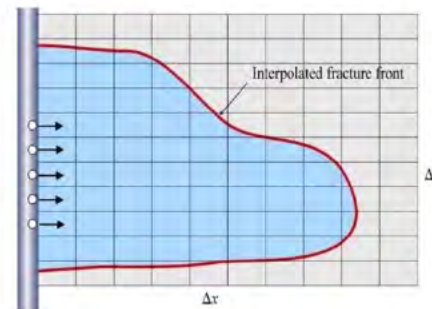
Targeted formations,  
small-scale fracs

Tight sand gas -  
massive hydraulic fracs

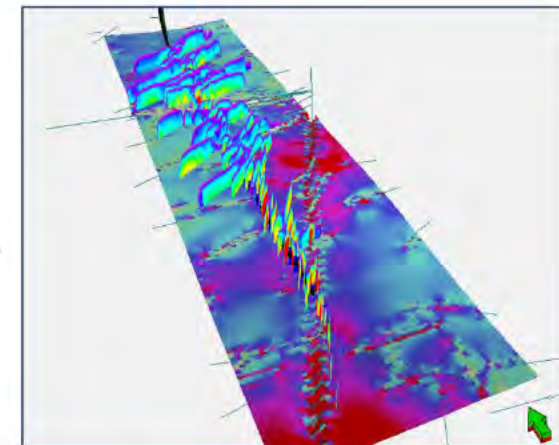
Shale development -  
Multiple horizontal wells  
with multi-stage fracs



Pseudo-3D



Planar 3D

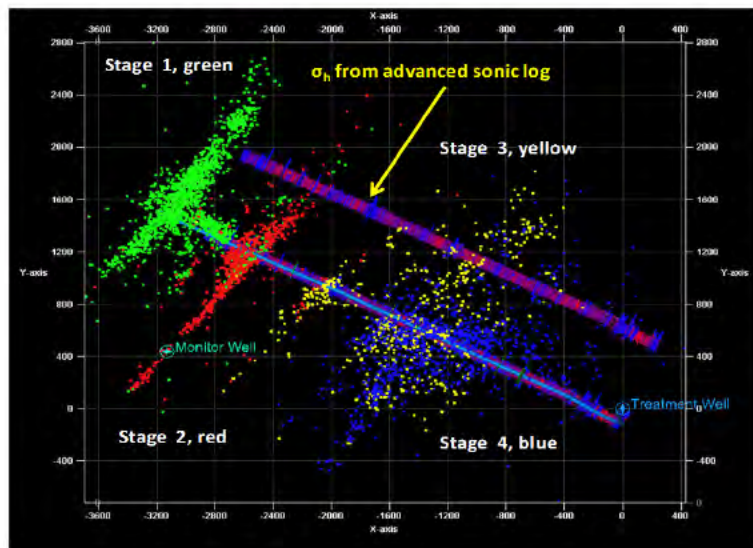


Complex fracture models

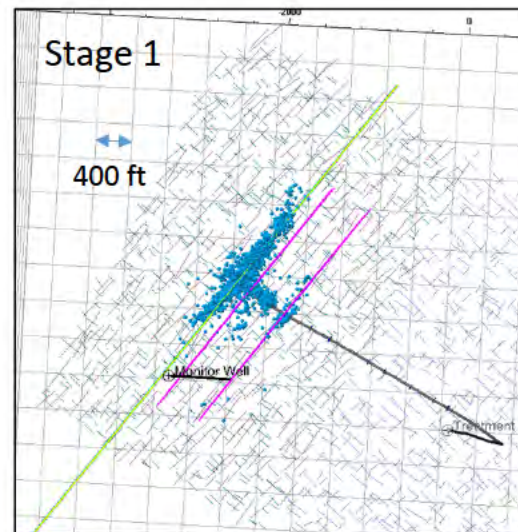


# Challenges in Modeling Fractures in Shale

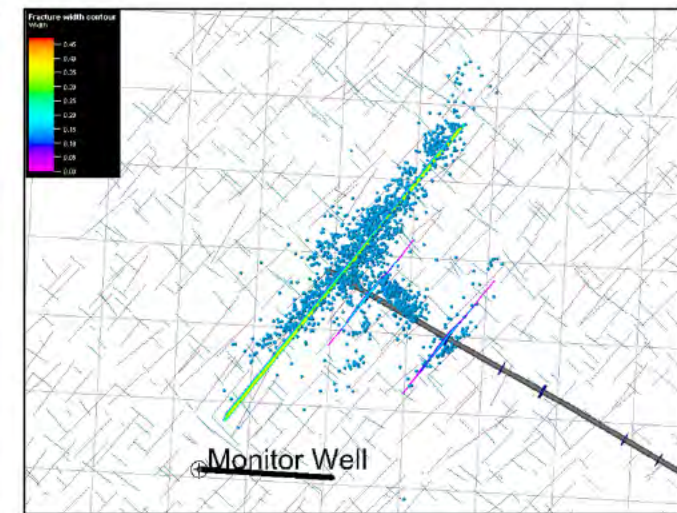
- Lack of direct measurements
- Reconcile microseismic observations and model prediction
  - Fracture dimensions: complex fracture network or simple planar fracs?
  - Where does fluid go: in HF network or leakoff into natural fracs?
  - Pressure response/shut-in decline



Daniels et al. SPE 110562



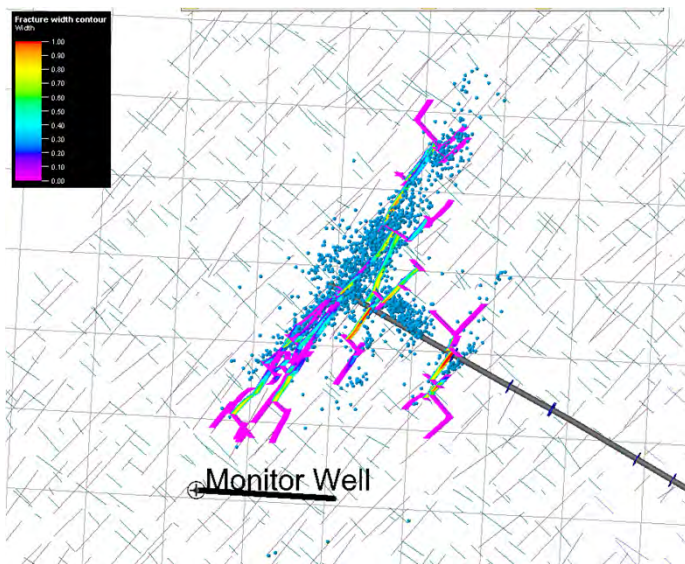
Planar fracture, no adjustment;  
Efficiency = 82%



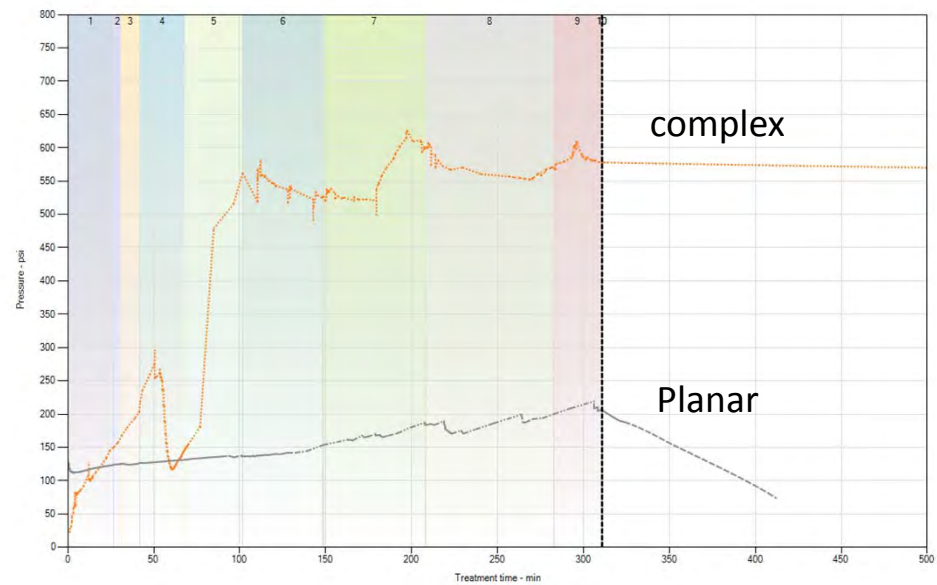
Planar fracture, 20x leakoff to  
match frac length, Efficiency = 12%

# Challenges in Modeling Fractures in Shale

- Reconcile microseismic observations and model prediction
  - Fracture dimensions: complex fracture network or simple planar fracs
  - Where does fluid go: in HF network or leakoff into natural fracs?
  - Pressure response/shut-in decline



Complex fracture,  
Efficiency = 90%

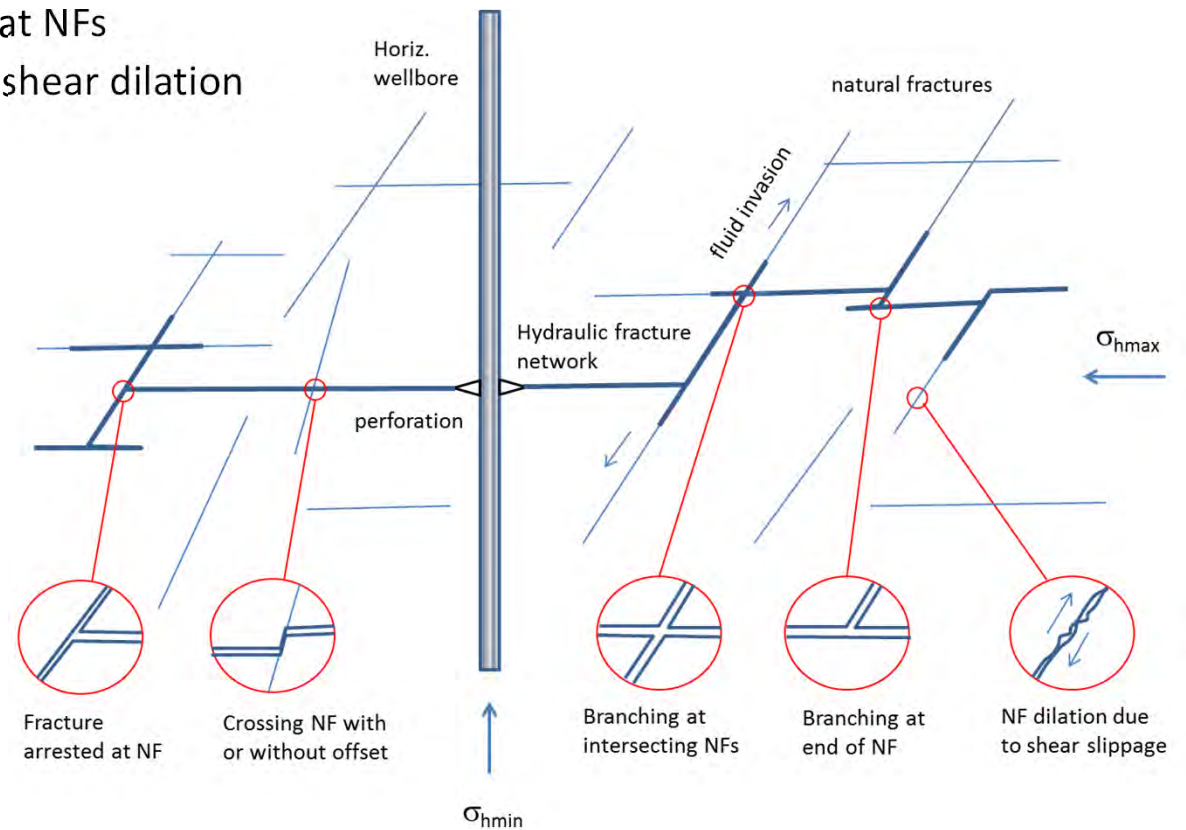


Net pressure



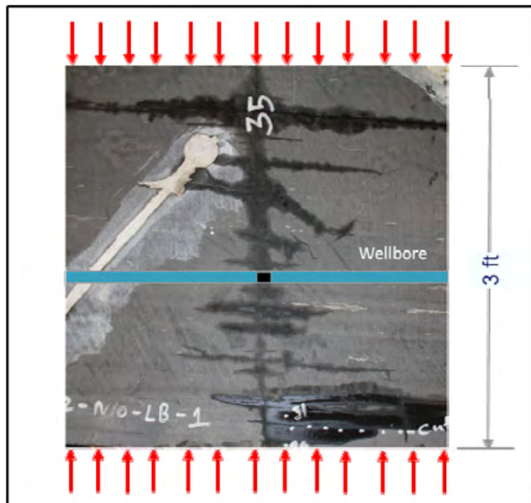
# Challenges in Modeling Fractures in Shale – Understanding of Physical Processes

- Lateral heterogeneity (natural fractures)
  - HF crossing/arrest/branching at NFs
  - Fluid penetration into NF and shear dilation

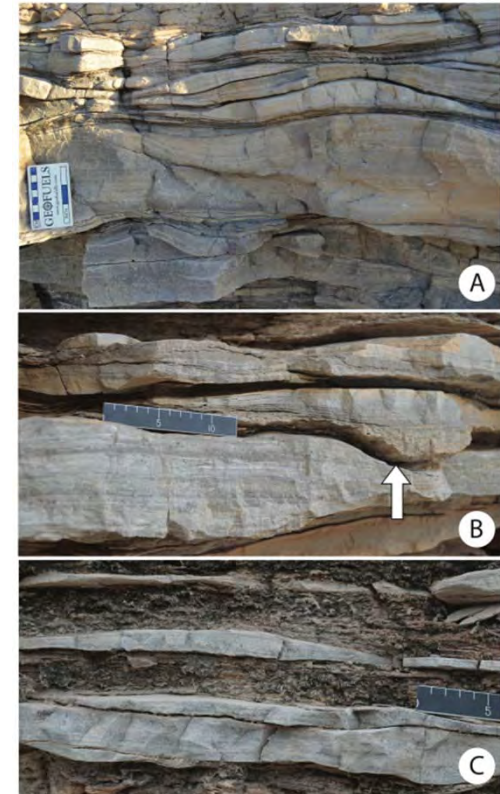


# Challenges in Modeling Fractures in Shale – Understanding of Physical Processes

- Vertical heterogeneity
  - Effects of bed interfaces on frac height growth
  - Fluid penetration into bed interfaces
  - Impact of thin soft layers (ash beds) on height growth and production
  - Potential of horizontal or T-shaped fracs



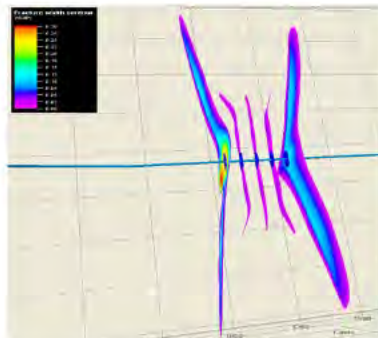
Large block test,  
Suarez-Rivera et al.  
IPTC 17018



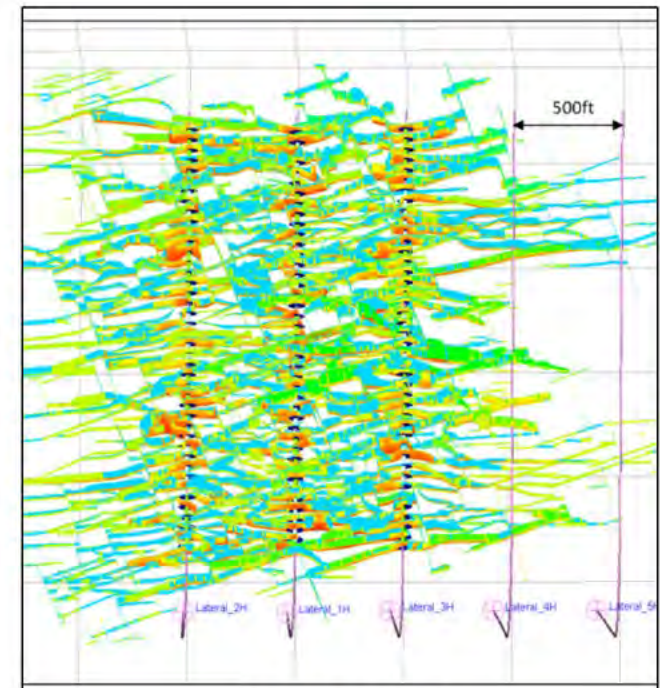
Eagle Ford outcrop,  
Wehner et al. SPE 178607

# Challenges in Modeling Fractures in Shale – Numerical Simulation

- Multi-scale, coupled geomechanical-flow problem
- Small scale
  - Fracture tips
  - HF-NF interaction
  - Shear slip propagation and fluid leakoff along NF or bedding planes
- Large scale
  - Overall fracture network propagation
  - Interaction among fractures (stress shadow)
- Computational performance



Interaction between propagating fracs



(SPE 175920)

Complex interaction between fracs from different stages and wells



# Fracture Propagation Session Focus Topics

- Effect of heterogeneity, interactions with natural fractures/beddings
- Stress shadow/fracture interference
- Planar vs. complex network
- Propagation criteria

# Invited Presentations

- Mark Mack (Itasca)
  - The effect of stress changes and natural fractures on hydraulic fracture interactions
- Ahmad Ghassemi (University of Oklahoma)
  - Impact of fracture interactions, rock anisotropy and heterogeneity on hydraulic fracturing – Some insights from numerical simulations
- Jon Olson (UT-Austin)
  - Hydraulic fracture complexity: what do we know and where are we going?

# Group Discussion (led by Sau-Wai Wong)

- Effect of heterogeneity, interactions with natural fractures/beddings
  - Andy Bungler
  - Uno Mutlu
  - Olga Kresse
- Stress shadow/fracture interference
  - Ripu Manchanda
- Planar vs. complex network
  - Ahmed Ouenes?
- Propagation criteria



# Discussion items for each topic

- Is the physical process reasonably well understood?
- Does it play a critical role in fracture propagation and when, and must it be included in the fracture models?
- Do the current fracture models adequately address this issue already? Where are the gaps?
- What are the challenges?