NEXT SHALE 2017

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Navigating the Future of Unconventional Resources

Securing Long-Term Well Productivity Through Managing Postfracturing Operations in Unconventional Reservoirs

Schlumberger

Managing Postfracturing Operations

~1–2 days *~3–15 days*

Fracturing

Frac Plug Millout

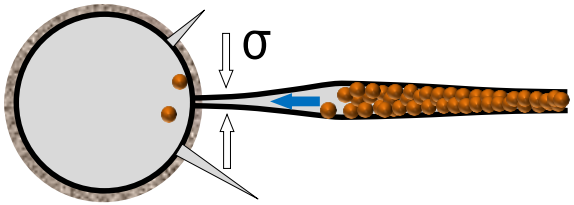
Fracture Cleanup and Flowback

Production

- Most common well completion type: Plug & Perf
- Postfracturing operations traditionally managed using operational objectives
- Fracture and formation damage may have detrimental impact on long-term well productivity

Fracture and Formation Damage Mechanisms

- Uncontrolled sand flowback and fracture closure
  - Leaving unpropped area in near-wellbore (NWB) zone
  - Increased risk of pinch-pointing if size of unpropped area exceeds geomechanical criteria
  - Additional resistance to oil and gas flow through tubulars
  - 50%–80% of sand flowback happens during drillout
- Rock failure
  - Excessive drawdown may cause destabilization of formation and particles migration
- Scaling and precipitation
  - Reduction in fracture conductivity
  - Reduction in well completion outflow performance
  - Impact on surface equipment



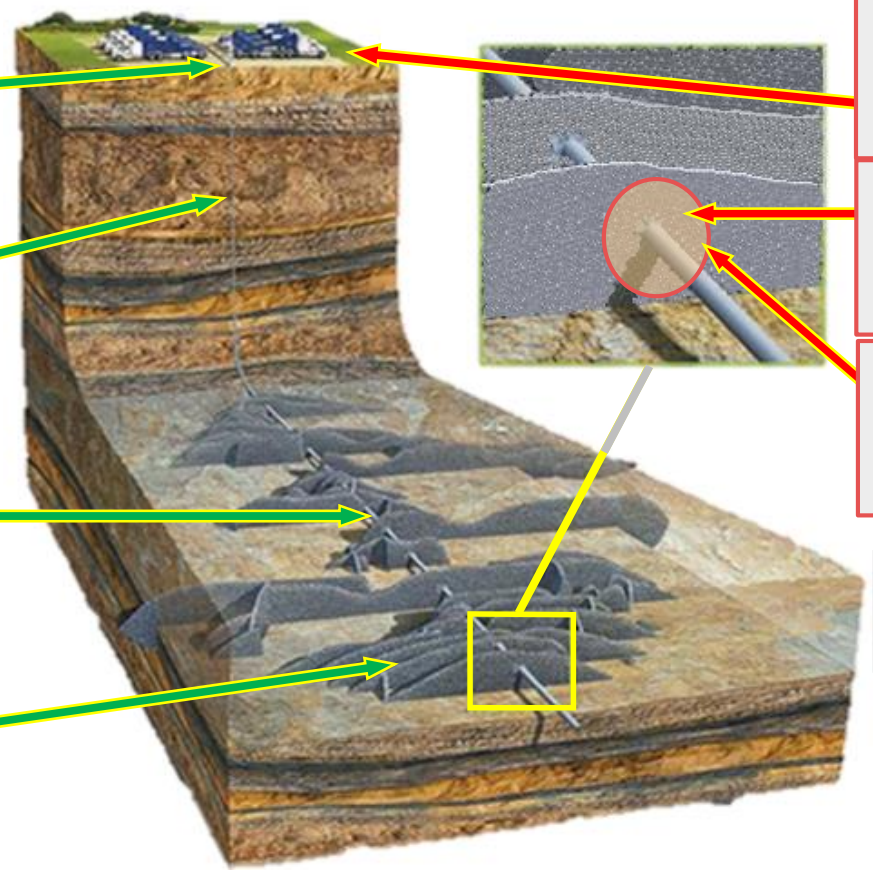
Frac Plug Drillout and Well Flowback: Considerations

Keep the choke from plugging

Flow fast enough to lift liquids out

Flow fast enough to lift solids out of the wellbore

Flow fast enough to move the gel out of the fractures



Do not flow too fast to overwhelm separation equipment

Do not drop pressure too much to avoid damaging the fracture

Do not flow too fast to avoid mobilizing proppant out of fracture

Define what is the best lift solution for production

Optimize next stimulation job

Characterize early production

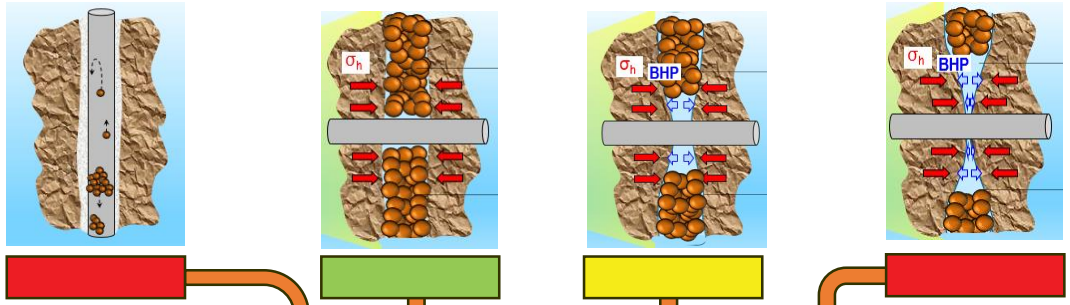
Secure Operating Envelope (SOE)

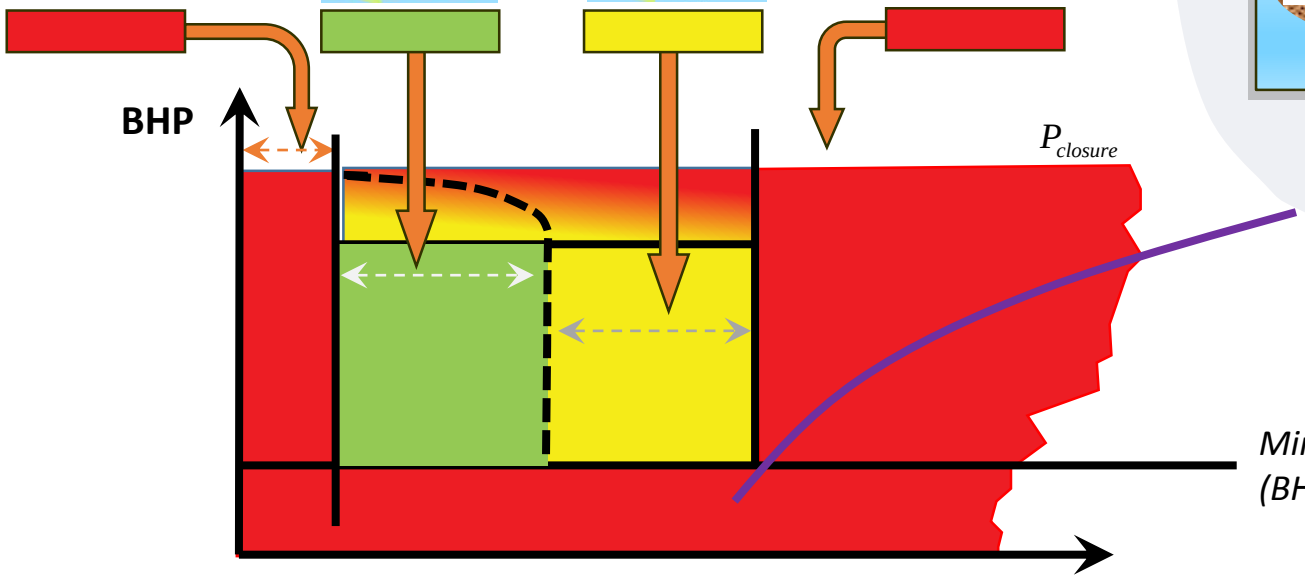
Risk of proppant settling in vertical section

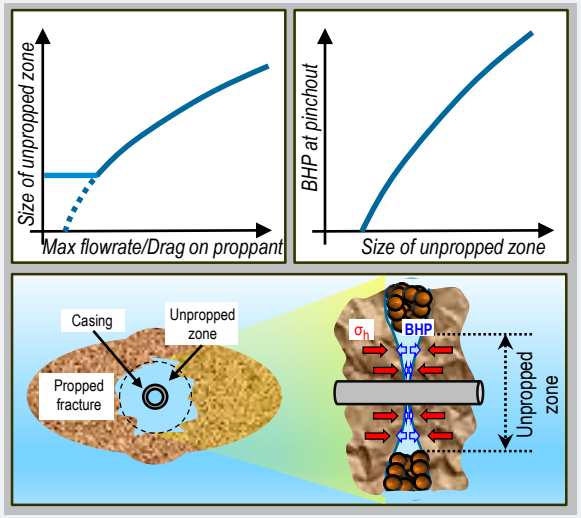
No extension of unpropped zone. Maintained fracture connection

Some extension of unpropped zone. Maintained fracture connection

Excessive extension of unpropped zone resulting in loss of fracture connection





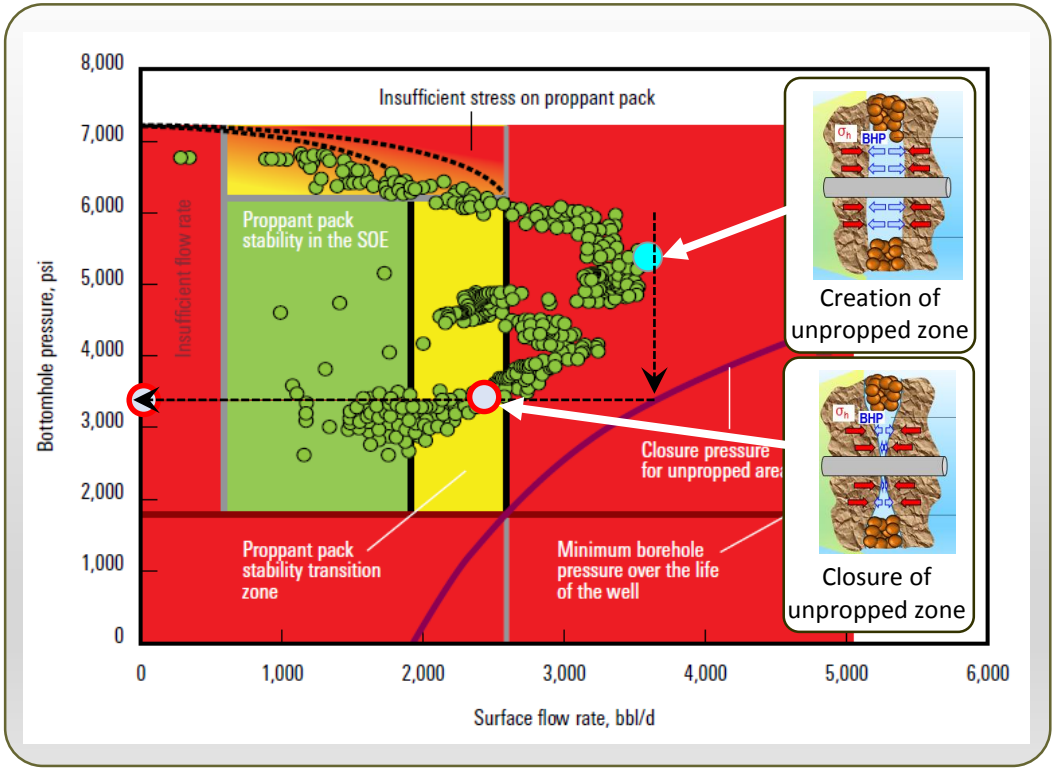


Pinchout pressure for unpropped area

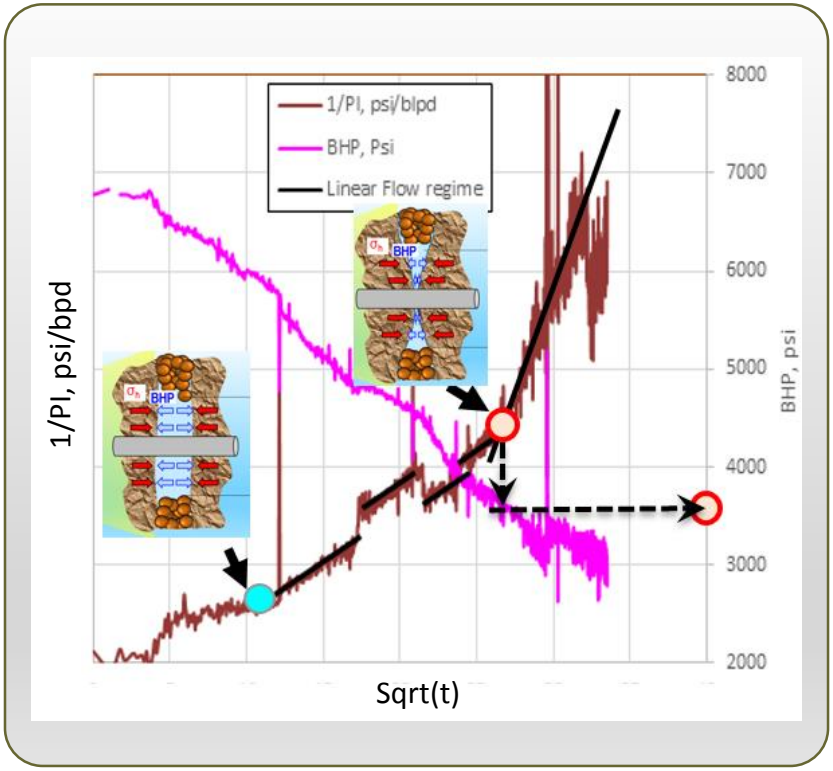
Minimum bottomhole pressure (BHP) during life of the well

Example: Application of SOE during Well Flowback

Secure Operating Envelope



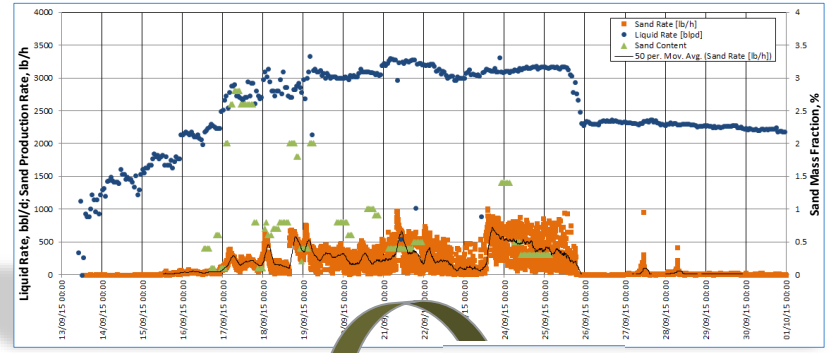
Rate Transient Analysis

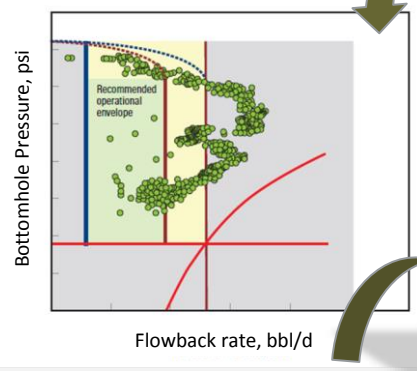


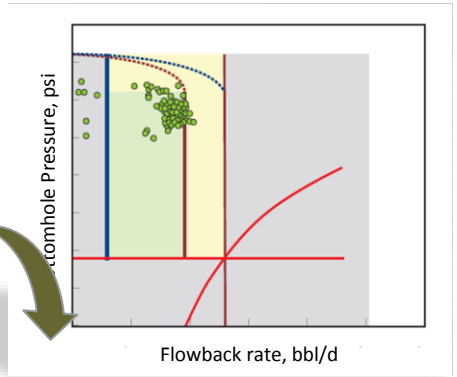
- Predicting and avoiding fracture damage
- Identifying fracture damage

Minimizing Proppant Flowback

- Challenge
  - Proppant flowback detected by continuous solids monitoring device and samples collection
- Solution
  - Apply SOE for defining well operating strategy
  - Avoid losing fracture conductivity near wellbore due to development of unpropped area
- Results
  - Proppant flowback eliminated on the following series of wells







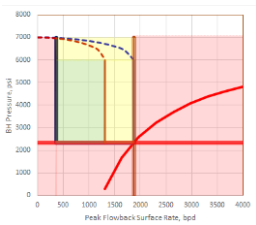
Engineering and Operational Workflow

Design

Formation Properties

Fracture Treatment Design

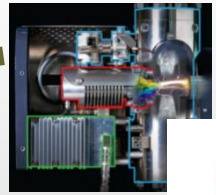
Well Completion Parameters

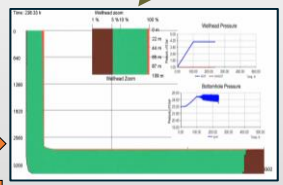


Secure operating envelope

Execution: Monitoring and Control

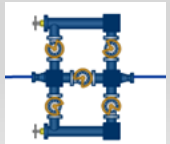
Real-time measurements
Sand monitoring



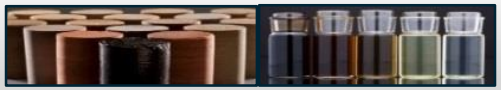


Flowback Advisor

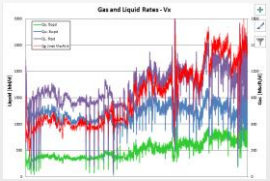
Choke adjustment

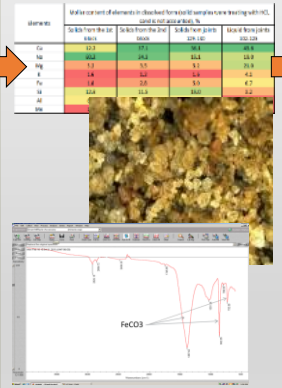


Sampling



Evaluation





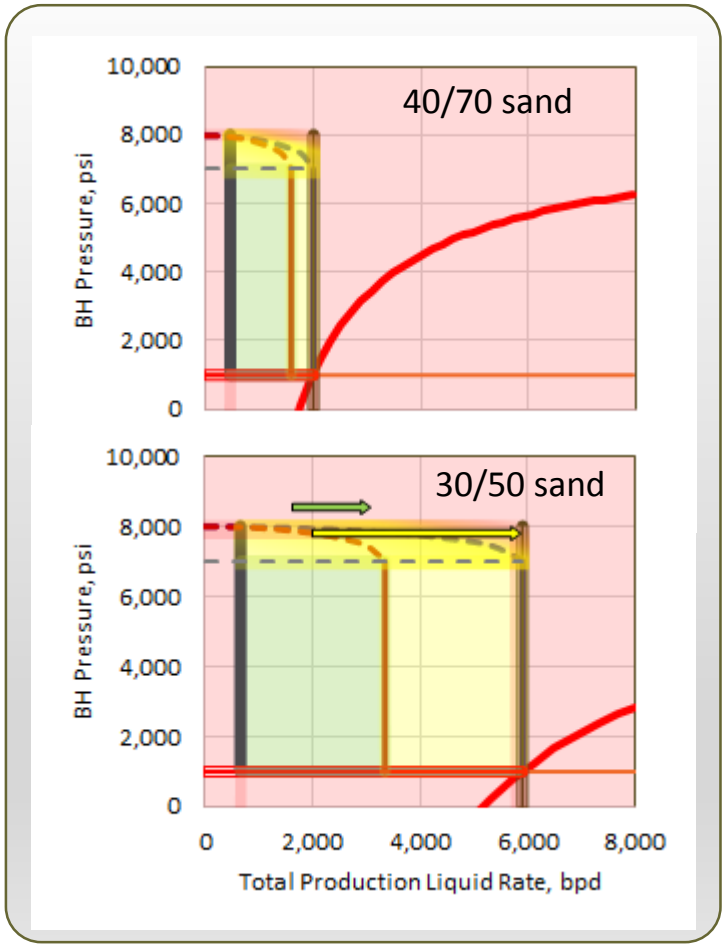
Future wells

Recommendations

- Fracturing
- CT operations
- Well flowback

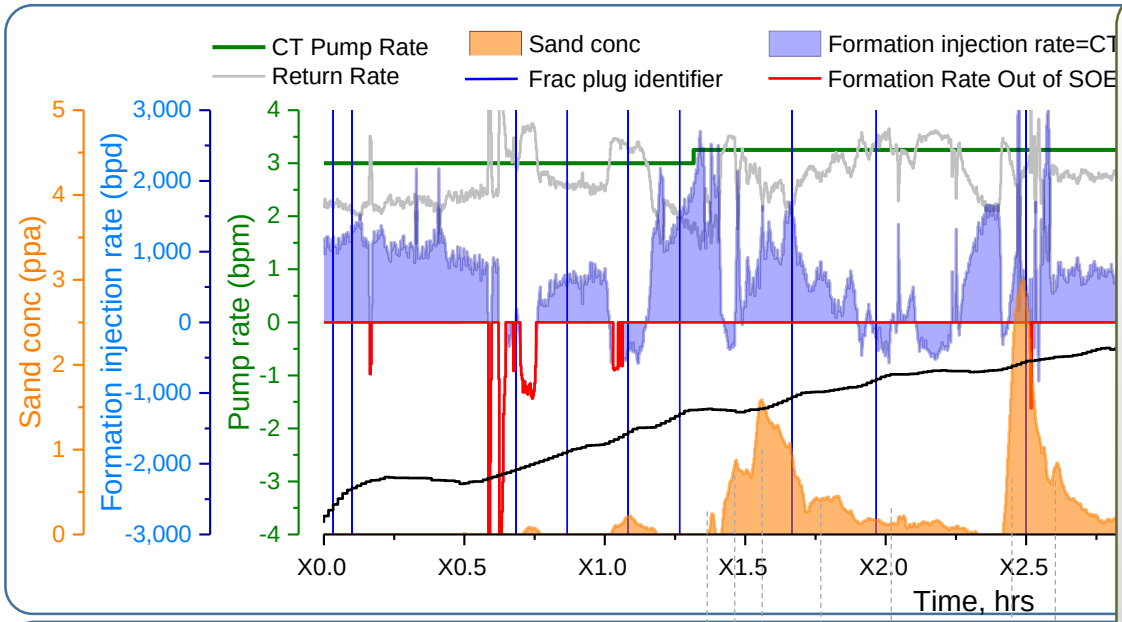
Extension of Secure Operating Envelope

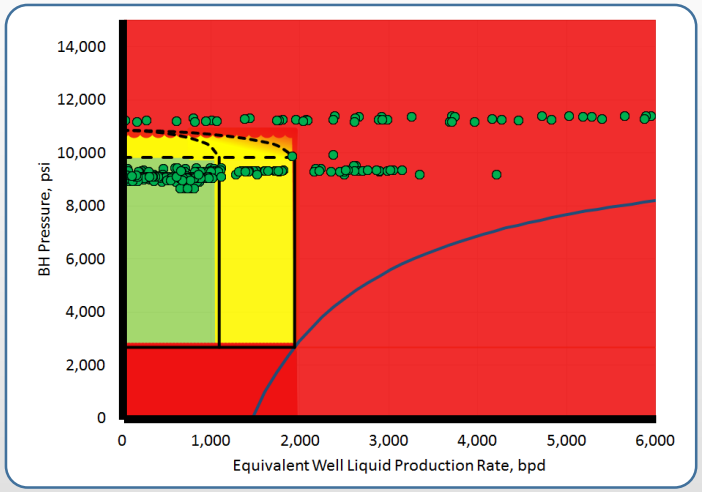
- Extension of SOE as an alternative to "slowback" strategy
- Precompletion analysis is critical
  - Ensuring consistency between well completion and well operating plans
- Using SOE to assess option for increasing fracture stability
  - Proppant type
  - Permeability of proppant pack
  - Fracture width
  - Proppant flowback control
  - …
- Final decision to be made based on economic considerations



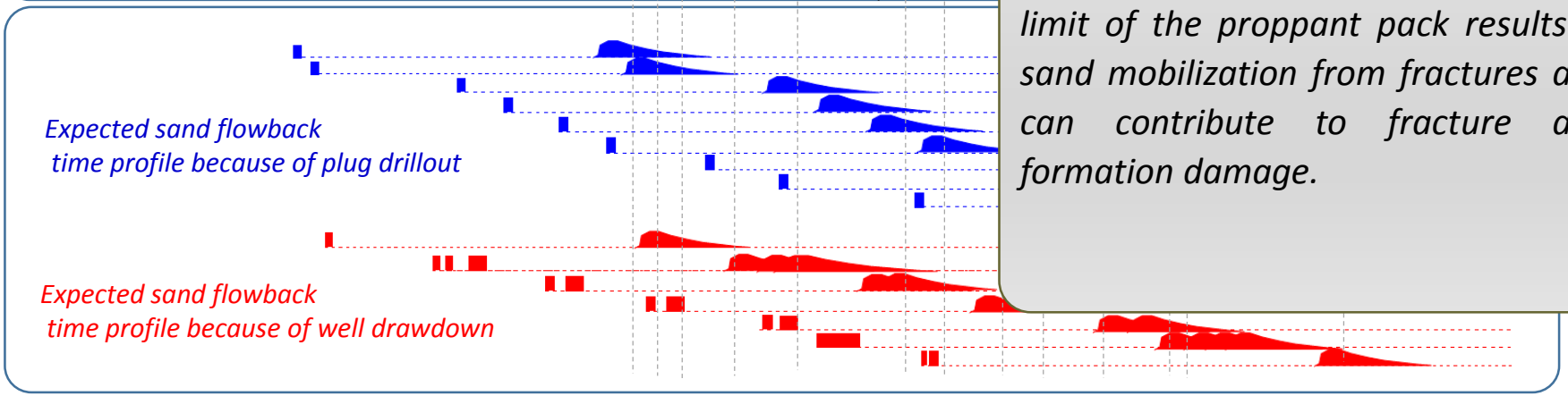
Example: Impact of proppant type in near-wellbore zone on fracture stability limit

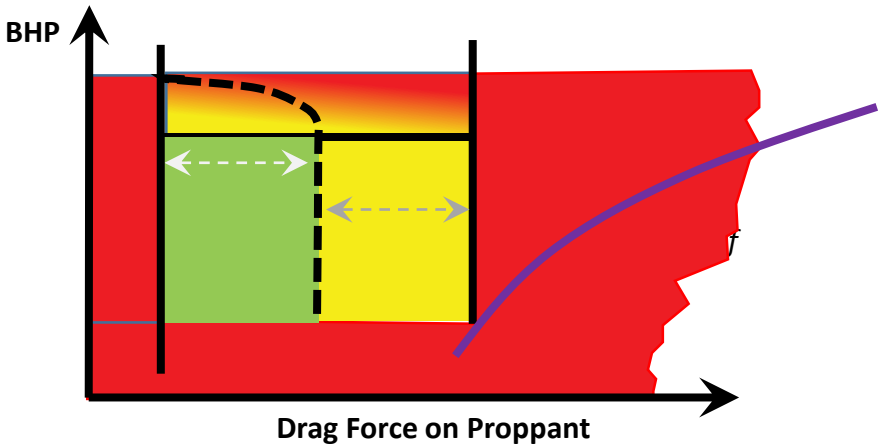
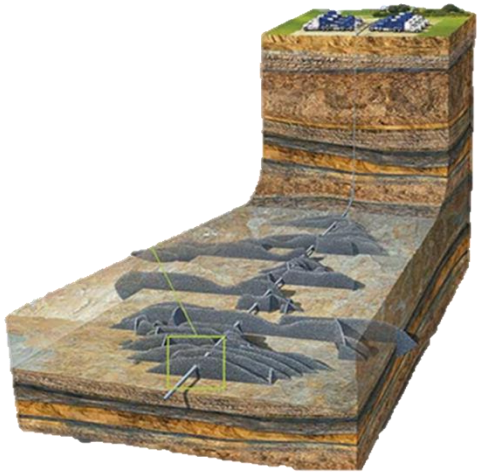
Plug Drillout Operations





Operating a well beyond the stability limit of the proppant pack results in sand mobilization from fractures and can contribute to fracture and formation damage.



Summary

- The new coupled geomechanics and fluid dynamics model enabled defining the secure operating envelope for poststimulation operations and minimizing the risk of fracture and formation damage
- Real-time high-frequency multiphase rate monitoring is essential for controlling postfracture operations, especially plug drillout operations
- Optimization of poststimulation operations should be performed considering well completion practices
- The developed workflow for monitoring and managing poststimulation operations has been successfully applied in more than 50 wells