CT Frac Sleeves: What's Next?

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ICOTA Roundtable 2014

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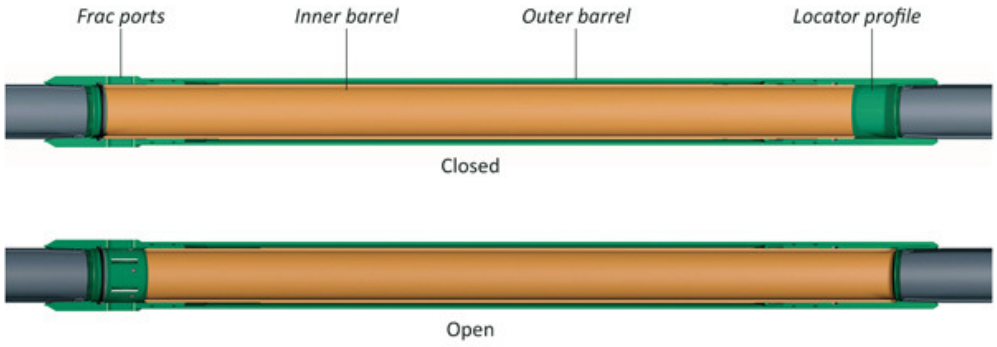
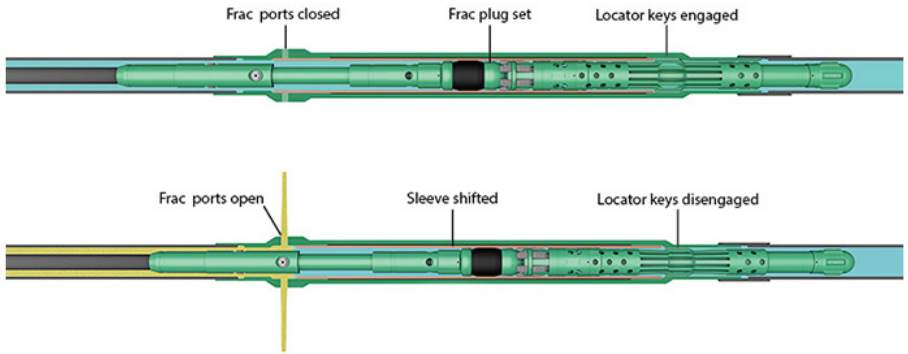
What is a CT Frac Sleeve?

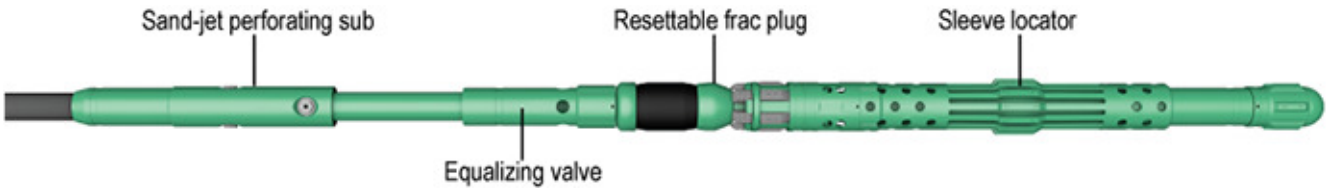
- Installed with completion casing string
- Full-bore, over the drift ID of the casing string
- Typically cemented in place
- BHA ran on CT to locate, shift, and frac



How does a CT Frac Sleeve Work?

- BHA is ran to depth on CT
- Sleeve is located
- Resettable frac plug is set
- Sleeve is shifted down to open
- Frac is pumped
- Zone is equalized
- BHA is moved to next frac sleeve





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Why Use CT Frac Sleeves?

- Unlimited number of stages
- Precise frac location– doing what is best for the formation
- Optimized stage spacing
- Contingencies available
  - Cemented well completion
  - Screen-out management => system allows more aggressive fracs
- Fully open bore without mill runs
- Save operators $
  - Reduced fluid volumes
  - Reduced horsepower requirements
  - Reduced operation time between fracs

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Stuck Open

- But…what do CT sleeves, ball drop, P&P have in common?
- No control over zonal isolation
  - Proppant flow-back
  - Pressure management
  - Water management
- First time your valve opens…

What's Next: Closeable Sleeves

- Fixing the handle: closeable sleeves
- Sleeve shifted and frac'd as normal
- BHA shifts the sleeve open **and closed**
- Force-limited locking profile prevents accidental shifting

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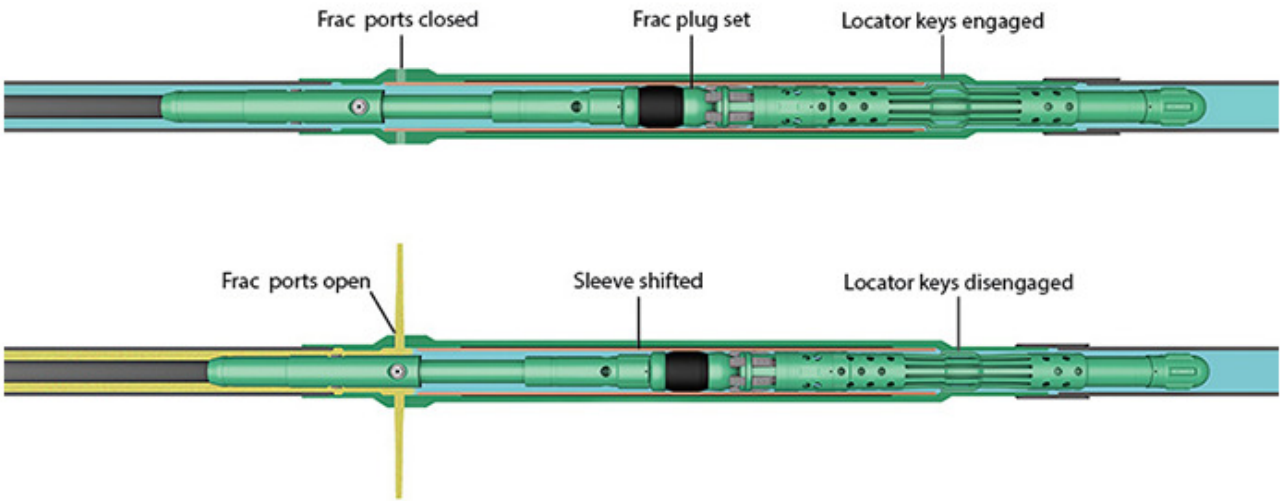
Closeable Sleeves: Technical Advantages

- Proppant flowback
  - Reduce or eliminate wellbore cleanouts
  - Increase frac effectiveness
    - Keep near-wellbore proppant in the reservoir



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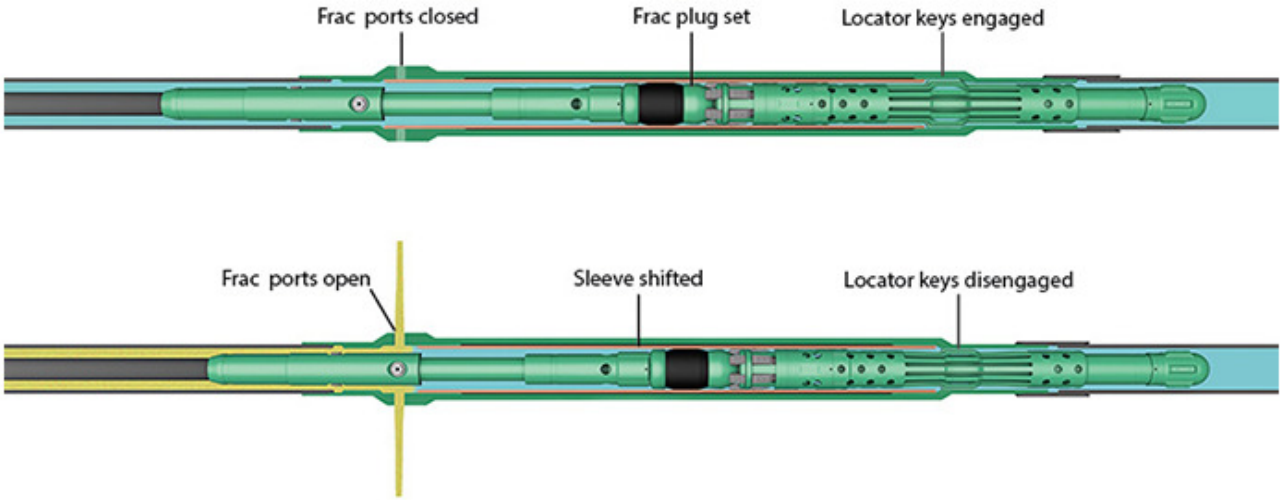
Closeable Sleeves: Technical Advantages

- Pressure management
  - Circulation advantages
  - Lower equalizing pressures
  - Isolate sub-hydrostatic zones
  - Annular refrac capability



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Closeable Sleeves: Technical Advantages

- Water management
  - Production
  - Injection points
- Creative solutions
  - Well testing – incremental production monitoring
  - Gas lift – frac sleeve in tie-back string

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Closeable Sleeves – Design Challenges

- Locking profile – space limited
- Spring loaded – force limits
  - Too high => shifting troubles
  - Too low => accidental shifts
- Tightly controlled
  - Highly dependent on friction
  - ~95% of shifts at nominal +/- 20%

Closeable Sleeves – Design Challenges

- Seal design
- Flow testing
  - 600 kg/m^3 proppant, 4 m^3/min
  - (Thanks for the help Calfrac!)
- Multiple shift cycles
- Differential unloading
- Long-term shifting & sealing
  - Waxes
  - Scale
- Effective washing (patent pending)

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CT Sleeves – Operational Challenges

- 6000m coil depths
- Getting on depth
  - Big coil
  - Heavy tapers
- World record: 93 stages in the Bakken in a single trip
  - 5975 m MD
  - 2” coil, .203” to .134” wall (50.8 mm coil, 5.16 mm – 3.40 mm wall)
- Locate vs drag
- Even more important with closeables

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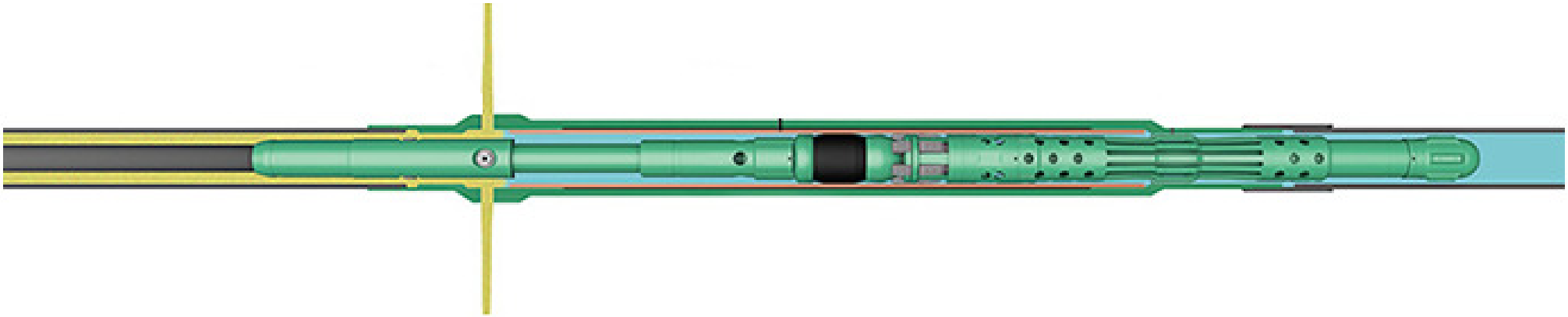
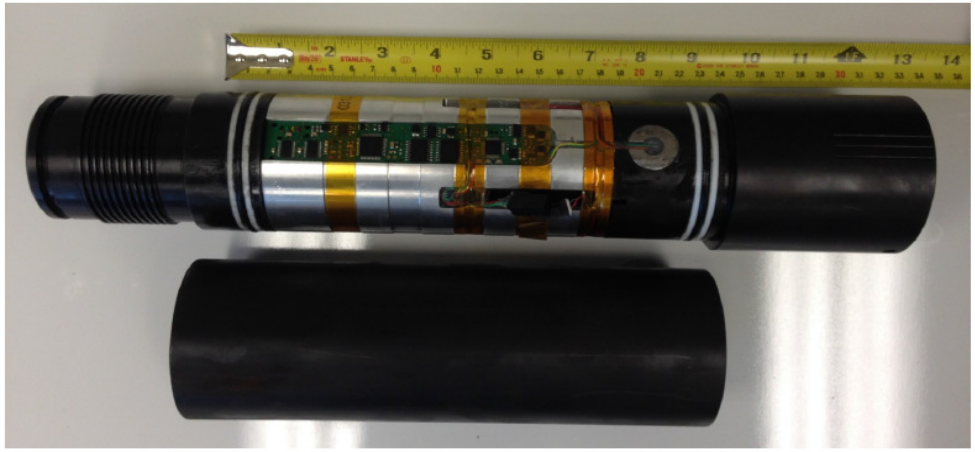
Closeable Sleeves – Operational Challenges

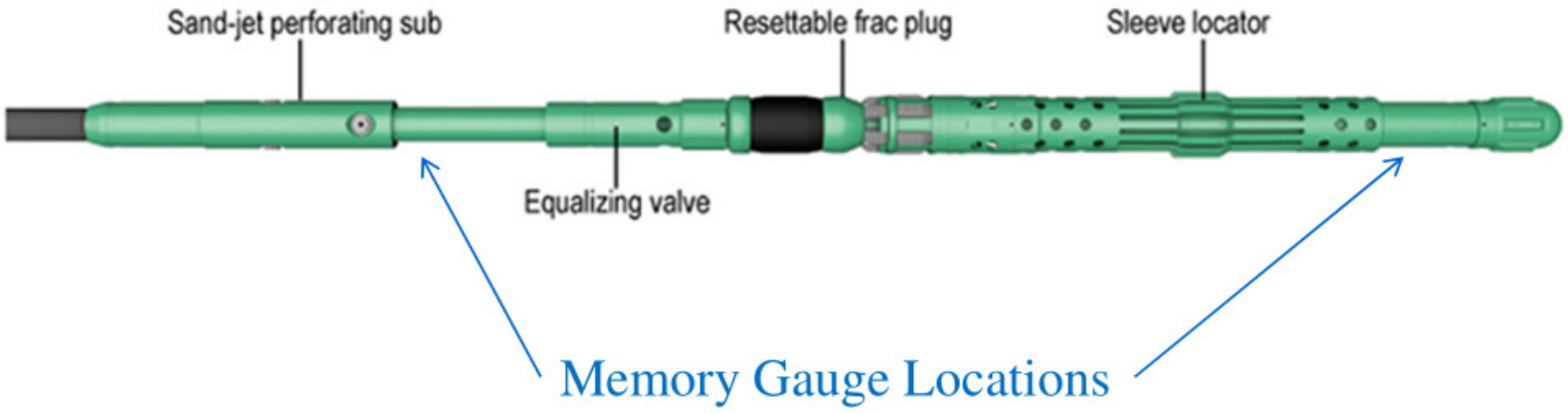
- Closing against differentials
  - Large piston area => large forces
- Shift force + differential force
- Commonly ~8,000 daN at BHA (~17,000 daN at surface)
- Differential shift or equalize & shift?



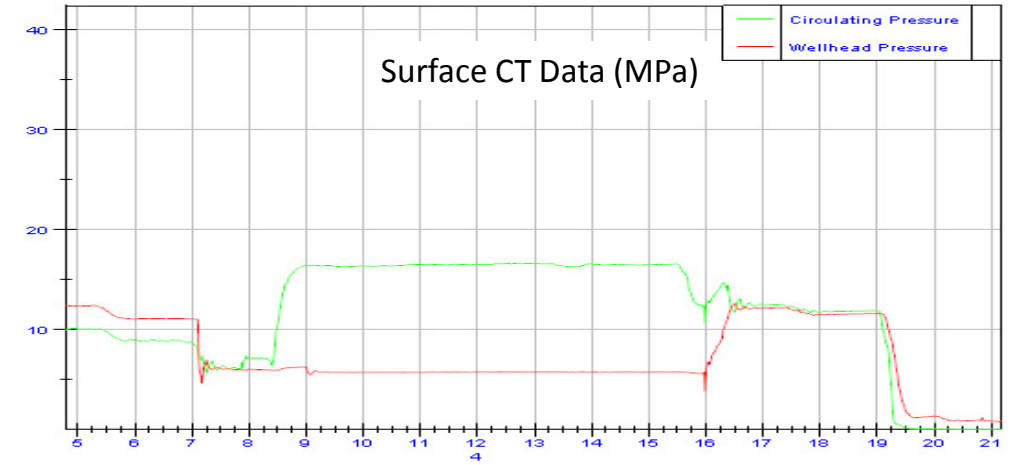
Downhole Data

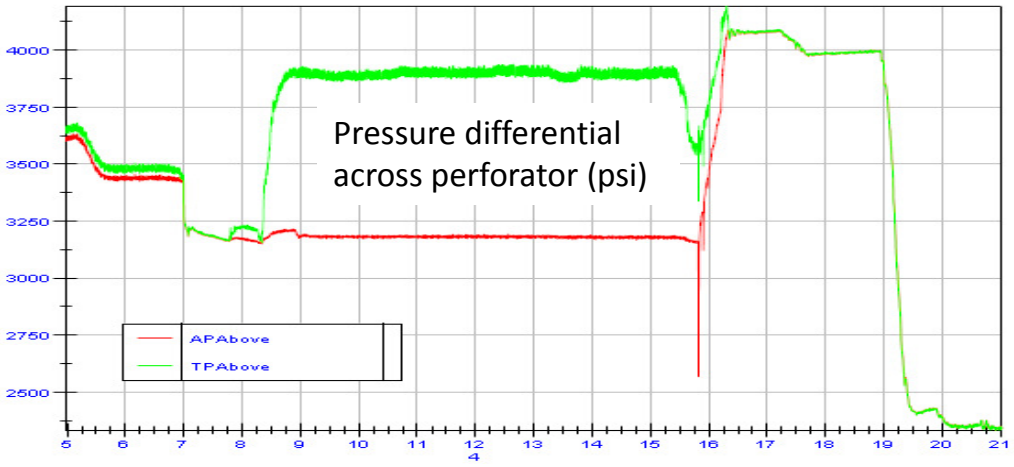
- BHA memory gauge
- Typically x2 per BHA

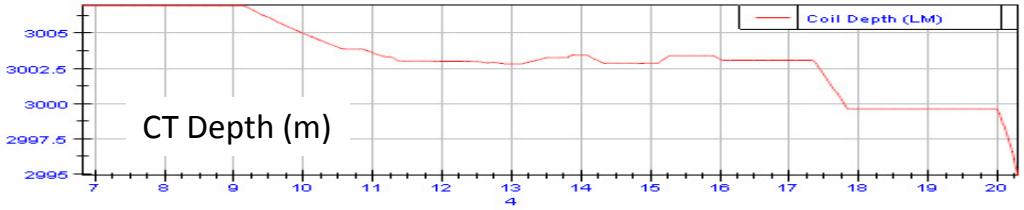


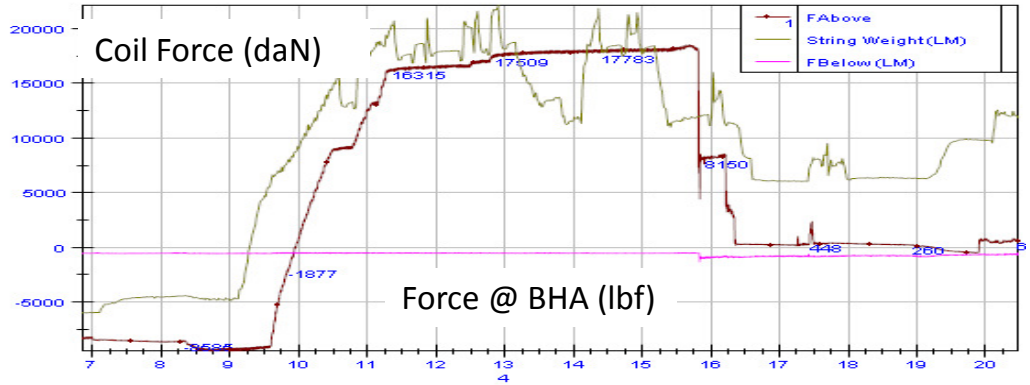


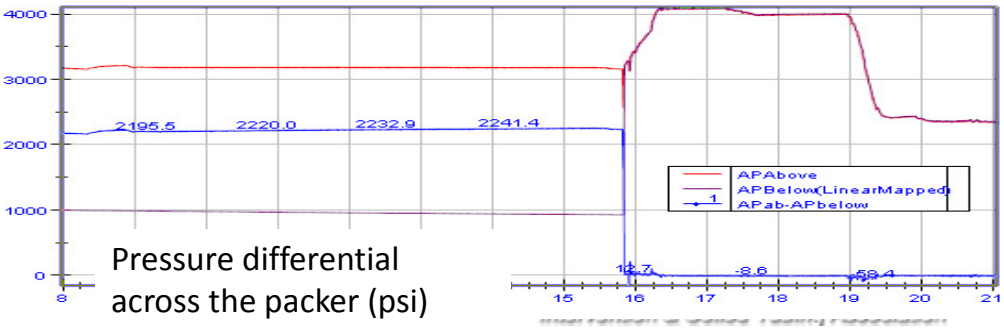
Differential Shift



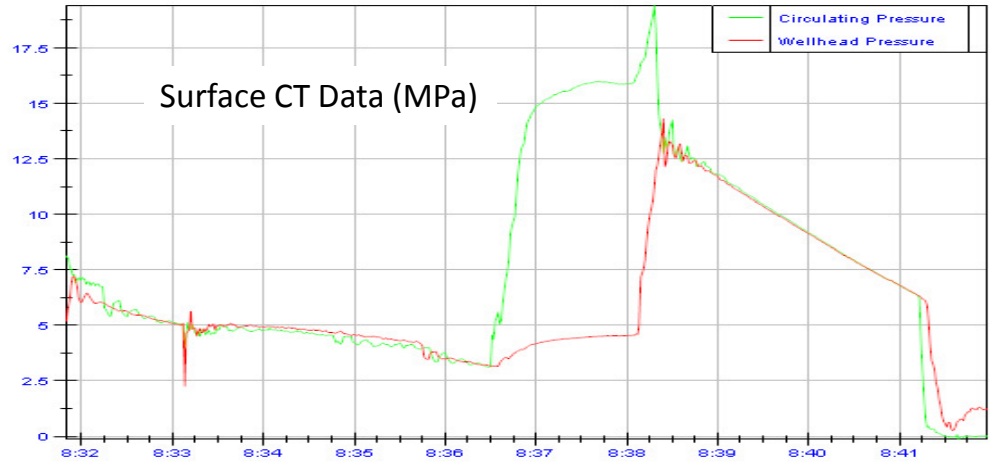


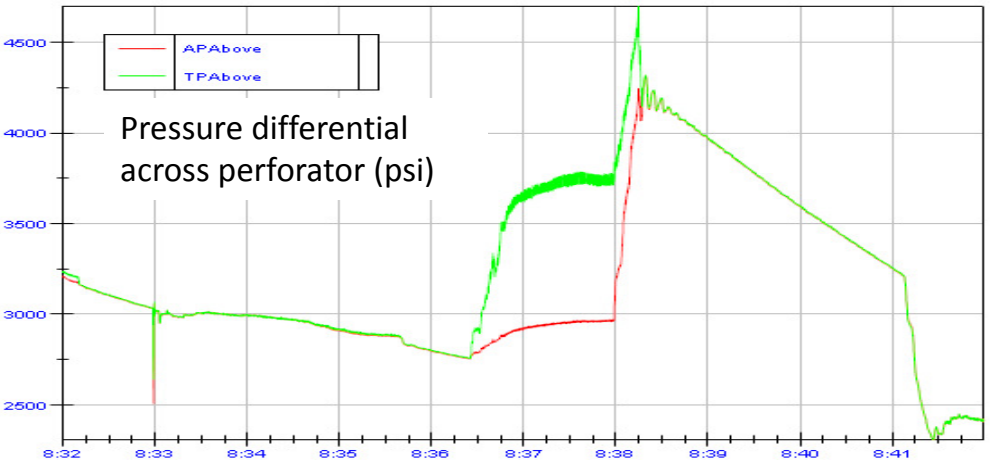


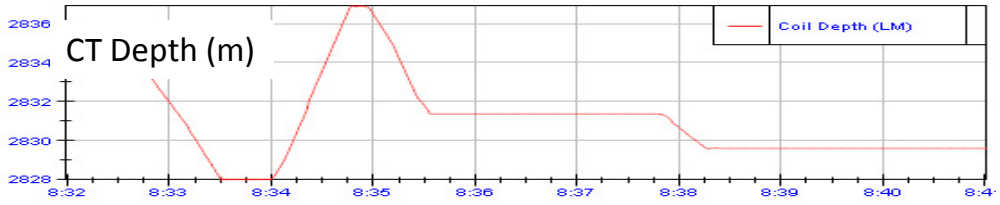


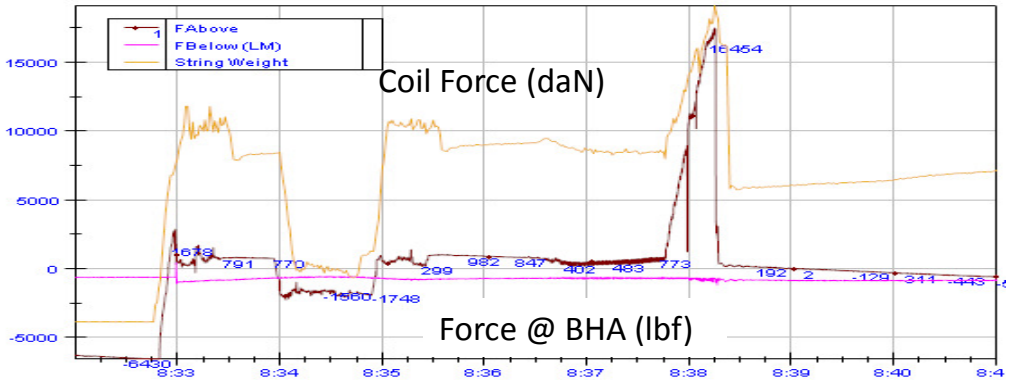


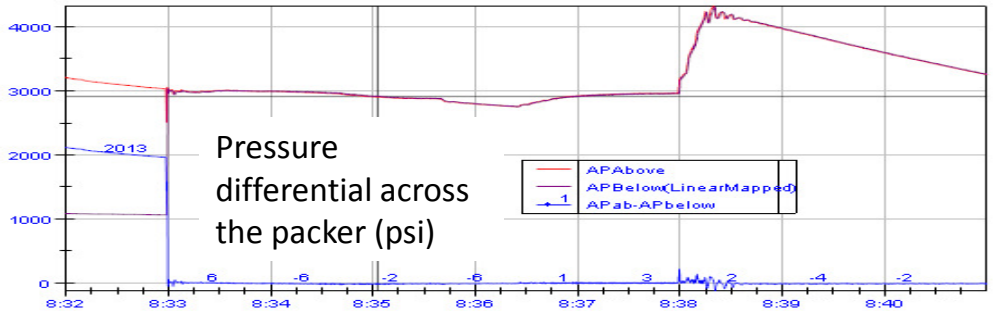
Equalized Shift











What's Next: Closeable Sleeves!

- First closeable sleeves in the ground July 13th 2013
- Good results with pressure test on closed sleeves
- Excellent results with sand flow-back
  - 3 wells with no sand & no cleanouts
- Improved pressure management methods
- Annular refrac opportunities
- Creative solutions
- Cheap insurance

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Thanks!

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