Operating in Difficult Times – What to use ? When to Use?

Robello Samuel

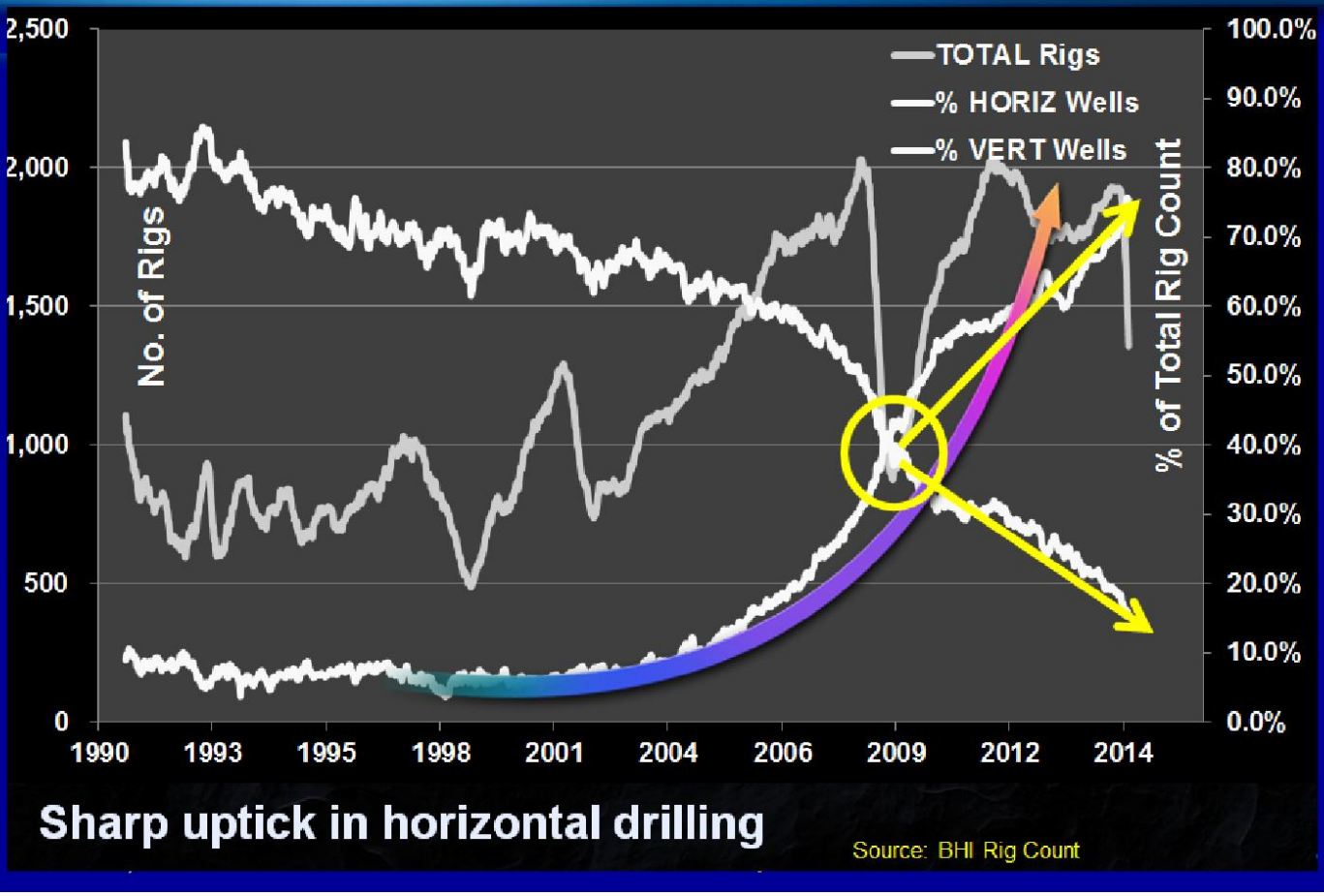
Aniket Kumar

HALLIBURTON

As move

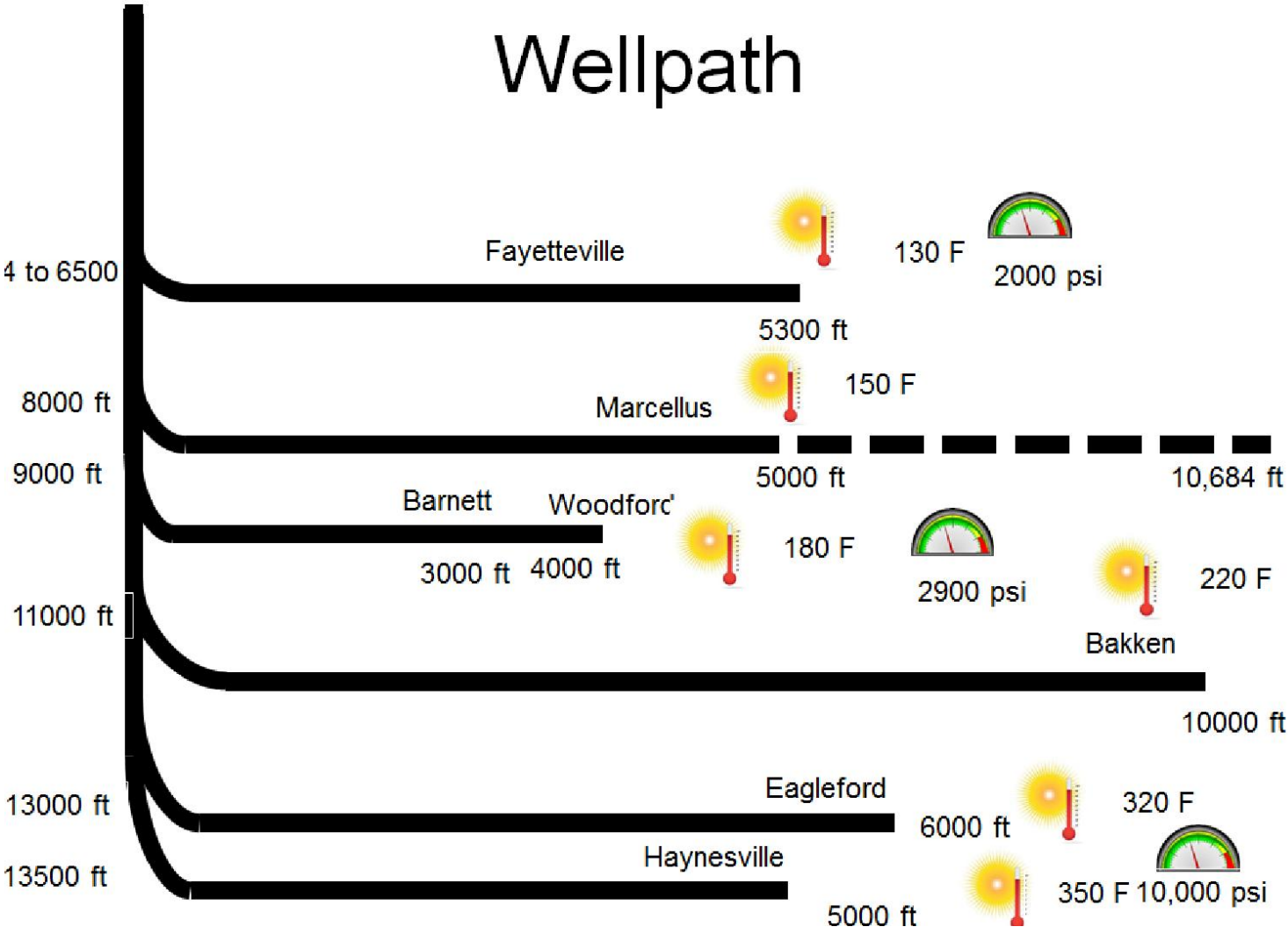
forward in deep earth exploration

Stretching the Space

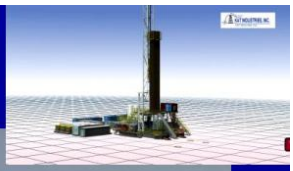


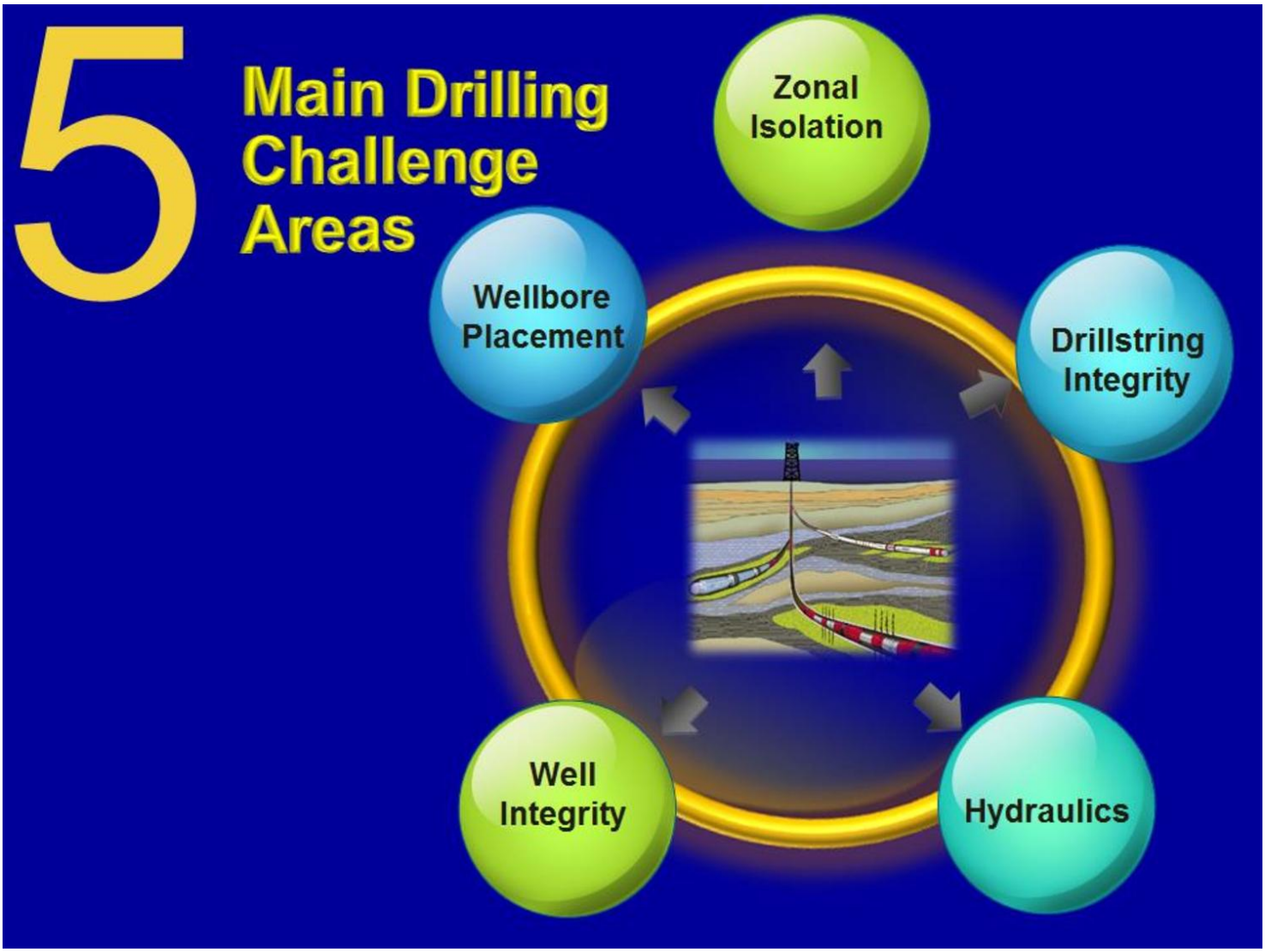
Sharp uptick in horizontal drilling

Source: BHI Rig Count


Wellpath
4 to 6500
Fayetteville
130 F
2000 psi
5300 ft
8000 ft
Marcellus
150 F
9000 ft
5000 ft
10,684 ft
Barnett
Woodford
3000 ft
4000 ft
180 F
2900 psi
220 F
11000 ft
Bakken
10000 ft
13000 ft
Eagleford
6000 ft
320 F
13500 ft
Haynesville
5000 ft
350 F
10,000 psi

Walking Rigs

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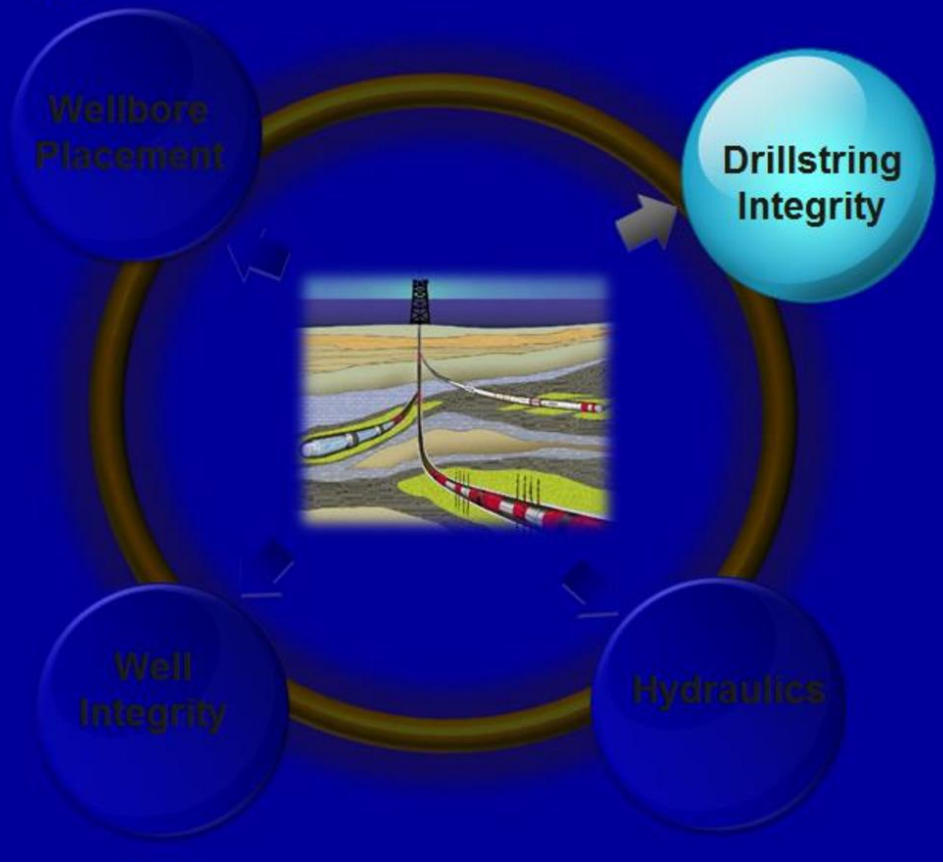
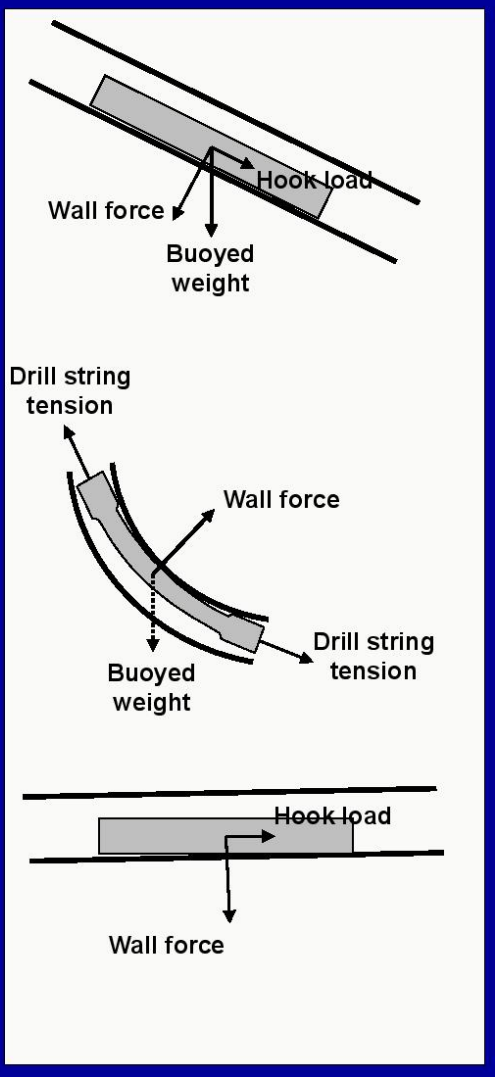
Main Drilling Challenge Areas
Zonal Isolation
Drillstring Integrity
Hydraulics
Well Integrity
Wellbore Placement

1st Main Drilling Challenge Area

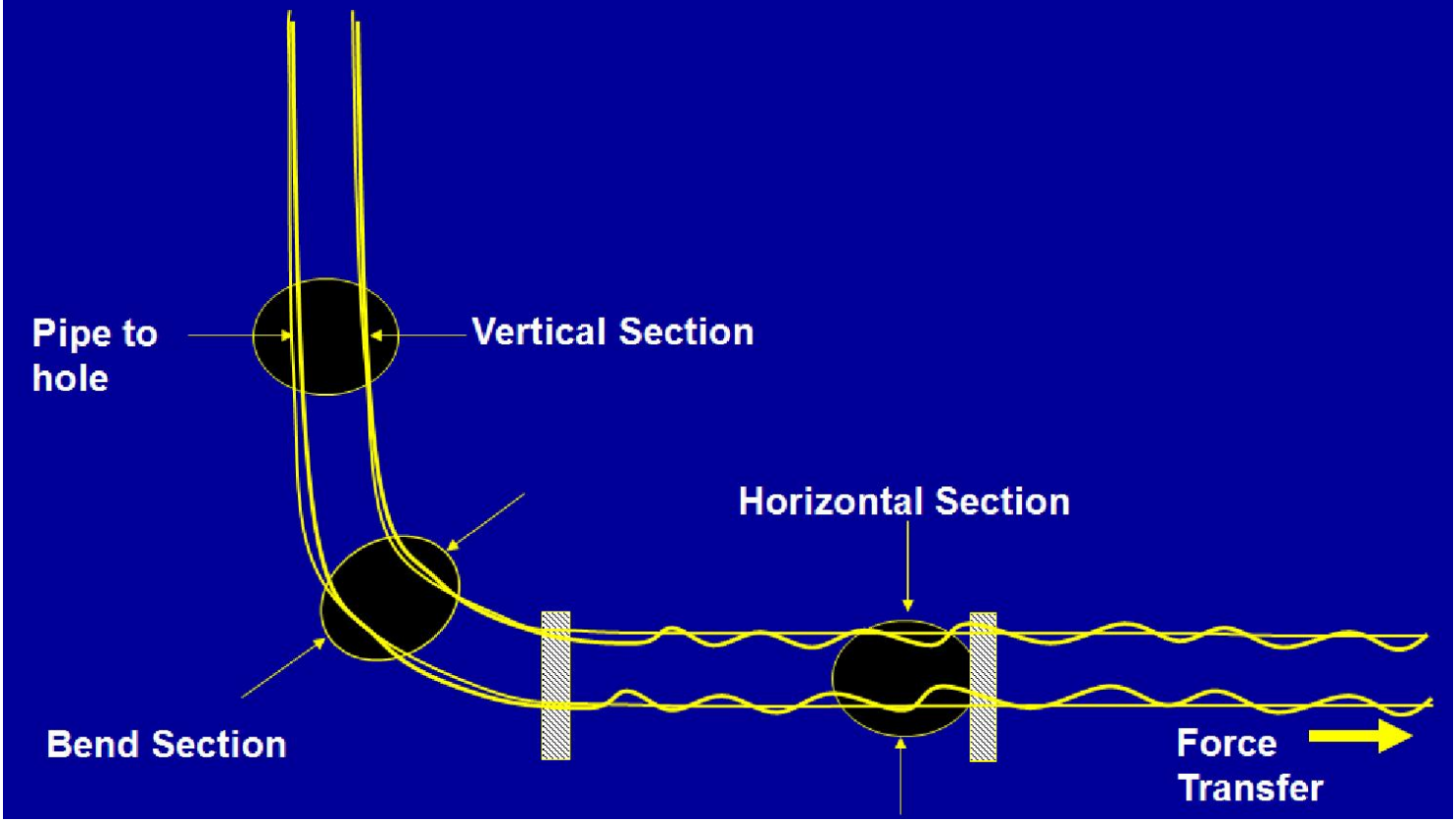


Drillstring Integrity- Basics

- Gravity
- Hole curvature or dog legs
- Buckling
- Centrifugal forces



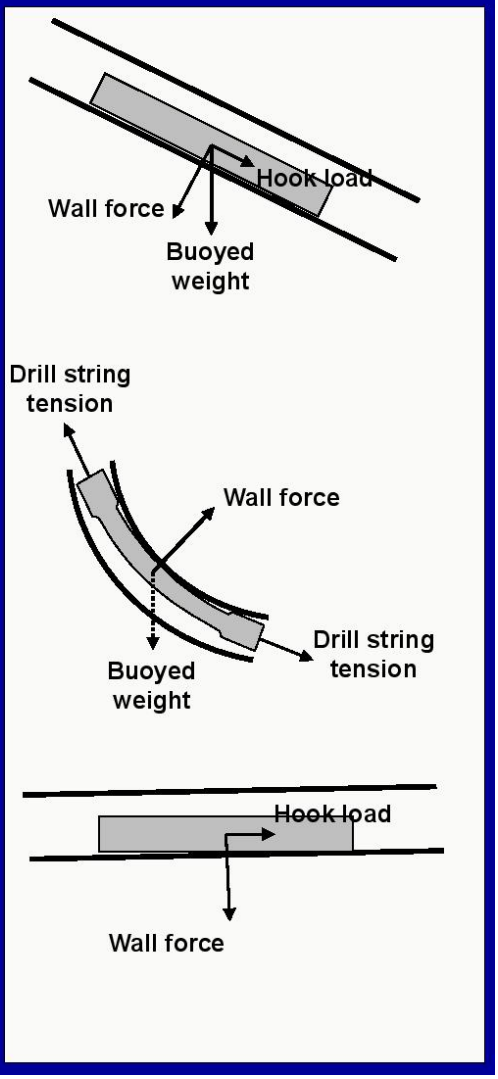
Drillstring Integrity- Basics



Drillstring Integrity-Basics

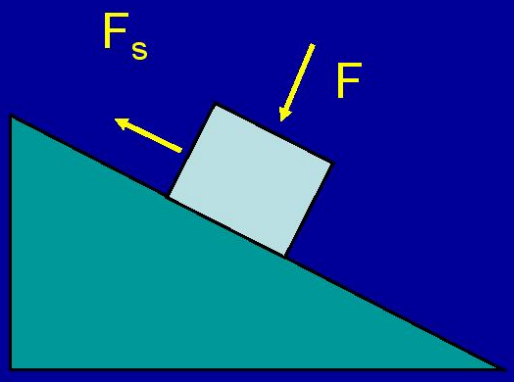
- Friction along the wellbore

- Gravity
- Hole curvature or dog legs
- Buckling
- Centrifugal forces



Drillstring Integrity-Basics

- Friction



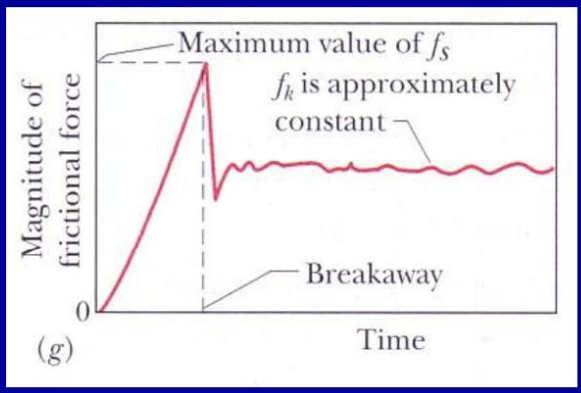
- Friction Factor

$F_s = \mu_s F$

μ_s = *coefficient of static friction*

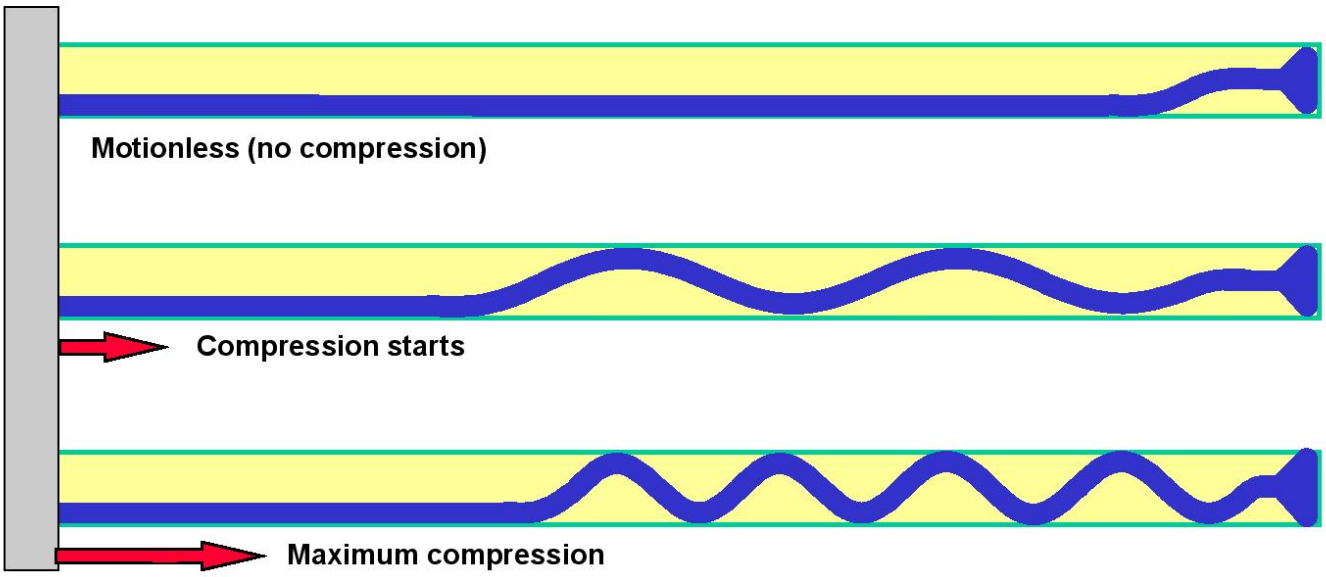
$F_k = \mu_k F$

μ_k = *coefficient of kinetic friction*



Buckling – Critical buckling

Development of Buckling



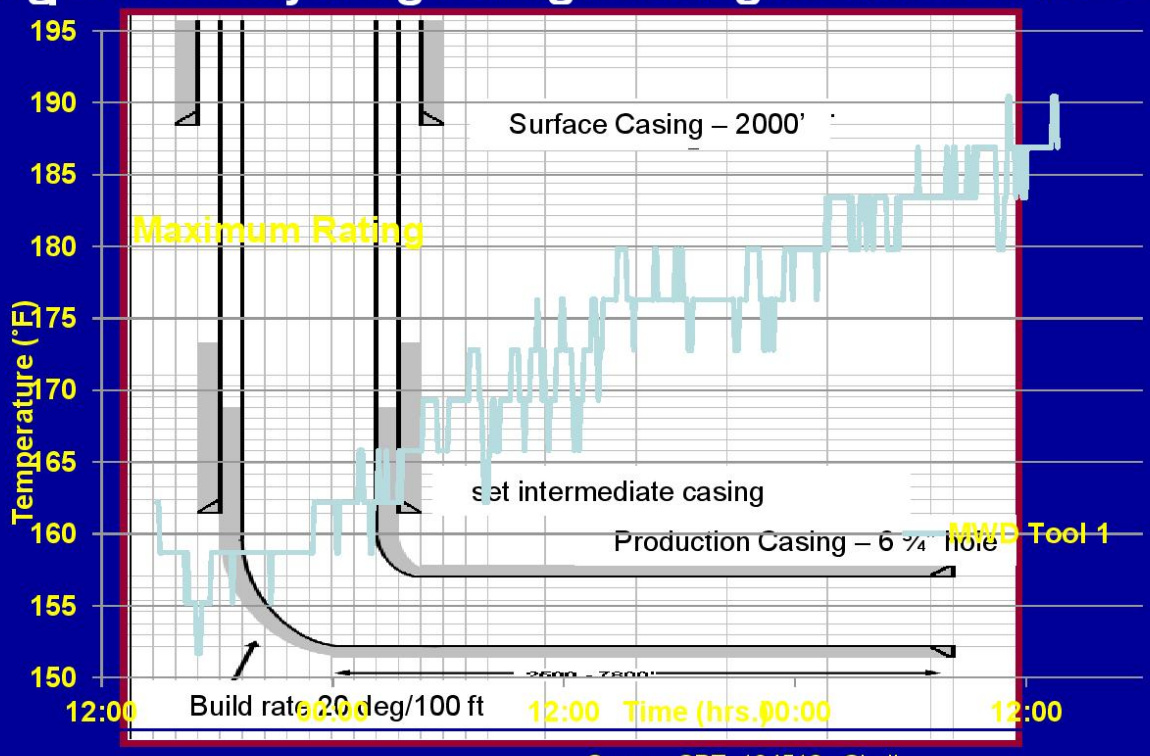
Drillstring Integrity- Challenges

- Weight transfer & Buckling
- Increased Torque and Drag
- Vibration
  - •Lateral Vibration – Bit/Drillpipe Whirl
  - •Torsional Vibration – Stick/Slip
  - •Axial Vibration – Bit Bounce
- Excessive tubular Wear
- Wellbore heating

Courtesy: BP Alaska Well

Drillstring Integrity- Challenges

- Tangential borehole contact High heat generation due to friction

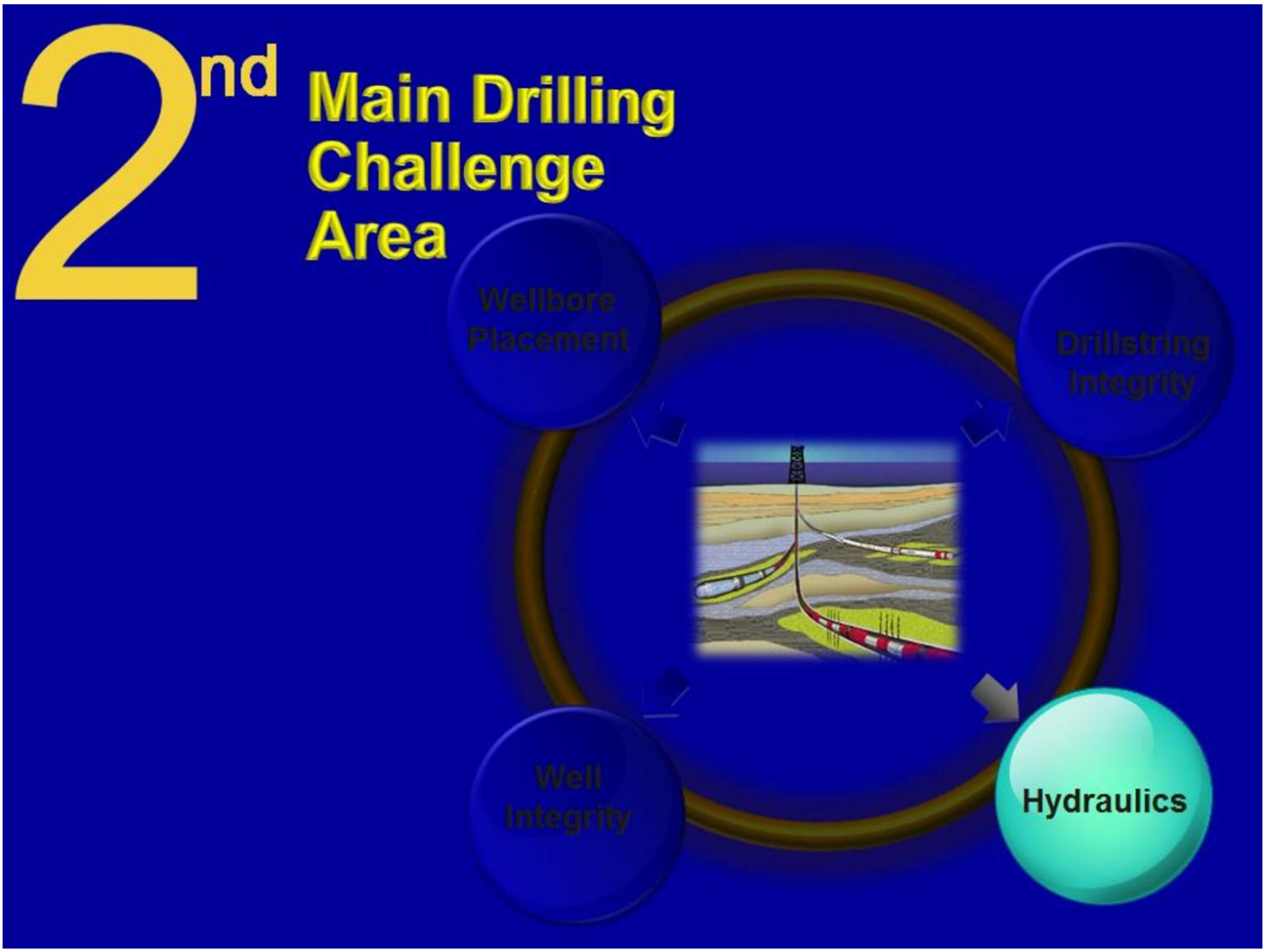


Source: SPE 134512 - Shell

Drillstring Integrity- Advancements

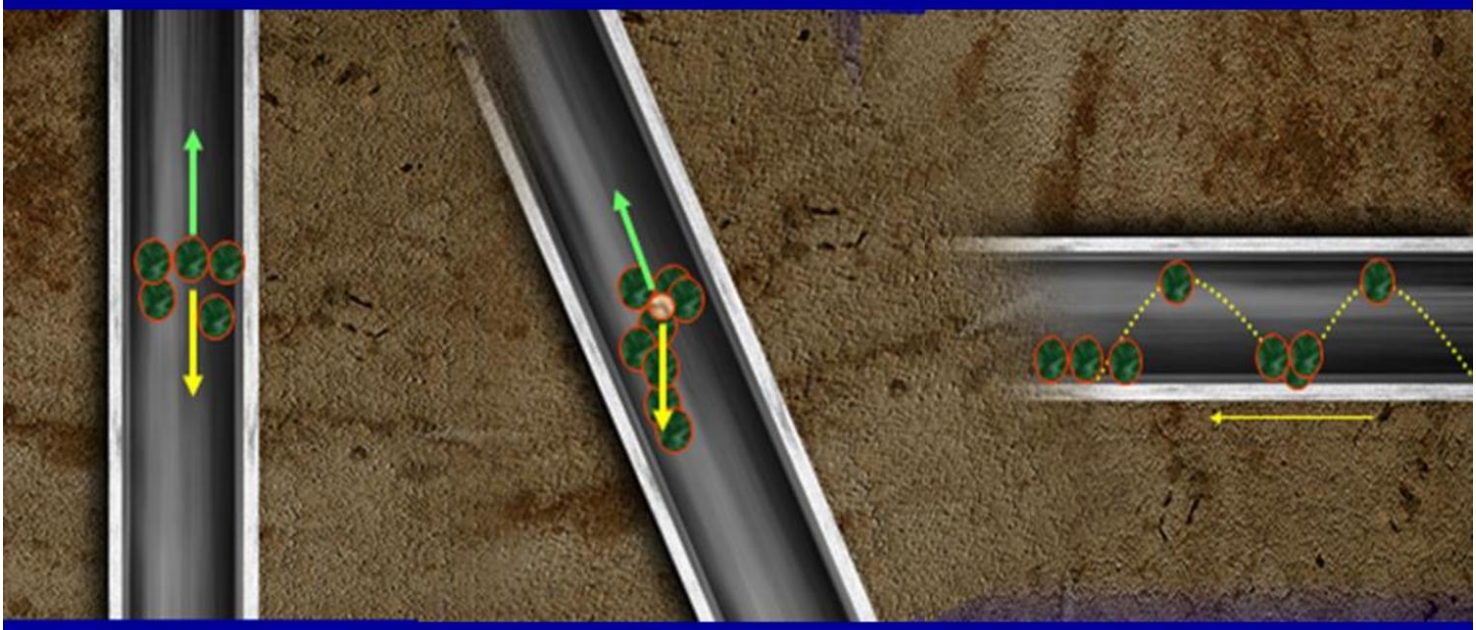
- Improved torque and drag modeling
- Provide additional torque to Rotary steerables with mud motors
- Vibration measurements through multiple tools
- Tools to convert sliding to rolling friction such as agitator tools, tractors
- Mechanical lubricants – glass, polymer

2nd Main Drilling Challenge Area



Particle Transport- Basics

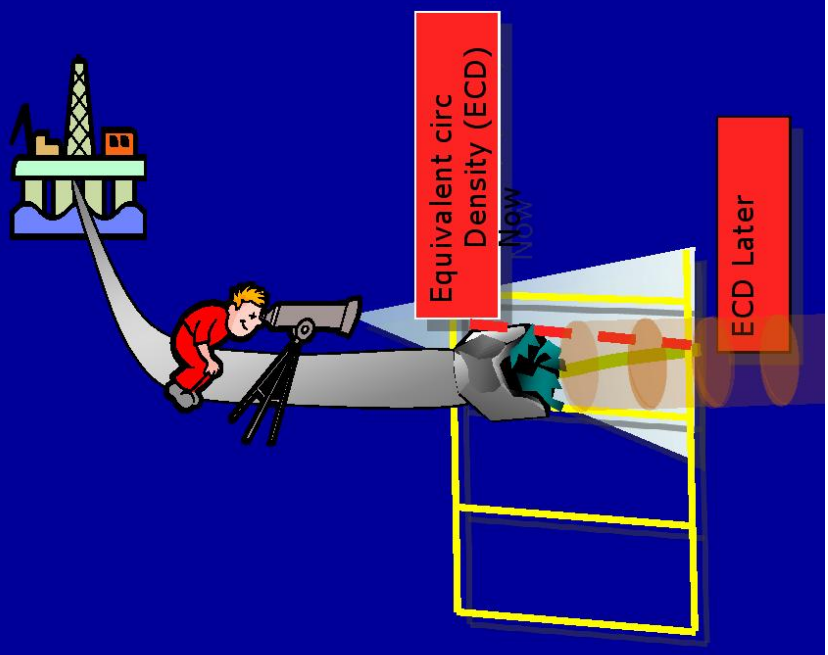
Vertical (0° -20°) Deviated (20°-70°) Horizontal (70°-90°)



- Settling
- Sliding
- Rolling

Hydraulics Challenges

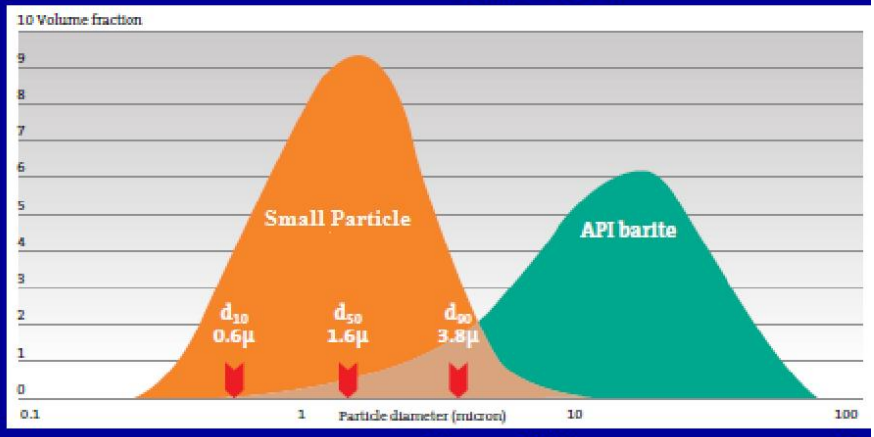
- Cuttings bed and barite Sag
- Annular Pressure Management and Loss Circulation



Hydraulics- Advancements

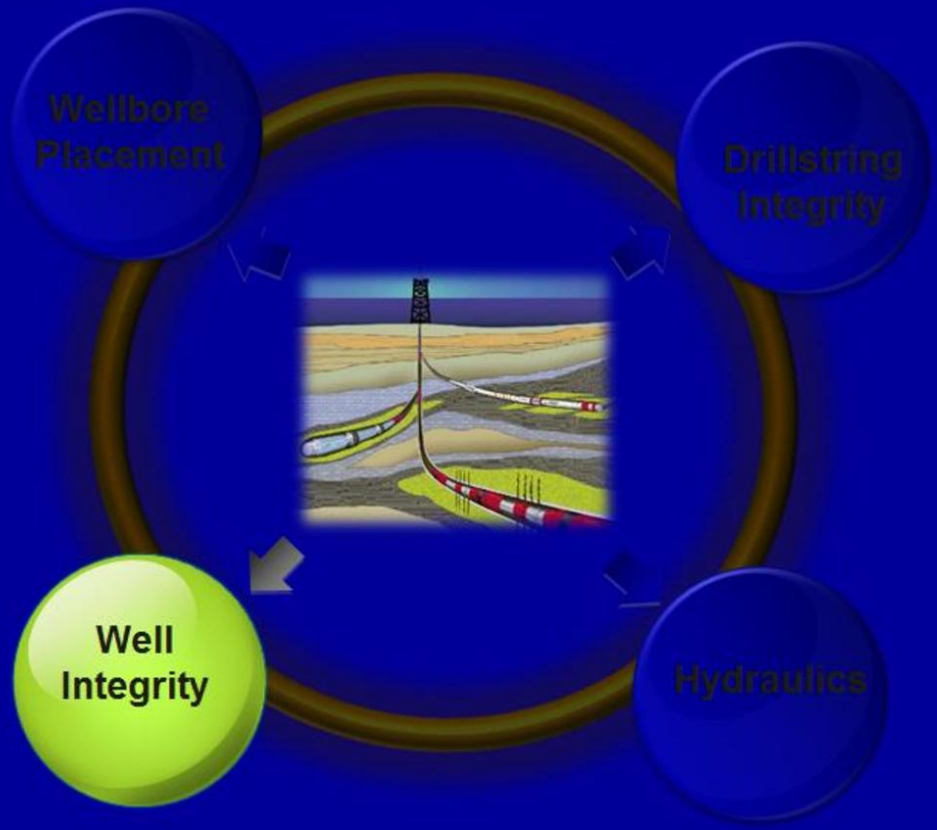
- Mechanical Hole Cleaning Devices
- Small micronized weighting agent
- Improved understanding and modeling

Source: TUDRP



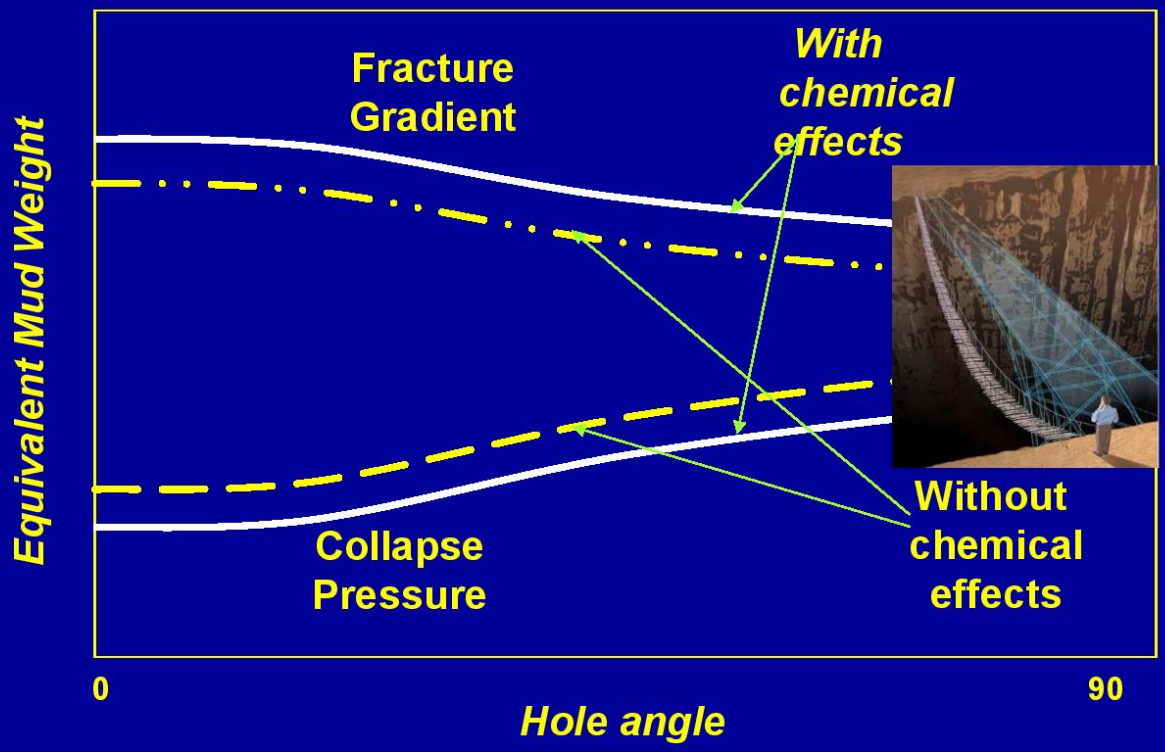
Source: M-I Swaco

3rd Main Drilling Challenge Area



Wellbore Integrity - Basics

- Bridging the collapse Pressure/Frac Gradient Gap

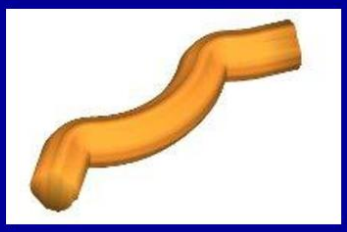


Wellbore Integrity - Challenges

- Wellbore Stability
  - Collapsing shale/carbonates
- Borehole erosion

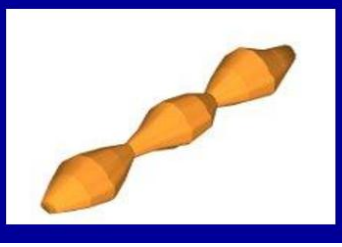
One Other Issue: Hole Quality

- Rippling
  - Slide mode



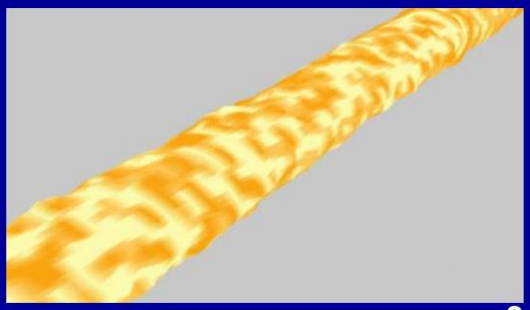
- Spiraling
  - Rotate mode

- Hourglassing
  - Caused by lateral vibration
  - Slide and rotate modes



Wellbore Integrity - Advancements

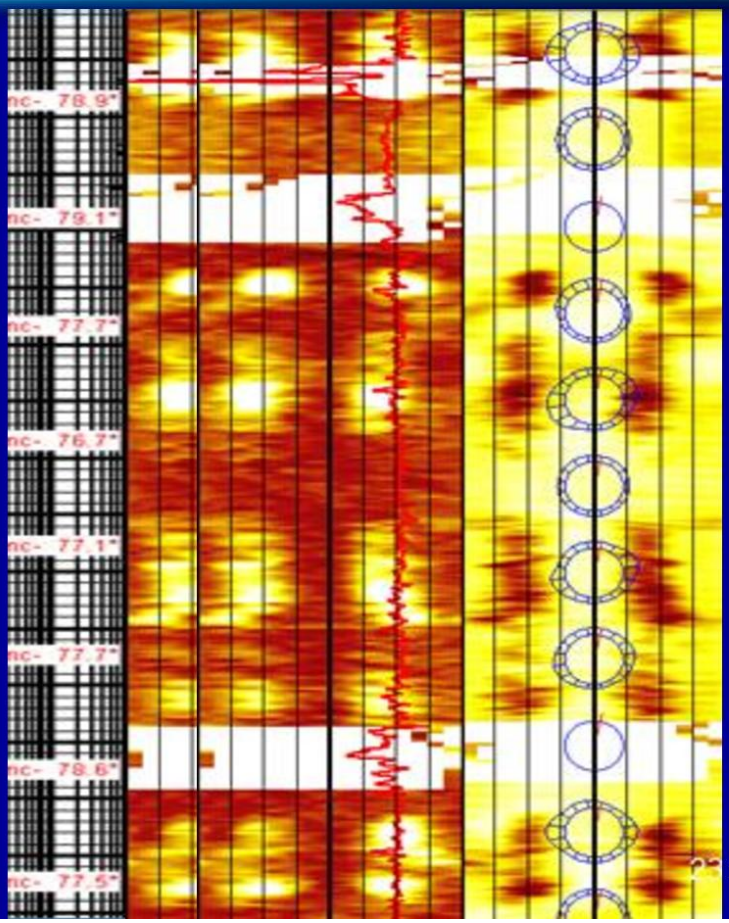
- Smooth wellpath with improved bit design and downhole tools
- Advanced measurement tools for borehole imaging
- Improved salinity control to inhibit shale activity levels



Wellbore Integrity - Advancements

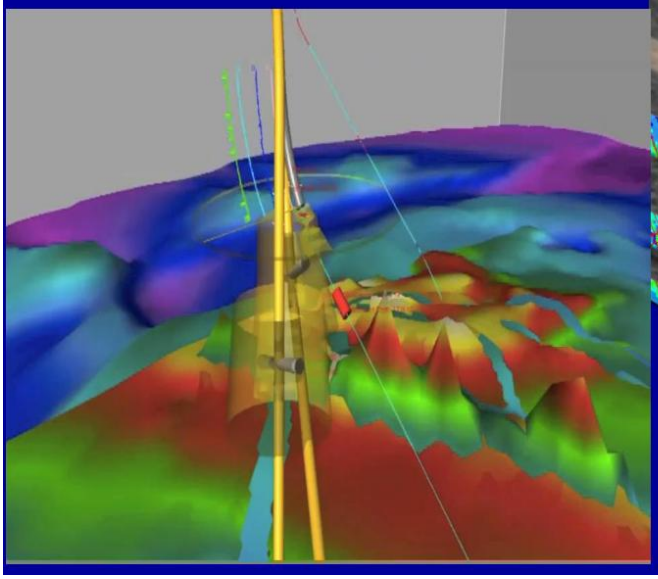
Azimuthal density imaging and acoustic standoff imaging tools used to map the borehole breakout

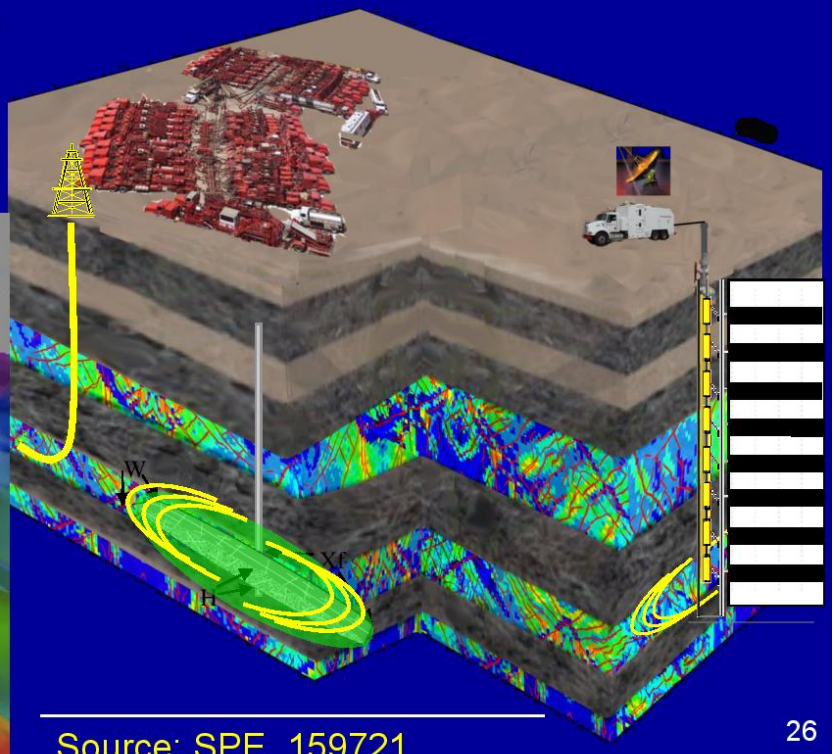
Irregular hole shapes - Eyeliding



Fracture Uncertainty – Real Time Analysis

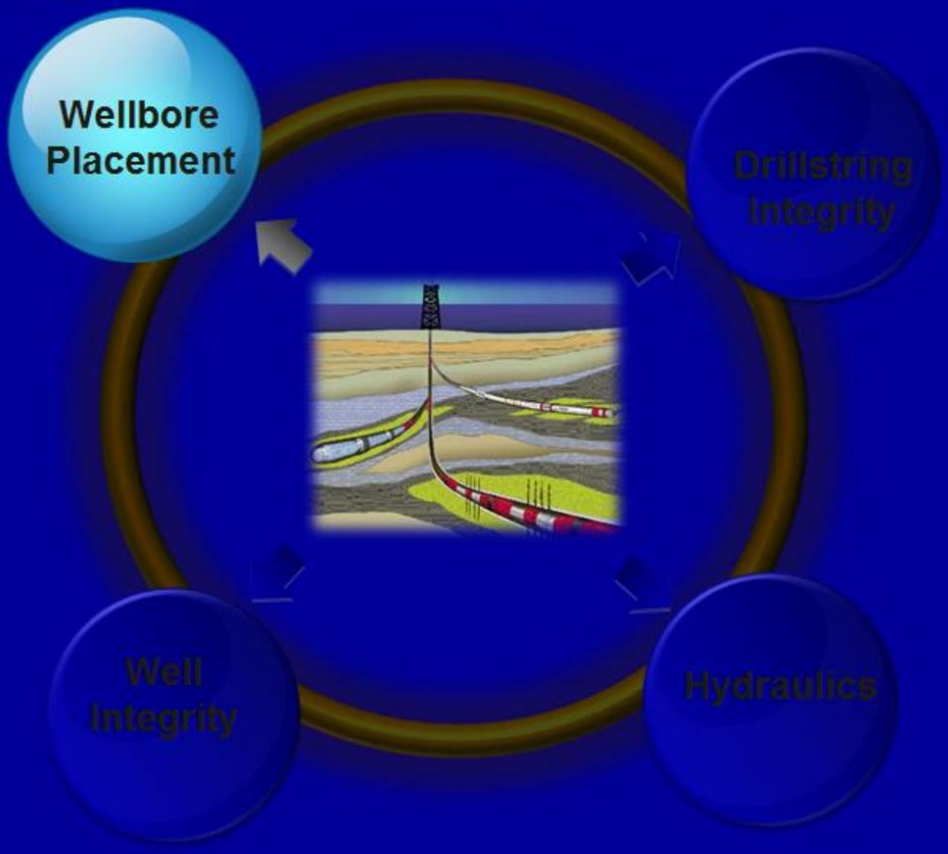
3D Visualization to prevent fracture interference while drilling



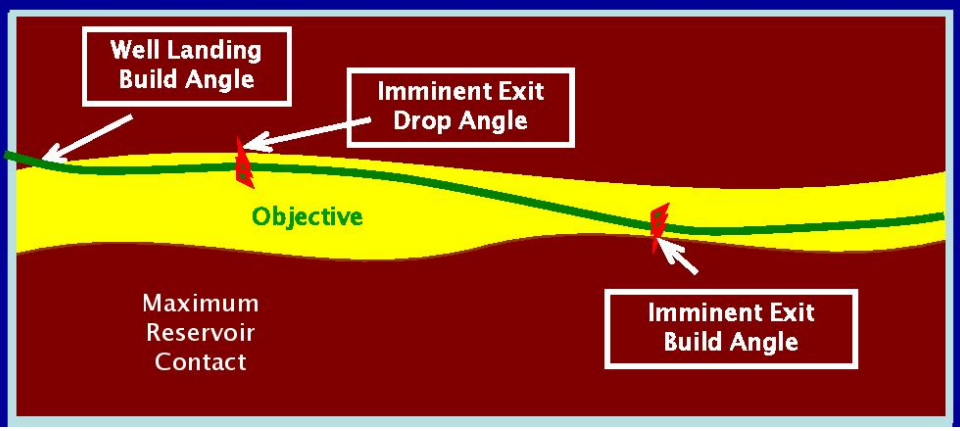


Source: SPE 159721

4th Main Drilling Challenge Area



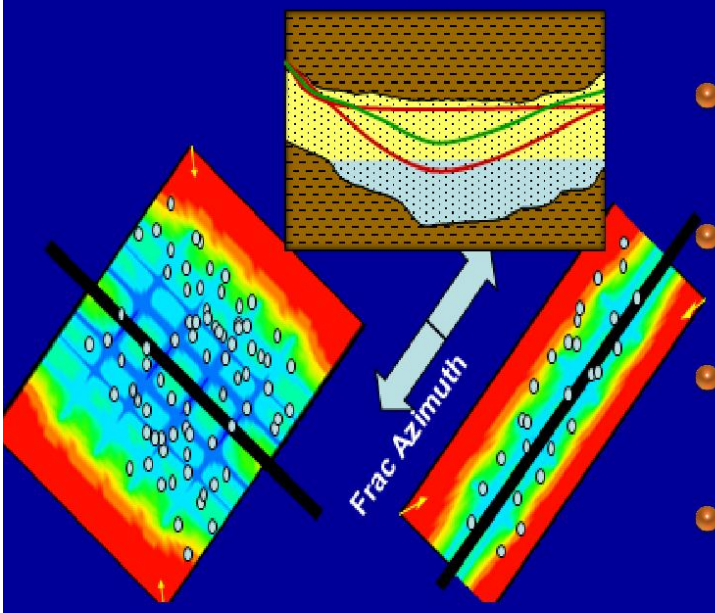
Wellbore Placement - Basics



Toolface Control

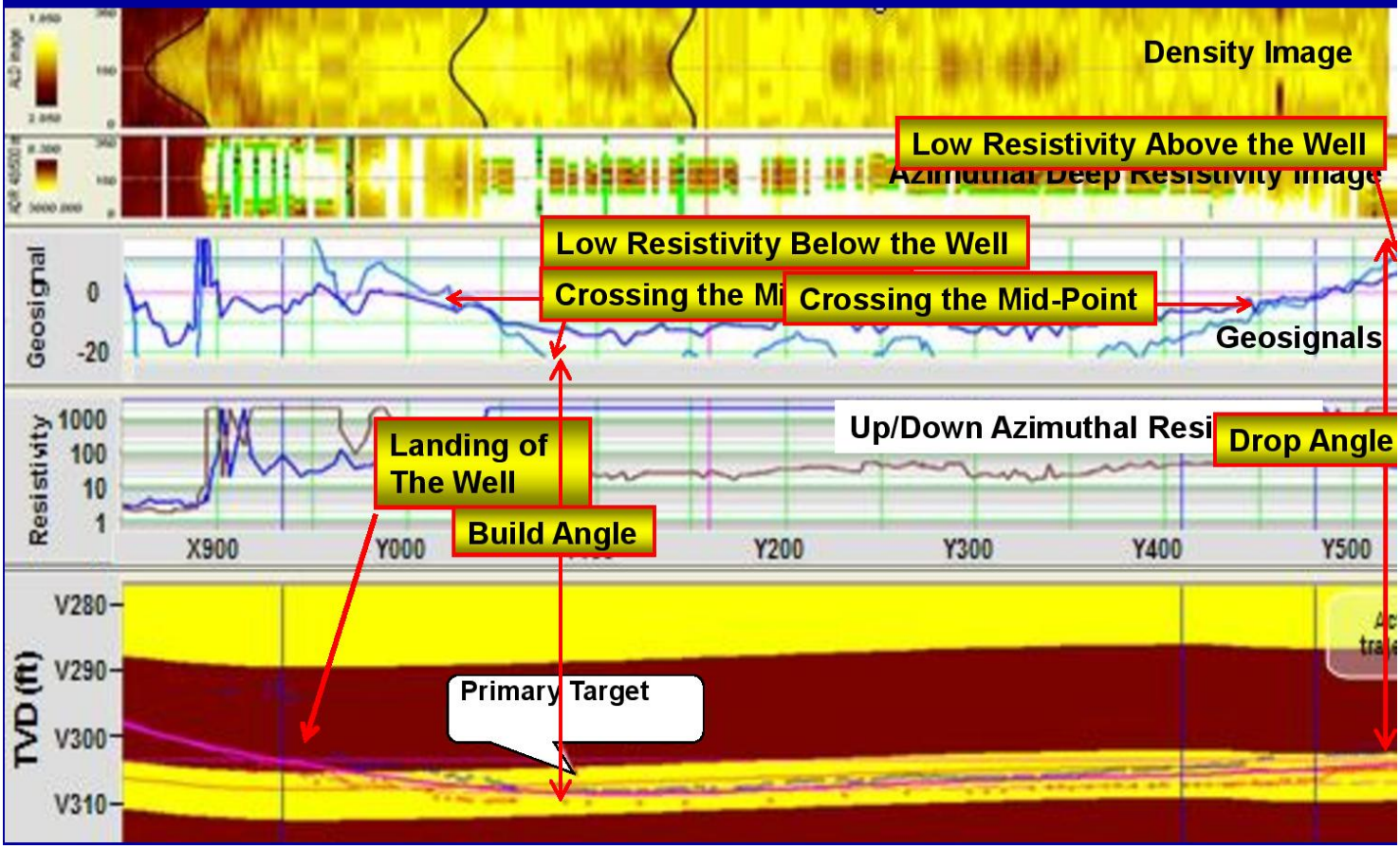
Problems are solved. Issues need to be resolved....

Well Placement - Challenges



- True Vertical Depth Control
- Collision Avoidance
- Fracture avoidance
- Wellbore interference
- Proximity placement

Geosteering - Advancements



Challenges, advancements progress.

Challenges remain…

- Axial force transfer
- Hole cleaning
- Wellbore stability
- TVD control and real-time data
- Reliability of tools

Key Points…

- Improved technologies have provided capabilities to drill further to some extent
- Industry is responding to the needs but more advancements needed through continuous research
- Better use of real-time data and automation to meet the challenges instantaneously
- Some of the problems cannot be fixed but can be mitigated

Q&A

Robello Samuel

Robello.samuel@halliburton.com

"Plan for the Quadrant not for the coordinate"